

**REPORT NUMBER: TWG-MGA-20-001**

**SIDE AIRBAG OUT-OF-POSITION INJURY  
TECHNICAL WORKING GROUP**

**HYUNDAI MOTOR COMPANY  
2020 Hyundai Accent SE 4-Door Sedan  
NHTSA No.: M20204202TWG2**

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



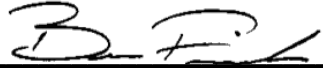
**Test Date: August 10, 2020**


**Final Report Date: June 30, 2021**

**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**

**SIGNATURE APPROVAL PAGE**

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Approved by:   
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Approval Date: June 30, 2021

FINAL REPORT ACCEPTANCE BY:

\_\_\_\_\_

Date: \_\_\_\_\_

The results presented in this report relate only to the specified test items.

**TECHNICAL REPORT DOCUMENTATION PAGE**

<b>1. Report No.</b> TWG-MGA-20-001		<b>2. Government Accession No.</b>		<b>3. Recipient's Catalog No.</b>																															
<b>4. Title and Subtitle</b> Final Report of Side Airbag Out-of-Position Injury Technical Working Group evaluation of a 2020 Hyundai Accent SE 4-Door Sedan, NHTSA No.: M20204202TWG2				<b>5. Report Date</b> June 30, 2021																															
<b>7. Author(s)</b> Ben Fischer, Project Manager				<b>6. Performing Organization Code</b> MGA																															
<b>9. Performing Organization Name and Address</b> MGA Research Corporation 5000 Warren Road Burlington, WI 53105				<b>8. Performing Organization Report No.</b> TWG-MGA-20-001																															
<b>12. Sponsoring Agency Name and Address</b> U.S. Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards (NRM-110) 1200 New Jersey Ave, SE, Room W43-410 Washington, D.C. 20590				<b>10. Work Unit No.</b>																															
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<b>15. Supplementary Notes</b>				<b>13. Type of Report and Period Covered:</b> Final Test Report August 10, 2020 to June 30, 2021																															
				<b>14. Sponsoring Agency Code</b> NRM-110																															
<b>16. Abstract</b> A Side Airbag Out-of-Position Injury evaluation was conducted on the subject 2020 Hyundai Accent SE 4-Door Sedan in accordance with the specifications of the Side Airbag Out-of-Position Injury Technical Working Group Laboratory Test Procedure for the generation of consumer information. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on August 10, 2020.																																			
<table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th rowspan="2">Units</th> <th colspan="2">Driver ATD (SID-IIs)</th> </tr> <tr> <th>Threshold</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC<sub>15</sub>)</td> <td></td> <td>723</td> <td>23</td> </tr> <tr> <td>Nij</td> <td></td> <td>1</td> <td>0.80</td> </tr> <tr> <td>Neck Tension</td> <td>N</td> <td>1490</td> <td>399</td> </tr> <tr> <td>Neck Compression</td> <td>N</td> <td>1820</td> <td>354</td> </tr> <tr> <td>Maximum Chest Displacement</td> <td>mm</td> <td></td> <td></td> </tr> <tr> <td>Maximum Chest Displacement Rate</td> <td>m/s</td> <td></td> <td></td> </tr> </tbody> </table>						Measurement Description	Units	Driver ATD (SID-IIs)		Threshold	Result	Head Injury Criteria (HIC <sub>15</sub> )		723	23	Nij		1	0.80	Neck Tension	N	1490	399	Neck Compression	N	1820	354	Maximum Chest Displacement	mm			Maximum Chest Displacement Rate	m/s		
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## **SECTION 1 TEST PURPOSE AND PROCEDURE**

This side airbag out-of-position test is part of the MY2020 New Car Assessment Program (NCAP), sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number 693JJ919D000006. The purpose of this test is to obtain data on the performance of side airbags with out-of-position occupants in a 2020 Hyundai Accent SE 4-Door Sedan. The airbag test was conducted in accordance with the Office of Crashworthiness Standard's Side Airbag Out-of-Position Laboratory Test Procedure, dated November 2019.

## **SECTION 2 SUMMARY OF TEST RESULTS**

The effects of both a curtain and torso airbag deployment in a 2020 Hyundai Accent SE 4-Door Sedan with an out-of-position Hybrid III 6-Year-Old child dummy were evaluated. The curtain and seat airbags were fired remotely. The test was performed by MGA Research Corporation on August 10, 2020. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Three high-speed cameras (2,700 fps) were used to document the side airbag deployment event. The following camera locations were used:

- Left Side Through Removed Driver Door
- Left Side Oblique Through Windshield
- Front Through Windshield

One Hybrid III 6-Year-Old child dummy (Serial Number 144) was placed in the right front passenger seat situated in the forward-facing position along the outboard edge of the seat per Section 3.3.3.5 according to dummy placement instructions specified in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as prepared by the Side Airbag Out-of-Position Injury Technical Working Group (TWG).

The dummy was instrumented with the following instrumentation:

- Head Accelerometers
- Upper Neck Load Cell
- Lower Neck Load Cell

The 18 channels of data were recorded using an off board data acquisition system. Appendix B contains the dummy data traces.

The Hybrid III 6-Year-Old child dummy's visible contact points were as follows:

- Side curtain airbag to top of head
- Side torso/pelvis airbag to right side of torso and pelvis

The Hybrid III 6-Year-Old child dummy was placed in the right front passenger seat. The dummy was seated on the outboard edge of a foam block aligning the upper spine with the deployment trajectory of the airbag. The head was placed between the seat bolster and pillar/side trim to minimize the fore-aft clearance between the neck and seatback. Legs were aligned such that they cross the heel placement points on the seat cushion. The dummy's pelvis was slid forward (parallel to the centerline of the vehicle) until the neck/torso junction was aligned vertically with the top edge of the airbag module. The dummy's outboard arm was raised to clear the vehicle armrest. The pelvis/torso of the dummy was in contact with the door.

The dummy's skullcap seam was covered with 4mm electrical tape to prevent the airbag from getting caught in the seam. The dummy's head skin was cleaned with alcohol and dusted with baby powder to achieve acceptable frictional characteristics.

This orientation complies with Section 3.3.3.5 of the TWG Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as defined by Lund, et al and the Technical Working Group First Revision dated July 2003.

**SECTION 3  
OCCUPANT AND VEHICLE INFORMATION**



**DATA SHEET NO. 1  
TEST SUMMARY**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
 Test Date: 8/10/2020

**TEST CONFIGURATION INFORMATION**

Seating Position	P2	Right Front Seating Position
Test Section	3.3.3.5*	Forward-Facing Child Dummy
Curtain Airbag	Roof-Rail Mounted	Side Curtain Airbag
Torso Airbag	Seat Mounted	Side Torso/Pelvis Airbag
ATD Type/Serial No.	Hybrid III 6-Year-Old	S/N: 144
Vehicle	Hyundai	Accent
Previous Crash Test	Side MDB NCAP	January 7, 2020 – M20204202

\*Procedure as defined by Lund, et al and the Technical Working Group dated July 2003

**EQUIPMENT INFORMATION**

Number of Data Channels	18
Number of Airbag Channels	4
Number of High-Speed Video	3

**VISIBLE DUMMY CONTACT POINTS**

Head	Side curtain airbag to top of head
Upper Torso	Side torso/pelvis airbag
Lower Torso	Side torso/pelvis airbag
Knee	None

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

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
Test Date: 8/10/2020

**TEST VEHICLE INFORMATION AND OPTIONS**

NHTSA No.	M20204202	Traction Control System (TCS)	Yes
Model Year	2020	Auto-Leveling System	No
Make	Hyundai	Automatic Door Locks (ADL)	Yes
Model	Accent SE	Power Window Auto-Reverse	No
Body Style	4-Door Sedan	Other Optional Feature	No
VIN	3KPC24A66LE103968	Driver Front Airbag	Yes
Body Color	Urban Gray	Driver Curtain Airbag	Yes
Odometer Reading (km/mi)	77 km / 48 mi	Driver Head/Torso Airbag	No
Engine Displacement (L)	1.6 L	Driver Torso Airbag	No
Type/No. Cylinders	Inline 4	Driver Torso/Pelvis Airbag	Yes
Engine Placement	Lateral	Driver Pelvis Airbag	No
Transmission Type	Manual	Driver Knee Airbag	No
Transmission Speeds	6	Rear Pass. Curtain Airbag	Yes
Overdrive	Yes	Rear Pass. Head/Torso Airbag	No
Final Drive	FWD	Rear Pass. Torso Airbag	No
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	No
Power Seats	No	Driver Load Limiter	Yes
Anti-Lock Brakes (ABS)	Yes	Rear Pass. Load Limiter	No
		Other Restraint Feature	N/A

**DATA FROM CERTIFICATION LABEL**

Manufactured By	HYUNDAI MOTOR COMPANY
Date of Manufacture	09/19
Vehicle Type	Passenger Car

GVWR (kg)	1560
GAWR Front (kg)	880
GAWR Rear (kg)	840

**VEHICLE SEATING AND WEIGHT CAPACITY DATA**

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3		5	
Capacity Weight (VCW) (kg)				385	(A)
DSC x 68.04 kg				340	(B)
Rated Cargo and Luggage Weight (RCLW) (kg)				45	(A-B)

**VEHICLE SEAT TYPE**

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

**DATA SHEET NO. 3  
SEAT ADJUSTMENT DATA**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
 Test Date: 8/10/2020

**VEHICLE SEAT FORE/AFT POSITION**

Seat	Total Fore/Aft Travel		Test Position from Forward-Most Position	
	mm	Detents (1 <sup>st</sup> as 1)	mm	Detent (1 <sup>st</sup> as 0)
Right Front Passenger Seat	240	38	88	14
Right Rear Passenger Seat				
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Rearmost and lowest adjustment			
	Seat Track Adjustments: Allowed to ensure proper alignment of the ATD upper spine and airbag deployment trajectory			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

**VEHICLE SEAT BACK ANGLE ADJUSTMENT**

Seat	Total Seat Back Angle Range		Test Position from Vertical	
	Degrees	Detents (1 <sup>st</sup> as 1)	Degrees	Detent (1 <sup>st</sup> as 0)
Right Front Passenger Seat	60.1	32	9.2	9
Right Rear Passenger Seat				
OEM Back Angle Design Position	1.0° measured on outboard headrest post			
Method of Measuring Back Angle Position	Angle measured on outboard headrest post			
Seat Back Position per TWG Guidelines	Initial Position: Manufacturer's design angle			
	Seat Back Adjustments: 2 detents rearward of design position			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

**VEHICLE SEAT HEIGHT ADJUSTMENT**

Seat	Total Seat Height Travel		Test Position from Lowest Position	
	mm	Detents (1 <sup>st</sup> as 1)	mm	Detent (1 <sup>st</sup> as 0)
Right Front Passenger Seat	Fixed		Fixed	
Right Rear Passenger Seat				
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Rearmost and lowest adjustment			
	Seat Height Adjustments: None			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

**DATA SHEET NO. 4**  
**DUMMY SETUP AND POSITIONING DATA**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
Test Date: 8/10/2020

ATD Type	Hybrid III 6-Year-Old child dummy
Serial Number	144
Qualification Date	7/31/2020
Qualification Type	Full
Clothing	Cotton shirt and pants, shoes
Other ATD Preparation	Skullcap seam covered with 4mm electrical tape. Head skin cleaned with alcohol and dusted with baby powder.

**DATA SHEET NO. 5  
DUMMY INJURY CRITERIA VALUES**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
Test Date: 8/10/2020

**RECORDED DATA – MINIMUMS AND MAXIMUMS**

Channel	Unit	CFC	Maximum	Time (ms)	Minimum	Time (ms)
Passenger Head X	g	1000	37.1	8.2	-13.2	30.5
Passenger Head Y			26.6	8.7	-32.0	9.0
Passenger Head Z			13.2	19.0	-45.4	8.2
Passenger Upper Neck Fx	N	1000	459.4	13.9	-53.0	275.2
Passenger Upper Neck Fy			52.2	6.2	-217.0	12.6
Passenger Upper Neck Fz			399.2	22.6	-353.6	8.6
Passenger Upper Neck Mx	Nm	600	15.6	12.7	-14.4	24.4
Passenger Upper Neck My			39.9	12.9	-27.6	31.1
Passenger Upper Neck Mz			2.2	62.6	-5.2	26.2
Passenger Lower Neck Fx	N	1000	240.3	16.1	-413.8	5.9
Passenger Lower Neck Fy			119.2	7.6	-96.6	4.4
Passenger Lower Neck Fz			301.5	29.6	-236.2	43.0
Passenger Lower Neck Mx	Nm	600	5.9	216.8	-27.7	14.5
Passenger Lower Neck My			9.4	271.1	-55.4	15.3
Passenger Lower Neck Mz			7.2	43.9	-28.3	13.1

**HEAD INJURY SUMMARY**

HIC <sub>15</sub>	T <sub>1</sub> (ms)	T <sub>2</sub> (ms)	HIC <sub>36</sub>	T <sub>1</sub> (ms)	T <sub>2</sub> (ms)
23	7.8	22.8	26	7.6	31.8

**NECK INJURY SUMMARY**

Injury Criteria	Unit	Value	Time (ms)
Upper Neck NTF		0.34	14.1
Upper Neck NTE		0.80	30.8
Upper Neck NCF		0.38	11.7
Upper Neck NCE		0.57	34.5
Peak Tension	N	399.2	22.6
Peak Compression	N	353.6	8.6

**DATA SHEET NO. 5 (CONT.)  
DUMMY INJURY CRITERIA DATA**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
Test Date: 8/10/2020

**CHEST INJURY SUMMARY**

<b>Injury Criteria</b>	<b>Unit</b>	<b>Value</b>	<b>Time (ms)</b>
Chest Deflection	mm		
Deflection Rate <sup>1</sup>	m/s		

<sup>1</sup>Deflection rate is calculated based on Chest Deflection potentiometer.

**RESEARCH VALUE SUMMARY**

<b>Research Injury Criteria<sup>1</sup></b>	<b>Unit</b>	<b>Value</b>	<b>Time (ms)</b>
Upper Neck Lateral Moment	Nm	15.6	12.7
Upper Neck Twist Moment	Nm	5.2	26.2
Lower Neck Flexion Moment	Nm	9.4	271.1
Lower Neck Extension Moment	Nm	55.4	15.3
Lower Neck Lateral Moment	Nm	27.7	14.5
Lower Neck Twist Moment	Nm	28.3	13.1
Lower Neck Tension	N	301.5	29.6
Lower Neck Compression	N	236.2	43.0
Spine Acceleration	g		

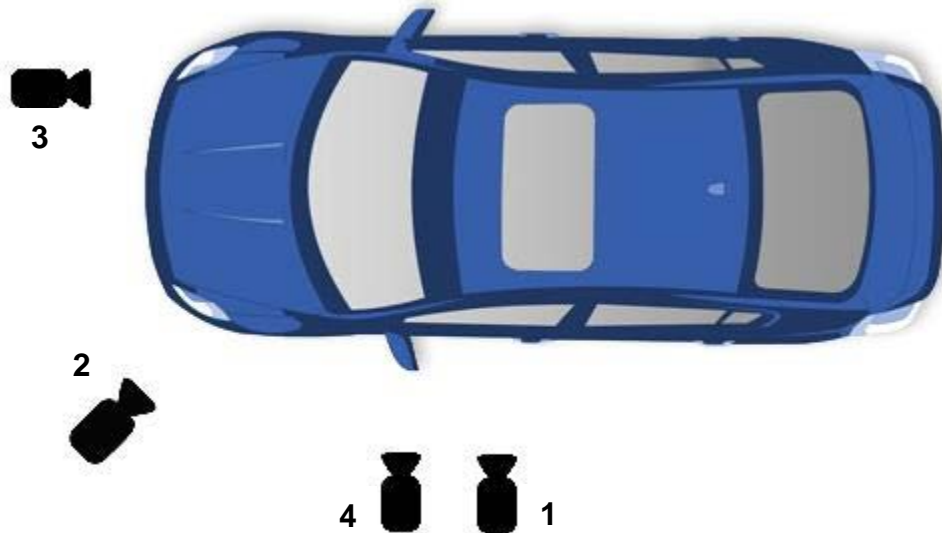
<sup>1</sup>These injury criteria are only monitored and not considered pass/fail.

**DATA SHEET NO. 6  
CAMERA SETUP AND DESCRIPTION**

Test Vehicle: 2020 Hyundai Accent SE 4-Door Sedan  
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20204202TWG2  
 Test Date: 8/10/2020

**CAMERA SETUP DIAGRAM FOR OOP TESTS**



**CAMERA LOCATIONS**

No.	Camera View	Location			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Left View	2204	-1250	-1061	24	2700
2	Oblique View	3756	-1105	-1615	24	2700
3	Front View	4300	315	-1443	24	2700
4	Real Time (optional)					30

Reference:

+X = Forward of Rear Surface of Vehicle (RSOV)

+Y = Right of Vehicle Centerline

+Z = Down from Ground

**APPENDIX A**  
**PHOTOGRAPHS**

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Photo No. 001 - Right Three-Quarter Front View of Vehicle, As Received



Photo No. 002 - Vehicle Certification Placard



Photo No. 003 - Pre-Test Vehicle Left Side View



Photo No. 004 - Post-Test Vehicle Left Side View



Photo No. 005 - Pre-Test Dummy Left Side View



Photo No. 006 - Post-Test Dummy Left Side View



Photo No. 007 - Pre-Test Dummy Left Side Close-Up View

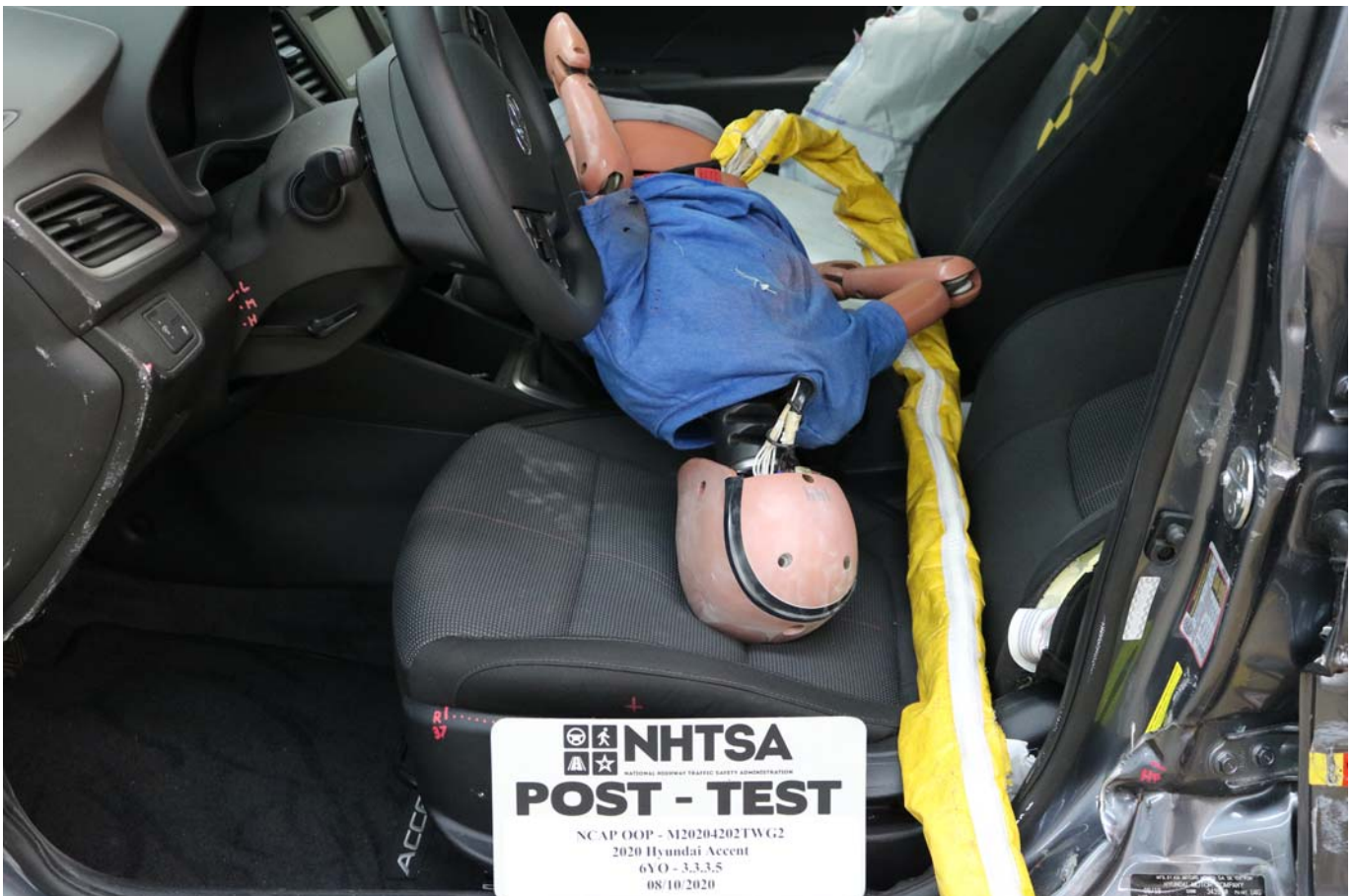


Photo No. 008 - Post-Test Dummy Left Side Close-Up View



Photo No. 009 - Pre-Test Dummy Left Three-Quarter Front View



Photo No. 010 - Post-Test Dummy Left Three-Quarter Front View



Photo No. 011 - Pre-Test Dummy Left Three-Quarter Front Close-Up View



Photo No. 012 - Post-Test Dummy Left Three-Quarter Front Close-Up View

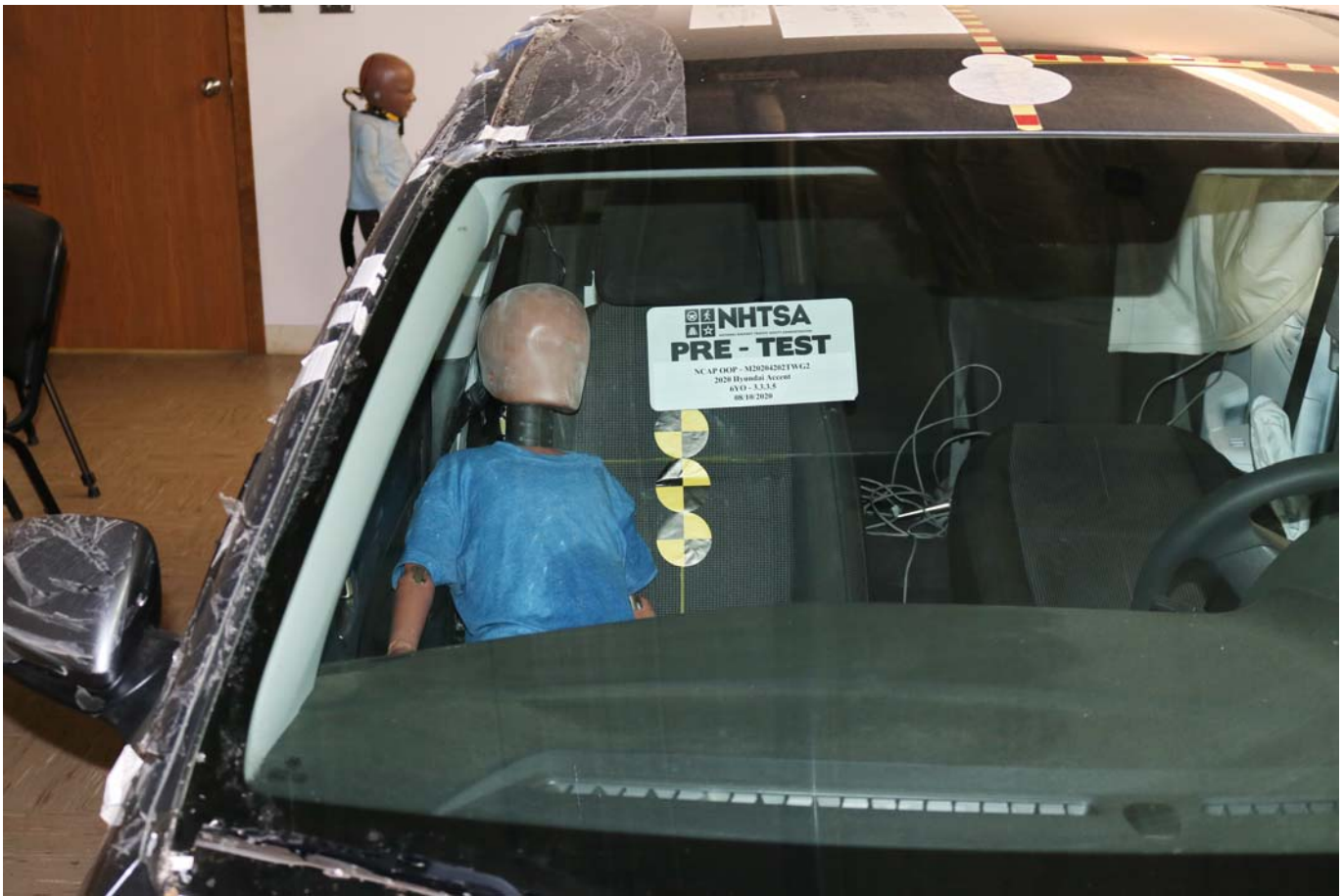


Photo No. 013 - Pre-Test Dummy Front View



Photo No. 014 - Post-Test Dummy Front View



Photo No. 015 - Pre-Test Dummy Front Close-Up View



Photo No. 016 - Post-Test Dummy Front Close-Up View





Photo No. 017 - Pre-Test Dummy Right Three-Quarter Front View



Photo No. 018 - Post-Test Dummy Right Three-Quarter Front View



Photo No. 019 - Pre-Test Dummy Right Side View



Photo No. 020 - Post-Test Dummy Right Side View



Photo No. 021 - Post-Test Dummy Right Side View (Door Open)



