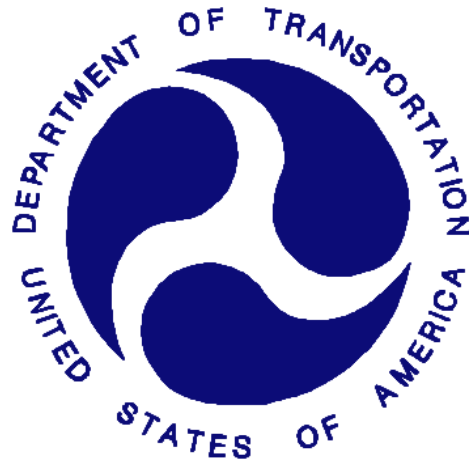


REPORT NUMBER: TWG-MGA-20-004

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

**GENERAL MOTORS LLC
2020 Cadillac CT5 Luxury 4-Door Sedan
NHTSA No.: M20200105TWG2**

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



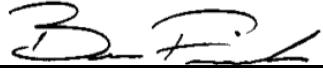
Test Date: August 13, 2020


Final Report Date: April 12, 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

Prepared by: 
Ben Fischer, Project Manager

Approved by: 
Robert Schnorenberg, Project Engineer

Approval Date: April 12, 2021

FINAL REPORT ACCEPTANCE BY:

Date: _____

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

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. TWG-MGA-20-004	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Final Report of Side Airbag Out-of-Position Injury Technical Working Group evaluation of a 2020 Cadillac CT5 Luxury 4-Door Sedan, NHTSA No.: M20200105TWG2		5. Report Date April 12, 2021
7. Author(s) Ben Fischer, Project Manager		6. Performing Organization Code MGA
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		8. Performing Organization Report No. TWG-MGA-20-004
12. Sponsoring Agency Name and Address 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		10. Work Unit No.
15. Supplementary Notes		11. Contract or Grant No. 693JJ919D000006
16. Abstract A Side Airbag Out-of-Position Injury evaluation was conducted on the subject 2020 Cadillac CT5 Luxury 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 13, 2020.		13. Type of Report and Period Covered: Final Test Report August 13, 2020 to April 12, 2021
		14. Sponsoring Agency Code NRM-110

Measurement Description	Units	Driver ATD (SID-IIs)	
		Threshold	Result
Head Injury Criteria (HIC ₁₅)		570	9
Nij		1	0.48
Neck Tension	N	1130	31
Neck Compression	N	1380	761
Maximum Chest Displacement	mm		
Maximum Chest Displacement Rate	m/s		

Note: The passenger's side curtain airbag only partially deployed.

17. Key Words Side Airbag Out-of-Position Technical Working Group OOP TWG HIII 3YO	18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division, NPO-411 1200 New Jersey Ave, SE Washington, DC 20590		
19. Security Classification of Report Unclassified	20. Security Classification of Page Unclassified	21. No. of Pages 68	22. Price

TABLE OF CONTENTS

<u>Section</u>		<u>Page No.</u>
1	Test Purpose and Procedure	1
2	Summary of Test Results	2
3	Occupant and Vehicle Information	4

<u>Data Sheet No.</u>		<u>Page No.</u>
1	Test Summary	5
2	General Test and Vehicle Parameter Data	6
3	Seat Adjustment Data	7
4	Dummy Setup and Positioning Data	8
5	Dummy Injury Criteria Values	9
6	Camera Setup and Description	11

<u>Appendix</u>		
A	Photographs	A
B	Dummy Response Data Traces	B
C	Dummy Configuration and Performance Verification Data	C
D	Test Equipment and Instrumentation Calibration Data	D

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 Cadillac CT5 Luxury 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 Cadillac CT5 Luxury 4-Door Sedan with an out-of-position Hybrid III 3-Year-Old child dummy were evaluated. The curtain and seat airbags were fired remotely. The test was performed by MGA Research Corporation on August 13, 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 3-Year-Old child dummy (Serial Number 082) was placed in the right front passenger seat situated in the lying on seat position per Section 3.3.3.4 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 3-Year-Old child dummy's visible contact points were as follows:

- Side torso/pelvis airbag to top/side of head

Note: The passenger's side curtain airbag only partially deployed.

The Hybrid III 3-Year-Old child dummy was placed in the right front passenger seat. The dummy was placed on the seat, lying on its back with its arms at its sides so that its rearmost arm contacts the seatback. The dummy was slid outboard until the CG of the head is aligned with the vertical centerline of the airbag module. The dummy's legs were supported by the center console. Clearance between the dummy's head and the right front passenger door panel was minimized while avoiding contact.

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 3.3.3.4 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 Cadillac CT5 Luxury 4-Door Sedan
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
 Test Date: 8/13/2020

TEST CONFIGURATION INFORMATION

Seating Position	P2	Right Front Seating Position
Test Section	3.3.3.4*	Child Dummy Lying on Seat
Curtain Airbag	Roof-Rail Mounted	Side Curtain Airbag
Torso Airbag	Seat Mounted	Side Torso/Pelvis Airbag
ATD Type/Serial No.	Hybrid III 3-Year-Old	S/N: 082
Vehicle	Cadillac	CT5
Previous Crash Test	Side MDB NCAP	June 19, 2020 – M20200105

*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 torso/pelvis airbag to top/side of head
Upper Torso	None
Lower Torso	None
Knee	None

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

Test Vehicle: 2020 Cadillac CT5 Luxury 4-Door Sedan
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
Test Date: 8/13/2020

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20200105	Traction Control System (TCS)	Yes
Model Year	2020	Auto-Leveling System	No
Make	Cadillac	Automatic Door Locks (ADL)	Yes
Model	CT5 Luxury	Power Window Auto-Reverse	Yes
Body Style	4-Door Sedan	Other Optional Feature	No
VIN	1G6DW5RK8L0129841	Driver Front Airbag	Yes
Body Color	Shadow Metallic	Driver Curtain Airbag	Yes
Odometer Reading (km/mi)	6 km / 4 mi	Driver Head/Torso Airbag	No
Engine Displacement (L)	2.0 L	Driver Torso Airbag	No
Type/No. Cylinders	Inline 4	Driver Torso/Pelvis Airbag	Yes
Engine Placement	Longitudinal	Driver Pelvis Airbag	No
Transmission Type	Automatic	Driver Knee Airbag	Yes
Transmission Speeds	10	Rear Pass. Curtain Airbag	Yes
Overdrive	Yes	Rear Pass. Head/Torso Airbag	No
Final Drive	RWD	Rear Pass. Torso Airbag	No
Roof Rack	No	Rear Pass. Torso/Pelvis Airbag	No
Sunroof/T-Top	Yes	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	Yes	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	GENERAL MOTORS LLC
Date of Manufacture	02/20
Vehicle Type	Passenger Car

GVWR (kg)	2097
GAWR Front (kg)	962
GAWR Rear (kg)	1134

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3		5	
Capacity Weight (VCW) (kg)				396	(A)
DSC x 68.04 kg				340	(B)
Rated Cargo and Luggage Weight (RCLW) (kg)				56	(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 Cadillac CT5 Luxury 4-Door Sedan
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
 Test Date: 8/13/2020

VEHICLE SEAT FORE/AFT POSITION

Seat	Total Fore/Aft Travel		Test Position from Forward-Most Position	
	mm	Detents (1 st as 1)	mm	Detent (1 st as 0)
Right Front Passenger Seat	240		40	
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 head and vertical centerline of the 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 st as 1)	Degrees	Detent (1 st as 0)
Right Front Passenger Seat	62.3		-6.3	
Right Rear Passenger Seat				
OEM Back Angle Design Position	6.4° forward of vertical, 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: None			
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 st as 1)	mm	Detent (1 st 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 Cadillac CT5 Luxury 4-Door Sedan
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
Test Date: 8/13/2020

ATD Type	Hybrid III 3-Year-Old child dummy
Serial Number	082
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 Cadillac CT5 Luxury 4-Door Sedan
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
Test Date: 8/13/2020

RECORDED DATA – MINIMUMS AND MAXIMUMS

Channel	Unit	CFC	Maximum	Time (ms)	Minimum	Time (ms)
Passenger Head X	g	1000	11.6	10.9	-5.3	6.3
Passenger Head Y			24.4	6.4	-4.7	43.7
Passenger Head Z			28.1	7.5	-5.5	43.7
Passenger Upper Neck Fx	N	1000	113.6	11.0	-49.7	29.8
Passenger Upper Neck Fy			16.8	105.4	-237.5	12.4
Passenger Upper Neck Fz			30.9	173.5	-761.2	10.7
Passenger Upper Neck Mx	Nm	600	16.6	12.8	-7.0	123.3
Passenger Upper Neck My			9.2	12.7	-1.2	6.2
Passenger Upper Neck Mz			0.7	116.4	-7.4	18.8
Passenger Lower Neck Fx	N	1000	109.9	13.2	-32.7	7.4
Passenger Lower Neck Fy			25.0	107.4	-190.0	13.5
Passenger Lower Neck Fz			30.6	171.2	-707.0	10.1
Passenger Lower Neck Mx	Nm	600	1.1	206.1	-9.3	48.1
Passenger Lower Neck My			10.4	30.6	-3.3	11.0
Passenger Lower Neck Mz			0.7	116.9	-7.1	23.0

HEAD INJURY SUMMARY

HIC ₁₅	T ₁ (ms)	T ₂ (ms)	HIC ₃₆	T ₁ (ms)	T ₂ (ms)
9	6.2	14.0	9	6.2	14.0

NECK INJURY SUMMARY

Injury Criteria	Unit	Value	Time (ms)
Upper Neck NTF		0.04	165.4
Upper Neck NTE		0.01	4.4
Upper Neck NCF		0.48	11.0
Upper Neck NCE		0.22	8.4
Peak Tension	N	30.9	173.5
Peak Compression	N	761.2	10.7

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

Test Vehicle: 2020 Cadillac CT5 Luxury 4-Door Sedan
Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
Test Date: 8/13/2020

CHEST INJURY SUMMARY

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

¹Deflection rate is calculated based on Chest Deflection potentiometer.

RESEARCH VALUE SUMMARY

Research Injury Criteria¹	Unit	Value	Time (ms)
Upper Neck Lateral Moment	Nm	16.6	12.8
Upper Neck Twist Moment	Nm	7.4	18.8
Lower Neck Flexion Moment	Nm	10.4	30.6
Lower Neck Extension Moment	Nm	3.3	11.0
Lower Neck Lateral Moment	Nm	9.3	48.1
Lower Neck Twist Moment	Nm	7.1	23.0
Lower Neck Tension	N	30.6	171.2
Lower Neck Compression	N	707.0	10.1
Spine Acceleration	g		

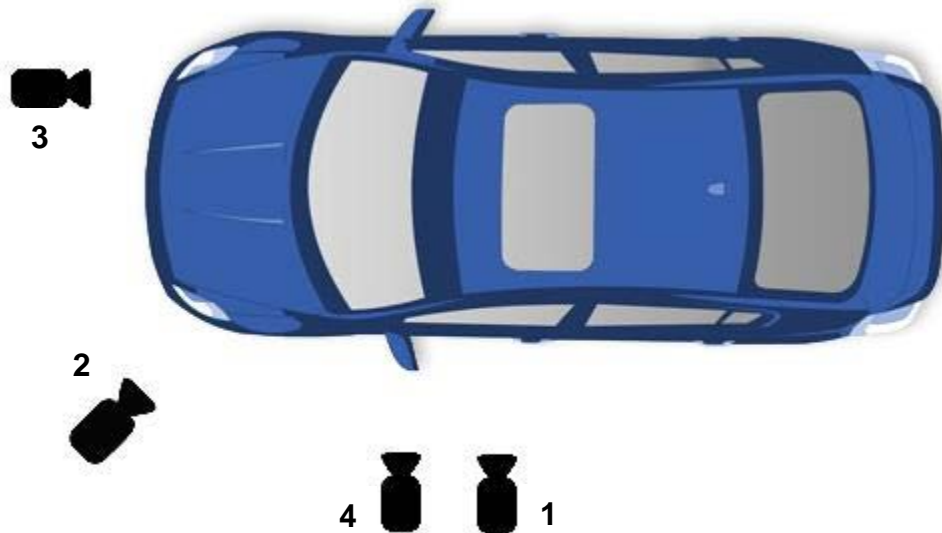
¹These injury criteria are only monitored and not considered pass/fail.

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

Test Vehicle: 2020 Cadillac CT5 Luxury 4-Door Sedan
 Test Program: NCAP Side Airbag Out-of-Position

NHTSA No.: M20200105TWG2
 Test Date: 8/13/2020

CAMERA SETUP DIAGRAM FOR OOP TESTS



CAMERA LOCATIONS

No.	Camera View	Location			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Left View	2685	-1390	-1394	24	2700
2	Oblique View	4285	-1140	-1792	24	2700
3	Front View	4900	550	-2314	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

		<u>Page No.</u>
Photo No. 001	Right Front Three-Quarter View of Vehicle, As Delivered	A-1
Photo No. 002	Vehicle Certification Label	A-1
Photo No. 003	Pre-Test Vehicle Left Side View	A-2
Photo No. 004	Post-Test Vehicle Left Side View	A-2
Photo No. 005	Pre-Test Dummy Left Side View	A-3
Photo No. 006	Post-Test Dummy Left Side View	A-3
Photo No. 007	Pre-Test Dummy Left Side Close-up View	A-4
Photo No. 008	Post-Test Dummy Left Side Close-up View	A-4
Photo No. 009	Pre-Test Dummy Left Three-Quarter Front View	A-5
Photo No. 010	Post-Test Dummy Left Three-Quarter Front View	A-5
Photo No. 011	Pre-Test Dummy Left Three-Quarter Front Close-up View	A-6
Photo No. 012	Post-Test Dummy Left Three-Quarter Front Close-up View	A-6
Photo No. 013	Pre-Test Dummy Front View	A-7
Photo No. 014	Post-Test Dummy Front View	A-7
Photo No. 015	Pre-Test Dummy Front Close-up View	A-8
Photo No. 016	Post-Test Dummy Front Close-up View	A-8
Photo No. 017	Pre-Test Dummy Right Three-Quarter Front View	A-9
Photo No. 018	Post-Test Dummy Right Three-Quarter Front View	A-9
Photo No. 019	Pre-Test Dummy Right Side View	A-10
Photo No. 020	Post-Test Dummy Right Side View	A-10
Photo No. 021	Post-Test Dummy Right Side View (Door Open)	A-11
Photo No. 022	Post-Test Curtain Air Bag Left Side View	A-11
Photo No. 023	Post-Test Curtain Air Bag Left Three-Quarter Front View	A-12
Photo No. 024	Post-Test Curtain Air Bag Front View	A-12
Photo No. 025	Post-Test Curtain Air Bag Right Side View (Door Open)	A-13
Photo No. 026	Post-Test Partial Deployment of Curtain Air Bag	A-13



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

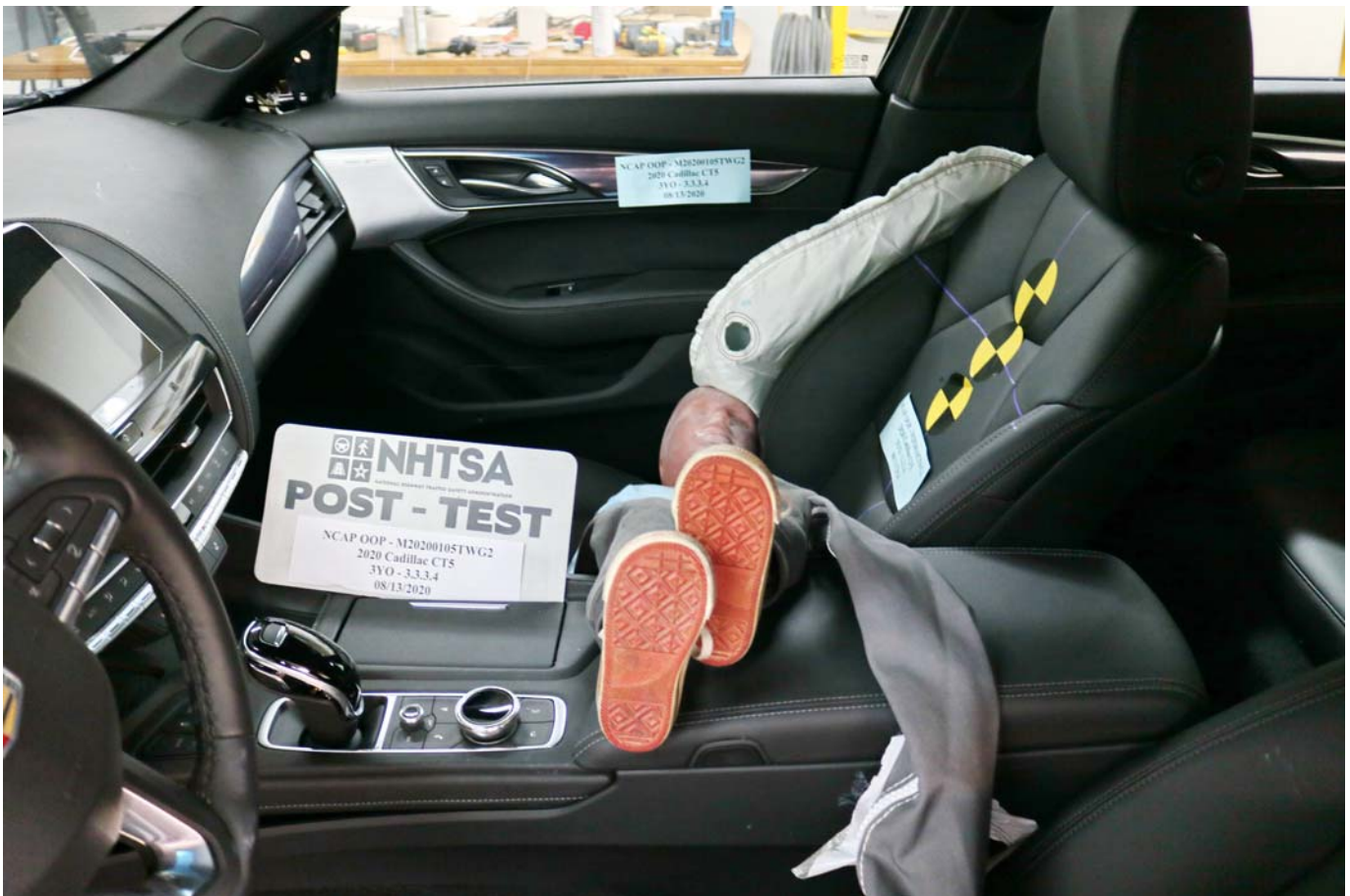


Photo No. 006 - Post-Test Dummy Left Side View



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

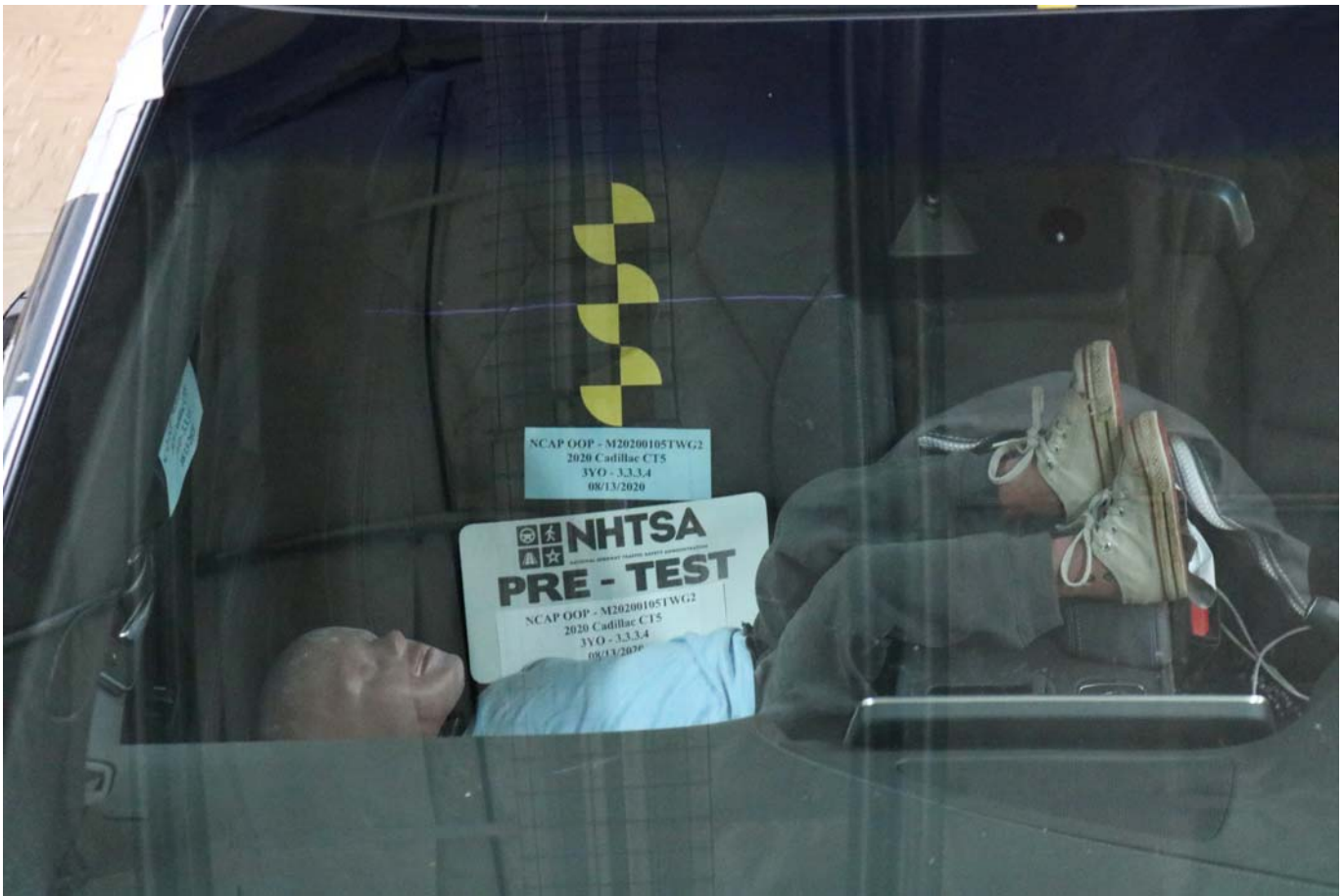


Photo No. 015 - Pre-Test Dummy Front Close-Up View



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

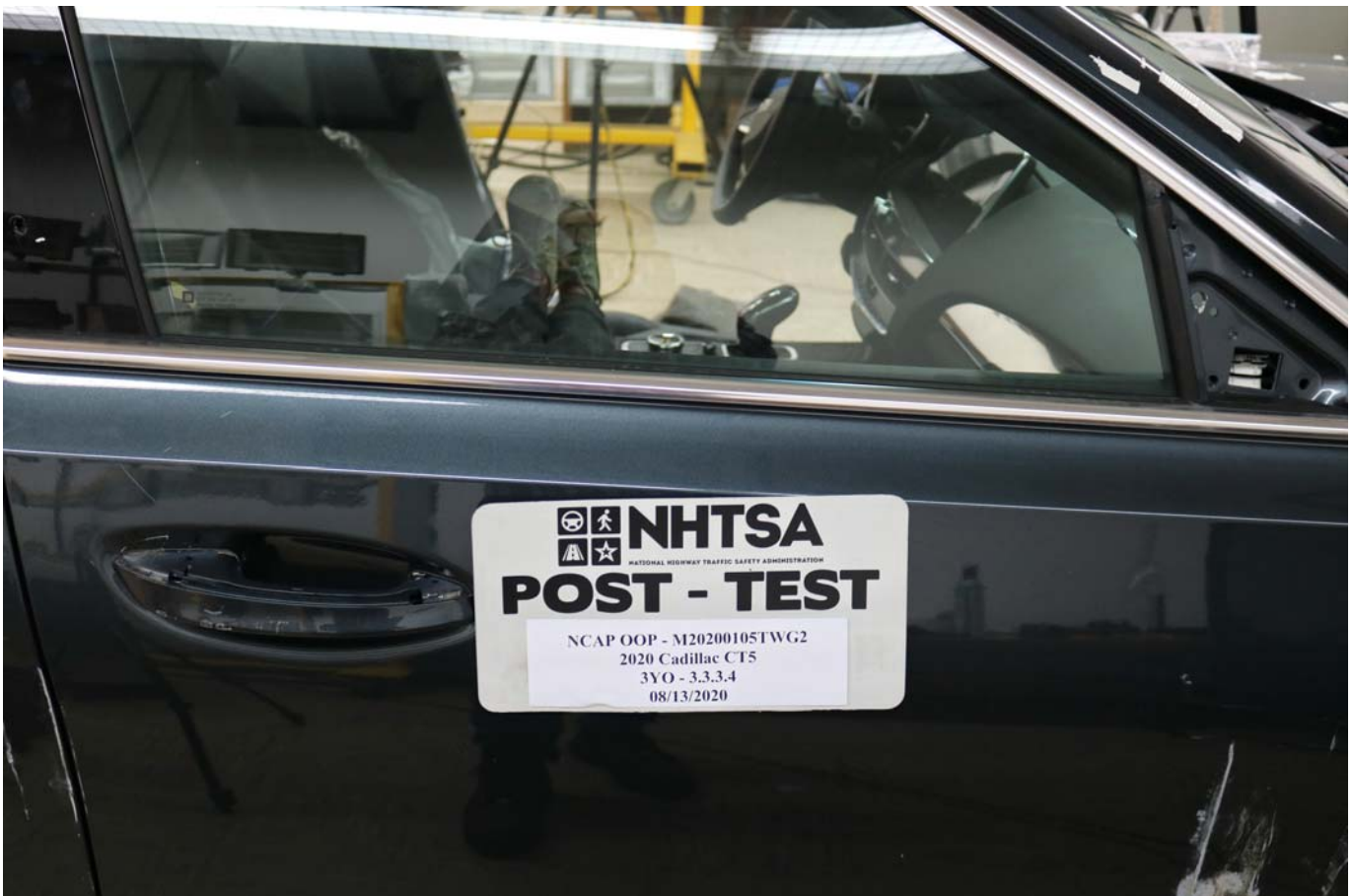


Photo No. 020 - Post-Test Dummy Right Side View



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)

