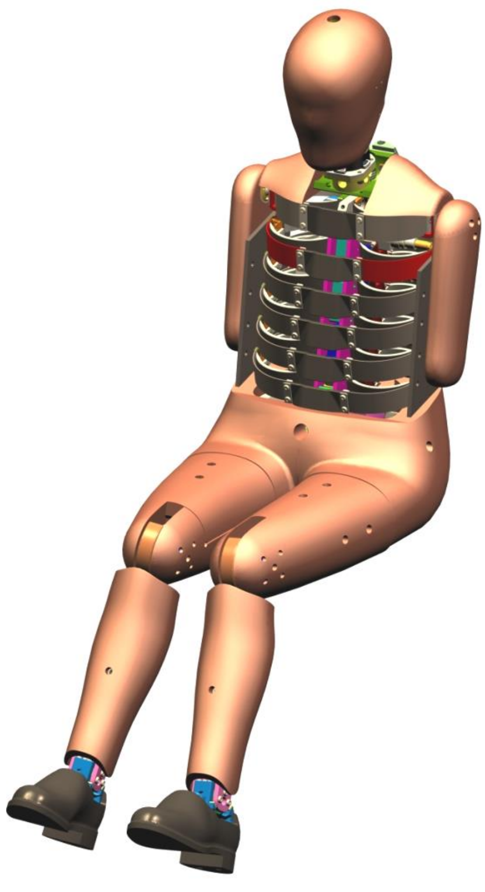
User Manual
WorldSID Small Female



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Section 1 - Introduction

1.1 History

In the past, different dummies were regulated in different countries, which significantly raised the cost of safer car development efforts for the automotive industry. In 1997, the industry and government came together and initiated the WorldSID, the World Side Impact Dummy program. This program was to develop a new, worldwide acceptable, side impact crash test dummy with advanced technology for improved assessment of injury risk to vehicle occupants in lateral collisions. Two major motives drive the development of WorldSID. First, improved understanding of human responses in side impact will drive an enhanced dummy design, hence creating means to improve occupant protection. Second, harmonization will eliminate the use of different dummies in different areas of the world.

The ISO WorldSID Task Group acts on behalf of the sponsors and reports to the ISO working group on Anthropomorphic Test Devices (TC22/SC12/WG5). The Task Group consists of experts from industry and governments representing three regional WorldSID advisory groups: Americas, Europe and Asia/Pacific. The Task Group is chaired, in turn, by each of the chairpersons of the three regional groups.

The first WorldSID prototype was assembled in Michigan in September 2000, and was followed by a workshop in December 2000 in Australia. After a series of evaluation tests of the prototype - over 340 combined sled and pendulum tests - the design was optimized and re-evaluated. In 2003, eleven pre-production dummies were built and delivered worldwide for further evaluation - three in the Asia/Pacific region, three in Europe, and five in North America. After evaluation tests of these eleven dummies, some minor changes were proposed to improve the durability and handling. In March 2004, the WorldSID production version was officially released. Later, the WorldSID was adopted by ISO as an official ISO standard 15830.

1.2 Background

The European commission has been supporting new developments in vehicle safety through subsequent framework projects. Worldwide, vehicle safety experts agree that significant further reductions in fatalities and injury numbers could be achieved by deploying appropriate passive safety strategies. In an effort to reduce the road injuries, the FP6 **A**dvanced **Pro**tection **Sys**tem, APROSYS Integrated Project (IP) developed and introduced critical technologies that improve passive safety for all European road users for prioritized accident types and levels of crash severity. The field of passive safety concerns in particular human injury biomechanics, and vehicle crashworthiness and protection systems. Under this European commission strategy, SP5 biomechanics project, one of the nine Sub-projects, was tasked to develop a new WorldSID 5^{th} percentile female dummy. Since the WorldSID 50^{th} percentile dummy was successfully developed with an overall Biofidelity of 7.6 on a scale of 10 according to ISO TR9790, the SP5 decided to scale down the design concepts from the WorldSID 50^{th} dummy to develop this new WorldSID 5^{th} dummy. The first prototype dummy was assembled at the beginning of October 2005. The prototypes dummies were evaluated by Transport Canada and by the APROSYS members BASt, INRETS, LAB, PDB, TRL and UPM INSIA, during 2006 and 2007. Revision1 was developed in 2007-2008 to address comments from these groups based on the prototype tests. The revision 1 dummy, SBL B, comprises of changes in the half arms and the suit (anthropometry and arm biomechanics), the thorax (rib durability, sternum), the abdomen area and the lower legs (mass distribution). Also a 2D IR-TRACC was developed to measure deflection in anterior posterior and lateral direction to address thorax oblique loading sensitivity. Further the internal wiring system was developed to improve connector reliability and durability. The 2D IR-TRACC and i-dummy cabling are a standard part of SBL B in the Revision1 update. As result of the APROSYS revision1 evaluation, issues that were found, were addressed in a new update (Build level C) These changes are related to handling and durability only and they are not expected to change the biofidelity. The changes to revision1 were completed by FTSS in 2009 and include:

- Increase of rotation angle of the 2D-IR-Tracc to 2*45 degrees about z-axis; Left and Right symmetric design of the 2D-IR-Tracc spine interface; electrical cable robustness and ball joint retaining improvement at 2D-IR-Tracc small end;
- Improved lifting bracket for better handling;
- Shoulder ball joint play eliminated;
- Reduction metal-to-metal contact in lumbar area;
- Development of WorldSID style lower leg and integrated foot & shoe, design of low weight tibia load cell.

1.3 Symbols, Subscripts and Abbreviated Terms

1.3.1 Symbols

The symbols used in this International Standard are listed with their definitions in Table 1.1.

Symbol	Definition
a	Linear Acceleration
cg	Centre of Gravity
F	Force
G	Gravitational Acceleration
g	Grams
in	Inch
kg	1000 grams
lbf	Pound force
m	Meters
mm	Millimeters
m/s	Meters per second
ms	0,001 seconds
M	Moment
N	Newtons
s	Seconds
x	In accordance with SAE J211-1 or ISO 6487
y	In accordance with SAE J211-1 or ISO 6487
z	In accordance with SAE J211-1 or ISO 6487
β	Angular displacement of head form
δ	Deflection
θ	Angular displacement
φ	Rotation

Table 1.1 - Definitions of symbols

1.3.2 Subscripts

The subscripts used in this International Standard are listed with their definitions in Table 1.2.

Symbol	Definition
F	Forward
H	Head
R	Rearward
x, y, z	In the x, y, or z direction; about the x, y, or z axis where x, y, or z are in accordance with ISO 6487 or SAE J211-1

Table 1.2 - Definitions of subscripts

1.3.3 Abbreviated Terms

The abbreviated terms used in the International Standard are listed in Table 1.3.

Abbreviation	Definition
AMVO	Anthropometry for Motor Vehicle Occupants dataset (established by UMTRI)
A-P	Anterior-Posterior
APROSYS	Advanced Protection Systems (European Framework Program 6 Integrated Project 2004-2009)
ASIS	Anterior superior iliac spine
ASPECT	Automotive Seat and Package Evaluation and Comparison Tools (a Society of Automotive Engineers cooperative research program)
ATD	Anthropomorphic Test Device
BHCS	Button head cap screw, also referred to as a hexagon socket button head screw as defined by ISO 7380
CPSS	Cone point set screw, also referred to as a hexagon socket set screw with cone point as defined by ISO 4027
CPSSS	Cone point socket set screw as defined by ISO 4027
CPNT	Cone point nylon tip
DAS	Data acquisition system
FHCS	Flat head cap screw, also referred to as a hexagon socket countersunk head screw as defined by ISO 10642
FTSS	First Technology Safety Systems
IHRA	International Harmonization Research Activities
ISO	International Organization for Standardization
LHSHCS	Low head socket head cap screw
MDB	Movable deformable barrier
NM	Not measured
NTSS	Nylon tip set screw
OC	Occipital condyle
PAM	Percentile adult male
PC	Personal computer
R-L	Right-left
SHCS	Socket head cap screw, also referred to as a hexagon socket head cap screw as defined by ISO 4762
SHSS	Socket head shoulder screw, also referred to as a hexagon socket head shoulder screw as defined by ISO 7379
SI	Sacro-iliac
SSCP	Set screw with cup point, also referred to as a hexagon socket set screw with cup point as defined by ISO 4029
SSFP	Set screw with flat point, also referred to as a hexagon socket set crew with flat point as defined by ISO 4026
SSHDP	Set screw with half dog point, as defined by ISO 4026
SSNT	Set screw with nylon tip
UMTRI	University of Michigan Transportation Research Institute

Table 1.3 - Abbreviated Terms

1.4 Anthropometry

The 5th WorldSID female represents a small-sized adult female car occupant. As the 50th percentile WorldSID dummy, the 5th WorldSID anthropometry is based on the UMTRI dataset [9], [20]. This dataset describes many anthropometry details of a small-sized adult female in an automotive posture. Included are a 3D surface description, almost 150 anatomical reference points (including joint centers), and definitions of segments and derivation of inertial properties of these segments. The internal skeleton anthropometry for the pelvis bone was derived from Reynolds data. Inertial properties of body parts of the dummy are also taken from the UMTRI dataset.

The 5th WorldSID will have a total mass of:
48.2 kg ± 1.2 kg (~2.5%) with two full arm, excluding dummy suit.
45.8 kg ± 1.2 kg (~2.5%) with two half arms, excluding dummy suit.

At the waist the dummy deviates from the UMTRI anthropometry. The outer surface dimension at the waist would drive the dummy design towards abdominal ribs off set towards the mid-saggital plane by 10 mm w.r.t. the thoracic ribs. The discontinuity due to offset abdomen ribs would give non humanlike sensitivity to car environment features in the abdomen area, likely to affect repeatability. As there are no clear advantages, the discontinuous abdomen ribs are avoided.

1.5 Instrumentation

Component	Instrumentation	Part	Channels
Head	Head CG acceleration ($a_{x,y,z}$)	7268C-2000*	3
	Rotational acceleration ($\alpha_{x,y,z}$)	7302BM4*	3
Neck	Upper Neck loads ($F_{x,y,z}$, $M_{x,y,z}$)	W50-71000	6
	Lower Neck loads ($F_{x,y,z}$, $M_{x,y,z}$)	W50-71000	6
Shoulder	Shoulder load ($F_{x,y,z}$)	W5-7101	3
	Shoulder deflection (δ_y)	W5-7103	1
	Shoulder acceleration ($a_{x,y,z}$)	7268C-2000*	3
	Shoulder acceleration (a_x) Mounted on part W5-3156	7264C-2000	1
Thorax	T1 ($a_{x,y,z}$) acceleration	7268C-2000*	3
	T4 ($a_{x,y,z}$) acceleration	7268C-2000*	3
	T12 ($a_{x,y,z}$) acceleration	7268C-2000*	3
	T12 Rotational acceleration (α_x)	7302BM4*	1
	5x 2D IR-TRACC Rib deflection & rotation ((δ_y, φ_z)	3710-00	10
	5x Rib Ay acceleration Mounted on part W5-4040	7264C-2000*	5
	5x Rib $a_{x,y,z.}$ acceleration	7268C-2000*	15
Lumbar Spine	Lumbar Spine loads ($F_{x,y,z}$, $M_{x,y,z}$)	W50-71120	6
Pelvis	Sacro-Iliac loads ($F_{x,y,z}$, $M_{x,y,z}$)	W50-71130	12
	Pelvis acceleration ($a_{x,y,z}$)	7268C-2000*	3
	Pubic loads ($F_{y,}$)	W50-71105	1
	Rotational acceleration (α_x)	7302BM4*	1
Upper Leg	Femoral Neck load ($F_{x,y,z}$) Left & Right	W5-7102	3
	Femur load ($F_{x,y,z}$ $M_{x,y,z}$) Left & Right	W50-71070	6
	4x Knee load (Fy)	W50-71020	1
Lower Leg	Upper and Lower Tibia load ($F_{x,y,z}$ $M_{x,y,z}$)	W5-7108	

* Accelerometer model 7268C-2000M1 and 7264C-2000 and rotational accelerometer model 7302BM4are products supplied by Endevco Corp. San Juan Capistrano, California, USA. This information is given for the convenience of users and does not constitute an endorsement of the product named. Alternative products may be used if they can be shown to lead to the same results.

Section 2 – Head Assembly

2.1 Head

2.1.1 Parts List

Table 2.1 lists the parts required for assembling the WorldSID 5th Head, which are illustrated in Figure 2.1. Part numbers correspond to those on drawing W5-1000.

2.1.2 Head Assembly Description

The head assembly shall consist of the components and assemblies listed in head assembly parts list.

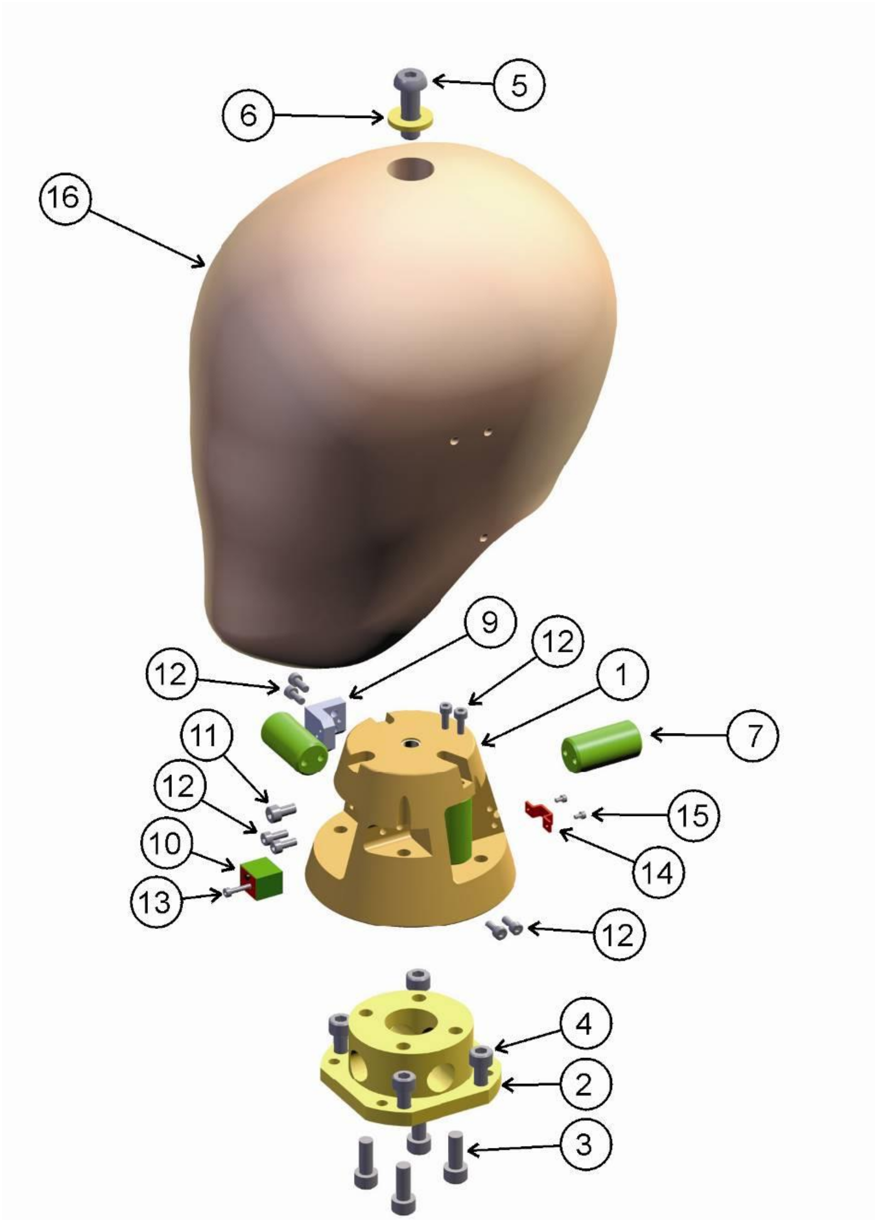


Figure 2.1 - Head Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-1010	HEAD CORE
2	1	W50-71003	STRUCTURAL REPLACEMENT, NECK LOADCELL
3	4	5000081	SCREW, SHCS M6 X 1 X 16
4	4	5000281	SCREW, SHCS M6 X 1 X 12
5	1	5000255	SCREW, BHCS M8 X 1.25 X 25
6	1	5000123	WASHER, FLAT M8 (8.9 ID X 18.8 OD X 2.3 THK.)
7	3	W50-10010	ROTATIONAL ACCELEROMETER REPLACEMENT, ENDEVCO 7302BM4
8	1	W50-10011	TILT SENSOR STRUCTURAL REPLACEMENT (MSC260D/GP-M)
9	1	W5-1011	ACCELEROMETER MOUNTING BRACKET, HEAD, ENDEVCO 7268C-M1
10	1	7268C-M1	ACCELEROMETER, LINEAR TRIAXIAL, ENDEVCO 7268C-M1 (REF)
11	1	5000024	SCREW, SHCS M4 X .7 X 8
12	8	5000388	SCREW, SHCS M3 X .5 X 8
13	1	5000509	SCREW, SHCS M2 X 0.4 X 16
14	1	W5-1012	BRACKET, CABLE RETAINER
15	2	5000063	SCREW, SHCS M1.6 X 0.35 X 3
16	1	W5-1020	HEAD MOLDED, TESTED/CERTIFIED

Table 2.1- Head Assembly (W5-1000) Part List

2.2 Disassembling the Head

As shown in Figure 2.2, remove the BHCS M8 x 25 and M8 flat washer from the top of the head. Lift the molded head (W5-1020) off the head core assembly (W5-1010). If the head sticks to the core, tap the bottom edge of the head lightly with a plastic hammer.

Figure 2.2 - Removal of Molded Head

Remove the four SHCS M6 x 12 that connect the head core assembly (W5-1010) to the neck assembly (W5-2000) as shown in Figure 2.3.

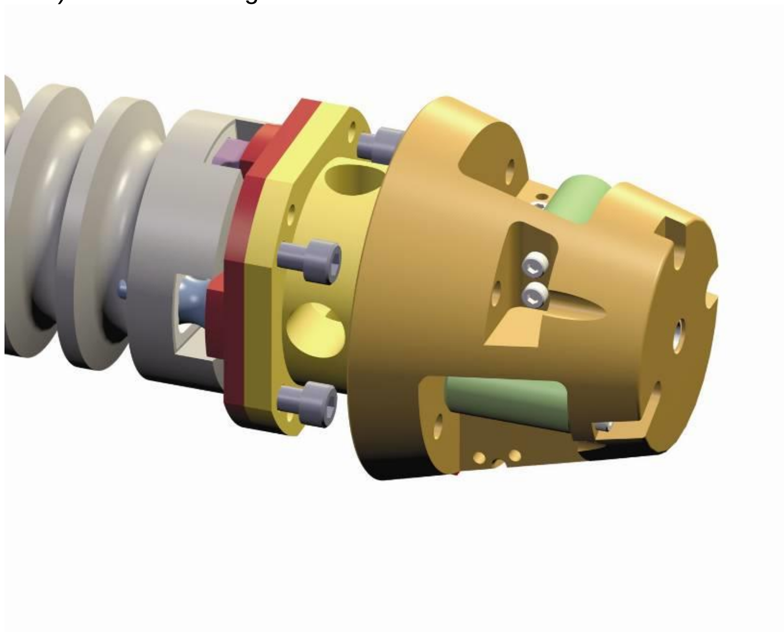


Figure 2.3 - Separating the Head Core from the Neck

Remove the four SHCS M6 x 16 from the bottom of the upper neck load cell structural replacement (W50-71003) that attaches to the bottom of the head core as shown in Figure 2.4.

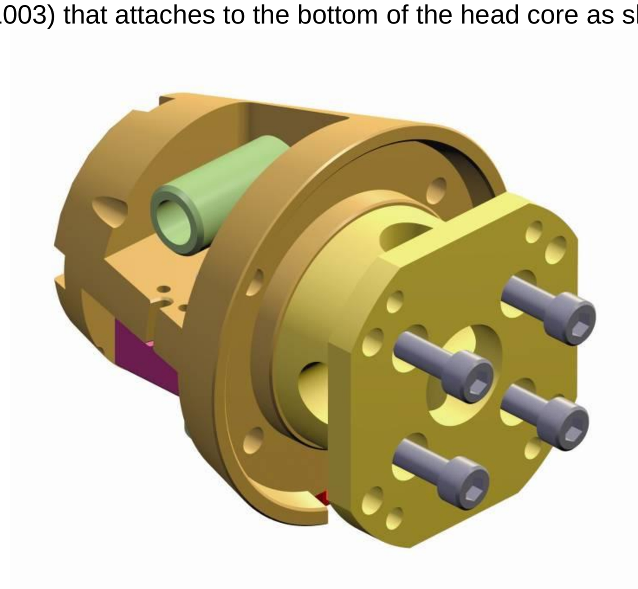


Figure 2.4 - Removing Upper Neck Load cell from Instrumented Head Core

2.3 Assembling the Head

Install the head instrumentation as described in 2.4. Use four SHCS M6 x 16 to attach the upper neck load cell (IF-xxx) to the bottom of the head core (W5-1010). 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 N·m. Attach the head core assembly (W5-1010) to the neck assembly (W5-2000) using four SHCS M6 x 12. Torque the screws to 6 N·m

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 x 25. Tighten the screw 1/4 - 1/2 turn after engagement of the screw head and the skull.

As shown in Figure 2.5, 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 to the plugged into the DAS modules from the other wiring so it can be plugged into an off board readout during setup. As shown in Figure 2.5, make sure that the cable has some slack.

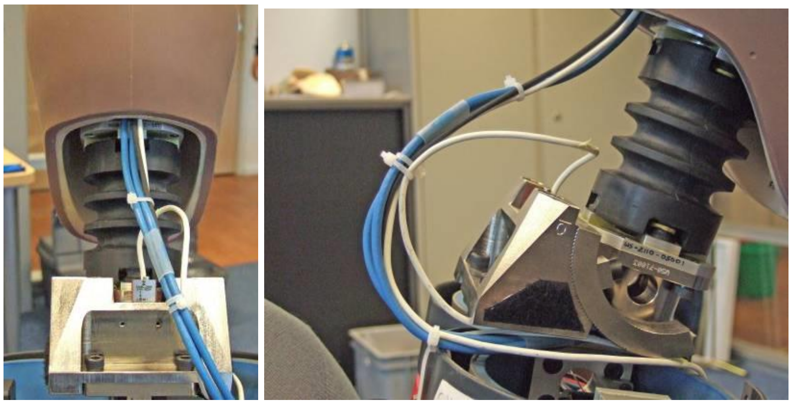


Figure 2.5 – Wire routing for head instrumentation

2.4 Instrumentation Mounting

Note that, as shown in Figure 2.6, the head core can be instrumented with three rotational accelerometers (Figure 2.6, Item 3), one linear triaxial accelerometer (Figure 2.6, Item 5), and one dual-axis tilt sensor (Figure 2.6, Item 4). Note that each rotational accelerometer is secured with two SHCS M3 x 6 (Figure 2.6, 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 x 16 (Figure 2.6, Item 8) that is accessed from the right. Mount the tilt sensor in the right-rear chamber with one SHCS M4 x 10 (Figure 2.6, Item 9) accessed from the right-front chamber. Note that the instrumentation in the right-rear chamber must 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.

