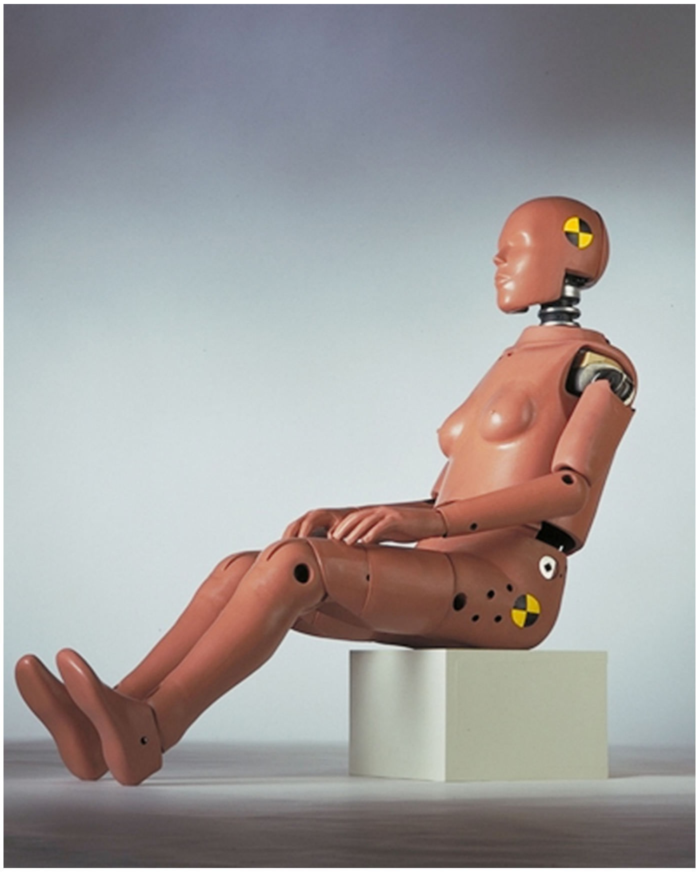
Hybrid III 5th Female User Manual 880105-000-XH



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Notice: This product may contain lead

A list of components that may contain lead is being maintained on the Humanetics web site. The list, organized by dummy type, shows subcomponents that may currently or in the past have contained lead or a lead-based alloy. Please refer to the Humanetics web site under ATD Lead Disclosure for information regarding lead in this product. http://www.humaneticsatd.com/Lead_Disclosure

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Section – 1 Introduction

1.1 Foreword

In the late 1980's the Center for Disease Control (CDC) awarded Ohio State University a grant to develop multi-sized test dummies based on the Hybrid III design. To aid in this endeavor, the Mechanical Human Simulation Subcommittee of the Society of Automotive Engineers (SAE) formed a Task Group to define the specifications for an adult size small female dummy which would have, at least, the same level of biofidelity and measurement capacity as the 50th Hybrid III Dummy.

The Hybrid III Small Female Test Dummy is based on the characteristic size and weight measurements taken from anthropometry studies of the 5th percentile adult female. Its impact response requirements for the head, neck, chest, hip, knee and ankle were extrapolated from the biofidelity requirements of the Hybrid III mid-size male dummy. (see Mertz, H. J., Irwin, A. I., Melvin, J. W., Stalnaker, R. L., Beebe, M. S., "Size, Weight, and Biomechanical Impact Response Requirements for Adult Size Small Female and Large Male Dummies", SAE #890756, SP-782, 1989.) The Hybrid III small female dummy is designed to represent the lower extreme of the United States adult population.

1.2 Manual Overview

1.2.1 Appendices

Several guidelines and procedures apply to various parts throughout the dummy, and are included in the appendices for easier reference. First, when handling an instrumented dummy, improper techniques can damage instrumentation, particularly accelerometers. Appendix A contains guidelines for safe handling of instrumented dummies. Second, the vinyl flesh of dummies can be damaged, but is often repairable. Appendix B contains instructions for repairing dummy flesh. Third, procedures for adjusting the joints throughout the dummy are included in Appendix C.

1.2.2 SAE Documents

In addition to the attached appendices, other SAE publications are particularly useful when working with the Hybrid III dummies. SAE J211 provides the most recent guidelines and procedures for dummy instrumentation and filtering. SAE Information Report J1733 illustrates the instrumentation available for the Hybrid III dummy, along with descriptions of how to apply the positive right-hand rule sign convention.

1.2.3 SAE Test Definitions

Calibration Test:

Calibration tests are specified for dummy responses which could affect dummy measurements that are used by government and safety engineers to assess occupant injury potential. Calibration tests are performed by the dummy manufacturer to assure that a new component or assembly meets the SAE specified response requirements. The crash dummy user will periodically perform the calibration tests to assure the dummy is maintained at the SAE specified performance levels.

Inspection Test:

Inspection tests are supplemental to the calibration tests to insure that a component meets its design intent. They are performed by the dummy manufacturer on new parts. The dummy user may conduct inspection tests when a part is damaged or replaced.

1.2.4 Abbreviations

The following threaded fastener abbreviations are used in this manual.

SHCS………………………….Socket Head Cap Screw
FHCS………………………….Flat Head Cap Screw
BHCS………………………….Button Head Cap Screw
SHSS………………………….Socket Head Shoulder Screw
SSCP………………………….Socket Screw, Cup Point
RHMS…………………………Round Head Machine Screw

1.3 Construction

- The skull and skull cap are both one-piece cast aluminum, with a removable one-piece vinyl head and skull cap skin. The skull cap is removable for access to the head instrumentation. The vinyl skin is tuned to give human-like response to forehead impacts.
- The neck has a biofidelic “angle versus moment” response in both dynamic flexion (forward bending) and extension (rearward bending) articulations.
- A neck cable controls stretching responses, and increases the neck’s durability to high axial tension forces.
- The two-piece aluminum clavicle and clavicle-link assembly have cast integral scapulae to prevent interface with shoulder belts.
- Six spring steel ribs with polymer-based damping material approximate the human chest force-deflection response characteristics. The sternum assembly connects to the front of the ribs and incorporates a slider for a chest deflection transducer to measure rib cage deflection relative to the thoracic spine.
- A straight lumbar spine gives a sitting posture to simulate a person of larger stature in the driving position.
- The pelvis has a human shape and comes equipped with load cell replacements for pelvis submarining-indicating transducers.
- A knee slider mechanism is used that consists of steel sliders with energy absorbing molded rubber mounted on aluminum knees. This allows for displacement of the tibia relative to the femur, simulating ligament response.
- The leg assemblies are steel tubes covered with vinyl. The legs are interchangeable with instrumented versions.
- Constant friction movable joints are used that need few adjustments and provide consistent articulations.
- The standard model has a "seated" pelvis construction. A “sit/stand" pelvis version is optional as are a neck covering for airbag testing, a deformable face for steering wheel rim testing, and a deformable abdomen for lap belt submarining and steering wheel rim evaluations.

1.4 Clothing

When used in testing, the dummy should wear snug-fitting cotton knit T-shirt and pants. The neckline should be small enough to prevent contact between a shoulder belt and the dummy’s skin. The pants should end above the dummy’s knee. The T-shirt and pants should each weigh no more than 0.14 kg (0.3 lb). Garments similar to thermal underwear (trimmed to be short-sleeved and above the knee) usually meet these requirements. To improve the quality of high-speed films taken of the dummy during testing (by avoiding excessive glare); the garments are usually dyed to a light pink. The shoes used with the small adult female dummy are women’s low dress black oxfords; size 7-1/2 E that meet military specification MIL-S-21711E. Each shoe weighs 0.41 ± 0.09 kg (.9 ± 0.2 lb). To make it easier to put the shoe on the dummy, the shoe should be cut to extend the tongue. Talc may also be applied to the foot.

1.5 Instrumentation

When ordering a new dummy, inform the dummy manufacturer of the type and model of accelerometer you intend to use. This will ensure that you obtain the correct accelerometer mounts for the head, chest and pelvis.

The following is an instrumentation list currently available for the Hybrid III 5th Female dummy.

Instrument	Part Number	Number of Channels	Quantity
Head Accelerometers	IE-103	3	3
Upper Neck Load Cell	IF-205	6	1
	IF-205J	6	1
	IF-207	6	1
	IF-256	4	1
	IF-2564	3	1
Lower Neck Load Cell	IF-211	5	1
	IF-228	6	1
	IF-238	6	1
Chest Accelerometers	IE-103	3	3
Sternum Accelerometers	IE-103	3	3
Spine Accelerometers	IE-103	3	3
Chest Deflection: Rotary Pot	78051-342	1	1
Thoracic Spine Load Cell	IF-300	6	1
	IF-302	5	1
Clavicle Load Cell	IF-353	2	1
Lumbar Spine Load Cell	IF-404	5	1
	IF-406	6	1
	IF-429	3	1
Rib Load Cell	IF-455	4	1
Pelvis Accelerometers	IE-103	3	3
ASIS Load Cells	IF-509	2	1
Femur Load Cells	IF-604	2	2
	IF-625	6	2
	IF-628	6	2
Knee Clevis Load Cells	IF-805	2	2
Knee Sheer Displacement	880105-516	1	2
Upper Tibia Load Cells	IF-820	8	2
	IF-857	5	2
Lower Tibia Load Cells	IF-819	8	2
	IF-825	8	2
	IF-853	5	2

Table 1.1 – Instrumentation

* The load cell part numbers listed in the table are for 350 ohm’s. 120 ohm’s load cells are also available.

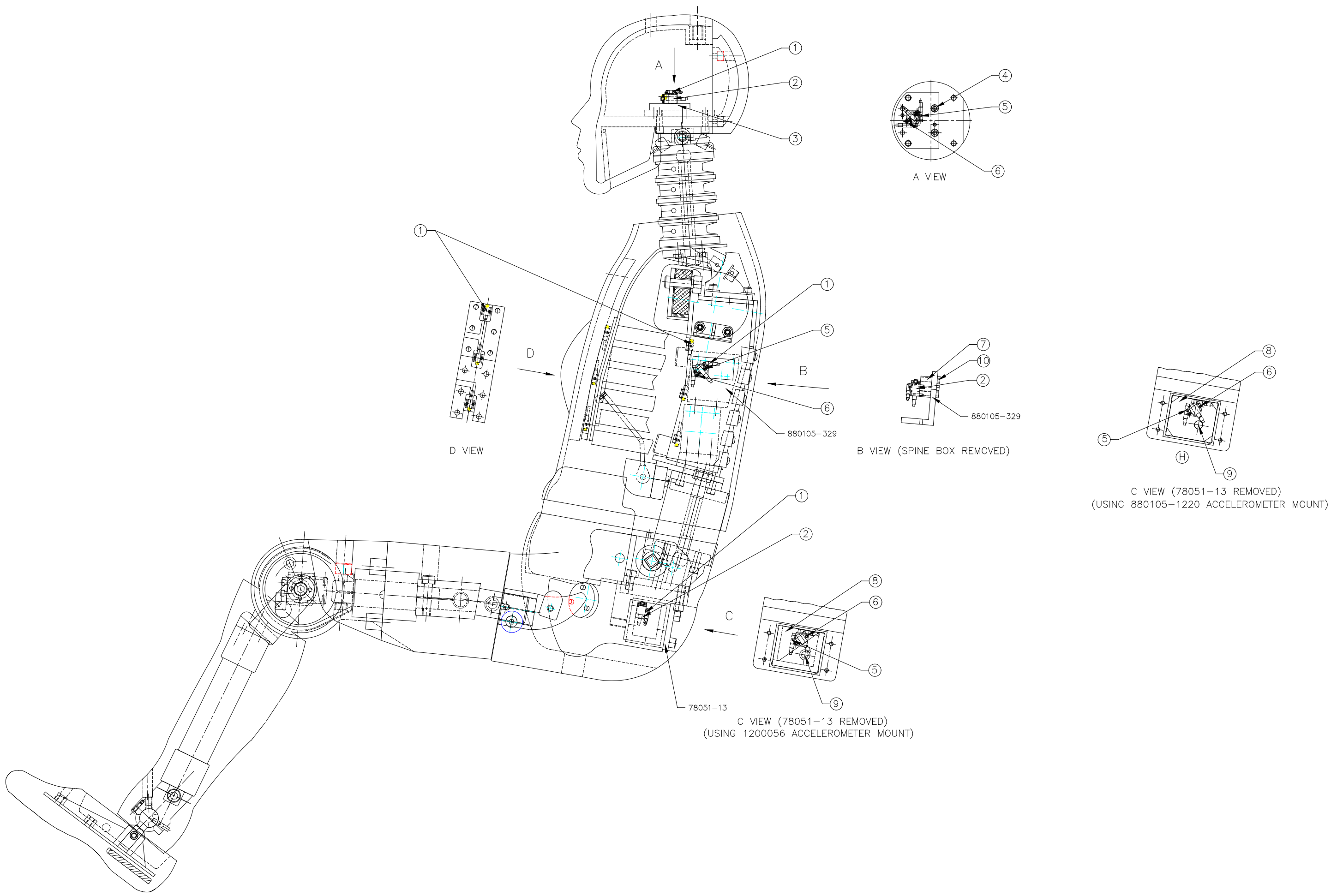


Figure 1.1 – Accelerometer Location in Dummy

ITEM	QTY	PART NO.	DESCRIPTION
1	15	IE-103	ACCELEROMETER ENDEVCO/ENTRAN 7264-2000 (REF)
2	3	H350-1005	TRIAXIAL MOUNTING BLOCK
3	1	880105-1211	HEAD ACCELEROMETER MOUNT
4	4	9000487	SCREW, SHCS #10-24 X 3/8
5	18	9000152	SCREW, SHCS #0-80 X 1/8 (REF)
6	6	9000531	SCREW, SHCS #2-56 X 5/8
7	1	H350-1006	CHEST ACCELEROMETER MOUNT
8	1	880105-1220	PELVIC ACCELEROMETER MOUNT (OPTIONAL)
		1200056	PELVIC ACCELEROMETER MOUNT
9	1	9000490	SCREW, SHCS 3/8-16 X 3/4
10	4	9000624	SCREW, SHCS #10-24 X 1/2

Table 1.2- Accelerometer Location Parts List

1.6 Special Tools

The following special tools will allow assembly, disassembly and calibration of the Hybrid III 95th Male dummy. For information concerning tool availability, contact the dummy manufacturers.

- Neck compression tool
- Ball hex wrench set
- Lumbar cable nut wrench
- Pelvis angle measurement tool
- Chest depth gauge

Section 2 – Head and Neck Removal

2.1 Disassembly

To disassemble the head and neck, detach the head-neck assembly from the upper torso. This is done by removing the 3/8-16 x 1 SHCS Nylok® (Item 1, Figure 2.1) and clamping washer (Item 2) that hold the upper neck bracket to the lower neck bracket.

Notice that the clamping washer is curved on one side. This curvature is designed to mate with the radius on the underside of the lower neck bracket; be sure to install this properly during reassembly. With this screw removed, remove the hex jam nut (Item 3), flat washer (Item 4), and four 10-24 x 5/8 SHCS (Item 5) that hold the upper neck bracket to the sternum bib and neck assembly. Remove the neck from the sternum bib.

To disassemble the head assembly from the neck, remove the four 10-24 x 1/2 SHCS (Item 6) that hold the skull cap in place. Completing the removal of the head from the neck will require the use of a compression tool to squeeze the nodding blocks (Item 7) located between the head and neck. If the nodding blocks are not compressed, it will be difficult and possibly damaging to remove the neck pivot pin (Item 12, Figure 3.1). When disassembling the head, the load cell can remain in the head. Loosen the two set screws (Item 11, Figure 3.1) that hold the pivot pin.

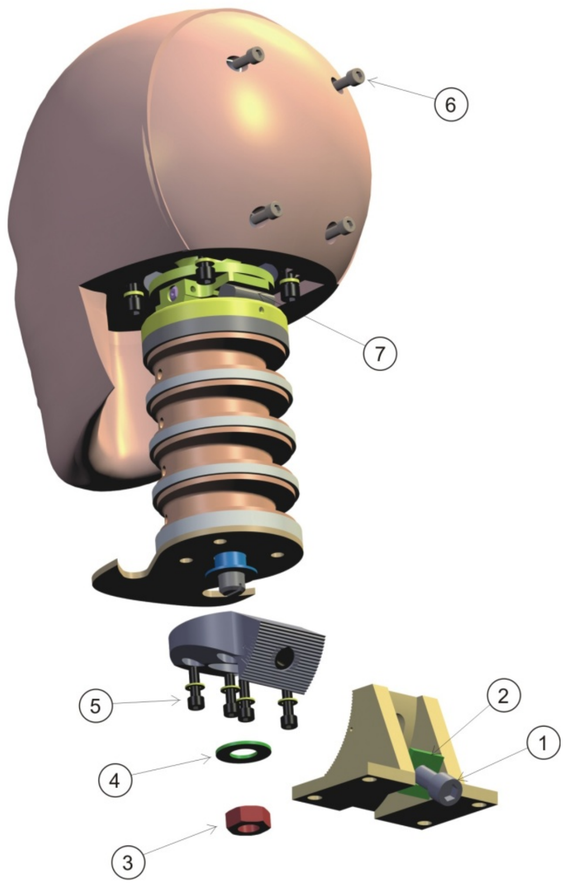


Figure 2.1- Disassembling the Head and Neck

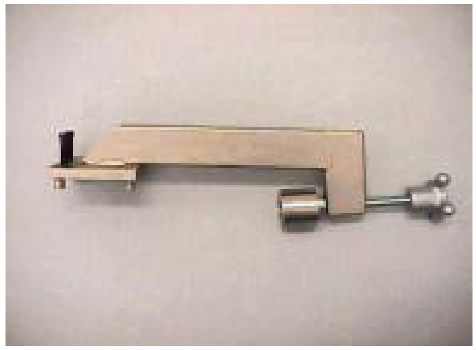


Figure 2.2 – Neck Compression Tool

Remove the skull cap and attach the H3-5 adapter to the back of the head using at least two 10-24 x 3/8 SHCS . Then place the exposed portion of the neck cable in the cylindrical cup on the tool, and attach the compression tool to the adapter plate as shown in Figure 2.3 with at least two 1/4-20 x 1-3/8 SHCS. With the tool attached, turn the handle until the nodding blocks are compressed enough to relieve the pressure on the pin. The pivot pin should slide out of the load cell or load cell replacement easily, but may require a light tap with a rubber mallet.

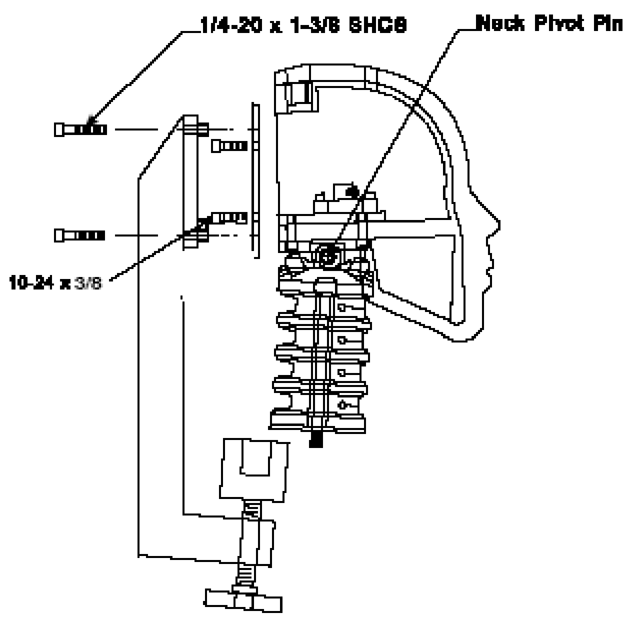


Figure 2.3 – Neck Removal

After the pin is removed, detach the tool. The neck will then be free to be pulled away from the head assembly. There are two brass washers located inside of the pivot pin joint that will fall out as the two components are separated. Do not confuse the brass washers with any others; they are trimmed for the proper fit of this joint.

Note: Newly purchased washers (78051-253) should be trimmed using the following procedure:

Trimming can be accomplished in several ways. The easiest is to rub the washer on coarse sandpaper or a file and check and recheck the fit of the joint. Repeat the trimming until the nodding joint and the load cell can be assembled snugly with the washers.

The fit of the nodding joint and load cell should be snug but easily assembled.

2.2 Reassembly

- Reattach the neck to the head.
- Reattach the skull cap to the back of the head.
- Reattach the neck and the upper neck bracket to the sternum bib.
- Position the upper neck bracket so it is positioned at the zero degree mark on the neck bracket.
- Reattach the upper neck bracket to the lower neck bracket.

2.3 Inspection

- Check for tears or breaks in the neck.

Section 3- Head Assembly

Figure 3.1 is an exploded view of the Head Assembly. Table 3.1 gives a general description of each item.

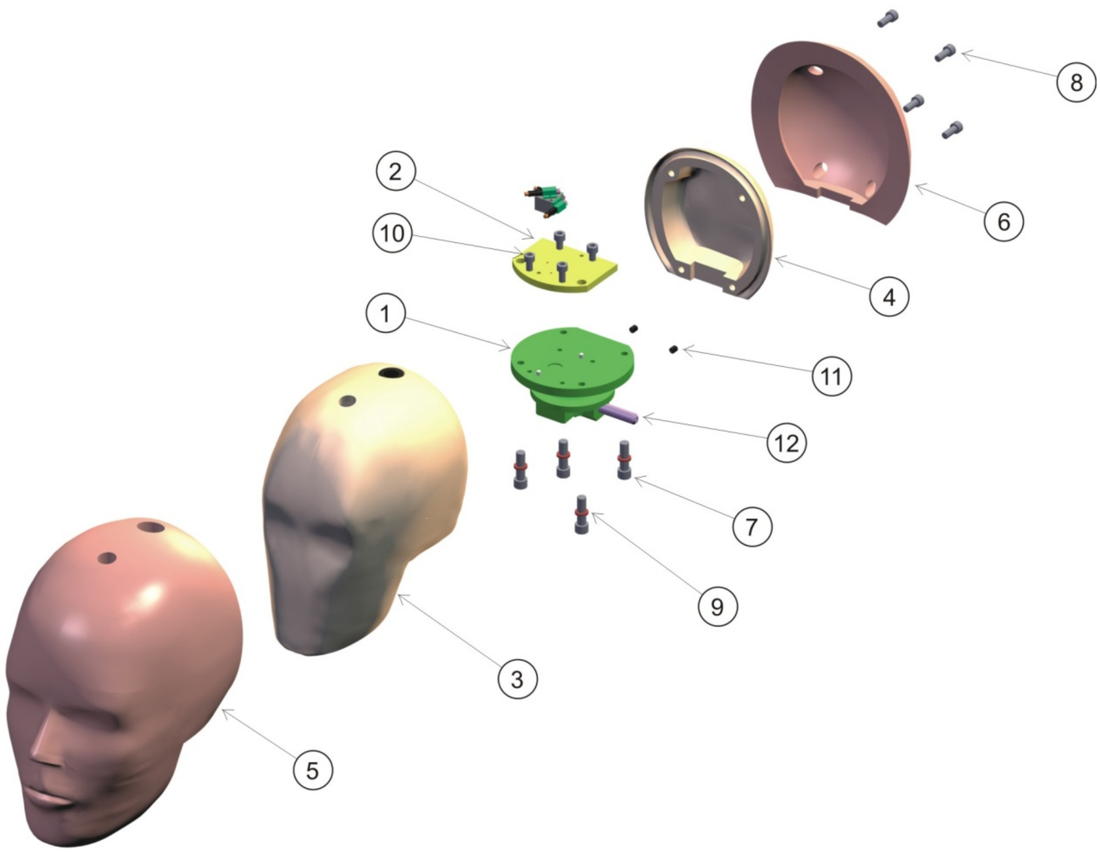


Figure 3.1 – Head Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	78051-383X	STRUCT. REPLACEMENT 6-AXIS NECK TRANS.
2	1	880105-1211	HEAD ACCEL. MOUNT 7264-2000 (REF)
3	1	880105-102	SKULL , 6-AXIS NECK
4	1	880105-103	SKULL CAP
5	1	880105-109	SKIN, HEAD
6	1	880105-106	SKIN, SKULL CAP
7	4	9000264	SCREW, SHCS ¼-28 X 7/8
8	4	9000624	SCREW, SHCS 10-24 X 1/2
9	4	9000677	WASHER, ¼ ID X 3/8 OD X 1/16
10	4	9000487	SCREW, SHCS #10-24 X 3/8 (REF)
11	2	9000452	SCREW, SSCP #8-32 X 1/4
12	1	780951-339	PIVOT PIN, NECK TRANDUCER

Table 3.1 - Head Assembly (880105-100X) Part List

3.1 Disassembly

When the neck is detached from the head, the remaining components can be disassembled from the head assembly. Remove the four 1/4-28 x 7/8 SHCS (Item 7, Figure 3.1) from the six-channel load cell or structural replacement. To remove the six-channel neck load cell or structural replacement from the assembly, it is necessary to pull the load cell out from the inside of the head through the back of the head.

The head skin can be pulled off of the head assembly by lifting the skin away from the skull at the back of the skull and "peeling" the flesh from the assembly. The head skin recommended for use by SAE is shown in Side view of head skin with filled chin (Figure 3.2 and 3.3). This version's design is intended to keep deploying airbags from getting between the back surface of the jaw flesh and the front surface of the neck.

3.2 Reassembly

- Put the head skin back on the skull, paying close attention to the fit of the flesh around the skull, particularly in the forehead area.
- Reattach the six-channel load cell or structural replacement.

3.3 Inspection

- Check the head skin for cracks or tears. Repair the head skin as indicated in Appendix B. Do not repair damage in the forehead region as this will affect test results; instead, replace the head skin.
- If the head skin does not feel soft and pliable, re-certify or replace the head skin.
- Check the skull for cracks or dents. Replace the skull if structurally damaged in any way.

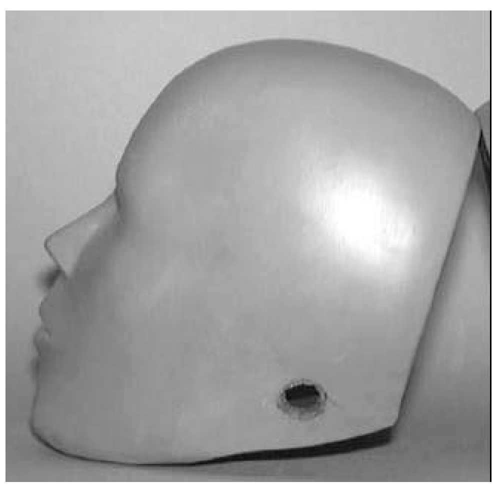


Figure 3.2 – Side view of head skin with filled chin

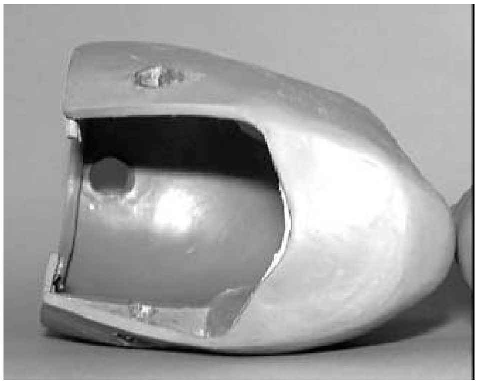


Figure 3.3 – Bottom of head skin with filled chin

Section 4 – Neck Assembly

Figure 4.1 is an exploded view of the Neck Assembly. Table 4.1 gives a general description of each item.

