LSTC Hybrid III Dummies

Positioning & Post-Processing

Dummy Version: LSTC.H3.103008_v1.0
Documentation Date: October 30, 2008

Sarba Guha
Dilip Bhalsod
Jacob Krebs
(LSTC Michigan)

VERSION 1.0 RELEASE NOTE

This release contains the Rigid 5th, 50th, and 95th Percentile Dummies. All feedback is appreciated. Comments and suggestions can be sent to ***sarba@lstc.com***.

LS-PREPOST VERSION

LS-PrePost 2.3 is required, particularly for the POSITIONING portion of this document. We recommend downloading the latest build for your OS from ***ftp://beta:keyboard@ftp.lstc.com/lsprepost/2.3/***

INTRODUCTION

LSTC's previous set of Hybrid III dummies consists of the following: 5th Percentile Female, 50th Percentile Male, and 95th Percentile Male each with both a Rigid and Deformable version. Since these dummies were released in the mid 90's, a number of shortcomings have been identified including difficulty in positioning, difficulty in injury/response extraction, and lack of documentation

Efforts are now underway to update the full set of dummies to address the problems listed above and also to take full advantage of advancements in both LS-DYNA and LS-PrePost. The ultimate goal is to provide dummies that are easy to use, run quickly and robustly, and are useful in solving real-world problems (particularly in the area of airbag/restraint system development).

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

UNITS

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

CALIBRATION

5th Neck Extension Test

Parameter		Specification	Result
Pendulum Impact Speed		5.95 m/s ≤ speed ≤ 6.19 m/s	6.06 m/s
Pendulum ΔV With Respect to Impact Speed	@ 10 ms	1.5 m/s ≤ ΔV ≤ 1.9 m/s	1.87 m/s
	@ 20 ms	3.1 m/s ≤ ΔV ≤ 3.9 m/s	3.54 m/s
	@ 30 ms	4.6 m/s ≤ ΔV ≤ 5.6 m/s	5.15 m/s
Plane D Rotation		Peak Moment -65Nm ≤ moment ≤ -53 Nm during the following rotation angle: 99° ≤ angle ≤ 114°	-57.6 Nm @ 103°
Negative Moment Decay		Time to Decay to -10 Nm 94 ms ≤ time ≤ 114 ms	110 ms

5th Neck Flexion Test

Parameter		Specification	Result
Pendulum Impact Speed		6.89 m/s ≤ speed ≤ 7.13 m/s	7.01 m/s
Pendulum ΔV With Respect to Impact Speed	@ 10 ms	2.1 m/s ≤ ΔV ≤ 2.5 m/s	2.13 m/s
	@ 20 ms	4.0 m/s ≤ ΔV ≤ 5.0 m/s	4.01 m/s
	@ 30 ms	5.8 m/s ≤ ΔV ≤ 7.0 m/s	5.85 m/s
Plane D Rotation		Peak Moment 69Nm ≤ moment ≤ 83 Nm during the following rotation angle: 77° ≤ angle ≤ 91°	76.4 Nm @ 89.0°
Positive Moment Decay		Time to Decay to 10 Nm 80 ms ≤ time ≤ 100 ms	81.2 ms

5th Thorax Impact

Parameter	Specification	Result
Test Probe Speed	6.59 m/s ≤ speed ≤ 6.83 m/s	6.71 m/s
Chest Compression	50.0 mm ≤ compression ≤ 58.0 mm	50.8 mm
Peak Force Between 50.0 mm and 58.0 mm Chest Compression	3900 N ≤ peak force ≤ 4400 N	3901 N
Peak Force Between 18.0 mm and 50.0 mm Chest Compression	Peak Force ≤ 4600 N	4293 N
Internal Hysteresis	69% ≤ hysteresis ≤ 85%	81.8%

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	17.8
	@ 20 ms	14.0 ≤ g ≤ 19.0	16.7
	@ 30 ms	11.0 ≤ g ≤ 16.0	14.8
	> 30 ms	22.0 g maximum	Met
First Pendulum Decay to 5 g		38 ms ≤ time ≤ 46 ms	39.3 ms
Plane D Rotation		81° ≤ maximum rotation ≤ 106°	**108°**
		72 ms ≤ time of maximum rotation ≤ 82 ms	75 ms
Time for Plane D Rotation to Cross 0° During First Rebound		147 ms ≤ time ≤ 174 ms	165 ms
Maximum Moment		-80.0 Nm ≤ moment ≤ -52.9 Nm	-70.1 Nm
		65 ms ≤ time ≤ 79 ms	65.5 ms
Negative Moment Decay		Time of First Decay to 0 Nm 120 ms ≤ time ≤ 148 ms	**117.5 ms**

