

**REPORT NUMBER: NCAP-MGA-2008-004**

**NEW CAR ASSESSMENT PROGRAM  
FRONTAL BARRIER IMPACT TEST**

**TOYOTA MOTOR CORPORATION  
2008 TOYOTA HIGHLANDER 4X4  
NHTSA NUMBER: M85110**

**PREPARED BY:  
MGA RESEARCH CORPORATION  
5000 WARREN ROAD  
BURLINGTON, WI 53105**



**Test Date: September 19, 2007**

**Final Report Date: October 19, 2007**

**FINAL REPORT**

**PREPARED FOR:  
U.S. DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
RULEMAKING  
OFFICE OF CRASHWORTHINESS STANDARDS  
1200 NEW JERSEY AVENUE, SE, ROOM W43-410  
WASHINGTON, D.C. 20590**

This final test report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, in response to Contract Number DTNH22-06-D-00028.

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### Technical Report Documentation Page

| 1. <i>Report No.</i><br>NCAP-MGA-2008-004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 2. <i>Government Accession No.</i>                          | 3. <i>Recipient's Catalog No.</i>                                                                                                                                                                       |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
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| 4. <i>Title and Subtitle</i><br>Final Report of New Car Assessment Program Testing of a Toyota Highlander 4x4<br>NHTSA No.: M85110                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                             | 5. <i>Report Date</i><br>October 19, 2007                                                                                                                                                               |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
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| 7. <i>Author(s)</i><br>Ben Fischer, Project Engineer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                             | 8. <i>Performing Organization Report No.</i><br>NCAP-MGA-2008-004                                                                                                                                       |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| 9. <i>Performing Organization Name and Address</i><br>MGA Research Corporation<br>5000 Warren Road<br>Burlington, WI 53105                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                             | 10. <i>Work Unit No.</i>                                                                                                                                                                                |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
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| 12. <i>Sponsoring Agency Name and Address</i><br><br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration<br>Rulemaking, Office of Crashworthiness Standards<br>1200 New Jersey Ave, SE, Room W43-410, NVS-111<br>Washington, D.C. 20590                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                             | 13. <i>Type of Report and Period Covered</i><br>Final Report<br>9/19/2007 – 10/19/2007                                                                                                                  |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
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| 15. <i>Supplementary Notes</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                             |                                                                                                                                                                                                         |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| 16. <i>Abstract</i><br>A frontal barrier impact was conducted on a 2008 Toyota Highlander 4x4 at MGA Research Corporation on September 19, 2007. This test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), 301, and foot well intrusion performance. The impact velocity was 56.6 km/h. The ambient temperature at the barrier face at the time of impact was 21 degrees Celsius. The vehicle's maximum post test static crush is 527 mm located to the left of the vehicle's centerline. The test vehicle is equipped with a 3-point continuous belt system and an airbag in both front outboard seating positions. With respect to FMVSS 208 "Occupant Crash Protection", the occupant injury criteria summary is as follows: <table style="width: 100%; margin-top: 10px;"> <thead> <tr> <th style="text-align: left;"><u>Measurement Description</u></th> <th style="text-align: left;"><u>Units</u></th> <th style="text-align: left;"><u>Threshold</u></th> <th style="text-align: left;"><u>Driver ATD</u></th> <th style="text-align: left;"><u>Pass. ATD</u></th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC)</td> <td>N/A</td> <td>1000</td> <td>378</td> <td>557</td> </tr> <tr> <td>Max. Thorax Accel. (3ms Clip)</td> <td>G's</td> <td>60</td> <td>39</td> <td>44</td> </tr> <tr> <td>Left Femur Force</td> <td>Newton</td> <td>10009</td> <td>-1625</td> <td>-2685</td> </tr> <tr> <td>Right Femur Force</td> <td>Newton</td> <td>10009</td> <td>-2618</td> <td>-2692</td> </tr> </tbody> </table> |                                                             |                                                                                                                                                                                                         |                   | <u>Measurement Description</u> | <u>Units</u> | <u>Threshold</u> | <u>Driver ATD</u> | <u>Pass. ATD</u> | Head Injury Criteria (HIC) | N/A | 1000 | 378 | 557 | Max. Thorax Accel. (3ms Clip) | G's | 60 | 39 | 44 | Left Femur Force | Newton | 10009 | -1625 | -2685 | Right Femur Force | Newton | 10009 | -2618 | -2692 |
| <u>Measurement Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Units</u>                                                | <u>Threshold</u>                                                                                                                                                                                        | <u>Driver ATD</u> | <u>Pass. ATD</u>               |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| Head Injury Criteria (HIC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | N/A                                                         | 1000                                                                                                                                                                                                    | 378               | 557                            |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| Max. Thorax Accel. (3ms Clip)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | G's                                                         | 60                                                                                                                                                                                                      | 39                | 44                             |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| Left Femur Force                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Newton                                                      | 10009                                                                                                                                                                                                   | -1625             | -2685                          |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| Right Femur Force                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Newton                                                      | 10009                                                                                                                                                                                                   | -2618             | -2692                          |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| 17. <i>Key Words</i><br><br>56.3 km/h NCAP Frontal Barrier Impact Test<br>New Car Assessment Program (NCAP)<br>2008 Toyota Highlander<br>NHTSA No: M85110                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                             | 18. <i>Distribution Statement</i><br>Copies of this report are available from:<br>National Highway Traffic Safety Adm.<br>Technical Ref. Division,<br>1200 New Jersey Ave, SE<br>Washington, D.C. 20590 |                   |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |
| 19. <i>Security Classif. (of this report)</i><br>Unclassified                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20. <i>Security Classif. (of this page)</i><br>Unclassified | 21. <i>No. of Pages</i><br>173                                                                                                                                                                          | 22. <i>Price</i>  |                                |              |                  |                   |                  |                            |     |      |     |     |                               |     |    |    |    |                  |        |       |       |       |                   |        |       |       |       |

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## **SECTION 1**

### **PURPOSE AND SUMMARY OF TEST**

#### **PURPOSE**

This frontal barrier impact test is part of the Vehicle Barrier Impact Testing Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-06-D-00028. The purpose of this test was to obtain vehicle crashworthiness and occupant restraint system performance data for an impact in excess of the current 48.3 kph requirements.

#### **SUMMARY**

A load cell barrier was impacted by a 2008 Toyota Highlander at a velocity of 56.6 kph. The test was performed at MGA Research Corporation on September 19, 2007. Pre-and post-test photographs of the vehicle and dummies can be found in Appendix A.

One real-time camera and sixteen high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in this report.

Two Part 572E, 50<sup>th</sup> percentile male anthropomorphic test devices (ATDs), were placed in the driver and right-front passenger seating positions according to dummy placement instructions specified in the Laboratory Indicant Test Procedure.

Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometer, upper neck transducers, right/left femur load cells, and lower leg instrumentation. The driver (position 1) ATD (Serial No. 066) and right-front passenger (position 2) ATD (Serial No. 065) were calibrated previous to this test. Certification details, along with instrumentation calibration data, are found in Appendix C.

The 102 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy head, chest, and femur response data traces.

There was 100 percent windshield retention and no intrusion into the protected zone of the windshield during the event. There was no Stoddard Solvent leakage after the event or during any phase of the static rollover.

The maximum static crush of the vehicle was 527 mm and both the driver and passenger side doors remained closed and latched during the impact event and were operable after the impact.

The driver's head and chest contacted the airbag. The driver's head also contacted the headrest and visor. The driver's knees contacted the knee bag. The passenger's head and chest contacted the airbag. The passenger's head also contacted the visor. The passenger's knees contacted the glove box.

The occupant data is summarized below:

| ATD position | HIC | T <sup>1</sup> | T <sup>2</sup> | Clip<br>(g) | T <sup>1</sup> | T <sup>2</sup> | Chest<br>Disp.<br>(mm) | Left<br>Femur<br>(N) | Right<br>Femur<br>(N) |
|--------------|-----|----------------|----------------|-------------|----------------|----------------|------------------------|----------------------|-----------------------|
| Driver       | 378 | 60.6           | 85.6           | 39          | 67.2           | 72.6           | -26                    | -1625                | -2618                 |
| Passenger    | 557 | 62.6           | 98.6           | 44          | 68.7           | 71.7           | -30                    | -2685                | -2692                 |

The test data can be found on the NHTSA website at [www.nhtsa.dot.gov](http://www.nhtsa.dot.gov).

### TEST NOTES

There was no valid data collected for:  
Left Foot Z – Front after 60 msec.

**SECTION 2**  
**OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS**

**DATA SHEET NO. 1**  
**CRASH TEST SUMMARY**

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

**DOOR OPENING AND SEAT TRACK INFORMATION**

| Description           | Driver                                                         | Passenger                                                      |
|-----------------------|----------------------------------------------------------------|----------------------------------------------------------------|
| Locked/Unlocked Doors | Doors were unlocked                                            | Doors were unlocked                                            |
| Front Door Opening    | Door remained closed and latched;<br>Door opened without tools | Door remained closed and latched;<br>Door opened without tools |
| Rear Door Opening     | Door remained closed and latched;<br>Door opened without tools | Door remained closed and latched;<br>Door opened without tools |
| Seat Track Shift (mm) | 0                                                              | 0                                                              |
| Seat Back Failure     | None                                                           | None                                                           |
| Glazing Damage        | The windshield cracked.                                        |                                                                |

**VEHICLE REBOUND FROM BARRIER**

| Measured Parameter | Units | Value |
|--------------------|-------|-------|
| Left Side          | mm    | 1338  |
| Center             | mm    | 1342  |
| Right Side         | mm    | 1347  |
| Average            | mm    | 1342  |

**BELT LENGTH DATA**

| Measurement Description                          | Units | Driver | Passenger |
|--------------------------------------------------|-------|--------|-----------|
| Shoulder belt length as measured on ATD          | mm    | 878    | 903       |
| Lap belt length as measured on ATD               | mm    | 812    | 922       |
| Remainder of belt on reel                        | mm    | 934    | 861       |
| Total belt length for continuous webbing systems | mm    | 2624   | 2686      |

**DATA SHEET NO. 2**  
**GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

**TEST VEHICLE INFORMATION**

|                                                         |                   |
|---------------------------------------------------------|-------------------|
| Manufacturer                                            | Toyota            |
| Model                                                   | Highlander        |
| Body Style                                              | SUV               |
| NHTSA No.                                               | M85110            |
| VIN                                                     | JTEES41A582004426 |
| Color                                                   | Cypress Pearl     |
| Delivery Date                                           | 9/14/2007         |
| Odometer Reading (mile)                                 | 130               |
| Dealer                                                  | Wilde Toyota      |
| Transmission                                            | Automatic         |
| Final Drive                                             | 4 Wheel           |
| Number of Cylinders                                     | 6                 |
| Engine Displacement (L)                                 | 3.5               |
| Engine Placement                                        | Lateral           |
| Automatic Door Lock (ADL)                               | No                |
| Owners Manual Details<br>Instructions on Disabling ADLs | N/A               |
| Bucket Seats                                            | Yes               |

**TEST VEHICLE OPTIONS**

|                                    |     |
|------------------------------------|-----|
| Front Airbag                       | Yes |
| Driver Side Curtain Airbag         | Yes |
| Driver Side Torso Airbag           | Yes |
| Rear Passenger Side Curtain Airbag | Yes |
| Rear Passenger Side Torso Airbag   | No  |
| Force Limiter                      | Yes |
| Pretensioner                       | Yes |
| Power Steering                     | Yes |
| Power Door Locks                   | Yes |
| Tilt Wheel                         | Yes |
| Air Conditioning                   | Yes |
| Anti-lock Brakes                   | Yes |
| Traction Control                   | Yes |
| All Wheel Drive                    | Yes |
| Power Seats                        | No  |

**DATA FROM CERTIFICATION LABEL**

|                     |                          |
|---------------------|--------------------------|
| Manufactured By     | Toyota Motor Corporation |
| Date of Manufacture | 06/07                    |

|                 |      |
|-----------------|------|
| GVWR (kg)       | 2720 |
| GAWR Front (kg) | 1340 |
| GAWR Rear (kg)  | 1585 |

| Measured Parameter      | Front  | Rear   | Third | Total |
|-------------------------|--------|--------|-------|-------|
| Type of Seats           | Bucket | Bucket | Bench |       |
| Number of Occupants     | 2      | 3      | 2     | 7     |
| Capacity Wt. (VCW) (kg) |        |        |       | 544   |
| Cargo Wt. (RCLW) (kg)   |        |        |       | 68    |

**DATA SHEET NO. 2... (CONTINUED)**  
**GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

**TEST VEHICLE WEIGHTS**

|        | Units | As Delivered (UVW) (Axle) |       |        | As Tested (ATW) (Axle) |       |        |
|--------|-------|---------------------------|-------|--------|------------------------|-------|--------|
|        |       | Front                     | Rear  | Total  | Front                  | Rear  | Total  |
| Left   | kg    | 541.6                     | 441.8 |        | 590.6                  | 506.2 |        |
| Right  | kg    | 530.7                     | 420.5 |        | 572.9                  | 484.0 |        |
| Ratio  | %     | 55.4                      | 44.6  |        | 54.0                   | 46.0  |        |
| Totals | kg    | 1072.3                    | 862.3 | 1934.6 | 1163.5                 | 990.2 | 2153.7 |

**TARGET TEST WEIGHT CALCULATION**

| Measured Parameter                      | Units | Value  |
|-----------------------------------------|-------|--------|
| Total Delivered Weight (UVW)            | kg    | 1934.6 |
| Weight of 2 P572E ATDs                  | kg    | 156.0  |
| Rated Cargo/Luggage Weight (RCLW)       | kg    | 68     |
| Calculated Vehicle Target Weight (TVTW) | kg    | 2158.6 |

**TEST VEHICLE ATTITUDES AND CG**

|              | Units | LF  | RF  | LR  | RR  | CG (aft of front axle) |
|--------------|-------|-----|-----|-----|-----|------------------------|
| As Delivered | mm    | 838 | 849 | 852 | 858 | 1241                   |
| As Tested    | mm    | 817 | 831 | 826 | 834 | 1280                   |
| Post Test    | mm    | 846 | 913 | 837 | 811 |                        |

Vehicle Wheelbase (mm): 2785

Weight of Ballast secured in cargo area (kg): 0

Vehicle Components Removed: Rear muffler, spare tire, cargo compartment tools,  
and carpet

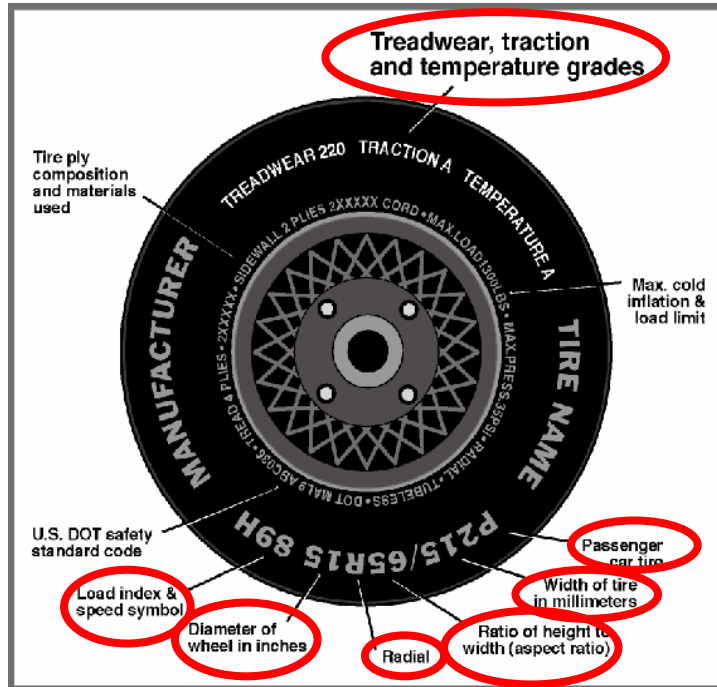
Ballast weight does not include instrumentation and data acquisition system.

### DATA SHEET NO. 3

#### TEST VEHICLE TIRE INFORMATION

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007



#### DATA FROM TIRE PLACARD

| Measured Parameter                      | Front         | Rear          |
|-----------------------------------------|---------------|---------------|
| Maximum Tire Pressure (kPa)             | 300           | 300           |
| Cold Pressure (kPa)                     | 210           | 210           |
| Recommended Tire Size                   | P245/65R17    | P245/65R17    |
| Tire Size on Vehicle                    | P245/65R17    | P245/65R17    |
| Tire Manufacturer                       | Bridgestone   | Bridgestone   |
| Tire Name                               | Dueler H/L    | Dueler H/L    |
| Tire Type                               | Passenger M+S | Passenger M+S |
| Tire Width (mm)                         | 245           | 245           |
| Ratio of Height to Width (aspect ratio) | 65            | 65            |
| Radial                                  | R             | R             |
| Wheel Diameter                          | 17            | 17            |
| Load Index & Speed Symbol               | 105S          | 105S          |
| Treadwear                               | 400           | 400           |
| Traction Grade                          | B             | B             |
| Temperature Grade                       | B             | B             |

**DATA SHEET NO. 4**  
**TEST VEHICLE INFORMATION**

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

**NORMAL DESIGN RIDING POSITION**

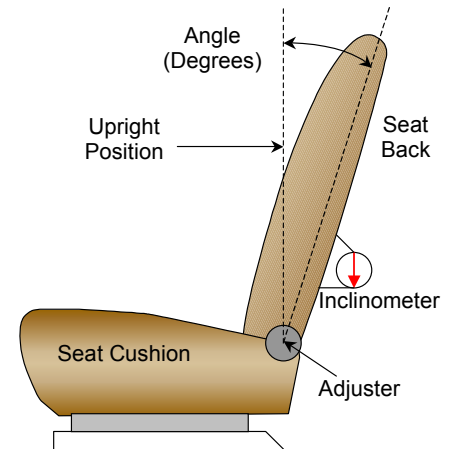
The driver and passenger seat back is positioned to the manufacturer's designated angle. The procedure is as follows: 6<sup>th</sup> detent with for forward-most detent defined as 0.

Driver seat back angle: 6<sup>th</sup> detent (forward-most as 0)

Passenger seat back angle: 6<sup>th</sup> detent (forward-most as 0)

**SEAT FORE/AFT POSITIONING**

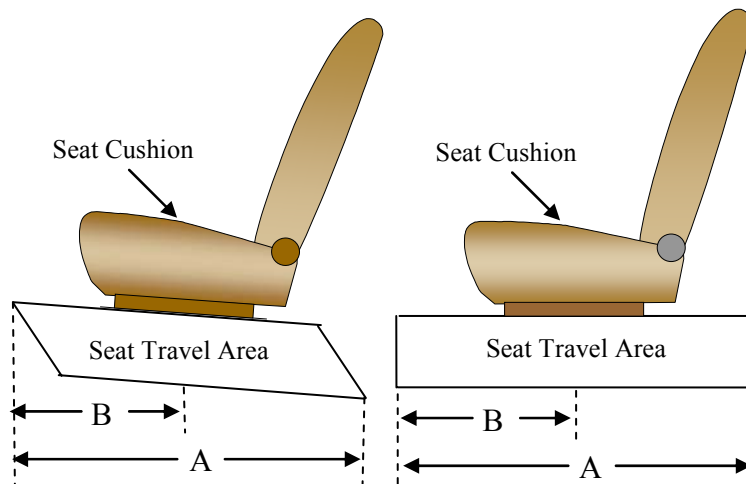
|                | Total Fore/Aft Travel | Placed in Position #                          |
|----------------|-----------------------|-----------------------------------------------|
| Driver Seat    | 17 detents            | 8 <sup>th</sup> detent (1 <sup>st</sup> as 0) |
| Passenger Seat | 16 detents            | 8 <sup>th</sup> detent (1 <sup>st</sup> as 0) |



*FRONT SEAT ASSEMBLY*

**ADJUSTABLE D-RING POSITION**

The driver and passenger D-rings were placed in position 1 with the uppermost detent defined as 0.



## DATA SHEET NO. 4...(CONTINUED)

### TEST VEHICLE INFORMATION

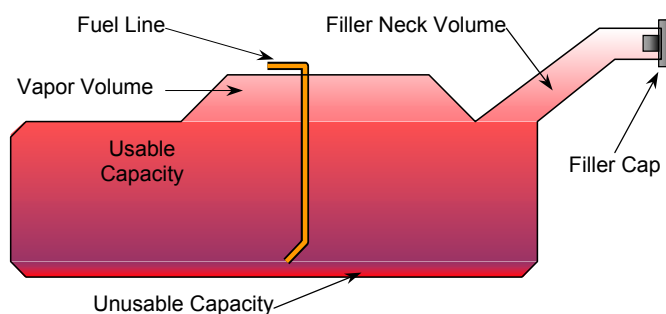
Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

### FUEL TANK CAPACITY

|                                    | Liters      |
|------------------------------------|-------------|
| Usable Capacity of "Standard Tank" | 72.7        |
| Usable Capacity of "Optional" Tank |             |
| 92-94% of Usable Capacity          | 66.8 – 68.3 |
| Actual Amount of Solvent used      | 67.5        |
| 1/3 of Usable Capacity             | 24.2        |

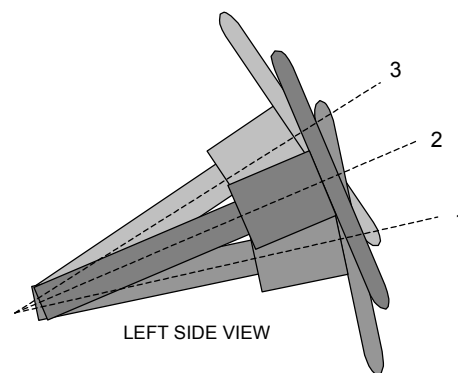
The test vehicle is equipped with an electric fuel pump. The fuel pump will pump fuel when the ignition is on.



VEHICLE FUEL TANK ASSEMBLY

### STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. An aluminum plate is placed across the rim of the steering wheel, an inclinometer is placed on the plate and the angle is measured.



STEERING COLUMN ASSEMBLY

### STEERING COLUMN POSITIONS

|                                 | Fore/Aft Position (mm) | Degrees |
|---------------------------------|------------------------|---------|
| Lowermost position No. 1        | 40                     | 61.8    |
| Geometric center position No. 2 | 20                     | 63.3    |
| Uppermost position No. 3        | 0                      | 64.8    |

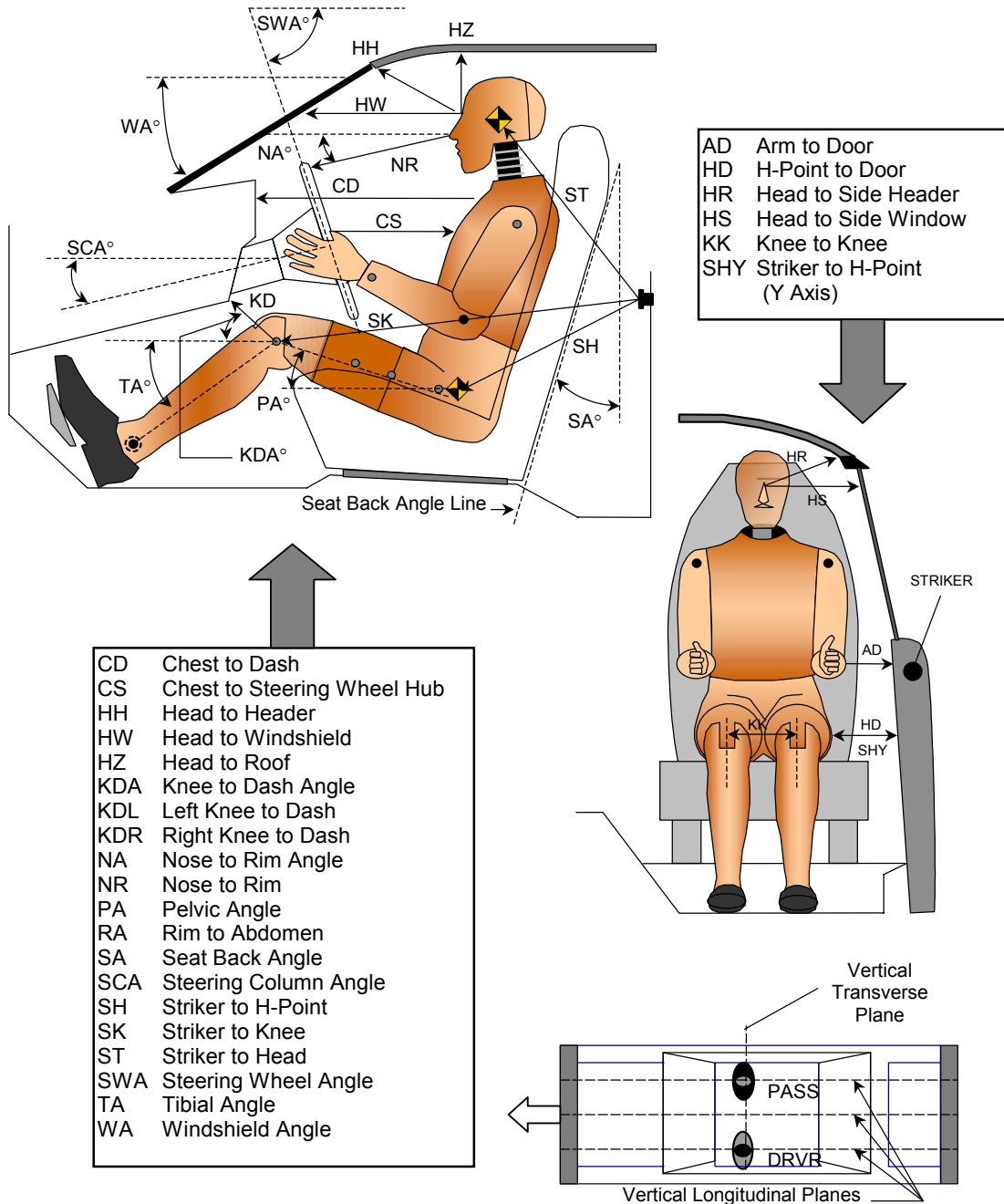
## DATA SHEET NO. 5

### DUMMY POSITIONING IN VEHICLE

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

#### DUMMY MEASUREMENTS FOR FRONT SEAT OCCUPANTS



# DATA SHEET NO. 5... (CONTINUED)

## DUMMY POSITIONING IN VEHICLE

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

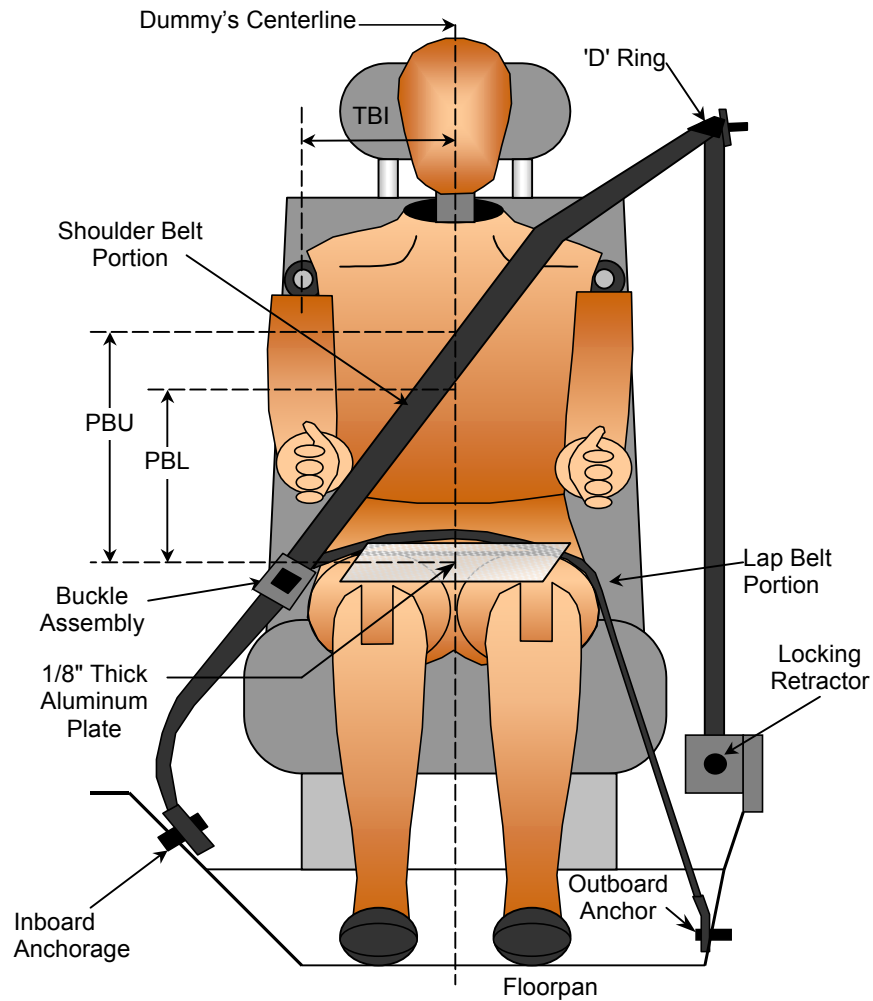
### TEST DUMMY POSITION MEASUREMENTS

| Code | Measurement Description            | Driver      |           | Passenger   |           |
|------|------------------------------------|-------------|-----------|-------------|-----------|
|      |                                    | Length (mm) | Angle (°) | Length (mm) | Angle (°) |
| WA   | Windshield Angle                   |             | 29.3      |             |           |
| SWA  | Steering Wheel Angle               |             | 63.3      |             |           |
| SCA  | Steering Column Angle              |             | 26.1      |             |           |
| SA   | Seat Back Angle (on headrest post) |             | 4.0       |             | 0.5       |
| HZ   | Head to Roof (Z)                   | 237         | 90        | 194         | 90        |
| HH   | Head to Header                     | 421         | 19.3      | 381         | 20.7      |
| HW   | Head to Windshield                 | 745         | 0         | 676         | 0         |
| HR   | Head to Side Header (Y)            | 239         |           | 234         |           |
| NR   | Nose to Rim                        | 456         | 10.4      |             |           |
| CD   | Chest to Dash                      | 571         |           | 552         |           |
| CS   | Chest to Steering Hub              | 358         | 2.8       |             |           |
| RA   | Rim to Abdomen                     | 184         | 0         |             |           |
| KDL  | Left Knee to Dash                  | 176         | 26.4      | 131         |           |
| KDR  | Right Knee to Dash                 | 148         |           | 151         | 26.2      |
| PA   | Pelvic Angle                       |             | 23.4      |             | 21.3      |
| TA   | Tibia Angle                        |             | 43.2      |             | 45.7      |
| KK   | Knee to Knee (Y)                   | 321         |           | 270         |           |
| SK   | Striker to Knee                    | 624         | 97.8      | 644         | 101.3     |
| ST   | Striker to Head                    | 464         | 11.1      | 469         | 14.3      |
| SH   | Striker to H-Point                 | 278         | 131.6     | 278         | 127.6     |
| SHY  | Striker to H-Point (Y)             | 285         |           | 288         |           |
| HS   | Head to Side Window                | 342         |           | 351         |           |
| HD   | H-Point to Door (Y)                | 154         |           | 156         |           |
| AD   | Arm to Door (Y)                    | 116         |           | 142         |           |
| AA   | Ankle to Ankle                     | 314         |           | 208         |           |

# **DATA SHEET NO. 6** **SEAT BELT POSITIONING DATA**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007



## **SEAT BELT POSITIONING MEASUREMENTS**

| Measurement Description                           | Units | Driver | Passenger |
|---------------------------------------------------|-------|--------|-----------|
| PBU - Top surface of reference to belt upper edge | mm    | 385    | 385       |
| PBL - To surface of reference to belt lower edge  | mm    | 310    | 310       |

**DATA SHEET NO. 7**  
**VEHICLE ACCELEROMETER LOCATIONS**

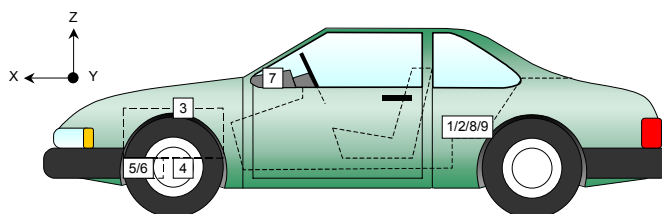
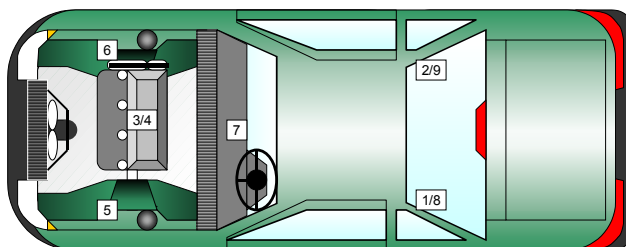
Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

**VEHICLE ACCELEROMETER PRE-TEST LOCATIONS**

| No. | Accelerometer Location | Measurements (mm) |      |     |
|-----|------------------------|-------------------|------|-----|
|     |                        | X                 | Y    | Z   |
| 1   | Left Rear X-Member X   | 1859              | -365 | 489 |
| 2   | Right Rear X-Member X  | 1859              | 376  | 489 |
| 3   | Engine Top X           | 4080              | -8   | 886 |
| 4   | Engine Bottom X        | 4010              | 47   | 309 |
| 5   | Left Brake Caliper X   | 3970              | -709 | 286 |
| 6   | Right Brake Caliper X  | 3989              | 709  | 286 |
| 7   | Instrument Panel X     |                   |      |     |
| 8   | Left Rear X-Member Z   | 1859              | -365 | 489 |
| 9   | Right Rear X-Member Z  | 1859              | 376  | 489 |

Reference Points: X - Rear Surface of Vehicle (+ forward)  
 Y - Vehicle Centerline (+ to right)  
 Z - Ground Plane (+ up)



## DATA SHEET NO. 8

### SUMMARY OF FMVSS 212 AND FMVSS 219 (Partial) DATA

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

#### Windshield Mounting Details:

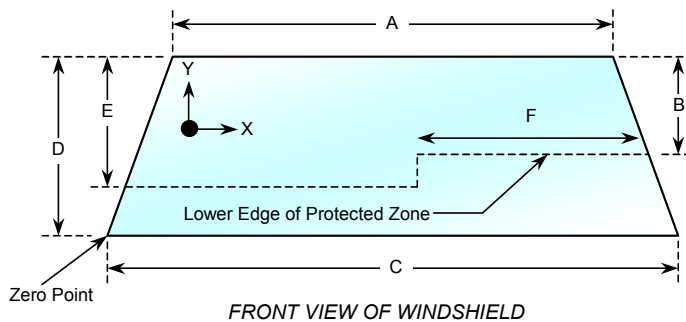
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

The standard requires that the post-test retention measurement be a minimum of 75 percent of the pretest total periphery measurement for vehicles not equipped with occupant passive restraints and 50 percent for each side of the windshield for vehicles, which are equipped with occupant passive restraints.

Temperature of windshield molding during test: 21°C

#### WINDSHIELD PERIPHERY MEASUREMENTS

| Measurement | Pre-Test (mm) | Post-Test (mm) | % of Retention |
|-------------|---------------|----------------|----------------|
| Left Side   | 2458          | 2458           | 100            |
| Right Side  | 2458          | 2458           | 100            |
| Total       | 4916          | 4916           | 100            |



| Item | Units | Value |
|------|-------|-------|
| A    | mm    | 1293  |
| B    | mm    | 562   |
| C    | mm    | 1625  |
| D    | mm    | 801   |
| E    | mm    | 557   |
| F    | mm    | 449   |

#### AREA OF PROTECTED ZONE FAILURES - NONE

A. Provide coordinates of the area that the protected zone was penetrated more than 0.25 inches by a vehicle component other than one that is normally in contact with the windshield. **None**

| X | Y |
|---|---|
|   |   |
|   |   |
|   |   |
|   |   |

B. Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component. **None**

| X | Y |
|---|---|
|   |   |
|   |   |
|   |   |
|   |   |

**DATA SHEET NO. 9**  
**SUMMARY OF FMVSS 301 DATA**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

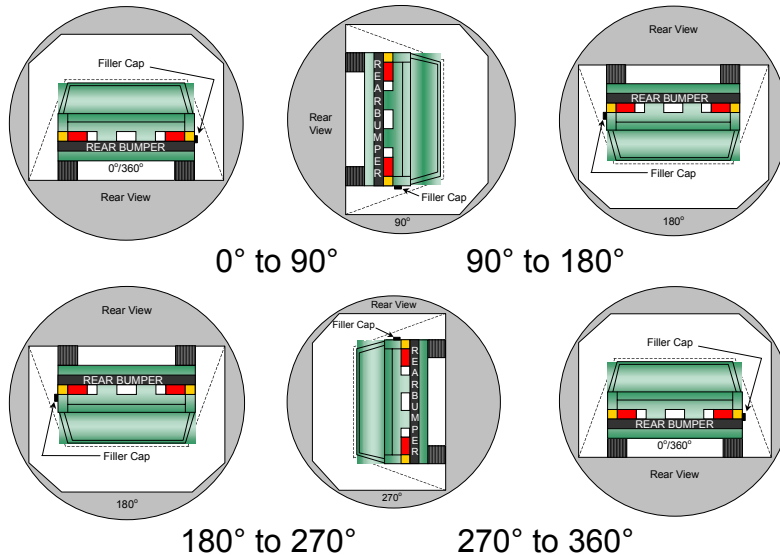
**FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA**

Temperature at Time of Impact: 21° C      Test Time: 12:05 pm

**Stoddard Solvent Spillage Measurements**

- A. From impact until vehicle motion ceases: 0 oz.  
 (Maximum Allowable = 1 ounce)
- B. For the 5 minute period after motion ceases: 0 oz.  
 (Maximum Allowable = 5 ounces)
- C. For the following 25 minutes: 0 oz.  
 (Maximum Allowable = 1 oz. /minute)
- D. Spillage: None

**FMVSS 301 STATIC ROLLOVER DATA**



1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.

2. The position hold time at each position is 300 seconds (minimum).

3. Details of Stoddard Solvent spillage locations:

**None**

| Test Phase   | Rotation Time (sec.) | Hold Time (sec.) | Spillage (oz.) |
|--------------|----------------------|------------------|----------------|
| 0° to 90°    | 120                  | 300              | 0              |
| 90° to 180°  | 117                  | 300              | 0              |
| 180° to 270° | 113                  | 300              | 0              |
| 270° to 360° | 119                  | 300              | 0              |

**DATA SHEET NO. 10**  
**VEHICLE MEASUREMENTS**

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

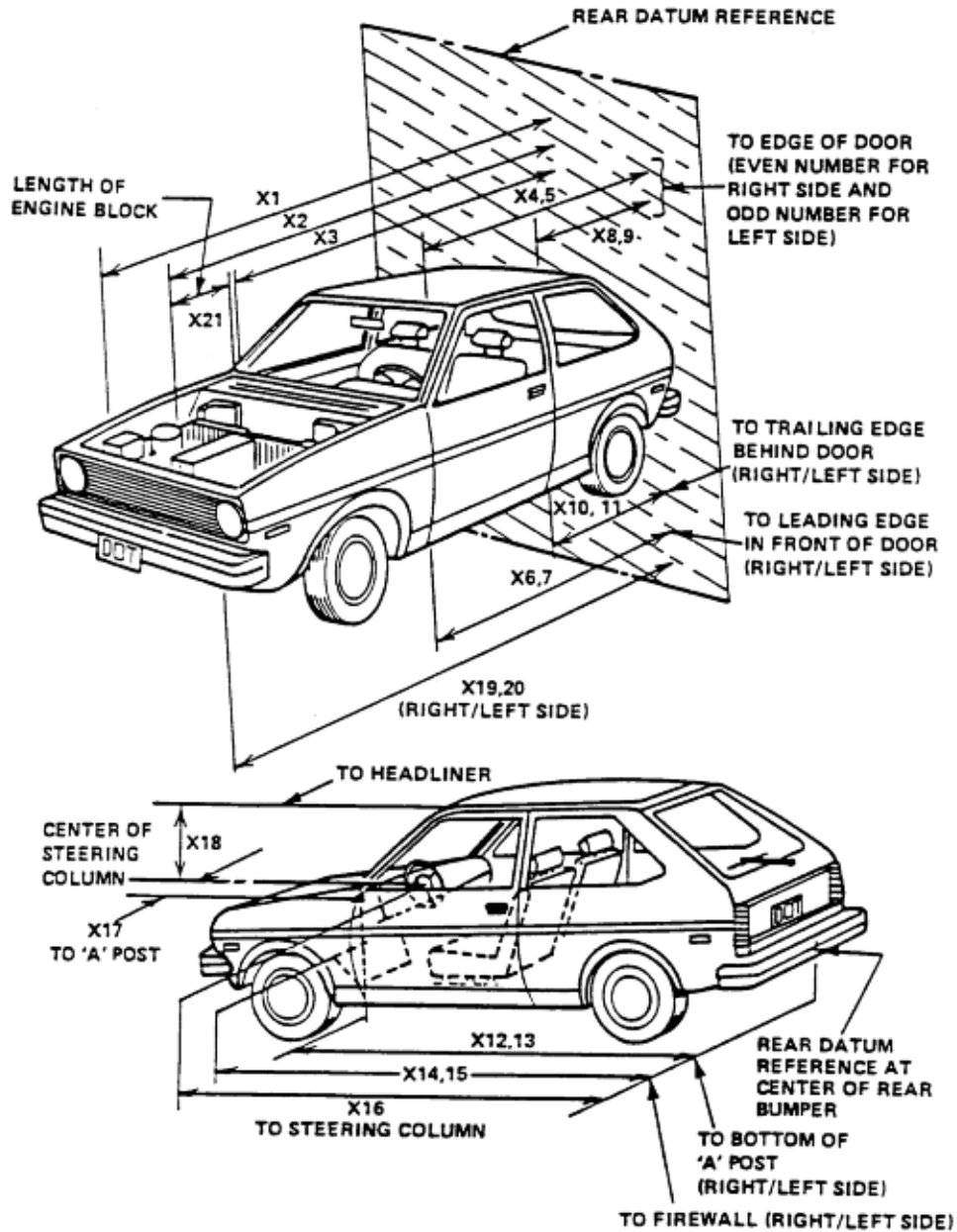
| No. | Measurement Description                      | Units | Pre-Test | Post-Test | Difference |
|-----|----------------------------------------------|-------|----------|-----------|------------|
| 1   | Total length of vehicle at centerline        | mm    | 4800     | 4274      | 526        |
| 2   | RSOV to front of engine                      | mm    | 4275     | 3815      | 460        |
| 3   | RSOV to firewall centerline                  | mm    | 3859     | 3691      | 168        |
| 4   | RSOV to leading edge of right door           | mm    | 3318     | 3344      | -26        |
| 5   | RSOV to leading edge of left door            | mm    | 3336     | 3337      | -1         |
| 6   | RSOV to lower leading edge of right door     | mm    | 3306     | 3302      | 4          |
| 7   | RSOV to lower leading edge of left door      | mm    | 3312     | 3305      | 7          |
| 8   | RSOV to upper leading edge of right door     | mm    | 2222     | 2245      | -23        |
| 9   | RSOV to upper leading edge of left door      | mm    | 2228     | 2242      | -14        |
| 10  | RSOV to lower trailing edge of right door    | mm    | 2220     | 2221      | -1         |
| 11  | RSOV to lower trailing edge of left door     | mm    | 2226     | 2221      | 5          |
| 12  | RSOV to bottom of right 'A' pillar           | mm    | 3258     | 3255      | 3          |
| 13  | RSOV to bottom of left 'A' pillar            | mm    | 3271     | 3255      | 16         |
| 14  | RSOV to firewall on right side               | mm    | 3884     | 3792      | 92         |
| 15  | RSOV to firewall on left side                | mm    | 3919     | 3876      | 43         |
| 16  | RSOV to steering column                      | mm    | 2938     | 2960      | -22        |
| 17  | Center of steering column to left 'A' pillar | mm    | 254      | 421       | -167       |
| 18  | Center of steering column to headlining      | mm    | 441      | 530       | -89        |
| 19  | RSOV to right side of front bumper           | mm    | 4744     | 4266      | 478        |
| 20  | RSOV to left side of front bumper            | mm    | 4746     | 4209      | 537        |
| 21  | Length of engine block                       | mm    | 529      | 529       | 0          |
| RD  | RSOV to right side of dash panel             | mm    | 3052     | 3092      | -40        |
| CD  | RSOV to center of dash panel                 | mm    | 3073     | 3168      | -95        |
| LD  | RSOV to left side of dash panel              | mm    | 3094     | 3090      | 4          |

# DATA SHEET NO. 10... (continued)

## VEHICLE MEASUREMENTS

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007



**DATA SHEET NO. 10... (continued)****VEHICLE MEASUREMENTS**Test Vehicle: 2008 Toyota Highlander 4x4Test Program: 35mph Frontal ImpactNHTSA No.: M85110Test Date: 9/19/2007**Target Vehicle Structural Measurement**

|    | Elements                              | Pre-Test (mm) |
|----|---------------------------------------|---------------|
| 1  | Total Length                          | 4800          |
| 2  | Total Width                           | 1886          |
| 3  | Bumper Top Height                     | 746           |
| 4  | Bumper Bottom Height                  | 564           |
| 5  | Longitudinal Member Top Height        | 764           |
| 6  | Distance between Longitudinal Members | 798           |
| 7  | Longitudinal Member Width             | 63            |
| 8  | Engine Top Height                     | 842           |
| 9  | Engine Bottom Height                  | 229           |
| 10 | Engine and gearbox width              | 772           |
| 11 | Front bumper-engine distance          | 488           |
| 12 | Front shock absorber fixing height    | 1016          |
| 13 | Bonnet leading edge height            | 1008          |
| 14 | Front shock absorber fixing width     | 1209          |
| 15 | Front bumper – front axle distance    | 926           |
| 16 | Front axle – a pillar distance        | 574           |
| 17 | A-pillar – B-pillar distance          | 1128          |
| 18 | B-Pillar – rear axle distance         | 1177          |
| 19 | B-pillar – C-pillar distance          | 1052          |
| 20 | Roof sill bottom height               | 1621          |
| 21 | Roof sill top height                  | 1673          |
| 22 | Floor sill bottom height              | 229           |
| 23 | Floor sill top height                 | 444           |

**DATA SHEET NO. 11**  
**CAMERA LOCATIONS**

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

| No. | Camera View              | Location (mm) * |       |       | Lens (mm) | Speed (fps) |
|-----|--------------------------|-----------------|-------|-------|-----------|-------------|
|     |                          | X               | Y     | Z     |           |             |
| 1   | Real-Time Left Side View |                 |       |       | 13        | 24          |
| 2   | Left Front Half          | 1420            | -4895 | 1150  | 24        | 1000        |
| 3   | Steering Column Top      | 1165            | -5130 | 1265  | 25        | 1000        |
| 4   | Steering Column Bottom   | 1165            | -5130 | 885   | 25        | 1000        |
| 5   | Driver Close-up          | 1415            | -5930 | 1175  | 35        | 1000        |
| 6   | Driver Angle             | 7115            | -5375 | 2105  | 50        | 1000        |
| 7   | On Board Driver Side     |                 |       |       | 8         | 1000        |
| 8   | On Board Passenger Side  |                 |       |       | 8         | 1000        |
| 9   | Right Overall            | 2140            | 7130  | 1250  | 24        | 1000        |
| 10  | Right Passenger Half     | 1320            | 5245  | 1070  | 24        | 1000        |
| 11  | Right Close-up           | 1555            | 6090  | 1400  | 35        | 1000        |
| 12  | Right Angle              | 7125            | 5155  | 2170  | 50        | 1000        |
| 13  | Windshield               | -285            | 0     | 2960  | 12.5      | 1000        |
| 14  | Top Driver               | -135            | -470  | 2240  | 24        | 1000        |
| 15  | Top Passenger            | -110            | 420   | 2240  | 24        | 1000        |
| 16  | Pit Front                | 1105            | 0     | -3150 | 24        | 1000        |
| 17  | Pit Rear                 | 3275            | 0     | -3150 | 24        | 1000        |

**\*COORDINATES:**

+X = forward of impact plane  
+Y = right of monorail centerline  
+Z = above ground level

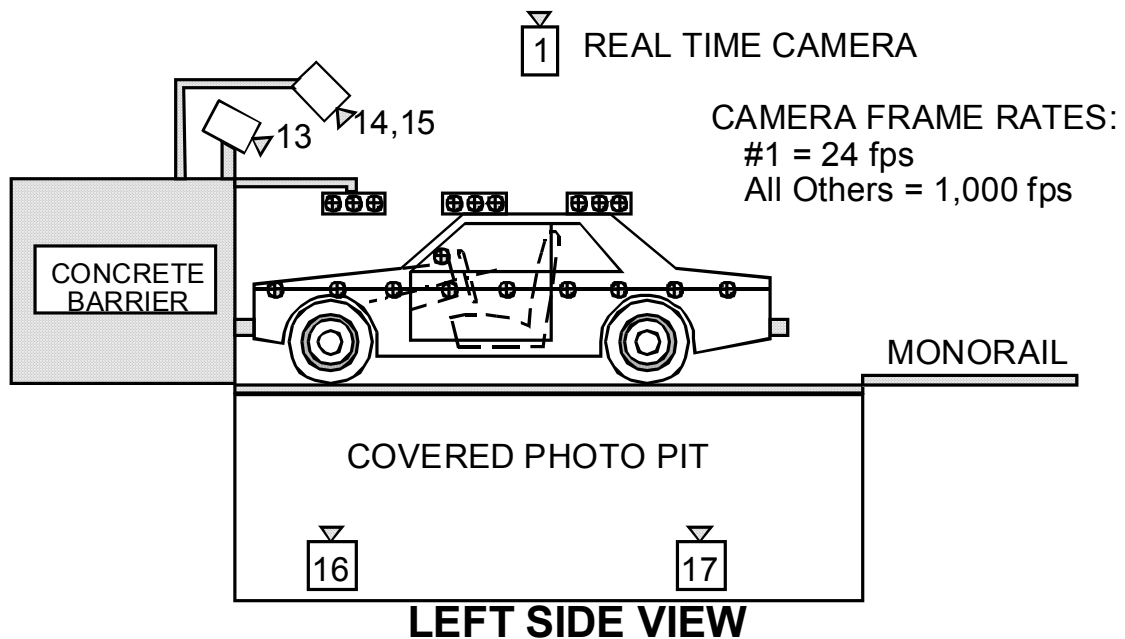
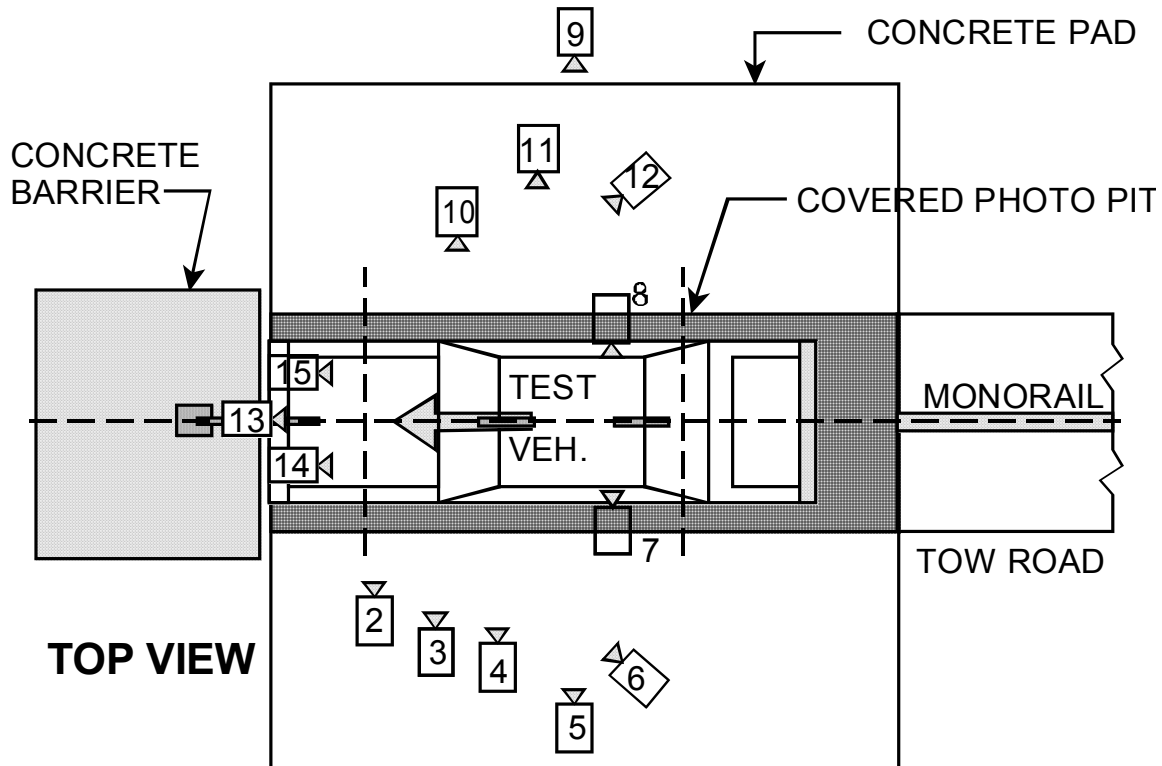
DATA SHEET NO. 11... (continued)

