

SECTION 10- LOWER ABDOMEN ASSEMBLY

10.1 Lower Abdomen Assembly Description and Features

The lower abdomen is defined as the region of the human body between the lower thoracic rib cage and the pelvic girdle. The component is primarily constructed of deformable materials to produce a compression response similar to human cadaver test data. This region of the dummy is subjected primarily to belt loading, however interaction with the steering wheel and airbag is also possible. Instrumentation has been incorporated into the lower abdomen assembly to measure the three-dimensional displacement of the region at two distinct points. A drawing of the complete lower abdomen assembly is provided in **Figure 10.1**.

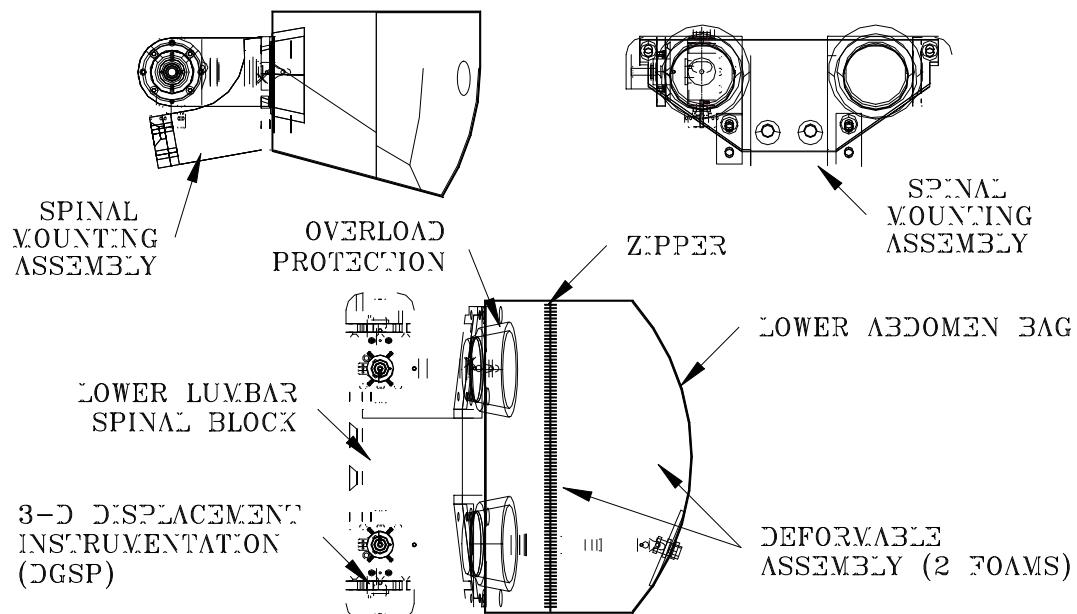


Figure 10.1- Lower abdomen assembly

The lower abdomen assembly consists of a Cordura nylon bag that encloses a series of layered foam, which have been contoured to the geometry of the abdominal section. The Cordura is a very durable fabric and the seams of the bag are sewn with Kevlar thread to prevent tearing. A zipper provides access to the interior of the bag for inspecting the foam and instrumentation. There are two different layers of foams that are used to obtain the proper compression response. Two holes are cut through each layer to allow the DGSP units to pass through to the front cover. The lower abdomen assembly is secured to the base of the spine assembly through a series of mounting plates which rest on either side of the lumbar spine region.

The instrumentation for the lower abdomen unit consists of two DGSP (Double Gimbaled String Potentiometer) units. These units provide complete deflection data for the assembly at two distinct points on the abdominal surface during the impact event. The operation and function of these units are covered in great detail in Section 16 - DGSP Assembly.

10.2 Assembling the Lower Abdomen

10.2.1 Parts List

The parts list and all quantities for the lower abdomen assembly are listed in Appendix I - Bill of Materials under the Lower Abdomen subsection. Refer to drawing T1LAM000 in the THOR drawing set for a detailed mechanical assembly drawing. **Figure 10.2** is a photograph of the exploded lower abdomen assembly and hardware.