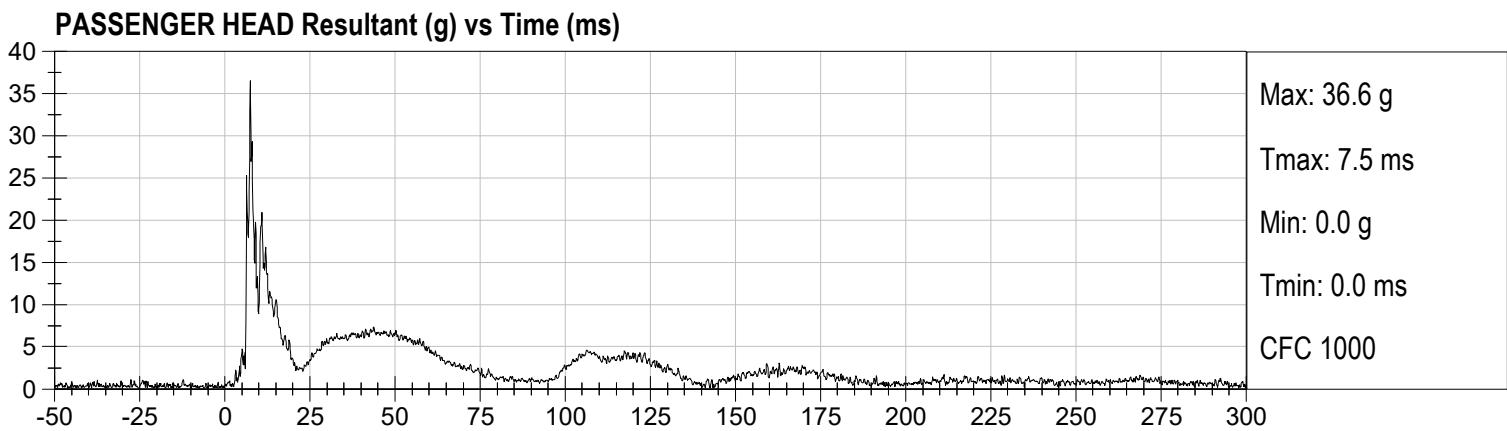
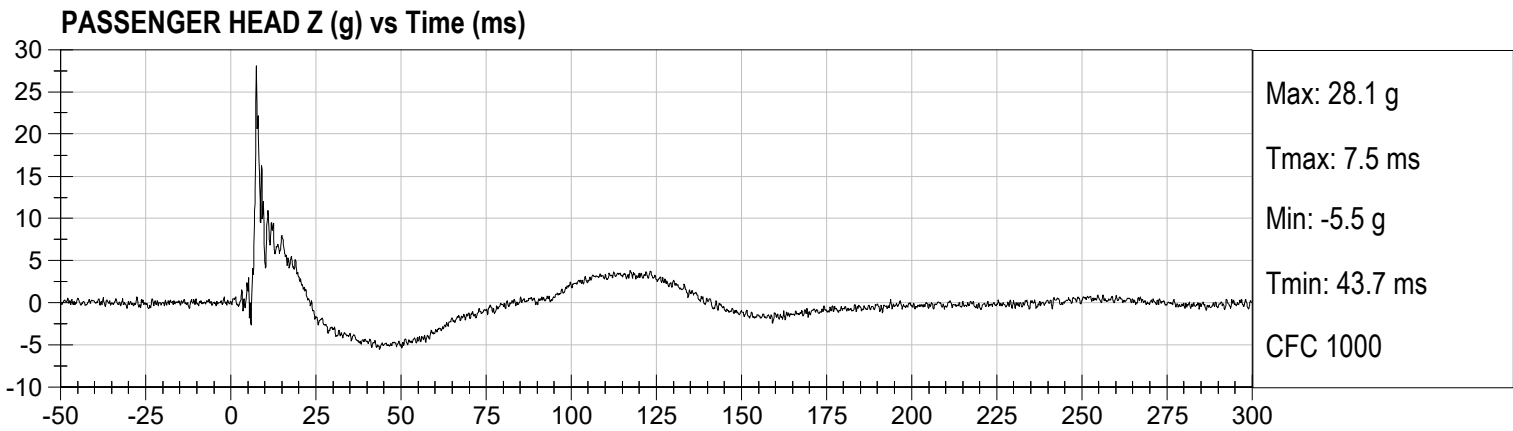
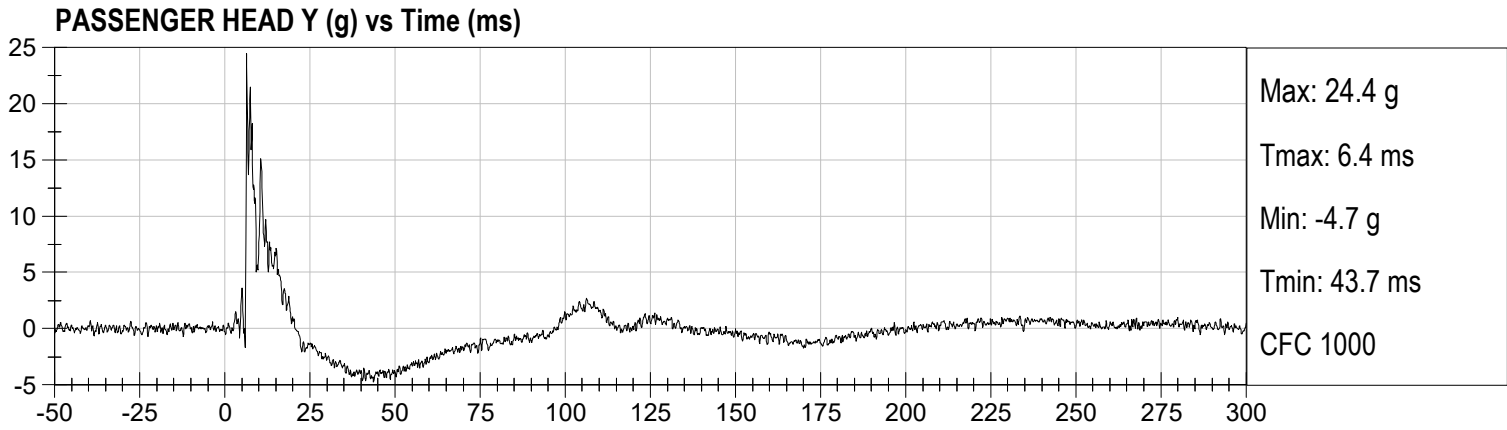
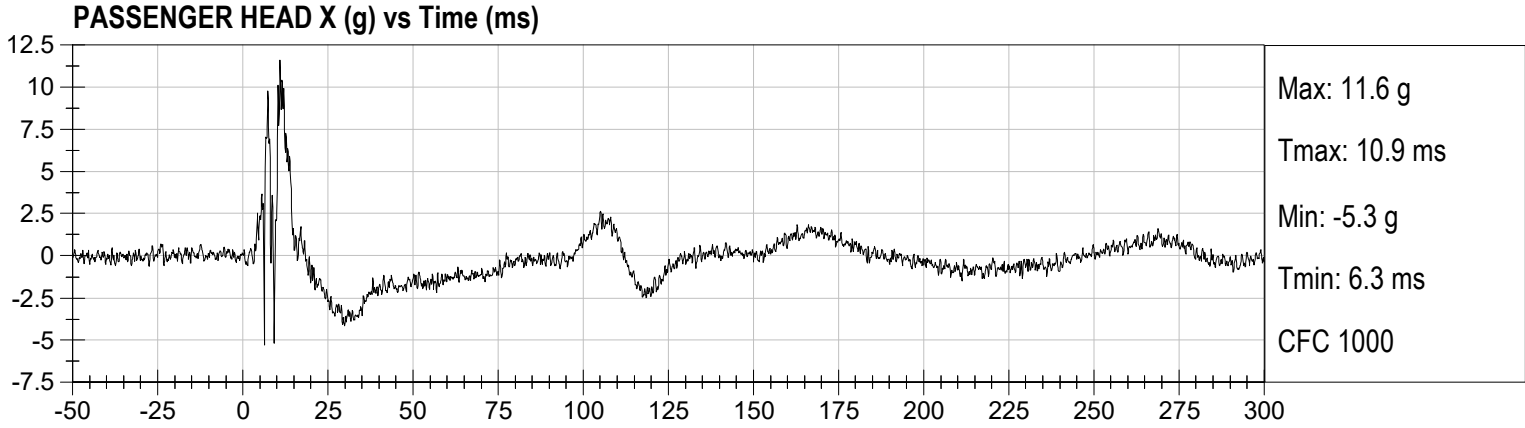


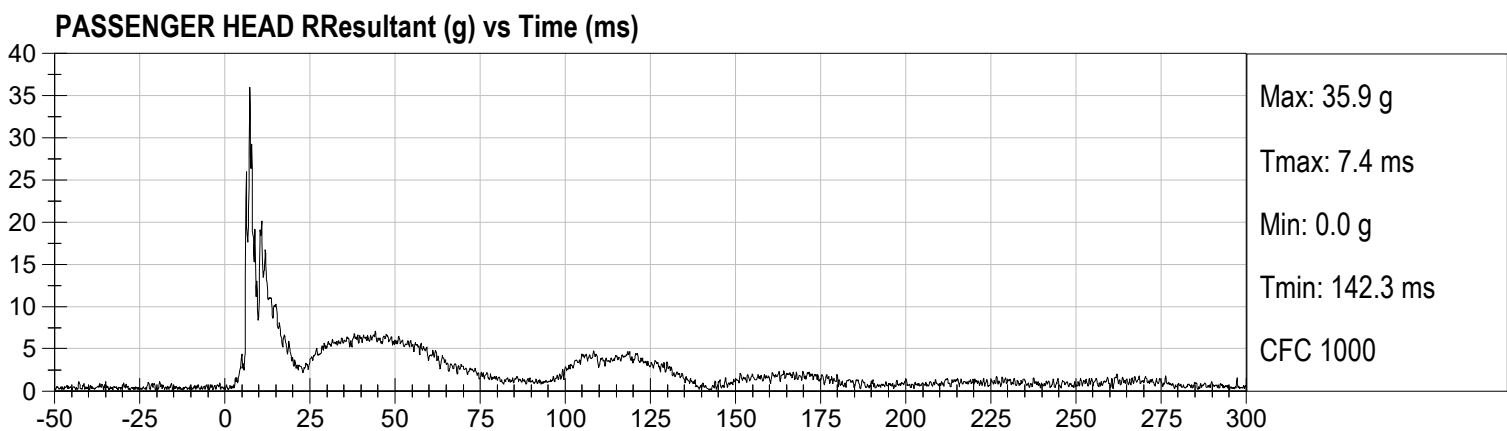
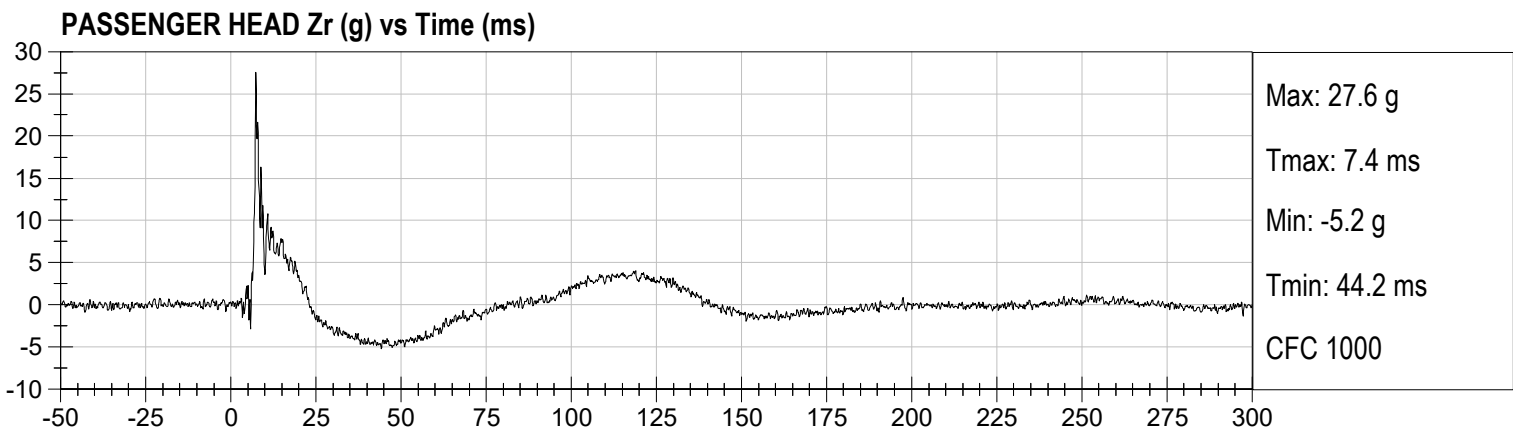
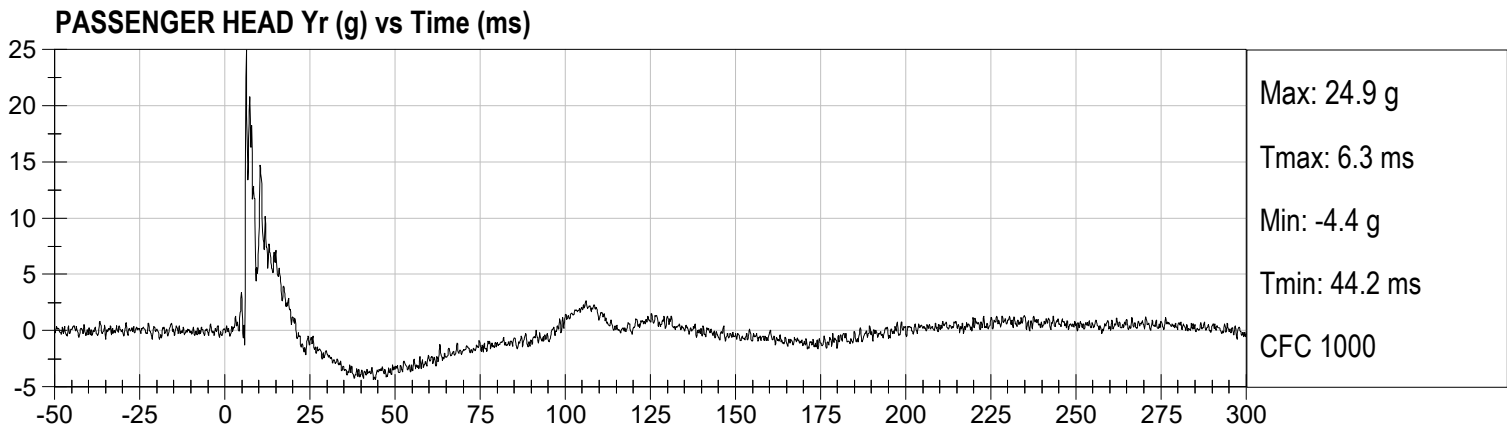
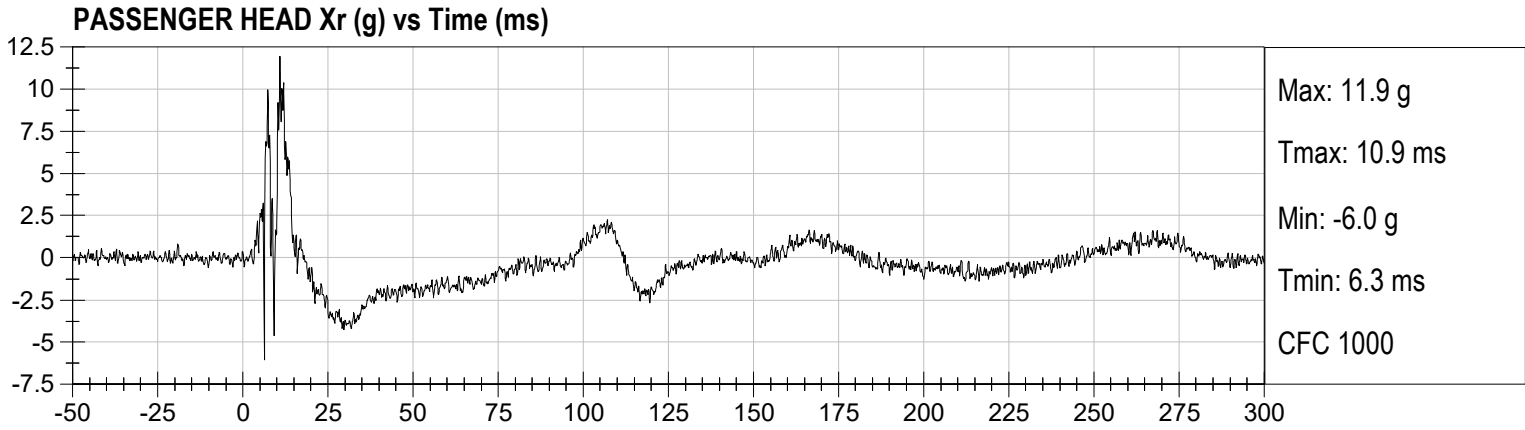
Photo No. 026 - Post-Test Partial Deployment of Curtain Airbag

APPENDIX B
DUMMY RESPONSE DATA TRACES

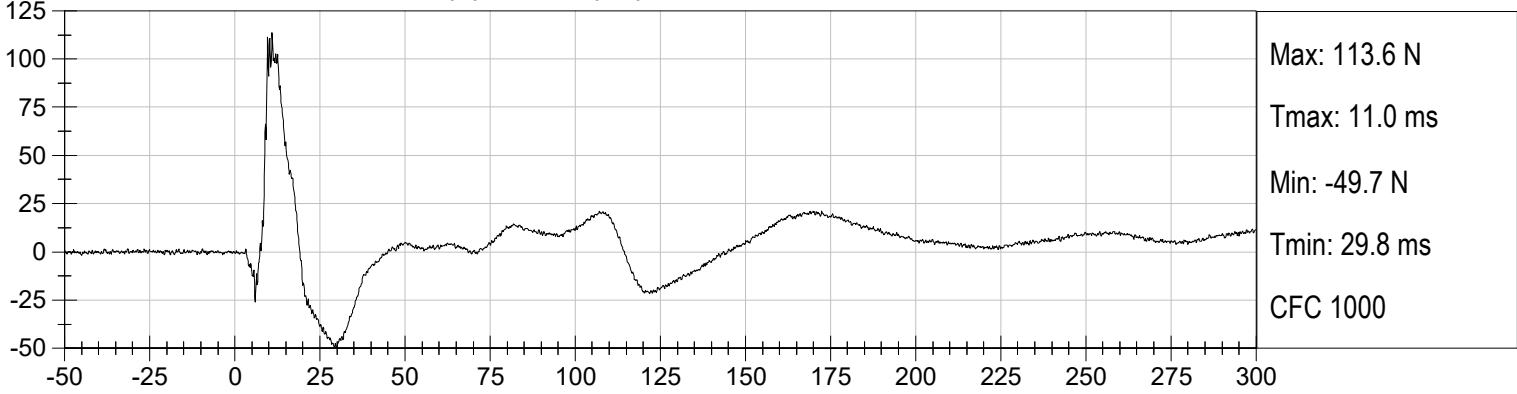
TABLE OF DATA PLOTS

	<u>Page No.</u>
Passenger Head X Acceleration vs. Time	B-1
Passenger Head Y Acceleration vs. Time	B-1
Passenger Head Z Acceleration vs. Time	B-1
Passenger Head Resultant Acceleration vs. Time	B-1
Passenger Head Xr Acceleration vs. Time	B-2
Passenger Head Yr Acceleration vs. Time	B-2
Passenger Head Zr Acceleration vs. Time	B-2
Passenger Head Resultant Acceleration vs. Time	B-2
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

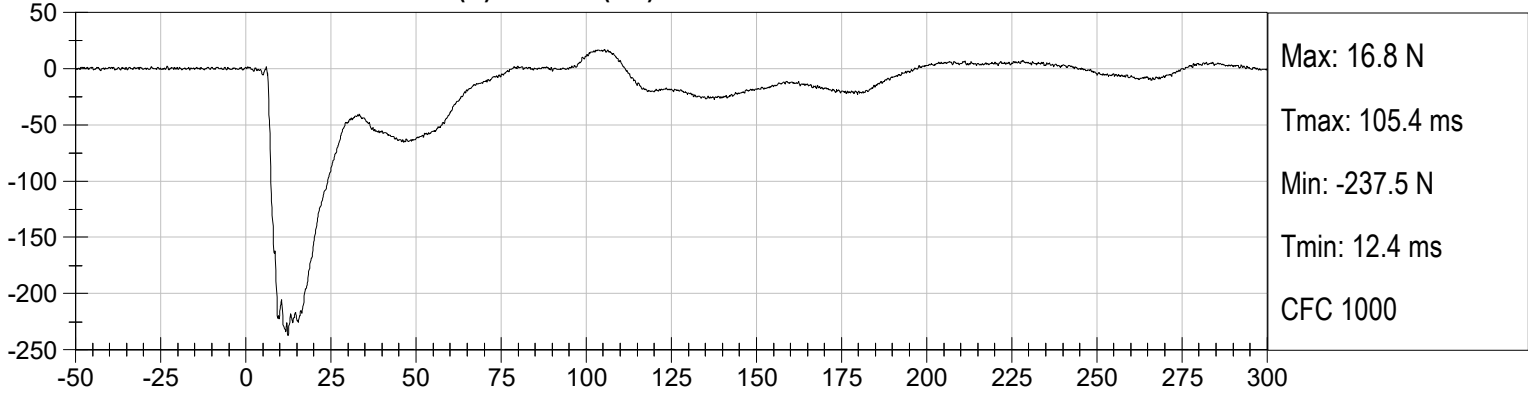




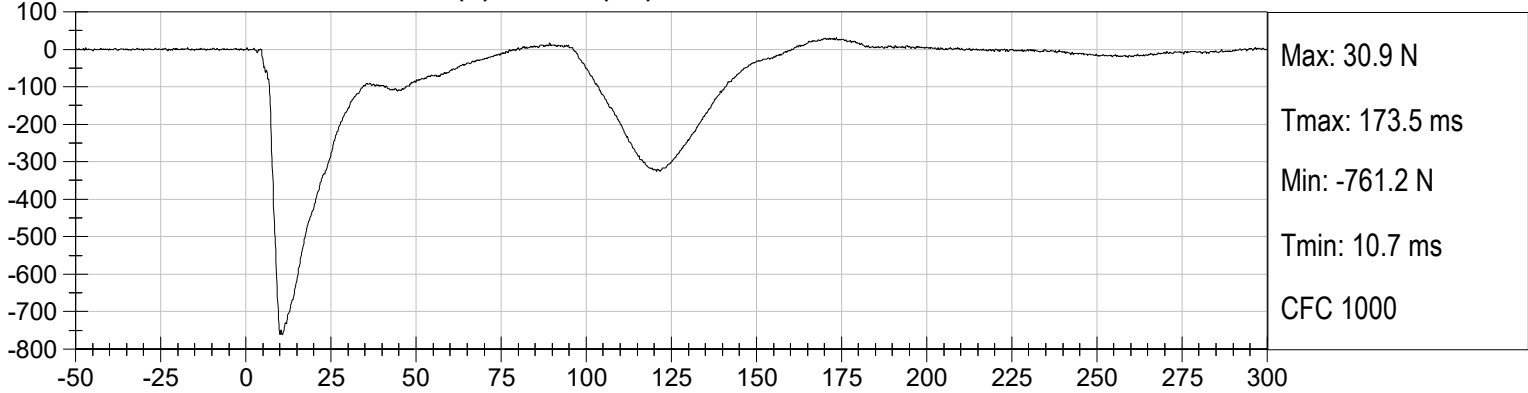
PASSENGER UPPER NECK FX (N) vs Time (ms)



