**REPORT NUMBER: 214P-MGA-2011-015**

# SAFETY COMPLIANCE TESTING FOR FMVSS 214
# DYNAMIC SIDE IMPACT PROTECTION
# RIGID POLE

**FUJI HEAVY INDUSTRIES LTD.**
**2011 SUBARU LEGACY 4-DR SEDAN**
**NHTSA NUMBER: CB5502**

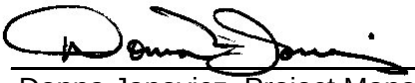
**PREPARED BY:**
**MGA RESEARCH CORPORATION**
**5000 WARREN ROAD**
**BURLINGTON, WI 53105**

**Test Date: April 27, 2011**

**Report Date: May 18, 2011**

**FINAL REPORT**

**PREPARED FOR:**
**U.S. DEPARTMENT OF TRANSPORTATION**
**NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION**
**ENFORCEMENT**
**OFFICE OF VEHICLE SAFETY COMPLIANCE**
**1200 NEW JERSEY AVENUE, SE**
**WEST BUILDING (NVS-220)**
**WASHINGTON, DC 20590**

Prepared by: 
Donna Janovicz, Project Manager

Approved by: 
Joe Fleck, Project Engineer

Approval Date: May 18, 2011

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted by: James A. Jones

Acceptance Date: 5/25/2011

## Technical Report Documentation Page

| | | |
|---|---|---|
| *1. Report No.*<br>214P-MGA-2011-015 | *2. Government Accession No.* | *3. Recipient's Catalog No.* |
| *4. Title and Subtitle*<br>Final Report of FMVSS 214P Compliance Test<br>Side Impact Protection Testing of 2011 Subaru Legacy 4-Dr Sedan; NHTSA No.: CB5502 | | *5. Report Date*<br>May 18, 2011<br>*6. Performing Organization Code*<br>MGA |
| *7. Author(s)*<br>Donna Janovicz, Project Manager<br>Joe Fleck, Project Engineer | | *8. Performing Organization Report No.*<br>214P-MGA-2011-015 |
| *9. Performing Organization Name and Address*<br>MGA Research Corporation<br>5000 Warren Road<br>Burlington, WI 53105 | | *10. Work Unit No.*<br>*11. Contract or Grant No.*<br>DTNH22-07-D-00062 |
| *12. Sponsoring Agency Name and Address*<br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration<br>Office of Vehicle Safety Compliance (NVS-220)<br>1200 New Jersey Ave, SE<br>Washington, DC 20590 | | *13. Type of Report and Period Covered:*<br>Final Test Report<br>4/27/2011 to 5/18/2011<br>*14. Sponsoring Agency Code*<br>NVS-220 |
| *15. Supplementary Notes* | | |

*16. Abstract*

A 32 km/h (20 mph), 75° oblique impact compliance test was conducted on the subject 2011 Subaru Legacy 4-Dr Sedan in accordance with the specifications of the Office of Vehicle Safety Compliance TP-214P-01 for the determination of FMVSS No. 214 Side Impact Protection compliance. The test was conducted at MGA Research Corporation, in Burlington, Wisconsin, on April 27, 2011.

The impact velocity was 31.6 km/h, and the ambient temperature at the struck (driver's) side of the test vehicle at the time of impact was 21°C. The test vehicle post-test maximum crush was 316 mm at level 3. The test vehicle's performance follows:

| Measurement Description | Units | Result |
|---|---|---|
| Head Injury Criteria ($HIC_{36}$) | N/A | 365 |
| Max. Rib Deflection | mm | 38 |
| Sum of Abdomen Forces | N | 1127 |
| Pubic Symphysis Force | N | 2149 |

The doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite side doors did not open during the side impact event.

| | | | |
|---|---|---|---|
| *17. Key Words*<br>Compliance Testing<br>Side Impact Protection<br>Pole Test<br>ES-2re<br>SID-IIs | | *18. Distribution Statement*<br>Copies of this report are available from:<br>National Highway Traffic Safety Administration<br>Technical Information Services (TIS)<br>Room E12-100 East Building<br>1200 New Jersey Ave.<br>Washington, D.C. 20590<br>Telephone No. (202) 366-2588 | |
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Form DOT F1700.7 (8-72)

TABLE OF CONTENTS

## SECTION 1
## PURPOSE AND SUMMARY OF TEST

PURPOSE

This side impact test is part of the FY 2011 FMVSS 214 Side Impact Protection Compliance Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-07-D-00062. The purpose of this test was to evaluate side impact protection in a 2011 Subaru Legacy 4-Dr Sedan. The side impact test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure (TP-214P-01, dated January 2010).

SUMMARY

A rigid pole side impact test was conducted on a 2011 Subaru Legacy 4-Dr Sedan. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.6 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin, on April 27, 2011. Pre-test and post-test photographs of the test vehicle and side impact dummy are included in Appendix A of this report.

One Part 572U dummy was placed in the left front outboard designated seating position according to instructions specified in TP-214P-01, dated January 2010. The side impact event was documented by ten (10) cameras.

The ES-2re male dummy was instrumented with a triaxial accelerometer pack located in the head, 3 rib displacement transducers located in the chest, 3 load cells located in the abdomen and a load cell located in the pubic symphysis.

A summary of the test results follows:

**DUMMY INJURY VALUES**

| Dummy | HIC (36ms) | Thorax Deflection (mm) | | Abdomen Forces (N) | | Pubic Symphysis (N) |
|---|---|---|---|---|---|---|
| ES-2re 50th Percentile Male | 365 | Upper | 38.0 | Front | 279.8 | 2148.6 |
| | | Middle | 31.5 | Mid | 395.6 | |
| | | Lower | 24.2 | Rear | 525.5 | |
| | | Max. | 38.0 | Sum | 1127.4 | |

## GENERAL COMMENTS

There was no valid data collected for:

Left Floor Sill Y

B Pillar Low Y after 25 msec.

MGA does not endorse or certify products. The manufacturer's name appears solely for identification purposes.

## SECTION 2

## OCCUPANT AND VEHICLE INFORMATION

### DATA SHEET NO. 1

### TEST VEHICLE INFORMATION AND OPTIONS

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

| VEHICLE INFORMATION | |
|---|---|
| Make | Subaru |
| Model | Legacy |
| Body Style | Sedan |
| VIN | 4S3BMAA67B1239547 |
| Body Color | Graphite Gray Metallic |
| Engine Displacement (L) | 2.5 |
| # of Cylinders | 4 |
| Engine Placement | Longitudinal |
| Transmission Type | Manual |
| Transmission Speeds | 6 |
| Overdrive | Yes |
| Final Drive | AWD |
| Odometer Reading | 82 miles |

| OPTIONS | |
|---|---|
| ESC | Yes |
| All Wheel Drive | Yes |
| Power Steering | Yes |
| Tilt Steering Wheel | Yes |
| Driver Side Curtain Airbag | Yes |
| Driver Side Torso/Pelvis Airbag | Yes |
| Driver Knee Bag | No |
| Driver Seat Belt Pretentioners | Yes |
| Driver Seat Belt Load Limiters | Yes |
| Driver Power Seat | No |
| Rear Pass. Curtain Airbag | Yes |
| Rear Pass. Side Torso Airbag | No |
| Rear Pass. Seat Belt Pretentioners | No |
| Rear Pass. Seat Belt Load Limiters | No |
| Rear Pass. Power Seats | No |
| Power Windows | Yes |
| Air Conditioning | Yes |
| AM/FM CD | Yes |
| Automatic Door Locks (ADL) | Yes |
| Does owner's manual provide instructions to disable ADL's? | No |
| Anti-Lock Brakes | Yes |

### DATA FROM CERTIFICATION LABEL

| | |
|---|---|
| Manufactured By | Fuji Heavy Industries Ltd. |
| Date of Manufacture | 01/11 |

| | |
|---|---|
| GVWR (kg) | 2010 |
| GAWR Front (kg) | 1070 |
| GAWR Rear (kg) | 1060 |

### VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

| Measured Parameter | Front | Rear | Third | Total |
|---|---|---|---|---|
| Type of Seats | Bucket | Split Bench | | |
| Number of Occupants | 2 | 3 | | 5 |
| Capacity Weight (VCW) (kg) | | | | 385 |
| Cargo Weight (RCLW) (kg) | | | | 45 |

## DATA SHEET NO. 2

## GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

### TIRE PRESSURES

| | Units | LF | RF | RR | LR |
|---|---|---|---|---|---|
| As Delivered | kPa | 230 | 230 | 220 | 220 |
| As Tested | kPa | 230 | 230 | 220 | 220 |

### TEST VEHICLE WEIGHTS

| | Units | As Delivered | | | Fully Loaded | | | As Tested | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Front Axle | Rear Axle | Total | Front Axle | Rear Axle | Total | Front Axle | Rear Axle | Total |
| Left | kg | 431.8 | 332.0 | | 464.0 | 385.5 | | 448.6 | 387.8 | |
| Right | kg | 414.6 | 313.0 | | 417.3 | 347.1 | | 433.6 | 337.1 | |
| Ratio | % | 56.7 | 43.3 | | 54.6 | 45.4 | | 54.9 | 45.1 | |
| Totals | kg | 846.4 | 645.0 | 1491.4 | 881.3 | 732.6 | 1613.9 | 882.2 | 724.9 | 1607.1 |

### TEST VEHICLE TARGET WEIGHT (TVTW) CALCULATION

| Measured Parameter | Units | Value |
|---|---|---|
| As Delivered Weight | kg | 1491.4 |
| Weight of 1 P572U ATD (ES-2re) Dummy | kg | 77.1 |
| Rated Cargo/Luggage Weight (RCLW) | kg | 45 |
| Calculated Target Vehicle Test Weight (TVTW) | kg | 1613.5 |

### TEST VEHICLE ATTITUDES

| | Units | LF | RF | RR | LR |
|---|---|---|---|---|---|
| Fully Loaded | mm | 695 | 706 | 704 | 688 |
| As Tested | mm | 699 | 706 | 704 | 702 |
| Difference | mm | -4 | 0 | 0 | -14 |

### CALCULATION OF THE VERTICAL IMPACT REFERENCE LINE

| Measurement Parameter | Units | Value |
|---|---|---|
| Test Vehicle Wheel Base | mm | 2750 |
| Vertical Impact Reference Line (Aft of Front Axle) | mm | 1385 |

### WEIGHT of BALLAST and VEHICLE COMPONENTS REMOVED TO MEET VEHICLE TEST WEIGHT

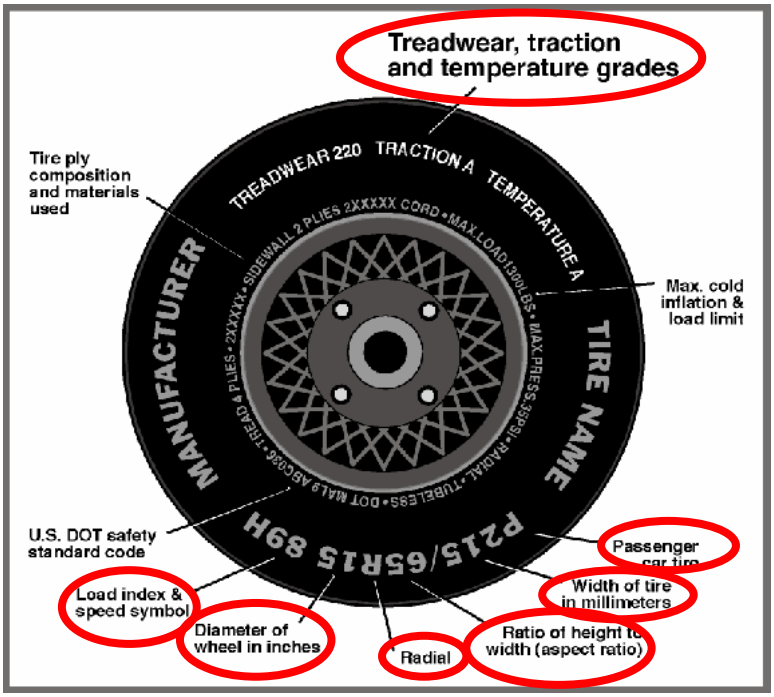
| Description of Component | Weight (kg) |
|---|---|
| Ballast | 0 |
| Deck Lid Inner Lining | 0.9 |
| Left and Right Tail Lights | 2.3 |

**DATA SHEET NO. 3**

**VEHICLE TIRE INFORMATION**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

**VEHICLE TIRE INFORMATION**




| Measured Parameter | Front | Rear |
|---|---|---|
| Max. Tire Pressure (kPa) | 275 | 275 |
| Cold Pressure (kPa) | 230 | 220 |
| Recommended Tire Size | P205/60R16 | P205/60R16 |
| Tire Size on Vehicle | P205/60R16 | P205/60R16 |
| Tire Manufacturer | Bridgestone | Bridgestone |
| Tire Name | Turanza | Turanza |
| Tire Type | Passenger | Passenger |
| Tire Width | 205 | 205 |
| Aspect Ratio | 60 | 60 |
| Radial | Yes | Yes |
| Wheel Diameter | 16 | 16 |
| Load Index/Speed Symbol | 91V | 91V |
| Treadwear | 260 | 260 |
| Traction Grade | A | A |
| Temperature Grade | A | A |

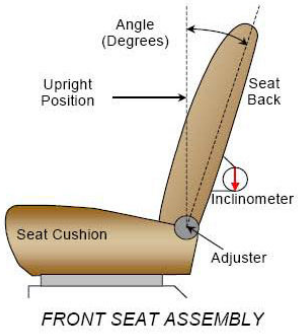
**DATA SHEET NO. 4**

**SEAT AND SEAT BELT ADJUSTMENT DATA**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

**NORMAL DESIGN RIDING POSITION**

The driver seat back is positioned to the manufacturer's designated angle. The procedure is as follows: Set the seat back angle at 7 degrees when measured at headrest post. The reference plane is the door sill. The angle of the door sill is 0 degree.



FRONT SEAT ASSEMBLY

**SEAT BACK ANGLE**

| | Degrees | Detents |
|---|---|---|
| Driver without Seated Dummy | 8.2° at headrest post | 8th detent (forward-most as 0) |

**SEAT FORE/AFT POSITION**

The method used for determining seat fore/aft position is as follows: For seat track adjustments, set in mid track position.

**SEAT FORE/AFT POSITIONING**

| | Total Fore/Aft Travel | Placed in Position # |
|---|---|---|
| Front Seat | 26 detents | 13th detent (forward-most as 0) |

**SEAT BELT UPPER ANCHORAGE**

The method of positioning the seat belt upper anchorage is as follows: Detents to the nominal design position are measured with respect to the uppermost detent. Place in the 1st detent for the 50th percentile male.

**SEAT BELT UPPER ANCHORAGE**

| | Total # of Positions | Placed in Position # |
|---|---|---|
| Driver Seat | 5 detents | 1st detent (uppermost detent defined as 0) |

**HEADREST RESTRAINT**

The headrest was placed in the uppermost position.

## DATA SHEET NO. 5

## FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

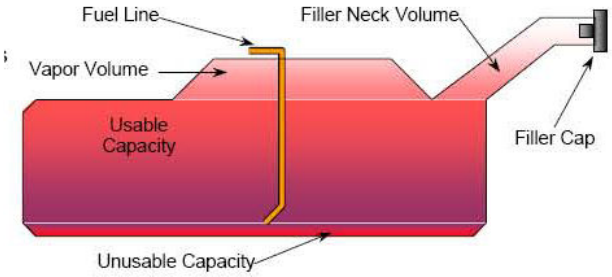
Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

### FUEL TANK CAPACITY

| | Liters |
|---|---|
| Usable Capacity (Form 1) | 70.0 |
| Usable Capacity (Owner's Manual) | 70.0 |
| 92-94% of Usable Capacity | 64.4 to 65.8 |
| Actual Amount of Solvent Used | 65.1 |

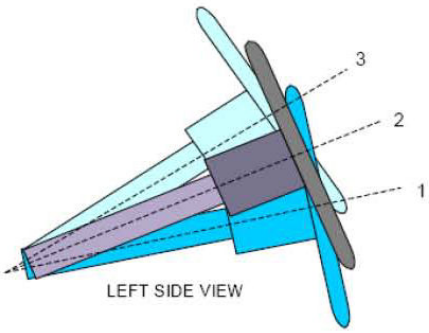
### FUEL PUMP

Describe the fuel pump type, its behavior, and the location of the fuel filler pipe. The test vehicle is equipped with an electric fuel pump. Pump operates a few seconds after an ignition switch is turned ON. After that, pump operates only while engine is running. The fuel pipe is on the right side.




### STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the center of its geometric locus it describes when it moves 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

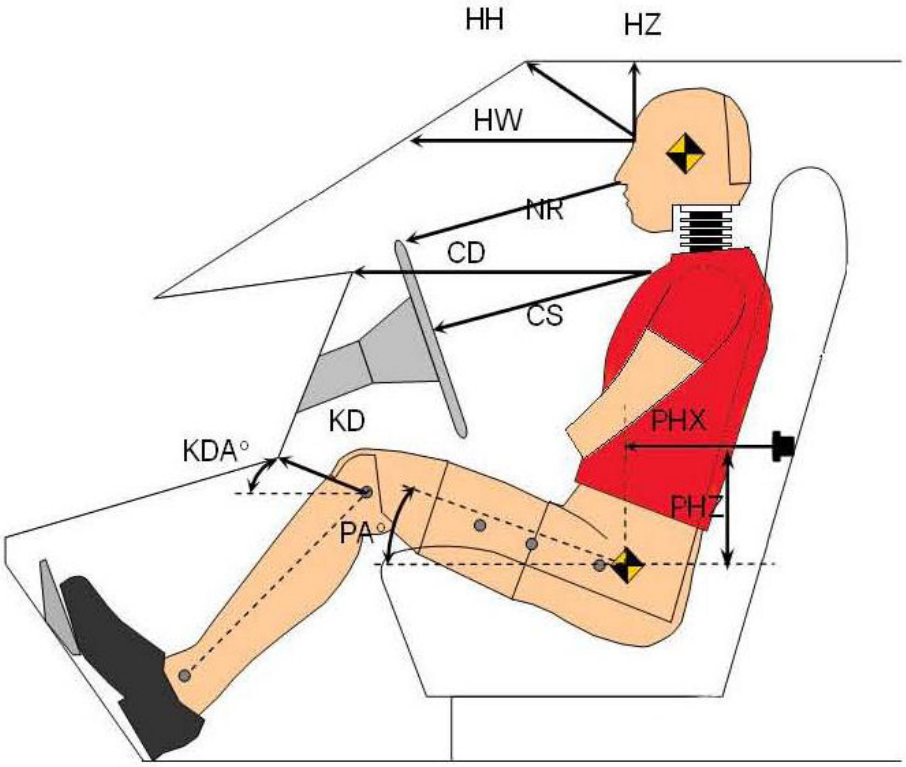
### STEERING COLUMN POSITIONING

| | Degrees | Fore/Aft Position (mm) |
|---|---|---|
| Lowermost - Position 1 | 68.8 | 125 |
| Geometric Center – Position 2 | 67.3 | 105 |
| Uppermost – Position 3 | 65.8 | 85 |
| Telescoping Steering Wheel Travel | | 40 |
| Test Position | 67.3 | 105 |

## .DATA SHEET NO. 6

## DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

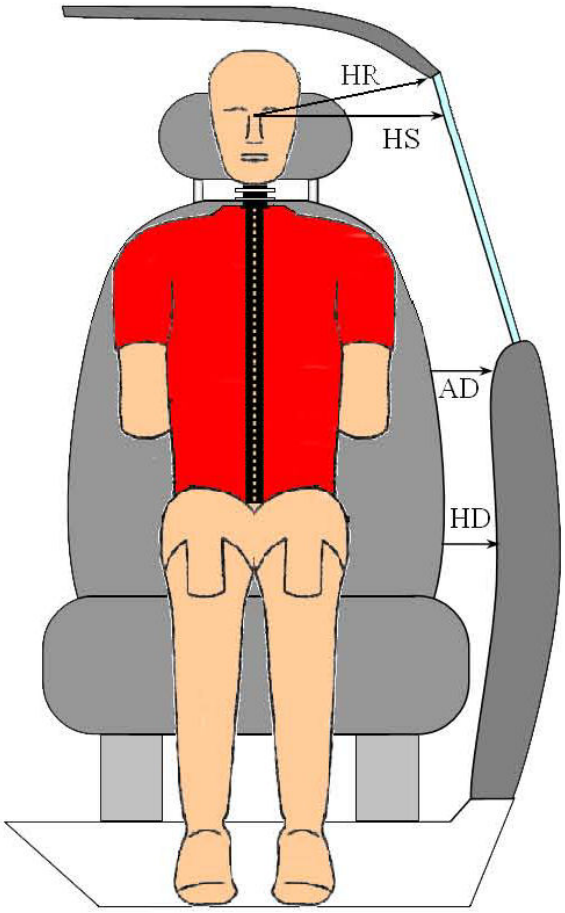



| Driver Code | Measurement Description | Length (mm) | Angle (°) |
|---|---|---|---|
| HH | Head to Header | 398 | |
| HW | Head to Windshield | 650 | |
| HZ | Head to Roof | 182 | |
| NR | Nose to Rim | 488 | |
| CD | Chest to Dash | 556 | |
| CS | Chest to Steering Wheel | 374 | |
| KDL | Left Knee to Dash | 175 | 27.7 |
| KDR | Right Knee to Dash | 155 | 22.9 |
| PA | Pelvis Angle X | | 28.4 |
| | Torso Angle Y | | -0.3 |
| PHX | H-Point to Striker (X-Axis) | 206 | |
| PHZ | H-Point to Striker (Z-Axis) | 161 | |

**DATA SHEET NO. 7**

**DUMMY LATERAL CLEARANCE DIMENSIONS**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

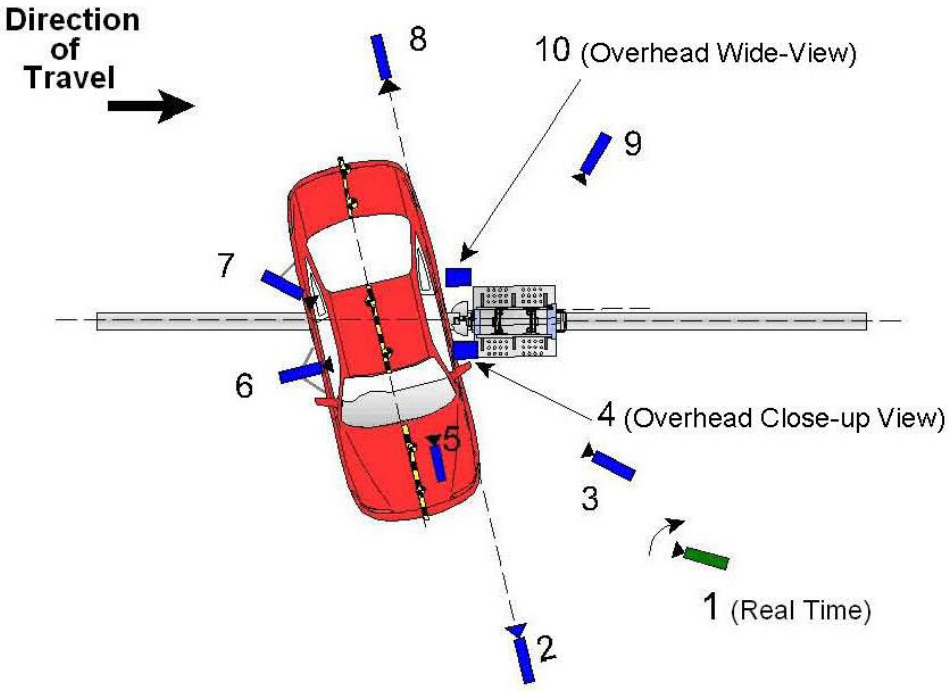



| Code | Measurement Description | Units | Front Occupant |
|---|---|---|---|
| HR | Head to Side Header | mm | 208 |
| HS | Head to Side Window | mm | 324 |
| AD | Arm to Door | mm | 79 |
| HD | H-Point to Door | mm | 149 |

**DATA SHEET NO. 8**

**HIGH SPEED CAMERA LOCATIONS AND DATA**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011



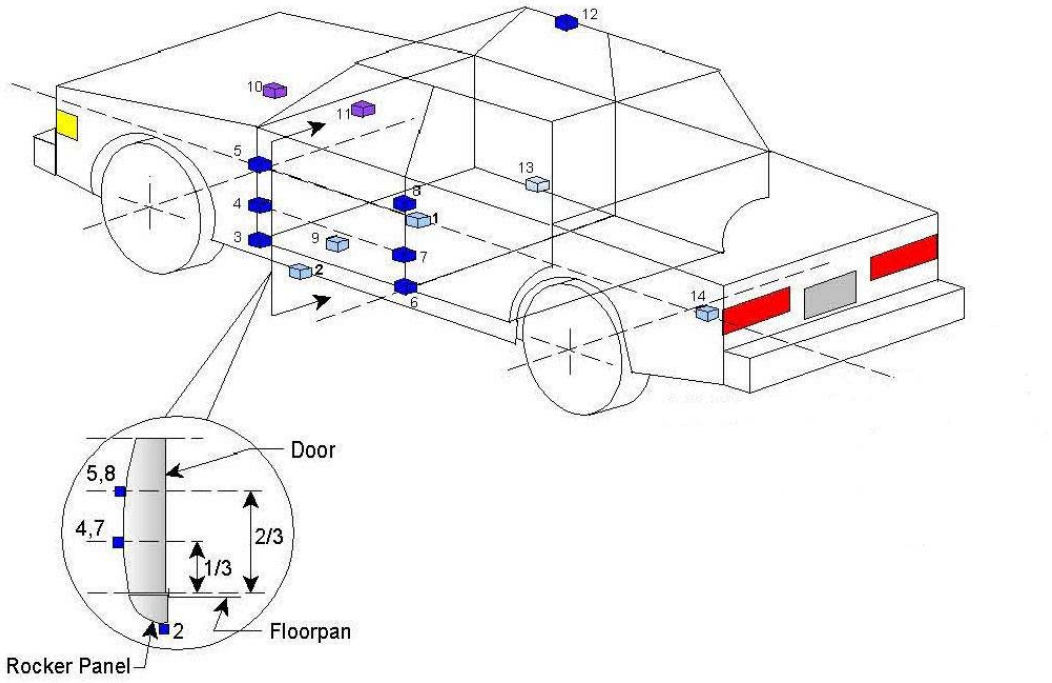

Reference: From Point of Impact for X and Y; from Ground for Z):
+X = Right of Impact, + Y = Forward of Impact, +Z = Up

| Camera No. | View | Coordinates (mm) | | | Lens (mm) | Film Speed (fps) |
|---|---|---|---|---|---|---|
| | | X | Y | Z | | |
| 1 | Real-Time | | | | | 30 |
| 2 | Front Ground Level | 5810 | 30 | 1690 | 24 | 1000 |
| 3 | Impact Side 45° Forward | 4590 | 2150 | 1800 | 20 | 1000 |
| 4 | Overhead Closeup | 0 | 80 | 4520 | 50 | 1000 |
| 5 | Onboard – Driver Front | | | | 16 | 1000 |
| 6 | Onboard – Driver Side | | | | 8 | 1000 |
| 7 | Onboard – Driver Rear | | | | 8 | 1000 |
| 8 | Rear Ground Level | -5750 | 40 | 1650 | 24 | 1000 |
| 9 | Impact Side 45° Rearward | -3970 | 3940 | 1810 | 20 | 1000 |
| 10 | Overhead Wide | 0 | -310 | 4610 | 14 | 1000 |

**DATA SHEET NO. 9**

**TEST VEHICLE ACCELEROMETER LOCATIONS**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011




| Loc. No. | Accelerometer Location | | | |
|---|---|---|---|---|
| | ID | Coordinates (mm) | | |
| | | X | Y | Z |
| 1 | Vehicle CG | 2502 | -190 | -195 |
| 2 | Left Floor Sill | 2685 | -720 | -180 |
| 3 | A Pillar Sill | 3282 | -720 | -173 |
| 4 | A Pillar Low | 3206 | -705 | -494 |
| 5 | A Pillar Mid | 3252 | -790 | -756 |
| 6 | B Pillar Sill | 2170 | -725 | -185 |
| 7 | B Pillar Low | 2082 | -724 | -456 |
| 8 | B Pillar Mid | 2082 | -728 | -735 |
| 9 | Seat | 2262 | -569 | -332 |
| 10 | Engine | 3983 | 0 | -822 |
| 11 | Firewall | 3614 | 70 | -845 |
| 12 | Roof | 2027 | 570 | -1497 |
| 13 | Floor Sill | 2034 | 725 | -196 |
| 14 | Rear Deck | 205 | 0 | -310 |

Reference: X – Test Vehicle Rear Bumper (+ forward)
Y – Test Vehicle Centerline (+ to right)
Z – Ground Plane (+ down)

**DATA SHEET NO. 10**

**TEST VEHICLE ACCELEROMETER DATA SUMMARY**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

| Loc. No. | Description | Peak Values (g's) | | | |
|---|---|---|---|---|---|
| | | Max | Time (ms) | Min | Time (ms) |
| 1 | Vehicle CG (X) | 7.6 | 15.2 | -9.6 | 42.7 |
| | Vehicle CG (Y) | 53.9 | 13.3 | -8.2 | 67.0 |
| | Vehicle CG (Z) | 16.9 | 13.2 | -11.3 | 51.1 |
| | Resultant | 56.9 | 13.3 | | |
| 2 | Left Floor Sill (Y) | (1) | (1) | (1) | (1) |
| 3 | A Pillar Sill (Y) | 17.7 | 13.6 | -3.6 | 4.7 |
| 4 | A Pillar Low (Y) | 25.1 | 19.3 | -0.9 | 42.8 |
| 5 | A Pillar Mid (Y) | 19.3 | 19.0 | -2.0 | 1.9 |
| 6 | B Pillar Sill (Y) | 71.4 | 13.1 | -2.1 | 200.8 |
| 7 | B Pillar Low (Y) | (2) | (2) | (2) | (2) |
| 8 | B Pillar Mid (Y) | 50.1 | 17.5 | -11.3 | 10.5 |
| 9 | Seat (Y) | 62.6 | 42.9 | -7.7 | 66.5 |
| 10 | Engine (X) | 3.2 | 65.7 | -13.4 | 45.5 |
| | Engine (Y) | 19.0 | 58.6 | -3.6 | 197.8 |
| 11 | Firewall (Y) | 10.8 | 40.4 | -0.8 | 252.1 |
| 12 | Roof (Y) | 42.2 | 37.5 | -1.0 | 254.9 |
| 13 | Floor Sill (Y) | 16.7 | 36.9 | -0.7 | 218.9 |
| 14 | Rear Deck (X) | 2.8 | 113.7 | -9.9 | 16.0 |
| | Rear Deck (Y) | 19.0 | 18.2 | -2.8 | 300.0 |

(1) No valid data collected for Left Floor Sill Y
(2) No valid data collected for B Pillar Low Y after 25 msec.

**DATA SHEET NO. 11**

**DUMMY INJURY RESPONSE DATA**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

| Dummy S/N | Positive | | Negative | |
|---|---|---|---|---|
| | MAX | TIME (ms) | MAX | TIME (ms) |
| **HEAD ACCELERATION (G)** | | | | |
| Longitudinal (X) | 6.2 | 151.6 | 28.3 | 59.6 |
| Lateral (Y) | 54.3 | 54.2 | 11.4 | 79.6 |
| Vertical (Z) | 10.1 | 55.6 | 13.9 | 63.6 |
| Resultant (R) | 58.3 | 57.0 | | |
| HIC36 (t1, t2) | 365 | | t1 = 44.2 | t2 = 69.0 |
| **THORAX DEFLECTION (mm)** | | | | |
| Upper Rib | | | 38.0 | 56.5 |
| Middle Rib | | | 31.5 | 58.6 |
| Lower Rib | | | 24.2 | 41.9 |
| **ABDOMINAL FORCES (N)** | | | | |
| Front | 279.8 | 53.6 | | |
| Middle | 395.6 | 48.3 | | |
| Rear | 525.5 | 47.7 | | |
| Sum | 1127.4 | 49.5 | | |
| **PELVIS FORCE (N)** | | | | |
| Pubic Symphysis | | | 2148.6 | 45.7 |

Reference: Positive Direction -Longitudinal (X) = forward
-Lateral (Y) = to right
-Vertical (Z) = down

## DATA SHEET NO. 12

## POST TEST OBSERVATIONS

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

### TEST DUMMY INFORMATION AND CONTACT

| Description | Front Occupant |
|---|---|
| Dummy Type / Serial No. | ES-2re / 016 |
| Head Contact | Curtain Airbag, Headrest, Side Header |
| Upper Torso Contact | Side Airbag |
| Lower Torso Contact | Side Airbag, Door Panel |
| Left Knee Contact | Door Panel |
| Right Knee Contact | Left Knee |

### POST TEST DOOR OPENING AND SEAT TRACK INFORMATION

| Description | Front | Rear |
|---|---|---|
| Left Side Doors | Remained closed and jammed shut | Remained closed and jammed shut |
| Right Side Doors | Remained closed and operational | Remained closed and operational |
| Hatch and Other Doors | | |
| Seat Movement | 0 | 0 |
| Seat Back Failure | None | None |

### POST-TEST STRUCTURAL OBSERVATIONS

| Critical Areas of Performance | Observations and Conclusions |
|---|---|
| Pillar Performance | No Separation |
| Sill Separation | None |
| Windshield Damage | Cracked |
| Window Damage | Left Front Window Broke |
| Other Notable Effects | None |

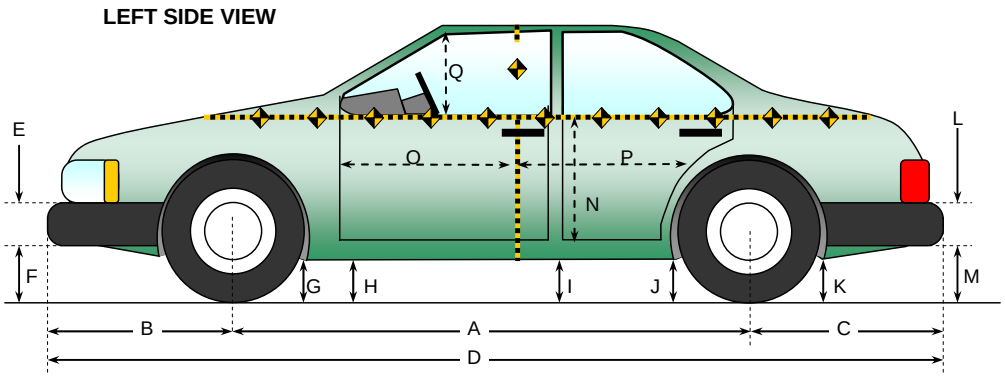
### SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

| Restraint Type | Front Occupant | |
|---|---|---|
| | Installed | Operated |
| Frontal Airbag | Yes | Yes |
| Side Torso/Pelvis Airbag | Yes | Yes |
| Head Airbag | No | |
| Curtain Airbag | Yes | Yes |
| Knee Airbag | No | |
| Seat Belt Pretensioner | Yes | Yes |
| Seat Belt Load Limiter | Yes | |

## DATA SHEET NO. 13

## VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

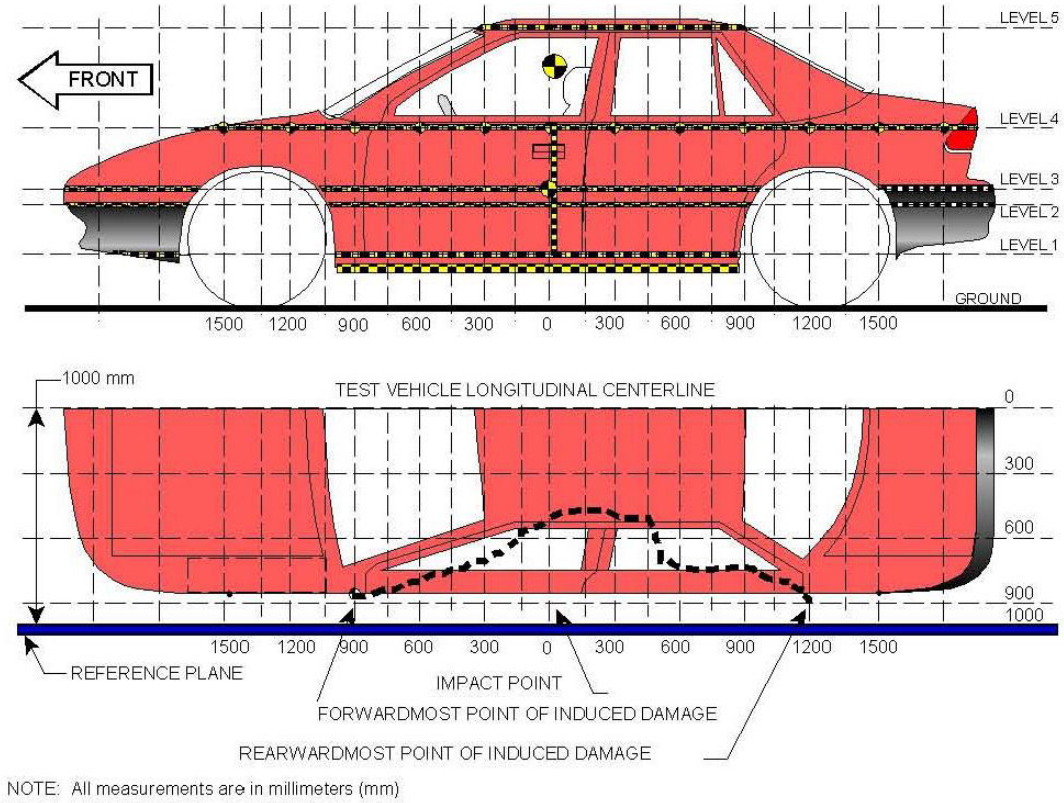



| Code | Measurement Description | Pre-Test (mm) | Post-Test (mm) | Difference (mm) |
|---|---|---|---|---|
| A | Wheelbase | 2750 | 2715 | 35 |
| B | Front Axle to FSOV | 965 | 965 | 0 |
| C | Rear Axle to RSOV | 1020 | 1020 | 0 |
| D | Total Vehicle Length at Centerline | 4735 | 4700 | 35 |
| E | Front Bumper Thickness | 120 | 120 | 0 |
| F | Front Bumper Bottom to Ground | 229 | 253 | -24 |
| G | Sill Height at Front Wheel Well | 156 | 152 | 4 |
| H | Sill Height at Front Door Leading Edge | 161 | 158 | 3 |
| I | Sill Height at B Pillar | 161 | 175 | -14 |
| J1 | Sill Height at Rear Wheel Well | 161 | 188 | -27 |
| J2 | Pinch Weld Height at Rear Wheel Well | 168 | 186 | -18 |
| K | Sill Height Aft of Rear Wheel Well | 233 | 243 | -10 |
| L | Rear Bumper Thickness | 140 | 140 | 0 |
| M | Rear Bumper Bottom to Ground | 302 | 305 | -3 |
| N | Sill Height to Window Bottom Sill | 722 | 710 | 12 |
| O | Front Door Leading Edge to Impact CL | 896 | 894 | 2 |
| P | Rear Door Trailing Edge to Impact CL | 1094 | 1125 | -31 |
| Q | Front Window Opening | 472 | 437 | 35 |
| R | Right Side Length | 3620 | 3625 | -5 |
| S | Left Side Length | 3620 | 3556 | 64 |
| T | Vehicle Width at B Post | 1790 | 1615 | 175 |

**DATA SHEET NO. 14**

**EXTERIOR CRUSH MEASUREMENTS**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011




NOTE: All measurements are in millimeters (mm)

**Maximum Exterior Crush Measurements**

| Level | Measurement Description | Maximum Exterior Static Crush | Distance from Impact | Height Above Ground (mm) |
|---|---|---|---|---|
| 1 | Sill Top | 249 | 0 | 293 |
| 2 | Occupant H-Point | 309 | 0 | 559 |
| 3 | Mid-Door | 316 | 0 | 630 |
| 4 | Window Sill | 293 | 0 | 937 |
| 5 | Window Top | 116 | -75 | 1426 |

**DATA SHEET NO. 15**

**VEHICLE EXTERIOR CRUSH PROFILES**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

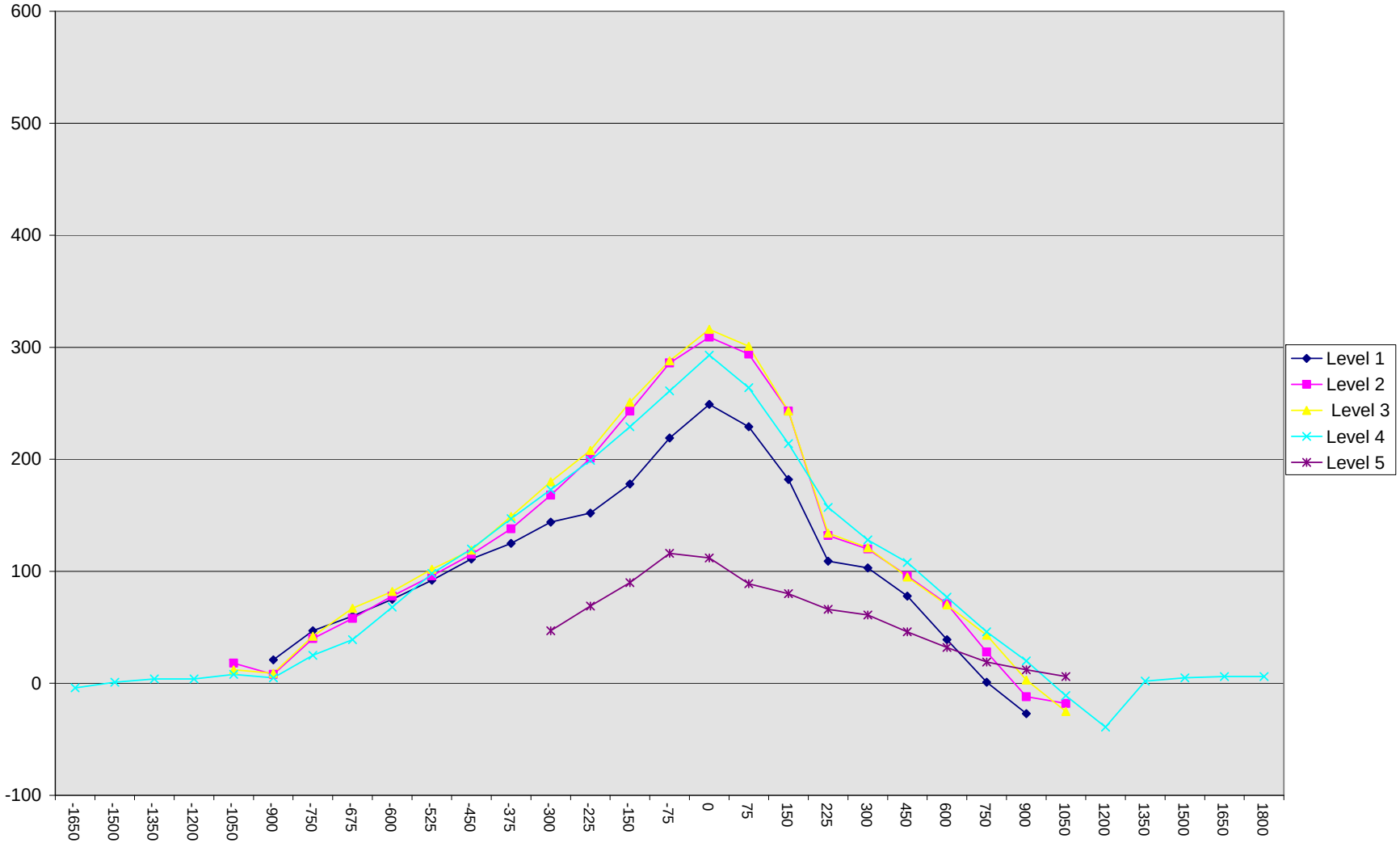
| | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 |
|---|---|---|---|---|---|
| Maximum Crush (mm) | 249 | 309 | 316 | 293 | 116 |
| Distance From Impact (mm) | 0 | 0 | 0 | 0 | -75 |

| | Pre-Test | | | | | Post-Test | | | | | Difference | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| -1650 | | | | 317 | | | | | 313 | | | | | -4 | |
| -1500 | | | | 303 | | | | | 304 | | | | | 1 | |
| -1350 | | | | 290 | | | | | 294 | | | | | 4 | |
| -1200 | | | | 287 | | | | | 291 | | | | | 4 | |
| -1050 | | 190 | 191 | 280 | | | 208 | 203 | 288 | | | 18 | 12 | 8 | |
| -900 | 235 | 213 | 215 | 276 | | 256 | 221 | 224 | 281 | | 21 | 8 | 9 | 5 | |
| -750 | 260 | 219 | 216 | 271 | | 307 | 259 | 258 | 296 | | 47 | 40 | 42 | 25 | |
| -675 | 262 | 218 | 214 | 271 | | 322 | 276 | 281 | 310 | | 60 | 58 | 67 | 39 | |
| -600 | 262 | 217 | 213 | 269 | | 337 | 295 | 295 | 337 | | 75 | 78 | 82 | 68 | |
| -525 | 262 | 217 | 212 | 266 | | 354 | 313 | 314 | 364 | | 92 | 96 | 102 | 98 | |
| -450 | 262 | 215 | 211 | 264 | | 373 | 330 | 330 | 384 | | 111 | 115 | 119 | 120 | |
| -375 | 262 | 215 | 210 | 261 | | 387 | 353 | 359 | 408 | | 125 | 138 | 149 | 147 | |
| -300 | 262 | 213 | 209 | 260 | 469 | 406 | 381 | 389 | 433 | 516 | 144 | 168 | 180 | 173 | 47 |
| -225 | 262 | 213 | 208 | 255 | 461 | 414 | 414 | 416 | 454 | 530 | 152 | 201 | 208 | 199 | 69 |
| -150 | 262 | 212 | 208 | 253 | 457 | 440 | 455 | 459 | 482 | 547 | 178 | 243 | 251 | 229 | 90 |
| -75 | 262 | 212 | 208 | 250 | 457 | 481 | 498 | 496 | 511 | 573 | 219 | 286 | 288 | 261 | 116 |
| 0 | 261 | 212 | 208 | 251 | 458 | 510 | 521 | 524 | 544 | 570 | 249 | 309 | 316 | 293 | 112 |
| 75 | 260 | 211 | 208 | 248 | 456 | 489 | 505 | 509 | 512 | 545 | 229 | 294 | 301 | 264 | 89 |
| 150 | 260 | 212 | 208 | 247 | 456 | 442 | 455 | 451 | 461 | 536 | 182 | 243 | 243 | 214 | 80 |
| 225 | 261 | 213 | 209 | 244 | 457 | 370 | 345 | 343 | 401 | 523 | 109 | 132 | 134 | 157 | 66 |
| 300 | 260 | 213 | 209 | 240 | 457 | 363 | 333 | 330 | 368 | 518 | 103 | 120 | 121 | 128 | 61 |
| 450 | 259 | 214 | 210 | 237 | 457 | 337 | 310 | 305 | 345 | 503 | 78 | 96 | 95 | 108 | 46 |
| 600 | 260 | 215 | 211 | 237 | 456 | 299 | 286 | 281 | 314 | 488 | 39 | 71 | 70 | 77 | 32 |
| 750 | 259 | 217 | 212 | 236 | 453 | 260 | 245 | 255 | 282 | 472 | 1 | 28 | 43 | 46 | 19 |
| 900 | 229 | 211 | 212 | 237 | 460 | 202 | 199 | 215 | 257 | 472 | -27 | -12 | 3 | 20 | 12 |
| 1050 | | 190 | 187 | 240 | 474 | | 172 | 162 | 229 | 480 | | -18 | -25 | -11 | 6 |
| 1200 | | | | 243 | | | | | 204 | | | | | -39 | |
| 1350 | | | | 247 | | | | | 249 | | | | | 2 | |
| 1500 | | | | 251 | | | | | 256 | | | | | 5 | |
| 1650 | | | | 257 | | | | | 263 | | | | | 6 | |
| 1800 | | | | 266 | | | | | 272 | | | | | 6 | |