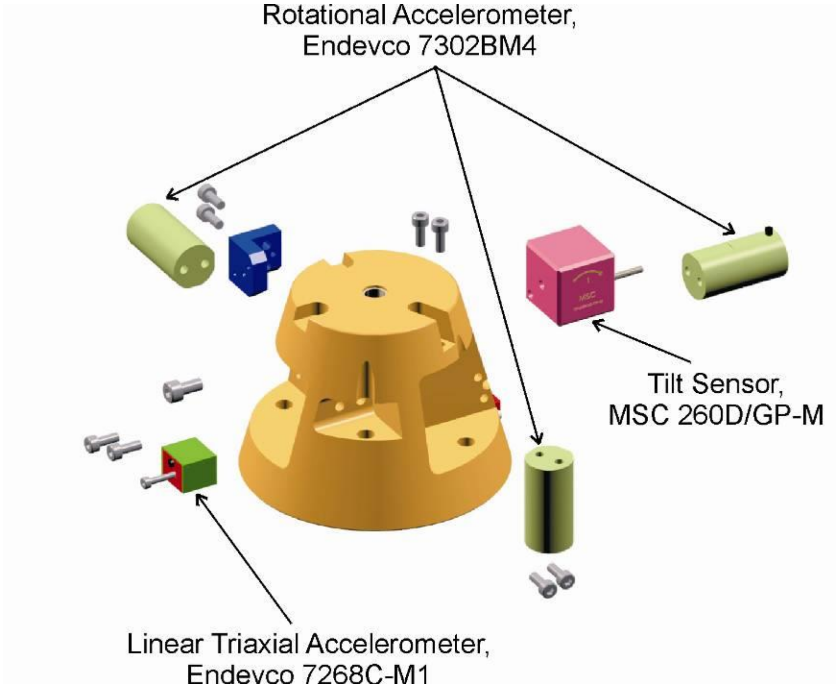


Figure 2.6 - Head Instrumentation

Section 3 – Neck Assembly

3.1 Neck

3.1.1 Parts List

Note that Table 3.1 lists the parts required for assembling the WorldSID 5th Neck, which are shown in Figure 3.1. Note that part numbers correspond to those found on drawing W5-2000.

3.1.2 Neck Assembly Description

The neck assembly shall consist of the components and assemblies listed parts list.

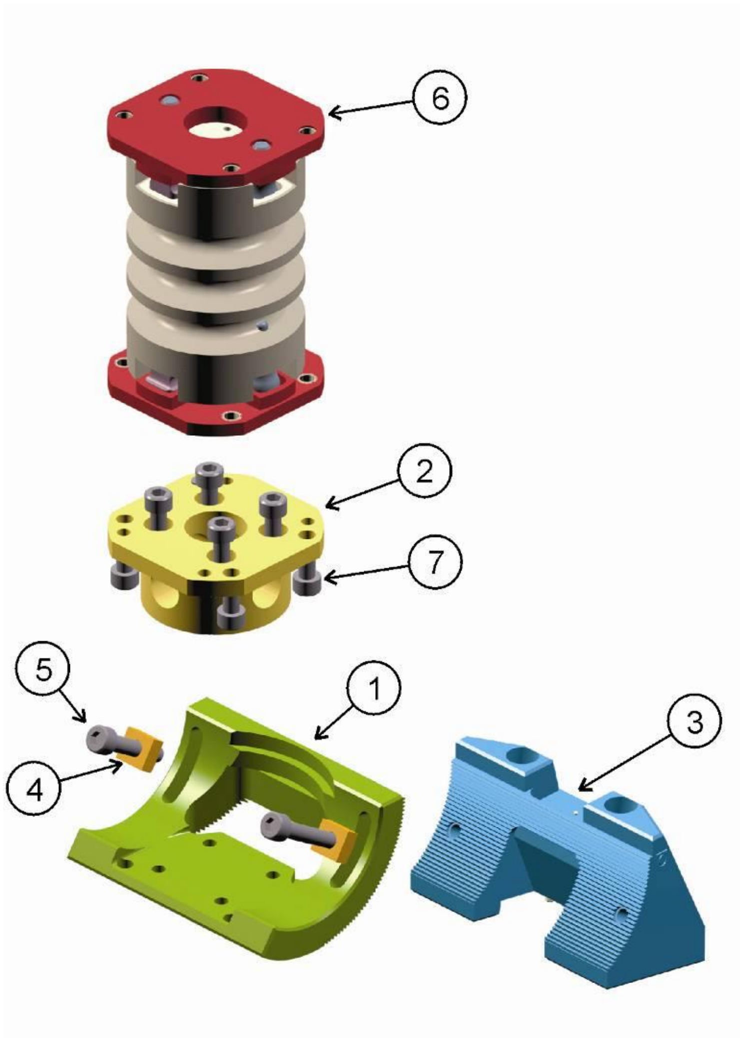


Figure 3.1 - Neck Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W50-20102	UPPER NECK BRACKET
2	1	W50-71003	STRUCTURAL REPLACEMENT, NECK LOADCELL
3	1	W5-2020	LOWER NECK BRACKET
4	2	W50-20103	SPACER, NECK
5	2	5000008	SCREW, SHCS M6 X 1 X 30
6	1	W5-2100	NECK ASSEMBLY, TESTED & CERTIFIED
7	8	5000281	SCREW, SHCS M6 X 1 X 12

Table 3.1 - Neck Assembly (W5-2000) Part List

3.2 Disassembling the Neck

Separate the upper (W50-20102) and lower (W5-2020) neck brackets by removing two SHCS M6 x 30 and spacer (W50-20103).

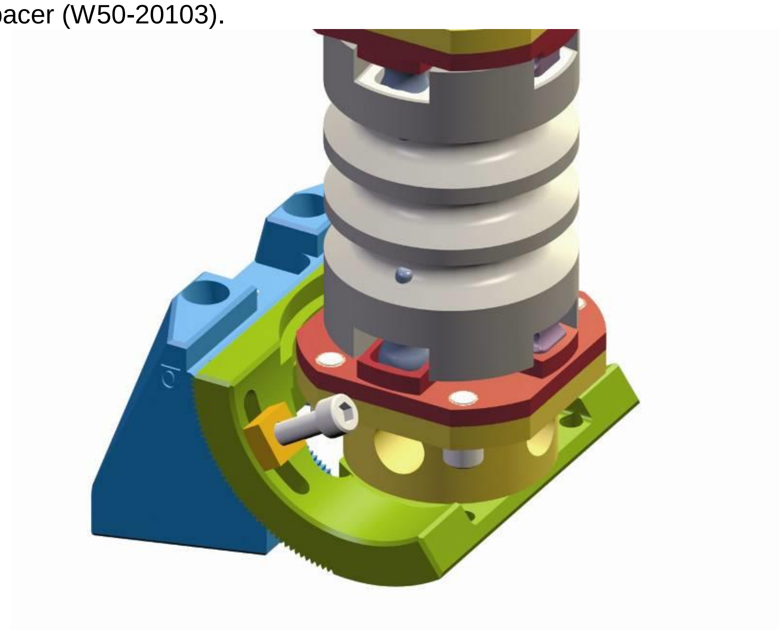


Figure 3.2 - Removing Lower Neck Bracket

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 accessed from the bottom as shown in Figure 3.3. Remove the lower neck load cell from the upper neck bracket by removing four SHCS M6 x 12.

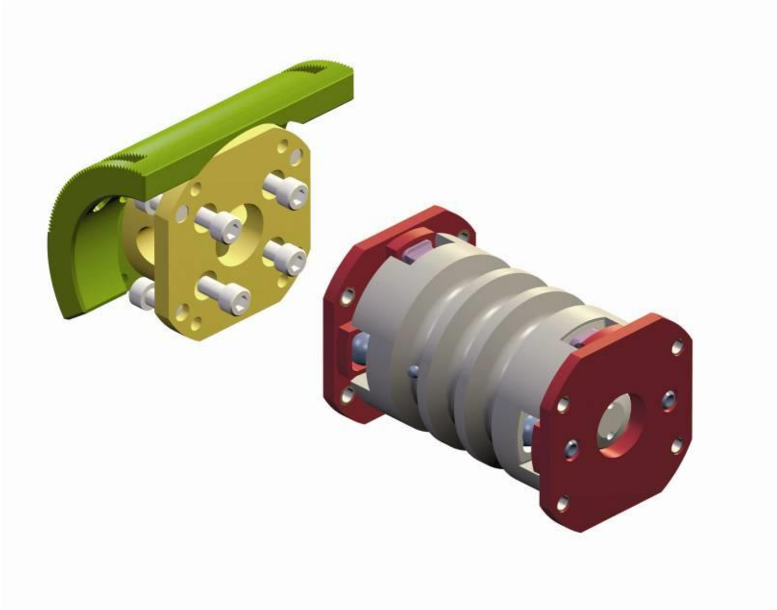


Figure 3.3 - Removing Upper Neck Bracket

To take apart the neck assembly, use the neck compression wrench to remove the half-spherical screw from the neck, as shown in Figure 3.4. After the neck buffer retaining plates come off, remove the four dampers by pulling them out, as shown in Figure 3.5.

Figure 3.4 - Removing half-spherical screws and retaining plates

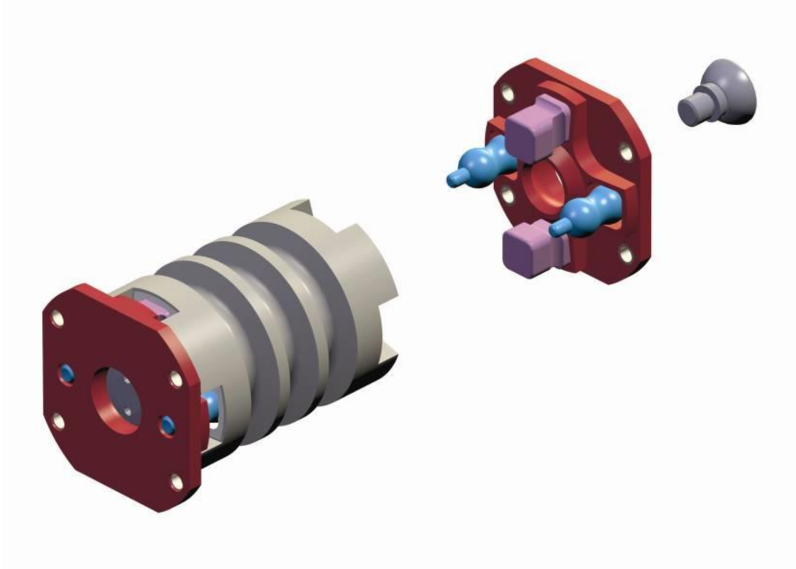


Figure 3.5 - Neck Dampers are free to be removed when retaining plates are removed

3.3 Assembling the Neck

When assembling the neck, mount the neck buffers with the circular cross-sections on the lateral sides of the neck in the square with through holes, and mount the neck buffers with the square cross-sections on the front and rear of the neck. As shown in Figure 3.6, note that the lateral locations for the buffers in the interface plates are closest from the holes for mounting the neck to the head and torso.

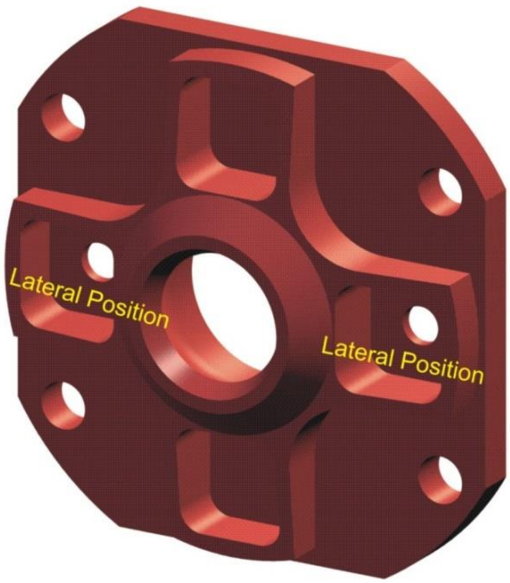


Figure 3.6 - Lateral positions for Neck Buffers

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 counter bore 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 one of the three different hardness of lateral circular cross-section buffers. When installing the flexion/extension buffers in the interface plates, position them as shown in Figure 3.7 so the end that sticks out farther is facing the interface plates away from the molded neck.

Figure 3.7 - Assembling of Neck Buffers

Position the neck buffer retaining plate (W5-2110) with the installed buffers over one end of the neck. Lubricate the surface of the half-spherical screw (W5-2133) with the “Never Seez” high-pressure grease, which is provided in the toolbox. Attach the retaining plate to the neck by tightening the half-spherical screws to 10 N·m using the neck compression tool. Repeat for the other end of the neck.

Place the upper neck bracket (W50-20102) over the lower neck bracket (W5-2020) and engage the teeth in the desired orientation. Insert the two SHCS M6 x 30 to secure the brackets together.

Mount the neck load cell or its structural replacement (W50-71003) to the neck bracket with four SHCS M6 x 12. Tighten the screws to 6 N·m, Attach the neck assembly (W5-2100) to the neck bracket/load cell assembly with four SHCS M6 x 12 accessed from the bottom. Tighten the screws to 6 N·m

3.4 Instrumentation Mounting

Note that 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 (W50-75201) can be mounted in the recess back part of the lower neck bracket. Install the triaxial accelerometer or its mass replacement to the lower neck bracket using a SHCS M2 x 16 as shown in Figure 3.8.

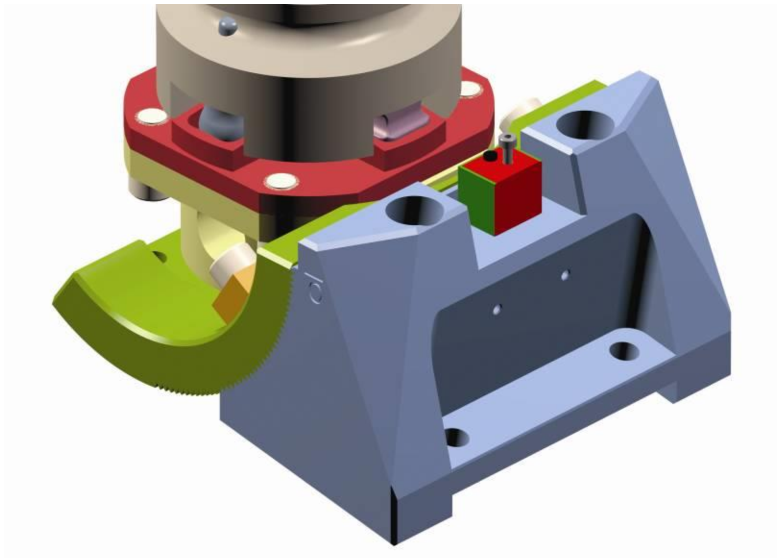


Figure 3.8 - Neck Triaxial Accelerometer Installation

Section 4 – Thorax Assembly

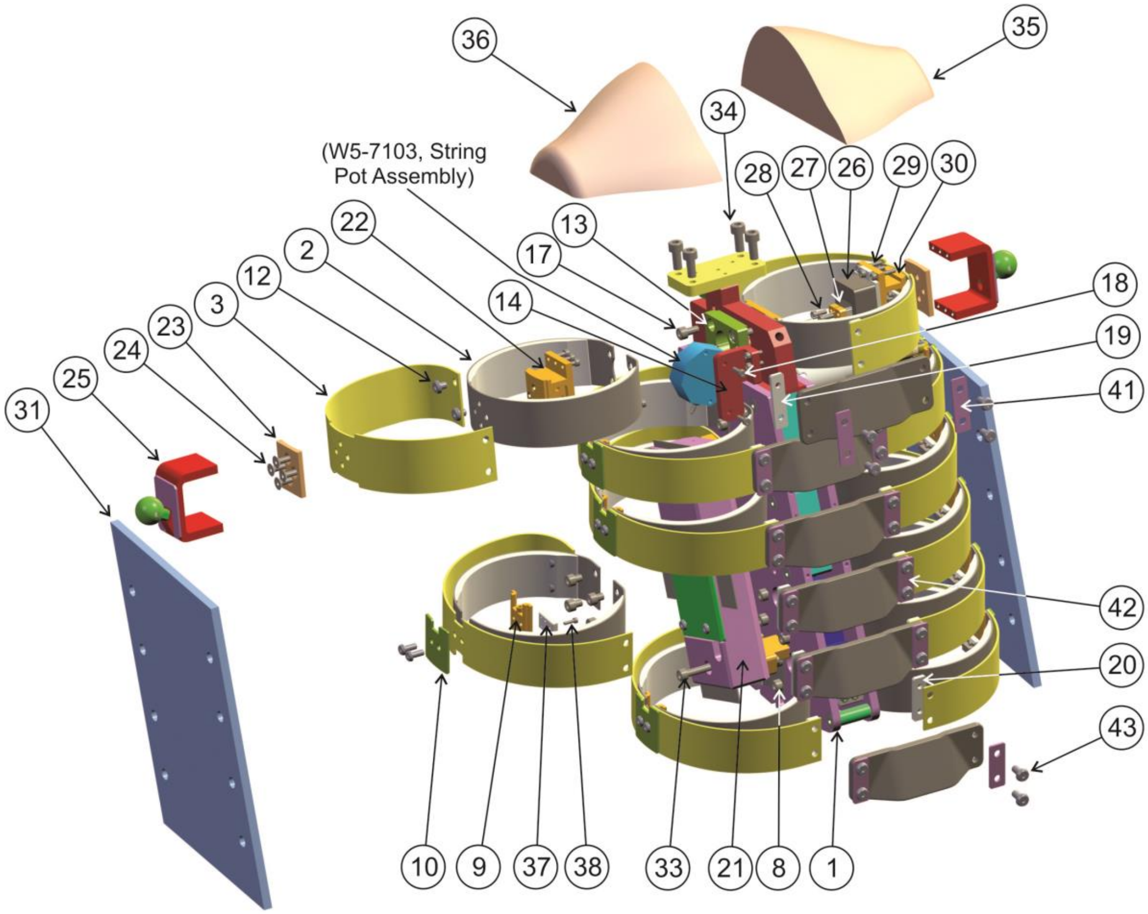
4.1 Thorax Assembly

4.1.1 Parts List

Note that Table 4.1 lists the parts required for assembling the WorldSID 5th Thorax and Shoulder which are illustrated in Figure 4.1. Note that part numbers correspond to those on drawing W5-3000. The WorldSID small female revision1 (SBL B) was updated in the thorax with single rib sternum couplers for shoulder (W5-5352) and thorax and abdomen ribs (W5-3351). Reduced gauge metal (1.2mm) inner ribs with 5mm blue damping material for shoulder (W5-3270) thorax (W5-3272) and abdomen (W5-3271) ribs.

4.1.2 Thorax Assembly Description

The Thorax Assembly shall consist of the components and assemblies listed in the parts list.



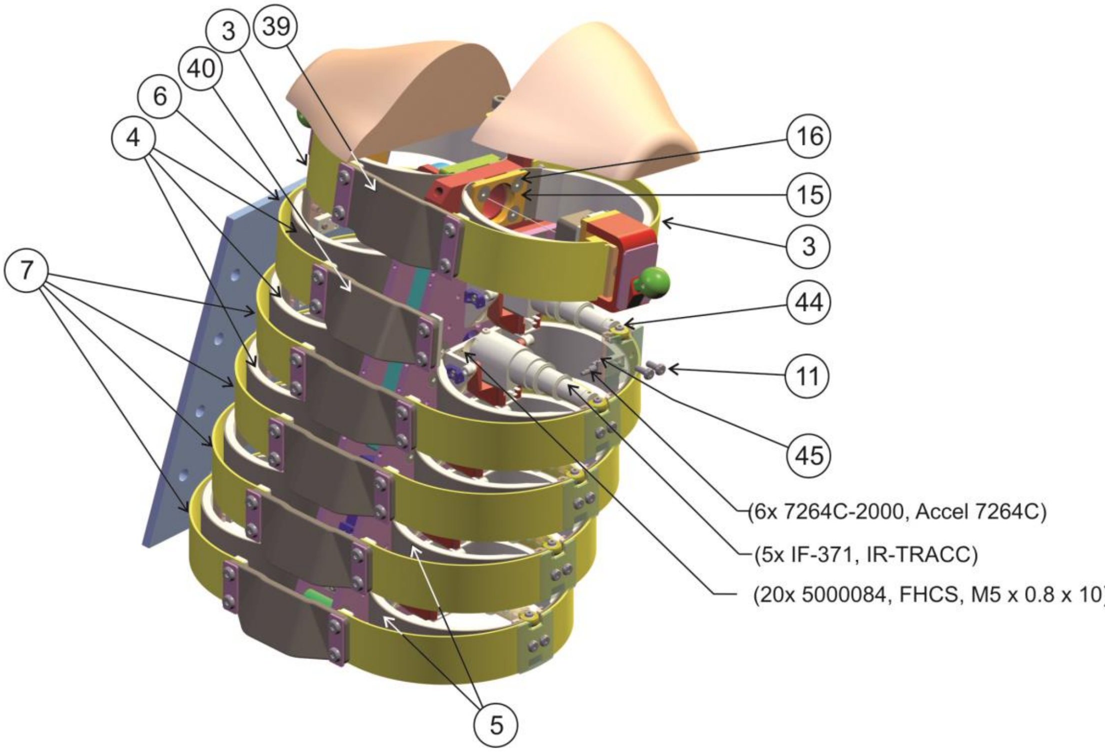


Figure 4.1 - Thorax Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-3100	SPINE BOX ASSEMBLY
2	2	W5-3270	INNER RIB ASSEMBLY, SHOULDER
3	2	W5-3210	OUTER RIB ASSY SHOULDER
4	6	W5-3272	INNER RIB ASSEMBLY, THORAX
5	4	W5-3271	INNER RIB ASSEMBLY, ABDOMEN
6	2	W5-3220	OUTER RIB ASSY THORAX #1
7	8	W5-3230	OUTER RIB ASSY THORAX #2&3, ABDOMEN
8	40	5000700	SCREW, SHCS M5 X .8 X 6
9	10	W5-3301	ACCELEROMETER MOUNT, RIB, ENDEVCO 7268C-M1
10	10	W5-3303	CLAMPING BRACKET, RIB
11	20	5000010	SCREW, BHCS M4 X 0.7 X 10
12	24	5000214	SCREW, BHCS M5 X 0.8 X 6
13	1	W5-3308	STRING POT MOUNT A, SHOULDER
14	1	W5-3309	STRING POT MOUNT B, SHOULDER
15	1	W5-3307	RIB DAMPING CLAMP, SHOULDER
16	4	5000374	SCREW, FHCS M5 X 0.8 X 12
17	4	5000291	SCREW, SHCS M5 X .8 X 10
18	4	5000119	SCREW, SHCS M3 X .5 X 10
19	2	W5-3312	STERNUM CLAMP THREADED, SHOULDER RIB
20	10	W5-3314	STERNUM CLAMP THREADED, LOWER RIBS
21	1	W5-3320	BATTERY BOX ASSEMBLY
22	2	W5-3341	SHOULDER LOAD CELL STRUCT REPLACEMENT
23	2	W5-3344	SHOULDER RIB CLAMP
24	8	5000326	SCREW, FHCS M4 X 0.7 X 12
25	2	W5-3340	MOUNTING BRACKET ASSEMBLY, SHOULDER
26	1	W5-3150	SHOULDER RIB STOP ASSEMBLY
27	1	W5-3153	MOUNT, STRING
28	10	5000388	SCREW, SHCS M3 X .5 X 8
29	6	5000437	SCREW, SHCS M3 X .5 X 16
30	1	W5-3156	ACCEL MOUNT, SHOULDER, ENDEVCO 7268C-M1
31	2	W5-3004	THORAX PAD
32	8	6002055	CABLE TIE, HOOK & LOOP, 11 INCH (NOT SHOWN)
33	2	5000471	SCREW, SHCS M5 X .8 X 30
34	4	5000604	SCREW, SHCS M6 X 1 X 14
35	1	W5-3350-1	SHOULDER PAD, LEFT
36	1	W5-3350-2	SHOULDER PAD, RIGHT
37	10	W5-4040	ACCELEROMETER MOUNT, LINEAR, SINGLE AXIS
38	10	5000083	SCREW, SHCS M2 X 0.4 X 8
39	1	W5-3352	W5 RIB COUPLER
40	5	W5-3351	W5 RIB COUPLER
41	2	W5-3311	STERNUM CLAMP, SHOULDER RIB
42	10	W5-3313	STERNUM CLAMP, LOWER RIBS
43	24	5000003	SCREW, BHCS M5 X 0.8 X 10
44	5	5000436	SCREW, BHCS M3 X 0.5 X 10
45	12	5000338	SCREW, SHCS M1.6 X 0.35 X 5

Table 4.1 - Thorax Assembly (W5-3000) Part List

4.2 Spine Box Assembly

4.2.1 Parts List

Note that Table 4.2 list the parts required for assembling the WorldSID 5th Spine Box. Note that part numbers correspond to those on drawing W5-3100 and shown in Figure 4.2.