CAMERA LOCATIONS

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007

CAMERA POSITIONS FOR FRONTAL IMPACTS

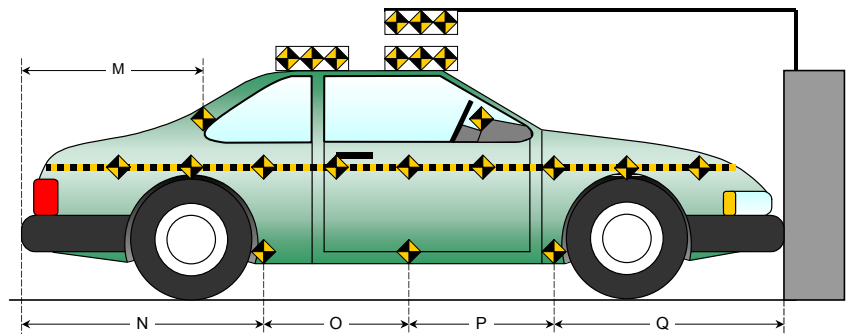
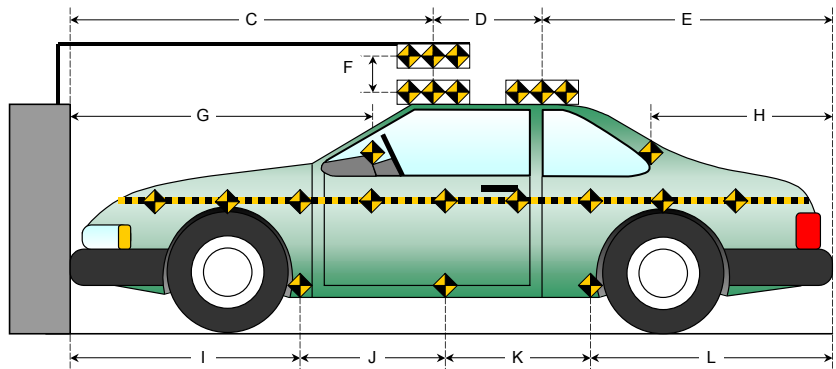
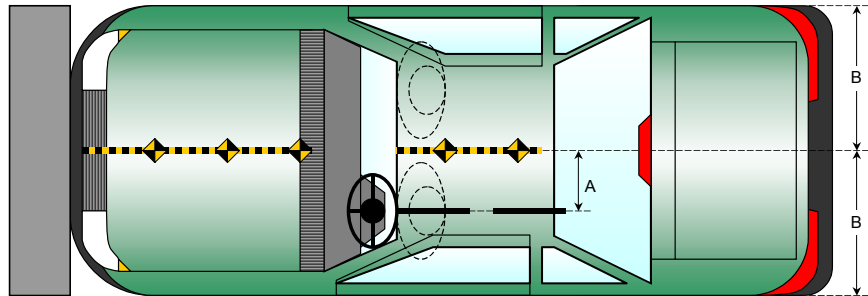


# **DATA SHEET NO. 12** **PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

| Item | Value |
|------|-------|
| A    | 401   |
| B    | 943   |
| C    | 2085  |
| D    | 915   |
| E    | 1800  |
| F    | 1717  |
| G    |       |
| H    |       |
| I    | 1417  |
| J    | 907   |
| K    | 903   |
| L    | 1573  |
| M    |       |
| N    | 1568  |
| O    | 903   |
| P    | 904   |
| Q    | 1425  |



**DATA SHEET NO. 13**  
**VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

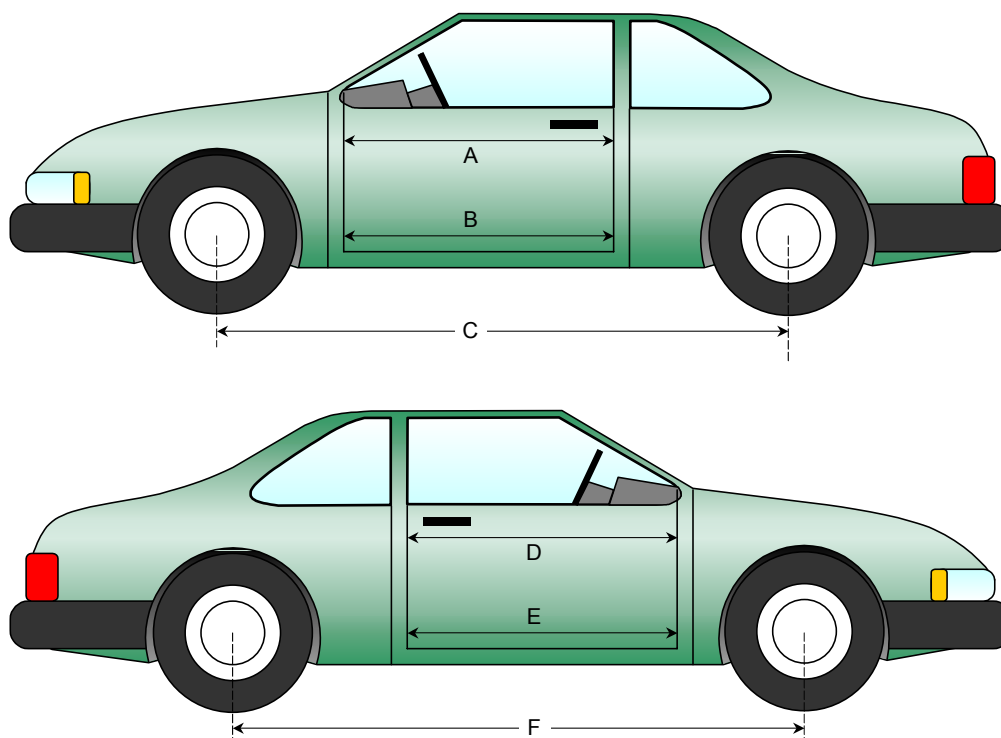
NHTSA No.: M85110  
 Test Date: 9/19/2007

**DOOR OPENING WIDTH**

| Item | Description      | Units | Pre-Test | Post-Test | Difference |
|------|------------------|-------|----------|-----------|------------|
| A    | Left Side Upper  | mm    | 1006     | 1004      | 2          |
| B    | Left Side Lower  | mm    | 927      | 932       | -5         |
| D    | Right Side Upper | mm    | 1004     | 1002      | 2          |
| E    | Right Side Lower | mm    | 928      | 924       | 4          |

**WHEELBASE MEASUREMENTS**

| Item | Description          | Units | Pre-Test | Post-Test | Difference |
|------|----------------------|-------|----------|-----------|------------|
| C    | Left Side Wheelbase  | mm    | 2785     | 2740      | 45         |
| F    | Right Side Wheelbase | mm    | 2785     | 2751      | 34         |



**DATA SHEET NO. 13... (continued)**  
**VEHICLE INTRUSION MEASUREMENTS**

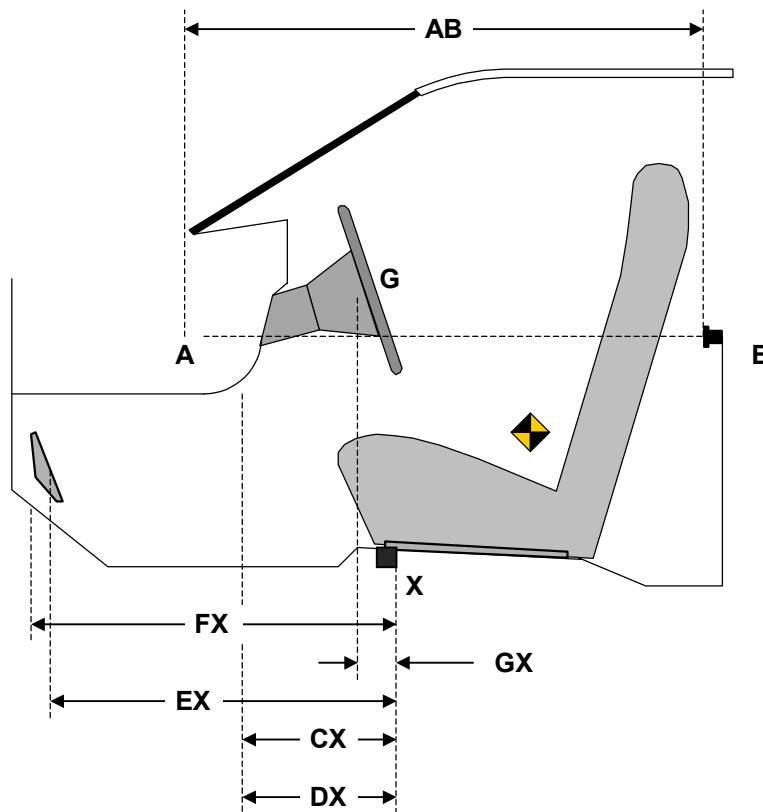
Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

**DRIVER COMPARTMENT INTRUSION**

| Item | Description                              | Units | Pre-Test | Post-Test | Difference |
|------|------------------------------------------|-------|----------|-----------|------------|
| AB   | Door Opening (Inside window jam)         | mm    | 873      | 868       | 5          |
| CX   | Left Knee Bolster to X                   | mm    | 277      | 284       | -7         |
| DX   | Right Knee Bolster to X                  | mm    | 269      | 289       | -20        |
| EX   | Brake Pedal to X                         | mm    | 576      | 559       | 17         |
| FX   | Foot Rest to X                           | mm    | 567      | 554       | 13         |
| GX   | Center of Steering Column Wheel Hub to X | mm    | 98       | 140       | -42        |

X = Front of Seat Track (stationary)

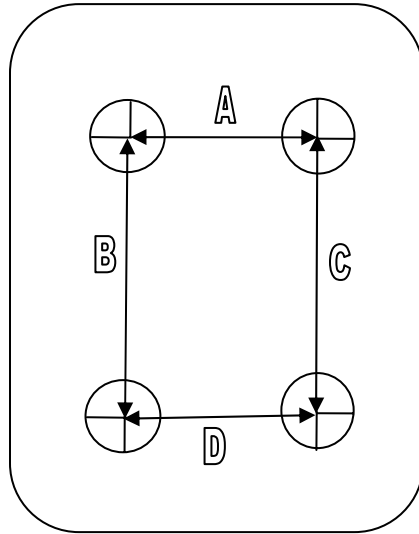


**DRIVER COMPARTMENT**

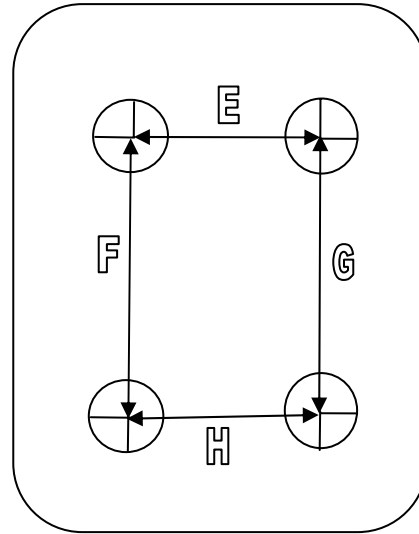
**DATA SHEET NO. 13... (continued)**  
**VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007



Driver



Passenger

**UNDERBODY FLOORBOARD DEFORMATION**

| Measurement | Pre-Test | Post-Test | Difference |
|-------------|----------|-----------|------------|
| A           | 318      | 318       | 0          |
| B           | 236      | 237       | -1         |
| C           | 245      | 245       | 0          |
| D           | 320      | 321       | -1         |
| E           | 308      | 308       | 0          |
| F           | 245      | 245       | 0          |
| G           | 182      | 182       | 0          |
| H           | 317      | 317       | 0          |

## DATA SHEET NO. 14

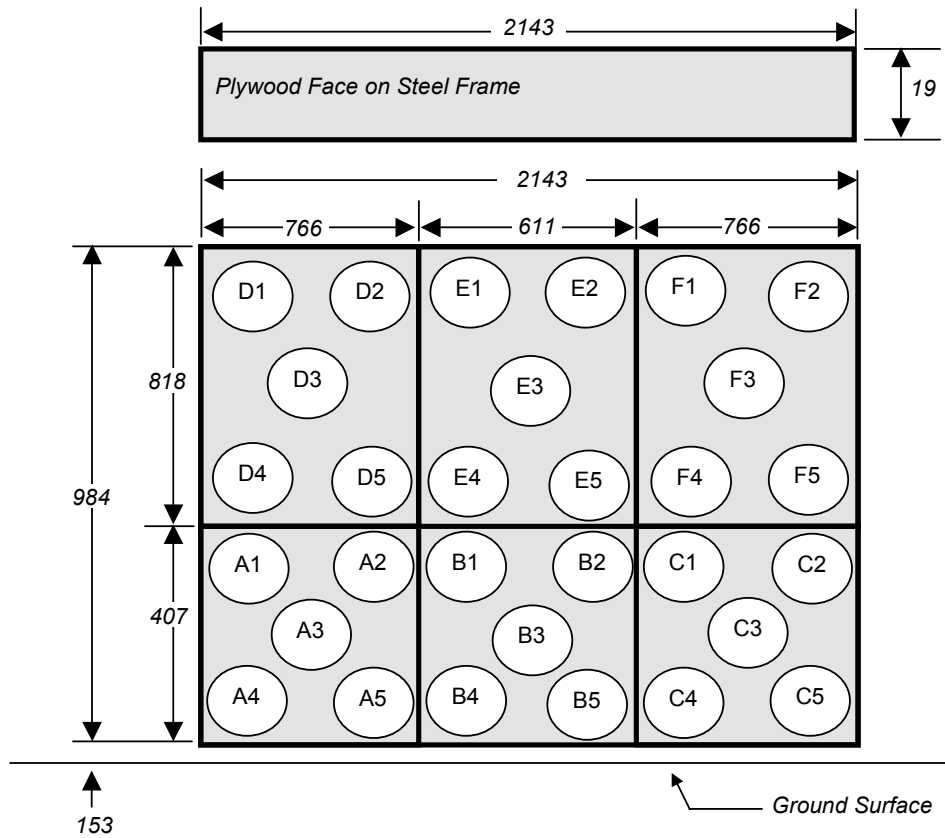
### LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

#### 30 Load Cell Rigid Barrier

#### Load Cell Locations on Fixed Barrier



|                  |                  |                  |
|------------------|------------------|------------------|
| Group 4<br>D1-D5 | Group 5<br>E1-E5 | Group 6<br>F1-F5 |
| Group 1<br>A1-A5 | Group 2<br>B1-B5 | Group 3<br>C1-C5 |

6 Groups of 5 Load Cells Each

**DATA SHEET NO. 15**  
**ACCIDENT INVESTIGATION DIVISION DATA**

Test Vehicle: 2008 Toyota Highlander 4x4  
 Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
 Test Date: 9/19/2007

**VEHICLE INFORMATION**

VIN: JTEES41A582004426 Wheelbase (mm) : 2785  
 Vehicle Size Category: SUV Test Weight (kg) : 2153.7

**ACCELEROMETER DATA**

Accelerometer Locations: As per measurements on Page 12  
 Cal. Procedure/Interval: MGA procedure / 6 month  
 Integration Algorithm: Trapezoidal Linearity: > 99%  
 Impact Velocity (km/h): 56.6  
 Velocity Change (km/h): 63.0 Time of Separation (msec): 207

**CRUSH PROFILE**

Collision Deformation Classification: Frontal Midpoint of Damage: Centerline  
 Damage Region Length (mm): 1259 Impact Mode: Frontal

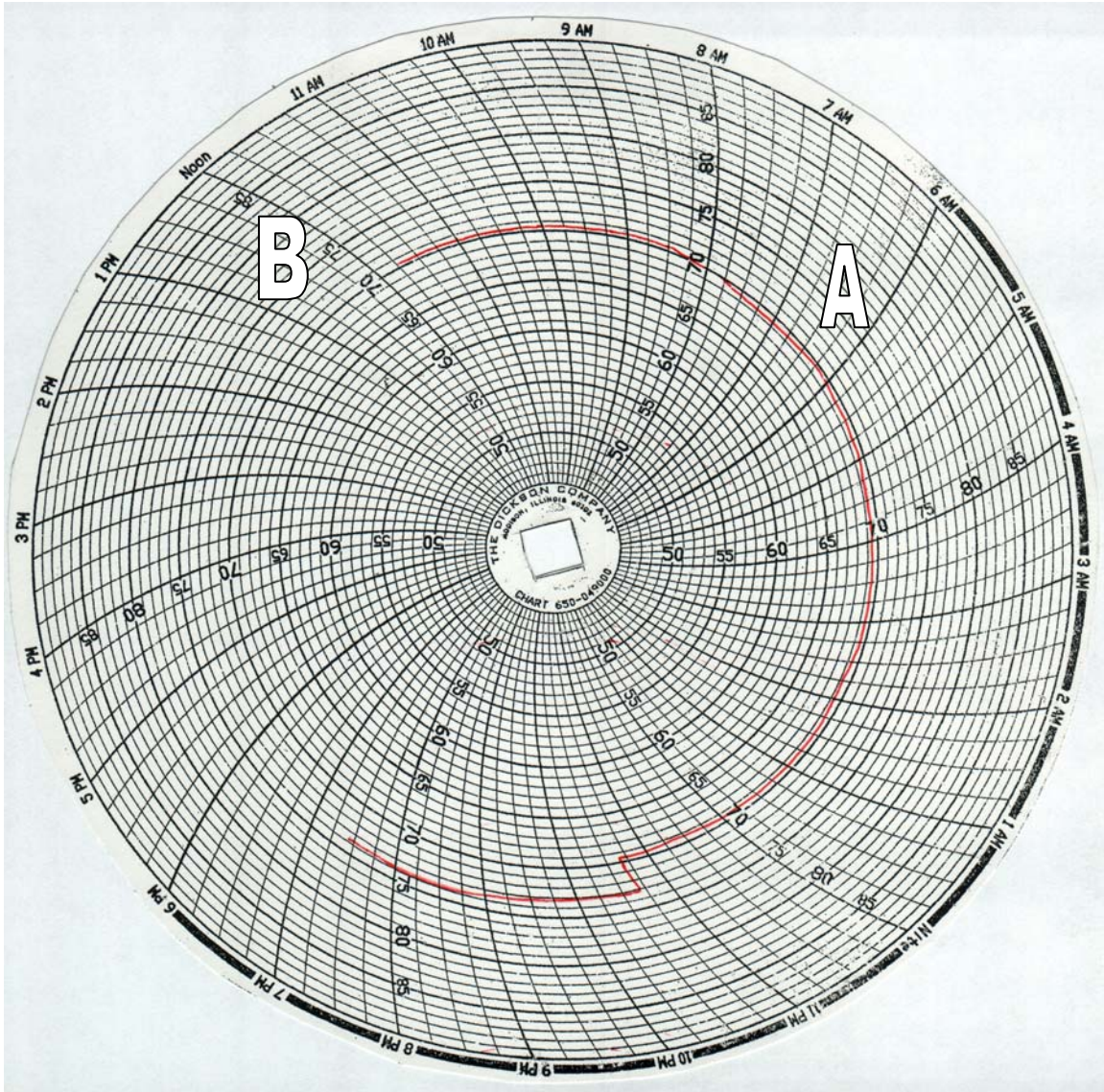
| No. | Measurement Description    | Units | Pre-Test | Post-Test | Difference |
|-----|----------------------------|-------|----------|-----------|------------|
| C1  | Crush zone 1 at left side  | mm    | 4601     | 4209      | 392        |
| C2  | Crush zone 2 at left side  | mm    | 4746     | 4260      | 486        |
| C3  | Crush zone 3 at left side  | mm    | 4767     | 4240      | 527        |
| C4  | Crush zone 4 at right side | mm    | 4761     | 4245      | 516        |
| C5  | Crush zone 5 at right side | mm    | 4744     | 4251      | 493        |
| C6  | Crush zone 6 at right side | mm    | 4678     | 4266      | 412        |
| L   | C1 TO C6                   | mm    | 1259     | 1260      | -1         |

## DATA SHEET NO. 16

### DUMMY / VEHICLE TEMPERATURE STABILIZATION CHART

Test Vehicle: 2008 Toyota Highlander 4x4  
Test Program: 35mph Frontal Impact

NHTSA No.: M85110  
Test Date: 9/19/2007



A = Dummies installed in vehicle at 6:00 a.m.

B = Test conducted at 12:05 pm

**APPENDIX A**  
**PHOTOGRAPHS**

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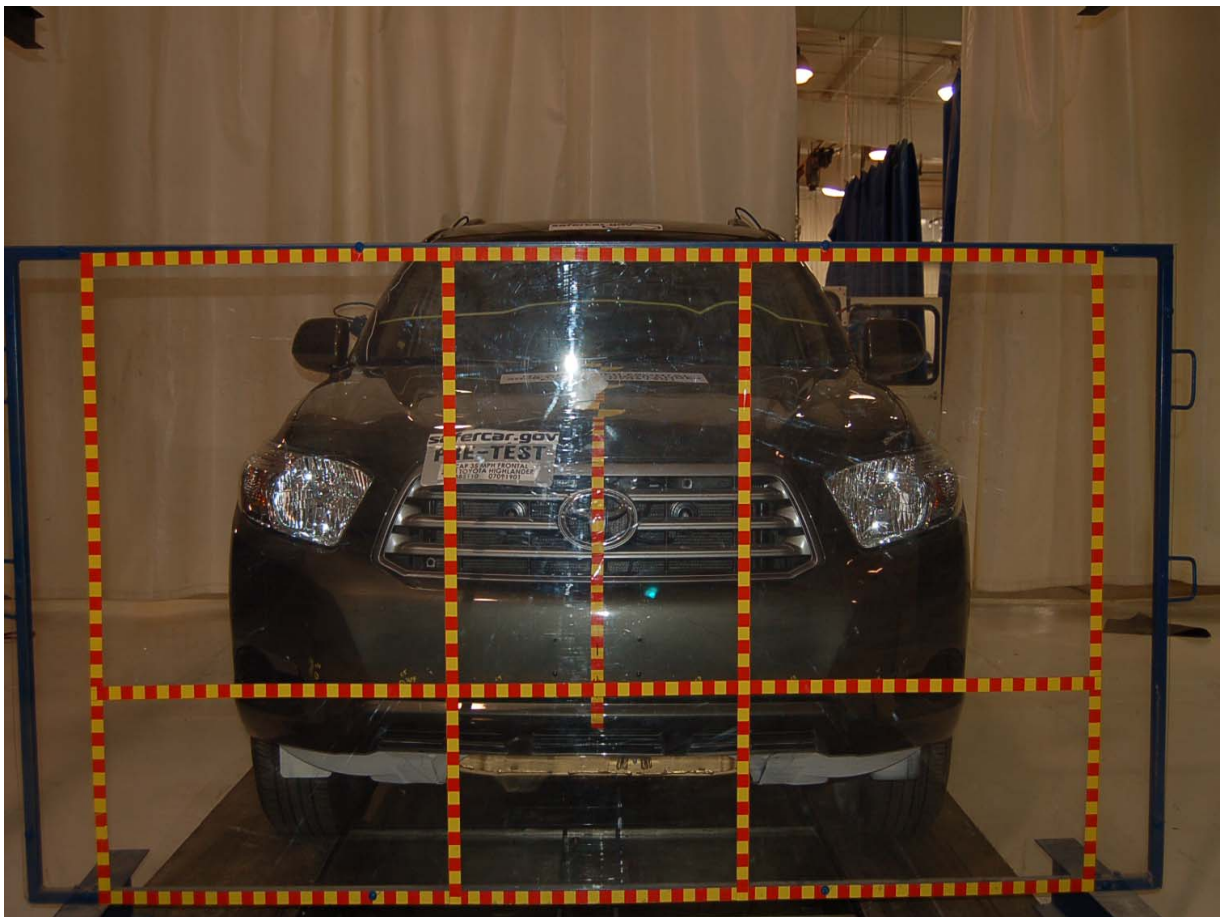
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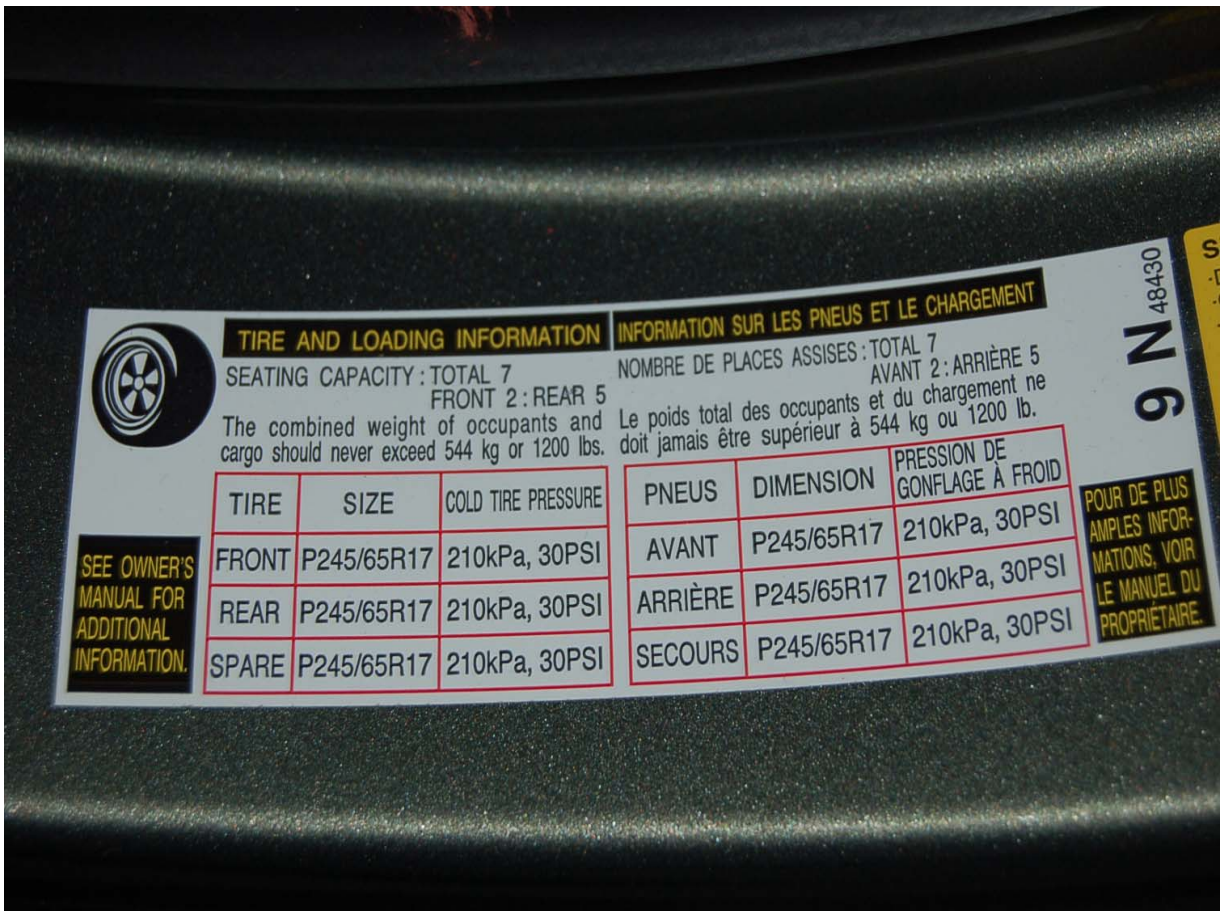
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Load Cell Location



Manufacturer's Label



Tire Placard



Left Front  $\frac{3}{4}$  View, As Received



Right Rear  $\frac{3}{4}$  View, As Received



Pre-Test Front View



Post-Test Front View



Pre-Test Left Side View



Post-Test Left Side View



Pre-Test Right Side View



Post-Test Right Side View



Pre-Test Right Front  $\frac{3}{4}$  View



Post-Test Right Front  $\frac{3}{4}$  View



Pre-Test Left Rear  $\frac{3}{4}$  View



Post-Test Left Rear  $\frac{3}{4}$  View



Pre-Test Left Side 3/4 View of Doors



Post-Test Left Side 3/4 View of Doors After Impact



Pre-Test Right Side  $\frac{3}{4}$  View of Doors



Post-Test Right Side  $\frac{3}{4}$  View of Doors After Impact



Pre-Test Windshield View



Post-Test Windshield View



Pre-Test Engine Compartment View



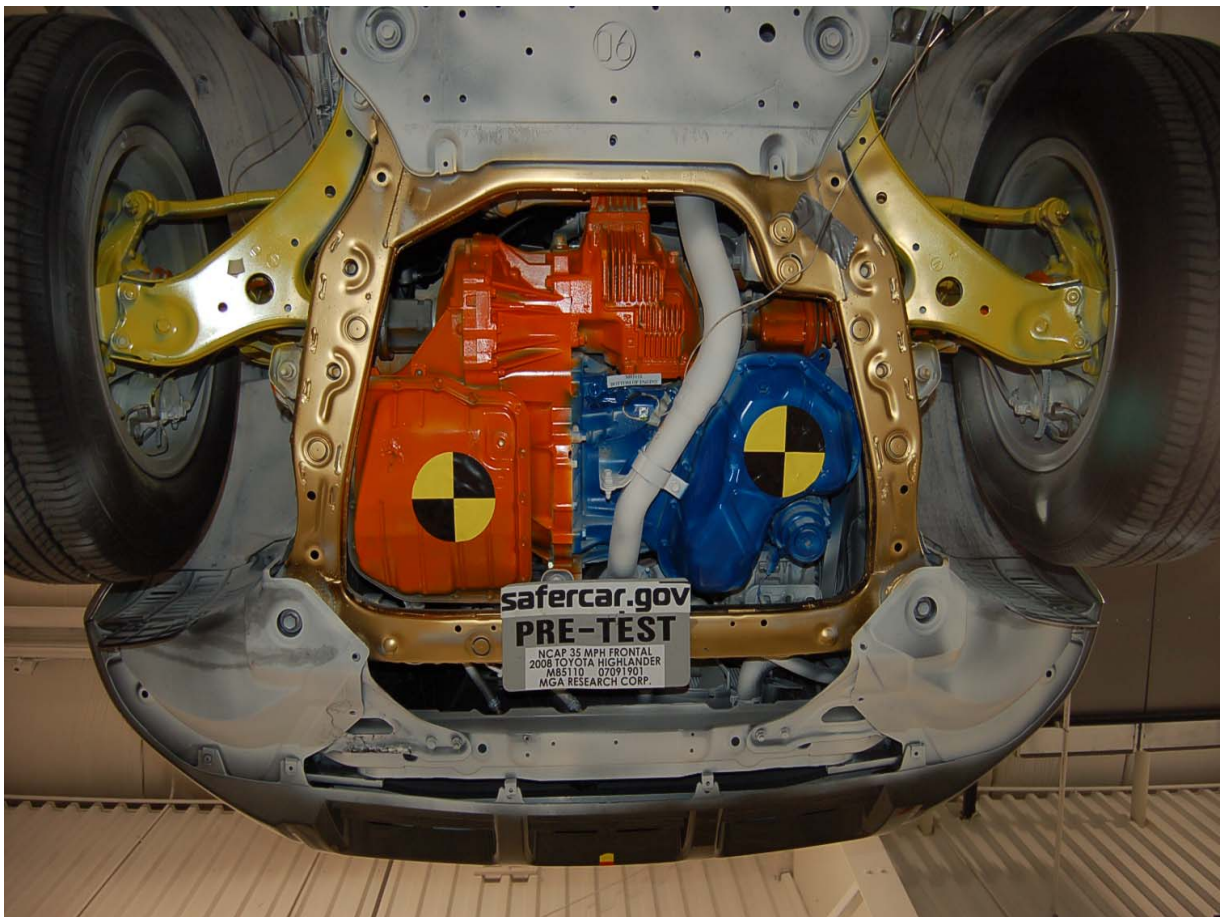
Post-Test Engine Compartment View



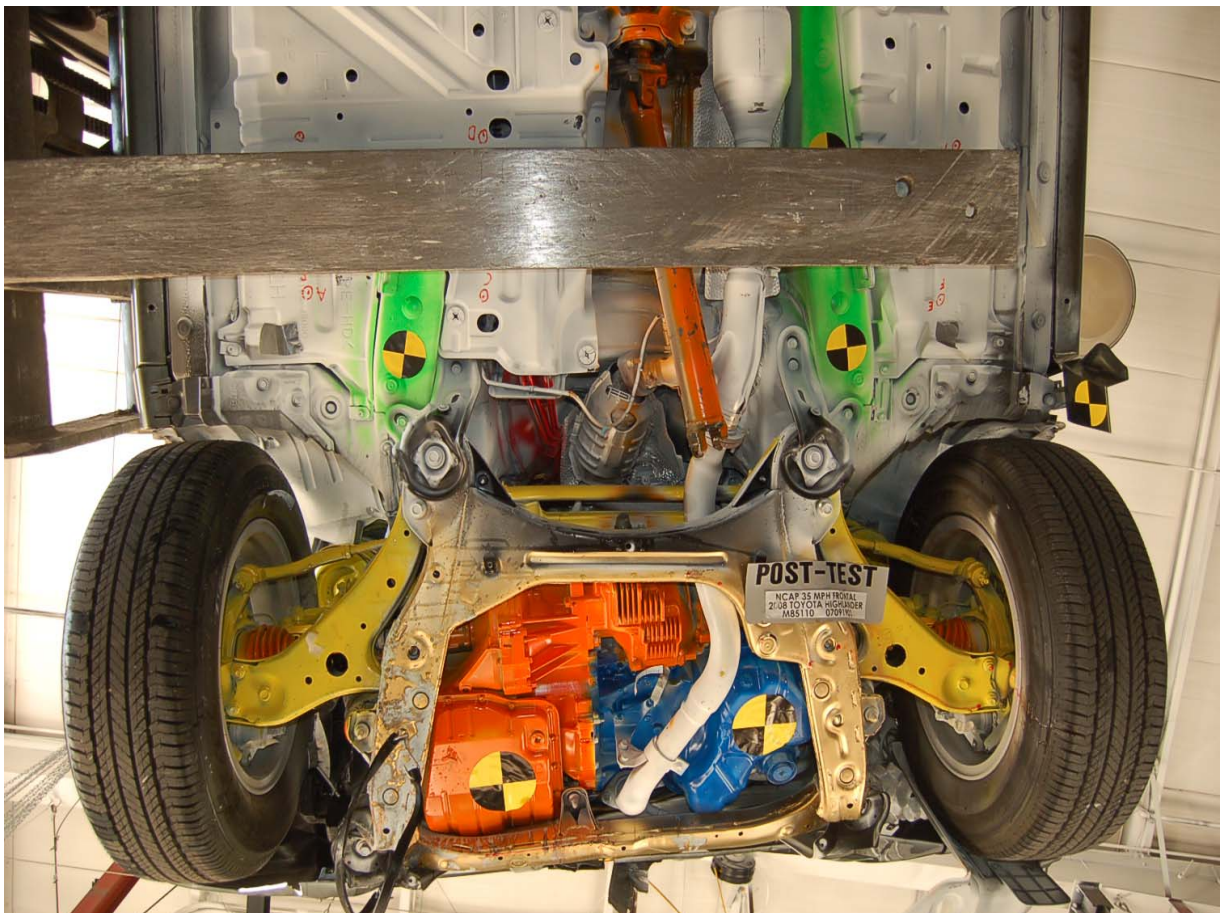
Pre-Test Fuel Cap View



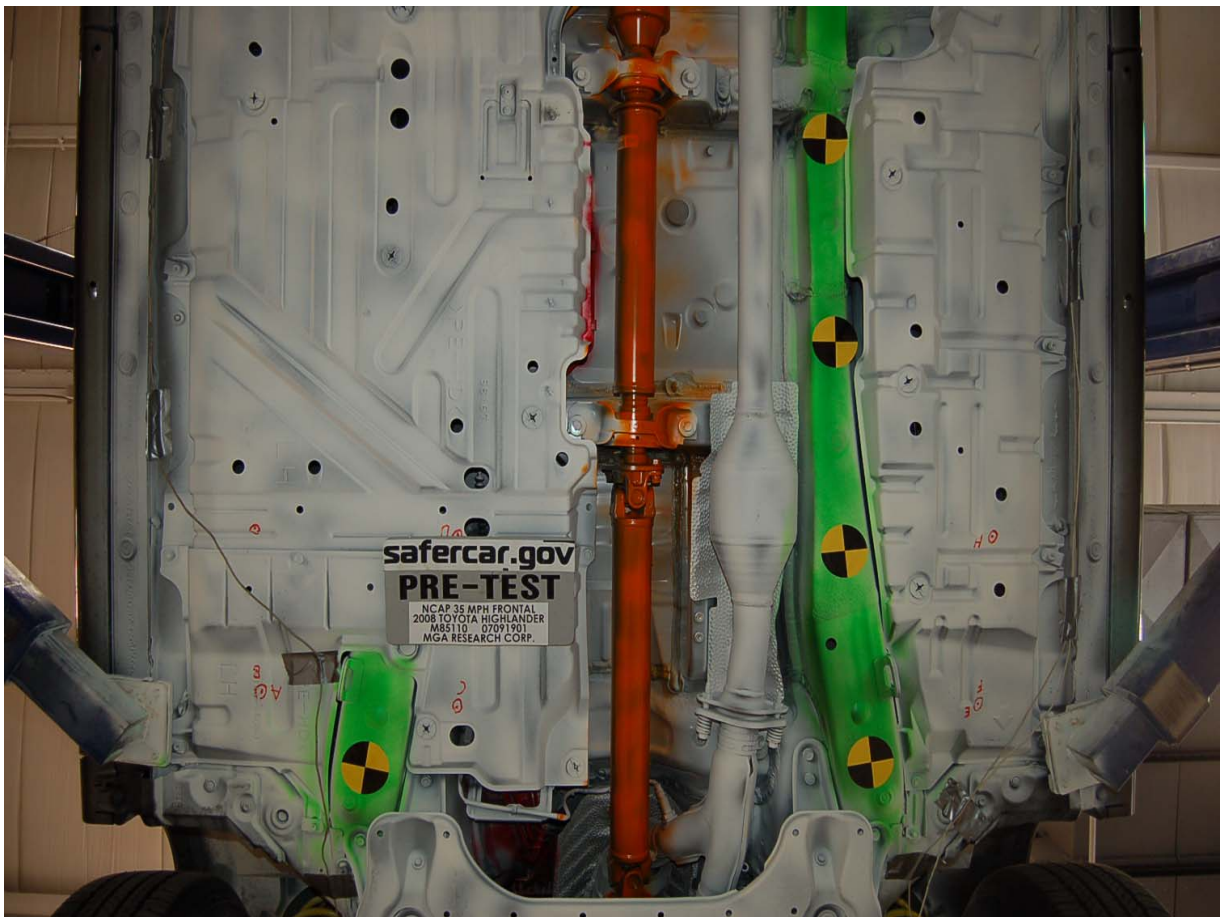
Post-Test Fuel Cap View



Pre-Test Front Underbody View



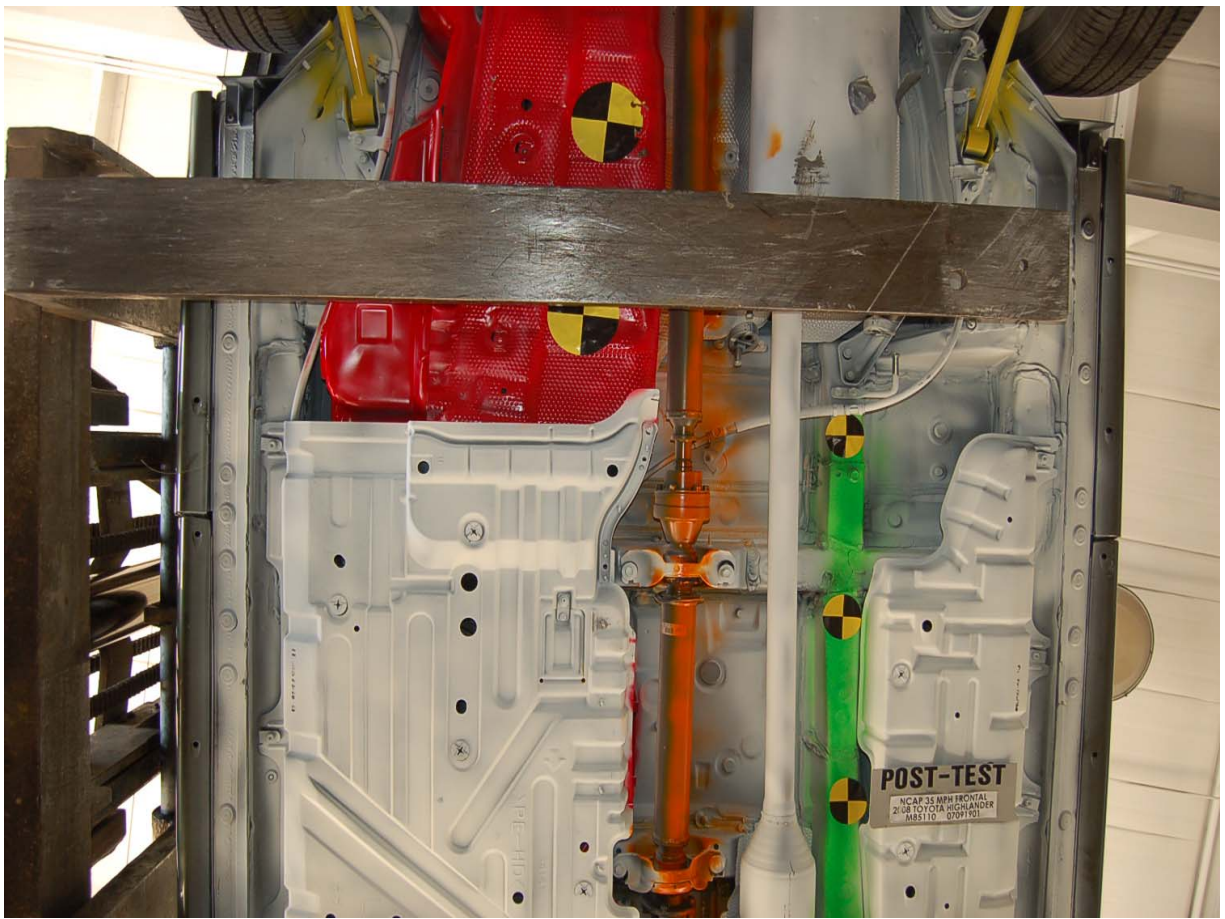
Post-Test Front Underbody View



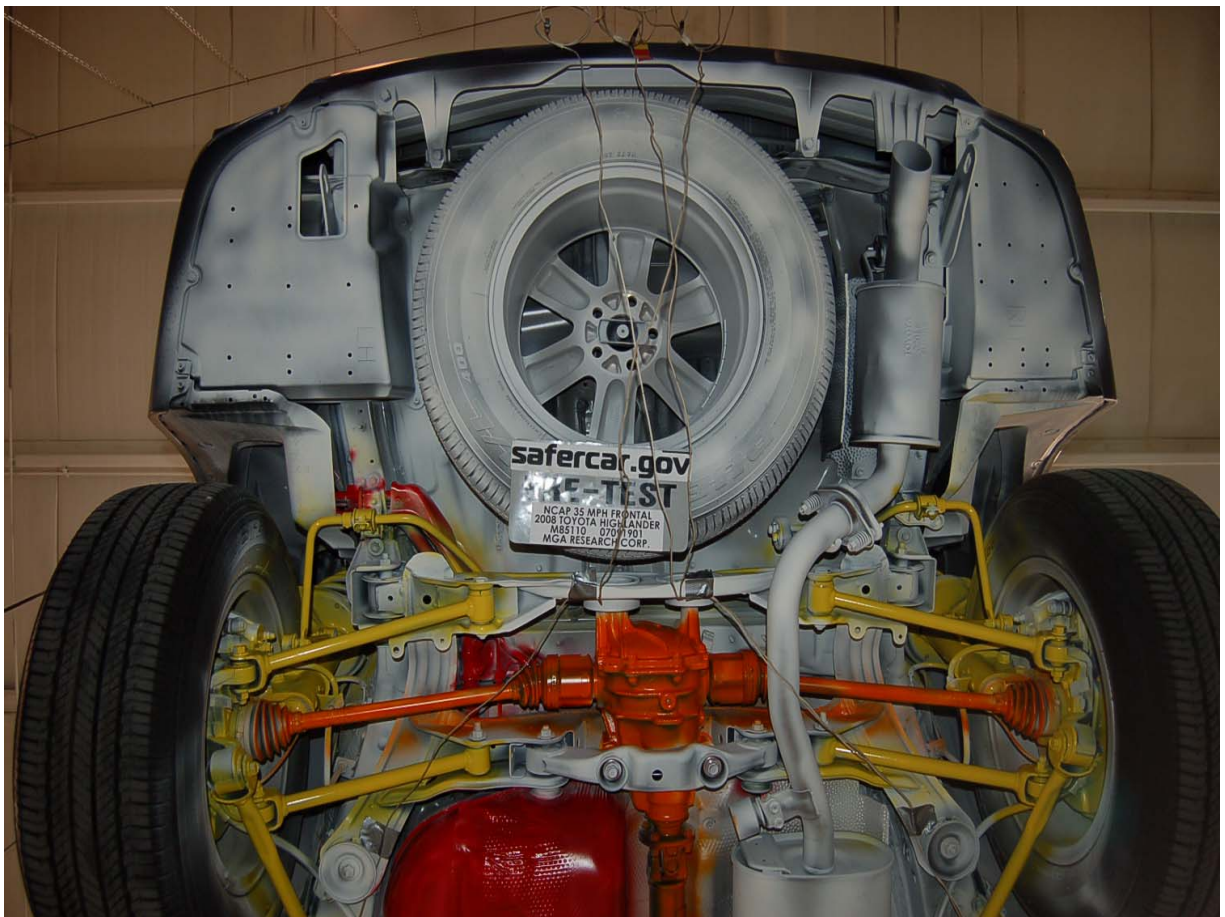
Pre-Test Mid Front Underbody View



Pre-Test Mid Rear Underbody View



Post-Test Mid Underbody View



Pre-Test Rear Underbody View



Post-Test Rear Underbody View



Pre-Test Driver Dummy Front View (Head Position)



Post-Test Driver Dummy Front View (Head Position)



Pre-Test Driver Dummy (Through Window)



Post-Test Driver Dummy (Through Window)



Pre-Test Driver Dummy (Door Open)



Post-Test Driver Dummy (Door Open)



Pre-Test Driver Dummy Feet



Post-Test Driver Dummy Feet



Pre-Test Driver Side Knee Bolster



Post-Test Driver Side Knee Bolster



Pre-Test Driver Side Floor Pan



Post-Test Driver Side Floor Pan



Post-Test Driver Dummy Head Contact (headrest)



Post-Test Driver Dummy Head Contact (visor)



Post-Test Driver Dummy Knee Contact



Post-Test Driver Dummy Airbag Contact



Pre-Test Passenger Dummy Front View (Head Position)



Post-Test Passenger Dummy Front View (Head Position)



Pre-Test Passenger Dummy (Through Window)



Post-Test Passenger Dummy (Through Window)



Pre-Test Passenger Dummy (Door Open)



Post-Test Passenger Dummy (Door Open)