## DATA SHEET NO. 15 (CONTINUED)

## VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011



## DATA SHEET NO. 16

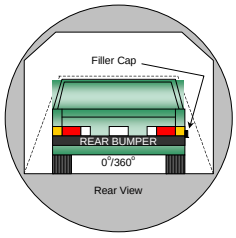
## SUMMARY OF FMVSS 301 FUEL SYSTEM DATA

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

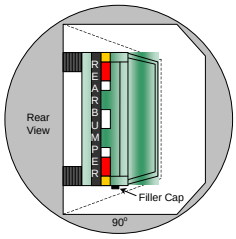
### FUEL SYSTEM INTEGRITY POST IMPACT DATA

| Time Interval | FMVSS 301 Maximum Allowable Spillage | Spillage (g) |
|---|---|---|
| Impact Until Motion Ceases | 28 g | 0 |
| First Five Minutes Following Impact | 142 g | 0 |
| Next 25 Minutes | 28 g / 1 minute | 0 |

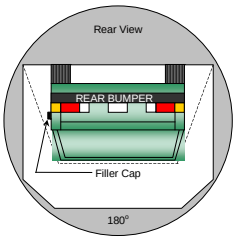
### STATIC ROLLOVER DATA



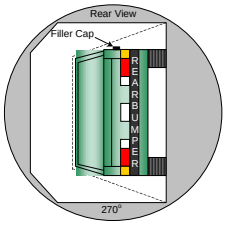

**0/360**




**90**




**180**




**270**

**REAR VIEW**

| Rollover Stage | Rotation Time (spec. 1-3 min) | | | | FMVSS 301 Hold Time | | Total Time | | | | Next Whole Minute Interval | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0° - 90° | 1 | minutes | 59 | seconds | 5 | minutes | 6 | minutes | 59 | seconds | 7 | minutes |
| 90° - 180° | 1 | minutes | 56 | seconds | 5 | minutes | 6 | minutes | 56 | seconds | 7 | minutes |
| 180° - 270° | 1 | minutes | 51 | seconds | 5 | minutes | 6 | minutes | 51 | seconds | 7 | minutes |
| 270° - 360° | 1 | minutes | 58 | seconds | 5 | minutes | 6 | minutes | 58 | seconds | 7 | minutes |

| Rollover Stage | Spillage (g) | | | |
|---|---|---|---|---|
| | First 5 min. from onset of rotation | 6th min. | 7th min. | 8th min. (if required) |
| 0° - 90° | 0 | 0 | 0 | |
| 90° - 180° | 0 | 0 | 0 | |
| 180° - 270° | 0 | 0 | 0 | |
| 270° - 360° | 0 | 0 | 0 | |
| FMVSS 301 Maximum Allowable (for each 90° stage) | 142 | 28 | 28 | 28 |

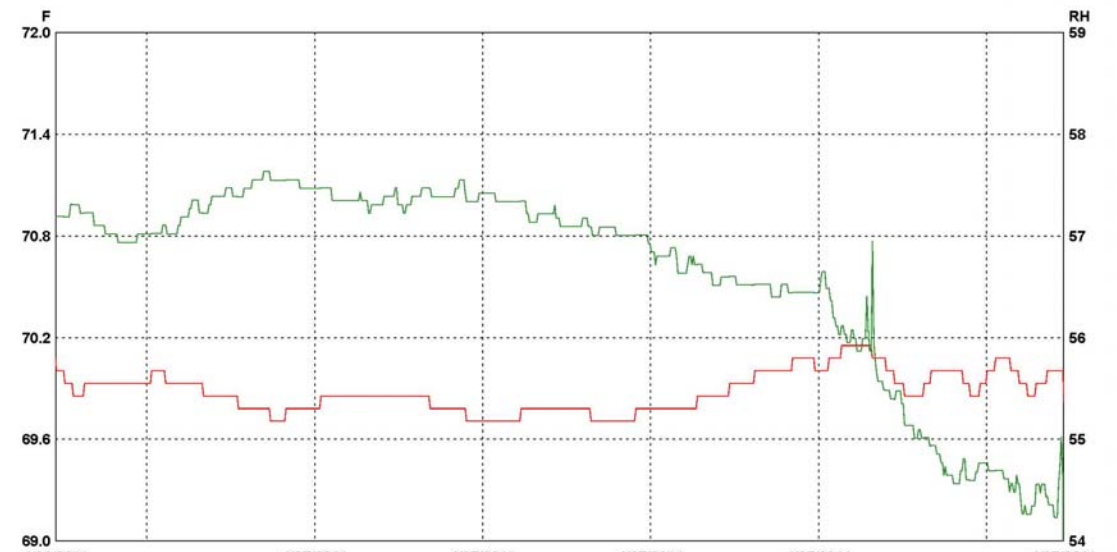
| Rollover Stage | Spillage Location(s) |
|---|---|
| 0° to 90° | None |
| 90° to 180° | None |
| 180° to 270° | None |
| 270° to 360° | None |

**DATA SHEET NO. 17**

**TEMPERATURE AND HUMIDITY TRACES**

Test Vehicle: 2011 Subaru Legacy 4-Dr Sedan NHTSA No. CB5502
Test Program: FMVSS 214 Pole Test Date: 4/27/2011

Time of Impact: 10:52 am




| LN | Serial # | Description | CH | Value | Maximum | Average | Minimum | Units | CH description | Logger file |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10102056 | Vehicle Prep | 1 | | 70.15 | 69.88 | 69.71 | F | Temperature | 10102056_Vehicle_Prep.spl |
| 2 | 10102056 | Vehicle Prep | 2 | | 57.6 | 56.6 | 54.2 | RH | Humidity | 10102056_Vehicle_Prep.spl |

# APPENDIX A

# PHOTOGRAPHS

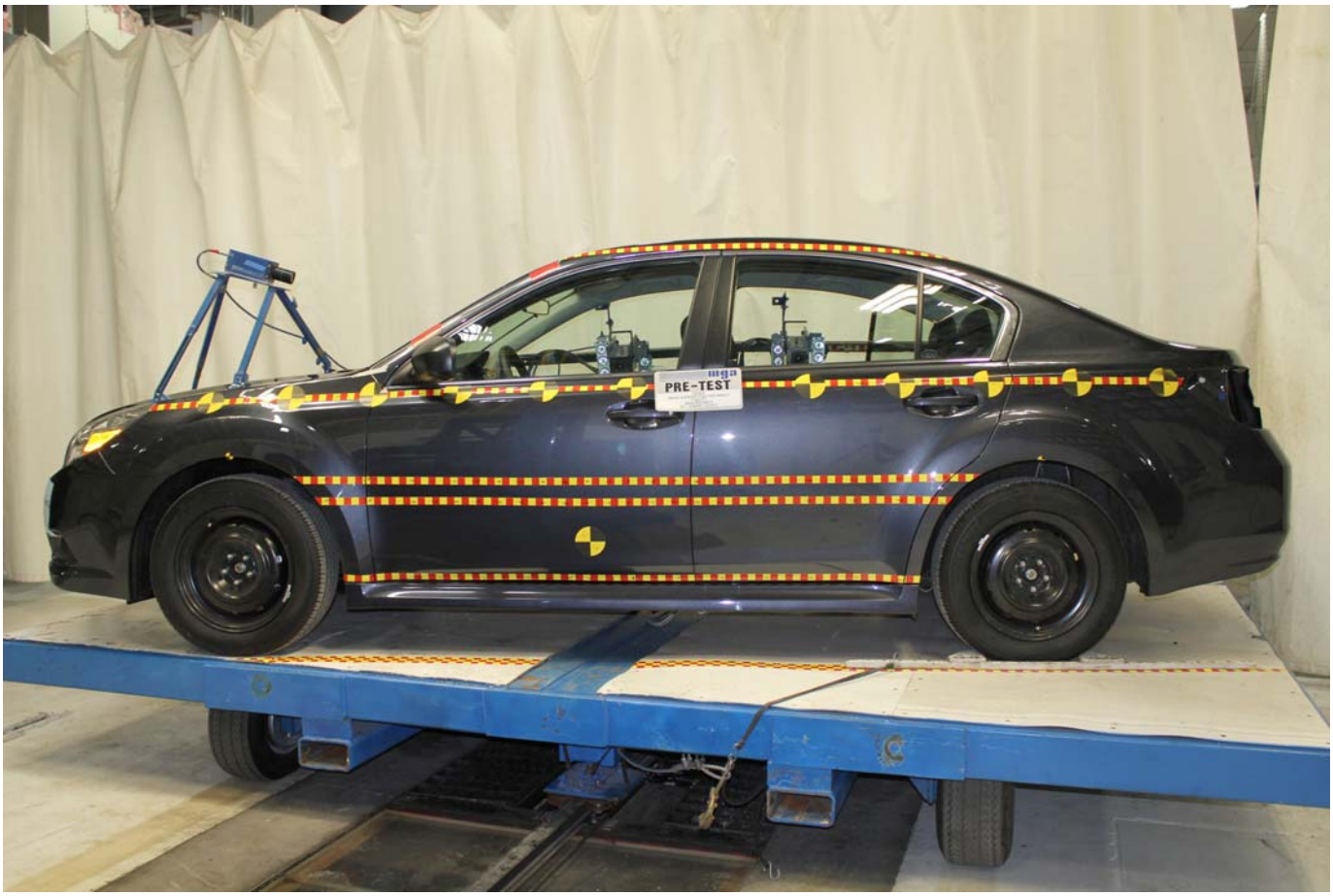
TABLE OF PHOTOGRAPHS


Pre-Test Frontal View of Test Vehicle


Post-Test Frontal View of Test Vehicle

Pre-Test Rear View of Test Vehicle

Post-Test Rear View of Test Vehicle

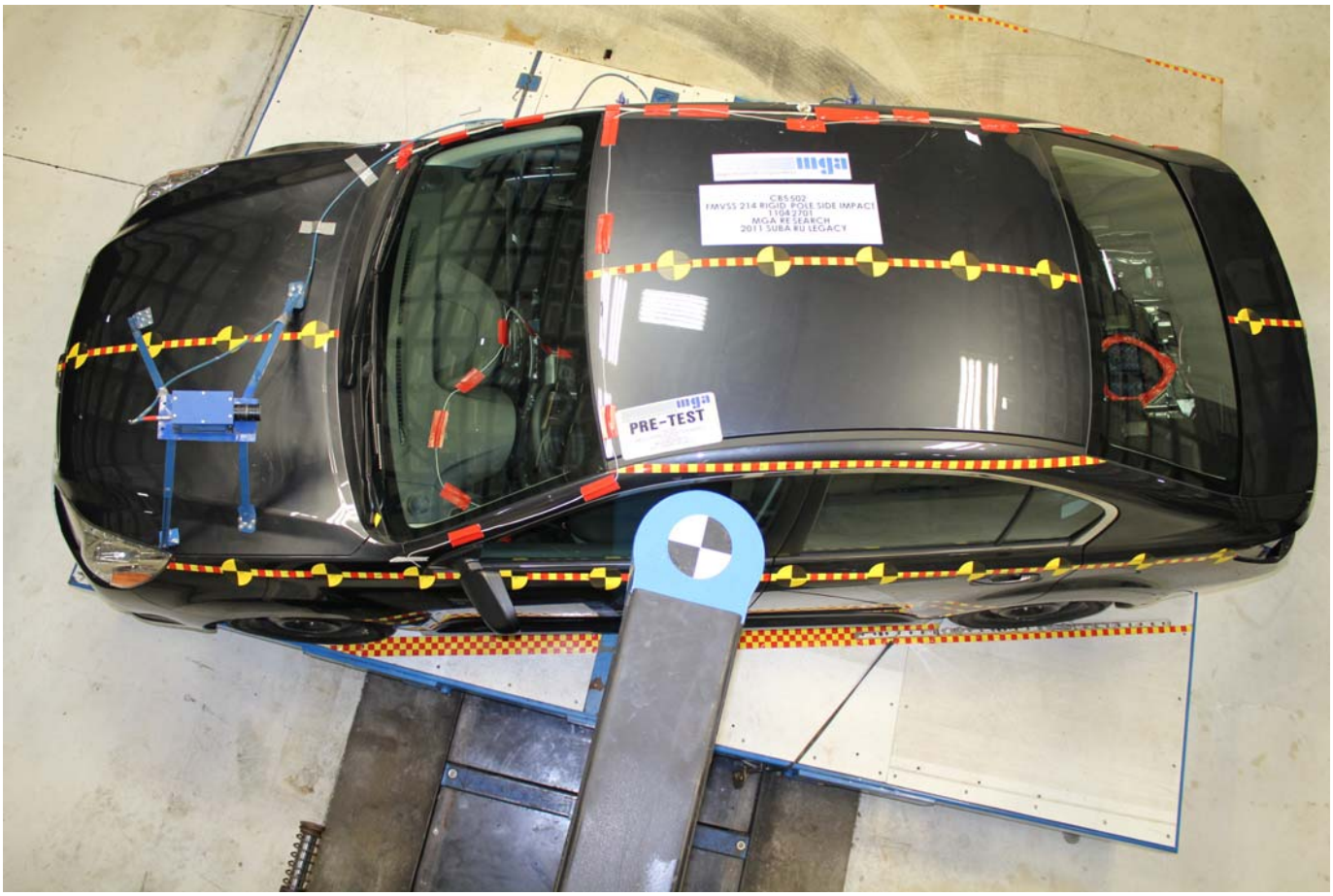



Pre-Test Impacted Side View of Test Vehicle


Post-Test Impacted Side View of Test Vehicle


Pre-Test Left ¾ Front View of Vehicle and Pole

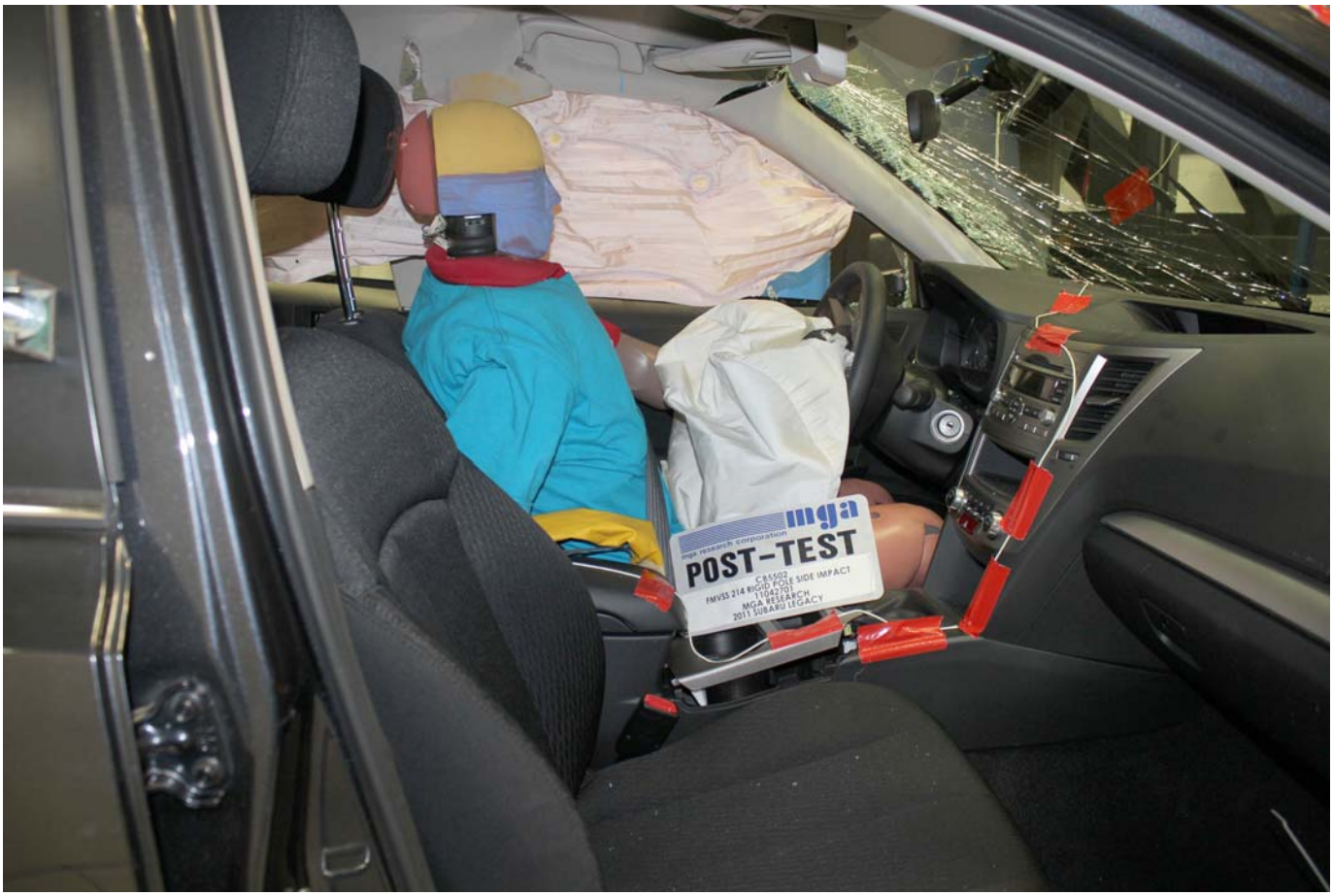

Pre-Test Left ¾ Rear View of Vehicle and Pole




Pre-Test Overhead View of Test Vehicle


Post-Test Overhead View of Test Vehicle

Pre-Test Dummy Through Opposite Window



Post-Test Dummy Through Opposite Window

Pre-Test Close-up of Dummy with Door Closed (Impact Side)

Post-Test Dummy with Door Closed (Impact Side)

Pre-Test Dummy Door Open

Pre-Test Dummy Shoulder and Door Top View

Post-Test Dummy Shoulder and Door Top View

Pre-Test Interior of Front Door Closed

Post-Test Interior of Front Door Showing Dummy Impact Locations

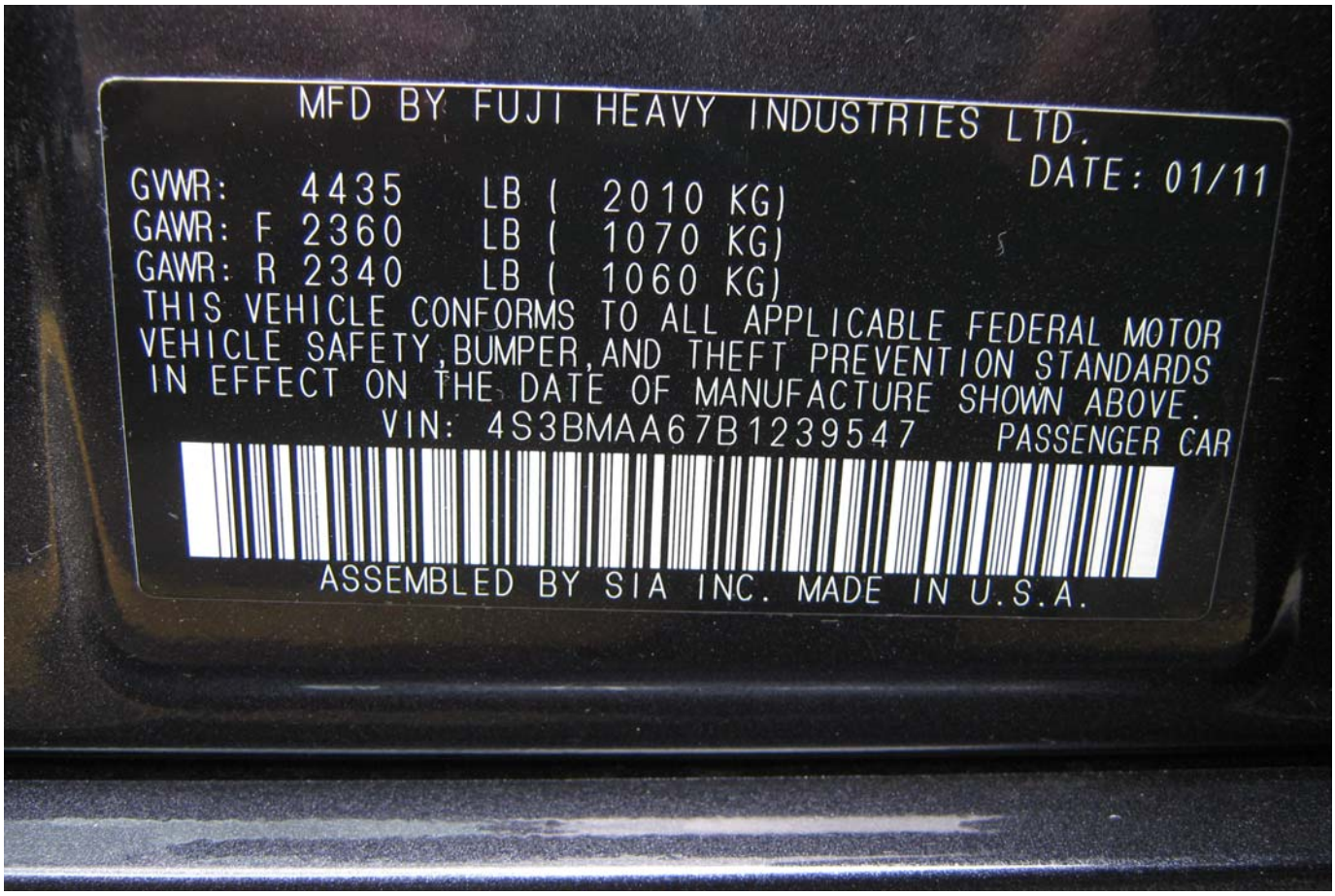

Impact Event


Post-Test Impact Zone Close-up View

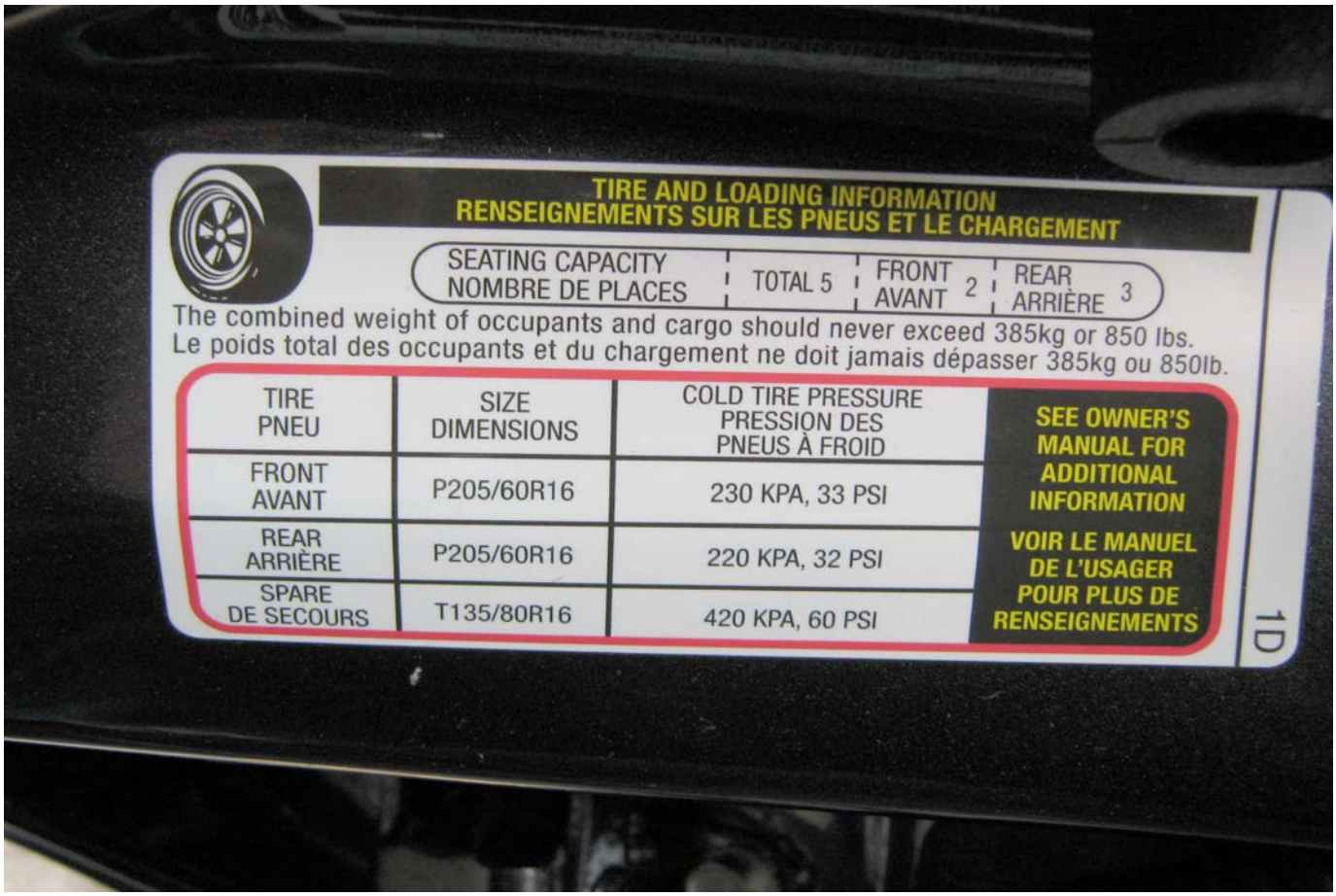

Post-Test ¾ Front View of Impact Zone


Post-Test ¾ Rear View of Impact Zone

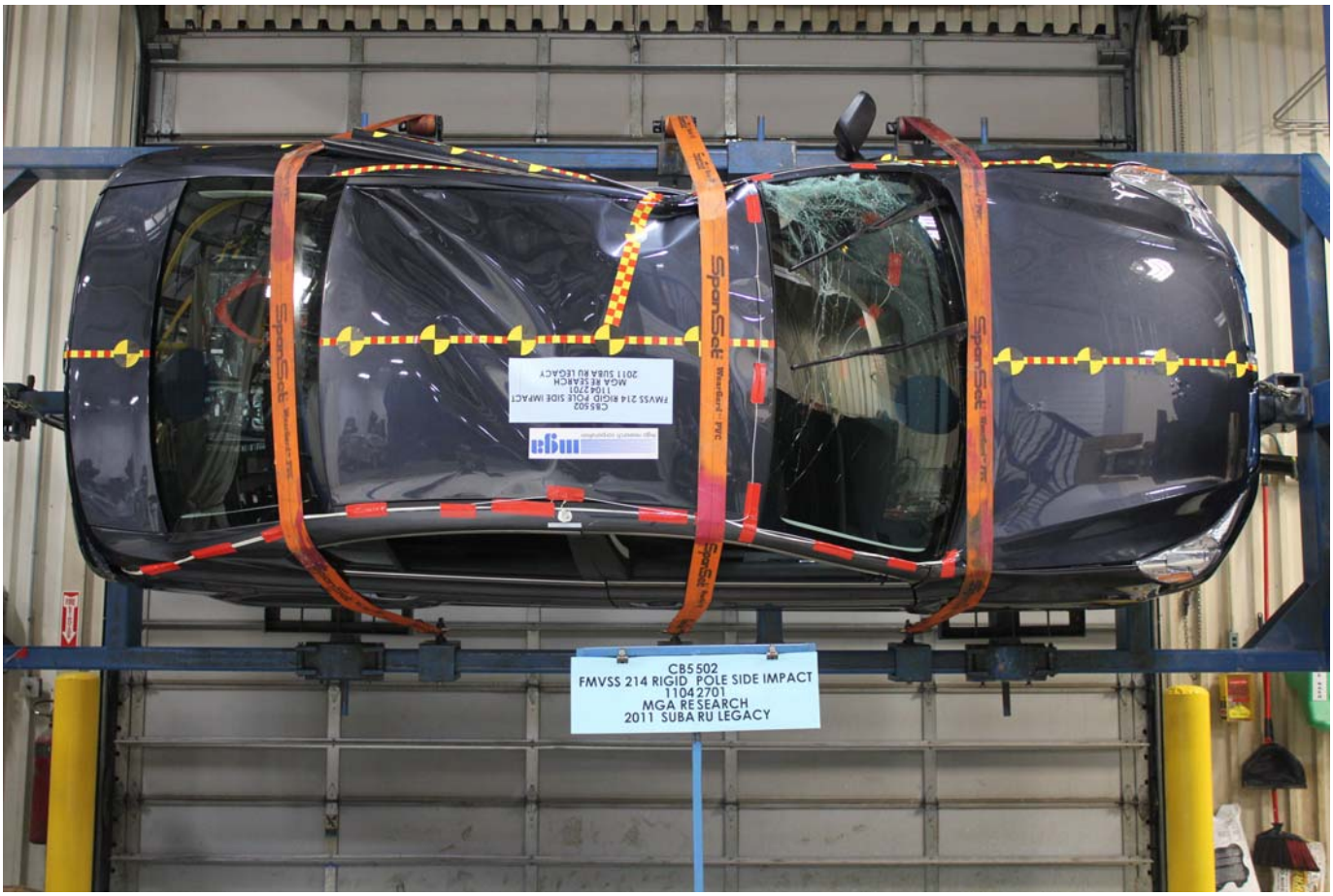
Post-Test Close-up View of Impact Point Target



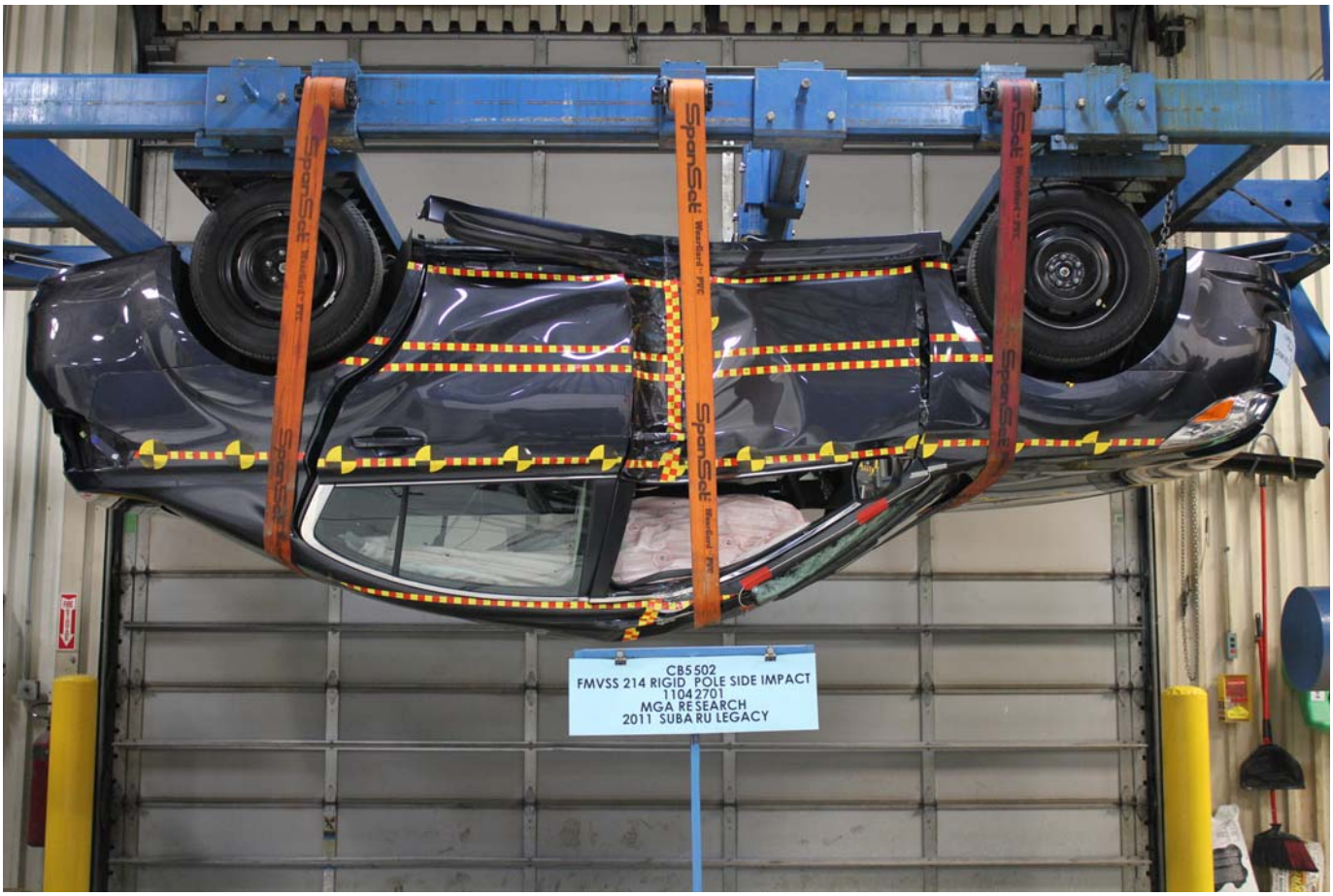

Close-up View of Vehicle's Certification Label



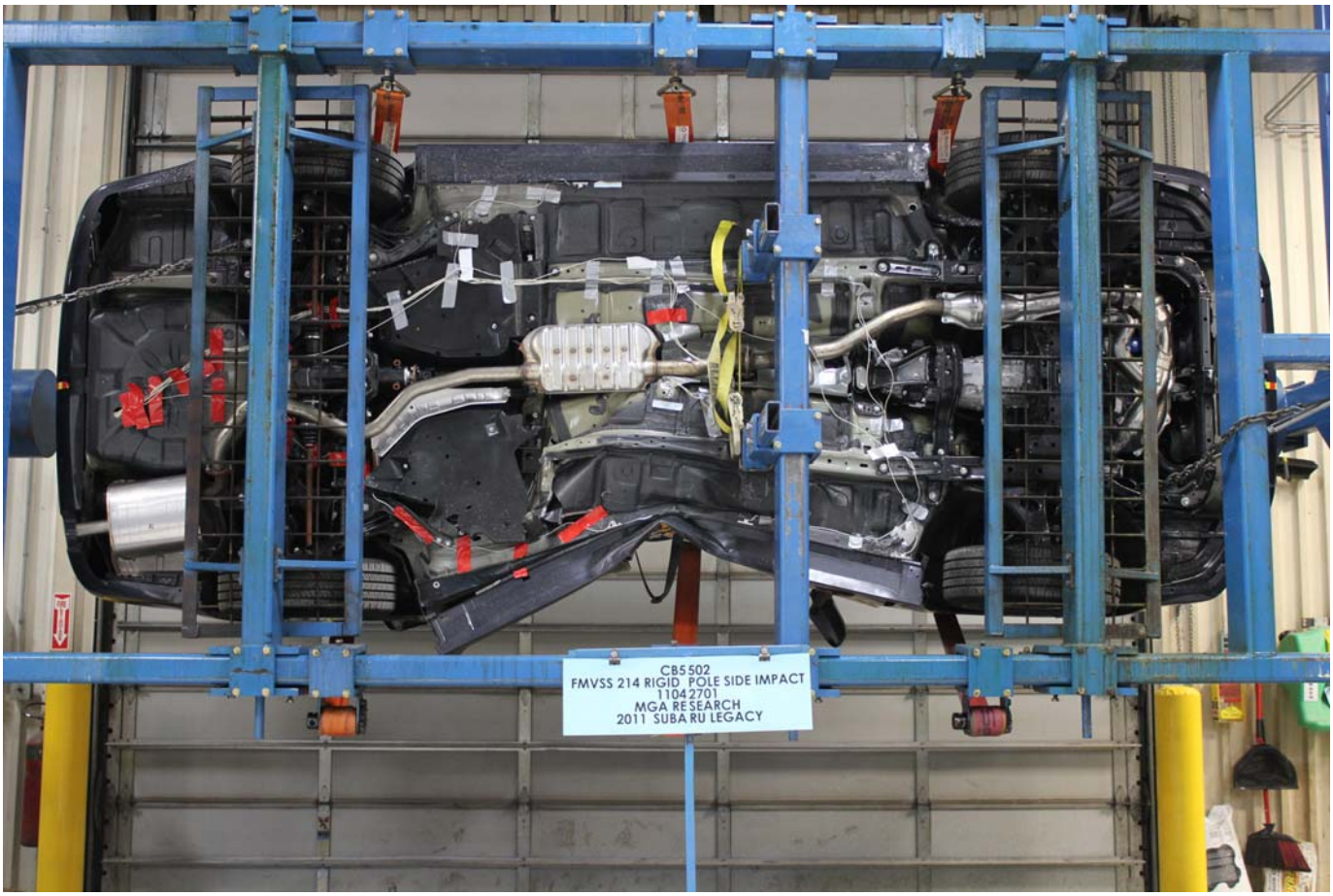

Close-up View of Vehicle's Tire Placard Label




Post-Test Vehicle at 90 Degree Rollover




Post-Test Vehicle at 180 Degree Rollover




Post-Test Vehicle at 270 Degree Rollover


Post-Test Vehicle at 360 Degree Rollover

# APPENDIX B

# DUMMY RESPONSE DATA

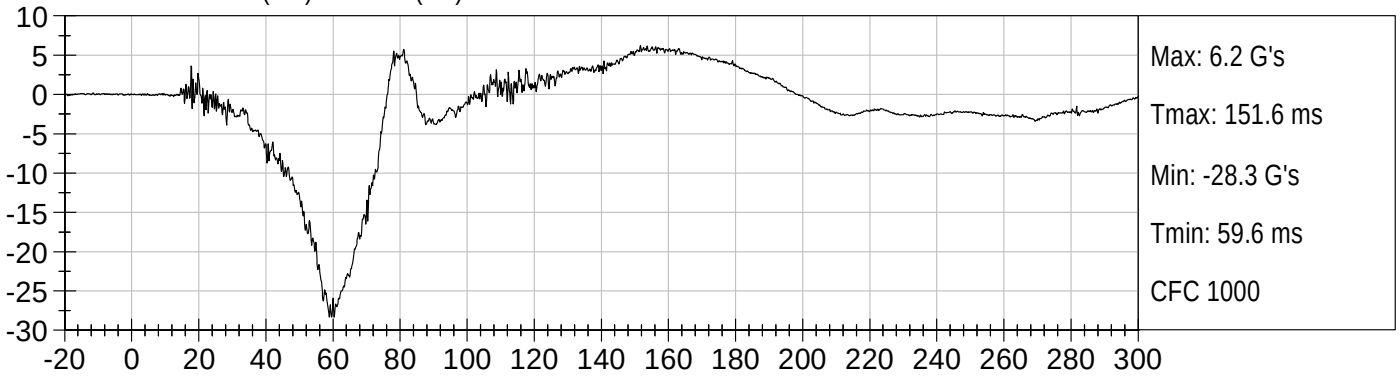
## TABLE OF DATA PLOTS

### Dummy Instrumentation Plots
### FILTERED DATA

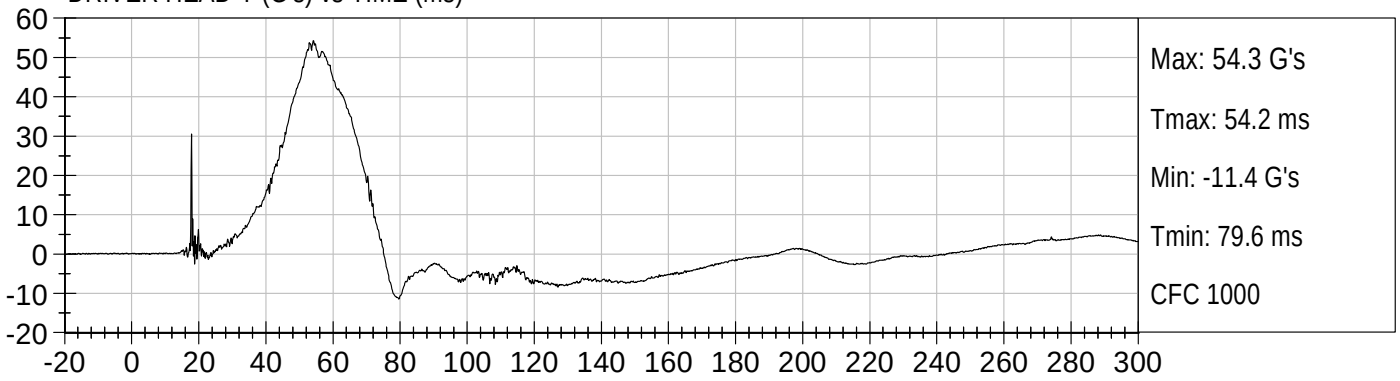
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

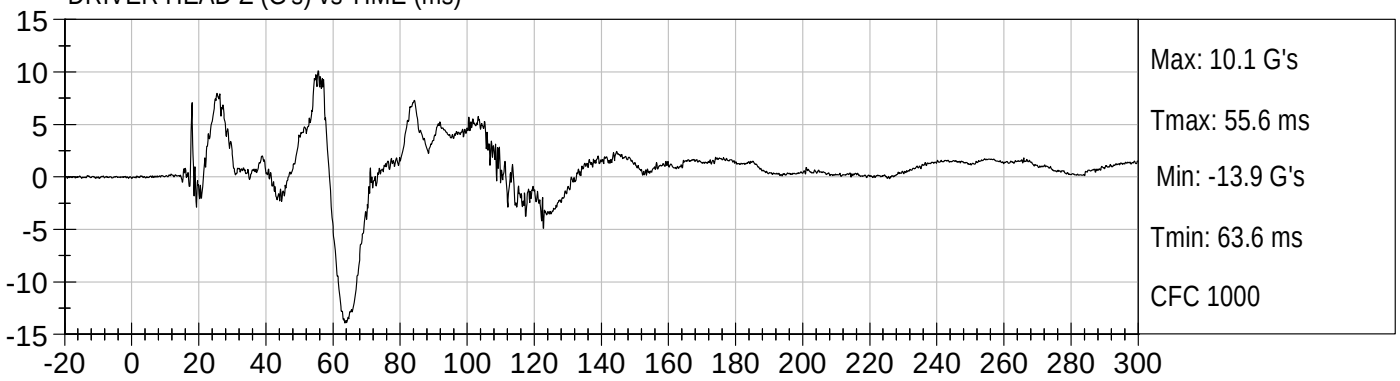
DRIVER HEAD X (G's) vs TIME (ms)



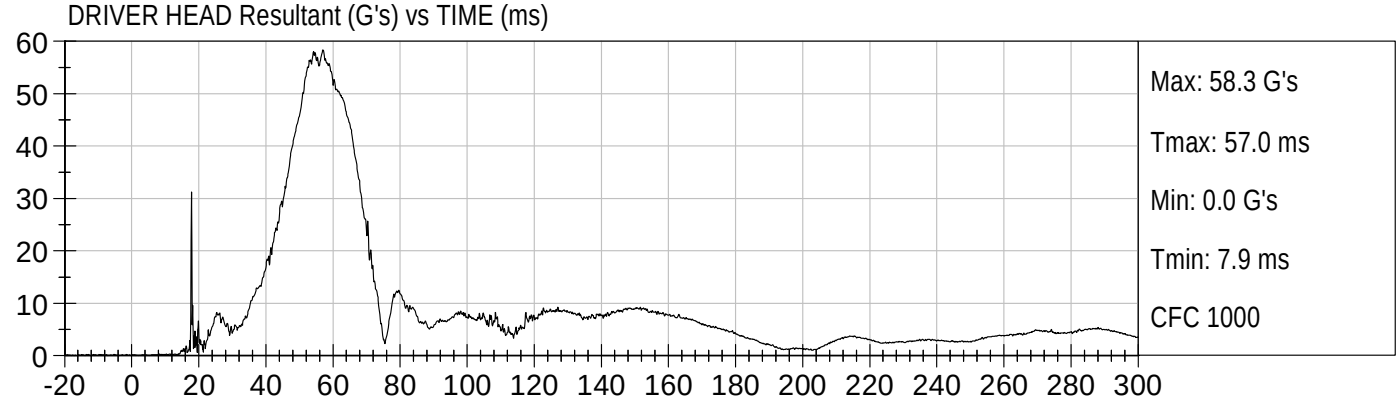

DRIVER HEAD Y (G's) vs TIME (ms)



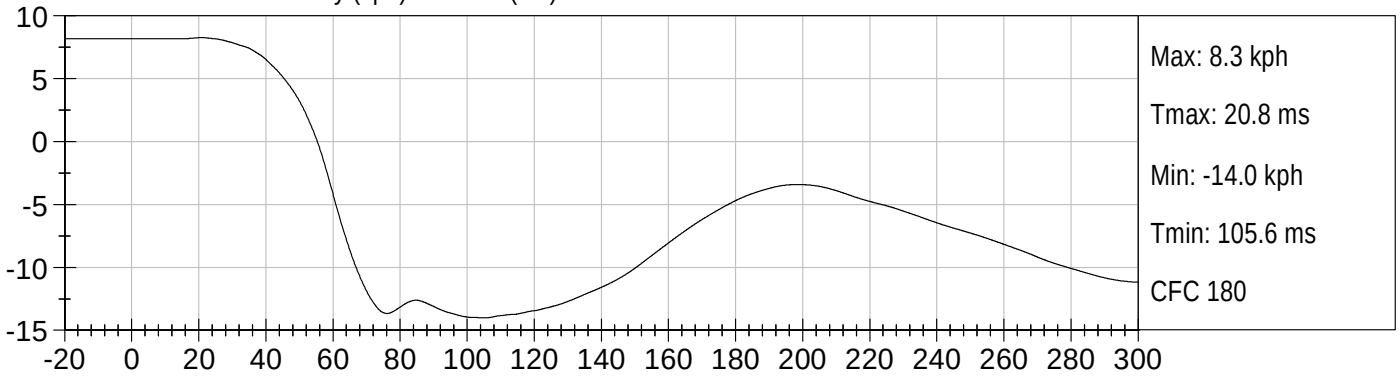

DRIVER HEAD Z (G's) vs TIME (ms)



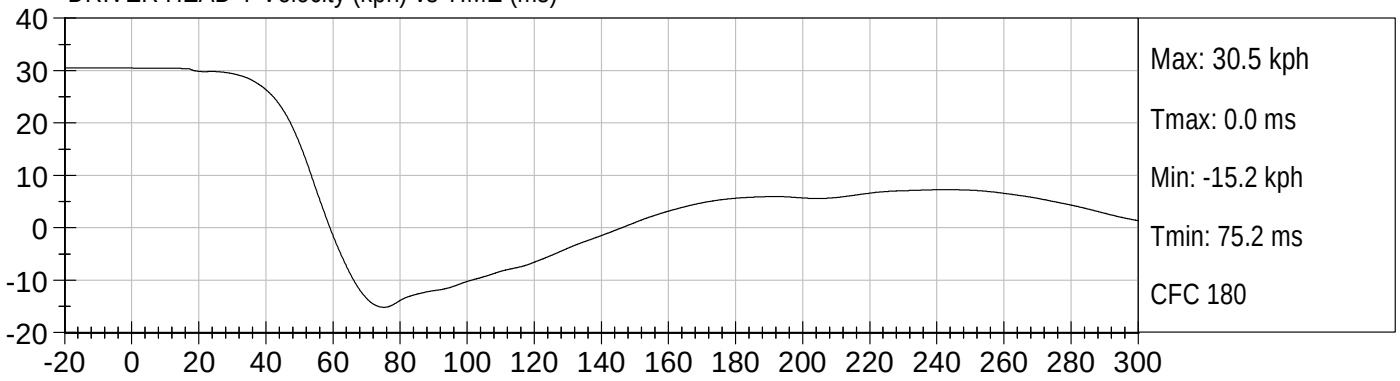

DRIVER HEAD Resultant (G's) vs TIME (ms)