Photo No. 022 - Post-Test Curtain Airbag Left Side View



Photo No. 023 - Post-Test Curtain Airbag Left Three-Quarter Front View



Photo No. 024 - Post-Test Curtain Airbag Front View

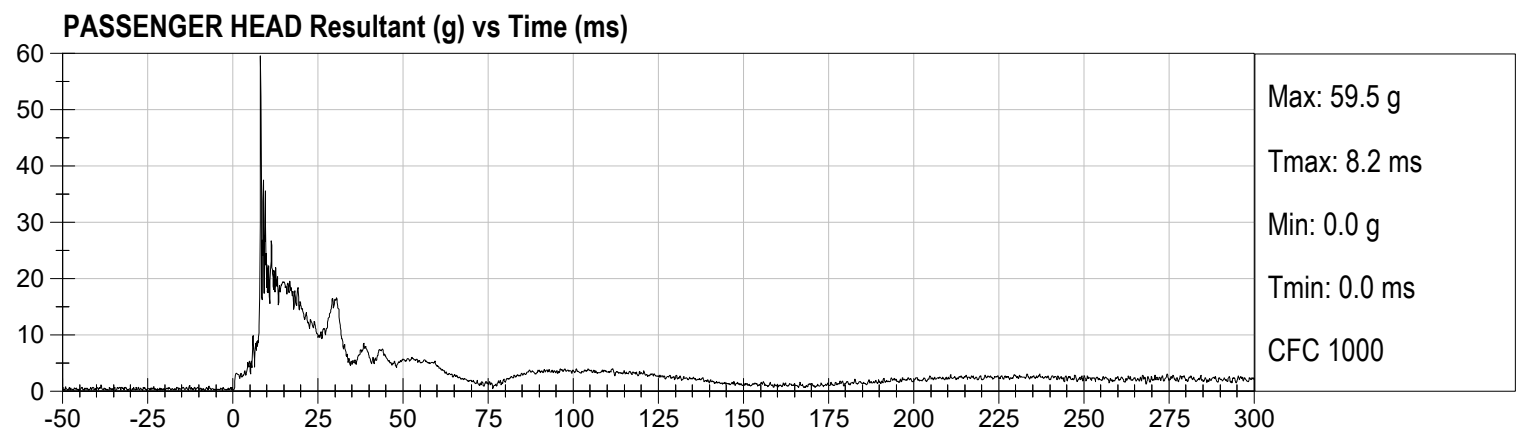
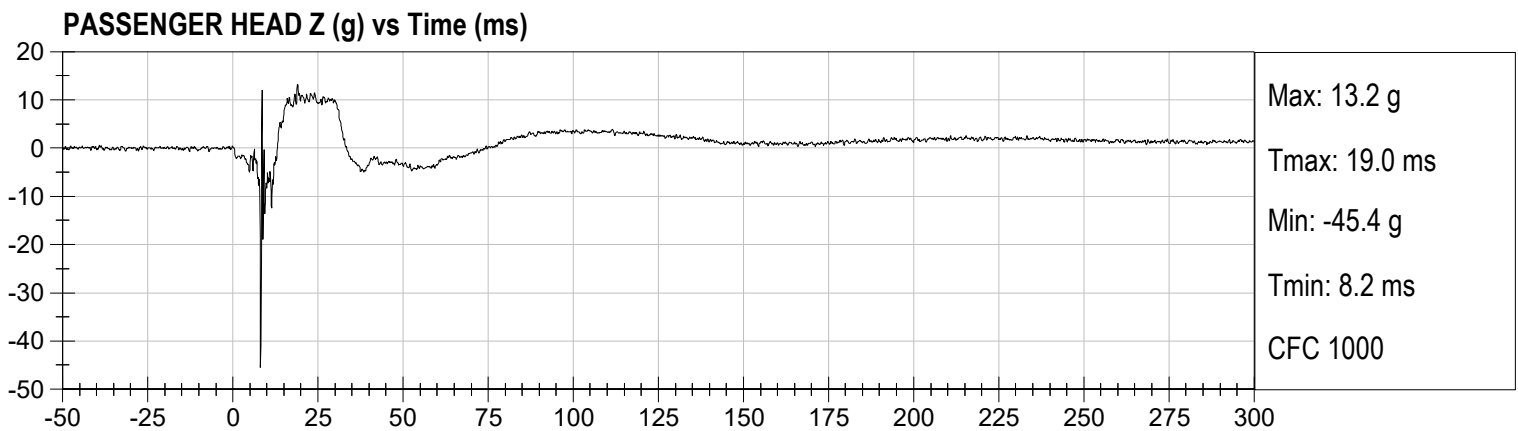
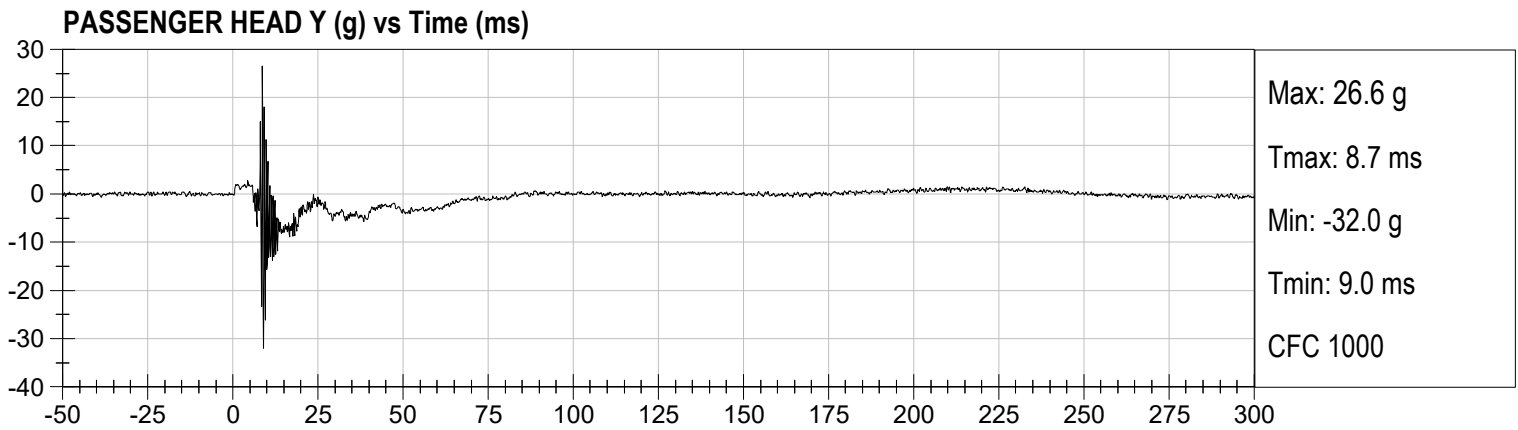
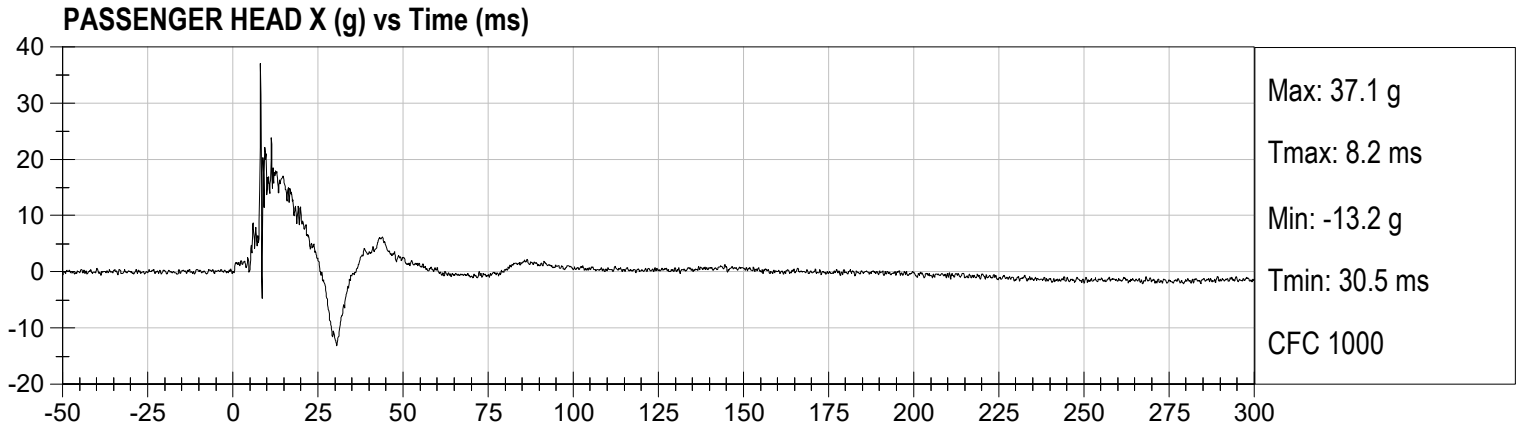


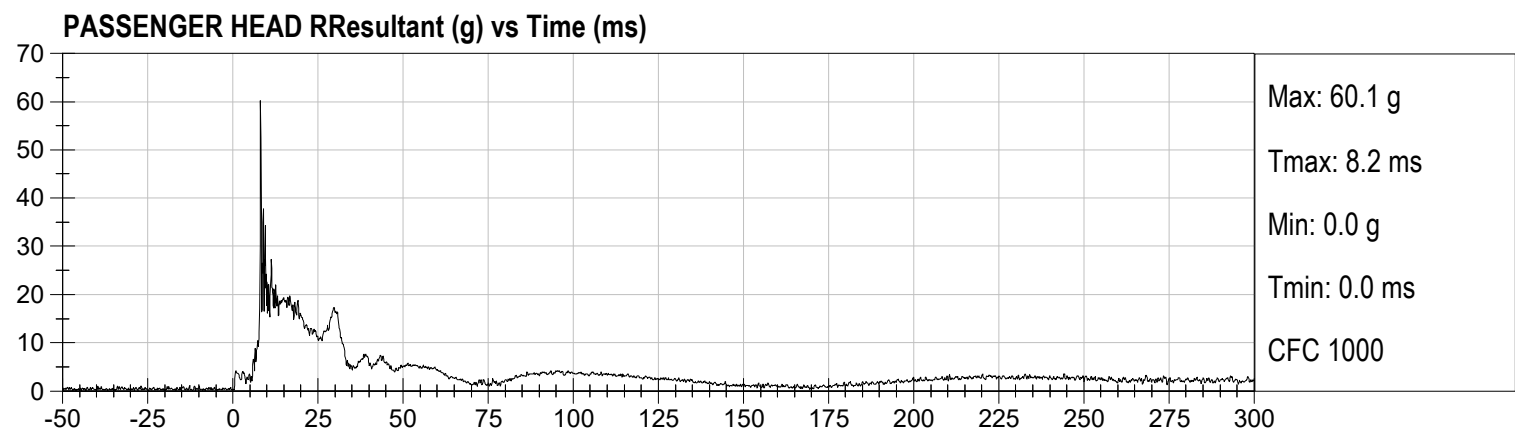
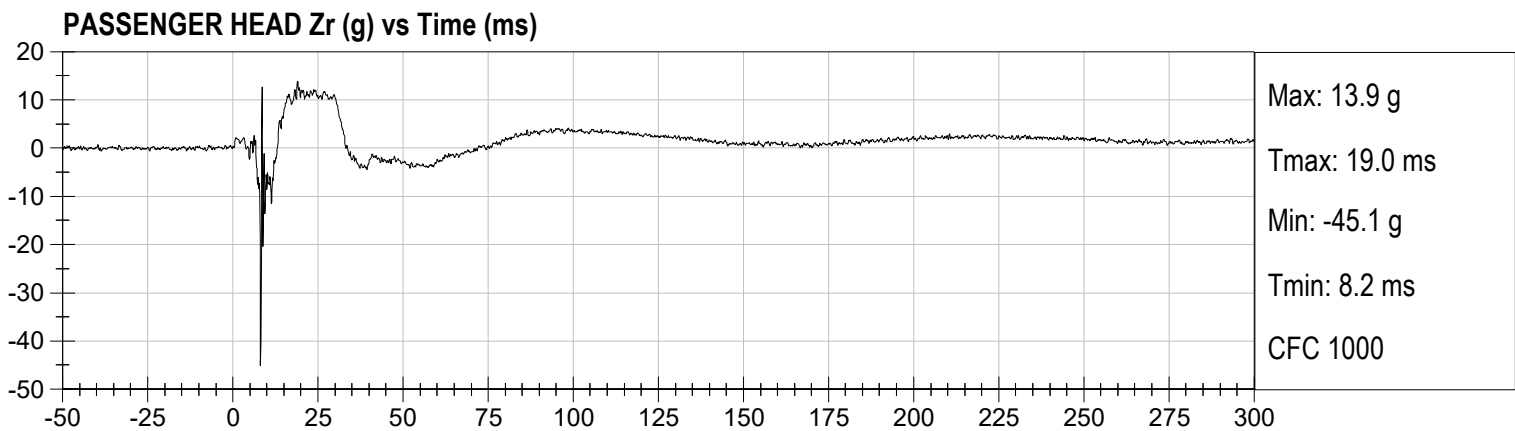
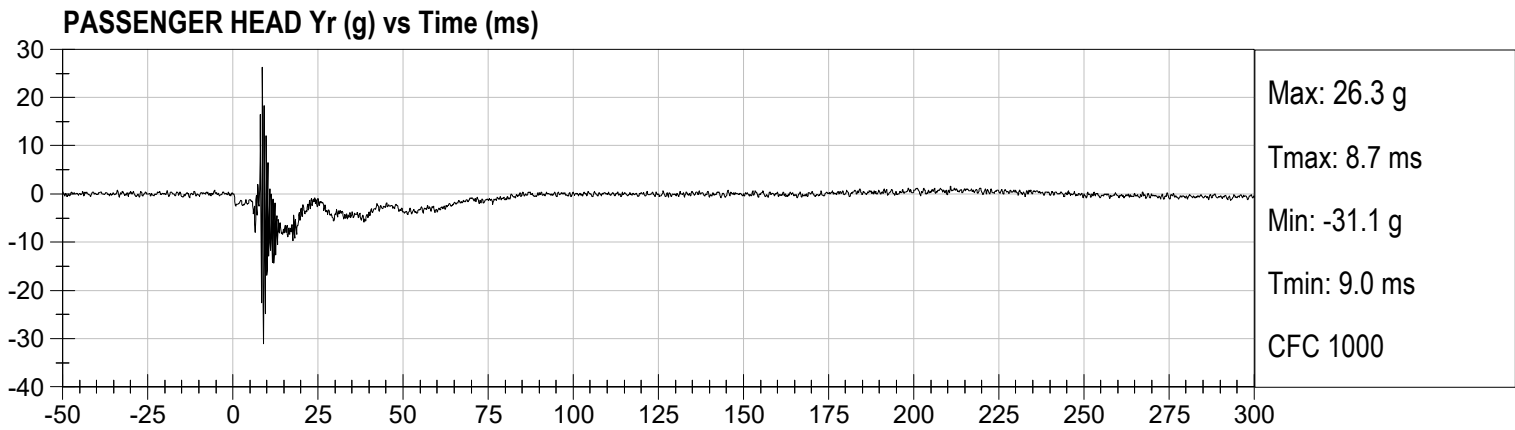
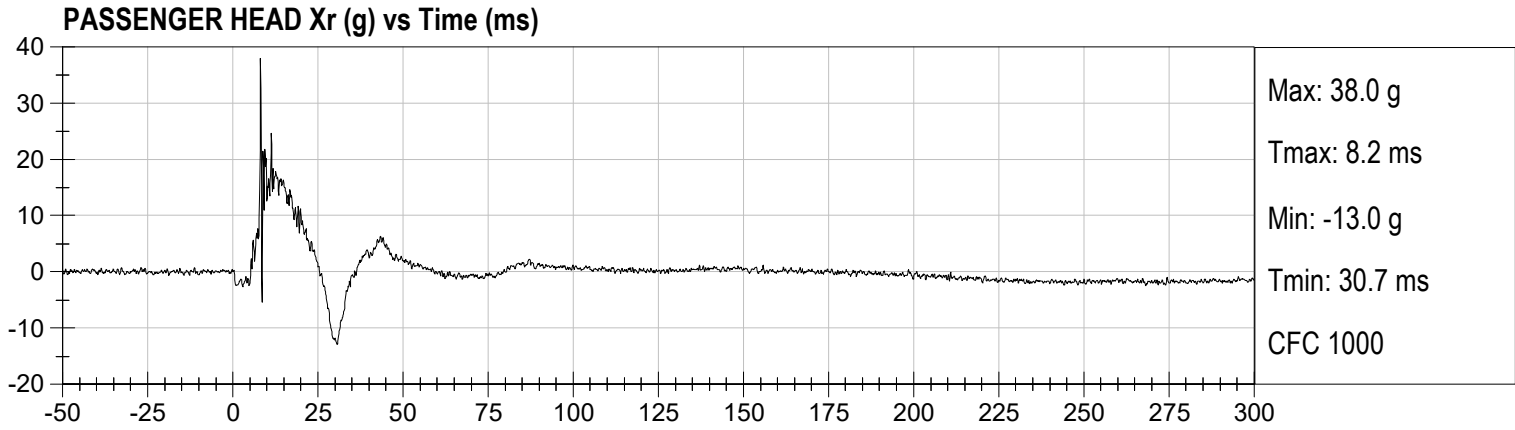
Photo No. 025 - Post-Test Curtain Airbag Right Side View (Door Open)

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

**TABLE OF DATA PLOTS**

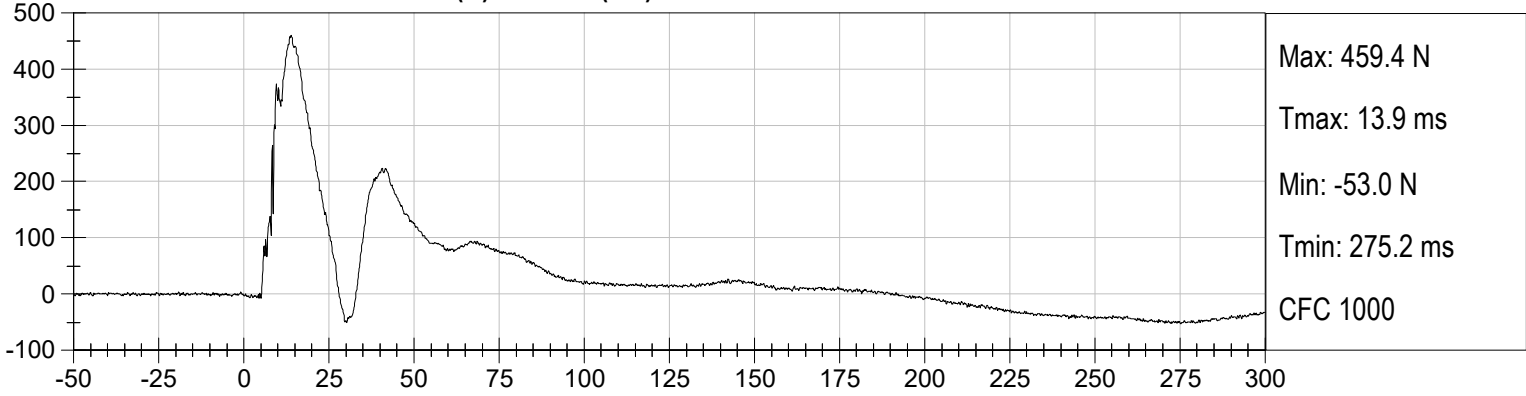
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Passenger Upper Neck X Force vs. Time	B-3
Passenger Upper Neck Y Force vs. Time	B-3
Passenger Upper Neck Z Force vs. Time	B-3
Passenger Upper Neck Resultant Force vs. Time	B-3
Passenger Upper Neck X Moment vs. Time	B-4
Passenger Upper Neck Y Moment vs. Time	B-4
Passenger Upper Neck Z Moment vs. Time	B-4
Passenger Upper Neck Resultant Moment vs. Time	B-4
Passenger Lower Neck X Force vs. Time	B-5
Passenger Lower Neck Y Force vs. Time	B-5
Passenger Lower Neck Z Force vs. Time	B-5
Passenger Lower Neck Resultant Force vs. Time	B-5
Passenger Lower Neck X Moment vs. Time	B-6
Passenger Lower Neck Y Moment vs. Time	B-6
Passenger Lower Neck Z Moment vs. Time	B-6
Passenger Lower Neck Resultant Moment vs. Time	B-6
Passenger Curtain Airbag – Fire Voltage vs. Time	B-7
Passenger Curtain Airbag – Fire Current vs. Time	B-7
Passenger Seat Airbag – Fire Voltage vs. Time	B-7
Passenger Seat Airbag – Fire Current vs. Time	B-7
Passenger Nij (NTF)	B-8
Passenger Nij (NTE)	B-8
Passenger Nij (NCF)	B-8
Passenger Nij (NCE)	B-8



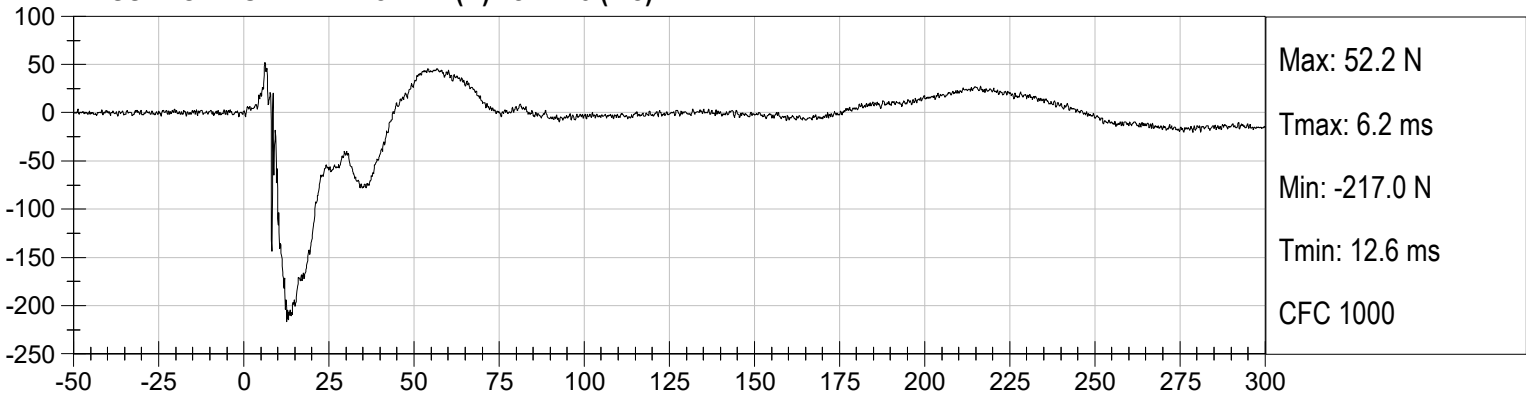




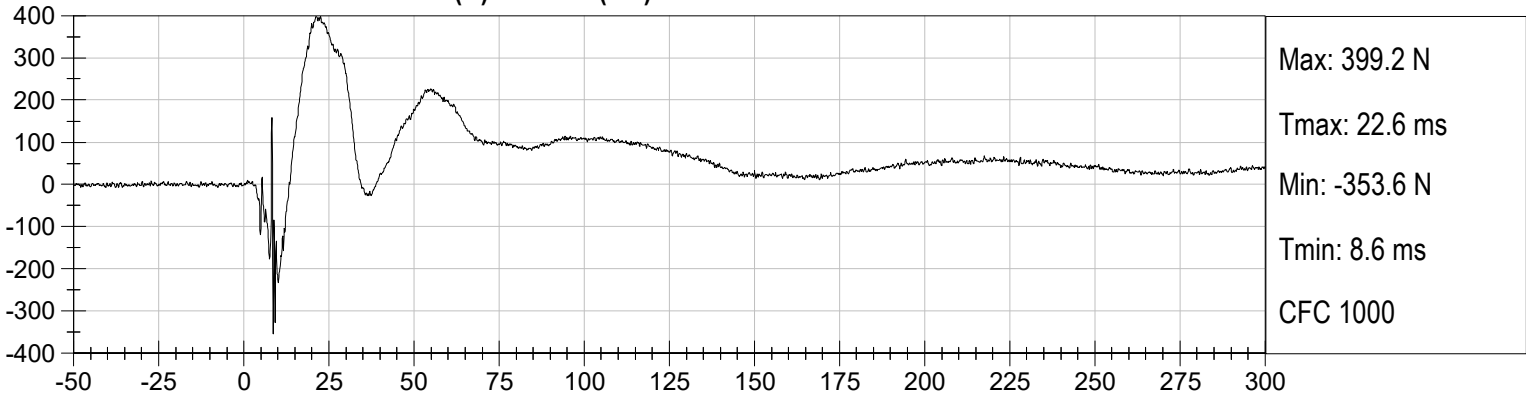
**PASSENGER UPPER NECK FX (N) vs Time (ms)**



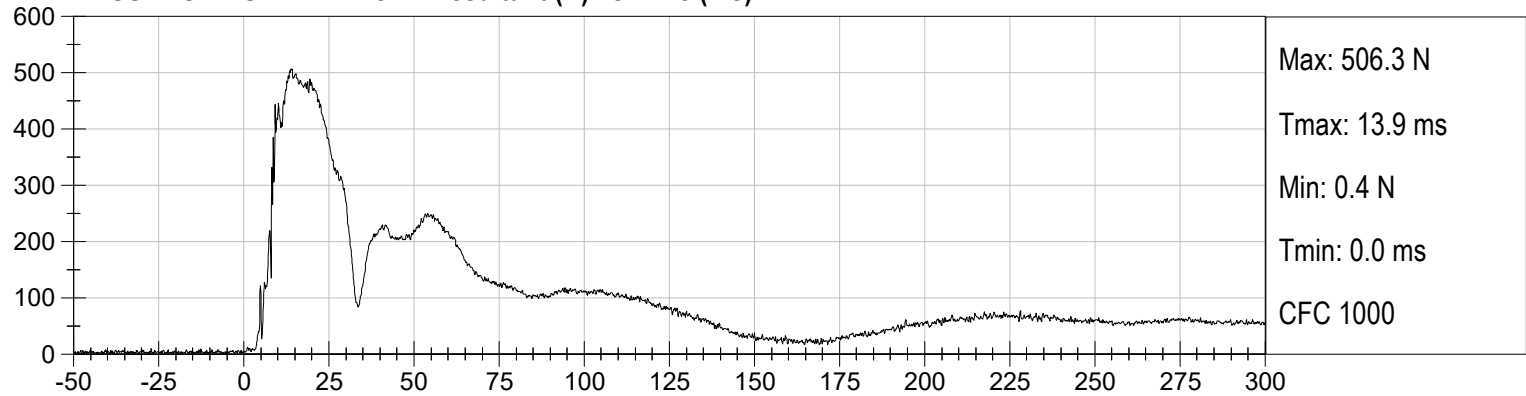
**PASSENGER UPPER NECK FY (N) vs Time (ms)**

