LSTC Hybrid III 50^{th} Fast Dummy

Positioning & Post-Processing

Dummy Version: LSTC.H3_50TH_FAST.111130_V2.0
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INTRODUCTION

This document contains recommended procedures for performing dummy positioning and post-processing (response extraction) using LS-PrePost.

VERSION 2.0 RELEASE NOTE

This release contains the Hybrid III 50th Percentile Fast Dummy. All feedback is appreciated. Comments and suggestions can be sent to ***atds@lstc.com***.

LS-PREPOST VERSION

LS-PrePost 3.2 is required, particularly for the POSITIONING portion of this document. We recommend downloading the latest build for your OS from ***http://ftp.lstc.com/anonymous/outgoing/lsprepost/3.2/***

UNITS

All LSTC dummies use the ***mm-ms-kg-kN*** unit system. See Appendix C for help on unit system conversions.

GENERAL RECOMMENDATIONS

To achieve results consistent with the calibration results presented in this document, run with a time step of 1 microsecond or smaller.

To obtain acceleration data that can be effectively filtered, use a *DATABASE_NODOUT output interval of 0.01 millisecond or smaller.

CALIBRATION

50th Neck Extension Test

Parameter		Specification	Result
Pendulum Impact Speed		5.94 m/s ≤ speed ≤ 6.19 m/s	6.06 m/s
Pendulum Deceleration vs. Time Pulse	@ 10 ms	17.2 ≤ g ≤ 21.2	17.22 gs
	@ 20 ms	14.0 ≤ g ≤ 19.0	16.55 gs
	@ 30 ms	11.0 ≤ g ≤ 16.0	13.16 gs
	> 30 ms	22.0 g maximum	Met
First Pendulum Decay to 5 g		38 ms ≤ time ≤ 46 ms	39.9 ms
Plane D Rotation		81° ≤ maximum rotation ≤ 106°	105.0°
		72 ms ≤ time of maximum rotation ≤ 82 ms	78 ms
Time for Plane D Rotation to Cross 0° During First Rebound		147 ms ≤ time ≤ 174 ms	170 ms
Maximum Moment		-80.0 Nm ≤ moment ≤ -52.9 Nm	-64.35 Nm
		65 ms ≤ time ≤ 79 ms	70.9 ms
Negative Moment Decay		Time of First Decay to 0 Nm 120 ms ≤ time ≤ 148 ms	121.9 ms

50th Neck Flexion Test

Parameter		Specification	Result
Pendulum Impact Speed		6.89 m/s ≤ speed ≤ 7.13 m/s	7.02 m/s
Pendulum Deceleration vs. Time Pulse	@ 10 ms	22.5 ≤ g ≤ 27.5	23.22 gs
	@ 20 ms	17.6 ≤ g ≤ 22.6	19.50 gs
	@ 30 ms	12.5 ≤ g ≤ 18.5	17.60 gs
	> 30 ms	29.0 g maximum	Met
First Pendulum Decay to 5 g		34 ms ≤ time ≤ 42 ms	34.8 ms
Plane D Rotation		64° ≤ maximum rotation ≤ 78°	**78.5°**
		57 ms ≤ time of maximum rotation ≤ 64 ms	59.8 ms
Time for Plane D Rotation to Cross 0° During First Rebound		113 ms ≤ time ≤ 128 ms	121.8 ms
Maximum Moment		88.1 Nm ≤ moment ≤ 108.5 Nm	95.00 Nm
		47 ms ≤ time ≤ 58 ms	50.7 ms
Positive Moment Decay		Time of First Decay to 0 Nm 97 ms ≤ time ≤ 107 ms	**108.0 ms**

Note: bold entries are narrowly out of range

50th Thorax Impact

Parameter	Specification	Result
Test Probe Speed	6.59 m/s ≤ speed ≤ 6.83 m/s	6.71 m/s
Chest Compression	63.5 mm ≤ compression ≤ 72.6 mm	69.3 mm
Peak Resistance Force	5160 N ≤ peak force ≤ 5894 N	5362 N
Internal Hysteresis	69% ≤ hysteresis ≤ 85%	74.53%