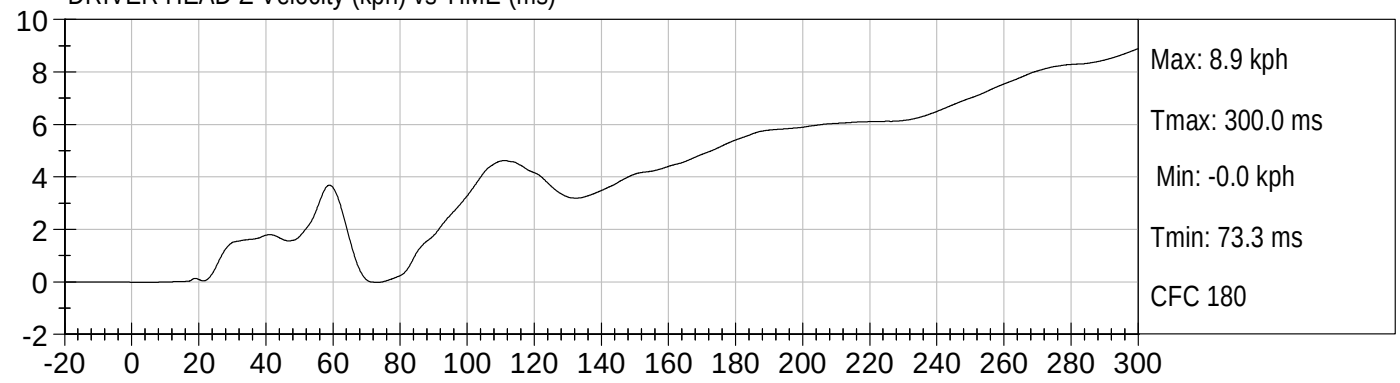
DRIVER HEAD X Velocity (kph) vs TIME (ms)



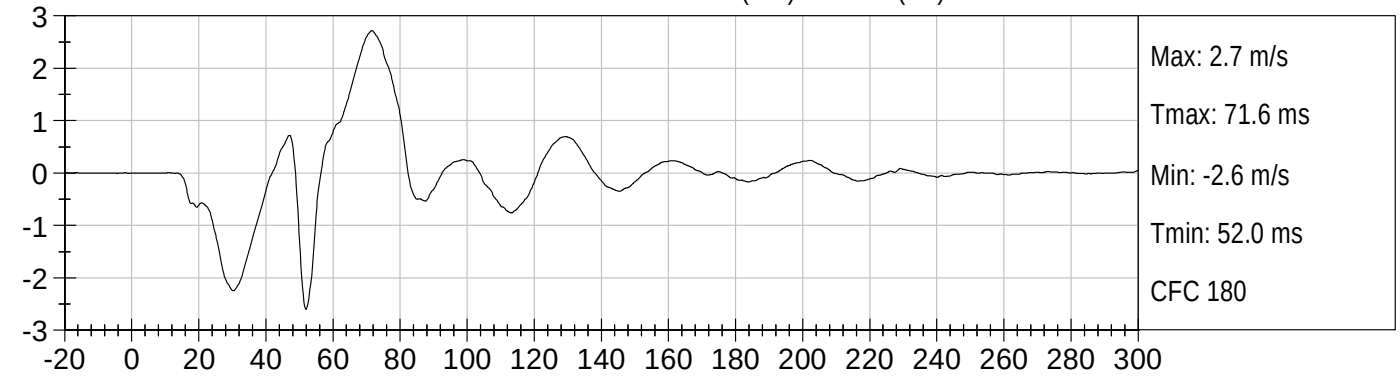

DRIVER HEAD Y Velocity (kph) vs TIME (ms)



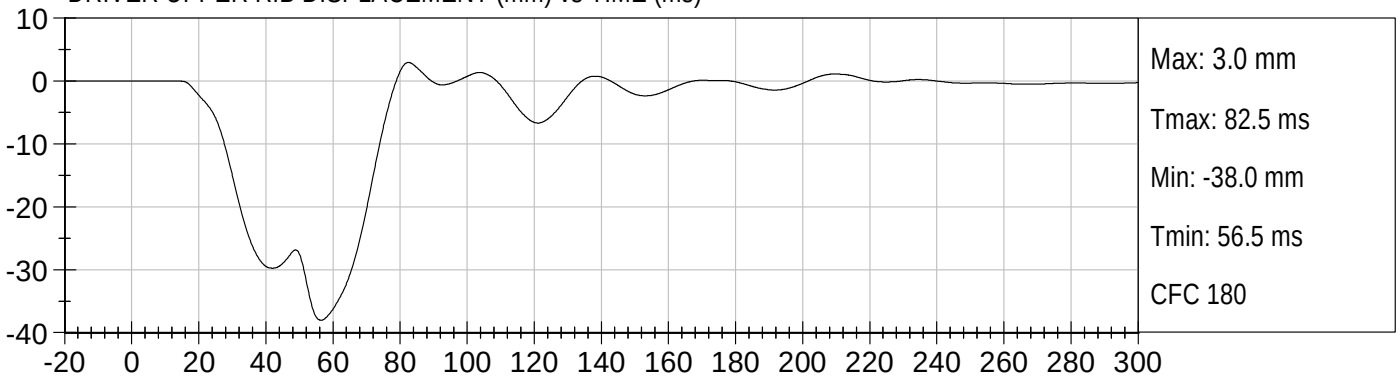

DRIVER HEAD Z Velocity (kph) vs TIME (ms)



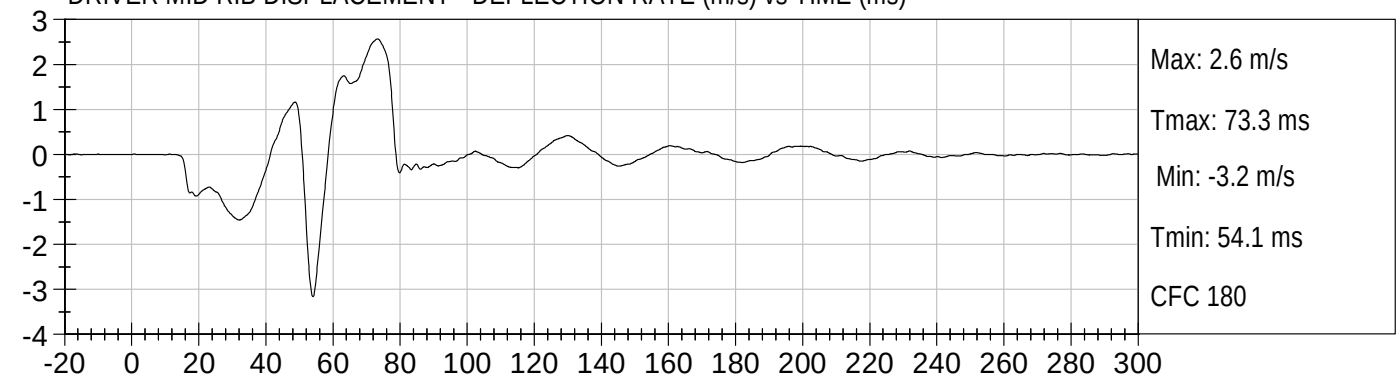
DRIVER UPPER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



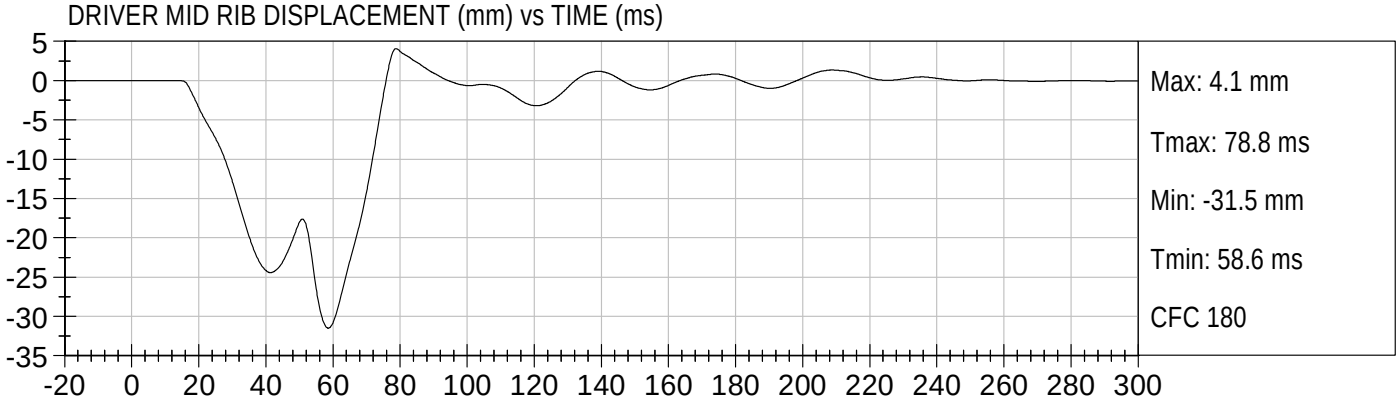

DRIVER UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



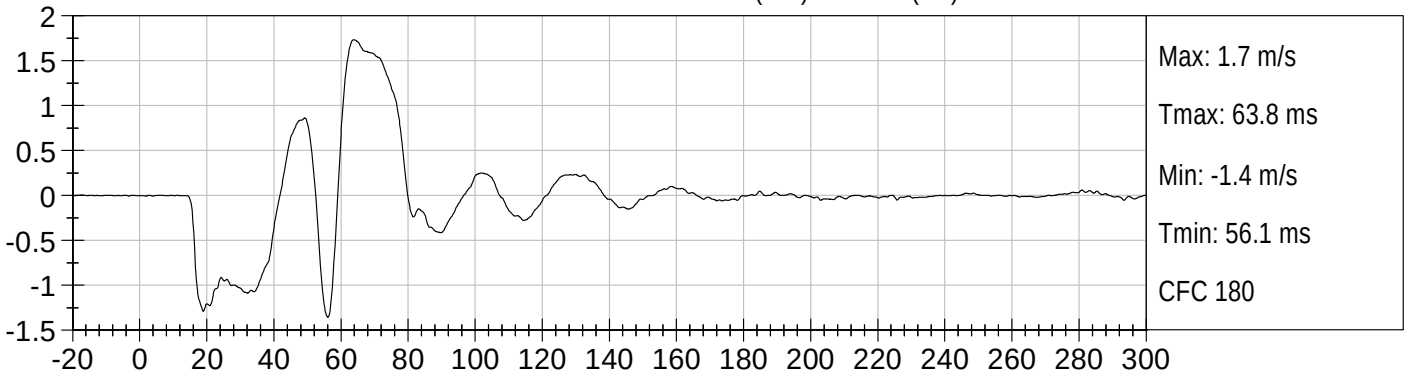

DRIVER MID RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



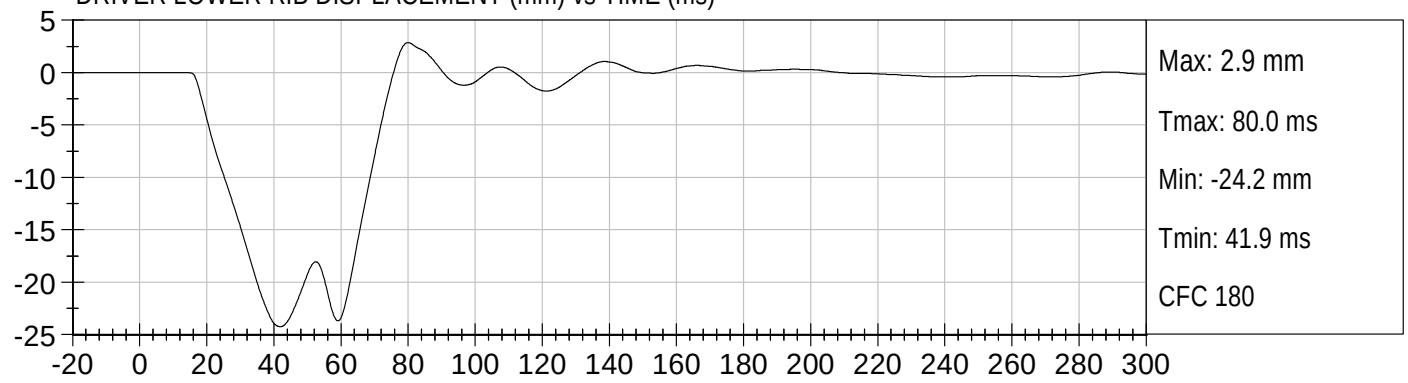

DRIVER MID RIB DISPLACEMENT (mm) vs TIME (ms)



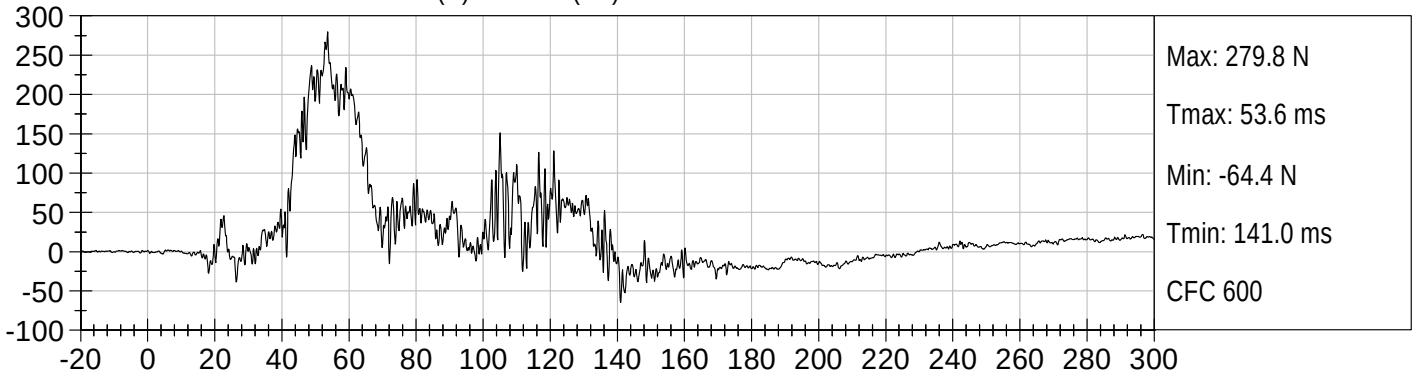
DRIVER LOWER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



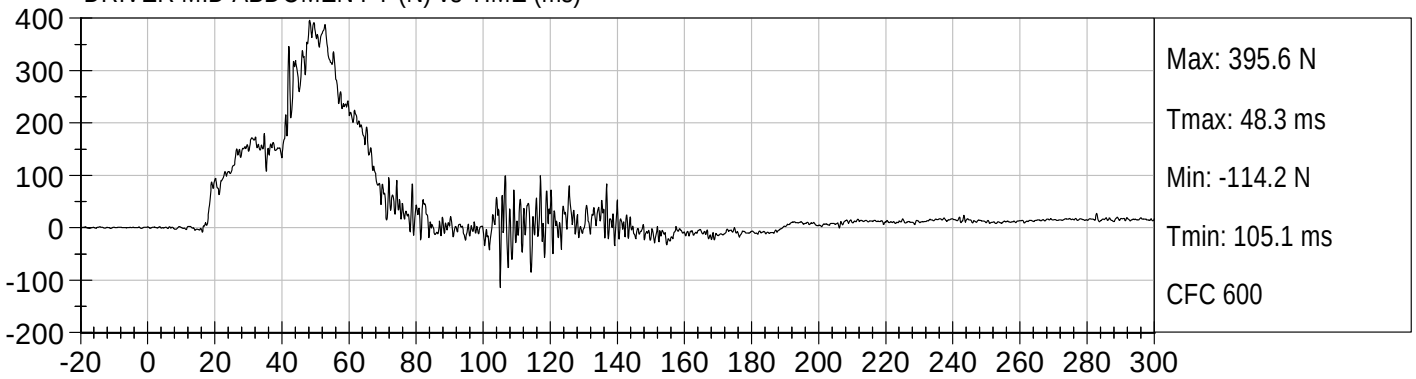

DRIVER LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



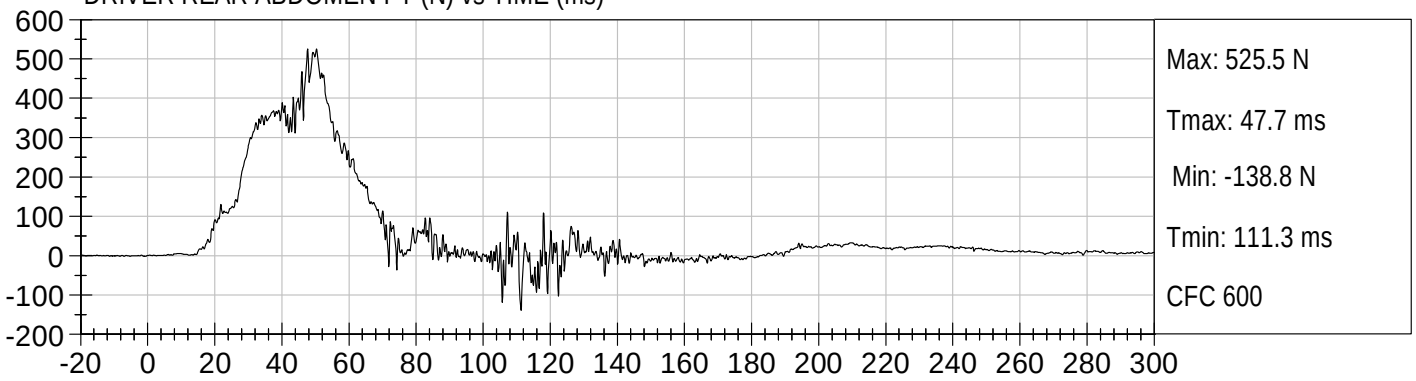
DRIVER FRONT ABDOMEN FY (N) vs TIME (ms)



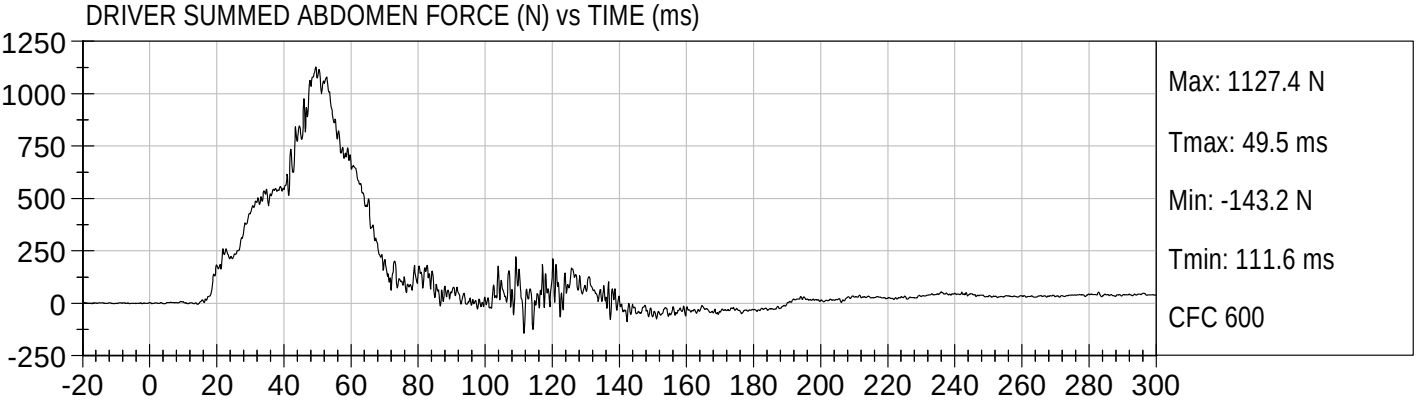

DRIVER MID ABDOMEN FY (N) vs TIME (ms)




DRIVER REAR ABDOMEN FY (N) vs TIME (ms)

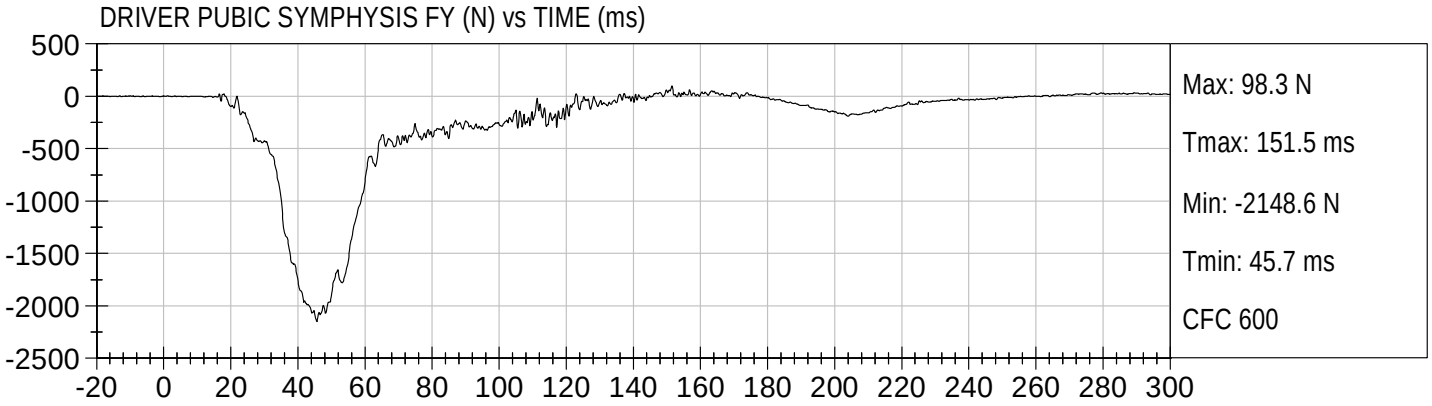



DRIVER SUMMED ABDOMEN FORCE (N) vs TIME (ms)



FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)



# APPENDIX C

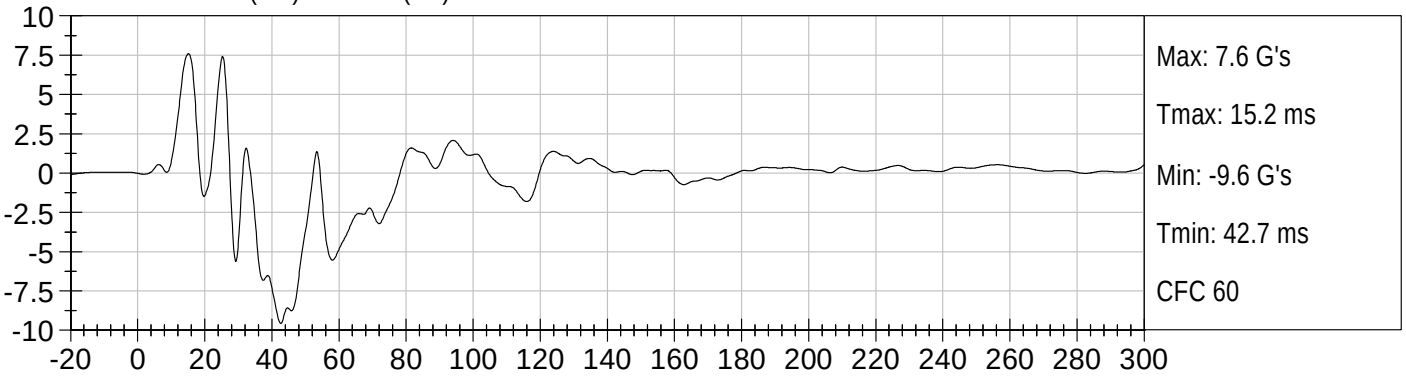
# VEHICLE ACCELEROMETER RESPONSE DATA

## TABLE OF DATA PLOTS

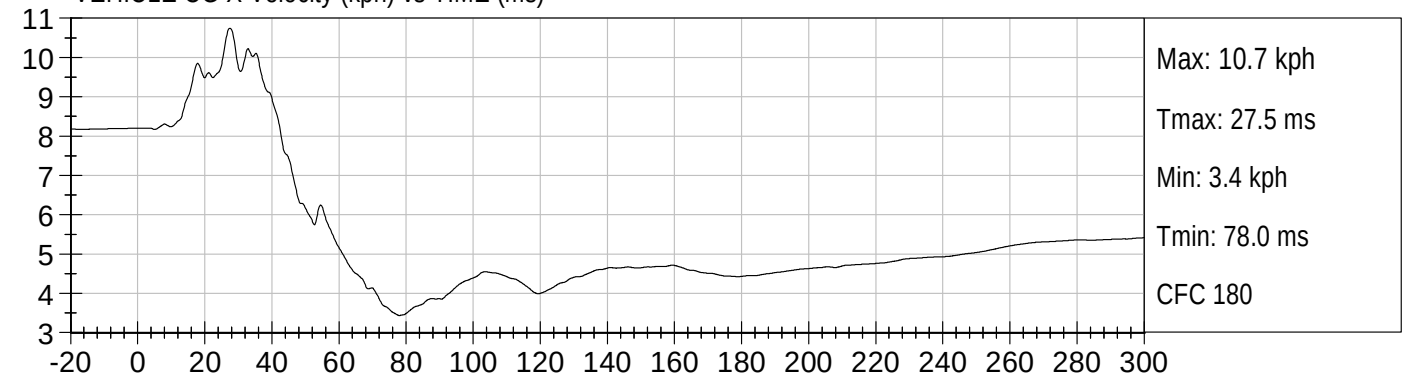
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

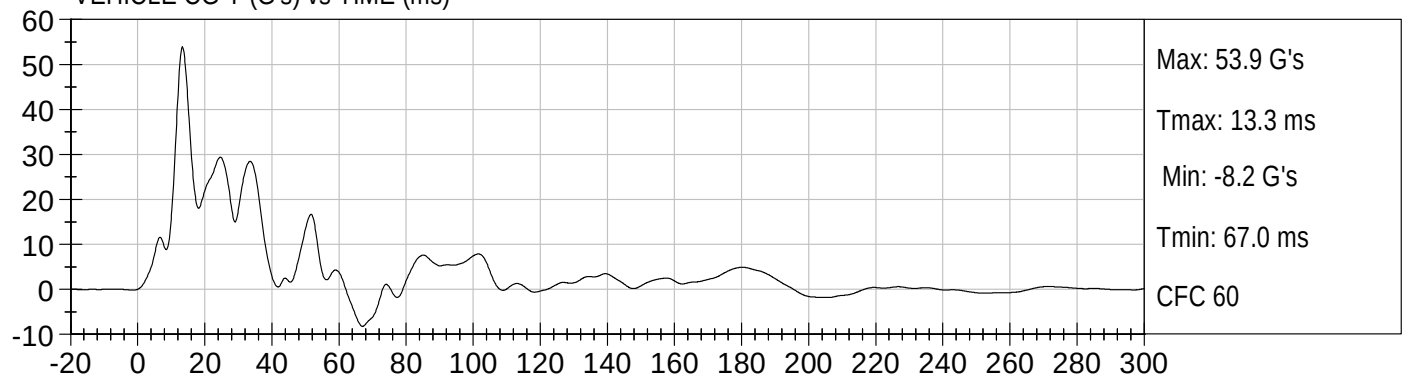
VEHICLE CG X (G's) vs TIME (ms)



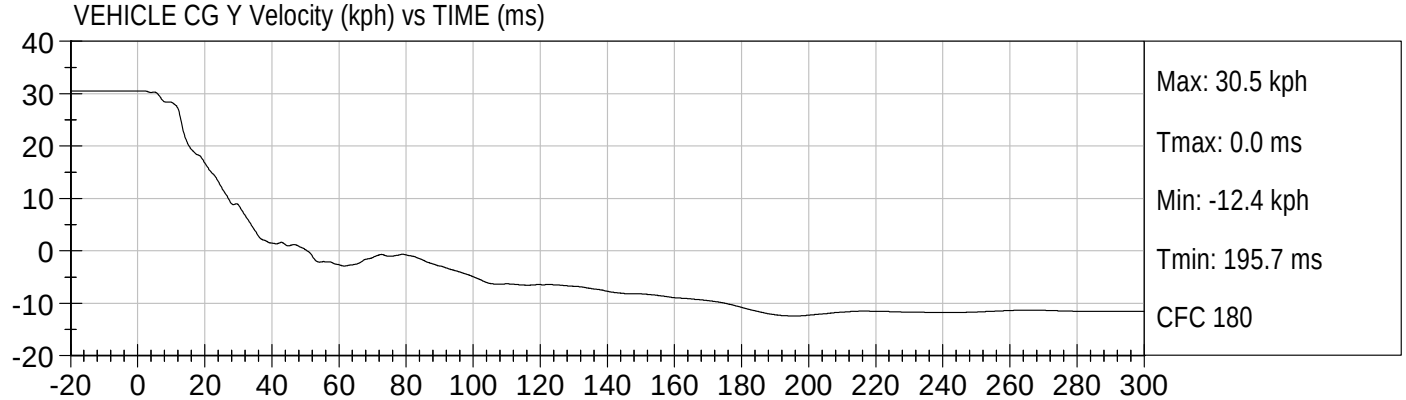

VEHICLE CG X Velocity (kph) vs TIME (ms)



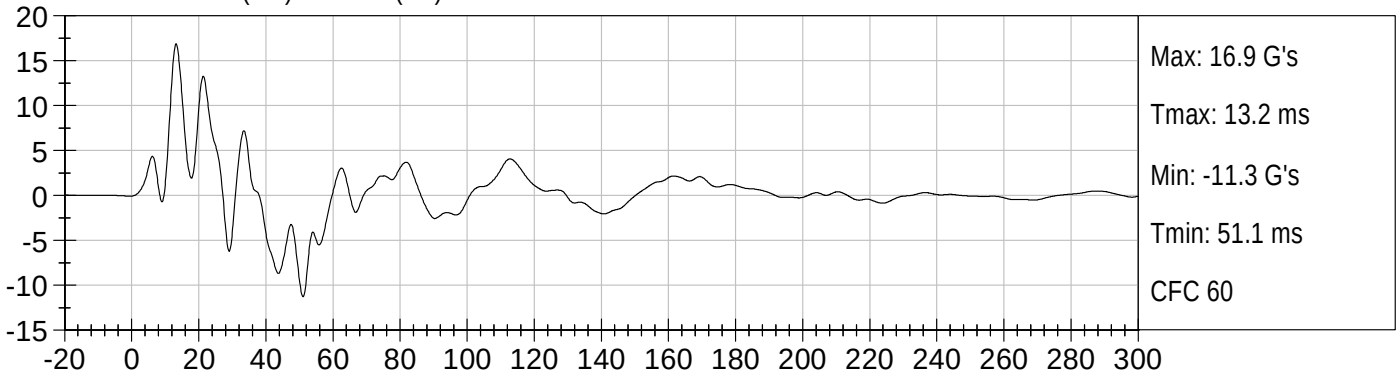

VEHICLE CG Y (G's) vs TIME (ms)



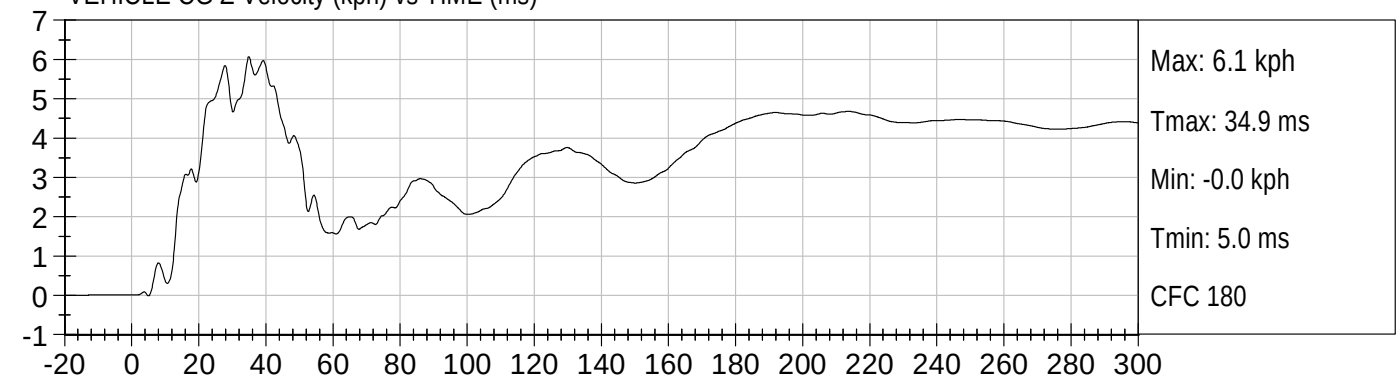

VEHICLE CG Y Velocity (kph) vs TIME (ms)



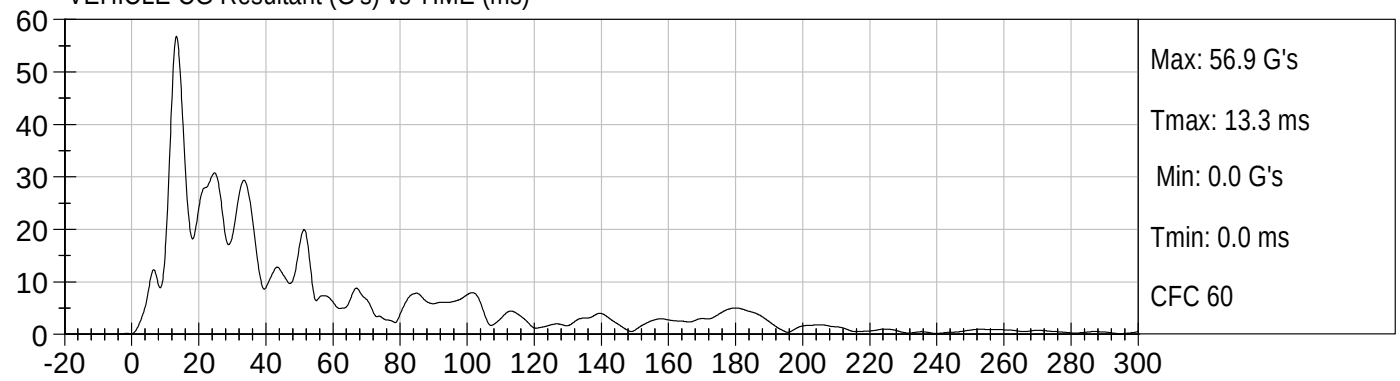
VEHICLE CG Z (G's) vs TIME (ms)




VEHICLE CG Z Velocity (kph) vs TIME (ms)



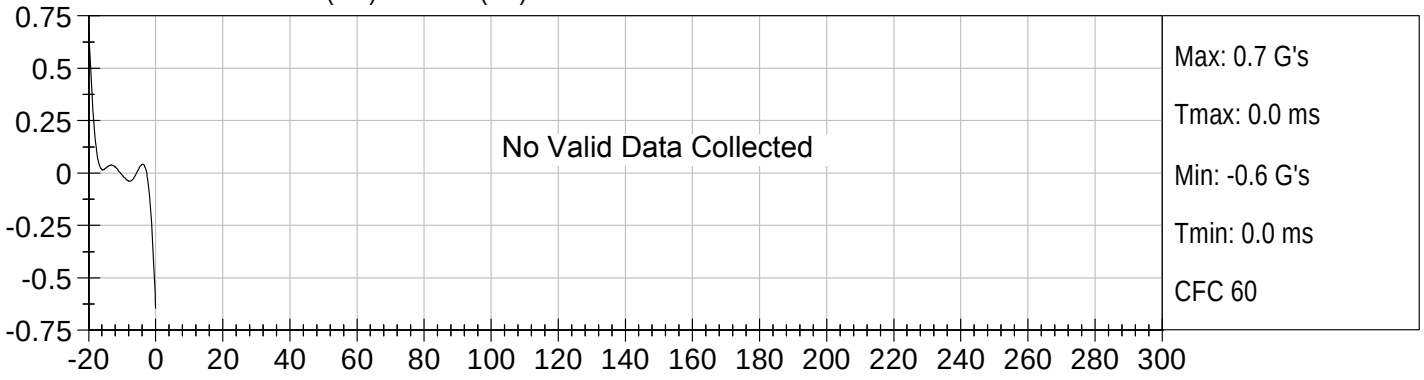

VEHICLE CG Resultant (G's) vs TIME (ms)



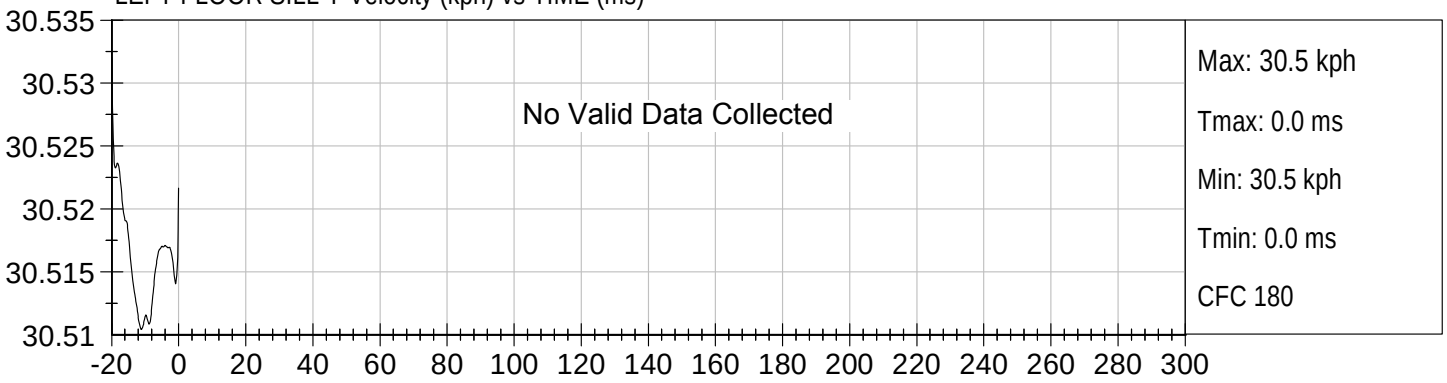
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

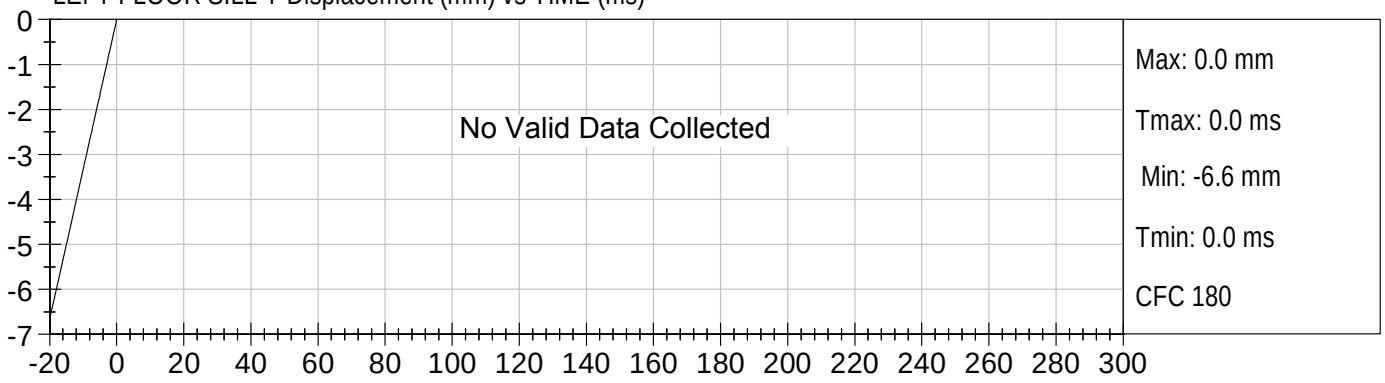
LEFT FLOOR SILL Y (G's) vs TIME (ms)



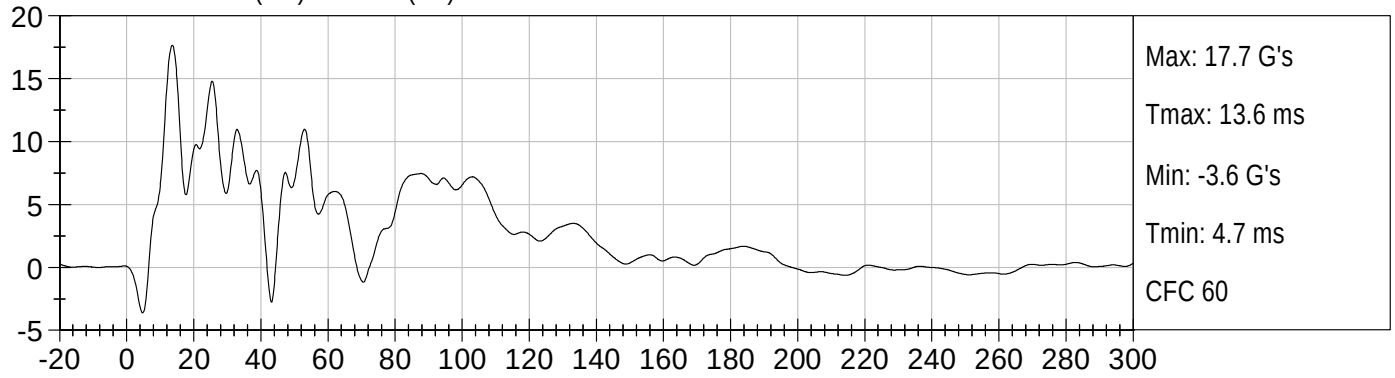

LEFT FLOOR SILL Y Velocity (kph) vs TIME (ms)



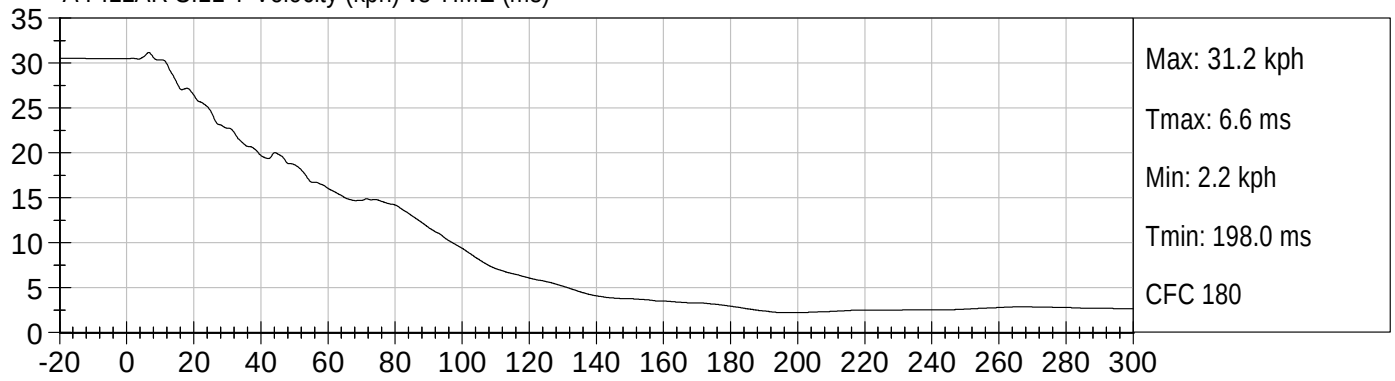

LEFT FLOOR SILL Y Displacement (mm) vs TIME (ms)



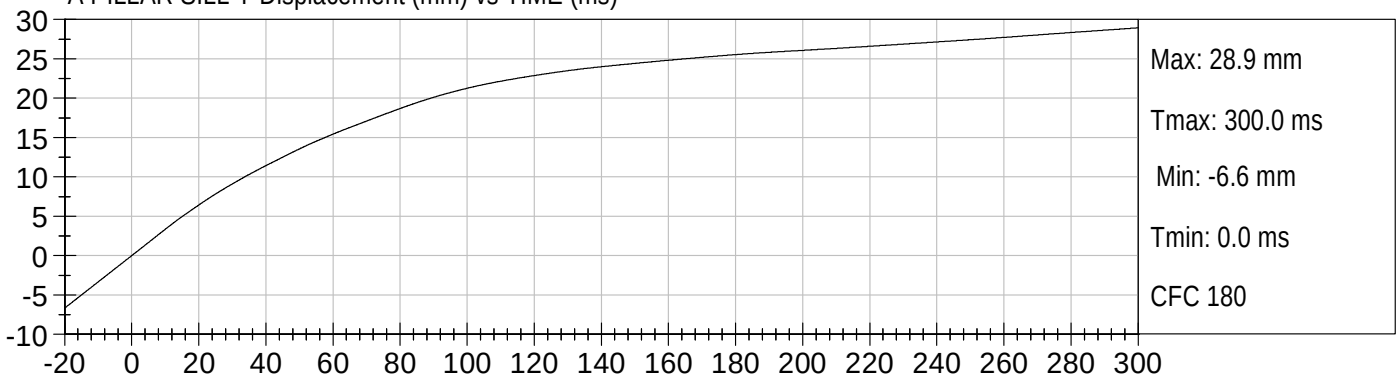
A PILLAR SILL Y (G's) vs TIME (ms)



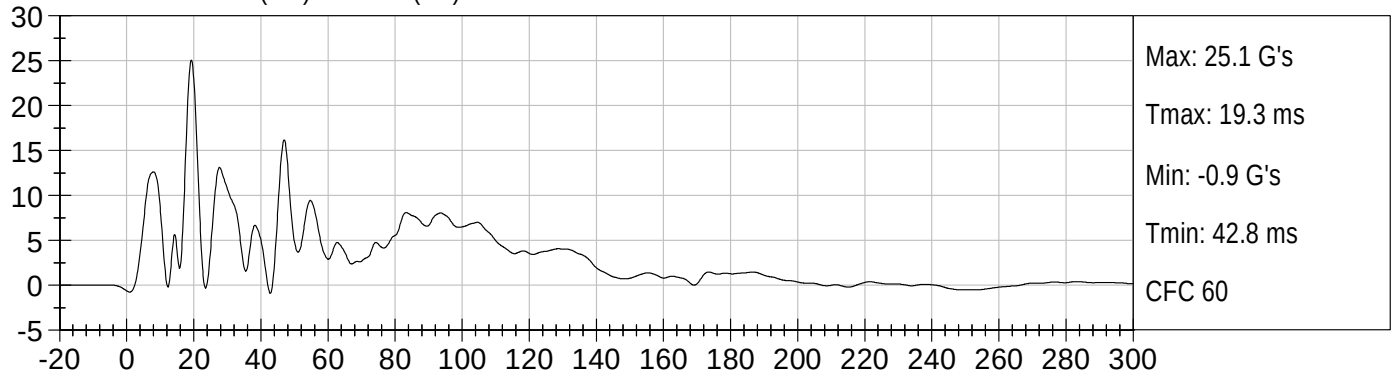

A PILLAR SILL Y Velocity (kph) vs TIME (ms)



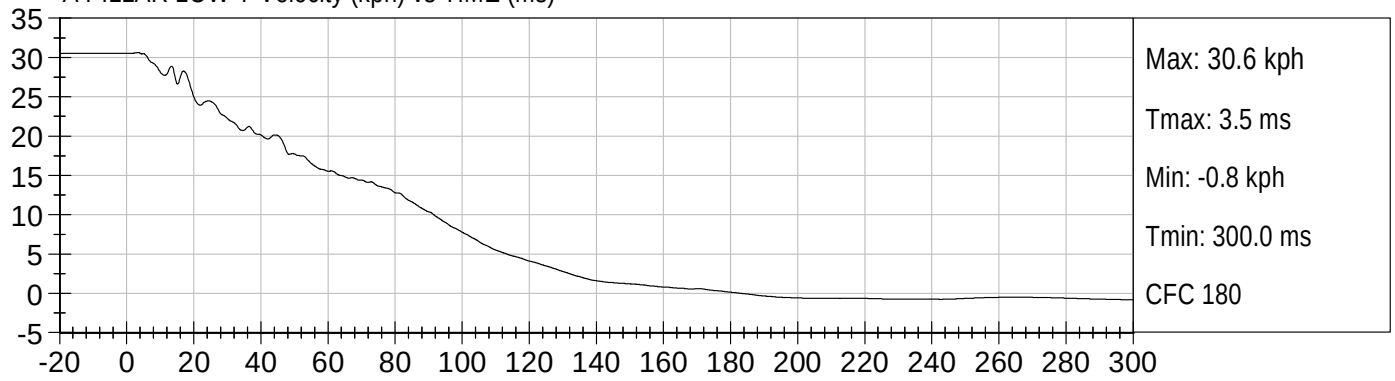

A PILLAR SILL Y Displacement (mm) vs TIME (ms)



