

REPORT NUMBER: SPNCAP-MGA-20-019

**NEW CAR ASSESSMENT PROGRAM (NCAP)
Side Impact Pole Test**

**HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC
2020 Hyundai Sonata SE 4-Door Sedan
NHTSA No.: O20204207**

**MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105**



Test Date: March 18, 2020

Final Report Date: May 21, 2020

FINAL REPORT

**U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crashworthiness Standards
Mail Code: NRM-110
1200 New Jersey Ave, SE
Room W43-410
Washington, DC 20590**

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Approval Date: May 21, 2020

FINAL REPORT ACCEPTANCE BY OCWS:

Division Chief, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

COTR, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

TECHNICAL REPORT DOCUMENTATION PAGE

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|---|--|--|------------------|-------------------------|-------|----------------------|--|-----------|--------|---|--|------|-----|------------------------------------|---|----|----|---|---|------|------|---------------------------------|----|-----|----|--------------------------------|----|-----|----|
| 4. Title and Subtitle Final Report of New Car Assessment Program Side Impact Pole Testing of a 2020 Hyundai Sonata SE 4-Door Sedan NHTSA No.: O20204207 | | 5. Report Date May 21, 2020 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7. Author(s) Ben Fischer, Project Engineer | | 6. Performing Organization Code MGA | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | 14. Sponsoring Agency Code NRM-110 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16. Abstract A 32.20 km/h, 75° oblique impact Side NCAP Test was conducted on the subject 2020 Hyundai Sonata SE 4-Door Sedan in accordance with the specifications of the Office of Crashworthiness Standards Side NCAP Pole Laboratory Test Procedure for the generation of consumer information on vehicle side pole crash protection. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on March 18, 2020. The impact velocity was 32.42 km/h, and the ambient temperature at the struck (driver's) side of the target vehicle at the time of impact was 21.4°C. The test vehicle post-test maximum crush was 331 mm at level 3. The test vehicle's performance was as follows: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="text-align: center;">Measurement Description</th> <th rowspan="2" style="text-align: center;">Units</th> <th colspan="2" style="text-align: center;">Driver ATD (SID-IIs)</th> </tr> <tr> <th style="text-align: center;">Threshold</th> <th style="text-align: center;">Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₃₆)</td> <td></td> <td style="text-align: center;">1000</td> <td style="text-align: center;">288</td> </tr> <tr> <td>Resultant Lower Spine Acceleration</td> <td style="text-align: center;">g</td> <td style="text-align: center;">82</td> <td style="text-align: center;">38</td> </tr> <tr> <td>Total Pelvic Force (sum of acetabular and iliac forces)</td> <td style="text-align: center;">N</td> <td style="text-align: center;">5525</td> <td style="text-align: center;">2566</td> </tr> <tr> <td>Maximum Thoracic Rib Deflection</td> <td style="text-align: center;">mm</td> <td style="text-align: center;">38*</td> <td style="text-align: center;">25</td> </tr> <tr> <td>Maximum Abdomen Rib Deflection</td> <td style="text-align: center;">mm</td> <td style="text-align: center;">45*</td> <td style="text-align: center;">17</td> </tr> </tbody> </table> | | | | Measurement Description | Units | Driver ATD (SID-IIs) | | Threshold | Result | Head Injury Criteria (HIC ₃₆) | | 1000 | 288 | Resultant Lower Spine Acceleration | g | 82 | 38 | Total Pelvic Force (sum of acetabular and iliac forces) | N | 5525 | 2566 | Maximum Thoracic Rib Deflection | mm | 38* | 25 | Maximum Abdomen Rib Deflection | mm | 45* | 17 |
| Measurement Description | Units | Driver ATD (SID-IIs) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Threshold | Result | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Head Injury Criteria (HIC ₃₆) | | 1000 | 288 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Resultant Lower Spine Acceleration | g | 82 | 38 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Pelvic Force (sum of acetabular and iliac forces) | N | 5525 | 2566 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maximum Thoracic Rib Deflection | mm | 38* | 25 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maximum Abdomen Rib Deflection | mm | 45* | 17 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Proposed IARV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| The doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite doors did not open during the side impact event. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17. Key Words New Car Assessment Program (NCAP) Side Impact Pole Part 572V SID-IIs | | 18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division 1200 New Jersey Ave, SE Washington, DC 20590 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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SECTION 1 PURPOSE AND SUMMARY OF TEST

PURPOSE

This side pole impact test is part of the MY 2020 New Car Assessment Program Side Impact Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-14-D-00353. The purpose of this test is to generate comparative side impact performance in a 2020 Hyundai Sonata SE 4-Door Sedan. The side impact test was conducted in accordance with the Office of Crashworthiness Standard's Side NCAP Pole Laboratory Test Procedure, dated April 2018.

SUMMARY

A rigid pole side impact test was conducted on a 2020 Hyundai Sonata SE 4-Door Sedan. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 32.42 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin on March 18, 2020. Pre-test and post-test photographs of the test vehicle and side impact dummy (SID-IIs) are included in Appendix A of this report.

One Part 572V (SID-IIs) dummy was placed in the driver designated seating position according to instructions specified in the OCWS Side NCAP Pole Laboratory Test Procedure dated April 2018. Camera locations and other pertinent camera information are included in this report.

The Part 572V (SID-IIs) dummy was instrumented accordingly:

- Primary and Redundant Head CG Triaxial Accelerometers
- Head Triaxial Angular Rate Sensors
- Thorax Upper, Middle, and Lower Rib Displacement Potentiometers
- Abdomen Upper Rib and Lower Rib Displacement Potentiometers
- Lower Spine (T12) Triaxial Accelerometers
- Iliac Load Cell
- Acetabulum Load Cell

Appendix B contains the vehicle and dummy response data. Dummy configuration and performance verification data can be found in Appendix C of this report. Appendix D contains the test equipment and instrumentation calibration data.

Injury readings for the SID-IIs dummy were recorded as follows:

| Measurement Description | Units | Driver ATD (SID-IIs) | |
|---|-------|----------------------|--------|
| | | Threshold | Result |
| Head Injury Criteria (HIC ₃₆) | | 1000 | 288 |
| Resultant Lower Spine Acceleration | g | 82 | 38 |
| Total Pelvic Force (sum of acetabular and iliac forces) | N | 5525 | 2566 |
| Maximum Thoracic Rib Deflection | mm | 38* | 25 |
| Maximum Abdomen Rib Deflection | mm | 45* | 17 |

*Proposed IARV

Supplemental restraint information is given below:

| Restraint Type | Struck Side Driver | | Struck Side Left Rear Passenger | |
|--------------------------|--------------------|----------|---------------------------------|----------|
| | Mounted | Deployed | Mounted | Deployed |
| Frontal Airbag | Yes | No | | |
| Knee Airbag | Yes | No | | |
| Side Curtain Airbag | Yes | Yes | Yes | Yes |
| Side Torso/Pelvis Airbag | Yes | Yes | No | |
| Side Torso Airbag | No | | Yes | Yes |
| Seat Belt Pretensioner | Yes | Yes | No | |
| Seat Belt Load Limiter | Yes | | No | |
| Other: | No | | No | |

The test data can be found on the NHTSA website at www.nhtsa.gov

GENERAL COMMENTS

Left Floor Sill Y recorded no valid data after 60 ms.

Left Lower B-Post Y recorded questionable data.

Load Cell Pole #8 Fy recorded no valid data.

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

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

**DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
Test Date: 3/18/2020

TEST VEHICLE INFORMATION AND OPTIONS

| | | | |
|--------------------------|-------------------|-----------------------------------|-----|
| NHTSA No. | O20204207 | Traction Control System (TCS) | Yes |
| Model Year | 2020 | Auto-Leveling System | No |
| Make | Hyundai | Automatic Door Locks (ADL) | Yes |
| Model | Sonata SE | Power Window Auto-Reverse | Yes |
| Body Style | 4-Door Sedan | Other Optional Feature | No |
| VIN | 5NPEG4JA5LH000454 | Driver Front Airbag | Yes |
| Body Color | Calypso Red | Driver Curtain Airbag | Yes |
| Odometer Reading (km/mi) | 135 km / 84 mi | Driver Head/Torso Airbag | No |
| Engine Displacement (L) | 2.5 L | Driver Torso Airbag | No |
| Type/No. Cylinders | Inline 4 | Driver Torso/Pelvis Airbag | Yes |
| Engine Placement | Lateral | Driver Pelvis Airbag | No |
| Transmission Type | Automatic | Driver Knee Airbag | Yes |
| Transmission Speeds | 8 | Rear Pass. Curtain Airbag | Yes |
| Overdrive | Yes | Rear Pass. Head/Torso Airbag | No |
| Final Drive | FWD | Rear Pass. Torso Airbag | Yes |
| Roof Rack | No | Rear Pass. Torso/Pelvis Airbag | No |
| Sunroof/T-Top | No | Rear Pass. Pelvis Airbag | No |
| Running Boards | No | Driver Seat Belt Pretensioner | Yes |
| Tilt Steering Wheel | Yes | Rear Pass. Seat Belt Pretensioner | No |
| Power Seats | No | Driver Load Limiter | Yes |
| Anti-Lock Brakes (ABS) | Yes | Rear Pass. Load Limiter | No |
| | | Other Safety Restraint | N/A |

| | |
|---|----|
| Does owner's manual provide instruction to turn off automatic door locks? | No |
|---|----|

DATA FROM CERTIFICATION LABEL

| | | | |
|---------------------|--|-----------------|------|
| Manufactured By | HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC | GVWR (kg) | 1975 |
| Date of Manufacture | Oct/24/19 | GAWR Front (kg) | 1140 |
| Vehicle Type | Passenger Car | GAWR Rear (kg) | 1050 |

VEHICLE SEATING AND WEIGHT CAPACITY DATA

| Measured Parameter | Front | Rear | Third | Total | |
|--|-------|------|-------|-------|-------|
| Designated Seating Capacity (DSC) | 2 | 3 | | 5 | |
| Capacity Weight (VCW) (kg) | | | | 410 | (A) |
| DSC x 68.04 kg | | | | 340 | (B) |
| Rated Cargo and Luggage Weight (RCLW) (kg) | | | | 70 | (A-B) |

VEHICLE SEAT TYPE

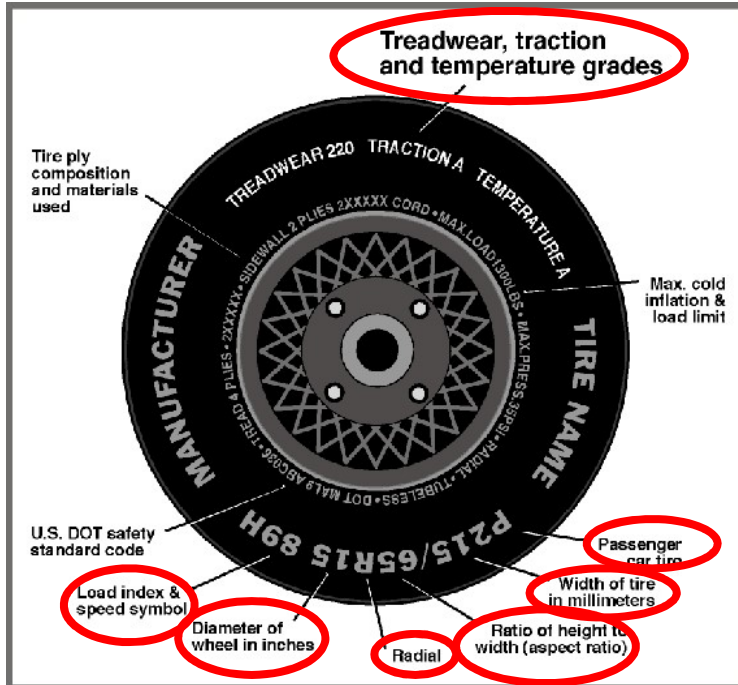
| Seating Location | Type of Seat Pan | | | | Type of Seat Back | | |
|--------------------|------------------|-------|-------------|-----------|-------------------|------------|---------|
| | Bucket | Bench | Split Bench | Contoured | Fixed | Adjustable | |
| | | | | | | w/ Lever | w/ Knob |
| Front Seat | X | | | | | X | |
| Rear or Second Row | | | | X | X | | |
| Third Row Seat | | | | | | | |

DATA SHEET NO. 1 (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020

VEHICLE TIRE INFORMATION



| Measured Parameter | Front | Rear |
|--------------------------|-----------------------------------|-----------------------------------|
| Max. Tire Pressure (kPa) | 350 | 350 |
| Cold Pressure (kPa) | 240 | 240 |
| Recommended Tire Size | 205/55R16 | 205/55R16 |
| Tire Size on Vehicle | 205/65R16 | 205/65R16 |
| Tire Manufacturer | Goodyear | Goodyear |
| Tire Model | Assurance Fuel Max | Assurance Fuel Max |
| Treadwear | 580 | 580 |
| Traction | A | A |
| Temperature Grade | A | A |
| Tire Plies Sidewall | 2 Polyester | 2 Polyester |
| Tire Plies Body | 2 Polyester, 2 Steel, 2 Polyamide | 2 Polyester, 2 Steel, 2 Polyamide |
| Load Index/Speed Symbol | 95H | 95H |
| Tire Material | Rubber | Rubber |
| DOT Safety Code Left | M63P KK1R 2819 | M63P KK1R 2819 |
| DOT Safety Code Right | M63P KK1R 2819 | M63P KK1R 2819 |

DATA SHEET NO. 1 (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020

TEST PRESSURES

| | Units | LF | RF | LR | RR |
|----------------|-------|-----|-----|-----|-----|
| As Delivered | kPa | 230 | 230 | 240 | 240 |
| Tire Placard | kPa | 240 | 240 | 240 | 240 |
| Owner's Manual | kPa | 240 | 240 | 240 | 240 |
| As Tested | kPa | 240 | 240 | 240 | 240 |

TEST AXLE VEHICLE WEIGHTS

| | Units | As Delivered (UVW) | | | As Tested (ATW) | | | Fully Loaded | | |
|--------|-------|--------------------|-------|--------|-----------------|-------|--------|--------------|-------|--------|
| | | Front | Rear | Total | Front | Rear | Total | Front | Rear | Total |
| Left | kg | 442.0 | 275.5 | | 458.5 | 334.0 | | 455.5 | 335.0 | |
| Right | kg | 440.0 | 274.0 | | 436.0 | 318.5 | | 439.5 | 323.5 | |
| Ratio | % | 61.6% | 38.4% | | 57.8% | 42.2% | | 57.6% | 42.4% | |
| Totals | kg | 882.0 | 549.5 | 1431.5 | 894.5 | 652.5 | 1547.0 | 895.0 | 658.5 | 1553.5 |

TARGET TEST WEIGHT CALCULATION

| Measured Parameter | Units | Value | |
|---|-------|--------|---------|
| Total Delivered Weight (UVW) | kg | 1431.5 | (A) |
| Actual Weight of 1 P572 ATD (SID-IIs) Used | kg | 52 | (B) |
| Rated Cargo/Luggage Weight (RCLW) | kg | 70 | (C) |
| Calculated Test Vehicle Target Weight (TVTWT) | kg | 1553.5 | (A+B+C) |

Does the measured As Tested Vehicle Weight lie within the required weight range (i.e. Calculated Test Vehicle Target Weight – 4.5 kg to 9 kg)? **YES**

TEST VEHICLE ATTITUDES AND CG

| | Units | As Delivered | As Tested | Fully Loaded | Meets Requirement |
|--|-------|--------------|-----------|--------------|-------------------|
| Driver Door Sill Angle (front-to-back)* | deg | -0.8 | -0.3 | -0.2 | Yes |
| Front Pass. Door Sill Angle (front-to-back)* | deg | -0.6 | -0.1 | 0.0 | Yes |
| Front Bumper Angle (left-to-right)** | deg | -0.1 | -0.2 | -0.2 | Yes |
| Rear Bumper Angle (left-to-right)** | deg | -0.1 | -0.2 | -0.2 | Yes |
| Vehicle CG (Aft of Front Axle) | mm | 1090 | 1198 | 1204 | |
| Vehicle CG (Left (+) / Right (-) from Longitudinal Centerline) | mm | 2 | 20 | 14 | |

* ND=Nose Down (-), NU=Nose Up (+) ** LD=Left Down (-), LU=Left Up (+)
 *** The "As Tested" vehicle attitude measurements must be equal to or between the "As Delivered" and "Fully Loaded" vehicle attitude measurements.

WEIGHT OF BALLAST AND VEHICLE COMPONENTS REMOVED TO MEET TVTWT

| Component Description | Units | Weight |
|--------------------------|-------|--------|
| Weight of Ballast Added | kg | 40 |
| Components Removed: none | kg | |

| | |
|---|----------------|
| Test height adjustable suspension setting, if applicable: | Not Applicable |
|---|----------------|

DATA SHEET NO. 2
SEAT, SEAT BELT, STEERING WHEEL ADJUSTMENT AND FUEL SYSTEM DATA

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020

SEAT POSITIONING

The driver's seat, front center seat (if applicable), and right front passenger's seat should be set to the forward-most, mid-height, mid-angle position. The struck-side rear passenger's seat, rear center seat, and non-struck side rear passenger's seats should be set to the rear-most, lowest, mid-angle position.

SCRL ANGLE RANGE

| Seat | SCRL (°) | | |
|---------------------------|----------|-------|-------|
| | Max | Min | Mid |
| Driver Seat | 16.2 | 13.2 | 14.7 |
| Front Passenger Seat | Fixed | Fixed | Fixed |
| Front Center Seat | | | |
| Struck Side Rear Seat | Fixed | Fixed | Fixed |
| Non-Struck Side Rear Seat | Fixed | Fixed | Fixed |
| Rear Center Seat | Fixed | Fixed | Fixed |

SEAT HEIGHT AND ANGLE

| Seat | As-Tested SCRL Angle (Mid) (°) | As-Tested SCRP Height (mm) | SCRP Height Position | SCRP Height (mm) | | |
|---------------------------|--------------------------------|----------------------------|----------------------|------------------|-------|--------------|
| | | | | Rear-Most | Mid | Forward-Most |
| Driver Seat | 14.7 | Fixed | Max | Fixed | Fixed | Fixed |
| | | | Mid | Fixed | Fixed | Fixed |
| | | | Min | Fixed | Fixed | Fixed |
| Front Passenger Seat | Fixed | Fixed | Max | Fixed | Fixed | Fixed |
| | | | Mid | Fixed | Fixed | Fixed |
| | | | Min | Fixed | Fixed | Fixed |
| Front Center Seat | | | Max | | | |
| | | | Mid | | | |
| | | | Min | | | |
| Struck Side Rear Seat | Fixed | Fixed | Max | Fixed | Fixed | Fixed |
| | | | Mid | Fixed | Fixed | Fixed |
| | | | Min | Fixed | Fixed | Fixed |
| Non-Struck Side Rear Seat | Fixed | Fixed | Max | Fixed | Fixed | Fixed |
| | | | Mid | Fixed | Fixed | Fixed |
| | | | Min | Fixed | Fixed | Fixed |
| Rear Center Seat | Fixed | Fixed | Max | Fixed | Fixed | Fixed |
| | | | Mid | Fixed | Fixed | Fixed |
| | | | Min | Fixed | Fixed | Fixed |

DATA SHEET NO. 2 (CONTINUED)
SEAT, SEAT BELT, STEERING WHEEL ADJUSTMENT, AND FUEL SYSTEM DATA

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

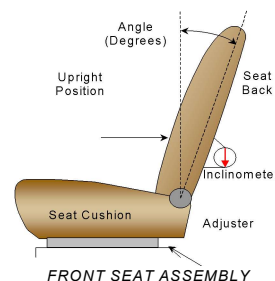
NHTSA No.: O20204207
 Test Date: 3/18/2020

SEAT FORE/AFT POSITIONS

| Seat | Total Fore/Aft Travel | | Test Position from Forward-Most Position | |
|---------------------------|-----------------------|--------------------------------|--|-------------------------------|
| | mm | Detents (1 st as 1) | mm | Detent (1 st as 0) |
| Driver Seat | 260 | 41 | 0 | 0 |
| Front Passenger Seat | 234 | 37 | 0 | 0 |
| Front Center Seat | | | | |
| Struck Side Rear Seat | Fixed | | Fixed | |
| Non-Struck Side Rear Seat | Fixed | | Fixed | |
| Rear Center Seat | Fixed | | Fixed | |

SEAT BACK ANGLE ADJUSTMENT

The driver's seat back is positioned such that the dummy's head is level. The front center and front passenger's seat backs are positioned in a similar manner as the driver's seat back. All rear passenger seat backs are positioned in accordance with the information provided by the manufacturer on Form No. 1 for the 5th percentile female dummy in a Side NCAP MDB test.



| Seat | Total Seat Back Angle Range | | Test Position from Vertical | |
|---------------------------|-----------------------------|--------------------------------|-----------------------------|-------------------------------|
| | Degrees | Detents (1 st as 1) | Degrees | Detent (1 st as 0) |
| Driver Seat | 62.2 | 32 | -4.7 | 6 |
| Front Passenger Seat | 63.8 | 32 | -3.9 | 6 |
| Front Center Seat | | | | |
| Struck Side Rear Seat | Fixed | | Fixed | |
| Non-Struck Side Rear Seat | Fixed | | Fixed | |
| Rear Center Seat | Fixed | | Fixed | |

All seat back angles measured on outboard headrest post.

SEAT BELT ANCHORAGE ADJUSTMENT

Seat belt anchorages are adjusted in accordance with the information provided by the manufacturer on Form No. 1.

| | Total # of Positions | Placed in Position # |
|-------------|----------------------|----------------------|
| Driver Seat | 4 | 0 (Uppermost as 0) |

HEAD RESTRAINT ADJUSTMENT

Head restraints are adjusted to the lowest and most full forward in-use position.

| | Total # of Positions | Placed in Position # |
|-------------|----------------------|----------------------------------|
| Driver Seat | 5 | 0 (Lowest as 0) / Fixed Fore-Aft |

DATA SHEET NO. 2 (CONTINUED)
SEAT, SEAT BELT, STEERING WHEEL ADJUSTMENT, AND FUEL SYSTEM DATA

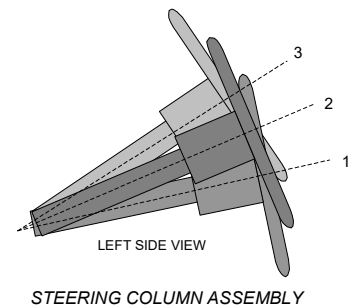
Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
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NHTSA No.: O20204207
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STEERING COLUMN ADJUSTMENT

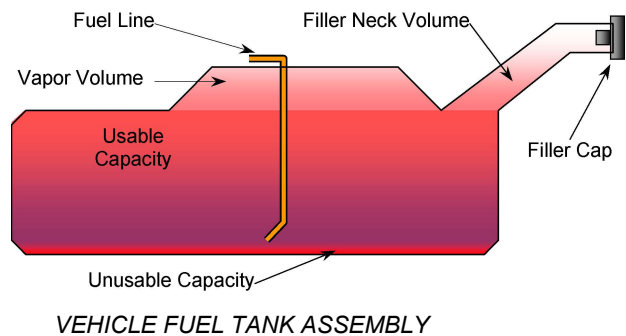
Steering wheel and column adjustments are made so that the steering wheel geometric locus is described when it moves through its full range of motion.

| | Wheel Angle (°) | Fore/Aft Position (mm) |
|-----------------------------------|-----------------|------------------------|
| Lowermost, Position 1 | 70.1 | |
| Geometric Center, Position 2 | 67.7 | |
| Uppermost, Position 3 | 65.2 | |
| Telescoping Steering Wheel Travel | | 50 |
| Test Position | 67.7 | 25 |



FUEL PUMP

The vehicle is equipped with an electronic fuel pump. The fuel pump will operate when engine system is normally operating. The filler neck is located on the driver's side



FUEL TANK CAPACITY DATA

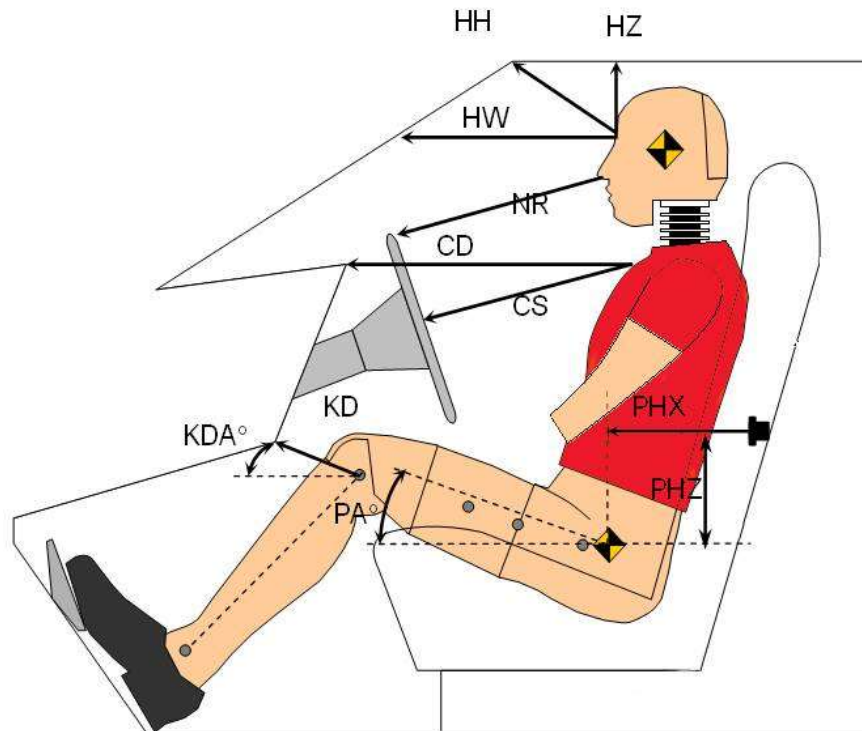
| | Liters |
|---|--------|
| Usable Capacity of Standard Tank (see Form No. 1) | 60.0 |
| Usable Capacity of Optional Tank (see Form No. 1) | |
| Usable Capacity of Standard Tank as Specified in Owner's Manual | 60.0 |
| Usable Capacity of Optional Tank as Specified in Owner's Manual | |
| 93% of Usable Capacity | 55.8 |
| Actual Amount of Solvent Used | 55.6 |
| 1/3 of Usable Capacity | 20.0 |

Is the actual amount of solvent used in the test equal to 93% ± 1% of the Usable Capacity stated in Form No. 1? **YES**

**DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



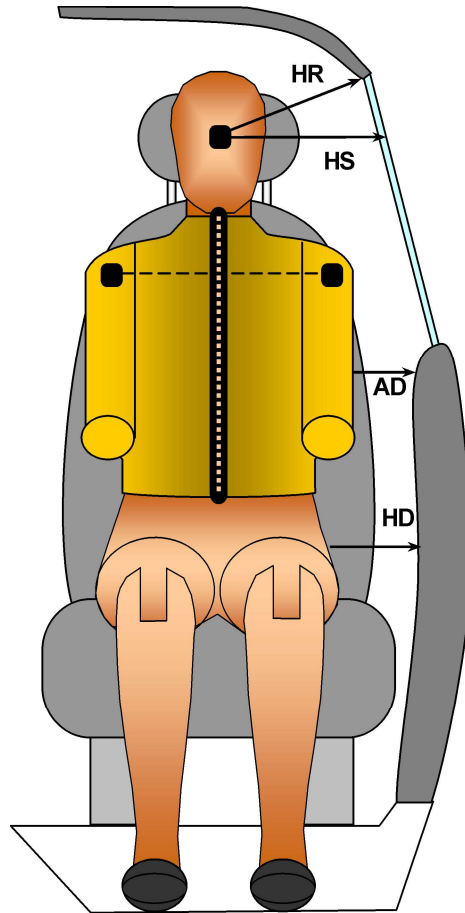
LEFT SIDE VIEW

| Code | Measurement Description | Driver | |
|------------|-------------------------------|-------------|-----------|
| | | Length (mm) | Angle (°) |
| HH | Head to Header | 242 | |
| HW | Head to Windshield | 546 | |
| HZ | Head to Roof Liner | 165 | |
| NR | Nose to Rim/Seat Back | 248 | |
| CD | Chest to Dashboard/Seat Back | 427 | |
| CS | Chest to Steering Wheel | 192 | |
| KDL / KDAL | Left Knee to Dash/Seat Back | 159 | 36.6 |
| KDR / KDAL | Right Knee to Dash/Seat Back | 159 | 38.3 |
| PAX | Pelvic Tilt Angle X | | 19.6 |
| PAY | Pelvic Tilt Angle Y | | -1.3 |
| PHX | Hip Point to Striker (X-Axis) | 320 | |
| PHZ | Hip Point to Striker (Z-Axis) | 197 | |

**DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



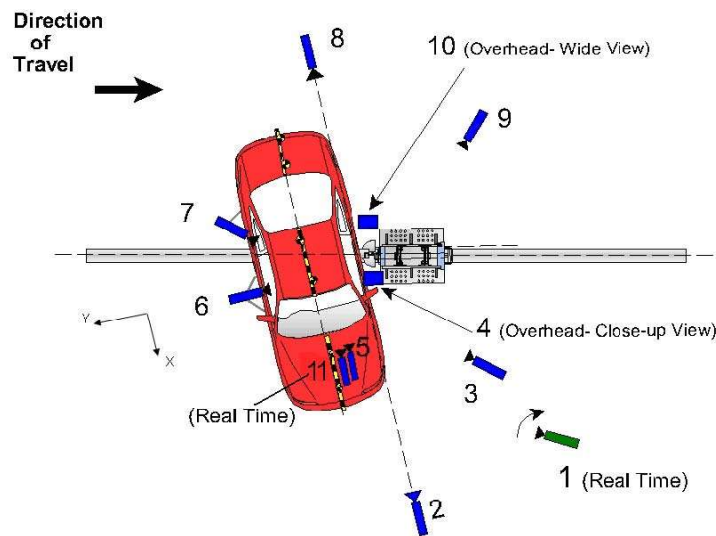
FRONT VIEW OF DUMMY

| Code | Measurement Description | Driver |
|------|-------------------------|-------------|
| | | Length (mm) |
| HR | Head to Side Header | 231 |
| HS | Head to Side Window | 369 |
| AD | Arm to Door | 87 |
| HD | Hip Point to Door | 173 |

**DATA SHEET NO. 5
CAMERA AND INSTRUMENTATION DATA**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



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

| No. | Camera View | Coordinates* (mm) | | | Lens (mm) | Frame Rate (fps) |
|-----|----------------------------|-------------------|-------|-------|-----------|------------------|
| | | X | Y | Z | | |
| 1 | Real-Time Pan View | | | | | 30 |
| 2 | Front Ground Level | 5810 | 500 | -1870 | 24 | 1000 |
| 3 | Impact Side 45° Forward | 4260 | -1460 | -1950 | 12 | 1000 |
| 4 | Overhead Closeup | 0 | 0 | -6700 | 85 | 1000 |
| 5 | Onboard – Driver Front | | | | 16 | 1000 |
| 6 | Onboard – Driver Side | | | | 8 | 1000 |
| 7 | Onboard – Driver Rear | | | | 8 | 1000 |
| 8 | Rear Ground Level | -6600 | 30 | -1850 | 24 | 1000 |
| 9 | Impact Side 45° Rearward | -3500 | -3630 | -1890 | 12 | 1000 |
| 10 | Overhead Wide View | 200 | 800 | -6540 | 12 | 1000 |
| 11 | Real-Time Dummy Front View | | | | | 30 |

*All measurements accurate to ±6 mm

Note: Vehicle was positioned at a 75° angle to the rigid pole.

Explain why camera(s) did not operate as intended: None

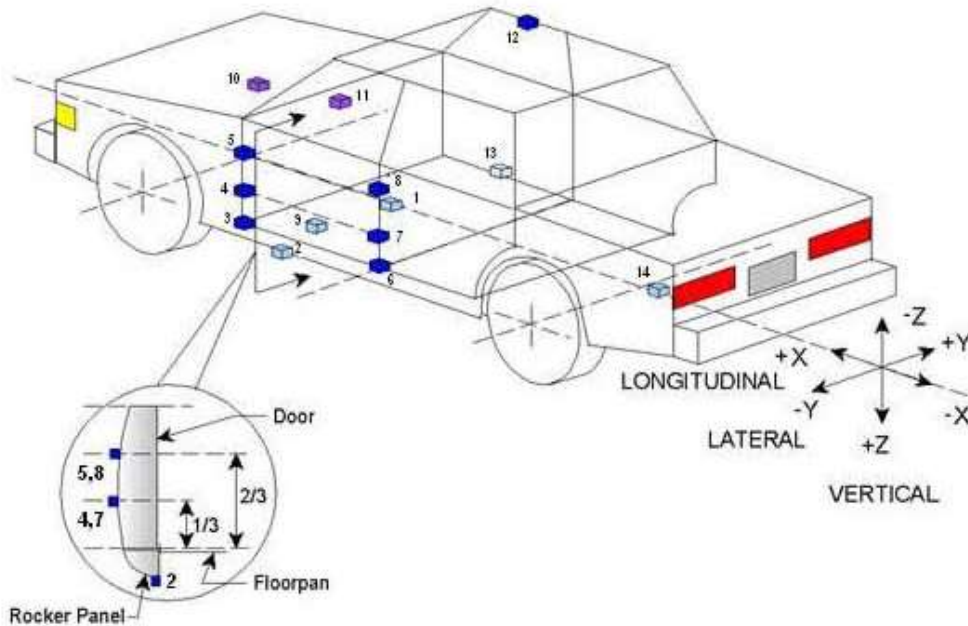
INSTRUMENTATION

| | Number of Channels |
|-------------------|--------------------|
| Driver Dummy | 19 |
| Vehicle Structure | 18 |
| Pole Load Cells | 8 |
| Total | 45 |

DATA SHEET NO. 6
TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
Test Date: 3/18/2020



TEST VEHICLE ACCELEROMETER LOCATIONS

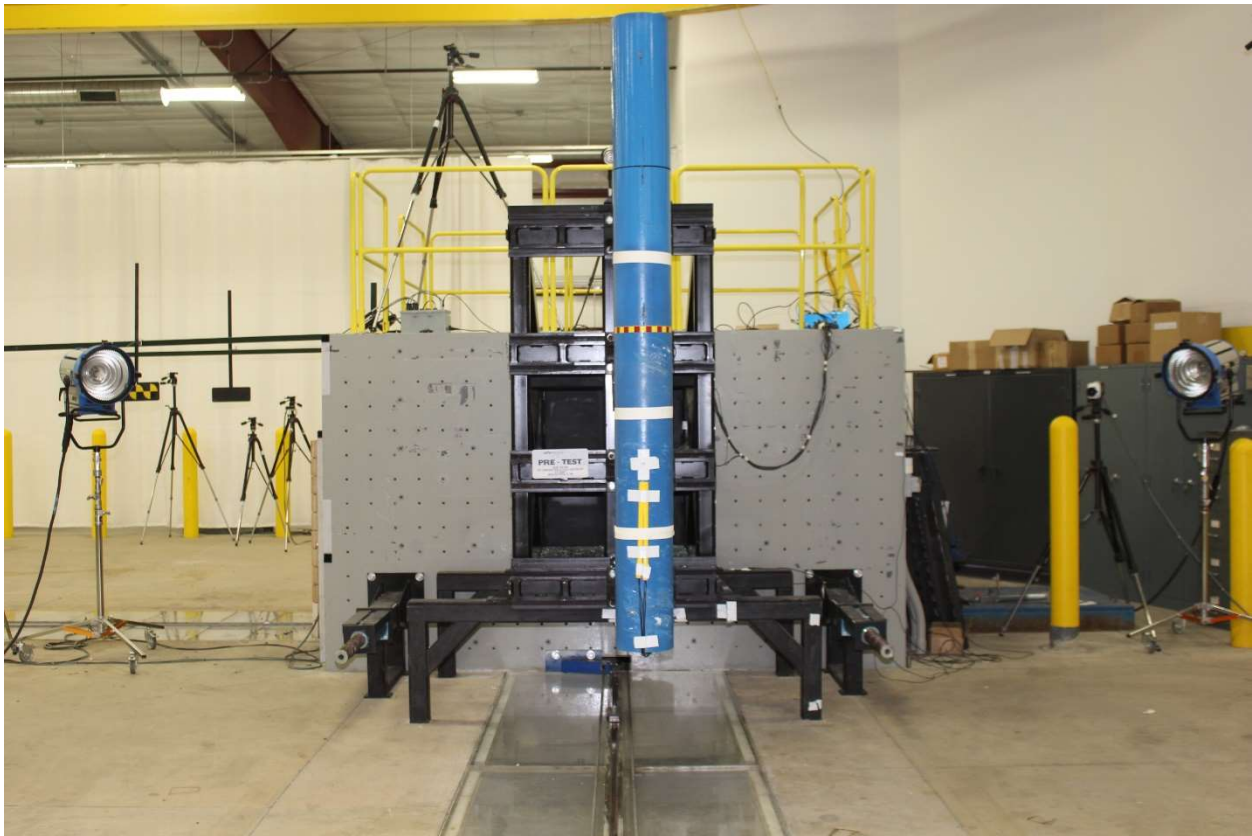
| No. | ID | Coordinates (mm) | | |
|-----|-------------------|------------------|------|-------|
| | | X | Y | Z |
| 1 | Vehicle CG | 2735 | 0 | -367 |
| 2 | Left Floor Sill | 3053 | -744 | -179 |
| 3 | A Pillar Sill | 3422 | -744 | -174 |
| 4 | A Pillar Low | 3357 | -854 | -528 |
| 5 | A Pillar Mid | 3352 | -860 | -740 |
| 6 | B Pillar Sill | 2270 | -744 | -187 |
| 7 | B Pillar Low | 2232 | -734 | -570 |
| 8 | B Pillar Mid | 2227 | -738 | -770 |
| 9 | Driver Seat Track | 2482 | -405 | -248 |
| 10 | Engine Top | 4102 | 182 | -849 |
| 11 | Firewall | 3757 | 0 | -871 |
| 12 | Right Roof | 2224 | 530 | -1408 |
| 13 | Right Floor Sill | 3053 | 744 | -177 |
| 14 | Rear Floorpan | 1061 | -20 | -514 |

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

**DATA SHEET NO. 7
RIGID POLE LOAD CELL DATA**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



254 mm Diameter Rigid Pole

| Load Cell Locations | |
|----------------------------|--|
| ID | Height from Impact Surface (mm) |
| 1 | 182 |
| 2 | 470 |
| 3 | 698 |
| 4 | 986 |
| 5 | 1212 |
| 6 | 1641 |
| 7 | 1854 |
| 8 | 2053 |

**DATA SHEET NO. 8
POST-TEST OBSERVATIONS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020

TEST DUMMY INFORMATION AND CONTACT POINTS

| Description | Driver Dummy (SID-IIs) |
|-------------------|--|
| Face | Curtain Airbag, Side Torso/Pelvis Airbag |
| Top of Head | Curtain Airbag |
| Left Side of Head | Curtain Airbag, Side Torso/Pelvis Airbag |
| Back of Head | Curtain Airbag, Headrest |
| Left Shoulder | Side Torso/Pelvis Airbag, Seatback |
| Upper Torso | Seatback |
| Lower Torso | Side Torso/Pelvis Airbag, Seatback |
| Left Hip | Side Torso/Pelvis Airbag |
| Left Knee | Door Panel |

POST-TEST DOOR PERFORMANCE

| Description | Struck Side | | Non-Struck Side | | Rear Hatch |
|--|-------------|------|-----------------|------|------------|
| | Front | Rear | Front | Rear | |
| Remained Closed and Operational | No | No | Yes | Yes | |
| Total Separation from Vehicle at Hinges or Latches | No | No | No | No | |
| Latch or Hinge Systems Pulled Out of Their Anchorages | No | No | No | No | |
| Disengaged from Latched Position | No | No | No | No | |
| Latch Separated from Striker | No | No | No | No | |
| Jammed Shut | Yes | Yes | No | No | |
| If Door Opened at Striker, Record Width of Opening at Striker (mm) | | | | | |

POST-TEST SEAT PERFORMANCE

| Description | Struck Side | | Non-Struck Side | |
|--|-------------|------|-----------------|------|
| | Front | Rear | Front | Rear |
| Seat Movement Along Seat Track | No | No | No | No |
| Seat Disengagement from Floor Pan | No | No | No | No |
| Seat Back Movement from Initial Position | No | No | No | No |
| Seat Back Collapse | No | No | No | No |

POST-TEST STRUCTURAL OBSERVATIONS

| Critical Areas of Performance | Observations and Conclusions |
|-------------------------------|------------------------------|
| Pillar Performance | No Separation |
| Sill Separation | None |
| Windshield Damage | Cracked |
| Side Window Damage | LF window broken |
| Other Notable Effects | None |

**DATA SHEET NO. 8 (CONTINUED)
POST-TEST OBSERVATIONS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
Test Date: 3/18/2020

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

| Restraint Type | Struck Side Driver | | Struck Side Left Rear Passenger | |
|--------------------------|-----------------------|----------|------------------------------------|----------|
| | Mounted | Deployed | Mounted | Deployed |
| | Frontal Airbag | Yes | No | |
| Knee Airbag | Yes | No | | |
| Side Curtain Airbag | Yes | Yes | Yes | Yes |
| Side Torso/Pelvis Airbag | Yes | Yes | No | |
| Side Torso Airbag | No | | Yes | Yes |
| Seat Belt Pretensioner | Yes | Yes | No | |
| Seat Belt Load Limiter | Yes | | No | |
| Other: | No | | No | |

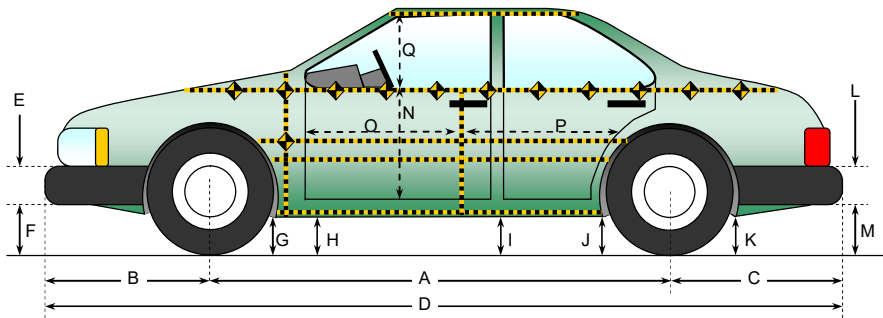
SPEED, ANGLE AT IMPACT, AND IMPACT POINT LOCATION DATA

| Measured Parameter | Units | Tolerance | Value |
|---|---------|------------------------------------|-------|
| Vertical Impact Reference Line (Aft of Front Axle) (Intended Impact Point) | mm | | 1188 |
| Actual Impact Point (Aft of Front Axle) | mm | | 1189 |
| Horizontal Offset (+forward / -rearward) | mm | +/- 38 of Intended Impact Point | -1 |
| Angle Between Vehicle's Longitudinal Centerline and Line of Forward Motion | degrees | 75 +/- 3 | 74.9 |
| Trap No. 1 Velocity (Primary) | km/h | 31.4 to 33.0 | 32.42 |
| Trap No. 2 Velocity (Redundant) | km/h | 31.4 to 33.0 | 32.44 |

**DATA SHEET NO. 9
TEST VEHICLE PROFILE MEASUREMENTS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
Test Date: 3/18/2020



All measurements in (mm) with tolerance of ± 3 mm

LEFT SIDE VIEW

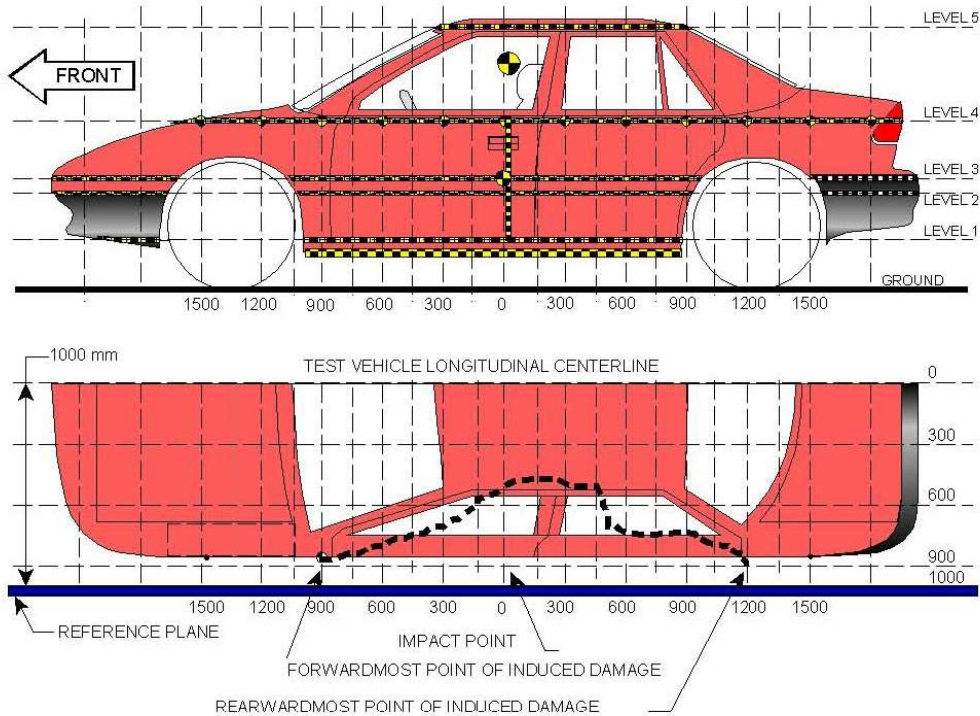
VEHICLE PRE- AND POST-TEST MEASUREMENT INFORMATION

| Code | Measurement Description | Pre-Test | Post-Test | Difference |
|------|--|----------|-----------|------------|
| A | Wheelbase | 2840 | 2777 | 63 |
| B | Front Axle to FSOV | 951 | 984 | -33 |
| C | Rear Axle to RSOV | 1112 | 1111 | 1 |
| D | Total Vehicle Length at Centerline | 4903 | 4872 | 31 |
| E | Front Bumper Thickness | 129 | 129 | 0 |
| F | Front Bumper Bottom to Ground | 193 | 205 | -12 |
| G | Sill Height at Front Wheel Well | 162 | 156 | 6 |
| H | Sill Height at Front Door Leading Edge | 163 | 161 | 2 |
| I | Sill Height at B-Pillar | 162 | 180 | -18 |
| J1 | Sill Height at Rear Wheel Well | 161 | 182 | -21 |
| J2 | Pinch Weld Height at Rear Wheel Well | 161 | 180 | -19 |
| K | Sill Height Aft of Rear Wheel Well | 197 | 204 | -7 |
| L | Rear Bumper Thickness | 115 | 115 | 0 |
| M | Rear Bumper Bottom to Ground | 276 | 270 | 6 |
| N | Sill Height to Bottom of Front Window Sill | 721 | 714 | 7 |
| O | Front Door Leading Edge to Impact CL | 735 | 609 | 126 |
| P | Rear Door Trailing Edge to Impact CL | 1283 | 1214 | 69 |
| Q | Front Window Opening | 392 | 356 | 36 |
| R | Right Side Length | 4061 | 4070 | -9 |
| S | Left Side Length | 4061 | 3994 | 67 |
| T | Vehicle Width at B-Pillars | 1831 | 1765 | 66 |
| U | Front Wheel Track Width | 2840 | 2777 | 63 |
| V | Rear Wheel Track Width | 951 | 984 | -33 |

**DATA SHEET NO. 10
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS**

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



NOTE: The measurements are taken along the vertical impact reference line.
 Vehicle measurements forward of the vertical impact reference line are negative.

