SECTION 11- PELVIS ASSEMBLY

11.1 Pelvis Assembly Description and Features

The pelvis assembly of the THOR dummy is a mechanical representation of the human pelvis. The assembly consists of a cast aluminum pelvic structure which was designed to approximate the geometry of the human pelvic bone structure. The location of two important anthropomorphic landmarks have been carefully maintained; the D-points and the ASIS points. These landmarks provide locations that can be directly related to the human pelvis. The front of the casting has been machined to accept the pelvic box assembly which holds the acetabular load cells and acetabular cups. The top of the pelvic casting was machined to accept the lumbar/pelvis mounting block to allow attachment of the spine assembly. **Figure 11.1** shows a drawing of the completed pelvic assembly.

There are several different types of instrumentation that have been incorporated into the pelvic region. A triaxial accelerometer mounting location is provided in the rear cavity of the pelvis to measure the accelerations of the pelvic center of gravity in three axes. Two acetabular load cells (Denton: Model 3455) were designed to measure the loads that are transferred through the femurs to the pelvic structure. Finally, the iliac crest region of the pelvic casting was instrumented with a miniature compression load cell on both the left and right sides to indicate the presence of belt loading.

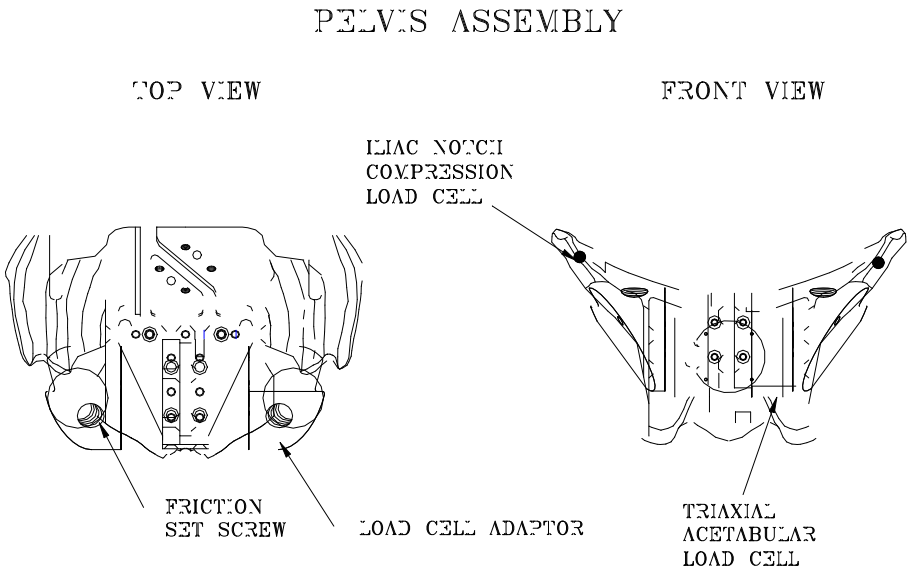

Figure 11.1- Pelvis assembly

11.2 Assembling the Pelvis

11.2.1 Parts List

The parts list and all quantities for the pelvis assembly are listed in Appendix I - Bill of Materials under the Pelvis subsection. Refer to drawing T1PLM000 in the THOR drawing set for a detailed mechanical assembly drawing. **Figure 11.2** is a photograph of the exploded pelvis assembly and hardware. The Left and Right Femur Ball Joint Assembly (T1FMM100/101) are shown below because they are assembled to the pelvis in this section but is considered to be part of the Femur Assembly (T1FMM000).