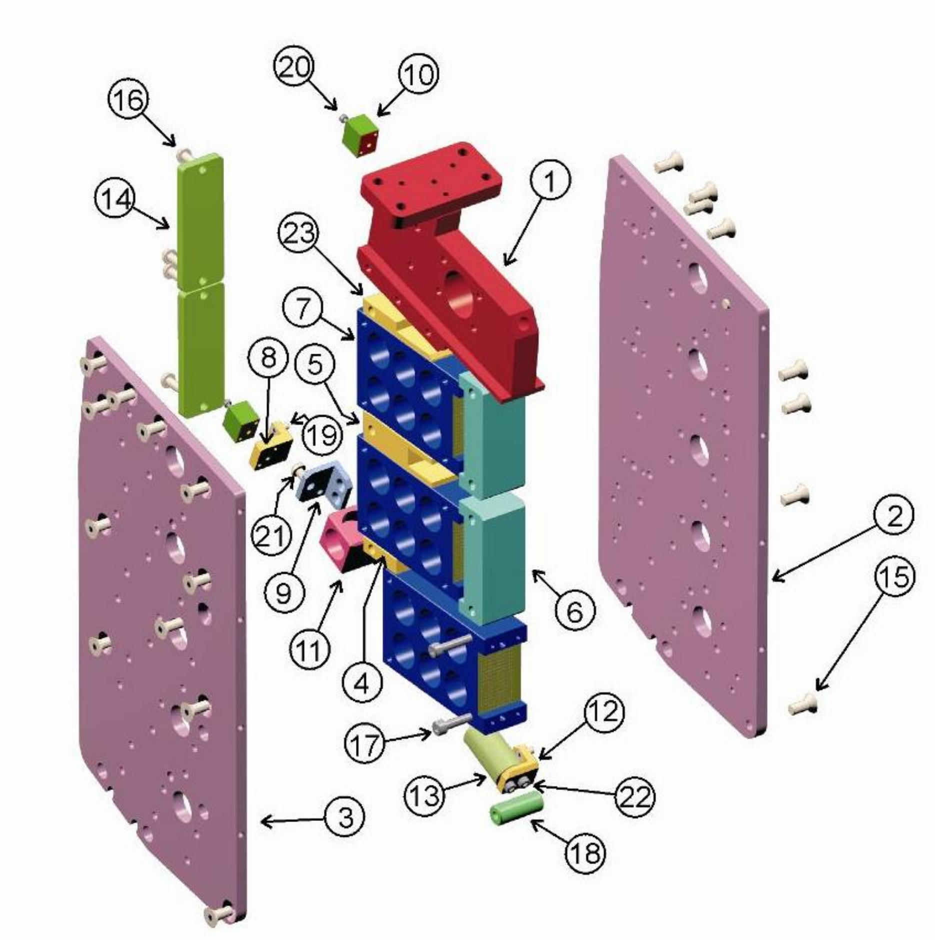


Figure 4.2 - Spine Box Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-3110	UPPER BRACKET WELDMENT, SPINE BOX
2	1	W5-3101	SIDE PLATE, SPINE BOX, LEFT
3	1	W5-3102	SIDE PLATE, SPINE BOX, RIGHT
4	2	W5-3121	DOCKING STATION GUIDE A
5	1	W5-3122	DOCKING STATION GUIDE B
6	2	W5-3126	INTERPOSER REPLACEMENT
7	3	W50-74307	G5 STRUCTURAL REPLACEMENT
8	1	W5-3125	ACCELEROMETER MOUNT, T12, (ENDEVCO 7268C-2000M1)
9	1	W5-3123	TILT SENSOR MOUNT, THORAX (MSC 260D-GP-M)
10	2	7268C-M1	ACCELEROMETER, LINEAR TRIAXIAL, ENDEVCO 7268C (REF)
11	1	W50-10011	TILT SENSOR STRUCTURAL REPLACEMENT (MSC260D\GP-M)
12	1	W5-3124	ACCEL MOUNT, THORAX (ENDEVCO 7302BM4)
13	1	W50-10010	ROTATIONAL ACCELEROMETER REPLACEMENT, ENDEVCO 7302BM4
14	2	W5-3131	G5 COVER
15	22	5000096	SCREW, FHCS M5 X 0.8 X 12
16	4	5000153	SCREW, BHCS M4 X 0.7 X 16

17	2	5000463	SCREW, SHCS M4 X .7 X 30
18	1	W5-3106	SPACER
19	6	5000116	SCREW, FHCS M3 X 0.5 X 8
20	2	5000509	SCREW, SHCS M2 X 0.4 X 16
21	1	5000334	SCREW, BHCS M4 X 0.7 X 6
22	2	5000388	SCREW, SHCS M3 X .5 X 8
23	1	W5-3127	DOCKING STATION GUIDE C

Table 4.2 - Spine Box Assembly (W5-3100) Parts List

4.3 Disassembling the Thorax and Pelvis

4.3.1 Separation of Thorax and Pelvis

To separate the Thorax and Pelvis, first make sure all the cables running between the Thorax and Pelvis are detached, these would normally include communication cables if the pelvis DAS is installed, sensor cables that were routed to the DAS in the thorax, and a ground cable. This step may require disassembling of the sternum to access the sensor collector. Thereafter, remove the four SHCS M8 x 18, two on each side of the bottom of the spine box, to separate the upper and lower torsos.

4.3.2 Shoulder

As shown in Figure 4.3, remove the shoulder load cell/structural replacement (W5-3341) by removing the six SHCS M3 x 12 that hold each in place.

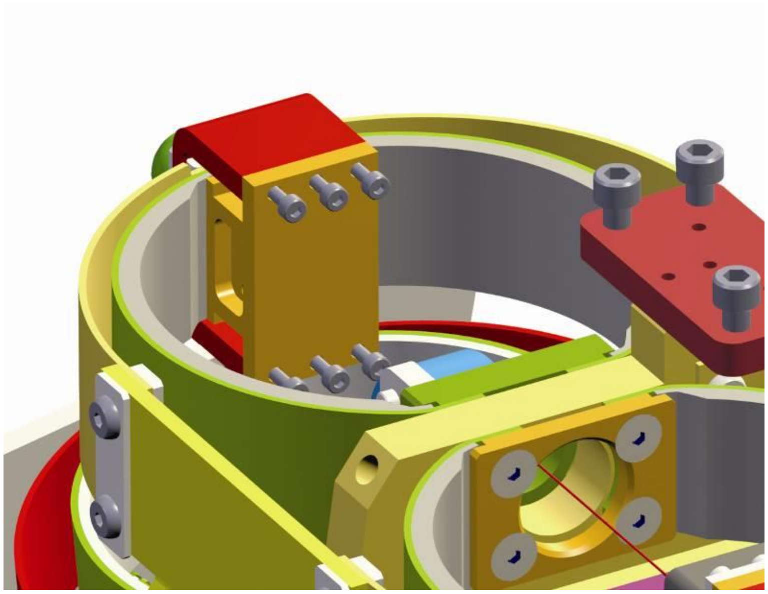


Figure 4.3 - Removing Shoulder Load cell/Structural Replacement

4.3.3 Thorax

Remove the thorax pad (W5-3004) by removing it from the Velcro® that holds them in place. Remove the shoulder pads (W5-3350-1/-2) by lifting them off of the dummy. Remove the lower neck bracket from the spine box by removing four SHCS M6 x 14.

Remove the shoulder rib mounting brackets (W5-3340). Detach the shoulder rib IR-TRACC (IF-369) from the shoulder rib mounting bracket by removing the BHCS M3 x 10.

Remove the linear triaxial accelerometer (W5-75201) from the shoulder rib mounting bracket by removing the SHCS M2 x 16. Detach the shoulder IR-TRACC assembly from the spine box by removing the SHCS M2.5 x 8.

As shown in Figure 4.4, disconnect the shoulder rib (W5-3210) at the front by removing the two BHCS M5 x 10 that attach the left and right shoulder ribs to the rib coupler, thorax (W5-3304). Removing a shoulder rib sternum clamp (W5-3311) and a threaded shoulder sternum clamp (W5-3312) which is removed from each side.

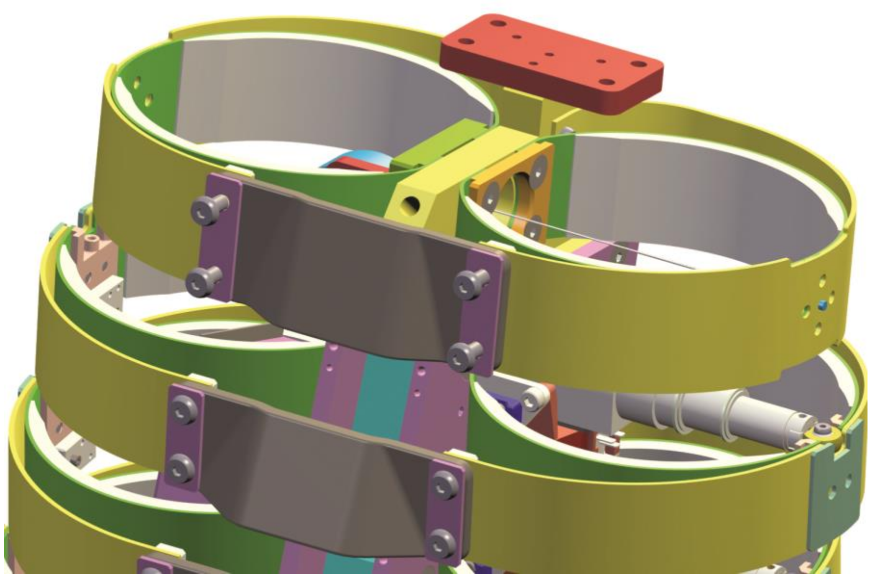


Figure 4.4 - Detaching shoulder rib at front from sternum

Detach the left and right shoulder ribs from the spine box at the rear by removing two BHCS M5 x 6 that hold each in place (see Figure 4.5). On the non-struck side, remove the two string pot mounts (W5-3308 & W5-3309).

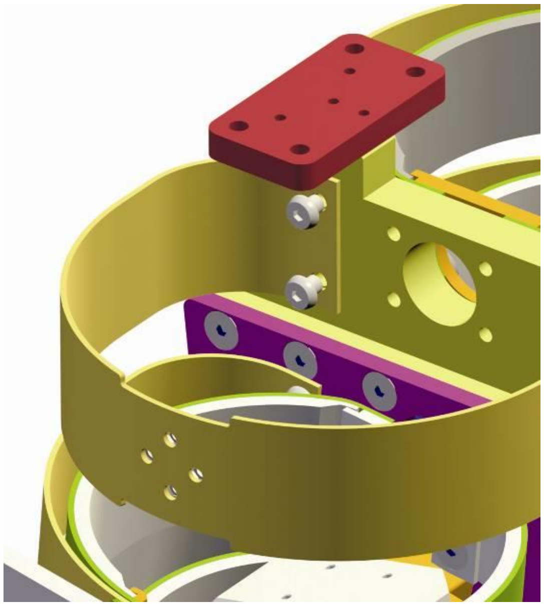


Figure 4.5 - Detaching the rib from the spine box at the rear

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 BHCS M4 x 10 and the clamping bracket (W5-3303). Remove the triaxial accelerometer (W50-75201) from the rib accelerometer mounting bracket (W5-3301) by removing the SHCS M2 x 16.

Remove the IR-TRACC by removing the FHCS M5 x 10 that secures it to the spine box. Detach it from the rib accelerometer bracket by removing the IR-TRACC BHCS M3 x 10.

Detach the thorax rib at the front by removing the four BHCS M5 x 10 that connects it to the rib coupler (W5-3304). Remove the sternum clamp (W5-3313) and the threaded sternum clamp (W5-3314). Detach the inner band of the thorax rib (W5-3280) by removing the four BHCS M5 x 10 that hold them in place. Remove the damping clamps (W5-3302). Detach the rib from the spine box at the rear by removing two BHCS M5 x 6 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 (W5-3305) and that the inner rib bands of the two abdomen ribs (W5-3285) are different than the inner bands of the three thorax ribs (W5-3280). Note that the first thorax outer rib (W5-3220) is different from the thorax ribs 2 and 3 and the abdominal ribs (W5-3230), which are the same.

After the ribs are removed (see Figure 4.1), detach the battery mass replacement (W5-3320) from the non-struck side by removing two SHCS M5 x 30.

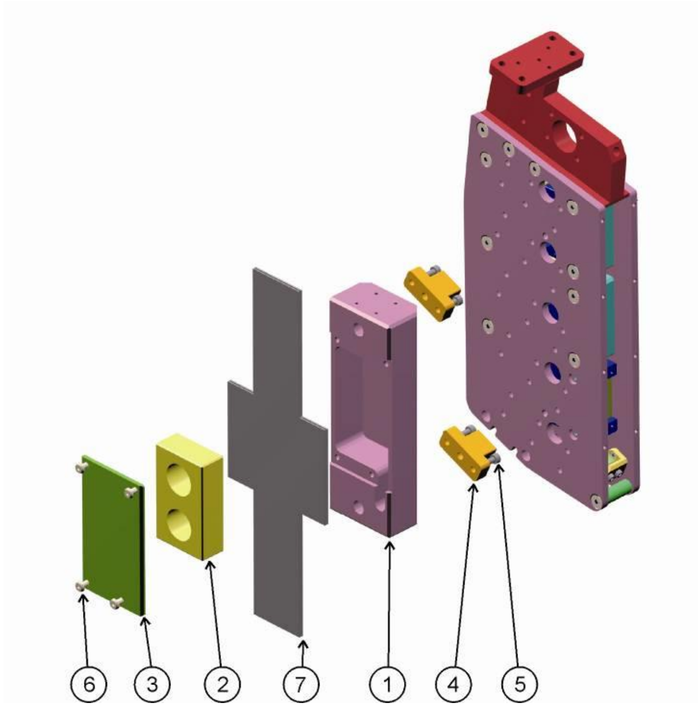


Figure 4.6 - Battery Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-3322	BATTERY MOUNT
2	1	W5-3325	BATTERY REPLACEMENT
3	1	W5-3323	BATTERY COVER
4	2	W5-3324	MOUNTING BRACKET
5	4	5000459	SCREW, SHCS M4 X.7 X 14
6	4	5000103	SCREW, BHCS M4 X .7 X 8
7	2	W5-3326	THERMAL PAD

Table 4.3 - Battery Assembly (W5-3320) Part List

4.4 Disassembling the Spine Box

Detach the right side plate (W5-3102) from the spine box by removing ten FHCS M5 x 12. Note that the internal components of the spine box will now be visible (see Figure 4.7).

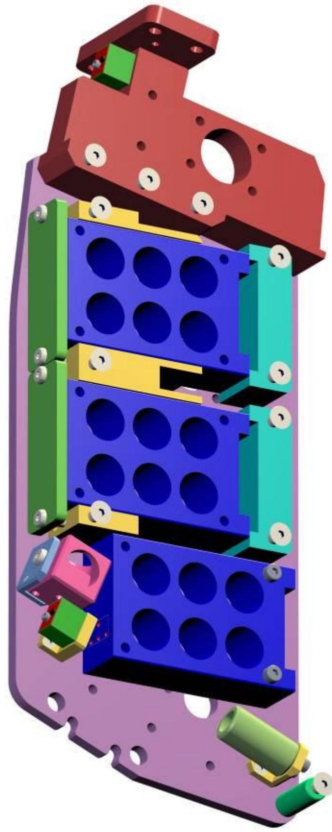


Figure 4.7 - Internal Spine Box Assembly

Remove the T12 accelerometer mount (W5-3125) from the spine box by removing the two SHCS M3 x 8 that secure the mount. Remove the linear accelerometer by removing the SHCS M2 x 16.

Note the rotational and linear accelerometer assembly shown in Figure 4.8. To detach the rotational accelerometer assembly from the spine box, remove the SHCS M3 x 8 that secure it to the spine box. Remove the dual-axis tilt sensor from the rotational accelerometer bracket by removing the SHCS M3 x 8 from the back of the bracket. Detach the two rotational accelerometers by removing the two FHCS M3 x 8 that secure each to the bracket.

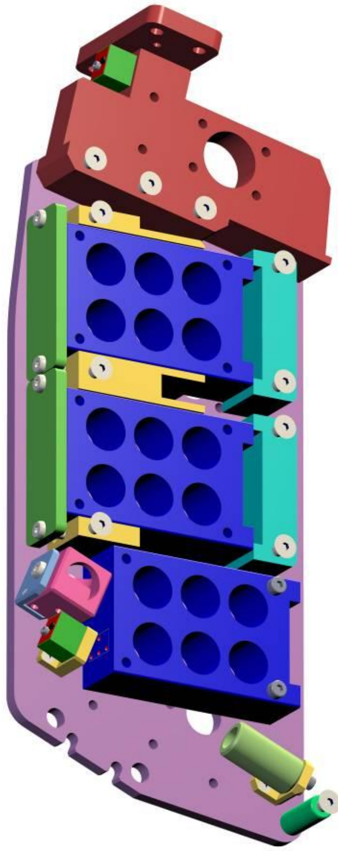


Figure 4.8 - Angular accelerometer Assembly

Begin removal of the upper or middle G5 module mass replacements (W50-74307) by removing the SHCS M5 x 12 that secure the docking station guide A (W5-3121) to the spine box weldment (W5-3110). Remove the FHCS M5 x 12 that secure the docking station guide B (W5-3122) to the spine box. Remove the middle or upper G5 module mass replacement assembly (W50-74307). Detach the spine box cover plate (W5-3131) from the back of each G5 module mass replacement by removing two BHCS M4 x 16. Slide the G5 module mass replacement from between the two docking stations (W5-3121 & W5-3122). Detach each interposer mass replacement (W5-3126) from the side plates by removing the four FHCS. Remove the lower G5 module mass replacement (W50-74307) from the spine box by detaching SHCS M4 x 30.

Turn the spine box over and remove FHCS M5 x 12 to remove the spacer (W5-3106) from the left side plate (W5-3101). Remove three more of the FHCS M5 x 12 to separate the upper spine box bracket weldment (W5-3110) from the left-side plate.

4.5 Assembling

4.5.1 Assembling Thorax

Note that Figure 4.9 shows the color coding scheme for the WorldSID ribs and that the shoulder rib is grey, the first thoracic rib is red, and the remaining ribs are white.

Note that the inner bands of the abdominal ribs (W5-3285) and the shoulder ribs (W5-3290) have a thicker layer of damping material than the inner bands of the thoracic ribs (W5-3280).

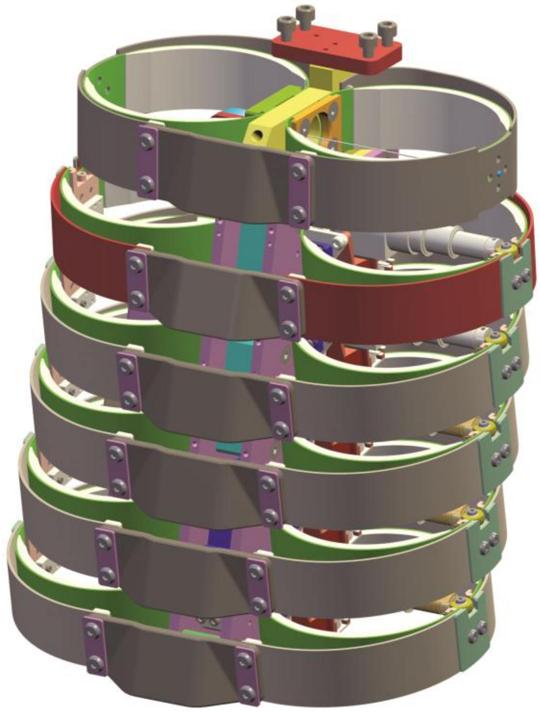


Figure 4.9 - Ribs

Begin assembly of the thorax by attaching the battery box assembly (W5-3320) with two SHCS M5 x 30 that secure it to the spine box on the non-struck side.

Begin assembly of the ribs from the bottom. Attach the lower abdominal rib (W5-3230) to the spine box at the rear using two BHCS M5 x 6. Secure the inner band of the abdomen (W5-3285) with the ball joint assembly (W5-3330) and four BHCS M5 x 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 x 8. Connect it to the accelerometer mounting bracket (W5-3301) with a BHCS M3 x 10. Connect the rib clamping bracket (W5-3303) and the rib accelerometer mounting bracket (W4-3301) to the inner band and rib with two BHCS M4 x 10. Secure the triaxial accelerometer to the rib accelerometer mounting bracket (W5-3301) with a SHCS M2 x 16.

As each IR-TRACC assembly and accelerometer is installed, route the cables toward the centre front (Figure 4.12 and Figure 4.13) of the dummy and plug them into the G5 module connectors.

Note that Figure 4.10 shows the arrangement of the components in the first thoracic rib and that all of the ribs have a similar general assembly. Note that the inner band of the rib (W5-3280) is attached to the spine box with ball joint assembly (W5-3330) and FHCS M5 x12. Note that the rib (W5-3220) is attached to the spine box at the rear with BHCS M5 x 6, and to the thorax rib coupler (W5-3304) at the front using BHCS M5 x 10 and the sternum mounting strip (W5-3313) and threaded sternum mounting strip (W5-3314). Attach the 2D IR-TRACC assemblies (IF-371) with a SHCS M2.5 x 8 to the ball joint components which are attached to the spine box. Secure the IR-TRACC to the rib accelerometer mounting bracket (W5-3301) with a BHCS M3 x 10. Note that a linear triaxial accelerometer is attached to the rib accelerometer mounting bracket (W5-3301), which is then secured to the inner rib, rib, and ball joint assembly (W5-3330) with a BHCS.

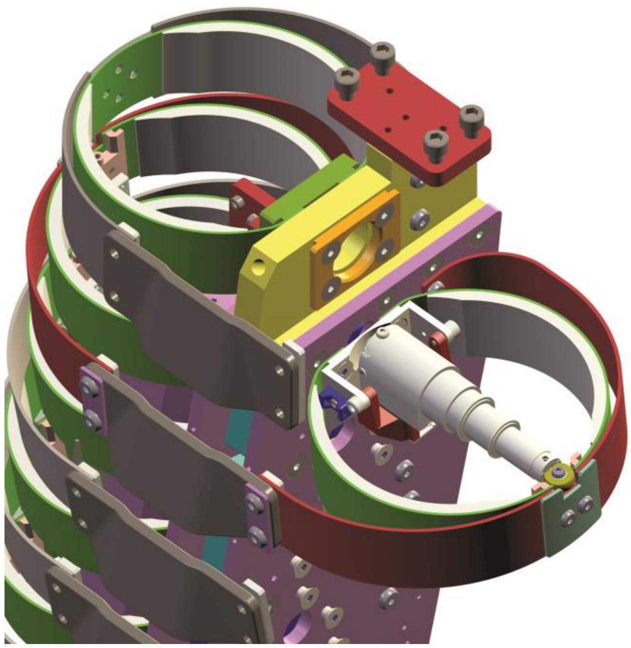


Figure 4.10 - Components of Thorax Ribs

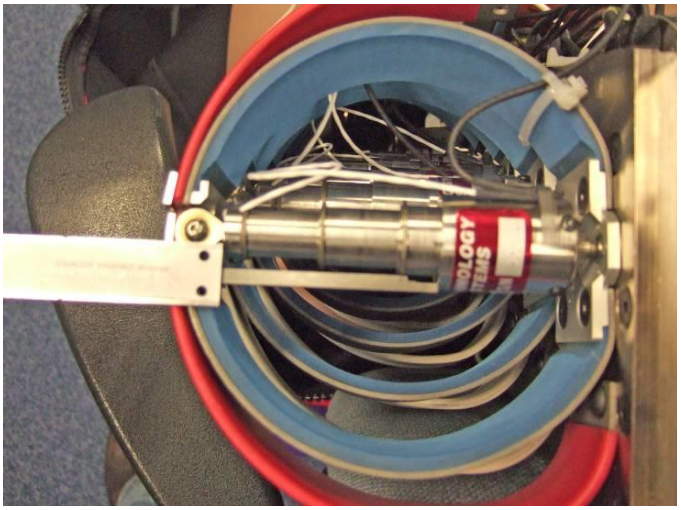


Figure 4.11 – Wire routing for rib instrumentation

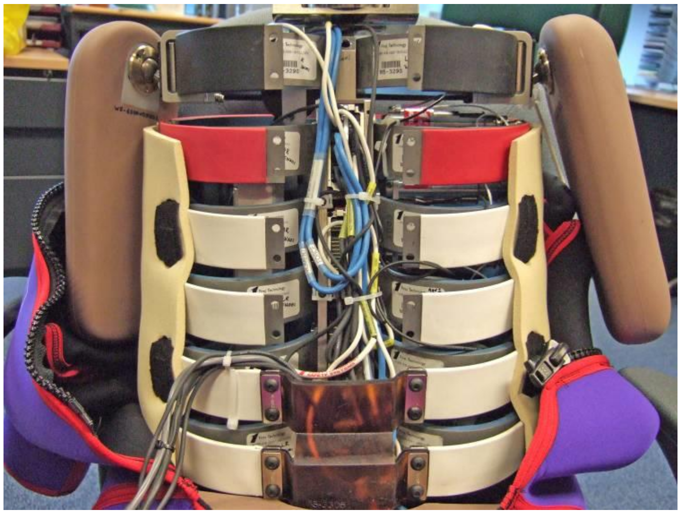


Figure 4.12 – Plugging rib instrumentation cables into the front of the G5 modules mounted in the spine box

Continue installing the ribs with the preceding procedure. Attach the shoulder load cell to the shoulder rib and shoulder rib stop assembly (W5-3150) with six SHCS M3 x 12.