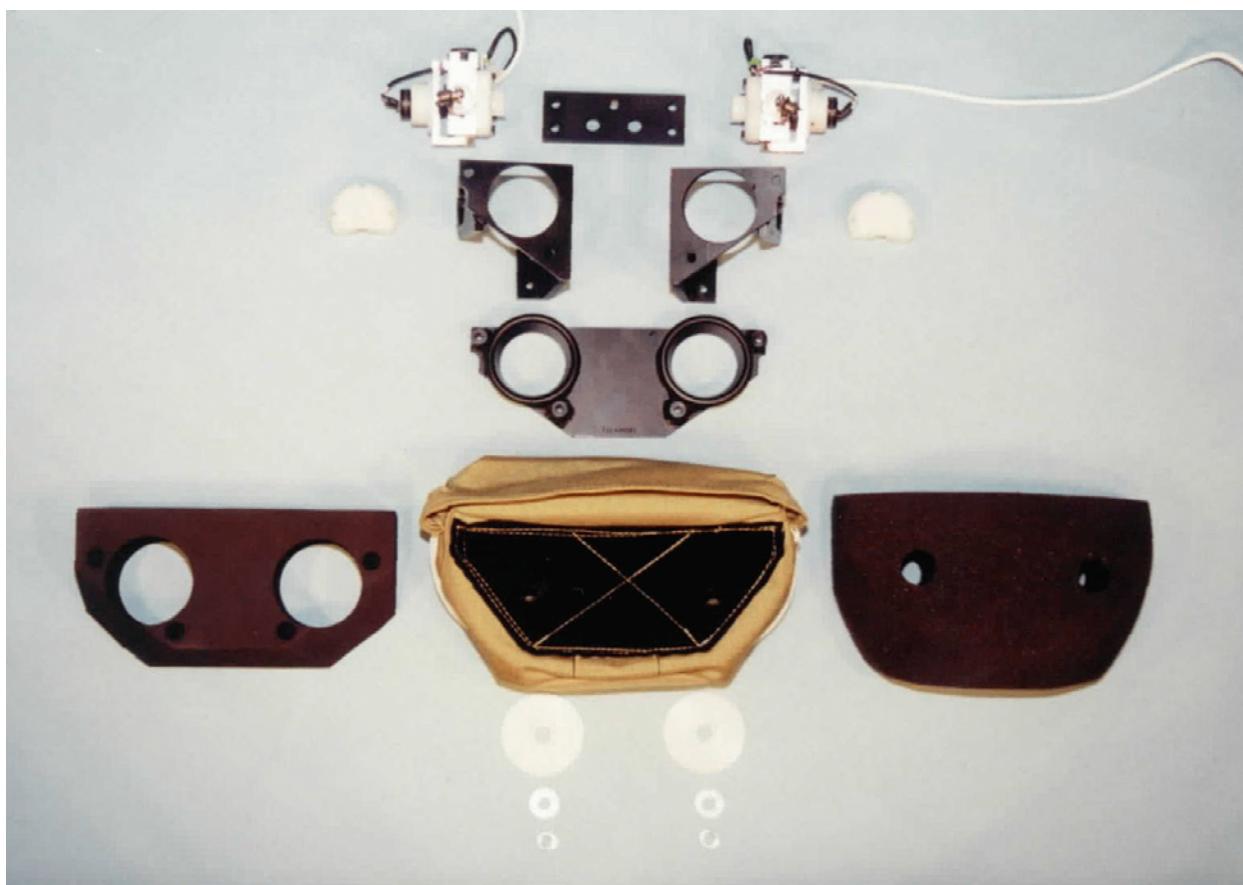


Figure 10.2- Exploded lower abdomen assembly

10.2.2 Assembling the Lower Abdomen Components

The following procedure is a step-by-step description of how to assemble the lower abdomen components. The numbers noted in () refer to a specific drawing / part number for each part. The numbers noted in the { } 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. Position the internal Mounting Welded Assembly (T1LAW080) into the interior of the Lower Abdomen Bag Assembly (T1LAF100), as shown in **Figure 10.3**.



Figure 10.3- Internal Mounting Weld assembly positioned properly inside of bag

2. Secure the Left Attachment Bracket (T1LAW040) to the left rear side of the lower abdomen assembly using two 1/4-20 x 3/4" BHSCS-NP {5/32}, as shown in **Figure 10.4**.



Figure 10.4- Left Attachment Bracket assembled to internal plate

3. Repeat Step 2 for the Right Attachment Bracket (T1LAM060). The lower abdomen mounting assembly is shown in **Figure 10.5**.