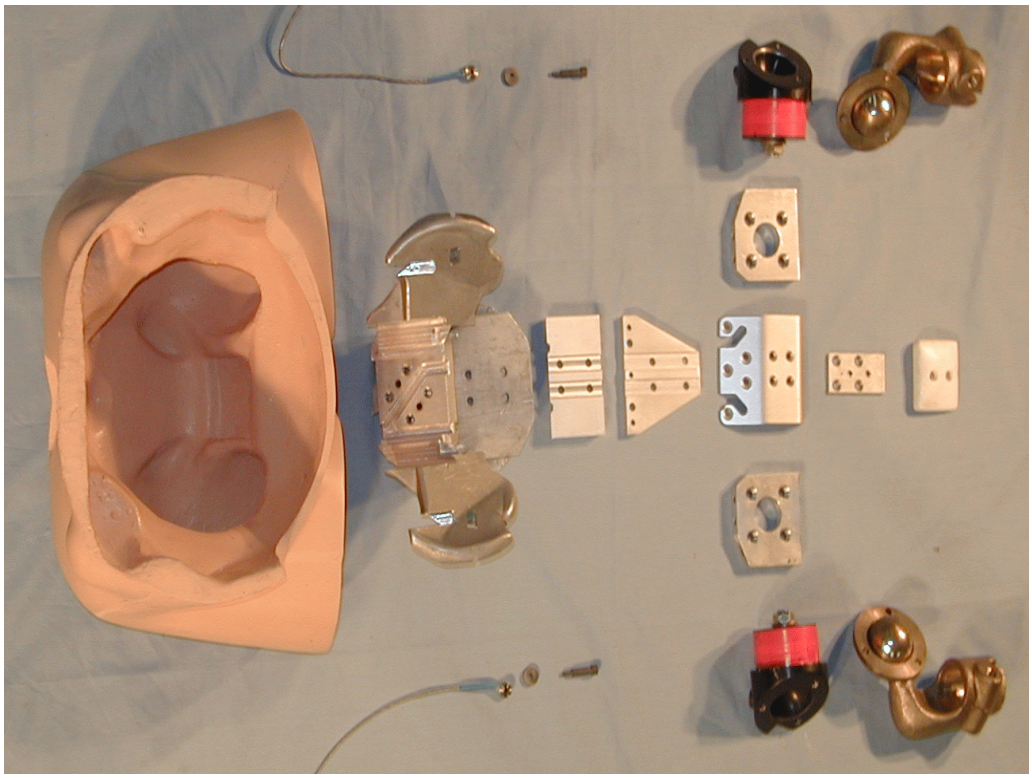

Figure 11.2- Exploded pelvis assembly

11.2.2 Assembling Pelvis Components

The following procedure is a step-by-step description of how to assemble the pelvis components. Completion and integration of several subassemblies is required to create the pelvis assembly. The numbers provided in ( ) refer to a specific drawing / part number of each part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values.

1. Attach the Left Load Cell Mounting Plate (T1PLM210) to the Left Acetabulum Load Cell (T1INM340) using four 1/4"-20 x 5/8" FHSCS-NP {5/32}. Orient the load cell wiring to the mounting plate as shown in **Figure 11.3.**

NOTE: Orientation of the acetabular load cell axes and wiring is critical to the assembly of the pelvis. Improper orientation will prevent the load cell from fitting within the pelvic casting.

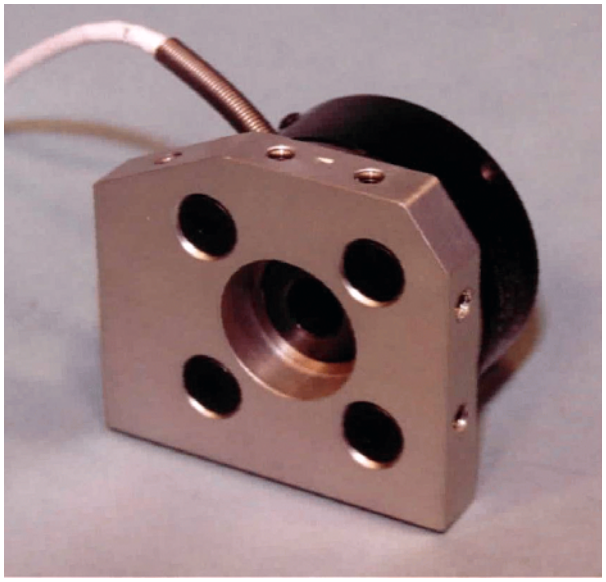

Figure 11.3- Orientation of Load Cell on plate

2. Insert the shaft of the Left Pelvic Socket Adaptor (T1PLM217) into the left acetabulum load cell. The orientation of the pelvic socket adaptor and the load cell is shown in **Figure 11.4**. Align the dowel pins holes of the load cell with the dowel pins in the socket adaptor. Insert the ½" ID flat washer onto the adaptor shaft. Use ½" nylon lock hex jam nut to secure the socket adaptor to the acetabulum load cell. Tighten securely to the torque range listed in section 2.1.3- Bolt Torque Values.

WARNING: There must be four 1/4" dowel pins between the pelvic socket adaptor and the acetabulum load cells to provide correct shear and rotational load transfer.

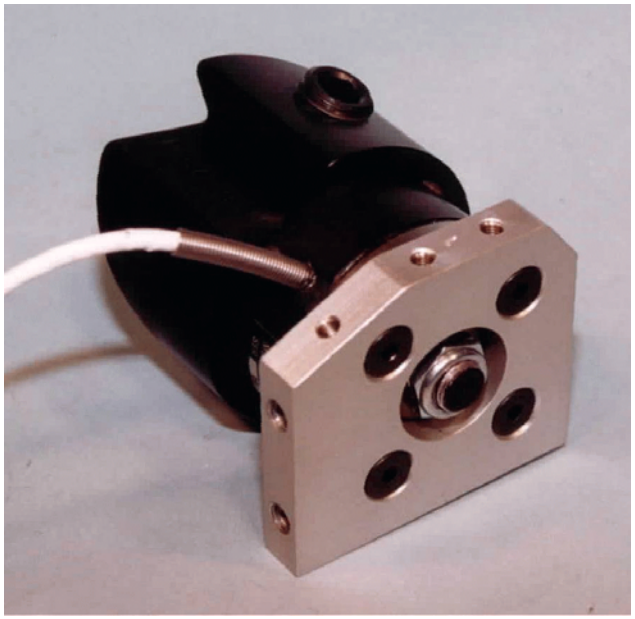

Figure 11.4- Orientation of socket adaptor to load cell

3. Attach the Rear Plate (T1PLM214) to the Bottom Plate (T1PLM212) using three #8-32 x ½" FHSCS {3/32}, as shown in **Figure 11.5**.