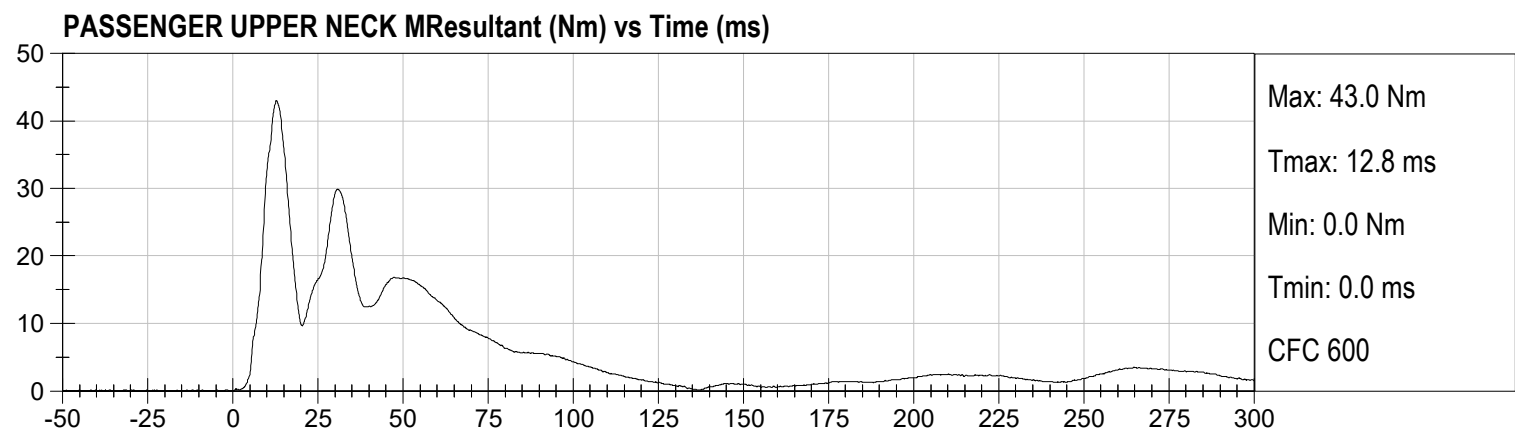
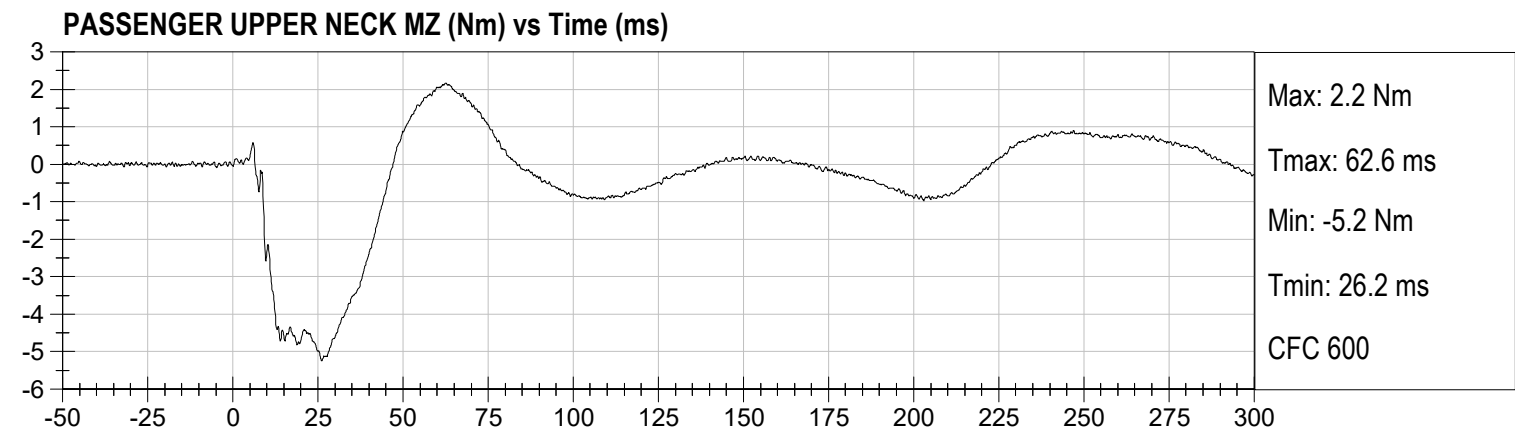
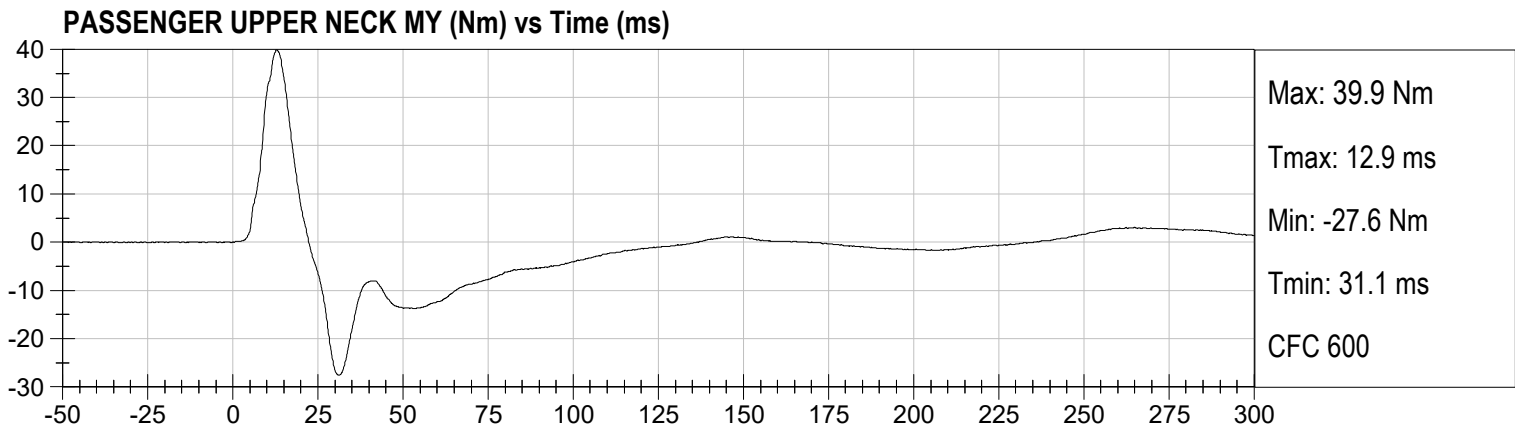
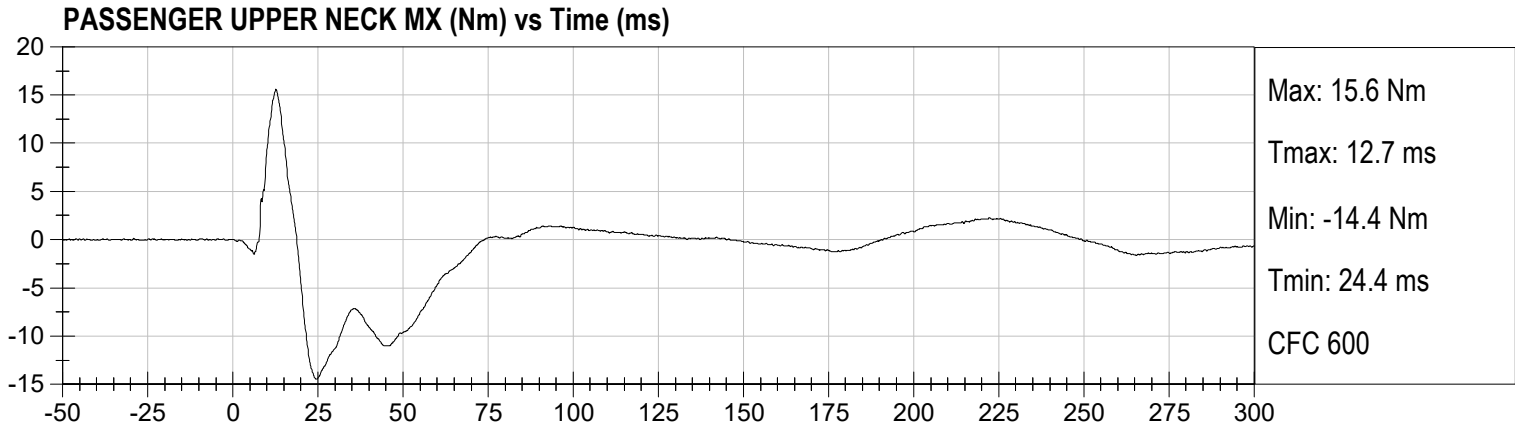


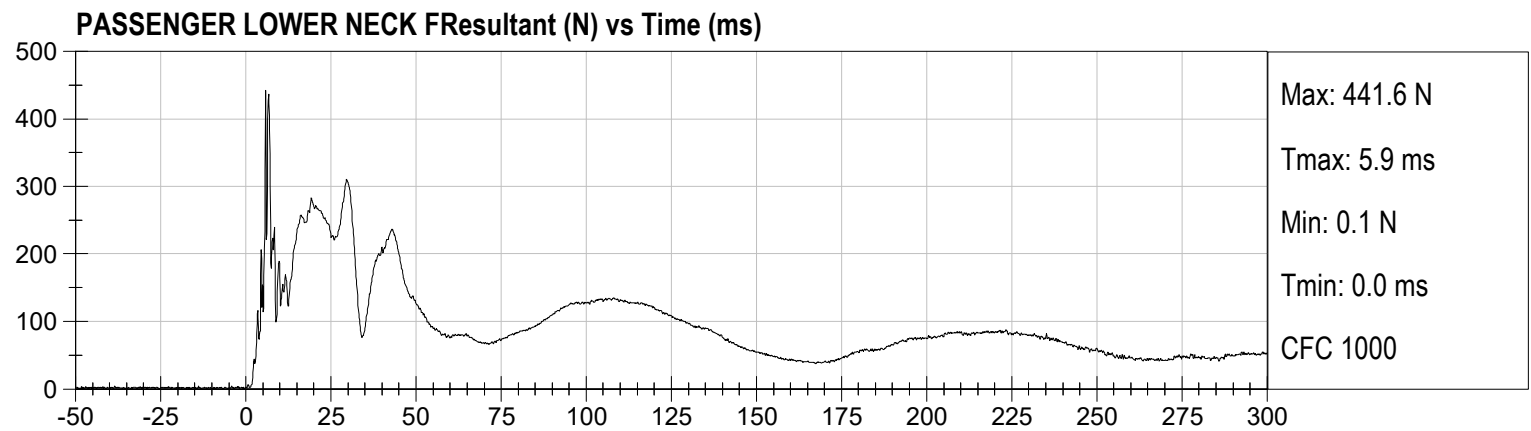
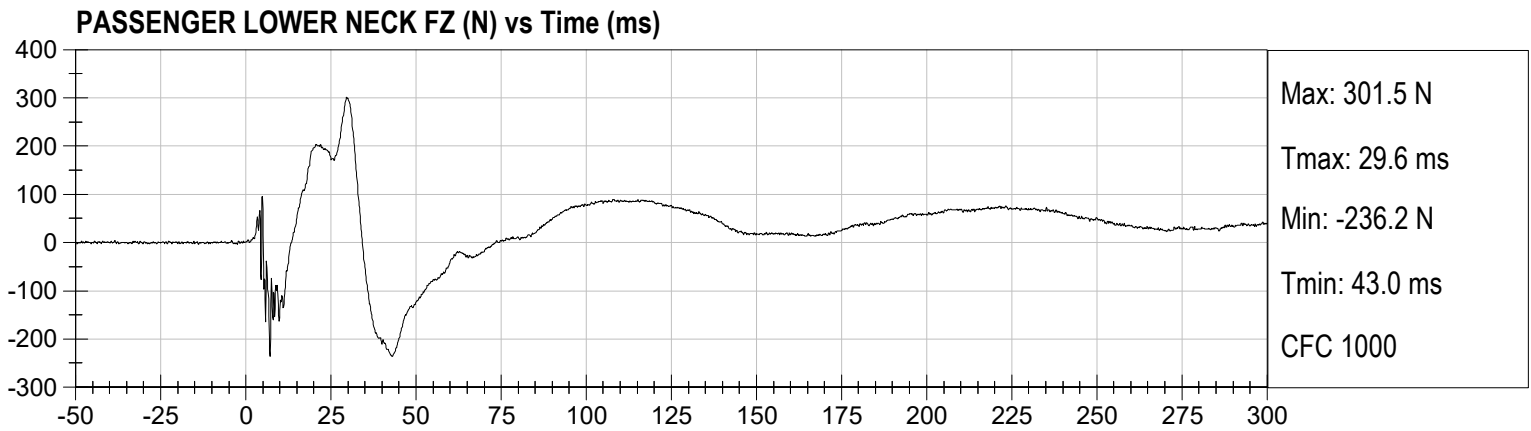
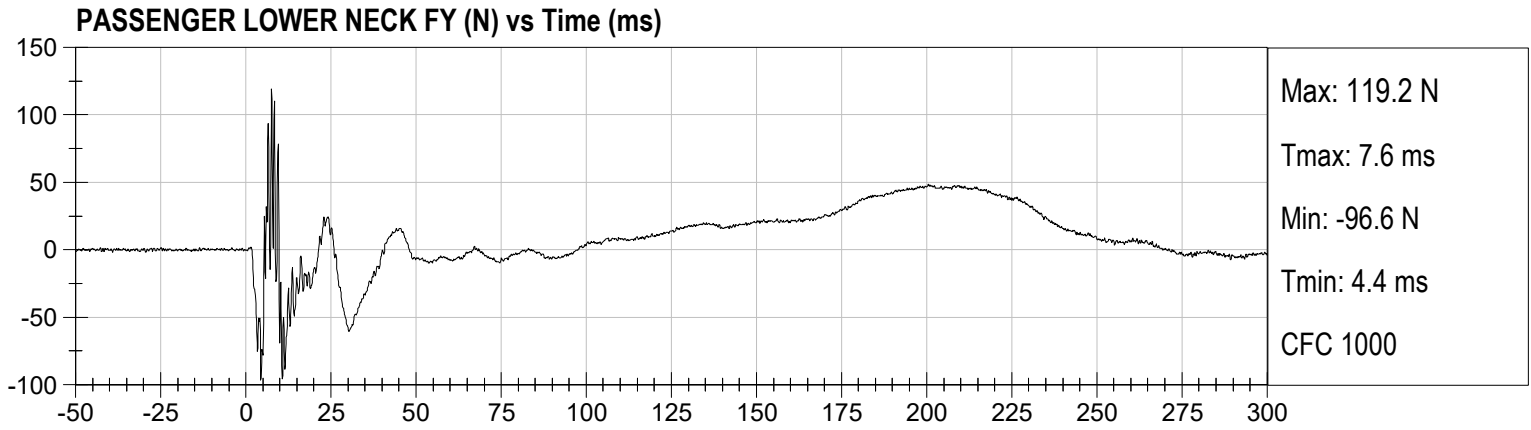
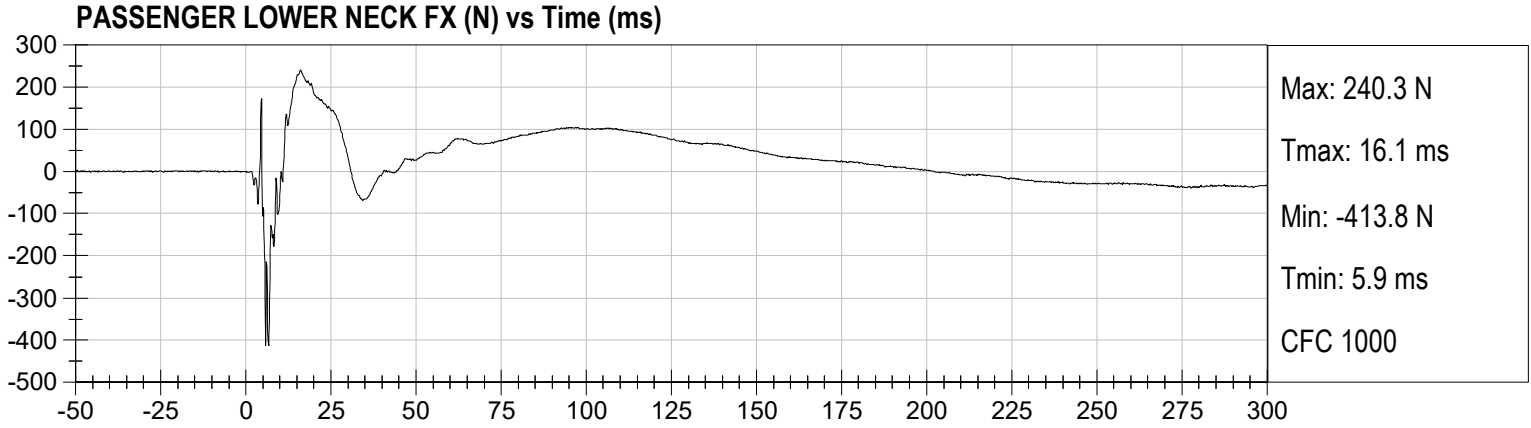
**PASSENGER UPPER NECK FZ (N) vs Time (ms)**

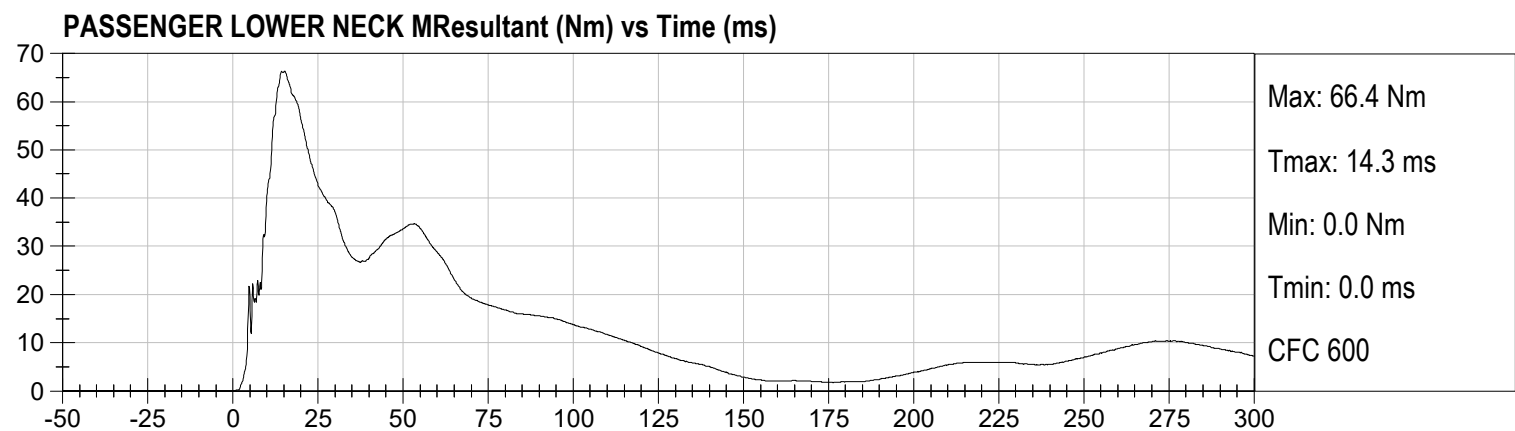
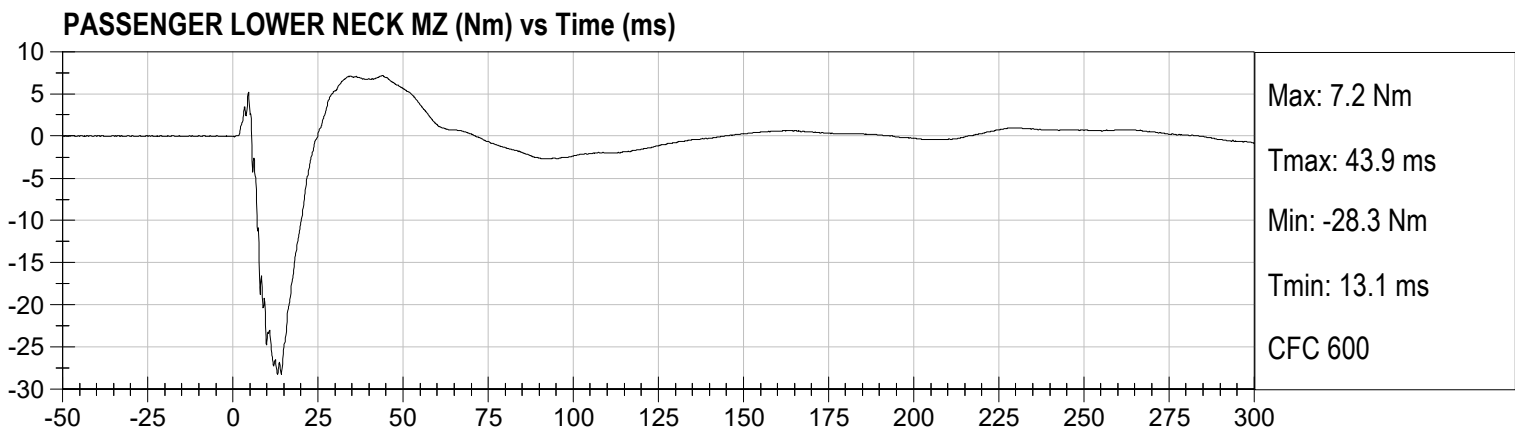
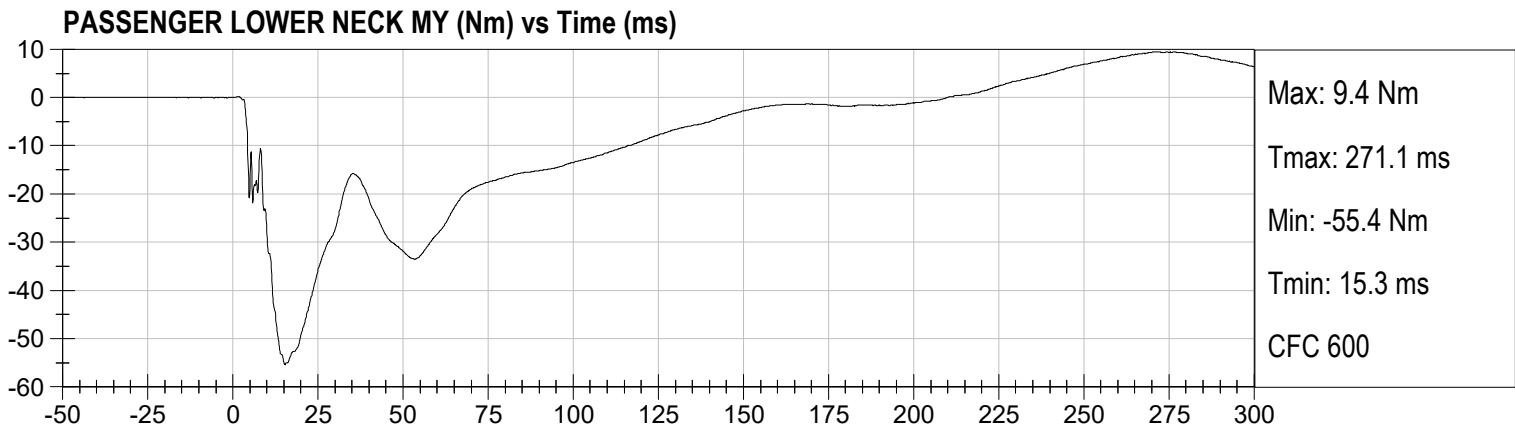
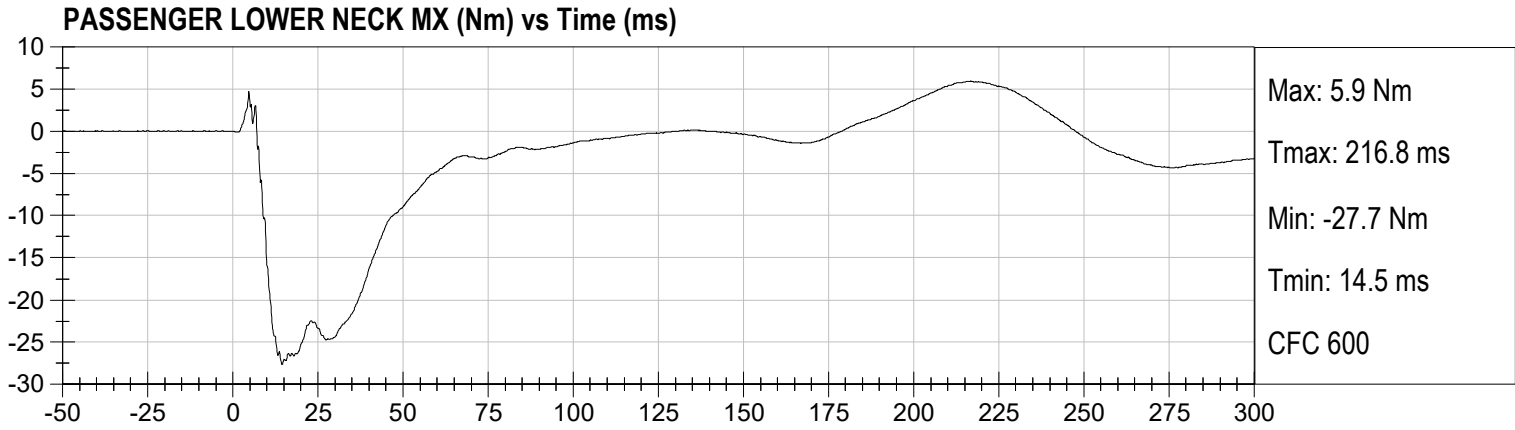


