Submitted by the IWG GTR7 PH2

Informal document **GRSP-54-05**
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agenda item 2)

Draft Addendum 1 - Specifications for the Construction, Preparation and Certification of the 50th percentile male Biofidelic Rear Impact Dummy, (BioRID-II) anthropometric test device

Contents

Draft Mutual Resolution Addendum 1

1. Introduction

This document, addendum 1 to the Mutual Resolution, aims to set out a standard specification for build and certification of the Biofidelic Rear Impact Dummy (BioRID-II) UN.

BioRID-II UN is a 50th percentile male dummy, developed to mimic occupant behaviour in automotive rear impact collisions of low severity.

BioRID-II UN has a fully articulated spine, providing a more anthropomorphic response in a collision while still maintaining the level of repeatability and reproducibility established by previous dummies used in automotive impact testing.

BioRID-II UN is able to record many measurements, including thorax loading and head acceleration and rotation, which can be correlated to the risk of whiplash associated disorders and other injuries.

1.1. General Design

For the purposes of application in the context of UN ECE Regulations, the BioRID II UN anthropometric test dummy is defined by compliance with the build and calibration requirements set out in this document and accompanying engineering drawings (Appendix X). The generic build level, e.g. BioRID IIg, is not sufficient to determine the status of the dummy and it is necessary to establish that the individual components that comprise the dummy are manufactured to the particular level of drawing revision that are tabled in Annex II.

BioRID-II UN incorporates a fully articulated two-dimensional spine with 24 vertebrae. The spine consists of seven cervical (C1-C7), twelve thoracic (T1-T12) and five lumbar (L1-L5) vertebrae.

The head assembly and the top cervical vertebra (C1) are connected using an occipital interface plate. Upon this interface is mounted a 6-channel or 3-channel upper neck load cell, or if no load cell is used, a load cell structural replacement. The superior thoracic vertebra (T1) is contoured as a cervical vertebra on the upper side and as a thoracic vertebra on the lower side in order to mate the cervical and thoracic regions. Similarly the upper surface of the superior lumbar vertebra (L1) is shaped like the thoracic vertebrae and the underside shaped like the lumbar vertebrae to mate the thoracic and lumbar regions. The lowest lumbar vertebra (L5) connects the spine to the pelvis through a sacrum lumbar and pelvis interface plate.

The vertebrae for the BioRID II UN are made of durable plastic and are connected with pins at each joint that allow for angular motion in the sagittal plane only. The occipital and pelvis interfaces are made of aluminium. There are rubber blocks glued to the top of each vertebra to simulate the compression resistance of the muscles and discs between each human vertebra.

To increase the biofidelity of the neck motion response, tensioning cables are incorporated into the neck region of the spine. There are three cables originating at the top of the neck, with threaded adjustments for controlling cable tension. One cable goes through the cervical vertebrae, around a damper assembly at the T4 vertebra and back through the vertebrae to the top

of the neck. The two other cables also start at the top of the neck but terminate at two spring-loaded cable-tensioning devices mounted on the right side of the torso.

The upper torso flesh is made of moulded silicone. Included in the flesh mould are: the left and right arm attachment yokes with reinforcement plates, the abdomen interface attachment, the abdomen cavity, the abdomen valve and the spine-torso interface. The flesh material and/or external surface characteristics enable positive attachment of adhesive targets.

The arms and legs are Hybrid III 50th percentile dummy assemblies and the head and pelvis are modified Hybrid III 50th percentile dummy assemblies.

1.2. Instrumentation

1.2.1. Available Instrumentation

Table 1 lists the available instrumentation for the BioRID II UN Dummy. Section 2.4 of Annex 1 describes cable installation requirements. Any instrumentation used shall not change the mass or centre of mass of components.

Note: table 1 and figure 1 will need amending once injury criteria are finalised!!!!

Table 1.
BioRID UN Instrumentation

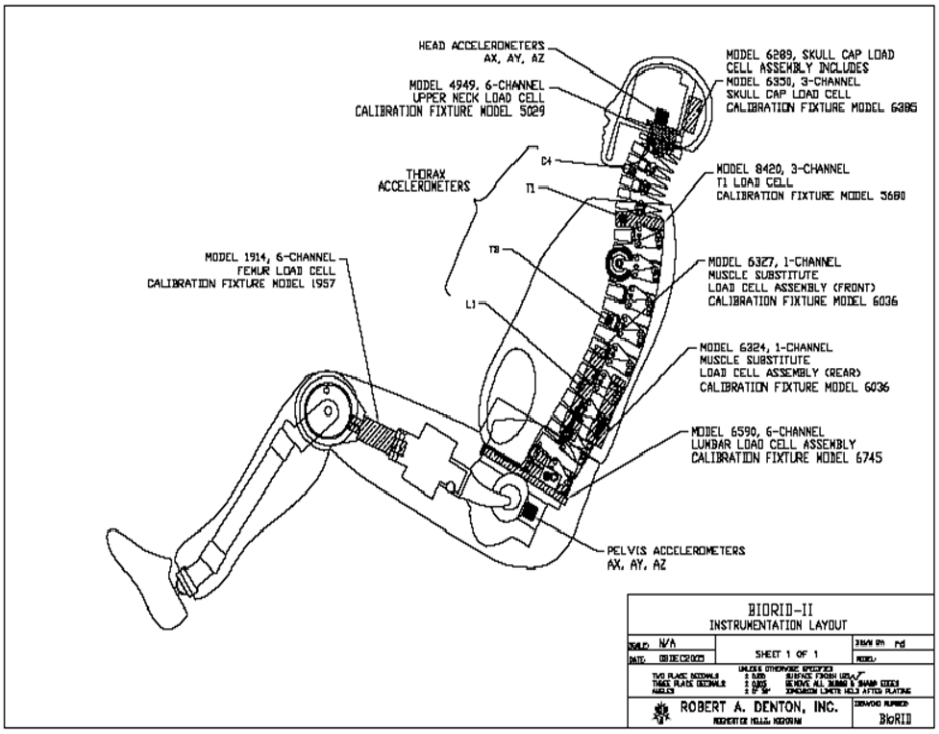
Location	*Type*	*Measurement*	*Number of Channels*
Head	Accelerometer	AX, AY, AZ	3
Head	Gyro	AVX, AVY, AVZ	1 - 3
Head	Skull Cap Load Cell	FX, FZ, MY	3
Head	Skull Cap Contact Switch	Event	1
Head	Tilt Sensor	Angle	1
Upper Neck	Load Cell	FX, FY, FZ, MX,MY,MZ	6
Neck (C4)	Accelerometer	AX, AZ	2
Thorax (T1)	Load Cell	FX, FZ, MY	3
Thorax (T1)	Accelerometer	AX, AZ	2
Thorax (T1)	Gyro	AVX, AVY, AVZ	1 - 3
Thorax (T1)	Tilt Sensor	Angle	1
Thorax (T8)	Accelerometer	AX, AZ	2
Thorax (T8)	Gyro	AVX, AVY, AVZ	1 - 3
Lumbar (L1)	Accelerometer	AX, AZ	2
Lumbar (L1)	Gyro	Angular	1 - 3
Lumbar Load Cell	Load Cell	FX, FX, FZ, MX, MY, MZ	6

Location	*Type*	*Measurement*	*Number of Channels*
Muscle Tension (2)	Load Cell	Force	2
Pelvis	Accelerometer	AX, AY, AZ	3
Pelvis	Gyro	AVX, AVY, AVZ	1 - 3
Pelvis	Tilt Sensor	Angle	1
Femur (Left and Right)	Load Cell	FX, FY,FZ, MX, MY, MZ	12

1.2.2. Instrumentation Location

The location of the instrumentation shall be as illustrated in figure 1.

Figure 1.
Instrumentation layout



1.3. Required Tools

The following special tools will allow assembly, disassembly and calibration of the BioRID II Rear Impact Dummy.

Hex spanner, Ball end (0.05" – 3/8" and 1.5 mm – 10 mm)

Hex spanner, ‘T’-handle (3/32" - 3/8" and 2 mm – 10 mm)

Screwdriver, standard tip (2.5 mm tip width)

Pin punch (6 mm (0.25") dia.)

Brass mallet

Thread locking adhesive (e.g. cyanoacrylate)

Open-end spanner (13 mm)

Synthetic gear oil of ISO viscosity grade 680

1.4. Abbreviations of Screw Types Used

The abbreviations listed in table 2 shall be used within this addendum

Table 2.
Abbreviations of screw types

Screw Type	Abbreviation
Socket Head Cap Screw	SHCS
Button Head Cap Screw	BHCS
Flat Head Cap Screw	FHCS
Socket Set Cup Point	SSCP
Socket Head Shoulder Screw	SHSS

2. Physical Properties

2.1. Dimensions

Table 2 specifies key dimensions that are checked when the dummy is seated in the dummy measurement chair. These measurements enable dimensional conformity to be checked without having to inspect every component, and allow the level of compression in the flesh to be monitored. They shall be performed whenever the dummy is certified and may additionally be performed outside certification if desired.

The dummy measurement chair shall feature a flat, rigid, smooth, clean, dry, horizontal surface. The seating surface shall 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. It shall feature an adjustable head strap capable of supporting the dummy's head against forward movement. A suitable chair is shown in figure 2.

The procedure for taking these measurements is as follows:

Level the seat of the dummy measurement chair such that it lies parallel to the X-Y plane in the coordinate reference system. Zero the digital inclinometer on the seat surface with it oriented in the X-coordinate direction.

Position the dummy on the measurement chair such that the dummy's midsagittal plane is vertical and centred upon the test surface, and position the head strap of the chair so it runs round the front of the head, directly under the nose (figure 2). Insert the head levelling tool on the top of the skull, then insert the H-Point tool through the pelvis into the H-Point reference square hole mounted at the base of the spine.

Position the lower torso so the H-Point reference hole on the H-point tool is between 13.5 – 14.0mm (5.3 – 5.5 inches) from the seat back on both sides of the dummy when measured in the X coordinate direction (figure 3). Measure the height (Z coordinate direction) from the seat to the H-Point reference hole (figure 4) and compare to the tolerance band specified in table 2. Place the inclinometer on the top of the H-Point tool (figure 5) and confirm that this angle is between 0 and 6 degrees; if it is not, adjust the dummy position and repeat the measurements of the H-point positions (X and Z directions) and angles until all are within tolerance .

Place the inclinometer on the top of the head levelling tool (figure 6). The head angle shall be 26.5 +/- 2 degrees. The head strap may be adjusted to allow slump on the spine in order to attain correct angle.

Measure the thigh clearance by placing a level across the highest point on the thighs and measuring the vertical distance (Z coordinate direction) from the seat to the bottom of the level on each side of the dummy (figure 7). Hold the measuring ruler in a vertical orientation such that it touches the outer thigh.

To find the buttock to knee length, place a level across the furthest forward point of both the knees and measure the distance (X coordinate direction) between the level to the seat back. Measurements shall be taken on either side such that the tape or ruler is oriented in the X direction and touches the side of the dummy (figure 8).

Place a level on the top of the head and centre the bubble. Measure the dimension from the seat to the underside of the level (Z coordinate direction) to find the seated height (figure 9).

Level the feet front to back by holding a digital inclinometer to the soles of the feet. Place a straight edge transversely under the balls of the feet, such that it contacts both feet, and measure the vertical distance between the straight edge and the knee pivot to find the knee pivot height on both sides of the dummy, as shown in figure 10. The measuring device shall be vertical and shall touch the dummy Measure the length and width of each foot using a ruler, at the longest and widest points of the foot respectively.

Figure 2.
Seating the dummy in the measurement chair

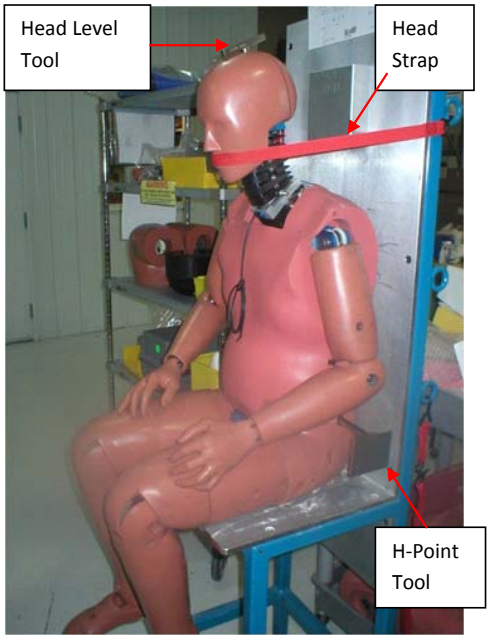


Figure 3.
Setting the longitudinal position of the lower torso

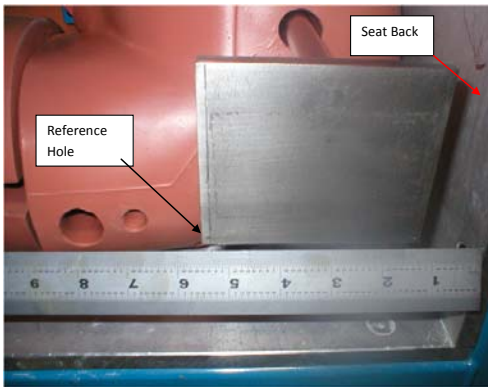


Figure 4.
Measuring the H-Point height (left side)

Figure 5.
Measuring the H-point tool angle

Figure 6.
Measuring the angle of the head levelling tool

Figure 7.
Measuring the thigh clearance

Figure 8.
Measuring the knee to buttock length

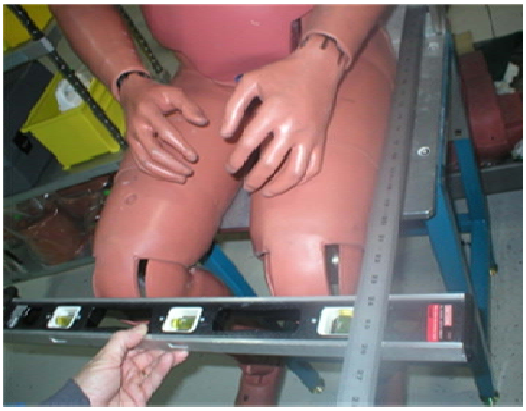


Figure 9
Measuring the seated height of the dummy

Figure 10
Measuring the left knee pivot height

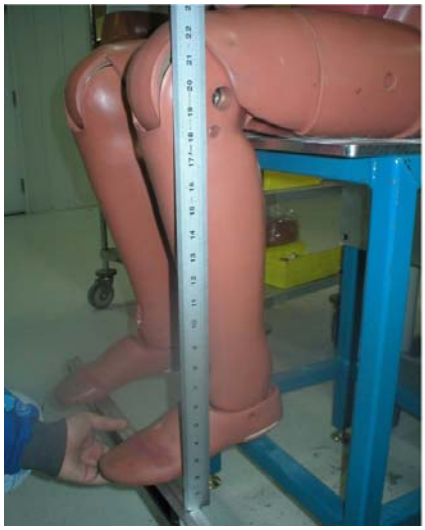


Table 3
Dimensions of BioRID UN

	Imperial (in)		*Metric (mm)*	
Feature	Lower	Upper	Lower	Upper
Right H-Point above seat	3.3	3.5	84	89
Left H-Point above seat	3.3	3.5	84	89
Right H-Point from Seat Rear	5.3	5.5	135	140
Left H-Point from Seat Rear	5.3	5.5	135	140
Seated Height	34.6	35	879	889
Right Thigh Clearance	5.5	6.1	140	155
Left Thigh Clearance	5.5	6.1	140	155
Right Buttock to Knee Length	22.8	23.8	579	605
Left Buttock to Knee Length	22.8	23.8	579	605
Right Knee Pivot Height	19.1	19.7	485	500
Left Knee Pivot Height	19.1	19.7	485	500
Right Foot Length	9.9	10.5	251	267
Left Foot Length	9.9	10.5	251	267
Right Foot Width	3.6	4.2	91	107
Left Foot Width	3.6	4.2	91	107

2.2. Masses

The masses of the BioRID II UN dummy shall conform to the specifications in table 4. After replacing parts, including instrumentation, the mass of the segment containing the replaced part shall be rechecked.

Table 4.
Masses of BioRID UN components

	Mass			
	lbs		kgs	
Assembly	Lower Corridor	Upper Corridor	Lower Corridor	Upper Corridor
Head	9.9	10.1	4.49	4.58
Torso	92.5	94.5	41.96	42.86
Right Upper Arm	4.2	4.6	1.91	2.09
Left Upper Arm	4.2	4.6	1.91	2.09
Right Lower Arm	3.65	3.85	1.66	1.75
Left Lower Arm	3.65	3.85	1.66	1.75
Right Hand	1.15	1.35	0.52	0.61
Left Hand	1.15	1.35	0.52	0.61
Right Upper Leg	13	13.4	5.90	6.08
Left Upper Leg	13	13.4	5.90	6.08
Right Lower Leg	9.3	9.6	4.22	4.35
Left Lower Leg	9.3	9.6	4.22	4.35
Right Foot	2.4	2.7	1.09	1.22
Left Foot	2.4	2.7	1.09	1.22

Annex 1

Assembly, disassembly and inspection

This annex deals with protocols for assembly, disassembly and maintenance of BioRID II UN. For parts lists and engineering drawings of the components referred to in this annex, see annex 2.

1. Mechanical Subsystems

1.1. Head

1.1.1. Assembly

BioRID II UN uses a modified Hybrid III 50th percentile head assembly. The skull base and ballast are modified to accommodate the upper neck load cell and the tensioning cables that extend out of the neck section. Figure 1 shows a breakdown of all head components, which are listed within Annex 2.

1.1.2. Removal

To remove the head from the neck assembly, loosen the two M4 nylon tipped set screws clamping the condyle pin to the O.C Plate and firmly press down on the top of the head assembly to compress the elastomer bumpers on the Occipital Condyle. While the bumpers are compressed, push the condyle pin out of the head-neck joint using a 1/4" (6mm) rod toward the dummy's right side. Once the pin is removed, pull the head away from the neck assembly.

1.1.3. Disassembly

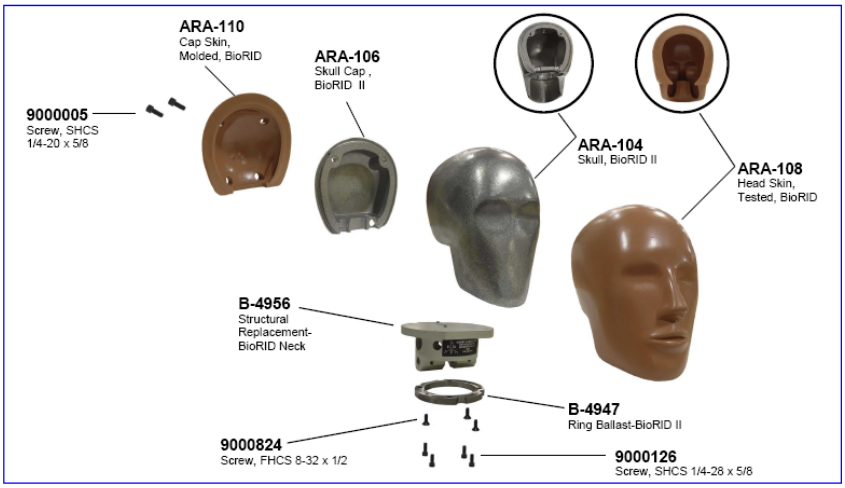
Take out the two 1/4-20 x 5/8" SHCS securing the skull cap assembly to the skull. Disconnect the two connector plugs at the top surface of the load cell, inside the head, by sliding the outer sleeve of the connector away from the load cell. Remove the four 1/4-28 x 7/8" SHCS at the base of the skull.