After the instrumentation is plugged into the connectors, position a threaded sternum clamp (W5-3314) behind the front holes on each rib, and place the abdominal rib coupler (W5-3305) over it. Put the sternum clamp (W5-3313) over the rib coupler and secure the rib at the front with two BHCS M5 x 10. Note that the installed rib couplers are shown in Figure 4.13.

Attach the lower neck bracket (W5-2020) to the spine box (W5-3100) with four SHCS M6 x 14. Attach the thorax pad (W5-3004) with Velcro®. Place the shoulder pads (W5-3350-1/-2) in position. To install the thorax pads, check fit the pad against the dummy to make sure the pad covers the ribs and press into place, engaging the Velcro® with light pressure.

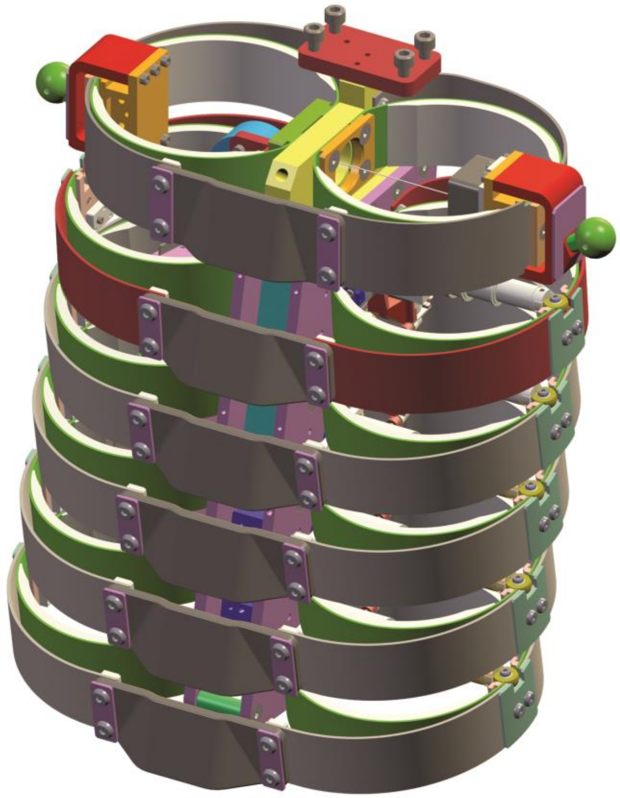


Figure 4.13 - The rib and abdominal couplers are attached to the ribs after instrumentation is plugged in

4.5.2 Assembling the Spine Box

Begin assembly of the spine box (W5-3100) by mounting the ball joints (W5-3330) for the IR-TRACC assemblies to the side plate so they face the struck-side of the dummy. Secure each ball joint assembly with four FHCS M5 x 12. Attach the spacer (W5-3106) to the struck-side plate (W5-3101) using FHCS M5 x 12. Attach the upper spine box bracket weldment (W5-3110) to the struck-side plate with three more FHCS M5 x 12.

As shown in Figure 4.14, attach the lower G5 module or its mass replacement (W50-74307) to the spine box with two SHCS M4 x 30. Connect each interposer or its mass replacement (W5-3126) to the side plates with FHCS M5 x 12. Secure the docking station guides to the spine box with a FHCS M5 x 12. Slide the G5 modules or their mass replacements between the docking stations. Attach the G5 cover plate (W5-3131) to the back of each G5 module or its mass replacement with two BHCS M4 x 16.

Next assemble the thorax accelerometer mount (W5-3123) with two FHCS M3 x 8 to the side plate (W5-3101). Attach the tilt sensor to the mount with a BHCS M4 x 6. Next, attach the T12 accelerometer mount (W5-3125) to the side plate (W5-3101) with two FHCS M3 x 8. Attach the linear triaxial accelerometer to the mount with a BHCS M4 x 6. Attach the thorax accelerometer mount (W5-3124) to the side plate (W5-3101) with two FHCS M3 x 8. Attach the rotational accelerometer with two SHCS M3 x 8 to the mount.

Attach the other side plate (W5-3102) to the spine box with FHCS M5 x 12. Make sure the cables from the T12 or angular accelerometer assembly are not pinched by the side plate.

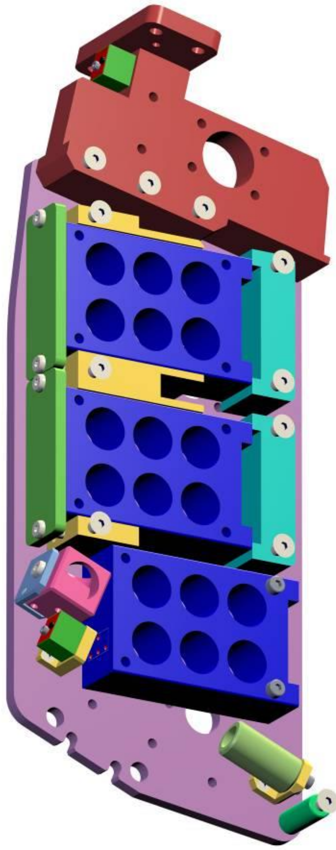


Figure 4.14 - Installation of G5 modules

4.6 Instrumentation Mounting

4.6.1 Thorax Instrumentation

Note that the thorax instrumentation for the WorldSID includes a 2D-IR-TRACC deflection measurement assembly for each struck-side rib. Note that the 2D IR-TRACC assembly (Figure 4.15, IF-371) is attached to the spine box with four FHCS M5 x 10, and that the small end of the IR-TRACC assembly is attached to the rib accelerometer mounting bracket (Figure 4.16, W5-3301) with a BHCS M3x10.

For the rib accelerations two options are available: a tri-axial accelerometer with sensitive axis in three directions x, y and z; and a single axis accelerometer with its sensitive axis in y-direction. Note that the linear triaxial accelerometer is secured to the rib accelerometer mounting bracket (W5-3301) with a SHCS M2 x 16 and that the rib accelerometer mounting bracket is secured to the inner band of the rib (W5-3280), the thorax rib (W5-3220), and the rib clamping bracket (W5-3303) with two BHCS M4 x 10. The single axis accelerometer is mounted on an adaptor plate part W5-4040 on part W5-3301 in a similar fashion as the tri-axial accelerometer. See Figure 4.1.

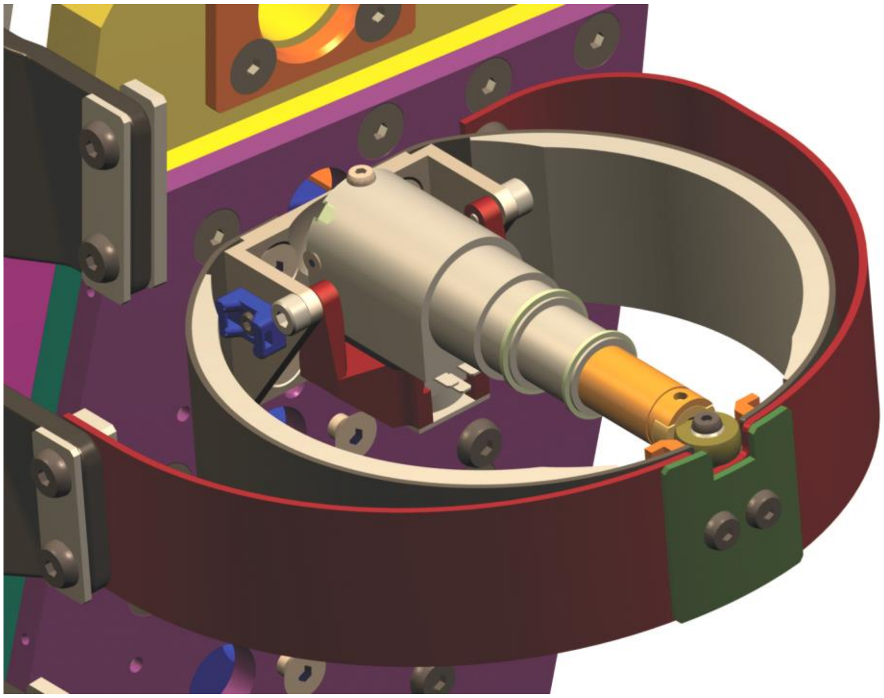


Figure 4.15 - WorldSID Rib Instrumentation

4.6.2 Spine Box Instrumentation

Note that the spine box includes mounting positions for two G5 DAS modules, one of which is shown in Figure 4.16. Note that for both of these, an interposer connector (see Figure 4.17) is attached to the mounting brackets, and the DAS module is plugged into this connector. Note that the connector for each DAS (see Figure 4.17), 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 4.18. Note 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 4.16 - G5 DAS Module

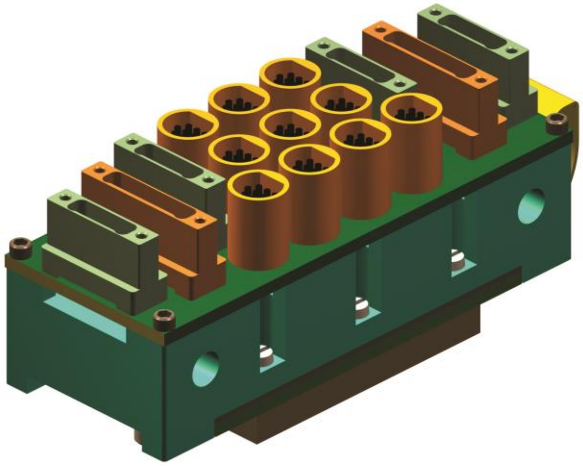


Figure 4.17 - Interposer Connector

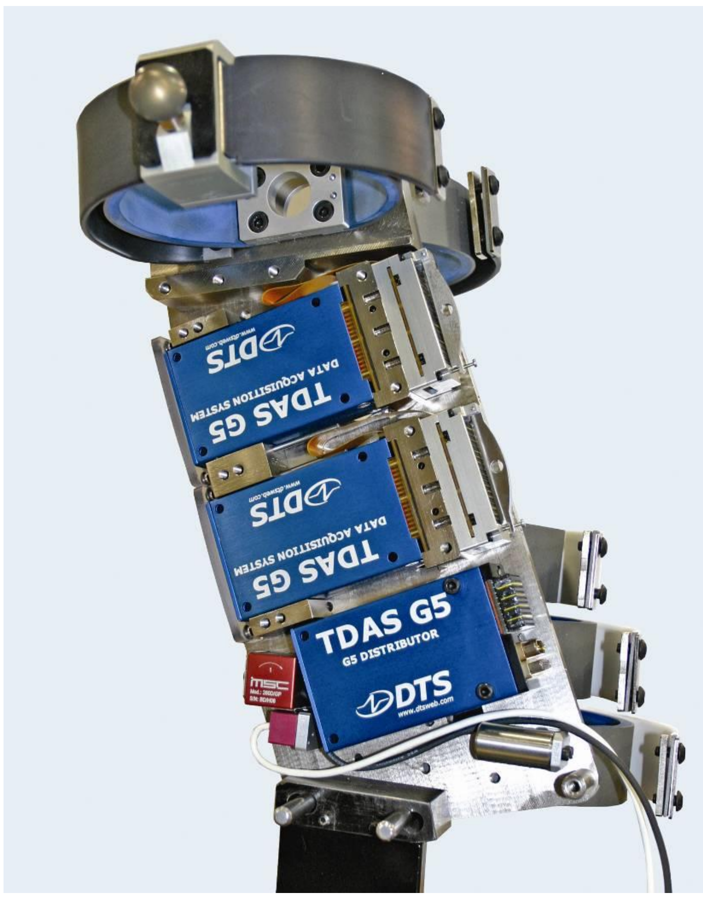


Figure 4.18 – Arrangement of DAS, interposer connector, and connector

Note that other instrumentation in the spine box includes a linear triaxial accelerometer, rotational accelerometer and a tilt sensor.

Section 5 - Arm Assembly

5.1 Arm

5.1.1 Parts List

Note that Table 5.1 lists the parts required for assembling the WorldSID 5th Arm, which are illustrated in Figure 5.1. Note that part numbers correspond to those on drawing W5-6000.Note that the WorldSID small female dummy is equipped with two identical L-R symmetric arm assemblies. The WorldSID small female revision1 (SBL B) was updated with new half arms (W5-6106), to meet anthropometric length and biomechanically based bone stiffness.

5.1.2 Arm Description and Specifications

The half arm assembly shall consist of the components and assemblies listed in arm assembly W5-6106.

Specifications:

- The arm assembly shall conform to half arm assembly drawing W5-6106 and the subassemblies and component drawings listed there in.
- The total assembly shall have a mass of 1.15 kg ± 0,05 kg.
- The materials used in the construction of the half arm assembly do not contain lead or lead alloys.
- The flesh material and/or external surface characteristics shall enable positive attachment of adhesive targets.

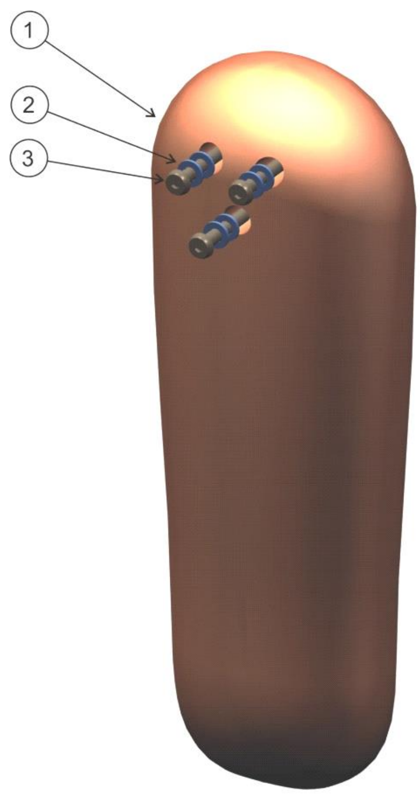


Figure 5.1 Half Arm Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-6107	ARM, MOLDED
2	6	5000586	WASHER, FLAT M5
3	3	W5-6103	SCREW,BHCS M5 X 0.8 X 30

Table 5.1 - Arm Assembly (W5-6106) Part List

5.2 Disassembling the Arm

Remove the arm from the shoulder by removing the three BHCS M5 x 30 and six washers.

5.3 Assembling the Arm

Assemble the arm in the reversed order of disassembly. Use two washers under each screw head. Tighten the three screws equally and lightly to achieve the required friction on the ball joint to just maintain the arm in horizontal position.

Section 6 – Pelvis Assembly

6.1 Pelvis Assembly

6.1.1 Parts List

Note that Table 6.1 lists the parts required for assembling the WorldSID Pelvis. Note that part numbers refer to those on drawing W5-4000.

6.1.2 Pelvis Assembly Description

The pelvis assembly shall consist of the components and assemblies listed in pelvis assembly drawing W5-4000. Please note that WorldSID small female Revision1 (SBL-B) uses updated lumbar bracket (W5-4041) and clamping plate (W5-4042) made of Tungsten to ballast the abdomen to the correct target mass. Please check that the correct parts are assembled.

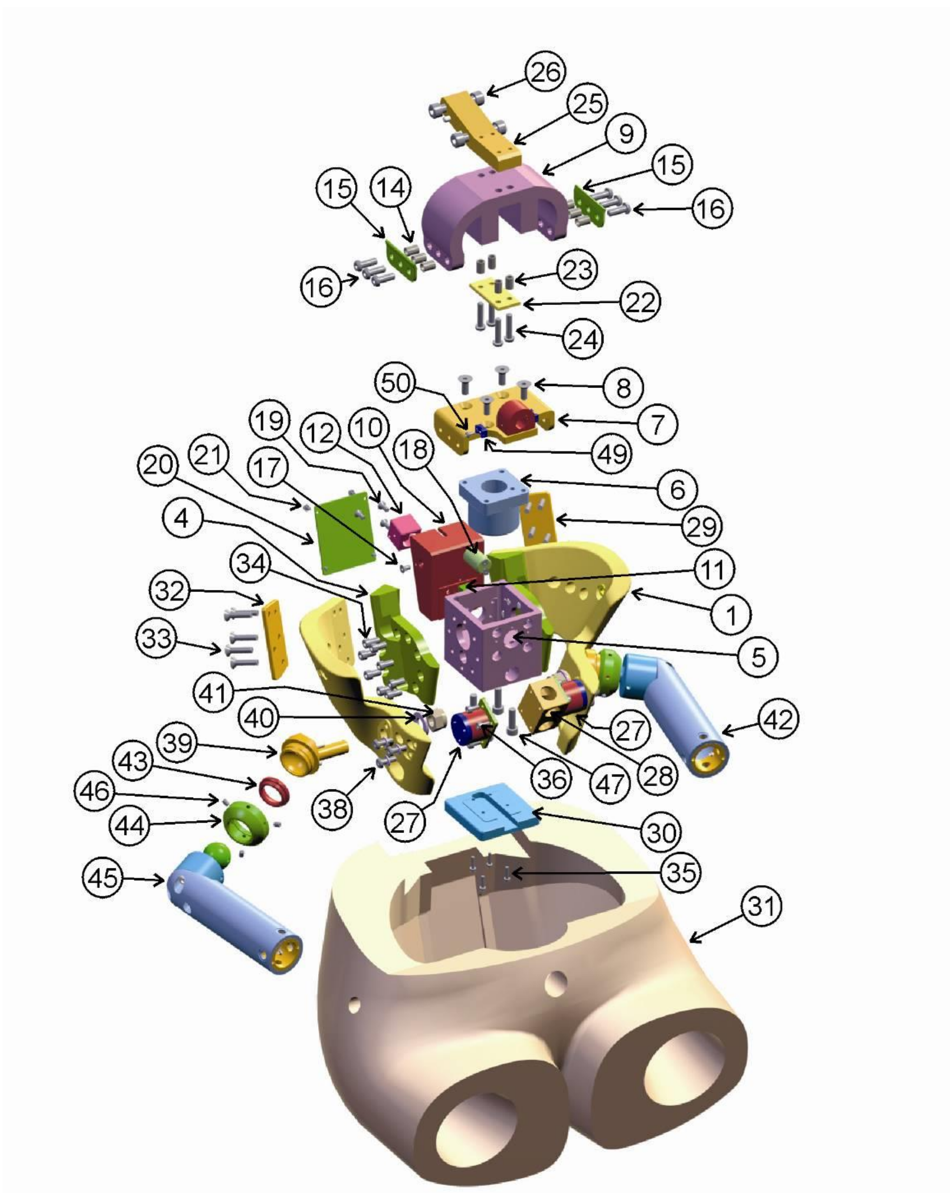


Figure 6.1 - Pelvis Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-4120-1	PELVIC BONE, LEFT
2	1	W5-4120-2	PELVIC BONE, RIGHT
3	1	W5-4010-1	INTERFACE BRACKET, LEFT
4	1	W5-4010-2	INTERFACE BRACKET, RIGHT
5	1	W50-71975	STRUCTURAL REPLACEMENT, SACROAC LOADCELL
6	1	W50-71122	STRUCTURAL REPLACEMENT, LUMBAR SPINE LOADCELL
7	1	W5-4020	WELDMENT, LOWER LUMBAR MOUNTING BRACKET
8	4	5000090	SCREW, FHCS M6 X 1 X 16
9	1	W5-4025	LUMBAR SPINE RUBBER
10	1	W5-4030	INSTRUMENTATION BRACKET PELVIS
11	1	7268C-M1	ACCELEROMETER, LINEAR TRIAXIAL, ENDEVCO 7268C-M1
12	1	W50-10011	TILT SENSOR STRUCTURAL REPLACEMENT (MSC 260D/GP-M)
13	1	W50-10010	ROTATIONAL ACCEL. REPLACEMENT, ENDEVCO 7302BM4
14	6	W5-4033	BUSHING, LUMBAR
15	2	W5-4031	CLAMPING PLATE, LOWER LUMBAR
16	6	5000465	SCREW, BHCS M6 X 1 X 18
17	1	5000646	SCREW, FHCS M4 X 0.7 X 8
18	2	5000116	SCREW, FHCS M3 X 0.5 X 8
19	3	5000023	SCREW, FHCS M4 X 0.7 X 10
20	1	W50-42031	INSTRUMENTATION COVER PLATE, PELVIS
21	4	5000674	SCREW, BHCS M3 X 0.5 X 5
22	1	W5-4042	CLAMPING PLATE, UPPER LUMBAR
23	4	W5-4034	BUSHING, LUMBAR, TOP
24	4		SCREW, FHCS M5 X 0.8 X 25
25	1	W5-4041	MOUNTING WEDGE, LUMBAR
26	4	5000209	SCREW, SHCS M8 X 1.25 X 18
27	2	W5-4110	PUBIC BUFFER, MOLDED
28	1	W50-71059	STRUCTURAL REPLACEMENT, PUBIC LOADCELL
29	1	W5-4038-1	CLAMP PLATE, PELVIC, LEFT
30	1	W5-4039	CABLE COVER, LUMBAR LOAD CELL
31	1	W5-4140	FLESH, PELVIS, MOLDED, TESTED & CERTIFIED
32	1	W5-4038-2	CLAMP PLATE, PELVIC, RIGHT
33	10	5000394	SCREW, FHCS M5 X 0.8 X 25
34	16	5000457	SCREW, SHCS M6 X 1 X 10
35	4	5000568	SCREW, SHCS M3 X .5 X 12
36	8	5000024	SCREW, SHCS M4 X .7 X 8
37	6	5000566	WASHER, FLAT M5 (5.3 ID 10.0 OD X 1.1 THK)
38	6	5000416	SCREW, BHCS M5 X 0.8 X 16
39	2	W5-4131	SOCKET ASSEMBLY, HIP JOINT
40	2	5000431	WASHER, FLAT M12 (13.0 ID X 24 OD X 2.4 THK)
41	2	5000462	NUT, LOCKNUT M12 X 1.75
42	1	W5-5150-1	FEMUR ASSEMBLY, LEFT
43	2	W50-42007	INNER RING HIP JOINT
44	2	W50-42008	HIP SOCKET RETAINER
45	1	W5-5150-2	FEMUR ASSEMBLY, RIGHT
46	6	5000464	SCREW, MSSFP M4 X 6
47	4	5000001	SCREW, SHCS M6 X 1 X 20
48	1	5000509	SCREW, SHCS M2 X 0.4 X 16
49	2	6002036	CABLE TIE MOUNT, #4 SCREW, NYLON
50	2	5000399	SCREW, BHCS M3 X 0.5 X 6

Table 6.1 - Pelvis Assembly (W5-4000) Part List

Figure 6.2 - Rear view of Pelvis Assembly

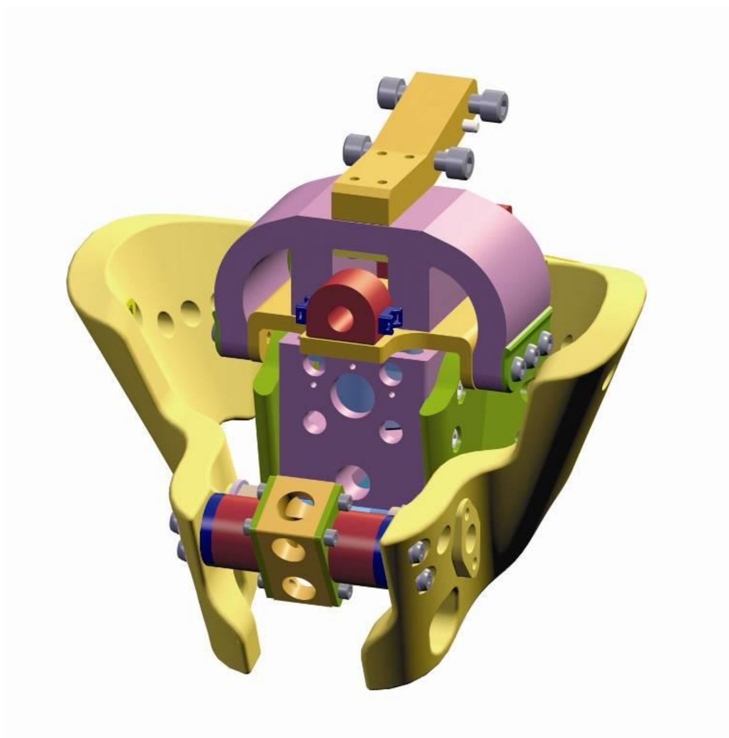


Figure 6.3 - Front view of Pelvis Assembly

6.1.3 Disassembling the Pelvis

As shown in Figure 6.4, remove the spine box (W5-3100) from the pelvis assembly by removing four SHCS M8 x 18 that connect it to the lumbar mounting wedge (W5-4037).

