USER MANUAL

Harmonized Hybrid III 95th Large Male Dummy

880995-000-H

HUMANETICS Innovative Solutions

Harmonized Hybrid III 95th Large Male User Manual
880995-9900-H [Rev A]

Left View　Front View　Iso View　Right View

Table of Contents **Page**

List of Figures

List of Tables

Section 1. Introduction

1.1. Introduction

The Hybrid III Large Male dummy was developed under a grant awarded by the Center for Disease Control (CDC) to the Ohio State University. A task force of experts from the Society of Automotive Engineers (SAE) Mechanical Human Simulation Subcommittee of the Human Biomechanics and Simulation Standards Committee supported the development activity. The design incorporated the same level of biofidelity and measurement capacity as the Hybrid III 50th percentile. Therefore, the calibration procedures are based on the test procedures that were developed for the Hybrid III 50th percentile dummy. The basic test fixtures are the same.

The Hybrid III Large Male Dummy is based on the characteristic size and weight measurements taken from anthropometry studies of the large adult male. Its impact response requirements for the head, neck, chest, hip, knee and ankle were scaled 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 Large Male dummy is designed to represent the upper extreme of the United States adult population. Much of the anthropometry and design is a scaled version of the Hybrid III 50th percentile midsize male dummy.

1.2. Getting Familiar with the User's Manual

1.2.1. Reference Materials

Appendices - Several guidelines and procedures apply to various parts throughout the dummy, and are included in Section 13, "Appendix", for easy reference.

- When handling an instrumented dummy, improper techniques can damage instrumentation, particularly accelerometers. **Appendix A** contains guidelines for safe handling of the accelerometers used in dummies.
- The vinyl flesh of dummies can be damaged, but is often repairable. **Appendix B** contains instructions for repairing dummy flesh.
- The procedure for validating the axial integrity of the neck is provided in **Appendix C**.

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.

1.2.2. Conventions Used in this Manual

SAE Test Definitions

- **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 tests** are supplemental to the calibration tests to ensure 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.

Fastener 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

Section 2. Dummy Preparation and Use

2.1. General

2.1.1. Hardware and 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 curved 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 the pelvis transducers used to indicate submarining.
- A knee slider mechanism is used that consists of steel ball 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 structures covered with vinyl. The legs are interchangeable with instrumented versions.
- Constant friction movable joints are used that need few adjustments and provide consistent articulations.

2.1.2. Required Tools

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

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

2.1.3. Fastener Torque Specifications

The recommended fastener torque values for commonly-used fasteners are provided below in **Table 2.1.3.1**. The recommended fastener torque values for specific or unique applications are specified throughout the text in this manual.

Table 2.1.3.1: Recommended Fastener Torque Specifications

Thread Size	Torque (in·lbf)	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
1/4 -20	144	16.3
1/4 -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

Notes:

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

2.2. Joint Resistive Torque Adjustments

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.

2.2.1. Hands and Arms

Step 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.

Step 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.

Step 3. Bend the elbow 90° 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.

Step 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.

Step 5. 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.

Step 6. 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.

Step 7. Adjust the wrist rotation bolt through access in the wrist flesh to hold it suspended at one G.

Step 8. Repeat procedure for other hand and arm.

2.2.2. Legs and Feet

Step 1. Remove the abdominal insert.

Step 2. With the lower leg at 90° to the upper leg, and the dummy in a seated position, lift the upper leg assembly above horizontal.

Step 3. Adjust the femur ball set screw so the upper leg is held suspended at one G.

Step 4. Rotate the lower leg assembly so it is horizontal.

Step 5. Adjust the knee clevis bolt so the lower leg is held suspended at one G.

Step 6. 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.

Step 7. Repeat procedure with other leg and foot.

2.3. Additional Reference Materials

2.3.1. External Measurement Procedure

Step 1. All of the measurements are made without the jacket except for the chest circumference (Y). It can be measured last.

Step 2. Place the dummy on a flat, rigid, smooth, clean, dry, horizontal surface. 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, as shown below in Figure 2.3.1.1.

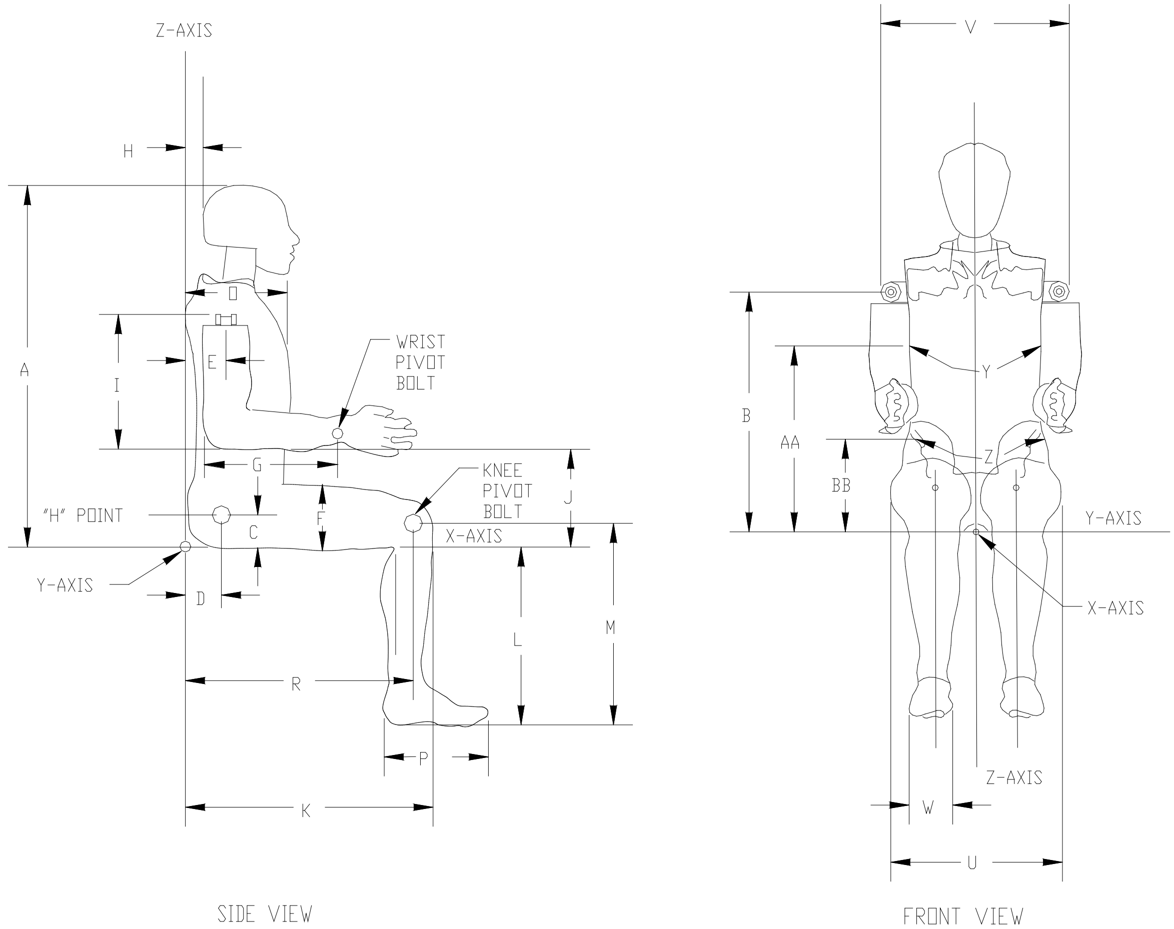


Figure 2.3.1.1: Dummy position for external dimension measurement

Step 3. Adjust the torques on all the joints to a 1g setting.

Step 4. Make sure the zero marks on the upper and lower adjusting neck brackets (880995-1270 and 78051-303, respectively) are aligned. Set the neck cable torque to 1.4 +/-0.2 N·m (12.0 +/- 2 in·lbf).

Step 5. Remove the four socket head cap screws which attach the lumbar spine to the thoracic spine. Set the torque for the two spine cables to 1.1 - 1.4 +/-0.2 N·m (10 - 12 +/-2 in·lbf).

Step 6. Reassemble the lumbar spine to the thoracic spine.

Step 7. Secure the dummy to the test fixture so the rear surface of the upper thorax is tangent to the rear vertical surface of the fixture. The dummy's midsagittal plane should be vertical.

Step 8. The hip pivot height (C) and hip pivot from the backline (D) shall be used to set up the test dummy dimensions. Install the H point gages on the left and right side of the test dummy, as shown below in **Figure 2.3.1.2**. Then measure the dimensions C and D, as shown in **Figure 2.3.1.3**. Adjust the dummy so that left and right measurements are the same; the maximum difference allowed between the two sides shall be 0.1 inches.

Figure 2.3.1.2: Installing the H point gages

Figure 2.3.1.3: Measuring the C and D dimensions

Step 9. Constrain the head so that the back of the skull cap is 3.5±0.1 inches from the backline (D), as shown below in **Figure 2.3.1.4**.

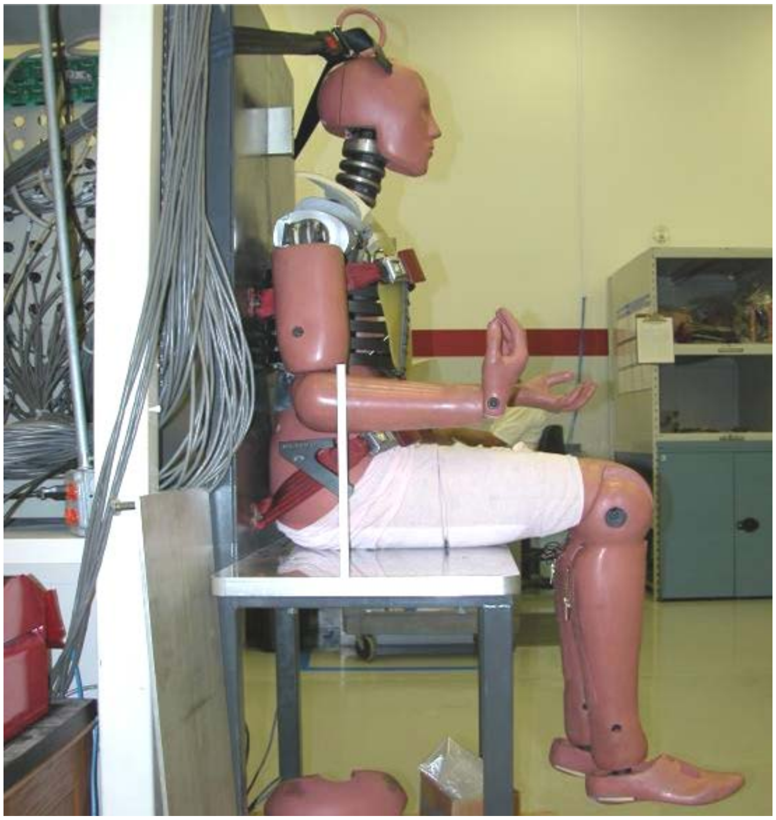


Figure 2.3.1.4: Constraining the test dummy head

Step 10. 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.

Step 11. Position the feet parallel to the dummy's midsagittal plane, with the bottoms horizontal and parallel to the seating surface.

Step 12. Position the upper arms vertically so the centerline between the shoulder and elbow pivots is parallel to the rear vertical surface of the fixture.

Step 13. Position the lower arms horizontally so the centerline between the elbow and wrist pivots are parallel to the seat surface.

Step 14. Record the following dimensions. The letter designation for each dimension is indicated in **Figure 2.3.1.1** above. These letter designations also correspond to the specifications listed in **Table 2.3.2.1** below:

- 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 - H-point height above seat surface (Set up dimension).
- D - H-point from seat's rear vertical surface (Set up dimension).
- E - Shoulder Pivot from Backline without Jacket: Center of the shoulder clevis to the fixture's rear vertical surface.
- F - Thigh Clearance at the Height Point of the Thigh Flesh: 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 - Skull cap skin to seat rear vertical surface (Set up dimension).
I - Top of the Shoulder Yoke 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 - Backline to Knee Length: The most forward surface of the knee flesh to the seat rear vertical surface.
L - Bottom of the Seating Surface to Bottom of Foot: Seat surface to the horizontal plane at the bottom of the feet.
M - Knee Pivot to Height: Knee pivot to the horizontal plane of the bottom of the feet, in line with the knee and ankle pivots.
N - Left blank
O - Chest depth without Jacket: The rearmost surface of spine box assembly to the front of the sternum slider, at the top of the third rib.
P - Foot Length: Tip of toe to rear of heel.
Q - Left blank
R - Backline to Knee Pivot Length: The seat rear vertical surface to the knee pivot bolt.
S - Left blank
T - Left blank
U - Hip Breadth at H Point: The width at H points.
V - Shoulder Breadth: Between outside edges of shoulder clevises, in line with the shoulder pivot bolt.
W - Foot Breadth: The widest part of the foot.
X - Left blank
Y - Chest Circumference: Measured 482.6 mm (19.0 in) above the seat surface, approximately at the top of the 5th rib.
Z - Waist Circumference: Measured 203.2 mm (8.0 in) above the seat surface.

2.3.2. External Dimensions, Assembly Weights, and CG Tables

Table 2.3.2.1 below summarizes the descriptions, specifications, and tolerances for each of the external dimensions listed and shown above in **Figure 2.3.1.1**.

Table 2.3.2.1: External dimension descriptions, specifications, and tolerances

Symbol	External Dimension Description	Spec. (in.)	Tol. (in.)
A	Total Sitting Height	36.20	0.6
B	Shoulder Pivot Height	21.10	0.6
C	Hip Pivot Height (Set up dimension)	4.00	0.3
D	Hip Pivot from Backline (Set up dimension)	6.10	0.2
E	Shoulder Pivot from Backline without Jacket	3.60	0.2
F	Thigh Clearance at the highest point of the thigh flesh	6.60	0.3
G	Back of Elbow to Wrist Pivot	12.20	0.3
H	Head Back From Backline (set up dimension)	3.50	0.1
I	Top of the shoulder yoke to elbow length	14.30	0.4
J	Elbow Rest Height	8.40	0.4
K	Backline to knee length	25.50	0.5
L	Bottom of seating surface to bottom of foot	18.50	0.5
M	Knee Pivot Height	21.00	0.5
O	Chest Depth without Jacket	9.70	0.3
P	Foot Length	10.40	0.3
R	Backline to knee pivot length	22.80	0.5
U	Hip Breadth at H Point	15.90	0.4
V	Shoulder Breadth	18.70	0.4
W	Foot Breadth	3.90	0.3
Y	Chest Circumference with Jacket	44.70	0.8
Z	Waist Circumference	39.70	0.8
AA	Reference Location for Chest Circumference	19.00	0.2
BB	Reference Location for Waist Circumference	8.00	0.2

Table 2.3.2.2 below summarizes the specified assembly weights for the different test dummy segment assemblies.

Table 2.3.2.2: Assembly weights for different test dummy segment assemblies

Assembly Weights				
Segment Assembly	**Specified Weights & Tol.**			
	Lbs.	**Lbs.**	**kg**	**kg**
Head Assembly	10.90	±0.10	4.94	±0.05
Neck Assembly	3.70	±0.10	1.68	±0.05
Upper Torso Assembly with Torso Jacket (Includes from the Neck Bracket to the Bottom of the Spine Box)	49.10	±0.80	22.27	±0.36
Lower Torso Assembly (Includes the Femurs and the Lower Lumbar Adapting Plate)	66.80	±0.80	30.30	±0.36
Upper Arm Assembly, Left or Right	6.20	±0.20	2.81	±0.09
Lower Arm Assembly, Left or Right	4.55	±0.10	2.06	±0.05
Hand Assembly, Left or Right	1.25	±0.10	0.57	±0.05
Upper Leg Assembly, Left or Right	18.10	±0.20	8.21	±0.09
Lower Leg Assembly, Left or Right	12.68	±0.20	5.75	±0.09
Foot Assembly, Left or Right	3.50	±0.10	1.59	±0.05
Total Dummy Weight	223.1	±3.6	101.2	±1.6

Table 2.3.2.3 below summarizes the specifications and tolerances for the center of gravity (CG) for different test dummy segment assemblies.

Table 2.3.2.3: Center of gravity information for different test dummy segment assemblies

Center of Gravity Dummy Segment	Reference Drawings	C.G. Axis	Spec. in.	Tol. in. ±
Head	880995-1100	X	2.52	0.10
	880995-1100	Z	1.40*	0.10
		Z	2.00**	0.10
Neck	880995-1250	X	-0.24	0.10
	880995-1250	Z	2.14	0.10
Upper Torso	880995-1300	X	4.10	0.20
	880995-1300	Z	-1.78	0.20
Lower Torso	880995-1450	X	0.24	0.20
	880995-1450	Z	-0.18	0.20
Upper Leg, Left	880995-1513	X	-6.73	0.20
	880995-1513	Z	0.82	0.20
Upper Leg, Right	880995-1514	X	-6.73	0.20
	880995-1514	Z	0.82	0.20
Lower Leg, Left	880995-1513	X	0.02	0.20
	880995-1513	Z	-7.75	0.20
Lower Leg, Right	880995-1514	X	0.02	0.20
	880995-1514	Z	-7.75	0.20
Foot, Left	880995-1600	X	1.93	0.20
	880995-1600	Z	-2.60	0.20
Foot, Right	880995-1601	X	1.93	0.20
	880995-1601	Z	-2.60	0.20
Upper Arm, Left	880995-730	X	0.00	0.20
	880995-730	Z	-5.42	0.20
Upper Arm, Right	880995-731	X	0.00	0.20
	880995-731	Z	-5.42	0.20
Lower Arm, Left	880995-730	X	3.70	0.20
	880995-730	Z	-0.23	0.20

Center of Gravity Dummy Segment	Reference Drawings	C.G. Axis	Spec. in.	Tol. in. ±
Lower Arm, Right	880995-731	X	3.70	0.20
	880995-731	Z	-0.23	0.20
Hand, Left	880995-730	X	2.25	0.20
	880995-730	Z	-0.06	0.20
Hand, Right	880995-731	X	2.25	0.20
	880995-731	Z	-0.06	0.20

Note:

- * Dimension is from Head CG to bottom surface of skull.
- ** Dimension is from Head CG to Head Neck Joint.

Section 3. Head Assembly

3.1. Description and Features of the Head Assembly

The head assembly consists of the six-axis neck skull, the skull cap, the skull and skull cap skin, the six-axis neck transducer (or representative structure), and the head accelerometer assembly.

3.2. Disassembling, Inspecting, Repairing, and Reassembling the Head

3.2.1. Exploded View

The exploded view for the head assembly parts and their corresponding item numbers are shown below in **Figure 3.2.1.1**.

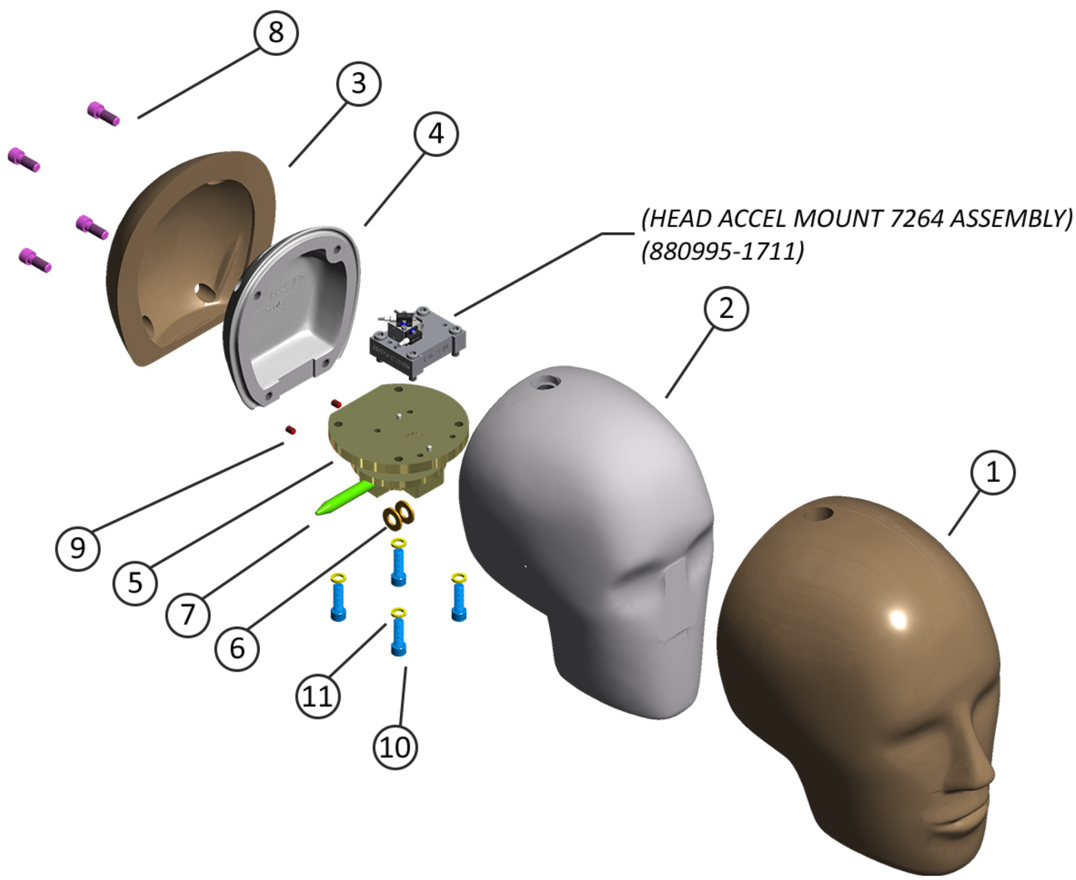


Figure 3.2.1.1: Head assembly exploded view

3.2.2. Parts List

The item numbers, part numbers, and part descriptions for the head assembly are shown below in **Table 3.2.2.1**.

Table 3.2.2.1: Head assembly (880995-1100) parts list

Item	Quantity	Part Number	Description
1	1	880995-105	Head Skin
2	1	880995-095X	Skull, 6 Axis
3	1	78051-229	Cap Skin
4	1	78051-220	Skull Cap
5	1	78051-383X	Neck Transducer Assembly
6	2	78051-253	Washer, Nodding Joint
7	1	1717	Pivot Pin Neck
8	4	9000144	1/4-20 X 5/8 Lg. SHCS
9	2	9000452	#8-32 X 1/4 Lg. SSSCP
10	4	9000453	1/4-28 X 3/4 Lg. SHCS
11	4	9000677	1/4 X 1/16 Thick Shoulder Screw Shim

3.2.3. Disassembling the Head

Step 1. Remove the chest jacket to permit easier access to the base of the neck bracket. For easy removal of the jacket, remove the arms first.

Step 2. Remove the SHCS fastener, as shown below in **Figure 3.2.3.1**, that holds the upper neck bracket to the lower portion of the neck bracket and permits adjustment of the neck angle.

Note: Check the condition of the curved steel washer and note how it fits on the neck bracket.

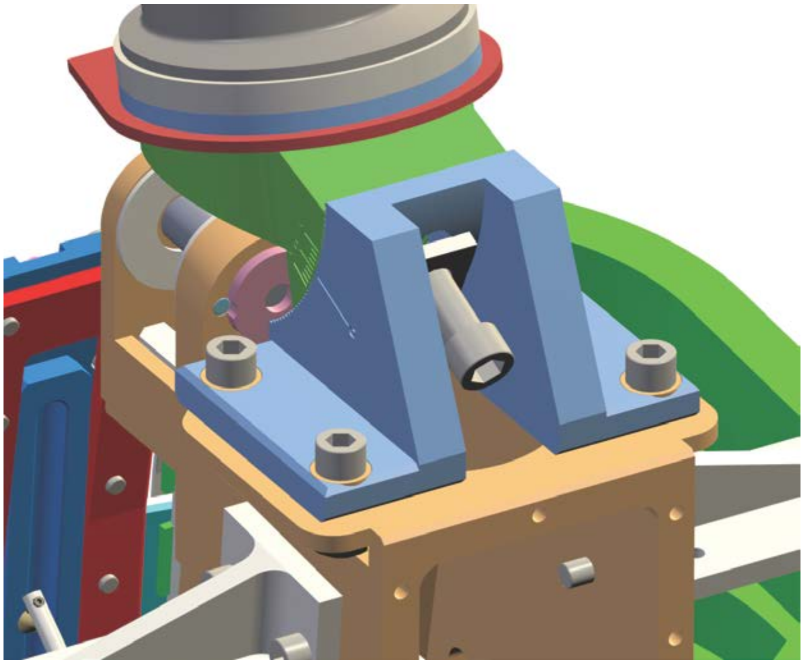


Figure 3.2.3.1: Neck adjustment SHCS fastener and washer

Step 3. Tilt the head and neck forward and remove the neck cable nut and four SHCS fasteners that hold the upper neck bracket to the base of the neck, as shown below in **Figure 3.2.3.2**.

Figure 3.2.3.2: Removing the neck cable nut and fasteners

Note: Check for the presence of four steel washers between these four SHCS and upper neck bracket upon reassembly. If they are missing, replace them upon reassembly.

The neck and head assembly is now disconnected from the plastic sternum-to-rib cage bib assembly.

Step 4. Remove the four SHCS fasteners from the rear skull cap, as shown below in **Figure 3.2.3.3**.

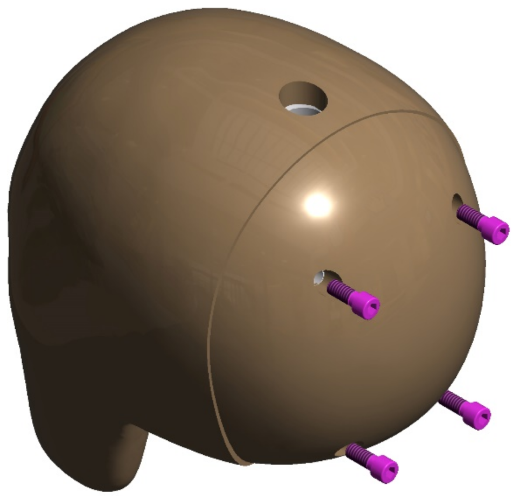


Figure 3.2.3.3: Removing the fasteners from the rear of the skull cap

Step 5. For the six-channel neck transducer or its structural replacement, loosen two SSCP fasteners that secure the head-to-neck pivot pin, as shown below in **Figure 3.2.3.4**.

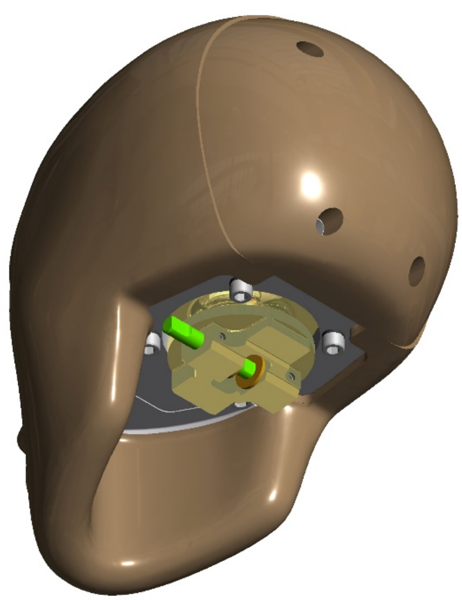


Figure 3.2.3.4: Loosening the head-to-neck pivot pin fasteners

Step 6. Mount the neck compression tool, which is shown below in **Figure 3.2.3.5**, to the head by fastening the flat plate on the tool to the flat surface on the back of the skull, as shown below in **Figure 3.2.3.6**.