Push the load cell into the inside of the skull and rotate it 90º so that the occipital condyle hole is vertical. The load cell can then be pulled out through the back of the skull.

Accelerometers may be mounted on the top surface of the neck load cell. To remove them from the load cell take out the four #10-24 x 1/4" SHCS that secure the mounting plate in place.

To remove the head skin from the assembly, lift the rear flaps and peel it away from the skull. Check the skin for damage.

Figure 1.
Head assembly exploded view



1.2. Spinal Column – Cervical portion

1.2.1. Assembly

The cervical portion of the spine assembly links the T1 vertebra to Occipital interface plate. Figure 2 shows a breakdown of the assembly, the components for which are listed within Annex 2.

1.2.2. Disassembly

Prior to disassembly of the spine, loosen or remove the muscle substitute assembly as described in section 1.2.3.2.

To disassemble the cervical spine, take off the M8 jam nuts on each side of the spine at the C7–T1 joint and loosen or remove the two M2.5 SHCS used to lock the T1 pin to the vertebrae, then push the T1 pin out of the assembly. Do not hammer or directly impact the joint; this may cause damage. Use a 6 mm punch and tap lightly to slide the remaining cervical spine pins out, until the cervical spine is completely disassembled.

Check the bumpers; if any are loose or have become detached; follow the procedure described in section 1.2.1.3.

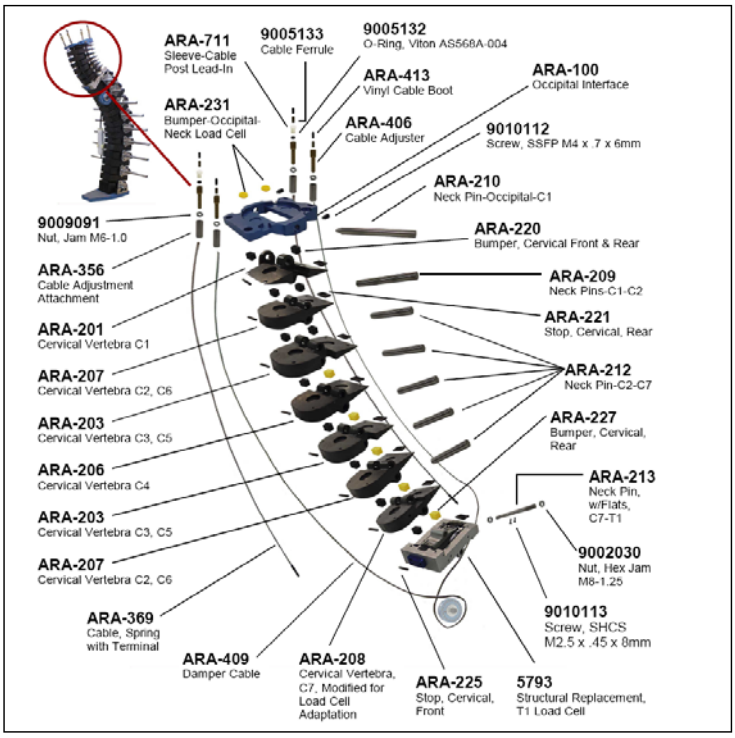
1.2.3. Bumper Replacement

There are rubber bumper pads on each vertebra. If any are loose or have fallen off, re-glue them to the vertebra as follows:

Remove old glue from the bumper and the vertebra and scrub the area with acetone or methyl ethyl ketone (MEK). Draw a line on the vertebra 2 mm from the anterior edge when replacing the anterior bumper to guide positioning; use this to position the bumpers 2mm from the edge when gluing. The posterior bumper shall be glued flush with the posterior edge of the vertebra when being replaced. The bumpers shall be centred relative to the sides of the vertebrae in all cases.

Apply a thin coat of cyanoacrylate adhesive to the bumper and gently press the bumper into place on the vertebra. Hold for approximately 30 seconds. Wipe away excess glue, using acetone or MEK if necessary.

Figure 2.
Breakdown of components in the cervical portion of the spinal column



1.3. Spinal Column - Thoracic and Lumbar Portions

1.3.1. Assembly

Figures 3 and 4 illustrate the thoracic and lumbar region of the spine; a list of components may be found in Annex 2.

1.3.2. Disassembly

To facilitate disassembly of the spine, the muscle substitute assembly shall first be loosened or removed as described in section 1.2.3.2.

Before starting to take off each vertebra, it is recommended that the operator mark each component with tape or paint to aid reassembly. The torsion adjustment washer position at each vertebral junction can be marked with a paint marker to show its position relative to the torsion washer.

Take out the four M6 X 1 X 20 FHCS at the underside of the interface plate and pull the pelvis interface plate away from the spine. Remove the M8 x 1.25 x 10 BHCS that lock the adjustment washers in place on the torsion washer.

To remove the pins, lay the spine assembly on a firm, flat work surface with the pins vertical. Use two wooden blocks to provide clearance under the spine for the pins to move downward. Then, starting with the pin joining S1 and L5, tap the pin out of the torsion washer on the dummy's left side using a 6 mm pin punch and a brass mallet or equivalent. Take care not to damage the pin, washer or vertebrae through use of excessive force.

Continue working along the spine assembly separating the torsion pins from the torsion washers. After all the pins on one side are loose, turn the spine

over and repeat the process on the opposite side until all the pins are free from the torsion washers.

Pull the pins and torsion washers from the spine assembly. For easier re-assembly, take out the pin–adjustment washer assemblies one at a time starting at the S1–L5 joint, working bottom to top, and set aside each part as it is taken off so it can be re-assembled in the same sequence. Note that there are shim or spacer washers at S1 between the torsion washer and the vertebra, and at T4 there is a cable pulley wheel inside; these must be reinstalled correctly upon reassembly. If any bumpers are loose or have fallen off, they shall be re-glued to the vertebra using the procedure described in 1.2.1.3.

Figure 3
Spinal Column Thoracic and Lumbar - Part 1

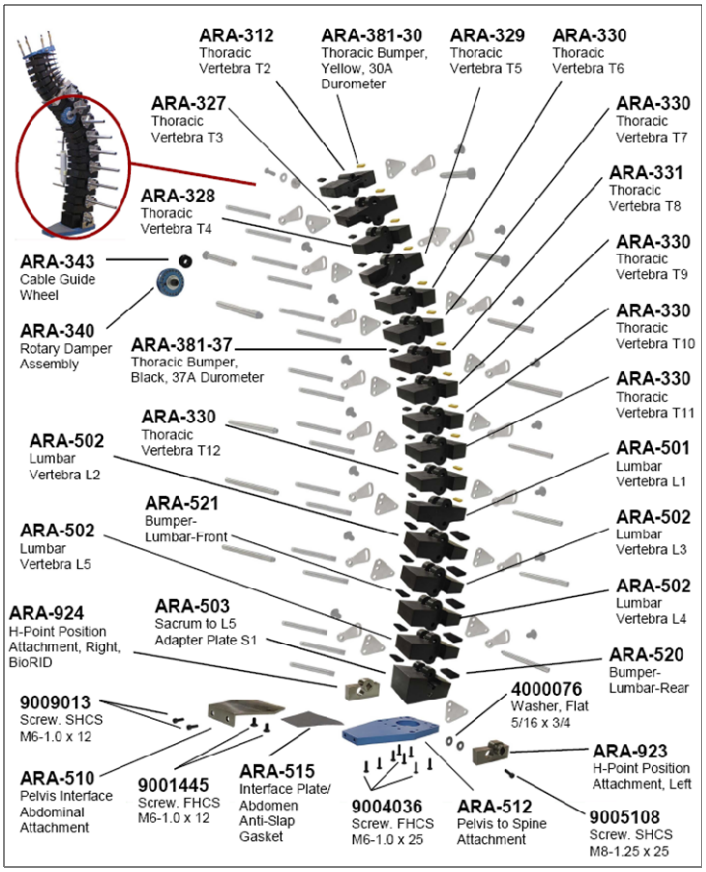
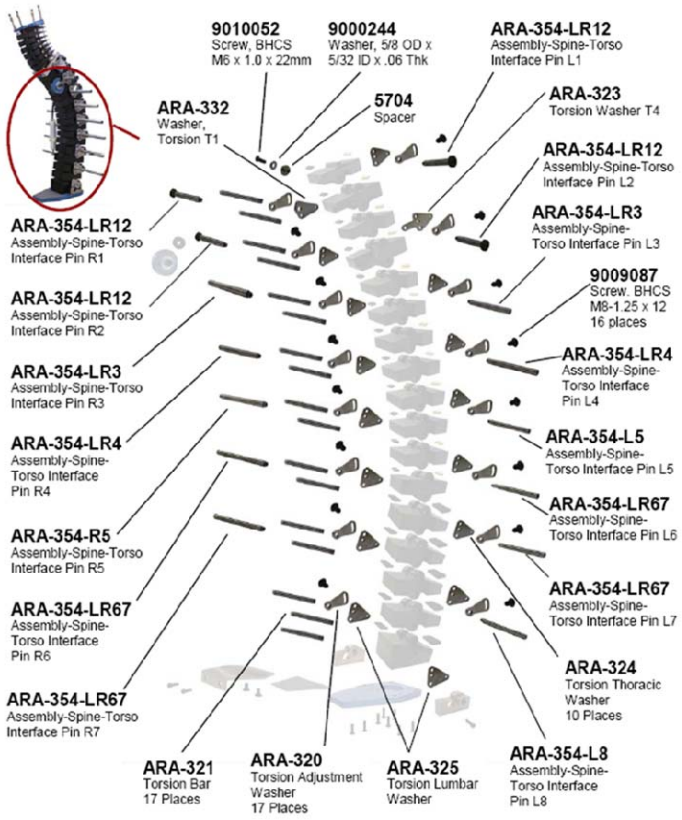


Figure 4
Spinal Column Thoracic and Lumbar - Part 2

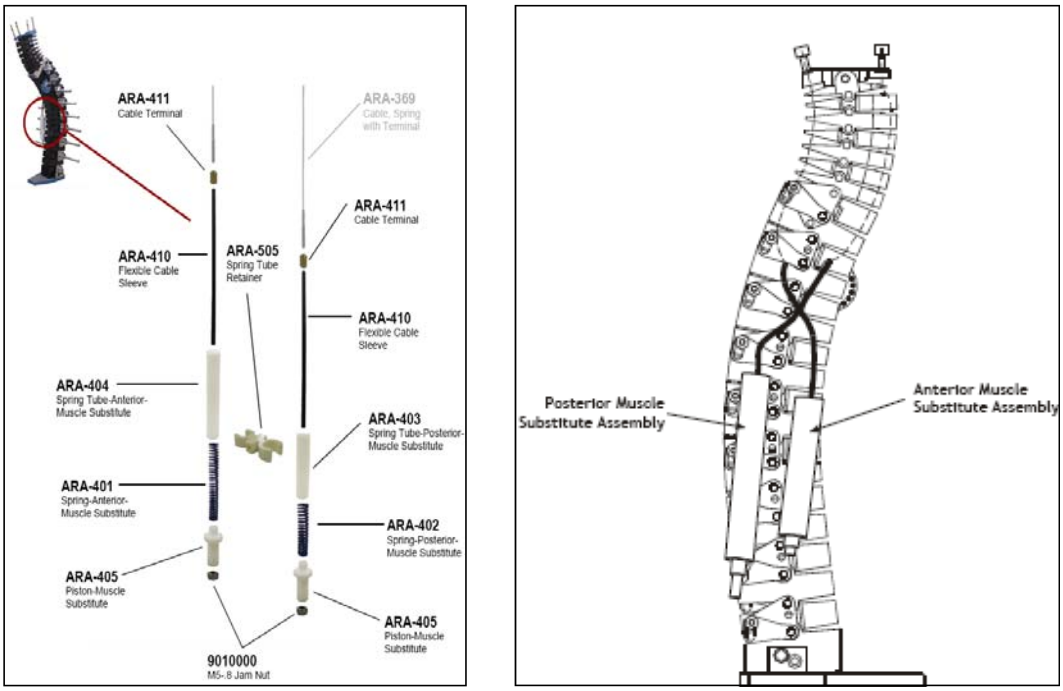


1.4. Spinal Column - Muscle Substitute System

1.4.1. Assembly

The muscle substitute assembly is a system of springs and cables running through each vertebra from the OC plate to T3. Figure 5 shows a breakdown of the assembly; a list of the components is in Annex 2.

Figure 5
Muscle Substitute Assembly Components



1.4.2. Disassembly

Prior to disassembly of the spine, the muscle substitute cables must be loosened or removed. The procedure for this is as follows.

1.4.2.1. Spring Loaded Muscle Substitutes:

Loosen and remove the two M5 nuts and lower spring cable adjusters at the base of each spring assembly and slide the springs out from the tubes.

Pull the cable through the adjustment screw at the top of the torso so that the cable crimp is accessible, and cut the cable below the crimp, between the crimp and the adjustment screw. Pull the cable down and out through the vertebrae and spring tubes.

1.4.2.2. Damper Loaded Muscle Substitute:

Loosen and remove the two M5 nuts and lower spring cable adjusters at the base of the spring assembly. Loosen the cable adjustment screws and posts at the top of the torso, on the dummy's left side, and adjust the posts all the way down.

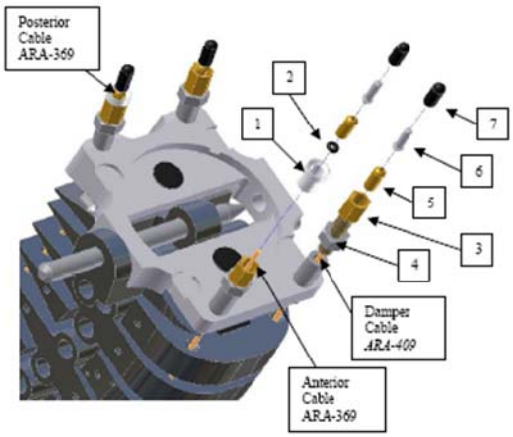
Compress cervical vertebrae toward the rear and pull the cable out of the rear adjustment screw, then cut the cable between the cable crimp and the adjustment screw. Repeat this procedure for the front adjustment screw.

Remove the damper mounting screw (M8 X 1.25 X 12 SHCS) located at T4 and pull the damper unit from the spine assembly. Loosen the two M3 SHSS that clamp the damper to the damper cable and remove the cable from the damper slot.

1.4.3. Cable Installation

Figure 6 is an exploded view of the upper neck components related to the three cables.

Figure 6.
Cable Detail



1.4.3.1. Damper cable

Feed the damper cable down through the top of the rear damper cable adjuster, and then down through the back cable holes of the vertebra, from the O.C. plate down through T3 (Figure 7). After cable is fed out through the damper cavity, feed it up through the front cable holes on the vertebra, from T3 up through the front damper cable adjuster on the O.C. plate (Figure 8).

Set the damper adjustment screw so that it is ½ turn open by turning it clockwise until travel stops, then turning it counter-clockwise ½ turn (Figure 9).

Overlap the cable as shown in Figure 10 and wrap the cable around the damper drum, making sure the cable is seated in the slot. Slide tapered projection of the end of the damper paddle into the tapered slot on the mounting plate (Figure 11) and slide clamp bracket over damper/plate assembly (Figure 12). Ensure that shallow slot on seal washer and the mating projection on the clamp bracket are mated (Figure 13).

Install the M8 mounting bolt and lock washer until it is finger tight. Tighten the M3 setscrew to firmly seat the damper into the tapered slot on the mounting plate (figure 14). Torque the mounting bolt to 5 ft/lbs (6.8 Nm).

Feed one #9005133 ferrule onto the end of the rear damper cable (Figure 15) and crimp the ferrule within 4" (100 mm) from the end of the cable (Figure 16).

Feed one #9005133 ferrule onto the end of the front damper cable (Figure 17). Ensure that the cable adjusters are adjusted all the way down, then pull up on both ends of cable with one hand so that the cable is seated tightly around the damper and so that rear ferrule touches the top of the cable adjuster.

Crimp the front ferrule while both front and rear ferrules are touching the adjacent adjuster (Figure 18). Leave both damper adjusters adjusted all the way down.

Figure 7
Damper cable installation (1)

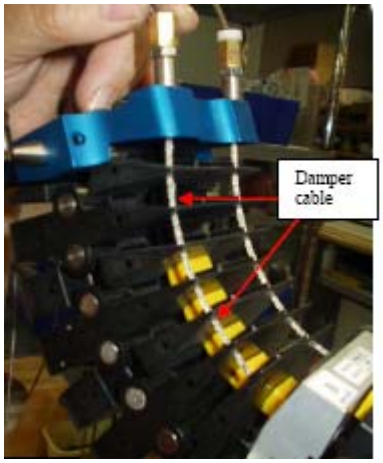


Figure 8
Damper Cable Installation (2)

