(R) Sign Convention for Vehicle Crash Testing

RATIONALE

Revisions to SAE J1733 are a continuing process and are considered at each five year review. Changes were made to include additional and new load cells and instrumentation along with procedures for determining their proper polarities.

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 Publications

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

2.1.1 SAE Publications

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

SAE J211 Instrumentation for Impact Test

SAE J670 Vehicle Dynamics Terminology

SAE J1594 Vehicle Aerodynamics Terminology

SAE J2052 Test Device Head Contact Duration Analysis

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

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.

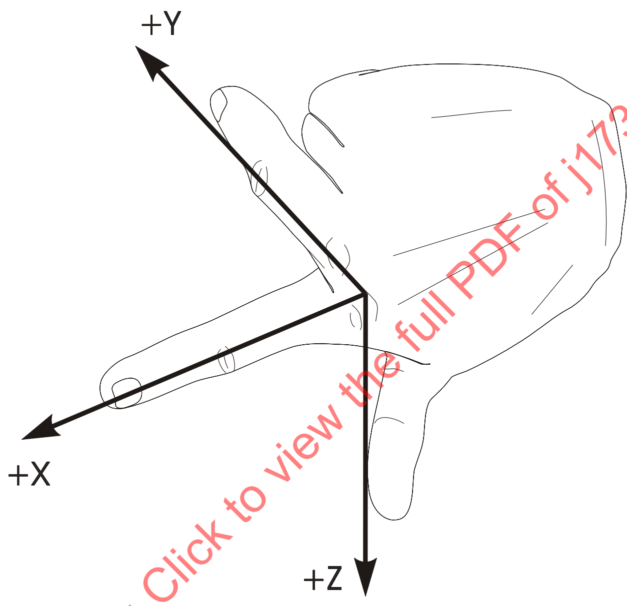


FIGURE 1 - THE CONFIGURATION OF A RIGHT-HANDED COORDINATE SYSTEM RELATIVE TO THE THUMB, FOREFINGER, AND MIDDLE FINGER OF THE RIGHT HAND

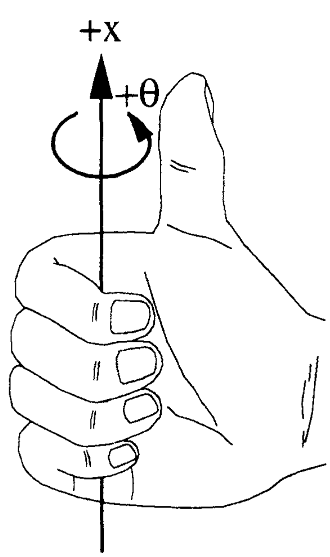


FIGURE 2 - RIGHT-HANDED SCREW RULE

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.

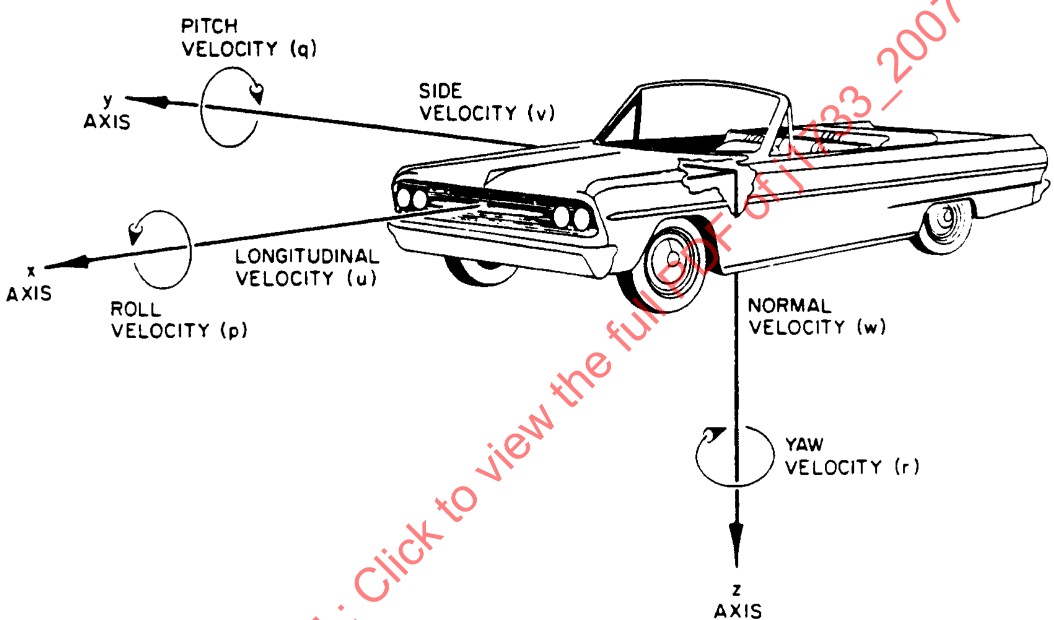


FIGURE 3 - VEHICLE DYNAMICS COORDINATE SYSTEM - SAE J670

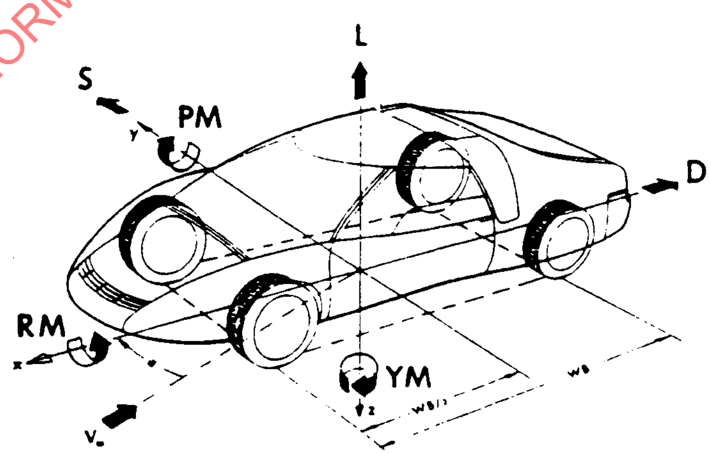


FIGURE 4 - VEHICLE AERODYNAMICS COORDINATE SYSTEM - SAE J1594

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.

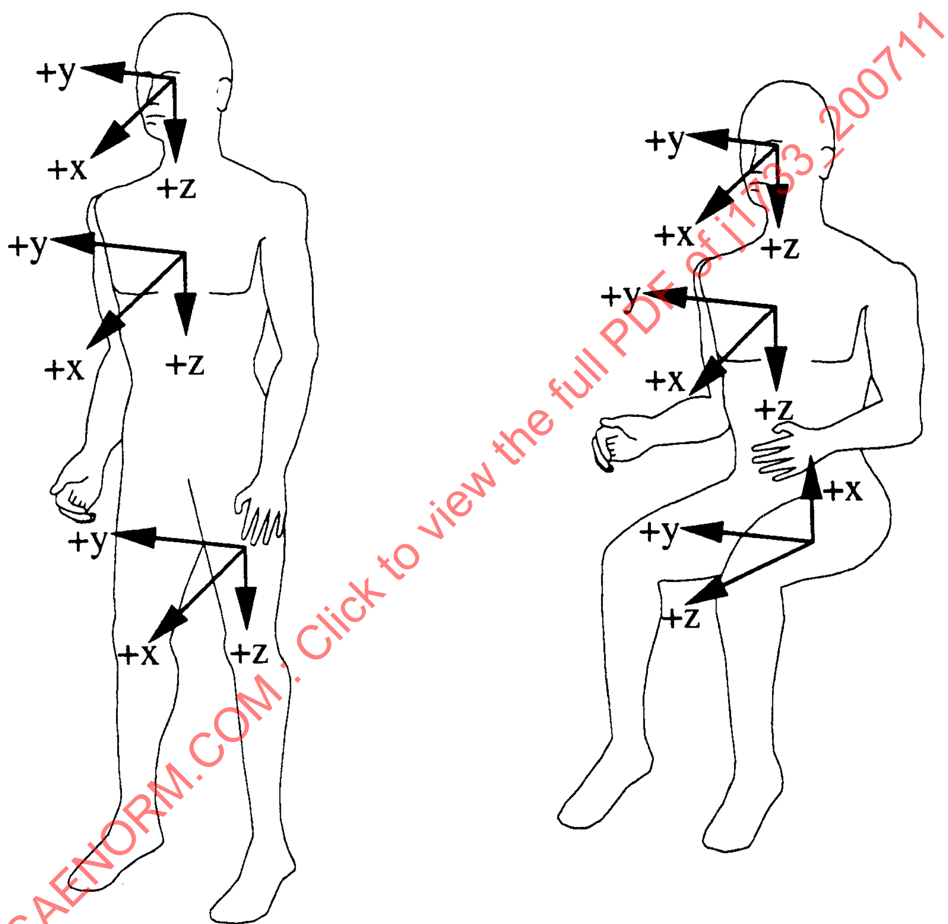


FIGURE 5 - ORIENTATIONS OF STANDARDIZED DUMMY COORDINATE SYSTEMS FOR STANDING AND SEATED POSTURES

6. STANDARD POLARITIES FOR RECORDED DUMMY MEASUREMENTS

6.1 Polarities of Acceleration, Velocity, 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. Note that since the SID dummy is only instrumented to measure accelerations, the polarities of its transducers are determined by the methods described in this section.

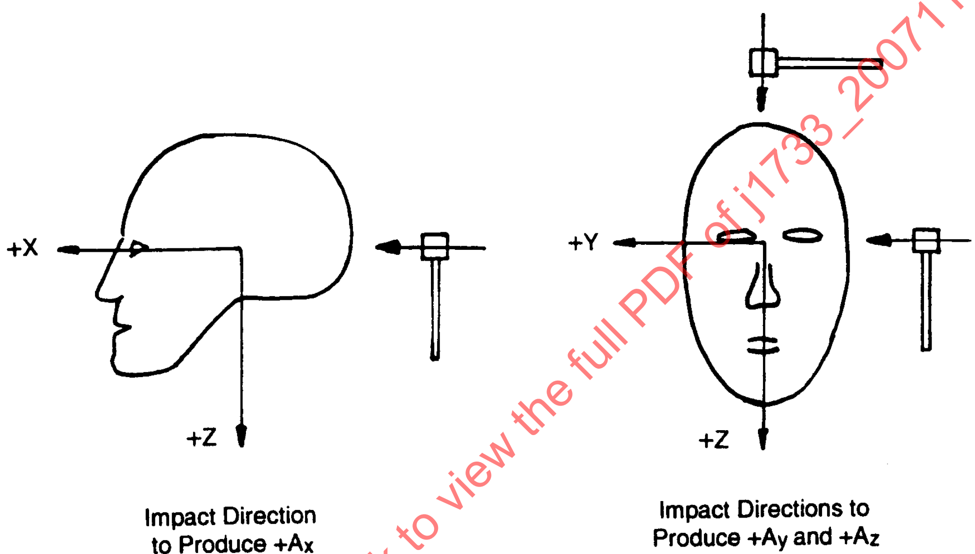


FIGURE 6 - HEAD IMPACT DIRECTIONS THAT PRODUCE POSITIVE HEAD ACCELERATIONS RELATIVE TO THE HEAD COORDINATE SYSTEM

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 compression 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 7. 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.

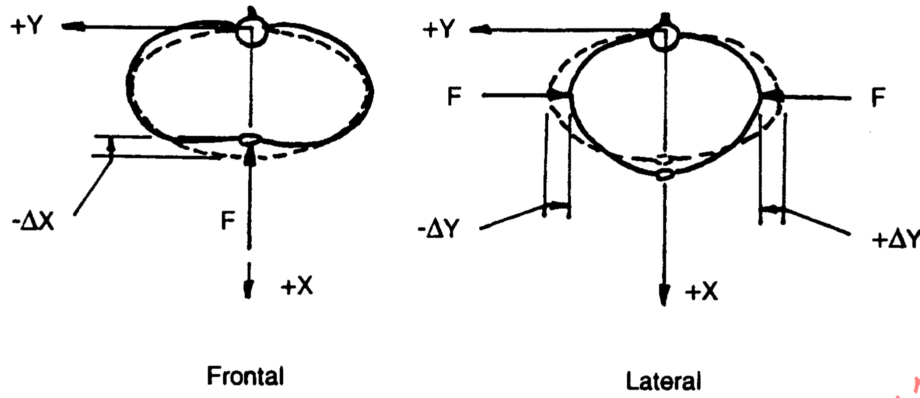


FIGURE 7 - DIRECTIONS OF FRONTAL AND LATERAL CHEST COMPRESSIONS

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. For the BIOSID, a lateral inward load applied to the crest of the left illium (+y) would be positive, while a lateral inward load applied to the crest of the right ilium (-y) would be negative.

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 8. 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. Free-body diagrams for specific dummy load cells showing the load systems that produce the required outputs that should be recorded with the specified polarities are given in Section 8.

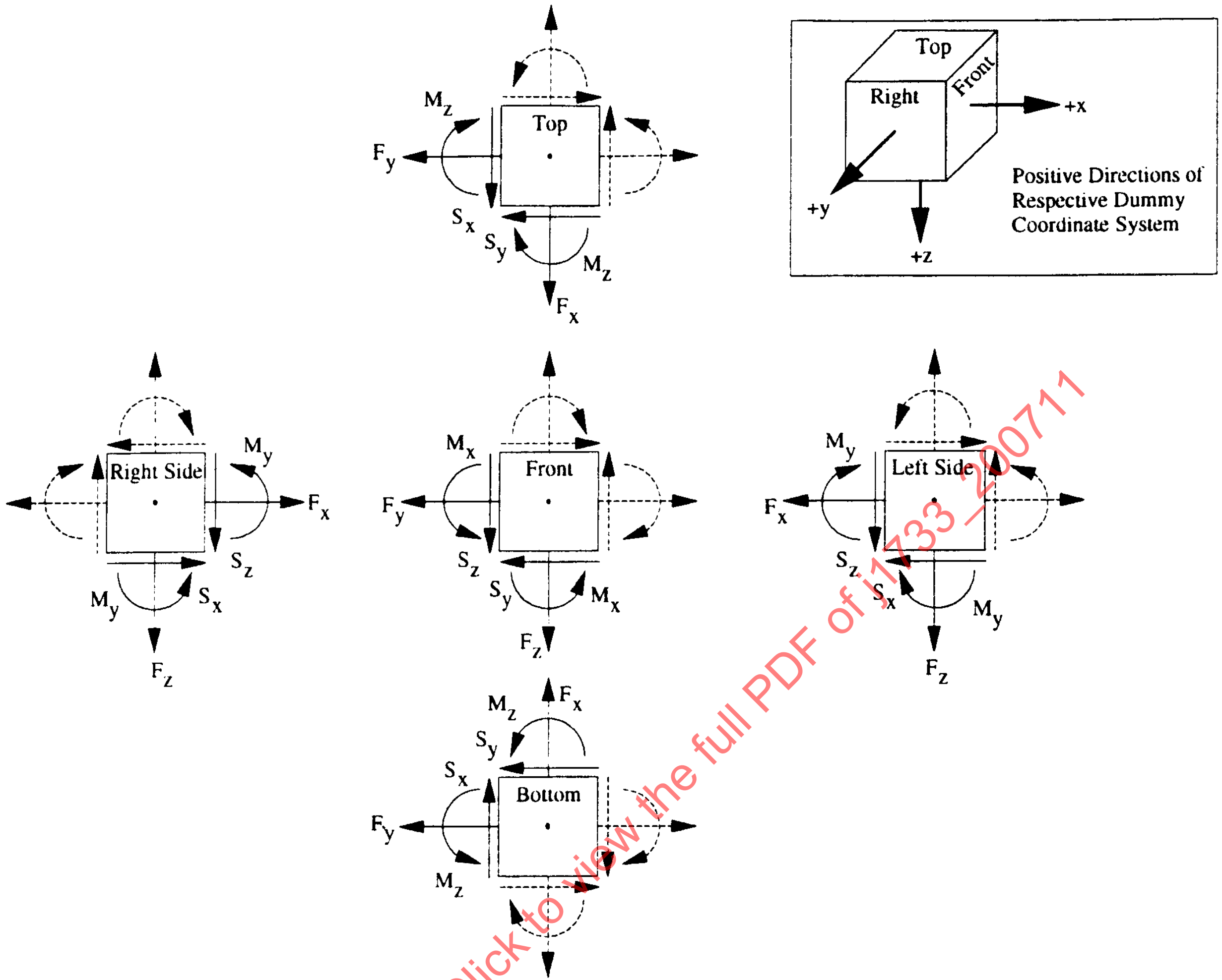


FIGURE 8 - FREE-BODY DIAGRAM OF A SECTIONED DUMMY PART CONTAINING THE LOAD CELL OF INTEREST (ILLUSTRATED AS A CUBE). PRINCIPLE AXES OF LOAD CELL ALIGNED PARALLEL TO RESPECTIVE AXES OF LOCAL DUMMY COORDINATE SYSTEM. BOLD ARROWS OF NORMAL FORCES (F), SHEAR FORCES (S), AND MOMENTS (M) SHOWN IN POSITIVE 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 vs External Loads

A test to determine an external vs 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 precdence. The 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 LOADS

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 load cells used in dummies.

