



SURFACE VEHICLE INFORMATION REPORT

J1733™

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Reaffirmed 2024-11

Superseding J1733 NOV2018

(R) Sign Convention for Vehicle Crash Testing

RATIONALE

The committee performed the recommended Five-Year Review of this Information Report and determined that a number of changes were necessary. The major changes are outlined below.

- Removed all references to BioSID.
- Replaced Figures 1, 2, 3, 4, 5, 6, 7, 9, and 10 with updated artwork.
- Added Angular Rate Sensor (ARS) and relevant ARS information and added ARS Figure 8.
- Added Table 2 for THOR-50M dummy manipulations for recorded sensor polarities.

SAE J1733 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

In order to compare test results obtained from different crash test facilities, standardized coordinate systems need to be defined for crash test dummies, vehicle structures, and laboratory fixtures. In addition, recorded polarities for various transducer outputs need to be defined relative to positive directions of the appropriate coordinate systems. This SAE Information Report describes the standardized sign convention and recorded output polarities for various transducers used in crash testing.

2. REFERENCES

2.1 Applicable Documents

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

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2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J211 Instrumentation for Impact Test

SAE J670 Vehicle Dynamics Terminology

SAE J1594 Vehicle Aerodynamics Terminology

SAE J2052 Test Device Head Contact Duration Analysis

3. RIGHT-HANDED COORDINATE SYSTEM

A right-handed coordinate system consists of an ordered set of three mutually perpendicular axes (x , y , z) which have a common origin and whose positive directions point in the same directions as the ordered set of the thumb, forefinger, and middle finger of the right hand when positioned as shown in Figure 1. Note that this configuration of x , y , and z axes always define a right-handed coordinate system independent of the orientation of the hand in space. To assure consistent vector directions of moments and angular velocities and accelerations calculated by vector multiplications all coordinate systems used in vehicle testing will be "right-handed". Sections 4 and 5 will define standardized orientations of coordinate systems for the vehicle and dummy, respectively.

Positive angular motion and moment directions are determined by the right-handed screw rule. If any of the three positive axes is grasped with the right hand with the thumb extended in the positive direction, as shown in Figure 2 for the x -axis, then the curl of the fingers indicate the positive direction for angular motions and moments with respect to that axis.

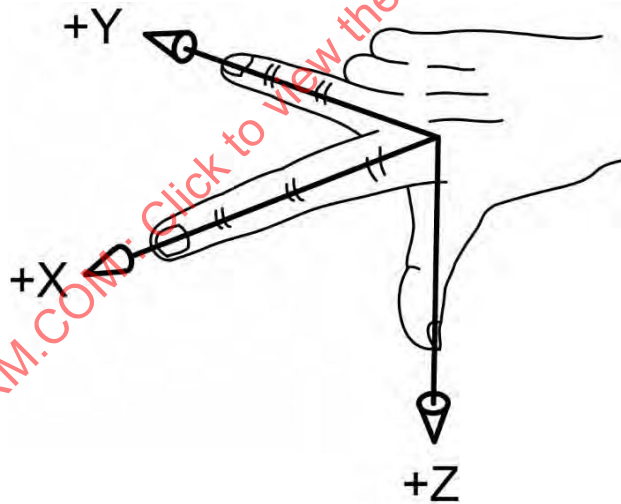


Figure 1 - The configuration of a right-handed coordinate system relative to the thumb, forefinger, and middle finger of the right hand

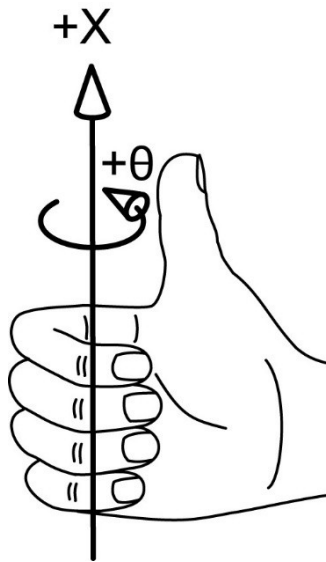


Figure 2 - Right-handed screw rule

A simple method to determine if a coordinate system is right-handed is to rotate the system 90 degrees about any of one of its positive axes using the right-handed screw rule. For a positive 90 degrees rotation about the +x-axis, the coordinate system is right-handed if the +y-axis rotates to the position previously occupied by the +z-axis. For a positive 90 degrees rotation about the +y-axis, the coordinate system is right-handed if the +z-axis rotates to the position previously occupied by the +x-axis. For a positive 90 degrees rotation about the +z-axis, the coordinate system is right-handed if the +x-axis rotates to the position previously occupied by the +y-axis.

4. VEHICLE COORDINATE SYSTEMS

Vehicle coordinate systems will be consistent with the orientations specified in SAE J670 and SAE J1594. These orientations are shown in Figures 3 and 4, respectively. For structures within the vehicle that have a principle axis of motion such as the steering wheel column, the vehicle coordinate system may be rotated about the y-axis such that the +x-axis or +z-axis is directed along the column axis.

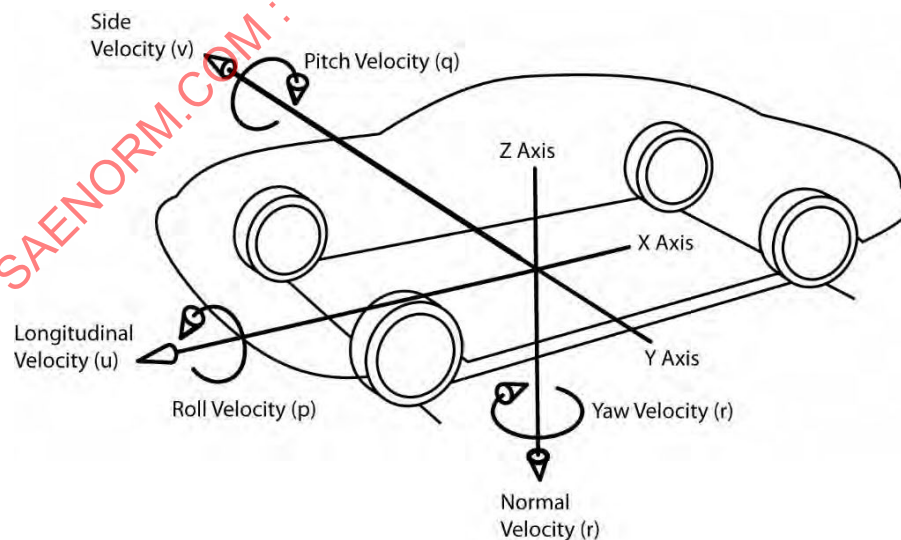


Figure 3 - Vehicle dynamics coordinate system - SAE J670

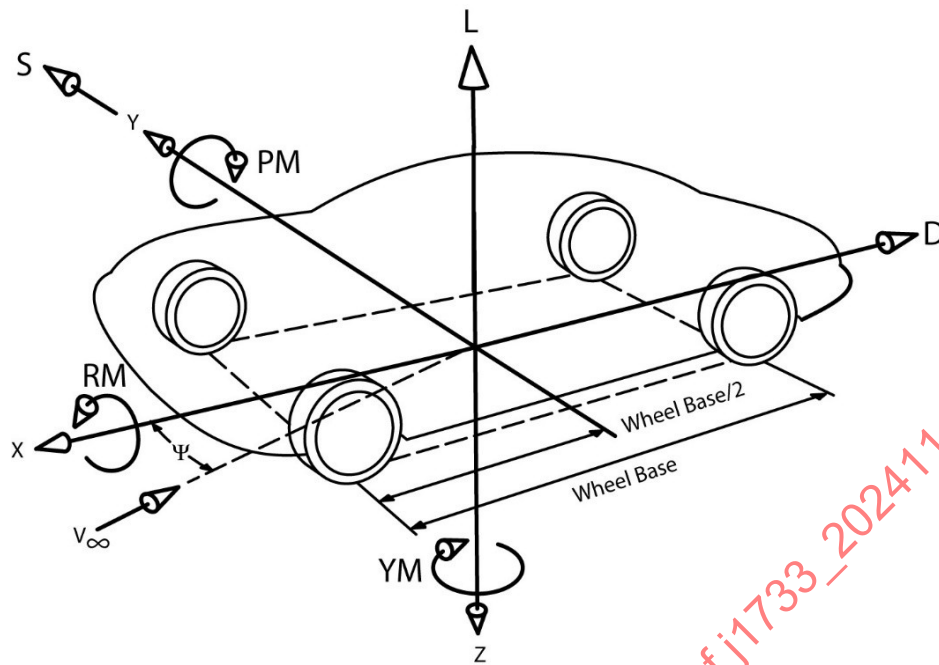


Figure 4 - Vehicle aerodynamics coordinate system - SAE J1594

5. DUMMY COORDINATE SYSTEMS

The definition of the dummy coordinate system given in SAE J211 will be used. A coordinate system can be affixed to any point on the dummy. The coordinate system will translate and/or rotate with the dummy part to which it is attached during the test. To define standard orientations of the coordinate axes, the dummy will always be considered as standing erect. For this posture, the +x-axis will be directed forward, the +y-axis will be directed from the dummy's left to its right side and the +z-axis will be directed downward from head to toe. In anatomical terminology, the +x-axis is directed from posterior to anterior (P-A), the +y-axis is directed from left to right (L-R), and the +z-axis is directed from superior to inferior (S-I). Figure 5 shows examples of this standardized orientation for coordinate systems attached to a few body points. Note that as the dummy is articulated to sit in a vehicle or during a test the coordinate systems rotate with their respective dummy parts.

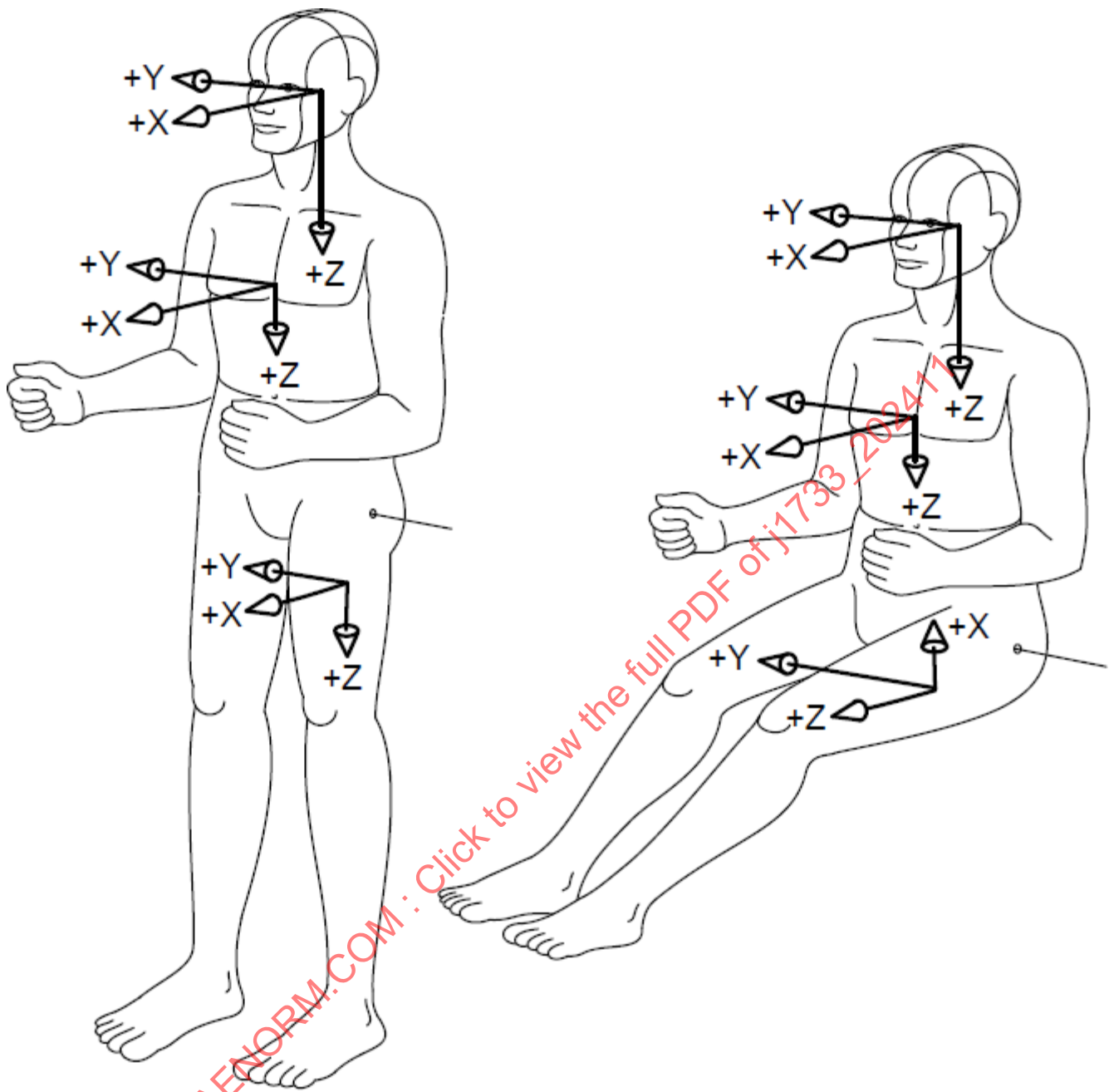


Figure 5 - Orientations of standardized dummy coordinate systems for standing and seated postures

6. STANDARD POLARITIES FOR RECORDED DUMMY MEASUREMENTS

6.1 Polarities of Acceleration, Angular Rate, and Displacement

Positive recorded outputs for these transducers are to be consistent with the positive axes of the coordinate system defined for the specific dummy or vehicle point being measured. In general, for any dummy component oriented in its standard standing position, blows to its back side, left side, and top will produce positive accelerations relative to its +x, +y, and +z directions, respectively. As illustrated in Figure 6, a blow to the back of the dummy's head produces an acceleration in the forward direction (+x) which should be recorded as a positive acceleration. A blow to the top of the head produces a +z acceleration. A blow to the left side of the head produces a +y acceleration. Figure 7 is a quasi-static method to determine polarity using gravity as the force to check for proper accelerometer polarities. Figure 8 describes a method to validate the polarity of the angular rate sensor (ARS). In order to accomplish this the sensor must be rotated with sufficient speed to correctly determine the polarity. Free body diagrams for specific dummy load cells showing the load systems that produce the required outputs should be recorded with the specified polarities given in Section 8.

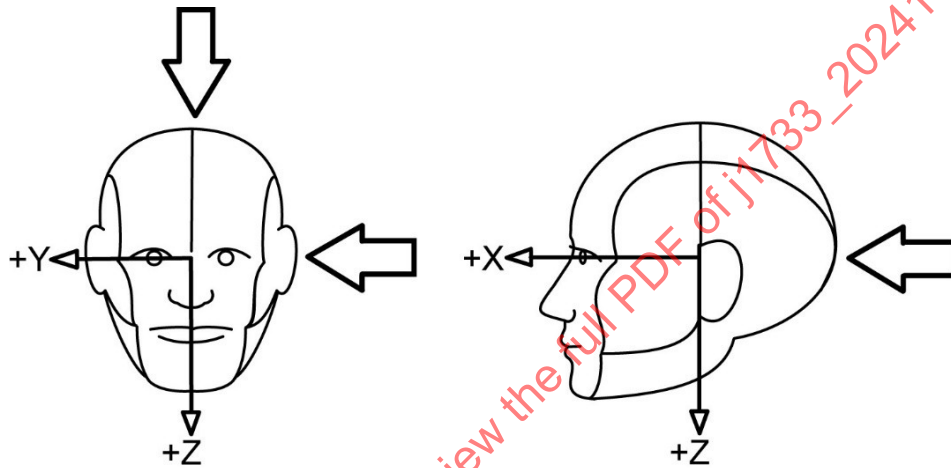


Figure 6 - Head impact directions that produce positive head accelerations relative to the head coordinate system

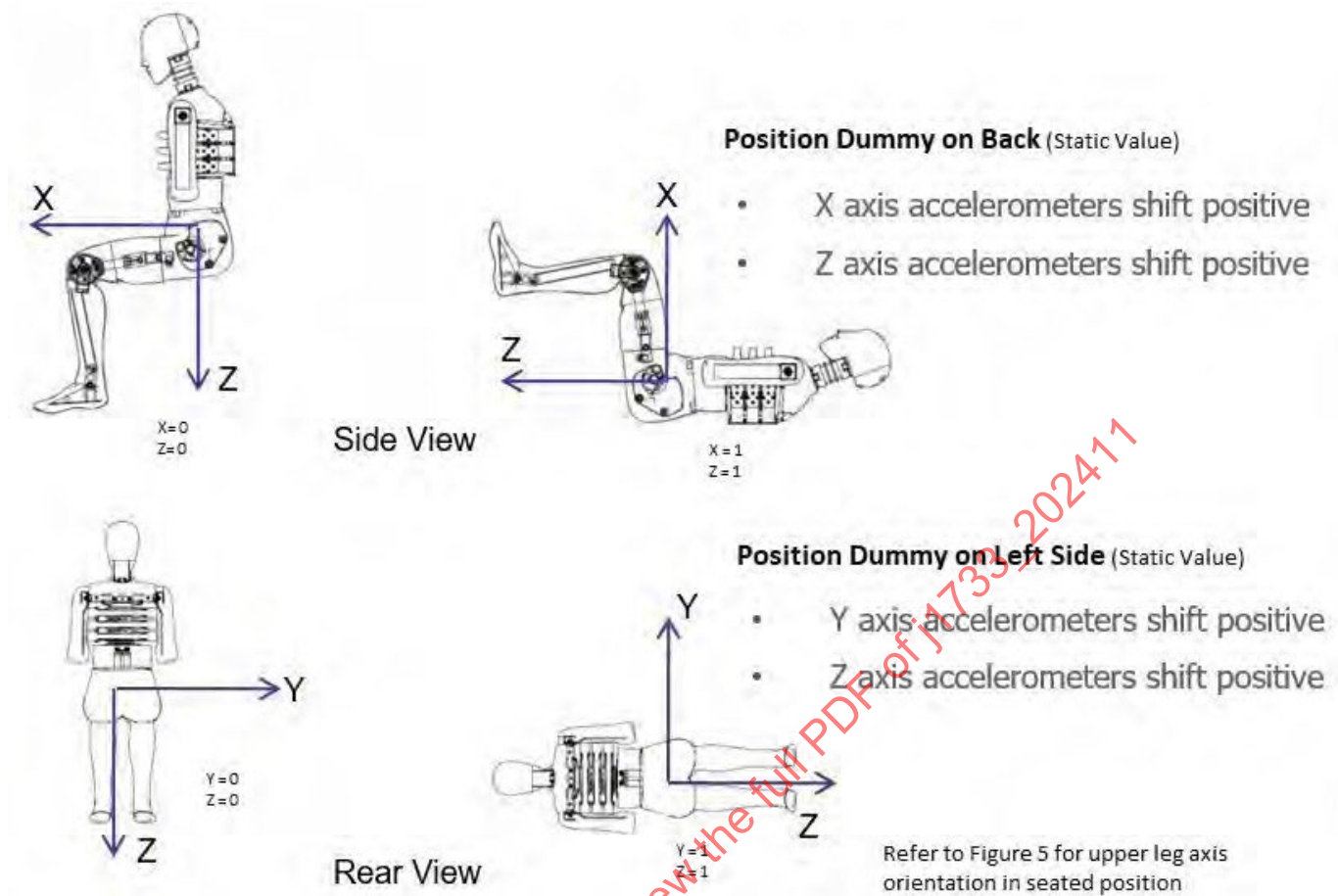


Figure 7 - Accelerometer polarity check by whole body positioning

As illustrated in Figure 8, ARS Polarity Checks are as follows:

- +X Angular Rate - Rotate ATD onto right side
- +Y Angular Rate - Rotate ATD rearwards
- +Z Angular Rate - Rotate ATD to right about vertical axis

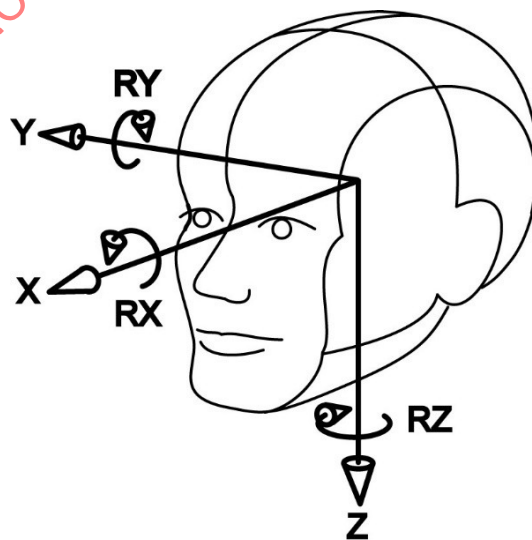


Figure 8 - ARS polarity check by rotation

For relative displacement of body parts, the coordinate system of interest must be defined. For example, frontal chest compression is the distance that the sternum moves relative to the thoracic spine. In this case, the coordinate system is fixed to the thoracic spine. When the sternum moves closer to the spine, its displacement is rearward relative to the spine which is in the negative x-direction. Hence, the polarity for chest deflection is negative. For lateral chest compression, a blow to the left side of the chest produces a positive displacement of the impacted ribs relative to the thoracic spine. However, a blow to the right side of the chest produces a negative rib displacement. The directions of these chest compressions are illustrated in Figure 9. The rearward displacement of the tibia relative to the femur that is measured by the knee shear transducer is in the negative x-direction. The polarity for this motion is negative.

