USER MANUAL

Harmonized Hybrid III 50th Male Pedestrian

78051-218-PED-H

Harmonized Hybrid III 50th Male Pedestrian User Manual
78051-9905-H [Rev. A]

HUMANETICS Innovative Solutions


Left View


Front View


Iso View


Right View

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Section 1. Introduction

1.1. Overview

The Hybrid III 50th male pedestrian dummy, shown below in **Figure 1.1.1**, is a modification of the Hybrid III 50th percentile male automotive crash test dummy which was developed by General Motors for use in evaluating automobile interior restraint systems with regard to frontal impact injury potential.

The pedestrian dummy modifications are made in the lower torso and in the legs to equip the dummy to be used in an erect standing position to simulate vehicle pedestrian impact. These modifications give it an erect seated posture, replacing the “driver slouch” of the automotive dummy. Provision is made for a transducer to measure spinal column loading.

Figure 1.1.1: Hybrid III 50th male pedestrian dummy

1.2. Hybrid III 50th Male Pedestrian Development, Features, and Performance Criteria

1.2.1. Use

The dummy is set free standing or supported by a rope or other means in the path of the car. During the vehicle -dummy interaction the dummies head strikes the hood and windshield so that head injury potential may be measured. Lower limb injury may be evaluated by using force and moment gauges. Literature concerning this dummy may be found in STAPP, SAE and by searching the web.

1.2.2. Anthropometry

The Pedestrian Dummy is a 50th percentile dummy that was developed based on the height and weight of the US adult male population.

1.2.3. Design

The dummy design incorporates the ranges of motion, centers of gravity, and body segment weights defined by the Society of Automotive Engineers' anthropometric studies to simulate those of human subjects. Weight and seated height measurements are modified slightly in the pedestrian dummy.

The pedestrian dummy design is based on the Hybrid III 50th male automotive dummy but modified to assume standing posture. Modified parts include:

a. A sit-stand pelvis with separate buttocks,
b. A straight cylindrical lumbar spine,
c. A modified lumbar bracket,
d. An adapter-lumbar to connect the top horizontal surface of the lumbar spine to the bottom angled surface of the spine box,
e. Solid blocks to replace the sliding knees in the legs,
f. A lumbar bracket base which may be replaced by a six-axis transducer covered by a ballast block to increase the weight, and
g. Transducer replacements in the head and the legs that allow a dummy assembly without transducers.

1.2.4. Measurements and Calibration Tests

The following measurements and calibration tests are performed on each dummy:

a. Mass and center of gravity (CG) of each body segment
b. Total dummy mass
c. External dimensions
d. Head drop test
e. Neck pendulum tests (both flexion and extension)
f. Thorax impact test
g. Knee impact tests (both left and right)

1.3. Getting Familiar with the User Manual

1.3.1. Purpose

The *Harmonized Hybrid III 50th Male Pedestrian User Manual* describes the development of the dummy and its use. It contains information required to maintain, store, assemble and disassemble the dummy and perform dimensional measurements and dynamic calibrations. It gives information on the component construction, mass properties, and peripheral equipment required for use of the dummy.

1.3.2. Reference Materials

Appendices - Guidelines and procedures that apply to various parts throughout the dummy are included in **Section 15, “Appendices”**, for easy reference.

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

SAE Documents - In addition to the attached appendices, other SAE publications are particularly useful when working with the Hybrid III 50th male pedestrian dummy.

- **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 and instructions on how to apply the positive right-hand rule sign convention.

Section 2. Dummy Preparation and Use

2.1. General

Humanetics Innovative Solutions' manufacturing and inspection procedures result in high quality machined and molded parts. Procedures include certification of materials, verification of dimensions, and inspection of overall appearance of finished components.

Every newly purchased harmonized Hybrid III 50th male pedestrian dummy should be completely disassembled and compared against the latest engineering drawing package. Pay particular attention to parts critical to the performance of the dummy qualification tests. The following procedures will help verify that the newly purchased dummy conforms to the engineering drawing package. These procedures will also provide the basis to validate the dynamic component responses of the dummy.

2.2. Hardware and Construction

This sub-section describes and discusses each of the major Hybrid III 50th male pedestrian dummy assemblies.

2.2.1. Head

The dummy uses a Hybrid III head which consists of a one-piece anthropomorphic aluminum skull and one-piece aluminum cap, each covered by vinyl skin. The parts separate to allow access for instrumentation.

2.2.2. Neck

A Hybrid III automotive neck is used. It is a rubber and aluminum segmented molding, having anthropomorphic angle versus moment response in dynamic flexion (forward bending) and extension (rearward bending). A cable through the axis of the neck limits stretching, controls response and increases durability. The neck attaches to the head through an aluminum nodding joint, rubber nodding blocks, and a stainless steel condyle pin. It attaches to the upper torso using automotive dummy two-piece adjustable aluminum neck brackets.

2.2.3. Upper Torso

The Hybrid III upper torso is used. It has a welded steel spine box containing an adapter to hold accelerometers and a chest deflection transducer. The ribs are fabricated of spring steel with composite damping material bonded on to absorb energy. The shoulders are two-piece aluminum castings. Shoulder yokes for attachment of the arms are high-tensile steel. The chest flesh is made from vinyl skin over urethane foam flesh. The lumbar spine is a rubber cylinder with steel plates bonded to each end. It connects to the spine box and to the pelvis through an upper angled adapter, a lower cylindrical adapter and ballast which can mount a 6-axis force and moment transducer.

2.2.4. Pelvis

The pelvis consists of vinyl skin and urethane foam over a machined aluminum casting. The left and right buttock sections of the pelvis are not molded with the pelvis. The separate left and right buttocks are molded from vinyl skin over urethane foam. This construction allows the dummy to assume a standing position for pedestrian use. It also allows rotation to the seated position. Cast femurs with femur balls working in concave sockets are attached to the pelvic bone to allow hip rotation and attach to the upper legs.

2.2.5. Legs

The dummy uses Hybrid III automotive legs with the exception of the knee slider assemblies which are replaced by rigid steel blocks allowing rotation but no sliding. The legs are steel bones covered by vinyl skin and urethane foam which may be removed from the upper legs, knees and lower legs. The knees are vinyl skin and urethane foam over rubber inserts mounted on aluminum knee caps. The dummy has ball joint ankles. The feet are solid vinyl over steel bones.

2.2.6. Arms

The arms are Hybrid III 50th male automotive dummy arms having steel bones with vinyl skin over urethane foam. The hands are solid vinyl over steel bones.

2.3. Recommended Tools

The following tools are recommended to assemble, disassemble and calibrate the Hybrid III 50th male pedestrian dummy. For information concerning tool availability, contact Humanetics Innovative Solutions, Inc.

- Neck compression tool
- Ball hex wrench set
- Lumbar cable nut wrench
- Head skin thickness gauge
- Chest depth gauge
- Clavicle washer alignment tool

2.4. Fasteners

2.4.1. Types and 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

2.5. Disassembling the Body Assemblies

The process of disassembling the various dummy sub-assemblies and components is explained in detail within the major sections for each body segment assembly.

2.6. Reassembling the Body Assemblies

Reassembling the various dummy sub-assemblies and components is just a reversal of the disassembly process. Remarks within the sections for each assembly are confined to special considerations that are unique to that assembly.

2.7. Joint Resistive Torque Adjustments

The joints of the Hybrid III dummies are adjusted to a “1 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 1.0 G setting.

2.7.1. Hands and Arms

Refer to **Figure 2.7.1.1** while completing the steps below.

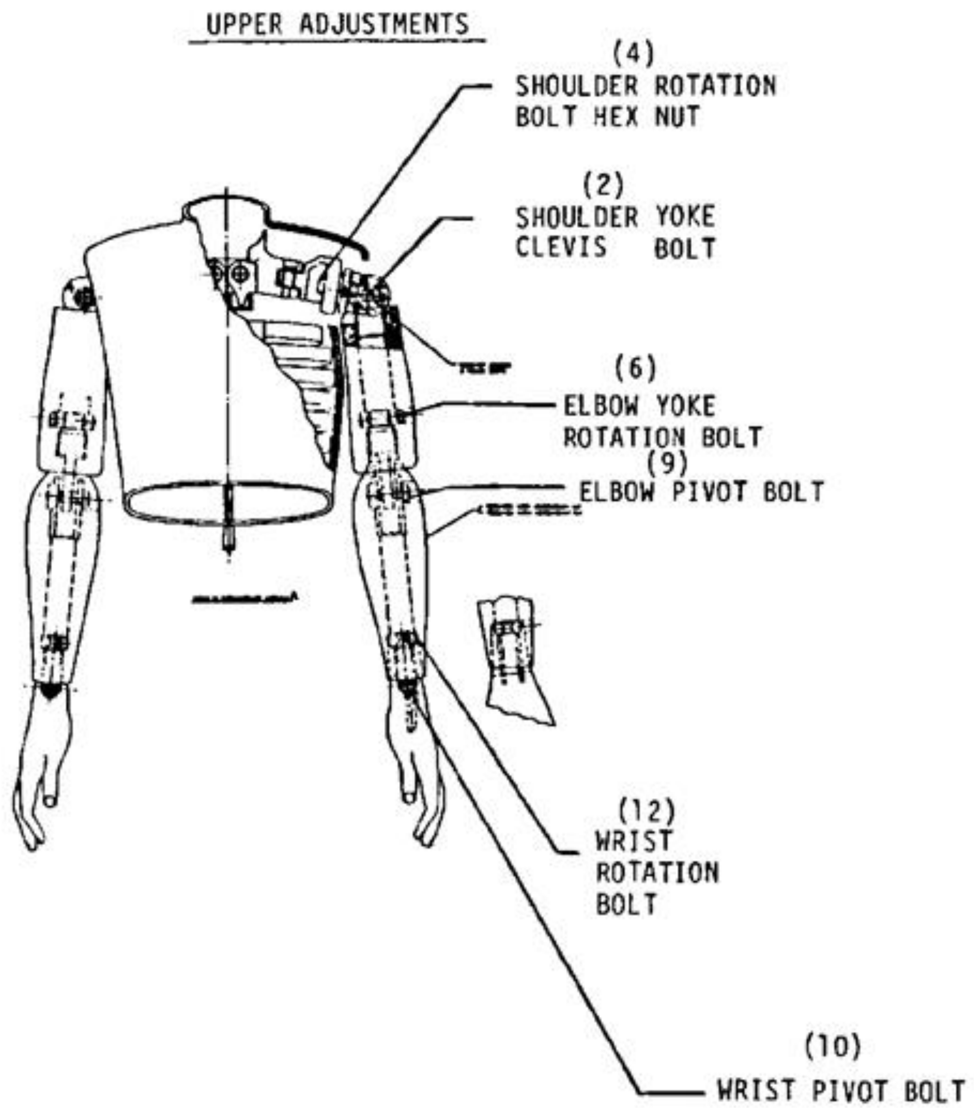

Figure 2.7.1.1: Hybrid III hand and arm joints requiring adjustment

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 1.0 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 1 G.

Step 3. Bend the elbow 90 degrees 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 1 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 1 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 1 G.

Step 7. Adjust the wrist rotation bolt through access in the wrist flesh to suspend it at 1 G.

Step 8. Repeat this procedure for the other hand and arm.

2.7.2. Legs and Feet

Refer to **Figure 2.7.2.1** while completing the steps below.

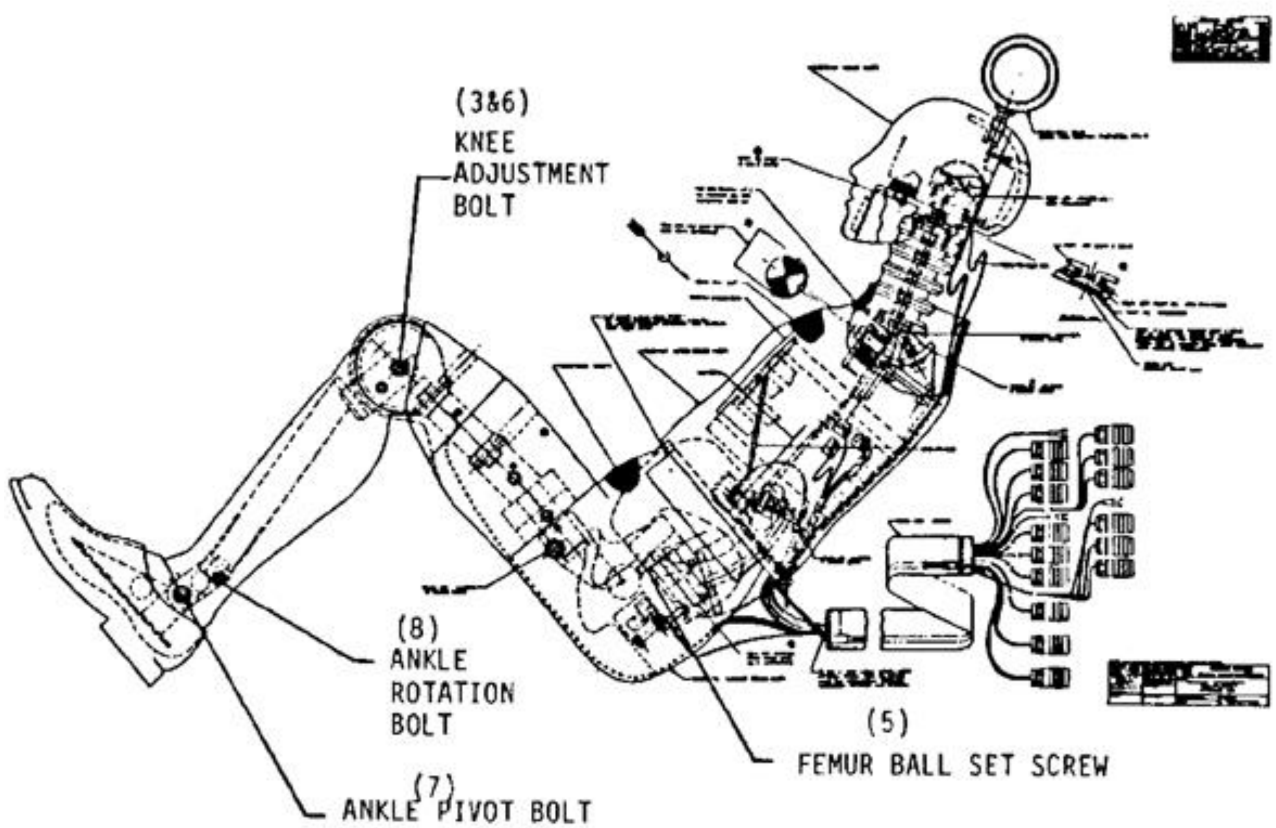

Figure 2.7.2.1: Hybrid III leg and feet joints requiring adjustment

Step 1. Remove the abdominal insert.

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

Step 3. Adjust the femur ball set screw so the upper leg is held suspended at 1 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 1 G.

Step 6. Adjust the ankle ball joint set screw so the foot is held suspended at 1 G (The ankle adjustment is not critical and is determined by individual feel).

Step 7. Repeat this procedure for the other foot and leg.

Section 3. External Measurement Procedure

3.1. External Measurement Procedure

Complete and record the following physical measurements in preparation for conducting any calibration tests.

Step 1. Remove the dummy's chest flesh and abdominal insert.

Step 2. Place the dummy on a flat, rigid, smooth, clean, dry, horizontal surface as shown in Figure 2.8.1.1 below.

- The seating surface must be at least 406 mm (16 in) wide and 406 mm (16 in) deep, with a vertical section at least 406 mm (16\ in) wide and 914 mm (36 in) high attached to the rear of the seating fixture.
- The dummy's midsagittal plane is vertical and centered on the test surface.

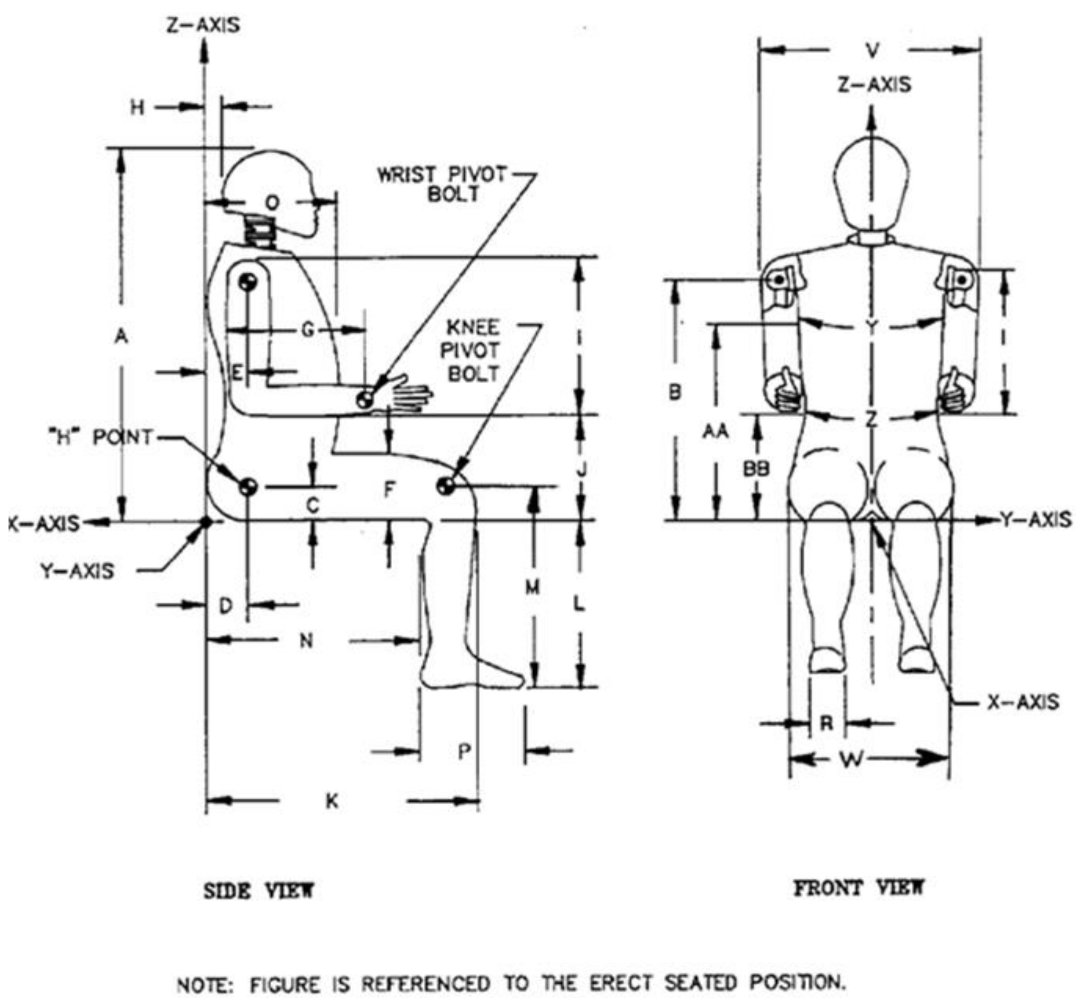

Figure 2.8.1.1: External dimensions setup specification

Step 3. Remove the four socket head cap screws which attach the lumbar spine to the thoracic spine. Torque the lumbar cable to compress the cylindrical lumbar spine to a length of 5.15 inches.

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

Step 4. Reassemble the lumbar spine to the thoracic spine.

Step 5. Secure the dummy to the test fixture so the rear surfaces of the upper thorax and buttocks are tangent to the rear vertical surface of the fixture (or as near tangent as possible). The dummy's midsagittal plane should be vertical.

Step 6. Secure the upper thorax to hold the dummy in position. Extend the neck to position the dummy's head so the occiput is 43.2 mm (1.7 in) ± 2.5 mm (0.1 in) forward of the test fixture's rear vertical surface. Secure the head in this position.

Step 7. 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 8. Position the feet parallel to the dummy's midsagittal plane, with the bottoms horizontal and parallel to the seating surface.

Step 9. 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 10. Position the lower arms horizontally so that the centerline between the elbow and wrist pivots is parallel to the seat surface.

Step 11. Record the following external dimensions. The letter designation for each dimension is indicated in **Figure 2.8.1.1** above. These letter designations also correspond to the specifications listed in **Table 2.8.1.2** below.

A. Total Sitting Height: From the seat surface to highest point on top of the head.
B. Shoulder Pivot Height: From the centerline of shoulder pivot bolt to the seat surface.
C. H-Point Height: From above seat surface (reference).
D. H-Point from Backline: From the seat rear vertical surface (reference).
E. Shoulder Pivot from Backline: From the center of the shoulder clevis to the rear vertical surface of the fixture.
F. Thigh Clearance: From the seat surface to highest point on the upper femur segment.
G. Back of Elbow to Wrist Pivot: From the back of the elbow flesh to the wrist pivot bolt.
H. Head Back (Skull Cap Skin) from Backline: To the seat rear vertical surface (reference).
I. Shoulder to Elbow Length: From 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: From the flesh below the elbow pivot bolt to the seat surface.
K. Buttock to Knee Length: From the most forward surface of the knee flesh to the rear surface of the buttocks, in line with the knee pivot and hip pivot.
L. Popliteal Height: From the seat surface to the horizontal plane at the bottom of the feet.
M. Knee Pivot Height: From the knee pivot to the horizontal plane of the bottom of the feet.

N. Buttock Popliteal Length: From the rearmost surface of the lower leg to the rear surface of the buttocks.

O. Chest depth without chest flesh: Measure at top of the third rib.

P. Foot Length: From tip of toe to rear of heel.

R. Foot Breadth: The widest part of the foot.

V. Shoulder Breadth: Between outside edges of shoulder clevises, in line with the shoulder pivot bolt.

W. Hip Breadth: The width of the hips at the H-Point.

Y. Chest Circumference: Measured 431.8 mm (17 in) above the seat surface (AA), approximately at the top of the 5th rib.

Z. Waist Circumference - Measured 228.6 mm (9 in) above the seat surface (BB).

AA. Reference location for Chest Circumference (Y).

BB. Reference location for Waist Circumference (Z).

Step 12. Reinstall the chest flesh and abdominal insert.

Step 13. Reposition the dummy on the test fixture.

Note: You do not need to level the head as specified for the previous measurements.

Step 14. Mark the locations and record the chest and waist circumference dimensions (Items "Y" and "Z", respectively, in **Figure 2.8.1.1** above).

Step 15. **Table 2.8.1.2** below summarizes the descriptions, specifications, and tolerances for each of the external dimensions listed and shown above in **Figure 2.8.1.1**. Compare the measured external dimensions to the specified external dimensions in **Table 2.8.1.2** below to determine the conformance to specifications.