Figure 3.2.3.5: The neck compression tool

Figure 3.2.3.6: Mounting the neck compression tool to the head

Step 7. Slip the round end of the tool over the cable and turn the knob until the neck begins to compress, as shown above in **Figure 3.2.3.6**.

Step 8. Slowly increase the compression on the neck until the condyle pin can be pushed or lightly tapped out with a minimal amount of effort.

Step 9. Reduce the compression on the head and neck, allowing the head and neck to separate at the occipital condyle joint, which is shown below in **Figure 3.2.3.7**.

Note: Two brass washers and the two rubber nodding blocks may fall out in the disassembly process.

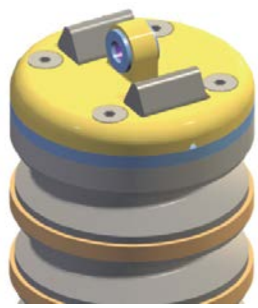


Figure 3.2.3.7: Occipital condyle joint

Step 10. Remove the four SHCS fasteners on the underside of the skull, as shown below in **Figure 3.2.3.8**.

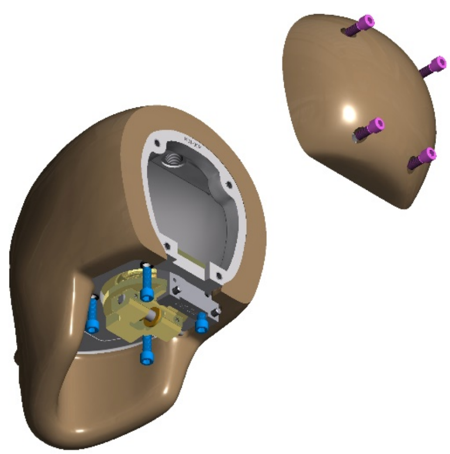


Figure 3.2.3.8: Removing the fasteners to access the neck transducer

Note:

- A steel shoulder screw washer, shown above in **Figure 3.2.1.1** under each of the cap screws, helps to protect the aluminum from being galled by the steel screws.
- These are special washers and must be used under the load cell attachment bolts.
- Larger washers will interfere with load cell operation.

Step 11. After the four SHCS fasteners have been removed, the transducer can then be removed by lifting it upward and out the back of the skull opening. The transducer may have to be turned slightly sideways to do this. The head accelerometer assembly (880995-1711) is shown above in **Figure 3.2.1.1**.

Note: Accelerometer mounts and cubes can differ depending on the accelerometer assembly being used and the manufacturer of the mount.

Step 12. To remove the flesh from the skull, hold the skull by the back of the skull opening. Peel the skin forward starting at the top rear of the skull and skin assembly. This should allow the skin to pull away from the skull and then slide off the chin area.

Step 13. To remove the cap skin from the machined skullcap, follow a similar procedure.

3.2.4. Inspecting and Repairing the Head

With the head and neck disassembled:

- Inspect the neck cable for imperfections. No evidence of the cable pulling through the end fittings should exist.
- Examine the machined metal parts and compare the rubber sections of the neck against the drawing.
- 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, as shown below in **Figure 3.2.4.1**.

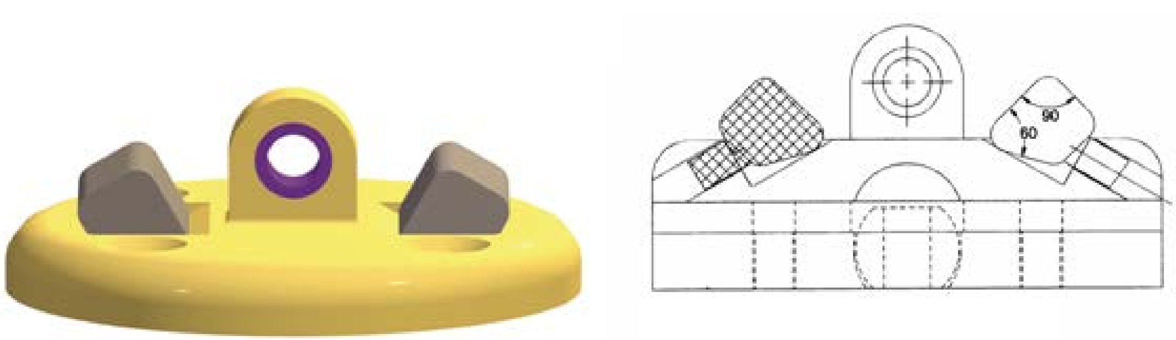


Figure 3.2.4.1: Nodding block orientation

- The skin should be inspected for nicks, tears or other damage that may be present after testing.
- Replace head skins that have damage in the forehead area, because the damage or attempts to repair it may affect test results.
- If damage is located in areas other than the forehead, repair the head skin as described in sub-Section 14.2, "Appendix B: Flesh Repair Procedure."
- Inspect the skull for smoothness and freedom from flat spots and pits.
- Examine the bond of the skull ballast.

3.2.5. Reassembling the Head

Step 1. Assemble the two sections of the neck bracket with the adjustment set to 0° and measure the bracket angle.

Note:

- The lug on the nodding joint must fit very tightly in the slot in the bottom of the neck load cell.
- The tightness is controlled by a brass washer on each side of the yoke. These washers must be lapped to produce a .000 to .025 mm (.000 to .001 in) interference fit at assembly.
- Because the inside diameter of these washers is also critical, validate this dimension against the drawing.

Step 2. To assemble the neck and head, compress the neck using the neck compression tool.

Note: Be sure that the nodding blocks, washers, and nodding joint are in place before compressing the neck.

Step 3. Once the neck is compressed, slide the condyle pin into place while orienting the flats on the pin toward the set screw locations.

Step 4. Tighten the set screws to finish the assembly.

Section 4. Neck Assembly

4.1. Description and Features of the Neck Assembly

The neck assembly consists of the nodding block, the nodding joint assembly, the neck molded assembly, the upper and lower neck bushings, and the upper neck bracket.

4.2. Disassembling, Inspecting, and Repairing the Neck

4.2.1. Exploded View

The exploded view for the neck assembly parts and their corresponding item numbers is shown below in **Figure 4.2.1.1**.

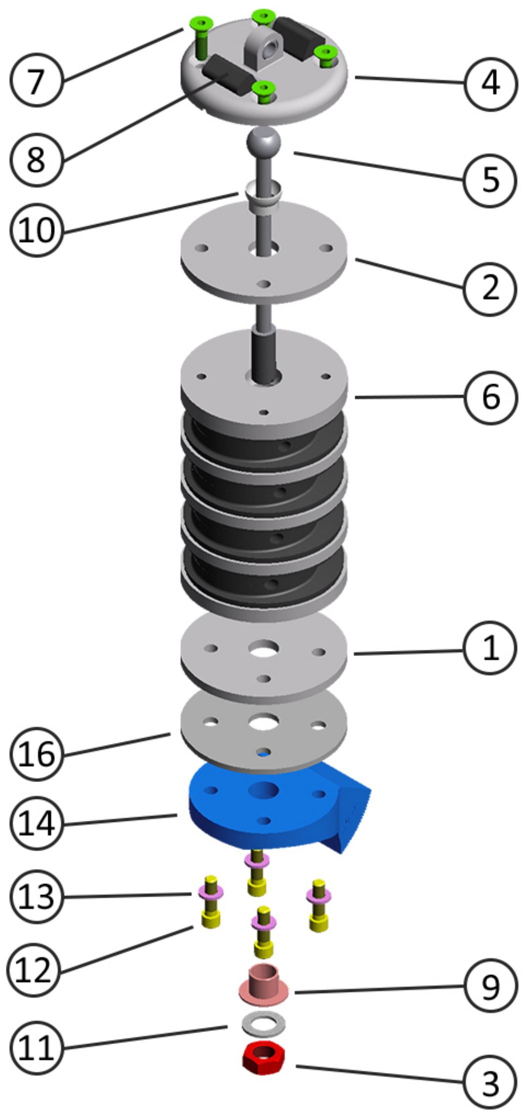


Figure 4.2.1.1: Neck assembly exploded view

4.2.2. Parts List

The item numbers, part numbers, and part descriptions for the neck assembly are shown below in **Table 4.2.2.1**.

Table 4.2.2.1: Neck assembly (880995-1250) parts list

Item	Quantity	Part Number	Description
1	1	880995-201	Neck Spacer, Lower
2	1	880995-203	Neck Spacer, Upper
3	1	9000018	1/2 -20 Hex Jam Nut Zinc
4	1	78051-297	Nodding Joint, Neck Assembly
5	1	880995-205	Neck Cable
6	1	880995-1260	Neck Molded Assembly
7	4	9000124	1/4-20X X 7/8 LG. FHCS Nylok®
8	2	78051-351-8505	Nodding Block
9	1	180-2005	Bushing, Lower Neck
10	1	180-2004	Bushing, Upper Neck
11	1	9003842	1/2 Flat Washer 18-8 SS
12	4	9000086	1/4 -20 X 7/8 Lg. SHCS
13	4	9003843	1/4 Flat Washer 18-8 SS
14	1	880995-1270	Bracket, Upper Neck Adjusting (Reference)
15	1	880995-1330	Bib Assembly (Reference, Not Shown)
16	1	78051-84	Bib Simulator (Reference)

Note: Use 1/4-20 SHCS, 1/4" Flat Washer, and Upper Neck Adjusting Bracket PN 880995-1270 for weight, Center of Gravity (CG), and calibration purposes.

4.2.3. Disassembling the Neck

Step 1. Remove the nodding blocks and set them aside.

Step 2. The condyle pin, brass washers, SHCS and steel washer, as well as the cable bushings, washer and nut have been previously removed, as shown above in sub-Section 3.2.3, "**Disassembling the Head**."

Step 3. Remove the four 1/4-20 X 7/8 FHCS from the top of the nodding joint bracket, as shown above in **Figure 4.2.1.1**. This completes the neck disassembly.

Note:

- The nodding joint bracket is separated from the upper neck by an upper neck spacer plate.
- The lower neck adjustment bracket is separated from the lower neck plate by a lower neck spacer plate.
- To ensure proper assembly, these spacer plates are distinguishable by their hole patterns:
    - The upper neck spacer plate has a symmetrical hole pattern that matches the nodding joint bracket.
    - The lower neck spacer plate has an offset hole pattern that matches the lower neck adjustment bracket.

4.2.4. Inspecting and Repairing the Neck

- 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 axial integrity of the neck as described in sub-Section 14.3, "**Appendix C: Axial Integrity of the Neck**."
- The neck cable should be torqued to 1.4 ± 0.2 N·m (12.0 ± 2 in·lbf)

Section 5. Upper Torso Assembly

5.1. Description and Features of the Upper Torso Assembly

The upper torso assembly consists of many sub-assemblies, including:

- The left and right shoulder and clavicle link sub-assemblies,
- The ribs and sternum sub-assembly, and
- The thoracic spine sub-assembly.

The upper torso assembly also includes the lower and upper neck brackets, the chest flesh and skin, and many types of instrumentation, including transducers, accelerometers, and potentiometers.

5.2. Disassembling, Inspecting, Instrumenting, and Reassembling the Upper Torso

5.2.1. Assembly Drawings

The overall and partial side view drawings for the upper torso assembly parts and their corresponding item numbers are shown below in **Figures 5.2.1.1** and **5.2.1.2**, respectively.

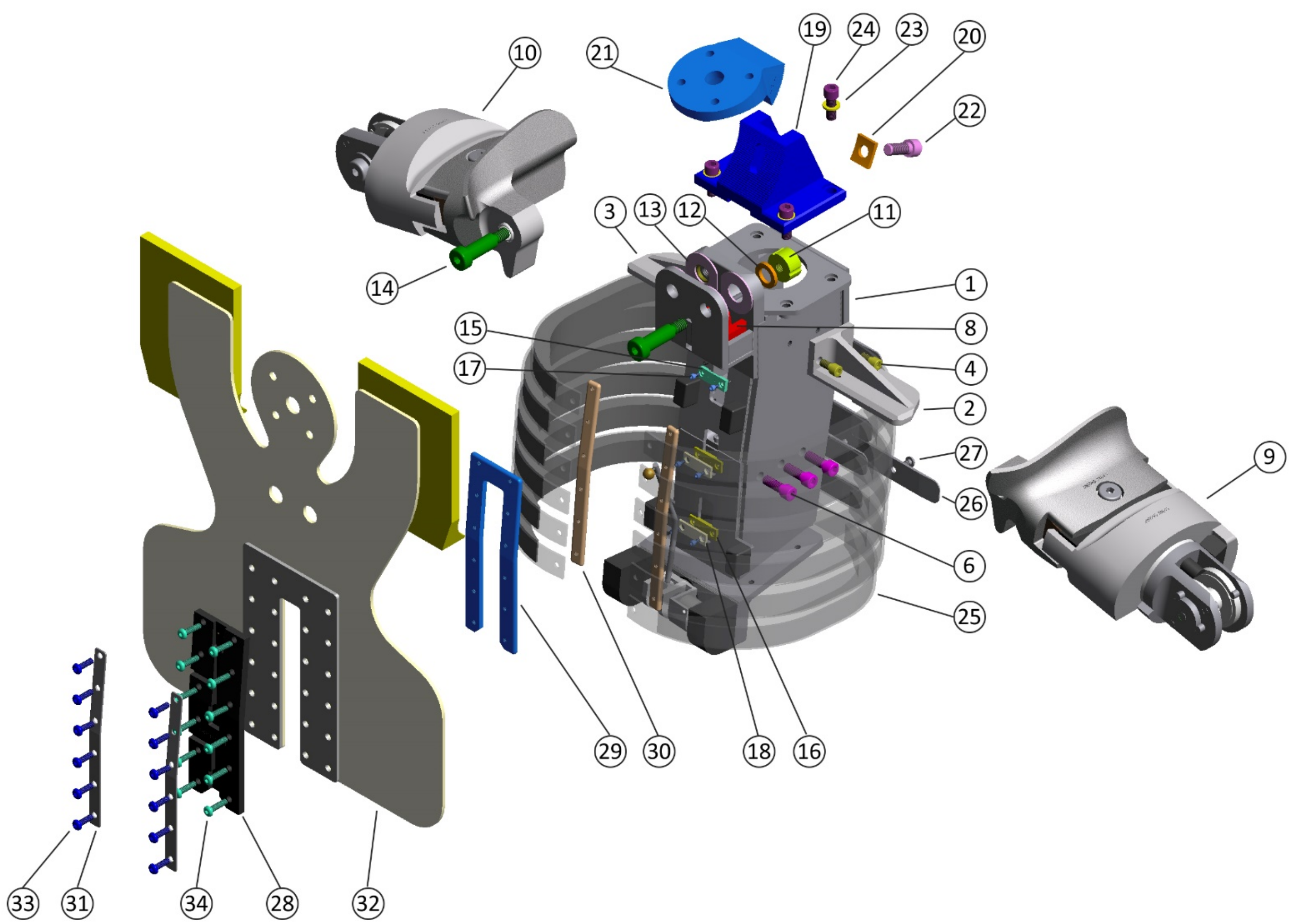


Figure5.2.1.1: Overall view - upper torso assembly drawing

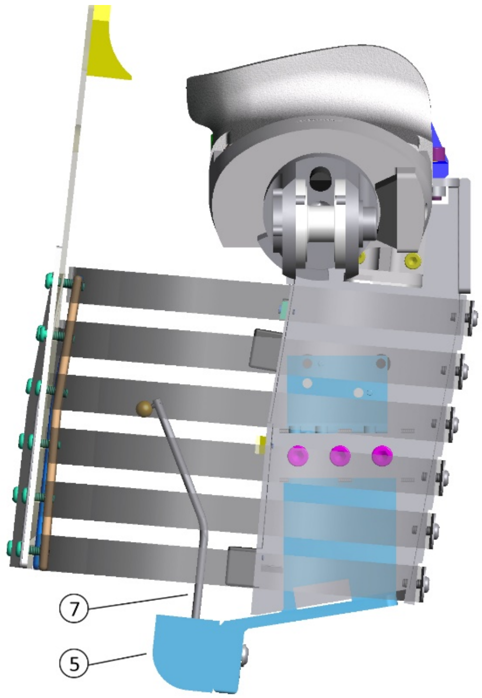


Figure 5.2.1.2: Partial side view - upper torso assembly drawing

5.2.2. Parts List

The item numbers, part numbers, and part descriptions for the upper torso assembly are shown below in **Table 5.2.2.1**.

Table 5.2.2.1: Upper torso assembly (880995-1300) parts list

Item	Quantity	Part Number	Description
1	1	880995-1000	Thoracic Spine Assembly
2	1	880995-1024-1	Upper Rib Stop Assembly, Left
3	1	880995-1024-2	Upper Rib Stop Assembly, Right
4	4	9003756	1/4-20 X 1/2 LG SHCS Nylok®
5	1	880995-357	Adapter Assembly
6	6	9000476	5/16-18 X 7/8 LG SHCS
7	1	880995-365	Transducer Assembly
8	2	880995-341	Bumper, Shoulder
9	1	880995-380	Shoulder Assembly, Left, H3-95th
10	1	880995-381	Shoulder Assembly, Right, H3-95th

Item	Quantity	Part Number	Description
11	2	78051-238	Nut, Clavicular Link Pivot
12	2	78051-237	Washer, Nut Clavicular
13	4	78051-236	Washer, Clavicular Link
14	2	9000055	1/2 X 1 1/4 LG SHSS
15	1	880995-1022	Top Accelerometer Mount, Spine Box
16	2	880995-1021	Mid/Lower Accelerometer Mount, Spine Box
17	6	9000528	#4-40 X 1/4 LG SHCS
18	2	880995-1023	Accelerometer Mount Pad
19	1	78051-303	Bracket, Neck, Adjusting Lower
20	1	78051-305	Washer, Clamping
21	1	880995-1270	Bracket, Neck, Adjusting Upper
22	1	9000021	3/8-16 X 1 LG SHCS Nylok®
23	4	9000022	5/16 Flat Washer, Plain A SS
24	4	9000113	5/16-24 X 7/8 LG SHCS
25	1	880995-RS	Rib Set, Complete
26	6	880995-320	Rib Support
27	12	9000026	#10-32 X 1/2 LG BHCS
28	1	880995-1050	Slider, Chest Deflection Transducer
29	1	880995-1051	Sternum
30	2	880995-323	Strip, Front End, Threaded
31	2	880995-324	Plate, Front End Stiffener
32	1	880995-1330	Bib Assembly, Sternum to Rib
33	12	9000025	#10-32 X 5/8 LG BHCS
34	12	9001193	#10-32 X 3/4 LG BHCS
35	1	880995-1335	Chest Flesh Assembly (Not Shown)

5.2.3. Disassembling and Inspecting the Shoulder and Clavicle Link

The drawings for the shoulder assembly parts and their corresponding item numbers are shown below in **Figure 5.2.3.1**.

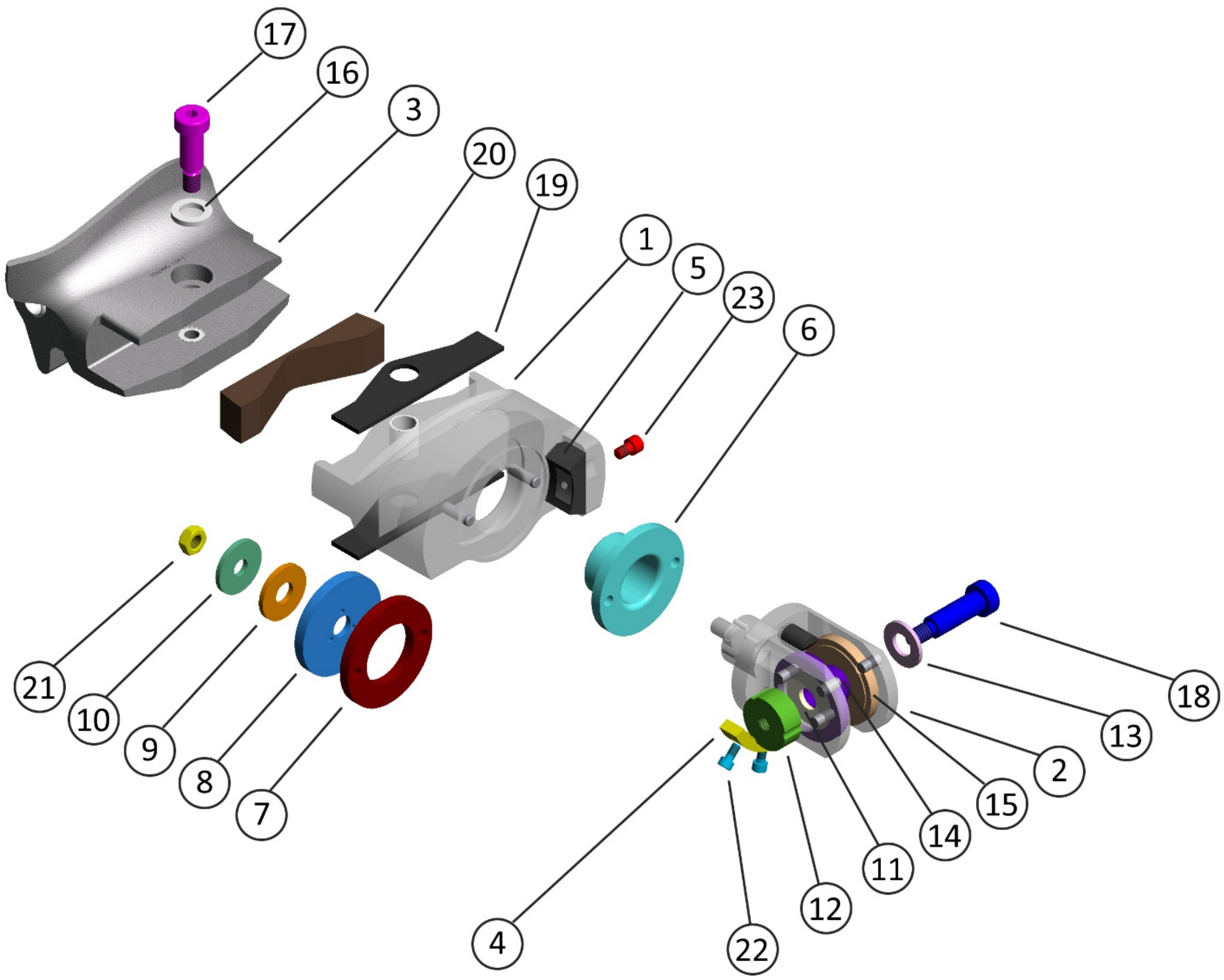


Figure 5.2.3.1: Shoulder sub-assembly drawing

The item numbers, part numbers, and part descriptions for the shoulder assembly are shown below in **Table 5.2.3.2**.

Table 5.2.3.2: Shoulder assembly (880995-380 left/-381 right) parts list

Item	Quantity	Part Number	Description
1	1	880995-336	Clavicle, Machined, Left
	1	880995-337	Clavicle, Right (Not Shown)
2	1	880995-343	Shoulder Yoke Assembly
3	1	880995-334	Clavicular Link, Left
	1	880995-335	Clavicular Link, Right (Not Shown)
4	1	880995-346	Stop, Steel, Shoulder Pivot
5	1	880995-347	Molded Stop Assembly, Shoulder Pivot
6	1	880995-348	Bushing, Shoulder Yoke Pivot
7	1	880995-349	Washer, Shoulder Yoke Pivot
8	1	78051-248	Washer, Steel Shoulder Yoke
9	1	78051-249	Washer, Shoulder Joint Spring
10	1	78051-250	Washer, Shoulder Yoke Retaining
11	1	880995-351	Washer, Elbow Joint Spring
12	1	78051-202	Nut, Elbow Pivot
13	1	9008021	Washer, Flat .531 ID X 1.062 OD
14	1	880995-709	Bushing, Upper Arms & Elbow Pivot
15	1	880995-708	Bushing, Upper Arms & Elbow Pivot
16	1	9008007	Washer, Flat .515 ID X .875 OD
17	1	9000043	Screw, SHSS 1/2 X 1 LG
18	1	9000496	1/2 X 1 3/8 LG SHSS
19	2	880995-339	Spacer, Clavicle
20	1	880995-338	Spring Clavicle Stop
21	1	9000800	Jam Nut, 3/8-16 Hex Lock, Zinc
22	2	9000047	Screw, SHCS #10-24 X 3/8 LG Nylok®
23	1	9000041	1/4-20 X 3/8 LG SCHCS Nylok®

The right and left shoulder-clavicle and link assemblies consist of three main sections: 1) The clavicle, 2) the clavicle link, and 3) the shoulder yoke. These three sections bolt to each other and then to the thoracic spine.

These sections permit arm rotation, up-down motion at the shoulder, forward-rear excursion (hunching), and up-down motion of the entire shoulder-clavicle unit.

An assembled view of the shoulder clavicle link is shown below in **Figure 5.2.3.3**.

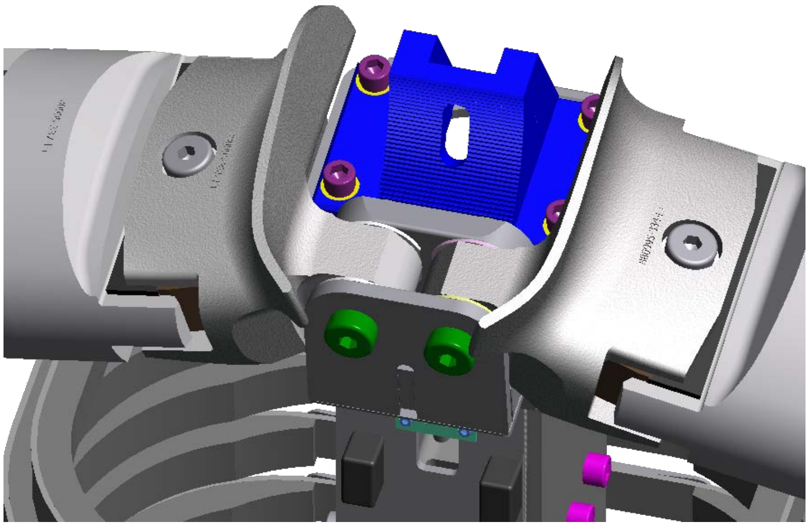


Figure 5.2.3.3: Shoulder-clavicle link assembly

Step 1. When disassembling the clavicles, it is optional to first remove each arm at the shoulder yoke by unscrewing the SHSS fasteners, as shown below in **Figure 5.2.3.4**.

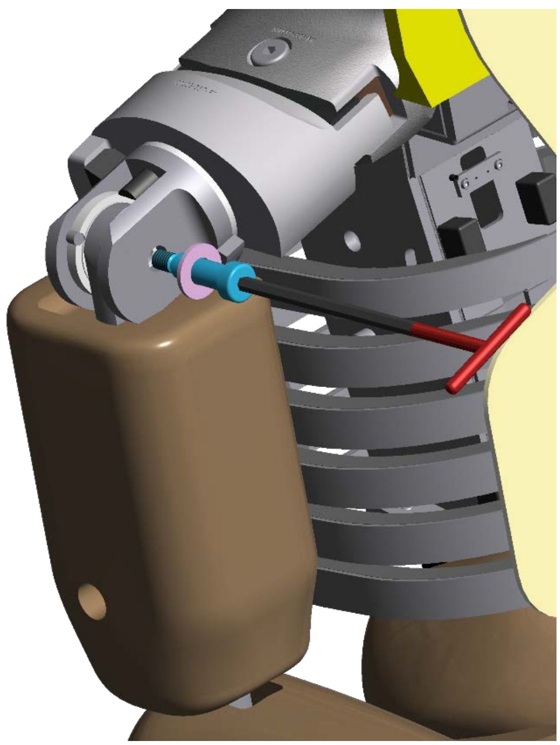


Figure 5.2.3.4: Removing the arm assembly at the shoulder yoke

Step 2. If necessary, clean the Delrin bushing and washers with a chlorinated solvent.