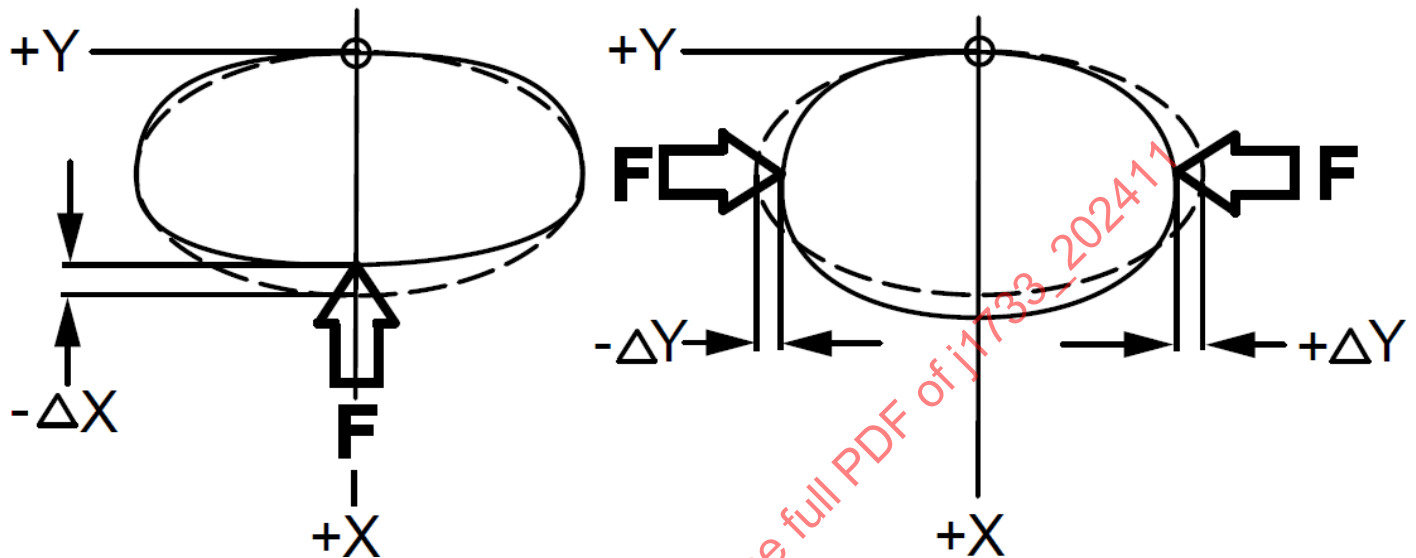


Figure 9 - Directions of frontal and lateral chest deflections

6.2 Polarities of Measured External Loads

For load cells that measure loads applied directly to the dummy or vehicle structure, their recorded output polarities should be consistent with the direction of the applied external load referenced to the standardized coordinate system at the point of the load application. For example, load cells that measure shoulder belt loading of the clavicle are designed to measure F_x and F_z applied to the clavicle. The rearward (-x) component of the shoulder belt force applied to the clavicle should be recorded with a negative polarity. The downward (+z) component should have a positive polarity.

6.3 Polarities of Measured Internal Loads

Defining recorded output polarities for load cells that measure loads internal to the dummy requires a standardized dummy sectioning scheme and a definition of what sectioned dummy part is to be loaded in the positive direction since internal loads occur in pairs of equal magnitudes but opposite directions. The standardized sectioning scheme is illustrated by the free-body diagram of a cube shown in Figure 10. It is assumed that the load cell of interest is contained within the cube and responds to loads applied to the surfaces of the cube. Load cell outputs should be recorded with positive polarities when normal loads, shear loads, torques, or moments are applied in the positive direction, as defined by the standardized coordinate system, to the right, front, and/or bottom surfaces of the cube. These loads are represented by solid arrows. For static equilibrium, equal magnitude but opposite direction loads (negative) must be applied to the left, back, and/or top surfaces of the cube as indicated by the dashed arrows.

For example, upper and lower neck, lumbar spine, and upper and lower tibia load cells should have positive recorded outputs when the dummy is sectioned below the load cell in question and positive loads are applied to the bottom surface of the sectioned body part that contains the load cell in question. Dummy manipulations for checking the recorded polarities of the outputs of various transducers are given in Section 7.

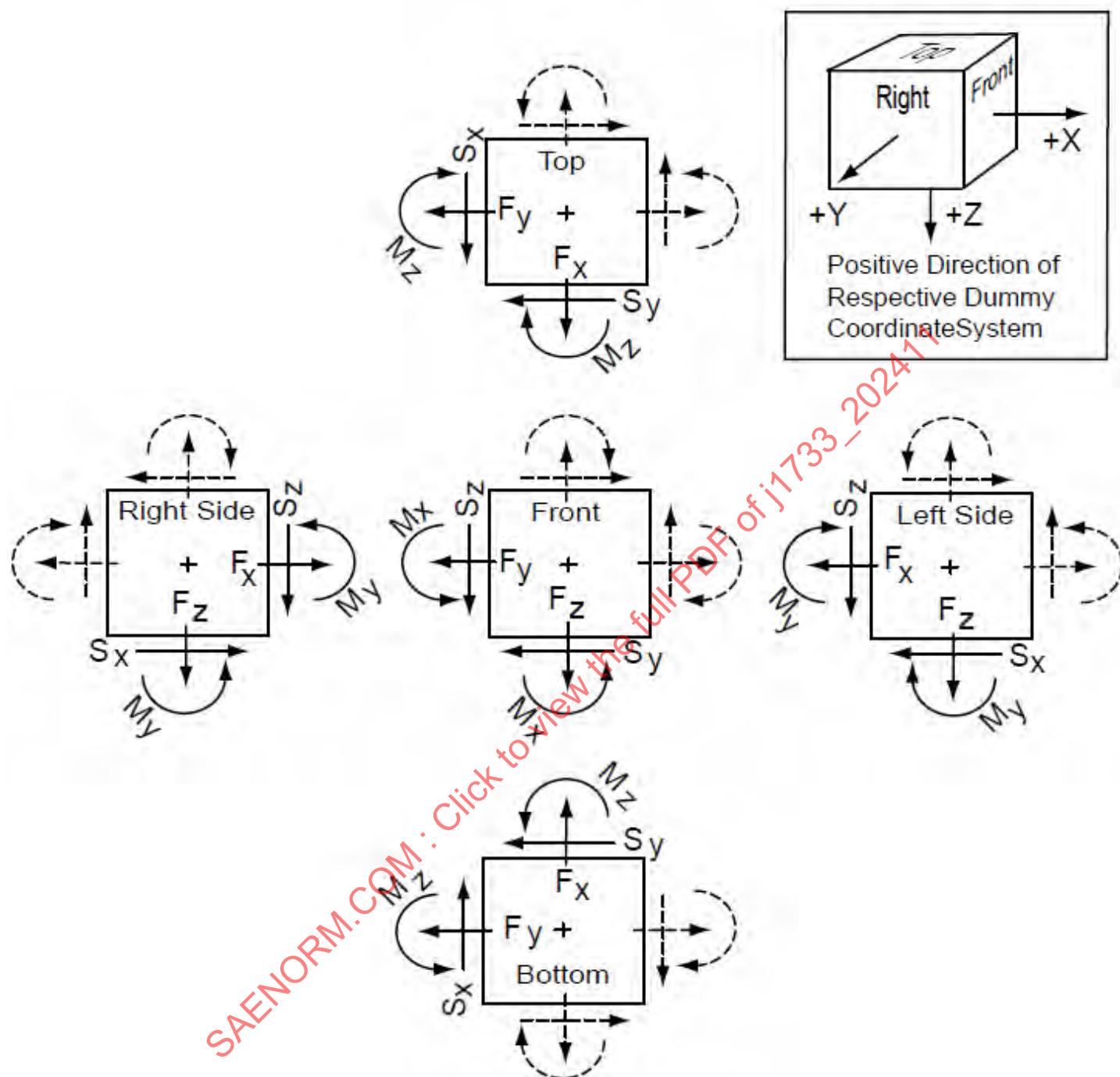


Figure 10 - Free-body diagram of a sectioned dummy part containing the load cell of interest (illustrated as a cube). Principle axes of load cell aligned parallel to respective axes of local dummy coordinate system. Bold arrows of normal forces (F), shear forces (S), and moments (M) shown in positive directions and applied to the front, right, and bottom surfaces of the cube. Dotted arrows indicate direction of loads applied to the back, left, and top surfaces for static equilibrium. All load cell outputs for this load system to be recorded with positive polarities.

6.4 Example of Internal Versus External Loads

A test to determine an external versus internal load cell is as follows. An internal load cell measures forces and moments between two body segments. A Eurosid shoulder load cell is mounted between the arm and clavicle and is considered internal. This load cell will also measure an external impact to the shoulder but the internal rule take precedence. The Hybrid III 10-Year-Old shoulder load cell is an external load cell. Although the load cell is mounted within the shoulder structure, it will only measure the external forces applied to the shoulder from the shoulder belt. Forces from the arm are not measured.

7. DUMMY MANIPULATIONS FOR CHECKING POLARITIES OF MEASURED RESPONSES

Table 1 contains descriptions of dummy manipulations that can be used to verify the correctness of the polarities of recorded outputs for some of the more common sensors used in dummies.

Table 2 contains descriptions of THOR-50M dummy manipulations for checking recorded sensor polarities relative to sign convention.

NOTE: For neck load cell force polarity checks, the manipulative force application point on the head should be in-line with OC joint to avoid inducing moments that can produce misleading output polarity.

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Table 1 - Dummy manipulations for checking recorded load cell polarity relative to sign convention

Load Cell	Measure	Dummy Manipulations	Polarity
Upper	F_x	Head Rearward, Chest Forward	+
and	F_y	Head Leftward, Chest Rightward	+
Lower	F_z	Head Upward, Chest Downward	+
Neck	M_x	Left Ear Toward Left Shoulder	+
Loads	M_y	Chin Toward Sternum	+
(All ATDs)	M_z	Chin Toward Left Shoulder	+
Left Shoulder	F_x	Arm Rearward, Chest Forward	+
Loads (SID IIs, Qs,	F_y	Arm Leftward, Chest Rightward	+
ES2, WorldSID)	F_z	Arm Upward, Chest Downward	+
Right Shoulder	F_x	Arm Forward, Chest Rearward	+
Loads (SID IIs, Qs,	F_y	Arm Rightward, Chest Leftward	+
ES2, WorldSID)	F_z	Arm Downward, Chest Upward	+
Right Clavicle Loads	F_x	Shoulder Forward, Chest Rearward	+
(Internal LC)	F_z	Shoulder Downward, Chest Upward	+
Left Clavicle Loads	F_x	Shoulder Rearward, Chest Forward	+
(Internal LC)	F_z	Shoulder Upward, Chest Downward	+
Right and Left	F_x	Shoulder Forward, Chest Rearward	+
Clavicle Loads	F_z	Shoulder Downward, Chest Upward	+
(External LC)			
Upper	F_x	Chest Rearward, Pelvis Forward	+
and	F_y	Chest Leftward, Pelvis Rightward	+
Lower	F_z	Chest Upward, Pelvis Downward	+
Thoracic & Lumbar	M_x	Left Shoulder Toward Left Hip	+
Spine	M_y	Sternum Toward Front of Legs	+
(All ATDs)	M_z	Right Shoulder Forward, Left Shoulder Rearward	+
Left Iliac Load	F_y	Left Iliac Rightward, Chest Leftward	+
(SID IIs)			
Right Iliac Load	F_y	Right Iliac Rightward, Chest Leftward	+
(SID IIs)			
Pubic Load	F_y	Right H-Point Pad Leftward, Left Pad Rightward	(-)
(Side Impact)			

Table 1 - Dummy manipulations for checking recorded load cell polarity relative to sign convention (continued)

Load Cell	Measure	Dummy Manipulations	Polarity
Crotch Belt	F_x	Pubic Rearward, Pelvis Forward	(-)
Loads	F_z	Pubic Upward, Chest Downward	(-)
Iliac Lap	F_x	Upper Iliac Spine Rearward, Pelvis Forward	(-)
Belt Loads	M_y	Upper Iliac Spine Rearward, Pelvis Forward	+
Left Side Abdominal Load (EUROSID-1, ES-2)	F_y	Left Side of Abdomen Rightward, Chest Leftward	+
Right Side Abdominal Load (EUROSID-1, ES-2)	F_y	Right Side of Abdomen Leftward, Chest Rightward	(-)
Femur	F_x	Knee Upward, Upper Femur Downward	+
Loads	F_y	Knee Rightward, Upper Femur Leftward	+
(Dummy in	F_z	Knee Forward, Pelvis Rearward	+
Seated Position,	M_x	Knee Leftward, Hold Upper Femur in Place	+
Femurs	M_y	Knee Upward, Hold Upper Femur in Place	+
Horizontal)	M_z	Tibia Leftward, Hold Pelvis in Place	+
Knee Clevis	F_z	Tibia Downward, Femur Upward	+
Upper Tibia	F_x	Tibia Forward, Knee Rearward	+
Loads	F_y	Tibia Rightward, Knee Leftward	+
(All ATDs)	F_z	Tibia Downward, Femur Upward	+
	M_x	Ankle Leftward, Hold Knee in Place	+
	M_y	Ankle Forward, Bottom of Knee Clevis Rearward	+
Lower Tibia	F_x	Ankle Forward, Knee Rearward	+
Loads	F_y	Ankle Rightward, Knee Leftward	+
(All ATDs)	F_z	Ankle Downward, Knee Upward	+
	M_x	Ankle Leftward, Hold Knee in Place	+
	M_y	Ankle Forward, Bottom of Knee Clevis Rearward	+
Backplate	F_x	Backplate Forward, Thorax Rearward	+
(EUROSID-1, ES-2)	F_y	Backplate Rightward, Thorax Leftward	+
	M_y	Push Forward on Bottom Edge of Backplate, Hold Thorax in Place	+
	M_z	Push on Left Edge of Backplate, Hold Thorax in Place	+

Table 1 - Dummy manipulations for checking recorded load cell polarity relative to sign convention (continued)

Load Cell	Measure	Dummy Manipulations	Polarity
T-12 Spine (EUROSID-1, ES-2)	F _x	Chest rearward, pelvis forward	+
	F _y	Chest leftward, pelvis rightward	+
	M _x	Left shoulder to left hip	+
	M _y	Chest forward, hold pelvis	+
Left Acetabulum (SID-IIs)	F _y	Hold pelvis, push on left side of H-point	+
Right Acetabulum (SID-IIs)	F _y	Hold pelvis, push on right side of H-point	(-)
Left Acetabulum (H3-3YO)	F _y	Left leg leftward, pelvis rightward	+
Right Acetabulum (H3-3YO)	F _y	Right leg rightward, pelvis leftward	+
Rib Force Sensor (SID-IIs)	F _x	Compression	(-)
Rib Loads (Hybrid III)	F _x	Ribs forward, spine rearward	+
	F _y	Ribs rightward, spine leftward	+
	F _z	Ribs downward, spine upward	+
	M _y	Push sternum upward, hold spine in place	+
Ankle Loads (Hybrid III)	F _x	Ankle rearward, foot forward	+
	F _y	Ankle leftward, foot rightward	+
	F _z	Ankle upward, foot downward	+
	M _x	Hold ankle, foot leftward	+
	M _y	Hold ankle toes upward	+
Toe Loads (Hybrid III)	F _z	Toe downward, ankle upward	+

Table 2 - THOR-50M dummy manipulations for checking recorded sensor polarity relative to sign convention

Sensor	Measure	Dummy Manipulations	Polarity
Head Accelerometers (CG)	A_x	Impact Rear of Head in Forward Direction	+
	A_y	Impact Left Side of Head in Rightward Direction	+
	A_z	Impact Top of Head in Downward Direction	+
Head CG Angular Rate Sensor	ω_x	Rotate Right Ear Toward Right Shoulder	+
	ω_y	Rotate Chin Toward Sternum	(-)
	ω_z	Rotate Chin Toward Right Shoulder	+
Upper and Lower Neck Loads	F_x	Head Rearward, Chest Forward	+
	F_y	Head Leftward, Chest Rightward	+
	F_z	Head Upward, Chest Downward	+
	M_x	Left Ear Toward Left Shoulder	+
	M_y	Chin Toward Sternum	+
	M_z	Chin Toward Left Shoulder	+
Front Neck Spring	F_z	Rotate Head Rearward	+
Rear Neck Spring	F_z	Rotate Chin Toward Chest	+
Occipital Condyle Rotary Pot	θ_y	Rotate Chin Toward Chest	(-)
Face Load Cell	F_x	Hold Back of Head, Push Face Rearward	(-)
T1 Accelerometer (Tri-Pack)	A_x	Impact Rear of Thorax in Forward Direction	+
	A_y	Impact Left Side of Thorax in Rightward Direction	+
	A_z	Impact Top of Thorax in Downward Direction	+
Mid-Sternum Accelerometer	A_x	Impact Rear of Thorax in Forward Direction	+
Thorax Accelerometer (Tri-Pack)	A_x	Impact Rear of Thorax in Forward Direction	+
	A_y	Impact Left Side of Thorax in Rightward Direction	+
	A_z	Impact Top of Thorax in Downward Direction	+
T4 Thorax Angular Rate Sensor	ω_x	Rotate Thorax Rightward	+
	ω_y	Rotate Thorax Rearward	+
	ω_z	Rotate Right Shoulder Backward and Left Shoulder Forward	+
T12 Accelerometer (Tri-Pack)	A_x	Impact Rear of Thorax in Forward Direction	+
	A_y	Impact Left Side of Thorax in Rightward Direction	+
	A_z	Impact Top of Thorax in Downward Direction	+

Table 2 - THOR-50M dummy manipulations for checking recorded sensor polarity relative to sign convention (continued)