**PASSENGER UPPER NECK FResultant (N) vs Time (ms)**

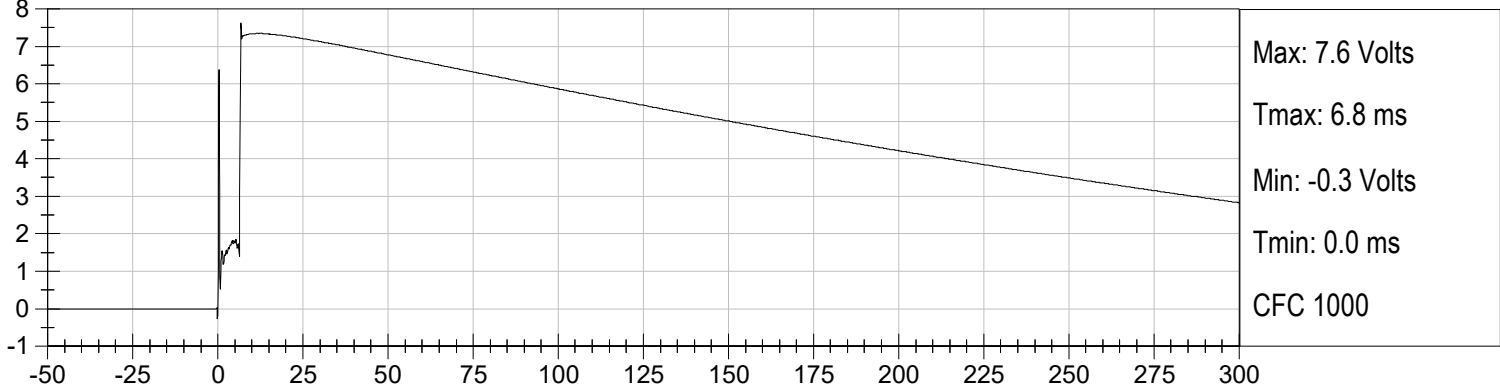




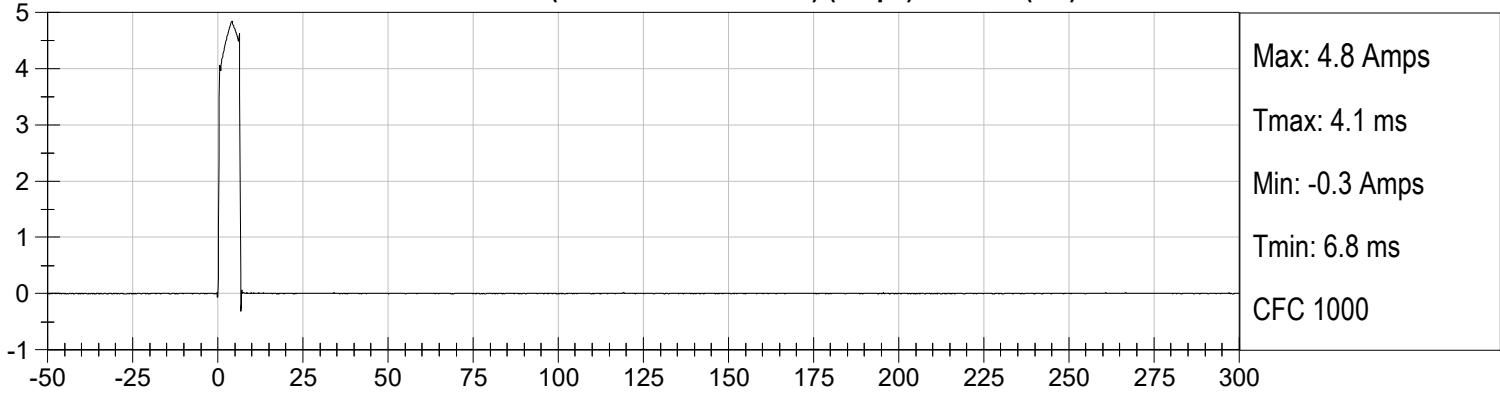




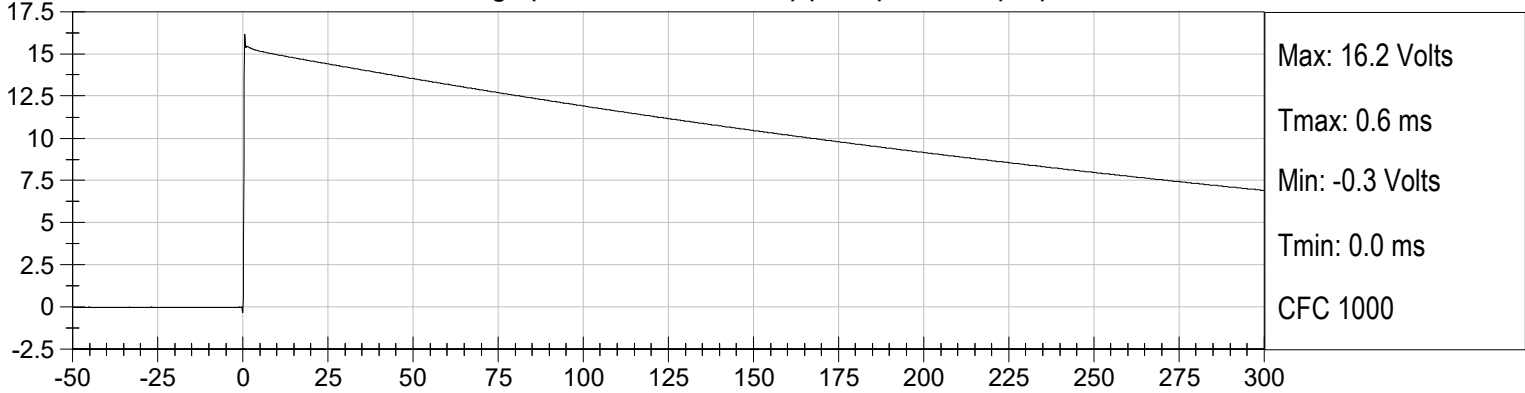
**PASSENGER CURTAIN AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)**



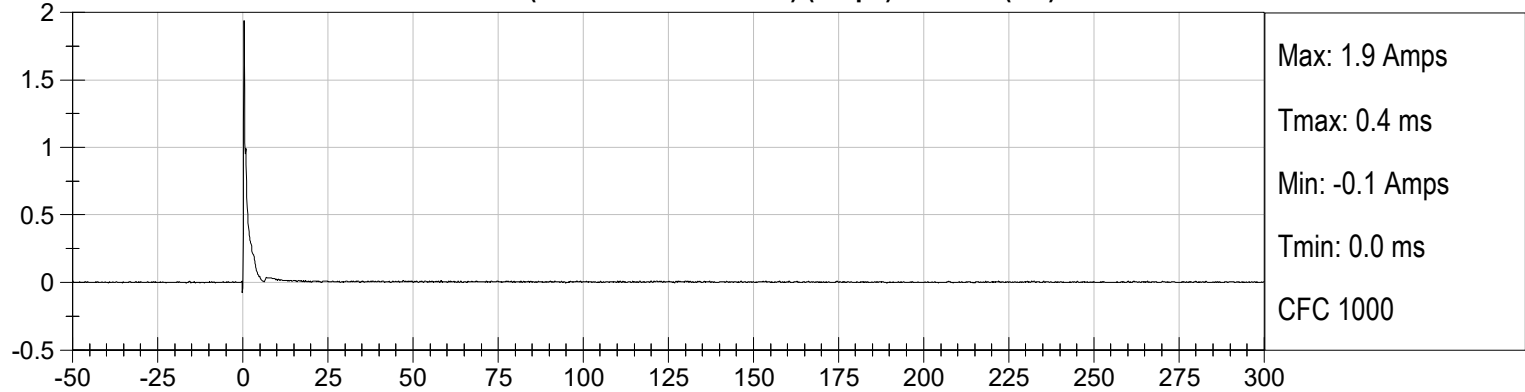
**PASSENGER CURTAIN AB - Fire Current (DC Constant Current) (Amps) vs Time (ms)**

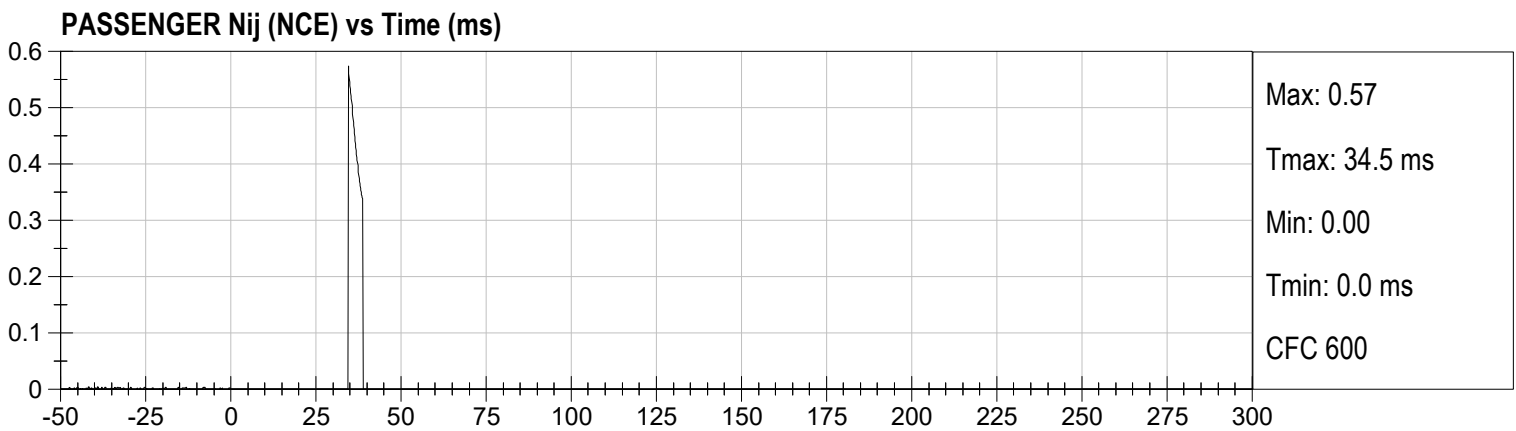
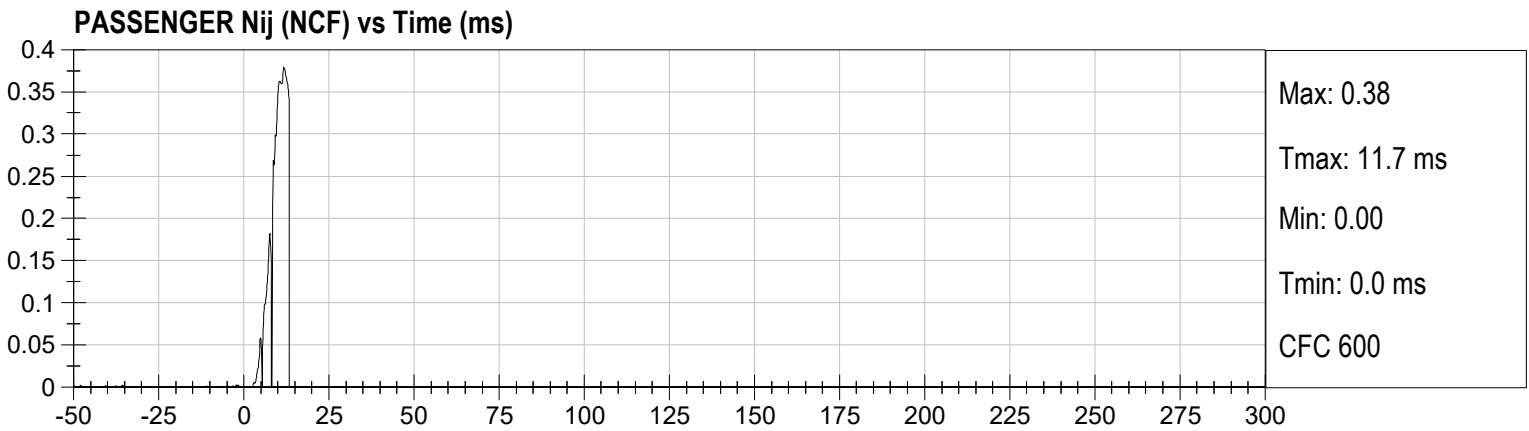
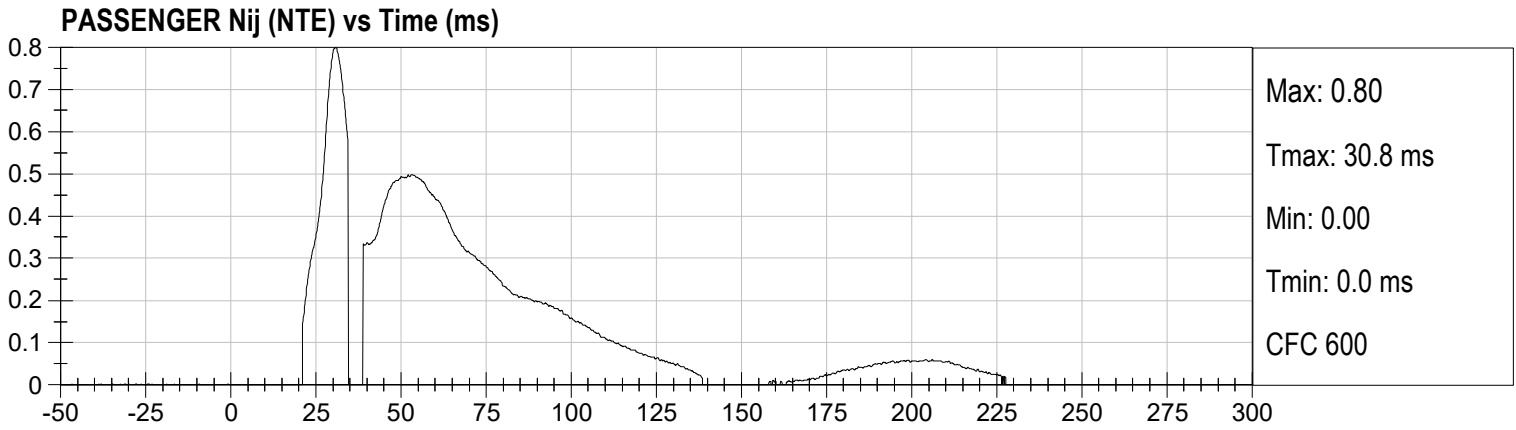
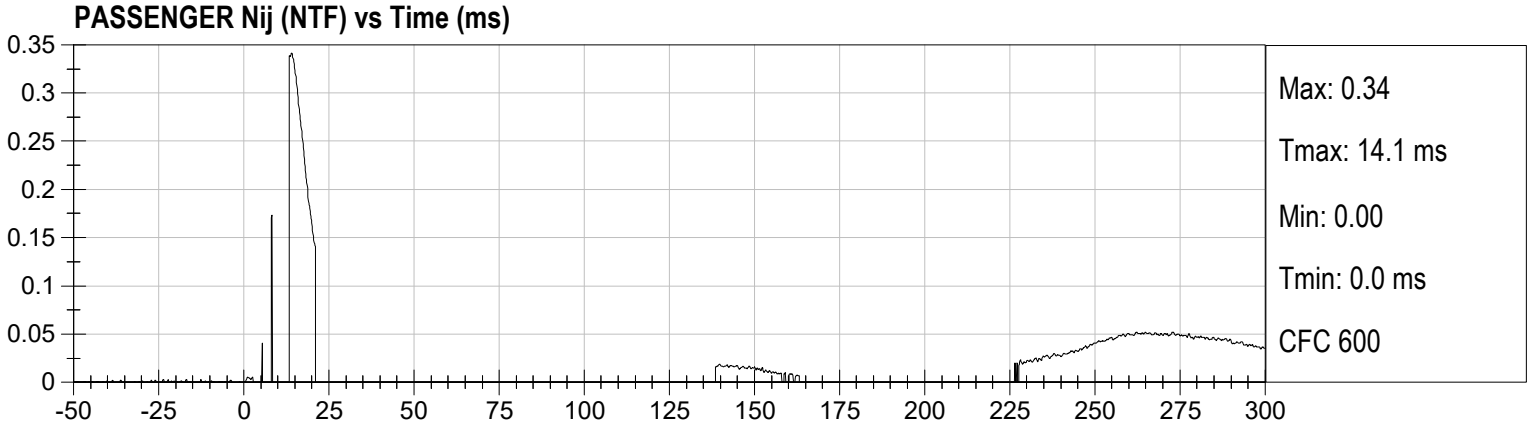


**PASSENGER SEAT AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)**



**PASSENGER SEAT AB - Fire Current (DC Constant Current) (Amps) vs Time (ms)**





**APPENDIX C**  
**DUMMY CONFIGURATION AND PERFORMANCE VERIFICATION DATA**

**CALIBRATION TEST RESULTS**

**PRE-TEST**

**Hybrid III 6-Year-Old ATD**



**MGA RESEARCH CORPORATION**  
**HEAD DROP TEST**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

Test ID: D201741

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	45	Pass
Peak Resultant Acceleration	G's	245 to 300	264	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-7.9	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

*Brian Roach*

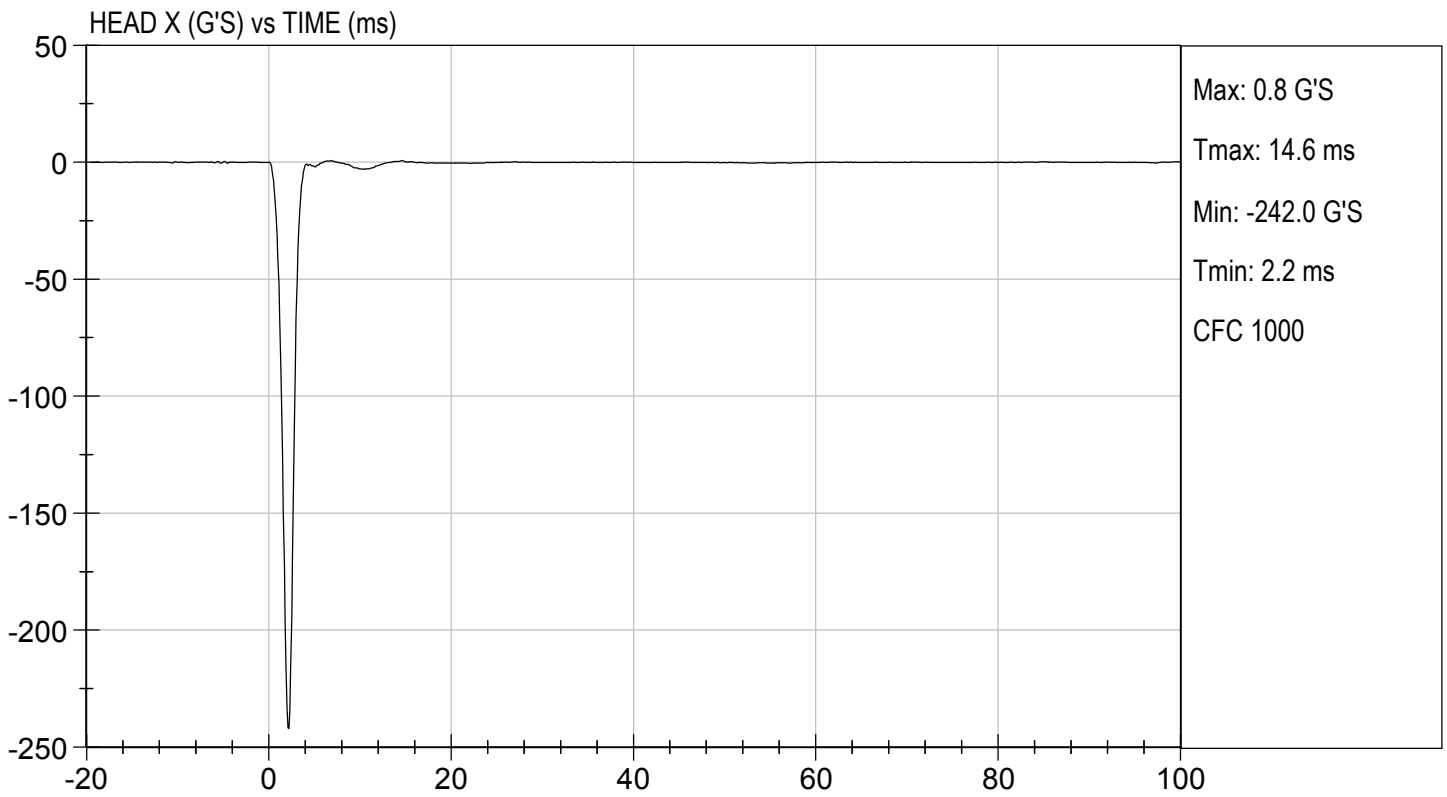
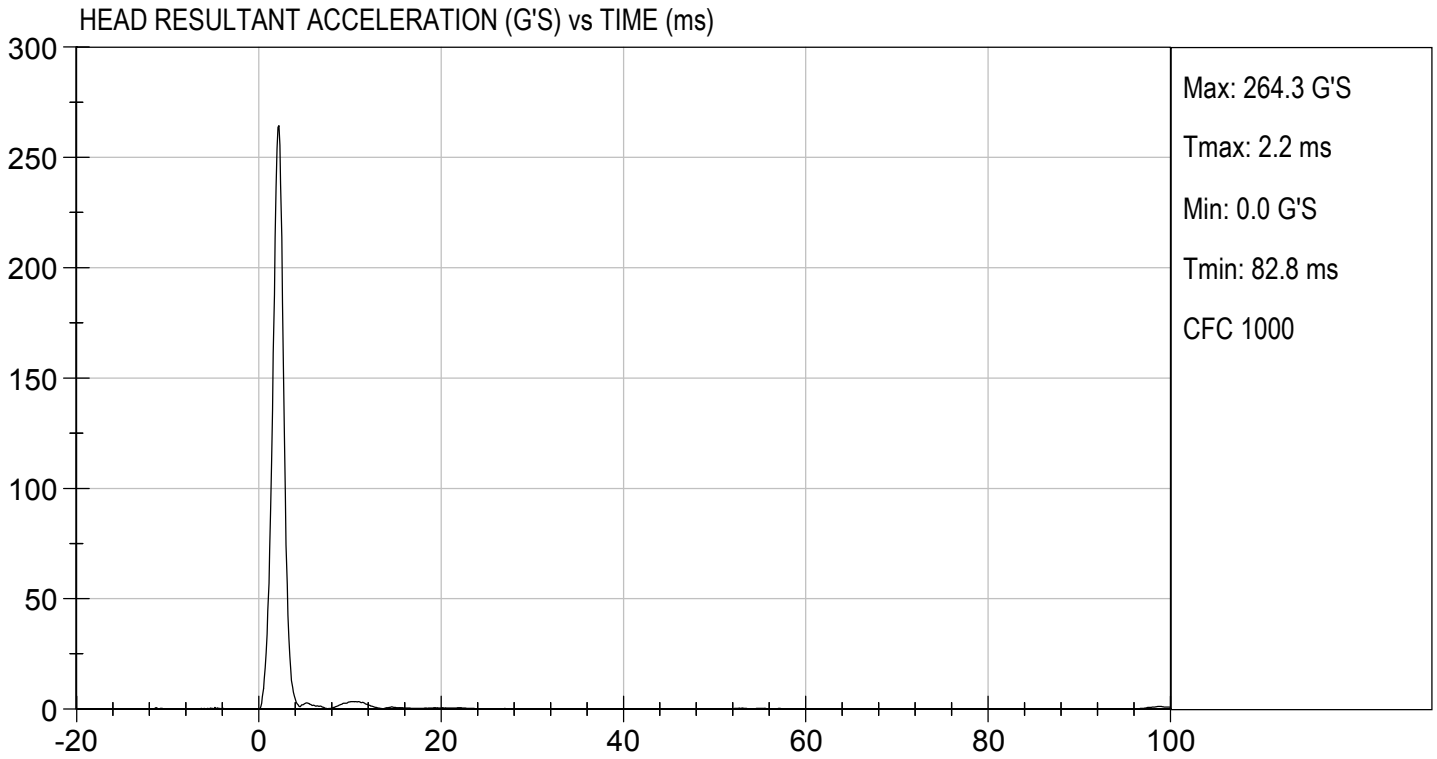
Laboratory Technician