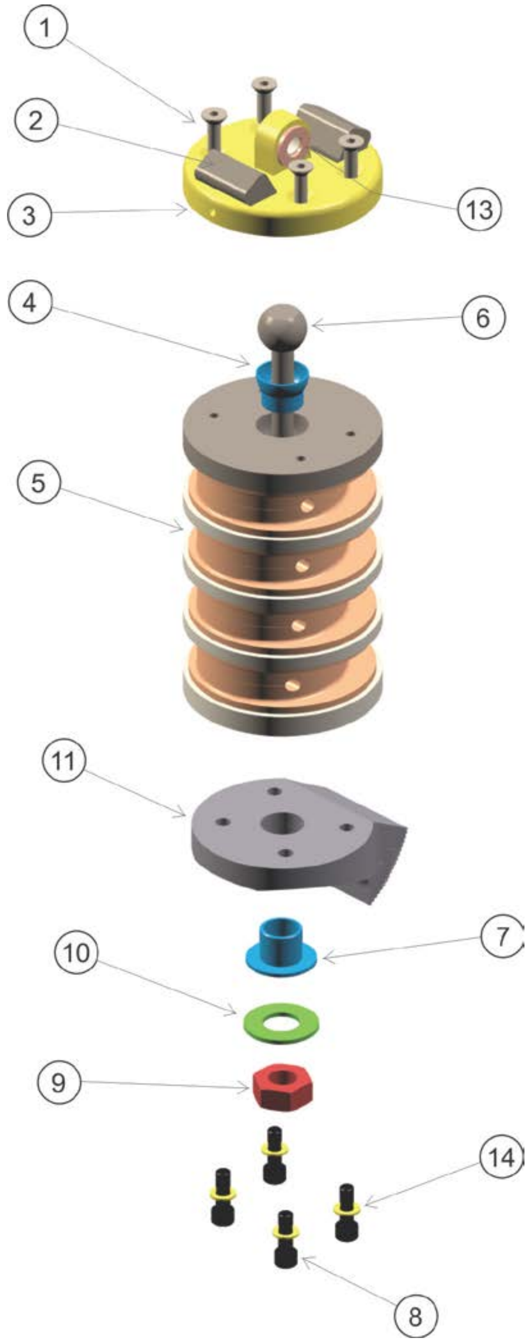


Figure 4.1 – Neck Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	4	9000566	SCREW, FHCS #10-24 x 5/8
2	2	78051-351	NODDING BLOCK
3	1	880105-201	NODDING JOINT NECK ASSEMBLY
4	1	180-2004	BUSHING UPPER
5	1	880105-255	NECK MOLDED-TESTED & CERT.
6	1	880105-206	NECK CABLE
7	1	180-2005	BUSHING LOWER
8	4	9000244	SCREW, SHCS #10-24 X 5/8
9	1	9000018	NUT, HEX JAM ½-20
10	1	9001260	WASHER, 1.06 OD X .53 ID X .06
11	1	880105-207	UPPER NECK BRACKET
12	1	880105-1060	BIB ASSEMBLY (REF) (NOT SHOWN)
13	2	78051-253	WASHER, NODDING JOINT
14	1	9000710	WASHER FLAT 7/32 ID X 3/8 OD X 1/32

Table 4.1 – Neck Assembly (880105-250) Part List

Once separated, check the condition of the two rubber neck nodding blocks on the top of the nodding joint. The 90° surfaces of the nodding blocks fit opposite, rather than inside, the 90° grooves of the head-to-neck adaptor bracket (Figure 4.2).

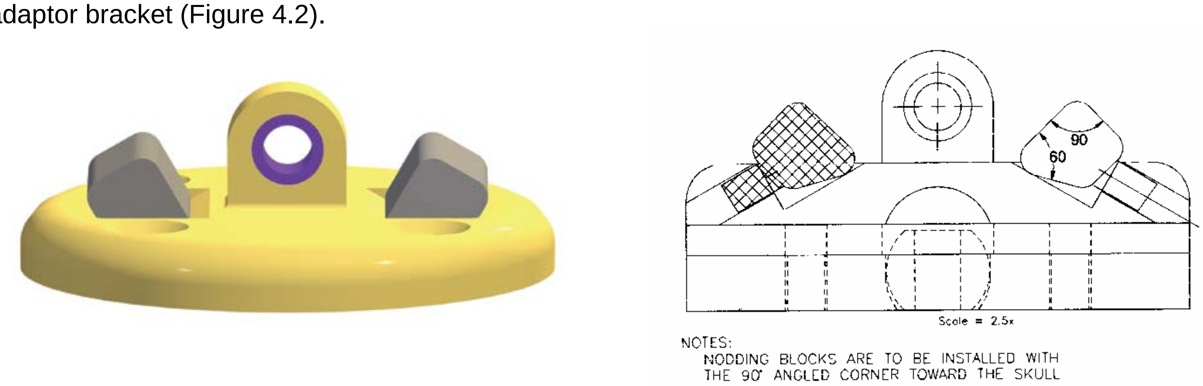


Figure 4.2 - Nodding Block Orientation

4.1 Disassembly

To disassemble the neck assembly, remove the four 10-24 x 5/8 FHCS (Item 1, Figure 4.1) from the top of the nodding joint. With the joint removed, the neck cable (Item 6, Figure 4.1) can be pulled out of the neck. Remove the cable bushings (Items 4 and 7, Figure 4.1) from each end of the cable.

4.2 Reassembly

- The upper end of the neck is machined to accept the cable ball end bushing of the neck cable. During reassembly, make sure that this area is free of any extraneous rubber material before installing the cable. Put the cable bushings on each end of the cable. The neck cable (Item 6, Figure 4.1) must be inserted in the neck with the “ball” end seated in the cup at the upper end of the neck.

- The torque on the Hex Jam Nut (Item 9, Figure 4.1) should be 1.4 ± 0.2 N·m (12 ± 2 in·lbf).

- Install the nodding joint to the neck using the four screws (Item 1, Figure 4.1).

- The SAE has recommended that a single layer of 6.3 mm (0.25 inch) thick by 244 mm (9.6 inch) long by 127 mm (5.0 inch) high neoprene closed-cell rubber foam be wrapped around the neck and secured with Velcro® (or equivalent) at the bottom in the rear. The Velcro® loop is 19 mm (0.75 inch) wide and 64 mm (2.5 inch) long. This neck shield is intended to prevent the airbag from getting into the slits in the rubber neck discs.

4.3 Inspection

- Check for tears or breaks in the neck.

- Check the nodding blocks for wear and deformation. Noise and improper loading of the nodding joint will occur with damaged blocks.

- Check the hardness of the nodding blocks often with a shore “A” type durometer. The specification is 80-90

- Check the axial integrity of the neck. (see Appendix D)

- The neck cable should be torqued to 1.4 ± 0.2 N·m (12.0 ± 2 in·lbf). Check the neck cable by observing the strands. If they are not tightly wound, or the cable seems larger in diameter on one end, replace the cable. If the cable cannot be properly torqued, replace the cable.

Section 5 – Upper Torso Assembly

Figures 5.1, 5.2 and 5.3 show the Upper Torso Assembly views. Table 5.1 gives a general description of each item.

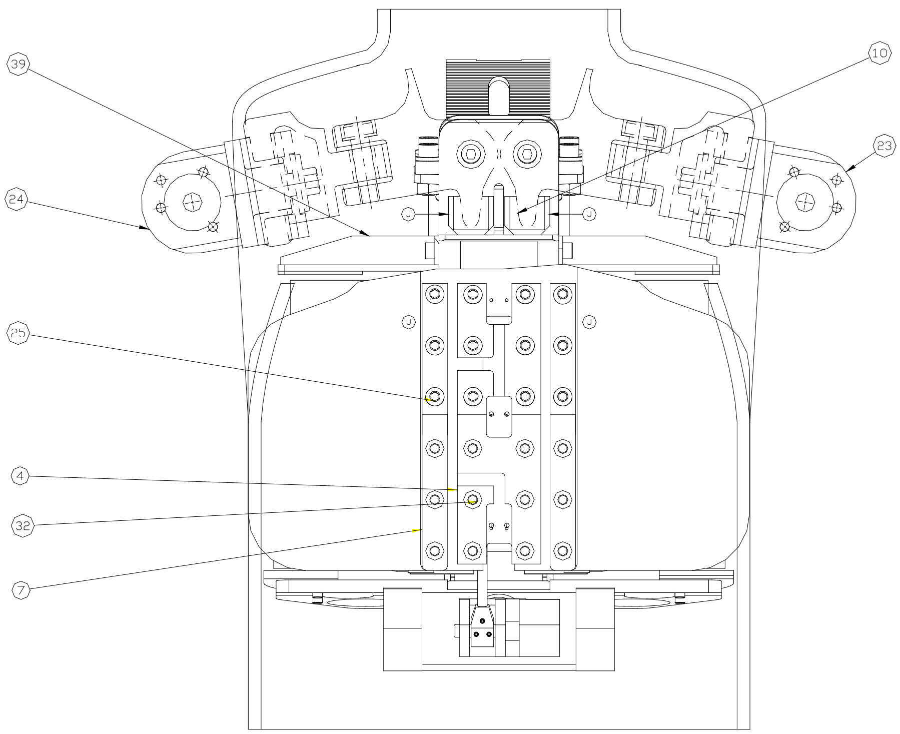


Figure 5.1 – Upper Torso Front View

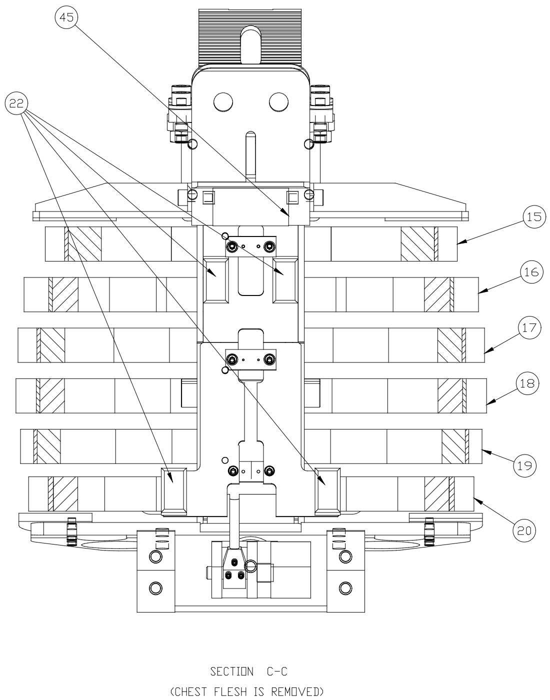


Figure 5.2 – Upper Torso Front View

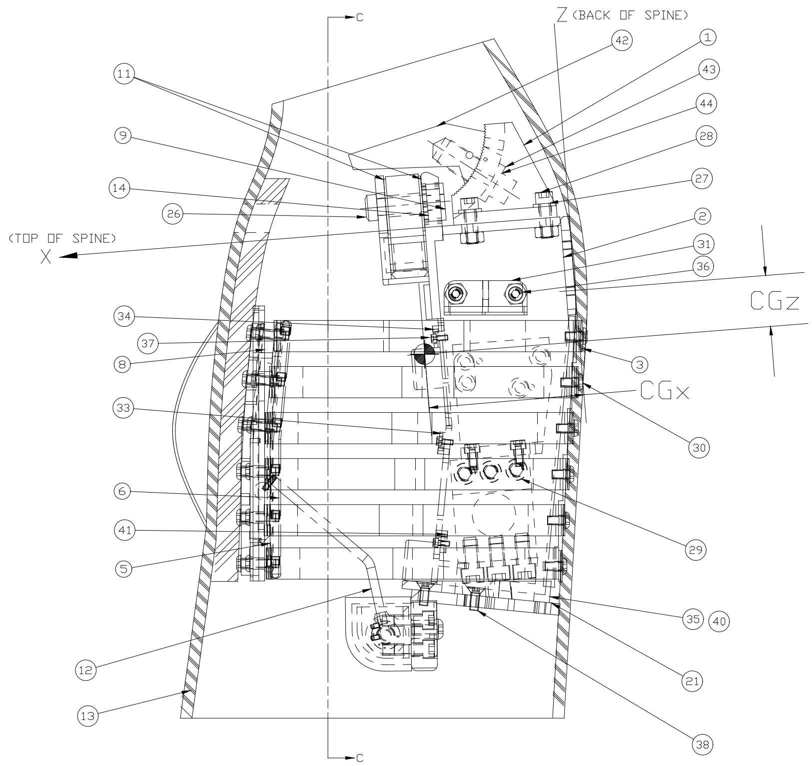


Figure 5.3- Upper Torso Side View

ITEM	QTY	PART NO.	DESCRIPITON
1	1	880105-208	LOWER NECK BRACKET
2	1	880105-1000	THORACIC SPINE WELDMENT
3	6	880105-320	REAR RIB SUPPORT
4	1	880105-1050	STERNUM SLIDER
5	1	880105-1051	STERNUM NUT PLATE
6	2	880105-323	STIFFENER STRIP (BEHIND RIBS)
7	2	880105-324	STIFFENER STRIP (FRONT)
8	1	880105-1060	BIB ASSEMBLY
9	2	880105-340	NUT
10	2	880105-341	SHOULDER BUMPER
11	4	880105-342	CLAVICLE LINK WASHER
12	1	880105-1080	CHEST DEFLECTION TRANDUCER ASSEMBLY
13	1	880105-355-E	CHEST FLESH
14	2	880105-359	WASHER STERNUM
15	1	880105-361-1	RIB NO. 1 ASSEMBLY
16	1	880105-361-2	RIB NO. 2 ASSEMBLY
17	1	880105-361-3	RIB NO. 3 ASSEMBLY
18	1	880105-361-4	RIB NO. 4 ASSEMBLY
19	1	880105-361-5	RIB NO. 5 ASSEMBLY

20	1	880105-361-6	RIB NO. 6 ASSEMBLY
21	1	880105-1085	ADAPTOR ASSEMBLY
22	2	78051-9	STOP STERNUM
23	1	880105-380	SHOULDER ASSEMBLY, LEFT
24	1	880105-381	SHOULDER ASSEMBLY, RIGHT
25	12	9000025	SCREW, BHCS #10-32 X 5/8
26	2	9000074	SCREW, SHSS 3/8 X 1.00
27	4	9000553	WASHER .281 ID X .500 OD X .060
28	4	9000454	SCREW, SHCS ¼-20 X 3/4
29	6	9000489	SCREW, SHCS 5/16-18 X 1/2
30	12	9000538	SCREW, BHCS #10-32 X 3/8
31	1	880105-1015-1	UPPER RIB STOP ASSEMBLY, LEFT
32	12	9001193	SCREW, BHCS #10-32 X 3/4
33	1	880105-1020	ACCELEROMETER MOUNT SPINE, MIDDLE
34	1	880105-1021	ACCELEROMETER MOUNT SPINE, TOP
35	1	880105-1030-1	LOWER RIB STOP, LEFT
36	4	9000147	SCREW, SHCS #10-32 X 1/2
37	6	9000528	SCREW, SHCS #4-40 X 1/4
38	4	9000208	SCREW, FHCS #10-32 X 1/2
39	1	880105-1015-2	UPPER RIB STOP ASSEMBLY, RIGHT
40	1	880105-1030-1	LOWER RIB STOP, RIGHT
41	1	880105-1022	ACCELEROMETER MOUNT SPINE, BOTTOM
42	1	880105-207	UPPER NECK BRACKET (REF)
43	1	9000021	SCREW, SHCS 3/8-16 X 1 (REF)
44	1	78051-305	WASHER-CLAMPING (REF)
45	1	880105-1090	FRONT SPINE URETHANE SHEET

Table 5.1 – Upper Torso Assembly (880105-300) Parts List

5.1 Disassembly

To begin the disassembly, take the arm assemblies off the upper torso. This is done by removing the two 3/8 x 1 SHSS (Item 12, Figure 7.1) which attach the arms to the shoulders. Pay close attention to placement of the washers in the shoulder joint. If any of the components are missing, the joint will not properly tighten to the one G adjustment. With the arms off, the chest flesh and the abdomen can be removed.

The shoulder assembly is detached by removing the 3/8 x 1 SHSS (Item 26, Figure 5.3) from the front of the spine box and pulling the assembly up and away from the torso. When the shoulder is removed, the two clavicle link washers (Item 11, Figure 5.3), the sternum washer (Item 14, Figure 5.3), and the nut (Item 9, Figure 5.3) will fall from the assembly.

Once the shoulder is detached, you can remove the shoulder bumper, (Item 10, Figure 5.1) a "U" shaped, black rubber part. These bumpers provide tension and noise damping for the clavicle link.

With the shoulders removed, the lower neck bracket can be taken off the spine box. The lower neck bracket is held in place by four 1/4-20 x 3/4 SHCS (Item 28, Figure 5.3) and washers.

To completely disassemble the ribs (Item 15-20, Figure 5.2), start by detaching the bib assembly (Item 8, Figure 5.3) from the rib assembly. This is done by taking out the twelve 10-32 x 5/8 BHCS (Item 25, Figure 5.1) that hold it to the ribs. Inside the rib assemblies are two behind rib strips (Item 6, Figure 5.3) that will fall when these screws are removed. Now remove the twelve 10-32 x 3/8 BHCS (Item 30, Figure 5.3) at the rear of the spine box. At the rear of the thorax are six rib rear supports or rib stiffeners (Item 3, Figure 5.3). With the screws from the front and rear of the rib set removed, each rib can be pulled away from the thorax. As the ribs are pulled away, it will be necessary to pull them open. However, do not open them so wide that the shape of the rib is permanently changed. Permanently changing the shape of one rib can alter the dynamic characteristics of the rib set.

To detach the upper rib stops (Item 31 & 39, Figure 5.1 & 5.3), remove the two SHCS 10-32x1/2 (Item 36) on the left and right sides. The lower rib stops (Item 35 & 40, Figure 5.3) are not recommended to be removed, unless the Delrin® stop has been damaged.

From the bib assembly, remove the transducer arm slider (Item 4, Figure 5.1). This is done by removing the twelve 10-32 x 5/8 BHCS (Item 25, Figure 5.1) that hold the slider in place on the bib-sternum assembly, and then pulling the slider upward to allow the transducer arm ball to slide out of the groove on the rear side of the slider.

5.2 Reassembly

- Install the transducer arm slider into the bib assembly.
- Reattach the upper rib stops if they have been removed.
- Reattach the ribs to the back of the spine box. Be sure that the 10-32 x 5/8 BHCS (Item 25, Figure 5.1) from the bib sternum assembly are replaced in the front of the thorax and not the rear. The correct screws to mount the ribs in the rear are 10-32 x 3/8 BHCS (Item 30, Figure 5.3); they are not long enough to properly hold the assembly together in the front.
- Install the rear rib support (Item 3, Figure 5.3) so the beveled ends of the supports face the ribs. If during reassembly these supports are reversed so that the bevels face away from the ribs, the stiffness of the rib set will be increased significantly. These supports are interchangeable.
- Reattach the bib assembly to the ribs. When reinstalling the threaded stiffener plates (Item 6, Figure 5.3), notice that the bars have a slight bend in the upper 1/3 of the bar. This bend is meant to conform to the natural curve of the thorax and should be replaced in the same orientation relative to the rib set, with the curve facing backward. Be sure to replace the front stiffener plates (Item 7, Figure 5.1) during reassembly.
- Reattach the lower neck bracket.
- Install the shoulder bumpers, the clavicle link washers, sternum washer, and the nut. Take care to replace the washers in the shoulder joint as shown in Figure 5.9. The clavicle link washers (Item 11, Figure 5.3) have a machined flat on the outside radius. This flat must mate with the other clavicle link washer for the opposite shoulder assembly or the two shoulder bolts (Item 26, Figure 5.3) will not go in.
- Reattach the shoulder assembly to the spine box. During the reassembly of the shoulder joint, it is sometimes necessary to apply force to the bumper to compress it so the shoulder screw can be inserted. This is accomplished by using a small 75-100 mm (3 - 4 in) "C" clamp. The clamp should be placed so the centerline of the shoulder screw hole passes through the compression arm of the clamp. Do not apply too much pressure to the shoulder. It is made of cast aluminum and too much pressure could crack the end.
- Place the chest jacket on the upper torso.
- Reattach the arm assemblies to the upper torso.
- The sternum and spine box accelerometers must all have the same seismic mass location as shown in Figure 1.1.

5.3 Inspection

- Because of the malleable nature of the damping material of the ribs, take care to insure that they are not damaged. The ribs are manufactured from three components: the rib steel, the damping material, and the epoxy that bonds the steel and damping sections.
- Check to make sure the ribs have not deformed using the chest depth gage shown in Figure 5.4, 5.5. As shown in Figure 5.6 with the rib cage fully assembled, insert the rod of the gage between rib #1 and rib #2. The rear flat on the handle (surface A) is held against the surface to which rib #1 is attached on the spine box. If the rod touches the thread strip, the chest depth at rib #1 has decreased below the acceptable range. To measure the chest depth at rib #6, insert the rod of the gage between rib #5 and rib #6, with the front flat on the handle (surface B) held against the surface to which rib #5 is attached on the spine box. If the rod touches the thread strip, the chest depth at rib #6 has decreased below the acceptable range.
- During reassembly, check the ribs and the rib damping material for cracks or warping of the damping material. Recertify and/or replace and recertify the ribs if they are damaged.
- Check the sternum stops for looseness. If they are loose, they can be glued back in place using epoxy cement. Be sure that when gluing them into position, they do not interfere with the chest deflection transducer assembly.

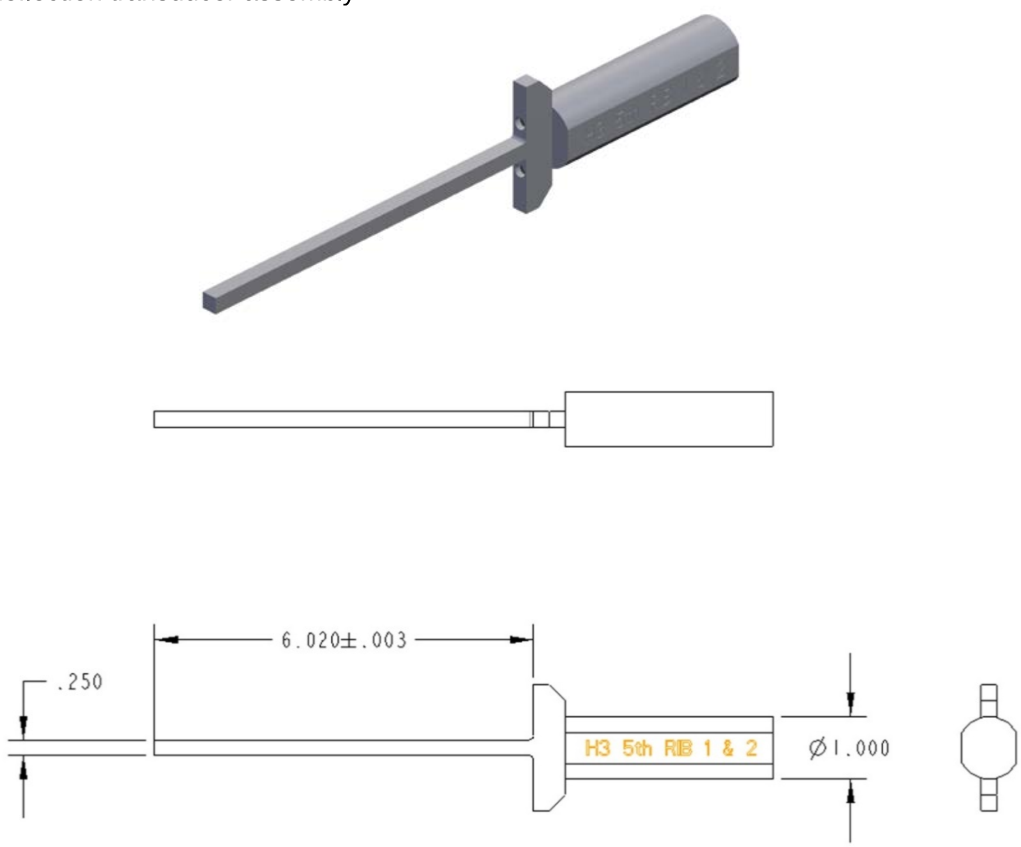


Figure 5.4- Chest Depth Gage (880105-811)

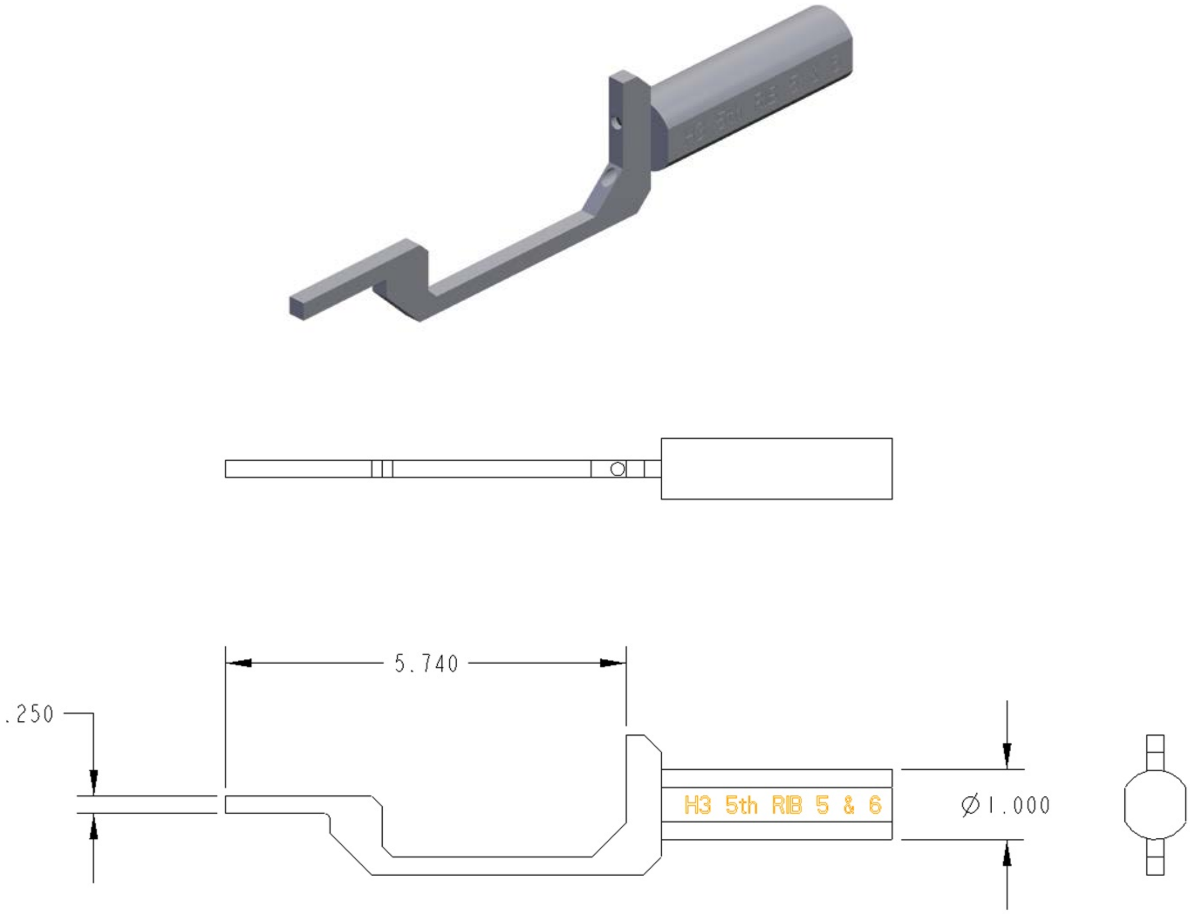


Figure 5.5- Chest Depth Gage (880105-813)