Sensor	Measure	Dummy Manipulations	Polarity
T12	F_x	Chest Rearward, Pelvis Forward	+
Load Cell	F_y	Chest Leftward, Pelvis Rightward	+
	F_z	Chest Upward, Pelvis Downward	+
	M_x	Rotate Left Shoulder Toward Left Hip	+
	M_y	Rotate Sternum Toward Front of Legs	+
Left & Right Clavicle Load Cell (Medial & Lateral)	F_x	Push Center of Clavicle Rearward Toward Spine	(-)
	F_z	Push Center of Clavicle Downward Toward Pelvis	+
Upper Left & Right Arm Load Cell	F_x	Shoulder Rearward, Elbow Forward	+
	F_y	Shoulder Leftward, Elbow Rightward	+
	F_z	Shoulder Upward, Elbow Downward	+
	M_x	Rotate Elbow Leftward	+
	M_y	Rotate Elbow Forward	+
	M_z	With Upper Arm Vertical and Lower Arm Horizontal, Rotate Hand Rightward	+
Upper Abdomen Accelerometer	A_x	Impact Front of Abdomen in Rearward Direction	(-)
Pelvis Accelerometer (Tri-Pack)	A_x	Impact Rear of Pelvis in Forward Direction	+
	A_y	Impact Left Side of Pelvis in Rightward Direction	+
	A_z	Impact Top of Pelvis in Downward Direction	+
Pelvis Angular Rate Sensor	ω_x	Move Left Leg Upward and Right Leg Downward	+
	ω_y	Rotate Pelvis Rearward	+
	ω_z	Move Upper Legs Rightward	+
Left Acetabulum Load Cell	F_x	Move Femur Forward, Pelvis Rearward	(-)
	F_y	Move Femur Rightward, Pelvis Leftward	(-)
	F_z	Move Femur Downward, Pelvis Upward	(-)
Right Acetabulum Load Cell	F_x	Move Femur Forward, Pelvis Rearward	+
	F_y	Move Femur Rightward, Pelvis Leftward	+
	F_z	Move Femur Downward, Pelvis upward	+

Table 2 - THOR-50M dummy manipulations for checking recorded sensor polarity relative to sign convention (continued)

Sensor	Measure	Dummy Manipulations	Polarity
ASIS Load Cell	F_x	Push Inward Toward Back of Pelvis	(-)
Left and Right	M_y	Push Top of ASIS Toward Back of Pelvis	+
Femur Loads	F_x	Knee Upward, Upper Femur Downward	+
Left & Right	F_y	Knee Rightward, Upper Femur Leftward	+
(Dummy in	F_z	Knee Forward, Femur Rearward	+
Seated Position,	M_x	Knee Leftward, Hold Upper Femur in Place	+
Femur Horizontal,	M_y	Knee Upward, Hold Upper Femur in Place	+
Knee Bent)	M_z	Tibia Leftward, Hold Pelvis in Place	+
Knee Shear Displacement	D_x	Hold Femur, Move Tibia Forward	+
Upper Tibia	F_x	Tibia Forward, Knee Rearward	+
Loads	F_y	Tibia Rightward, Knee Leftward	+
	F_z	Tibia Downward, Knee Upward	+
	M_x	Rotate Tibia Leftward, Hold Knee in Place	+
	M_y	Rotate Tibia Forward, Hold Knee in Place	+
Lower Tibia	F_x	Ankle Forward, Knee Rearward	+
Loads	F_y	Ankle Rightward, Knee Leftward	+
	F_z	Ankle Downward, Knee Upward	+
	M_x	Ankle Leftward, Hold Knee in Place	+
	M_y	Ankle Forward, Hold Knee in Place	+
Tibia	A_x	Impact Back of Tibia in Forward Direction	+
Accelerometer	A_y	Impact Left of Tibia in Rightward Direction	+
Achilles Load Cell	F_z	Hold Tibia, Move Toes Upward	+
Ankle Rotation	Θ_x	Hold Tibia, Rotate Bottom of Foot Leftward	+
Potentiometer	Θ_y	Hold Tibia, Pull Toe Upward	+
	Θ_z	Hold Tibia, Rotate Toe Rightward	+
Foot	A_x	Impact Back of Foot in Forward Direction	+
Accelerometer	A_y	Impact Left of Foot in Rightward Direction	+
	A_z	Impact Top of Foot in Downward Direction	+

Table 2 - THOR-50M dummy manipulations for checking recorded sensor polarity relative to sign convention (continued)

A. Thorax Instrumentation.

Thorax Manipulation	Transducer	Quadrant	Polarity Eng. Units	Polarity Raw Voltage
Push Ribcage Inward (toward spine)	IR-TRACC	Upper Left	(-)	+
		Upper Right	(-)	+
		Lower Left	(-)	+
		Lower Right	(-)	+
Push Ribcage Downward (head-to-pelvis)	Rotary Ry	Upper Left	(-)	(-)
		Upper Right	(-)	+
		Lower Left	(-)	(-)
		Lower Right	(-)	+
Push Ribcage to Dummy's Right (left-to-right)	Rotary Rz'	Upper Left	+	(-)
		Upper Right	+	(-)
		Lower Left	+	+
		Lower Right	+	+

NOTE: Prime symbol in Rz' indicates that the axes of the rotary potentiometers are not wholly aligned with the respective dummy thorax coordinates axes.

B. Abdomen Instrumentation.

Abdomen Manipulation	Transducer	Quadrant	Polarity Eng. Units	Polarity Raw Voltage
Push Ribcage Inward (toward spine)	IR-TRACC	Left	(-)	+
		Right	(-)	+
Push Ribcage Downward (head-to-pelvis)	Rotary Ry	Left	(-)	(-)
		Right	(-)	+
Push Ribcage to Dummy's Right (left-to-right)	Rotary Rz'	Left	+	+
		Right	+	+

NOTE: Prime symbol in Rz' indicates that the axes of the rotary potentiometers are not wholly aligned with the respective dummy thorax coordinates axes.

8. FREE BODY DIAGRAMS OF SPECIFIC DUMMY TRANSDUCERS SHOWING LOAD SYSTEMS THAT PRODUCE OUTPUTS THAT ARE TO BE RECORDED WITH SPECIFIED POLARITIES

8.1 Hybrid III Type Dummies (Large Male, Mid-Size Male, Small Female, 10-Year Old, 6-Year Old, and 3-Year Old)

- a. Upper Neck Load Cell - See Figure 11.
- b. Lower Neck Load Cell - See Figure 12.
- c. Neck Load Cells (3-year old) - See Figure 13.
- d. Shoulder Load Cells - See Figure 14.
- e. Lower Thoracic Spine Load Cell - See Figure 15.
- f. Chest Deflection Transducer - See Figure 16.
- g. Lower Lumbar Spine Load Cell - See Figure 17.
- h. Iliac Lap Belt Load Cell - See Figure 18.
- i. Pubic Load Cell - See Figure 19.
- j. Femur Load Cell - See Figure 20.
- k. Upper and Lower Tibia and Knee Clevis Load Cells - See Figure 21.
- l. Ankle/Toe Load Cell - See Figure 22.
- m. Clavicle Load Cell, External - See Figure 23.
- n. Clavicle Load Cell, Internal - See Figure 24.
- o. Acetabulum Load Cell (3-year old) - See Figure 25.
- p. Rib Load Cells - See Figure 26.
- q. Face Load Cell - See Figure 27.

8.2 CRABI Type Dummies (6, 12, and 18 Months Old)

- a. Upper Neck Load Cell - See Figure 28.
- b. Lower Neck Load Cell - See Figure 29.
- c. Shoulder Load Cells - See Figure 14.
- d. Lower Lumbar Spine Load Cell - See Figure 30.
- e. Pubic Load Cell - See Figure 19.

8.3 WorldSID

- a. Upper and Lower Arm and Elbow Load Cells - See Figure 31.
- b. Lower Neck Load Cell - See Figure 32.
- c. Upper Neck Load Cell - See Figure 33.
- d. Femur Load Cell - See Figure 34.
- e. Upper and Lower Tibia Load Cells - See Figure 35.
- f. Knee Load Cell Polarities - See Figure 36.
- g. Pubic Load Cell - See Figure 37.
- h. Femoral Neck Load Cells - See Figure 38.
- i. Shoulder Load Cell - See Figure 39.
- j. Lumbar Spine Load Cell - See Figure 40.
- k. Sacroiliac Load Cell - See Figure 41.
- l. Arm Accelerometers - See Figure 42.
- m. Head Accelerometers - See Figure 43.
- n. Pelvis Accelerometers - See Figure 44.
- o. Thorax Accelerometers - See Figure 45.
- p. Chest Deflection - See Figure 46.

8.4 THOR

- a. LX/FLX Lower Leg - See Figure 47.
- b. Face Load Cell - See Figure 27.
- c. Acetabulum Load Cell - See Figure 48.
- d. Lower Neck Load Cell - See Figure 49.

8.5 Eurosid-1, ES-2, ES-2re

- a. T-12 Load Cell - See Figure 50.
- b. Upper Neck Load Cell - See Figure 51.
- c. Lower Neck Load Cell - See Figure 52.
- d. Backplate Load Cell - See Figure 53.
- e. Shoulder Load Cell - See Figure 54.
- f. Pubic Load Cell - See Figure 55.
- g. Lumbar Load Cell - See Figure 56.
- h. Abdominal Load Cell - See Figure 57.

8.6 SID-IIs

- a. Rib Load Cell - See Figure 58
- b. Upper Neck Load Cell - See Figure 11.
- c. Lower Neck Load Cell - See Figure 12.
- d. Acetabulum Load Cell - See Figure 59.
- e. Upper Femur Load Cell - See Figure 60.
- f. Iliac Wing Load Cell - See Figure 61.
- g. Pubic Load Cell - See Figure 62.
- h. Femur Load Cell - See Figure 20.
- i. Shoulder Load Cell - See Figure 63.

8.7 BioRID

- a. T-1 Load Cell - See Figure 64.
- b. Upper Neck Load Cell - See Figure 11.
- c. Lumbar Load Cell - See Figure 17.

8.8 Q-Series

- a. Upper, Lower Neck and Lumbar Load Cells - See Figure 65.

8.9 Miscellaneous

- a. Airbag Interaction Arm - See Figure 66.