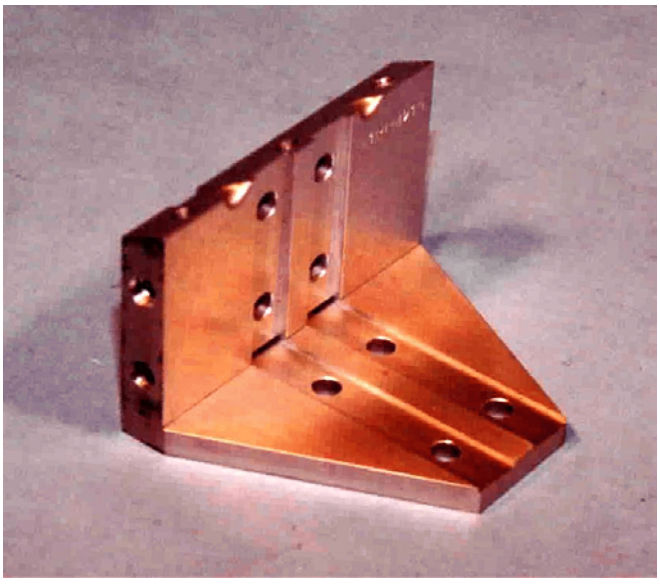

Figure 11.5- Rear Plate attached to Bottom Plate

4. Secure the left socket / load cell assembly, prepared in Step 2, into the left groove of the bottom plate, aligning the threaded holes with the thru holes of the base. Bolt the left socket / load cell assembly to the rear plate using two 1/4"-28 x 3/4" FHSCS {5/32}, as shown in **Figure 11.6**.

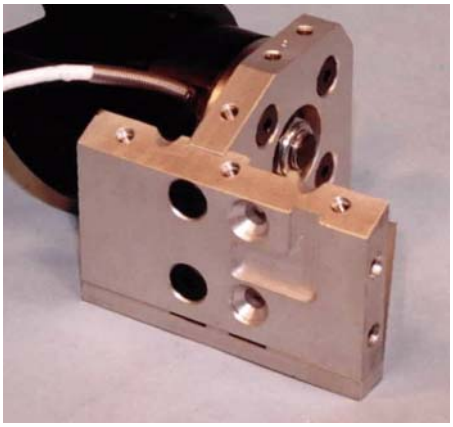

Figure 11.6- Left Socket assembly attached to Rear Plate

5. Attach the Right Load Cell Mounting Plate (T1PM211) to the Right Acetabulum Load Cell (T1INM341) using four 1/4"-20 x 5/8" FHSCS-NP {5/32}. Orient the load cell wiring to the mounting plate as shown in **Figure 11.7**.

NOTE: Orientation of the acetabular load cell axes and wiring is critical to the assembly of the pelvis. Improper orientation will prevent the load cell from fitting within the pelvic casting.

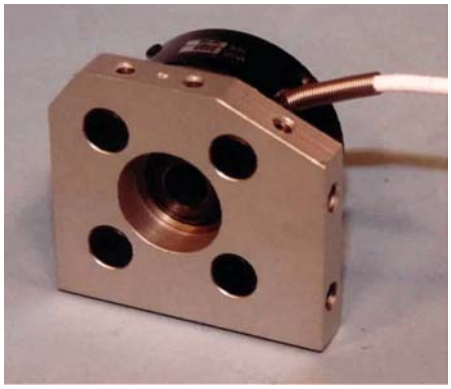

Figure 11.7- Orientation of Load Cell on Plate

6. Insert the shaft of the Right Pelvic Socket Adaptor (T1PLM218) into the right acetabulum load cell. The orientation of the pelvic socket adaptor and the load cell is shown in **Figure 11.8**. Align the dowel pin holes of the load cell with the dowel pins in the socket adaptor. Place the ½" ID flat washer onto the adaptor shaft. Use ½" nylon lock hex jam nut to secure the socket adaptor to the acetabulum load cell. Tighten securely to the torque range listed in Section 2.1.3- Bolt Torque Values.

WARNING: There must be four 1/4" dowels between the pelvic socket adaptor and the acetabulum load cells to provide correct shear and rotational load transfer.

Figure 11.8- Orientation of socket adaptor to load cell

7. Secure the right socket / load cell assembly, prepared in Step 6, into the right groove of the bottom plate, aligning the threaded holes with the thru holes of the base. Bolt the right socket / load cell assembly to the rear plate using two 1/4"-28 x 3/4" FHSCS {5/32}, as shown in **Figure 11.9**.