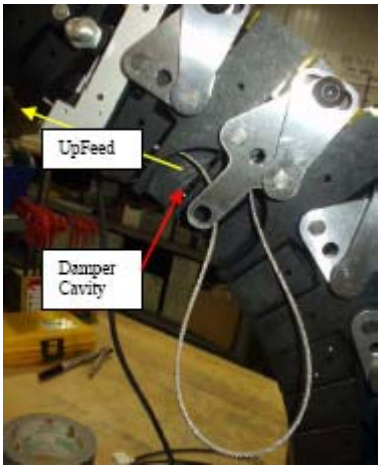


Figure 9
Damper Adjustment Screw setting

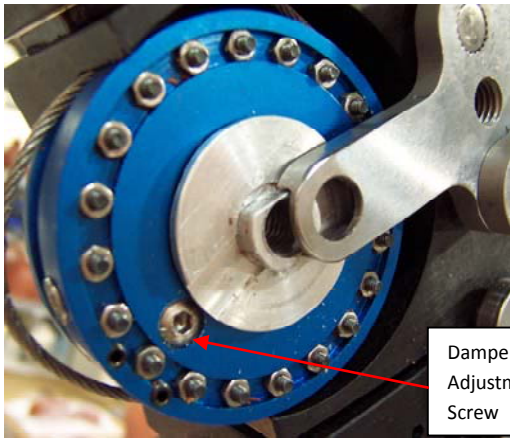


Figure 10
Damper Cable overlap

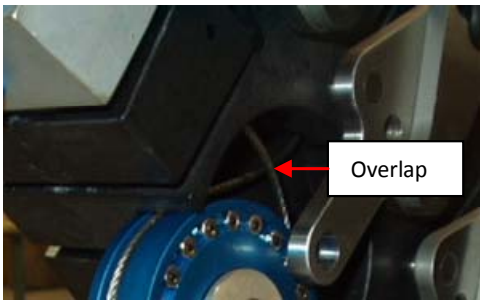


Figure 11
Slide damper into place

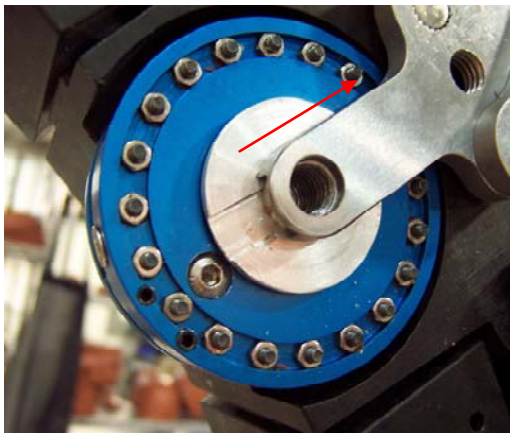


Figure 12
Install Damper Clamp Bracket

Figure 13
Damper Clamp Bracket mate

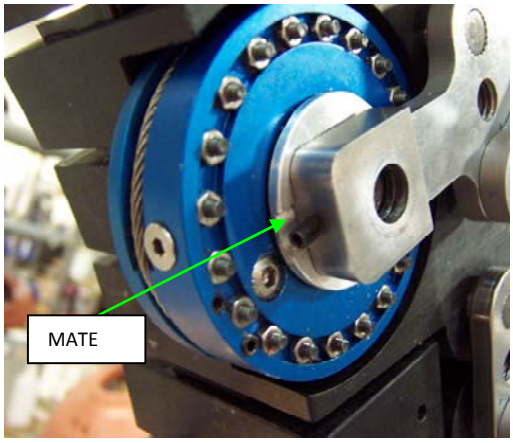


Figure 14
Damper Clamp Set Screw

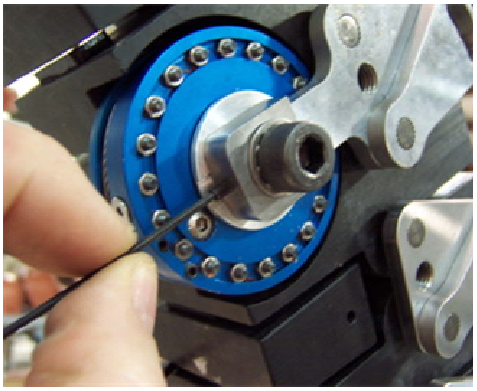


Figure 15
Damper Cable Ferrule installation

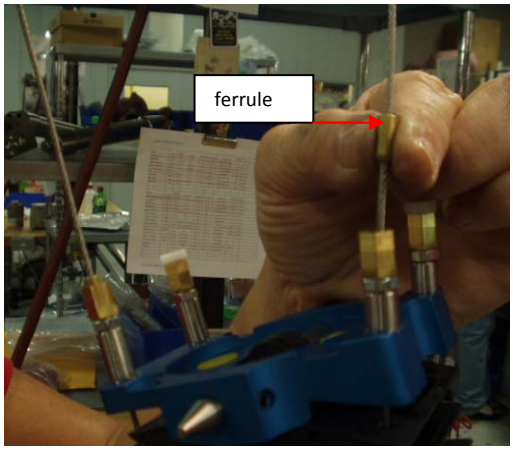


Figure 16
Ferrule crimping

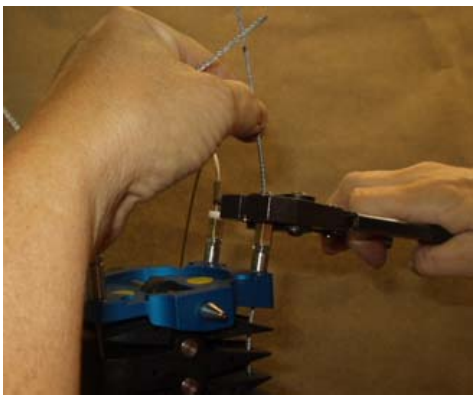


Figure 17
Damper Cable setting

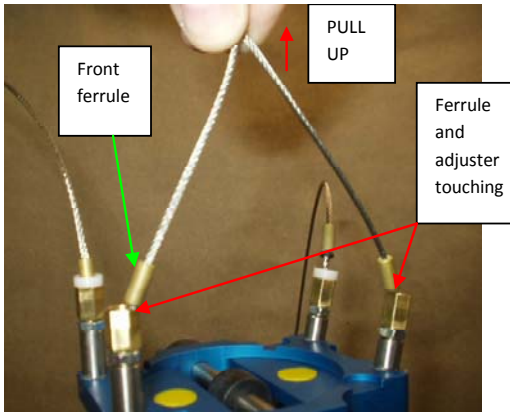
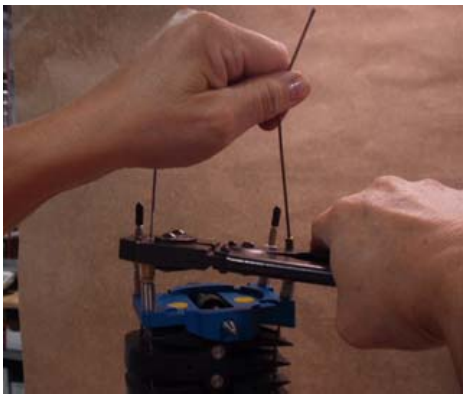


Figure 18.
Crimp Front Damper Ferrule



1.4.3.2. Spring Cable

Feed the anterior spring cable #ARA-369 through the small cable hole at the top of the longer spring tube (Figure 19), and up through all vertebra from T3 to the O.C. plate. Feed the anterior spring onto the end of the cable (Figure 20) and install the lower cable adjuster onto the threaded stud (Figure 21) until the adjuster is flush with the end of the cable stud.

Feed the posterior spring cable #ARA-369 through the small cable hole at the top of the shorter spring tube and up through all vertebra from T3 to the O.C. plate. Feed the posterior spring onto the end of the cable, install the lower cable adjuster and turn it upward so that there is 16 mm protruding (Figure 22). Masking tape may be used to assist in retaining the cable and spring assemblies in position through the next steps.

Ensure that both the front and the rear upper cable adjusters are adjusted all the way down. Install a #9005132 O-ring on both front and rear spring cables, followed by #9005133 ferrules, as shown in Figure 23.

Pull the anterior cable up to remove any slack remaining in the cable. Slide the ferrule down until it touches the top of the #ARA-711 cable guide (Figure 24) and crimp the ferrule in place. Repeat this step for the posterior spring cable assembly.

If smaller cable crimpers were used for ease, finish crimping all four ferrules with #9000827 cable crimpers, or equivalent. Use the smallest opening on the jaws.

Cut the ends of all four cables approximately 10mm above the ferrules. Place #9010293 cable caps on all four cables ends and crimp them in place with small crimpers. Place 1 drop of cyanoacrylate adhesive on the sides of each of the 4 cable caps and install vinyl caps #ARA-413 over them. Squeeze the vinyl caps briefly to ensure they adhere to the cable caps.

Figure 19
Anterior Spring Cable Insertion

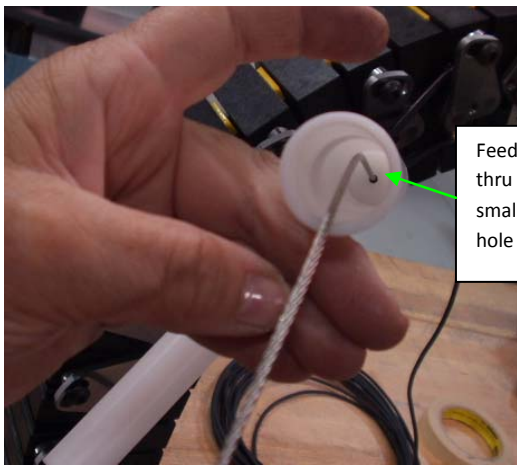


Figure 20
Anterior Spring Insertion

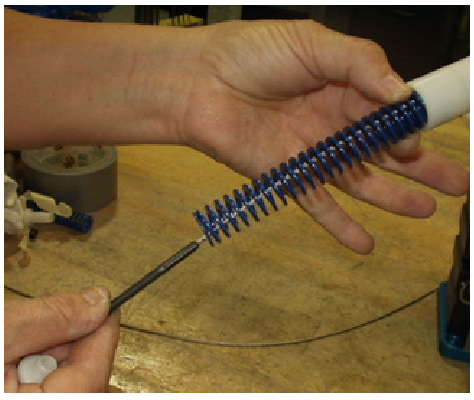


Figure 21
Cable Adjust Installation

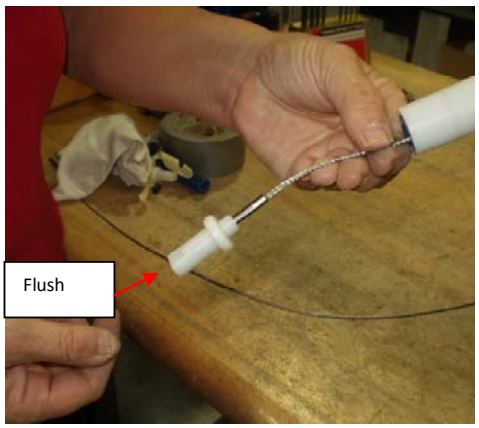


Figure 22
Setting the Posterior Spring Cable

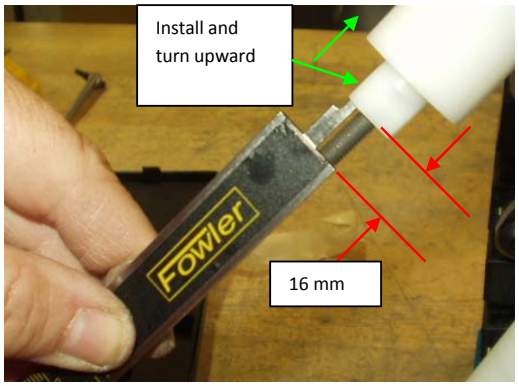


Figure 23
Ferrule Installation Front and Rear Spring Cable

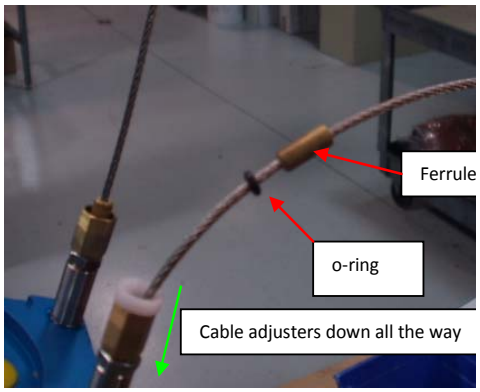
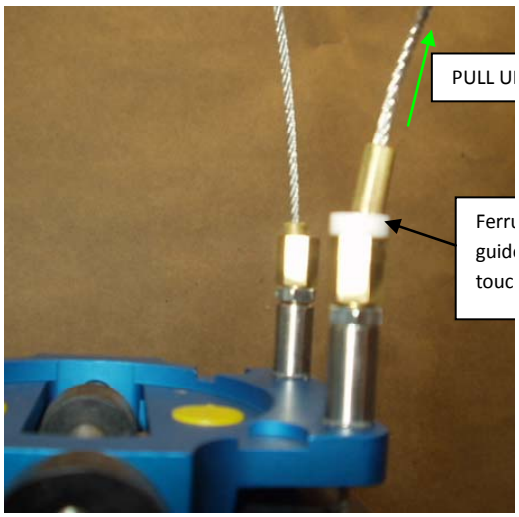


Figure 24
Remove Slack from Spring Cable



1.4.4. Damper Removal and Installation

In addition to damper replacement or maintenance, it is also necessary to remove the damper for maintenance work on the T1 load cell or for neck bumper replacement. The following are steps to remove and re-install the ARA-375 damper. Figure 25 is an exploded view of the damper assembly.

Loosen the locknuts on both adjusters for the damper cable, then turn the adjusters until they are at the lowest extremity of their travel, such that cable is as loose as possible (figure 26). Loosen both of the M3 cable clamping set screws to enable removal of cable from the mating slot on the side of the damper body (figure 27).

Back off the M3 setscrew (9010295) by two turns (figure 28). Remove the M8 damper mounting screw (9010294), then remove the Clamp Bracket (ARA-346). Slide the damper towards the front of the spine (figure 29) and

turn the damper to untwist cable (figure 30) and disengage the damper from the cable.

When re-installing the damper, be sure that the cable overlap is correct; see figure 31 for a view of the correct overlap direction. Engage the cable within the cable slot of the damper.

Slide the tapered projection of the paddle into the tapered slot on the mounting plate (figure 32). If the parts will not mate, then the projection is out of position.

Slide the damper all of the way into the mating slot on the plate, then slide the clamp bracket (ARA-346) over the damper/plate assembly. After installing the clamp bracket, be sure that the shallow slot on the seal washer and the mating projection on the clamp bracket are mated. It may be necessary to spin the washer to line-up the slot with the projection.

Install the M8 mounting bolt (9010294) and lock washer (9005200) with fingers until finger tight. Tighten the M3 set screw (9010295) to firmly seat damper into the tapered slot on the mounting plate.

Note that some damper units exist with only one M3 set screw to clamp the cable to the damper; these older units do not comply with the BioRID II UN specification, which requires two such screws.

Figure 25
Exploded View of Damper Assembly

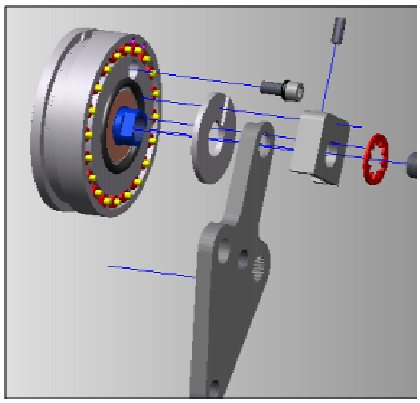


Figure 26.
Loosen Adjusters

Figure 27
Loosen M3 Clamping Screws

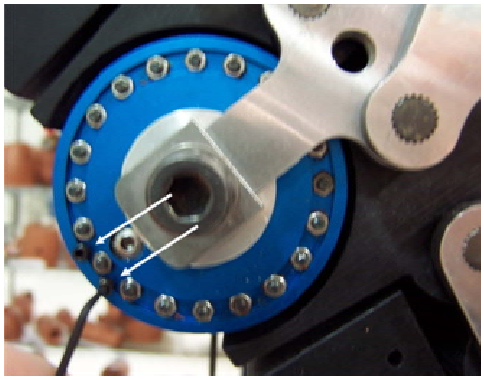


Figure 28
Back Off Set Screw

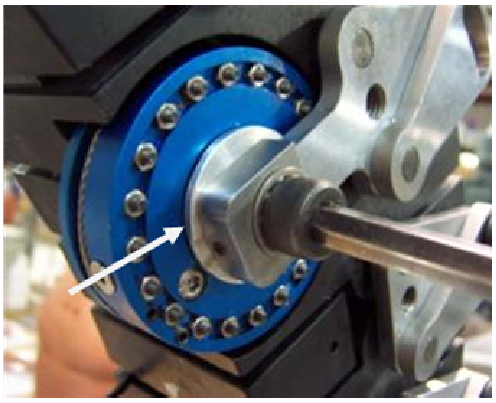


Figure 29
Slide Out Damper

Figure 30
Turn Damper and Disengage Cable

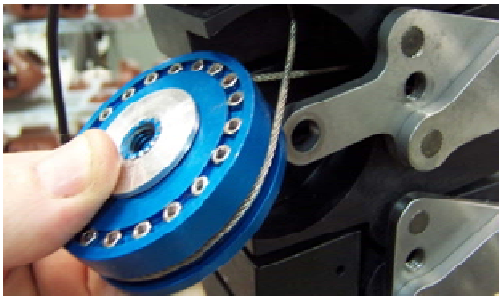


Figure 31
View of Correct Cable Overlap

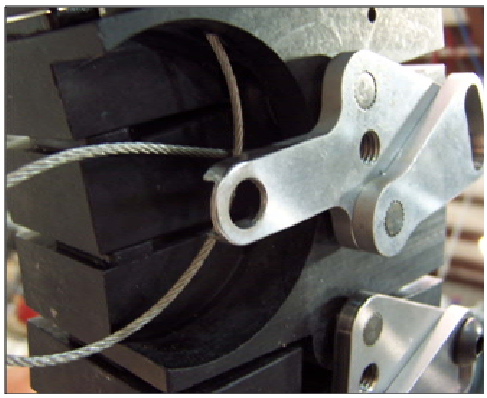
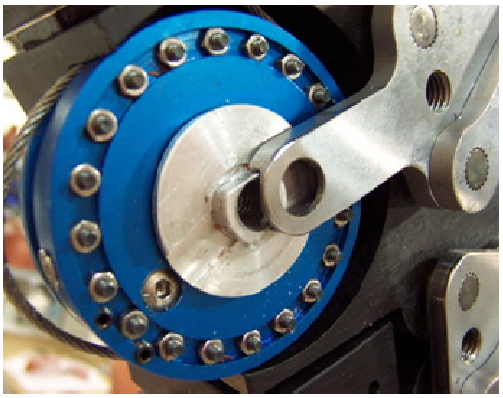


Figure 32
Install Damper



1.4.5. Damper Filling

Open the damper adjustment screw 2 full turns, by first closing the screw (turning it clockwise) to the full extent of its travel, and then opening the screw (turning it anticlockwise) by 720 degrees.

Remove Damper fill hole cover screw, M3 FHCS (Figure 33).

Install the M8 mounting screw and tighten until it is finger tight; this screw will be used for turning the paddle to isolate air pockets in the damper. Turn the M8 mounting screw all the way clockwise. If it is found that the screw loosens during subsequent steps, it may be further tightened with tools.

Using a syringe of ISO 680 damper oil, inject oil until it begins flowing out around the needle. After initial filling, it is then necessary to remove air pockets as follows:

Turn the paddle very slowly anticlockwise while holding the damper in one hand. A steady drag will be felt when oil is passing through the orifice inside the damper, but when an air pocket passes through the orifice, the drag is gone and the paddle suddenly rotates with much less resistance. This is easily felt when turning the damper by hand; even the smallest bubbles of air can be felt as small shock when they pass through the orifice.

After the air is felt to pass through the orifice and the drag suddenly starts again from the oil, stop rotating the paddle, and turn slowly back clockwise; the air will again be felt, but now the air pocket will be directly under the fill hole. Repeat filling with the syringe, and stop when oil flows out around the needle. Repeat this process until the damper is free of air through the entire rotation travel of the damper.

The fill hole cover screw may be installed between each syringe application, at the discretion of the user; this will help avoid accidentally pumping oil out of the damper if it is rotated too fast.

Coat the tapered portion of the cover screw with a silicone sealant or equivalent that is suitable for the temperature range encountered; silicone sealant containing copper is recommended (figure 34). Install the fill hole cover screw tightly and wipe away the excess sealant.

Figure 33.
Remove Oil Fill Screw

Figure 34
Add sealant to the cover screw

1.5. Static Spine Setup Procedure

The adjustments and tests described within this section shall be performed after any maintenance work (such as servicing or replacement of parts) is done upon the spine, and may be done more regularly (i.e. independent of maintenance work) as required. The procedures within this section are to be done in the sequence presented; it is not permissible to do parts of the process in isolation or in a different order.

1.5.1. Thoracic and Lumbar Spine

Place the spine on a bench top and ensure that all 17 torsion washer locking screws are loose. Insert the thoracic and lumbar vertebra spacer tool into the front of the lower spine as shown in Figure 35. Ensure the inside edge of tool is within 1 mm of the fronts of all thoracic and lumbar vertebrae; use a brass or hard rubber hammer to tap up and down along outer edge of tool to ensure correct location. Use optional attachment handles if necessary to aid installation.

Tighten the locking screws (Figure 36), beginning at the S1 lumbar plate screw on the right side of the spine and continuing upward on right side. Use 15 ft/lbs (20Nm) torque for each screw except for the T1 thoracic plate screw (Figure 37), which only requires 10 ft/lbs (14Nm). After all 9 screws on right side of spine are tight, tighten all 8 screws on left side of spine to 15 ft/lbs (20Nm), beginning at the L5 lumbar screw and continuing upward until all are tight. Hold the bottom of the spacer tool against the pelvis interface plate while tightening the L5 lumbar screw to prevent the spine tilting backward due to the torque.