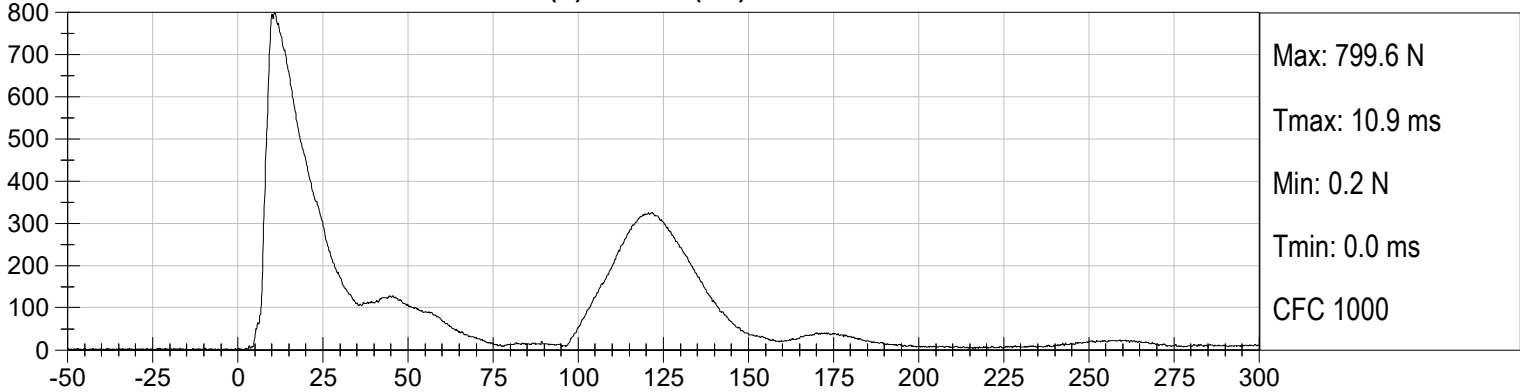
PASSENGER UPPER NECK FY (N) vs Time (ms)

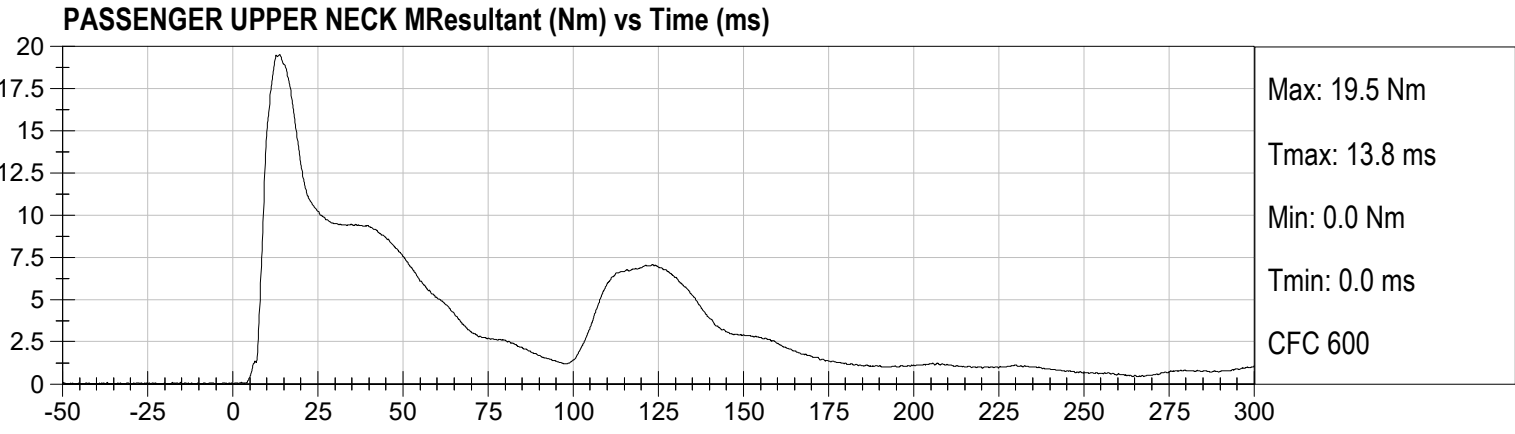
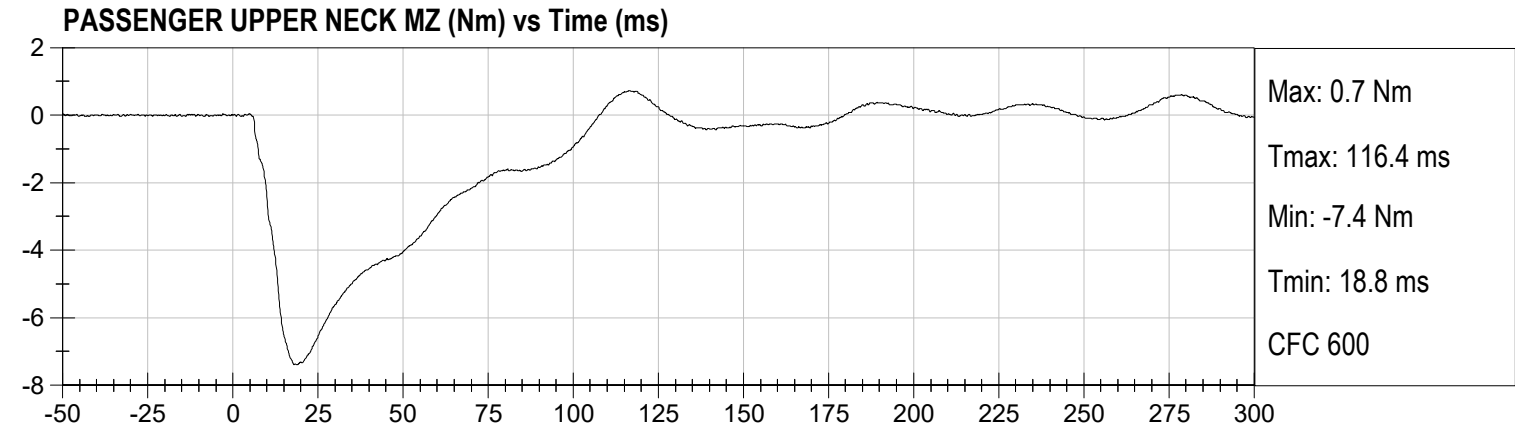
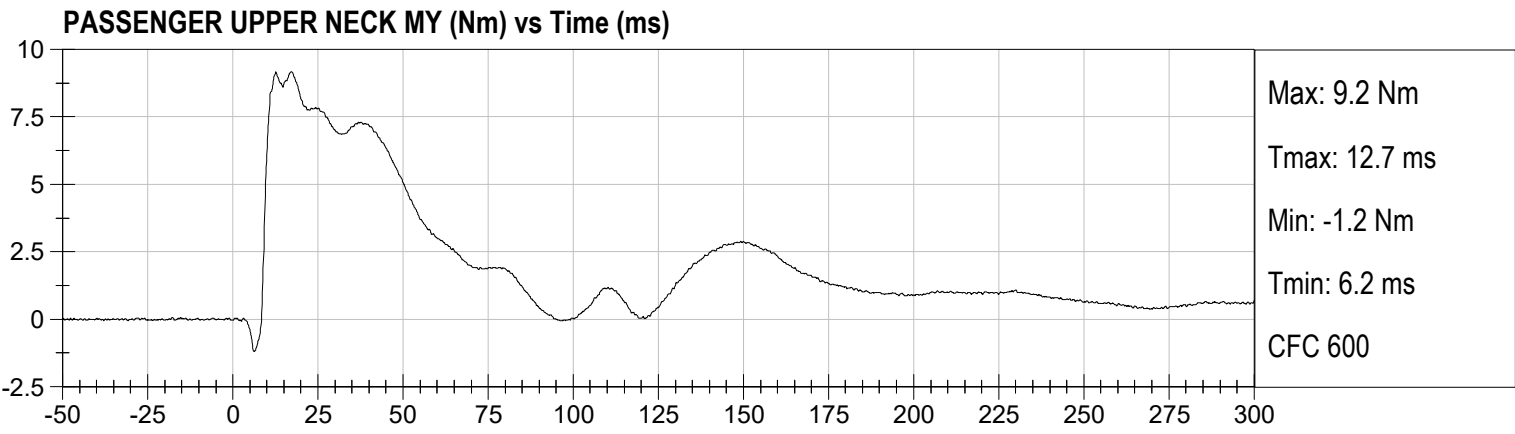
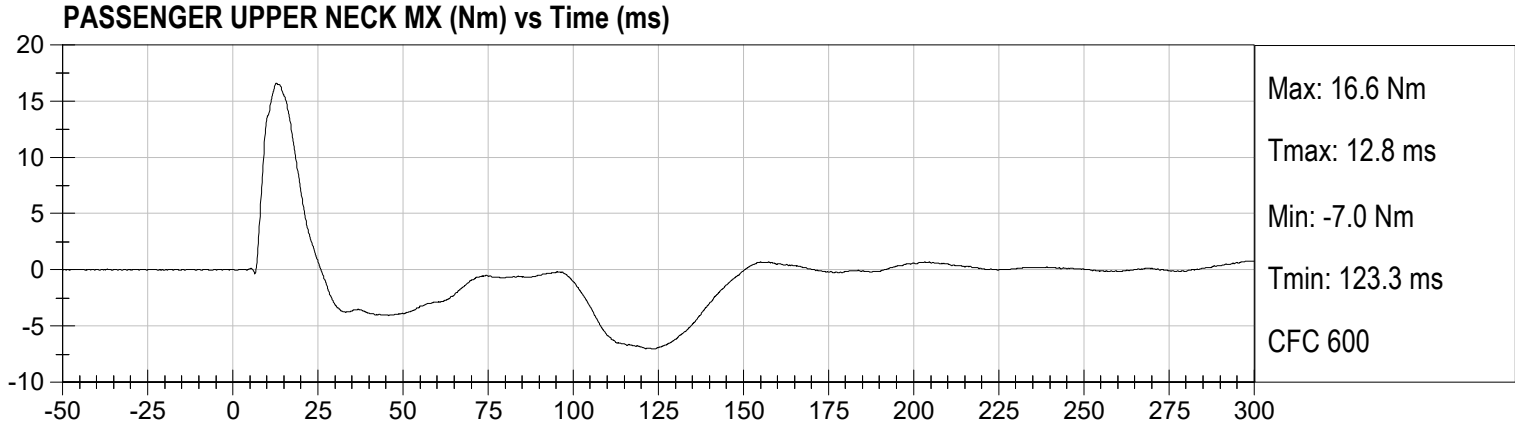


PASSENGER UPPER NECK FZ (N) vs Time (ms)

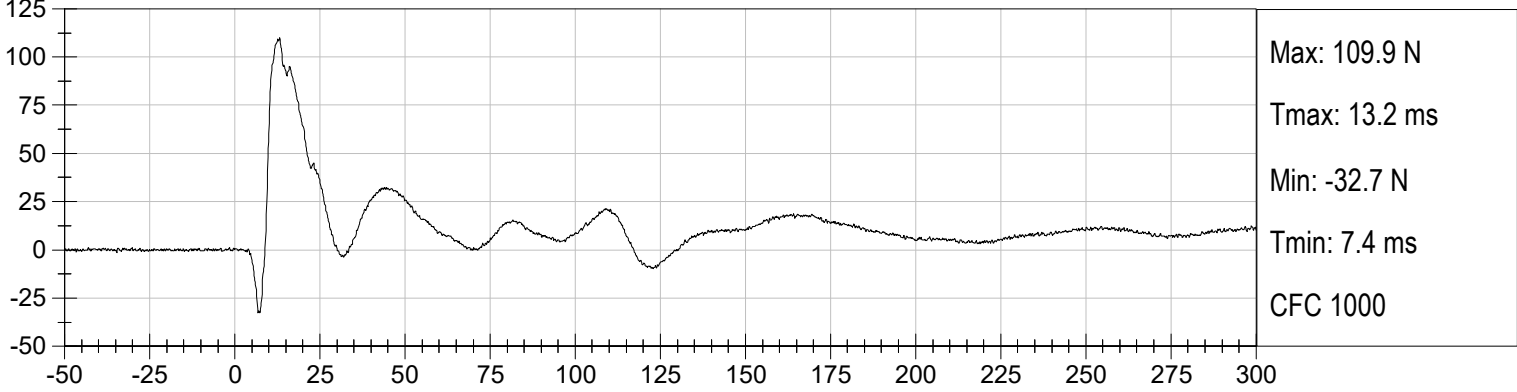


PASSENGER UPPER NECK FResultant (N) vs Time (ms)

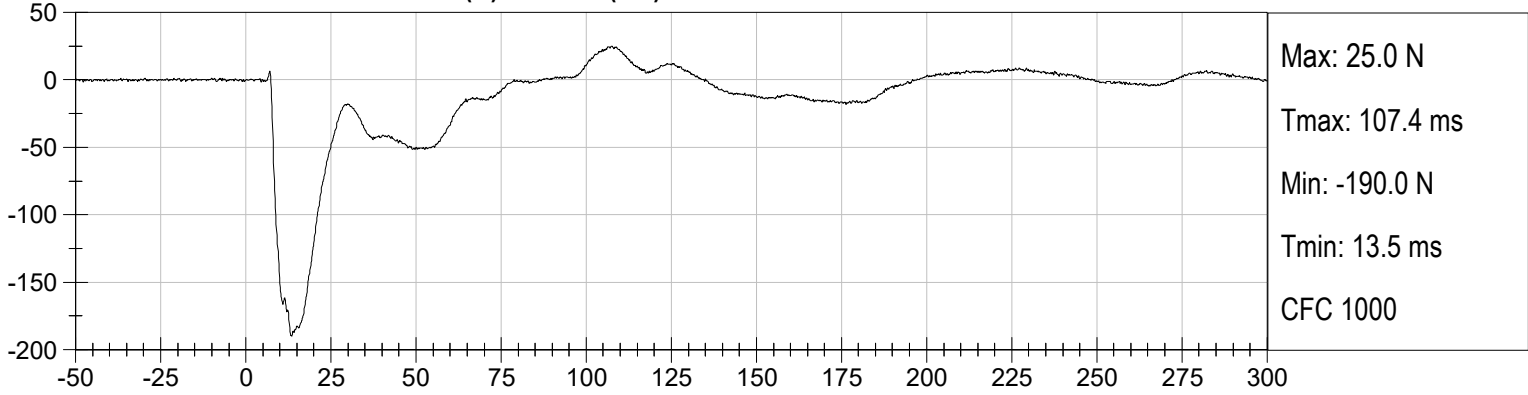




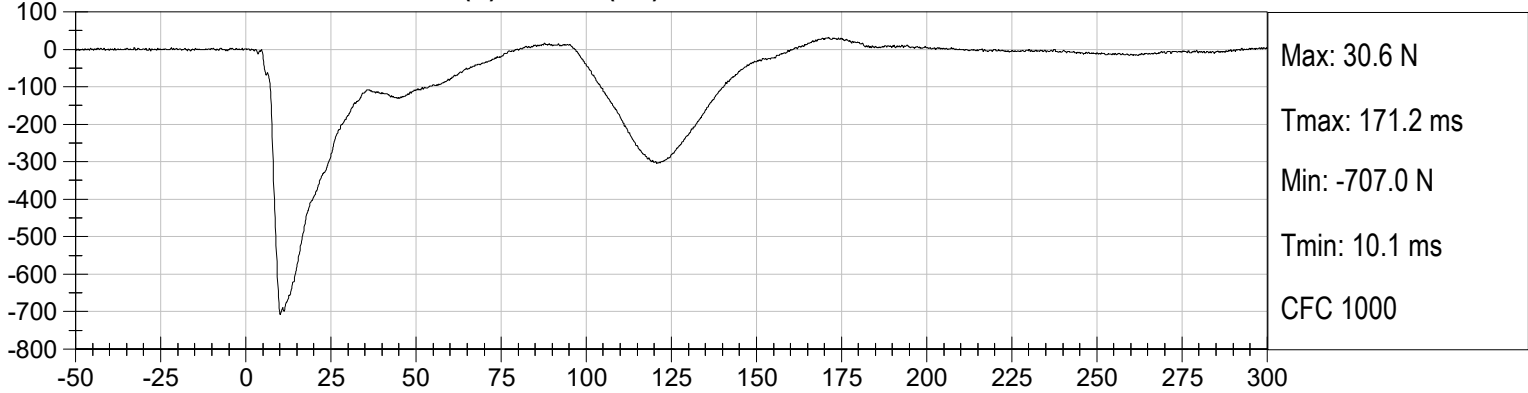
PASSENGER LOWER NECK FX (N) vs Time (ms)



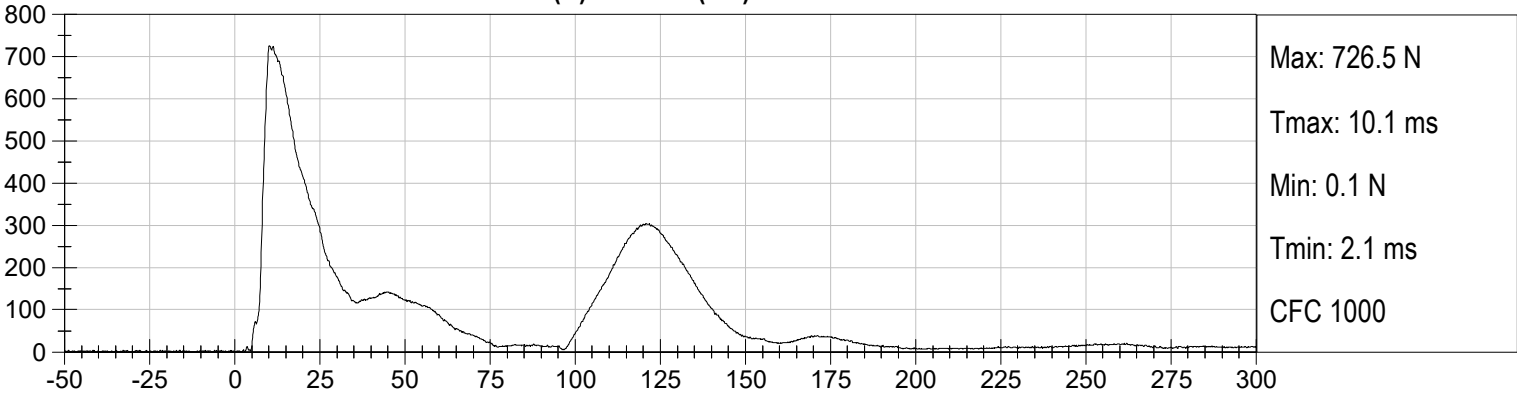
PASSENGER LOWER NECK FY (N) vs Time (ms)



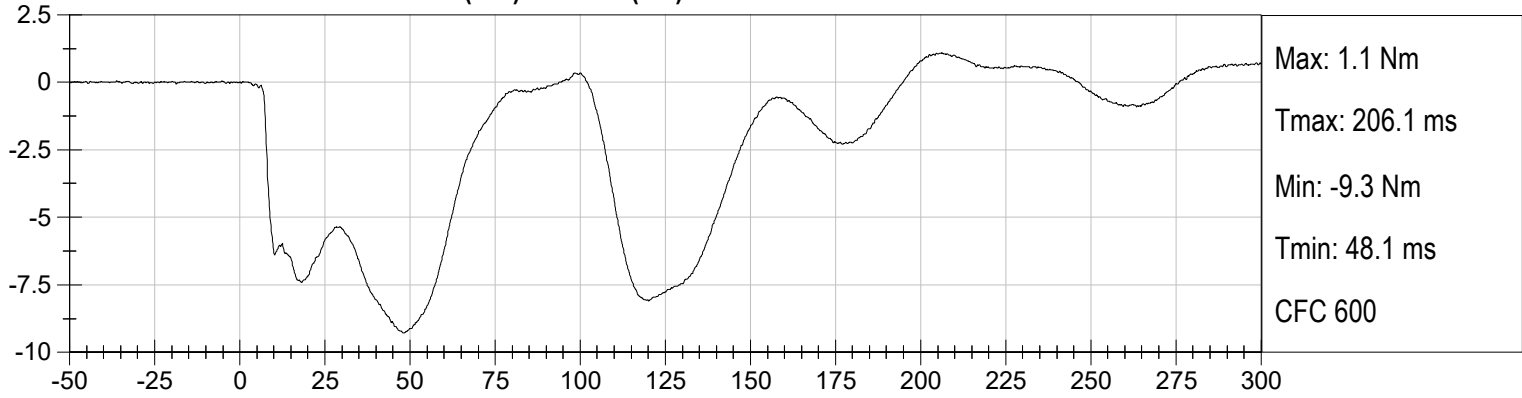
PASSENGER LOWER NECK FZ (N) vs Time (ms)



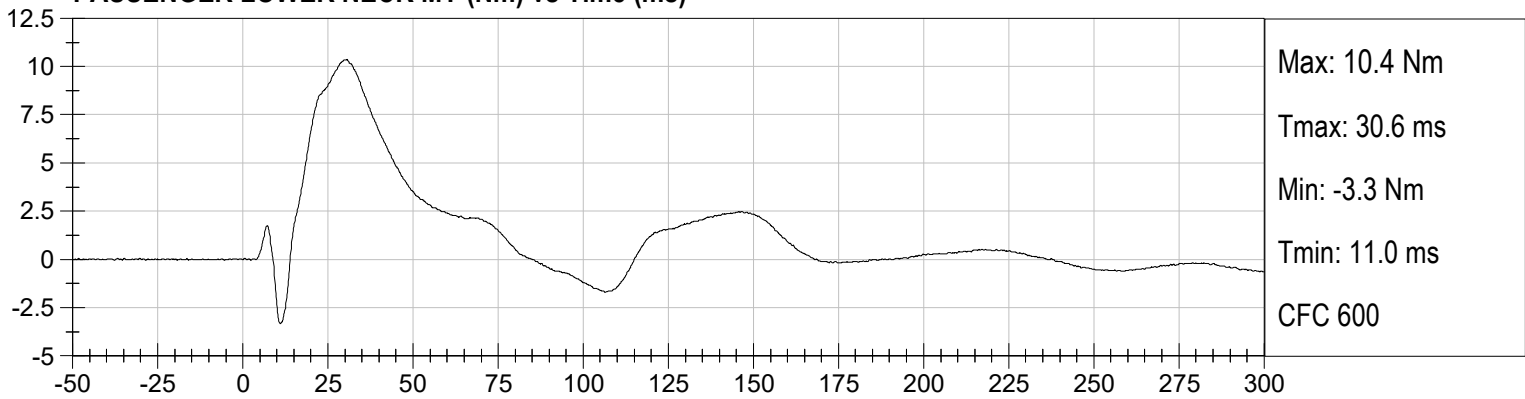
PASSENGER LOWER NECK FResultant (N) vs Time (ms)



