SURFACE VEHICLE INFORMATION REPORT

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Hybrid III Six-Year-Old Child Dummy User's Manual

RATIONALE

This technical report is being stabilized because it covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

STABILIZED NOTICE

This document has been declared "STABILIZED" by SAE Dummy Testing and Equipment Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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INTRODUCTION

FOREWORD

In the late 1980's, the Centers for Disease Control (CDC) awarded Ohio State University a grant to develop a multisized family of test dummies based on the Hybrid III design. As part of that endeavor, the Mechanical Human Simulation Subcommittee of the Society of Automotive Engineers (SAE) formed a task group to define the size, weight, impact response characteristics and response measurements for a 6-year-old child dummy which would have, at least, the same level of biofidelity and measurement capacity as the mid-size adult male Hybrid III dummy.

The size and weight specifications of the Hybrid III 6 year old dummy are based on the average characteristic dimensions taken from anthropometry studies of 6 year old boys and girls. The biofidelic impact response requirements for head, neck, chest, and knees were extrapolated from the corresponding Hybrid III adult male responses taking into account the differences in size, weight, and tissue material properties that exist between children and adults (see Mertz, H.J. and Irwin, A.L., "Biomechanical Bases for the CRABI and Hybrid III Child Dummies", SAE 973317, 41st Stapp Car Crash Conference, Nov. 1997).

1. SCOPE

This user's manual covers the Hybrid III 6-year-old child test dummy, including changes specified in 49 CFR Part 572, Subpart N in the final rule dated December 9, 2010. It is intended for technicians who work with this device. It covers the construction and clothing, disassembly and reassembly, available instrumentation, external dimensions and segment masses, as well as certification and inspection test procedures. Appendix A contains guidelines for safe handling of instrumented dummies. Appendix B contains instructions for repairing dummy flesh. Appendix C includes procedures for adjusting the joints throughout the dummy.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J211-1 Instrumentation for Impact Test - Part 1 - Electronic Instrumentation

SAE J1733 Sign Convention for Vehicle Crash Testing

SAE J2517 Hybrid III Family Chest Potentiometer Calibration Procedure

SAE J2570 Performance Specifications for Anthropomorphic Test Device Transducers

2.2 Drawing Package

All part numbers in this manual refer to the drawing package in the docket of the National Highway Traffic Safety Administration. Copies of the drawing package for this dummy can be obtained from Leet-Melbrook, Division of MBC, 18810 Woodfield Road, Gaithersburg, MD 20879, (301) 670-0090.

3. DEFINITIONS AND ABBREVIATIONS

3.1 BHCS

Button Head Cap Screw

3.2 CERTIFICATION TESTS

Tests conducted to assure that the dummy is manufactured and maintained at the SAE specified performance levels for responses which could affect dummy measurements that are used by government and safety engineers to assess occupant injury potential. Certification tests are performed by the dummy manufacturer to assure the performance of new components or assemblies. Certification tests are performed periodically by dummy users to assure that the dummy is properly maintained.

3.3 FHCS

Flat Head Cap Screw

3.4 INSPECTION TESTS

Inspection tests are supplemental to the certification tests to insure that a component meets its design intent. Inspection tests are performed by the dummy manufacturer on new parts. Inspection tests may be performed by dummy users when a part is damaged or replaced.

3.5 SHCS

Socket Head Cap Screw

3.6 SHSS

Socket Head Shoulder Screw

3.7 SSCP

Socket Screw, Cup Point

3.8 1 G JOINT SETTING

The torque setting of a joint that supports the weight of its distal limb and will move when a minimal external force is applied (see APPENDIX C – JOINT ADJUSTMENT PROCEDURES)

4. CONSTRUCTION

The skull and skull cap are each one-piece cast aluminum, with removable one-piece vinyl head and cap skins. The vinyl skin has been tuned to give a human-like response for forehead impacts.

The rubber neck has been tuned to give human-like angle versus moment response in dynamic flexion (forward bending) and extension (rearward bending) articulations. A cable through the neck's longitudinal axis controls stretching responses and increases the neck's durability to high axial loads.

Six spring steel ribs with polymer-based damping materials approximate the chest force-deflection response characteristics. Top and bottom rib stops control the vertical movement of the rib cage. The sternum assembly connects to the front of the ribs and incorporates a "slider" for the chest deflection transducer to measure rib cage deflection relative to the spine.

The two-piece aluminum clavicle and clavicle link assemblies have cast integral scapulae to interface with shoulder belts.

The chest flesh has a zipper for easy removal.

The cylindrical rubber lumbar spine gives an automotive sitting posture.

The pelvis and abdominal assembly has a seated design, with vinyl skin and foam flesh molded over an aluminum pelvis casting. The pelvis has a humanlike shape.

The thighs contain ball jointed femurs and retaining rings for the hip pivot joint. The solid vinyl knee impact surface controls impact response.

5. CLOTHING

When used in tests, the dummy should wear shirt and pants which are children's XS (size 4-5) thermal knit, waffle weave, 50%/50% polyester and cotton underwear or equivalent. 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 shirt and pants should each weigh no more than 0.09 kg (0.2 lb). The shoes should be children's size 13M canvas oxford style sneakers. Each shoe weighs 0.38 kg ± 0.05 kg (0.83 lb ± 0.10 lb).

6. INSTRUMENTATION

The following instrumentation, shown in Figure 1, is recommended by the SAE Task Group to evaluate child restraints and air bag interactions with children of this size:

Three uniaxial accelerometers in the head	SA572-S4
Six-channel upper neck load cell	SA572-S11
Six-channel lower neck load cell	SA572-S26
Chest deflection potentiometer	SA572-S50
Two triaxial accelerometers on the sternum	SA572-S4
Two triaxial accelerometers at the front of the spine box	SA572-S4
Triaxial accelerometers in the upper torso and pelvis	SA572-S4
Six-channel lumbar spine load cell	SA572-S12
Two-channel anterior superior iliac spine load cell	SA572-S13
Six-channel femur load cell (single axis available)	SA572-S10

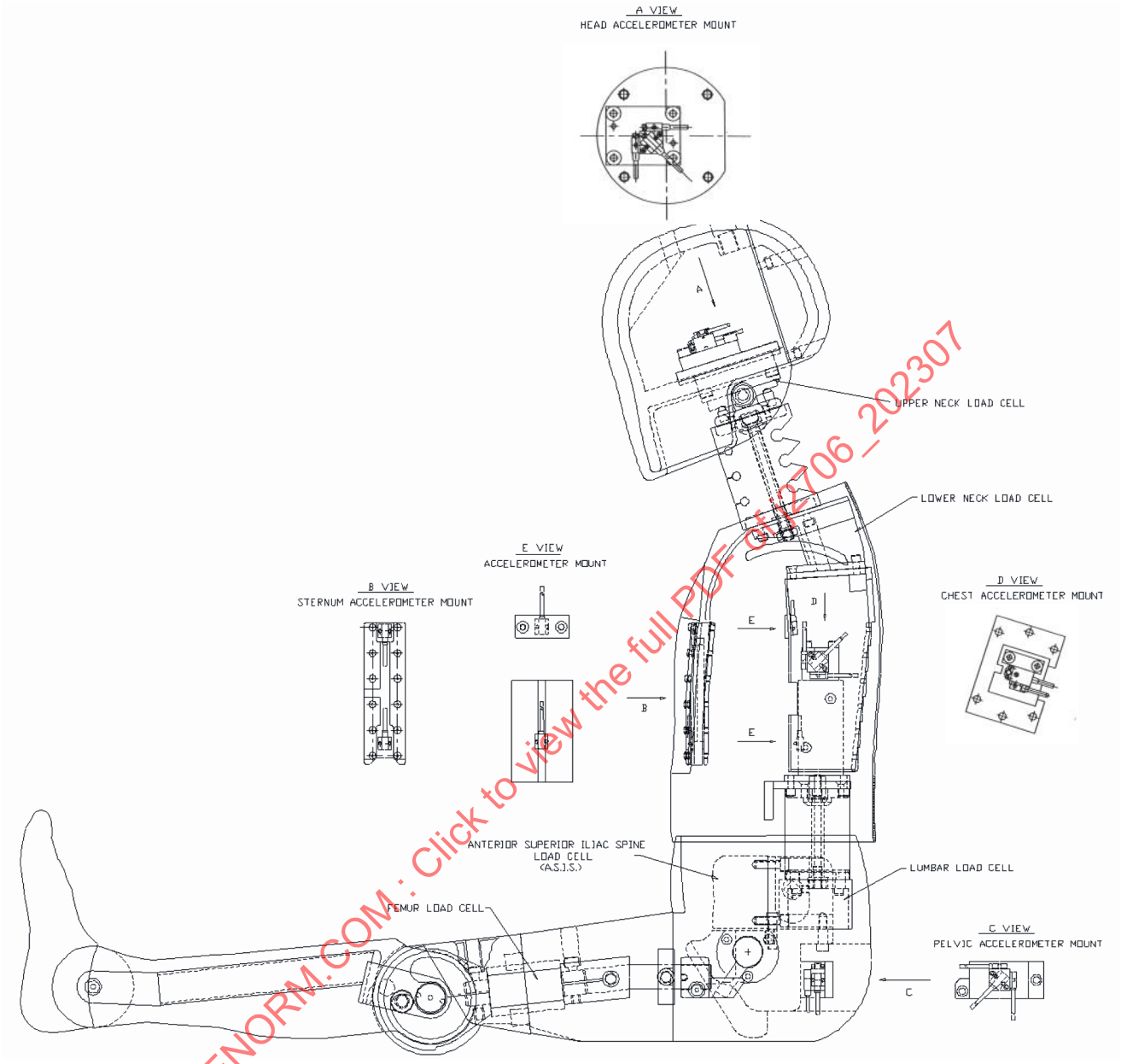


FIGURE 1 - INSTRUMENTATION LOCATIONS

7. DISASSEMBLY AND ASSEMBLY PROCEDURES

7.1 Head and Neck Assembly

The Head Assembly (127-1000) consists of:

Machined Skull	127-1001	Item-1, Figure 2
Load Cell Spacer	127-1003	Item-2, Figure 2
Machined Skull Cap	127-1004	Item-3, Figure 2
Head Skin	127-1008	Item-4, Figure 2
Skull Cap Skin	127-1009	Item-5, Figure 2
Pivot Pin, Neck Transducer	78051-339	Item-6, Figure 2
Neck Transducer, Structural Replacement	78051-383X	Item-7, Figure 2
Screw, SHCS 10-32 x 1/2	9000147	Item-8, Figure 2
Screw, SHCS 1/4-28 x 3/4	9000453	Item-9, Figure 2
Screw, SSCP 8-32 x 1/4	9000452	Item-10, Figure 2
Nodding Blocks	127-1020 (and 21)	Item-11, Figure 2
Screw, SHCS 10-32 x 1/2	9000147	Item-1, Figure 3
Modified SHCS (10-32 x 0.55)	127-2107	Item-3, Figure 3
Hex Nut 5/16-24	9000341	Item-4, Figure 3
Bib Assembly	127-8080	Item-5, Figure 3
Neck Bracket Assembly	127-8221	Item-6, Figure 3
Screw, SSCP 8-32 x 1/4	9000452	Item-1, Figure 4
Pivot Pin, Neck Transducer	78051-339	Item-2, Figure 4
Adaptor Plate	127-8221	Item-1, Figure 5
Pivot Pin, Neck Transducer	78051-339	Item-2, Figure 5
Nodding Blocks	127-1020 (and 21)	Item-3, Figure 5
Neck Transducer, Structural Replacement	78051-383X	Item-4, Figure 5
Load Cell Spacer	127-1003	Item-5, Figure 5