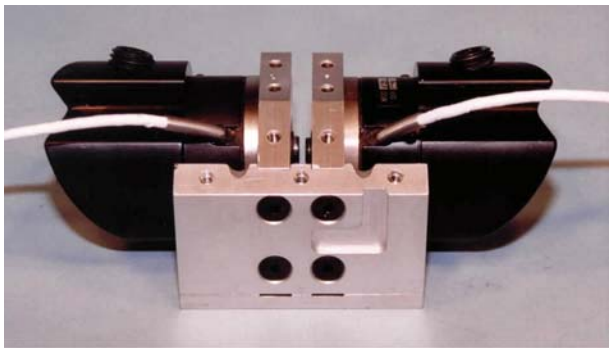

Figure 11.9- Socket assemblies attached to Rear Plate

8. Bolt the Top Plate (T1PLM213) to the top of the left and right load cell mounting plates, using nine #10-32 x 3/8" FHSCS {1/8}, as shown in **Figure 11.10**. The acetabular load cell wires must exit through the grooves at the rear of the top plate.

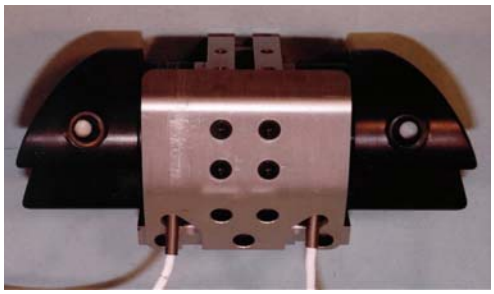

Figure 11.10- Top Plate assembled to Pelvic Box

9. Bolt the Front Plate (T1PLM215) on to the front of the left and right load cell mounting plates using four #10-32 x 3/8" FHSCS {1/8}, as shown in **Figure 11.11**.

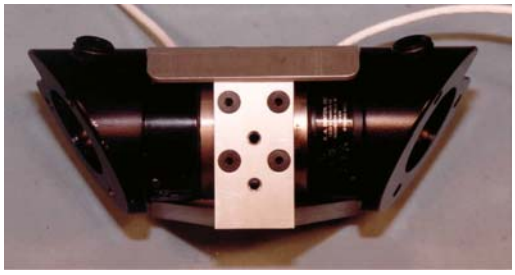

Figure 11.11- Front Plate attached to Pelvic Box

10. Attach the Front Pelvic Casting (T1PLM219) to the front plate using two #10-32 x 5/8" BHSCS {1/8}, as shown in **Figure 11.12**. At this stage, this assembly is referred to as the pelvic box assembly.

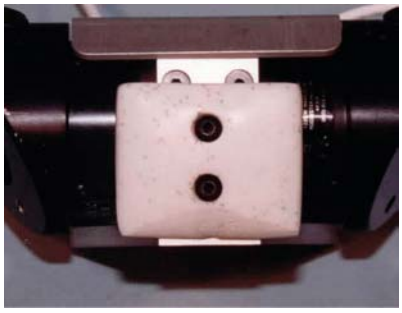

Figure 11.12- Front Casting

11. Place the Pelvic Box Assembly (T1PLM200) into the Machined Pelvic Casting (T1PLM010). Insert and begin tightening two 1/4"-28 x 3/4" FHSCS {5/32} on each side of the machined pelvic casting into the pelvic box assembly, as shown in **Figure 11.13**, leaving the bolts loose.

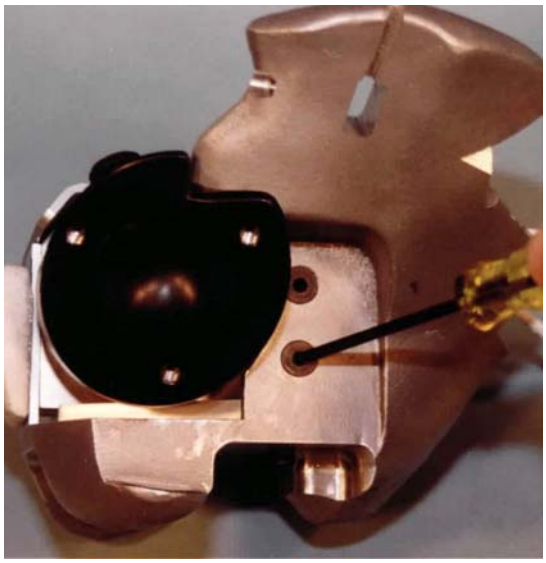

Figure 11.13- Pelvic Box side mounting bolt locations

12. Insert and tighten six 1/4"-28 x 3/4" SHCS {3/16} into the bottom of the pelvis, as shown in **Figure 11.14**. Tighten all the pelvis mounting bolts.