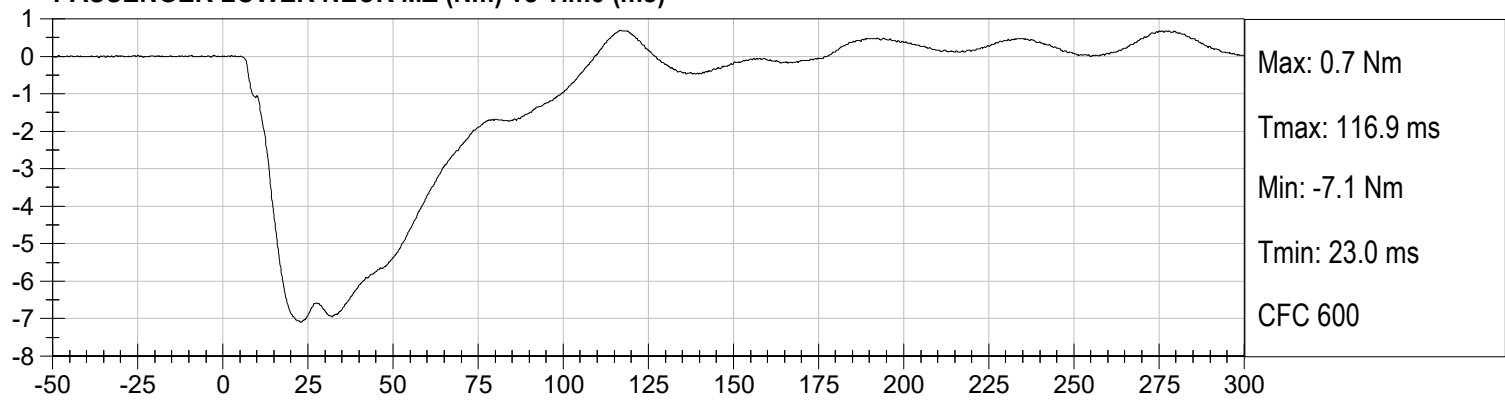
PASSENGER LOWER NECK MX (Nm) vs Time (ms)



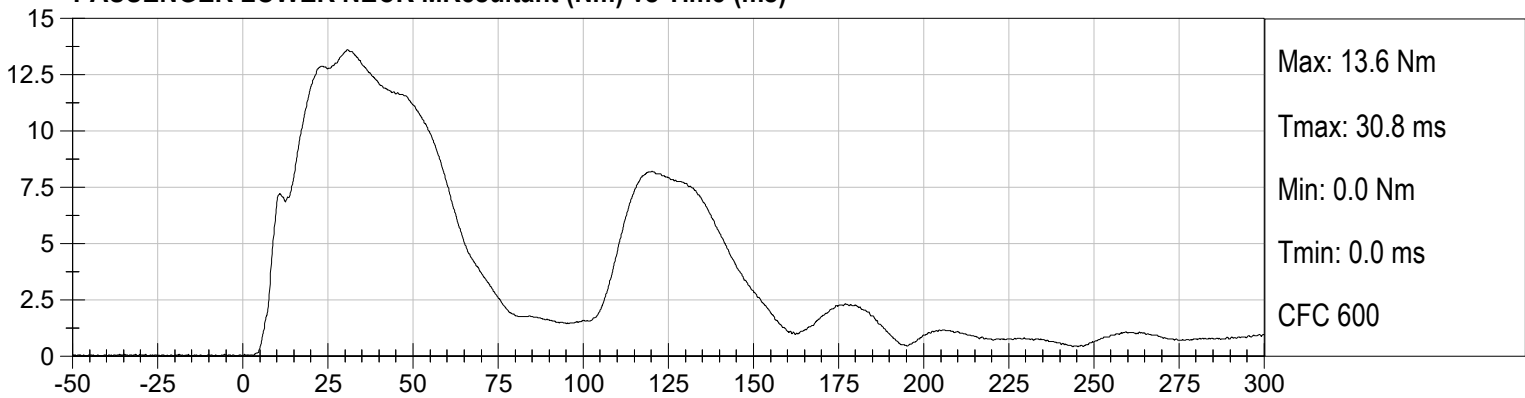
PASSENGER LOWER NECK MY (Nm) vs Time (ms)



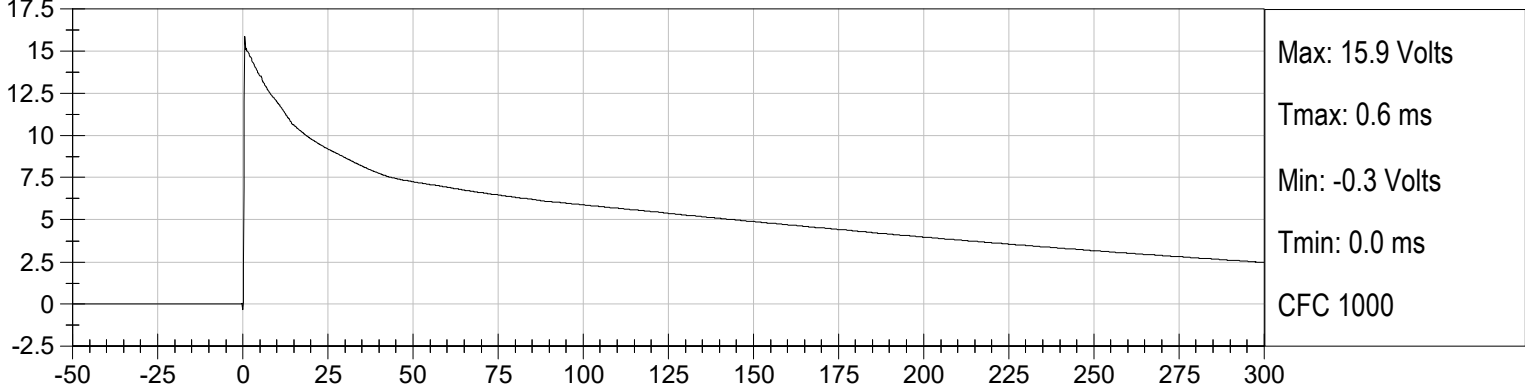
PASSENGER LOWER NECK MZ (Nm) vs Time (ms)



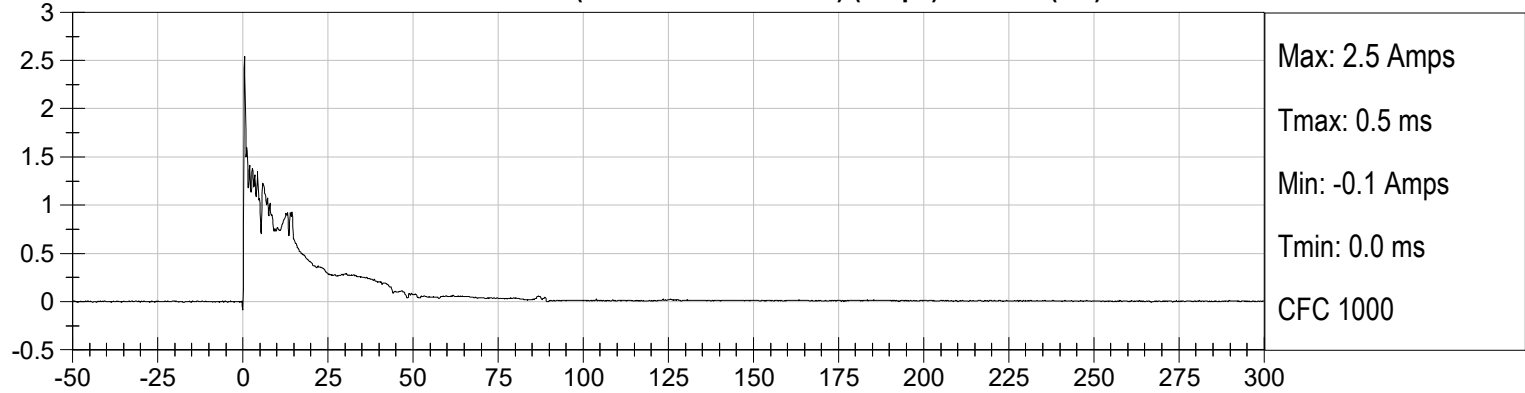
PASSENGER LOWER NECK MResultant (Nm) vs Time (ms)



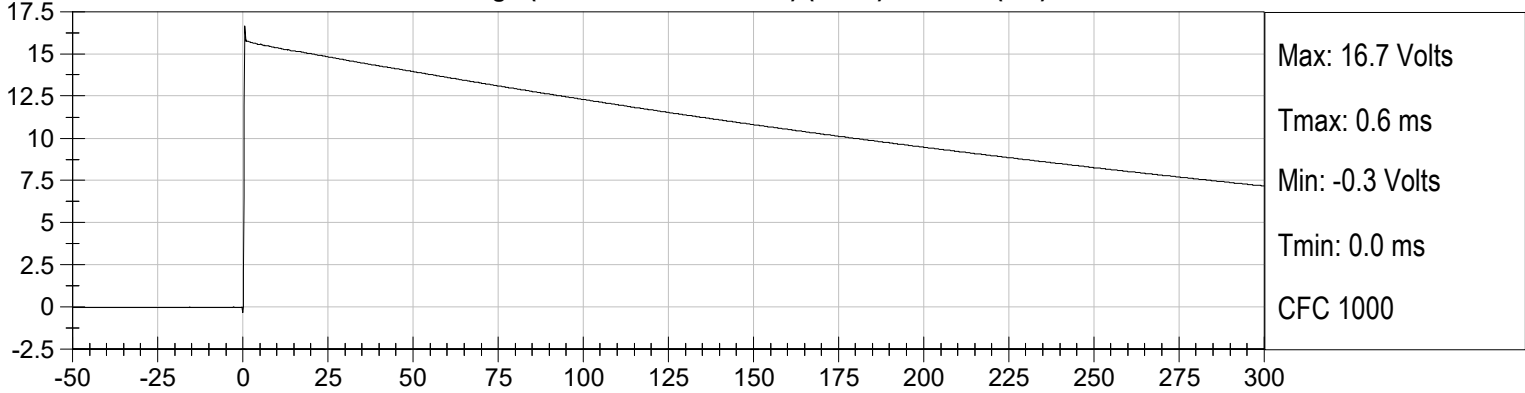
PASSENGER CURTAIN AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)



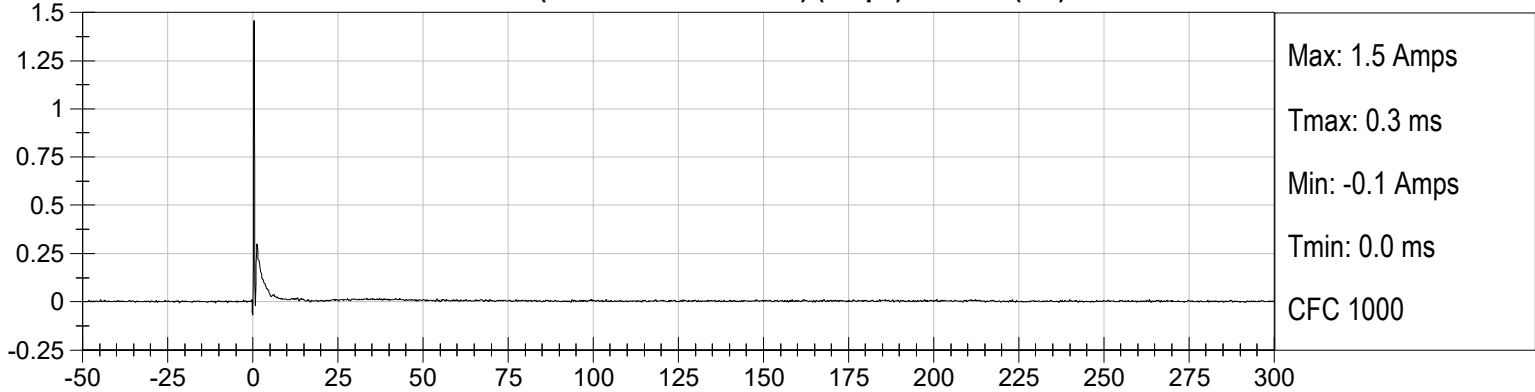
PASSENGER CURTAIN AB - Fire Current (DC Constant Current) (Amps) vs Time (ms)

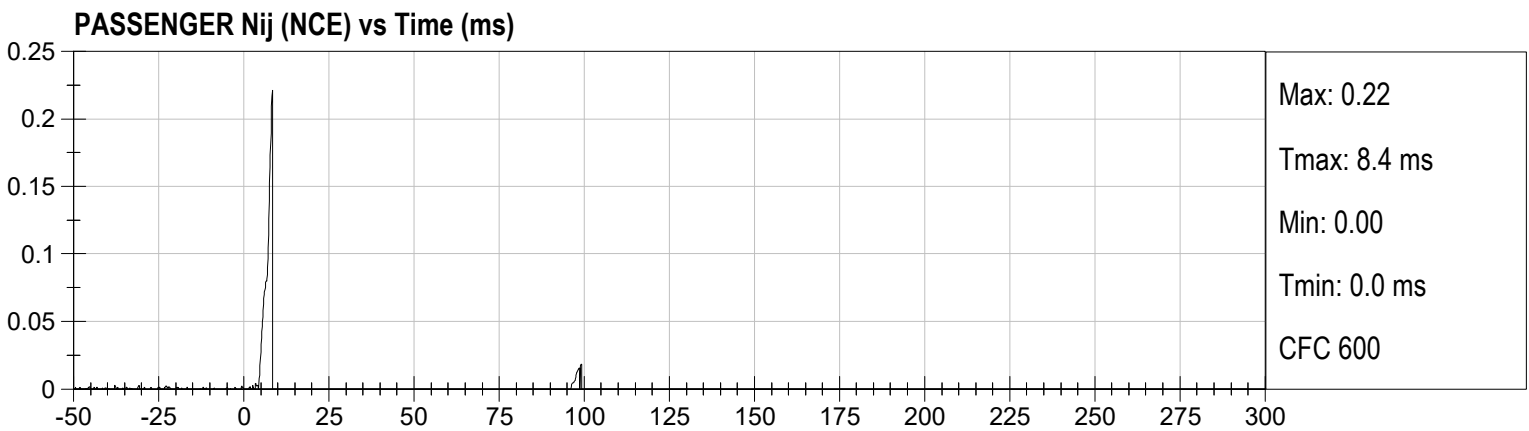
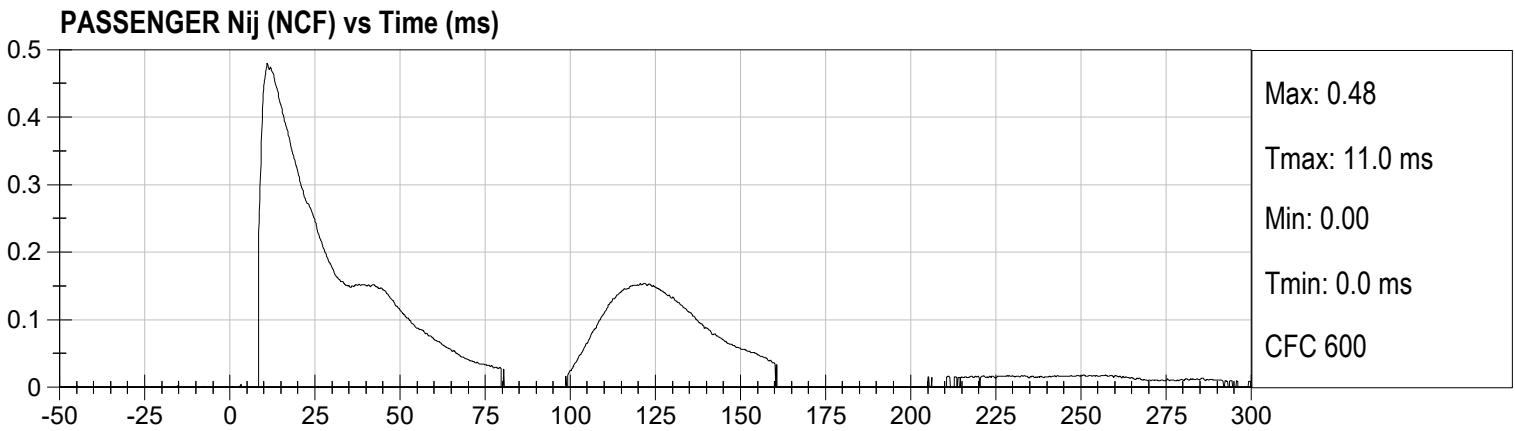
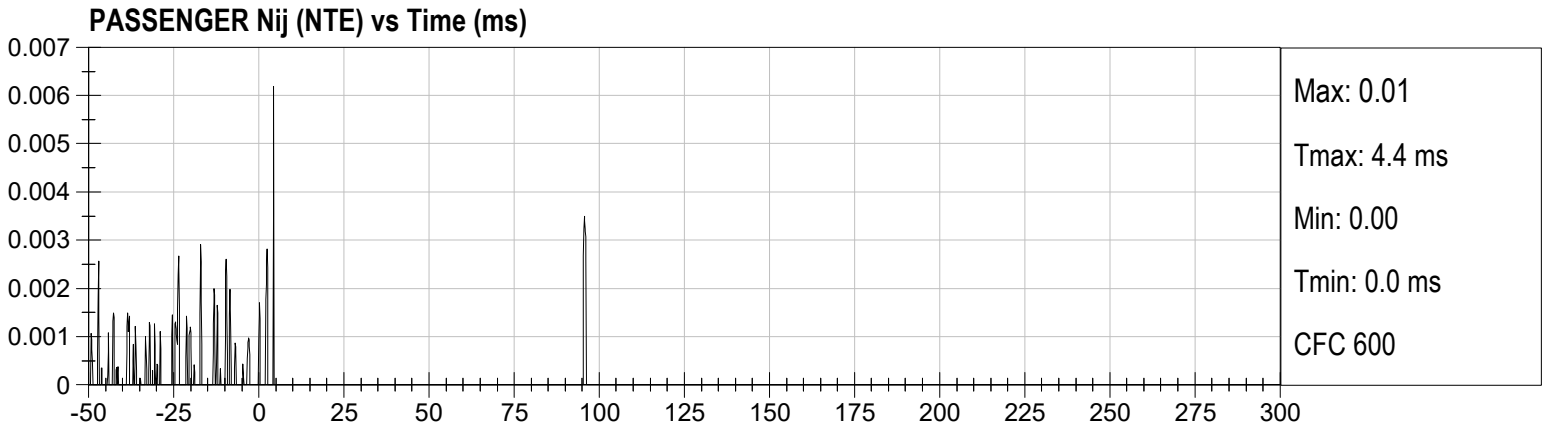
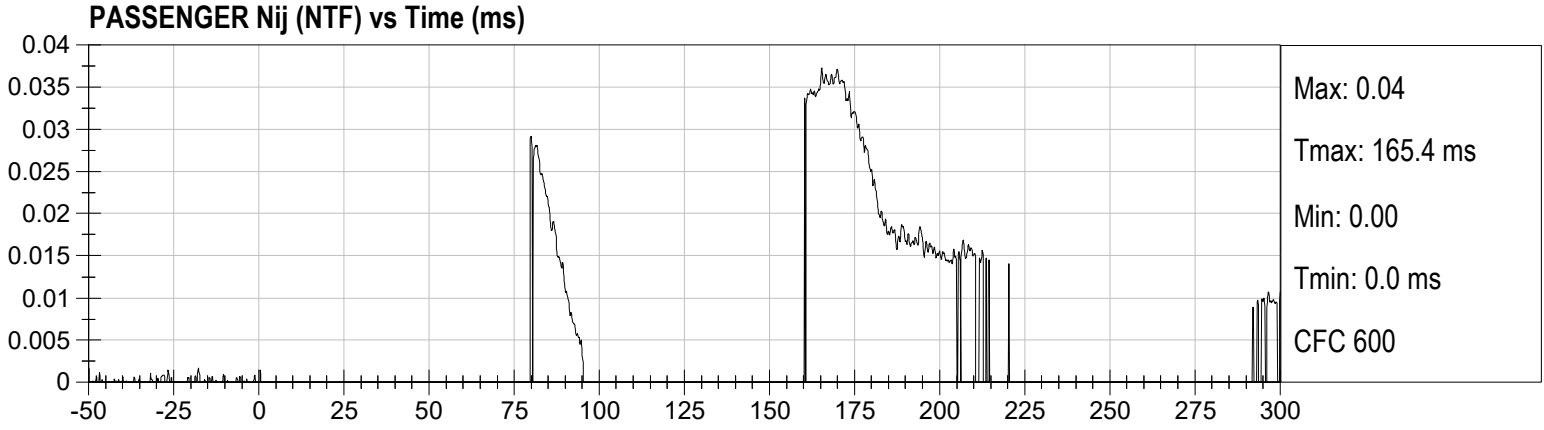


PASSENGER SEAT AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)



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 3-Year-Old ATD

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

Test ID: D201751

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	250 to 280	265	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-9.9	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