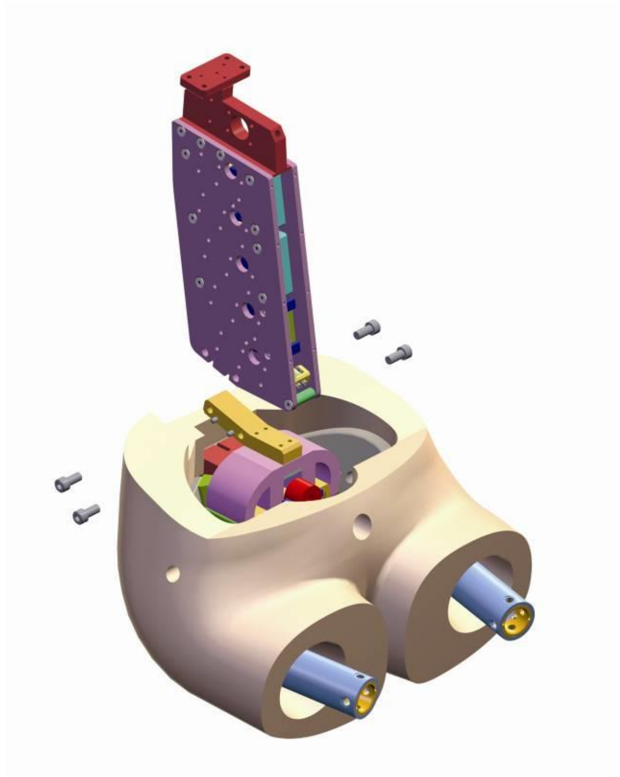


Figure 6.4 - Removing Spine Box from the Pelvis

Detach the femur assemblies by removing the locknut head screws M12 that attach each to the pelvis assembly (see Figure 6.5). Note that they are accessible from the interior of the pelvis bone and can be removed with a box end wrench.

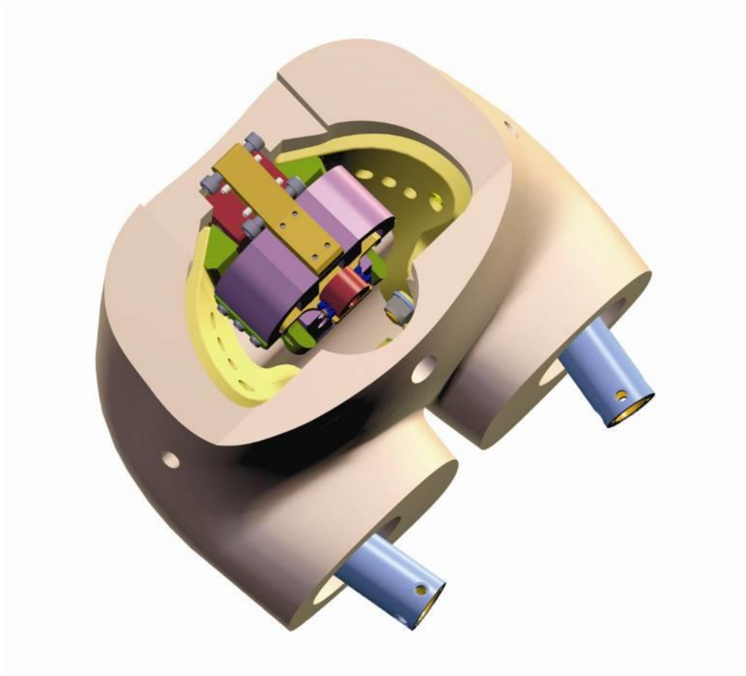


Figure 6.5 - Detaching the femur assemblies

Remove the pelvis flesh (W5-4140) by peeling it away from the pelvis bones (W5-4120-1/-2).

Figure 6.6 - Pelvis Flesh

As shown in Figure 6.7, remove the sacroiliac load cell backing plates (W5-4038-1/-2) by removing the FHCS M5 x 25 that secure them. Separate the two pelvis bones (W5-4120-1/-2), connected by the pubic buffers (W5-4110) and pubic load cell/structural replacement (W50-71059) from the lumbar instrumentation assembly.

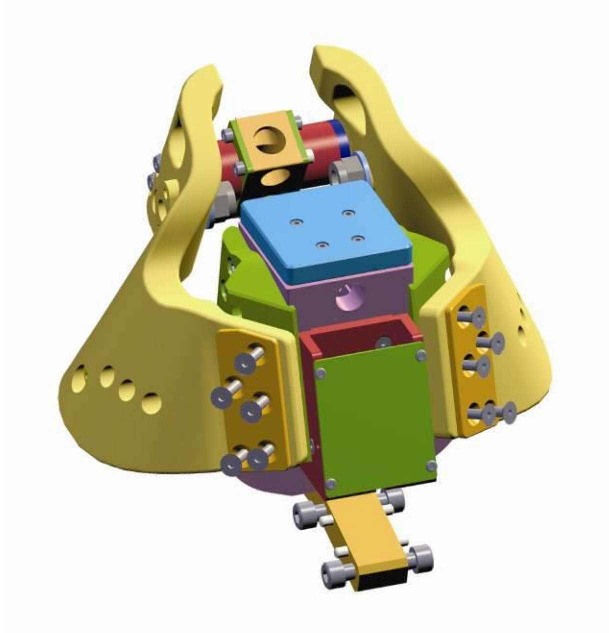


Figure 6.7 - Removing clamping plates to separate the pelvic bones

Detach the molded pubic buffers (W5-4110) from the molded pelvis by removing the BHCS M5 x 16 and M5 flat washers that hold each in place (see Figure 6.8).

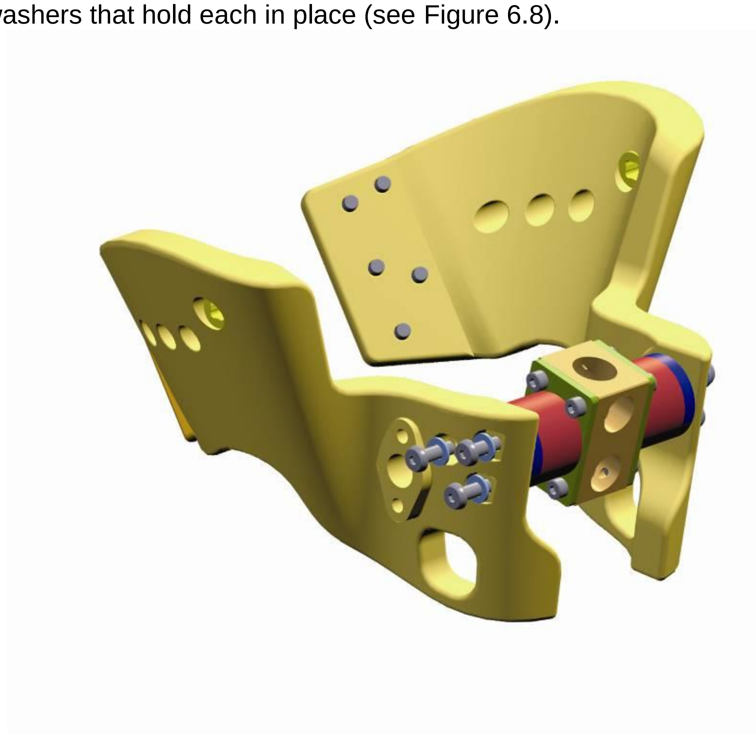


Figure 6.8 - Separating molded pelvis bone from the pubis assembly

Detach the pubic buffers (W5-4110) from the pubic load cell/structural replacement (W50-71059) by removing four SHCS M4 x 8 from each side, as shown in Figure 6.9.

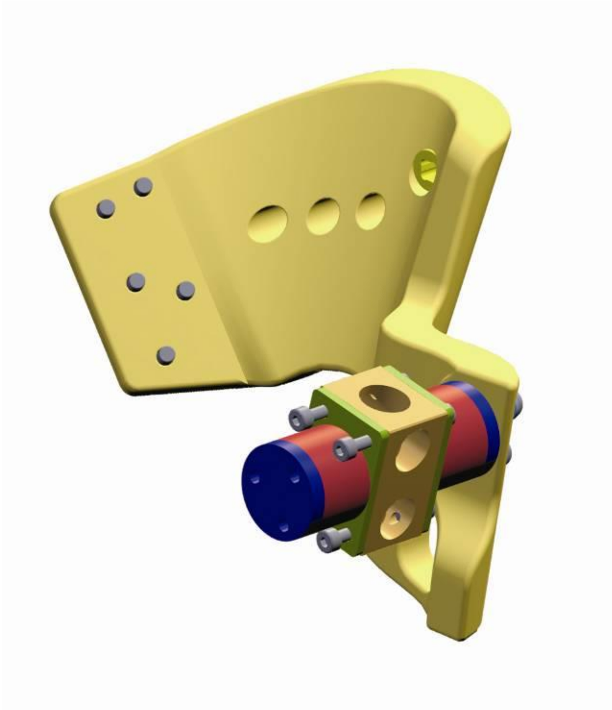


Figure 6.9 - Separating pubic buffers from pubic load cell structural replacement

As shown in Figure 6.10, detach the lumbar spine (W5-4025), remove the six BHCS M6 x 18 and six lumbar bushings (W5-4033) that attach it to the lower lumbar mounting bracket weldment (W5-4020). Remove the two lower lumbar clamping plates (W5-4031).

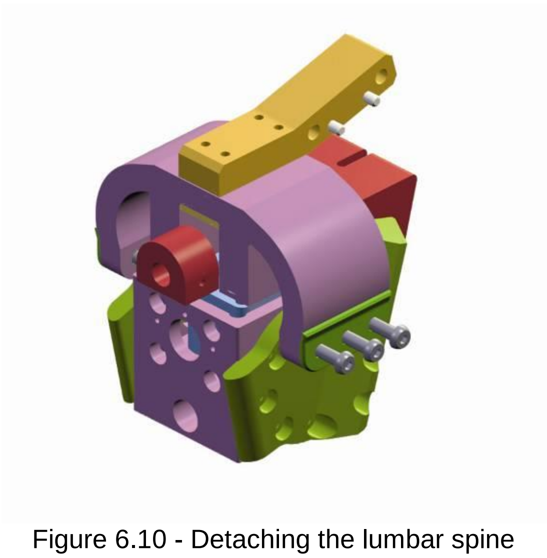


Figure 6.10 - Detaching the lumbar spine

Remove the upper lumbar clamping plate (W5-4032) from the lumbar spine by removing the four BHCS M5 x 25 that secure it (see Figure 6.11). Remove the lumbar mounting wedge (W5-4037).

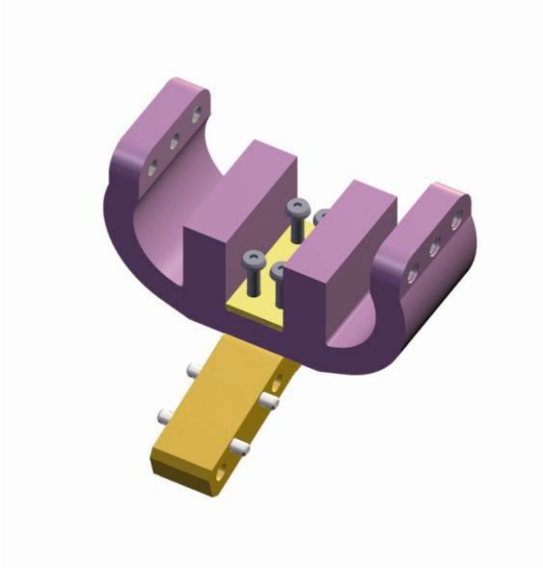


Figure 6.11 - Separating the upper lumbar clamping plate and lumbar mounting wedge

As shown in Figure 6.12, remove the lower lumbar mounting bracket weldment (W5-4020) from the lumbar load cell structural replacement (W50-71122) by removing four FHCS M6 x 16.

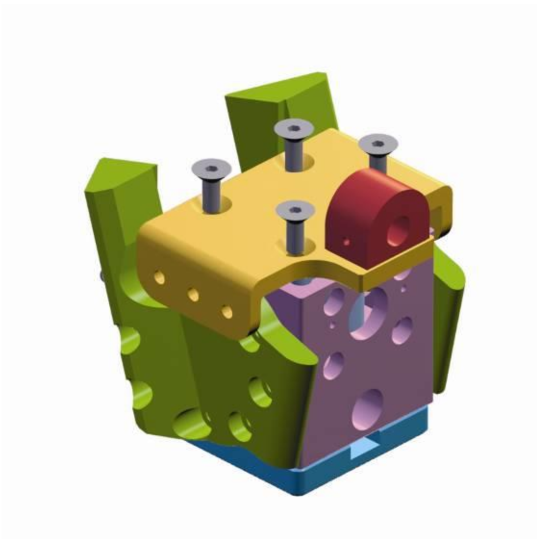


Figure 6.12 - Removing the lower lumbar mounting bracket weldment

Detach the left and right sacroiliac load cell interfaces (W5-4010-1/-2) by removing the eight SHCS M6 x 10 that hold each in place (see Figure 6.35).

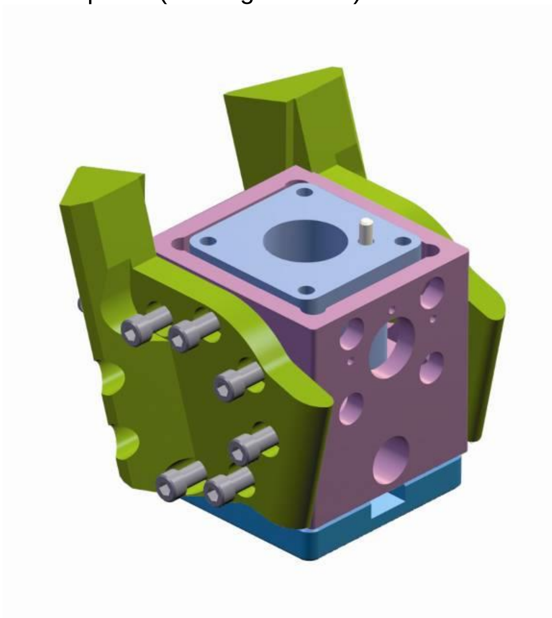


Figure 6.13 - Removing the sacroiliac load cell interface

As shown in Figure 6.14, remove the pelvis instrumentation cover plate (W50-42031) by removing four BHCS M3 x 5.

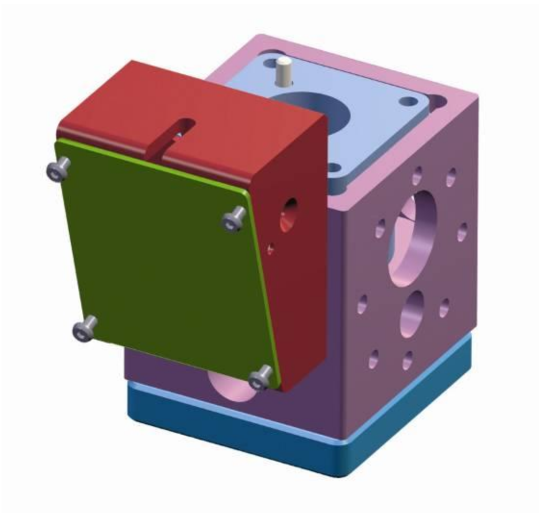


Figure 6.14 - Removing pelvis instrumentation cover plate

Detach the pelvis instrumentation bracket (W5-4030) from the sacroiliac load cell structural replacement by removing three FHCS M4 x 10 accessed from the back (see Figure 6.15).

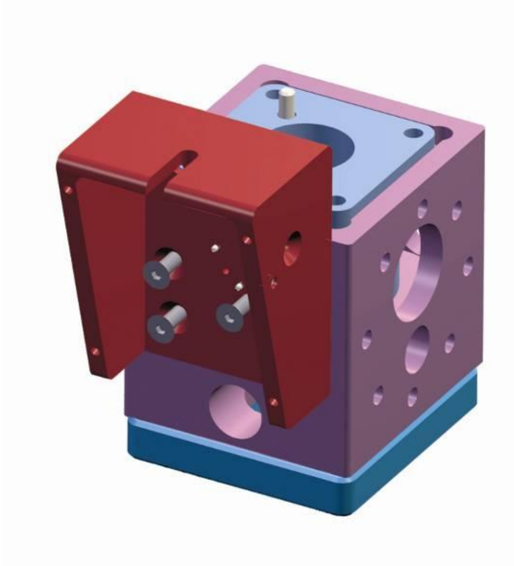


Figure 6.15 - Removing the pelvis instrumentation bracket

As shown in Figure 6.16, separate the structural replacements for the sacroiliac and lumbar spine load cells by removing the four SHCS M6 x 20 accessed from the bottom.

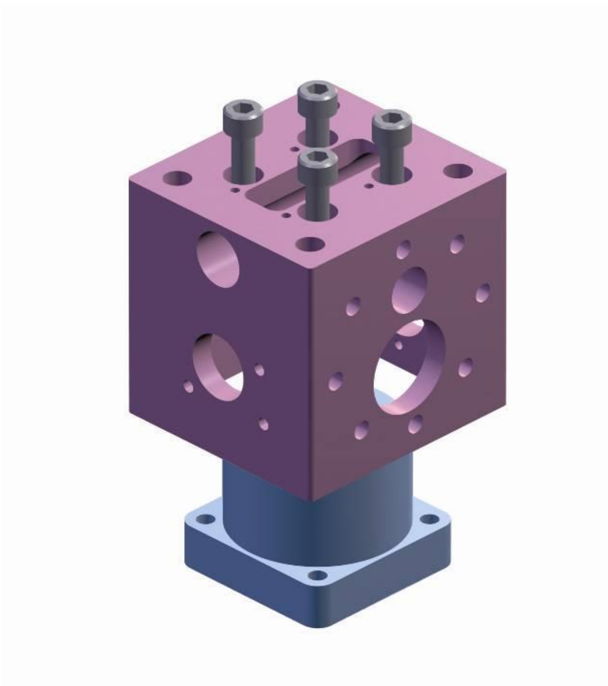


Figure 6.16 - Separating the sacroiliac and lumbar spine load cell structural replacements

6.1.4 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 5th Pelvis.

Join the lumbar spine load cell or its mass replacement to the sacroiliac load cell or its mass replacement using four SHCS M6 x 20.

Mount the linear triaxial accelerometer to the pelvis instrumentation bracket (W5-4030) using a SHCS M2 x 16 accessed from the back. Attach the dual-axis tilt sensor with an FHCS M4 x 8 accessed from the side. Secure the pelvis instrumentation bracket (W5-4030) to the sacroiliac load cell or its structural replacement with three FHCS M4 x 10. Mount the pelvis instrumentation cover plate (W50-42031) with four BHCS M3 x 5. Ensure that the wires for the accelerometer and tilt sensor exit the slot in the top of the instrumentation bracket. Route the accelerometer wire over the non-struck sacroiliac load cell interface towards the front of the dummy.

Attach the left and right sacroiliac load cell interfaces (W5-4010-1/-2) with eight SHCS M6 x 10 that holds each in place. Connect the lumbar mounting bracket weldment (W5-4020) to the lumbar load cell or its structural replacement with four FHCS M6 x 16. Place the lumbar mounting wedge (W5-4041) 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 (W5-4042) over the holes in the lumbar spine, with chamfers facing down and secure it with four BHCS M5 x 25 and top lumbar bushings (W5-4034). At this point also connect the first 6mm eyelet of the grounding wire according Figure 6.19 with one of the front screw heads.

Place the assembled lumbar spine (W5-4025) over the lumbar mounting bracket (W5-4020). Position a lower lumbar clamping plate (W5-4031) over the holes in the side of the lumbar spine so the curve of the plate matches the curve in the rubber. Secure the lumbar spine and clamping plate to the mounting bracket with three BHCS M6 x 18 and three lumbar bushings (W5-4033). Use one of the screws to connect the ground wire 6mm eyelet to the sacrum. Repeat the procedure for the other side of the lumbar spine.

Connect the pubic buffers (W5-4110) to the pubic load cell or its structural replacement with four SHCS M4 x 8 on each side. Attach the molded pubic buffers (W5-4110) to the molded pelvis with three BHCS M5 x 16 and three M5 flat washers on each side. At this point also assemble the grounding wire to the pubic load cell according fig. 6.19 with the 5mm eyelet. Position the central assembled portion of the pelvis within the molded pelvis (pubic assembly). Attach each clamping plate (W5-4038-1/-2) with five FHCS M5 x 25.

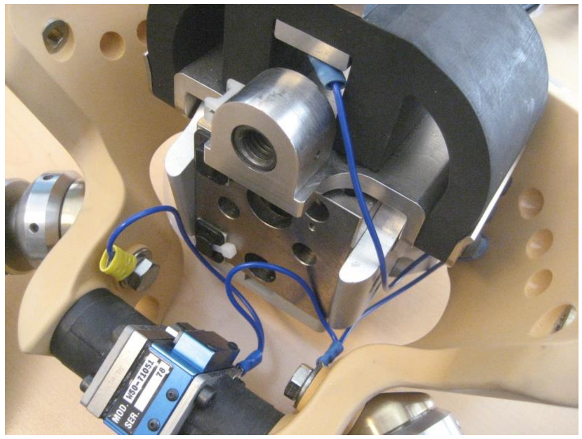


Figure 6.17 - Grounding wire connecting lumbar bracket, sacrum assembly, left and right femur and pubic load cell.

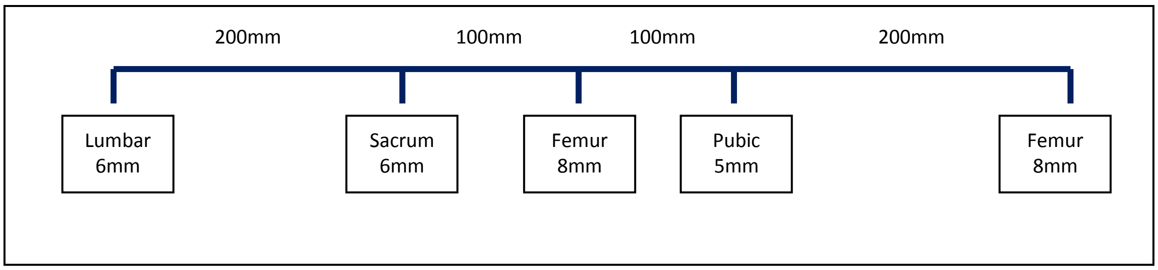


Figure 6.18 - Ground wire assembly eyelet size and wire lengths

If the pelvis DAS module is being used, plug in the connectors for the lumbar, pubic, and sacroiliac load cells and the pelvis triaxial accelerometer (see Figure 6.19). Make sure the connectors for the tilt sensor are free so they can be connected to the off-board readout later. If a pelvis DAS is not used, route the wires toward the front along the non-struck side so they can be plugged into the lower G5 module on the spine box.