Note: bold entries are narrowly out of range

50th Neck Flexion Test

Parameter		Specification	Result
Pendulum Impact Speed		6.89 m/s ≤ speed ≤ 7.13 m/s	7.01 m/s
Pendulum Deceleration vs. Time Pulse	@ 10 ms	22.5 ≤ g ≤ 27.5	24.4
	@ 20 ms	17.6 ≤ g ≤ 22.6	**23.7**
	@ 30 ms	12.5 ≤ g ≤ 18.5	13.3
	> 30 ms	29.0 g maximum	Met
First Pendulum Decay to 5 g		34 ms ≤ time ≤ 42 ms	**31.1 ms**
Plane D Rotation		64° ≤ maximum rotation ≤ 78°	73°
		57 ms ≤ time of maximum rotation ≤ 64 ms	58 ms
Time for Plane D Rotation to Cross 0° During First Rebound		113 ms ≤ time ≤ 128 ms	114 ms
Maximum Moment		88.1 Nm ≤ moment ≤ 108.5 Nm	**86.9 Nm**
		47 ms ≤ time ≤ 58 ms	47ms
Positive Moment Decay		Time of First Decay to 0 Nm 97 ms ≤ time ≤ 107 ms	**107.6 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	65.6 mm
Peak Resistance Force	5160 N ≤ peak force ≤ 5894 N	5452 N
Internal Hysteresis	69% ≤ hysteresis ≤ 85%	71.3%

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)
2. Import dummy model (File > Import > LS-DYNA Keyword)
    a. Click "Setting Offset" in the Import File dialog
    b. Enter Default Offset: 1000000 (we suggest offsetting by a nice round number such as one million so that the entity IDs referenced in the POST-PROCESSING section correspond to those in your dummy model in a straight-forward manner)
    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. 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 Page 5: DmyPos
2. Select "H-Point operations" in the side panel
3. Select "Translate" in the side panel
4. Enter X,Y,Z coordinates for the H-Point in the side panel (hitting *Enter* after each) ***or*** enter a "Distance" value in the lower panel and use the "+/-" buttons to translate the dummy

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

Pelvic Rotations

1. Select "H-Point operations" in the side panel (should already be selected)
2. Select "Rotate" in the side panel
3. Select "Local" in the lower panel (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" in the lower panel
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" in the side panel
2. Select the limb you would like to rotate by LEFT-clicking in the side panel 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.

Saving Positioned Dummy

Method 1:

1. Click “Write” in the side panel of the DmyPos interface
2. Select the dummy to output in the lower panel (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” in the lower panel

Method 2:

1. Go to Page 2: Subsys
2. Click “Yes” in the pop-up dialog (allows you to return to the dummy positioning interface and continue where you left off)
3. Select the dummy in the Subsys side panel
4. Click “Write” in the side panel
5. Enter a File Name and click “Save” in the Output File dialog

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

1. Load your d3plots in LS-PrePost (File > Open > Binary Plot)
2. Go to Page 1: ASCII
3. Select “nodout *” from the upper side panel list
4. Click “Load”
5. Select node "1" in the middle side panel list
6. Select “9-X-acceleration”, “10-Y-acceleration”, and “11-Z-acceleration” in the bottom side panel list (click and drag or use the *Ctrl* key to select multiple items at once)
7. Click “Plot” or “New” in the side panel (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: bw (Butterworth)
14. Select C/s (Hz): 180 (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

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

Pelvic Acceleration

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

Head Injury Criteria (HIC)

1. Load your d3plots in LS-PrePost (File > Open > Binary Plot)
2. Go to Page 1: Setting
3. Select “Hic/Csi const.”
4. Select Time units: msec
5. Select Gravity constant: 0.00981
6. Go to Page 1: ASCII
7. Select “nodout *” from the upper side panel list
8. Click “Load”
9. Select node "1" in the middle side panel list
10. Select “14-hic36” in the bottom side panel list
11. Click “HicCsi” in the side panel
12. Check “Apply pre-filter” in the lower panel
13. Select Filter: bw
14. Select C/s (Hz): 180
15. Click “Plot” or “New” in the side panel

Chest Severity Index (CSI)

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

Chest Deflection

There are two methods of calculating chest deflection:

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

In a physical dummy, the deflection is measured from the rotation of the chest potentiometer arm. This 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, 142.0mm, and 95.0mm 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 > Binary Plot)
2. Go to Page 1: ASCII
3. Select "deforc *" from the upper side panel list
4. Click "Load"
5. Change "Trans" to "Rotat" in the side panel drop-down menu
   Note that "Trans" is for linear springs, and "Rotat" is for rotational springs.
6. Select "10-R" in the middle side panel list (this is the spring at the base of the potentiometer that measures rotation)
7. Select "10-Relative Rotation" in the bottom side panel list
8. Click "Plot" or "New" in the side panel (plots angular spring rotation in rad/ms)
9. Click "Scale"
10. Enter Y-scale: 158.0 (for the 95th), 142.0 (for the 50th), or 95.0 (for the 5th)
11. Click "Apply"
12. Check "Autofit"
13. Click "Title"
14. Enter Y-Axis Label: Chest Deflection (mm)
15. Click "Apply"

Method 2: The easy method

1. Load your d3plots in LS-PrePost (File > Open > Binary Plot)
2. Go to Page 1: ASCII
3. Select "deforc *" from the upper side panel list
4. Click "Load"
5. Select "11-T" in the middle side panel list (this is the chest compression spring)
6. Select "5-Change in length" in the bottom side panel list
7. Click "Plot"

Comparing the results of both methods

Follow both methods above in sequence and click "PAdd" instead of "Plot" in step 7 of method 2. The curves should closely overlap especially in the region of highest chest deflection. Please notify us if you find results that differ by more than 1mm (in the peak region) using this method of comparison.