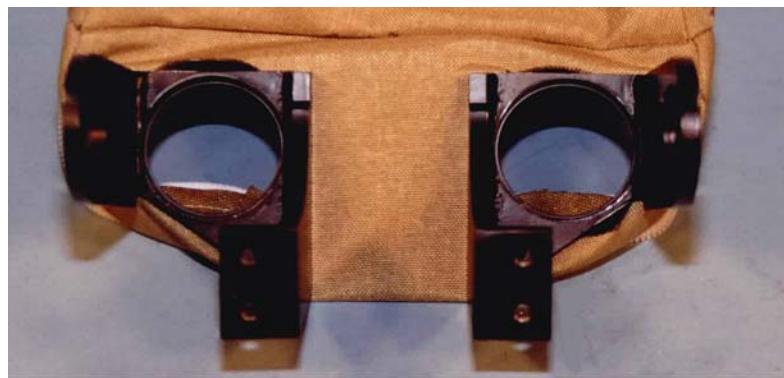


Figure 10.5- Right and Left Attachment Brackets installed

4. Check the DGSP units for calibration date. If a calibration is due, the units must be calibrated prior to assembly. This procedure is described in Section 17- DGSP Assembly.

NOTE: The DGSP units must be calibrated prior to insertion in the lower abdomen assembly.

5. Identify the left and right DGSP units. Note that the left and right units are assembled differently. The difference involves the position of the rotary potentiometer #1 in the final mounted position. On their perspective sides, the #1 rotary potentiometers are facing upward on the yoke and gimbal assembly. If facing downward, they will interfere with the side support brackets. **Figure 10.6** shows the left and right DGSP units for reference. Refer to Section 17 for further detail on the DGSP units.

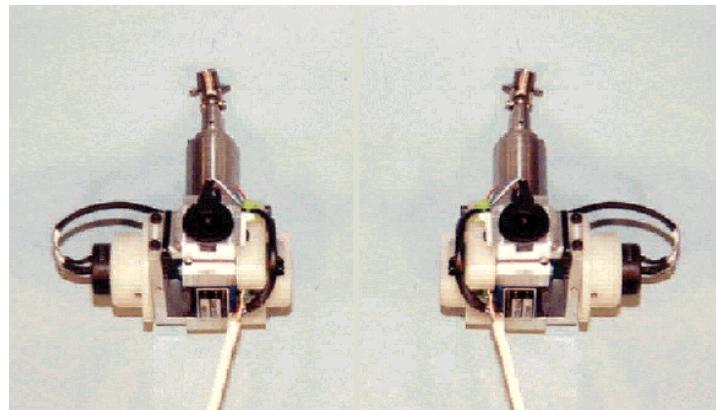


Figure 10.6- Left and Right DGSP assemblies

6. Locate the left DGSP unit (T1DPM000). Remove the two #4-40 x 3/8" SHCS {3/32} that hold the Right Yoke Arm (T1DPM213) to the Left Yoke Arm (T1DPM212) and Gimbal Assembly (T1DPM200), as shown in **Figure 10.7**.

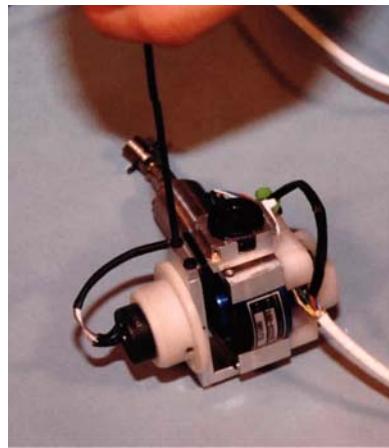


Figure 10.7- Yoke arm bolt
location

WARNING: Due to the soldered connections, there is only a small amount of distance allowed to separate the string potentiometer assembly from the yoke left arm. It is important to keep the two assemblies in close proximity to avoid applying tension to the wires.

7. Carefully separate Rotary Potentiometer #1, DGSP Right Arm and String Potentiometer Assembly (T1DPM300) from the DGSP yoke left arm, as shown in **Figure 10.8**. Two Teflon washers will fall off the lower trunnions of the string potentiometer assembly.