Note: Never lubricate any of the plastic bushings.

Step 3. Detach the shoulder-clavicle sub-assembly from the thoracic spine assembly by reaching through a hole in the plastic chest "bib" and removing the SHSS clavicle link bolts at the extreme top of the thoracic spine, as shown below in **Figure 5.2.3.5**.

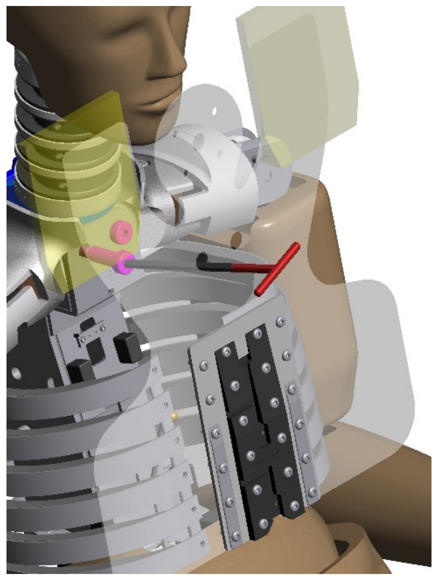


Figure 5.2.3.5: Removing the clavicle link bolts

Step 4. Pull the clavicle unit straight up.

Note:

- Check for the urethane washer at the rear of the cavity in the thoracic spine and for two Delrin washers isolating the clavicle from the spine.
- Make sure the pivot nut slides out freely.
- A Delrin bushing should also be present in the hole through the clavicle link.

Step 5. Use a pair of needle nose pliers to remove the rubber bumper stop from the Thoracic Spine, as shown below in **Figure 5.2.3.6**.

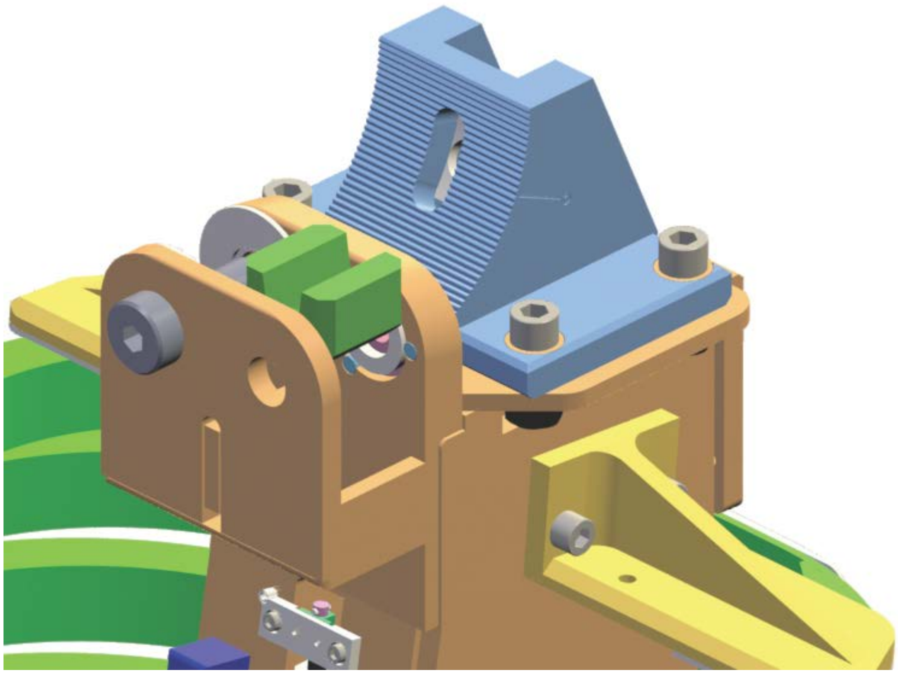


Figure 5.2.3.6: Removing the rubber bumper stop

Note: Inspect the shoulder yoke for damage. The stop should be free from tears or permanent deformation, and should be symmetrical in cross section.

Observation: Review the construction of the shoulder yoke assembly and note that it contains three stops; 1) a steel stop, 2) a rubber rear stop, and 3) the rubber shoulder pivot stop.

- The steel stop contacts a rubber rear stop when the arm is extended, as shown below in **Figure 5.2.3.7**.
- There are four holes available for positioning the steel stop on the shoulder yoke. The steel stop should be positioned in the two mounting holes furthest from the rear stop, as shown below in **Figure 5.2.3.7**.
- The third stop is the rubber shoulder pivot stop that prevents excessive arm abduction, as shown below in **Figure 5.2.3.8**.
- **Note:** Upon disassembly, all stops should be inspected for damage.

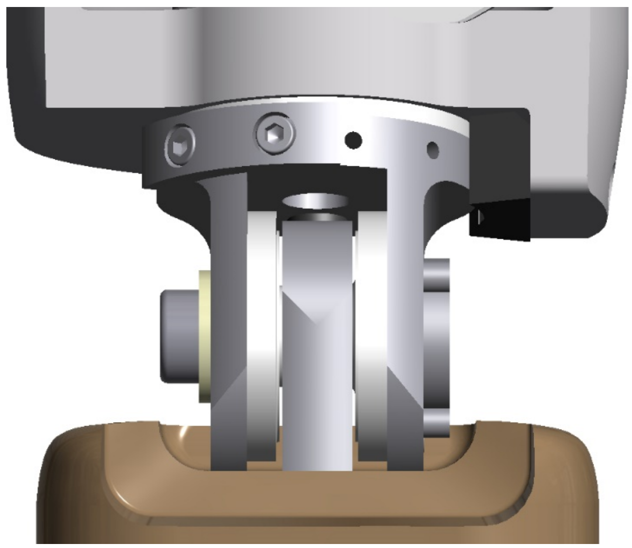


Figure 5.2.3.7: Contact between steel stop and rear rubber stop with arm extended

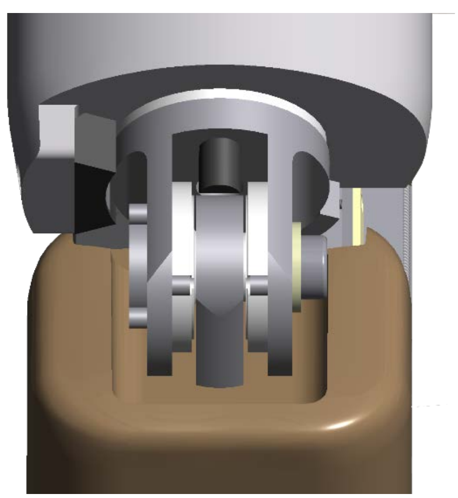


Figure 5.2.3.8: The rubber shoulder pivot stop preventing excessive arm abduction

Step 6. Remove the SHSS clavicle bolt and its steel washer that holds the two aluminum sections of the clavicle and its link together, as shown below in **Figure 5.2.3.9**.

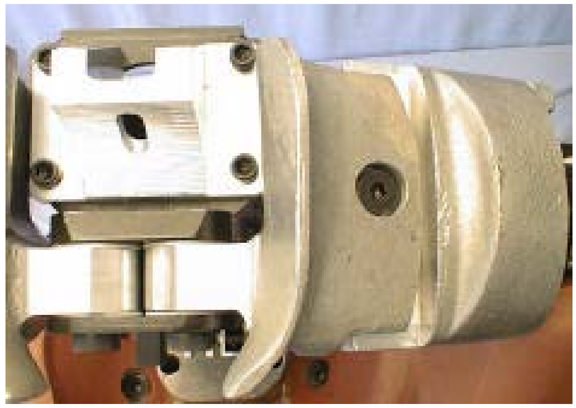


Figure 5.2.3.9: Removing the clavicle bolt that holds the clavicle together

Note: Confirm that the following parts are in place:

- A urethane spring "stop" should be located at the back of the cavity in the inner clavicle section, as shown below in **Figure 5.2.3.10**.
- Top and bottom thin Delrin strips should isolate the two sections, as shown below in **Figure 5.2.3.11**.

Figure 5.2.3.10: Location of urethane spring stop

Figure 5.2.3.11: Location of top and bottom Delrin strips

Step 7. The shoulder yoke connects the arm to the clavicle link. To remove the shoulder yoke, use an open wrench or equivalent tool to remove the lock nut, as shown below in **Figure 5.2.3.12**.

Figure5.2.3.12: Removing the shoulder yoke lock nut

Step 8. Once the nut is removed, the shoulder yoke will slide out and the disassembly is complete.

Note: Check for a steel stop on the rim of the shoulder yoke, held by two SHCS fasteners, as shown above in **Figure 5.2.3.7**.

- The stop can be installed in two positions: one for the right side and the other for the left.
- Inspect clavicle aluminum parts for porosity and cracks.
- This will complete the disassembly of the clavicle from the clavicle link.

5.2.4. Reassembling the Shoulder and Clavicle Link

Step 1. Before beginning reassembly of the shoulder and clavicle link subassembly, ensure that the urethane spring stop is in position. Use a clamp or compression tool to squeeze the clavicle and clavicle link in order to compress the urethane spring stop until insertion of the clavicle SHSS fastener is possible.

Step 2. First assemble the shoulder yokes, clavicles, and clavicle links in reverse order of the disassembly process steps.

Step 3. Assemble the clavicles to the thoracic spine assembly, again in reverse order of the disassembly process steps.

Note:

- The long flat Delrin strips are easily damaged during reassembly.
- The flat spots on the flat Delrin washers are on the side nearest the centerline of the spine.

5.2.5. Disassembling and Inspecting the Ribs and Sternum

Step 1. Remove the twelve BHCS fasteners holding the front of the ribs to the bib, as shown below in **Figure 5.2.5.1**.

Figure 5.2.5.1: Removal of the BHCS fasteners holding the front of the ribs to the bib

Step 2. Inspect the thin steel strips under the bolt heads for cracks.

Step 3. Inspect the thicker, slightly angled strips behind the rib ends for cracks.

Note: Be sure to check the way the strips fit the chest. The bend is not symmetrical; the upper portion is shorter than the lower.

Step 4. Allow the chest displacement slider arm to slide out the bottom of the sternum slider slot.

Step 5. Check that the open end of the aluminum plate is at the bottom, as shown below in **Figure 5.2.5.2**.

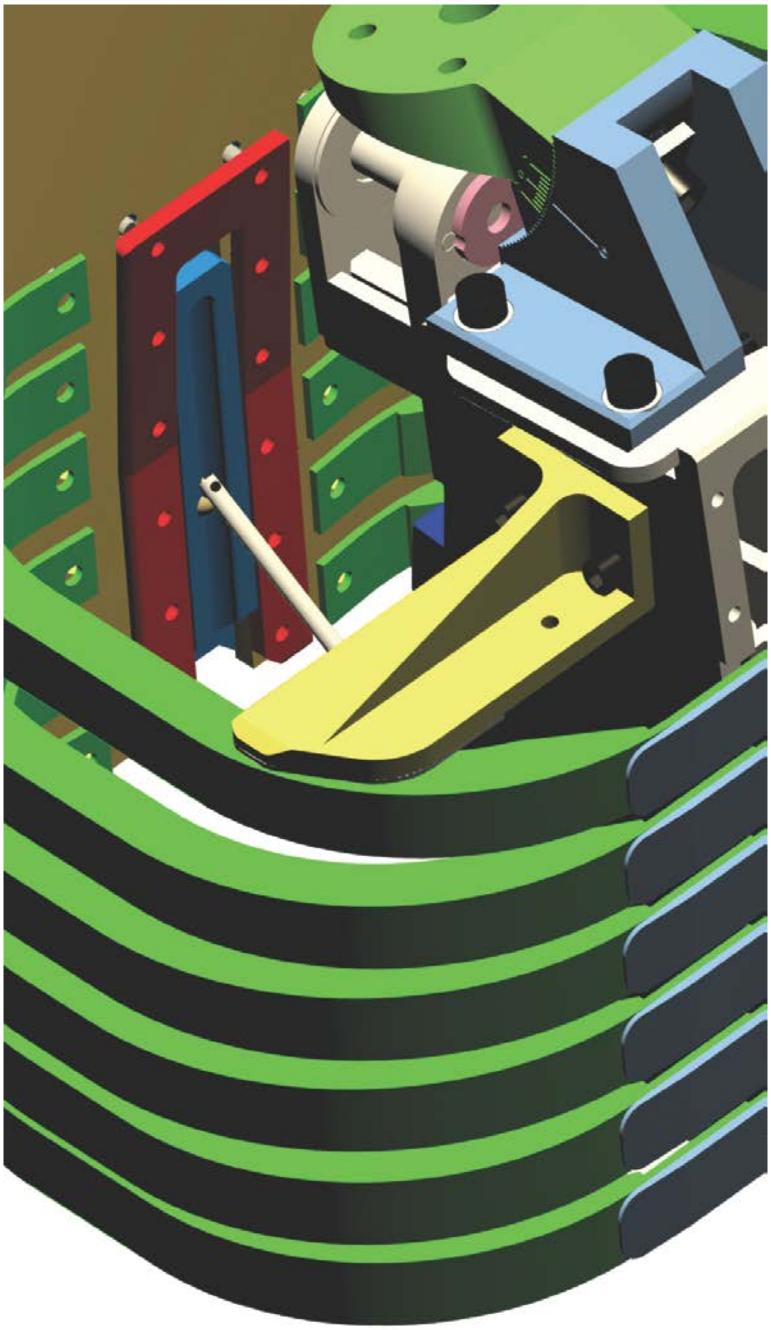


Figure 5.2.5.2: The sternum slider in the chest cavity

Step 6. Remove the twelve BHCS screws holding the Delrin slider assembly to the bib, as shown below in **Figure 5.2.5.3**.

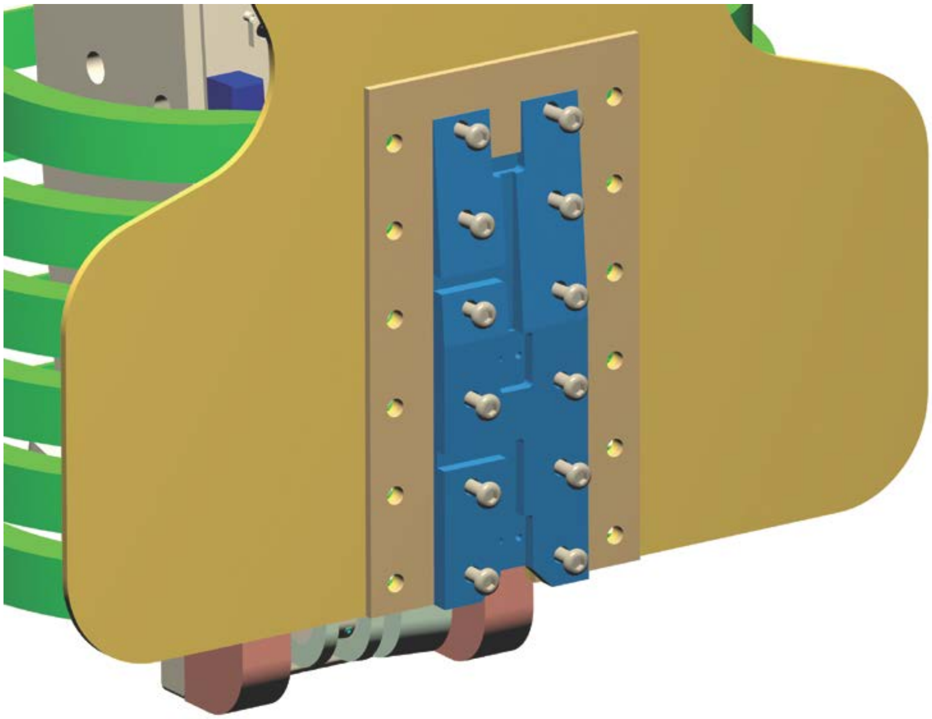


Figure 5.2.5.3: Removing the BHCS screws holding the slider assembly to the bib

Step 7. Examine the slider for damage and ensure that the slider ball moves freely in its track.

Step 8. Inspect the aluminum plate to which the slider assembly bolts.

Step 9. Inspect the bib for cracks, tears and imperfections. Compare the shape to the drawing.

Step 10. Clean all parts with isopropyl alcohol or an equivalent.

Step 11. Detach the six ribs and their rear rib supports by removing the twelve BHCS screws at the rear of the thoracic spine assembly, as shown below in **Figure 5.2.5.4**.

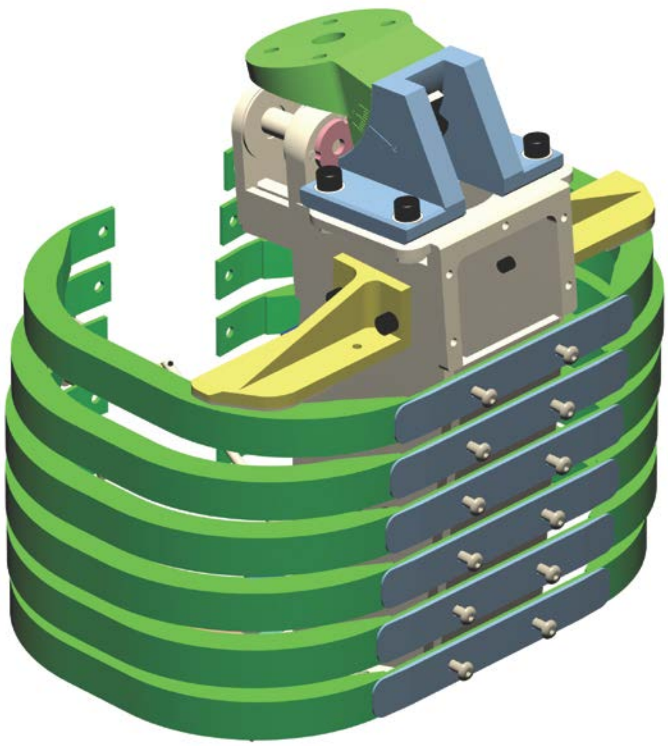


Figure 5.2.5.4: Detaching the ribs and rear rib supports

Step 12. Carefully examine each rib and the rib damping material for cracks.

Step 13. Check for gaps or other failures of the epoxy bond between the rib damping material and the rib metal, as shown below in **Figure 5.2.5.5**.

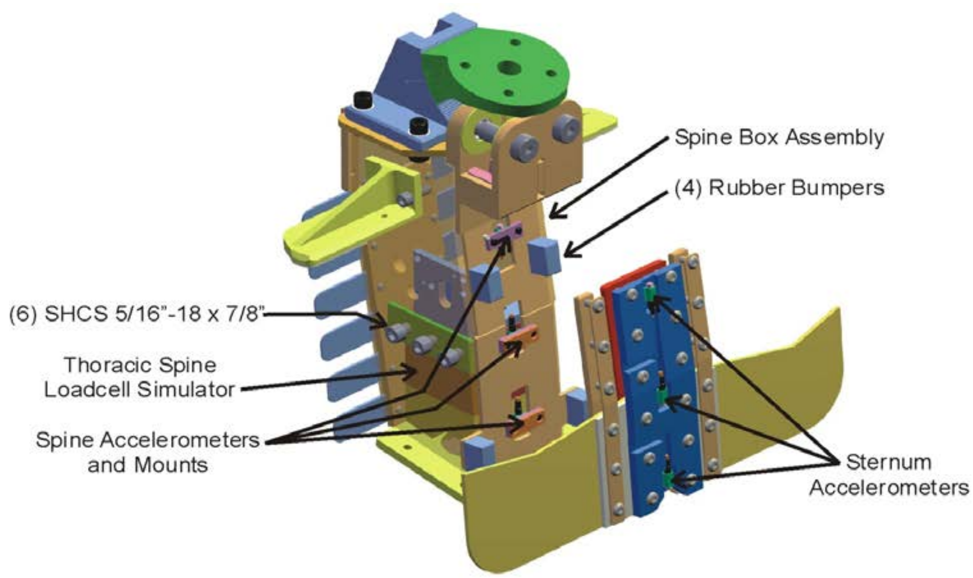
Figure 5.2.5.5: Rib damping material and metal

5.2.6. Reassembling the Ribs and Sternum

- When reassembling, make sure the rib supports are not bent or damaged and are mounted the correct way.
- The tapered side of the stiffener should be oriented toward the ribs.
- When assembling the ribs or checking their condition, use the special tool (83-5006-007) for measuring chest depth, as shown in sub-Section 12.5, "Chest Depth Measurements."

5.2.7. Disassembling and Instrumenting the Thoracic Spine

The front and rear detailed views of the thoracic spine sub-assembly and the individual part names are shown below in **Figure 5.2.7.1**.



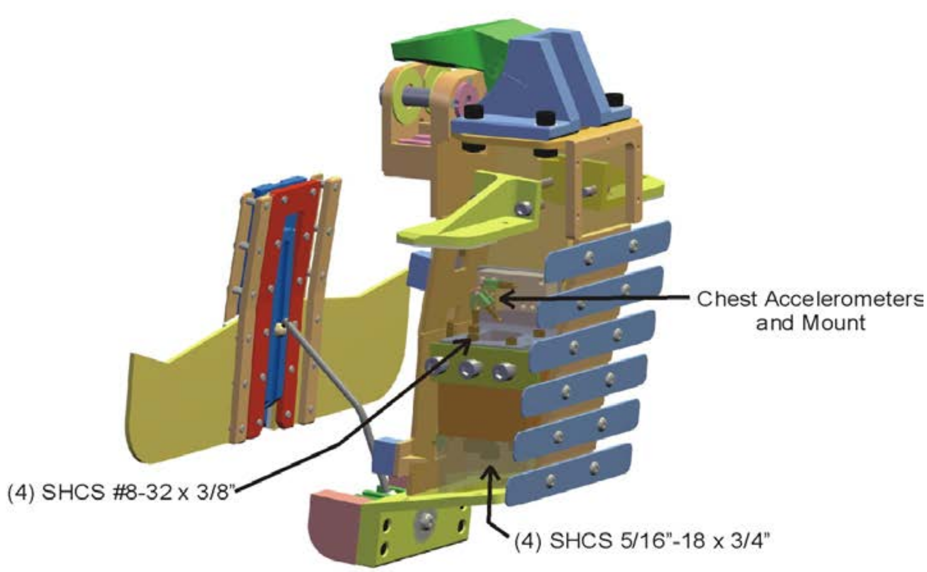


Figure 5.2.7.1: Thoracic spine sub-assembly front and rear isometric views

Step 1. Remove the four SHCS fasteners that attach the lumbar spine to the thoracic spine assembly and lift off the thoracic spine, as below shown in **Figure 5.2.7.2**.

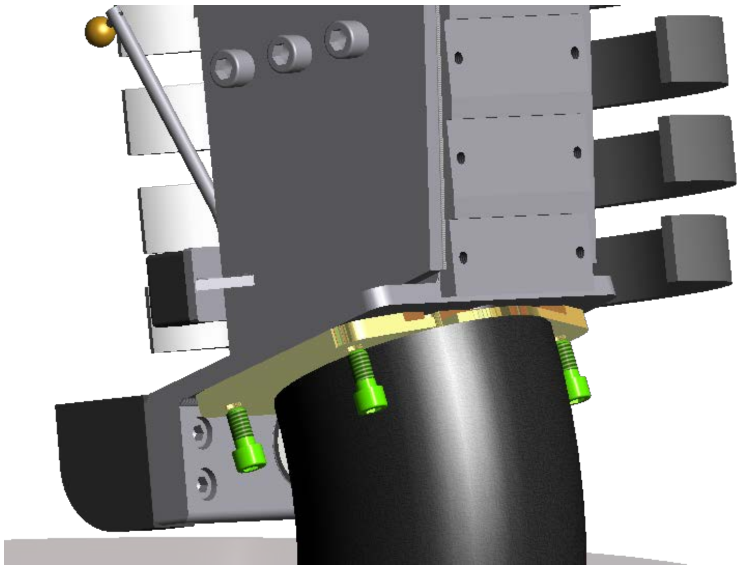


Figure 5.2.7.2: Removing the thoracic spine

Step 2. Remove the six SHCS fasteners from the side of the spine box and slide the thoracic insert out of the spine box cavity.

Step 3. The thoracic insert holds the chest accelerometer adapter assembly and chest displacement pot assembly to the bottom of the spine box. Slide the assembly out of the bottom of the spine box.

Step 4. Install the accelerometer block package and make sure no interference with the accelerometers occurs.

Step 5. Check the two larger rubber bumpers protecting the chest displacement potentiometer for damage, as shown below in **Figure 5.2.7.3**.

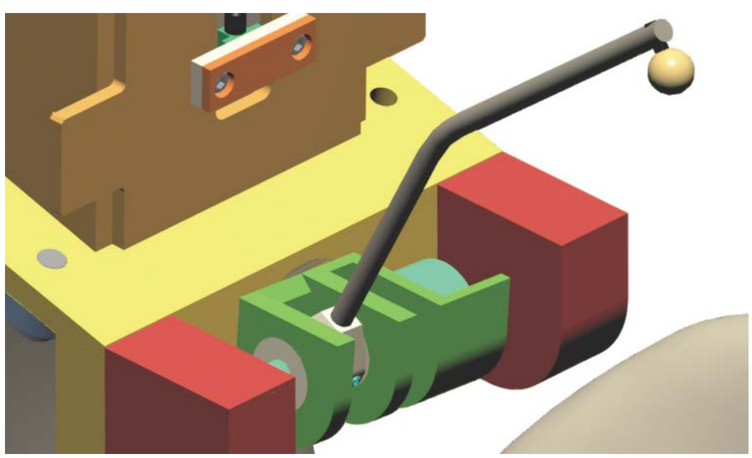


Figure 5.2.7.3: Location of rubber bumpers and chest displacement potentiometer

Step 6. To remove the rubber bumpers, remove each bumper's two SHCS fasteners from the back side of the spine mounting assembly.

Step 7. Carefully remove the chest deflection transducer assembly by removing the BHCS fastener and washer from the bearing. The assembly should easily push out.

Step 8. Check the bearing for smooth operation.

Step 9. To remove the thoracic load cell or simulator, first remove the four SHCS fasteners from the bottom of the spine mounting assembly.

Step 10. Removal of the four SHCS fasteners on the top of the thoracic load cell / simulator will allow for the removal of the T4 accelerometer mount, as shown above in **Figure 5.2.7.1**.

Step 11. The accelerometer mounts can be removed by removing the two SHCS from the front face of the spine box.

Step 12. The lower neck adjustment bracket can be disassembled from the spine box by removing four SHCS fasteners and washers from the top of the spine box.

Step 13. The two rib guides mounted to the side of the spine box can be removed by removing the two SHCS fasteners from each side of the spine box

5.2.8. Reassembling the Thoracic Spine

Note: When mounting the lower bracket to the top of the spine, ensure that the cap screws have metal washers to protect the aluminum.

5.3. Inspections and Repairs

5.3.1. Spine Box

The spine box weldment will have four rubber bumpers, shown above in **Figure 5.2.7.1**, fixed to the front of the spine box to prevent metal-to metal contact between the ribs and spine box under maximum deflection of the ribs.

- Inspect the bumpers for tears and ensure that they are fixed tightly to the spine box.
- Replace any damaged bumpers and refasten the bumpers if they begin to tear away from the spine box.

5.3.2. Accelerometer Mounts

The bumpers also prevent contact between the potentiometer arm and the accelerometers mounted on the three accelerometer mounts on the front of the spine box.

- The bottom two accelerometer mounts are the same.
- The top accelerometer mount is distinguishable by a notch that aligns with a roll pin to prevent miss-orientation during assembly.