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	+
	M_z	Chin Toward Left Shoulder	+
Left Shoulder	F_x	Arm Rearward, Chest Forward	+
Loads (SID IIs,	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,	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	+
Upper	F_x	Chest Rearward, Pelvis Forward	+
and	F_y	Chest Leftward, Pelvis Rightward	+
Lower	F_z	Chest Upward, Pelvis Downward	+
Lumbar	M_x	Left Shoulder Toward Left Hip	+
Spine	M_y	Sternum Toward Front of Legs	+
(All ATD's)	M_z	Right Shoulder Forward, Left Shoulder Rearward	+
Left Iliac Load (SID IIs)	F_y	Left Iliac Rightward, Chest Leftward	+
Right Iliac Load (SID IIs)	F_y	Right Iliac Rightward, Chest Leftward	+
Pubic Load (Side Impact)	F_y	Right H-Point Pad Leftward, Left Pad Rightward	(-)
Crotch Belt	F_x	Pubic Rearward, Pelvis Forward	(-)
Loads	F_z	Pubic Upward, Chest Downward	(-)

TABLE 1 - DUMMY MANIPULATIONS FOR CHECKING RECORDED LOAD CELL POLARITY RELATIVE TO SIGN CONVENTION (CONTINUED)

Load Cell	Measure	Dummy Manipulations	Polarity
Iliac Lap	F_x	Upper Iliac Spine Rearward, Chest Forward	(-)
Belt Loads	M_y	Upper Iliac Spine Rearward, Chest 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 ATD's)	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 ATD's)	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	+
(Euro-SID,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 (Euro-SID, 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	-
Rib Force Sensor (SID-IIs)	F_x	Compression	-

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 9.
b. Lower Neck Load Cell—See Figure 10.
c. Neck Load Cells (3-year old)—See Figure 11.
d. Shoulder Load Cells—See Figure 12.
e. Lower Thoracic Spine Load Cell—See Figure 13.
f. Chest Deflection Transducer—See Figure 14.
g. Lower Lumbar Spine Load Cell—See Figure 15.
h. Iliac Lap Belt Load Cell—See Figure 16.
i. Pubic Load Cell—See Figure 17.
j. Femur Load Cell—See Figure 18.
k. Upper and Lower Tibia and Knee Clevis Load Cells—See Figure 19.
l. Ankle/Toe Load Cell—See Figure 20.
m. Clavicle Load Cell, External—See Figure 21.
n. Clavicle Load Cell, Internal—See Figure 22.
o. Acetabulum Load Cell (3-year old)—See Figure 23.
p. Rib Load Cells—See Figure 24.
q. Face Load Cell—See Figure 25.

8.2 BIOSID

a. Upper and Lower Neck Load Cells—See Figure 9 and Figure 10.
b. Left Shoulder Load Cell—See Figure 26.
c. Right Shoulder Load Cell—See Figure 27.
d. Rib Deflection Transducers—See Figure 28.
e. Lower Lumbar Spine Load Cell—See Figure 29.
f. Iliac Wing Load Cell—See Figure 30.
g. Pubic Load Cell—See Figure 31.
h. Sacrum Load Cell—See Figure 32.
i. 2-Channel Sacrum Load Cell—See Figure 33.

j. Acetabulum Load Cell—See Figure 34.
k. Femur Load Cell—See Figure 35.

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

a. Upper Neck Load Cell—See Figure 36.
b. Lower Neck Load Cell—See Figure 37.
c. Shoulder Load Cells—See Figure 12.
d. Lower Lumbar Spine Load Cell—See Figure 38.
e. Pubic Load Cell—See Figure 16.

8.4 WorldSID

a. Upper and Lower Arm and Elbow Load Cells—See Figure 39.
b. Lower Neck Load Cell—See Figure 40.
c. Upper Neck Load Cell—See Figure 41.
d. Femur Load Cell—See Figure 42.
e. Upper and Lower Tibia Load Cells—See Figure 43.
f. Knee Load Cell Polarities—See Figure 44.
g. Pubic Load Cell—See Figure 45.
h. Femoral Neck Load Cells—See Figure 46.
i. Shoulder Load Cell—See Figure 47.
j. Lumbar Spine Load Cell—See Figure 48.
k. Sacro-Iliac Load Cell—See Figure 49.
l. Arm Accelerometers—See Figure 50.
m. Head Accelerometers—See Figure 51.
n. Pelvis Accelerometers—See Figure 52.
o. Thorax Accelerometers—See Figure 53.
p. Chest Dellection—See Figure 54.

8.5 THOR

a. LX/FLX Lower Leg—See Figure 55.
b. Face Load Cell—See Figure 25.
c. Acetabulum Load Cell—See Figure 56.
d. Lower Neck Load Cell—See Figure 57.

8.6 EuroSID

a. T-12 Load Cell—See Figure 58.
b. Upper Neck Load Cell—See Figure 59.
c. Lower Neck Load Cell—See Figure 60.
d. Backplate Load Cell—See Figure 61.
e. Shoulder Load Cell—See Figure 62.
f. Pubic Load Cell—See Figure 63.
g. Lumbar Load Cell—See Figure 64.
h. Abdominal Load Cell—See Figure 65.

8.7 SID-IIs

a. Rib Load Cell—See Figure 66
b. Upper Neck Load Cell—See Figure 9.
c. Lower Neck Lowad Cell—See Figure 10.
d. Acetabulum Load Cell—See Figure 34.
e. Upper Femur Load Cell—See Figure 35.
f. Iliac Wing Load Cell—See Figure 30.
g. Pubic Load Cell—See Figure 31.

h. Femur Load Cell—See Figure 18.
i. Shoulder Load Cell—See Figure 67.

8.8 BioRID

a. T-1 Load Cell—See Figure 68.
b. Upper Neck Load Cell—See Figure 9.
c. Lumbar Load Cell—See Figure 15.

8.9 Q-Series

a. Upper, Lower Neck and Lumbar Load Cells—See Figure 69.

8.10 Miscellaneous

a. Airbag Ineraction Arm—See Figure 70.

9. NOTES

9.1 Marginal Indicia

The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE DUMMY TESTING EQUIPMENT SUBCOMMITTEE
OF THE SAE HUMAN BIOMECHANICS AND SIMULATION STANDARDS COMMITTEE

