



SURFACE VEHICLE INFORMATION REPORT

J2858™

MAY2023

Issued 2017-10
Stabilized 2023-05

Superseding J2858 OCT2017

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

RATIONALE

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Documents

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FOREWORD

Government and industry researchers identified a need for a large-sized child dummy in 2000. An average ten-year-old was selected as the most appropriate size based on a study by Klinich et al., (Klinich, K. D.; Pritz, H. B.; Beebe, M. S.; Welty, K. E. 1994. Survey of older children in automotive restraints. *Thirty-eighth Stapp Car Crash Conference Proceedings*. pp. 245-264. SAE Report No. SAE 942222.) The Hybrid III Family Task Group met to define the size, weight, impact response characteristics and response measurements for a 10-year-old child dummy which would be similar in design to the midsize adult male Hybrid III dummy. Some variations from this design were included to address the multiple applications expected for this size of dummy, which include:

- testing child restraint systems at the upper end of the weight limits
- studying performance of restraint systems in vehicles with and without additional child restraint systems
- evaluating airbag deployment scenarios
- school-bus testing
- pedestrian impact testing

The size and weight specifications of the Hybrid III 10-year-old dummy are generally based on the average characteristic dimensions taken from anthropometry studies of 10-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.

TABLE OF CONTENTS

1.	SCOPE.....	4
1.1	Manual Overview	4
1.1.1	Appendices	4
1.1.2	Other SAE Documents.....	4
1.1.3	Test Definitions	4
1.1.4	Part Numbers.....	4
1.2	Construction	4
1.3	Clothing	5
1.4	Instrumentation	5
2.	REFERENCES.....	7
2.1	Applicable Documents	7
2.1.1	SAE Publications.....	7
3.	ABBREVIATIONS	7
4.	DISASSEMBLY AND ASSEMBLY PROCEDURES	7
4.1	Dummy Posture	7
4.2	Head.....	9
4.3	Neck	10
4.4	Upper Torso/Arms.....	13
4.4.1	Spine Box Disassembly	16
4.5	Lower Torso/Legs	18
5.	CERTIFICATION TEST PROCEDURES.....	25
5.1	Head Drop Test.....	25
5.2	Neck Tests	27
5.3	Thorax Impact Test.....	31
6.	INSPECTION TEST PROCEDURES	34
6.1	External Measurements	34
6.2	Mass Measurements.....	38
6.3	Knee Impact Test.....	39
6.4	Torso Flexion Test	40
7.	NOTES.....	43
7.1	Revision Indicator.....	43
APPENDIX A	ACCELEROMETER HANDLING GUIDELINES	44
APPENDIX B	GUIDELINES FOR REPAIRING FLESH	46
APPENDIX C	JOINT ADJUSTMENT PROCEDURES.....	47
Figure 1	Instrumentation locations	6
Figure 2	Front view of hybrid III 10YO	8
Figure 3	Side view of hybrid III 10YO in upright posture.....	8
Figure 4	Side view of hybrid III 10YO in slouched posture	9
Figure 5	Optional accelerometer block for the 10YO dummy head	9
Figure 6	Remove arm/shoulder assembly to gain access to neck.....	10
Figure 7	Left BHCS attaching neck assembly to spine box	11
Figure 8	Right BHCS and adjusting shoulder bolt attaching neck assembly to spine box	11
Figure 9	Right view showing neck angles achieved when placing adjusting shoulder bolt in different positions	12
Figure 10	Components of neck assembly.....	12
Figure 11	Components of joint between spine box and shoulder support assembly.....	13
Figure 12	Removing upper torso from lower torso.....	13
Figure 13	Removal of front rib end stiffener.....	14
Figure 14	Threaded rib strip on interior of ribs	14
Figure 15	Back rib stiffeners and posterior lower thorax accelerometer mount.....	15
Figure 16	Location of upper posterior thorax accelerometer	15