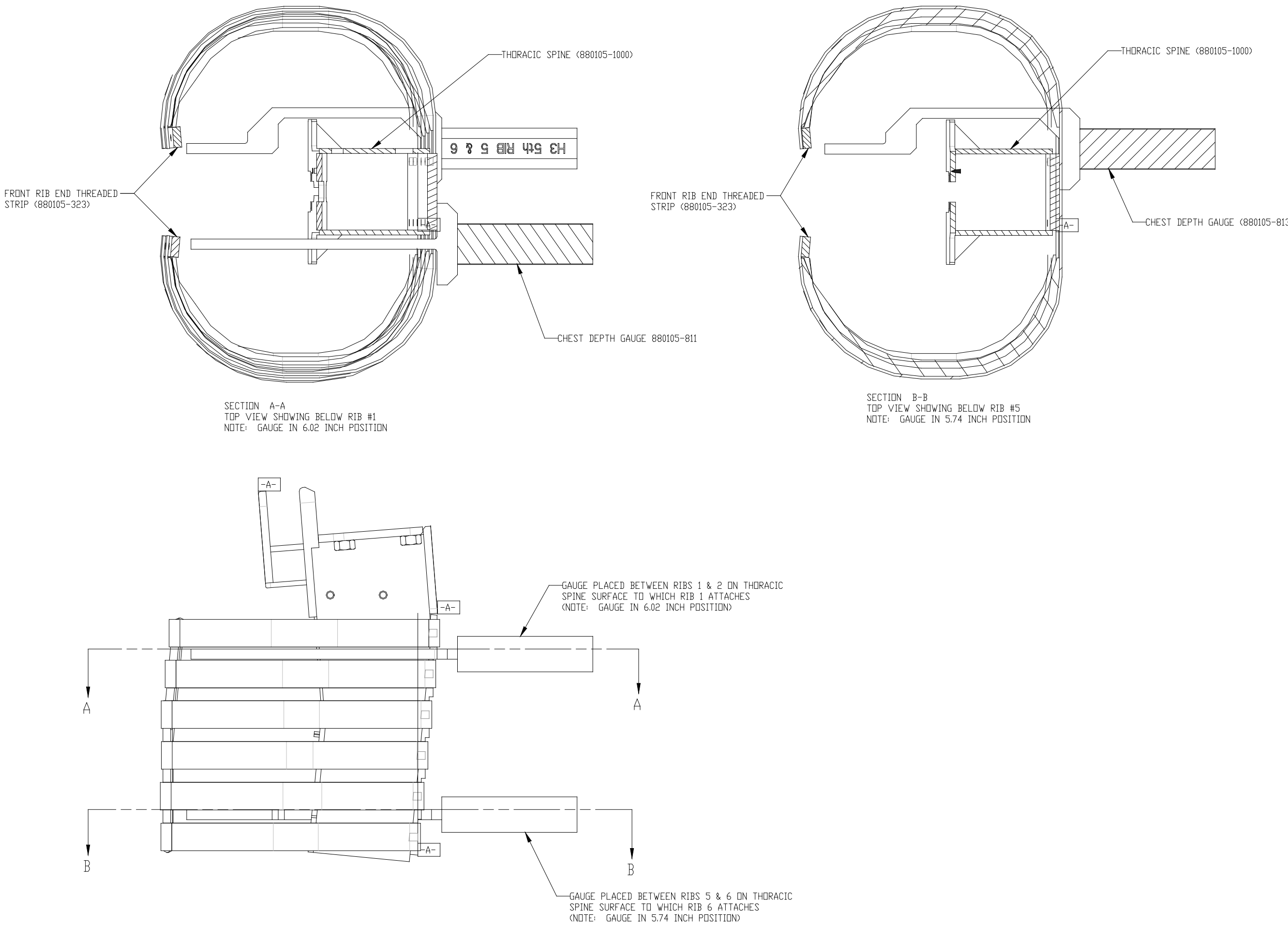


Figure 5.6- Chest Depth Measurement Setup

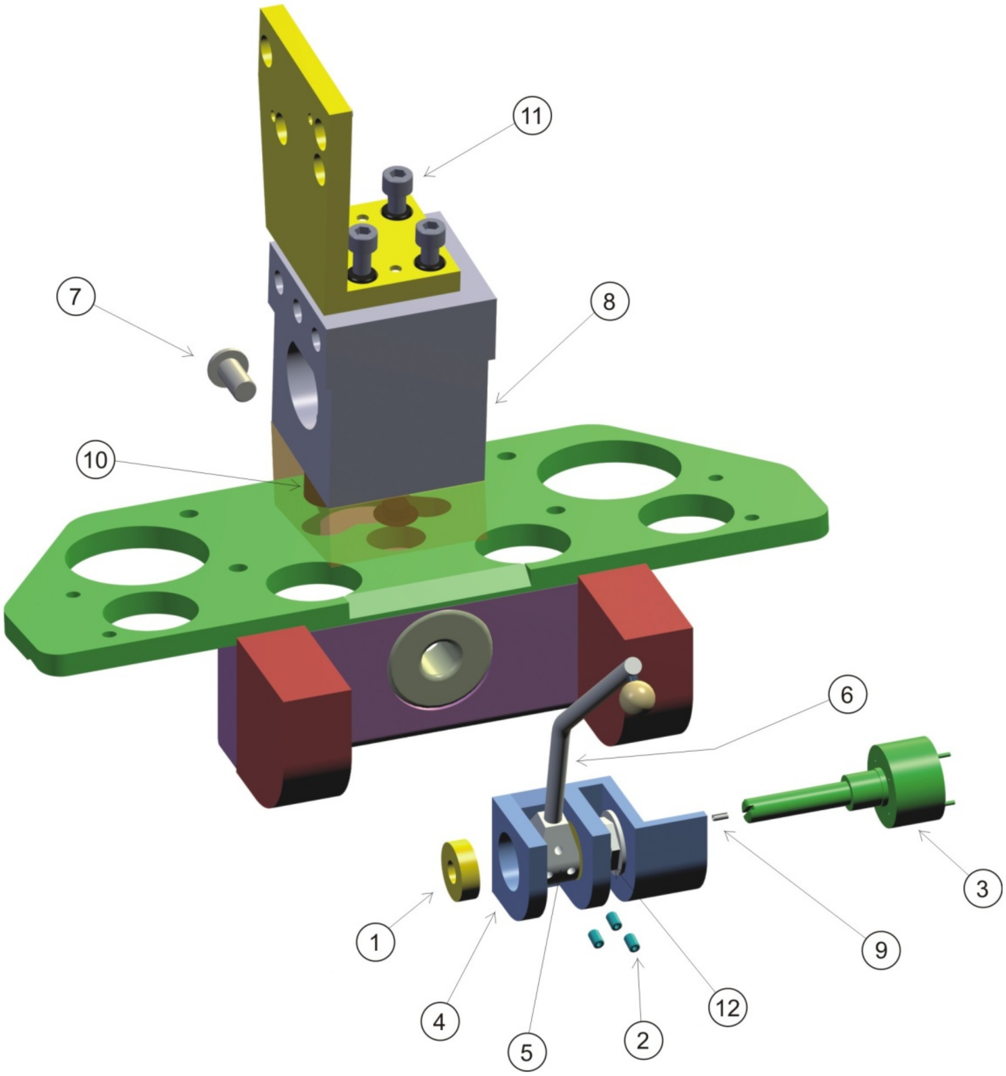


Figure 5.7- Chest Deflection Transducer Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	2	78051-314	BEARING
2	3	78051-334	SET SCREW
3	1	78051-342	POTENTIOMETER
4	1	78051-354	POT BRACKET
5	1	78051-355	CONNECTOR
6	1	880105-1071	TRANSDUCER ARM ASSEMBLY
7	1	9000407	SCREW, BHCS ¼-20 X 1/2
8	1	880105-1085	ADAPTOR ASSEMBLY LUMBAR THORACIC (REF)
9	1	9000033	PIN, SLOTTED SPRING .06 X .156
10	4	9000489	SCREW, SHCS 5/16-18 x ½
11	4	9000031	SCREW, SHCS #10-24 X 5/16 NYLOCK
12	1		JAM NUT (SUPPLIED WITH POTENTIOMETER)

Table 5.2- Chest Deflection Transducer Assembly (880105-1080) Parts List

5.4 Chest Deflection Disassembly

Separate the thorax from the lower torso by removing the four ¼-20 x .62 SHCS (Item 7, Figure 6.1) at the top of the lumbar spine mount assembly. Lift the thorax off the lower torso. Then remove six 5/16-18 x ½ SHCS (Item 29, Figure 5.3) (three on each side of the spine box). Remove the chest accelerometers if they are installed. Pull the adapter assembly out of the spine box. With the adapter assembly out of the spine box, the load cell simulator, load cell mount and the accelerometer mount bracket are accessible. Disassemble the adapter assembly by removing the four 5/16-18 x 1/2 SHCS (Item 10, Figure 5.7) that hold the load cell mount to the load cell structural replacement. These screws are accessible through the holes in the base of the adapter. To remove the chest accelerometer mounting bracket from the load cell simulator, remove the four 10-24 x 5/16 SHCS (Item 11, Figure 5.7) screws at the upper surface of the adapter.

To remove the deflection transducer from the adapter assembly, take out the 1/4-20 x 1/2 BHCS (Item 7, Figure 5.7) that holds the potentiometer bracket (Item 4, Figure 5.7) in place. By loosening the 4-40 SSCP on the potentiometer connector, the transducer arm (Item 6, Figure 5.7) can be pulled out of the assembly. With the transducer arm disconnected, remove the bracket with the potentiometer from the dummy. Next, loosen the jam nut (Item 12, Figure 5.7) that holds the potentiometer in place and slide the potentiometer out of the bracket.

5.5 Chest Deflection Reassembly

- Slide the potentiometer into the bracket and tighten the jam nut. When reassembling unit, be sure that the roll pin, which is used to keep the potentiometer body from turning, is properly positioned on the potentiometer body so as not to damage the transducer.
- Reattach the potentiometer bracket.
- Reattach the transducer arm to the bracket.
- Reattach the bracket to the adaptor assembly.
- Reattach the chest accelerometer mounting bracket to the load cell simulator.
- Install the adapter assembly to the load cell mount and load cell structural replacement. When installing the thoracic spine load cell, position the transducer so the cables leaving the body are toward the rear of the spine box. There could be some binding when the adapter assembly is replaced in the spine box and this may damage the cables if they are not positioned toward the rear.
- Put the adapter assembly into the spine box.
- Replace the accelerometers if needed.
- Place the thorax on the lower torso, and attach using the four fasteners to the lumbar spine mount assembly.

5.6 Chest Deflection Inspection

Depending upon the stack up of tolerances and how far the potentiometer bracket (Item 4, Figure 5.7) pivot bearing is pressed into the adaptor (Item 8, Figure 5.7), the transducer arm (Item 6, Figure 5.7) may contact the spine weldment before the sternum contacts the sternum stops. This is not acceptable. When the transducer arm (Item 6, Figure 5.7) is removed from the chest deflection transducer slider (880105-1050), make sure it can be moved back to within 13 mm (1/2 inch) of the sternum stops without contacting the spine weldment. See Figure 5.8.

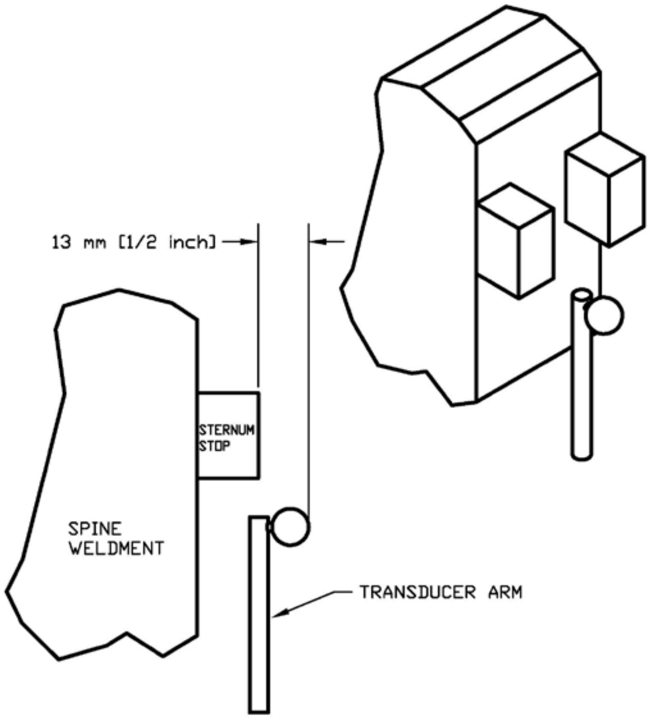


Figure 5.8- Transducer Arm Clearance Check

5.7 Shoulder Assembly

Figure 5.9 shows the Shoulder Assembly. Table 5.3 gives a general description of each item.

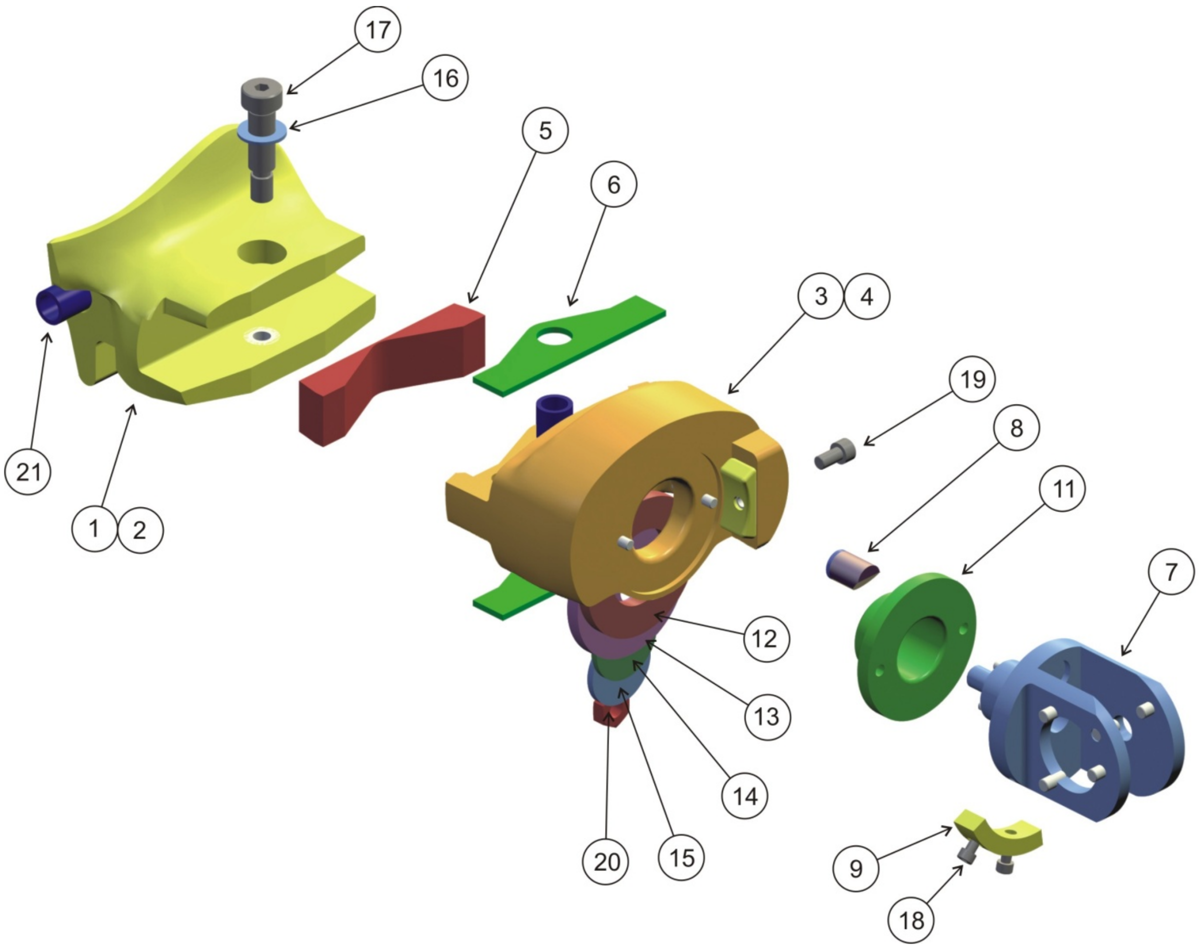


Figure 5.9- Shoulder Assembly Exploded View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-334	CLAVICLE LINK, LEFT
2	1	880105-335	CLAVICLE LINK, RIGHT (NOT SHOWN)
3	1	880105-336	CLAVICLE, LEFT
4	1	880105-337	CLAVICLE, RIGHT (NOT SHOWN)
5	1	880105-338	SPRING, CLAVICLE STOP
6	2	880105-339	SPACER, CLAVICLE
7	1	880105-343	SHOULDER YOKE
8	1	880105-344	SHOULDER STOP ASSEMBLY
9	1	880105-346	STOP, STEEL
10	1	880105-347	SHOULDER STOP ASSEMBLY
11	1	880105-348	BUSHING, SHOULDER YOKE PIVOT
12	1	880105-349	WASHER, SHOULDER YOKE PIVOT
13	1	880105-350	WASHER, RETAINING
14	1	880105-351	WASHER, SHOULDER JOINT SPRING
15	1	880105-352	WASHER, STEEL
16	1	880105-367	WASHER, CLAVICLE LINK
17	1	9000074	SCREW, SHSS 3/8 X 1.00
18	2	9000379	SCREW, SHCS #6-32 X 3/8
19	1	9000487	SCREW, SHCS #10-24 X 3/8
20	1	9000656	NUT, HEX JAM 5/16-18
21	1	880105-357	CLAVICULAR AND CLAVICULAR LINK BUSHING (REF)

Table 5.3- Shoulder Assembly (880105-380/381) Parts List

5.8 Shoulder Disassembly

The clavicle link is separated from the clavicle by removing the 3/8 x 1.00 SHSS (Item 17, Figure 5.9) from the upper side of the link assembly. When the two sections are pulled apart, two Delrin® spacers (Item 6, Figure 5.9) and a urethane spring stop (Item 5, Figure 5.9) will be free to drop from the assembly. The stop assembly (Item 8, Figure 5.9) acts as a limiting device for the arm upward or 'Z' motion. The stop assembly is held in place by a #10-24 x 3/8 SHCS (Item 19).

Once the link and the clavicle are detached, the shoulder yoke (Item 7, Figure 5.9) can be removed from the assembly. To remove these parts, take off the 5/16-18 lock nut (Item 20, Figure 5.9) located inside of the machined clavicle. With the nut removed, pull the steel washer (Item 15, Figure 5.9) away from the shoulder joint spring washer (Item 14, Figure 5.9) and the retaining washer (Item 13, Figure 5.9).

To remove the yoke pivot washer (Item 12, Figure 5.9) it may be necessary to use a small screwdriver to pry it away from the clavicle due to the close tolerances used in manufacturing the part. Be sure not to damage the friction surfaces (i.e. inside diameter, faces). Notice the two dowel pins pressed into the clavicle, which are used to locate and retain the bushing in its proper position.

The last component that can be removed from the shoulder yoke is the steel stop (Item 9, Figure 5.9). This stop is held in place with two #6-32 x 1/2 Nylok® SHCS (Item 18). The steel stop is used with the stop assembly to limit the range of motion of the arm.

5.9 Shoulder Reassembly

- Fasten the steel stop to the shoulder yoke.
- Install the inside bushing.
- Replace the components into the machined clavicle. The steel retaining washer should be placed closest to the lock nut and the urethane spring washer next to the large steel washer.
- Reattach the shoulder yoke to the assembly.
- Reattach the clavicle to the clavicle link; remember to replace the two Delrin® washers and the urethane spring stop.

5.10 Shoulder Inspection

- Examine the shoulder casting for cracks due to too much compression during assembly. Replace the casting if it is cracked.
- Because it is rubber, check the stop assembly for damage and replace it if necessary.

Section 6 – Lower Torso Assembly

Figure 6.1 represents the exploded view of the lower torso. Table 6.1 is a list of general part descriptions.

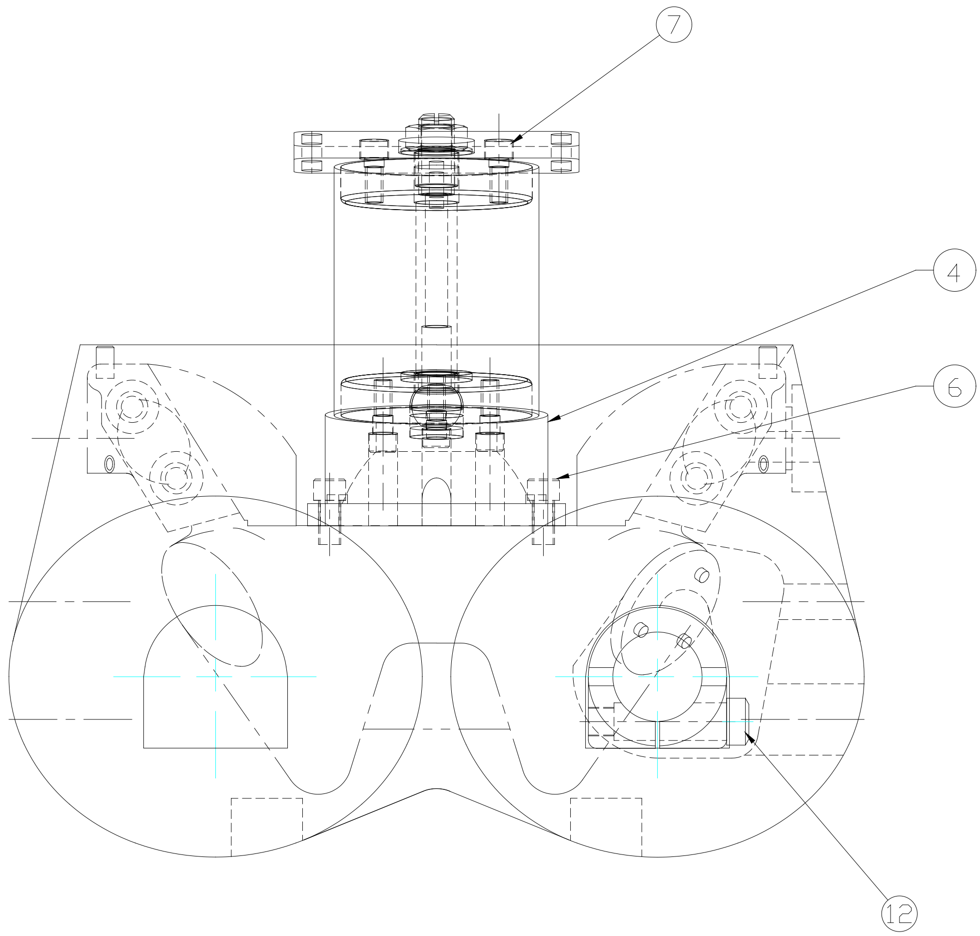


Figure 6.1 – Lower Torso Front View

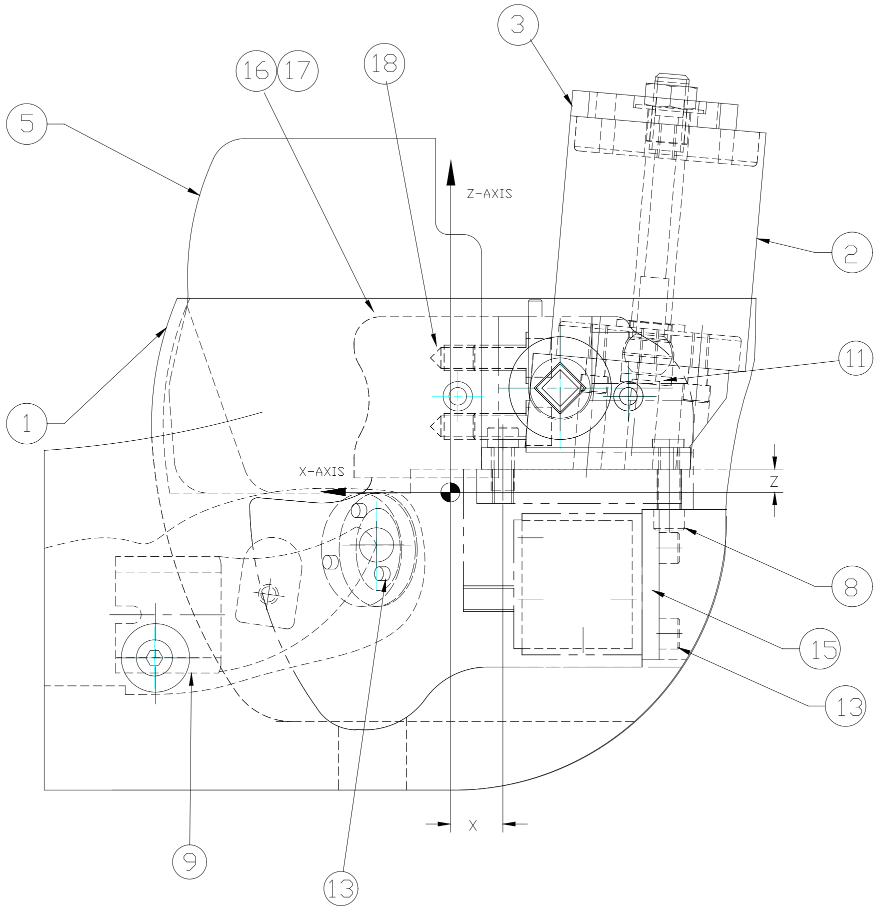


Figure 6.2- Lower Torso Side View

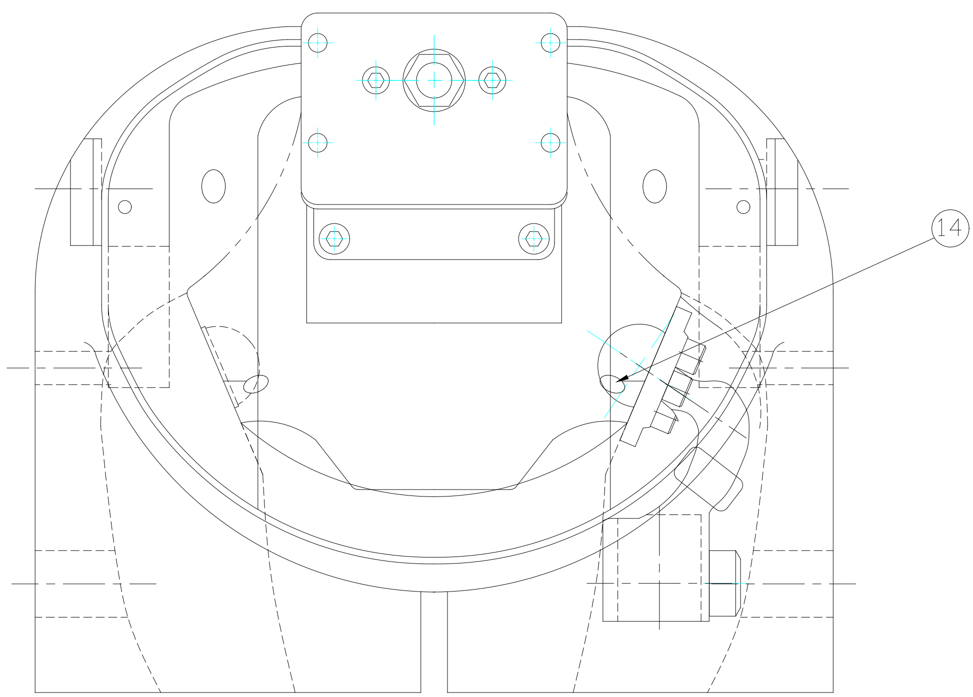


Figure 6.3 – Lower Torso Top View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-440	PELVIC STRUCTURE MOLDED ASSEMBLY
2	1	880105-1096	LUMBAR SPINE ASSEMBLY
3	1	880105-405	LUMBAR THORACIC ADAPTOR
4	1	880105-1094	LUMBAR PELVIC ADAPTOR WELDMENT
5	4	880105-434	ABDOMINAL INSERT
6	2	9000142	SCREW, SHCS 5/16-18 X .62
7	6	9000144	SCREW, SHCS 1/4-20 X .62
8	6	9000476	SCREW, SHCS 5/16-18 X .87
9	2	880105-420	FEMUR LEFT WITH BUMPER
10	1	880105-421	FEMUR RIGHT WITH BUMPER (NOT SHOWN)
11	2	880105-1091	LUMBAR PAD
12	1	880105-1101	MODIFIED SCREW
13	3	9000624	SCREW, SHCS #10-24 X 1/2
14	1	1200051	PELIVC PLUNGER SET SCREW
15	2	78051-13	COVER PELVIC INSTRUMENT CAVITY
16	1	880105-432-1	LOADCELL SIMULATOR (INSERT), LEFT
17	1	880105-432-2	LOADCELL SIMULATOR (INSERT), RIGHT
18	4	9000750	SCREW, SHCS 3/8-24 X 3/4

Table 6.1 – Lower Torso Assembly (880105-450) Parts List

6.1 Lumbar Disassembly

The lumbar-thorax adapter, lumbar spine, spine cable and the lumbar-pelvic adapter can be removed from the lower torso as one single assembly. Remove the two 5/16-18 x 5/8 SHCS (Item 6, Figure 6.1) from the abdominal insert area at the base of the lumbar spine. Then remove the two 5/16-18 x 7/8 SHCS (Item 8, Figure 6.2) from inside the instrument cavity port at the rear of the pelvis. With those four screws extracted, the entire assembly will lift out of the pelvis.