Table 2.8.1.2: External dimension descriptions, specifications, and tolerances

Test Parameter	Designation	in	mm
Total Sitting Height	A	35.1 ±0.3	892 ±8
Shoulder Pivot Height	B	20.5 ±0.3	521 ±8
H-Point Height (ref.)	C	3.4 ±0.1	86.4 ±2.5
H-Point from Seat Back (ref.)	D	5.4 ±0.1	137.2 ±2.5
Shoulder Pivot from Backline	E	3.5 ±0.2	88.9 ±5.1
Thigh Clearance	F	5.8 ±0.3	147.3 ±7.6
Back of Elbow to Wrist pivot	G	11.7 ±0.3	297.2 ±7.6
Skull Cap to Backline	H	1.7 ±0.1	43.2 ±2.5
Shoulder to Elbow Length	I	13.3 ±0.3	337.8 ±7.6

Test Parameter	Designation	in	mm
Elbow Rest Height	J	7.9 ±0.4	200.7 ±10.2
Buttock to Knee Length	K	23.3 ±0.5	591.8 ±12.7
Popliteal Height	L	17.4 ±0.5	442.0 ±12.7
Knee Pivot to Floor Height	M	19.4 ±0.3	492.8 ±7.6
Buttock Popliteal Length	N	18.3 ±0.5	464.8 ±12.7
Chest Depth	O	8.7 ±0.3	221.0 ±7.6
Foot Length	P	10.2 ±0.3	259.1 ±7.6
Foot Width	R	3.9 ±0.3	99.1 ±7.6
Shoulder Width	V	16.9 ±0.3	429.3 ±7.6
Hip Width at H-Point	W	14.3 ±0.3	363.2 ±7.6
Chest Circumference	Y	38.8 ±0.6	985.5 ±15.2
Waist Circumference	Z	33.5 ±0.6	850.9 ±15.2
Reference Location for Chest Circumference (ref.)	AA	17.0 ±0.1	431.8 ±2.5
Reference Location for Waist Circumference (ref.)	BB	9.0 ±0.1	228.6 ±2.5

Section 4. Mass Measurements

4.1. Summary of Mass Specifications

Table 4.1.1 below summarizes the specified assembly mass for the different segment assemblies. Measure and record the mass of the various dummy segment assemblies on initial inspection and in preparation for conducting any calibration tests, and confirm that they meet the assembly mass specified in **Table 4.1.1**.

Table 4.1.1: Table of body segment assembly masses

ASSEMBLY	MASS	
	lb	kg
Head Assembly	10.00 ±0.10	4.54 ±0.05
Neck Assembly	3.40 ±0.10	1.54 ±0.05
Upper Torso Assembly with Chest Flesh (includes from lower neck bracket to bottom of spine box)	37.90 ±0.30	17.19 ±0.14
Lower Torso Assembly (includes femurs and lower lumbar adapting plate)	51.70 ±0.30	23.45 ±0.14
Upper Leg Assembly, Left	13.10 ±0.20	5.94 ±0.09
Upper Leg Assembly, Right	13.10 ±0.20	5.94 ±0.09
Lower Leg Assembly, Left (includes foot)	12.50 ±0.40	5.66 ±0.18
Lower Leg Assembly, Right (includes foot)	12.50 ±0.40	5.66 ±0.18
Upper Arm Assembly, Left	4.40 ±0.1.0	2.00 ±0.05
Upper Arm Assembly, Right	4.40 ±0.10	2.00 ±0.05
Lower Arm/Hand Assembly, Left	5.00 ±0.20	2.27 ±0.09
Lower Arm/Hand Assembly, Right	5.00 ±0.20	2.27 ±0.09
Total Dummy Mass	173.00 ±5.30	78.50 ±2.40

Note: After replacing any parts, accelerometers, or other hardware, **always** recheck the mass of the pertinent segment.

4.2. Summary of Body Segment Centers of Gravity

The center of gravity for each of the dummy's body segments is listed on drawing number 78051-338, sheets 1 and 2. Origins and axis locations are shown on the assembly drawing for each component. For convenience and increased clarity, **Table 4.2.1** below summarizes the center of gravity information. The upper and lower torso values, leg, and foot values are modified in the pedestrian dummy.

Table 4.2.1: Table of body segment assembly centers of gravity

Center of Gravity						
Segment	Axis	Location		Tolerance		Reference
		(mm)	(in)	(mm)	(in)	
Head	X	63.5	2.50	±2.5	±0.10	Interface surface between skull and skull cap
	Y					Midsagittal plane
	Z	35.6	1.40	±2.5	±0.10	Bottom surface of skull
Neck & Upper Neck Bracket	X	-5.1	-0.20	±2.5	±0.10	CL of hole in UNB for neck cable
	Y					CL of hole in UNB for neck cable
	Z	50.8	2.00	±2.5	±0.10	Top surface of the UNB which contacts the bib simulator
Upper Torso	X	94.0	3.70	±5.1	±0.20	Rear surface of spine box upper back plate (78051-187)
	Y					Midsagittal plane
	Z	-50.8	-2.00	±5.1	±0.20	CL of bottom holes on spine box upper back plate (78051-187)
Lower Torso	X	N/A	N/A	N/A	N/A	Line connecting centers of two front lumbar to pelvic adapter mounting holes in the pelvic bone
	Y					Midsagittal plane
	Z	N/A	N/A	N/A	N/A	Top surface of the pelvic bone where the lumbar to pelvic adapter attaches
Upper Arm *Left & Right	X	-1.5	-0.06	±5.1	±0.20	Line connecting the shoulder pivot point and elbow pivot point
	Y					Line connecting the shoulder pivot point & elbow pivot point
	Z	-132.1	-5.20	±5.1	±0.20	Shoulder pivot point
Lower Arm	X	87.9	3.46	±5.1	±0.20	Elbow pivot point

Center of Gravity Segment	Axis	Location (mm)	(in)	Tolerance (mm)	(in)	Reference
*Left & Right	Y					Line connecting elbow pivot point and wrist pivot point
	Z	-5.3	-0.21	±5.1	±0.20	Line connecting elbow pivot point and wrist pivot point
Hand Left & Right	X	57.2	2.25	±5.1	±0.20	Center of wrist pivot
	Y					Center of wrist pivot
	Z	-1.5	-0.06	±5.1	±0.20	Midpoint between the two sides of the wrist clevis
Upper Leg Left & Right	X	159.0	-6.26	±5.1	±0.20	Knee pivot point
	Y					Line passing through knee pivot point passing 0.935 inches below centerline of upper leg bone and parallel to midsagittal plane
	Z	19.3	0.76	±5.1	±0.20	Line passing through knee pivot point passing 0.935 inches below centerline of upper leg bone and parallel to midsagittal plane
Lower Leg *Left & Right	X	1.0	0.04	±5.1	±0.20	Line connecting knee pivot and ankle pivot
	Y					Line connecting knee pivot and ankle pivot
	Z	-193.0	-7.59	±5.1	±0.20	Knee pivot point
Foot Left & Right	X	54.1	2.13	±5.1	±0.20	Center of ankle pivot
	Y					Center of ankle pivot
	Z	-46.7	-1.84	±5.1	±0.20	Center of ankle pivot

NOTE: Left and Right are interchangeable.

Section 5. Top Level Dummy Assembly

5.1. Top Level Assembly

5.1.1. Exploded View

An exploded view of the top level dummy assembly (78051-218-PED) is shown below.

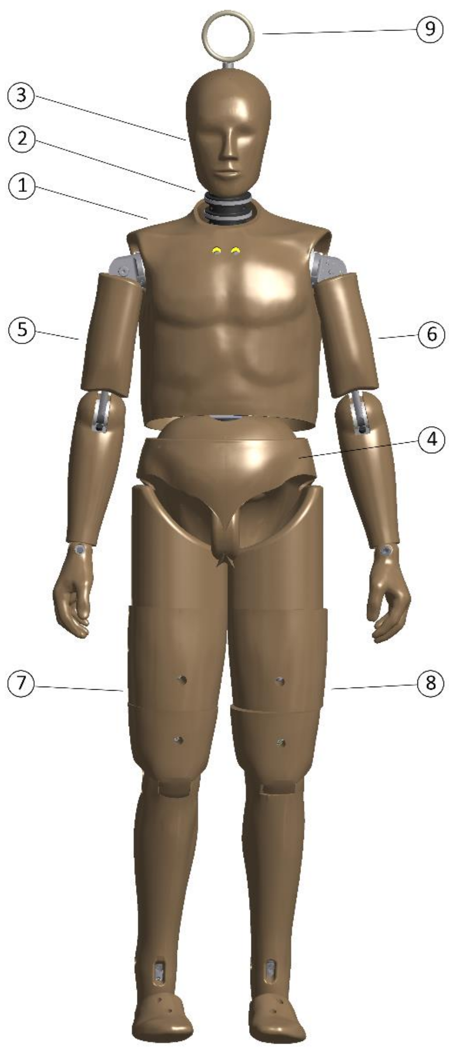

Figure 5.1.1.1: Top level assembly exploded view

5.1.2. Parts List

The table below gives a general description of each item in the top level assembly (refer to top level assembly drawing 78051-218-PED).

Table 5.1.2.1: Top level assembly parts list

Item	Quantity	Part Number	Description
1	1	78051-89	Upper Torso Assembly
2	1	78051-90	Neck Assembly
3	1	78051-61X	Head Assembly
4	1	78051-70P	Lower Torso, 50th Pedestrian
5	1	78051-123	Left Arm Assembly
6	1	78051-124	Right Arm Assembly
7	1	86-5001-001P	Leg Assembly, Pedestrian, Left
8	1	86-5001-002P	Leg Assembly, Pedestrian, Right
9	1	78051-231	Lifting Ring

Section 6. Head and Neck Assembly

6.1. Head Assembly

6.1.1. Exploded View

An exploded view of the head assembly (78051-61X) is shown below in **Figure 6.1.1.1**.

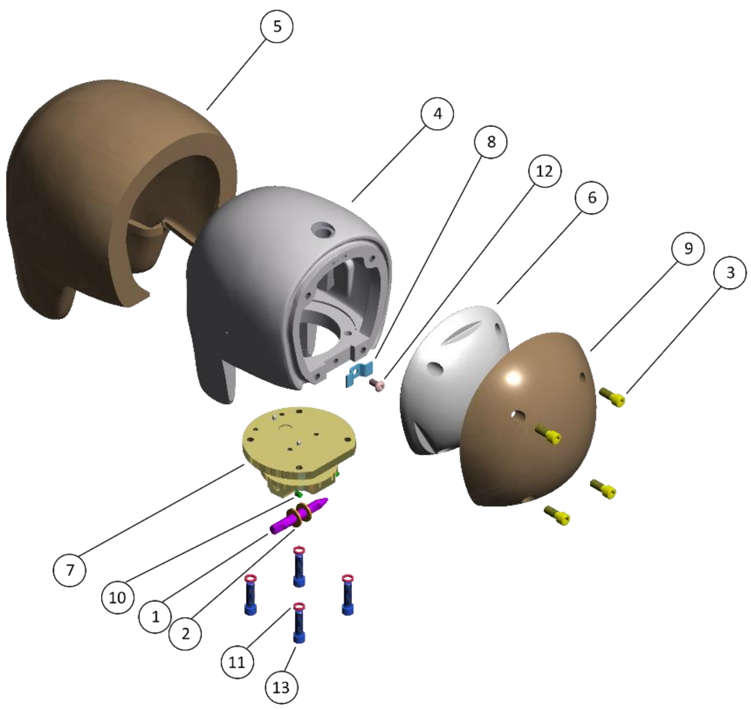

Figure 6.1.1.1: Head assembly exploded view

6.1.2. Parts List

Table 6.1.2.1 below gives a general description of each item in the head assembly (refer to head assembly drawing 78051-61X.

Table 6.1.2.1: Head assembly parts list

Item	Quantity	Part Number	Description
1	1	1717	Pivot Pin, Neck
2	2	78051-253	Washer, Nodding Joint
3	4	9000005	Screw, SHCS 1/4-20 x 5/8 LG. Nylok®
4	1	78051-77X	Skull, Machined, Six-Axis Neck
5	1	78051-228	Head Skin
6	1	78051-220	Skull Cap

Item	Quantity	Part Number	Description
7	1	78051-383X	Neck Transducer Assembly
8	1	83-5006-001	Skull Cable Clip
9	1	78051-229	Cap Skin, Molded
10	2	9000452	Screw, SSSCP #8-32 X 1/4 LG.
11	4	9000677	Shoulder Screw Shim, 1/4 X 1/16 Thick
12	1	9000538	Screw, BHCS #10-32 X 3/8 LG.
13	4	9000264	Screw, SHCS 1/4-28 X 7/8 LG.

6.2. Neck Assembly

6.2.1. Exploded View

An exploded view of the neck assembly (78051-90) is shown below in **Figure 6.2.1.1**.

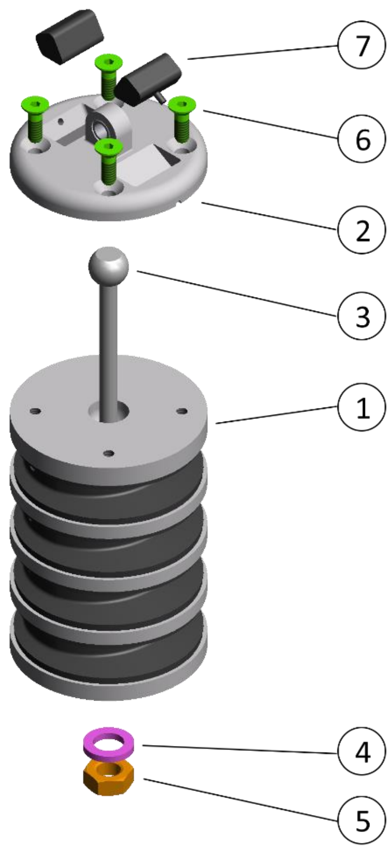

Figure 6.2.1.1: Neck assembly exploded view

6.2.2. Parts List

Table 6.2.2.1 below gives a general description of each item in the neck assembly (refer to neck assembly drawing 78051-90.

Table 6.2.2.1: Neck assembly parts list

Item	Quantity	Part Number	Description
1	1	78051-336	Molded Neck Assembly
2	1	78051-297	Nodding Joint, Neck
3	1	78051-301	Cable - Neck
4	1	9008007	Washer, Flat 0.515 ID X 0.875 OD
5	1	9000018	Nut, Jam 12-20
6	4	9000447	Screw, FHCS ¼-20 X 3/4
7	2	78051-351-8550	Nodding Blocks*

***Note:** The nodding blocks are included and tested with the molded neck assembly, and must be kept with it to ensure proper calibration.

6.2.3. Disassembling the Neck

Step 1. Remove the chest flesh to permit easier access to the base of the neck bracket.

Step 2. Remove the 3/8-16 X 1 SHCS and washer that hold the upper neck bracket to the lower portion neck bracket and permit adjustment of the neck angle, as shown below in **Figure 6.2.3.1**.

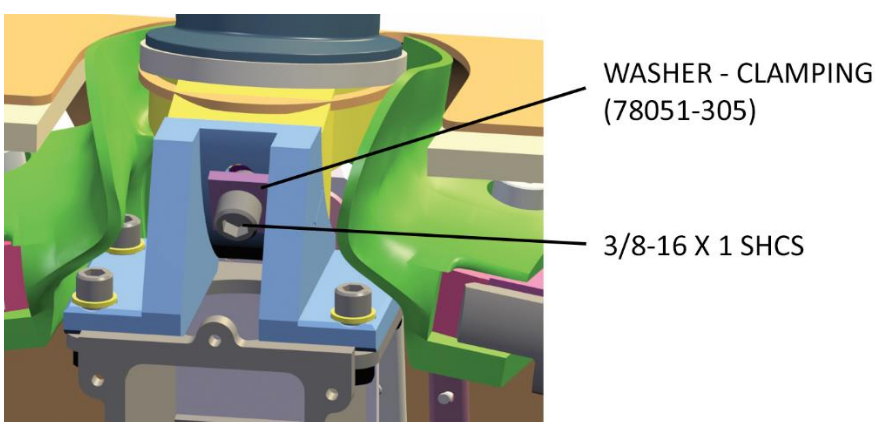

Figure 6.2.3.1: Neck angle adjustment screw and washer

Step 3. Check the condition of the curved steel washer, 78051-305 and note how it fits on the neck bracket.

Step 4. Tilt the head and neck forward and remove the neck cable nut and four 1/4-20 x 5/8" socket head cap screws that hold the upper neck bracket to the base of the neck, as shown in **Figure 6.2.3.2**.

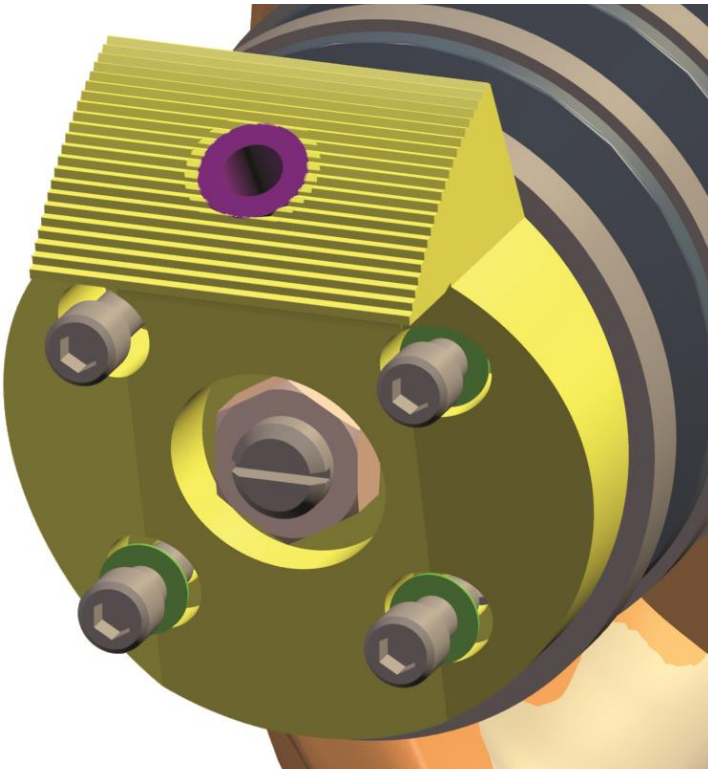

Figure 6.2.3.2: Neck to upper neck bracket attachment

Step 5. If they are missing, install steel washers between these four socket head cap screws and upper neck bracket during reassembly. The neck and head assembly is now disconnected from the plastic sternum-to-rib cage bib assembly.

Step 6. To separate the head and neck use the neck compression tool, shown below in **Figure 6.2.3.3**, to compress the nodding blocks.

Figure 6.2.3.3: Neck compression tool

Step 7. Loosen the set screw in the bottom of the three-axis neck transducer replacement or those in the back of the six-axis neck transducer replacement.

Step 8. Slide the pivot pin out.

Step 9. Separate the nodding joint from the neck.

Note: Do not lose the nodding blocks or the brass washers.

Step 10. Remove four 1/4-20 x 5/8” cap screws from the rear skull cap.

Step 11. For the three-axis neck transducer or its structural replacement, remove the three 1/4-20 x 3/4” socket head cap screws beneath the skull.

Step 12. Separate the head from the transducer or its structural replacement.

Note: Do not stress the neck transducer cable.

Step 13. Loosen the two #10-32 x 1/4 inch long set screws and reinstall the transducer to the head.

Step 14. Reinstall the washers.

Step 15. Insert the neck nodding block lug into the transducer replacement between the washers.

Step 16. Fasten the neck compression tool, shown above in **Figure 6.2.3.3**, to the back of the skull.

Step 17. Slip the round end of the tool over the cable and turn the knob until the neck is just being compressed, as shown below in **Figure 6.2.3.4**.

Figure 6.2.3.4: Neck compression tool installed on head and neck assembly

Step 18. Insert the pivot pin, align its flats with the set screws, and then tighten the set screws.

Step 19. For the six-channel neck transducer or its structural replacement, loosen two small 8-32 x 1/4” socket head set screws, as shown in **Figure 6.2.3.5**, which secure the head-to-neck pivot pin, as shown in **Figure 6.2.3.6**.

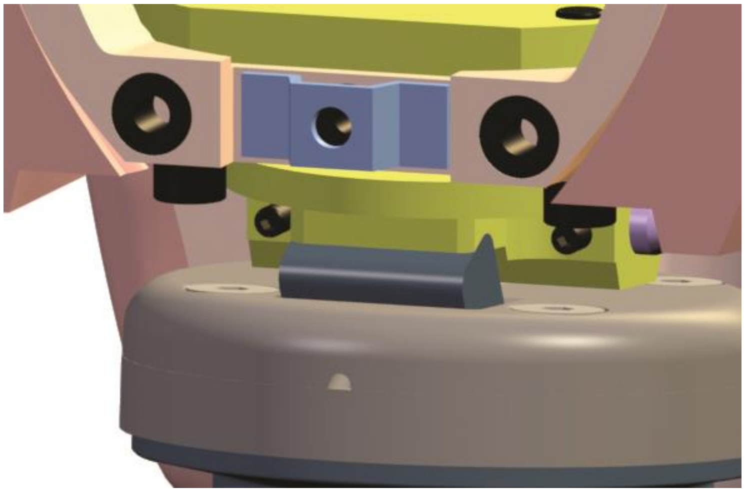

Figure 6.2.3.5: Neck pivot pin set screw

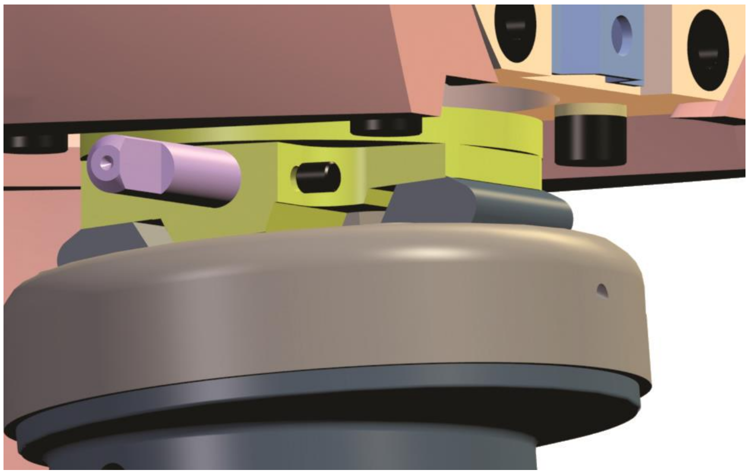

Figure 6.2.3.6: Installing the neck pivot pin

Step 20. Slowly increase the compression on the neck until the pivot pin can be pushed or lightly tapped out with a minimum of effort with either transducer.

Note: Be careful not to drop the neck pivot pin washers (PN 1717) which will become loose when the pin is removed.

