REPORT NUMBER: TWG-MGA-20-008

SIDE AIRBAG OUT-OF-POSITION INJURY
TECHNICAL WORKING GROUP

NISSAN MOTOR CO., LTD.
2020 Nissan Leaf S 5-Door Hatchback
NHTSA No.: M20205205TWG3

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: February 12, 2021

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: _____
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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.	2. Government Accession No.	3. Recipient's Catalog No.
TWG-MGA-20-008		

4. Title and Subtitle	5. Report Date
Final Report of Side Airbag Out-of-Position Injury Technical Working Group evaluation of a 2020 Nissan Leaf S 5-Door Hatchback, NHTSA No.: M20205205TWG3	April 12, 2021
	6. Performing Organization Code MGA
7. Author(s) Ben Fischer, Project Manager	**8. Performing Organization Report No.** TWG-MGA-20-008
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105	**10. Work Unit No.**
	11. Contract or Grant No. 693JJ919D000006
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	**13. Type of Report and Period Covered:** Final Test Report February 12, 2021 to April 12, 2021
	14. Sponsoring Agency Code NRM-110

15. Supplementary Notes

16. Abstract

A Side Airbag Out-of-Position Injury evaluation was conducted on the subject 2020 Nissan Leaf S 5-Door Hatchback 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 February 12, 2021.

Measurement Description	Units	RR Pass ATD (3YO)	
		Threshold	Result
Head Injury Criteria (HIC_{15})		570	358
Nij		1	1.26
Neck Tension	N	1130	173
Neck Compression	N	1380	1430
Maximum Chest Displacement	mm		
Maximum Chest Displacement Rate	m/s		

Note: Nij and Neck Compression peak values exceeded allowable thresholds.

17. Key Words	18. Distribution Statement
Side Airbag Out-of-Position Technical Working Group OOP TWG HIII 3YO	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	20. Security Classification of Page	21. No. of Pages	22. Price
Unclassified	Unclassified	67	

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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 Nissan Leaf S 5-Door Hatchback. 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 Nissan Leaf S 5-Door Hatchback 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 February 12, 2021. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Two 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 Left Rear Passenger Door
- Left Side Oblique Through Windshield

One Hybrid III 3-Year-Old child dummy (Serial Number 082) was placed in the right rear passenger seat situated in the lying on seat position per Section 3.3.3.3 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: Nij and Neck Compression peak values exceeded allowable thresholds.

The Hybrid III 3-Year-Old child dummy was placed in the right rear 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 torso was supported by a wedge-shaped foam block, allowing the head to rest in a neutral position on the right rear passenger door armrest.

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 3.3.3.3 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 Nissan Leaf S 5-Door Hatchback
Test Program: NCAP Side Airbag Out-of-Position
NHTSA No.: M20205205TWG3
Test Date: 2/12/2021

TEST CONFIGURATION INFORMATION

Seating Position	P3	Right Rear Seating Position
Test Section	3.3.3.3*	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	Nissan	Leaf
Previous Crash Test	Side MDB NCAP	August 6, 2020 – M20205205

*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 Nissan Leaf S 5-Door Hatchback NHTSA No.: M20205205TWG3
Test Program: NCAP Side Airbag Out-of-Position Test Date: 2/12/2021

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20205205	Traction Control System (TCS)	Yes
Model Year	2020	Auto-Leveling System	No
Make	Nissan	Automatic Door Locks (ADL)	Yes
Model	Leaf S	Power Window Auto-Reverse	Yes
Body Style	5-Door Hatchback	Other Optional Feature	No
VIN	1N4AZ1BP9LC301028	Driver Front Airbag	Yes
Body Color	Deep Blue Pearl	Driver Curtain Airbag	Yes
Odometer Reading (km/mi)	16 km / 10 mi	Driver Head/Torso Airbag	No
Engine Displacement (L)		Driver Torso Airbag	No
Type/No. Cylinders	Electric	Driver Torso/Pelvis Airbag	Yes
Engine Placement	Lateral	Driver Pelvis Airbag	No
Transmission Type	Automatic	Driver Knee Airbag	Yes
Transmission Speeds	1	Rear Pass. Curtain Airbag	Yes
Overdrive	No	Rear Pass. Head/Torso Airbag	No
Final Drive	FWD	Rear Pass. Torso Airbag	No
Roof Rack	No	Rear Pass. Torso/Pelvis Airbag	Yes
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	Yes
Power Seats	No	Driver Load Limiter	Yes
Anti-Lock Brakes (ABS)	Yes	Rear Pass. Load Limiter	Yes
		Other Restraint Feature	N/A

DATA FROM CERTIFICATION LABEL

Manufactured By	NISSAN MOTOR CO., LTD.
Date of Manufacture	12/19
Vehicle Type	Passenger Car

GVWR (kg)	2035
GAWR Front (kg)	1070
GAWR Rear (kg)	985

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3		5	
Capacity Weight (VCW) (kg)				390	(A)
DSC x 68.04 kg				340	(B)
Rated Cargo and Luggage Weight (RCLW) (kg)				50	(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 Nissan Leaf S 5-Door Hatchback NHTSA No.: M20205205TWG3
Test Program: NCAP Side Airbag Out-of-Position Test Date: 2/12/2021

VEHICLE SEAT FORE/AFT POSITION

Seat	Total Fore/Aft Travel		Test Position from Forward-Most Position	
	mm	Detents (1st as 1)	mm	Detent (1st as 0)
Right Front Passenger Seat				
Right Rear Passenger Seat	Fixed		Fixed	
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Fixed Seat			
	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 (1st as 1)	Degrees	Detent (1st as 0)
Right Front Passenger Seat				
Right Rear Passenger Seat	Fixed		Fixed	
OEM Back Angle Design Position	Seatback is non-adjustable			
Method of Measuring Back Angle Position				
Seat Back Position per TWG Guidelines	Initial Position: Fixed Seat			
	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 (1st as 1)	mm	Detent (1st as 0)
Right Front Passenger Seat				
Right Rear Passenger Seat	Fixed		Fixed	
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Fixed Seat			
	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 Nissan Leaf S 5-Door Hatchback
Test Program: NCAP Side Airbag Out-of-Position
NHTSA No.: M20205205TWG3
Test Date: 2/12/2021

ATD Type	Hybrid III 3-Year-Old child dummy
Serial Number	082
Qualification Date	2/1/2021
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 Nissan Leaf S 5-Door Hatchback
Test Program: NCAP Side Airbag Out-of-Position
NHTSA No.: M20205205TWG3
Test Date: 2/12/2021

RECORDED DATA – MINIMUMS AND MAXIMUMS

Channel	Unit	CFC	Maximum	Time (ms)	Minimum	Time (ms)
Passenger Head X	g	1000	86.3	12.0	-6.6	35.1
Passenger Head Y			148.5	8.8	-7.7	293.9
Passenger Head Z			81.2	8.9	-4.4	7.2
Passenger Upper Neck Fx	N	1000	3.5	1.4	-484.1	23.2
Passenger Upper Neck Fy			1.8	5.6	-513.9	21.2
Passenger Upper Neck Fz			173.0	40.6	-1430.1	13.7
Passenger Upper Neck Mx	Nm	600	25.2	10.5	-7.1	43.4
Passenger Upper Neck My			10.0	75.2	-23.8	23.1
Passenger Upper Neck Mz			3.3	27.8	-5.5	68.4
Passenger Lower Neck Fx	N	1000	16.4	7.7	-546.2	23.6
Passenger Lower Neck Fy			4.9	83.6	-339.5	13.6
Passenger Lower Neck Fz			185.1	38.7	-1248.4	14.0
Passenger Lower Neck Mx	Nm	600	8.5	300.0	-34.8	20.8
Passenger Lower Neck My			37.4	23.8	-0.4	7.6
Passenger Lower Neck Mz			7.3	26.9	-4.7	65.8

HEAD INJURY SUMMARY

HIC_{15}	T_1 (ms)	T_2 (ms)	HIC_{36}	T_1 (ms)	T_2 (ms)
358	7.5	19.3	358	7.5	19.3

NECK INJURY SUMMARY

Injury Criteria	Unit	Value	Time (ms)
Upper Neck NTF		0.18	75.1
Upper Neck NTE		0.32	32.9
Upper Neck NCF		0.16	291.8
Upper Neck NCE		1.26	20.3
Peak Tension	N	173.0	40.6
Peak Compression	N	1430.1	13.7

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

Test Vehicle: 2020 Nissan Leaf S 5-Door Hatchback
Test Program: NCAP Side Airbag Out-of-Position
NHTSA No.: M20205205TWG3
Test Date: 2/12/2021

CHEST INJURY SUMMARY

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

[1]Deflection rate is calculated based on Chest Deflection potentiometer.

RESEARCH VALUE SUMMARY

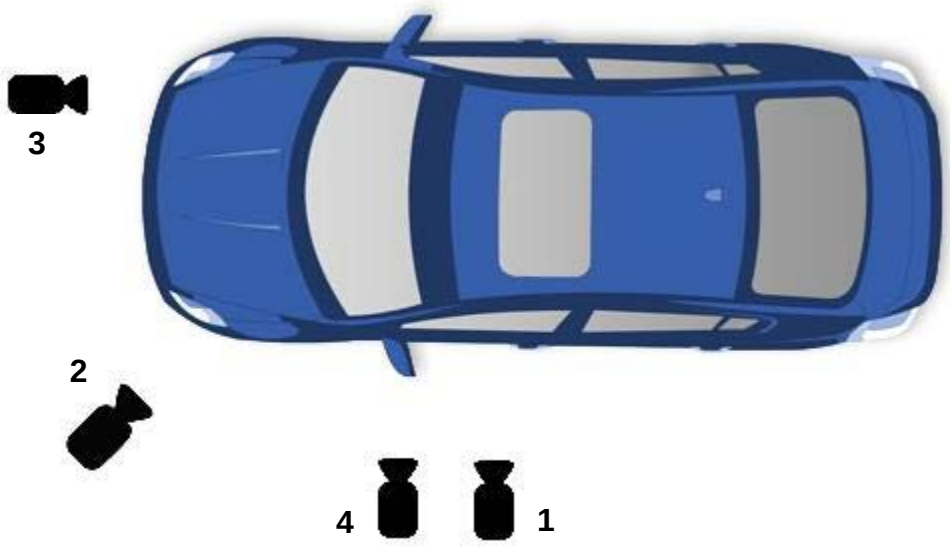
Research Injury Criteria[1]	Unit	Value	Time (ms)
Upper Neck Lateral Moment	Nm	25.2	10.5
Upper Neck Twist Moment	Nm	5.5	68.4
Lower Neck Flexion Moment	Nm	37.4	23.8
Lower Neck Extension Moment	Nm	0.4	7.6
Lower Neck Lateral Moment	Nm	34.8	20.8
Lower Neck Twist Moment	Nm	7.3	26.9
Lower Neck Tension	N	185.1	38.7
Lower Neck Compression	N	1248.4	14.0
Spine Acceleration	g		

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

DATA SHEET NO. 6
CAMERA SETUP AND DESCRIPTION

Test Vehicle: 2020 Nissan Leaf S 5-Door Hatchback
NHTSA No.: M20205205TWG3
Test Program: NCAP Side Airbag Out-of-Position
Test Date: 2/12/2021

CAMERA SETUP DIAGRAM FOR OOP TESTS



CAMERA LOCATIONS

No.	Camera View	Location			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Left View	1310	-1890	-1220	24	2700
2	Oblique View	3400	-2230	-1710	50	2700
3	Front View					
4	Real Time (optional)					30

*Camera No. 3 – Front View was not used, as it would have been obstructed by the front seat occupant (NHTSA# M20205205TWG2)

Reference:
+X = Forward of Rear Surface of Vehicle (RSOV)
+Y = Right of Vehicle Centerline
+Z = Down from Ground