The rubber lumbar spine assembly can be detached from the lumbar pelvic adaptor weldment (Item 6, Figure 6.4) by removing the four 1/4-20 x .62 SHCS. To disassemble the rubber lumbar spine, remove the two 1/4-20 x .62 SHCS (Item 7, Figure 6.4) from the top surface of the lumbar thoracic adaptor (Item 10, Figure 6.4) and then remove the jam nut (Item 3, Figure 6.4) on the spine cable. After removing the nut and screws from the upper part of the assembly, remove the spine cable for inspection or replacement. Remove the bushings (Items 2 and 4, Figure 6.4) from each and of the cable.

6.2 Lumbar Reassembly

- Install the lumbar-thorax adapter, lumbar spine, spine cable, and the lumbar-pelvic adapter into the lower torso.

- Fasten the lumbar-thorax adapter, lumbar spine, spine cable, and the lumbar-pelvic adapter to the lower torso with the fasteners in the instrument cavity port. Finish attaching using fasteners at the base of the lumbar spine.

Note: The jam nut (Item 3, Figure 6.4) must be torqued to 1.24 ± 0.1 N·m (11 ± 1 in·lbf) during assembly and should be checked before using the dummy for testing. The lumbar spine cable nut should not be left torqued when the dummy is in storage. This will cause permanent deformation to the spine.

6.3 Pelvis Disassembly

To remove the femurs (Item 9 & 10, Figure 6.2), first loosen the femur plunger set screw (Item 14, Figure 6.3) in the abdominal insert area near the base of the lumbar-pelvic assembly. This will allow the femurs to move freely. If you remove the plunger, notice on one end of the part a Nylon® rod inserted into the screw. The nylon is what actually pushes down on the femur when the set screw is tightened and supplies the friction necessary to adjust the joint to the 'one-G' specification for testing. Now remove the three #10-24 x 1/2 SHCS Nylok® (Item 13, Figure 6.2) that hold the femur flange against the pelvis bone. To remove these screws, insert a long "T- hex wrench" into the access holes on each side of the pelvis. To make the job somewhat easier, insert a small flashlight into the upper leg port.

By looking through one of the access holes on the side, the wrench tip can be viewed and guided into the socket head.

Following the removal of all three screws, the femur can be pulled out of the pelvis flesh. The femur will be difficult to pull out; using a rod machined to fit like an upper leg bone in the femur will make it easier.

The load cell simulators (Item 16 and 17, Figure 6.2) are also found in this region of the pelvis. These simulators are located on the front edge of the iliac wings and are attached with four 3/8-24 x 3/4 SHCS (Item 18, Figure 6.2) inserted into access ports at the rear of the iliac wings. To install the anterior superior iliac spine transducers, remove the simulators and replace them with the actual transducers using the same four 3/8-24 x 3/4 SHCS.

The 'H' Point for the pelvis structure can be measured from the centerline of the square hole provided in the lumbar bracket. An access hole is positioned directly in the path of the square hole to allow for this measurement. The dummy 'H' point is a reference location for the centerline of both left and right hip sockets. This point is frequently used in positioning the dummy relative to specific points in a vehicle or seat.

To find the 'H' Point on the Hybrid III small female pelvis, measure forward from the Square Hole center (toward the dummy's front) 68 mm (2.69 in) and down 59 mm (2.33 in) toward the seating surface.

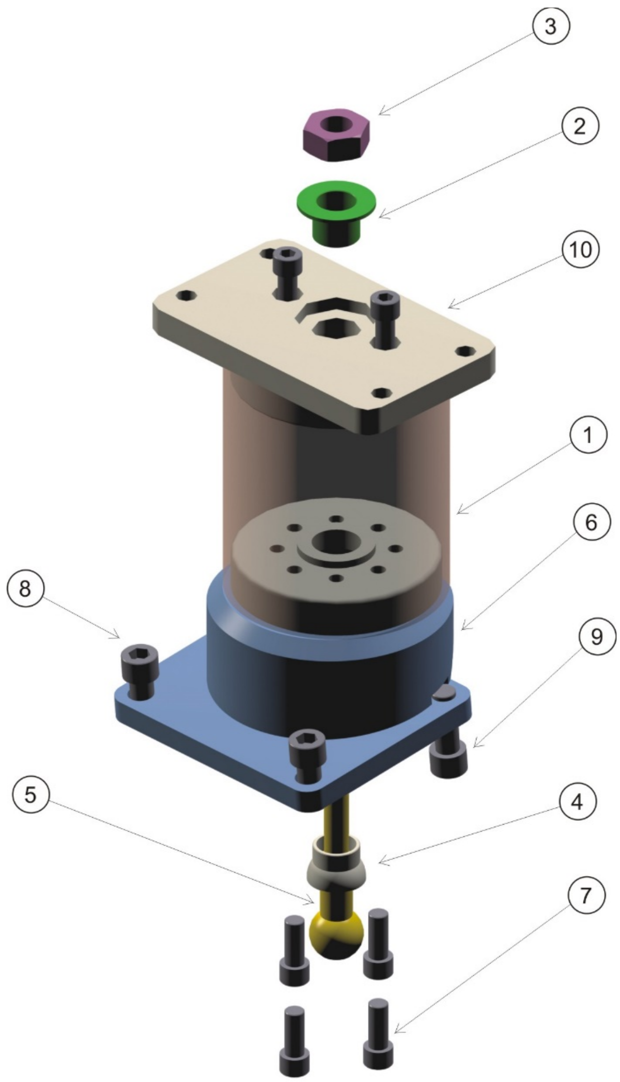


Figure 6.4- Lumbar Spine Assembly

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-1095	LUMBAR SPINE MOLDED
2	1	180-2005	NECK BUSHING LOWER
3	1	9000018	NUT, HEX JAM 1/2-20
4	1	180-2004	NECK BUSHING UPPER
5	1	880105-404	LUMBAR SPINE CABLE
6	1	880105-1094	LUMBAR PELVIC ADAPTOR WELDMENT (REF)
7	6	9000144	SCREW, SHCS 1/4-20 X .62 (REF)
8	2	9000142	SCREW, SHCS 5/16-18 X .62 (REF)
9	2	9000476	SCREW, SHCS 5/16-18 X .87 (REF)
10	1	880105-405	LUMBAR THORACIC ADAPTOR (REF)

Table 6.2- Lumbar Spine Assembly (880105-1096) Parts List

6.4 Pelvis Reassembly

- Reassemble the lumbar spine.
- Reattach the lumbar spine to the lumbar-pelvis block.
- Install the anterior superior iliac spine transducers in place of the simulators if necessary.
- Insert the femurs in to the pelvis flesh and fasten with the three screws that hold the femur flange to the pelvis bone.
- Install the femur plunger set screws.

6.5 Lower Torso Inspection

- Look for cracks in the lumbar spine rubber.
- Look for tears in the pelvis vinyl.
- Look for broken metal pieces or stripped screws or threads.

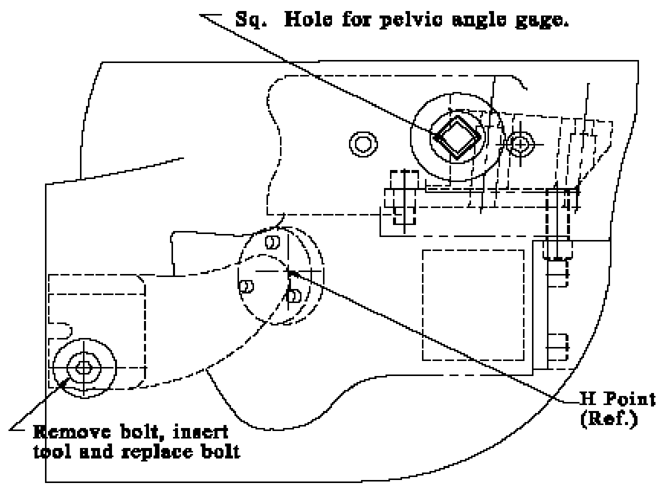


Figure 6.5- Pelvic Reference

Note: The “Square Hole” is provided to allow insertion of a Pelvic Angle Gage (78051-532) to measure the angle of the pelvis.

Section 7- Arm Assembly

Figure 7.1 represents the exploded view of the lower torso. Table 7.1 is a list of general part descriptions.

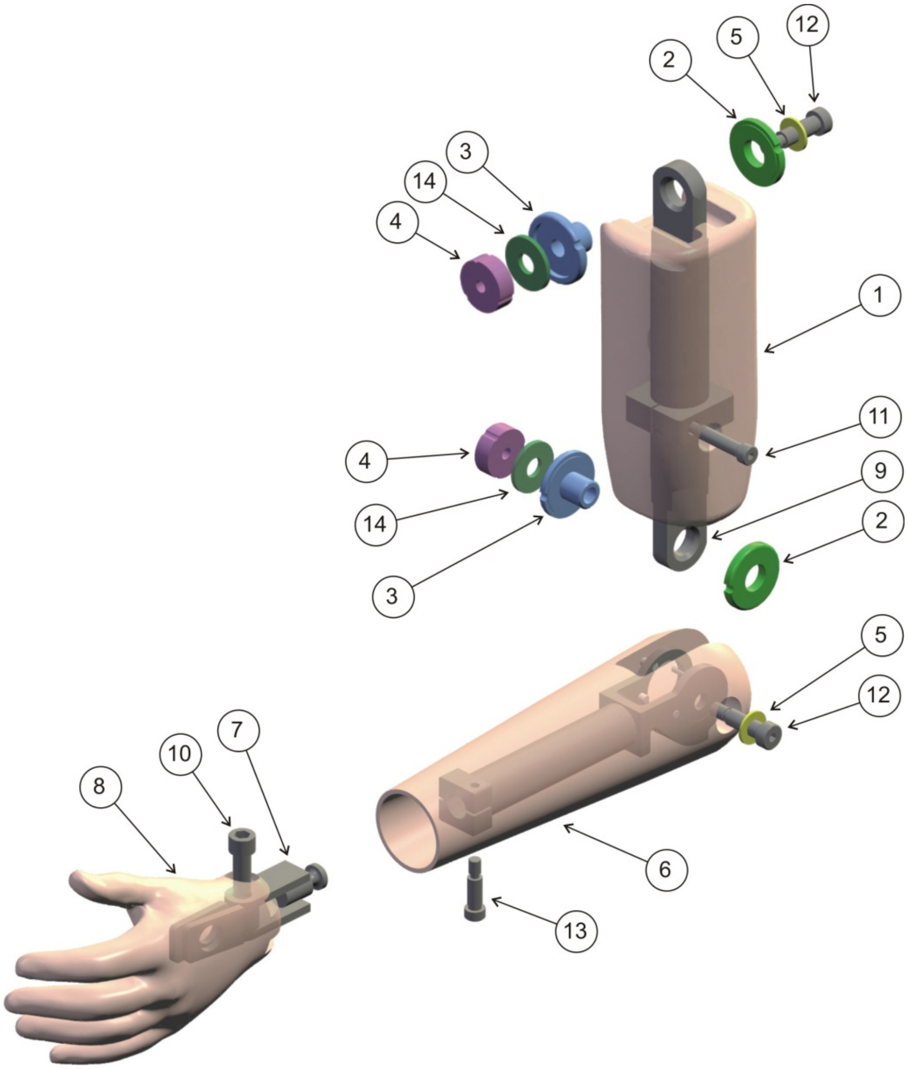


Figure 7.1- Arm Assembly Exploded View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-700	UPPER ARM ASSEMBLY, MOLDED
2	2	880105-708	WASHER,UPPER ARM AND ELBOW
3	2	880105-709	BUSHING, UPPER ARM AND ELBOW
4	2	880105-710	NUT, UPPER ARM PIVOT
5	2	880105-711	WASHER, UPPER ARM PIVOT
6	1	880105-712	LOWER ARM MOLDED ASSEMBLY
7	1	880105-718	WRIST ROTATION ASSEMBLY
8	1	880105-722/723	HAND ASSEMBLY, LEFT/RIGHT
9	1	880105-705	UPPER ARM, LOWER PART
10	1	9000079	SCREW, SHCS 3/8-16 X 1.00
11	1	9000248	SCREW, SHSS 5/16 X 1-1/4
12	2	9000074	SCREW, SHSS 3/8 X 1.00

13	1	9000578	SCREW, SHSS 5/16 X 3/4
14	2	880105-351	WASHER, SHOULDER JOINT SPRING

Table 7.1- Arm Assembly (880105-728-1/-2) Part List

7.1 Disassembly

To detach the upper arm from the lower arm, remove the 3/8 x 1.00 SHSS (Item 12, Figure 7.1) from the elbow joint. The bushing (Item 3, Figure 7.1) in the joint is made of Delrin®.

The lower part of the upper arm provides the capability for the lower arm to rotate. To remove this part, take out the 5/16 x 1-1/4 SHSS (Item 11, Figure 7.1) and pull the upper arm lower part (Item 9, Figure 7.1) away from the upper arm (Item 1, Figure 7.1).

The hand is removed by taking out the 3/8-16 x 1 SHCS (Item 10, Figure 7.1) that joins the wrist rotation assembly and the hand. The wrist rotation assembly (Item 7, Figure 7.1) is detached from the lower arm by taking out the 5/16 x 3/4 SHSS (Item 13, Figure 7.1) located toward the hand end of the lower arm.

7.2 Reassembly

- Reattach the wrist rotation assembly to the lower arm.
- Reattach the hand to the wrist rotation assembly.
- Reattach the lower part of the upper arm to the upper arm.
- Reattach the lower arm to the upper arm. There are two washers at the elbow; one is a standard steel flat washer (Item 5, Figure 7.1) and the other is made of Neoprene® (Item 14, Figure 7.1). These two washers must be replaced during reassembly or the joint will not perform properly. Take care not to damage the Delrin® bushing (Item 3, Figure 7.1) while attempting to insert the shoulder bolt. Damage to this area may affect the friction of the joint.

7.3 Inspection

- Check the arms for flesh rips or tears. If damaged, repair according to Appendix B. If the flesh on an arm has been seriously damaged, it can be returned to the manufacturer and remolded.
- Check the washers in each elbow joint. If any washer is damaged, replace it.

Section 8- Leg Assembly

Figure 8.1 represents the exploded view of the leg. Table 8.1 is a list of general part descriptions of the right leg.

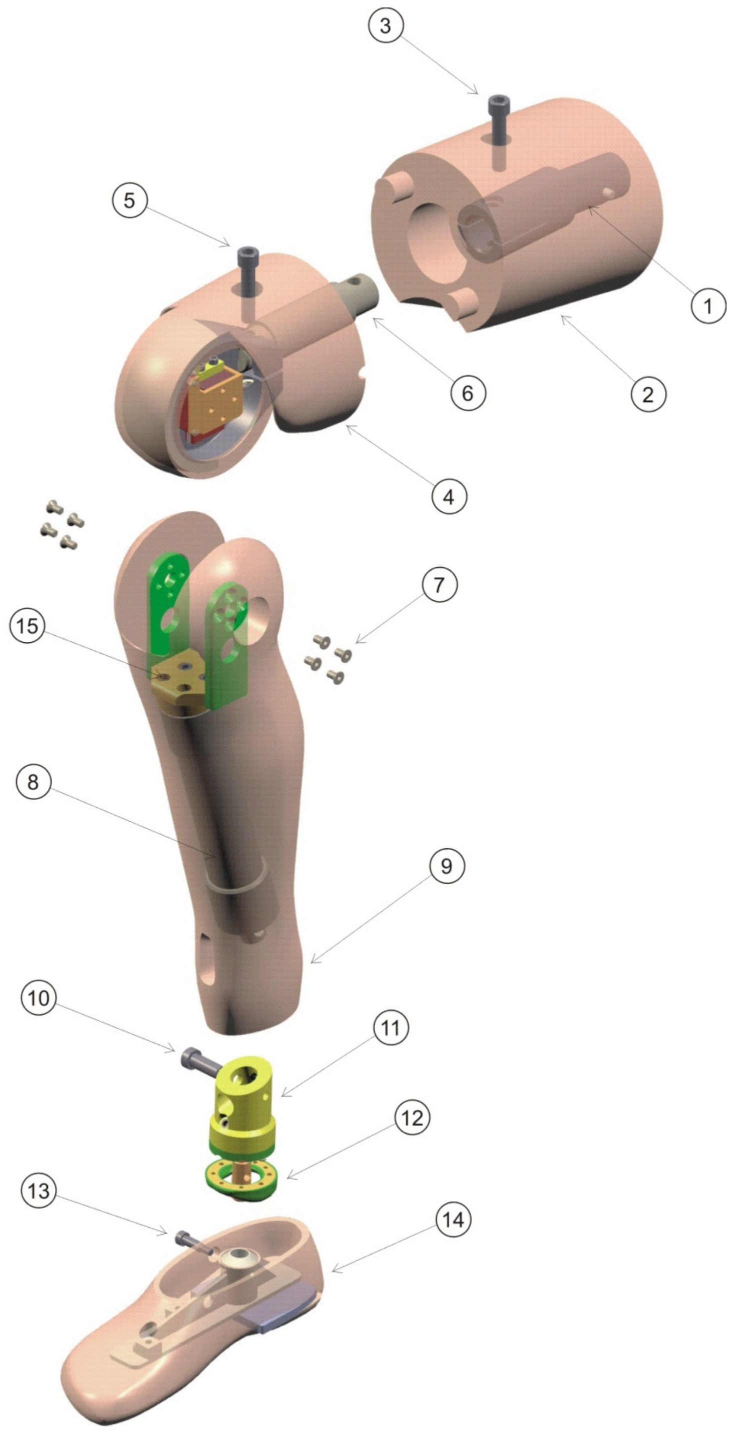


Figure 8.1- Leg Assembly Exploded View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-503	UPPER LEG WELDMENT, RIGHT
2	1	880105-530R	UPPER LEG FLESH,RIGHT
3	1	9000479	SCREW, SHCS 3/8-16 X 1-1/2
4	1	880105-528R	SLIDING KNEE ASSEMBLY, RIGHT
5	1	9000449	SCREW, SHCS 3/8-16 X 1-3/4
6	1	78051-319	LOADCELL SIMULATOR
7	8	9000249	SCREW, FHCS #10-32 X 3/8
8	1	880105-603	LOWER LEG STRUCTURAL REPLACEMENT
9	1	880105-601	LOWER LEG FLESH
10	1	A-1887	BOLT, ANKLE TO LEG ATTACHMENT (REF)
11	1	880105-660	ANKLE ASSEMBLY
12	1	880105-631	BUMPER, ANKLE ASSEMBLY
13	1	9000619	SCREW, SHSS ¼ X 5/8
14	1	880105-651	FOOT ASSEMBLY, RIGHT
15	4	9000115	SCREW, SHCS ¼-28 X1/2

Table 8.1- Leg Assembly, Right (880105-560-2) Part List

8.1 Leg Disassembly

To detach the lower leg from the upper leg, remove the eight #10-32 x 3/8 FHCS (Item 7, Figure 8.1) that attach the lower leg to the knee slider. Once the screws are removed, pull the lower leg from the upper leg assembly. To remove the upper leg flesh from the bone, remove the knee by unthreading the 3/8-16 x 1-1/2 SHCS (Item 3, Figure 8.1) and pulling the flesh off from the knee end of the upper leg. Sometimes this can be quite difficult because of adhesion of the flesh to the bone, but it can be done without damaging the parts.

8.2 Leg Reassembly

- To install the femur load cell, remove the two 3/8-16 SHCS (Items 3 and 5, Figure 8.1) at each end of the load cell replacement (Item 6, Figure 8.1).
- Take the load cell replacement out of the leg by pulling the knee away from the upper leg. With the load cell replacement out of the assembly, insert the load cell into the replacement's position and reinsert the two 3/8-16 SHCS at each end.
- Be careful to replace the longer bolt (3/8-16 x 1-3/4 SHCS [Item 5, Figure 8.1]) at the end nearest the knee. These two screws will be torqued to 40.7 N·m (30 ft·lbf) to prevent slippage in the joint during testing.
- Replace the leg flesh.
- Replace the eight #10-32 x 3/8 FHCS (Item 7) to attach the lower leg to the upper leg.

8.3 Leg Inspection

Check the leg for flesh rips or tears. If damaged, repair according to Appendix B. If flesh on a limb has been seriously damaged, it can be returned to the manufacturer and remolded.

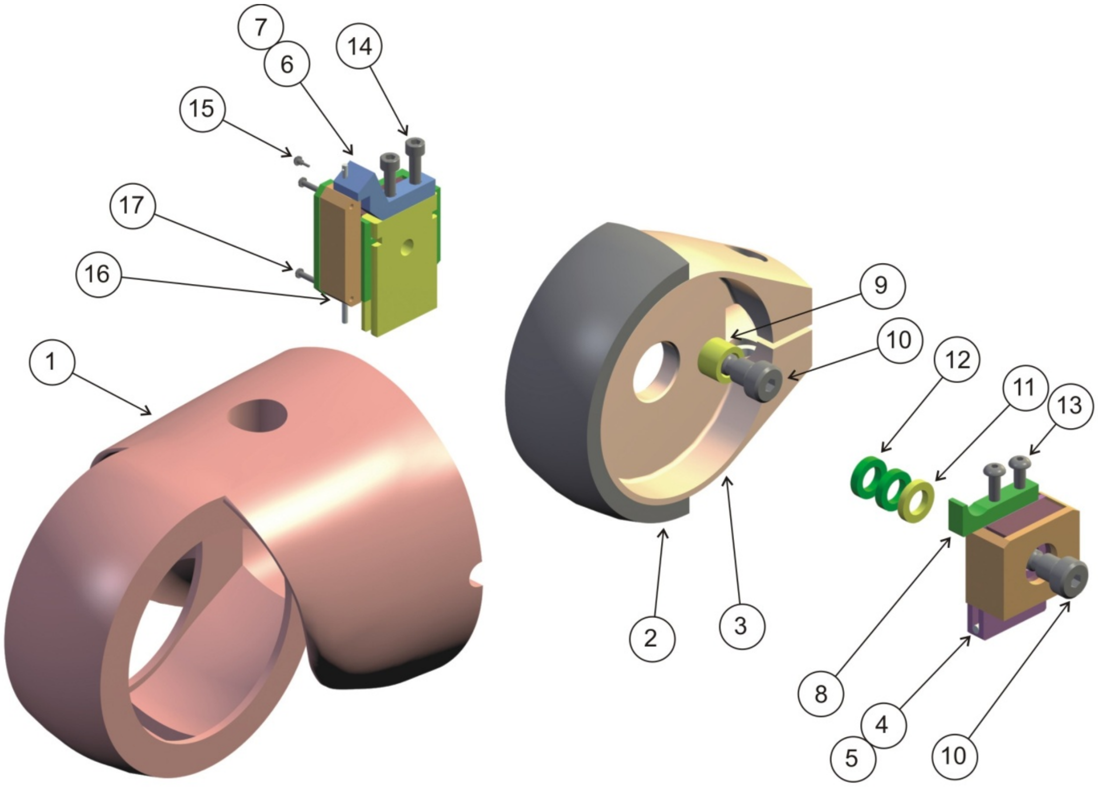


Figure 8.2- Sliding Knee Exploded View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-508	KNEE FLESH & SKIN
2	1	880105-511	KNEE FLESH INSERT
3	1	880105-510	KNEE CAP MACHINED
4	1	880105-67	KNEE SLIDER ASSEMBLY, RIGHT
5	1	880105-66	KNEE SLIDER ASSEMBLY, LEFT (NOT SHOWN)
6	1	880105-515-02	POT SHAFT SUPPORT LINEAR, RIGHT
7	1	880105-515-01	POT SHAFT SUPPORT LINEAR, LEFT (NOT SHOWN)
8	1	880105-526	ROTATION STOP ARM
9	1	79051-34	ROTATION STOP COVER
10	2	880105-527	SHOULDER BOLT, SLIDING KNEE
11	1	79051-32	WASHER, SLIDING KNEE
12	2	79051-33	COMPRESSION WASHER
13	2	9000076	SCREW, BHCS #8-32 X 1/2
14	2	9000516	SCREW, SHCS #8-32X 1/2
15	1	79051-19	PIN, POTENTIOMETER SHAFT
16	1	880105-516	POTENTIOMETER (REF)
17	2	9000340	SCREW, RDMS #1-72 X 5/8 (REF)

Table 8.2 – Sliding Knee Assembly (880105-528R & 528L) Parts List

8.4 Lower Leg Disassembly

Take the knee assembly apart by removing the modified shoulder bolt (Item 10 Figure 8.2) from the knee slider assembly (Item 4 and 5, Figure 8.2). This screw is also used to adjust the tibia-femur joint friction. When removing this screw, be careful not to lose the two washers in the outboard slider. One washer is stainless steel and the other is Neoprene®; the stainless steel washer is located closest to the head of the shoulder screw. The knee insert (Item 2, Figure 8.2) is used to adjust femur loads into the proper load corridor. The machined knee can be separated from the knee flesh and inserted by rotating the large radius of the machined knee away from the knee flesh.