Brian Roach

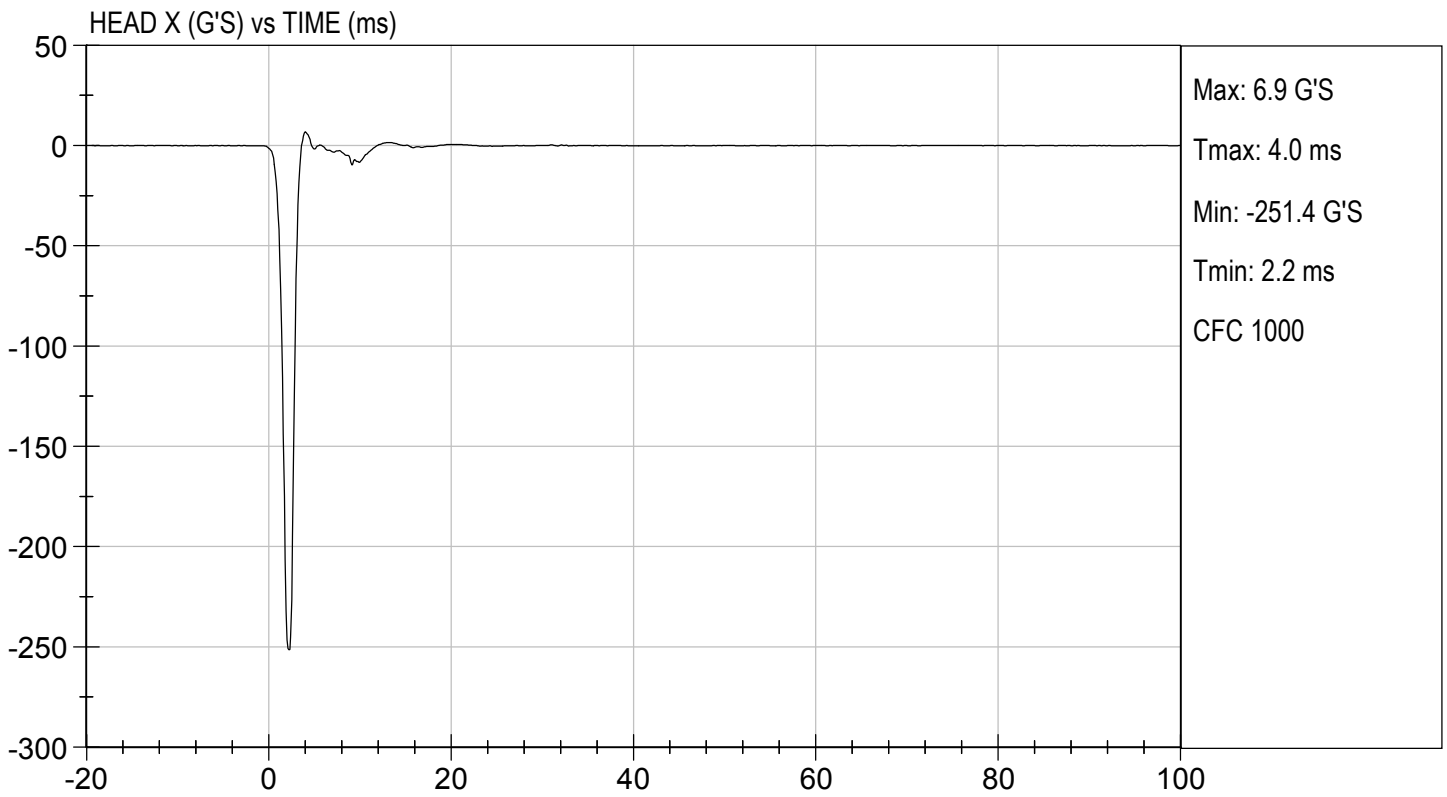
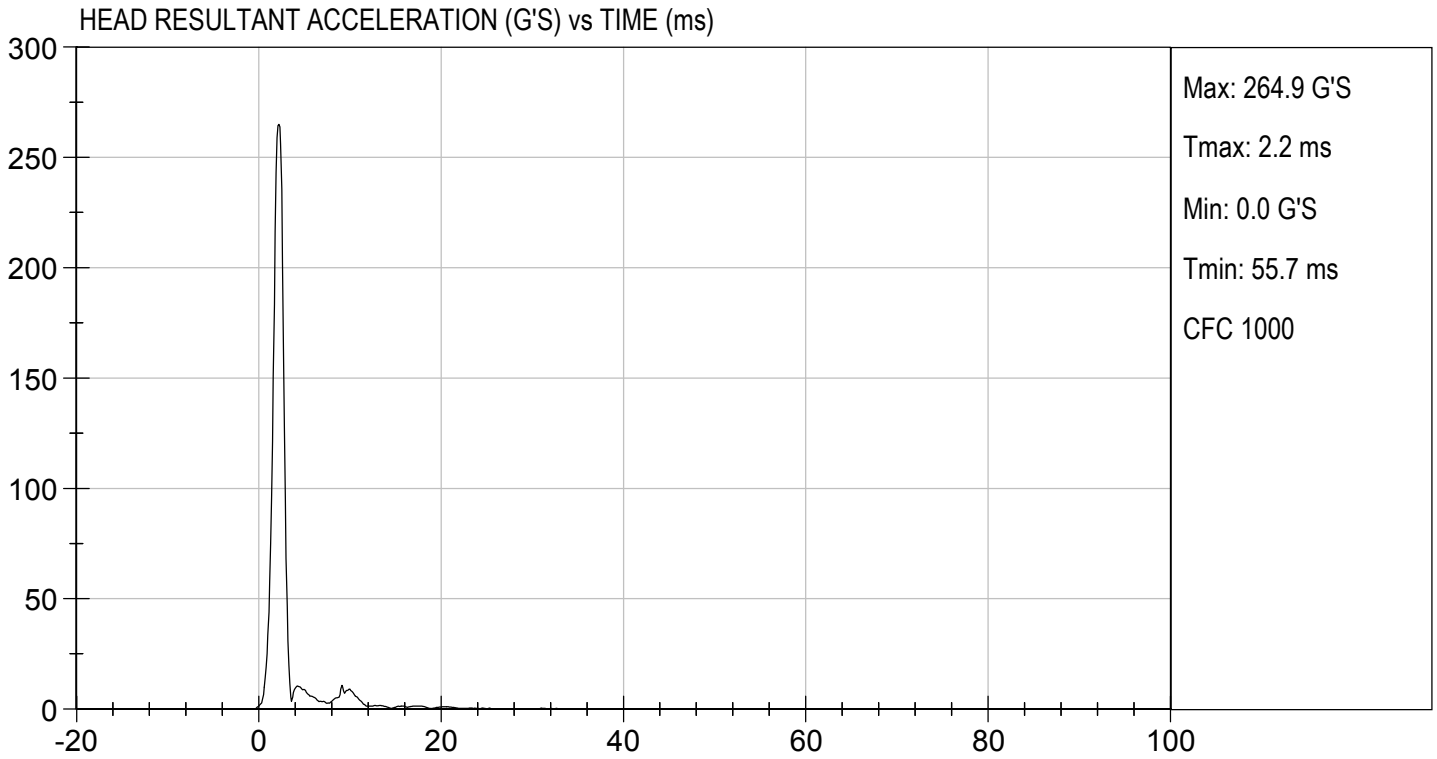
Laboratory Technician

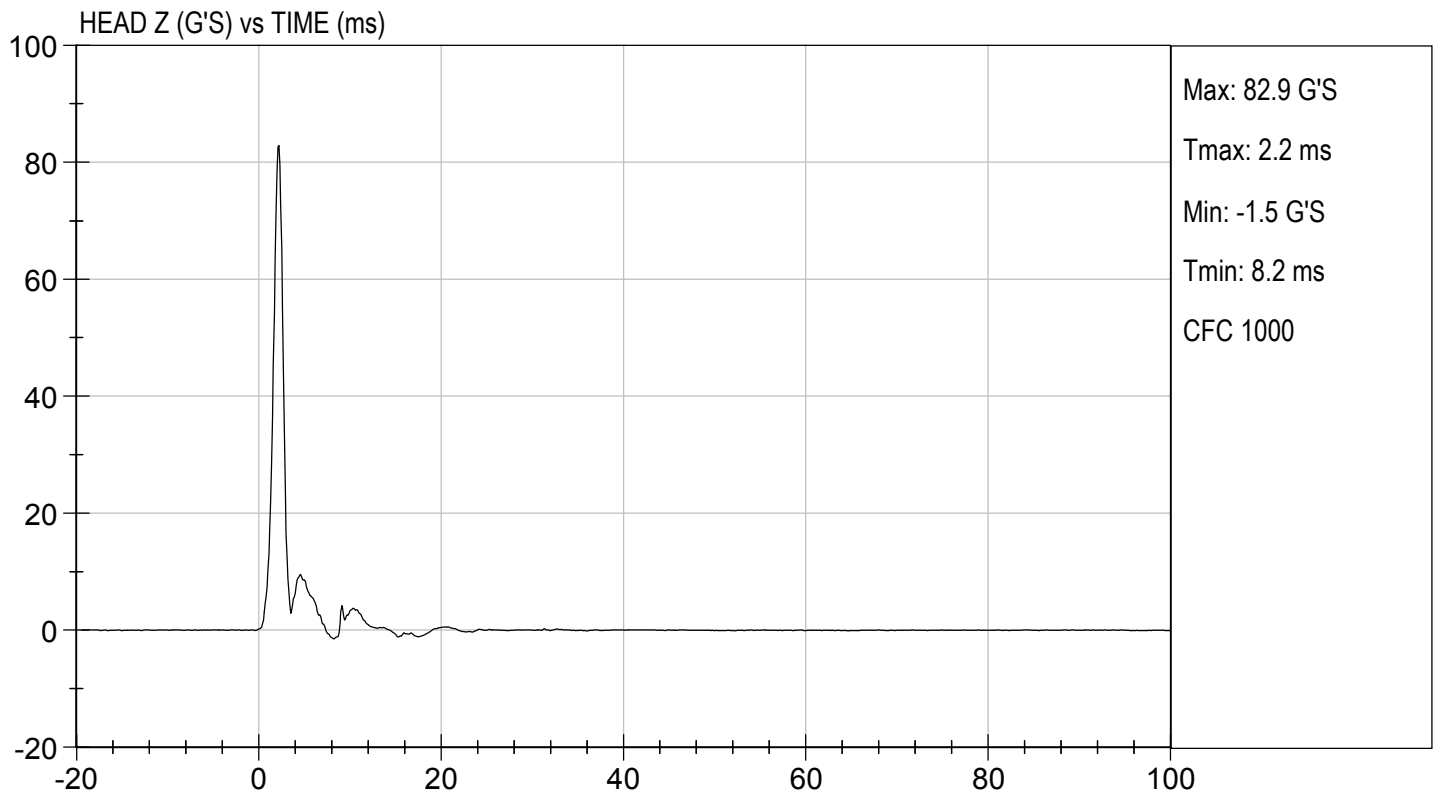
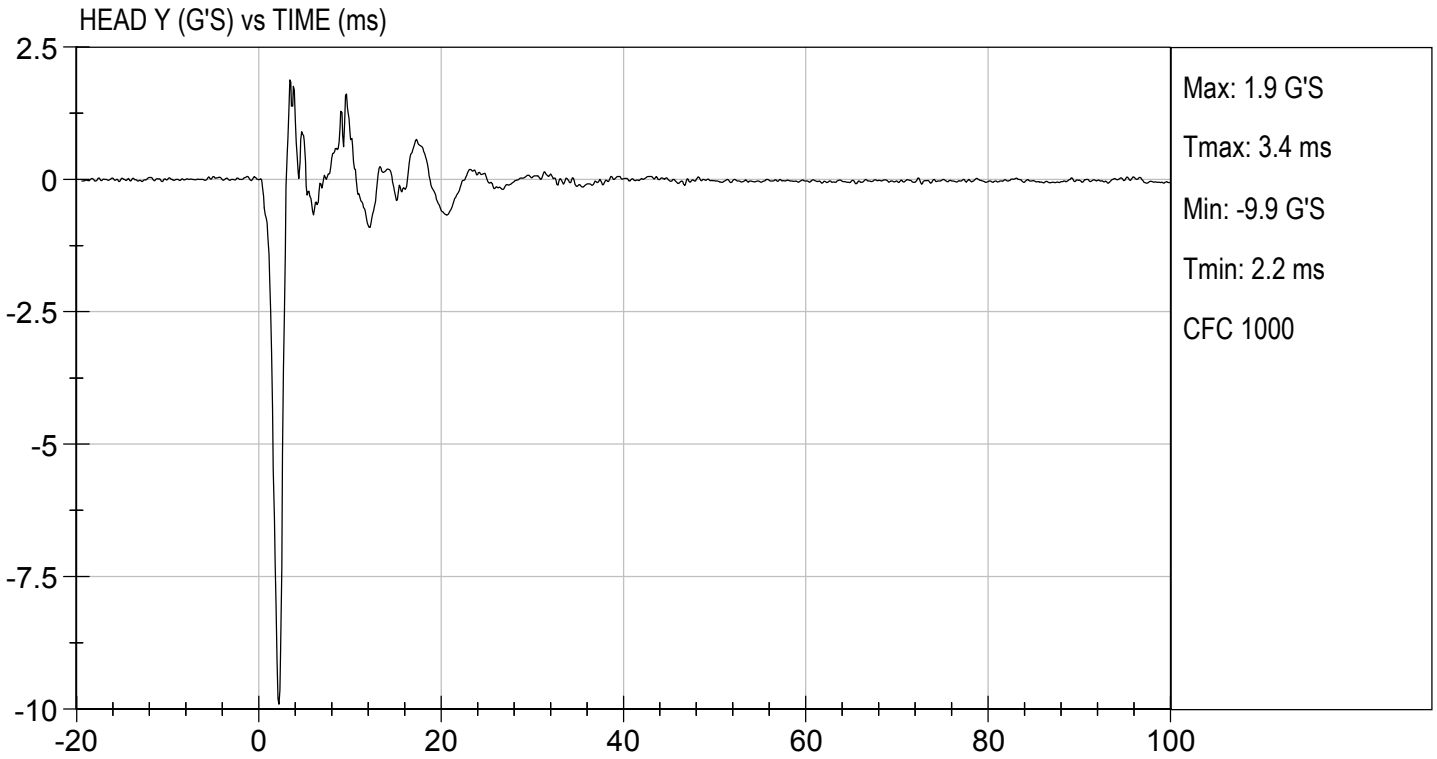
07/21/2020

Test Date

B. F. H.

Approved By





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082

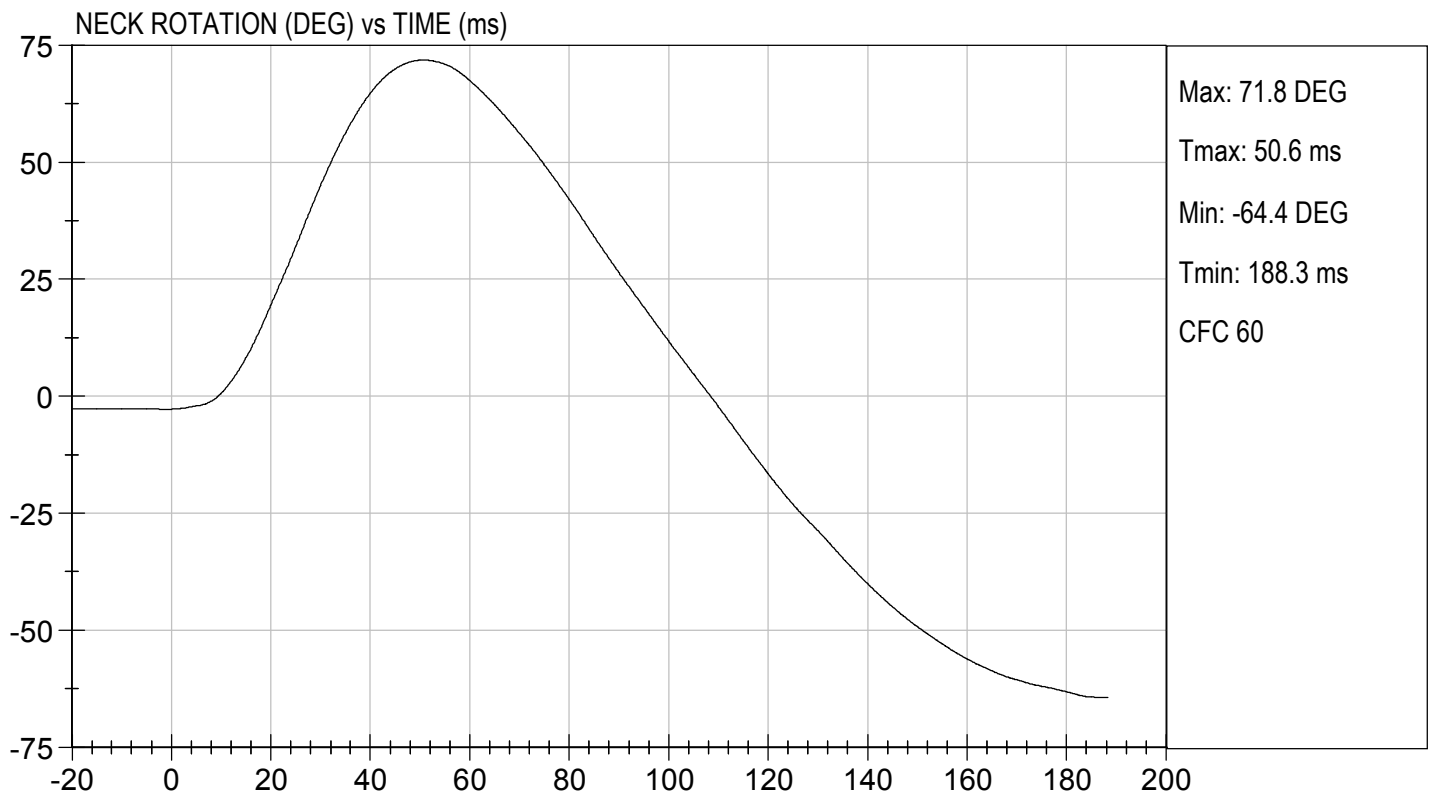
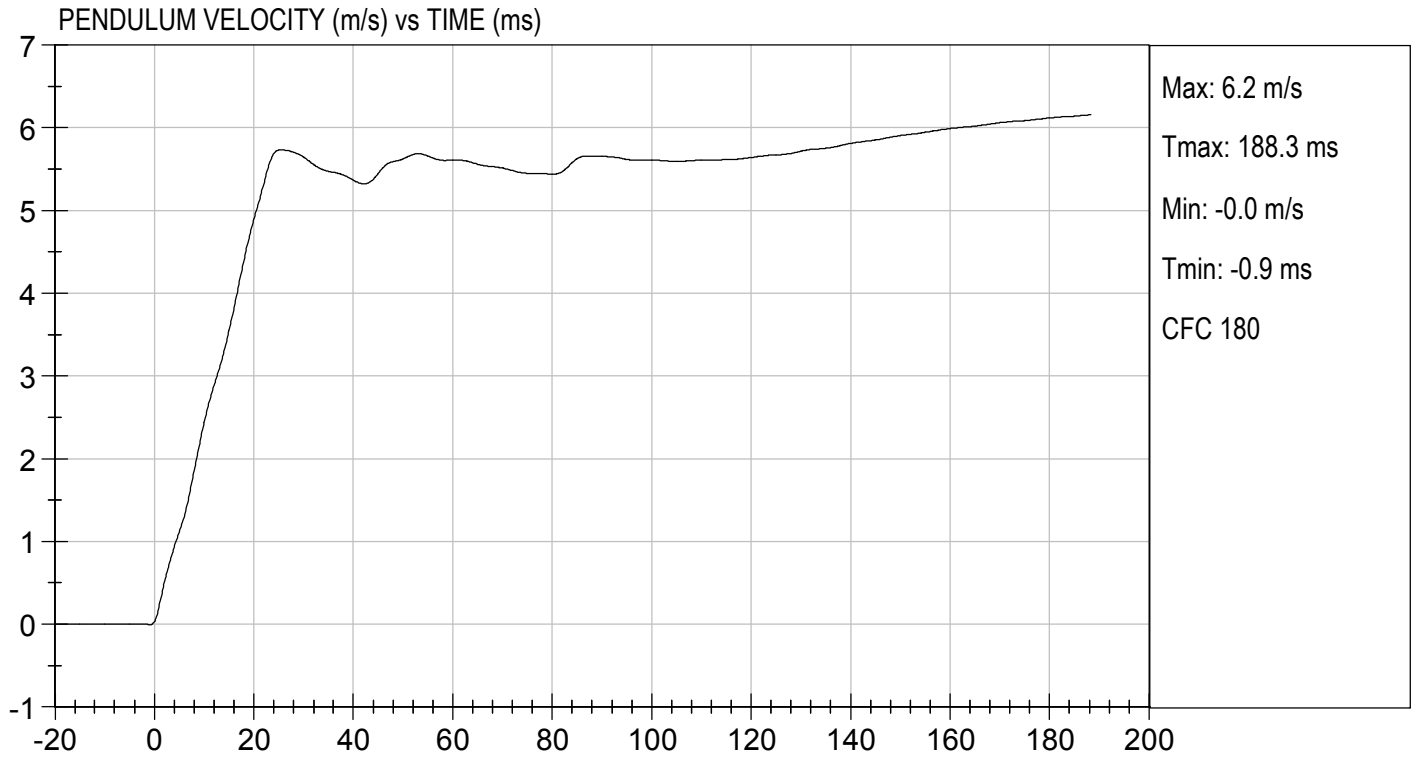
Test I.D.: D201752

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	5.40 to 5.60	5.46	Pass
Pendulum Velocity	10 msec	m/s	2.0 to 2.7	2.4	Pass
	15 msec	m/s	3.0 to 4.0	3.5	Pass
	20 msec	m/s	4.0 to 5.1	4.9	Pass
D Plane Rotation		deg	70 to 82	72	Pass
Peak Moment within Deflection Corridor		Nm	42.0 to 53.0	44.2	Pass
Positive Moment - Time Curve Decay to 10 Nm		msec	60.0 to 80.0	68	Pass
Overall Test Results					Pass