Pre-Test Passenger Dummy Feet



Post-Test Passenger Dummy Feet



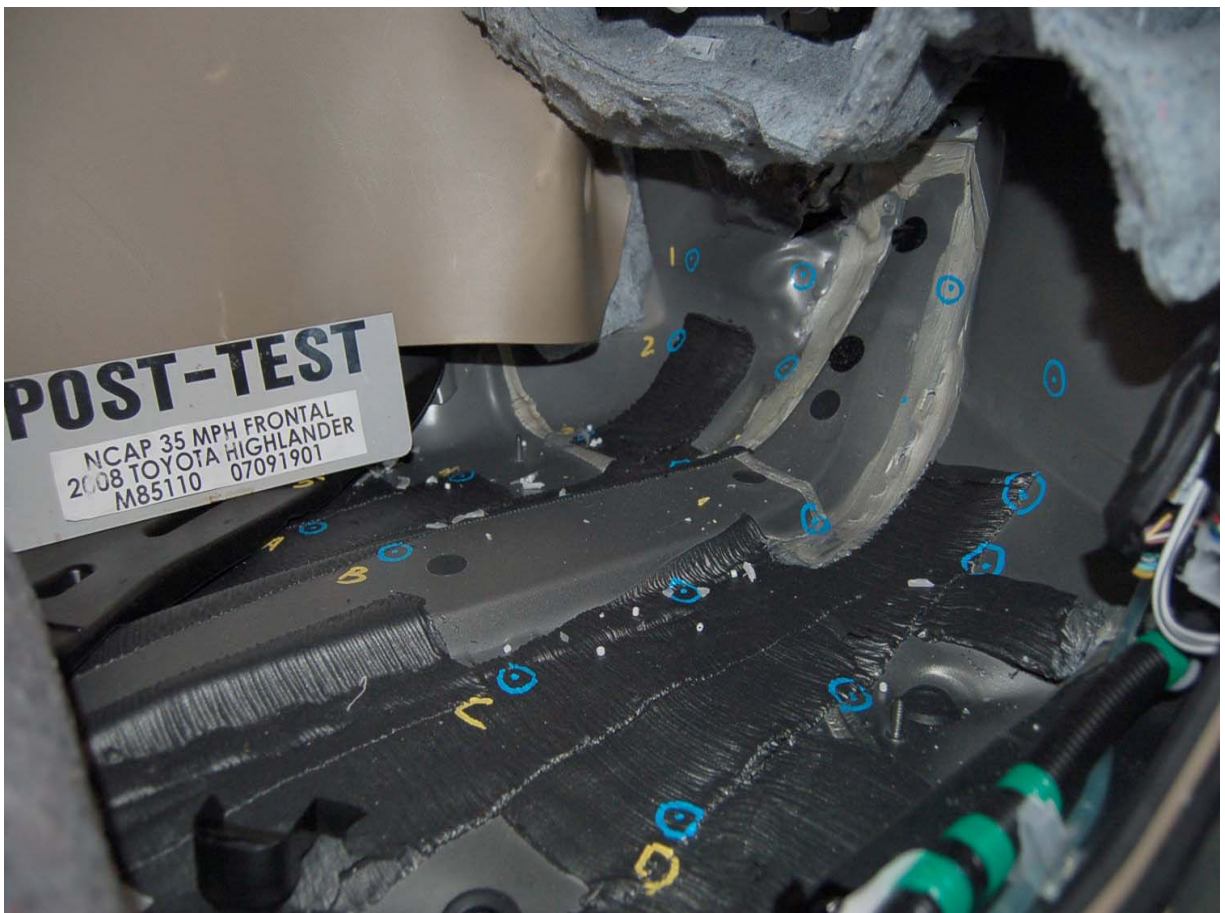
Pre-Test Passenger Side Glove Box



Post-Test Passenger Side Glove Box



Pre-Test Passenger Side Floor Pan



Post-Test Passenger Side Floor Pan



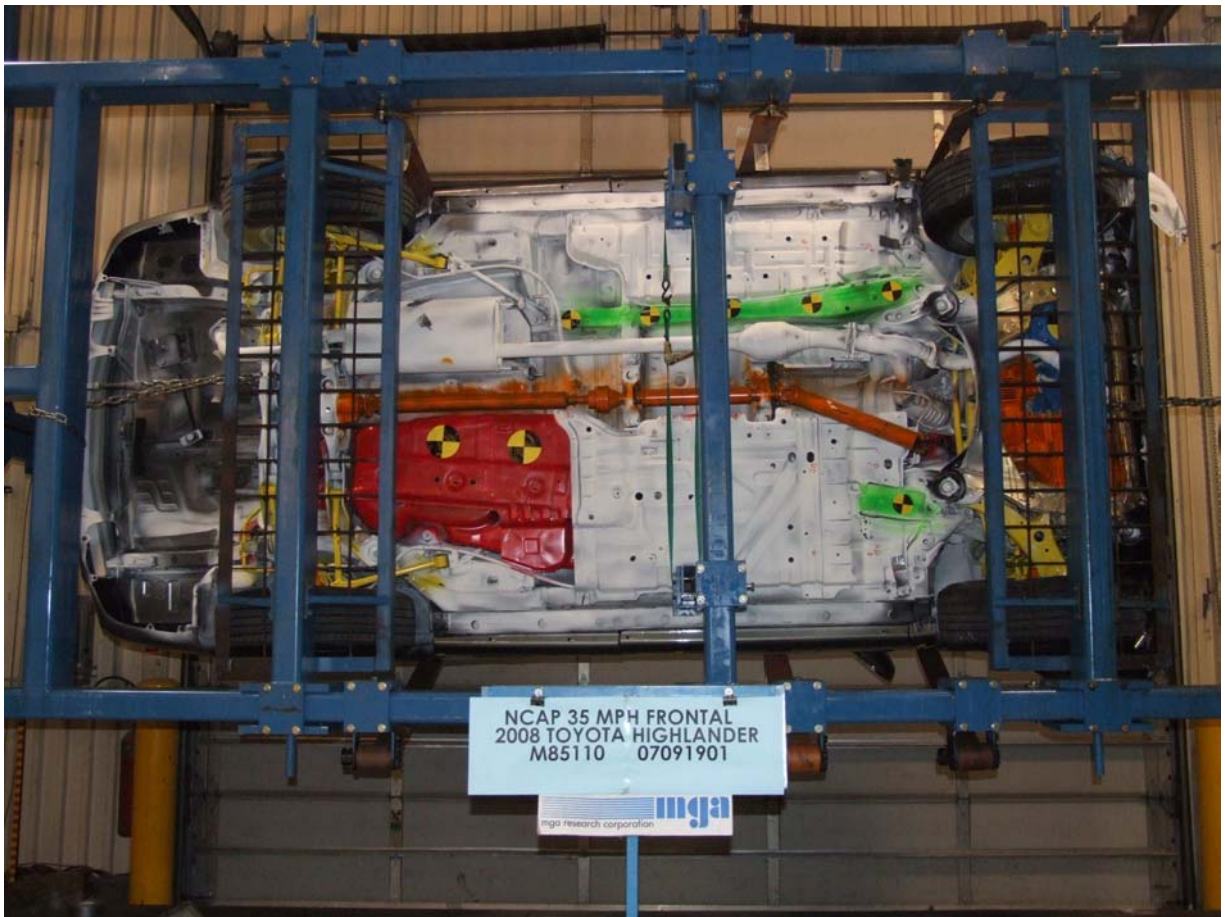
Post-Test Passenger Dummy Head Contact (visor)



Post-Test Passenger Dummy Knee Contact



Post-Test Passenger Dummy Airbag Contact



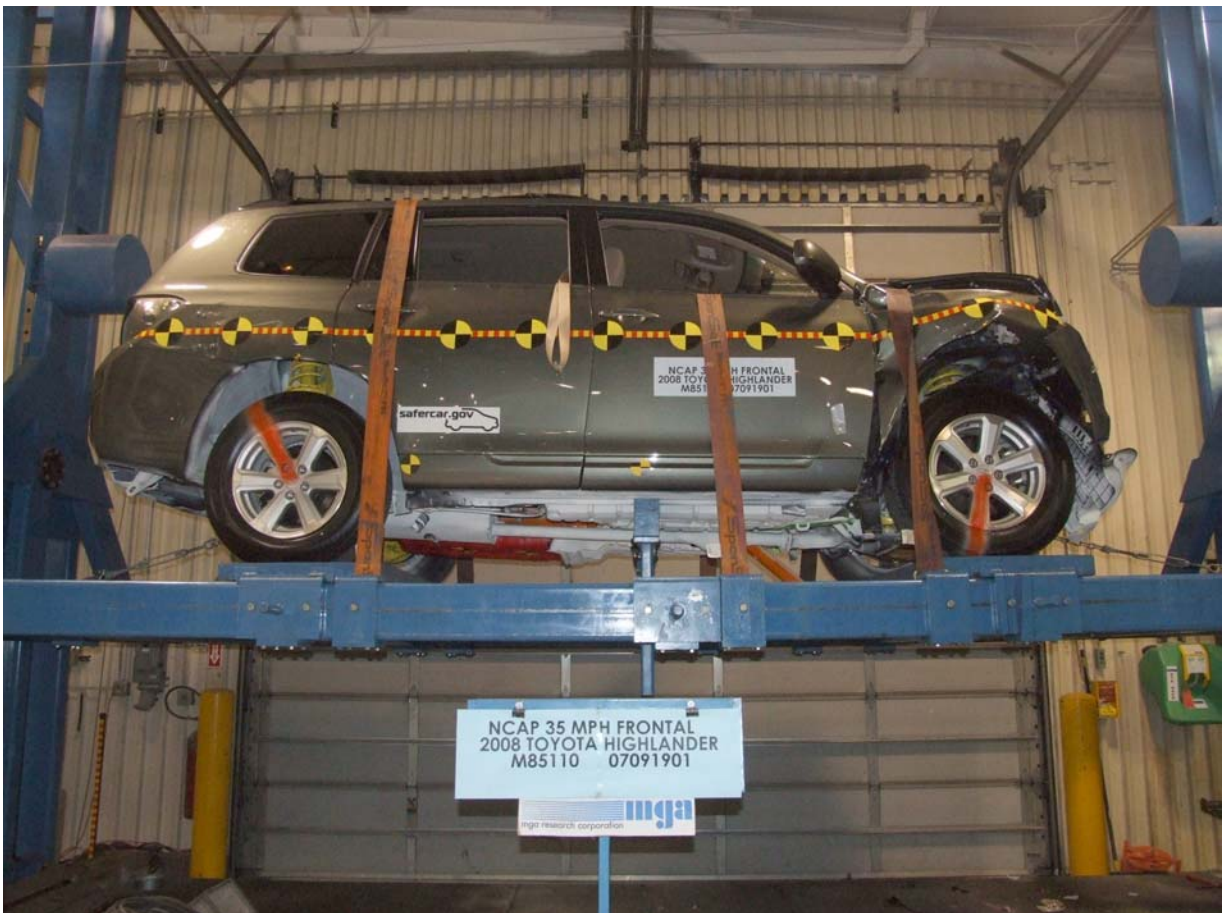
Rollover 90 Degrees



Rollover 180 Degrees



Rollover 270 Degrees



Rollover 360 Degrees



Vehicle Impact

**APPENDIX B**  
**DUMMY RESPONSE DATA TRACES**

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**The following dummy and vehicle response data can be found in the R&D section of the NHTSA website at [www.nhtsa.dot.gov](http://www.nhtsa.dot.gov)**

Driver Head X Redundant

Driver Head Y Redundant

Driver Head Z Redundant

Driver Upper Neck Force X

Driver Upper Neck Force Y

Driver Upper Neck Force Z

Driver Upper Neck Moment X

Driver Upper Neck Moment Y

Driver Upper Neck Moment Z

Driver Chest X Redundant

Driver Chest Y Redundant

Driver Chest Z Redundant

Driver Chest Displacement

Driver Pelvis X

Driver Pelvis Y

Driver Pelvis Z

Driver Shoulder Belt Force

Driver Lap Belt Force

Driver Left Upper Tibia Moment X

Driver Left Upper Tibia Moment Y

Driver Left Upper Tibia Force Z

Driver Left Lower Tibia Moment X

Driver Left Lower Tibia Moment Y

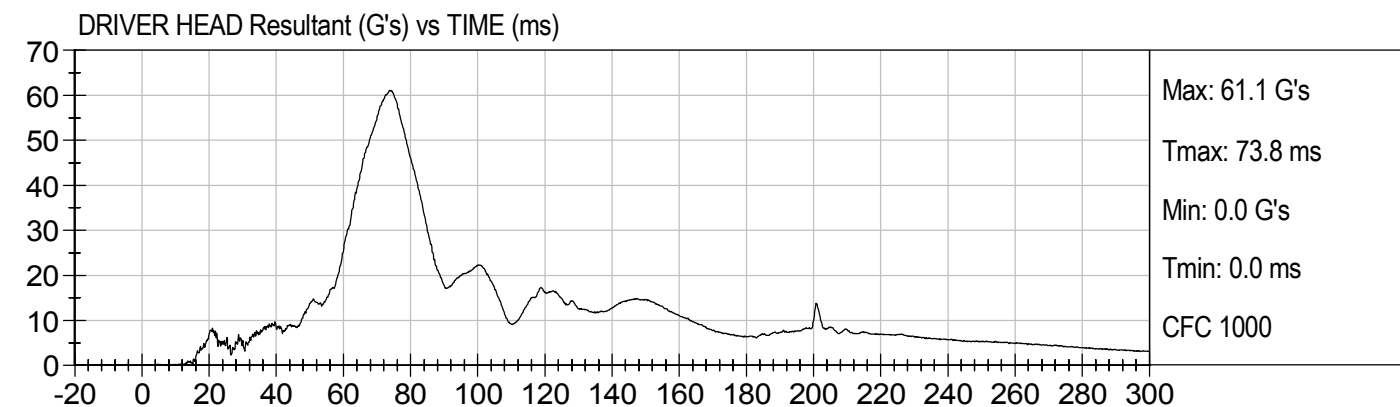
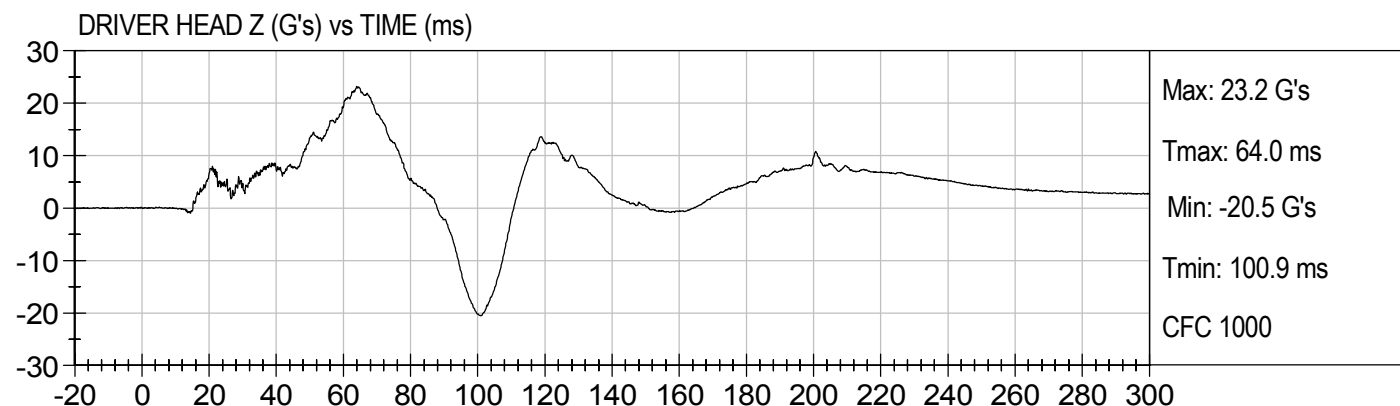
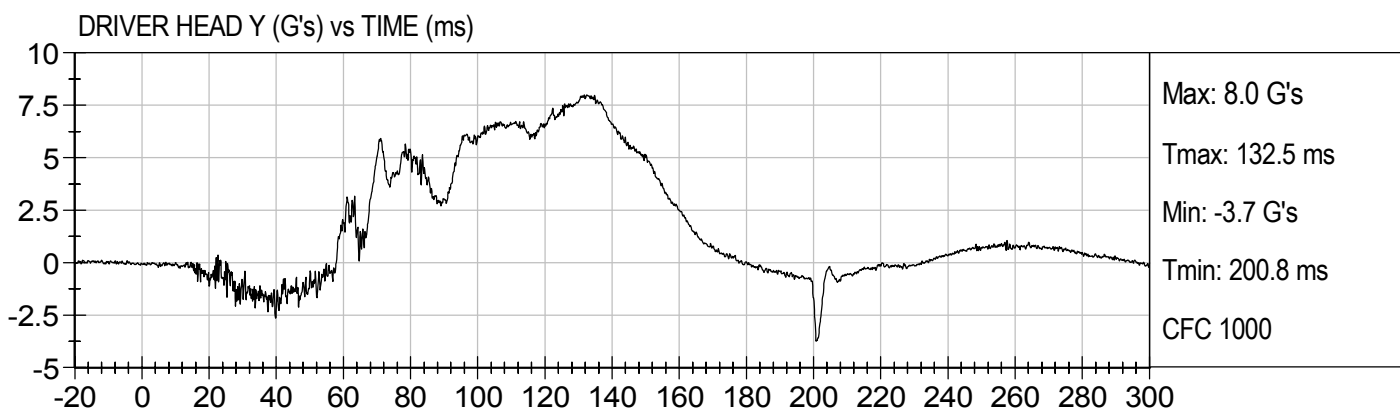
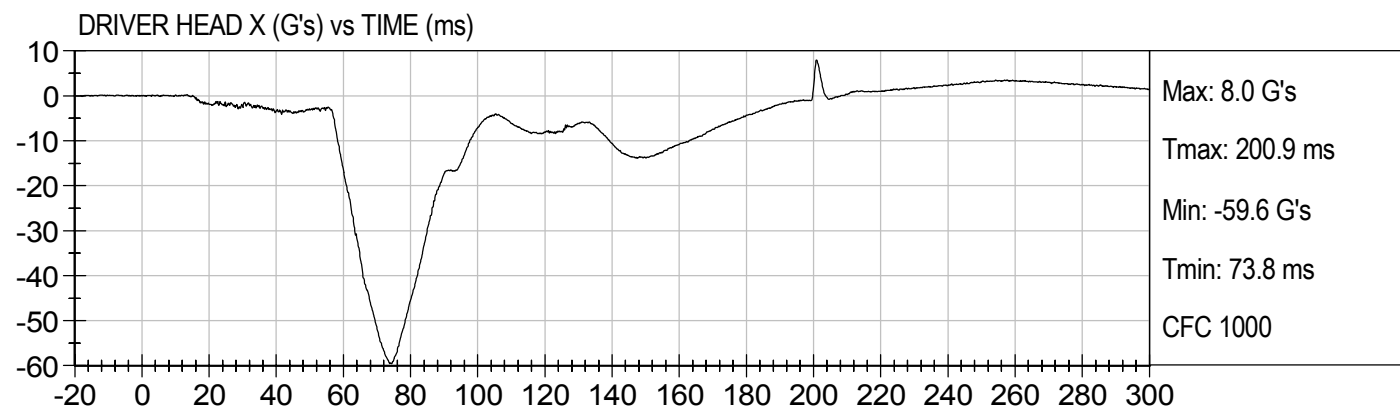
Driver Left Lower Tibia Force Z

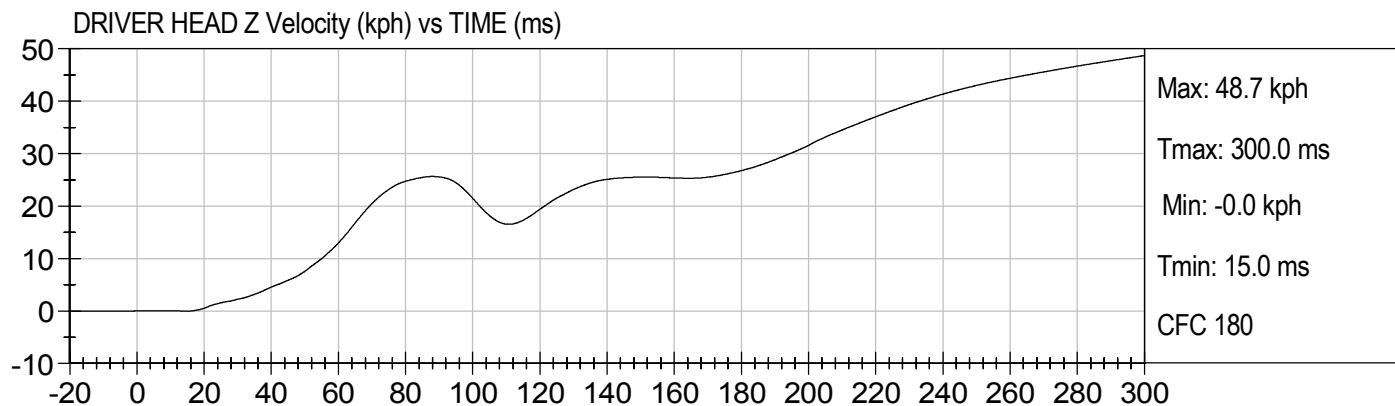
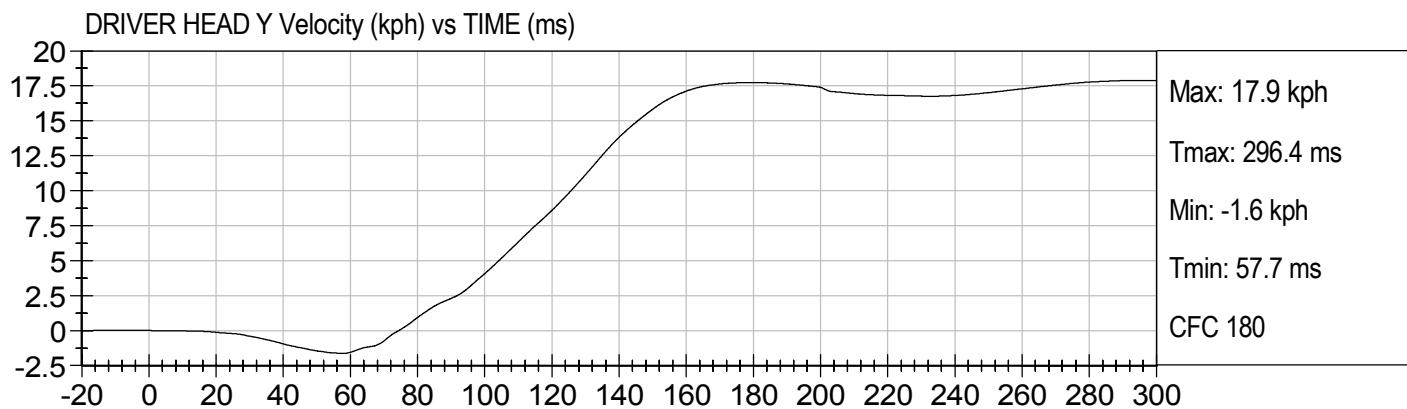
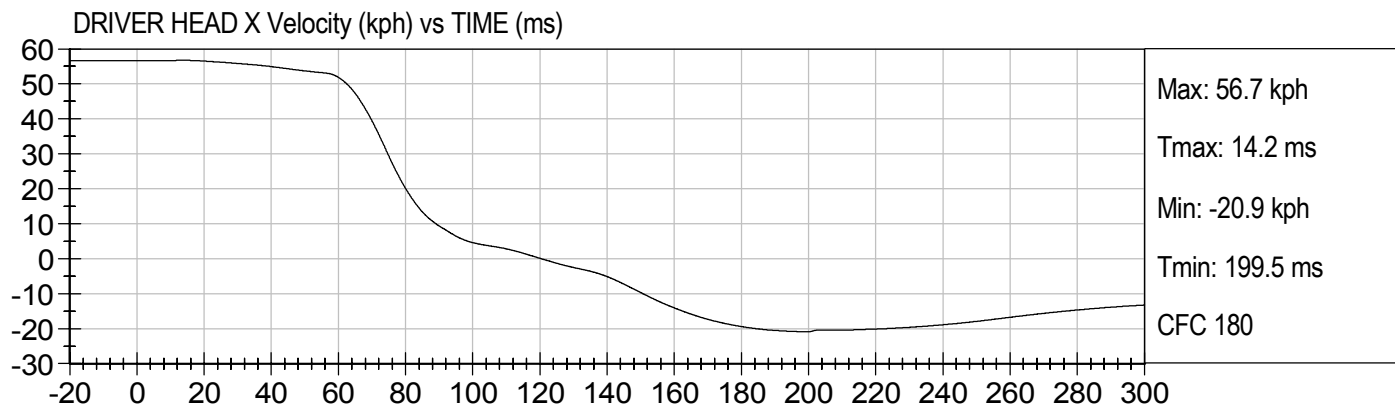
Driver Right Upper Tibia Moment X

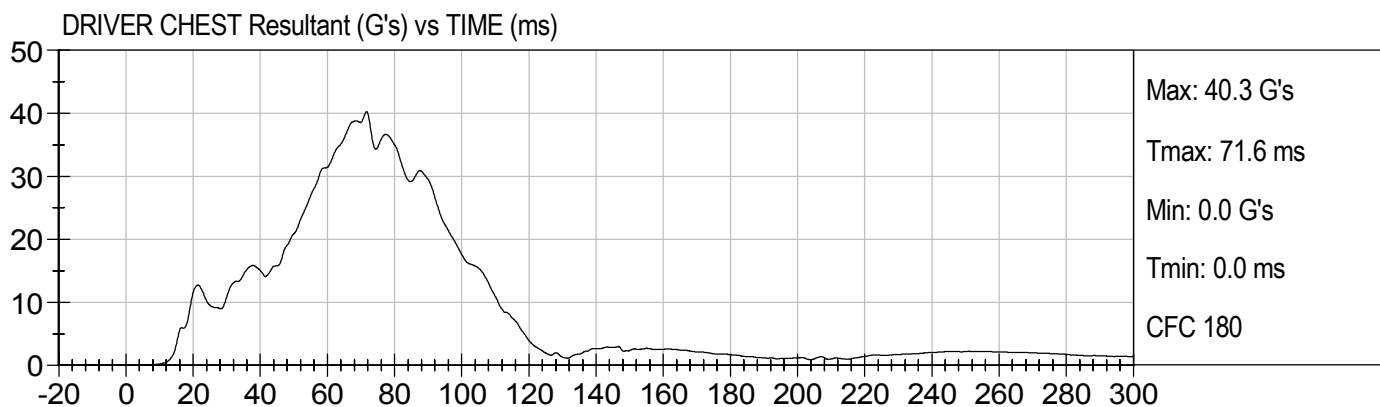
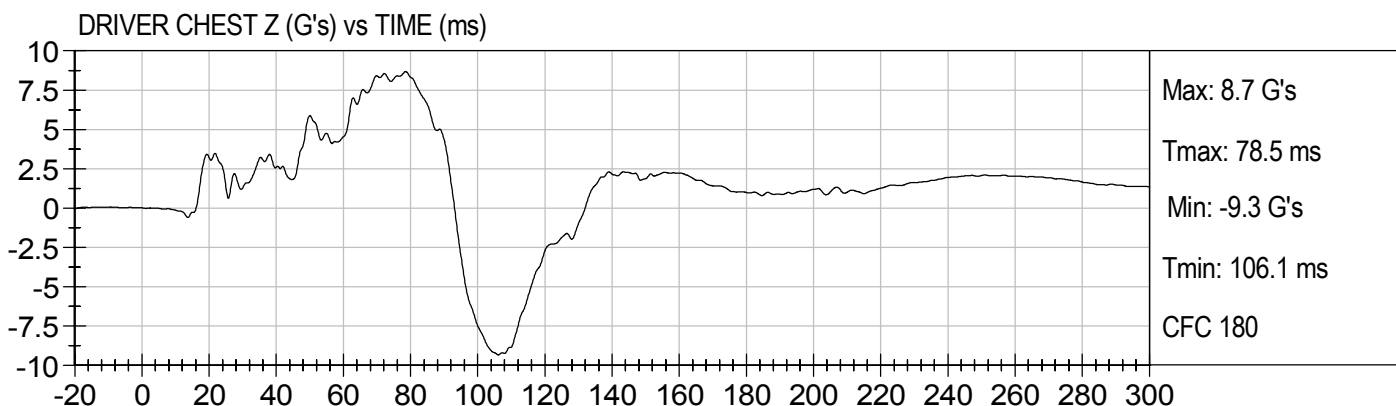
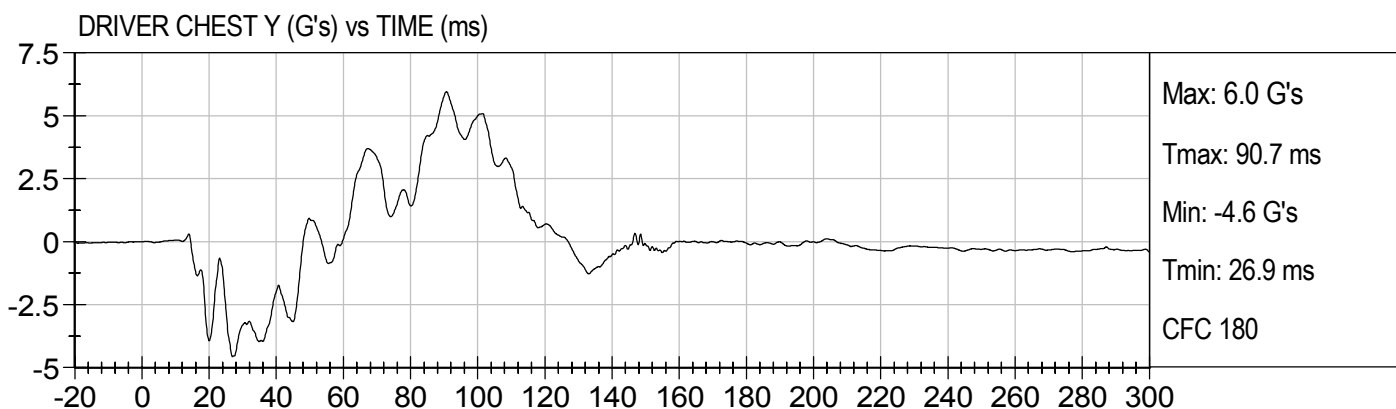
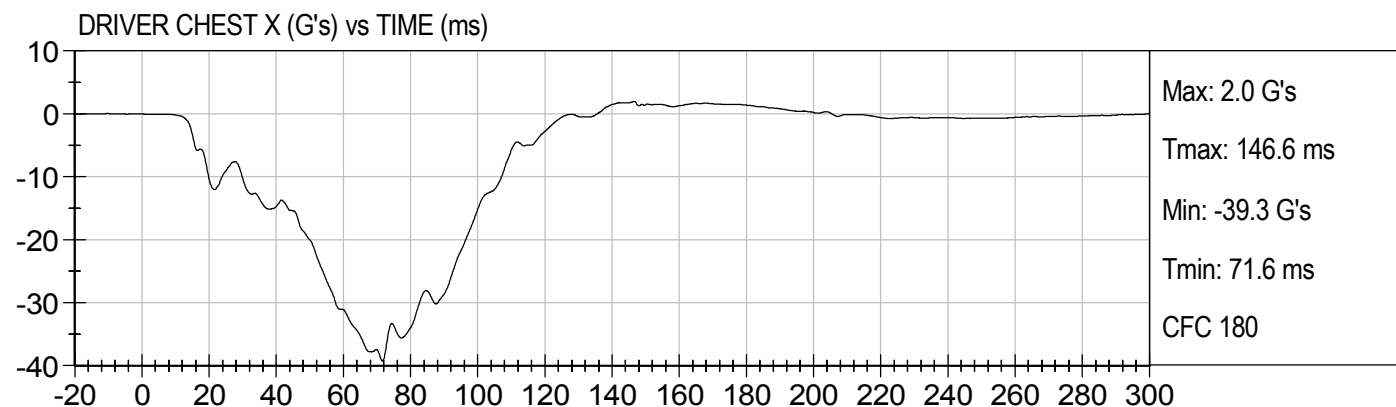
Driver Right Upper Tibia Moment Y

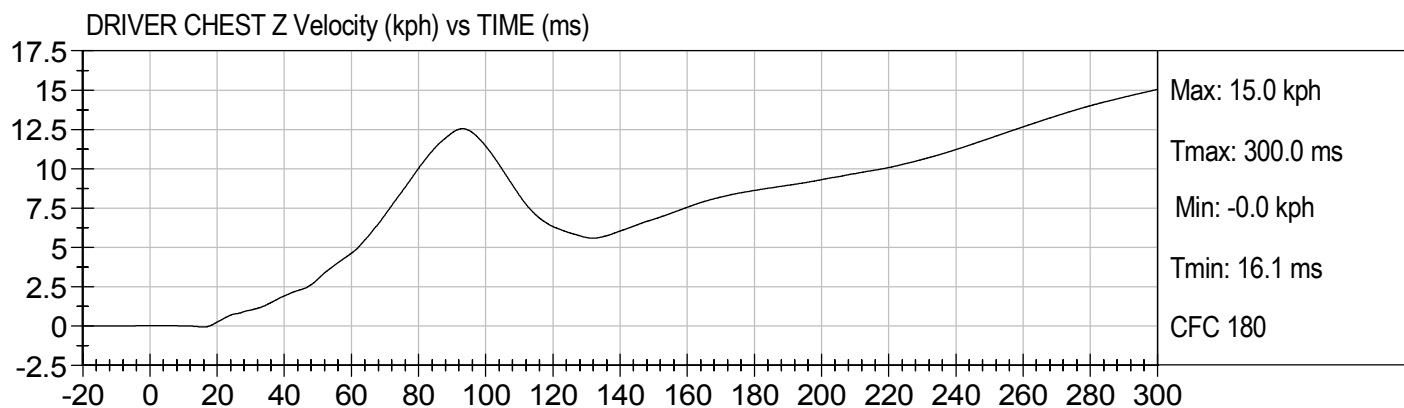
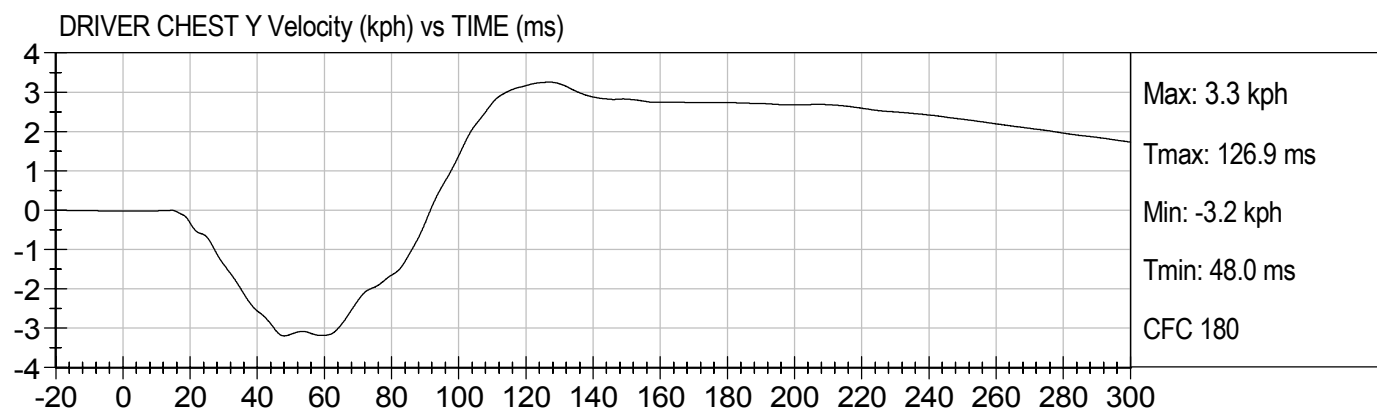
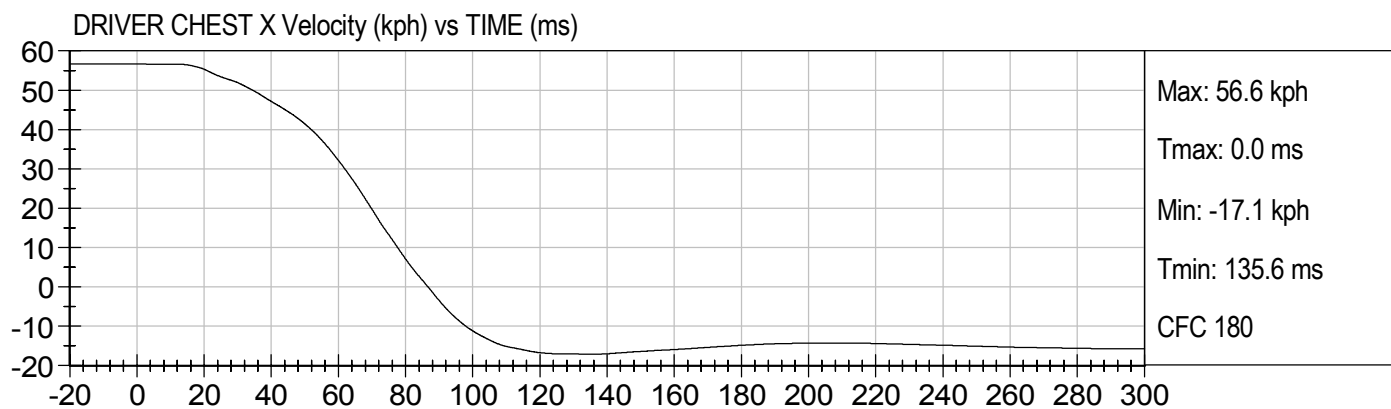
Driver Right Upper Tibia Force Z  
Driver Right Lower Tibia Moment X  
Driver Right Lower Tibia Moment Y  
Driver Right Lower Tibia Force Z  
Driver Left Foot Fore Z  
Driver Left Foot Aft X  
Driver Left Foot Aft Z  
Driver Right Foot Fore Z  
Driver Right Foot Aft X  
Driver Right Foot Aft Z  
Passenger Head X Redundant  
Passenger Head Y Redundant  
Passenger Head Z Redundant  
Passenger Upper Neck Force X  
Passenger Upper Neck Force Y  
Passenger Upper Neck Force Z  
Passenger Upper Neck Moment X  
Passenger Upper Neck Moment Y  
Passenger Upper Neck Moment Z  
Passenger Chest X Redundant  
Passenger Chest Y Redundant  
Passenger Chest Z Redundant  
Passenger Chest Displacement  
Passenger Pelvis X  
Passenger Pelvis Y  
Passenger Pelvis Z  
Passenger Shoulder Belt Force  
Passenger Lap Belt Force  
Passenger Left Upper Tibia Moment X  
Passenger Left Upper Tibia Moment Y  
Passenger Left Upper Tibia Force Z  
Passenger Left Lower Tibia Moment X

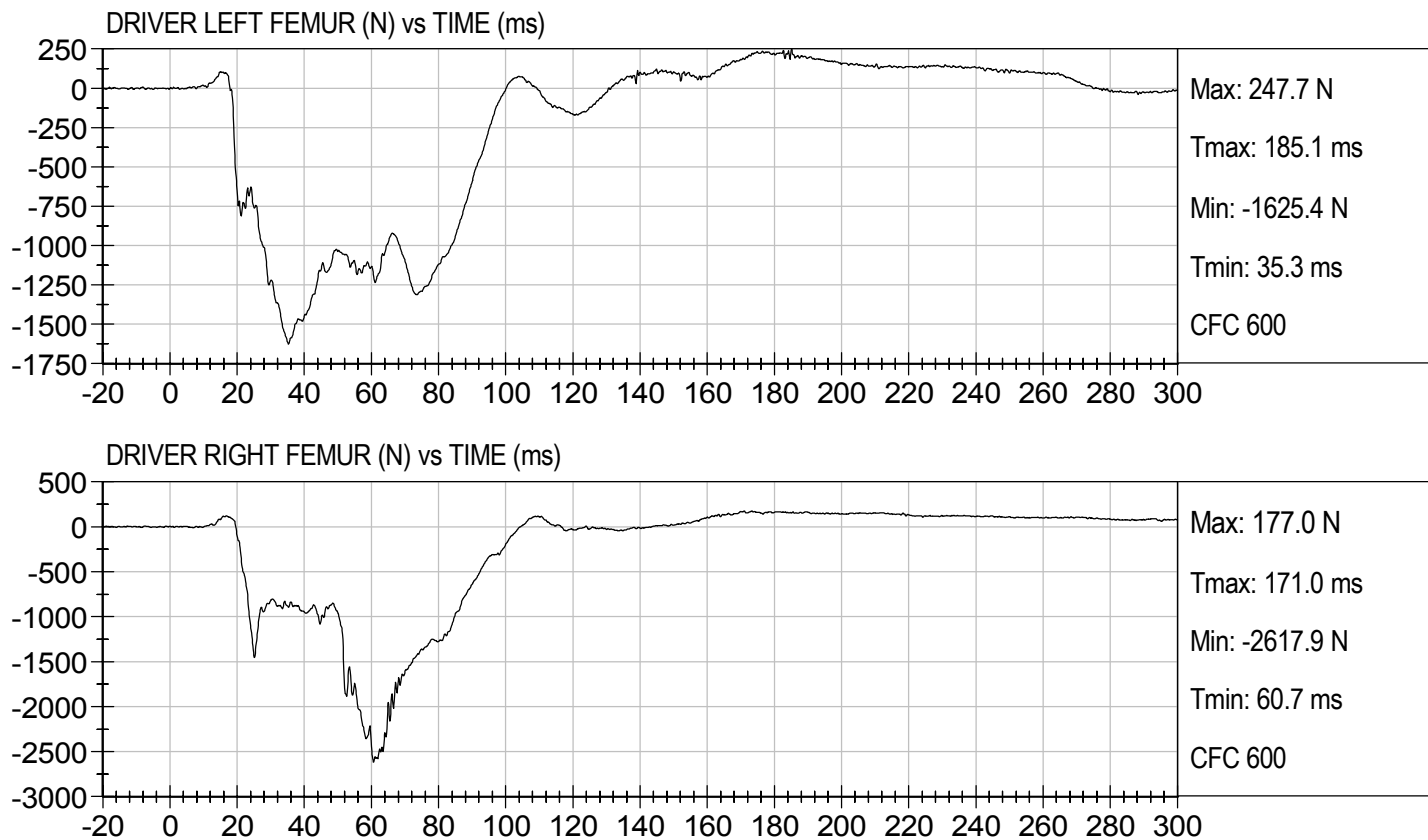
Passenger Left Lower Tibia Moment Y  
Passenger Left Lower Tibia Force Z  
Passenger Right Upper Tibia Moment X  
Passenger Right Upper Tibia Moment Y  
Passenger Right Upper Tibia Force Z  
Passenger Right Lower Tibia Moment X  
Passenger Right Lower Tibia Moment Y  
Passenger Right Lower Tibia Force Z  
Passenger Left Foot Fore Z  
Passenger Left Foot Aft X  
Passenger Left Foot Aft Z  
Passenger Right Foot Fore Z  
Passenger Right Foot Aft X  
Passenger Right Foot Aft Z  
Left Rear Seat Crossmember X  
Left Rear Seat Crossmember Z  
Right Rear Seat Crossmember X  
Right Rear Seat Crossmember Z  
Vehicle Engine Top X  
Vehicle Engine Bottom X  
Vehicle Left Brake Caliper X  
Vehicle Right Brake Caliper X  
Barrier Force – Upper Left  
Barrier Force – Upper Center  
Barrier Force – Upper Right  
Barrier Force – Lower Left  
Barrier Force – Lower Center  
Barrier Force – Lower Right

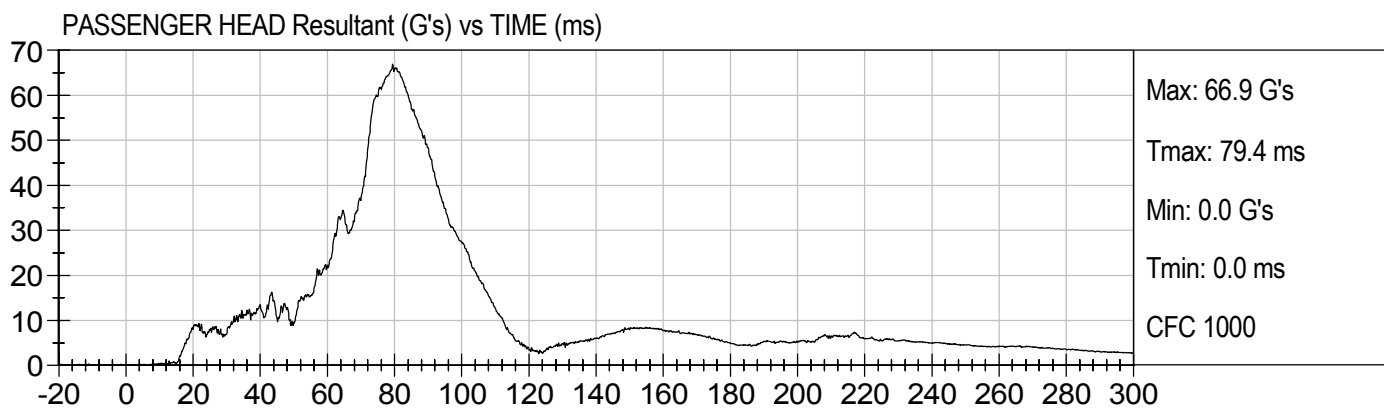
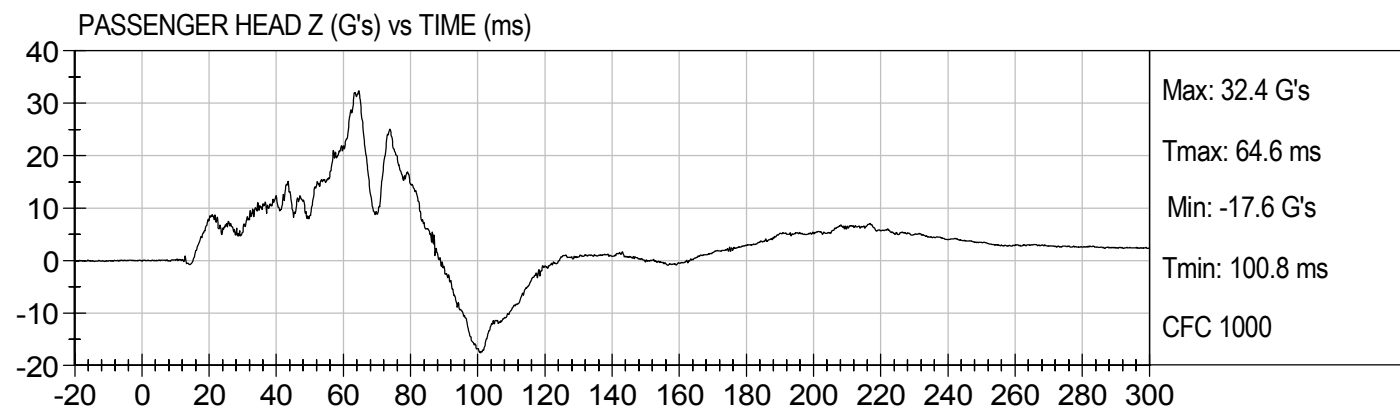
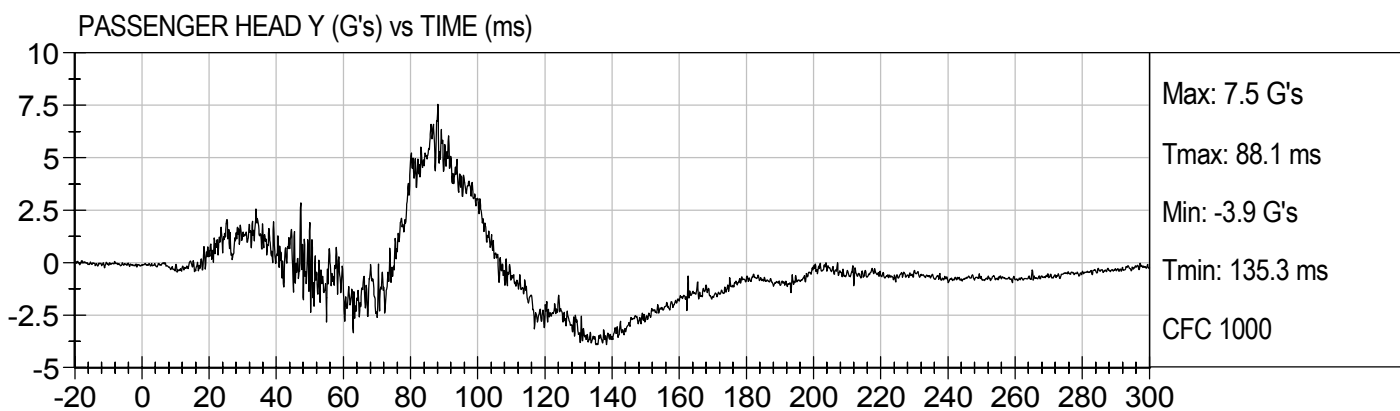
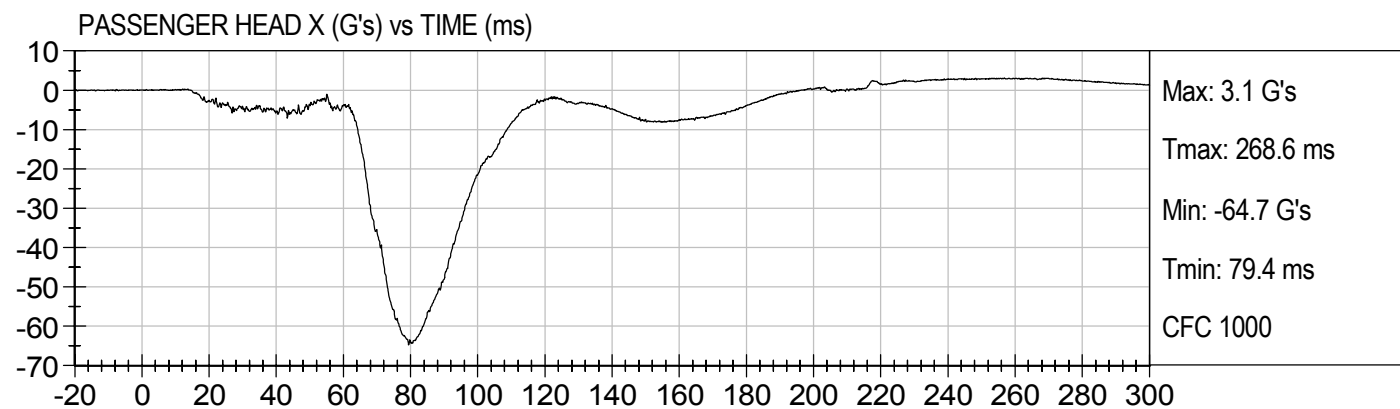