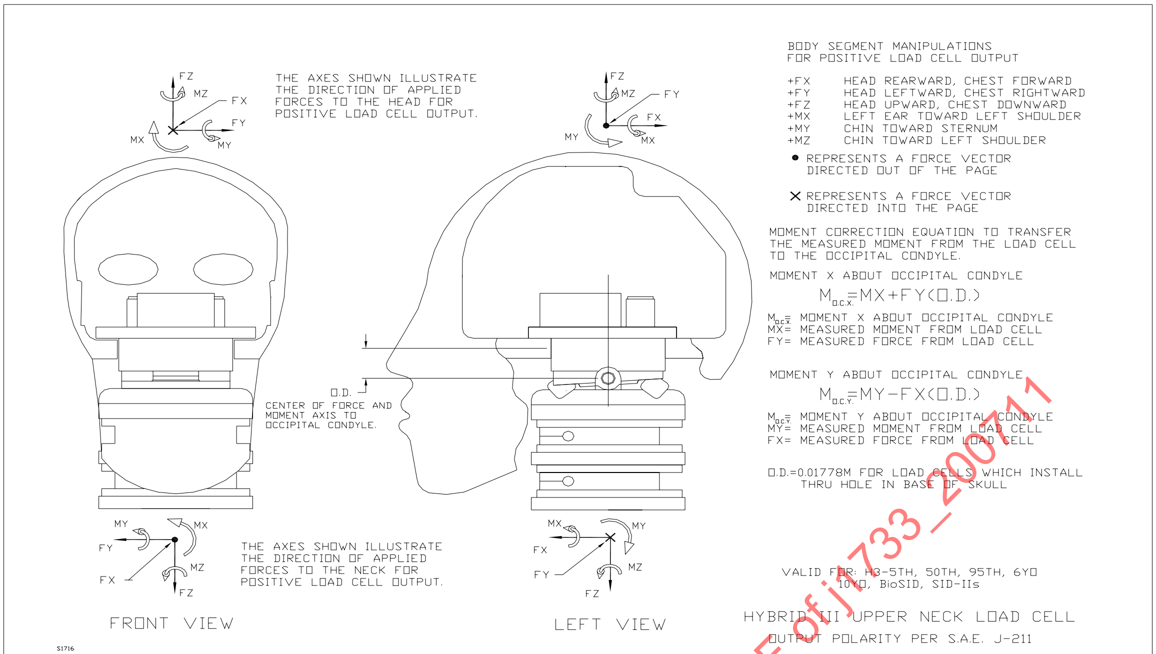


FIGURE 9 - UPPER NECK LOAD CELL

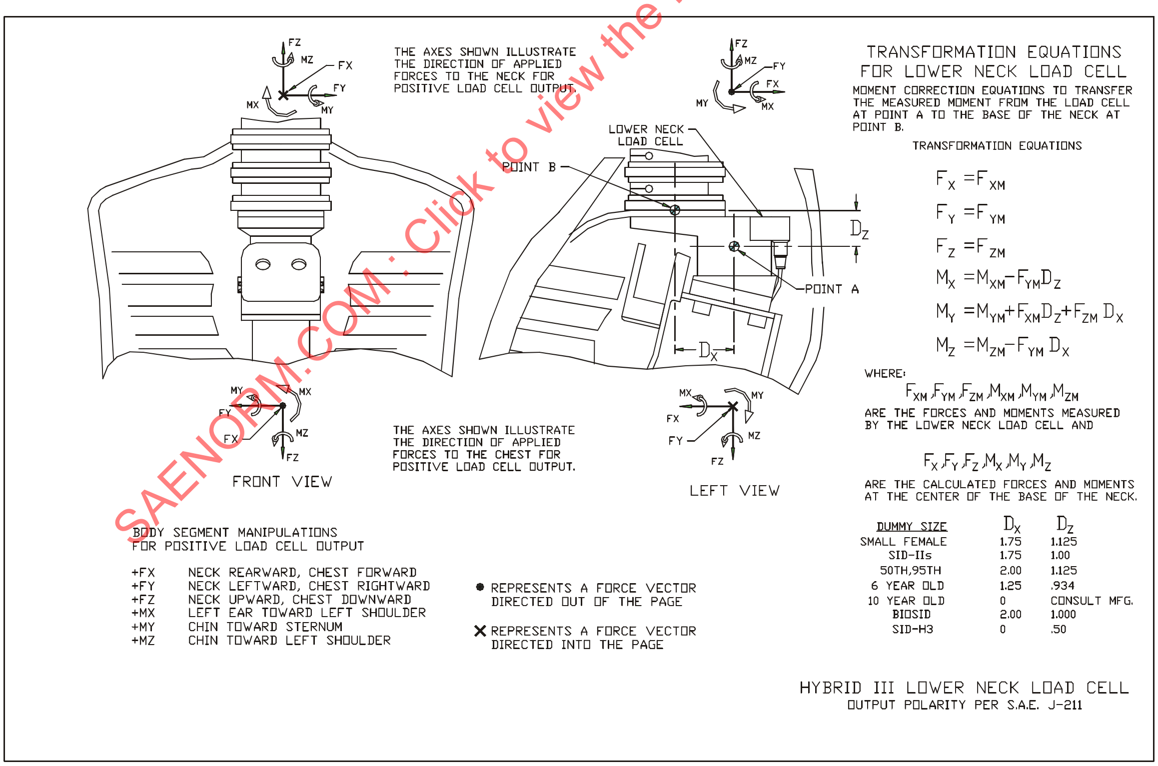


FIGURE 10 - LOWER NECK LOAD CELL

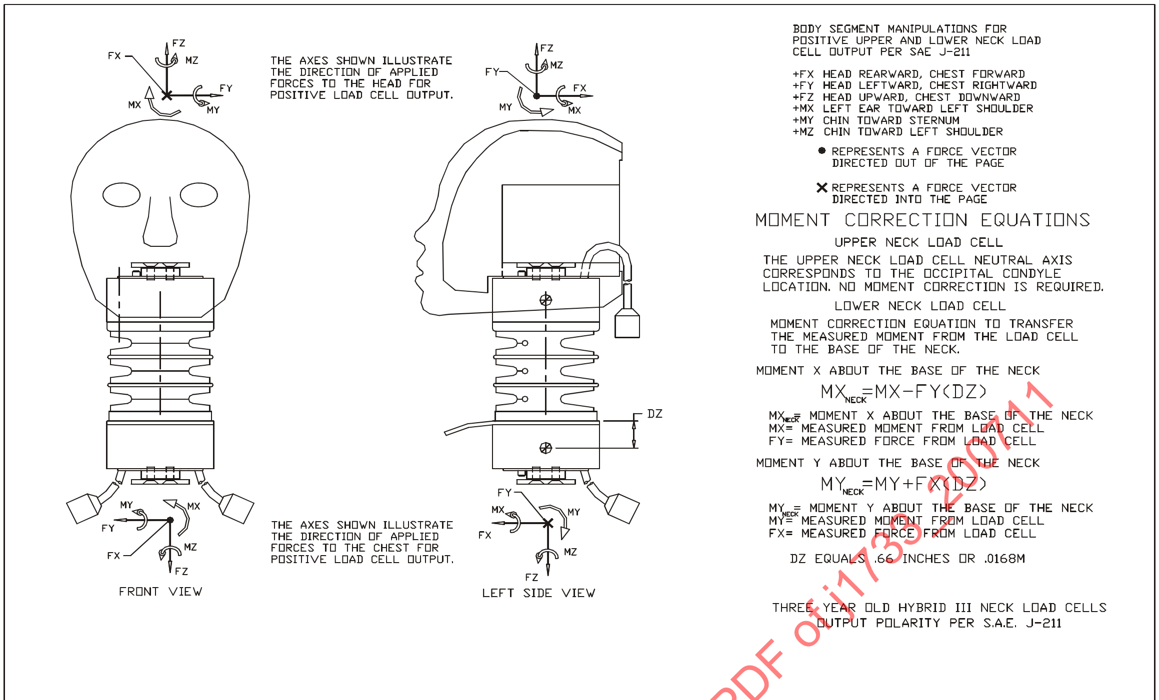


FIGURE 11 - NECK LOAD CELLS

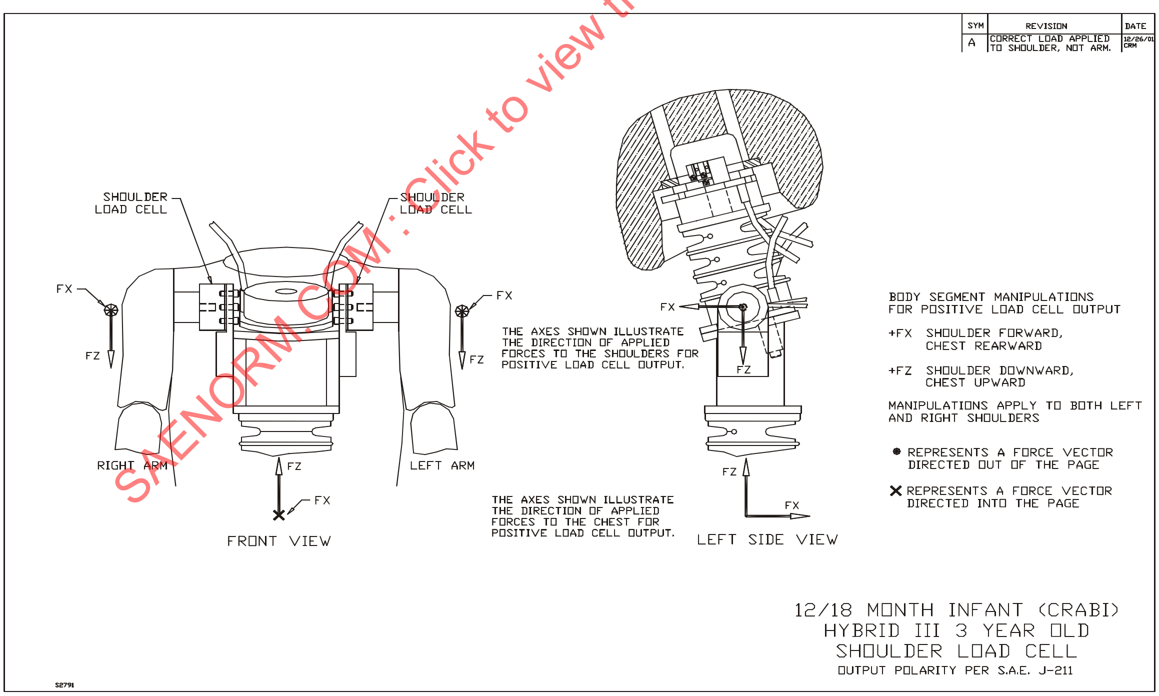


FIGURE 12 - SHOULDER LOAD CELLS

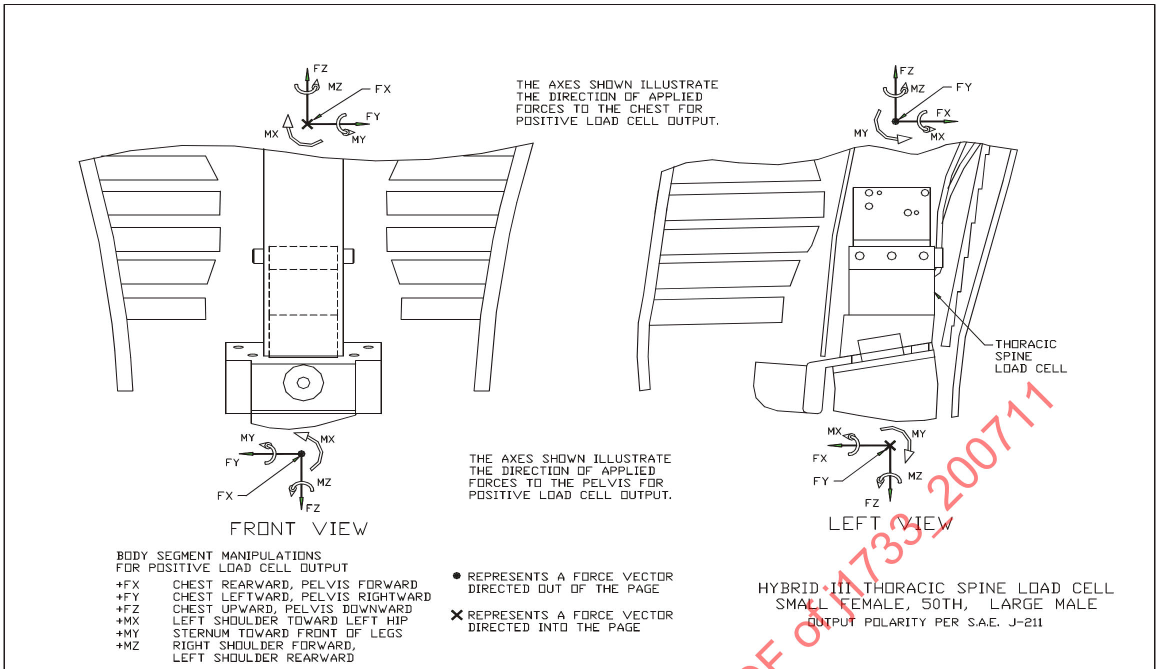


FIGURE 13 - LOWER THORACIC SPINE LOAD CELL

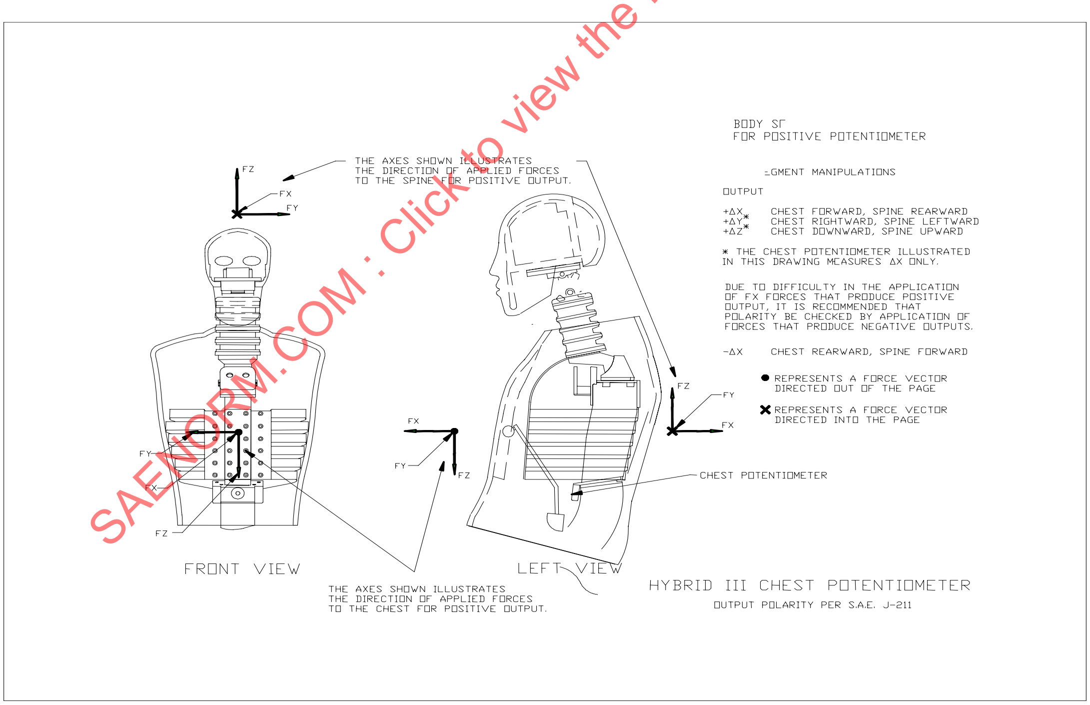


FIGURE 14 - CHEST DEFLECTION TRANSDUCER

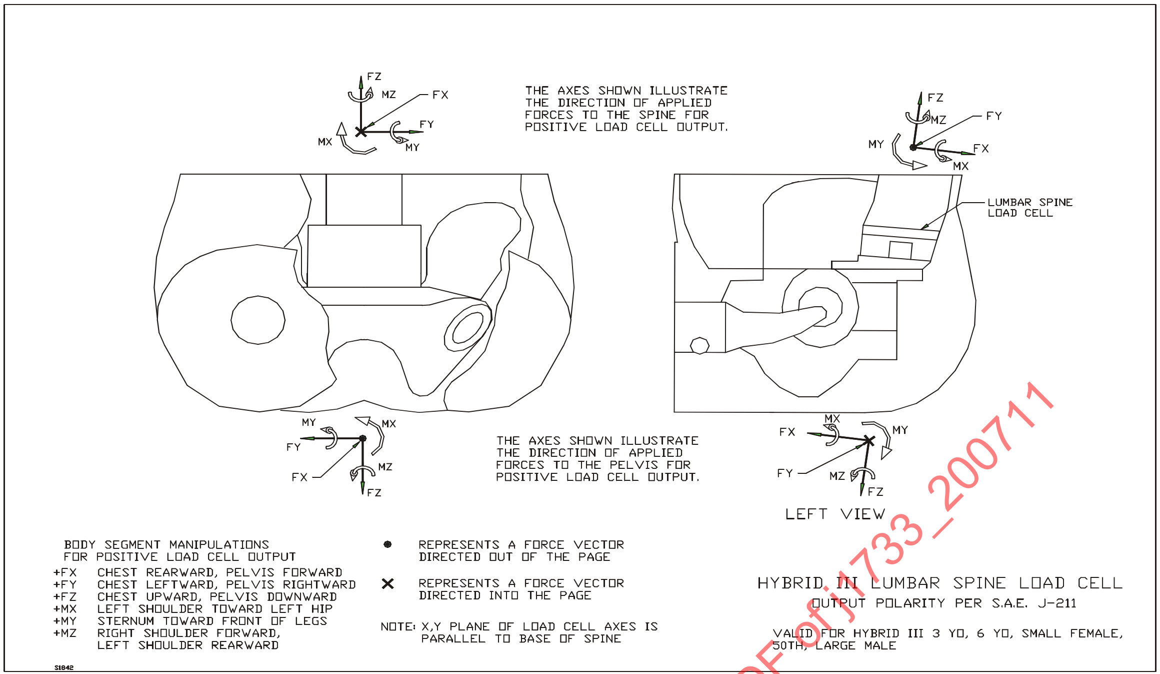


FIGURE 15 - LOWER LUMBAR SPINE LOAD CELL

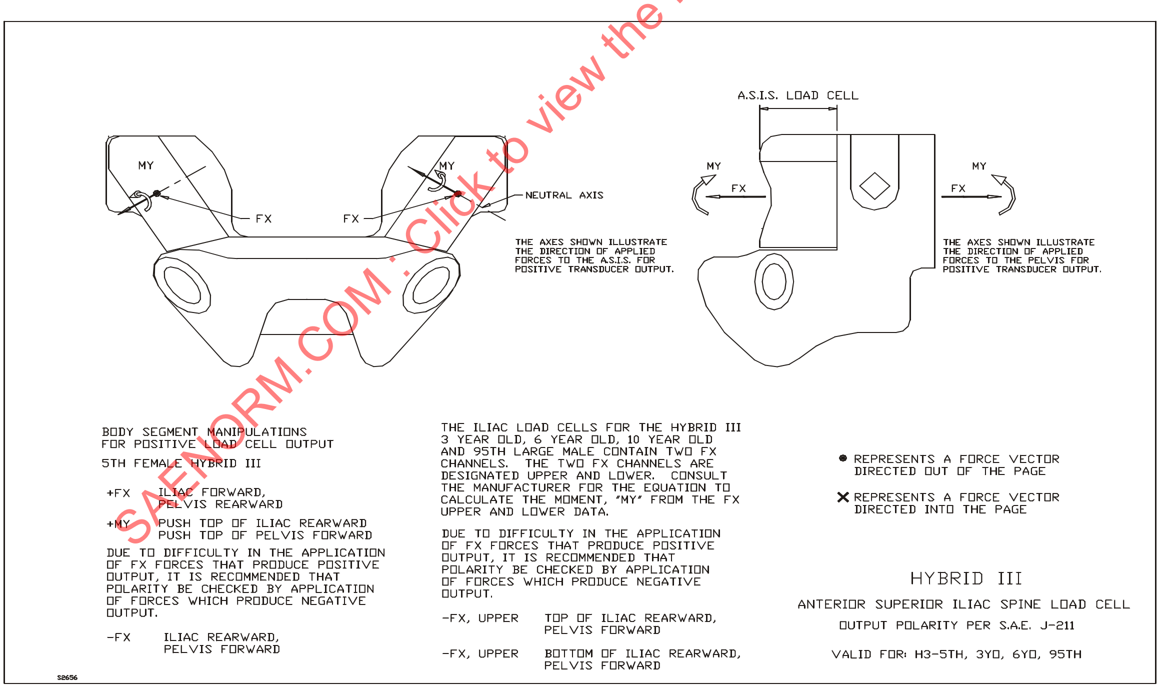


FIGURE 16 - ILIAC LAP BELT LOAD CELL

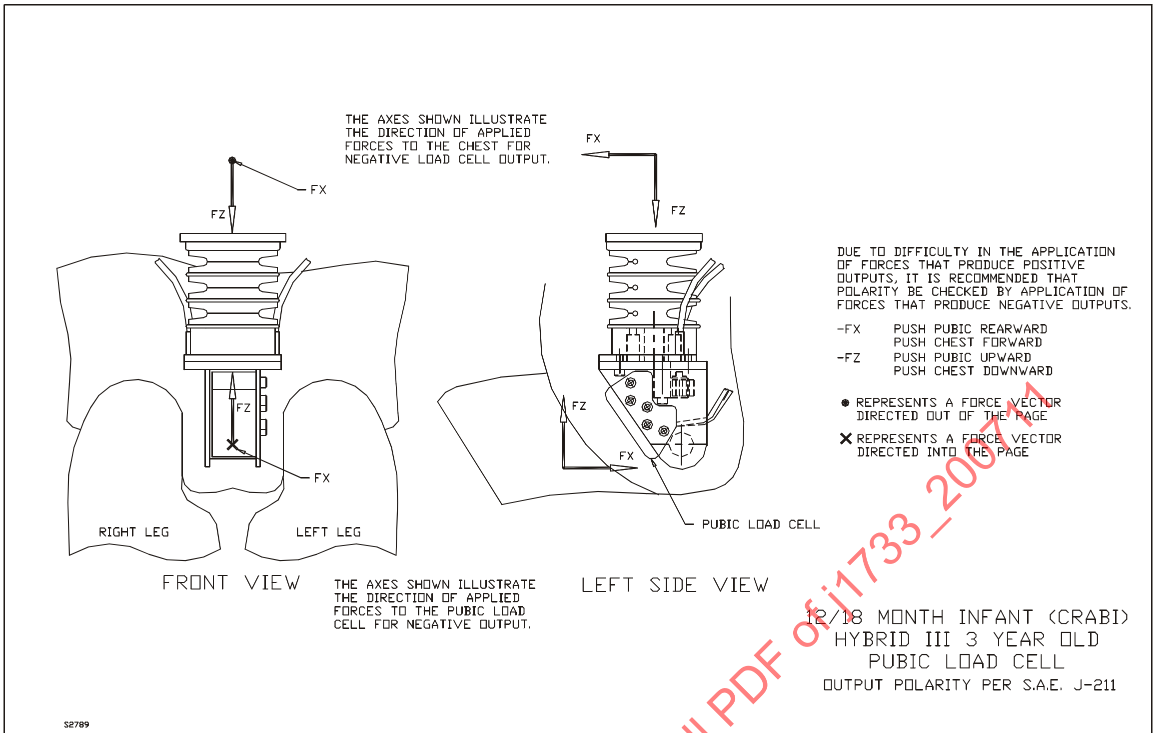


FIGURE 17 - PUBIC LOAD CELL

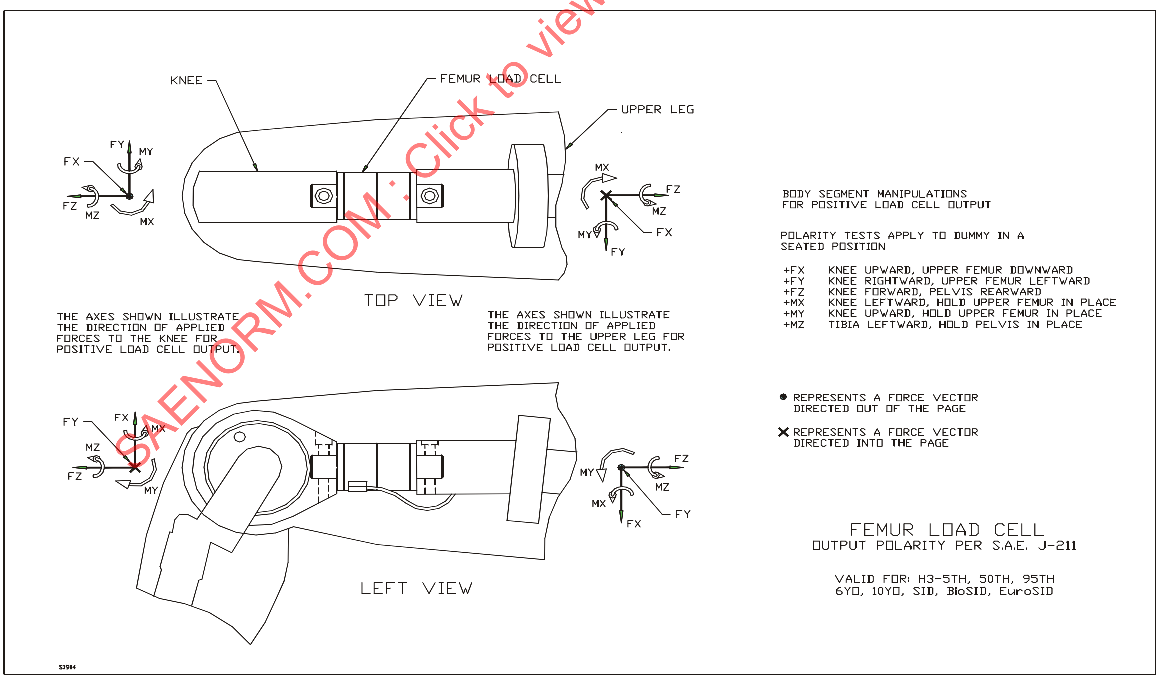


FIGURE 18 - FEMUR LOAD CELL

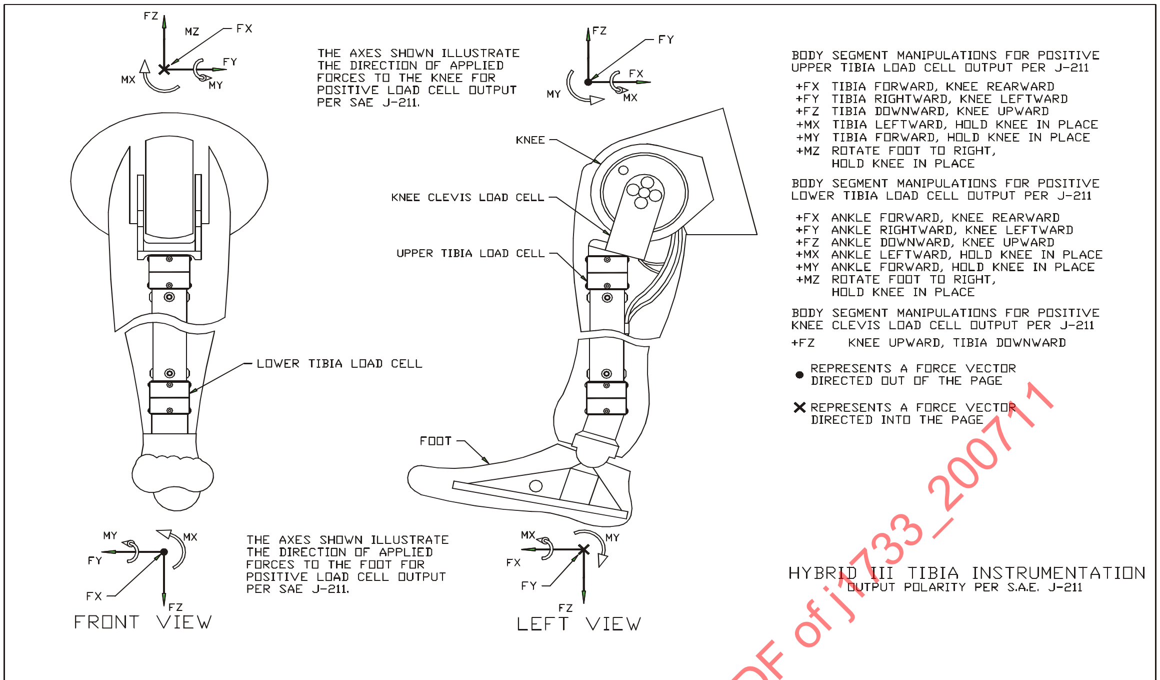


FIGURE 19 - UPPER AND LOWER TIBIA AND KNEE CLEVIS LOAD CELLS

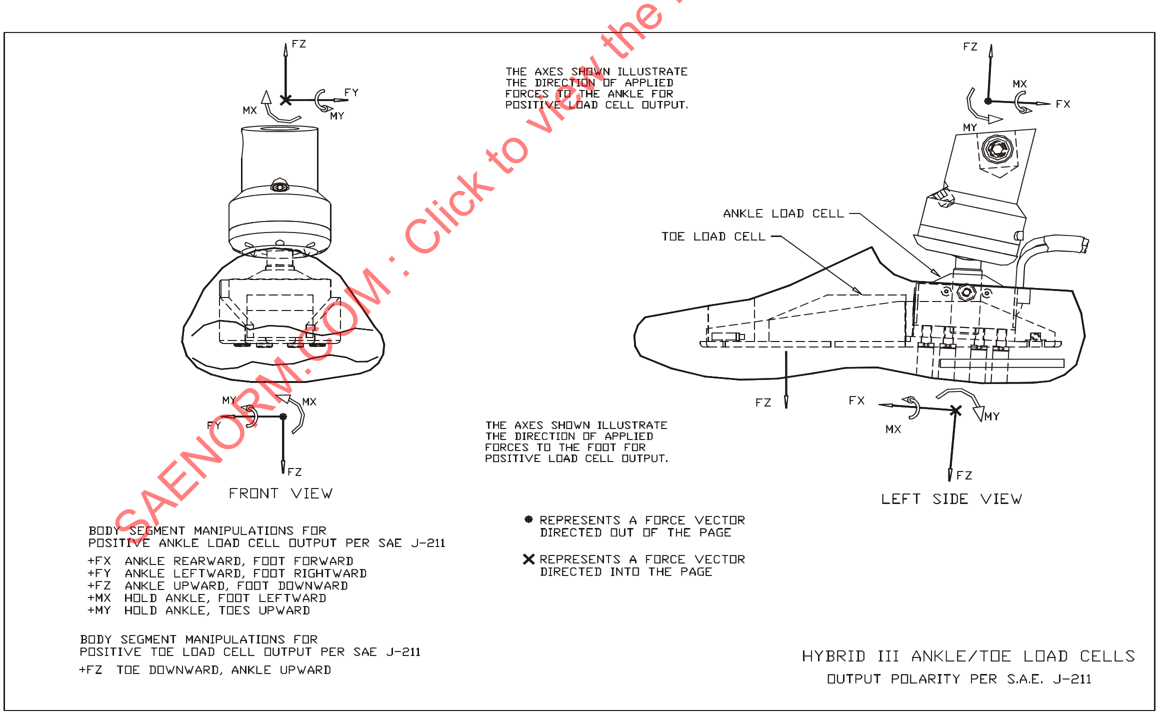


FIGURE 20 - ANKLE/TOE LOAD CELL