Step 21. Remove the nodding joint and disassemble the neck. The rubber sections of the neck are permanently bonded to the aluminum spacers and cannot be disassembled.

Step 22. Check the two rubber neck nodding blocks shown in **Figure 6.2.3.7** on the top of the nodding joint. The blocks must conform to the drawing, which specifies a durometer between 80-90 Shore A. The 90° surfaces of the nodding blocks fit opposite, rather than inside, the 90° grooves of the head-to neck adaptor bracket. A drawing of the nodding block orientation appears below in **Figure 6.2.3.8**.

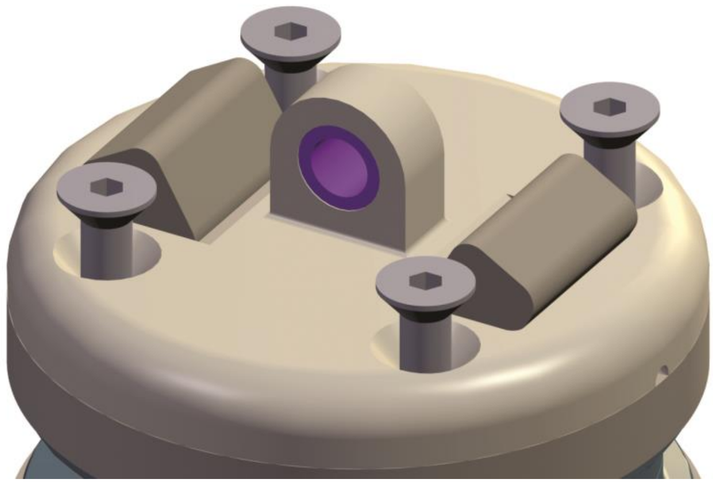

Figure 6.2.3.7: Rubber neck nodding blocks on nodding joint

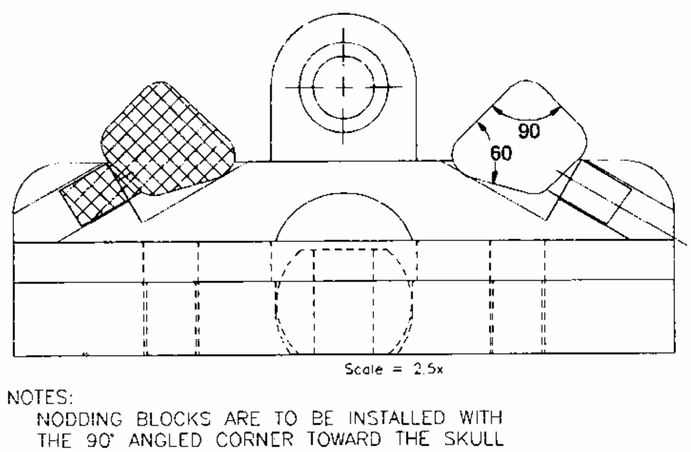

Figure 6.2.3.8: Nodding block orientation

Step 23. 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.

Step 24. Remove the lower portion of the neck bracket. A steel washer under each of the cap screws helps to protect the aluminum from being galled by the steel screws. 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 is allowed to occur. Replace damaged or questionable parts and materials as required.

Step 25. Assemble the two sections of the neck bracket with the adjustment set to 0° and measure the bracket angle. The angle should be 13° 45' ± 30' relative to the bottom surface of the lower neck bracket.

Step 26. When using either optional neck transducer (three or six channel), the lug on the nodding joint must fit very tightly in the slot in the bottom of the neck load cell, as shown in **Figure 6.2.3.9**. The tightness is controlled by a brass washer on each side of the yoke. These washers must be lapped to produce a 0.000 to 0.025 mm (0.000 to 0.001 in) interference fit at assembly. Because the inside diameter of these washers is also critical, validate this dimension against drawing number 78051-253.

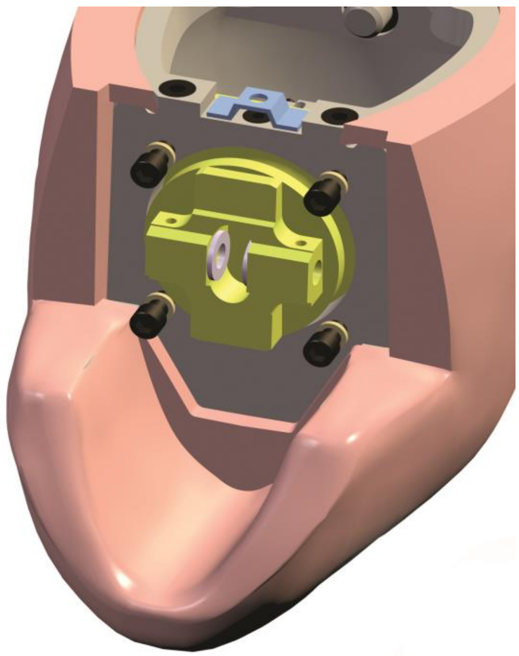

Figure 6.2.3.9: Neck load cell pivot joint and screws

Step 27. In separating the six-channel load cell from the head, remove the four 1/4 X 28-7/8" long cap screws from the bottom, as shown below in **Figure 6.2.3.10**. Special 1/4 ID x 3/8 OD x 1/16" washers are provided and must be used under the load cell attachment bolts. Larger washers will interfere with load cell operation. The use of ball hex wrenches is recommended.

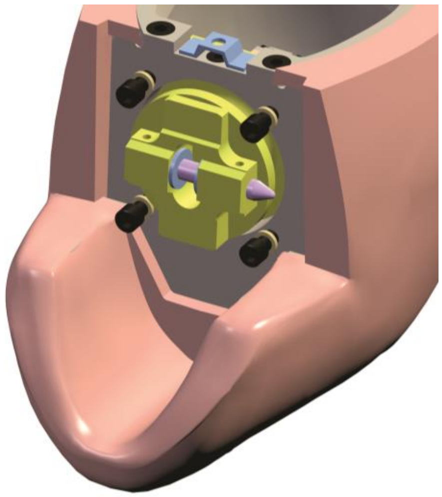

Figure 6.2.3.10: Special washers for six channel neck transducer

Step 28. Remove the skin from the skull and skull cap and check for tears and general quality. Inspect the skull for smoothness and freedom from flat spots and pits. Examine the bond of the skull ballast. If the ballast must be reinstalled or changed, see drawing number 78051-61X for instructions.

Note: It is recommended to have weight and center of gravity (C. G.) adjustments and securing of the ballast done by Humanetics Innovative Solutions, Inc.

Step 29. Replace the skin on the skull and cap. Measure the thickness of the skin in the locations shown in drawing 78051-61X. The thickness must be 11.2 ± 0.8 mm (0.441 ± 0.031 in) as measured by the special thickness tool.

Step 30. Install the neck transducer and accelerometer block with simulated accelerometers as shown in drawing 78051-61X. Install the skull cap. Weigh the assembly. The weight and center of gravity (C.G.) must conform to drawing 78051-338.

Note:

- If the head assembly does not comply with these weight and C.G. requirements, see drawing 78051-61X for instructions.
- In addition, **Table 4.2.1** (shown previously in this manual) summarizes the C.G. specifications for the whole dummy.

Section 7. Upper Torso Assembly

This section on the upper torso assembly includes the thoracic spine assembly, the sternum assembly, the ribs, and the shoulder and clavicle assemblies and links.

7.1. Disassembling, Inspecting, and Reassembling the Upper Torso

7.1.1. Exploded View

An exploded view of the upper torso assembly (78051-89) is shown below.

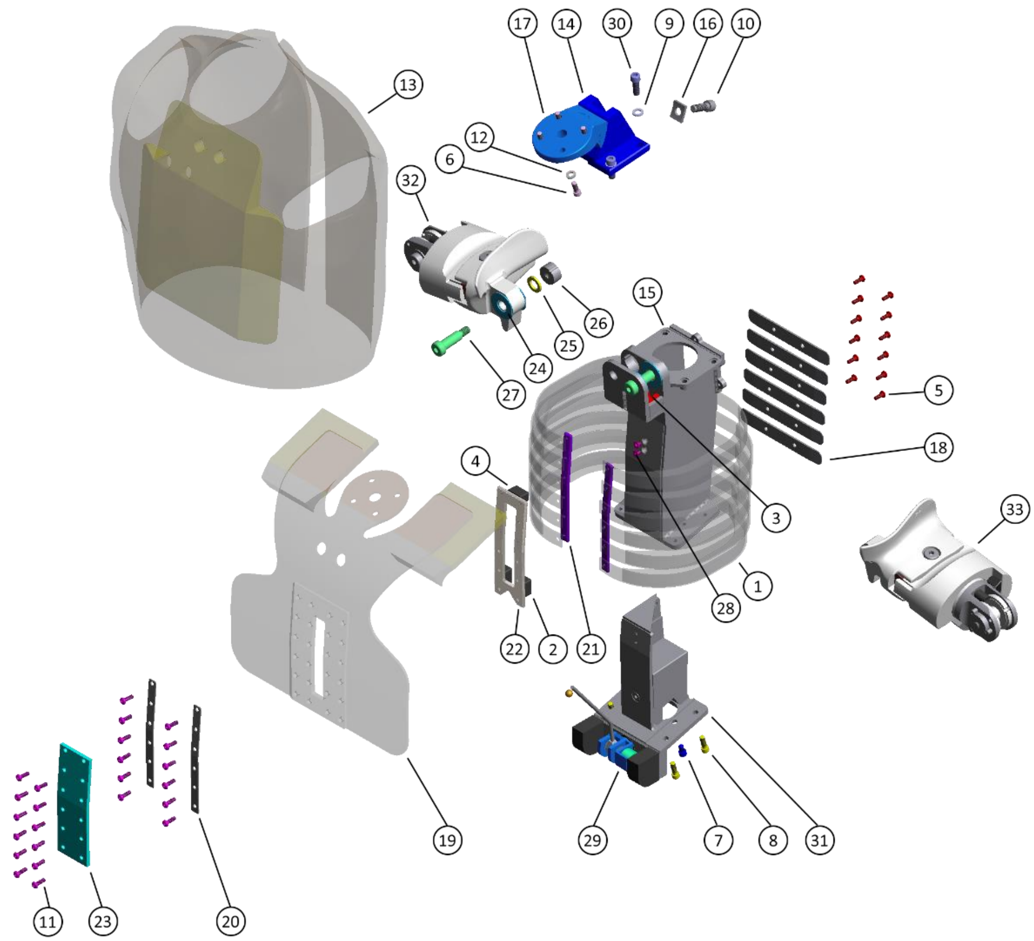

Figure 7.1.1.1: Upper torso assembly exploded view

7.1.2. Parts List

Table 7.1.2.1 below gives a general description of each item in the upper torso assembly (refer to upper torso assembly drawing 78051-89).

Table 7.1.2.1: Upper torso assembly parts list

Item	Quantity	Part Number	Description
1	1	78051-RS	Rib Set, Complete
2	2	78051-356	Stop, Sternum
3	2	78051-235	Bumper, Shoulder
4	1	78051-9	Stop, Sternum
5	12	9000026	BHCS, #10-32 X 1/2” Lg.
6	4	9000144	SHCS, 1/4-20 X 5/8” Lg.
7	2	9000597	SHCS, 1/4-20 X 3/8” Lg.
8	4	9000454	SHCS, 1/4-20 X 3/4” Lg.
9	4	9000022	Flat washer, 5/16” Plain A SS
10	1	9000079	SHCS, 3/8-16 X 1.0” Lg.
11	24	9000025	BHCS, #10-32 X 5/8” Lg.
12	4	9003843	Flat washer, 1/4” Plain A SS
13	1	78051-169	Chest Flesh and Skin Assembly (not shown)
14	1	78051-303	Bracket, Neck, Adjusting Lower
15	1	78051-179	Thoracic Spine Assembly
16	1	78051-305	Washer, Clamping
17	1	78051-307	Bracket Assembly, Neck Adjusting Upper
18	6	78051-304	Support, Rib, Rear
19	1	78051-215	Bib Assembly, Sternum to Rib
20	2	78051-233	Plate, Front End Stiffener
21	2	78051-234	Strip, Front End
22	1	78051-232	Sternum

Item	Quantity	Part Number	Description
23	1	78051-316	Slider, Chest Deflection
24	4	78051-236	Washer, Clavicular Link
25	2	78051-237	Washer, Nut Clavicular
26	2	78051-238	Nut, Clavicle Link Pivot
27	2	78051-239	Clavicular Link, Pivot Screw
28	2	78051-225	Screw, Hex Socket Flat
29	1	78051-317	Transducer Assembly
30	4	9000113	SHCS, 5/16-24 X 7/8” Lg.
31	1	78051-88	Adapter Assembly
32	1	78051-420	Shoulder Assembly, Right
33	1	78051-410	Shoulder Assembly, Left

7.1.3. Disassembling and Inspecting the Thoracic Spine

Step 1. Remove the four 1/4-20 X 3/4” SHCS that attach the lumbar spine to the thoracic spine assembly and lift off the thoracic spine.

Step 2. From the bottom of the thoracic spine, remove the two 1/4-20 X 5/8” long cap screws that hold the chest accelerometer adapter assembly (shown below in **Figure 7.1.3.1,** ballast weight, and chest displacement potentiometer assembly to the bottom of the spine box.

Note: Before separating this unit from the spine box, remove the two #10-32 X 1/2” long flat head cap screws located about midway up the front of the spine box.

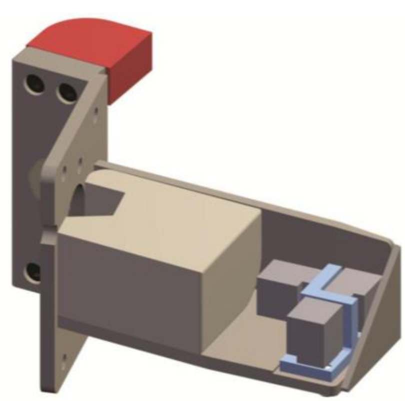

Figure 7.1.3.1: Chest accelerometer adaptor assembly

Step 3. Slide the assembly out of the bottom of the spine box.

Note:

- On earlier versions of the Hybrid III dummy, this is the only way to reach the chest accelerometer package.
- Dummies built more recently should have a series of holes on the side of the spine, as shown below in **Figure 7.1.3.2**, to allow removal of the accelerometer block mounting screws.
- This allows removal of the block from the upper rear spine opening.
- These holes have been incorporated into the drawing package.

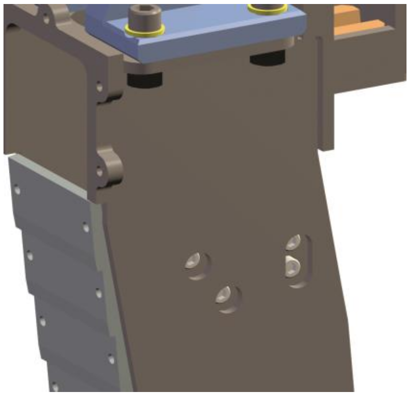

Figure 7.1.3.2: Spine box holes for removal of accelerometer block screws

Step 4. Install the accelerometer block package and make sure no interference with the accelerometers occurs. Check the two larger rubber bumpers protecting the chest displacement potentiometer, as shown below in **Figure 7.1.5.1**, sub-Section 7.1.5, "Disassembling and Inspecting the Ribs and Sternum".

Step 5. Carefully remove the chest deflection transducer assembly from its bearing. A 1/4-20 X 1/2" long BHCS and flat washer, shown in assembly drawing 78051-317, hold it in place. The assembly should easily push out.

Step 6. The chest deflection transducer assembly appears below in **Figure 7.1.3.3**. Check the bearing for smooth operation.

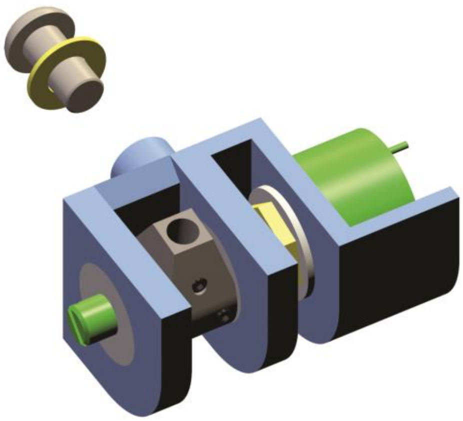

Figure 7.1.3.3: Chest deflection transducer assembly

7.1.4. Reassembling the Thoracic Spine

Assembling the thoracic spine assembly and its components is just a reversal of the disassembly process. Remarks in this section will be confined to special considerations that are unique to that assembly.

Step 1. If the dummy does not have the holes drilled in the side of the spine box to aid in the chest accelerometer mount installation, drill the holes shown in **Figure 7.1.3.2** above and in the drawing package.

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

Step 3. Install the lumbar adaptor assembly (with the thorax weight and transducers) into the bottom of the thoracic spine. Install the thoracic spine, with adaptor assembly, to the lumbar spine.

Step 4. When mounting the lower neck bracket to the top of the spine, ensure that the cap screws have metal washers to protect the aluminum.

7.1.5. Disassembling and Inspecting the Ribs and Sternum

Step 1. Remove the (12) #10-32 X 5/8” long button head cap screws holding the front of the ribs to the bib.

Step 2. Inspect the thin steel strips under the bolt heads for cracks. Check the thicker, slightly bent strips behind the rib ends for cracks. Note the way the strips fit the chest. The bend is not symmetrical; the upper portion is shorter than the lower.

Step 3. Detach the bib assembly.

Do not loosen the set screw, shown below in **Figure 7.1.5.1**, because this will invalidate the chest displacement transducer calibration of SAE Recommended Practice J-2517.

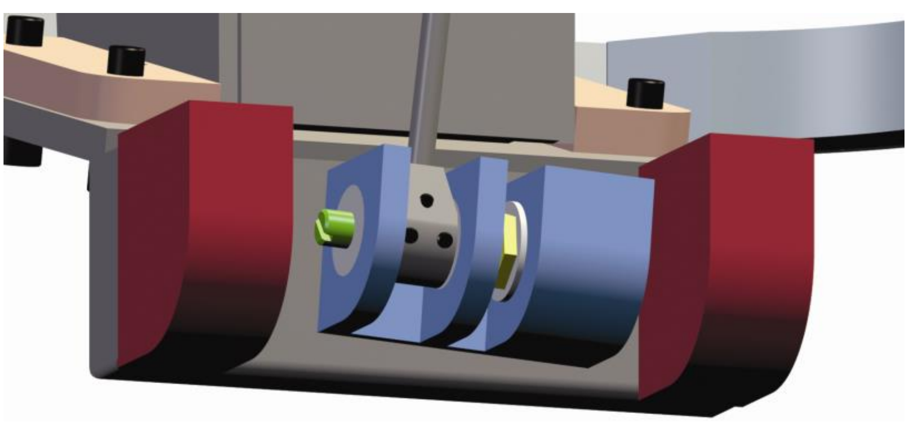

Figure 7.1.5.1: Chest displacement transducer and set screw

Step 4. Remove the (12) #10-32 X 5/8 long screws holding the Delrin™ slider assembly to the bib, as shown below in **Figure 7.1.5.2**.

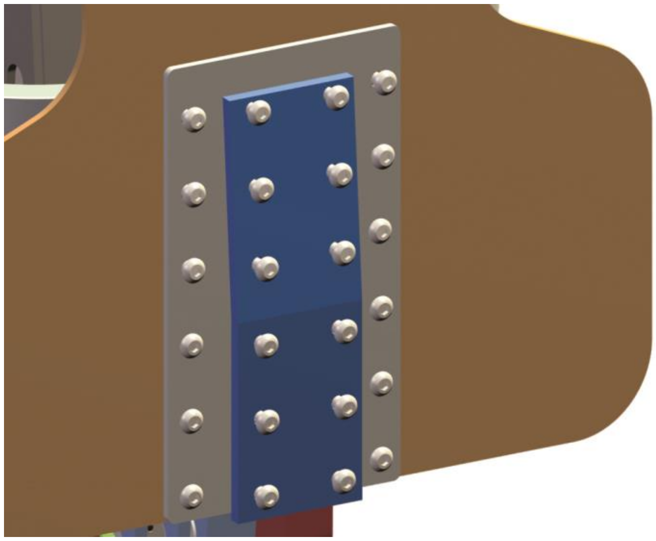

Figure 7.1.5.2: Slider assembly attached to bib

Step 5. Examine the slider for damage and ensure that the slider ball moves freely in its track. Inspect the aluminum plate to which the slider assembly bolts. Check that the "V" shaped groove is at the bottom, as shown below in **Figure 7.1.5.3**.

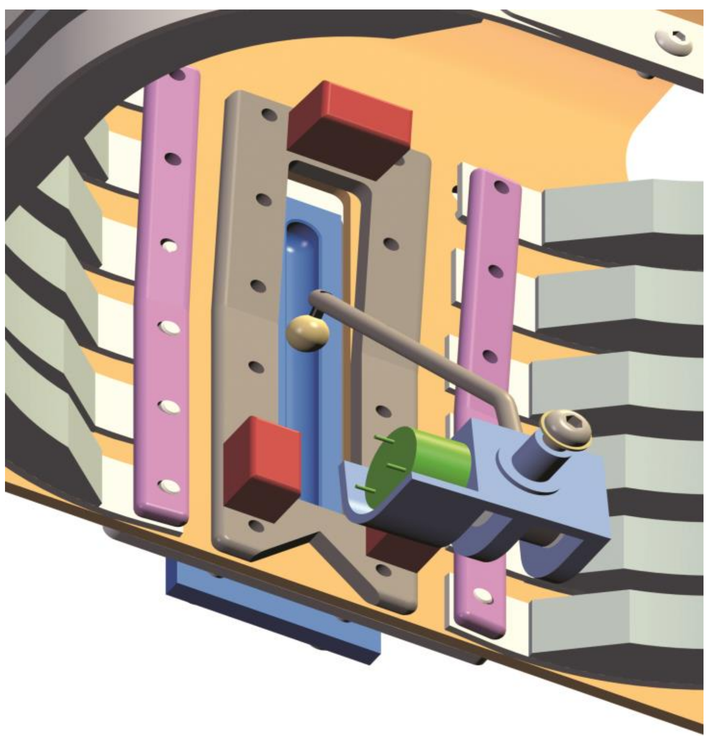

Figure 7.1.5.3: Sternum installed

Step 6. Three rubber bumps stops prevent the sternum assembly from striking the spine box during testing. The two lower stops can be mounted to either the sternum assembly, as shown in **Figures 7.1.5.3** (above) and **7.1.5.4** (below), or to the spine box, as shown in **Figure 7.1.5.5** (also below). Mounting the stops to the spine box reduces the possibility of interaction with the sternal deflection rod.