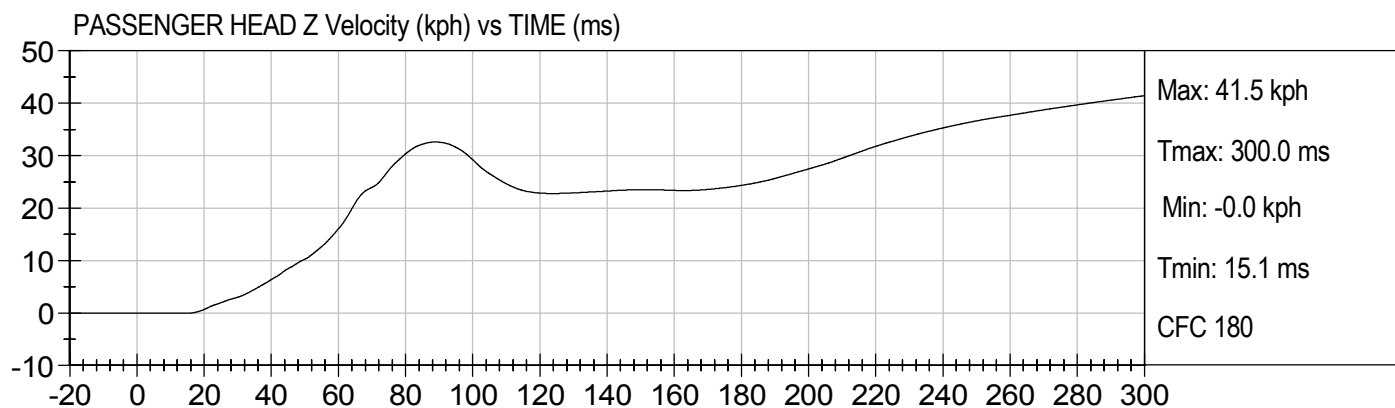
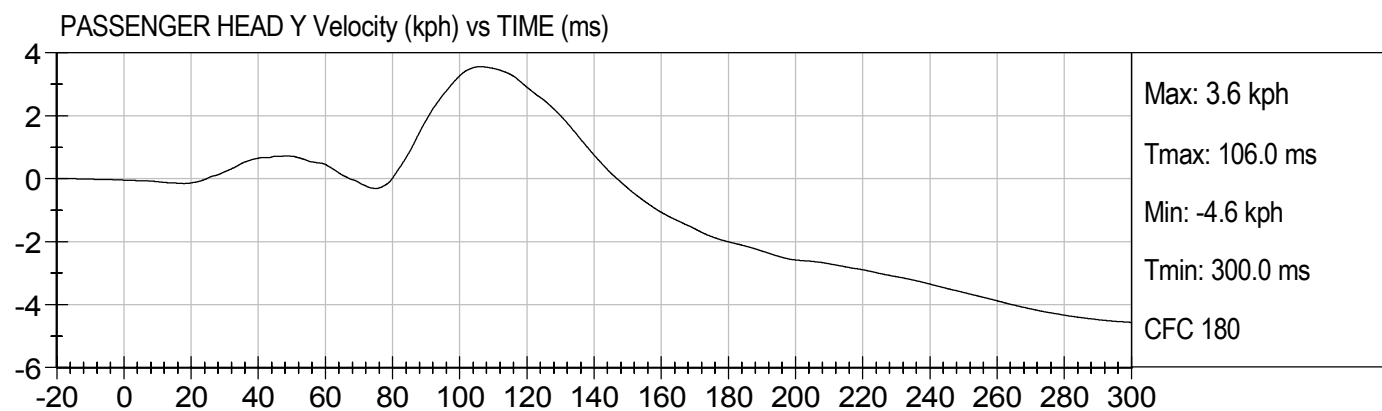
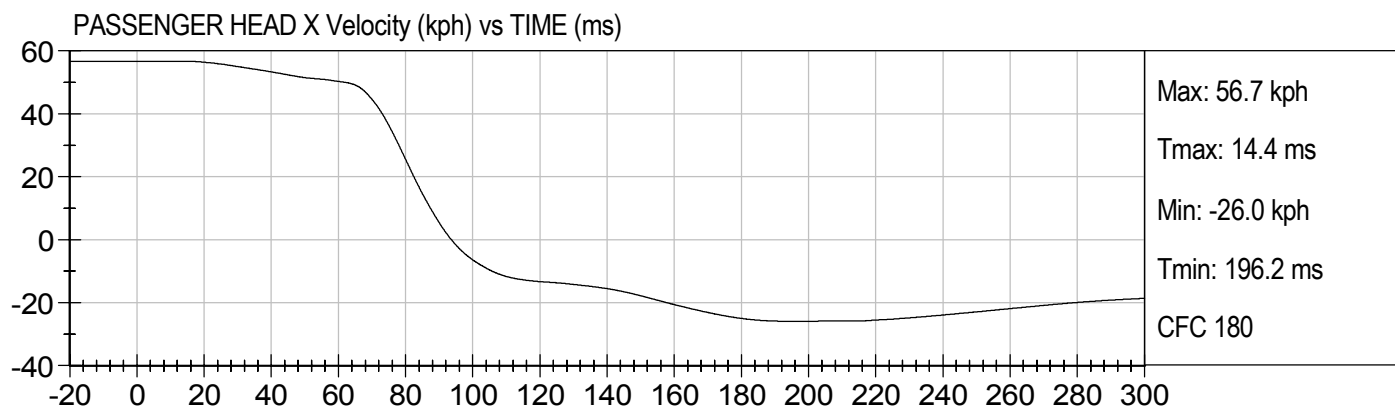


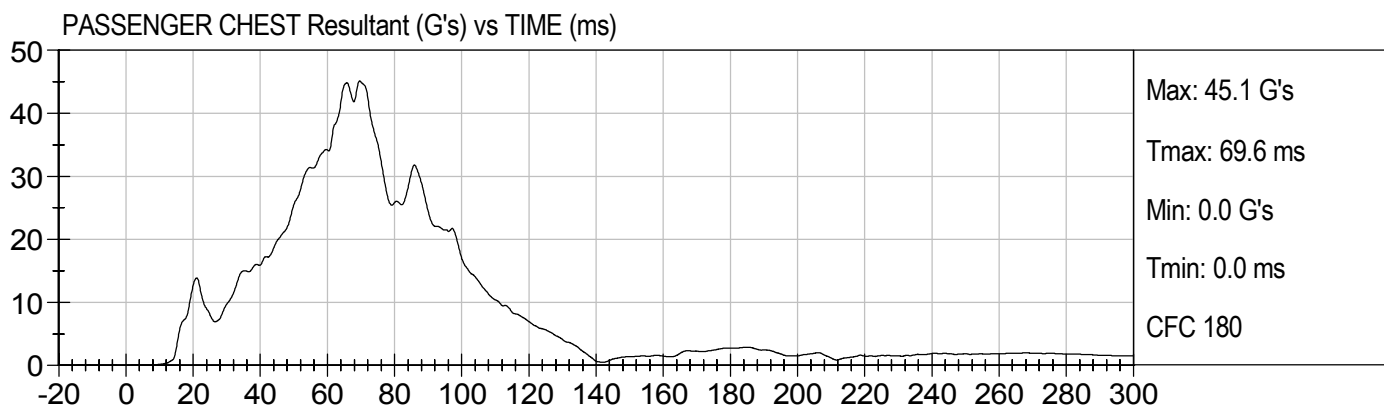
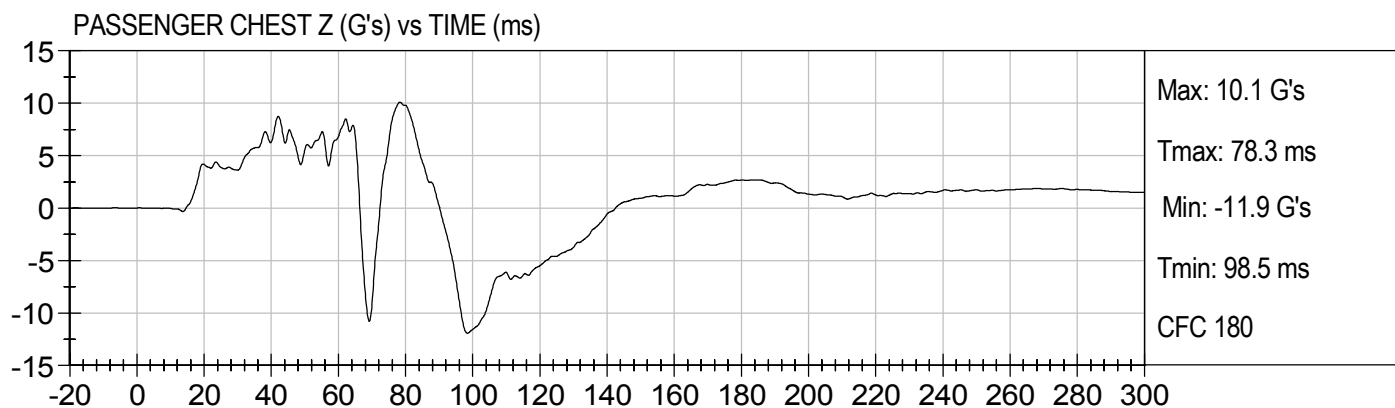
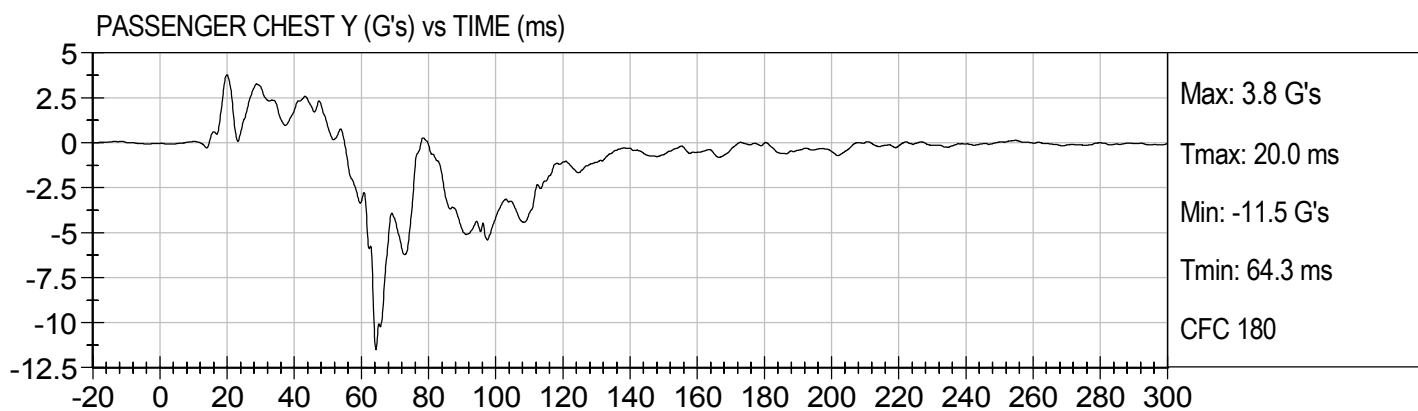
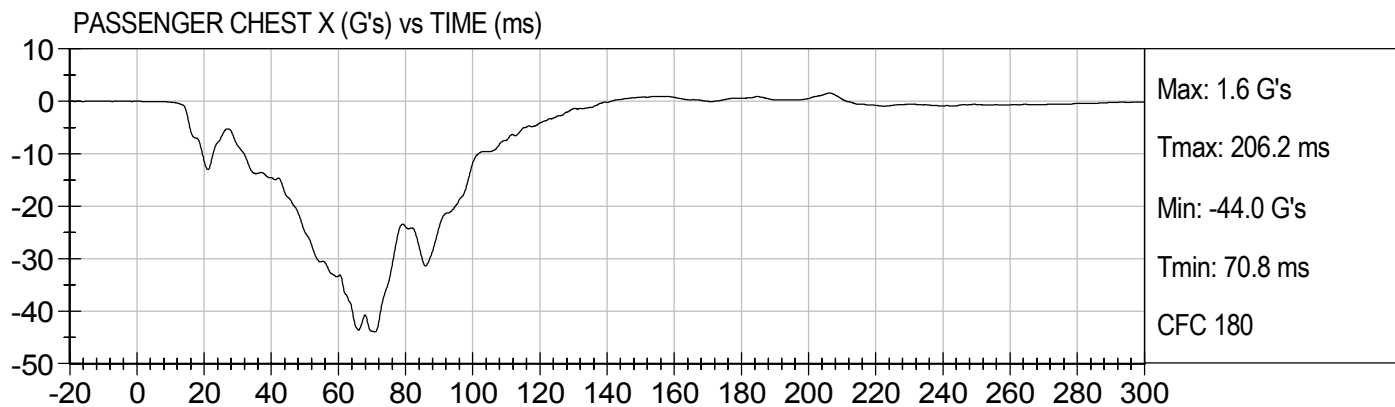


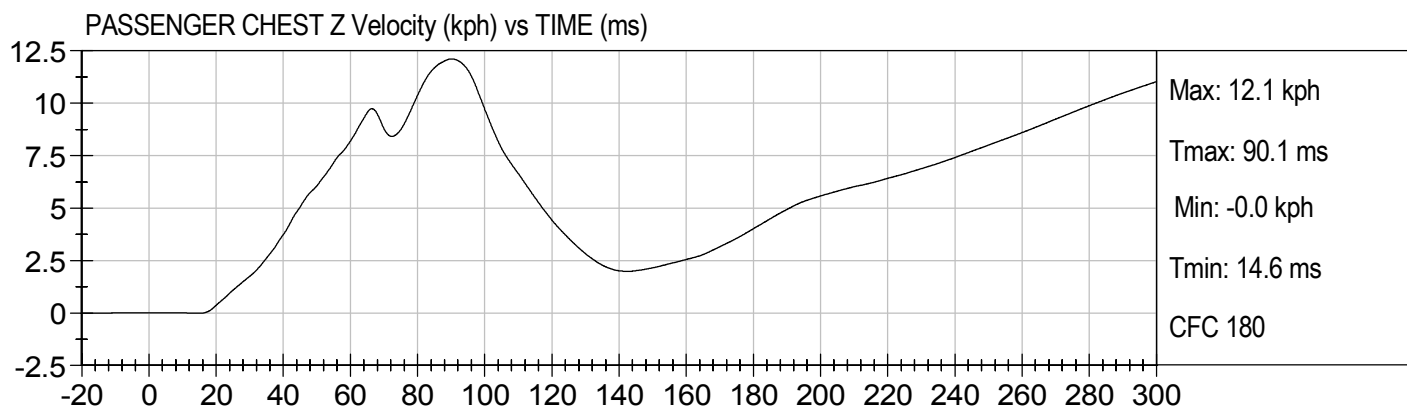
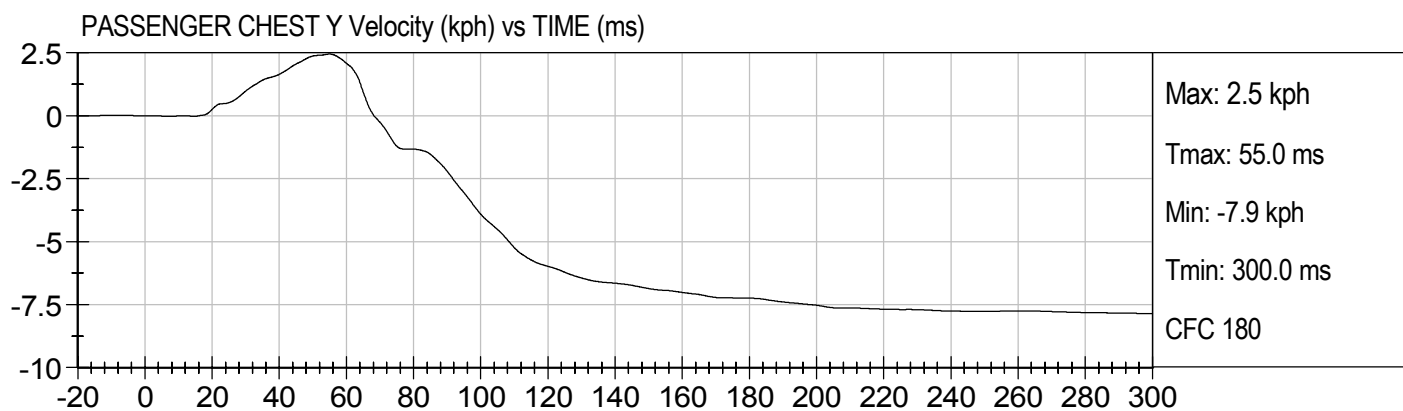
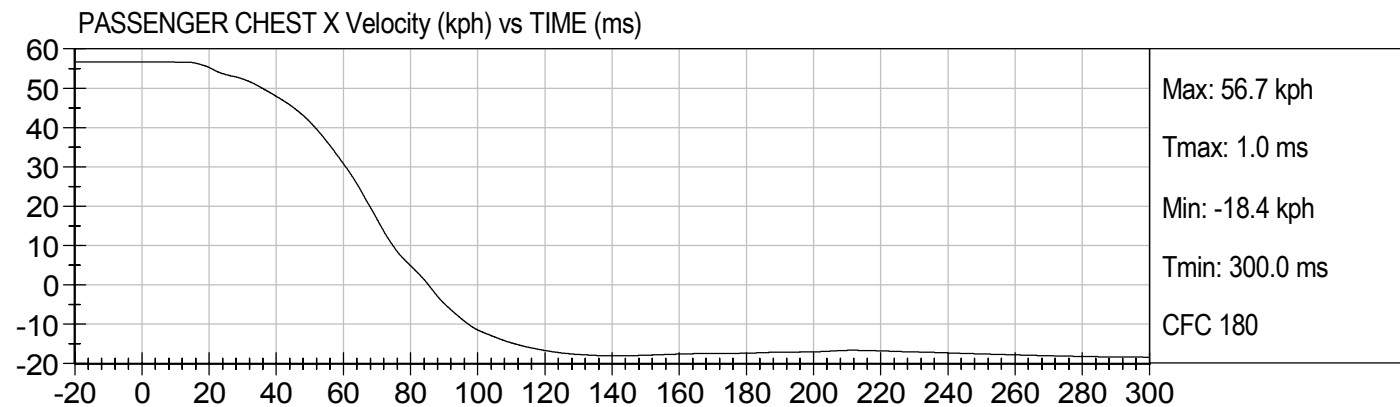


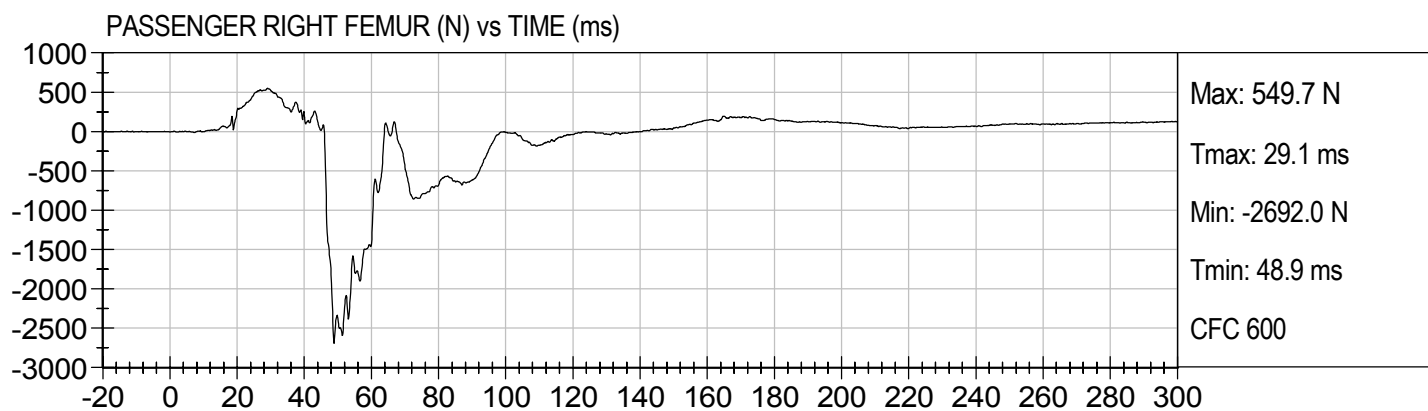
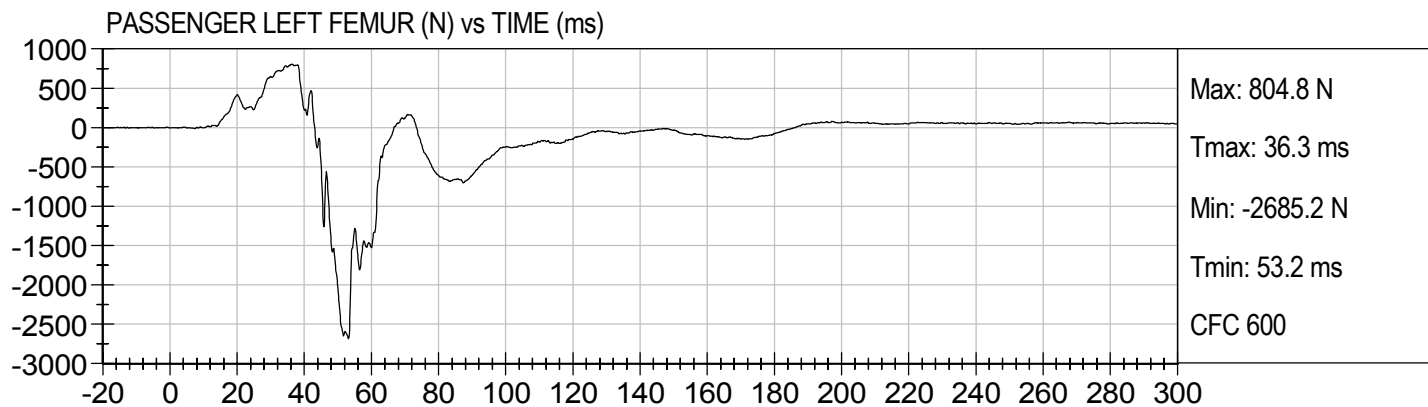












**APPENDIX C**  
**DUMMY CALIBRATION DATA**

**MGA RESEARCH CORPORATION**  
**HEAD DROP TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test ID:** D072851

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 - 25.6        | 20.9   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 41     | Pass      |
| Peak Resultant Acceleration  | G's   | 225 - 275          | 267    | Pass      |
| Peak Lateral Acceleration    | G's   | <= +/- 15.0        | 9.0    | Pass      |
| Unimodal                     | N/A   | Yes                | Yes    | Pass      |
| Oscillations                 | N/A   | within 10% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    | Pass   |           |

  
Laboratory Technician

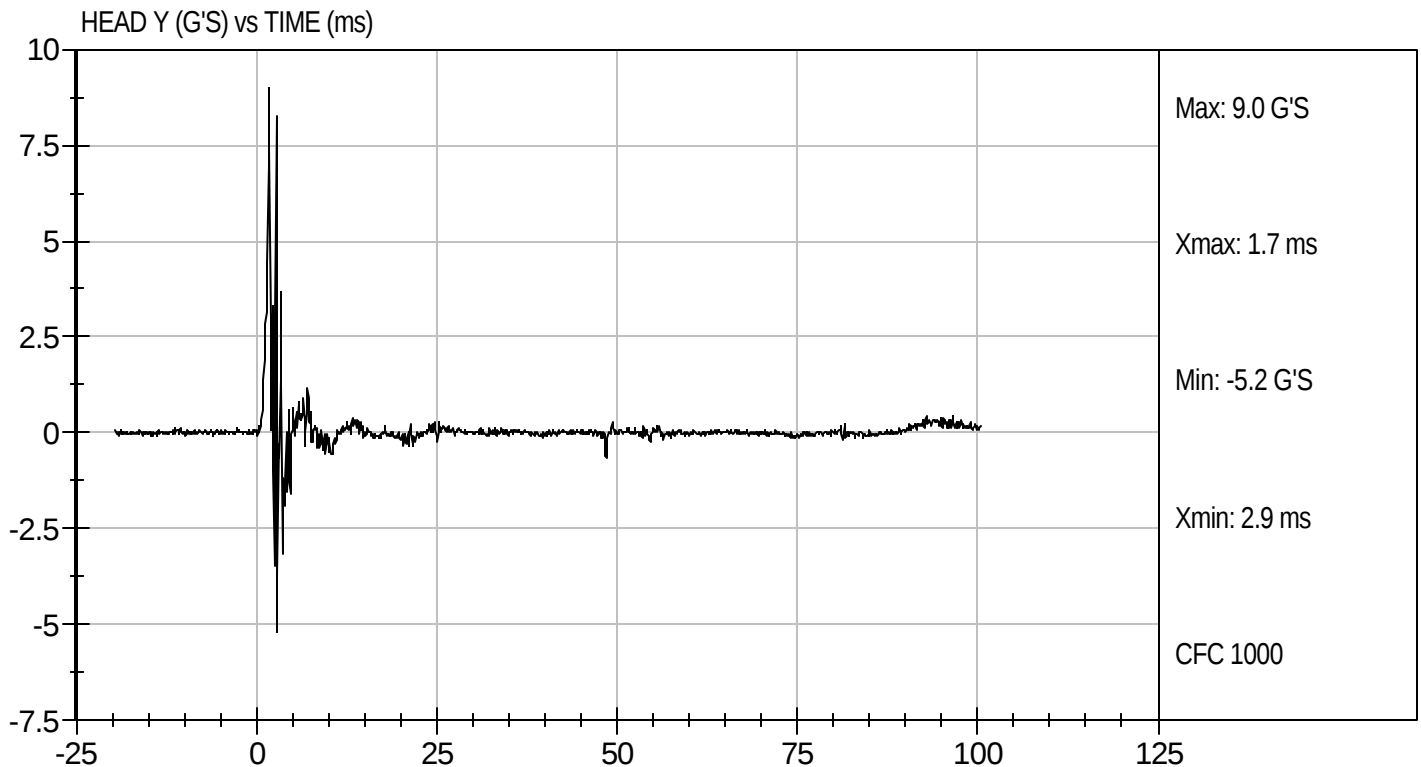
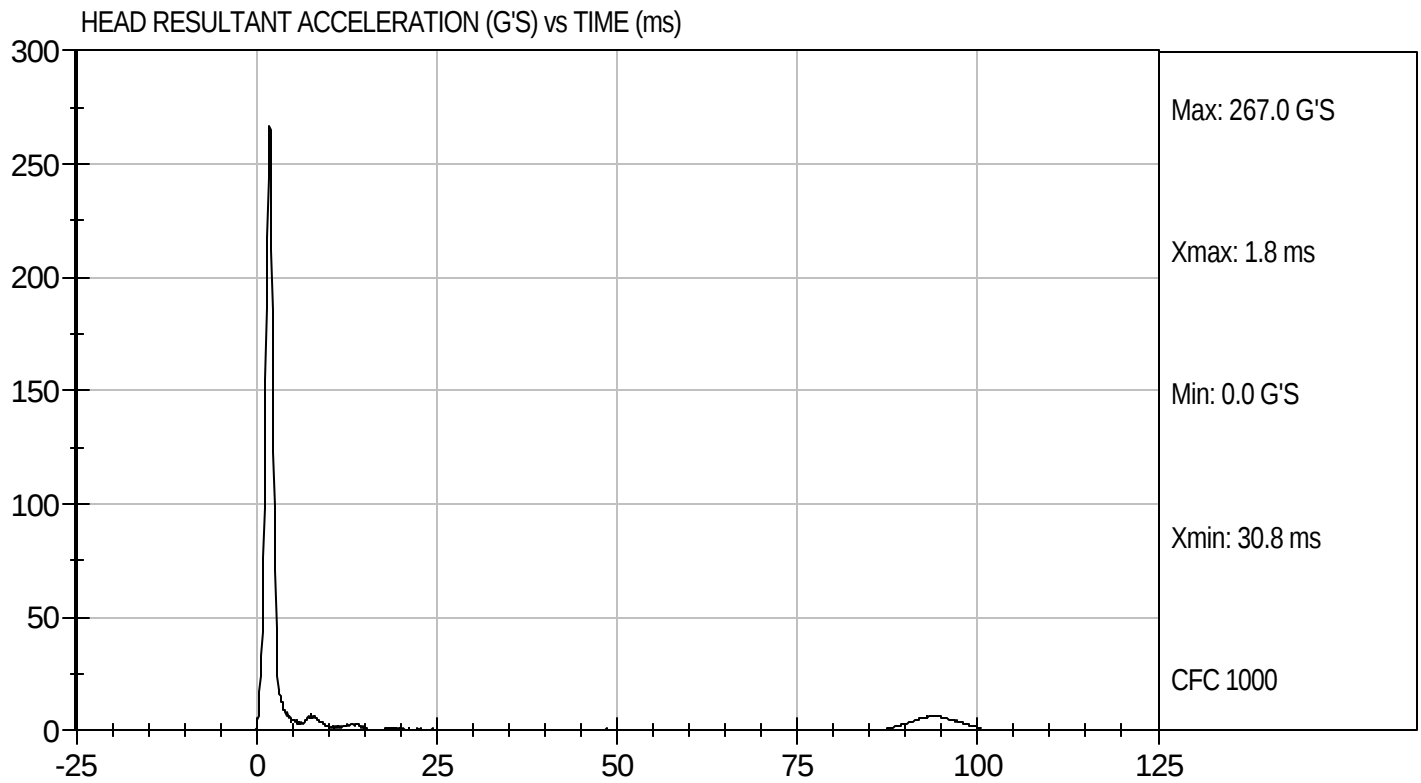
9/11/07  
Test Date

  
Approved By



Test Desc: Head Drop  
Component ID: D072851

Test Date: 9/11/07  
Velocity: 0 ft/s, 0.00 m/s



**MGA RESEARCH CORPORATION**  
**NECK FLEXION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test I.D:** D072852

| Tested Parameter                               |         | Units   | Specification  | Result | Pass/Fail |
|------------------------------------------------|---------|---------|----------------|--------|-----------|
| Laboratory Temperature                         |         | deg C   | 20.6 to 22.2   | 20.9   | Pass      |
| Laboratory Relative Humidity                   |         | %       | 10 to 70       | 36     | Pass      |
| Pendulum Velocity                              |         | m/s     | 6.89 to 7.13   | 7.06   | Pass      |
| Pendulum Deceleration                          | 10 msec | G's     | 22.50 to 27.50 | 24.18  | Pass      |
|                                                | 20 msec | G's     | 17.60 to 22.60 | 19.53  | Pass      |
|                                                | 30 msec | G's     | 12.50 to 18.50 | 14.71  | Pass      |
| Peak Pendulum Deceleration After 30 msec       |         | G's     | <= 29.0        | 14.63  | Pass      |
| Deceleration Decay Time to Cross 5 G's         |         | msec    | 34.0 to 42.0   | 35.0   | Pass      |
| Maximum "D" Plane Rotation                     | Maximum | Degrees | 64.0 to 78.0   | 69.4   | Pass      |
|                                                | Time    | msec    | 57.0 to 64.0   | 57.9   | Pass      |
| "D" Plane Rotation Decay Time To Zero Crossing |         | msec    | 113.0 to 128.0 | 114.8  | Pass      |
| Moment About Occipital Condyle                 | Maximum | N m     | 88.1 to 108.5  | 93.5   | Pass      |
|                                                | Time    | msec    | 47.0 to 58.0   | 47.3   | Pass      |
| Positive Moment Decay Time To Zero Crossing    |         | msec    | 97.0 to 107.0  | 100.8  | Pass      |
| Overall Test Results                           |         |         |                |        | Pass      |

*Jessica Hall*  
 Laboratory Technician

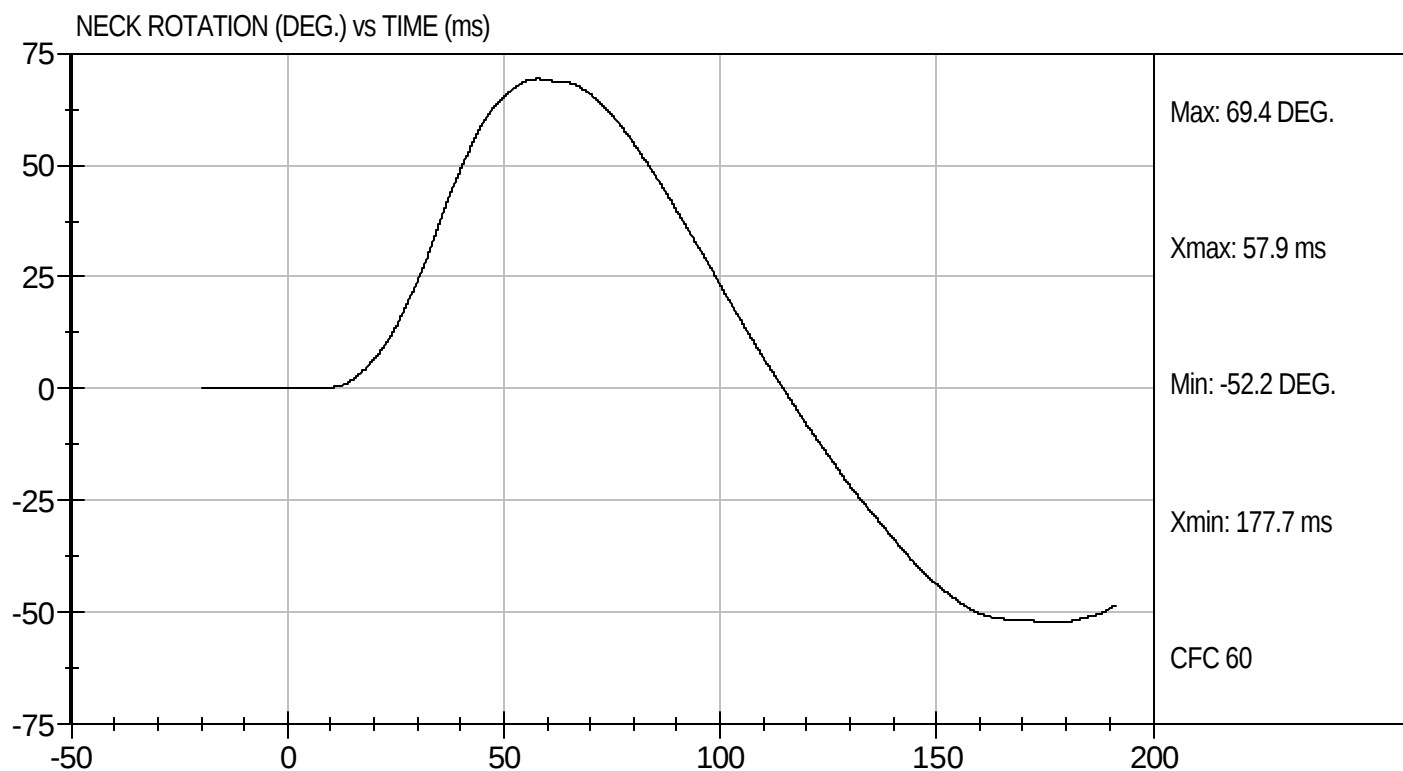
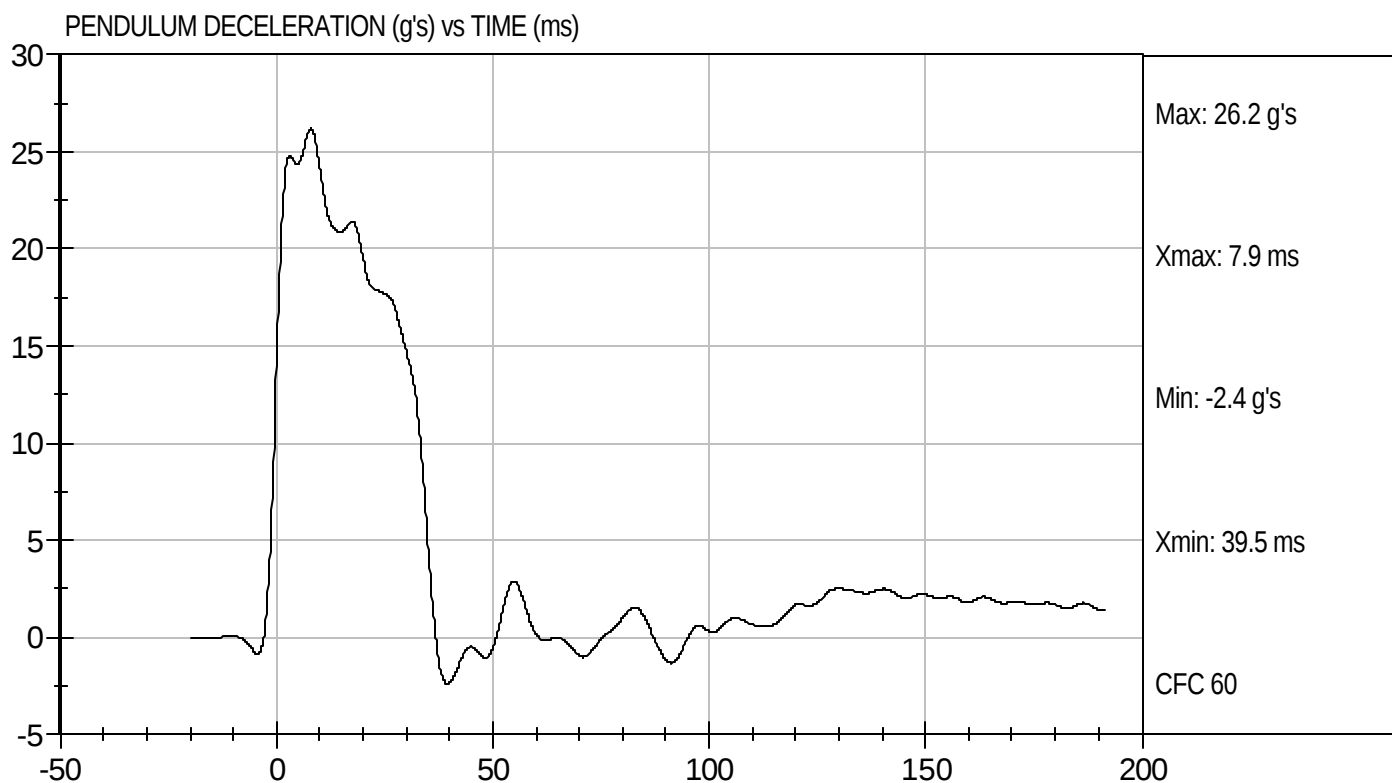
9/11/07  
 Test Date

*David Winkelbauer*  
 Approved By



Test Desc: Neck Flexion  
Component ID: D072852

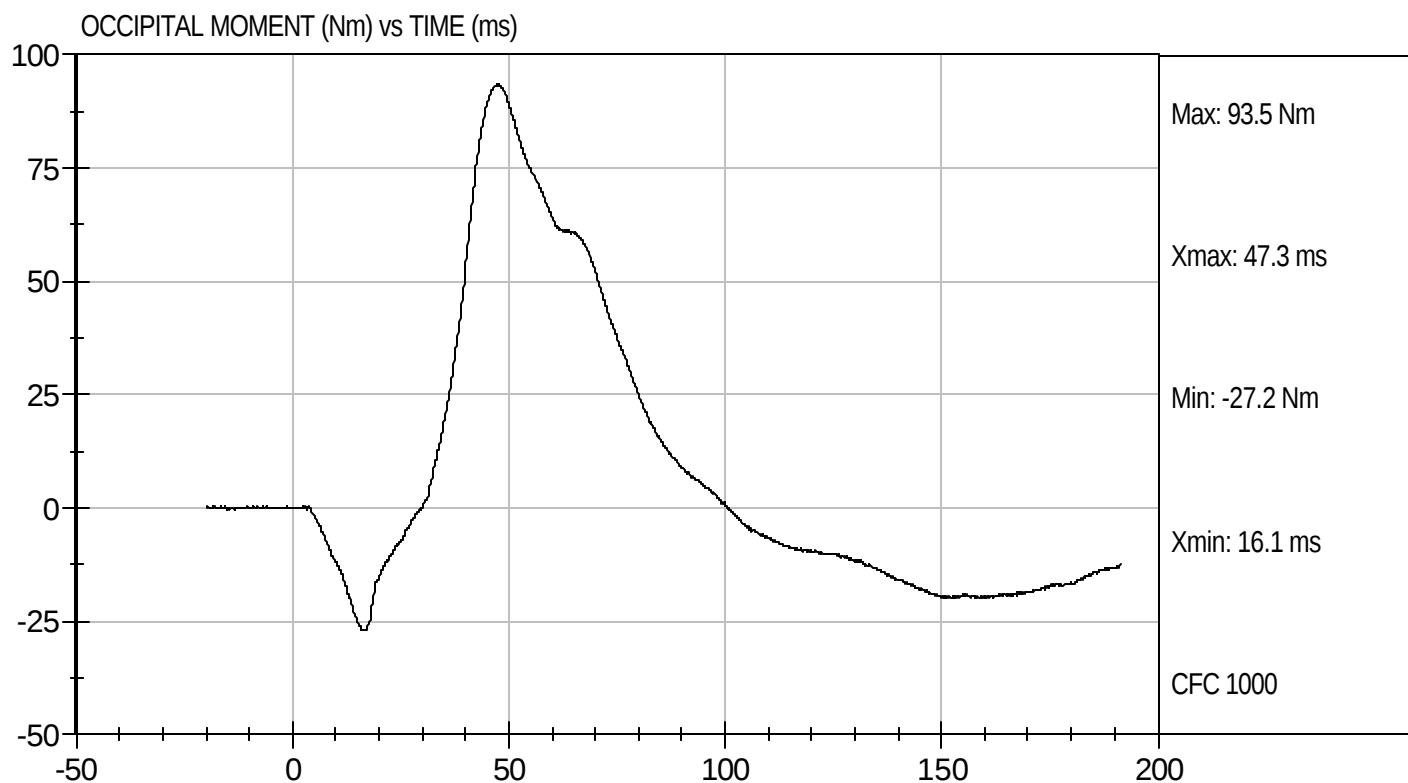
Test Date: 9/11/07  
Velocity: 23.15 ft/s, 7.06 m/s





Test Desc: Neck Flexion  
Component ID: D072852

Test Date: 9/11/07  
Velocity: 23.15 ft/s, 7.06 m/s

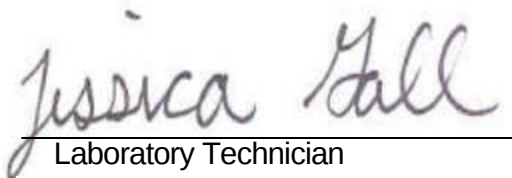


**MGA RESEARCH CORPORATION**  
**NECK EXTENSION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

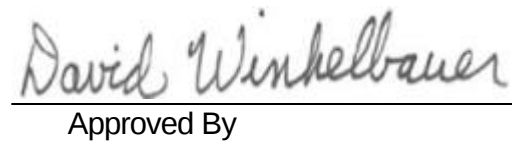
**ATD Serial No:** 066

**Test I.D:** D072853

| Tested Parameter                               |         | Units   | Specification  | Result | Pass/Fail |
|------------------------------------------------|---------|---------|----------------|--------|-----------|
| Laboratory Temperature                         |         | deg C   | 20.6 to 22.2   | 20.9   | Pass      |
| Laboratory Relative Humidity                   |         | %       | 10 to 70       | 36     | Pass      |
| Pendulum Velocity                              |         | m/s     | 5.95 to 6.19   | 6.12   | Pass      |
| Pendulum Deceleration                          | 10 msec | G's     | 17.20 to 21.20 | 19.84  | Pass      |
|                                                | 20 msec | G's     | 14.00 to 19.00 | 17.65  | Pass      |
|                                                | 30 msec | G's     | 11.00 to 16.00 | 13.24  | Pass      |
| Peak Pendulum Deceleration After 30 msec       |         | G's     | <= 22.0        | 13.15  | Pass      |
| Deceleration Decay Time to Cross 5 G's         |         | msec    | 38.0 to 46.0   | 38.2   | Pass      |
| Maximum "D" Plane Rotation                     | Maximum | Degrees | 81.0 to 106.0  | 98.0   | Pass      |
|                                                | Time    | msec    | 72.0 to 82.0   | 74.7   | Pass      |
| "D" Plane Rotation Decay Time To Zero Crossing |         | msec    | 147.0 to 174.0 | 153.0  | Pass      |
| Moment About Occipital Condyle                 | Maximum | N m     | -52.9 to -79.9 | -62.6  | Pass      |
|                                                | Time    | msec    | 65.0 to 79.0   | 69.8   | Pass      |
| Negative Moment Decay Time To Zero Crossing    |         | msec    | 120.0 to 148.0 | 141.2  | Pass      |
| Overall Test Results                           |         |         |                |        | Pass      |

  
Laboratory Technician

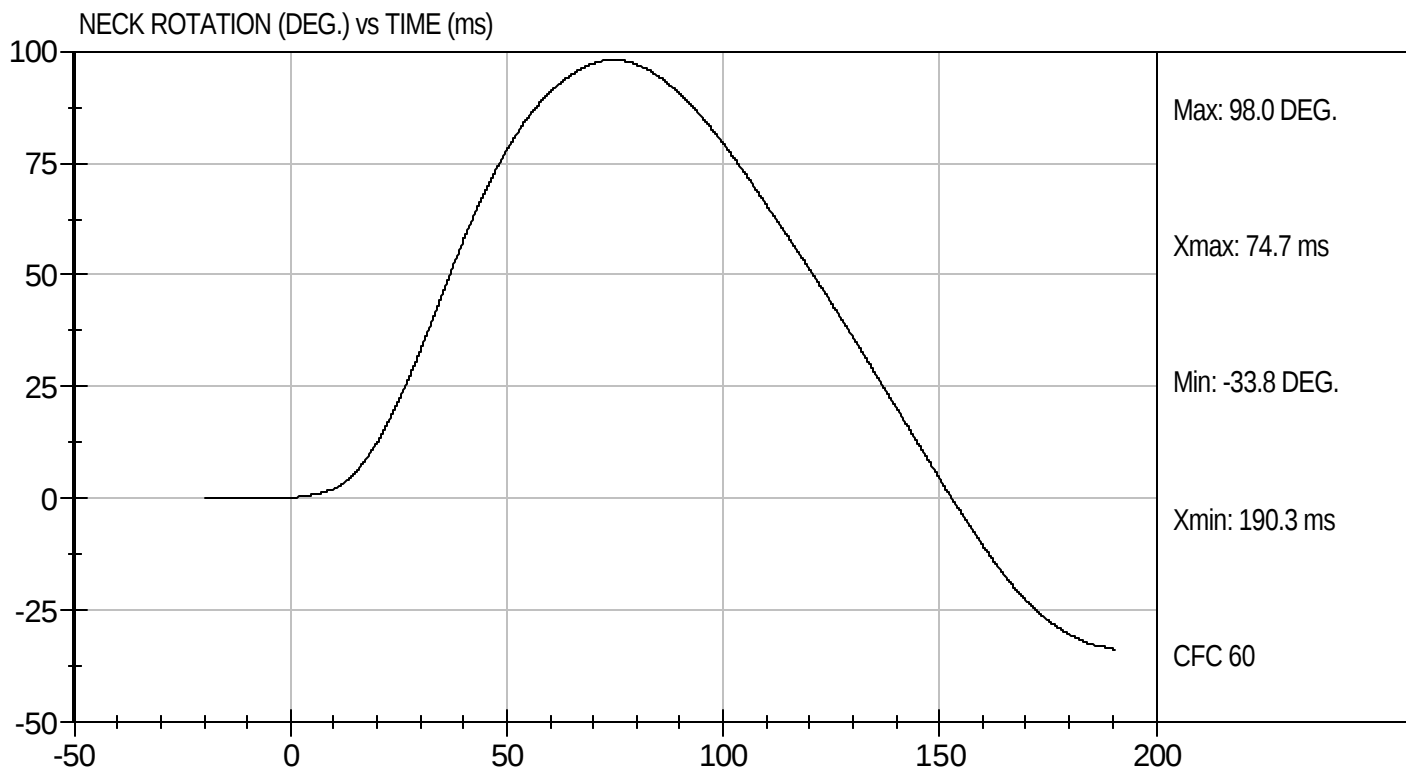
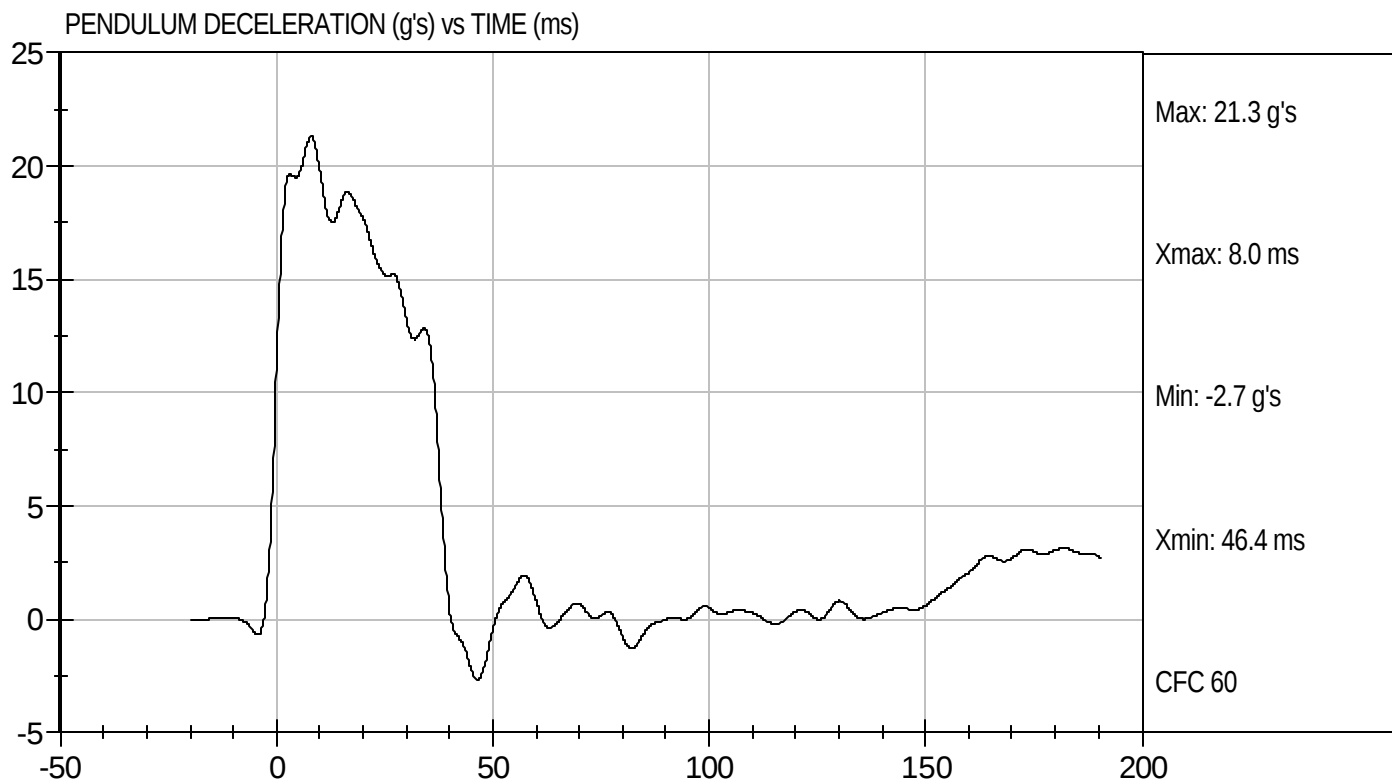
9/11/07  
Test Date