APPENDIX A

PHOTOGRAPHS

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

Photo No. 002 - Vehicle Certification Placard

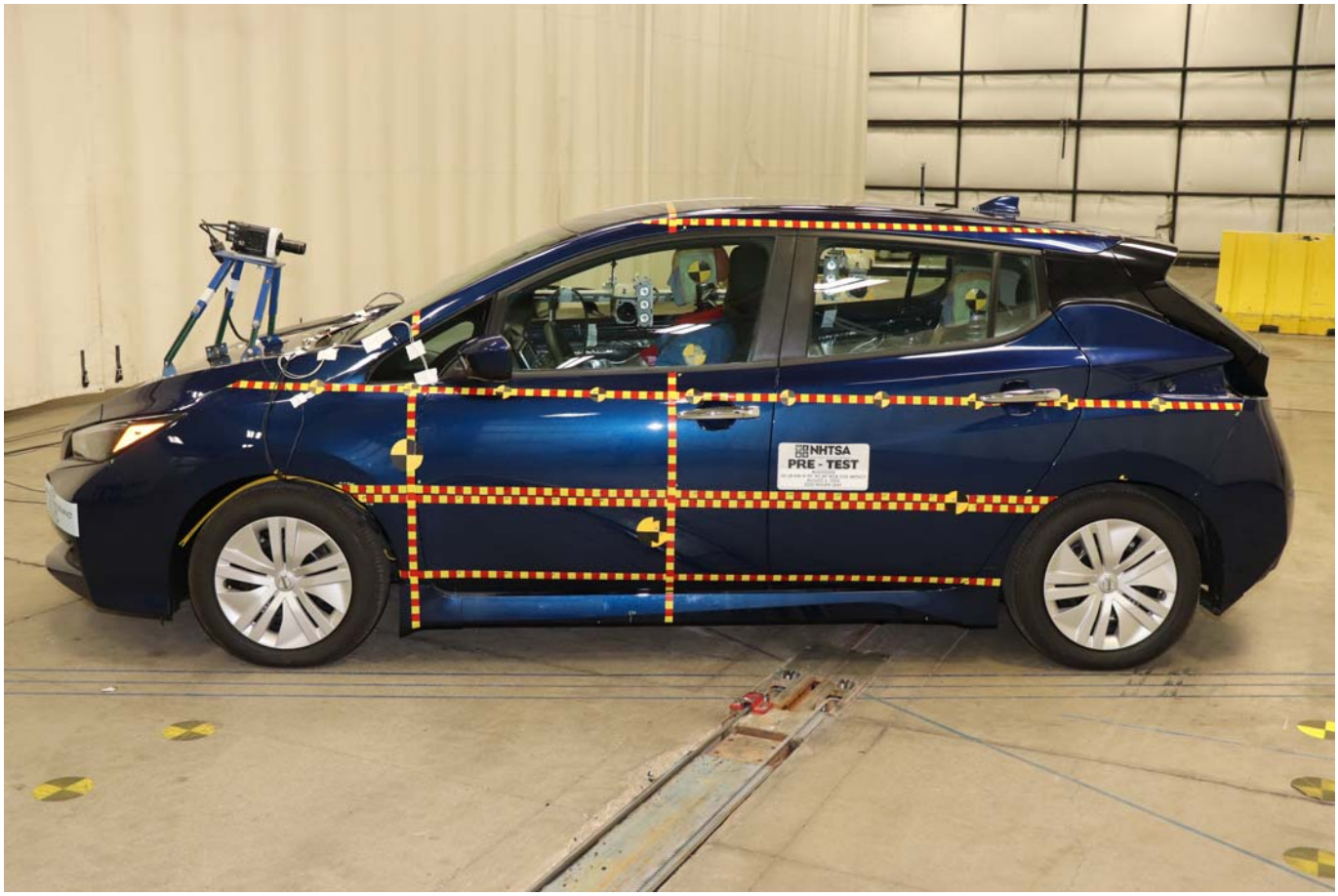


Photo No. 003 - Pre-Test Vehicle Left Side View

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

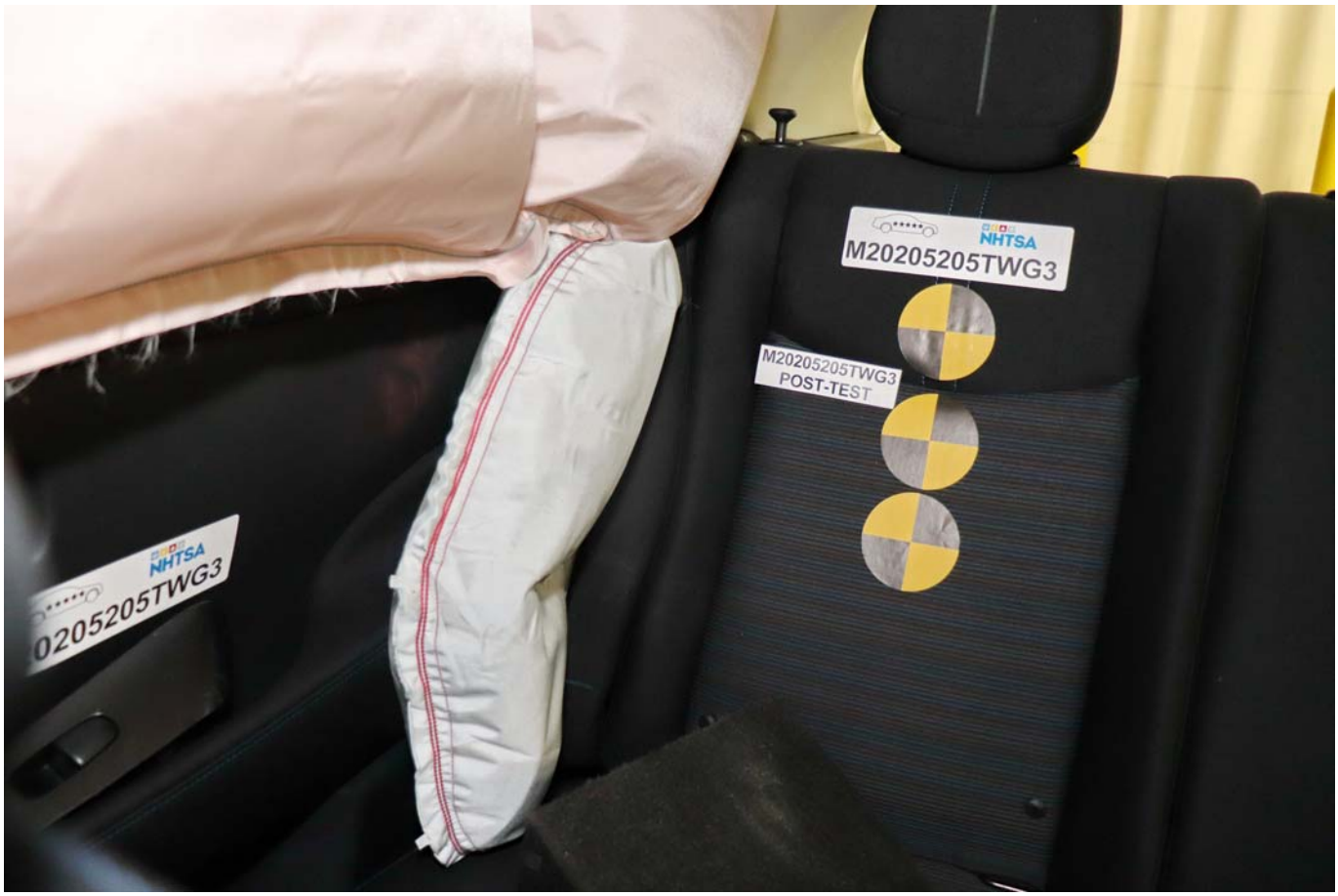


Photo No. 014 - Post-Test Dummy Front View

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

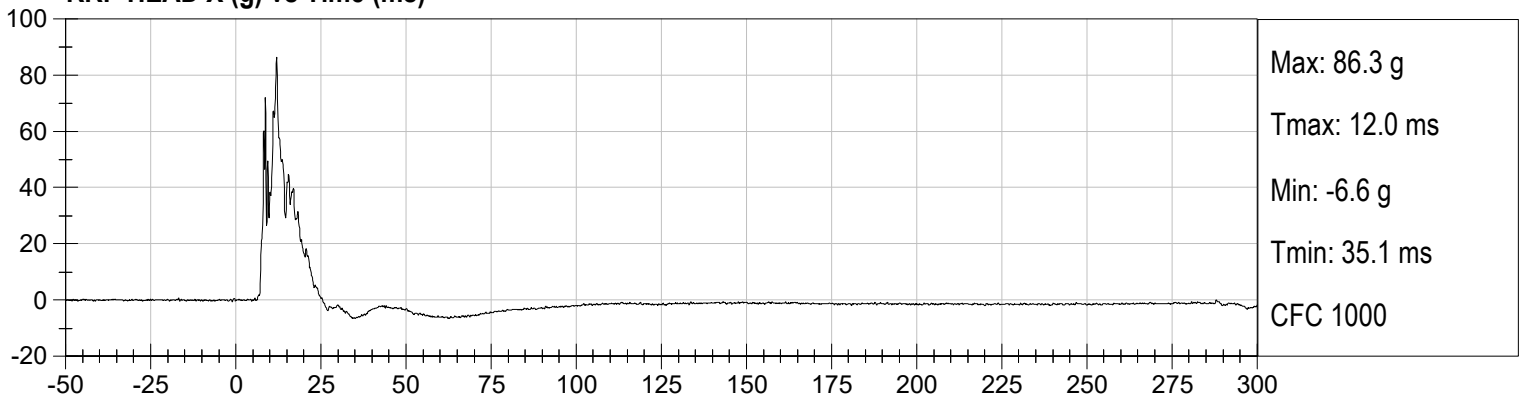
Photo No. 025 - Post-Test Curtain Airbag Right Side View (Door Open)

APPENDIX B

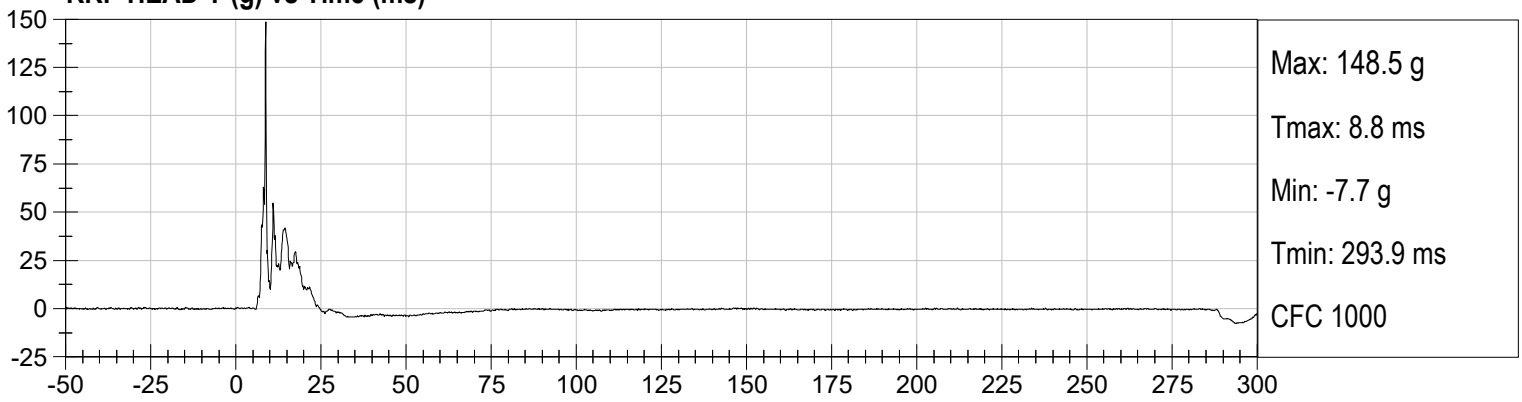
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