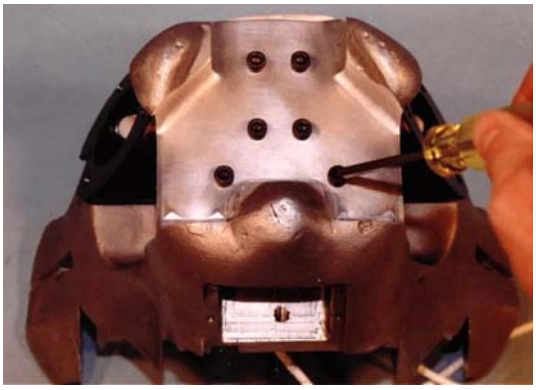

Figure 11.14- Pelvic Box bottom mounting bolt locations

13. A triaxial accelerometer unit can be attached to a mounting plate which will be attached at the pelvis CG. The THOR dummy is designed to accept mounting plates for both the triaxial cube and tri-pack accelerometer configurations. The mounting procedure for each type of triaxial accelerometer is explained in detail below:

    Triaxial cube type accelerometers: Refer to drawing T1PLM100 for additional details. This type of triaxial accelerometer is a one-piece unit (T1INM120). The unit is attached to the Pelvis Triaxial Mounting Bracket (T1TXM110) using two #4-40 x 1/4" FHSCS {1/16}, as shown in **Figure 11.15**.

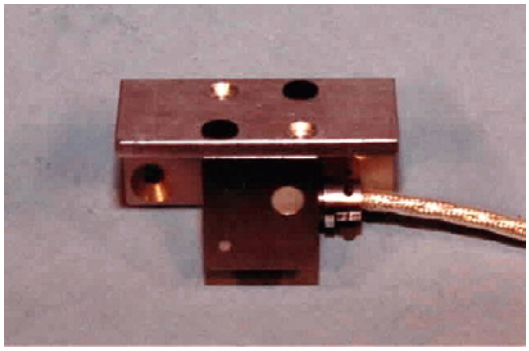

Figure 11.15- Triaxial accelerometer mounted on bracket

The stamped markings on the unit are oriented in the following manner: +X forward, +Y right, +Z down. This sign convention is in agreement with the SAE coordinate system. The pelvis triaxial mounting bracket is mounted in the cavity at the rear of the pelvic casting using four #6-32 x 3/8" SHCS {7/64}, as shown in **Figure 11.16**.

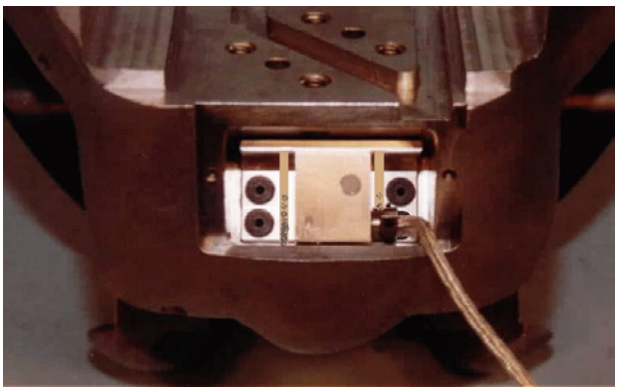

Figure 11.16- Accelerometer mounted in pelvis

Tri-Pack type accelerometers: Refer to drawing T1PLM101 for additional details. This type of triaxial accelerometer consists of a Tri-Pack Block (T1INM130) which holds three Uniaxial Accelerometers (T1INM110) on the outer surface. The three uniaxial accelerometers are mounted on the tri-pack block using six #0-80 x 1/4" SHCS {0.05}. The instrumented tri-pack block is mounted to the top of the Pelvis Tri-Pack Mounting Bracket (T1PLM112) using two #2-56 x 9/16" SHCS {5/64}, as shown in **Figure 11.17**.

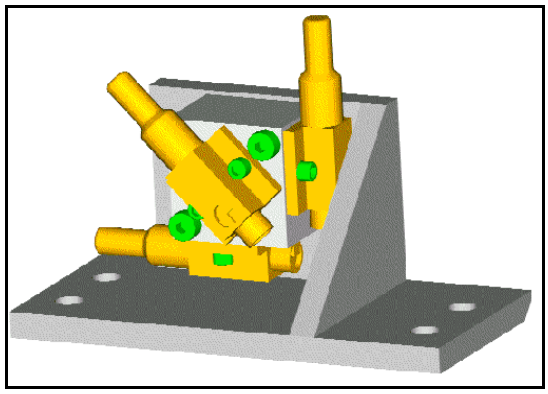

Figure 11.17- Tri-pack accelerometer assembled on mounting bracket

The orientation of the accelerometers is: +X forward, +Y right, +Z down. This sign convention is in agreement with the SAE coordinate system. The pelvis triaxial mounting bracket is mounted in the cavity at the rear of the pelvic casting using four #6-32 x 3/8" SHCS {7/64}, as shown in **Figure 11.18**.