Figure 17	Removing stops from chest deflection transducer assembly.....	16
Figure 18	Thorax instrumentation block used with chest deflection transducer assembly.....	16
Figure 19	Removal of shoulder stop components.....	17
Figure 20	Shoulder assembly.....	17
Figure 21	Components of arm to shoulder joint	18
Figure 22	Remove lumbar spine from pelvis using two SHCS accessible from the top	19
Figure 23	Removal of pelvic instrumentation block. the two remaining SHCS that attach the lumbar spine assembly are also shown.....	19
Figure 24	Exploded view of lumbar spine assembly	20
Figure 25	Adjustment of the lumbar spine angle.....	20
Figure 26	Lumbar spine assembly, with lumbar adjustment angles marked, and designations for Standard Posture (SP) and Standard Slouched (SS) indicated	20
Figure 27	Orientation of right iliac load cell	21
Figure 28	Access for installing iliac load cells	21
Figure 29	Shoulder bolt connects thigh to the femur component	22
Figure 30	Three SCHS, accessible through three rearmost holes in dummy flesh, connect the hip joint to the pelvis	22
Figure 31	The thigh and knee assembly are connected by the femur load cell replacement.....	23
Figure 32	Exploded view of knee assembly	23
Figure 33	Exploded view of lower leg	24
Figure 34	Exploded view of ankle joint.....	25
Figure 35	Head drop test set-up specifications.....	27
Figure 36	Neck pendulum arm specifications	28
Figure 37	Instrumentation setup for neck flexion test	30
Figure 38	Thorax impact test setup.....	33
Figure 39	Hysteresis calculation	34
Figure 40	External dimensions.....	36
Figure 41	Knee impact test setup.....	40
Figure 42	Example of torso flexion test set-up.....	41
Figure 43	Example of torso flexion pull bracket	42
Figure 44	Front view of abdomen set up.....	42
Figure 45	Side view of abdomen set up.....	43
Table 1	Pendulum impulse specification for neck flexion test	30
Table 2	Pendulum impulse specification for neck extension test	31
Table 3	External dimensions.....	37
Table 4	Assembly masses	38

1. SCOPE

This user's manual covers the Hybrid III 10-year old child test dummy. The manual is intended for use by technicians who work with this test device. It covers the construction and clothing, assembly and disassembly, available instrumentation, external dimensions and segment masses, as well as certification and inspection test procedures. It includes guidelines for handling accelerometers, guidelines for flesh repair, and joint adjustment procedures. Finally, it includes drawings for some of the test equipment that is unique to this dummy.

1.1 Manual Overview

1.1.1 Appendices

Several guidelines and procedures apply to various parts throughout the dummy, and are included in the appendices for easier reference. First, when handling an instrumented dummy, improper techniques can damage instrumentation, particularly accelerometers. Appendix A contains guidelines for safe handling of instrumented dummies. Second, the vinyl flesh of dummies can be damaged, but is often repairable. Appendix B contains instructions for repairing dummy flesh. Third, procedures for adjusting the joints throughout the dummy are included in Appendix C.

1.1.2 Other SAE Documents

In addition to the attached appendices, other SAE publications are particularly useful when working with the Hybrid III dummies. SAE J211-1 provides the most recent guidelines and procedures for dummy instrumentation and filtering. SAE Information Report J1733 illustrates the instrumentation available for the Hybrid III dummies, along with descriptions of how to apply the positive right-hand rule sign convention.

1.1.3 Test Definitions

Test procedures are classified as either Certification Tests or Inspection Tests. Certification tests are specified for dummy responses which could affect dummy measurements that are used by governments and safety engineers to assess occupant injury potential. Certification tests are performed by the dummy manufacturer to assure that a new component or assembly meets the SAE specified response requirements. The crash dummy user will periodically perform the certification tests to assure the dummy is maintained at the SAE specified performance levels. Inspection tests are supplemental to the certification tests to ensure that a component meets its design intent. They are performed by the dummy manufacturer on new parts. The dummy user may conduct inspection tests when a part is damaged or replaced.

1.1.4 Part Numbers

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 Reprographic Technologies, www.repro-tech.com, 18810 Woodfield Rd., Gaithersburg MD 20879, (301)-670-7874.

1.2 Construction

- One-piece cast aluminum skull with removable vinyl head and cap skins. The vinyl skin has been tuned to give human-like response for forehead impacts. The head is the same one used in the Hybrid III small female dummy.
- A rubber segmented neck that has been tuned to give human-like angle versus moment response in dynamic flexion (forward bending) and extension (rearward bending) articulations.
- Neck can be adjusted to four different positions from 0 to 22°.
- Cable through the neck's longitudinal axis to increase the neck's durability to high axial loads.
- Six spring steel ribs with polymer-based damping materials to provide the chest with a human-like force-deflection response and a minimum deflection space of 60 mm.
- Top and bottom rib stops to control the vertical movement of the rib cage.