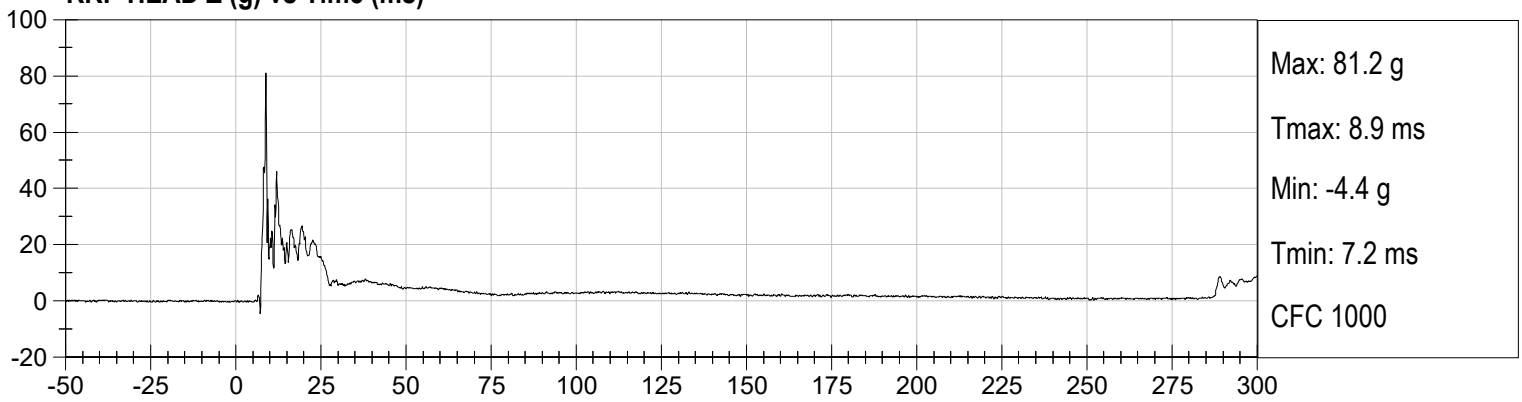
RRP HEAD X (g) vs Time (ms)



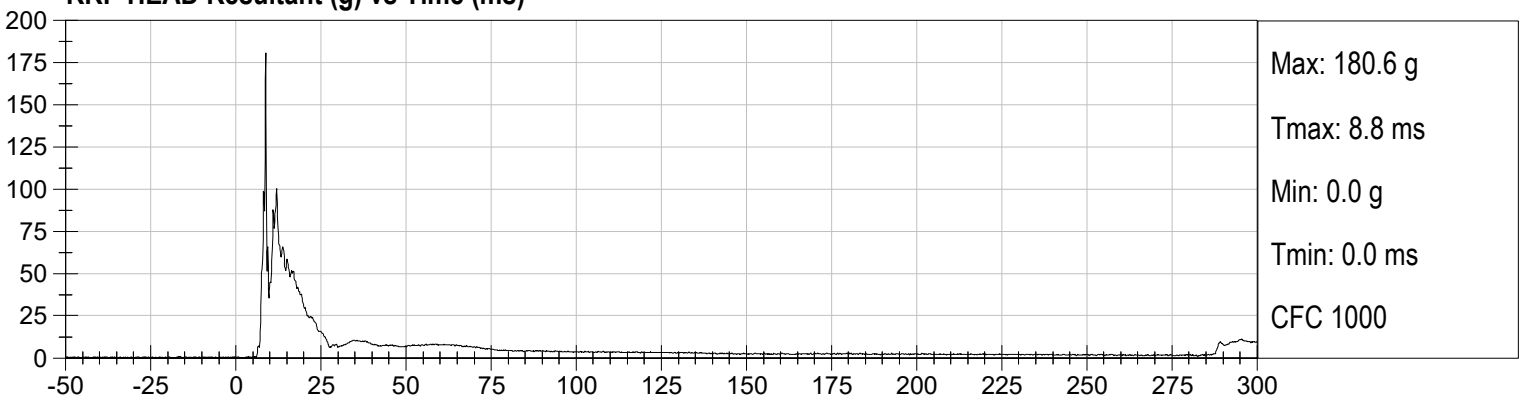
RRP HEAD Y (g) vs Time (ms)



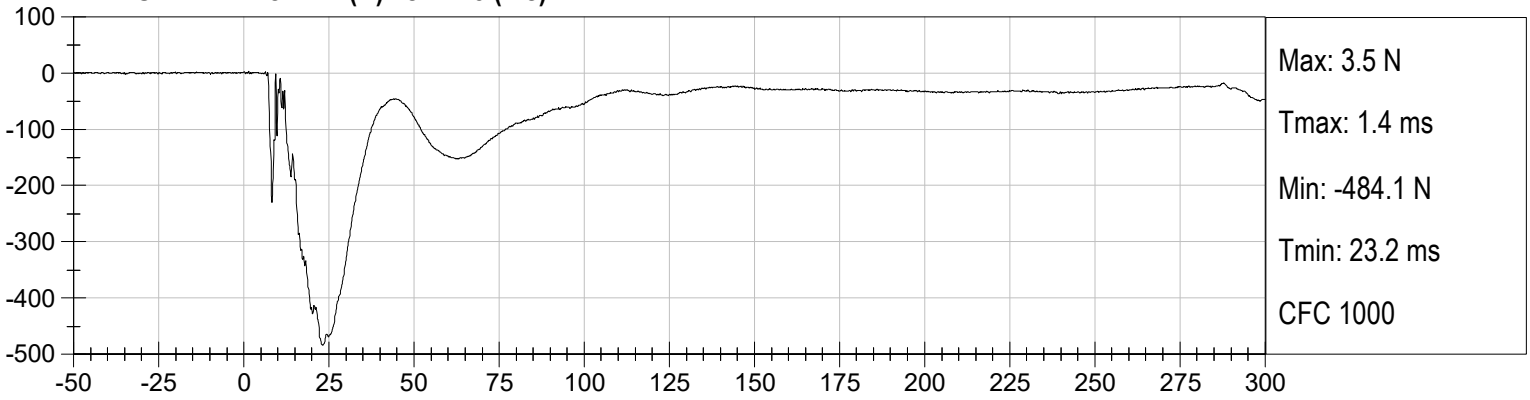
RRP HEAD Z (g) vs Time (ms)



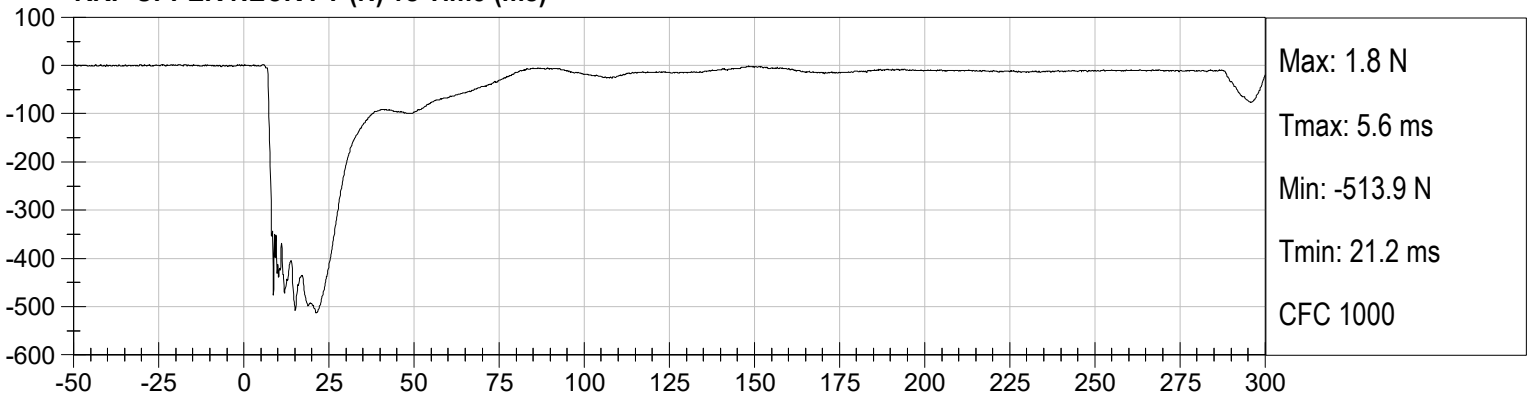
RRP HEAD Resultant (g) vs Time (ms)



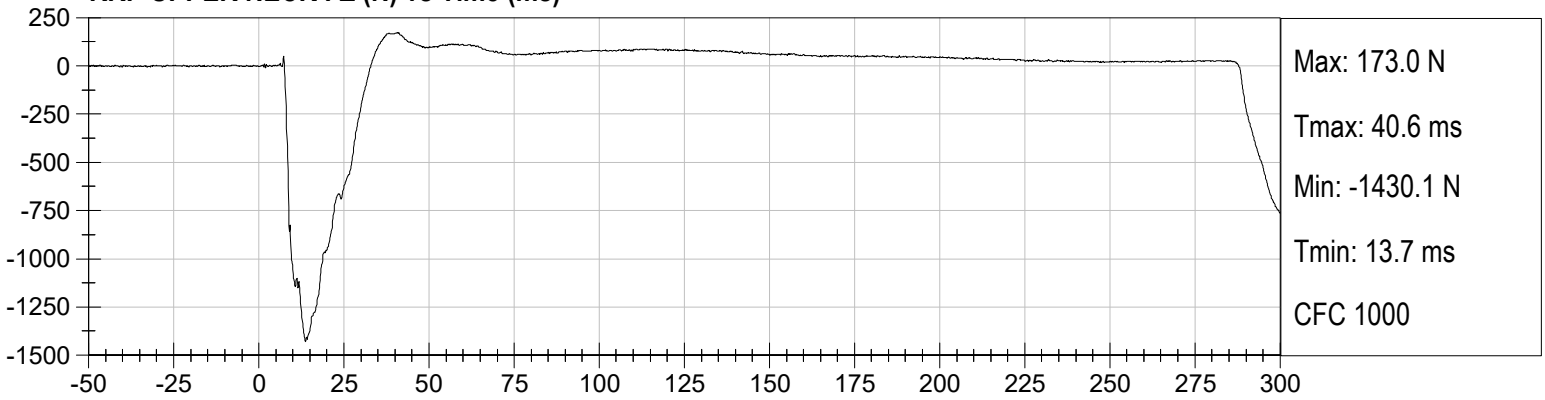
RRP UPPER NECK FX (N) vs Time (ms)



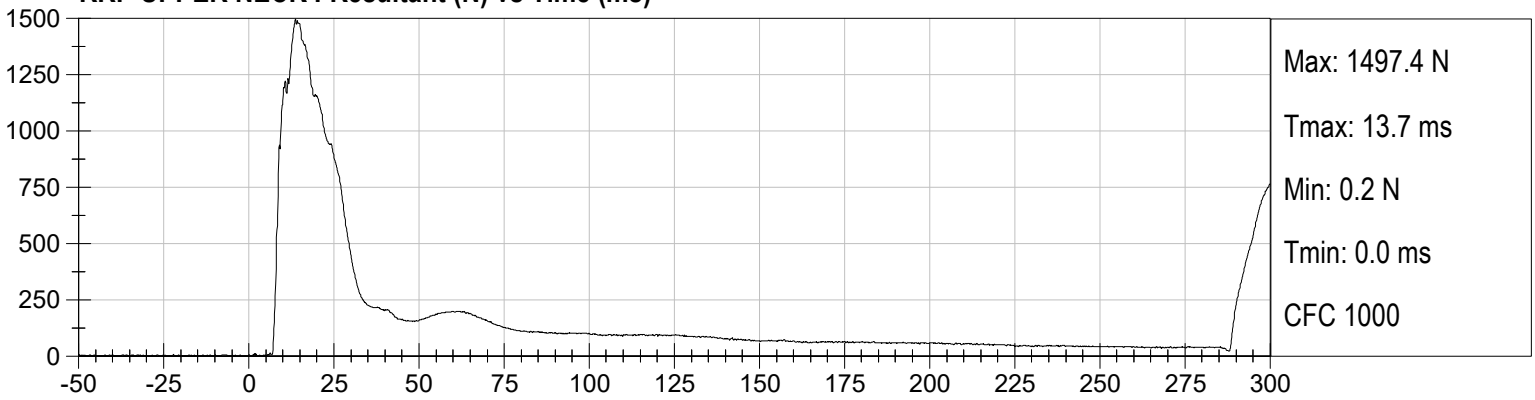
RRP UPPER NECK FY (N) vs Time (ms)