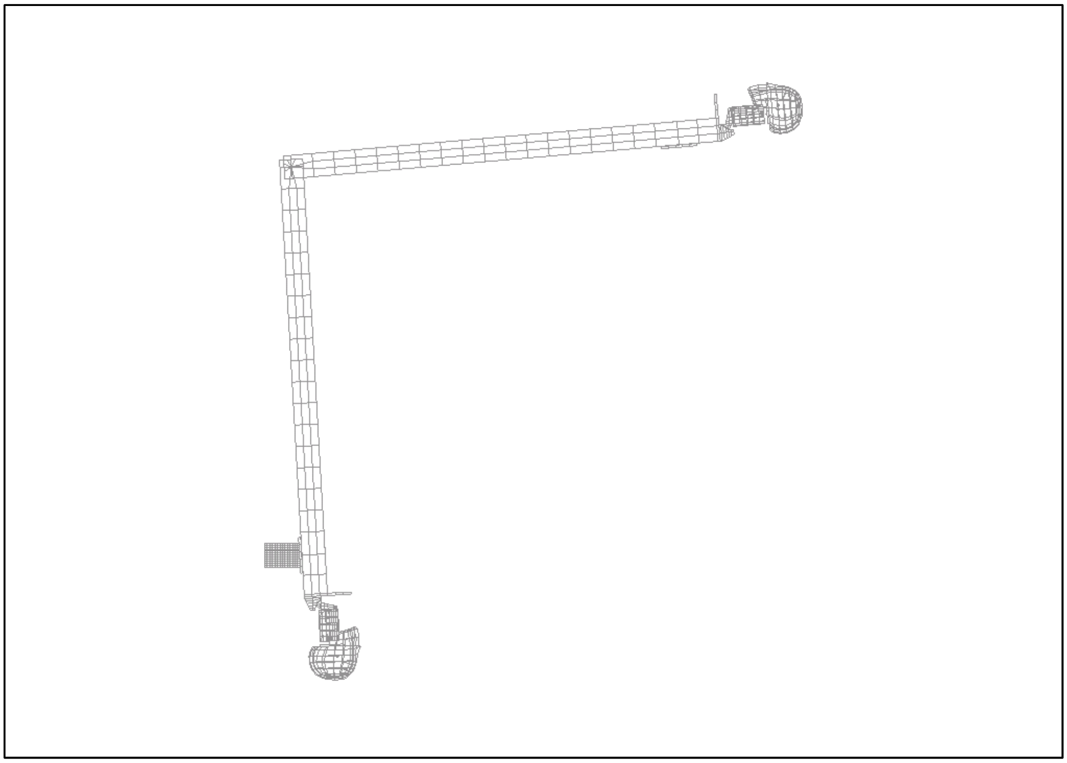

Figure 1 - Neck Extension Pendulum Positions

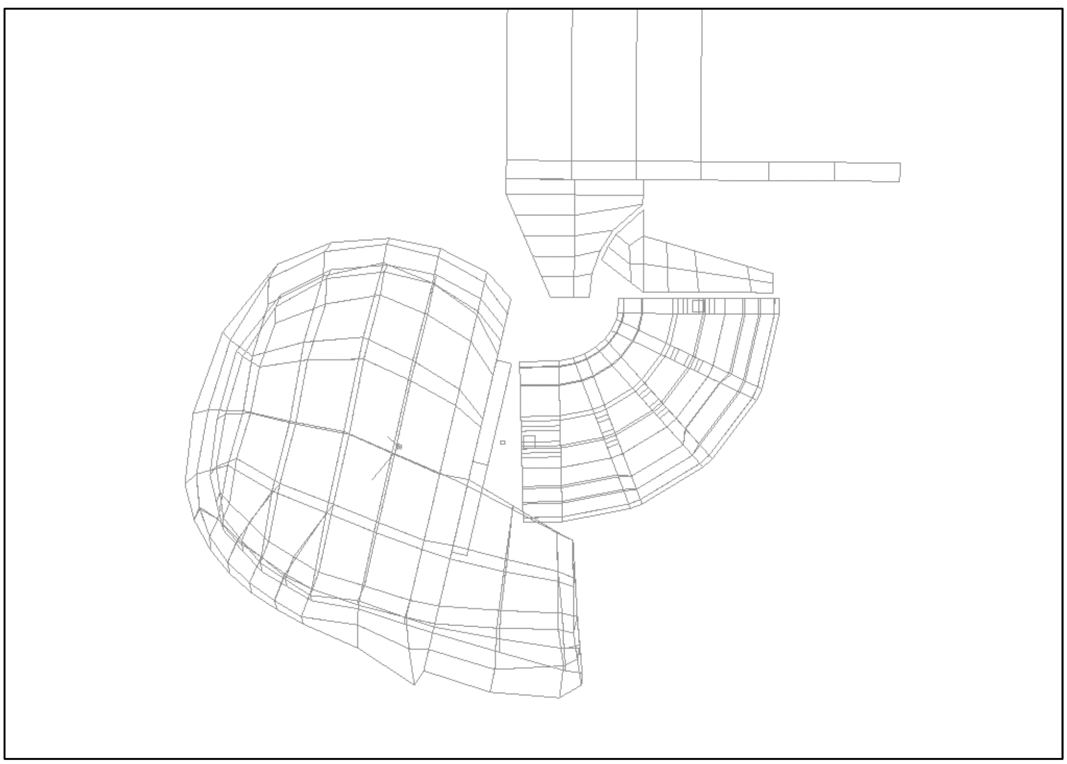

Figure 2 - Neck Extension Extreme Position

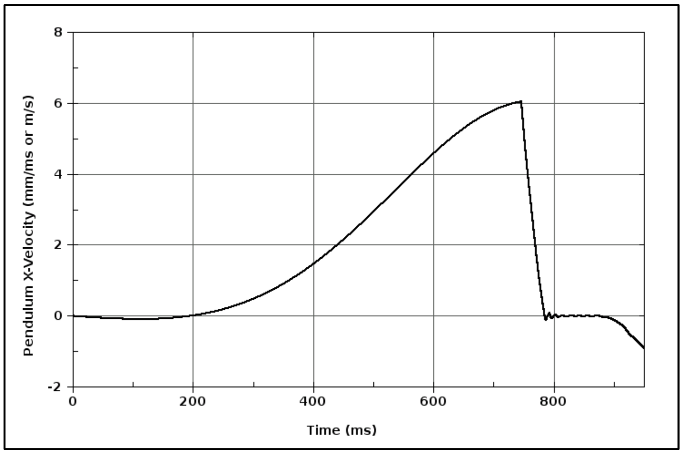

Figure 3 - Neck Extension Pendulum Velocity

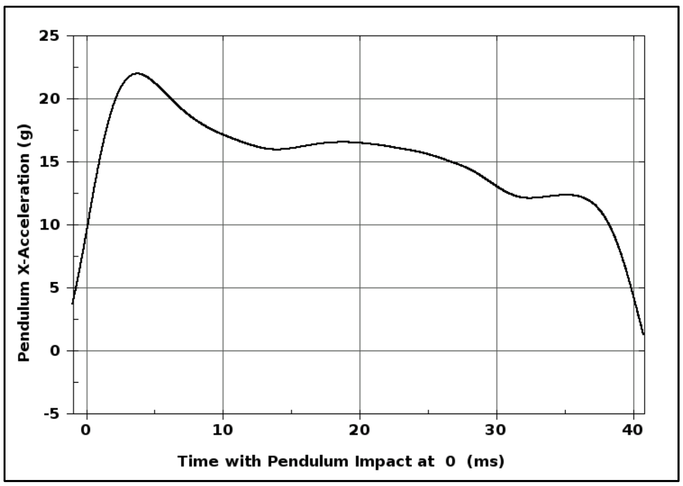

Figure 4 - Neck Extension Pendulum Acceleration

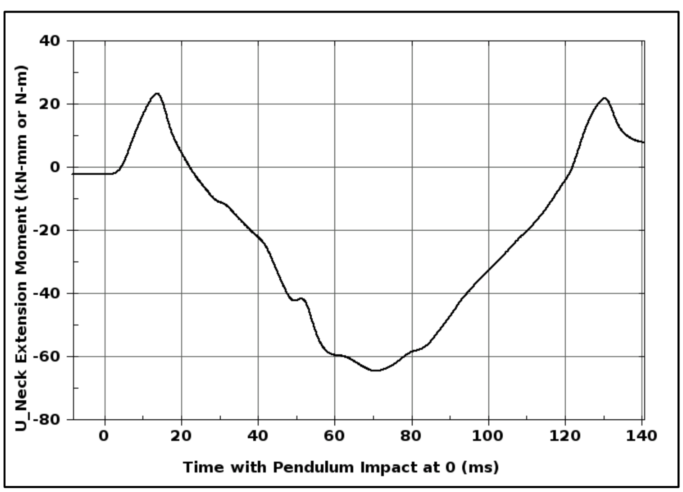

Figure 5 - Neck Extension Upper Neck Moment

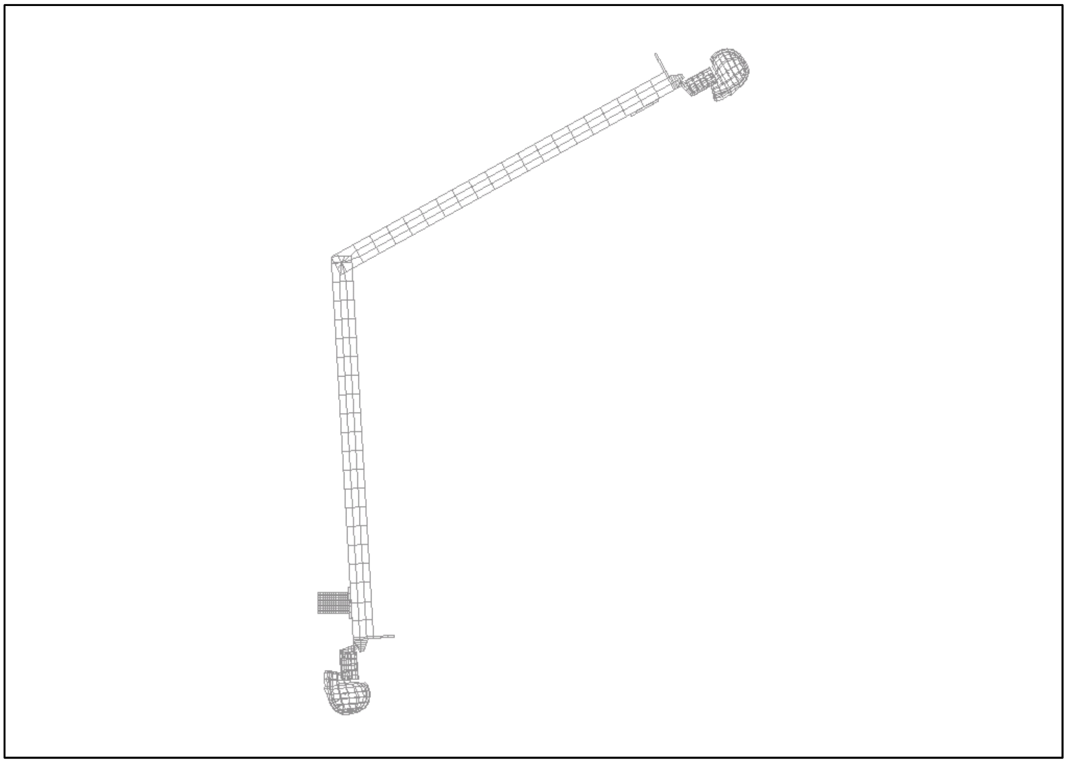

Figure 6 - Neck Flexion Pendulum Positions

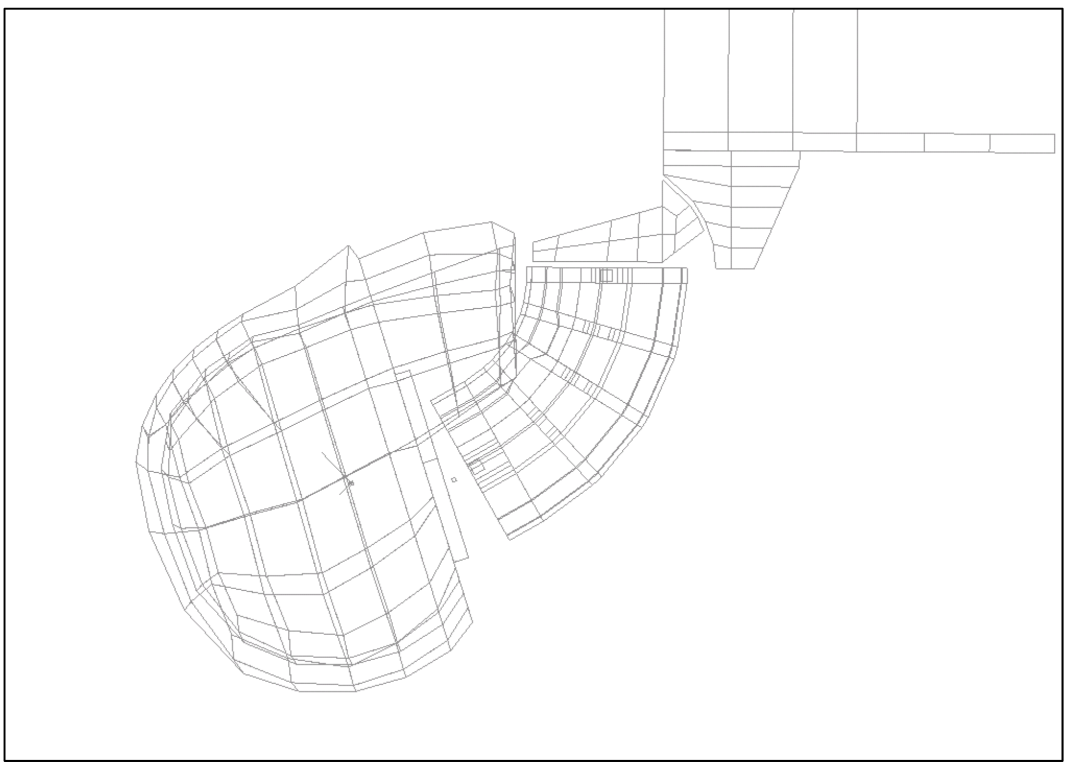

Figure 7 - Neck Flexion Extreme Position

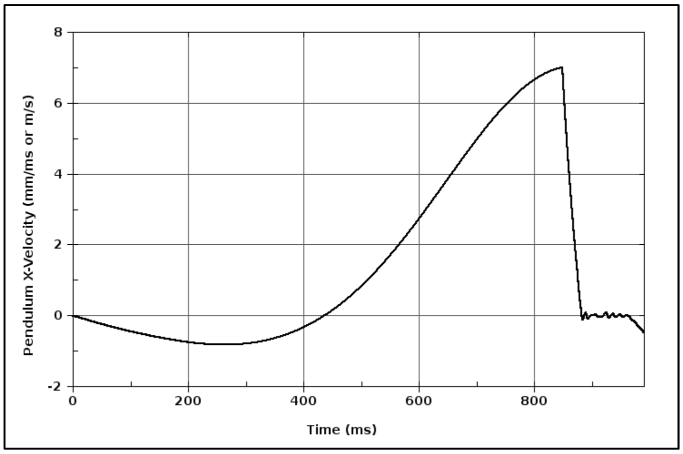

Figure 8 - Neck Flexion Pendulum Velocity

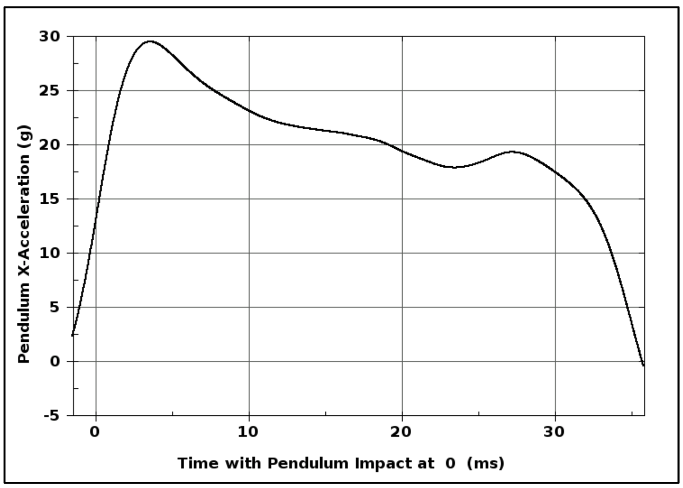

Figure 9 - Neck Flexion Pendulum Acceleration

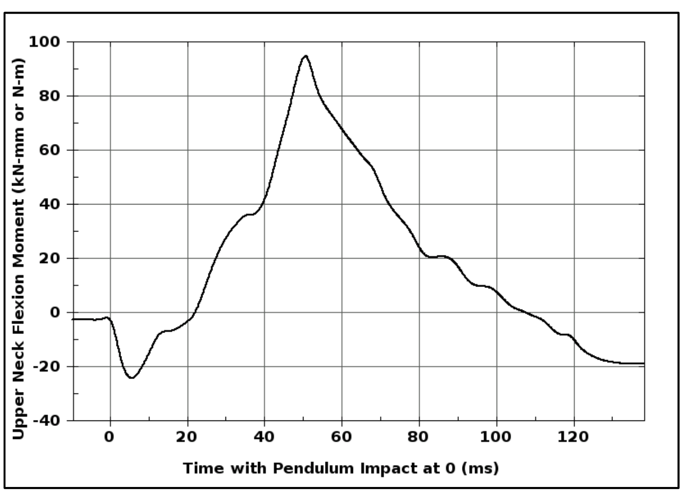

Figure 10 - Neck Flexion Upper Neck Moment

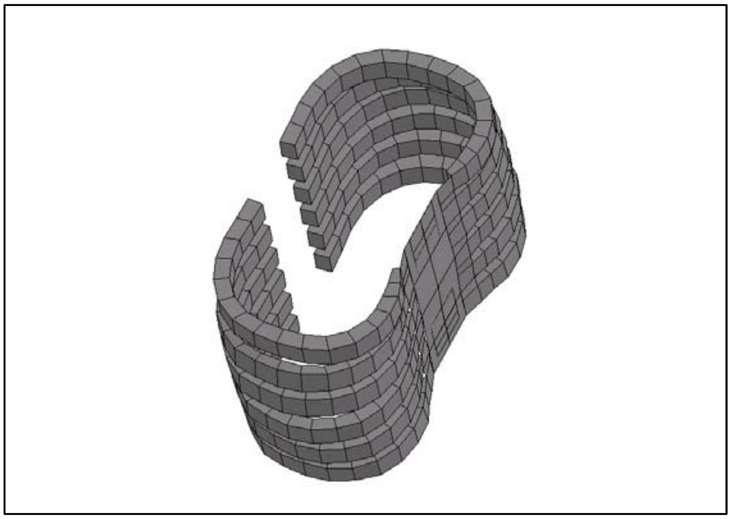

Figure 11 - Chest Calibration Rib Collapse

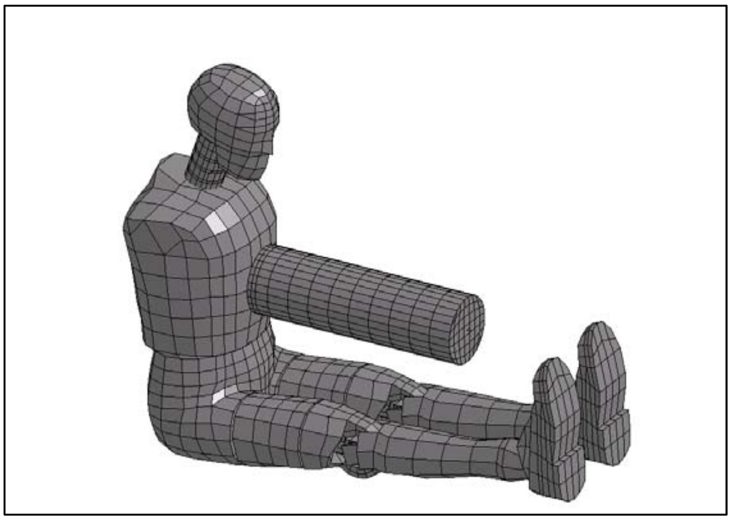

Figure 12 - Chest Calibration Starting Picture

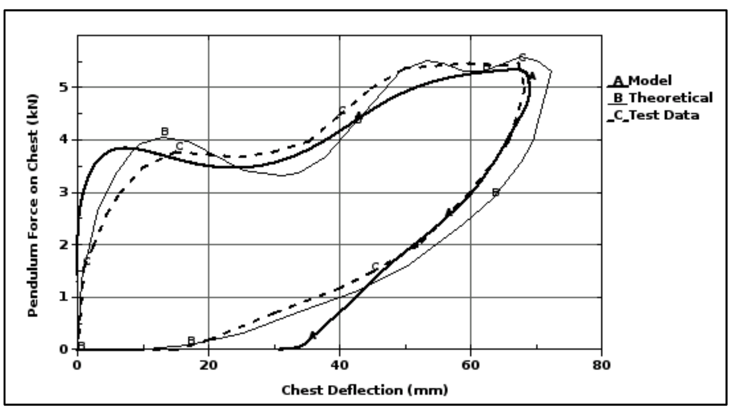

Figure 13 - Chest Calibration Force Deflection

POSITIONING