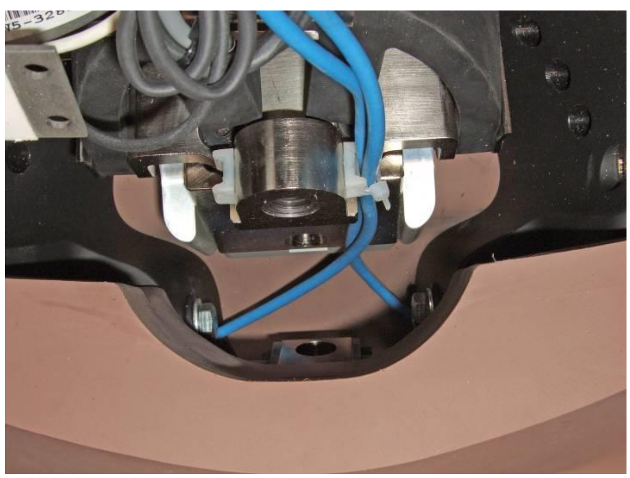


Figure 6.19 – Routing of wires for pelvis instrumentation

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 femur assembly, apply grease to the hip joint inner ring (W50-42007) and hip joint socket (W5-4131) before tightening the hip socket retainer (W50-42008). Insert the femur assembly through the front access hole in the pelvis flesh. Secure from the inside of the pelvis with a hexagon head screw M8x16mm, one of the 8mm eyelets of the ground wire and the 8.4mm flat washer. Rotate the ground wire eyelet pointing down and tighten the screw with a 13mm box spanner. Repeat for other side femur. Place the assembled spine box (W5-3100) over the lumbar wedge (W5-4037) and secure with four SHCS M8 x 18 (see figure 6.1).

6.2 Parts for Femur Assembly

Note that Table 6.2 lists the parts required for assembling the WorldSID 5th Femur Assembly, w which is illustrated in Figure 6.20. There left and right femurs are not identical. The left femur is marked W5-5155-1 and the right femur is marked W5-5155-2.

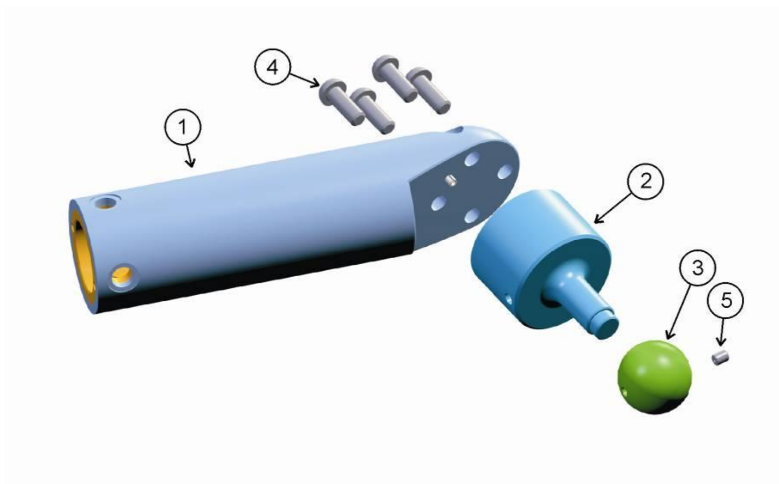


Figure 6.20 - Femur Assembly

ITEM	QTY	PART NO.	DESCRIPITION
1	1	W5-5155-1	FEMUR TUBE ASSEMBLY, LEFT
2	1	W5-5152	STRUCTURAL REPLACEMENT, FEMUR LOADCELL
3	1	W50-51038	FEMUR BALL
4	4	5000072	SCREW, BHCS M6 X 1 X 16
5	1	5000406	SCREW, SSCP M4 X 0.7 X 5

Table 6.2 - Femur Assembly Left (W5-5150-1) Part List

ITEM	QTY	PART NO.	DESCRIPITION
1	1	W5-5155-2	FEMUR TUBE ASSEMBLY, RIGHT
2	1	W5-5152	STRUCTURAL REPLACEMENT, FEMUR LOADCELL
3	1	W50-51038	FEMUR BALL
4	4	5000072	SCREW, BHCS M6 X 1 X 16
5	1	5000406	SCREW, SSCP M4 X 0.7 X 5

Table 6.2 - Femur Assembly Right (W5-5150-2) Part List

6.2.1 Disassembling the Femur

Disassemble the femur assembly by loosening the SSCP M4 x 5 that holds the femur ball in place and unthread the ball (W50-51038) from the femur load cell/structural replacement. 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 femur load cell/structural replacement. Be careful not to damage the surface of the ball during disassembly and re-assembly. Remove the four BHCS M6 x 16 that attach the assembly to the femur load cell/structural replacement. Note that these screws can be removed without removing the ball using a modified hex key wrench (W50-51003).

6.2.2 Assembling the Femur

Thread the femur ball onto the femur load cell/structural replacement until tight. Tighten the ball onto 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 femur load cell/structural replacement . Be careful not to damage the surface of the ball during disassembly and re-assembly. Secure the ball by tightening the SSCP M4 x 5 to 2 N·m torque.

6.2.3 Instrumentation Mounting

Note that the pelvis instrumentation for the WorldSID includes pubic, sacroiliac, and lumbar spine load cells. Note that the pelvis instrumentation cavity can be equipped with a linear triaxial accelerometer and a dual-axis tilt sensor and a rotational acceleration sensor in x direction.

Section 7 – Full Leg Assembly

7.1 Full Leg Assembly

Note that the full leg assembly includes the knee assembly, the femur flesh (Left W5-5010-1, Right W5-5010-2) and DAS structural replacement W5-5021 and the lower leg assembly. The left and right knees are not identical. The left knee is marked W5-5120-1 and the right knee is marked W5-5120-2. The TDAS G5 structural replacement should always be kept in the thigh flesh during testing to assure the correct thigh mass.

7.2 Parts for Knee Assembly

Note that Table 7.1 lists the parts required for assembling the WorldSID 5th Knee Assembly, which is illustrated in Figure 7.1.

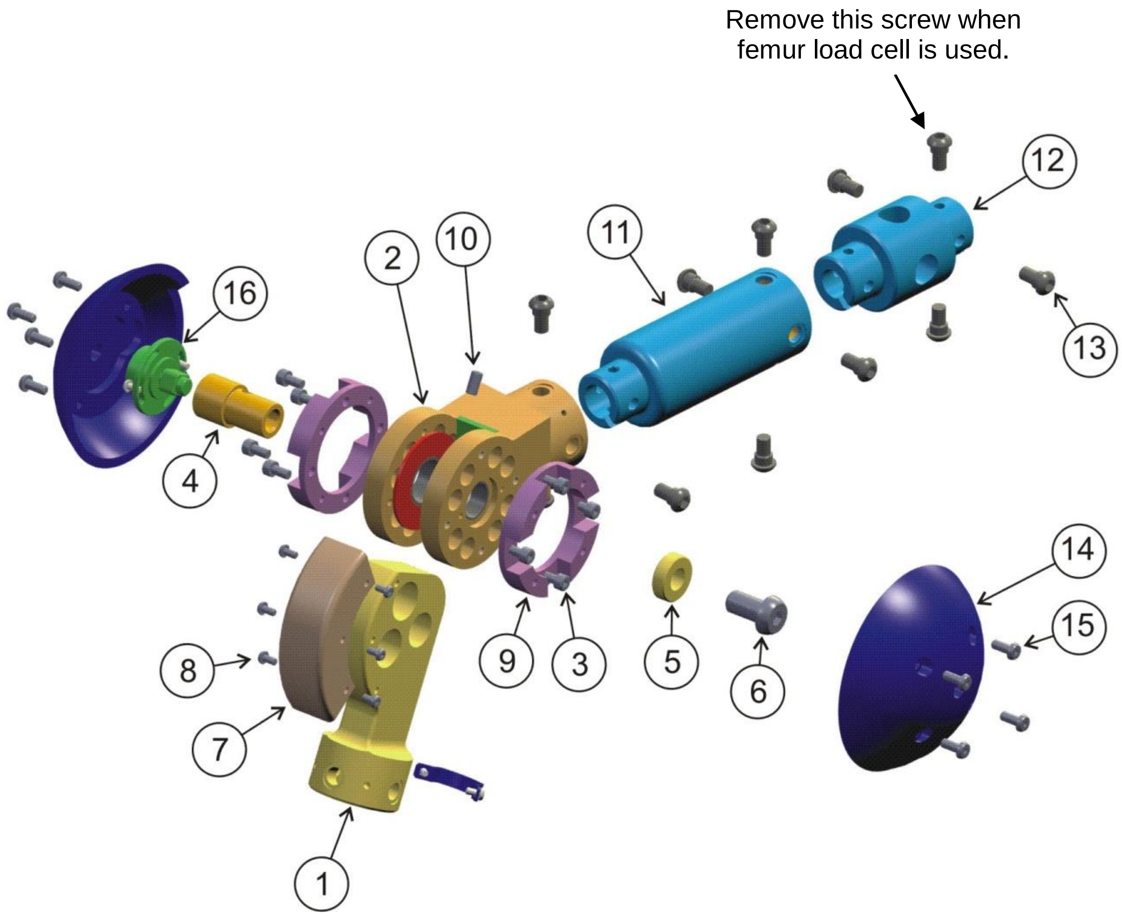


Figure 7.1 - Knee Assembly

ITEM	QTY	PART NO.	DESCRIPITION
1	1	W5-5130	KNEE BONE
2	1	W5-5120-1	KNEE CLEVIS, ASSEMBLY, LEFT
3	2	W50-52015	STRUCTURAL REPLACEMENT KNEE CONTACT LC
4	1	W5-5101	KNEE PIVOT SHAFT
5	1	5000681	BEARING, THRUST, 10MM I.D, MCM #6655K55
6	1	5000539	SCREW, BHCS M10 X 1.5 X 20
7	1	W5-5111	KNEE PAD, MOLDED
8	12	5000399	SCREW, BHCS M3 X 0.5 X 6
9	8	5000024	SCREW, SHCS M4 X .7 X 8
10	1	5000550	SCREW, SSCP M5 X 0.8 X 10
11	1	W5-5105	LEG EXTENSION TUBE ASSEMBLY, WSID 5TH
12	1	W50-61041	STRUCTURAL REPLACEMENT, UNIVERSAL LEG LOAD CELL
13	12	W50-61042	BUTTON HEAD SHOULDER SCREW, NON STANDARD
14	2	W5-5125	KNEE COVER
15	8	5000010	SCREW, BHCS M4 X 0.7 X 10
16	1	W50-61027	ROTARY POTENTIOMETER (REF)
Not Shown	1	W5-5010-1	FEMUR FLESH LEFT
	1	W5-5021	TDAS G5 FEMUR STRUCTURAL REPLACMENT

Table 7.1 - Knee Assembly Left (W5-5100-1) Part List

ITEM	QTY	PART NO.	DESCRIPITION
1	1	W5-5130	KNEE BONE
2	1	W5-5120-2	KNEE CLEVIS, ASSEMBLY, RIGHT
3	2	W50-52015	STRUCTURAL REPLACEMENT KNEE CONTACT LC
4	1	W5-5101	KNEE PIVOT SHAFT
5	1	5000681	BEARING, THRUST, 10MM I.D, MCM #6655K55
6	1	5000539	SCREW, BHCS M10 X 1.5 X 20
7	1	W5-5111	KNEE PAD, MOLDED
8	12	5000399	SCREW, BHCS M3 X 0.5 X 6
9	8	5000024	SCREW, SHCS M4 X .7 X 8
10	1	5000550	SCREW, SSCP M5 X 0.8 X 10
11	1	W5-5105	LEG EXTENSION TUBE ASSEMBLY, WSID 5TH
12	1	W50-61041	STRUCTURAL REPLACEMENT, UNIVERSAL LEG LOAD CELL
13	12	W50-61042	BUTTON HEAD SHOULDER SCREW, NON STANDARD
14	2	W5-5125	KNEE COVER
15	8	5000010	SCREW, BHCS M4 X 0.7 X 10
16	1	W50-61027	ROTARY POTENTIOMETER (REF)
Not Shown	1	W5-5010-2	FEMUR FLESH RIGHT
	1	W5-5021	TDAS G5 FEMUR STRUCTURAL REPLACMENT

Table 7.2 - Knee Assembly Right (W5-5100-2) Part List

7.3 Parts for Lower Leg Assembly

Note that Table 7.2 lists the parts required for assembling the WorldSID 5th Lower Leg Assembly, which is illustrated in Figure 7.2. The left and right lower leg assemblies are identical. Only the foot is Left or Right.

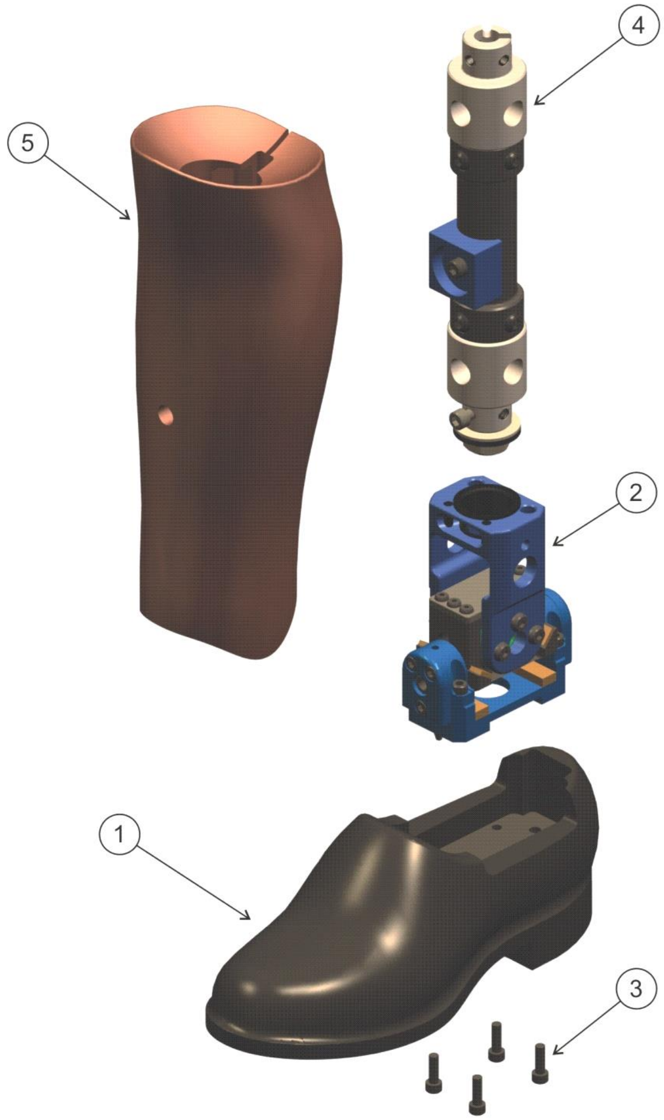


Figure 7.2 - Lower Leg Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-5504	SHOE, LEFT
2	1	W5-5454	ANKLE ASSEMBLY
3	4	5000020	SCREW, SHCS M5 X .8 X 16
4	1	W5-5453	LOWER LEG ASSEMBLY
5	1	W5-5302	LOWER LEG FLESH

Table 7.3 – Lower Leg Assembly, Left (W5-5456) Part List

7.4 Parts for Ankle Assembly

Note that Table 7.3 lists the parts required for assembly of the WorldSID 5th Ankle, which is illustrated in Figure 7.3.

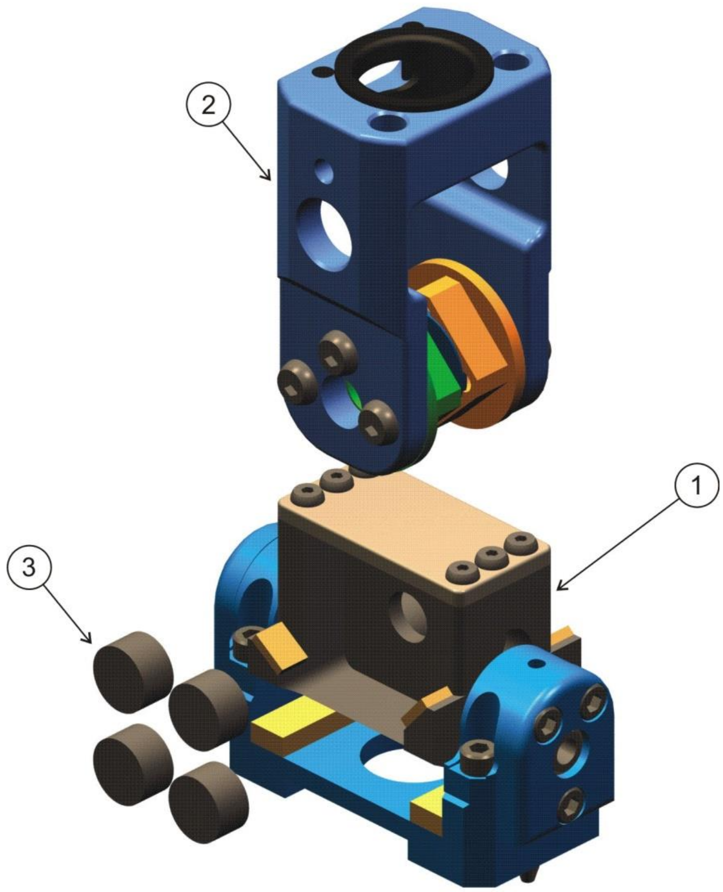


Figure 7.3 - Ankle Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	W5-5446	X-VERSION ASSEMBLY
2	1	W5-5450	Y-VERSION ASSEMLBY
3	1	W5-5436	RESISTIVE ELEMENT FOR DORSIFLEXION & PLANTARFLEXION

Table 7.3 - Ankle Assembly (W5-5454) Part List

7.5 Disassembling

7.5.1 Knee

Detach the lower leg assembly by removing the four modified BHCS (W50-61042) that attach the knee assembly to the leg load cell at the upper tibia position.

Remove the knee covers (W5-5125) by removing the four BHCS M4 x 10 holding each cover in place. Remove the potentiometer assembly (W50-61027) by taking out the BHCS M3 x 6 at each side of the potentiometer. Note that the knee contact load cell structural replacement (Figure A.75, Item 3) is positioned directly beneath the knee cover and is removed by taking out four SHCS M4 x 8 for each load cell.

Remove the knee bone (W5-5130) by taking out the SSCP M5 x 10. Remove the BHCS M10 x 20 and the M10 thrust bearing.

Remove the knee pivot shaft (W5-5101) by sliding it out of the assembly. Slide the knee bone (W5-5130) out of the knee clevis assembly (W5-5120-1/-2). Remove the knee pad (W5-5111) from the knee bone by taking out the BHCS M3 x 6 (three on each side) that hold it in position. Inspect the knee pad for tearing and/or cuts in the material.

7.5.2 Lower Leg

Remove the lower leg flesh (W5-5302). Remove the radial limit screw (W50-54041) which connects the ankle (W5-5454) and the lower leg (W5-5453). Remove the four, SHCS M5 x 16 that attaches the foot (W5-5504) and the ankle (W5-5454).

7.5.3 Ankle

Remove six BHCS M6 x 16 from the Y-version ankle assembly (W5-5450) to the X-version ankle assembly (W5-5446), this will detach the two assemblies and the eight resistive elements for dorsiflexion and plantarflexion (W5-5436).

7.6 Assembling

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 5th leg.

7.6.1 Knee

To assemble the knee, start by placing the knee bone (W5-5130) in the knee clevis (W5-5120-1/-2) and push the knee pivot shaft (W5-5101) into the pivot hole. Align the shaft-locking hole with the SSCP M5 x 10. Tighten the SSCP M5 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 M10 thrust bearing. Secure them with a BHCS M10 x 20, 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. Insert the two BHCS M3 x 6 into the potentiometer and thread them into the knee clevis. Tighten these two BHCS M3 so that the potentiometer body is secure and will not rotate.

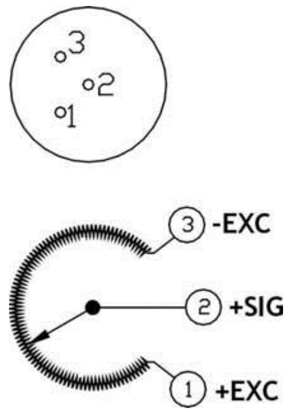


Figure 7.4 – Knee potentiometer wiring

Attach the knee contact load cell, using four SHCS M4 x 8 for each load cell. 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 N·m, using the M4 “star” pattern (see Figure 7.4) so as to distribute the load equally across the load cell.

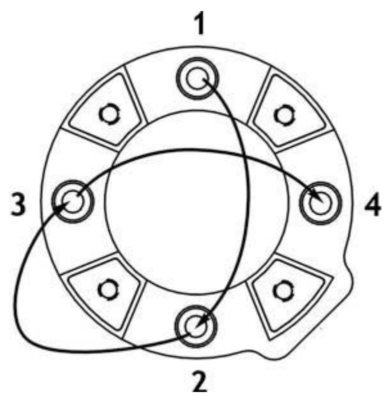


Figure 7.5 – Knee potentiometer installation

Attach the knee covers (W5-5125) and pad (W5-5111). Attach the knee covers directly to the knee contact load cells with four BHCS M4 x10. Re-attach the knee covers using the same “star” pattern as the knee contact load cell (see Figure 7.4). Check that the notch on the knee cover is in line with the extension tube (W5-5105). Attach the knee pad (W5-5111) using six BHCS M3 x6.

7.6.2 Lower Leg

Starts with the lower leg (W5-5453), attach it to the ankle (W5-5454) with a radial limit screw (W50-54041). Attach the shoe (W5-5504) to the ankle using four, SHCS M5 x 16. Next attach the lower leg flesh (W5-5302) over the assembly.

7.6.3 Ankle

Position the eight resistive elements in the X-version ankle assembly (W5-5446). Slide the Y-version (W5-5450) over it and attach it with the six BHCS, M6 x 16.

Section 8 – Suit Assembly

8.1 Suit Assembly

8.1.1 Parts list for Suit

The part number for the WorldSID 5th suit is W5-8202. This part was update in revision 1 dummy (SBL B). The updated suit can be recognized by the red fabric on the inside of the sleeve (arm pit). The prototype version had neoprene inside sleeve.

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8.1.2 Disassembly

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

8.1.3 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.

Section 9 - Certification Test Procedures

9.1 Head Test

9.1.1 Principle

Certify the dynamic response of a head assembly by performing a 200 mm lateral drop on each side of the head and a 376 mm drop on the forehead.

9.1.2 Apparatus

- 49 CFR Part 572, Subpart E, horizontal head impact surface
    - Chrome plated rigidly supported horizontal steel plate
    - 50.8 mm x 610 mm x 610mm
    - 8 – 80 rms micron/mm surface finish
- Head drop tool assembly (drawing W50-82100)
- Instrumented head assembly (drawing W5-1000) including the instrumentation insert and upper neck load cell or structural replacement
- Two SHCS M6 x 12

9.1.3 Sensors

Use triaxial linear accelerometers.

9.1.4 Preparation

- Expose the head assembly to an environment with a temperature of 21.4º C ± 0.8º C and a relative humidity between 10% and 70% for a period of at least four hours prior to a test.
- Clean the head skin surface and the surface of the impact plate with 1, 1, 1 trichlorethane or equivalent.
- Install the triaxial accelerometer in the head assembly.
- Install the upper neck load cell, angular accelerometers and dual-axis tilt sensor, or their structural or mass replacements.
- Attach the head drop tool to the bottom of the upper neck load cell or its structural replacement with two SHCS M6 x 12. Mount the tool for left or right lateral or frontal drops as shown in Figures 9.1, 9.2, 9.3 and 9.4. When mounted for lateral drops, position the head such that its midsagittal plane has an angle of 35° ± 1° with the impact surface and its anterior-posterior axis is horizontal to within 1 degree.
- Suspend the head above the drop table using the head drop tool and a quick release mechanism.
- For lateral tests, position the head so its lowest point is 200 mm ± 0, 25 mm above the impact surface and drop the head.
- For a frontal test, position the head so the lowest point on the forehead is 376 mm ± 0.25 mm above the impact surface.