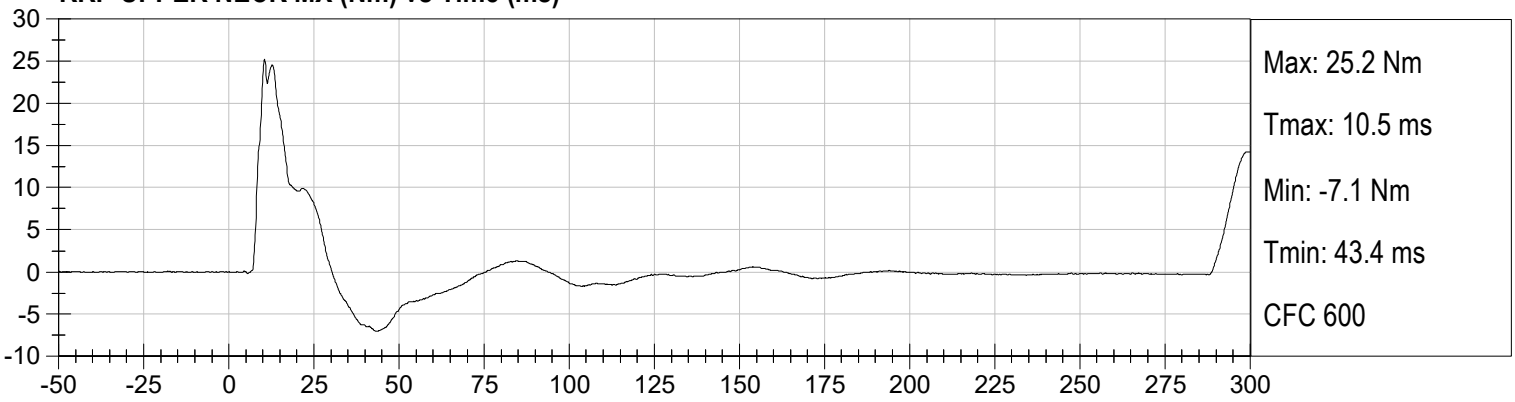
RRP UPPER NECK FZ (N) vs Time (ms)



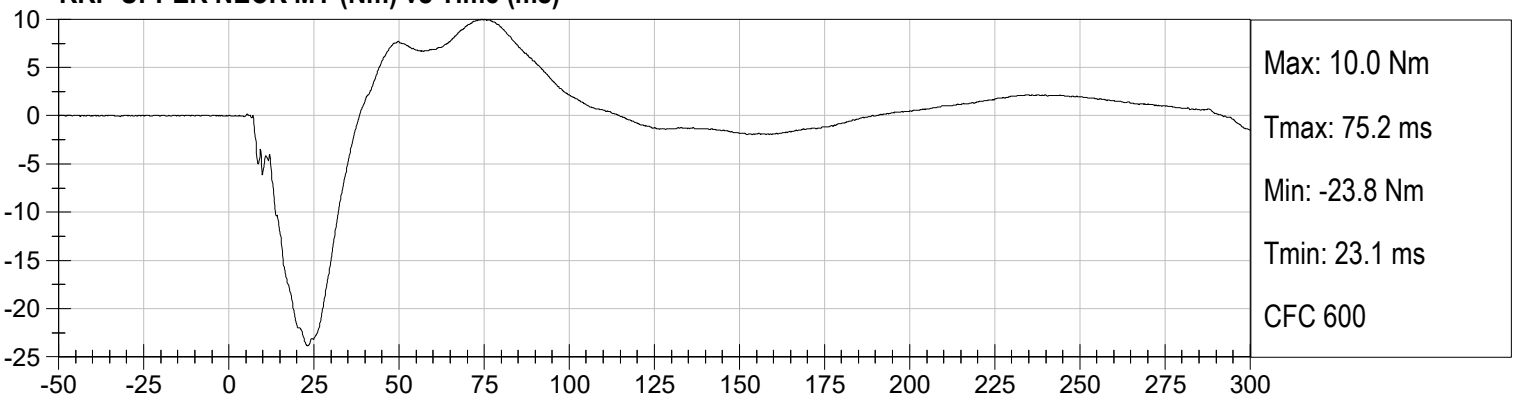
RRP UPPER NECK FResultant (N) vs Time (ms)



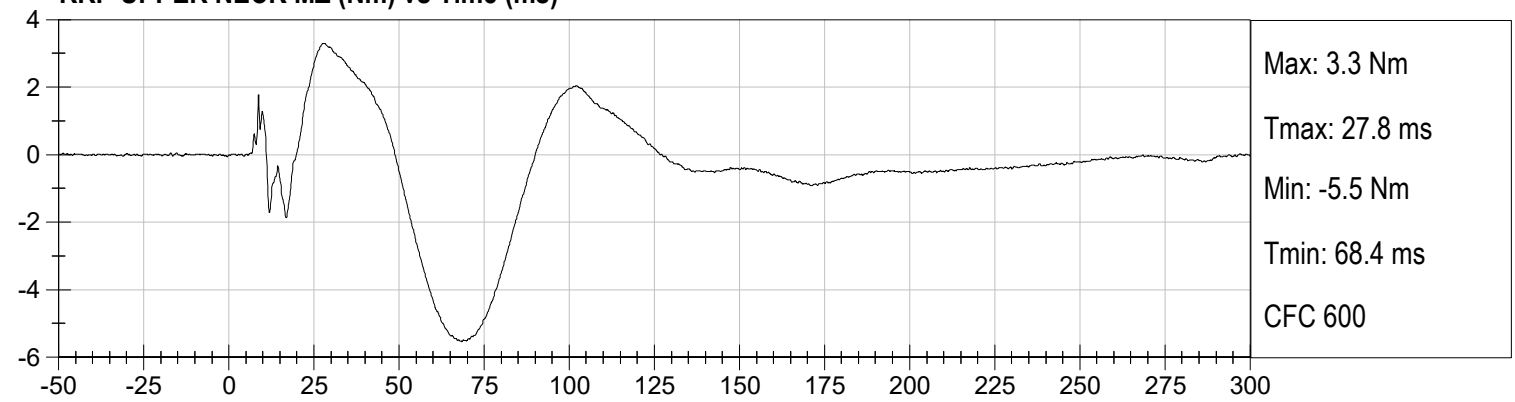
RRP UPPER NECK MX (Nm) vs Time (ms)



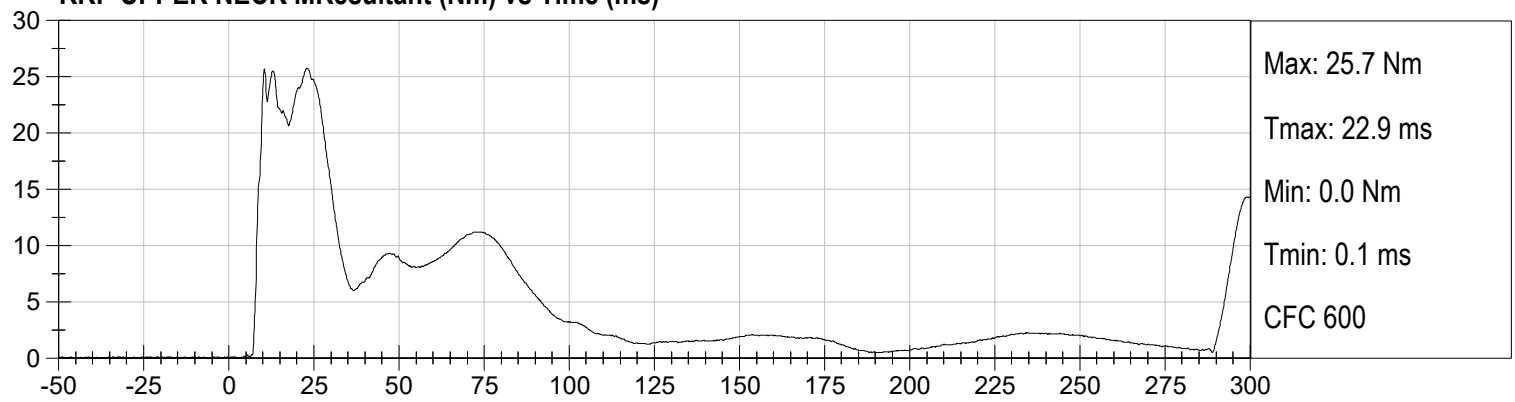
RRP UPPER NECK MY (Nm) vs Time (ms)



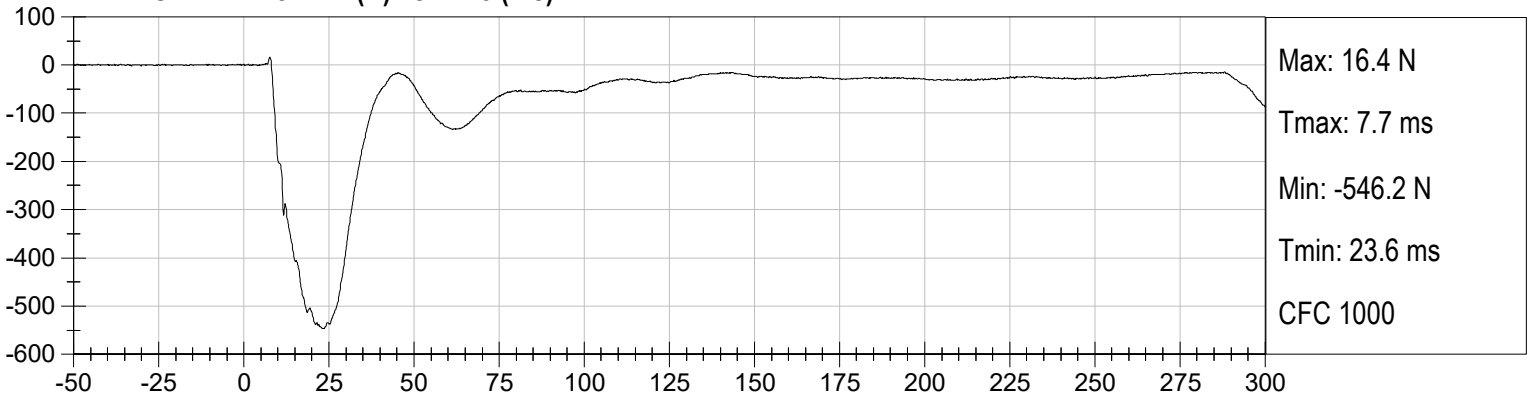
RRP UPPER NECK MZ (Nm) vs Time (ms)



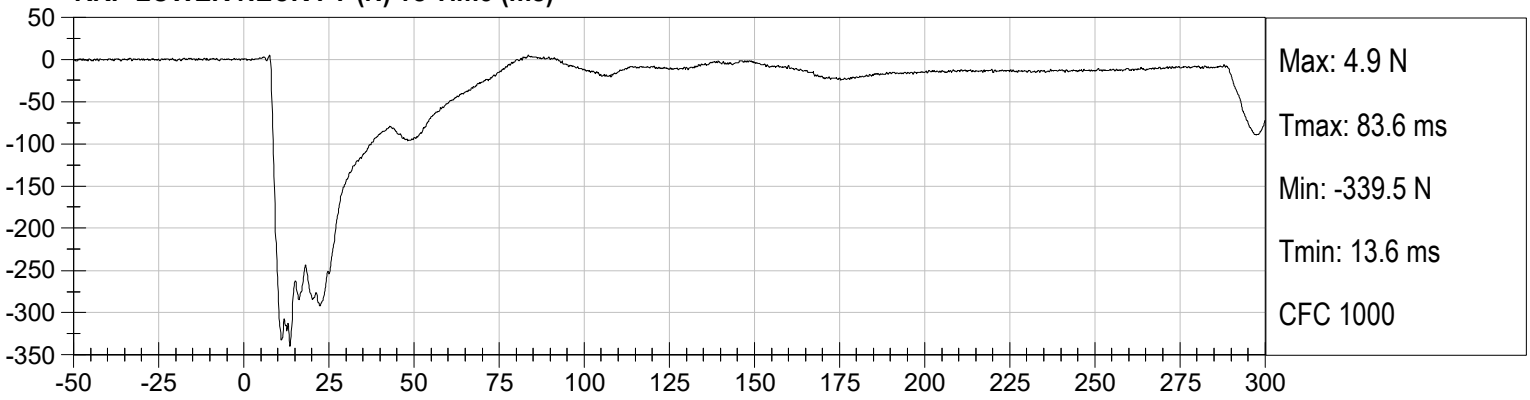
RRP UPPER NECK MResultant (Nm) vs Time (ms)