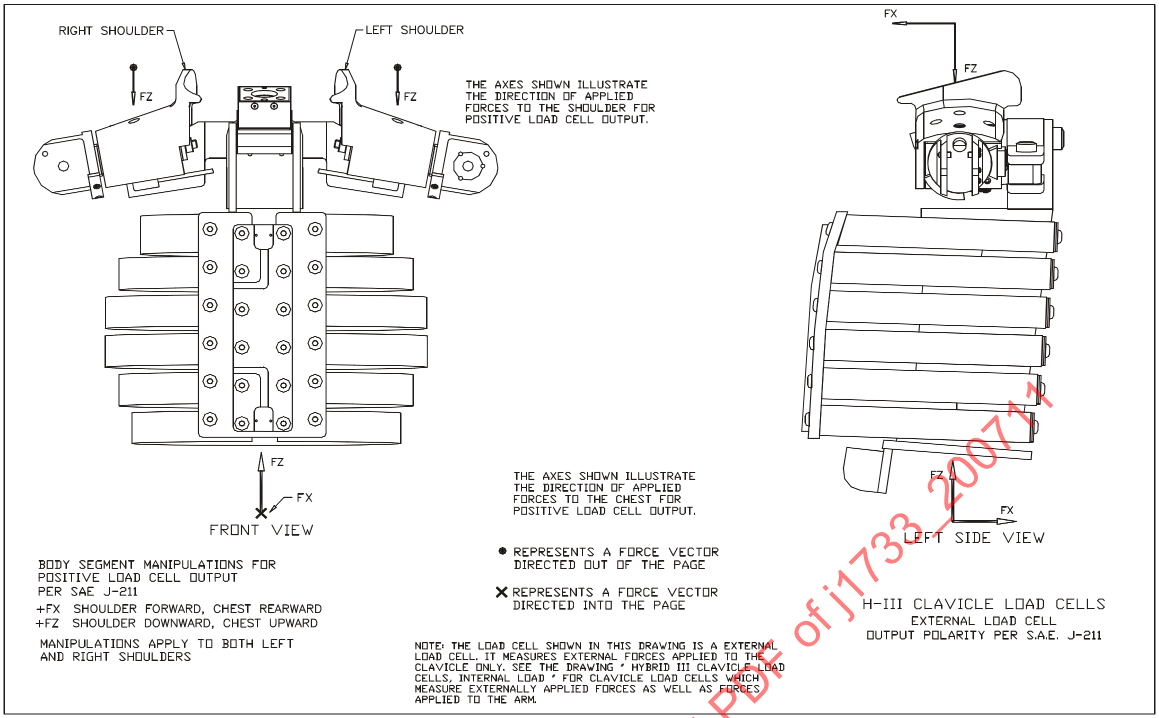


FIGURE 21 - CLAVICLE LOAD CELL, EXTERNAL

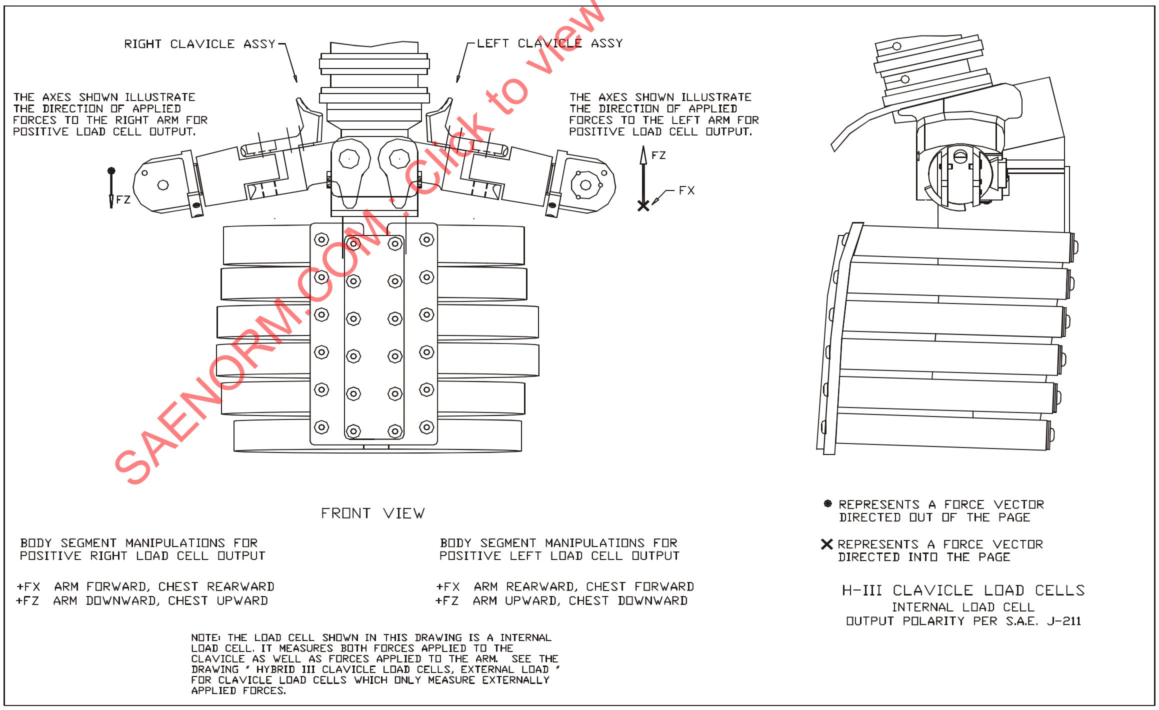


FIGURE 22 - CLAVICLE LOAD CELL, INTERNAL

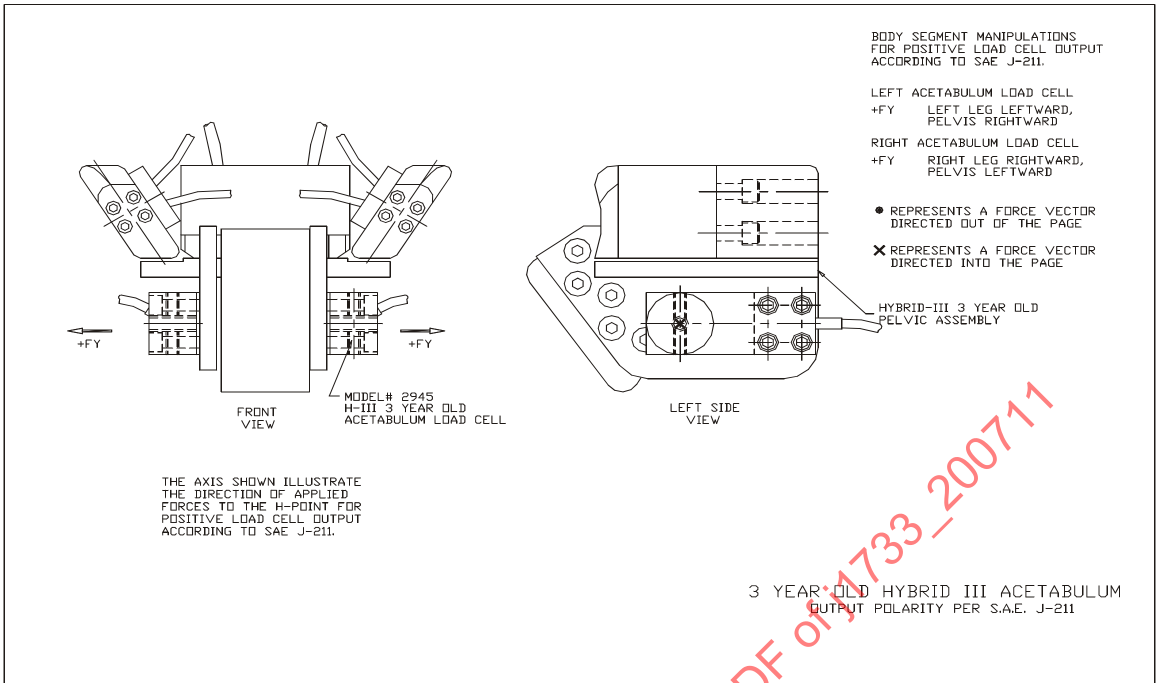


FIGURE 23 - ACETABULUM LOAD CELL

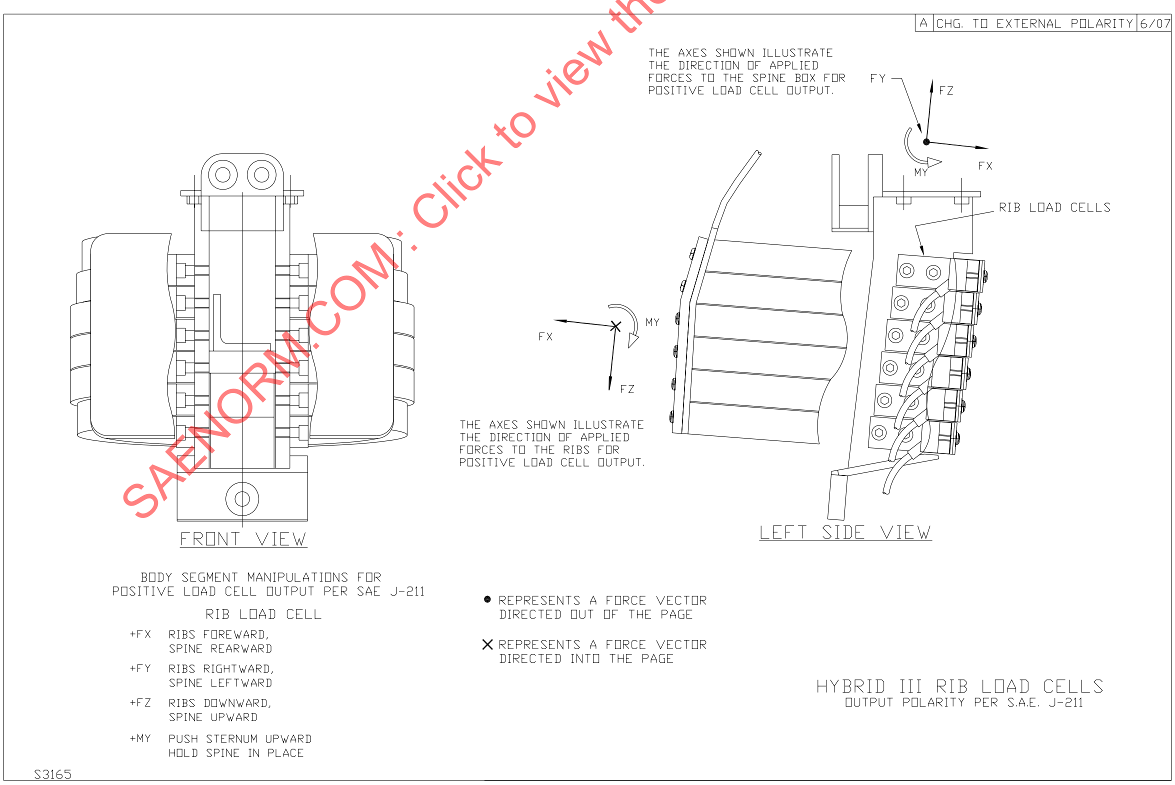


FIGURE 24 - RIB LOAD CELLS

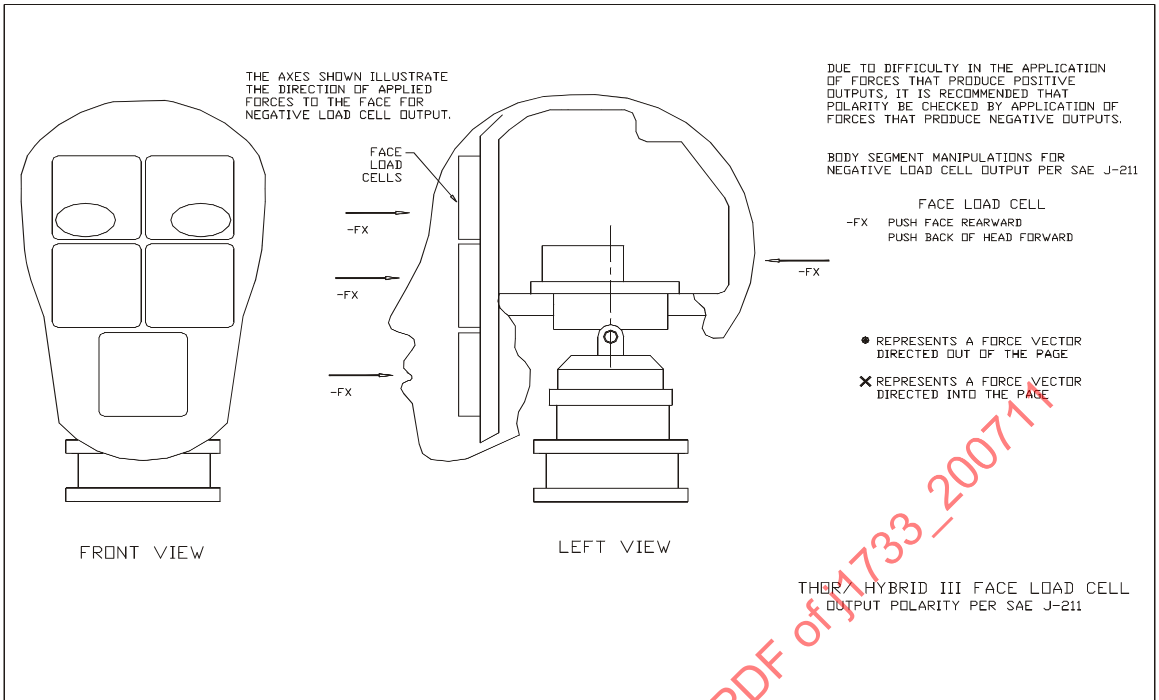


FIGURE 25 - FACE LOAD CELL

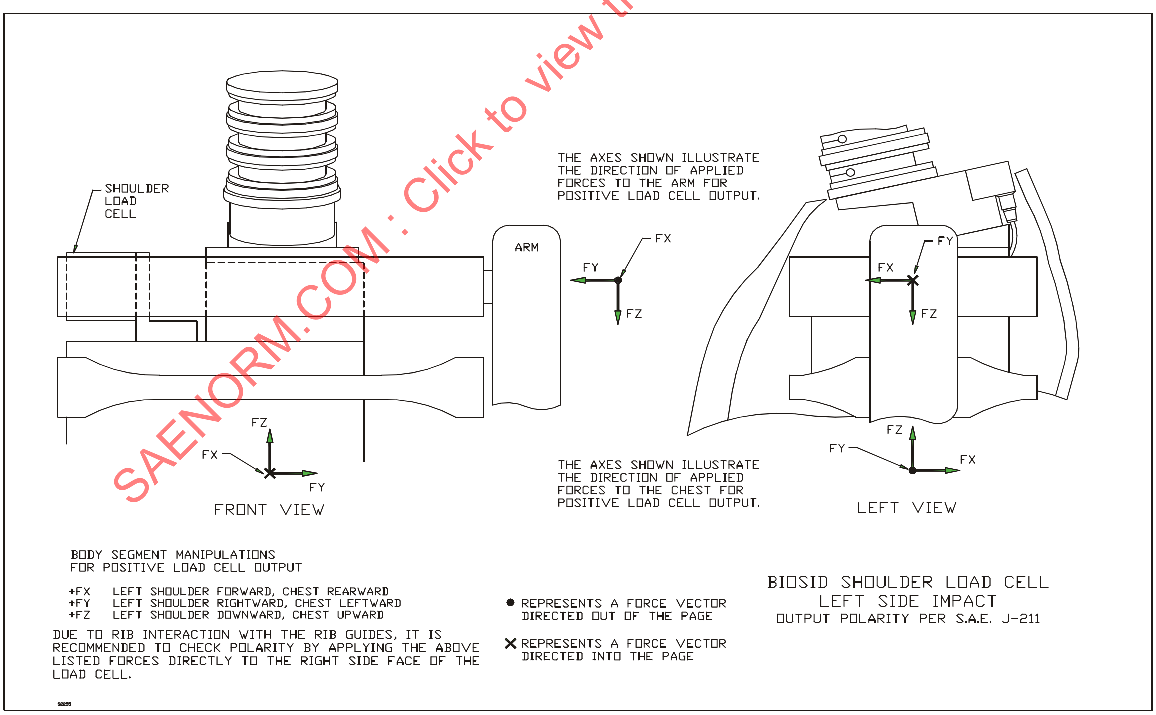


FIGURE 26 - LEFT SHOULDER LOAD CELL

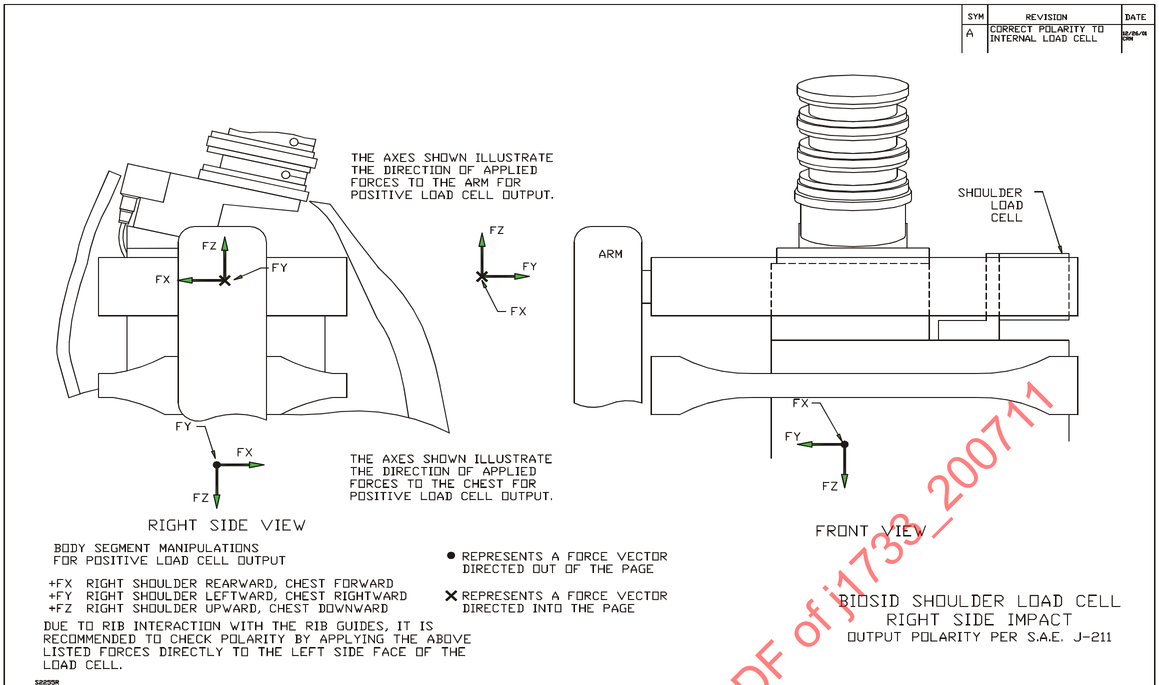


FIGURE 27 - RIGHT SHOULDER LOAD CELL

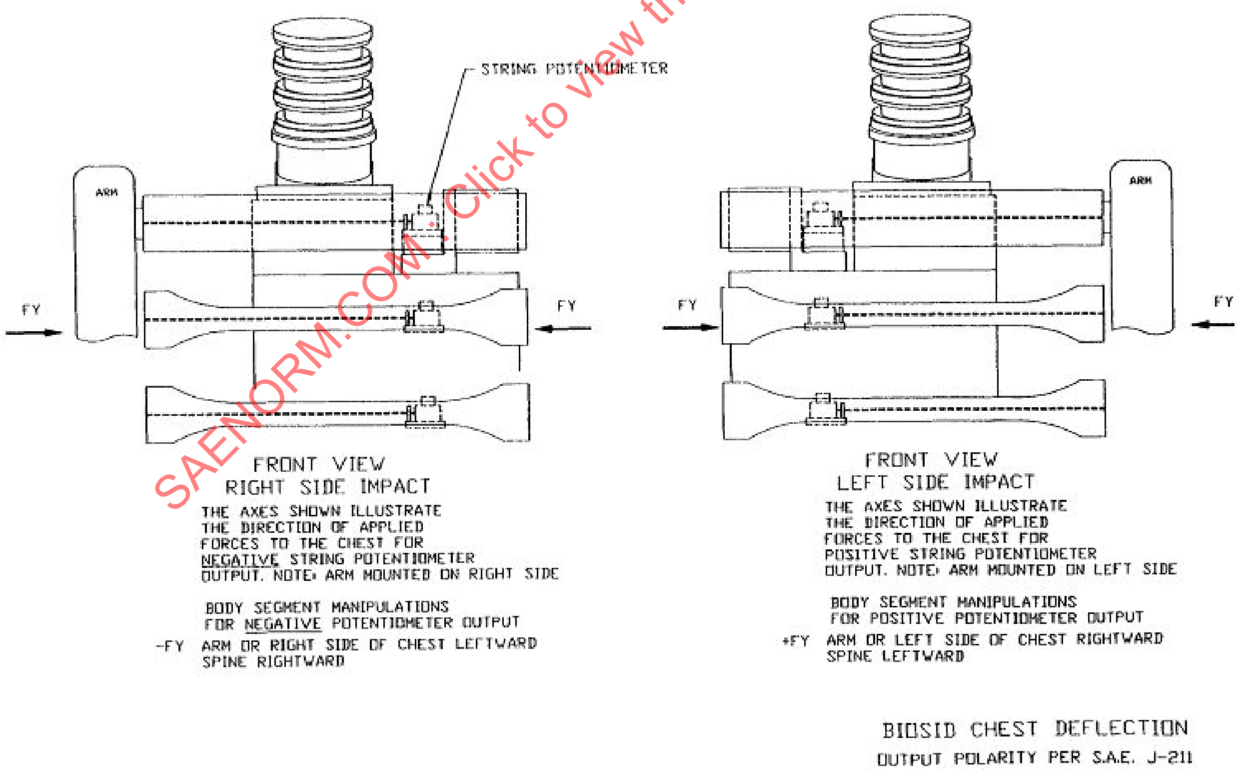


FIGURE 28 - RIB DEFLECTION TRANSDUCERS

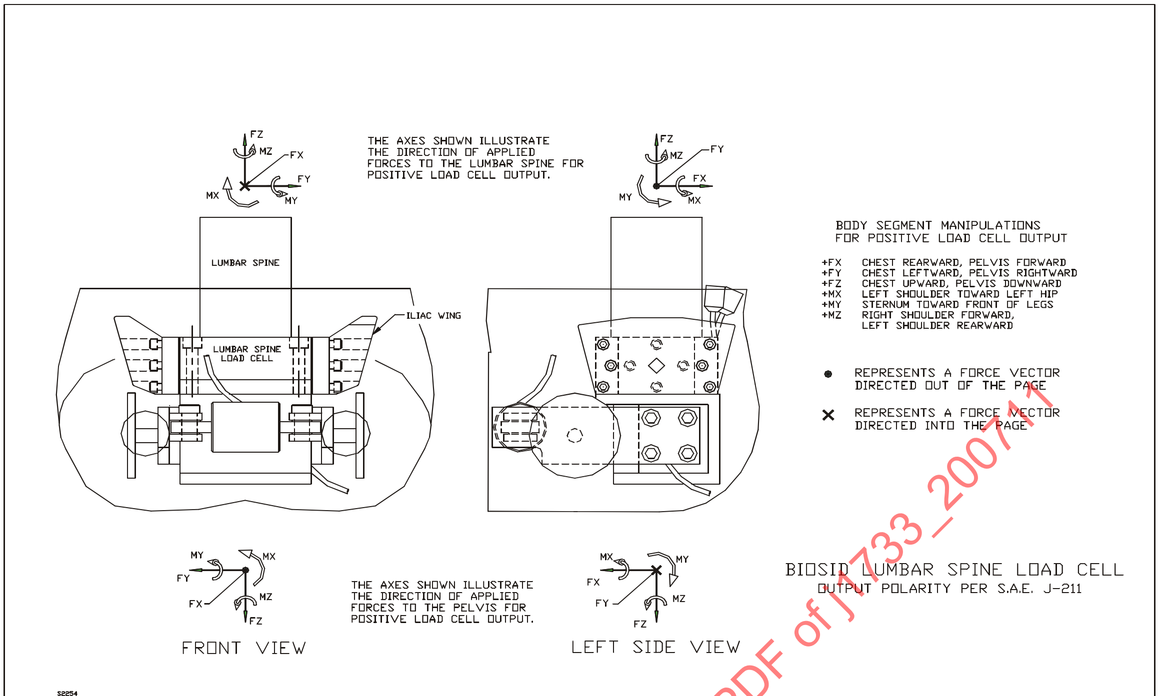


FIGURE 29 - LOWER LUMBAR SPINE LOAD CELL

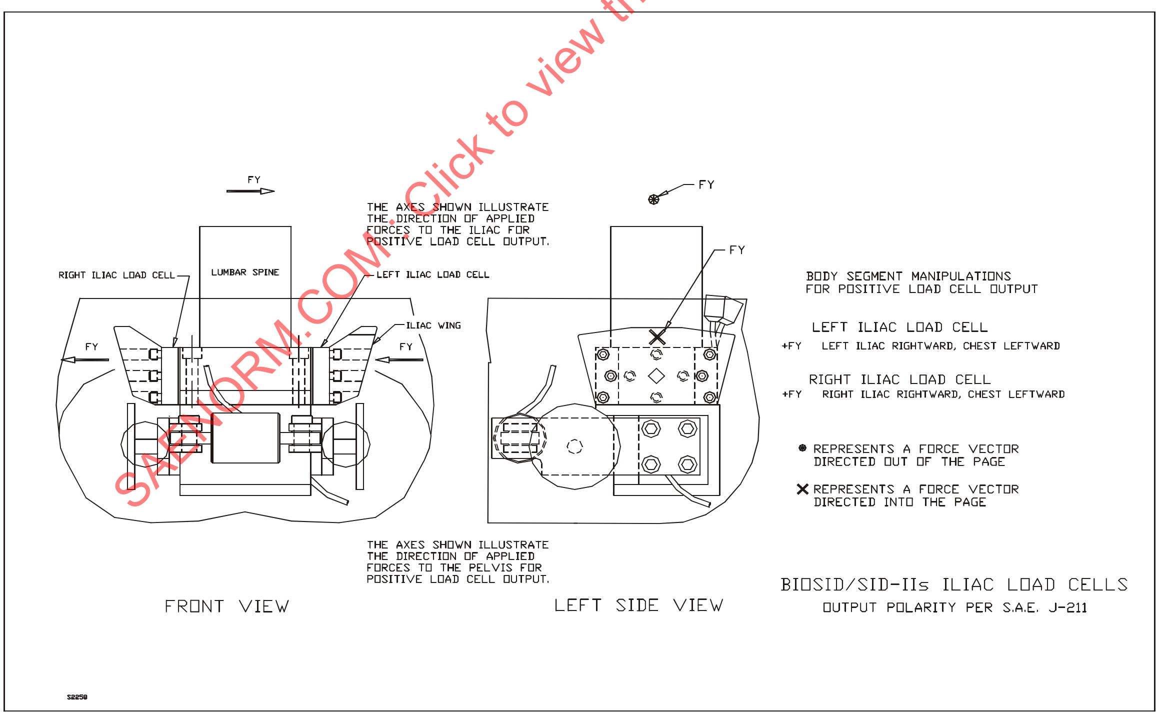


FIGURE 30 - ILIAC WING LOAD CELL

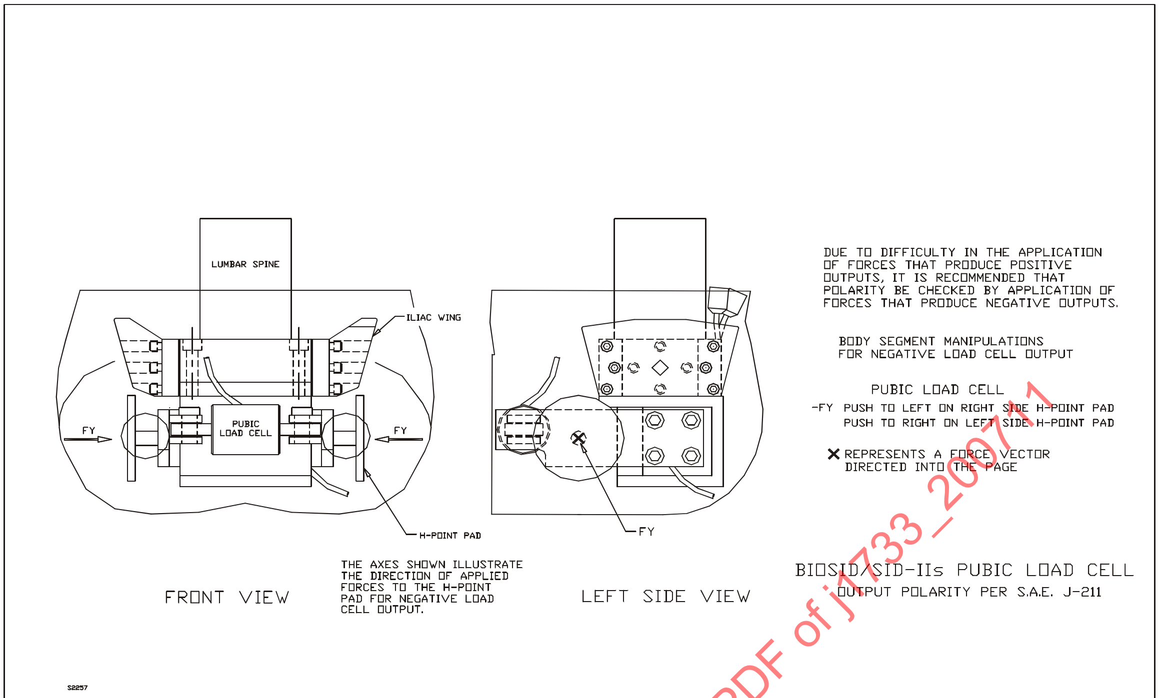


FIGURE 31 - PUBIC LOAD CELL

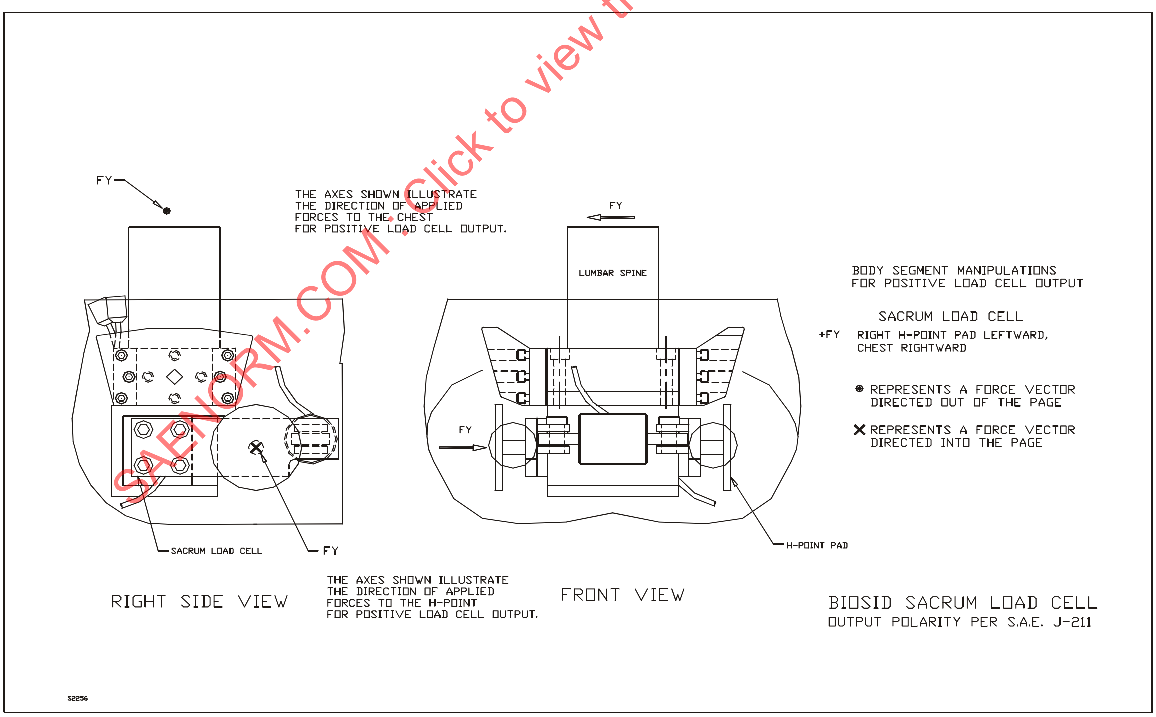


FIGURE 32 - SACRUM LOAD CELL

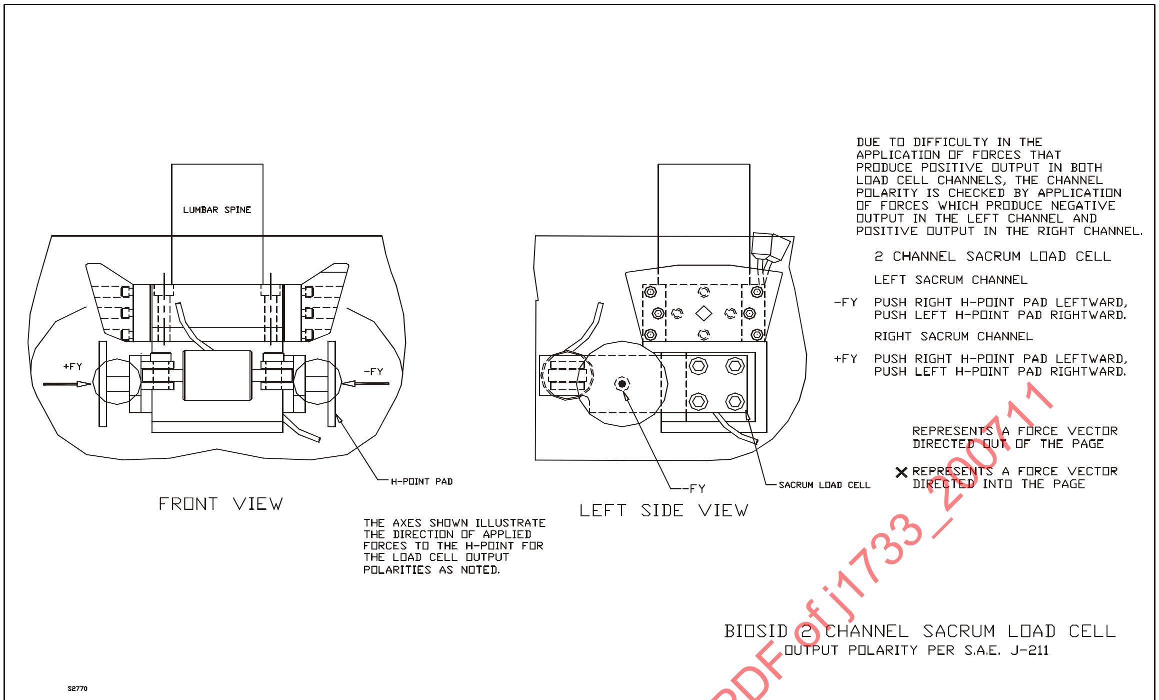