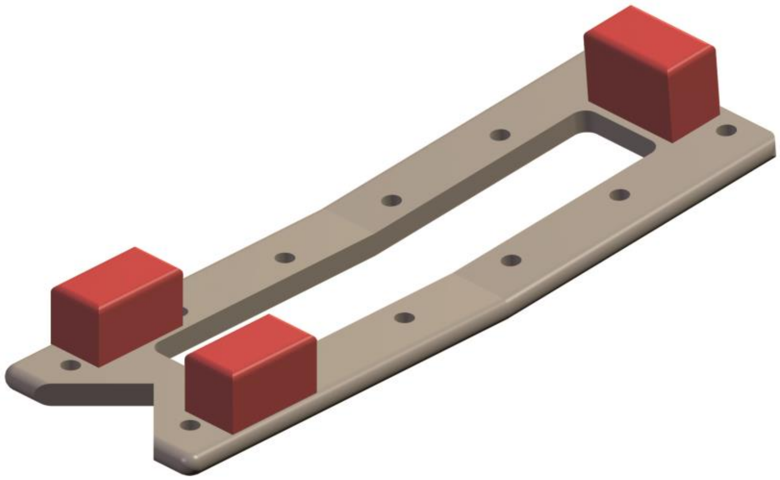

Figure 7.1.5.4: Sternum assembly with rubber stops

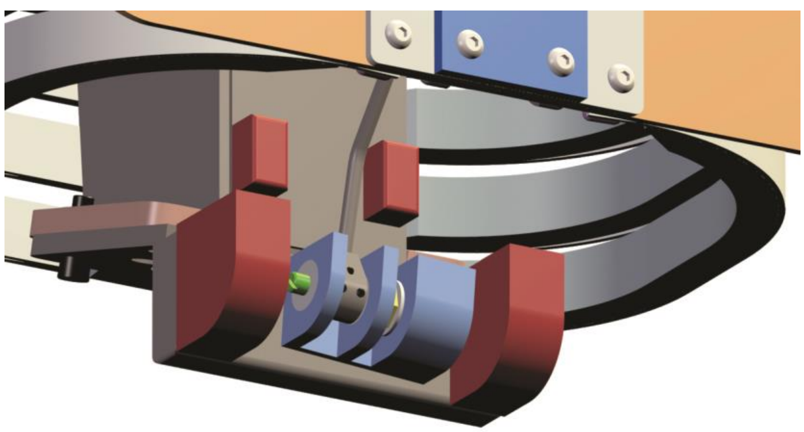

Figure 7.1.5.5: Lower sternum stops mounted to the spine

Step 7. Inspect the bib for cracks, tears and imperfections. Compare the shape to the drawing. Clean all parts with isopropyl alcohol or an equivalent.

Step 8. Detach the six ribs in the rib assembly shown below in **Figure 7.1.5.6,** and their rear rib supports shown below in **Figure 7.1.5.7** by removing the (12) #10-32 x 1/2 long screws at the rear of the thoracic spine assembly.

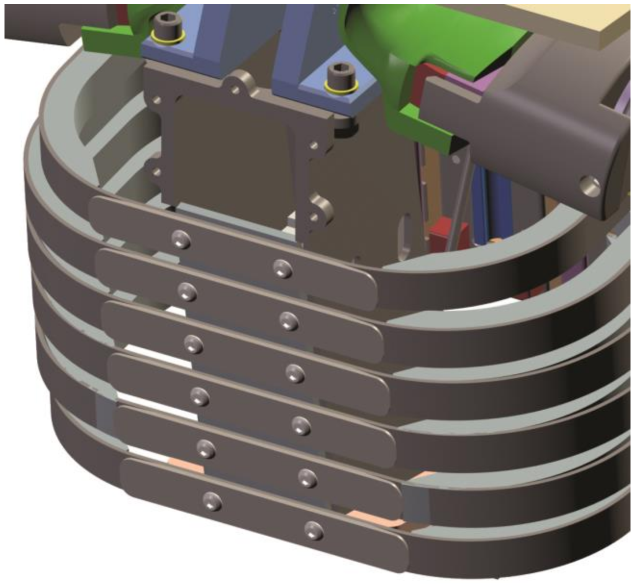

Figure 7.1.5.6: Rib assembly

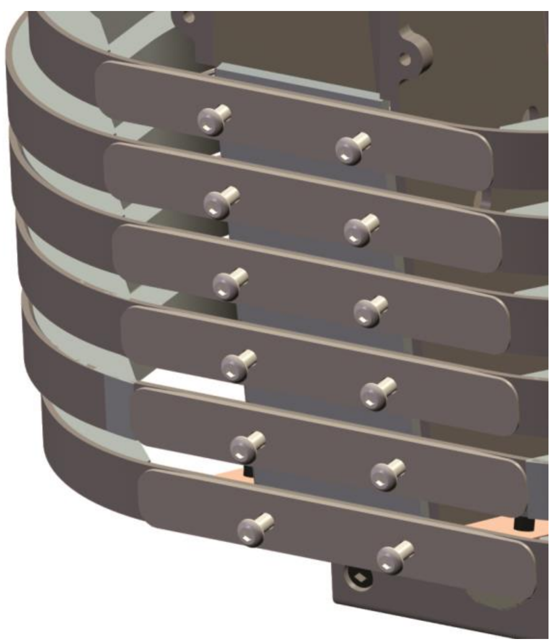

Figure 7.1.5.7: Rear rib supports

Step 9. Carefully examine each rib and the rib damping material for cracks. Check for gaps or other failures of the epoxy bond between the rib damping material and the rib metal, as shown below in **Figure 7.1.5.8**.

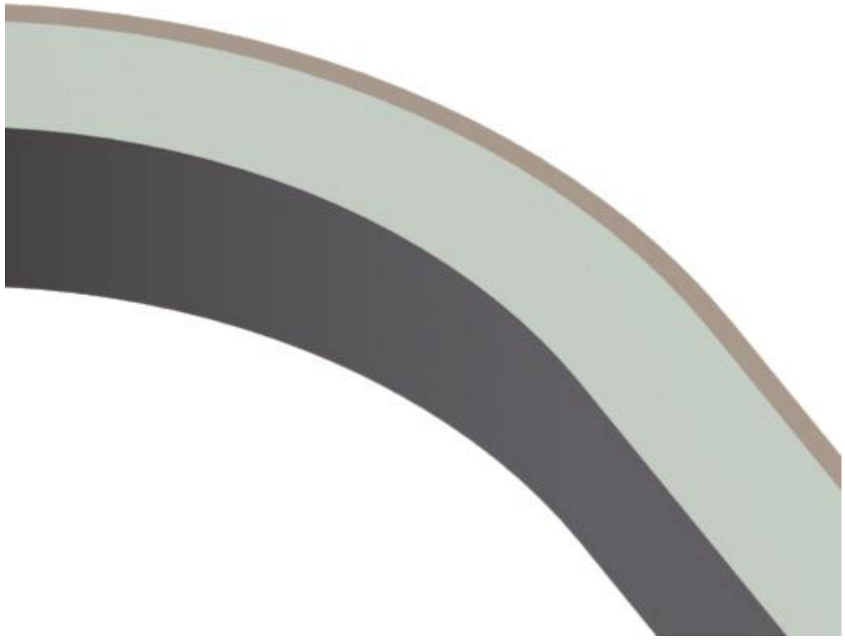

Figure 7.1.5.8: Steel rib and bonded damping material

Step 10. Verify the contours of each rib against a template made from the information obtained from the rib drawings. When the rib ends are matched to the template, the rib contour should be within ±1.50 mm (.060 in) of the template. Minor reshaping of the ribs may be done by hand.

Step 11. Measure the rib thickness.

Step 12. The Rockwell C hardness of each rib and rib support must fall between 44 and 46 at the center of the metal between the two screw holes.

Step 13. When reassembling, make sure the rib supports are not bent or damaged and are mounted the correct way with the beveled ends facing the front of the dummy.

Step 14. After assembling the ribs, or when checking rib conditions, use the special tool (gage probe) to check for correct chest depth, as shown below in **Figure 7.1.5.9**.

- The gauge is used to check the chest cavity depth at ribs number 1 and number 6.
- The gauge has two separate calibrated surfaces for ribs number 1 and number 6.
- The gauge should be pressed against the back edge of the spine box (not the rear rib supports).

Note: If the gauge probe contacts the front rib end threaded strip, the condition is unacceptable and the ribs must be replaced.

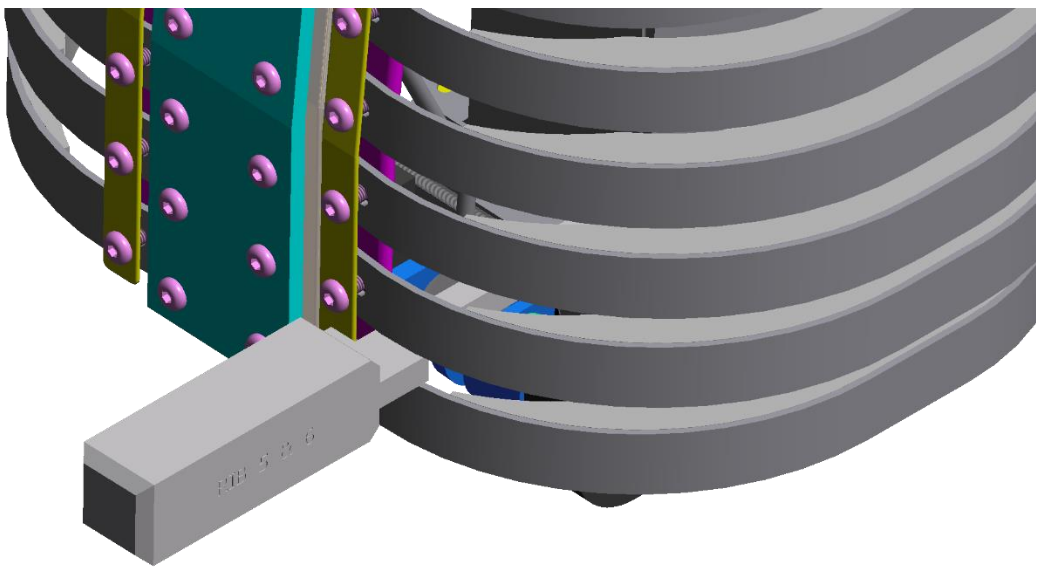

Figure 7.1.5.9: Chest depth gauge

7.1.6. Reassembling the Ribs and Sternum

Reassembling the ribs and sternum assembly and its components is just a reversal of the disassembly process. Remarks in this section will be confined to special considerations that are unique to that assembly.

Step 1. Attach the ribs and rear rib supports to the thoracic spine assembly. Do not tighten the screws. Attach the bib to the ribs using the rib stiffeners shown below in **Figure 7.1.6.1**.

Figure 7.1.6.1: Thick and thin rib stiffeners at the bib

Step 2. Install the aluminum sternum to the inside surface of the bib and attach the Delrin™ track. Ensure that the chest displacement rod ball engages the Delrin™ track properly (see **Figure 7.1.5.3** above).

Step 3. Check the spacing and alignment of the ribs and then tighten the screws. A 3/8" diameter rod can be used to control the space between the ribs.

7.1.7. Description and Features of the Shoulder-Clavicle and Link Assemblies

The right and left shoulder-clavicle and link assemblies consist of three main sections that bolt to each other and then to the thoracic spine. These three sections permit arm rotation, up-down motion at the shoulder, forward-rear excursion (hunching), and up-down motion of the entire shoulder-clavicle unit. See drawing 78051-89 for details of this assembly.

7.1.8. Disassembling and Inspecting the Shoulder and Clavicle Assemblies and Links

Note: Disassembly of the arm at the shoulder yoke is discussed below in **sub-Section 9.1.3**, "**Disassembling the Arm**." This same yoke provides shoulder rotation by rotating at the outer end of the clavicle.

Step 1. Detach the shoulder-clavicle unit from the thoracic spine assembly by reaching through a hole in the plastic chest "bib" and removing the socket head shoulder screw at the extreme top of the thoracic spine, as shown below in **Figure 7.1.8.1**.

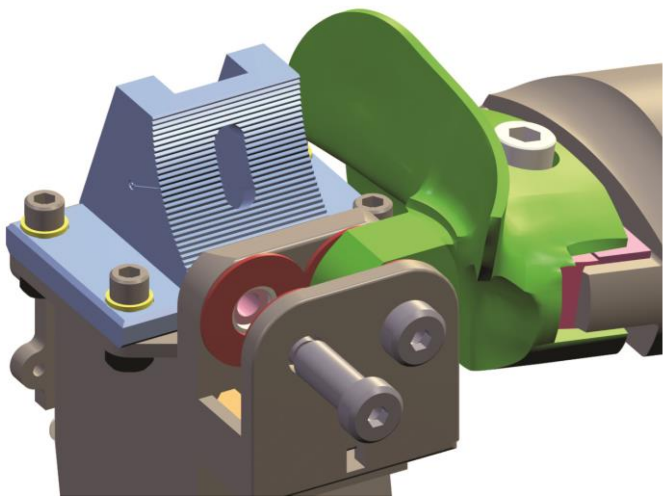

Figure 7.1.8.1: Clavicle link to spine attachment screws

Step 2. Pull the clavicle unit straight up.

Step 3. 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 4. At this time, use a pair of needle nose pliers to remove the rubber bump stop from the thoracic cavity, as shown below in **Figure 7.1.8.2**. The stop must be free from tears or permanent deformation, and must be symmetrical in cross section. The durometer of this bump stop must fall between 75 - 85 Shore A.

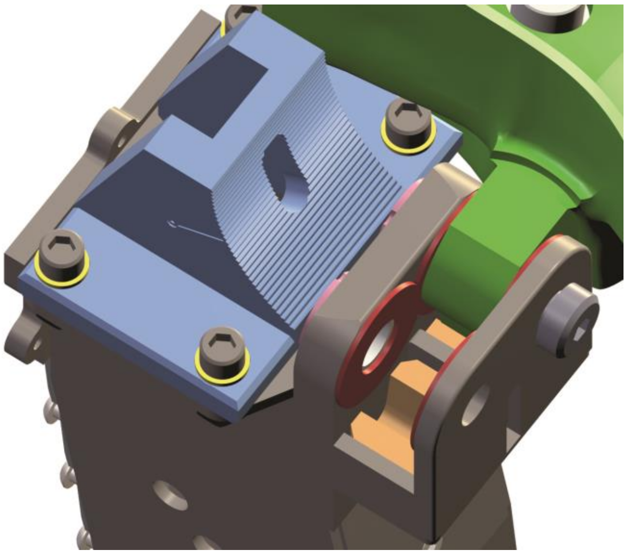

Figure 7.1.8.2: Thoracic rubber bump stop

Step 5. Remove the 1/2" X 1" long shoulder clavicle link screw and its steel washer that holds the two aluminum sections of the clavicle and its link together, as shown below in **Figure 7.1.8.3**.

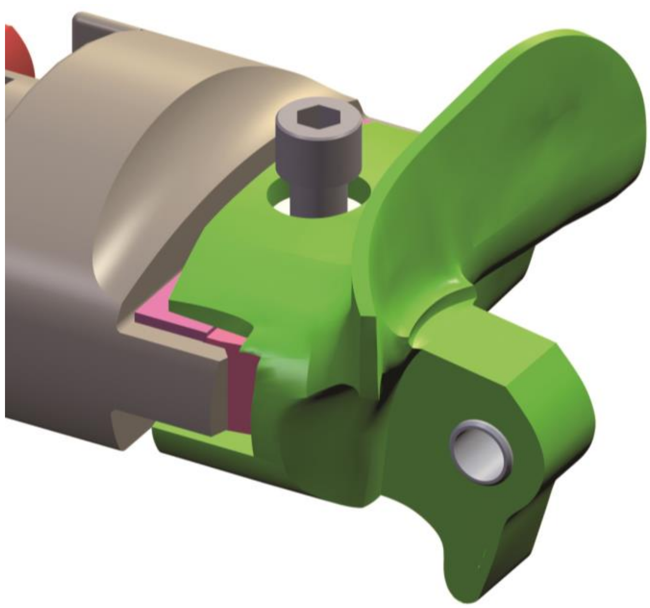

Figure 7.1.8.3: Clavicle to clavicle link screw

Step 6. Top and bottom thin Delrin™ strips should isolate the two sections, as shown below in **Figure 7.1.8.4**. A urethane spring "stop" should be located at the back of the cavity in the inner clavicle section, as shown below in **Figure 7.1.8.5**.

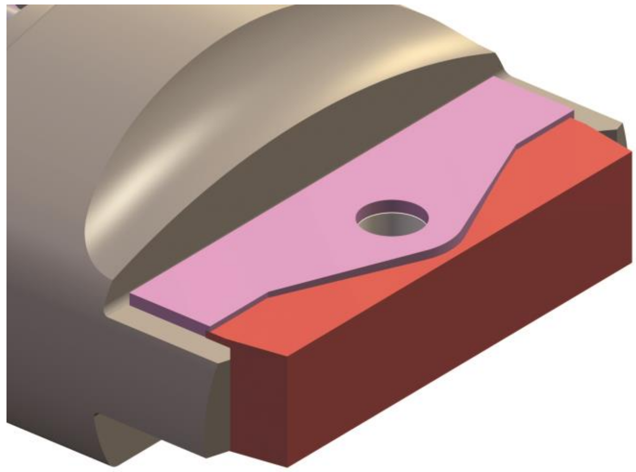

Figure 7.1.8.4: Clavicle, Delrin strip, and urethane spring stop

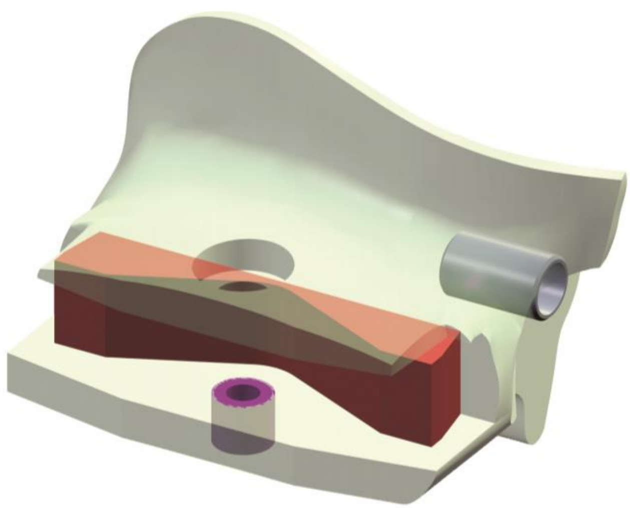

Figure 7.1.8.5: Urethane spring stop

7.1.9. Reassembling the Shoulder and Clavicle Assemblies and Links

Note: Reassembling the arm to the shoulder yoke is discussed below in **sub-Section 9.1.5**, "**Connecting the Arm Assembly to the Shoulder**." This same yoke provides shoulder rotation by rotating at the outer end of the clavicle.

Assembling the shoulder, clavicle, and clavicle links and their components is just a reversal of the disassembly process. Remarks in this section will be confined to special considerations that are unique to that assembly.

Step 1. Assemble the shoulder yokes, clavicles, and clavicle links. The long flat Delrin™ strips are easily damaged during assembly. An alignment tool will assist in this operation.

Step 2. Assemble the clavicles to the thoracic spine assembly. As shown below in **Figure 7.1.9.1**, insert the clavicular link nuts, followed by the urethane washer nuts, into the holes provided on the spine box.

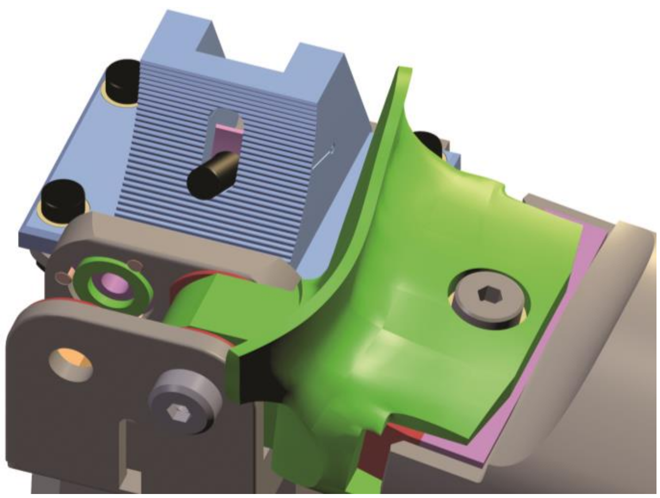

Figure 7.1.9.1: Installing clavicular link nuts and urethane washer nuts

Step 3. Place the clavicular washers onto the clavicular link with the flats in a vertical position toward the center, as shown below in **Figure 7.1.9.2**. The flat spots on the flat Delrin™ washers are on the side nearest the centerline of the spine.

Figure 7.1.9.2: Adding clavicular washers

Note: The following steps use two 15 cm (6 in) C-clamps to assemble the clavicles more easily.

Step 4. With the upper neck bracket removed, and the clavicle and clavicular link already assembled, place the clavicular link into the slot provided on the spine box and position the C-clamp.

Step 5. If the holes on the clavicular link and the spine box are not aligned after the previous step, use a second C-clamp.

Step 6. Mount the head and neck assembly. The neck cable should be torqued to 1.36 N·m ± 0.27 N·m (1.0 ft·lbf ± 0.2 ft·lbf).

Step 7. Install the chest flesh.

7.1.10. Further Inspection of the Shoulder and Clavicle Assemblies and Links

Step 1. The durometer of the fore and aft rubber bump stop is 40-45 Shore A. Be careful not to install this stop backwards. Examine the plastic parts for physical damage. Check the shoulder-clavicle yoke for a rubber shoulder rotation bump stop, shown below in **Figure 7.1.10.1**, at the rear outer edge of the outer clavicle section for control of arm rotation.