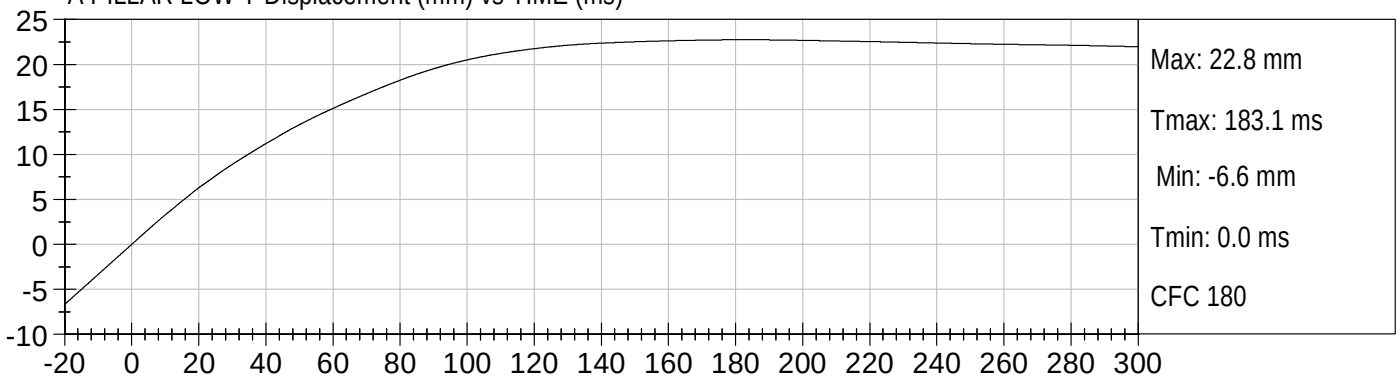
A PILLAR LOW Y (G's) vs TIME (ms)



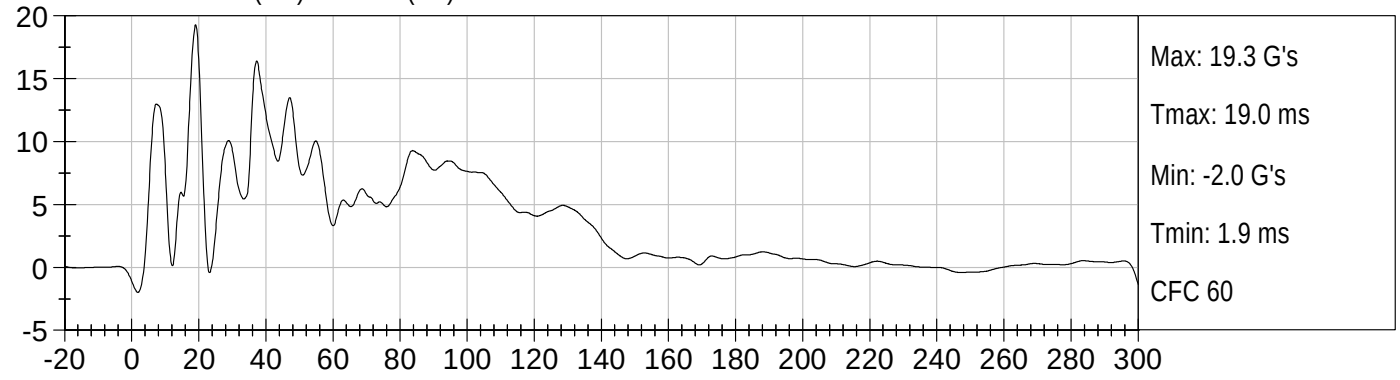

A PILLAR LOW Y Velocity (kph) vs TIME (ms)



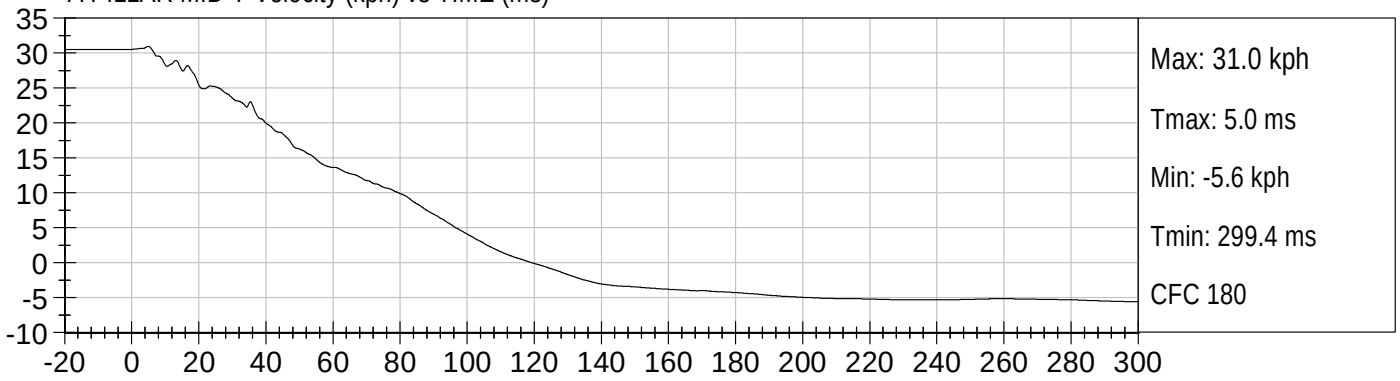

A PILLAR LOW Y Displacement (mm) vs TIME (ms)



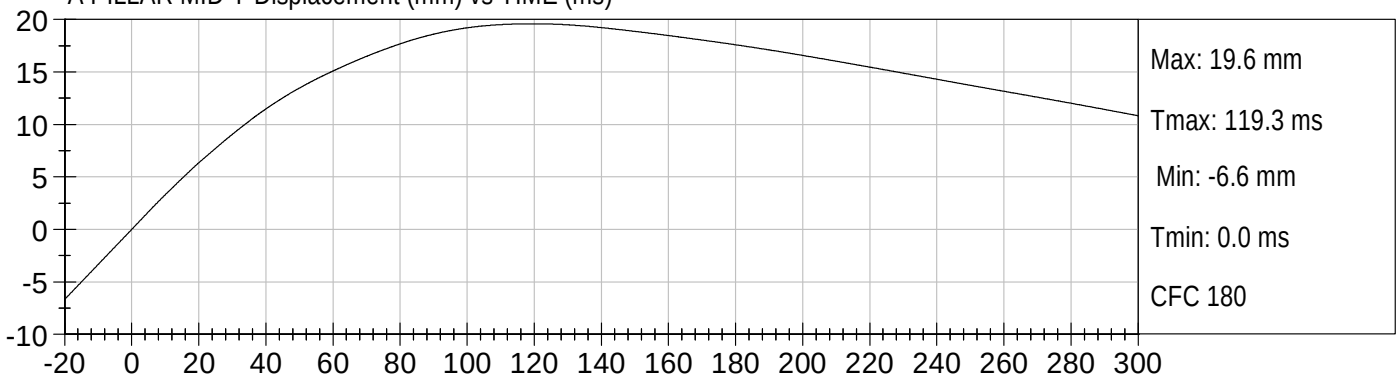
A PILLAR MID Y (G's) vs TIME (ms)



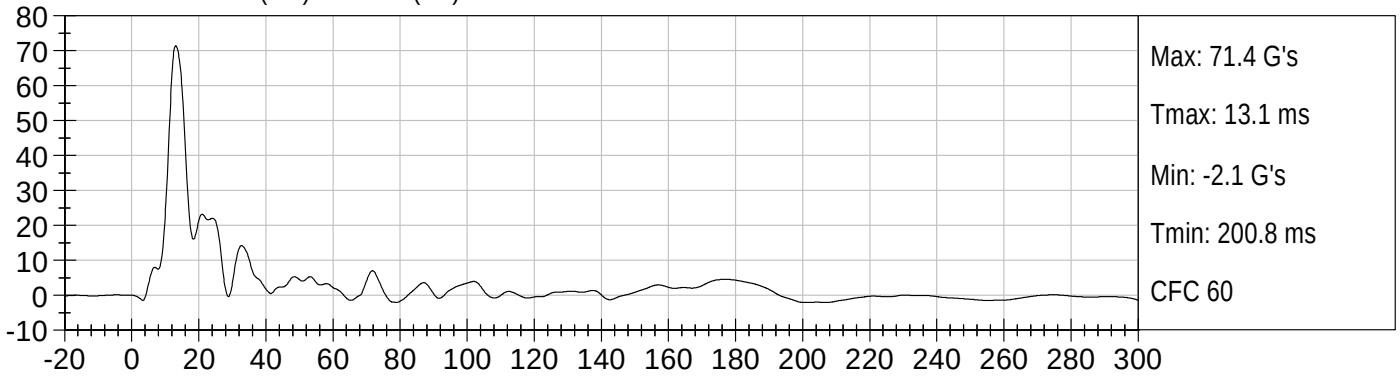

A PILLAR MID Y Velocity (kph) vs TIME (ms)



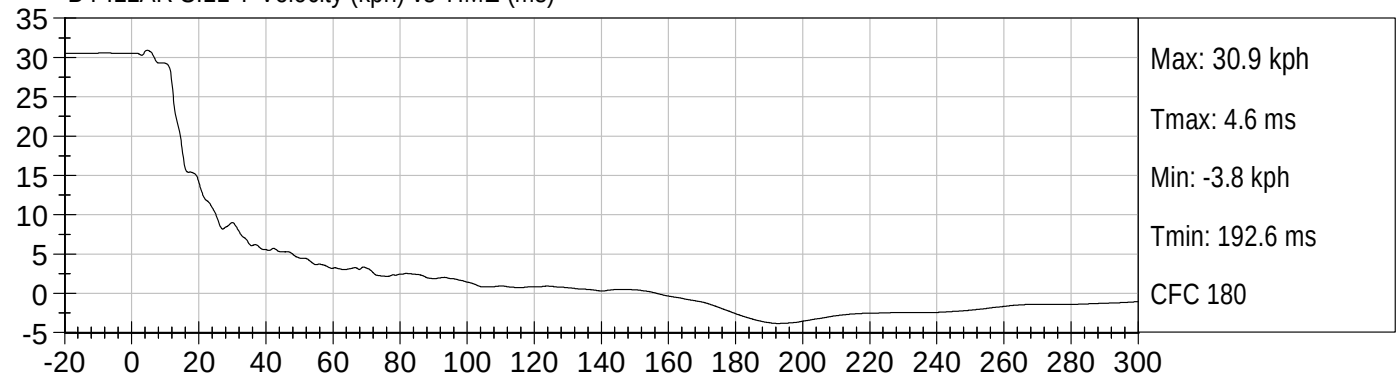

A PILLAR MID Y Displacement (mm) vs TIME (ms)



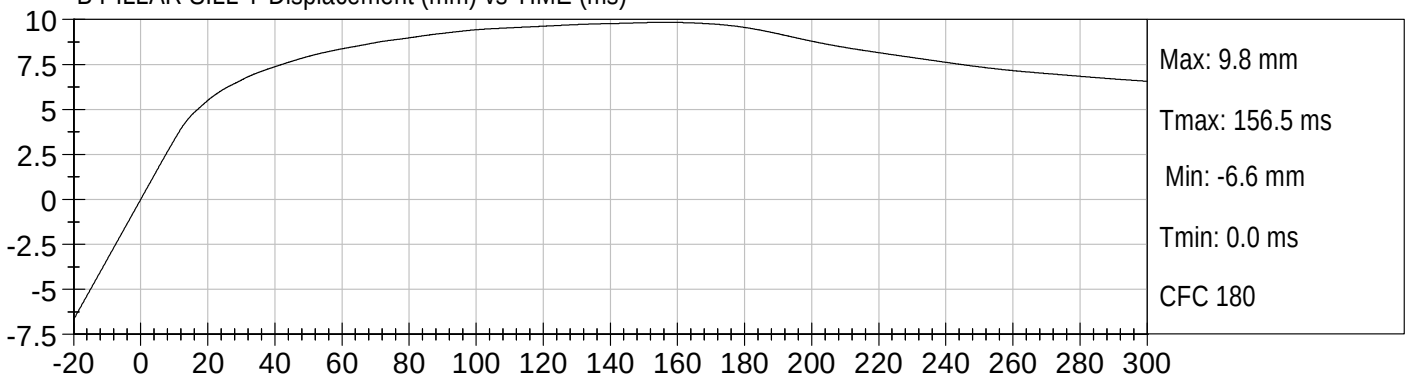
B PILLAR SILL Y (G's) vs TIME (ms)



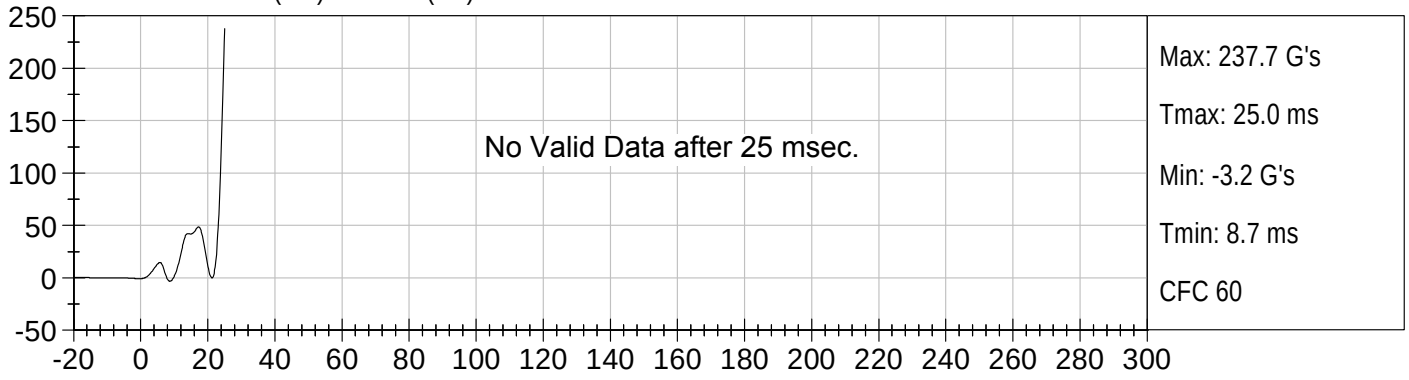

B PILLAR SILL Y Velocity (kph) vs TIME (ms)



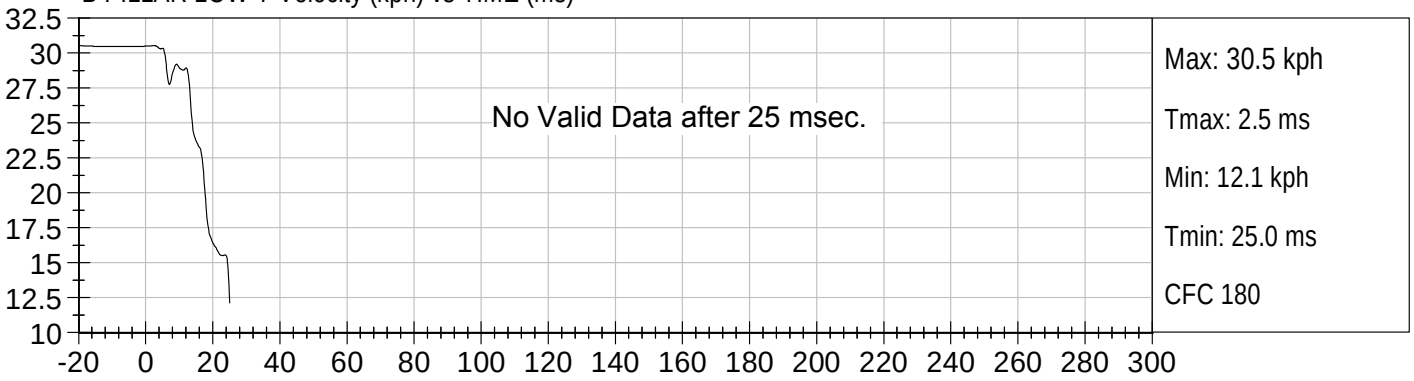

B PILLAR SILL Y Displacement (mm) vs TIME (ms)



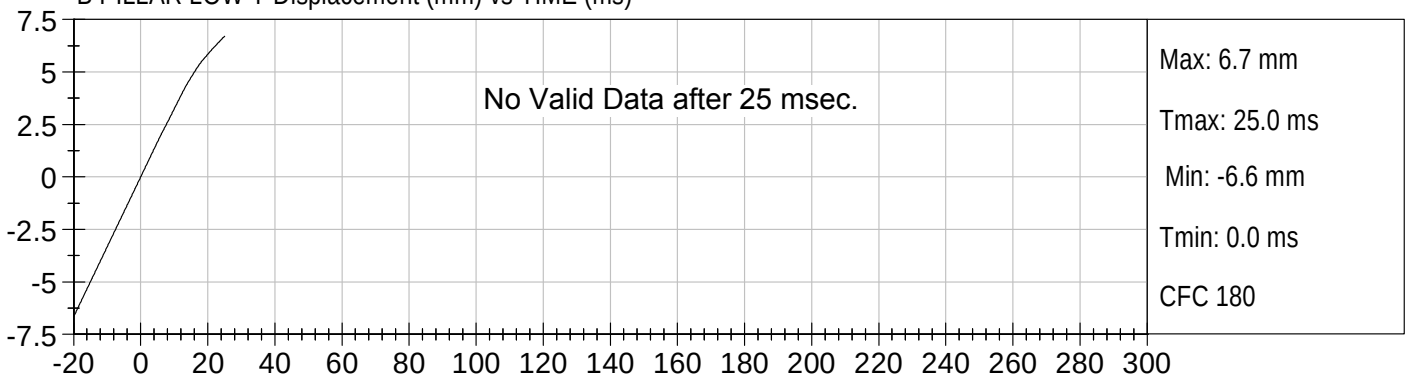
B PILLAR LOW Y (G's) vs TIME (ms)



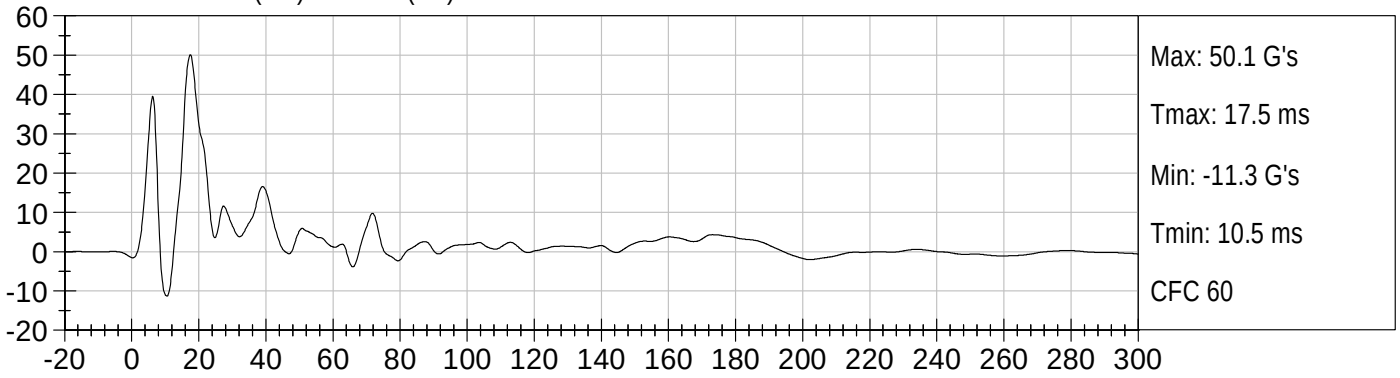

B PILLAR LOW Y Velocity (kph) vs TIME (ms)



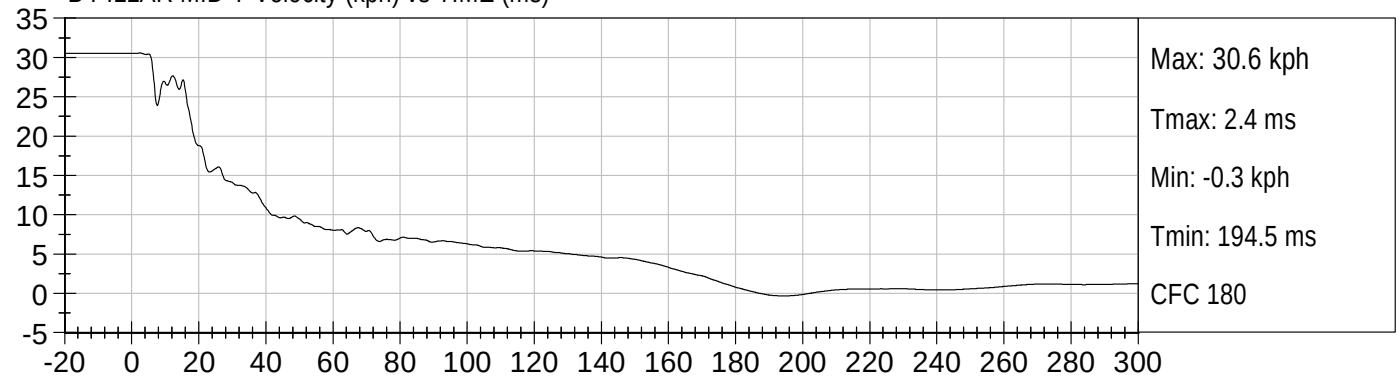

B PILLAR LOW Y Displacement (mm) vs TIME (ms)



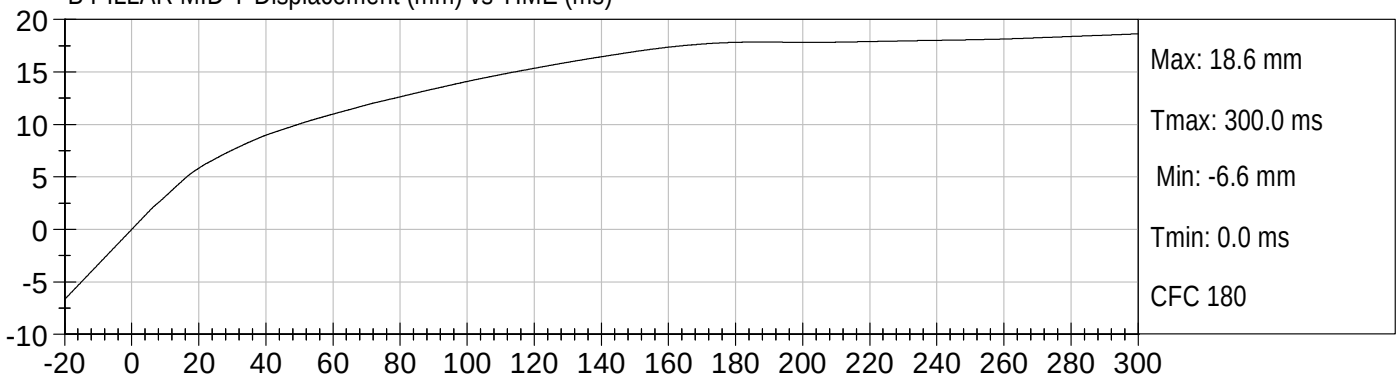
B PILLAR MID Y (G's) vs TIME (ms)



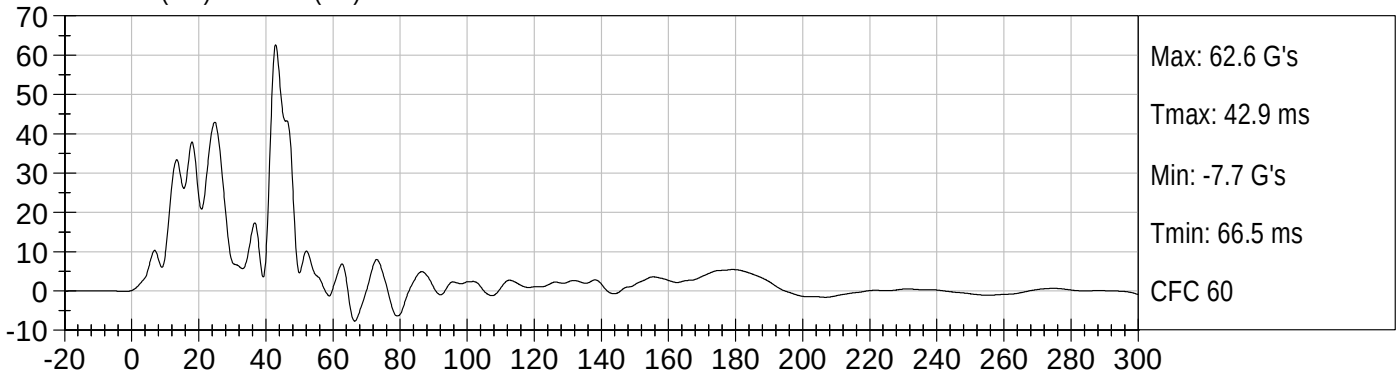

B PILLAR MID Y Velocity (kph) vs TIME (ms)



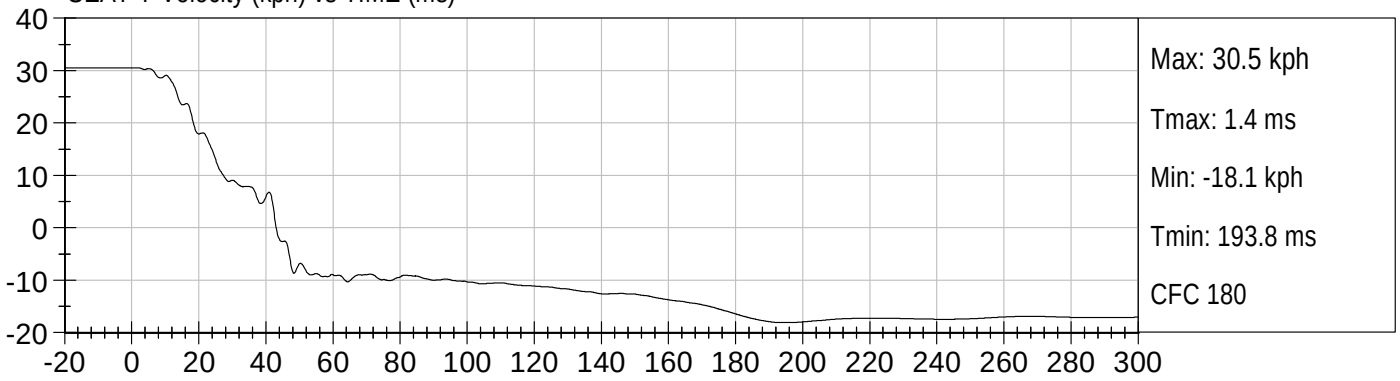

B PILLAR MID Y Displacement (mm) vs TIME (ms)



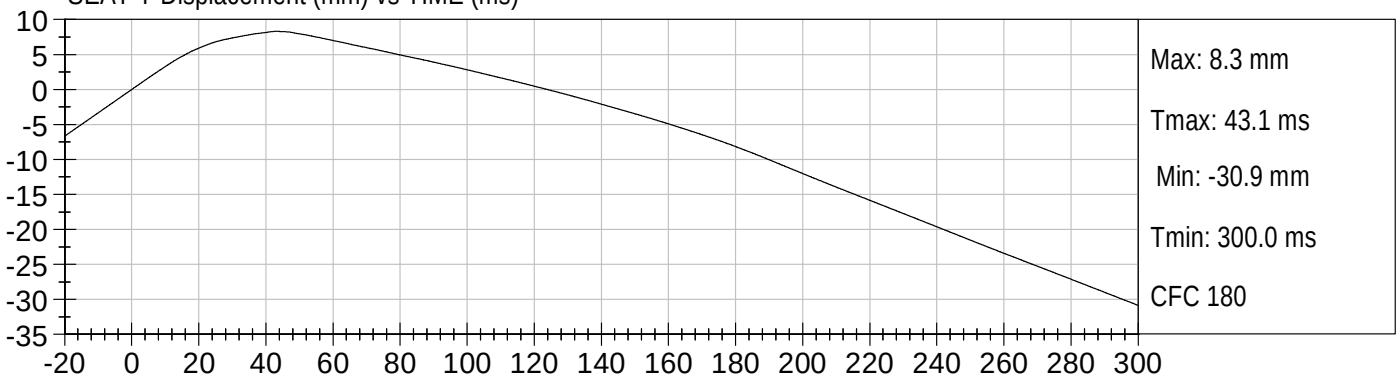
SEAT Y (G's) vs TIME (ms)




SEAT Y Velocity (kph) vs TIME (ms)



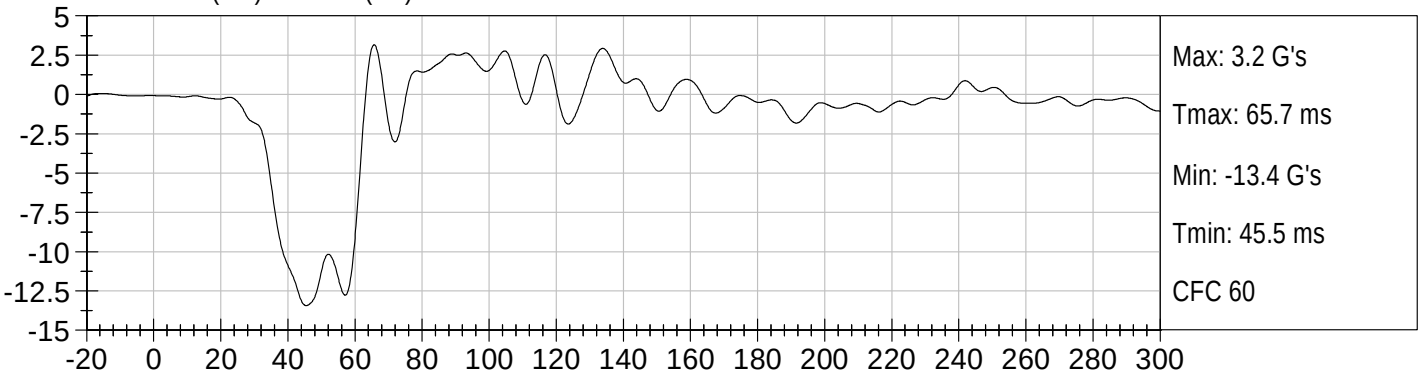

SEAT Y Displacement (mm) vs TIME (ms)



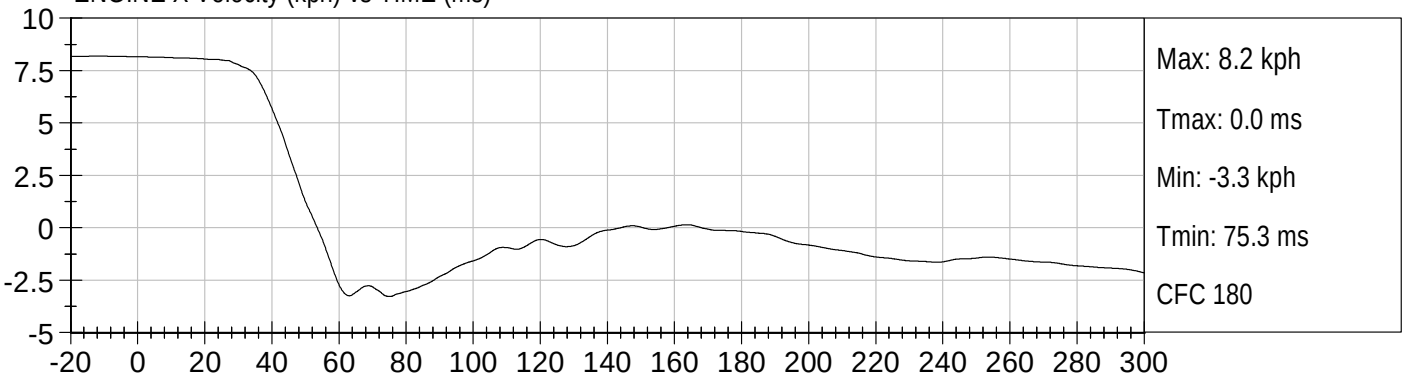
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

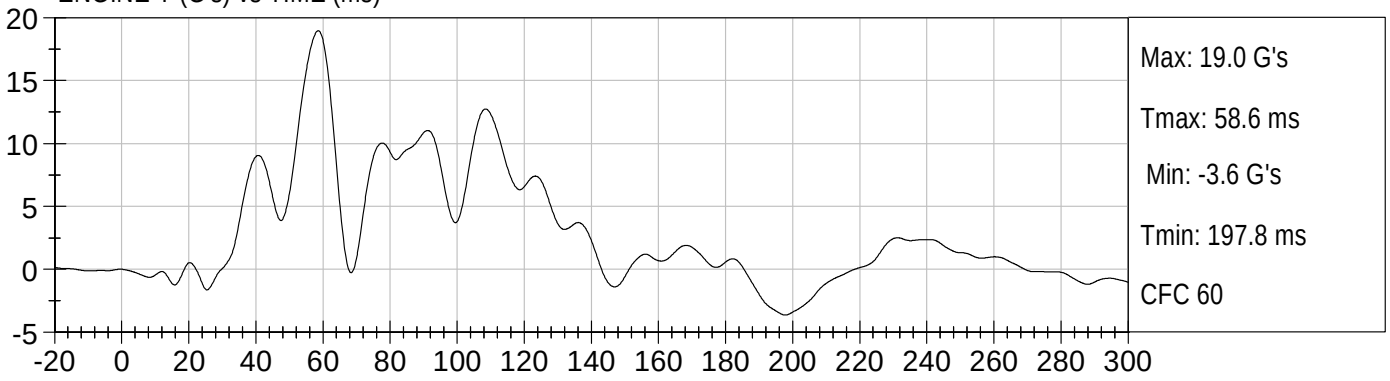
ENGINE X (G's) vs TIME (ms)



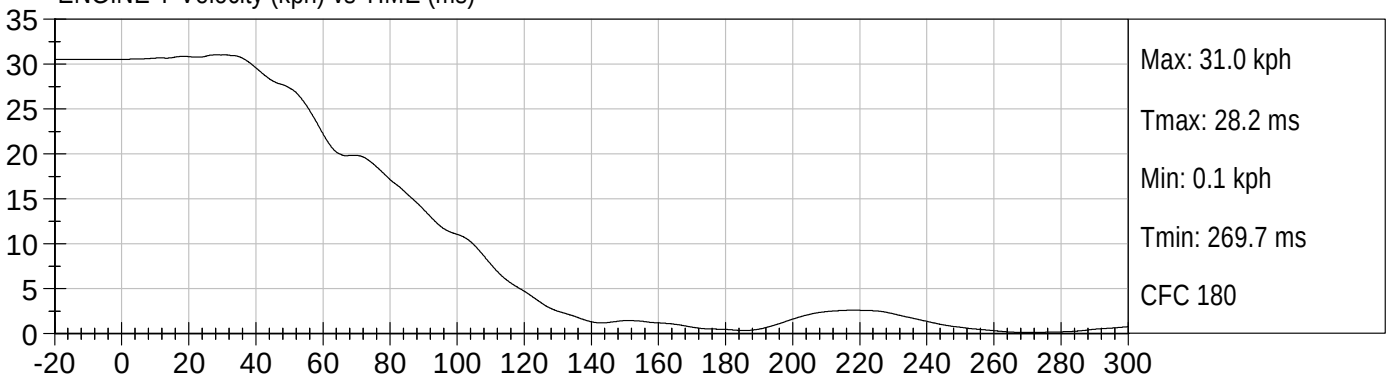

ENGINE X Velocity (kph) vs TIME (ms)




ENGINE Y (G's) vs TIME (ms)



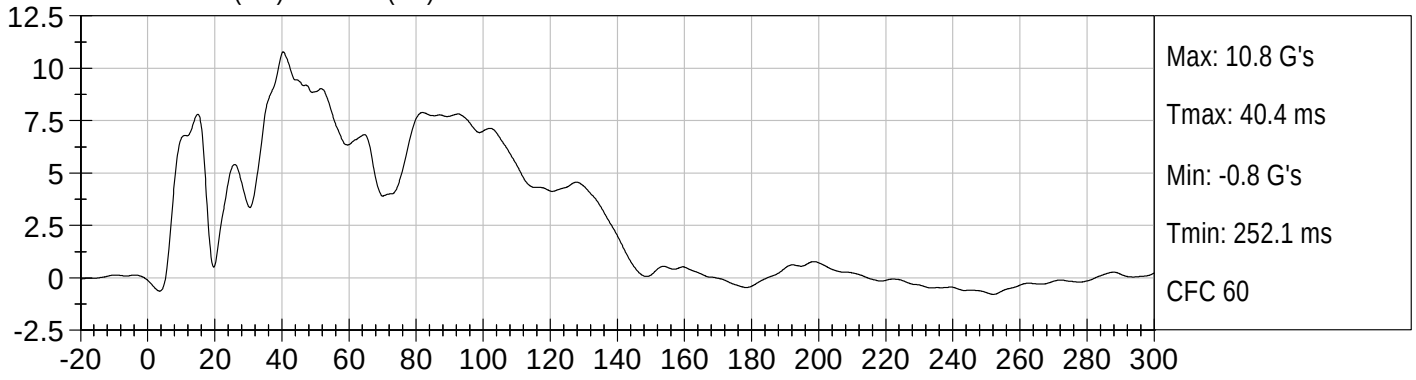

ENGINE Y Velocity (kph) vs TIME (ms)



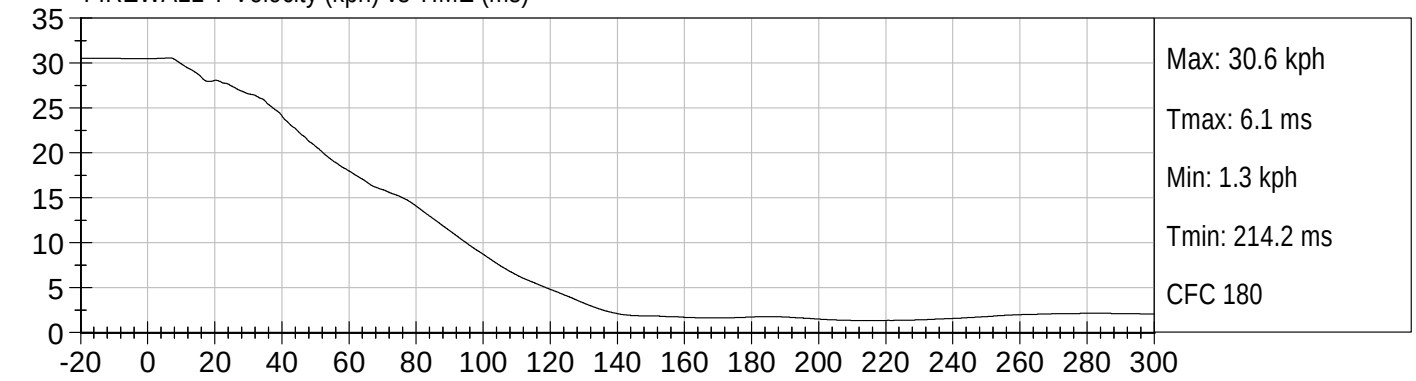
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

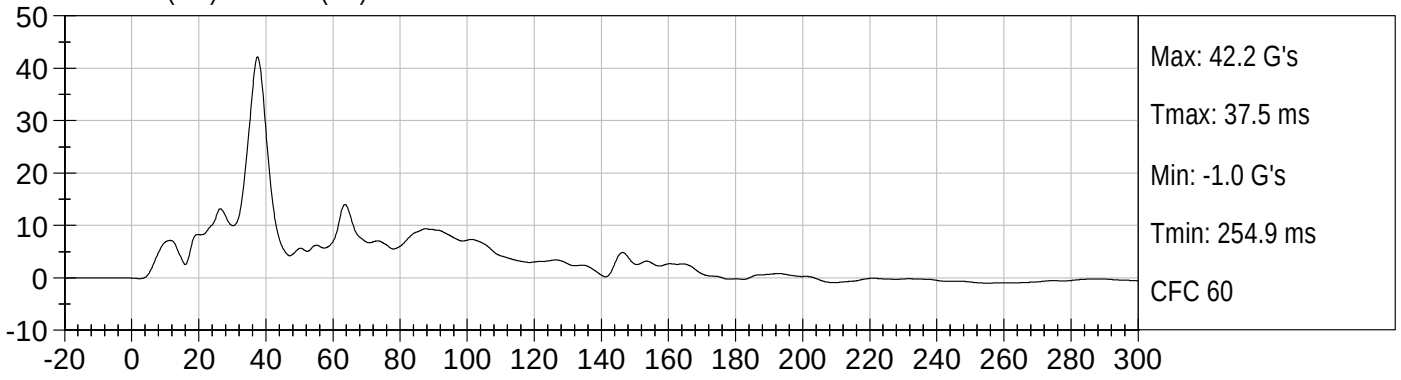
FIREWALL Y (G's) vs TIME (ms)



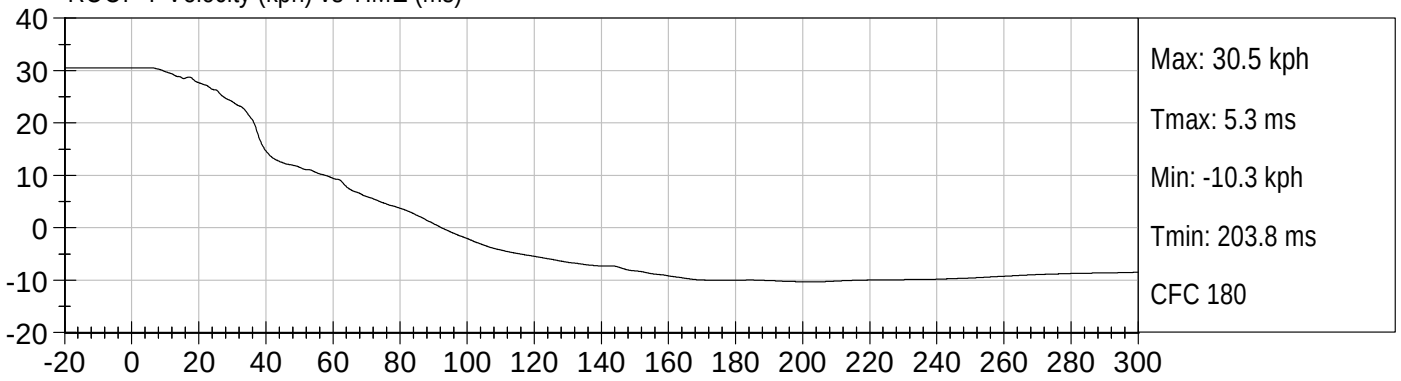

FIREWALL Y Velocity (kph) vs TIME (ms)



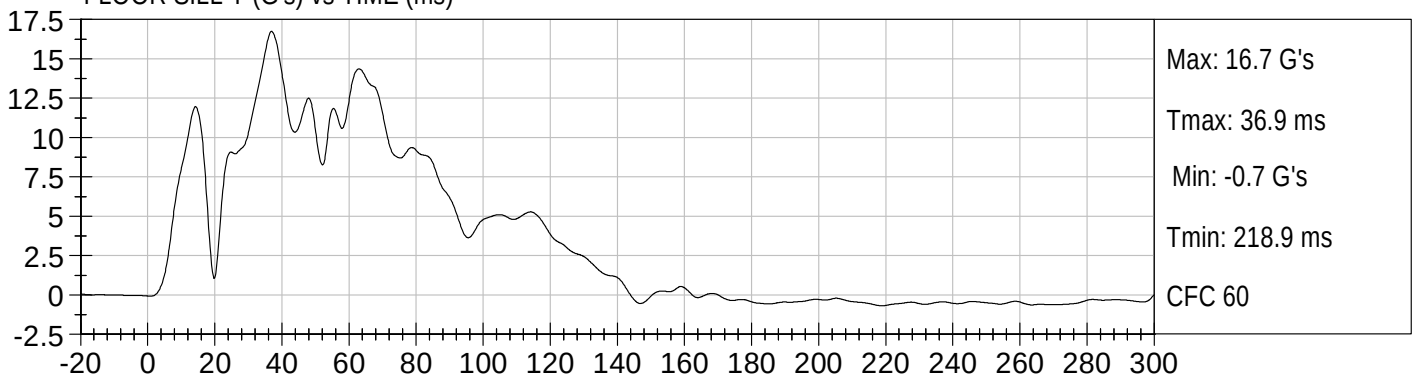
ROOF Y (G's) vs TIME (ms)



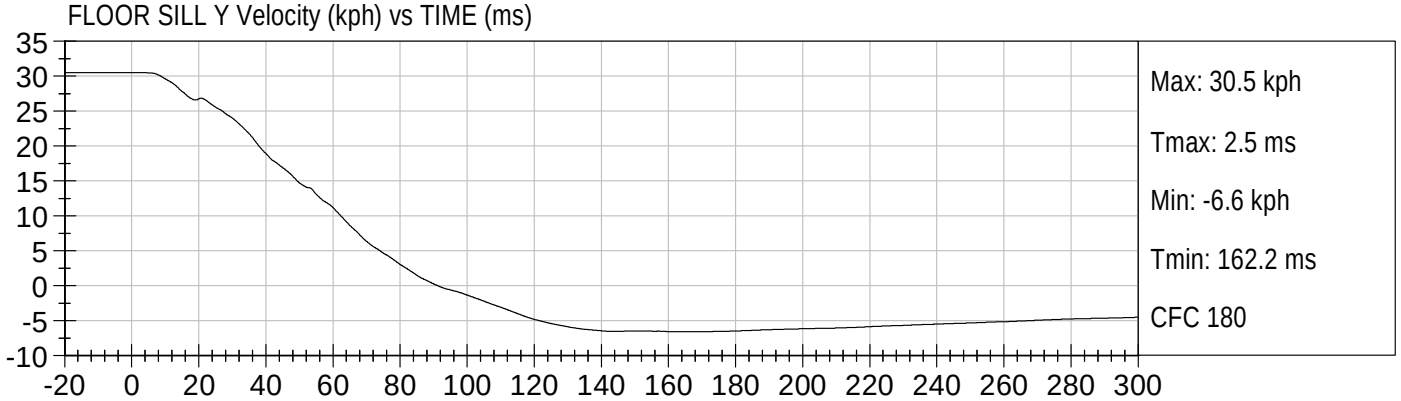

ROOF Y Velocity (kph) vs TIME (ms)




FLOOR SILL Y (G's) vs TIME (ms)



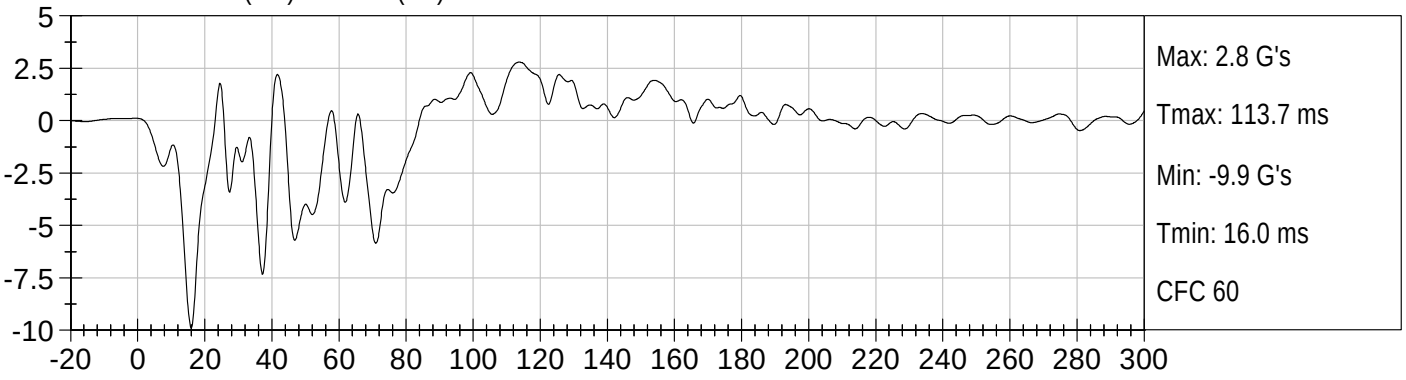

FLOOR SILL Y Velocity (kph) vs TIME (ms)