5.3.3. Rib Guides

Inspect the Teflon sheets on the underside of the rib guides for damage, and replace them if necessary.

5.3.4. Special Care and Maintenance

- Check for rib deformation using the chest depth gauge described in Calibration Test Procedure section
- Check the ribs and rib damping material for warping or cracks. Replace and re-certify damaged ribs.
- Sternum stops should be periodically checked for looseness. If they become loose, they can be glued back into place using an instant adhesive.
- Check the shoulder castings for compression damage from assembly. Replace damaged castings.
- Check the rubber shoulder stop for damage and replace as necessary.
- Check the chest jacket for tears and cracks. Repair any tears and cracks if it is possible.

Section 6. Arm Assembly

6.1. Description and Features of the Arm Assembly

The arm assembly consists of many sub-assemblies and parts, including:

- The upper arm assembly,
- The lower arm assembly,
- The hand assembly,
- The elbow joint, and
- The wrist joint.

6.2. Disassembling, Inspecting, and Repairing the Arm

6.2.1. Exploded View

The exploded view for the arm assembly parts and their corresponding item numbers is shown below in **Figure 6.2.1.1**.

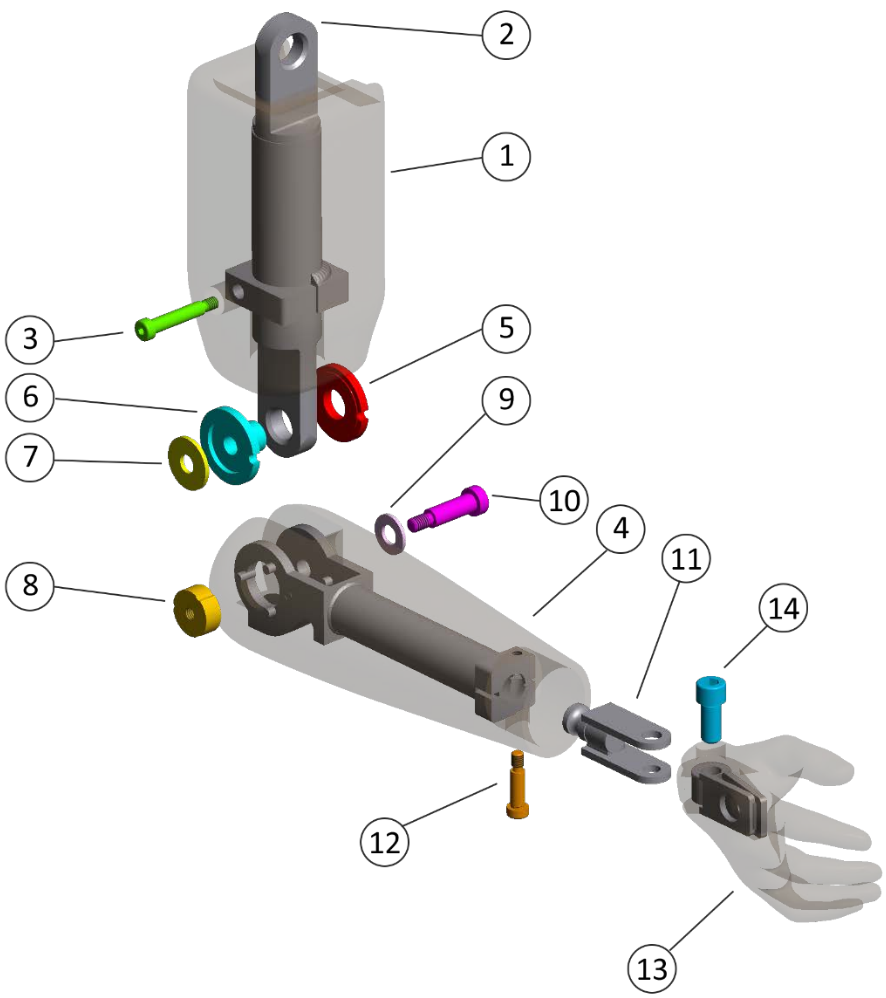


Figure 6.2.1.1: Arm assembly exploded view

6.2.2. Parts List

The item numbers, part numbers, and part descriptions for the arm assembly are shown below in **Table 6.2.2.1**.

Table 6.2.2.1: Arm assembly (880995-730 left/-731 right) parts list

Item	Quantity	Part Number	Description
1	1	880995-700	Upper Arm Molded Assembly
2	1	880995-705	Upper Arm, Lower Part Weldment
3	1	9000193	Screw, SHSS 3/8 X 1-3/4 LG
4	1	880995-732	Lower Arm Molded Assembly
5	1	880995-708	Washer, Upper Arm & Elbow Pivot
6	1	880995-709	Bushing, Upper Arm/Elbow Pivot
7	1	880995-351	Washer, Elbow Joint Spring
8	1	78051-202	Nut, Elbow & Upper Arm Pivot
9	1	9008021	Washer, Flat .531 ID X 1.062 OD
10	1	9000496	Screw, SHSS 1/2 X 1-3/8 LG
11	1	880995-718	Wrist Rotation Structural Assembly
12	1	9000074	Screw, SHSS 3/8 X 1 LG
13	1	78051-209	Hand Assembly, Molded Right, HYBRID III
	1	78051-208	Hand Assembly, Molded Left, HYBRID III (Not Shown)
14	1	78051-214	Screw, Wrist Pivot

6.2.3. Disassembling the Arm

Step 1. Separate the lower arms from the upper arms. Note that the elbow rotation joints have no stops.

Step 2. At this point, conduct the inspections and repairs noted below in **sub-Section 6.3.1**.

Step 3. Detach the hands from the lower arms and disconnect the wrist rotation joint. Note that the wrist rotation joints have no stops.

Step 4. At this point, conduct the inspections and repairs noted below in **sub-Section 6.3.2**.

6.3. Inspections and Repairs

6.3.1. Elbow Joint

- Examine the elbow joints, noting the condition and position of the various parts as for the shoulder joints.
- Look to see that the two elbow rubber stops are in place.
- Remove the elbow pivot nut and check that the nut slides freely in the hole.
- Check the elbow joint washers and replace if damaged.
- Lubricate these rotation joints with an anti-seize agent.
- Examine all metal parts for burrs and sharp edges and remove them as necessary.
- Check the flesh for rips or tears. Repair or remold.
- Inspect vinyl-to-foam adhesion, cracked or cut vinyl skin, cracked or damaged bushings, and the condition of the threaded holes.

6.3.2. Wrist Joint

- Lubricate these rotation joints with an anti-seize agent.
- Examine all metal parts for burrs and sharp edges and remove them as necessary.
- Lubricate these rotation joints with an anti-seize agent.
- Examine all metal parts for burrs and sharp edges and remove them as necessary.
- Check the flesh for rips or tears. Repair or remold.
- Inspect vinyl-to-foam adhesion, cracked or cut vinyl skin, cracked or damaged bushings, and the condition of the threaded holes.

Section 7. Lower Torso Assembly

7.1. Description and Features of the Lower Torso Assembly

The lower torso assembly consists of many sub-assemblies and parts, including:

- The pelvic assembly,
- The left and right femur sub-assemblies,
- The lumbar spine sub-assembly, and
- The abdominal insert.

7.2. Disassembling, Instrumenting, and Reassembling the Lower Torso

7.2.1. Exploded View

The exploded view for the lower torso assembly parts and their corresponding item numbers is shown below in **Figure 7.2.1.1**.

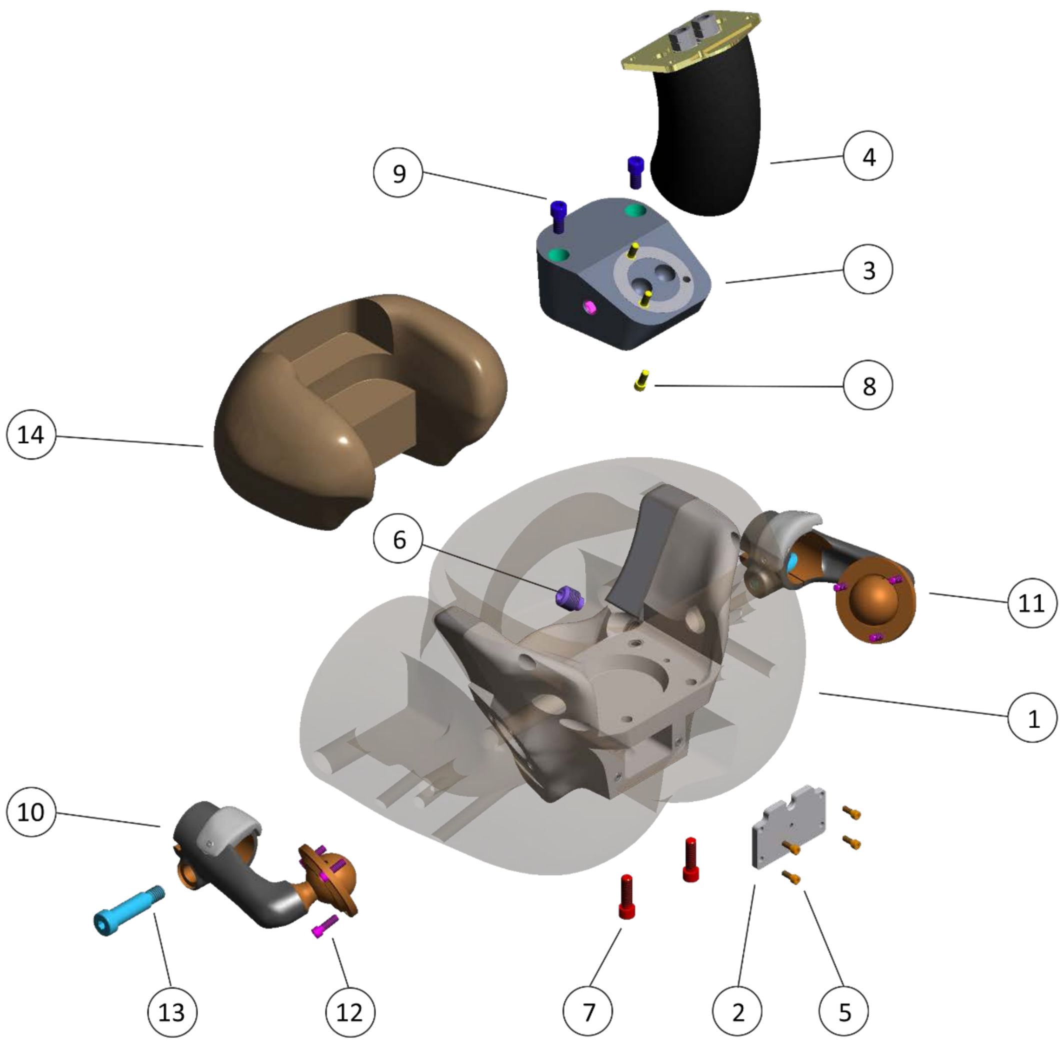


Figure 7.2.1.1: Lower torso assembly exploded view

7.2.2. Parts List

The item numbers, part numbers, and part descriptions for the lower torso assembly are shown below in **Table 7.2.2.1**.

Table 7.2.2.1: Lower torso assembly (880995-1450) parts list

Item	Quantity	Part Number	Description
1	1	880995-1430	Pelvic Assembly, Molded
2	1	78051-13	Cover, Pelvic Instrumentation Cavity
3	1	78051-53	Lumbar Spine Bracket, Molded
4	1	880995-1440	Lumbar Spine Assembly
5	4	9000624	Screw, SHCS #10-24 X 1/2 LG
6	2	78051-259	Set Screw Assembly
7	2	9000060	Screw, SHCS 3/8-16 X 1-1/4 LG Nylok®
8	3	9000005	Screw, SHCS 1/4-20 X 5/8 LG Nylok®
9	2	9000059	Screw, SHCS 3/8-16 X 3/4 LG Nylok®
10	1	880995-1410	Femur Assembly, Left
11	1	880995-1411	Femur Assembly, Right
12	6	9000009	Screw, SHCS 1/4-20 X 3/4 LG Nylok®
13	2	9000063	Screw, SHSS 5/8 X 1-3/4 LG
14	1	880995-1416	Abdominal Insert, Tested

7.2.3. Disassembling the Lumbar Spine

Step 1. The lumbar spine is more easily accessed if the legs are detached. Remove the SHSS fasteners (one per leg) holding the rear of the upper leg to the brass femur. These bolts are located through holes in the flesh at the side and front of the pelvis, as shown below in **Figure 7.2.3.1**.

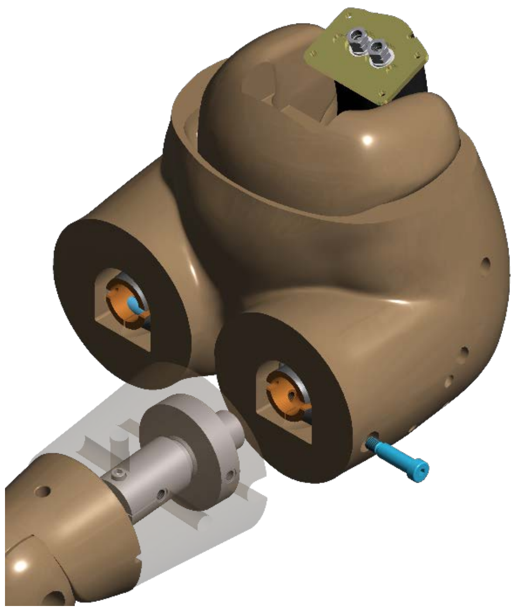


Figure 7.2.3.1: Removing the upper legs from the brass femur

Step 2. Detach the leg assemblies from the lower torso. The remaining lower torso assembly (with the abdominal insert removed) is shown below in **Figure 7.2.3.2**.

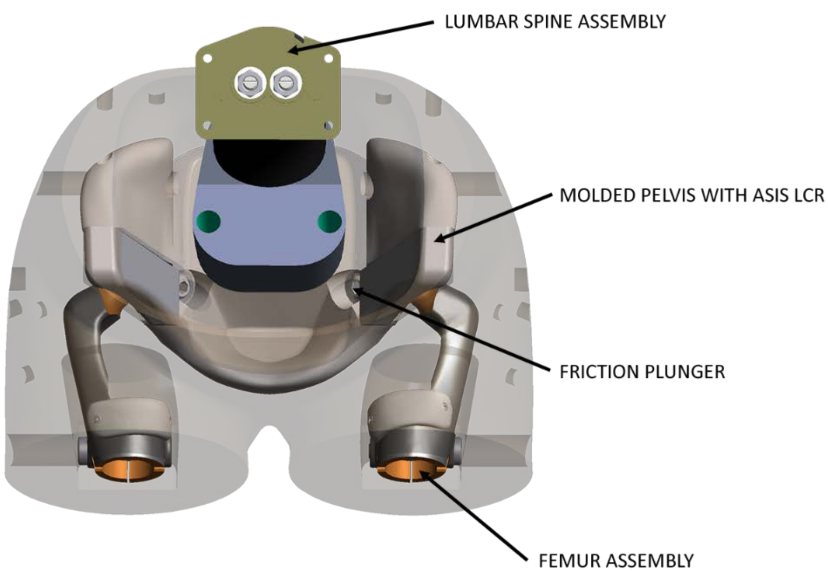


Figure 7.2.3.2: Lower torso assembly with upper legs and abdominal insert removed

Step 3. Remove the four SHCS fasteners holding the pelvic instrument cavity cover (PN 78051-13 in **Figure 7.2.1.1** above) in the rear of the molded pelvis.

Step 4. Once the cover is removed, remove the accelerometer block by removing the one SHCS fastener.

Step 5. Separate the lumbar spine and its lumbar spine bracket from the pelvis by removing two SHCS from the front of the bracket and two SHCS above the pelvic instrumentation cavity, as shown above in **Figure 7.2.1.1**.

Step 6. Separate the lumbar spine assembly (PN 880995-1440) from the lumbar spine bracket (PN 78051-53) by removing the three SHCS fasteners (PN 9000005) from the bottom of the lumbar spine bracket, as shown above in **Figure 7.2.1.1**.

Note: Check the upper and lower surfaces of the lumbar spine bracket.

- The lower surface must be flat and smooth.
- The lower surface must be flat and smooth.

Step 7. Detach the two lumbar cables by removing the two hex and jam nuts on the top of each cable and pulling the cables through the spine.

Step 8. At this point, conduct the inspections and repairs noted below in **sub-Section 7.3.1**.

7.2.4. Reassembling the Lumbar Spine

Step 1. Torque the lumbar cables to 1.1-1.4 N·m (10-12 in·lbf).

Note: Do not leave the lumbar spine cable torqued when storing the dummy. This will cause permanent deformation of the spine.

Step 2. Install the lumbar adaptor assembly (with the thorax weight and transducers) into the bottom of the thoracic spine.

Step 3. Install the thoracic spine, with the adaptor assembly, to the lumbar spine.

7.2.5. Disassembling the Pelvis and Femur

Step 1. Loosen the friction plungers as shown above in **Figure 7.2.3.2**.

Step 2. Remove the femur assembly from each side of the pelvis by unscrewing the three SHCS fasteners per side. Access is gained through the three one-half inch diameter holes in each side of the pelvic flesh, as shown below in **Figure 7.2.5.1**.

- First remove the two rear screws and then rotate the femur assembly towards the pelvic center to allow access to the third screw.

Note: When removing the femurs, be careful not to tear the urethane bumpers on the top of each femur.

- A small amount of talcum powder can be used on the bumpers to reduce friction.

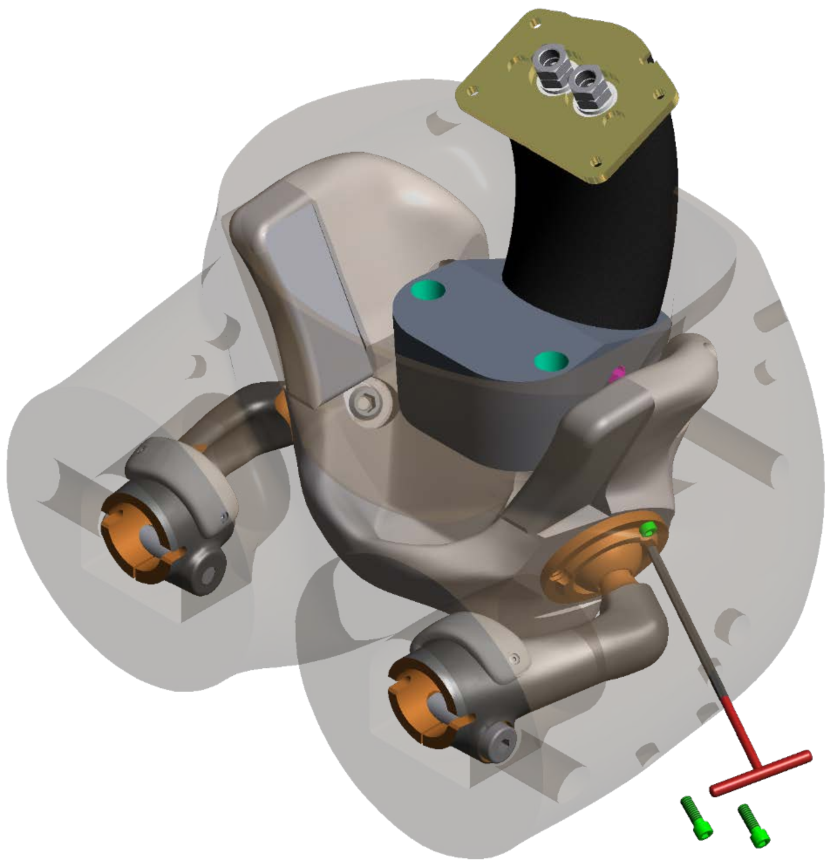


Figure 7.2.5.1: Removing the femur assemblies from the pelvis

Step 3. Remove the two BHCS fasteners holding in place the bumpers, which are the yellow-colored strips shown on each femur shown below in **Figure 7.2.5.2**.

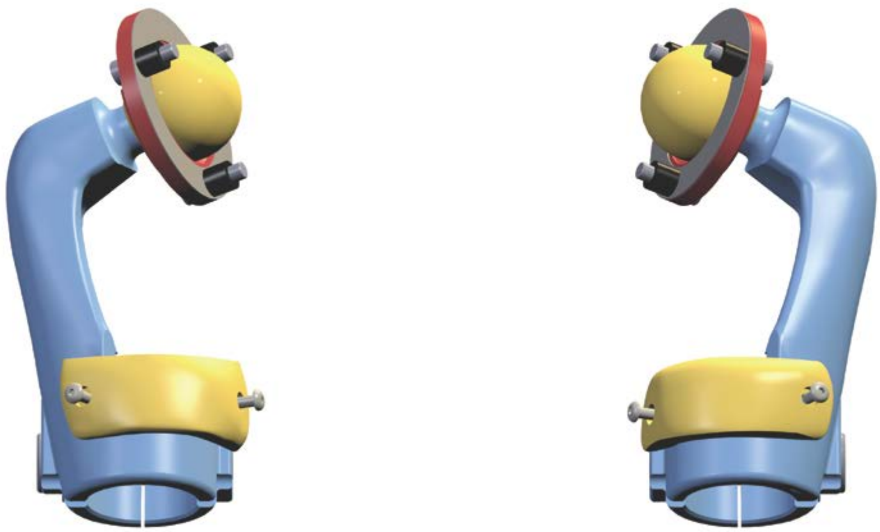


Figure 7.2.5.2: The femur assemblies with bumpers in place

Step 4. At this point, conduct the inspections and repairs noted below in **sub-Section 7.3.3**.

Step 5. The pelvic bone houses two ASIS load cells or simulators. To remove these from the pelvis, remove the four SHCS fasteners from the access holes in the rear of the pelvis, as shown below in **Figure 7.2.5.3**).

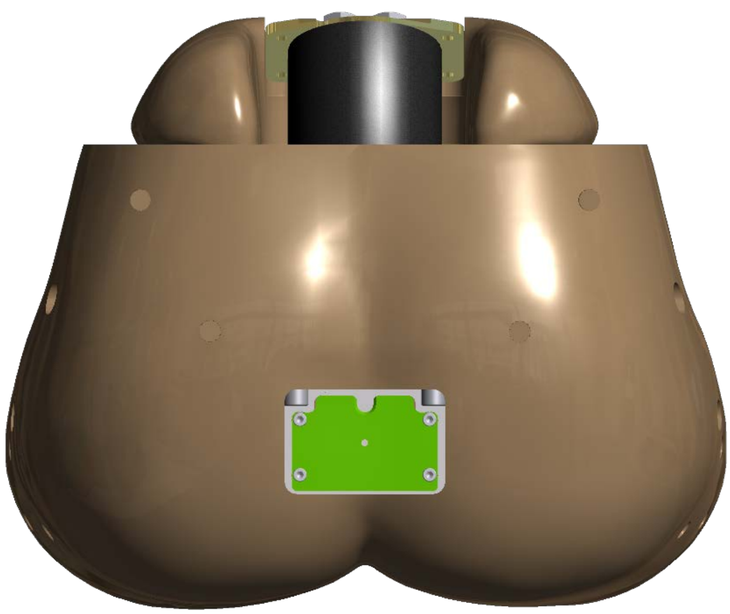


Figure 7.2.5.3: Removing the ASIS iliac load cells or simulators

Step 6. At this point, conduct the inspections and repairs noted below in **sub-Section 7.3.4**.

7.3. Inspections and Repairs

7.3.1. Lumbar Spine

- Check for cracks in the lumbar spine rubber.
- Check for chipped, cracked or broken metal pieces or stripped screws and threads.
- Check the top and bottom end plates for flatness and for complete adhesion to the rubber.
- Make sure sufficient clearance between the swaged balls and the hemispherical seats exists.

Each cable will have an upper and lower Delrin bushing.

- Check the bushing for damage.
- Clean with a chlorinated solvent if necessary.
- These bushings are not interchangeable with the neck bushings.

7.3.2. Abdominal Insert

- Examine the abdominal insert, shown below in **Figure 7.6.2.1**, for:
  - ✓ Skin-to-foam separation,
  - ✓ Tears and/or cuts in the vinyl skin, and
  - ✓ Air tightness.

Note: Air-shipped inserts are only partially sealed and must be fully sealed by the user. When compressed, no air should escape.

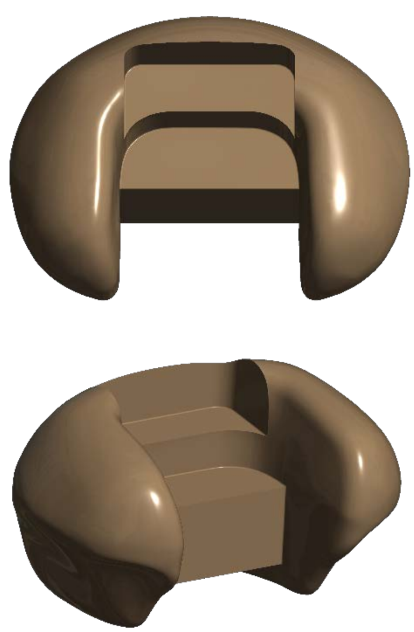


Figure 7.6.2.1: Top and isometric views of the abdominal insert

7.3.3. Femur

The bumper is designed to prevent metal-to-metal contact between the femur and the flange/screws that hold the femur, when the femur is rotated towards the pelvis. This holds true when the femur is parallel to the midsagittal plane, as well as 7º inboard and outboard of this plane.

- Inspect the femur bumpers for tears or cracks and replace if necessary.
- Check for chipped, cracked or broken metal pieces or stripped screws and threads.
- Check the femur sockets and femur ball for galling.
- Confirm that the nylon-tipped femur friction adjusting screws (PN 9000063 shown above in **Figure 7.2.1.1**) are not damaged.

7.3.4. Pelvis

- Examine the pelvis for flesh tears and/or cuts, and the skin for foam separation.
- Check for tears in the pelvis vinyl.
- Check for chipped, cracked or broken metal pieces or stripped screws and threads.
- If the pelvis cavity for the femur shows signs of deterioration such as these, it will affect the pelvis range of motion and the pelvis should be remolded.

Section 8. Leg, Knee, Ankle and Foot Assemblies

8.1. Description and Features of the Leg, Knee, Ankle and Foot Assemblies

A description and listing of the features of the leg, knee, ankle, and foot assemblies are provided in the sub-sections below. A discussion of the optional instrumented lower leg is provided in **Section 9**.

8.2. Disassembling, Inspecting, Repairing, and Reassembling the Leg and Knee

8.2.1. Exploded Views and Parts Lists

The exploded view of the upper leg assembly and knee assembly parts, and their corresponding item and part numbers, is shown below in **Figure 8.2.1.1**.