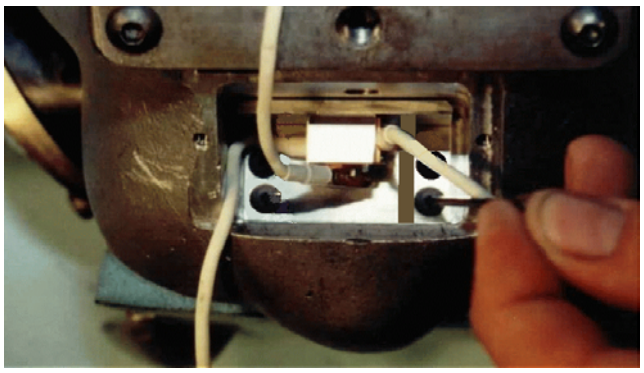

Figure 11.18- Tri-pack installed in pelvis

14. Secure the triaxial accelerometer wires to the inside of the Pelvis Triaxial Cover (T1PLM111) using a 1/8" wire clamp, a #6-32 x ½" FHSCS and a #6-32 nylock nut, as shown in **Figure 11.19**. These wires are then joined to the bundle of wires at the base of the spine.

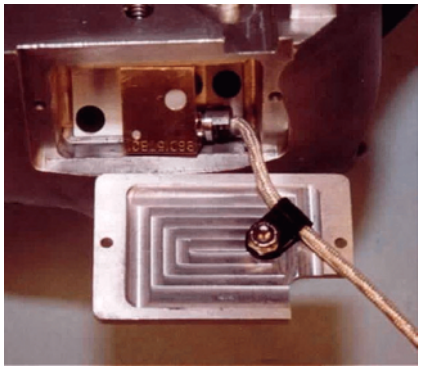

Figure 11.19- Strain relief

15. Install the Pelvis Triaxial Cover (T1PLM111) over the cavity in the pelvis casting using two #4-40 x 3/8" FHSCS {1/16}, as shown in **Figure 11.20**. The cover must be oriented with the wire exit hole at the top-right corner as shown.

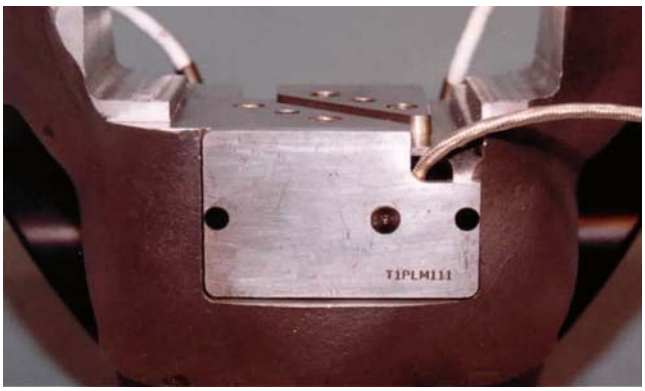

Figure 11.20- Triaxial accelerometer cover

16. Position a Uniaxial Compression Load Cell (T1INM410) in the machined grove on the left iliac wing of the pelvis. Slide the Iliac Load Cell Washer (T1PLM017) behind the load cell and align the through holes in the washer and load cell. The placement of the washer and load cell is shown in **Figure 11.21**. The wires for the load cells are strain relieved with a 1/8" cable clamp and a #6-32 x ½" BHSCS {5/64}, and joined to the bundle of wires running down the back of the spine.

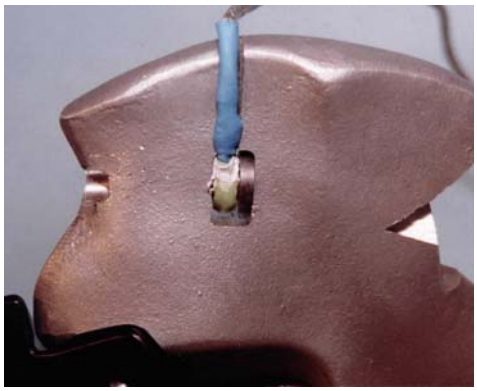

Figure 11.21- Iliac load cell and washer

17. Insert the Iliac Load Cell Plunger (T1PLM018) into the hole located at the left iliac notch and push the plunger toward the rear to mate with the load cell and load washer, as shown in **Figure 11.22**.

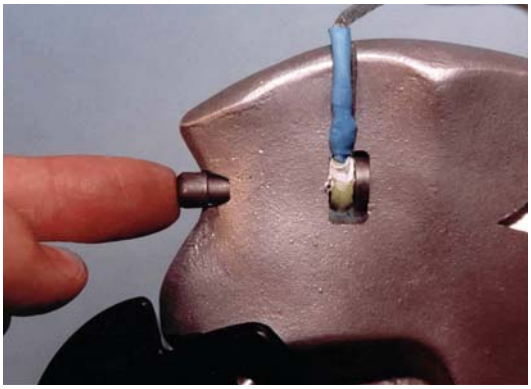

Figure 11.22- Iliac load cell plunger

18. Repeat Steps 16 and 17 for the right iliac wing load cell.

19. Attach the Left Femur Ball Joint Assembly (T1FMM100) to the Left Pelvic Socket Adaptor (T1PLM217) using three 1/4"-28 x 5/8" SHCS {3/16} as shown in **Figure 11.23**.