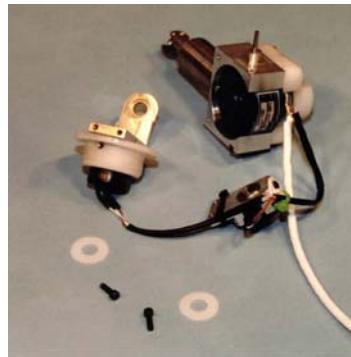


Figure 10.8- Separation of
DGSP

8. Pass the wire which connects the Rotary Potentiometer #1 (T1INM210) to the Yoke Axis Rotary Potentiometer (T1DPM210) through the slot in the rear of the Lower Abdomen Attachment Bracket - Left (T1LAW040). The DGSP assembly should be oriented to the inside of the attachment bracket as shown in **Figure 10.9**.



Figure 10.9- Potentiometer wire routing through slot
in rear of bracket

9. Insert the left DGSP telescope into the left access hole in the rear of the lower abdominal bag mounting plate, as shown in **Figure 10.10**.

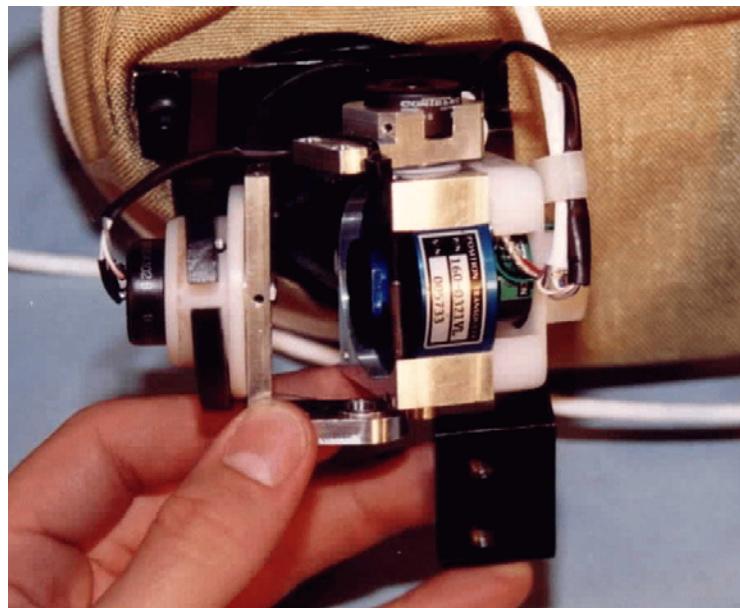


Figure 10.10- Insert DGSP telescope into access hole

10. Insert the Rotary Bushing (T1DPM211) and Yoke Axis Rotary Potentiometer (T1DPM210) through the 1.25" diameter hole of the left attachment bracket, as shown in **Figure 10.11**.

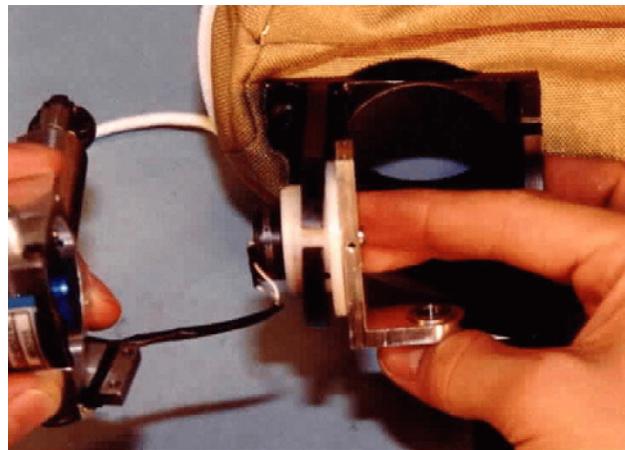


Figure 10.11- Insert Rotary bushing through
1.25" hole

11. Rotate the flanged surface of the bushing until the engraved arrow is pointing upwards as shown in **Figure 10.12**. The orientation of the arrow will ensure proper operation of the yoke axis rotary potentiometer during the dynamic test event.