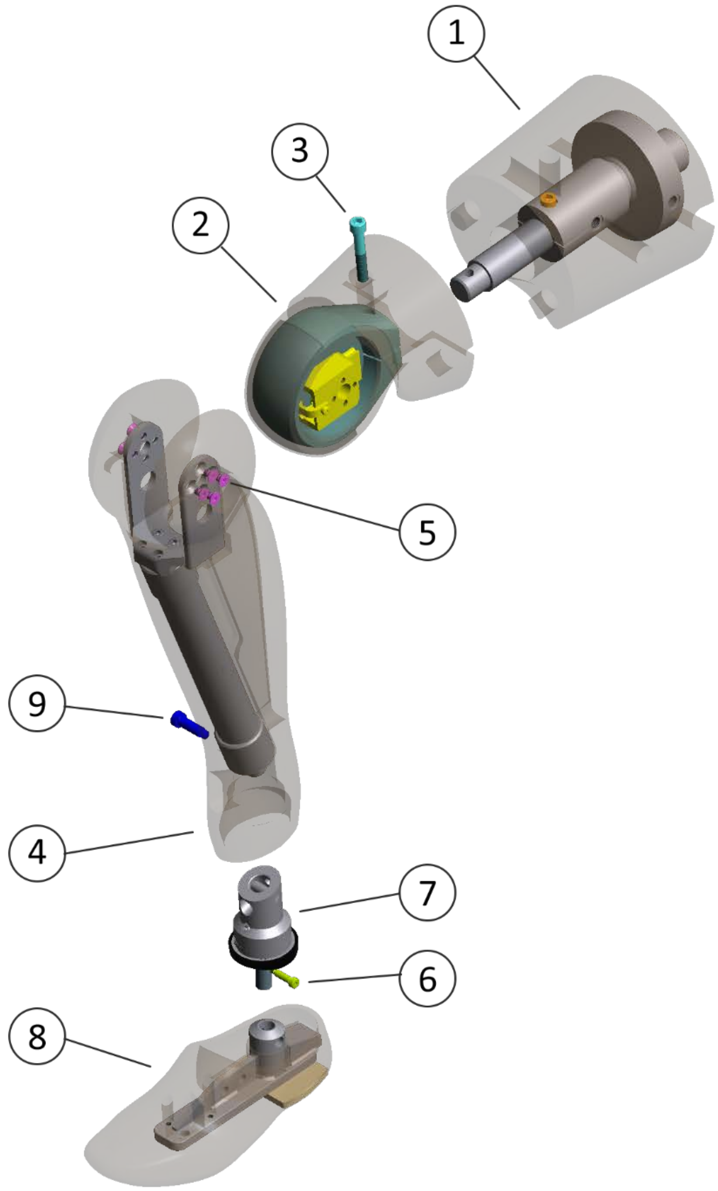


Figure 8.2.1.1: Complete leg assembly exploded view

The Item numbers, part numbers, and part descriptions for the complete leg assembly are shown below in **Table 8.2.1.1**.

Table 8.2.1.1: Complete leg assembly (880995-1513, left/ 880995-1514, right) parts list

Item	Quantity	Part Number	Description
1	1	880995-1500	Upper Leg Assembly
2	1	880995-1515	Sliding Knee Assembly, Left
	1	880995-1516	Sliding Knee Assembly, Right (Not Shown)
3	1	9000361	3/8-16 X 2-1/4 LG. SHCS
4	1	880995-1550	Lower Leg Assembly
5	8	9000313	Screw, FHCS 1/4-28 X 3/8 LG
6	1	A-1886	Foot Attachment Bolt
7	1	B-1889	Ankle Assembly
8	1	880995-1600	45° Foot Molded, Left
	1	880995-1601	45° Foot Molded, Right (Not Shown)
9	1	A-1887	Ankle to Leg Attachment Bolt

The exploded view of the upper leg assembly and knee assembly parts, and their corresponding item and part numbers, is shown below in **Figure 8.2.1.2**

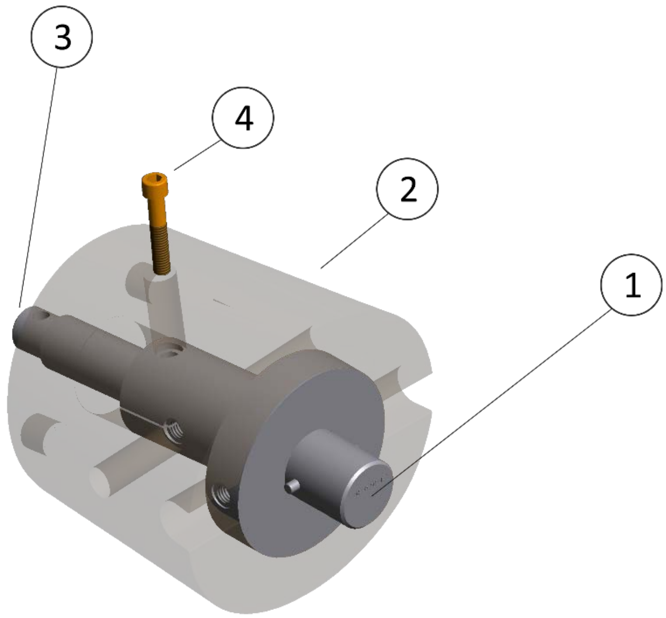


Figure 8.2.1.2: Upper leg assembly exploded view

The Item numbers, part numbers, and part descriptions for the complete leg assembly are shown below in **Table 8.2.1.2**.

Table 8.2.1.2: Upper leg assembly (880995-1500) parts list

Item	Quantity	Part Number	Description
1	1	880995-502	Upper Leg Weldment
2	1	880995-1527	Upper Leg Flesh
3	1	78051-319	Load Cell Simulator - Femur HYBRID III
4	1	9000066	Screw, SHCS 3/8-16 X 2 Nylok®

The exploded view of the upper leg assembly and knee assembly parts, and their corresponding item and part numbers, is shown below in **Figure 8.2.1.3.**

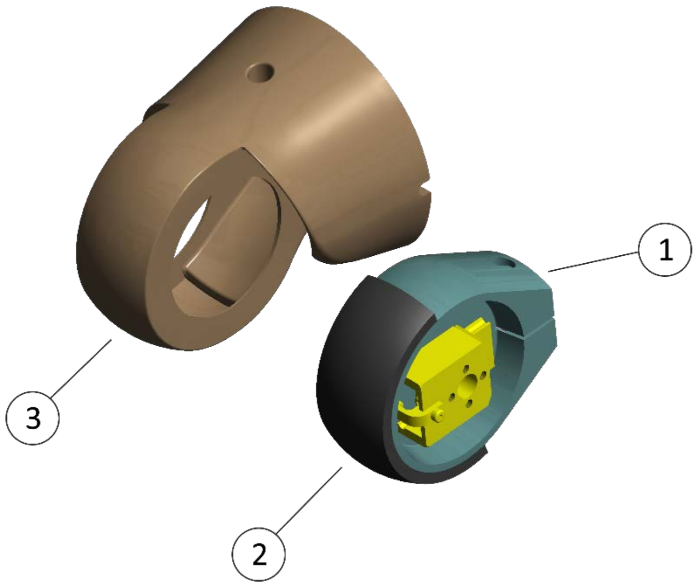


Figure 8.2.1.3: Sliding knee assembly exploded view

The Item numbers, part numbers, and part descriptions for the sliding knee assembly are shown below in **Table 8.2.1.3**.

Table 8.2.1.3: Sliding knee assembly (880995-1515 left/-1516 right) parts list

Item	Quantity	Part Number	Description
5	1	880995-1630-1	Left Knee Assembly, Ball Knee Slider
6	1	880995-1630-2	Right Knee Assembly, Ball Knee Slider (Not Shown)
7	1	880995-511	Knee Insert
8	1	880995-508	Knee Flesh

The exploded view of the ball slider knee assembly parts and their corresponding item numbers are shown below in **Figure 8.2.1.4**.

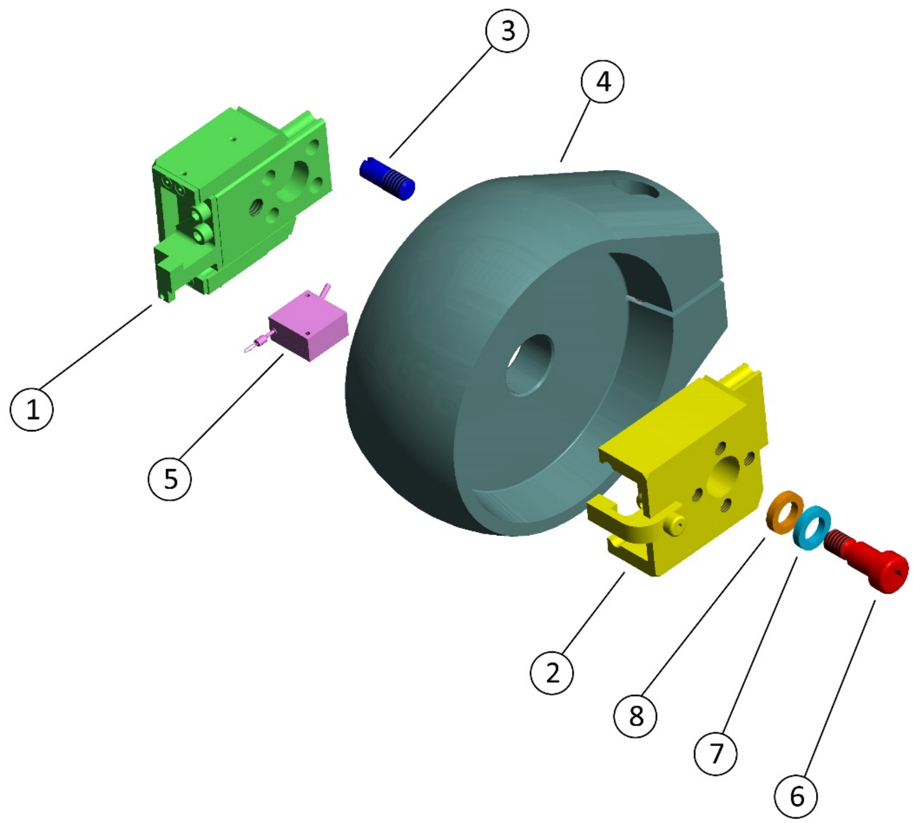


Figure 8.2.1.4: Ball slider knee assembly exploded view

The Item numbers, part numbers, and part descriptions for the ball slider knee assembly are shown below in **Table 8.2.1.5**.

Table 8.2.1.5: Ball slider knee assembly (880995-1630-1 left/-2 right) parts list

Item	Qty.	Part Number	Description
1	1	880995-1631-1/2	Inboard Assembly, Ball Knee Slider, Left & Right
2	1	880995-1632	Outboard Assembly, Ball Bearing Knee Slider
3	1	880995-1637	Knee Stop Pin
4	1	880995-1510	Machined Knee Cap Assembly
5	1	150-0121V	Potentiometer, String, Mini, Universal
6	1	9002346	3/8 X 1/2 LG. SHSS
7	1	79051-32	Washer, Sliding knee
8	1	79051-33	Washer, Compression

8.2.2. Disassembling the Upper Leg and Knee

Step 1. Separate the knee and upper leg sections by removing the two SHCS fasteners that secure the load cell or the femur load cell simulator, upper leg weldment and machined knee.

Note: A pair of the upper femur load cells is available to replace the upper leg weldment shown above in **Figure 8.2.1.1**. See additional information below in **sub-Section 8.2.3**.

Step 2. Separate the lower leg from the machined knee by removing the eight FHCS fasteners shown above in **Figure 8.3.1.1** from the clevis. This exposes the knee slider assembly.

Step 3. The slider is detached by removing the 3/8 X 1/2 LG. SHSS fastener that has a metal and a urethane washer, as shown above in **Figure 8.2.1.4**.

Step 4. Remove the two parts of the slider assembly from the machined knee cap.

Step 5. Disassemble the inboard assembly by removing the two #8-32 x 3/8 Lg. SHCS from string holder assembly (PN 880995-1650-2, left / -1, right (not shown)), as shown below in **Figure 8.2.1.5**.

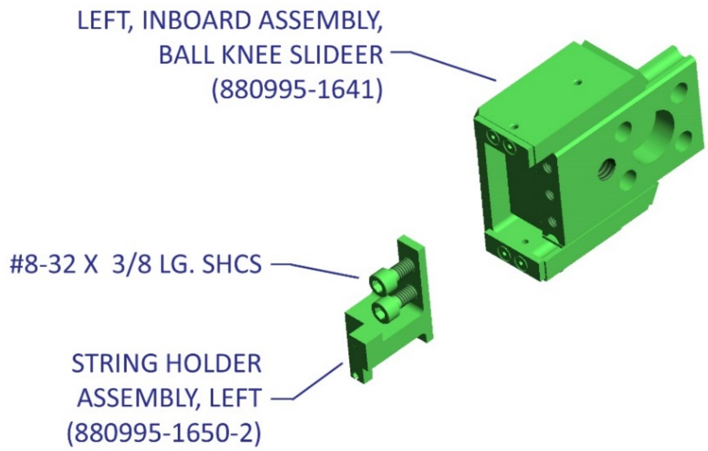


Figure 8.2.1.5: Disassemble inboard assembly

Step 6. At this point, conduct the inspections and repairs noted below in **sub-Section 8.2.3**.

8.2.3. Inspecting and Repairing the Upper Leg and Knee

- Inspect the rubber blocks of the slider and the rubber stops for damage.
- Inspect the balls in the tracks of the slider to ensure they are in the track securely.
- If damaged, contact the manufacturer for guidance.
- Inspect the knee skin and rubber knee insert by first removing the machined knee cap (PN 880995-1510 above in **Figure 8.2.1.1**).
- Examine these flesh parts for cuts and tears.
- Clean the inside and outside of the insert and adjoining knee skin with isopropyl alcohol or equivalent.

8.2.4. Reassembling the Upper Leg and Knee

When attaching the knees, position them so that the potentiometer mounts inboard in order to provide easier access to the knee adjustment screw when seating the dummy.

Note:

- A pair of six-channel femur load cells is available for use in place of the single-axis femur load cells. The six-channel load cells measure axial and shear loads, and moment in three axes, while the single-axis load cells measure axial load only.
- When assembling the knees with the standard, non-instrumented lower legs, the shoulder bolt head is mounted on the outboard side of both knees.
- The shoulder bolt for the machined knee acts as a control for the motion between the lower leg and knee.

8.3. Disassembling and Reassembling the Lower Leg, Ankle and Foot

8.3.1. Isometric Views, Exploded Views, and Parts Lists

The isometric view of the lower leg assembly parts and their corresponding item numbers is shown below in **Figure 8.3.1.6**.

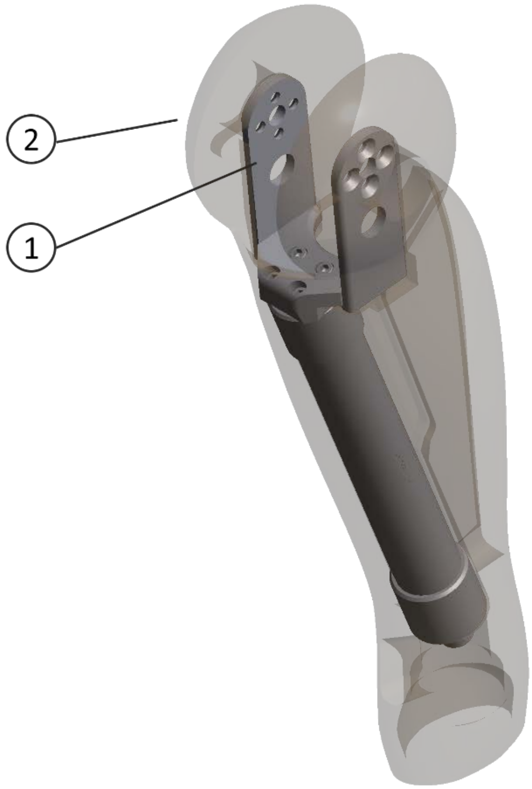


Figure 8.3.1.6: Lower leg assembly isometric view

The item numbers, part numbers, and part descriptions for the lower leg assembly are shown below in **Table 8.3.1.2**.

Table 8.3.1.2: Lower leg assembly (880995-1550) parts list

Item	Quantity	Part Number	Description
1	1	880995-630	Lower Leg Bone Assembly
2	1	880995-1614	Lower Leg Flesh with Zipper

The exploded view of the ankle assembly parts and their corresponding item numbers is shown below in **Figure 8.3.1.7.**

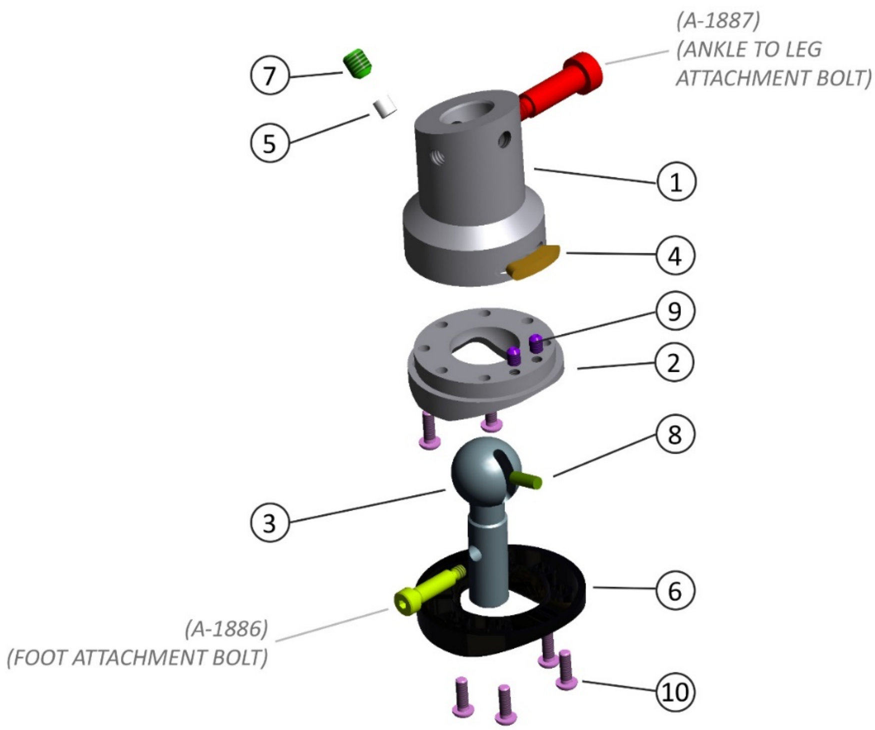


Figure 8.3.1.7: Ankle assembly exploded view

The item numbers, part numbers, and part descriptions for the ankle assembly are shown below in **Table 8.3.1.4**.

Table 8.3.1.4: Ankle assembly (B-1889) parts list

Item	Quantity	Part Number	Description
1	1	C-1884	Ankle Shell, Upper
2	1	C-1885	Ankle Shell, Lower
3	1	A-1590	Ankle Shaft
4	1	A-1672	Stop Pin Retainer
5	1	A-1888	Friction Pad
6	1	78051-610	Ankle Bumper
7	1	9000073	5/16-18 X 3/8 LG. SSSCP
8	1	9000072	3/16 X 1/2 LG. Dowel
9	2	9000011	#10-32 X 1/4 LG. SSSCP
10	6	9000076	#8-32 X 1/2 LG. BHCS

The isometric view of the foot assembly parts and their corresponding item numbers is shown below in **Figure 8.3.1.8**.

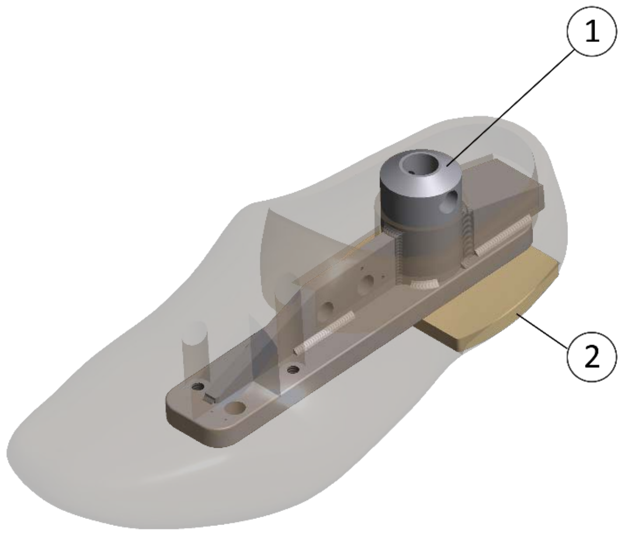


Figure 8.3.1.8: **Foot assembly isometric view**

The item numbers, part numbers, and part descriptions for the ankle assembly are shown below in **Table 8.3.1.6**.

Table 8.3.1.6: Foot assembly (880995-1600/1601) parts list

Item	Quantity	Part Number	Description
1	1	880995 -1601	45° Foot Weldment, Left
		880995 -1602	45° Foot Weldment, Right (Not Shown)
2	1	78051- 608	Heel Pad, Foam

8.3.2. Disassembling the Lower Leg, Ankle, and Foot

Step 1. Separate the 45⁰ foot and ball joint ankle assembly from the lower leg assembly by removing the modified SHSS fastener (PN A-1887 in Figure 8.3.1.1 above) at the ankle-lower leg intersection.

Step 2. The ankle assembly and foot can be separated by removing the foot attachment bolt (PN A -1886 shown above in Figure 8.3.1.3 above) from the ankle shaft (PN A-1590**)**.

Step 3. Remove the four BHCS fasteners from the ankle bumper (PN 9000076 and 78051-610, respectively, shown above in **Figure 8.3.1.3**). This will remove the bumper and expose the lower ankle shell (PN C-1885 shown above in **Figure 8.3.1.3**).

Step 4. Two SHCP will be inset to hold in the pin retainer. Two BHCS will hold the lower shell to the ankle shell. Remove the two BHCS and SSCP to remove the ankle shaft.

Step 5. The pin retainer and dowel pin (PN A-1672 and 9000072, respectively, shown above in **Figure 8.3.1.3**) can now be removed easily from the ankle assembly.

Step 6. A single SHCP fastener and Delrin friction pad (PN A-1888 shown above in **Figure 8.3.1.3**) can be found opposite the dowel pin and pin retainer on the ankle shell.

Note: When assembled, the SHCP can be tightened onto the friction pad. This will push against the ball of the ankle shell and control the movement of the ankle joint.

Step 7. Remove the heel insert and inspect for deterioration, as discussed in **sub-Section 8.3.3** below.

8.3.3. Inspecting the Foot

- Inspect the foot flesh for tears or damage.
- Make sure that the ankle bumper is in place and inspect for deterioration.

Section 9. Optional Instrumented Lower Leg Assembly

9.1. Description and Features of the Optional Instrumented Lower Leg Assembly

The instrumented lower leg option can measure knee (tibia-to-femur) shear, knee clevis axial loads (inside and outside the knee), upper leg fore-aft and lateral moments plus shear and axial forces, and lower leg fore-aft and lateral moments plus shear. Load cells with four channels to measure various combinations of forces and moments are available for the upper and lower tibias.

The standard lower leg, shown above in **Figure 8.3.1.1**, is a welded assembly with a bolt-on knee clevis that can be replaced with an optional instrumented leg.

The following sub-Section describes the assembly of the optional instrumented lower leg.

9.2. Assembling and Instrumenting the Optional Instrumented Lower Leg

- The upper part of the optional instrumented lower leg assembly consists of the clevis that is bolted to the upper tibia load cell by four SHCS fasteners.
- The optional upper and lower tibia load cells are separated by a heavy wall, aluminum tube that protects the load cell connectors. The upper and lower tibia load cells are each attached to the tube by four modified BHCS fasteners.

Note: If lateral shear and moment are preferred, the lower load cell may be rotated 90º by using the second slot in the ankle-to-tibia adapter; or this load cell may be purchased with both moment measurements built in.

9.3. Adjusting the Optional Instrumented Lower Leg

No adjustments are needed except for a friction adjustment at the ankle ball.

9.4. Inspections and Repairs

- Check the knee, leg and foot flesh for rips and tears. Repair or remold.
- Check the knee assembly for bent rotation stops and improper assembly.
- Check the ankle bumper for damage.
- Check the ankle ball for damage.

Section 10. Clothing

10.1. Description and Features of the 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 0.27 kg (0.6 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.
- A size large shirt (XXL) and double extra large pants (XXL) are suggested sizes for proper fit and weight.
- The shoes used with the large male dummy are men's dress Oxfords, size 11 XW, which meet military specification MIL-S-13192P.
  - ✓ Each shoe weighs 0.613 ± 0.09 kg (1.35 ± 0.2 lb).
  - ✓ To make it easier to put the shoe on the dummy, the shoe may be cut to extend the tongue. Talcom powder may also be applied to the foot.

Section 11. Instrumentation and Wiring

11.1. Overview

When ordering a new dummy, inform Humanetics 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.

11.1.1. Instrumentation Parts List and Descriptions

A list and description of the instrumentation used in the harmonized H III 95th percentile male test dummy is shown below in **Table 11.1.1.1**.

Table 11.1.1.1: Instrumentation Parts List and Descriptions

Instrumentation	Part Number	Number of Channels	Quantity
Head Accelerometers	IE-103	3	3
Upper Neck Load Cell	IF-205	6	1
Lower Neck Load Cell	IF-242	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-312	5	1
Lumbar Spine Load Cell	IF-439	6	1
	IF-402	3	1
Pelvis Accelerometers	IE-103	3	3
ASIS Load Cells	IF-511	4	1
Upper Femur Load cells	IF-612	12	2
Femur Load Cells	IF-625	12	2
	IF-608	10	2
	IF-604	2	2
Knee Clevis Load Cells	IF-823	4	2
Upper Tibia Load Cells	IF-820	8	2
Lower Tibia Load Cells	IF-819	8	2
	IF-825	8	2
Foot Accelerometers	IE-103	6	6

Note: The load cell part numbers listed above in **Table 11.1.1.1** are for 350 ohm's. 120 ohm's load cells are also available.

11.1.2. Instrumentation Location

The location of the instrumentation used in the harmonized H III 95th percentile male test dummy is shown below in **Figure 11.1.2.1**.

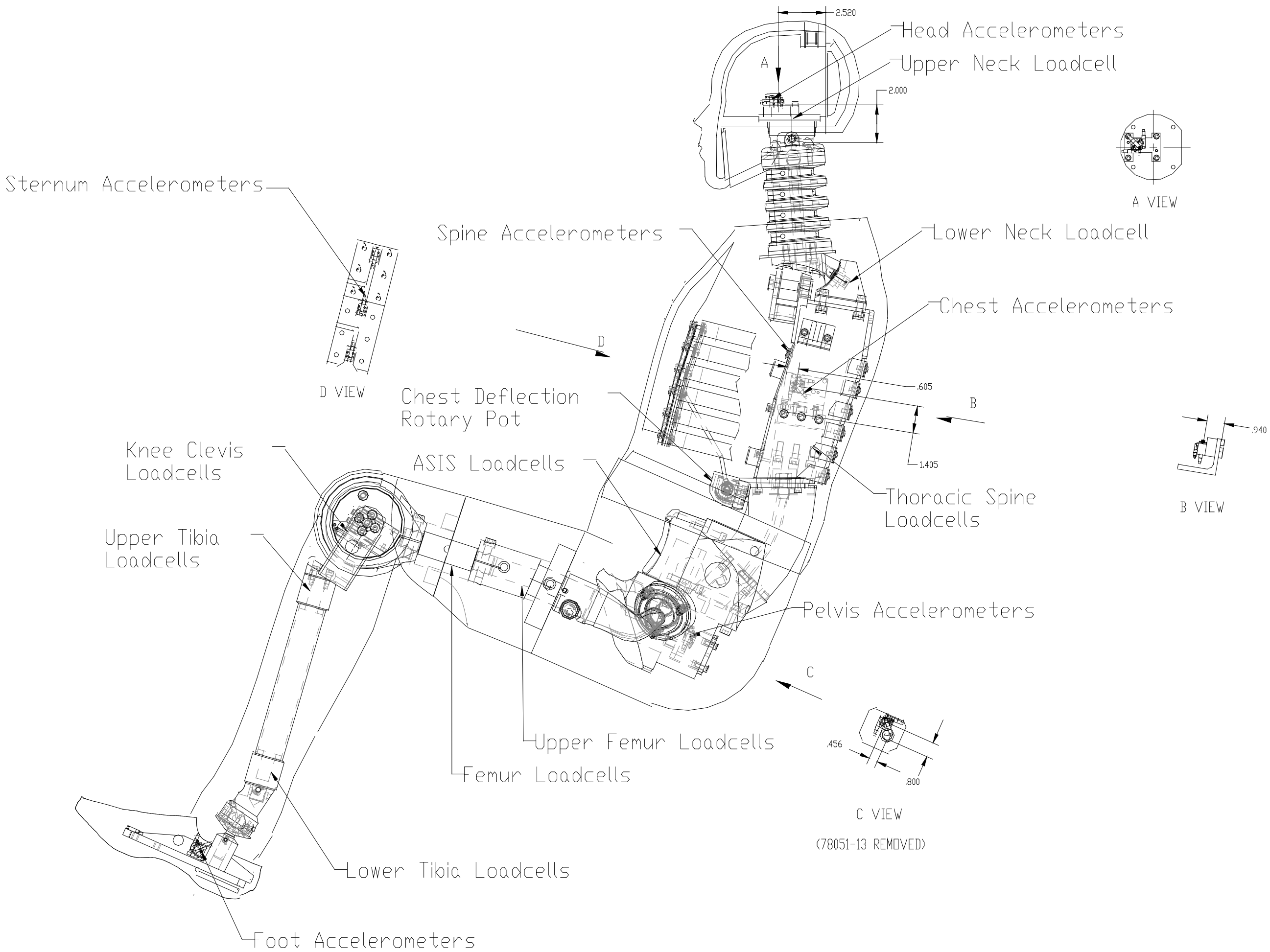


Figure 11.1.2.1: Instrumentation Location in Test Dummy

Section 12. Calibration Tests

12.1. Overview

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.