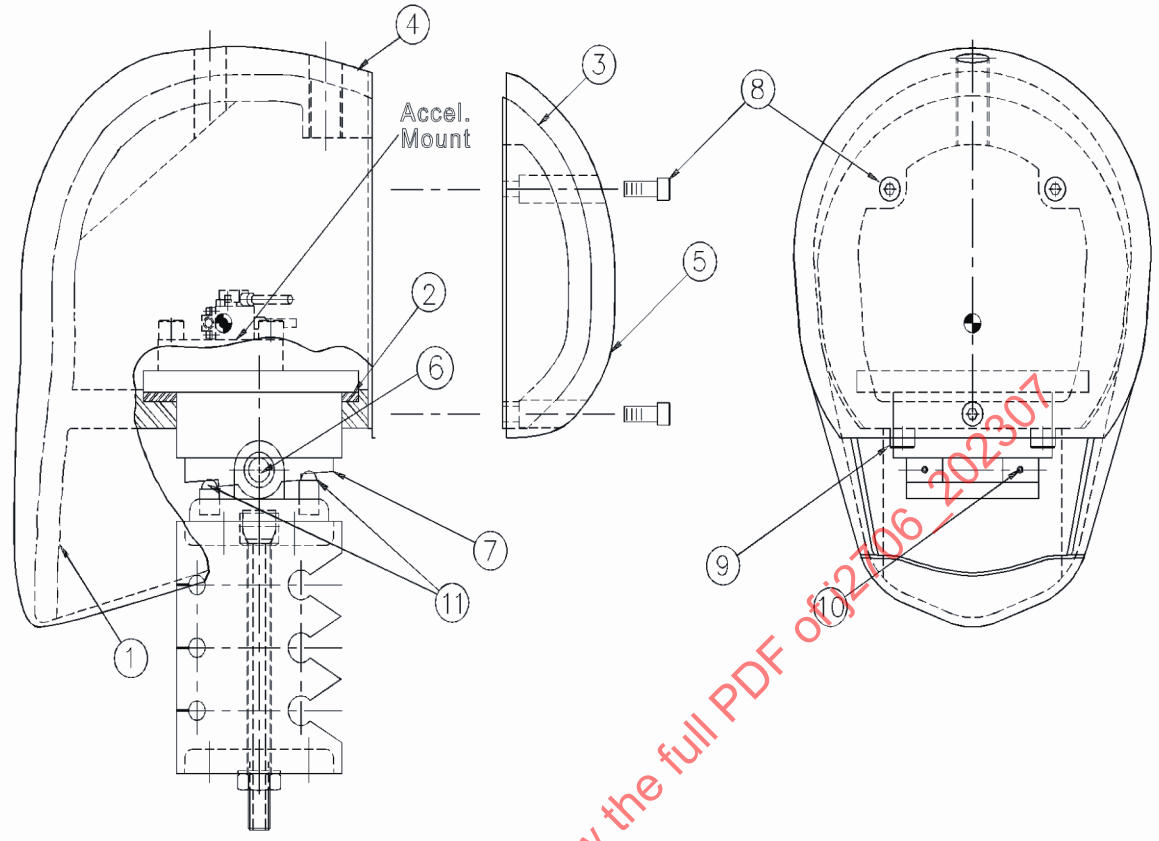


FIGURE 2 - HEAD ASSEMBLY

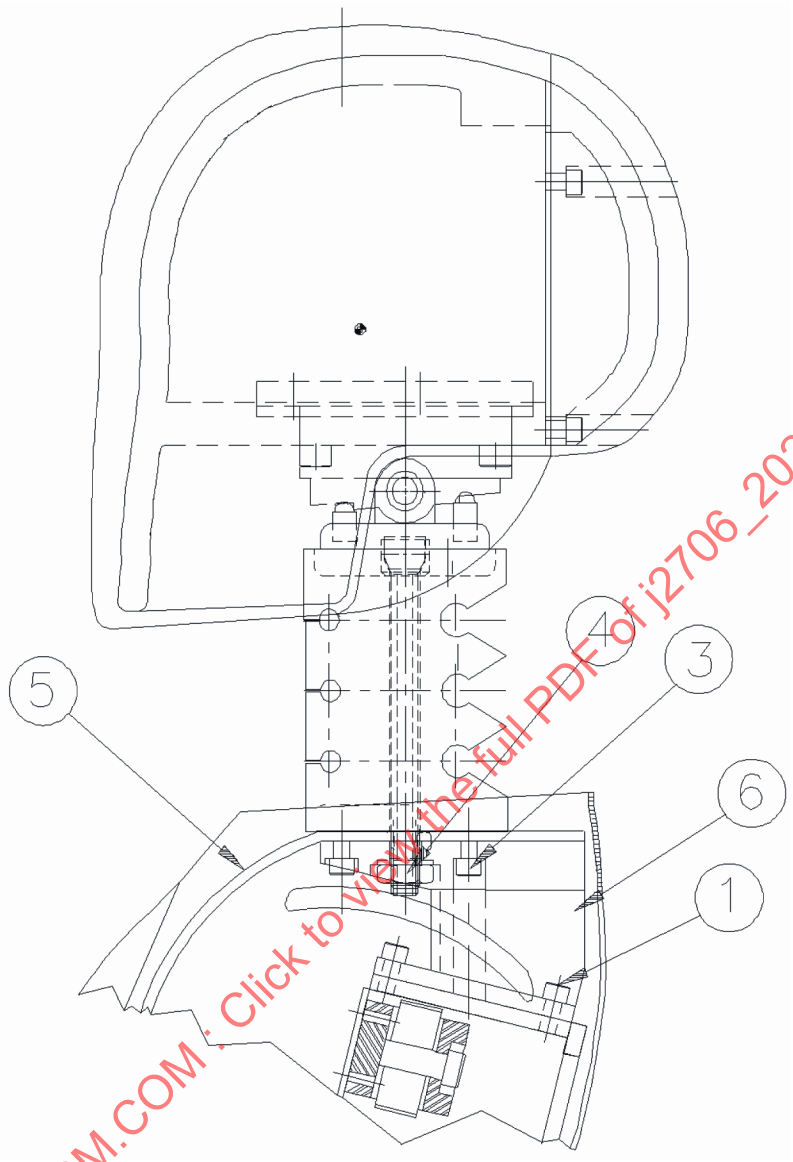


FIGURE 3 - HEAD AND NECK ASSEMBLY

7.2 Head and Neck Disassembly

Before beginning disassembly of the head and neck, remove the abdomen from the dummy. This is done to allow any screws that may fall during the disassembly process to drop into the abdominal cavity for easy retrieval. Remove the abdominal insert (127-8210) (Item-15, Figure 13) from the dummy by first removing the chest flesh (127-2010) (Item-5, Figure 7). To remove the chest flesh, first remove the arms (127-5000-1 Left, and -2 Right). This is done by taking out the 5/16 x 3/4 SHSS (Item-9, Figure 7) or (Item-5, Figure 8) at the arm-to-shoulder pivot. When removing the arm assemblies, notice the yoke spring washer (Item-1, Figure 8), bushings (Item-2, Figure 8) and pivot nut (Item-3, Figure 8) at the arm-to-shoulder pivot. This is important for reattaching the arms during reassembly.

With the arms out of the way, the chest flesh (127-2010) (Item-5, Figure 7) can be removed. Unzip the chest flesh at the rear of the dummy and pull it off the torso one side at a time. The flesh is resilient, but be careful not to tear it while pulling it off over the shoulder assemblies. With the chest flesh removed, push the upper torso rearward and pull the abdominal insert out through the opening in the front.

Begin disassembly of the head by removing the head-neck assemblies from the dummy. Remove the accelerometers and disconnect the load cell cables from the head first.

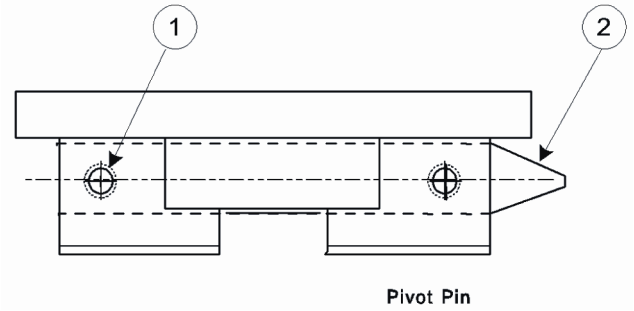


FIGURE 4 - ENLARGED VIEW OF THE UPPER NECK LOAD CELL

You can access these items by taking out the three 10-32 x 1/2 SHCS (Item-8, Figure 2) that hold the skull cap to the head.

To remove the neck bracket from the spine box, the shoulders must first be loosened to gain access to the front screws. To do this, loosen the 5/16 x ¾ SHSS (Item-30, Figure 9) and push the shoulder assembly down. Then remove the four 10-32 x 1/2 SHCS (Item-1, Figure 3) that hold the neck bracket (Item-6, Figure 3) to the spine box, starting with the two rear screws. At this point, the head-neck assembly will still be connected to the upper torso by the bib assembly (Item-5, Figure 3). Remove the four 10-32 x 0.55 modified SHCS (Item-3, Figure 3) and the 5/16-24 Hex Nut (Item-4, Figure 3) from the underside of the neck bracket and pull the bracket away from the neck, allowing the assembly to be free from the bib assembly (Item-5, Figure 3) and upper torso.

With the head-neck assemblies free from the dummy, remove the head from the neck. Remove the two 8-32 x 1/4 SSCP (Item-10, Figure 2 or Item-1, Figure 4) that hold the load cell pivot pin (Item-6, Figure 2 or Item-2, Figure 4) in place. These two screws are located in the load cell/load cell replacement (Item-7, Figure 2) at the rear of the skull.

To take the head off the neck, it is recommended to use a neck compression tool (see Figure 5) and an adaptor plate (Item-1, Figure 5). First, attach the adaptor plate to the rear surface of the skull using three 10-32 x 1/2 SHCS. Next, attach the neck compression tool to the adaptor plate with at least two 1/4-20 x 1-3/8 SHCS. Compress the nodding blocks (Item-3, Figure 5) by turning the screw handle on the neck compression tool. Be sure the neck cable is inside the cylindrical cup (see Figure 5). With the nodding blocks compressed, the pivot pin (Item-2, Figure 5) should slide out of the nodding joint/load cell with little resistance. With the pivot pin out of the assembly, the neck can be easily pulled away from the head.

While separating the head and the neck, pay attention to the components that can fall out of the assembly. The nodding blocks (Item-3, Figure 5) sometimes fall out of the head-neck assembly. Also, there are two brass washers (Item-8, Figure 6) that will fall out. Do not confuse the brass washers with any others; they are trimmed for the proper fit of this joint.

NOTE: Newly purchased washers (78051-253) can be trimmed in several ways. The easiest is to rub the washer on coarse sandpaper or a file and check and recheck the fit of the joint. Repeat the trimming until the nodding joint and the load cell can be assembled snugly with the washers. The fit of the nodding joint and load cell should be snug but easily assembled.

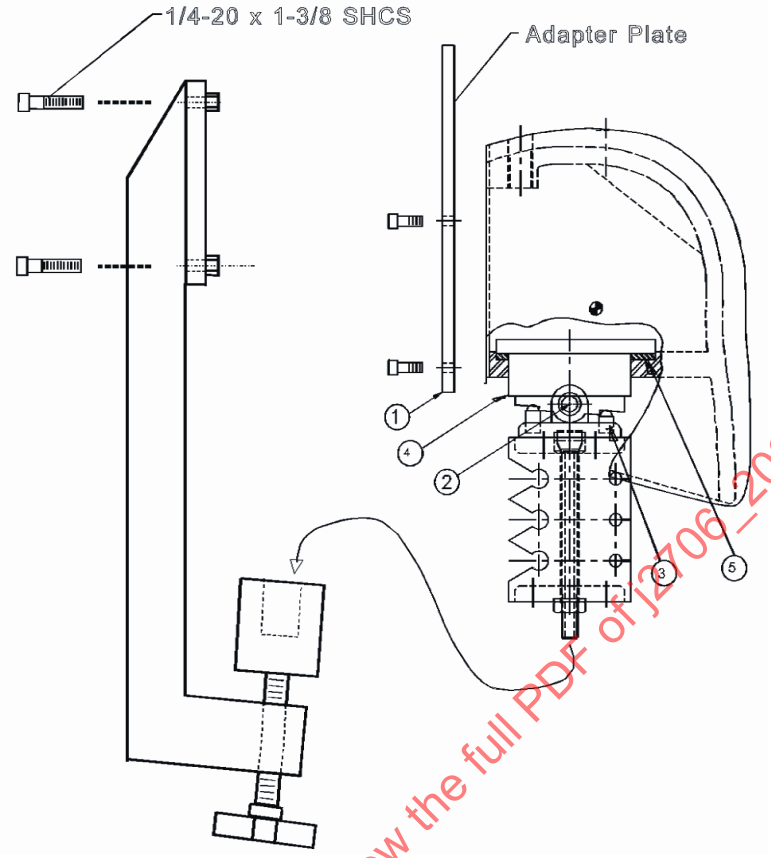


FIGURE 5 - NECK COMPRESSION TOOL

The head skin can be peeled away from the skull by firmly pulling the two components apart at the rear of the head. The cap skin is removed from the skull cap in the same manner as the head skin and skull.

Remove the Neck Transducer Structural Replacement (Item-4, Figure 5) by taking out the four 1/4-28 X 3/4 SHCS (Item-9, Figure 2) at the base of the skull. With the screws removed, the neck transducer structural replacement can be removed from inside of the skull. Remove the load cell spacer (Item-5, Figure 5) located between the neck transducer structural replacement and base of the skull.

7.3 Head and Neck Inspection

With all of the components separated, inspect each part for damage or flaws.

- Inspect the head skin for any cracks or tears. The skin should feel soft and pliable. If not, have the head skin re-certified or replaced.
- Check the skull, inside and out. Look for any dents, cracks, damaged threads, or loose ballast.
- When the neck is separated from the dummy, look to see if it is permanently deformed. If any tears or breaks are evident, the neck should be replaced.

7.4 Head and Neck Reassembly

- Install the Load Cell Spacer and the Neck Transducer Structural Replacement at the base of the skull.
- Put the skin back on the skull and skull cap. During reassembly, make sure that the skin is properly installed so no gap exists between the skin and the skull in the frontal, or forehead, area.
- Connect the neck to the head. Make sure that the shorter nodding block is in the front of the neck and the taller nodding block is in the back.
- Connect the head-neck assembly to the upper torso by connecting it to the bib assembly.
- Connect the neck bracket to the spine box.

7.5 Neck

The Neck assembly (127-1015) consists of:

Screw, FHCS 10-32 x 1/2	9000208	Item-1, Figure 6
Nodding Joint Assembly	127-1022	Item-2, Figure 6
Nodding Block, Back (taller)	127-1021	Item-3, Figure 6
Nodding Block, Front (shorter)	127-1020	Item-4, Figure 6
Molded Neck Assembly	127-1017	Item-5, Figure 6
Neck Cable	127-1016	Item-6, Figure 6
Hex Nut 5/16-24	9000341	Item-7, Figure 6
Nodding Joint Washer	78051-253	Item-8, Figure 6
Mounting Plate Insert	910420-048	Item-9, Figure 6
Washer Urethane	210-2050	Item-10, Figure 6

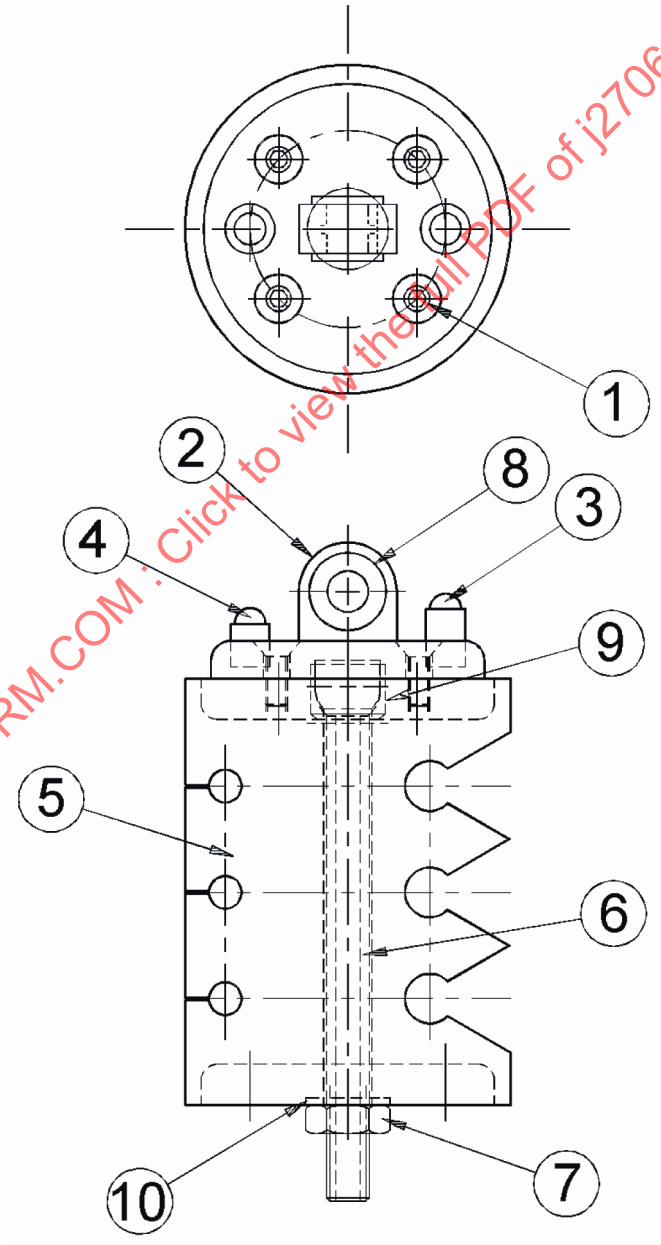


FIGURE 6 - NECK ASSEMBLY

7.6 Neck Disassembly

The first step of the neck disassembly is to remove the nodding blocks (Item-3 and 4, Figure 6). Notice that the front nodding block is shorter than the rear one; they are not interchangeable. If their positions are switched, the resistance to motion in the forward direction, or chin to chest motion, will be increased. The moment about the occipital condyle will go up and the total rotation will go down. The two nodding blocks are removed from the assembly by simply pulling them from their respective positions. Next, remove the four 10-32 x 1/2 FHCS (Item-1, Figure 6) from the top surface of the nodding joint and the nodding joint assembly will be free. Remove the 5/16-24 hex nut (Item 7, Figure 6) and urethane washer (Item 10, Figure 6) from the neck cable. The neck cable (Item-6, Figure 6) is removed by pulling it from the upper side of the molded neck, which is the nodding joint end.