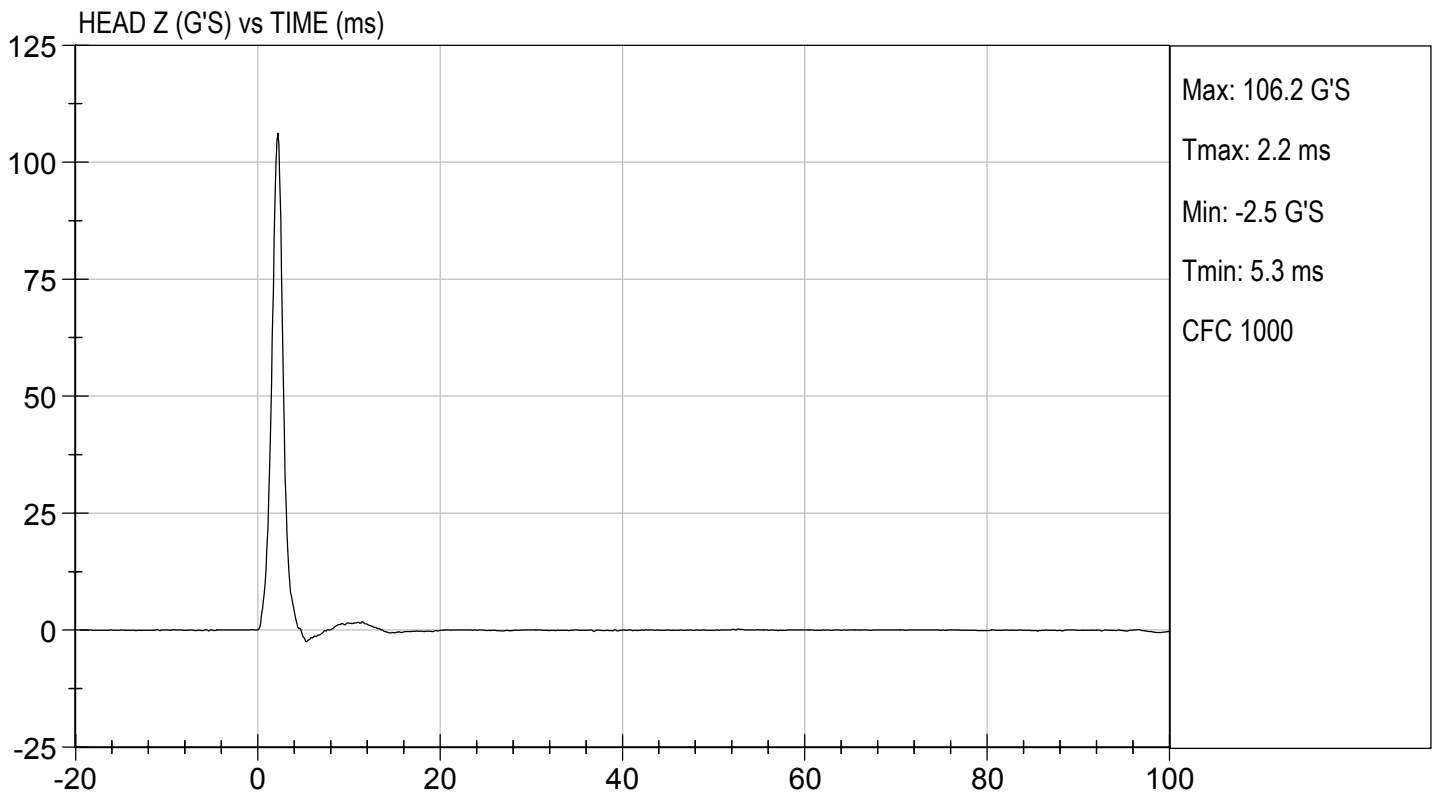
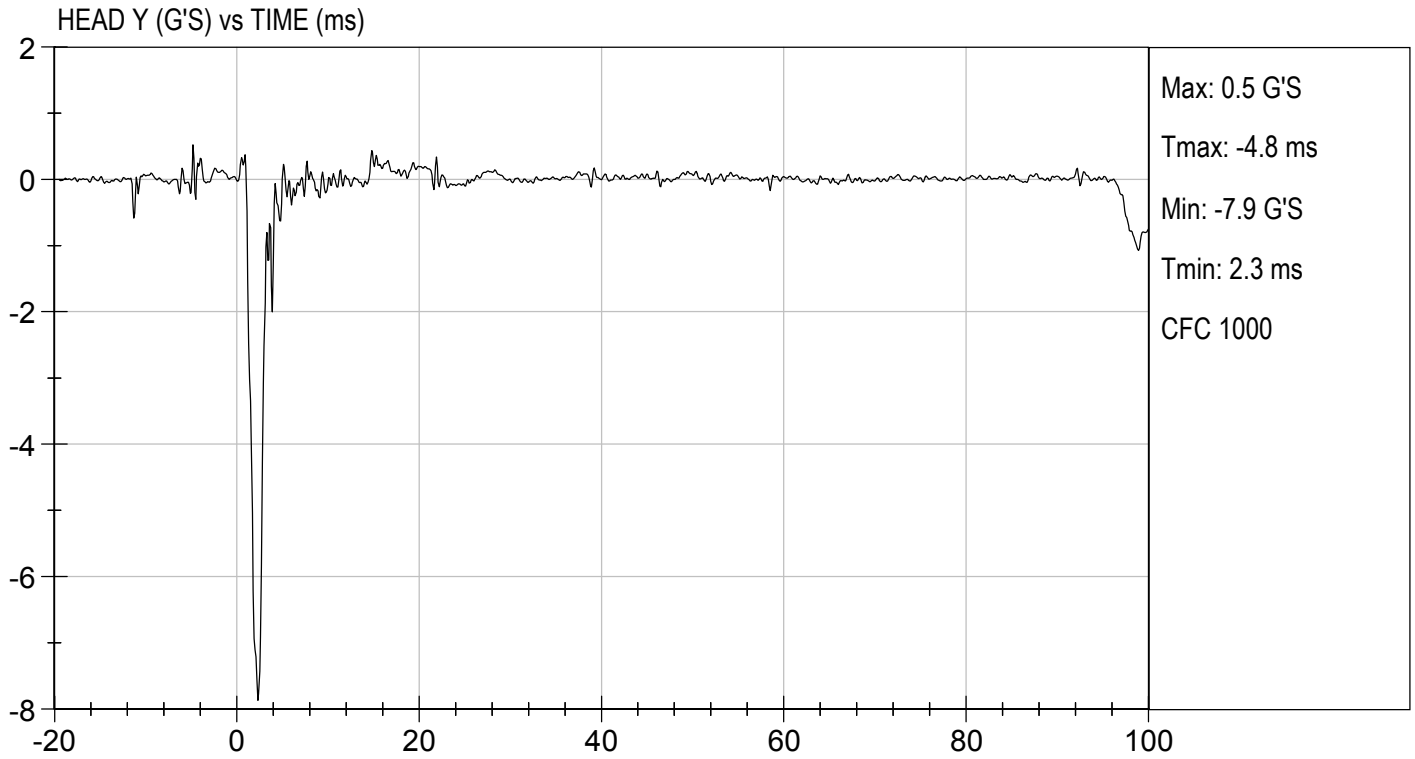
07/17/2020

Test Date

*B. F. K.*

Approved By





**MGA RESEARCH CORPORATION**

**NECK FLEXION TEST**

**HYBRID III 6 YEAR OLD**

**ATD Serial No:** 144

**Test I.D.:** D201742

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	40	Pass	
Pendulum Speed	m/s	4.83 to 5.07	4.84	Pass	
Pendulum Velocity	10 ms	m/s	1.2 to 1.6	1.5	Pass
	20 ms	m/s	2.4 to 3.4	3.0	Pass
	30 ms	m/s	3.8 to 5.0	4.3	Pass
D Plane Rotation	Max	deg	74 to 92	75	Pass
Occipital Condyle Moment within Deflection Corridor	Nm	27 to 33	30.8	Pass	
Positive Moment Time Curve Decay to 5 Nm	ms	103 to 123	106	Pass	
Overall Results				Pass	

*Brian Roach*

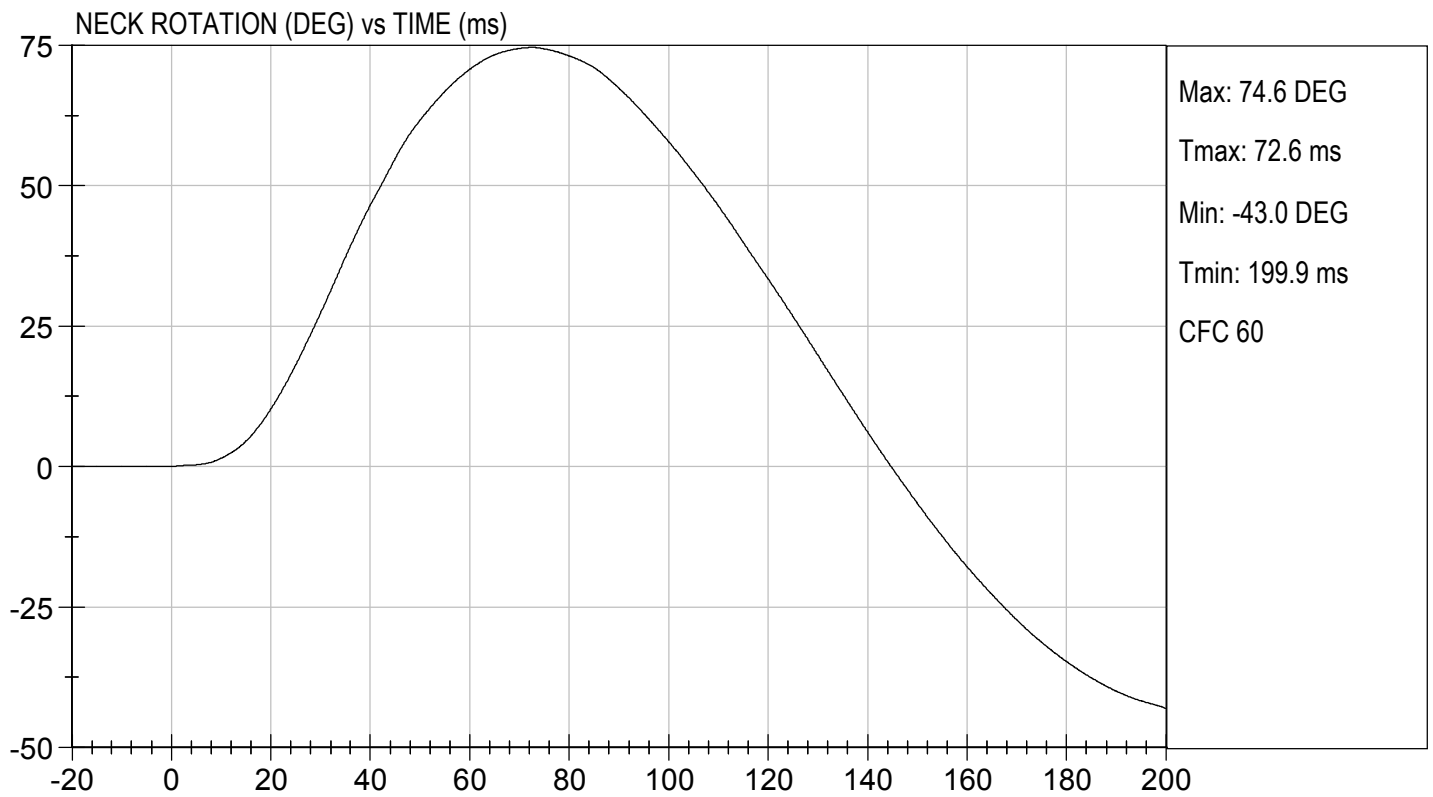
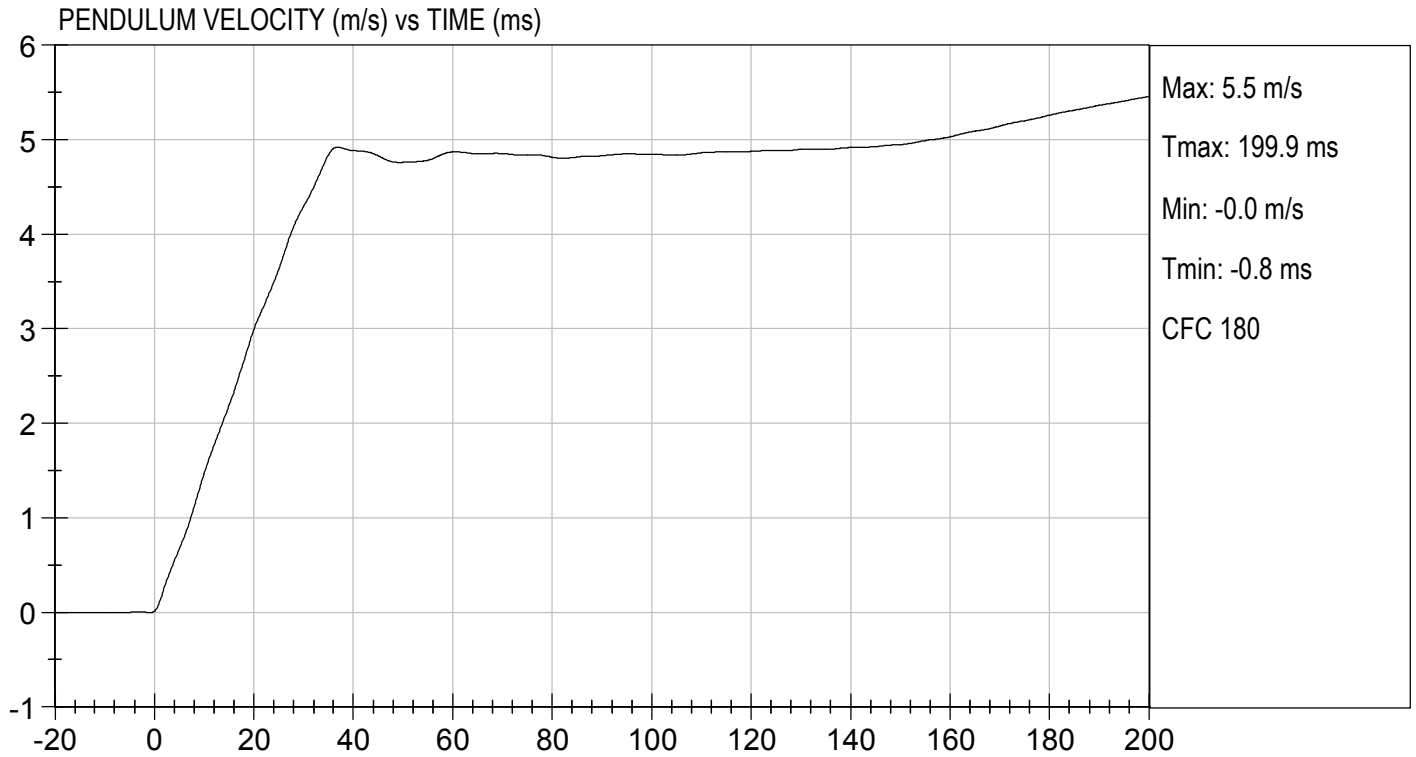
Laboratory Technician

07/28/2020

Test Date

*B. F. K.*

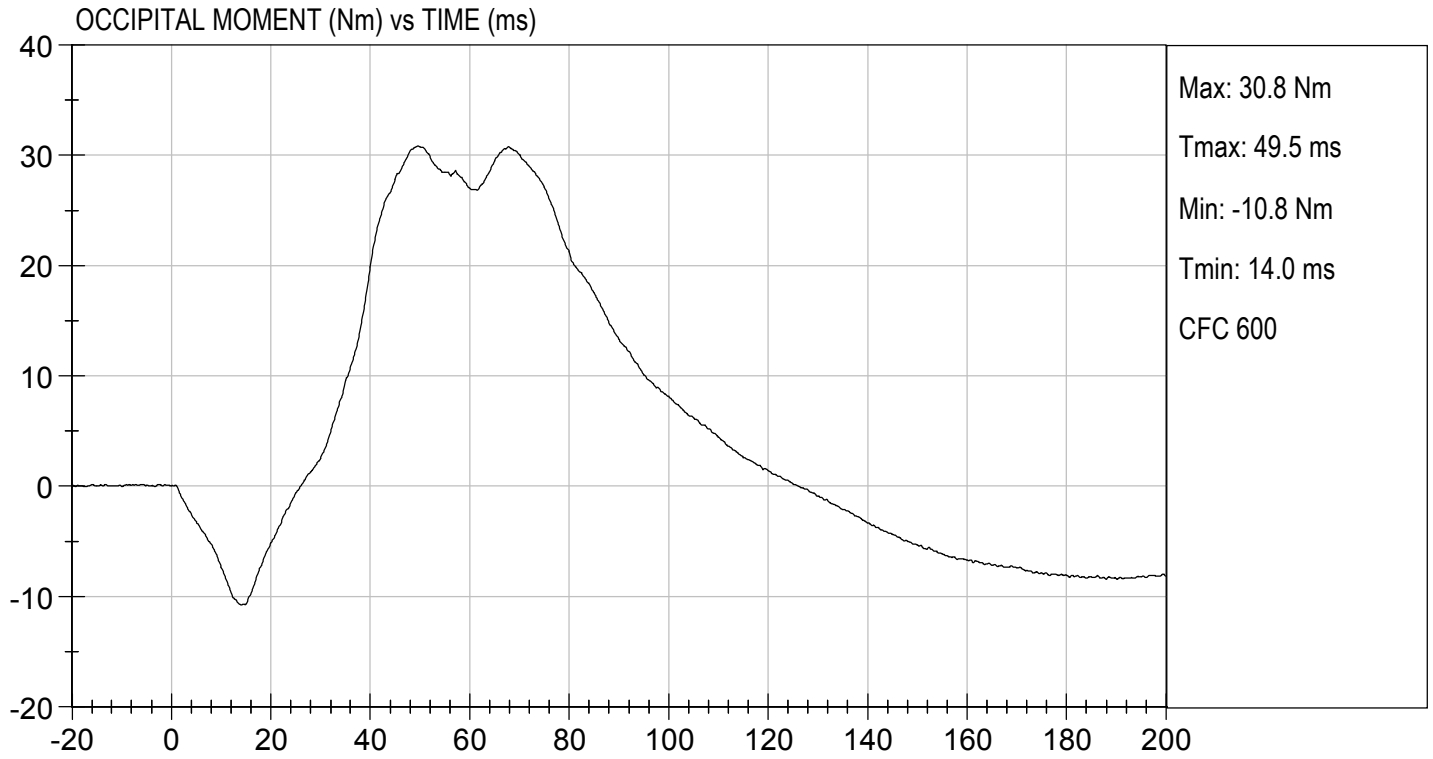
Approved By





TEST DESC: NECK FLEXION  
VELOCITY: 15.87 ft/s, 4.84 m/s

TEST DATE: 07/28/2020  
TEST #: D201742



**MGA RESEARCH CORPORATION**

**NECK EXTENSION TEST**

**HYBRID III 6 YEAR OLD**

**ATD Serial No:** 144

**Test I.D:** D201743

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	40	Pass
Pendulum Speed		m/s	4.18 to 4.42	4.20	Pass
Pendulum Velocity	10 ms	m/s	1.0 to 1.4	1.2	Pass
	20 ms	m/s	2.2 to 3.0	2.4	Pass
	30 ms	m/s	3.2 to 4.2	3.7	Pass
D Plane Rotation	Max	deg	85 to 103	90	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	-19 to -24	-20	Pass
Positive Moment Time Curve Decay to 5 Nm		msec	123 to 147	128	Pass
<b>Overall Results</b>					<b>Pass</b>

*Brian Roach*

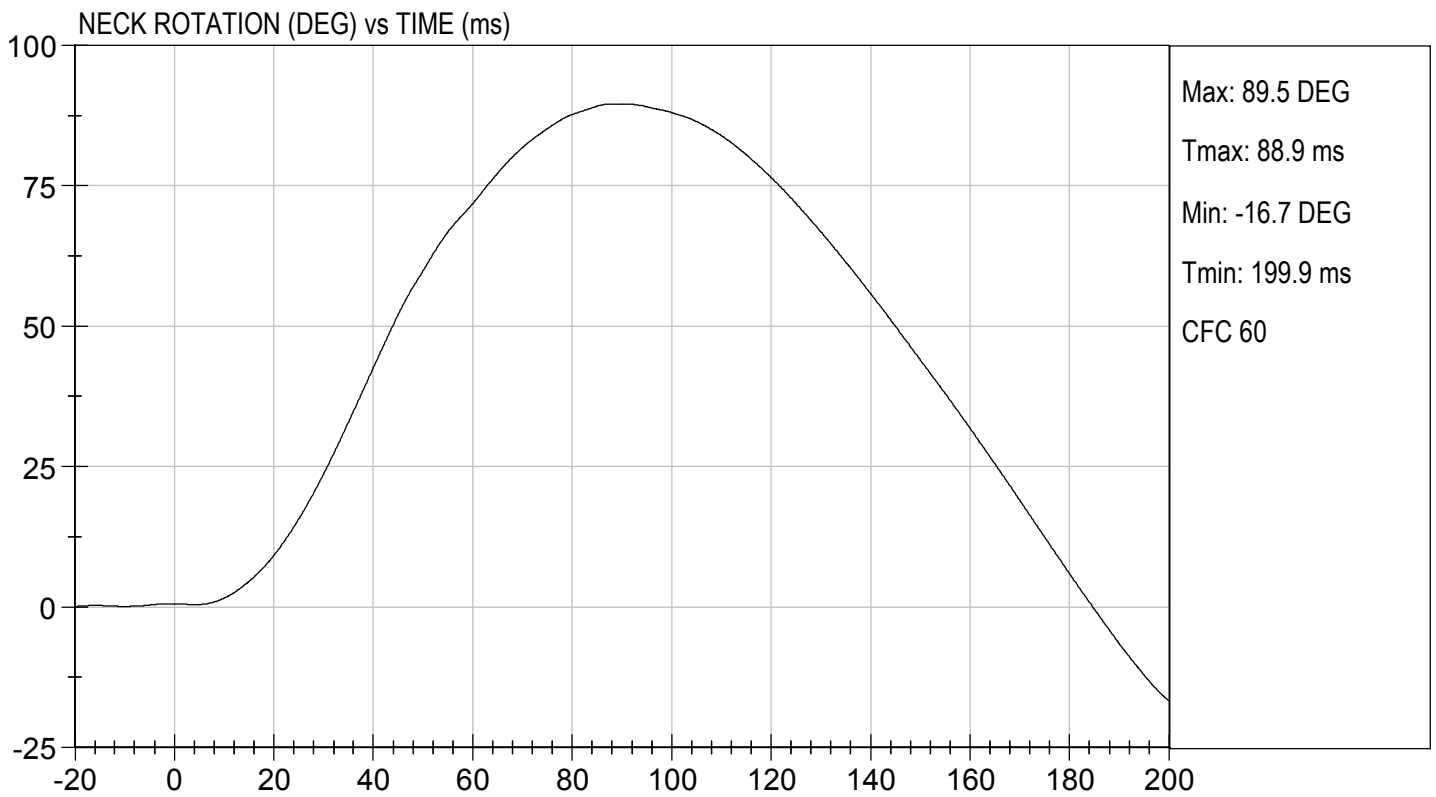
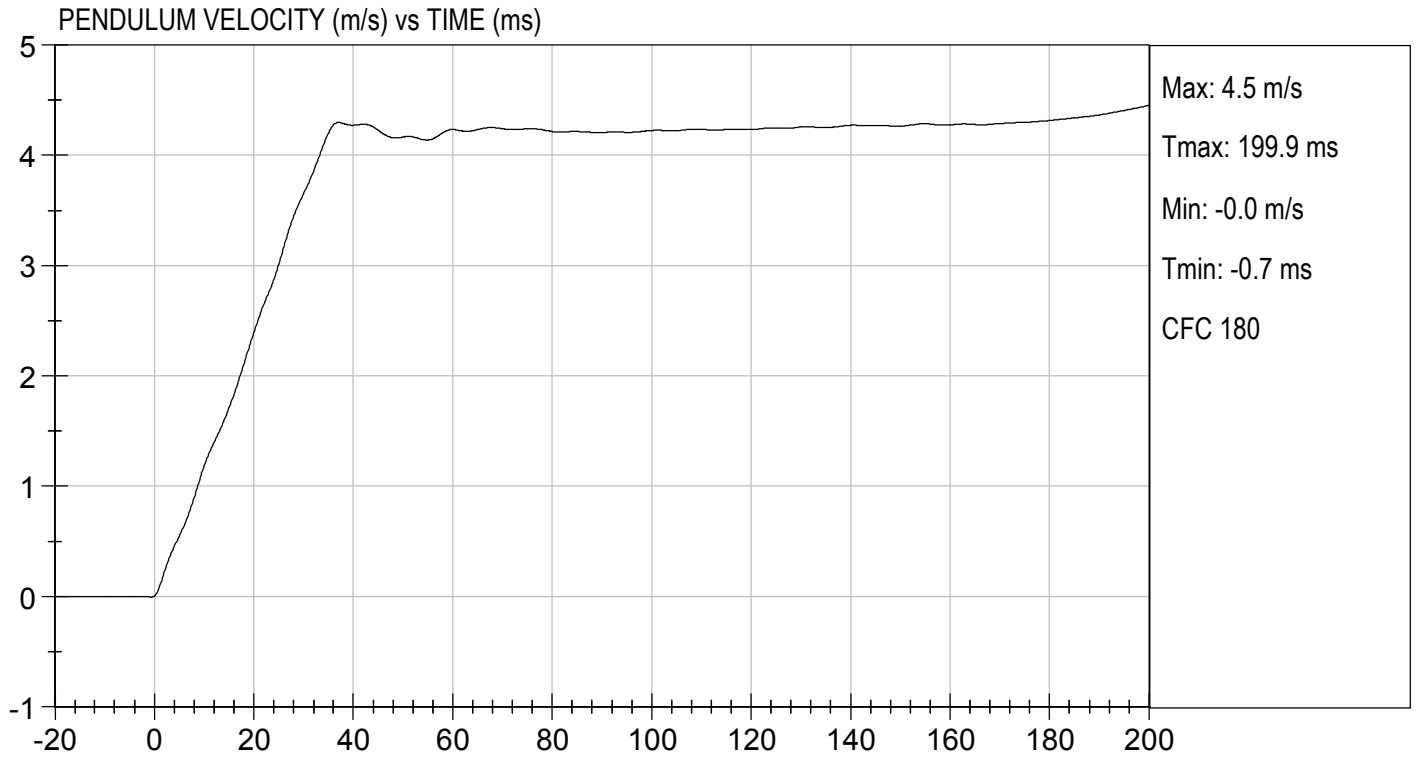
Laboratory Technician

07/28/2020

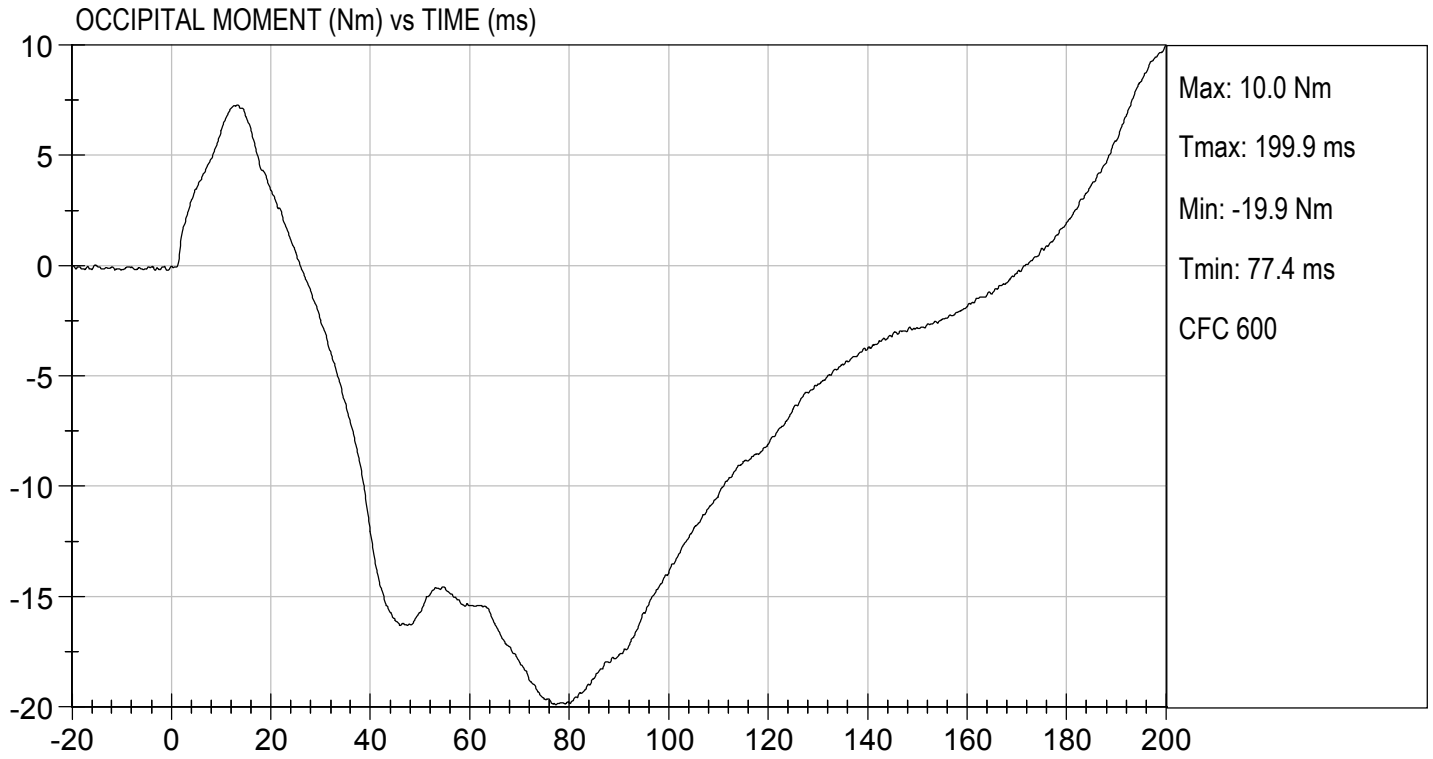
Test Date

*B. F. K.*

Approved By







**MGA RESEARCH CORPORATION**  
**THORAX IMPACT**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

Test I.D: D201744

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.2	Pass
Relative Humidity	%	10 to 70	40	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	38.0 to 46.0	38.6	Pass
Peak Resistive Force w/in Deflection Corridor	N	1150 to 1380	1,332	Pass
Internal Hysteresis	%	65 to 85	76	Pass
Peak Force 12.5 mm - 38.0 mm	N	<= 1,500	1,390	Pass
Overall Test Results				Pass