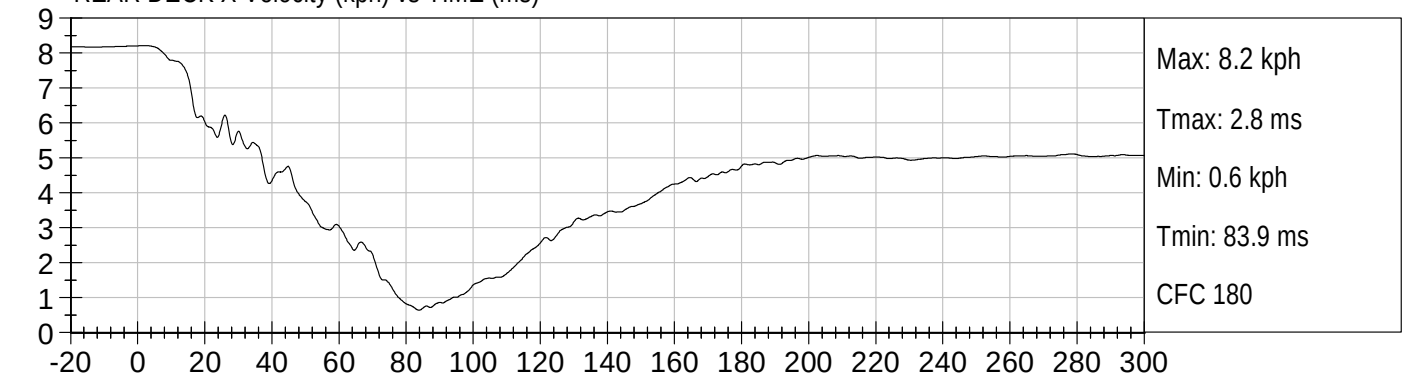
FMVSS 214 Rigid Pole Side Impact
2011 Subaru Legacy - CB5502

Test Date: 04/27/2011
Speed: 19.6 mph (31.6 km/h)

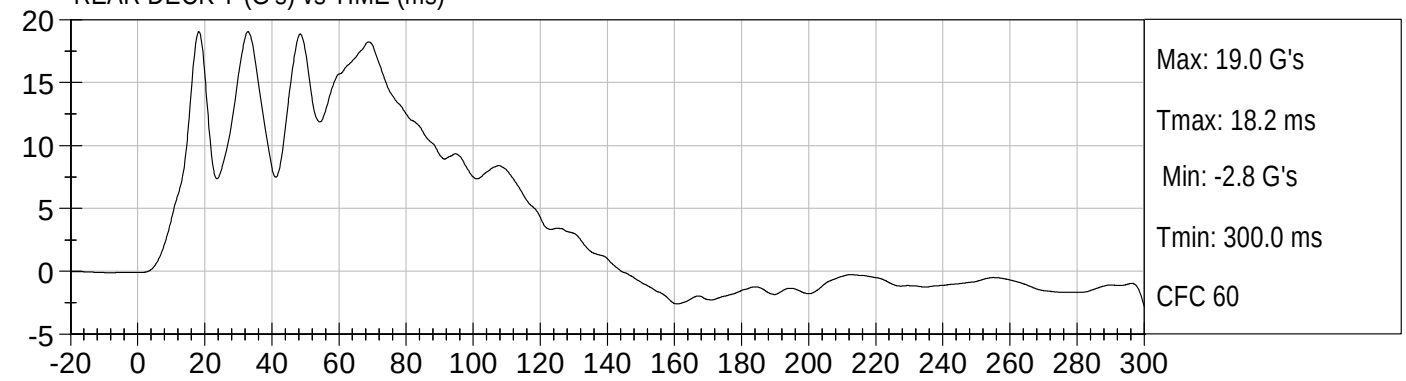
REAR DECK X (G's) vs TIME (ms)



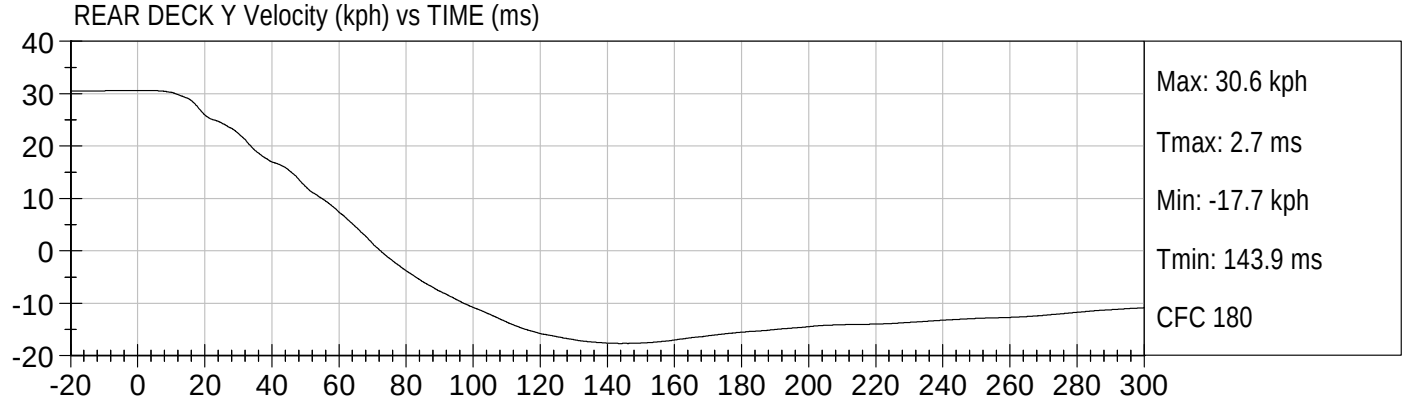

REAR DECK X Velocity (kph) vs TIME (ms)




REAR DECK Y (G's) vs TIME (ms)




REAR DECK Y Velocity (kph) vs TIME (ms)



# APPENDIX D

# DUMMY PERFORMANCE CALIBRATION TEST DATA

**MGA RESEARCH CORPORATION**

**HEAD DROP TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test ID:** D111501

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 18.9 to 25.6 | 21.9 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 29 | Pass |
| Peak Resultant Acceleration | G's | 125 to 155 | 142 | Pass |
| Peak Lateral Acceleration | G's | +/- 15 | -12.5 | Pass |
| Unimodal | N/A | Yes | Yes | Pass |
| Oscillations | N/A | within 15% of peak | Yes | Pass |
| | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

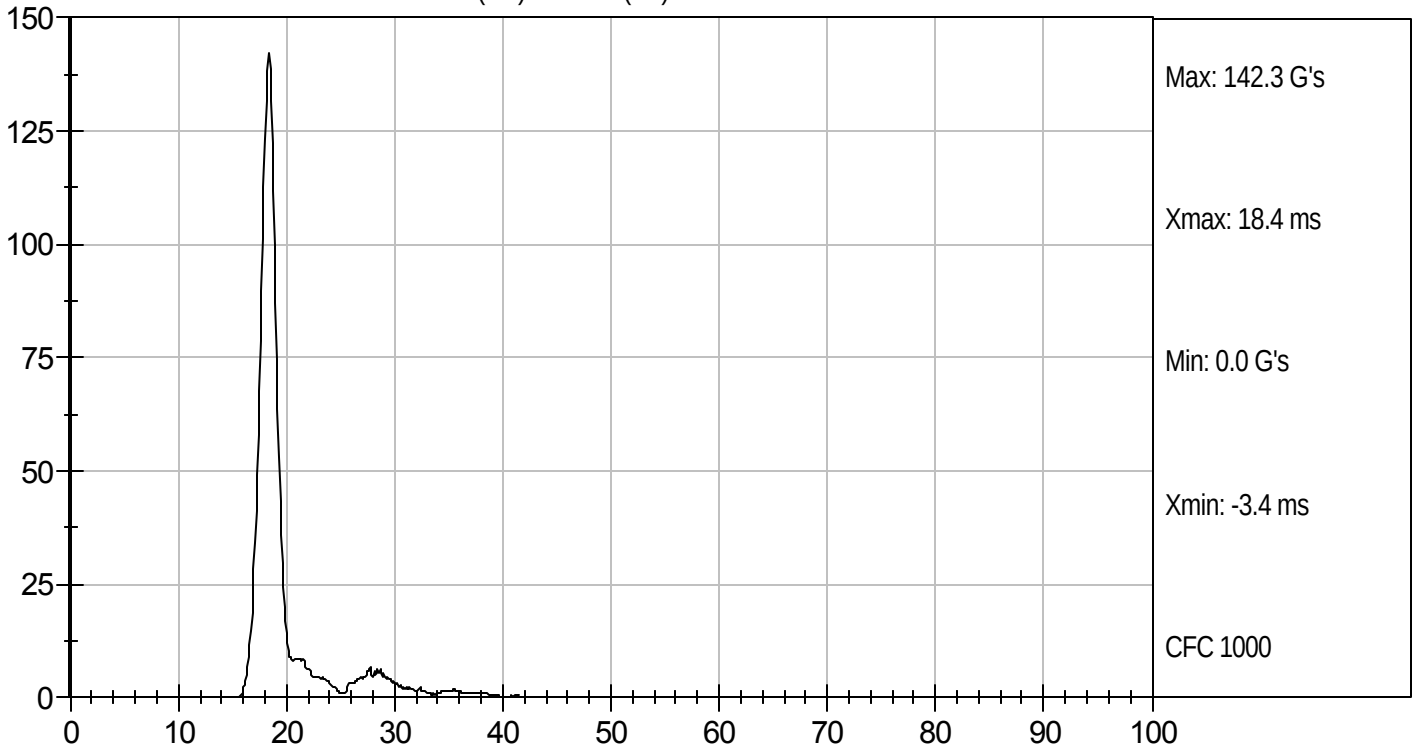
4/21/11
Test Date

David Winkelbauer
Approved By

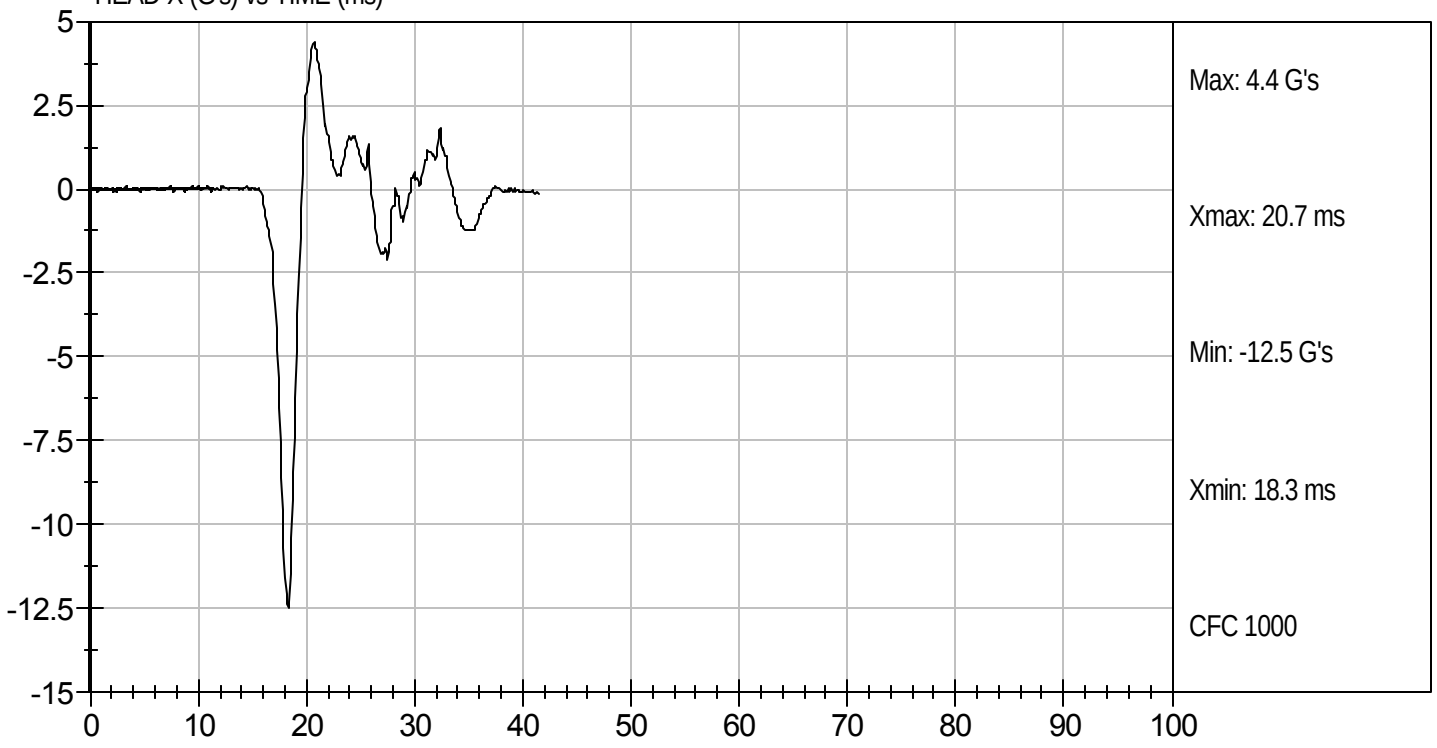
Test Desc: Head Drop
Component ID: D111501

Test Date: 4/21/11
Velocity: 0 ft/s, 0 m/s

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




HEAD X (G's) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**NECK PENDULUM TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111502

| Tested Parameter | | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|---|
| Laboratory Temperature | | deg C | 18.0 to 22.0 | 21.6 | Pass |
| Laboratory Relative Humidity | | % | 10 to 70 | 26 | Pass |
| Pendulum Speed | | m/s | 3.3 to 3.5 | 3.4 | Pass |
| Pendulum Deceleration | 1 ms | m/s | 0.00 to -0.05 | -0.02 | Pass |
| | 3 ms | m/s | -0.25 to -0.375 | -0.32 | Pass |
| | 14 ms | m/s | -3.20 to -3.70 | -3.37 | Pass |
| Maximum Flexion Angle | | deg | 49.0 to 59.0 | 50.0 | Pass |
| Time of Maximum Flexion Angle | | ms | 54.0 to 66.0 | 58.8 | Pass |
| Head Rotation Decay Time to 0 degree | | ms | 53.0 to 88.0 | 55.0 | Pass |
| | | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

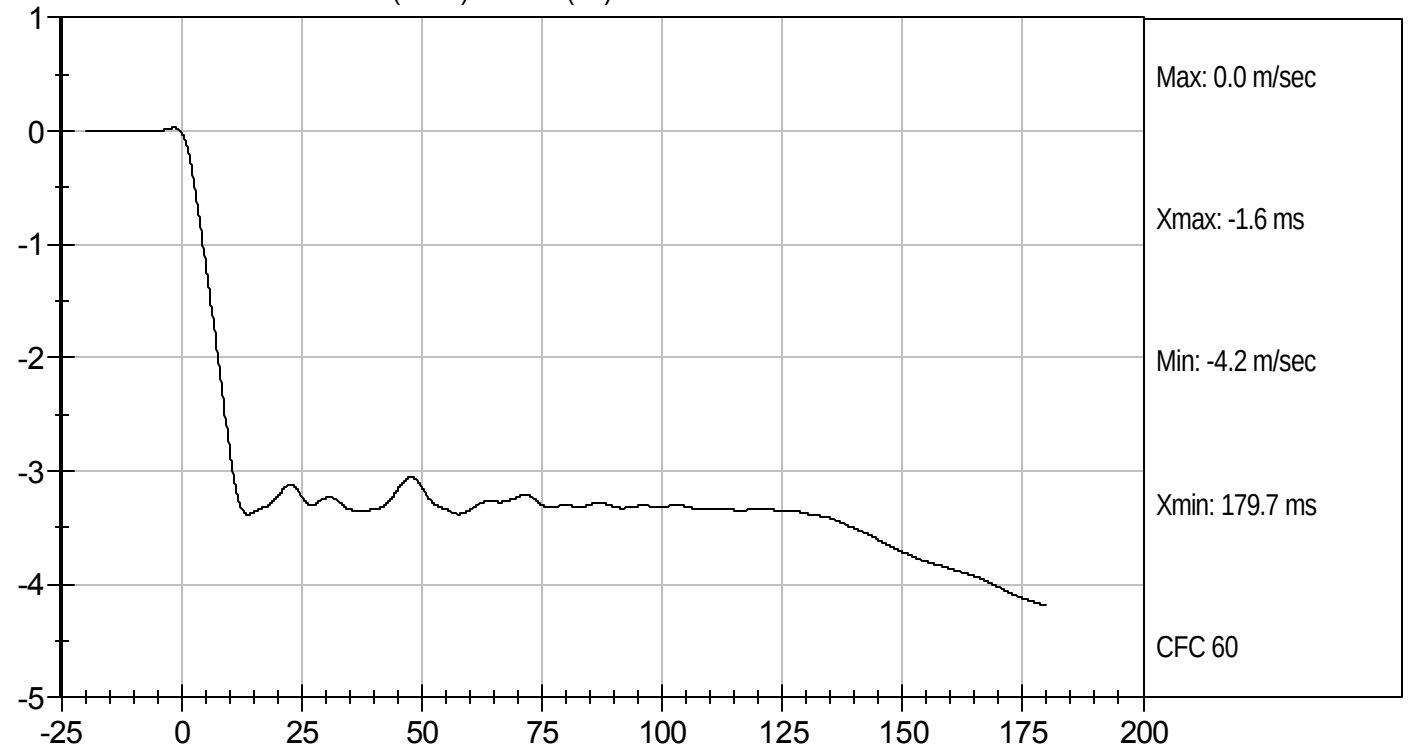
4/21/11
Test Date

David Winkelbauer
Approved By

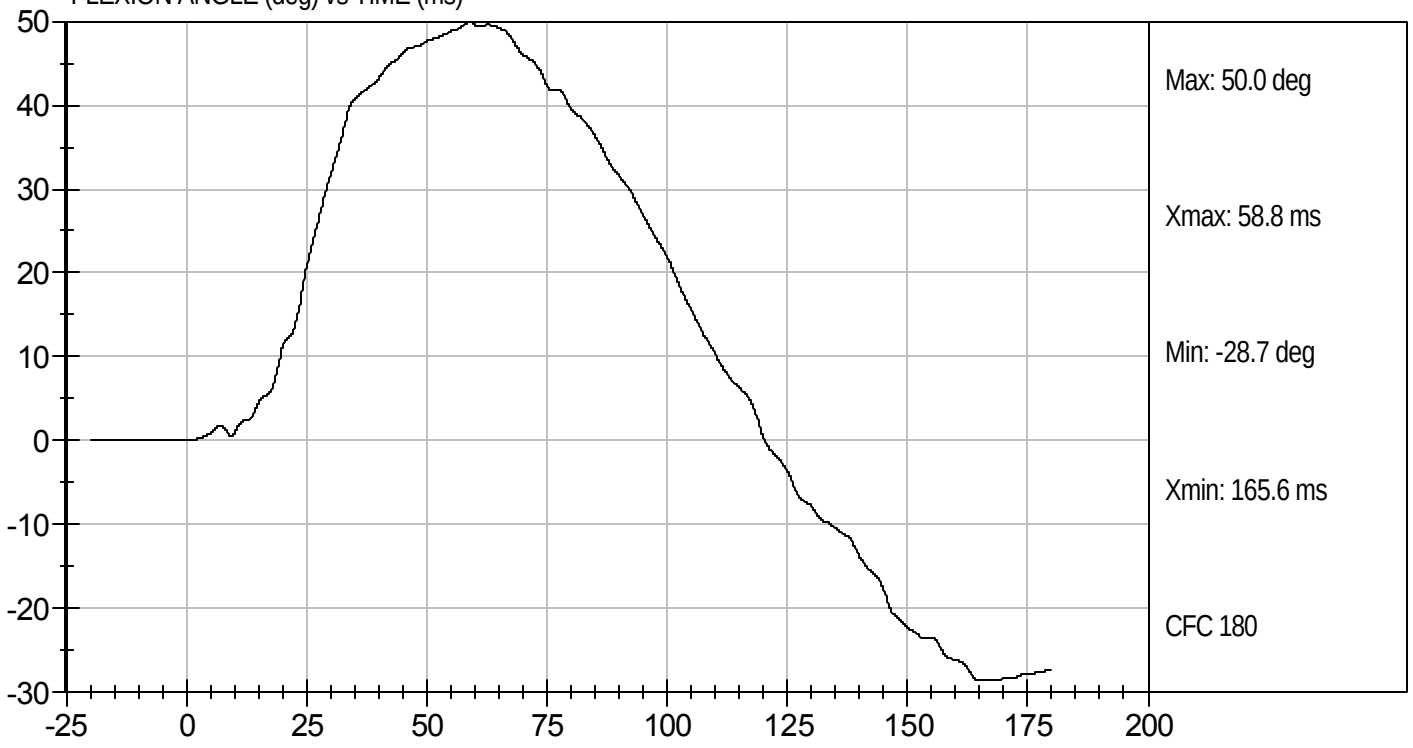
Test Desc: Neck Bending
Component ID: D111502

Test Date: 4/21/11
Velocity: 11.26 ft/s, 3.4 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

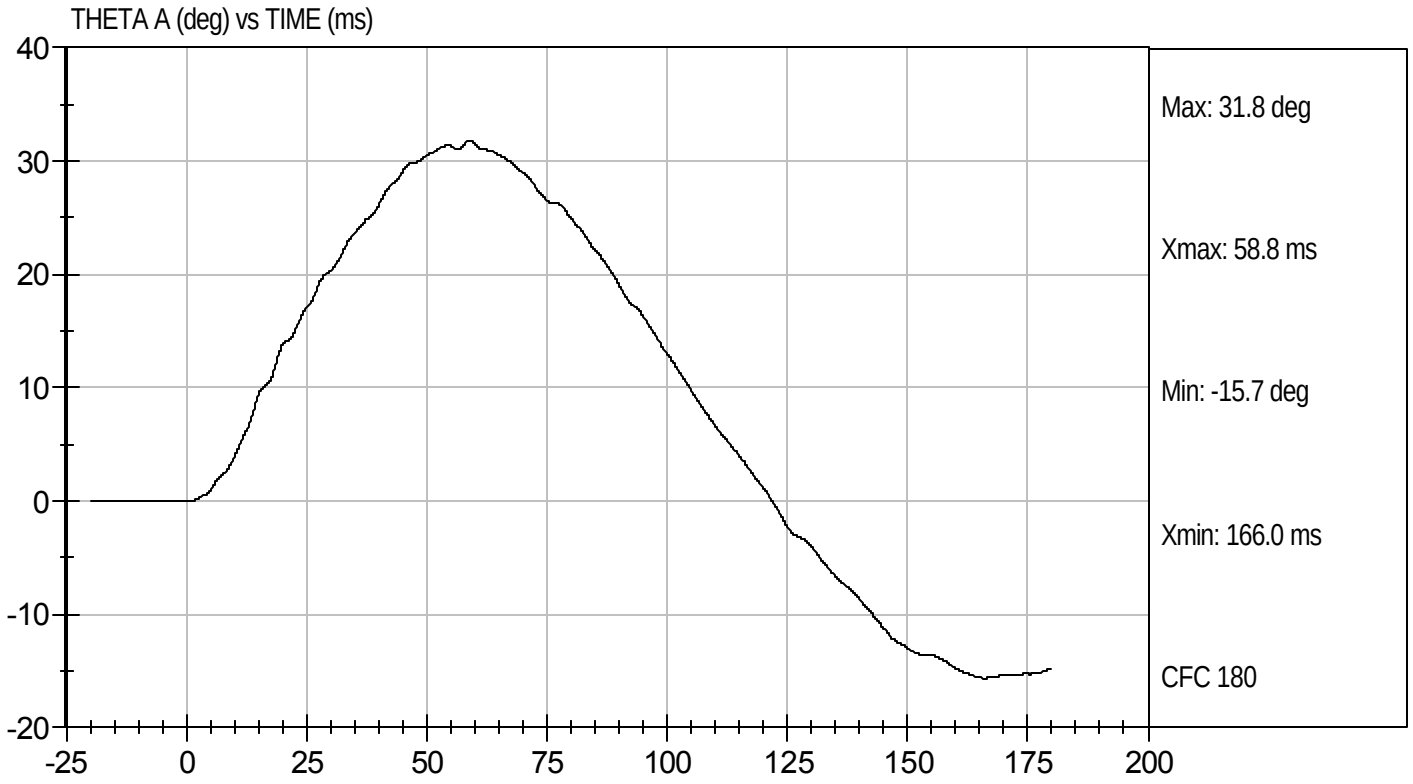


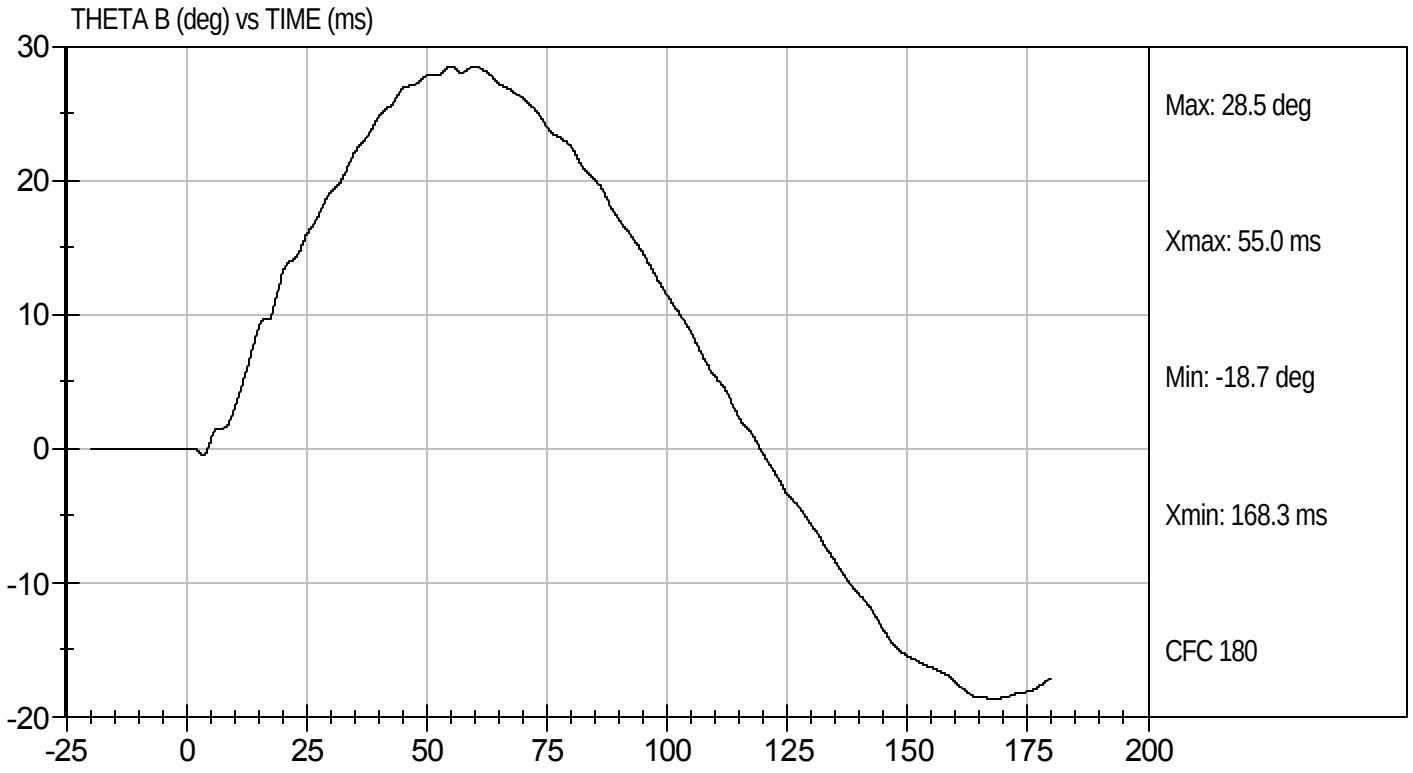

FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111502

Test Date: 4/21/11
Velocity: 11.26 ft/s, 3.4 m/s



**MGA RESEARCH CORPORATION**

**SHOULDER IMPACT TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111503

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 20.7 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 28 | Pass |
| Pendulum Speed | m/s | 4.2 to 4.4 | 4.3 | Pass |
| Peak Shoulder Acceleration | G's | 7.5 to 10.5 | 9.0 | Pass |
| Time of Peak Shoulder Acceleration | ms | NA | 18.7 | Pass |
| | | Overall Test Results | | Pass |

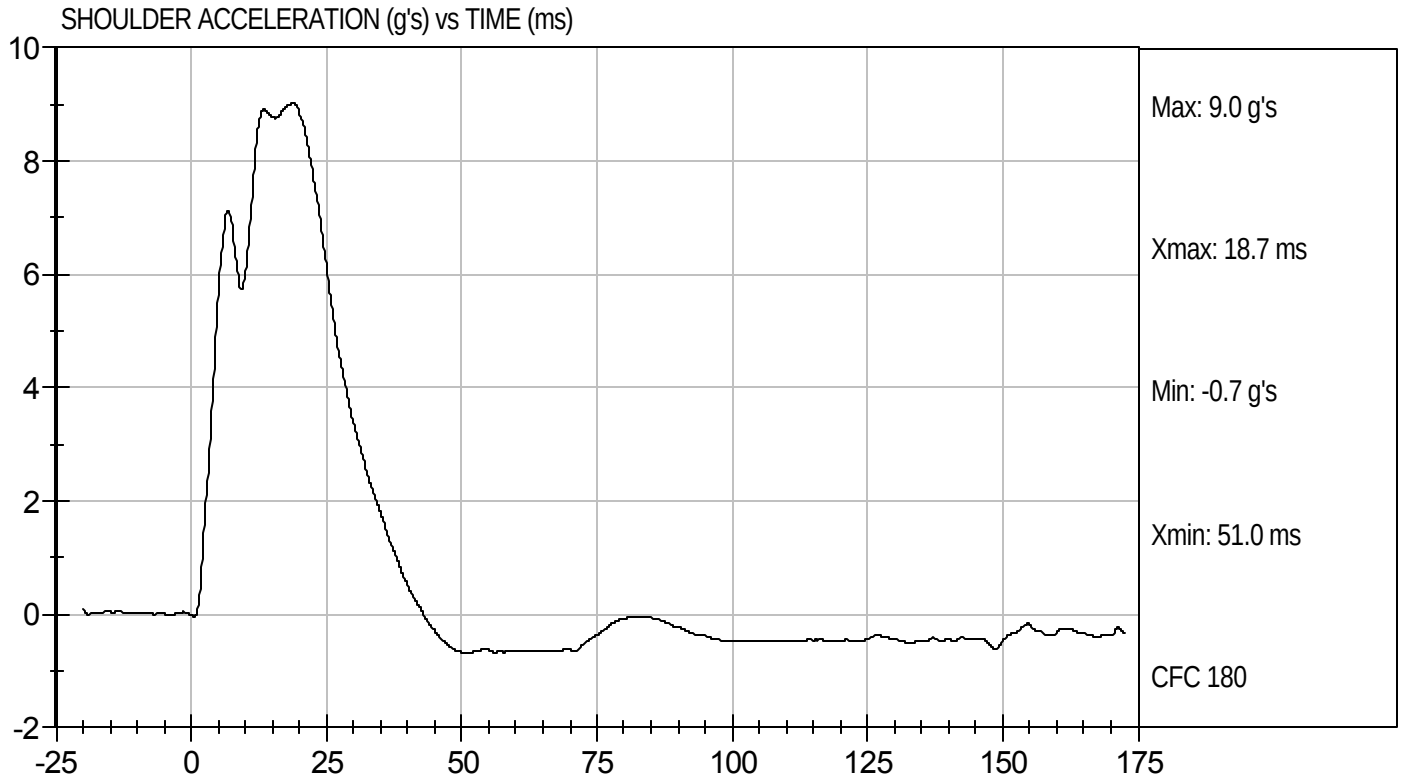
Jessica Gall
Laboratory Technician

4/21/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111503

Test Date: 4/21/11
Velocity: 14.24 ft/s, 4.3 m/s



**MGA RESEARCH CORPORATION**

**UPPER RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111504

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 27 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 38.7 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 49.3 | Pass |
| | | Overall Test Results | | Pass |

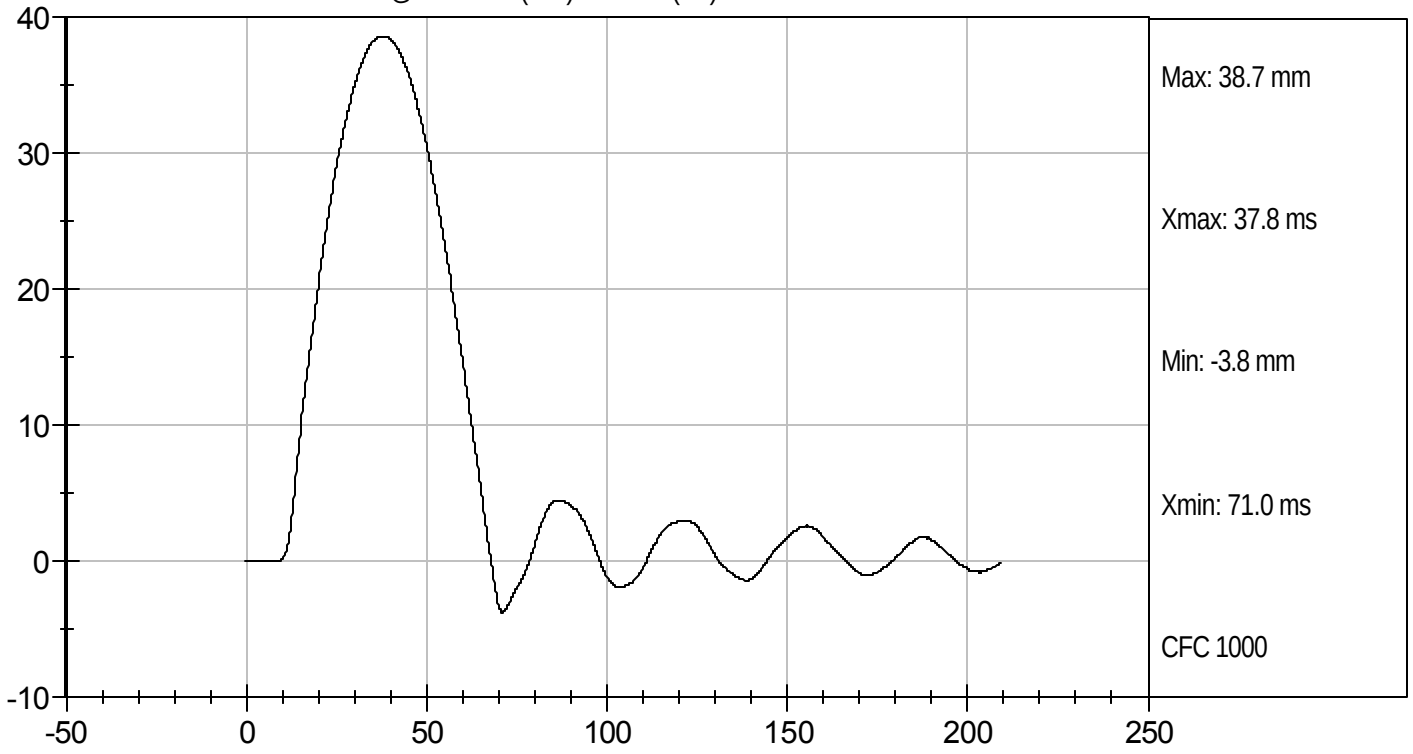
Jessica Hall
Laboratory Technician

4/21/11
Test Date

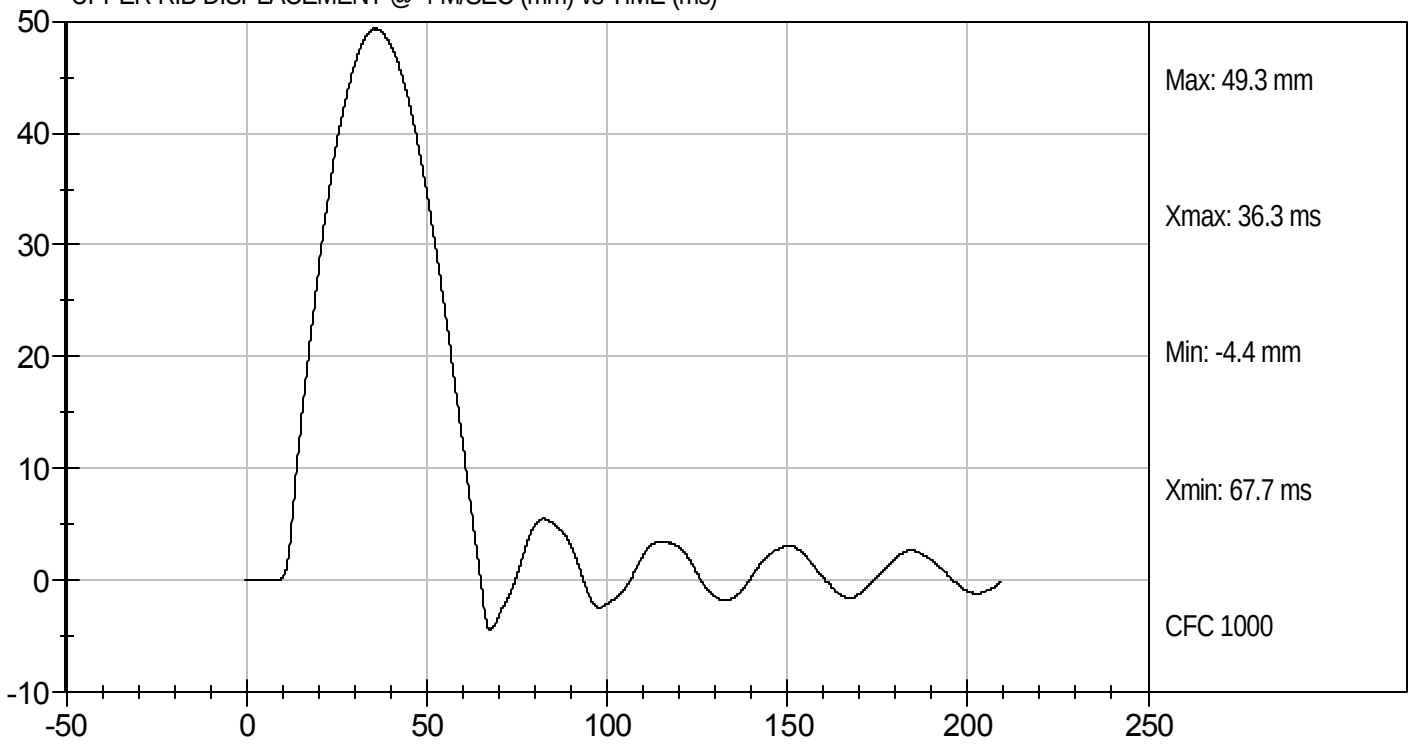
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111504
Test Date: 4/21/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**MID RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111505

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 27 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 38.6 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 49.2 | Pass |
| | | Overall Test Results | | Pass |

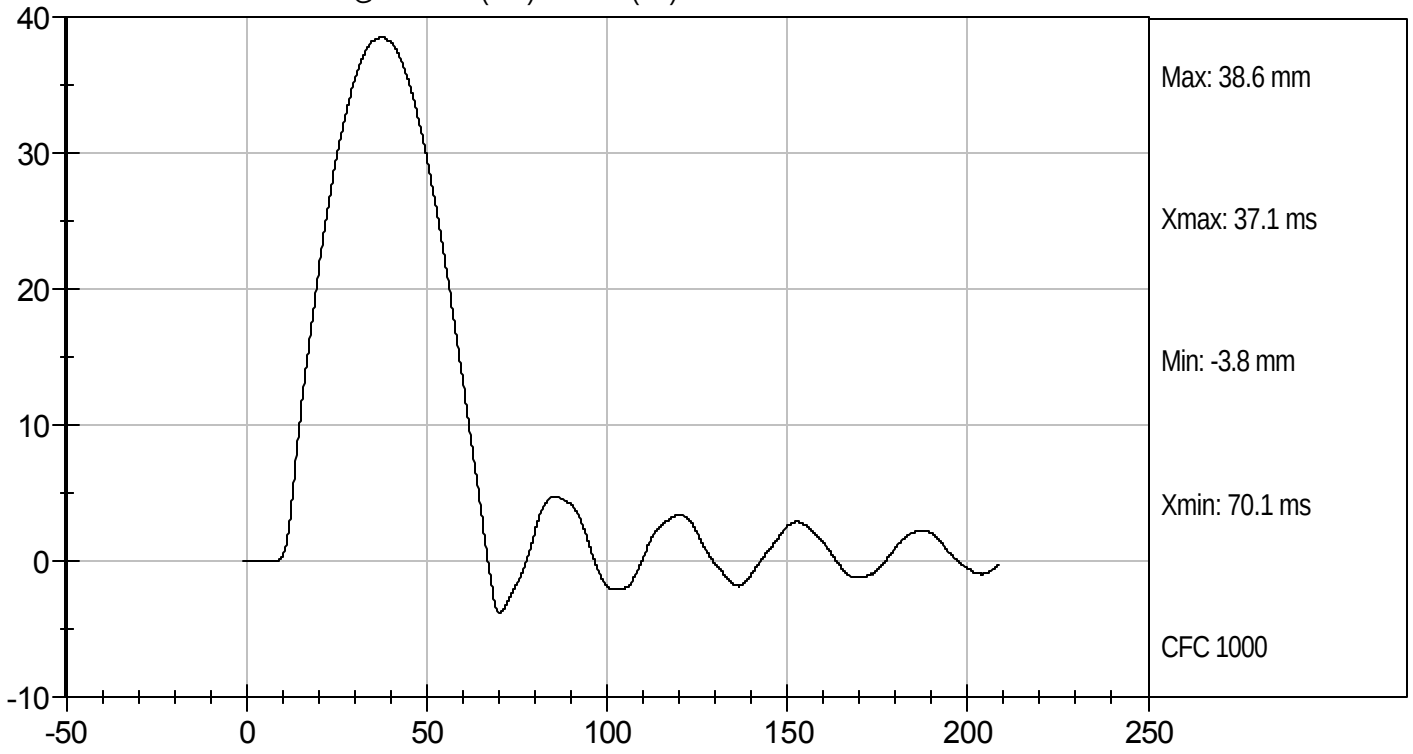
Jessica Hall
Laboratory Technician

4/21/11
Test Date

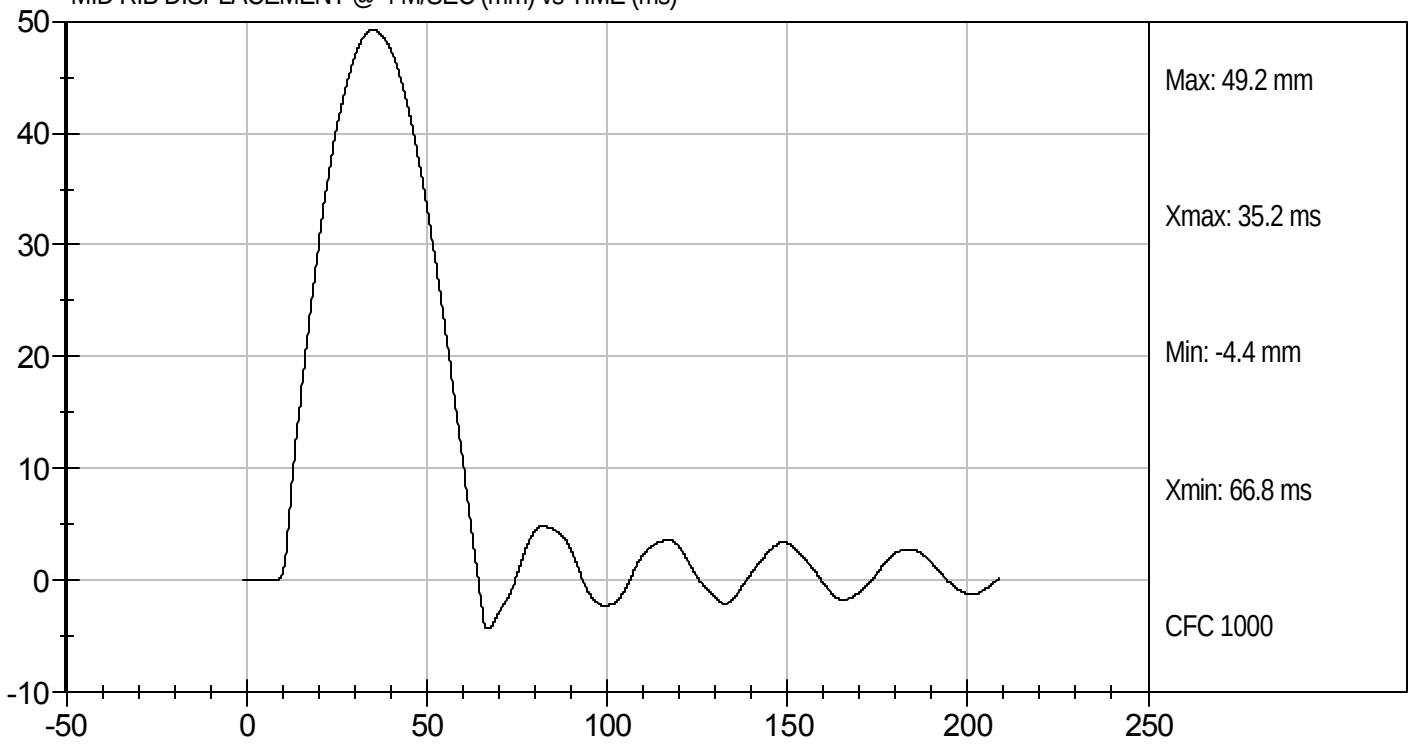
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111505
Test Date: 4/21/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**LOWER RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111506

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 27 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 38.9 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 49.8 | Pass |
| | | Overall Test Results | | Pass |