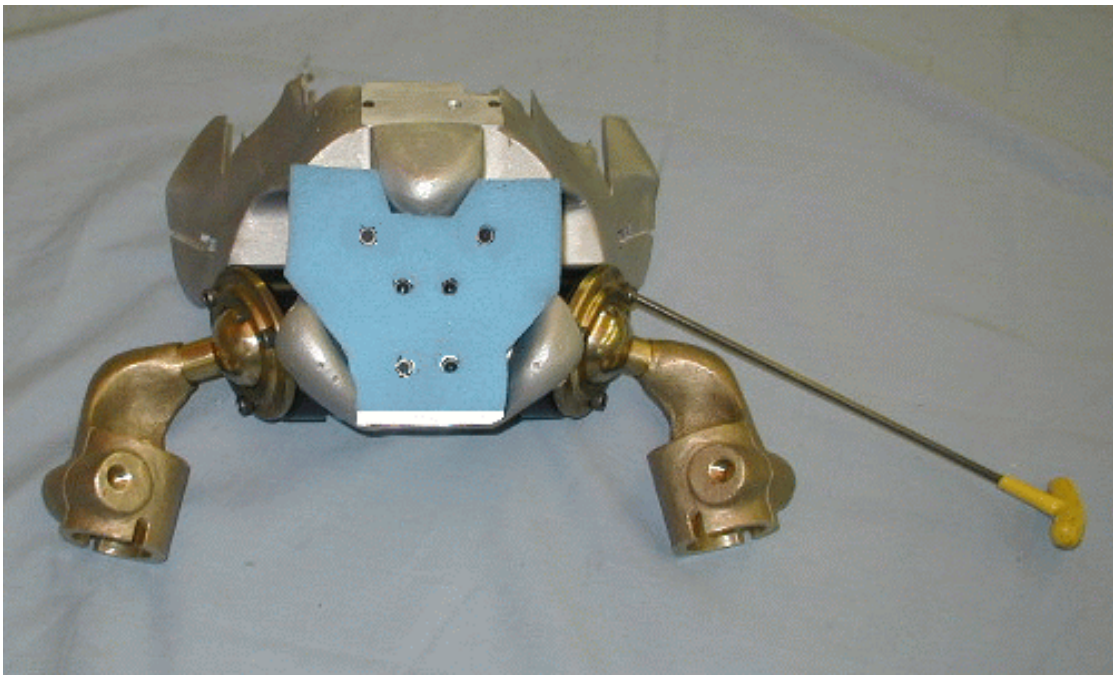

Figure 11.23- Femur ball joint assemblies attached to pelvis

20. Repeat Step 20 for the Right Femur Ball Joint Assembly (T1FMM101).

21. Install the completed mechanical pelvis assembly into the Molded Pelvis Skin (T1PLS000), as shown in **Figure 11.24.**

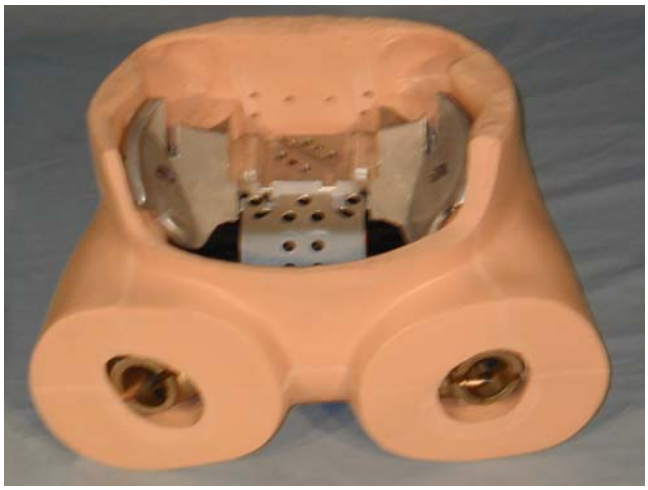

Figure 11.24- Pelvis assembly installed into skin

11.2.3 Attaching the Pelvis to the Spine

The following procedure is a step-by-step description of how to attach the completed Spine Assembly (T1SPM000) to the completed Pelvis Assembly (T1PLM000). The numbers provided in ( ) refer to a specific drawing / part number of each particular part. The numbers noted in { } after the bolt size indicate the hex wrench size required to perform that assembly step. All bolts should be tightened to the torque specifications provided in Section 2.1.3- Bolt Torque Values. For additional details, refer to Section 6.2.1- Steps 1 through 3.

1. Remove the Pelvis / Lumbar Mounting Block (T1SPM810) from the Lumbar Flex joint (T1SPM700) by removing the four 5/16-18 x 3/4" FHSCS-NP {3/16}.

2. The pelvis / lumbar spine mounting block is attached to the Pelvis Assembly (T1PLM000) using the four 1/4-20 x 1" SHCS {3/16}, as shown in **Figure 11.25**. The mounting block is positioned with the tilt sensor assembly toward the front of the pelvis assembly. The wires from the pelvic acetabular load cells must be routed with the pelvis tilt sensor wire in the grooves provided in the pelvis assembly which lie under this block's mounting surface.