Remove the plastic bushing at each end of the cable. These bushings are used to eliminate the possibility of metal-to-metal contact between the neck cable and the metal neck plates.

The molded rubber neck assembly (Item-5, Figure 6) is the final component of the neck assembly. If the assembly does not meet the certification requirements, this part is usually the problem. Be sure that the neck cable is torqued properly before conducting any tests with this device.

The neck cable torque should be: 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf).

7.7 Neck Inspection

- Inspect the nodding blocks. If are split or deformed, replace them because damaged nodding blocks will not provide the proper loading of the nodding joint allowing the head to rattle in the joint. Over time, this could damage the nodding joint.
- Check the neck cable. It should be tightly wound: the groups of strands should not be easily discernible. If the cable seems fatter in the middle, replace it.
- If the neck cannot be properly torqued, the cable has been stretched and should be replaced.

7.8 Neck Reassembly

- Place the cable with the two plastic bushings back in the molded rubber neck assembly
- Torque the neck cable to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf)
- Install the nodding joint assembly
- Install the two nodding blocks. Make sure the shorter nodding block is in the front and the longer nodding block in the rear.

NOTE: Always make sure that the neck cable is properly torqued to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf) before conducting any tests with this device. To properly torque it, the cable must be held with a screwdriver in the slot in the end of the cable. This prevents the cable from winding up as the nut is torqued. A special torque wrench is required.

7.9 Thorax

The Upper Torso assembly (127-2000) consists of:

Bib Assembly	127-8080	Item-3, Figure 7
Chest Flesh	127-2010	Item-5, Figure 7
Screw, BHCS 6-32 x 5/8	9000430	Item-7, Figure 7
Rib Set	127-RS	Item-8, Figure 7
Screw, SHSS 5/16 x 3/4	9000578	Item-9, Figure 7
Front Rib Stiffeners	127-2048	Item-13, Figure 7
Front Rib Strip, Threaded	127-8200	Item-14, Figure 7
Transducer Mount Assembly	127-8230	Item-16, Figure 7
Chest Deflection Transducer Assembly	127-8050	Item-18, Figure 7
Shoulder Assembly, Left	127-2079-1	Item-19, Figure 7
Shoulder Assembly, Right	127-2079-2	Item-20, Figure 7
Shoulder Elevation Bumpers	127-2082	Item-21, Figure 7
Screw, BHCS 6-32 x 1/2	9000247	Item-28, Figure 7
Ball Slider	127-8051	Item-32, Figure 7
Yoke Spring Washer	127-2102	Item-1, Figure 8
Bushing	127-2105-1	Item-2, Figure 8
Nut	127-5028	Item-3, Figure 8
Screw, SHSS 5/16 x 3/4	9000578	Item-5, Figure 8
Neck Bracket Assembly	127-8221	Item-1, Figure 9
Sternum	127-8240	Item-2, Figure 9
Sternum Stop	127-8090	Item-4, Figure 9
Spine Box, Welded	127-8000	Item-6, Figure 9
Screw, BHCS 6-32 x 3/8	9001213	Item-10, Figure 9
Screw, SHCS 10-32 x 1/2	9000147	Item-12, Figure 9
Rear Ribs Stiffener	127-8180	Item-15, Figure 9
Transducer Mount Assembly	127-8230	Item-16, Figure 9
Thorax C.G. Weight Assembly	127-8061	Item-17, Figure 9
Chest Deflection Assembly	127-8050	Item-18, Figure 9
Shoulder Elevation Bumpers	127-2082	Item-21, Figure 9
Shoulder Elevation Bushings	127-2085	Item-22, Figure 9
Nut	127-5028	Item-23, Figure 9
Screw, BHCS 10-32 x 5/16	9001369	Item-24, Figure 9
Pin, Dowel 1/8 x 3/8	9000046	Item-25, Figure 9
Transducer Arm Connector	127-2073	Item-26, Figure 9
Screw, SHCS 10-32 x 1/2	9000147	Item-27, Figure 9
Screw, SHCS 10-32 x 1/2	9000147	Item-29, Figure 9
Screw, SHSS 5/16 x 3/4	9000578	Item-30, Figure 9
Transducer Arm	127-8052	Item-33, Figure 9
Top Rib Stop Assembly	127-8015-1 (Left), -2 (Right)	Item-34, Figure 9
Lower Rib Stop	127-8030-1 (Left), -2 (Right)	Item-35, Figure 9
Screw, SHCS 10-32 x 1/2	9000147	Item-36, Figure 9
Screw, FHCS 10-32 x 3/4	9000262	Item-37, Figure 9

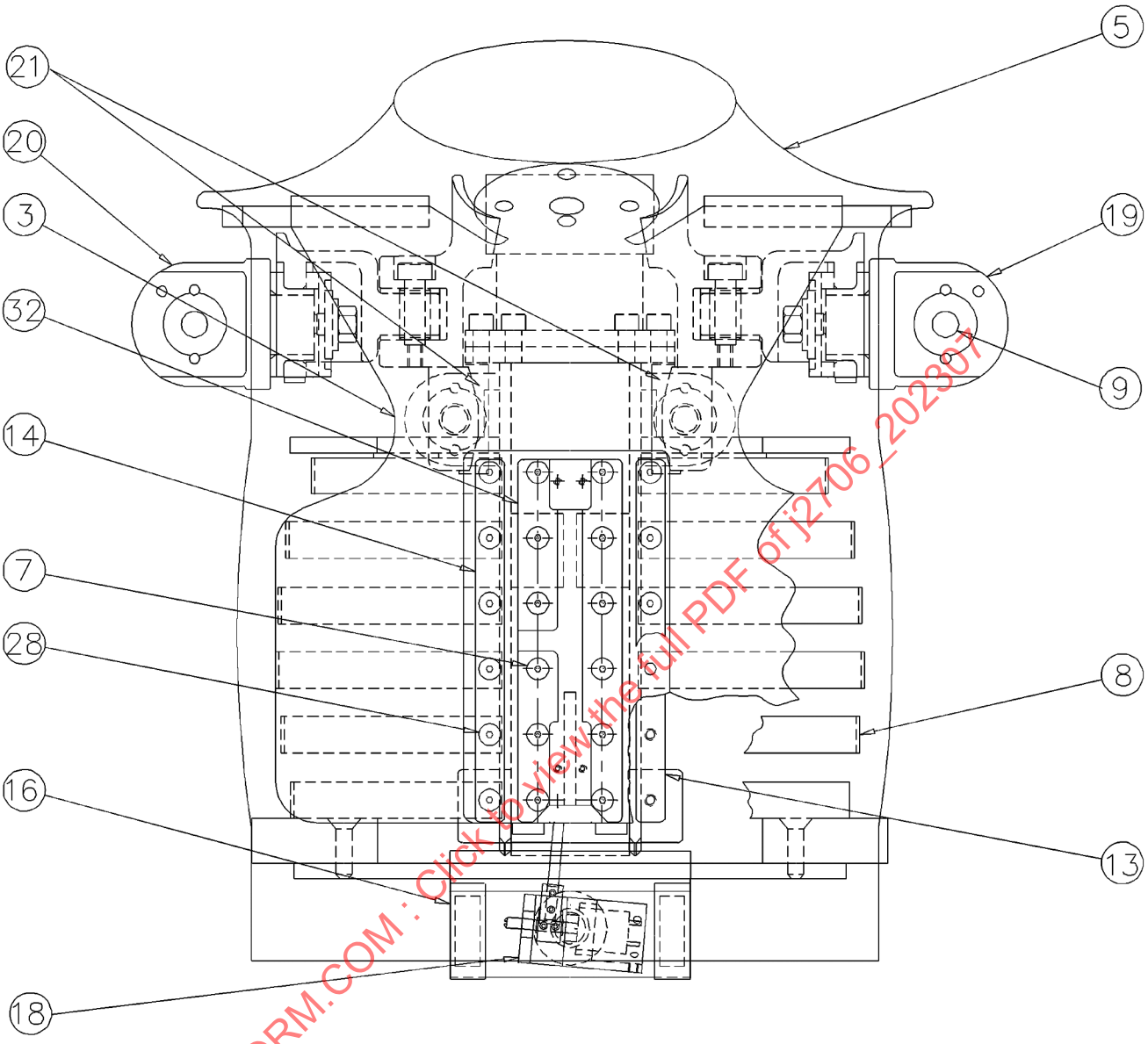


FIGURE 7 - FRONT VIEW OF CHEST ASSEMBLY

7.10 Upper Torso Disassembly

With the abdomen previously removed, remove the four 10-32 x 1/2 SHCS (Item-12, Figure 9) holding the upper torso to the lower torso. Lift the upper torso off the lower torso. Note that the transducer arm (127-8052) (Item-33, Figure 9) will slide out of the ball slider (Item-32, Figure 7). Remove the four 10-32 x 1/2 SHCS (Item-29, Figure 9) from the underside of the transducer mount assembly (127-8230) (Item-16, Figure 7). This removes the thorax C.G. weight assembly (127-8061) (Item-17, Figure 9) from the lower torso.

Note that once calibrated according to J2715, “Hybrid III Family Chest Potentiometer Calibration Procedure” the chest potentiometer assembly consisting of the transducer arm (Item 33, Figure 9), chest deflection assembly (Item 18, Figure 9) should not be mechanically adjusted or further disassembled.

Note that the thorax accelerometer mount attaches to the thorax C.G. weight assembly.

To take off the shoulder assemblies, remove the 5/16 x 3/4 SHSS (Item-30, Figure 9), one for each shoulder, attaching the shoulders to the spine box. Pull the shoulders away from the spine box and watch for the shoulder elevation bumpers (127-2082) (Item-21, Figure 9 and Figure 7) on each side of the spine, which can fall out.

In the shoulder joint, there are two shoulder elevation bushings (127-2085) (Item-22, Figure 9), one near the head of the shoulder screw and the other near the nut. There is a flat edge machined into the outside diameter of the part. Notice during disassembly that this flat edge is positioned toward the spine box.

To remove the bib assembly (127-8080) (Item-3, Figure 7) take out the twelve 6-32 x 1/2 BHCS (Item-28, Figure 7) holding the bib to the rib set. Be careful when removing the last screw because the front rib strip (through holes) (127-8200) (Item-14, Figure 7) and the front rib stiffeners (threaded holes) (127-2048) (Item-13, Figure 7) will fall off.

Take out the twelve 6-32 x 5/8 BHCS (Item-7, Figure 7) holding the ball slider (Item-32, Figure 7) to the bib. Again, watch the sternum assembly (127-8240) (Item-2, Figure 9) to keep it from falling off. The sternum assembly is a threaded aluminum bar used to hold the ball slider to the bib assembly. Once the button head screws are removed, the slider is removed from the bib. Next, remove both the left and right top rib stops (127-8015) (Item-34, Figure 9). This is done by removing the four 10-32 x 1/2 SHCS (Item-36, Figure 9) that hold the stops to the spine box.

With the bib and sternum assemblies removed, the only fasteners holding the ribs in place are twelve 6-32 x 1/2 BHCS (Item-10, Figure 9) along with the rear rib supports (127-8180) (Item-15, Figure 9) in the rear of the spine box. Take out these screws and their supports. Pull the ribs off from the bottom of the spine. Be careful not to pull the ribs open too much. Any change in the geometry of a rib will change its performance. Notice also that each of the ribs are different in size. The ribs are stamped in the rear with the numbers 1 through 6. These numbers correspond to their positions on the spine box; the number 1 rib is the highest on the spine and the number 6 rib is the lowest.

Next remove both the left and right lower rib stops (1278030) (Item-35, Figure 9). This is done by removing the four 10-32 x 3/8 FHCS (Item-37, Figure 9) that hold the lower stops to the spine box. You can now clearly see the front of the spine box where the sternum stop (Item-4, Figure 9) is glued.