MAXIMUM EXTERIOR CRUSH MEASUREMENTS

| Level | Measurement Description | Height Above Ground | Maximum Exterior Static Crush | Distance from Impact |
|-------|-------------------------|---------------------|-------------------------------|----------------------|
| 1 | Sill Top | 309 | 268 | 0 |
| 2 | Occupant H-Point | 527 | 320 | 0 |
| 3 | Mid Door | 611 | 331 | 0 |
| 4 | Window Sill | 924 | 290 | 0 |
| 5 | Window Top | 1361 | 71 | 150 |

DATA SHEET NO. 10 (CONTINUED)
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020

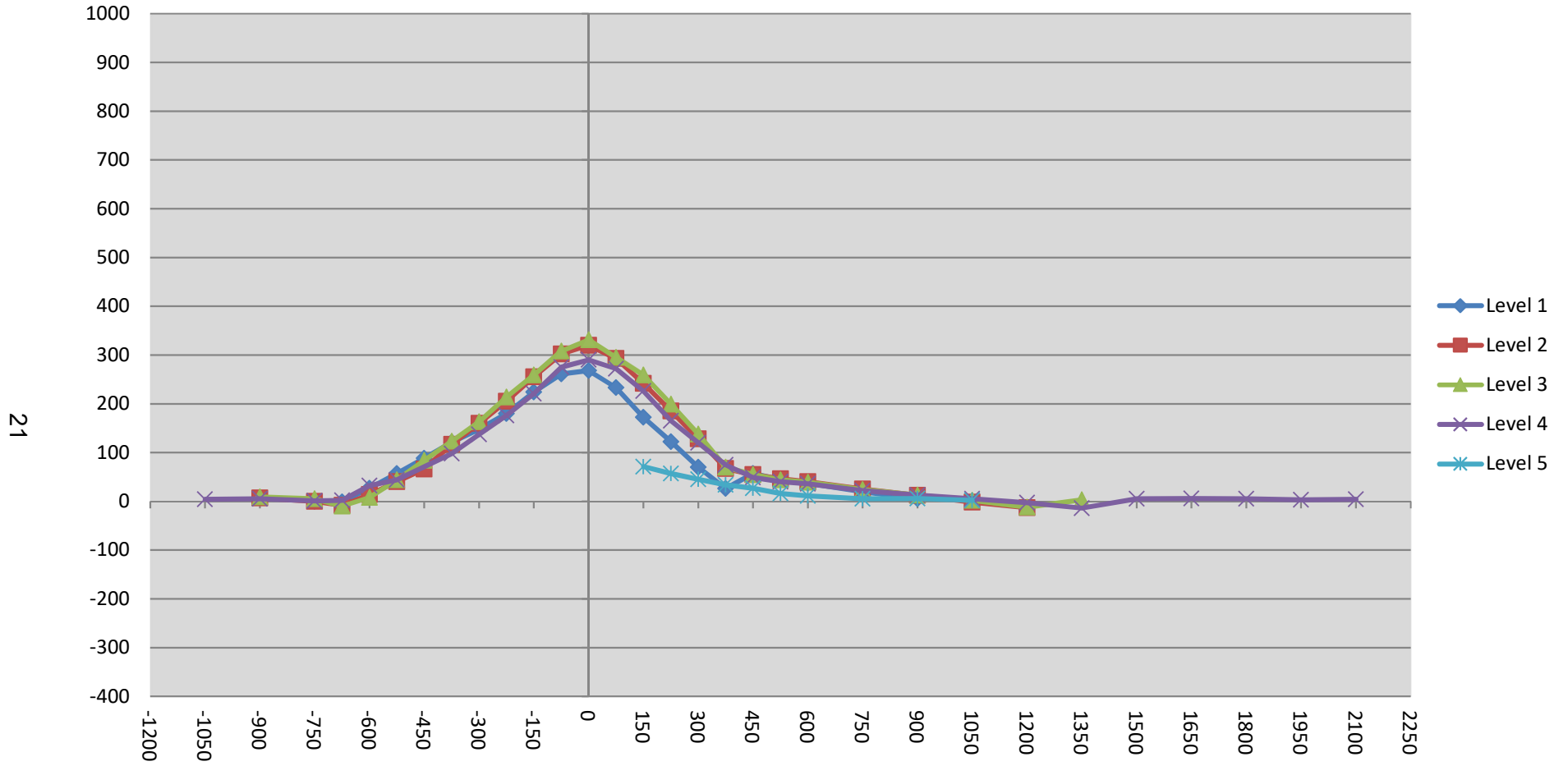
Pre-test measurements are taken when the vehicle is in the “As Tested” weight condition. Vehicle measurements forward of the vertical impact reference line are negative. The crush profile grid is established prior to the test based on an estimated impact point.

| | Pre-Test | | | | | Post-Test | | | | | Difference | | | | |
|-------|----------|-----|-----|-----|-----|-----------|-----|-----|-----|-----|------------|-----|-----|-----|----|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| -2700 | | | | | | | | | | | | | | | |
| -2550 | | | | | | | | | | | | | | | |
| -2400 | | | | | | | | | | | | | | | |
| -2250 | | | | | | | | | | | | | | | |
| -2100 | | | | | | | | | | | | | | | |
| -1950 | | | | | | | | | | | | | | | |
| -1800 | | | | | | | | | | | | | | | |
| -1650 | | | | | | | | | | | | | | | |
| -1500 | | | | | | | | | | | | | | | |
| -1350 | | | | | | | | | | | | | | | |
| -1200 | | | | | | | | | | | | | | | |
| -1050 | | | | 310 | | | | | 314 | | | | | 4 | |
| -900 | | 172 | 170 | 292 | | | 179 | 179 | 297 | | | 7 | 9 | 5 | |
| -825 | | | | | | | | | | | | | | | |
| -750 | 191 | 178 | 180 | 274 | | 191 | 178 | 185 | 275 | | 0 | 0 | 5 | 1 | |
| -675 | 197 | 183 | 182 | 268 | | 196 | 175 | 172 | 270 | | -1 | -8 | -10 | 2 | |
| -600 | 202 | 186 | 183 | 261 | | 229 | 200 | 191 | 293 | | 27 | 14 | 8 | 32 | |
| -525 | 204 | 187 | 183 | 258 | | 261 | 227 | 227 | 302 | | 57 | 40 | 44 | 44 | |
| -450 | 208 | 188 | 183 | | | 296 | 254 | 267 | | | 88 | 66 | 84 | | |
| -375 | 213 | 189 | 183 | 249 | | 334 | 306 | 306 | 347 | | 121 | 117 | 123 | 98 | |
| -300 | 216 | 189 | 183 | 247 | | 364 | 349 | 346 | 384 | | 148 | 160 | 163 | 137 | |
| -225 | 219 | 190 | 183 | 244 | | 399 | 395 | 397 | 420 | | 180 | 205 | 214 | 176 | |
| -150 | 222 | 190 | 184 | 242 | | 446 | 445 | 443 | 463 | | 224 | 255 | 259 | 221 | |
| -75 | 225 | 190 | 184 | 241 | | 486 | 492 | 492 | 516 | | 261 | 302 | 308 | 275 | |
| 0 | 228 | 190 | 184 | 239 | | 496 | 510 | 515 | 529 | | 268 | 320 | 331 | 290 | |
| 75 | 231 | 191 | 184 | 238 | | 464 | 484 | 479 | 510 | | 233 | 293 | 295 | 272 | |
| 150 | 233 | 192 | 185 | 236 | 501 | 405 | 434 | 444 | 462 | 572 | 172 | 242 | 259 | 226 | 71 |
| 225 | 235 | 192 | 185 | 236 | 491 | 357 | 377 | 384 | 401 | 548 | 122 | 185 | 199 | 165 | 57 |
| 300 | 236 | 193 | 185 | 235 | 487 | 306 | 321 | 323 | 355 | 532 | 70 | 128 | 138 | 120 | 45 |
| 375 | 237 | 193 | 185 | 235 | 486 | 263 | 260 | 255 | 310 | 520 | 26 | 67 | 70 | 75 | 34 |
| 450 | 239 | 193 | 185 | 235 | 484 | 296 | 248 | 240 | 284 | 511 | 57 | 55 | 55 | 49 | 27 |
| 525 | 239 | 193 | 186 | 235 | 484 | 283 | 239 | 230 | 175 | 500 | 44 | 46 | 44 | -60 | 16 |
| 600 | 238 | 194 | 186 | 235 | 486 | 275 | 234 | 225 | 271 | 497 | 37 | 40 | 39 | 36 | 11 |
| 675 | | | | | | | | | | | | | | | |
| 750 | 235 | 193 | 185 | 236 | 490 | 255 | 218 | 209 | 258 | 495 | 20 | 25 | 24 | 22 | 5 |
| 825 | | | | | | | | | | | | | | | |
| 900 | 227 | 191 | 183 | 239 | 498 | 232 | 203 | 196 | 252 | 504 | 5 | 12 | 13 | 13 | 6 |
| 1050 | | 186 | 180 | 242 | 521 | | 184 | 182 | 247 | 523 | | -2 | 2 | 5 | 2 |
| 1200 | | 173 | 173 | 243 | | | 160 | 161 | 240 | | | -13 | -12 | -3 | |
| 1350 | | | 168 | 244 | | | | 171 | 230 | | | | 3 | -14 | |
| 1500 | | | | 245 | | | | | 250 | | | | | 5 | |
| 1650 | | | | 247 | | | | | 253 | | | | | 6 | |
| 1800 | | | | 251 | | | | | 256 | | | | | 5 | |
| 1950 | | | | 260 | | | | | 263 | | | | | 3 | |
| 2100 | | | | 273 | | | | | 277 | | | | | 4 | |
| 2250 | | | | | | | | | | | | | | | |
| 2400 | | | | | | | | | | | | | | | |
| 2550 | | | | | | | | | | | | | | | |
| 2700 | | | | | | | | | | | | | | | |

DATA SHEET NO. 10 (CONTINUED)
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
Test Program: NCAP Side Pole Impact Test

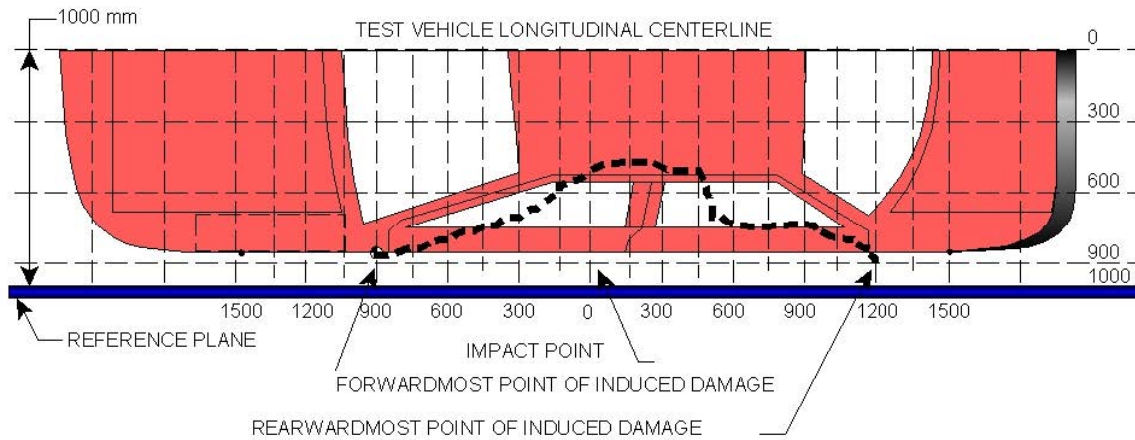
NHTSA No.: O20204207
Test Date: 3/18/2020



DATA SHEET NO. 10 (CONTINUED)
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



VEHICLE DAMAGE PROFILE DISTANCES

| DPD | Distance from Impact Point (mm) | Level | Pre-Test (mm) | Post-Test (mm) | Max. Static Crush (mm) |
|-----|---------------------------------|-------|---------------|----------------|------------------------|
| 1 | 410 | 3 | 185 | 236 | 51 |
| 2 | 185 | 3 | 185 | 419 | 234 |
| 3 | -40 | 3 | 184 | 506 | 322 |
| 4 | -265 | 3 | 183 | 370 | 187 |
| 5 | -490 | 3 | 183 | 247 | 64 |
| 6 | -715 | 3 | 181 | 196 | 15 |

DATA SHEET NO. 11
FMVSS NO. 301 STATIC ROLLOVER RESULTS

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

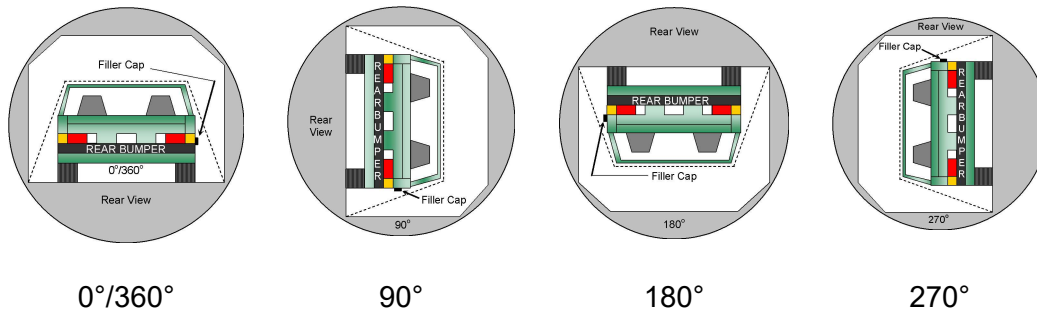
NHTSA No.: O20204207
 Test Date: 3/18/2020

Test Time: 10:48 am

Temperature: 21.4°C

- A. From impact until vehicle motion ceases: (Maximum Allowable = 1 ounce) 0.0 oz.
 B. For the 5 minute period after motion ceases: (Maximum Allowable = 5 ounces) 0.0 oz.
 C. For the following 25 minutes: (Maximum Allowable = 1 ounce / minute) None
 D. Spillage Details: None

FMVSS 301 STATIC ROLLOVER DATA



ROLLOVER SOLVENT COLLECTION TIME TABLE IN SECONDS

| Test Phase | Rotation Time | Hold Time | Total Time |
|--------------|---------------|-----------|------------|
| 0° to 90° | 111 | 300 | 411 |
| 90° to 180° | 110 | 300 | 410 |
| 180° to 270° | 107 | 300 | 407 |
| 270° to 360° | 111 | 300 | 411 |

FMVSS 301 ROLLOVER SPILLAGE TABLE (UNITS IN OUNCES)

| Test Phase | First 5 Minutes | Sixth Minute | Seventh Minute | Eighth Minute |
|--------------|-----------------|--------------|----------------|---------------|
| 0° to 90° | 0.0 | 0.0 | 0.0 | |
| 90° to 180° | 0.0 | 0.0 | 0.0 | |
| 180° to 270° | 0.0 | 0.0 | 0.0 | |
| 270° to 360° | 0.0 | 0.0 | 0.0 | |

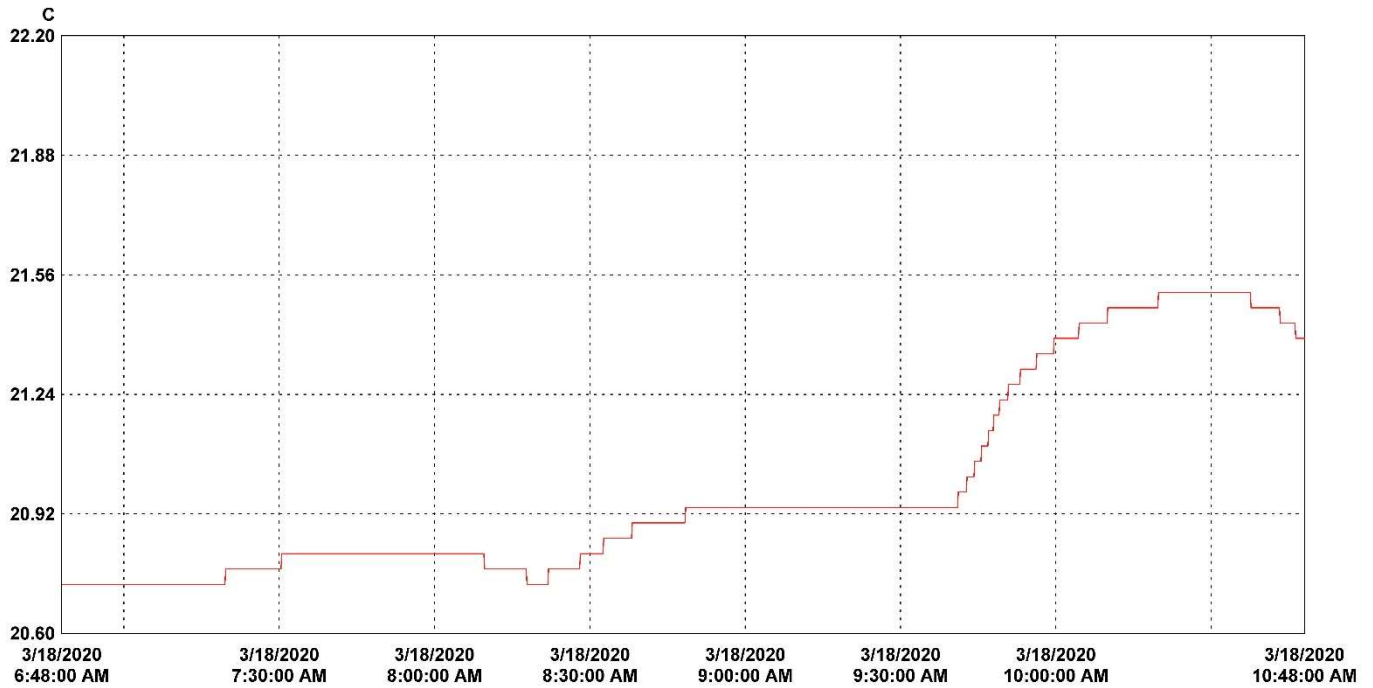
ROLLOVER SOLVENT SPILLAGE LOCATION TABLE

| Test Phase | Spillage Location |
|--------------|-------------------|
| 0° to 90° | |
| 90° to 180° | |
| 180° to 270° | |
| 270° to 360° | |

DATA SHEET NO. 12
DUMMY/VEHICLE TEMPERATURE AND HUMIDITY STABILIZATION DATA

Test Vehicle: 2020 Hyundai Sonata SE 4-Door Sedan
 Test Program: NCAP Side Pole Impact Test

NHTSA No.: O20204207
 Test Date: 3/18/2020



30 minutes/div 4 hours (M/d/yyyy h:mm:ss tt) Central Time Graph file (truncated): O20204207 2020 Hyundai Sonata SE 4-Door Sedan SPNCAP.spg

| LN | Serial # | Description | CH | Value | Maximum | Average | Minimum | Units | CH description | Logger file |
|----|----------|----------------|----|-------|---------|---------|---------|-------------|-----------------------------|-------------|
| 1 | 18352041 | VSC_South_Hall | 1 | 21.51 | 20.99 | 20.73 | C | Temperature | 18352041_VSC_South_Hall.spl | |

**APPENDIX A
PHOTOGRAPHS**

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Photo No. 001 - As Delivered Right Front Three-Quarter View of Test Vehicle



Photo No. 002 - As Delivered Left Rear Three-Quarter View of Test Vehicle

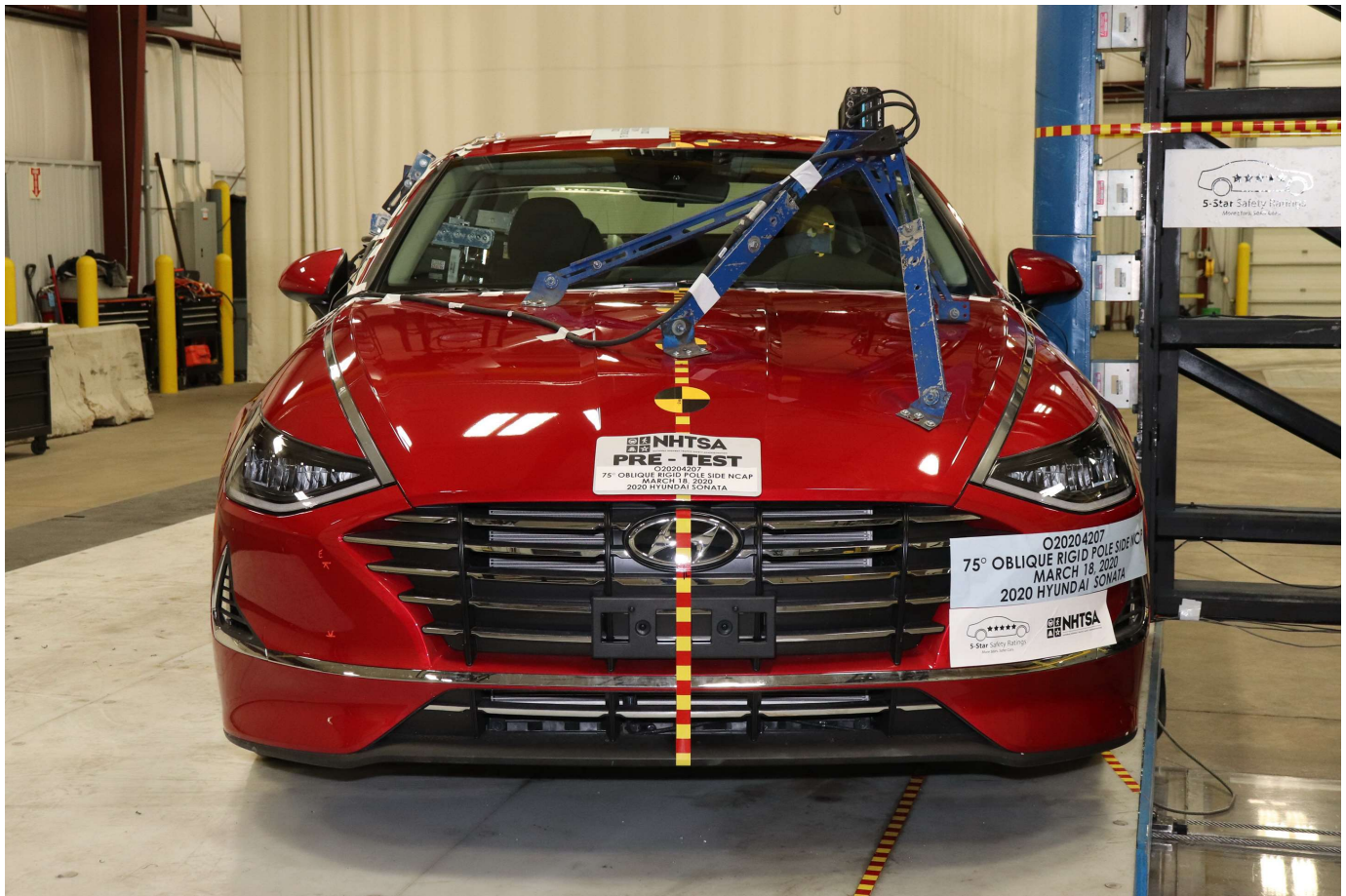


Photo No. 003 - Pre-Test Frontal View of Test Vehicle



Photo No. 004 - Post-Test Frontal View of Test Vehicle



Photo No. 005 - Pre-Test Left Front Three-Quarter View of Test Vehicle



Photo No. 006 - Post-Test Left Front Three-Quarter View of Test Vehicle



Photo No. 007 - Pre-Test Left Side View of Test Vehicle



Photo No. 008 - Post-Test Left Side View of Test Vehicle



Photo No. 009 - Pre-Test Left Rear Three-Quarter View of Test Vehicle



Photo No. 010 - Post-Test Left Rear Three-Quarter View of Test Vehicle



Photo No. 011 - Pre-Test Rear View of Test Vehicle



Photo No. 012 - Post-Test Rear View of Test Vehicle



Photo No. 013 - Pre-Test Right Side View of Test Vehicle



Photo No. 014 - Post-Test Right Side View of Test Vehicle



Photo No. 015 - Pre-Test Overhead View of Test Area

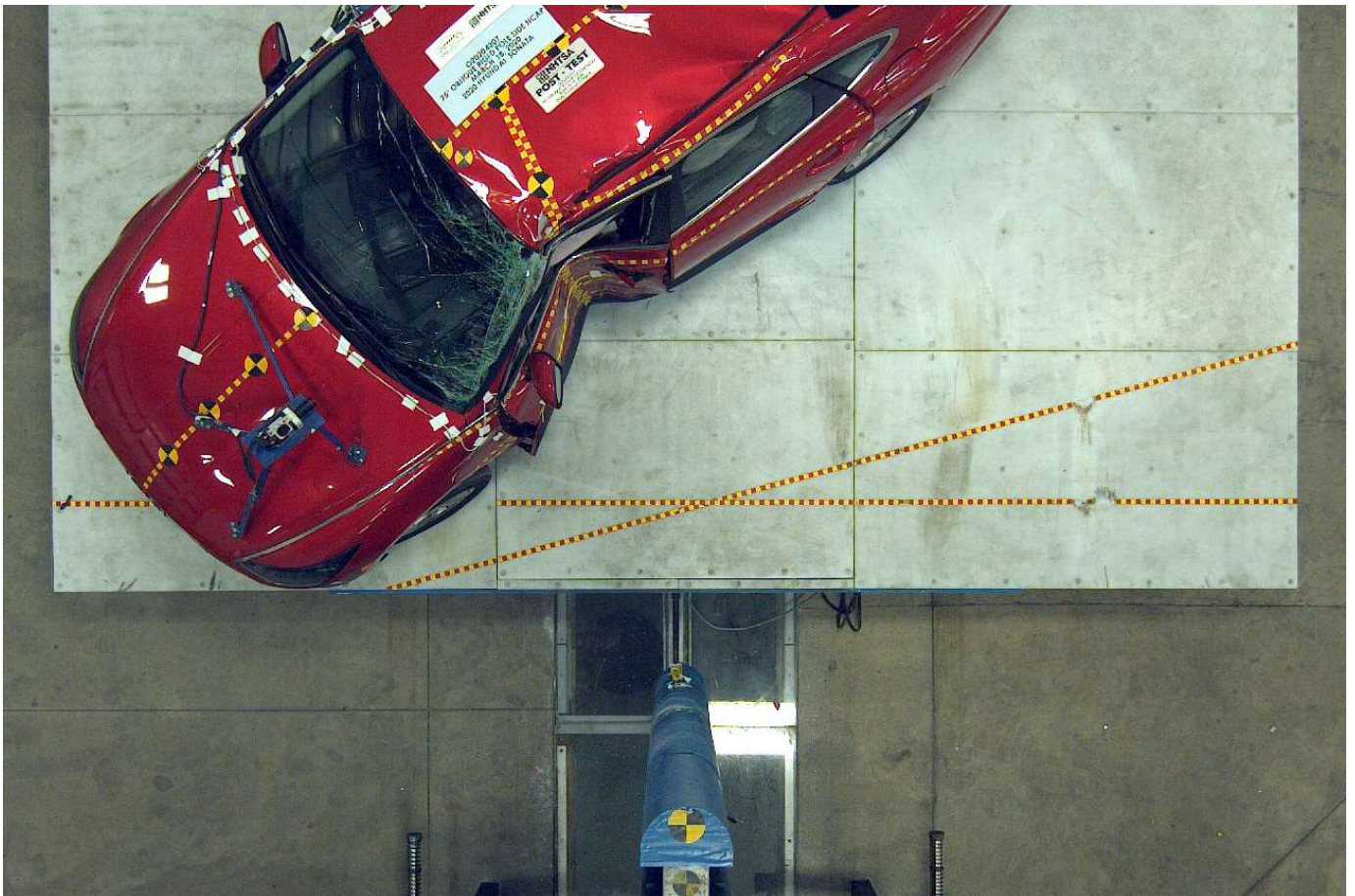


Photo No. 016 - Post-Test Overhead View of Test Area



Photo No. 017 - Pre-Test Left Side View of Pole Positioned Against Side of Vehicle



Photo No. 018 - Pre-Test Right Side View of Pole Positioned Against Side of Vehicle

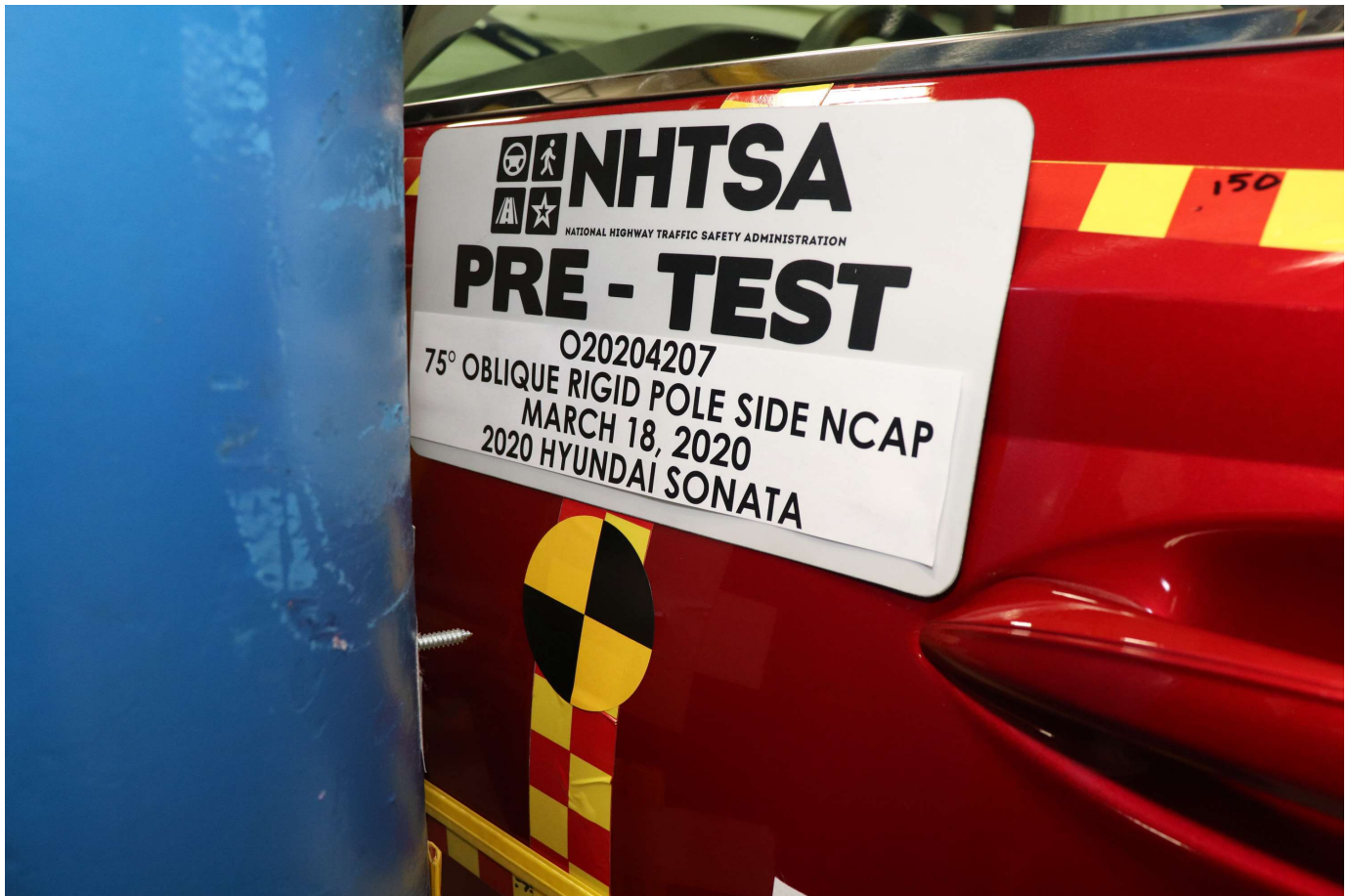


Photo No. 019 - Pre-Test Close-Up View of Impact Point Target



Photo No. 020 - Post-Test Close-Up View of Impact Point Target Showing Impact Location



Photo No. 021 - Pre-Test Front Close-Up View of Dummy Head and Chest



Photo No. 022 - Post-Test Front Close-Up View of Dummy



Photo No. 023 - Pre-Test Left Side View of Dummy Showing Belt and Chalking



Photo No. 024 - Pre-Test Left Side View of Dummy Shoulder and Door Top View



Photo No. 025 - Post-Test Left Side View of Dummy Shoulder and Door Top View



Photo No. 026 - Pre-Test Front View of Seat Back Prior to Dummy Positioning



Photo No. 027 - Pre-Test Front Close-Up View of Dummy Head and Shoulders in Relation to Head Restraint



Photo No. 028 - Pre-Test Front View of Seat Pan Prior to Dummy Positioning



Photo No. 029 - Pre-Test Overhead View of Dummy Thighs on Seat Pan



Photo No. 030 - Pre-Test Left Side View of Dummy Neck Showing Position of Adjustable Neck Bracket



Photo No. 031 - Pre-Test Left Side View of Dummy Head Showing Dummy Head is Level



Photo No. 032 - Pre-Test Placement of Dummy Feet



Photo No. 033 - Pre-Test View of Belt Anchorage for Dummy



Photo No. 034 - Pre-Test Left Side View of Steering Wheel

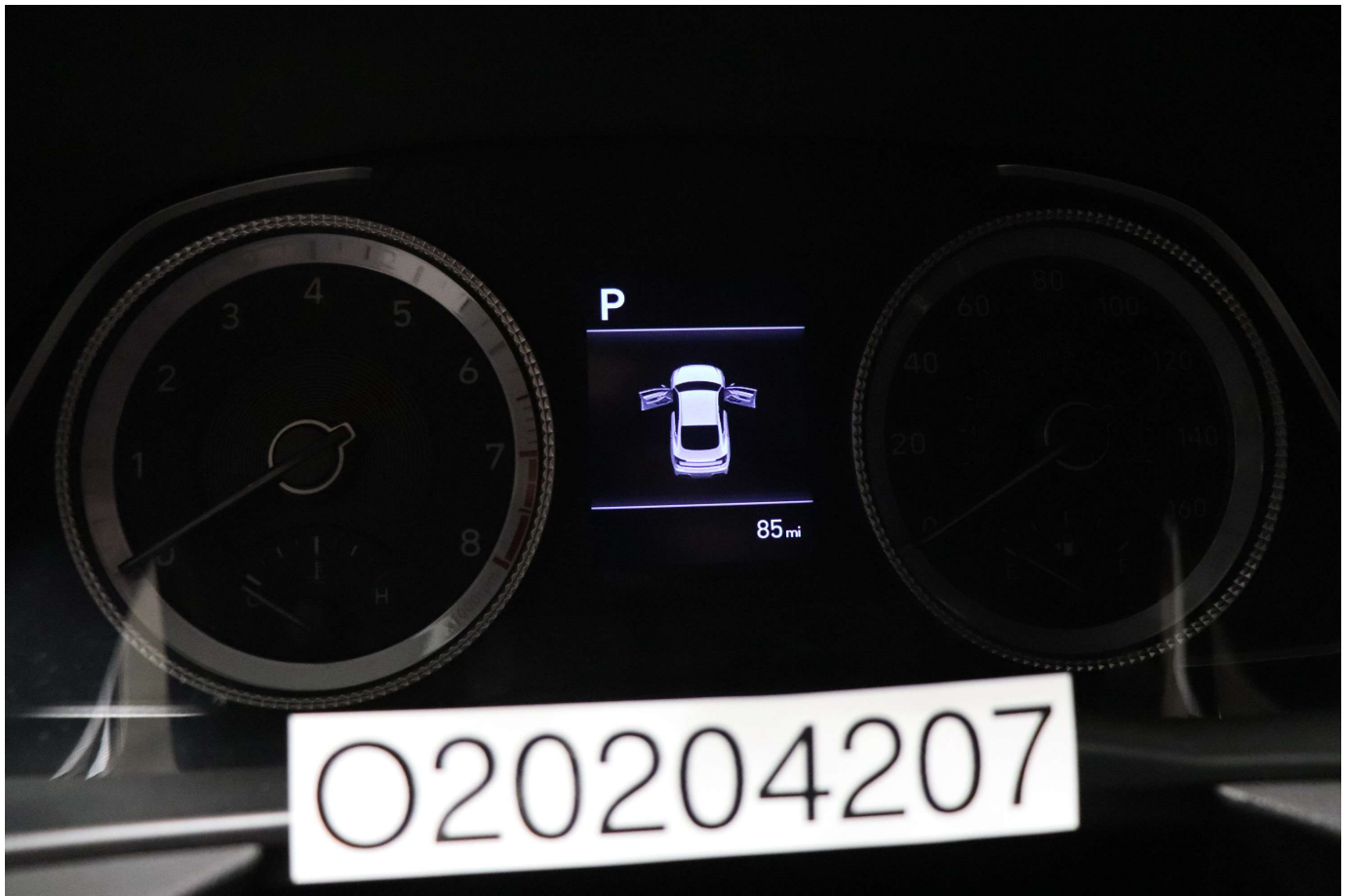


Photo No. 035 - Pre-Test View of Disengaged Parking Brake



Photo No. 036 - Pre-Test View of Parking Brake



Photo No. 037 - Pre-Test Close-Up Left Side View of Driver Seat Track



Photo No. 038 - Pre-Test Close-Up Left Side View of Driver Seat Back



Photo No. 039 - Pre-Test Close-Up View of Driver Seat Back or Head Restraint



Photo No. 040 - Pre-Test Dummy and Door Clearance View

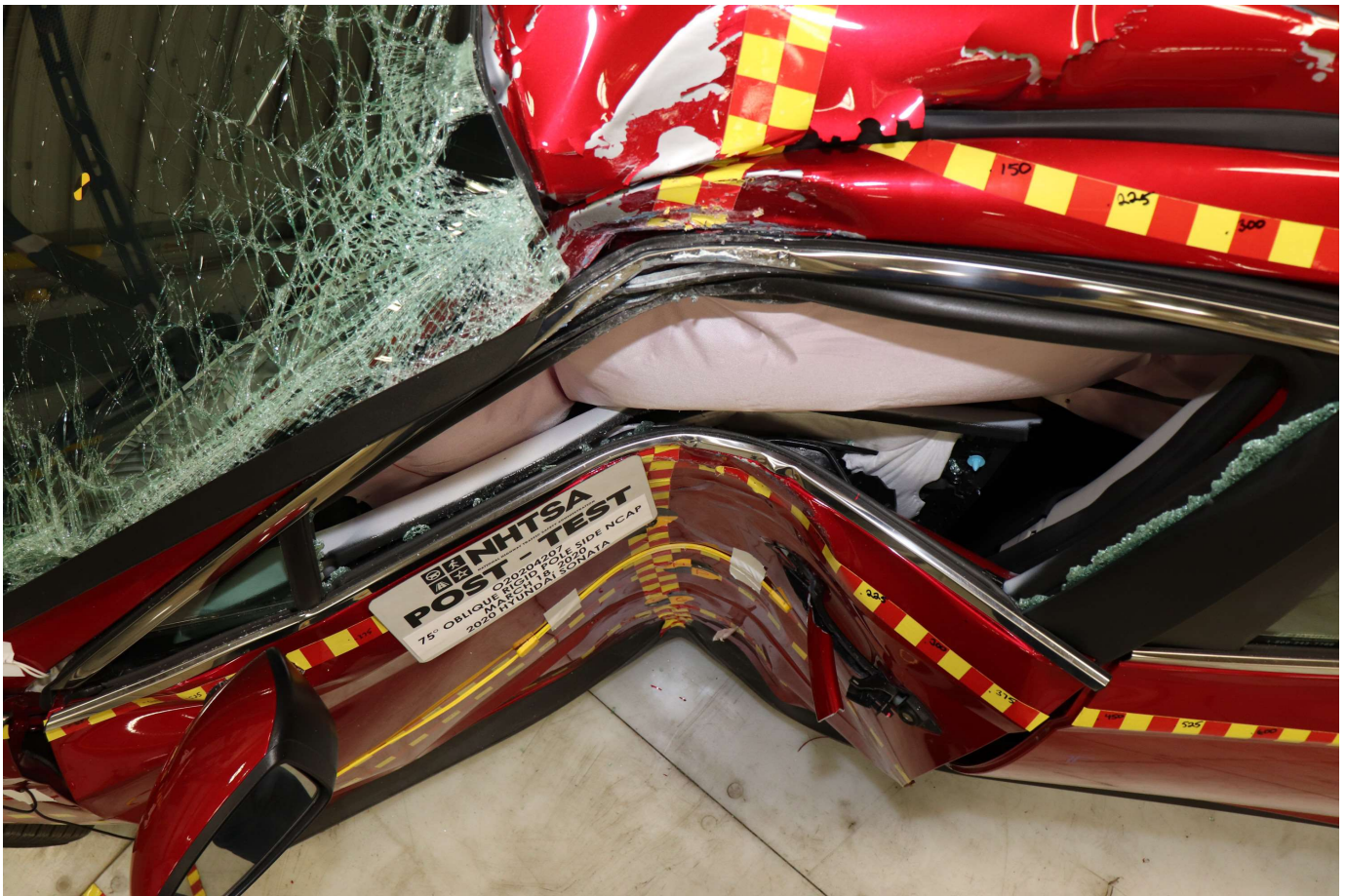


Photo No. 041 - Post-Test Dummy and Door Clearance View



Photo No. 042 - Pre-Test Right Side View of Dummy and Front Seat of Occupant Compartment



Photo No. 043 - Post-Test Right Side View of Dummy and Front Seat of Occupant Compartment



Photo No. 044 - Pre-Test Inner Door Panel View



Photo No. 045 - Post-Test Inner Door Panel View Showing Dummy Contact Location



Photo No. 046 - Post-Test Dummy Close-Up Head Contact with Vehicle Interior View



Photo No. 047 - Post-Test Dummy Close-Up Head Contact with Side Air Bag View



Photo No. 048 - Post-Test Dummy Close-Up Torso Contact with Vehicle Interior View



Photo No. 049 - Post-Test Dummy Close-Up Torso Contact with Side Air Bag View

PHOTOGRAPH NOT APPLICABLE

Photo No. 050 - Post-Test Dummy Close-Up Pelvis Contact with Vehicle Interior View



Photo No. 051 - Post-Test Dummy Close-Up Pelvis Contact with Side Air Bag View



Photo No. 052 - Post-Test Dummy Close-Up Knee Contact with Vehicle Interior View



Photo No. 053 - Pre-Test View of Fuel Filler Cap or Fuel Filler Neck



Photo No. 054 - Post-Test View of Fuel Filler Cap or Fuel Filler Neck



Photo No. 055 - Close-Up View of Vehicle Certification Label



Photo No. 056 - Close-Up View of Vehicle Tire Information Placard or Label



Photo No. 056a - Close-Up View of Vehicle Load Carrying Capacity Reduction Label

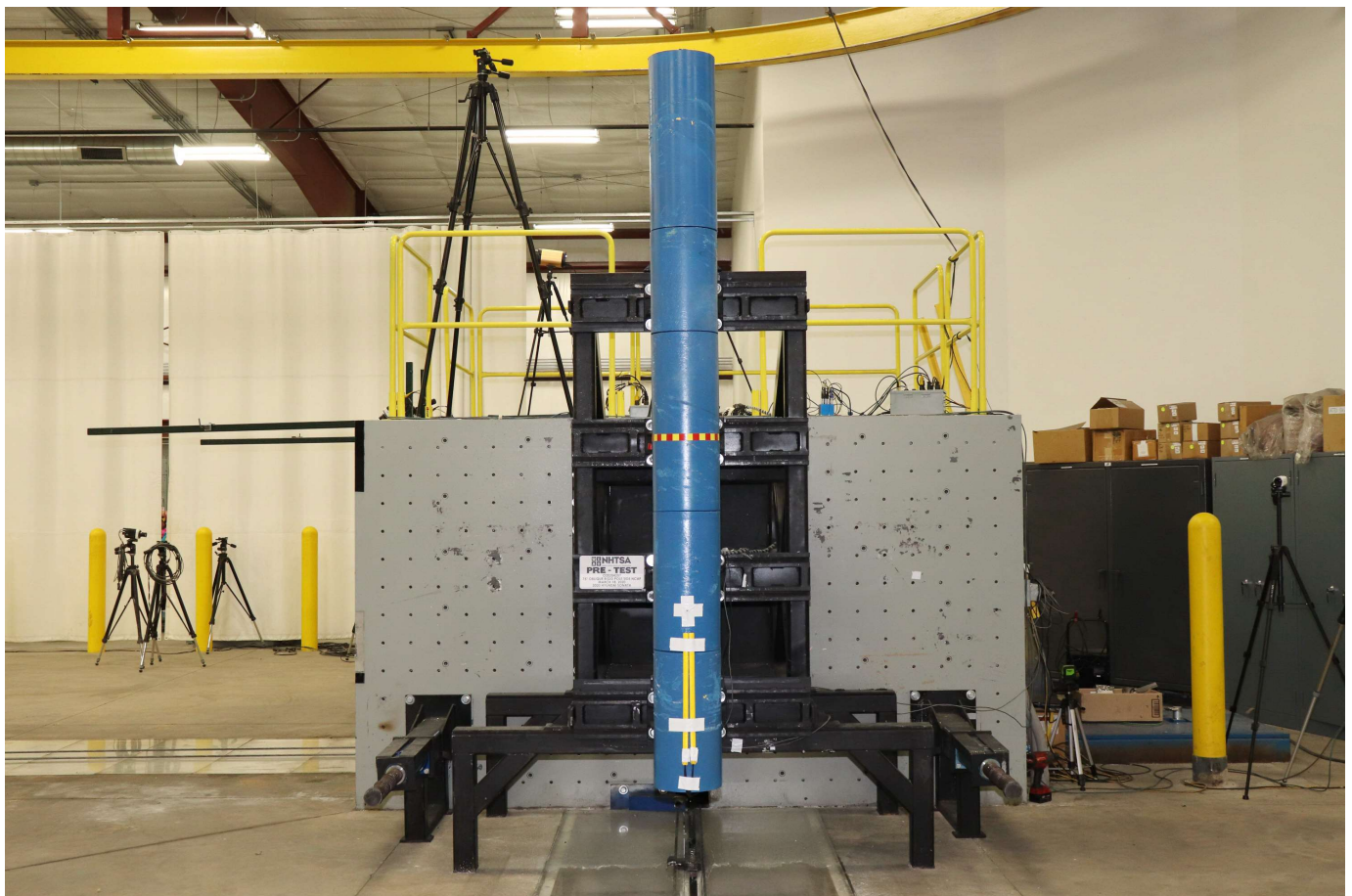


Photo No. 057 - Pre-Test Pole Barrier Front View

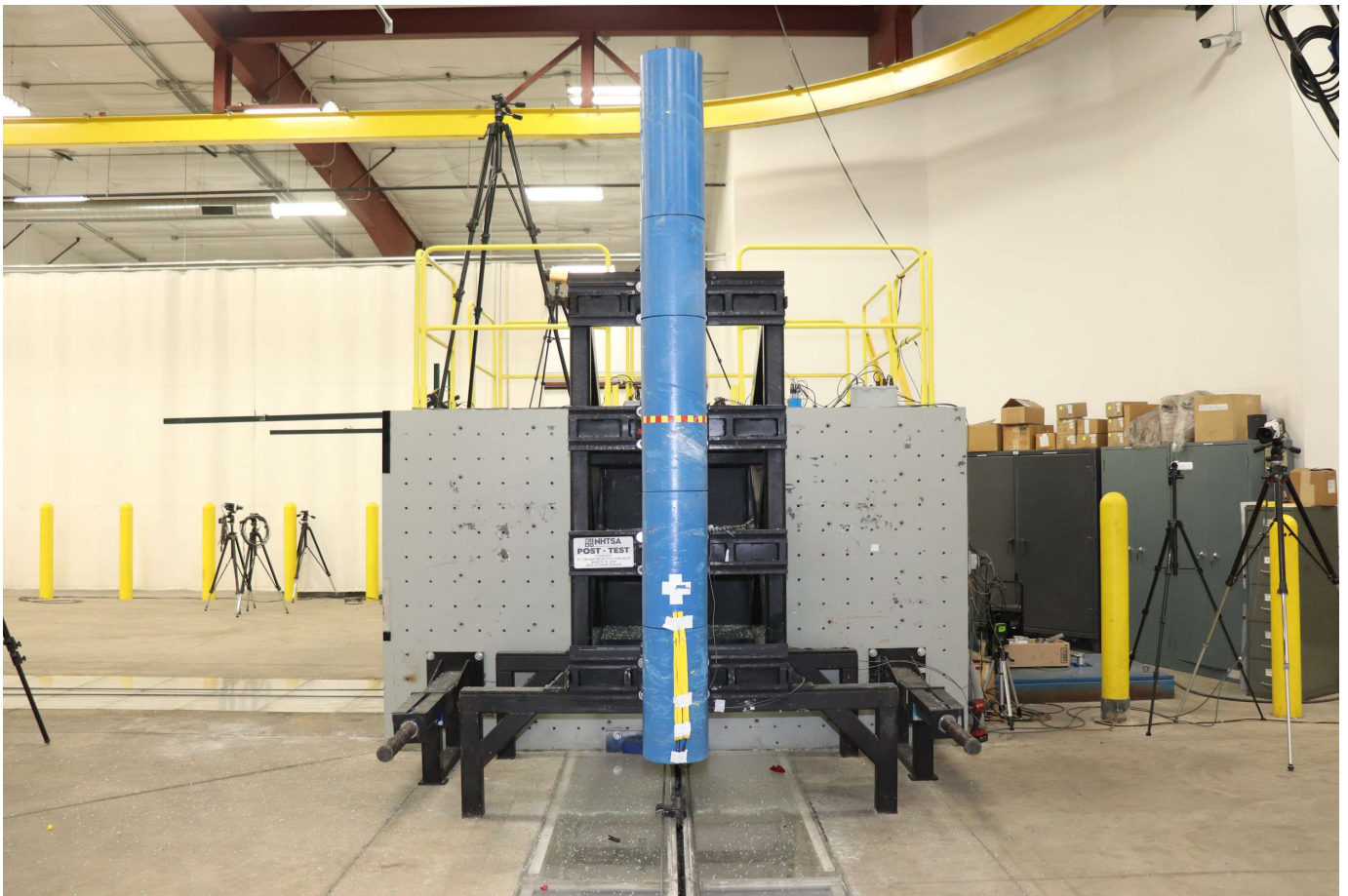


Photo No. 058 - Post-Test Pole Barrier Front View



Photo No. 059 - Pre-Test Pole Barrier Side View



Photo No. 060 - Post-Test Pole Barrier Side View



Photo No. 061 - Pre-Test Ballast View



Photo No. 062 - Post-Test Primary and Redundant Speed Trap Read-Out



Photo No. 063 - FMVSS Photo No. 301 Static Rollover 0 Degrees

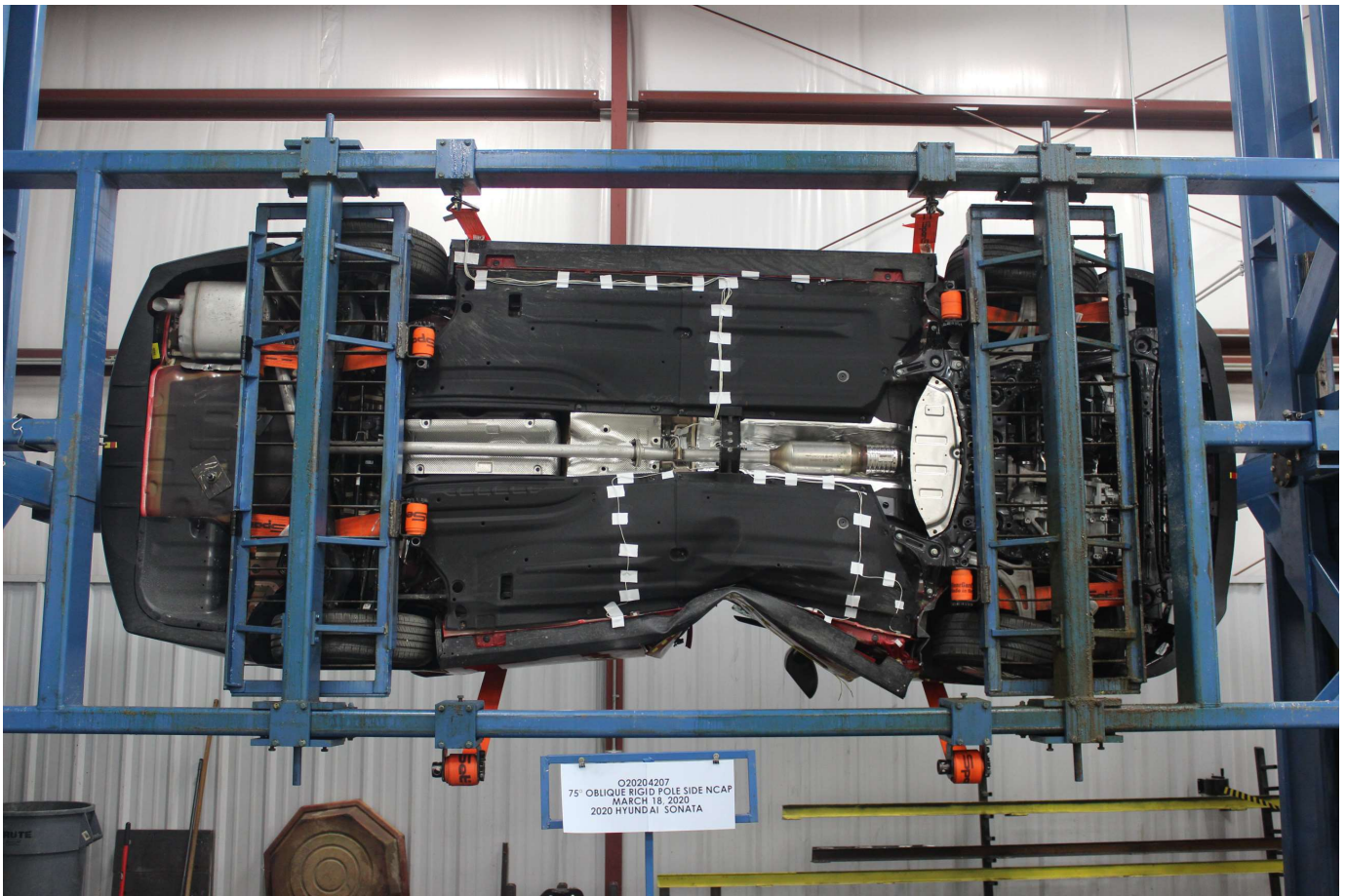


Photo No. 064 - FMVSS Photo No. 301 Static Rollover 90 Degrees



Photo No. 065 - FMVSS Photo No. 301 Static Rollover 180 Degrees



Photo No. 066 - FMVSS Photo No. 301 Static Rollover 270 Degrees



Photo No. 067 - FMVSS Photo No. 301 Static Rollover 360 Degrees



Photo No. 068 - Impact Event

| | | | |
|---|--|--|--|
| HYUNDAI | | 2020 SONATA SE | |
| SOLD TO: NY122 SIMMONS ROCKWELL HYUNDAI 784 COUNTY ROAD 84, BUILDING 3 ELMIRA NY 14903 | | SHIPPED TO: NY122 | |
| VIN: SNPEG4JASLH000454 MODEL: G4KNK000321 ENGINE: MA PORT OF ENTRY: MA EXTERIOR COLOR: CALYPSO RED INTERIOR/SEAT COLOR: BLACK/BLACK TRANSPORT: TRUCK ACCESSORY WEIGHT: 14 lbs./ 6 kgs. EMISSIONS: This vehicle meets California Emissions regulations and is Certified as a Super Ultra Low Emission Vehicle (SULEV) | | GOVERNMENT 5-STAR SAFETY RATINGS This vehicle has not been rated by the government for overall vehicle score, frontal crash, side crash or rollover risk. Source: National Highway Traffic Safety Administration (NHTSA). www.safercar.gov or 1-888-327-4236 | |
| STANDARD FEATURES: AMERICA'S BEST WARRANTY *5-year/60,000-mile New Vehicle Warranty* *10-year/100,000-mile Powertrain Warranty* *7-year/Unlimited-mile Anti-perforation Warranty* *5-year/Unlimited-mile Roadside Assistance* *Unlimited warranties, see dealer for details ADVANCED SAFETY TECHNOLOGY *Forward Collision-Avoidance Assist w/ Pedestrian Detection *Lane Follow Assist and Lane Keeping Assist *ABS w/ Electronic Brake Force Distribution & Brake Assist *Front, Front Side Impact, Side Curtain & Driver Knee Airbags *Smart Cruise Control with Stop & Go *Tire Pressure Monitoring System *LED Daytime Running Lights *Rearview Camera w/ Dynamic Guidelines POWERTRAIN TECHNOLOGY *Smartstream 2.5L 4-Cylinder Engine w/ GDI and MPI *101 Horsepower @6,100 rpm / 161 lb-ft Torque @ 4,000 rpm *Dual Continuous Variable Valve Timing *Smartstream 8-Speed Automatic Transmission w/ SHIFTRONIC® *Idle Stop & Go COMFORT & CONVENIENCE *16-inch Alloy Wheels & P205/65R16 Tires *LED Headlights w/ Automatic Light Control and High Beam Assist *Solar Control Window Glass *Electronic Parking Brake w/ Automatic Vehicle Hold *Remote Keyless Entry w/ Alarm *Power Door Locks & Windows w/ Auto Up/Down Driver Window *3.5-inch mono LCD instrument cluster display *Premium Cloth Seating Surfaces *6-way Adjustable Driver's Seat *60/40 Split-Folding Rear Seat *Tilt & Telescopic Steering Wheel w/ Cruise & Audio Controls *Advanced Trip Computer w/ Custom Settings *Air Conditioning *8-inch Color Touchscreen Display Audio *AM/FM/HD Radio® w/ USB & Auxiliary Input Jacks *Apple CarPlay (TM) & Android Auto (TM) Integration *Bluetooth® Phone System *Temporary Spare Tire *Full Tank of Gas | | Manufacturer's Suggested Retail Price: \$23,400.00 ADDED FEATURES: *Carpeted Floor Mats \$135.00 *Cargo Tray \$115.00 *Rear Bumper Appliqué \$70.00 Inland Freight & Handling: \$930.00 Total Price: \$24,650.00 | |

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EPA DOT Fuel Economy and Environment Gasoline Vehicle

Fuel Economy
32 MPG Large Cars range from 14 to 103 MPG. The best vehicle rates 136 MPG.
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Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs \$7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$ 2.70 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

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 Calculate personalized estimates and compare vehicles

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Manufacturer's suggested retail price includes manufacturer's recommended pre-delivery service. Gasoline license and title fees, state and local taxes and dealer installed options and accessories are not included in the manufacturer's suggested retail price. This label has been affixed to this vehicle by Hyundai Motor America, pursuant to the requirements of 15 U.S.C. 1231 et seq. which prohibits its removal or alteration prior to delivery to the ultimate purchaser.