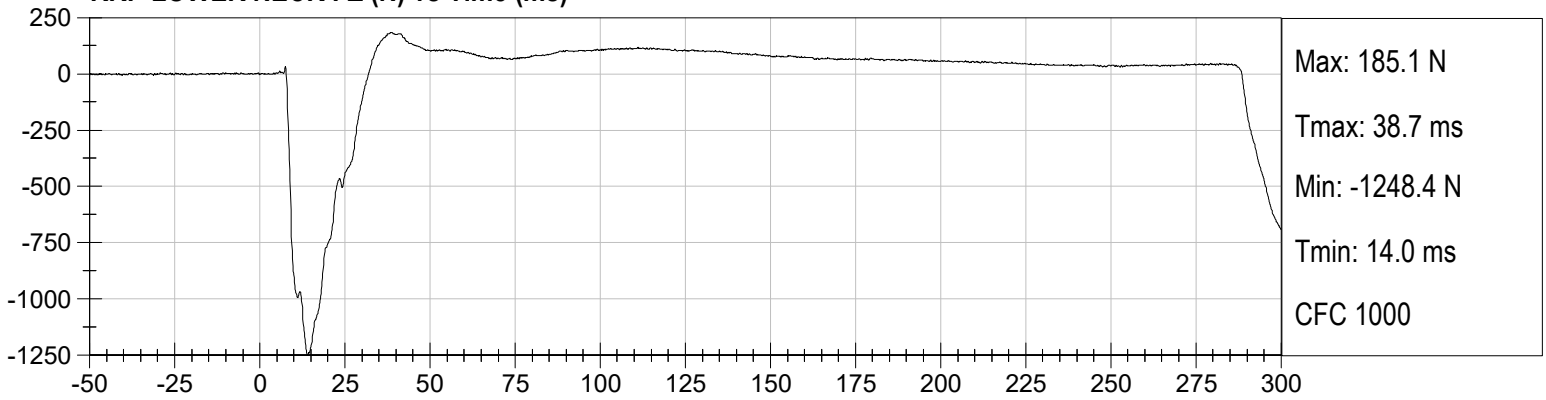
RRP LOWER NECK FX (N) vs Time (ms)



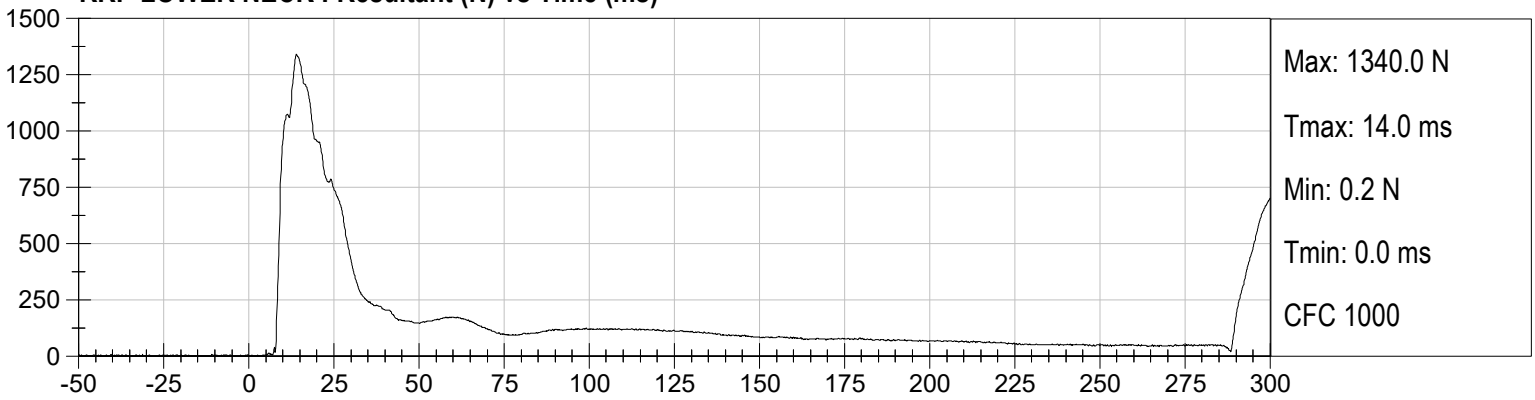
RRP LOWER NECK FY (N) vs Time (ms)



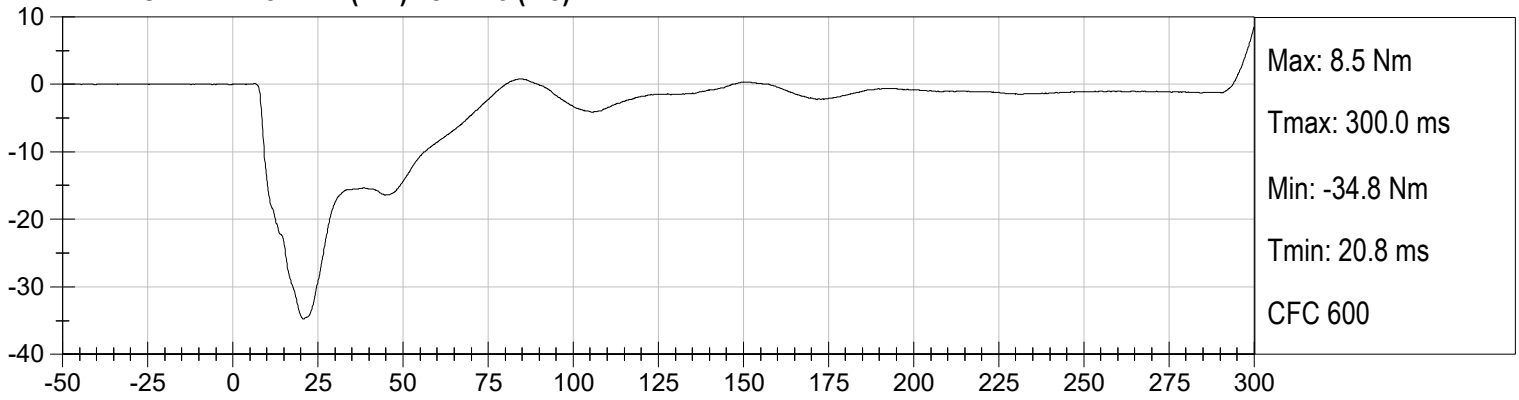
RRP LOWER NECK FZ (N) vs Time (ms)



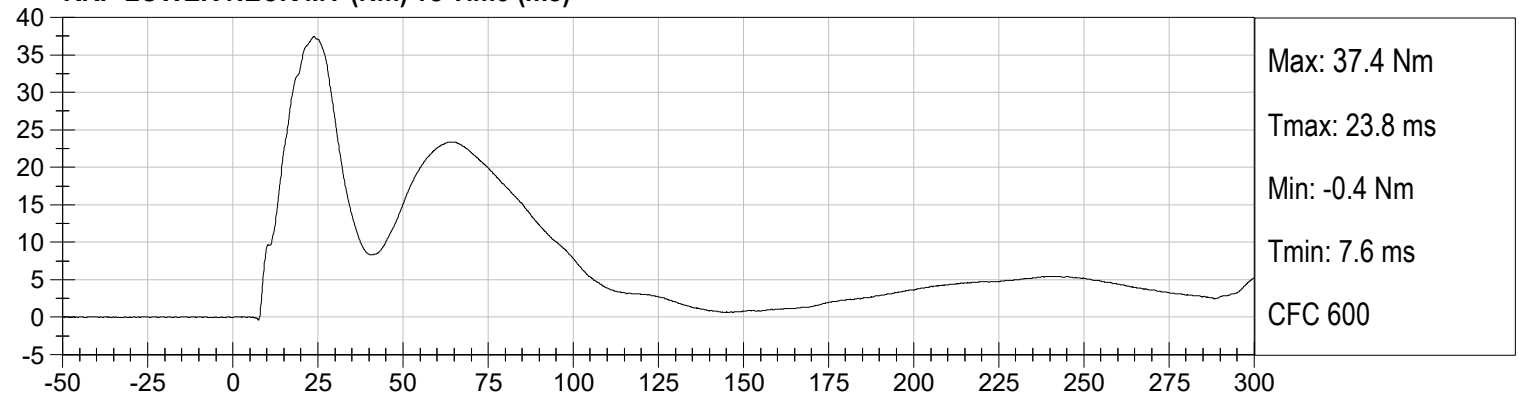
RRP LOWER NECK FResultant (N) vs Time (ms)



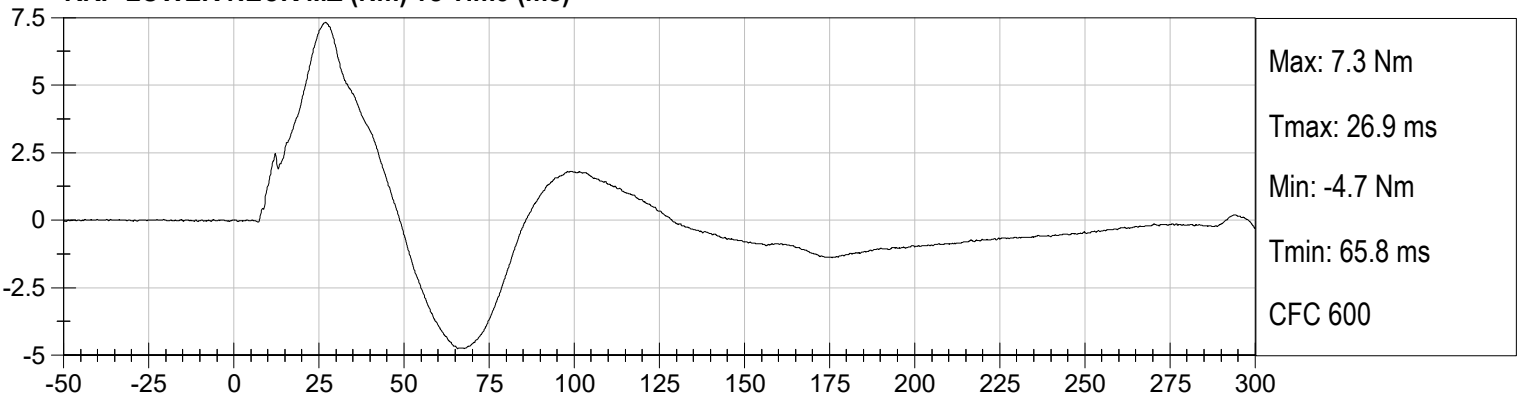
RRP LOWER NECK MX (Nm) vs Time (ms)



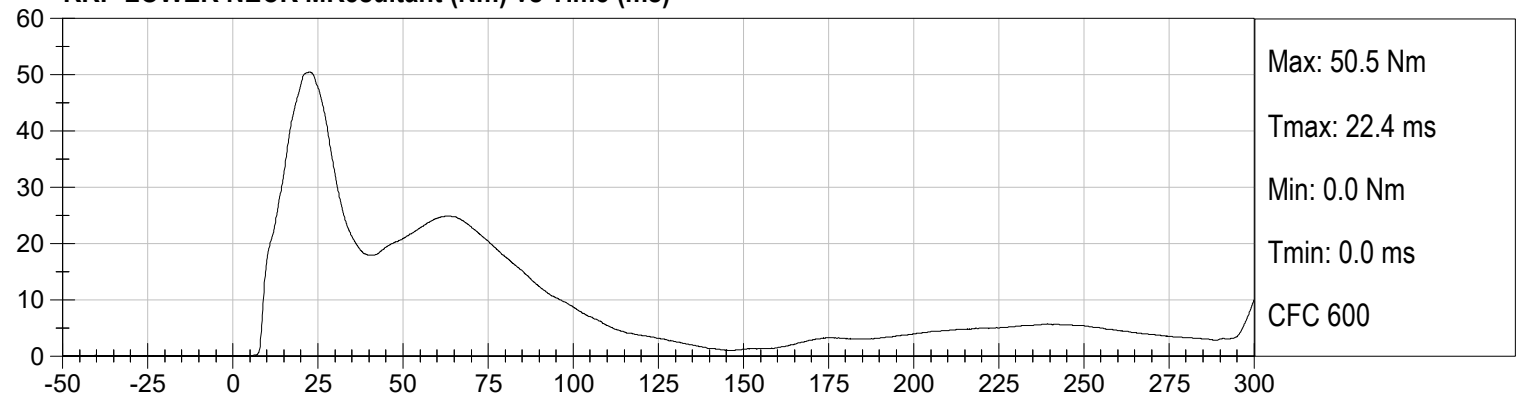
RRP LOWER NECK MY (Nm) vs Time (ms)