There are many ways in which dummies can be positioned and included in an LS-DYNA analysis, but this documentation will focus on the following common approach:

1. Load vehicle/structure into LS-PrePost (File > Open > LS-DYNA Keyword File)
2. Import dummy model (File > Import > LS-DYNA Keyword File)
    a. Click “Setting Offset” in the Import File dialog
    b. Enter Default Offset: 1000000 (we suggest offsetting by a number such as one million so that the entity IDs referenced in the POST-PROCESSING section correspond to those in your model)
    c. Click “Set”
    d. Click “Import”
3. Position dummy
4. Write out positioned dummy as a separate file
5. Setup dummy contacts (see APPENDIX A)
6. Write out vehicle/structure as a separate file (with contacts)
7. Include positioned dummy in analysis using *INCLUDE

For anyone interested, the offsetting described in step 2b can also be performed independently of positioning the dummy. The instructions for this can be found in APPENDIX B. However, we do not recommend using *INCLUDE_TRANSFORM to offset dummy IDs because LS-DYNA does not offset the corresponding tree file IDs in the process. Instead, we recommend transforming dummy IDs within LS-PrePost only. The following sections explain steps 3-4 above in greater detail.

H-Point Positioning

The dummy “as supplied" is in a rear-facing, upright sitting position. Some important information regarding the H-Point:

I. The H-Point is located at global 0,0,0 (NID 10201)
II. A “Rigid Marker” sits at the H-Point for convenient visualization (PID 236)
III. A local coordinate system has its origin at the H-Point (CSID 66, which is parallel to the global axis in the “as supplied” position)
IV. These 3 entities are rigidly attached to the dummy and rotate/travel with it

Once the dummy is imported into your model, positioning begins as follows:

1. Go to Application > Dummy Positioning
2. Select “H-Point operations”
3. Select “Translate”
4. Enter X,Y,Z coordinates for the H-Point (hitting *Enter* after each) ***or*** enter a “Distance” value and use the “+/-“ buttons to translate the dummy

Note that the H-Point location gets continuously updated as adjustments are made to “Global X”, “Global Y”, and “Global Z”. If a pre-positioned dummy is read into LS-PrePost, the H-Point location is displayed immediately.