Remove the spacer tool by tapping with a brass or hard rubber hammer, toward the right side of the spine.

Figure 35.
Thoracic and Lumbar Vertebra Spacer Tool with Optional Handles

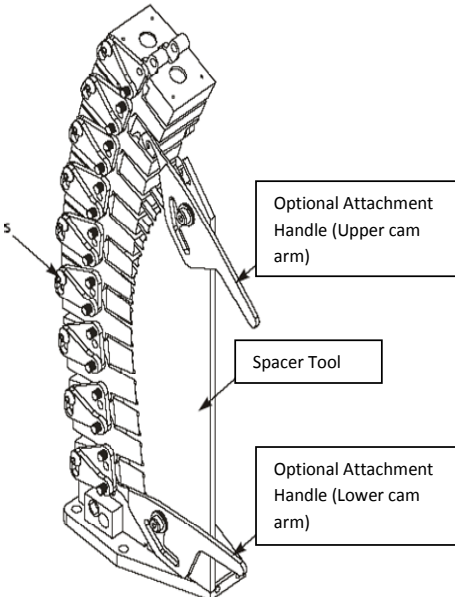
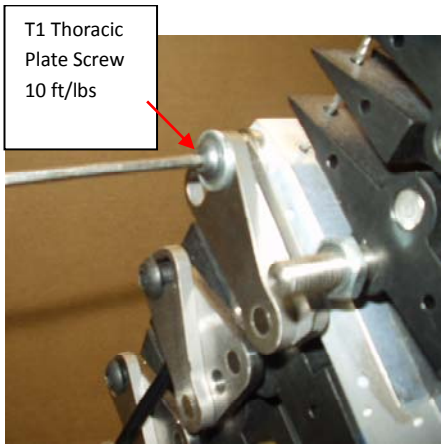


Figure 36.
Tighten locking screws

Figure 37
T1 plate screw torque



1.5.2. Cervical Spine Set-up (Pretension)

Place the spine on a bench top and ensure that the front and rear upper spring cable adjusters and the damper cable adjusters are set all the way down with the locknuts loose (figure 38), and that the cable is not clamped to the damper.

Adjust the lower spring cable adjuster on the front spring until the bottom is flush with the end of the spring cable stud (the front spring is attached to the front of the O.C. plate, and is the longer spring tube). Adjust the lower spring cable adjuster on the rear spring until the cable stud is protruding out from

bottom of adjuster by 16mm (the rear spring is attached to the rear of the O.C. plate, and is the shorter spring tube). This is shown in figure 39.

Check the amount of slack in the spring cables by pulling them up at the point where they exit the upper cable adjusters (Figure 40) and allowing them to drop. Remove slack from the cables by turning the upper front and rear cable adjusters anticlockwise until no slack can be felt. Be careful not to add tension.

After removing all slack, tighten both locknuts onto the upper spring cable adjusters.

Figure 38.
Cable adjuster and locknut

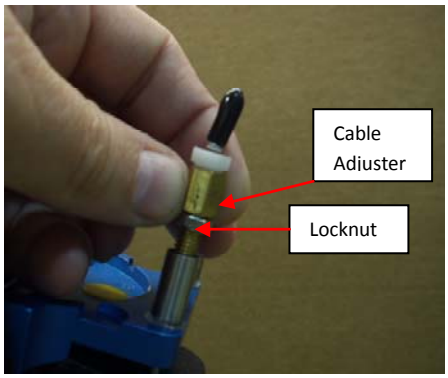


Figure 39
Front and rear Spring Cable Adjusters

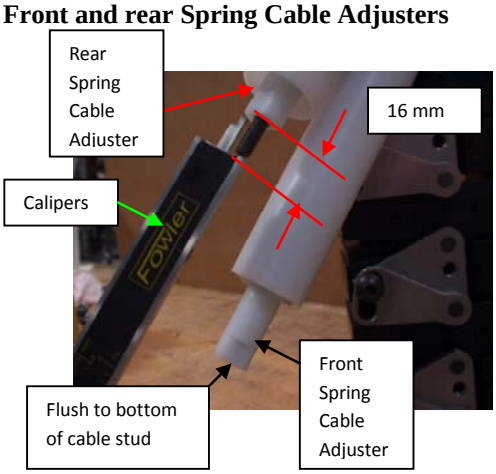
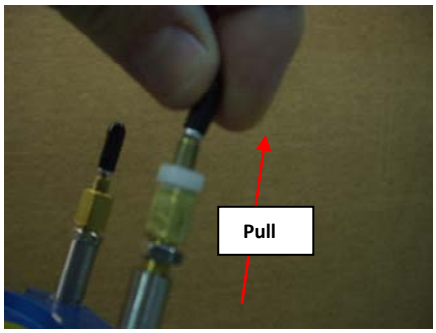


Figure 40
Check for Slack



1.5.3. Cervical Spine Setup (Tension)

This procedure is to be used only after removing the slack from the cables as described in 1.2.4.2.

Using digital callipers for measurement, adjust the rear lower spring cable adjuster counter-clockwise (down) 10 mm so that the cable stud is now protruding by 6 mm (Figure 41). At this time there is 10mm free play in the rear cable. Next, adjust the front lower spring cable adjuster clock-wise (up) so that cable stud is now protruding 24 mm instead of flush. (Figure 42). This will leave an overall bias of 14mm (24mm added, 10mm subtracted).

Place locknuts on both cable studs and lock them against the spring cable adjusters, as shown in figure 43, then push up on the ends of both lower cable adjusters to release any twist in the cables that may have resulted from cable adjustments. Check that the length by which the cables protrude remains at 6mm (rear cable) and 24mm (front cable).

Place a digital inclinometer on the top of the spine/pelvis interface plate in the orientation illustrated in figure 44, and zero it. Grasp the O.C plate with both hands and force the plate to tilt it down in the front, such that the front spring and bumpers will force the plate to return upward in the front to settle to a new stationary position. After allowing the O.C. plate to remain in this position for 30 seconds, measure the angle about the y axis (i.e. forward rotation) on the O.C. plate (Figure 45). This angle must be not less than 30 degrees. If this condition is not achieved, reset front and rear springs at lower adjusters to values shown in Figure 46, then repeat the test in this paragraph.

Grasp the O.C plate with both hands and use force to tilt the plate down in the back, to the degree that the rear spring and bumpers will force the plate to return upward in the rear to a new position. After allowing the O.C. plate to remain in this position for 30 seconds, measure the angle about the y axis on the O.C. plate (Figure 47). This angle must be not more than 26 degrees. If this angle cannot be held, reset front and rear springs at lower adjusters to values shown in Figure 48 and repeat the test in this paragraph. If the angle still cannot be held, there is likely to be a problem with the front 8 cervical bumpers (ARA-220). Refer to 1.2.1.3 for bumper maintenance procedures.

Once the O.C. plate is confirmed to be adjusted correctly, re-lock the cable stud locknuts.

Figure 41
Rear Lower Spring Cable adjustment

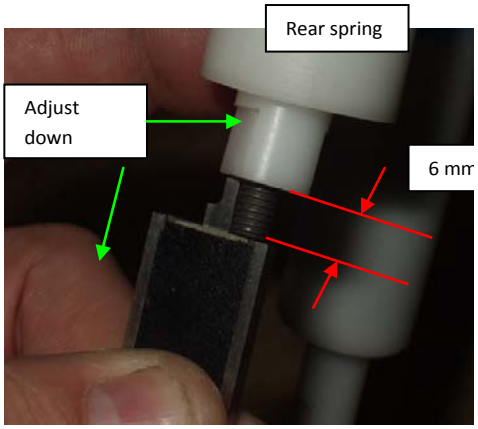


Figure 42
Front Lower Spring Cable adjustment

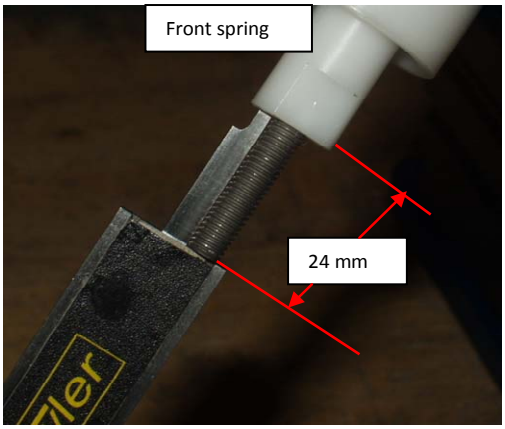


Figure 43
Lock the Spring Cable Adjusters

Figure 44
Zero Digital Inclinometer

Figure 45
Tilt OC Plate down in front

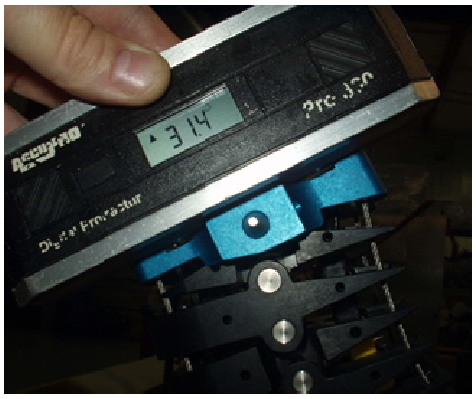


Figure 46
Front (left) and Rear (right) Spring Adjustment if front angle cannot be held with original values

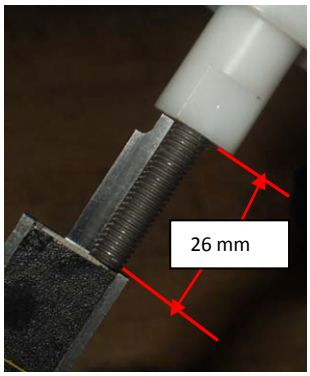
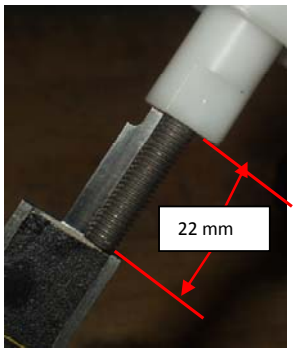
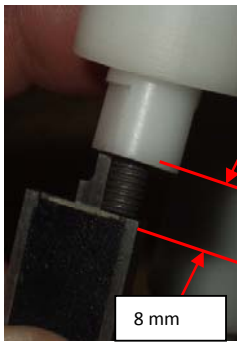


Figure 47
Tilt OC Plate down at the back

Figure 48
Front and Rear Spring Adjustment if back angle cannot be held





1.5.4. Damper Cable Adjustment

Commence this step with the spine in the position obtained in 1.2.4.3.

Adjust the damper cable adjusters (Figure 49) upward until tension is added to damper cable around damper drum, then clamp the cable to the damper with both M3 set screws (Figure 50).

Place a digital inclinometer laterally across the O.C. plate as shown in figure 51 and add tension to the damper cable using both cable adjusters, until the angle across the O.C. plate is zero +/- 0.5 degrees. Once the angle is correct, tighten both locknuts on the damper cable adjusters and leave the spine in position for the next step.

Figure 49
Damper Cable Adjusters

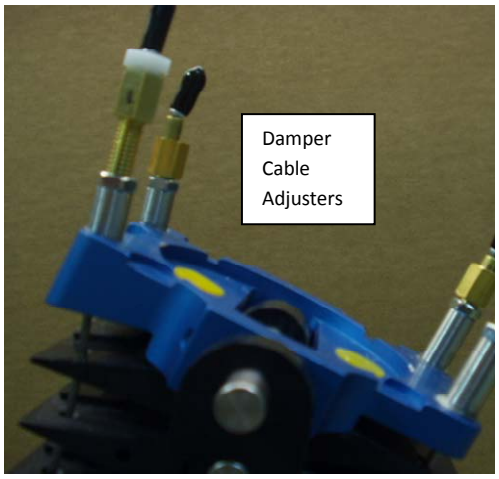


Figure 50.
Damper Adjustments

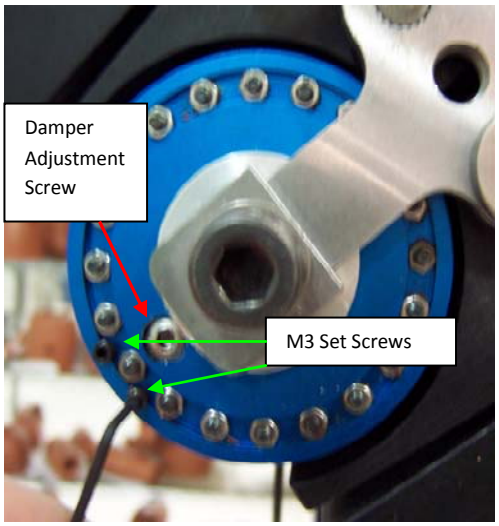
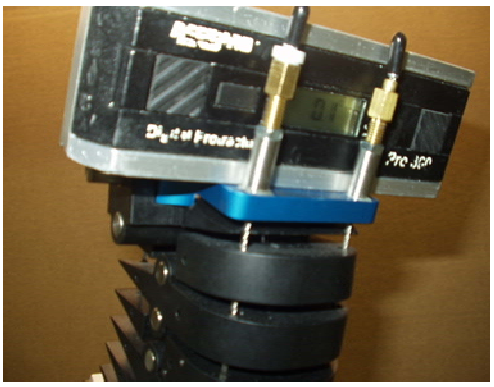


Figure 51
OC Plate Lateral Angle Setting



1.5.5. Static Spine Measurements

Static spine measurements are used to ensure that the posture of the dummy is correct; figure 52 shows a summary of these measurements. The measurements shall be verified after any maintenance or adjustment of the spine or muscle substitute assembly, and during certification of the dummy. Record the measurements that are taken.

Commence this step with the dummy in the position obtained during 1.2.4.4. By hand, force O.C. plate to an angle between 29-30 degrees of forward tilt (about the y-axis), using the digital inclinometer to verify. The O.C. plate will hold this angle with the damper in the system (Figure 53).

Measure the Z dimension from the centre of the O.C. pin to the bottom of the spine/pelvis inter-face plate (which contacts the bench top). This dimension shall be 570-580 mm. Alternatively, measure the Z dimension between the O.C. pin and the H-point; this dimension shall be 604-614 mm.

Measure the X dimension from the centre of the O.C. pin to the centre of the H-point tool square insertion hole. This dimension shall be 199-209 mm. Alternatively, measure the X dimension from the centre of the O.C. pin to the H-point; this shall be 151-161 mm.

Figure 54 shows an optional measuring tool that can be used to assist. Figure 55 shows an optional H-point block insert, useful for accurately indicating centre of H-point block square hole.

Using the digital inclinometer, verify the angle on the rear of T2 vertebra at 36.5-37.5 degrees (Figure 56); if this is not achieved, adjust the spine position within the allowable tolerances and repeat the measurements within this section until the correct angle is achieved.

If a spine position satisfying all the required dimensions cannot be achieved, the spine does not conform to the BioRID II UN specification.

Figure 52
Spine Setup Measurements

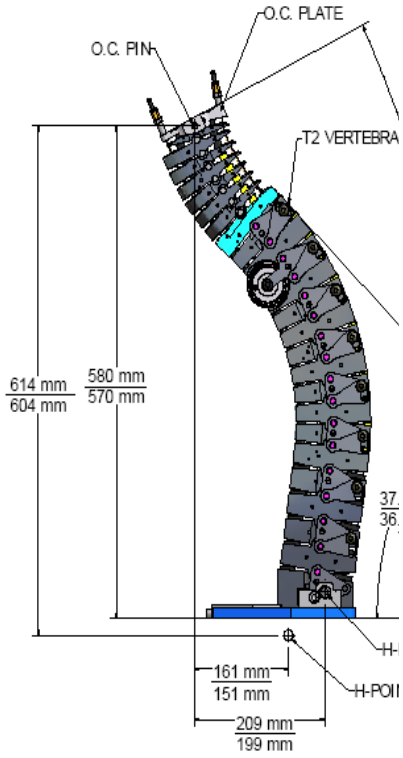


Figure 53
OC Plate angle setting

Figure 54
X and Z Measurement Tool

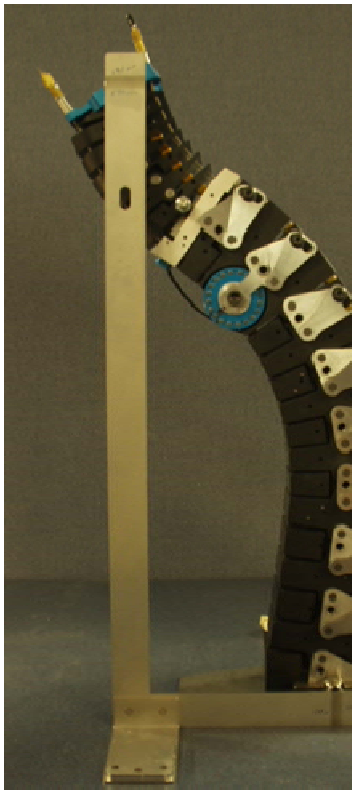


Figure 55
H-Point Measurement Tool

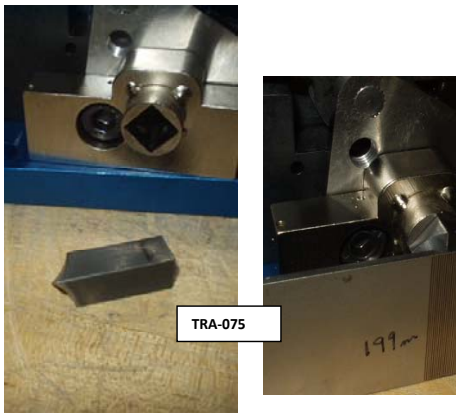
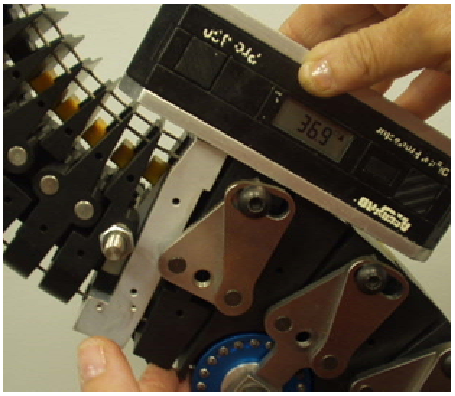


Figure 56
T2 angle setting

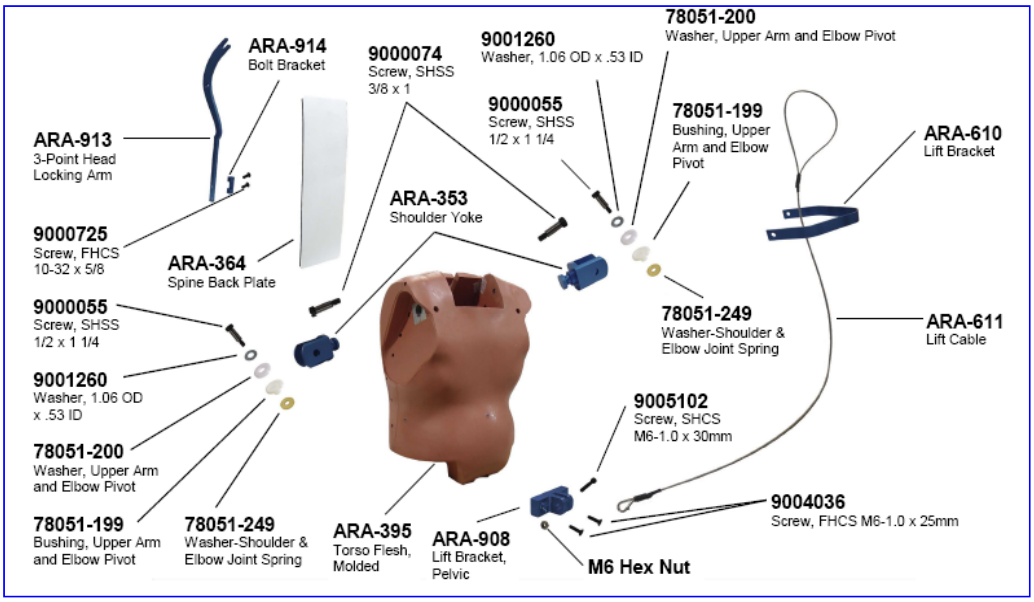


1.6. Torso Flesh and Lifting Bracket

1.6.1. Assembly

Figure 57 shows a breakdown of the jacket and lifting cable assemblies. The components are listed within Annex 2.