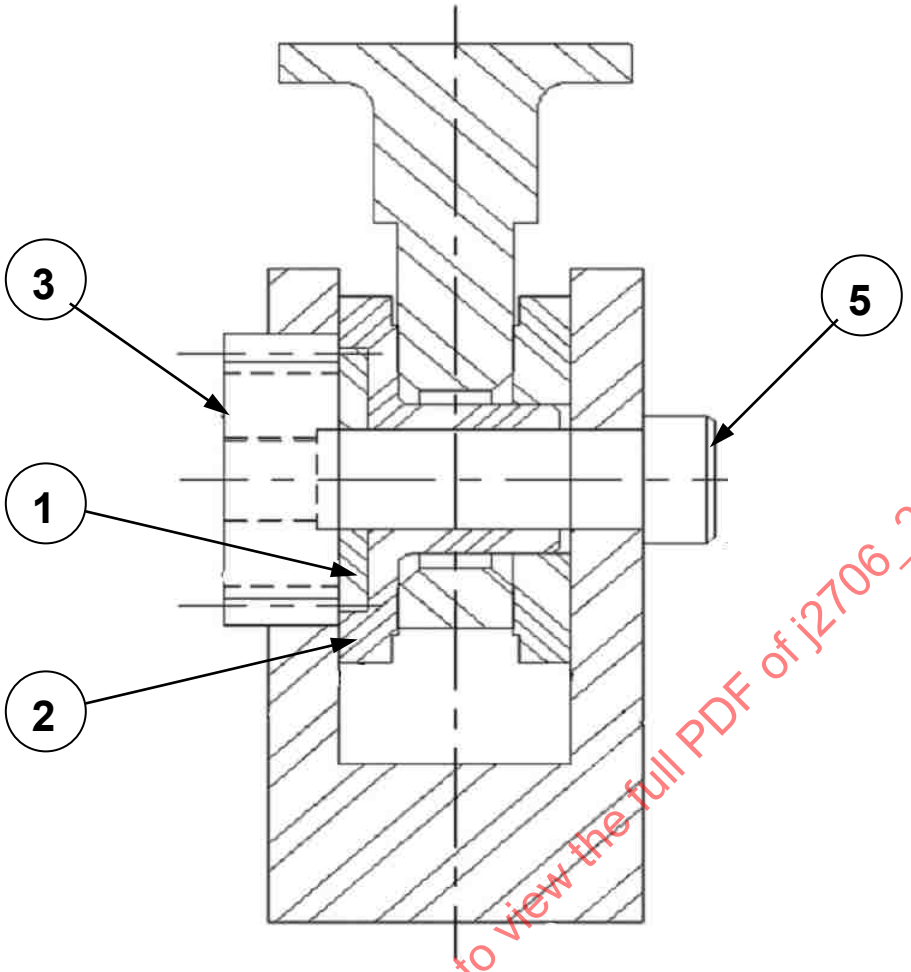


FIGURE 8 - SHOULDER AND ARM WASHERS

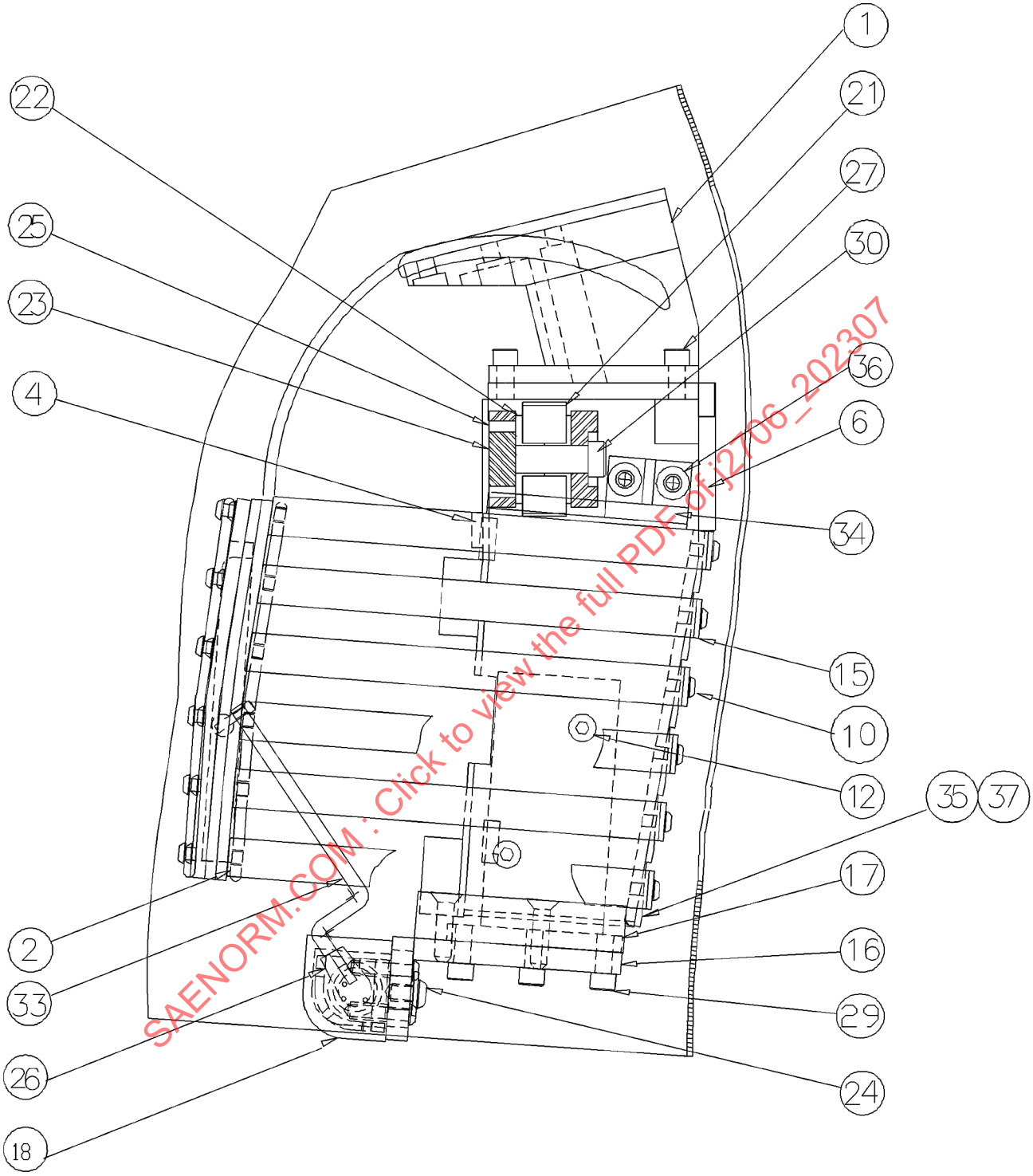


FIGURE 9 - SIDE VIEW OF CHEST ASSEMBLY

7.11 Upper Torso Inspection

- The compression washer used in the shoulders of the dummy should be checked often for signs of permanent deformation and tearing.
- Check the sternum stop from time to time, especially during assembly and disassembly to ensure that the rubber is intact.
- The ribs, rib stiffeners, and rib stops should be checked often for signs of bending and deformation. Any change in the geometry of the rib will change its performance. Severely bent ribs should be replaced.

7.12 Upper Torso Reassembly

- Install the sternum stop.
- Install the lower rib stops.
- Install the six ribs and their supports. Note that the number 1 rib is at the top of the spine and the number 6 rib is at the bottom.
- Install the upper rib stops.
- Attach the ball slider to the bib assembly.
- Attach the bib assembly to the rib set. Do not forget the front rib strip and front rib stiffeners. Notice that the front rib stiffeners are slightly bent; the outside of the arc should be placed toward the bib assembly. The end of the stiffener (Item-13, Figure 7) and strip (Item-14, Figure 7) which has the shorter distance from the bend to the end goes down.
- Attach the shoulder assemblies. Make sure the shoulder elevation bumpers are positioned with their flat edges toward the spine box. Without these bumpers the shoulders will be free to move uncontrollably. Such motion will cause noise in test data. When installing the shoulder assembly it will be easier to do it a C-clamp is used as shown in Figure 10.
- Attach the thorax C.G. weight assembly to the lower torso.
- Attach the upper torso to the lower torso.
- Put the chest flesh back on.
- Attach both of the arms. The arms must be reattached with the urethane compression washer next to the pivot nut. If not, the operator will be unable to adjust the arm joint to the proper torque.
- The arm joints (as well as all other limbs) should be adjusted to a 1 G suspended setting. The technique for joint adjustment is found in Appendix C.

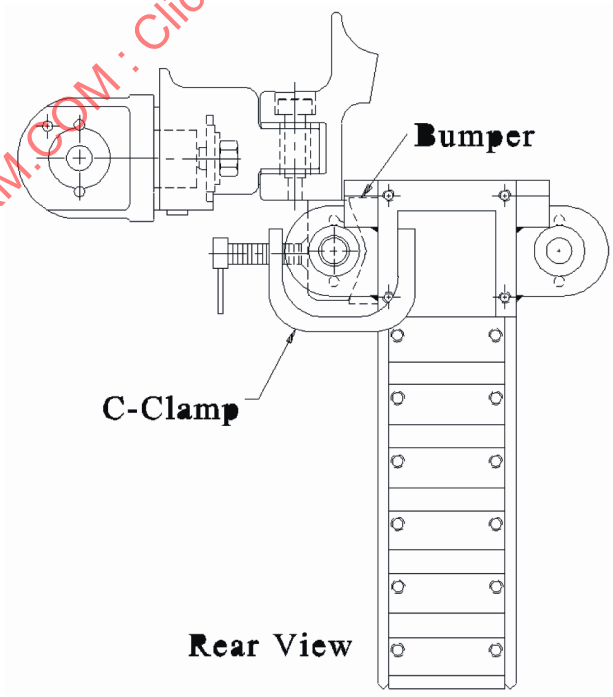


FIGURE 10 - REINSTALLING SHOULDER

7.13 Shoulder

The Shoulder assembly (127-2079-1 (left) and -2 (right)) consists of:

Clavicular Link	127-2080-1 and -2	Item-1, Figure 11, Figure 12
Clavicle Link Bushing	127-2081	Item-2, Figure 11,
Clavicle Stop	127-2086	Item-3, Figure 11, Figure 12
Clavicle Spacer	127-2087	Item-4, Figure 11, Figure 12
Clavicle	127-2090	Item-5, Figure 11, Figure 12
Rib Protection Pad	127-2092	Item-6, Figure 12
Shoulder Yoke	127-2095	Item-7, Figure 11, Figure 12
Shoulder Bushing	127-2098	Item-8, Figure 11, Figure 12
Bushing Washer	127-2100	Item-9, Figure 11, Figure 12
Yoke Retaining Washer	127-2101	Item-10, Figure 11, Figure 12
Urethane Yoke Spring Washer	127-2102	Item-11, Figure 11, Figure 12
Hex Nut 1/4-28	9000110	Item-12, Figure 11, Figure 12
Flat Washer 1/4	9000244	Item-13, Figure 11, Figure 12
Screw, SHSS 5/16 x 3/4	9000578	Item-14, Figure 11
Screw, FHCS 4-40 x ¼	9000621	Item-15, Figure 12
Bushing	127-2085	Item-16, Figure 11

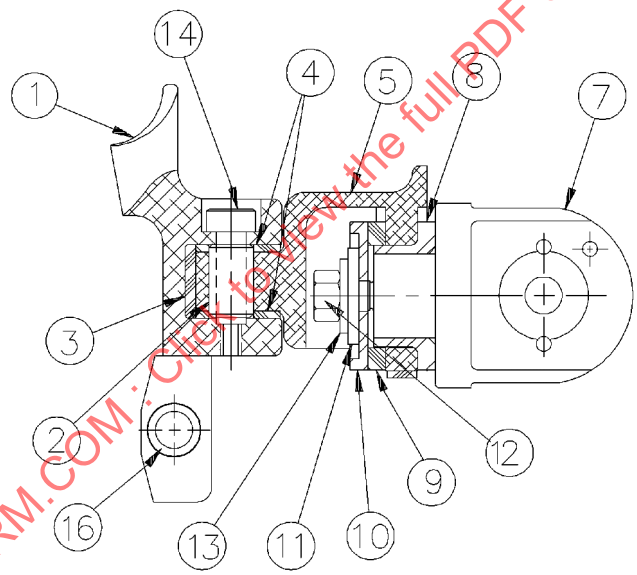


FIGURE 11 - SHOULDER ASSEMBLY - FRONT VIEW

7.14 Shoulder Disassembly

To disassemble the shoulder, start by removing the shoulder yoke (Item-7, Figure 11). This is done by clamping the yoke in a vise and taking off the 1/4-28 hex nut (Item-12, Figure 11) from the underside of the clavicle. With this nut removed, take out the 1/4 flat washer (Item-13, Figure 11), urethane yoke spring washer (127-2102) (Item-11, Figure 11) and steel yoke retaining washers (127-2101) (Item-10, Figure 11). At this point the shoulder yoke can be pulled from the clavicle (Item-5, Figure 11). The shoulder bushing (127-2098) (Item-8, Figure 11) and bushing washer (127-2100) (Item-9, Figure 11) are now accessible for inspection (see below).

To remove the bushing and washer it may be necessary to use a small, flat blade screwdriver or some other prying tool. Be sure not to damage the friction surfaces while trying to remove these components.

At the underside of the clavicle, there is a rib protection pad (127-2092) (Item-6, Figure 12). The purpose of this part is to protect the number 1 rib from damage by acting as a cushion between the rib and the clavicle. Check this pad to ensure that it is in good condition.

To disassemble the clavicle from the clavicle link (Item-1, Figure 11 & Figure 12), remove the 5/16 x 3/4 SHSS (Item-14, Figure 11) and pull the two components apart. When the clavicle and clavicle link are pulled apart the clavicle spacers (2 each side) (127-2087) (Item-4, Figure 11) will fall out of the assembly. Seated inside the cutout on the clavicle link is a urethane pad called the clavicle stop (127-2086) (Item-3, Figure 11). Check the spacers and stop for damage (burrs, cracks, etc.) and check the stop for permanent deformation.

7.15 Shoulder Inspection

- Inspect the shoulder bushing and bushing washer. Make sure they are free of burrs and scratches. Any imperfection can affect the friction of the joint and should be repaired or replaced.
- Inspect the rib protection pad to ensure that it is in good condition.
- Make sure that the clavicle spacers are free of burrs and cracks.
- Check the clavicle stop for burrs and cracks and for any permanent deformation.

7.16 Shoulder Reassembly

- Place the clavicle stop inside the clavicle link and the clavicle spacers between the clavicle and clavicle link and assemble the clavicle to the clavicle link.
- Install the shoulder bushing and bushing washer.
- Install the shoulder yoke.
- Install the retaining washers, the urethane spring, and the flat washer.
- Install the hex nut that attaches the shoulder yoke to the shoulder.

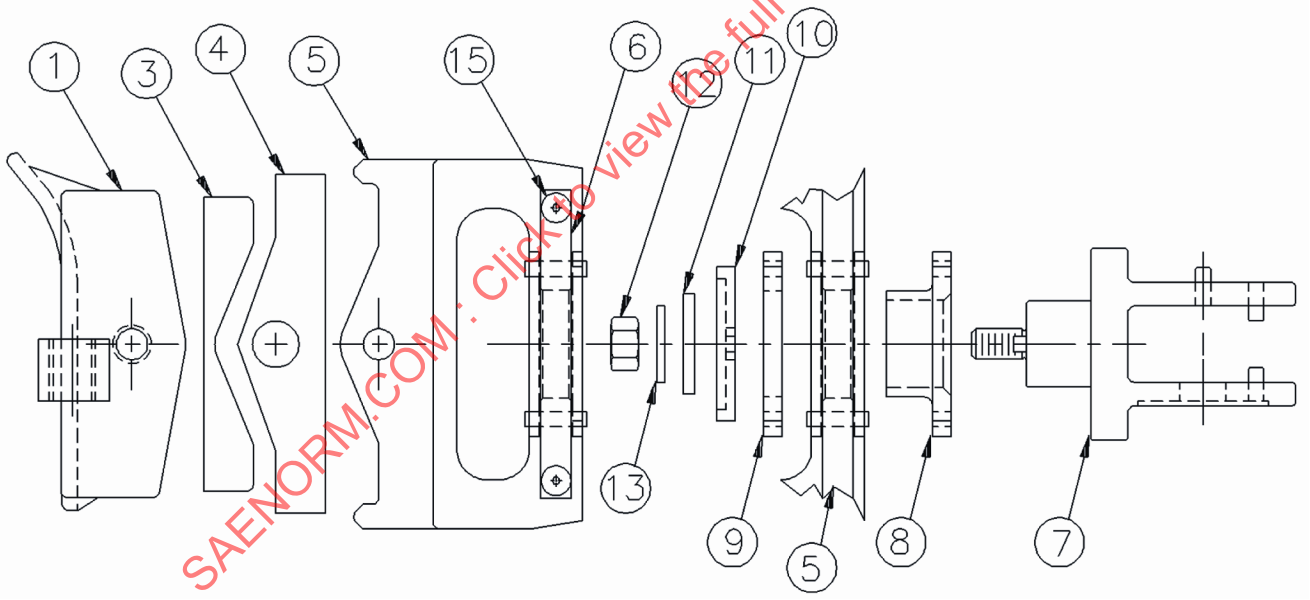


FIGURE 12 - EXPLODED TOP VIEW OF THE SHOULDER ASSEMBLY

7.17 Lower Torso

The Lower Torso assembly (127-3000) consists of:

Transducer Mount Assembly	127-8230	Item-1, Figure 13
Lumbar Spine	127-3002	Item-2, Figure 13
Lumbar Adaptor	127-3005	Item-3, Figure 13
Molded Pelvis	127-3011	Item-4, Figure 13
Femur Assembly	127-3016-1S (Left) -2S (Right)	Item-5,6, Figure 13
Spine Cable	127-8095	Item-7, Figure 13
Femur Friction Plunger Assembly	6C-1105	Item-8, Figure 13
Screw, SHSS 1/4 x 3/4	9000075	Item-9, Figure 13
Screw, SHCS 10-32 x 1/2		Item-10, Figure 13
Screw, FHCS 10-32 x 1/2	9000208	Item-11, Figure 13
Nut, Hex Jam 5/16 - 24	9001336	Item-12, Figure 13
Screw, SHCS 1/4-20 x 7/8		Item-13, Figure 13
Screw, SHCS 10-32 x 1/2	9000147	Item-14, Figure 13
Abdominal Insert	127-8210	Item-15, Figure 13
Screw, SHCS 1/4-20 x 7/8	9000086	Item-16, Figure 13
A.S.I.S. Load Cell	SA572-S13-L and -R	Item-17, Figure 13
Screw, SHCS 1/4-28 x 3/4	9000453	Item-18, Figure 13
Nylon® Mounting Plate Insert	910420-048	Item-19, Figure 13
Bushing, Nylon Shoulder for 5/16 x ¼ Screw	9001373	Item-20, Figure 13

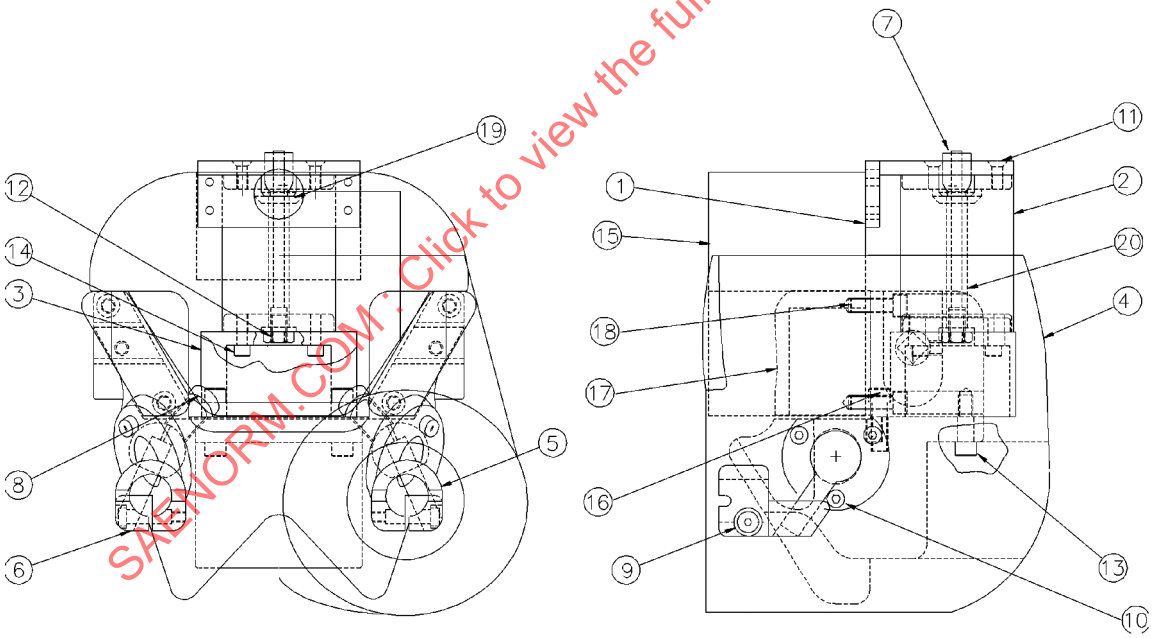


FIGURE 13 - PELVIC ASSEMBLY

7.18 Lower Torso Disassembly

To disassemble the lower torso, start by taking out the accelerometer mount located at the back of the pelvis. Next, take out the lumbar assembly (Item-2, Figure 13). This is done by taking out the four 1/4-20 x 7/8 SHCS that hold it in position. Two of these screws are located in the abdominal section of the pelvis (Item-16, Figure 13) and two are accessed through the pelvic instrument cavity at the rear of the pelvis (Item-13, Figure 13). Lift the lumbar assembly from the pelvis and set it aside for later disassembly.

The next assemblies to be removed from the pelvis are the legs. Remove the 1/4 x 3/4 SHSS (Item-9, Figure 13) that attach the leg assemblies to the femurs. The femur assemblies are removed by first loosening the femur plunger set screws (Item-8, Figure 13) in the abdominal insert area near the base of the lumbar-pelvic assembly. This will allow the femurs to move freely. When removing the plungers, notice that on one end of these parts there is a Nylon® rod inserted into the screw. Then take out the three 10-24 x 1/2 SHCS (Item-10, Figure 13) that hold each femur in position. These screws are accessed through the three holes in each side of the pelvis. With the screws removed, the femur assembly can be pulled out of the pelvis flesh. On each iliac wing there is an A.S.I.S. load cell (Item-17, Figure 13). Remove the two 1/4-28 x 3/4 SHCS (Item-18, Figure 13) to remove the A.S.I.S. load cells.

The lumbar assembly is disassembled by removing the four 10-32 x 1/2 SHCS (Item-14, Figure 13) found at the underside of the lumbar adaptor. The (chest potentiometer) transducer mount assembly is taken off the lumbar spine by removing the three 10-32 x 1/2 FHCS (Item-11, Figure 13) at the top of the spine. To remove the spine cable (Item-7, Figure 13) from the lumbar spine, take off the 5/16-24 Hex Jam Nut (Item-12, Figure 13) and pull the cable out of the lumbar spine. Be careful not to lose the Nylon® insert (Item-19, Figure 13) at the top of the spine cable and the bushing (Item-20, Figure 13) at the bottom. The Nylon® inserts are similar to the Nylon® inserts used in the neck.

NOTE: The hex jam nut on the lumbar spine cable must be torqued to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf). To properly torque it, the cable must be held with a screwdriver in the slot in the end of the cable. This prevents the cable from winding up as the nut is torqued. This does require a special torque wrench.

7.19 Lower Torso Inspection

- Look for cracks in the lumbar spine rubber
- Inspect the mounting plate insert and bushing and replace if damaged
- Check the lumbar cable. It should be tightly wound: the groups of strands should not be easily discernible. If the cable is fatter in the middle, replace it.
- Look for tears in the pelvis vinyl
- Look for broken metal pieces or stripped screws and threads

7.20 Lower Torso Reassembly

- Insert the spine cable into the lumbar spine; torque the hex jam nut to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf)
- Attach the transducer mount assembly to the lumbar spine
- Attach the lumbar assembly to the lumbar adaptor
- Install the A.S.I.S. load cells
- Attach the femur assemblies to the pelvis
- Attach the leg assemblies to the femurs
- Attach the lumbar assembly to the pelvis

7.21 Arms

The Arm assembly (127-5000-1 (left) and -2 (right)) consists of:

Yoke Spring Washer	127-2102	Item-1, Figure 14
Bushing, Elbow	127-2105-1	Item-2, Figure 14
Bushing Washer, Elbow	127-2106	Item-3, Figure 14
Upper Arm Molded Assembly	127-5001	Item-4, Figure 14
Upper Arm Lower Part Weldment	127-5006	Item-5, Figure 14
Lower Arm Molded Assembly	127-5015	Item-6, Figure 14
Pivot Nut	127-5028	Item-7, Figure 14
Lower Arm Wrist Rotation	127-5033	Item-8, Figure 14
Hand Assembly Molded	127-5040-1 (Left) and -2 (Right)	Item-9, Figure 14
Screw, SHSS 1/4 x 3/4	9000075	Item-11, Figure 14
Screw, SHCS 1/4-20 x 1.00	90001334	Item-12, Figure 14
Screw, SHSS 5/16 x 3/4	9000578	Item-13, Figure 14
Screw, SHSS 1/4 x 1/2	9001027	Item-14, Figure 14
Screw, SHCS 6-32 x 1.00	9000316	Item-15, Figure 14

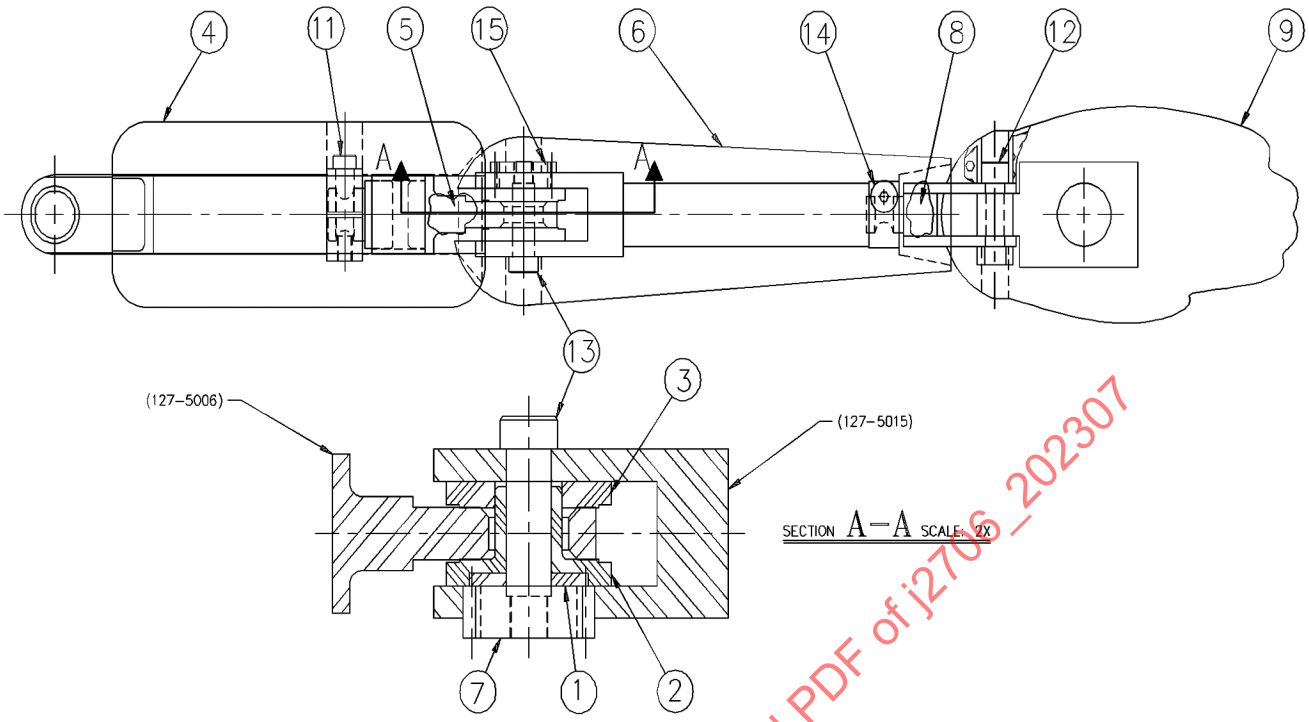


FIGURE 14 - ARM ASSEMBLY

7.22 Arm Disassembly

Disassembly of the arm starts with detaching the upper arm from the lower arm. Remove the 5/16 x 3/4 SHSS (Item-13, Figure 14) and pull the subassemblies apart. As with the shoulder joint, pay attention to the orientation of the urethane yoke spring washer (Item-1, Figure 14). This washer must be positioned on the pivot nut side (Item-7, Figure 14) of the joint or the proper joint adjustment will not be possible. Next, remove the upper arm lower part weldment from the upper arm assembly. This is done by removing the 1/4 x 3/4 SHSS (Item-11, Figure 14) from the upper arm and pulling the lower part from the assembly. The upper arm lower part functions much the same as the wrist in the lower arm assembly. Both weldments allow their respective assemblies to rotate 360 degrees.

To remove the hand and wrist assemblies from the lower arm, take out the 1/4 x 1/2 SHSS (Item-14, Figure 14) and pull the hand away. The wrist is detached from the hand by taking out the 1/4-20 x 1 SHCS (Item-12, Figure 14) that connect the two.

7.23 Arm Inspection

- The upper arm, lower arm, and hand flesh are all molded parts. Each can be repaired using the techniques described in the Appendix B of this manual. To replace these parts it may not be necessary to purchase an entire molded assembly (flesh and bone).
- If the inner metal structure (also known as the “bone”) is not damaged, it is possible to remold the part using the existing bone and thus save the cost of buying the full assembly.
- Be sure to check the range of motion and joint friction in each movable section of the arm assembly.
- Check the weldments for burrs or other abnormalities.

7.24 Arm Reassembly

- Attach hand to wrist.
- Attach hand and wrist to lower arm.
- Attach the upper arm lower part to the upper arm assembly.
- Attach the lower arm to the upper arm and make sure that the urethane compression washer is positioned on the pivot nut side.
- Adjust all upper extremity joints to "1 G suspended setting" as described in Appendix C.

7.25 Legs

The Leg assembly (127-4000-1 (left) and -2 (right)) consists of:

Yoke Spring Washer	127-2102	Item-1, Figure 15
Bushing, Knee	127-2105-2	Item-2, Figure 15
Bushing Washer, Knee	127-2106	Item-3, Figure 15
Upper Leg Assembly	127-4001	Item-4, Figure 15
Knee Assembly	127-4010	Item-5, Figure 15
Lower Leg Assembly	127-4014	Item-6, Figure 15
Foot Assembly	127-4030-1 (Left) and -2 (Right)	Item-7, Figure 15
Pivot Nut	127-5028	Item-9, Figure 15
Screw, SHCS 1/4-20 x 1-1/4	9001170	Item-10, Figure 15
Screw, SHSS 5/16 x 1-1/4	9000248	Item-11, Figure 15
Screw, SHSS 1/4 x 1.00	9000535	Item-12, Figure 15
Lower Leg Rotation Stop Assembly	127-4025	Item-13, Figure 15
Femur Load Cell Simulator	127-4007	Item-14, Figure 15
Screw, SHCS 1/4-20 x 1.00	9000133	Item-15, Figure 15
Upper Leg Weldment	127-4003	Item-16, Figure 15
Lower Leg Weldment	127-4015	Item-17, Figure 15
Machined Knee	127-4013	Item-18, Figure 15