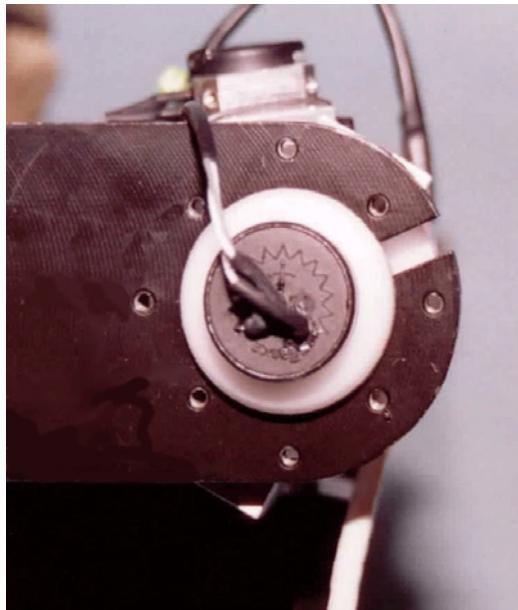


Figure 10.12- Align potentiometer so
that the arrow is pointing up

12. Secure the rotary bushing to the left attachment bracket using four #4-40 x 3/8" FHSCS {1/16}, as shown in **Figure 10.13**. Ensure that the engraved arrow is still oriented upwards.

NOTE: There are two patterns of #4-40 holes on the attachment bracket. The bushing will only fit on the bolt pattern with the smaller diameter.

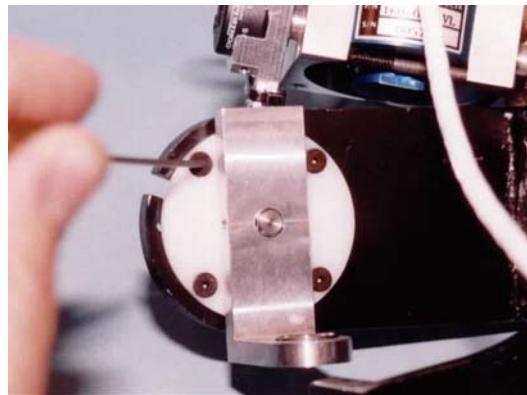


Figure 10.13- Attachment of rotary bushing to bracket

13. Place the Teflon washers onto the lower trunnions of the String Potentiometer Assembly (T1DPM300) and reinsert the trunnion into the bearings of the DGSP yoke left arm. Replace the two #4-40 x 3/8" SHCS that hold the Right Yoke Arm (T1DPM213) to the Left Yoke Arm (T1DPM212) and Gimbal Assembly (T1DPM200) as shown in **Figure 10.14**.



Figure 10.14- DGSP assembly

14. Place the Potentiometer Cover (T1LAM011) over the exposed terminals of the yoke axis rotary potentiometer, so that the small groove in the cover provides strain relief to the wire. Align the hole pattern of the cover with the pattern on the side support bracket, and secure the covers to the brackets using three #4-40 x 5/8" SHCS {3/32}, as shown in **Figure 10.15**.



Figure 10.15-
Potentiometer cover

15. Repeat the same steps for the right-hand DGSP unit.
16. At this time, make sure that the panel nut and stainless steel washer on the DGSP U-joints are removed. Attach the threaded end of a DGSP assembly cable to the tapped hole in the end of each DGSP unit.
17. Line up the four $\frac{1}{2}$ " diameter bores in the Rear Abdominal Foam Layer (T1LAM013) with the posts protruding from the inside face of the internal mounting plate. Pass the DGSP assembly cables through the large bored holes in the rear foam layer. Press the rear layer of foam over the cones and against the internal mounting plate, as shown in **Figure 10.16**. The foam should be on the inside of the abdominal bag.

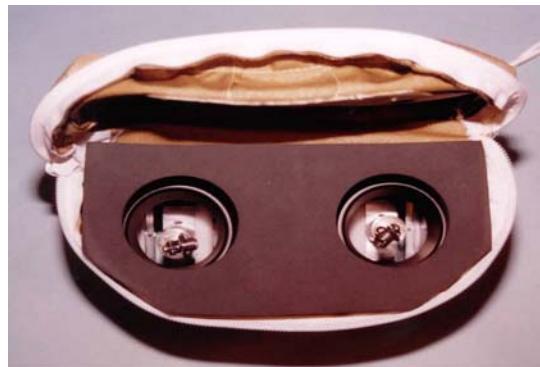


Figure 10.16- Rear foam layer inserted
into bag

18. Examine the Front Abdominal Foam Layer (T1LAM012), position the flat face against the exposed surface of the rear foam layer, as shown in **Figure 10.17**. Again, pass the DGSP assembly cables through the large bored holes in the front foam layer.