FIGURE 33 - 2-CHANNEL SACRUM LOAD CELL

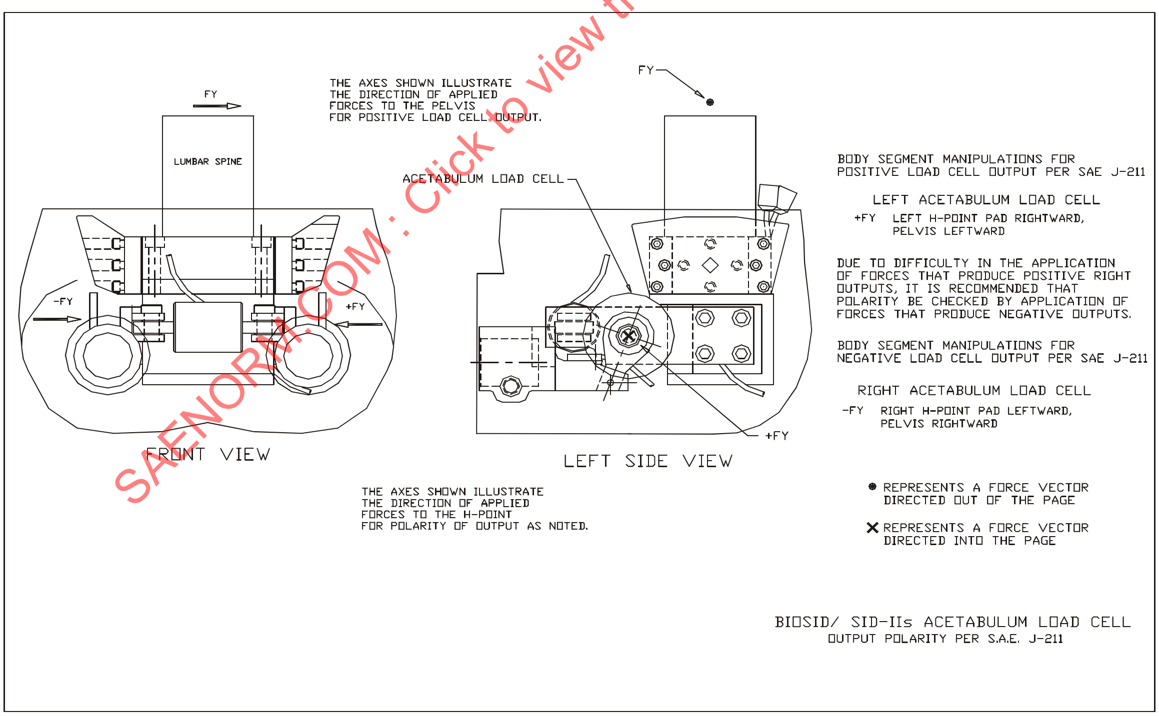


FIGURE 34 - ACETABULUM LOAD CELL

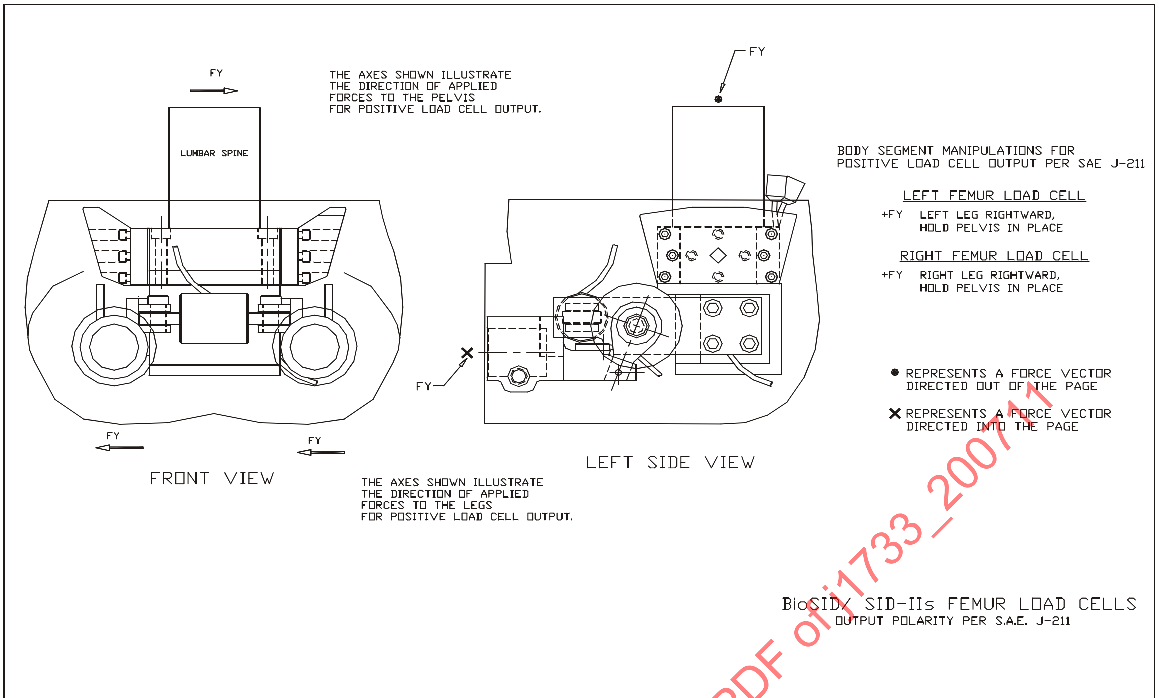


FIGURE 35 - FEMUR LOAD CELL

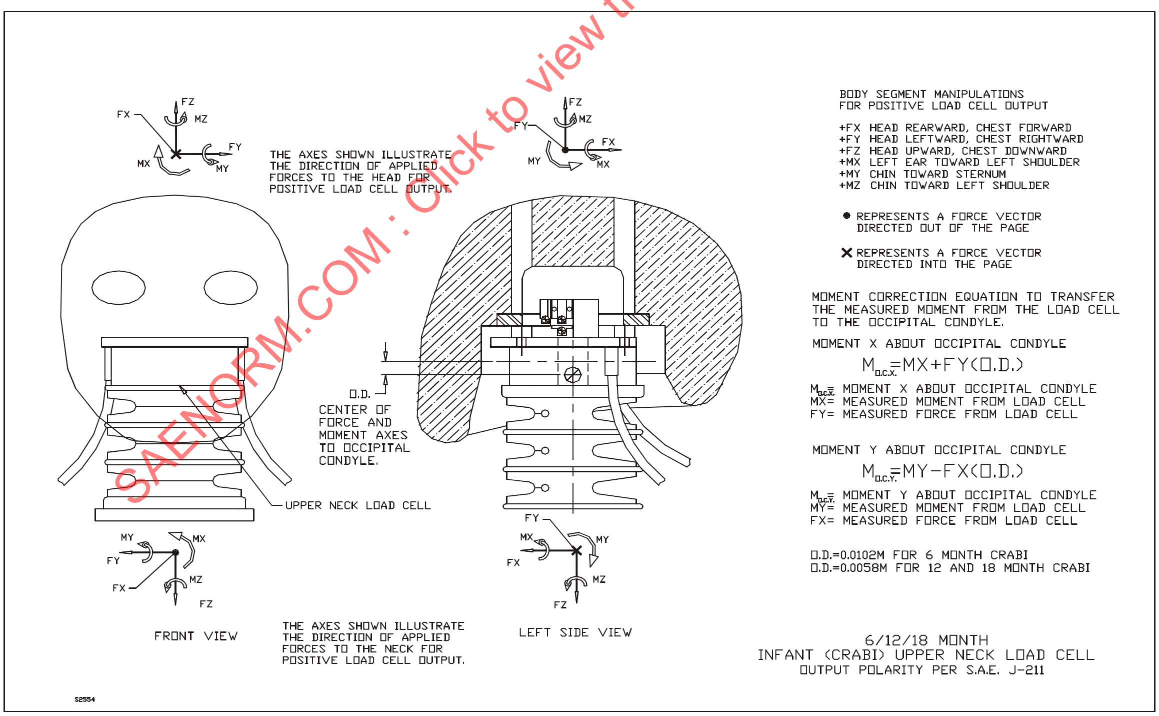


FIGURE 36 - UPPER NECK LOAD CELL

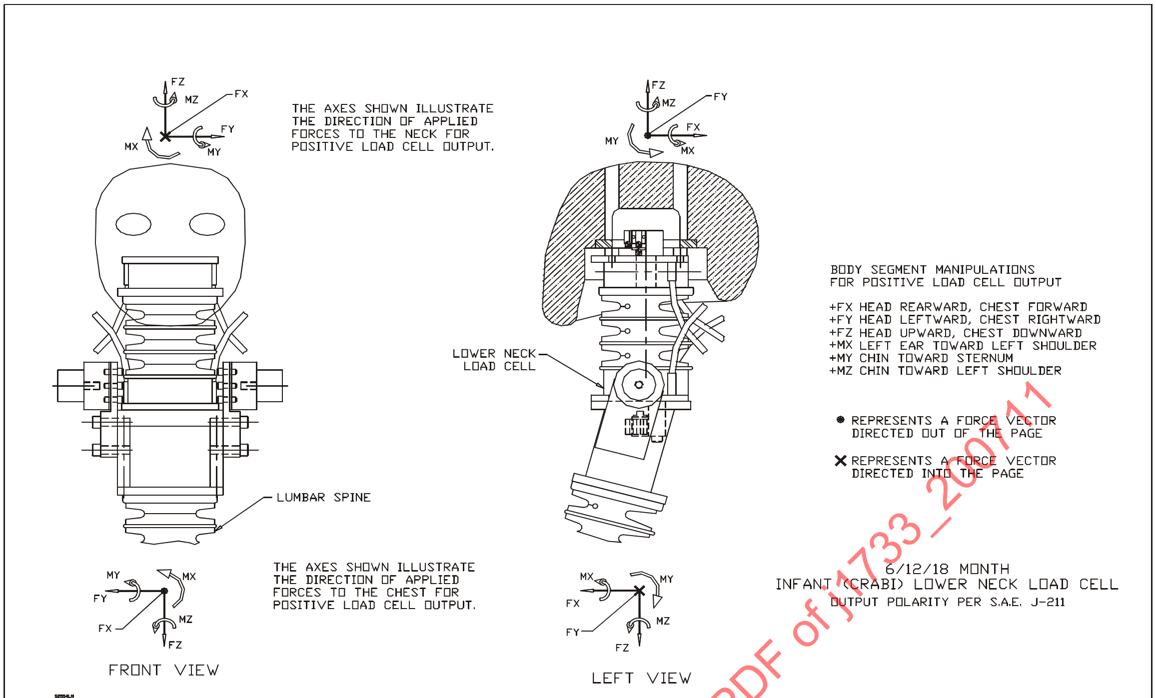


FIGURE 37 - LOWER NECK LOAD CELL

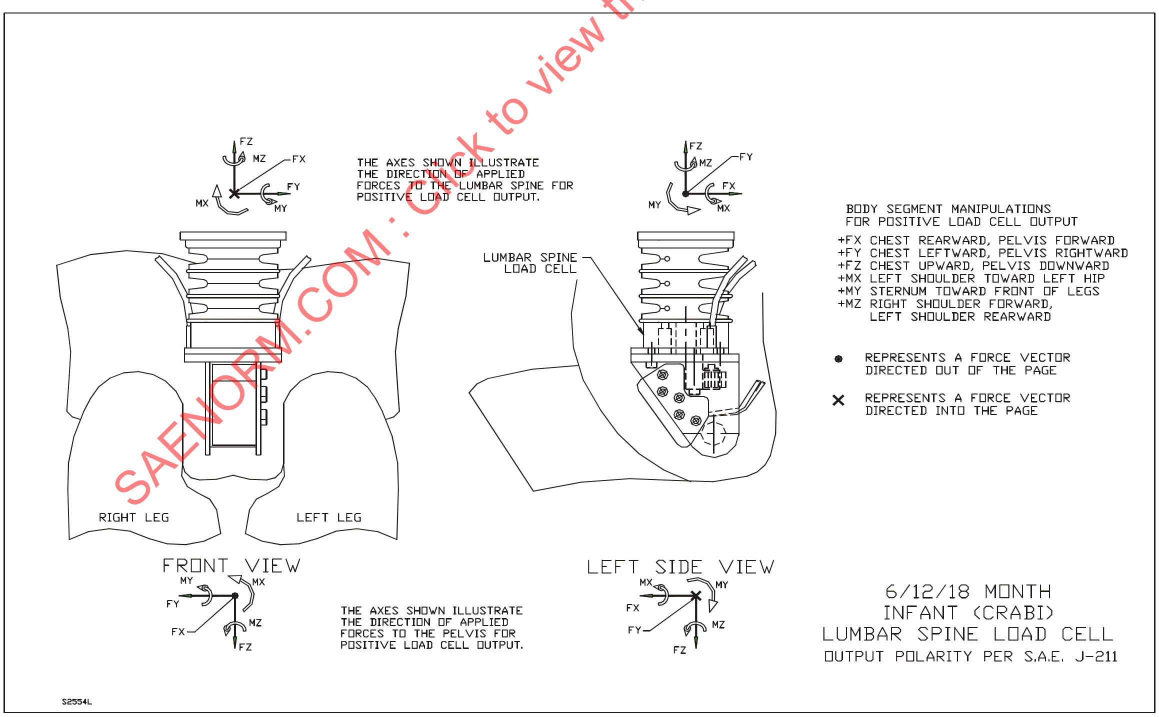


FIGURE 38 - LOWER LUMBAR SPINE LOAD CELL

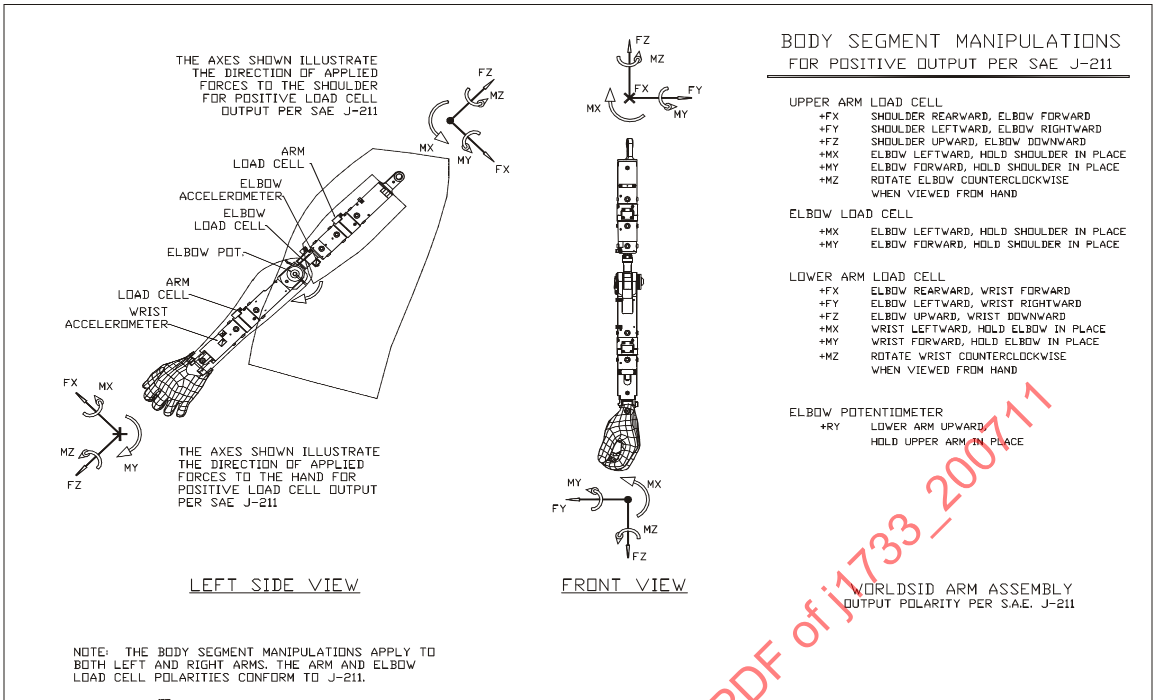


FIGURE 39 - UPPER AND LOWER ARM AND ELBOW LOAD CELLS

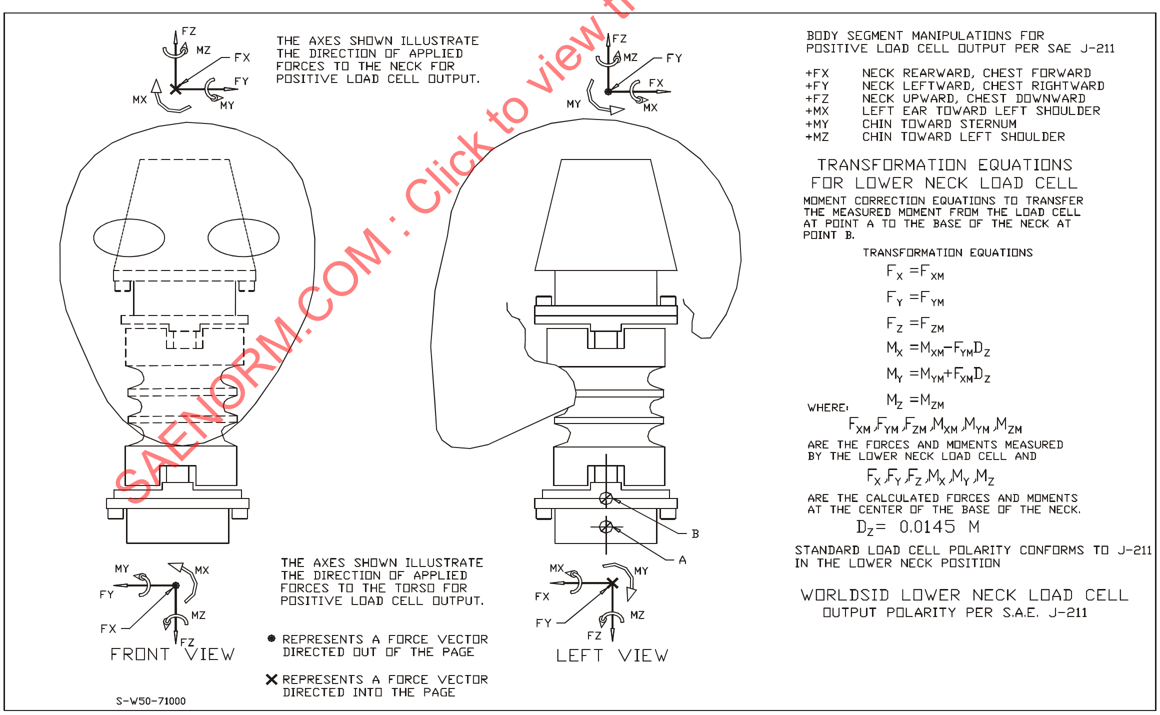


FIGURE 40 - LOWER NECK LOAD CELL

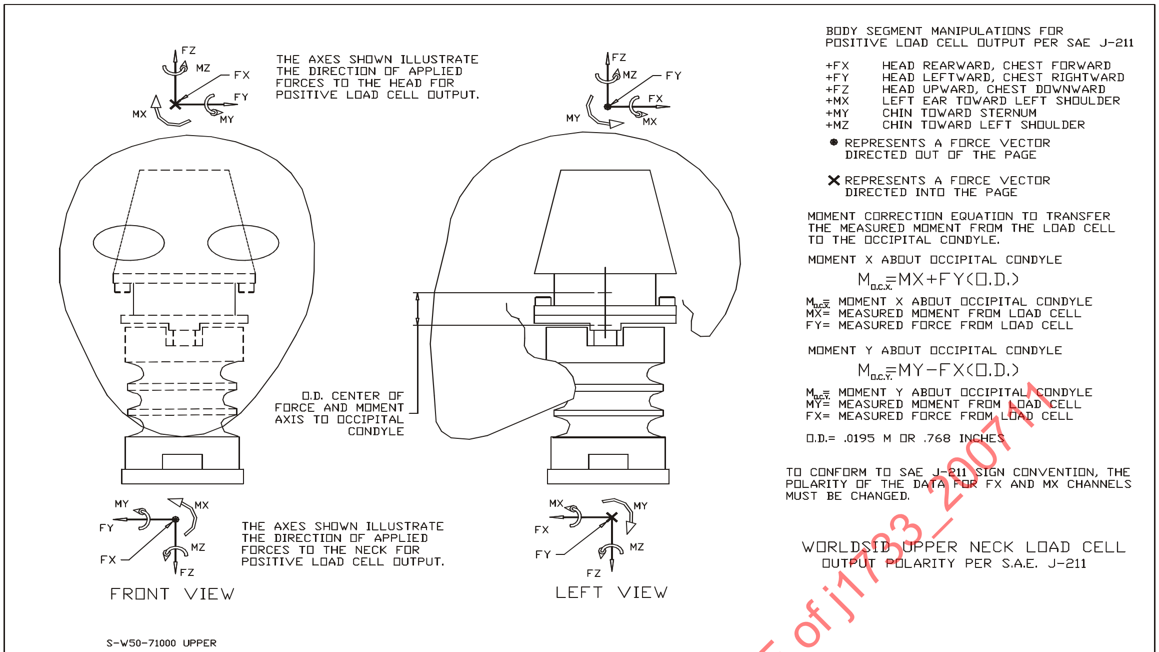


FIGURE 41 - UPPER NECK LOAD CELL

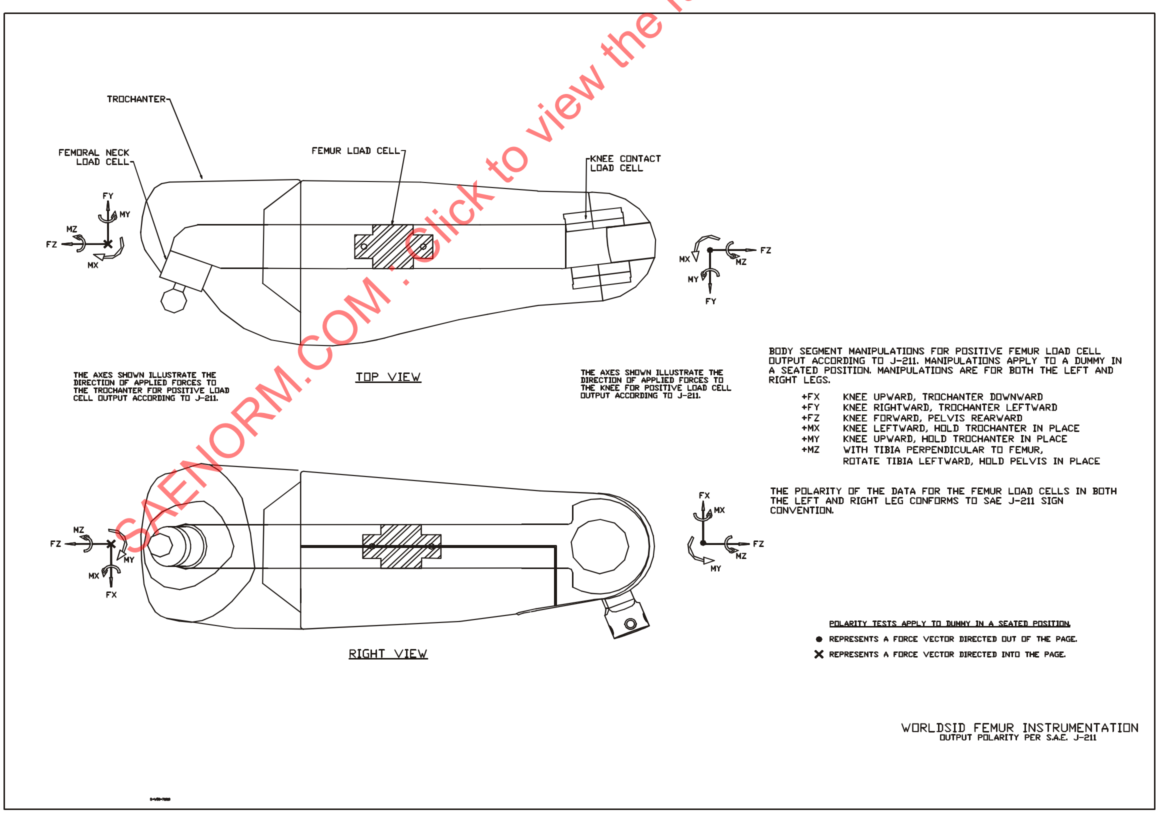


FIGURE 42 - FEMUR LOAD CELL

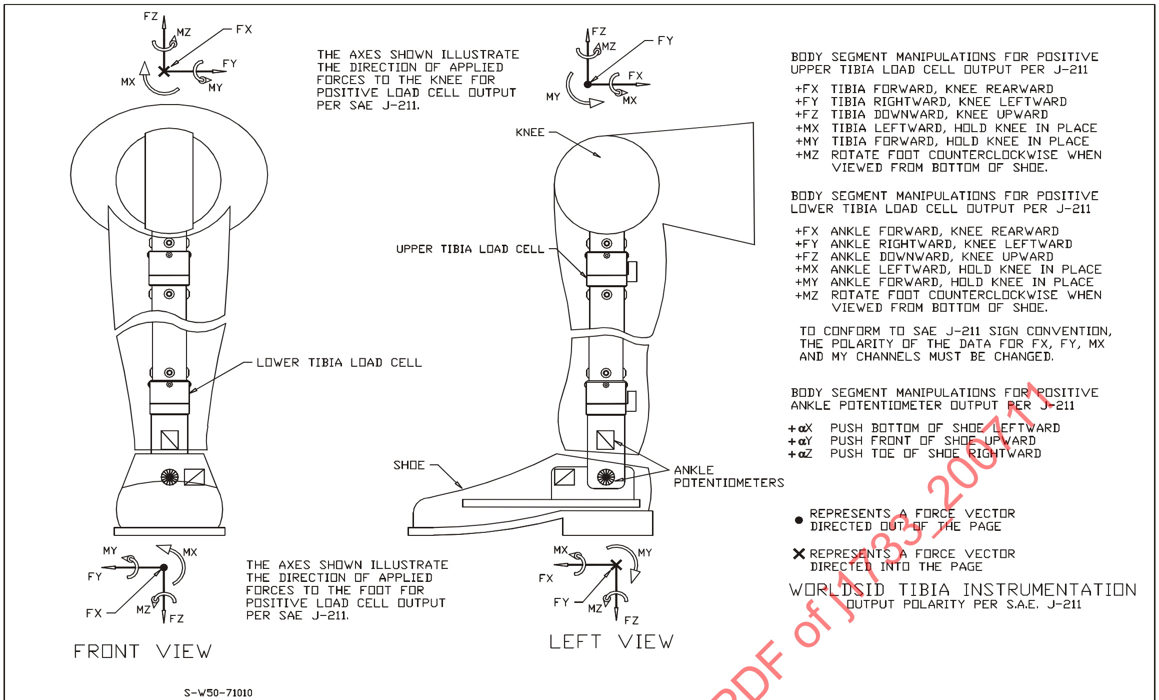


FIGURE 43 - UPPER AND LOWER TIBIA LOAD CELLS

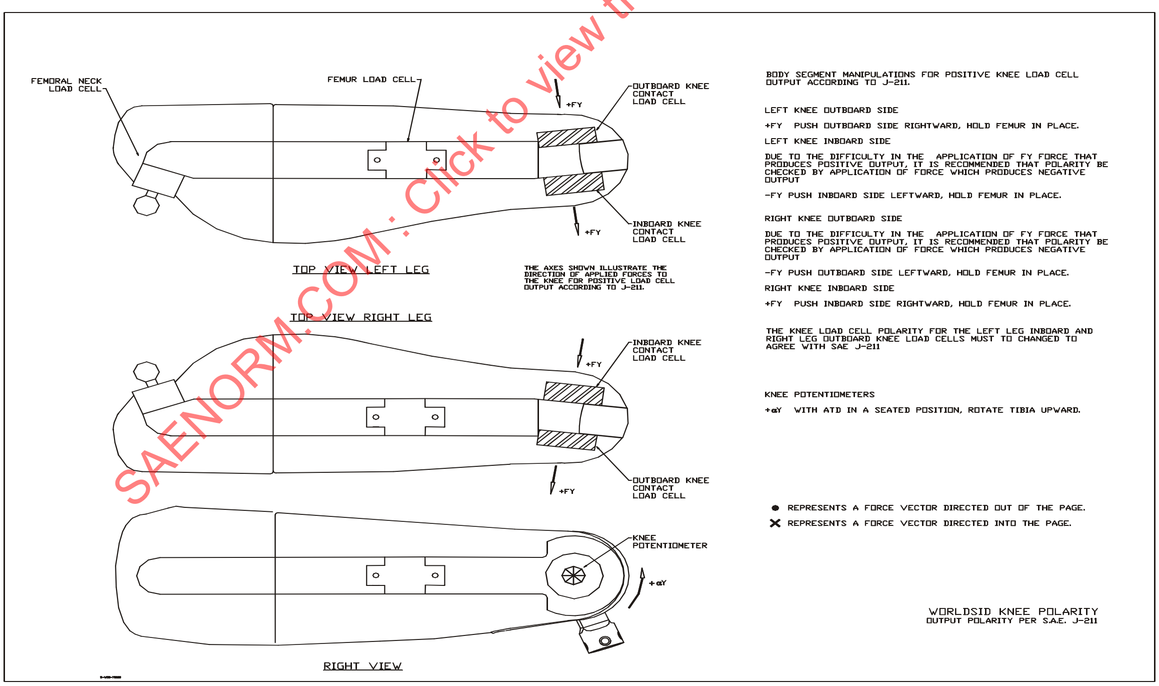


FIGURE 44 - KNEE LOAD CELL POLARITIES

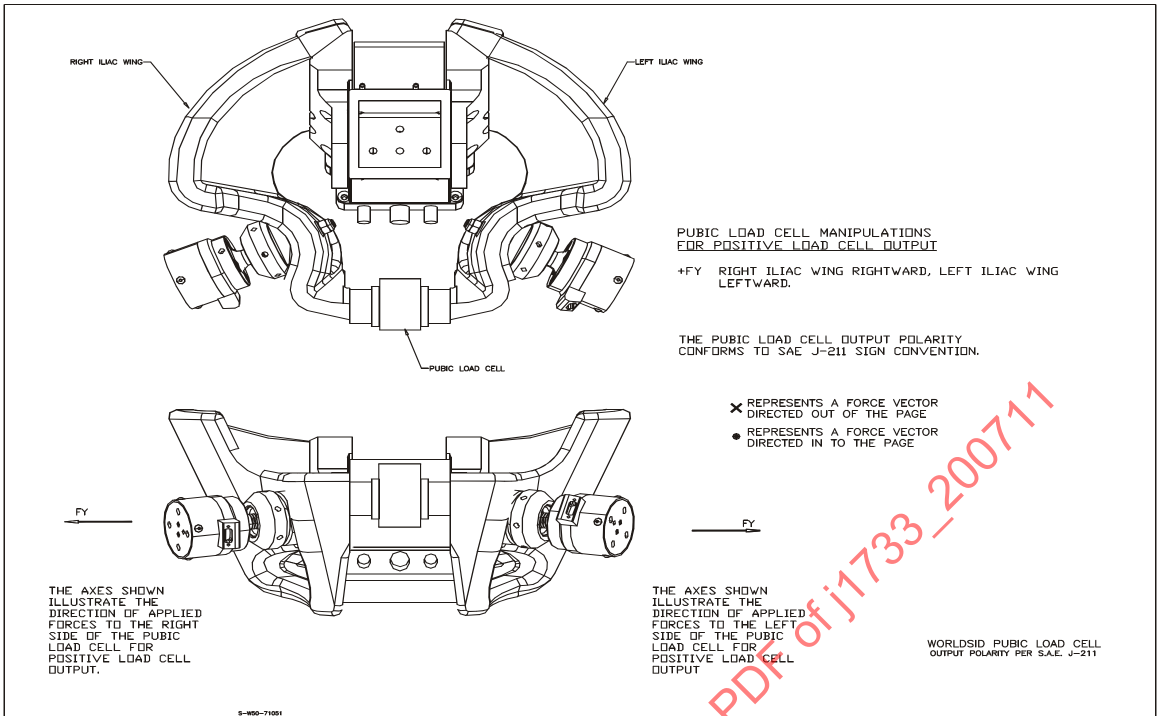