Figure 57
Torso Flesh and Lifting Bracket assembly components



1.6.2. Removal

To separate the upper torso from the pelvis and legs, remove the two M10 X 1.5 X 40 mm SHCS located at the rear of the modified Hybrid III pelvis structure and the M10 X 1.5 X 40 mm SHCS located at the front, accessed through the bottom of the pelvis. The pelvis and legs can then be pulled away from the upper torso

Remove the arms by taking out the 3/8 x 1-1/2" SHSS located on the front of the torso at the shoulder pivot and pull the shoulder yoke and arm assembly away from the upper torso as one unit.

After both arms are removed from the upper torso, the torso flesh can be removed. Take out the back plate from the rear of the torso flesh, remove the two M6 X 1 X 12 SHCS located at the base of the upper torso flesh in the front of the dummy, and take out the interface pins along each side of the torso (these are the fifteen pins that connect the spine and torso). Lay the upper torso on a clean, flat surface with the chest down and loosen the upper four screws (two on each side) with an M6 Allen key, then remove the remaining screws with an M4 Allen key. Pull the spring loaded muscle substitute assemblies (2 pieces) from their holder in the torso flesh, then pull the flesh away from the spine assembly.

1.6.3. Abdomen Filling Procedure

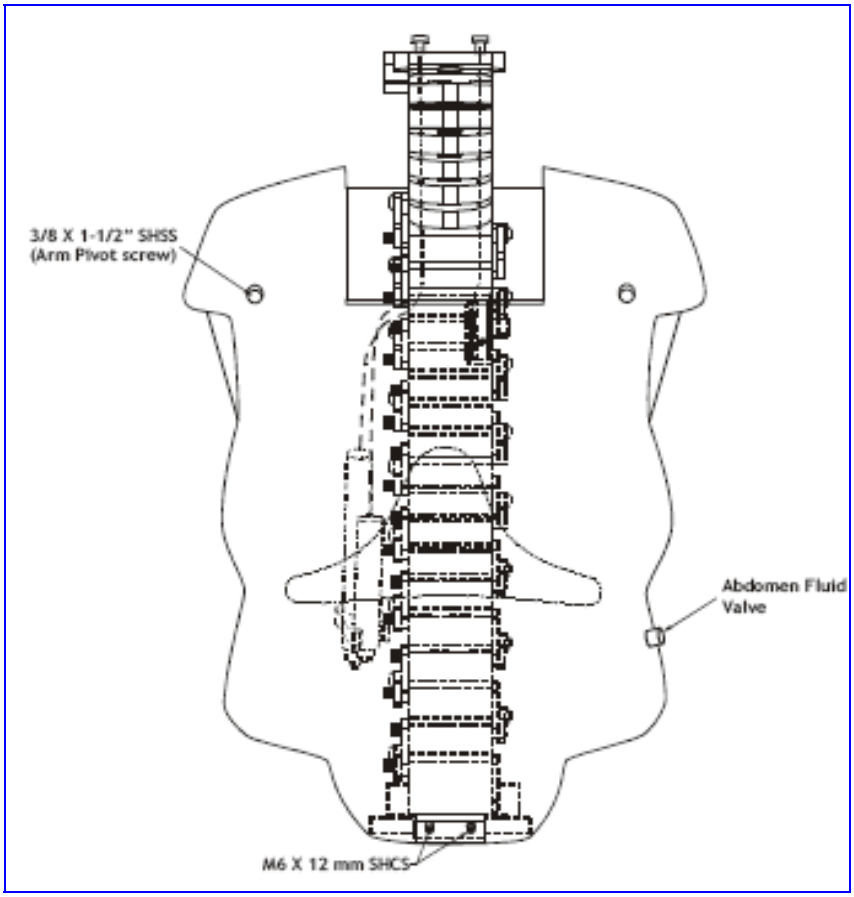
The abdomen shall be filled with 2.06 litres (4.35 lbs) of water through the valve on the left side of the torso flesh (figure 58). A one gallon bottle with a three foot long hose and a 14 gauge (1.7 mm ID) X 1-1/2" long needle is used to fill the abdomen.

Fill the bottle with the required 2.06 litres (4.35 lb) of fresh water. The spigot valve must be closed. Lay the torso down with the abdomen filling valve pointed upward, then remove the plastic cap covering the valve and take out the valve core; this can be achieved using a generic valve core tool.

Insert the needle into the valve opening. Holding the bottle and hose assembly above the abdomen, open the spigot on the bottle. After all the water is emptied from the bottle and the hose into the abdomen, remove the needle from the valve. Do not over fill.

Reinstall the valve core. Depress the core to allow air to escape and gently squeeze the abdomen to remove all the remaining air. Water will be visible in the valve when all the air is removed. It may be necessary to do this step several times while tilting the torso in different directions. Reinstall the plastic valve cap to complete the procedure.

Figure 58
Location of the Abdomen Fluid Valve

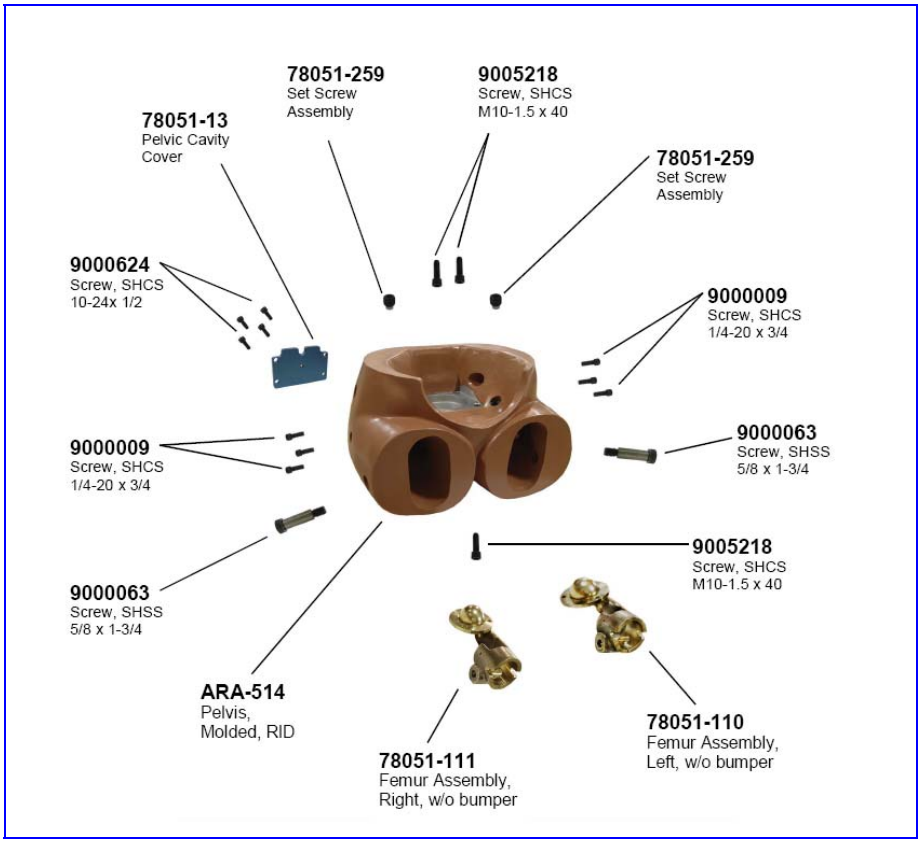


1.7. Pelvic Assembly

1.7.1. Assembly

BioRID II UN uses a modified Hybrid III 50th Percentile pelvis. The assembly consists of the moulded pelvis structure, the femur assemblies (left and right) and two femur friction plungers used to apply force to the femur ball and provide resistance to leg motion. Figure 59 shows a breakdown of the components, which are listed within Annex 2.

Figure 59
Pelvic Assembly components



1.7.2. Disassembly

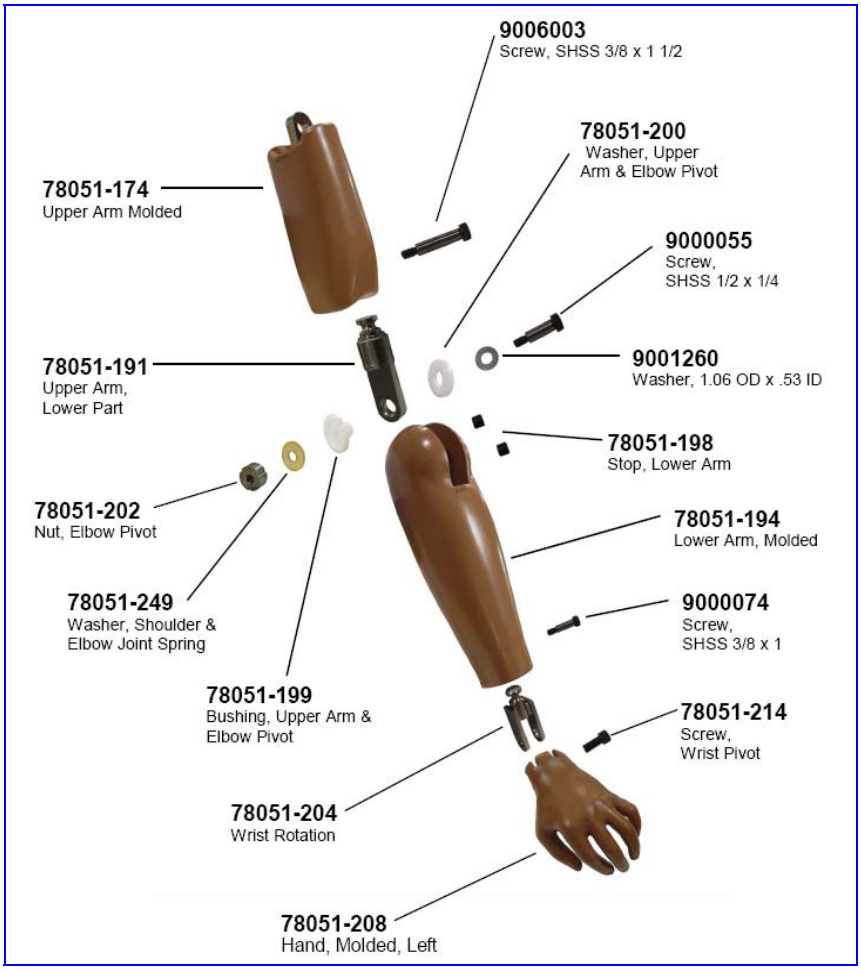
Remove the 5/8 X 1-3/4" SHSS in the pelvis that secure the legs in the femurs, and remove the legs. Take out the three 1/4-20 x 3/4" SHCS that secure each femur flange to the pelvis bone and remove the femur assemblies. Check the femur ball for damage or metal deposit build-up.

1.8. Arms

1.8.1. Assembly

BioRID II UN uses Hybrid III 50th percentile Male Dummy arms. Figure 60 shows a breakdown of the components in a left arm assembly. The components are listed within Annex 2.

Figure 60
Arm Assembly components (left shown)



1.8.2. Disassembly

Remove the 1/2 X 1-1/4" SHSS bolt and associated washer at the elbow joint and remove the lower arm assembly by rotating the lower arm rearward. Within the elbow joint are the pivot washer, pivot bushing, pivot nut and spring washer. Check each component for damage, and replace as necessary.

To separate the lower part of the upper arm, take out the 3/8 X 1-1/2" SHSS in the upper arm section, just above the elbow. The upper arm assembly can then be pulled from the upper arm lower part. The upper arm lower part is the component that is inserted into the elbow joint.

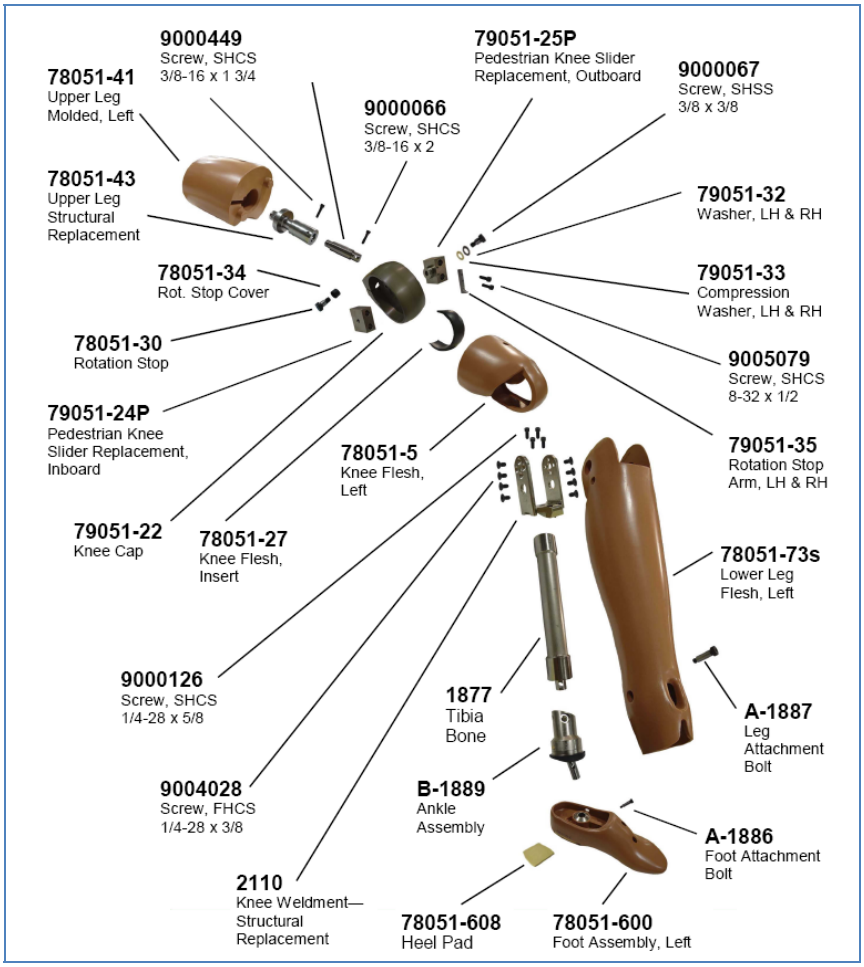
The moulded hand is detached from the lower arm assembly by taking out the wrist pivot screw (modified 1/2-20 X 1-1/4" SHCS) and pulling the hand from the wrist assembly. The wrist assembly is removed by taking out the 3/8 X 1" SHSS and pulling the wrist assembly from the lower arm.

1.9. Legs

1.9.1. Assembly

The BioRID II UN dummy uses Hybrid III 50th Male Dummy legs. Figure 61 shows a breakdown of the components in a left leg assembly; a list of these components is within Annex 2.

Figure 61
Leg Assembly components (left shown)



1.9.2. Removal

To detach the upper and lower leg sections, pull the flesh flaps away from the knee section and take out the four modified 1/4-28 X 3/8" FHCS on each side of the knee (i.e. a total of 8 per leg), then slide the knee clevis off the knee assembly.

To disassemble the upper leg assembly, take out the 3/8-16 X 1-3/4" SHCS at the top of the assembly toward the knee end, then pull the knee assembly away from the thigh.

The femur load cell is installed between the knee and thigh and can be removed by taking out the 3/8-16 X 2" SHCS in the knee assembly. With the knee detached, the femur flesh can be slid off the upper femur bone by pushing it toward the knee.

To disassemble the knee assembly, take out the knee pivot bolt (modified 3/8" diameter SHSS) at the pivot centre of the knee slider replacement assembly. There are two washers used with this bolt; one is steel and one is synthetic. The synthetic (compression) washer shall be installed into the outboard (outer surface of the knee) knee slider first, and then the steel one inserted after this. Do not reverse the sequence upon reinstallation, or the synthetic washer will be damaged.

There is also a rotation stop installed on the outboard side of the knee bone. The stop consists of a modified 3/8 X 3/8" SHSS and a rubber sleeve. The stop is removed by taking out the 3/8" screw and pulling the sleeve off the shoulder. Be sure the threads of the screw do not extend into the inboard knee slider replacement rotation path.

The knee flesh is removed by holding the knee bone and peeling the flesh off the outer knee radius (the impact surface). The knee insert (the black rubber part between the flesh and the knee bone) can be taken off the knee bone at the same time as the flesh. Inspect the flesh and insert for damage.

To take off the moulded foot assembly, take out the modified 1/4 X 3/4" SHSS at the foot–ankle joint. With the foot removed, the lower leg flesh may be slid down the tibia toward the ankle to remove it.

Remove the knee clevis by taking out the four 1/4-28 X 5/8" SHCS.

To disassemble the ankle, take out the leg attachment bolt and pull the ankle off the lower leg assembly. Take out the 5/16-18 x 3/8" SSCP and the friction pad to remove the force on the ankle shaft. Remove the two #10-32 x 1/4" SSCPs holding the stop pin retainer in place and pull out the pin retainer, allowing the stop pin to fall out of the assembly. Take out the six #8-32 x 1/2" BHCS that connect the upper and lower ankle shells. Four of these button head screws hold the ankle bumper in place and two are under the pad. Before reassembling the ankle, make sure the ankle shaft and inside surfaces of the shells are clean and free of burrs.

Grease or liquid lubricants shall be avoided inside the ankle assembly. Use graphite or equivalent dry lubricant if necessary.

1.10. Joint Adjustment Procedure

The joints of the Hybrid III dummies shall be adjusted to a "one G suspended setting." This is defined as a torque level on the joint where the friction will allow an assembly to move toward the earth when a small force is applied to the unsupported end of the assembly, but where the friction is sufficient to support the assembly when it is static and no external forces are applied. For example, when the dummy's arm is fully extended laterally so it is perpendicular to the body, the shoulder yoke clevis bolt must be tight enough to support the weight of the arm, but loose enough so that when the dummy's wrist is given a light tap, the whole arm will slowly fall towards the dummy. Multiple iterations of the testing and adjustment are likely to be required in each instance.

1.10.1. Joint adjustment - Arms and Hands

Extend complete arm laterally outward to a horizontal position at the side of the dummy. Twist the arm so the elbow faces downward, to ensure the elbow cannot rotate downward under gravity. Tighten the shoulder yoke clevis bolt to achieve a one G suspended setting.

Rotate the complete arm assembly so it points forward and is horizontal (i.e. is parallel to the X coordinate direction). Twist the arm so the elbow cannot rotate downward. Adjust the shoulder yoke rotation hex nut (figure 62) to achieve a one G suspended setting.

Bend the elbow 90□ so the lower arm is vertical and pointing upwards, then rotate the arm so that the upper arm is horizontal in front of the chest, maintaining the 90□ elbow bend. Adjust the elbow rotation bolt through the access hole in the upper arm (figure 63) to hold the lower arm in a one G suspended setting. Note that the figure shows the arm positioned for

convenient bolt access, not in the position for the one G suspended setting test.