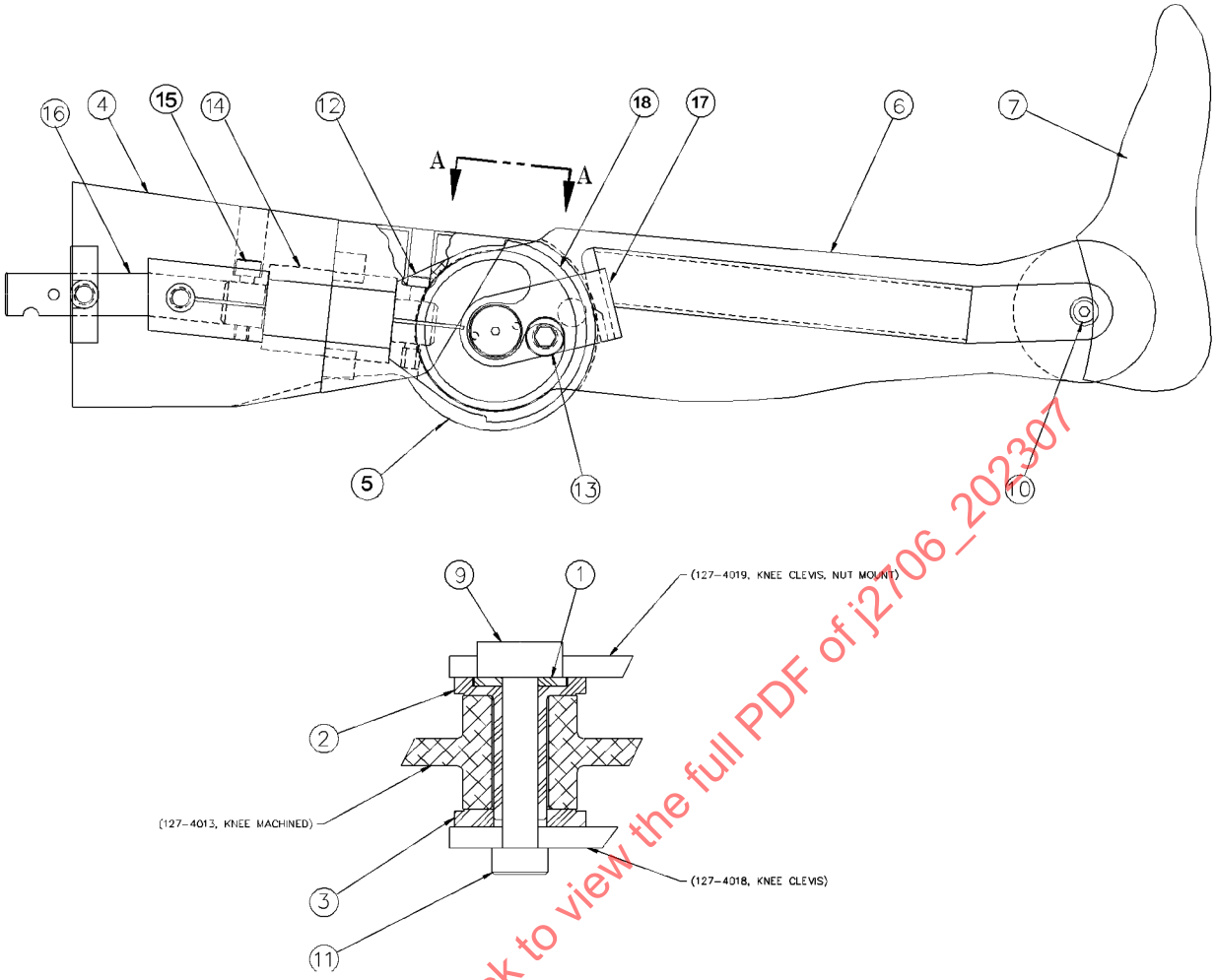


FIGURE 15 - LEG ASSEMBLY

7.26 Leg Disassembly

Disassembly of the leg starts by taking off the lower leg. This is done by removing the 5/16 x 1-1/4 SHSS (Item-11, Figure 15) at the knee-lower leg joint. Before the lower leg can be pulled from the knee, the pivot nut (127-5028) (Item-9, Figure 15) and lower leg rotation stop assembly (127-4025) (Item-13, Figure 15) must be removed. Note that the rotation stop also has a urethane sleeve which acts like a soft stop. Pull the pivot nut out of the locating pins and unscrew the rotation stop so the lower leg can be removed. As the lower leg is removed, watch for the yoke spring washer (127-2102) (Item-1, Figure 15) which may fall out of the knee assembly.

The knee assembly is removed from the upper leg by taking out the 1/4 x 1 SHSS (Item-12, Figure 15) that connects the knee to the femur load cell simulator (Item-14, Figure 15). To take out the load cell simulator, remove the 1/4-20 x 1 SHCS (Item-15, Figure 15).

The upper leg bone weldment (Item-16, Figure 15) can be removed from the upper leg by holding the end that is inserted into the femur and pulling the flesh away.

To remove the flesh from the knee, rotate the machined knee (Item-18, Figure 15) while holding the flesh in place. There are two bushings (127-2105-2) (Item-2, Figure 15) and (127-2105) (Item-3, Figure 15) in the machined knee. Remove and check these components for signs of wear and burrs.

The foot is detached from the lower leg by removing the 1/4-20 x 1-1/4 SHCS (Item-10, Figure 15).

7.27 Leg Inspection

- Check the two bushings (Item-2 and Item-3, Figure 15) for signs of wear and burrs.
- Check weldments and castings for damage.
- Be sure to check the range of motion and joint friction in each movable section of the leg assembly.

7.28 Leg Reassembly

- Attach foot to lower leg.
- Replace bushings in machined knee and place machined knee back in flesh.
- Install upper leg bone weldment.
- Install femur load cell simulator.
- Attach knee assembly to upper leg.
- Attach lower leg to knee, making sure that the urethane washer is in place.
- Install pivot nut and rotation stop.
- Adjust all lower extremity joints to "1G suspended setting" as described in Appendix C

8. CERTIFICATION TEST PROCEDURES

8.1 Head Drop Test

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

b. The head assembly consists of:

- head assembly (127-1000)
- 6-channel neck transducer (SA572-S11) or a structural replacement (78051-383X)
- head-to-neck pivot pin (78051-339)
- three accelerometers (SA572-S4)

- The mass of the head assembly is 3.47 kg ± 0.05 kg (7.66 lb ± 0.10 lb).

c. The test fixture consists of a structure to suspend the head assembly and a rigidly supported, flat, horizontal, steel plate. 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 microinches/inch rms. A surface finish close to 8 microinch/inch rms is preferred. The suspension system and accelerometer cable masses should be as light as possible to minimize the external forces acting on the head.

d. The Data Acquisition System, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Filter all data channels using Channel Class 1000 phaseless filters.

e. Test Procedure

1. Visually inspect the head skin for cracks, cuts, or abrasions, etc. Replace the head skin if abrasions or cuts to the frontal area are more than superficial, or repair any minor damage. Torque the 10-32 skull cap screws to 3.4 N·m (30 in-lbf) and the 10-24 accelerometer mount cap screws to 3.4 N·m (30 in-lbf).

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

   Mount the accelerometers in the head on the horizontal transverse bulkhead so the sensitive axes intersect at the Center of Gravity point as defined in drawing number 127-1001. 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 the sensitive axis parallel to the horizontal bulkhead and perpendicular to the midsagittal plane ("Y" axis). Ensure that all transducers are properly installed, oriented and calibrated.

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

4. Suspend the head assembly in a manner similar to that shown in Figure 16. The lowest point on the forehead is 376 mm ± 1.0 mm (14.8 in ± 0.04 in) from the impact surface. The 1.57 mm (0.062 in) diameter holes located on either side of the dummy's head may be used to ensure that the head is level with respect to the impact surface. The angle is 62 degrees ± 1 degree between the lower surface of the neck transducer or structural replacement and the impact surface. This angle can be measured with an inclinometer.

5. Drop the head assembly from a height of 376.0 mm ± 1.0 mm (14.8 in ± 0.04 in) by a means that ensures a smooth, instant release onto the impact surface.

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

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

f. Performance Specifications

1. The peak resultant acceleration should be not less than 245 G's and not more than 300 G's.

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

3. The lateral acceleration should not exceed 15 G's (zero to peak).

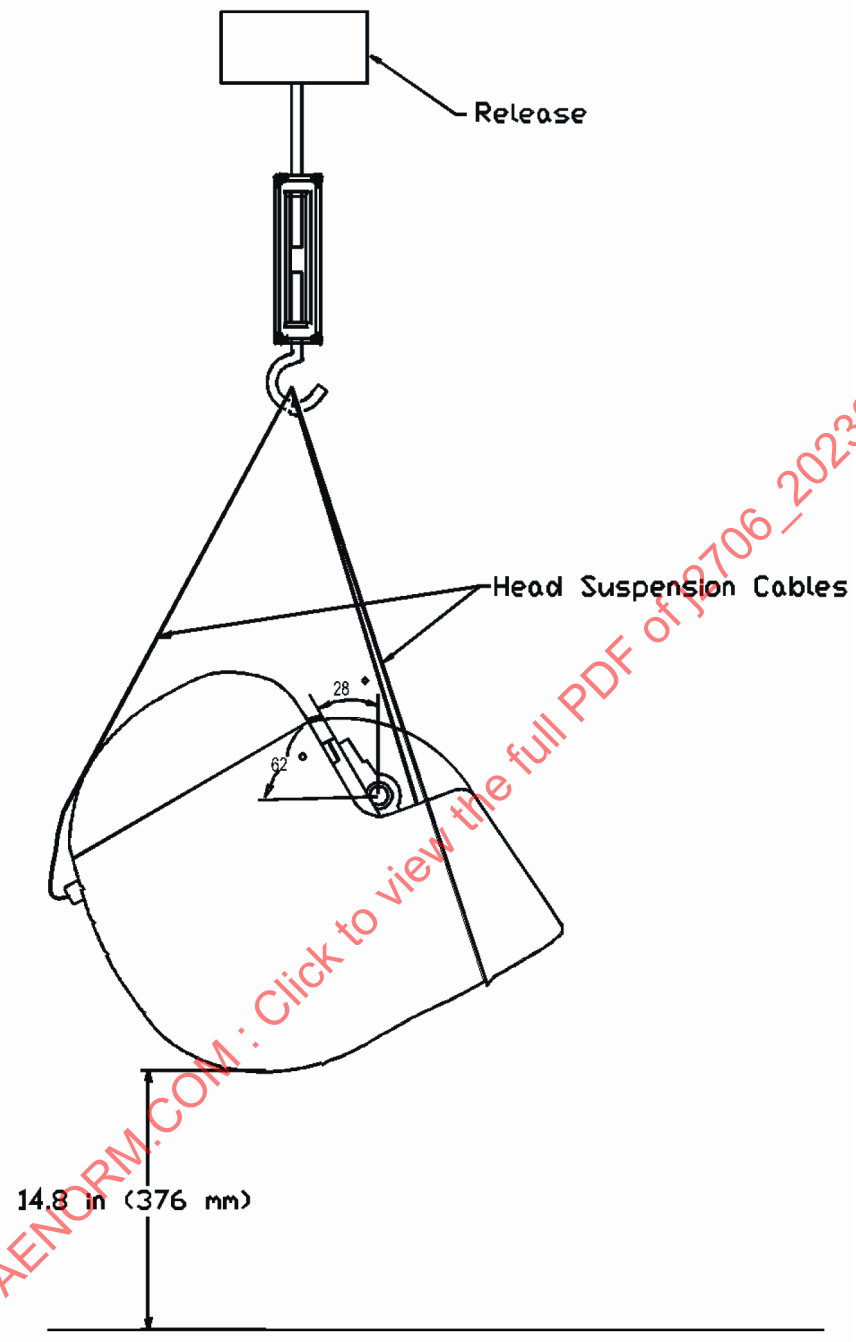


FIGURE 16 - HEAD DROP TEST SET-UP SPECIFICATIONS

8.2 Neck Tests

a. The components required for the neck tests are:

- head assembly (127-1000)
- neck assembly (127-1015)
- bib simulator (127-1025)
- neck bracket (127-8221)
- a six-channel neck transducer to measure the "X" axis force and the "Y" axis moment (SA572-S11)
- transducers to measure the rotation of the "D" plane (horizontal plane parallel to the base of the skull) with respect to the pendulum's longitudinal centerline
- 3 accelerometers (SA572-S4)
- three actual or simulated accelerometers in the head to maintain the proper weight and center of gravity location; data from the accelerometers is not required
- an adaptor block is required to mount the head/neck mounting bracket assembly to the pendulum arm so the neck is parallel to the longitudinal centerline of the pendulum arm

b. The test fixture pendulum arm with specifications appears in Figure 17. The aluminum honeycomb material is commercial grade, 152.4 mm (6.0 in) thick, 0.8 kg (1.8 lb) per cu ft with 19 mm (0.75 in) diameter cells. Mount the accelerometer with its sensitive axis aligned with the arc formed at a radius 1657.4 mm (65.25 in) from the pivot point.

c. The Data Acquisition System, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Using phaseless filters, filter the neck "force" data channel using Channel Class 1000, the neck "moment" data channel using Channel Class 600, the pendulum acceleration data channel using Channel Class 180, and the neck rotation data channels using Channel Class 60.

d. Test Procedure

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 percent for at least four hours prior to a test. The test environment should have the same temperature and humidity requirements as the soak environment. Monitor the temperature of the neck by placing a thermo-sensor into one of the holes in the neck.

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

3. Inspect the nodding blocks (127-1020 and 127-1021) for any deterioration and replace as necessary. The durometer should be 80 to 90 Shore A. Ensure that the nodding blocks are installed correctly.

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

5. Mount the head-neck assembly on the pendulum so the midsagittal plane of the head is vertical. As shown in Figure 18 for the Flexion test, the midsagittal plane should coincide with the plane of motion of the pendulum's longitudinal centerline.

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

7. Torque the hex nut on the neck cable (127-1016) to 0.23 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf) before each test on the same neck. To properly torque it, the cable must be held with a screwdriver in the slot in the end of the cable. This prevents the cable from winding up as the nut is torqued. This does require a special torque wrench.

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, pre-crush the honeycomb material, if necessary, by lightly impacting it so the desired honeycomb surface contacts the pendulum striker plate.

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

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

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

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

e. Performance Specifications - Neck Flexion

1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 4.95 m/s ± 0.12 m/s (16.2 ft/s ± 0.4 ft/s), measured at the center of the accelerometer on the pendulum.

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

3. Stop the pendulum from the initial velocity with an acceleration vs. time pulse which meets the velocity change as specified in Table 1 below. Integrate the pendulum acceleration data channel to obtain the velocity vs. time curve:

TABLE 1 – PENDULUM IMPULSE

TIME	PENDULUM IMPULSE	
ms	m/s	ft/s
10	1.2 - 1.6	3.9 - 5.3
20	2.4 - 3.4	7.9 - 11.2
30	3.8 - 5.0	12.5 - 16.4

4. The maximum rotation of "D" plane of the head should be between 74.0° and 92.0° with respect to the pendulum.

5. During the time interval while the rotation is within the corridor specified in Section 4.2(e)(4), the peak moment about the “Y” axis of the head, measured with respect to the occipital condyles, shall be not less than 27.0 N·m (19.9 ft-lbf) and not more than 33.0 N·m (24.3 ft-lbf). The positive moment shall decay for the first time to 5 N·m (3.7 ft-lbf) between 103 and 123 ms after time-zero (T_0).

f. Performance Specifications - Neck Extension

1. Release the pendulum and allow it to fall freely from a height to achieve an impact velocity of 4.30 m/s ± 0.12 m/s (14.10 ft/s ± 0.40 ft/s), measured at the center of the accelerometer on the pendulum.

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

3. Stop the pendulum from the initial velocity with an acceleration vs. time pulse which meets the velocity change as specified in Table 2 below. Integrate the pendulum acceleration vs. time curve to determine the velocity vs. time curve.