Pelvic Rotations

1. Select "H-Point operations" (should already be selected)
2. Select "Rotate"
3. Select "Local" (operations here will "successively rotate" CSID 66 in any order chosen by the user about the X, Y, and Z Axes)
4. Select "Z Axis"
5. Enter a "Rot. Ang." value (in degrees) and use the "+/-" buttons to rotate the dummy
6. Repeat steps 4-5 for the X and Y axes if desired

Two methods are available to report the angles the dummy has been rotated by (relative to the "as supplied" position). When reporting these angles, we cannot keep track of the exact sequence in which a user chooses to perform rotations. However, we can always report at least one sequence of rotation angles that would result in the current position.

There are "12 distinct sequences of rotations" that can be adopted. Divided into 2 groups of 6, they are:

- Bryant Angle rotations: XYZ, XZY, YXZ, YZX, ZXY, and ZYX
- Euler Angle rotations: XYX, XZX, YXY, YZY, ZXZ, and ZYZ

Note that in the Bryant Angle scheme, all three axes are different, whereas in the Euler Angle scheme, the first and the third axes are the same.

Since we cannot report all twelve schemes, we have chosen what we consider the most important one from each group: the Bryant ZYX and the Euler ZYZ. This was based on the idea that for most dummy positioning scenarios, rotations about the X axis are very unlikely because this places the dummy on its side. Usually the first two rotations in either scheme with suffice (Z and Y).

As the dummy is rotated, the angles are continuously updated and reported. One can toggle between the ZYX and ZYZ tabs in the lower panel to view the output. Also, if a pre-positioned dummy is read into LS-PrePost, the ZYX and ZYZ output will be displayed immediately. We recommend reviewing both sets of angles because often one is more "intuitive" than the other.

Limb Rotations

1. Select "Limb operations"
2. Select the limb you would like to rotate by LEFT-clicking in the list or RIGHT-clicking directly in the graphics window
   Note that as soon as a limb is selected, a pair of local coordinate systems appears on the screen. One is attached to the "parent component", and the other is attached to the "child". Initially, both are coincident, and their origin represents the joint location about which the limb can rotate.
3. To rotate the Limb, drag from side-to-side while holding down the left mouse button or enter a "Rot. Ang." Value and use the "+/-" buttons
   Note that during this operation the "child LCS" will rotate with respect to the "parent"

Please note that not all degrees of freedom are active for every joint. Many limb joints are "revolute" and have only one axis of rotation available. The other axes cannot even be selected (they are grayed-out). For "spherical" joints, two or more axes of rotation can be selected.

Also note that certain “stop angles" that have been defined in the dummy model beyond which limbs cannot rotate. A message appears on the screen when such a condition is met. For spherical joints, even when an axis of rotation can be selected, one may not be able to rotate about it because the defined stop angles may be very small (~0.1 degrees). This is to prevent the limb from rotating in a non-physical way, and this feature cannot be overridden inside LS-PrePost. The only way to change it is to modify the stop angles in the input deck, but this is ***not*** recommended.

Lumbar Rotations

1. Load the dummy model in LS-PrePost 3.2 or later
   Note that LS-PrePost will automatically open the Dummy Positioning interface.
2. Select “Lumbar Operations”
3. Enter any value for “Total rotated angle”
   Note that his angle is absolute and not additive. In other words, the angle is always with respect to the “as released” curvature. To clearly see the rotation, enter a large value (ex: 45) and turn off the jacket and pelvis.
4. Click “Apply”
5. Click “+” or “-“ next to “Increment” to make minor adjustments (this step is optional)
6. Click “Accept”

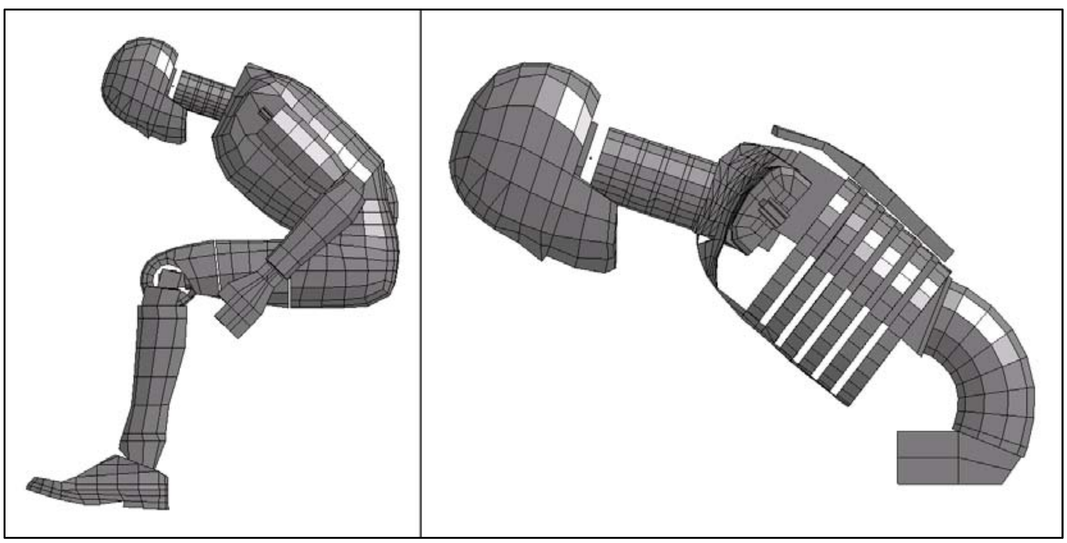

Figure 14 - Lumbar Rotated 45 Degrees

Notes on Lumbar Rotations:

1) This procedure is recommended for small rotations only (<5 degrees). The large angle shown in the figure above is strictly for the purpose of illustration.

2) The upper body of the Hybrid III dummy is attached to the lower body through the Lumbar. During dummy positioning in the lab, the lumbar is often "bent" by some amount from the "as designed" condition. This occurs because the dummies are very heavy, and lab technicians have to apply great physical force to position them correctly. However, in most dummy models, there is no quick way to bend the lumbar to match the test position. As a result, even when the H-Point and pelvic angle are

set to exactly match test measurements, the “head target" does not match.

3) There are no "joints" in the lumbar of the physical dummy. Any upper body rotation that takes place in the lab is due to actual "bending” of the lumbar, and this is what creates a problem when attempting to create a matching FE Model. To address this issue, an option has been added to LS-PrePost to smoothly and uniformly bend the lumbar to make upper body rotations match lab dummy positions more accurately.

4) As a rule of thumb for this release of the Hybrid III 50th Percentile dummy, rotating the lumbar by 2.7 degrees from "as released" will move the "head target" about 1 inch forward and about 1/3 inch downward.

5) To accommodate lumbar rotations, new blocks of information had to be added to the Tree File (see Appendix D). Therefore, this new release is not compatible with the old tree format and vice-versa.

6) When the dummy model is initially loaded, LS-PrePost calculates the lumbar rotation (relative to the “as-released” configuration), and this angle is displayed in the Dummy Positioning interface. This way, LS-PrePost can be used to quickly check the amount of lumbar rotation that has been applied to a “pre-positioned” dummy.