12.2. Head Drop Calibration Test

12.2.1. Test Purpose

This test measures the forehead response to frontal impacts with a hard surface.

12.2.2. Required Test Parts

The head assembly parts required for this test are the:

- Head assembly (88000995-1100),
- Head accelerometer assembly (880995-1711), and
- Three accelerometers.

In addition, the mass of the head assembly must be 4.94 ± 0.05 kg (10.9± 0.1 lb).

12.2.3. Test Fixture

- The test fixture consists of a structure to suspend the head assembly and a rigidly supported, flat, horizontal, steel plate.
- The square plate shall be 50.8 ± 2 mm (2.0 ± 0.08 in) thick, with a length and width of 610 ± 10 mm (24 ± 0.4 in), and have a smooth surface finish of (8 to 80 micro inches/inch) rms. A surface finish close to (8 micro inches/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.

Note:

- The effective suspension cable and accelerometer cable masses are to be less than 25 g (0.05 lb).
- The effective mass can be estimated by multiplying the mass/unit length of the cable by the length of cable between the head and the first support.

12.2.4. Data Acquisition

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.

Note:

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

12.2.5. Test Procedure

Step 1. Visually inspect the head skin for cracks, cuts, abrasions, etc. Replace or repair the head skin if abrasions or cuts to the frontal area are more than superficial.

Step 2. Torque the 1/4-20 skull cap screws to 18 N·m (160 in·lbf) and the #10-24 accelerometer mount screws to 7.5 N·m (66 in·lbf).

Step 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 Drawing 880995-1100.

- The first accelerometer is aligned with the sensitive axis perpendicular to the horizontal bulkhead in the midsagittal plane (Z-axis).
- The second accelerometer is aligned with the sensitive axis parallel to the horizontal bulkhead in the midsagittal plane (X-axis).
- The third accelerometer is aligned with its sensitive axis parallel to the horizontal bulkhead and perpendicular to the midsagittal plane (Y-axis).

Step 4. Ensure that all transducers are properly installed, oriented and calibrated.

Step 5. Prior to the test, clean the impact surface of the skin and the impact plate surface with isopropyl alcohol or an equivalent. The impact surface and the skin must be clean and dry for testing.

Step 6. Soak the head assembly in a controlled environment with a temperature of 18.9 to 25.6 ^{o}C (66.0 to 78.0 ^{o}F) and a relative humidity from 10.0 to 70.0 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.

Step 7. Suspend the head assembly in a manner similar to that shown below in **Figure 12.2.5.1.**

- The lowest point on the forehead shall be 12.7 ± 1 mm (0.5 ± 0.04 in) below the lowest point of 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 head are used to ensure that the head is level with respect to the impact surface, as shown below in **Figure 12.2.5.2**.

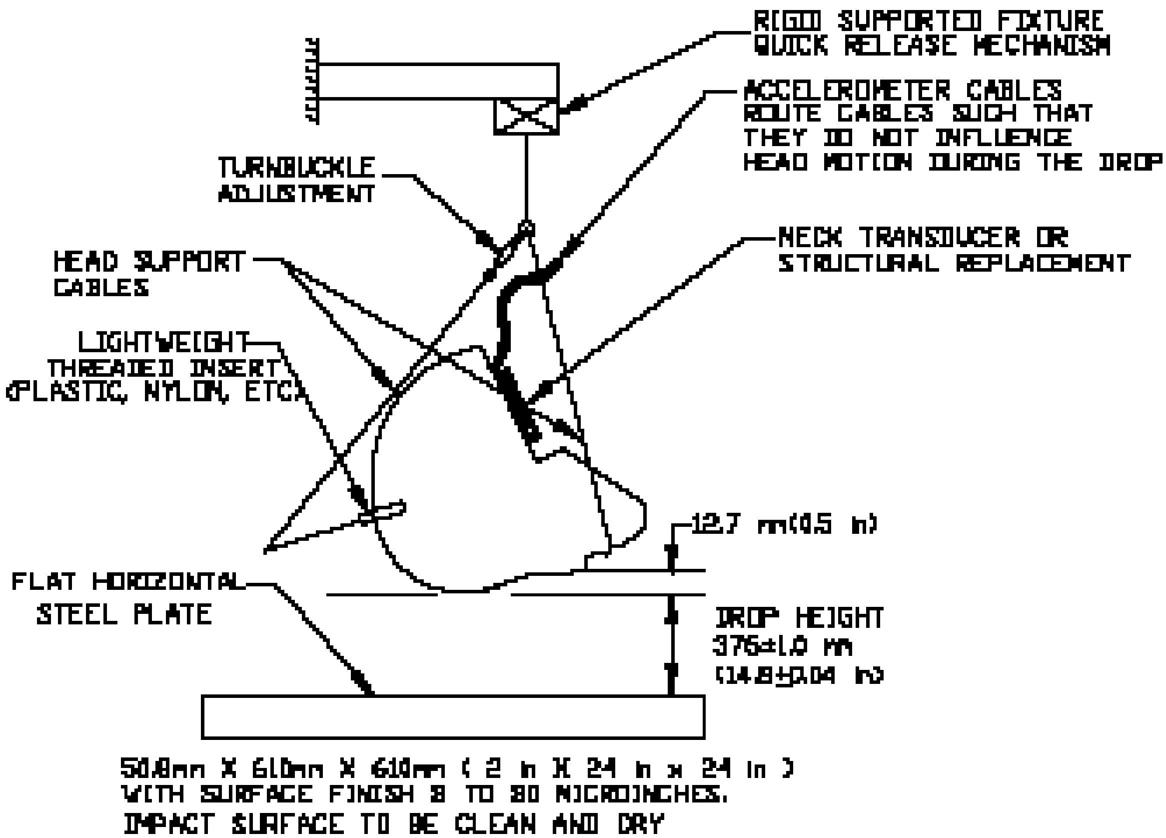


Figure 12.2.5.1: Head drop test setup specifications

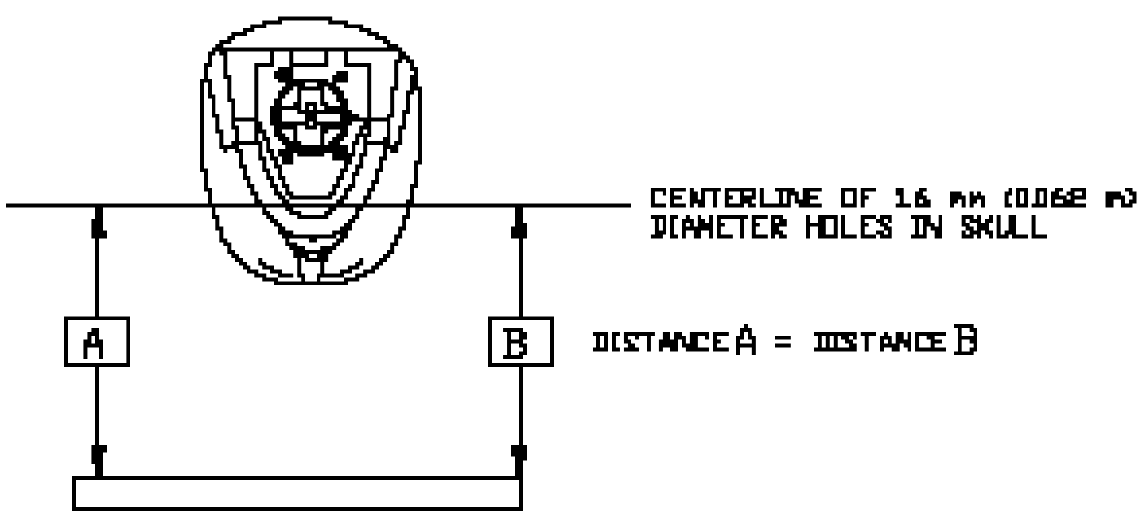


Figure 12.2.5.2: Head leveling method

Step 8. Drop the head assembly from a height of 376 ± 1 mm (14.8 ± 0.04 in) by a means that ensures a smooth, clean release onto the impact surface.

Step 9. Wait at least two hours between successive tests on the same head assembly.

12.2.6. Performance Specifications

The performance specifications for the head drop test are shown below in **Table 12.2.6.1**.

Table 12.2.6.1: Head drop performance specifications

Parameters	Specifications
Peak Resultant Force	220 - 265 G
Peak Lateral Force	15.0 to (- 15.0) G

Note: The resultant acceleration vs. time history curve shall be unimodal to the extent that oscillations occurring after the main acceleration pulse are less than 10% (zero to peak) of the main pulse.

12.3. Neck Calibration Test

12.3.1. Required Test Parts

The neck assembly parts required for this test are the:

- Head assembly (880995-1100),
- Neck assembly (880995-1250),
- Upper neck bracket (880995-1270),
- Lower neck bracket (78051-303),
- Bib simulator (78051-84),
- Six-channel neck transducer to measure the X-axis force and the 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,
- Head accelerometer assembly (880995-1711), and
- Three actual or simulated accelerometers in the head to maintain the proper weight and center of gravity location.

Note: Data from the accelerometers are not required.

12.3.2. Test Fixture

The test fixture pendulum arm with specifications appears below in **Figure 12.3.2.1.**

- The aluminum honeycomb material is commercial grade, 0.8 kg (1.8 lb) per cubic 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.

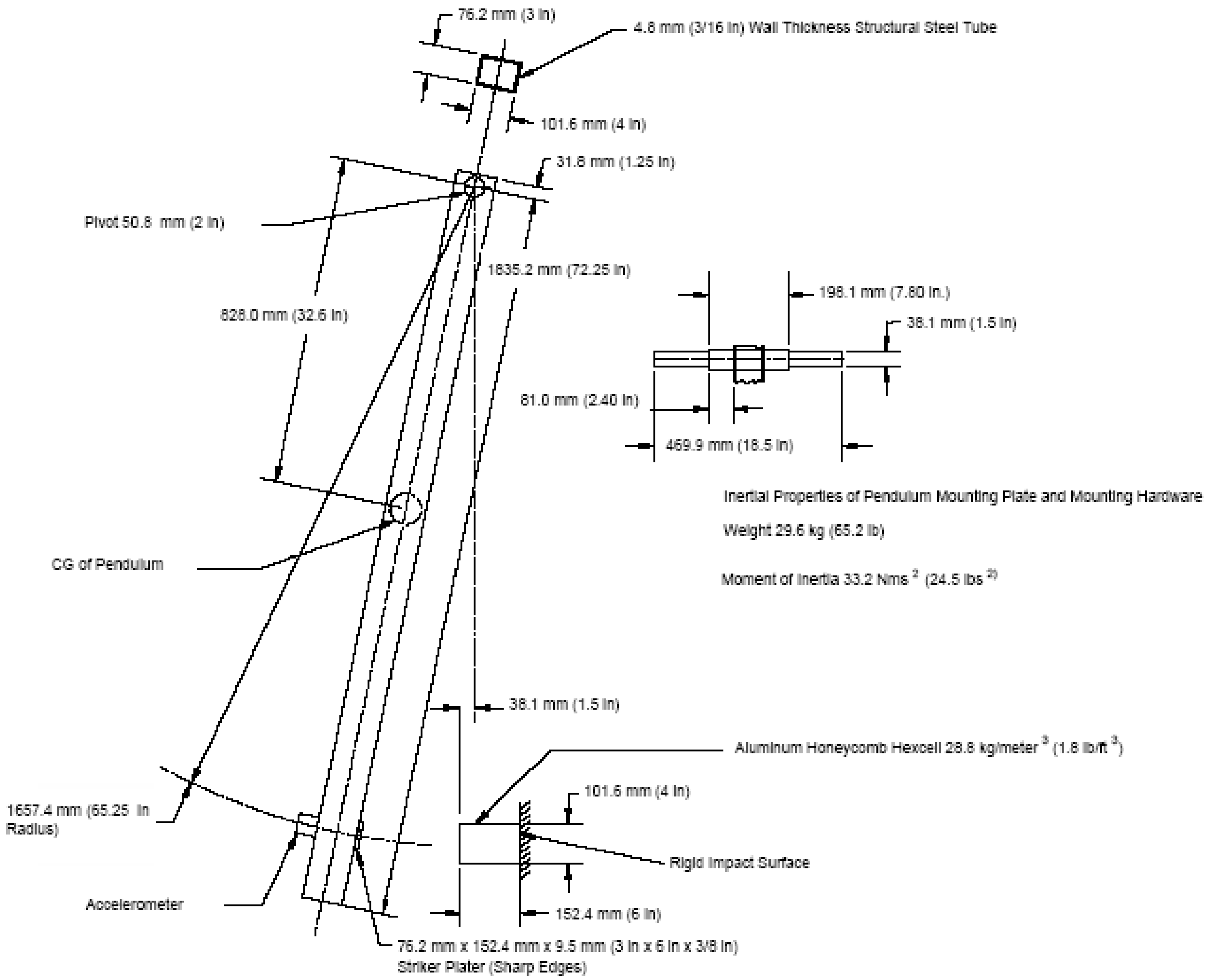


Figure 12.3.2.1: Neck pendulum arm specifications

12.3.3. Data Acquisition

The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211.

- Filter the neck force data channel using Channel Class 1000.
- Filter the neck moment data channel using Channel Class 600.
- Filter the pendulum acceleration data channel using Channel Class 180.
- Filter the neck rotation data channels using Channel Class 60.
- All filters should be phaseless.

Note:

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

12.3.4. Test Procedure

Step 1. Inspect the neck assembly for cracks, cuts, and separation of the rubber from the metal segment.

Step 2. Inspect the nodding blocks (78051-351, 880995-207) for any deterioration and replace as necessary.

- Replace the blocks if they are less than 80% of their original height.
- The durometer shall be 60 to 90 Shore A.

Step 3. Ensure that the nodding blocks are installed correctly, as shown on Drawing 880995-1250 and in Figure 3.2.4.1, "Nodding Block Orientation".

Step 4. Inspect the nodding joint washers for an interference fit. Adjust or replace as required.

Step 5. Mount the head-neck assembly on the pendulum so the midsagittal plane of the head is vertical.

Step 6. As shown below in **Figure 12.3.4.1** for the flexion test and **Figure 12.3.4.2** for the extension test, the midsagittal plane shall coincide with the plane of motion of the pendulum's longitudinal centerline.

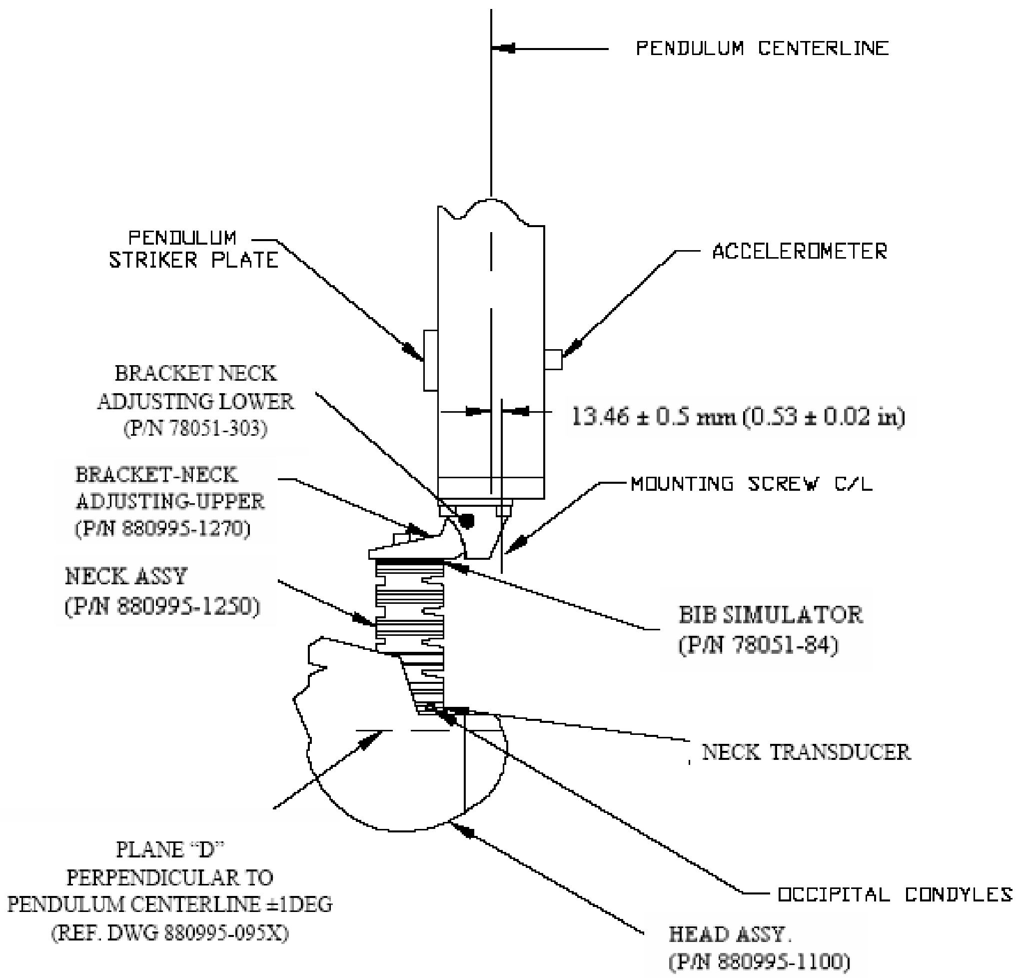


Figure 12.3.4.1: Neck flexion test set-up specifications

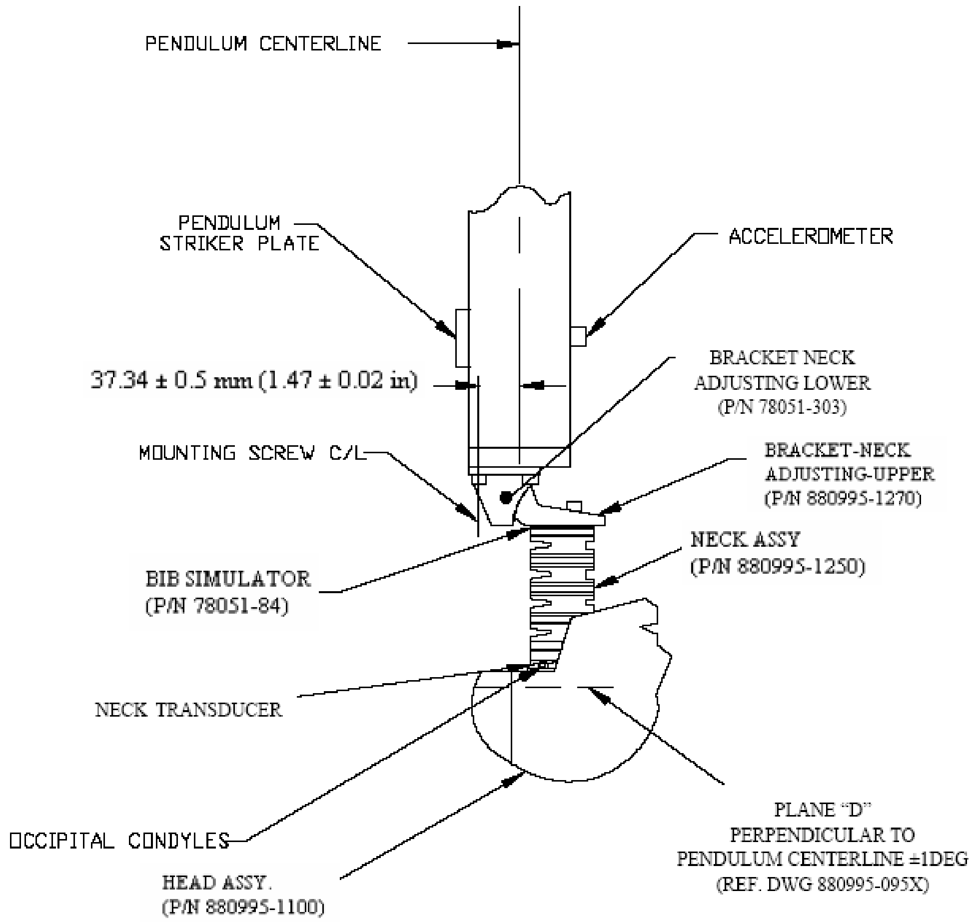


Figure 12.3.4.2: Neck extension test set-up specifications

Step 7. 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 minimize their influence on the performance of the head-neck assembly.

Step 8. Torque the jam nut on the neck cable with bushings to 1.4 ± .2 N·m (12 ± 2 in·lbf) before each test on the same neck.

Step 9. The number of cells in the honeycomb material 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. Prior to the test, it is an option to pre-crush the honeycomb material by lightly impacting it so 90% to 100% of the projected honeycomb surface contacts the pendulum strike plate.

Step 10. Soak the neck assembly in a controlled environment at a temperature between 20.6 to 22.2 ^{o}C (69.0 to 72.0 ^{o}F) and a relative humidity from 10.0 to 70.0 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. Check that internal neck temperature reaches the soak temperature by placing a thermo-sensor into one of the holes in the neck.

Step 11. With the pendulum resting against the honeycomb material, adjust the neck bracket until the longitudinal centerline of the pendulum is perpendicular ±1º to the D-plane on the dummy's head.

Step 12. Calculate the moment about the occipital condyle for both flexion and extension tests using the following formulae for a six-channel neck transducer:

- Metric Units: Moment (N·m) = [My (N·m)] - [0.01778 m] [Fx (N)]
- English Units: Moment (ft·lbf) = [My (ft·lbf)] - [0.05833 ft] [Fx (lbf)]

Note: These formulae are based on the sign convention contained in the latest revision of SAE Recommended Practice J211, and SAE Information Report J1733.

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

12.3.5. Test Procedure and Performance Specifications: Neck Flexion

The performance specifications for the neck flexion test are listed below in **Table 12.3.5.1**.

Table 12.3.5.1: Neck flexion performance specifications

CORRIDORS	LOWER	UPPER	UNITS
Velocity	6.89 22.60	7.13 23.39	m/s ft/s
Pendulum Pulse At 10 ms	2.2 7.2	2.7 8.9	m/s ft/s
Pendulum Pulse At 20 ms	4.0 13.1	5.0 16.4	m/s ft/s
Pendulum Pulse At 30 ms	5.7 18.7	6.9 22.6	m/s ft/s
Maximum D-Plane Rotation	61.0	75.0	Deg
Maximum Occipital Moment During Rotation Interval	110.0 81.1	130.0 95.9	N·m Lbf·ft
Moment Decay Time from t-zero to 10.0 N·m	77.0	97.0	Sec

12.3.6. Test Procedure and Performance Specifications: Neck Extension

The performance specifications for the neck extension test are listed below in **Table 12.3.6.1**.

Table 12.3.6.1: Neck extension performance specifications

CORRIDORS	LOWER	UPPER	UNITS
Velocity	5.95 19.52	6.19 20.31	m/s ft/s
Pendulum Pulse At 10 ms	1.8 5.9	2.2 7.2	m/s ft/s
Pendulum Pulse At 20 ms	3.4 11.2	4.2 13.8	m/s ft/s
Pendulum Pulse At 30 ms	4.8 15.7	5.8 19.0	m/s ft/s
Maximum D-Plane Rotation	81.0	98.0	deg
Maximum Occipital Moment During Rotation Interval	-66.0 -48.7	-84.0 -62.0	N·m Lbf·ft
Moment Decay from t-zero to 10 N·m	100.0	120.0	ms

12.4. Thorax Impact Calibration Test

12.4.1. Required Test Parts

The complete dummy assembly (880995-0000) is required, including the clothing, but without the shoes.

12.4.2. Test Fixture

- The fixture consists of a smooth, clean, dry, steel seating surface and a test probe.
- The test probe is a 152.4 ± 0.25 mm (6.0 ± 0.01 in) diameter rigid cylinder with a mass of 23.36 ± 0.02 kg (51.5 ± 0.05 lb), including instrumentation, rigid attachments and the lower 1/3 of the suspension cable mass.
- The impacting surface has a flat, right angle face with an edge radius of 12.7 ± 0.3 mm (0.5 ± 0.01 in).
- Mount an accelerometer to the probe with its sensitive axis in line with the longitudinal centerline of the test probe.

12.4.3. Data Acquisition

The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211. Filter the probe acceleration data using Channel Filter Class 180 phaseless filter and filter the chest deflection using Channel Filter Class 600 phaseless filter.

Note:

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

12.4.4. Test Procedure

Step 1. Remove the chest skin and visually inspect the thorax assembly for cracks, cuts, abrasions, etc. Pay particular attention to the rib damping material, chest displacement transducer assembly, and the rear rib supports.

Step 2. Torque the spine cables to 1.1-1.4 N·m (10-12 in·lbf).

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

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

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

Step 6. Place the arm assemblies horizontal ± 2.0° and parallel to the midsagittal plane.

Step 7. Secure the arms by tightening the adjustment nut that holds the arm yoke to the clavicle assembly. If necessary, prop the arms up with a rod that will fall away during the test.

Step 8. Level the ribs both longitudinally and laterally ± 0.5 °and adjust the pelvis angle to 13.0 ± 2.0°.

- Use the special tool that inserts into the pelvic structure and extends outward beyond the pelvic skin surface.
- The tool permits the use of an angle measurement device to determine the pelvis angle.