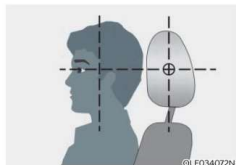
PARTS CONTENT INFORMATION FOR VEHICLE IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 45%
MAJOR SOURCES OF FOREIGN PARTS CONTENT: KOREA: 40%

Note: Parts content does not include final assembly, distribution, or other non-parts costs.

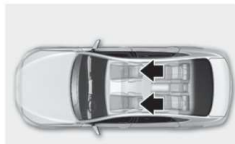
FOR THIS VEHICLE:
FINAL ASSEMBLY POINT: MONTGOMERY, ALABAMA U.S.A.
COUNTRY OF ORIGIN:
ENGINE: U.S.A.
TRANSMISSION: U.S.A.

310 A 1

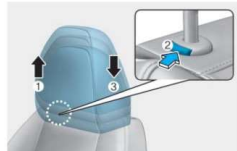
Photo No. 069 - Monroney Label



Front seat head restraints



Both the driver's and passenger's front seat are equipped with adjustable head restraints for the safety and comfort.



NOTICE
To prevent damage, NEVER hit or pull on the head restraints.

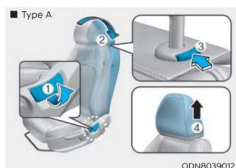
CAUTION
When there are no occupants in the rear seats, adjust the height of the head restraint to the lowest position. The rear seat head restraint can reduce the visibility of the rear area.

Adjusting the height up and down
To raise the head restraint:
1. Pull it up to the desired position (1).

To lower the head restraint:
1. Push and hold the release button (2) on the head restraint support.
2. Lower the head restraint to the desired position (3).



NOTICE
If you recline the seatback towards the front with the head restraint and seat cushion raised, the head restraint may come in contact with the sunvisor or other parts of the vehicle.



Type A



Type B

Removal/Reinstallation
To remove the head restraint:
1. Recline the seatback (2) rearward using the seatback angle lever (1).
2. Raise the head restraint as far as it can go.
3. Press the head restraint release button (3) while pulling the head restraint up (4).



Type A



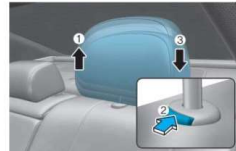
Type B

To reinstall the head restraint:
1. Put the head restraint poles (2) into the holes while pressing the release button (1).
2. Adjust the head restraint to the appropriate height.
3. Adjust the seatback (4) forward using the seatback angle lever (3).

Rear seat head restraints



The rear seats are equipped with head restraints in all the seating positions for the passenger's safety and comfort.



Adjusting the height up and down
To raise the head restraint:
1. Pull it up to the desired position (1).

To lower the head restraint:
1. Push and hold the release button (2) on the head restraint support.
2. Lower the head restraint to the desired position (3).

Photo No. 070 - Head Restraint Use and Adjustment Information from Vehicle Owners Manual



Photo No. 071 - Post-Test View of Shattered Vehicle Inner Door Panel

APPENDIX B
DUMMY RESPONSE DATA PLOTS

TABLE OF DATA PLOTS
Driver Dummy Instrumentation Plots

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| Figure No. 1. | Driver Head CG Acceleration (X) vs. Time | B-1 |
| Figure No. 2. | Driver Head CG Acceleration (Y) vs. Time | B-1 |
| Figure No. 3. | Driver Head CG Acceleration (Z) vs. Time | B-1 |
| Figure No. 4. | Driver Head CG Resultant Acceleration (X) vs. Time | B-1 |
| Figure No. 5. | Driver Lower Spine T12 Acceleration (X) vs. Time | B-2 |
| Figure No. 6. | Driver Lower Spine T12 Acceleration (Y) vs. Time | B-2 |
| Figure No. 7. | Driver Lower Spine T12 Acceleration (Z) vs. Time | B-2 |
| Figure No. 8. | Driver Lower Spine T12 Resultant Acceleration vs. Time | B-2 |
| Figure No. 9. | Driver Iliac Wing Force on Impact Side (Y) vs. Time | B-3 |
| Figure No. 10. | Driver Acetabulum Force on Impact Side (Y) vs. Time | B-3 |
| Figure No. 11. | Driver Total Pelvis Force on Impact Side (Y) vs. Time | B-3 |

The following additional data for this test can be obtained from the Research and Development section of the NHTSA website. The website can be found at www.nhtsa.gov

Additional Driver Dummy Instrumentation Data

Driver Head CG Redundant Acceleration (X) vs. Time
Driver Head CG Redundant Acceleration (Y) vs. Time
Driver Head CG Redundant Acceleration (Z) vs. Time
Driver Head Angular Velocity X (Deg/Sec) vs. Time
Driver Head Angular Velocity Y (Deg/Sec) vs. Time
Driver Head Angular Velocity Z (Deg/Sec) vs. Time
Driver Upper Thorax Rib Deflection (Y)
Driver Middle Thorax Rib Deflection (Y)
Driver Lower Thorax Rib Deflection (Y)
Driver Upper Abdomen Rib Deflection (Y)
Driver Lower Abdomen Rib Deflection (Y)

Vehicle Instrumentation Data

Vehicle Center of Gravity Acceleration (X)

Vehicle Center of Gravity Acceleration (Y)

Vehicle Center of Gravity Acceleration (Z)

Left Floor Sill Acceleration (Y)

Left A-Pillar Sill Acceleration (Y)

Left Lower A-Pillar Acceleration (Y)

Left Mid A-Pillar Acceleration (Y)

Left B-Pillar Sill Acceleration (Y)

Left Lower B-Pillar Acceleration (Y)

Left Mid B-Pillar Acceleration (Y)

Driver Seat Track at Dummy Hip Point Acceleration (Y)

Engine Top Acceleration (X)

Engine Top Acceleration (Y)

Firewall Center Acceleration (Y)

Right Roof at Vertical Impact Reference Line Acceleration (Y)

Right Sill at Vertical Impact Reference Line Acceleration (Y)

Rear Floorpan Behind Rear Axle at Centerline Acceleration (X)

Rear Floorpan Behind Rear Axle at Centerline Acceleration (Y)

Pole Instrumentation Data

Load Cell Pole Barrier #1 Force (Y)

Load Cell Pole Barrier #2 Force (Y)

Load Cell Pole Barrier #3 Force (Y)

Load Cell Pole Barrier #4 Force (Y)

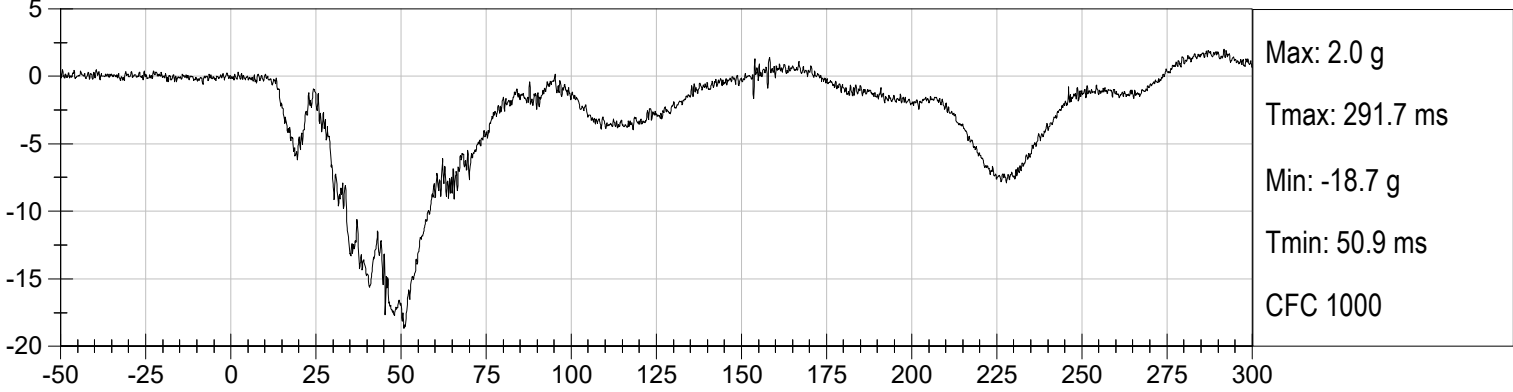
Load Cell Pole Barrier #5 Force (Y)

Load Cell Pole Barrier #6 Force (Y)

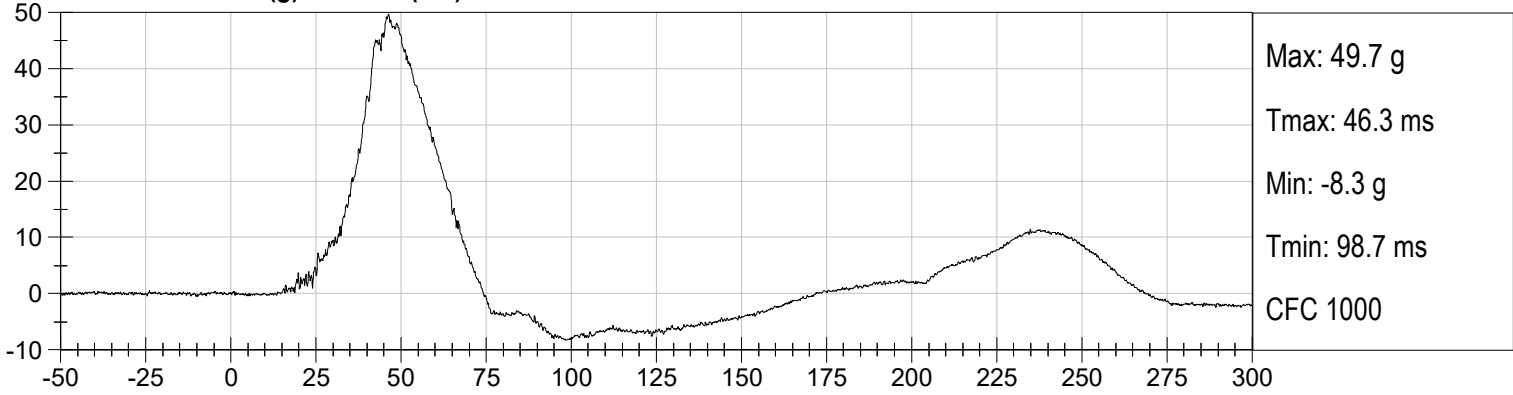
Load Cell Pole Barrier #7 Force (Y)

Load Cell Pole Barrier #8 Force (Y)

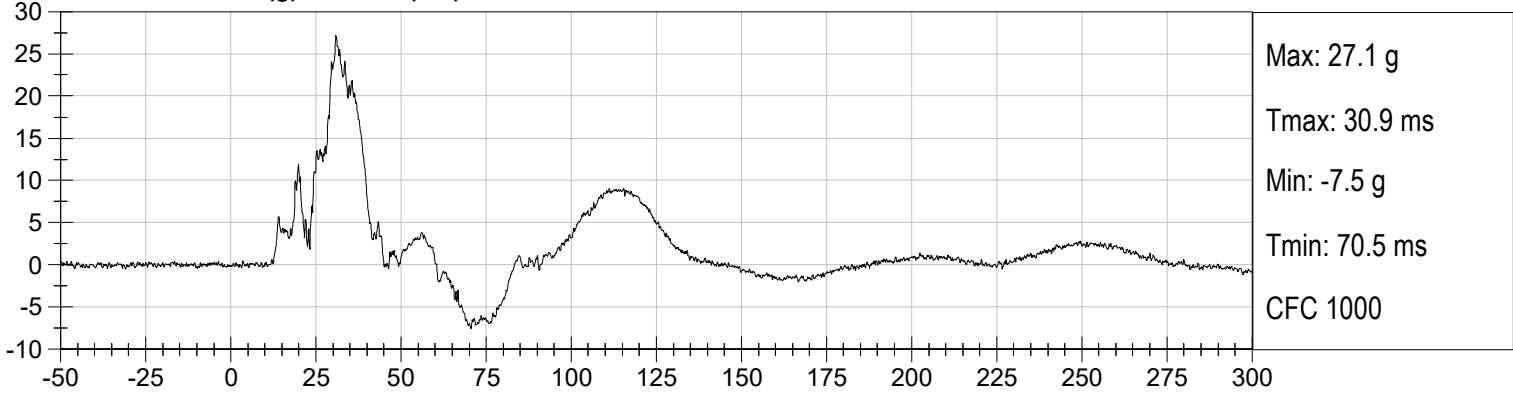
DRIVER HEAD X (g) vs Time (ms)



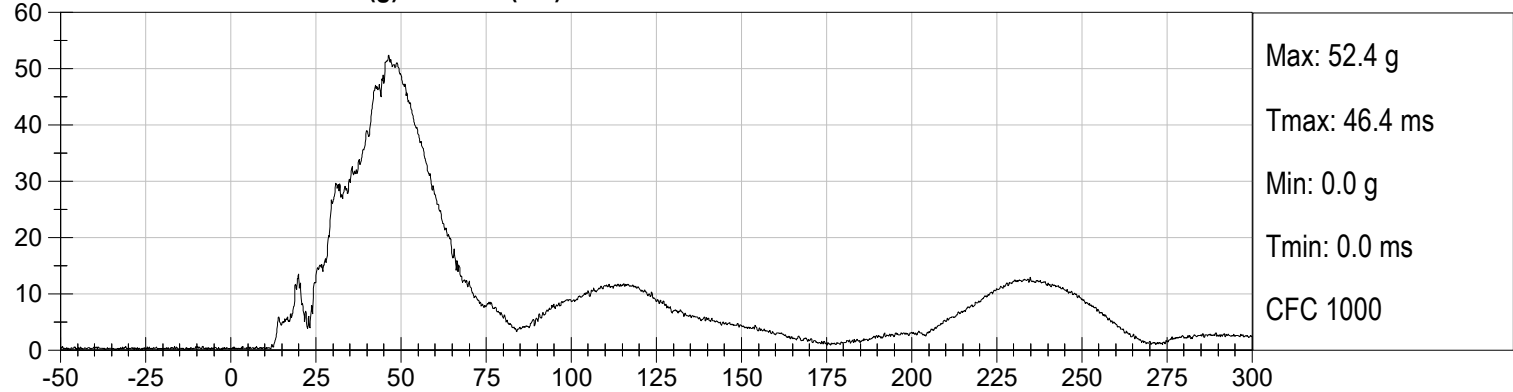
DRIVER HEAD Y (g) vs Time (ms)



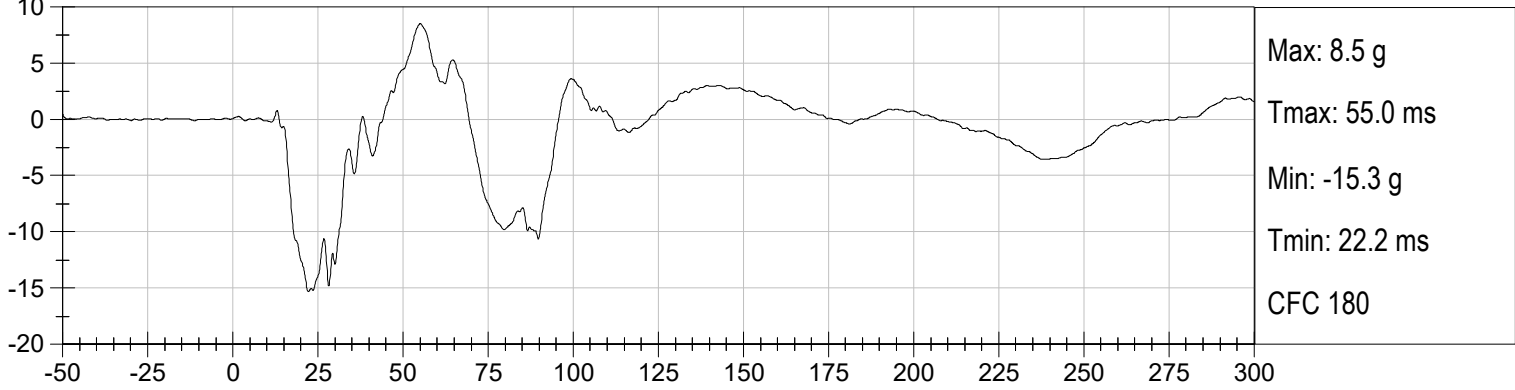
DRIVER HEAD Z (g) vs Time (ms)



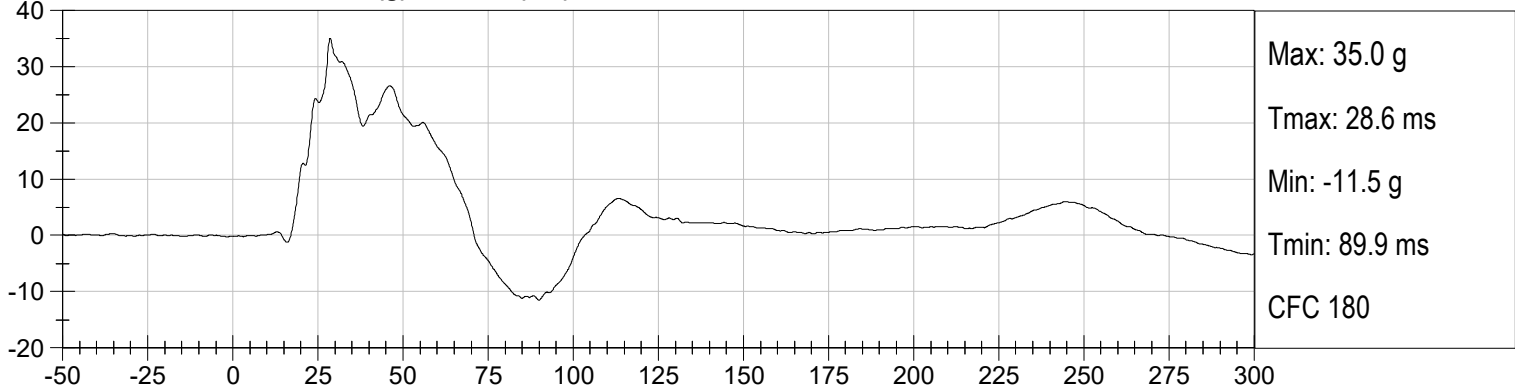
DRIVER HEAD Resultant (g) vs Time (ms)



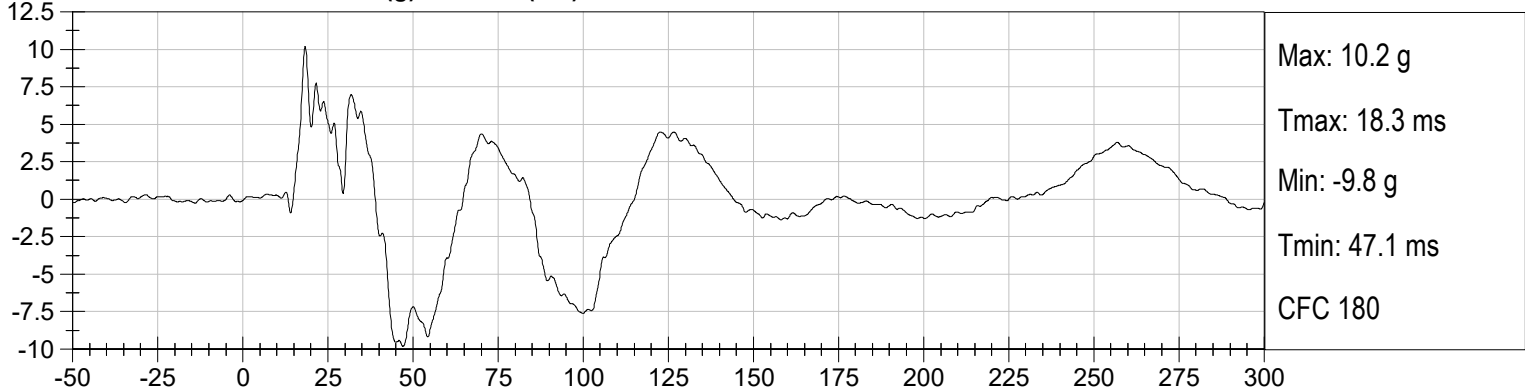
DRIVER LOWER SPINE X (g) vs Time (ms)



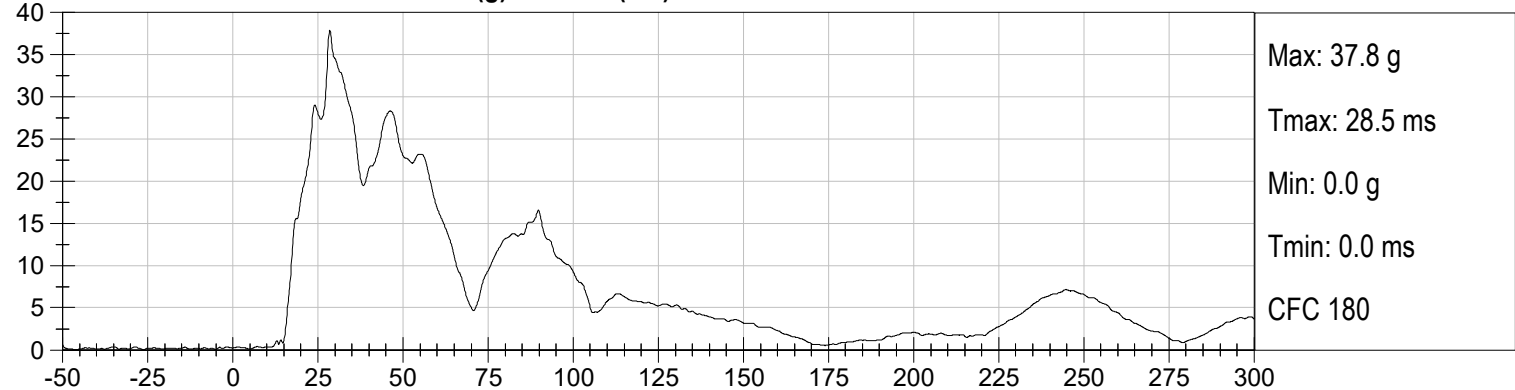
DRIVER LOWER SPINE Y (g) vs Time (ms)



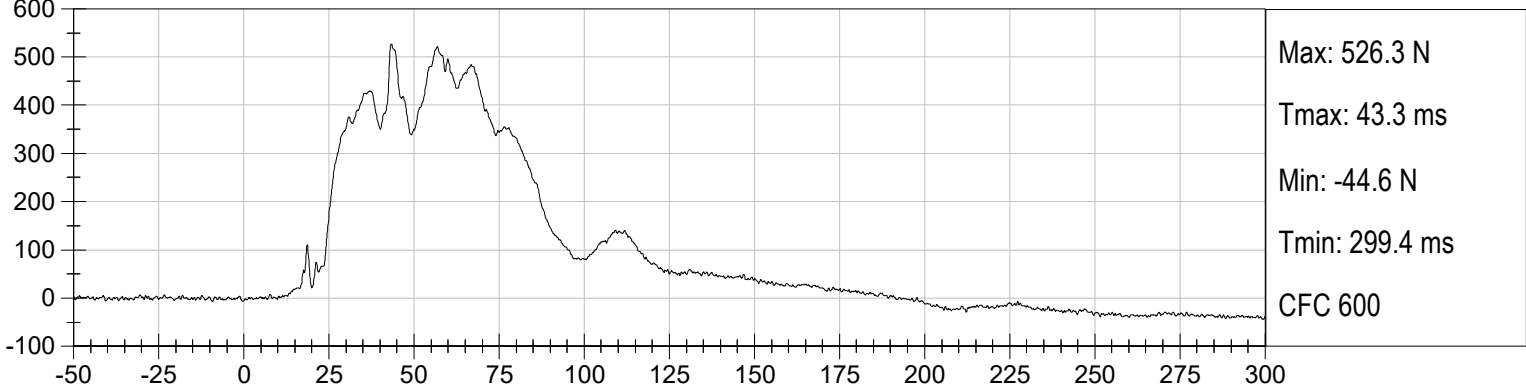
DRIVER LOWER SPINE Z (g) vs Time (ms)



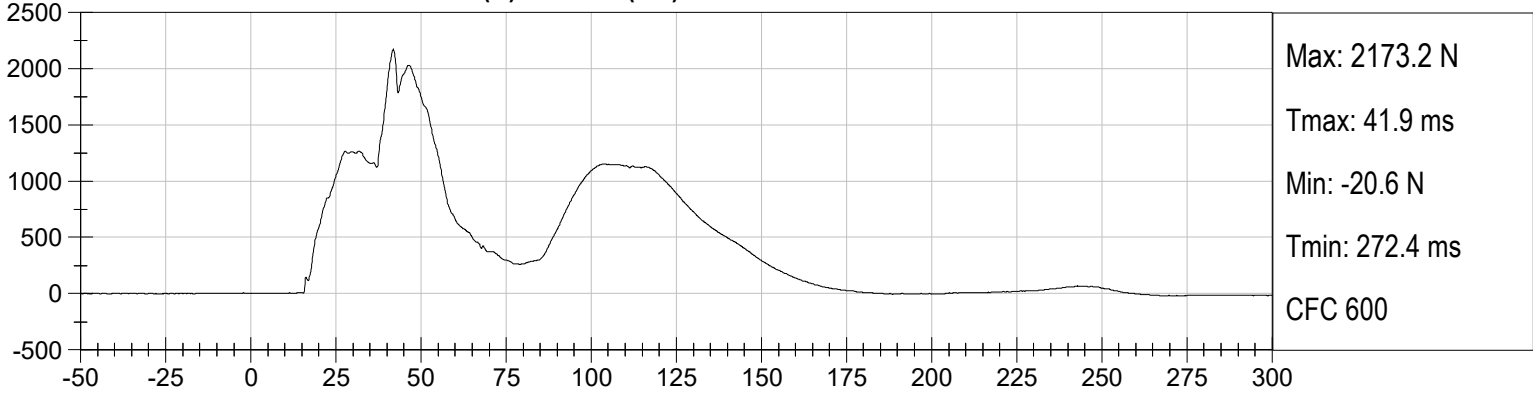
DRIVER LOWER SPINE Resultant (g) vs Time (ms)



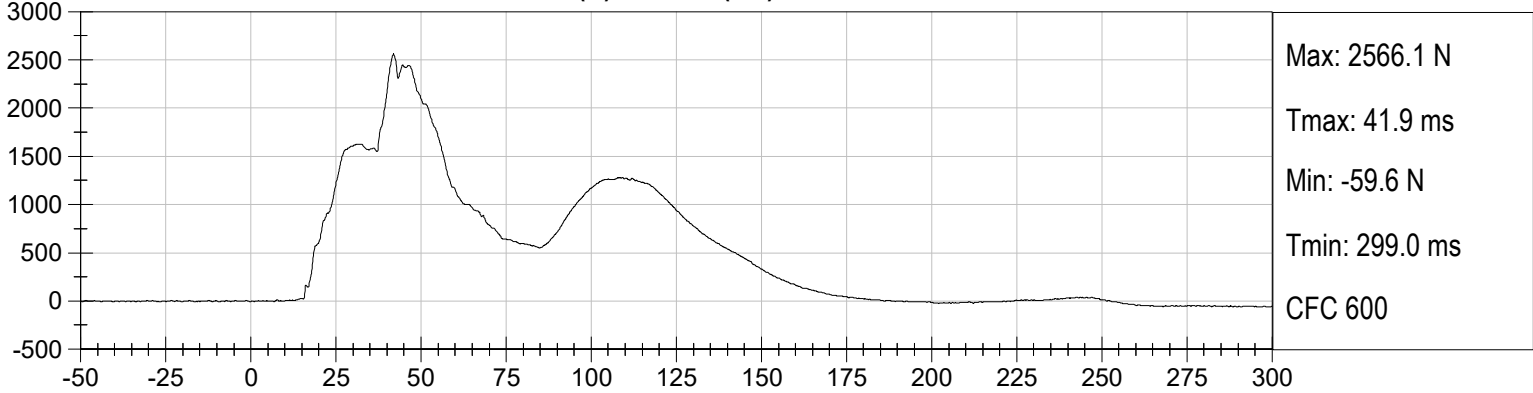
DRIVER LEFT ILIUM CREST FY (N) vs Time (ms)



DRIVER LEFT ACETABULUM FY (N) vs Time (ms)



DRIVER LEFT LATERAL PELVIC FORCE (N) vs Time (ms)



APPENDIX C
DUMMY CONFIGURATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

SID-IIS 5TH PERCENTILE FEMALE - DRIVER ATD

SID-IIsD External Measurements
SN: 306

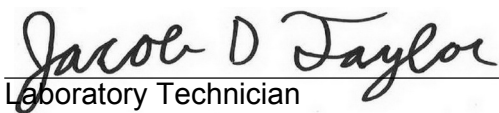
| No. | Name | Spec. (mm) | Result | Pass/Fail |
|------------|-------------------------------|-------------------|---------------|------------------|
| A | Sitting Height | 772 - 788 | 785 | Pass |
| B | Shoulder Pivot Height | 437 - 453 | 449 | Pass |
| C | H-point Height | 79 - 89 | 86 | Pass |
| D | H-point from Seatback | 141 - 151 | 147 | Pass |
| E | Shoulder Pivot from Backline | 97 - 107 | 99 | Pass |
| F | Thigh Clearance | 119 -135 | 120 | Pass |
| G | Head Breadth | 140 - 148 | 141 | Pass |
| H | Head Back from Backline | 40 - 46 | 45 | Pass |
| I | Head Depth | 178 - 188 | 182 | Pass |
| J | Head Circumference | 541 - 551 | 550 | Pass |
| K | Buttock to Knee Length | 514 - 540 | 538 | Pass |
| L | Popliteal Height | 343 - 369 | 349 | Pass |
| M | Knee Pivot to Floor Height | 392 - 409 | 394 | Pass |
| N | Buttock Popliteal Length | 416 - 442 | 435 | Pass |
| O | Chest Depth w/o Jacket | 195 - 211 | 198 | Pass |
| P | Foot Length | 216 - 232 | 222 | Pass |
| Q | Hip Breadth (w/ pelvic plugs) | 313 - 323 | 317 | Pass |
| R | Arm Length | 249 - 259 | 250 | Pass |
| S | Knee Joint to Seatback | 477 - 493 | 483 | Pass |
| V | Shoulder Width | 341 - 357 | 351 | Pass |
| W | Foot Width | 78 - 94 | 82 | Pass |
| Y | Chest Circumference w/ jacket | 851 - 881 | 863 | Pass |
| Z | Waist Circumference | 761 - 791 | 782 | Pass |

MGA RESEARCH CORPORATION
HEAD DROP TEST
SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 306

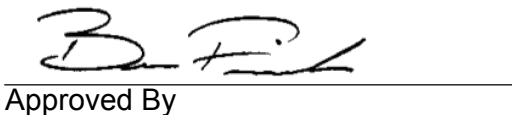
Test ID: D200651

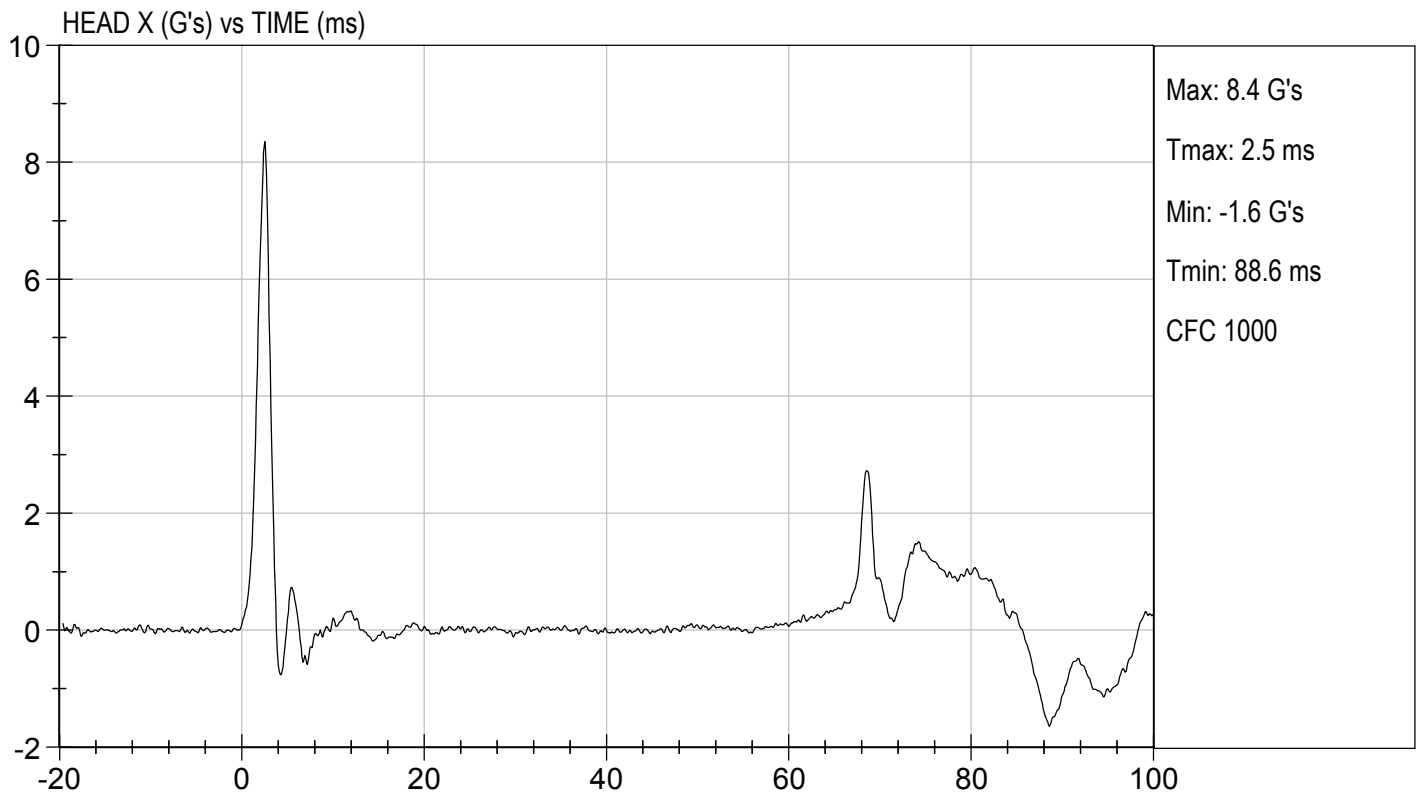
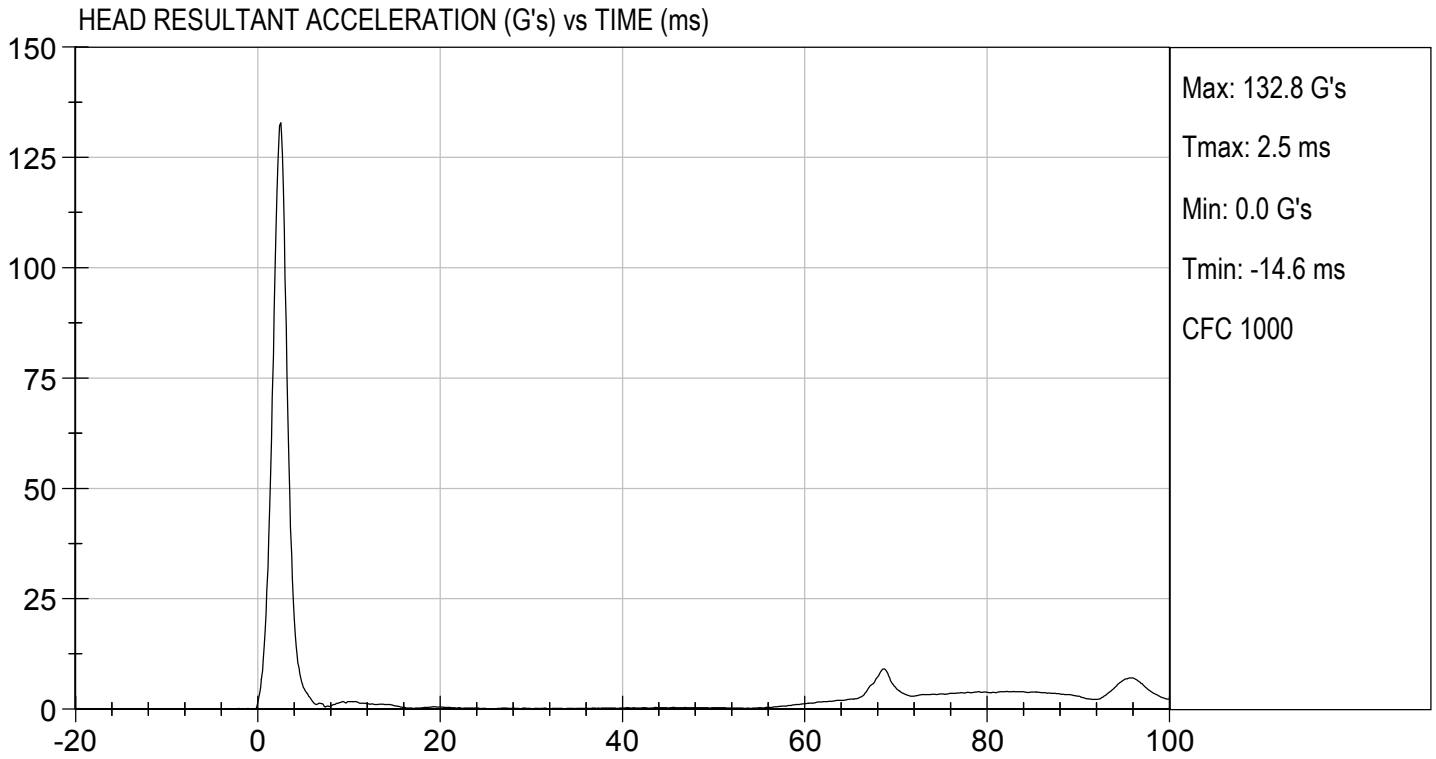
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|--------------------------------|-------|---------------|--------|-----------|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.4 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 20 | Pass |
| Peak Resultant Acceleration | G's | 115 to 137 | 133 | Pass |
| Peak Longitudinal Acceleration | G's | +/- 15 | 8.4 | Pass |
| Unimodal | N/A | Yes | Yes | Pass |
| Oscillations | N/A | <15% | Yes | Pass |
| Overall Test Results | | | | Pass |

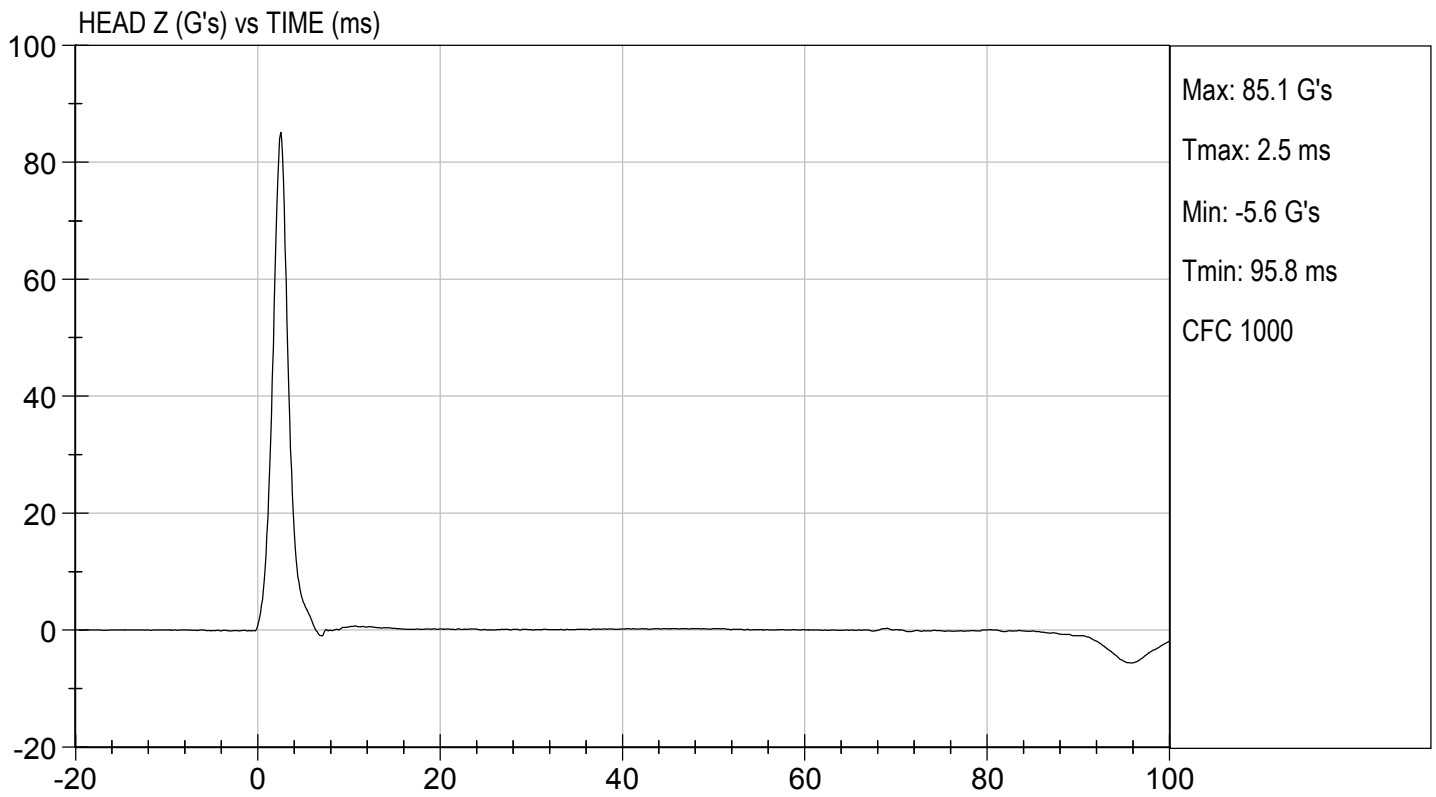
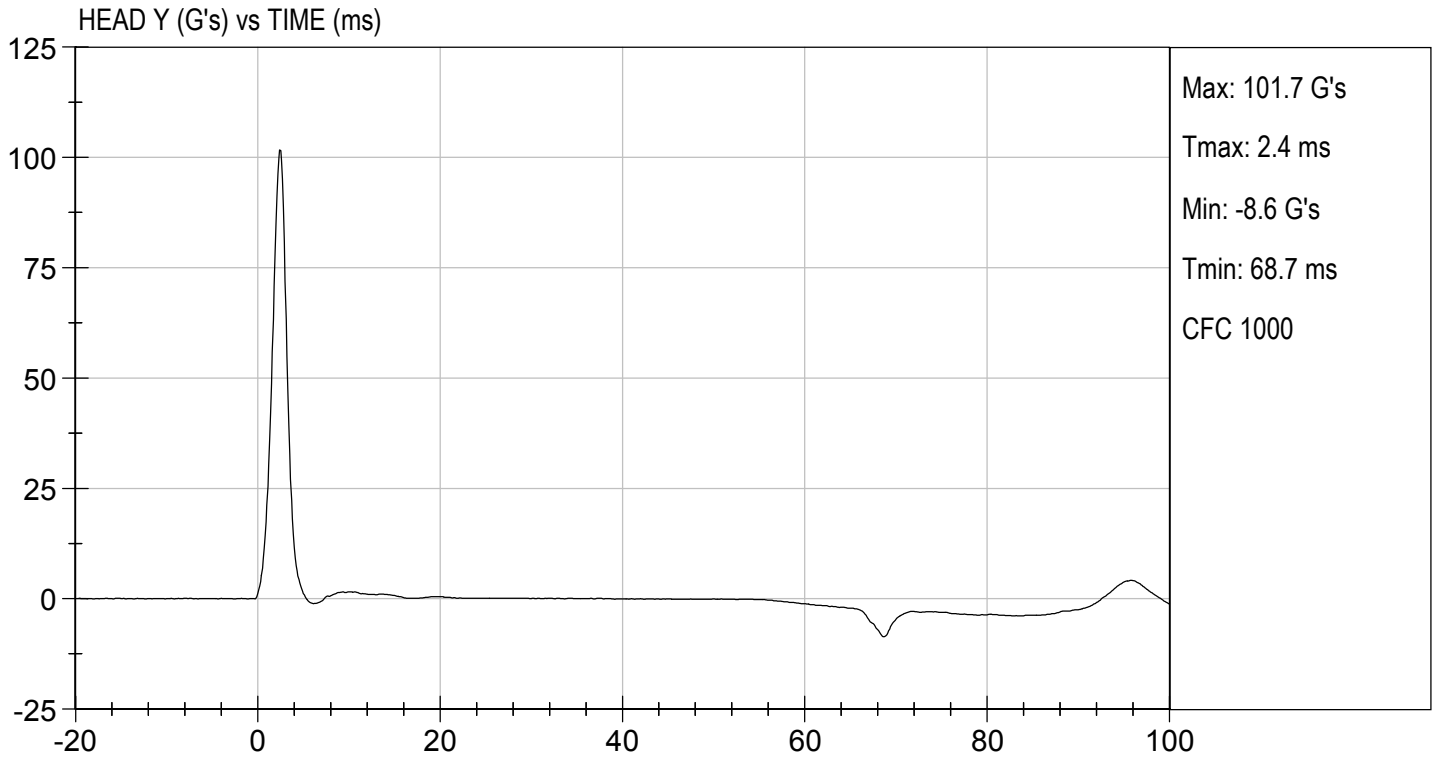