  
Approved By



Test Desc: Neck Extension  
Component ID: D072853

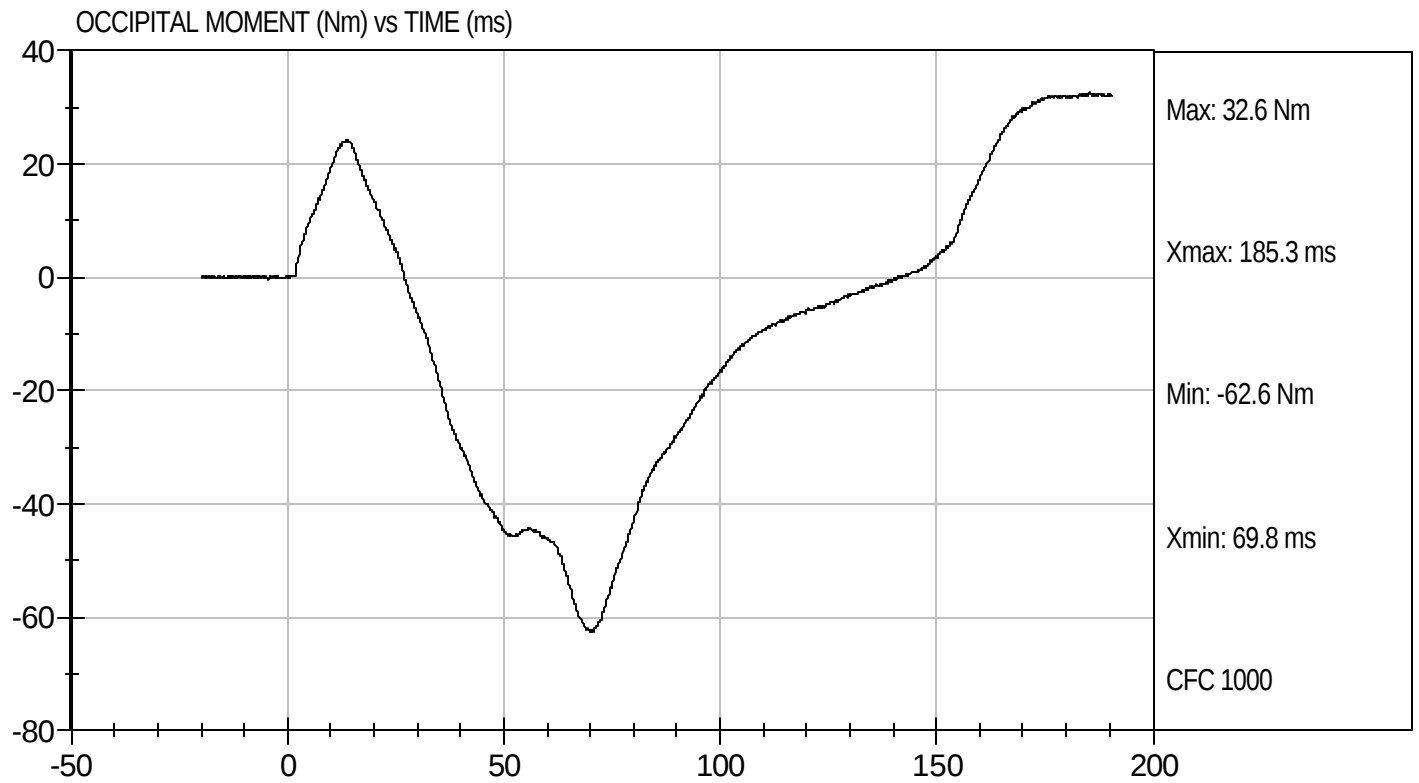
Test Date: 9/11/07  
Velocity: 20.08 ft/s, 6.12 m/s





Test Desc: Neck Extension  
Component ID: D072853

Test Date: 9/11/07  
Velocity: 20.08 ft/s, 6.12 m/s



**MGA RESEARCH CORPORATION**  
**THORAX IMPACT**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test I.D:** D072854

| Tested Parameter             | Units | Specification | Result               | Pass/Fail |
|------------------------------|-------|---------------|----------------------|-----------|
| Laboratory Temperature       | deg C | 20.6 to 22.2  | 20.8                 | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70      | 34                   | Pass      |
| Probe Velocity               | m/s   | 6.58 to 6.82  | 6.68                 | Pass      |
| Peak Probe Force             | N     | 5159 to 5893  | 5,306                | Pass      |
| Peak Sternum Displacement    | cm    | 6.35 to 7.26  | 6.48                 | Pass      |
| Internal Hysteresis          | %     | 69 to 85      | 71                   | Pass      |
|                              |       |               | Overall Test Results | Pass      |



Laboratory Technician



Approved By

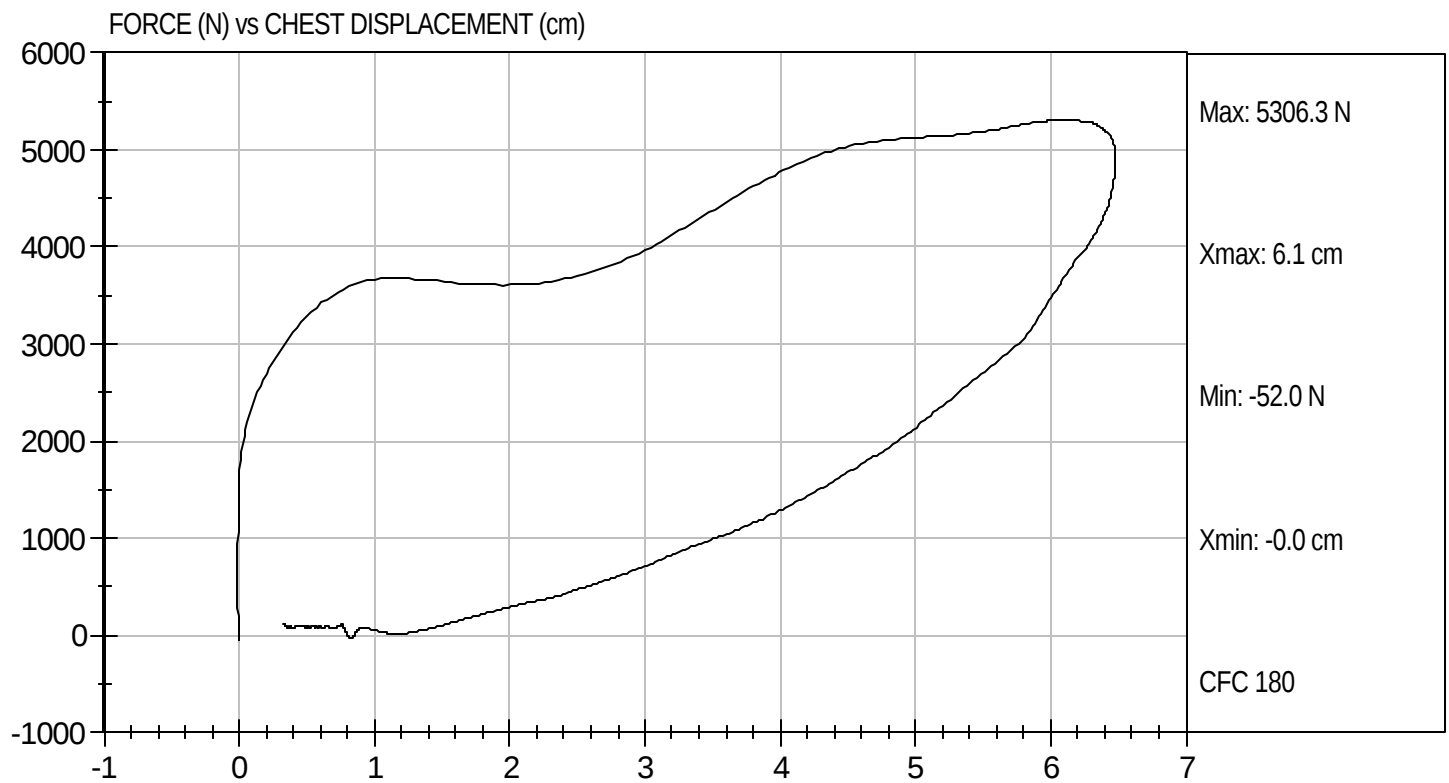
9/11/07

Test Date



Test Desc: Thorax Impact  
Component ID: D072854

Test Date: 9/11/07  
Velocity: 21.929 ft/s, 6.68 m/s

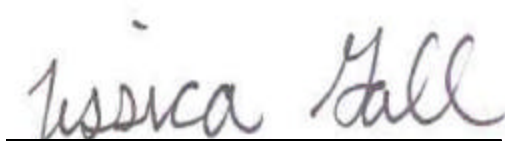


**MGA RESEARCH CORPORATION**  
**RIGHT KNEE IMPACT TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test I.D:** D072855

| Tested Parameter             | Units   | Specification | Result | Pass/Fail |
|------------------------------|---------|---------------|--------|-----------|
| Laboratory Temperature       | deg C   | 18.9 to 25.5  | 20.9   | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70      | 38     | Pass      |
| Probe Velocity               | m/sec   | 2.07 to 2.13  | 2.11   | Pass      |
| Peak Probe Force             | Newtons | 4715 to 5782  | 5,536  | Pass      |
| Overall Test Results         |         |               |        | Pass      |

  
Laboratory Technician

  
Approved By

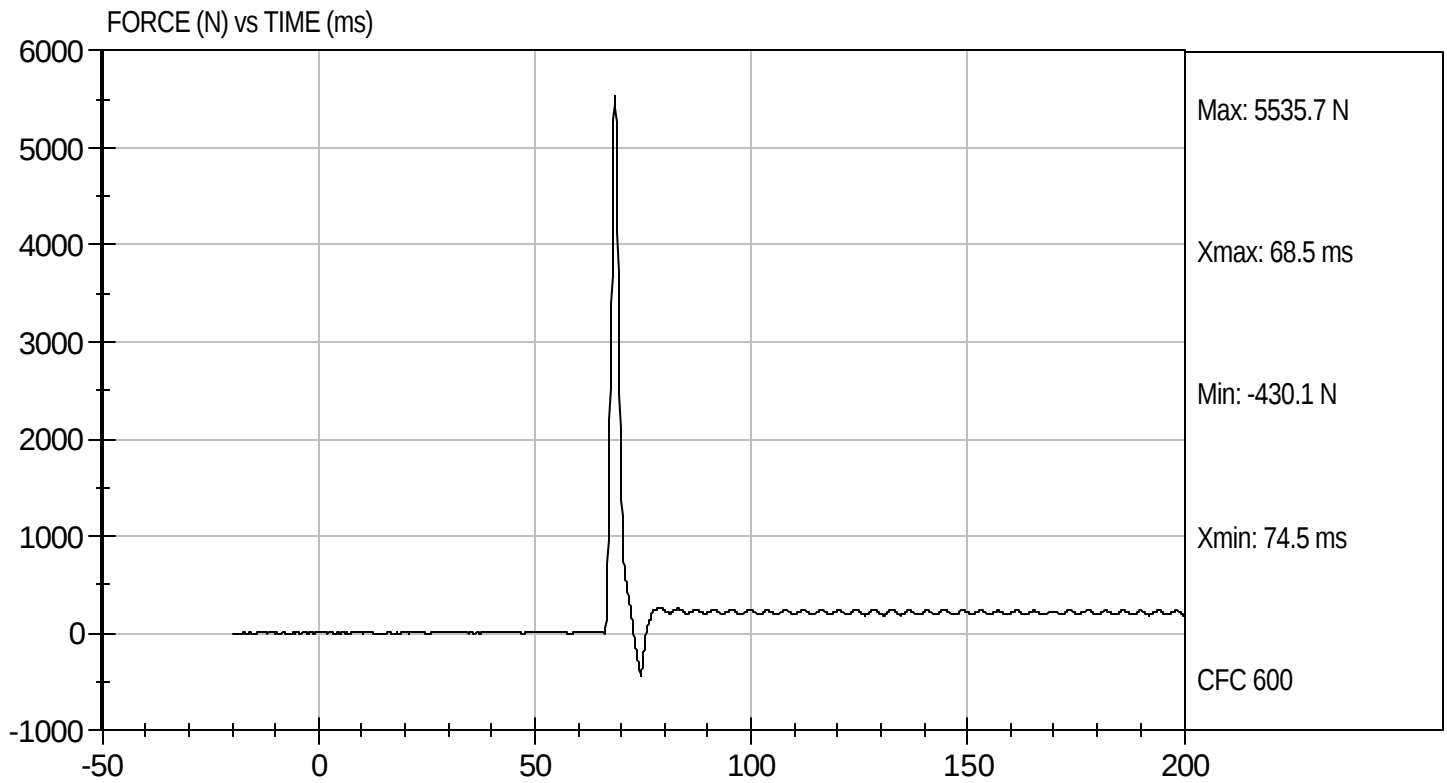
9/11/07

Test Date



Test Desc: Right Knee  
Component ID: D072855

Test Date: 9/11/07  
Velocity: 6.92 ft/s, 2.11 m/s

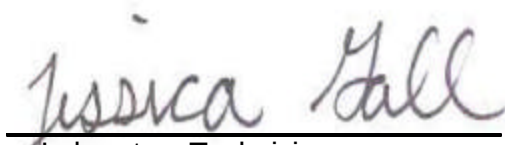


**MGA RESEARCH CORPORATION**  
**LEFT KNEE IMPACT TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test I.D:** D072856

| Tested Parameter             | Units   | Specification | Result | Pass/Fail |
|------------------------------|---------|---------------|--------|-----------|
| Laboratory Temperature       | deg C   | 18.9 to 25.5  | 20.9   | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70      | 38     | Pass      |
| Probe Velocity               | m/sec   | 2.07 to 2.13  | 2.11   | Pass      |
| Peak Probe Force             | Newtons | 4715 to 5782  | 4,920  | Pass      |
| Overall Test Results         |         |               |        | Pass      |

  
Laboratory Technician

  
Approved By

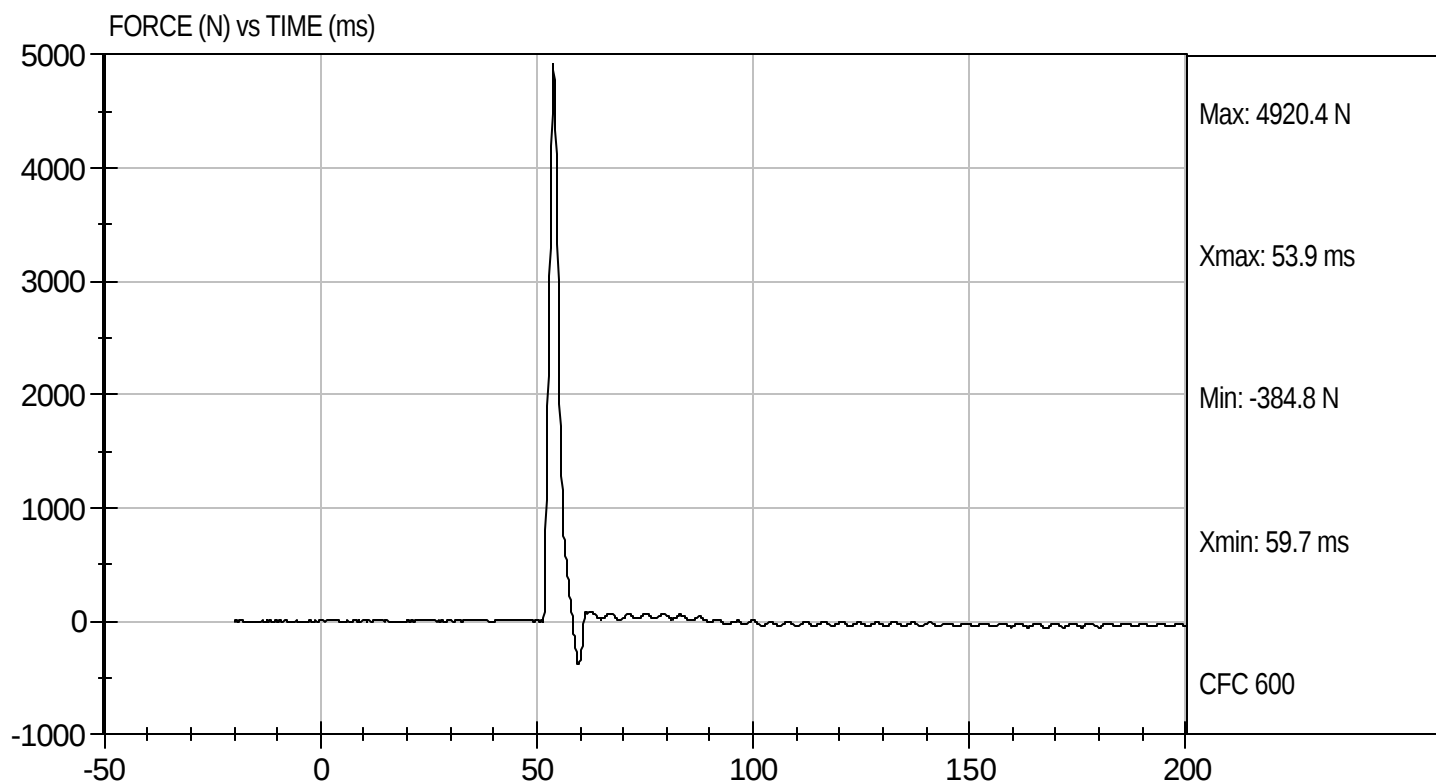
9/11/07

Test Date



Test Desc: Left Knee  
Component ID: D072856

Test Date: 9/11/07  
Velocity: 6.92 ft/s, 2.11 m/s



**MGA RESEARCH CORPORATION**  
**HIP-FEMUR FLEXION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 066

**Test I.D:** D072850

| Tested Parameter             | Units   | Specification                 | Result |      | Pass/Fail |
|------------------------------|---------|-------------------------------|--------|------|-----------|
|                              |         |                               | Right  | Left |           |
| Laboratory Temperature       | deg C   | 18.9 to 25.6                  | 20.9   | 20.9 | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70                      | 40     | 40   | Pass      |
| Rotation Rate                | deg/sec | 5 -10                         | 8      | 8    | Pass      |
| 30 Degrees                   | Nm      | 94.9 Nm Max                   | 65.6   | 61.6 | Pass      |
| 150 ft-lbf / 203.4 Nm        | Deg     | 40- 50 Degree<br>Max Rotation | 41     | 40   | Pass      |
| Overall Test Results         |         |                               |        |      | Pass      |

  
 Laboratory Technician

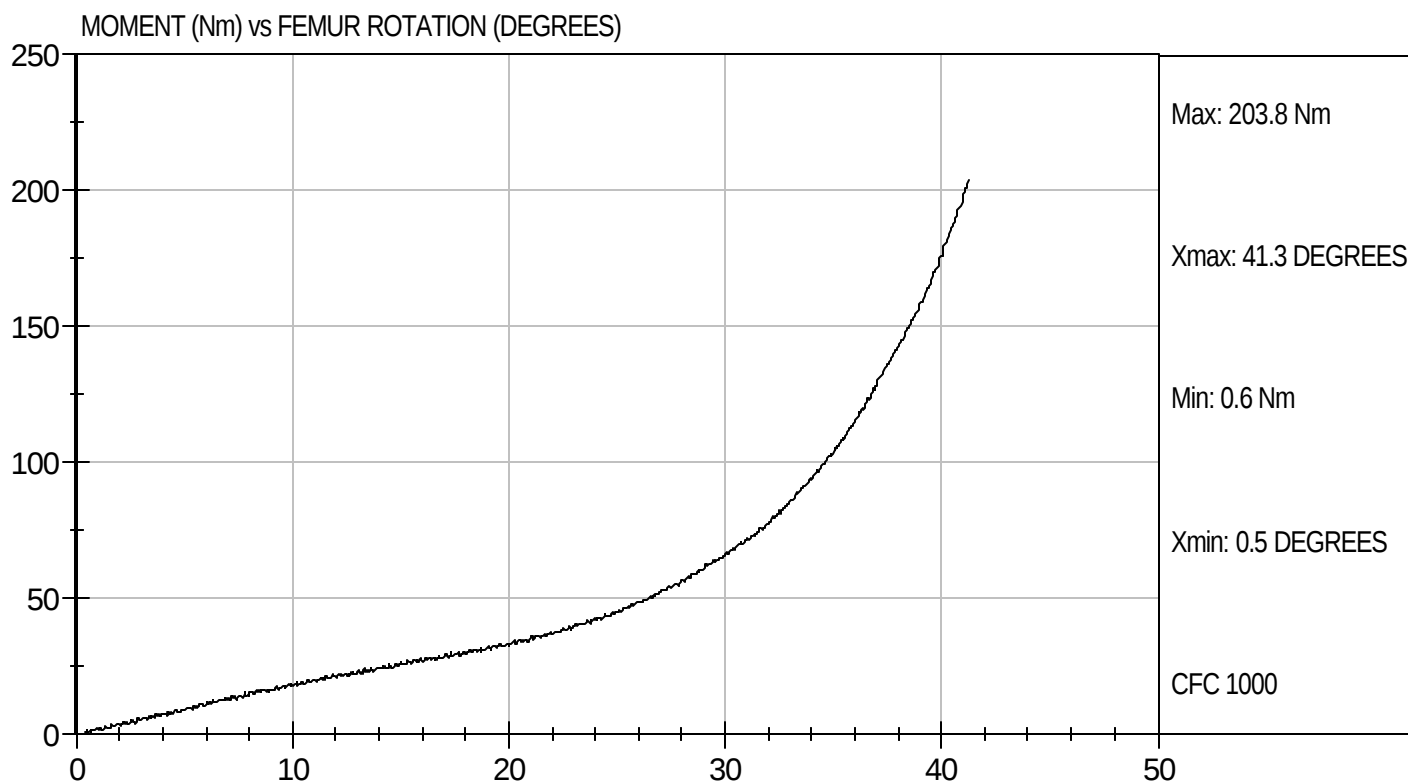
09/11/07  
 Test Date

  
 Approved By



Test Desc: Hip Femur Flexion  
Component ID: D072859

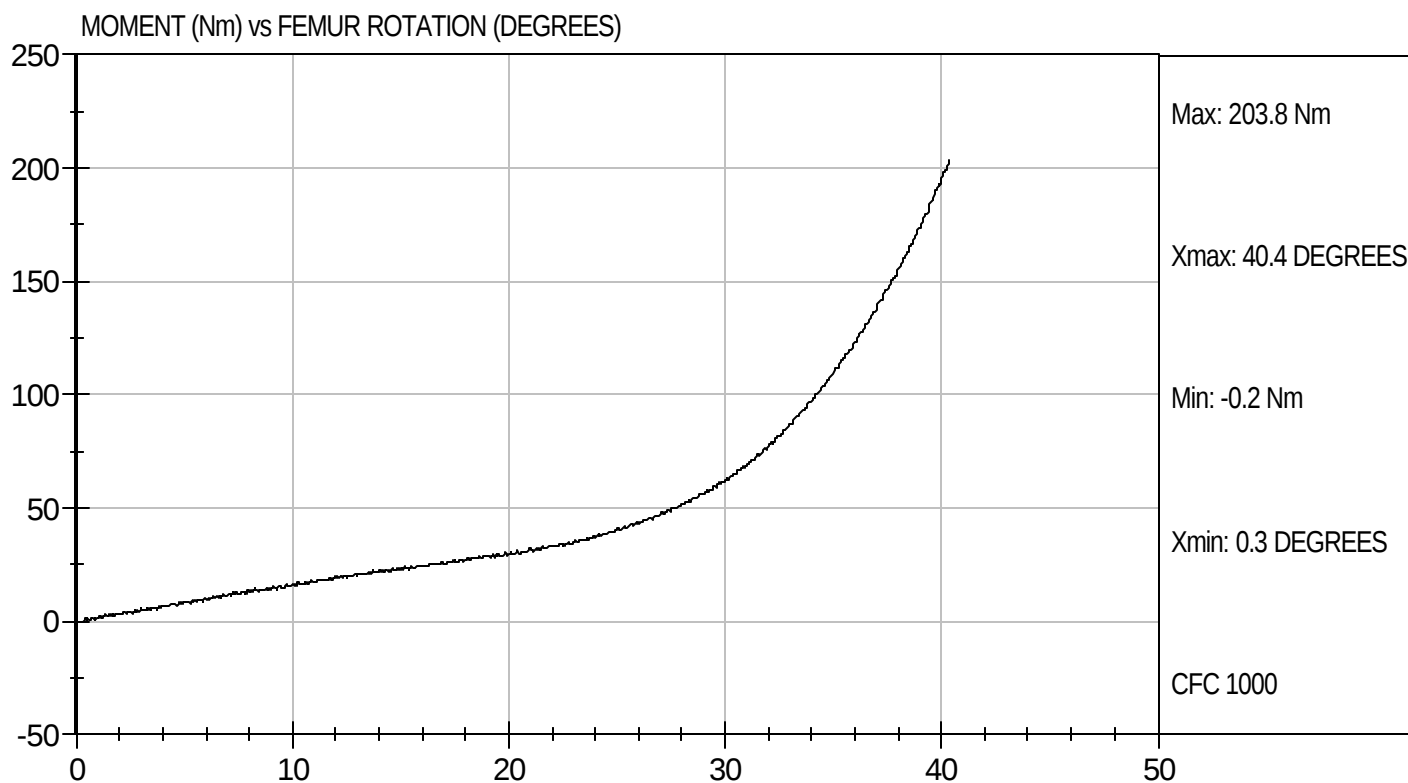
Test Date: 9/11/07  
Velocity: 0 ft/s, 0.00 m/s





Test Desc: Hip Femur Flexion  
Component ID: D072850

Test Date: 09/11/07  
Velocity: 0 ft/s, 0.00 m/s



**MGA RESEARCH CORPORATION**  
**HEAD DROP TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test ID:** D072841

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 - 25.6        | 20.9   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 41     | Pass      |
| Peak Resultant Acceleration  | G's   | 225 - 275          | 227    | Pass      |
| Peak Lateral Acceleration    | G's   | <= +/- 15.0        | -2.8   | Pass      |
| Unimodal                     | N/A   | Yes                | Yes    | Pass      |
| Oscillations                 | N/A   | within 10% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    |        | Pass      |

  
Laboratory Technician

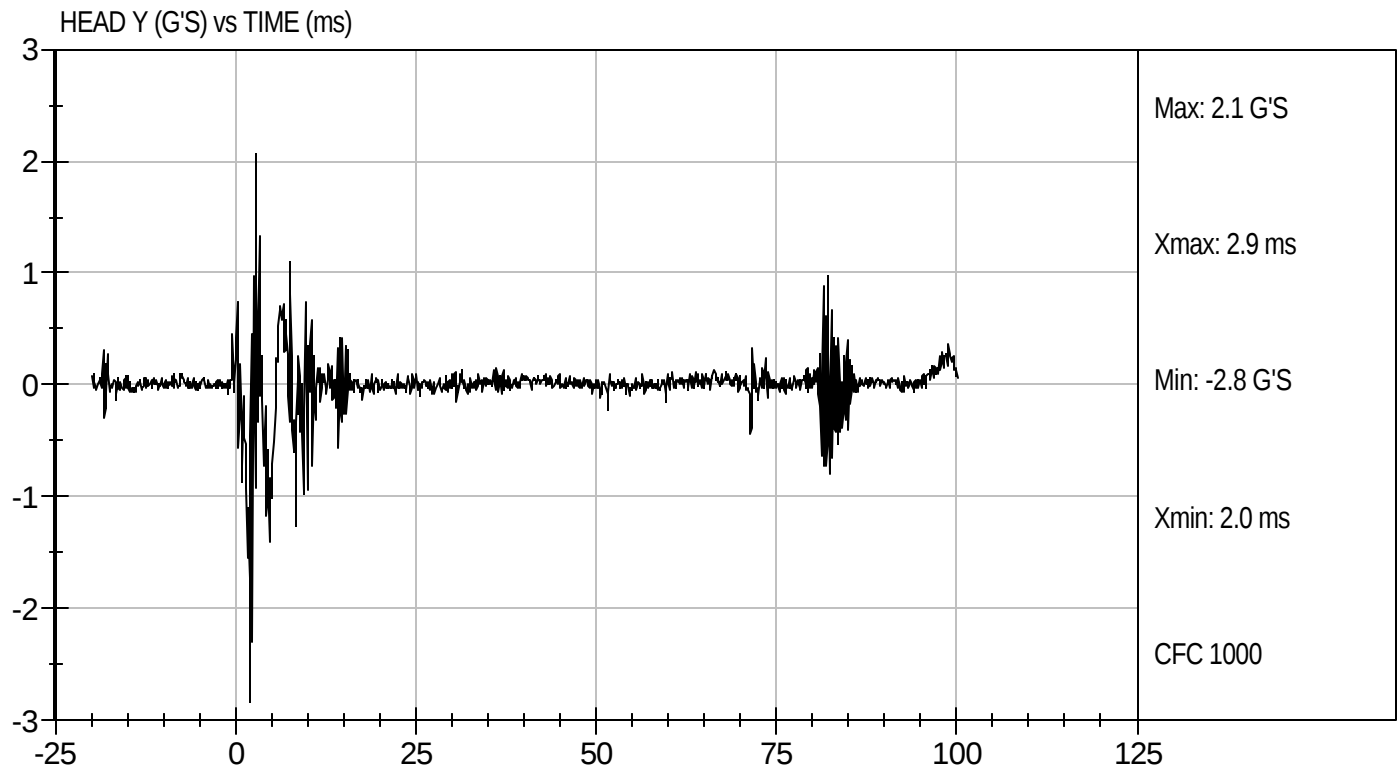
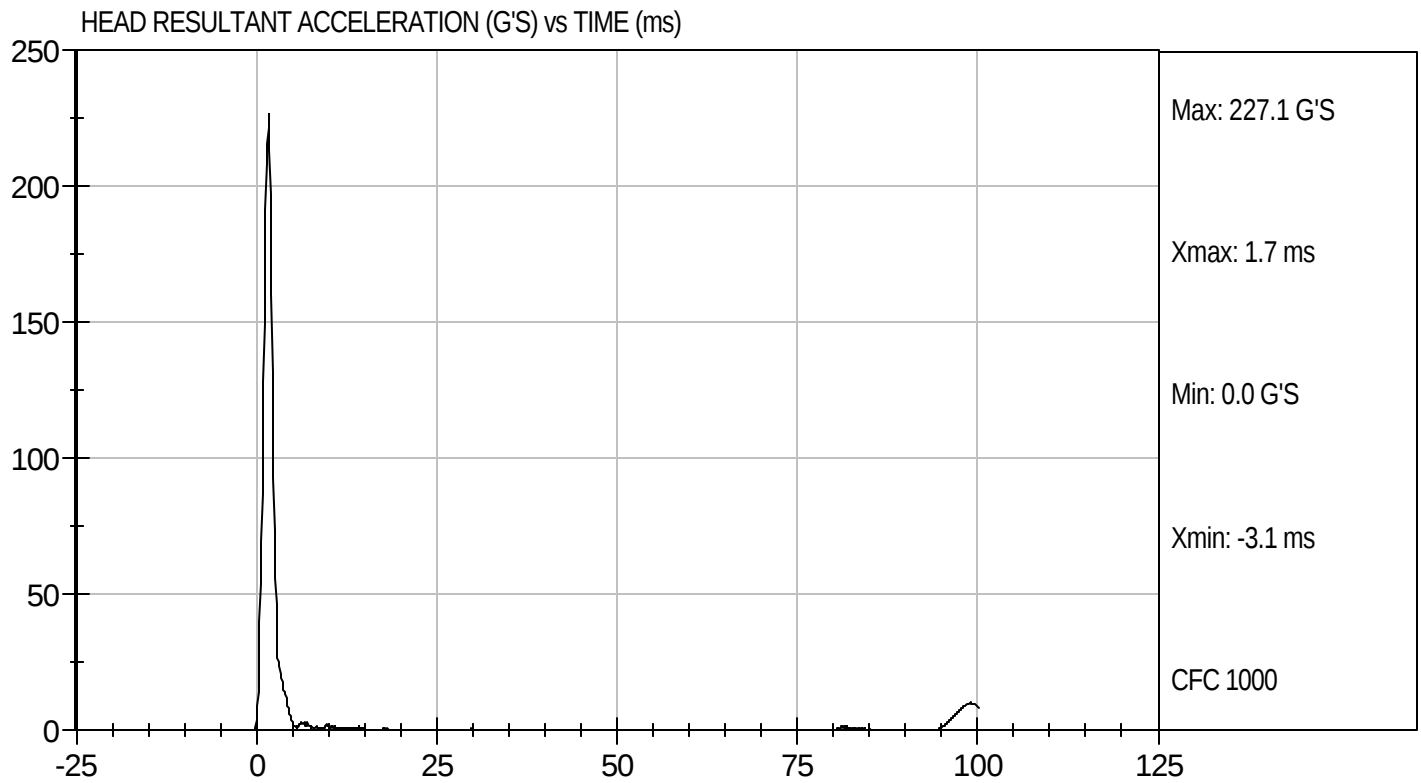
9/11/07  
Test Date

  
Approved By



Test Desc: Head Drop  
Component ID: D072841

Test Date: 9/11/07  
Velocity: 0 ft/s, 0.00 m/s



**MGA RESEARCH CORPORATION**  
**NECK FLEXION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test I.D:** D072842

| Tested Parameter                               |         | Units   | Specification  | Result | Pass/Fail |
|------------------------------------------------|---------|---------|----------------|--------|-----------|
| Laboratory Temperature                         |         | deg C   | 20.6 to 22.2   | 20.9   | Pass      |
| Laboratory Relative Humidity                   |         | %       | 10 to 70       | 36     | Pass      |
| Pendulum Velocity                              |         | m/s     | 6.89 to 7.13   | 7.06   | Pass      |
| Pendulum Deceleration                          | 10 msec | G's     | 22.50 to 27.50 | 24.38  | Pass      |
|                                                | 20 msec | G's     | 17.60 to 22.60 | 18.49  | Pass      |
|                                                | 30 msec | G's     | 12.50 to 18.50 | 14.46  | Pass      |
| Peak Pendulum Deceleration After 30 msec       |         | G's     | <= 29.0        | 14.42  | Pass      |
| Deceleration Decay Time to Cross 5 G's         |         | msec    | 34.0 to 42.0   | 35.2   | Pass      |
| Maximum "D" Plane Rotation                     | Maximum | Degrees | 64.0 to 78.0   | 68.2   | Pass      |
|                                                | Time    | msec    | 57.0 to 64.0   | 63.5   | Pass      |
| "D" Plane Rotation Decay Time To Zero Crossing |         | msec    | 113.0 to 128.0 | 113.1  | Pass      |
| Moment About Occipital Condyle                 | Maximum | N m     | 88.1 to 108.5  | 92.9   | Pass      |
|                                                | Time    | msec    | 47.0 to 58.0   | 47.8   | Pass      |
| Positive Moment Decay Time To Zero Crossing    |         | msec    | 97.0 to 107.0  | 101.3  | Pass      |
| Overall Test Results                           |         |         |                |        | Pass      |

*Jessica Hall*  
 Laboratory Technician

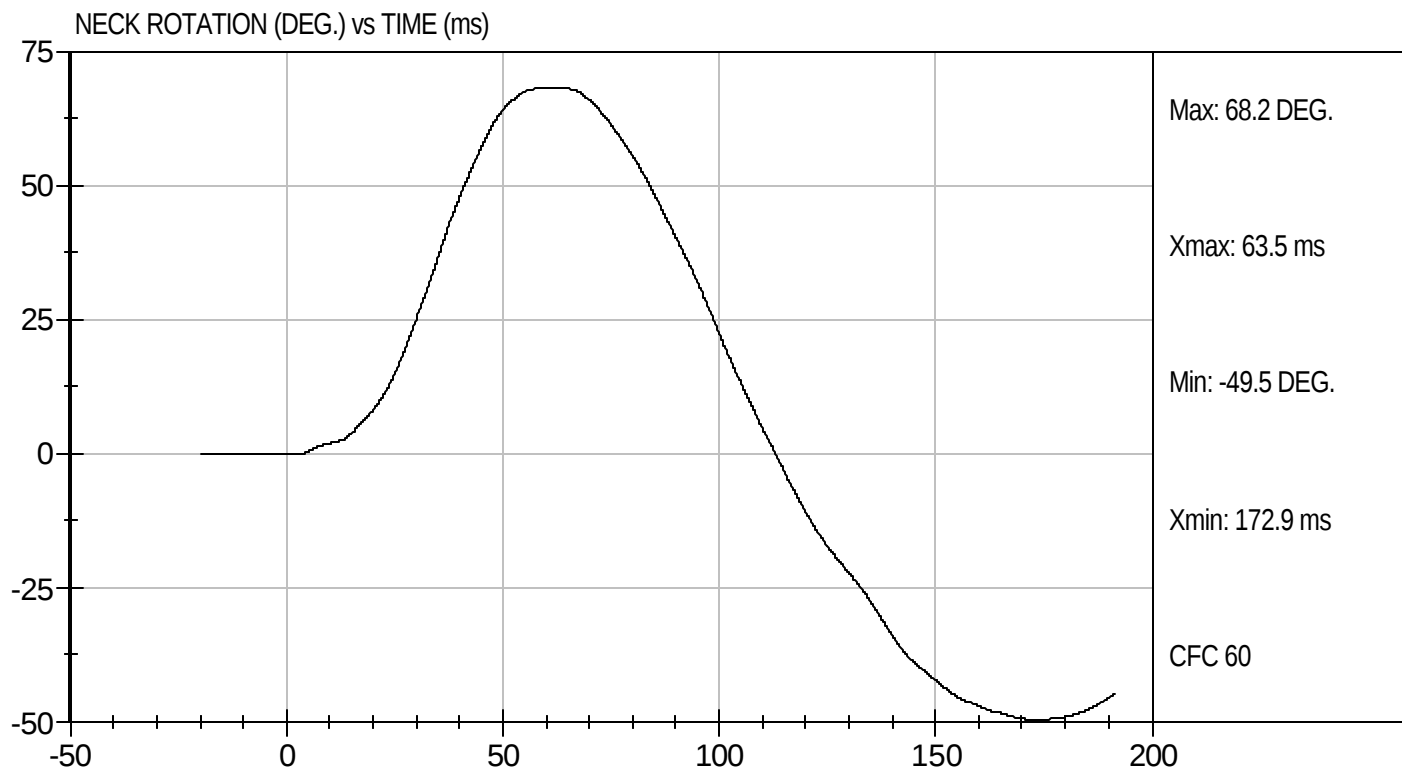
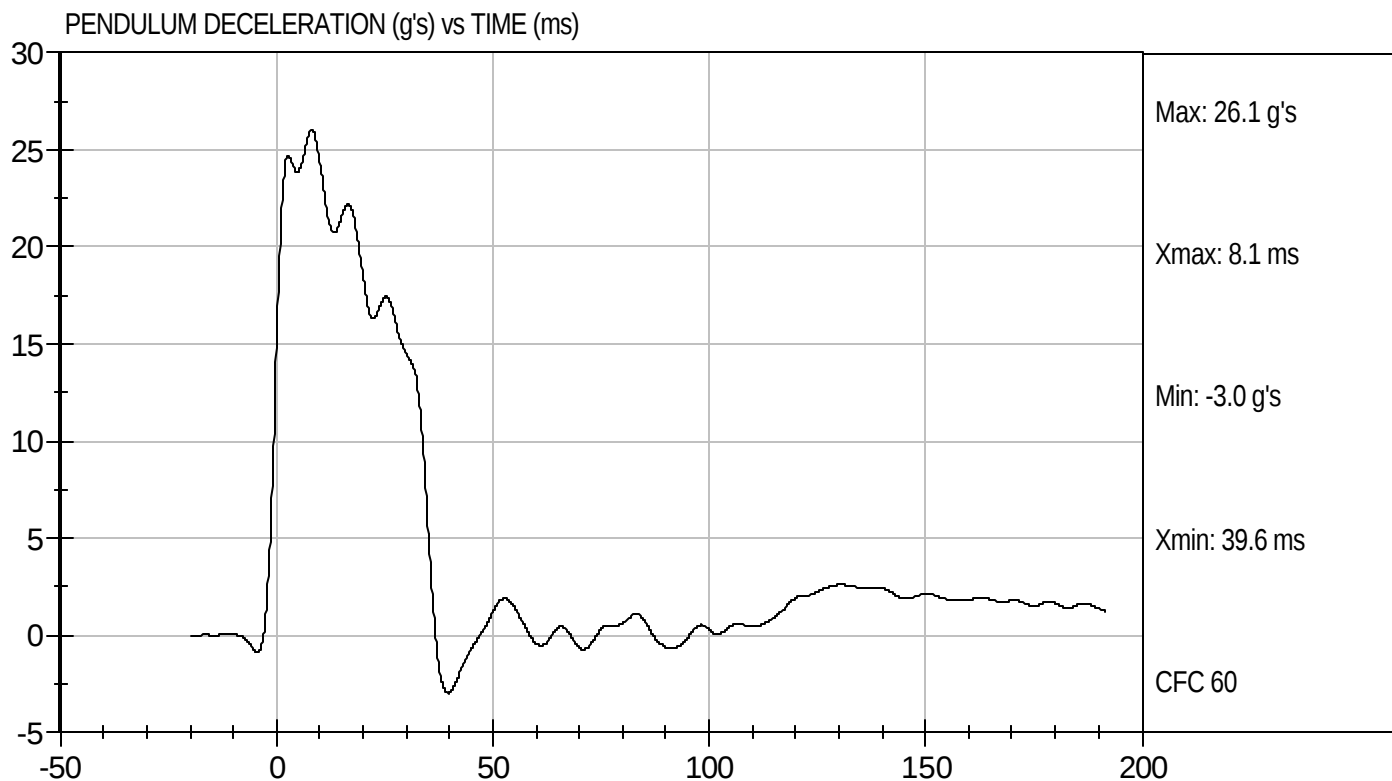
9/11/07  
 Test Date

*David Winkelbauer*  
 Approved By



Test Desc: Neck Flexion  
Component ID: D072842

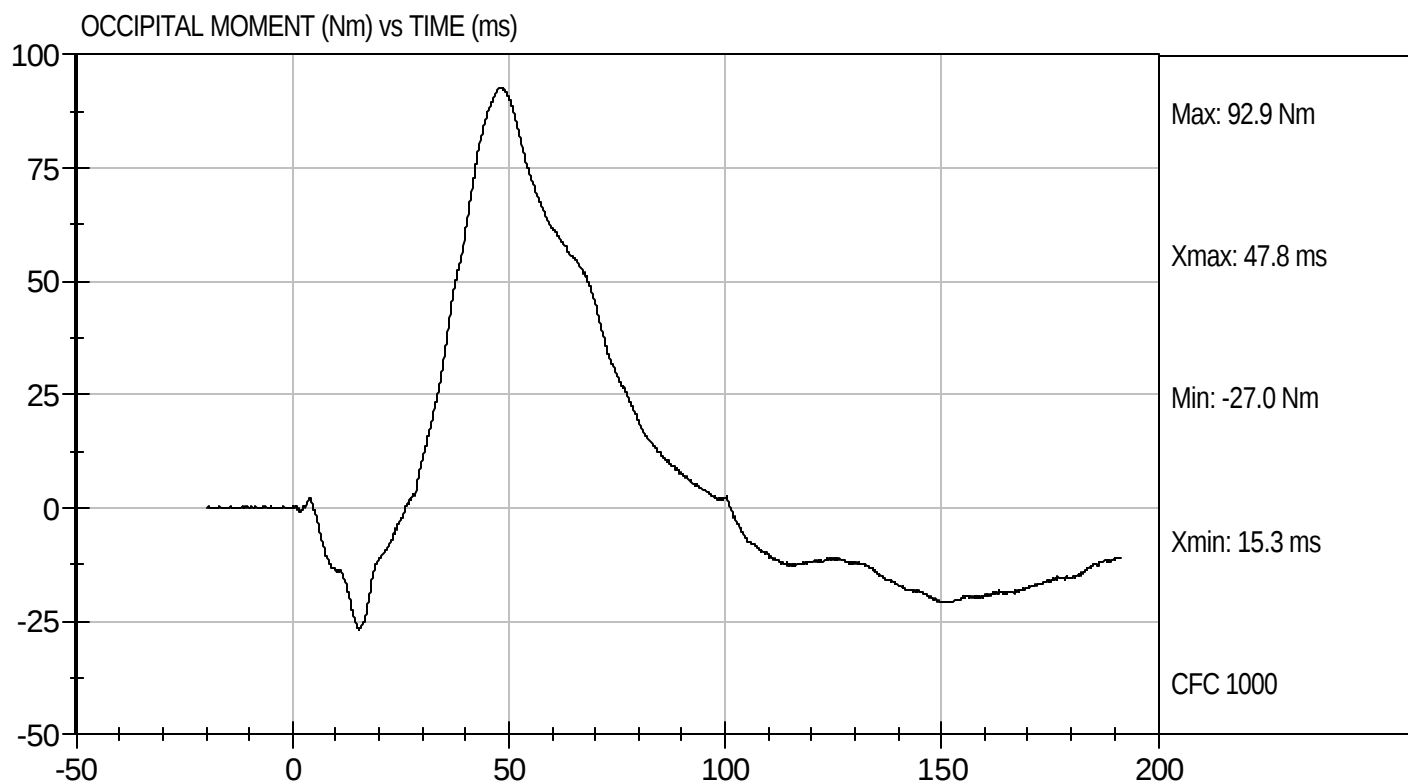
Test Date: 9/11/07  
Velocity: 23.15 ft/s, 7.06 m/s





Test Desc: Neck Flexion  
Component ID: D072842

Test Date: 9/11/07  
Velocity: 23.15 ft/s, 7.06 m/s

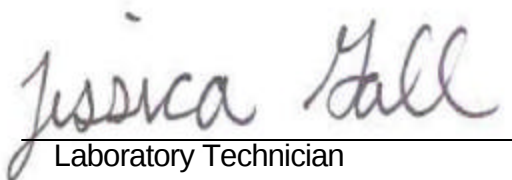


**MGA RESEARCH CORPORATION**  
**NECK EXTENSION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

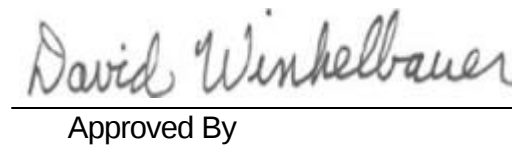
ATD Serial No: 065

Test I.D.: D072843

| Tested Parameter                               |         | Units   | Specification  | Result | Pass/Fail |
|------------------------------------------------|---------|---------|----------------|--------|-----------|
| Laboratory Temperature                         |         | deg C   | 20.6 to 22.2   | 20.9   | Pass      |
| Laboratory Relative Humidity                   |         | %       | 10 to 70       | 36     | Pass      |
| Pendulum Velocity                              |         | m/s     | 5.95 to 6.19   | 6.04   | Pass      |
| Pendulum Deceleration                          | 10 msec | G's     | 17.20 to 21.20 | 18.79  | Pass      |
|                                                | 20 msec | G's     | 14.00 to 19.00 | 16.07  | Pass      |
|                                                | 30 msec | G's     | 11.00 to 16.00 | 13.16  | Pass      |
| Peak Pendulum Deceleration After 30 msec       |         | G's     | <= 22.0        | 13.13  | Pass      |
| Deceleration Decay Time to Cross 5 G's         |         | msec    | 38.0 to 46.0   | 38.1   | Pass      |
| Maximum "D" Plane Rotation                     | Maximum | Degrees | 81.0 to 106.0  | 94.5   | Pass      |
|                                                | Time    | msec    | 72.0 to 82.0   | 73.3   | Pass      |
| "D" Plane Rotation Decay Time To Zero Crossing |         | msec    | 147.0 to 174.0 | 152.3  | Pass      |
| Moment About Occipital Condyle                 | Maximum | N m     | -52.9 to -79.9 | -59.9  | Pass      |
|                                                | Time    | msec    | 65.0 to 79.0   | 69.4   | Pass      |
| Negative Moment Decay Time To Zero Crossing    |         | msec    | 120.0 to 148.0 | 139.5  | Pass      |
| Overall Test Results                           |         |         |                |        | Pass      |

  
 Laboratory Technician

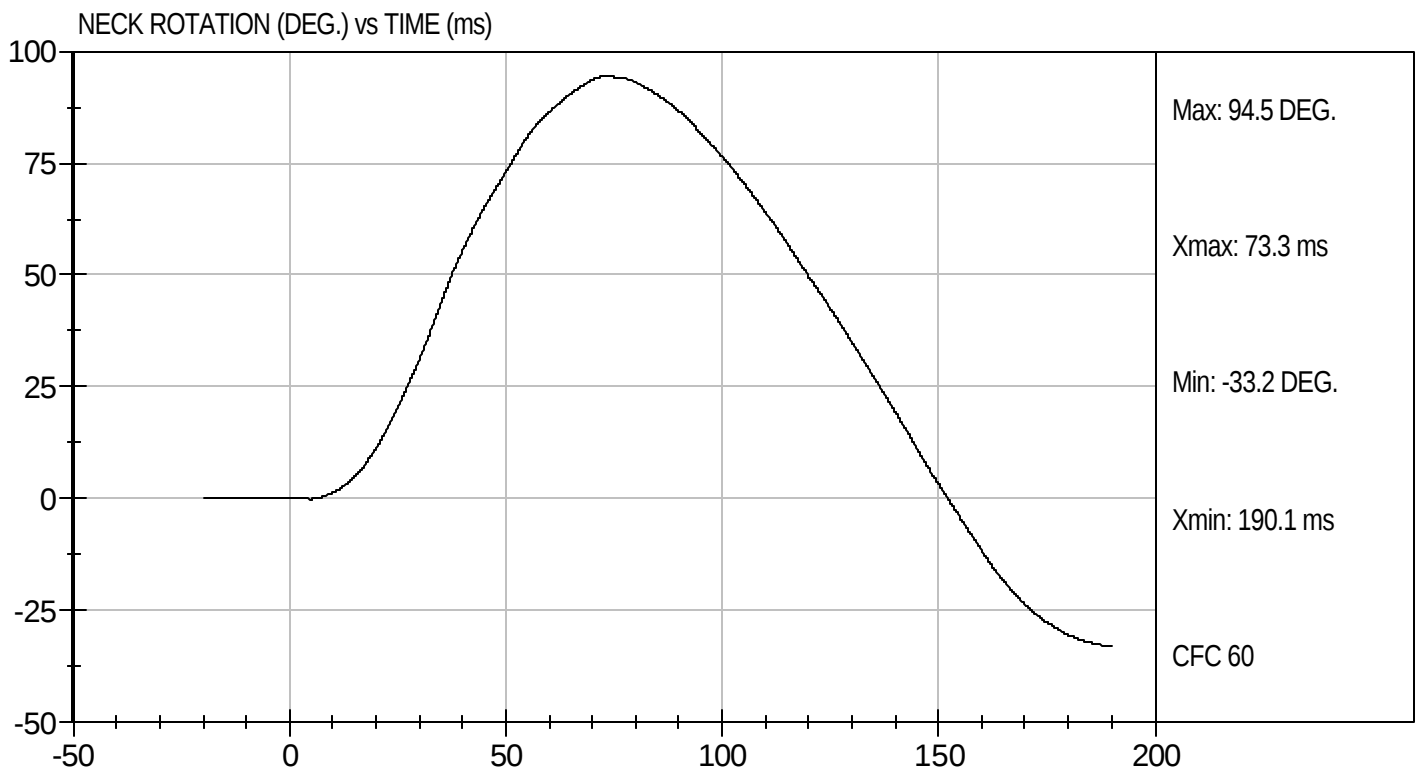
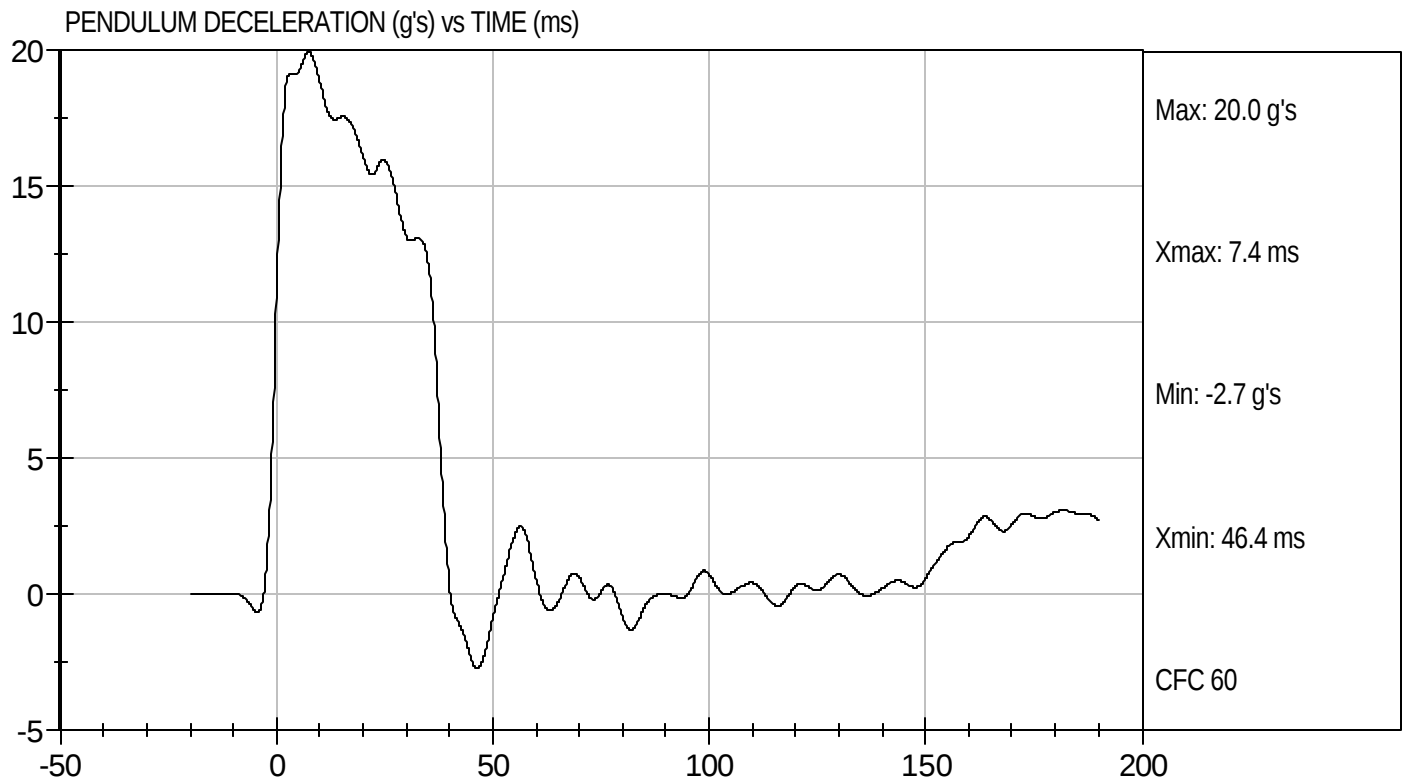
9/11/07  
 Test Date