Brian Roach
Laboratory Technician

07/29/2020
Test Date

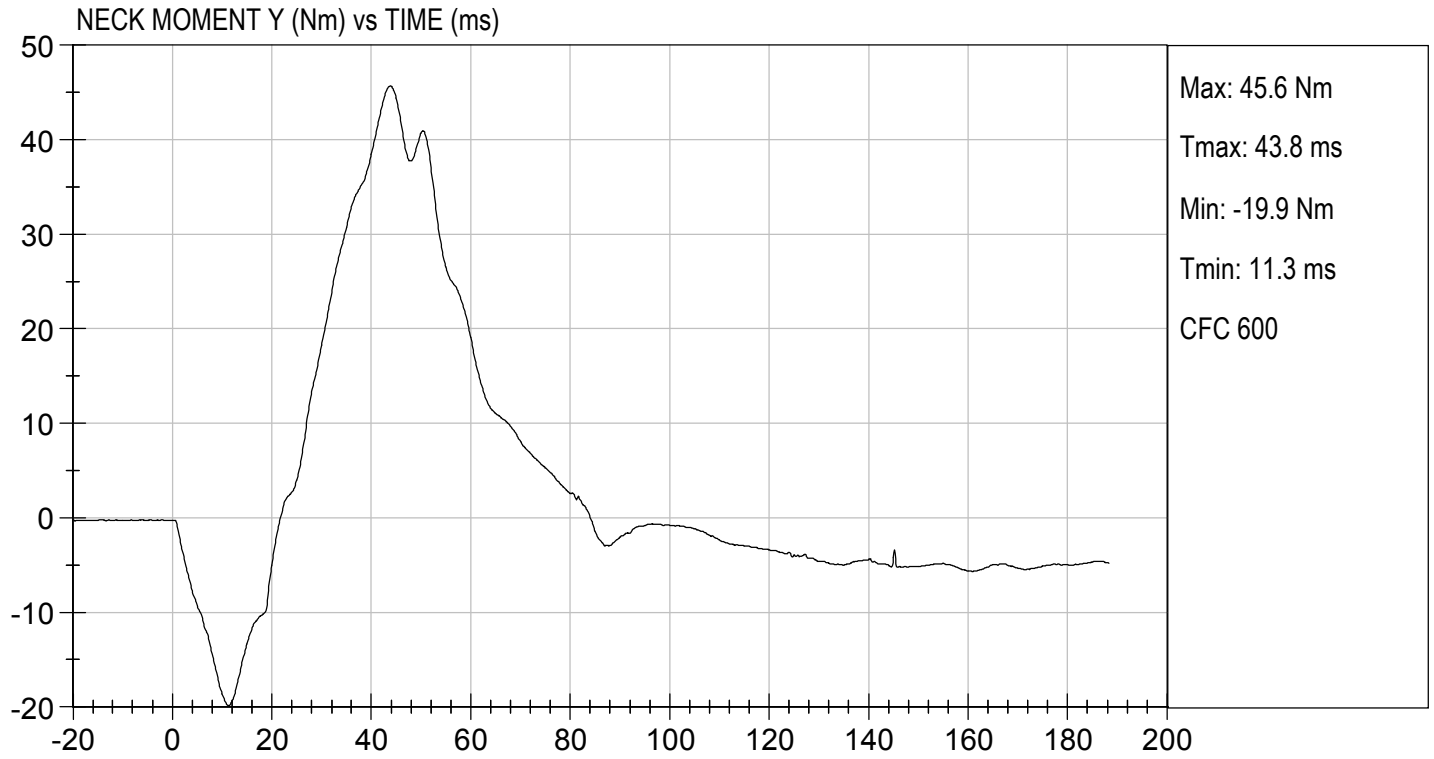
B. F. K.
Approved By





TEST DESC: NECK FLEXION
VELOCITY: 17.92 ft/s, 5.46 m/s

TEST DATE: 07/29/2020
TEST #: D201752



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

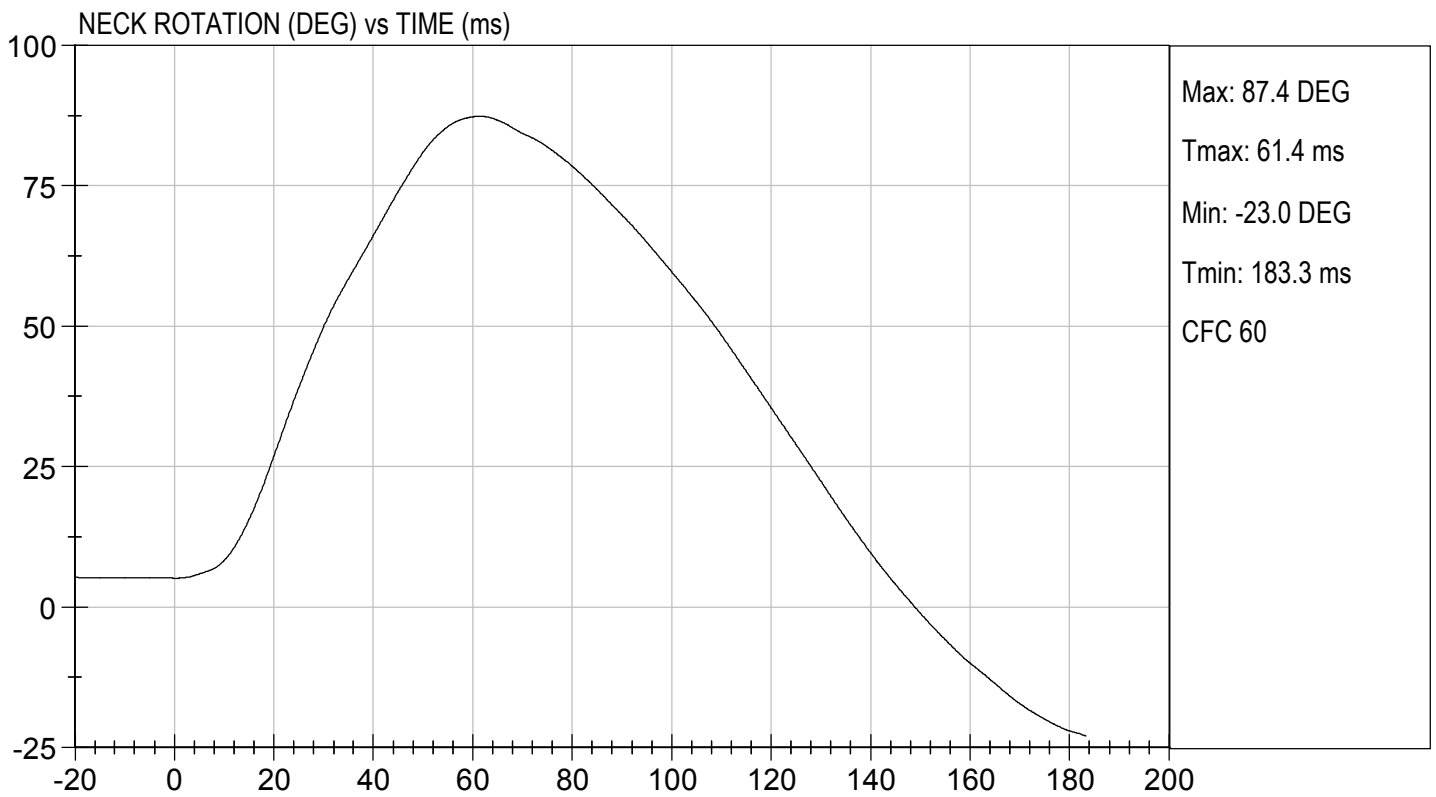
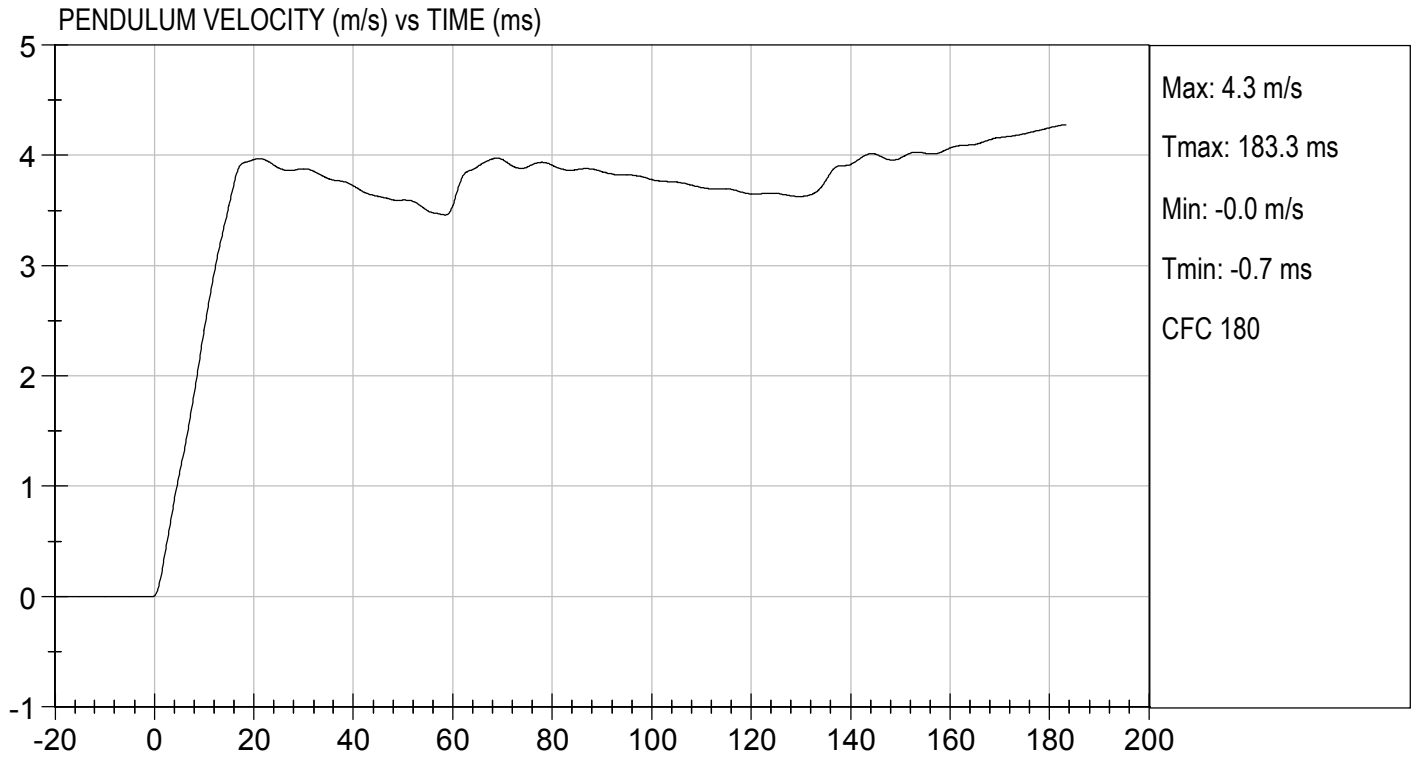
Test I.D: D201753

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	3.55 to 3.75	3.71	Pass
Pendulum Velocity	6 ms	m/s	1.0 to 1.4	1.3	Pass
	10 ms	m/s	1.9 to 2.5	2.4	Pass
	14 ms	m/s	2.8 to 3.5	3.4	Pass
D Plane Rotation		deg	83 to 93	87	Pass
Peak Moment within Deflection Corridor		Nm	-53.3 to -43.7	-44.5	Pass
Negative Moment - Time Curve Decay to -10 Nm		ms	60.0 to 80.0	67	Pass
Overall Test Results					Pass

Brian Roach
Laboratory Technician

07/29/2020
Test Date

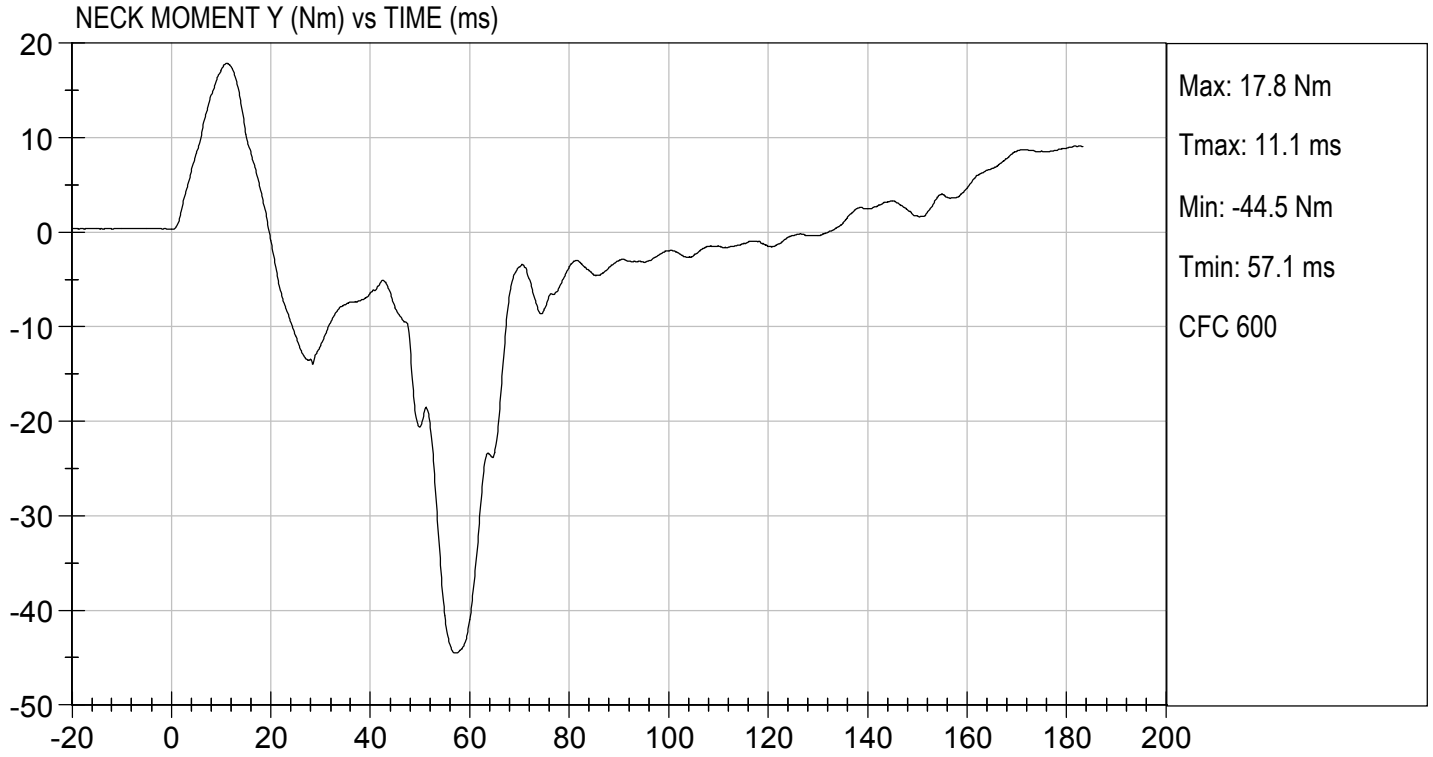
B. Fick
Approved By





TEST DESC: NECK EXTENSION
VELOCITY: 12.17 ft/s, 3.71 m/s

TEST DATE: 07/29/2020
TEST #: D201753



**MGA RESEARCH CORPORATION
THORAX IMPACT TEST
HYBRID III 3 YEAR OLD**

ATD Serial No: 082

Test I.D: D201754

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
Probe Velocity	m/s	5.9 to 6.1	6.05	Pass
Peak Deflection	mm	32 to 38	34.6	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	721	Pass
Internal Hysteresis	%	65 to 85	74.7	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	764	Pass
Overall Test Results				Pass

Brian Roach

Laboratory Technician

07/31/2020

Test Date

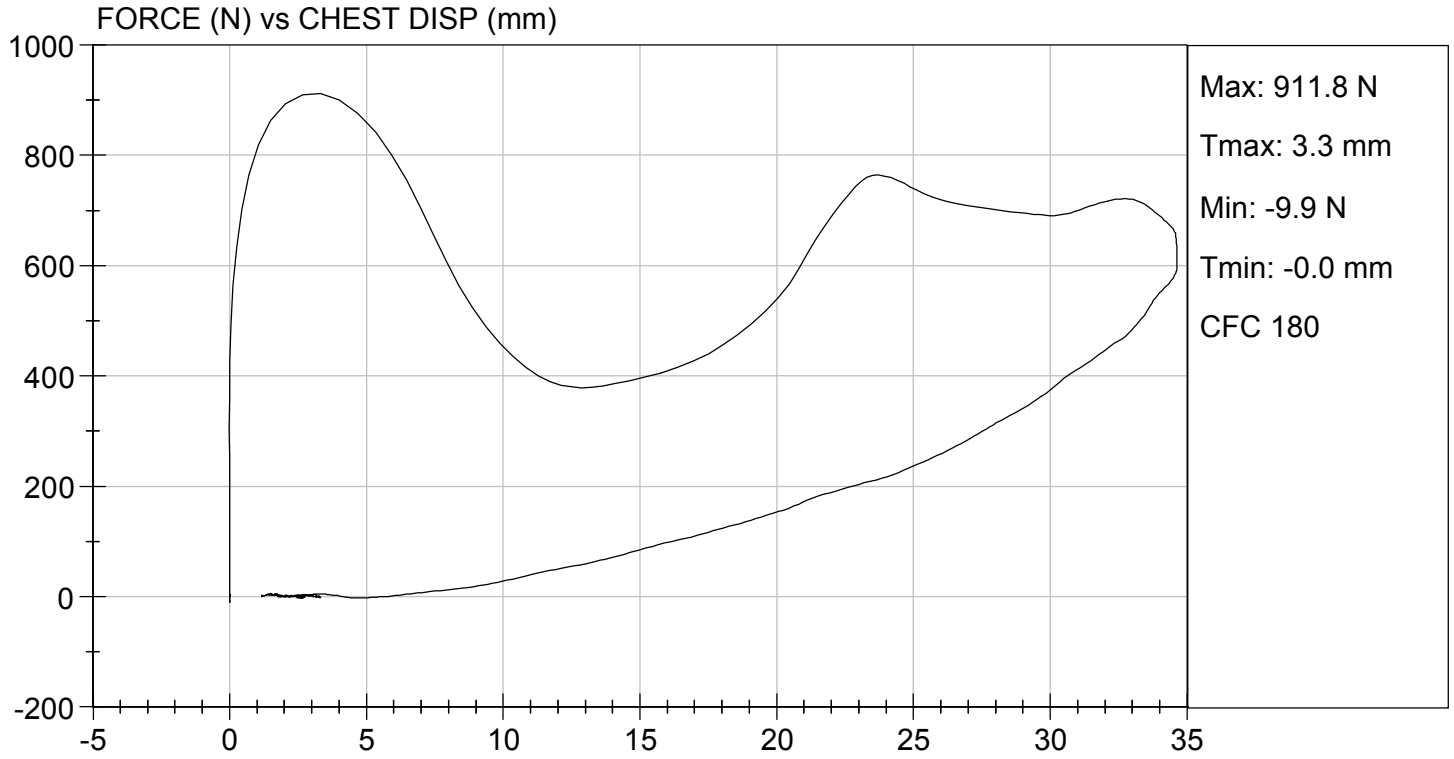
B.F.K.

Approved By



TEST DESC: THORAX IMPACT
VELOCITY: 19.84 ft/s, 6.05 m/s

TEST DATE: 07/31/2020
TEST #: D201754



MGA RESEARCH CORPORATION
TORSO FLEXION TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

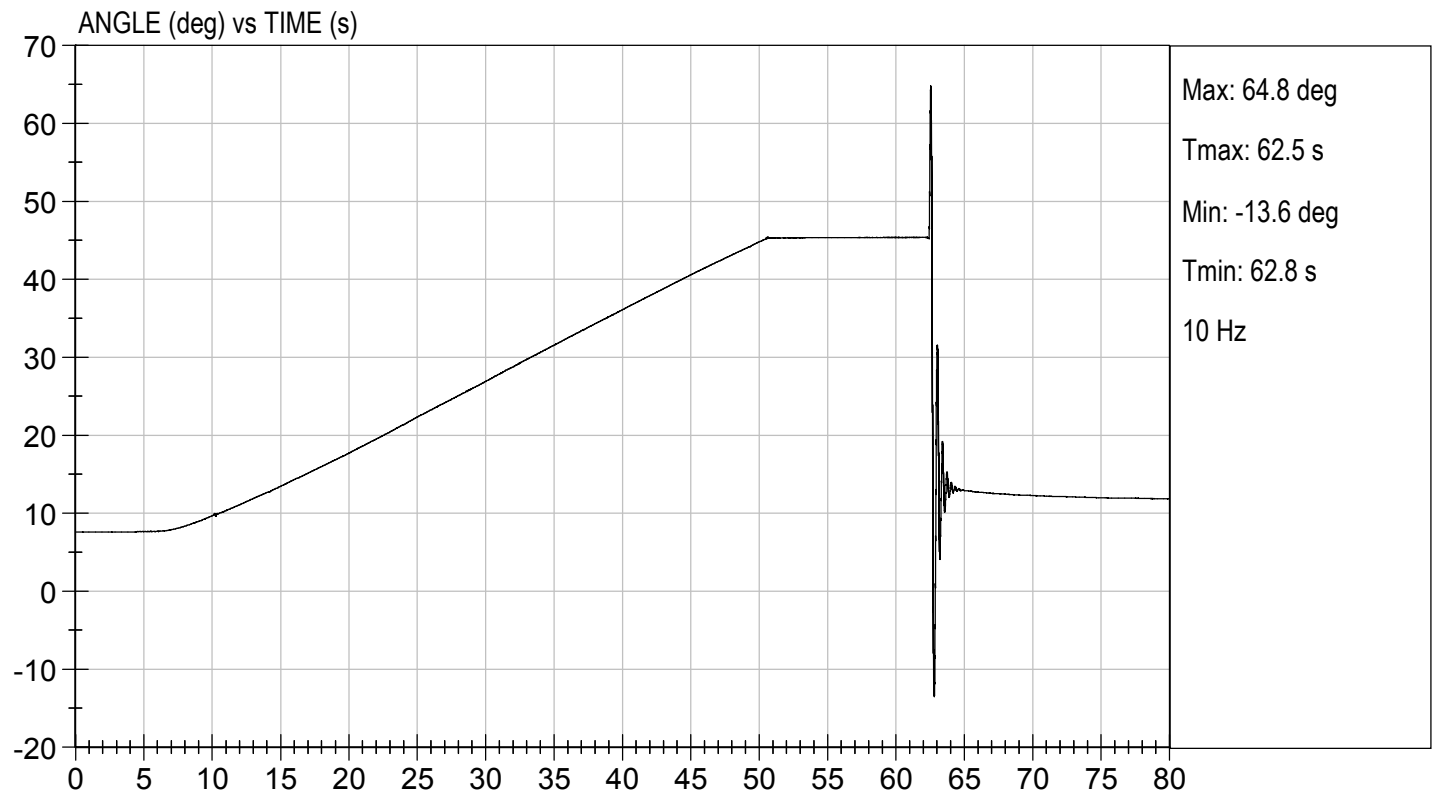
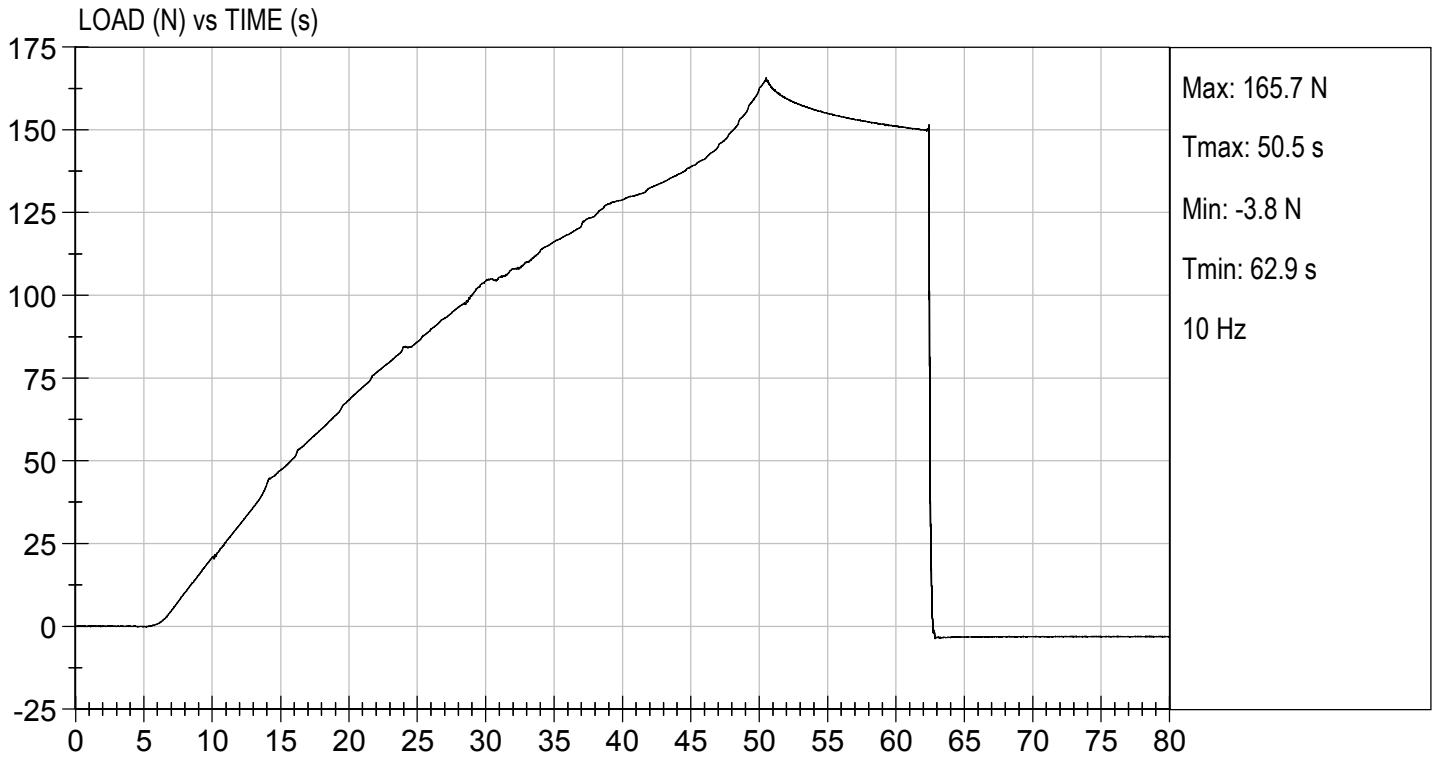
Test I.D: D201757

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 15	8	Pass
Return Angle	deg	-10 to 10	4	Pass
Force at 45 deg	N	130 to 180	166	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.9	Pass
Overall Test Results				Pass