9. NOTES

9.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

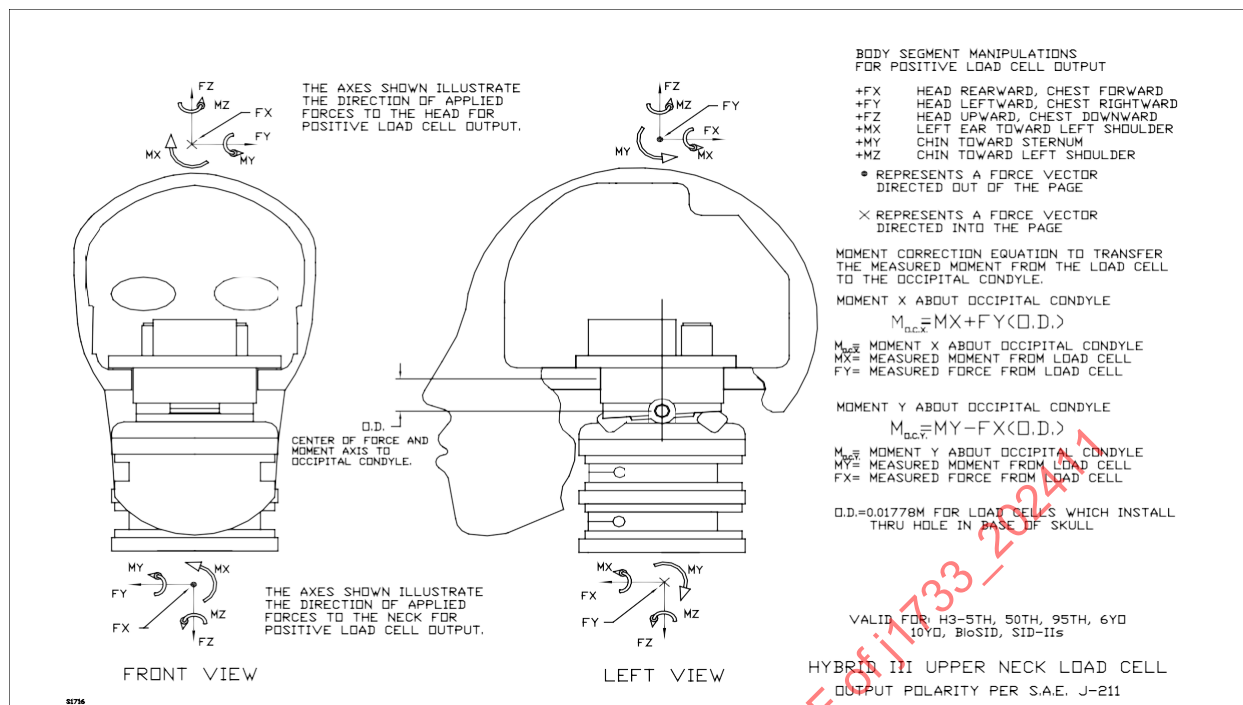


Figure 11 - Upper neck load cell

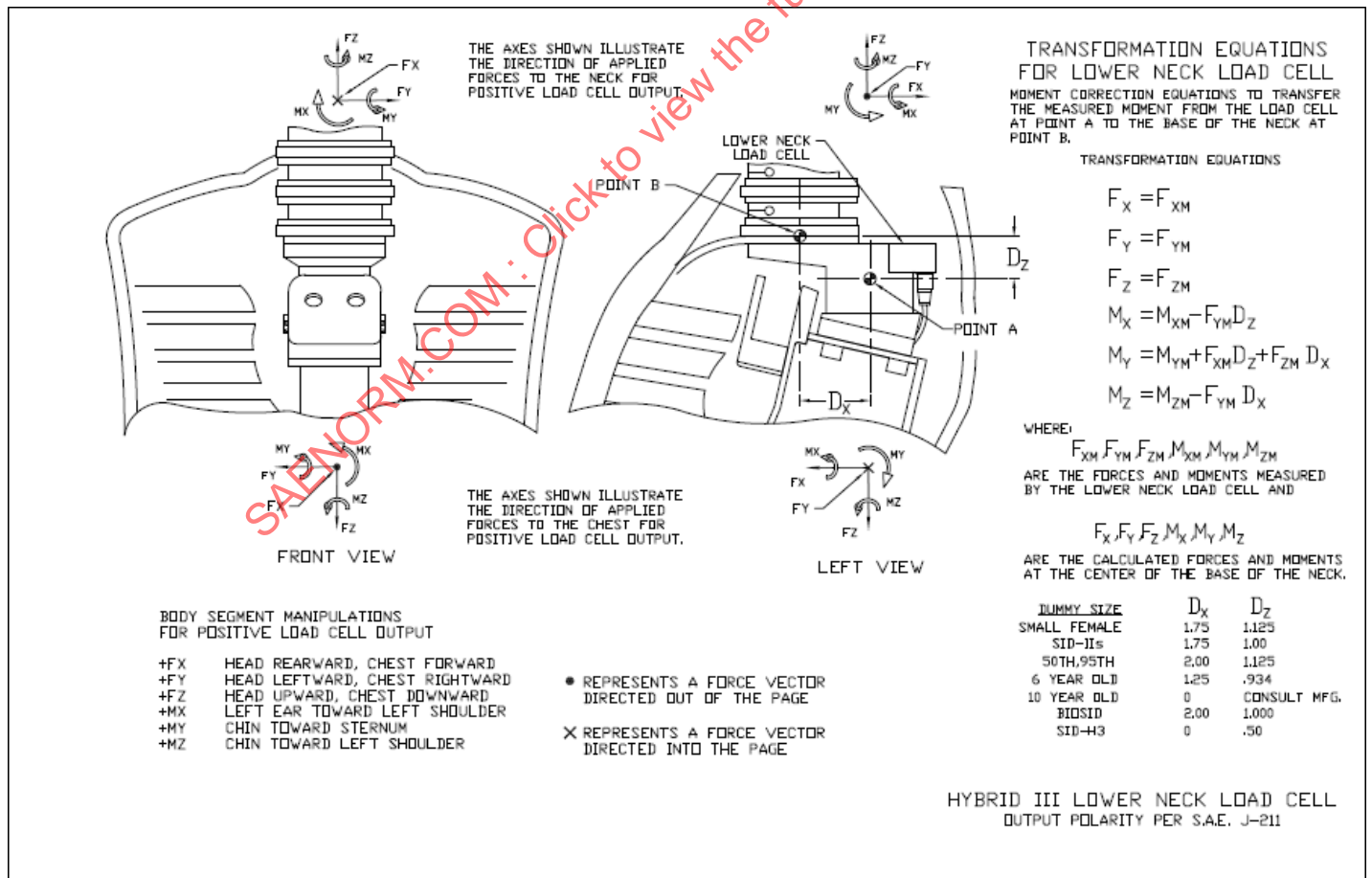


Figure 12 - Lower neck load cell

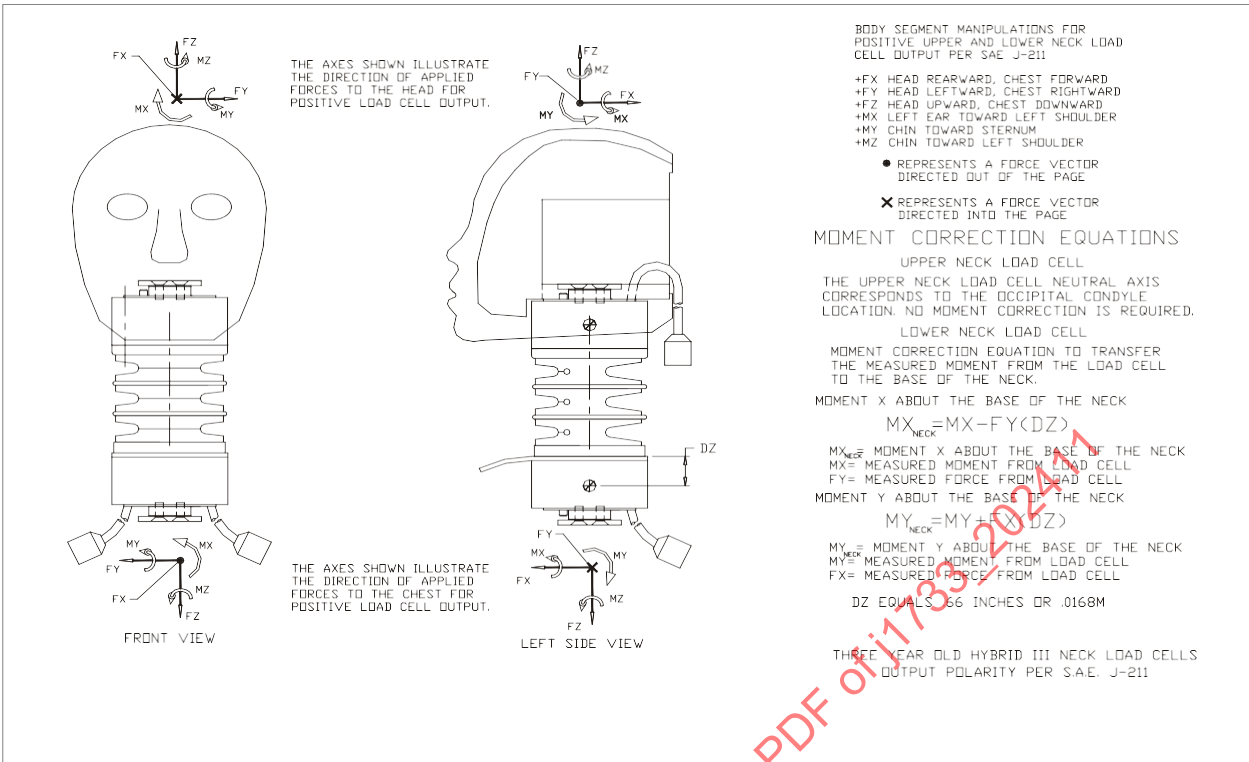


Figure 13 - Neck load cells

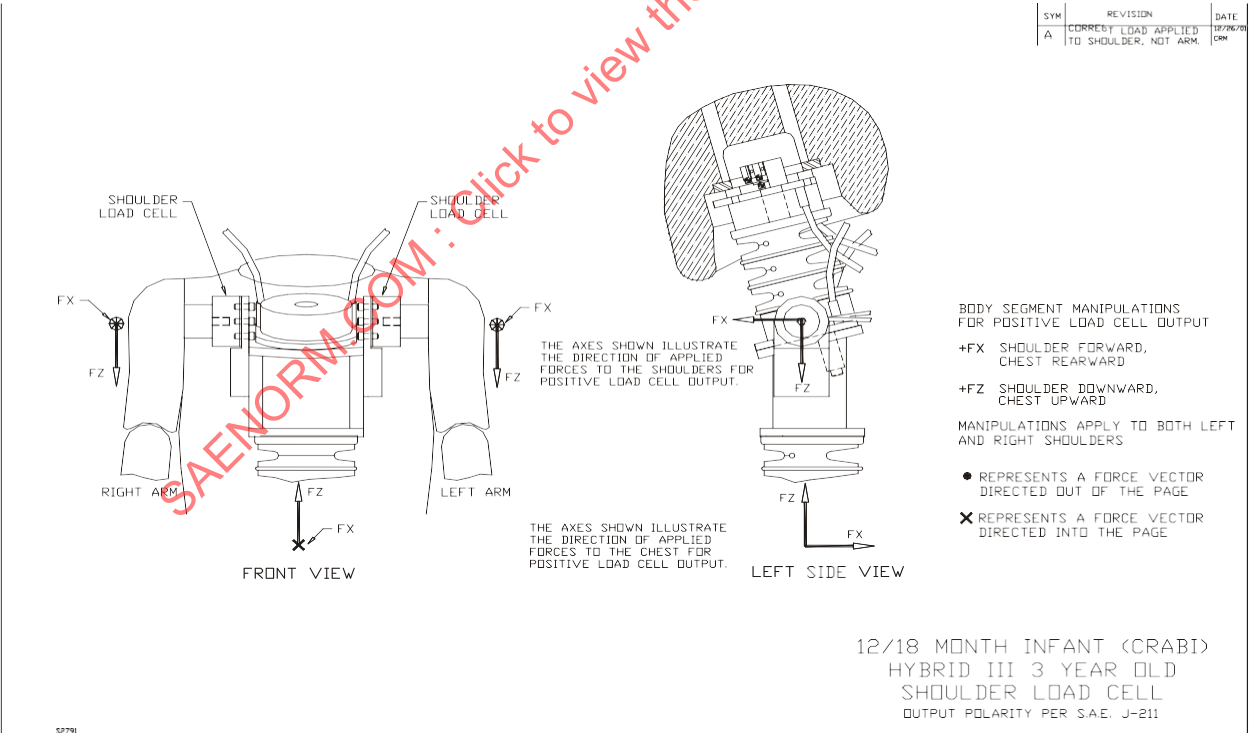


Figure 14 - Shoulder load cells

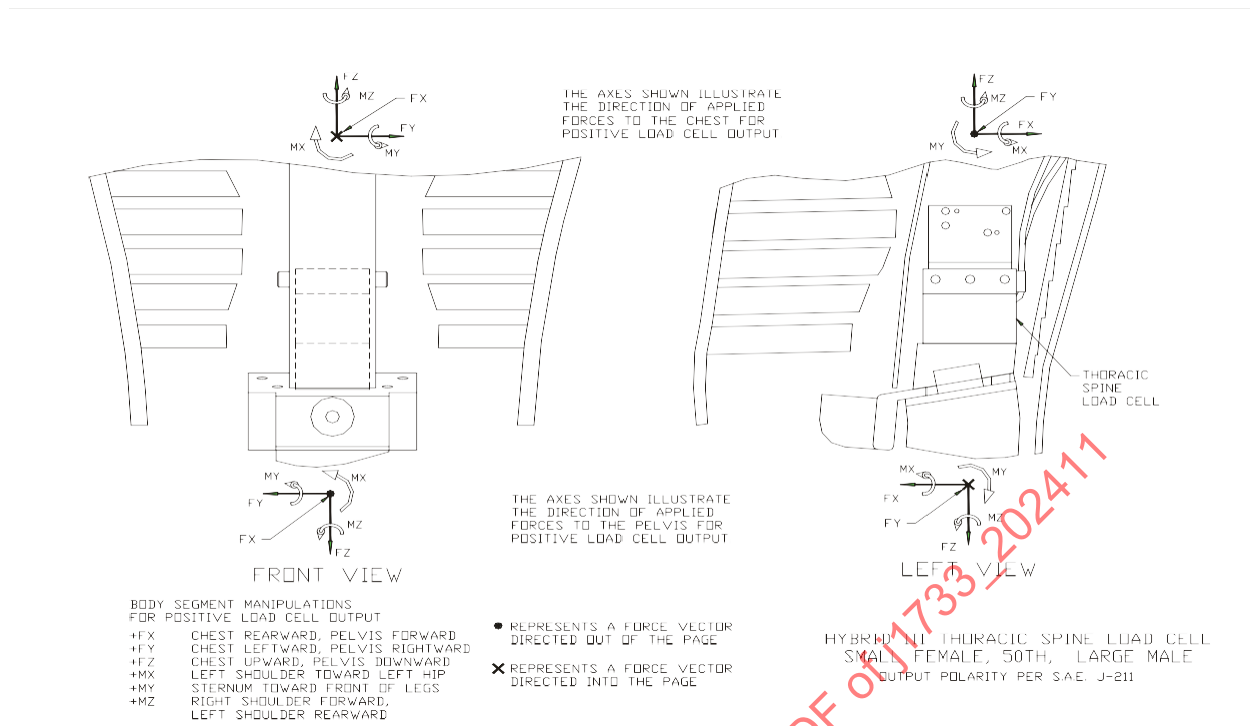


Figure 15 - Lower thoracic spine load cell

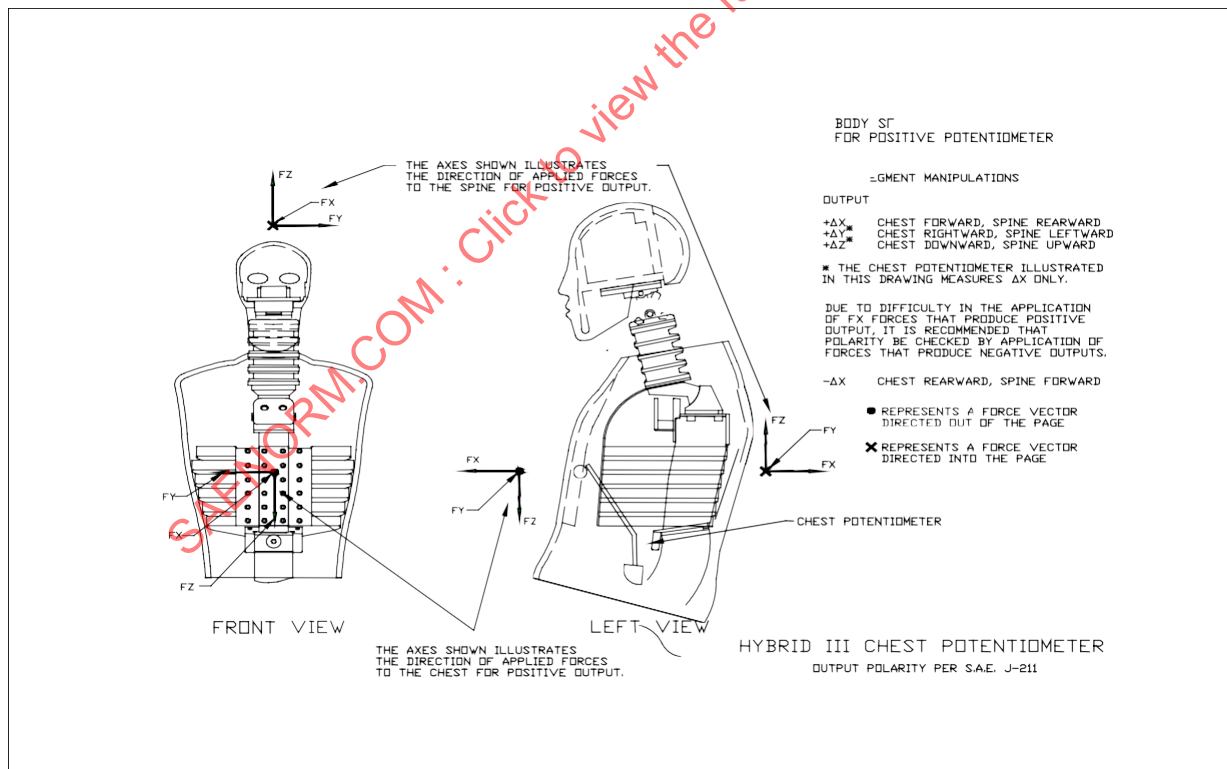


Figure 16 - Chest deflection transducer

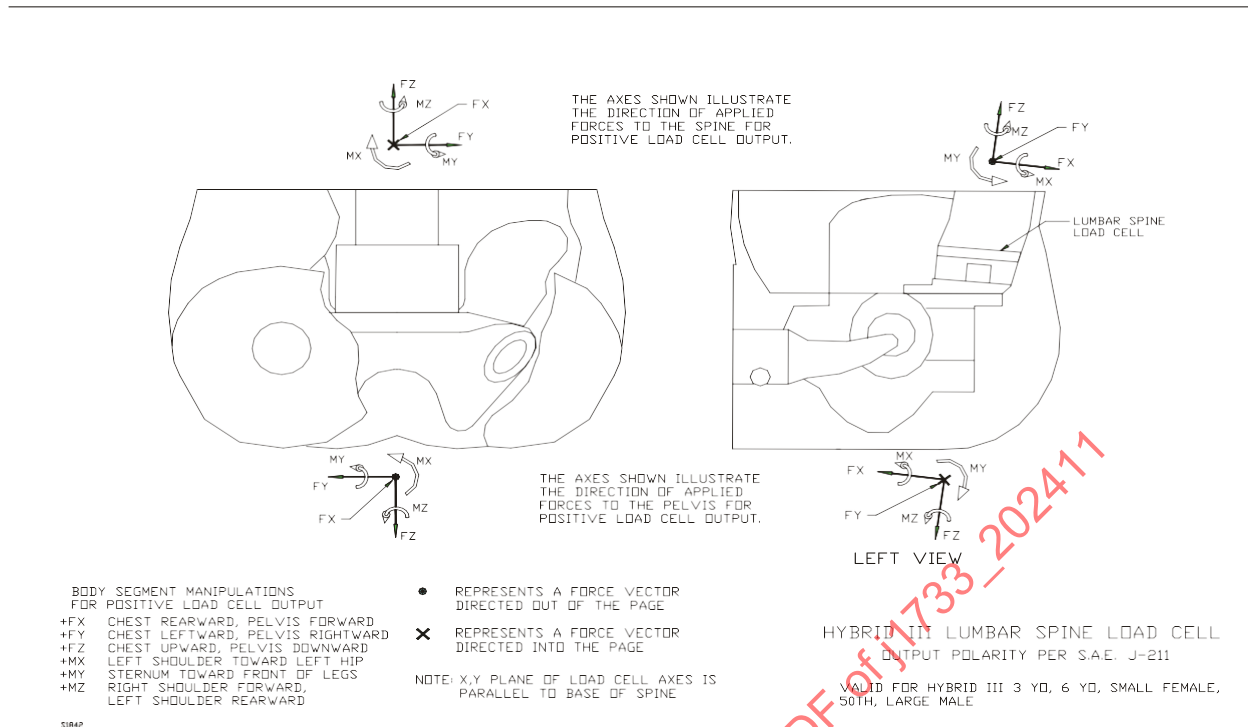


Figure 17 - Lower lumbar spine load cell