The optional potentiometer that is installed on the inboard knee slider is a 1000 ohm linear potentiometer. Two screws are used to hold it in position, 1-72 x 5/8 RHMS (Item 17, Figure 8.2).
To remove the tibia bone from the flesh, take off the ankle foot assembly by removing the modified shoulder bolt (Item 10, Figure 8.1) at the ankle-tibia joint. Grasp the tibia at the knee clevis and pull the bone from the flesh. This will require considerable force as the fit of the two parts is quite snug, but it can be done without damaging the flesh.

To separate the knee clevis from the lower leg remove the four 1/4-28 x 1/2 SHCS (Item 15, Figure 8.1) from the inside surface of the clevis.

To remove the ankle from the foot, take out the SHSS ¼ x 5/8 (Item 13, Figure 8.1) in the foot and pull the two parts away from each other. The parts should separate easily; if not, there is probably damage to the "through-hole" or the ankle shaft itself.

8.5 Lower Leg Reassembly

- Reattach the foot to the ankle using the ¼ x 5/8 (Item 13, Figure 8.1) shoulder bolt.
- If the flesh was removed from the tibia, use a small amount of talcum powder to act as a lubricant when assembling the parts again.
- Bolt the knee clevis to the lower leg, then reattach the ankle to the tibia at the ankle-tibia joint with a modified shoulder bolt.
- To install the potentiometer, start by tightening the two 1- 72 screws on the potentiometer body. Then check that the shaft runs smoothly through the potentiometer shaft support; if it does not, you can adjust the clearance, slightly, by loosening the two #8-32 x 1/2 SHCS (Item 14) that hold the potentiometer shaft support. Once the shaft can run easily through the support, install the potentiometer shaft pin (Item 15, Figure 8.2).
- Install the knee insert and knee flesh. The insert is to be positioned on the knee so that it rests inside the cavity on the knee flesh. If not, there will be too much tension on the knee flesh and knee insert and thus inhibit the humanlike response of the design. Install the knee slider assembly.

8.6 Lower Leg Inspection

- Check the machined knee. Scratches in the machined knee show improper assembly, bent rotation stop arms, or possibly overloading of the femur load cell.
- Check all limbs for flesh rips or tears. If damaged, repair according to Appendix B. If flesh on the knee has been seriously damaged, it can be returned to the manufacturer and remolded.

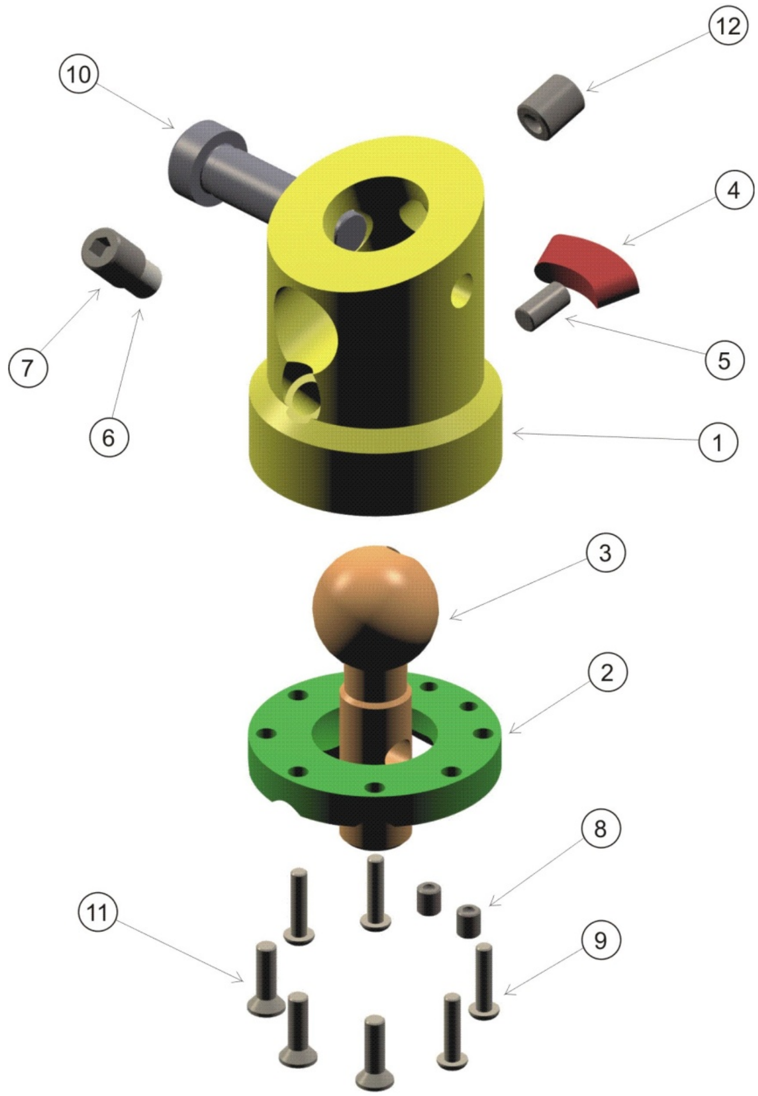


Figure 8.3 – Ankle Assembly Exploded View

ITEM	QTY	PART NO.	DESCRIPTION
1	1	880105-609	ANKLE, UPPER SHELL
2	1	880105-633	ANKLE, LOWER SHELL
3	1	880105-615	ANKLE SHAFT
4	1	880105-626	STOP PIN RETAINER
5	1	9000044	DOWEL, PIN 3/16 X 3/8
6	1	A-1888	FRICTION PAD
7	2	9000073	SCREW, SSCP 5/16-18 X 3/8
8	2	9000452	SCREW, SSCP #8-32 X 1/4
9	4	9000247	SCREW, BHCS #6-32 X 1/2
10	1	A-1887	ANKLE TO LEG ATTACHMENT BOLT
11	3	9001279	SCREW, FHCS #6-32 X 1/2
12	1	9000073	SCREW, SSCP 5/16-18 x 3/8

Table 8.3 – Ankle Assembly (880105-660) Part List

8.7 Ankle Disassembly

To take apart the ankle, start by loosening the 5/16-18 x 3/8 set screw (Item 7, Figure 8.3). This will release the tension on the joint. By removing the two #8-32 x 1/4 SSCP set screws (Item 8, Figure 8.3), the stop pin retainer and dowel pin (Items 4 and 5, Figure 8.3) can be removed. The dowel pin limits the rotation of the ankle shaft (Item 3, Figure 8.3) and can be pulled out of the upper ankle shell (Item 1, Figure 8.3) to release the shaft and allow it to be removed from the assembly. Remove the four #6-32 x 1/2 BHCS screws (Item 9, Figure 8.3) and #6-32 x ½ FHCS screws (Item 11, Figure 8.3) which hold the upper and lower ankle shells together; this will allow access to the ankle shaft.

8.8 Ankle Reassembly

- Attach the upper and lower ankle shells together.
- Install the dowel pin, then the stop pin retainer in the upper ankle shell.
- Insert and fasten the set screws.

8.9 Ankle Inspection

- Check the ankle bumper (Item 12, Figure 8.1) for damage.

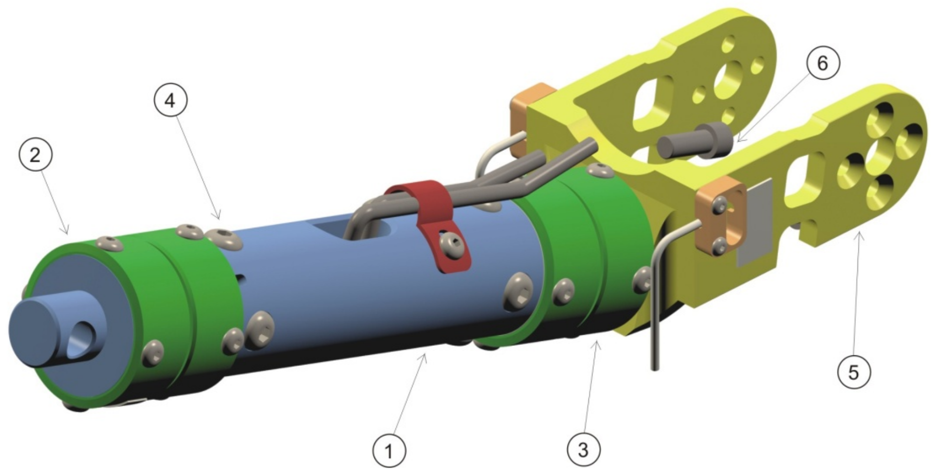


Figure 8.4- Instrumented Lower Leg

ITEM	QTY	PART NO.	DESCRIPTION
1	2	8180-40	5TH FEMALE LEG TUBE LOADCELL ASSEMBLY
2	2	IF-819	LOWER TIBIA LOADCELL ASSEMBLY
3	2	IF-820	UPPER TIBIA LOADCELL ASSEMBLY
4	16	8080-93	SCREW, MODIFIED FOR LEG TUBE
5	2	IF-805	5TH FEMALE CLEVIS LOADCELL ASSEMBLY
6	8	9000126	SCREW, SHCS ¼-28 X 5/8

Table 8.4 – Instrumented Lower Leg (8090-00) Part List

8.10 Instrumented Leg Disassembly

Occasionally the instrumented lower leg may have to be disassembled for calibration, repair, or replacement of one or more of the components.

To detach the knee clevis, simply remove the four 1/4-28 x 5/8 SHCS (Item 6) found inside the clevis yoke at the top of the assembly.

To remove the two tibia transducers, first loosen the cable clamp holding the cable where it exits the tibia bone. Then, take out the four 1/4-28 BHCS that hold the transducers at each end of the tibia bone. Loosen only one transducer at a time. Be sure to only use these bolts in this location; any other bolt can damage the load cell.

Be sure that the cable can freely move into the tibia bone so no unnecessary stress will be put on the cable or the connector. Pull the transducer from the bone just enough to gain access to the cable connector.

Disconnect the connector from the transducer by lifting the sliding outer wall of the connector away from the transducer. The instrument is now free to be completely taken off the assembly.

8.11 Instrumented Leg Reassembly

- Install the tibia transducers and bolt the knee clevis back together.
- To install the Instrumented Lower Leg, slide the transducer package into the lower leg flesh in place of the original tibia-clevis assembly. To make it somewhat easier, try putting a small amount of talcum powder in the leg flesh before attempting to push the bone in.
- When replacing the lower tibia load cell, be aware that the load cell can be installed in two different positions. One position measures forces in the forward direction, the other measures forces in the lateral direction.

Section 9– Calibration Tests

DEFINITION: Calibration tests are specified for dummy responses that could affect dummy measurements that are used by governments and safety engineers to assess occupant injury potential. Calibration tests are performed by the dummy manufacturer to assure that a new component or assembly meets the SAE specified response requirements. The crash dummy user will periodically perform the calibration tests to assure the dummy is maintained at the SAE specified performance levels.

9.1 Head Drop Test

(A) The test measures the forehead response to frontal impacts with a hard surface.

(B) The head assembly consists of:

- head assembly (880105-100X)
- 6-channel neck transducer or a structural replacement (IF-205 or 78051-383X)
- head-to-neck pivot pin (78051-339)
- three accelerometers

The mass of the head assembly is 3.73 ± 0.045 kg (8.23 ± 0.1 lb).

(C) The test fixture consists of a structure to suspend the head assembly and a rigidly supported, flat, horizontal, steel plate. The plate should be 610 ± 10 mm (24 ± 0.4 in) square with a thickness of 50.8 ± 2 mm (2.0 ± 0.08 in), and have a smooth surface finish of 8 to 80 micro inches/ inch rms. A surface finish close to 8 micro inch/inch rms is preferred. The suspension system and accelerometer cable masses should be as light as possible to minimize the external forces acting on the head.

(D) The Data Acquisition System, including transducers, must conform to the requirements of the latest revision of SAE Recommended Practice J211. Filter all data channels using Channel Class 1000 phaseless filters.

(E) Test Procedure:

1. Visually inspect the head skin for cracks, cuts, abrasions, etc. Repair or replace the head skin if abrasions or cuts to the frontal area are more than superficial. Torque the #10-24 skull cap screws to 7.5 N·m (66 in·lbf) and the #10-24 accelerometer mount cap screws to 7.5 N·m (66 in·lbf).

2. Soak the head assembly in a controlled environment with a temperature of 18.9 to 25.6 °C (66 to 78 °F) and a relative humidity from 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

3. Mount the accelerometers in the head on the horizontal transverse bulkhead so the sensitive axes intersect at the Center of Gravity point as defined by 880105-100X. One accelerometer is aligned with the sensitive axis perpendicular to the horizontal bulkhead in the midsagittal plane (Z-axis). The second axis is parallel to the horizontal bulkhead in the midsagittal plane (X-axis). The third accelerometer is aligned with the sensitive axis parallel to the horizontal bulkhead and perpendicular to the midsagittal plane (Y-axis). Ensure that all transducers are properly installed, oriented, and calibrated.

4. Prior to the test, clean the impact surface of the skin and the impact plate surface with isopropyl alcohol or equivalent. The impact surface and the skin must be clean and dry for testing.

5. Suspend the head assembly in a manner similar to that shown in Figure 9.1. The lowest point on the forehead is 12.7 ± 1 mm (0.5 ± 0.04 in) below the lowest point on the dummy's nose

when the midsagittal plane is vertical. The 1.57 mm (0.062 in) diameter holes located on either side of the dummy's head are used to ensure that the head is level with respect to the impact surface.

6. Drop the head assembly from a height of 376 ± 1 mm (14.8 ± 0.04 in) by a means that ensures a smooth, instant release onto the impact surface.

7. Wait at least two hours between successive tests on the same head assembly.

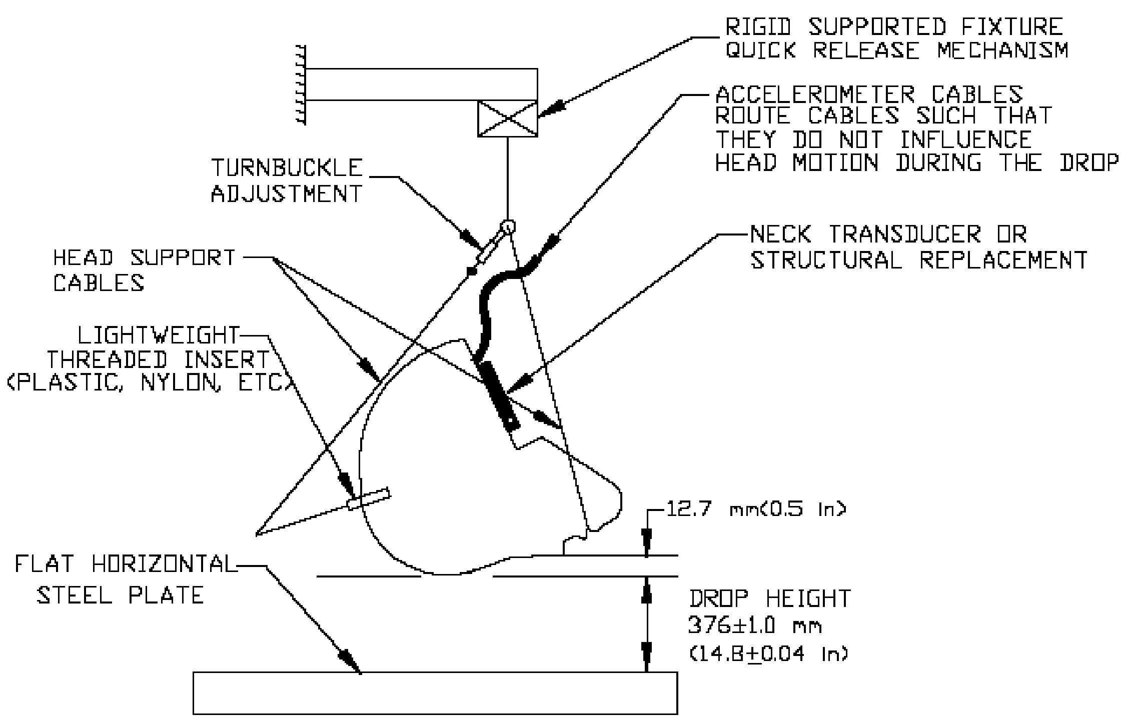
8. Time-zero is defined as the point of contact between the head and the impact surface. All data channels should be at the zero level at this time.

(F) Performance Specifications:

1. The peak resultant acceleration should be between 250 G's and 300 G's, inclusive.

2. The resultant acceleration vs. time history curve should be unimodal; oscillations occurring after the main pulse should be less than 10 percent of the peak resultant acceleration.

3. The lateral acceleration should not exceed 15 G's.



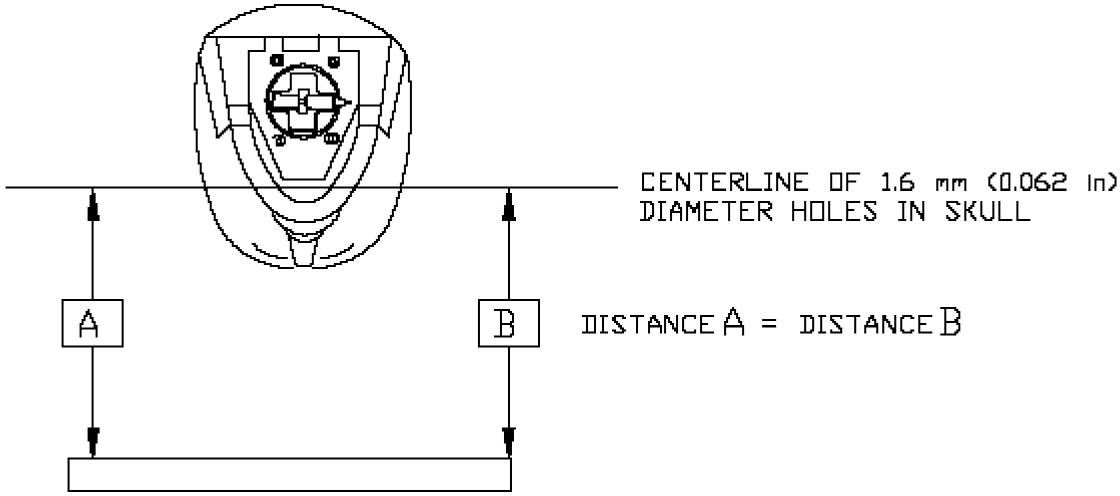


Figure 9.1- Head Drop Test Setup Specifications

9.2 Neck Test

(A) The components required for the neck tests are:

- head assembly (880105-100X)
- neck assembly (880105-250)
- bib simulator (880105-371)
- upper neck adjusting bracket (880105-207)
- lower neck adjusting bracket (880105-208)
- six-channel neck transducer to measure the x-axis force and y-axis moment
- transducers to measure the rotation of the D-plane (horizontal plane through the base of the skull) with respect to the pendulum's longitudinal centerline
- three actual or simulated accelerometers in the head to maintain the proper weight and center of gravity location; data from the accelerometers are not required
- Neck pendulum accelerometer

(B) The test fixture pendulum arm with specifications appears in Figure 9.2. The aluminum honeycomb material is commercial grade, 152.4 mm (6.0 in) thick, 0.8 kg (1.8 lb) per cu ft. with 19 mm (0.75 in) diameter cells. Mount the accelerometer with its sensitive axis aligned with the arc formed at a radius 1657.4 mm (65.25 in) from the pivot point.

(C) The Data Acquisition System, including transducers, must conform to the requirements of the latest revision of SAE Recommended Practice J211. Filter the neck force data channel using Channel Class 1000, the neck moment data channel using Channel Class 600, the pendulum acceleration data channel using Channel Class 180, and the neck rotation data channels using Channel Class 60. All filters should be phaseless.

(D) Test Procedure:

1. Soak the neck assembly in a controlled environment at a temperature between 20.6 and 22.2 °C (69 to 72 °F) and a relative humidity of 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment. Monitor the temperature of the neck by placing a thermo-sensor into one of the holes in the neck.

2. Inspect the neck assembly for cracks, cuts and separation of the rubber from the metal segments.

3. Inspect the nodding blocks (78051-351) for deterioration and replace as necessary. The durometer should be 80 to 90 Shore A. Ensure that the nodding blocks are installed correctly as shown on Drawing 880105-250 and in Figure 8.

4. Inspect the nodding joint washers, Drawing 78051-253, for an interference fit. Adjust or replace as required.

5. Mount the head-neck assembly on the pendulum so the midsagittal plane of the head is vertical. As shown in Figure 9.4 for the Flexion test and Figure 9.3 for the Extension test, the midsagittal plane should coincide with the plane of motion of the pendulum's longitudinal centerline.

6. Install the transducers or other devices for measuring the D-plane rotation with respect to the pendulum longitudinal centerline. These measurement devices should be designed to be as light as possible to minimize their influence on the performance of the head-neck assembly.

7. Torque the jam nut (78051-64) on the neck cable (880105-206) to 1.4 ± .2 N·m (12 ± 2 in·lbf) before each test on the same neck.

8. The number of cells in the honeycomb material which are required to produce the pendulum input pulse will be different for the flexion and extension tests. The number of cells required may also vary for each sheet and/or batch of material. If necessary to achieve the deceleration pulse, pre-crush the honeycomb material prior to the test by lightly impacting it with the pendulum so the desired honeycomb surface contacts the pendulum striker plate.

9. With the pendulum resting against the honeycomb material, adjust the neck bracket until the longitudinal centerline of the pendulum is perpendicular ± 1° to the D-plane on the dummy's head.

10. Wait at least 30 minutes between successive tests on the same neck.

11. Calculate the moment about the occipital condyles for both flexion and extension tests using the formulae:

For a six-channel neck transducer:

Metric Units
Moment (N·m) = [My (N·m)] - [0.01778m] [Fx (N)]

English Units
Moment (ft·lbf) = [My (ft·lbf)] - [0.05833 ft.] [Fx (lbf)]

NOTE: The formulae are based on the sign convention contained in SAE Recommended Practice J211, latest revision, Instrumentation for Impact Test.

(E) Performance Specifications-Neck Flexion

1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 7.01 ± 0.12 m/s (23.0 ± 0.4 ft/s) measured at the center of the pendulum accelerometer.

2. Time-zero is defined as the time of initial contact between the pendulum striker plate and the honeycomb material. All data channels should be at the zero level at this time.

3. Stop the pendulum from the initial velocity with an acceleration vs. time pulse which meets the velocity change as specified below. Integrate the pendulum acceleration data channel to obtain the velocity vs. time curve.

TIME	PENDULUM IMPULSE	
ms	m/s	ft/s
10	2.1 - 2.5	6.9 - 8.2
20	4.0 - 5.0	13.1 – 16.4
30	5.8 - 7.0	19.0 – 23.0

Table 9.1- Neck Flexion Pendulum Impulse

4. During the time interval while the rotation is within the corridor specified in Section 5, the peak moment about the “Y” axis of the head, measured with respect to the occipital condyles, shall be not less than 69 N·m (51 ft·lbf) and not more than 83 N·m (61 ft·lbf). The positive moment shall decay for the first time to 10 N·m (7.38 ft·lbf) between 80 and 100 ms after timezero (T_0).

5. The maximum rotation of the D-plane of the head should be 77 to 91° with respect to the pendulum.

(F) Performance Specifications-Neck Extension

1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 6.07 ± 0.12 m/s (19.9 ± 0.4 ft/s) measured at the center of the pendulum accelerometer.

2. Time-zero is defined as the time of initial contact between the pendulum striker plate and the honeycomb material. All data channels should be at the zero level at this time.

3. Stop the pendulum from the initial velocity with an acceleration vs. time pulse which meets the velocity change as specified below. Integrate the pendulum acceleration data channel to obtain the velocity vs. time curve.

TIME	PENDULUM IMPULSE	
ms	m/s	ft/s
10	1.5 - 1.9	4.9 - 6.2
20	3.1 - 3.9	10.2 – 12.8
30	4.6 - 5.6	15.1 – 18.4

Table 9.2- Neck Extension Pendulum Impulse

4. During the time interval while the rotation is within the corridor specified in Section 5, the peak moment about the "Y" axis of the head, measured with respect to the occipital condyles, shall be not less than -65 N·m (-47.9 ft·lbf) and not more than -53 N·m (-39.1 ft·lbf). The positive moment shall decay for the first time to -10 N·m (-7.38 ft·lbf) between 94 and 114 ms after time-zero (T_0).