TABLE 2 - PENDULUM IMPULSE

TIME	PENDULUM IMPULSE	
ms	m/s	ft/s
10	1.0 - 1.4	3.3 - 4.6
20	2.2 - 3.0	7.2 - 9.8
30	3.2 - 4.2	10.5 - 13.8

4. The maximum rotation of the "D" plane of the head should be between 85.0° and 103.0° with respect to the pendulum.

5. During the time interval while the rotation is within the corridor specified in Section 4.2(f)(4), the peak moment about the “Y” axis of the head, measured with respect to the occipital condyles, shall be not more than -19.0 N·m (-14.0 ft-lbf) and not less than -24.0 N·m (-17.7 ft-lbf). The negative moment shall decay for the first time to -5 N·m (-3.7 ft-lbf) between 123 and 147 ms after time-zero (T_0).

PENDULUM SPECIFICATIONS

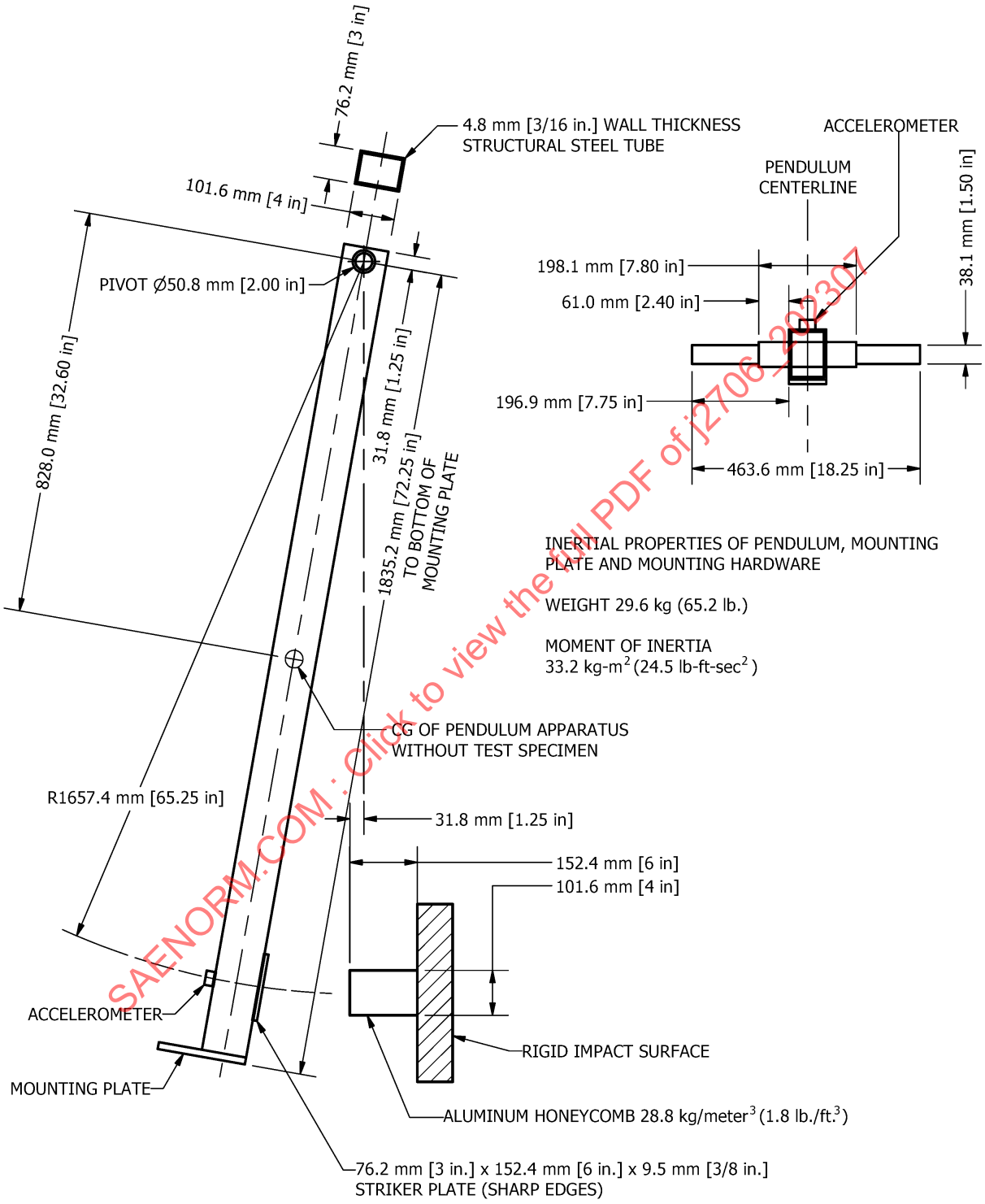


FIGURE 17 - NECK PENDULUM ARM SPECIFICATIONS

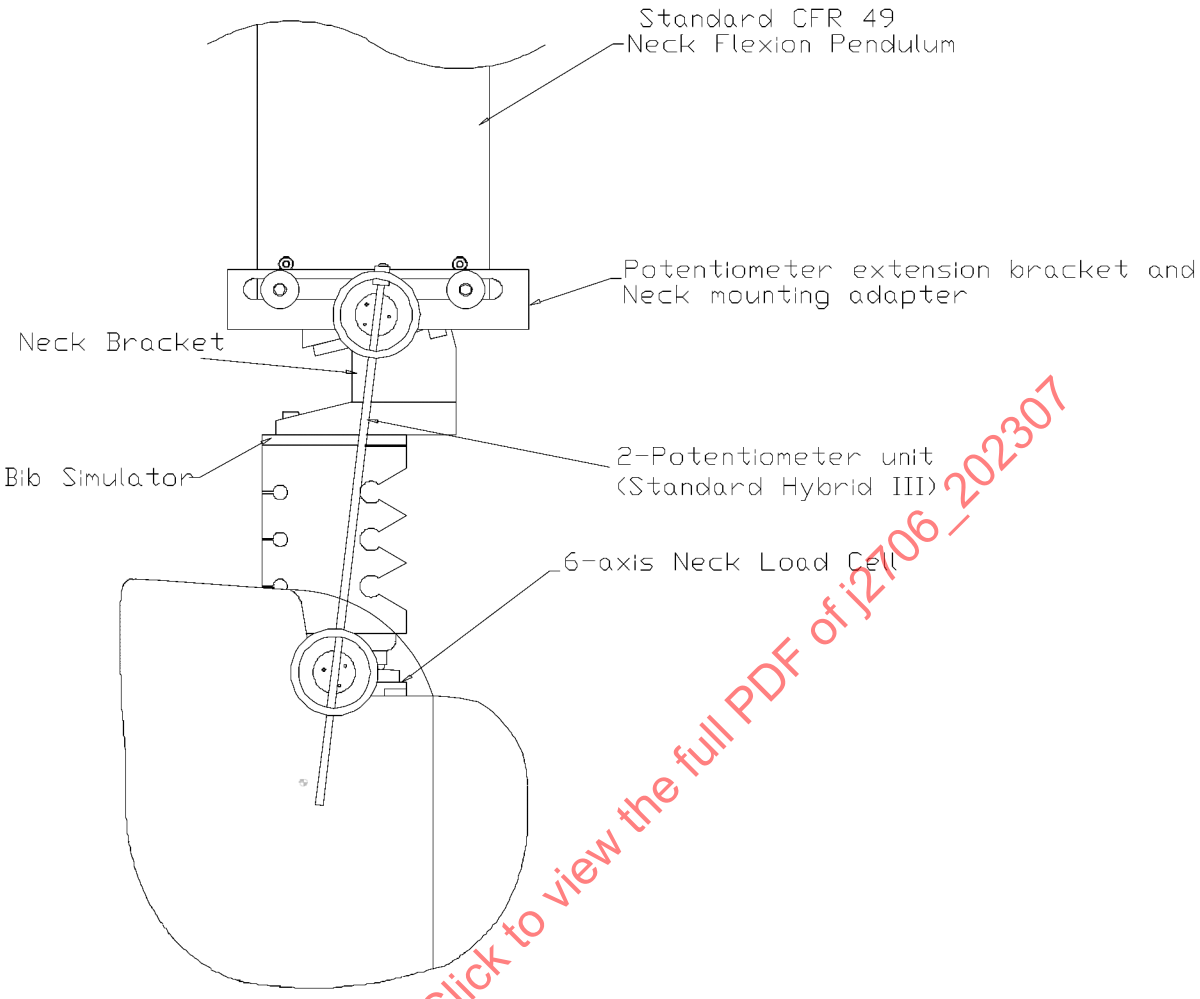


FIGURE 18 - NECK FLEXION TEST SET-UP SPECIFICATION

8.3 Thorax Impact Test

a. The complete assembled dummy (127-0000) is required, including the clothing [shirt and pants], but without the shoes (127-4030).

b. The fixture consists of a smooth, clean, dry, steel seating surface and a rigid test probe. The test probe mass is 2.86 kg ± 0.02 kg (6.30 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 101.6 mm ± 0.25 mm (4.00 in ± 0.01 in) and has a flat, right angle face with an edge radius between 7.6 mm (0.3 in) and 12.7 mm (0.5 in). Mount an accelerometer to the probe with its sensitive axis in line with the longitudinal centerline of the test probe.

c. The data acquisition system, including transducers, must conform to the specifications of the latest revision of SAE Recommended Practice J211-1. Filter the probe acceleration data using Channel Filter Class 180 phaseless filter and filter the chest deflection using Channel Filter Class 600 phaseless filter.

d. Test Procedure

1. Remove the chest flesh and visually inspect the thorax assembly for cracks, cuts, or abrasions. Pay particular attention to the rib damping material on each rib assembly (127-8110, 127-8120, 127-8130, 127-8140, 127-8150), chest displacement transducer assembly (127-4100), and the rear rib supports (127-8180). Torque the lumbar spine cable to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf).

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

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

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

5. Place the arm assemblies horizontal (±2 degrees) and parallel to the midsagittal plane. Tighten the arms to 1 G suspended setting by tightening the adjustment nut which holds the arm yoke to the shoulder assembly (127-2090). Level the ribs both longitudinally and laterally ±0.5 degree and adjust the pelvis angle to 8° ± 2°. Arm supports may be used, if necessary, to help stabilize the initial position of the dummy. These supports must be able to fall away and not influence to test.

   The midsagittal plane of the dummy is vertical ±1 degree and within 2 degrees of being parallel to the centerline of the test probe. The longitudinal centerline of the test probe is centered on the midsagittal plane of the dummy within ±2.5 mm (0.1 in). Align the test probe so its longitudinal centerline is 12.7 mm ± 1.1 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.

   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. 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. The test set-up appears in Figure 19.

6. Install the chest flesh 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.

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

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

9. The test probe velocity at the time of impact is 6.71 m/s ± 0.12 m/s (22.0 ft/s ± 0.4 ft/s).

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

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

e. Performance Specifications

1. The maximum sternum-to-spine deflection, as measured by the chest displacement transducer, should lie between -46.0 and -38.0 mm (-1.8 and -1.5 in).

2. During the time interval while the deflection is within the corridor specified in Section 4.2(e)(1), the peak force shall be not less than 1.15 kN (259 lbf) and not more than 1.38 kN (310 lbf). Calculate this force by multiplying the test probe acceleration by its mass.

3. The peak force after -12.5 mm (-0.5 in) of deflection and before -38.0 mm (-1.5 in) of deflection shall be not more than 1.50 kN (337.2 lbf).

4. The internal hysteresis should be greater than 65 percent but less than 85 percent. The hysteresis, determined from the force vs. displacement curve, is the ratio of the area between the loading and unloading portions of the curve to the area under the loading portion of the curve as shown in Figure 20.

5. The minimum clearance between the sternum and the spine box should be at least 48 mm (1.9 in). This is verified by following the procedure shown in Figure 21 using the tool shown in Figure 22.