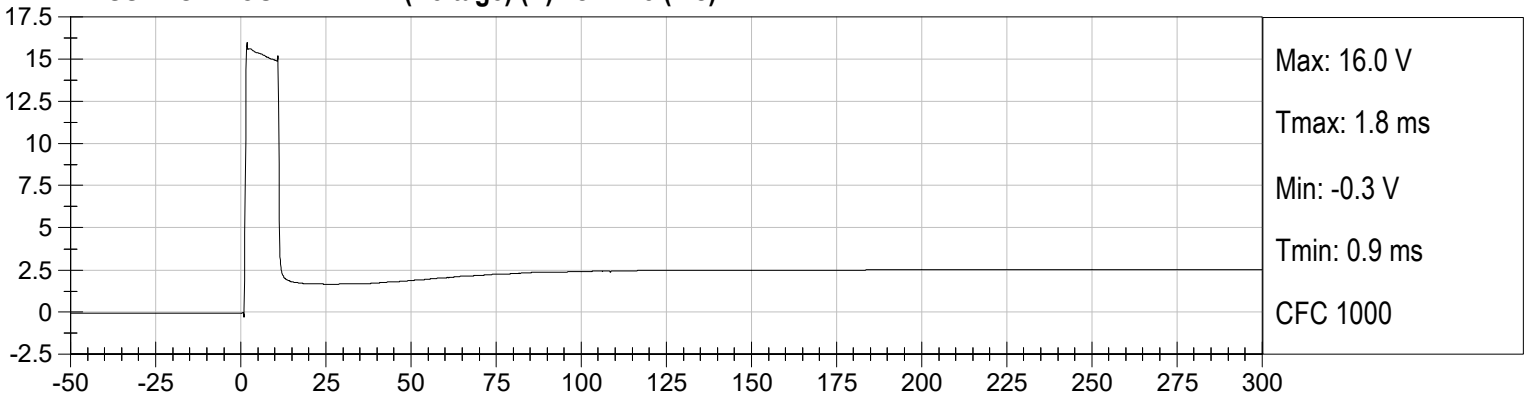
RRP LOWER NECK MZ (Nm) vs Time (ms)



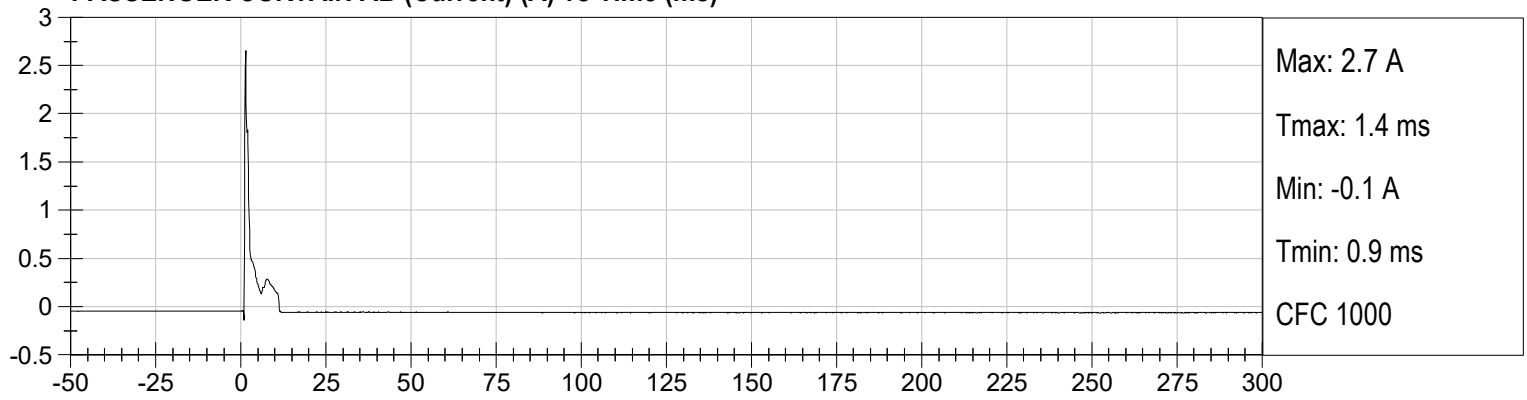
RRP LOWER NECK MResultant (Nm) vs Time (ms)



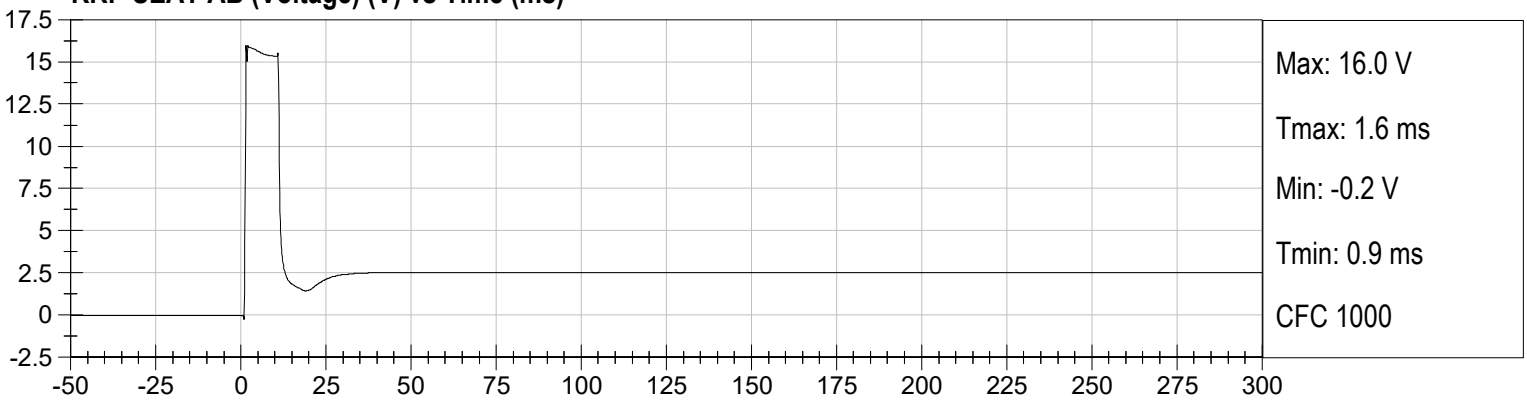
PASSENGER CURTAIN AB (Voltage) (V) vs Time (ms)



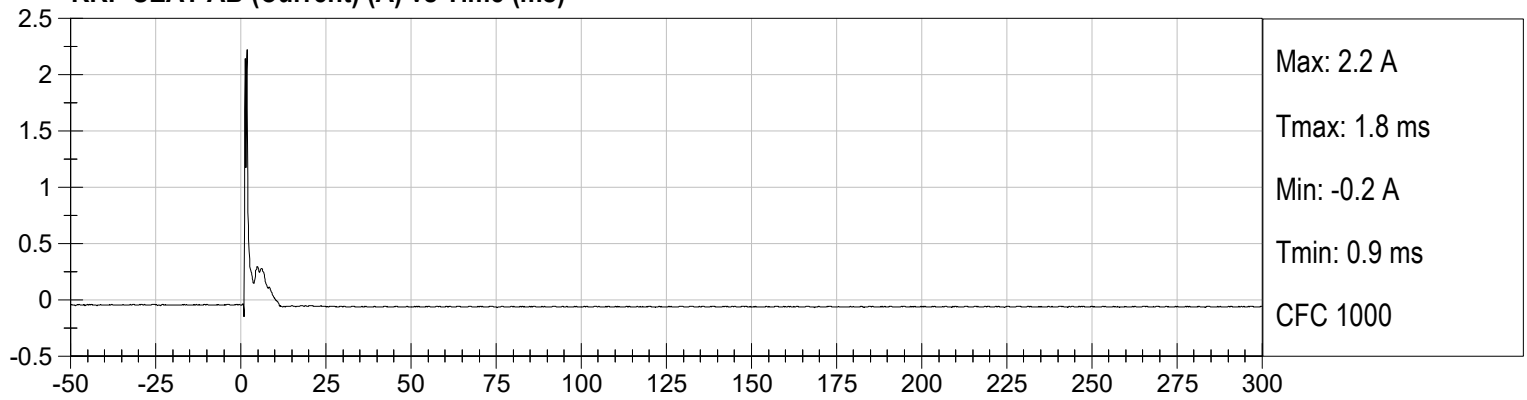
PASSENGER CURTAIN AB (Current) (A) vs Time (ms)



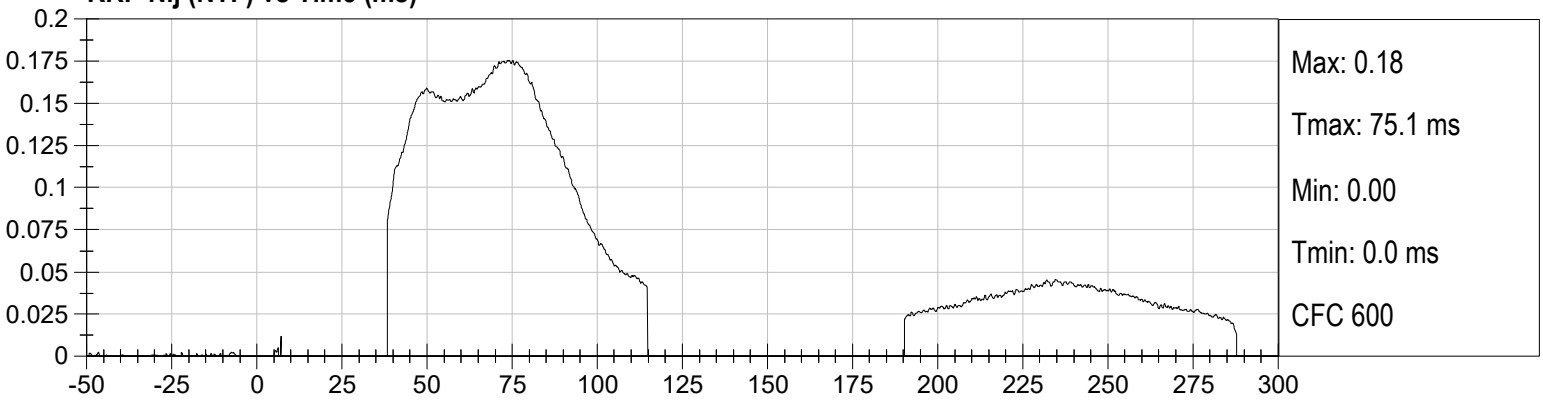
RRP SEAT AB (Voltage) (V) vs Time (ms)