5. The maximum rotation of the D-plane of the head should be 99 to 114° with respect to the pendulum.

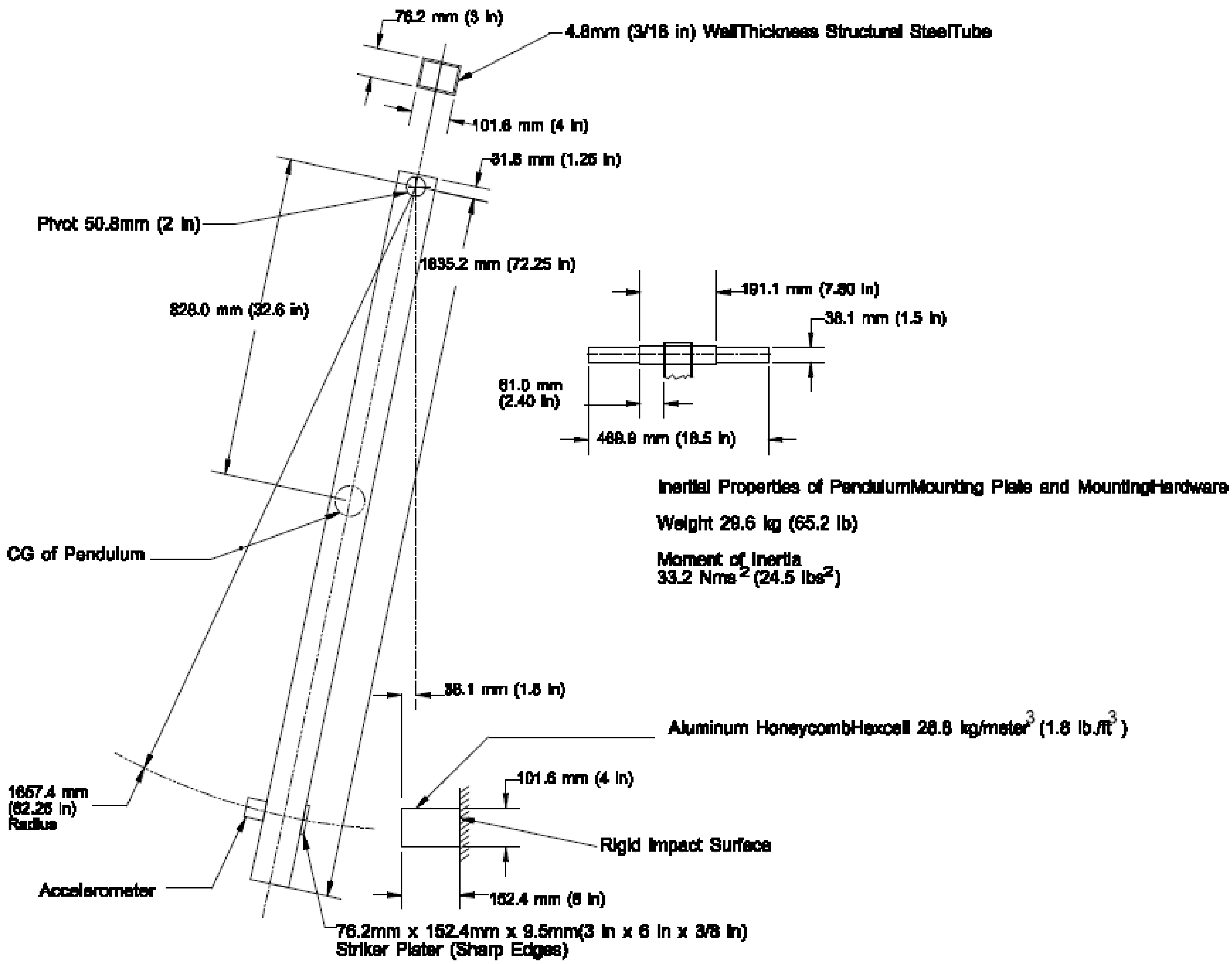


Figure 9.2 – Neck Pendulum Arm Specifications

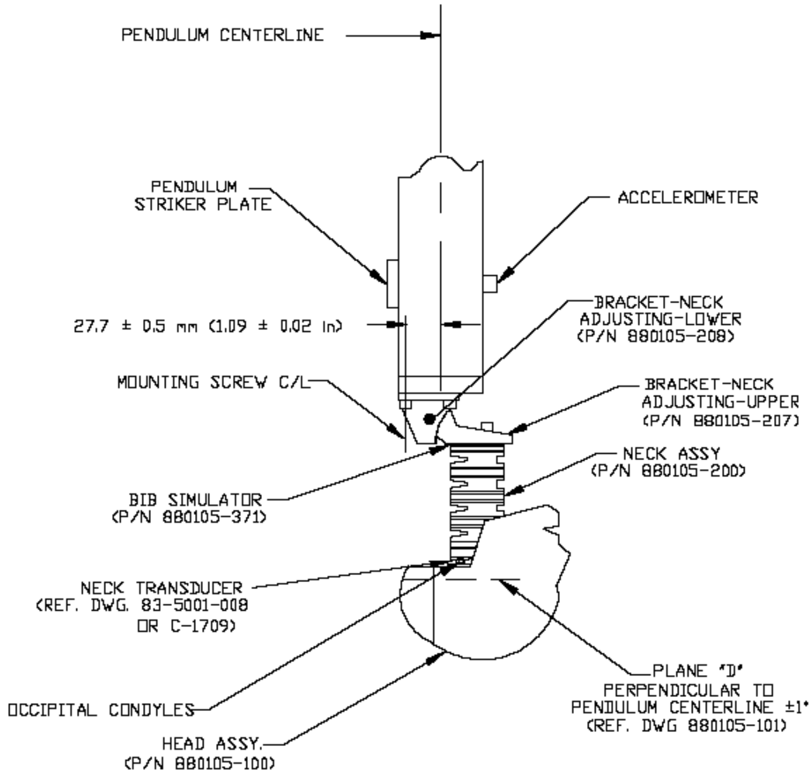


Figure 9.3 – Neck Extension Test Setup Specifications

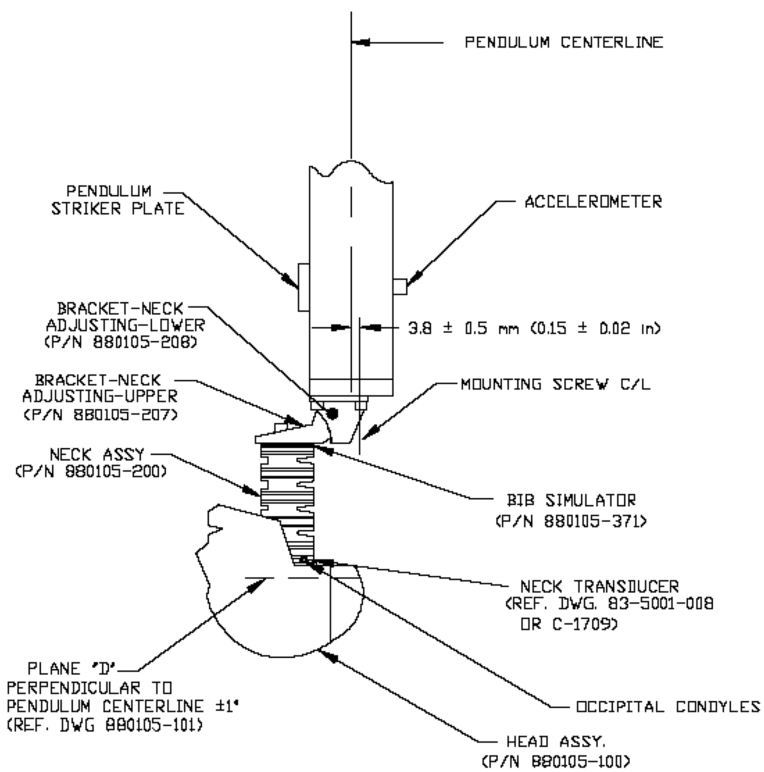


Figure 9.4 – Neck Flexion Test Set-Up Specifications

9.3 Thorax Impact Test

(A) The complete dummy assembly (880105-000) is required, including the clothing [vest (6001481) and pant (6001482)], but without the shoes.

(B) The fixture consists of a smooth, clean, dry, steel seating surface and a rigid test probe. The test probe mass is 13.97 ± 0.023 kg (30.8 ± 0.05 lb) including instrumentation, rigid attachments, and the lower 1/3 of the suspension cable mass. The diameter of the impacting face is 152.4 ± 0.25 mm (6.00 ± 0.01 in) and has a flat, right-angle face with an edge radius of 12.7 mm (0.5 in). Mount an accelerometer to the probe with its sensitive axis in line with the longitudinal centerline of the test probe.

(C) The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211. Filter all data channels using Channel Class 180 phaseless filters.

(D) Test Procedure:

1. Remove the chest skin and visually inspect the thorax assembly for cracks, cuts, abrasions etc. Pay particular attention to the rib damping material (880105-358-1 through 880105-358-6), chest displacement transducer assembly (880105-1080), and the rear rib supports (880105-320). Torque the spine cable to 1.1-1.4 N·m (10-12 in·lbf).

2. Soak the test dummy in a controlled environment with a temperature of 20.6 to 22.2 °C (69 to 72 °F) and a relative humidity from 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

3. Check that all transducers are properly installed, oriented and calibrated.

4. Seat the dummy (without the chest skin) on the test fixture surface. The surface must be long enough to support the pelvis and outstretched legs.

5. Align the upper and lower neck bracket index marks to the zero position.

6. Place the arm assemblies' horizontal ± 2° and parallel to the midsagittal plane. Secure the arms by tightening the adjustment nut that holds the arm yoke to the clavicle assembly (880105-336, 337).

   Level the ribs both longitudinally and laterally ± 0.5° and adjust the pelvis angle to 7°± 2°. The ribs may be measured at the third rib using flat stock as a fixture for the level. A special tool, which inserts into the pelvic structure and extends outward beyond the pelvic skin surface, may be used to determine the pelvis angle.

   The midsagittal plane of the dummy is vertical ± 1° and within 2° of being parallel to the centerline of the test probe. The longitudinal centerline of the test probe is centered on the midsagittal plane of the dummy within ± 3 mm (± 0.12 in). Align the test probe so its longitudinal centerline is 12.7 ± 1 mm (0.5 ± 0.04 in) below the horizontal centerline of the No. 3 rib and is within 0.5° of a horizontal line in the dummy's midsagittal plane.

   After completing the initial setup, record reference measurements from locations such as the rear surfaces of the thoracic spine and the lower neck bracket. These reference measurements are necessary to ensure that the dummy remains in the same position after installing the chest skin. When using a cable supported test, the dummy must be moved rearward from the test probe to account for the thickness of the chest skin, so the probe will impact at the lowest point on its arc of travel. The test set up appears in Figure 9.5.

7. Install the chest skin and reposition the dummy as described in the preceding paragraph using the recorded reference measurements. The reference locations must be accessible after installation of the chest skin, so it may be necessary to leave the chest skin unzipped until the references are checked, and then fasten it just prior to the test.

8. Impact the thorax with the test probe so the probe's longitudinal centerline is within 2° of a horizontal line in the dummy's midsagittal plane at the moment of impact.

9. Guide the probe so no significant lateral, vertical or rotational motion takes place during the impact.

10. The test probe velocity at the time of impact is 6.71 ± 0.12 m/s (22 ± 0.4 ft/s).

11. Time-zero is defined as the time of initial contact between the test probe and the chest skin. All data channels should be at the zero level at timezero.

12. Wait at least 30 minutes between successive tests on the same thorax.

(E) Performance Specifications -Thorax Impact

1. The maximum sternum-to-spine displacement, as measured by the chest displacement transducer, should lie between 50 and 58 mm (2.0 and 2.3 in).

2. During the time interval while the deflection is within the corridor specified in Section 1, the peak force shall be not less than 3.9 kN (877 lbf) and not more than 4.4 kN (989 lbf). Calculate this force by multiplying the test probe acceleration by its mass.

3. The peak force (test probe acceleration multiplied by its mass) after 18 mm of sternum displacement and prior to maximum sternum displacement shall not exceed, 4600 N, the value of the force measured in Section 2.

4. The internal hysteresis should be greater than 69 percent but less than 85 percent. The hysteresis, determined from the force vs. deflection curve, is the ratio of the area between the loading and unloading portions of the curve to the area under the loading portion of the curve as shown in Figure 9.6.

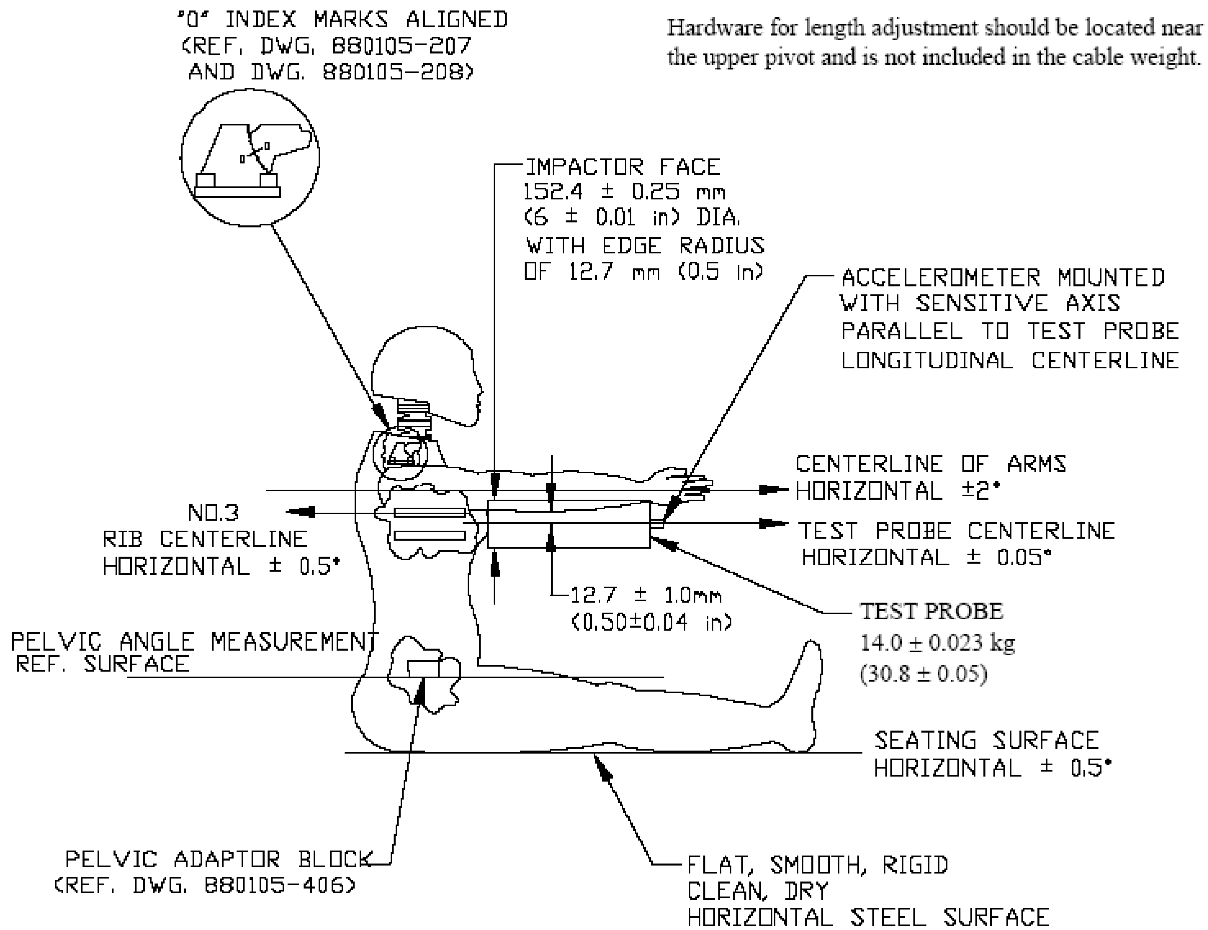


Figure 9.5 -Thorax Impact Test Setup Specifications

NOTE:

- No external support is required on the dummy to meet setup specifications

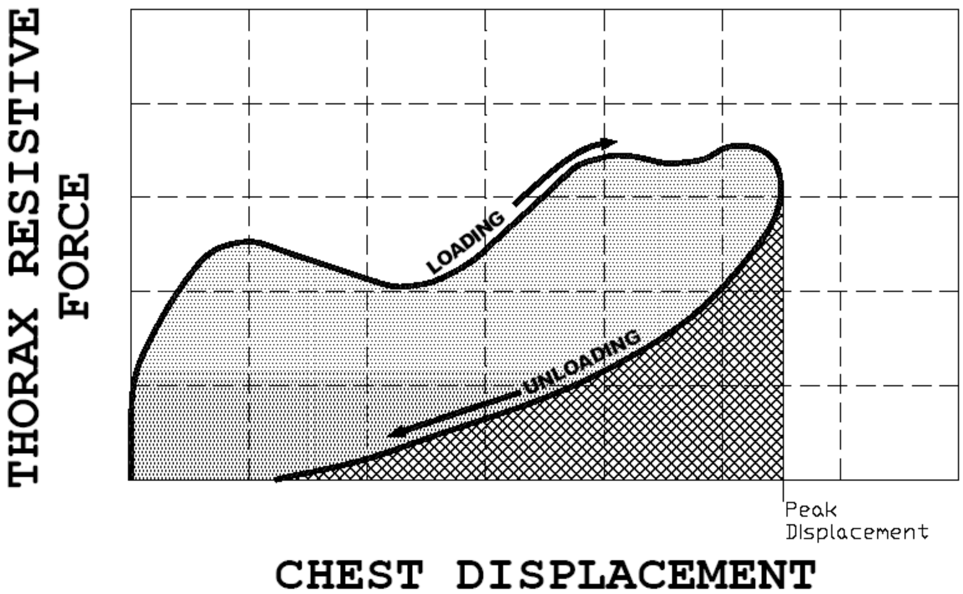


Figure 9.6 – Hystersis Definition

9.4 Knee Impact Test

(A) The components required for the knee impact test include:

- knee cap (880105-510)
- knee flesh and skin assembly (880105-508)
- knee insert (880105-511)
- knee slider assembly, optional
- lower leg assembly, optional
- femur load cell or structural replacement (78051-319)

(B) The test fixture consists of a rigid test probe and a method of rigidly supporting the knee and lower leg assembly. The test probe mass is 2.99 ± 0.023 kg (6.6 ± 0.05 lb), including instrumentation, rigid attachments and the lower 1/3 of the suspension cable mass. The impacting face has a diameter of 76.2 ± 0.25 mm (3.00 ± 0.01 in) with an edge radius of 0.5 mm (0.02 in). Mount an accelerometer on the probe with its sensitive axis in line with the longitudinal centerline of the test probe.

(C) The data acquisition system, including transducers, must conform to the requirements of the latest revision of SAE Recommended Practice J211. Filter all data channels using Channel Class 600 phaseless filter.

(D) Test Procedure:

1. Inspect the knee flesh and insert for cracks, cuts, abrasions, etc. If the machined knee is cracked or broken, replace it. If the insert is cut, replace the insert.

2. Soak the knee in a controlled environment with a temperature between 18.9 to 25.6 °C (66 to 78 °F) and a relative humidity from 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

3. Mount the knee assembly to the fixture using a femur load cell or load cell simulator. Torque the load cell simulator bolts to 40.7 N·m (30 ft·lbf) to prevent slippage of the assembly during the impact. If using the lower leg assembly, adjust the lower leg so the line between the knee and ankle pivots is at an angle of 24° ± 1° rearward of vertical. Do not let the foot contact any exterior surface. The test set up is shown in Figure 31.

4. Align the longitudinal centerline of the test probe so it is collinear within 2^{o} with the longitudinal centerline of the load cell simulator at the time of impact.

5. Guide the probe so no significant lateral, vertical or rotational motion occurs at time-zero.

6. Time-zero is defined as the time of initial contact between the test probe face and the knee skin. All data channels should be at the zero level at this time.

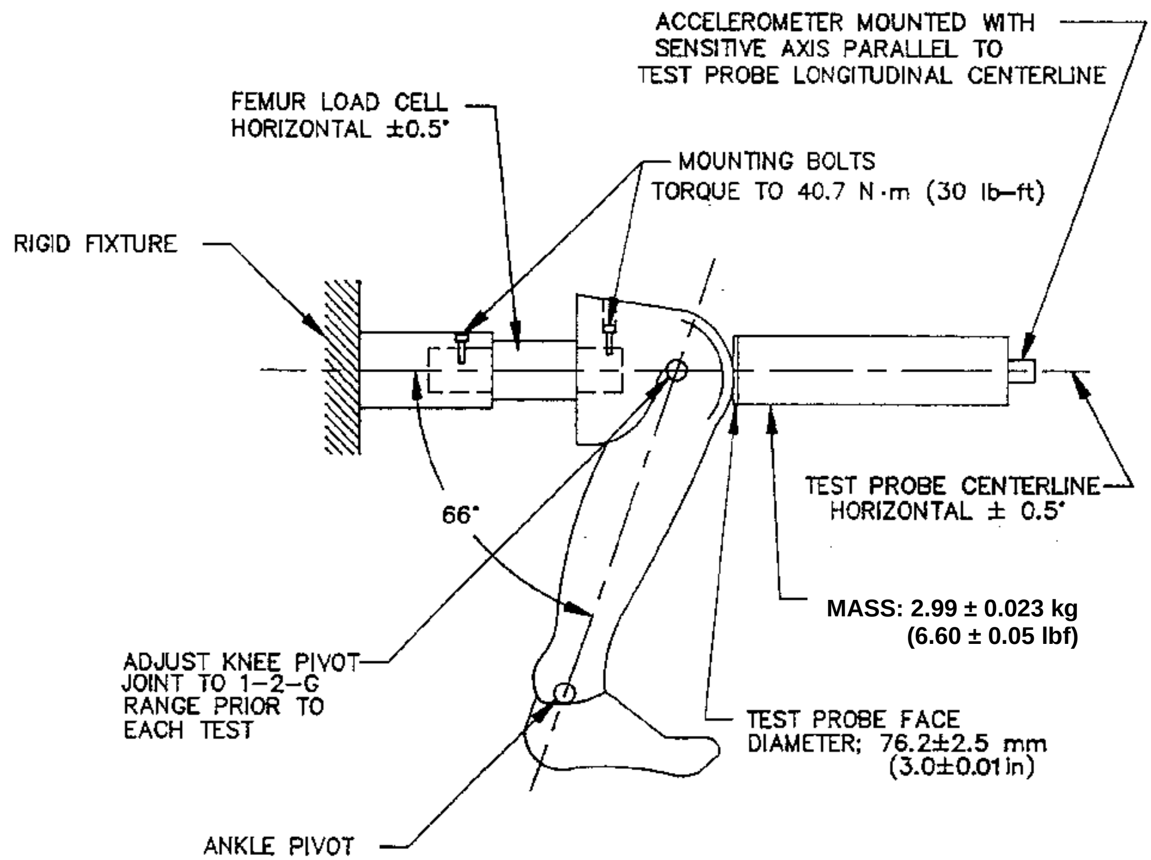
7. Impact the knee so the longitudinal centerline of the test probe is within 0.5^{o} of a horizontal line parallel to the load cell simulator at time-zero.

8. The test probe velocity at the time of the impact is 2.1 ± 0.03 m/s (6.9 ± 0.1 ft/s).

9. Wait at least 30 minutes between successive tests on the same knee.

(E) Performance Specifications

1. The peak impact force (defined as the product of the test probe mass and the deceleration) should lie between 3.45 and 4.06 kN (776 and 913 lbf).



* Hardware for length adjustment should be located near the upper pivot and is not included in the cable weight.

Figure 9.7 – Knee Impact Test Setup Specifications

9.5 Knee Slider Test

(A) The components required for the knee slider test are:

- left and right knee assembly (880105-529 left and 880105-529 right)
- displacement transducer
- femur load cell or structural replacement (78051-319)

(B) The test fixture consists of a rigid test probe and a method of rigidly supporting the knee assembly. The test probe mass is 7.26 ± 0.09 kg (16.0 ± 0.2 lb), including instrumentation, rigid attachments and the lower 1/3 of the suspension cable mass. The diameter of the impacting face is 76.2 ± 0.2 mm (3.00 ± 0.01 in) and has a flat, right angle face with an edge radius of 0.5 mm (0.02 in). A load distribution bracket is required to transmit the impact energy into the slider assembly, as seen in Figure 9.8.

(C) The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211. Filter the displacement data channel using Channel Class 180.

(D) Test Procedure:

1. Inspect the knee assembly for damage. Pay particular attention to the left and right side slider assemblies to ensure the tracks are clean and free from damage that could affect the operation.

2. Soak the knee assembly in a controlled environment with a temperature of 18.9 to 25.6°C (66 to 78°F) and a relative humidity from 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

3. Check that all transducers are properly installed, oriented, and calibrated.

4. Mount the knee assembly to the fixture using a femur load cell or load cell simulator (78051-319).. Torque the two mounting bolts to 40.7 N·m (30 ft·lbf) to prevent slippage of the assembly during impact. Attach the load distribution bracket to the slider assembly. The bracket is attached to the inboard and outboard slider assemblies (880105-512-01 and 880105-522-01) in the same manner as the knee clevis.

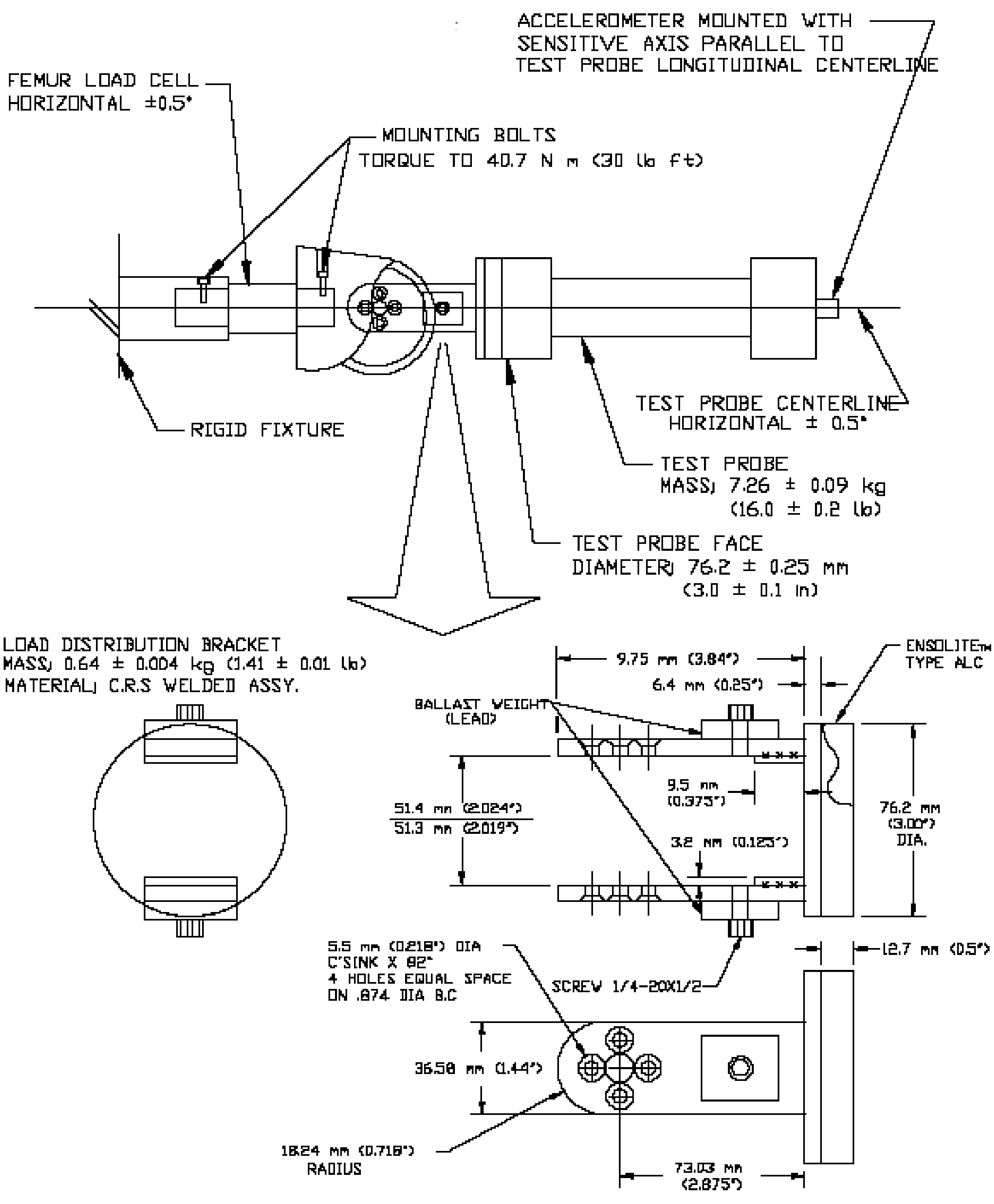
5. Align the longitudinal centerline of the test probe so at the time of impact, it is collinear (within 2°) with the longitudinal centerline between the load cell and the load distribution bracket. The test probe longitudinal centerline should be horizontal 0.5° . The test setup appears in Figure 9.8.

6. Guide the probe so no significant lateral, vertical or rotational motion occurs at the time of contact between the test probe face and the load distribution bracket.

7. The test probe velocity at the time of impact is 2.75 ± 0.05 m/s (9.02 ± 0.18 ft/s).

8. Time-zero is defined as the time of initial contact between the test probe and the load distribution bracket.

9. Wait at least 30 minutes between successive tests on the same knee slider assembly.



* Hardware for length adjustment should be located near the upper pivot and is not included in the cable weight.

Figure 9.8 – Knee Slider Test Setup Specifications

(E) Performance Specifications – Knee Slider

1. The peak deflection should lie between 12.7 to 15.5 mm (0.50 to 0.61 in).

Section 10 – Inspection Tests

DEFINITION: Inspection tests are supplemental to the calibration tests to insure that a component meets its design intent. They are performed by the dummy manufacturer on new parts. The dummy user may conduct inspection tests when a part is damaged or replaced.

10.1 External Measurement Procedure

(A) Remove the dummy's chest skin and abdominal insert.