Saving Positioned Dummy

1. Click “Write” in the Dummy Positioning interface
2. Select the dummy to output (it’s possible to have more than one)
3. Click “…” to browse to the desire folder
4. Enter a File Name and click “Save” in the Output File dialog
5. Click “Write”

POST-PROCESSING

These post-processing instructions are based on the Node/Element/Joint IDs that exist in the dummy model. Please be sure to carefully follow the steps related to ID offsetting in the POSITIONING section so that the entity IDs in your model coincide with those listed below.

We have attempted to upgrade the dummy model such that the "signs" of all injury responses listed below are correct. For example, a "-My" of the Upper-Neck in a physical test should come out as "-My" in the analysis response also. If you find this not to be the case, please let us know.

Head Acceleration *(in local CS #67 of head accelerometer)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “nodout *” from the upper list
4. Click “Load”
5. Select node "1" in the middle list
6. Select “9-X-acceleration”, “10-Y-acceleration”, and “11-Z-acceleration” in the bottom list (click and drag or use the *Ctrl* key to select multiple items at once)
7. Click “Plot” or “New” (Plot Window appears)
8. Click “Scale” (to convert from mm/ms^2 to Gs)
9. Enter Y-scale: 101.937 (1/0.00981)
10. Click “Apply”
11. Check “Autofit” (to bring scaled curve back into view)
12. Click "Filter" in the Plot Window
13. Select Filter: SAE
14. Select C/s (Hz): 108 (filter frequency)
15. Click “Apply”
16. Click “Oper”
17. Select “resultant3” from the list (you may have to scroll down)
18. Check “Curve1”
19. Select “1 X-acceleration” (the check mark will automatically move to “Curve2”)
20. Select “1 Y-acceleration” (the check mark will automatically move to “Curve 3”)
21. Select “1 Z-acceleration”
22. Click “Apply”

Chest Acceleration *(in local CS #68 of chest accelerometer)*

Follow steps for Head Acceleration except…
At step 5, select node “1787”

Pelvic Acceleration *(in local CS #73 of pelvic accelerometer)*

Follow steps for Head Acceleration except…
At step 5, select node “3304”

***Head, Chest, and Pelvic Accelerations** (in global CS)*

Follow the steps above except…
Use nodes “20001”, “21787”, and “23304” to plot the Head, Chest, and Pelvic accelerations respectively.

Head Injury Criteria (HIC)

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > Setting
3. Select “Hic/Csi const.”
4. Select Time units: msec
5. Select Gravity constant: 0.00981
6. Go to Post > ASCII
7. Select “nodout *” from the upper list
8. Click “Load”
9. Select node "1" in the middle list
10. Select “14-hic36” in the bottom list
11. Click “HicCsi”
12. Check “Apply pre-filter”
13. Select Filter: SAE
14. Select C/s (Hz): 108
15. Click “Plot” or “New”

Chest Severity Index (CSI)

Follow steps above for HIC except…
At step 9, select node “1787”
At step 10, select “15-csi”

Chest Deflection

In a physical dummy, the deflection is measured from the rotation of the chest potentiometer arm. The arm is connected to a potentiometer at the base which is calibrated for different rotation angles. This rotation is then multiplied by a "linearizing factor" (or "transfer function") which results in the chest deflection.

In our dummy models, the chest potentiometer arm is represented by PIDs 94 and 95. The arm is connected to a rotary spring of very low stiffness (ID 10). Plotting Rotation Angle (rad) vs. Time for spring 10 and then multiplying by a pre-determined linearizing factor gives Chest Deflection (mm) vs. Time.

The linearizing factors are 158.0mm, 145.0mm, and 96.0mm for the 95th, 50th, and 5th percentile dummies respectively. Please note that these factors should give chest deflections correct to within 1mm up to 50mm of chest deflection for the 95th and 50th and up to 40mm for the 5th (these being close to the upper limits for the respective dummies as allowed by most automotive companies).

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)

2. Go to Post > ASCII
3. Select “deforc *” from the upper list
4. Click “Load”
5. Change “Trans” to “Rotat” in the drop-down menu
   Note that “Trans” is for linear springs, and “Rotat” is for rotational springs.
6. Select “10-R” in the middle list (this is the spring at the base of the potentiometer that measures rotation)
7. Select "10-Relative Rotation" in the bottom list
8. Click “Plot” or “New” (plots angular spring rotation in rad/ms)
9. Click "Scale”
10. Enter Y-scale: 145.0 (for the 50th)
11. Click “Apply”
12. Check “Autofit”
13. Click “Title”
14. Enter Y-Axis Label: Chest Deflection (mm)
15. Click “Apply”

Femur Forces *(in local CS #69 for the left and local CS #70 for the right)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Select "Jt-24" (left femur) or “Jt-25” (right femur) from the middle list
6. Select "Z-force" from the bottom list
7. Click “Plot” or “New” (plots axial femur force in kN)
8. Click "Filter" in the Plot Window
9. Select Filter: SAE
10. Select C/s (Hz): 108
11. Click “Apply”

Upper Neck Forces *(in local CS #30)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Click “Jforc”
6. Select "Jt-39" from the middle list
7. Select "X-force" (Shear Force, Fx) or “Z-Force” (Tensile Force, Fz) from the bottom list
8. Click “Plot” or “New” (plots upper neck force in kN)

Upper Neck Moment at Occipital Condyle (Corrected My) *(in local CS #71)*

There are two methods of calculating Corrected My:

1) As measured from a physical dummy in the lab (either static or dynamic test)
2) The easy method (taking advantage of the fact that this is a CAE model)

Both methods are described below along with directions for comparing the results.

Method 1: As measured from a physical dummy in the lab

The reason for "correcting" the neck moment obtained from the upper neck load cell is as follows:

We are really interested in the upper neck moment at the Occipital Condyle of the dummy. Unfortunately, there is no room to install the upper neck load cell directly on top of the Occipital Condyle, so the load cell is installed 0.7in (17.78mm) above it (along the local z-axis of the Occipital Condyle). Due to this discrepancy in location, the reading of the load cell has to be mathematically "corrected" to reflect the true reading at the Occipital Condyle.

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select "jntforc *" from the upper list
4. Click "Load"
6. Select "Jt-39" from the middle list (this is the upper neck load cell)
7. Select "1-X-force" from the bottom list
8. Click "Plot" (plots Fx at the upper neck load cell)
9. Click "Filter"
10. Select Filter: SAE
11. Select C/s(Hz): 108
12. Click "Apply"
13. Click "Scale"
14. Enter Y-scale: 17.78
15. Click "Apply"
16. Check "Autofit" (this is the "correcting" moment)
17. Click "JStifR"
18. Select "StR-16" from the middle list (this is the "moment stiffness" at joint 39)
19. Select "18-theta-moment-stiffness" from the bottom list
20. Click "PAdd" (adds curve to plot from step 8 above)
21. Click "Oper"
22. Select "subtract_curves"
23. Check "Curve1"
24. Select "JSR-16" from the list at the lower left of the PlotWindow
25. Select "Jt-39" from the list (automatically is entered as "Curve2")
26. Click "Apply"
27. Enter "MyCorrected.crv" next to the "Save Result" button
28. Click "Save Result"

Essentially, we have multiplied Fx at the load cell by the distance between the load cell and the Occipital Condyle (17.78 mm). This gives us a moment that we subtract from the My measured at the load cell.