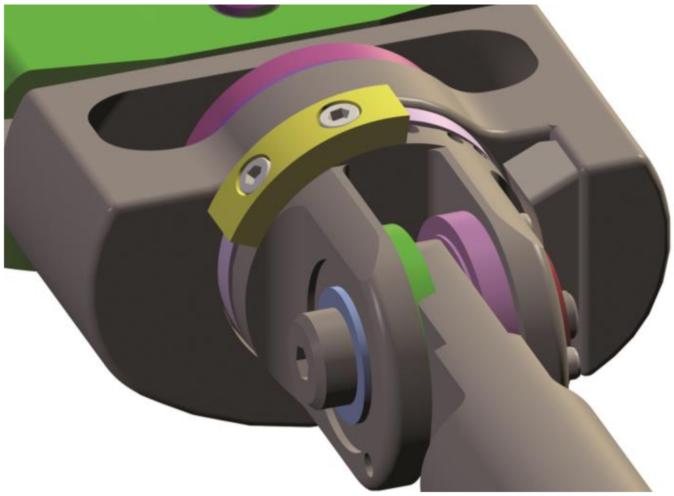

Figure 7.1.10.1: Rubber shoulder rotation bump stop

Step 2. Remove the shoulder-clavicle yolk to clavicle nut from the cavity on the bottom side of the outer clavicle section, shown below in **Figure 7.1.10.2**

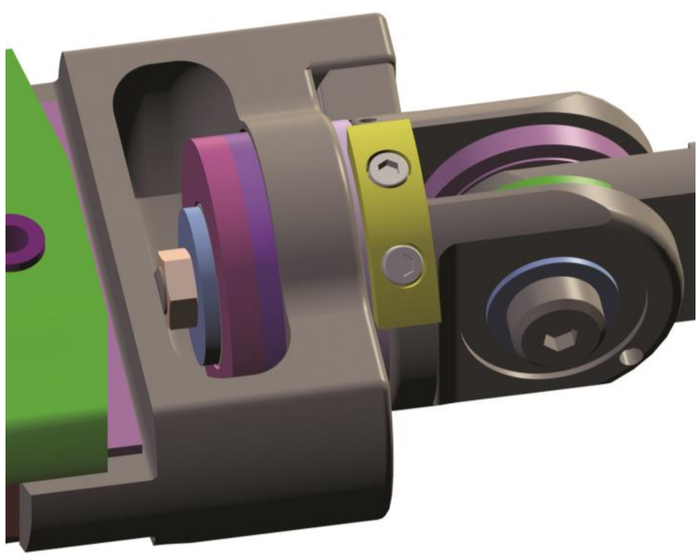

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Figure 7.1.10.2: Shoulder yolk to clavicle nut

Step 3. Pull out the shoulder-clavicle yoke and check for its two-piece Delrin™ bushing, elastomeric washer, and large and small steel washers upon which the nut tightens, as shown below in **Figure 7.1.10.3.**

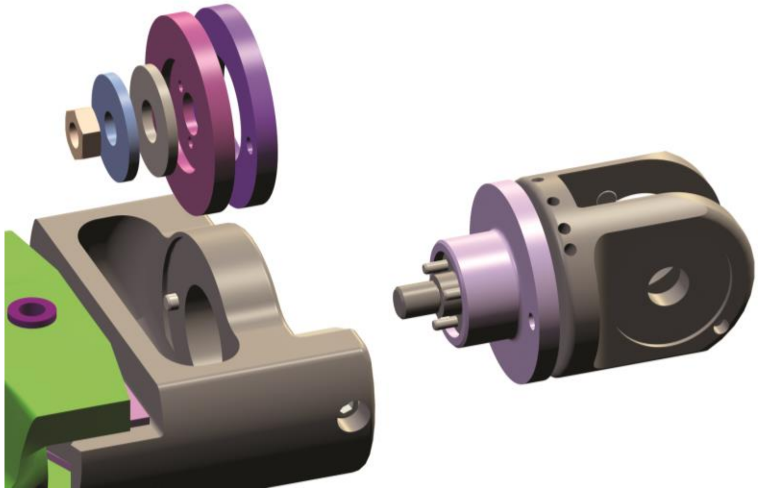

Figure 7.1.10.3: Exploded view of the shoulder-clavicle yolk

Step 4. Confirm that eight dowel pins are present.

Step 5. Check for a steel stop on the rim of the shoulder yoke, held by two #10-24 X 3/8" long screws, as shown above in **Figure 7.1.10.1**. The stop can be installed in two positions: one for the right side and the other for the left.

Step 6. Inspect clavicle aluminum parts for porosity and cracks.

Step 7. During reassembly, the steel shoulder yoke stop is installed on two of the four holes on the rim of the shoulder yoke, different on each side, to produce human like arm rotation.

Note: Confirm that arm rotation in the saggratal plane approximates human motion.

Section 8. Lower Torso Assembly

This section on the lower torso assembly includes the lumbar spine, the abdominal insert, and the pelvic assembly.

8.1. Disassembling, Inspecting, and Reassembling the Lower Torso

8.1.1. Exploded View

An exploded view of the lower torso assembly (78051-70P) is shown below in **Figures 8.1.1.1.**

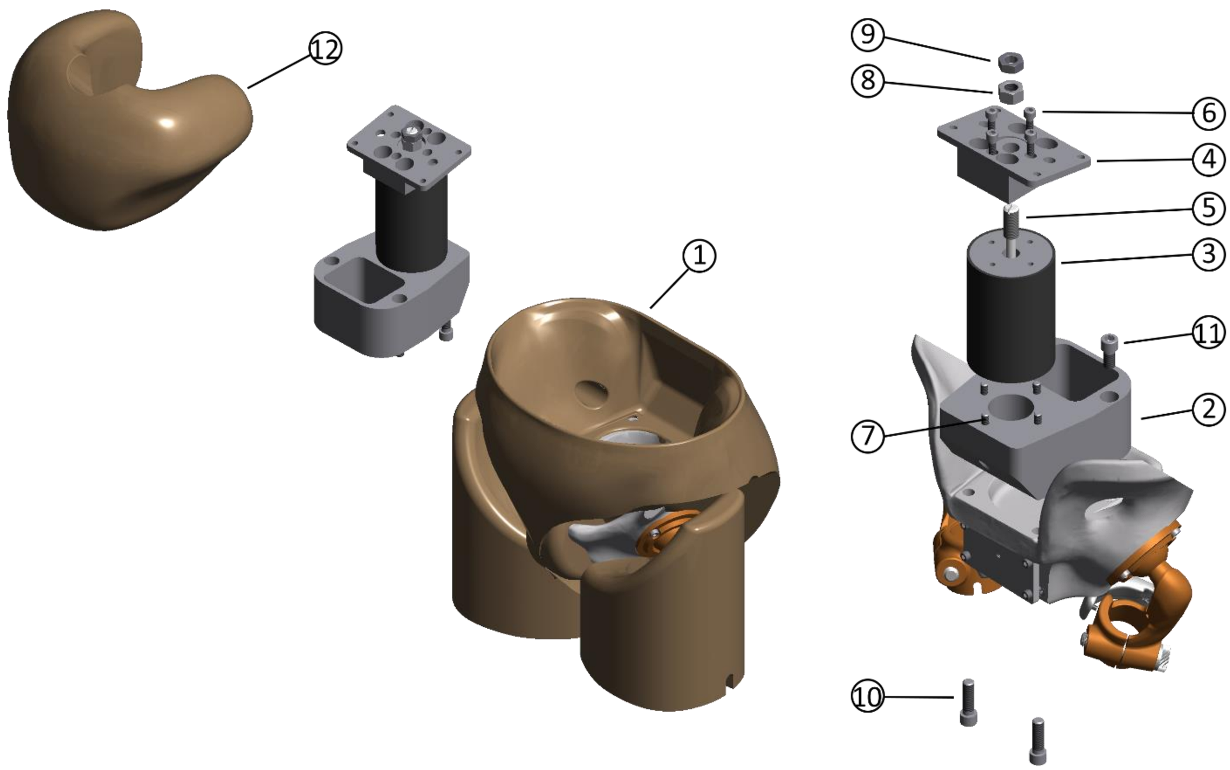

Figure 8.1.1.1: Lower torso assembly exploded view

8.1.2. Parts List

Tables 8.1.2.1 below gives a general description of each item in the lower torso assembly (refer to lower torso assembly drawing 78051-70P).

Table 8.1.2.1: Lower torso assembly parts list

Item	Quantity	Part Number	Description
1	1	78051-59P	Pelvic Assembly
2	1	78051-53P	Lumbar Spine Bracket
3	1	78051-66P	Lumbar Spine
4	1	78051-88P	Adaptor, Lumbar Thoracic
5	1	78051-69	Cable Assembly, Lumbar
6	4	9000144	SHCS, 1/4-20 x 5/8 Lg.
7	4	9000086	SHCS, 1/4-20 x 7/8 Lg.
8	1	9000057	Nut, 1/2-20 Hex, Zinc
9	1	9000018	Nut, 1/2-20 Jam
10	2	9000633	SHCS, 3/8-16 x 1 1/4 Lg.
11	2	9000490	SHCS, 3/8-16 x 3/4 Lg.
12	1	78051-52	Abdominal Insert

8.1.3. Disassembling and Inspecting the Lumbar Spine

Note: The lumbar spine is more easily accessed if the legs are detached.

Step 1. Remove the 5/8 X 1-3/4” long shoulder screw (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 8.1.3.1**. Detach the leg assemblies.

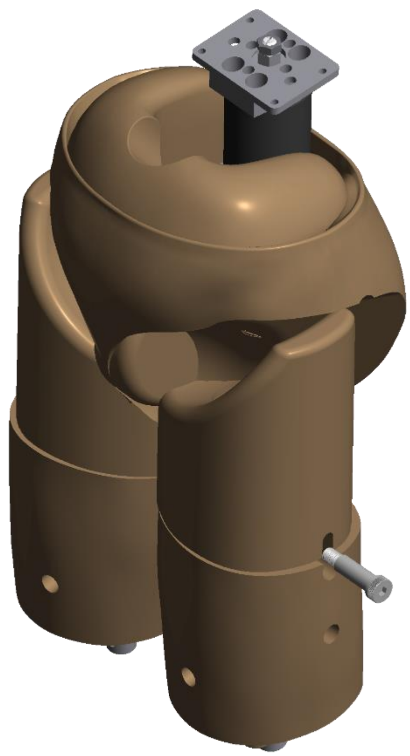

Figure 8.1.3.1: Upper leg access holes to femur

Step 2. Remove the four #10-24 X 1/2 SHCS holding the pelvic instrument cavity cover (refer to **Figure 8.1.3.2** below).

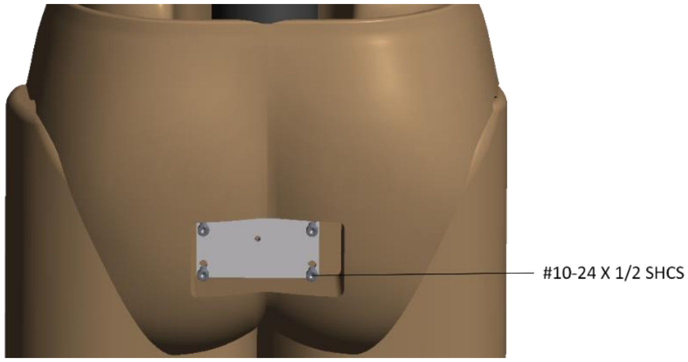

Figure 8.1.3.2: Pelvic instrumentation cavity cover

Step 3. Separate the lumbar spine and its lumbar-to-pelvic adaptor from the pelvis by removing two 3/8-16 X 3/4 SHCS from the front of the adaptor, and two 3/8-16 X 1-3/4 SHCS through the pelvic instrumentation cavity.

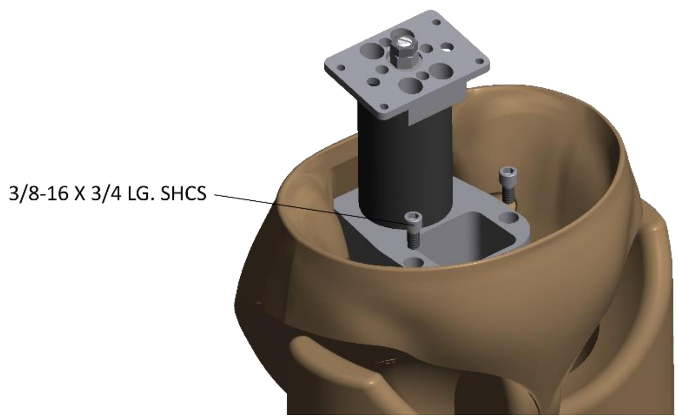

Figure 8.1.3.3: Separate lumbar spine from pelvis by removing 3/8-16 x 3/4 SHCS

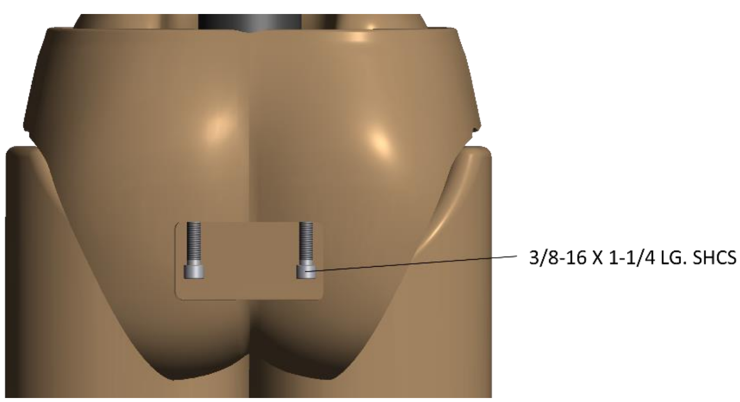

Figure 8.1.3.4: Separate lumbar spine from pelvis by removing 3/8-16 x 1-3/4 SHCS

Step 4. Separate the lumbar spine from the adaptor by removing four 1/4-20 X 7/8 long cap screws from the bottom of the lumbar adaptor.

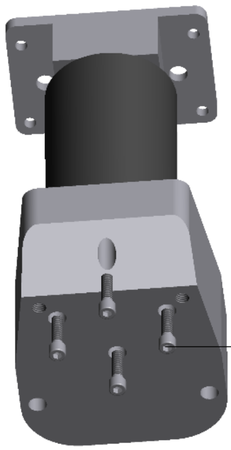

Figure 8.1.3.5: Separate lumbar spine from adaptor by removing 1/4-20 x 7/8 SHCS

Step 5. Check the upper and lower surfaces of the lumbar spine adaptor. The upper and lower surface must be flat and smooth.

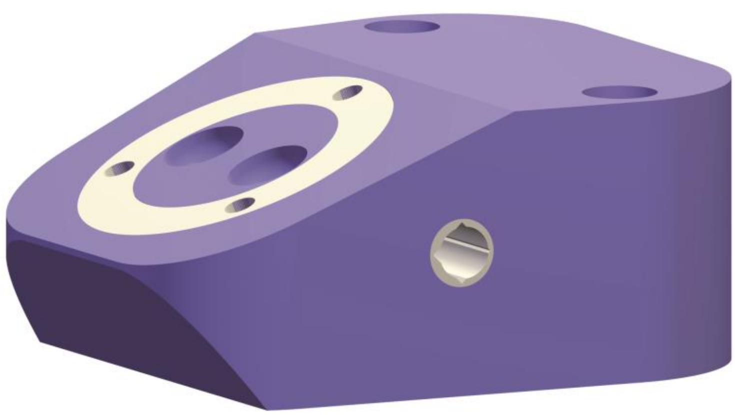

Figure 8.1.3.6: Lumbar spine adaptor

Step 6. Unscrew the ½-20 nut from the top of the lumbar cable using a screw driver to prevent the cable from turning and partially unwrapping.

Step 7. Inspect the rubber lumbar for cuts, cracks, or separation from the end plates.

Step 8. Remove the cable and check it for defects, unraveling, or slipping of the swaged ends.

8.1.4. Reassembling the Lower Torso

- Reassembly is in the reverse order.
- Tighten the nut to compress the lumbar spine to a height of 5.15 inches, measured using a machinist's rule or depth caliper.
- Use a 3/4-inch box end wrench to tighten the nut and align the neck top plate perpendicular to the bottom plate for consistent length readings.
- Torque the lumbar cable to compress the cylindrical lumbar spine to a length of 5.15 in. (130.8 mm).

8.1.5. Inspecting the Abdomen Assembly

- Examine the abdominal insert for skin-to-foam separation, for tears and/or cuts in the vinyl skin, and for air tightness.
- Air-shipped inserts are only partially sealed and must be fully sealed by the user.

8.1.6. Disassembling and Inspecting the Pelvis and Upper Femur Assemblies

Step 1. Remove the femur ball and flange assembly, as shown below in **Figure 8.1.6.1**, from each side of the pelvis by unscrewing three 1/4-20 X 3/4" long socket cap screws per side. Access to the screws is gained through the three one-half inch diameter holes in each side of the pelvic flesh.

Figure 8.1.6.1: Femur ball and flange assembly

Step 2. First remove the two rear screws and then rotate the femur assembly towards the pelvic center to allow access to the third screw. A tool made to fit in place of the upper leg bone will simplify this task.

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.

Step 3. Remove the two #8-32 X 3/8" button head cap screws holding the bumpers in place, as shown below in **Figure 8.1.6.2**.

Figure 8.1.6.2: Removal of upper femur bumpers for inspection

Step 4. Inspect the bumpers for tears or cracks and replace if necessary.

Step 5. The femur height should be inspected regularly to ensure that the femur has not deformed excessively. Femur deformation might change the geometry enough to allow metal-to-metal contact.

Step 6. The new upper femur 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 7° inboard and outboard of this plane.

Step 7. Remove the accelerometer block and ensure that the accelerometer mount will properly house the desired accelerometers.

Step 8. Confirm that the lead ballast in the top of the pelvic casting (see **Figure 8.1.6.3**) does not project above the surrounding aluminum structure.

Figure 8.1.6.3: Potted lead shot (ballast) in cavity on top of pelvis

Step 9. Check the femur sockets and femur ball for galling. Confirm that the nylon-tipped femur friction adjusting screws are not damaged.

Step 10. Examine the pelvis for flesh tears and/or cuts, and the skin for foam separation. If the pelvis cavity for the femur shows signs of deterioration such as these, it will probably not pass the range of motion calibration test, and the pelvis must be remolded.

Step 11. Check the buttock compression by mounting an adaptor to the top of the pelvis. Invert the pelvis and apply a 334 N (75 lbf) force to the bottom of the pelvis, perpendicular to the ground, through a 400x400 mm (16x16 in.) plate covering the entire buttock area.

Step 12. After five minutes, the distance between the adaptor-to pelvic interface and the 400x400 mm plate must be 90.4 to 93.5mm (3.56 to 3.68 in).

Section 9. Arm Assembly

9.1. Disassembling, Inspecting, and Reassembling the Arm

9.1.1. Exploded View

An exploded view of the arm assembly (78051-123, left and 78051-124, right) is shown in the figure below.

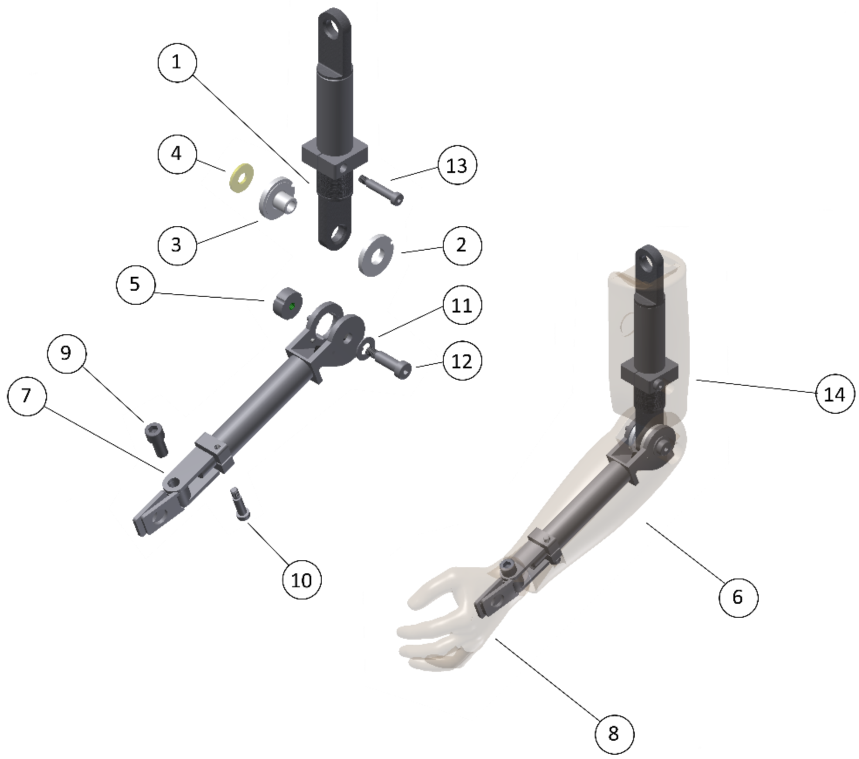

Figure 9.1.1.1: Arm assembly exploded view

9.1.2. Parts List

Tables 9.1.2.1 below gives a general description of each item in the arm assembly (refer to arm assembly drawing 78051-123, left and 78051-124, right.

Table 9.1.2.1: Arm assembly parts list

Item	Quantity	Part Number	Description
1	1	78051-191	Weldment, Upper Arm, Lower Part
2	1	78051-200	Washer, Upper Arm and Elbow Pivot
3	1	78051-199	Bushing, Upper Arm and Elbow Pivot

Item	Quantity	Part Number	Description
4	1	78051-249	Washer, Shoulder Joint Spring
5	1	78051-202	Nut, Elbow Pivot
6	1	78051-194	Lower Arm Assembly, Molded
7	1	78051-204	Wrist Rotation
8	1	78051-208	Hand, Molded, Left
	1	78051-209	Hand, Molded, Right (Not Shown)
9	1	78051-214	Screw, Wrist Pivot
10	1	9000074	SHSS, 3/8” x 1.0” Lg.
11	1	9001260	1/2” Flat Washer Plain Steel Cadmium
12	1	9000055	SHSS, 1/2” X 1 1/4” Lg.
13	1	9000082	SHSS, 3/8” X 1 1/2” Lg.
14	1	78051-174	Upper Arm, Molded, HIII 50th

9.1.3. Disassembling the Arm

Step 1. Remove each arm from the shoulder by unscrewing the 1/2” X 1 1/4” long socket head shoulder screw (SHSS), as shown below in **Figure 9.1.3.1**.

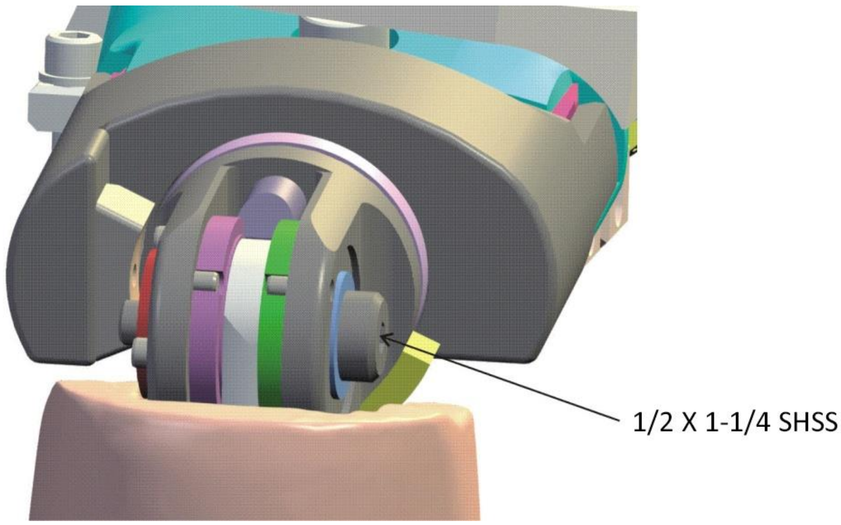

Figure 9.1.3.1: Remove the arm from the shoulder yoke assembly

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

Note: Never lubricate any of the plastic bushings.