(B) Place the dummy on a flat, rigid, smooth, clean, dry, horizontal surface as shown in Figure 33. The seating surface must be at least 406 mm (16 in) wide and 406 mm (16 in) deep, with a vertical section at least 406 mm (16\ in) wide and 914 mm (36 in) high attached to the rear of the seating fixture. The dummy's midsagittal plane is vertical and centered on the test surface.

(C) Remove the four socket head cap screws that attach the lumbar spine to the thoracic spine. Torque the spine cables to 1.13 - 1.35 N·m (10-12 in-lbf).

NOTE: At this point, inspect the thorax for damage. If required, remove the thorax displacement transducer for calibration. Use extreme caution to avoid damaging the instrumentation cables.

(D) Reassemble the lumbar spine to the thoracic spine.

(E) Secure the dummy to the test fixture so the button head screws (that attach the top rib to the thoracic spine) and the mounting plates (that connect the thoracic spine to the lumbar spine) are against the vertical surface of the fixture. The rear surface of the buttocks now contacts the fixture.

(F) Position the dummy's H-point so it is 83.8 ± 2.5 mm (3.3 ± 0.1 in) above the seat surface and 147.3 ± 2.5 mm (5.8 ± 0.1 in) forward of the rear vertical surface of the fixture. The H-point is located 68.6mm (2.7 in) forward and 58.4 mm (2.3 in) downward from the center of the pelvic angle reference hole.

(G) Extend the dummy's neck so the base of the skull is level, both fore and aft and side to side, within 0.5°. The rear surface of the skull cap should be 45.7 ± 2.5 mm (1.8 ± 0.1 in) from the vertical surface of the test fixture.

(H) Position the upper and lower legs parallel to the midsagittal plane so the centerline between the knee pivot and the screw attaching the ankle to the lower tibia is vertical.

(I) Position the feet parallel to the dummy's midsagittal plane with the bottoms horizontal and parallel to the seating surface.

(J) Position the upper arms downward vertically so the centerline between the shoulder and elbow pivots is parallel to the rear vertical surface of the fixture.

(K) Position the lower arms horizontally so the centerline between the elbow and wrist pivots is parallel to the seat surface.

(L) Record the following dimensions. (The symbols and description for each measurement are indicated in Figure 10.1.) They should conform to the specifications listed in Table 10.1.

A – Total Sitting Height: Seat Surface to highest point on top of the head.

B - Shoulder Pivot Height: Centerline of shoulder pivot bolt to the seat surface.

C – Hip Pivot Height: Above seat surface (reference).

D – Hip Pivot from Backline: From seat rear vertical surface (reference).

E - Shoulder Pivot from Backline: Center of the shoulder clevis to the fixture's rear vertical surface.

F - Thigh Clearance: Seat surface to highest point on the upper femur segment.

G - Back of Elbow to Wrist Pivot: The back of the elbow flesh to the wrist pivot.

H – Head Back from Backline: To seat rear vertical surface (reference).

I – Shoulder to Elbow Length: The highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow, in line with the elbow pivot bolt
.

J - Elbow Rest Height: The flesh below the elbow pivot bolt to the seat surface.

K – Buttock to Knee Length: The most forward surface of the knee flesh to the rear surface of the buttocks, in line with the knee pivot and hip pivot.

L – Popliteal Height: Seat surface to the horizontal plane at the bottom of the feet.

M - Knee Pivot Height: Knee pivot to the horizontal plane of the bottom of the feet.

N - Buttock Popliteal Length- The rearmost surface of the lower leg to the same point on the rear surface of the buttocks used for measurement "K".

O - Chest depth without Jacket: Measured 345.4 mm ± 12.7 mm (13.6 in ± 0.50 in) above the seat surface (AA).

P - Foot Length: Tip of toe to rear of heel.

R - Buttock to Knee Pivot Length- The rear surface of the buttocks to the knee pivot bolt.

S – Head Breadth: The widest part of the head.

T – Head Depth: Back of the head to the forehead.

U - Hip Breadth: The widest part of the hip.

V - Shoulder Breadth: Between outside edges of shoulder clevises.

W - Foot Breadth: The widest part of the foot.

X – Head Circumference: The circumference of the head measured at the point as in measurement "T".

(M) Install the chest skin and abdominal insert. Reposition the dummy on the test fixture. You do not need to level the head as specified for the previous measurements.

(N) Mark the locations and record the chest and waist circumference dimensions.

Y - Chest Circumference: Measured 345.4 mm ± 12.7 mm (13.6 in ± 0.50 in) above the seat surface (AA).

Z - Waist Circumference: Measured 165.1 mm ± 5.1 mm (6.5 in ± 0.20 in) above the seat surface (BB).

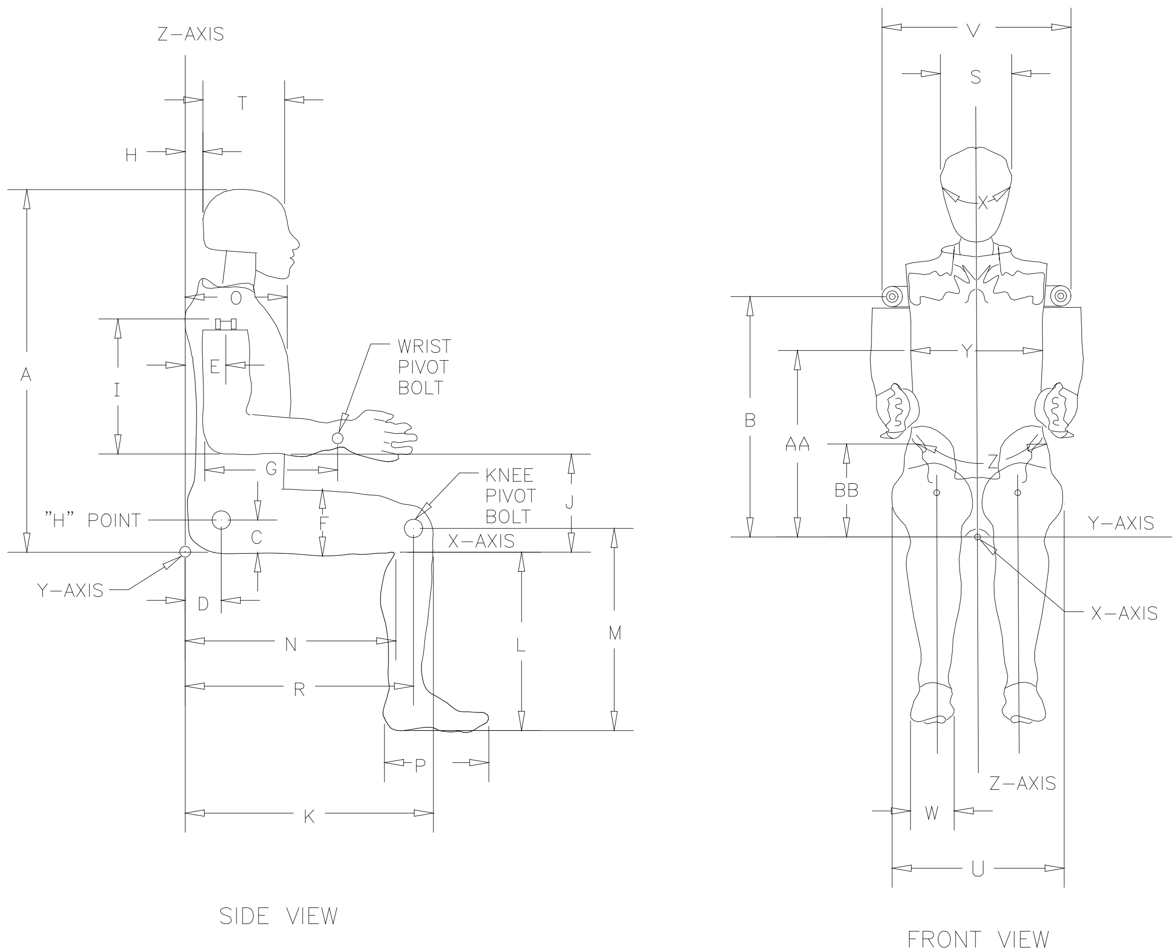


Figure 10.1 – External Dimension Measurement

SYMBOL	EXTERNAL DIMENSIONS	SPEC. in.	TOL. in.
A	Total Sitting Height	31.00	0.50
B	Shoulder Pivot Height	17.50	0.50
C	Hip Pivot Height	3.30	0.10
D	Hip Pivot from Backline	5.80	0.10
E	Shoulder Pivot from Backline	3.00	0.30
F	Thigh Clearance	5.00	0.30
G	Back of Elbow to Wrist Pivot	9.90	0.30
H	Head Back From Backline	1.80	0.10
I	Shoulder to Elbow Length	11.30	0.40
J	Elbow Rest Height	7.60	0.40
K	Buttock to Knee Length	21.00	0.50
L	Popliteal Height	14.40	0.40
M	Knee Pivot Height	16.00	0.50
N	Buttock popliteal length	16.80	0.50
O	Chest Depth without Jacket	7.20	0.50
P	Foot Length	8.90	0.30
Q	Standing Height (Theoretical)	59.1	-
R	Buttock to Knee Pivot Length	18.50	0.50
S	Head Breadth	5.60	0.20
T	Head Depth	7.20	0.20
U	Hip Breadth	12.10	0.30
V	Shoulder Breadth	14.10	0.30
W	Foot Breadth	3.40	0.30
X	Head Circumference	21.20	0.40
Y	Chest Circumference with Jacket at Nipple Height	34.10	0.60
Z	Waist Circumference	30.50	0.60
AA	Reference Location for Chest Circumference	13.60	0.50
BB	Reference Location for Waist Circumference	6.50	0.20

Table 10.1 – External Dimension Table

ASSEMBLY WEIGHTS				
SEGMENT ASSEMBLY	SPECIFIED WEIGHTS			
	lbs	lbs	kg	kg
HEAD ASSEMBLY	8.23	±0.10	3.73	±0.05
NECK ASSEMBLY	2.00	±0.20	0.91	±0.09
UPPER TORSO ASSEMBLY WITH TORSO JACKET (INCLUDES FROM NECK BRACKET TO BOTTOM OF SPINE BOX)	26.50	±0.30	12.02	±0.14
LOWER TORSO ASSEMBLY (INCLUDES FEMURS AND THE LOWER LUMBAR ADAPTING PLATE)	29.20	±0.30	13.25	±0.14
UPPER ARM ASSEMBLY, LEFT OR RIGHT	2.60	±0.10	1.18	±0.05
LOWER ARM ASSEMBBLY, LEFT OR RIGHT	1.98	±0.10	0.90	±0.05
HAND ASSEMBLY, LEFT OR RIGHT	0.62	±0.10	0.28	±0.05
UPPER LEG ASSEMBLY, LEFT OR RIGHT	6.90	±0.20	3.13	±0.09
LOWER LEG ASSEMBLY, LEFT OR RIGHT	7.20	±0.20	3.27	±0.09
FOOT ASSEMBLY, LEFT OR RIGHT	1.75	±0.10	0.79	±0.05
TOTAL DUMMY WEIGHT	108.03	±2.50	49.01	±1.13

Table 10.2 – Assembly Weights

10.2 Hip Joint Range of Motion

(A) This test monitors the moment vs. angle relationship of the femur and pelvis when each femur is rotated toward the pelvis.

(B) The parts required for testing are:

- left and right upper femur assemblies (880105-420 and 880105-421)
- pelvis (880105-440)

Optional components that may be in place during testing are:

- lumbar spine and lumbar adaptor (880105-1095, 880105-1094)
- upper torso assembly (880105-300)
- neck assembly (880105-250)
- head assembly (880105-100X)
- arm assemblies (880105-728-1,880105-728-2)

(C) The test fixture consists of a structure to hold the pelvis and upper femur assembly, and a device to apply a moment through each upper femur. A generalized test setup appears in Figure 10.1. The fixture's structure must be secured to prevent movement during the test. An adaptor mounted to the pelvis instrument cavity should mount the pelvis to the fixture and align it. The fixture should hold the pelvis so the bottom and rear skin of the pelvis do not contact the fixture. The fixture should hold the pelvis rigidly and prevent motion throughout the test. To ensure that the pelvis is restrained, an additional clamp to the fixture that is mounted through the two front bolt holes for the lumbar adaptor should be used. The moment arm should extend straight out of the upper femurs and have a disk (880105-428 or 429) the same size and mass as that on the femur bone. The disk should also be in the same location relative to the upper femurs as it is on the femur bone. The fixture should compensate for the effect of the mass of the moment arm, or include the effect when determining the applied torque. A guiding system is required to keep the moment arm aligned throughout the test.

(D) The Data Acquisition System, including transducers, must conform to the requirements of the latest version of SAE Recommended Practice J211.

(E) Test Procedure:

1. Clean the inside and front flesh of the pelvis with isopropyl alcohol or equivalent before initial assembly. Inspect the urethane stops on the upper femur (880105-428 or 429) for damage. Replace if necessary. Inspect the pelvis flesh inside and outside the femur cavity for tears. If the pelvis flesh or foam is torn or disintegrated in this area, it should be replaced. Insert the urethane stops into the upper femurs. Use a small amount of talcum powder applied to the pelvis flesh and urethane bumper as a lubricant (to prevent tearing of the urethane bumper) and insert the upper femurs (880105-420 or 421) into the pelvis. The femur friction adjustment screws (1200050) should be removed.

2. Soak the pelvis assembly in a controlled environment with a temperature of 18.9 to 25.6 °C (66 to 78 °F) and a relative humidity of 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

3. Mount the pelvis assembly on the fixture. Surface D on drawing 880105-440 should be perpendicular to the midsagittal plane within ± 0.3°. The pelvic instrumentation cover mounting surface, shall be perpendicular to the midsagittal plane within ± 0.3°.

4. Insert the moment-inducing arm into one of the upper femurs, and place the moment arm within the guiding system. The moment arm and upper femur should be parallel to the midsagittal plane within +/- 0.5° initially and throughout the test. Initially, the moment arm should be positioned so the bolt connecting the moment arm to the femur is perpendicular to the midsagittal plane within +/- 0.5°. The guiding system should constrain the moment arm to prevent twist about the moment arm axis of more than ± 0.5°.

5. The angle should be taken relative to the D surface of the pelvis.

6. Time zero is defined as the point at which the moment arm is parallel to the D surface of the pelvis. All data channels should be at the zero level at this time after filtering. However, the test must begin at a location approximately 10° ± 0.15 below horizontal to eliminate any static friction effects and allow time to achieve the correct load rate.

7. Apply a moment to the loading arm until at least 55 N·m (41 ft·lbf) is achieved. The applied moment should not be significantly above this value to prevent damage to the pelvis flesh. The rate of application between should be 5 and 10 degrees/second.

8. Testing should be performed on each femur separately. Each femur should be tested with the moment arm parallel to the midsagittal plane.

9. Wait at least ten minutes between successive tests on the same femur.

(F) Performance Specifications

1. The measured angle should be between 40° and 50°, inclusive, at an applied torque of 55 N·m (41 ft·lbf). In addition, the moment must remain below 43 N·m (32 ft·lbf) at angles up to 30°.

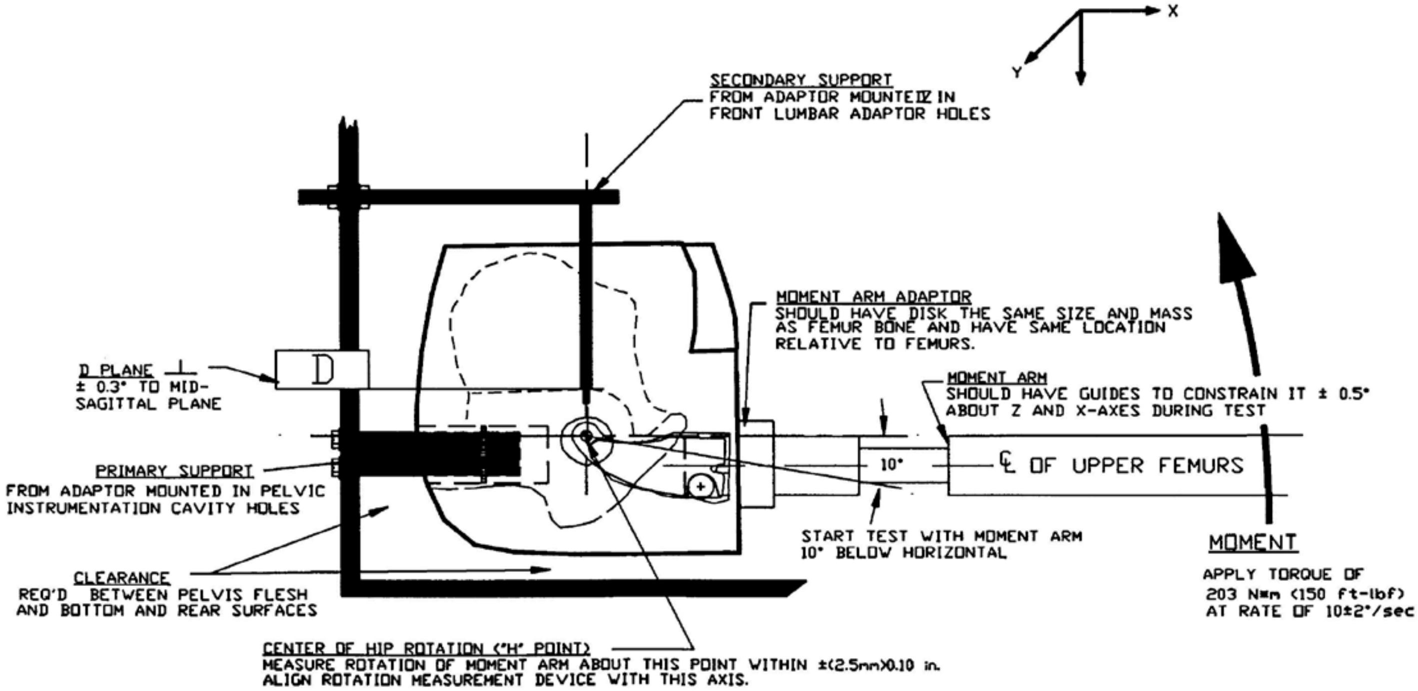


Figure 10.2- Hip Joint Range of Motion Test Setup

10.3 Design Reference, Foot Test

(A) The components required for the foot tests are:

- Foot Assembly (880105-650 or 880105-651) including the heel pad foam (880105-659)

(B) The test fixture consists of a compression testing machine equipped with a load cell and displacement gage. An example set-up appears in Figure 10.3. An ankle adaptor bracket is needed to attach the foot to the compression testing machine. To allow adjustment of the foot angle, two standoffs are inserted into the bolt holes in the foot weldment provided for this purpose.

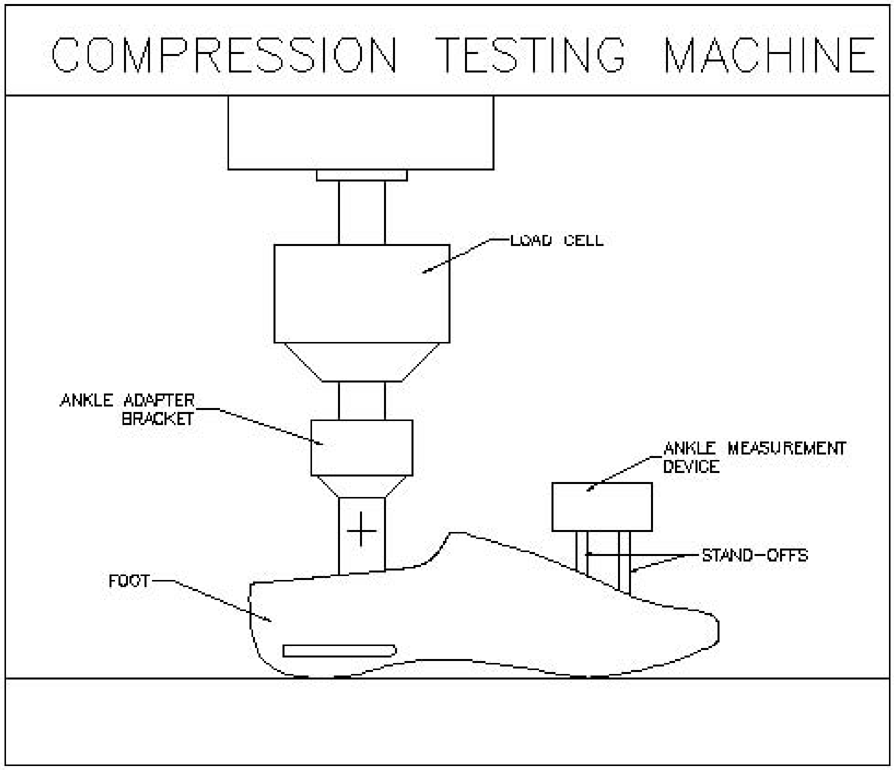


Figure 10.3 – Compression Test Setup

(C) The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211. Using phaseless filters filter the force and displacement channels using Channel Class 60.

(D) Test Procedure:

1. Soak the foot assembly in a controlled environment at a temperature between 18.9 to 25.6°C (66 to 78°F) and a relative humidity from 10 to 70% for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

2. Inspect the foot assembly for cracks, cuts, and separation of the rubber from the metal segment. Inspect the heel pad foam for signs of deterioration.

3. Attach the standoffs on the foot. Install the ankle adaptor bracket to the foot, and attach it to the compression testing machine.

4. Lower the foot until it first contacts the base of the test fixture. Using an angle measurement device positioned on the standoffs, position the foot so it is level (relative to the test fixture) in the transverse and longitudinal directions within ± 1°

5. Wait at least 30 minutes between tests on the same foot.

(E) Performance Specifications

1. Load the foot at a rate of 15 ± 1 mm/min (0.59 ± .04 in/min) until the loading force reaches 0.9 kN (200 lbf).

2. Time-zero is the time when the loading force measures 0.0 to 2.2 N (0 to 0.5 lbf). (The foot is lowered until it just touches the base of the fixture.) The displacement channels should be at the zero level at this time.

3. The force vs. displacement response should fall within the corridor shown in Figure 10.4.

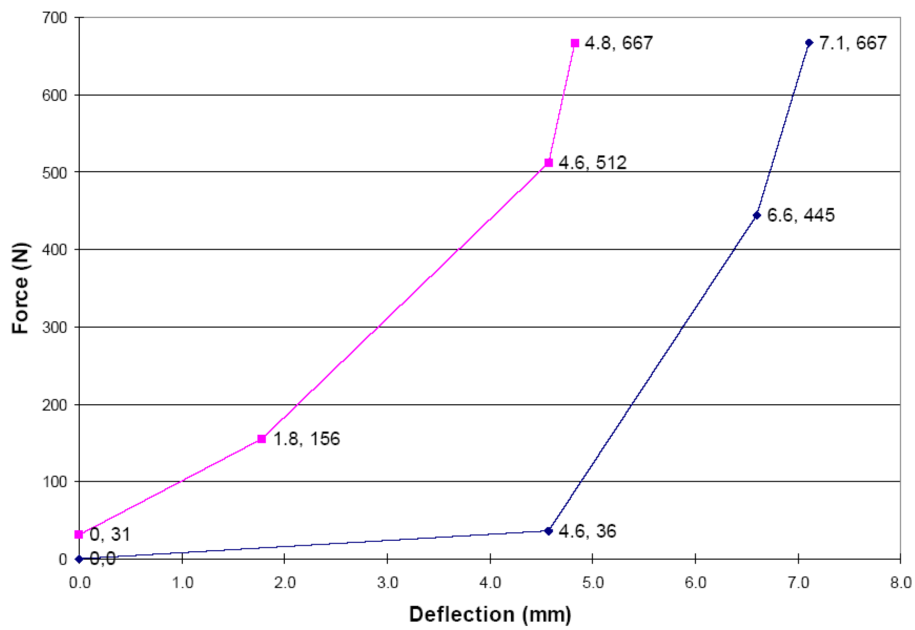


Figure 10.4- Foot Compression Test Performance Specifications

10.4 Design Reference, Ankle Motion Test

(A) The test monitors the range of motion and resistance to motion of the ankle joint in dorsi flexion, plantar flexion, eversion, and inversion.

(B) The parts required for testing are:

- Ankle Assembly (880105-660), Bumper (78051-610), Foot Left or Right (880105-650, 651).

(C) The test device consists of a rigid fixture that will hold the ankle shell. Two standoffs are mounted into the foot. Attached to the standoffs is a plate or bar that will allow a reference for angle measurement and a means for transmitting moment to the ankle joint.

(D) The Data Acquisition System, including transducers, must conform to the requirements of the latest version of SAE Recommended Practice J211.

(E) Test procedure:

1. Inspect the ankle bumper for uneven wear, tears, or other damage. Replace if necessary. Ensure that the ankle bumper is installed correctly, with the front part visibly thicker than the rear part. Adjust the ankle ball joint set screw so it applies no friction to the ball joint. Check for smooth rotation of the ankle shell on the ball. If rotation is not smooth, replace the ankle assembly. The tests are run with the ankle set screw loose.

2. As seen in Figures 10.5 and 10.6, an ankle reference plane is defined as the plane parallel to the sole plate of the foot that passes through the ankle ball joint center. This plane is 40.1 ± 0.2 mm (1.58 ±0.01 in) above the bottom of the standoff holes.

3. Mount the ankle shell to a rigid fixture using the existing 19 mm hole intended for attaching the ankle to the tibia. Insert the standoffs into the foot. Attach a device to the standoffs for applying the moment and providing an angle measurement reference surface.

4. Soak the ankle assembly in a controlled environment with a temperature between 18.9 and 25.6°C (66 to 78°F) and a relative humidity between 10 and 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

5. Install the moment and angle transducers. Angle and moment data should be measured continually throughout all tests.

6. Adjust the foot so the angle between an anterior/posterior line on the ankle reference plane and the longitudinal centerline of the ankle shell is 86 ±1°. In addition, the foot should be adjusted so a lateral/medial line on the ankle reference plane is perpendicular ±1°to the ankle shell longitudinal centerline. The medial/lateral centerline of the ankle shell should be perpendicular to the centerline of the foot within ±1° . (The centerline of the foot is 20° from a centerline through the two standoffs.)

7. Time zero is defined as the point at which the initial angles meet the requirements specified in Item 6. All data channels should be at the zero level at this time.

8. Dorsi flexion Test: apply a moment through the standoffs that rotates the toe towards the ankle shell about the ankle's medial/lateral axis until a moment of at least 35 N·m (28.5 lbf·ft) is reached at a rate not to exceed 5º per second.

9. Plantar flexion test: apply a moment through the standoffs that rotates the toe away from the ankle shell about the ankle's medial/lateral axis until a moment of at least 4 N·m (2.95 lbf·ft) is reached at a rate not to exceed 5º per second.

10. Inversion test: apply a moment through the standoffs that rotates the foot inward relative the ankle shell about the ankle's anterior/posterior axis until a moment of at least 4 N·m (2.95 lbf·ft) is reached at a rate not to exceed 5º per second.