Method 2: The easy way

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)

2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Click “JStifR” (allows us to study moments instead of forces)
6. Select "StR-44" from the middle list (this is the "generalized stiffness" for the Occipital Condyle, as represented by Joint ID 1 in our model)
7. Select "21-theta-moment-total" from the bottom list
8. Click “Plot” (plots corrected upper neck moment in kN-mm)
   Note that because we are measuring the moment at the Occipital Condyle directly, it does not have to be corrected.
9. Click “Filter”
10. Select Filter: SAE
11. Select C/s(Hz): 108
12. Click “Apply”

Comparing the results of both methods

Follow both methods above in sequence and click “PAdd” instead of “Plot” in step 8 of method 2. The curves should closely overlap, so please notify us if you find results that differ significantly.

Lower and Upper Tibia Forces *(in local CS #33 for the left and local CS #35 for the right)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Click “Jforc”
6. Select "Jt-42" (Lower Left Tibia) or “Jt-44” (Lower Right Tibia) from the middle list
7. Select "Jt-41" (Upper Left Tibia) or “Jt-43” (Upper Right Tibia) from the middle list
8. Select "3-Z-force" (or any other) from the bottom list
9. Click “Plot” (plots lower tibia force in kN)

Lower and Upper Tibia Moments *(in local CS #33 for the left and local CS #35 for the right)*

Follow steps above for Lower Tibia Forces except…
At step 5, click “JStifR”
At step 6, select "StR-19" (Lower Left Tibia) or “StR-21” (Lower Right Tibia)
At step 7, select "StR-18" (Upper Left Tibia) or “StR-20” (Upper Right Tibia)
At step 8, select “15-phi-moment-stiffness” for Mx or “18-theta-moment-stiffness” for My

Lower Lumbar Forces *(in local CS #29)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Click “Jforc”
6. Select "Jt-38" from the middle list

7. Select "3-Z-force" (or any other) from the bottom list
8. Click “Plot” in the side panel (plots lower tibia force in kN)
   Note that the Forces are output as per local coordinate system ID 29.

Lower Lumbar Moments *(in local CS #29)*

Follow steps above for Lower Lumbar Forces except…
At step 5, click “JStifR”
At step 6, select "StR-15"
At step 7, select “15-phi-moment-stiffness” for Mx or “18-theta-moment-stiffness” for My
Note that there are no Moment-Curves associated with this joint. Therefore the moment results must be checked against test results to ensure that they are valid.

Knee Slider Displacement *(in local CS #77 for the left and local CS #79 for the right)*

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Go to Post > ASCII
3. Select “jntforc *” from the upper list
4. Click “Load”
5. Click “JstifT”
6. Select "StT-45" (Left Knee Slider) or “StT-46” (Right Knee Slider) from the middle list
7. Select "26-x-displacement" from the bottom list
8. Click “Plot” (plots knee slider displacement in mm)

Animation with Keyword Visualization

Often, it is useful to animate d3plot results while visualizing keyword entities (Joints, Accelerometers, Local Coordinate Systems, Contacts, Sets, etc...). This can be achieved in LS-PrePost as follows:

1. Load your d3plots in LS-PrePost (File > Open > LS-DYNA Binary Plot)
2. Load the corresponding keyword input file (File > Open >LS-DYNA Keyword File)
3. Click “Yes” in the popup dialog
4. Go to Model > Display
5. Click “All”
6. Animate the model

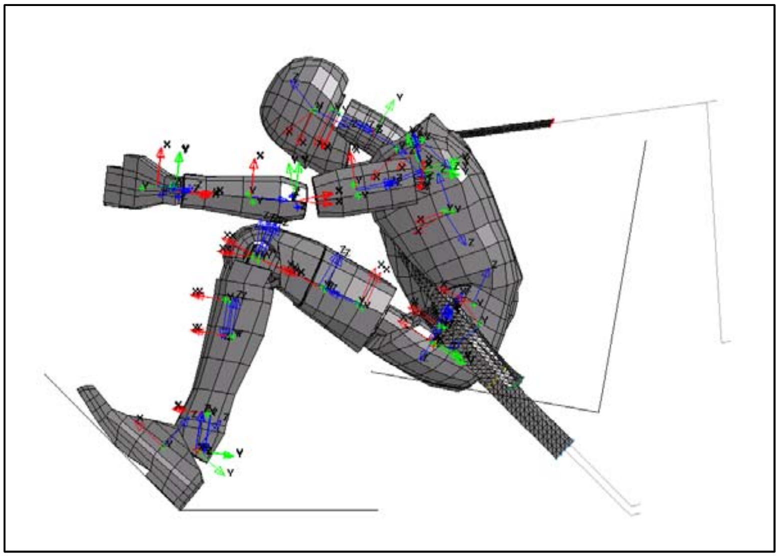

Figure 15 - Animation with Keyword Visualization

APPENDIX A – Part IDs for Contact

Part ID reference for setting up dummy to vehicle/structure contact (all PIDs listed belong to the dummy):

- Dummy to Airbag – PIDs 11, 50, 52, 59-72, 84, 86
- Shoes to Floor Pan – PIDs 73, 80
- Hips/Legs to Seat – PIDs 65-69, 72
- Arms/Hands to IP – PIDs 59-64
- Left Knee/Femur to Knee Bolster – PIDs 50, 66, 68, 70
- Right Knee/Femur to Knee Bolster – PIDs 52, 67, 69, 71

APPENDIX B – ID Offsetting

To perform ID offsetting independently of dummy positioning:

1. Load the dummy model (File > Open > LS-DYNA Keyword File)
2. Go to Model > Renumber
3. Select “Offset”
4. Enter Offset: 1000000
5. Click “SetAll” (all fields in the “StartID” column will be set to 1000000)
6. Click “Offset”
7. Save the offset dummy (File > Save As > Save Keyword As…)

Notes on ID Offsetting:

1) The method above can be used to apply a uniform offset for all checked entities. To use a custom offset for any specific entity type (nodes, elements, parts, etc...), click on the corresponding row in the “StartID” column of the table and manually enter a value.

2) We do not recommend using *INCLUDE_TRANSFORM to offset dummy IDs because LS-DYNA does not offset the corresponding tree file IDs in the process. Instead, we recommend transforming dummy IDs within LS-PrePost only.

APPENDIX C – Unit Transformation

Two input files are provided to help transform the dummy into alternate unit systems. Running either with produce a new file called *dyna.inc* which is the converted dummy model. The working portion of each file is listed below for reference. Please refer to the files themselves for an explanation of how the scale factors (*fctmas*, *fcttim*, and *fctlen*) were derived.