Femur Forces

1. Load your d3plots in LS-PrePost (File > Open > Binary Plot)
2. Go to Page 1: ASCII
3. Select “jntforc *” from the upper side panel list
4. Click “Load”
5. Select "Jt-24" (left femur) or “Jt-25” (right femur) from the middle side panel list
6. Select "Z-force" from the bottom side panel list
7. Click “Plot” or “New” in the side panel (plots axial femur force in kN)
8. Click "Filter" in the Plot Window
9. Select Filter: bw
10. Select C/s (Hz): 180
11. Click “Apply”

Upper Neck Forces

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

Upper Neck Moment at Occipital Condyle (Corrected My)

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 > Binary Plot)
2. Go to Page 1: ASCII
3. Select “jntforc *” from the upper side panel list
4. Click “Load”

6. Select "Jt-39" from the middle side panel list (this is the upper neck load cell)
7. Select "1-X-force" from the bottom side panel list
8. Click “Plot” in the side panel (plots Fx at the upper neck load cell)
9. Click “Filter”
10. Select Filter: bw
11. Select C/s(Hz): 180
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" in the side panel
18. Select “StR-16” from the middle side panel list (this is the “moment stiffness” at joint 39)
19. Select "18-theta-moment-stiffness" from the bottom side panel list
20. Click “PAdd” in the side panel (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 > Binary Plot)
2. Go to Page 1: ASCII
3. Select “jntforc *” from the upper side panel list
4. Click “Load”
5. Click “JStifR” in the side panel (allows us to study moments instead of forces)
6. Select "StR-44" from the middle side panel list (this is the "generalized stiffness" for the Occipital Condyle, as represented by Joint ID 1 in our model)
7. Select "18-theta-moment-stiffness" from the bottom side panel list
8. Click “Plot” in the side panel (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.

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 Tibia Forces

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

Lower Tibia Moments

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

Lower Lumbar Forces

1. Load your d3plots in LS-PrePost (File > Open > Binary Plot)
2. Go to Page 1: ASCII
3. Select "jntforc *" from the upper side panel list
4. Click "Load"
5. Click "Jforc" in the side panel
6. Select "Jt-38" from the middle side panel list
7. Select "3-Z-force" (or any other) from bottom side panel 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

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.

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)
2. Go to Page 2: Renum
3. Select "Offset"
4. Select "ALL" from the list (pop-up window will appear)
5. Enter Default Offset Value: 1000000 in the pop-up window
6. Click "Set" (all of the fields will be populated with a value of 1000000)
7. Click "Offset"
8. Save the offset dummy (File > Save Keyword As…)

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.RigidFE_50th.103008_v1.0.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.RigidFE_50th.103008_v1.0.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
...
%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_GENERIZED 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:

1st field If not trivial, the limb is not allowed to rotate about the x-axis (vertical x rotation).
2nd field If not trivial, the limb is not allowed to rotate about the y-axis (rotation axis).
3rd field 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)
3. Record the H-Point coordinates (on a piece of paper) from the Page 5: DmyPos 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 – .lspostrc for Occupant Positioning

To import dummies from the Page 5: DmyPos interface, a list of available occupants must be specified in the *.lspostrc* file. The *.lspostrc* file is a configuration file that is located in the same directory as the LS-PrePost executable. If it does not already exist, it can be generated by launching LS-PrePost and selecting File > Save Config. The following lines can then be added at the top of *.lspostrc*:

```
occupant_list = 3
lstc.h3.05, C:\LSTC\DUMMIES\LSTC.H3.RigidFE_05th, *, LSTC.H3.RigidFE_05th.103008_v1.0.k \
lstc.h3.50, C:\LSTC\DUMMIES\LSTC.H3.RigidFE_50th, *, LSTC.H3.RigidFE_50th.103008_v1.0.k \
lstc.h3.95, C:\LSTC\DUMMIES\LSTC.H3.RigidFE_95th, *, LSTC.H3.RigidFE_95th.103008_v1.0.k \
```

The details required for each occupant are:

`Identifier, Full Path` `to occupant model`**`, Tree File`** `name`**`, Keyword File`** `name`

Please note the following:

- The number of occupants in the database must be specified on the first line
- Each of the remaining lines should end with "\"
- *Identifier* can be any name you choose
- *Full Path* must be modified depending on where the occupants are located in your file system
- *Tree File* can be replaced with "*" if the tree file is not a separate file (if it's included at the end of the *Keyword File*)

Occupants defined in this manner can then be directly imported as follows:

1. Go to Page 5: DmyPos
2. Select an occupant identifier from the "Dummy Database" list
3. Click "Load"
4. Similarly import additional dummy models if desired (note that you can switch between models using the "Occ." drop-down menu)