Step 3. Push out the steel pivot nut in each shoulder yoke, as shown below in **Figures 9.1.3.2** and **9.1.3.3.** If the nut does not slide out freely, use the just-removed shoulder screw to help pull it out. Make sure the nut slides freely in its hole.

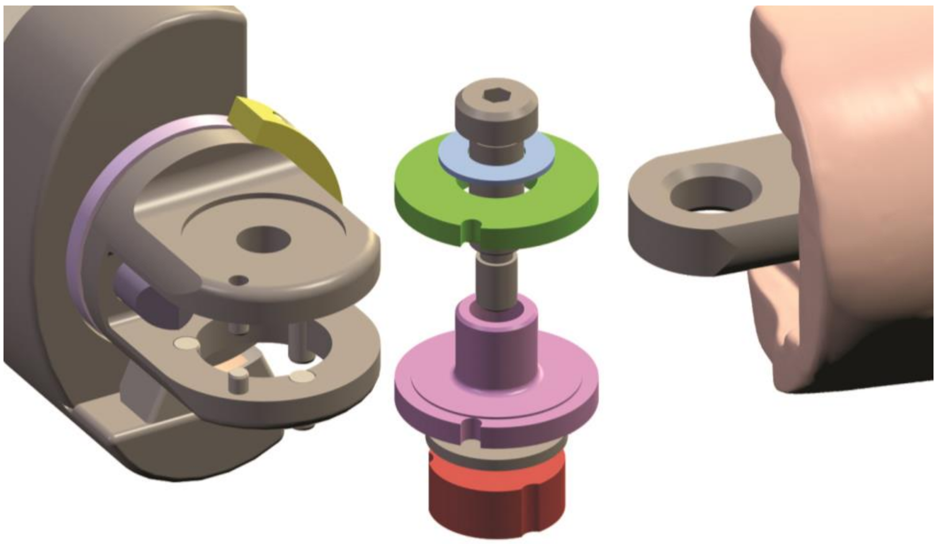

Figure 9.1.3.2: Exploded view of the shoulder yoke assembly

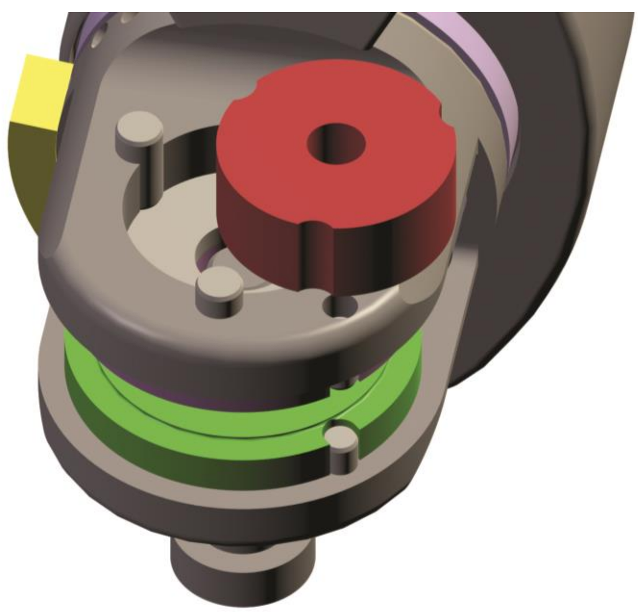

Figure 9.1.3.3: Shoulder yoke pivot nut

9.1.4. Inspecting the Arm Components

- Inspect each yoke to make sure each one contains five alignment dowel pins and one rubber bumper, as shown above in **Figures 9.1.3.1** and **9.1.3.2**).
- Examine all metal parts for burrs and sharp edges and remove them as necessary.
- Inspect vinyl-to-foam adhesion, cracked or cut vinyl skin, cracked or damaged bushings, and the condition of the threaded holes.
- Separate the lower arms from the upper arms and examine the elbow joints, noting the condition and position of the various parts as for the shoulder joints. Look to see that the two elbows with rubber stops are in place.
- Remove the elbow pivot size nut and check that the nut slides freely in the hole.
- Detach the hands from the lower arms and disconnect the wrist rotation joint. The elbow axial and wrist rotation joints have no stops.
- Lubricate the two rotation joints.

9.1.5. Connecting the Arm Assembly to the Shoulder

Step 1. Assemble the upper and lower arms and attach the arms to the shoulder yokes. The upper arm has a cutout on the upper inner side.

Step 2. The correct sequence of shoulder and elbow washers is:

1) Shoulder bolt
2) Steel flat washer
3) One half of yoke
4) Delrin™ bushing
5) Arm boss
6) Delrin™ bushing
7) Urethane washer
8) Other half of yoke
9) Steel sliding pivot/nut

9.1.6. Adjusting the Arm and Hand Joints

The procedure for adjusting the arm and hand joints is given in sub-Section 2.7, "**Joint Resistive Torque Adjustments**."

Section 10. Leg Assembly

10.1. Description and Features of the Leg Assembly

10.1.1. Non-Instrumented (Standard) and Instrumented (Optional) Lower Leg and Knee

Each Pedestrian lower leg assembly consists of a knee structural replacements (solid blocks) in place of the knee sliders as tibia displacement is not measured in the standing position. The lower leg is a weldment attaching the knee to the ankle.

A discussion of the instrumented (optional) lower leg is presented below in **Section 11, "Optional Instrumented Lower Leg Assembly"**.

The knees can be assembled so that the rotation stops are either outboard or inboard. **Figure 10.1.1.1** below shows the knees configured to hold the rotation stops outboard, while **Figure 10.1.1.2** below shows the knees configured to hold the rotation stops inboard.

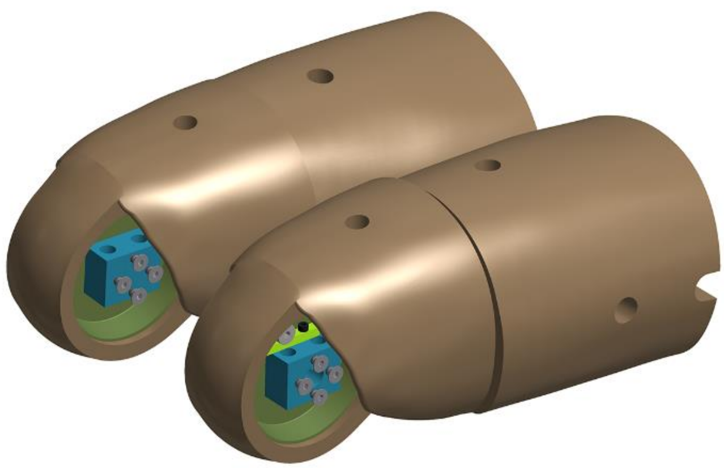

Figure 10.1.1.1: Knees assembled to allow outboard rotation stop placement

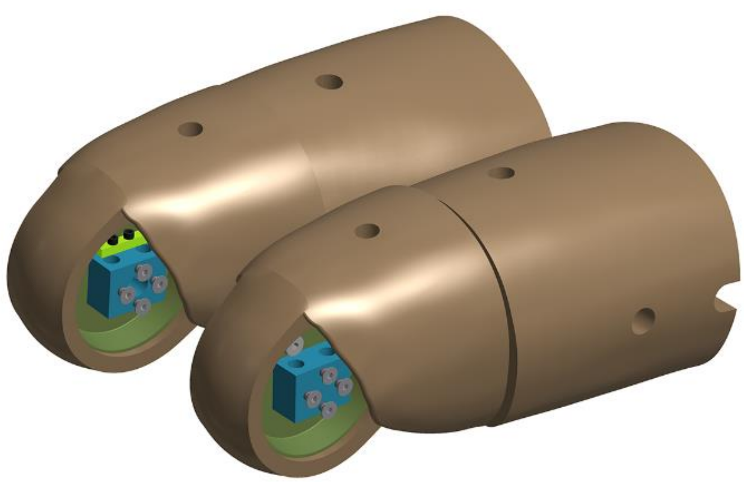

Figure 10.1.1.2: Knees assembled to allow inboard rotation stop placement

Note: Ensure that the knee structural replacement assembly and lower leg rotation stops are in place, as shown below in **Figures 10.1.1.3** and 10**.1.1.4**.

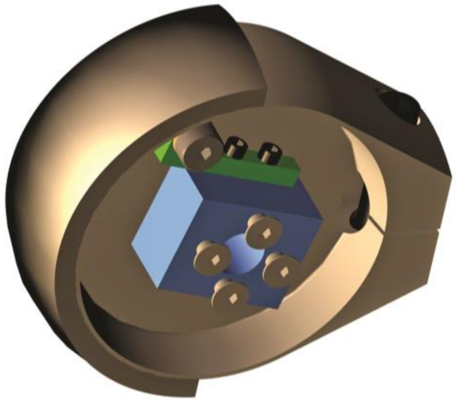

Figure 10.1.1.3: Knee structural replacement assembly and lower leg rotation stop

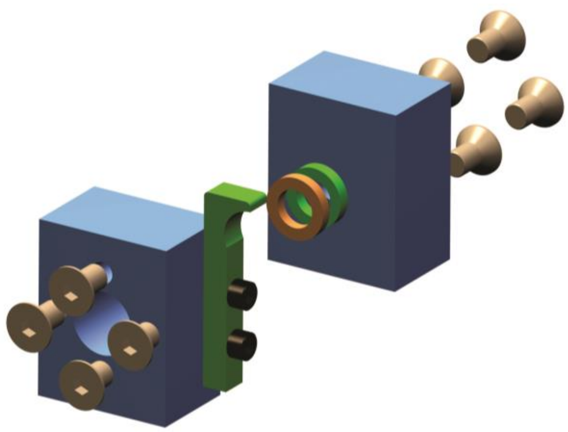

Figure 10.1.1.4: Exploded View of the Knee structural replacement assembly

The standard lower leg, shown below in **Figure 10.1.1.5**, is a welded assembly which can be replaced with an optional instrumented lower leg.

Figure 10.1.1.5: Standard (non-instrumented) lower leg

10.2. Disassembling, Inspecting, and Reassembling the Leg, Knee, Ankle, and Foot Assemblies

10.2.1. Exploded View

An exploded view of the leg assembly (86-5001-001P, left and 86-5001-002P, right) is shown in the figure below.

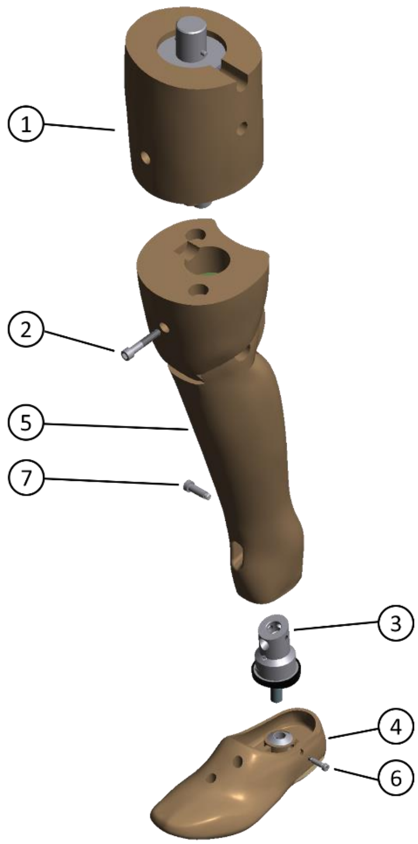

Figure 10.2.1.1: Leg assembly exploded view

10.2.2. Parts List

Table 10.2.2.1 below gives a general description of each item in the leg assembly (refer to leg assembly drawing (86-5001-001P, left and 86-5001-002P, right).

Table 10.2.2.1: Leg assembly parts list

Item	Quantity/Leg	Part Number	Description
1	1	78051-46	Upper Leg Assembly, Left
	1	78051-47	Upper Leg Assembly, Right (Not Shown)
2	1	9000066	SHCS, 3/8-16 X 2.0” Lg. NYLOK®
3	1	B-1889	Ankle Assembly
4	1	78051-600	Foot Assembly, Left
	1	78051-601	Foot Assembly, Right (Not Shown)
5	1	86-5001-003P	Knee & Lower Leg Assembly, Pedestrian, Left
	1	86-5001-004P	Knee & Lower Leg Assembly, Pedestrian, Right (Not Shown)
6	1	A-1886	FOOT ATTACHMENT BOLT
7	1	A-1887	ANKLE TO LEG ATTACHMENT BOLT

10.2.3. Disassembling the Upper Leg and Knee

Step 1. Separate the upper leg sections by removing the two 3/8-16 screws (one is 1-3/4” long and the other is 2” long) that secure the load cell or the femur load cell simulator to the femur and the knee cap. The longer screw is nearest to the knee.

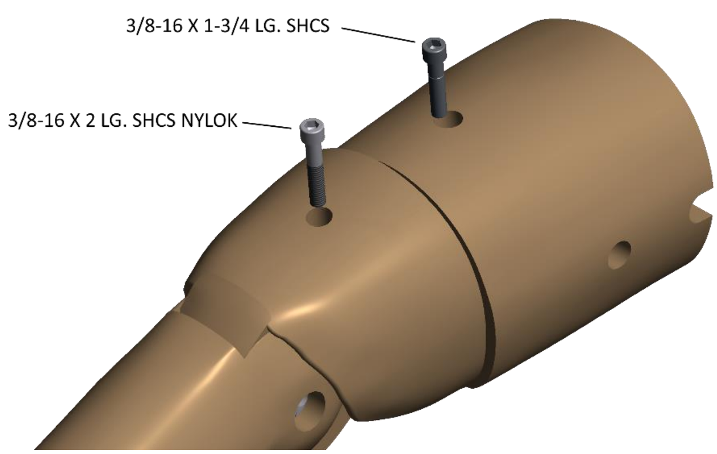

Figure 10.2.3.1: Separate upper leg by removing 3/18-16 screws

10.2.4. Disassembling and Inspecting the Knee

Step 1. Detach the lower leg from the machined knee by removing eight 1/4-28 X 7/16 long flat head cap screws. Refer to **Figures 10.2.4.1** below.

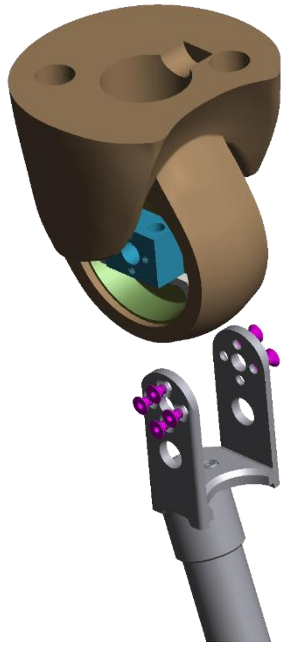

Figure 10.2.4.1: Detaching the lower leg from the knee

Step 2. Take off the knee skin and rubber knee insert, as shown below in **Figure 10.2.4.2**

- Examine these flesh parts for cuts and tears.
- Clean the inside and outside of the insert and adjoining knee skin with isopropyl to alcohol or equivalent.

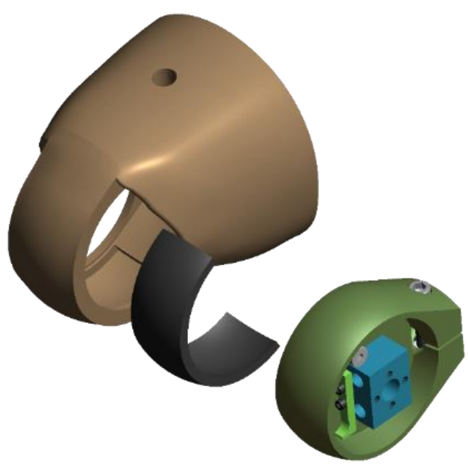

Figure 10.2.4.2: Knee, skin, and insert

10.2.5. Disassembling the Standard (Non-Instrumented) Lower Leg and Foot

Step 1. Separate the lower leg and ankle assembly by removing the Ankle to Leg Attachment Bolt, A-1887 at the foot-lower leg intersection.

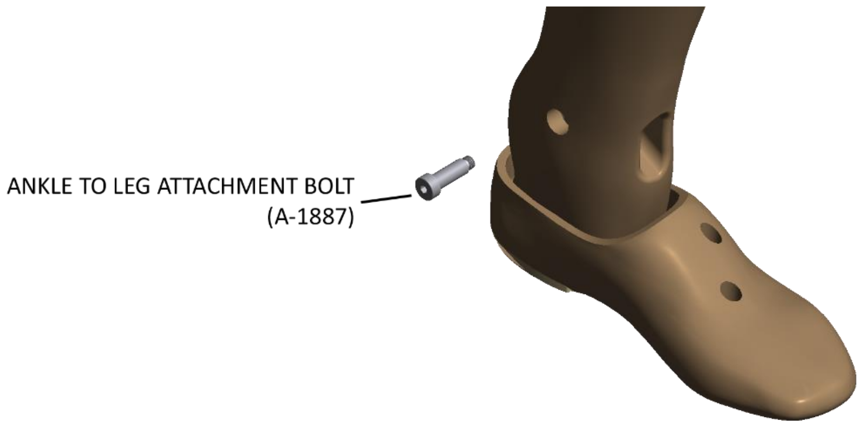

Figure 10.2.5.1: Ankle to leg attachment bolt to lower leg

Step 2. Remove the foot from the ankle by unscrewing the Foot Attachment Bolt, A-1886 from the side of the foot.

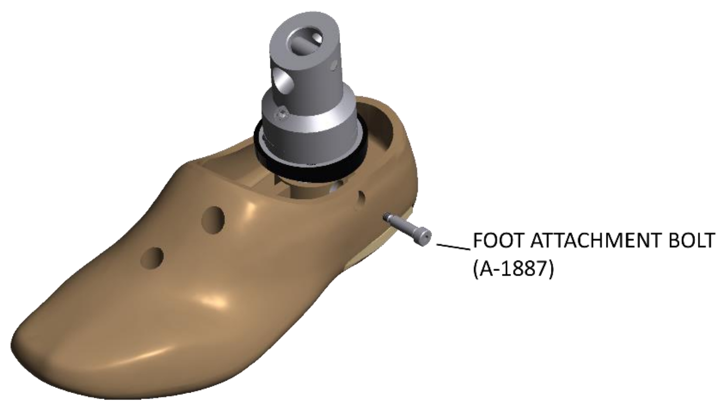

Figure 10.2.5.2: Foot and ankle

Step 3. Remove the heel insert and inspect for deterioration, as shown in **Figure 10.2.5.3.** Make sure that the ankle bumper is in place and inspect for deterioration.

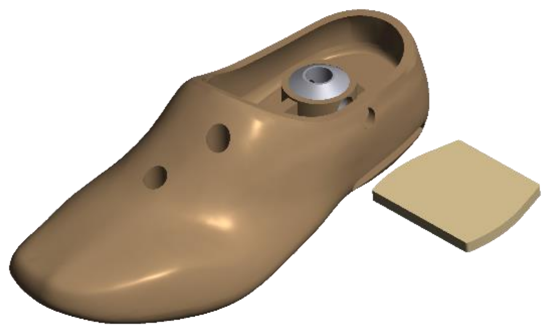

Figure 10.2.5.3: Heel Pad

10.2.6. Reassembling the Standard (Non-Instrumented) Lower Leg and Foot

- When assembling the knees with the standard, non-instrumented lower legs, the shoulder bolt head can be on the inboard or outboard side of both knees, as shown above in **Figures 10.1.1.1** and **10.1.1.2**, respectively..
- The modified 3/8" diameter shoulder bolt with a rubber sleeve mounted in the machined knee acts as a control for the motion between the lower leg and knee.

10.2.7. Adjusting the Leg and Foot Assemblies

The procedure for adjusting the leg and foot assemblies is given in **sub-Section 2.7**, "**Joint Resistive Torque Adjustments**."

Section 11. Optional Instrumented Lower Leg Assembly

11.1. Description and Features of the Instrumented Lower Leg

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. These 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. The lower load cell may be rotate 90° if lateral shear and moment are preferred, by using the second slot in the ankle-to-tibia adapter, or this load cell may be purchased with both moment measurements built in. No adjustments are needed except for a friction adjustment at the ankle ball.

A Pair of six-channel femur load cells is available for use in place of the single-axis femur load cells. Either type of load cell directly replaces the femur load cell simulator in each leg. The six-channel load cells measure axial and shear loads, and moment in three axes, while the single-axis load cells measure the axial load only.

11.2. Disassembly and Reassembly of the Optional Instrumented Lower Leg

11.2.1. Disassembling and Reassembling the Optional Instrumented Lower Leg

The optional instrumented lower leg, parts of which are shown below in **Figures 11.2.1.1, 11.2.1.2,** and **11.2.1.3**, replaces the standard (non-instrumented) lower leg, which is the welded assembly shown above in **Figure 10.1.1.5**.

Step 1. The upper part of the lower leg consists of the clevis with two Fz load cells. The clevis is bolted to the upper tibia load cell by four 1/4-28 x 5/8” long socket head cap screws, as shown in **Figure 11.2.1.1** below.

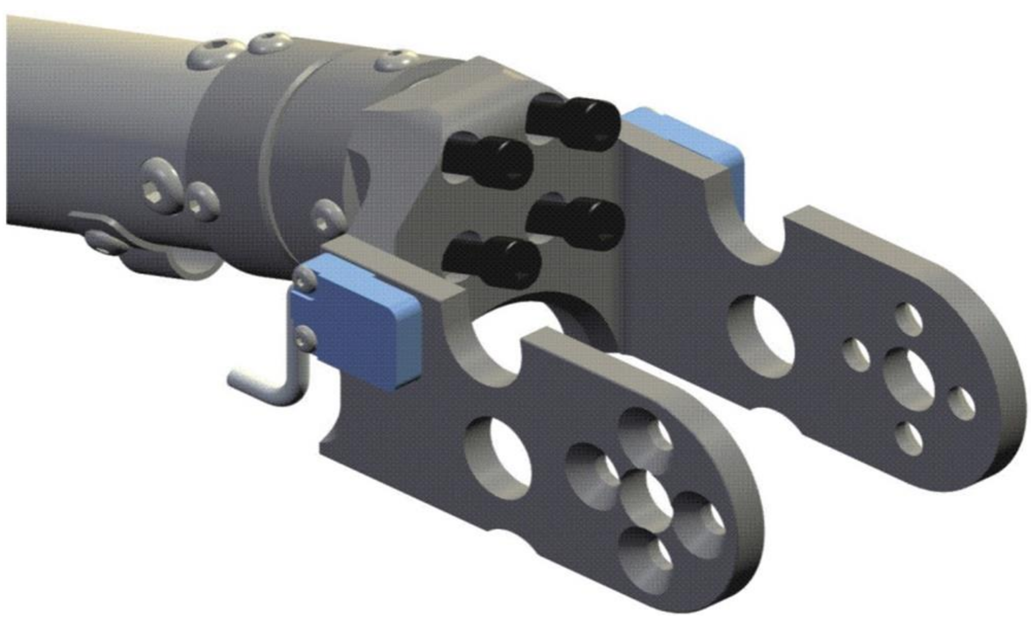

Figure 11.2.1.1: Upper part of lower leg (clevis to load cell)

Step 2. The optional upper and lower tibia load cells are separated by a heavy wall aluminum tube which protects the load cell connectors, as shown in **Figure 11.2.1.2** below.