Reposition the arm so that the upper arm is pointing downward and slightly forward, and the lower arm is horizontal and facing forward, as shown in figure 64. Adjust the elbow pivot bolt through the access holes in the lower arm flesh at the elbow to achieve a one G suspended setting.

Extend the arm and twist the palm so it faces down. Adjust the wrist pivot bolt at the base of the hand to achieve a one G suspended setting. Rotate the palm to the thumb up position and rotate the wrist 90□ so that the palm faces the torso. Adjust the wrist rotation bolt through access in the wrist flesh (figure 65) to achieve a one G suspended setting.

Repeat procedure for other arm and hand.

Figure 62
Shoulder joint setting

Figure 63
Access hole for the elbow rotation bolt

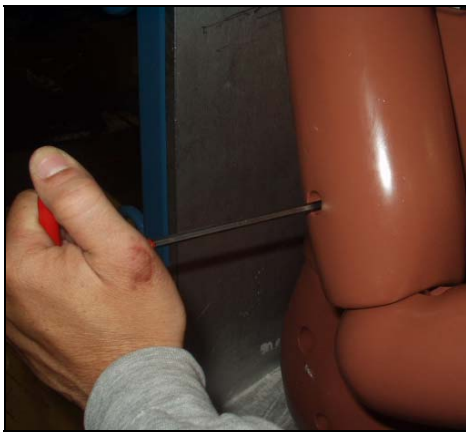


Figure 64
Adjusting the elbow pivot bolt

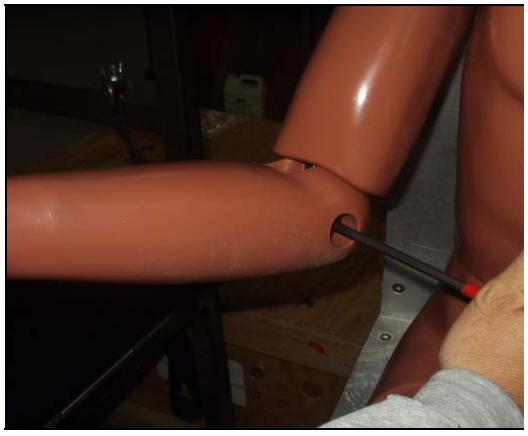
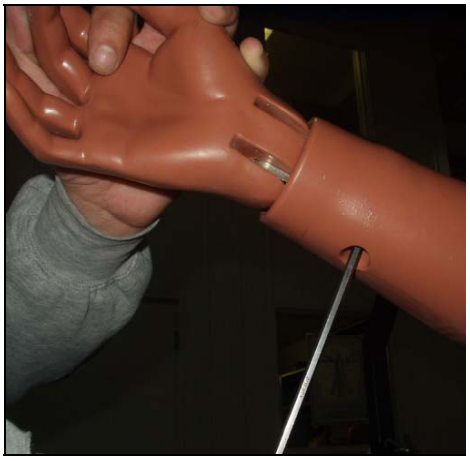


Figure 65
Adjusting the wrist rotation bolt



1.10.2. Joint adjustment - Legs and Feet

Remove the abdominal insert. With the lower leg at 90□ to the upper leg and the dummy in a seated position, lift the upper leg assembly above horizontal. Adjust the femur ball set screw (figure 66) to achieve a one G suspended setting.

Rotate the lower leg assembly so it is horizontal, i.e. the leg is straight and pointing forwards. Adjust the knee clevis bolt (figure 67) to achieve a one G suspended setting. Adjust the ankle ball joint set screw (figure 68) to achieve a one G suspended setting. The ankle adjustment is not critical and is determined by individual feel, as it will be found that it is difficult to achieve a precise one G suspended setting for this joint in practice.

Repeat procedure on other leg and foot.

Figure 66
Adjusting the Femur Ball Set Screw

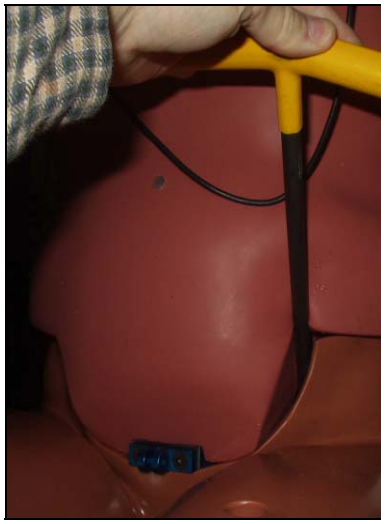


Figure 67
Knee joint setting

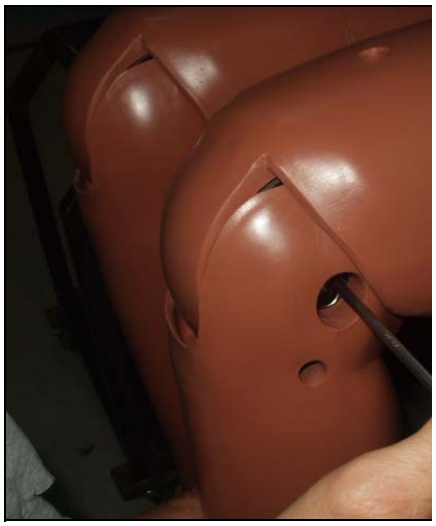


Figure 68
Ankle joint setting

1.11. Clothing

1.11.1. Shirts and Shorts

The BioRID II UN clothing consists of two pairs of shorts and two shirts, made of a stretchable synthetic fabric containing both nylon and an elastomer fibre made from polyurethane; these two fibre types shall account for the majority of the overall fabric. This fabric has a shiny texture on one side and a matt texture on the other. The clothing shall be placed upon the dummy in two layers such that the shiny sides of the materials come face to face with each other.

1.11.2. Shoes

The BioRID II UN Shoes are of the men's dress oxford type in US size 11 extra wide, meeting military specifications MILS-13192P. Each shoe weighs 0.61 +/-0.02 kg and has an overall length of 320-325mm.

2. Instrumentation

2.1. Head Assembly

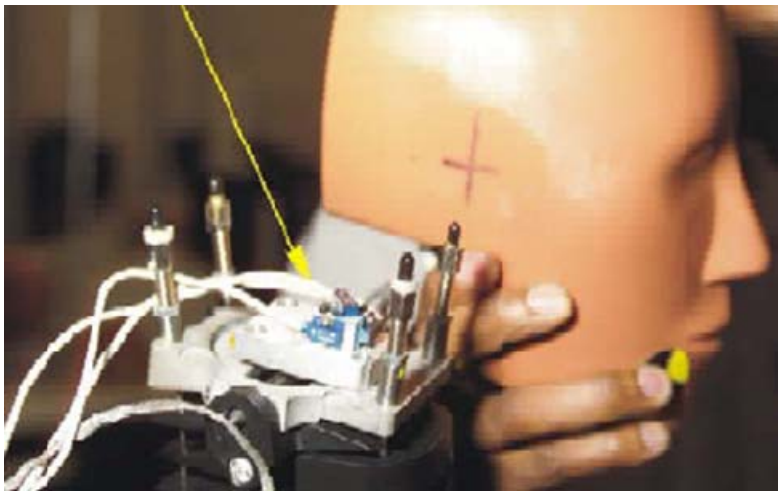
2.1.1. Assembly Components

The BioRID II UN Head is equipped to accept three uni-axial accelerometers mounted on a block to measure acceleration in the x, y and z coordinate directions at the head centre of gravity. Table 1 summarizes the parts used for instrumentation in the head. Figure 69 shows the orientation of the accelerometers with respect to the head.

Table 1.
Head instrumentation parts

Part Description	*Quantity*	*Part Number*
Uni-axial Piezoresistive Accelerometer	3	SA572-S4
#0-80 x 1/8" SHCS	6	9000152
Tri-axial Mount Block	1	SA572-S80
#2-56 x 5/8" SHCS	2	9000531

Figure 69
Head accelerometer orientation

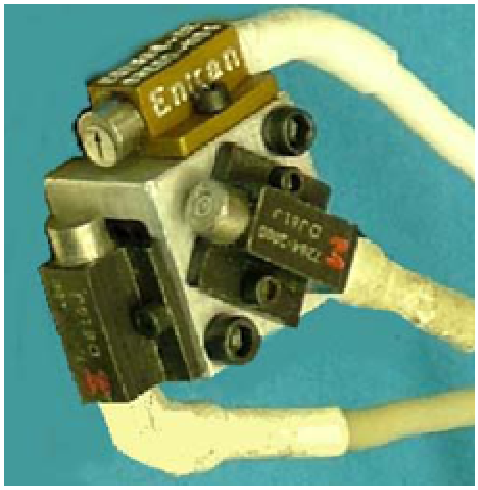


2.1.2. Installation

The three uni-axial piezoresistive accelerometers shall be mounted onto the tri-axial mount block (figure 70) with two #0-80 X 1/8" SHCS per accelerometer (4 total) so that their seismic masses all point to one corner of the block [needs further clarification- see questions emailed to Paul. Point where sensitive axes of accelerometers may need to be better defined, as it clearly affects results and will change if different accelerometers/ suppliers are used]. The tri-axial block shall be attached to the head mounting block using two #2-56 X 5/8" SHCS.

The head mounting block shall be attached to the upper neck load cell (or upper neck load cell structural replacement) using four #10-24 X 7/16" SHCS. The upper neck load cell or upper neck load cell structural replacement shall be inserted into the head cavity.

Figure 70
Head accelerometers installed on triaxial mount block



2.1.3. Skull Cap Contact Switch

The BioRID II UN dummy uses a skull cap skin with an electronic switch circuit. This is a direct replacement to the Hybrid III skull cap, and is designed to make electrical contact with an equivalent surface on the test apparatus. Figure 71 shows a skull cap with the contact switch circuit. The skull cap shown has additional holes to attach to the skull cap load cell; these are unacceptable for regulatory use as BioRID II UN does not include the option of using a skull cap load cell.

The BioRID II UN skull features a dowel that mates with a corresponding hole in the BioRID skull cap but prevents the use of a Hybrid III skull cap (which has no corresponding hole).

The BioRID II UN skull cap contains two electrodes, one on each side, which are electrically insulated from each other. The electrodes consist of conductive paint upon the surface of the skull cap skin, with wires connecting to this at the sides of the skull cap, away from the portion that will make contact with the head restraint (the location of these wires can be seen in the figure as rough patches at the outer edges of the electrodes). This method has been chosen as it provides better reproducibility than the use of conductive tape.

For the switch circuit to be closed, the skull cap must make contact with an electrically conductive surface. This surface shall be a conductive fabric placed over the head restraint; the use of conductive tape is not permitted.

Figure 71
Skull Cap Contact Switch

2.2 Spinal Column – Cervical portion

2.2.1. Assembly Components

The BioRID II UN dummy shall be equipped with the following neck instrumentation: an upper neck load cell measuring X, Y and Z forces and moments, two uni-axial piezoresistive accelerometers at C4, a lower neck load cell at T1 measuring Fx, Fz and My, and two uni-axial piesoresistive accelerometers at T1. Accelerometers may be located on the right or left side of the cervical vertebrae. Angular rate sensors may also utilize the accelerometer mounting on the cervical vertebrae.

2.2.2. Mounting of Accelerometers

Cervical spine accelerometers shall be mounted on the sides of the accelerometer block, and shall measure Ax and Az accelerations when the block is mounted on the spine. Two uni-axial piezoresistive accelerometers shall be mounted onto the tri-axial mount block with two each #0-80 X 1/8" SHCS (4 total) such that their seismic masses point to one corner of the block as shown in Figure 72.

2.3. Spinal Column - Thoracic and Lumbar Portions

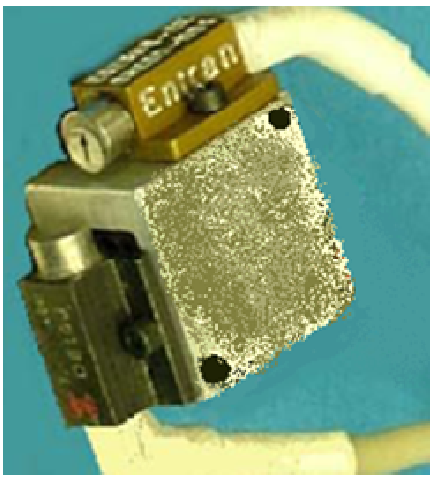
2.3.1. Assembly Components

The BioRID II UN dummy is equipped with two uni-axial piezoresistive accelerometers located at both the eighth thoracic vertebra and the first lumbar vertebra (4 accelerometers in total), measuring Ax and Az accelerations, and a lumbar load cell measuring X and Y axial forces and moments about Y axis. Accelerometers may be located on the right or left side of the thoracic vertebrae. Angular rate sensors may also utilize the accelerometer mounting on the thoracic vertebrae.

2.3.2. Mounting of Accelerometers

Thoracic spine accelerometers shall only be mounted on the sides of the accelerometer block, and when mounted to the spine shall measure Ax and Az accelerations. Two uni-axial piezoresistive accelerometers shall be mounted onto the tri-axial mount block with two each #0-80 X 1/8" SHCS (4 total) so that their seismic masses all point to one corner of the block as shown in Figure 72 [See note for point 2.1.1.2. This is awaiting further clarification from Paul]. This step is identical for T8 and L1 accelerometer locations.

Figure 72
Thoracic Spine Accelerometer Mount



2.4. Pelvis

2.4.1. Assembly components

BioRID II UN is equipped with an instrumentation cavity in the back of the pelvis for the installation of accelerometers, angular rate sensors, and/or tilt sensors to measure the pelvis Ax, Ay and Az accelerations, and also the AVx, AVy and AVz angular rates.

2.4.2. Mounting of accelerometers

Three uni-axial piezoresistive accelerometers shall be mounted onto the tri-axial mount block with two each #0-80 X 1/8" SHCS (6 total) so that their seismic masses all point to one corner of the block.

The tri-axial block shall be attached to the pelvis accelerometer mounting plate using two #2-56 X 5/8" SHCS. The pelvis mounting plate shall be attached to the pelvis instrumentation cavity.

2.5. Cable Routing

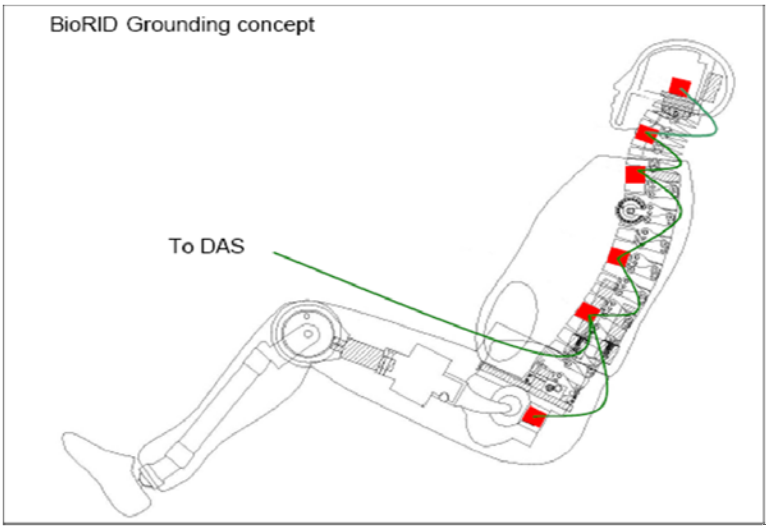
The instrumentation cables must be routed in and around the dummy in a manner that ensures that the dummy's motion is not affected by the cables and that the cables are not in a position where they are susceptible to damage from the test event.

2.5.1. Grounding

To reduce the possibility of static electricity discharge and subsequent noise in the data acquisition system, the metal bodies of the accelerometers and load cells shall be electrically connected to the ground. Figure 73 shows a

typical grounding scheme. It shall be ensured that there are no electrical ground loops in the system.

Figure 73
Suggested instrumentation grounding scheme



2.5.2. Head and Neck Cable Routing

Bundle together and tie wrap the wiring for the head accelerometers and upper neck load cell. Install the skull cap, ensuring that the wiring bundle is in the recessed area of the skull so that the wiring is not damaged.

Route the cable bundle along the neck and add the C4 accelerometer cables to the bundle near C4. Continue to route cable to the T1 vertebrae, adding the T1 accelerometer and load cell cables to the bundle at the side of T1.

2.5.3. Thoracic Spine Cable Routing.

Figure 74 illustrates the proper cable routing for BioRID II UN, which is used to prevent the instrumentation harness influencing spine movement. The method for installing the cabling is as follows:

Affix self adhesive cable tie bases to the side plates of the spine. Add a cable tie to each base and tighten until the diameter of the tie is 10 mm. No cables are inside this tie loop.

Secure the cable bundle together and to the first set of cable ties with a second set of cable ties, with one tie in the second set linking to each tie from the first set. All the cables will go through the second set of cable ties and none through the first set; the first set is present to provide a flexible link between the cables and the spine.

Add any accelerometer or other instrumentation cables to the bundle as necessary.

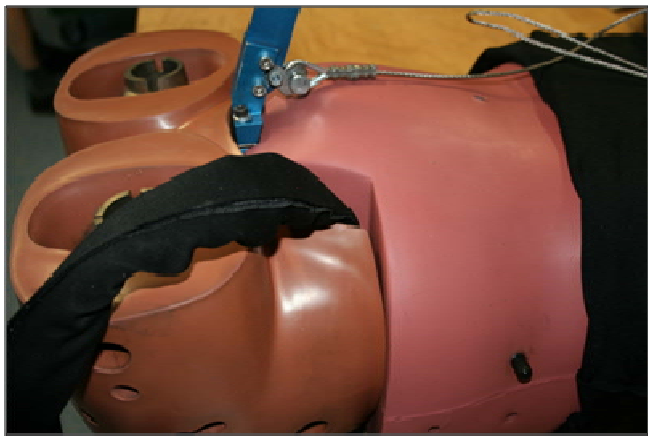
Figure 74
Thoracic Spine cable routing

2.5.4. Pelvis Cable Routing

Bundle the instrumentation cables together inside the instrumentation cavity in the back of the pelvis. Route the cable up the back on the top of the pelvis.

Combine all instrumentation bundles on the top of the pelvis and exit the entire bundle between the jacket and the top of the pelvis. Figure 75 shows the cable bundle exiting the dummy.

Figure 75
Cable Bundle Exit



2.6. Accelerometer Handling

2.6.1. Care

Avoid dropping the accelerometer or striking the unit against hard surfaces and keep the unit in its protective sleeve until it is installed.

2.6.2. Preliminary Checks

Before installing accelerometers in the dummy, the accelerometers shall be checked in accordance with the accelerometer manufacturer's instructions to ensure correct operation and conformity to specified tolerances.

2.6.3. Installation Procedure

The mounting surface shall be clean and free of burrs, with a surface roughness of not more than .813 µm (32 micro inches) rms.

Remove the accelerometer from the protective sleeve. Handling it by the case, not the cable, place the unit on the mounting surface and align the mounting holes. When mounting the accelerometer, use only the materials and parts which are supplied with the accelerometer and use the mounting torque recommended by the accelerometer manufacturer. If applicable, use the supplied mounting washers and screws or mounting stud. Do not over torque the screws or use snap type torque wrenches (which can result in shocks that damage the accelerometer). Do not cement the unit to the mounting structure.

Where practical, tie down the cable within 40 to 60 mm (1.6 to 2.4 in) of the accelerometer to prevent strain upon the join between the cable and accelerometer.