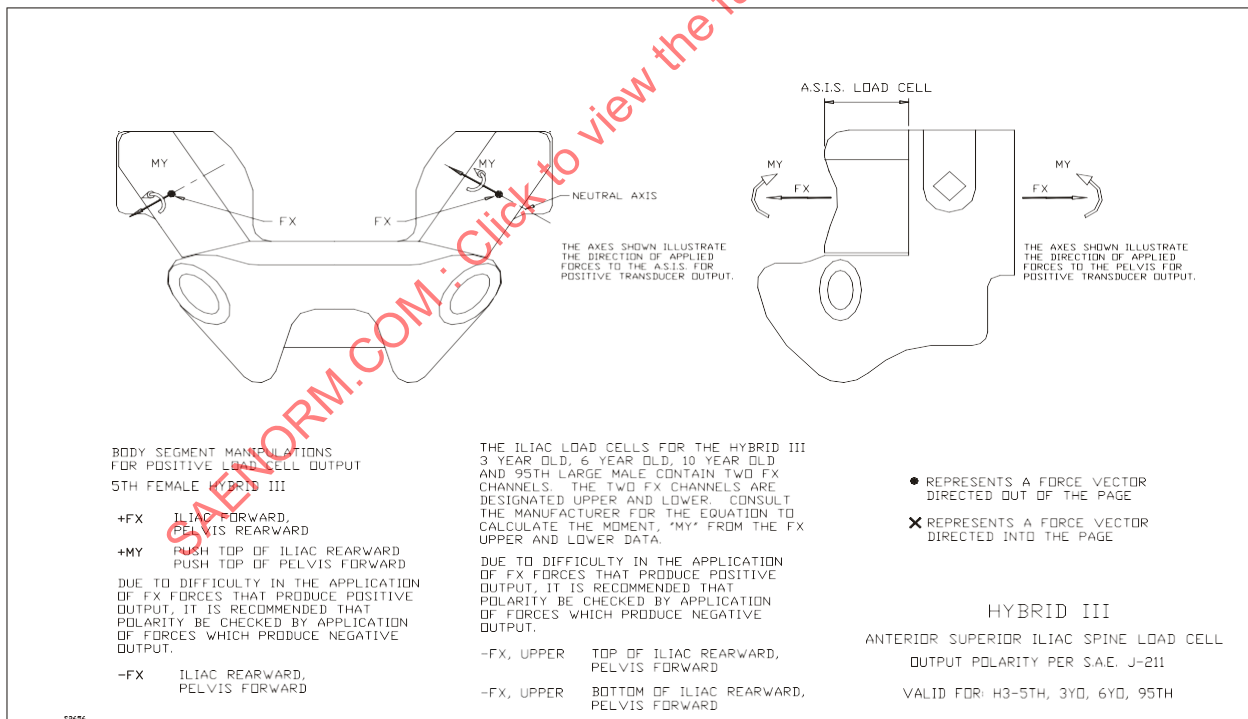


Figure 18 - Iliac lap belt load cell

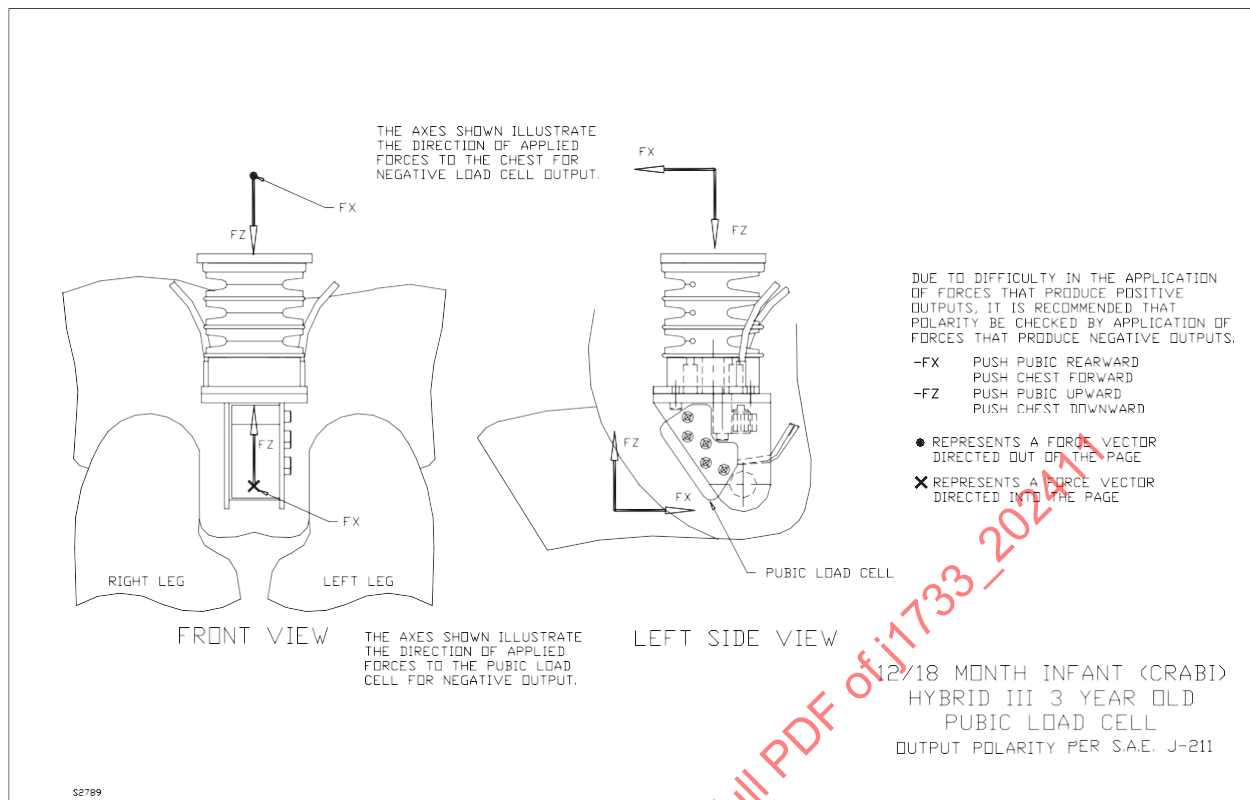


Figure 19 - Pubic load cell

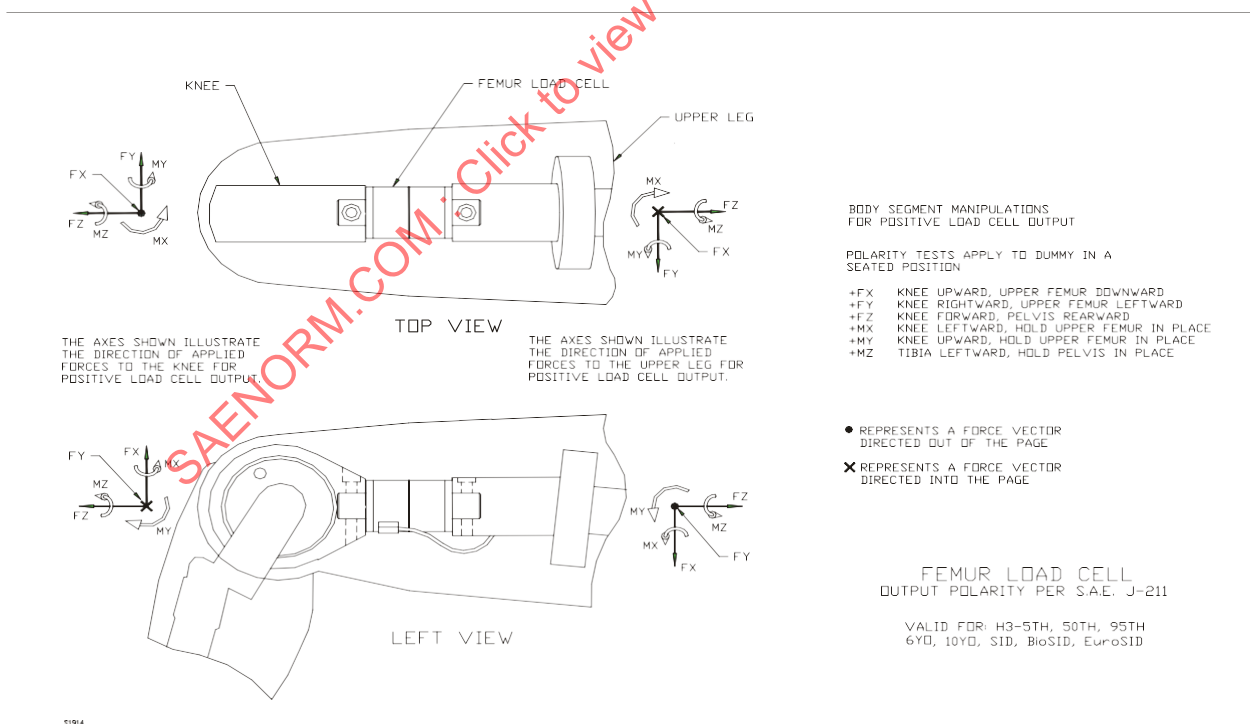


Figure 20 - Femur load cell

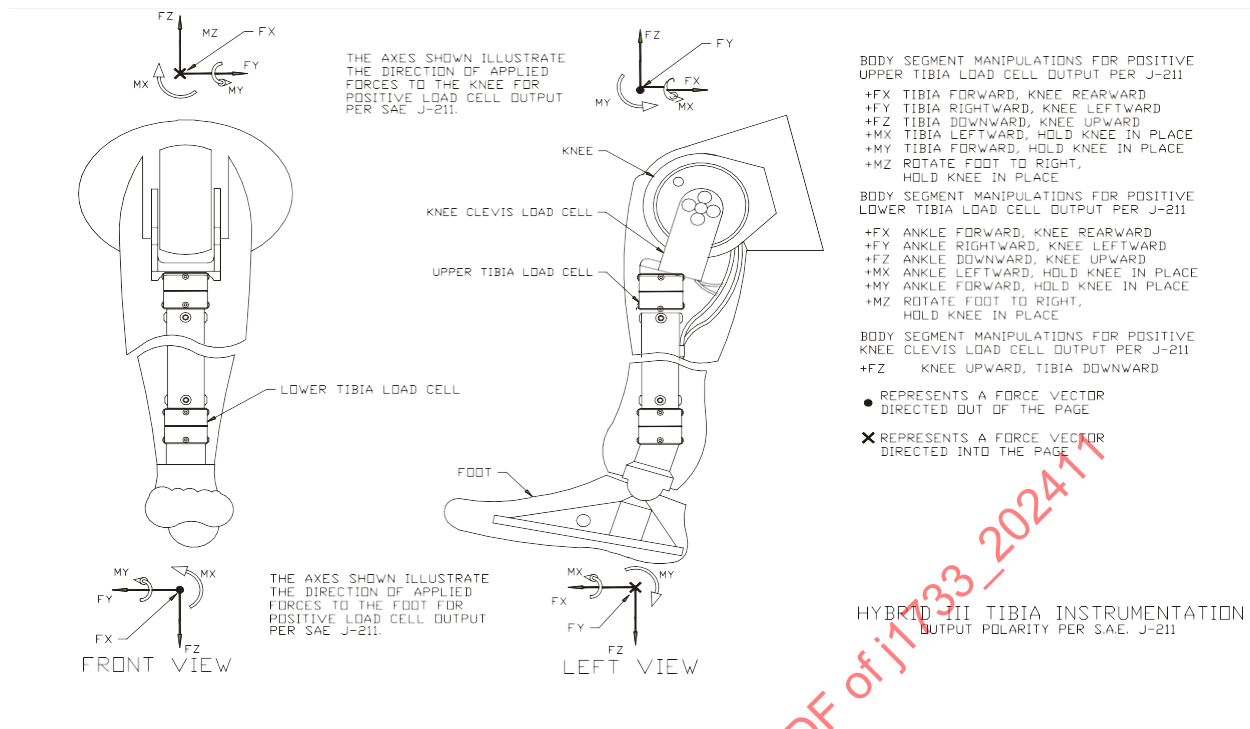


Figure 21 - Upper and lower tibia and knee clevis load cells

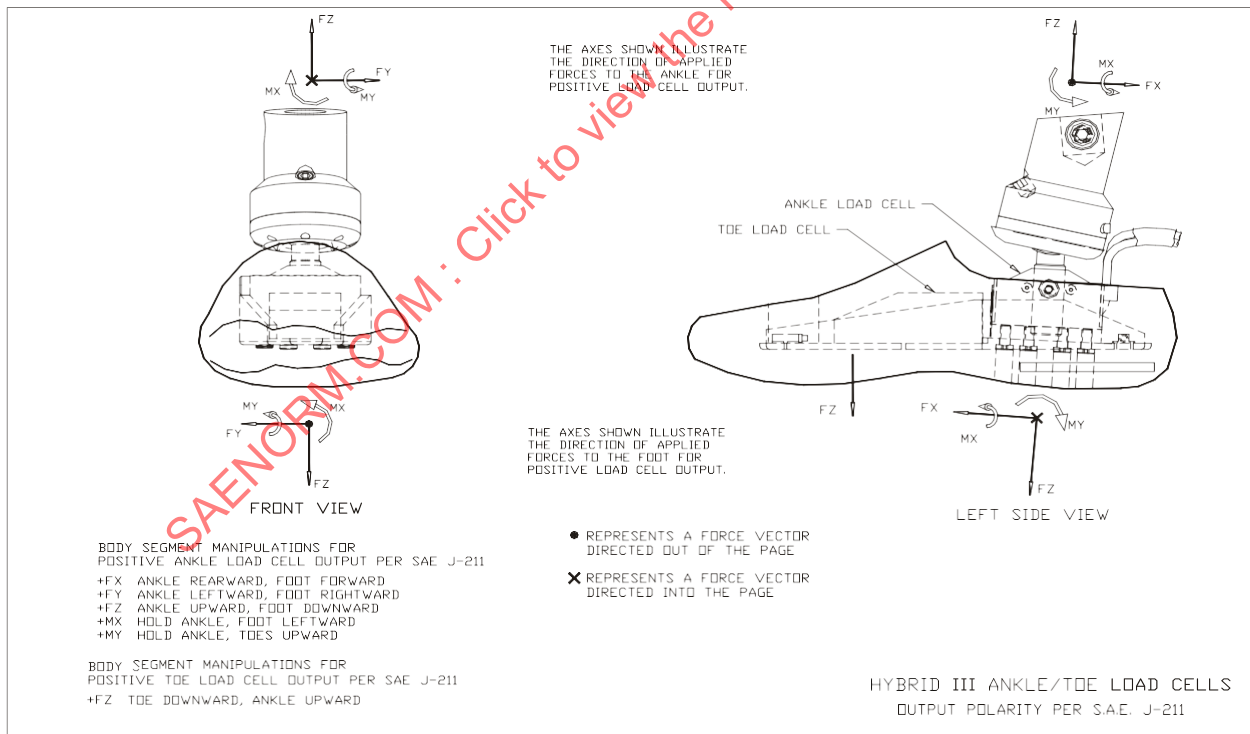


Figure 22 - Ankle/toe load cell

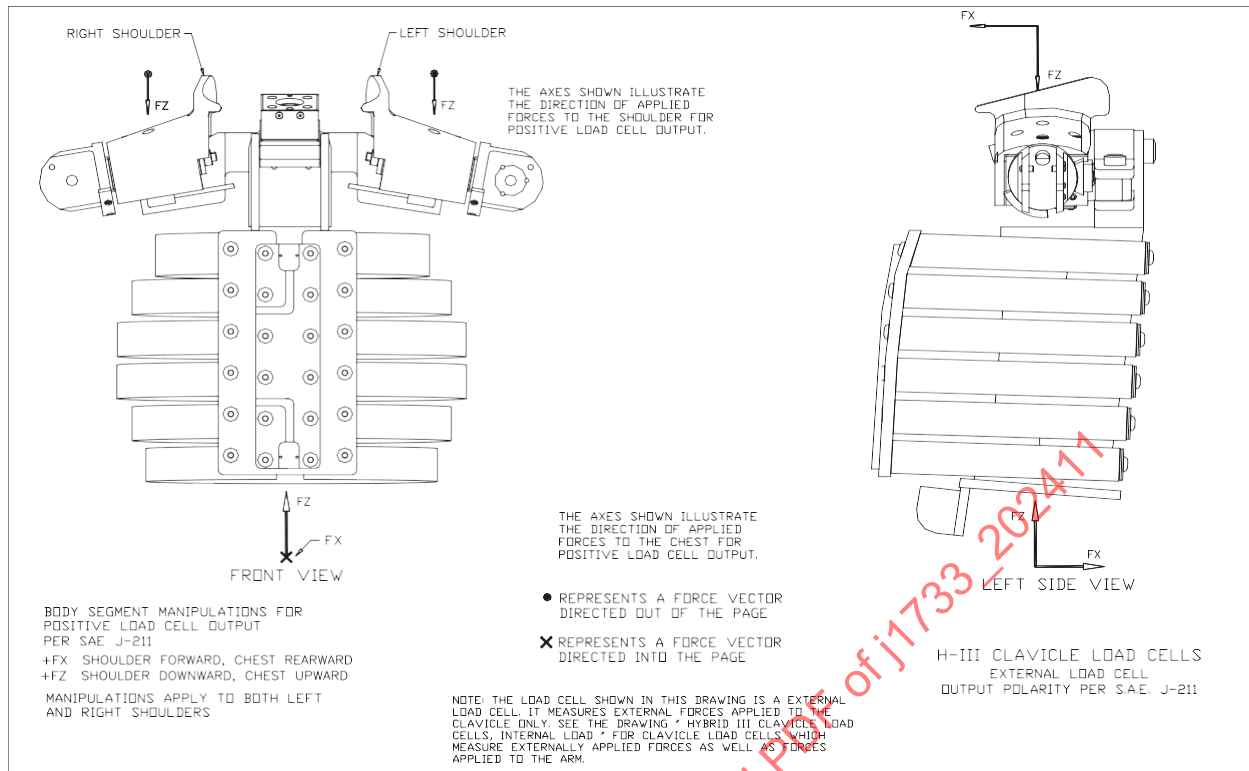


Figure 23 - Clavicle load cell, external

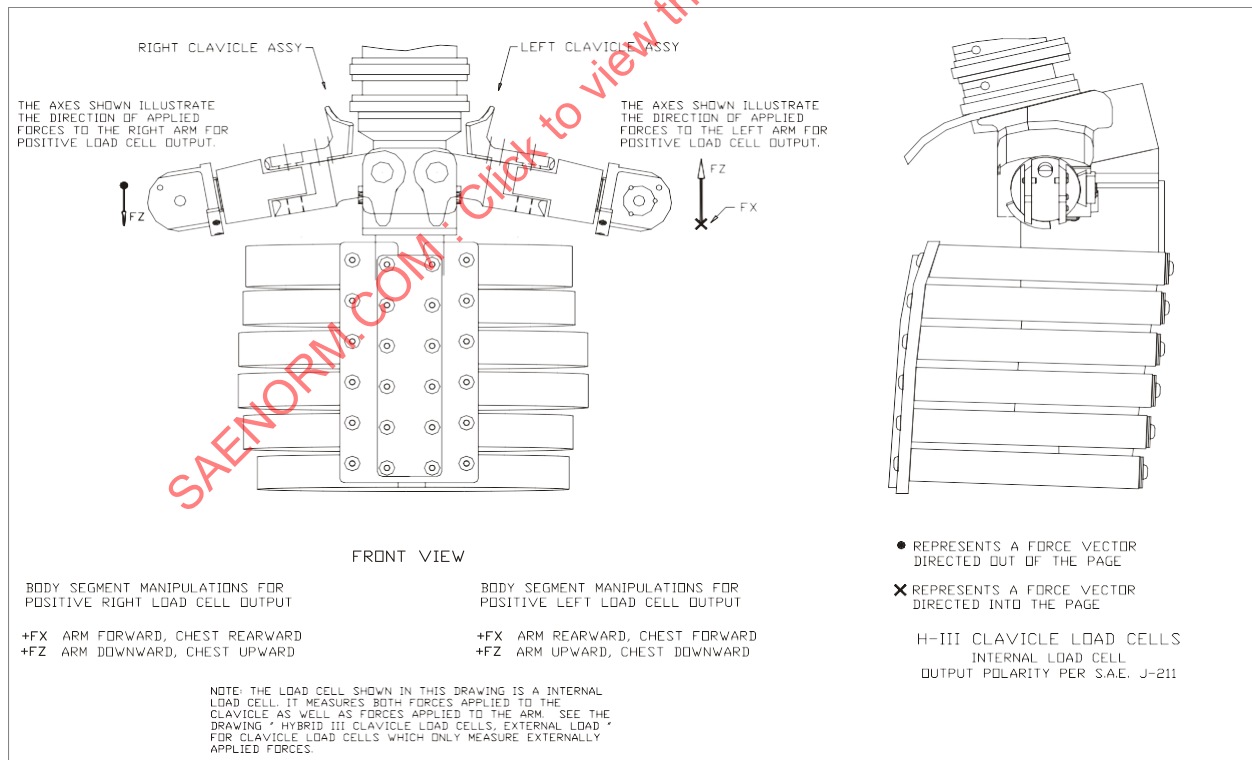


Figure 24 - Clavicle load cell, internal

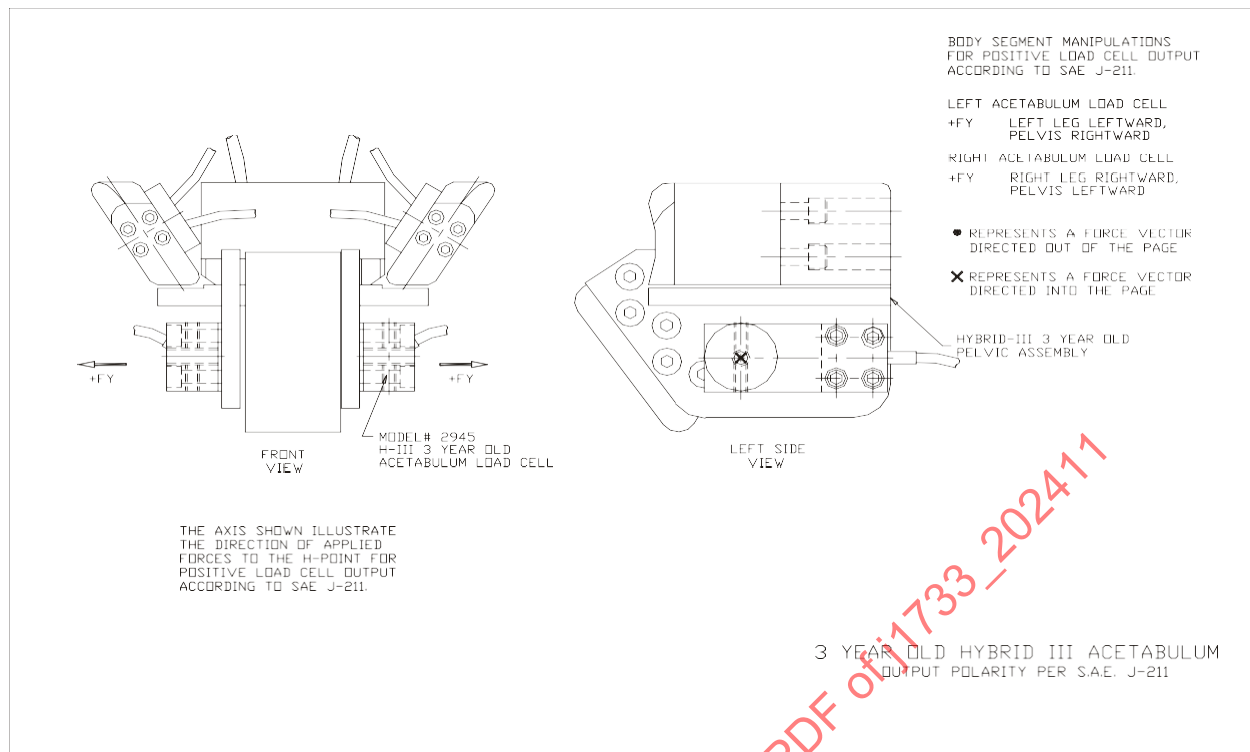
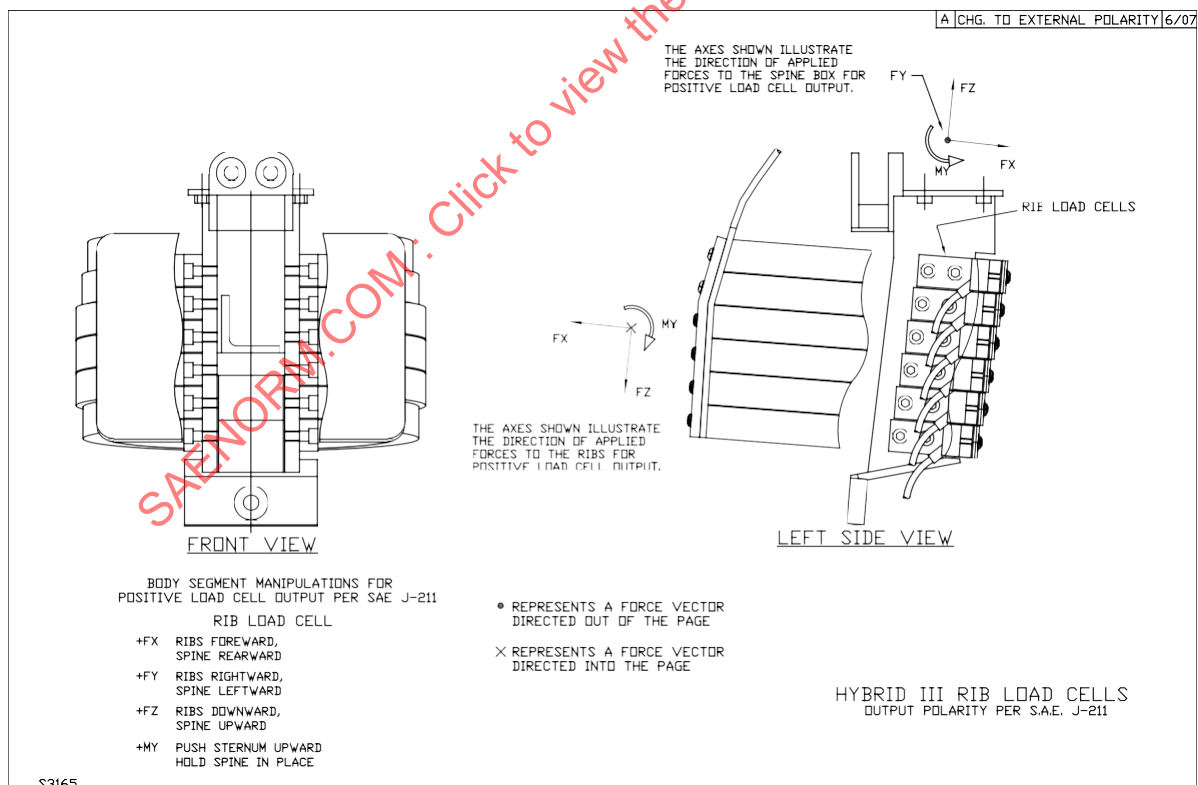