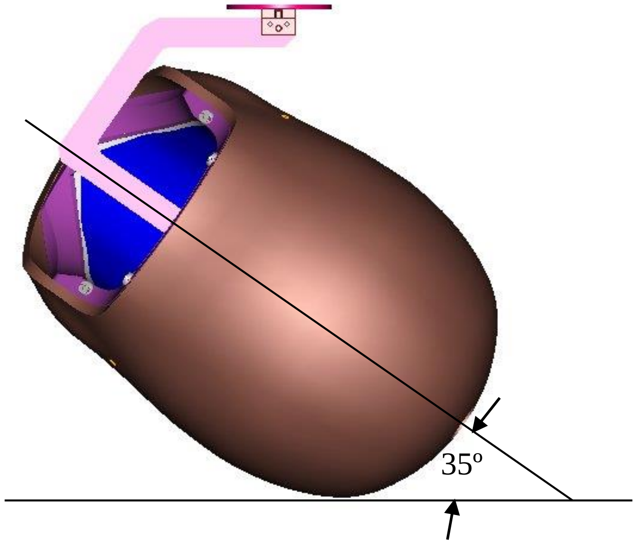


Figure 9.1 — Lateral head drop angle (Ref. Only)

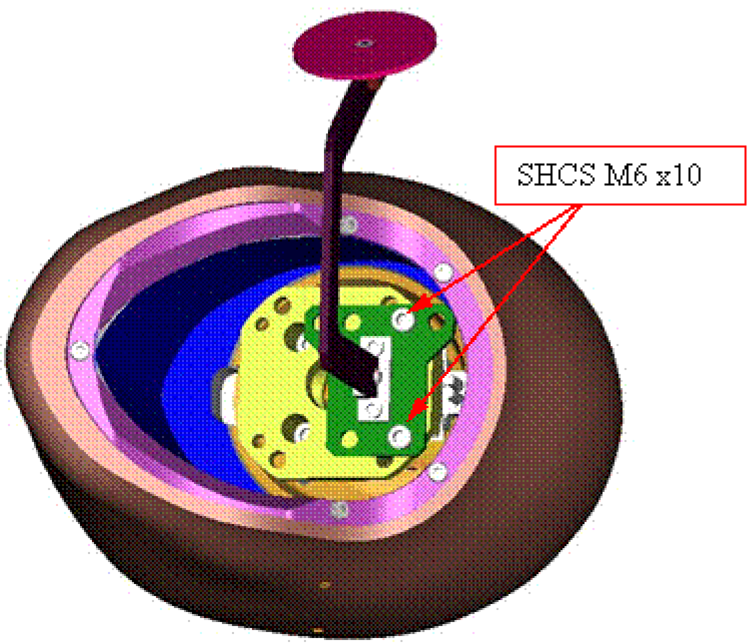


Figure 9.2 — Head bracket installation for lateral drops (Ref. Only)

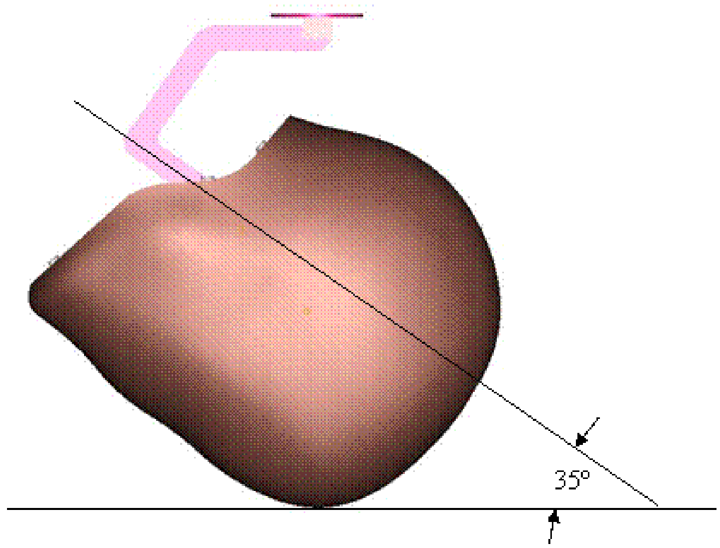


Figure 9.3 — Frontal head drop angle (Ref. Only)

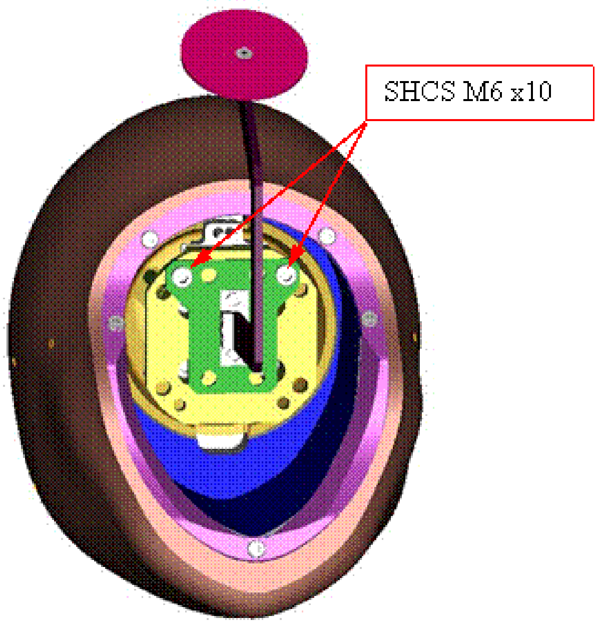


Figure 9.4 — Head bracket installation for frontal drops (Ref. Only)

9.1.5 Procedure

- Record and filter the head accelerations from the triaxial accelerometer according to SAE J211 and ISO 6487 Channel filter class 1000.
- Drop the head onto the rigid plate from the specified height by means that ensure quick release.
- Visually inspect the head for damage to the skin or skull, and note any such damage in the test report.
- Allow at least 2 hours between successive tests on the same head.

9.1.6 Test Report

Document the results of both the left and right lateral and the frontal drop tests. The performance shall meet the specifications as defined in Table 9.1.

Frontal Drop	
Variable	Absolute value
Peak resultant acceleration (G)	250 to 300
Peak lateral acceleration (a_y) (G)	<15
Maximum percentage, subsequent-to-main peak (%)	<10
Lateral Drop	
Variable	Absolute value
Peak resultant acceleration at CG (G)	124 to 149
Peak longitudinal acceleration (a_x) (G)	<15
Maximum percentage, subsequent-to-main peak (%)	<10

Table 9.1 — WorldSID head certification specifications

9.2 Neck Test

9.2.1 Principle

Certify the dynamic response of the neck assembly by performing lateral pendulum tests.

9.2.2 Materials

For the pendulum stop, use aluminum honeycomb, of density 28.8kg/m^3 ± 4.90kg/m^3 and dimensions 102 mm minimum x 102 mm minimum with a thickness along the cells of 76.2 mm ± 4 mm or alternative products which can be shown to lead to the same results.

9.2.3 Apparatus

- Neck assembly as specified in drawing W5-2000
- WorldSID head form (drawing W5-8600)
- Neck pendulum apparatus as specified in 49CFR Part 572, Subpart E

9.2.4 Sensors

Perform the test using the sensors given in Table 9.2.

Variable	Sensor	Performance
Pendulum acceleration	Single axis accelerometer Endevco 7231C-750[a]	SAE J2570
Pendulum velocity	Not specified	Resolution 0.02m/s or better
Angular displacement of forward pendulum-to-head form sliding rod, positive when doing a right side impact (θ_F)	Angular potentiometer	SAE J2570
Angular displacement of rearward pendulum-to-head form sliding rod, positive when doing a right side impact (θ_R)	Angular potentiometer	SAE J2570
Angular displacement of head form about forward pendulum-to-head form sliding rod, positive when doing a right side impact (θ_H)	Angular potentiometer	SAE J2570
Neck moment M_x	Upper neck load cell	SAE J2570
Neck force F_y	Upper neck load cell	SAE J2570
a Accelerometer model 7231C-750 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.		

Table 9.2 — Sensors for neck assembly

9.2.5 Preparation

Expose the neck to the conditions specified in Table 9.3 for at least four hours prior to a test.

Variable	Specification
Temperature (degrees C)	21.4 ± 0.8
Relative humidity (%)	40 ± 30

Table 9.3 — Neck test preconditions

- Attach the top of the neck to the head form.
- Attach the bottom of the neck to the pendulum interface. Ensure that the screws do not protrude into the neck rubber as this may influence the response. If the screws are too long, insert washers under the head of the screw in order to prevent rubber contact. Mount the pendulum interface to the pendulum such that the head form’s midsagittal plane is vertical and is perpendicular to the plane of motion of the pendulum’s longitudinal centerline.
- Slide the carbon fiber rods through the potentiometer housings on the pendulum. First slide the pivot of the potentiometer closest to the pendulum over the central steel rod in the head form, then install the small spacer ring and the second pivot. Carefully tighten the second pivot.

9.2.6 Procedure

- Record and filter the data according to Channel filter class 1000.
- Release the pendulum and allow it to fall freely from a height such that the velocity at impact is 3.4m/s ± 0.1m/s, measured at the centre of the pendulum mounted accelerometer.
- Decelerate the pendulum arm using the 28.8kg/m^3 aluminum honeycomb or alternative products which can be shown to lead to the same results, to achieve the pendulum pulse given in Table 9.4.
- Allow the neck to flex without impact of the head or neck with any object other than the pendulum arm.
- Conduct the test such that the time between raising the pendulum and releasing it does not exceed 5 minutes.
- Conduct the test such that the time between any tests on the same WorldSID neck is not less than 30 minutes.

Variable	Value
Velocity change at 4 ms[a]	0.77m/s to 1.04m/s
Velocity change at 8 ms[a]	1.60m/s to 2.16m/s
Velocity change at 12 ms[a]	2.43m/s to 3.29m/s
a T=0 s at initial contact with honeycomb or alternative products which can be shown to lead to the same results.	

Table 9.4 — Pendulum arm deceleration pulse

9.2.7 Calculation Procedures

- Filter the data as given in Table 9.5.
- Integrate the filtered and adjusted acceleration time histories.
- Calculate the flexion angle of the head form using the following equation:

$$\beta = \theta_F + \theta_H$$

where:

β = angular displacement of head form relative to the pendulum

θ_F = Angular displacement of forward pendulum-to-head form sliding rod, positive when doing a right side impact

θ_H = Lateral angular displacement of head form about forward pendulum-to-head form sliding rod, positive when doing a right side impact

- After performing this calculation, digitally filter all angular displacements using ISO 6487 or SAE J211 CFC 180
- Calculate the moment about the occipital condyle as $M_{OCx} = M_X + (F_y) \times (0.0195\text{m})$, where the M_X and F_y polarities are in accordance with the SAE J211 sign convention.

Variable	Filters[a]
Pendulum acceleration	CFC 60
Pendulum velocity	No digital filtering
Angular displacement of forward rod (θ_F)	CFC 1000
Angular displacement rear rod (θ_R)	CFC 1000
Angular displacement of head form (θ_H)	CFC 1000
Neck moment M_x	CFC 600
Neck force F_y	CFC 1000
a ISO 6487 or SAE J211	

Table 9.5 — Filter specification for neck test

9.2.8 Test Reports

Document the results of the test. The performance shall meet the specifications as defined in Table 9.6.

Variable	Absolute value
Maximum angular displacement of the head form relative to the pendulum, β (degrees)	58.5 to 71.4
Decay time of β to 0 degrees (ms)	57.3 to 76.5
Peak moment at occipital condyle (Nm)	34.2 to 51.0
Peak moment decay time to 0 Nm (ms)[a]	69.4 to 93.3
Peak forward potentiometer angular displacement (degrees)	38.4 to 46.9
Time of peak forward potentiometer angular displacement (ms)[a]	56.0 to 68.5
Peak rearward potentiometer angular displacement, θ_F (degrees)	33.9 to 41.5
Time of peak rearward potentiometer angular displacement, θ_R (ms)[a]	56.5 to 69.1
a T=0 s at initial pendulum contact with honeycomb or alternative products which can be shown to lead to the same results.	

Table 9.6 — WorldSID neck certification specifications

9.3 Thorax/Shoulder Tests

9.3.1 Full Body Test

9.3.1.1 Materials

Use PTFE (Teflon®1) sheets of sufficient size to cover seat.

9.3.1.2 Apparatus

- H-Point tool (drawing W50-82500)
- Tilt sensor or inclinometer
- Dummy certification test bench
- Seat and back Teflon® sheets

9.3.1.3 Préparation

Expose the dummy, clothed in its suit, to the conditions given in Table 9.7 for at least four hours prior to a test.

Variable	Value
Temperature (degrees C)	21.4 ± 0.8
Relative humidity (%)	40 ± 30

Table 9.7 — Dummy full body test preconditions

9.3.1.4 Setup Procedure

- Install the H-point tool
- Install dual axis tilt sensors in the head, thorax and pelvis to check the angles about x and y direction
- Cover the seat back and base with PTFE (Teflon®) sheets
- Seat the dummy on the rigid seat as shown in Figure 9.5 and 9.6
- Place the dummy on the seat and position it using either mechanical measurements on a dummy component or tilt sensors to verify the positions. The relationship between mechanical angle measurements and the tilt sensors are given in Table 9.8.
- Position the dummy according to the criteria given in Table 9.9.

1) Teflon® is a commercial product name for PolyTetraFlourEthylene (PTFE). This information is given for the convenience of users of this Standard and does not constitute an endorsement of the product named. Alternative products may be used if they can be shown to lead to the same results.

Location	Mechanical Reference	Tilt sensor (angular displacement about the noted axis)
Head zero	Landmark on head is horizontal	X : 0º, Y : 0º
Thorax zero	Top of the lower neck bracket is horizontal	X : 0º, Y : 0º
Pelvis zero	X angle zero degree H-point tool oriented at 45º below horizontal (Y)	X : 0º, Y : 14.5º

Table 9.8 — Relationship between mechanical measurement indicators and the tilt sensors

Variable	Criteria	Sensor Readings
Thorax angle	0º ± 2º	
Pelvic orientation	5º ± 2º[a]	This pelvic orientation is coincident with H-point tool at 40º ± 2º below horizontal, and a pelvic tilt sensor at 19.5º ± 2º
Distance between knee centers	138 mm ± 50 mm	
[a] Due to the low friction of the Teflon® pieces, the dummy is not able to sit at zero pelvis angle. Five degrees is an achievable angle on the test bench.		

Table 9.9 — Dummy set up criteria

Figure 9.5 — Front view of setup for full dummy certification tests

Figure 9.6 — Side view of setup for full dummy certification tests

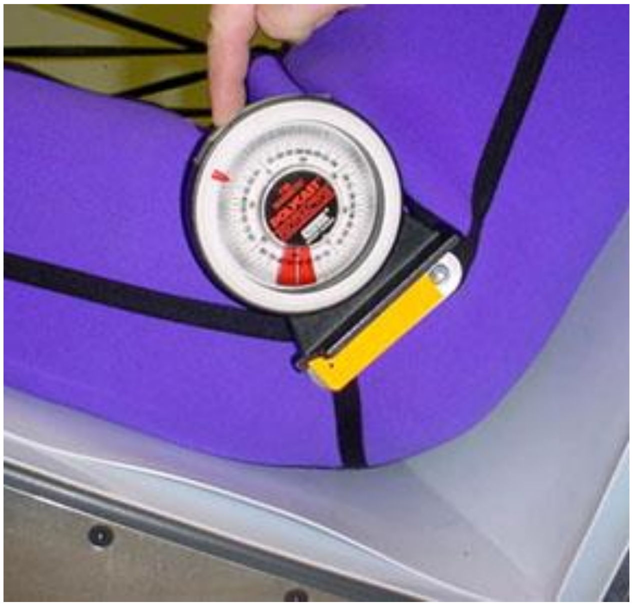


Figure 9.7 — Using an inclinometer with the H-point tool to check pelvis angle

9.3.2 Shoulder Test

9.3.2.1 Principle

Perform a test involving a lateral impact to the shoulder in order to certify the dynamic response of the shoulders.

9.3.2.2 Apparatus

Use SID IIs thorax pendulum (13.97 kg).

9.3.2.3 Sensors

Install instrumentation to obtain data for the items given in Table 9.10.

Variable	Sensor	Performance
Pendulum acceleration (G)	See Table 9.2	Per SAE J2570
Shoulder rib deflection (mm)	String potentiometer	See sensor specification details on electronic drawing number W5-7103
Impact velocity (m/s)	Not specified	Resolution 0.02m/s or better

Table 9.10 — Sensors for shoulder test

9.3.2.4 Procedure

- Set up the dummy in standard test posture as described in 9.3.1 with the half arm align horizontal on the impact side as shown in Figure 9.8.
- Align the pendulum centerline with the centerline of the shoulder y-axis rotation point.
- Raise the pendulum to achieve a 4.3 ± 0.1m/s impact velocity.
- Release the pendulum to impact the dummy.

Figure 9.8 — Shoulder test, dummy and arm position

9.3.2.5 Calculation procedures and expression of results

- Filter the data as given in Table 9.11.
- Calculate the pendulum impactor force by multiplying the pendulum acceleration time history by the measured impactor mass.
- Graph the time histories of impactor force and shoulder deflection.

Variable	Filter
Pendulum acceleration (G)	CFC 180
Shoulder deflection (mm)	CFC 600

Table 9.11 — Filter specifications for shoulder test

9.3.2.6 Test Reports

Document the results of the test. The performance shall meet the specifications as defined in Table 9.12.

Variable	Absolute Value
Peak pendulum force (kN)	1.58 to 2.28
Peak shoulder rib deflection (mm)	23.4 to 36.6

Table 9.12 — WorldSID shoulder certification specifications

9.4 Thorax with Half Arm

9.4.1 Principle

Perform a test involving a lateral impact to the thorax with the half arm in order to certify the dynamic response of the thorax.

9.4.2 Apparatus

Use SID IIs thorax pendulum (13.97 kg).

9.4.3 Sensors

Install instrumentation in order to obtain data for the items given in Table 9.13.

Variable	Sensor	Performance
Pendulum acceleration (G)	See Table 9.2	SAE J2570
Upper spine (T4) y-axis acceleration (G)	Triaxial linear accelerometer	SAE J2570
Lower spine (T12) y-axis acceleration (G)	Triaxial linear accelerometer	SAE J2570
First, second and third thorax rib compression and rotation (mm and degrees)	2D-IR-TRACC	See sensor specification details on electronic drawing number IF-371
Impact velocity (m/s)	Not specified	Resolution 0.02m/s or better

Table 9.13 — Sensor specifications for thorax with half arm test

9.4.4 Procedure

- Set up the dummy in standard test posture as described in 9.3.1 with the half arm parallel to the thorax
- Align the pendulum centerline with the centerline of the middle thorax rib
- Raise the pendulum to achieve a 6.7m/s ± 0.1m/s impact velocity
- Release the pendulum to impact the dummy

9.4.5 Calculation procedures and expression of results

- Filter the data as given in Table 9.14.
- Calculate the pendulum impactor force by multiplying the pendulum acceleration time history by the measured impactor mass
- Calculate the lateral displacement for each rib from the signals of the IR-TRACC compression and the rib rotation according the method described in Appendix A.
- Plot the time histories of impactor force, T4 and T12 y-axis accelerations, and 2D IR-Tracc compression and calculated lateral displacement of thorax ribs 1, 2, and 3.

Note:

- Peak thorax rib deflection: measurements from IRTRACC directly.
- Peak thorax rib lateral deflection: calculated deflection from IRTRACC and rotary pot measurements.

Variable	Filter
Pendulum acceleration (G)	CFC 180
T4 y-axis acceleration (G)	CFC 180
T12 y-axis acceleration (G)	CFC 180
Thorax rib 1, 2, 3 compression (mm)	CFC 600
Thorax rib 1, 2, 3 rotation (degrees)	CFC 600

Table 9.14— Filter specifications for thorax with half arm test

9.4.6 Test Reports

Document the results of the test. The performance shall meet the specifications as defined in Table 9.15.

Variable	Absolute Value
Peak pendulum force (kN)	5.02 to 6.13
Peak T4 acceleration along y axis (G)	34.7 to 52.0
Peak T12 acceleration along y axis (G)	44.5 to 54.9
Peak thorax rib 1 compression Dy (mm)	18.3 to 26.4
Peak thorax rib 1 lateral displacement Y in (mm)	19.0 to 30.1
Peak thorax rib 2 compression Dy (mm)	21.6 to 26.4
Peak thorax rib 2 lateral displacement Y in (mm)	24.5 to 30.0
Peak thorax rib 3 compression Dy (mm)	19.7 to 26.6
Peak thorax rib 3 lateral displacement Y in (mm)	21.0 to 28.9

Table 9.15 — WorldSID thorax with half-arm certification specifications

9.5 Thorax without Arm

9.5.1 Principle

Perform a test involving a lateral impact to the thorax without the arm in order to certify the dynamic response of the thorax.

9.5.2 Apparatus

Use SID IIs thorax pendulum (13.97 kg).

9.5.3 Sensors

Install instrumentation to obtain data for the items given in Table 9.16.

Variable	Sensor	Performance
Pendulum acceleration (G)	See Table 9.2	SAE J2570
Upper spine (T4) y-axis acceleration (G)	Triaxial linear acceleration	SAE J2570
Lower spine (T12) y-axis acceleration (G)	Triaxial linear acceleration	SAE J2570
First, second and third thorax rib compression and rotation (mm and degrees)	2D-IR-TRACC	See sensor specification details on electronic drawing number IF-371
Impact velocity (m/s)	Not specified	Resolution 0.02m/s or better

Table 9.16 — Sensor specifications for thorax without arm test

9.5.4 Procedure

Set up the dummy without arm in standard test posture as described in 9.3.1. Raise the arm to a vertical orientation as shown in Figure 9.9.

- Align the pendulum centerline with the centerline of the middle thorax rib.
- Raise the pendulum to achieve a 4.3 ± 0.1m/s impact velocity.
- Release the pendulum to impact the dummy.

Figure 9.9 — Thorax test without arm, dummy and arm position

9.5.5 Calculation procedures and expression of results

- Filter the data as given in Table 9.17.
- Calculate the pendulum impactor force by multiplying the pendulum acceleration time history by the measured impactor mass.
- Calculate the lateral displacement for each rib from the signals of the IR-TRACC compression and the rib rotation according the method described in Appendix A.
- Graph the time histories of impactor force, T4 and T12 y-axis accelerations, and deflections of thorax ribs 1, 2, and 3.

Variable	Filter
Pendulum acceleration (G)	CFC 180
T4 y-axis acceleration (G)	CFC 180
T12 y-axis acceleration (G)	CFC 180
Thorax rib 1, 2, 3 compression (mm)	CFC 600
Thorax rib 1, 2, 3 rotation (degrees)	CFC 600

Table 9.17 — Filter specifications for thorax without half arm test

9.5.6 Test Reports

Document the results of the test. The performance shall meet the specifications as defined in Table 9.18.

Variable	Absolute Value
Peak pendulum force (kN)	2.64 to 3.22
Peak T4 acceleration along y axis (G)	21.2 to 27.5
Peak T12 acceleration along y axis (G)	20.6 to 28.9
Peak thorax rib 1 compression Dy (mm)	20.5 to 27.7
Peak thorax rib 1 lateral displacement Y in (mm)	19.7 to 31.9
Peak thorax rib 2 compression Dy (mm)	21.7 to 26.7
Peak thorax rib 2 lateral displacement Y in (mm)	24.6 to 33.3
Peak thorax rib 3 compression Dy (mm)	20.9 to 27.3
Peak thorax rib 3 lateral displacement Y in (mm)	23.1 to 29.7

Table 9.18 — WorldSID thorax without arm certification specifications

9.6 Abdomen Test

9.6.1 Principle

Perform a test involving a lateral impact to the abdomen in order to certify the dynamic response of the abdomen ribs.

9.6.2 Apparatus

Use the following items:

- Use SID IIs abdomen pendulum (13.97 kg).

9.6.3 Sensors

Install instrumentation in order to obtain data for the items given in Table 9.19.