 Laboratory Technician

02/24/2020

Test Date


 Approved By





**MGA RESEARCH CORPORATION
LATERAL NECK PENDULUM TEST
SID-IIs BUILD LEVEL D DUMMY**

ATD Serial No: 306

Test I.D.: D200652

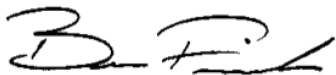
| Tested Parameter | Units | Specification | Result | Pass/Fail | |
|----------------------------------|-----------|---------------|--------------|-------------|------|
| Temperature | deg C | 20.6 to 22.2 | 21.3 | Pass | |
| Humidity | % | 10 to 70 | 20 | Pass | |
| Impact Velocity | m/s | 5.51 to 5.63 | 5.58 | Pass | |
| Pendulum Velocity | 10 ms | m/s | 2.20 to 2.80 | 2.47 | Pass |
| | 15 ms | m/s | 3.30 to 4.10 | 3.69 | Pass |
| | 20 ms | m/s | 4.40 to 5.40 | 5.10 | Pass |
| | 25 ms | m/s | 5.40 to 6.10 | 5.71 | Pass |
| | 25-100 ms | m/s | 5.50 to 6.20 | 5.71 | Pass |
| Maximum D-Plane Rotation | deg | 71 to 81 | 75 | Pass | |
| Time of Maximum D-Plane Rotation | ms | 50 to 70 | 63 | Pass | |
| Maximum Occipital Condyle Moment | Nm | -44 to -36 | -39 | Pass | |
| Time of Moment Decay to 0 Nm | ms | 102 to 126 | 119 | Pass | |
| Overall Test Results | | | | Pass | |



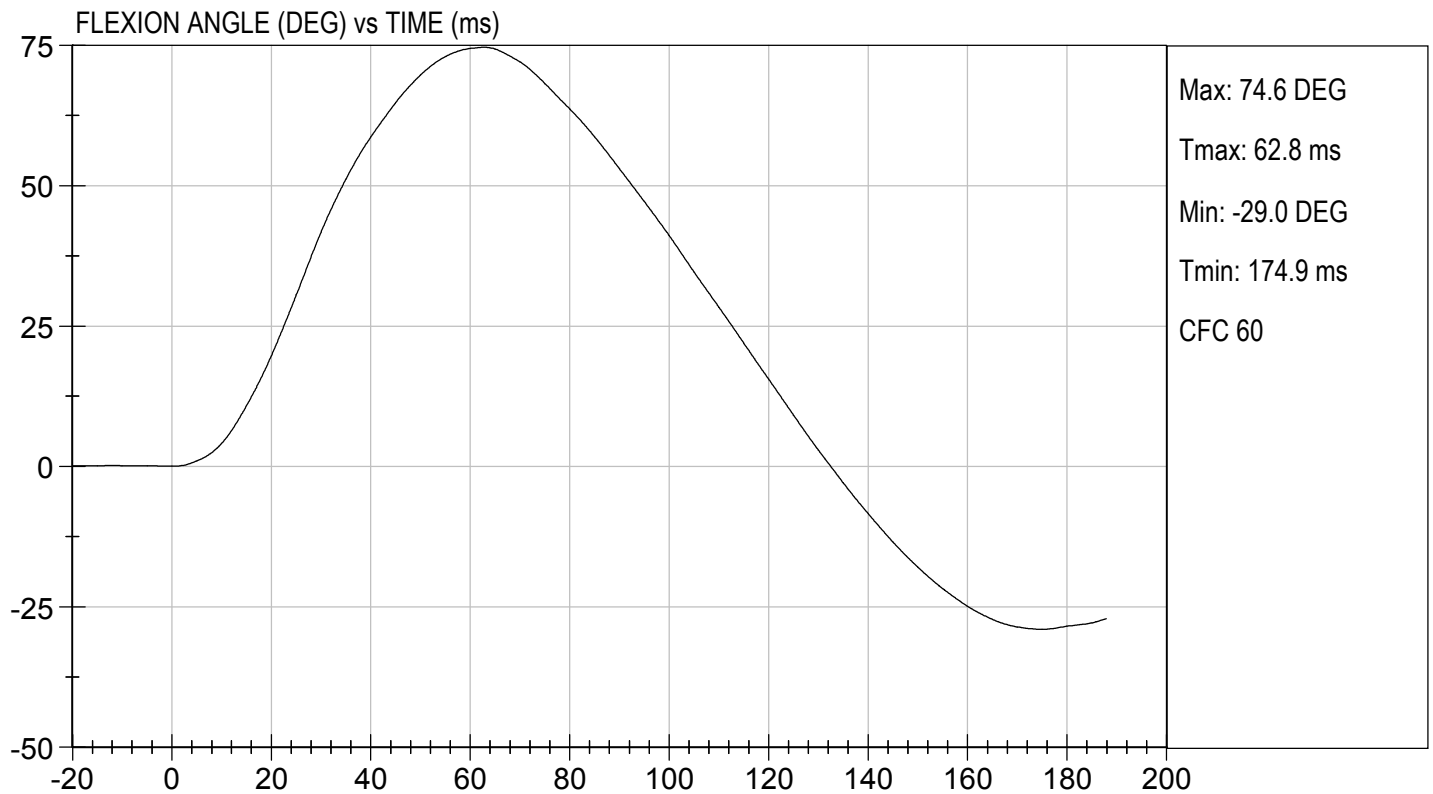
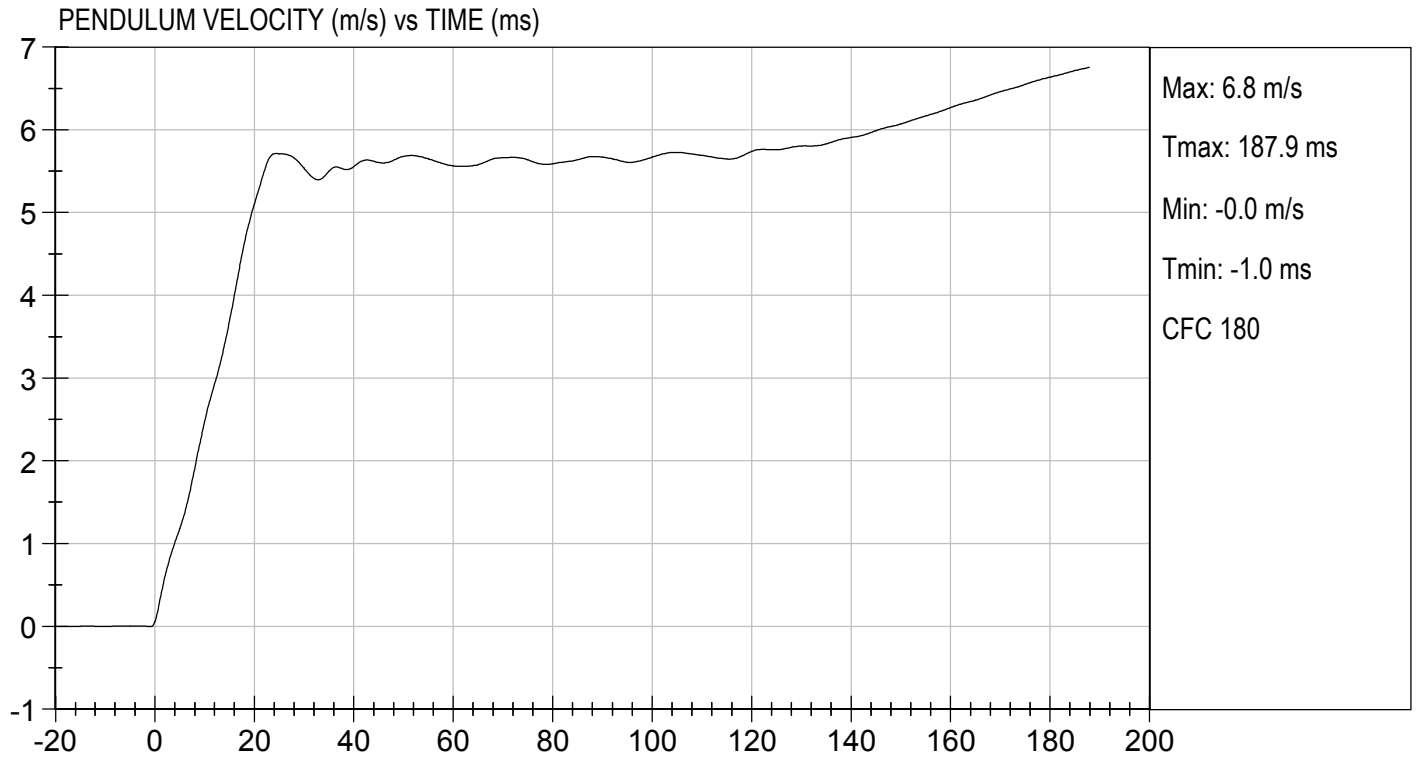
Laboratory Technician

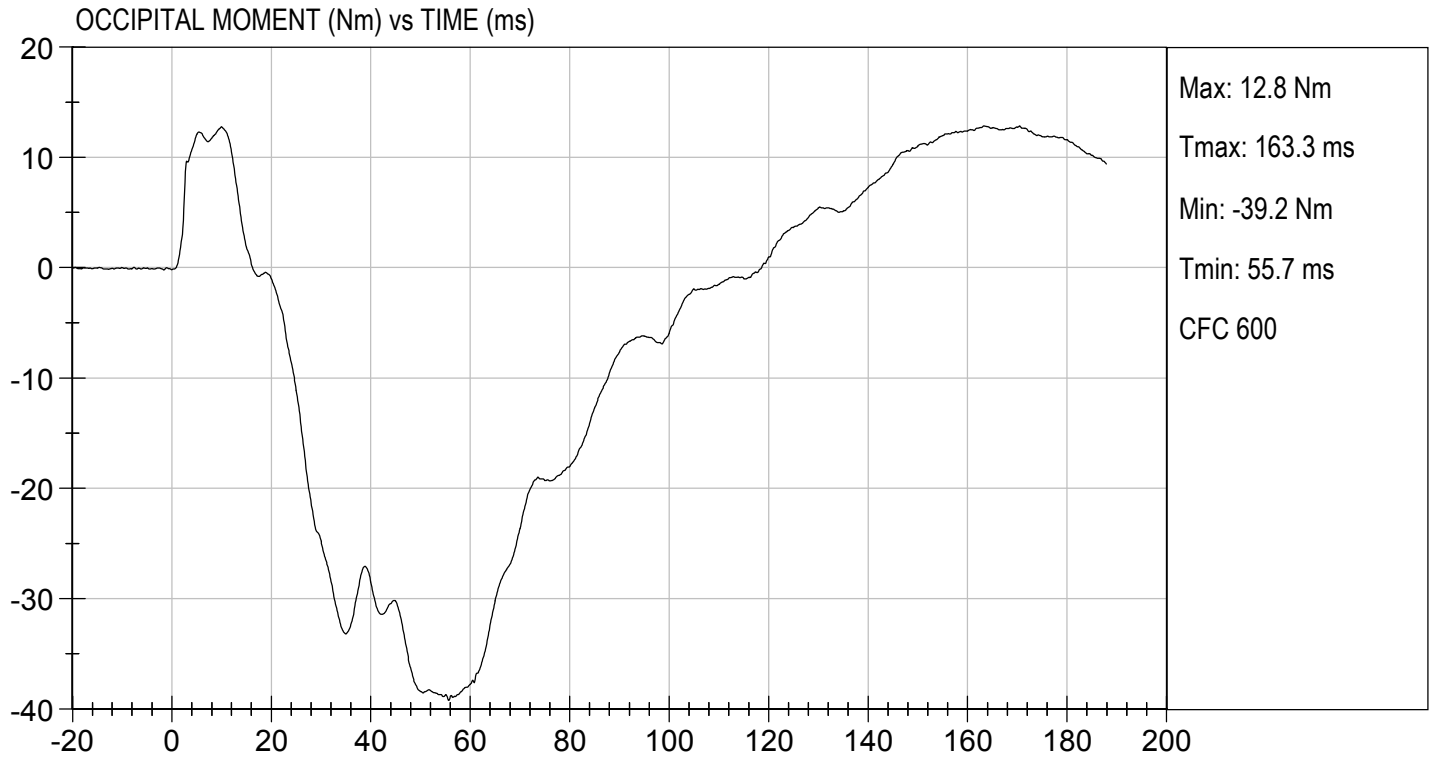
02/26/2020

Test Date



Approved By






**MGA RESEARCH CORPORATION
SHOULDER IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY**

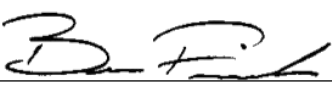
ATD Serial No: 306

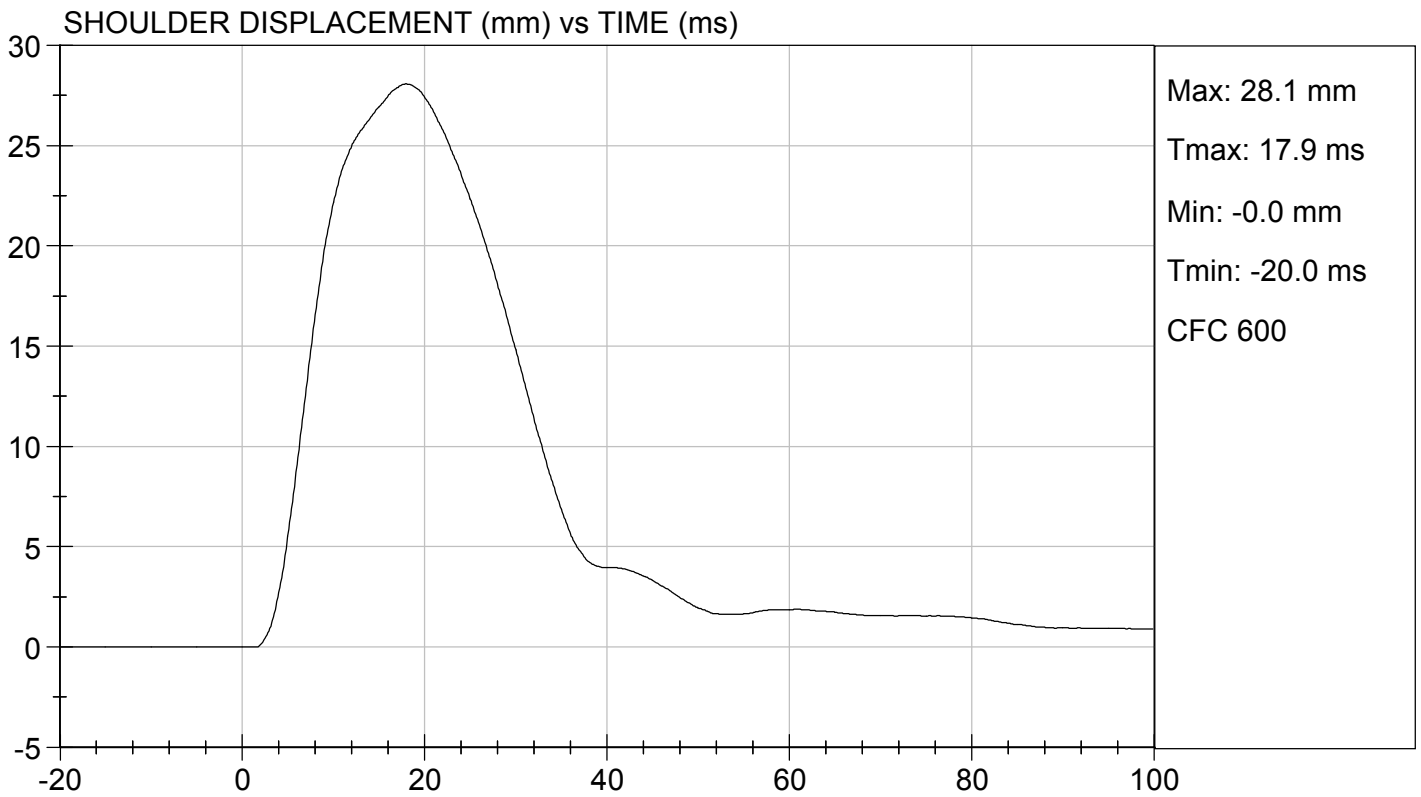
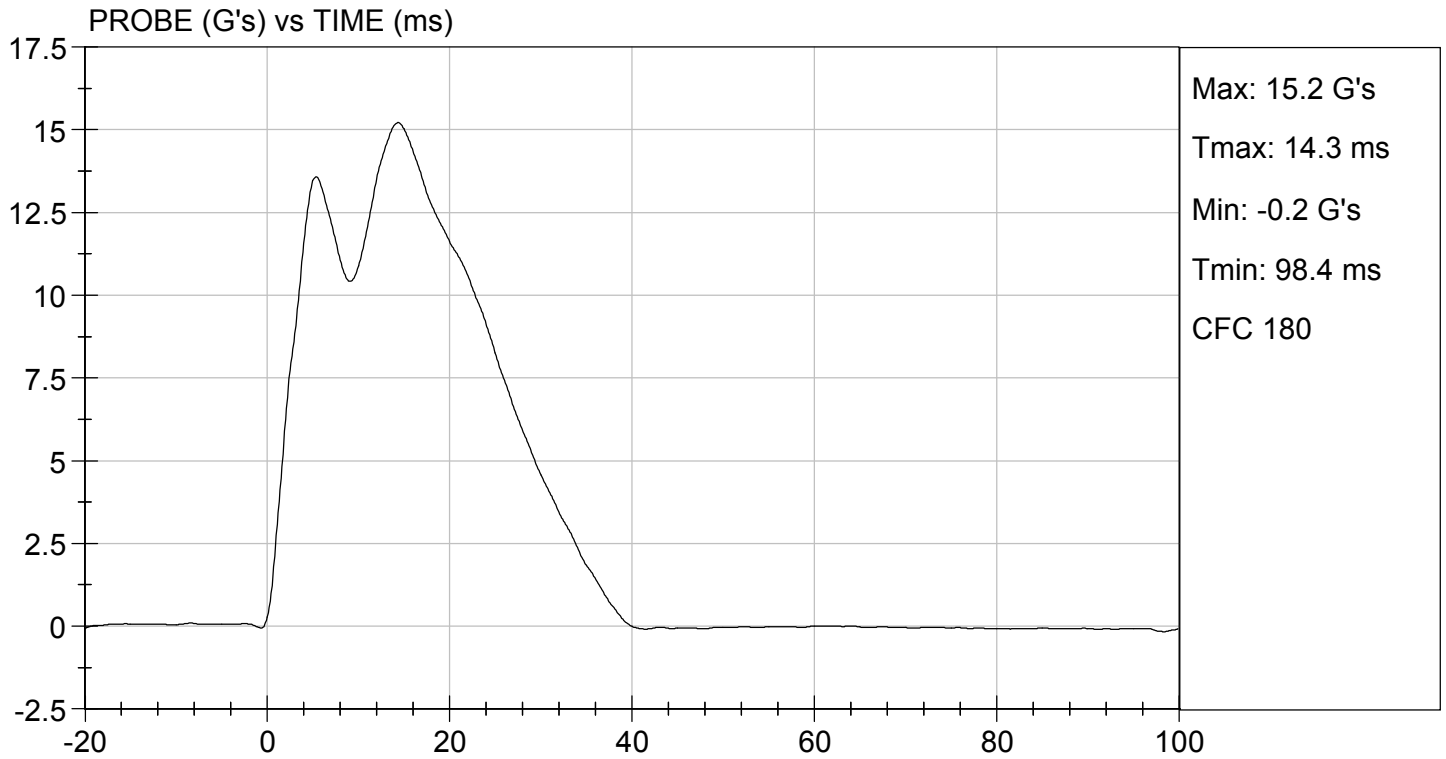
Test ID: D200653

| 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 | 20 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.38 | Pass |
| Maximum Probe Acceleration | G's | 13 to 18 | 15 | Pass |
| Shoulder Displacement | mm | 28 to 37 | 28 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 17 to 22 | 19 | Pass |
| Overall Test Results | | | | Pass |


Laboratory Technician

02/26/2020
Test Date

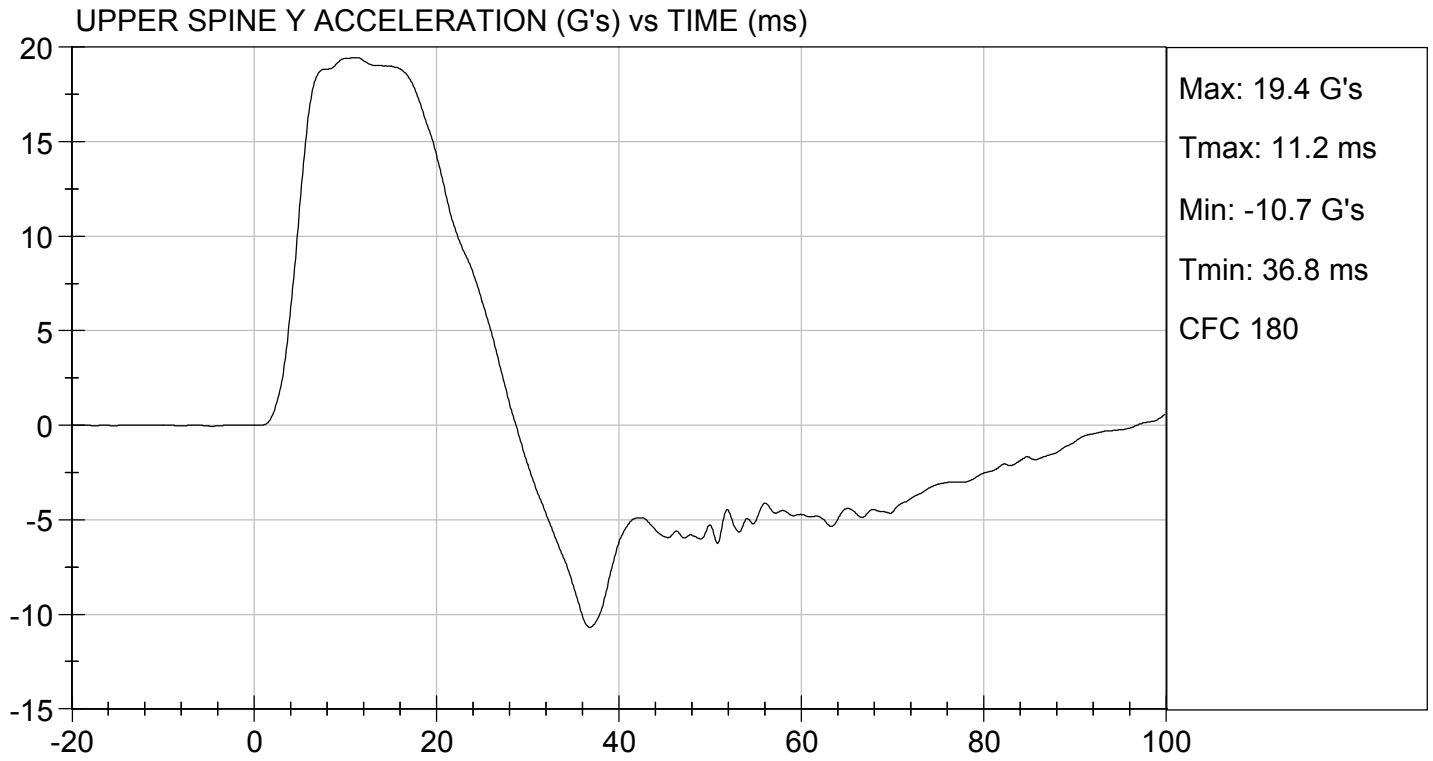

Approved By





TEST DESC: SHOULDER IMPACT
VELOCITY: 14.37 ft/s, 4.38 m/s

TEST DATE: 02/26/2020
TEST #: D200653




MGA RESEARCH CORPORATION
THORAX (WITH ARM) IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

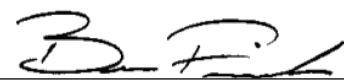
ATD Serial No: 306

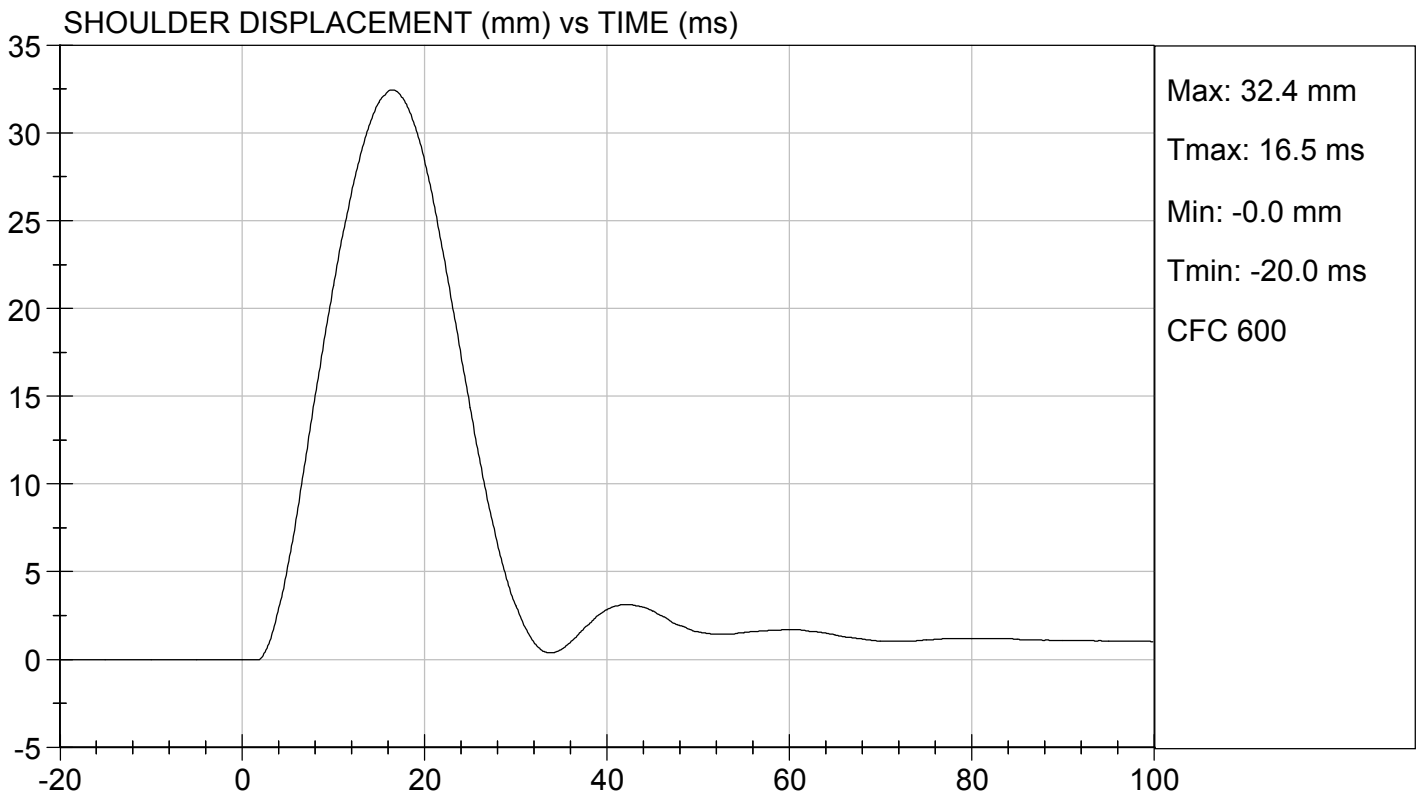
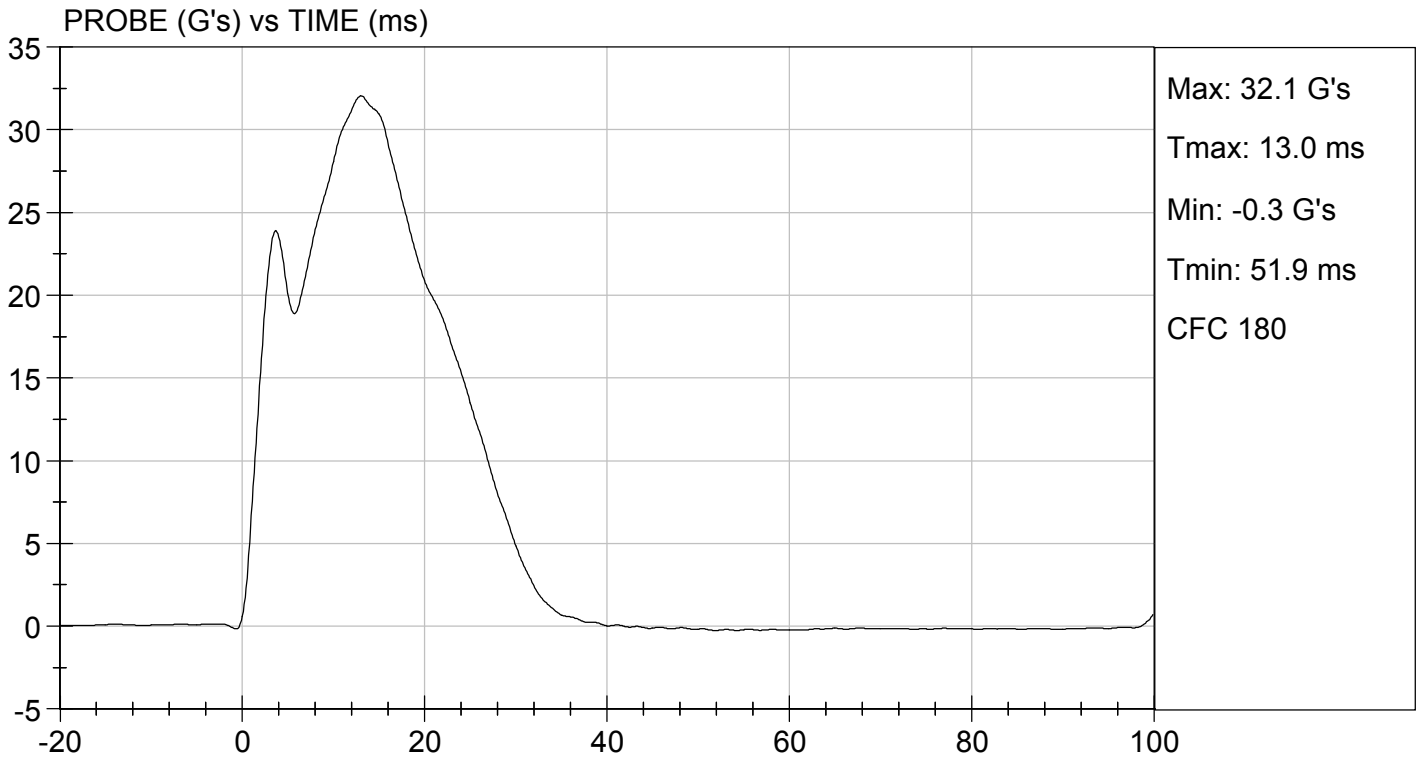
Test I.D: D200654

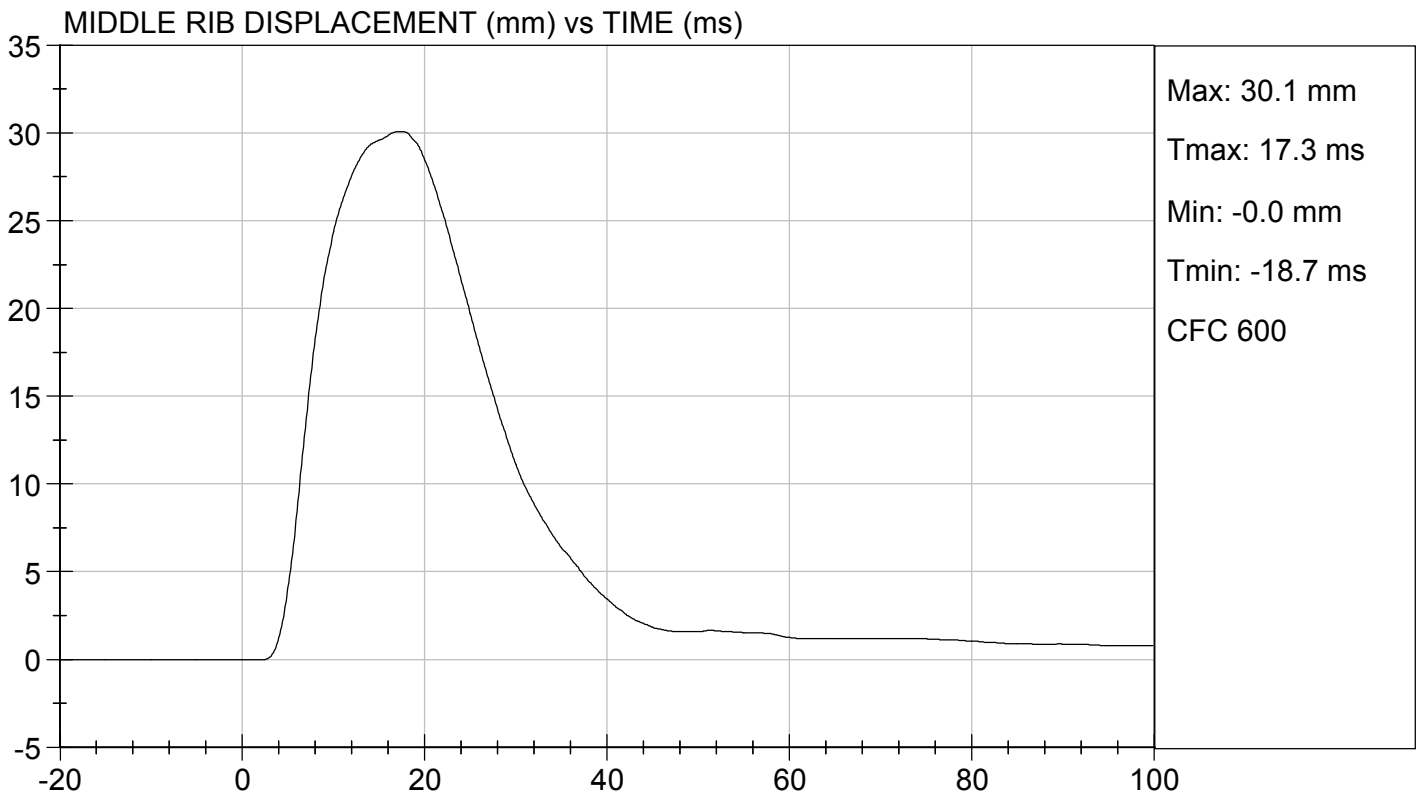
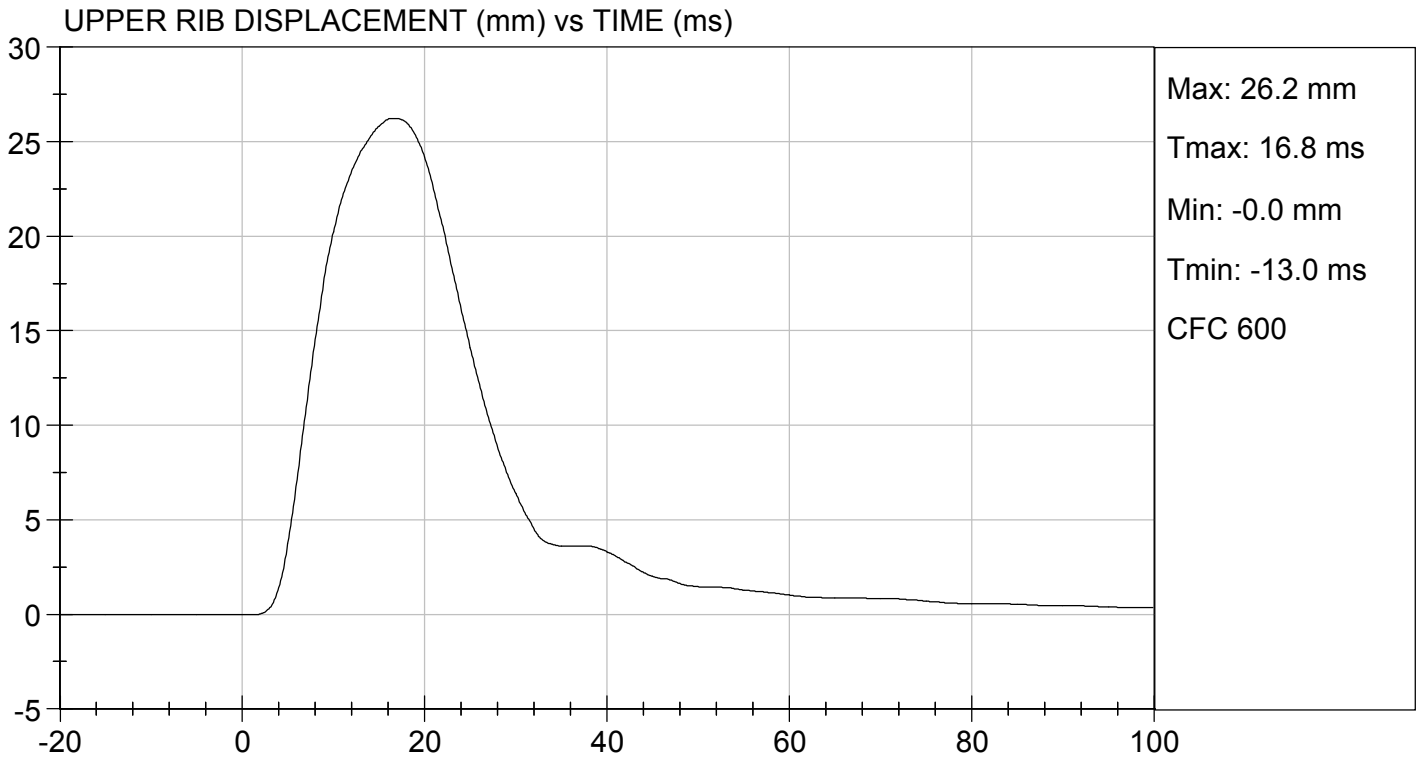
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-----------|
| Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Humidity | % | 10 to 70 | 20 | Pass |
| Impact Velocity | m/s | 6.60 to 6.80 | 6.68 | Pass |
| Maximum Probe Acceleration | G's | 30 to 36 | 32 | Pass |
| Shoulder Displacement | mm | 31 to 40 | 32 | Pass |
| Upper Rib Displacement | mm | 25 to 32 | 26 | Pass |
| Middle Rib Displacement | mm | 30 to 36 | 30 | Pass |
| Lower Rib Displacement | mm | 32 to 38 | 32 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 34 to 43 | 41 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 29 to 37 | 31 | Pass |
| Overall Test Results | | | | Pass |

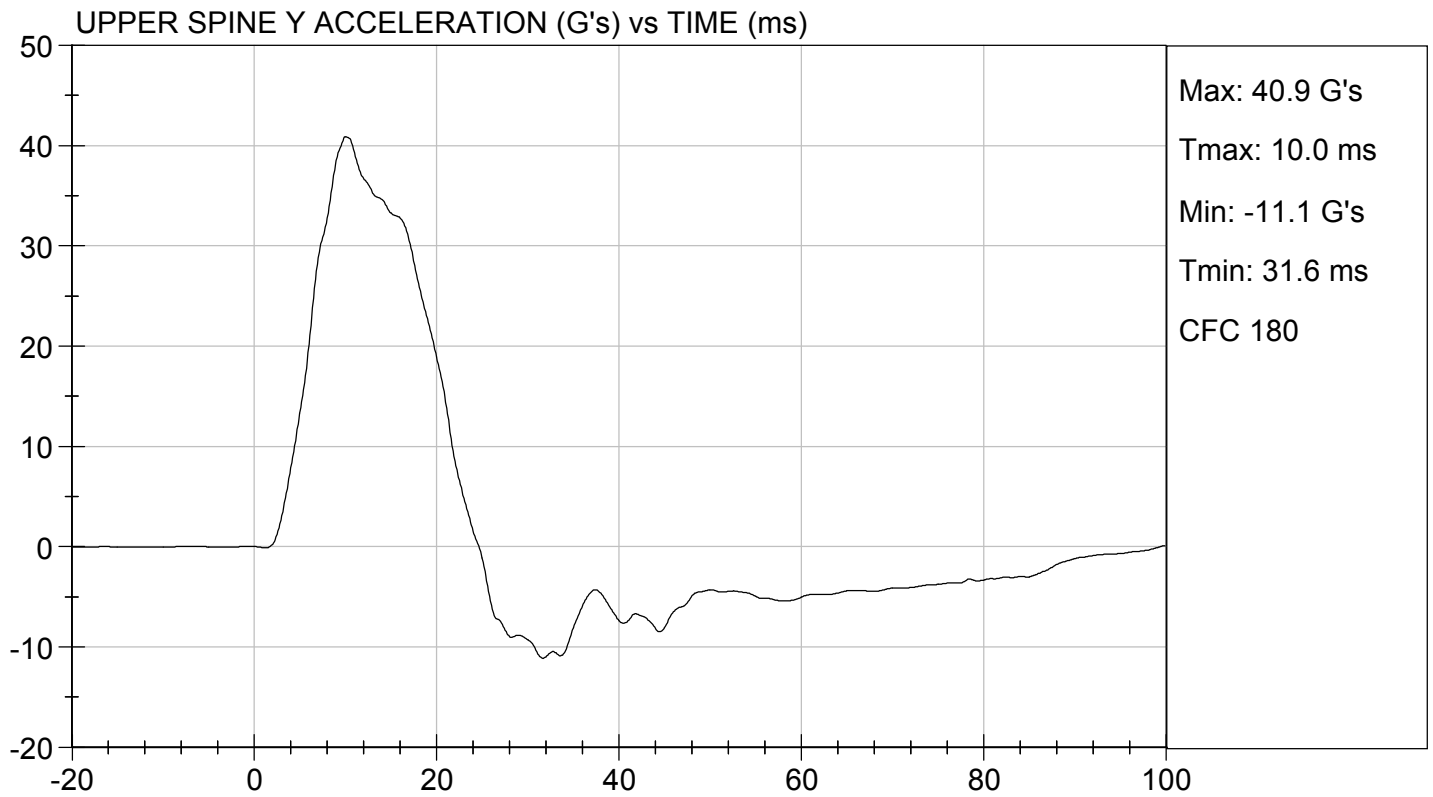
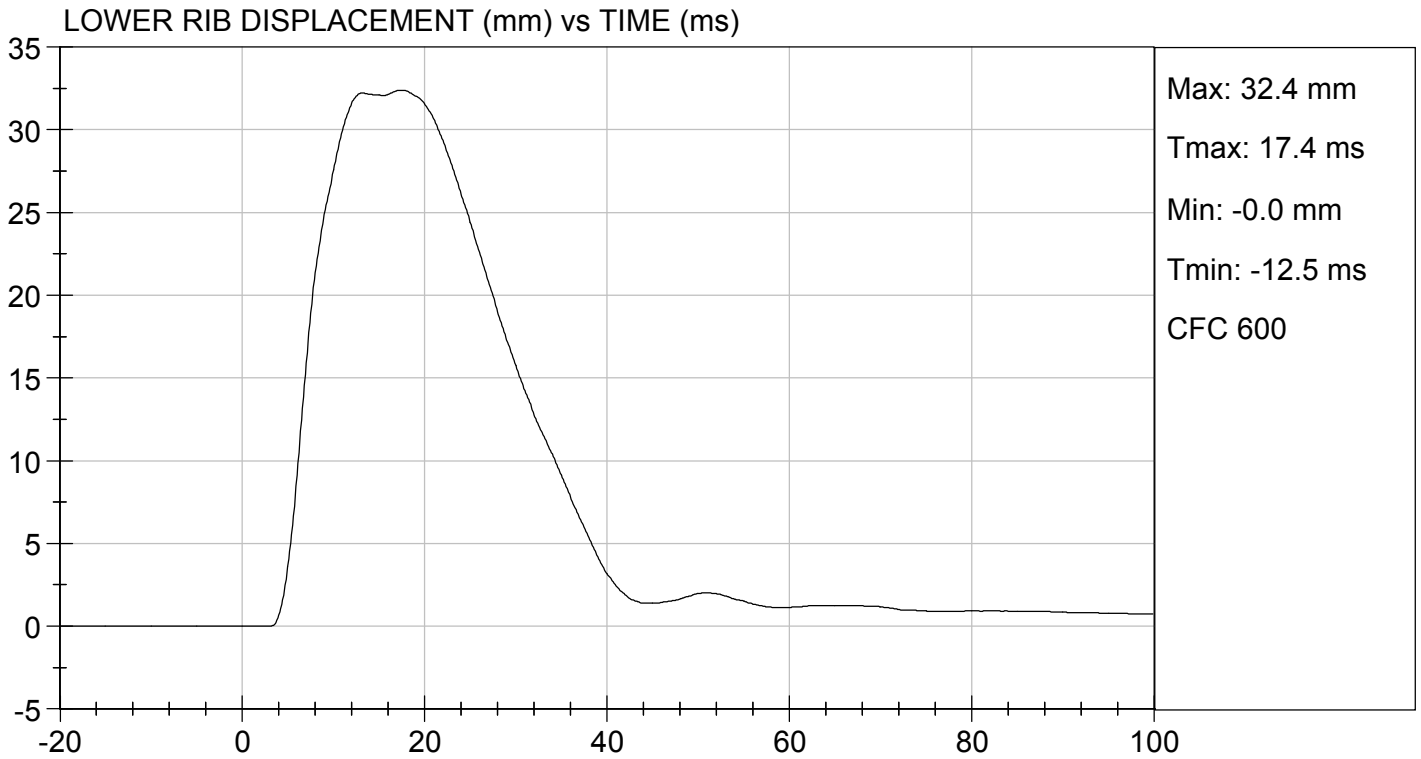