  
 Approved By



Test Desc: Neck Extension  
Component ID: D072843

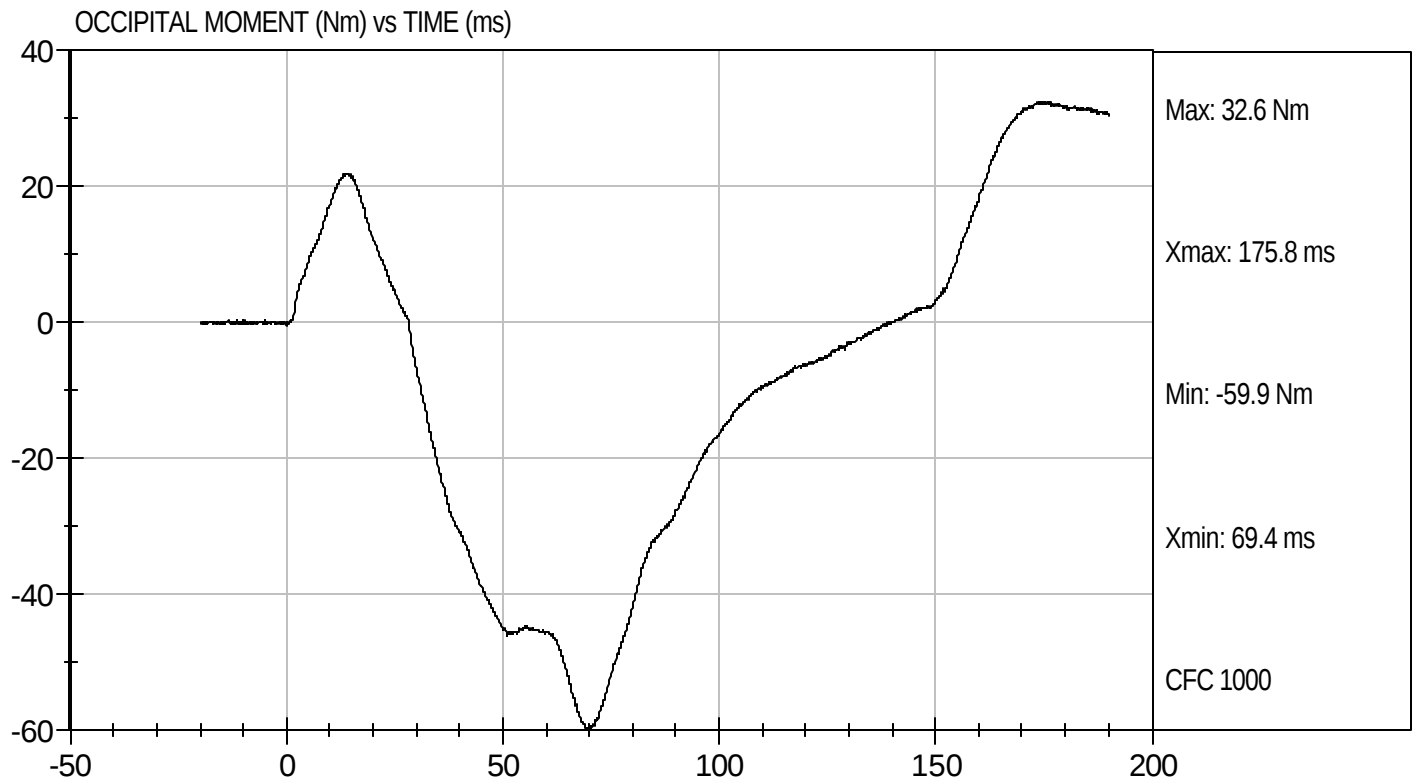
Test Date: 9/11/07  
Velocity: 19.83 ft/s, 6.04 m/s





Test Desc: Neck Extension  
Component ID: D072843

Test Date: 9/11/07  
Velocity: 19.83 ft/s, 6.04 m/s



**MGA RESEARCH CORPORATION**  
**THORAX IMPACT**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test I.D:** D072844

| Tested Parameter             | Units | Specification | Result               | Pass/Fail |
|------------------------------|-------|---------------|----------------------|-----------|
| Laboratory Temperature       | deg C | 20.6 to 22.2  | 20.8                 | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70      | 34                   | Pass      |
| Probe Velocity               | m/s   | 6.58 to 6.82  | 6.77                 | Pass      |
| Peak Probe Force             | N     | 5159 to 5893  | 5,400                | Pass      |
| Peak Sternum Displacement    | cm    | 6.35 to 7.26  | 6.55                 | Pass      |
| Internal Hysteresis          | %     | 69 to 85      | 73                   | Pass      |
|                              |       |               | Overall Test Results | Pass      |



Laboratory Technician



Approved By

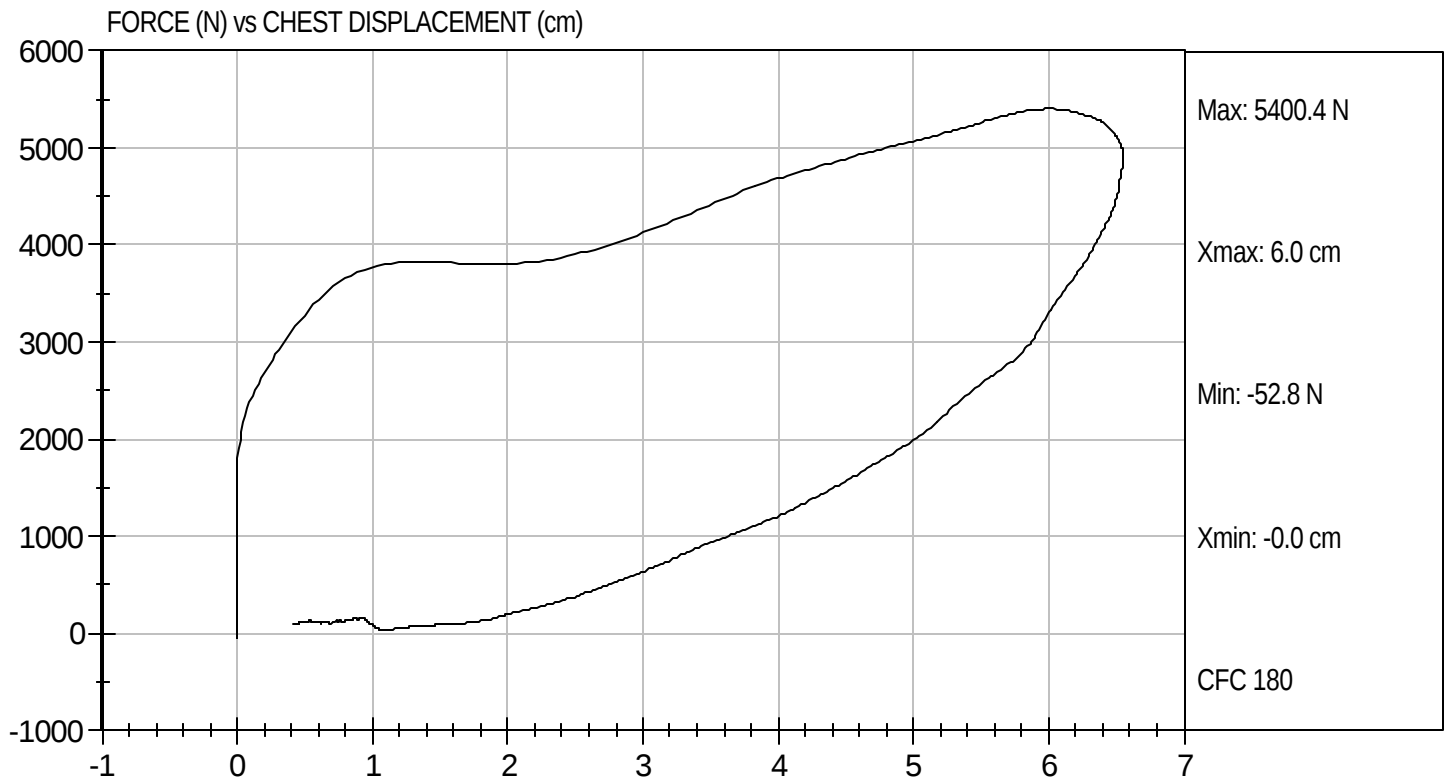
9/11/07

Test Date



Test Desc: Thorax Impact  
Component ID: D072844

Test Date: 9/11/07  
Velocity: 22.222 ft/s, 6.77 m/s

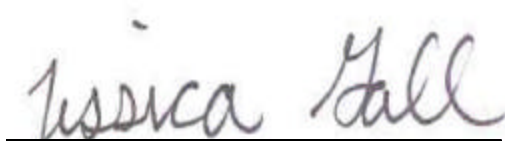


**MGA RESEARCH CORPORATION**  
**RIGHT KNEE IMPACT TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test I.D:** D072845

| Tested Parameter             | Units   | Specification | Result | Pass/Fail |
|------------------------------|---------|---------------|--------|-----------|
| Laboratory Temperature       | deg C   | 18.9 to 25.5  | 20.8   | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70      | 37     | Pass      |
| Probe Velocity               | m/sec   | 2.07 to 2.13  | 2.08   | Pass      |
| Peak Probe Force             | Newtons | 4715 to 5782  | 5,686  | Pass      |
| Overall Test Results         |         |               |        | Pass      |

  
Laboratory Technician

  
Approved By

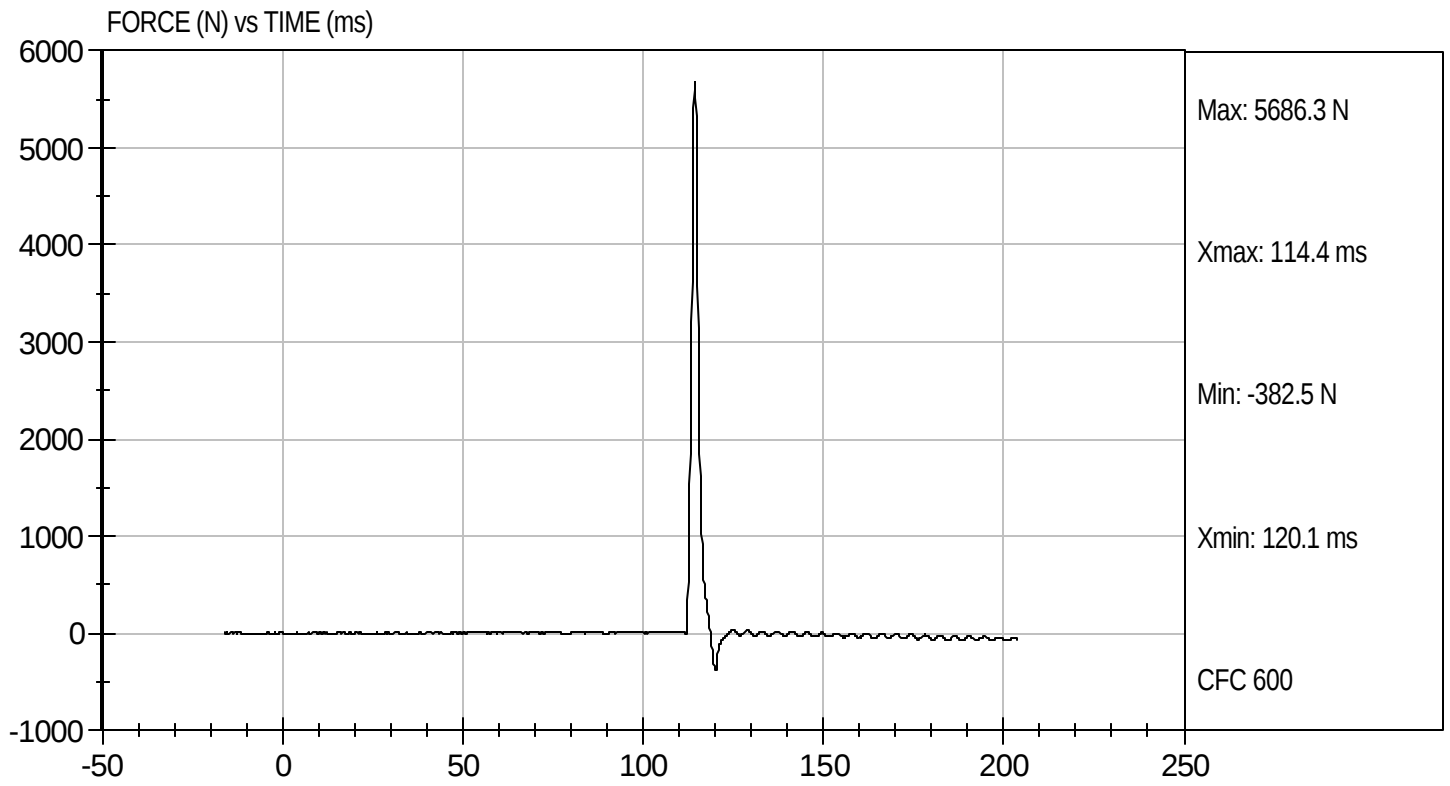
9/11/07

Test Date



Test Desc: Right Knee  
Component ID: D072845

Test Date: 9/11/07  
Velocity: 6.83 ft/s, 2.08 m/s

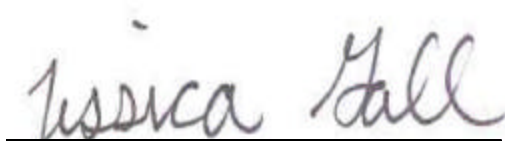


**MGA RESEARCH CORPORATION**  
**LEFT KNEE IMPACT TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test I.D:** D072846

| Tested Parameter             | Units   | Specification | Result | Pass/Fail |
|------------------------------|---------|---------------|--------|-----------|
| Laboratory Temperature       | deg C   | 18.9 to 25.5  | 20.9   | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70      | 38     | Pass      |
| Probe Velocity               | m/sec   | 2.07 to 2.13  | 2.10   | Pass      |
| Peak Probe Force             | Newtons | 4715 to 5782  | 5,608  | Pass      |
| Overall Test Results         |         |               |        | Pass      |

  
Laboratory Technician

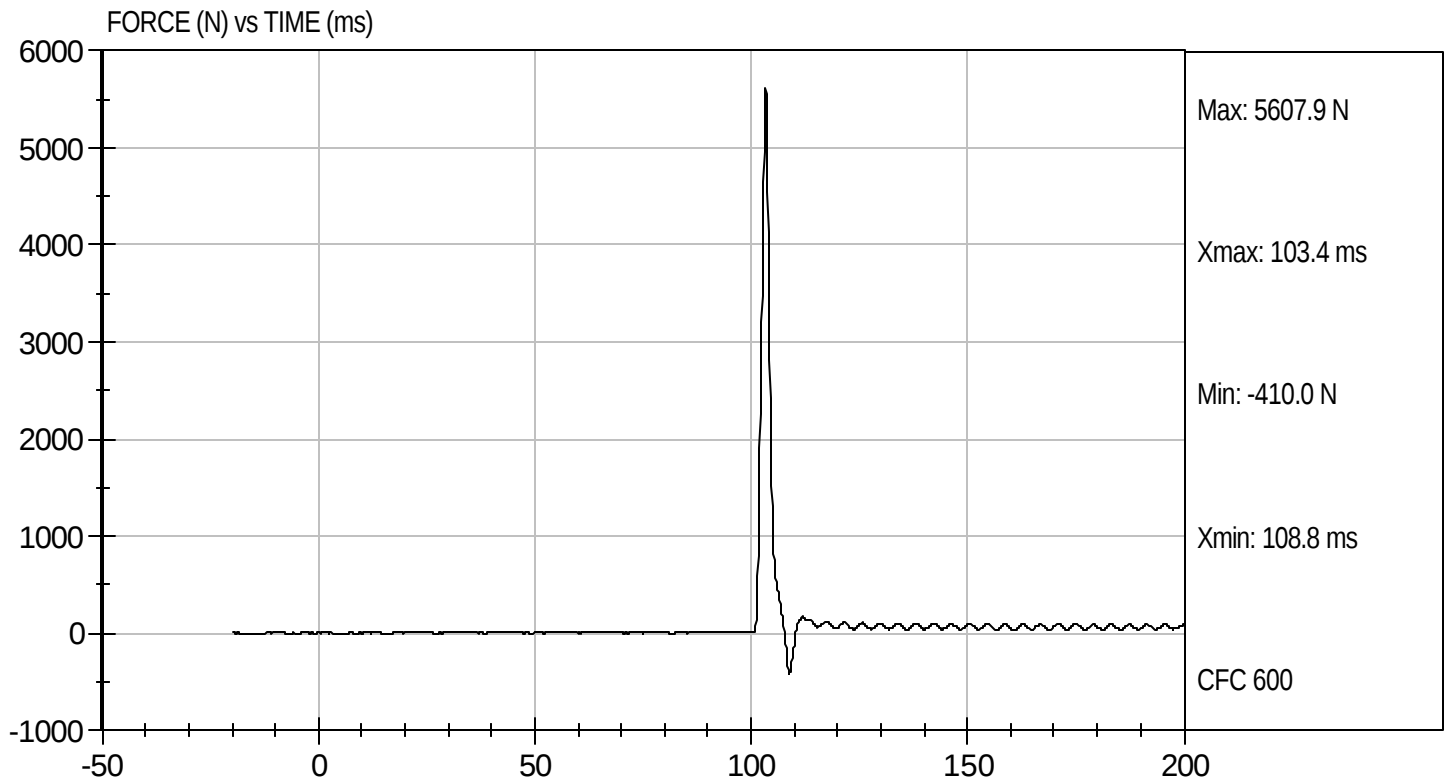
  
Approved By

9/11/07  
Test Date



Test Desc: Left Knee  
Component ID: D072846

Test Date: 9/11/07  
Velocity: 6.89 ft/s, 2.10 m/s



**MGA RESEARCH CORPORATION**  
**HIP-FEMUR FLEXION TEST**  
**HYBRID III 50TH PERCENTILE MALE**

**ATD Serial No:** 065

**Test I.D:** D072840

| Tested Parameter             | Units   | Specification                 | Result |      | Pass/Fail |
|------------------------------|---------|-------------------------------|--------|------|-----------|
|                              |         |                               | Right  | Left |           |
| Laboratory Temperature       | deg C   | 18.9 to 25.6                  | 20.8   | 20.8 | Pass      |
| Laboratory Relative Humidity | %       | 10 to 70                      | 43     | 43   | Pass      |
| Rotation Rate                | deg/sec | 5 -10                         | 8      | 8    | Pass      |
| 30 Degrees                   | Nm      | 94.9 Nm Max                   | 65.5   | 59.3 | Pass      |
| 150 ft-lbf / 203.4 Nm        | Deg     | 40- 50 Degree<br>Max Rotation | 42     | 42   | Pass      |
| Overall Test Results         |         |                               |        |      | Pass      |

  
 Laboratory Technician

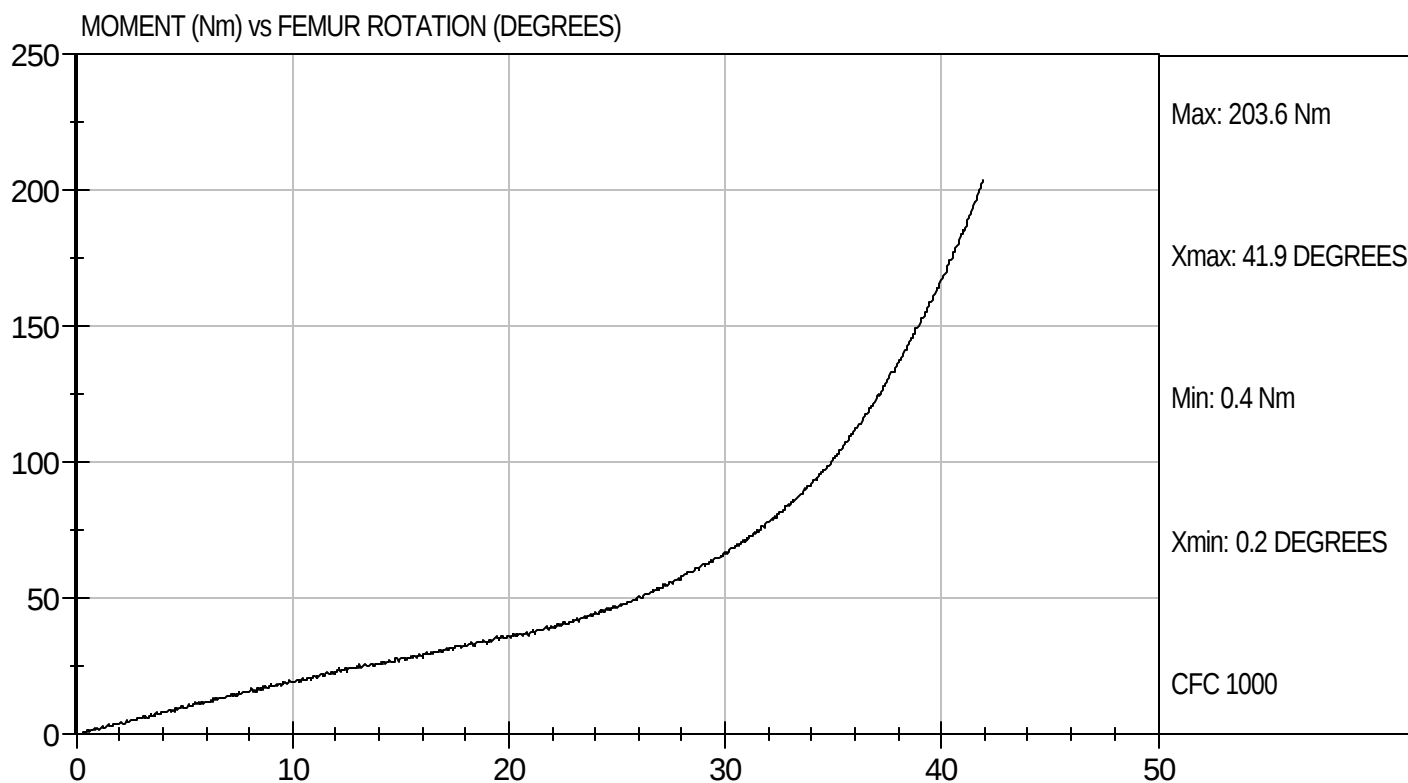
9/11/07  
 Test Date

  
 Approved By



Test Desc: Hip Femur Flexion  
Component ID: D072849

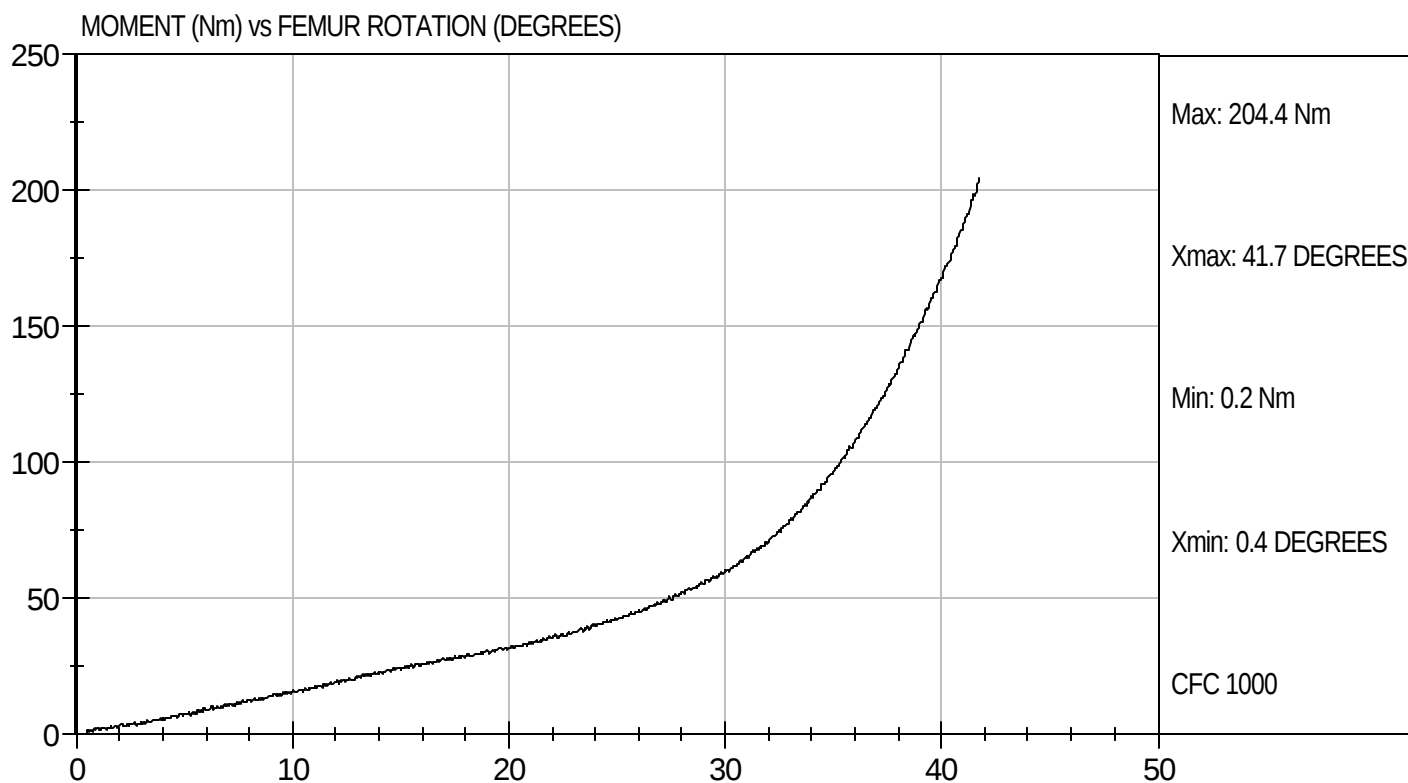
Test Date: 9/11/07  
Velocity: 0 ft/s, 0.00 m/s





Test Desc: Hip Femur Flexion  
Component ID: D072840

Test Date: 9/11/07  
Velocity: 0 ft/s, 0.00 m/s



**APPENDIX D**  
**CHILD DUMMY DATA**

## SUMMARY OF TEST

| Measurement Description         | Units | Threshold | P3 ATD | P4 ATD |
|---------------------------------|-------|-----------|--------|--------|
| Head Injury Criteria (HIC36)    | N/A   | N/A       | 1182   | 1276   |
| Head Injury Criteria (HIC15)    | N/A   | 390       | 596    | 903    |
| Max. Thorax Accel. (3msec Clip) | G's   | 50        | 63     | 59     |

Both child dummies were instrumented with head, chest, and upper six axial neck force and moment sensors.

The right rear (Position 3) child dummy (S/N 093) and left rear (Position 4) child dummy (S/N 090) were calibrated previous to this test. Child dummy certification information can be found in this Appendix.

Positions 3 and 4 were rear facing and used the vehicle LATCH attachment.

## TEST VEHICLE WEIGHTS

|        | Units | As Tested (ATW) (Axle) |       |        |
|--------|-------|------------------------|-------|--------|
|        |       | Front                  | Rear  | Total  |
| Left   | kg    | 590.6                  | 506.2 |        |
| Right  | kg    | 572.9                  | 484.0 |        |
| Ratio  | %     | 54.0                   | 46.0  |        |
| Totals | kg    | 1163.5                 | 990.2 | 2153.7 |

As tested weight of vehicle includes two ATDs, two CRABIs with CRS, cargo, equipment and instrumentation.

## TEST NOTES

None.

**TEST DUMMY INFORMATION**

| Description             | Position 3 CRS                  | Position 4 CRS                            |
|-------------------------|---------------------------------|-------------------------------------------|
| Dummy Type / Serial No. | 12 month old CRABI / 093        | 12 month old CRABI / 090                  |
| Number of Data Channels | 12                              | 12                                        |
| Restraint System        | Graco Snugride<br>(Rear Facing) | Peg Perego Primo Viaggio<br>(Rear Facing) |

**POST TEST SEAT DATA**

| Location         | Seat Movement (mm) | Seat Back Failure |
|------------------|--------------------|-------------------|
| P1 (Left Front)  | 0                  | None              |
| P2 (Right Front) | 0                  | None              |
| P3 (Right Rear)  | 0                  | None              |
| P4 (Left Rear)   | 0                  | None              |

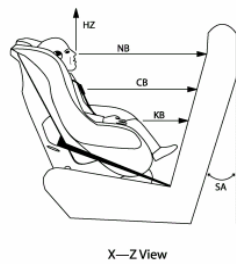
**VISIBLE DUMMY CONTACT POINTS**

| Description         | Position 3 CRS            | Position 4 CRS            |
|---------------------|---------------------------|---------------------------|
| Head Contact        | Back of head to CRS       | Back of head to CRS       |
| Upper Torso Contact | None                      | None                      |
| Lower Torso Contact | None                      | None                      |
| Left Foot Contact   | Foot to vehicle rear seat | Foot to vehicle rear seat |
| Right Foot Contact  | Foot to vehicle rear seat | Foot to vehicle rear seat |

## CHILD DUMMY POSITIONING IN VEHICLE

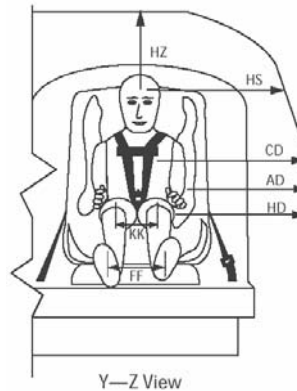
|                                     |                              |
|-------------------------------------|------------------------------|
| Child Restraint System (Position 3) | Graco Snugride (Rear Facing) |
| NHTSA No.                           | M85110                       |

Dummy Measurements for Rear-facing CRS Passengers



X—Z View

|    |   |                             |
|----|---|-----------------------------|
| HZ | - | Head to Roof                |
| NB | - | Nose to Front of Back Seat  |
| CB | - | Chest to Front of Back Seat |
| KB | - | Knee to Front of Back Seat  |
| SA | - | Seat Back Angle             |



Y—Z View

X—Z View

|    |   |                          |
|----|---|--------------------------|
| HZ | - | Head to Roof             |
| HS | - | Head to Side Window      |
| CD | - | Chest to Door            |
| AD | - | Arm to Door              |
| HD | - | H-Point to Door          |
| KK | - | Knee to Knee             |
| FF | - | Foot to Foot             |
| NB | - | Nose to Front Seat Back  |
| CB | - | Chest to Front Seat Back |
| KB | - | Knee to Front Seat Back  |
| TB | - | Toe to Front Seat Back   |
| SA | - | Seat Back Angle          |

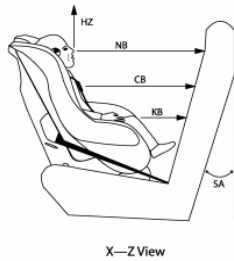
| Measurement | Pre-Test (mm) | Post-Test (mm) |
|-------------|---------------|----------------|
|             | P3 CRS (093)  | P3 CRS (093)   |
| SA (deg)    | 8.5           | 5.0            |
| HS          | 395           | 374            |
| CD          | 397           | 376            |
| AD          | 275           | 262            |
| HD          | 330           | 291            |
| HZ          | 456           | 402            |
| NB          | 614           | 541            |
| CB          | 481           | 458            |
| KK          | 110           | 98             |
| FF          | 105           | 86             |
| KB - LEFT   | 225           | 235            |
| KB - RIGHT  | 225           | 240            |
| TB - LEFT   | 103           | 113            |
| TB - RIGHT  | 100           | 132            |

All dimensions in mm (unless noted)  
P3 – Right Rear Passenger (Rear Facing)

## CHILD DUMMY POSITIONING IN VEHICLE

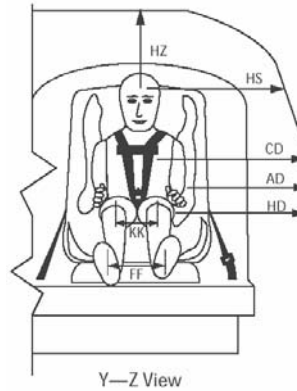
|                                     |                                        |
|-------------------------------------|----------------------------------------|
| Child Restraint System (Position 4) | Peg Perego Primo Viaggio (Rear Facing) |
| NHTSA No.                           | M85110                                 |

Dummy Measurements for Rear-facing CRS Passengers



X—Z View

|    |   |                             |
|----|---|-----------------------------|
| HZ | - | Head to Roof                |
| NB | - | Nose to Front of Back Seat  |
| CB | - | Chest to Front of Back Seat |
| KB | - | Knee to Front of Back Seat  |
| SA | - | Seat Back Angle             |



Y—Z View

X—Z View

|    |   |                          |
|----|---|--------------------------|
| HZ | - | Head to Roof             |
| HS | - | Head to Side Window      |
| CD | - | Chest to Door            |
| AD | - | Arm to Door              |
| HD | - | H-Point to Door          |
| KK | - | Knee to Knee             |
| FF | - | Foot to Foot             |
| NB | - | Nose to Front Seat Back  |
| CB | - | Chest to Front Seat Back |
| KB | - | Knee to Front Seat Back  |
| TB | - | Toe to Front Seat Back   |
| SA | - | Seat Back Angle          |

| Measurement | Pre-Test (mm) | Post-Test (mm) |
|-------------|---------------|----------------|
|             | P4 CRS (090)  | P4 CRS (090)   |
| SA (deg)    | 9.9           | 7.3            |
| HS          | 380           | 415            |
| CD          | 375           | 340            |
| AD          | 250           | 251            |
| HD          | 312           | 270            |
| HZ          | 451           | 408            |
| NB          | 491           | 212            |
| CB          | 398           | 244            |
| KK          | 101           | 128            |
| FF          | 96            | 106            |
| KB - LEFT   | 178           | 159            |
| KB - RIGHT  | 180           | 115            |
| TB - LEFT   | 35            | 0              |
| TB - RIGHT  | 36            | 0              |

All dimensions in mm (unless noted)  
P4 – Left Rear Passenger (Rear facing)

### CRS PERFORMANCE DATA

|                                     |                                        |
|-------------------------------------|----------------------------------------|
| Child Restraint System (Position 3) | Graco Snugride (Rear Facing)           |
| Child Restraint System (Position 4) | Peg Perego Primo Viaggio (Rear Facing) |
| NHTSA No.                           | M85110                                 |

#### POSITION 3 CRS POST-TEST INSPECTION

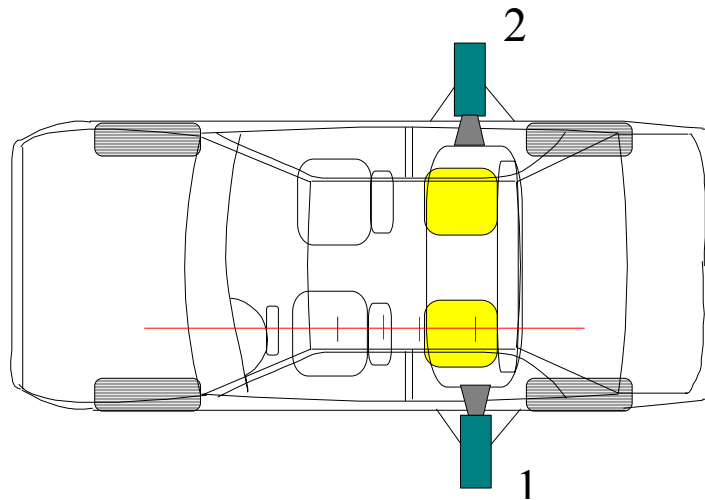
| Location                       | Damage | Remarks            |
|--------------------------------|--------|--------------------|
| Upper Tether Strap             |        |                    |
| Upper Tether Buckle            |        |                    |
| Upper Tether Hook              |        |                    |
| Vehicle Upper Tether Anchor    |        |                    |
| Lower Anchor Strap             | None   |                    |
| Lower Anchor Buckle            |        |                    |
| Lower Anchor Hooks             | None   |                    |
| Vehicle Lower CRS Anchors      | None   |                    |
| Five Point Harness Connections | None   |                    |
| Cracks on CRS                  | None   |                    |
| Fabric Tears on CRS            | None   |                    |
| Vehicle Seat Structure         | None   |                    |
| Vehicle Seat Fabric Tears      | None   |                    |
| Child Dummy                    | None   | CRABI 12 Month Old |

#### POSITION 4 CRS POST-TEST INSPECTION

| Location                       | Damage | Remarks            |
|--------------------------------|--------|--------------------|
| Upper Tether Strap             |        |                    |
| Upper Tether Buckle            |        |                    |
| Upper Tether Hook              |        |                    |
| Vehicle Upper Tether Anchor    |        |                    |
| Lower Anchor Strap             | None   |                    |
| Lower Anchor Buckle            |        |                    |
| Lower Anchor Hooks             | None   |                    |
| Vehicle Lower CRS Anchors      | None   |                    |
| Five Point Harness Connections | None   |                    |
| Cracks on CRS                  | None   |                    |
| Fabric Tears on CRS            | None   |                    |
| Vehicle Seat Structure         | None   |                    |
| Vehicle Seat Fabric Tears      | None   |                    |
| Child Dummy                    | None   | CRABI 12 Month Old |

## CRS CAMERA DATA

|                                     |                                        |
|-------------------------------------|----------------------------------------|
| Child Restraint System (Position 3) | Graco Snugride (Rear Facing)           |
| Child Restraint System (Position 4) | Peg Perego Primo Viaggio (Rear Facing) |
| NHTSA No.                           | M85110                                 |



| No. | Camera View                 | Location (mm) * |   |   | Angle (deg) | Lens (mm) | Speed (fps) |
|-----|-----------------------------|-----------------|---|---|-------------|-----------|-------------|
|     |                             | X               | Y | Z |             |           |             |
| 1   | Left Side CRS Lateral View  |                 |   |   |             | 8         | 1000        |
| 2   | Right Side CRS Lateral View |                 |   |   |             | 8         | 1000        |

\*COORDINATES:

+X = film plane rearward of barrier

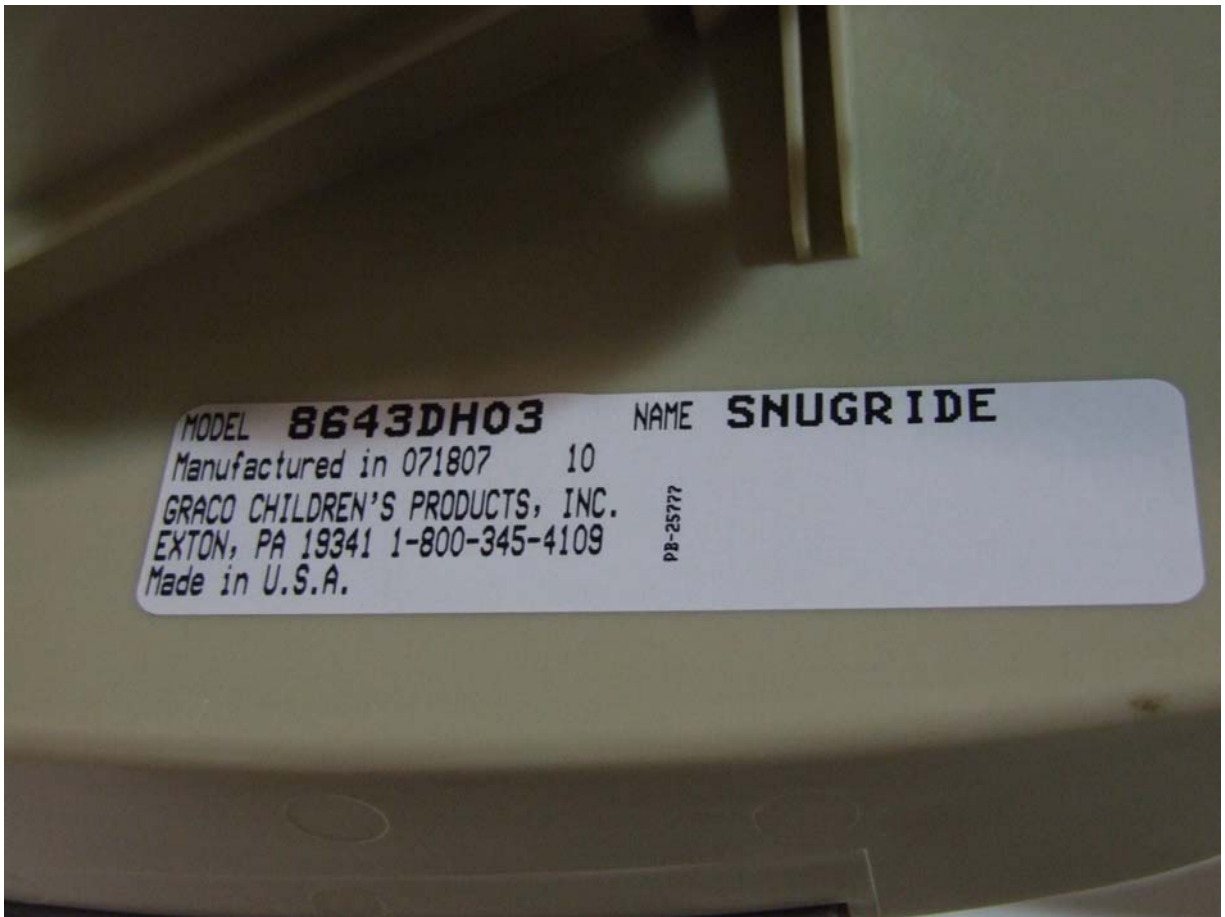
+Y = film plane to right of monorail centerline

+Z = film plane above ground level

## PHOTOGRAPHS

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| Figure No. 27. | Post-Test Position 4 Feet Contact           | D-21            |



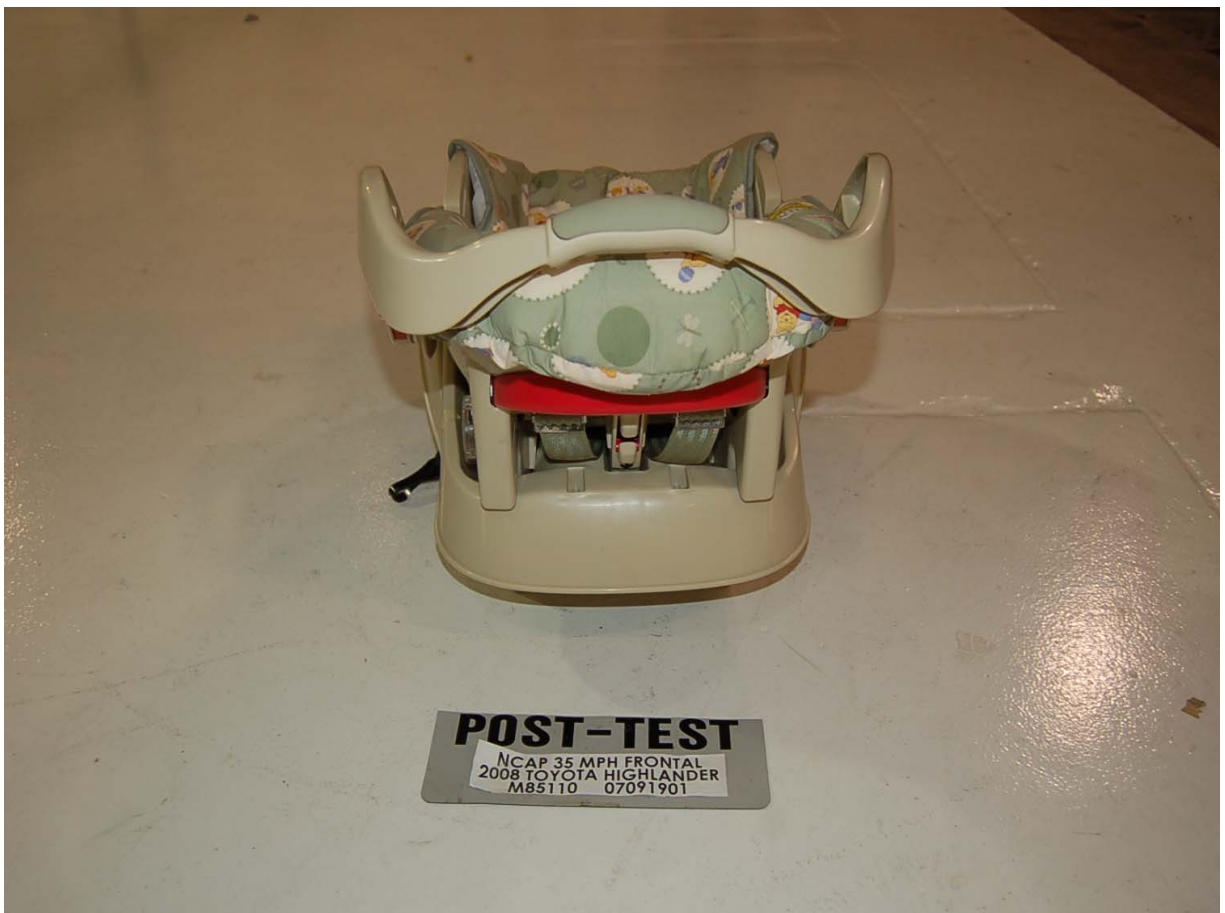
Close-up View of Position 3 CRS Label



Post-Test Front View of Position 3 CRS



Pre-Test Rear View of Position 3 CRS



Post-Test Rear View of Position 3 CRS



Pre-Test Left Side View of Position 3 CRS



Post-Test Left Side View of Position 3 CRS



Pre-Test Right Side View of Position 3 CRS



Post-Test Right Side View of Position 3 CRS



Close-up View of Position 4 CRS Label



Pre-Test Front View of Position 4 CRS



Post-Test Front View of Position 4 CRS



Pre-Test Rear View of Position 4 CRS



Post-Test Rear View of Position 4 CRS



Pre-Test Left Side View of Position 4 CRS



Post-Test Left Side View of Position 4 CRS



Pre-Test Right Side View of Position 4 CRS



Post-Test Right Side View of Position 4 CRS



Pre-Test Position 3 Left Side View



Post-Test Position 3 Left Side View



Pre-Test Position 4 Left Side View



Post-Test Position 4 Left Side View



Pre-Test Position 3 Right Side View



Post-Test Position 3 Right Side View



Pre-Test Position 4 Right Side View



Post-Test Position 4 Right Side View



Post-Test Position 4 Head Contact



Post-Test Position 4 Feet Contact

## CHILD DUMMY RESPONSE DATA TRACES

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**The following dummy response data can be found in the R&D section of the NHTSA website at [www.nhtsa.dot.gov](http://www.nhtsa.dot.gov)**