FIGURE 45 - PUBIC LOAD CELL

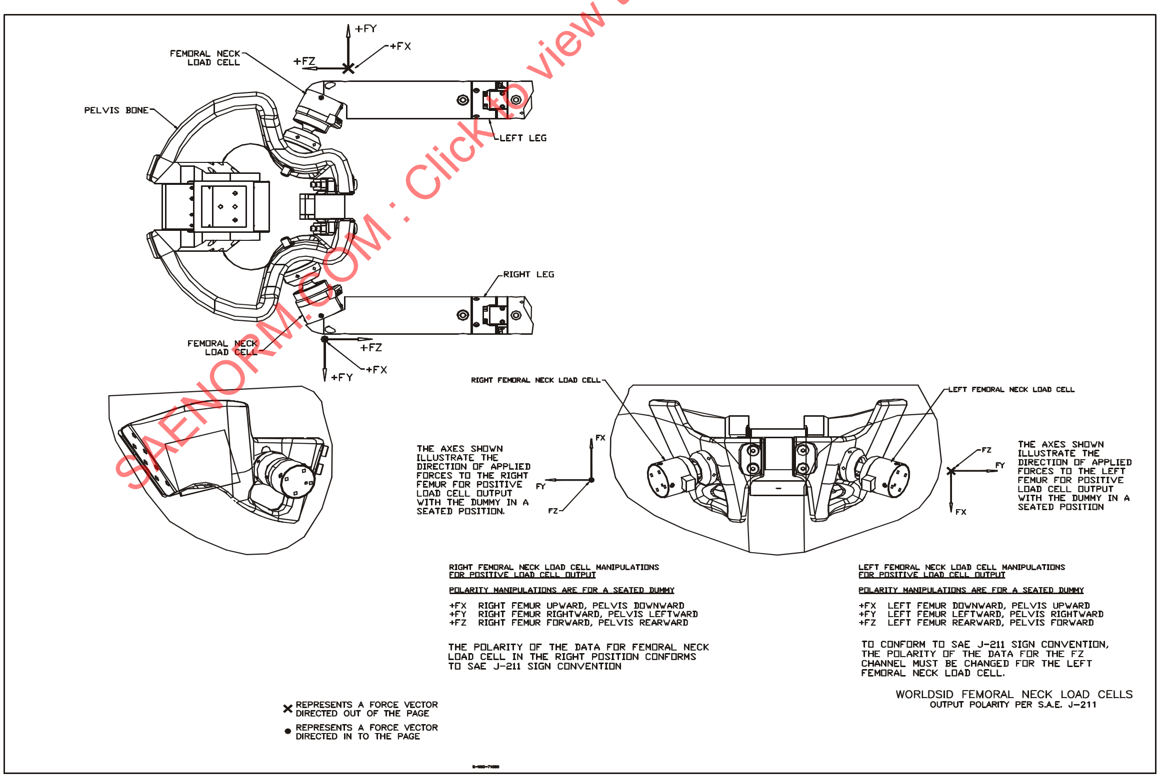


FIGURE 46 - FEMORAL NECK LOAD CELLS

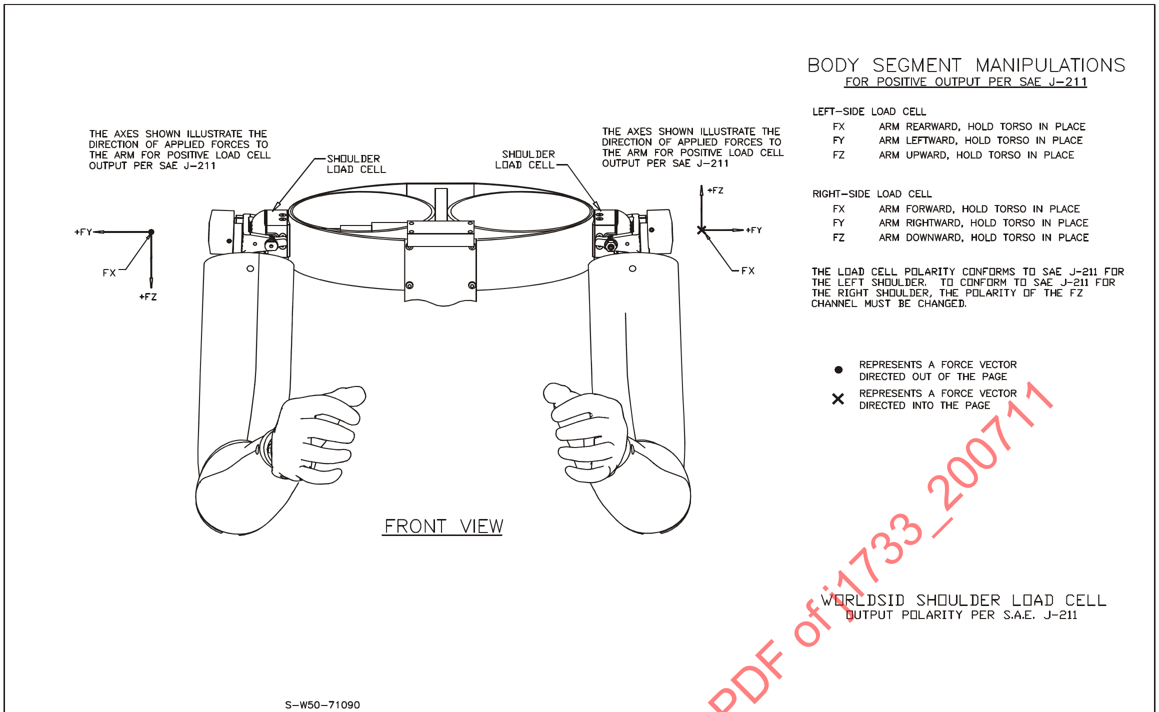


FIGURE 47 - SHOULDER LOAD CELL

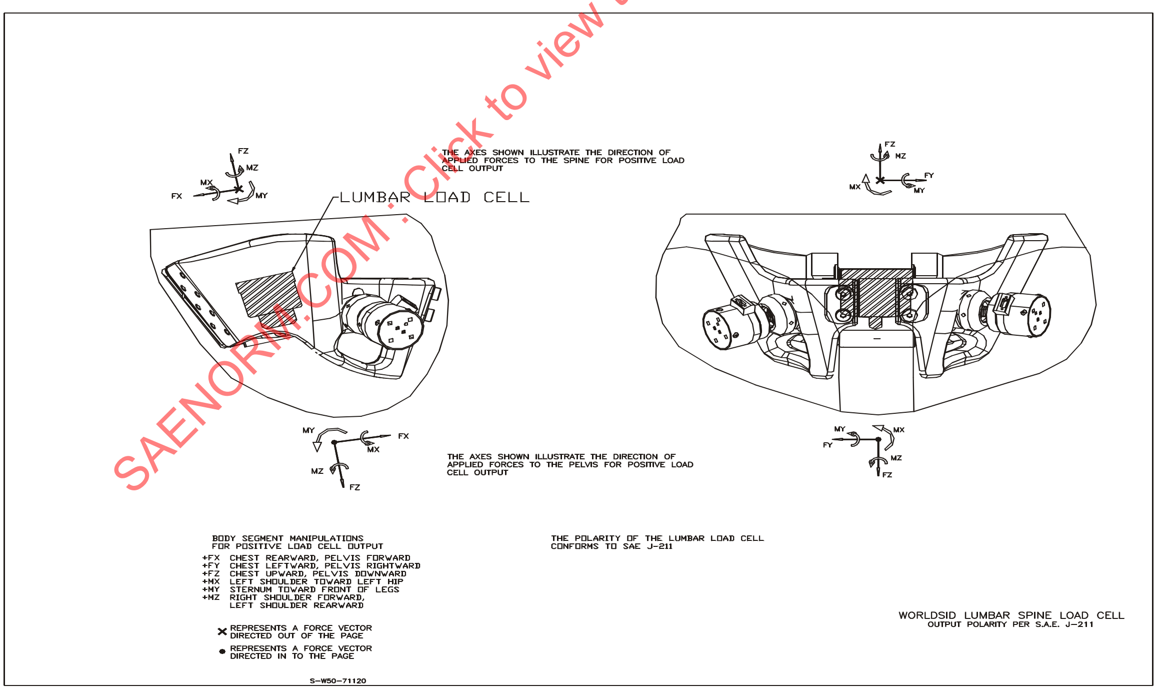


FIGURE 48 - LUMBAR SPINE LOAD CELL

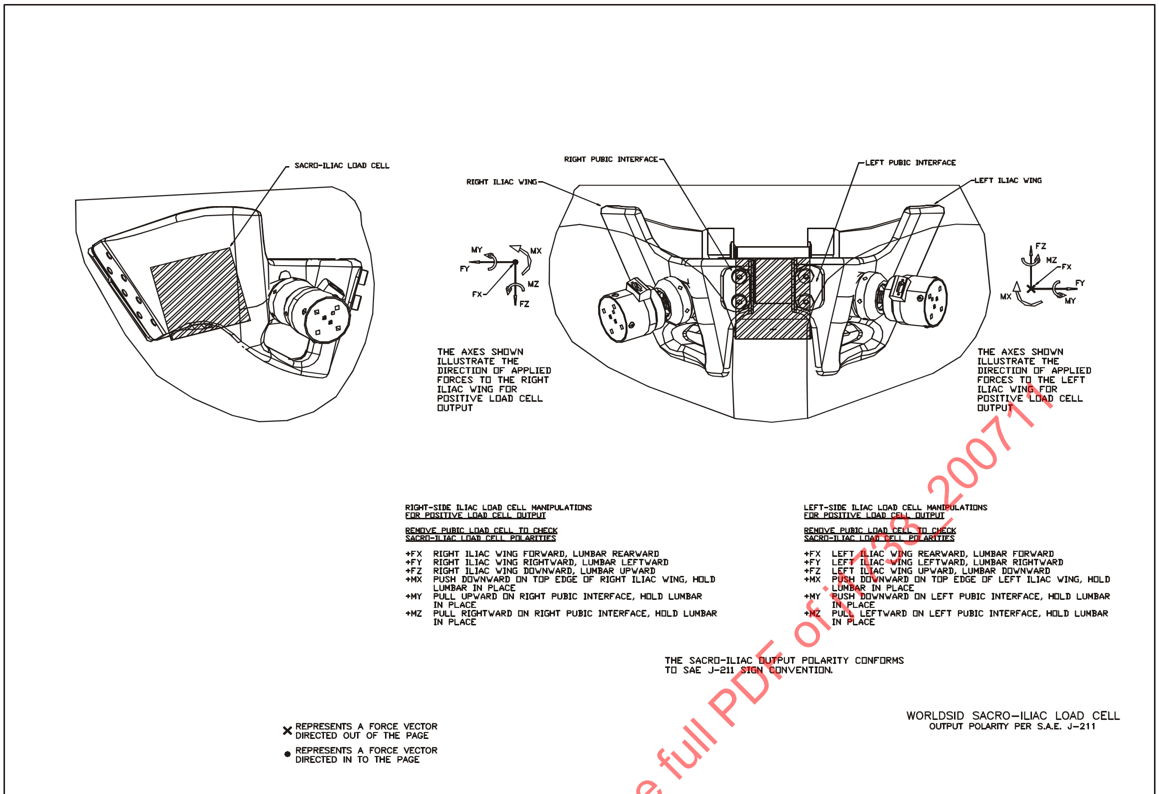
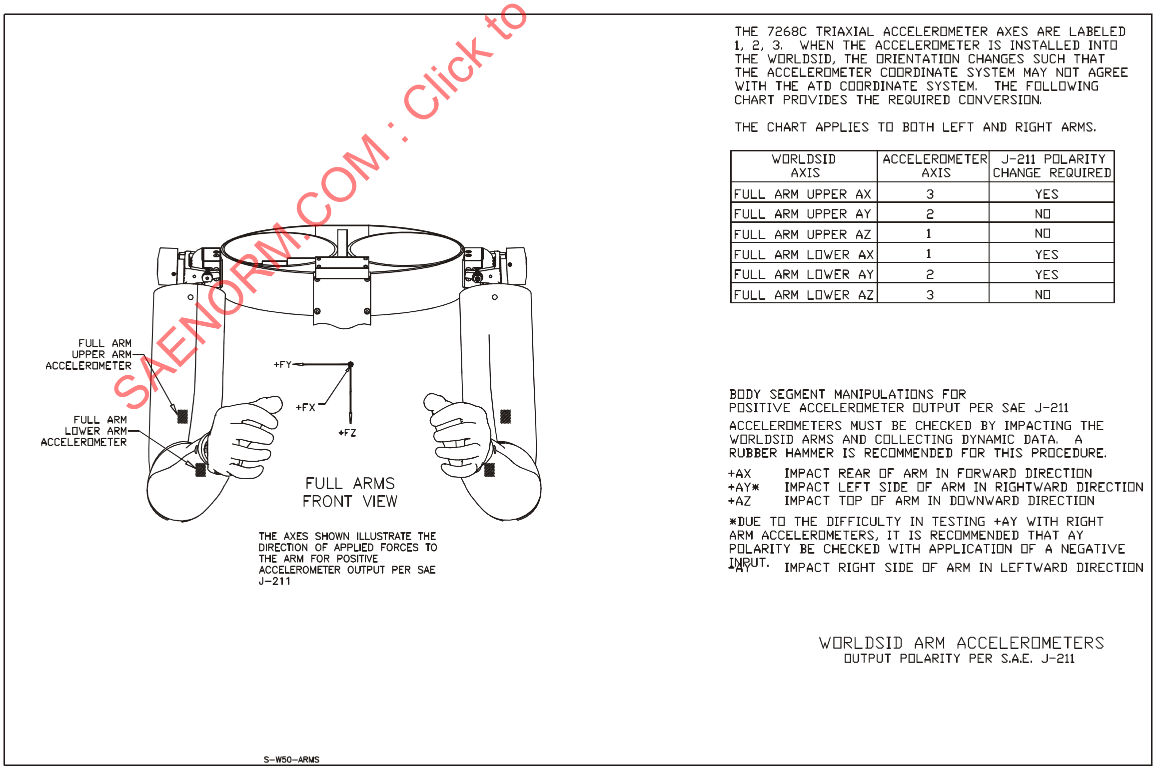


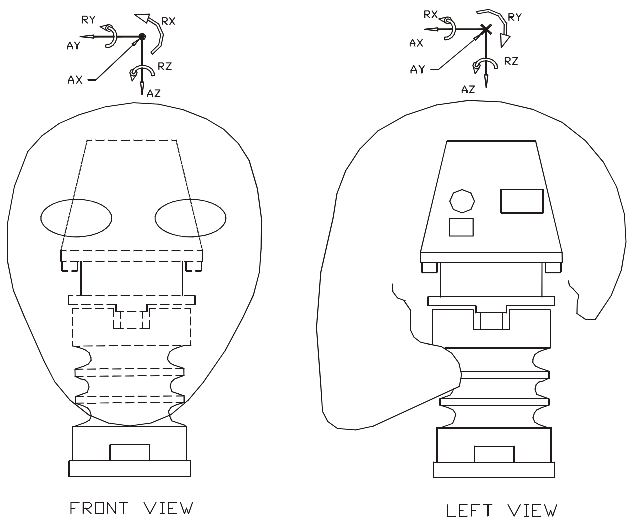
FIGURE 49 - SACRO-ILIAC LOAD CELL



WORLDSID AXIS	ACCELEROMETER AXIS	J-211 POLARITY CHANGE REQUIRED
FULL ARM UPPER AX	3	YES
FULL ARM UPPER AY	2	NO
FULL ARM UPPER AZ	1	NO
FULL ARM LOWER AX	1	YES
FULL ARM LOWER AY	2	YES
FULL ARM LOWER AZ	3	NO

FIGURE 50 - ARM ACCELEROMETERS

THE AXES SHOWN ILLUSTRATE THE DIRECTION OF APPLIED IMPACTS TO THE HEAD FOR POSITIVE ACCELEROMETER OUTPUT.



BODY SEGMENT MANIPULATIONS FOR POSITIVE ACCELEROMETER OUTPUT PER SAE J-211

ACCELEROMETERS MUST BE CHECKED BY IMPACTING THE WORLDSID HEAD AND COLLECTING DYNAMIC DATA. A RUBBER HAMMER IS RECOMMENDED FOR THIS PROCEDURE.