 Laboratory Technician

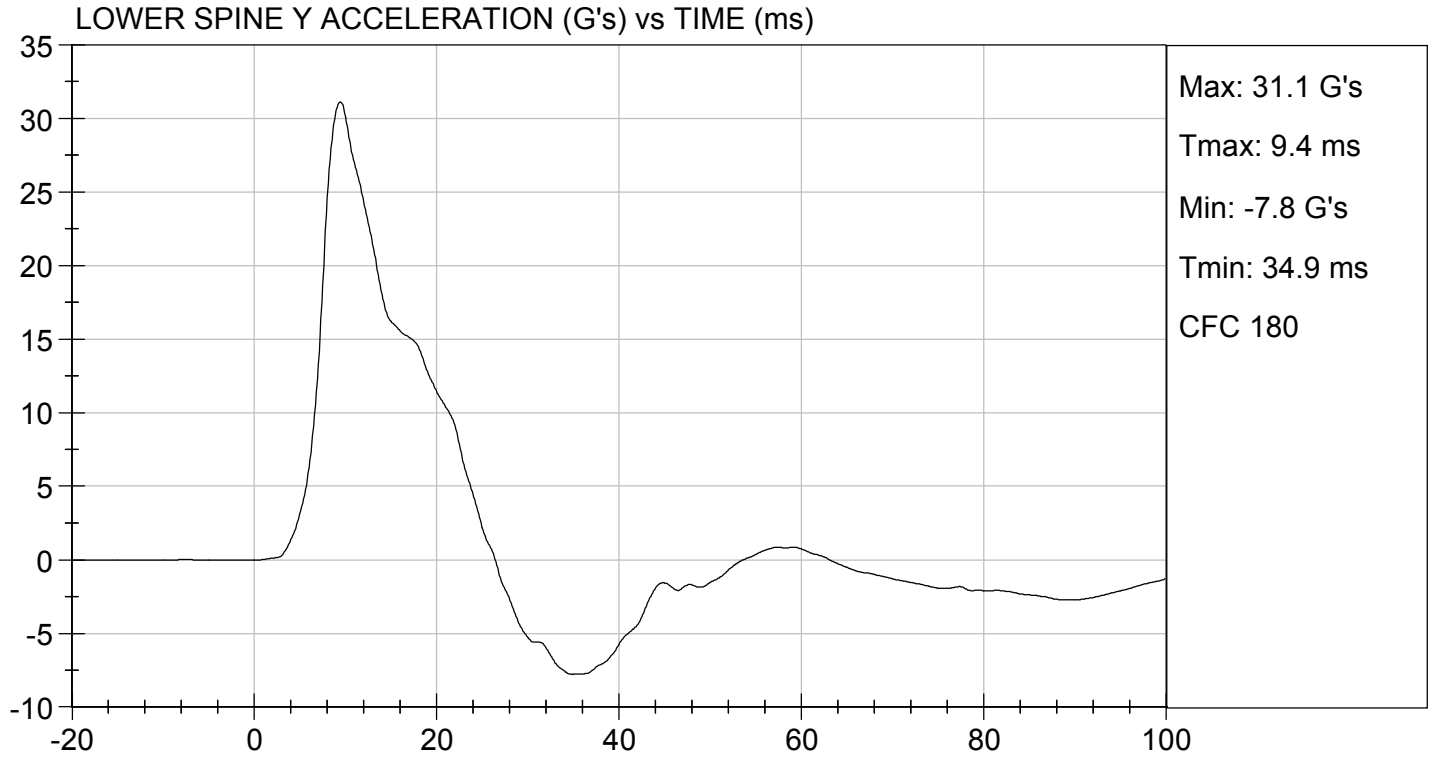
02/26/2020
 Test Date


 Approved By









MGA RESEARCH CORPORATION
THORAX (WITHOUT ARM) IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 306

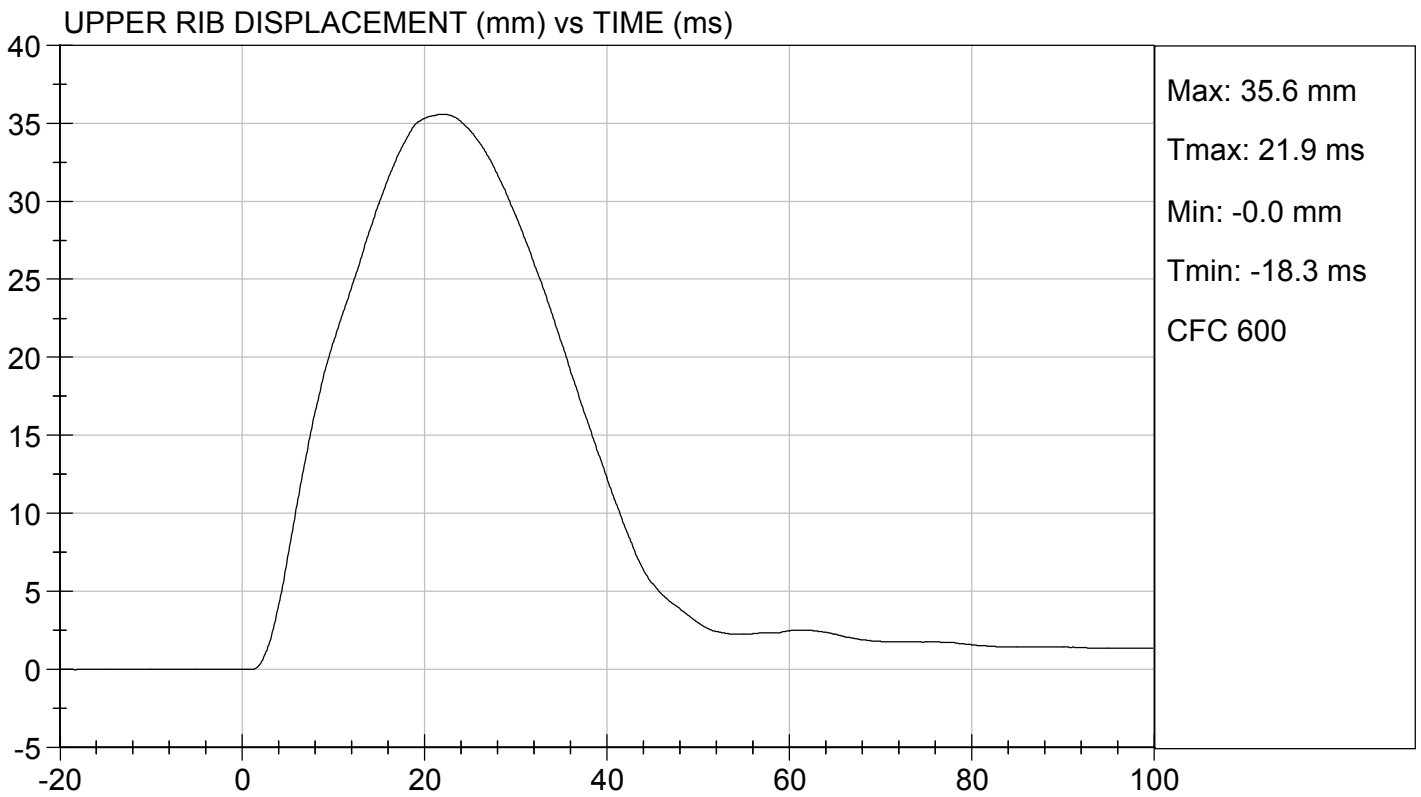
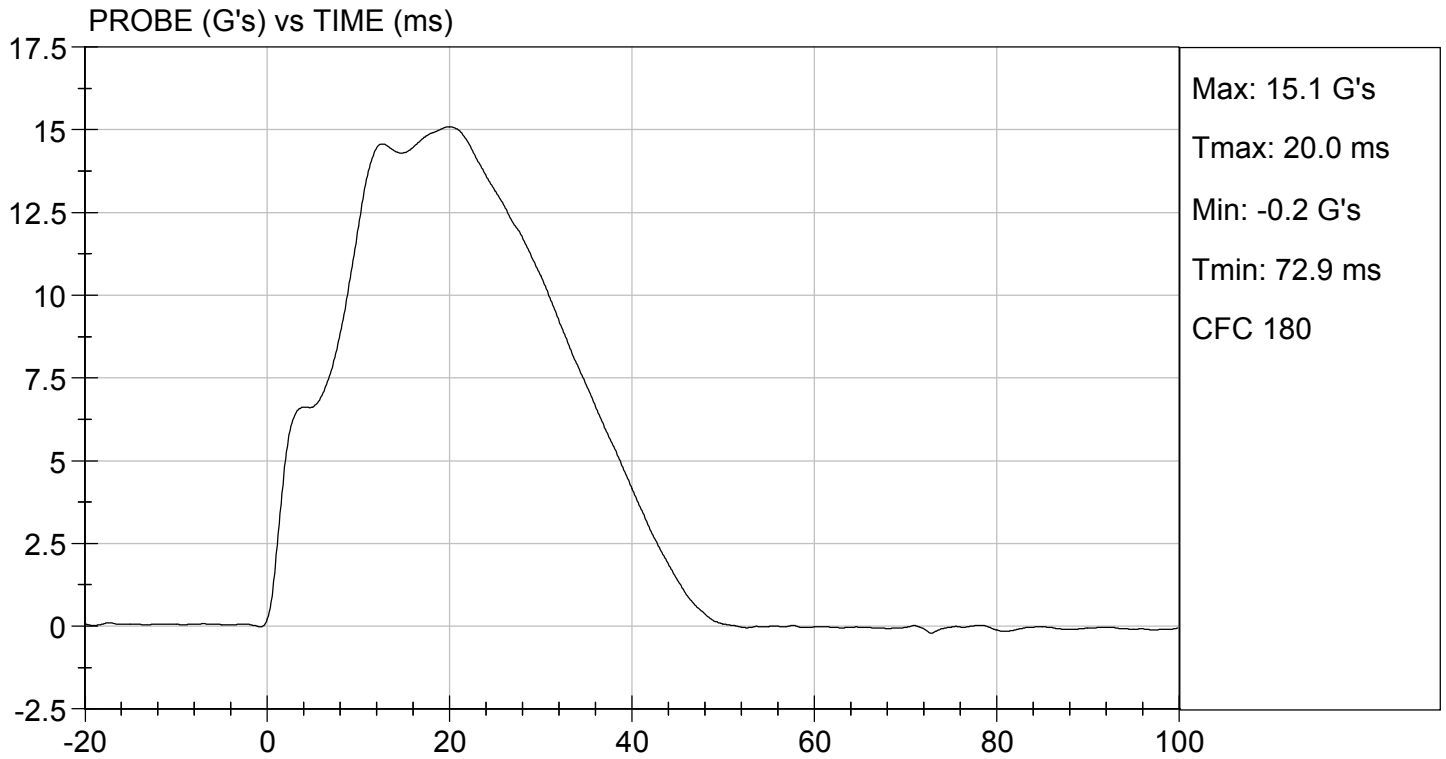
Test I.D: D200655

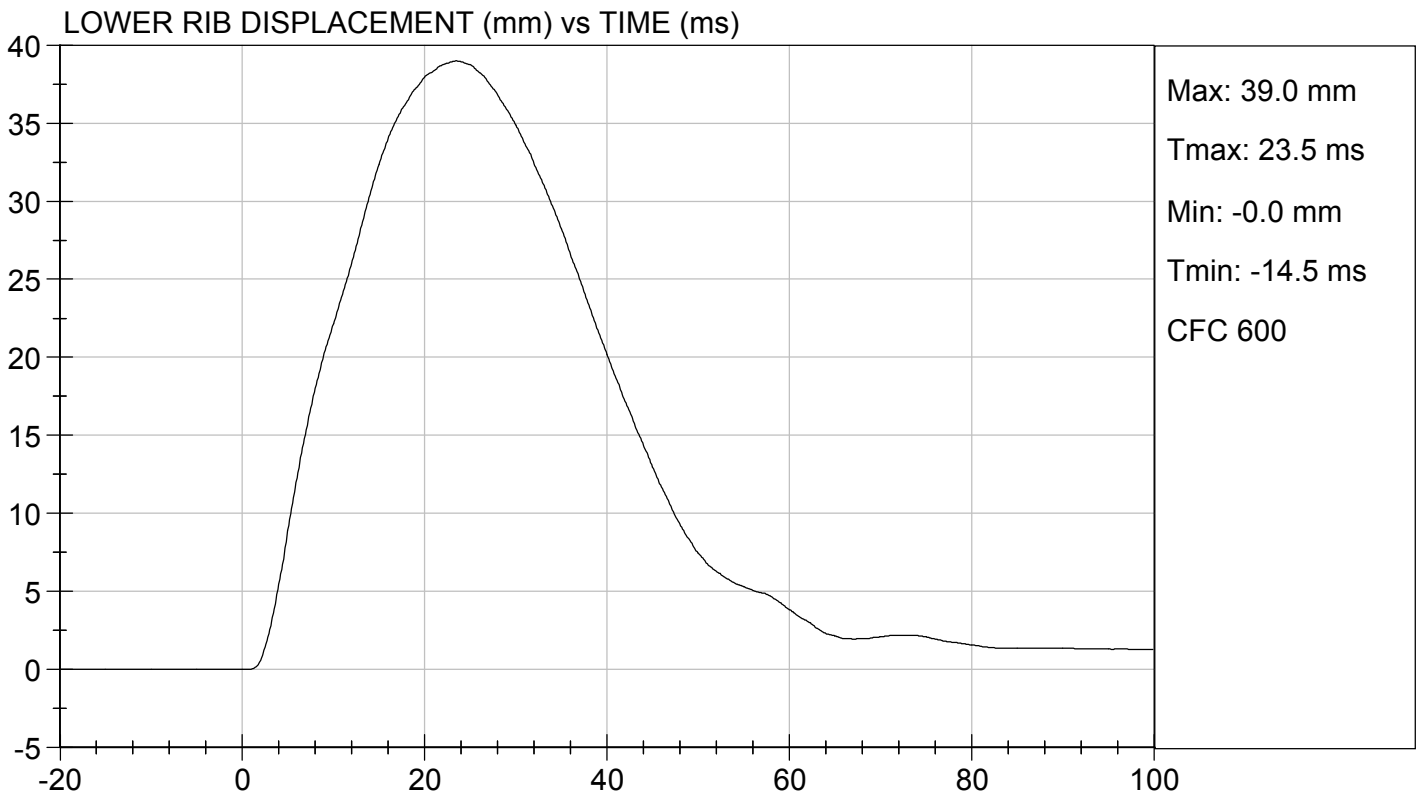
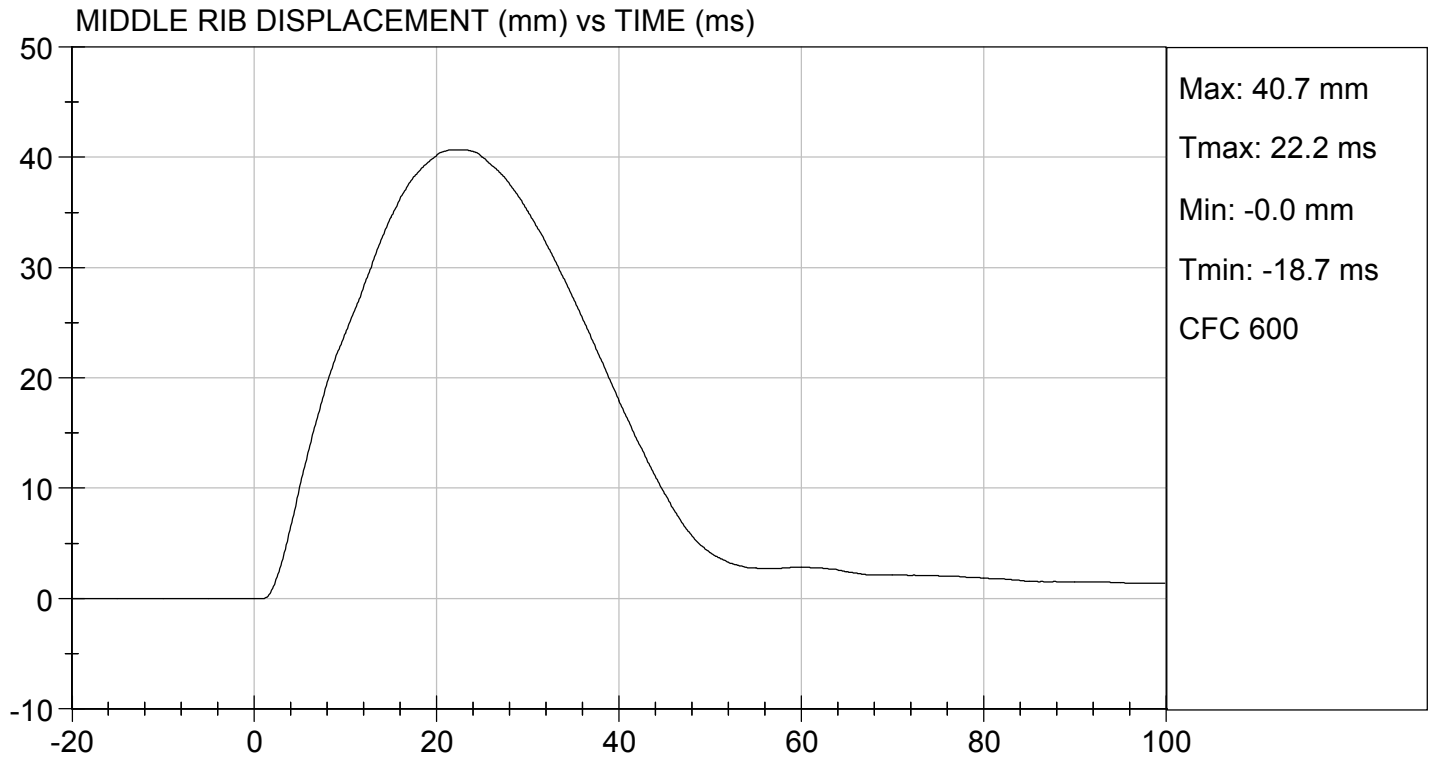
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.4 | Pass |
| Humidity | % | 10 to 70 | 22 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.30 | Pass |
| Maximum Probe Acceleration | G's | 14 to 18 | 15 | Pass |
| Upper Rib Displacement | mm | 32 to 40 | 36 | Pass |
| Middle Rib Displacement | mm | 39 to 45 | 41 | Pass |
| Lower Rib Displacement | mm | 35 to 43 | 39 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 13 to 17 | 15 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 7 to 11 | 9 | Pass |
| Overall Test Results | | | | Pass |

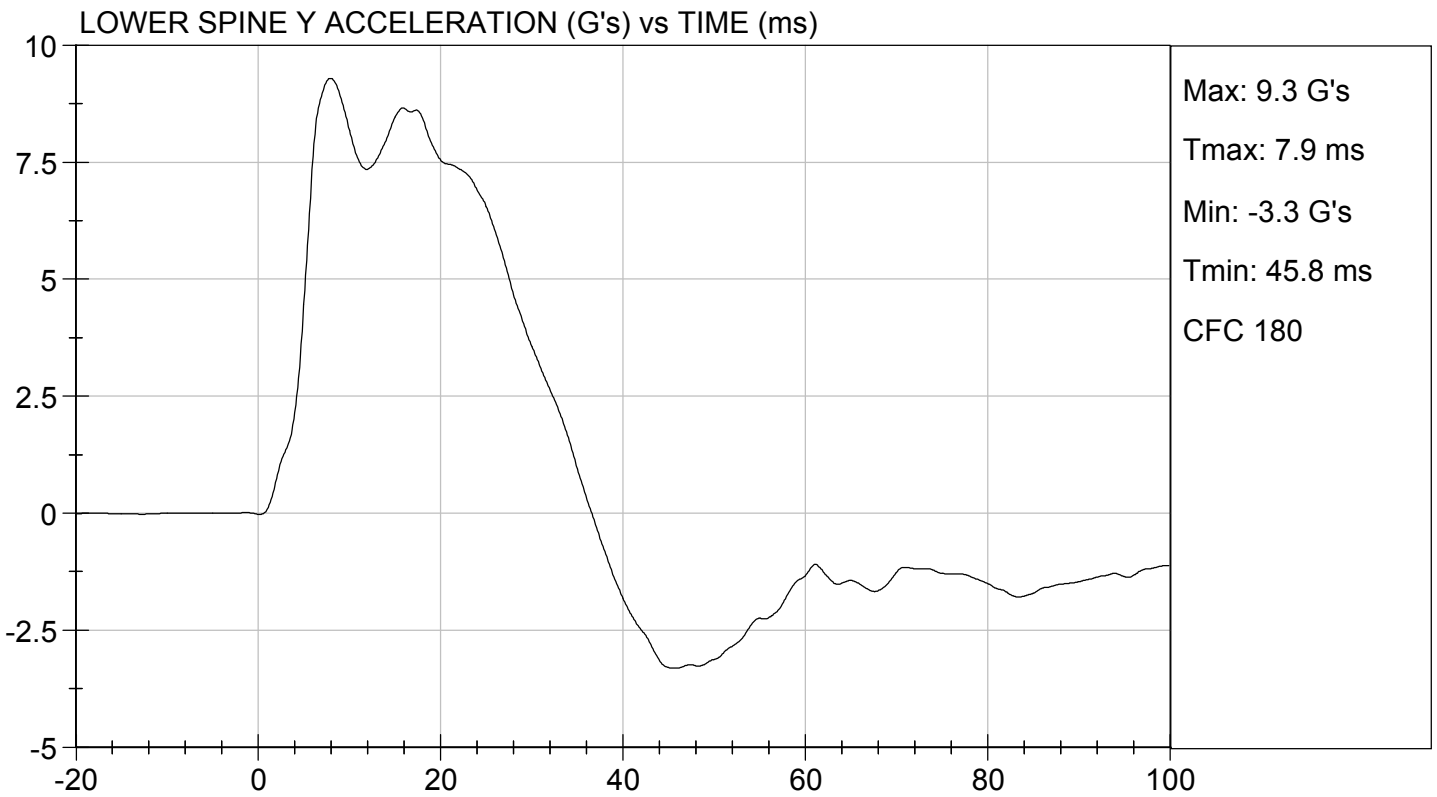
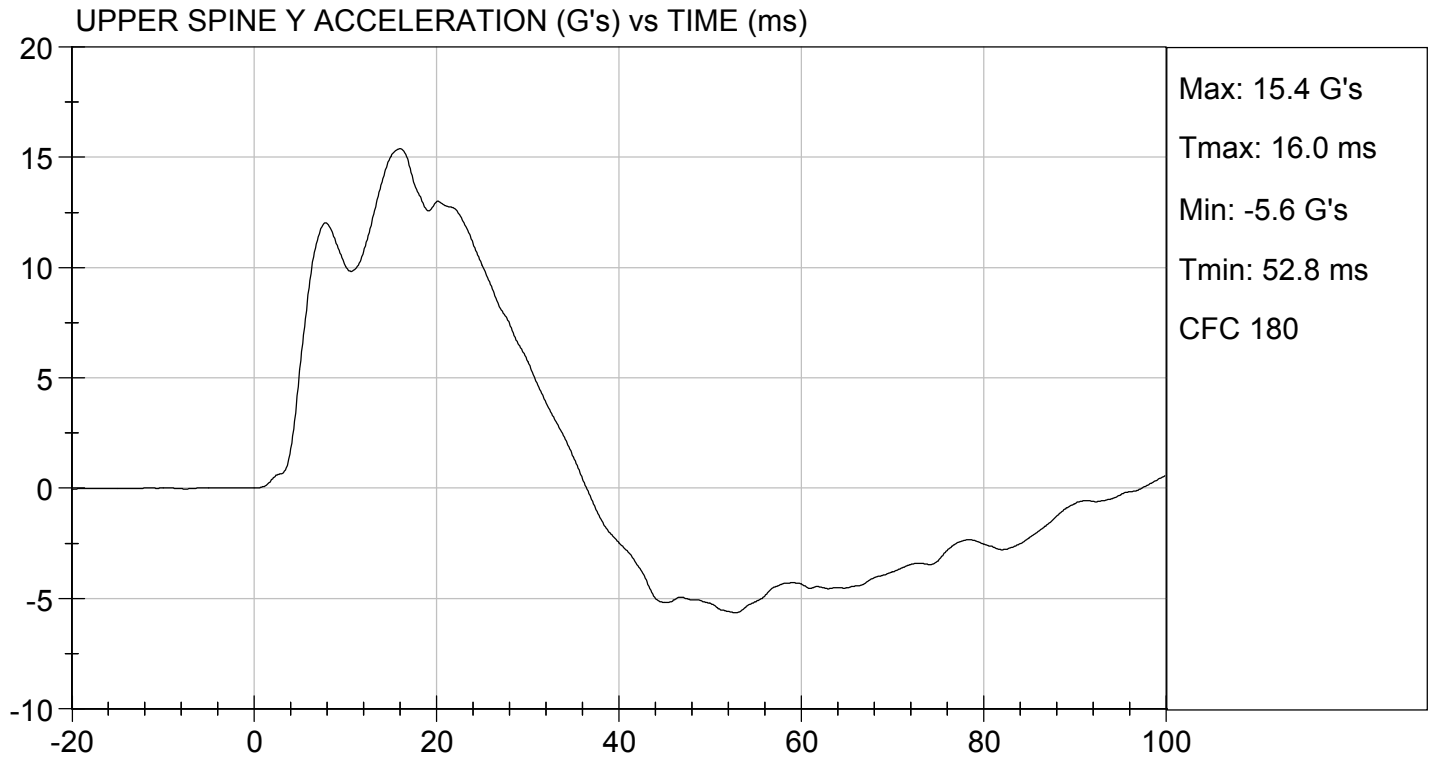

 Laboratory Technician

02/25/2020
 Test Date


 Approved By







**MGA RESEARCH CORPORATION
 ABDOMINAL IMPACT TEST
 SID-IIs BUILD LEVEL D DUMMY**

ATD Serial No: 306

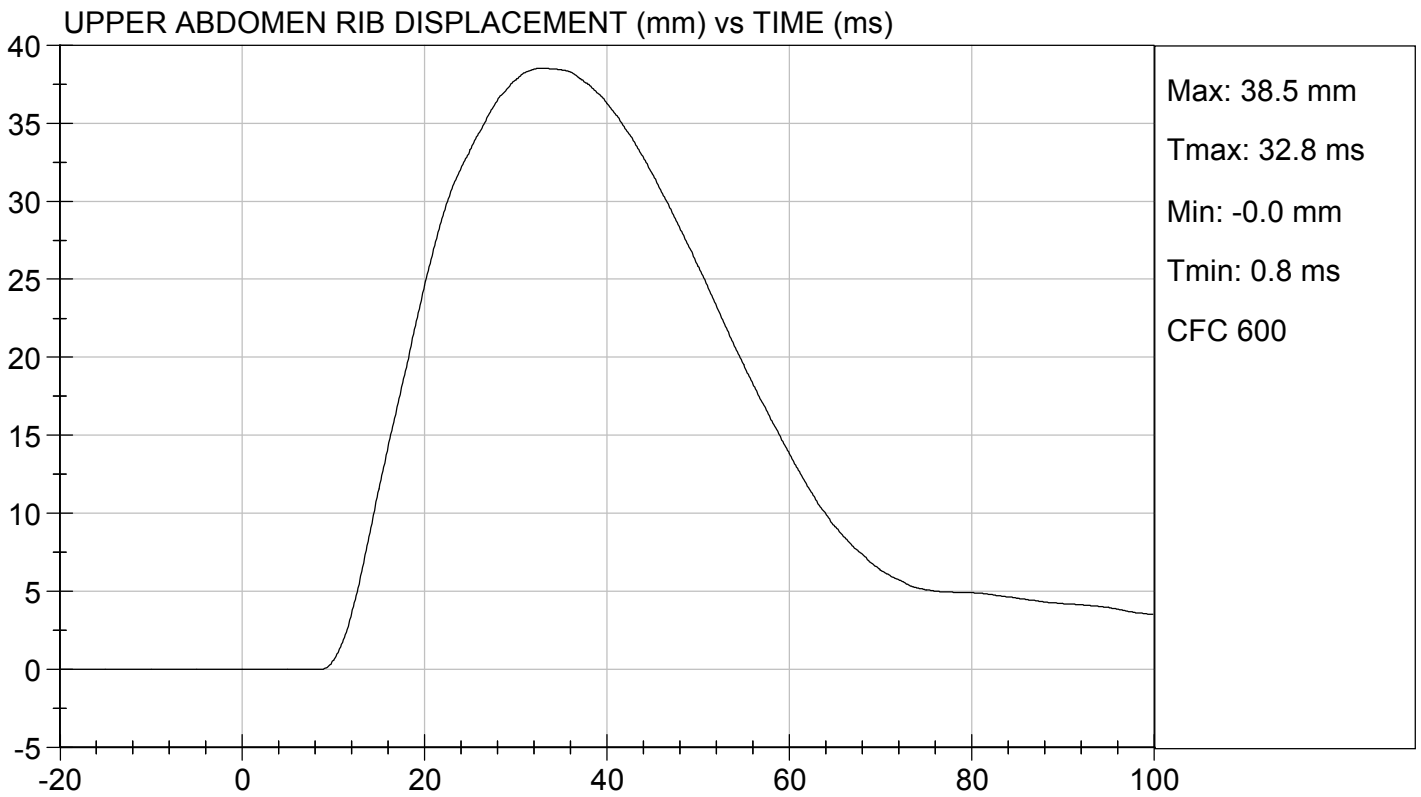
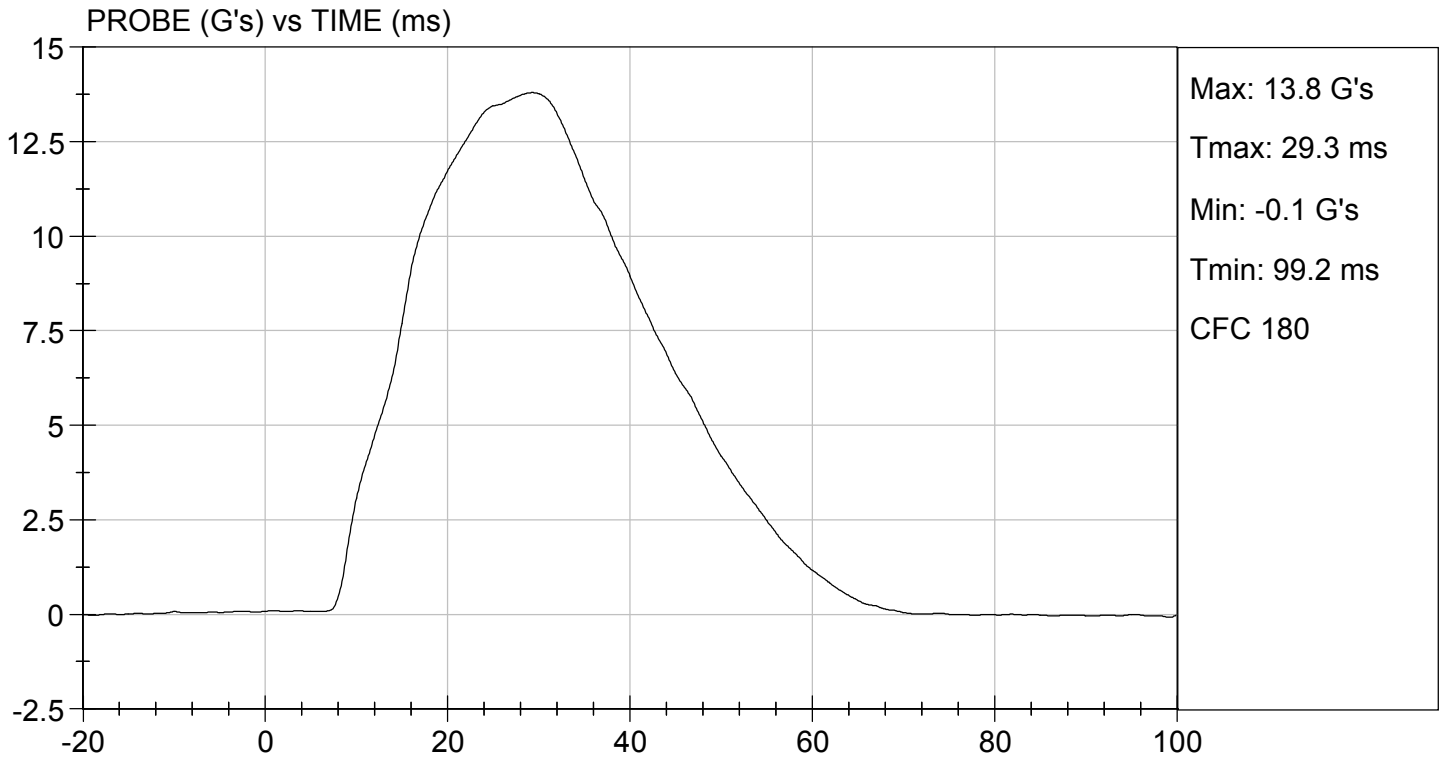
Test I.D: D200656

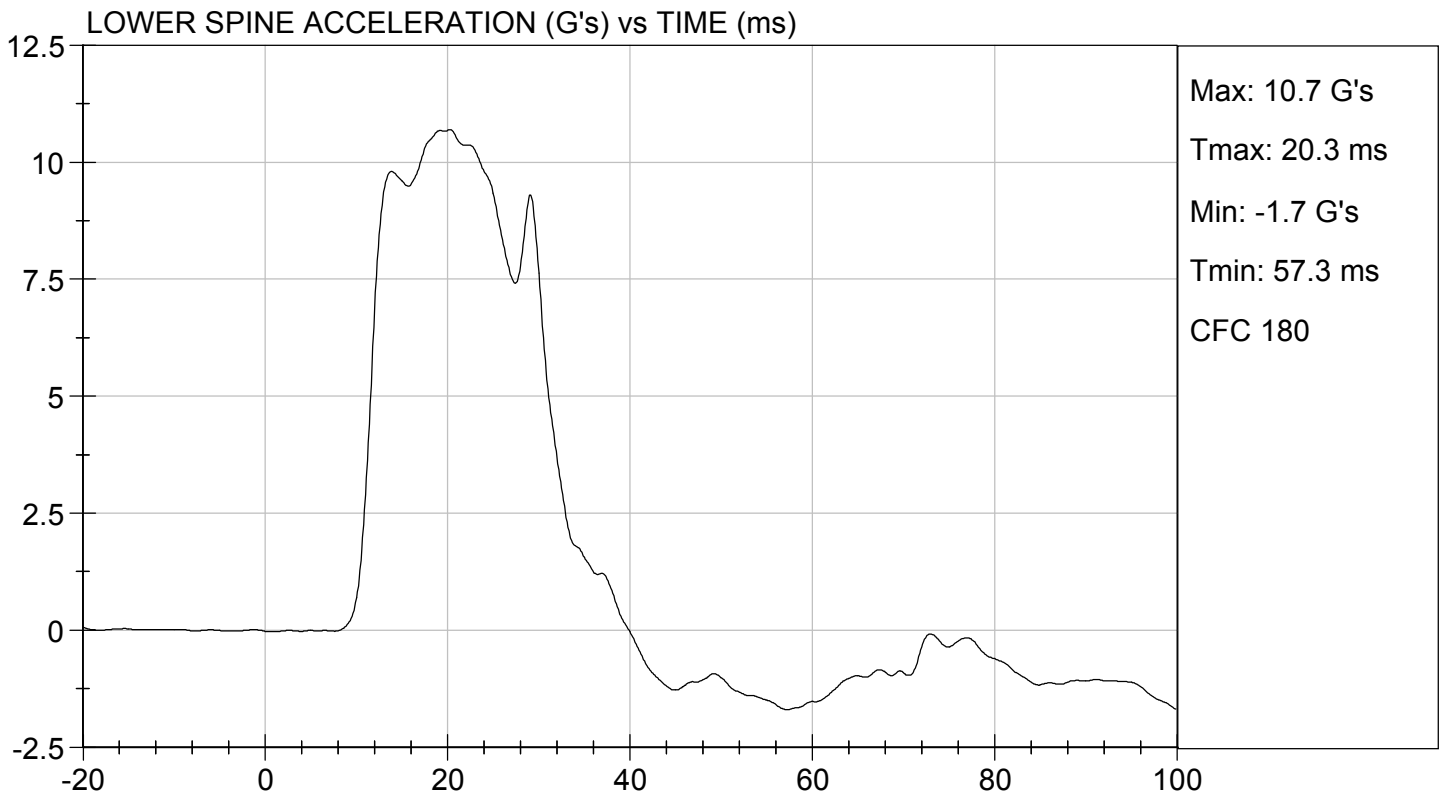
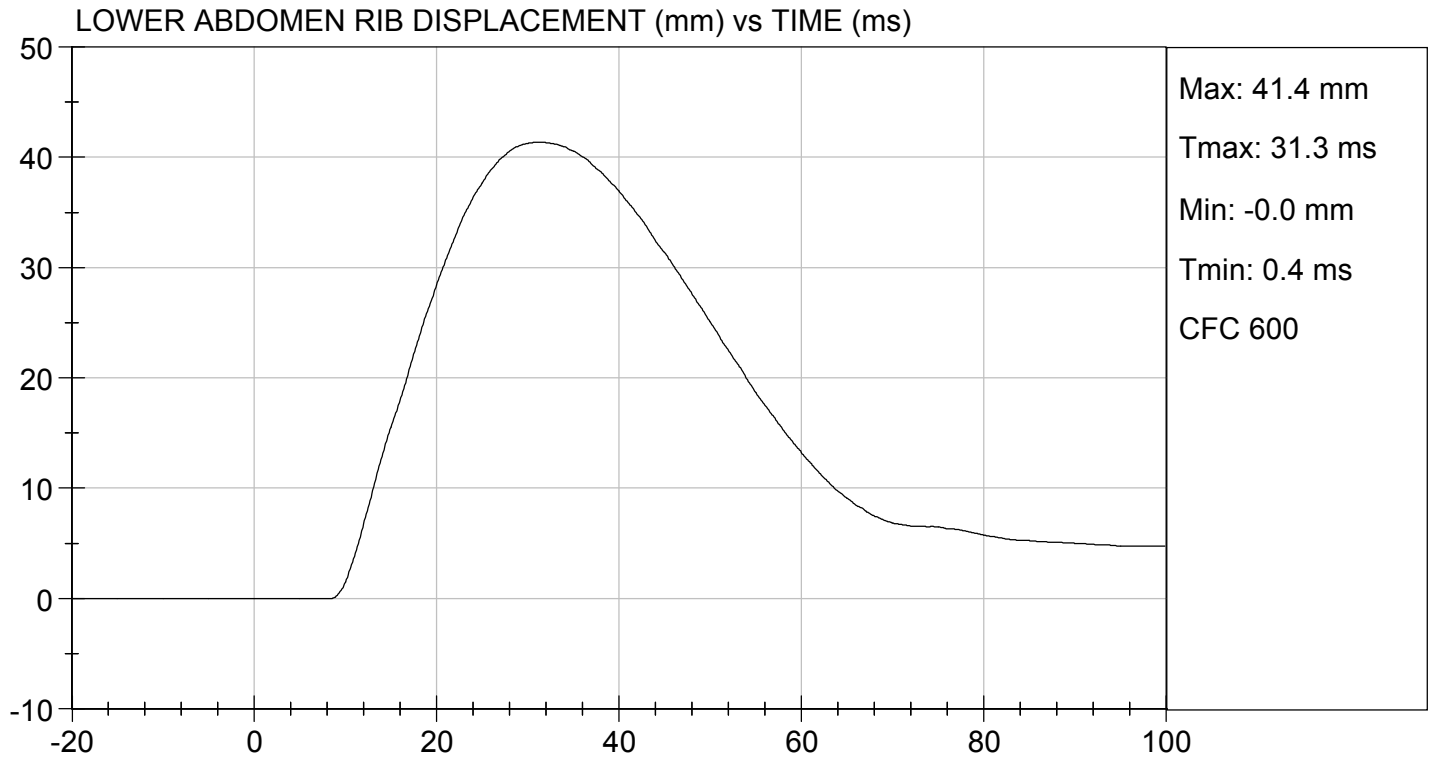
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.4 | Pass |
| Humidity | % | 10 to 70 | 22 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.34 | Pass |
| Maximum Probe Acceleration | G's | 12 to 16 | 14 | Pass |
| Upper Abdomen Rib Displacement | mm | 36 to 47 | 39 | Pass |
| Lower Abdomen Rib Displacement | mm | 33 to 44 | 41 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 9 to 14 | 11 | Pass |
| Overall Test Results | | | | Pass |

Alex Thomae
 Laboratory Technician

02/25/2020
 Test Date

B. Fink
 Approved By





MGA RESEARCH CORPORATION
PELVIS IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

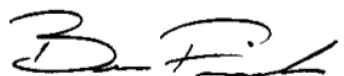
ATD Serial No: 306

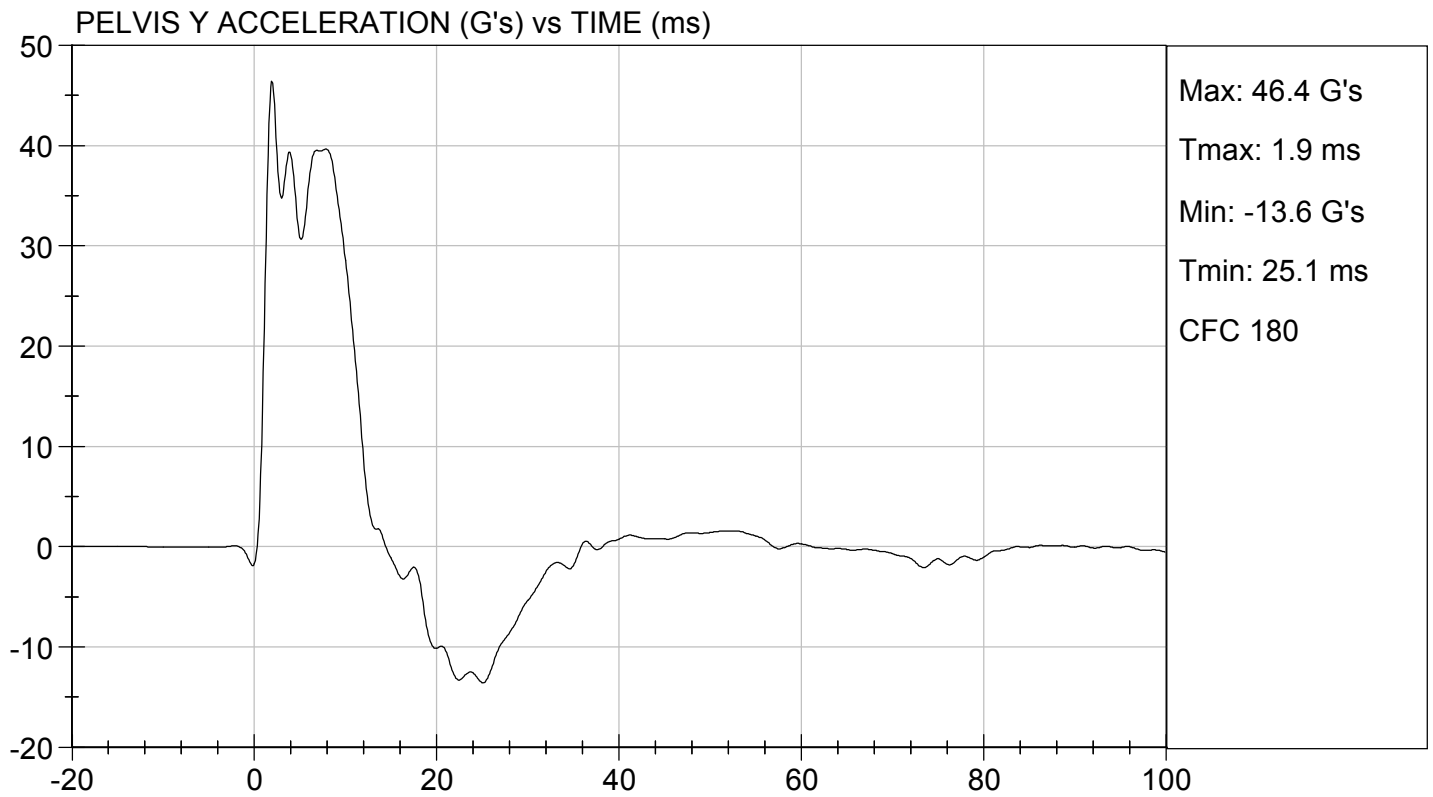
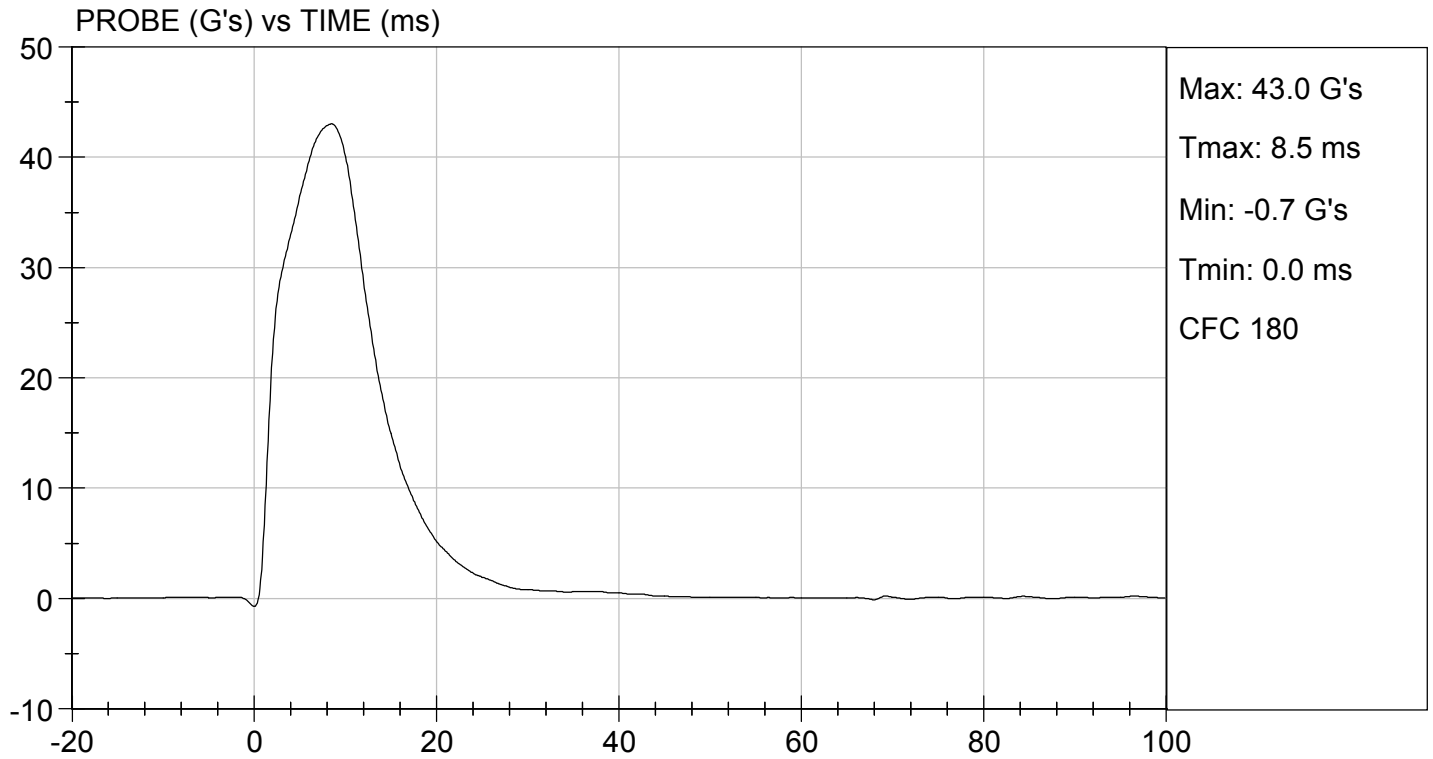
Test I.D: D200657

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Humidity | % | 10 to 70 | 20 | Pass |
| Impact Velocity | m/s | 6.60 to 6.80 | 6.60 | Pass |
| Maximum Probe Acceleration | G's | 38 to 47 | 43 | Pass |
| Pelvis Y Acceleration After 6 ms | G's | 34 to 42 | 40 | Pass |
| Peak Acetabulum Force | N | 3600 to 4300 | 3,900 | Pass |
| Overall Test Results | | | | Pass |


 Laboratory Technician

02/26/2020
 Test Date

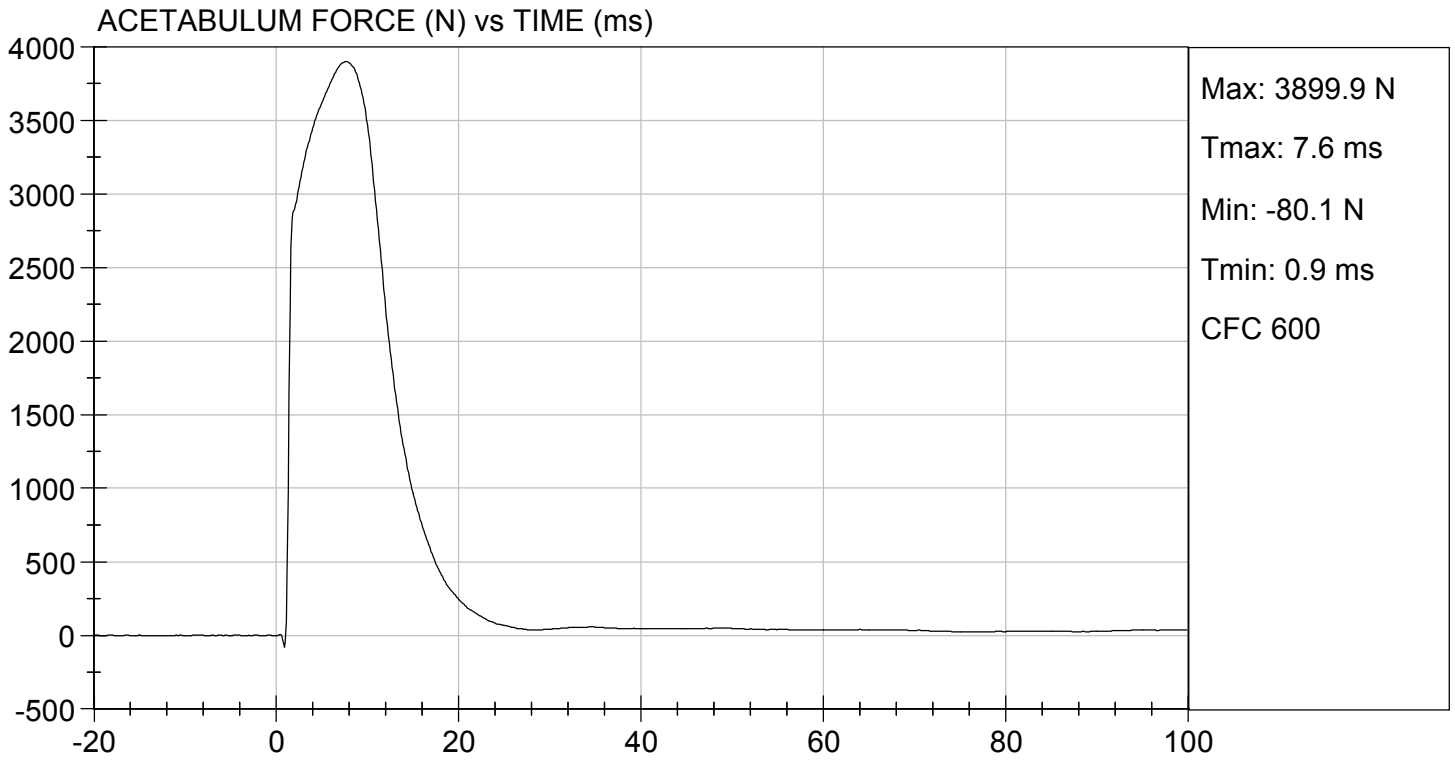

 Approved By





TEST DESC: PELVIS IMPACT
VELOCITY: 21.65 ft/s, 6.60 m/s

TEST DATE: 02/26/2020
TEST #: D200657




MGA RESEARCH CORPORATION
ILIAC IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 306