Figure 25 - Acetabulum load cell



S3165

Figure 26 - Rib load cells

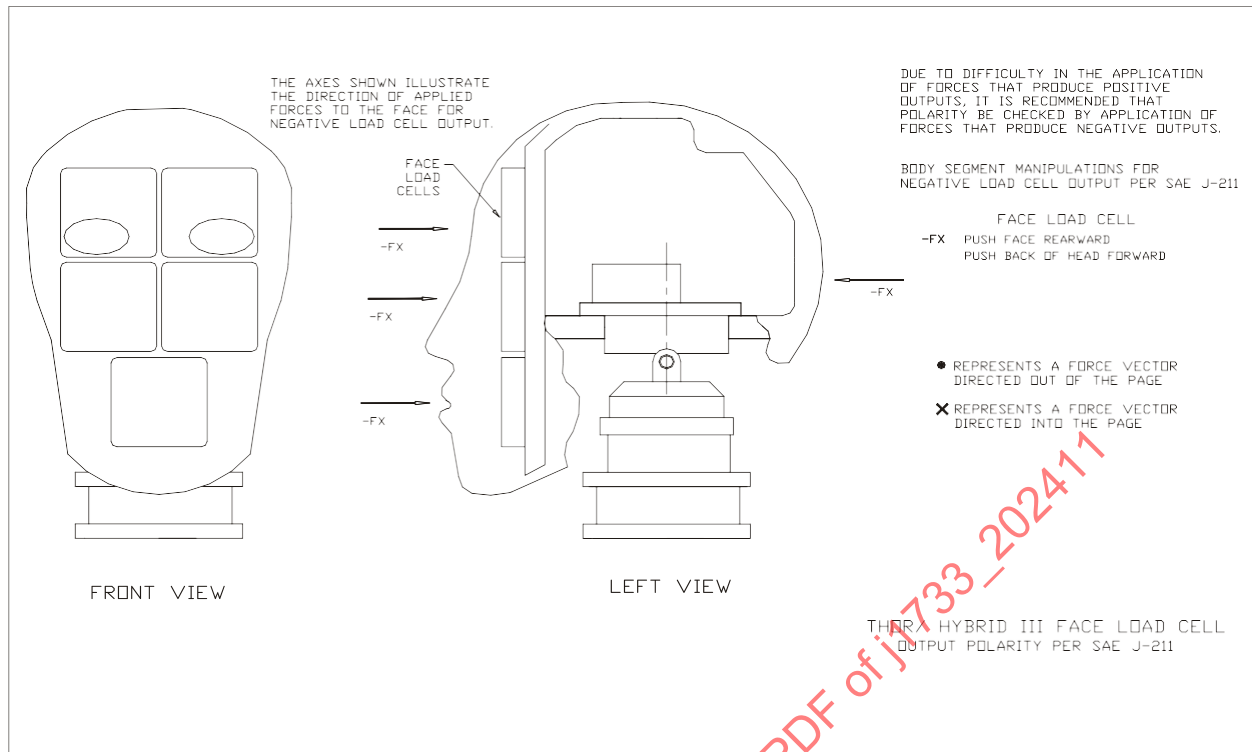


Figure 27 - Face load cell

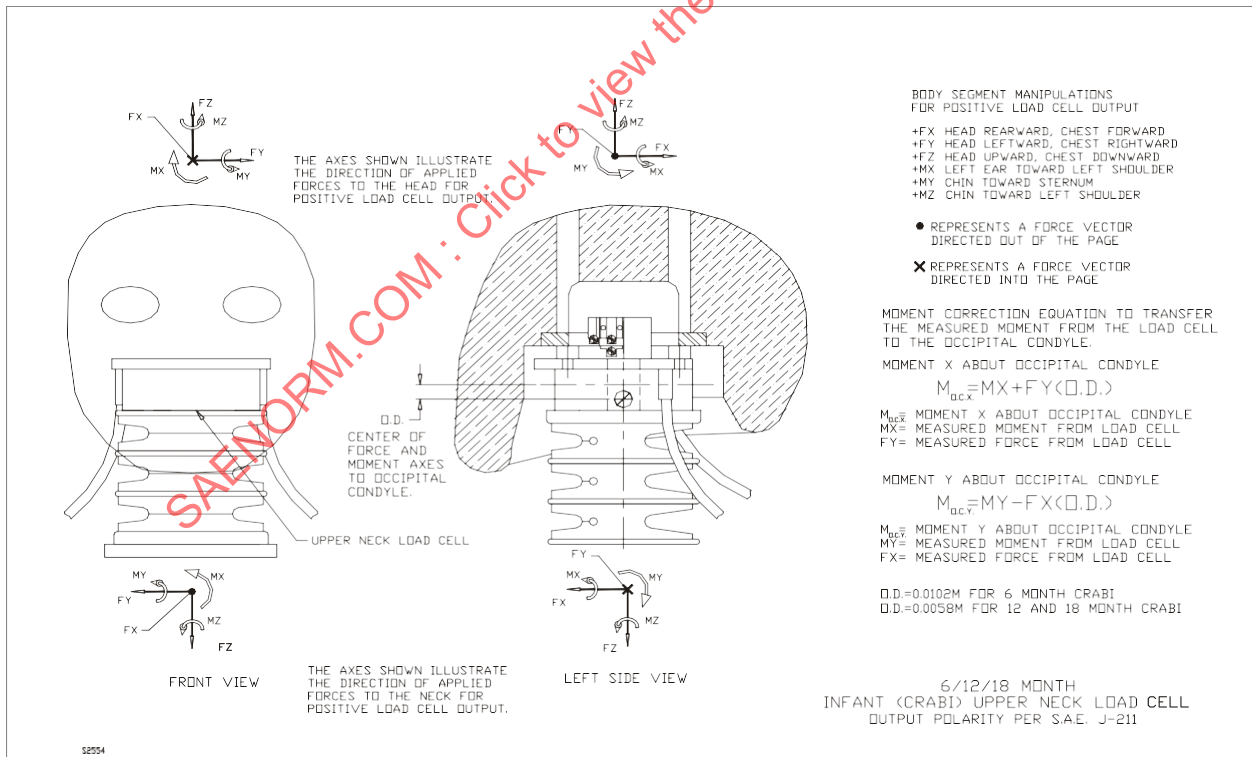


Figure 28 - Upper neck load cell

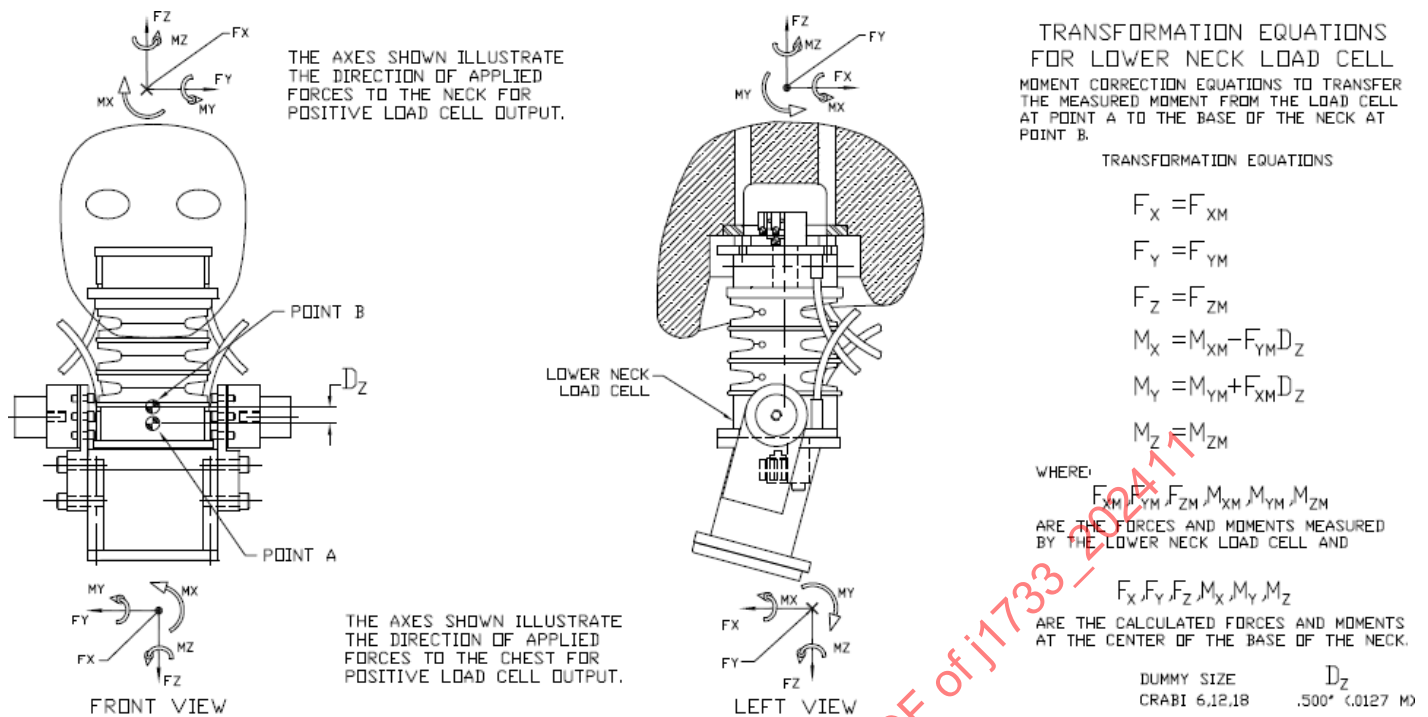


Figure 29 - Lower neck load cell

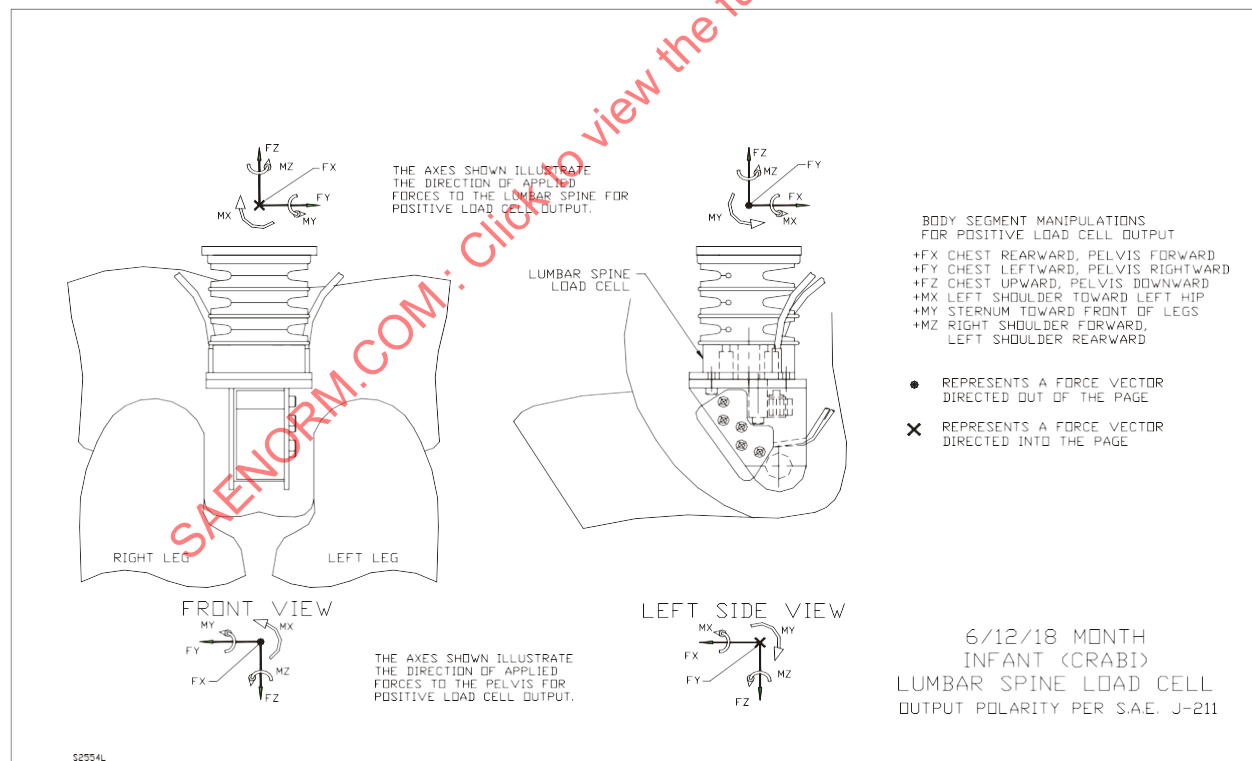


Figure 30 - Lower lumbar spine load cell

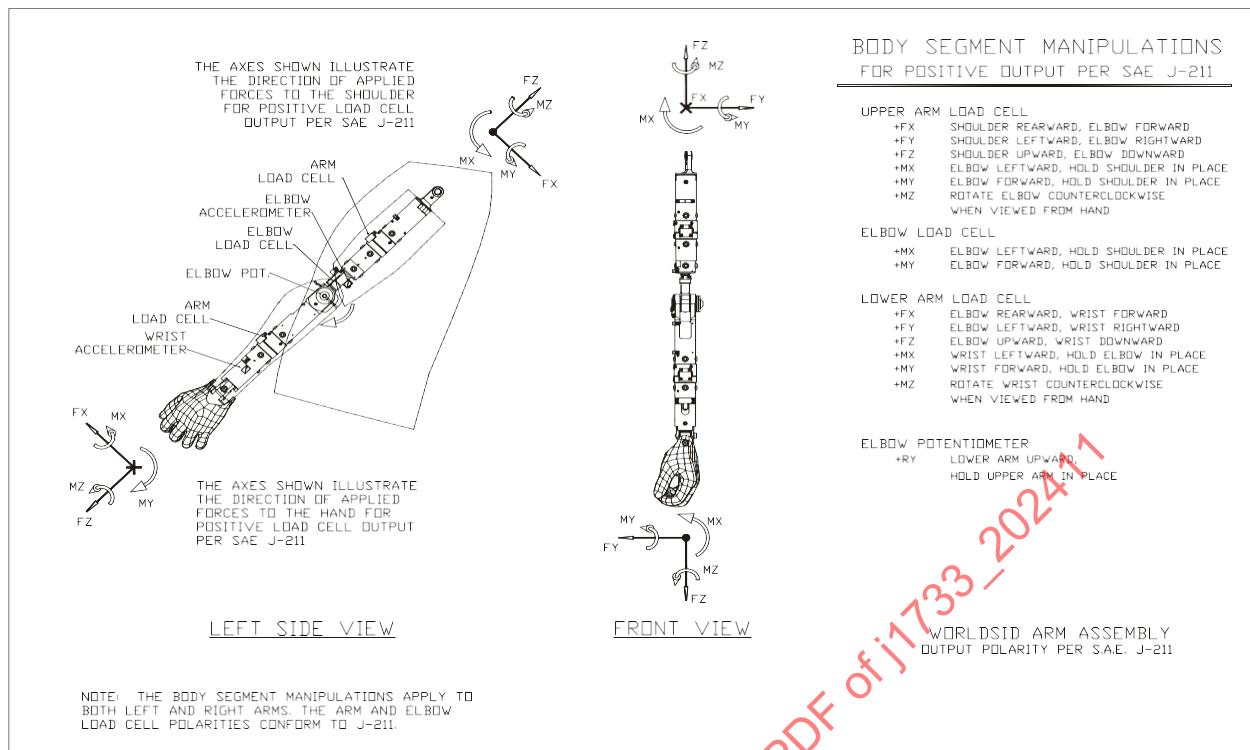


Figure 31 - Upper and lower arm and elbow load cells

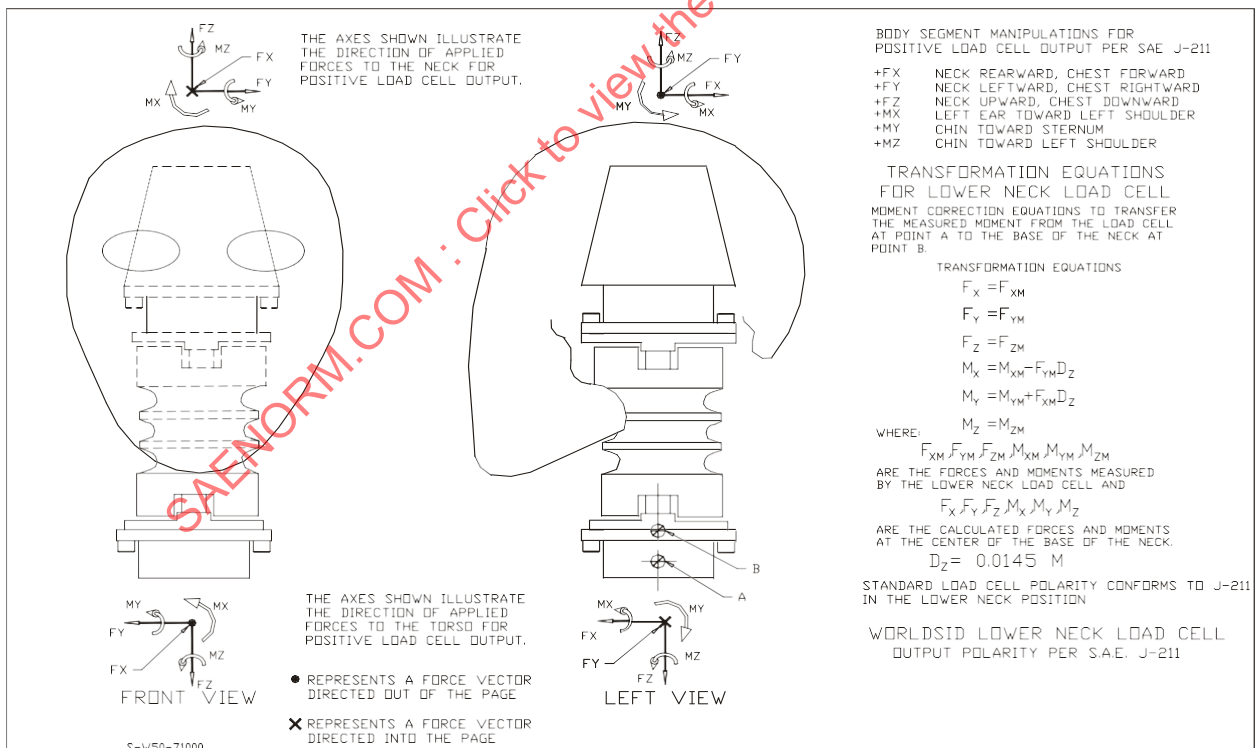


Figure 32 - Lower neck load cell