Confirm that:

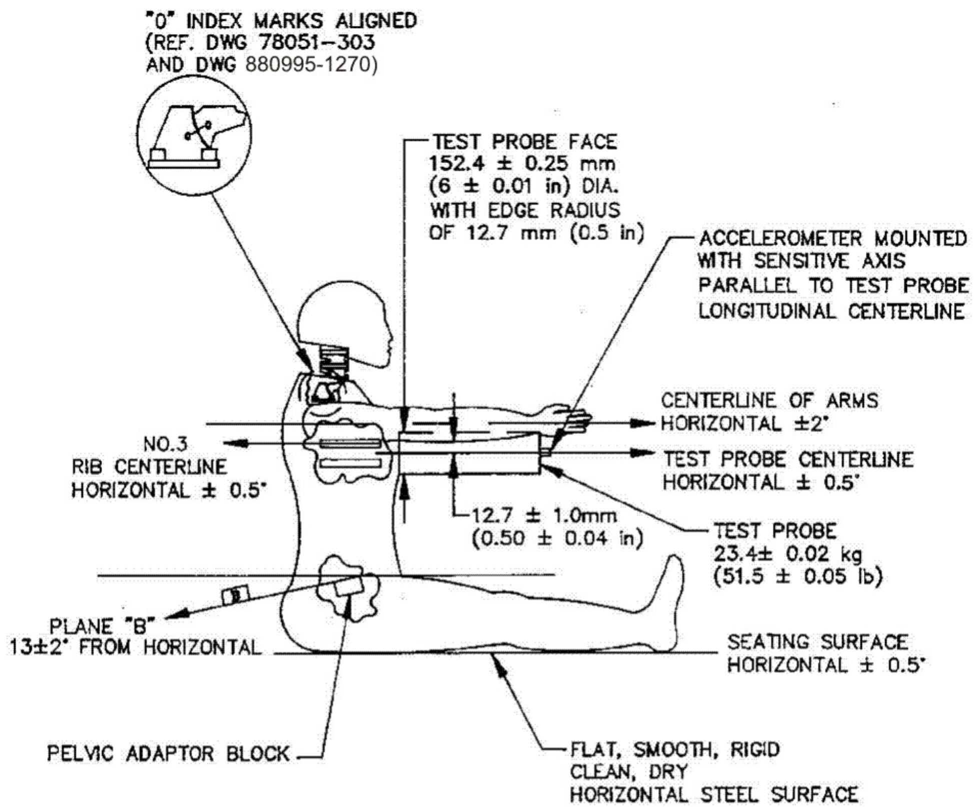
- The midsagittal plane of the dummy is ± 1.0° of vertical and ± 2.0° of parallel to the centerline of the test probes.
- The longitudinal centerline of the test probe is centered on the midsagittal plane of the dummy within 3 ± 0.25 mm (0.12 ± 0.01 in).

Step 9. 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.

Step 10. 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 probe, 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 is shown below in **Figure 12.4.4.1**.



NOTE:

A) NO EXTERNAL SUPPORT IS REQUIRED ON THE DUMMY TO MEET SETUP SPECIFICATIONS

B) THE MIDSAGITTAL PLANE OF THE DUMMY IS VERTICAL (± 1°) AND WITHIN 2° OF THE CENTERLINE OF THE TEST PROBE

C) THE MIDSAGITTAL PLANE OF THE DUMMY IS CENTERED ON THE CENTERLINE OF THE PENDULUM WITHIN 3 mm (0.12 in)

Figure 12.4.4.1: Thorax impact test set-up specifications

Step 11. Soak the test dummy in a controlled environment with a temperature of 20.6 to 22.2°C (69.0 to 72.0 °F) and a relative humidity from 10.0 to 70.0 percent for at least four hours prior to the test, until the rib temperature has reached the soak temperature. The test environment should have the same temperature and humidity requirements as the soak environment.

Step 12. Install the chest skin and reposition the dummy as described in the preceding paragraph using the recorded reference measurements.

Note: 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.

Step 13. 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.

Step 14. Guide the probe so no significant lateral, vertical or rotational motion takes place during the impact.

Step 15. The test probe velocity at the time of impact shall be 6.59 to 6.83 m/s (21.6 to 22.4 ft/s).

Step 16. Wait at least 30 minutes between successive tests on the same thorax.

12.4.5. Performance Specifications

The performance specifications for the thorax impact test are listed below in **Table 12.4.5.1**.

Table 12.4.5.1: Thorax impact performance specifications

Parameters	Specifications
Maximum Resistive Force in Displacement Corridor	5.10 – 5.90 kN
Peak Chest Displacement	66.0 - 76.0 mm
Internal Hysteresis	69.0 - 85.0 %

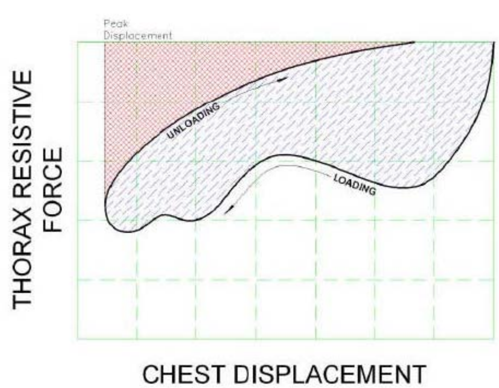
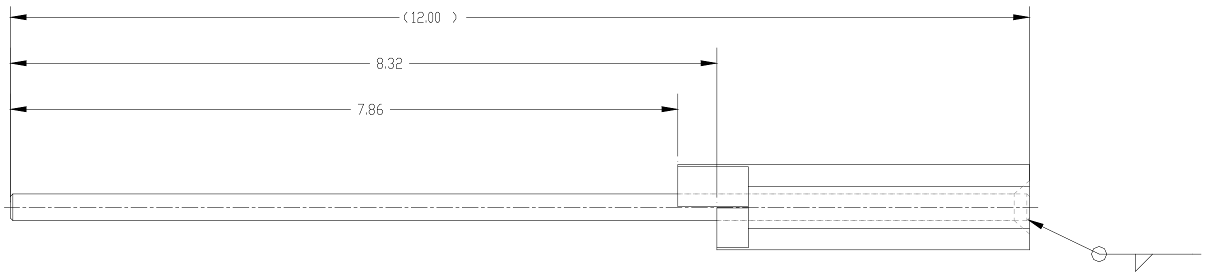


Figure 12.4.5.2: Hysteresis Definition

12.5. Chest Depth Calibration Measurements

12.5.1. Measurement Purpose

The chest depth measurement tool, shown below in **Figure 12.5.1.1**, is used to measure permanent deformation of the rib cage due to impact.



Note: Dimensions are after weld.

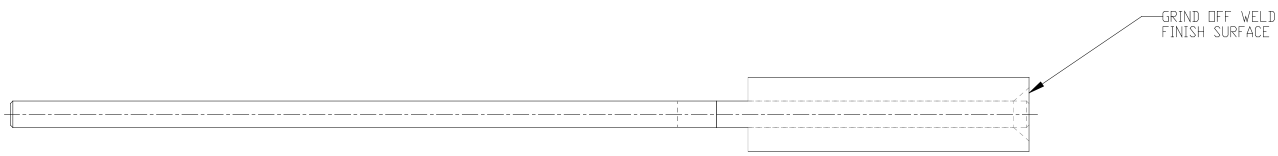


Figure 12.5.1.1: Chest depth measurement tool

12.5.2. Required Measuring Tools

Refer to the chest depth measurement tool shown above in **Figure 12.5.1.1**.

12.5.3. Data Acquisition

- Decreases in the front to back dimensions (A-P) of ribs #1 and #6 are measured using two flats on the gauge handle.
- The measurement is made with the rib cage fully assembled. It is necessary only to unzip the chest flesh to access the rear of the torso. Disassembly of the dummy is not required.

12.5.4. Test Procedure

To measure the chest depth at rib #1:

Step 1. The rod of the tool is inserted between ribs #1 and #2, as shown below in **Figure 12.5.4.1**.

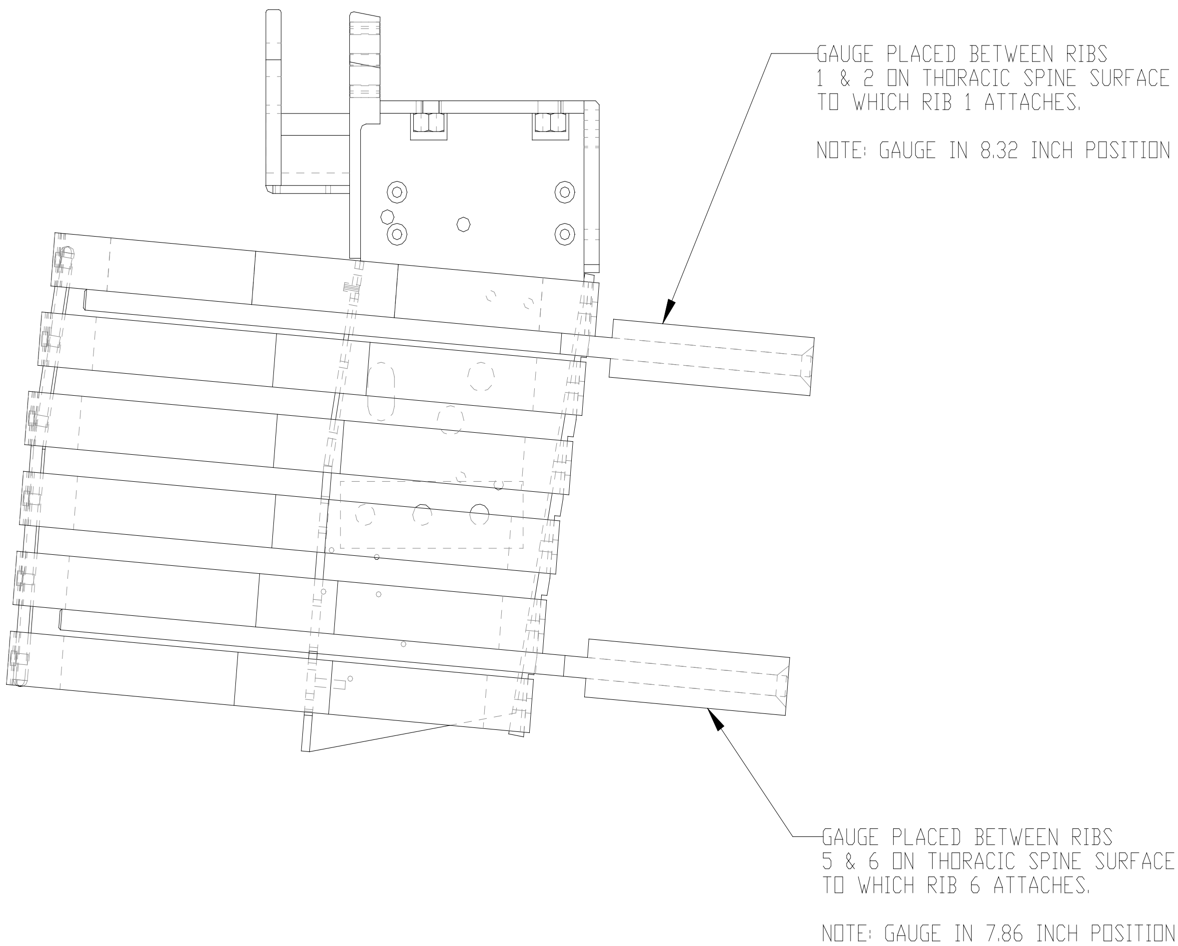


Figure 12.5.4.1: Measuring the chest depth

Step 2. The rear flat on the handle (8.32 inches from the tool's rod end) is held against the surface to which rib #1 is attached on the thoracic spine (880995-301), as shown above in **Figure 12.5.4.1** and below in **Figure 12.5.4.2**.

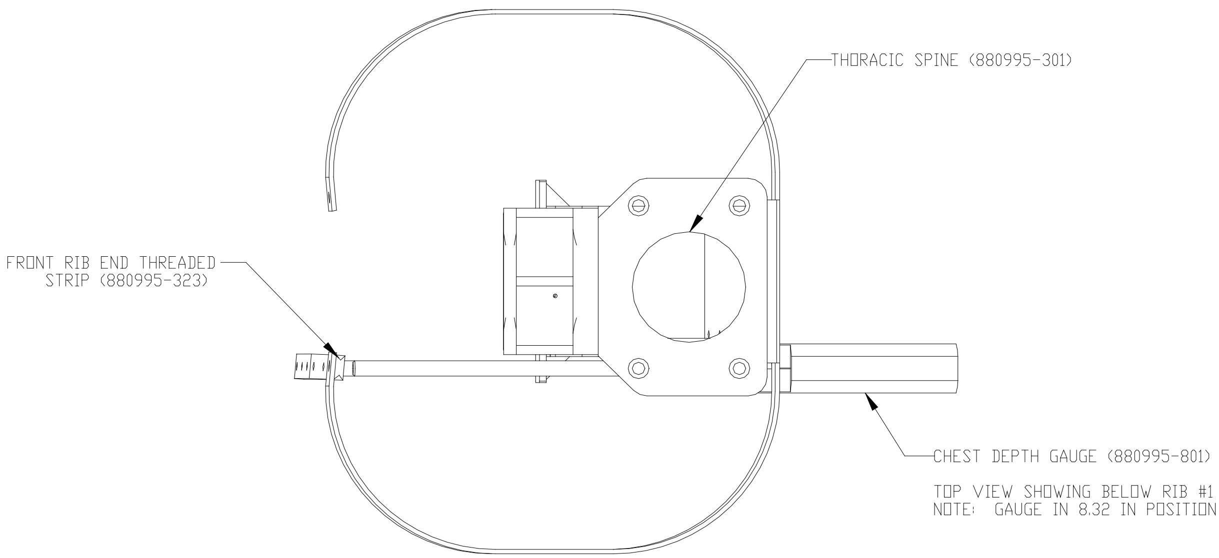


Figure 12.5.4.2: Top view of measuring chest depth at rib #1

To measure chest depth at rib #6:

Step 1. The rod of the gauge is inserted between ribs #5 and #6, as shown above in **Figure 12.5.4.1**.

Step 2. The front flat on the handle (7.86 inches from the tool's rod end) is held against the surface to which rib #5 is attached on the thoracic spine (880995-301), as shown above in **Figure 12.5.4.1** and below in **Figure 12.5.4.3**.

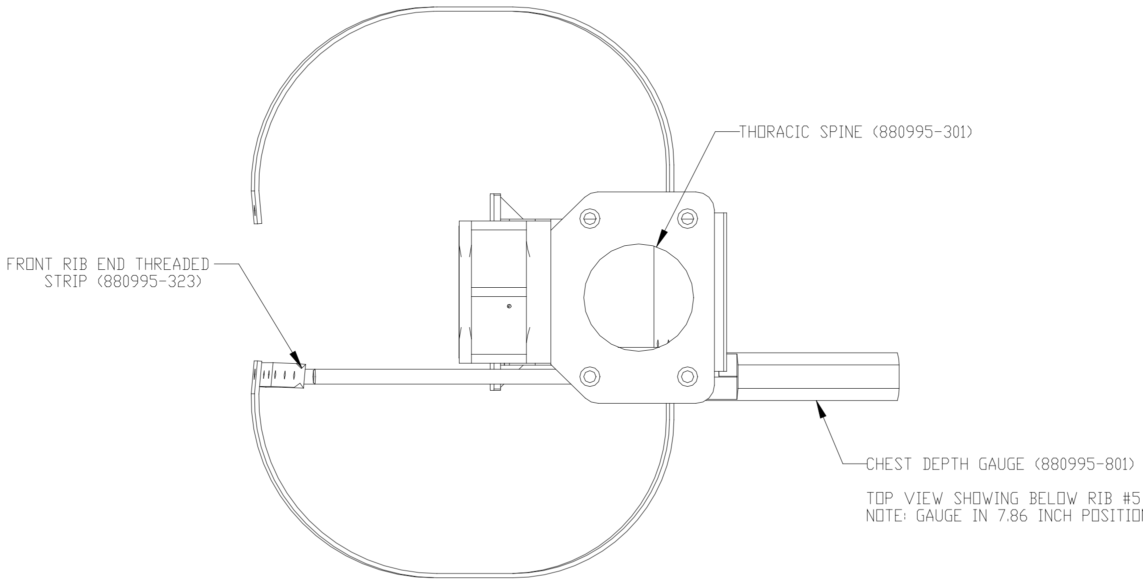


Figure 12.5.4.3: Top view of measuring chest depth at rib #5

Note: Although the measurement procedure is shown from the left side, it shall also be conducted on the right side of the thorax as well.

12.5.5. Performance Specifications

- The tool's rod should fall short of touching the front rib end-threaded strip (880995-323).
- If the rod touches the strip, the chest depth at rib #1 or #6 (whichever is being measured) has decreased below the acceptable range.
- When the tool indicates unacceptably decreased chest depth at either rib #1 or rib #6, the rib set (ribs #1 through #6) shall be removed and replaced with a set in dimensional tolerance.

12.6. Knee Impact Calibration Test

12.6.1. Required Test Parts

The required parts for the knee impact test are the:

- Knee cap (880995-1510),
- Knee flesh (880995-508),
- Knee insert (880995-511), and
- Femur load cell or structural replacement (78051-319).

12.6.2. Optional Test Parts

The optional parts for the knee impact test are the:

- Knee slider assembly, and
- Lower leg assembly.

12.6.3. Test Fixture

The test fixture consists of a rigid test probe and a method of rigidly supporting the knee and lower leg assembly, as shown below in **Figure 12.6.3.1**.

- The probe mass is 5.0 ± 0.02 kg (11.0 ± 0.04 lb), including instrumentation, rigid attachments and the lower 1/3 of the suspension cable mass.
- The diameter of the impacting face is 76.2 ± 0.25 mm (3.0 ± 0.01 in) with an edge radius of 0.5 mm (0.02 in).
- Mount an accelerometer on the end opposite the impacting face, with its sensitive axis collinear to the longitudinal centerline of the test probe.

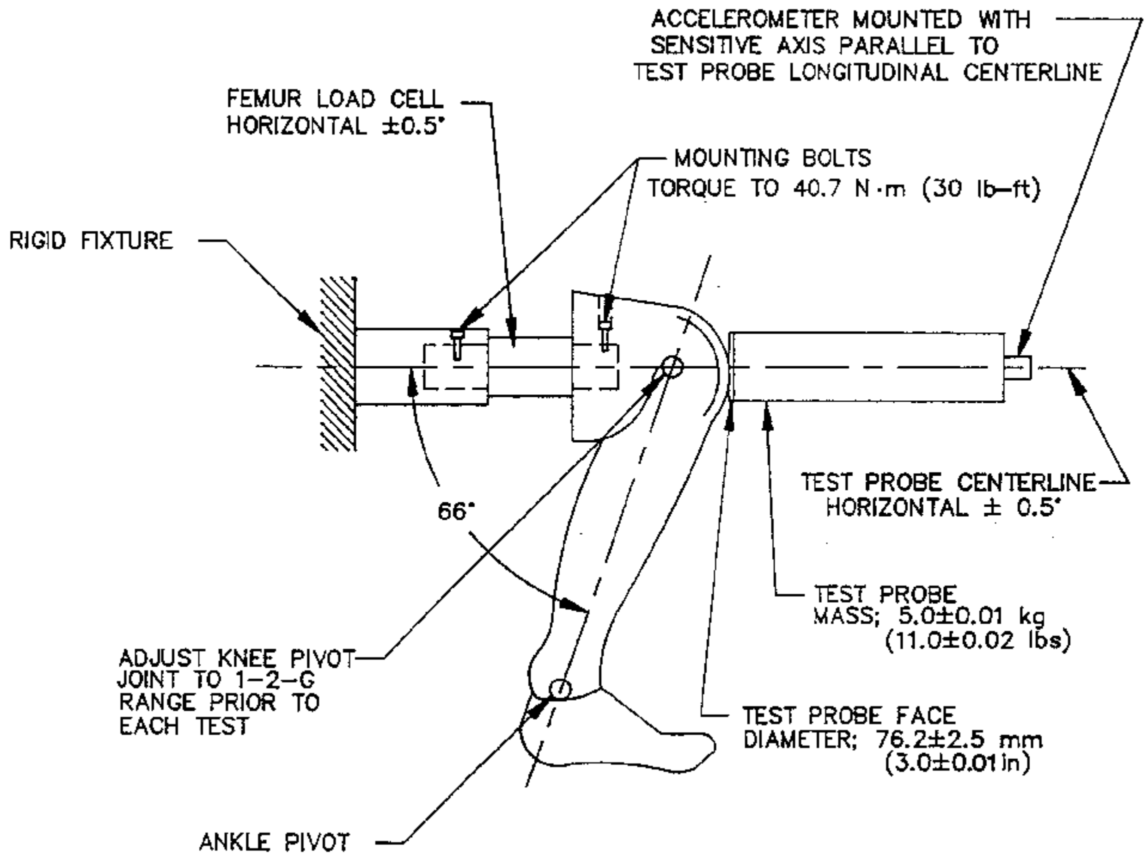


Figure 12.6.3.1: Knee impact test set-up

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

12.6.4. Data Acquisition

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.

Note:

- 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.

12.6.5. Test Procedure

Step 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.

Step 2. Mount the knee/lower leg assembly to the fixture using a femur load cell or load cell simulator.

Step 3. Torque the load cell simulator bolts to 40.7 N·m (30 ft·lbf) to prevent slippage of the assembly during the impact.

Step 4. 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^{o} rearward of vertical.

Step 5. Do not let the foot contact any exterior surface.

Step 6. 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.

Step 7. Guide the probe so there is no significant lateral, vertical or rotational movement at time-zero.

Step 8. Soak the knee assembly in a controlled environment with a temperature between 18.9 and 25.6 ^{o}C (66.0 to 78.0 ^{o}C) and a relative humidity from 10.0 to 70.0 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.

Step 9. 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.

Step 10. The test probe velocity at the time of the impact shall be 2.07 to 2.13 m/s (6.8 to 7.0 ft/s).

Step 11. Wait at least 30 minutes between successive tests on the same knee.

12.6.6. Performance Specifications

The performance specifications for the knee impact test are listed below in **Table 12.6.6.1**.

Table 12.6.6.1: Knee impact test specifications

Parameters	Specifications
Knee Impact Force	4.9 – 7.3 kN

12.7. Knee Slider Calibration Test

12.7.1. Required Test Parts

The required parts for the knee slider test are the:

- Left and right knee assembly (880995-1515/1516),
- Displacement transducer, and
- Femur load cell (78051-265) or structural replacement (78051-319).

12.7.2. Test Fixture

The test fixture consists of a rigid test probe and a method of rigidly supporting the knee assembly, as shown below in **Figure 12.7.2.1**.

- The test probe mass is 12.0 ± 0.14 kg (26.5 ± 0.3 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 (3.0 ± 0.01 in) 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 below in **Figure 12.7.2.1**.

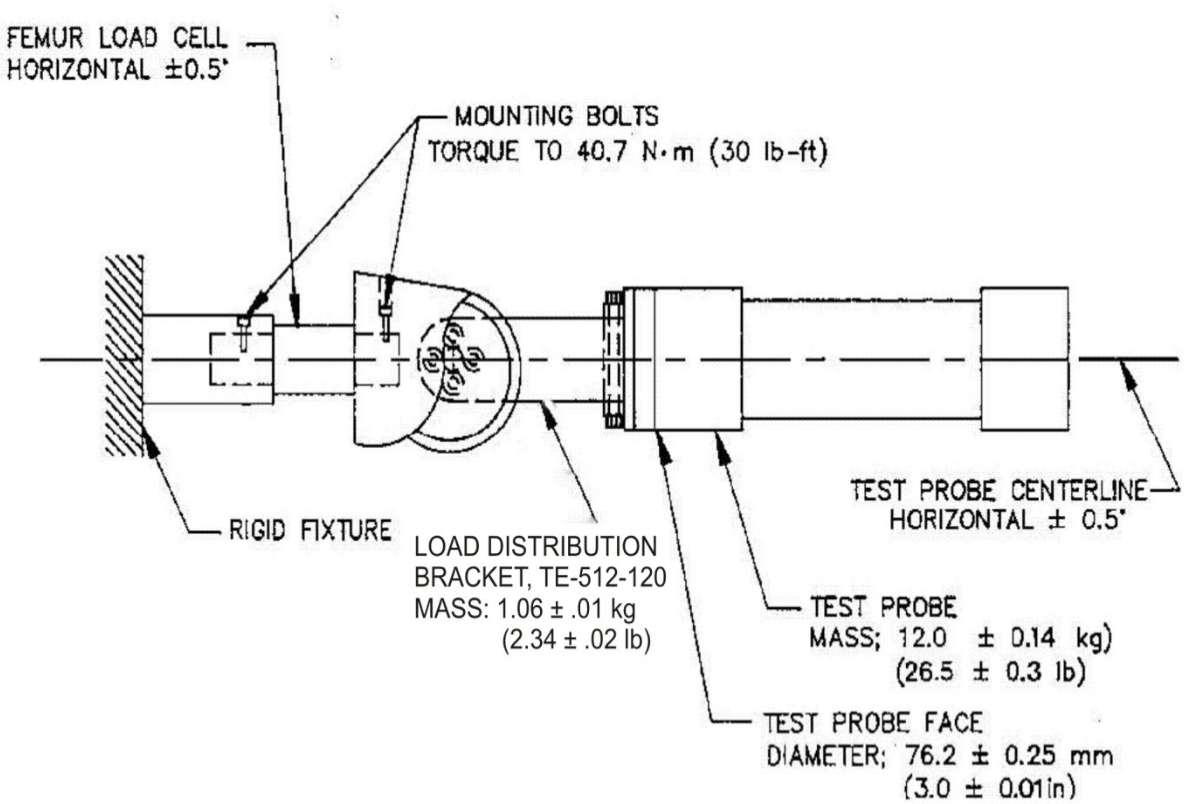


Figure 12.7.2.1: Knee slider test set-up

12.7.3. Data Acquisition

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 filter.

Note:

- Time-zero is defined as the time of initial contact between the test probe and the load distribution bracket.
- All data channels should be at zero level at this time.

12.7.4. Test Procedure

Step 1. Inspect the knee insert and flesh for damage. Pay particular attention to the left and right side assemblies to ensure the ball tracks are clean and free from damage that could affect the operation. Inspect the rubber for separation and the travel stops and ball retainers for damage.

Step 2. Check that all transducers are properly installed, oriented, and calibrated.

Step 3. Mount the knee assembly to the fixture using a femur load cell.

Step 4. Torque the two mounting bolts to 40.7 N·m (30 ft·lbf) to prevent slippage of the assembly.

Step 5. Attach the load distribution bracket to the slider assembly. The bracket is attached to the inboard and outboard slider assemblies in the same manner as the knee clevis.

Step 6. 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°.

Step 7. Guide the probe so there is no significant lateral, vertical or rotational motion occurs at the time of contact between the test probe face and the load distribution bracket.

Step 8. Soak the knee assembly in a controlled environment with a temperature between 18.9 and 25.6°C (66.0 to 78.0 °F) and a relative humidity from 10.0 to 70.0 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.

Step 9. The test probe velocity at the time of impact shall be 2.70 to 2.80 m/s (8.86 to 9.20 ft/s). Allow one breaking test before the calibration test.

Step 10. Wait at least 30 minutes between successive tests on the same knee slider assembly.

12.7.5. Performance Specifications

The performance specifications for the knee impact test are listed below in **Table 12.7.5.1**.

Table 12.7.5.1: Knee slider test specifications

Parameters	Specifications
Maximum Slider Deflection	15.0 - 18.3 mm

Section 13. Design References

13.1. Overview

Design references 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 refer to design references when a part is damaged or replaced.

13.2. Torso Flexion Design Reference

13.2.1. Test Purpose

This procedure tests the forward flexion of the torso of the dummy.

13.2.2. Required Test Parts

The fully assembled dummy with or without the lower leg assemblies below the femur link can be used in this test.

13.2.2.1. Test Fixture

The test fixtures consist of the torso flexion test table, shown below in **Figure 13.2.2.1**, and the torso flexion pull bracket, shown below in **Figure 13.2.2.2**.