*Brian Roach*

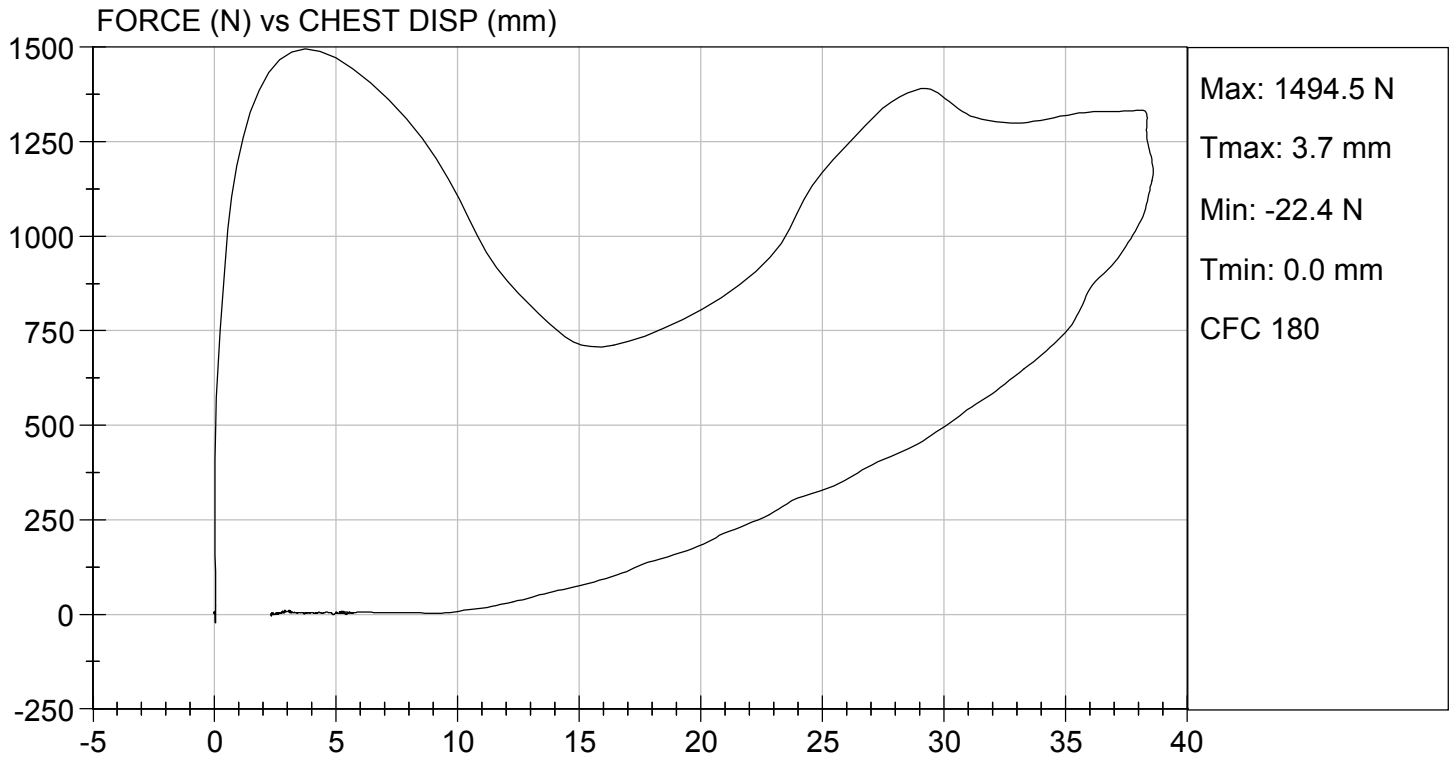
Laboratory Technician

07/31/2020

Test Date

*B. F.*

Approved By



**MGA RESEARCH CORPORATION**  
**RIGHT KNEE IMPACT TEST**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

Test I.D: D201745

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	45	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	2000 to 3000	2496	Pass
Overall Test Results				Pass

Brian Roach  
Laboratory Technician

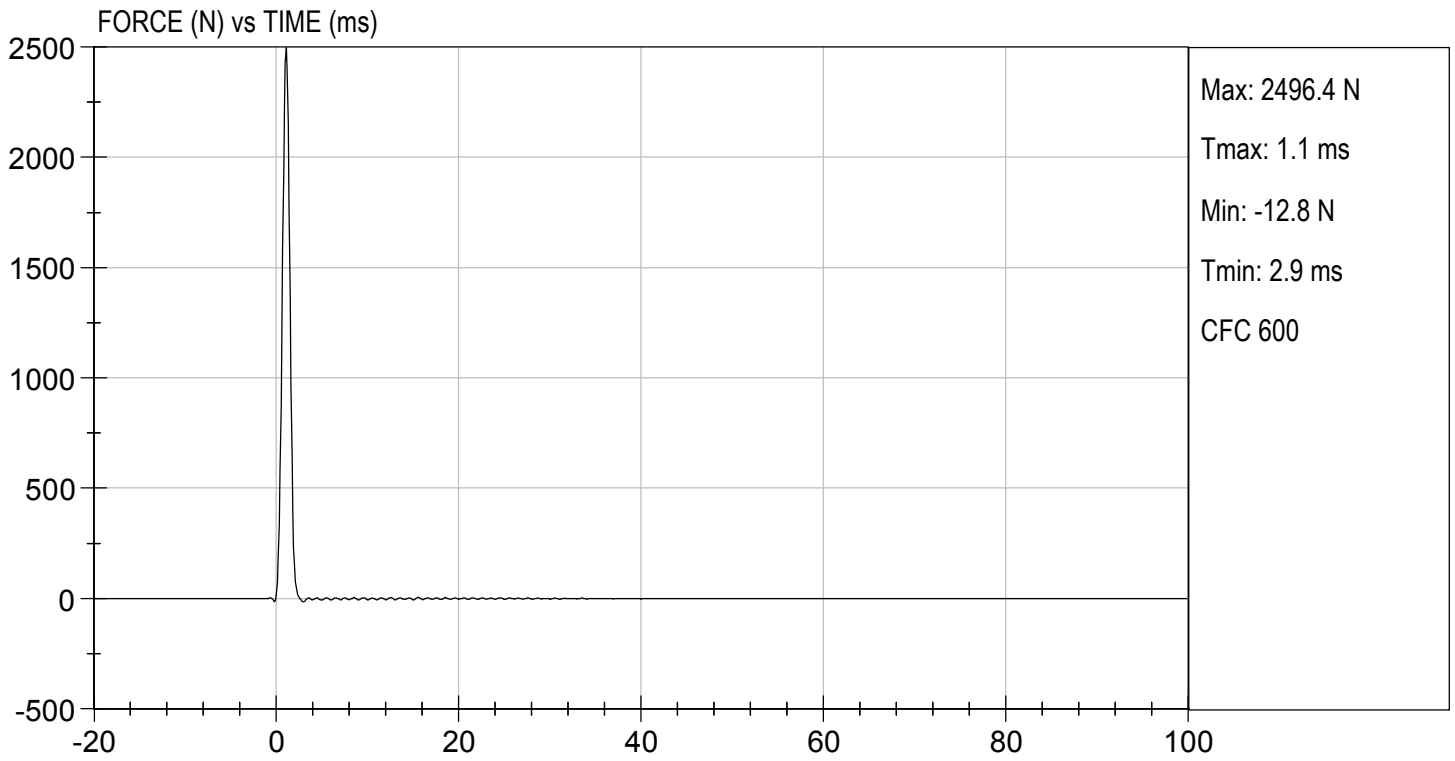
07/17/2020  
Test Date

B. F. L.  
Approved By



TEST DESC: RIGHT KNEE  
VELOCITY: 6.97 ft/s, 2.12 m/s

TEST DATE: 07/17/2020  
TEST #: D201745



**MGA RESEARCH CORPORATION**  
**LEFT KNEE IMPACT TEST**  
**HYBRID III 6 YEAR OLD**

**ATD Serial No:** 144

**Test I.D:** D201746

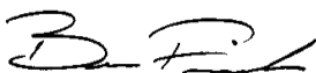
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	45	Pass
Probe Speed	m/s	2.07 to 2.13	2.10	Pass
Maximum Force	N	2000 to 3000	2406	Pass
Overall Test Results				Pass



Laboratory Technician

07/17/2020

Test Date

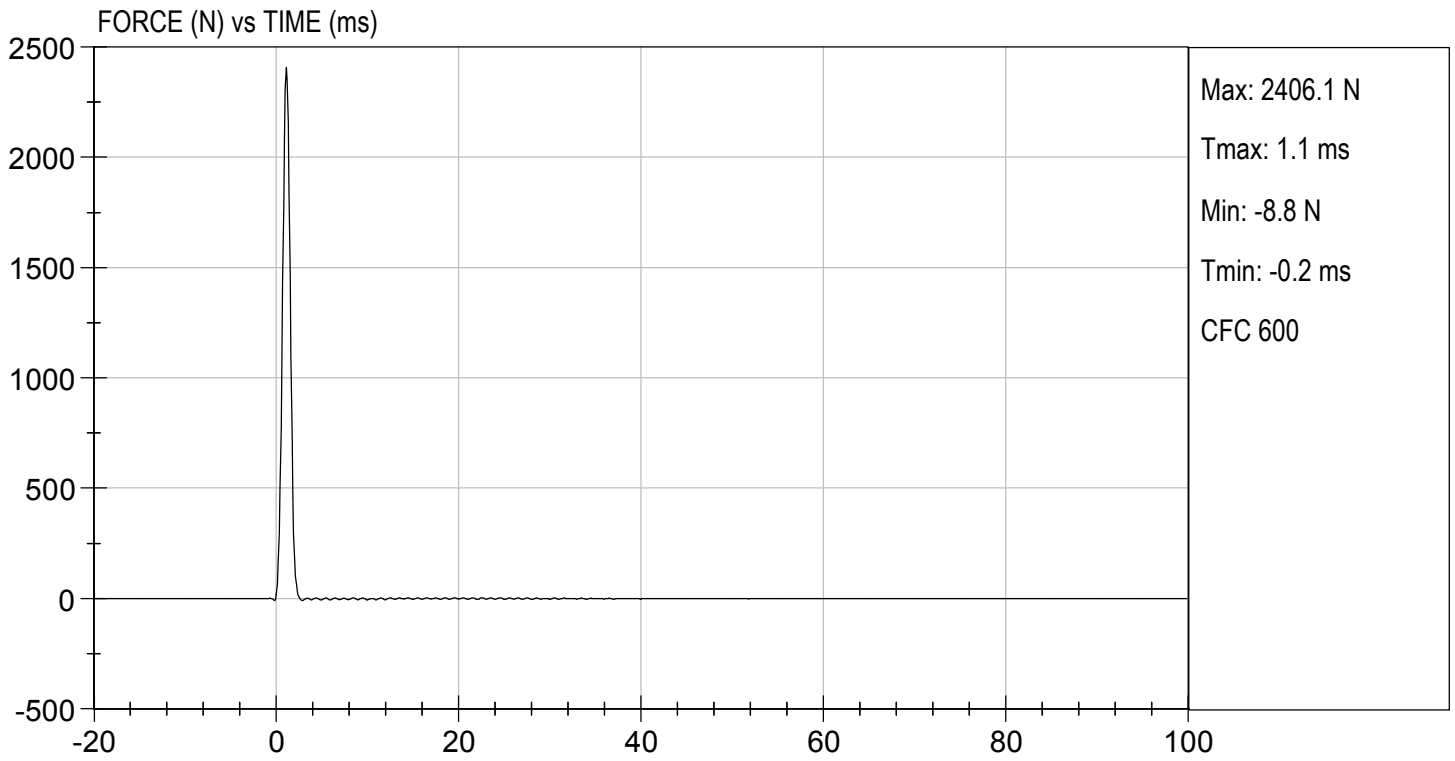


Approved By



TEST DESC: LEFT KNEE  
VELOCITY: 6.89 ft/s, 2.10 m/s

TEST DATE: 07/17/2020  
TEST #: D201746



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 6 YEAR OLD

ATD Serial No: 144

Test I.D: D201747

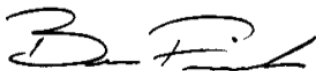
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	43	Pass
Initial Angle	deg	0 to 22	18	Pass
Return Angle	deg	+/- 8	6	Pass
Force at 45 deg	N	147 to 200	186	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
Overall Result				Pass



Laboratory Technician

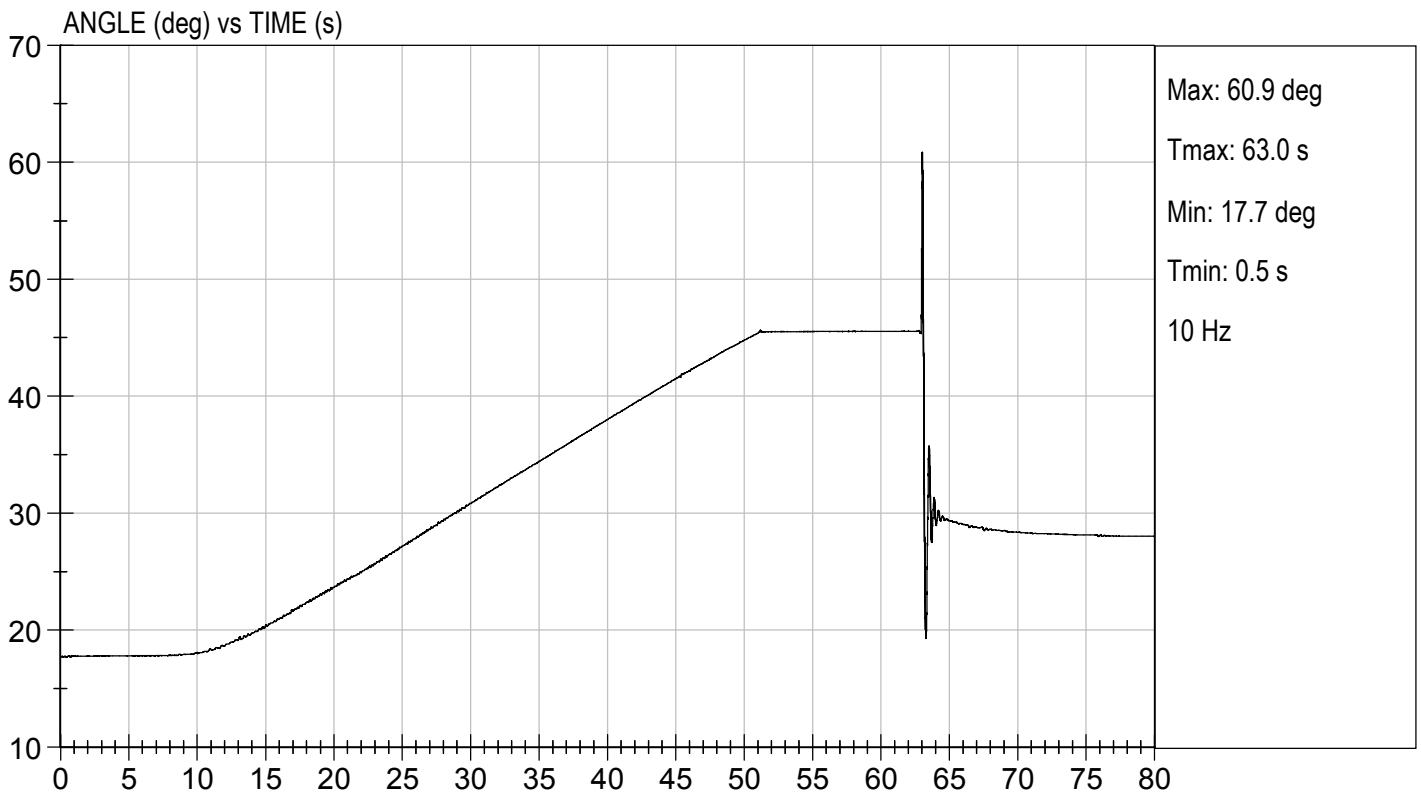
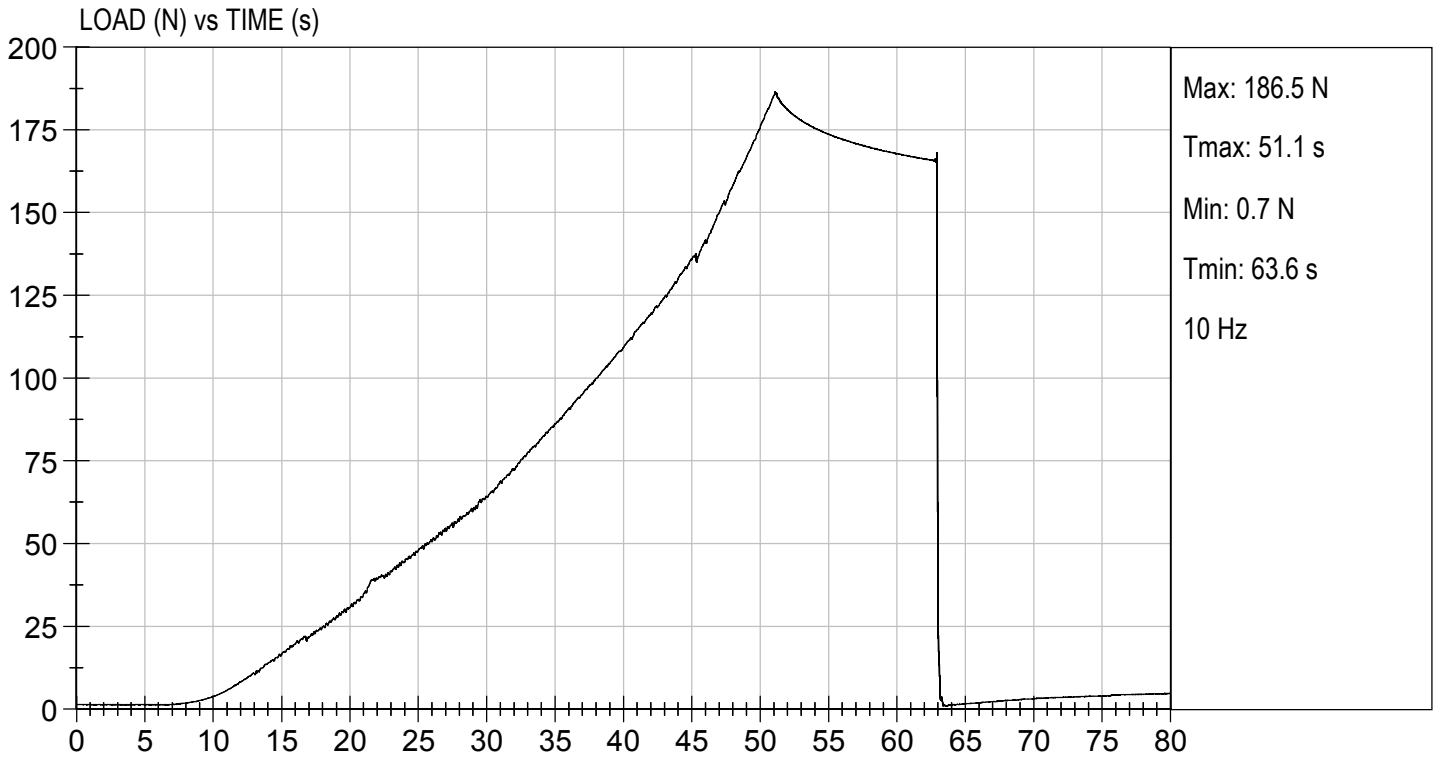
07/29/2020

Test Date



Approved By





**CALIBRATION TEST RESULTS**

**POST-TEST**

**Hybrid III 6-Year-Old ATD**

**MGA RESEARCH CORPORATION**  
**HEAD DROP TEST**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

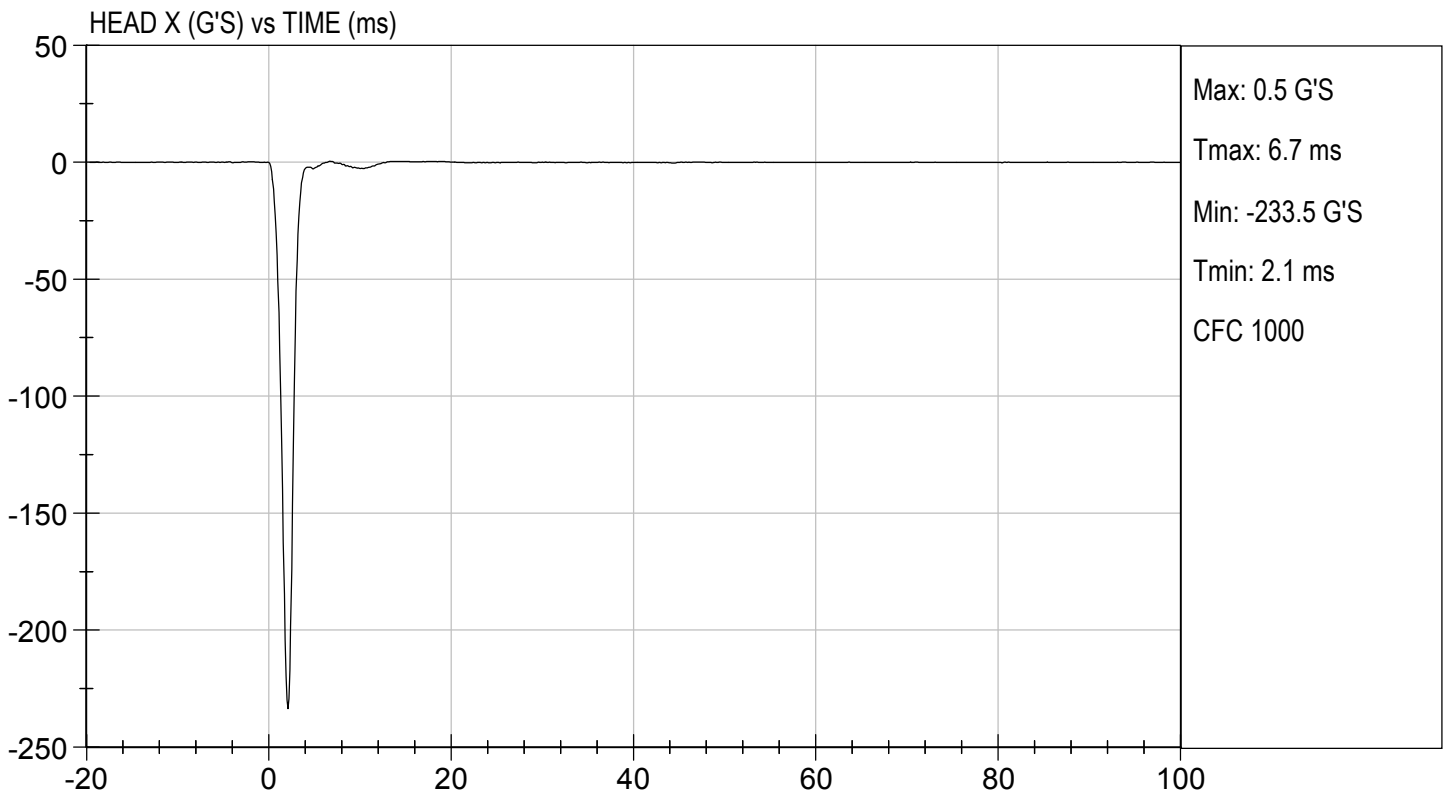
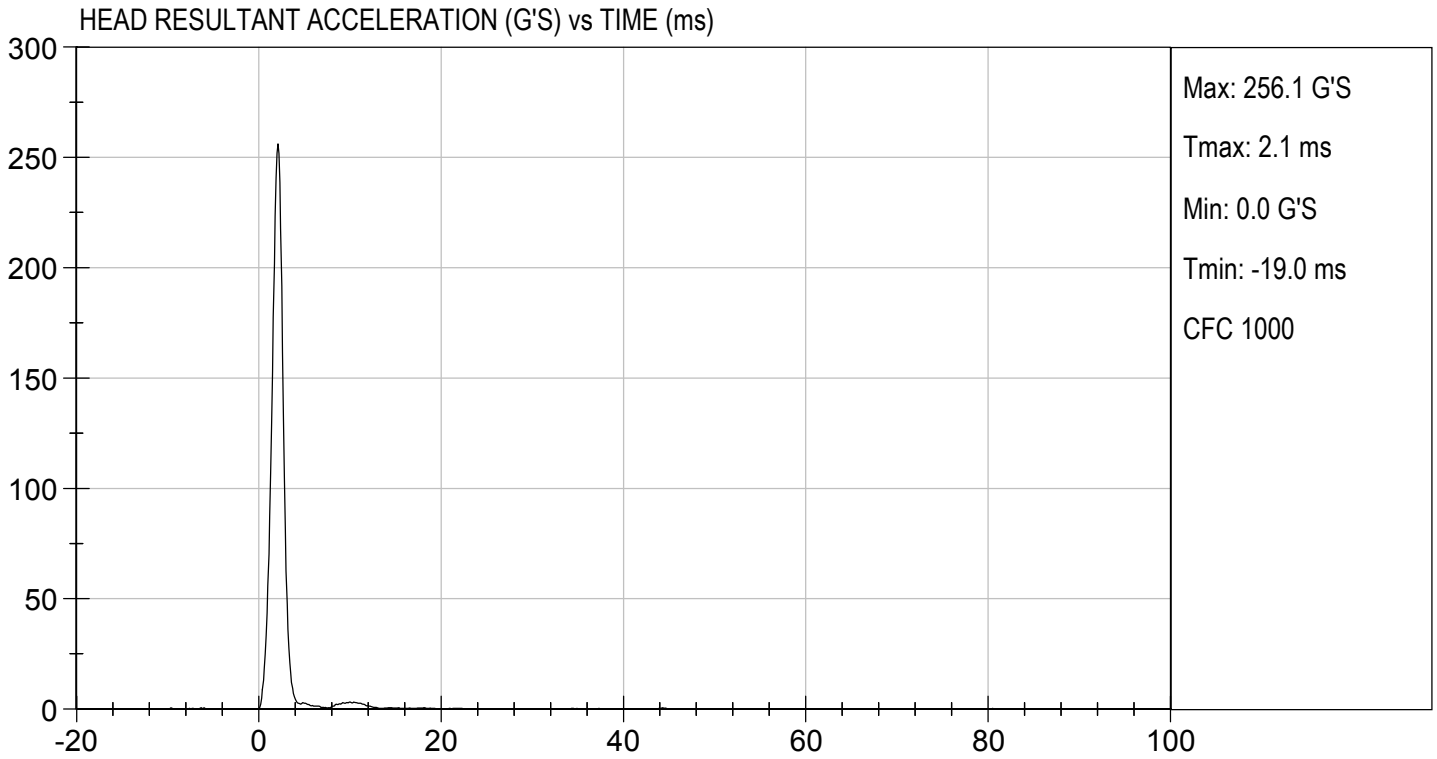
Test ID: D202071