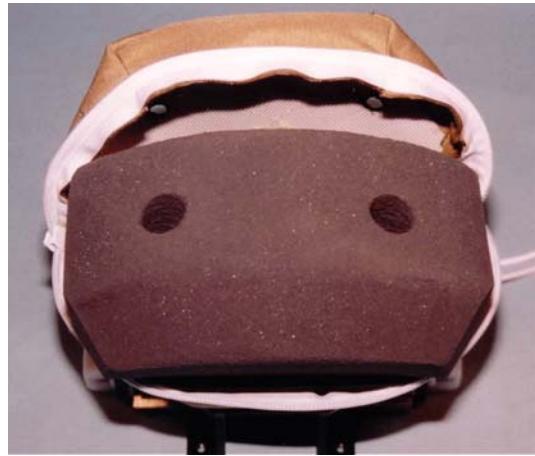


Figure 10.17- Internal front foam layer

19. Thread a Load Distribution Plate (T1LAM014) onto each DGSP assembly cable, as shown in **Figure 10.18**. The small counter bore in one side of the distribution plate must be oriented toward the DGSP assembly. These load distribution plates will rest inside the lower abdomen bag and distribute the tension in the string potentiometer to a large area of the foam.



Figure 10.18- Load distribution plate over cable

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20. Thread each DGSP assembly cable through their respective holes in the front of the abdominal bag.
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NOTE: A good trick is to use a binder clip on the cables to prevent them from pulling back into the lower abdomen bag accidentally.

21. Close the lower abdominal bag and adjust the foam within the bag geometry.
Zip the bag closed.
 22. Thread a stainless steel washer and a panel nut onto each DGSP assembly cable.
 23. Grasp the left hand DGSP assembly cable and pull the DGSP telescope into an extended position. Change the angle of pull as necessary to "steer" the DGSP U-joint through the load distribution washer and lower abdomen bag. Continue holding tension on the cable.
 24. Secure the DGSP unit to the front of the lower abdomen assembly using the washer and panel nut. Tighten the panel nut { $\frac{1}{2}$ " crescent wrench} until it is flush with the threaded end of the U-Joint, as shown in **Figure 10.19**.
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WARNING: Do not over tighten the DGSP panel nuts. This would cause the U-joints to protrude further than necessary from the lower abdomen assembly.



Figure 10.19- Securing of cable to outside
of bag

25. Repeat Steps 22 and 23 for the right hand DGSP. The completed lower abdomen assembly is shown in **Figure 10.20**.



Figure 10.20- Completed Lower Abdomen assembly

10.2.3 Attaching the Lower Abdomen to THOR Dummy

The following procedure is a step-by-step description of how to attach the lower abdomen to the THOR dummy. 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. The lower abdomen can be installed any time after the spine is connected to the pelvis assembly.

1. Loosen the center bolt of the lower thoracic spine pitch change mechanism as described in Section 6.3.1, Adjustment Procedure for Lower Thoracic Spine Pitch Change Mechanism. Rotate the upper thorax and spine rearwards to open the thoracic cavity and allow easy access.
2. Align the gap between the Left and Right Attachment Brackets (T1LAW040 & T1LAW060) with the Lumbar / Pelvis Mounting Block (T1SPM810).

NOTE: If the gap between the attachment brackets is too small, slightly loosen the lower 1/4-20 BHSCS {5/32} on each bracket. This will provide a small amount of clearance that may be needed to slip the abdomen into position. Remember to tighten the bolts at the end of the assembly.

3. Tilt the top of the lower abdomen forward and insert the abdomen into the cavity of

the dummy. Carefully guide the DGSP units and their wires around the proper sides of the spine. The insertion of the lower abdomen assembly is shown in **Figure 10.21**.