Variable	Sensor	Performance
Pendulum acceleration (G)	See Table 9.2	SAE J2570
Lower spine (T12) y-axis acceleration (G)	Triaxial linear accelerometer	SAE J2570
Abdomen rib 1 and 2 compression and rotation (mm and degrees)	2D-IR-TRACC	See sensor specification details on electronic drawing number IF-371
Impact velocity (m/s)	Not specified	Resolution 0.02m/s or better

Table 9.19 — Sensor specifications for abdomen test

9.6.4 Procedure

- Set up the dummy in standard test posture as described in 9.3.1 with the half arm in the driving posture as shown in Figure 9.9.
- Align the wood block face so it is aligned with and parallel to the middle of the two abdomen ribs.
- Place the wood block in contact with the side of the dummy.
- Raise the pendulum to achieve a 4.3 ± 0.1m/s impact velocity.
- Release the pendulum to impact the dummy.

9.6.5 Calculation procedures and expression of results

- Filter the data as given in Table 9.20.
- Calculate the pendulum impactor force by multiplying the pendulum acceleration time history by the combined measured mass of the pendulum and armrest simulator.
- Calculate the lateral displacement for each rib from the signals of the IR-TRACC compression and the rib rotation according the method described in Appendix A.
- Graph the time histories of impactor force, T12 y-axis acceleration, and deflections of abdomen ribs 1 and 2.

Variable	Filter
Pendulum acceleration (G)	CFC 180
T12 y-axis acceleration (G)	CFC 180
Abdomen rib 1, 2 deflection (mm)	CFC 600
Abdomen rib 1, 2 rotation (degrees)	CFC 600

Table 9.20 — Filter specifications for abdomen test

9.6.6 Test Reports

Document the results of the abdomen test. The performance shall meet the specifications as defined in Table 9.21.

Variable	Absolute Value
Peak pendulum force (kN)	2.21 to 2.70
Peak T12 acceleration along y axis (G)	24.4 to 30.6
Peak abdomen rib 1 compression Dy (mm)	23.1 to 31.2
Peak abdomen rib 1 lateral displacement Y in (mm)	26.3 to 32.2
Peak abdomen rib 2 compression Dy (mm)	22.7 to 27.8
Peak abdomen rib 2 lateral displacement Y in (mm)	22.6 to 28.2

Table 9.21 — WorldSID abdomen certification specifications

9.7 Pelvis Test

9.7.1 Principle

Perform a test involving a lateral impact to the pelvis in order to certify the dynamic response of the pelvis.

9.7.2 Apparatus

Use SID IIs pelvis pendulum (13.97 kg).

9.7.3 Sensors

Install instrumentation to obtain data for the items given in Table 9.22.

Variable	Sensor	Performance
Pendulum acceleration (G)	See Table 9.2	SAE J2570
Lower spine (T12) y-axis acceleration (G)	Triaxial linear accelerometer	SAE J2570
Pelvis acceleration (G)	Triaxial linear accelerometer	SAE J2570
Pubic lateral force [N]	Pubic load cell	SAE J2570
Impact velocity (m/s)	Not specified	Resolution 0.02m/s or better

Table 9.22 — Sensor specifications for pelvis test

9.7.4 Procedure

- Set up the dummy with half arm in standard test posture as described in 9.3.1.
- Align the pendulum centerline with the H-point.
- Raise the pendulum to achieve a 6.7 ± 0.1 m/s impact velocity.
- Release the pendulum to impact the dummy.

9.7.5 Calculation procedures and expression of results

- Filter the data as given in Table 9.23.
- Calculate the pendulum impactor force by multiplying the pendulum acceleration time history by the measured impactor mass.
- Graph the time histories of impactor force, pelvis and T12 y-axis accelerations.

Variable	Filter
Pendulum acceleration (G)	CFC 180
T12 y-axis acceleration (G)	CFC 180
Pelvis y-axis acceleration (G)	CFC 180
Pubic lateral force [N]	CFC 1000

Table 9.23 — Filter specifications for pelvis test

9.7.8 Test Reports

Document the results of the pelvis test. The performance shall meet the specifications as defined in Table 9.24.

Variable	Absolute Value
Peak pelvis pendulum force (kN)	4.62 to 5.65
Peak pubic lateral force along y axis [N]	-1200 to -770
Peak T12 acceleration along y axis (G)	11.8 to 15.8
Peak acceleration along y axis (G)	48.6 to 74.4

Table 9.24— WorldSID pelvis certification specifications

9.7.9 Data Zero Values

For all certification tests, set all data channels to a zero value at the time of initial contact of the moving component with the stationary component.

Note: When using IR-TRACC sensors, due to the non-linear input-output relationship, the voltage should be converted to engineering units before setting the data channel to zero as required above.

Appendix A- 2D-IR-TRACC, IF-371

A.1 Introduction

In the European Framework Program 6 Integrated Project APROSYS, a computer model study (reported in AP SP52 0025) was carried on oblique impact sensitivity of the WorldSID dummy. The study was set up to assess candidate systems that could lead to improved sensitivity of the WorldSID thorax to oblique impact [i]. This study indicated that there was potential for 2-dimensional rib deflection sensor the output of which correlates well with both impact angle and impact severity. Based on this study a 2D deflection sensor system was designed and prototypes were built. Prototypes were installed in the WorldSID small female dummy for evaluation. The 2D rib deflection system measures the position of the most lateral rib segment in the XY rib plane to improve oblique impact sensitivity of the thorax and abdomen ribs. The current version, part IF-371 was further developed from the initial prototype to provide left and right symmetric assembly and a larger rotation range up to 45° forward and backward. Also changes were implemented in the small end cable exit to provide better wire protection. Interpretation software was written to calculate rib deflection in x and y directions in the dummy coordinate system and the resultant deformation of the rib in the x-y plane. The data processing is explained in paragraph A.3.

A.2 Disassembly/Assembly

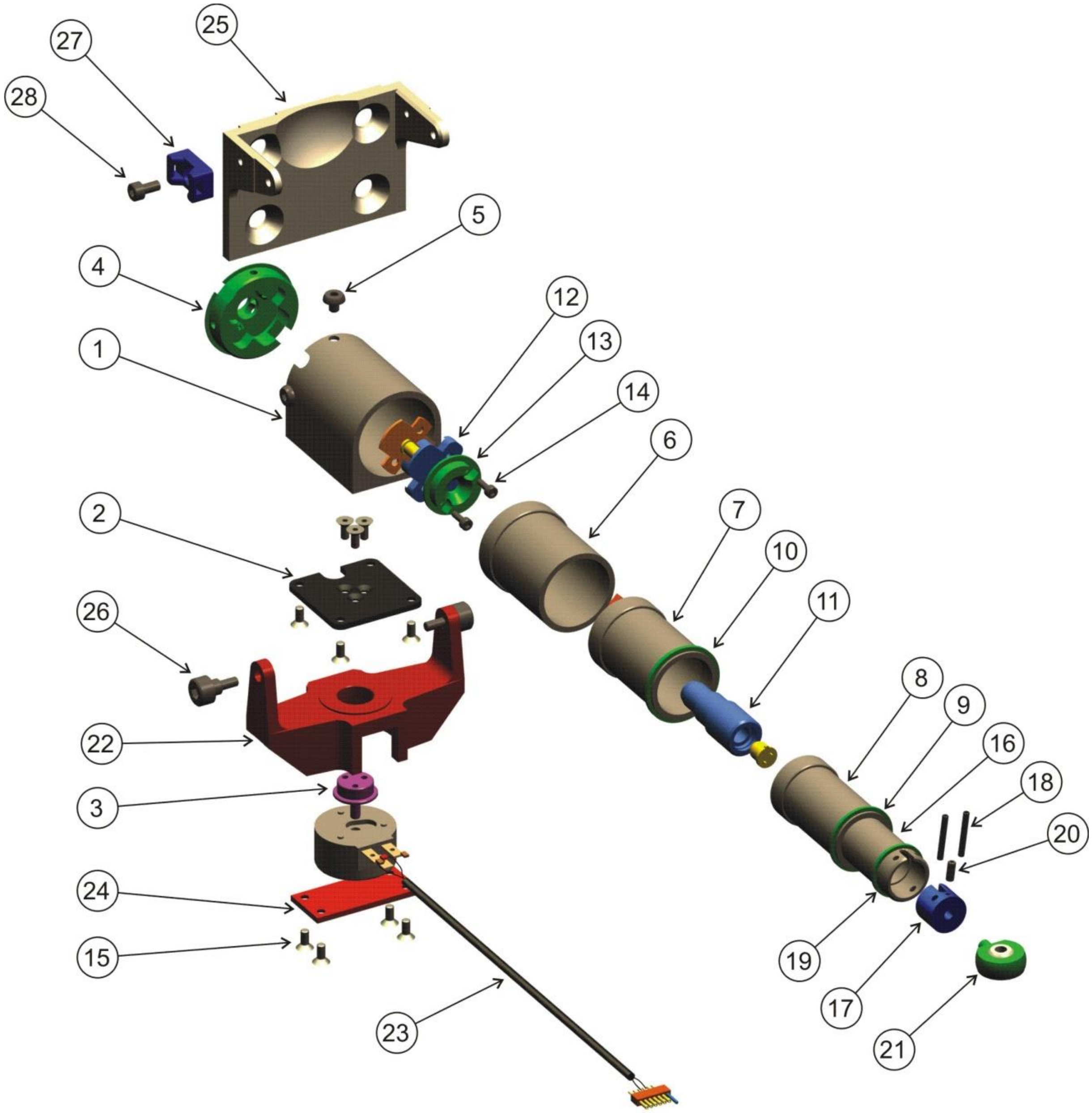


Figure A1- 2D-IR-TRACC Exploded Assembly, 3710-00

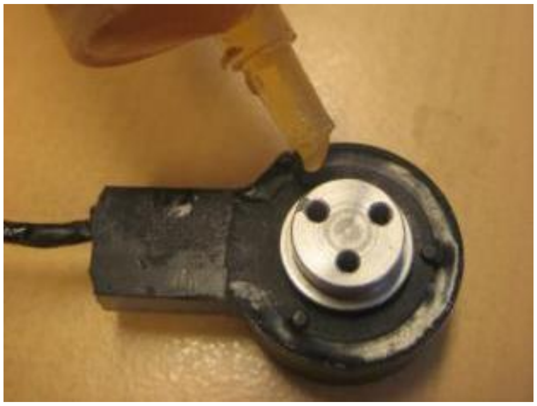
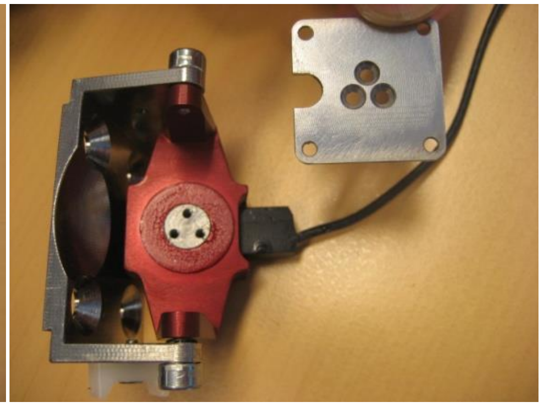
ITEM	QTY	PART NO.	DESCRIPTION
1	1	3700-02	BIG END 2D IR-TRACC
2	1	3700-03	POT BASE
3	1	3700-04	POT AXIS
4	1	3620-06	ENDCAP
5	4	5000248	SCREW, BHCS M2.5 X 0.45 X 3
6	1	3690-04	COLUMN #4, IRTRACC WORLDSID
7	1	3690-03	COLUMN #3, IRTRACC WORLDSID
8	1	3690-02	COLUMN #2, IRTRACC WORLDSID
9	1	9002958	RETAINING RING, 5/8 EXTERNAL SS 91650A430
10	1	9002959	RETAINING RING, 3/4 EXTERNAL SS 91650A440
11	1	3710-10	ELECTRONICS ASSEMBLY, 2D IRTRACC SHORT RANGE
12	1	3620-16	LED MOUNTING DISK
13	1	3620-43	INTERNAL SPACER
14	2	5000338	SCREW, SHCS M1.6 X 0.35 X 5
15	11	5000753	SCREW, FHCS M2 X 0.4 X 5
16	1	3670-04	COLUMN 1, IRTRACC WORLDSID
17	1	3670-06	BALL JOINT ADAPTOR
18	2	5000839	ROLL PIN, M1.5 X 12
19	1	9002957	RETAINING RING, 1/2 EXTERNAL SS 91650A420
20	1	5000474	SCREW, SSCP M2 X 0.4 X 5
21	1	3690-10	BALL JOINT, IRTRACC WORLDSID
22	1	3670-13	YOKE
23	1	3670-12	CABLE ASSEMBLY, POTENTIOMETER TO 6 PIN
24	1	3670-03	COVER, POTENTIOMETER
25	1	3700-07	2D IRTRACC BRACKET
26	2	3700-08	PIVOT SCREW
27	1	6002036	CABLE TIE MOUNT, #4 SCREW, NYLON
28	1	5000641	SCREW, SHCS M2.5 X 0.45 X 5

Table A1- Parts List, 2D-IR-TRACC, 3710-00

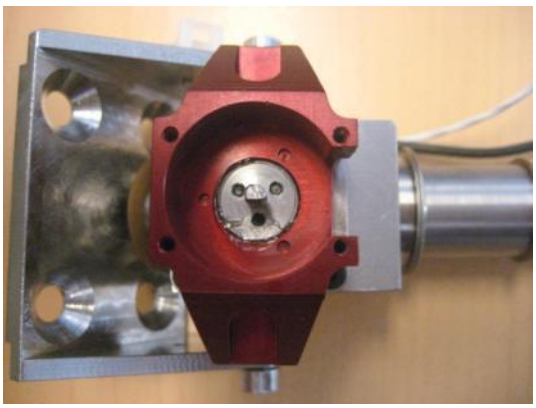
To disassemble the 2D-IR-TRACC, start by removing the two pivot screws (Item 26). This will allow the yoke (Item 22) and the bracket (Item 25) to come apart. Next, remove the four FHCS M2 x 5 (Item 15) from the pot cover (Item 24) and the four FHCS M2 x 5 (Item 15) from the pot base (Item2). There is access to the bottom of the potentiometer. Remove, three FHCS M2 x 5 (Item 15) from the top of the pot base, now there is full access to the pot axis, potentiometer and cable. The IR-TRACC is now disassembled from the yoke, but the 2D-IR-TRACC its self is not to be disassembled.

Assembling the 2D-IR-TRACC is the reverse of the disassembly.

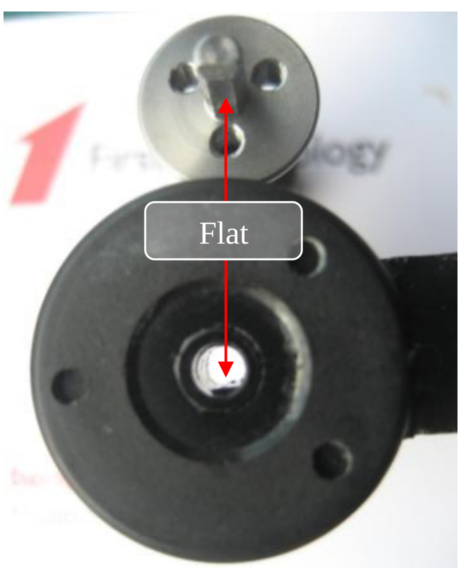
Note: When assembling, apply a small quantity of light grease on the Pot Axis (3700-04) when inserting it into the Yoke (3670-13) and on the Pot Base (3700-03), see pictures below.

Note: When assembling the Pot Axis (3700-04) to the Pot Base (3700-03) make sure that the flat on the Pot Axis is aligned with the compression axis of the IR-TRACC, see pictures below.




Note: When assembling the Potentiometer onto the Pot Axis, make sure that the flat face in the bore of the Potentiometer is aligned with the flat on the Pot Axis, see picture below. The flat face of the Potentiometer can be aligned by gently inserting a small screw driver in the bore and gently rotate the bore to align with the flat on the axis.



A.3 Data Processing and Interpretation Software

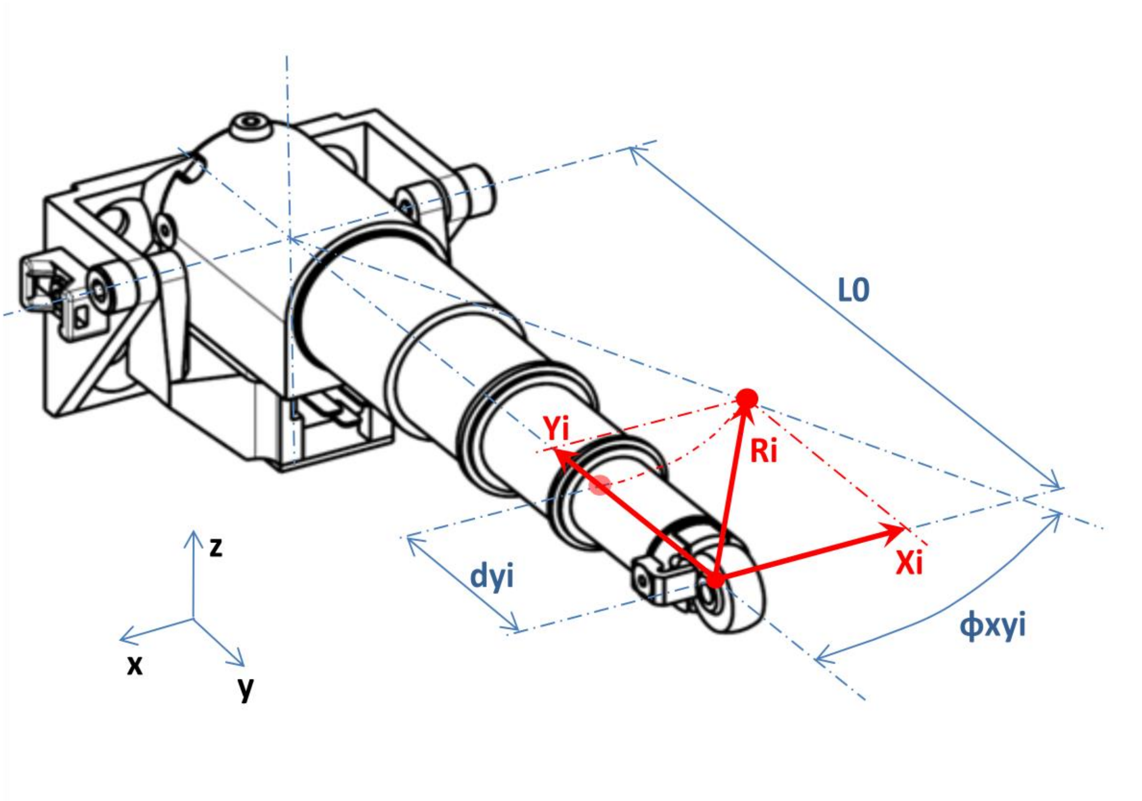


Figure A2- Symbols used in the calculation

Interpretation software was written in a spreadsheet (MS Excel) to calculate rib deflection in x- and y- direction in the dummy co-ordinate system and the resultant deformation of the rib in the x-y plane. This spreadsheet calculates rib deflection of WorldSID small female dummy from the output of the IR-TRACC compression dyi and the IR-TRACC rotation φxyi. Each time step the displacement of the small end ball joint is calculated from the IR-TRACC angle φxyi and IR-TRACC compression dyi. L0 the reference length of each individual IR-TRACC assembly is an important parameter. Also it is important that input for compression and rotation are synchronised in time.

Parameter	Description
t_0 [s]	Time zero
L_0 [mm]	Reference length at t_0.
dyi [mm]	IR-TRACC compression at ti
φxyi [degrees]	IR-TRACC angle at time i (positive angle indicated)
X [mm]	Calculated x displacement w.r.t. x0 (time zero x)
Y [mm]	Calculated y displacement w.r.t. y0 (time zero y)
R [mm]	Calculated Resultant displacement w.r.t .R0 (time zero R)

Table A2- Calculation- parameters, symbols, and description

The following formulas are used in the spreadsheet:

$$xi = (L_0 - dyi) * \sin(\varphi xyi) \quad (1)$$
$$yi = L_0 - (L_0 - dyi) * \cos(\varphi xyi) \quad (2)$$
$$Ri = \sqrt{(xi^2 + yi^2)} \quad (3)$$

The output of the sensors dyi, φxyi and the time step can be entered into columns in the spreadsheet. The results of xi, yi and Ri are given in the adjacent columns.
L_0, pivot to pivot distance at t_0 of the IR-TRACC can be obtained from the dimension measurement taken prior to test, or the nominal value can be used if there is no permanent deformation in the ribs. For the WorldSID small female dummy the nominal value of the pivot to pivot distance at t_0 of the IR-TRACC is 88.2mm.

If there is doubt about the initial length at t_0, It can be obtained by checking the voltage output of the IR-TRACC at t_0 and calculate L_0 back from the voltage at reference length 90mm, which was recorded for each individual IR-TRACC during installation.

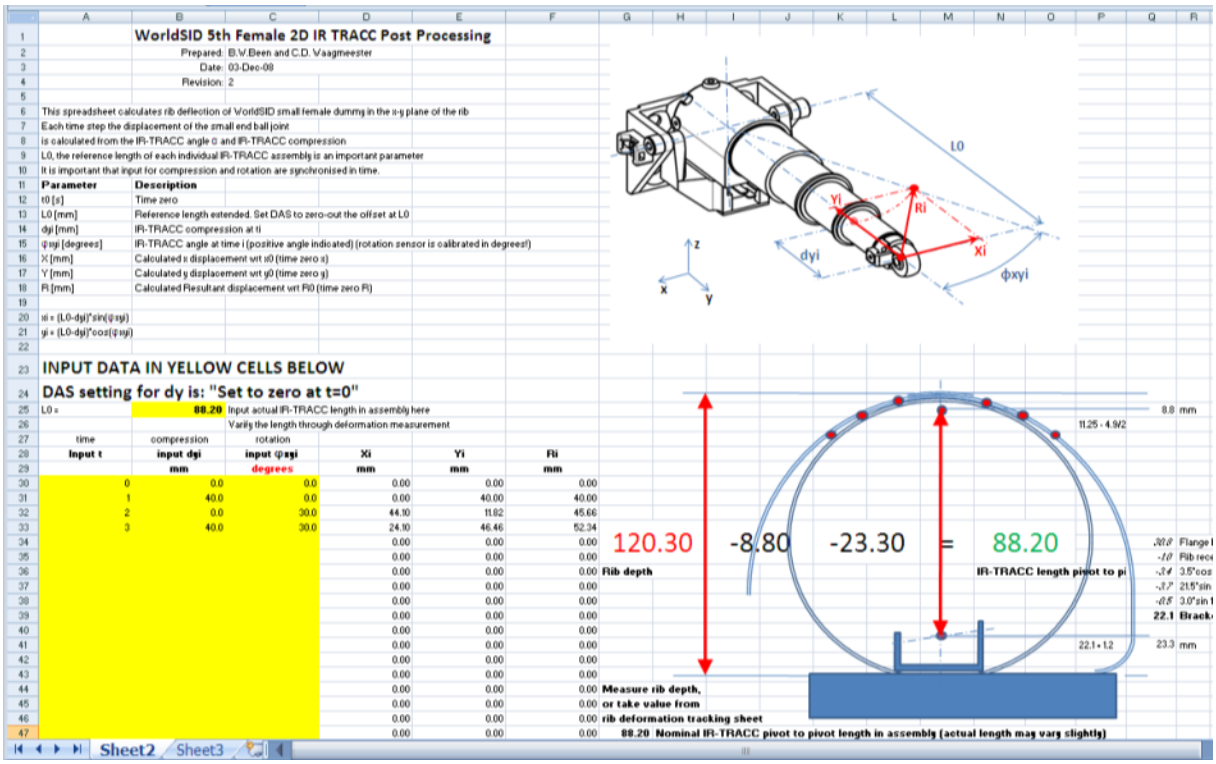


Figure A3- Screen plot of the calculation spreadsheet for post processing 2D IR-TRACC results

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[i] Bernard Been, Mat Philippens, Jeroen Brandse 'WorldSID Instrumented Rib Load Sensitivity Study' Aprosys Technical Report AP SP52 0025

Manual Update Log

Rev. D, May 2011
Manual changed from FTSS to Humanetics

Rev. E, Aug. 2015
File name W5-9900 WorldSID 5th User Manual was USER MANUAL WORLDSID 5TH REV D
Page 2: Added lead material statement