WARNING: Care must be exercised to avoid pinching any pelvic instrumentation wires during this step.

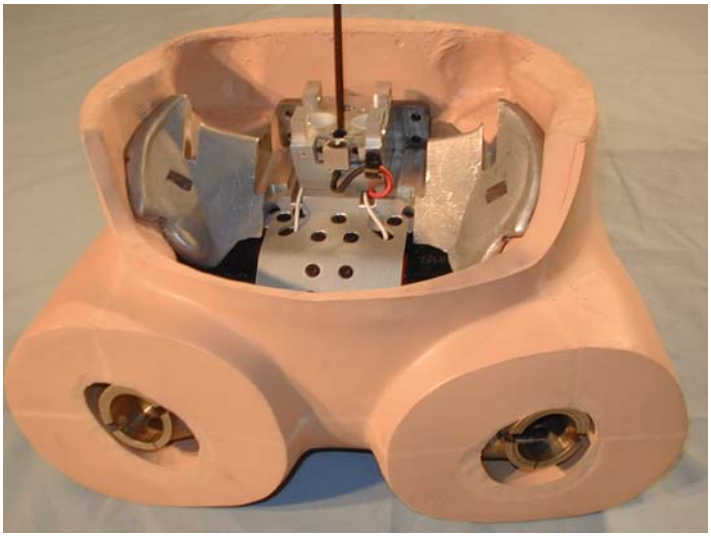

Figure 11.25- Lumbar spine block attached to pelvis and wires routed underneath

3. Reverse Step 1 to reattach the Pelvis Lumbar Mounting Block (T1SPM810) to the Lumbar Flex joint (T1SPM700).

11.3 Adjusting the Pelvis Assembly

The pelvis assembly requires a joint resistive torque adjustment for each acetabular cup. The goal of the adjustment is to provide a 1 g joint friction torque.

C Check the adjustment by straightening the leg of the dummy and raising it in front of the dummy. The leg should remain in position, but move easily under external force.

11.4 Wire Routing and Electrical Connections:

The wire routing for the instrumentation in the pelvis assembly is fairly straightforward. Each instrument in this assembly will be covered individually.

Acetabular Load Cells: The wires from the pelvic acetabular load cells and the pelvis tilt sensor wire are routed in the grooves provided in the pelvis assembly which lie under the pelvis / lumbar spine mounting block. These wires are joined to the main wire bundle at the rear of the spine.

Iliac Load Cells: The wires for the load cells are strain relieved with a 1/8" cable clamp and a #6-32 x ½" BHSCS {5/64} in the hole provided. These load cell wires are then routed around the external surface of the pelvic casting on the left and right sides. Finally, the wire is routed to join the bundle of wires at the base of the spine.

Pelvis CG Triaxial Accelerometer: The wire from the pelvis CG triaxial cube exits the rear cover at the upper right corner. It is attached to the inside of the rear cover with a cable clamp to provide strain relief. The wire is routed to join the bundle of wires at the base of the spine.

11.5 Pelvis Certification

The pelvis assembly with skin is checked for the appropriate hip range of motion in flexion, extension, abduction, and adduction. The certification procedures for these tests are described in the THOR Certification Manual - available from the manufacturer as a separate publication.

11.6 Inspection and Repairs

After a test series has been performed, there are several inspections that may be made to ensure the integrity of the dummy has remained intact. Use good engineering judgement to determine the frequency of these inspections, however, the manufacturer recommends a thorough inspection after twenty tests have been performed. The frequency of the inspections should increase if the tests are particularly severe, or if unusual data signals are being recorded. Both electrical and mechanical inspections are most easily done during dummy disassembly. Disassembly of the pelvis components can be performed by simply reversing the assembly

procedure.

11.6.1 Electrical Inspections (Instrumentation Check)

Begin with the visual and tactile inspection of all instrument wires. The wires should be checked for nicks, cuts, pinch points, and damaged electrical connections that would prevent signals from being properly transferred to the data acquisition system. Instrument wires should be checked to ensure they are properly strain relieved. A more detailed check on the individual instruments will be covered in Section 15 - Instrumentation and Wiring.

11.6.2 Mechanical Inspection

Several components in the pelvis assembly will need a visual inspection to determine if they are still functioning properly. At this time, perform a quick check for any loose bolts in the main assembly. Each mechanical inspection area is covered in detail below. Please contact the manufacturer regarding questions about items that fail the mechanical inspection.

Iliac Load Cells: The following checklist should be used when inspecting for post-test damage:

- Check the wiring for proper routing.
- Check the position of the plunger to be sure that the tip is through both the load cell and the washer.

Acetabular Socket Adaptors: The following checklist should be used when inspecting for post-test damage:

- Check the inside surface of the cup joint for wear and scuffing
- Check the fit and condition of the Pelvis Friction Adjustment Set Screw (T1PLM300)

Pelvic Skin: The following checklist should be used when inspecting for post-test damage:

- Check the pelvic skin for cuts, nicks and tears