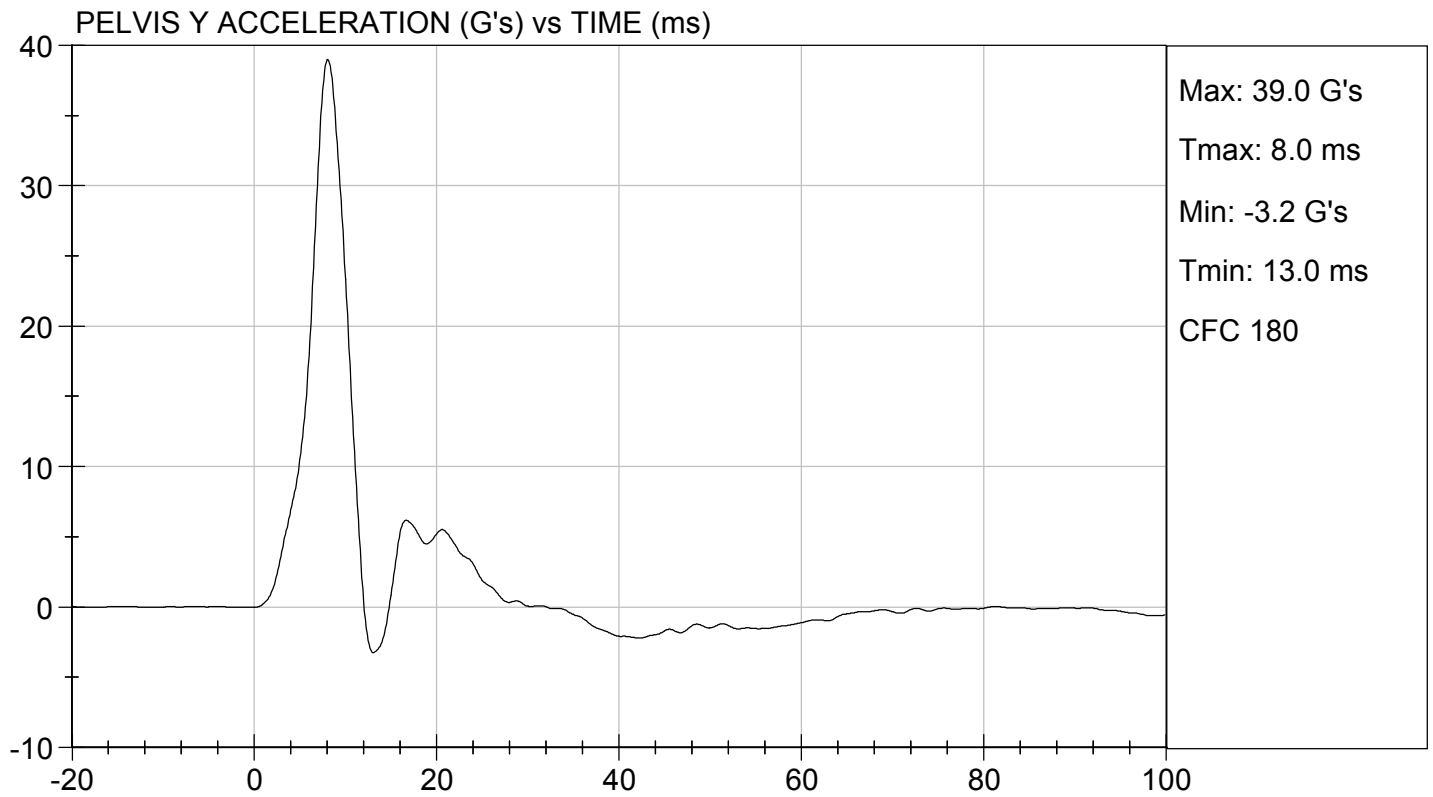
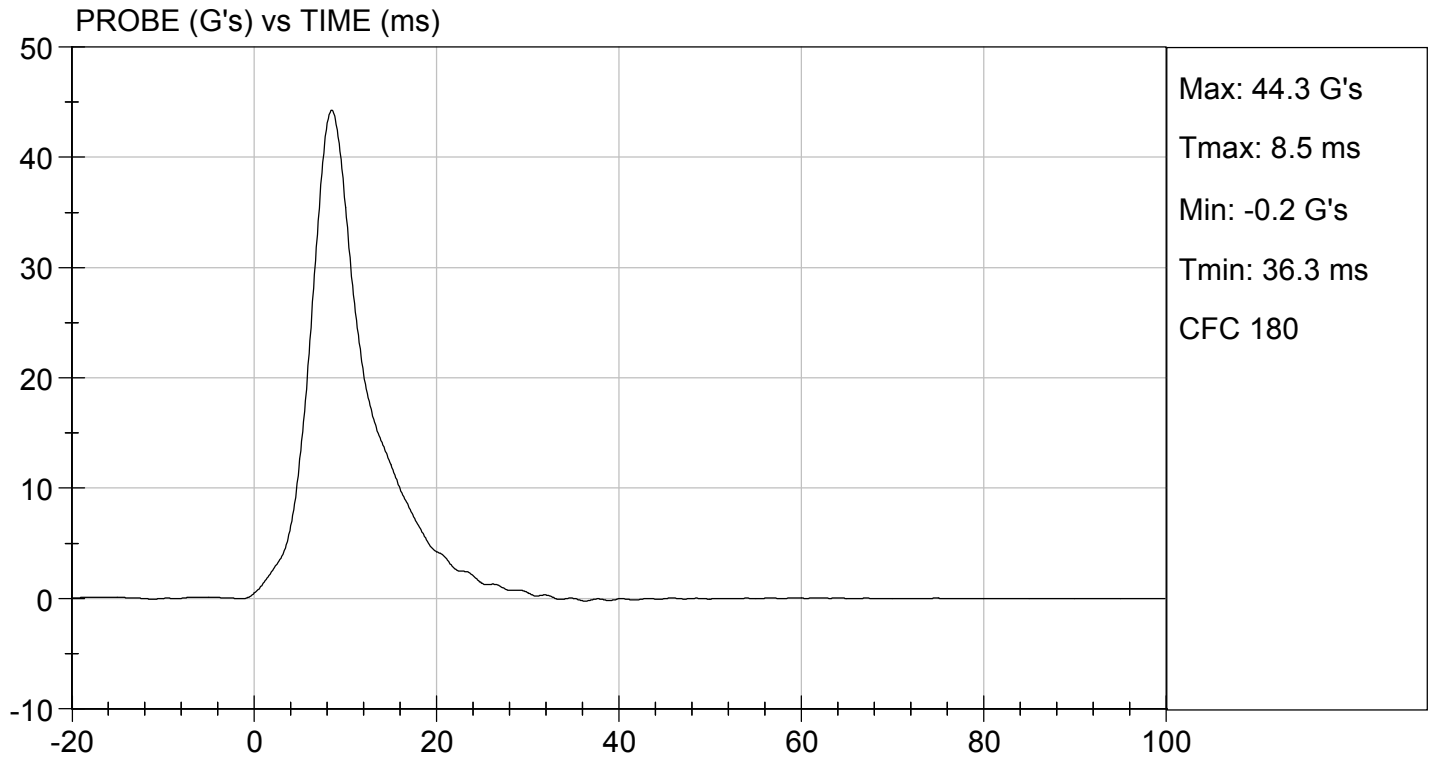
Test I.D: D200658

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------|-------|---------------|--------|-----------|
| Temperature | deg C | 20.6 to 22.2 | 21.5 | Pass |
| Humidity | % | 10 to 70 | 20 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.27 | Pass |
| Maximum Probe Acceleration | G's | 36 to 45 | 44 | Pass |
| Pelvis Y Acceleration | G's | 28 to 39 | 39 | Pass |
| Peak Pelvis Iliac Force | N | 4100 to 5100 | 5,078 | Pass |
| Overall Test Results | | | | Pass |


 Laboratory Technician

02/26/2020
 Test Date

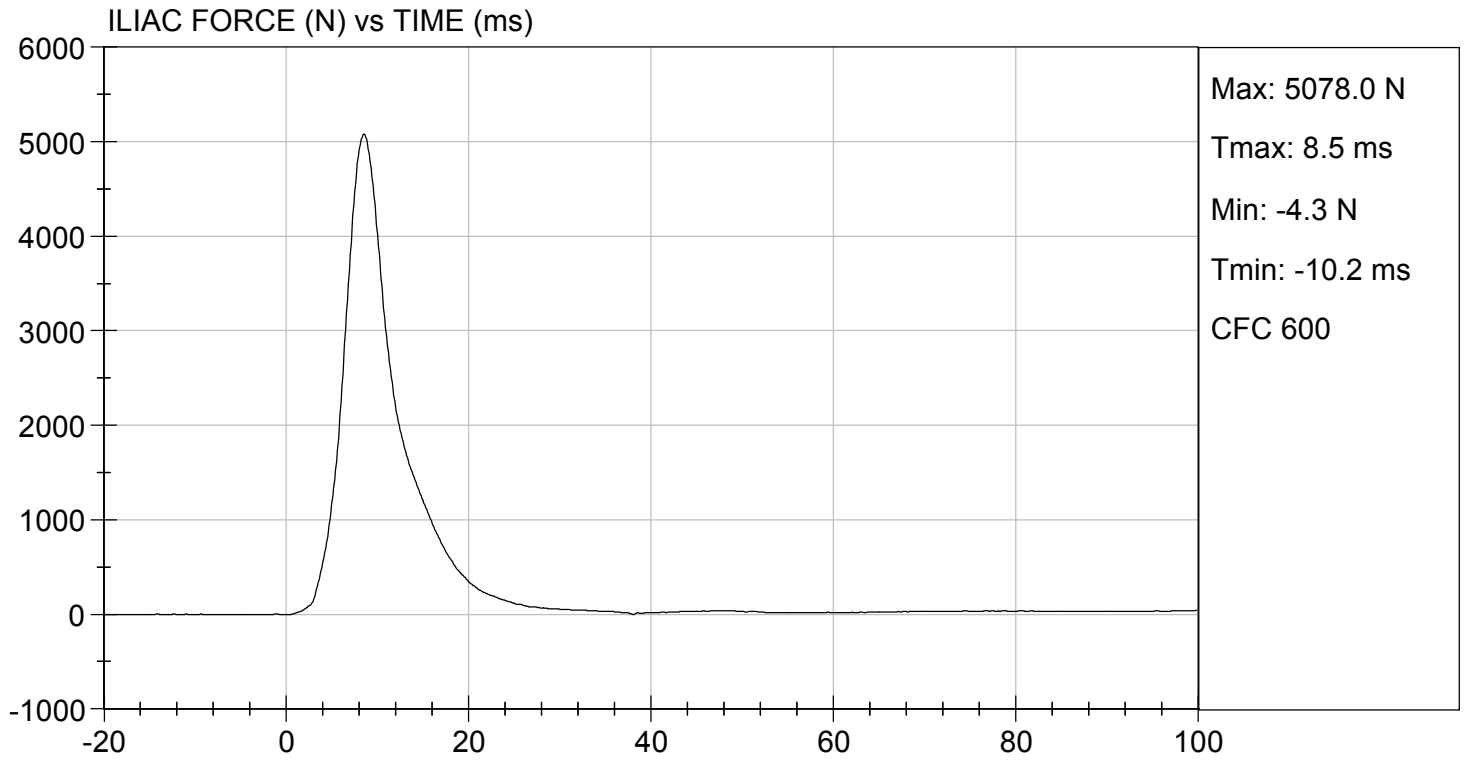

 Approved By





TEST DESC: ILLIAC
VELOCITY: 14.01 ft/s, 4.27 m/s

TEST DATE: 02/26/2020
TEST #: D200658



CALIBRATION TEST RESULTS

POST-TEST

SID-IIS 5TH PERCENTILE FEMALE - DRIVER ATD

SID-IIsD External Measurements
SN: 306

| No. | Name | Spec. (mm) | Result | Pass/Fail |
|------------|-------------------------------|-------------------|---------------|------------------|
| A | Sitting Height | 772 - 788 | 785 | Pass |
| B | Shoulder Pivot Height | 437 - 453 | 449 | Pass |
| C | H-point Height | 79 - 89 | 86 | Pass |
| D | H-point from Seatback | 141 - 151 | 147 | Pass |
| E | Shoulder Pivot from Backline | 97 - 107 | 99 | Pass |
| F | Thigh Clearance | 119 -135 | 120 | Pass |
| G | Head Breadth | 140 - 148 | 141 | Pass |
| H | Head Back from Backline | 40 - 46 | 45 | Pass |
| I | Head Depth | 178 - 188 | 182 | Pass |
| J | Head Circumference | 541 - 551 | 550 | Pass |
| K | Buttock to Knee Length | 514 - 540 | 538 | Pass |
| L | Popliteal Height | 343 - 369 | 349 | Pass |
| M | Knee Pivot to Floor Height | 392 - 409 | 394 | Pass |
| N | Buttock Popliteal Length | 416 - 442 | 435 | Pass |
| O | Chest Depth w/o Jacket | 195 - 211 | 198 | Pass |
| P | Foot Length | 216 - 232 | 222 | Pass |
| Q | Hip Breadth (w/ pelvic plugs) | 313 - 323 | 317 | Pass |
| R | Arm Length | 249 - 259 | 250 | Pass |
| S | Knee Joint to Seatback | 477 - 493 | 483 | Pass |
| V | Shoulder Width | 341 - 357 | 351 | Pass |
| W | Foot Width | 78 - 94 | 82 | Pass |
| Y | Chest Circumference w/ jacket | 851 - 881 | 863 | Pass |
| Z | Waist Circumference | 761 - 791 | 782 | Pass |

MGA RESEARCH CORPORATION
HEAD DROP TEST
SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 306

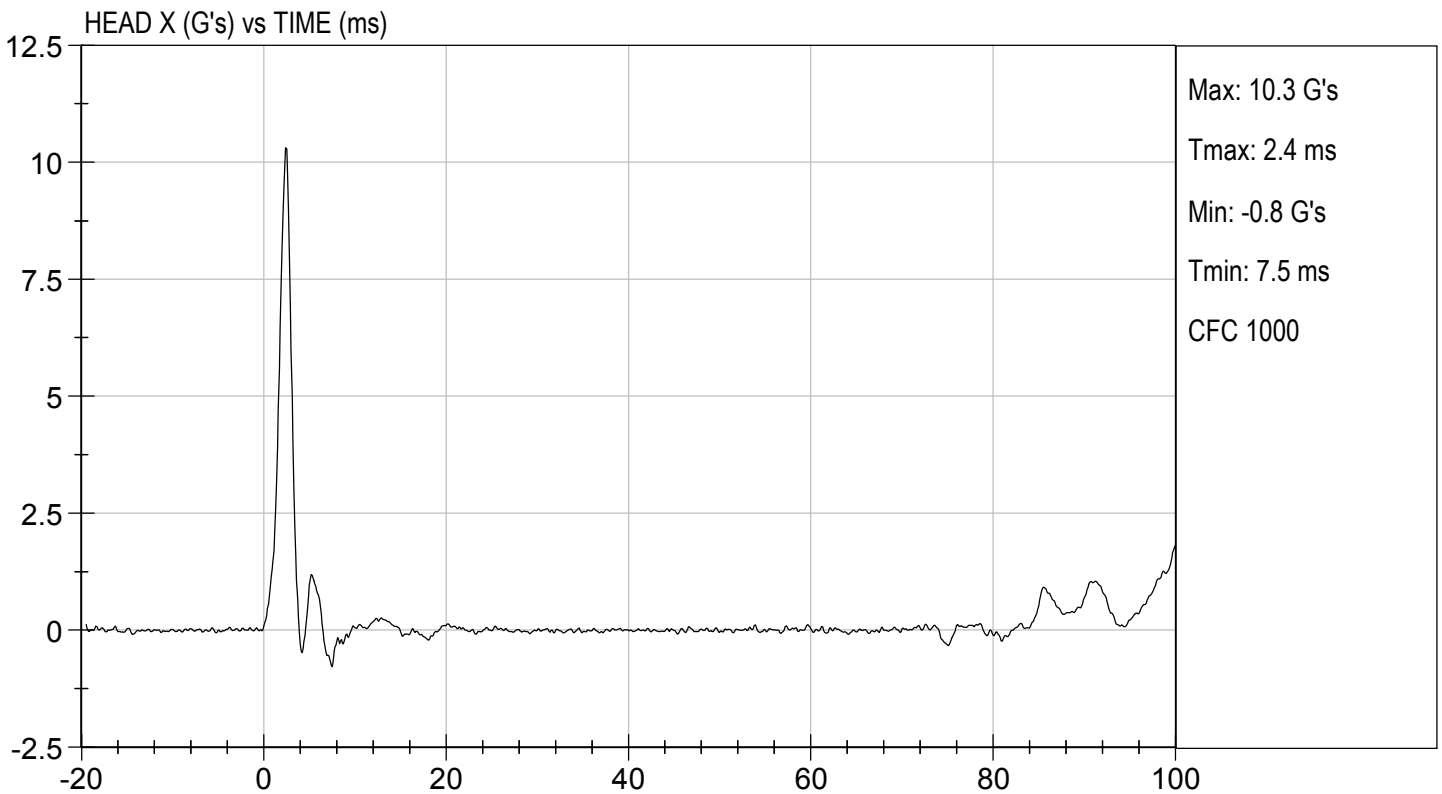
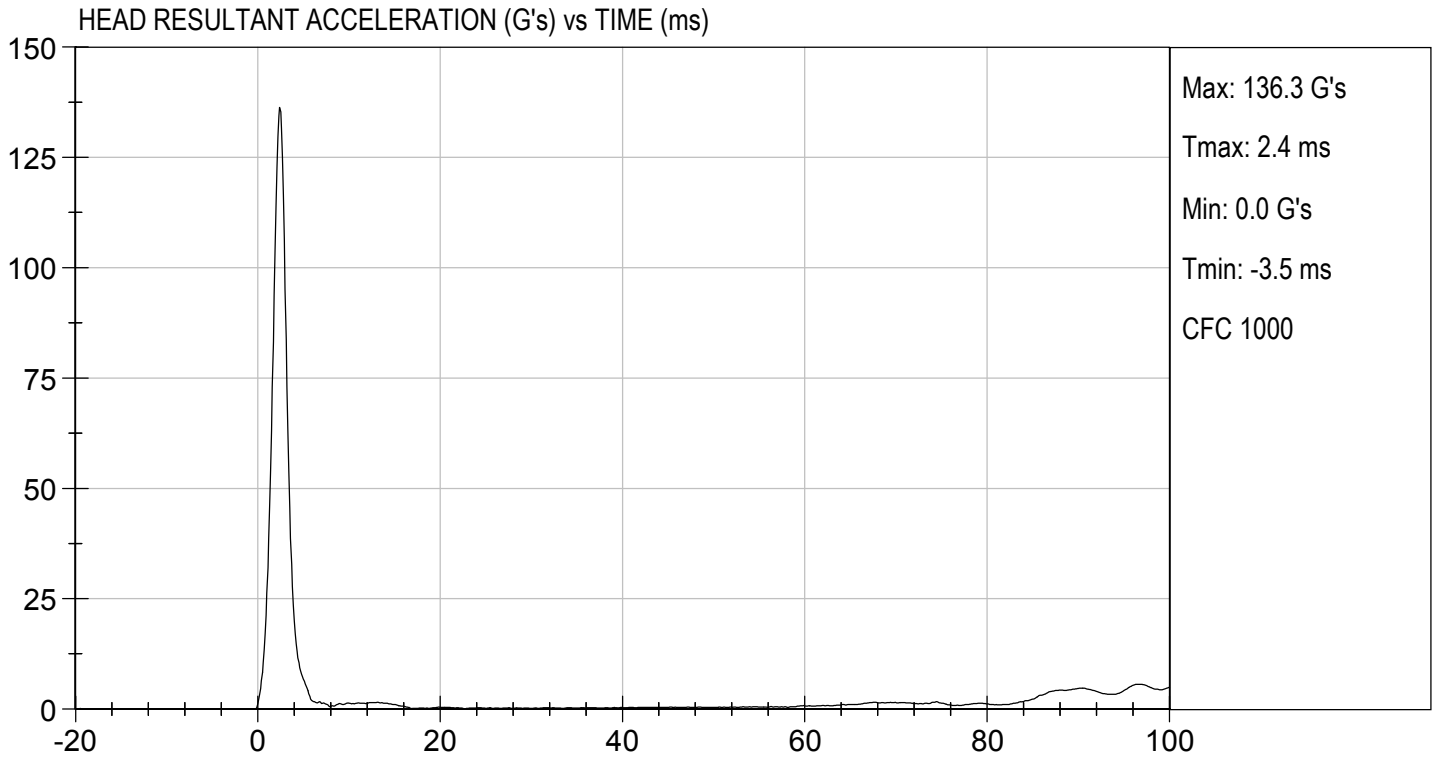
Test ID: D201031

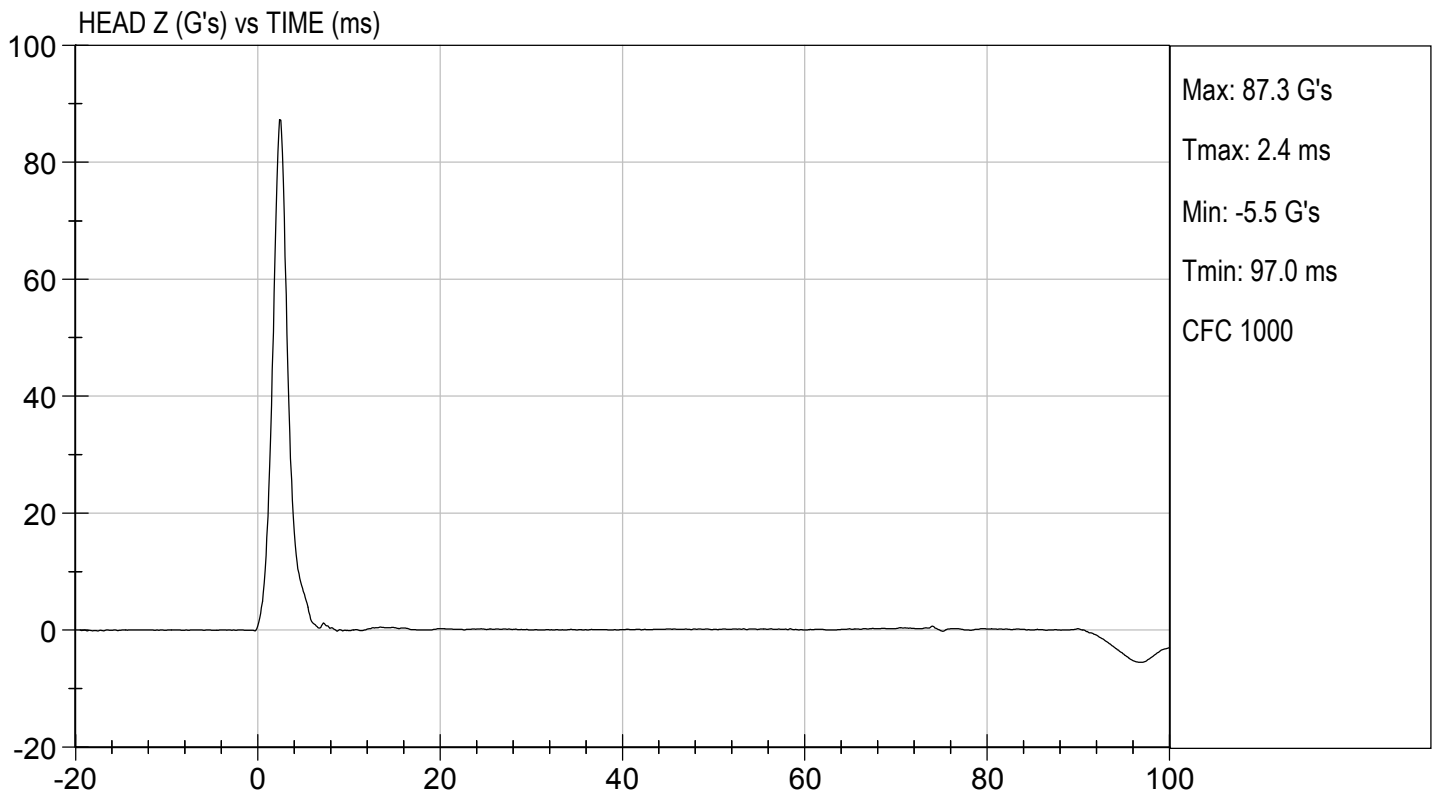
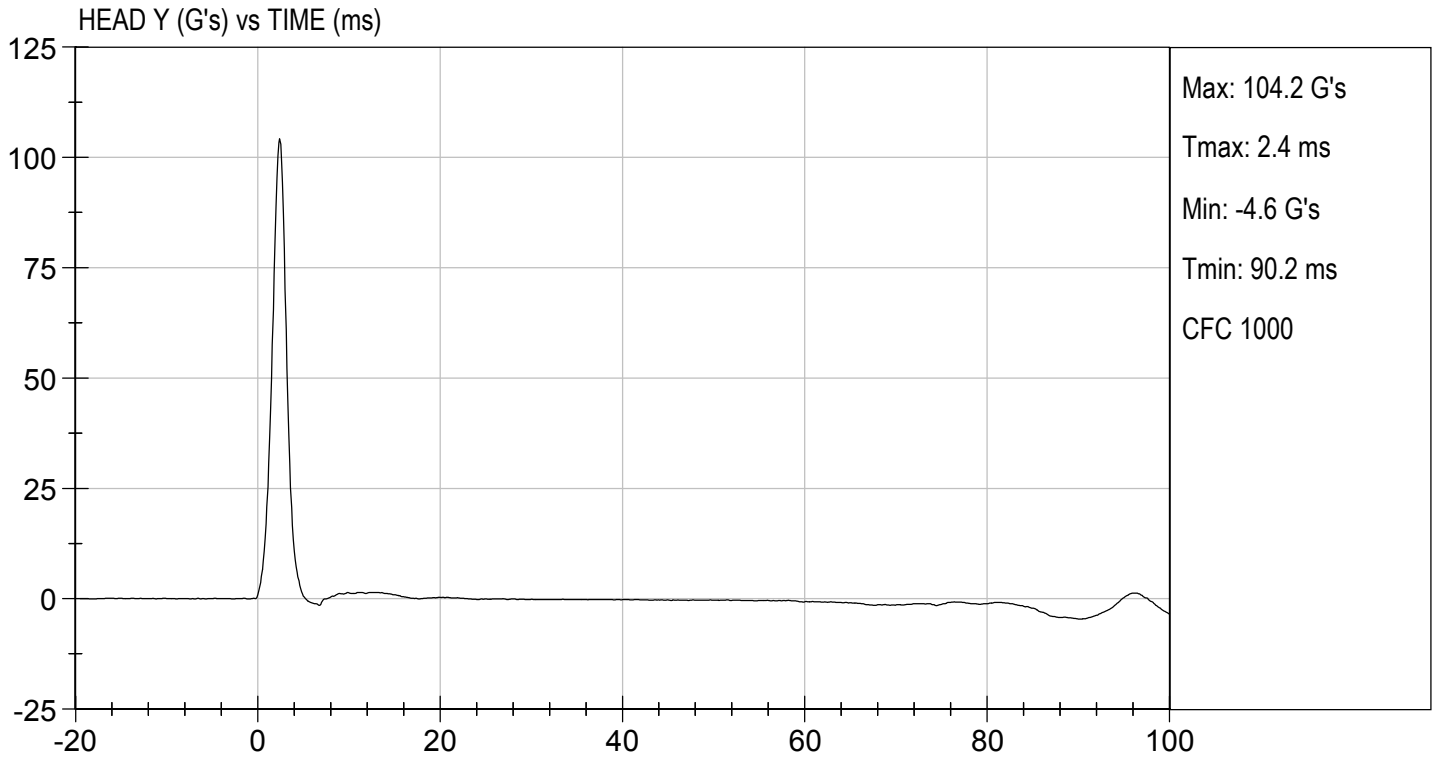
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|--------------------------------|-------|---------------|--------|-----------|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 31 | Pass |
| Peak Resultant Acceleration | G's | 115 to 137 | 136 | Pass |
| Peak Longitudinal Acceleration | G's | +/- 15 | 10.3 | Pass |
| Unimodal | N/A | Yes | Yes | Pass |
| Oscillations | N/A | <15% | Yes | Pass |
| Overall Test Results | | | | Pass |


 Laboratory Technician

03/19/2020
 Test Date


 Approved By






**MGA RESEARCH CORPORATION
LATERAL NECK PENDULUM TEST
SID-IIs BUILD LEVEL D DUMMY**

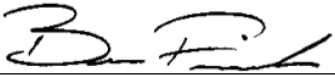
ATD Serial No: 306

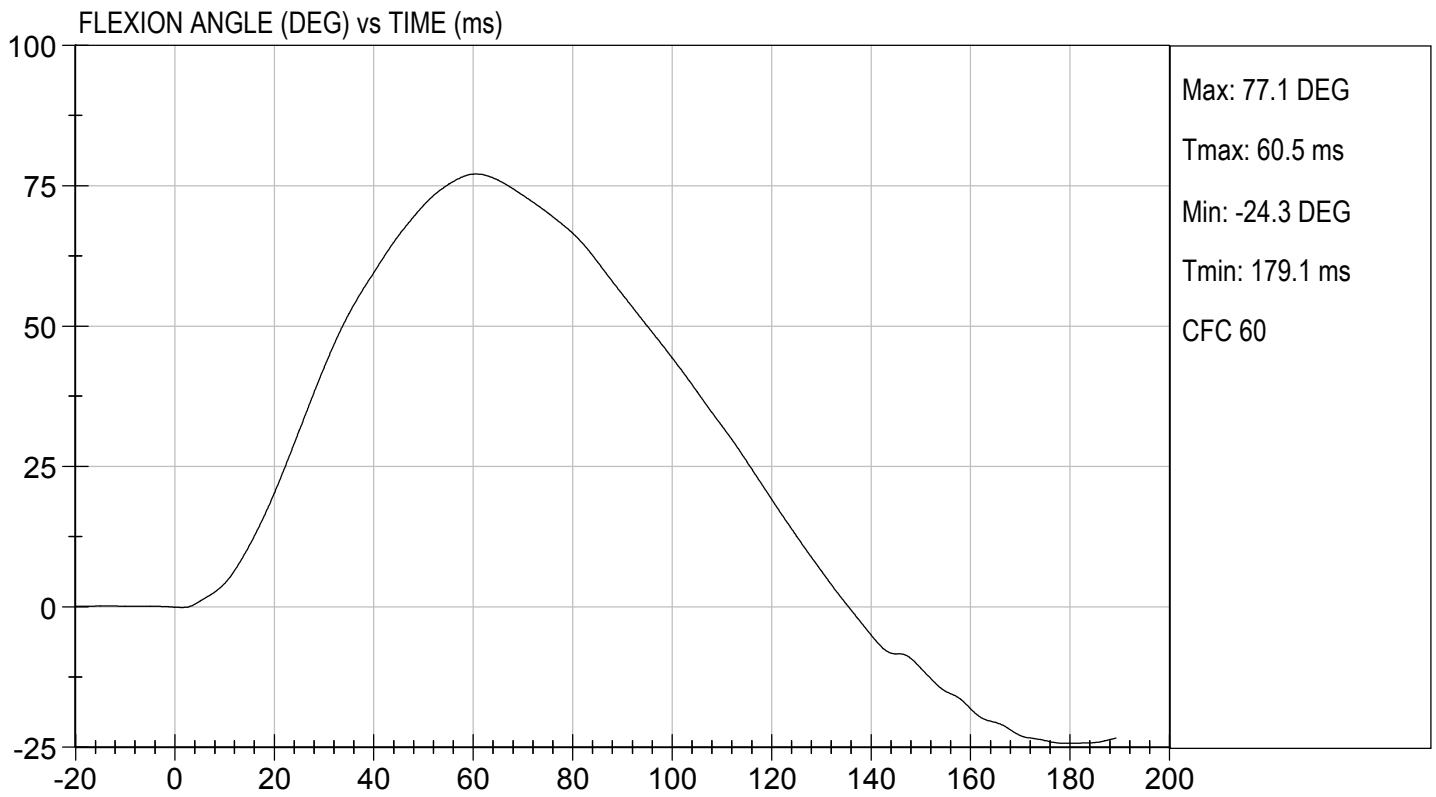
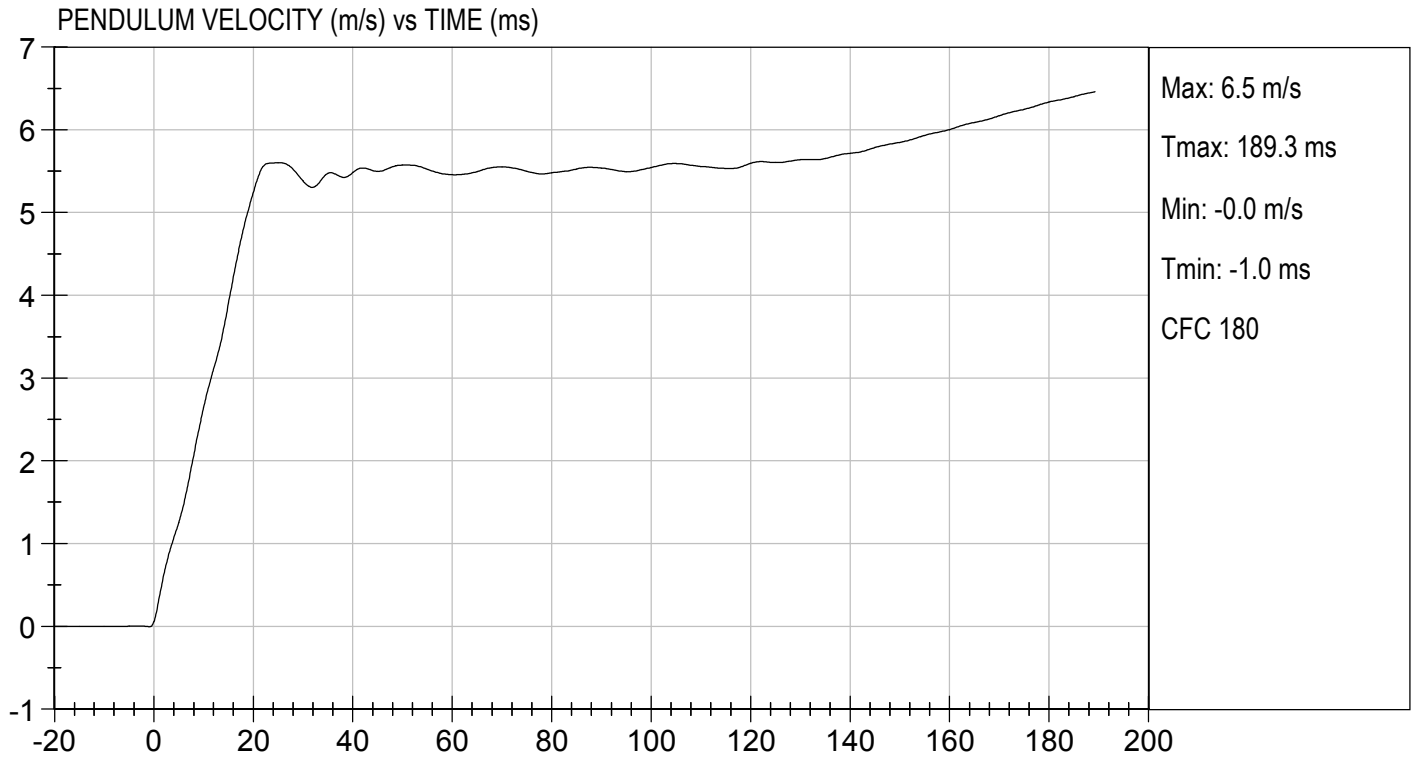
Test I.D.: D201032

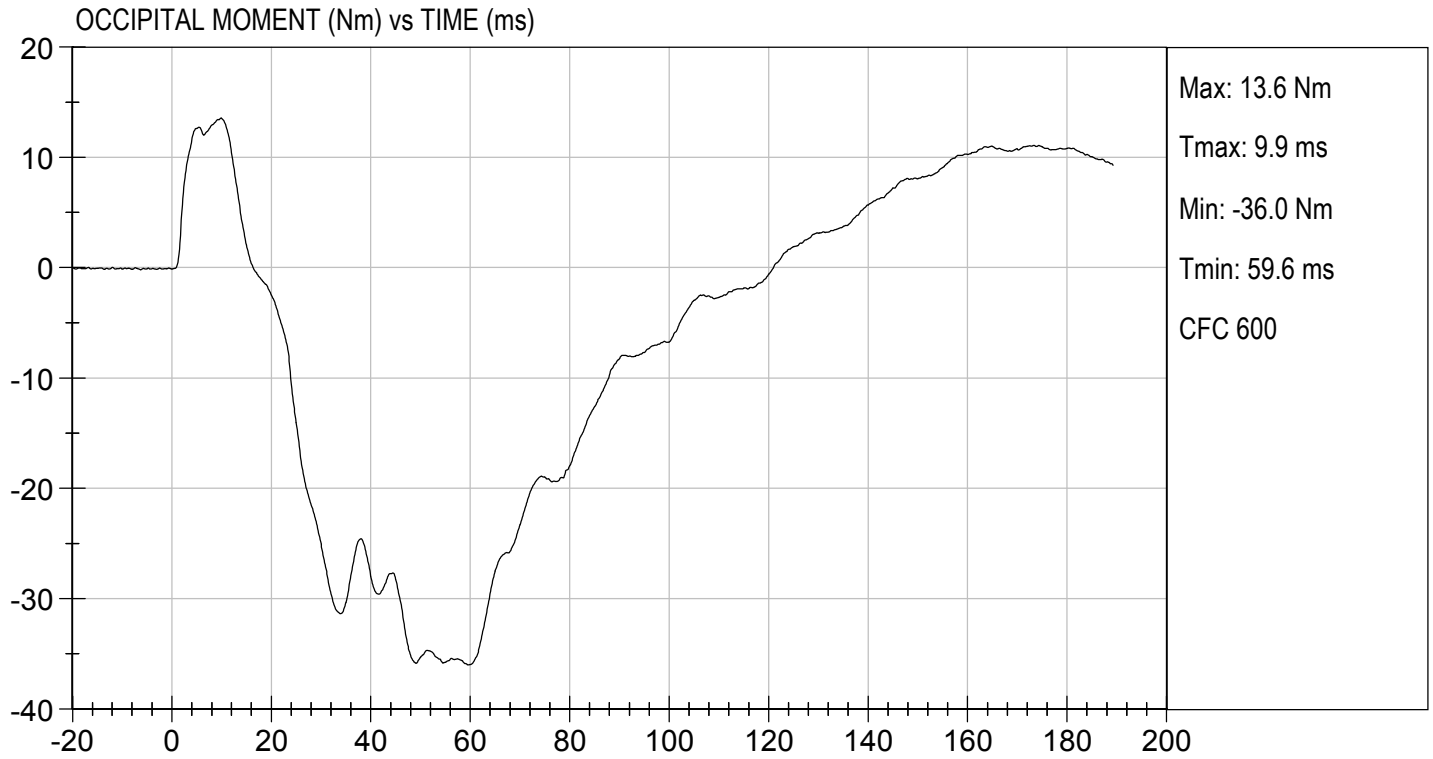
| Tested Parameter | Units | Specification | Result | Pass/Fail | |
|----------------------------------|-----------|---------------|--------------|-------------|------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass | |
| Humidity | % | 10 to 70 | 31 | Pass | |
| Impact Velocity | m/s | 5.51 to 5.63 | 5.52 | Pass | |
| Pendulum Velocity | 10 ms | m/s | 2.20 to 2.80 | 2.64 | Pass |
| | 15 ms | m/s | 3.30 to 4.10 | 3.91 | Pass |
| | 20 ms | m/s | 4.40 to 5.40 | 5.24 | Pass |
| | 25 ms | m/s | 5.40 to 6.10 | 5.60 | Pass |
| | 25-100 ms | m/s | 5.50 to 6.20 | 5.60 | Pass |
| Maximum D-Plane Rotation | deg | 71 to 81 | 77 | Pass | |
| Time of Maximum D-Plane Rotation | ms | 50 to 70 | 61 | Pass | |
| Maximum Occipital Condyle Moment | Nm | -44 to -36 | -36 | Pass | |
| Time of Moment Decay to 0 Nm | ms | 102 to 126 | 121 | Pass | |
| Overall Test Results | | | | Pass | |


Laboratory Technician

03/20/2020
Test Date


Approved By





**MGA RESEARCH CORPORATION
SHOULDER IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY**

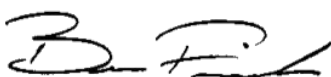
ATD Serial No: 306

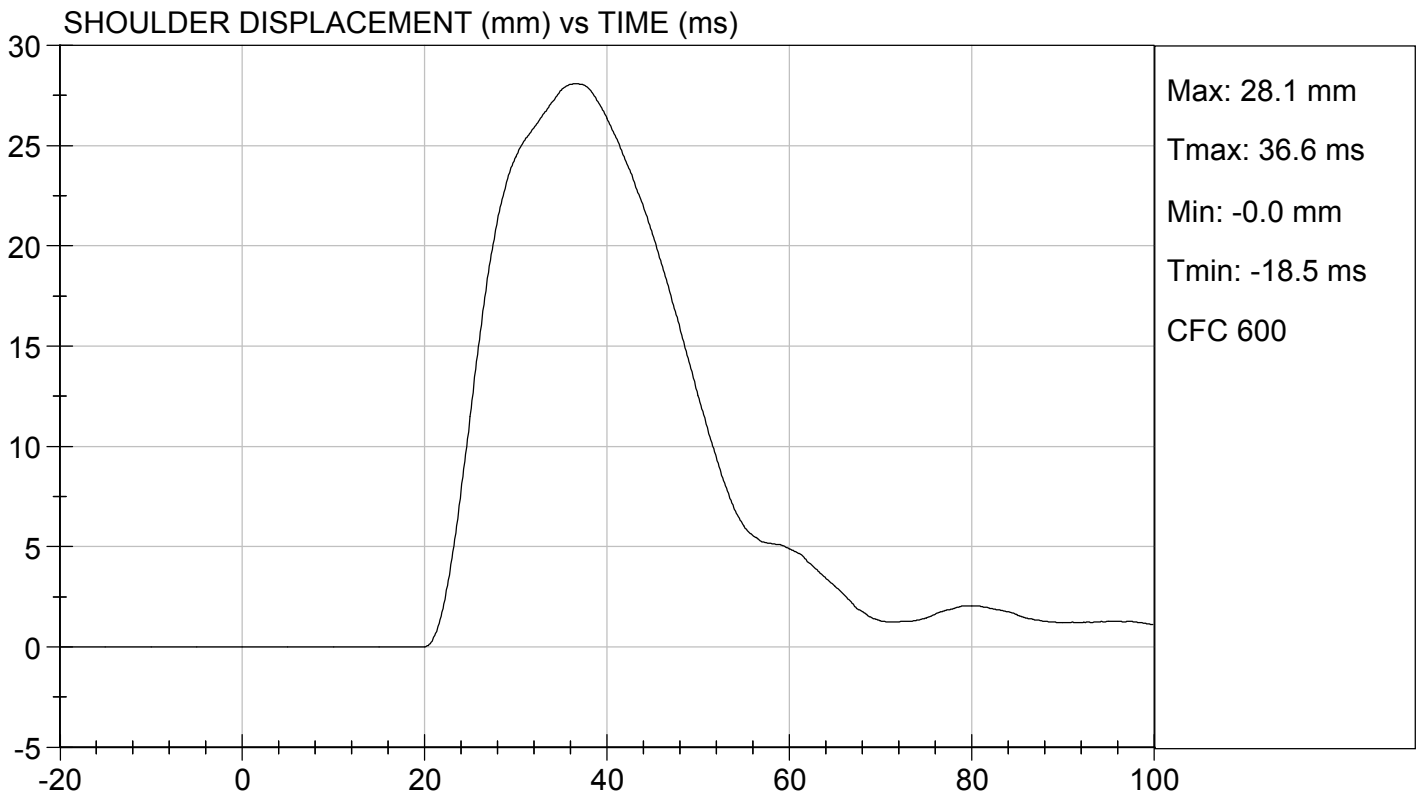
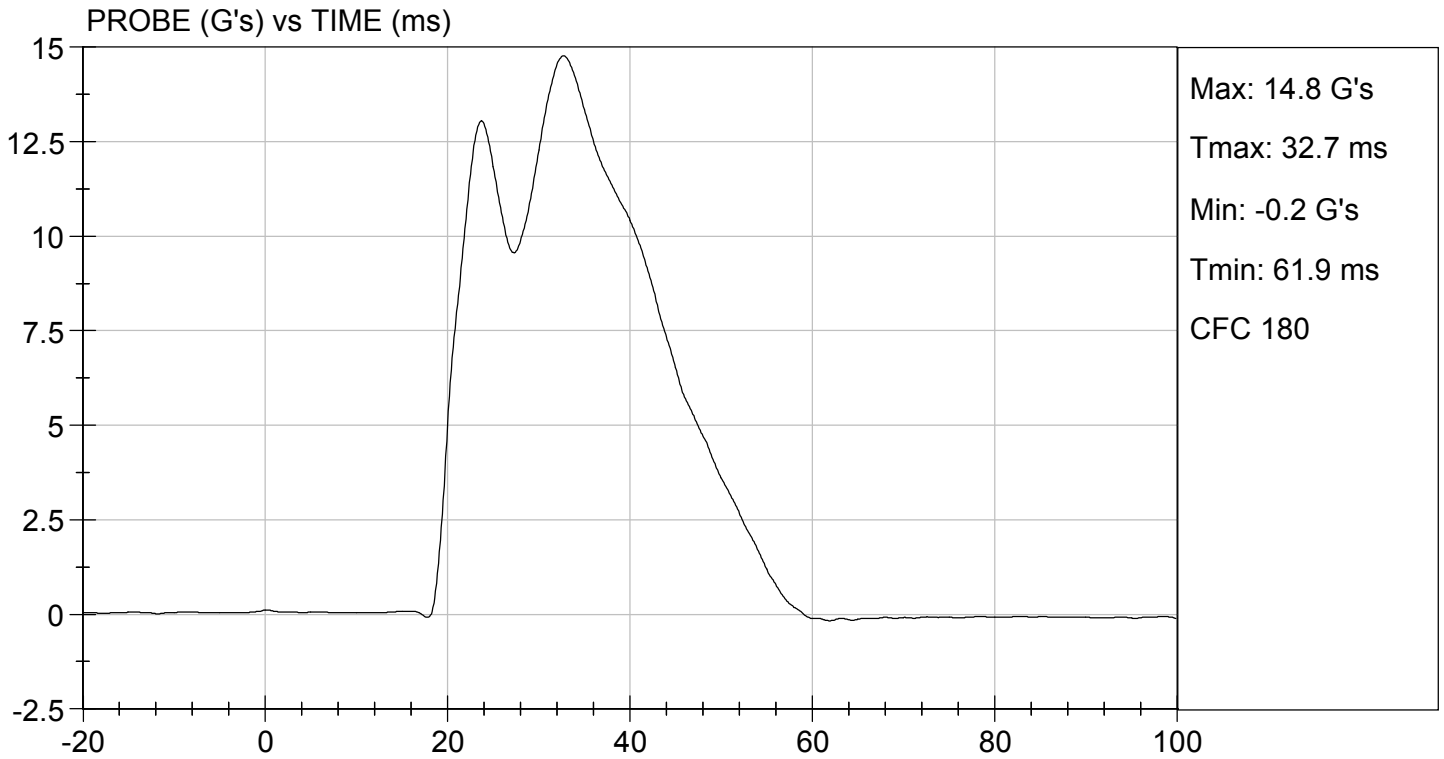
Test ID: D201033