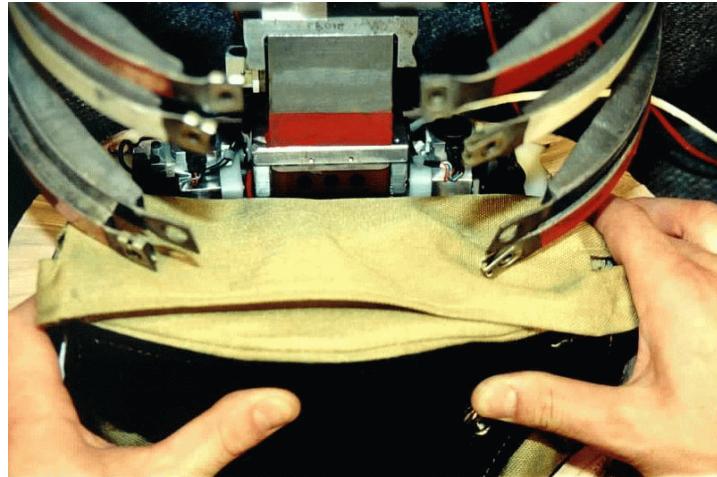


Figure 10.21- Insertion of Lower Abdomen into dummy

4. Attach the Rear Attachment Plate (T1LAM010) to the rear of the pelvis / lumbar mounting block using two 3/8-16 x 1" FHSCS {7/32}, as shown in **Figure 10.22**. The bottom surface of the plate should be flush with the bottom surface of the block.

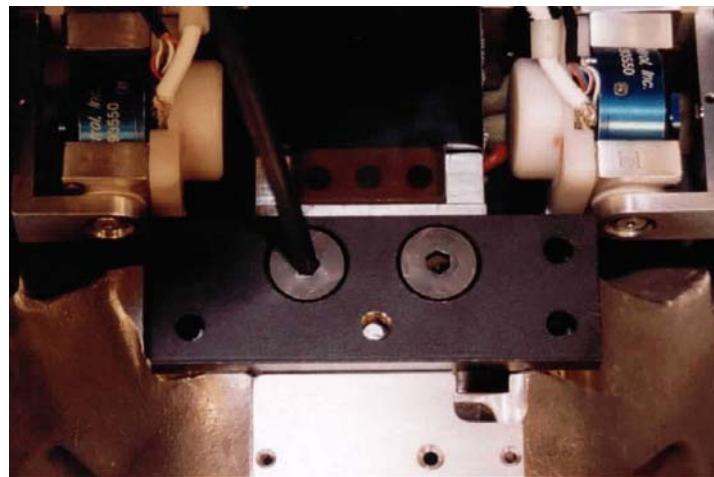


Figure 10.22- Rear attachment plate to spine

5. Attach the rear flange of the lower abdomen assembly to the rear support plate using four 1/4-20 x 5/8" BHSCS-NP {5/32}, as shown in **Figure 10.23**.

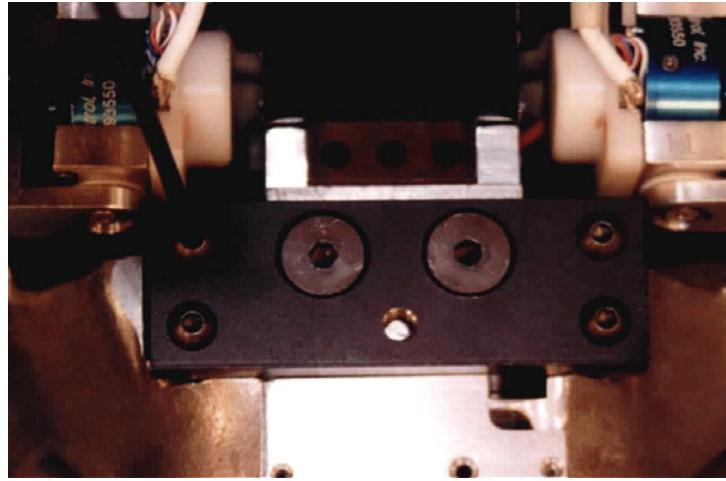


Figure 10.23- Lower Abdomen to Rear Attachment Plate

6. Adjust the lower thoracic pitch change mechanism to the desired setting. Refer to Section 6.3.1 for detailed instructions on this procedure.
7. After the installation of the lower abdomen is complete, cover the front surfaces of the upper and lower abdomen assemblies with the Upper and Lower Abdomen Velcro Cover (T1LAF117), as shown in **Figure 10.24**.