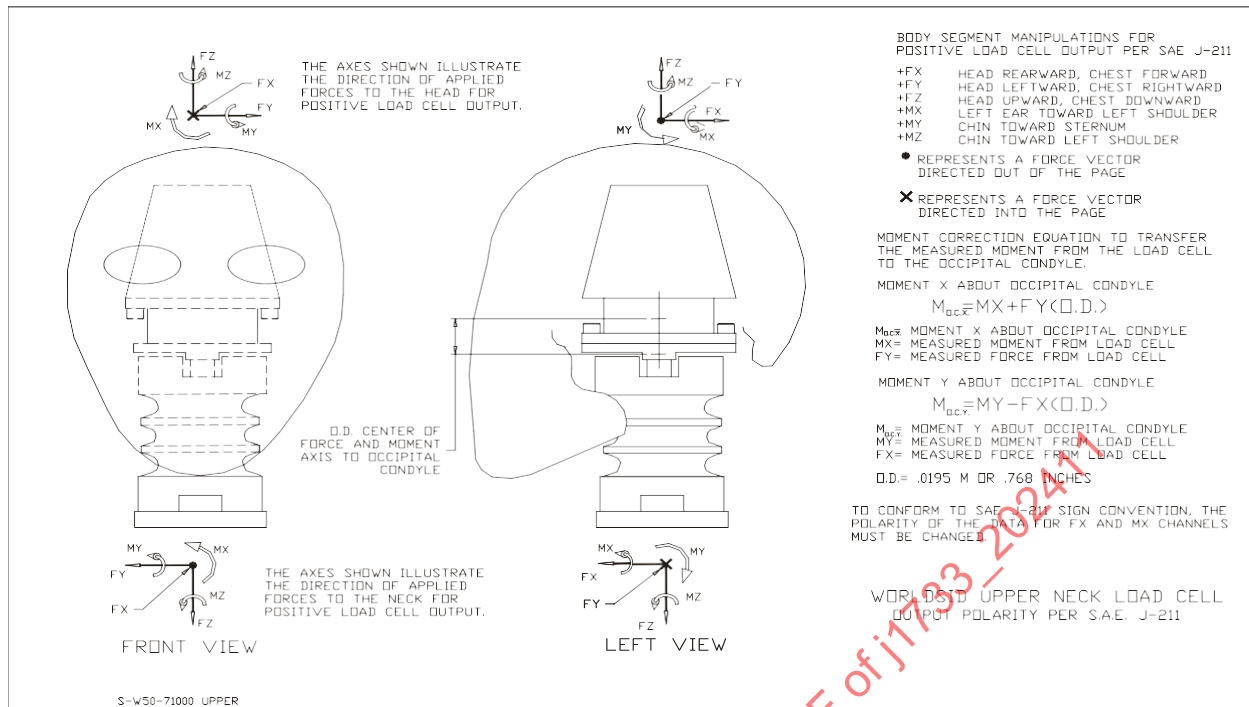


Figure 33 - Upper neck load cell

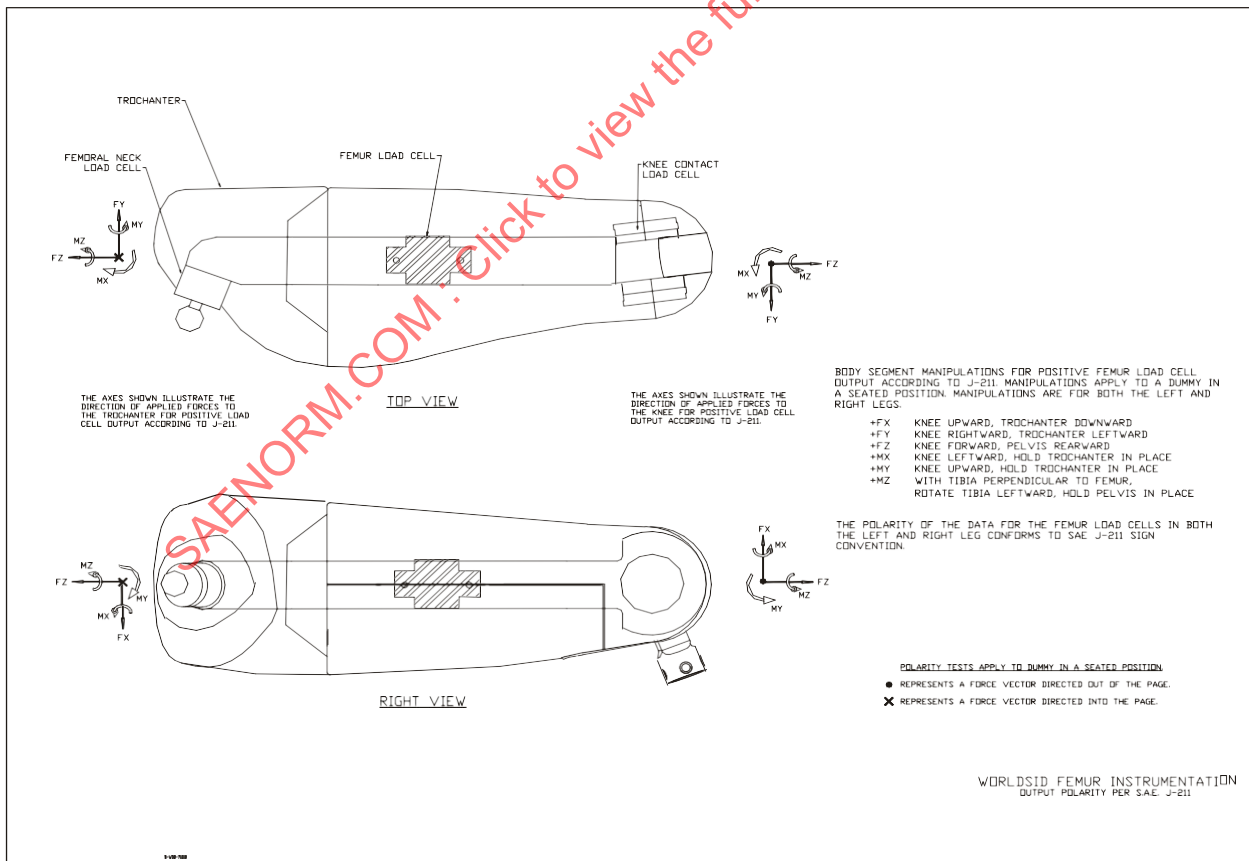


Figure 34 - Femur load cell

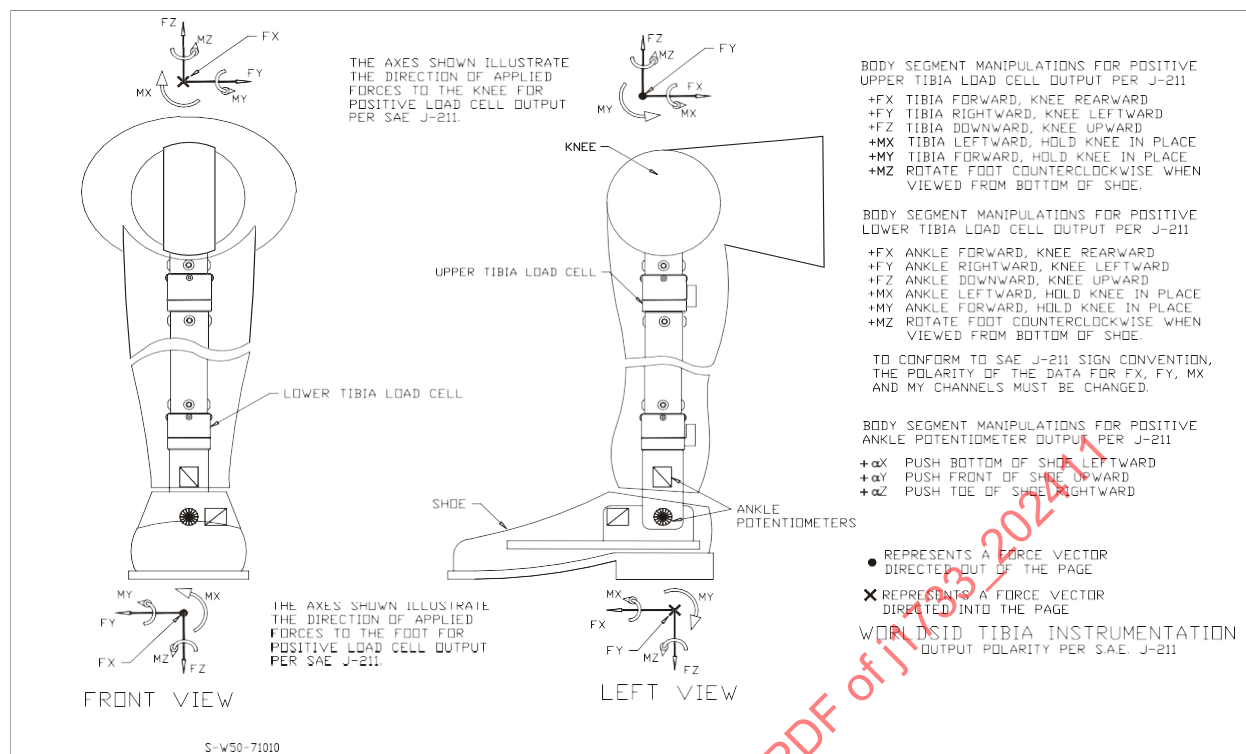


Figure 35 - Upper and lower tibia load cells

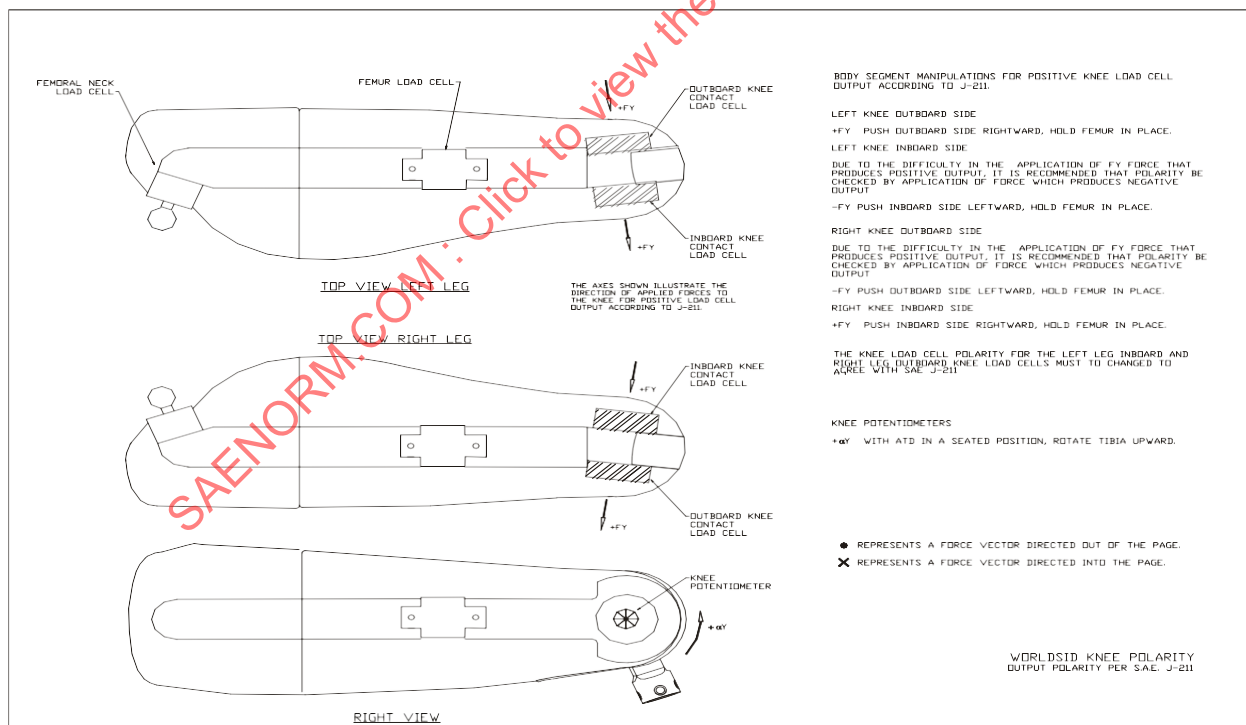


Figure 36 - Knee load cell polarities

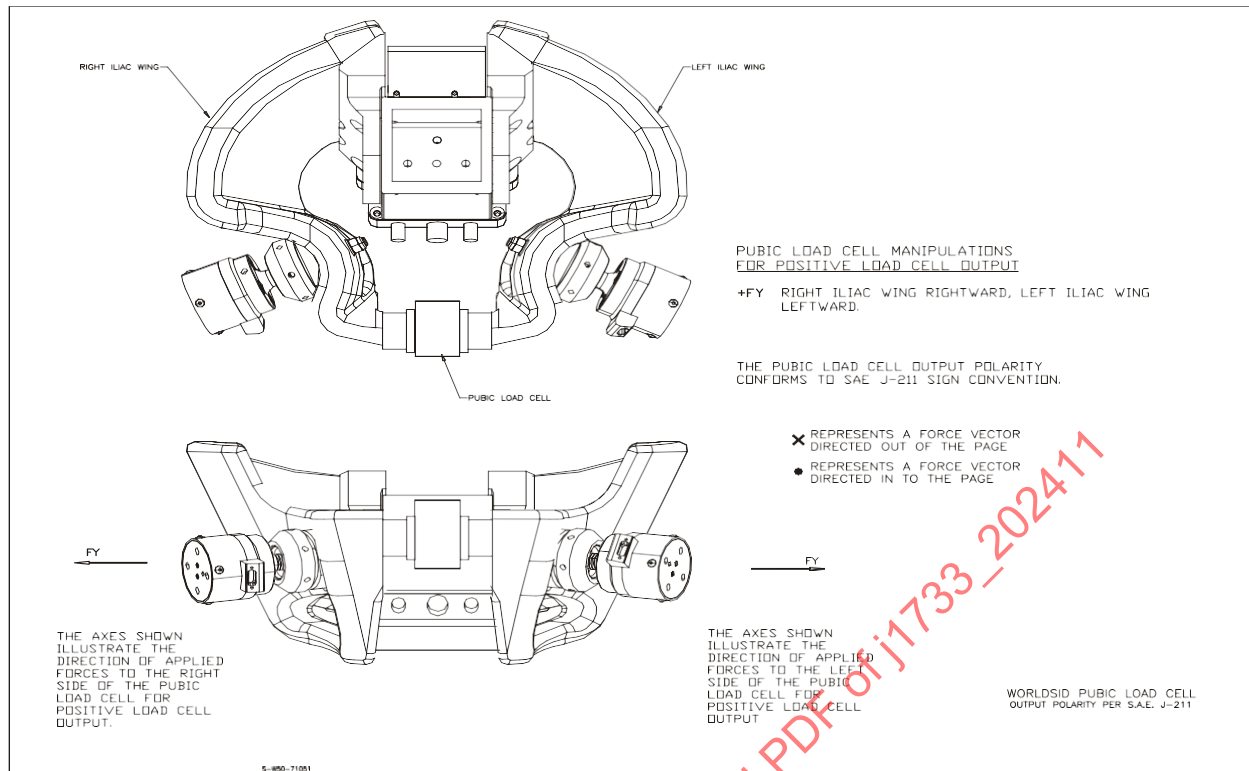


Figure 37 - Pubic load cell

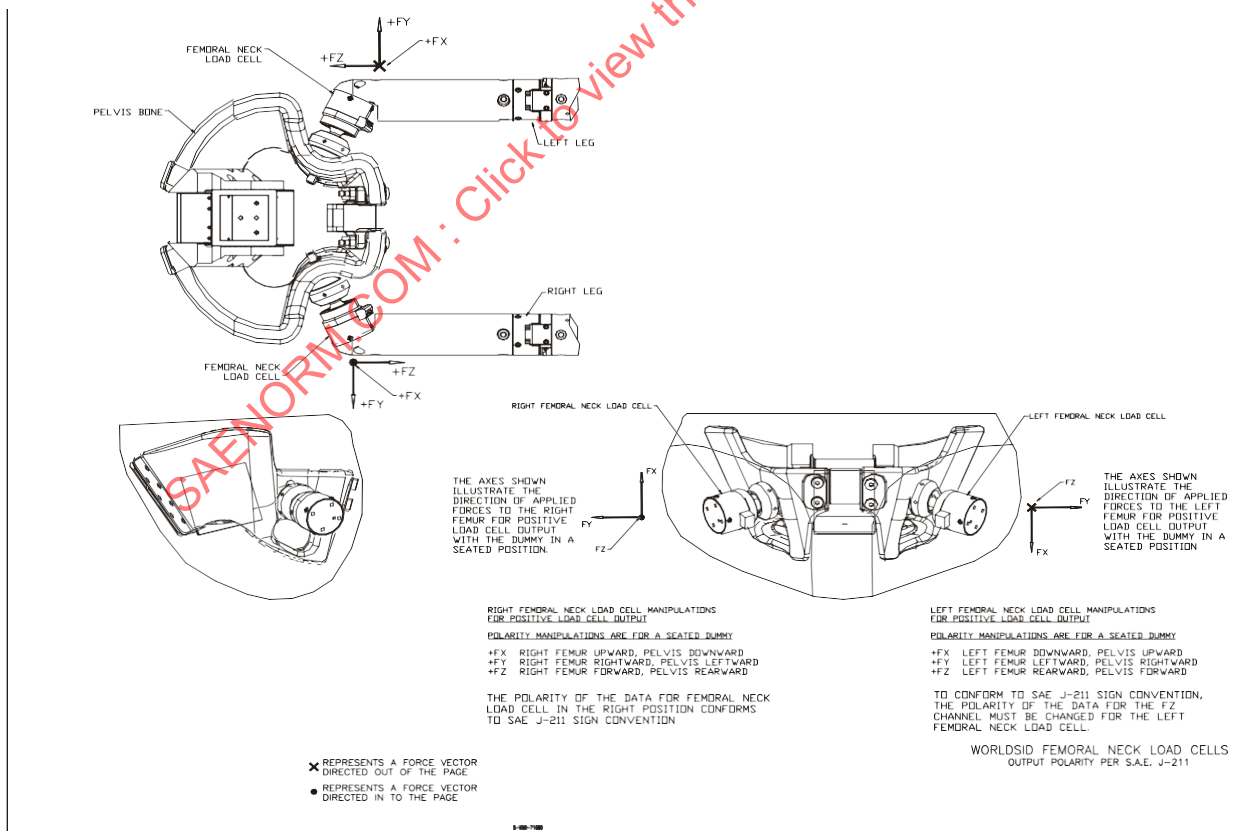


Figure 38 - Femoral neck load cells

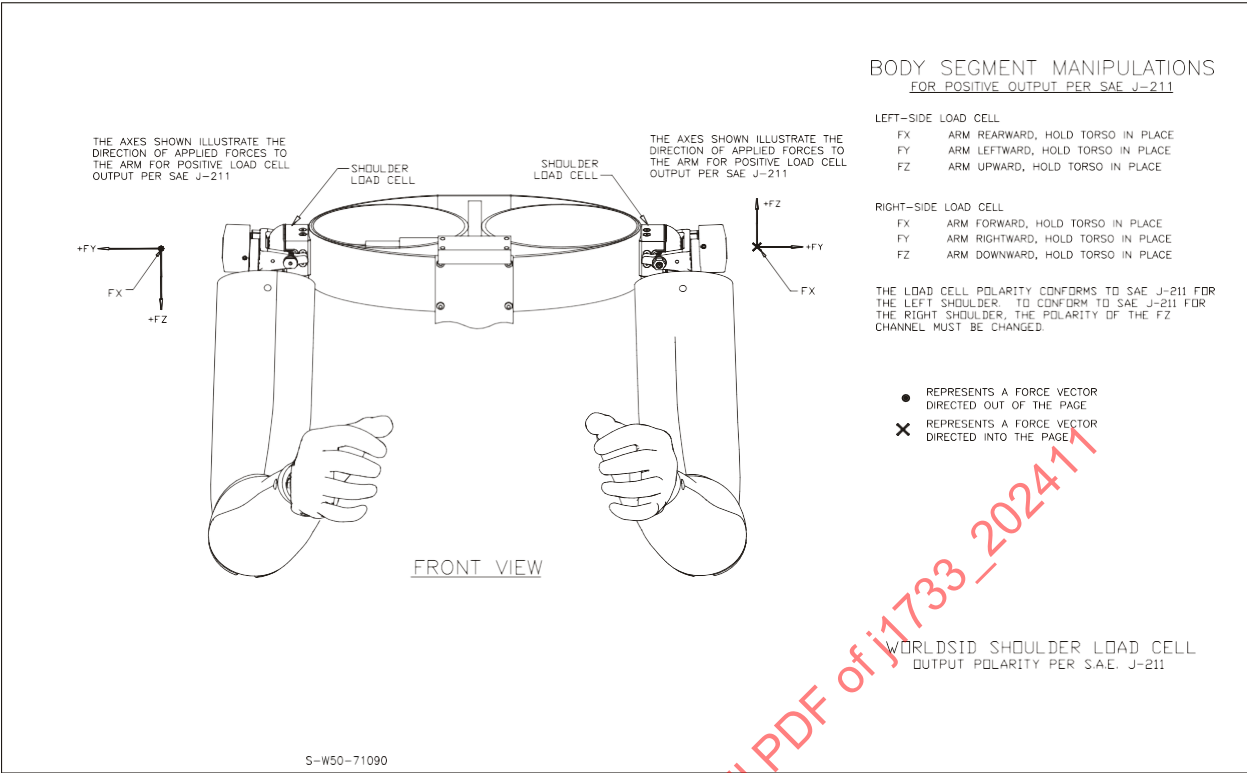


Figure 39 - Shoulder load cell