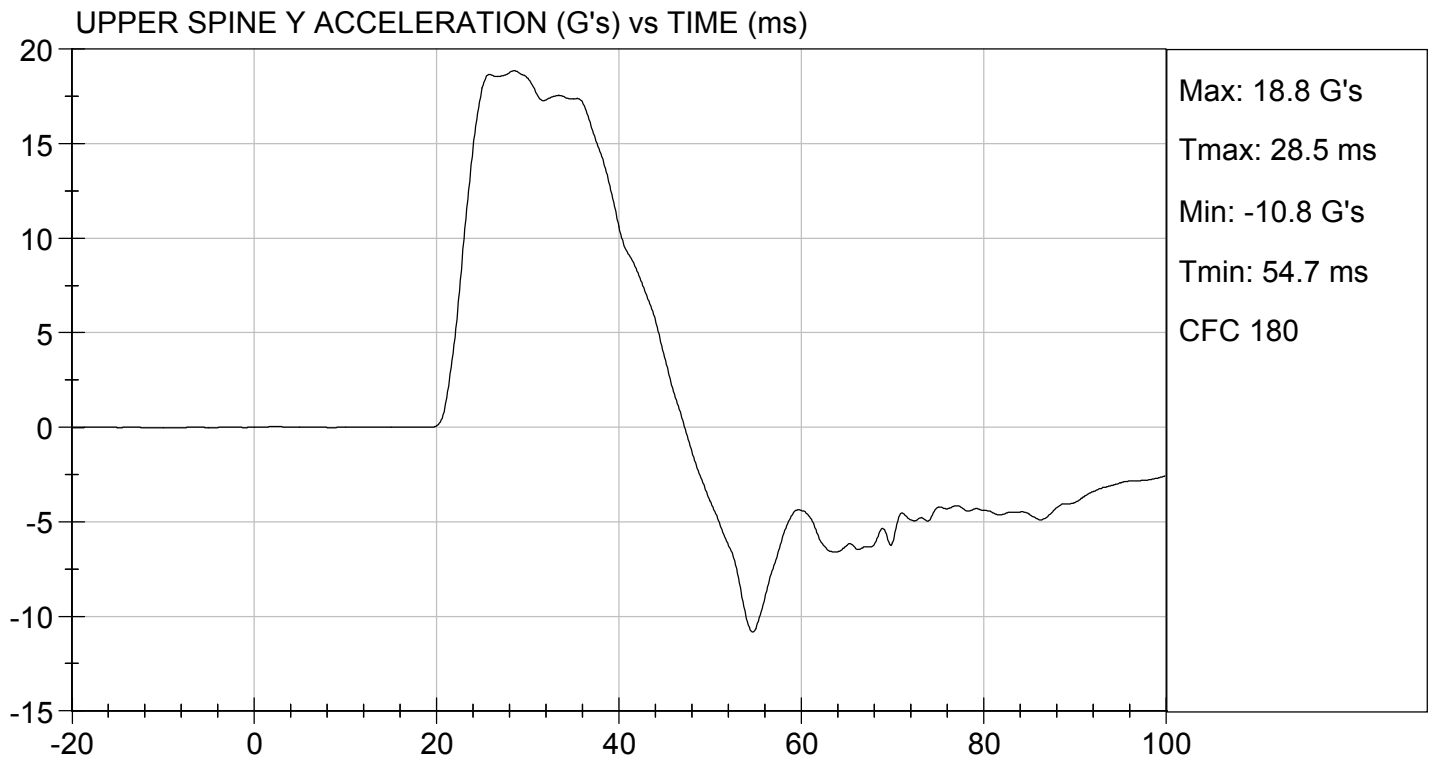
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|---------------------------------|-------|---------------|--------|-----------|
| Laboratory Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Laboratory Relative Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.27 | Pass |
| Maximum Probe Acceleration | G's | 13 to 18 | 15 | Pass |
| Shoulder Displacement | mm | 28 to 37 | 28 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 17 to 22 | 19 | Pass |
| Overall Test Results | | | | Pass |


Laboratory Technician

03/19/2020
Test Date


Approved By






**MGA RESEARCH CORPORATION
THORAX (WITH ARM) IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY**

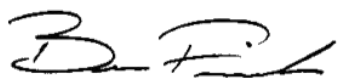
ATD Serial No: 306

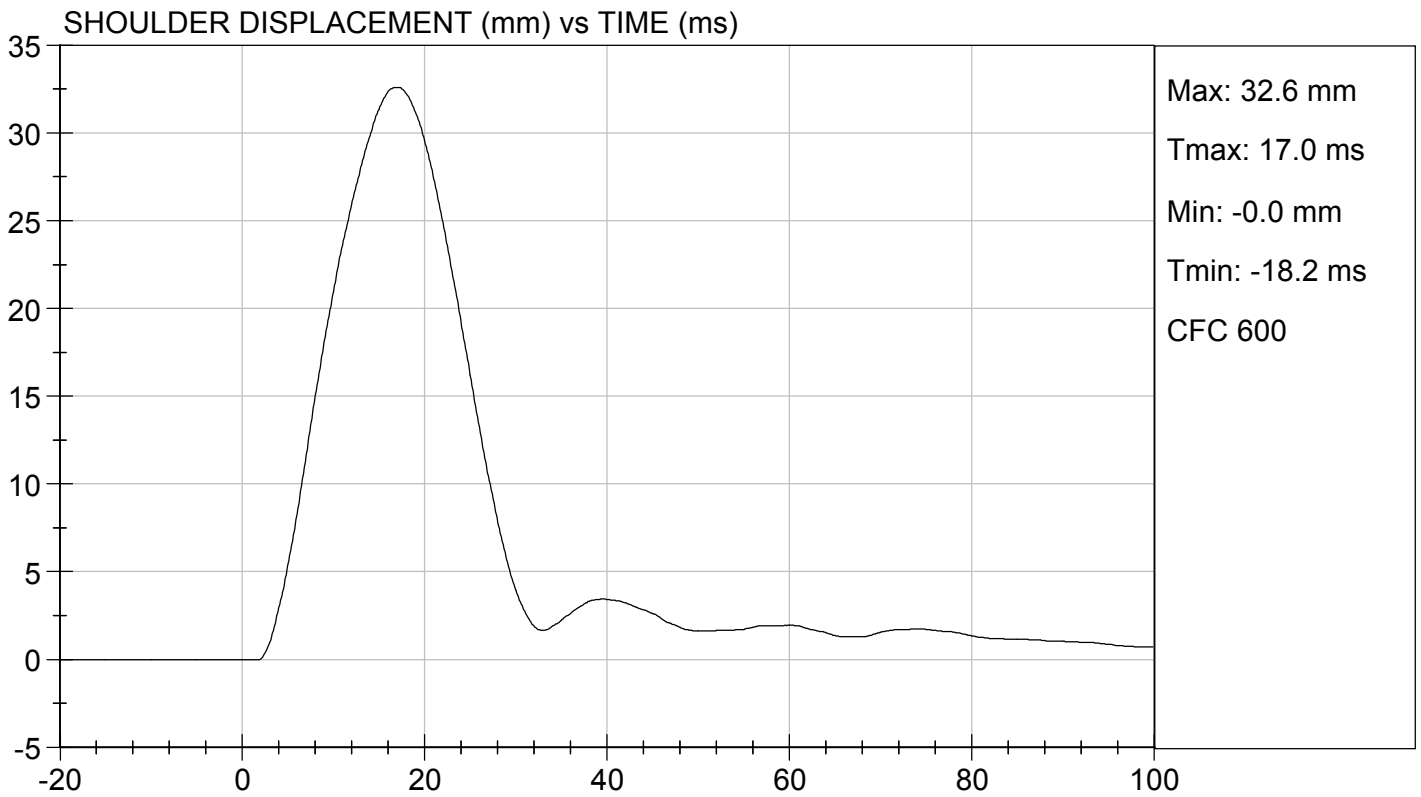
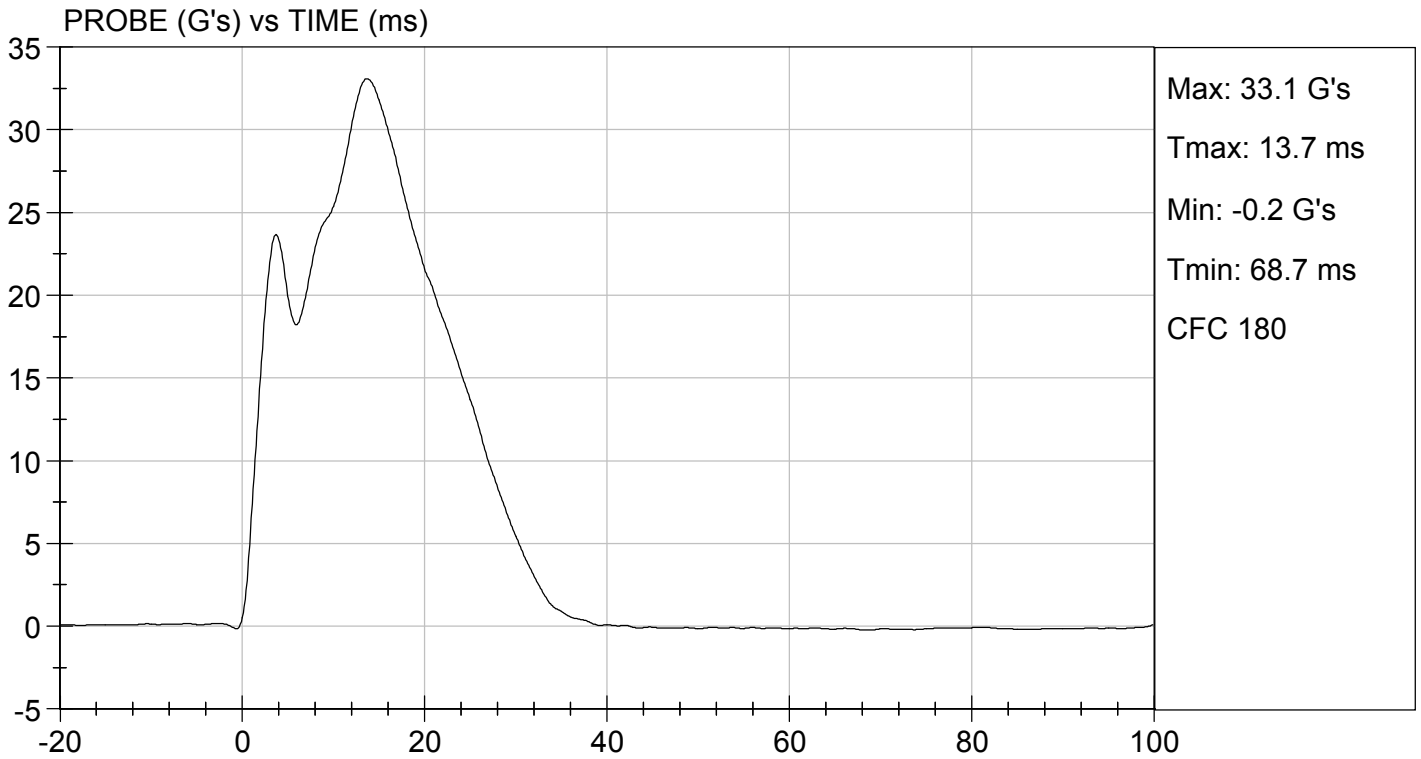
Test I.D: D201034

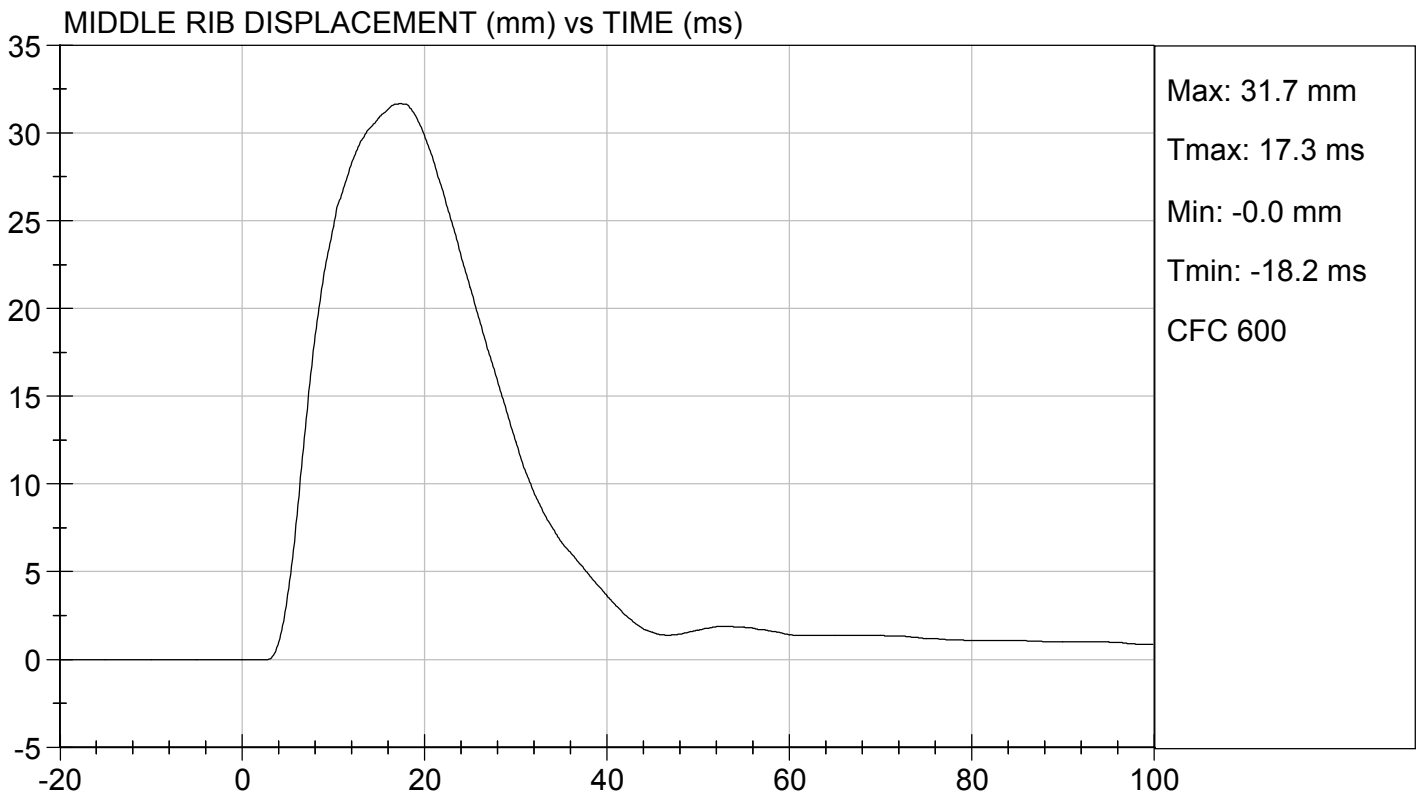
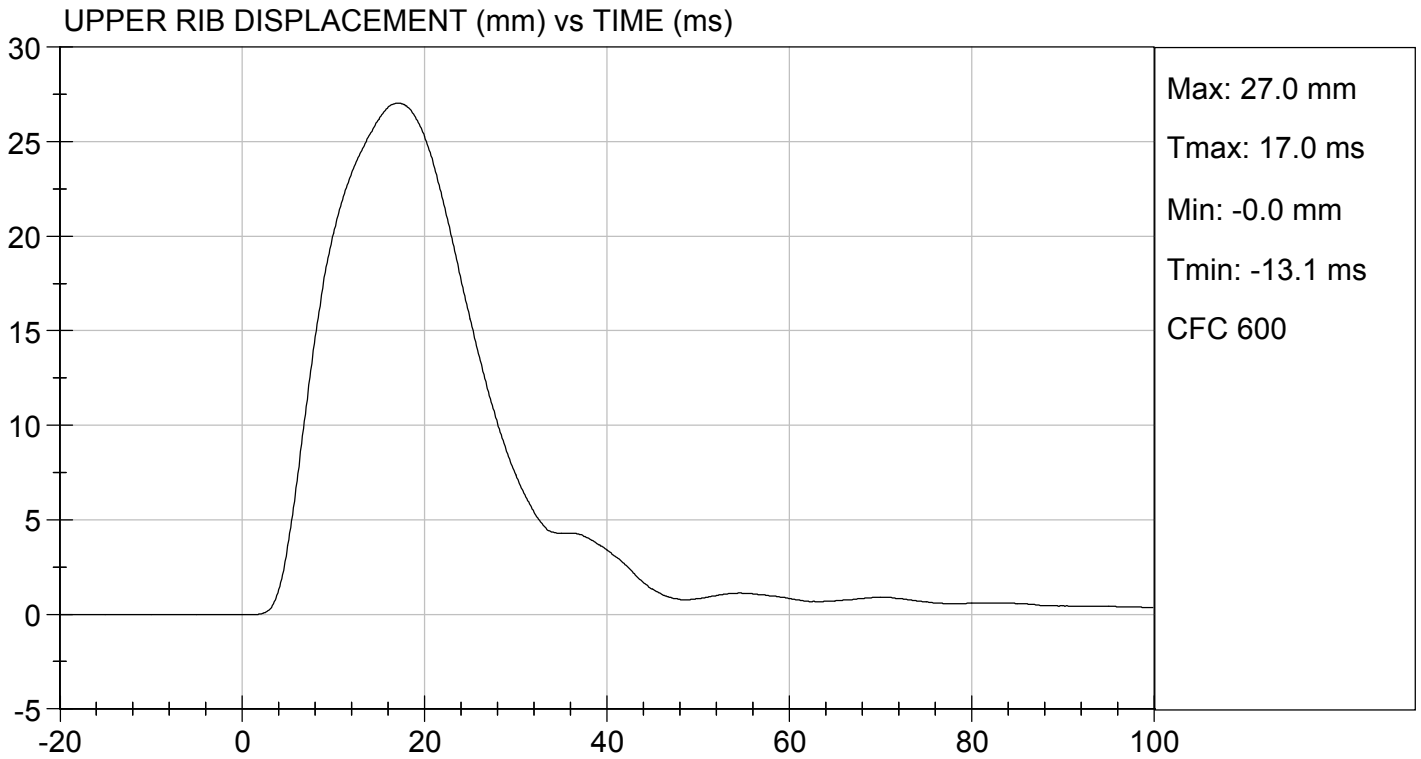
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 6.60 to 6.80 | 6.77 | Pass |
| Maximum Probe Acceleration | G's | 30 to 36 | 33 | Pass |
| Shoulder Displacement | mm | 31 to 40 | 33 | Pass |
| Upper Rib Displacement | mm | 25 to 32 | 27 | Pass |
| Middle Rib Displacement | mm | 30 to 36 | 32 | Pass |
| Lower Rib Displacement | mm | 32 to 38 | 35 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 34 to 43 | 39 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 29 to 37 | 33 | Pass |
| Overall Test Results | | | | Pass |

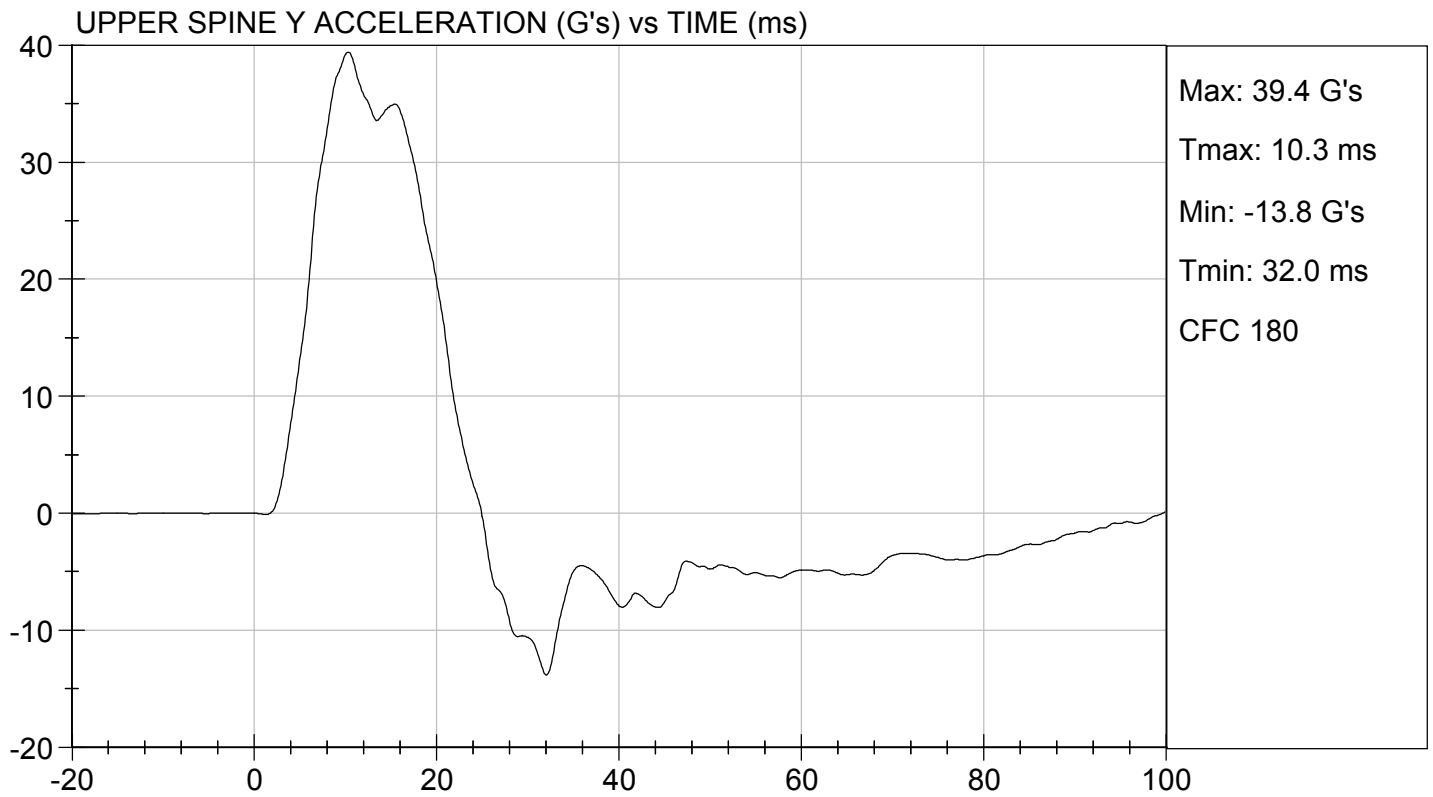
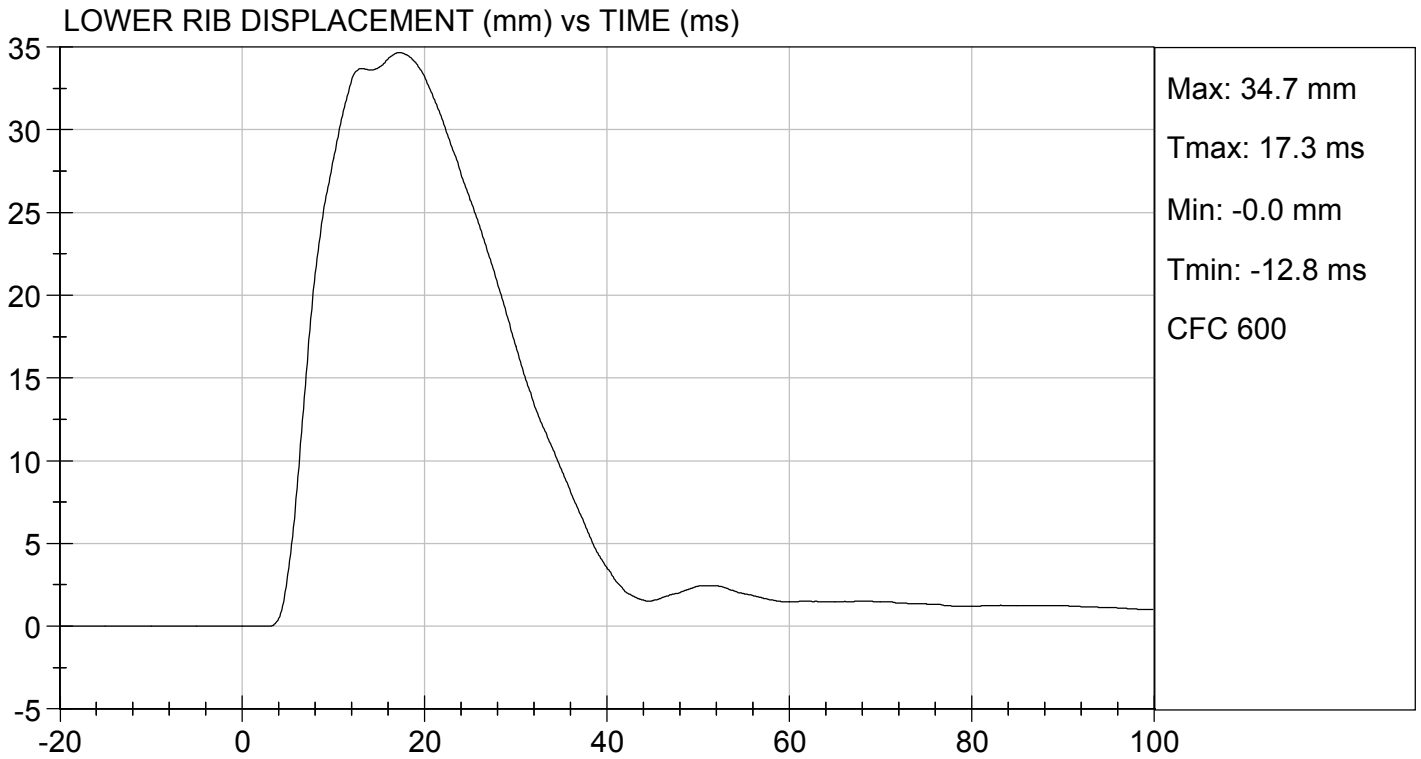

Laboratory Technician

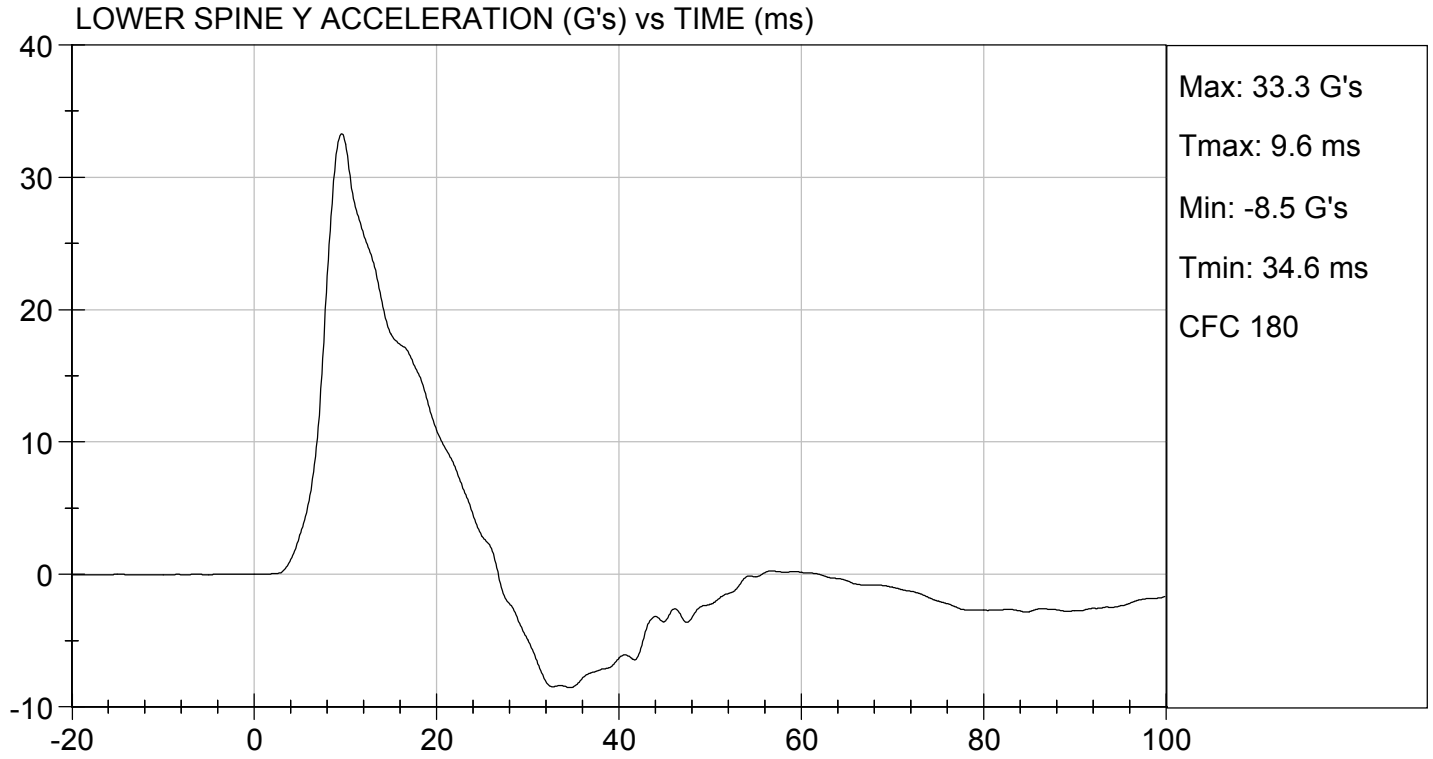
03/19/2020
Test Date


Approved By










MGA RESEARCH CORPORATION
THORAX (WITHOUT ARM) IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 306

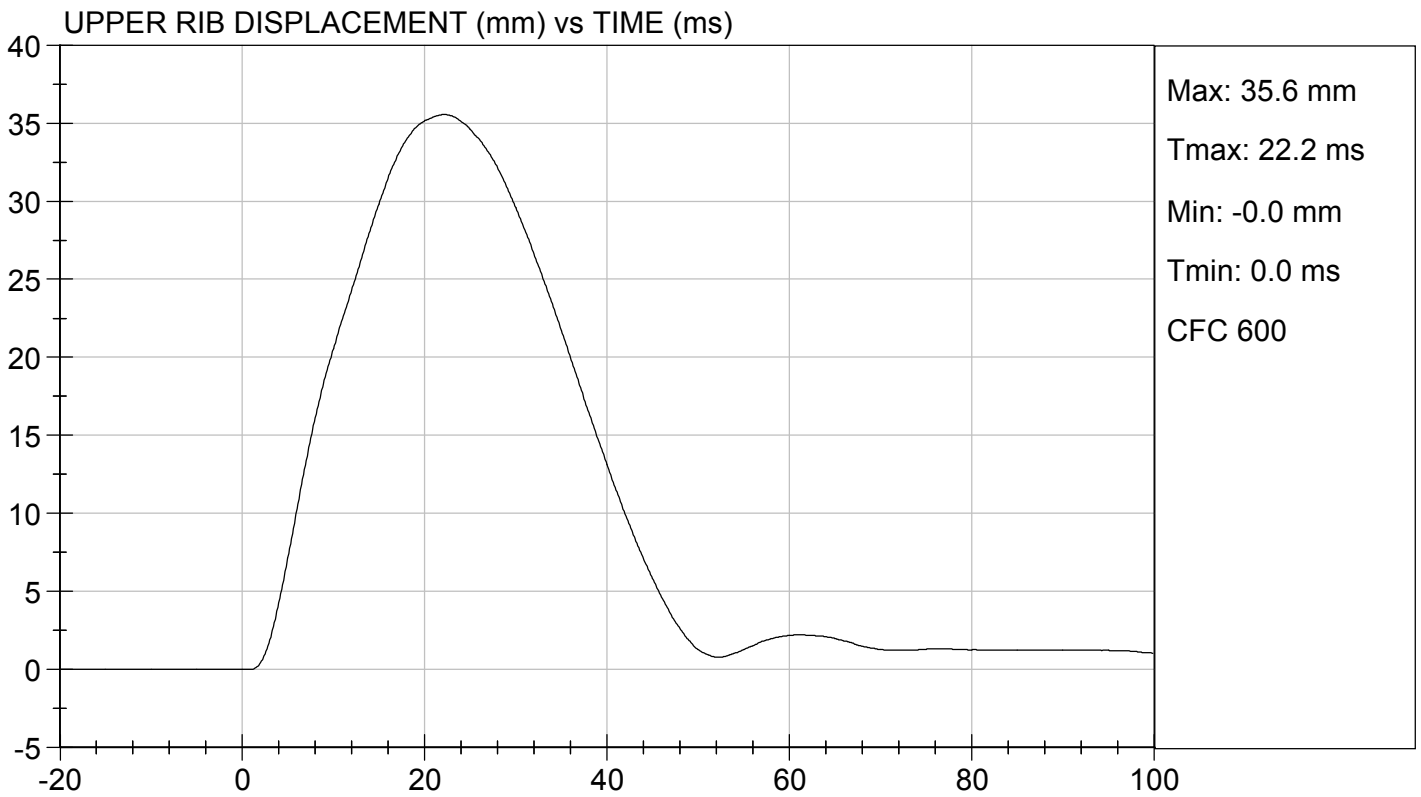
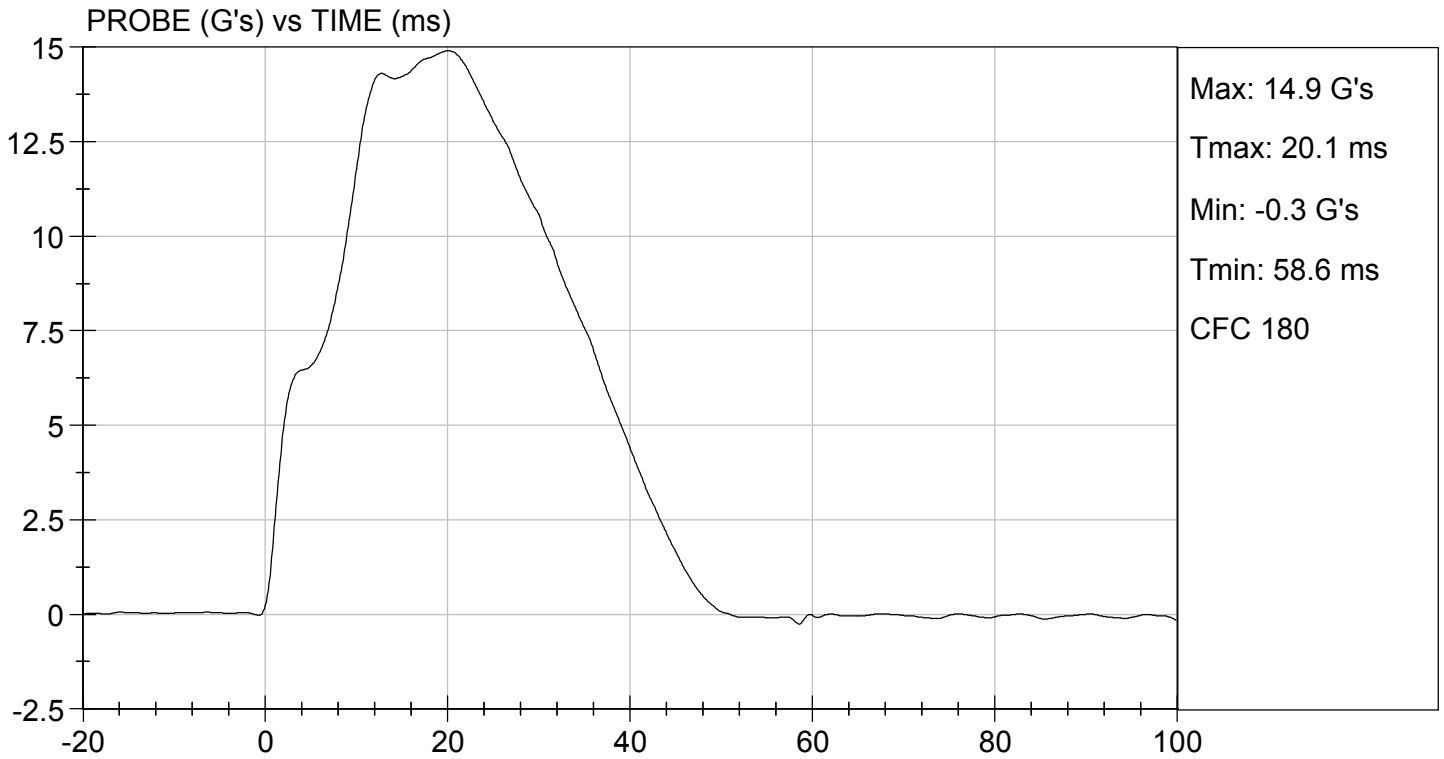
Test I.D: D201035

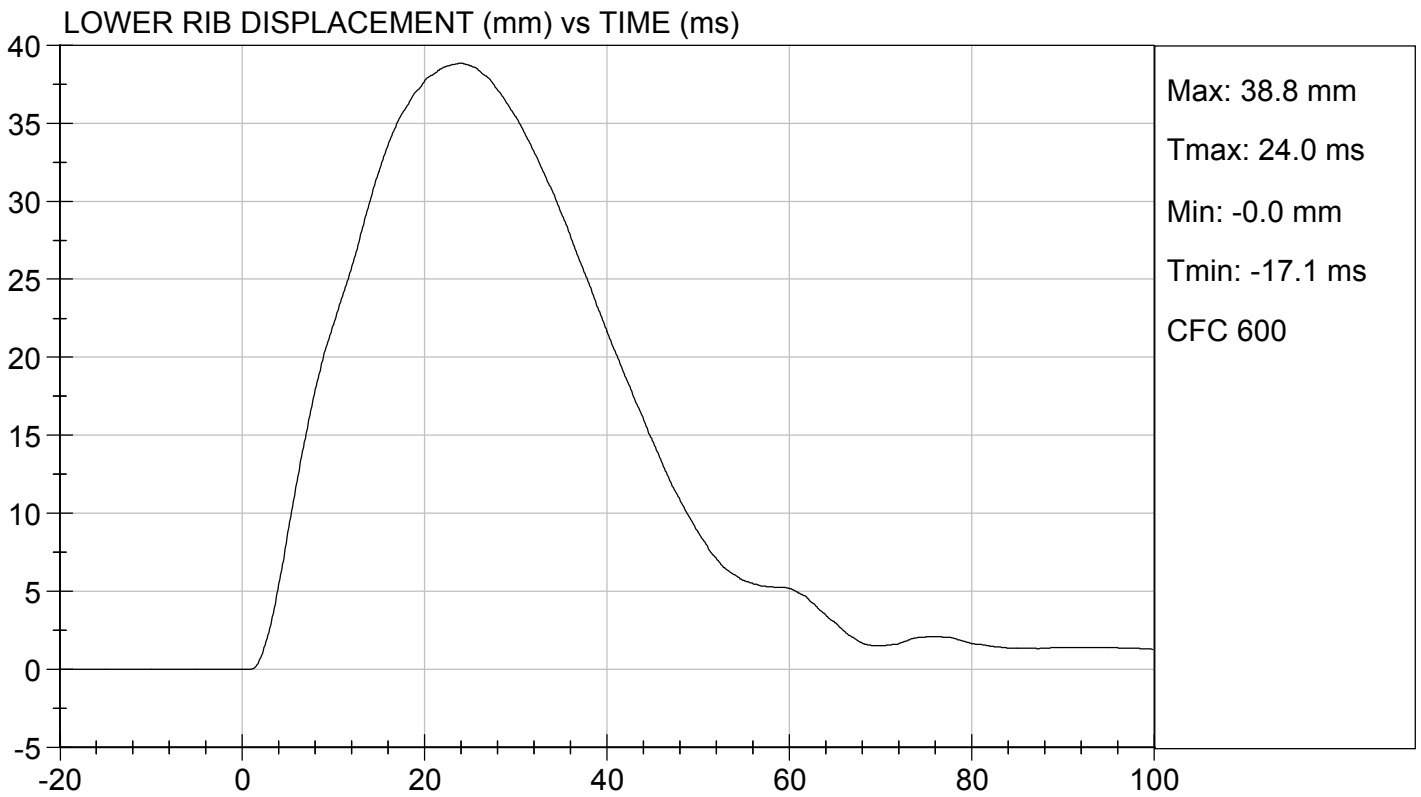
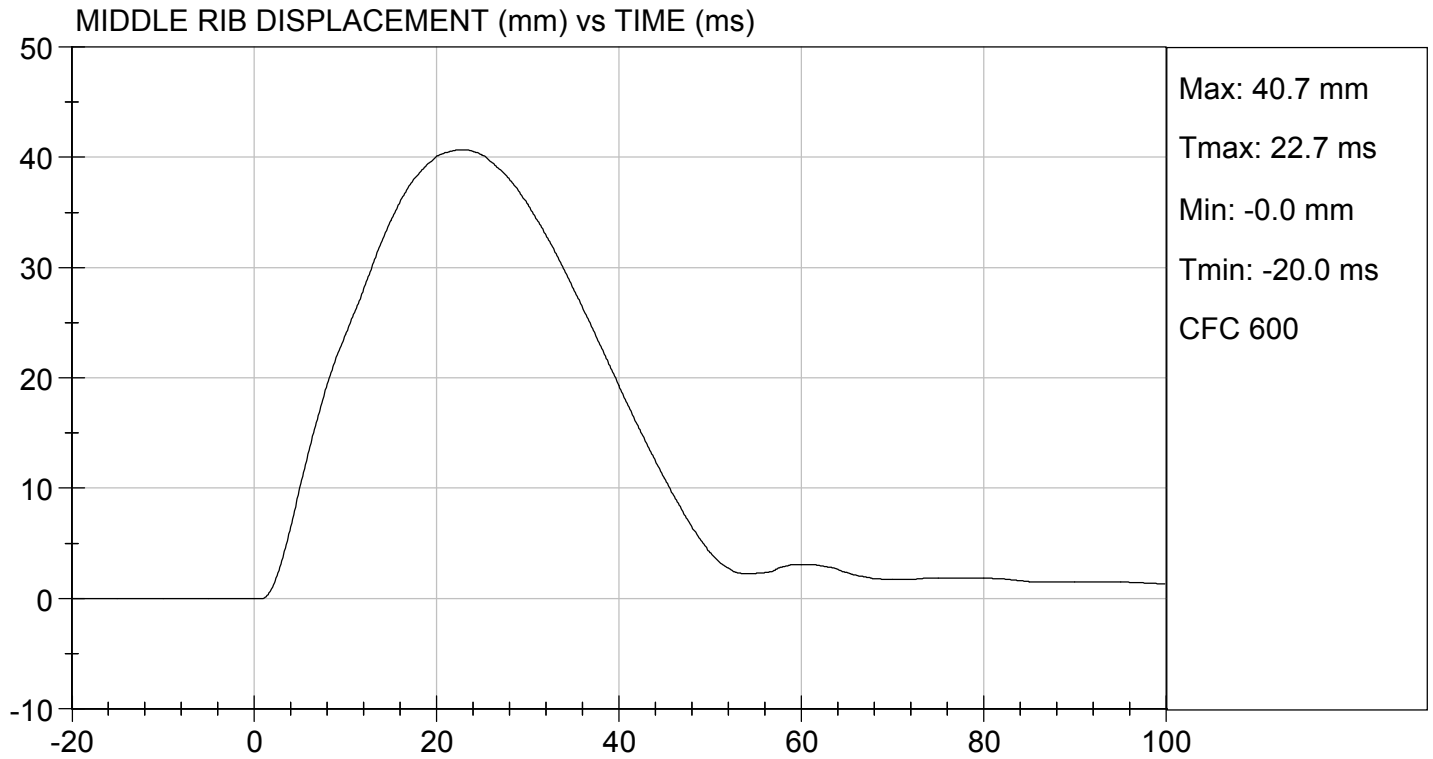
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.30 | Pass |
| Maximum Probe Acceleration | G's | 14 to 18 | 15 | Pass |
| Upper Rib Displacement | mm | 32 to 40 | 36 | Pass |
| Middle Rib Displacement | mm | 39 to 45 | 41 | Pass |
| Lower Rib Displacement | mm | 35 to 43 | 39 | Pass |
| Upper Spine (T1) Y Acceleration | G's | 13 to 17 | 15 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 7 to 11 | 9 | Pass |
| Overall Test Results | | | | Pass |

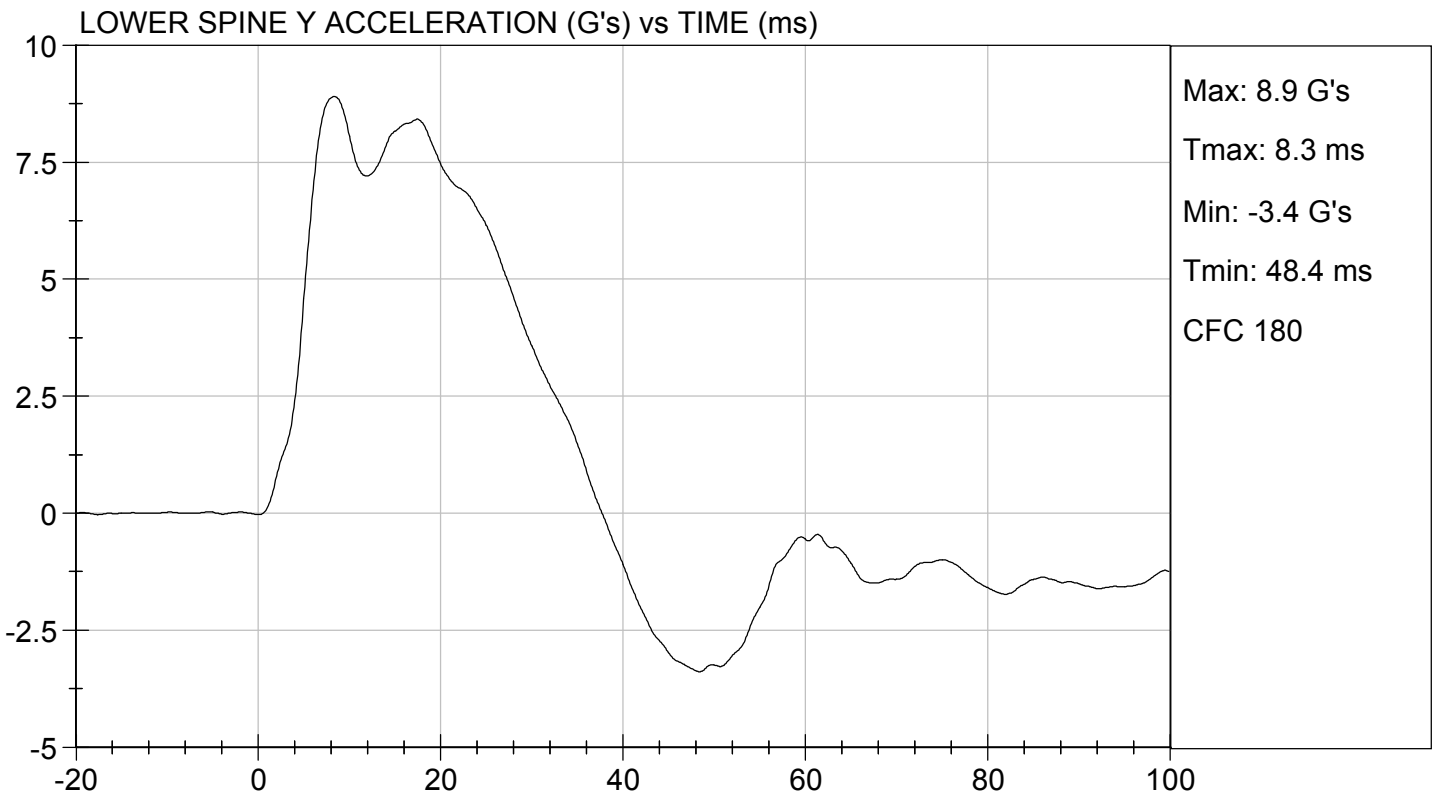
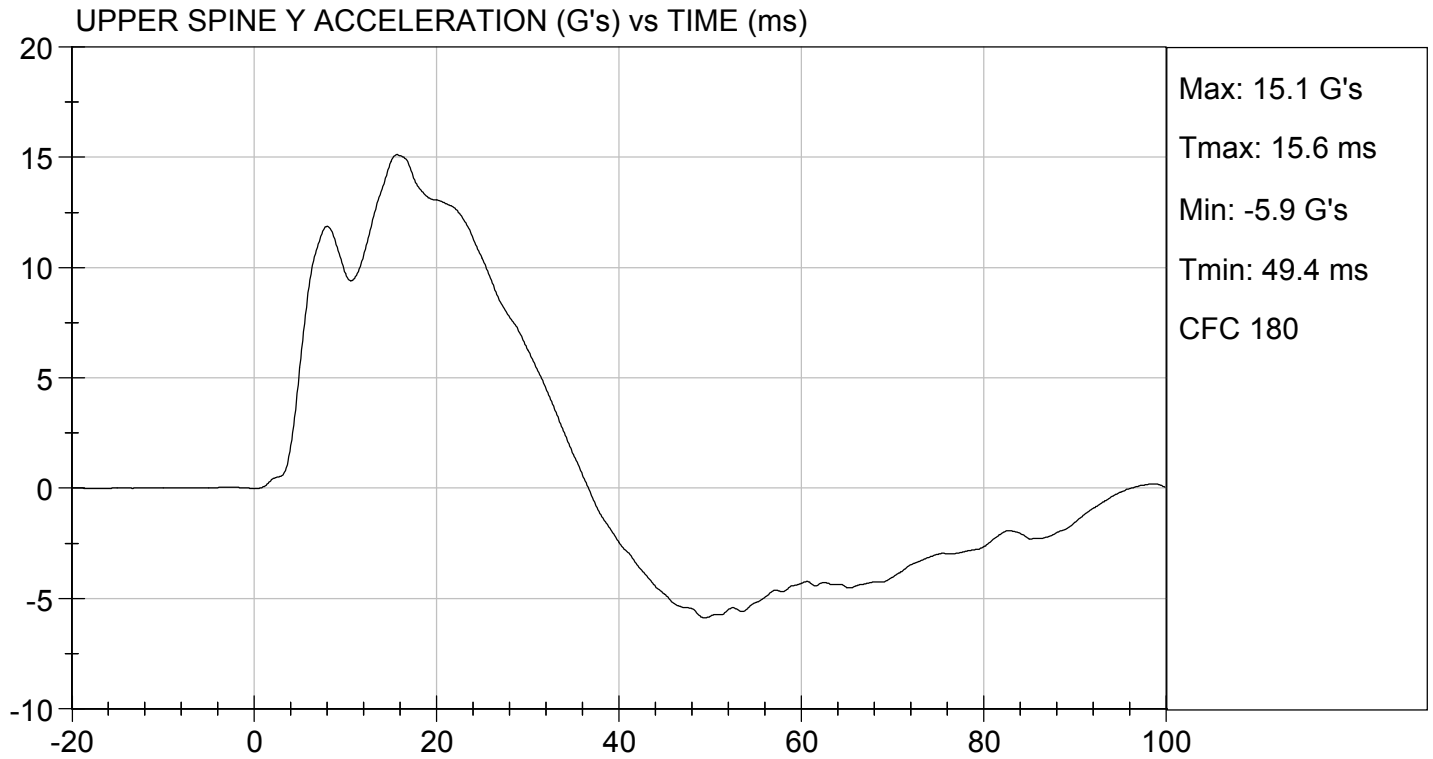