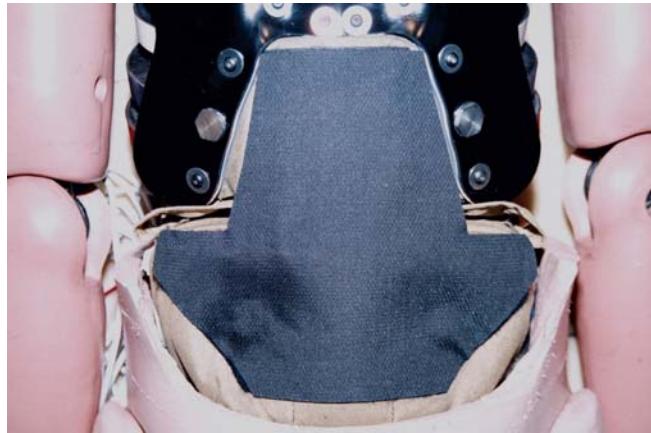


Figure 10.24- Upper and Lower abdomen cover

10.3 Adjusting the Lower Abdomen Assembly

The lower abdomen assembly does not require any adjustments for testing.

10.3.1 Storage and Handling:

The storage of the Lower Abdomen unit can greatly effect the longevity of the unit. Due to the nature of the string potentiometers in the DGSP units, the lower abdomen is subjected to constant compressive loading. Over time, due to storage and shipment, this loading can cause permanent compression of the lower abdomen foam. This condition can be eliminated during storage and shipping by using one of the following two techniques:

- 1) Release the DGSP units at the front of the lower abdomen bag assembly using the DGSP cables, and allow the cable to retract slowly into the bag. This will remove cable tension from the assembly, but requires reattachment of the cable prior to further testing.
- or 2) Using the abdomen storage fixture will relieve the tension placed on the foam by the DGSP units. This optional fixture may be obtained from the manufacturer by ordering part number T1FDT210. The use of this fixture is described in Section 2.8- Abdomen Storage Fixture.

10.4 Electrical Connections and Requirements

The lower abdomen has two primary instruments; the left and right DGSP units.

Left DGSP Unit: This wire exits the string potentiometer at the rear of the DGSP unit and is routed on the left side of the spine to joint the bundle of wires running down the back of the spine.

Right DGSP Unit: This wire exits the string potentiometer at the rear of the DGSP unit and is routed on the right side of the spine to joint the bundle of wires running down the back of the spine.

10.5 Lower Abdomen Certification

The lower abdomen assembly is certified by the manufacturer using a dynamic impact test. This test is conducted with a 1-inch diameter rigid rod with a total mass of 32.3 kg which is accelerated to 5.5 m/s. The results of the dynamic testing, produce a graph of impact force versus internal deflection measured by the DGSP units. Certification procedures for this test are described in the THOR Certification Manual - available from the manufacturer as a separate publication.

10.5.1 DGSP Calibration

The calibration of the DGSP sensors should be performed prior to the installation into the lower abdominal assembly. The DGSP calibration sheets are included with the shipment of the instruments. In the event that the DGSP needs to be recalibrated, the procedure is described in detail in Section 17 - DGSP Assembly.

10.6 Inspection and Repairs

After a test series has been performed, there are several inspections which may be made to ensure that the dummy integrity has remained intact. Good engineering judgement should be used to determine the frequency of these inspections, however, the manufacturer recommends a thorough inspection 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 carried out during dummy disassembly. The disassembly of the lower abdomen components can be performed by simply reversing the assembly procedure.

10.6.1 Electrical Inspections (Instrumentation Check)

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

10.6.2 Mechanical Inspection

Several components in the lower abdomen assembly will need a visual inspection to determine if they are still functioning properly. This mechanical inspection should also involve a quick check for any loose bolts in the main assembly. Each area of mechanical inspection will be covered in detail below. Please contact the manufacturer regarding questions about items that fail the mechanical inspection.

Bag and Zipper Inspection: The following checklist should be used when inspecting the dummy's lower abdomen bag and zipper for post-test damage:

- C Check the bag for tears, cuts and broken stitches. Repair or replace as necessary.
- C Check the zipper for broken or damaged teeth and/or slider mechanism.

Foam Inspection: The following checklist should be used when inspecting the dummy's lower abdomen foam for post-test damage:

- C Check the foam for tears and rips.
- C Check the foam for permanent compression caused by the tension of the cable in the string potentiometer. Permanent compression can be eliminated through careful storage and handling, as described in Section 9.3.1- Storage and handling

DGSP Unit Inspection: The procedure for inspecting the dummy's DGSP units for post-test damage is described in Section 17.6.2- Mechanical Inspection