+AX IMPACT REAR OF HEAD IN FORWARD DIRECTION
+AY IMPACT LEFT SIDE OF HEAD IN RIGHTWARD DIRECTION
+AZ IMPACT TOP OF HEAD IN DOWNWARD DIRECTION
+RX IMPACT TOP LEFT OF HEAD IN RIGHTWARD DIRECTION
+RY IMPACT TOP FRONT OF HEAD IN REARWARD DIRECTION
+RZ IMPACT LEFT FRONT OF HEAD IN RIGHTWARD DIRECTION

THE 7268B TRIAXIAL ACCELEROMETER AXES ARE LABELED AX, AY, AZ. WHEN THE ACCELEROMETER IS INSTALLED INTO THE HEAD, THE ORIENTATION CHANGES SUCH THAT THE ACCELEROMETER COORDINATE SYSTEM DOES NOT AGREE WITH THE ATD COORDINATE SYSTEM. THE FOLLOWING CHART PROVIDES THE REQUIRED CONVERSION.

WORLDSID AXIS	ACCELEROMETER AXIS	J-211 POLARITY CHANGE REQUIRED
AX	1	NO
AY	3	NO
AZ	2	YES
RX	RX	YES
RY	RY	NO
RZ	RZ	NO

● REPRESENTS A FORCE VECTOR DIRECTED OUT OF THE PAGE

✕ REPRESENTS A FORCE VECTOR DIRECTED INTO THE PAGE

WORLDSID HEAD ACCELEROMETERS
OUTPUT POLARITY PER S.A.E. J-211

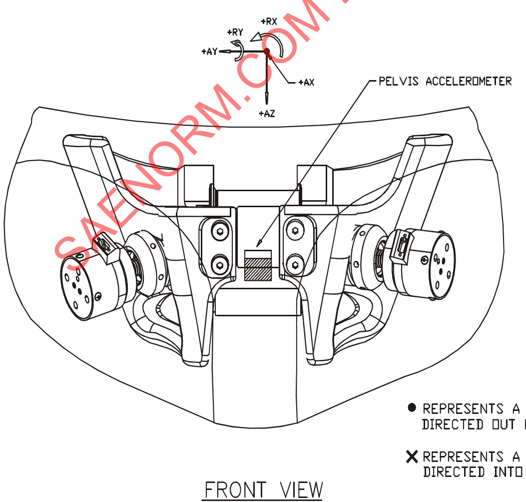
J-W50-11000

FIGURE 51 - HEAD ACCELEROMETERS