- Two methods available for chest deflection measurement: a traditional ball-slider rotary potentiometer mechanism, as well as the IR-TRACC.
- More humanlike shoulder shape.
- Zippered chest jacket for easy removal.
- Cylindrical rubber lumbar spine.
- Pelvis and abdominal assembly has a seated design with vinyl skin and foam flesh molded over an aluminum pelvis casting. Features have been incorporated to allow the dummy to be seated in a humanlike slouched posture when appropriate.
- The thighs contain ball-jointed femurs and retaining rings for hip pivot joint. A knee insert under a vinyl knee impact surface controls impact response. The flesh has a more realistic seated cross section.

1.3 Clothing

When used in testing, the dummy should wear shirt (children's size 10 to 12) and pants (children's 14 to 16) which are 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 0.14 kg (0.31 pound). The shoes should be children's size 2-1/2 wide leather athletic shoe. Each shoe weighs $0.59 \text{ kg} \pm 0.05 \text{ kg}$ (1.30 pounds ± 0.10 pound).

1.4 Instrumentation

The following is the instrumentation which the SAE Task Group agreed would be needed to evaluate child restraints and air bag interactions with children of this size, also illustrated in Figure 1:

- Three uniaxial accelerometers in the head
- Two tilt sensors in the head
- Six-channel upper neck load cell
- Six-channel lower neck load cell
- Chest Deflection Rotary Potentiometer or IR-TRACC
- Two accelerometers on the sternum
- Two accelerometers at the back of the spine box
- Triaxial accelerometers in the upper torso and pelvis
- Two-channel shoulder load cells
- Six-channel lumbar spine load cell
- Two-channel anterior superior iliac spine load cells
- Six-channel femur load cell (single axis available)
- Six-channel leg load cells at mid shaft (single axis available)