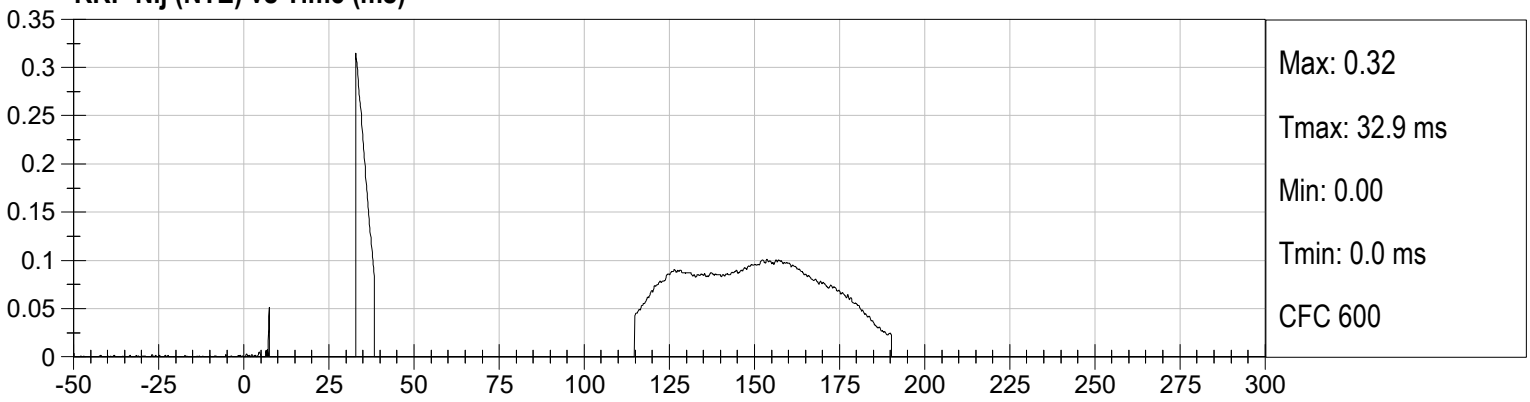
RRP SEAT AB (Current) (A) vs Time (ms)



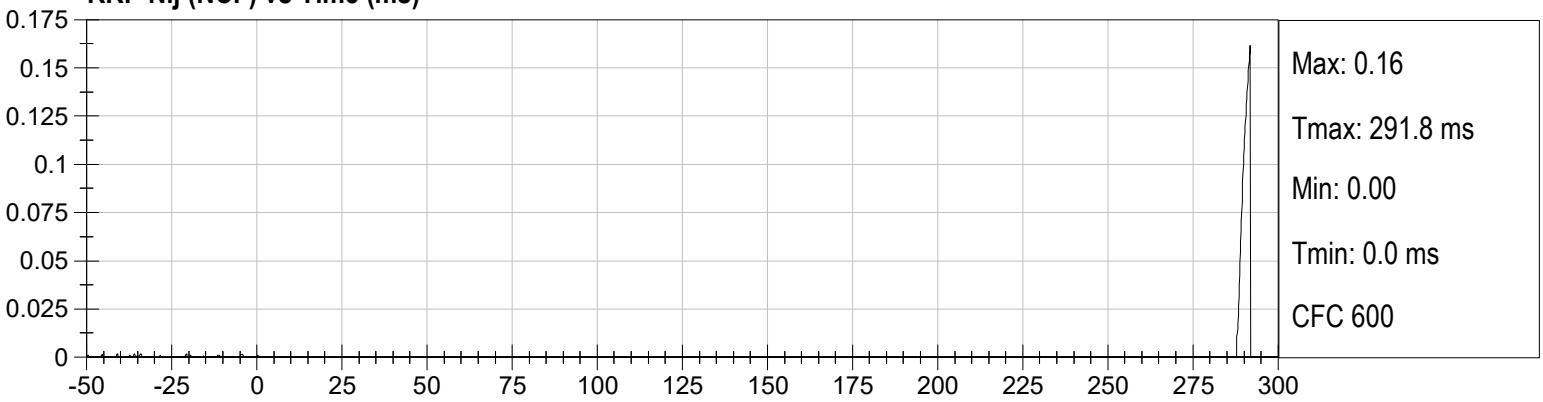
RRP Nij (NTF) vs Time (ms)



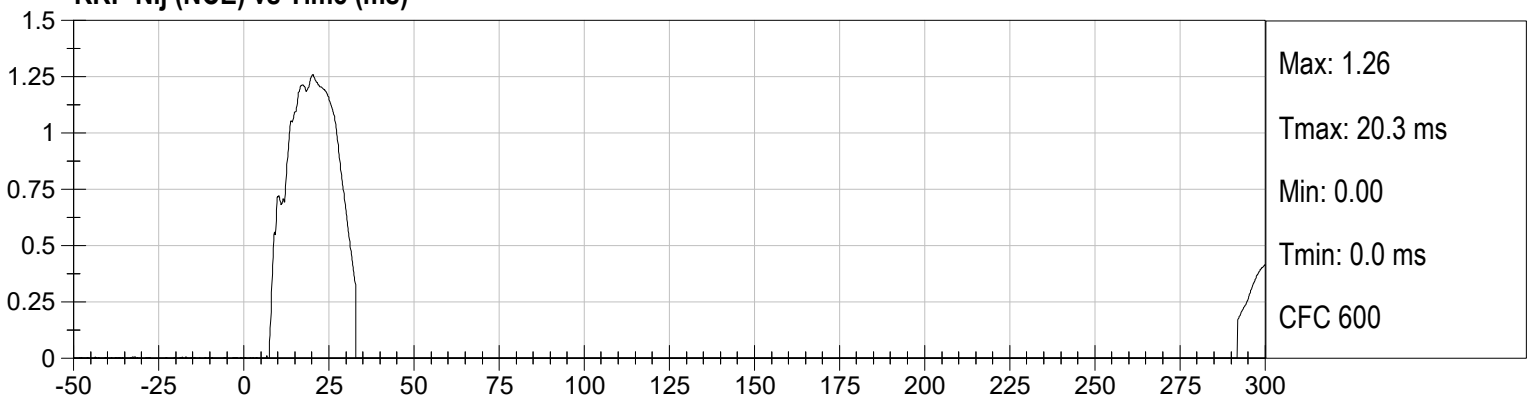
RRP Nij (NTE) vs Time (ms)



RRP Nij (NCF) vs Time (ms)



RRP Nij (NCE) 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:** D210231

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	24	Pass
Peak Resultant Acceleration	G's	250 to 280	271	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-2.2	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