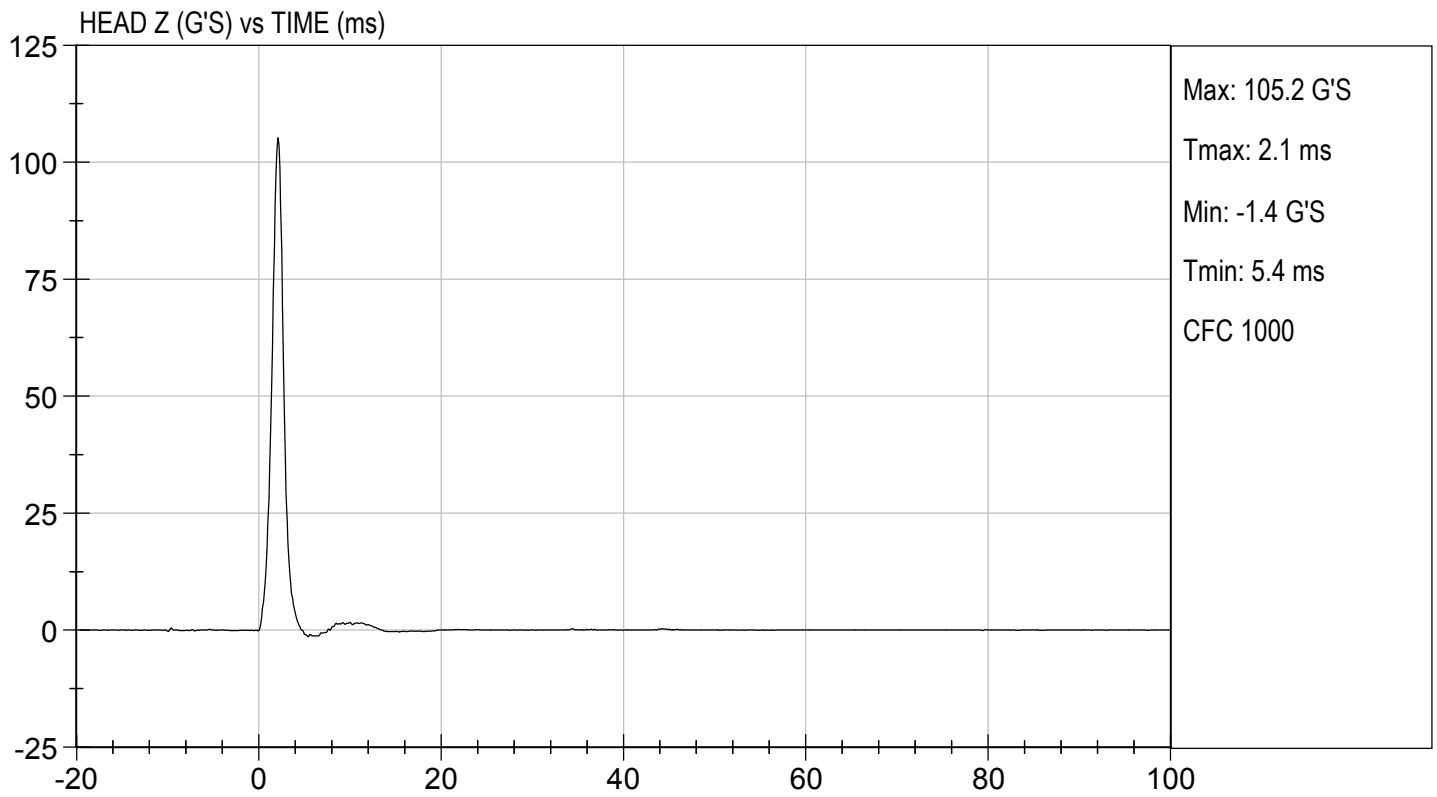
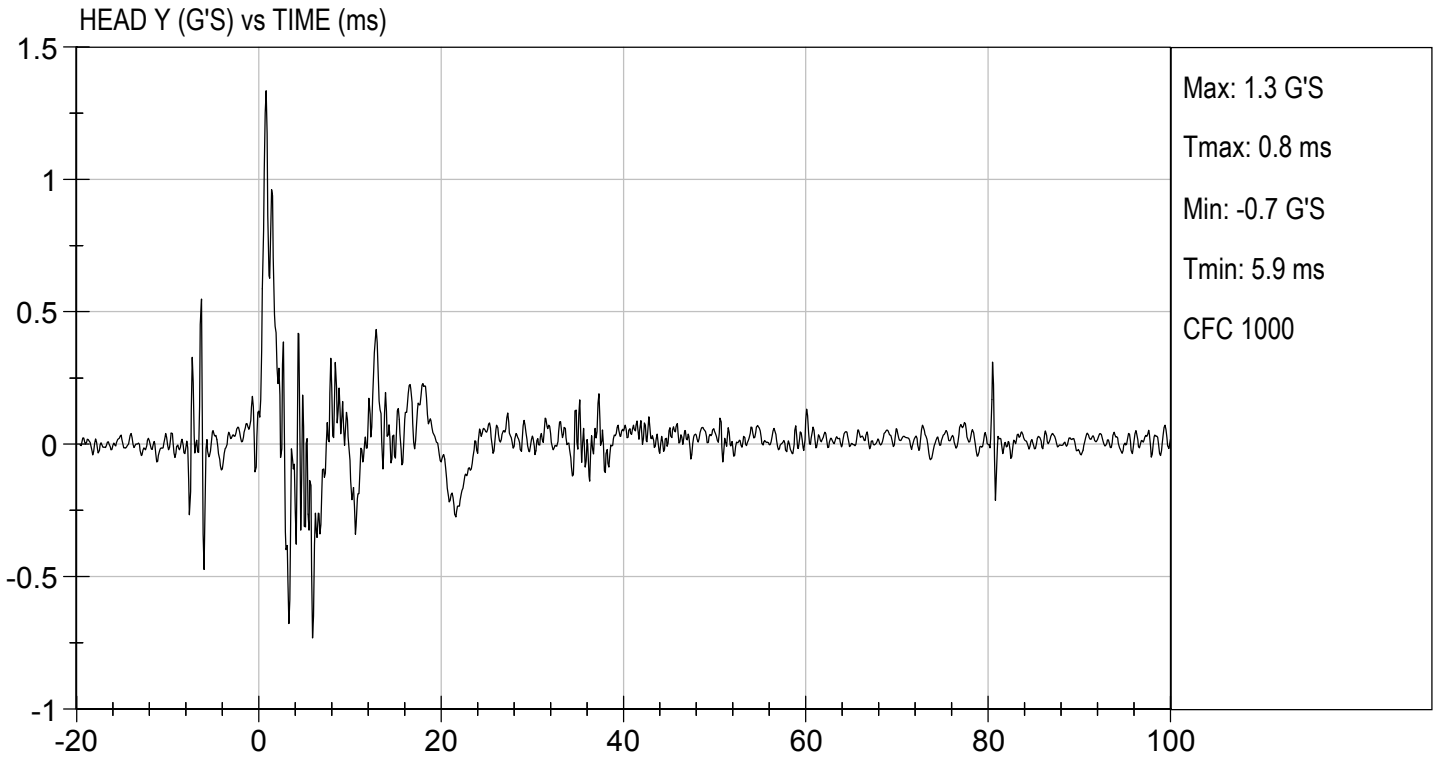
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	41	Pass
Peak Resultant Acceleration	G's	245 to 300	256	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	1.3	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

Brian Roach  
 Laboratory Technician

08/18/2020  
 Test Date

B. F. K.  
 Approved By





**MGA RESEARCH CORPORATION**

**NECK FLEXION TEST**

**HYBRID III 6 YEAR OLD**

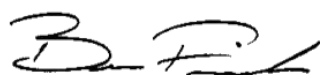
**ATD Serial No:** 144

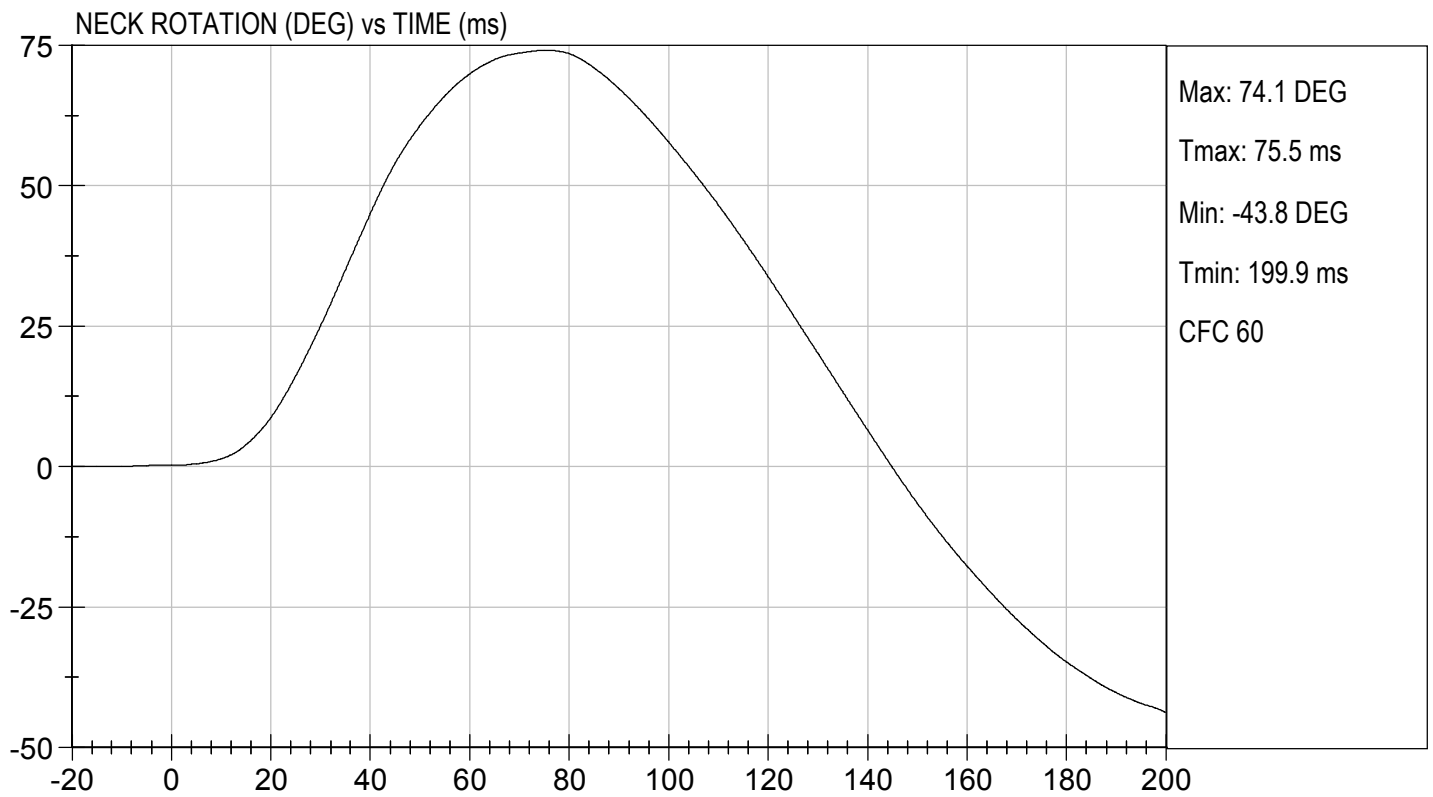
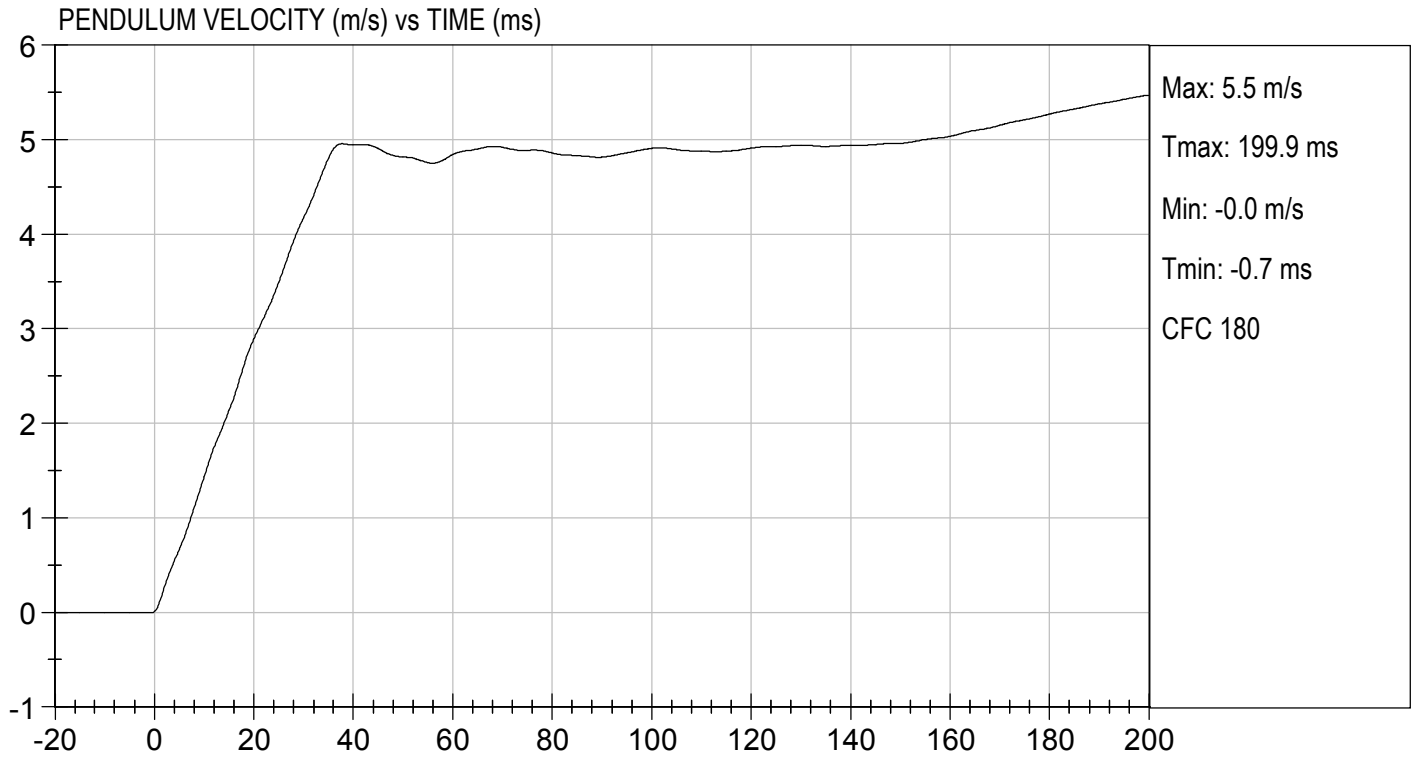
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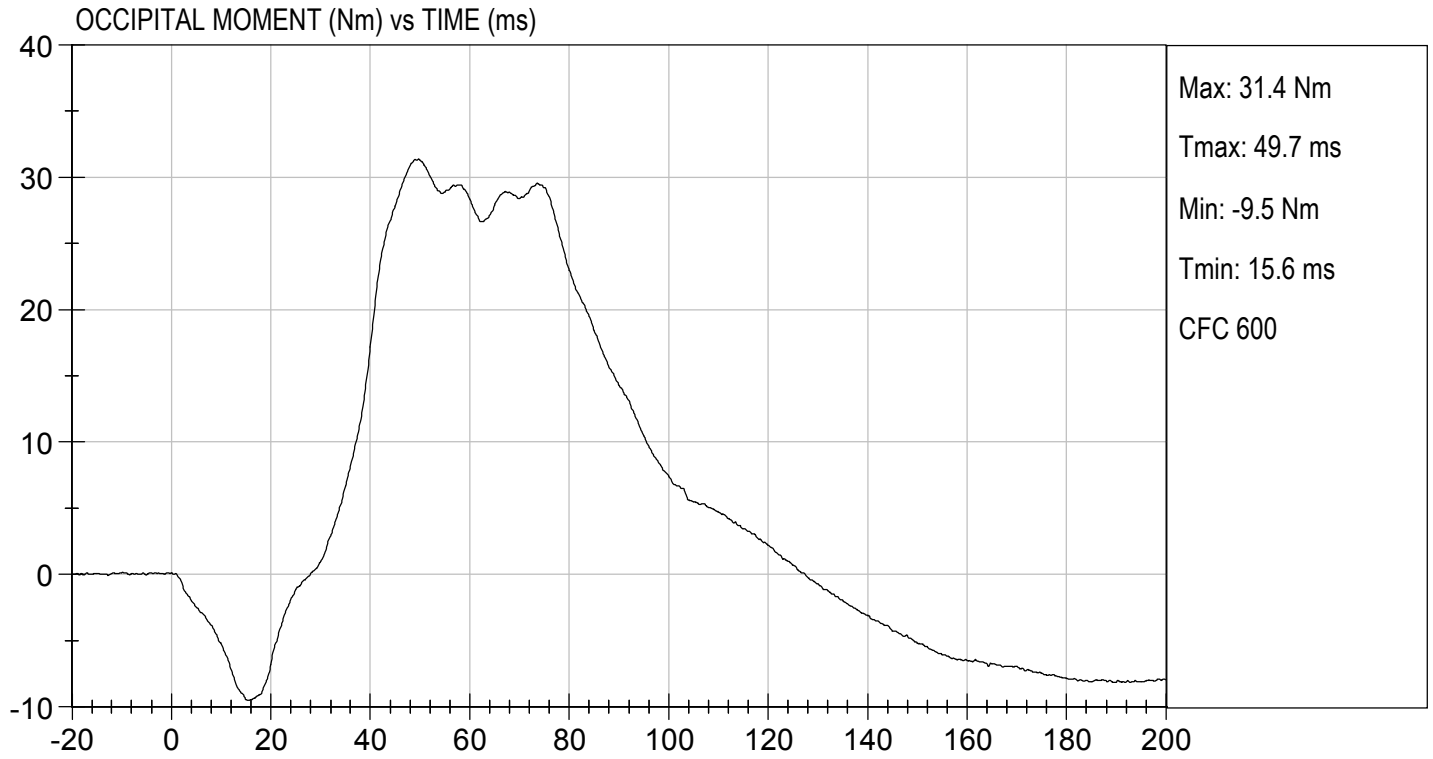
Tested Parameter	Units	Specification	Result	Pass/Fail	
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass	
Laboratory Relative Humidity	%	10 to 70	40	Pass	
Pendulum Speed	m/s	4.83 to 5.07	4.89	Pass	
Pendulum Velocity	10 ms	m/s	1.2 to 1.6	1.4	Pass
	20 ms	m/s	2.4 to 3.4	2.9	Pass
	30 ms	m/s	3.8 to 5.0	4.2	Pass
D Plane Rotation	Max	deg	74 to 92	74	Pass
Occipital Condyle Moment within Deflection Corridor	Nm	27 to 33	29.5	Pass	
Positive Moment Time Curve Decay to 5 Nm	ms	103 to 123	103	Pass	
Overall Results				Pass	