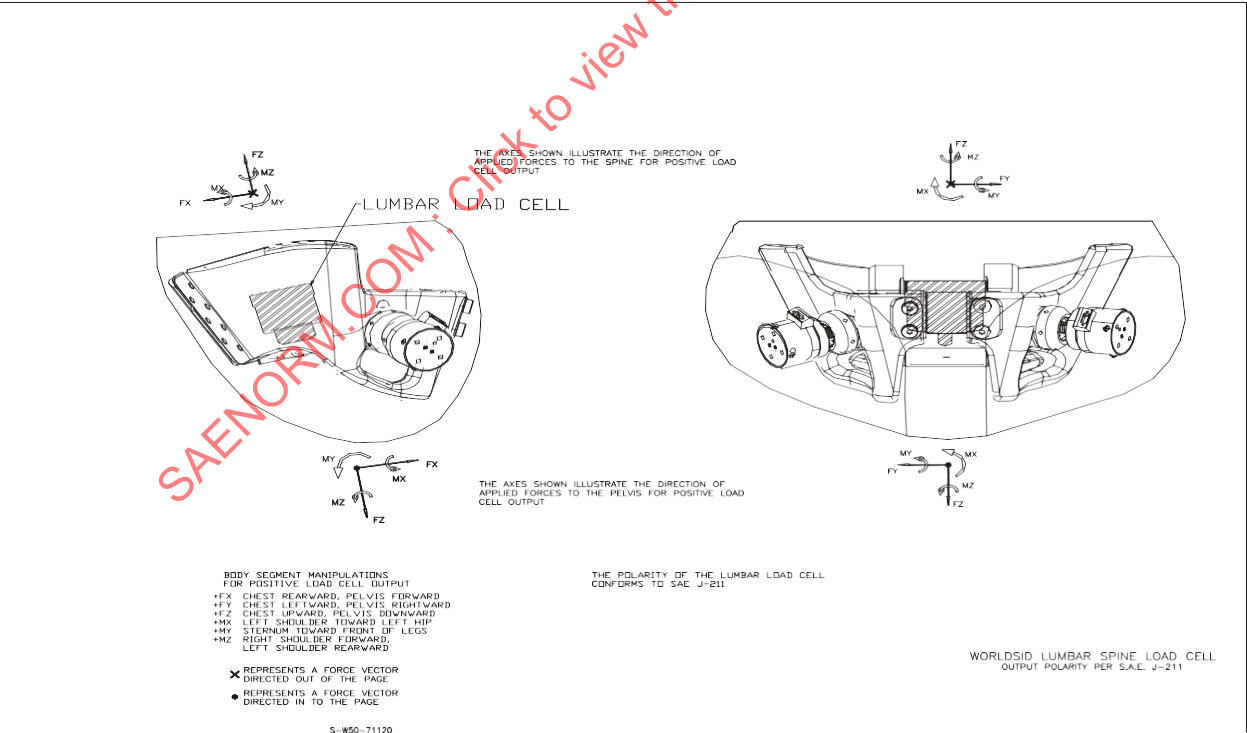


Figure 40 - Lumbar spine load cell

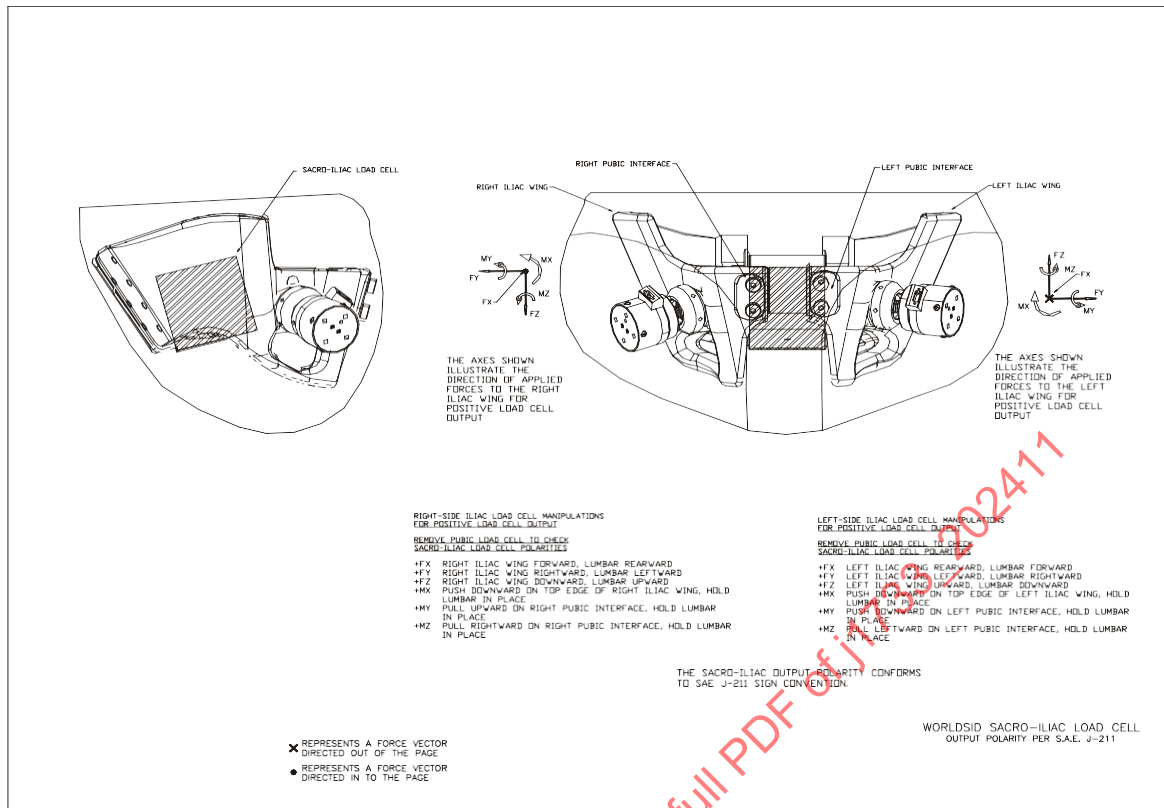


Figure 41 - Sacro-iliac load cell

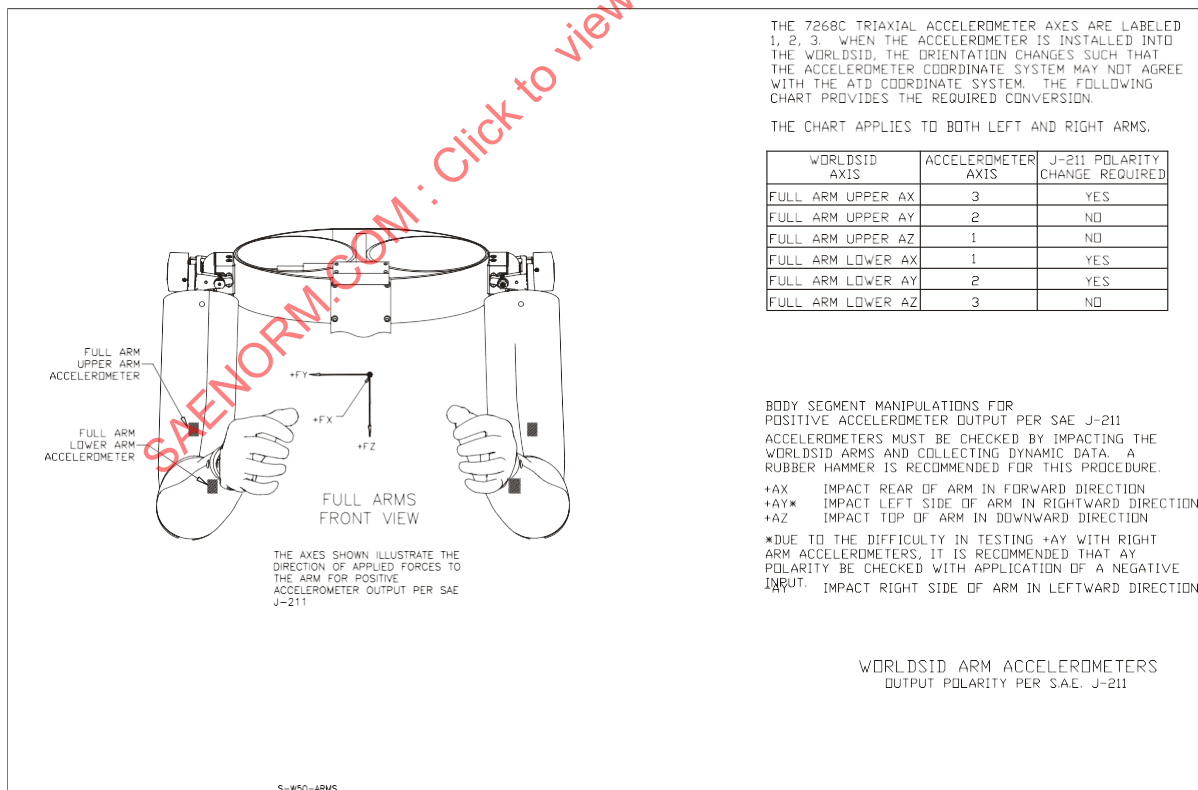


Figure 42 - Arm accelerometers

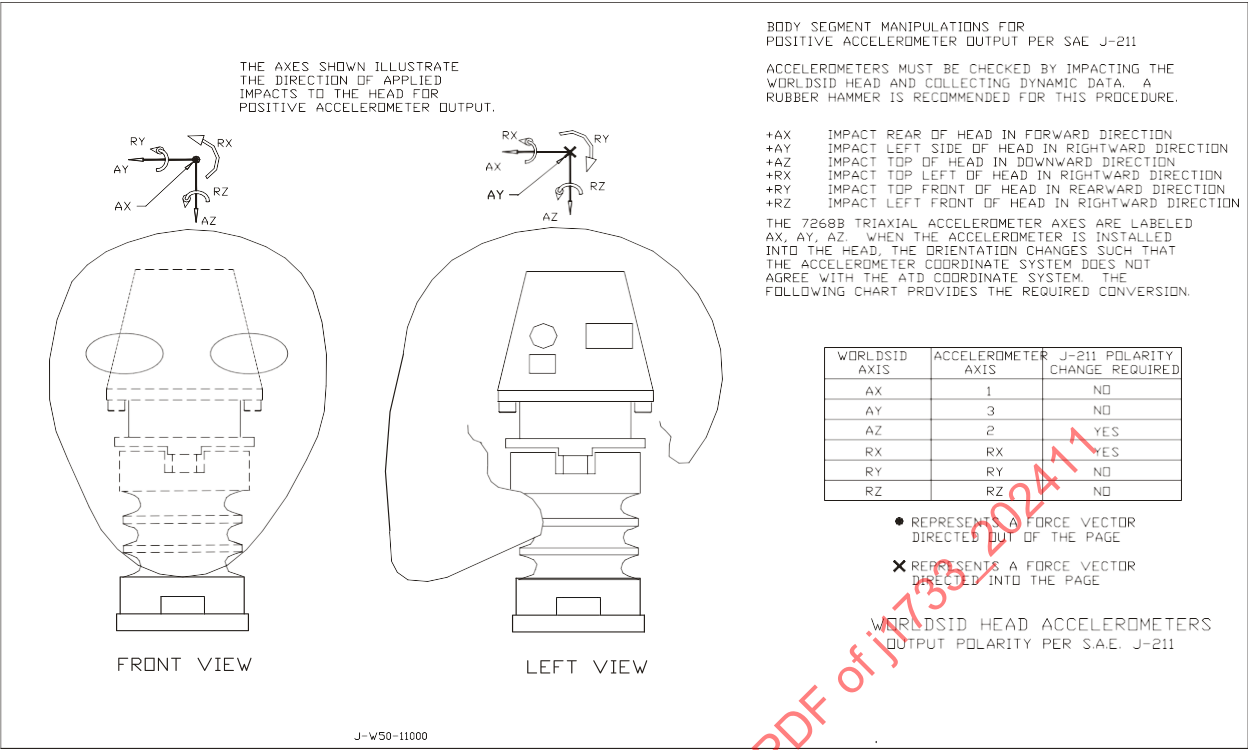


Figure 43 - Head accelerometers

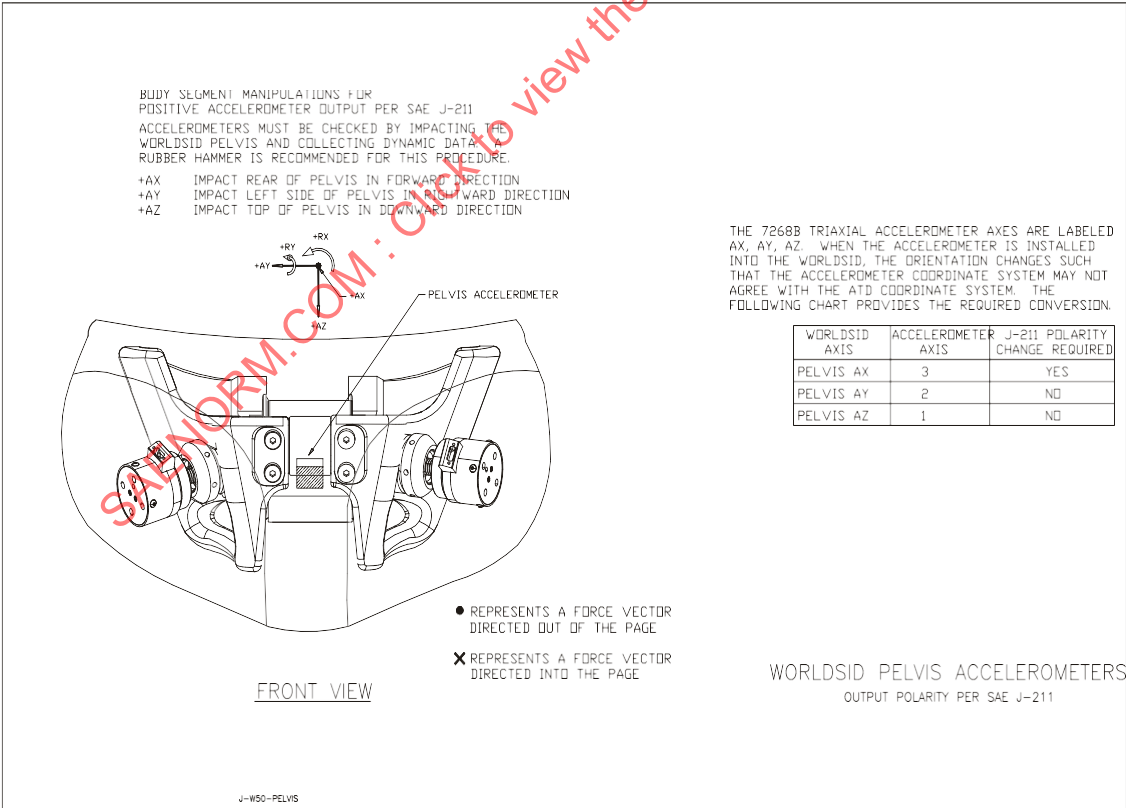


Figure 44 - Pelvis accelerometers

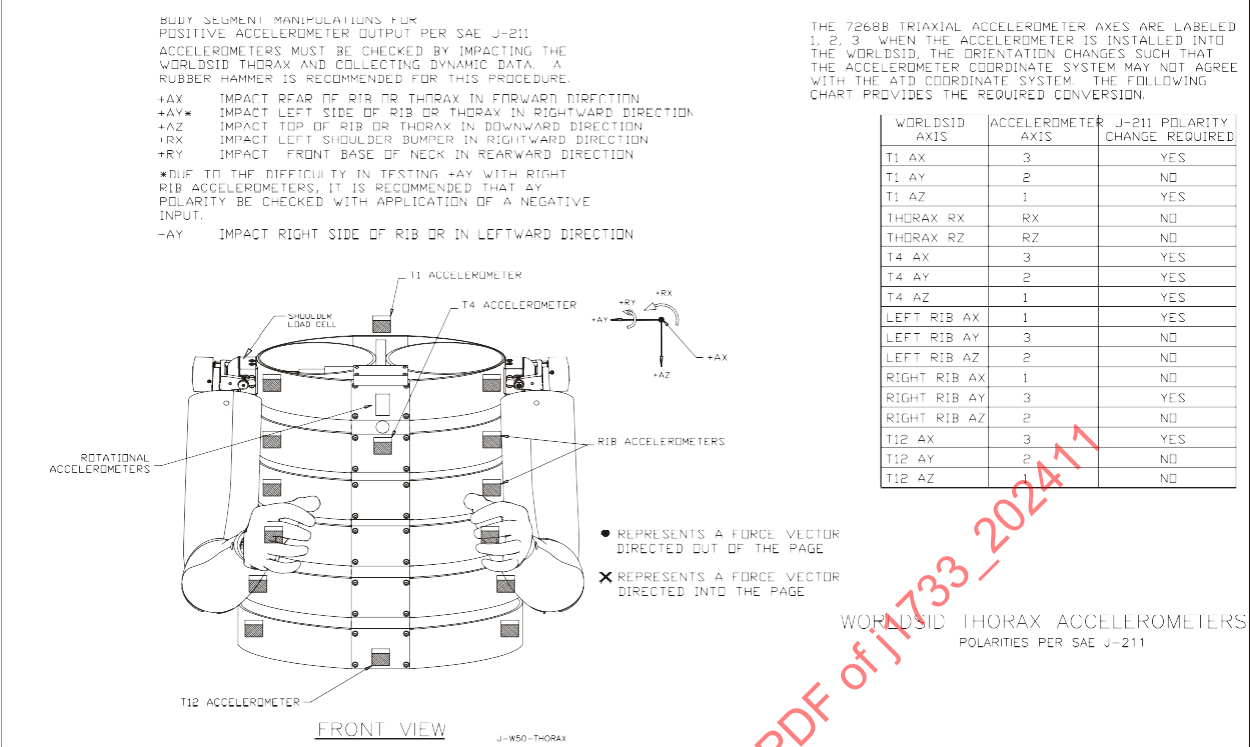


Figure 45 - Thorax accelerometers

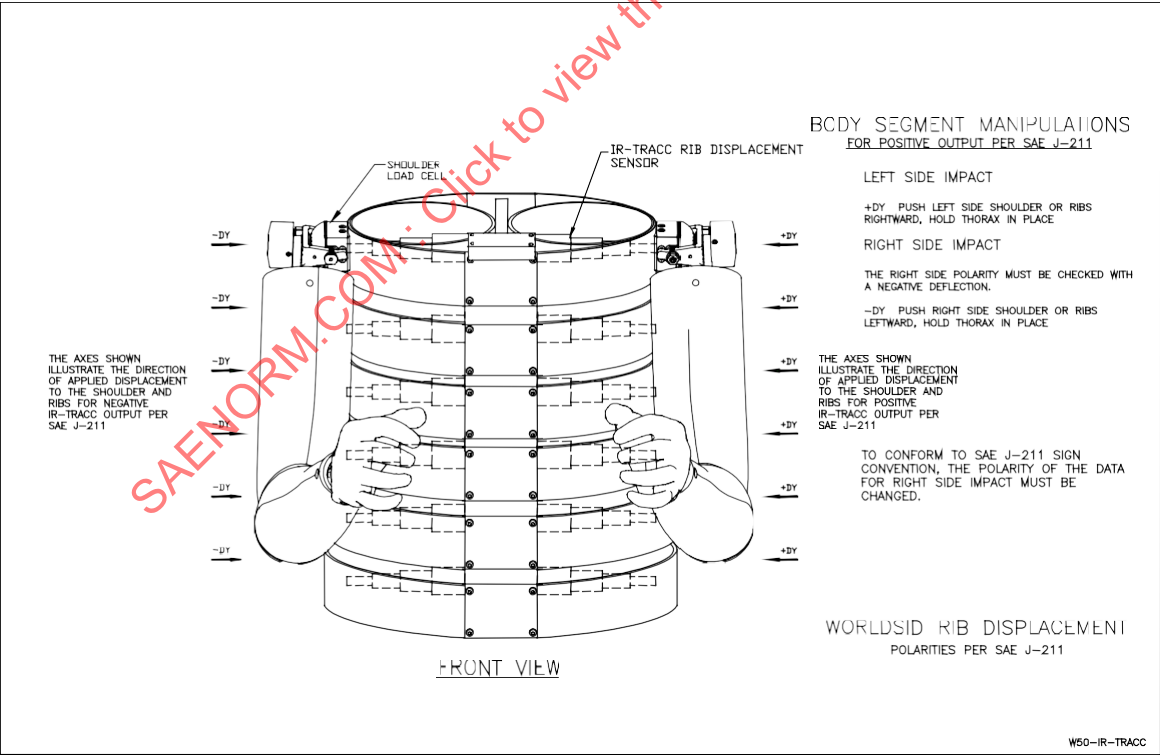


Figure 46 - Rib displacement