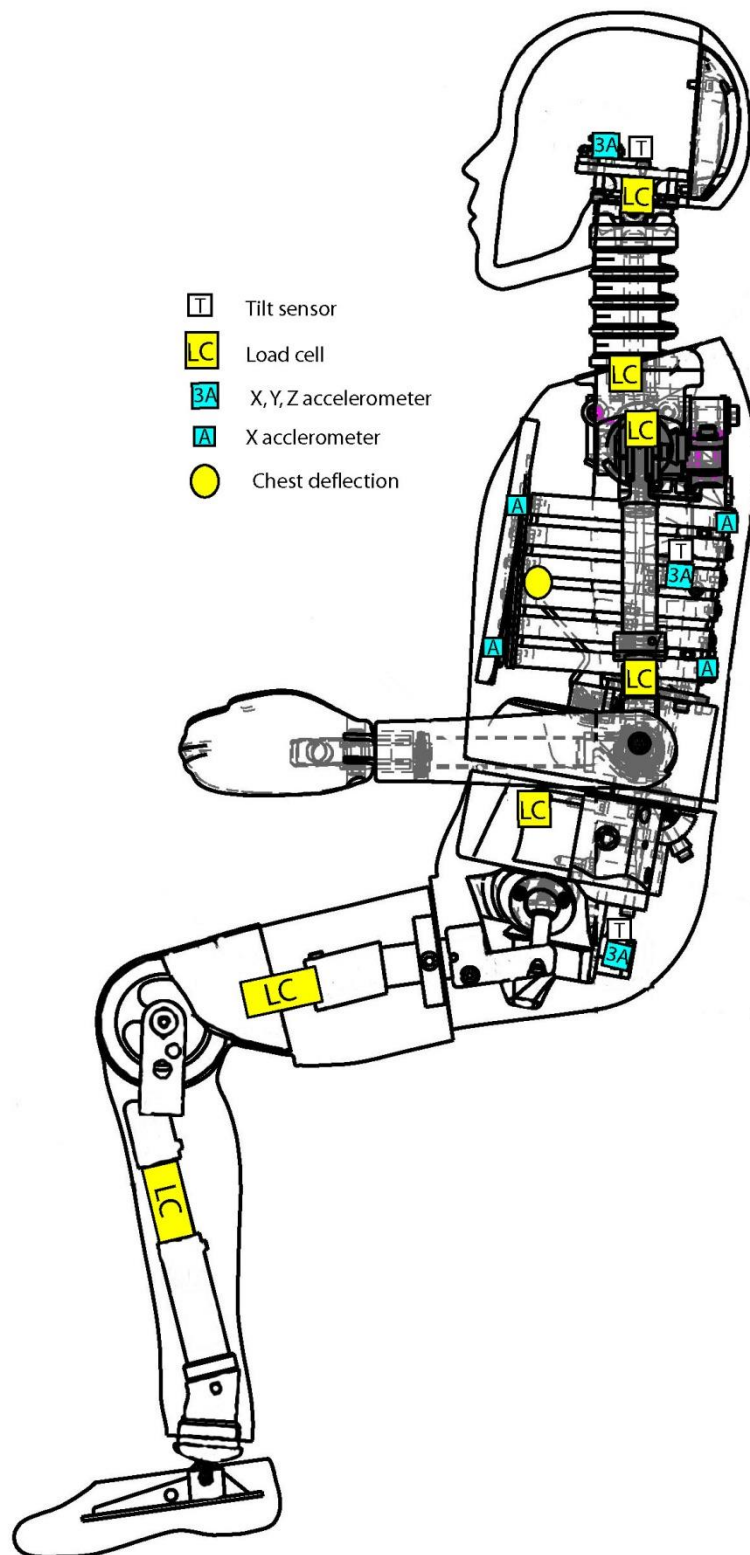


Figure 1 - Instrumentation locations

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 issue 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 +1 724-776-4970 (outside USA), www.sae.org.

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

SAE J211-1-2 Instrumentation for Impact Test—Part 2: Photographic Instrumentation

SAE J1733 Sign Convention for Vehicle Crash Testing

SAE J2517 Hybrid III Family Chest Potentiometer Calibration Procedure

3. ABBREVIATIONS

Threaded fastener abbreviations used in manual:

3.1 SHCS

Socket Head Cap Screw

3.2 FHCS

Flat Head Cap Screw

3.3 BHCS

Button Head Cap Screw

3.4 SHSS

Socket Head Shoulder Screw

3.5 SSCP

Socket Screw, Cup Point

4. DISASSEMBLY AND ASSEMBLY PROCEDURES

4.1 Dummy Posture

The Hybrid III 10YO has an adjustable neck and lumbar spine to allow a variety of postures. The neck angle can be set to 0, 8, 16, or 23° relative to the spine box. The lumbar spine can be adjusted from 0 to 24° relative to the top of the pelvis in increments of 4°. Standard upright dummy posture, shown in Figures 2 and 3, is achieved by setting the neck angle at 16° and the lumbar angle at 12°. A standard slouched posture, shown in Figure 4, is achieved by setting the neck angle to 23° and the lumbar angle to 0°. Other slouched postures are also possible.



Figure 2 - Front view of Hybrid III 10YO



Figure 3 - Side view of Hybrid III 10YO in upright posture



Figure 4 - Side view of Hybrid III 10YO in slouched posture

4.2 Head

The head of the 10YO dummy is the same one used on the Hybrid III small female dummy. The small female accelerometer block may be used with the 10YO. However, there is a different accelerometer block available for the 10YO that allows mounting of tilt sensors (Figure 5).