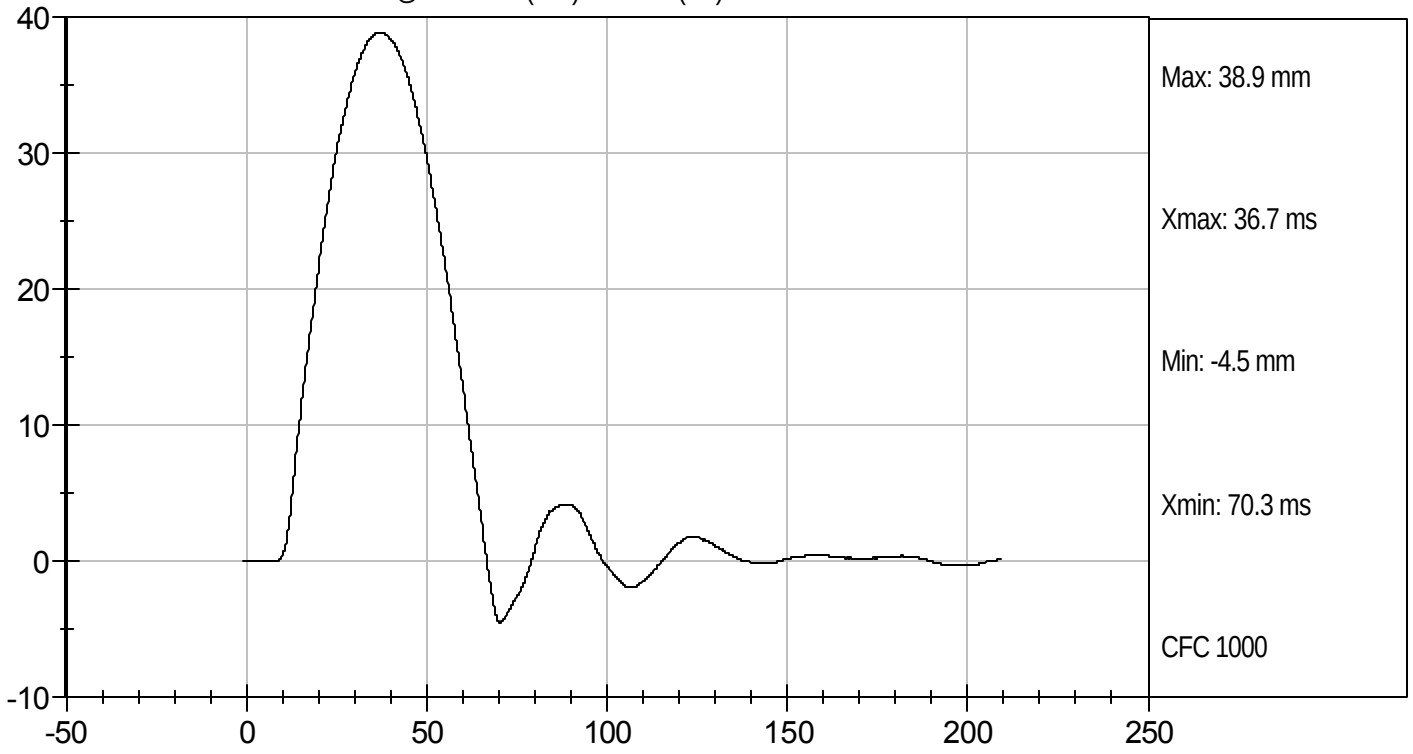
Jessica Gall
Laboratory Technician

4/21/11
Test Date

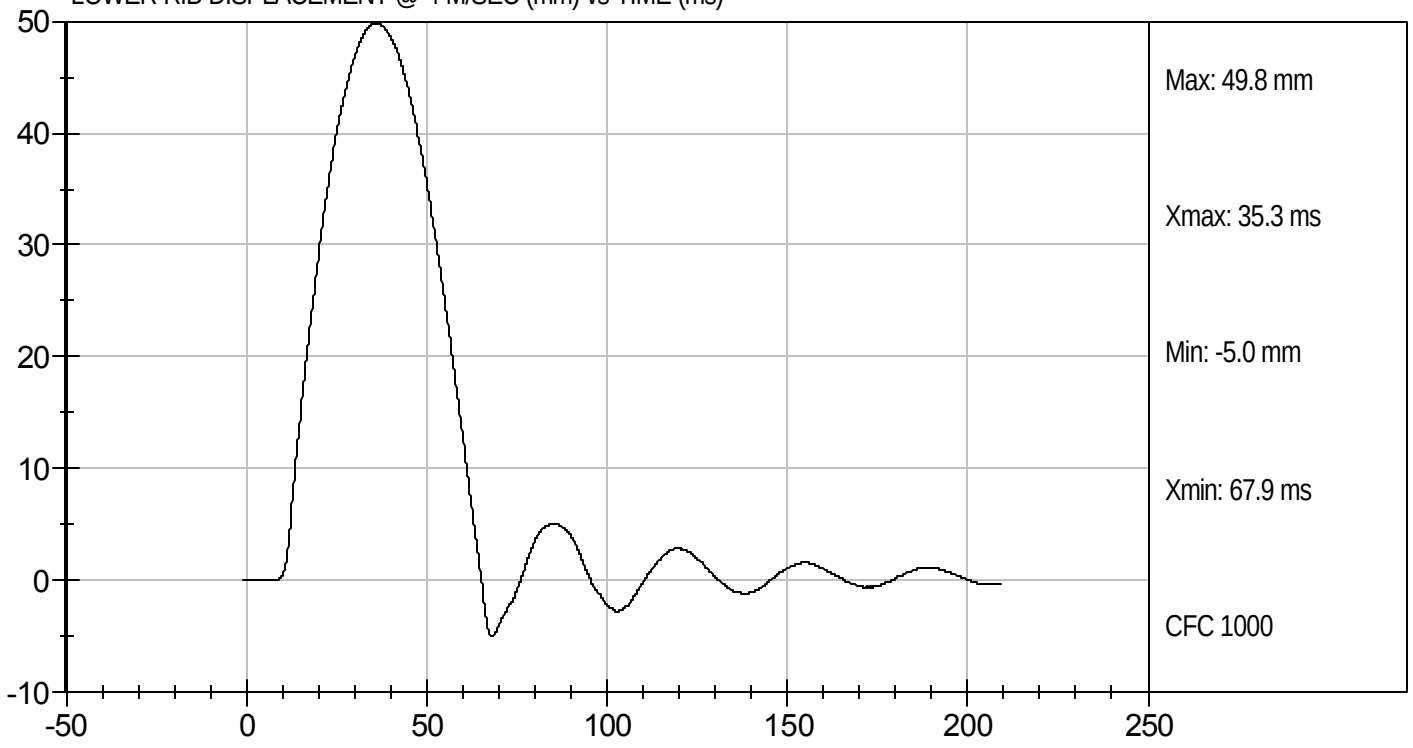
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111506
Test Date: 4/21/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**ABDOMEN TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111507

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 20.7 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 28 | Pass |
| Probe Speed | m/s | 3.90 to 4.10 | 4.10 | Pass |
| Maximum Impact Force | kN | 4.00 to 4.80 | 4.37 | Pass |
| Time of Maximum Impactor Force | ms | 10.60 to 13.00 | 11.30 | Pass |
| Maximum Total Abdomen Force | kN | 2.20 to 2.70 | 2.59 | Pass |
| Time of Maximum Abdomen Force | ms | 10.00 to 12.30 | 10.70 | Pass |
| | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

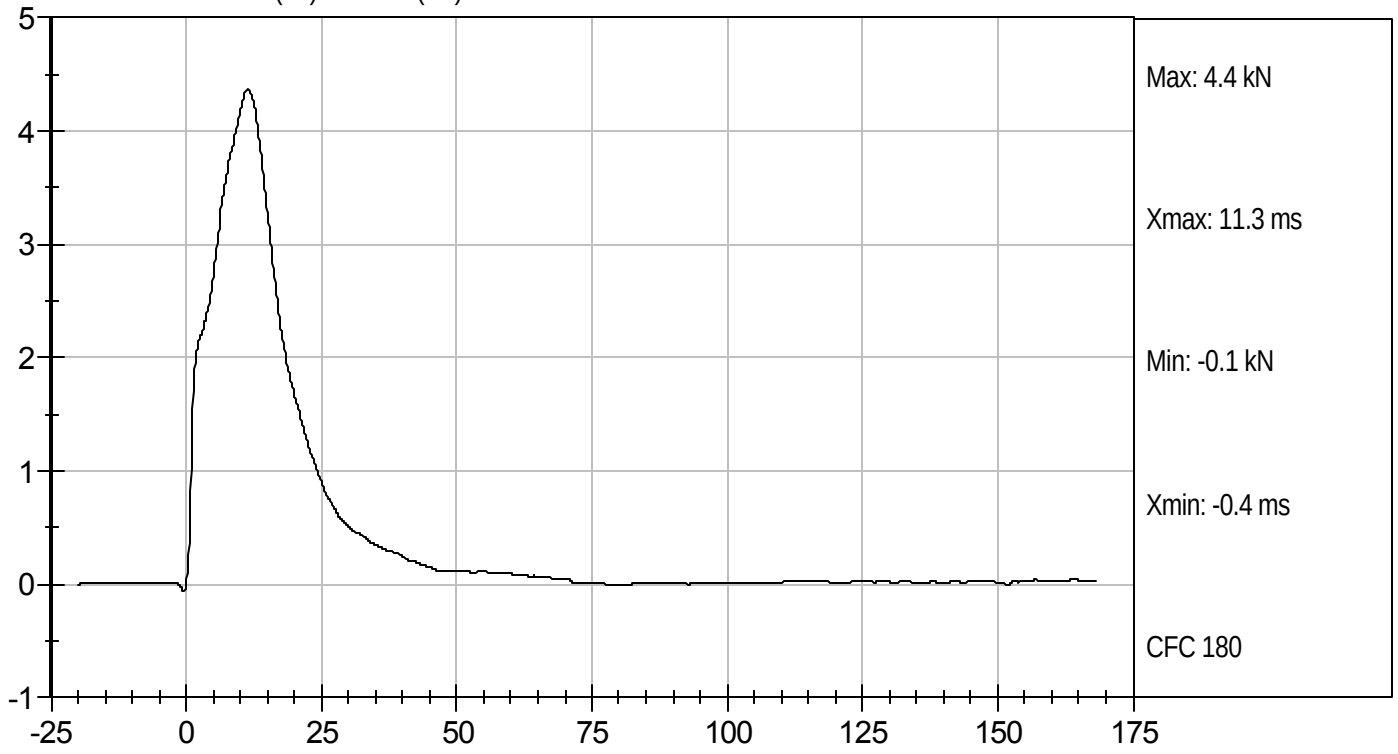
4/21/11
Test Date

David Winkelbauer
Approved By

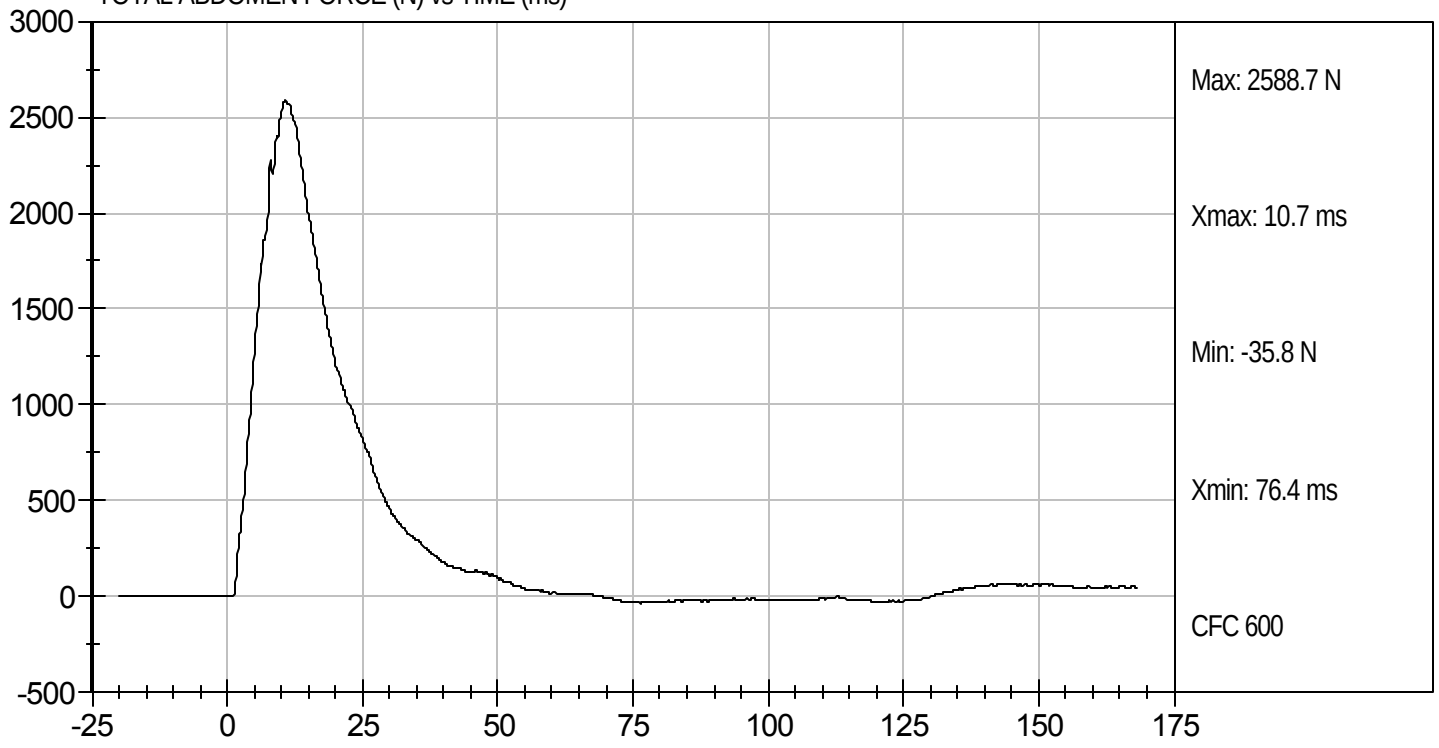
Test Desc: Abdomen Impact
Component ID: D111507

Test Date: 4/21/11
Velocity: 13.44 ft/s, 4.1 m/s

IMPACTOR FORCE (kN) vs TIME (ms)




TOTAL ABDOMEN FORCE (N) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**LUMBAR SPINE TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111508

| Tested Parameter | | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|---|
| Laboratory Temperature | | deg C | 20.6 to 22.2 | 21.6 | Pass |
| Laboratory Relative Humidity | | % | 10 to 70 | 26 | Pass |
| Pendulum Speed | | m/s | 5.95 to 6.15 | 6.12 | Pass |
| Pendulum Deceleration | 1 ms | m/s | -0.05 to 0.00 | -0.02 | Pass |
| | 3.7 ms | m/s | -0.425 to -0.24 | -0.41 | Pass |
| | 27 ms | m/s | -6.50 to -5.80 | -5.81 | Pass |
| | 30 ms | m/s | >= -6.5 | -6.24 | Pass |
| Maximum Flexion Angle | | deg | 45.0 to 55.0 | 45.1 | Pass |
| Time of Maximum Flexion Angle | | ms | 39.0 to 53.0 | 44.2 | Pass |
| Headform Rotation Decay to Initial Position | | ms | 37 to 57 | 45 | Pass |
| | | | Overall Results | | Pass |

Jessica Gall
Laboratory Technician

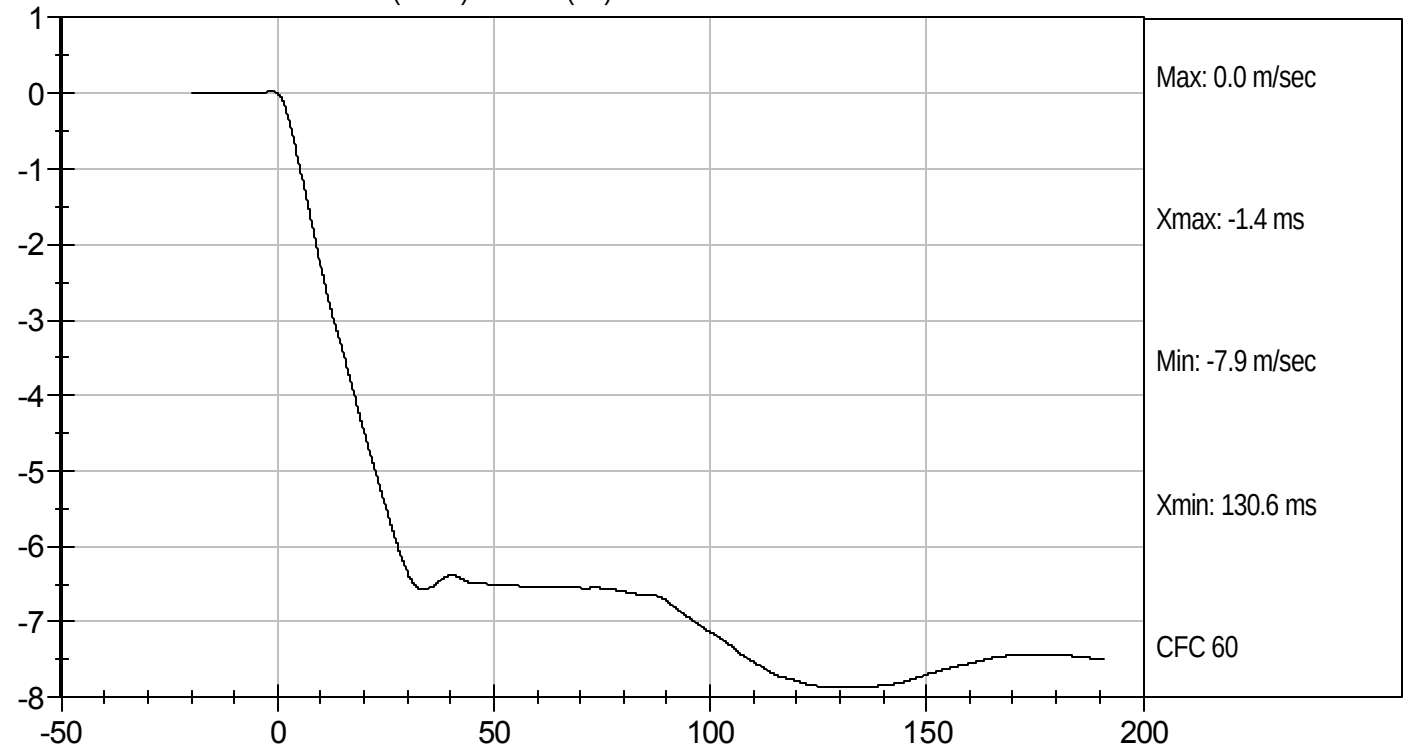
4/21/11
Test Date

David Winkelbauer
Approved By

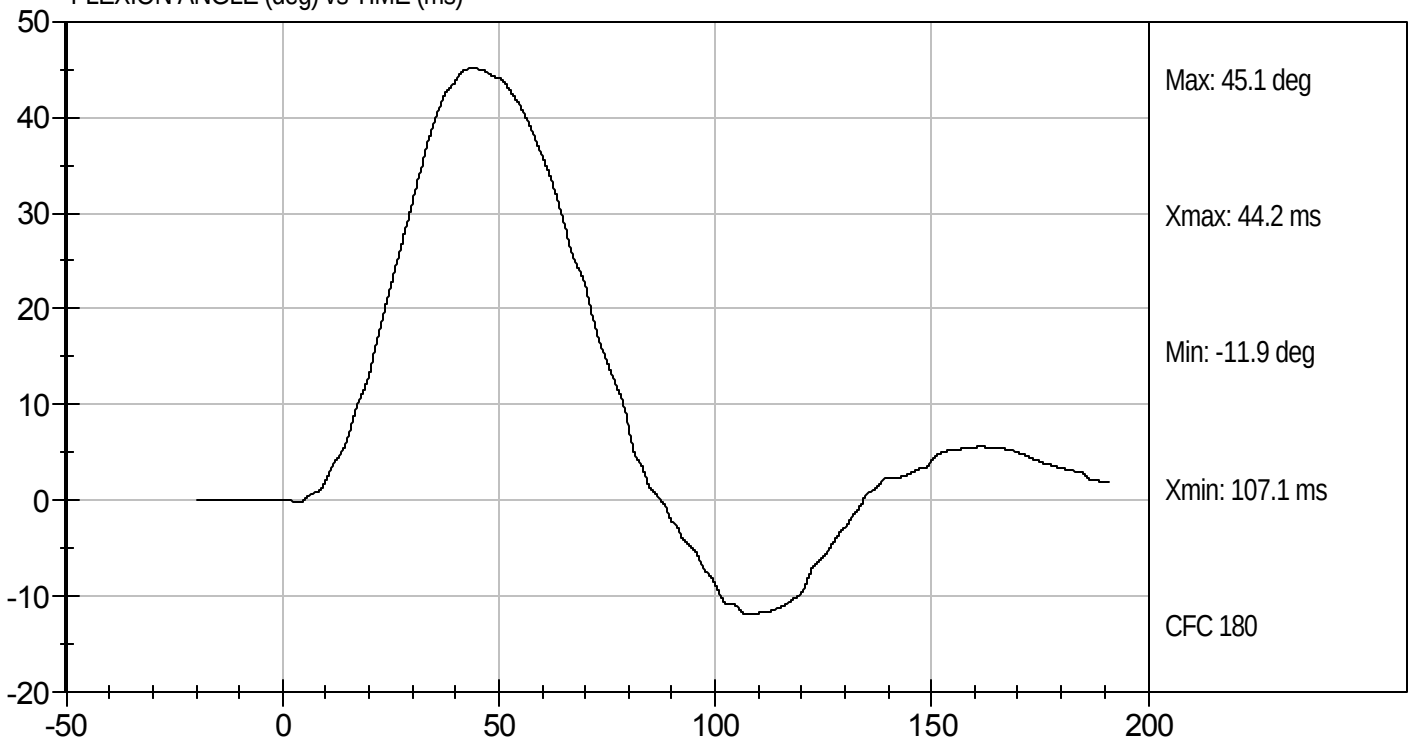
Test Desc: Lumbar Bending
Component ID: D111508

Test Date: 4/21/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

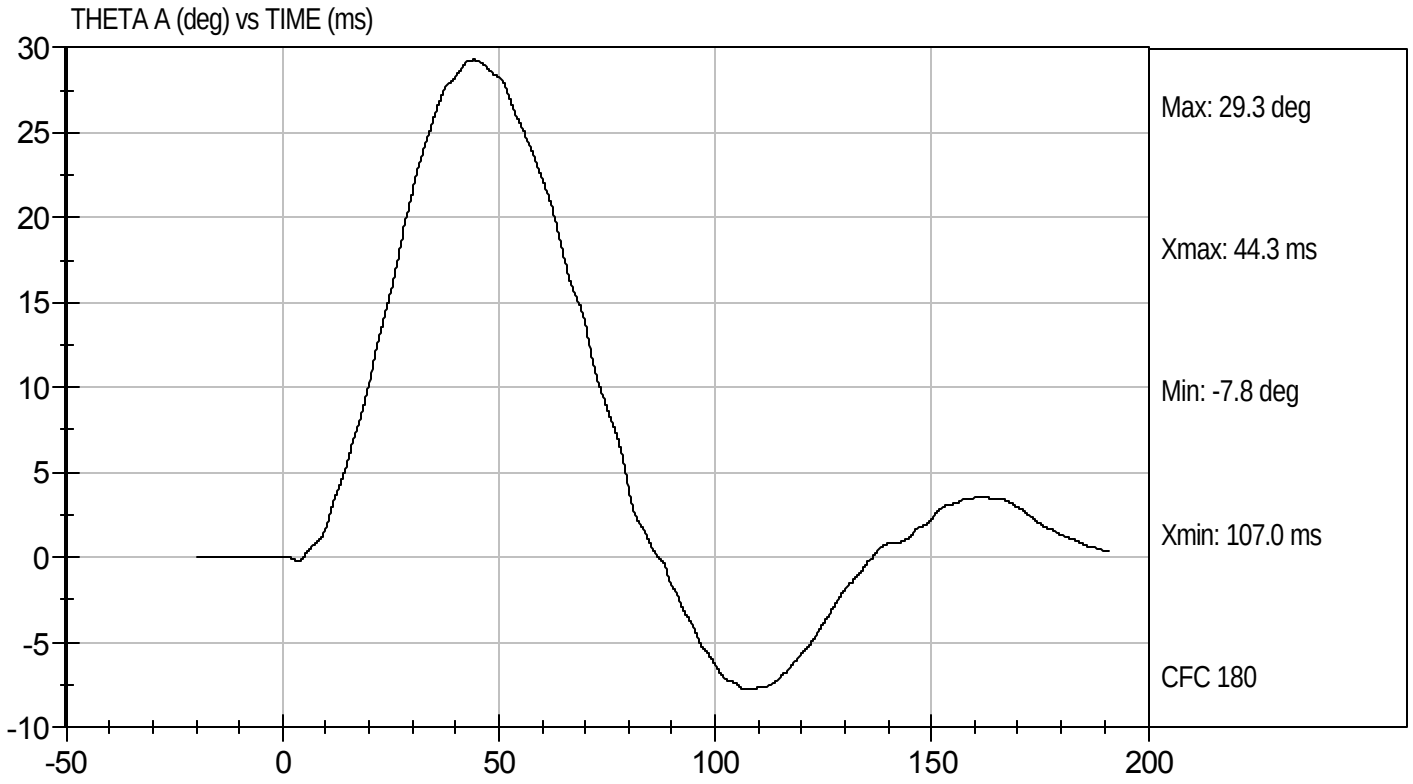


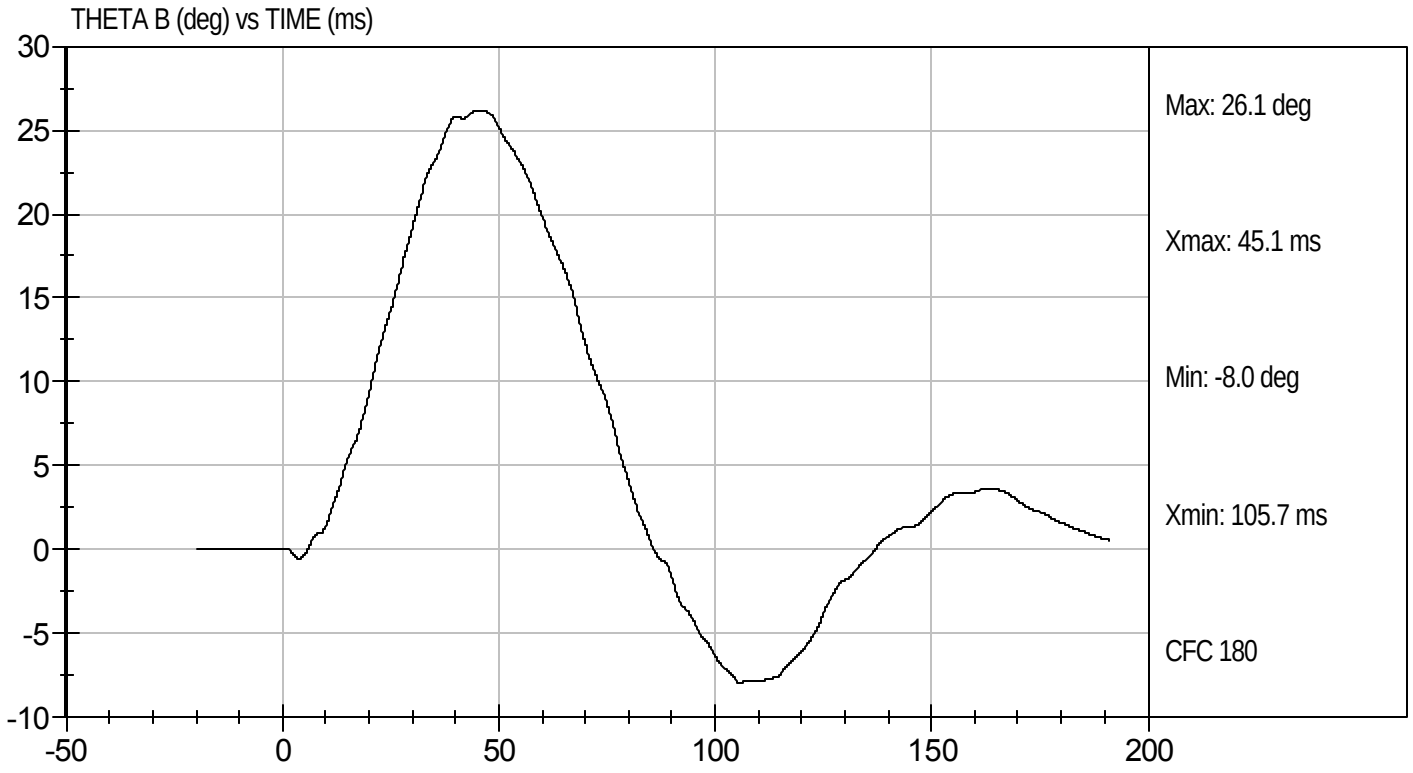

FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111508

Test Date: 4/21/11
Velocity: 20.08 ft/s, 6.12 m/s



**MGA RESEARCH CORPORATION**

**PELVIS TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111509

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 20.7 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 28 | Pass |
| Probe Speed | m/s | 4.20 to 4.40 | 4.34 | Pass |
| Maximum Impactor Force | kN | 4.70 to 5.40 | 4.79 | Pass |
| Time of Maximum Impactor Force | ms | 11.80 to 16.10 | 13.60 | Pass |
| Maximum Pubic Force | kN | 1.23 to 1.59 | 1.41 | Pass |
| Time of Maximum Pubic Force | ms | 12.20 to 17.00 | 15.80 | Pass |
| | | Overall Test Results | | Pass |

Jessica Gall
Laboratory Technician

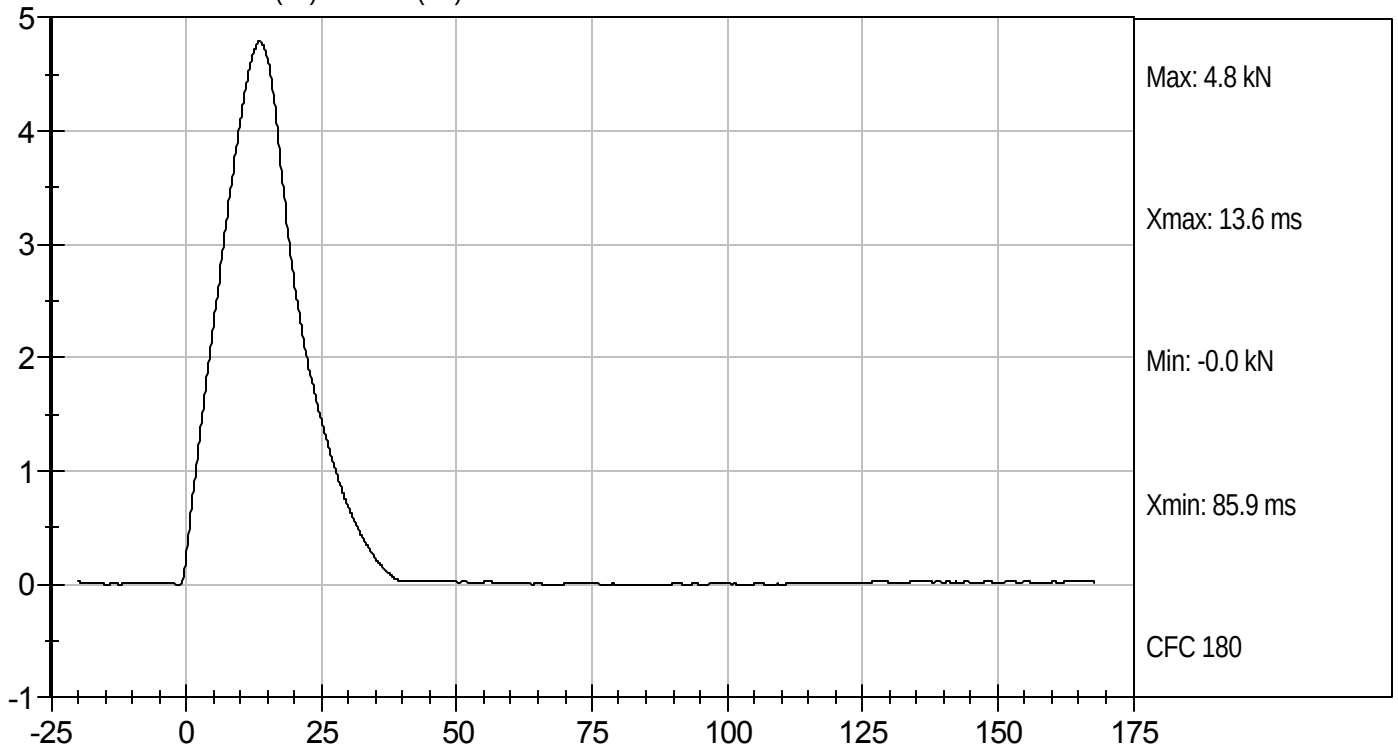
4/21/11
Test Date

David Winkelbauer
Approved By

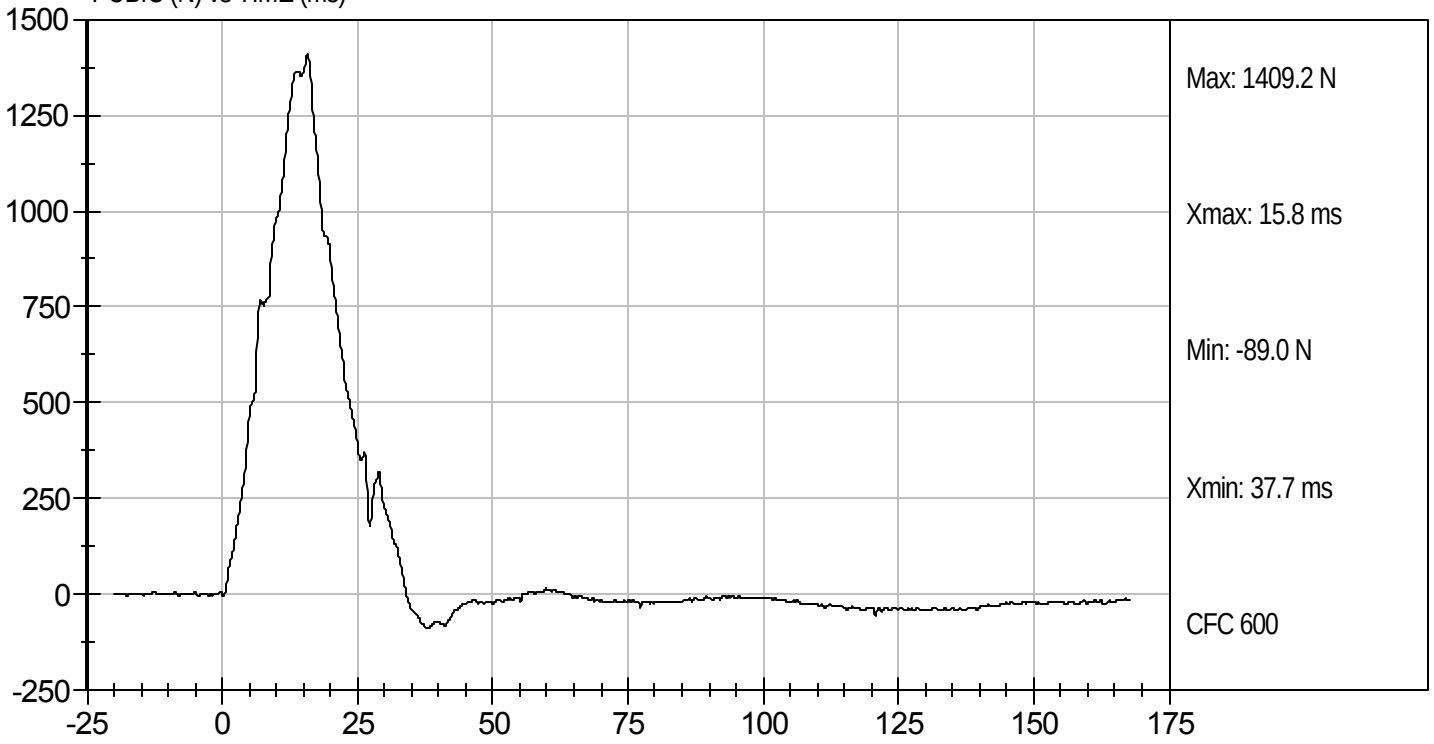
Test Desc: Pelvis Impact
Component ID: D111509

Test Date: 4/21/11
Velocity: 14.24 ft/s, 4.34 m/s

IMPACTOR FORCE (kN) vs TIME (ms)




PUBIC (N) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**FULL BODY THORAX IMPACT TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111500

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Temperature | deg C | 20.6 to 22.2 | 20.7 | Pass |
| Humidity | % | 10 to 70 | 28 | Pass |
| Probe Speed | m/s | 5.40 to 5.60 | 5.58 | Pass |
| Maximum Impactor Force (after 6 ms) | kN | 5.10 to 6.20 | 5.12 | Pass |
| Upper Rib Displacement | mm | 34.0 to 41.0 | 39.2 | Pass |
| Middle Rib Displacement | mm | 37.0 to 45.0 | 41.5 | Pass |
| Lower Rib Displacement | mm | 37.0 to 44.0 | 40.5 | Pass |
| | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

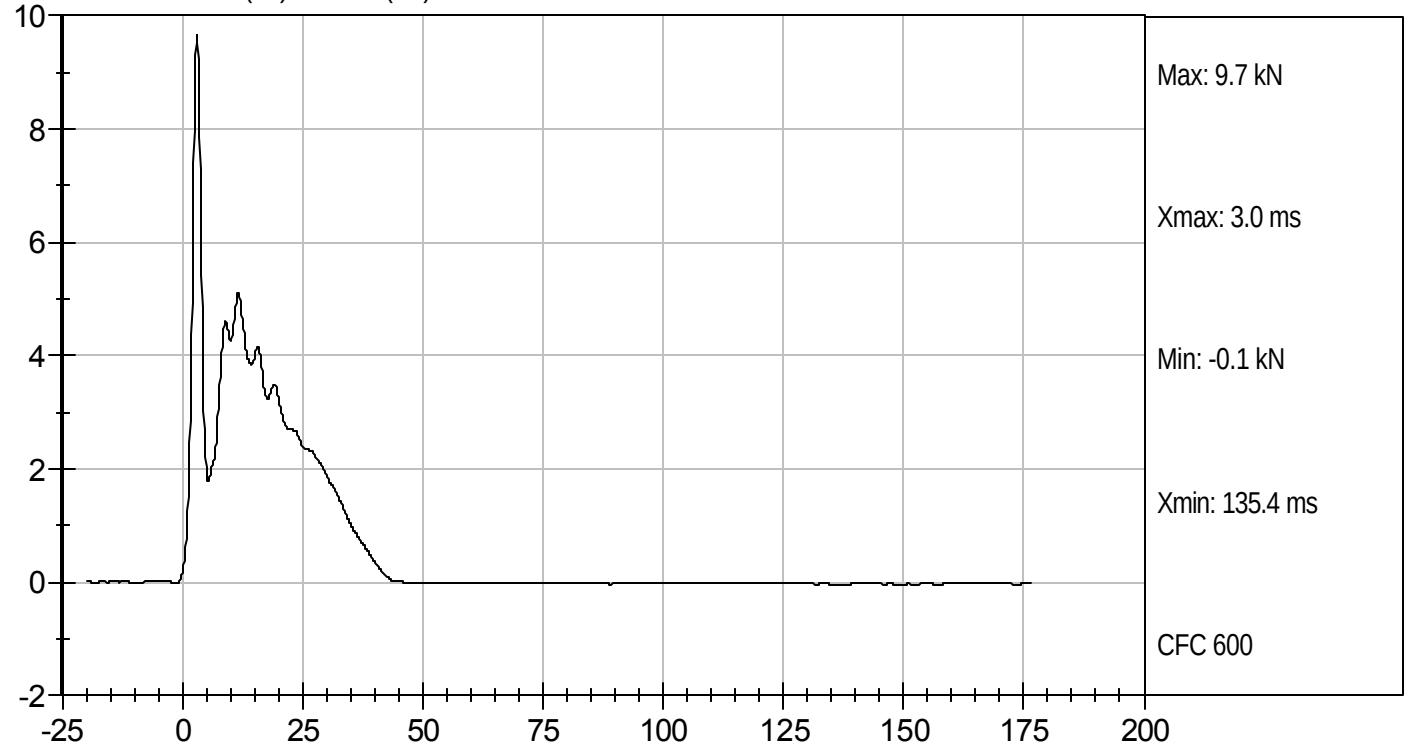
4/21/11
Test Date

David Winkelbauer
Approved By

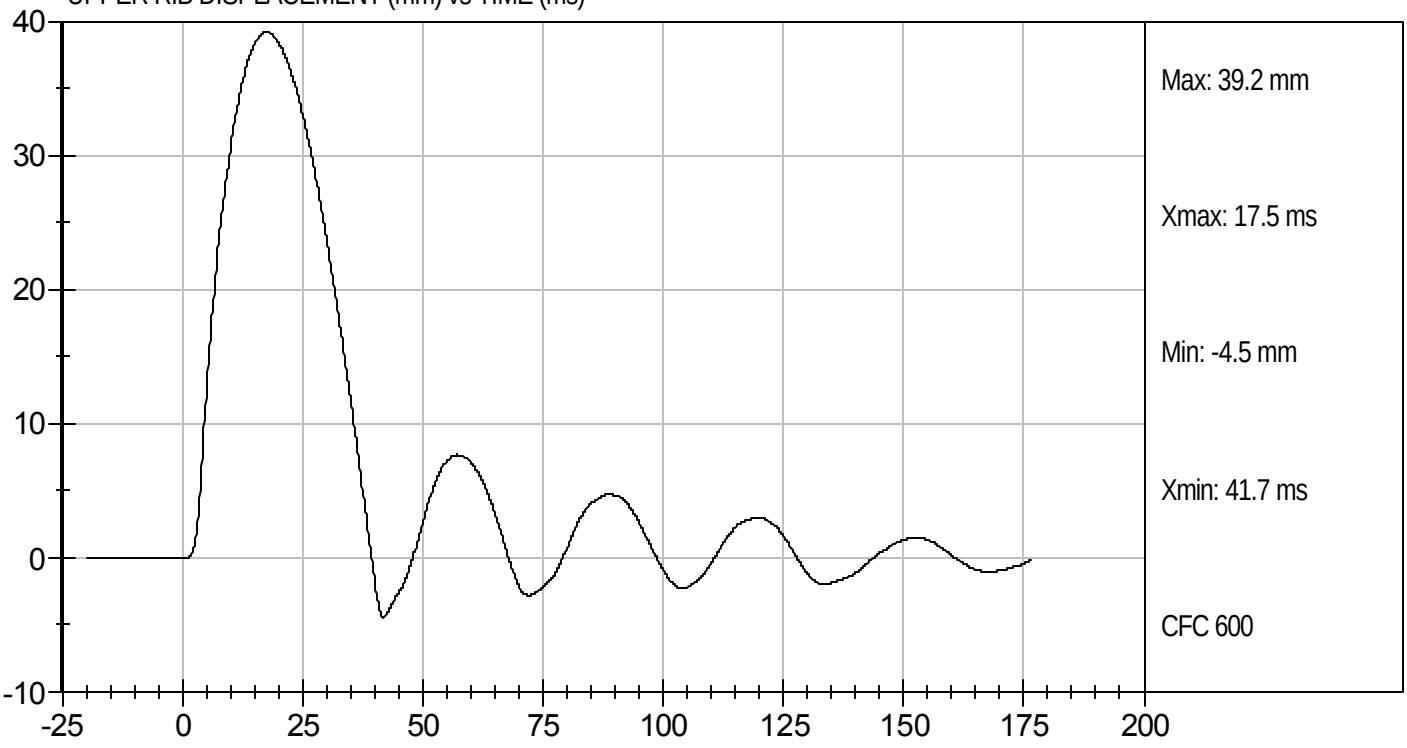
Test Desc: Thorax Impact
Component ID: D111500

Test Date: 4/21/11
Velocity: 18.31 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



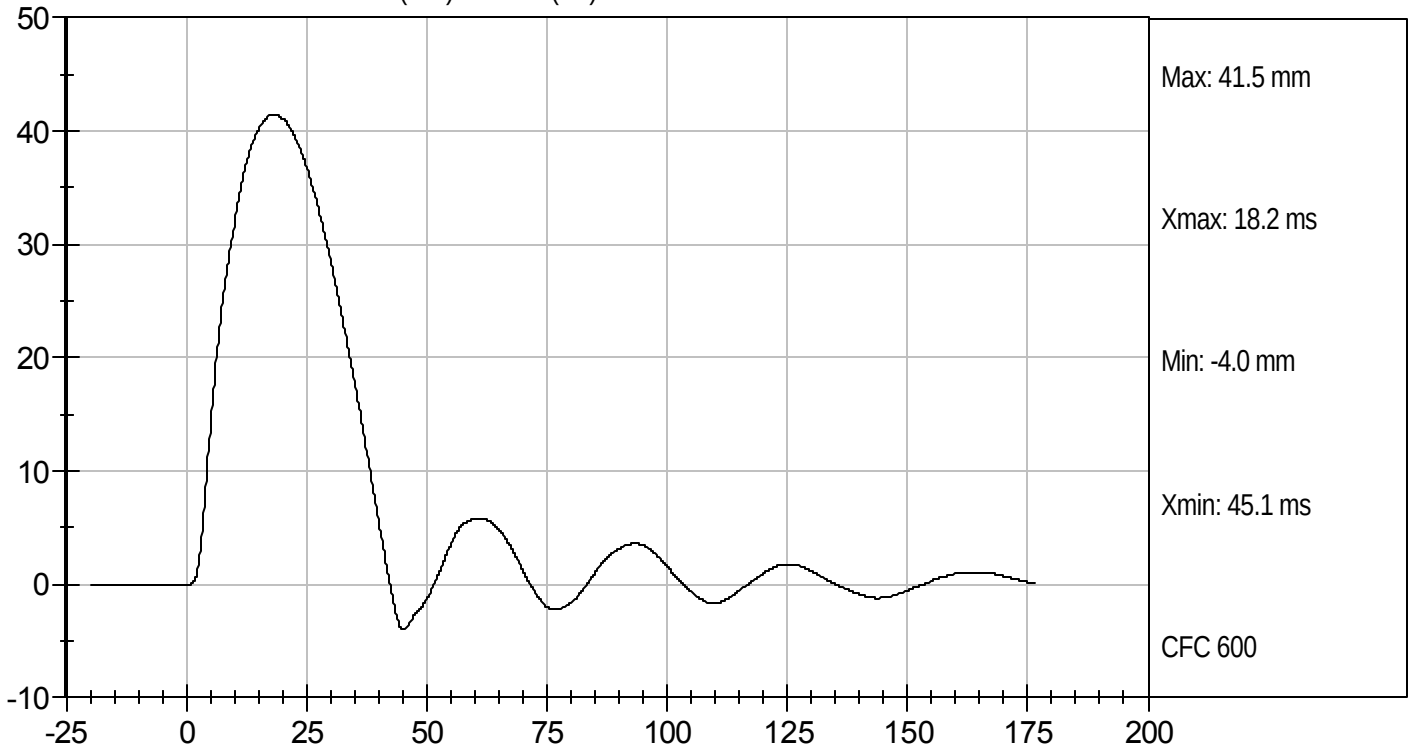

UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



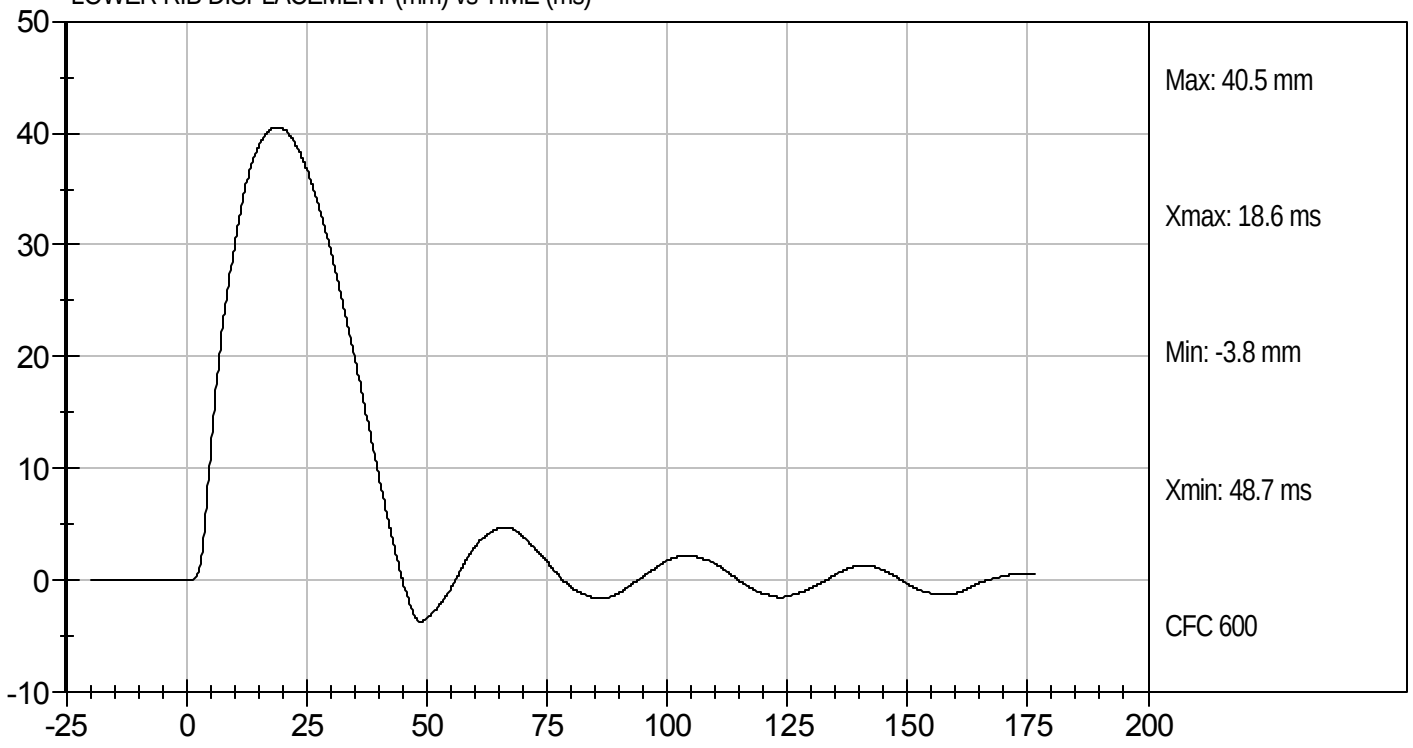
Test Desc: Thorax Impact
Component ID: D111500