LRP Child Upper Neck Force X vs. Time

LRP Child Upper Neck Force Y vs. Time

LRP Child Upper Neck Force Z vs. Time

LRP Child Upper Neck Force Resultant vs. Time

LRP Child Upper Neck Moment X vs. Time

LRP Child Upper Neck Moment Y vs. Time

LRP Child Upper Neck Moment Z vs. Time

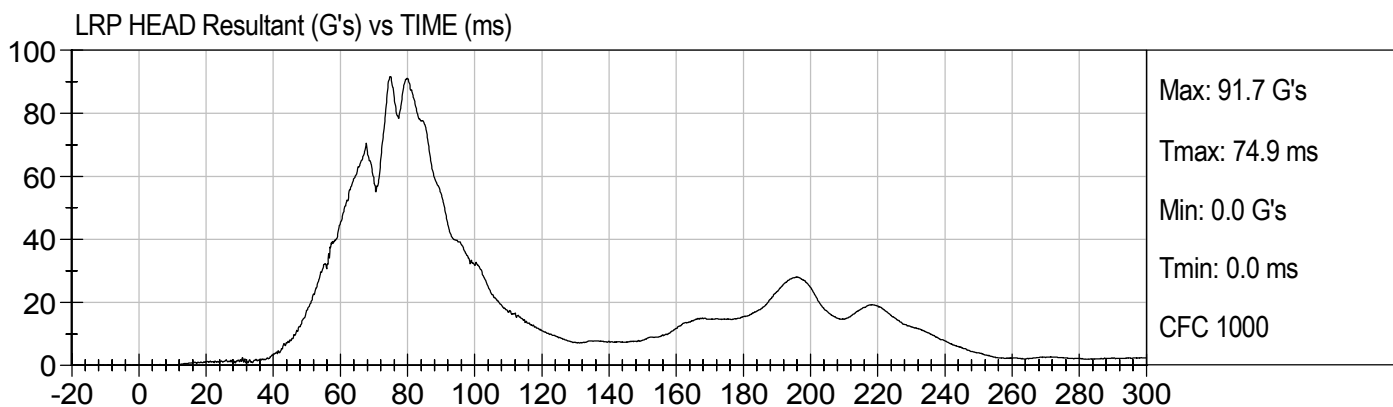
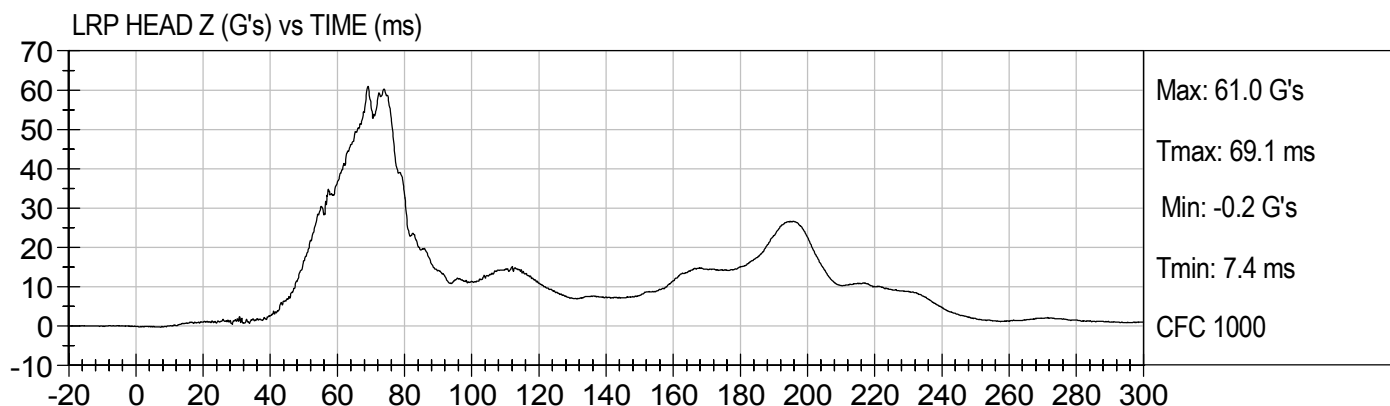
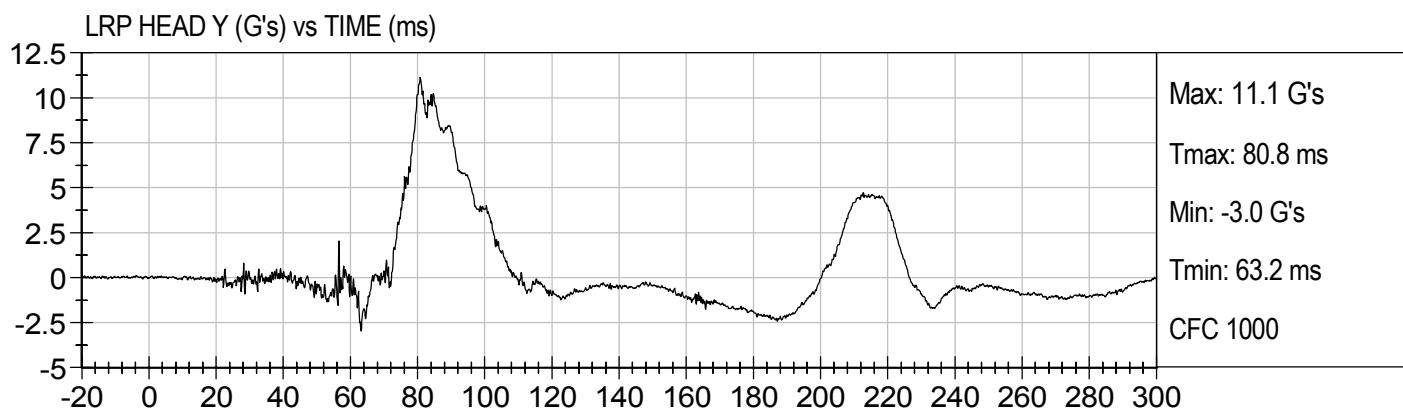
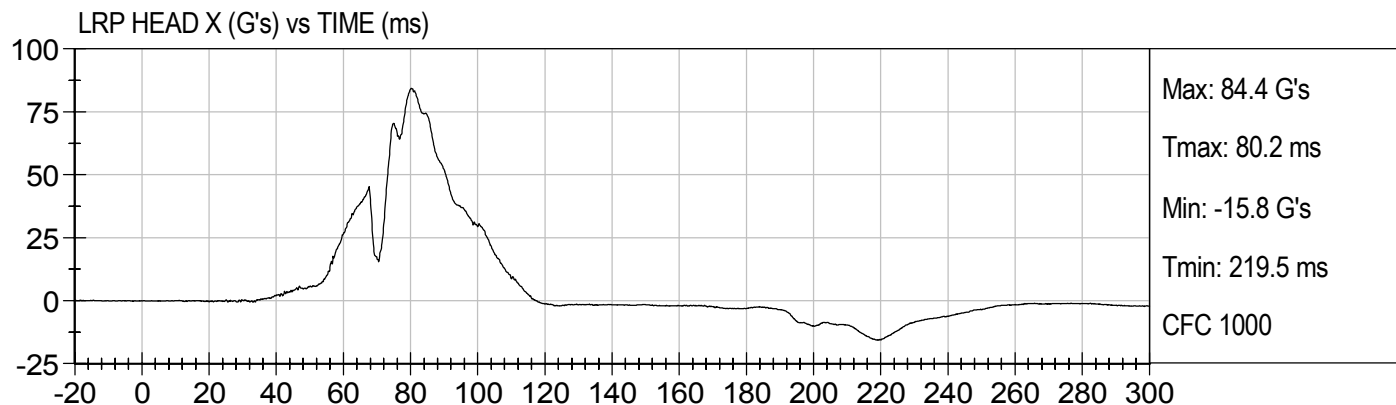
LRP Child Upper Neck Moment Resultant vs. Time

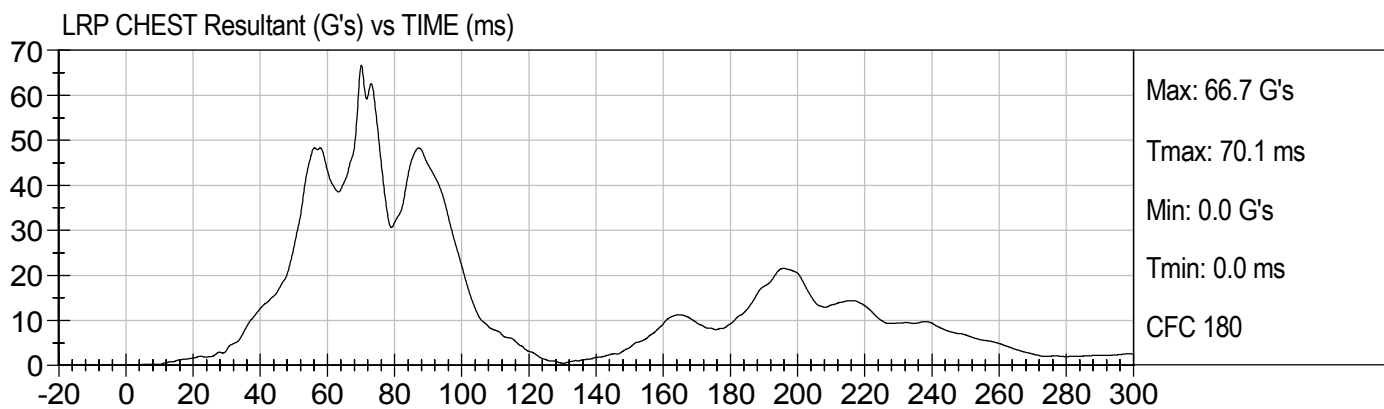
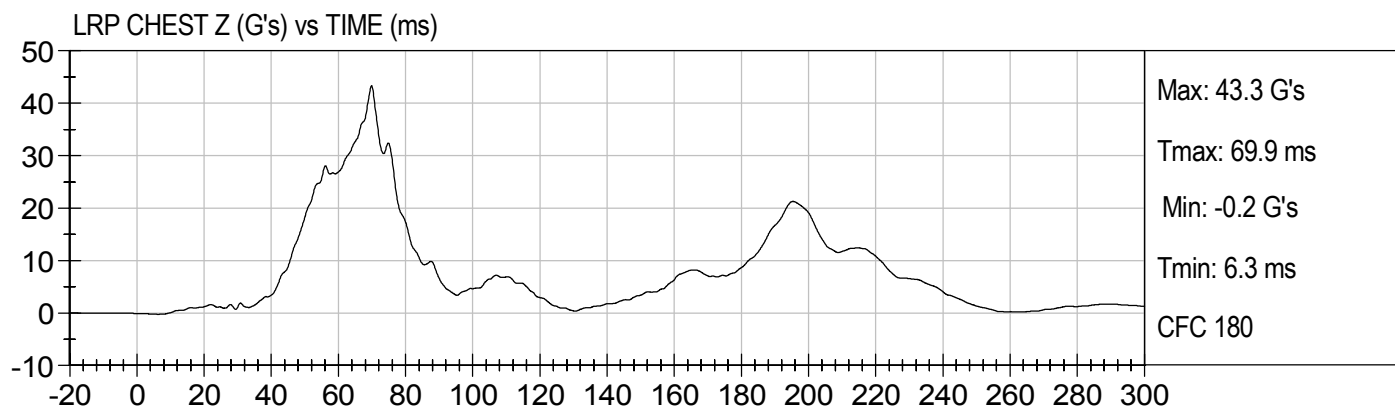
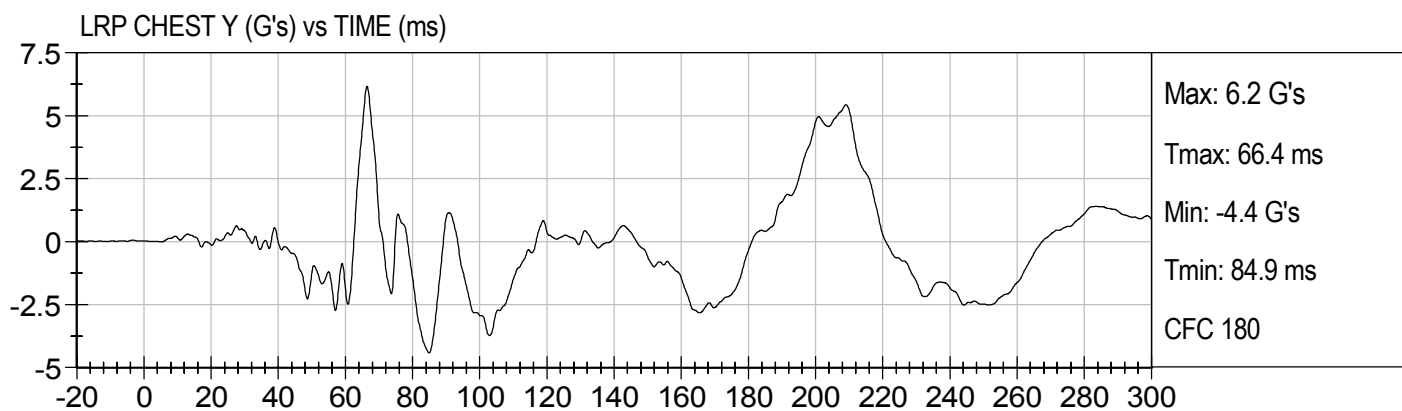
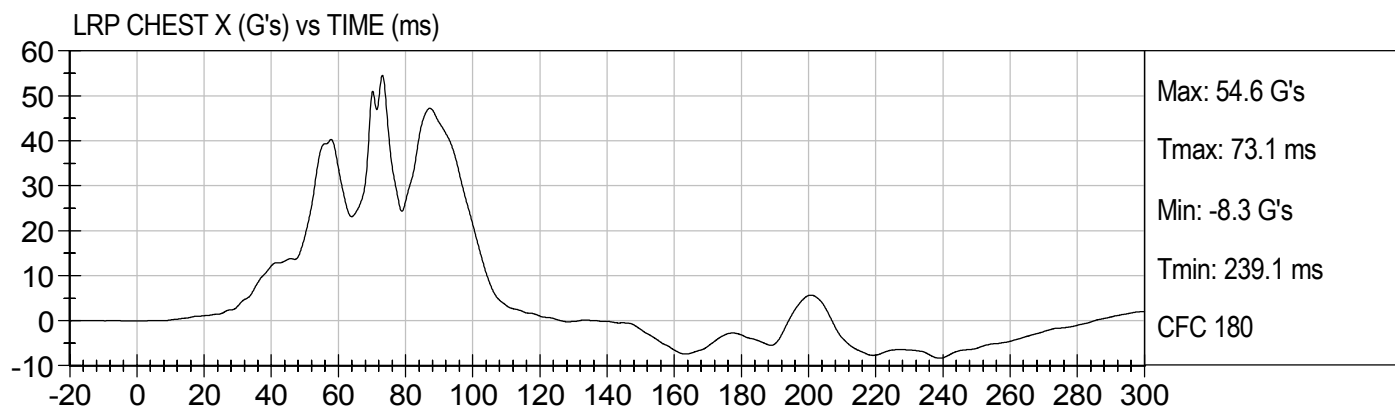
RRP Child Upper Neck Force X vs. Time  
RRP Child Upper Neck Force Y vs. Time  
RRP Child Upper Neck Force Z vs. Time  
RRP Child Upper Neck Force Resultant vs. Time  
RRP Child Upper Neck Moment X vs. Time  
RRP Child Upper Neck Moment Y vs. Time  
RRP Child Upper Neck Moment Z vs. Time  
RRP Child Upper Neck Moment Resultant vs. Time  
LRP Child Seat X Acceleration vs. Time  
LRP Child Seat Y Acceleration vs. Time  
LRP Child Seat Z Acceleration vs. Time  
LRP Child Seat Resultant Acceleration vs. Time  
RRP Child Seat X Acceleration vs. Time  
RRP Child Seat Y Acceleration vs. Time  
RRP Child Seat Z Acceleration vs. Time  
RRP Child Seat Resultant Acceleration vs. Time

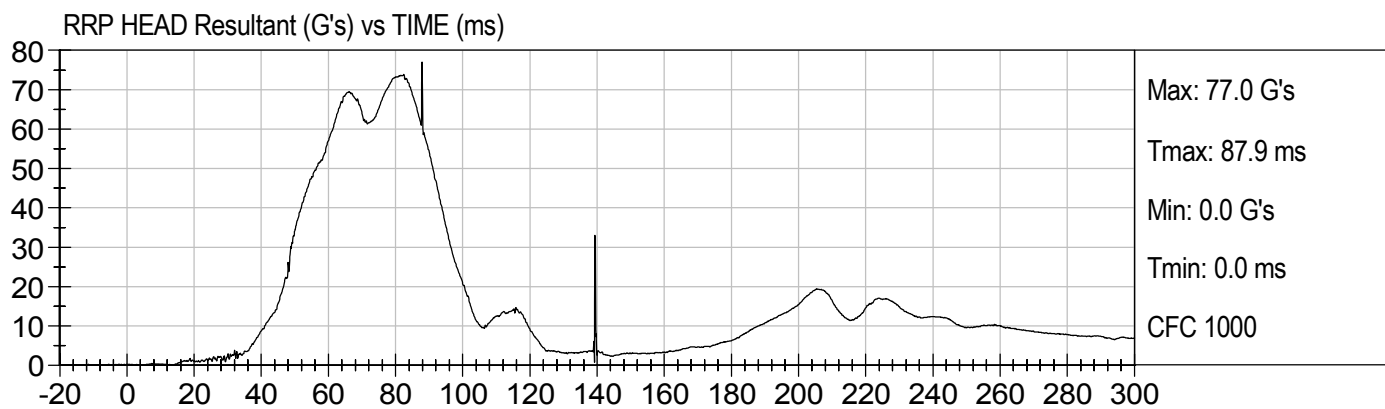
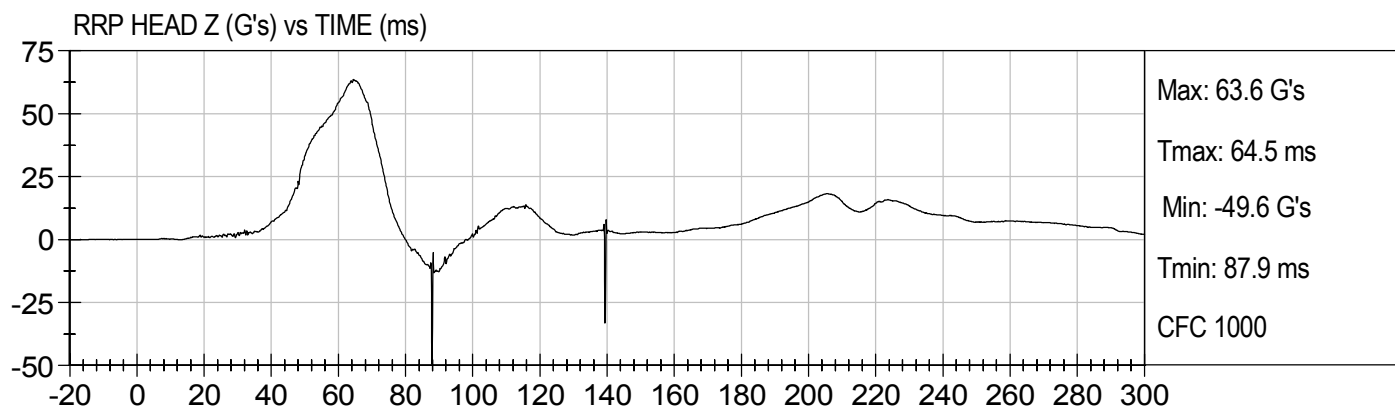
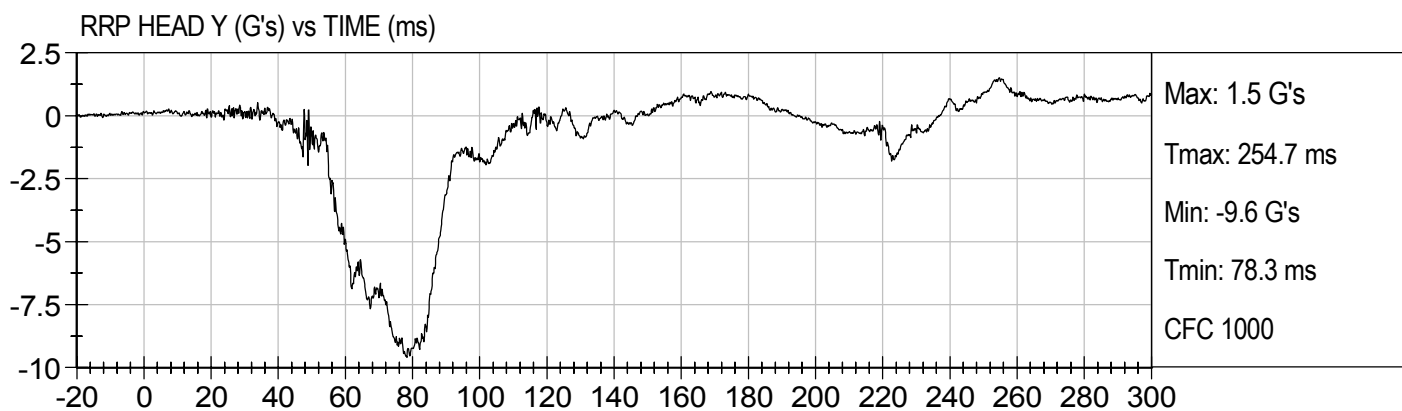
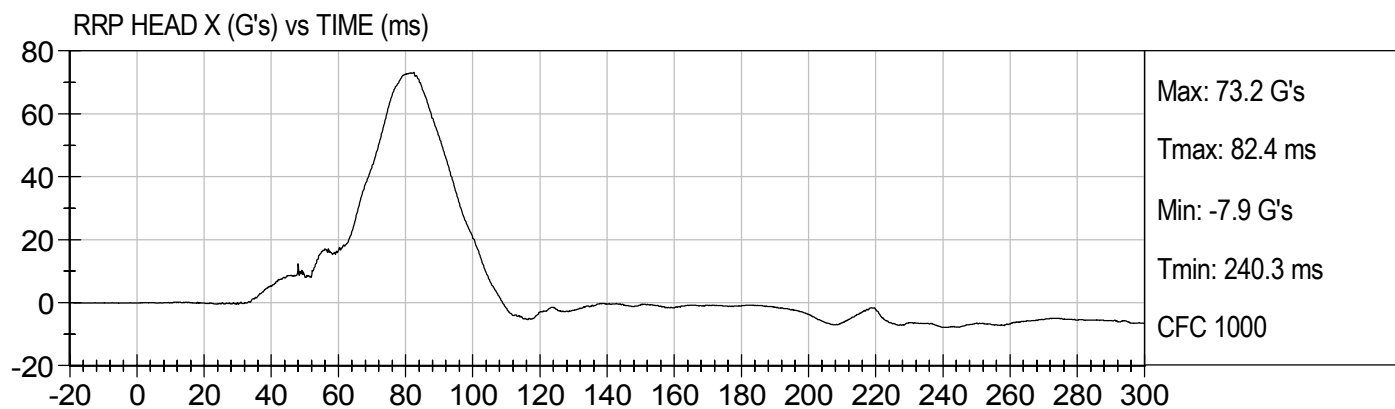


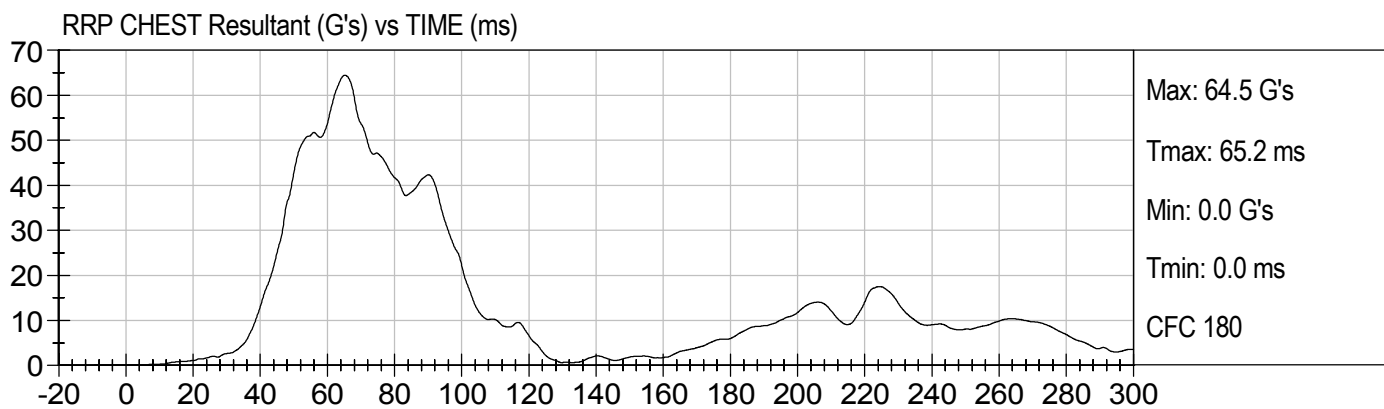
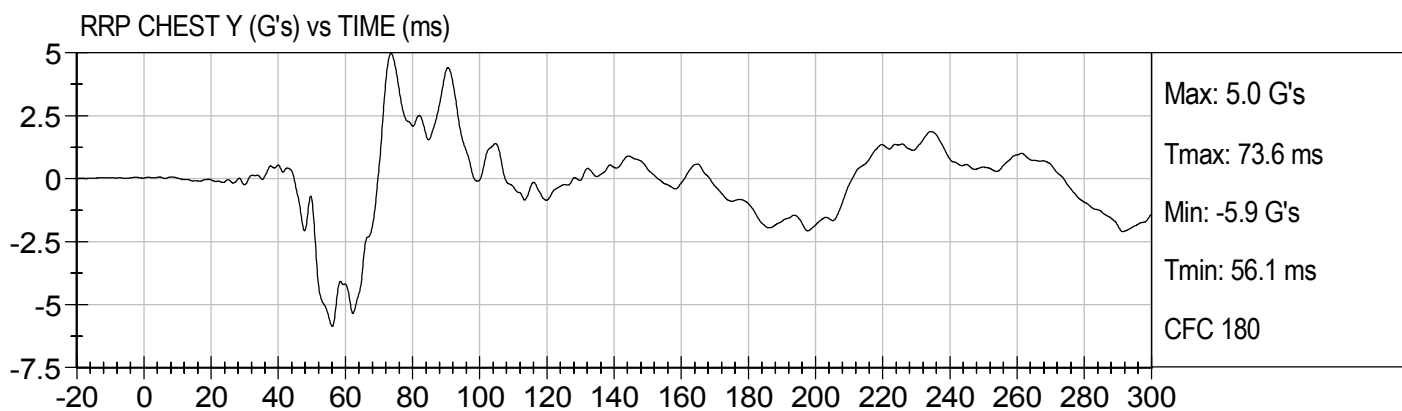
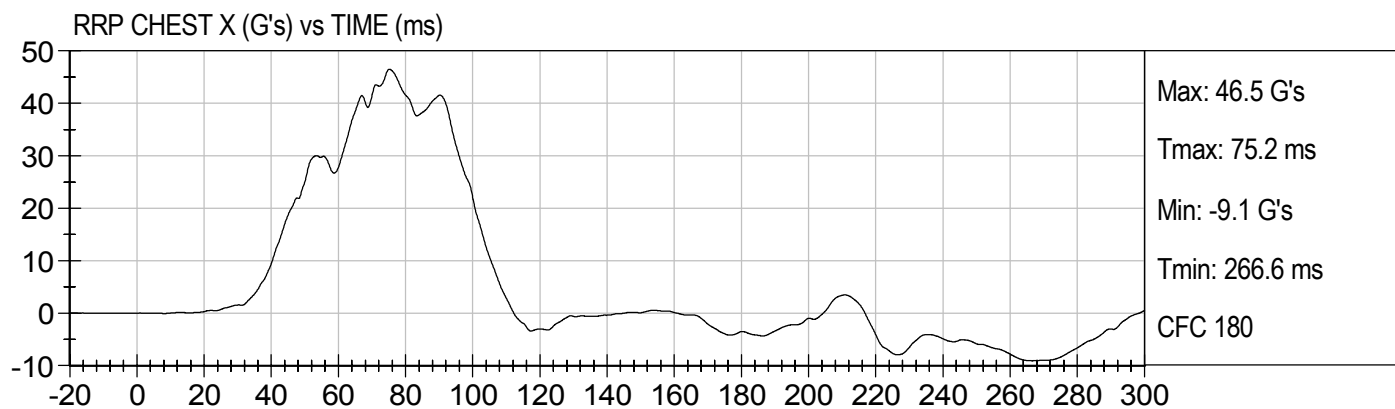
FRONTAL NCAP  
2008 TOYOTA HIGHLANDER  
M85110

Test Date: 09/19/2007  
Speed: 35.2 mph (56.6 km/h)









## CHILD DUMMY CALIBRATION INFORMATION

**MGA RESEARCH CORPORATION**  
**FRONT HEAD DROP TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 093

**Test ID:** D072541

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 to 25.6       | 20.8   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 47     | Pass      |
| Peak Resultant Acceleration  | G's   | 100 to 120         | 110    | Pass      |
| Peak Lateral Acceleration    | G's   | +/- 15             | -3     | Pass      |
| Unimodal                     | N/A   | within 17% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    |        | Pass      |

  
Laboratory Technician

  
Approved By

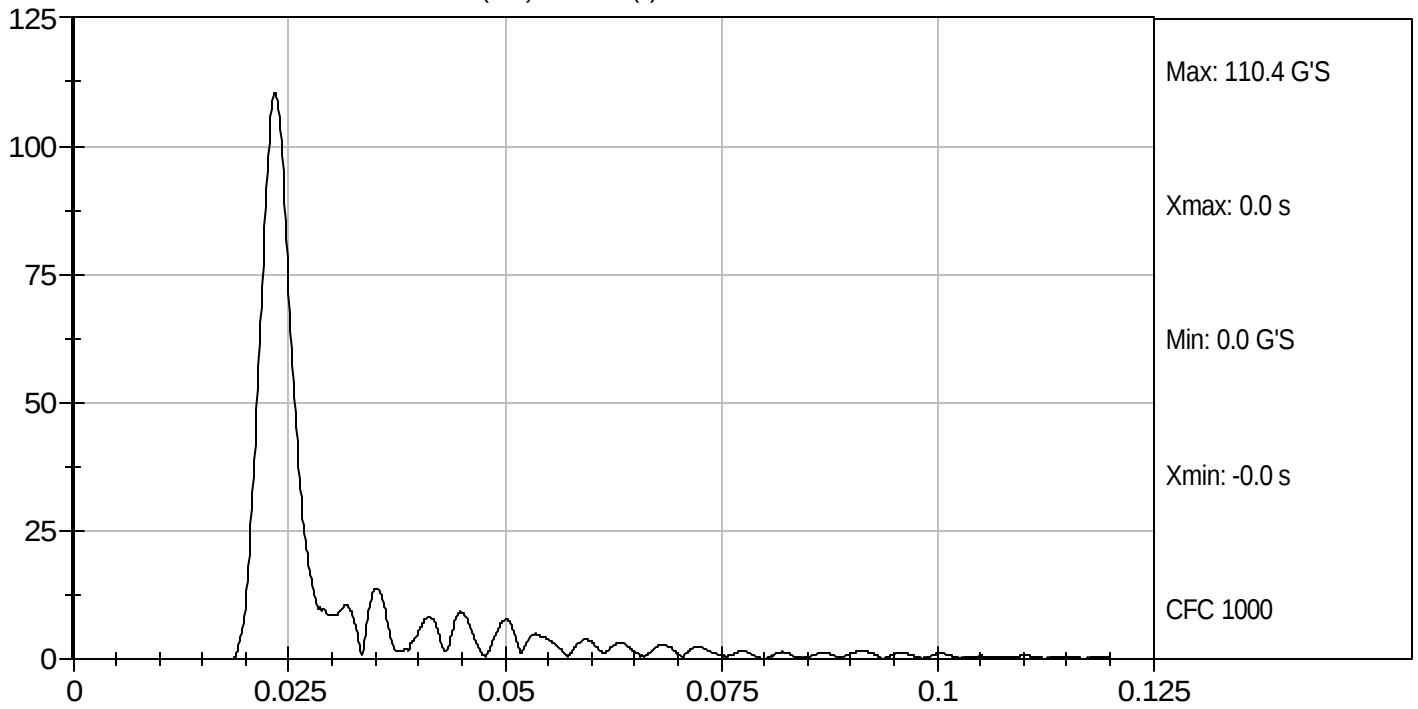
8/23/07  
Test Date



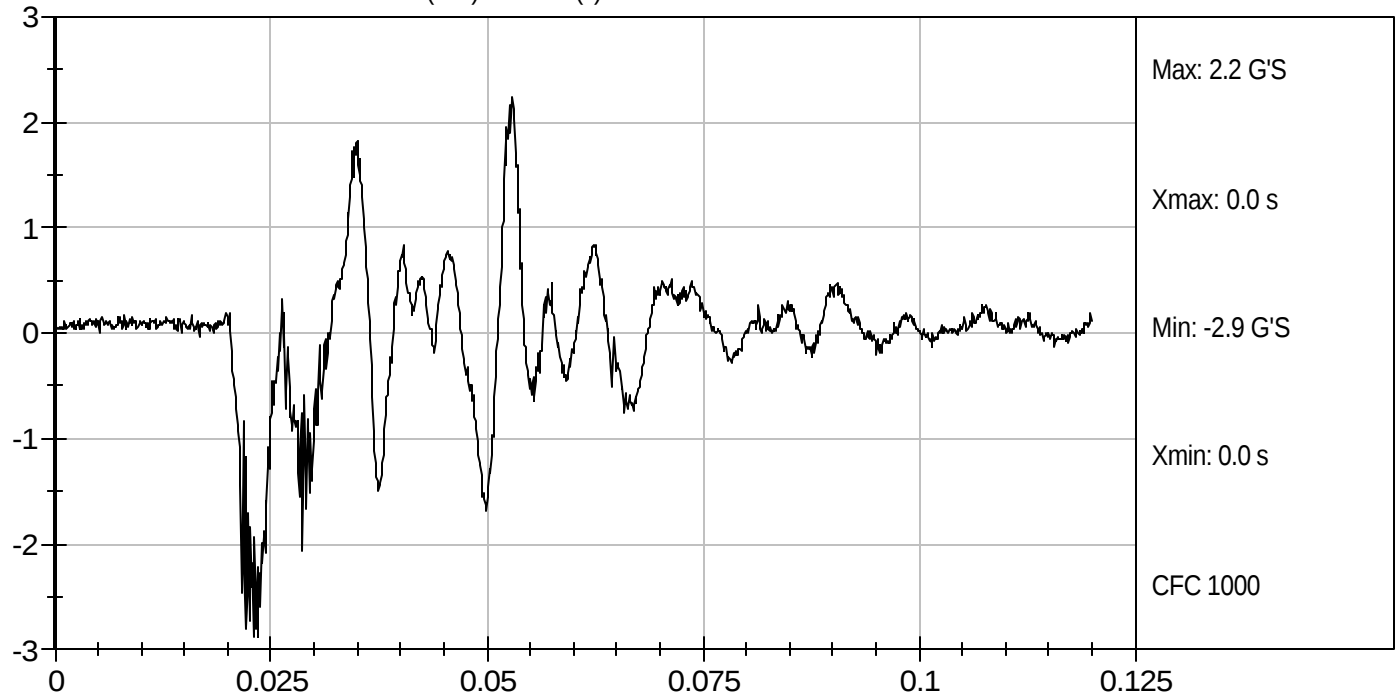
Test Desc: Head Drop  
Component ID: D072541

Test Date: 8/23/07  
Velocity: 0 ft/s, 0 m/s

PEAK RESULTANT ACCELERATION (G'S) vs TIME (s)



PEAK LATERAL ACCELERATION (G'S) vs TIME (s)



**MGA RESEARCH CORPORATION**  
**NECK FLEXION TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 093

**Test I.D:** D072542

| Tested Parameter                           |         | Units | Specification | Result | Pass/Fail |
|--------------------------------------------|---------|-------|---------------|--------|-----------|
| Temperature                                |         | deg C | 20.6 to 22.2  | 20.8   | Pass      |
| Humidity                                   |         | %     | 10 to 70      | 46     | Pass      |
| Impact Velocity                            |         | m/s   | 5.1 to 5.3    | 5.2    | Pass      |
| Pendulum Deceleration                      | 10 msec | m/s   | 1.6 to 2.3    | 1.9    | Pass      |
|                                            | 20 msec | m/s   | 3.4 to 4.2    | 3.6    | Pass      |
|                                            | 25 msec | m/s   | 4.3 to 5.2    | 4.4    | Pass      |
| D Plane Rotation                           |         | deg   | 75.0 to 86.0  | 83.1   | Pass      |
| Moment About Occipital Condyle             |         | Nm    | 36.0 to 45.0  | 40.2   | Pass      |
| Positive Moment - Time Curve Decay to 5 Nm |         | msec  | 60 to 80      | 74     | Pass      |
| Overall Test Results                       |         |       |               |        | Pass      |



Laboratory Technician

8/23/07

Test Date



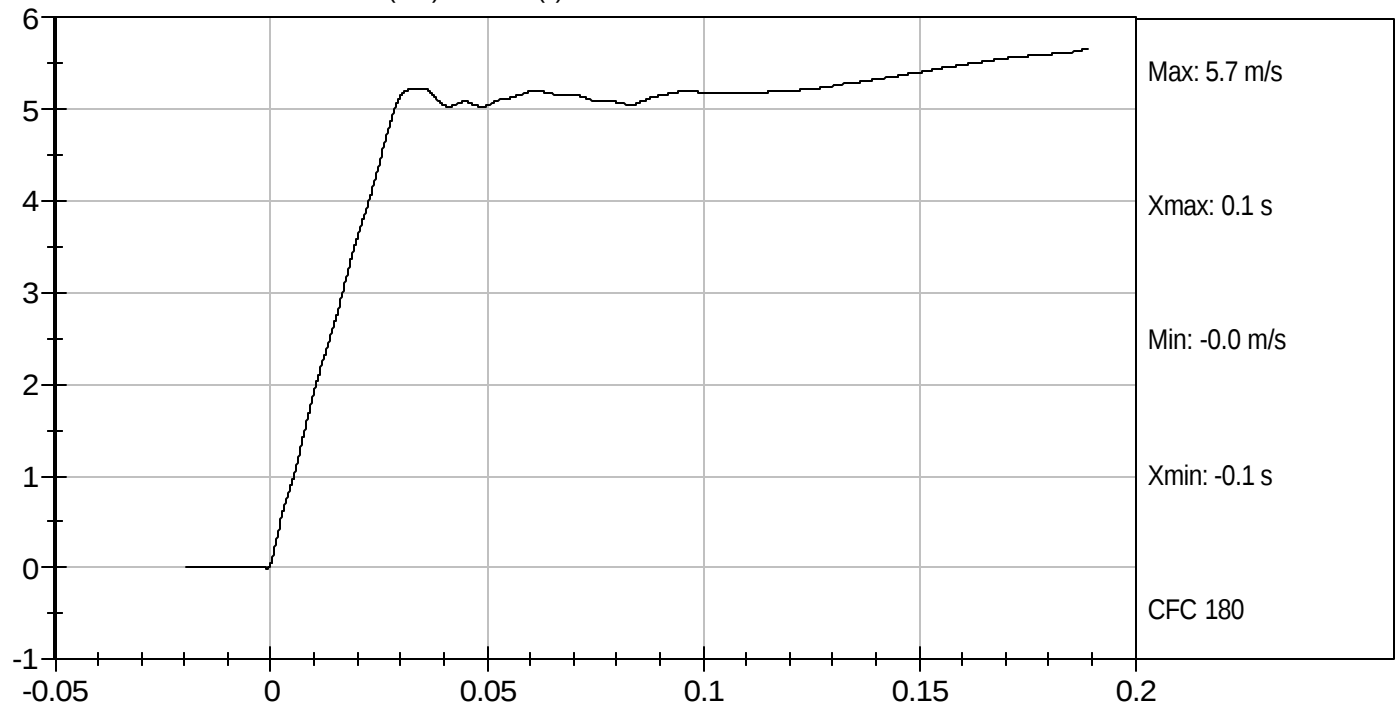
Approved By



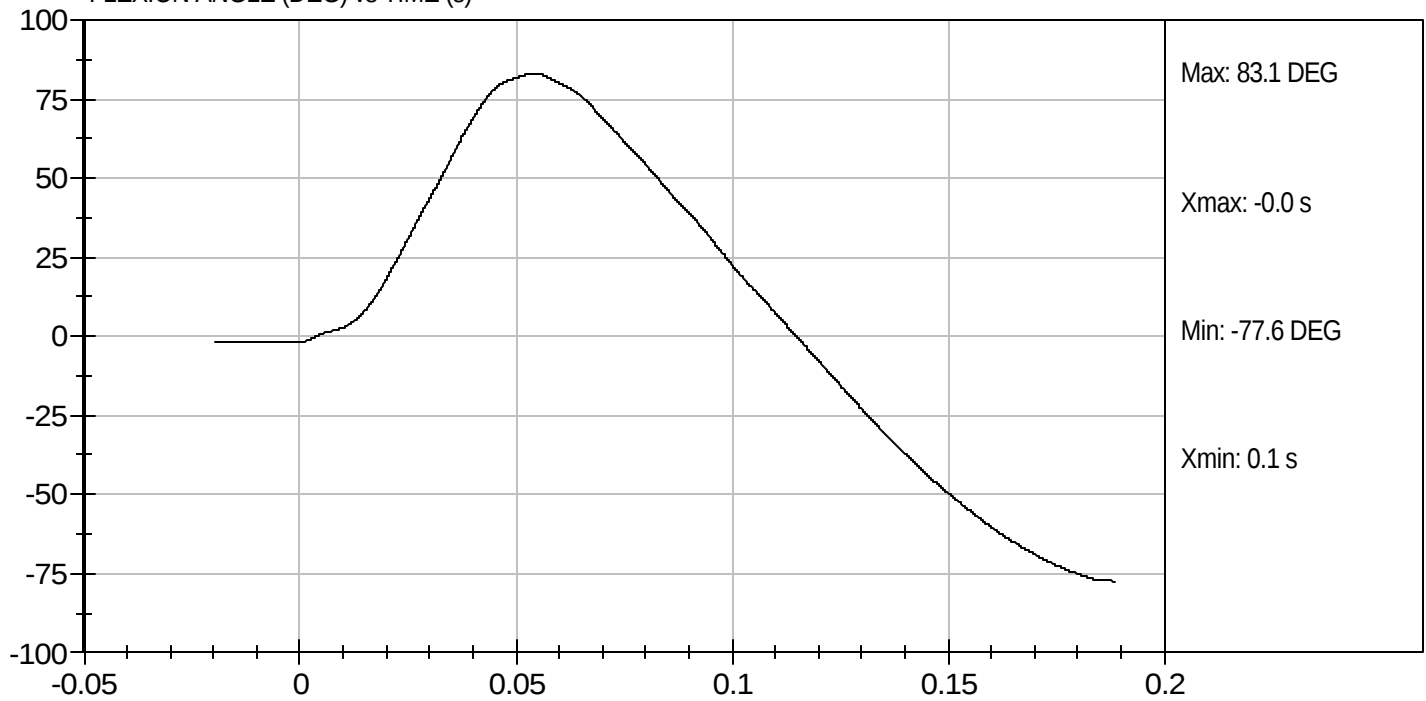
Test Desc: Neck Flexion  
Component ID: D072542

Test Date: 8/23/07  
Velocity: 17.006 ft/s, 5.2 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



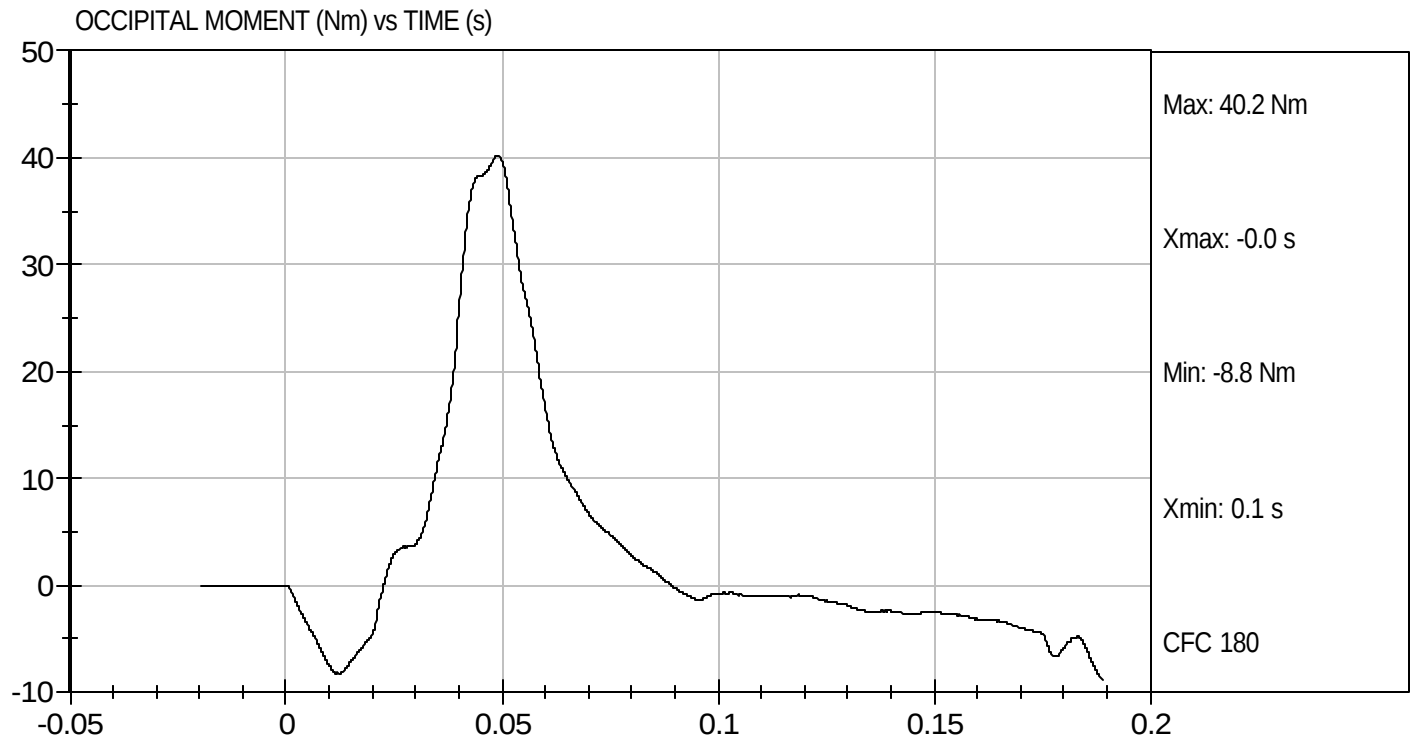
FLEXION ANGLE (DEG) vs TIME (s)





Test Desc: Neck Flexion  
Component ID: D072542

Test Date: 8/23/07  
Velocity: 17.006 ft/s, 5.2 m/s



**MGA RESEARCH CORPORATION**  
**NECK EXTENSION TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 093

**Test I.D:** D072543

| Tested Parameter                            |         | Units | Specification  | Result | Pass/Fail |
|---------------------------------------------|---------|-------|----------------|--------|-----------|
| Temperature                                 |         | deg C | 20.6 to 22.2   | 20.8   | Pass      |
| Humidity                                    |         | %     | 10 to 70       | 46     | Pass      |
| Pendulum Speed                              |         | m/s   | 2.4 to 2.6     | 2.5    | Pass      |
| Pendulum Deceleration                       | 6 msec  | m/s   | 0.8 to 1.2     | 1.0    | Pass      |
|                                             | 10 msec | m/s   | 1.5 to 2.1     | 2.0    | Pass      |
|                                             | 14 msec | m/s   | 2.2 to 2.9     | 2.3    | Pass      |
| D Plane Rotation                            |         | deg   | 80.0 to 92.0   | 80.3   | Pass      |
| Moment About Occipital Condyle              |         | Nm    | -23.0 to -12.0 | -19.1  | Pass      |
| Negative Moment - Time Curve Decay to -5 Nm |         | msec  | 76 to 90       | 77     | Pass      |
| Overall Test Results                        |         |       |                | Pass   |           |



Laboratory Technician

8/23/07

Test Date

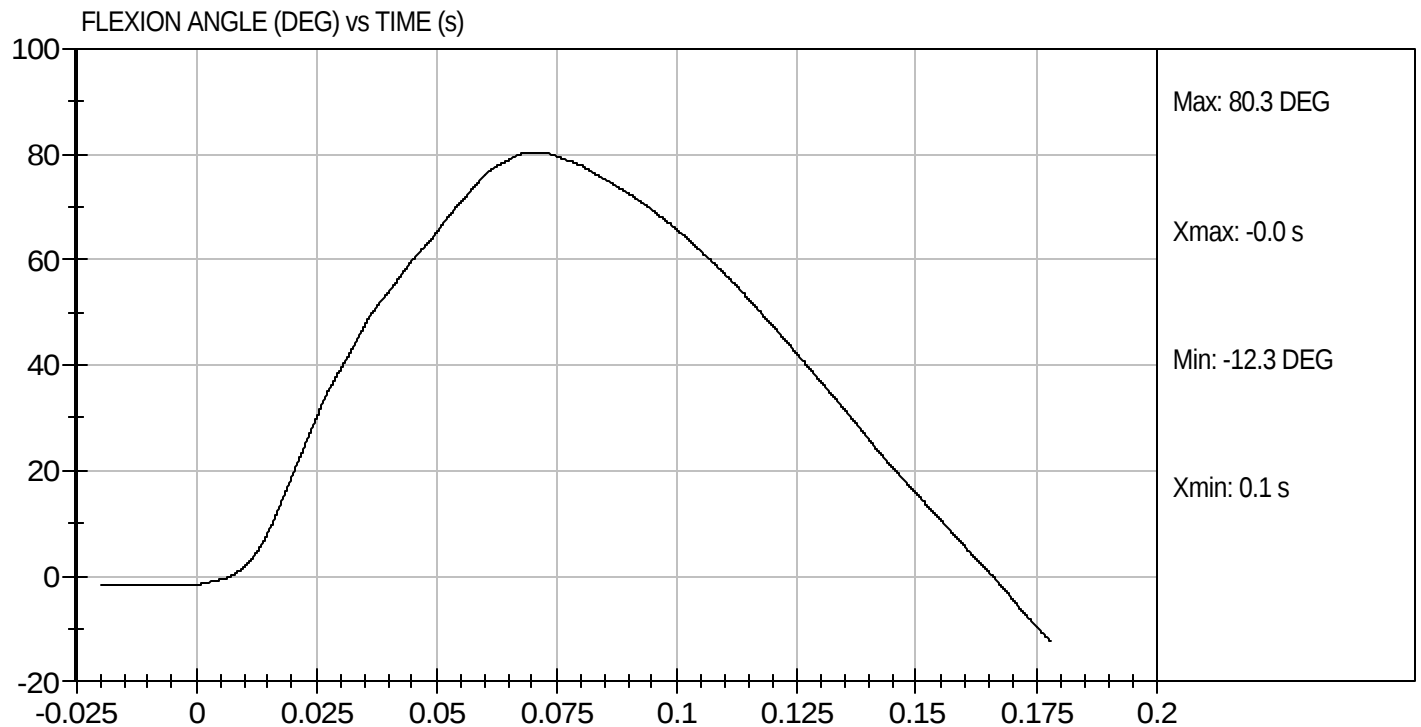
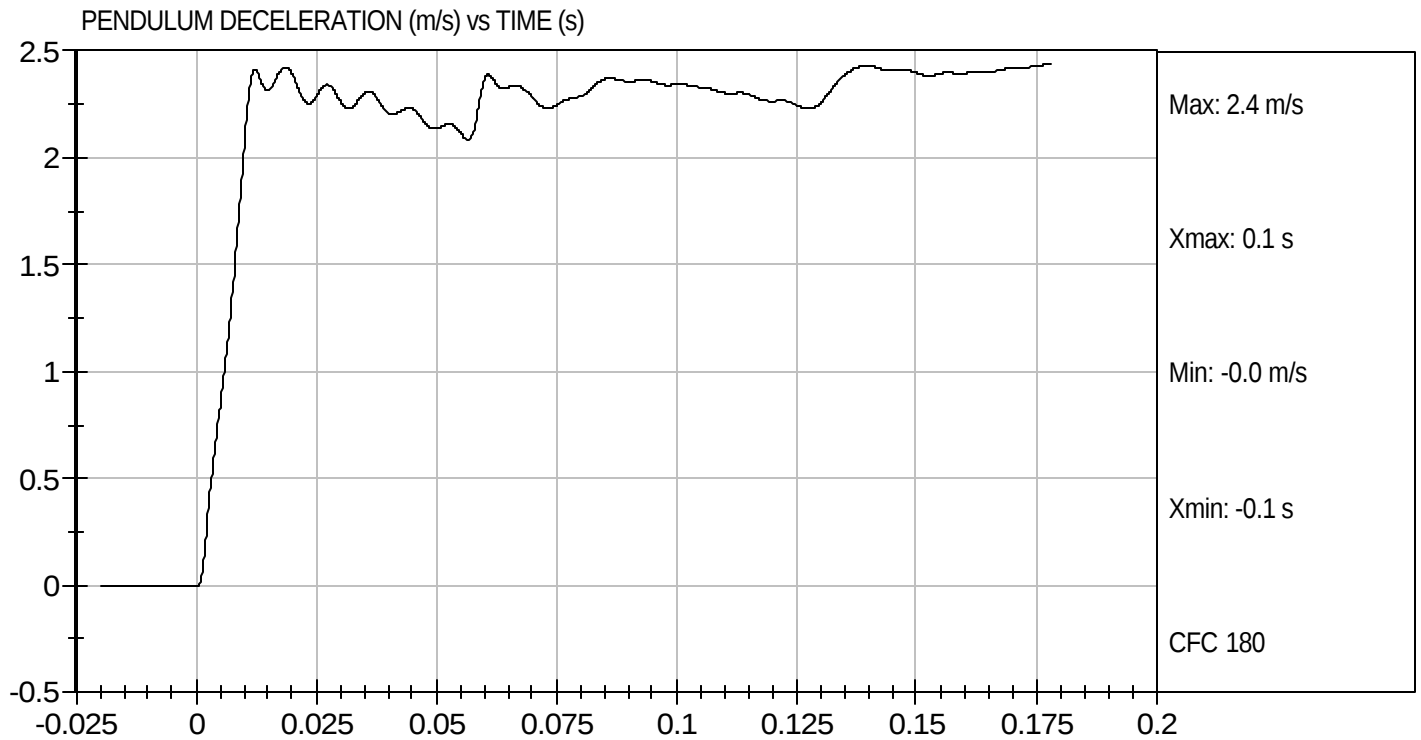