  
 \_\_\_\_\_  
 Laboratory Technician

08/18/2020  
 \_\_\_\_\_  
 Test Date

  
 \_\_\_\_\_  
 Approved By







**MGA RESEARCH CORPORATION**

**NECK EXTENSION TEST**

**HYBRID III 6 YEAR OLD**

**ATD Serial No:** 144

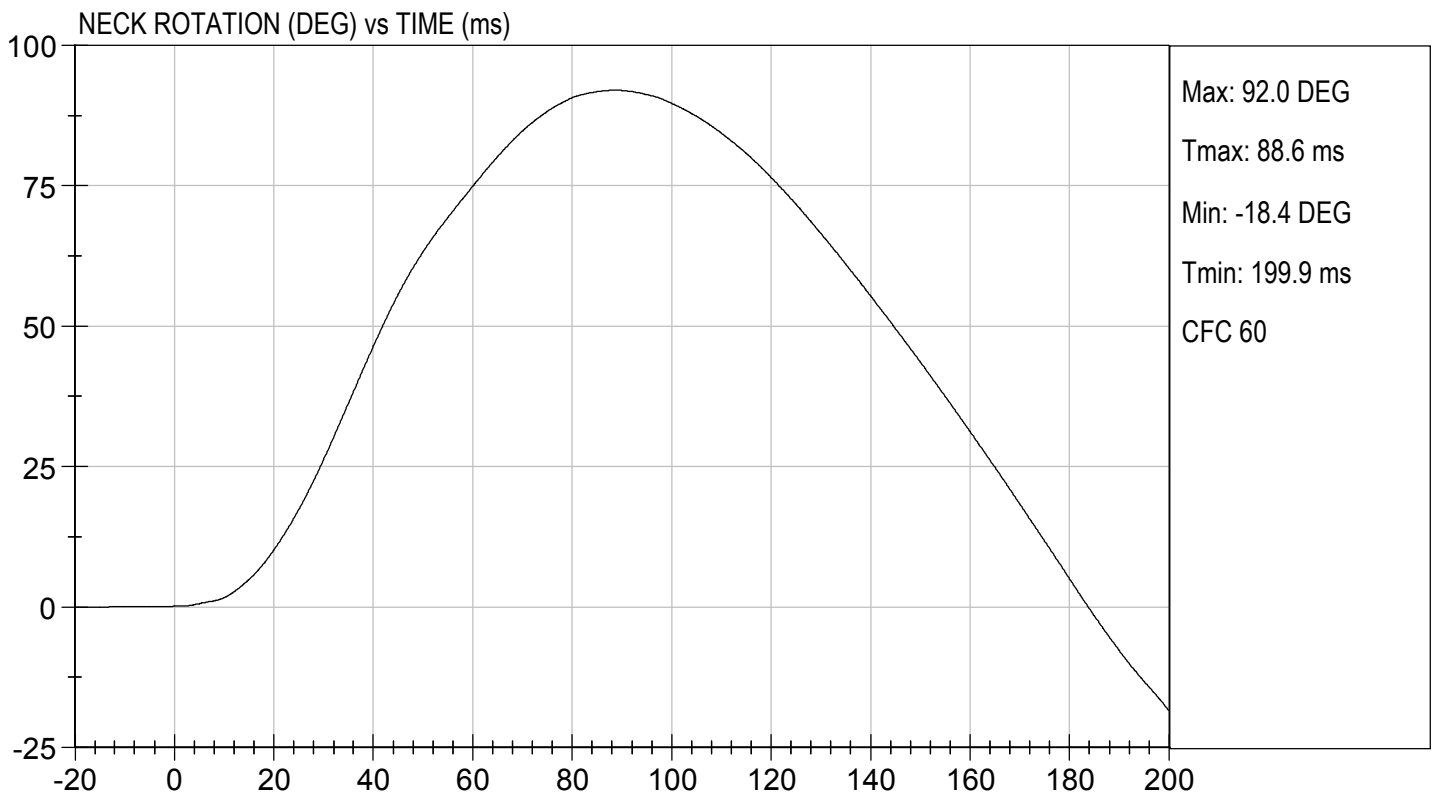
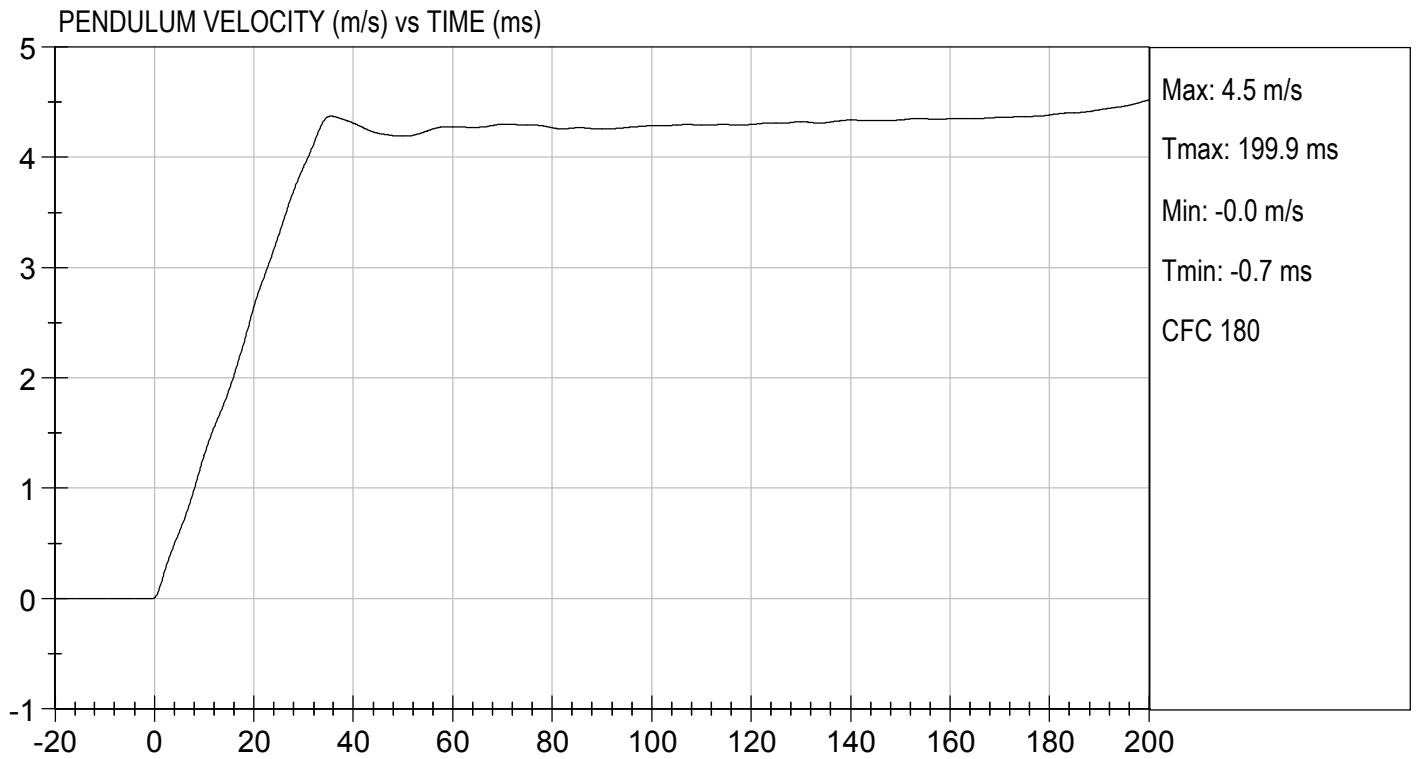
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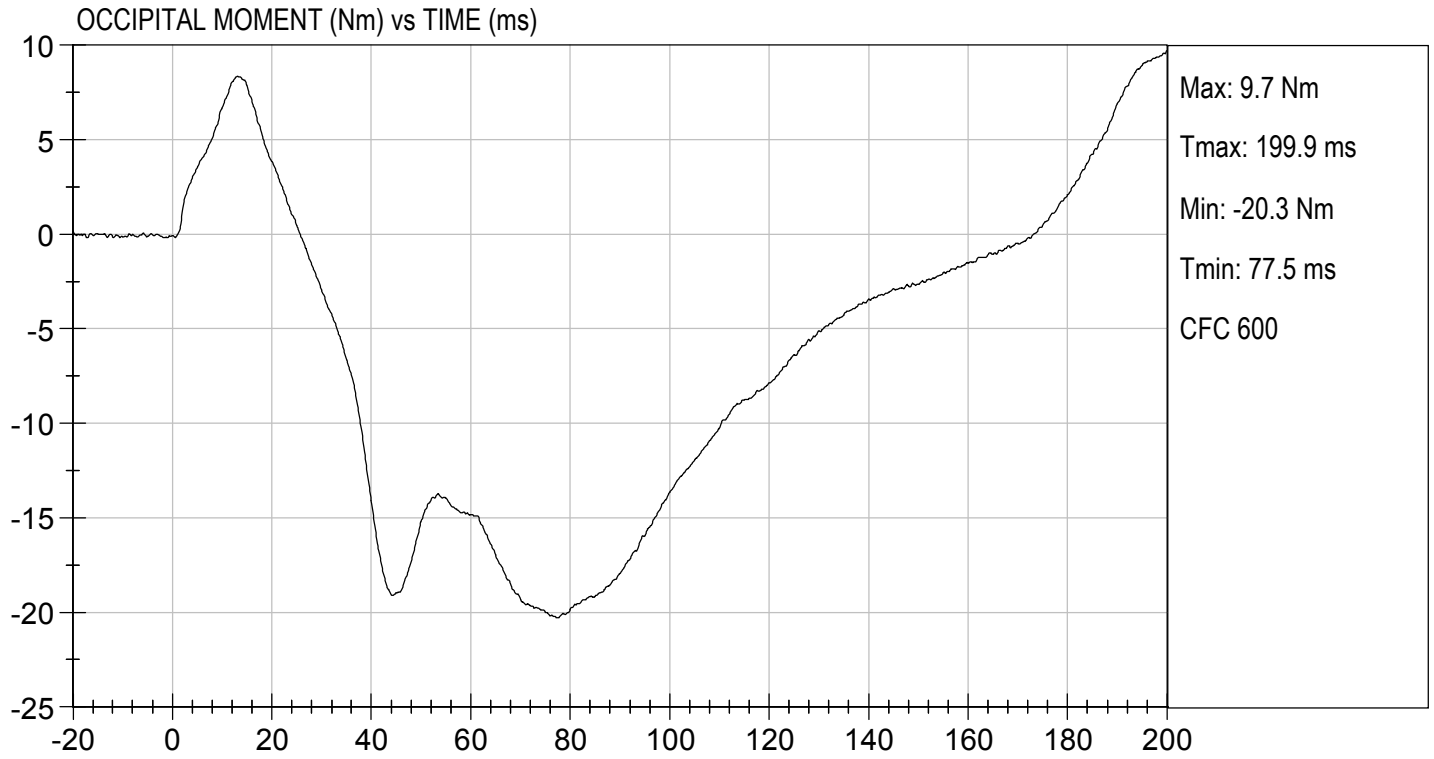
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity		%	10 to 70	40	Pass
Pendulum Speed		m/s	4.18 to 4.42	4.23	Pass
Pendulum Velocity	10 ms	m/s	1.0 to 1.4	1.3	Pass
	20 ms	m/s	2.2 to 3.0	2.6	Pass
	30 ms	m/s	3.2 to 4.2	3.9	Pass
D Plane Rotation	Max	deg	85 to 103	92	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	-19 to -24	-20	Pass
Positive Moment Time Curve Decay to 5 Nm		msec	123 to 147	128	Pass
<b>Overall Results</b>					<b>Pass</b>

Brian Roach  
Laboratory Technician

08/18/2020  
Test Date

B. F.  
Approved By





**MGA RESEARCH CORPORATION**  
**THORAX IMPACT**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

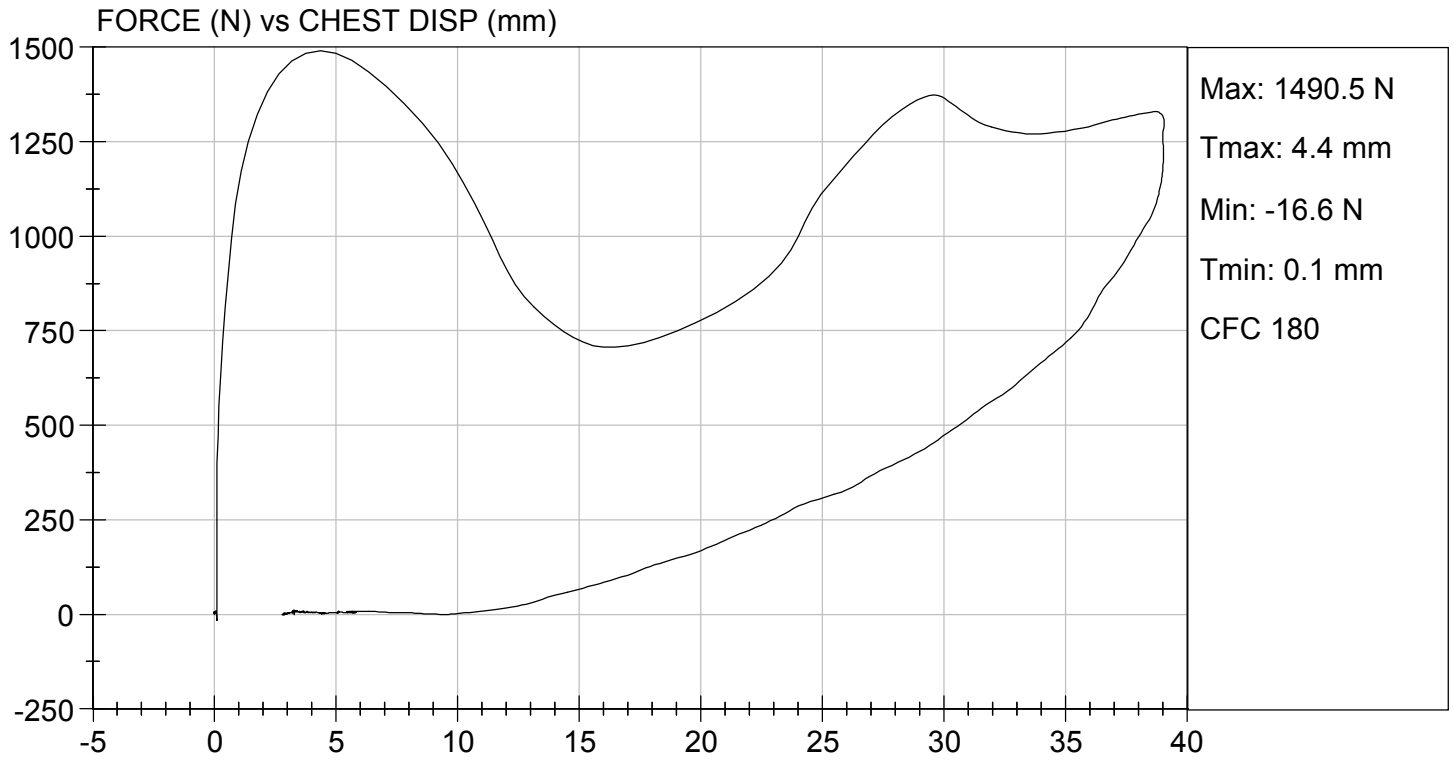
Test I.D: D202074

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.3	Pass
Relative Humidity	%	10 to 70	43	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	38.0 to 46.0	39.1	Pass
Peak Resistive Force w/in Deflection Corridor	N	1150 to 1380	1,329	Pass
Internal Hysteresis	%	65 to 85	76	Pass
Peak Force 12.5 mm - 38.0 mm	N	<= 1,500	1,373	Pass
Overall Test Results				Pass

  
 Laboratory Technician

08/18/2020  
 Test Date

  
 Approved By



**MGA RESEARCH CORPORATION**  
**RIGHT KNEE IMPACT TEST**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

Test I.D: D202075

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	40	Pass
Probe Speed	m/s	2.07 to 2.13	2.13	Pass
Maximum Force	N	2000 to 3000	2575	Pass
Overall Test Results				Pass

Brian Roach  
Laboratory Technician

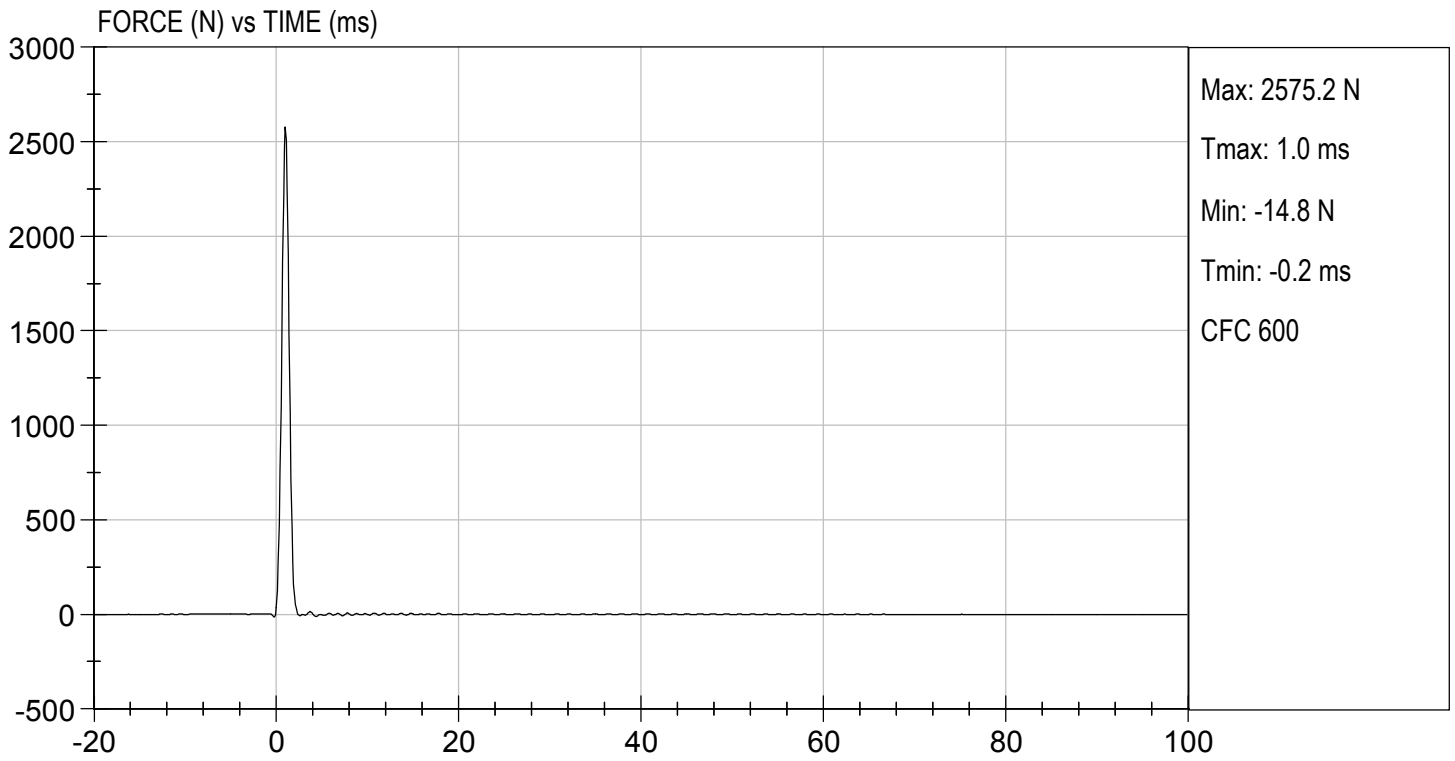
08/18/2020  
Test Date

B. F. K.  
Approved By



TEST DESC: RIGHT KNEE  
VELOCITY: 7.00 ft/s, 2.13 m/s

TEST DATE: 08/18/2020  
TEST #: D202075



**MGA RESEARCH CORPORATION**  
**LEFT KNEE IMPACT TEST**  
**HYBRID III 6 YEAR OLD**

ATD Serial No: 144

Test I.D: D202076

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	40	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	2000 to 3000	2584	Pass
Overall Test Results				Pass

  
 Laboratory Technician

08/18/2020  
 Test Date

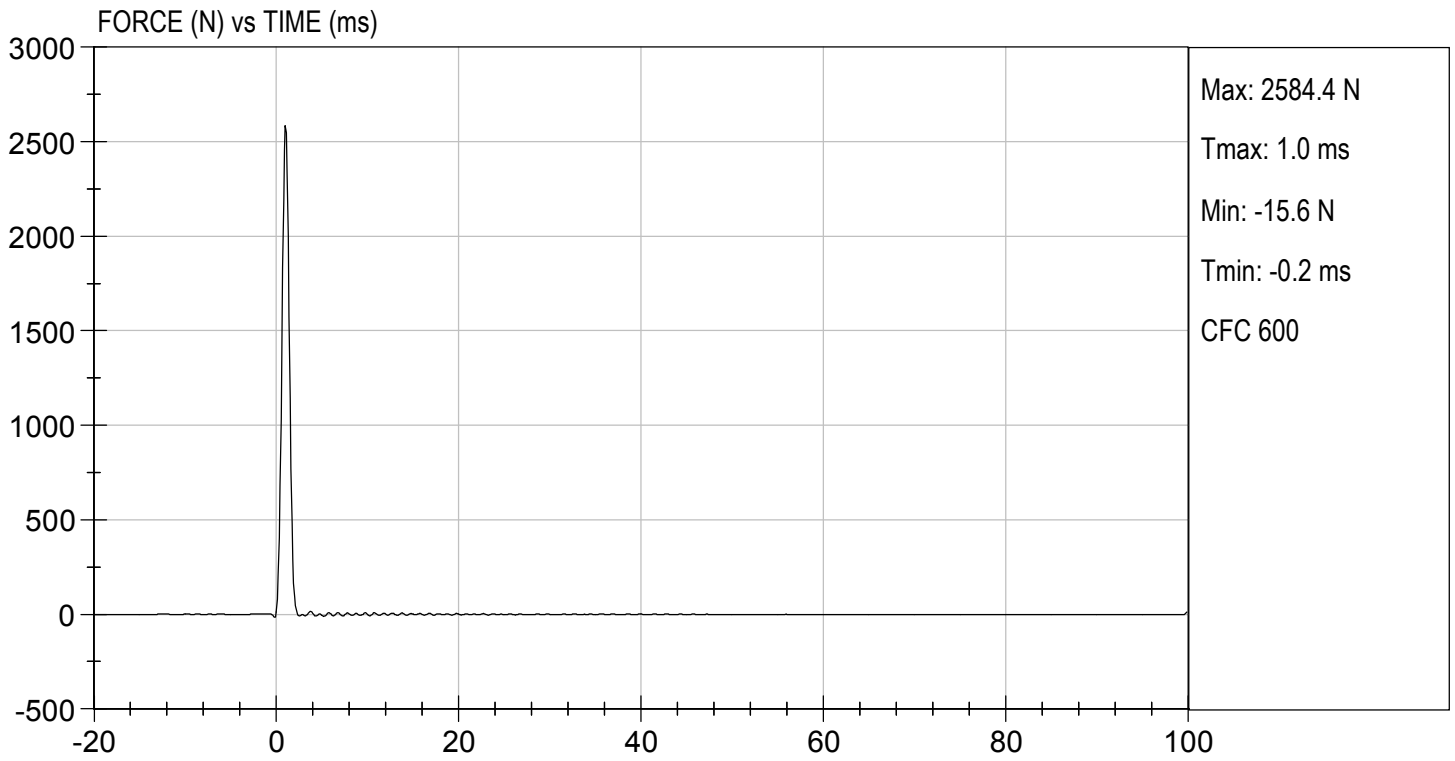
  
 Approved By





TEST DESC: LEFT KNEE  
VELOCITY: 6.97 ft/s, 2.12 m/s

TEST DATE: 08/18/2020  
TEST #: D202076



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 6 YEAR OLD

ATD Serial No: 144

Test I.D: D202077

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	41	Pass
Initial Angle	deg	0 to 22	17	Pass
Return Angle	deg	+/- 8	8	Pass
Force at 45 deg	N	147 to 200	185	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
Overall Result				Pass

*Brian Roach*

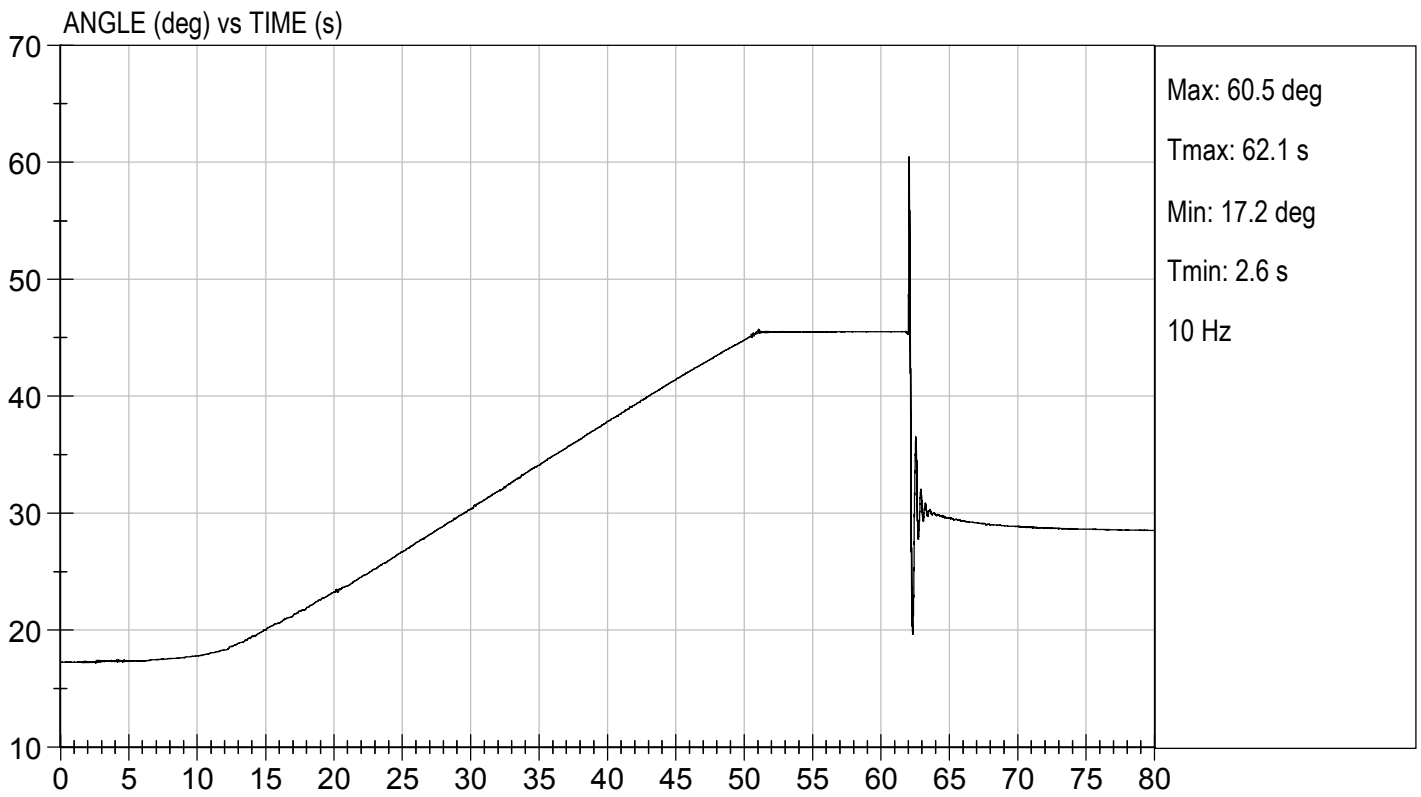
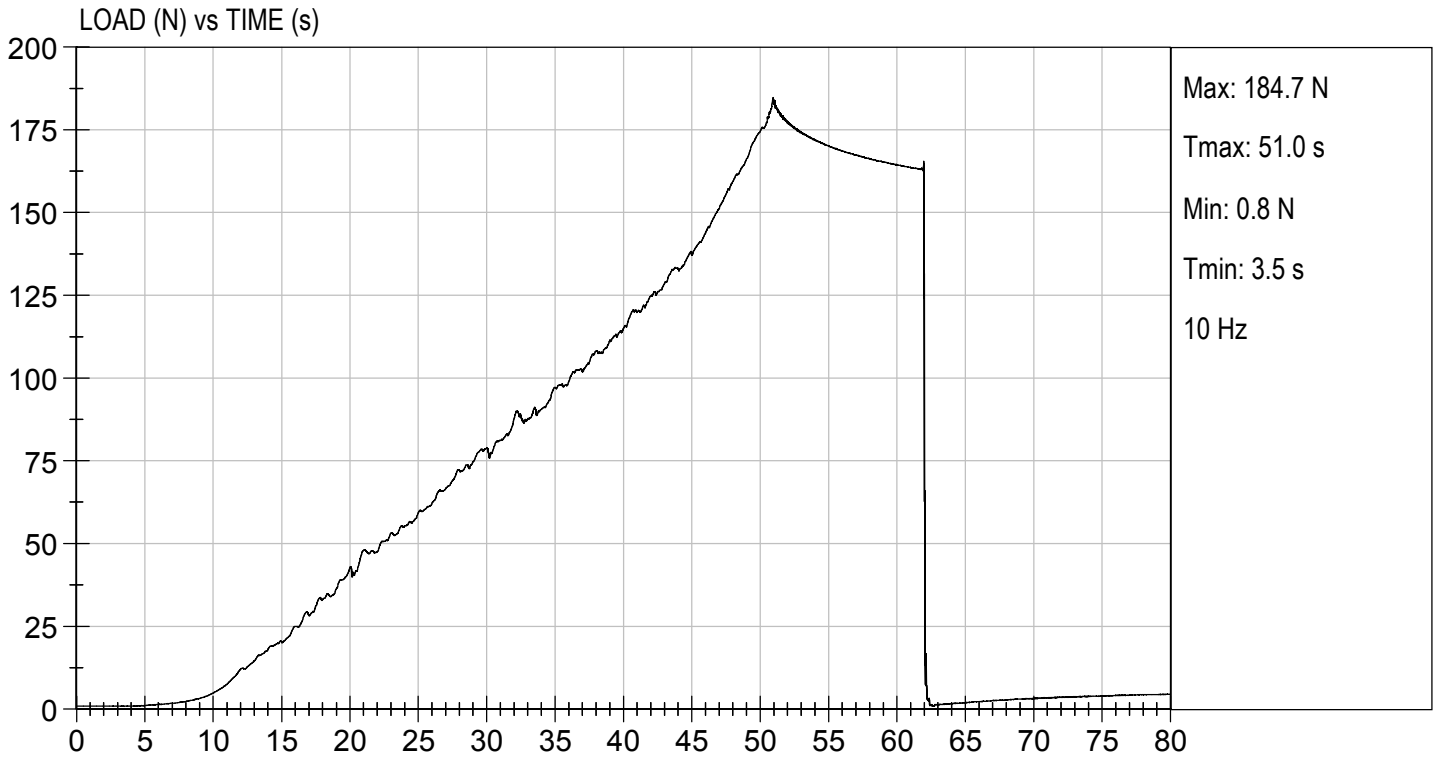
Laboratory Technician

08/18/2020

Test Date

*B. Fik*

Approved By



**APPENDIX D  
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA**

**Table 1 – Dummy Instrumentation**

		<b>HIII 6-Year-Old S/N 144</b>		
		Serial Number	Manufacturer	Calibration Date
Head CG Accelerometers	X	P82611	Endevco	07/14/2020
	Y	P82612	Endevco	07/14/2020
	Z	P82613	Endevco	07/14/2020
Upper Neck Load Cell		NG1746	Denton	07/17/2020
Lower Neck Load Cell		LNG139	Denton	07/17/2020