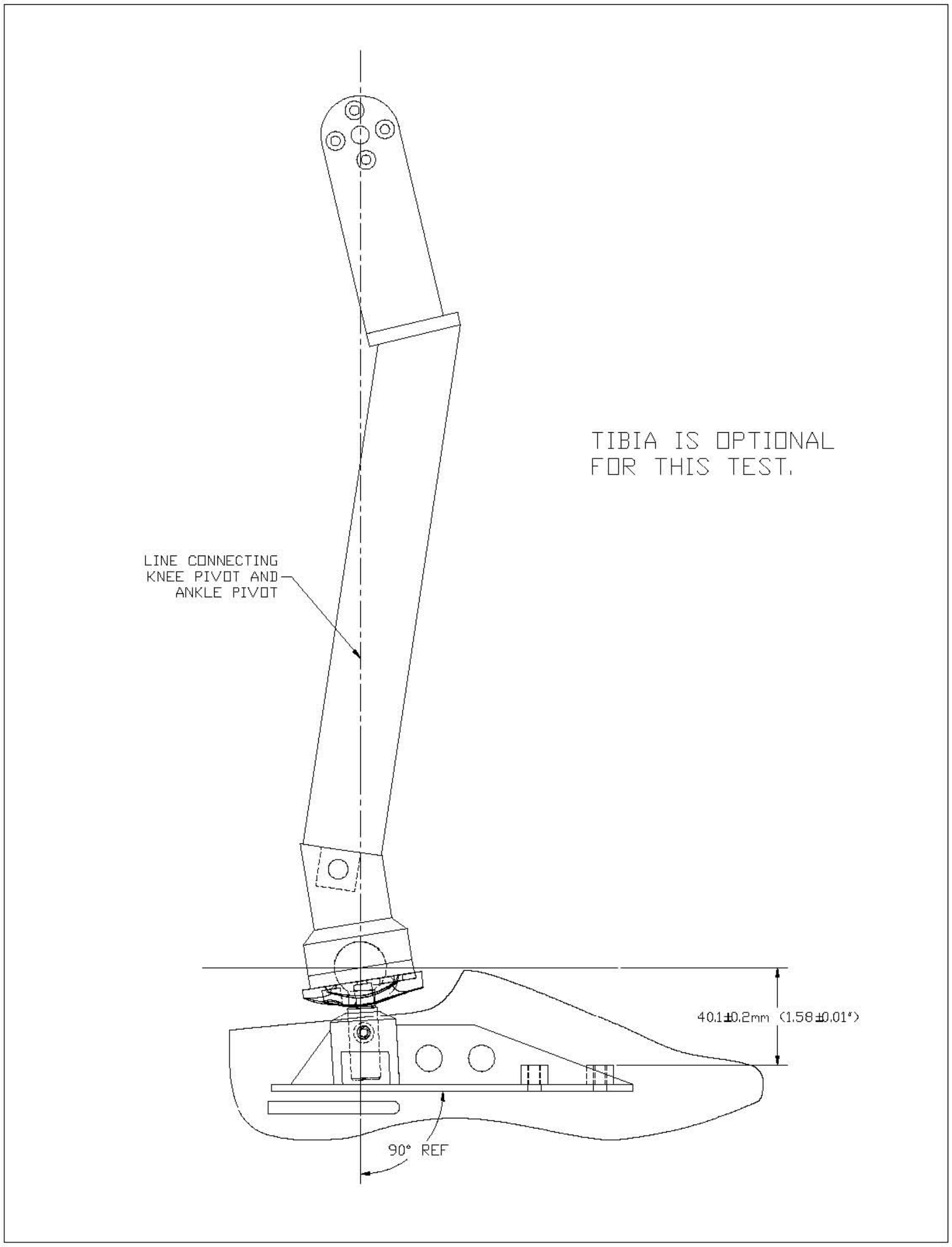


Figure 10.5 – Leg Reference Planes

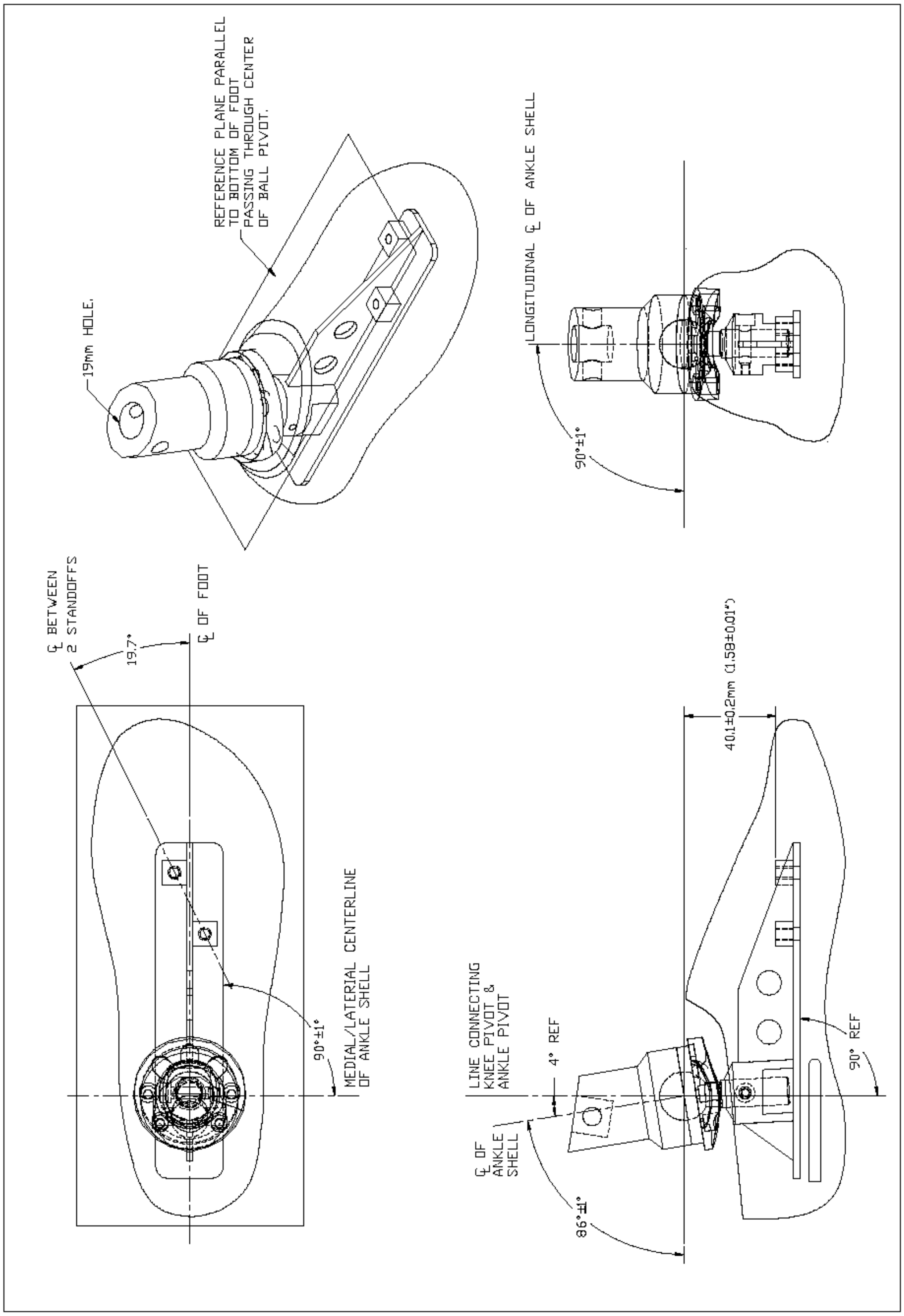


Figure 10.6- Ankle/Foot Reference Planes

11. Eversion test: apply a moment through the standoffs that rotates the foot outward relative the ankle shell about the ankle's anterior/posterior axis until a moment of at least 4 N·m (2.95 lbf·ft) is reached at a rate not to exceed 5º per second.

12. Testing should be performed on each ankle joint separately.

13. Wait at least 5 minutes between successive tests on the same ankle.

(F) Performance Specifications

1. Dorsiflexion: at a moment of 35 N·m (25.8 ft·lbf) the angle should measure 45 ± 2°. The moment in dorsiflexion up to 34° must be less than 6 N·m (4.42 ft·lbf).

2. Plantar flexion: at a moment of 4.0 N·m (2.95 ft·lbf), the angle should measure 33 ± 2°.

3. Inversion: at a moment of 4.0 N·m (2.95 ft·lbf) the angle should measure 22 ± 1°.

4. Eversion: at a moment of 4.0 N·m (2.95 ft·lbf) the angle should measure 22 ± 1°.

10.5 Design Reference, Torso Flexion Test

(A) This procedure tests the forward flexion of the torso of the dummy. The fully assembled dummy with or without the lower leg assemblies below the femur link can be used in this test.

(B) The test fixture consists of the torso flexion test table shown in Figure 10.8 and the torso pull bracket shown in Figure 10.7.

(C) The Data Acquisition System, must confirm to the specification of the latest revision of SAE recommended practice J211. Filter the force channel using class 60 phaseless filter.

(D) Test Procedure:

1. Soak the dummy in a controlled environment with a temperature between 20.6 to 22.2°C (69 to 72°F) and a relative humidity from 10 to 70 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

2. Remove the knees and lower legs from the dummy, if needed. Clean and dry all component surfaces. Disassemble the lumbar spine bracket from the pelvis separating the dummy. Adjust the torque on the lumbar cable hex nut to 1.13 - 1.35 N·m (10 – 12.7 in·lbf).

3. Fasten a pelvic support bracket to the outside of the pelvic instrument cavity with four screws.

4. Reassemble the dummy by attaching the lumbar bracket to the pelvis.

5. Adjust all joint torques to 1 to 2 G's.

6. Mount the dummy rigidly onto the torso flexion test table using the pelvic support bracket. The pelvic surface to which the lumbar spine mounts must be horizontal ± 2° and the bottom surface of the pelvis is between ½ and 1 inches above the table surface. The test set-up appears in Figure 10.8.

7. If the lower legs are removed, use two hex nuts to attach a socket head cap screw with the head downward to the knee end of each femur load link. Adjust each femur load link to horizontal within 0 to -6 degrees. If the lower legs are attached, rest them on the table surface.

8. Flex the elbow joints to 90º and point the forearms laterally away from the dummy torso to clear the table.

9. Attach a torso pull bracket (Figure 10.7) to the instrument cavity-mating surface at the back of the spine box using four screws.

10. Position the upper torso of the dummy so that the instrument cavity mating surface at the back of the thoracic spine is 15 ± 4° degrees forward of vertical.

11. Apply a forward pull force to the pull bracket through a cable attached at the occipital condyle location to flex the dummy forward at any rate between 0.5 and 1.5 degrees per second. Flex the dummy forward until the instrument cavity mating surface at the back of the spine box is at 45º. Apply the force so that it is perpendicular to the undeformed neck centerline at 45º (this will be a pull angle of 59º from horizontal).

12. Record the highest force required to flex the dummy to the 45º angle.

13. Wait at least 30 minutes between successive tests on the same components.

(D) Performance Specifications

The dummy will flex forward to an angle reading of 45º from vertical. The force required to flex the dummy to this angle shall be not less than 320 N (72 lbf) and not more than 390 N (88 lbf).

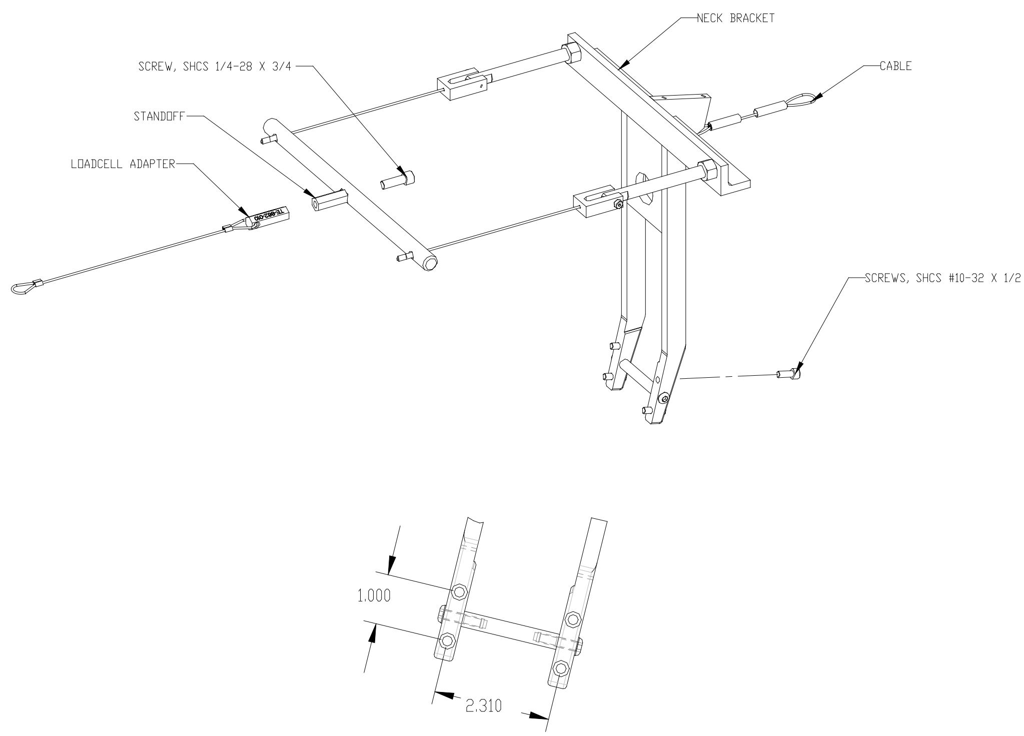


Figure 10.7- Torso Flexion Bracket Assembly

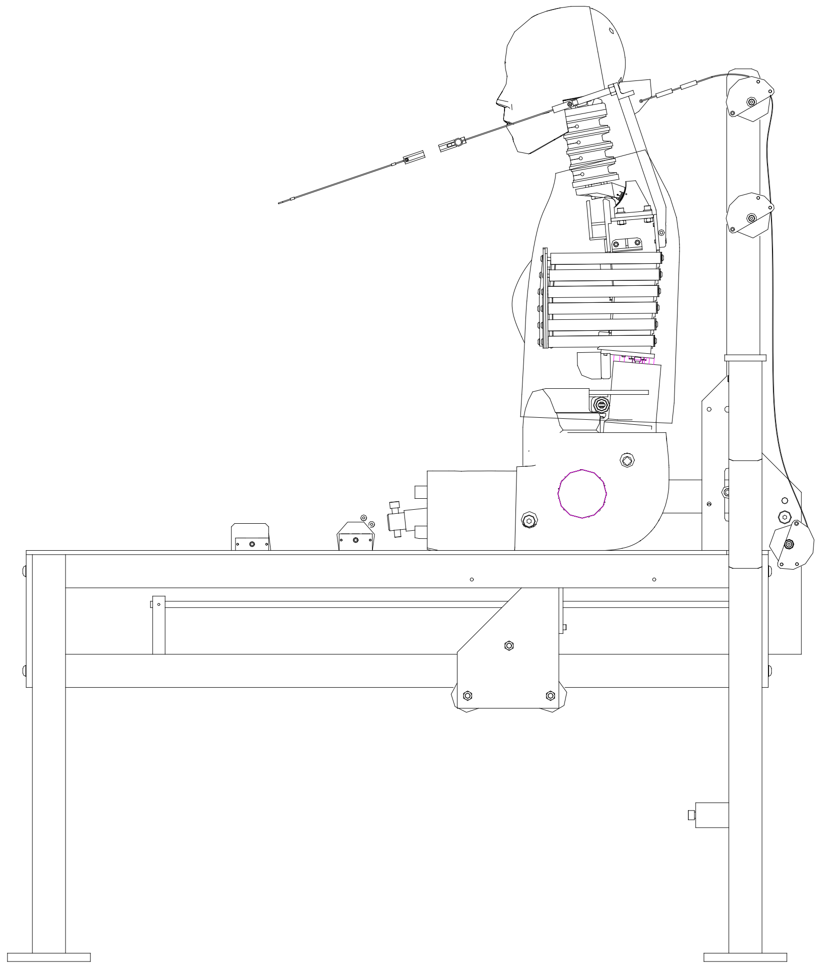


Figure 10.8 – Torso Flexion Test Setup

Section 11 – Appendices

11.1 Appendix A

11.1.1 Accelerometer Handling Guidelines

11.1.1.1 General

The accelerometers used in anthropomorphic test dummies, such as the Hybrid III Dummy Family, are small, low mass piezoresistive accelerometers. Because of their design and inherent mechanics, certain precautions must be observed when handling and mounting accelerometers to avoid damaging them. When handling and mounting the accelerometer, avoid dropping the accelerometer or striking the unit against hard surfaces. Keep the unit in its protective sleeve until the unit is installed.

11.1.1.2 Preliminary Check-Out

Before installing any accelerometer into the dummy, check that it operates properly. Three simple tests that require minimal test equipment should be conducted:

1. Impedance Test: Read the input impedance (Red to Black) and output impedance (Green to White) with an ohmmeter. Compare the measured values to those on the accelerometer Calibration Data Sheet. The measured impedance should be within +/- 25% of the calibrated value.

2. Insulation Resistance: If the input and output impedances are within acceptable limits use a multimeter, ohmmeter, or megohmmeter set at 50 volts maximum. Measure the insulation resistance between:
   - all leads connected together and the cable shield
   - all leads connected together and the accelerometer case
   - cable shield and the transducer case

   All three readings should be at least 100 megohms. Be careful when connecting 50VDC to eliminate the possibility of voltage spikes.

3. Zero Measured Output: After the impedance and insulation resistance tests, measure the output of the accelerometer with zero G acceleration. With the unit still in its sleeve, turn the unit on its side so the accelerometer mounting surface is perpendicular to the table top (sensitive axis horizontal and perpendicular to the gravity field.) Apply the specified excitation voltage to the accelerometer and measure its output with a DC millivolt meter. Allow the unit to warm-up for two minutes. The accelerometer should have a Zero Measured Output (ZMO) within the manufacturer's specified limits.

If any of these initial checks do not give proper readings, indicating a possible malfunction, remove the excitation source immediately and take the following measurements.

1. Check and record leg 1, leg 2, leg 3, and leg 4 resistances.
2. Disconnect, check and record excitation voltage from the source.
3. Reconnect, check, and record excitation with the unit connected.
4. Check and record ZMO again.
5. Check and record static outputs +1G and -1G and compare to calibrated sensitivity.
6. Check that the temperature and environment fall within accelerometer specification.
7. Check to see if the accelerometer case is under stress.
8. Check leads for abrasion or cuts.

If the reason for the erroneous reading cannot be found, contact the accelerometer manufacturer.

11.1.1.3 Installation

When mounting or removing the accelerometer, you must use the proper techniques and tools. The mounting surface should be clean and free of burrs. A recommended surface roughness is 32 micro inch rms or less. Make sure that no dirt or particles can be clamped between the unit and mounting surfaces.

Remove the unit from the protective sleeve. With the sleeve absent, handle the unit by the case, not the cable. This will prevent the unit from slapping the mounting surface during installation. Place the unit on the mounting surface and align the mounting holes.

Correct torque is important to ensure correct mounting and performance. When mounting the accelerometer, use only the materials and parts which are supplied with the accelerometer. Always use the proper mounting torque recommended by the accelerometer manufacturer. If applicable, use the supplied mounting washers and screws, or mounting stud. Using the supplied wrench, turn the screws into the mounting holes using the recommended torque. Usually, this is roughly equivalent to finger tight with the supplied wrench. Installation of the unit with higher torque values, dry threads, or thread adhesives is not recommended as excessive torque will be required to break the screw loose when the accelerometer is dismounted. EXCESSIVE TORQUE CAN CREATE AN OVERRANGE TRANSIENT SHOCK PULSE UPON REMOVAL OF THE UNIT, WITH SUFFICIENT HIGH FREQUENCY CONTENT TO DAMAGE OR DESTROY THE UNIT. Do not over torque the screws. Do not use snap type torque wrenches. Do not cement the unit to the mounting structure.

Where practical, tie down the cable within 4 to 6 cm (1.6 to 2.4 in) of the unit. Whipping of the cable during vibration and shock will strain the cable unnecessarily at the unit.

Connect the unit to the signal conditioner and check for proper functioning through the use of standard techniques such as shunt calibration across the passive arms of the accelerometer.

11.1.1.4 Recalibration

Sensitivity and Zero Measured Output calibrations should be performed at 6 to 12 month intervals, depending on usage. Usually, 12 month intervals are sufficient if you know the accelerometer has not been used beyond its rated specifications. If the unit is used under severe environments, the shorter calibration interval may be desirable.

11.1.1.5 Cleaning

Dirty units may be wiped clean using a damp cloth and a solvent such as acetone. DO NOT SOAK OR IMMERSE the unit in any solvent or water. Do not use any sharp tool such as a screwdriver to remove dirt or contaminants. If tools such as pliers are needed to handle the accelerometer, cover the jaws with masking tape to prevent unwanted metal-to-metal contact.

11.2 Appendix B

11.2.1 Guidelines for Repairing Flesh

Dummy flesh is often damaged, but can be repaired. The most common types or flesh damage are punctures, tears, and scrapes. Scrapes can be fixed by rubbing an iron, at low temperature, over the affected area several times. Punctures and tears require patching.

To repair the flesh, use an iron to bond the dummy's flesh to patches of repair materials. The iron is similar to a standard electronic soldering iron. Its output should range from 60 to 90 Watts. The best tip is a broad, flat paddle tip like the one in the dummy tool kit provided by the dummy manufacturers. For best results, a variable power supply should be used to control the heat output from the iron. Without this control, repairs will be more difficult and may be unsightly from black flakes of burnt flesh imbedded in the flesh. These flakes are caused by overheating the flesh, which happens when an iron is too hot or remains in one position too long. Another cause of black residue in the flesh is improper or infrequent cleaning of the iron tip. The tip should be cleaned frequently during the repair job, between each melting of flesh if possible. The best method for doing this is to tap the iron quickly on a buffing wheel.

Conduct all flesh preparations and repairs in a well-ventilated area. When patching, first clear away any loose material which may be hanging from the damaged areas, such as shredded vinyl or foam. Clean the area with 99% solution isopropyl alcohol and let dry for fifteen minutes. Any residue from tape or chalk must be removed. If it remains after the initial cleaning, continue to clean with isopropyl alcohol until the area is completely clean. Since isopropyl alcohol is flammable, make sure the surface is dry before applying heat. Do not use soldering flux or any other chemical on the flesh or repair iron.

After preparation, a patch can be bonded to the flesh. Cut a patch of adequate size from the material provided in the dummy tool kit. The patch should be approximately 10 mm (0.4 in) wider than the damaged area on all sides. To check that the iron is at a usable temperature, test it on a small piece of patch material. The flesh should easily melt but not instantly burn. With the patch held over the damaged area, slide the iron between the patch and dummy flesh. Hold the iron in position until you see both materials melting. When both the patch and the flesh look like a gel, move the iron to a new point while holding the patch in place until they have both cooled. Continue this all the way around the damaged area until the patch is completely bonded to the flesh.

For large areas, or areas where the patch must bend to conform to the dummy part, it may be easier to "tack" a few points around the edge of the patch to hold it in place, then return to fill in the unbonded sections. Once you bond the patch to the flesh, you need to blend the patch into the flesh. This will eliminate any protruding edges that may later snag and ruin the repair. To blend the patch, work the iron tip around the patch edges in a circular motion, blending the patch material into the flesh as you work your way around the patch. If the iron is too hot, black flakes will appear; if it is too cold, the patch will not readily melt, and the patch is probably not very well bonded to the flesh. Continue working the patch into the flesh until the repair is fairly well hidden and let it cool. After the area cools, you can return to touch-up any areas.

If a certain area of flesh is frequently damaged and is not expected to contribute significantly to dummy response, duct tape can be placed on the flesh but under the clothing to help protect it. Tape should not be used on any area which directly affects the test data, such as head, neck, ribs or spine. The engineer running the test should approve use of additional reinforcement such as tape before conducting tests.

11.3 Appendix C

11.3.1 Joint Adjustment Procedures

The joints of the Hybrid III dummies are adjusted to a “one G suspended setting.” This is defined as a torque level on the joint where the friction will allow an assembly to move toward the earth when a small force is applied to the unsupported end of the assembly. For example, when the dummy’s arm is fully extended laterally so it is perpendicular to the body, the shoulder yoke clevis bolt should be tight enough to support the weight of the arm, but loose enough so when you tap the dummy’s wrist, the whole arm will slowly fall towards the dummy. The following sections describe how to position the body parts and which joints to tighten to allow a one G setting.

11.3.1.1 Hands and Arms

1. Extend complete arm laterally outward to a horizontal position. Twist the arm so the elbow cannot rotate downward. Tighten the shoulder yoke clevis bolt so the arm is suspended at one G.

2. Rotate the complete arm assembly so it points forward and is horizontal. Twist the arm so the elbow cannot rotate downward. Adjust the shoulder yoke rotation hex nut so the arm is suspended at one G.

3. Bend the elbow 90º so the hand moves toward the chest. Adjust the elbow rotation bolt through access in the upper arm to hold the lower arm horizontally suspended at one G.

4. Reposition the arm so it points forward and is horizontal. Twist the lower arm at the elbow, so the lower arm can pivot downward to vertical. Adjust the elbow pivot bolt through access holes in the lower arm flesh at the elbow to hold the lower arm suspended at one G.

5. Extend the arm and twist the palm so it faces down. Adjust the wrist pivot bolt at the base of the hand so it is suspended at one G.

6. Adjust the wrist rotation bolt through access in the wrist flesh to hold it suspended at one G.

7. Repeat procedure for other hand and arm.

11.3.1.2 Legs and Feet

1. Remove abdominal insert.

2. With the lower leg at 90º to the upper leg, and the dummy in a seated position, lift the upper leg assembly above horizontal. Adjust the femur ball set screw so the upper leg is held suspended at one G.

3. Rotate the lower leg assembly so it is horizontal. Adjust the knee clevis bolt so the lower leg is held suspended at one G.

4. Adjust the ankle ball joint set screw so the foot is held suspended at one G. The ankle adjustment is not critical and is determined by individual feel.

5. Repeat procedure on other leg and foot.

11.4 Appendix D

11.4.1 Axial Integrity of the Neck

If the axial integrity of the neck is in question, the neck without its cable can be pull tested to 5.34kN (1200 lbf). No separation should occur. Replace as required.

11.5 Appendix E

THREAD SIZE	TORQUE (in·lb)	TORQUE (N·m)
0-80	1.00	0.113
2-56	2.50	0.283
4-40	12.0	1.36
6-32	23.0	2.60
8-32	41.0	4.63
10-24	60.0	6.78
10-32	68.0	7.68
¼ -20	144	16.3
¼ -28	168	19.0
5/16-18	300	33.9
5/16-24	300	33.9
3/8-16	540	61.0
3/8-24	600	67.8

Table 11.1 – Torque Specifications

Notes:

1. This applies to clean and dry parts. A lubricated screw requires less torque (15% to 25% less) to attain the same clamping force as a non-lubricated screw.

2. The references for this specification are Smith Fastener Company, Brake Products Inc., and C & J Fastener Inc.

Manual Update Log

Rev. C, June 2008
Manual updated to FTSS standards.

Rev. D, Aug. 2011
Manual changed from FTSS to Humanetics, updated order of Neck assembly parts, Figure 4.1.

Rev. E, Jun. 2014
Added #9 balloon in lumbar spine assembly image. Updated Figure 5.5, 5.740 was 6.240.

Rev. F, Jul. 2015
Page 2:
Added lead material statement

Rev. G, May 2020
Table 10.2: LOWER LEG ASSEMBLY, LEFT OR RIGHT, ±0.09 WAS ±0.05; TOTAL DUMMY WEIGHT lbs TOL ±2.50 WAS ±2.00; TOTAL DUMMY WEIGHT kg 49.01 WAS 49.05; kg TOL ±1.13 WAS ±0.91;
Update address