BODY SEGMENT MANIPULATIONS FOR POSITIVE ACCELEROMETER OUTPUT PER SAE J-211

ACCELEROMETERS MUST BE CHECKED BY IMPACTING THE WORLDSID PELVIS AND COLLECTING DYNAMIC DATA. A RUBBER HAMMER IS RECOMMENDED FOR THIS PROCEDURE.

+AX IMPACT REAR OF PELVIS IN FORWARD DIRECTION
+AY IMPACT LEFT SIDE OF PELVIS IN RIGHTWARD DIRECTION
+AZ IMPACT TOP OF PELVIS IN DOWNWARD DIRECTION



THE 7268B TRIAXIAL ACCELEROMETER AXES ARE LABELED AX, AY, AZ. WHEN THE ACCELEROMETER IS INSTALLED INTO THE WORLDSID, THE ORIENTATION CHANGES SUCH THAT THE ACCELEROMETER COORDINATE SYSTEM MAY NOT AGREE WITH THE ATD COORDINATE SYSTEM. THE FOLLOWING CHART PROVIDES THE REQUIRED CONVERSION.

WORLDSID AXIS	ACCELEROMETER AXIS	J-211 POLARITY CHANGE REQUIRED
PELVIS AX	3	YES
PELVIS AY	2	NO
PELVIS AZ	1	NO

● REPRESENTS A FORCE VECTOR DIRECTED OUT OF THE PAGE

✕ REPRESENTS A FORCE VECTOR DIRECTED INTO THE PAGE

WORLDSID PELVIS ACCELEROMETERS
OUTPUT POLARITY PER SAE J-211

J-W50-PELVIS

FIGURE 52 - PELVIS ACCELEROMETERS