Brian Roach
 Laboratory Technician

07/30/2020
 Test Date

B. Fick
 Approved By



CALIBRATION TEST RESULTS

POST-TEST

Hybrid III 3-Year-Old ATD

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

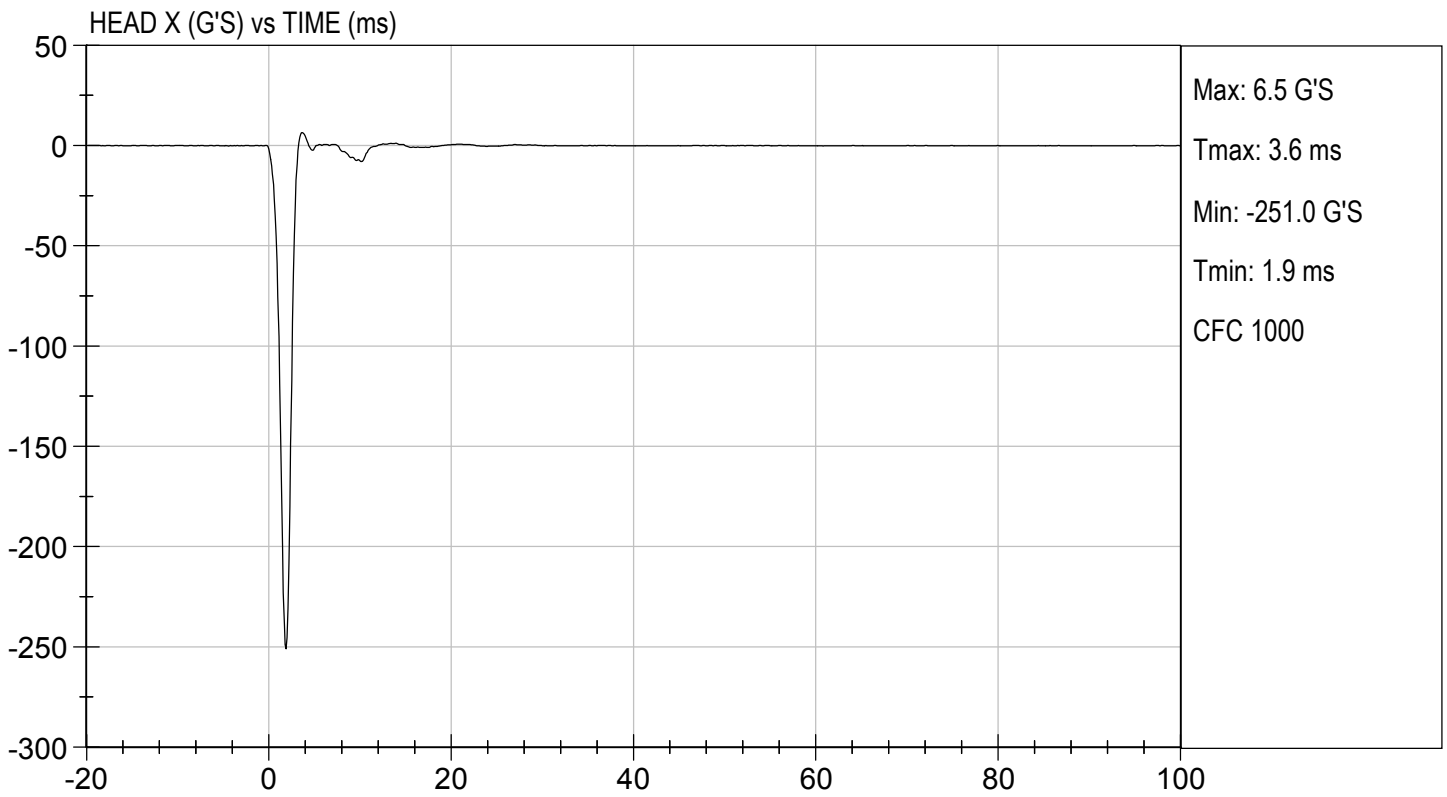
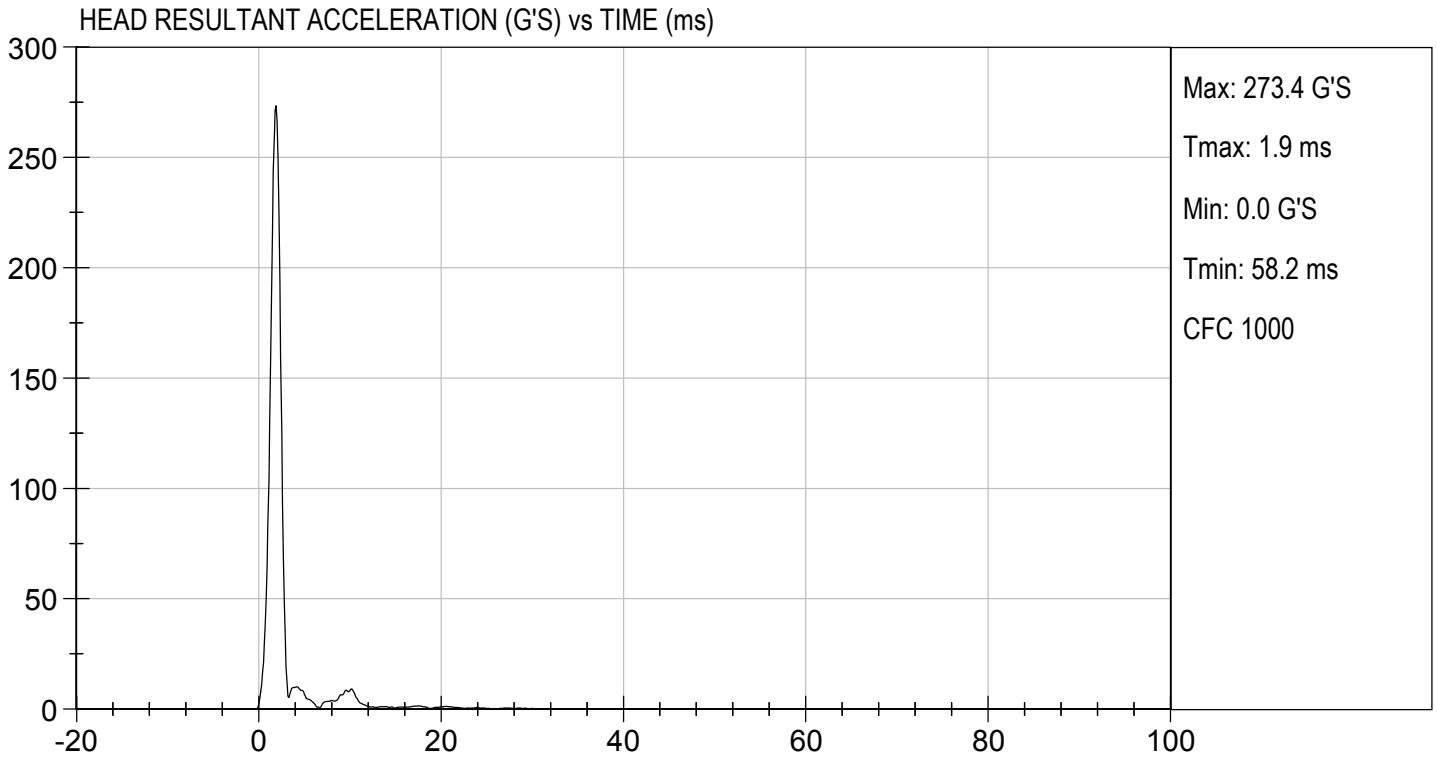
Test ID: D202361

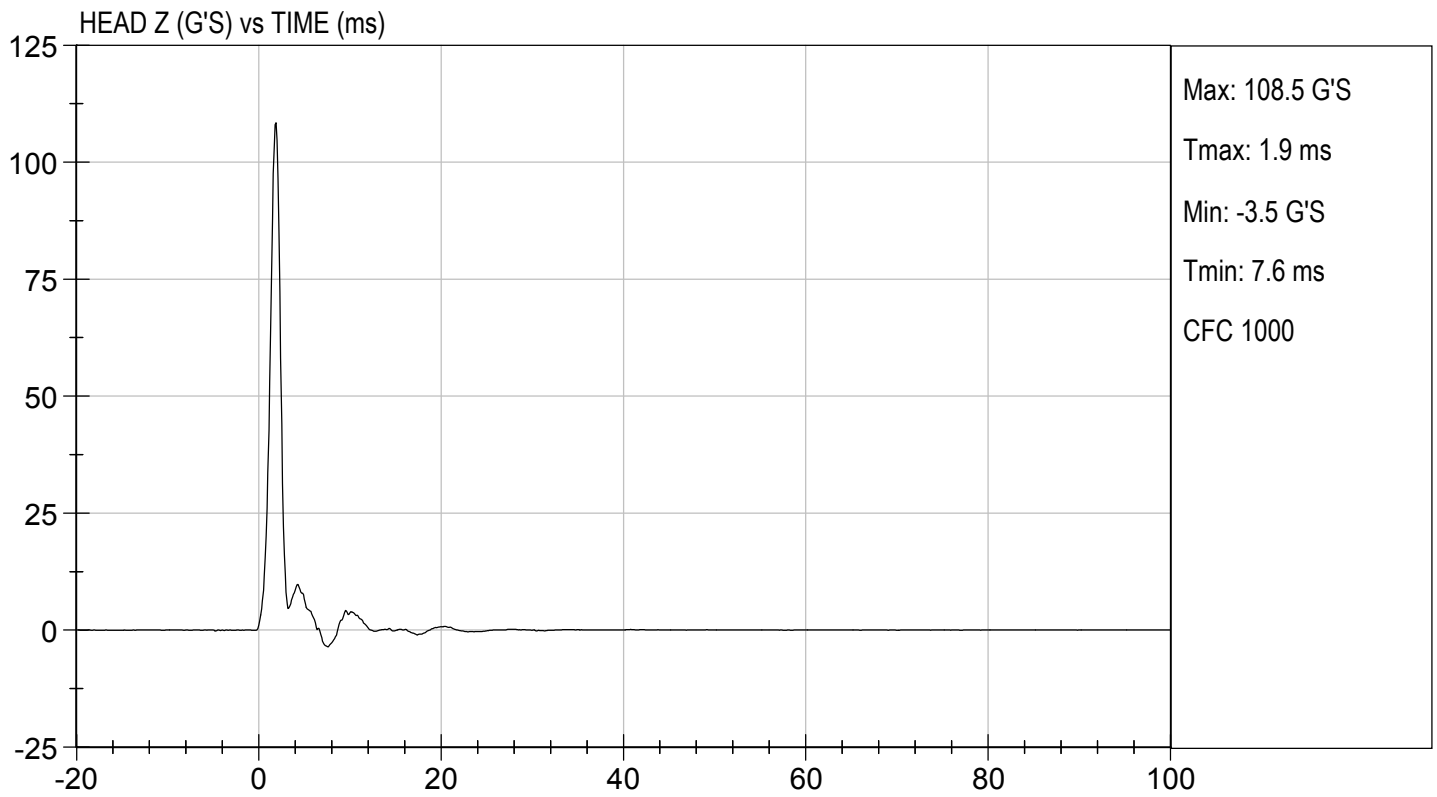
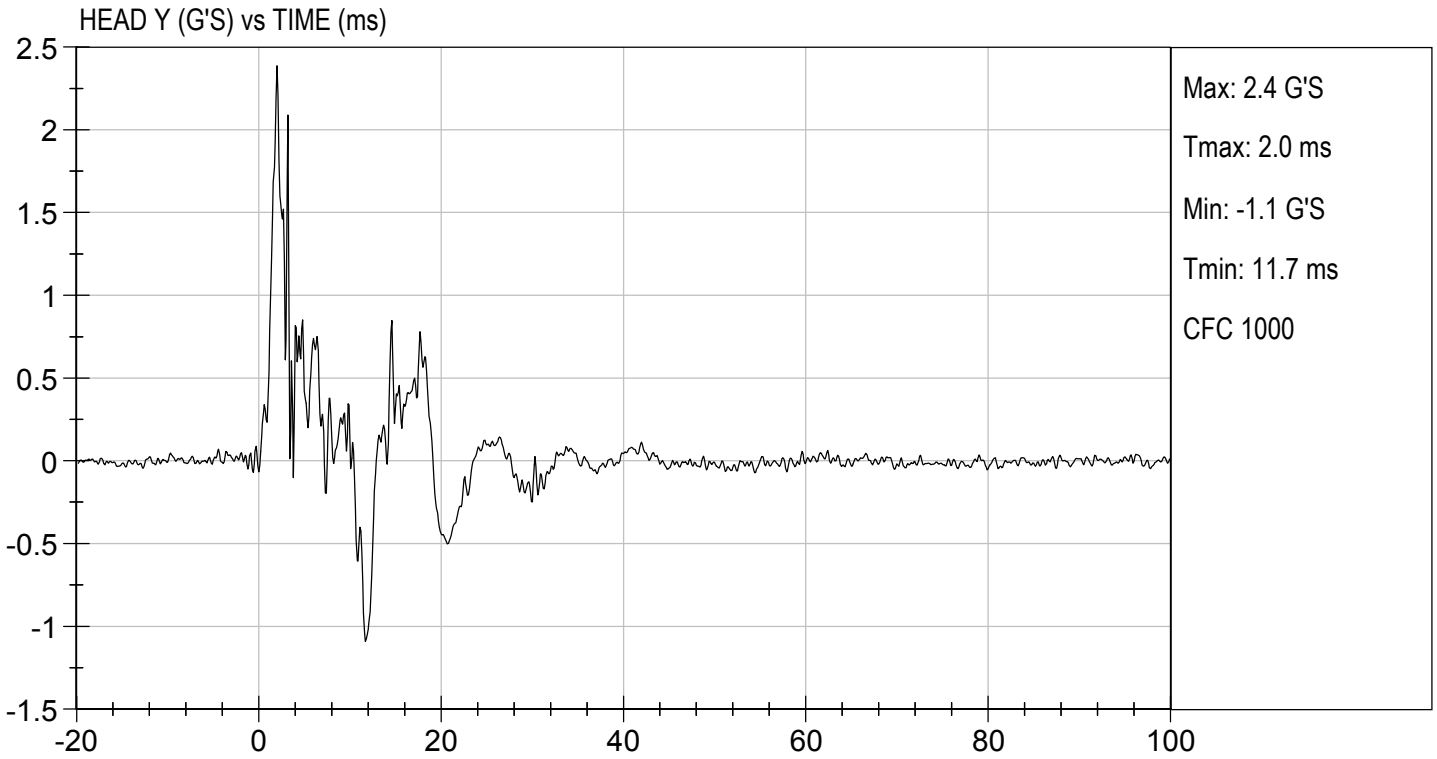
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	38	Pass
Peak Resultant Acceleration	G's	250 to 280	273	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	2.4	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

Brian Roach
 Laboratory Technician

09/21/2020
 Test Date

B. F. H.
 Approved By





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082

Test I.D: D202362

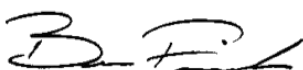
Tested Parameter	Units	Specification	Result	Pass/Fail	
Laboratory Temperature	deg C	20.6 to 22.2	21.2	Pass	
Laboratory Relative Humidity	%	10 to 70	38	Pass	
Pendulum Speed	m/s	5.40 to 5.60	5.58	Pass	
Pendulum Velocity	10 msec	m/s	2.0 to 2.7	2.6	Pass
	15 msec	m/s	3.0 to 4.0	3.8	Pass
	20 msec	m/s	4.0 to 5.1	5.0	Pass
D Plane Rotation	deg	70 to 82	71	Pass	
Peak Moment within Deflection Corridor	Nm	42.0 to 53.0	42.1	Pass	
Positive Moment - Time Curve Decay to 10 Nm	msec	60.0 to 80.0	68	Pass	
Overall Test Results				Pass	



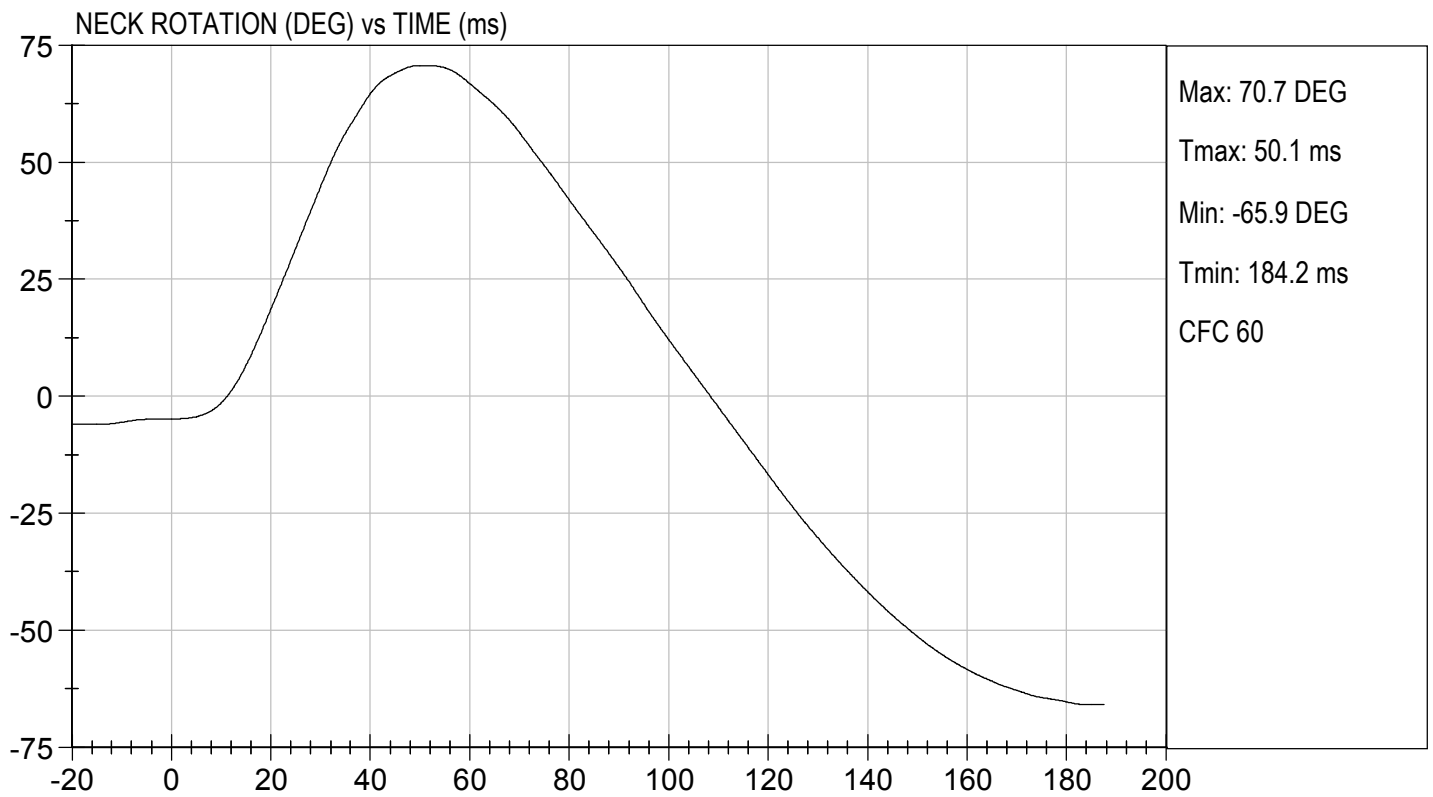
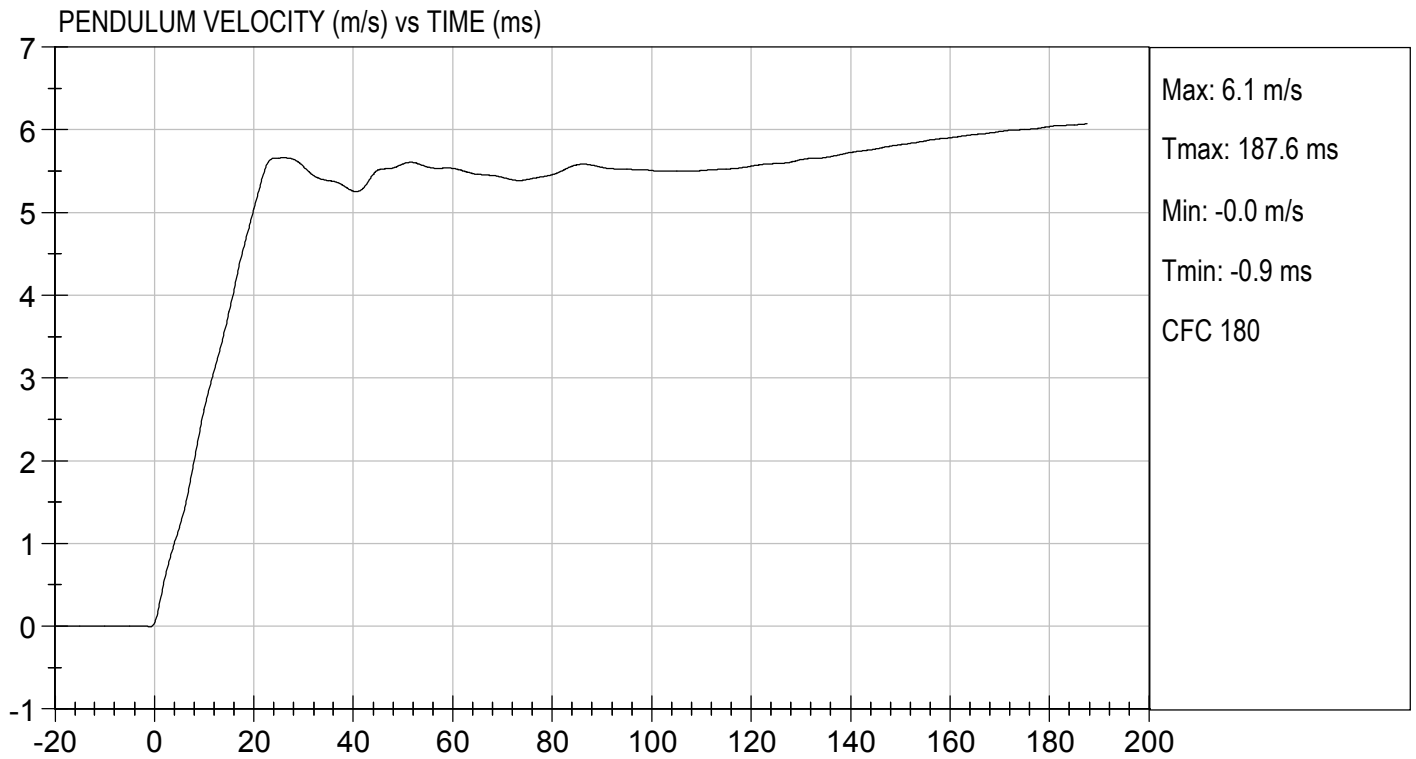
 Laboratory Technician