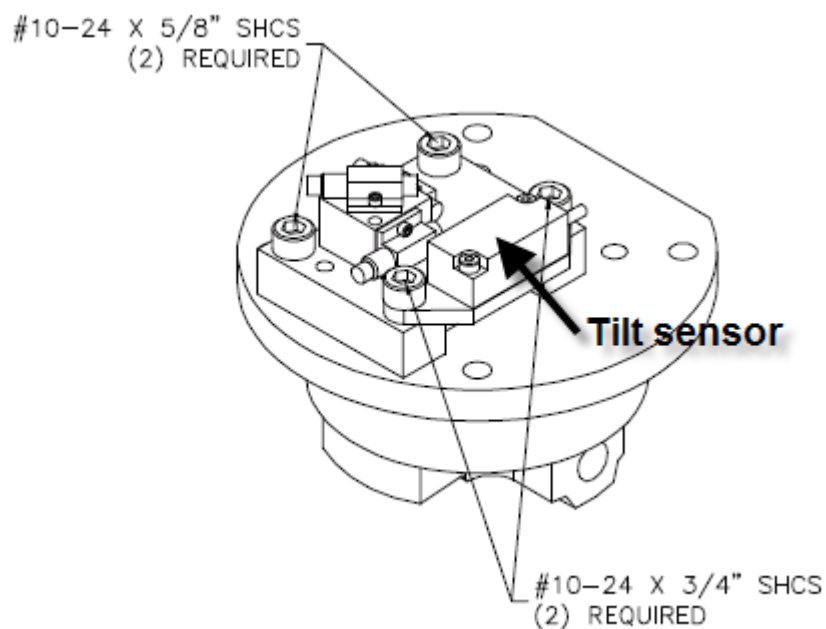


Figure 5 - Optional accelerometer block for the 10YO dummy head

4.3 Neck

Before the neck can be removed, the chest jacket, and the arm/shoulder assemblies should be removed (Figure 6). To reassemble this joint, slip the pivot nut into the bottom part of the shoulder support bracket. Place the shoulder washer into the recess of the pivot nut. Put the shoulder pivot washers on either side of the hole on the shoulder assembly. Place the shoulder assembly and pivot washers into the shoulder support. Insert the SHSS through the flat washer and into the partially assembled shoulder.

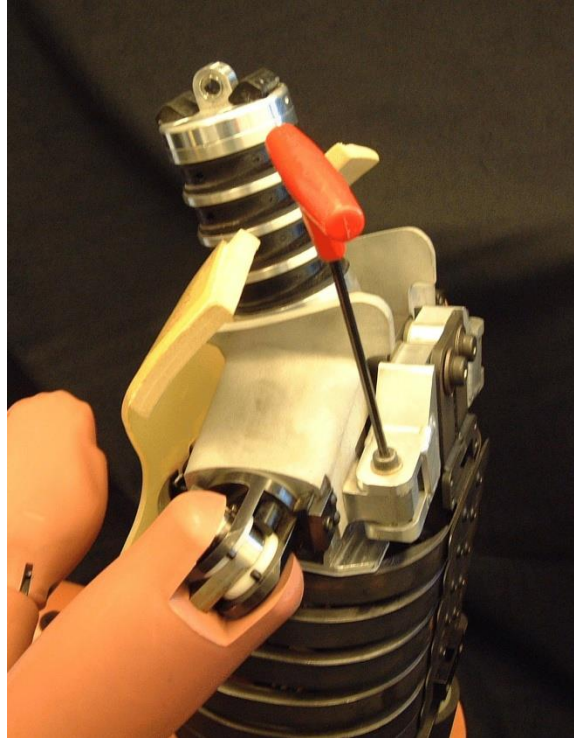


Figure 6 - Remove arm/shoulder assembly to gain access to neck

To adjust the neck angle, loosen the two BHCS shown in Figure 7 - for the left and Figure 8 - for the right. Select the neck angle by removing the shoulder bolt, washers, and nut shown in these figures. Different angles are achieved by inserting the shoulder bolt into different holes as indicated in Figure 9.

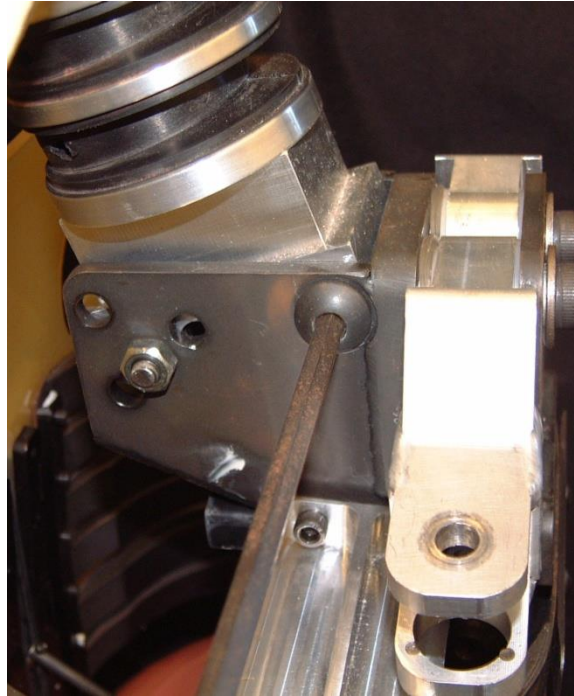


Figure 7 - Left BHCS attaching neck assembly to spine box



Figure 8 - Right BHCS and adjusting shoulder bolt attaching neck assembly to spine box



Figure 9 - Right view showing neck angles achieved when placing adjusting shoulder bolt in different positions

To remove the neck assembly, remove the two BHCS and the adjusting shoulder bolt shown in Figure 7 - and Figure 8 -. The components of the neck assembly are shown in Figure 10. To assemble, place the upper bushing on the neck cable, insert the neck cable into the neck, attach the lower bushing, then the washer, and a jam nut. Torque the neck cable to $0.9 \text{ Nm} \pm 0.2 \text{ Nm}$ (8 in-lb $\pm$ 2 in-lb) using a screwdriver to hold the end of the cable. Add another jam nut. Attach the lower neck load cell with four SHCS; dowel pins orient it so you can't put it on backwards. Place the nodding blocks (same fore and aft) in the nodding joint, and attach the nodding joint with 4 FHCS.