Figure 11.2.1.2: Optional heavy-wall aluminum tube and tibia load cells

Step 3. The upper and lower tibia load cells are each attached to the tube by four modified 1/4 x 28 button head cap screws. The lower load cell may be rotated 90° if lateral shear and moment are preferred, by using the second bottom slot in the ankle-to-tibia adaptor, as shown in **Figure 11.2.1.3**, or this load cell may be purchased with both moment measurements built in. However, no adjustments are possible except for a friction adjustment at the ankle ball.

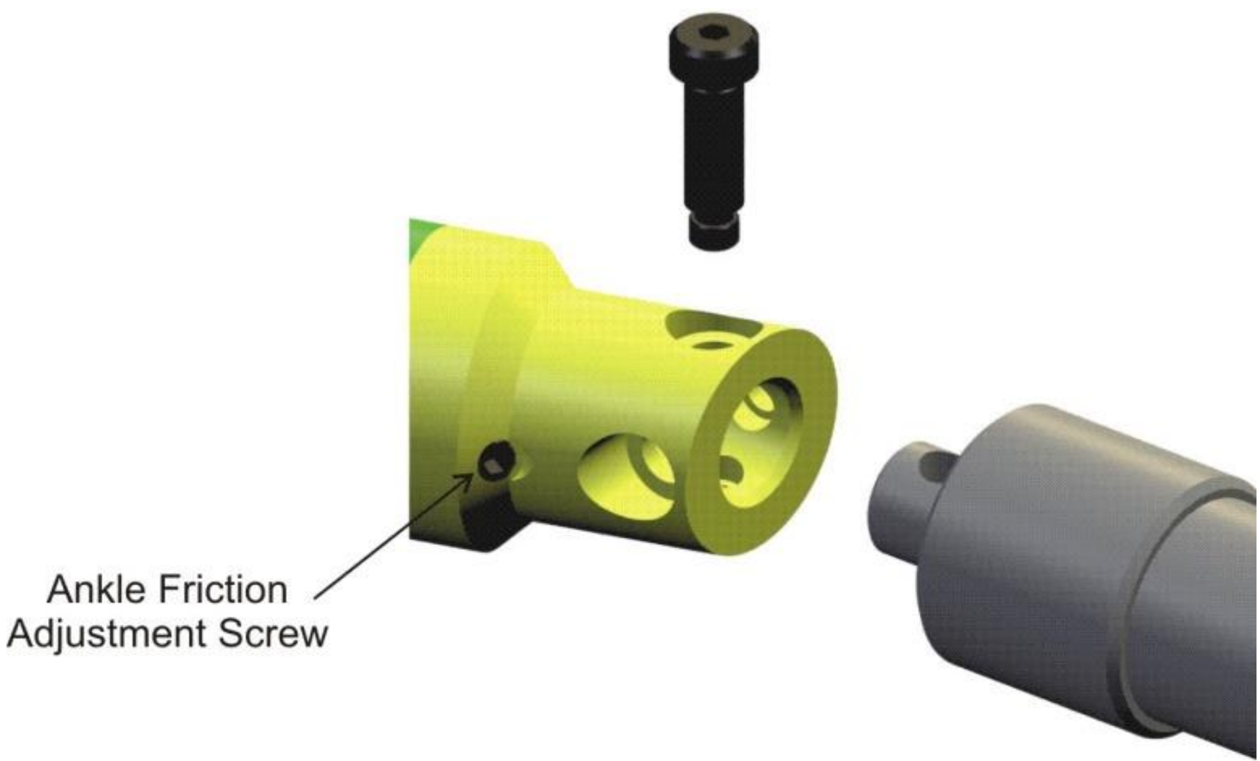

Figure 11.2.1.3: Lower tibia transducer with second bottom slot for 90° rotation of transducer

Section 12. Jacket and Clothing Assembly

12.1. Description and Features of the Jacket and Clothing Assembly

- 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 lbs). 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 light pink.
- The shoes used with the 50th male dummies are men's dress oxfords, size 11XW that meet military specification MIL-S-13192P and whose weight each is 1.25± 0.2 lbs (0.57 ± 0.09 kg).

Section 13. Instrumentation

13.1. Overview

13.1.1. Recommendations when Ordering and/or Purchasing an ATD (Dummy)

When ordering a new test 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.

When purchasing a new head (or an original dummy), inform Humanetics which neck transducer (three or six channel) you intend to use. The skulls are not interchangeable. A six channel upper neck load cell may be furnished with only three channels active and it will fit in the six axis head.

13.1.2. Instrumentation Parts List

The instrumentation parts list for measuring and recording acceleration, deflection, force, and moments with the Hybrid III 50th male pedestrian dummy is summarized below in **Table 13.1.2.1**.

Table 13.1.2.1: Hybrid III 50th male pedestrian dummy instrumentation parts list

Dummy Segment	Acceleration			Deflection			Force and Moment			Channels/ Segment
	P/N	Number of Channels	Qty	P/N	Number of Channels	Qty	P/N	Number of Channels	Qty	
Head	IE-103	1	3				IF-205	6	1	9
Upper Torso	IE-103	1	3	78051 - 317*	1	1				4
Lower Torso	IE-103	1	3				IF-405	6	1	9
Left/Right Upper Leg							IF-625	6	2	12
Left/Right Lower Leg							IF-801	20	1	20
Total										54

Note: *indicates instrumentation included with the dummy

Lab Certification	Optional

13.1.3. Optional Instrumentation Availability

The Hybrid III dummy has many optional but recommended transducers that are listed below in **Table 13.1.3.1**. On the lower extremities, they allow measurement of knee shear (tibia-femur displacement), knee clevis axial load (relative to the knee and ankle joints), and tibia-ankle shear and bending moments, plus three forces. For the neck (both top and bottom) spine, six channel transducers that measure three moments and three forces are becoming preferred.

Table 13.1.3.1: Required and optional instrumentation availability

Instrumentation Location	Measurement	Number of Channels	Required	Optional
Head C.G.	Acceleration	3	X	
Head	Angular Acceleration	9 or 12		X
Head	Angular Rate	3		X
Head-Neck Interface	Force & Moment	3	X	
Head-Neck Interface	Force & Moment	6		X
Thorax C.G.	Acceleration	3	X	
Thoracic Spine	Force & Moment	5		X
Sternum	Displacement	1	X	
Sternum	Displacement	8		X
Lumbar Spine	Force & Moment	5		X
Pelvis	Acceleration	3		X
Pelvis	Lap Belt Position	6		X
Upper Femur	Force & Moment	6 each		X
Lower Femur	Force	1 each	X	
Lower Femur	Force & Moment	6 each		X
Knee-Tibia	Displacement	1 each		X
Knee-Clevis	Force	2 each		X
Upper Tibia	Force & Moment	4 each		X
Lower Tibia	Force & Moment	4 each		X
Foot/Ankle/Toe	Force & Moment	6 each		X

Instrumentation Location	Measurement	Number of Channels	Required	Optional
Shoulder	Force	2 each		X
Sternum	Acceleration	2		X

Section 14. Calibration Tests

14.1. Overview

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

14.2. Head Drop Test

14.2.1. Test Purpose

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

14.2.2. Required Test Parts

The head assembly, the mass of which must be 4.54 kg ± 0.05 kg (10.0 lb ± 0.1 lb), and other assemblies and parts required for this calibration test include the following:

- Head assembly (3 axis)
- Neck transducer or a structural replacement; can be 3-channel or 6-channel
- Head-to-neck pivot pin
- Three accelerometers

14.2.3. Test Fixture

The test fixture consists of a structure to suspend the head assembly and a rigidly supported, flat, horizontal, steel plate. A sample test setup is shown below in **Figure 14.2.5.1**.

- The square plate should be 50.8 mm ± 2 mm (2.0 in ± 0.08 in) thick, with a length and width of 610 mm ± 10 mm (24 in ± 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.
- Effective suspension cable and accelerometer cable masses are to be less than 25 g (0.05 lb).
- 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.

14.2.4. Data Acquisition

The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Filter all data channels using Channel Class 1000 phase-less 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.

14.2.5. 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 cap screws to 7.5 N·m (66 in-lbf).

Step 3. Soak the head assembly in a controlled environment with a temperature of 18.9 to 25.6 °C (66 to 78 °F) and a relative humidity from 10 to 70% for at least four hours prior to a test. The test environment must have the same temperature and humidity requirements as the soak environment.

Step 4. 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 78051-338, Page 2 of 2.

- One 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).
- Ensure that all transducers are properly installed, oriented and calibrated.

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

Step 6. Suspend the head assembly in a manner similar to that shown below in **Figure 14.2.5.1**.

- The lowest point on the forehead is 12.7 mm ± 1 mm (0.5 in ± 0.04 in) below the lowest point of the dummy's nose when the midsagittal plane is vertical.
- The 1.6 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.

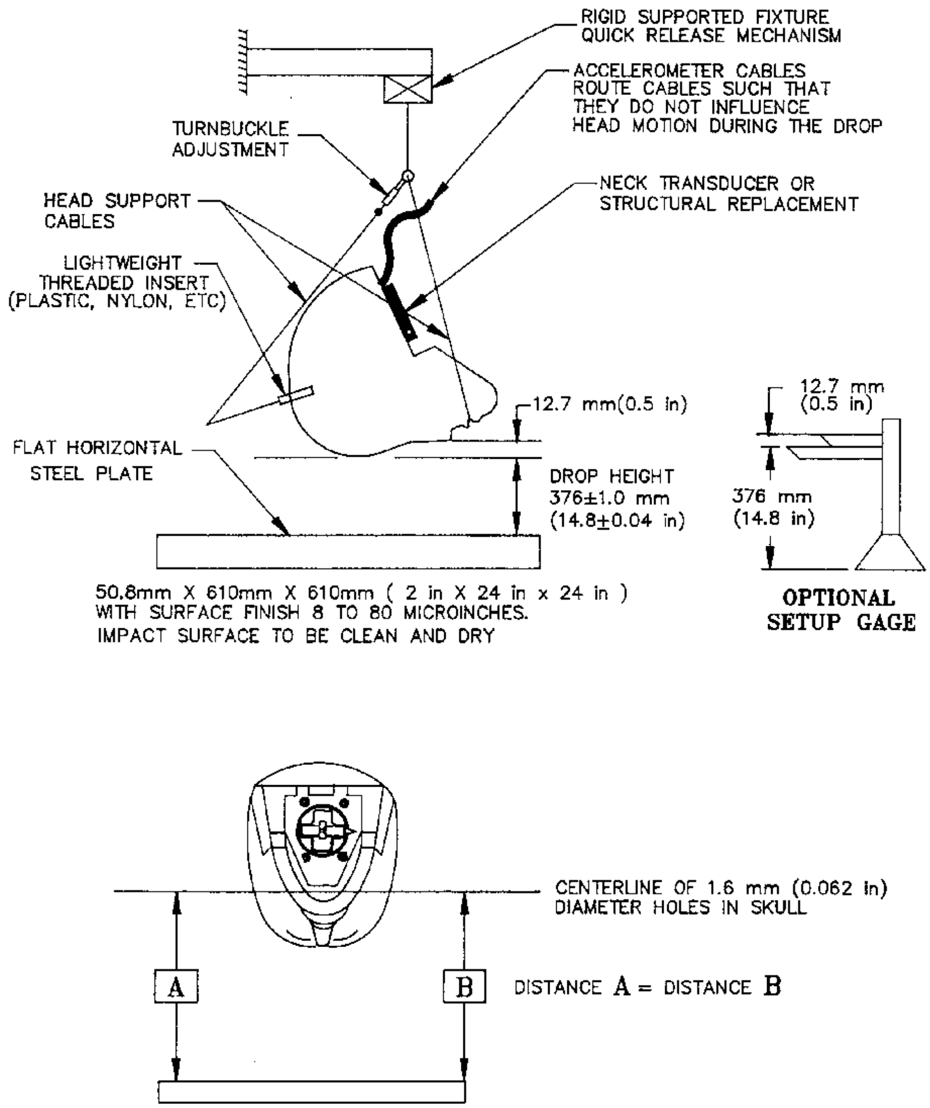

Figure 14.2.5.1: Head drop test/calibration setup specification

Step 7. Drop the head assembly from a height of 376 mm ± 1 mm (14.8 in ± 0.04 in) by a means that ensures a smooth, clean release onto the impact surface.

Step 8. Wait at least three hours between successive tests on the same head assembly.

14.2.6. Performance Specifications

- The peak resultant acceleration must be between 225.0 G and 275.0 G, inclusive.
- The resultant acceleration versus time history curve must be unimodal so that oscillations occurring after the main acceleration pulse are less than 10% (zero to peak) of the main pulse.
- The peak lateral acceleration vector should not exceed 15 G.

14.3. Neck Test

14.3.1. Required Test Parts

The following assemblies and parts are required for this test:

- Head assembly
- Neck assembly
- Upper neck bracket
- Lower neck bracket
- Bib simulator
- Three- or 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.
- Three actual or simulated accelerometers in the head to maintain the proper weight and center of gravity location; data from the accelerometers are not required.

14.3.2. Test Fixture

The test fixture pendulum arm with specifications appears below in **Figure 14.3.2.1**.

- 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.

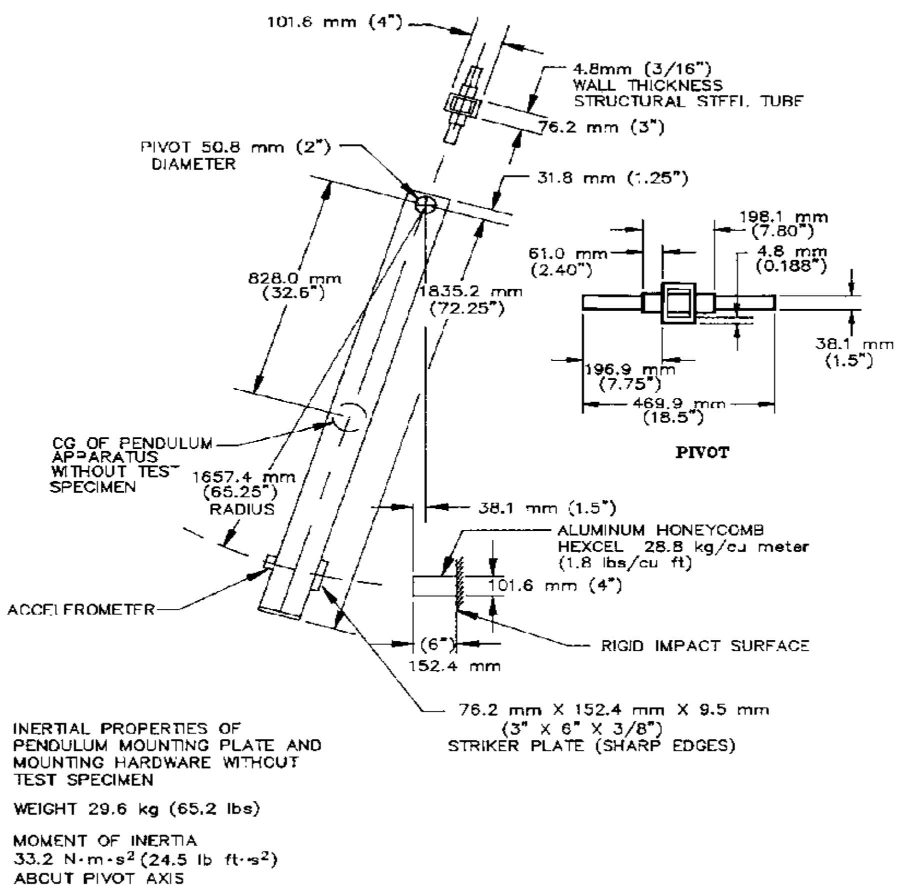

Figure 14.3.2.1: Neck test fixture pendulum arm and specifications

14.3.3. Data Acquisition

The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Use phaseless filters to filter:

- The neck force data channel using Channel Class 1000,
- The neck moment data channel using Channel Class 600,
- The pendulum acceleration data channel using Channel Class 60, and
- The neck rotation data channels using Channel Class 60.

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.

14.3.4. Test Procedure

Step 1. Soak the neck assembly in a controlled environment at a temperature between 20.6 to 22.2 °C (69 to 72 °F) and a relative humidity from 10 to 70% for at least four hours prior to a test. The test environment must 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 2. Inspect the neck assembly for cracks, cuts, and separation of the rubber from the metal segment.

Step 3. Inspect the nodding blocks for any deterioration and replace as necessary. Replace the blocks if they are less than 80% of their original height. The durometer should be 80 to 90 Shore A. Ensure that the nodding blocks are installed correctly, as shown in **Figure 6.2.3.7**.

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. As shown below in **Figure 14.3.4.1** for the flexion test and **Figure 14.3.4.2** for the extension test, the midsagittal plane must coincide with the plane of motion of the pendulum's longitudinal centerline.

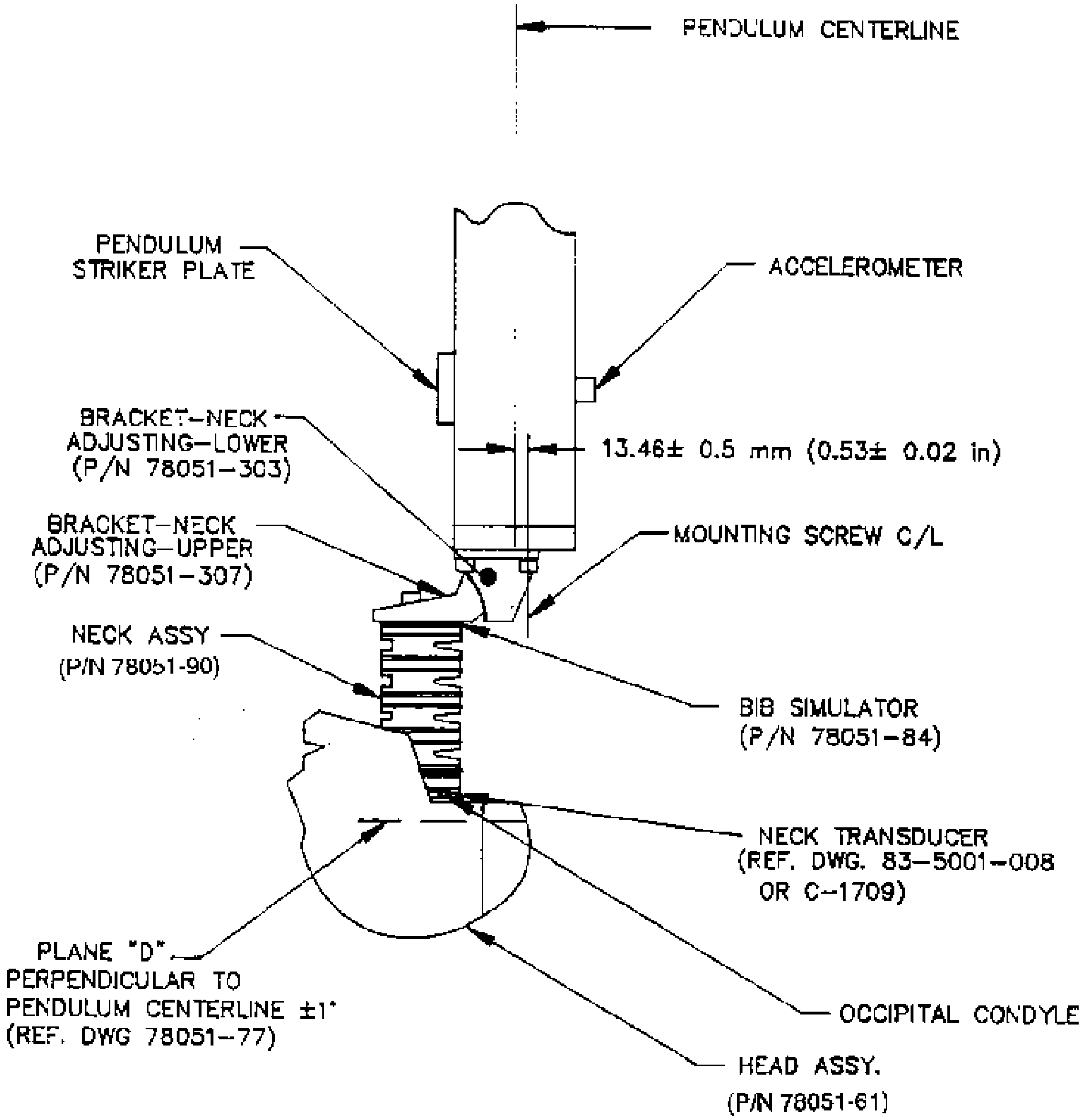

Figure 14.3.4.1: Neck flexion test set-up specification

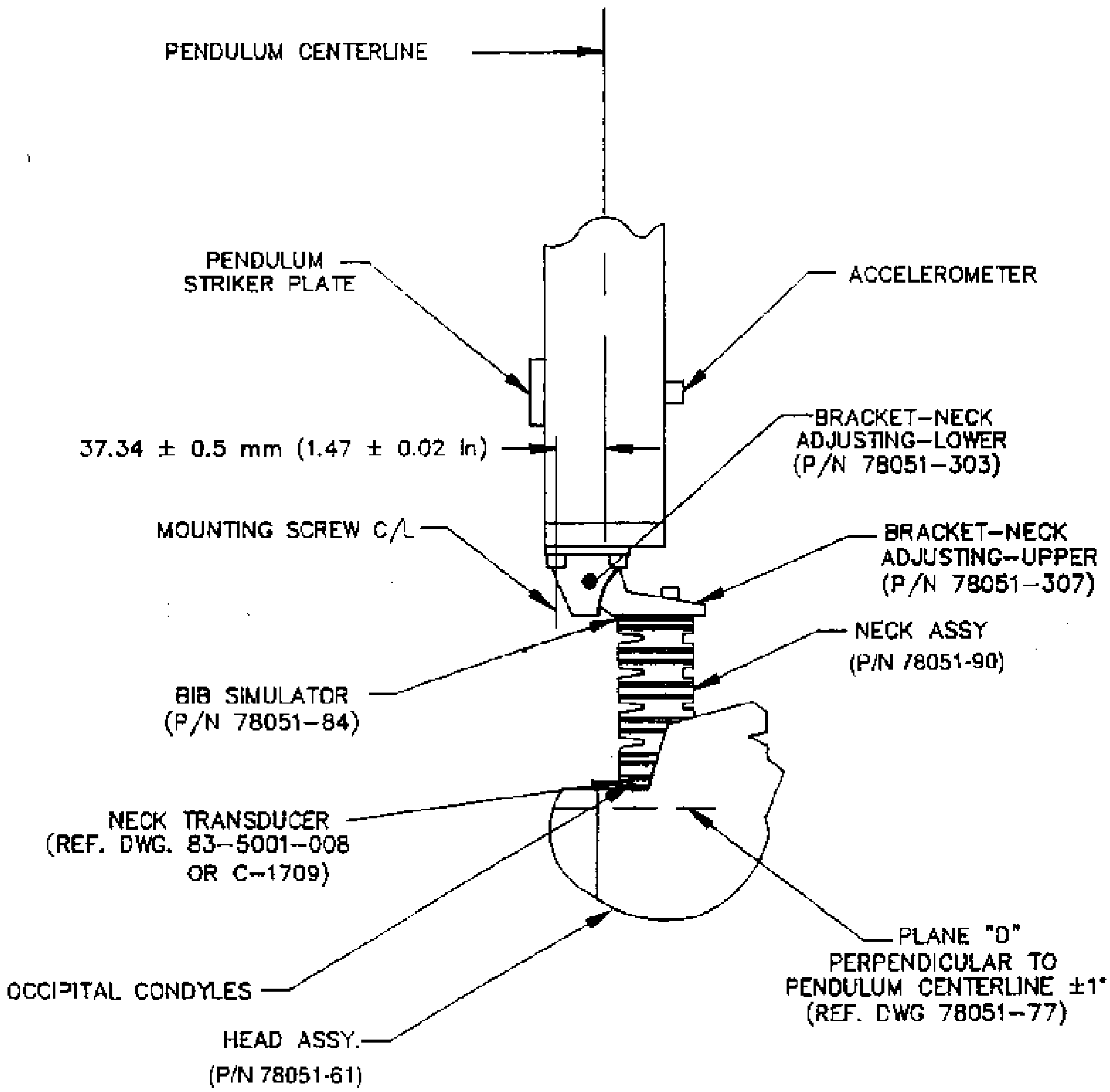

Figure 14.3.4.2: Neck extension test set-up specification

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

Step 7. Torque the jam nut (78051-64) on the neck cable (78051-301) to 1.36 N·m ± 0.27 N·m (1.0 lb-ft ± 0.2 lb-ft) before each test on the same neck.