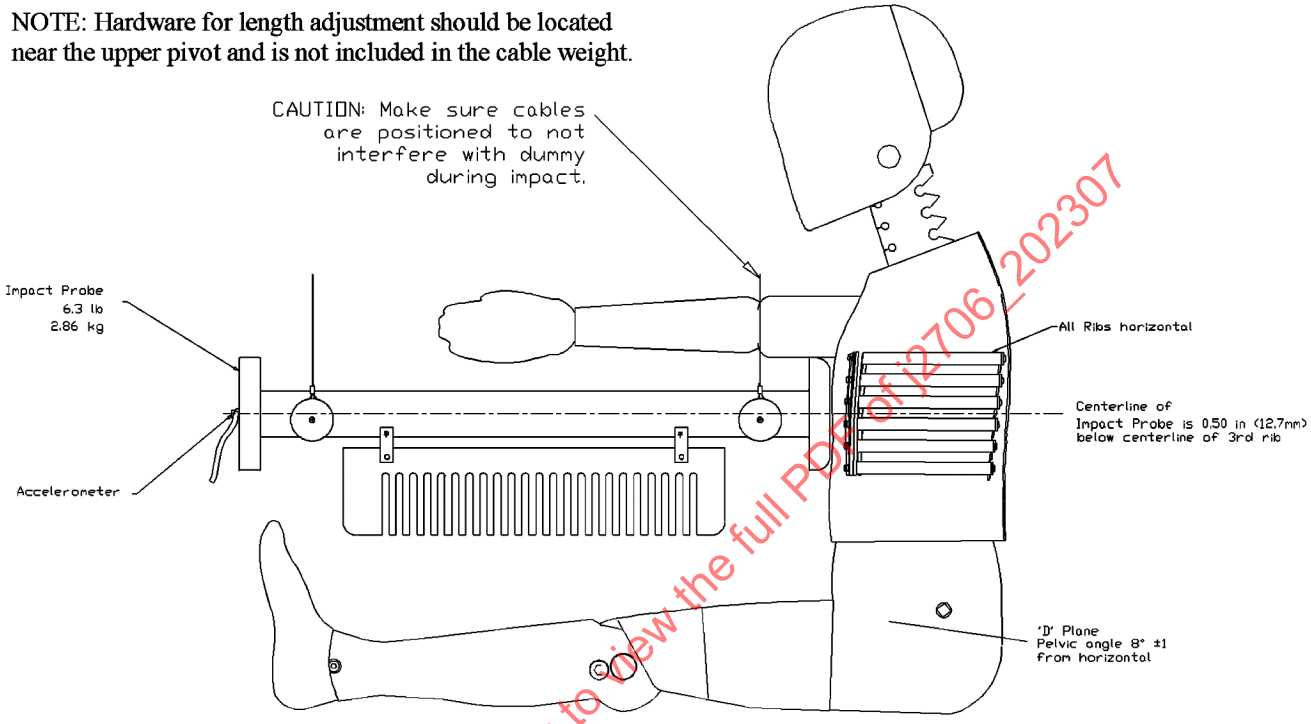


FIGURE 19 - THORAX IMPACT TEST SET-UP SPECIFICATION

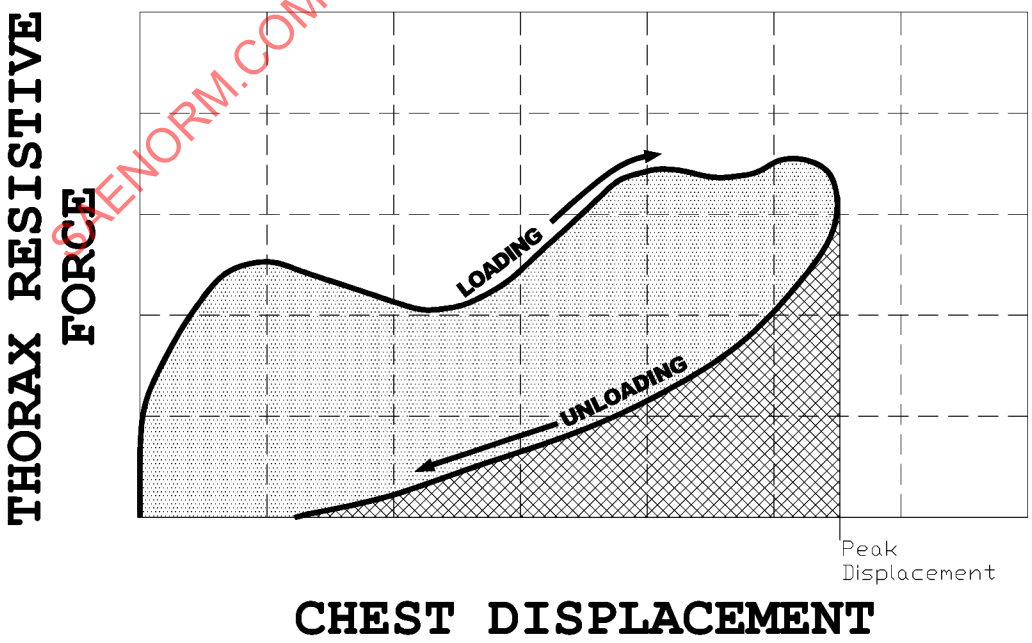
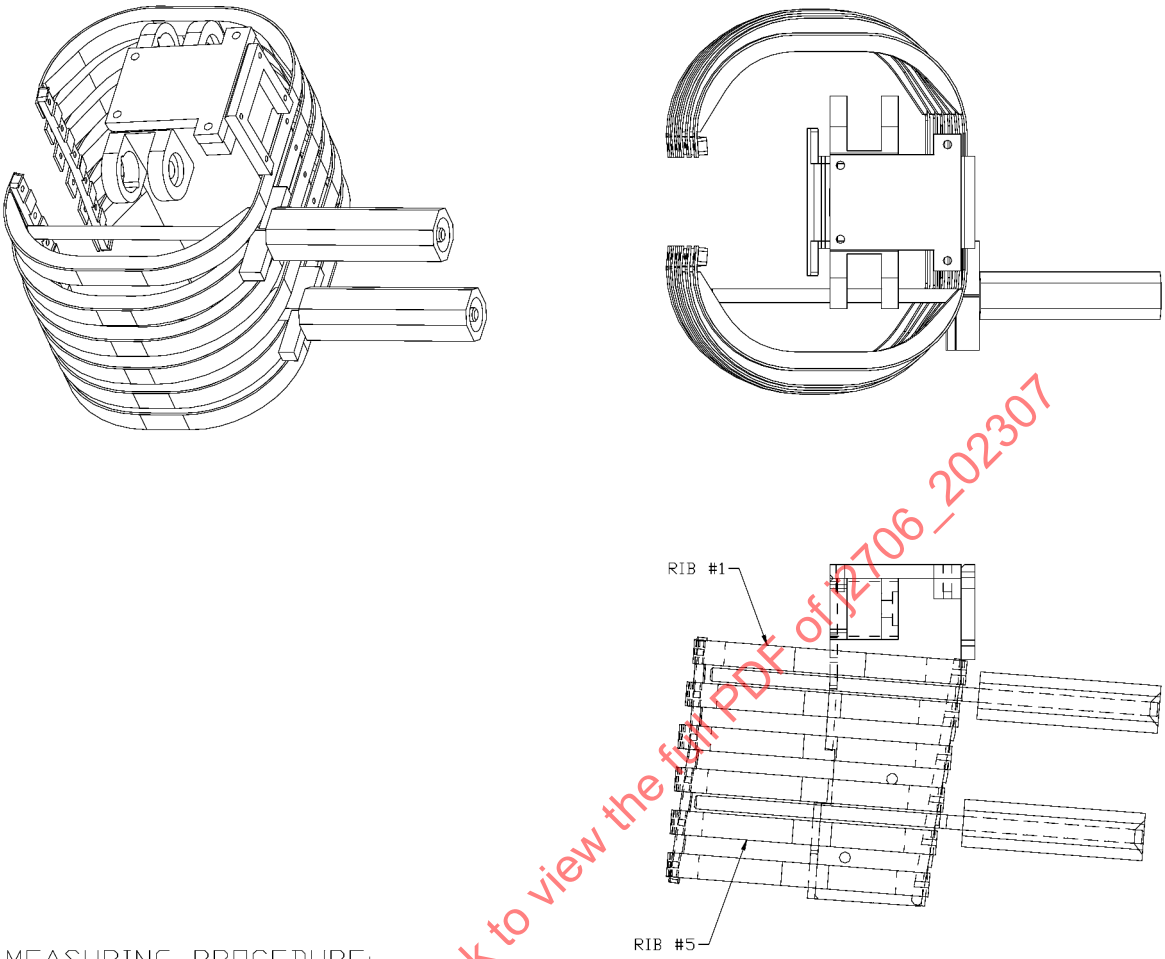


FIGURE 20 - HYSTERESIS REGIONS



MEASURING PROCEDURE:

TO MEASURE THE CHEST DEPTH AT RIB #1, THE ROD OF THE GAUGE IS INSERTED BETWEEN RIB #1 AND RIB #2 AND THE REAR FLAT ON THE HANDLE (SURFACE A) IS HELD AGAINST THE SURFACE TO WHICH RIB #1 IS ATTACHED ON THE SPINE BOX (127-8000). IF THE ROD TOUCHES THE THREAD STRIP (127-8200) THE CHEST DEPTH AT RIB #1 HAS DECREASED BELOW THE ACCEPTABLE RANGE.

TO MEASURE THE CHEST DEPTH AT RIB #5, THE ROD OF THE GAUGE IS INSERTED BETWEEN RIB #4 AND RIB #5 AND THE FRONT FLAT ON THE HANDLE (SURFACE B) IS HELD AGAINST THE SURFACE TO WHICH RIB #4 IS ATTACHED ON THE SPINE BOX (127-8000). IF THE ROD TOUCHES THE THREAD STRIP (127-8200) THE CHEST DEPTH AT RIB #5 HAS DECREASED BELOW THE ACCEPTABLE RANGE.

FIGURE 21 - CHEST DEPTH VERIFICATION PROCEDURE

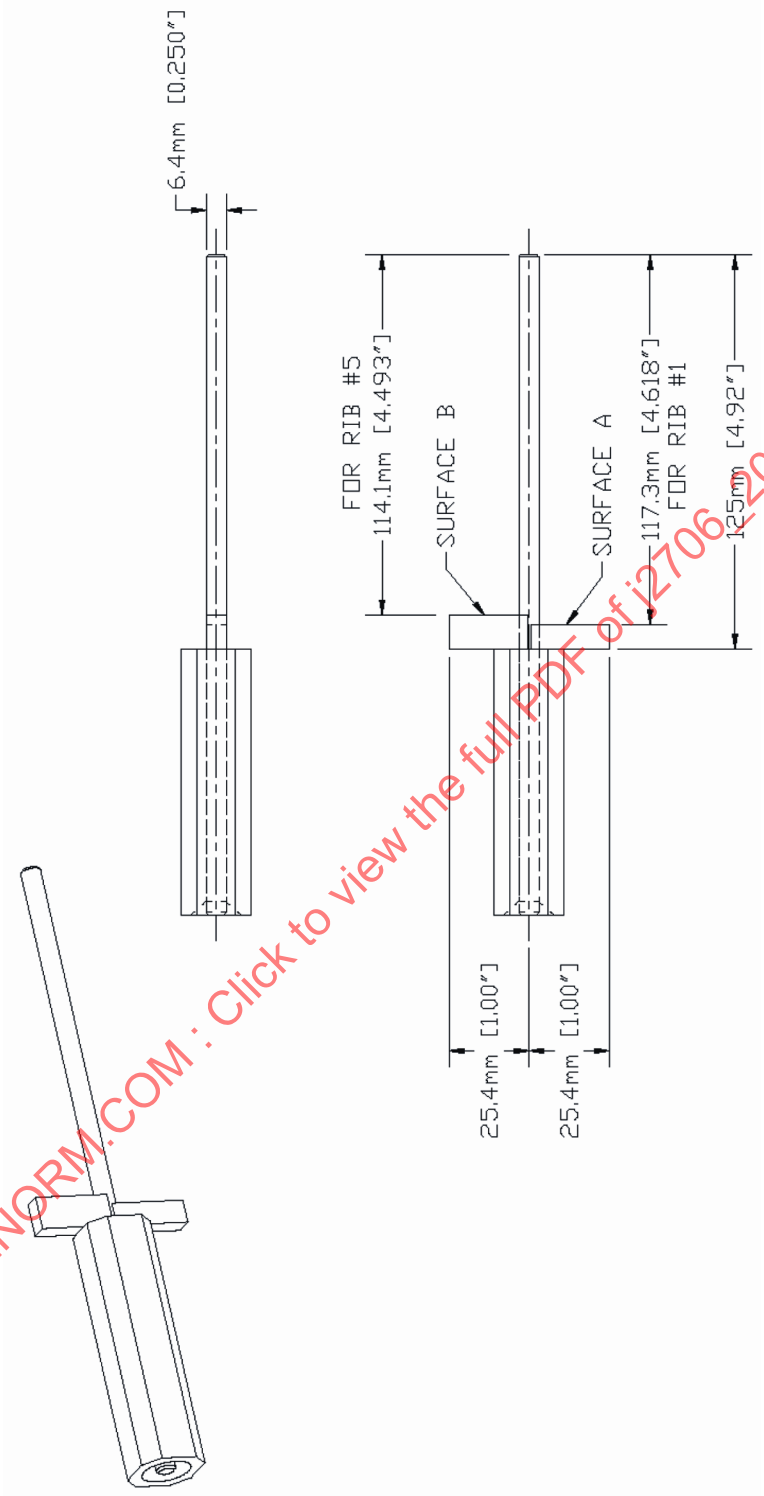


FIGURE 22 - CHEST DEPTH GAUGE

9. INSPECTION TEST PROCEDURES

9.1 External Measurements

PROCEDURE:

a. Remove the dummy's chest flesh (127-2010) and abdominal insert (127-8210).

b. Place the dummy on a flat, rigid, smooth, clean, dry, horizontal surface, as shown in Figure 23. The seating surface must be at least 406 mm (16 in) wide and 406 mm (16 in) deep, with a vertical section at least 406 mm (16 in) wide and 914 mm (36 in) high attached to the rear of the seating fixture. The dummy's midsagittal plane is vertical and centered on the test surface.

c. Remove the four socket head cap screws which attach the lumbar spine bracket to the pelvis. Two of the screws come up from the instrument cavity at the back of the pelvis. Torque the hex jam nut on the lumbar spine cable to 0.22 N·m ± 0.02 N·m (2.0 in-lbf ± 0.2 in-lbf).

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

d. Reassemble the lumbar spine bracket to the pelvis.

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

f. Position the dummy's H-point so it is 68.6 mm ± 5.1 mm (2.7 in ± 0.2 in) above the seat surface and 94.0 mm ± 5.1 mm (3.7 in ± 0.2 in) forward of the rear vertical surface of the fixture. The H-point is located 48.7 mm (1.917 in) forward and 34.5 mm (1.36 in) downward from the center of the pelvic angle reference hole.

g. Extend the dummy's neck so the base of the skull is level, both fore and aft and side to side, within 0.5° (the vertical mating surface between the skull and skull cap will be vertical). The rear surface of the skull cap should be 20.3 mm ± 2.5 mm (0.80 in ± 0.10 in) from the vertical surface of the test fixture. Secure the head in this position.

h. Position the upper and lower legs parallel to the midsagittal plane so the knee and ankle pivot centerlines are parallel, forming a 90° angle between the tibia and femur.

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

j. Position the upper arms vertically so the centerlines of the shoulder yoke and elbow pivots are parallel.

k. Position the lower arms horizontally so the centerlines of the elbow and wrist pivots are parallel.

l. Record the following dimensions. (The symbols and description for each measurement are indicated.)

- DESIGNATIONS:
- A.Total Sitting Height - Seat Surface to highest point on top of the head.
- B.Shoulder Pivot Height - Centerline of shoulder pivot bolt to the seat surface.
- C.Hip Pivot Height - H-point height above seat surface.

- D.Hip Pivot from Backline - H-point from seat's rear vertical surface.
- E.Shoulder Pivot from Backline - Center of the shoulder clevis to the fixture's rear vertical surface.
- F.Thigh Clearance - Seat surface to highest point on the upper femur segment.
- G.Back of Elbow to Wrist Pivot - The back of the elbow flesh to the wrist pivot, in line with the elbow and wrist pivots.
- H.Head Back from Backline - Skull cap skin to seat rear vertical surface.
- I.Shoulder to Elbow Length - The highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow, in line with the elbow pivot bolt.
- J.Elbow Rest Height - The flesh below the elbow pivot bolt to the seat surface.
- K.Buttock to Knee Length - The most forward part of the knee flesh to the fixture's rear vertical surface.
- L.Popliteal Height - Seat surface to the horizontal plane at the bottom of the feet.
- M.Knee Pivot to Floor Height – The knee pivot to the horizontal plane at the bottom of the feet, in line with the knee and ankle pivots.
- N.Buttock Popliteal Length - The rearmost part of the lower leg to the fixture's rear vertical surface.
- O.Chest Depth - The depth of the chest measured 330.2 mm (13.00 in) vertical from the seating surface.
- P.Foot Length - Tip of toe to rear of heel.
- R.Buttock to Knee Pivot Length - The rearmost surface of the buttock to the knee pivot bolt.
- S.Head Breadth - The widest part of the head.
- T.Head Depth - Back of the head to the forehead.
- U.Hip Breadth - The widest location of the hips.
- V.Shoulder Breadth - Between the outside shoulder edges, in line with the shoulder pivot bolt.
- W.Foot Breadth - The widest part of the foot.
- X.Head Circumference - The circumference of the head measured at the point as in measurement "T".

m. Reinstall the chest flesh and abdominal insert. Reposition the dummy on the test fixture. You do not need to level the head as specified for the previous measurements. Mark the locations and record the chest and waist circumference dimensions.

- AA - Reference location for chest circumference measurement - Measured 330.2 mm (13.0 in) vertical from seating surface.
- BB - Reference location for waist circumference measurement - Measured 158.8 mm (6.3 in) vertical from seating surface.
- Y - Chest Circumference with Chest Flesh - Measured 330.2 mm (13.0 in) vertical from seating surface.
- Z - Waist Circumference - Measured 158.8 mm (6.3 in) vertical from seating surface.