2.6.4. Recalibration

Sensitivity and Zero Measurand Output calibrations shall be performed at intervals of not more than 12 months to ensure conformity with manufacturer tolerances. If the unit has been used beyond its rated specifications, a shorter calibration interval is recommended. Zero measurand output is defined as the output of the accelerometer when the accelerometer is stationary with its sensitive axis perpendicular to the gravitational field.

2.6.5. Cleaning

Dirty units may be wiped clean using a damp cloth and a solvent such as acetone. Do not soak or immerse the unit in any solvent or water. Do not use any sharp tools (such as a screwdriver) to remove dirt or contaminants. If tools such as pliers are needed to handle the accelerometer, cover the jaws with masking tape to prevent metal to metal contact.

3. Bumper Maintenance

3.1. Overview

The cervical region of the spine (vertebrae C1 through C7 plus T1) contains sixteen cube-shaped bumpers. The eight front bumpers are 40A durometer, black in colour and 10mm in height. The eight rear bumpers are split into 2 regions; the uppermost three are the same 40A, 10mm height bumpers as used in the front, and the bottom 5 are 30A durometer, yellow in colour and 9 mm in height.

3.2. Replacement Interval

The dummy shall only be used for certification if the front cervical bumpers were last replaced not more than 4 months before the date of the test. A dummy that is being recertified shall be fitted with replacements for all 8 front bumpers [ongoing discussion point, may need updating]. If the

bumpers are not in good condition due to compression, the effect on the calibration data will show a higher amplitude in Pot A and/or Pot B Rotation.

3.3. Replacement Procedure

Remove both lower cable adjusters and muscle substitute springs from the lower ends of the spring cables and tap or push the O.C. pin out of the spine (figure 76).

Pull the spring cables up out of the upper cable adjusters as far as possible and turn the O.C. plate up and over (figure 77). It will not swing in the other direction as the damper cable does not allow enough travel. Slide out the pins from C1 down to C7; these are easily removed and reinstalled by tapping gently or pushing with a punch.

Use a sharp pick to dislodge the bumper from each vertebra, from C1 down to C7, and to remove any glue or bumper residue.

Place one drop of cyanoacrylate adhesive in centre of the bore in the vertebrae. Place the new bumper in the bore while the adhesive is wet, and centre it side-to-side and front-to-back. Press downward on the bumper with one finger for 10 seconds to bond. Repeat for all bumpers from C1 to C7.

Remove the two M2.5 SHCS that retain the T1 pin at the C7-T1 joint (figure 78), using a 2mm Allen key. Slide the T1 pin out of the vertebrae joint and set it aside along with the two M2.5 SHCS for re-installation later.

Use the pick to dislodge the front bumper in the T1 load cell vertebra and to remove any remaining glue or bumper residue (figure 79). Place one drop of cyanoacrylate adhesive in centre of the rectangular cavity in the T1 vertebrae. While the adhesive is still wet, place the new bumper in the cavity and press downward upon it with one finger for 10 seconds to bond. It will be positively located as the cavity is approximately the same shape as the bumper.

Re-install the T1 pin through the C7-T1 joint, taking care to avoid damaging the C7 vertebra or the T1 load cell joint with the threads on the T1 pin. Align the edge of the flat on the pin to the edge of the vertebra , as illustrated in figure 80, and orient the face of flat to be parallel with the back end face of T1 load cell. This must be done to line up the threaded holes for the M2.5 SHCS. The face of the flat on the pin is precisely perpendicular to the threaded holes for two M2.5 SHCS

Re-install both M2.5 SHCS with a 2mm Allen key. Be careful not to over-torque; a torque of 15 inch pounds (1.7 Nm) is advised.

Re-install all pins from C1 to C7 by tapping lightly or pushing with a punch. The ends of the pins will be flush with the vertebrae when finished. Re-install the muscle substitute springs and lower spring cable adjusters onto both spring cables.

Figure 76.
Push out OC Pin

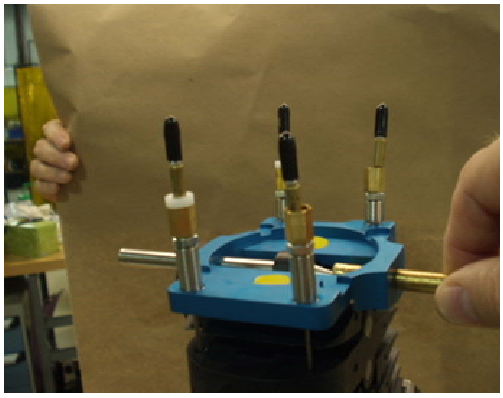


Figure 77
Remove pin and separate vertebra

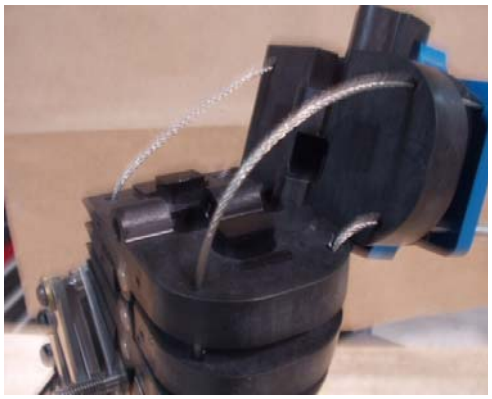


Figure 78
Remove T1 Retaining Screws

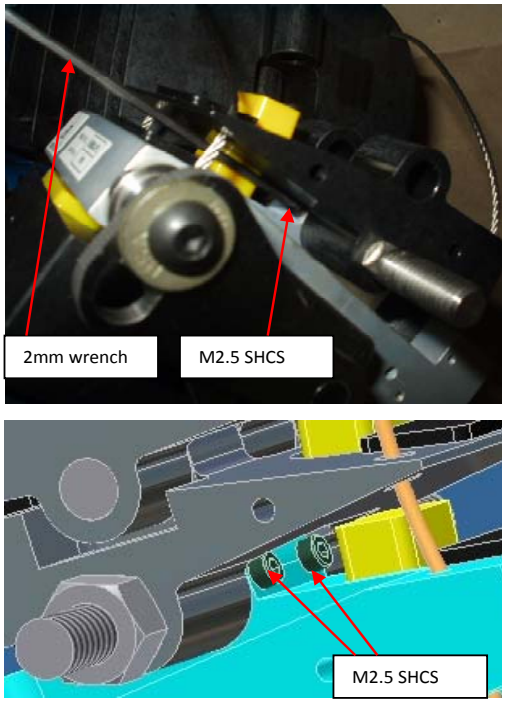


Figure 79
Use pick to remove bumper

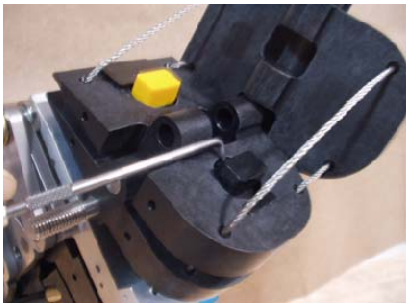
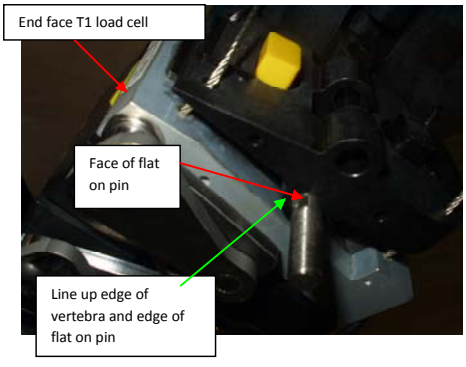


Figure 80
T1 Pin Alignment



4. Storage and Handling

4.1. Transport Chair

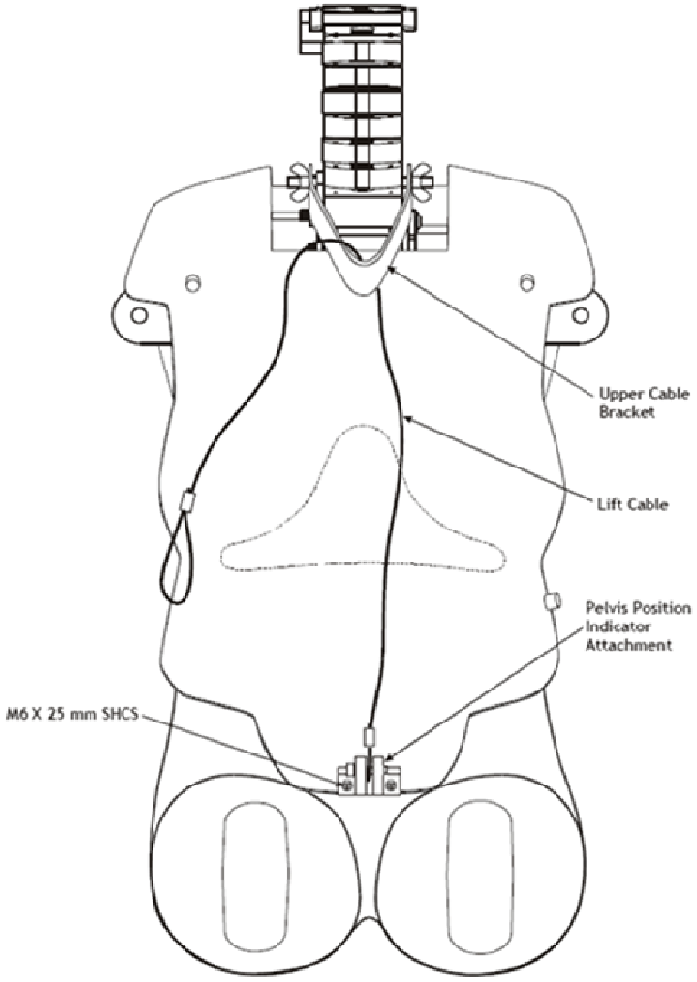
Any chair may be used for transport and storage of the dummy provided that it spreads the load on the jacket and pelvis to avoid damage occurring over time due to compression, and that it allows the spine to rest in a position where minimal loads are placed upon the bumpers.

4.2. Lifting Procedure

To lift the dummy, the pelvis position indicator attachment is used as a point for lift cable attachment. An upper cable bracket is mounted at T-1 with a M8 wing nut on each side (figure 81).

After the dummy is moved and positioned for testing, remove the upper bracket and wing nuts and store them for future use. If the pelvis position indicator attachment interferes with the seatbelt it needs to be removed and replaced with the two M6 X 25 mm SHCS provided.

Figure 81
Lifting Cable and Bracket



5. Repairing the Vinyl Flesh and Silicone Jacket

5.1. Silicone Jacket

Small repairs to the silicone jacket can be accomplished using Room Temperature Vulcanising (RTV) Silicone. If the tears are large, replace the jacket.

5.2. Vinyl Limb Flesh

The most common types or flesh damage are punctures, tears, and scrapes.

Scrapes can be fixed by rubbing an iron, at low temperature, over the affected area several times. Punctures and tears require patching; the patching material used for this must be of identical composition to the damaged material on the limb flesh.

To bond the dummy's flesh to patches of repair materials, use an iron similar to a standard electronic soldering iron with an output range from 60 to 90 Watts and a broad, flat paddle tip. For best results, use a variable power supply to control the heat output from the iron, otherwise repairs will be more difficult and may be unsightly due to black flakes of burnt material imbedded in the flesh. These flakes are caused by overheating the flesh when an iron is too hot or remains in one position for too long.

Another cause of black residue in the flesh is improper or infrequent cleaning of the iron tip. The tip should therefore be cleaned frequently during the repair job, between each melting of flesh if possible, by tapping the bit on a buffing wheel.

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

After preparation, a patch can be bonded to the flesh. Cut a patch of adequate size material from a sheet of identical specification to that used in the original flesh. The patch should be approximately 10 mm (0.5 in) wider than the damaged area on all sides. To check that the iron is at a usable temperature, test it on a small piece of patch material. The flesh should easily melt but not instantly burn. With the patch held over the damaged area, slide the iron between the patch and dummy flesh. Hold the iron in position until you see both materials melting. When both the patch and the flesh look like a gel, move the iron to a new point while holding the patch in place until they have both cooled. Continue this all the way around the damaged area until the patch is completely bonded to the flesh.

For large areas, or areas where the patch must bend to conform to the dummy part, it may be easier to "tack" a few points around the edge of the patch to hold it in place, then return to fill in the un-bonded sections. Once the patch is tacked to the flesh, the two must be blended together; this will eliminate any protruding edges that may later snag and ruin the repair. To blend the patch, work the iron tip around the patch edges in a circular motion, blending the patch material into the flesh as you work your way around the patch. If the iron is too hot, black flakes will appear; if it is too cold, the patch will not readily melt, and the patch is likely to be poorly bonded to the flesh. Continue working the patch into the flesh until the repair is well hidden, then let it cool. If any rough areas are left after cooling, smooth them out by reapplying the hot iron.

6. Torque Value Table

Torque wrenches used shall be set to the values specified in table 2.

Table 2
Specified Torques

Item	*Specified Torque (Nm)*	*Specified Torque (lbf ins)*
9003016 — BHCS 10-32 x 5/8	3.4	30
9005002 — SHCS ¼ - 20 x 1	10.8	96
9005016 — SHCS ¼ - 20 x 7/8	10.8	96
9005023 — SHCS ¼ - 28 x 7/8	10.8	96
9005029 — SHCS 10 – 24 x 3/8	3.4	30
9005040 — SHCS 5/16 – 18 x ¾	22.4	198
9005060 — SHCS 5/16 – 18 x ¾	22.4	198
9005065 — SHCS 5/16 – 24 x 7/8	22.4	198
9006002 — SHSS 3/8 x 1	36.6	324
9006027 — SHSS ¼ - ¾	7.9	70
9007001 — FHCS ¼ - 20 x 1	6.8	60
78051-30 — SHSS 3/8 x .375	36.6	324
78051-92 — SHCS 10 – 24 x 1 ½	3.4	30
78051-94 — SHCS ¼ - 20 x 5/8	10.8	96
78051-98 — SHCS 3/8 – 16 x 1	36.6	324
78051-100 — SHCS 3/8 – 16 x 2	36.6	324
78051-103 — SHCS 10 – 24 x .30	3.4	30
78051-117 — BHCS 10 – 32 x 5/8	3.4	30
78051-118 — BHCS 10 – 32 x ½	3.4	30
78051-226 — FHCS 10 – 32 x .41	3.4	30
A-1898 — BHCS 8 – 32 x ½	2.6	23

Annex 2

Engineering Drawings and Parts List

1. Drawings

1.1. Introduction

The 2D engineering drawings contained within this Annex represent the essential dimensions of the assemblies and individual component parts of the BioRID II UN dummy. Reference is made to generic manufacturing processes only.

1.2. Drawing Descriptors

The drawings are listed by discrete body section in individual Appendices for ease of reference. The individual drawings are listed in an Index Table at the front of each Appendix. Each drawing has a UN ECE document reference that follows the standard UN ECE convention. The full document number is extended by a drawing descriptor – "Drg." – followed by a sequential Arabic number, e.g. TRANS/WP.29/78/Add.1/App.1/ Drg. 001, TRANS/WP.29/78/Add.1/App.1/ Drg. 002.

For each separate Appendix to this Annex the first drawing is numbered "1". i.e. TRANS/WP.29/78/Add.1/App.2/ Drg. 001, TRANS/WP.29/78/Add.1/App.3/ Drg. 001. etc.

1.3. Revisions

In accordance with standard engineering practice, the drawings in this Annex have their status identified by a "Revision Level". This is displayed as a capital Roman letter on the drawing and is referenced as " Drg. Rev." in column 4. to the Index Table.

Product and manufacturing advances can result in changes to, for example, dimensional tolerances or manufacturing procedures. This may result in improvements to the precision of the dummy's response (accuracy, repeatability or reproducibility). In such cases the use of components engineered to a later drawing level than listed in the accompanying tables is accepted.

More significant changes, for example, changes to a material, or the mass distribution about the dummy, may be subject to review before being adopted for regulatory use. These changes require a revised drawing to be registered.

Should a drawing be subject to change, the original drawing is retained in this register and the new drawing number inserted in the table immediately after the original. Identification of this new drawing also follows UN ECE convention, having the same UN ECE number as the original with the addition of the appropriate revision nomenclature, e.g. TRANS/WP.29/78/Add.1/App.1/ Drg. 001/Rev.1

2. Parts

Parts that are of commercial supply, or adequately defined by description, e.g. "Pin, Dowel 1/4" X 1/4"", are listed separately. These parts do not have a UN ECE reference number.

3. Part Numbers

The components that comprise the dummy, whether specified by drawing or by part, are identified in the market by established part numbers. These numbers are also listed in the tables of the Appendices to this Annex. These unique part numbers are not proprietary and are available for use by any commercial company.

4. List of appendices

Appendix 1. Assembly Drawings

Appendix 2. Head

Appendix 3. Cervical Spine

Appendix 4. Thoracic and Lumbar Spine

Appendix 5. Torso and Pelvis

Appendix 6. Muscle Substitute

Appendix 7. Limbs

Appendix 8. Tools

Drawing Appendices

Appendix 1

Assembly Drawings

Table 1
Drawing Index

TRANS/WP.29/78/Add.1/ App.1/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	86-5001-001br	Leg Assembly, Left	C	1	1	1	Add. 1 App. 8 Dwg 001
Drg. 2	86-5001-002br	Leg Assembly, Right	C	1	1	1	Add. 1 App. 8 Dwg 002
Drg. 3	ARA-001	Complete Assembly	J	1	1	1	
Drg. 4	ARA-002	Head & Upper Torso Assembly	C	1	1	1	
Drg. 5	ARA-200	Spine Assembly	P	2	1	1	
Drg. 6	ARA-275	Neck Assembly	-	1	1	1	
Drg. 7	ARA-500	Lower Torso Assembly	B	1	1	1	

Appendix 2

Head

Table 1
Drawings

TRANS/WP.29/78/Add.1/ App.2/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	4947	Ballast, Skull	C	1	1	1	
Drg. 2	4956	Assy - S.R. Neck Loadcell	C	2	1	1	
Drg. 3 (Unable to locate drawing!!!)	78051-311	Insert - Threaded - 1/2-20					
Drg. 4	ARA-100	Plate, Interface-Occipital Condyle	P	1	1	1	
Drg. 5	ARA-103	Head Assembly	D	1	1	1	
Drg. 6	ARA-104	Skull, BioRID	J	1	1	1	
Drg. 7	ARA-105	Assembly, Occipital Condyle Plate	B	1	1	1	
Drg. 8	ARA-106	Cap, Skull	G	1	1	1	
Drg. 9	ARA-107	Accelerometer Mount	F	1	1	1	
Drg. 10	ARA-108	Skin, Head	B	1	1	1	
Drg. 11	ARA-110	Cap Skin, Skull	C	1	1	1	

Table 2. Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9000005	¼-20 x 5/8 (UNC) SHCS			2	2	
9000126	¼-28 x 5/8 (UNF) SHCS			4	4	
9000824	8-32 x ½ (UNC) FHCS			3	3	