Figure 10 - Components of neck assembly

4.4 Upper Torso/Arms

Remove two modified SHCS that attach the left and right shoulder support assemblies to the spine box. The components of one joint are shown in Figure 11. When reassembling, slip the pivot nut into the spine box weldment. Place the shoulder pivot washers on either side of the shoulder support assembly, and slide them into place on the spine box. Insert the sternum washer between the pivot nut and shoulder pivot washer. Insert the modified screw through the flat washer, spine box, washers, and pivot nut already assembled.



Figure 11 - Components of joint between spine box and shoulder support assembly

Remove upper rib guides, each attached with two SHCS. To remove upper torso from lower torso, take out the abdomen component. Then remove 4 SHCS and washers from either side of the chest deflection transducer assembly as shown in Figure 12.

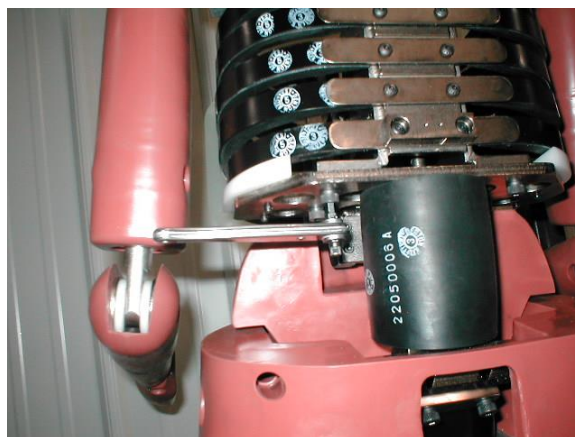


Figure 12 - Removing upper torso from lower torso

Remove left and right plate front rib end stiffener by removing the six BHCS that attach each side (Figure 13); the threaded rib strip on the inside of the ribs (Figure 14) will fall off. Remove the twelve BHCS from the sternum plate to allow the bib to lift off.

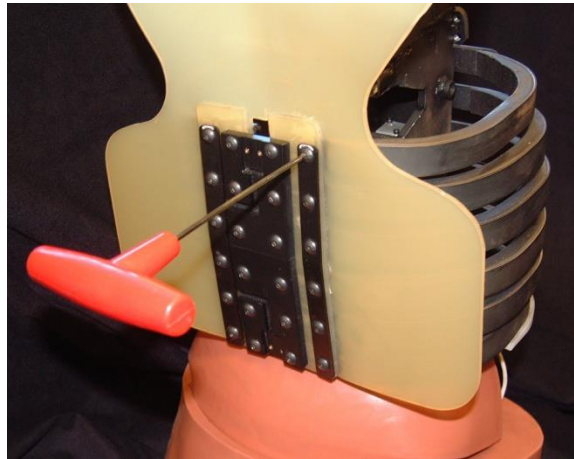


Figure 13 - Removal of front rib end stiffener

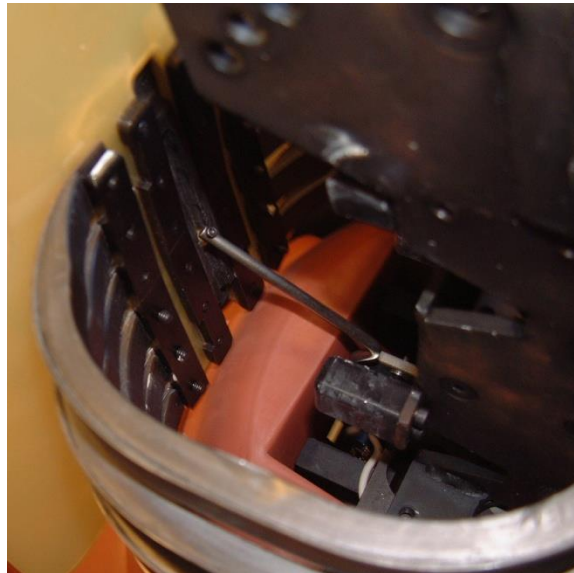


Figure 14 - Threaded rib strip on interior of ribs