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Test Desc: Neck Extension  
Component ID: D072543

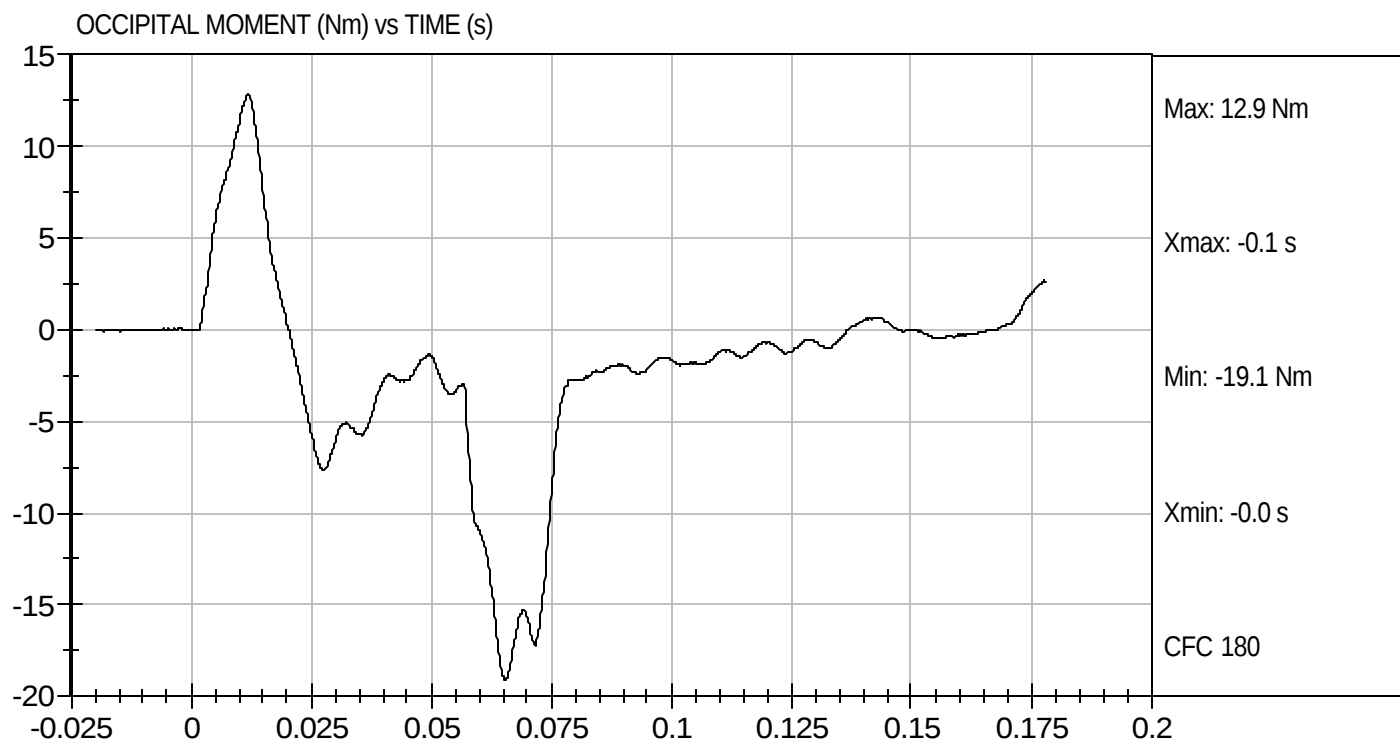
Test Date: 8/23/07  
Velocity: 8.33 ft/s, 2.5 m/s





Test Desc: Neck Extension  
Component ID: D072543

Test Date: 8/23/07  
Velocity: 8.33 ft/s, 2.5 m/s



**MGA RESEARCH CORPORATION**  
**THORAX IMPACT TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 093

**Test I.D:** D072544

| Tested Parameter             | Units | Specification | Result | Pass/Fail |
|------------------------------|-------|---------------|--------|-----------|
| Laboratory Temperature       | deg C | 20.6 to 22.2  | 20.6   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70      | 43     | Pass      |
| Probe Speed                  | m/sec | 4.9 to 5.1    | 5.03   | Pass      |
| Probe Force                  | kN    | 1.51 to 1.80  | 1.55   | Pass      |
| Overall Test Results         |       |               |        | Pass      |

  
Laboratory Technician

8/23/07

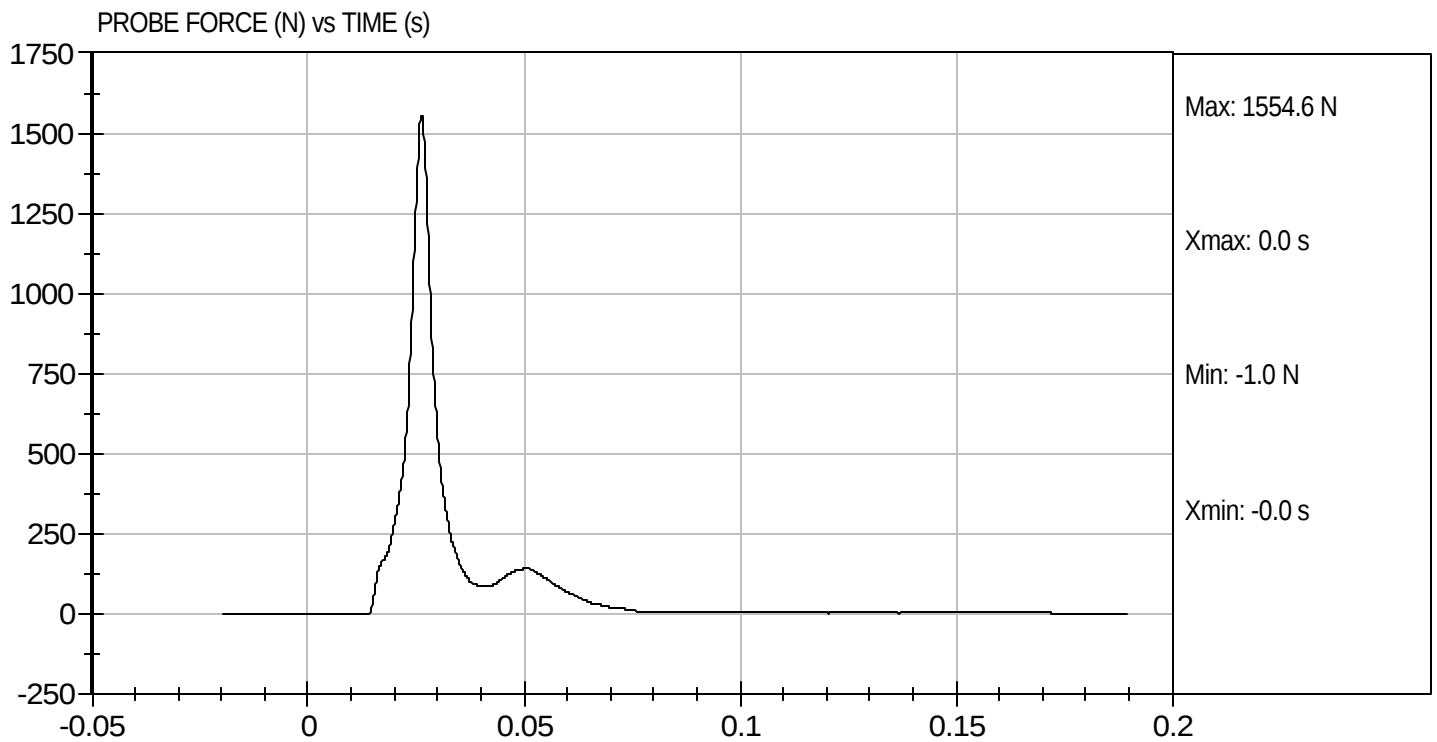
Test Date

  
Approved By



Test Desc: Thorax Impact  
Component ID: D072544

Test Date: 8/23/07  
Velocity: 16.5 ft/s, 5.03 m/s



**MGA RESEARCH CORPORATION**  
**REAR HEAD DROP TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 093

**Test ID:** D072545

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 to 25.6       | 20.8   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 47     | Pass      |
| Peak Resultant Acceleration  | G's   | 55 to 71           | 69     | Pass      |
| Peak Lateral Acceleration    | G's   | +/- 15             | 3      | Pass      |
| Unimodal                     | N/A   | within 17% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    |        | Pass      |

  
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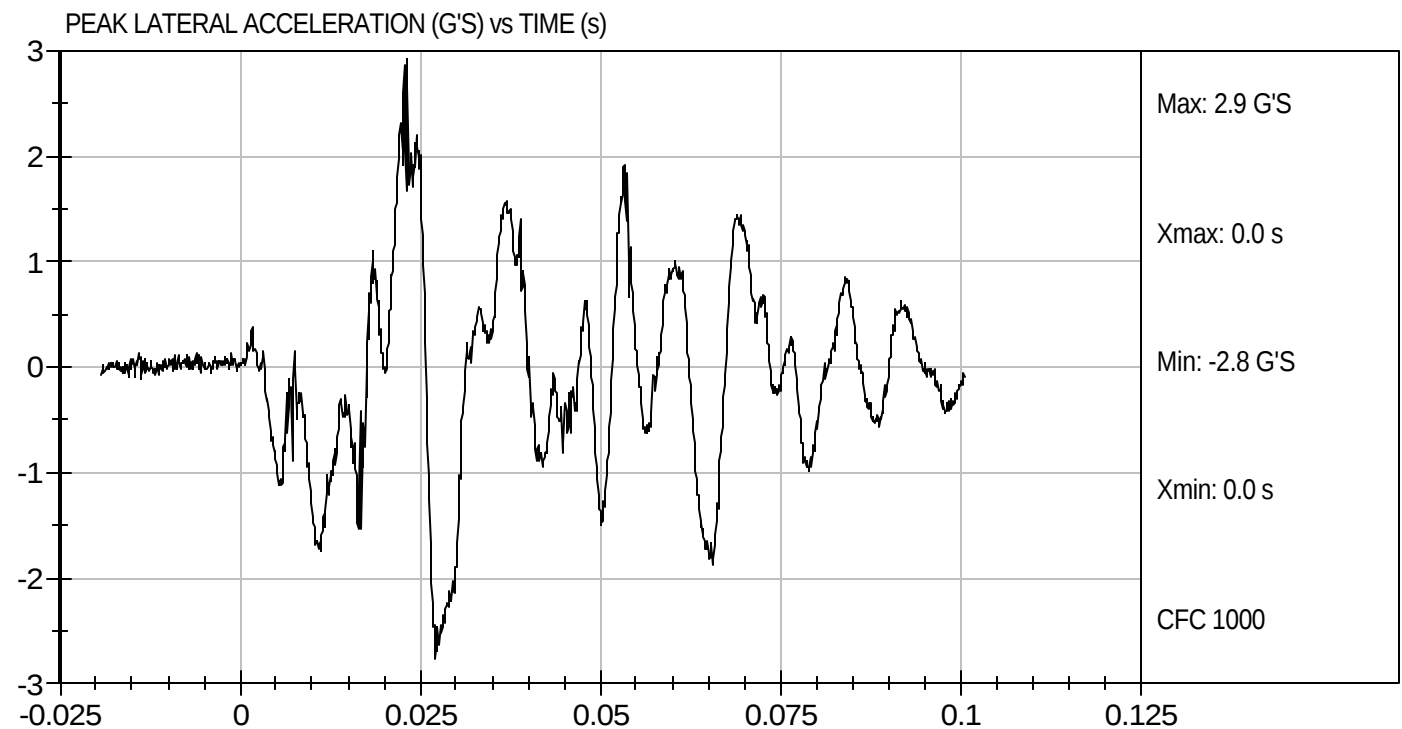
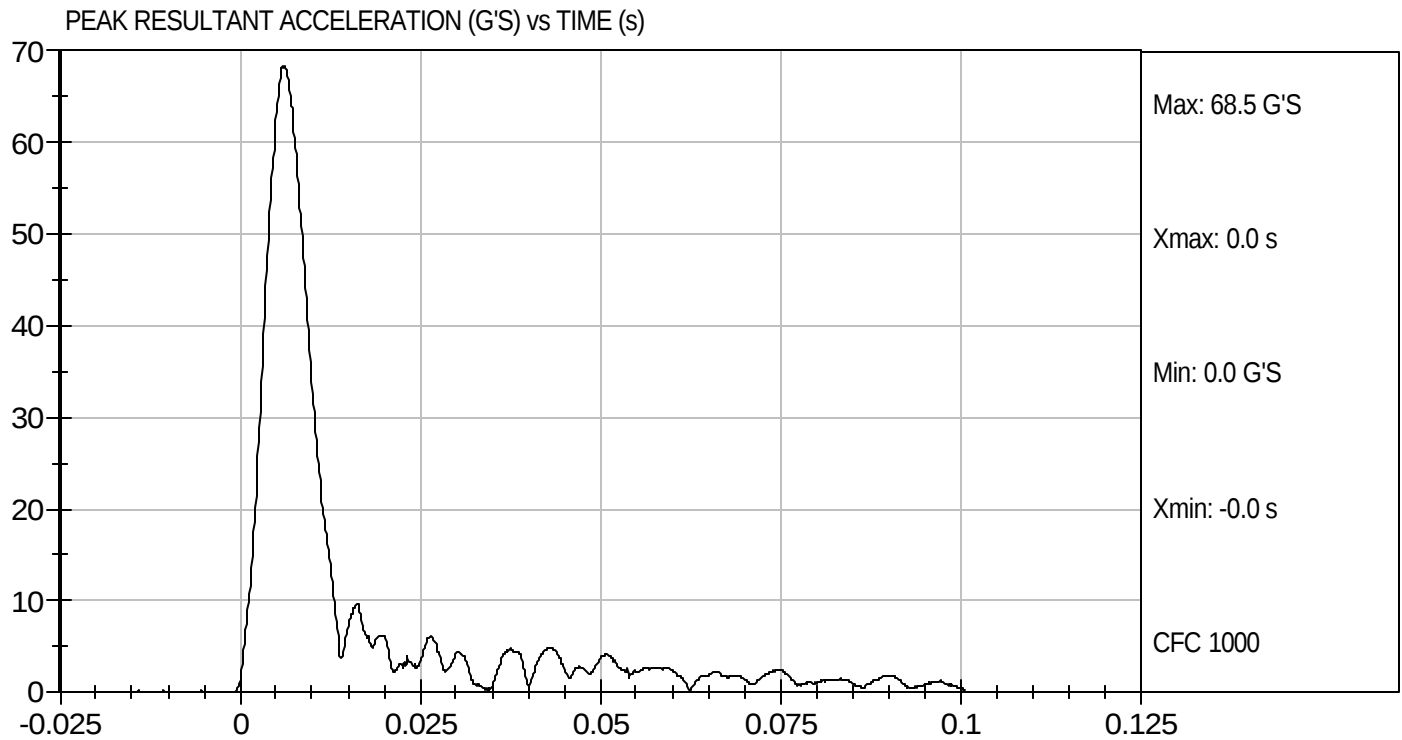
  
Approved By

8/23/07  
Test Date



Test Desc: Head Drop  
Component ID: D072545

Test Date: 8/23/07  
Velocity: 0 ft/s, 0 m/s



**MGA RESEARCH CORPORATION**  
**FRONT HEAD DROP TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 090

**Test ID:** D072531

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 to 25.6       | 20.7   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 45     | Pass      |
| Peak Resultant Acceleration  | G's   | 100 to 120         | 108    | Pass      |
| Peak Lateral Acceleration    | G's   | +/- 15             | -4     | Pass      |
| Unimodal                     | N/A   | within 17% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    |        | Pass      |

  
Laboratory Technician

  
Approved By

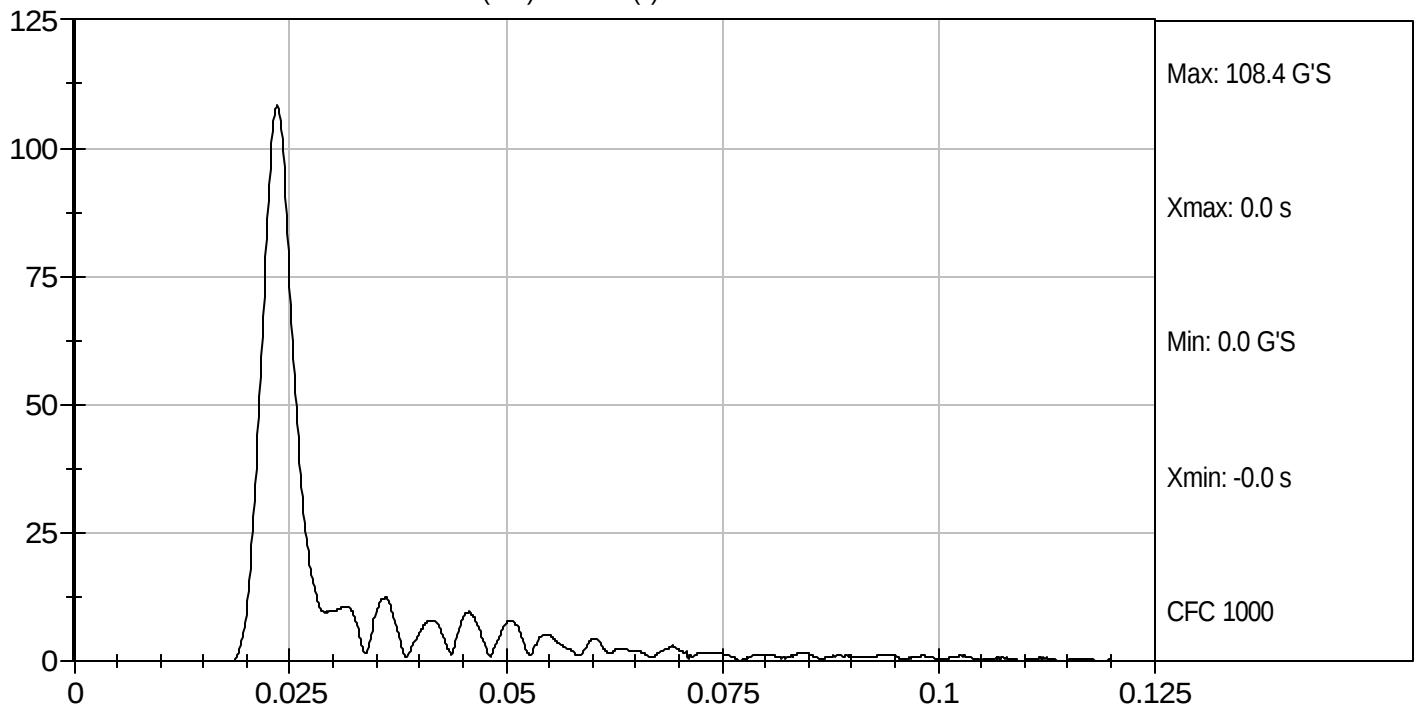
8/23/07  
Test Date



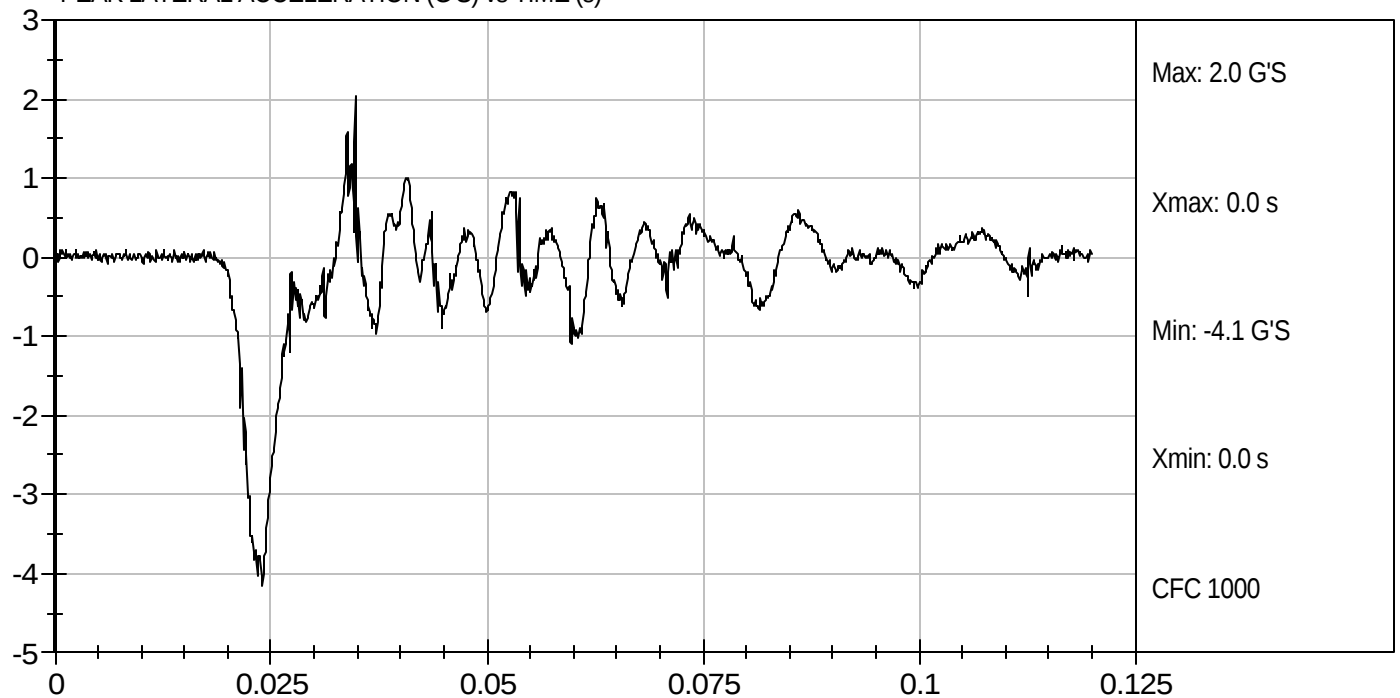
Test Desc: Head Drop  
Component ID: D072531

Test Date: 8/23/07  
Velocity: 0 ft/s, 0 m/s

PEAK RESULTANT ACCELERATION (G'S) vs TIME (s)



PEAK LATERAL ACCELERATION (G'S) vs TIME (s)



**MGA RESEARCH CORPORATION**  
**NECK FLEXION TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 090

**Test I.D:** D072532

| Tested Parameter                           |         | Units | Specification | Result | Pass/Fail |
|--------------------------------------------|---------|-------|---------------|--------|-----------|
| Temperature                                |         | deg C | 20.6 to 22.2  | 20.7   | Pass      |
| Humidity                                   |         | %     | 10 to 70      | 46     | Pass      |
| Impact Velocity                            |         | m/s   | 5.1 to 5.3    | 5.2    | Pass      |
| Pendulum Deceleration                      | 10 msec | m/s   | 1.6 to 2.3    | 2.0    | Pass      |
|                                            | 20 msec | m/s   | 3.4 to 4.2    | 3.6    | Pass      |
|                                            | 25 msec | m/s   | 4.3 to 5.2    | 4.3    | Pass      |
| D Plane Rotation                           |         | deg   | 75.0 to 86.0  | 79.7   | Pass      |
| Moment About Occipital Condyle             |         | Nm    | 36.0 to 45.0  | 37.0   | Pass      |
| Positive Moment - Time Curve Decay to 5 Nm |         | msec  | 60 to 80      | 75     | Pass      |
| Overall Test Results                       |         |       |               |        | Pass      |



Laboratory Technician

8/23/07

Test Date



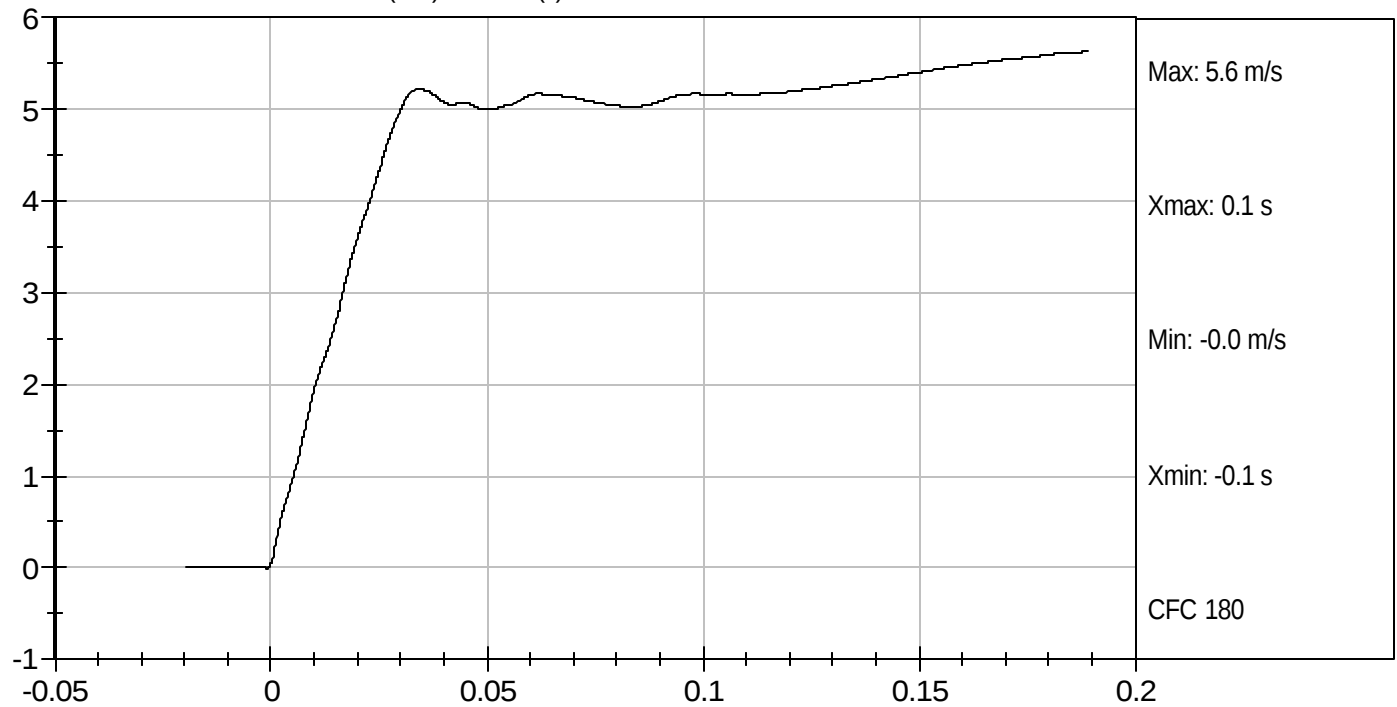
Approved By



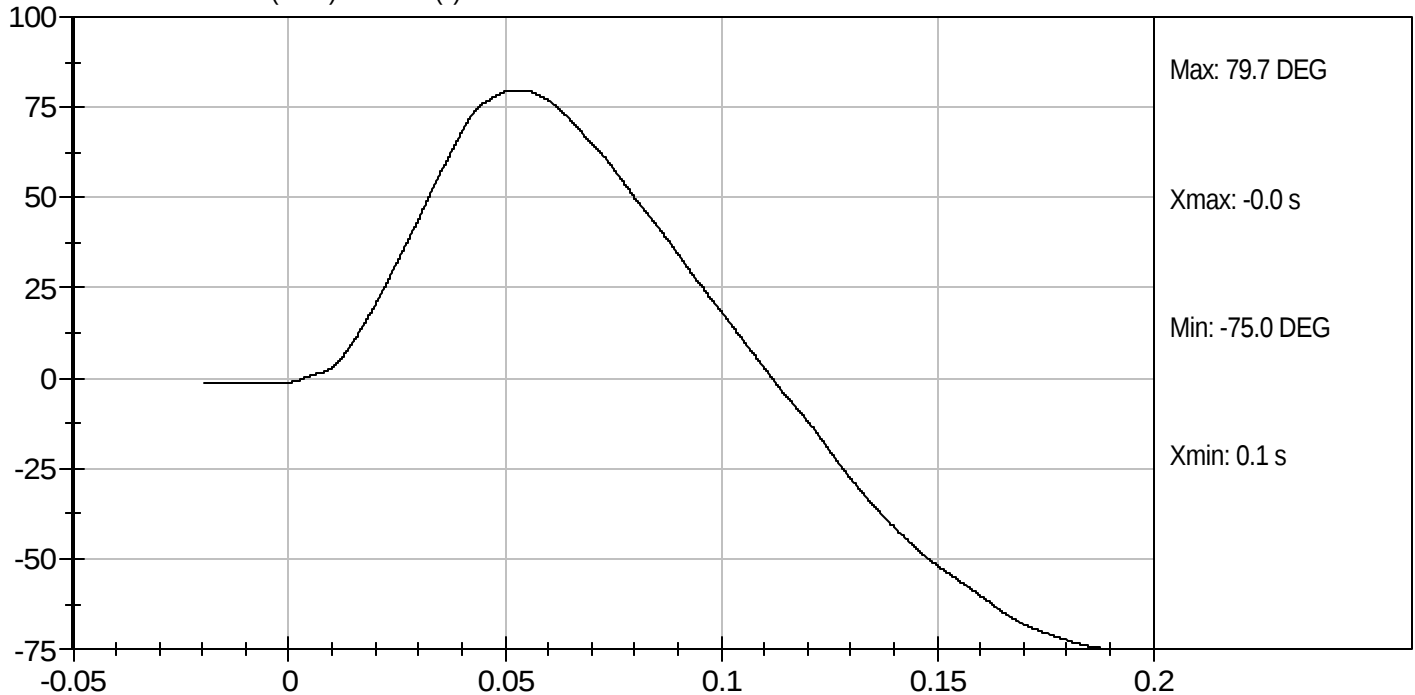
Test Desc: Neck Flexion  
Component ID: D072532

Test Date: 8/23/07  
Velocity: 17.182 ft/s, 5.2 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



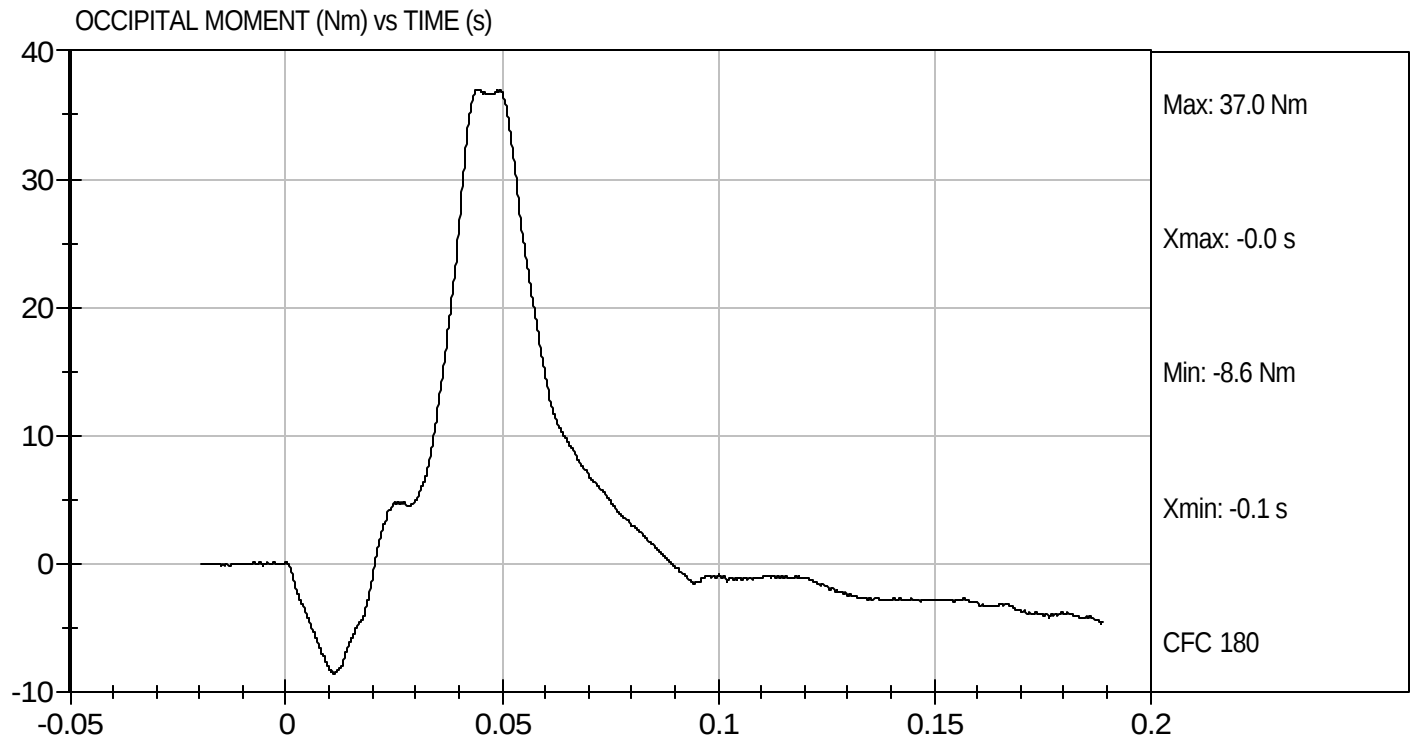
FLEXION ANGLE (DEG) vs TIME (s)





Test Desc: Neck Flexion  
Component ID: D072532

Test Date: 8/23/07  
Velocity: 17.182 ft/s, 5.2 m/s



**MGA RESEARCH CORPORATION**  
**NECK EXTENSION TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 090

**Test I.D:** D072533

| Tested Parameter                            |         | Units | Specification  | Result | Pass/Fail |
|---------------------------------------------|---------|-------|----------------|--------|-----------|
| Temperature                                 |         | deg C | 20.6 to 22.2   | 20.7   | Pass      |
| Humidity                                    |         | %     | 10 to 70       | 46     | Pass      |
| Pendulum Speed                              |         | m/s   | 2.4 to 2.6     | 2.5    | Pass      |
| Pendulum Deceleration                       | 6 msec  | m/s   | 0.8 to 1.2     | 0.9    | Pass      |
|                                             | 10 msec | m/s   | 1.5 to 2.1     | 1.7    | Pass      |
|                                             | 14 msec | m/s   | 2.2 to 2.9     | 2.3    | Pass      |
| D Plane Rotation                            |         | deg   | 80.0 to 92.0   | 80.2   | Pass      |
| Moment About Occipital Condyle              |         | Nm    | -23.0 to -12.0 | -14.8  | Pass      |
| Negative Moment - Time Curve Decay to -5 Nm |         | msec  | 76 to 90       | 84     | Pass      |
| Overall Test Results                        |         |       |                | Pass   |           |

  
 Laboratory Technician

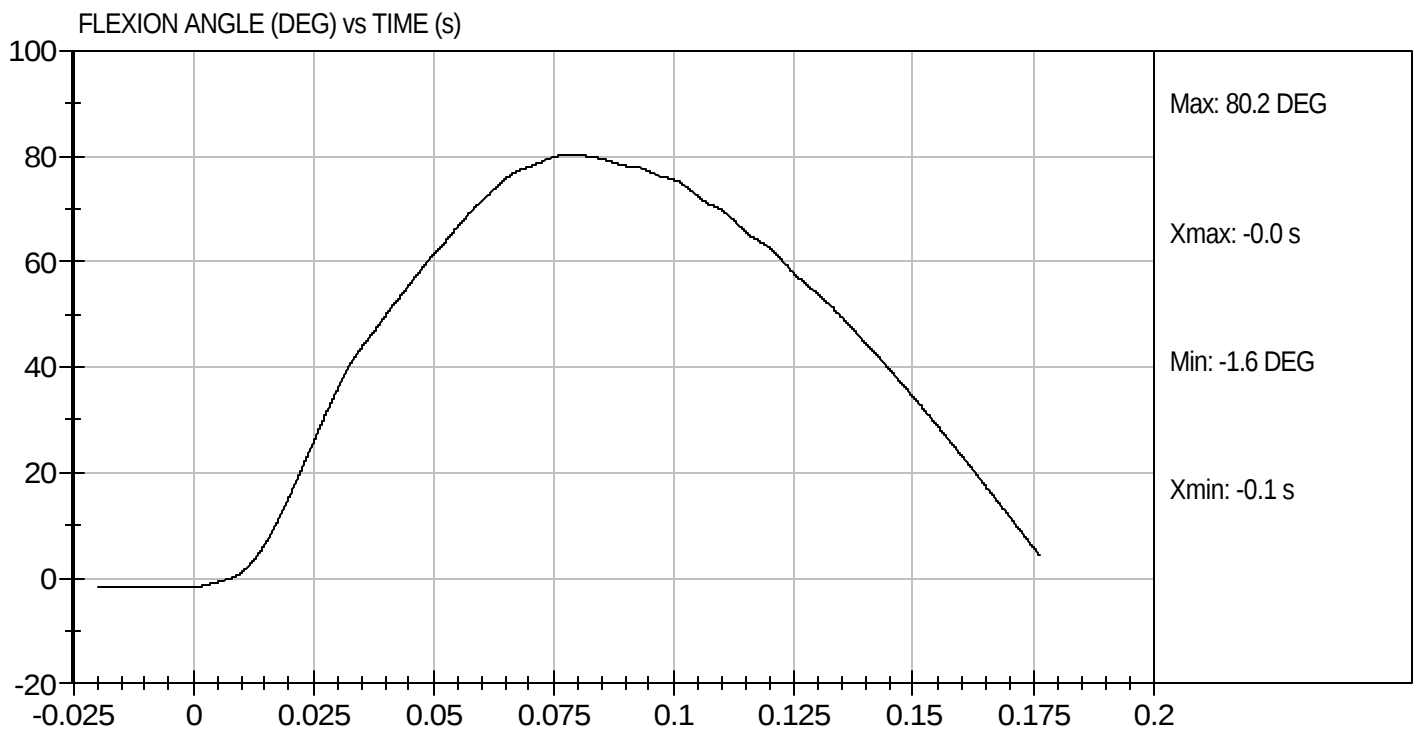
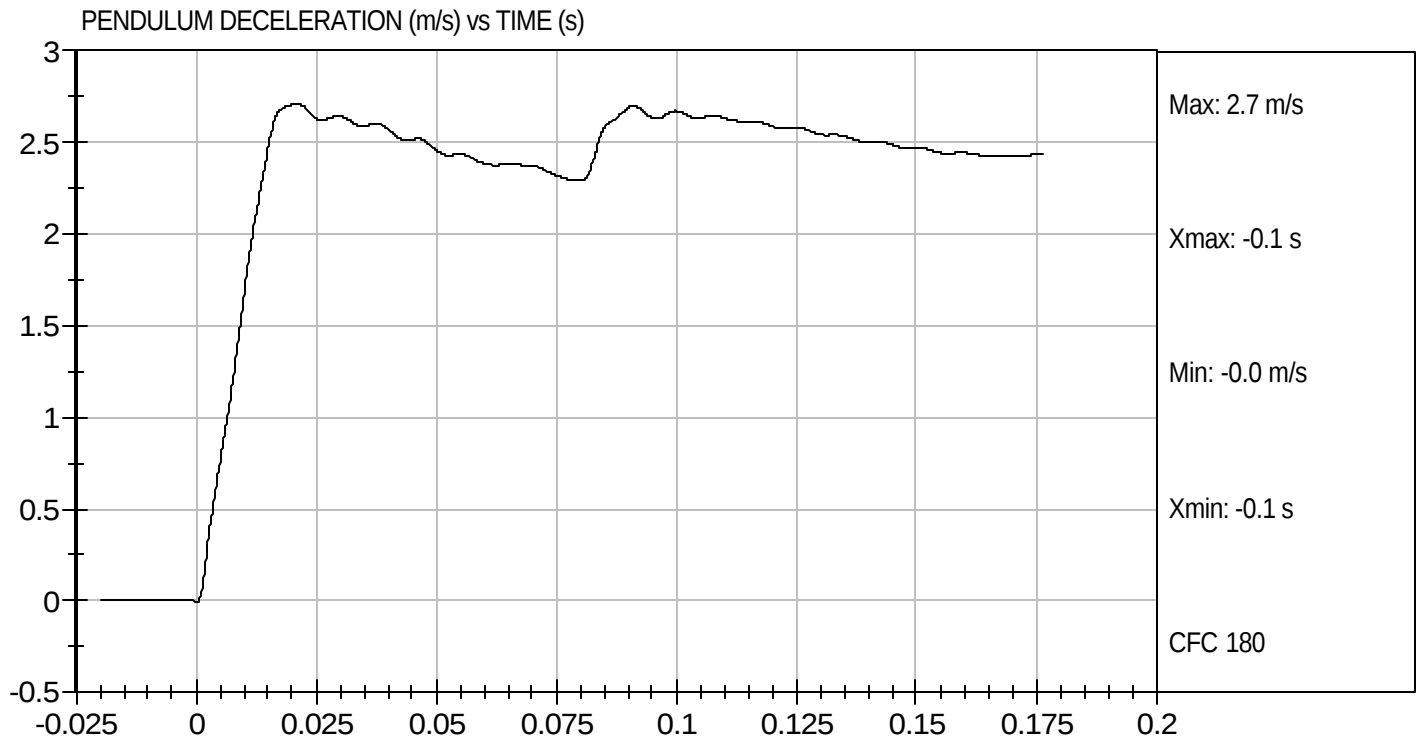
8/23/07  
 Test Date

  
 Approved By



Test Desc: Neck Flexion  
Component ID: D072533

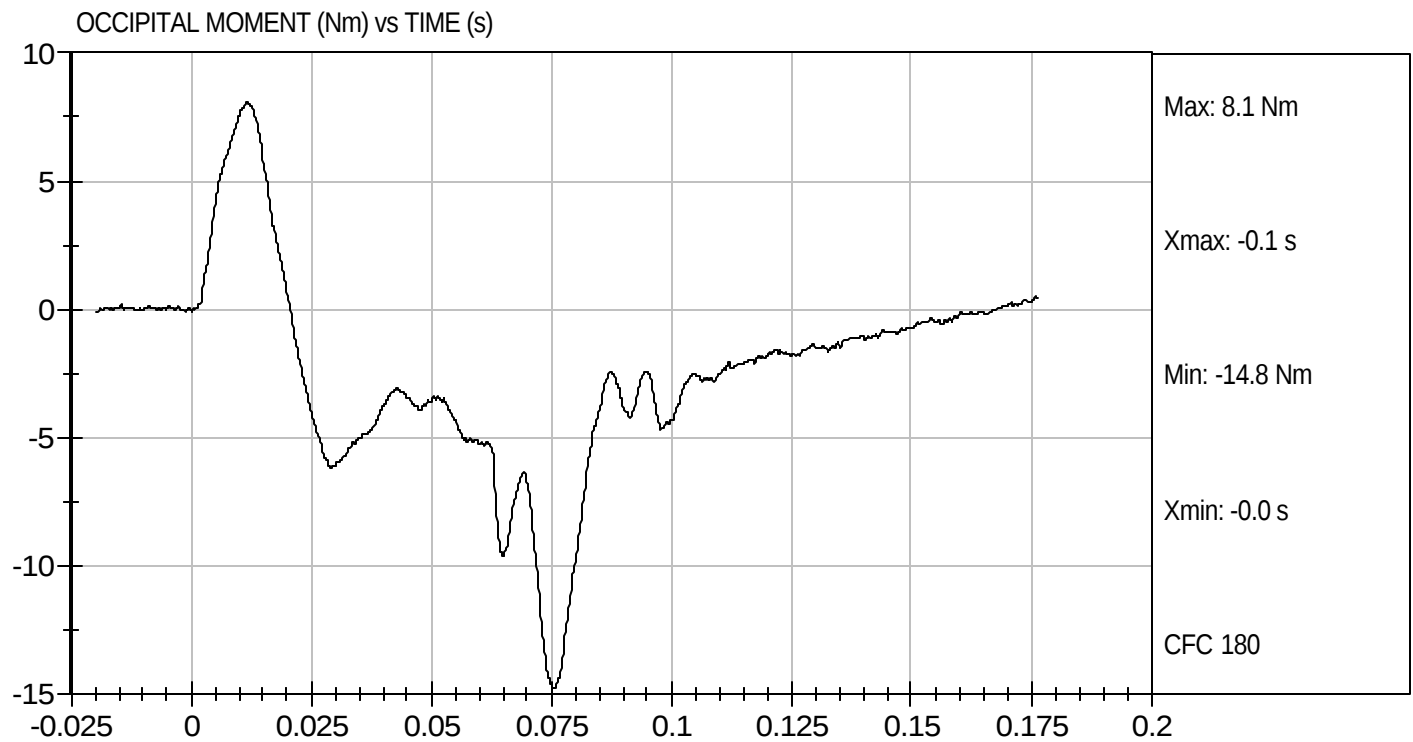
Test Date: 8/23/07  
Velocity: 8.33 ft/s, 2.5 m/s





Test Desc: Neck Flexion  
Component ID: D072533

Test Date: 8/23/07  
Velocity: 8.33 ft/s, 2.5 m/s



**MGA RESEARCH CORPORATION**  
**THORAX IMPACT TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 090

**Test I.D:** D072534

| Tested Parameter             | Units | Specification | Result | Pass/Fail |
|------------------------------|-------|---------------|--------|-----------|
| Laboratory Temperature       | deg C | 20.6 to 22.2  | 20.6   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70      | 43     | Pass      |
| Probe Speed                  | m/sec | 4.9 to 5.1    | 5.03   | Pass      |
| Probe Force                  | kN    | 1.51 to 1.80  | 1.55   | Pass      |
| Overall Test Results         |       |               |        | Pass      |



Laboratory Technician

8/23/07

Test Date

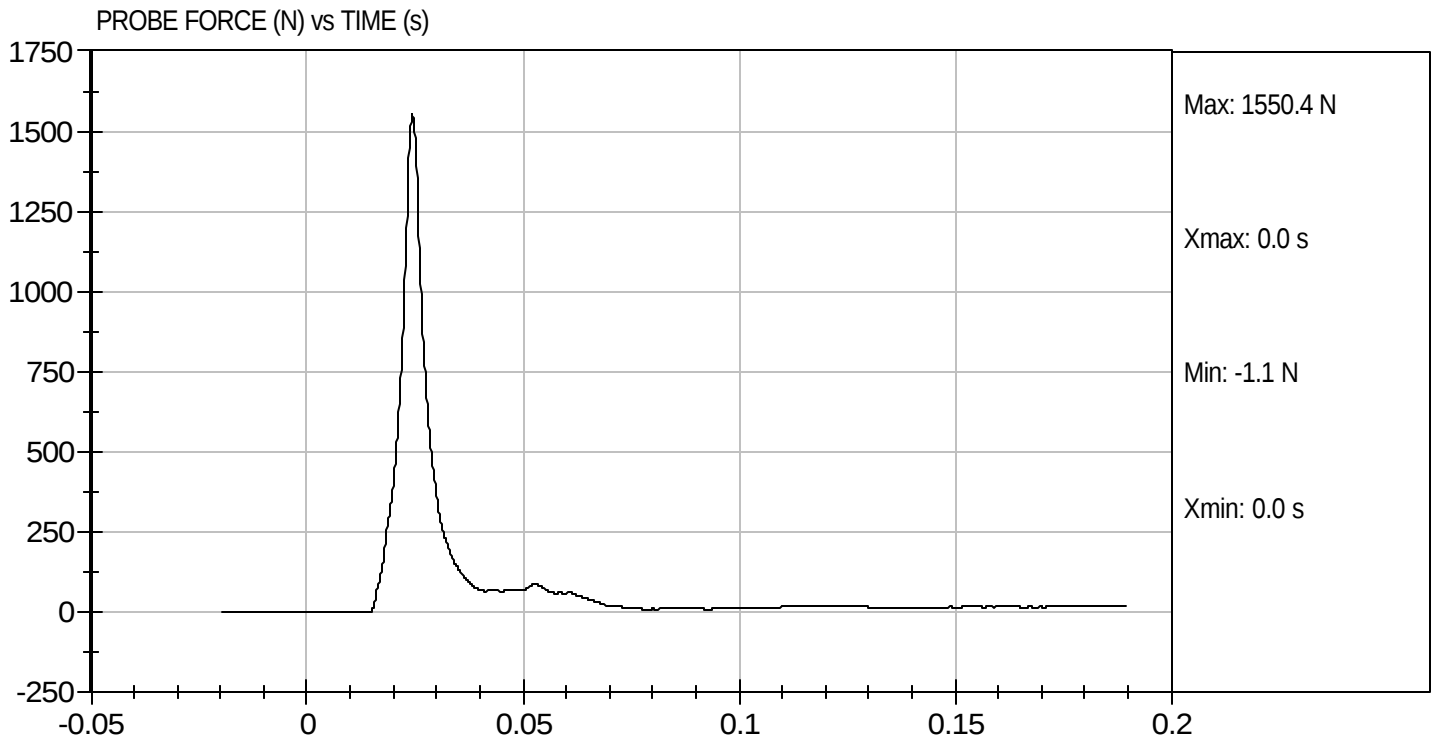


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Test Desc: Thorax Impact  
Component ID: D072534

Test Date: 8/23/07  
Velocity: 16.501 ft/s, 5.03 m/s



**MGA RESEARCH CORPORATION**  
**REAR HEAD DROP TEST**  
**CRABI 12 MONTH**

**ATD Serial No:** 090

**Test ID:** D072535

| Tested Parameter             | Units | Specification      | Result | Pass/Fail |
|------------------------------|-------|--------------------|--------|-----------|
| Laboratory Temperature       | deg C | 18.9 to 25.6       | 20.7   | Pass      |
| Laboratory Relative Humidity | %     | 10 to 70           | 45     | Pass      |
| Peak Resultant Acceleration  | G's   | 55 to 71           | 67     | Pass      |
| Peak Lateral Acceleration    | G's   | +/- 15             | -3     | Pass      |
| Unimodal                     | N/A   | within 17% of peak | Yes    | Pass      |
| Overall Test Results         |       |                    |        | Pass      |

  
Laboratory Technician

  
Approved By

8/23/07  
Test Date



Test Desc: Head Drop  
Component ID: D072535

Test Date: 8/23/07  
Velocity: 0 ft/s, 0 m/s