Appendix 3

Cervical Spine

Table 1. Drawings

TRANS/WP.29/78/Add.1/ App.3/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	8417	Split Bushing-Rear	B	1	4	8?	Add. 1 App. 4 Dwg 006
Drg. 2	8418	Split Bushing-Front	B	1	4	8?	Add. 1 App. 4 Dwg 007
Drg. 3	8420	T1 Load Cell Ass'y	B	1	1	1	
Drg. 4	ARA-201	Vertebra, Cervical - C1	T	1	1	1	
Drg. 5	ARA-203	Vertebrae, Cervical - C3,C5	R	1	2	2	
Drg. 6	ARA-206	Vertebra, Cervical - C4	P	1	1	1	
Drg. 7	ARA-207	Vertebrae, Cervical - C2,C6	R	1	2	2	
Drg. 8	ARA-208	Vertebra, Cervical - C7	L	1	1	1	
Drg. 9	ARA-209	Pin, Neck C1-C2	E	1	1	1	
Drg. 10	ARA-210	Pin, Neck-Occipital C1	G	1	1	1	
Drg. 11	ARA-212	Pin, Neck C2-C7	E	1	5	5	
Drg. 12	ARA-213	Pin, Neck	F	1	1	1	
Drg. 13	ARA-220	Bumper - Cervical Front And	G	1	12	12	

TRANS/WP.29/78/Add.1/ App.3/…	Part Number	Description	Drg. Rev.	No. of Sheets	QTY Per Assembly	QTY Per Dummy	Common with Addenda
		Rear					
Drg. 14	ARA-221	Bumper, Cervical – Rear	F	1	9	9	
Drg. 15	ARA-222	Assembly, Cervical Vertebra-C1	E	1	1	1	
Drg. 16	ARA-223	Assembly, Cervical Vertebra - C2	J	1	1	1	
Drg. 17	ARA-224	Assembly, Cervical Vertebra - C3	L	1	1	1	
Drg. 18	ARA-225	Stop, Cervical – Front	D	1	9	9	
Drg. 19	ARA-226	Assembly, Cervical Vertebra - C7	G	1	1	1	
Drg. 20	ARA-227	Bumper, Cervical – Rear	F	1	6	6	
Drg. 21	ARA-228	Assembly, Cervical Vertebra - C5	C	1	1	1	
Drg. 22	ARA-229	Assembly, Cervical Vertebra - C6	C	1	1	1	
Drg. 23	ARA-231	Bumper, Occipital	F	1	2	2	
Drg. 24	ARA-261	Assembly, Cervical Vertebra-C4	D	1	1	1	
Drg. 25	ARA-270	Washer, Damper	B	1	1	1	
Drg. 26	ARA-302	Sensor - T1	C	1	1	1	

Table 2
Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9010112	M4 x 6mm SSFP			2	2	
9002030	Nut, Hex M8			2	2	
9005132	O Ring			2	2	
9010113	M2.5 x 8mm SHCS			2	2	

Appendix 4

Thoracic and Lumbar Spine

Table 1
Drawings

TRANS/WP.29/78/Add .1/ App.4/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 001	5704	Spacer For C7, T1, and T2 Ass'y	C	1	1	1	
Drg. 002	6588	Adaptor, S1 Load Cell To L5	B	1	1	1	
Drg. 003	6589	Pelvis Spine Interface Plate	A	1	1	1	
Drg. 004	8701	Structural Replacement, S1 Load Cell	A	1	1	1	
Drg. 005	8703	Structural Replacement, S1 Lc Load Cell Ass'y	A	1	1	1	
Drg. 006	8417	Split Bushing – Rear	B	1	4	4	Add. 1 App. 3 Dwg 001
Drg. 007	8418	Split Bushing – Front	2	1	4	4	Add. 1 App. 3 Dwg 002
Drg. 008	8419	T1 Load Cell	A	1	1	1	
Drg. 009	ARA-301	S.R. Load Cell Assembly	B	1	1	1	
Drg. 010	ARA-312	Vertebra, Thoracic - T2	L	1	1	1	

TRANS/WP.29/78/Add .1/ App.4/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 011	ARA-319	Washer, Thoracic – Torsion	B	1	1	1	
Drg. 012	ARA-320	Washer, Torsion Adjustment	F	1	17	17	
Drg. 013	ARA-321	Pin, Torsion	F	1	17	17	
Drg. 014	ARA-324	Washer, Thoracic – Torsion	F	1	9	9	
Drg. 015	ARA-325	Washer, Lumbar – Torsion	F	1	6	6	
Drg. 016	ARA-327	Vertebra, Thoracic - T3	P	1	1	1	
Drg. 017	ARA-328	Vertebra, Thoracic - T4	K	1	1	1	
Drg. 018	ARA-329	Vertebra, Thoracic - T5	J	1	1	1	
Drg. 019	ARA-330	Vertebrae, Thoracic - T6,T7,T9-T12	J	1	6	6	
Drg. 020	ARA-331	Vertebra, Thoracic - T8	J	1	1	1	
Drg. 021	ARA-332	Washer, Torsion - T1 Load Cell	D	1	1	1	
Drg. 022	ARA-373	Washer, Torsion - T4	E	1	1	1	

TRANS/WP.29/78/Add .1/ App.4/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 023	ARA-379	Bumper, Thoracic – Rear	-	?	?	?	
Drg. 024	ARA-380	Bumper, Thoracic – Rear	-	?	?	?	
Drg. 025	ARA-381-30	Bumper, Thoracic – Rear	E	1	12	12	
Drg. 026	ARA-381-37	Bumper, Thoracic – Front	F	1	12	12	
Drg. 027	ARA-384	Assembly, Thoracic Vertebra - T3	G	1	1	1	
Drg. 028	ARA-385	Assembly, Thoracic Vertebra - T4	G	1	1	1	
Drg. 029	ARA-386	Assembly, Thoracic Vertebra - T5	G	1	1	1	
Drg. 030	ARA-387	Assembly, Thoracic Vertebrae- T6,T10,T12	H	1	3	3	
Drg. 031	ARA-388	Assembly, Thoracic Vertebrae - T7,T9,T11	G	1	3	3	
Drg. 032	ARA-389	Assembly, Thoracic Vertebra - T2	F	1	1	1	
Drg. 033	ARA-396	Assembly, Thoracic Vertebra-T8	D	1	1	1	
Drg. 034	ARA-501	Vertebra, Lumbar - L1	J	1	1	1	
Drg. 035	ARA-502	Vertebrae,	J	1	4	4	

Part Number	Description	Drg. Rev.	No. of Sheets	QTY Per Assembly	QTY Per Dummy	Common with Addenda
	Lumbar - L2 Thru L5					
ARA-520	Bumper, Lumbar – Rear	E	1	5	5	
ARA-521	Bumper, Lumbar – Front	D	1	5	5	
ARA-522	Assembly, Lumbar Vertebra - L1	F	1	1	1	
ARA-523	Assembly, Lumbar Vertebrae - L3,L5	F	1	2	2	
ARA-524	Assembly, Lumbar Vertebrae - L3,L5	E	1	2	2	
ARA-561	S1interface Plate Assembly	A	1	1	1	
ARA-562	S1 Vertebra	A	1	1	1	
ARA-563	Pelvis Spine Interface Plate	C	1	1	1	
ARA-564	S1 Vertebra with Load Cell	A	1	1	1	

Table 2
Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9005108	M8 x 25mm SHCS			1	1	
9004036	M6 x 25mm FCHS			4	4	
4000076	5/16 x ¾ Washer			2	2	
9005125	M8 x 12mm SHCS			16	16	
9010000	M5 Hex Nut			2	2	
9001447	M6 x 25mm SHCS			1	1	
9000776	9/32 x 5/8 Washer			1	1	
9009285	5/16 x 3/4 Washer			16	16	
9010443	Tension Washer			1	1	
9010454	M6 Low Head SHCS			6	6	
6588	Adaptor S1 LC			1	1	
9010051	M4 x 10mm SHCS			6	6	
9005170	M2.5 x 12mm SHCS			10	10	
9001445	M6 x 12mm FHCS			2	2	

Appendix 5

Torso and Pelvis

Table 1
Drawings

TRANS/WP.29/78/Add.1/ App.5/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	ARA-347	Spine-Torso Interface – Left	C	1	1	1	
Drg. 2	ARA-348	Pelvis Interface Abdomen Attachment	C	1	1	1	
Drg. 3	ARA-349	Reinforcement, Arm Attachment	D	1	2	2	
Drg. 4	ARA-350	Spine-Torso Interface – Right	B	1	1	1	
Drg. 5	ARA-351	Attachment, Arm	G	1	2	2	
Drg. 6	ARA-352	Arm Attachment Assembly – Right	H	1	1	1	
Drg. 7	ARA-353	Shoulder Yoke	B	1	2	2	
Drg. 8	ARA-354-L5	Spine, Torso Interface Pin Assembly	G	1	1	1	
Drg. 9	ARA-354-L8	Spine, Torso Interface Pin Assembly	G	1	1	1	
Drg. 10	ARA-354-Lr3	Spine, Torso Interface Pin Assembly	G	1	2	2	
Drg. 11	ARA-354-Lr4	Spine, Torso Interface Pin	G	1	2	2	
Drg. 12	ARA-354-Lr12	Spine, Torso Interface Pin Assembly	G	1	4	4	
Drg. 13	ARA-354-	Spine, Torso	G	1	4	4	

TRANS/WP.29/78/Add.1/ App.5/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
	Lr67	Interface Pin Assembly					
Drg. 14	ARA-354-R5	Spine, Torso Interface Pin Assembly	G	1	1	1	
Drg. 15	ARA-358	Bushing, Shoulder	D	1	2	2	
Drg. 16	ARA-359	Block, Bushing	F	1	2	2	
Drg. 17	ARA-362	Plate, Back	B	1	1	1	
Drg. 18	ARA-363	Plate, Back	B	1	1	1	
Drg. 19	ARA-364	Plate, Back – Spine	B	1	1	1	
Drg. 20	ARA-391	Arm Attachment Assembly – Left	G	1	1	1	
Drg. 21	ARA-395	Torso Jacket Assembly	F	1	1	1	
Drg. 22	ARA-505	Retainer, Spring Tube	H	1	1	1	Add. 1 App. 6 Dwg 022
Drg. 23	ARA-510	Pelvis Interface Abdomen Att.	E	1	1	1	
Drg. 24	ARA-513	Bone, Pelvis	J	1	1	1	
Drg. 25	ARA-514	Pelvis, Moulded	F	1	1	1	
Drg. 26	ARA-515	Gasket, Anti-Slap	C	1	1	1	
Drg. 27	ARA-908	Pelvis Lift Bracket			1	1	
Drg. 28	ARA-933	H-Point Left			1	1	
Drg. 29	ARA-934	H-Point Right			1	1	

Table 2
Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9004036	M6 x 25mm FHCS			2	2	

Appendix 6

Muscle Substitute

Table 1
Drawings

TRANS/WP.29/78/Add .1/ App.6/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	ARA-326	Body, Rotary Damper	U	1	1	1	
Drg. 2	ARA-343	Wheel, Cable Guide	D	1	1	1	
Drg. 3	ARA-346	Damper Paddle Clamp Bracket	D	1	1	1	
Drg. 4	ARA-355	Cover, Damper	J	1	1	1	
Drg. 5	ARA-356	Adjustment, Cable – Attachment	C	1	4	4	
Drg. 6	ARA-369	Cable, Muscle Substitute	E	1	2	2	
Drg. 7	ARA-372	Calibration Screw	D	1	1	1	
Drg. 8	ARA-374	Damper Paddle Wheel	C	1	1	1	
Drg. 9	ARA-375	Assembly, Rotary Damper	P	1	1	1	
Drg. 10	ARA-376	Biorid Calibration Screw-O-Ring Assy	A	1	1	1	
Drg. 11	ARA-377	Damper & Mounting Plate Assembly	-	1	1	1	
Drg. 12	ARA-401	Spring, Anterior	D	1	1	1	

TRANS/WP.29/78/Add .1/ App.6/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
		Muscle Substitute					
Drg. 13	ARA-402	Spring, Posterior Muscle Substitute	E	1	1	1	
Drg. 14	ARA-403	Tube Spring - Posterior Muscle Substitue	D	1	1	1	
Drg. 15	ARA-404	Tube, Spring - Anterior Muscle Substitute	D	1	1	1	
Drg. 16	ARA-405	Piston, Muscle Substitute	E	1	2	2	
Drg. 17	ARA-406	Adjuster, Cable	C	1	4	4	
Drg. 18	ARA-409	Cable, Damper	H	1	1	1	
Drg. 19	ARA-410	Sleeve, Cable – Flexible	B	1	2	2	
Drg. 20	ARA-411	Terminal, Cable	D	1	2	2	
Drg. 21	ARA-413	Cap, Vinyl	B	1	4	4	
Drg. 22	ARA-505	Spring Tube Retainer			1	1	Add. 1 App. 5 Dwg 022
Drg. 23	ARA-711	Cable Post Sleeve			2	2	

Table 2
Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9009091	Cable Adjuster			4	4	

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9010293	Cable Cap			4	4	

Appendix 7

Arms and Hands

Table 1
Drawings

TRANS/WP.29/78/Add.1/ App.7/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	78051□123	Arm Assembly, Left			1		
Drg. 2	78051□124	Arm Assembly, Right			1		
Drg. 3	78051□174	Upper Arm			1		
Drg. 4	78051□191	Upper Arm, Lower Part			1		
Drg. 5	78051□194	Lower Arm			1		
Drg. 6	78051□198	Stop ASM-Lower Arm			1		
Drg. 7	78051□199	Bushing, Upper Arm and Elbow	-		2		
Drg. 8	78051□200	Washer, Upper Arm and Elbow	-		2		
Drg. 9	78051□202	Elbow Pivot Nut			1		
Drg. 10	78051□204	Wrist Rotation			1		
Drg. 11	78051□208	Hand, Left			1		
Drg. 12	78051□209	Hand, Right			1		
Drg. 13	78051□214	Wrist Pivot					

TRANS/WP.29/78/Add.1/ App.7/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
		Screw					
Drg. 14	78051□249	Washer, Joint Spring			2/4		

Table 2
Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9010283	M10 x 45mm SHCS			3	6	
9006003	3/8 x 1 1/2 SHSS			1	2	
9000055	1/2 x 1 1/4 SHSS			1	2	
9001260	1.06 x .53 Washer			1	2	
9000074	3/8 x 1 SHSS			1	2	
9006003	3/8 x 1 1/2 SHSS			1	2	
9000055	1/2 x 1 1/4 SHSS			1	2	
9001260	1.06 x .53 Washer			1	2	
9000074	3/8 x 1 SHSS			1	2	

Appendix 8

Legs and Feet

Table 1
Drawings (Leg Assembly)

TRANS/WP.29/78/Add.1/ App.7/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	86-5001-001BR	Leg Assembly, Left			1		
Drg. 2	86-5001-002BR	Leg Assembly, Right			1		
Drg. 3	78051-5	Knee Flesh, Left			1		
Drg. 4	78051-6	Knee Flesh, Left			1		
Drg. 5	78051-27	Knee Insert			1		
Drg. 6	78051-41	Upper Leg, Moulded			1		
Drg. 7	78051-42	Upper Leg, Moulded			1		
Drg. 8	78051-43	Upper Leg Bone			1		
Drg. 9	78051-44	Upper Leg Bone			1		
Drg. 10	78051-73S	Lower Leg Flesh			1		
Drg. 11	78051-74S	Lower Leg Flesh			1		
Drg. 12	78051-319	Load Cell Simulator			1		
Drg. 13	78051-600	Foot Assembly, Left			1		
Drg. 14	78051-601	Foot Assembly, Right			1		
Drg. 15	78051-608	Pad, Heel - Foam			1		

TRANS/WP.29/78/Add.1/ App.7/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 16	78051-610	Ankle Bumper			1		
Drg. 17	79051-22	Knee Cap			1		
Drg. 18	79051-24P	Pedestrian Knee Slider Replacement			1		
Drg. 19	79051-25P	Pedestrian Knee Slider Replacement			1		
Drg. 20	79051-30	Shoulder Bolt, Modified			2		
Drg. 21	79051-32	Washer			1		
Drg. 22	79051-33	Compression Washer			1		
Drg. 23	79051-34	Rotation Stop Cover			1		
Drg. 24	79051-35	Rotation Stop Arm			1		
Drg. 25	A-1590	Ankle Shaft			1		
Drg. 26	A-1672	Stop Pin Retainer			1		
Drg. 27	A-1886	Foot Attachment Bolt			1		
Drg. 28	A-1887	Leg Attachment Bolt			1		
Drg. 29	A-1888	Ankle Friction Pad			1		
Drg. 30	B-1889	Ankle Assembly					
Drg. 31	B-2110-D	Knee Structural Replacement			1		

TRANS/WP.29/78/Add.1/ App.7/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 32	C-1884	Ankle Upper Shell			1		
Drg. 33	C-1885	Ankle Lower Shell			1		
Drg. 38 (Drawing not present!!!)	2110	Knee Weldment			1		
Drg. 39 (Drawing not present!!!)	1877	Tibia Bone			1		

Table 4. Parts

Part Number	*Description*	*Drwg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
9000126	1/4]28 x 5/8 SHCS			4		
9000072	3/16 x 1/2 Dowel Pin			1		
9000073	5/16-18 x 3/8 SSCP			1		
9006010	10-32 x 1/4 SSCP			2		
9000076	8-32 x 1/2 BHCS			2		
9000449	3/8-16 x 1 3/4 SHCS			1		
9000066	3/8-16 x 2 SHCS			1		
9005079	8-32 x 1/2 SHCS			2		
9004028	1/4-28 x 3/8 FHCS			8		

Appendix 9

Tools

Table 1. Drawings

TRANS/WP.29/78/Add.1/ App.8/…	*Part Number*	*Description*	*Drg. Rev.*	*No. of Sheets*	*QTY Per Assembly*	*QTY Per Dummy*	*Common with Addenda*
Drg. 1	3023	Alignment Tool	D	1	1	1	
Drg. 2	ARA-610	Lift Bracket	C	1	1	1	
Drg. 3	ARA-611	Lift Cable	E	1	1	1	
Drg. 4	ARA-907	Head Levelling Tool	D	1	1	1	
Drg. 5	ARA-912	Head Locking Device	A	1	1	1	
Drg. 6	ARA-913	Locking Arm	B	1	1	1	
Drg. 7	ARA-914	Bolt Bracket	B	1	1	1	
Drg. 8	ARA-915	Assy, Pelvis Angle Indicator	-	1	1	1	
Drg. 9	ARA-916	Arm, Pelvis Angle Indicator	C	1	1	1	
Drg. 10	ARA-917	Bracket, Pelvis Angle Indicator	C	1	1	1	
Drg. 11	ARA-920	Biorid Shorts Pattern And Specifications	B	1	1	1	
Drg. 12	ARA-921	Biorid Shirt	B	1	1	1	
Drg. 13	ARA-930	T1 Angle Indicator Assembly	-	1	1	1	
Drg. 14	ARA-931	T1 Indicator	-	1	1	1	

Part Number	Description	Drg. Rev.	No. of Sheets	QTY Per Assembly	QTY Per Dummy	Common with Addenda
	Mounting Bracket					
Drg. 15	ARA-932	T1 Angle Indicator Bar	-	1	1	1
Drg. 16	B-5643	H-point Locator	C	1	1	1
Drg. 17	TRA-042	Spine Vertebrae Spacing Fixture Assembly	C	1	1	1
Drg. 18	TRA-043	Vertebrae Spacer Upper Cam Arm	E	1	1	1
Drg. 19	TRA-044	Vertebrae Spacer Lower Cam Arm	F	1	1	1
Drg. 20	TRA-045	Vertebrae Spacer	D	1	1	1

Table 2
Parts

Part Number	Description	Drwg. Rev.	No. of Sheets	QTY Per Assembly	QTY Per Dummy	Common with Addenda

Annex 3

Certification Procedures

1. Sled Test – without head restraint
2. Sled test – with head restraint
3. Torso Flesh Stiffness.
4. Pelvis stiffness

Appendix 1 – Schematic and General Arrangement of Equipment

Appendix 2 – Certification Corridors