Run *Transform_mm-ms-kg_To_mm-s-tonne.k* to convert the dummy to mm-s-tonne-N:

```
*KEYWORD
*INCLUDE_TRANSFORM
$# filename
LSTC.H3_50TH_FAST.111130_V2.0.k
$#  idnoff    ideoff    idpoff    idmoff    idsoff    idfoff    iddoff
         0         0         0         0         0         0         0
$#  idroff
         0
$#  fctmas    fcttim    fctlen    fcttem   incout1
     0.001     0.001     1.000     1.000         1
$#  tranid
         0
*END
```

Run *Transform_mm-ms-kg_To_English_Units.k* to convert the dummy to English units:

```
*KEYWORD
*INCLUDE_TRANSFORM
$# filename
LSTC.H3_50TH_FAST.111130_V2.0.k
$#  idnoff    ideoff    idpoff    idmoff    idsoff    idfoff    iddoff
         0         0         0         0         0         0         0
$#  idroff
         0
$#  fctmas    fcttim    fctlen    fcttem   incout1
  0.005708     0.001   0.03937     1.000         1
$#  tranid
         0
*END
```

APPENDIX D – Tree File

OCCINFO/ENDOCCINFO

The “tree file” is located immediately after *END in the input file. It describes the relationship between limbs for all dummies in the model and is enclosed by two identifiers **`%occinfo`** `and` **`%endoccinfo`**

OCCUPANT

The tree file may contain several %occupant blocks (one for each dummy in the model) within the %occinfo section. This block may contain sub-blocks to further describe an occupant as shown below. Note that sub-blocks may appear in any order.

```
%occupant {
  %name
  %limbs {
    limb1,
    limb2,
    ...,
    Limbn
  }
  %globals {
    %h_point {}
    %rotation {}
    %vertical {}
  }
  %limb1 {}
  %limb2 {}
  ...
  %limbn {}
}
```

%name	Name of occupant.
%limbs	Names of all limbs that compose the occupant.
%globals	Global data related to the occupant.
%h_point	Coordinates of h-point.
%rotation	Primary rotation axis of occupant.
%vertical	Up-right axis of occupant.
%limbn	Limb definitions (see below for more detail).

LIMB

These blocks are used to reconstruct the occupant’s limbs each time a positioning operation is performed. They define the limb composition as well as its parent/child relationships.

```
%limb1  {
  %cps { node1 / 0, node2 / 0 }
  %lock { 0 / 1, 0 / 1, 0 / 1 }
  %lcid { 0, 0, 0}
  %part { pid1, pid2, ..., pidn }
  %children { child1, child2, ..., childn / 0 }
  %parent { parent_name / 0, node / 0 }
}
```

%cps Control points.

- *node1* Node1 defines the center of rotation for the limb. If it is zero, the limb must be the root limb, and the h-point will be assigned to it.
- *node2* The vector from node1 to node2 forms an axis for the limb to rotate about. If node2 is zero, the rotational axis will be the default axis for this occupant as defined in the %globals block.

%lock Defines how a limb is allowed to rotate about its connecting joint. When the connecting joint is a spherical joint, the lock configuration will decide which axis or axes the limb is allowed to rotate about. The positioner will overlook the lock configuration if the rotation axis is defined by node1 and node2 in %cps. Caution must be exercised if there is a *CONSTRAINED_JOINT_STIFFNESS_GENERALIZED keyword defined at the connecting nodes for two limbs and the joint is a cylindrical joint. An incorrect configuration of this lock may violate the keyword input rules, and the positioner may end up creating an occupant model that LS-DYNA will not run. Each field of the lock block represents the axis it intends to prevent from rotation:

- *field1* If not trivial, the limb is not allowed to rotate about the x-axis (vertical x rotation).
- *field2* If not trivial, the limb is not allowed to rotate about the y-axis (rotation axis).
- *field3* If not trivial, the limb is not allowed to rotate about the z-axis (vertical axis).

%lcid These are load curve ids for connecting nodes on limbs (just for backward compatibility and not used anywhere in the occupant positioning).

%part Parts that assimilate the limb.

%children Children that connect to the limb. If the limb has no child, insert 0.

%parent Parent limb information and the connecting nodes on the parent part. The root limb does not have any parent information, so insert 0.

- *parent_name* Name of the parent limb.
- *node* Node id that is at the parent limb for connecting two limbs together. This node shall coincide with node1 in the %cps block. Note that the two nodes will automatically form a spherical joint between two limbs.

APPENDIX E – Dummy Replacement

The following steps describe how to replace a previous (positioned) dummy model with the latest one (with minimal effort). Note that this method assumes your dummy model is in a separate file and has been included in your main deck using *INCLUDE. This method also assumes that your dummy model contains a "Tree File" following *END. Be aware that this procedure will not work for LSTC dummies released prior to May 2007. Only dummies released after this date have Tree Files that can be processed by LS-PrePost to extract the required angles.

1. Launch a new session of LS-PrePost
2. Load the OLD dummy model (File > Open > LS-DYNA Keyword File)
3. Record the H-Point coordinates (on a piece of paper) from the Application > Dummy Positioning interface
4. Select "Rotate" in the side panel
5. Record Angle1, Angle2, and Angle3 (under "ZYZ") from the bottom panel
   Note that Angles 1, 2, and 3 correspond to Z, Y, and Z respectively and that Angle3 = 0 for most automotive frontal-crash situations.
6. Select "Limb operations" in the side panel
7. Record Angle1, Angle2, and Angle3 (under "ZYX") for every limb
   Note that Angles 1, 2, and 3 correspond to Z, Y, and X respectively and that there may be only one angle for some limbs.
8. Launch a new session of LS-PrePost
9. Load the NEW dummy model
10. Enter the H-Point coordinates you recorded in step 3 above
11. Select "Rotate" in the side panel
12. Rotate the dummy using the angles from step 5 above
13. Select "Limb operations" in the side panel
14. Rotate each limb using the angles from step 7 above
15. If the old dummy had any ID offsets applied, use Page 2: Renum to apply the same offsets to the new dummy (click "Yes" when prompted to save your changes when leaving the DmyPos interface)
16. Save the new dummy model (File > Save Keyword As…)
17. "Include" the new dummy in your main deck (replacing the old dummy)

APPENDIX F – Extracting ASCII Data from BINOUT

MPP versions of LS-DYNA combines ASCII data into the BINOUT file. LS-PrePost can be used to extract the individual ASCII files as follows:

1. Go to Post > Binout
2. Click “Load”
3. Open “binout” or “binout0000”
4. Select the file from the “Open File List” panel
5. Click “Save”
6. Activate “As ASCII(es)”
7. Click “Apply”

This will extract all ASCII data to the current working directory.

APPENDIX G – A Note on Curve Filters

We recommend using SAE filters when post-processing curves. LS-PrePost's SAE filters are the same as "Channel Frequency Class" (CFC) filters that are commonly used in the automotive industry.

LS-PrePost also provides "Butterworth" (BW) filters. Multiplying a BW frequency by 0.6 produces a roughly equivalent SAE frequency. For example, since 180*0.6=108, a BW-180 filter and an SAE-108 filter will produce similar results.