 Laboratory Technician

03/19/2020
 Test Date


 Approved By







**MGA RESEARCH CORPORATION
 ABDOMINAL IMPACT TEST
 SID-IIs BUILD LEVEL D DUMMY**

ATD Serial No: 306

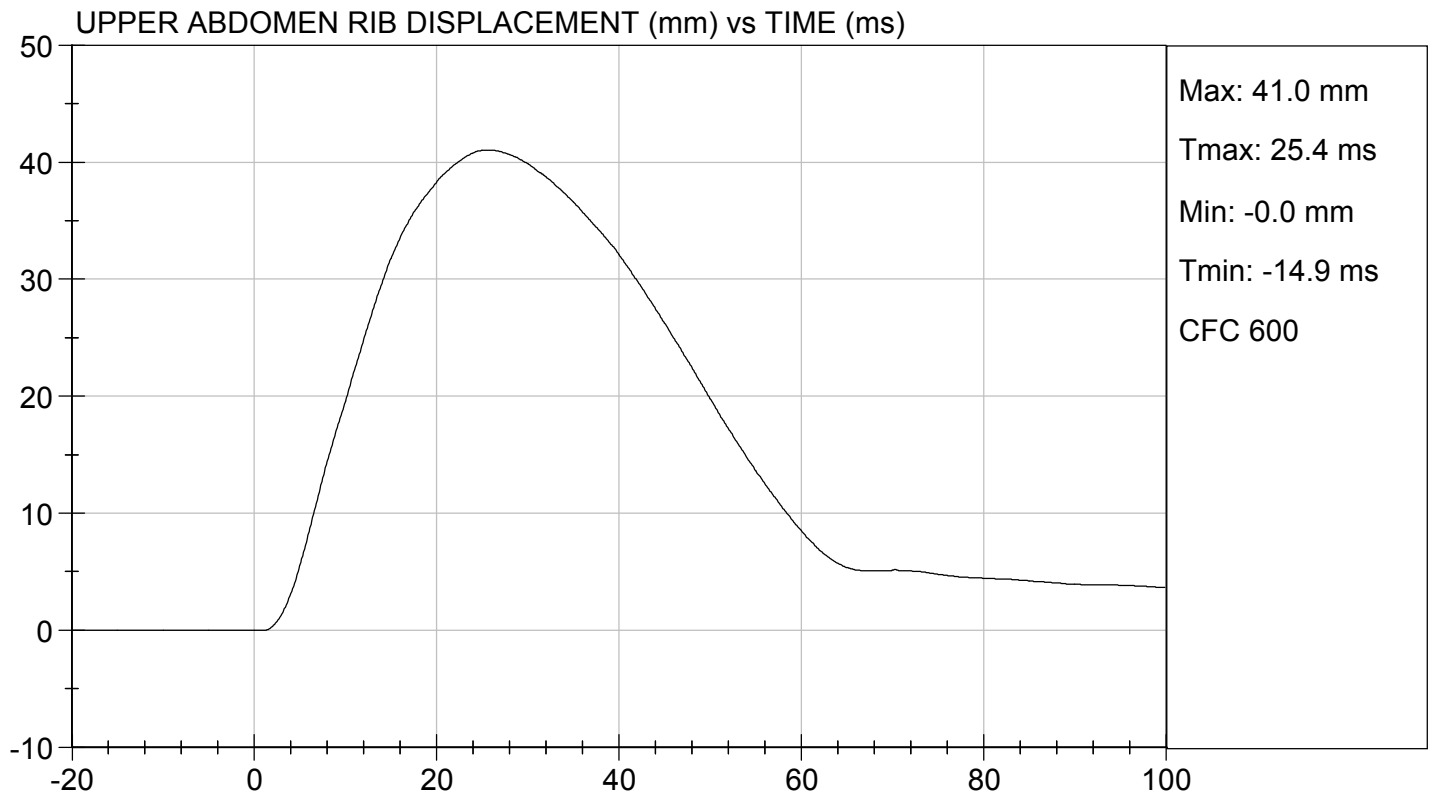
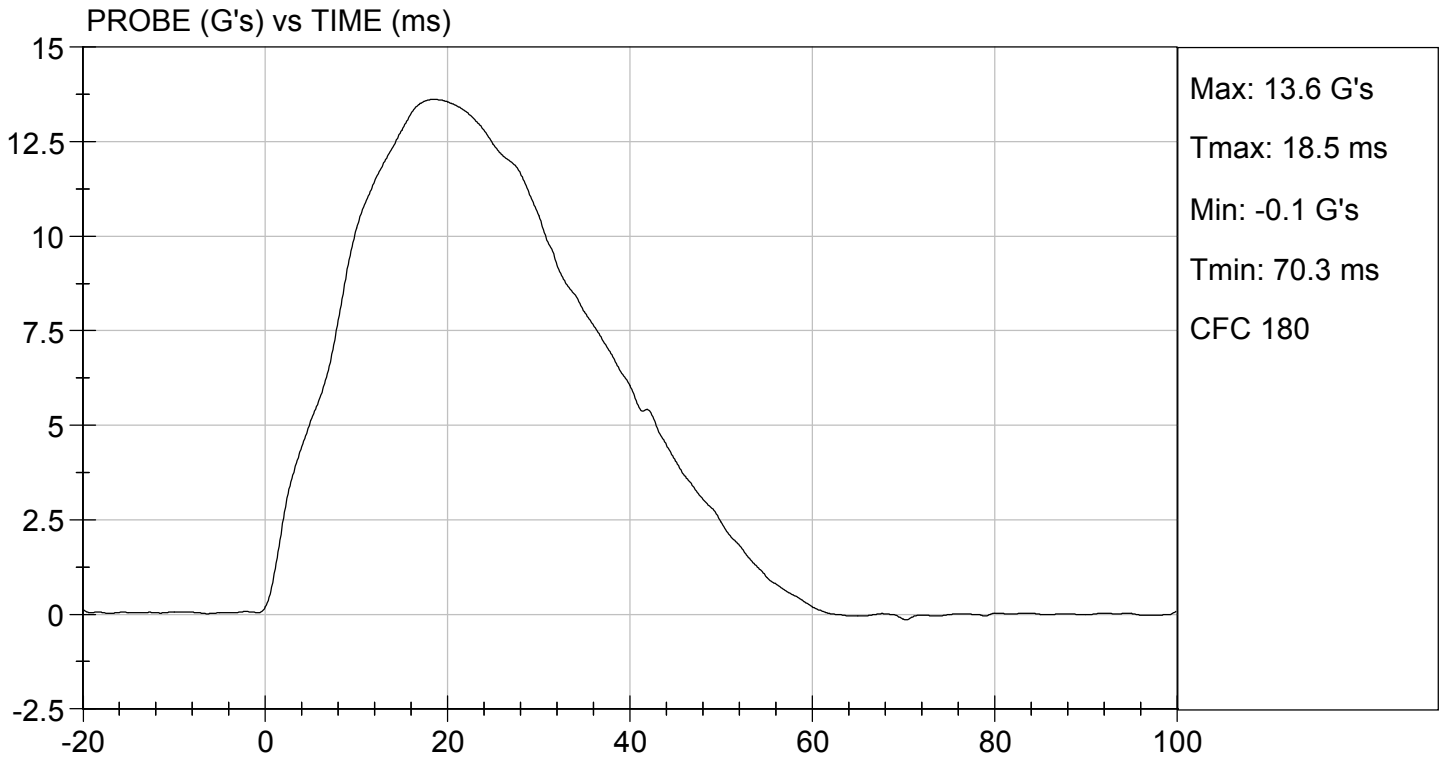
Test I.D: D201036

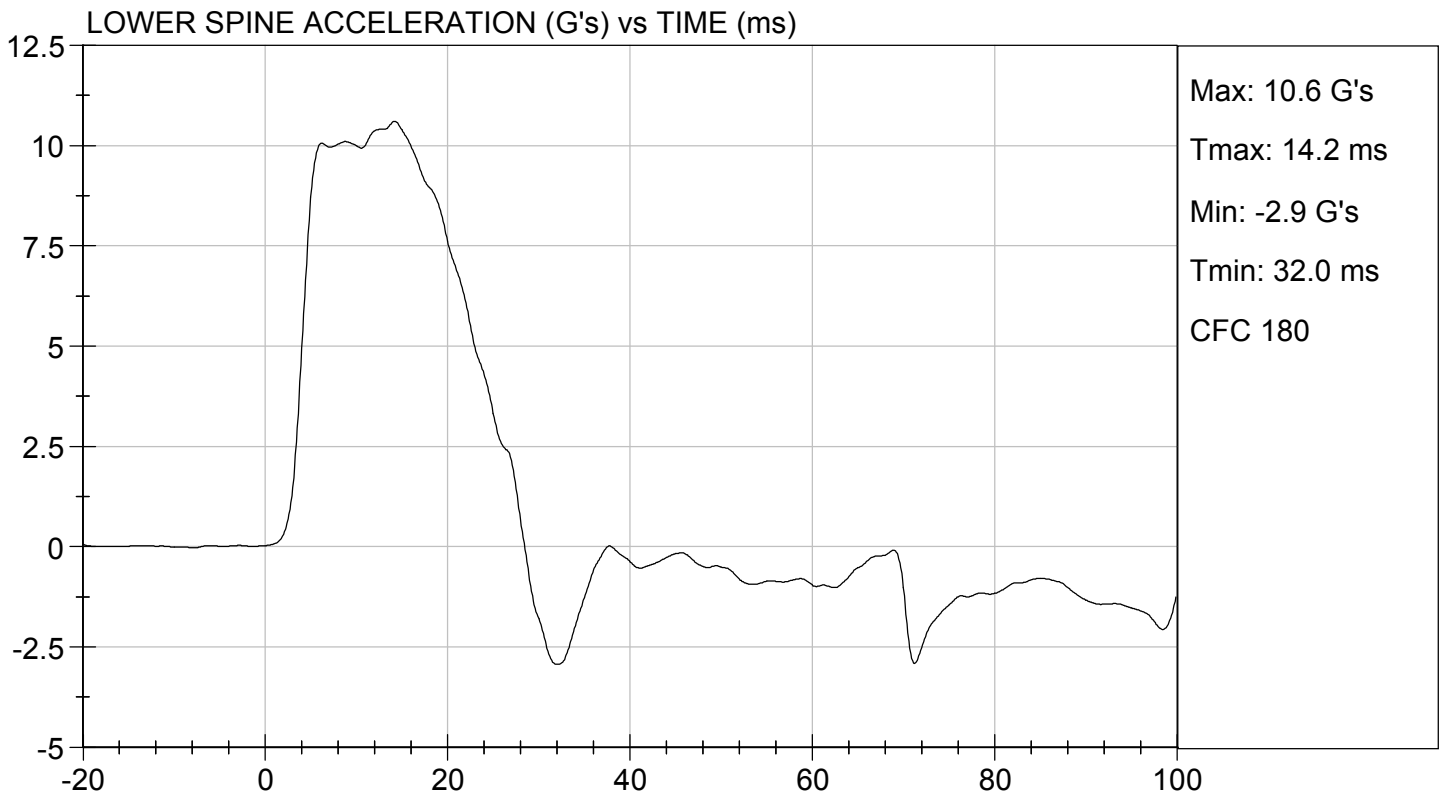
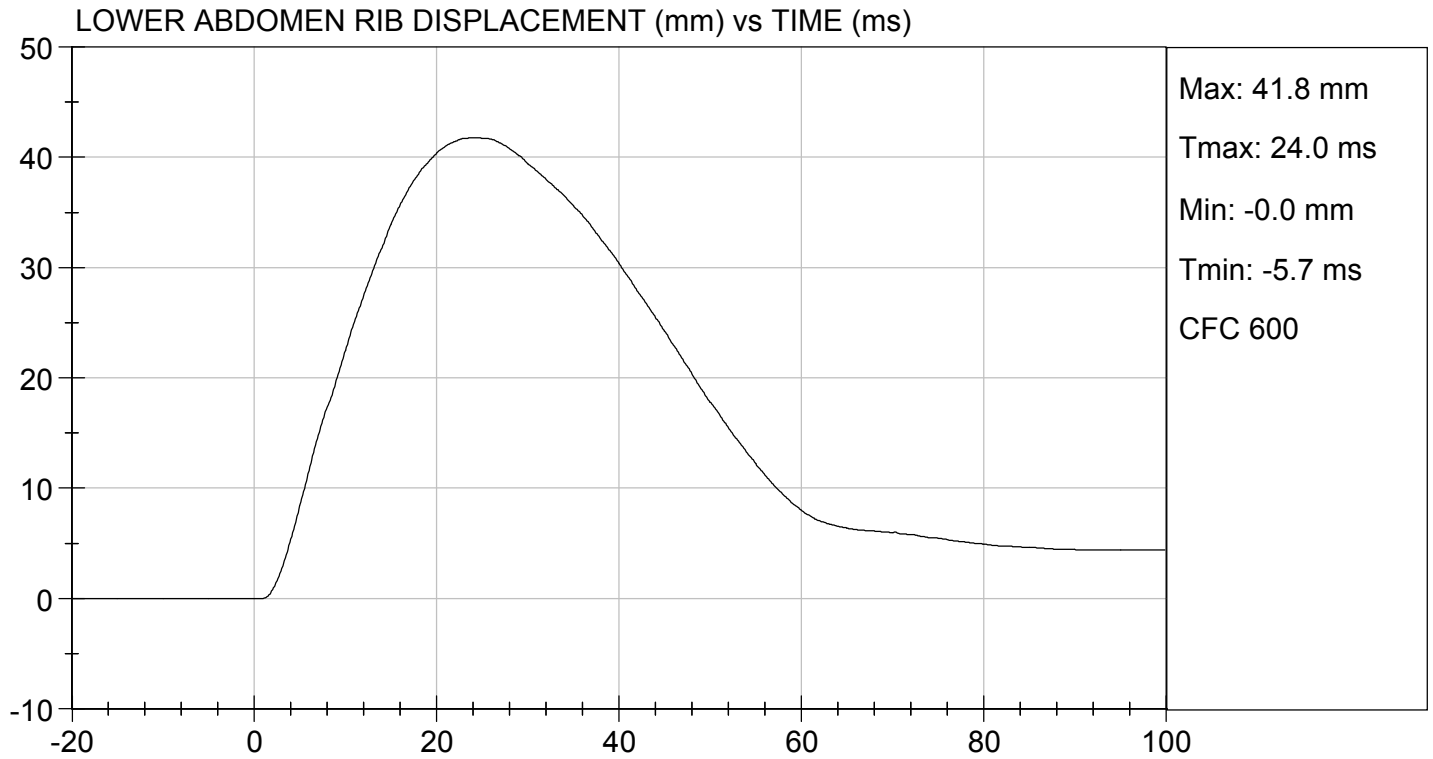
| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-----------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.27 | Pass |
| Maximum Probe Acceleration | G's | 12 to 16 | 14 | Pass |
| Upper Abdomen Rib Displacement | mm | 36 to 47 | 41 | Pass |
| Lower Abdomen Rib Displacement | mm | 33 to 44 | 42 | Pass |
| Lower Spine (T12) Y Acceleration | G's | 9 to 14 | 11 | Pass |
| Overall Test Results | | | | Pass |

Alex Thomas
 Laboratory Technician

03/19/2020
 Test Date

B. F. K.
 Approved By





MGA RESEARCH CORPORATION
PELVIS IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

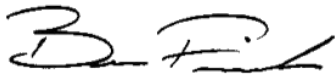
ATD Serial No: 306

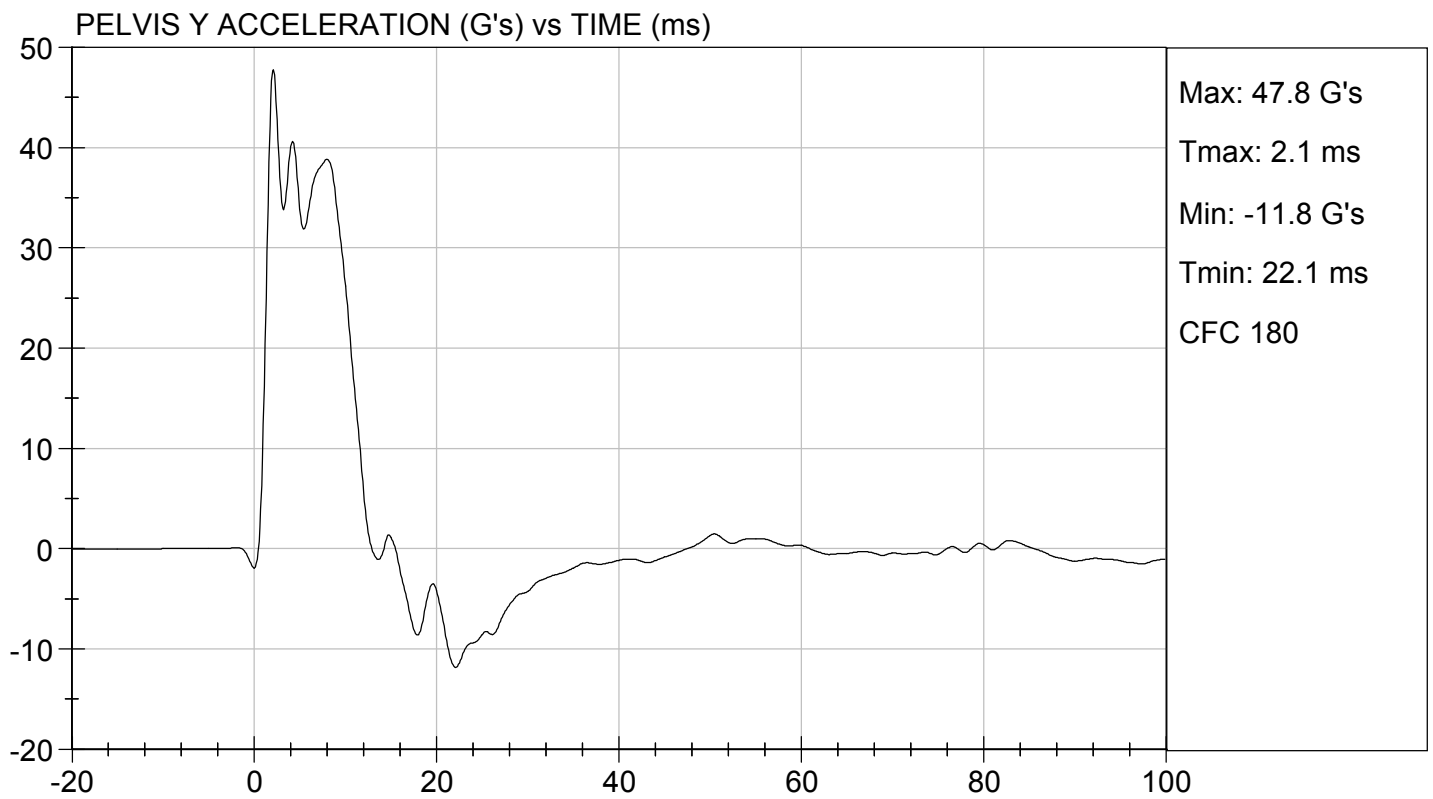
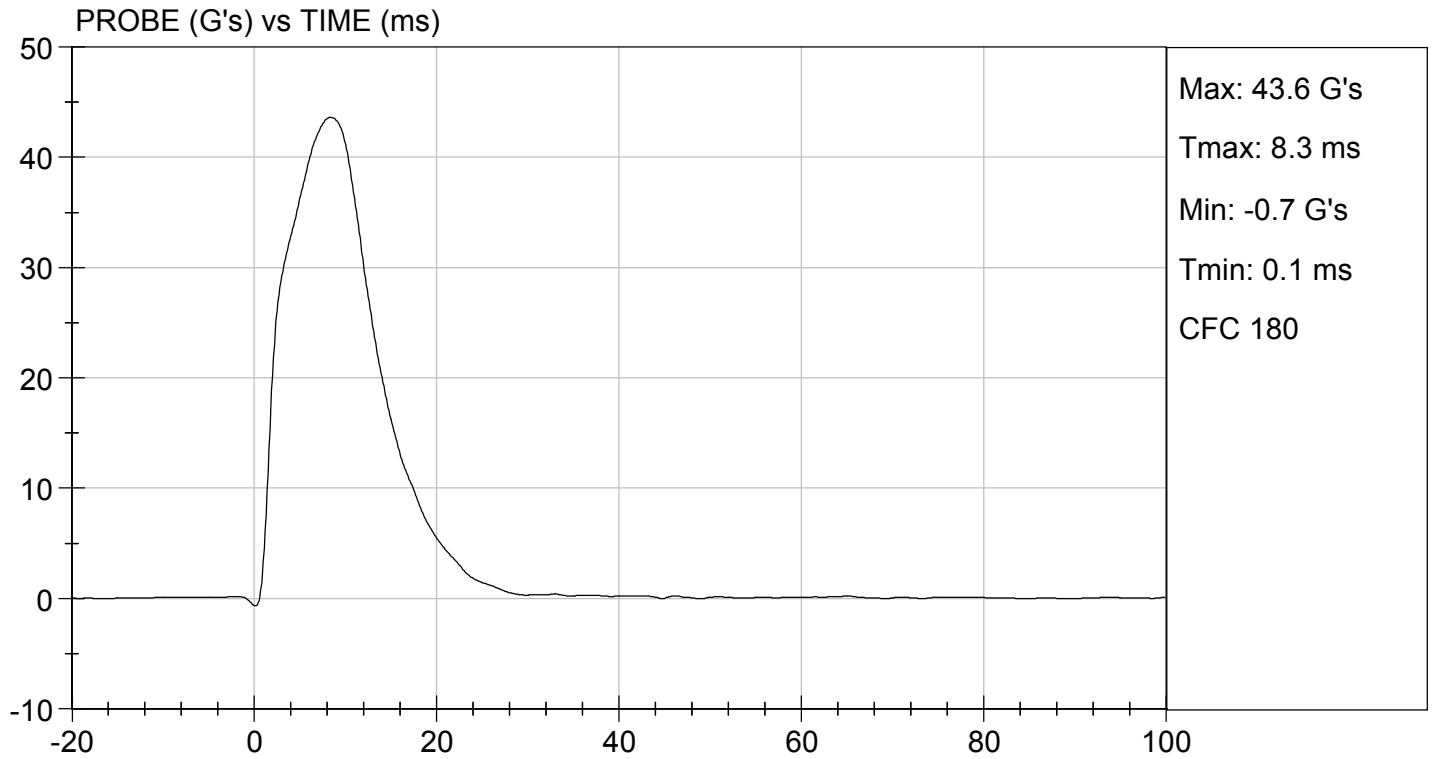
Test I.D: D201037

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------------|-------|---------------|--------|-------------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 6.60 to 6.80 | 6.60 | Pass |
| Maximum Probe Acceleration | G's | 38 to 47 | 44 | Pass |
| Pelvis Y Acceleration After 6 ms | G's | 34 to 42 | 39 | Pass |
| Peak Acetabulum Force | N | 3600 to 4300 | 3,932 | Pass |
| Overall Test Results | | | | Pass |


 Laboratory Technician

03/19/2020
 Test Date

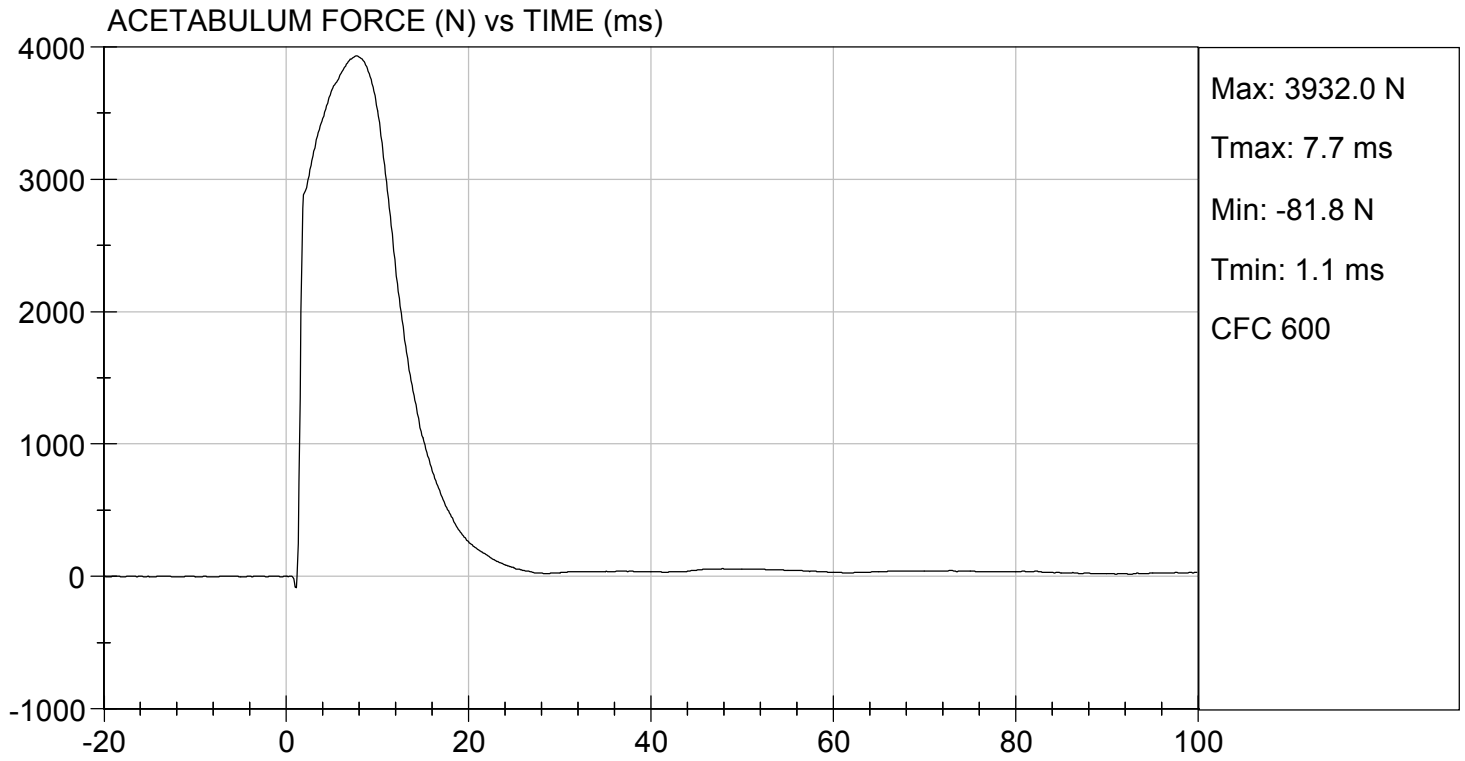

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TEST DESC: PELVIS IMPACT
VELOCITY: 21.65 ft/s, 6.60 m/s

TEST DATE: 03/19/2020
TEST #: D201037




MGA RESEARCH CORPORATION
ILIAC IMPACT TEST
SID-IIs BUILD LEVEL D DUMMY

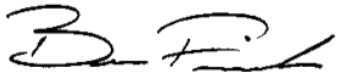
ATD Serial No: 306

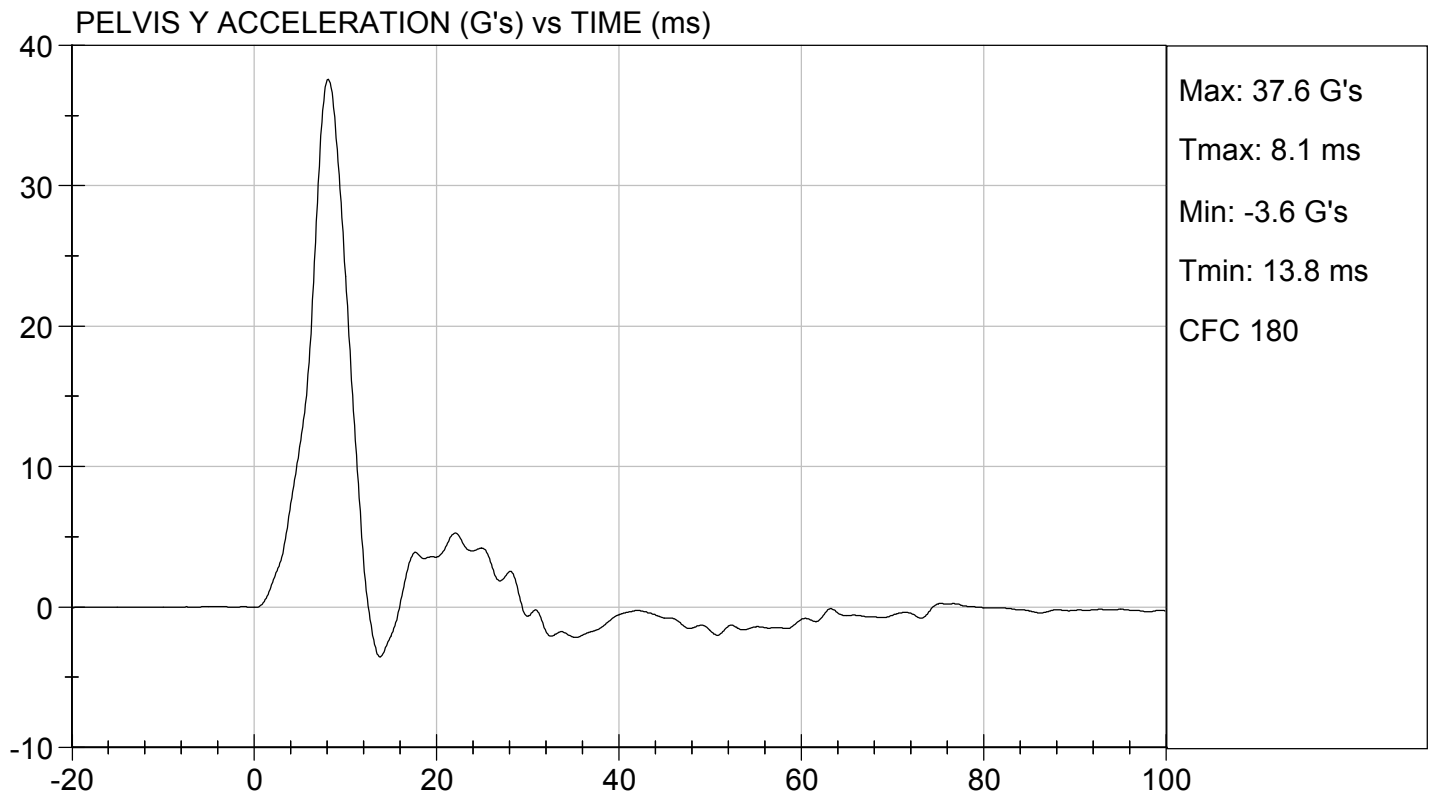
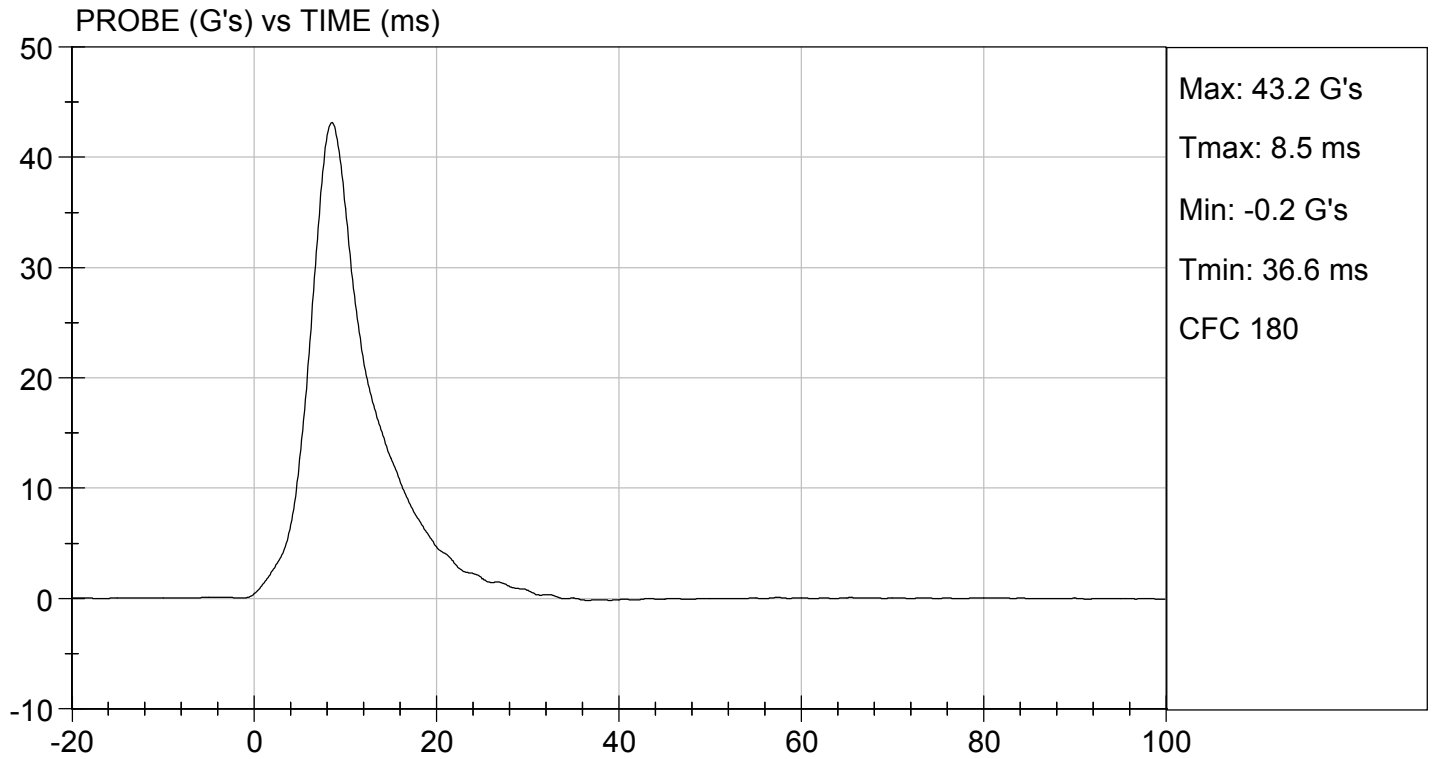
Test I.D: D201038

| Tested Parameter | Units | Specification | Result | Pass/Fail |
|----------------------------|-------|---------------|--------|-----------|
| Temperature | deg C | 20.6 to 22.2 | 21.2 | Pass |
| Humidity | % | 10 to 70 | 31 | Pass |
| Impact Velocity | m/s | 4.20 to 4.40 | 4.27 | Pass |
| Maximum Probe Acceleration | G's | 36 to 45 | 43 | Pass |
| Pelvis Y Acceleration | G's | 28 to 39 | 38 | Pass |
| Peak Pelvis Iliac Force | N | 4100 to 5100 | 4,952 | Pass |
| Overall Test Results | | | | Pass |


 Laboratory Technician

03/19/2020
 Test Date

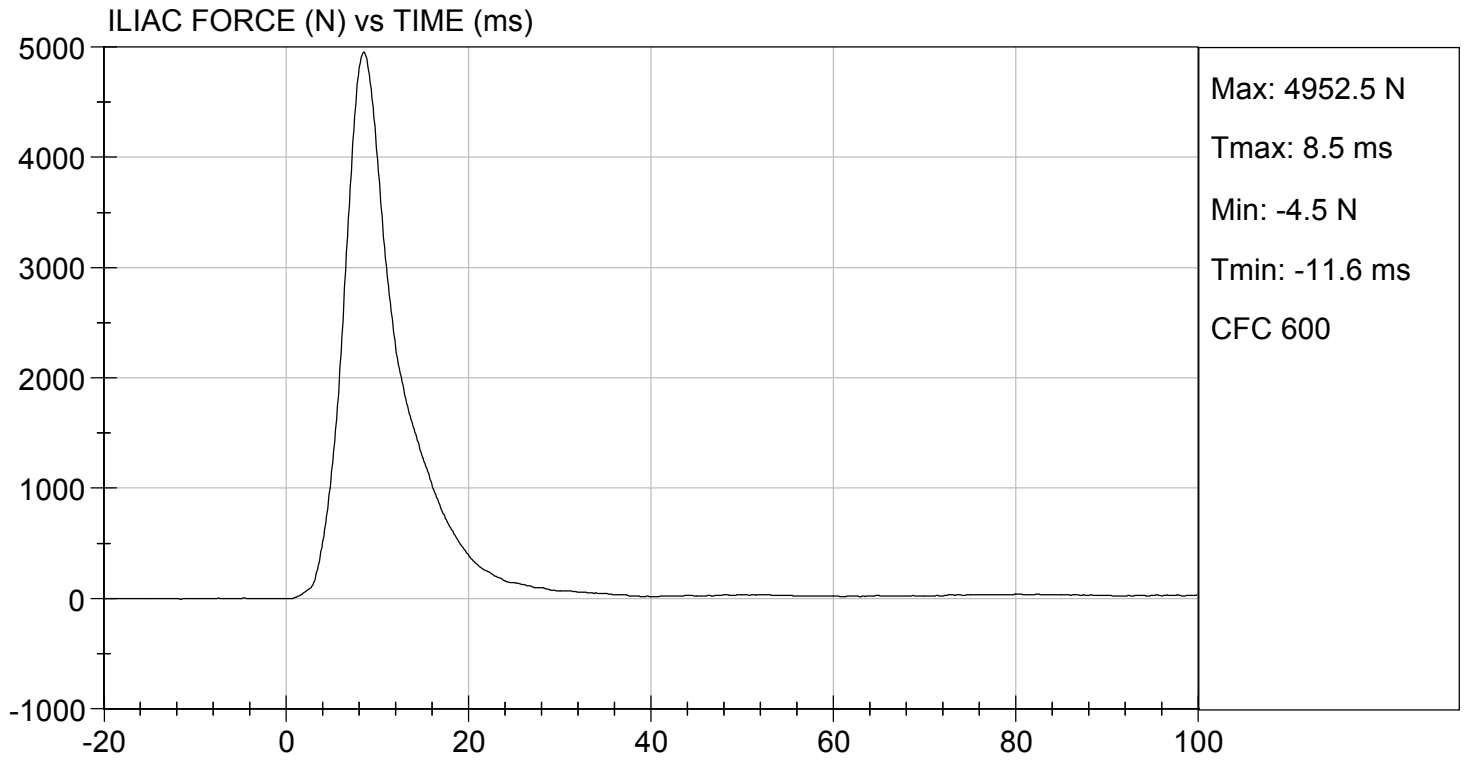

 Approved By





TEST DESC: ILLIAC
VELOCITY: 14.01 ft/s, 4.27 m/s

TEST DATE: 03/19/2020
TEST #: D201038





SID-IIs Pelvis Plug Certification Test

Plug S/N 12553

Test Number 7481

Report Number 7496

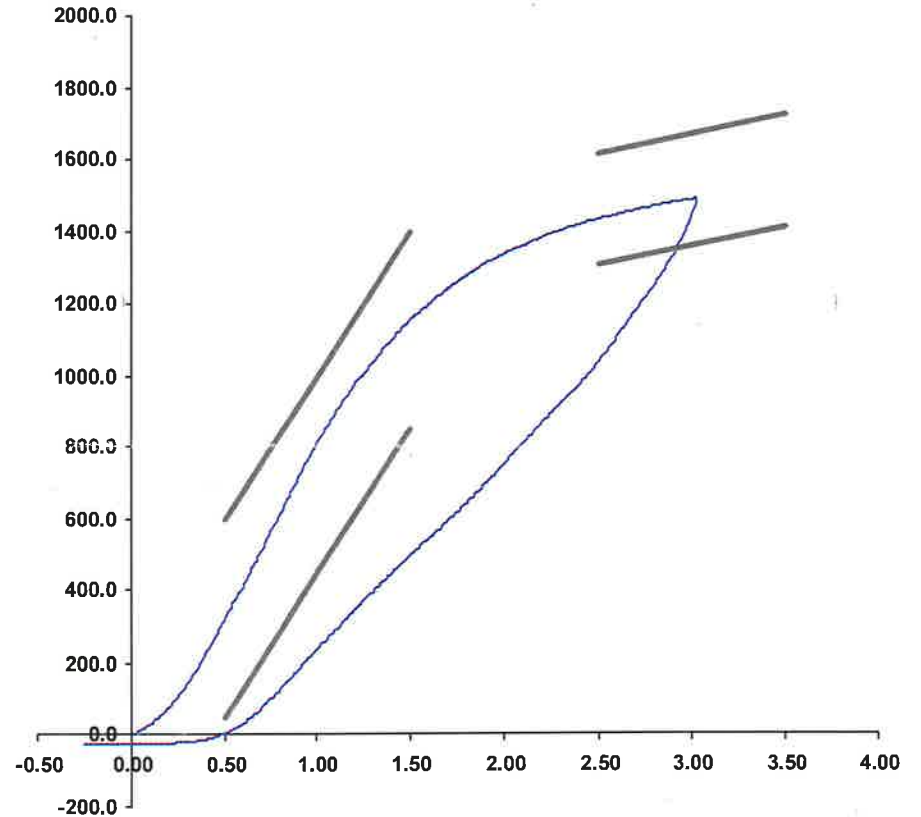
Test Date 10/2/2018 12:08:16 PM

| | <u>Test Results</u> | <u>Spec Min</u> | <u>Spec Max</u> |
|--------------------|---------------------|-----------------|-----------------|
| Force @ 0.5 mm (N) | 316.51 | 50.00 | 600.00 |
| Force @ 1.5 mm (N) | 1,161.11 | 850.00 | 1,400.00 |
| Force @ 2.5 mm (N) | 1,436.35 | 1,306.00 | 1,618.00 |
| Force @ 3.0 mm (N) | 1,490.87 | 1,361.00 | 1,673.00 |

Testing Machine STM-20 5965542
 Load Cell S/N (FI360947), Units (LBS) 1000
 Crosshead Speed (mm / min) or Rate 12.7
 Extension or Position Measured by XHD_100 (XHD100)

Notes:

Force (-N) vs Extension (-mm)



Operator _____
 Part Number 180-4450

Template No 107 02-Oct-18
 SACO Research

By : DC Date : 10/2/18



SID-IIs Pelvis Plug Certification Test

Plug S/N 13181

Test Number 10576

Report Number 10611

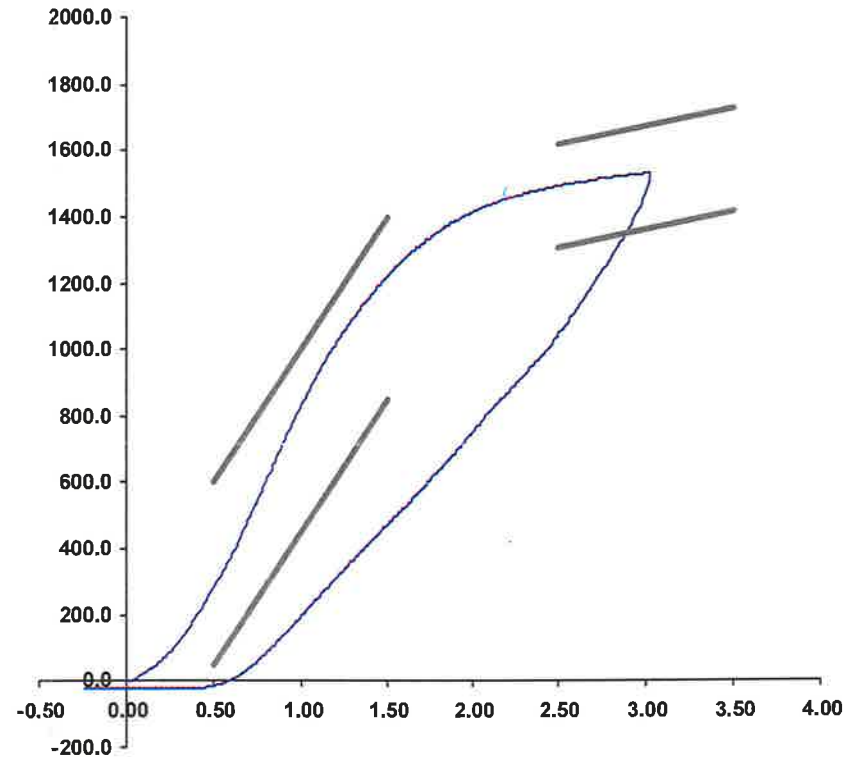
Test Date 8/8/2019 11:25:36 AM

| | <u>Test Results</u> | <u>Spec Min</u> | <u>Spec Max</u> |
|--------------------|---------------------|-----------------|-----------------|
| Force @ 0.5 mm (N) | 288.67 | 50.00 | 600.00 |
| Force @ 1.5 mm (N) | 1,220.16 | 850.00 | 1,400.00 |
| Force @ 2.5 mm (N) | 1,494.07 | 1,306.00 | 1,618.00 |
| Force @ 3.0 mm (N) | 1,531.55 | 1,361.00 | 1,673.00 |

Testing Machine STM-20 5965542
 Load Cell S/N (FI360947), Units (LBS) 1000
 Crosshead Speed (mm / min) or Rate 12.7
 Extension or Position Measured by XHD_100 (XHD100)

Notes:

Force (-N) vs Extension (-mm)



Operator 131

Part Number 180-4450

Template No 107 08-Aug-19
 SACO Research

By : DC Date : 8/8/2019

APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation

| | | | SID-IIs S/N 306 | | | |
|----------------------------------|---------------|--------|-----------------|--------------|------------------|------------|
| | | | Serial Number | Manufacturer | Calibration Date | |
| Head CG Accelerometers | | | X | P79721 | Endevco | 1/2/2020 |
| | | | Y | P79724 | Endevco | 1/2/2020 |
| | | | Z | P79445 | Endevco | 1/2/2020 |
| | | | Xr | P84999 | Endevco | 1/2/2020 |
| | | | Yr | P85000 | Endevco | 1/2/2020 |
| | | | Zr | P85001 | Endevco | 1/2/2020 |
| Head Angular Rate Sensors | | | X | ARS7416 | DTS | 7/8/2019 |
| | | | Y | ARS7442 | DTS | 7/8/2019 |
| | | | Z | ARS7475 | DTS | 7/8/2019 |
| Displacement Potentiometers | Thoracic Rib | Upper | Y | G033 | FTSS | 1/2/2020 |
| | | Middle | Y | G1261 | FTSS | 1/2/2020 |
| | | Lower | Y | G1270 | FTSS | 1/2/2020 |
| | Abdominal Rib | Upper | Y | G032 | FTSS | 1/2/2020 |
| | | Lower | Y | G1304 | FTSS | 1/2/2020 |
| Lower Spine Accelerometers (T12) | | | X | P96332 | Endevco | 1/2/2020 |
| | | | Y | P96335 | Endevco | 1/2/2020 |
| | | | Z | P96341 | Endevco | 1/2/2020 |
| Acetabulum Load Cell | | | Y | ACG4285 | FTSS | 11/27/2019 |
| Iliac Wing Load Cell | | | Y | IWG3023 | FTSS | 11/27/2019 |
| Pelvis Plug (struck side) | | | | 12553 | SACO | 10/2/2018 |
| Pelvis Plug (non-struck side) | | | | 13181 | SACO | 8/8/2019 |

Table 2 – Vehicle Instrumentation

| | | Serial Number | Manufacturer | Calibration Date |
|---------------------------|---|---------------|--------------|------------------|
| Vehicle Center of Gravity | X | P94396 | Endevco | 11/15/2019 |
| Vehicle Center of Gravity | Y | T19553 | Endevco | 11/15/2019 |
| Vehicle Center of Gravity | Z | T19311 | Endevco | 10/24/2019 |
| Left Floor Sill | Y | T20719 | Endevco | 11/27/2019 |
| A-Pillar Sill | Y | T17825 | Endevco | 12/18/2019 |
| A-Pillar Low | Y | T20733 | Endevco | 1/2/2020 |
| A-Pillar Mid | Y | T20727 | Endevco | 1/2/2020 |
| B-Pillar Sill | Y | T21444 | Endevco | 3/5/2020 |
| B-Pillar Low | Y | T20029 | Endevco | 11/13/2019 |
| B-Pillar Mid | Y | T21391 | Endevco | 3/5/2020 |
| Driver Seat | Y | T22691 | Endevco | 2/11/2020 |
| Engine Top | X | T19970 | Endevco | 3/5/2020 |
| Engine Top | Y | T17569 | Endevco | 3/5/2020 |
| Firewall | Y | T22778 | Endevco | 2/21/2020 |
| Right Roof | Y | T20775 | Endevco | 11/27/2019 |
| Right Floor Sill | Y | PCB1282 | PCB | 3/05/2020 |
| Rear Floorpan | X | T22594 | Endevco | 2/21/2020 |
| Rear Floorpan | Y | T22718 | Endevco | 2/21/2020 |

Table 3 – Pole Instrumentation

| | Serial Number | Manufacturer | Calibration Date |
|-------------|---------------|--------------|------------------|
| Load Cell 1 | DG6277 | FTSS | 7/30/2018 |
| Load Cell 2 | DG6278 | FTSS | 7/30/2018 |
| Load Cell 3 | DG6279 | FTSS | 7/30/2018 |
| Load Cell 4 | DG6280 | FTSS | 7/30/2018 |
| Load Cell 5 | DG6281 | FTSS | 7/30/2018 |
| Load Cell 6 | DG6283 | FTSS | 7/30/2018 |
| Load Cell 7 | DG6284 | FTSS | 7/30/2018 |
| Load Cell 8 | DG6582 | FTSS | 7/30/2018 |