09/21/2020

 Test Date



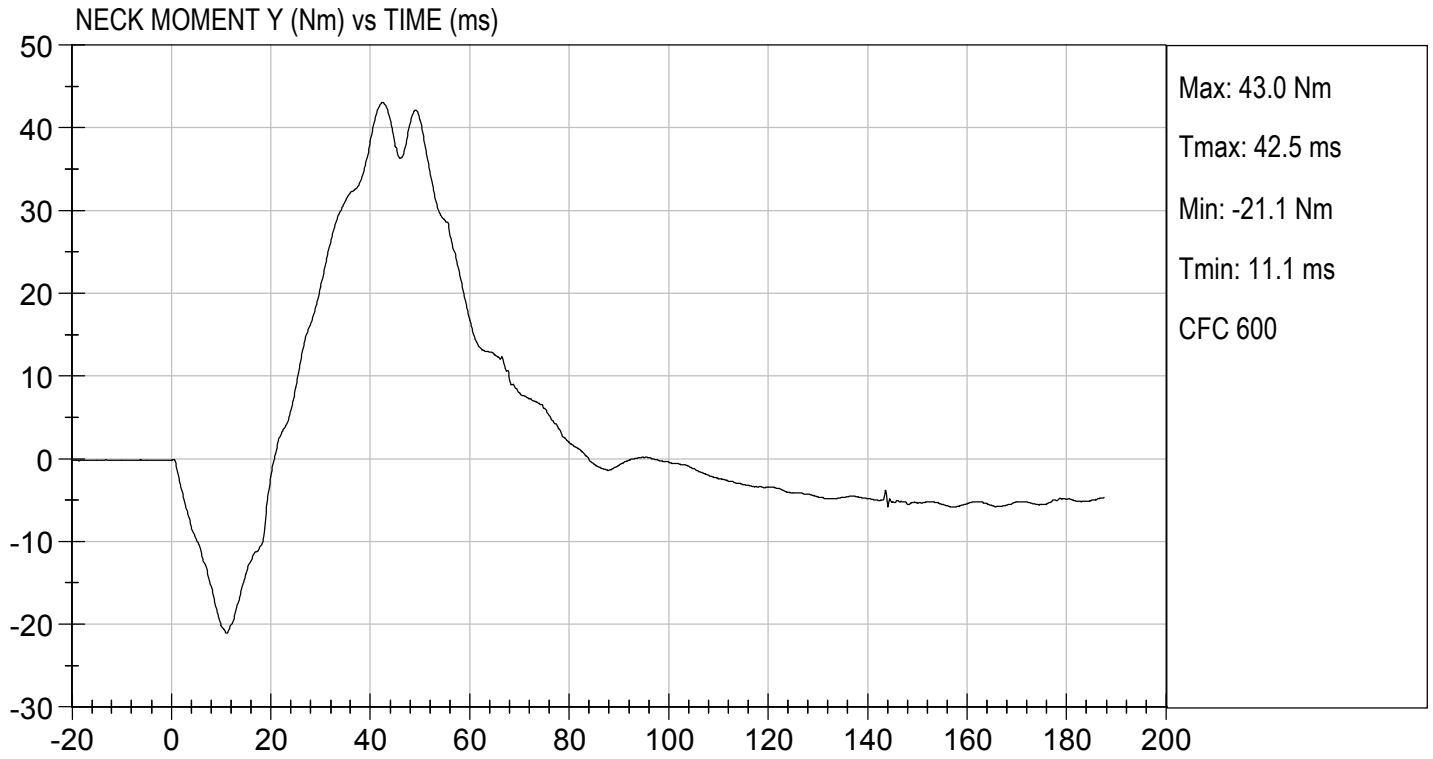
 Approved By





TEST DESC: NECK FLEXION
VELOCITY: 18.31 ft/s, 5.58 m/s

TEST DATE: 09/21/2020
TEST #: D202362



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

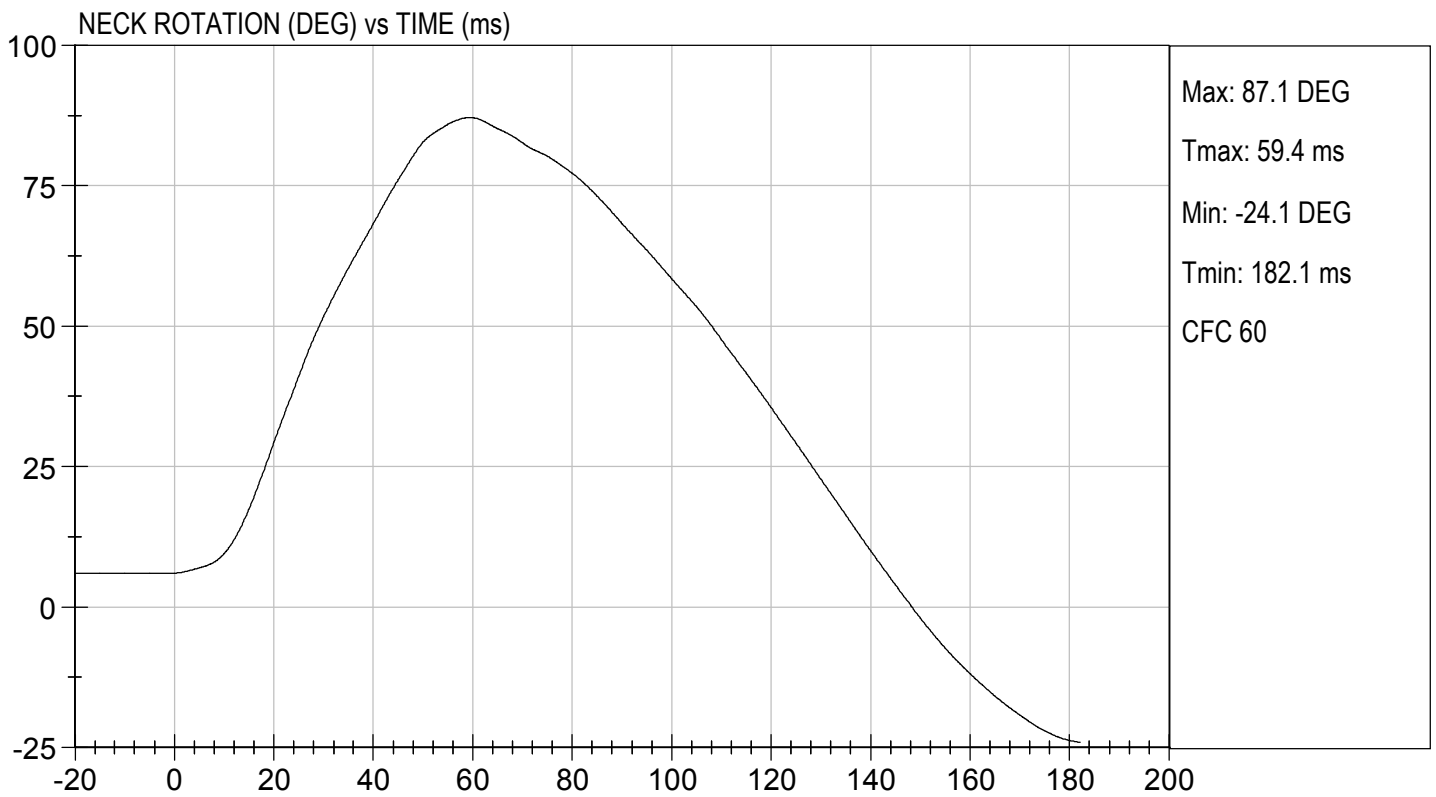
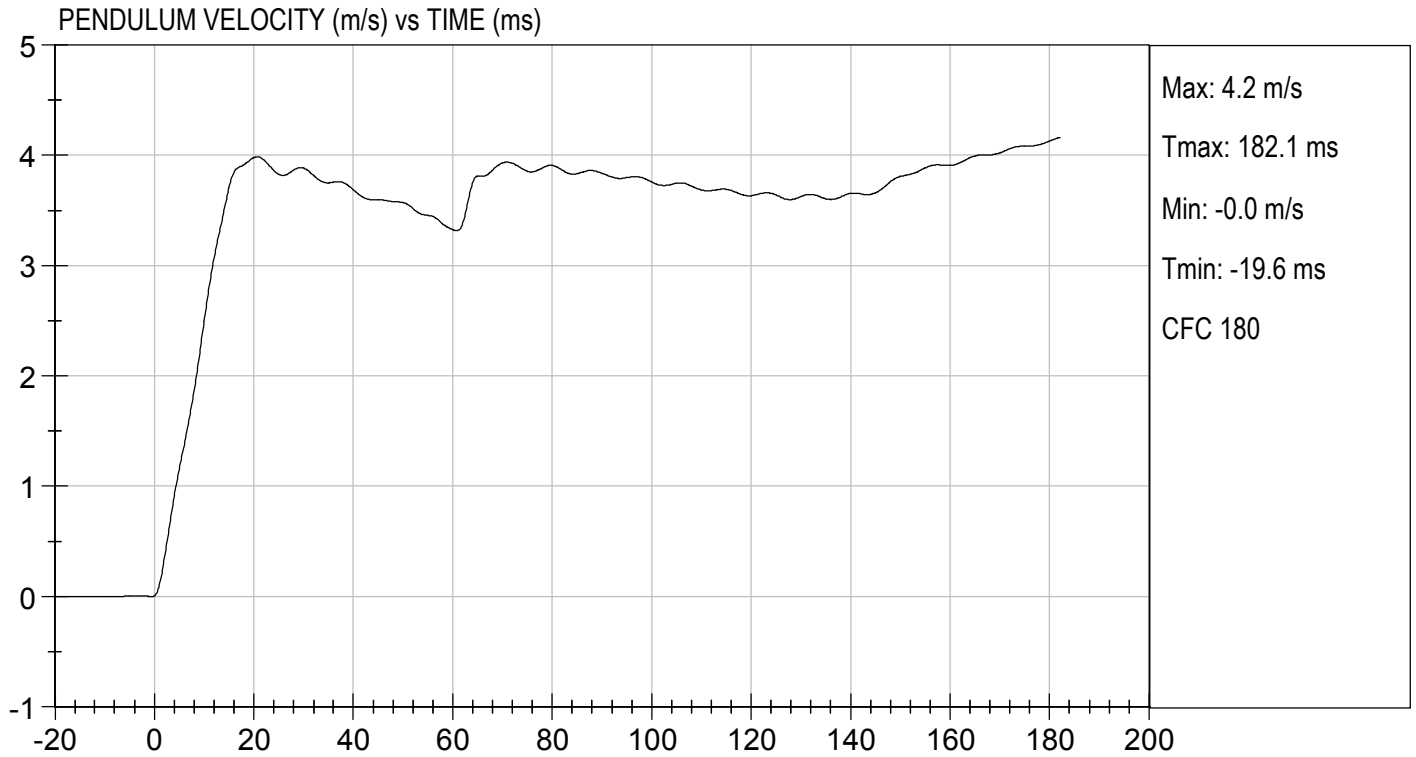
Test I.D: D202363

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	38	Pass
Pendulum Speed		m/s	3.55 to 3.75	3.73	Pass
Pendulum Velocity	6 ms	m/s	1.0 to 1.4	1.4	Pass
	10 ms	m/s	1.9 to 2.5	2.5	Pass
	14 ms	m/s	2.8 to 3.5	3.5	Pass
D Plane Rotation		deg	83 to 93	87	Pass
Peak Moment within Deflection Corridor		Nm	-53.3 to -43.7	-46.2	Pass
Negative Moment - Time Curve Decay to -10 Nm		ms	60.0 to 80.0	64	Pass
Overall Test Results					Pass

Brian Roach
Laboratory Technician

09/21/2020
Test Date

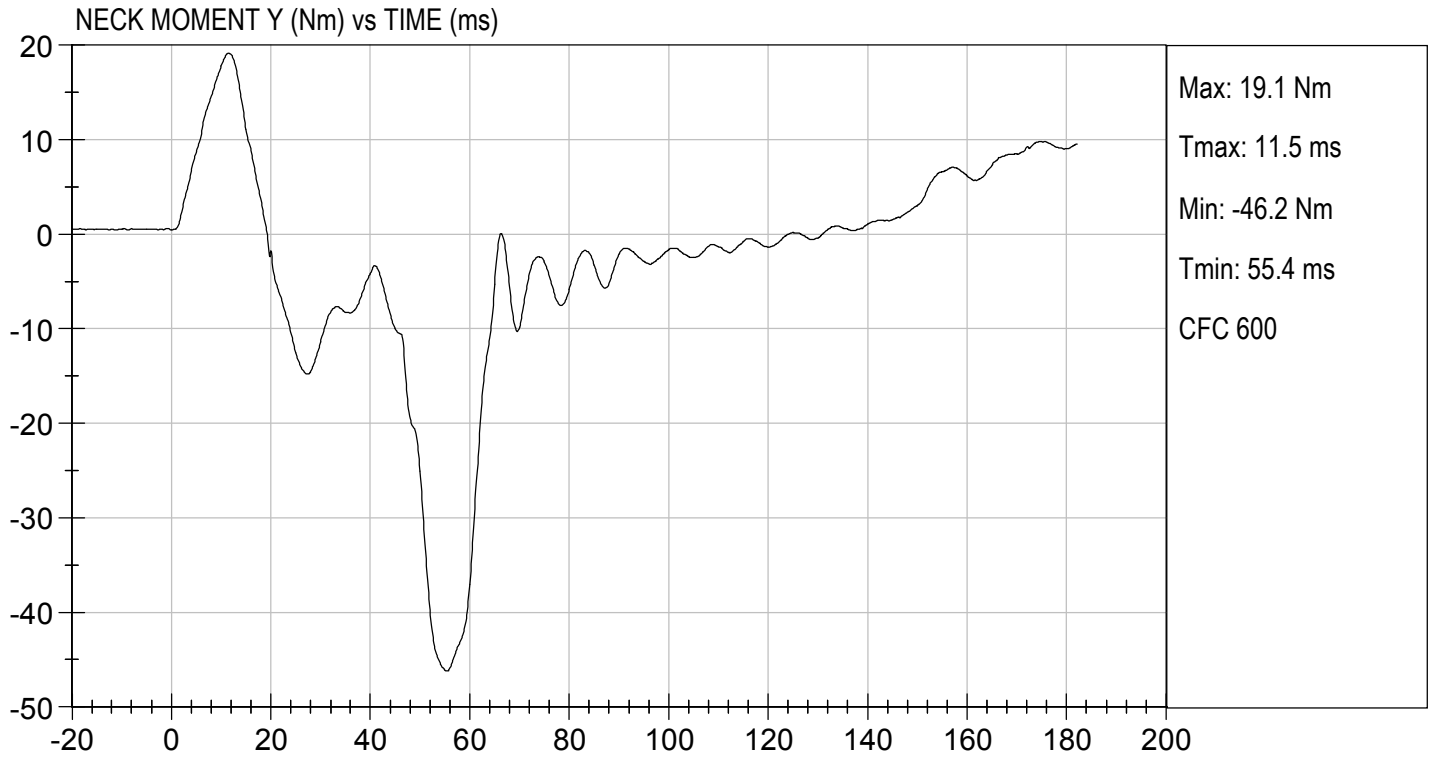
B. F. H.
Approved By





TEST DESC: NECK EXTENSION
VELOCITY: 12.25 ft/s, 3.73 m/s

TEST DATE: 09/21/2020
TEST #: D202363



MGA RESEARCH CORPORATION
THORAX IMPACT TEST
HYBRID III 3 YEAR OLD

ATD Serial No: 082

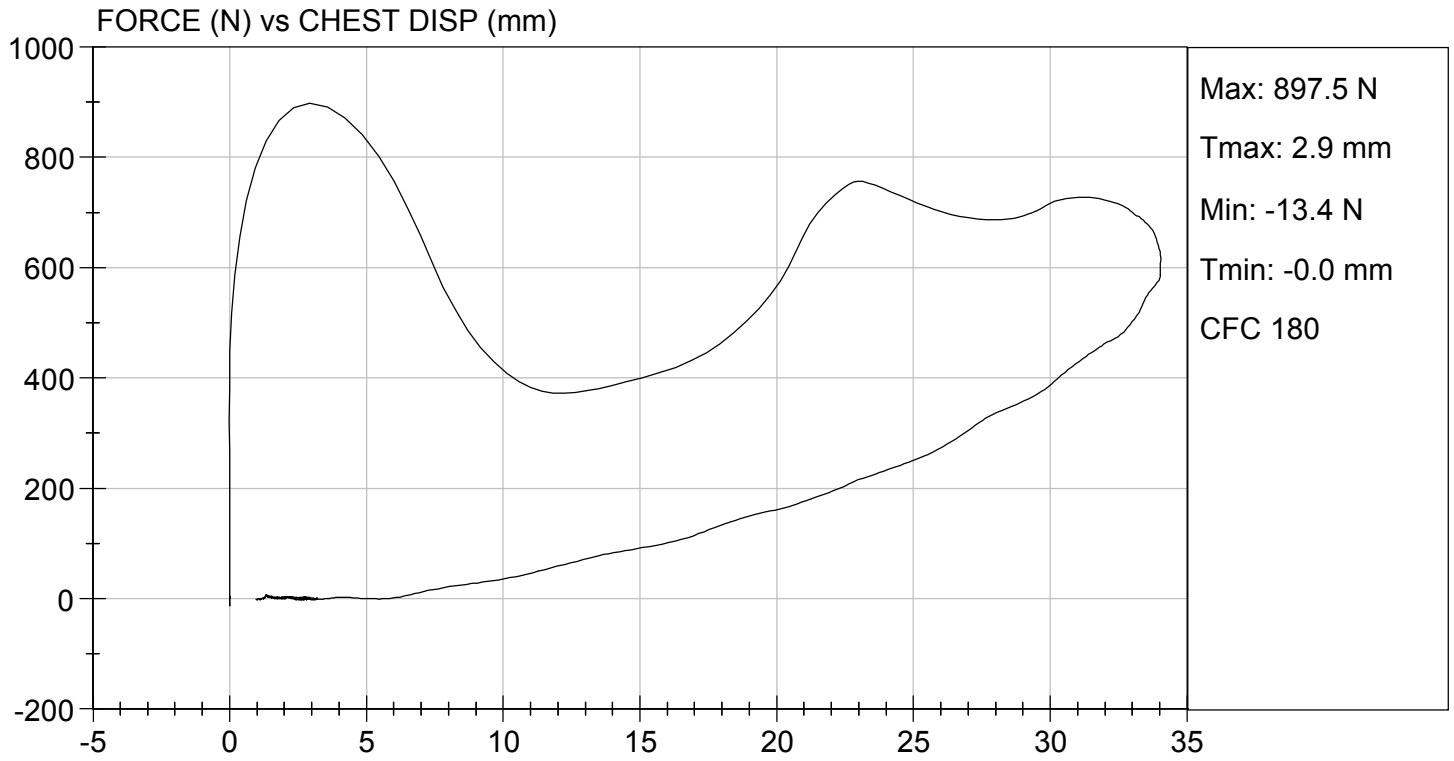
Test I.D: D202364

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	39	Pass
Probe Velocity	m/s	5.9 to 6.1	6.05	Pass
Peak Deflection	mm	32 to 38	34.0	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	721	Pass
Internal Hysteresis	%	65 to 85	74.0	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	757	Pass
Overall Test Results				Pass

Brian Roach
 Laboratory Technician

09/18/2020
 Test Date

B. F. K.
 Approved By



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082

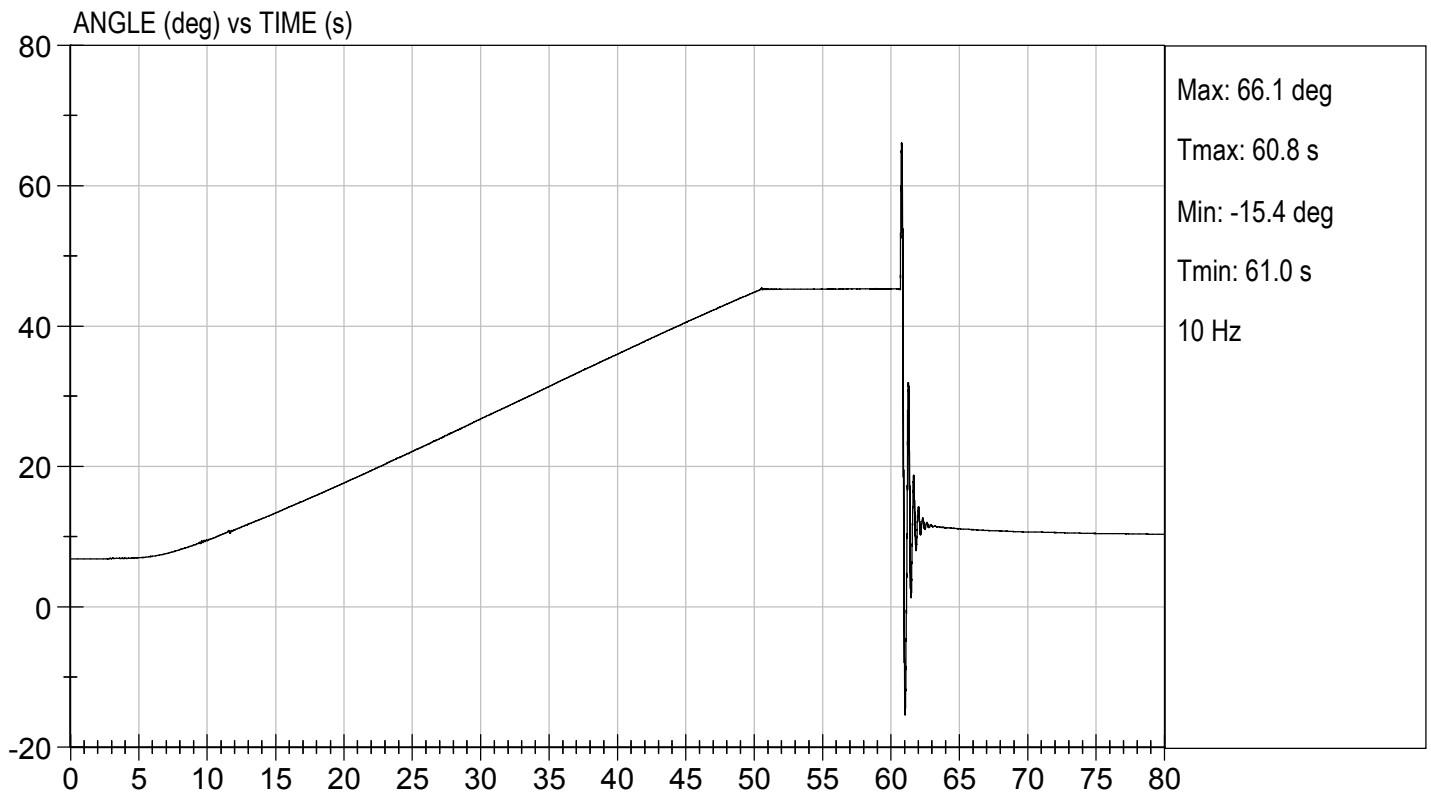
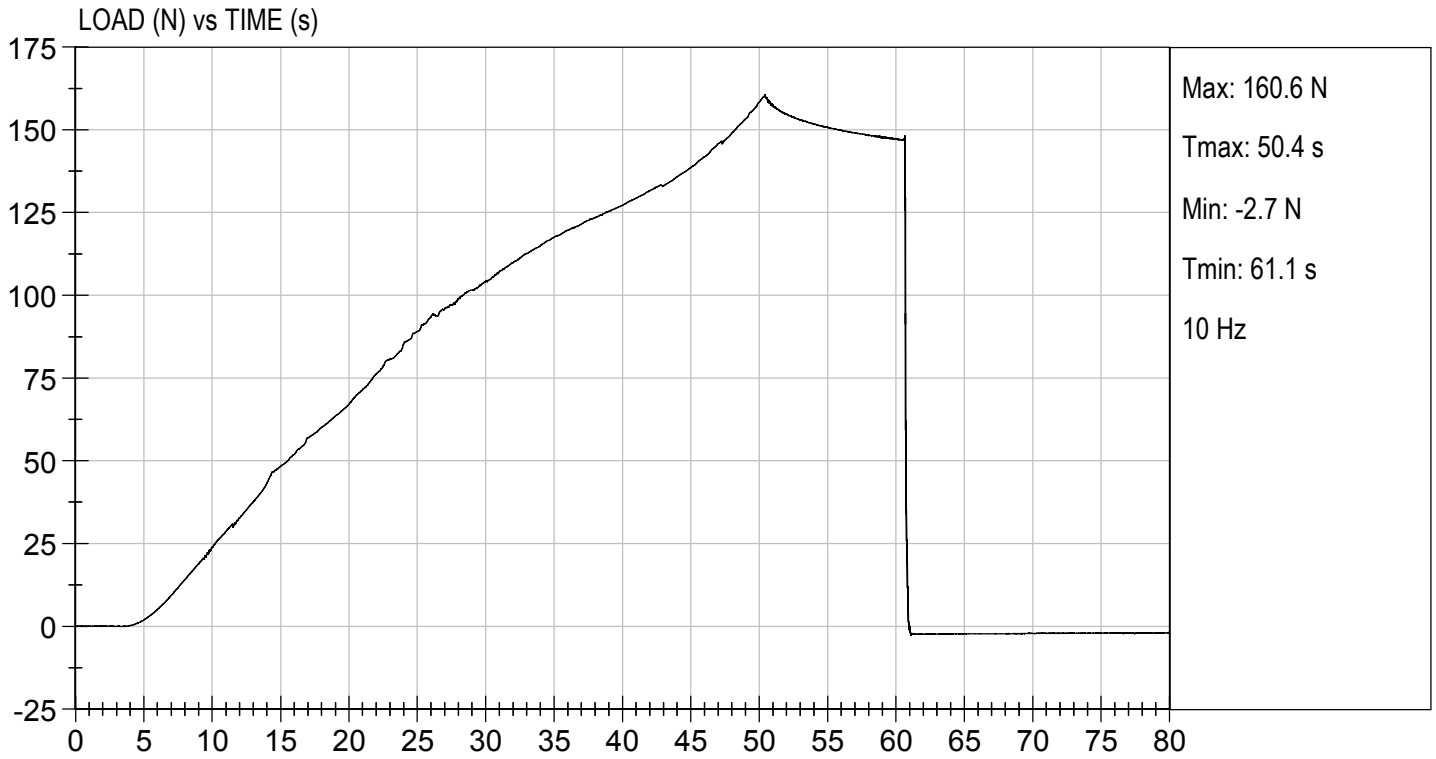
Test I.D: D202367

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	39	Pass
Initial Angle	deg	0 to 15	7	Pass
Return Angle	deg	-10 to 10	4	Pass
Force at 45 deg	N	130 to 180	161	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.9	Pass
Overall Test Results				Pass

Brian Roach
Laboratory Technician

09/18/2020
Test Date

B. F. H.
Approved By



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

Table 1 – Dummy Instrumentation

		HIII 3-Year-Old S/N 082		
		Serial Number	Manufacturer	Calibration Date
Head CG Accelerometers	X	T22492	Endevco	07/29/2020
	Y	T22493	Endevco	07/29/2020
	Z	T22505	Endevco	07/29/2020
Upper Neck Load Cell		NG249	Denton	07/17/2020
Lower Neck Load Cell		NG124	Denton	07/17/2020