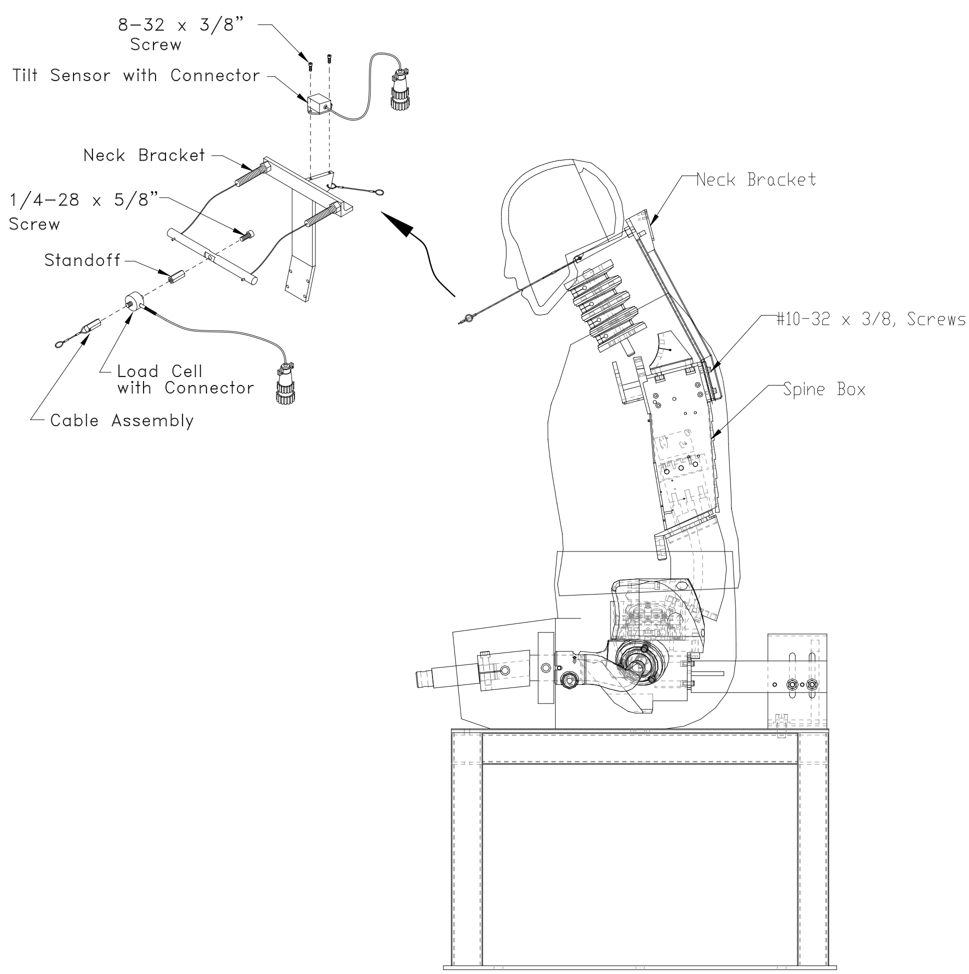


Figure 13.2.2.1: Torso flexion test table

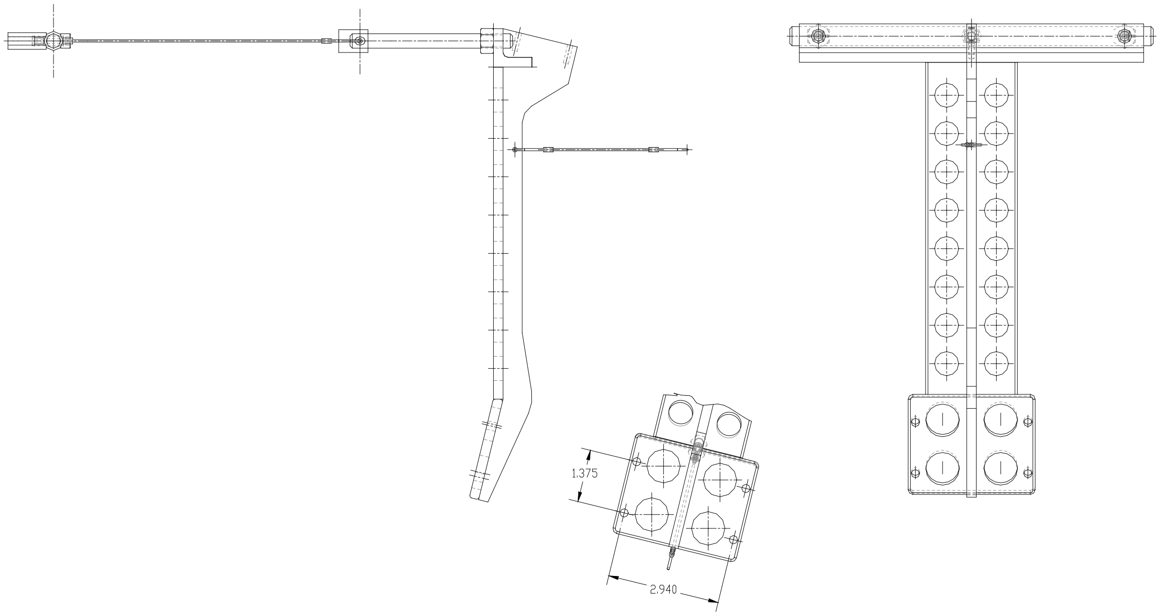


Figure 13.2.2.2: Torso flexion pull bracket

13.2.3. Data Acquisition

The data acquisition system must confirm to the specification of the latest revision of SAE recommended practice J211. Filter the force channel using a class 60 phaseless filter.

13.2.4. Test Procedure

Step 1. Remove the knees and lower legs from the dummy, if needed or desired.

Step 2. Clean and dry all component surfaces.

Step 3. Disassemble the lumbar spine bracket from the pelvis, which will separate the dummy into two sub-assemblies.

Step 4. Adjust the torque on the lumbar cable hex nut to 1.1 - 1.4 N·m (10 - 12 in·lbf).

Step 5. Fasten a pelvic support bracket to the outside of the pelvic instrument cavity with four screws.

Step 6. Reassemble the dummy by attaching the lumbar bracket to the pelvis.

Step 7. Adjust all joint torques to 1 to 2 G's as specified in Appendix C, **sub-Section 2.2, "Joint Resistive Torque Adjustments."**

Step 8. Mount the dummy rigidly onto the torso flexion test table, as shown above in **Figure 13.2.2.1**, using the pelvic support bracket. The pelvic surface to which the lumbar spine mounts must be horizontal ± 2°.

Step 9. 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.

Step 10. Adjust each femur load link to horizontal within +0° / -6°. If the lower legs are attached, rest them on the table surface.

Step 11. Flex the elbow joints to 90º and point the forearms laterally away from the dummy torso to clear the table.

Step 12. Attach the torso flexion pull bracket, which is shown above in **Figure 13.2.2.2**, to the instrument cavity-mating surface at the back of the spine box using four screws.

Step 13. Position the upper torso of the dummy so that the instrument cavity mating surface at the back of the thoracic spine is 0^o to 27^o forward of vertical (initial angle). If the test set up does not result in a 0^o to 27^o initial angle, check the possibility of replacing the lumbar and/or abdomen.

Step 14. Soak the dummy in a controlled environment with a temperature between 20.6 to 22.2°C (69.0 to 72.0 °F) and a relative humidity from 10.0 to 70.0 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.

Step 15. Apply a forward pull force to the pull bracket through a cable attached at the occipital condyle location to flex the dummy forward at a flexion test 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 from vertical.
- Apply the force so that it is perpendicular to the un-deformed neck centerline at 45º (this will be a pull angle of 59º from horizontal).

Step 16. Record the highest force required to flex the dummy to the 45º angle.

Step 17. Wait at least 30 minutes between successive tests on the same components.

13.2.5. Performance Specifications

- The dummy will flex forward to an angle reading of from 44.5 to 45.5º from vertical for a 10 second period as measured on the instrument cavity-mating surface at the back of the thoracic spine.
- The force required to flex the dummy to this angle shall be not less than 475.0 N (107.0 lbf) and not more than 550.0 N (124.0 lbf).
- The dummy's torso shall return to within 12º (return angle) of the initial angle (see Step 13 in the test procedure above).

13.3. Ankle Motion Design Reference

13.3.1. Test Purpose

These tests monitor the range of motion and resistance to motion of the ankle joint in dorsi flexion, plantar flexion, eversion, and inversion.

13.3.2. Required Test Parts

The neck assembly parts required for this test are the:

- Ankle Assembly (B-1889),
- Foot Attachment Bolt (A-1886),
- Molded Foot Left or Right (880995-1600, 1601) and
- Ankle Bumper (78051-610).

13.3.3. Test Fixture

The test device consists of a rigid fixture that will hold the ankle shell.

- Two standoffs are mounted into the foot.
- Attached to each standoff is a plate or bar that will allow a reference for angle measurement and a means for transmitting moment to the ankle joint.
- As shown below in **Figures 13.3.3.1** and **13.3.3.2**, 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 47.7 ± 0.2 mm (1.88 ±0.01 in) above the bottom of the standoff holes.

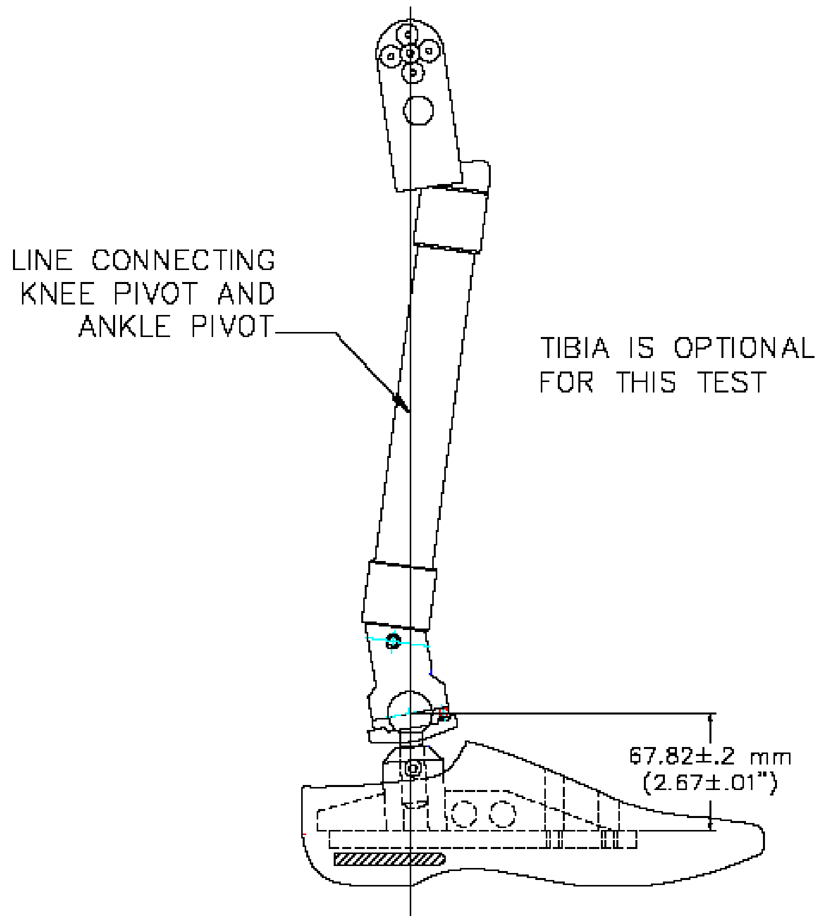


Figure 13.3.3.1: Leg and foot assembly reference planes

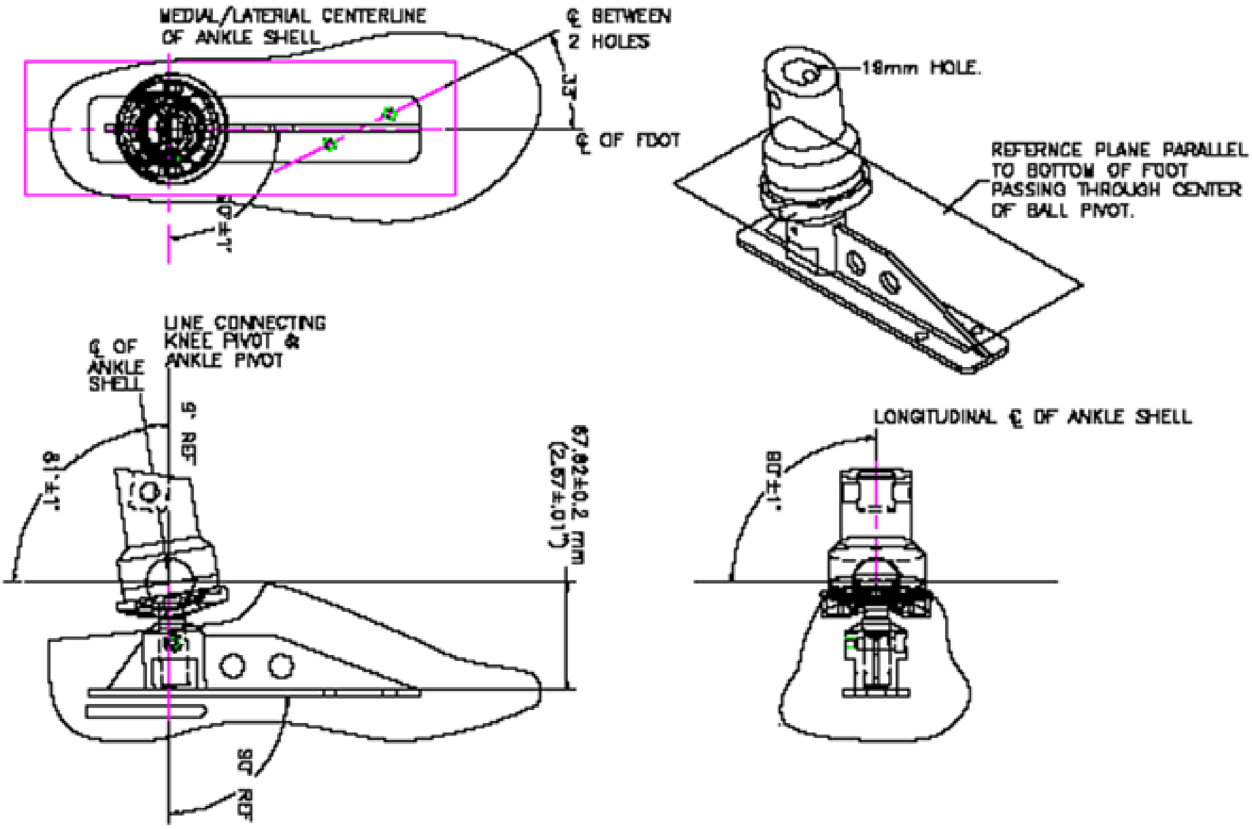


Figure 13.3.3.2: Ankle and foot assembly reference planes

13.3.4. Data Acquisition

The data acquisition system, including transducers, must conform to the requirements of the latest version of SAE Recommended Practice J211.

Note:

- Time zero is defined as the point at which the initial angles meet the requirements specified below in Test Procedure **Step 9**.
- All data channels should be at zero level at this time.

13.3.5. Test Procedure

Note: All of these tests are run with the ankle set screw loose.

Step 1. Inspect the ankle bumper for uneven wear, tears, or other damage. Replace if necessary.

Step 2. Ensure that the ankle bumper is installed correctly, with the front part visibly thicker than the rear part.

Step 3. Adjust the ankle ball joint set screw so it applies no friction to the ball joint.

Step 4. Check for smooth rotation of the ankle shell on the ball. If rotation is not smooth, replace the ankle assembly.

Step 5. Mount the ankle shell to a rigid fixture using the existing 19 mm hole intended for attaching the ankle to the tibia.

Step 6. Insert the standoffs into the foot.

Step 7. Attach a device to the standoffs for applying the moment and providing an angle measurement reference surface.

Step 8. Install the moment and angle transducers.

Note: Angle and moment data should be measured continually throughout all tests.

Step 9. 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 81.0 ± 1.0º. In addition:

- The foot should be adjusted so a lateral/medial line on the ankle reference plane is perpendicular ± 1.0º to the ankle shell longitudinal centerline.
- The medial/lateral centerline of the ankle shell should be perpendicular to the centerline of the foot ± 1.0º (the centerline of the foot is 26.4º from a centerline through the two standoffs.)

Step 10. Soak the ankle assembly in a controlled environment with a temperature between 18.9 and 25.6ºC (66 to 78ºF) 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.

Step 11. Testing should be performed on each ankle joint separately.

Step 12. Wait at least five minutes between successive tests on the same ankle.

Step 13. **For the dorsi flexion test:** Apply a moment through the standoffs that rotates the toe towards the ankle shell and about the ankle's medial/lateral axis until a moment of at least 40 N·m (29.5 lbf·ft) is reached at a rate not to exceed 5º per second.

Step 14. **For the plantar flexion test:** Apply a moment through the standoffs that rotates the toe away from the ankle shell and 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.

Step 15. **For the inversion test:** Apply a moment through the standoffs that rotates the foot inward relative to the ankle shell and 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.

Step 16. For the eversion test: Apply a moment through the standoffs that rotates the foot outward relative to the ankle shell and 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.

13.3.6. Performance Specifications

The performance specifications for the ankle motion tests are listed below in **Table 13.3.6.1**.

Table 13.3.6.1: Ankle motion performance specifications

Test Type	Moment	Angle
Dorsi Flexion *	40.0 N·m (29.5 lbf·ft)	45° ± 2°
Plantar Flexion	4.0 N·m (2.95 lbf·ft)	33° ± 2°
Inversion	4.0 N·m (2.95 lbf·ft)	22° ± 1°
Eversion	4.0 N·m (2.95 lbf·ft)	22° ± 1°

Note: * The moment in dorsi flexion up to 34º must be less then 6N·m (4.42 lbf·ft).

13.4. Foot Design Reference

13.4.1. Required Test Parts

The complete foot assembly (880995-1600 or 880995-1601) is required, including the heel pad foam (78051-608).

13.4.2. Test Fixture

The test fixture consists of a compression testing machine equipped with a load cell and displacement gage, as shown below in **Figure 13.4.2.1**.

- 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.

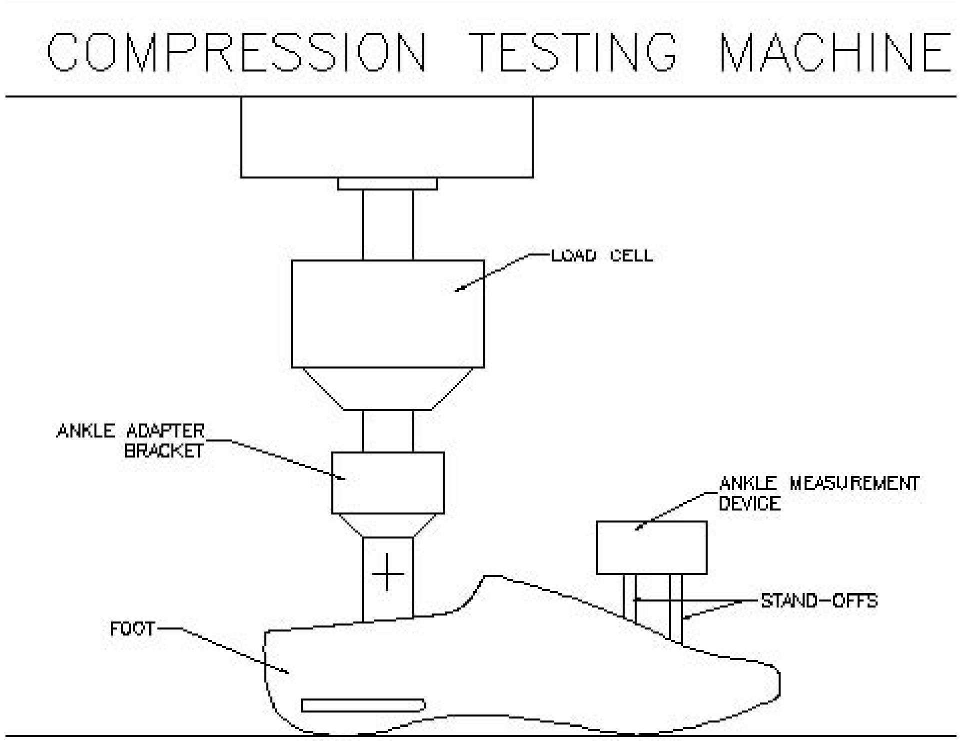


Figure 13.4.2.1: Compression testing machine

13.4.3. Data Acquisition

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.

13.4.4. Test Procedure

Step 1. Inspect the foot assembly for cracks, cuts, and separation of the rubber from the metal segment.

Step 2. Inspect the heel pad foam for signs of deterioration.

Step 3. Attach the standoffs to the foot.

Step 4. Install the ankle adaptor bracket to the foot, and attach it to the compression testing machine.

Step 5. 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.°

Step 6. Soak the foot assembly in a controlled environment at a temperature between 18.9 to 25.6°C (66.0 to 78.0 °F) and a relative humidity from 10.0 to 70.0% for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment.

Step 7. Wait at least 30 minutes between tests on the same foot.

13.4.5. Performance Specifications

The performance specifications for the foot test are listed below in **Figure 13.4.5.1** and **Table 13.4.5.2**.

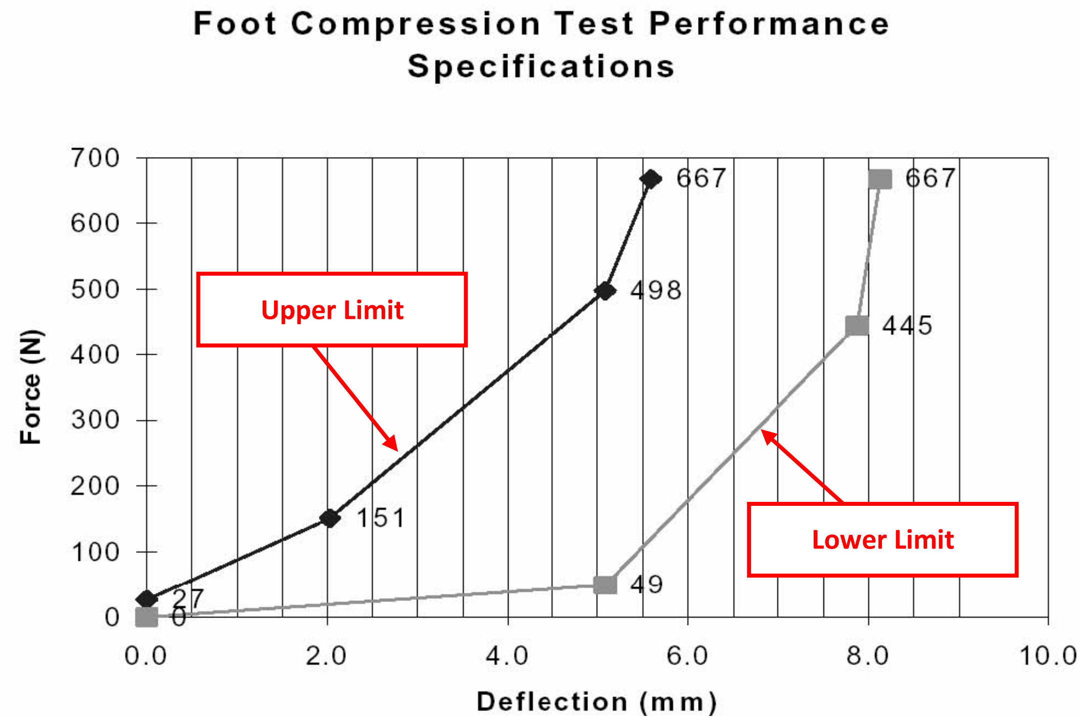


Figure 13.4.5.1: Foot test performance specifications as a graph

Table 13.4.5.2: Foot test performance specifications as a table

Parameters	Specifications
Foot Load	15 ± 1 mm/min (0.59 ± .04 in/min.)
Peak Deflection	8.9 mm (0.35 in.)
Time-zero	4.45 kg (1 lbf)

Section 14. Appendices

14.1. Appendix A: Accelerometer Handling Guidelines

14.1.1. General Information

The accelerometers used in anthropomorphic test dummies, such as the Hybrid III Dummy Family, are small, low mass piezo-resistive 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.

14.1.2. 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:
    a. Read the input impedance (Red to Black) and output impedance (Green to White) with an ohmmeter.
    b. Compare the measured values to those on the accelerometer calibration data sheet.
    c. The measured impedance should be within ± 25% of the calibrated value.
2. Insulation Resistance:
    a. If the input and output impedances are within acceptable limits, use a multimeter, ohmmeter, or megohmmeter set at 50 volts maximum to measure the insulation resistance between:
        - All leads connected together and the cable shield.
        - All leads connected together and the accelerometer case.
        - The cable shield and the transducer case.
    b. All three readings should be at least 100 megohms. Be careful when connecting 50VDC to eliminate the possibility of voltage spikes.
3. Zero Measurand Output:
    a. After the impedance and insulation resistance tests, measure the output of the accelerometer with zero G acceleration.
    b. 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).
    c. Allow the unit to warm-up for two minutes.
    d. Apply the specified excitation voltage to the accelerometer and measure its output with a DC millivolt meter.
    e. The accelerometer should have a Zero Measurand 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.

14.1.3. Accelerometer 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 .8128 m (32 micro inches) 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 at 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.

Note: Excessive torque can create an over-range transient impulse shock 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.

14.1.4. Accelerometer Recalibration

Sensitivity and Zero Measurand 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.

14.1.5. Accelerometer Cleaning

Dirty units may be wiped clean using a damp cloth and a solvent such as acetone.

Note:

- Do not soak or immerse the accelerometer 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.

14.2. Appendix B: Flesh Repair Procedures

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.

A. 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.
   - Do not use soldering flux or any other chemical on the flesh or repair iron.

Note: Conduct all flesh preparations and repairs in a well-ventilated area.

B. 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.

Note: Since isopropyl alcohol is flammable, make sure the surface is dry before applying heat.

C. 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 (0.5 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.

D. 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.

E. 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.

14.3. Appendix C: 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 7kN (1575 lbf).

- No separation should occur.
- Replace as required.

Section 15. Legal Disclaimers and Notices

15.1. Disclaimer

The information in this manual is furnished for informational use only, and is subject to change without notice. Humanetics Innovative Solutions Inc. assumes no responsibility for liability on errors or inaccuracies that may appear in this manual.

15.2. Proprietary Statement

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, photocopying, recording, mechanical, or otherwise, without the expressed written consent of Humanetics Innovative Solutions Inc.

15.3. Notice of Lead Content in Product

The product referred to in this manual may contain lead. A list of components that may contain lead is being maintained on the Humanetics website by ATD (test dummy) type and subcomponents. The list includes items that may currently or in the past have contained or a lead-based alloy. Please refer to www.humaneticsatd.com/Lead_Disclosure for information regarding possible lead content in this product.

15.4. About Humanetics

Humanetics Innovative Solutions Inc. is a global company whose strategy is to harness the best of today's technologies for the creation of high-quality products which play an important role in improving safety, comfort, and protection of people and their environment. Humanetics is the world's leading supplier in the design and manufacture of sophisticated crash test dummies, associated technical support, and laboratory services and load cell crash wall systems. Furthermore, Humanetics develops and supplies finite element software-based dummy models for computerized crash test simulations, and specializes in static and dynamic strain measurements.

For additional information on Humanetics and its products and services, please refer to www.humaneticsatd.com or contact:

Humanetics Innovative Solutions Inc.
47460 Galleon Drive
Plymouth, Michigan 48170 USA
Telephone: 734-451-7878
Fax: 734-451-9549

For information on HITEC products and services, please refer to www.hitecorp.com.

For information on SDI products and services, please refer to www.sendev.com.

Section 16. User Manual Update Log

Table 15.1: User manual update log

Revision Level	Revision Date	Revision Author	Revision Description
A	Nov 2016	M. Tran	Release of updated user manual.