Test Date: 4/21/11
Velocity: 18.31 ft/s, 5.58 m/s

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)




LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**HEAD DROP TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test ID:** D111571

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 18.9 to 25.6 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 33 | Pass |
| Peak Resultant Acceleration | G's | 125 to 155 | 145 | Pass |
| Peak Lateral Acceleration | G's | +/- 15 | -8.6 | Pass |
| Unimodal | N/A | Yes | Yes | Pass |
| Oscillations | N/A | within 15% of peak | Yes | Pass |
| | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

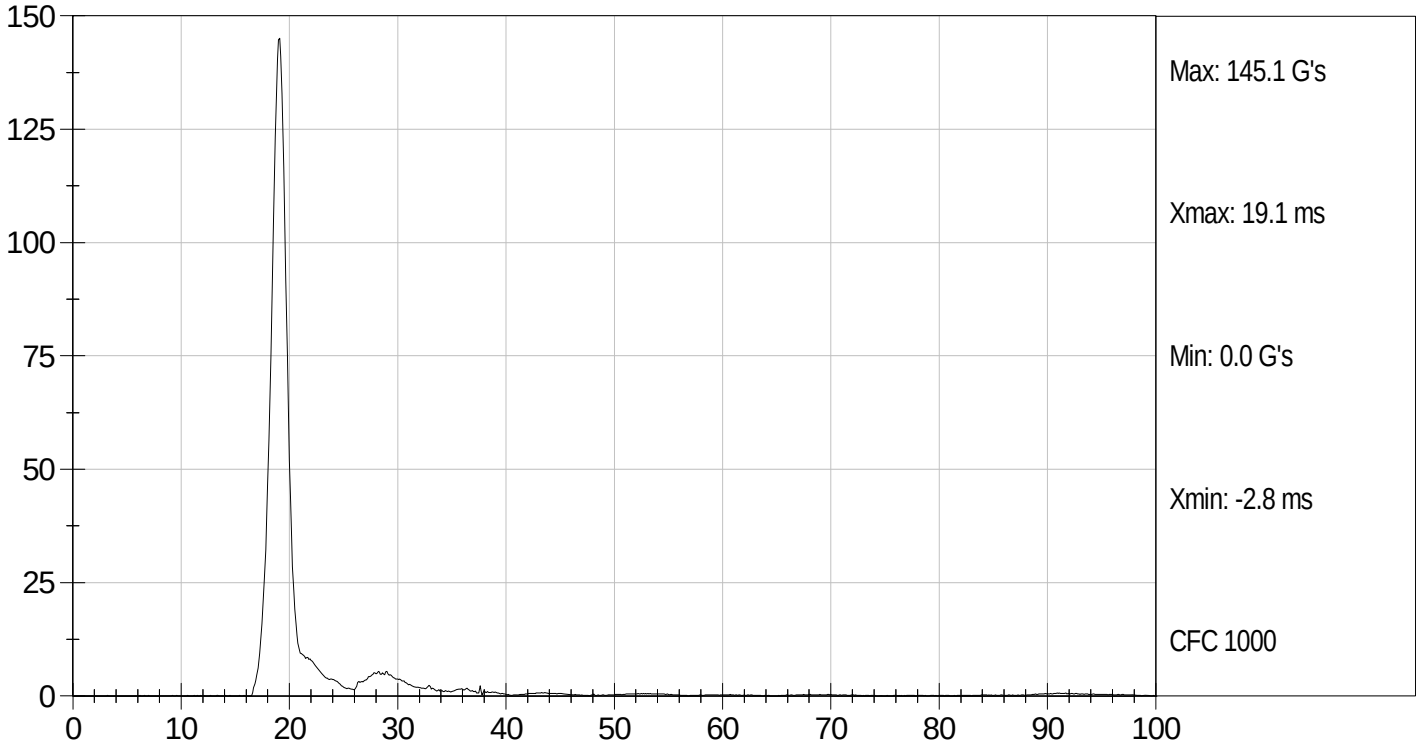
4/28/11
Test Date

David Winkelbauer
Approved By

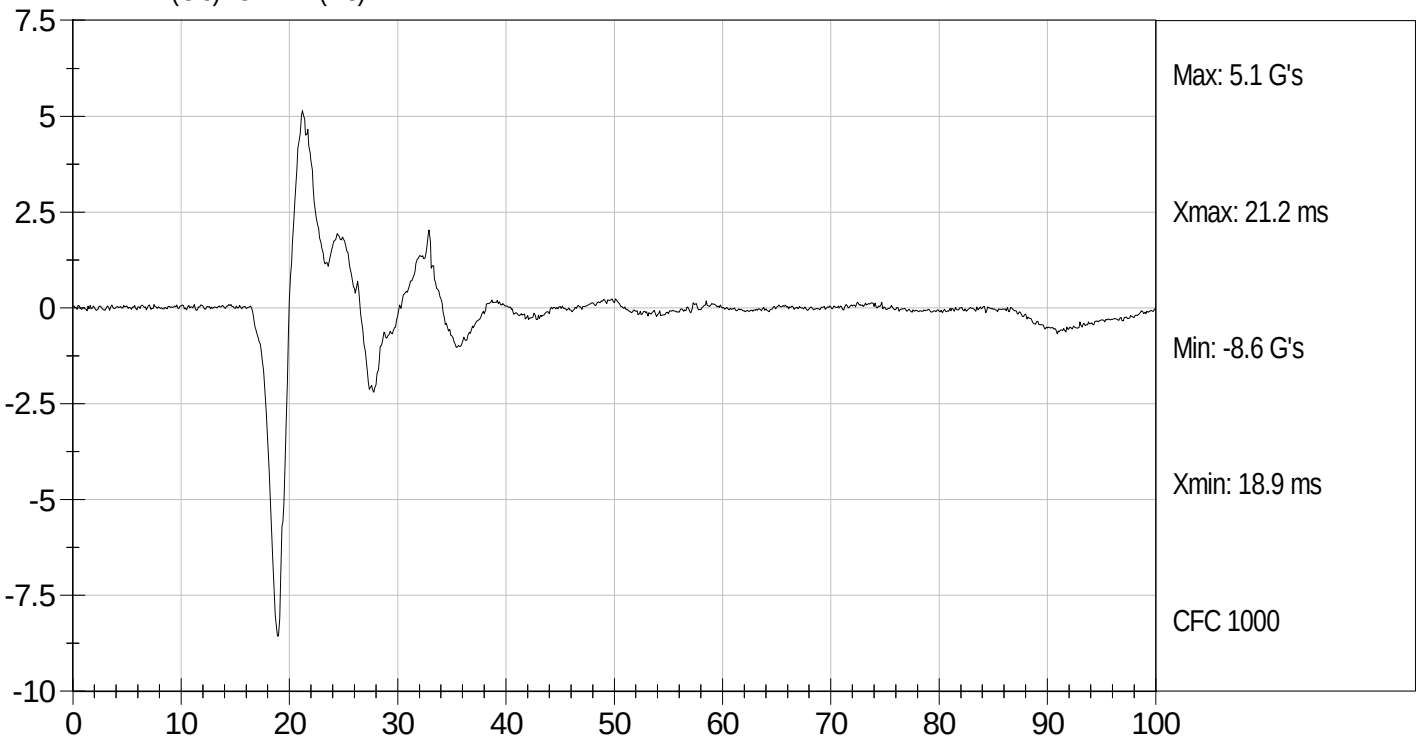
Test Desc: Head Drop
Component ID: D111571

Test Date: 4/28/11
Velocity: 0 ft/s, 0 m/s

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




HEAD X (G's) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**NECK PENDULUM TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111572

| Tested Parameter | | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|---|
| Laboratory Temperature | | deg C | 18.0 to 22.0 | 22.0 | Pass |
| Laboratory Relative Humidity | | % | 10 to 70 | 43 | Pass |
| Pendulum Speed | | m/s | 3.3 to 3.5 | 3.5 | Pass |
| Pendulum Deceleration | 1 ms | m/s | 0.00 to -0.05 | -0.02 | Pass |
| | 3 ms | m/s | -0.25 to -0.375 | -0.32 | Pass |
| | 14 ms | m/s | -3.20 to -3.70 | -3.34 | Pass |
| Maximum Flexion Angle | | deg | 49.0 to 59.0 | 51.7 | Pass |
| Time of Maximum Flexion Angle | | ms | 54.0 to 66.0 | 63.0 | Pass |
| Head Rotation Decay Time to 0 degree | | ms | 53.0 to 88.0 | 57.9 | Pass |
| | | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

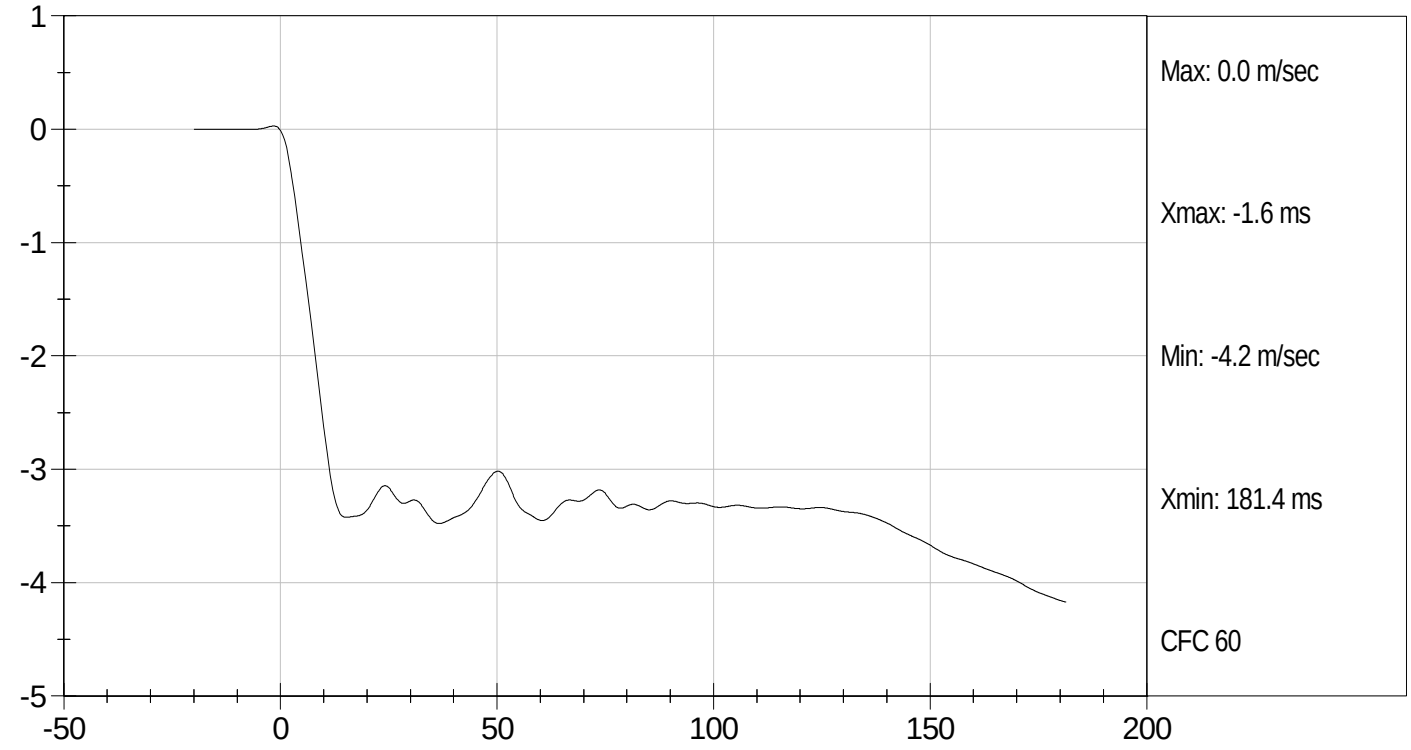
4/27/11
Test Date

David Winkelbauer
Approved By

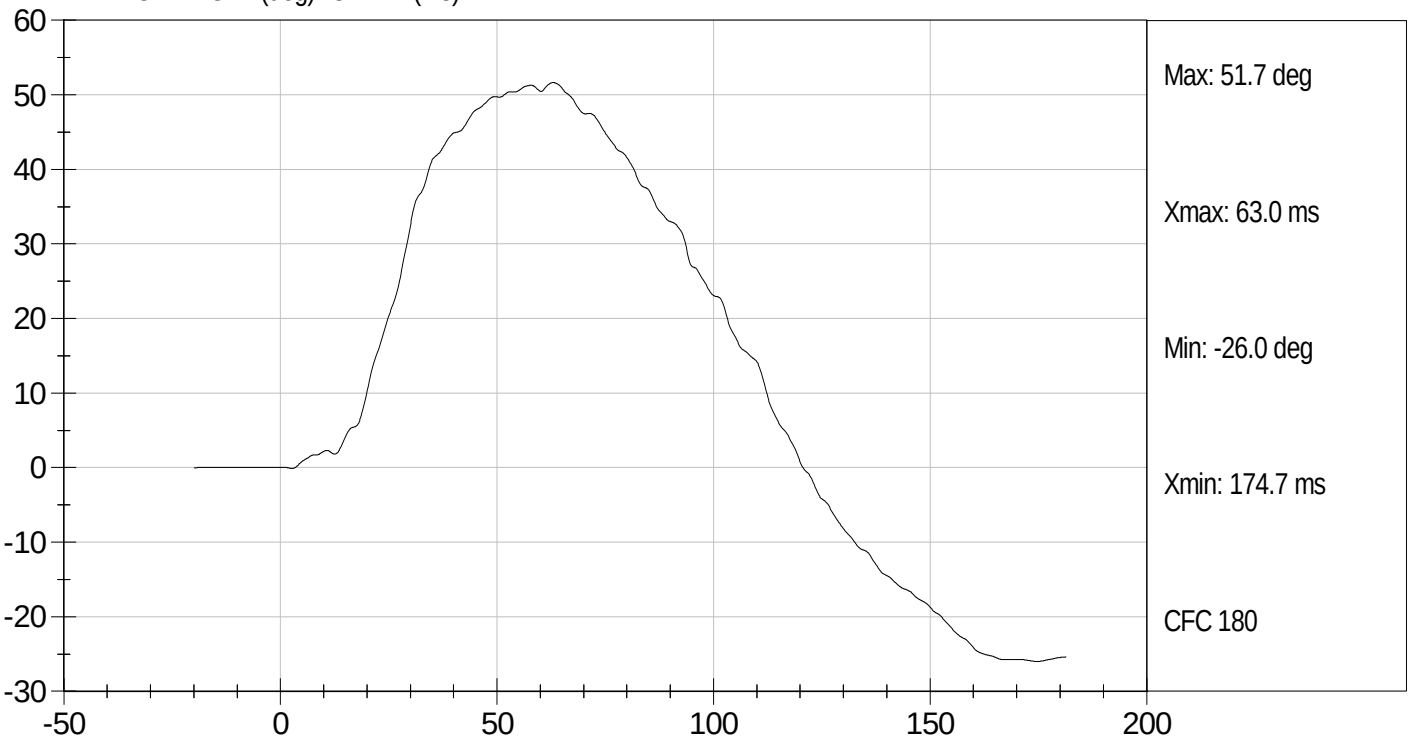
Test Desc: Neck Bending
Component ID: D111572

Test Date: 4/27/11
Velocity: 11.42 ft/s, 3.5 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)



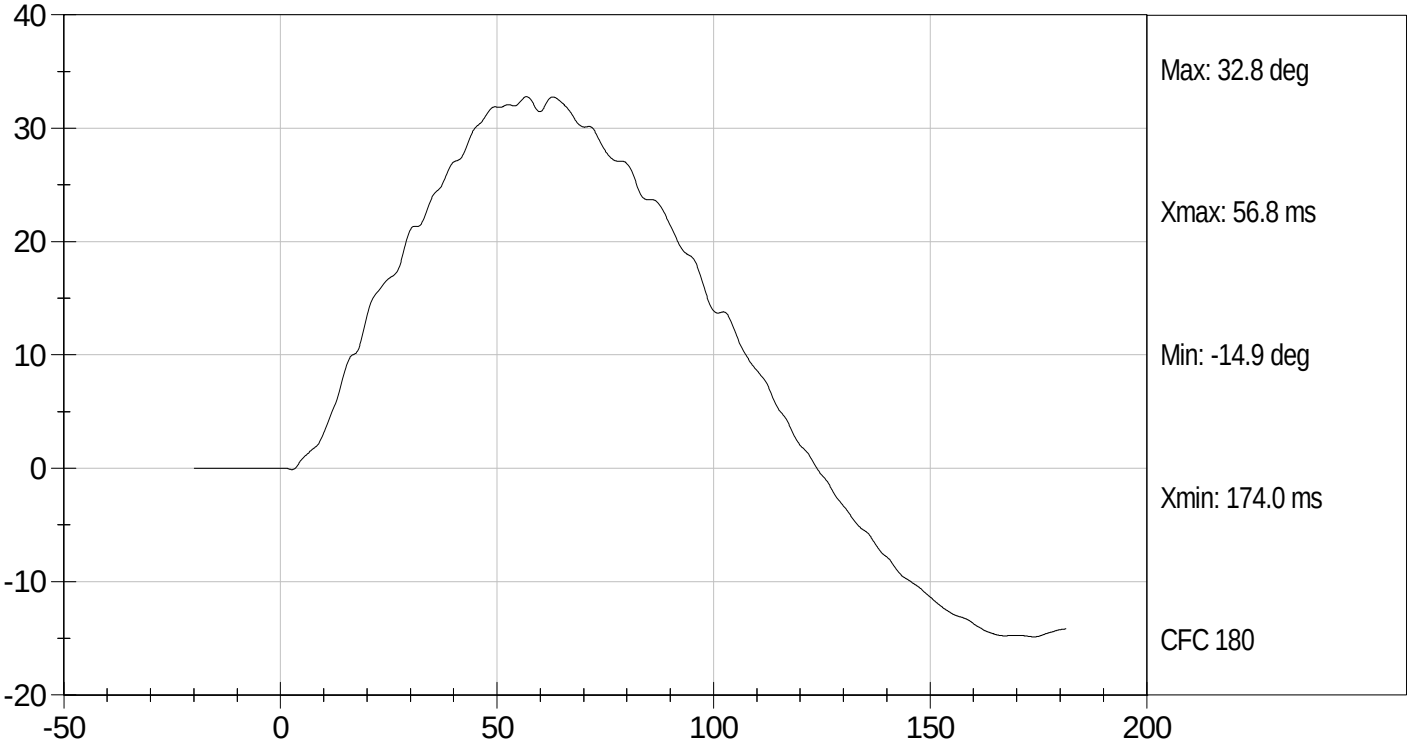

FLEXION ANGLE (deg) vs TIME (ms)



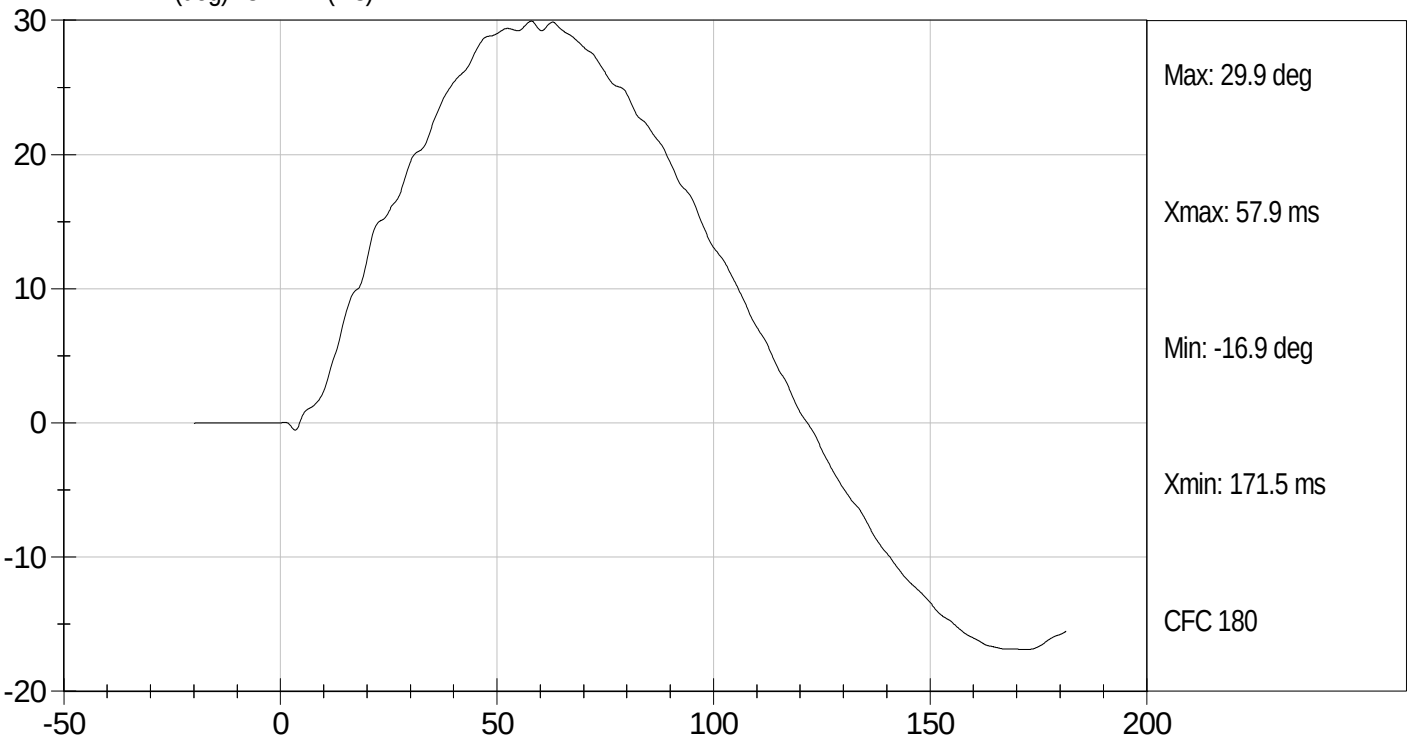
Test Desc: Neck Bending
Component ID: D111572

Test Date: 4/27/11
Velocity: 11.42 ft/s, 3.5 m/s

THETA A (deg) vs TIME (ms)




THETA B (deg) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**SHOULDER IMPACT TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111573

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 36 | Pass |
| Pendulum Speed | m/s | 4.2 to 4.4 | 4.3 | Pass |
| Peak Shoulder Acceleration | G's | 7.5 to 10.5 | 9.1 | Pass |
| Time of Peak Shoulder Acceleration | ms | NA | 18.3 | Pass |
| | | Overall Test Results | | Pass |

Jessica Hall
Laboratory Technician

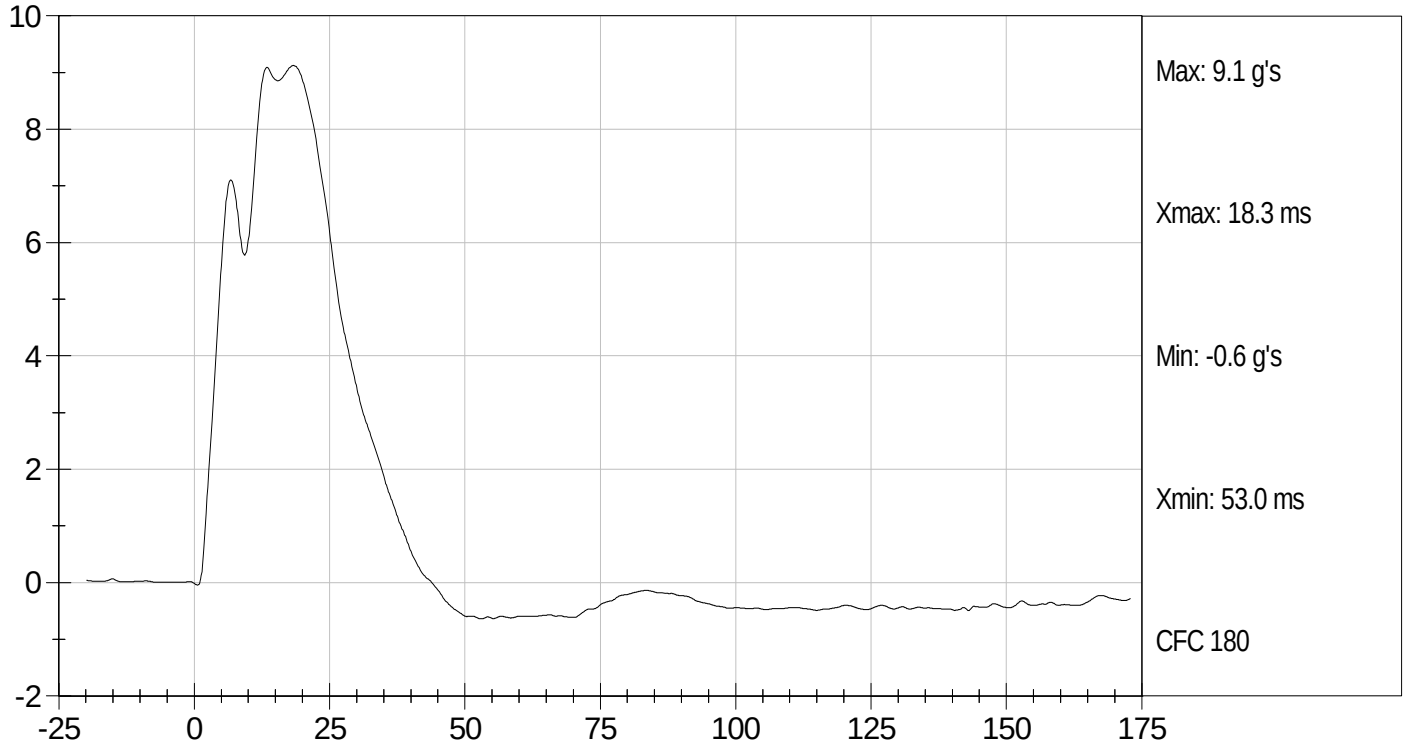
4/28/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111573

Test Date: 4/28/11
Velocity: 14.24 ft/s, 4.3 m/s

SHOULDER ACCELERATION (g's) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**UPPER RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111574

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 41 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 38.8 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 49.5 | Pass |
| | | Overall Test Results | | Pass |

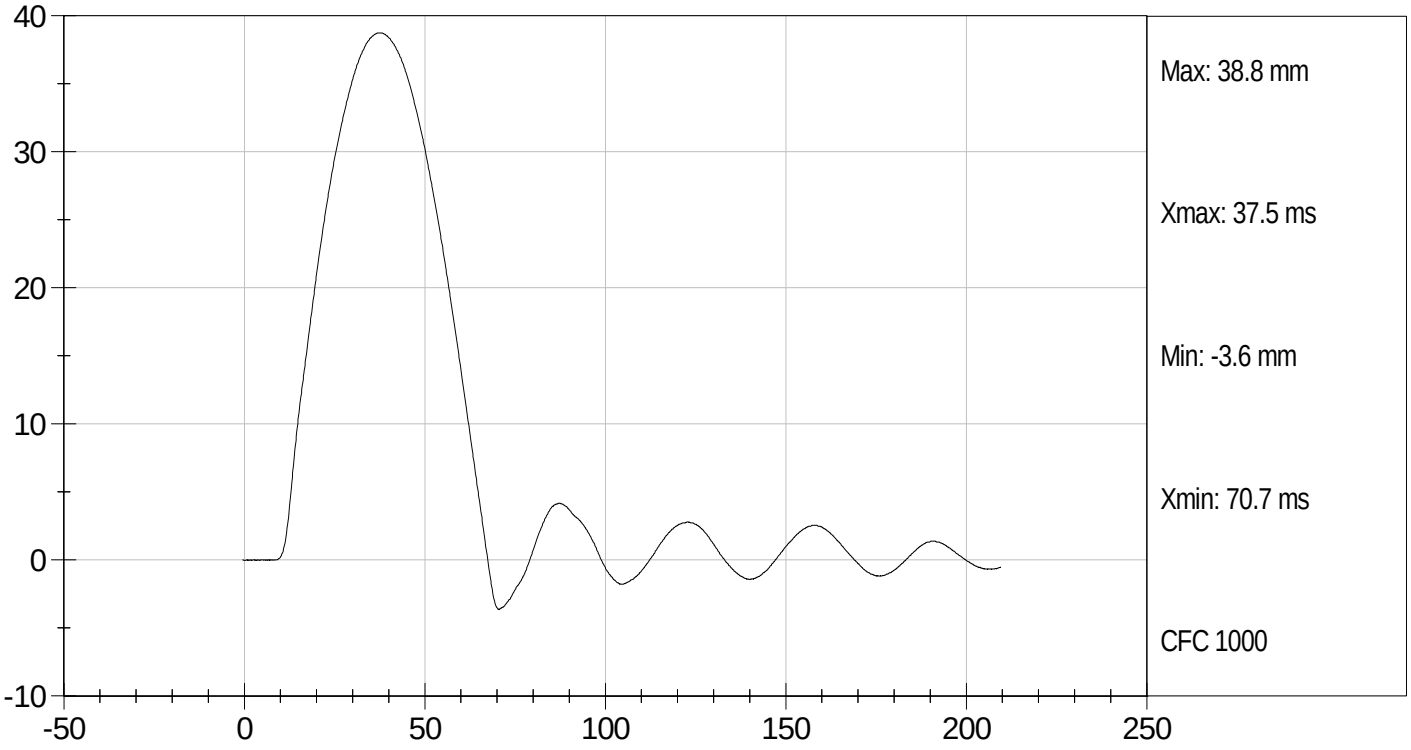
Jessica Gall
Laboratory Technician

4/27/11
Test Date

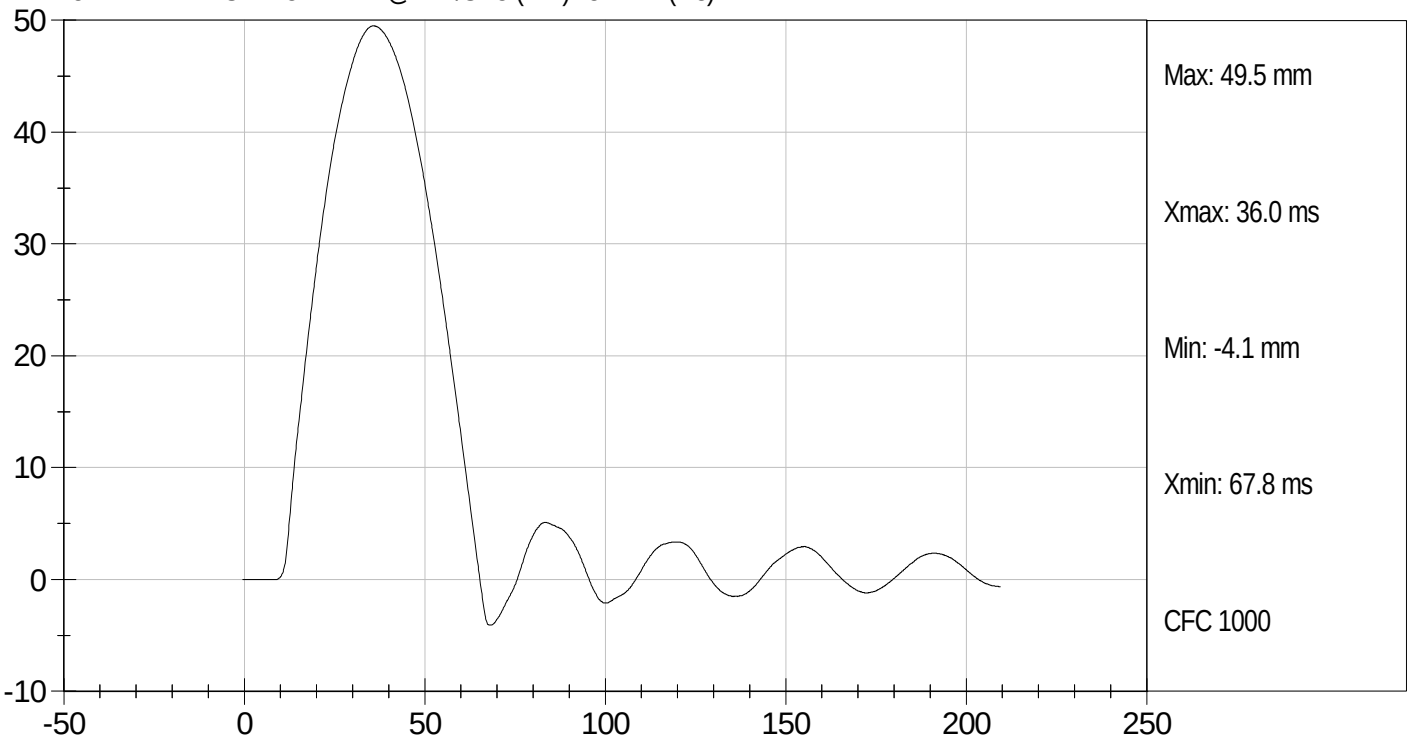
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111574
Test Date: 4/27/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**MID RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111575

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 41 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 38.7 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 48.8 | Pass |
| | | Overall Test Results | | Pass |

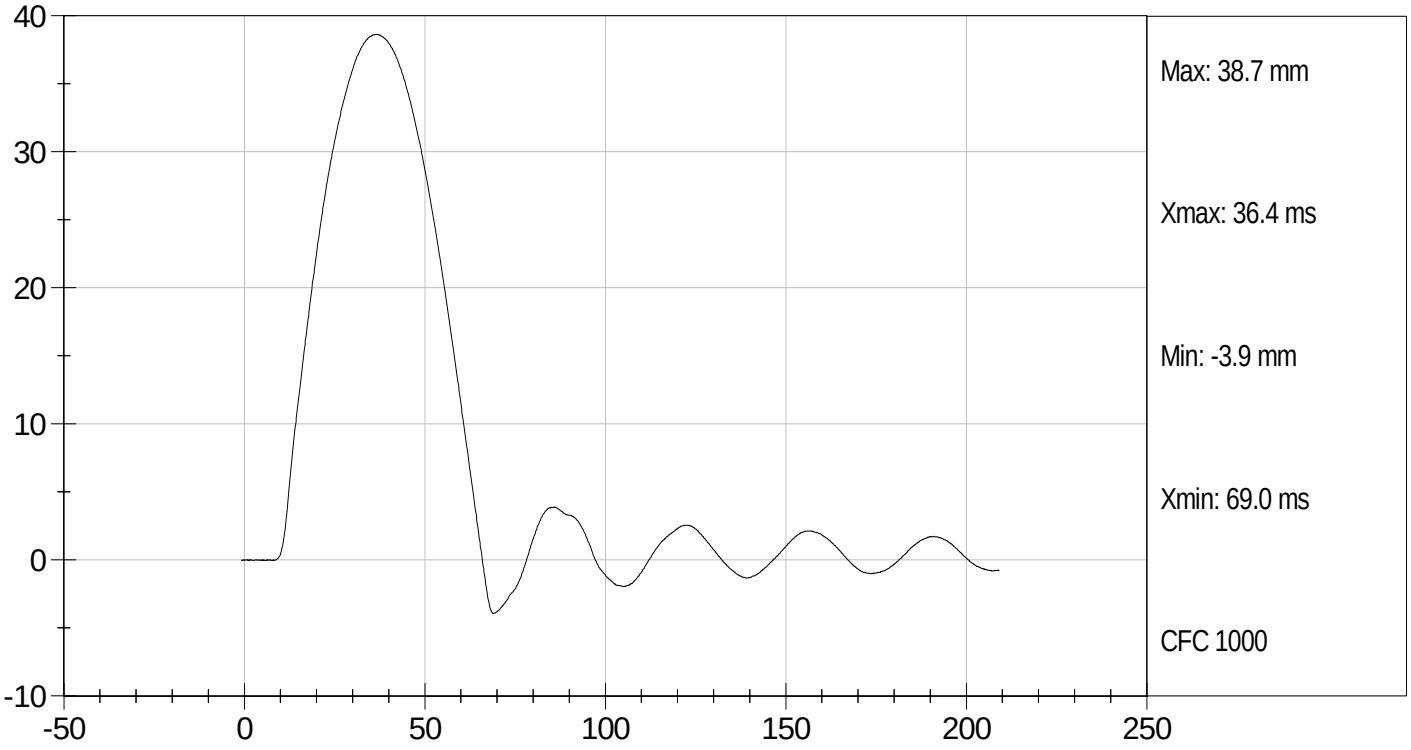
Jessica Gall
Laboratory Technician

4/27/11
Test Date

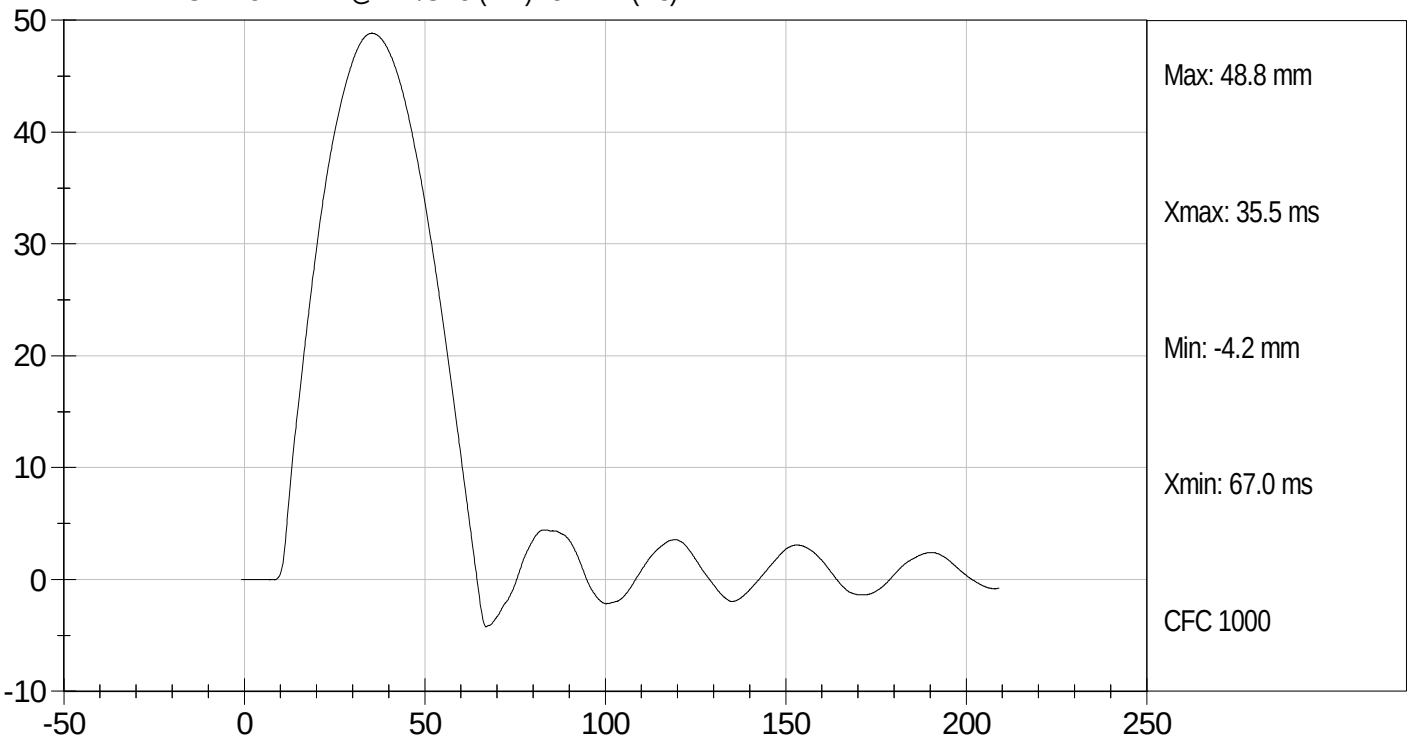
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111575
Test Date: 4/27/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**LOWER RIB TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111576

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 41 | Pass |
| Displacement at 3 m/s | mm | 36.0 to 40.0 | 39.0 | Pass |
| Displacement at 4 m/s | mm | 46.0 to 51.0 | 49.3 | Pass |
| | | Overall Test Results | | Pass |

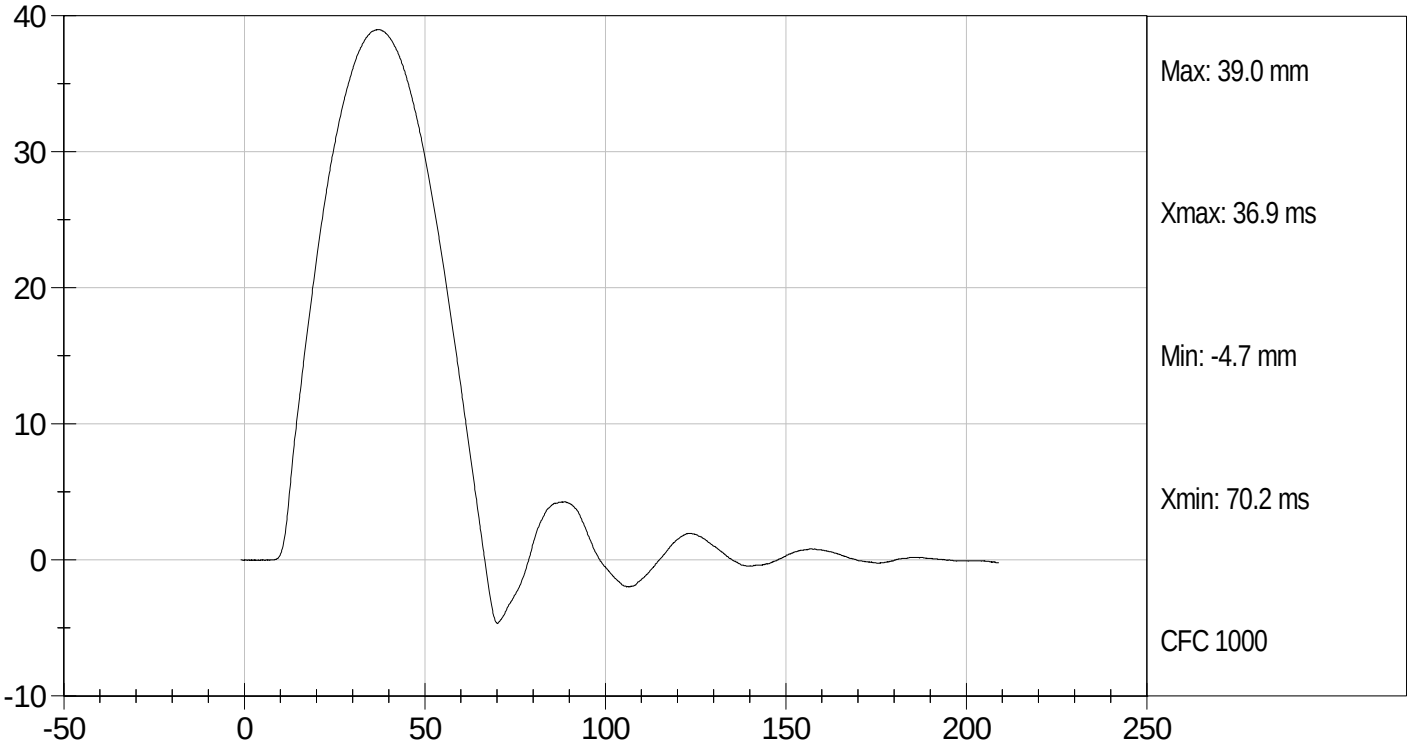
Jessica Hall
Laboratory Technician

4/27/11
Test Date

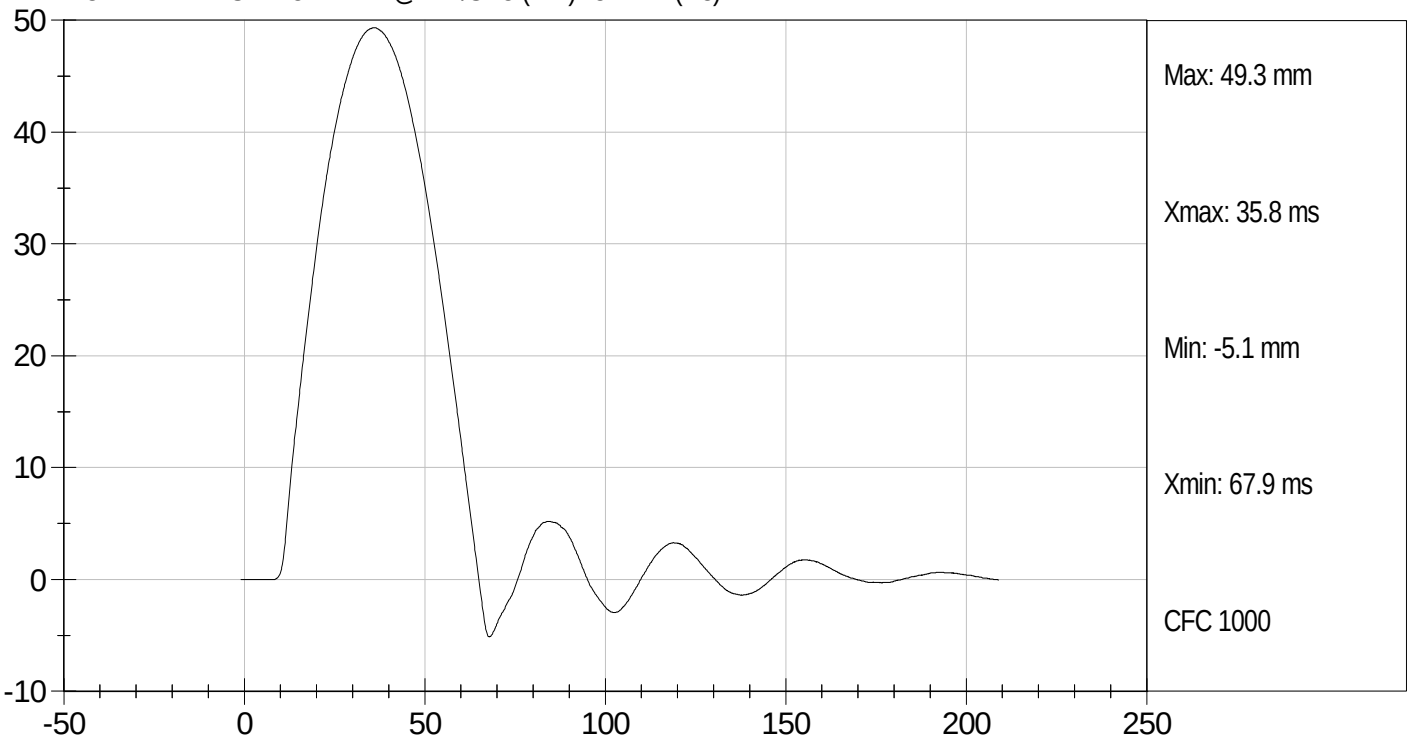
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111576
Test Date: 4/27/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)




LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**ABDOMEN TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111577

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 36 | Pass |
| Probe Speed | m/s | 3.90 to 4.10 | 4.10 | Pass |
| Maximum Impact Force | kN | 4.00 to 4.80 | 4.40 | Pass |
| Time of Maximum Impactor Force | ms | 10.60 to 13.00 | 11.30 | Pass |
| Maximum Total Abdomen Force | kN | 2.20 to 2.70 | 2.58 | Pass |
| Time of Maximum Abdomen Force | ms | 10.00 to 12.30 | 11.10 | Pass |
| | | Overall Test Results | | Pass |

Jessica Gall
Laboratory Technician

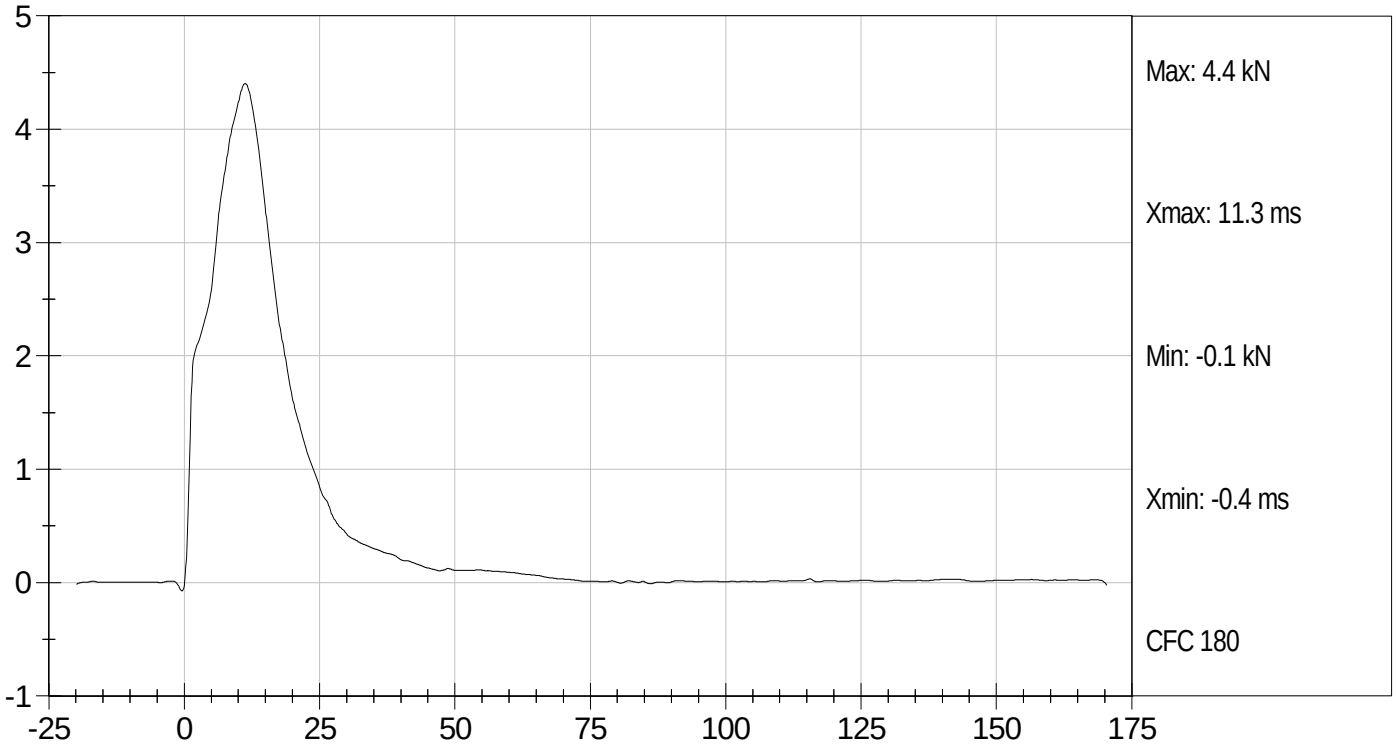
4/28/11
Test Date

David Winkelbauer
Approved By

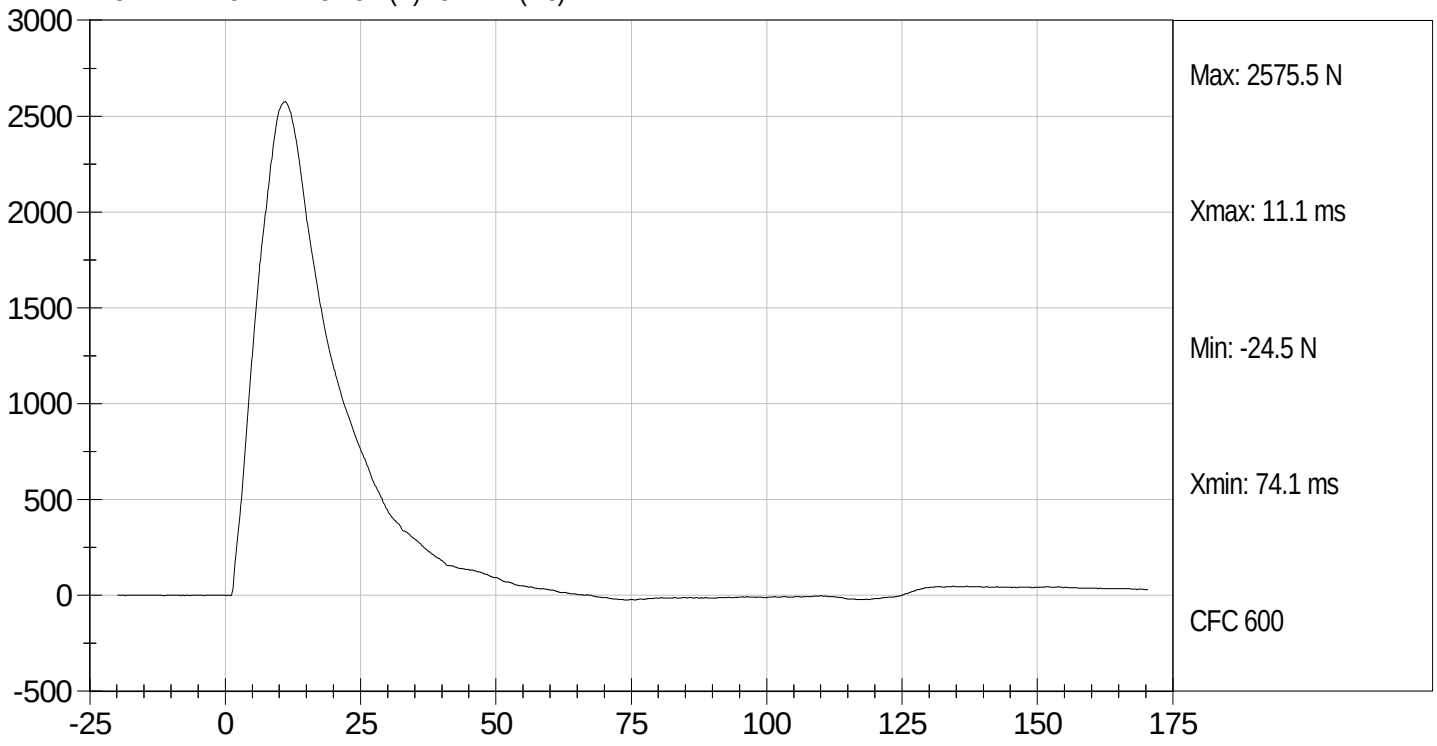
Test Desc: Abdomen Impact
Component ID: D111577

Test Date: 4/28/11
Velocity: 13.44 ft/s, 4.1 m/s

IMPACTOR FORCE (kN) vs TIME (ms)




TOTAL ABDOMEN FORCE (N) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**LUMBAR SPINE TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111578

| Tested Parameter | | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|---|
| Laboratory Temperature | | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | | % | 10 to 70 | 43 | Pass |
| Pendulum Speed | | m/s | 5.95 to 6.15 | 6.12 | Pass |
| Pendulum Deceleration | 1 ms | m/s | -0.05 to 0.00 | -0.02 | Pass |
| | 3.7 ms | m/s | -0.425 to -0.24 | -0.42 | Pass |
| | 27 ms | m/s | -6.50 to -5.80 | -5.81 | Pass |
| | 30 ms | m/s | >= -6.5 | -6.23 | Pass |
| Maximum Flexion Angle | | deg | 45.0 to 55.0 | 45.3 | Pass |
| Time of Maximum Flexion Angle | | ms | 39.0 to 53.0 | 48.4 | Pass |
| Headform Rotation Decay to Initial Position | | ms | 37 to 57 | 46 | Pass |
| | | | Overall Results | | Pass |

Jessica Hall
Laboratory Technician

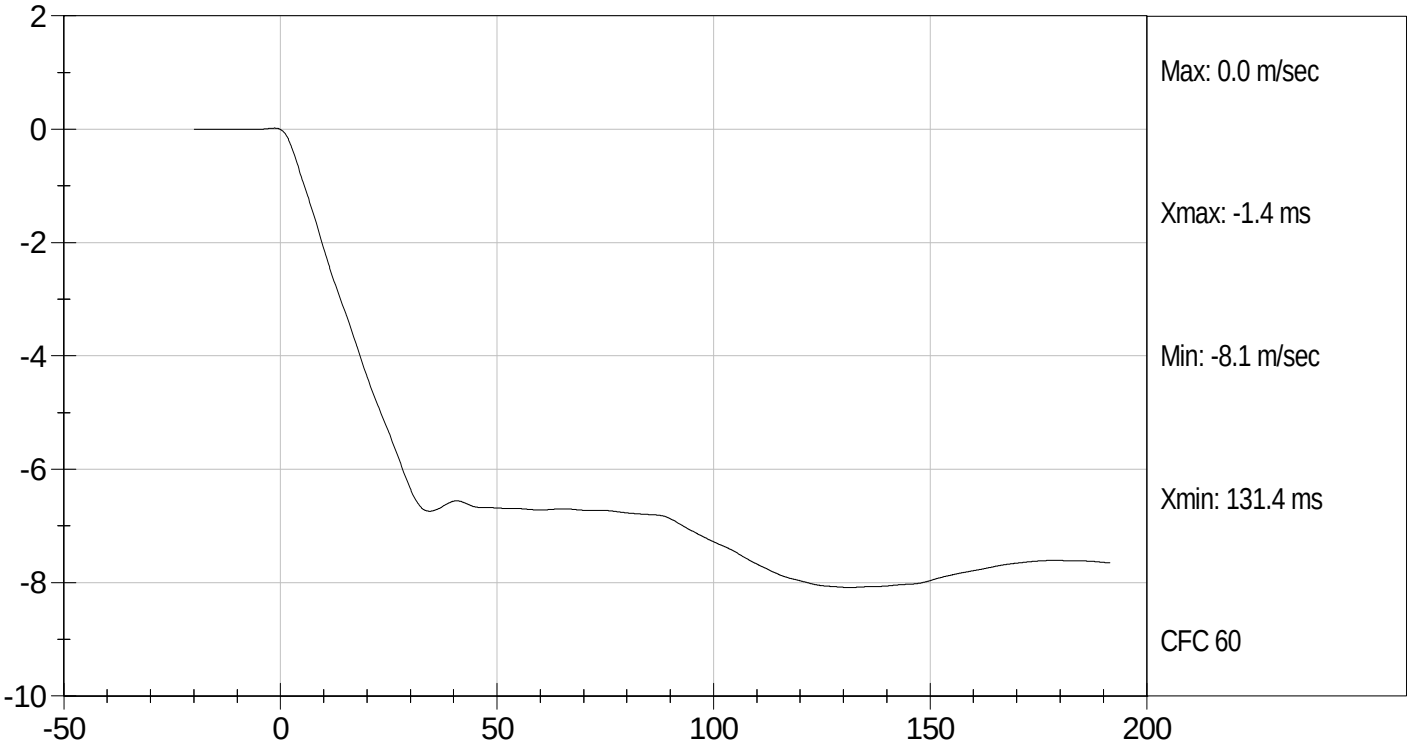
4/27/11
Test Date

David Winkelbauer
Approved By

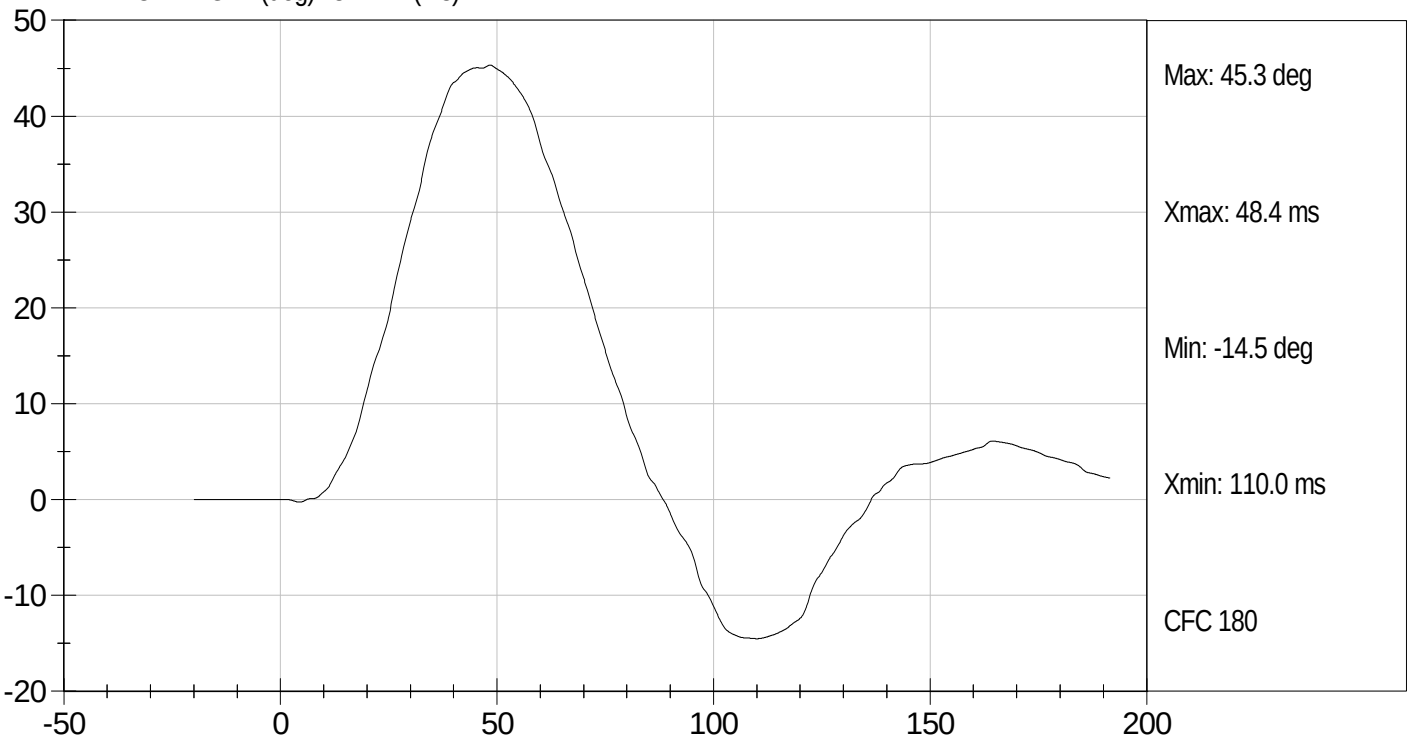
Test Desc: Lumbar Bending
Component ID: D111578

Test Date: 4/27/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)



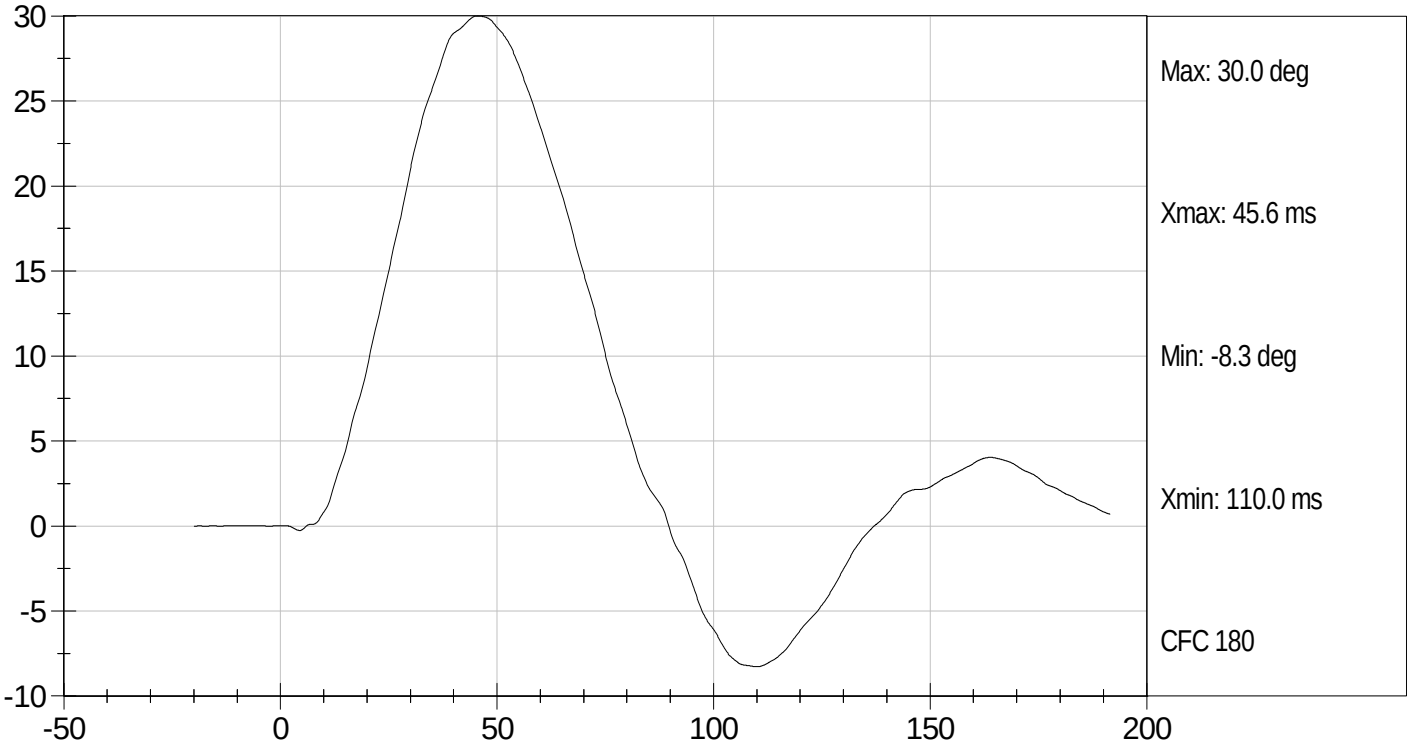

FLEXION ANGLE (deg) vs TIME (ms)



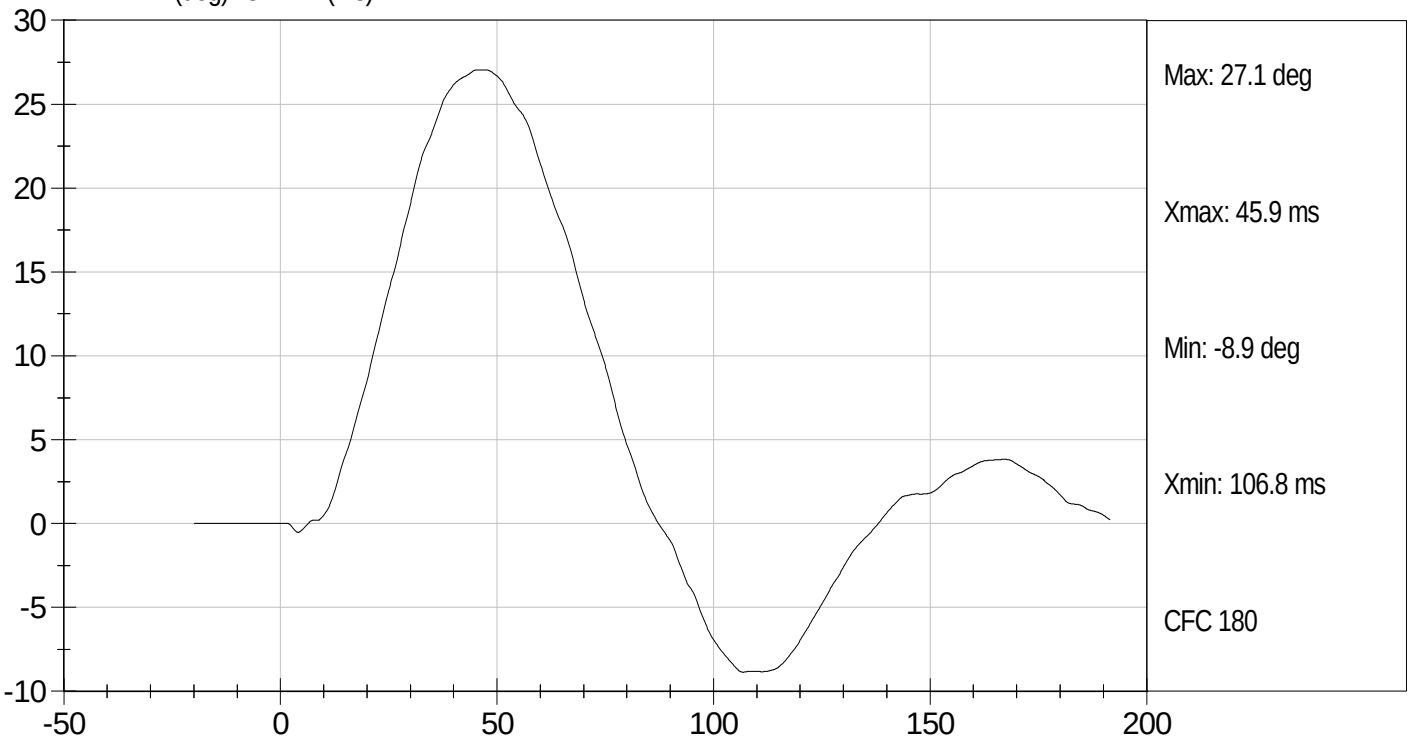
Test Desc: Lumbar Bending
Component ID: D111578

Test Date: 4/27/11
Velocity: 20.08 ft/s, 6.12 m/s

THETA A (deg) vs TIME (ms)




THETA B (deg) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**PELVIS TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111579

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 36 | Pass |
| Probe Speed | m/s | 4.20 to 4.40 | 4.34 | Pass |
| Maximum Impactor Force | kN | 4.70 to 5.40 | 4.81 | Pass |
| Time of Maximum Impactor Force | ms | 11.80 to 16.10 | 13.70 | Pass |
| Maximum Pubic Force | kN | 1.23 to 1.59 | 1.42 | Pass |
| Time of Maximum Pubic Force | ms | 12.20 to 17.00 | 14.70 | Pass |
| | | Overall Test Results | | Pass |

Jessica Gall
Laboratory Technician

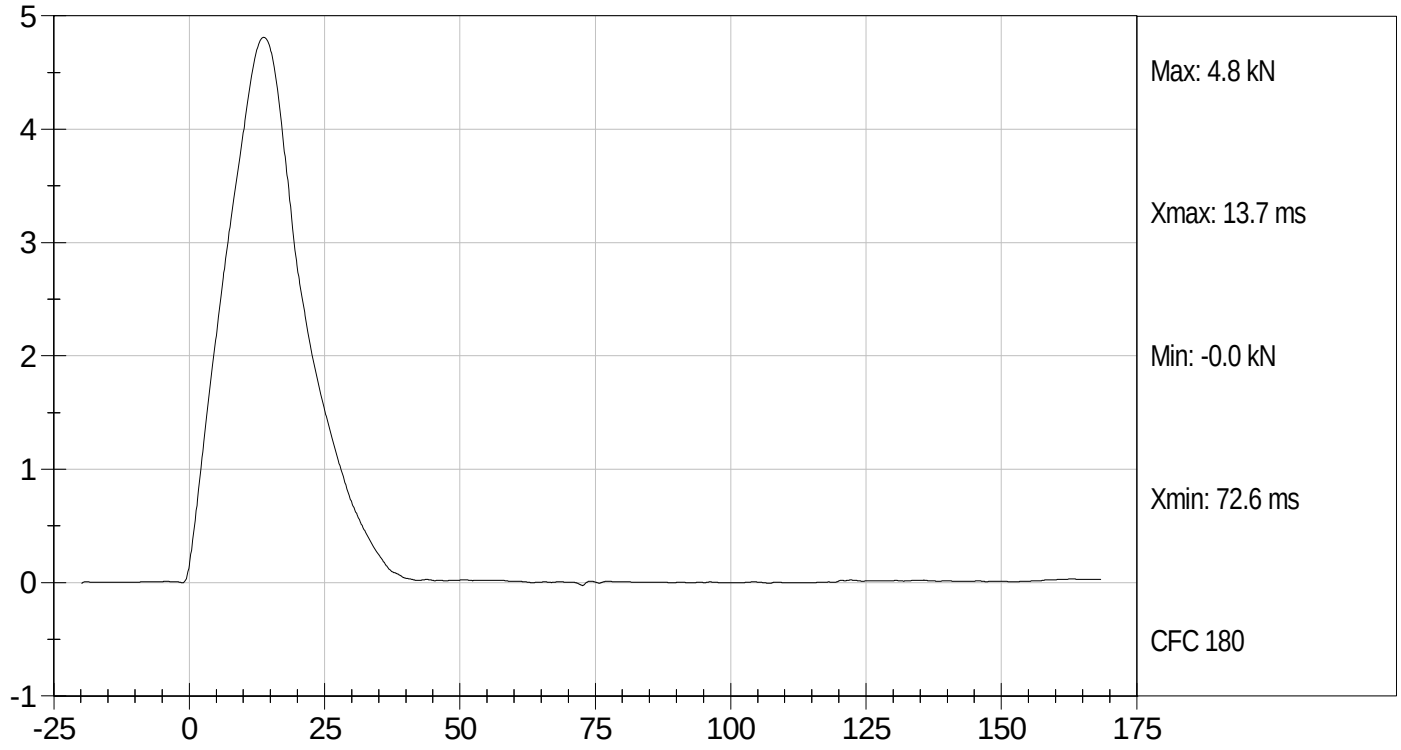
4/28/11
Test Date

David Winkelbauer
Approved By

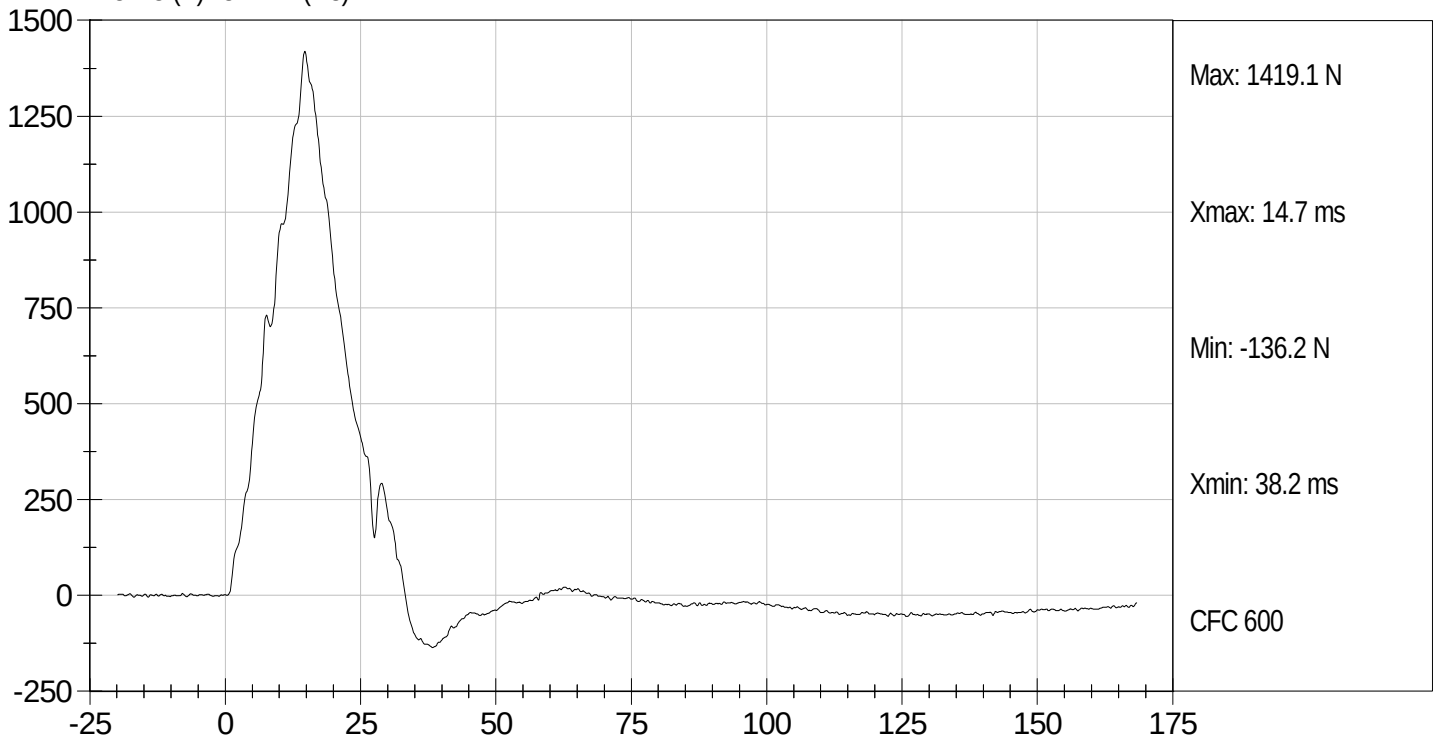
Test Desc: Pelvis Impact
Component ID: D111579

Test Date: 4/28/11
Velocity: 14.24 ft/s, 4.34 m/s

IMPACTOR FORCE (kN) vs TIME (ms)




PUBIC (N) vs TIME (ms)



**MGA RESEARCH CORPORATION**

**FULL BODY THORAX IMPACT TEST**

**ES-2re DUMMY**

**ATD Serial No:** 016 **Test I.D:** D111570

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---|---|---|---|---|
| Temperature | deg C | 20.6 to 22.2 | 22.0 | Pass |
| Humidity | % | 10 to 70 | 36 | Pass |
| Probe Speed | m/s | 5.40 to 5.60 | 5.58 | Pass |
| Maximum Impactor Force (after 6 ms) | kN | 5.10 to 6.20 | 5.12 | Pass |
| Upper Rib Displacement | mm | 34.0 to 41.0 | 38.8 | Pass |
| Middle Rib Displacement | mm | 37.0 to 45.0 | 40.8 | Pass |
| Lower Rib Displacement | mm | 37.0 to 44.0 | 40.0 | Pass |
| | | Overall Test Results | | Pass |

Jessica Gall
Laboratory Technician

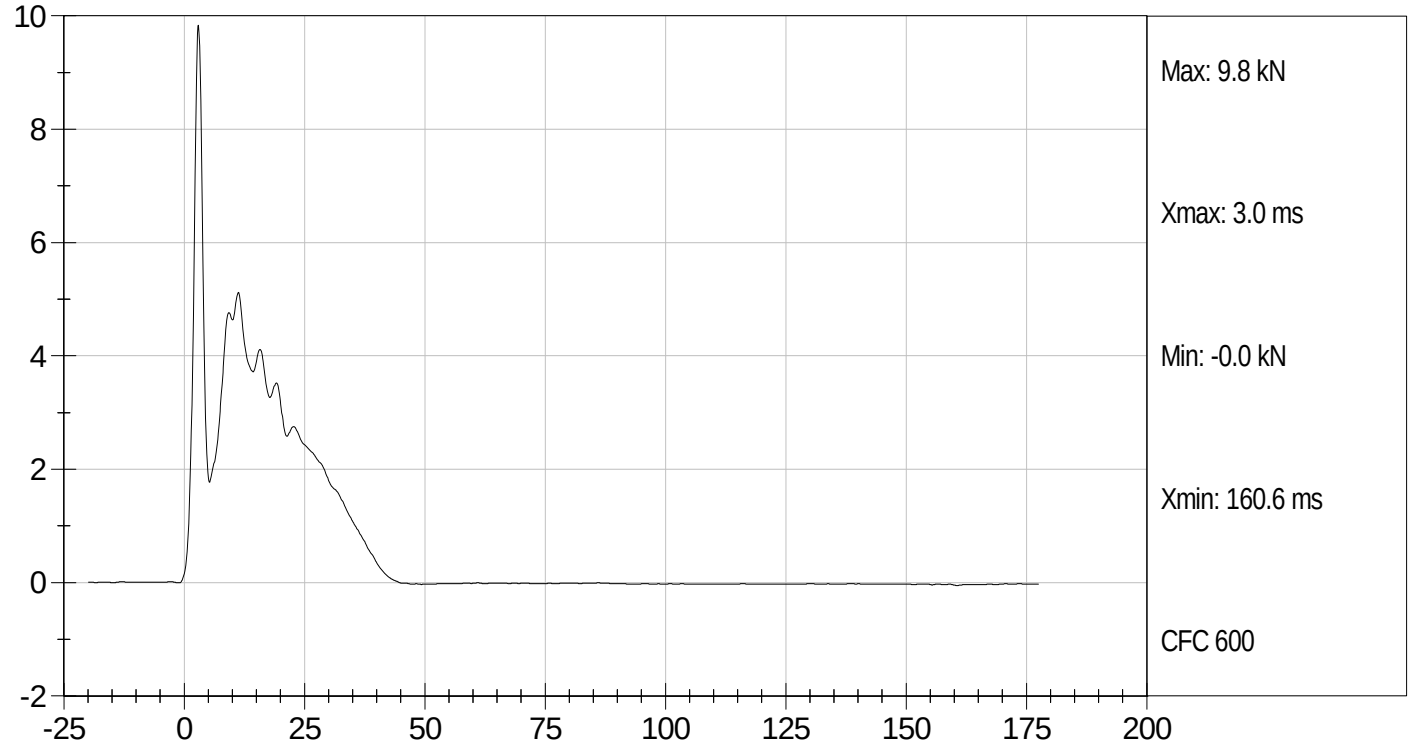
4/28/11
Test Date

David Winkelbauer
Approved By

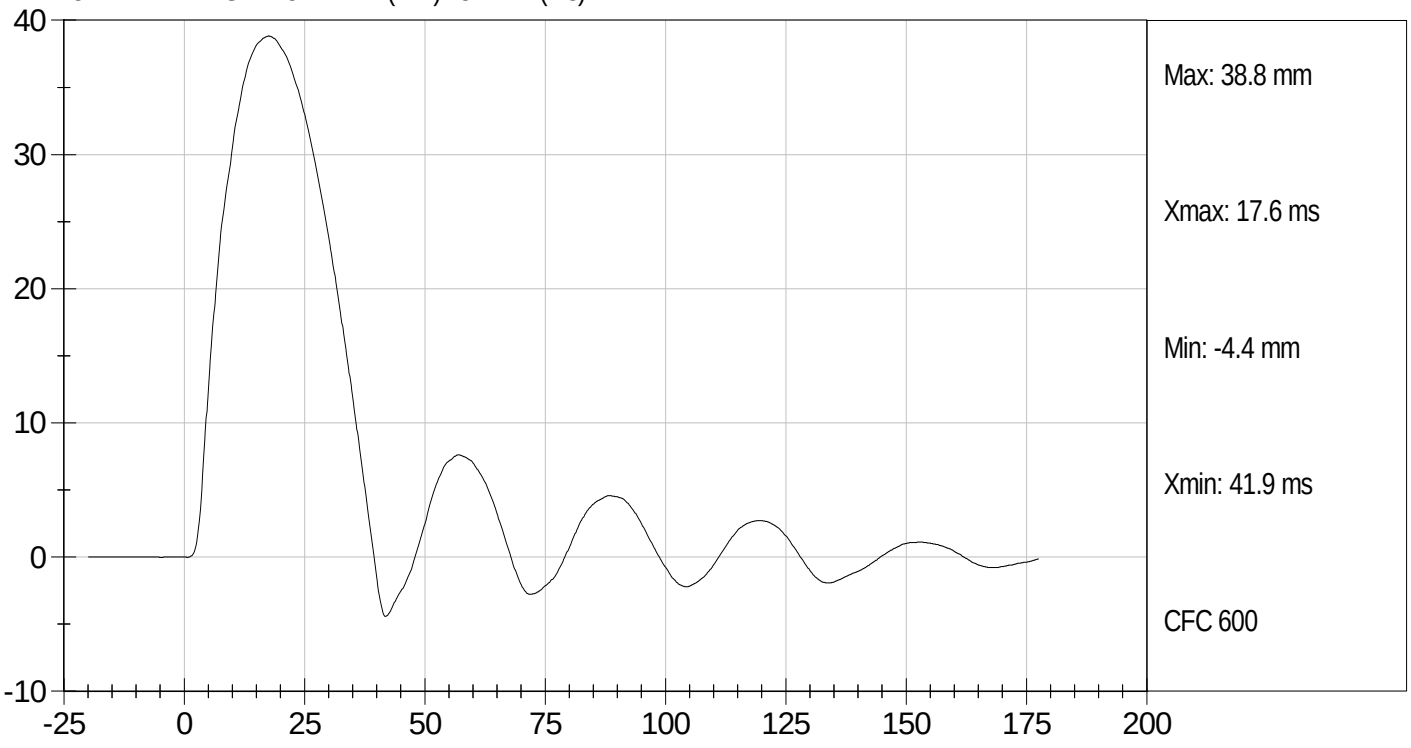
Test Desc: Thorax Impact
Component ID: D111570

Test Date: 4/28/11
Velocity: 18.31 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



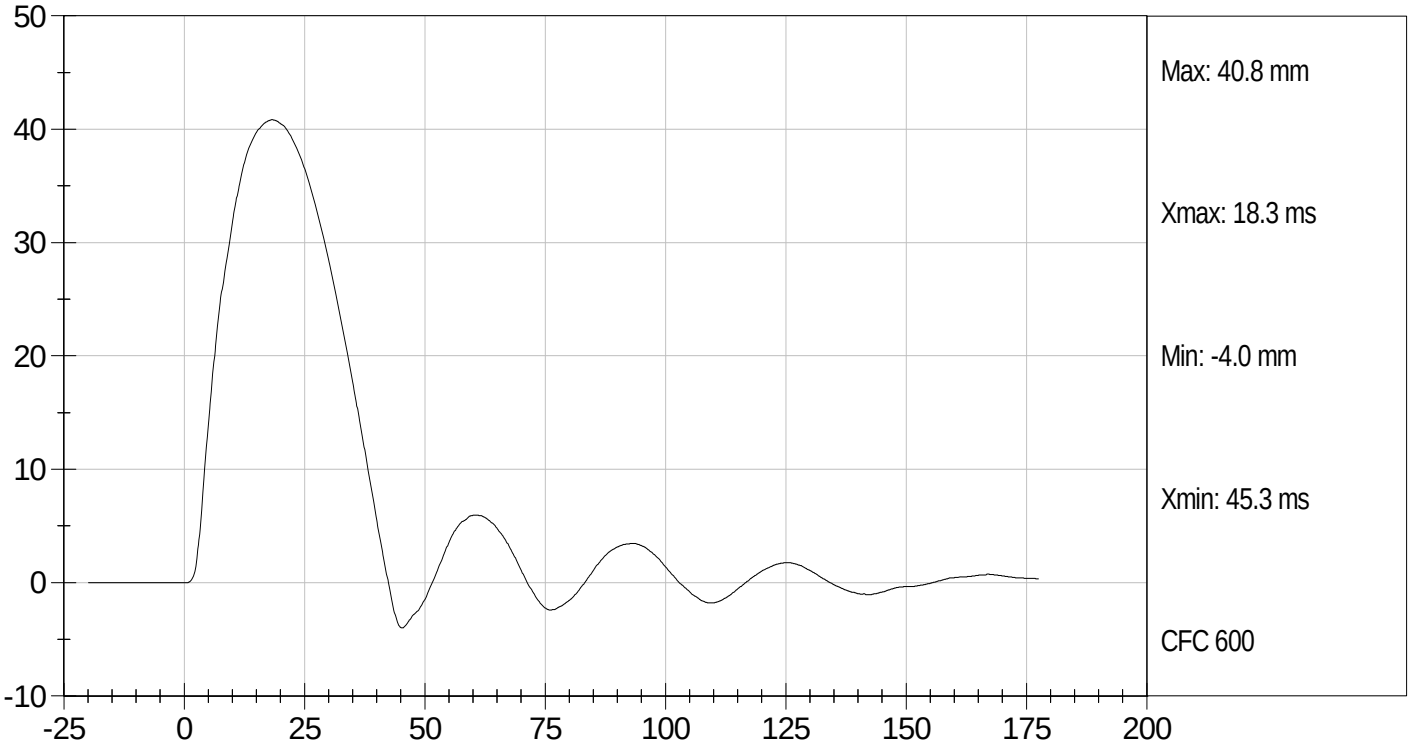

UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



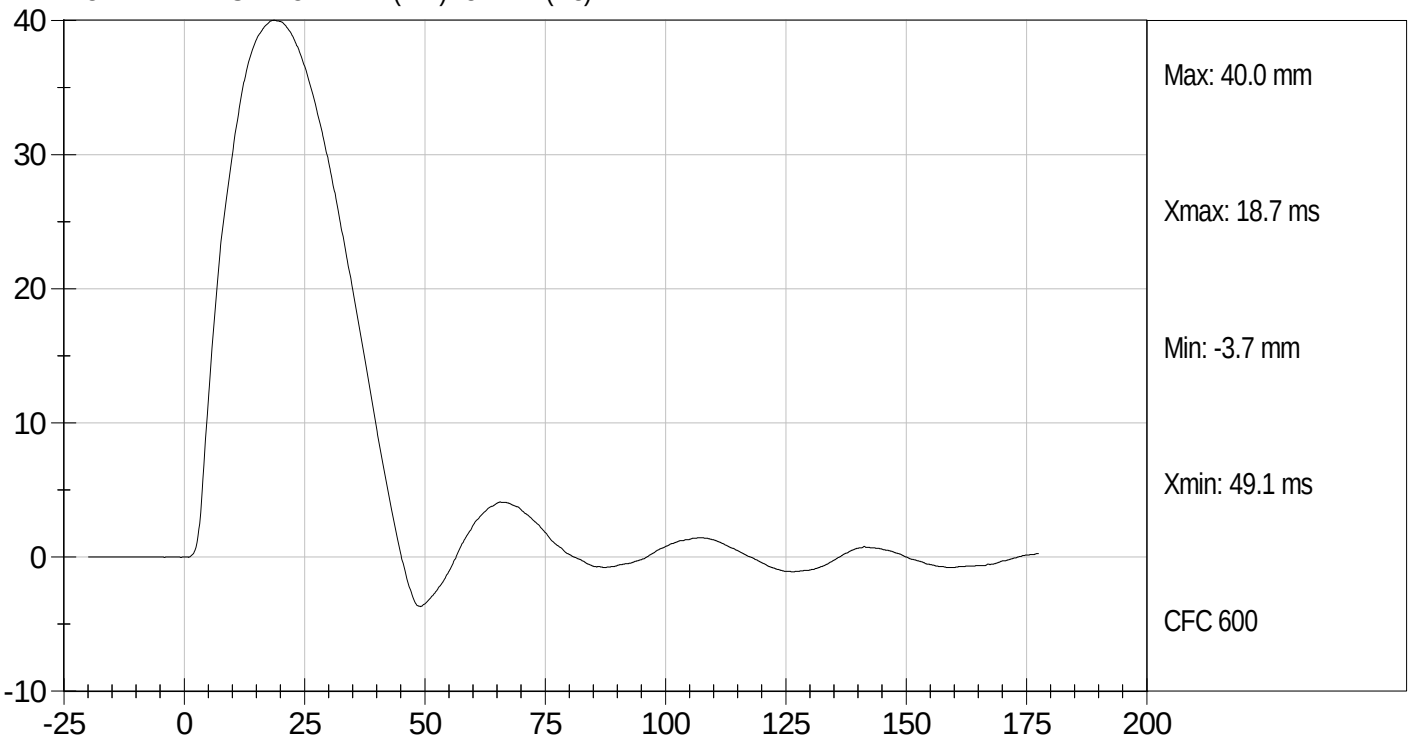
Test Desc: Thorax Impact
Component ID: D111570

Test Date: 4/28/11
Velocity: 18.31 ft/s, 5.58 m/s

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)




LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



# APPENDIX E

# TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION

**Table 1 – Dummy Instrumentation**

| | | ES-2re S/N: 016 | | |
|---|---|---|---|---|
| | | Serial Number | Manufacturer | Calibration Date |
| Head Accelerometers | X | P66854 | Endevco | 2/14/2011 |
| | Y | P66855 | Endevco | 2/14/2011 |
| | Z | P66856 | Endevco | 2/14/2011 |
| Thorax Potentiometers | Upper Rib (Y) | G144 | Honeywell | 2/17/2011 |
| | Middle Rib (Y) | G143 | Honeywell | 2/17/2011 |
| | Lower Rib (Y) | G142 | Honeywell | 2/17/2011 |
| Abdomen Load Cells | Forward (Y) | ABG119 | FTSS | 11/01/2010 |
| | Middle (Y) | ABG120 | FTSS | 11/01/2010 |
| | Rear (Y) | ABG121 | FTSS | 11/01/2010 |
| Pubic Symphysis Load Cell (Y) | | PG431 | Denton | 11/01/2010 |

**Table 2 – Vehicle Instrumentation**

| | Serial Number | Manufacturer | Calibration Date |
|---|---|---|---|
| Vehicle CG (X) | P59264 | Endevco | 2/19/2011 |
| Vehicle CG (Y) | P59266 | Endevco | 2/19/2011 |
| Vehicle CG (Z) | P59265 | Endevco | 2/19/2011 |
| Left Floor Sill (Y) | P49447 | Endevco | 11/05/2010 |
| A Pillar Sill (Y) | P52169 | Endevco | 11/05/2010 |
| A Pillar Low (Y) | P59287 | Endevco | 2/19/2011 |
| A Pillar Mid (Y) | P49518 | Endevco | 12/22/2010 |
| B Pillar Sill (Y) | P59350 | Endevco | 1/13/2011 |
| B Pillar Low (Y) | P47118 | Endevco | 3/15/2011 |
| B Pillar Mid (Y) | P55725 | Endevco | 11/05/2010 |
| Seat (Y) | P59283 | Endevco | 1/13/2011 |
| Engine (X) | P52187 | Endevco | 11/05/2010 |
| Engine (Y) | P52186 | Endevco | 11/05/2010 |
| Firewall (Y) | P59247 | Endevco | 11/05/2010 |
| Roof (Y) | P47810 | Endevco | 2/19/2011 |
| Floor Sill (Y) | P49503 | Endevco | 1/13/2011 |
| Rear Deck (X) | P52281 | Endevco | 12/13/2010 |
| Rear Deck (Y) | P52282 | Endevco | 12/13/2010 |