Step 8. 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 9. With the pendulum resting against the honeycomb material, adjust the neck bracket until the longitudinal centerline of the pendulum is perpendicular within ±1 degree to the D-plane on the dummy's head.

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

Step 11. Calculate the moment about the occipital condyles for both flexion and extension tests using the appropriate formulas from below.

NOTE: The formulas are based on the sign convention contained in the latest revision of SAE Recommended Practice J211-1, and SAE Information Report J1733.

For a three-channel neck transducer:

- **Metric units:** Moment (N·m) = [M_y (N·m)] - [0.008763 m] [F_x (N)]
- **English Units:** Moment (ft-lbf) = [M_y (ft-lbf)] - [0.02875 ft] [F_x (lbf)]

For a six-channel neck transducer:

- **Metric Units:** Moment (N·m) = [M_y (N·m)] - [0.01778 m] [F_x (N)]
- **English Units:** Moment (ft-lbf) = [M_y (ft-lbf)] - [0.05833 ft] [F_x (lbf)]

14.3.5. Test Procedure and Performance Specifications: Neck Flexion

Step 1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 6.89 to 7.13 m/s (22.6 to 23.4 ft/s), measured at the center of the accelerometer.

Step 2. Stop the pendulum from the initial velocity with an acceleration vs. time pulse which meets the velocity change as specified below in **Table 14.3.5.1**. Integrate the pendulum acceleration data channel to obtain the velocity vs. time curve.

Table 14.3.5.1: Neck flexion pendulum deceleration

Time (ms)	Pendulum Deceleration (m/s)
10.00	22.5 - 27.5
20.00	17.6 - 22.6
30.00	12.5 - 18.5
Max. After 30.00	29.0

Decal Time (ms)	Pendulum Deceleration (g)
34-42	to 5

Step 3. The maximum rotation of the head D-plane must be 64.0 to 78.0 degrees with respect to the pendulum and should occur between 57.0 and 64.0 milliseconds after time zero. The decaying head rotation versus time curve must cross the zero angle between 113.0 and 128.0 milliseconds after time-zero.

Step 4. The moment about the Y-axis of the head, measured with respect to the occipital condyles, must have a maximum value between 88.1 and 108.4 N·m (65 and 80 ft-lbf) and must occur between 47.0 and 58.0 milliseconds. The decaying moment versus time curve must first cross zero between 97.0 and 107.0 milliseconds after time-zero.

14.3.6. Test Procedure and Performance Specifications: Neck Extension

Step 1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 5.94 to 6.19 m/s (19.5 to 20.3 ft/s), measured at the center of the accelerometer.

Step 2. Stop the pendulum from the initial velocity with an acceleration versus time pulse which meets the values specified in **Table 14.3.6.1**. Integrate the pendulum acceleration data channel to obtain the velocity versus time curve.

Table 14.3.6.1: Test parameters and performance specifications: Neck extension

Time (msec)	Pendulum Deceleration (m/s)
10.00	17.2 - 21.2
20.00	14.0 - 19.0
30.00	11.0 - 16.0
Max. After 30.00	22.0

Decal Time (ms)	Pendulum Deceleration (g)
38-46	to 5

Step 3. The maximum rotation of the head D-plane must be 81.0 to 106.0 degrees with respect to the pendulum and should occur between 72.0 and 82.0 milliseconds after time-zero. The decaying head rotation versus time curve must cross the zero angle between 147.0 and 174.0 milliseconds after time-zero.

Step 4. The moment about the Y-axis of the head, measured with respect to the occipital condyles, must have a maximum value between -52.9 and -80.0 N·m (-39 to -59 ft-lbf) and must occur between 65.0 and 79.0 milliseconds. The decaying moment versus time curve must first cross zero between 120.0 and 148.0 milliseconds after reaching its peak value.

14.4. Thorax Impact Test

14.4.1. Required Test Parts

The complete dummy assembly is required for this test, including the clothing (shirt and pants), but not including the shoes.

Note: This test must be performed with the automotive (not pedestrian) lower torso and legs.

14.4.2. Test Fixture

The fixture consists of a smooth, clean, dry, steel seating surface and a test probe. The positioning of the dummy for testing purposes is shown below in **Figure 14.4.4.1**.

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

14.4.3. Data Acquisition

The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Filter all data channels using Channel Class 180 phaseless filters.

Note:

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

14.4.4. Test Procedure

Step 1. Remove the chest flesh 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 two lumbar cables to 1.1 to 1.4 N·m (10 to 12 in·lbf).

Step 3. Soak the test dummy in a controlled environment with a temperature of 20.6 to 22.2 °C (69 to 72 °F) and a relative humidity from 10 to 70% 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 4. Check that all transducers are properly installed, oriented, and calibrated.

Note: For the remainder of the steps in this procedure, please refer to **Figure 14.4.4.1** below.

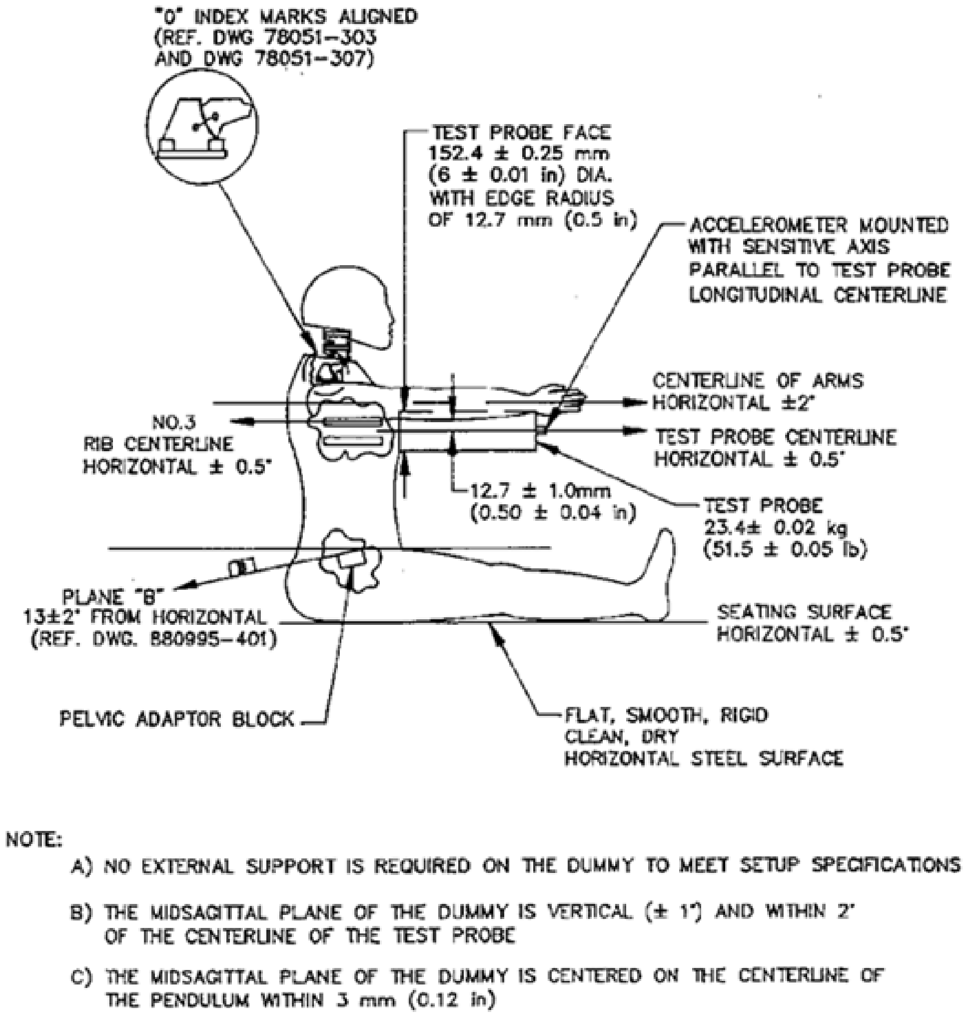

Figure 14.4.4.1: Thorax impact test setup specifications

Step 5. Seat the dummy (without the chest flesh but with the pants) on the test fixture surface. The surface must be long enough to support the pelvis and outstretched legs.

Step 6. Align the upper and lower neck bracket index marks to the zero position.

Step 7. Place the arm assemblies horizontal (± 2°) and parallel to the midsagittal plane. Secure the arms in position by tightening the adjustment nut which 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 to within ±0.5° and adjust the pelvis angle to 13 ± 2°. (Use the special tool which 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.)

Step 9. The midsagittal plane of the dummy must be within ± 1° of vertical and within ±2° of being parallel to the centerline of the test probe.

Step 10. The longitudinal centerline of the test probe is centered on the midsagittal plane of the dummy within 3 mm ± 0.25 mm (0.12 in ± 0.01 in).

Step 11. Align the test probe so its longitudinal centerline is 12.7 mm ± 1 mm (0.5 in ± 0.04 in) below the horizontal centerline of the No. 3 rib and is within 0.5 degree of a horizontal line in the dummy's midsagittal plane.

Step 12. 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 flesh.

Step 13. 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 flesh, so the probe will impact at the lowest point on its arc of travel.

Step 14. Install the chest flesh and shirt and reposition the dummy as described in the preceding paragraph using the recorded reference measurements. The reference locations must be accessible after installation of the chest flesh, so it may be necessary to leave the chest flesh unzipped until the references are checked, and then fasten it just prior to the test.

Step 15. Impact the thorax with the test probe so the probe's longitudinal centerline is within 2 degrees of a horizontal line in the dummy's midsagittal plane at the moment of impact.

Step 16. Guide the probe so no significant lateral, vertical or rotational motion takes place during the impact.

Step 17. 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 18. Wait at least 30 minutes between successive tests on the same thorax.

14.4.5. Performance Specifications

- The maximum sternum-to-spine deflection, as measured by the chest displacement transducer, should lie between 63.5 and 72.6 mm (2.50 to 2.86 in).
- The maximum force applied to the thorax by the test probe should measure between 5160 and 5894 N (1160 to 1325 lb.).
- The hysteresis ratio, determined from the force versus deflection curve, is the ratio of the area between the loading and unloading portions of the curve to the area under the loading portion of the curve. The internal hysteresis ratio for this test must be greater than 69% but less than 85%.

14.5. Knee Impact Test

14.5.1. Required Test Parts

The required assemblies and parts for the knee impact test are the:

- Knee cap
- Knee flesh and skin assembly
- Knee insert

14.5.2. Optional Test Parts

The optional assemblies and parts for the knee impact test are the:

- Knee slider assembly
- Lower leg assembly
- Femur load cell or structural replacement

14.5.3. Test Fixture

The test fixture consists of a rigid test probe and a method of rigidly supporting the knee and lower leg assembly. The test setup is shown below in **Figure 14.5.3.1**.

- The test probe mass is 5.0 kg ± 0.01 kg (11.0 lb ± 0.02 lb), including instrumentation, rigid attachments, and the lower 1/3 of the suspension cable mass.
- The diameter of the impacting face is 76.2 mm ± 0.25 mm (3.0 in ± 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.

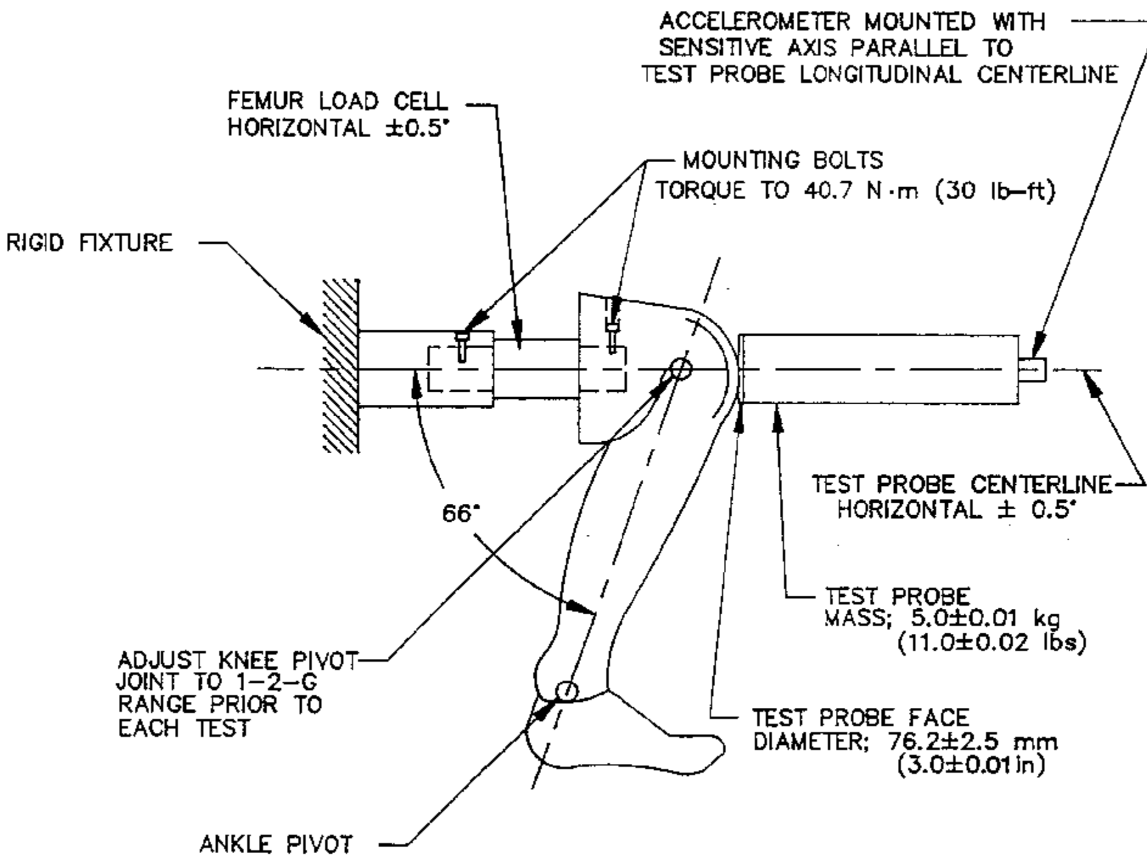

Figure 14.5.3.1: Knee impact test setup and specifications

14.5.4. Data Acquisition

The data acquisition system, including transducers, must conform to the requirements of the latest revision of SAE Recommended Practice J211-1. Filter all data channels using Channel Class 600 phaseless filters.

Note:

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

14.5.5. Test Procedure

Step 1. Inspect the knee assembly for cracks, cuts, abrasions, etc. If the machined knee is cracked or broken in the impact area, replace the machined knee. If the insert is cut, replace the insert.

Step 2. Soak the knee assembly in a controlled environment with a temperature of 18.9 to 25.6 °C (66 to 78 °F) and a relative humidity from 10 to 70% 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 3. Mount the knee/lower leg assembly to the fixture using a femur load cell or load cell simulator. Torque the load cell simulator bolts to 40.7 N·m (30 ft-lbf) to prevent slippage of the assembly during the impact. When using the lower leg assembly, adjust the lower leg so the line between the knee and ankle pivots is at an angle of 24 ± 1° rearward of vertical. Do not let the foot contact any exterior surface.

Step 4. Align the longitudinal centerline of the test probe so it is collinear (within ± 2.0 degrees) with the longitudinal centerline of the load cell simulator at the time of impact.

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

Step 6. Impact the knee so the longitudinal centerline of the test probe is within 0.5 degree of a horizontal line parallel to the load cell simulator at time-zero.

Step 7. The test probe velocity at the time of the impact must be 2.07 to 2.13 m/s (6.8 to 7.0 ft/s).

Step 8. Wait at least 30 minutes between successive tests on the same knee.

14.5.6. Performance Specifications

The peak impact force (defined as the product of the test probe mass and the deceleration) must be between 4715 and 5782 N (1060 and 1300 lbf).

Section 15. Appendices

15.1. Appendix A: Accelerometer Handling Guidelines

15.1.1. General Information

The accelerometers used in anthropomorphic test dummies, such as the Hybrid III dummy family, are small, low mass piezoresistive accelerometers. Because of their design and inherent mechanics, certain precautions must be observed when handling and mounting accelerometers to avoid damaging them.

When handling and mounting the accelerometer, avoid dropping or striking it against hard surfaces. Keep the unit in its protective sleeve until the unit is installed.

15.1.2. Preliminary Check-Out

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

1) **Impedance Test:** Read the input impedance (red to black) and output impedance (green to white) with an ohmmeter. Compare the measured values to those on the accelerometer calibration data sheet. The measured impedance should be within ±25% of the calibrated value.
2) **Insulation Resistance:** If the input and output impedances are within acceptable limits, use a multi-meter, ohmmeter, or mega-ohmmeter 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.

   All three readings should be at least 100 megohms. Be careful when connecting 50 VDC to eliminate the possibility of voltage spikes.
3) **Zero Measurand Output:** After the impedance and insulation resistance tests, measure the output of the accelerometer with 0 G acceleration.
    - With the unit still in its sleeve, turn the unit on its side so the accelerometer mounting surface is perpendicular to the table top (sensitive axis horizontal and perpendicular to the gravity field.)
    - After letting the accelerometer warm up for two minutes, apply the specified excitation voltage it and measure its output with a DC millivolt meter.
    - 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:

Step 1. Check and record leg 1, leg 2, leg 3, and leg 4 resistances.

Step 2. Disconnect, check and record excitation voltage from the source.

Step 3. Reconnect, check, and record excitation with the unit connected.

Step 4. Check and record ZMO again.

Step 5. Check and record static outputs +1 G and -1 G and compare to calibrated sensitivity.

Step 6. Check that the temperature and environment fall within accelerometer specification.

Step 7. Check to see if the accelerometer case is under stress.

Step 8. Check leads for abrasion or cuts.

If the reason for the erroneous reading cannot be found after completing all of the above checks, contact the accelerometer manufacturer.

15.1.3. Installation

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

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

Correct torque is important to ensure correct mounting and performance. When mounting the accelerometer, use only the materials and parts which are supplied with the accelerometer. Always use the proper mounting torque recommended by the accelerometer manufacturer. If applicable, use the supplied mounting washers and screws, or mounting stud. Using the supplied wrench, turn the screws in the mounting holes to 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 removed.

Note:

- Excessive torque can create an over-range transient shock pulse when removing 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 due to 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.

15.1.4. 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.

15.1.5. Cleaning

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

Note:

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

15.2. Appendix B: Guidelines for Repairing Flesh

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

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

Conduct all flesh preparations and repairs in a well-ventilated area. When patching, first clear away any loose material which may be hanging from the damaged areas, such as shredded vinyl or foam. Clean the area with 99% solution isopropyl alcohol and dry for 15 minutes. Any residue from tape or chalk must be removed. If it remains after the initial cleaning, continue to clean with isopropyl alcohol until the area is completely clean. Since isopropyl alcohol is flammable, make sure the surface is dry before applying heat. Do not use soldering flux or any other chemical on the flesh or repair iron.

After preparation, a patch can be bonded to the flesh. Cut a patch of adequate size from the material provided in the dummy tool kit. The patch should be approximately 10 mm (0.5 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. Once you bond the patch to the flesh, you need to blend the patch into the flesh. This will eliminate any protruding edges that may later snag and ruin the repair. To blend the patch, work the iron tip around the patch edges in a circular motion, blending the patch material into the flesh as you work your way around the patch. If the iron is too hot, black flakes will appear; if it is too cold, the patch will not readily melt, and the patch is probably not very well bonded to the flesh. Continue working the patch into the flesh until the repair is fairly well hidden and let it cool. After the area cools, you can return to touch-up any areas.

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

15.3. 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 5.34kN (1200 lbf). No separation should occur. Replace as required.

Section 16. Legal Disclaimers and Notices

16.1. 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.

16.2. Proprietary Statement

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16.3. 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.

16.4. About Humanetics

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http://www.stholdingsinc.com/our-companies

Section 17. User Manual Update Log

Table 17.1: User manual update log

Revision Level	Revision Date	Revision Author	Revision Description
A	May 2017	M. Tran	Initial release of harmonized user manual.