02/01/2021

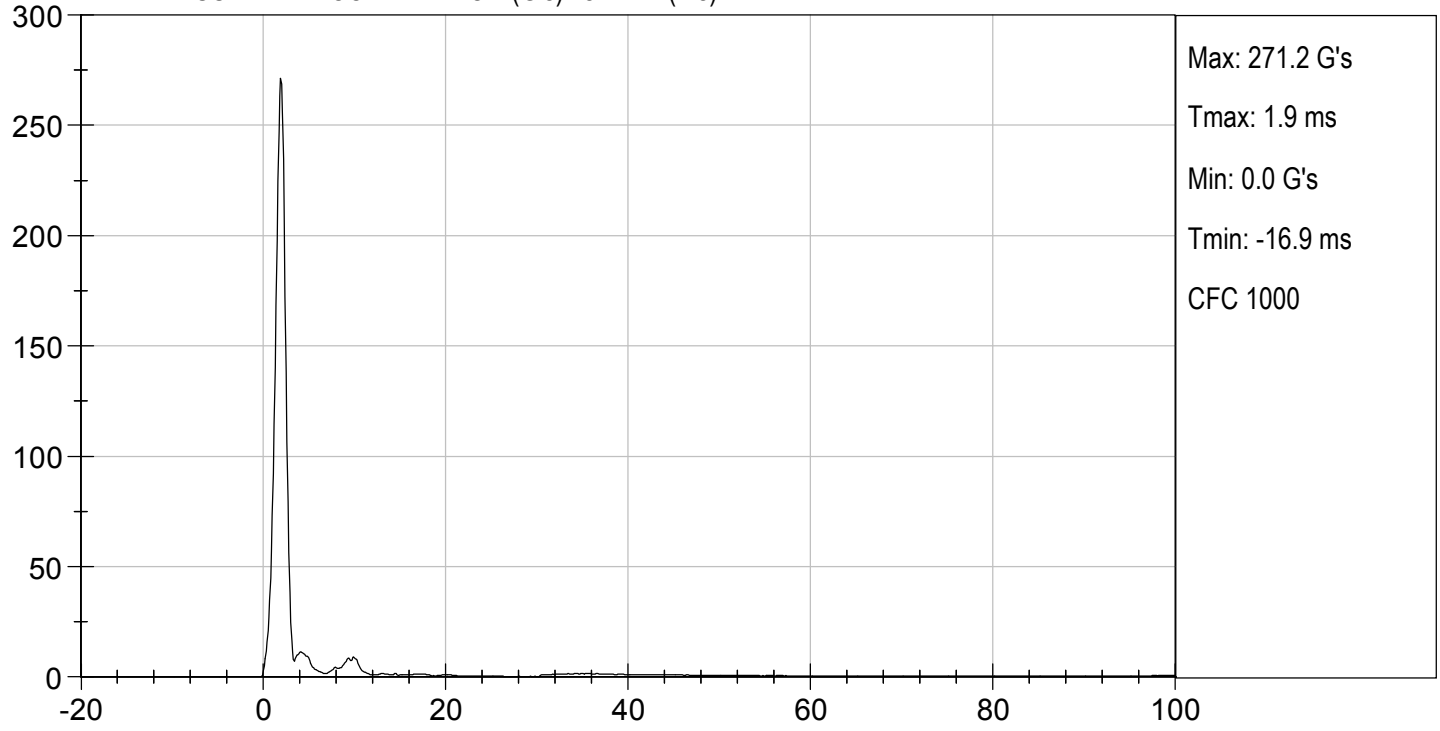
Test Date

Approved By

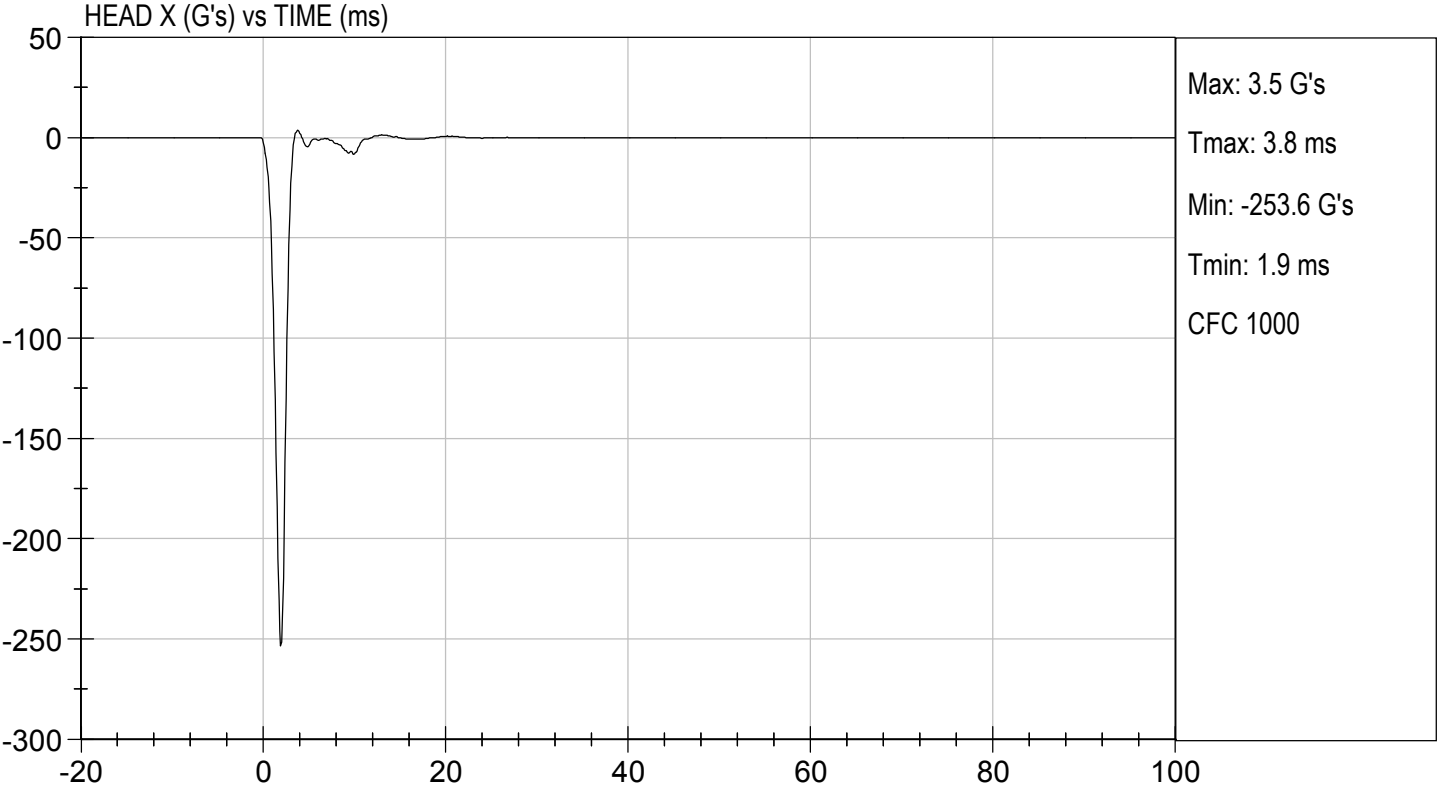
TEST DESC: HEAD DROP

TEST DATE: 02/01/2021
TEST #: D210231

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

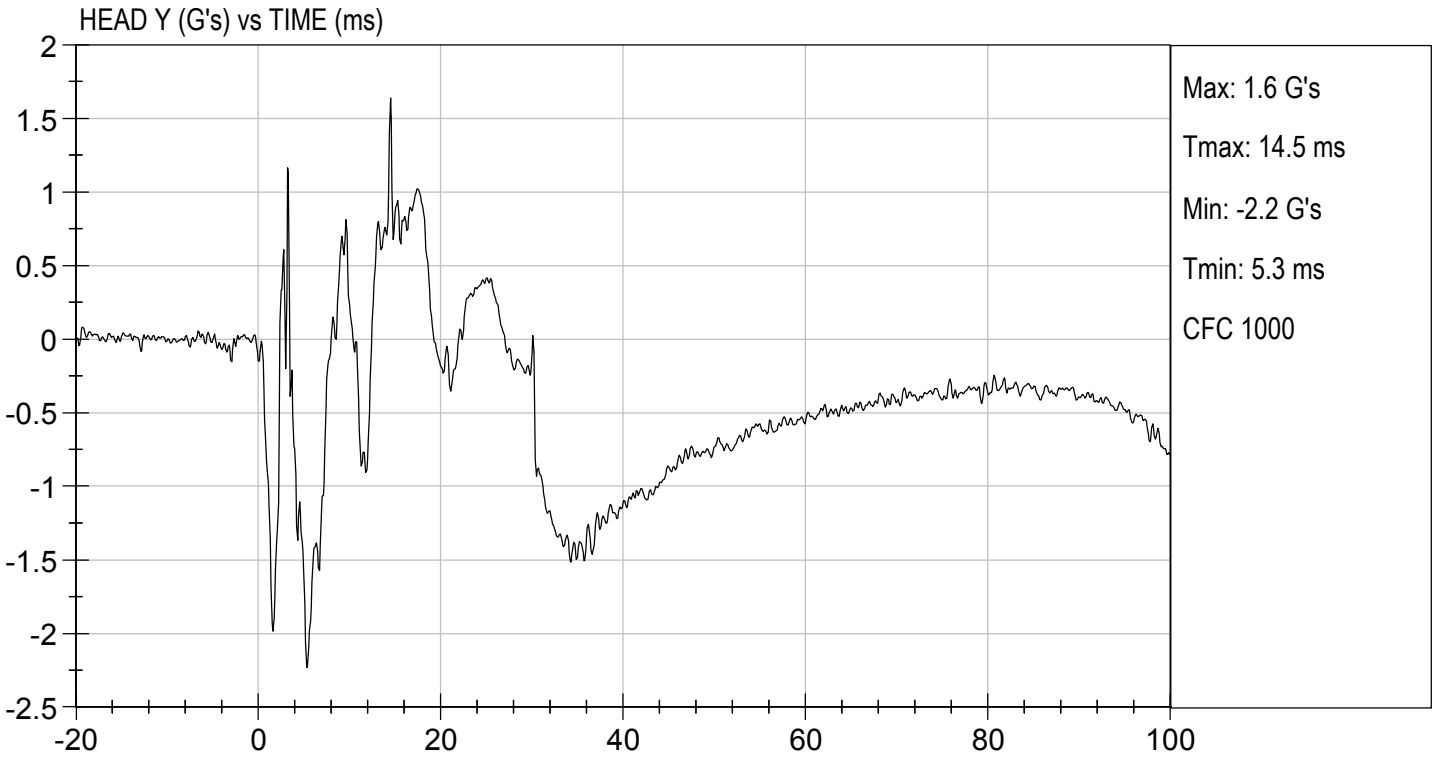


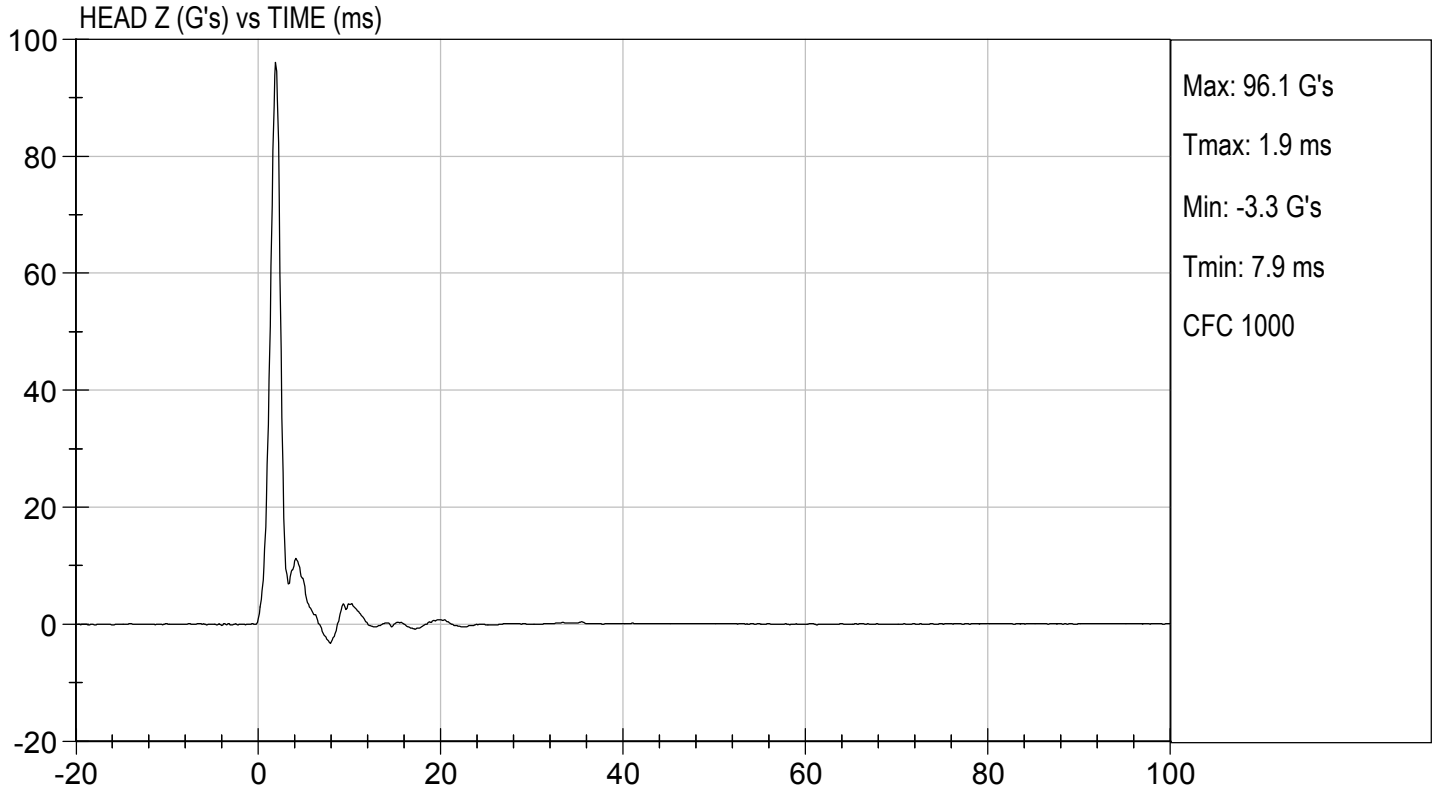
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 02/01/2021
TEST #: D210231





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210232

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity		%	10 to 70	24	Pass
Pendulum Speed		m/s	5.40 to 5.60	5.58	Pass
Pendulum Velocity	10 msec	m/s	2.0 to 2.7	2.5	Pass
	15 msec	m/s	3.0 to 4.0	3.7	Pass
	20 msec	m/s	4.0 to 5.1	5.0	Pass
D Plane Rotation		deg	70 to 82	73	Pass
Peak Moment within Deflection Corridor		Nm	42.0 to 53.0	45.2	Pass
Positive Moment - Time Curve Decay to 10 Nm		msec	60.0 to 80.0	68	Pass
			Overall Test Results		Pass

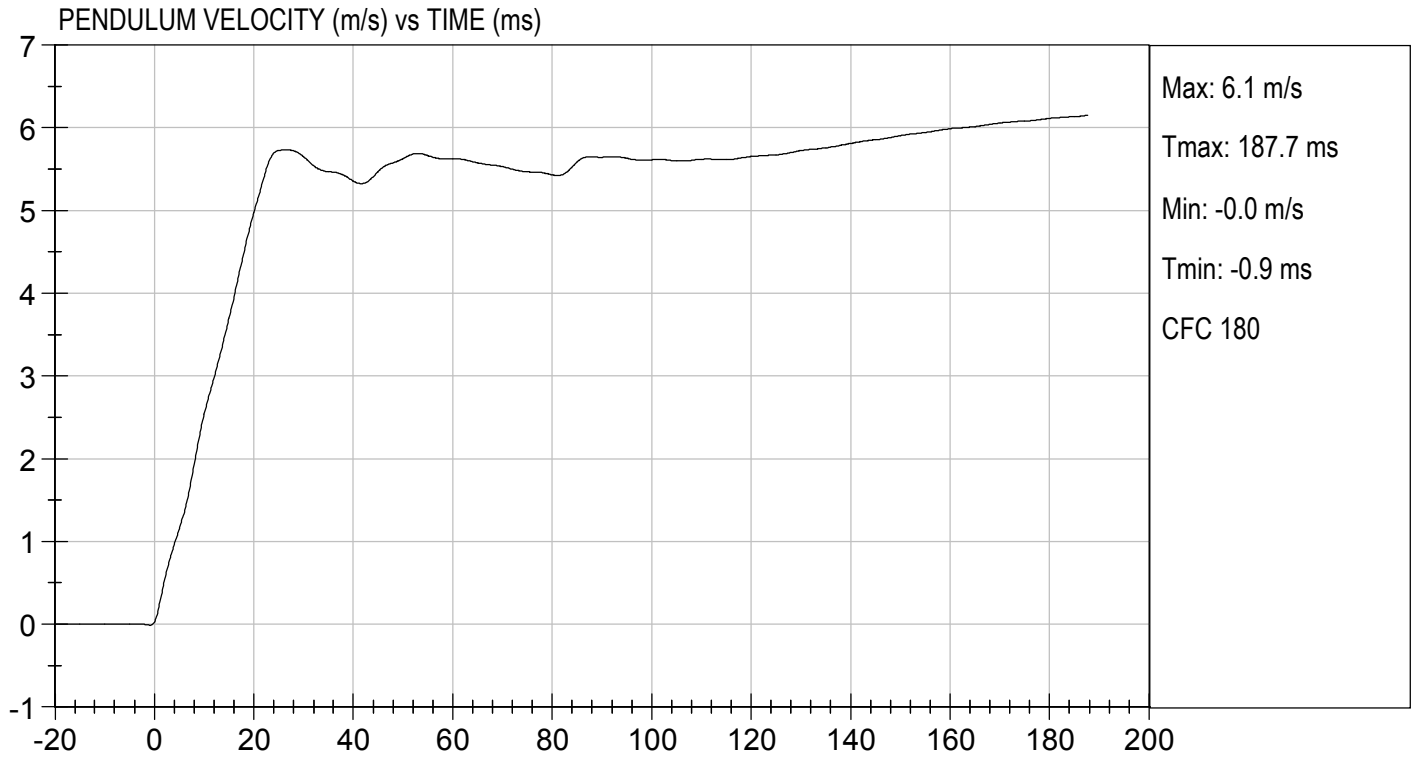
Brian Roach
Laboratory Technician

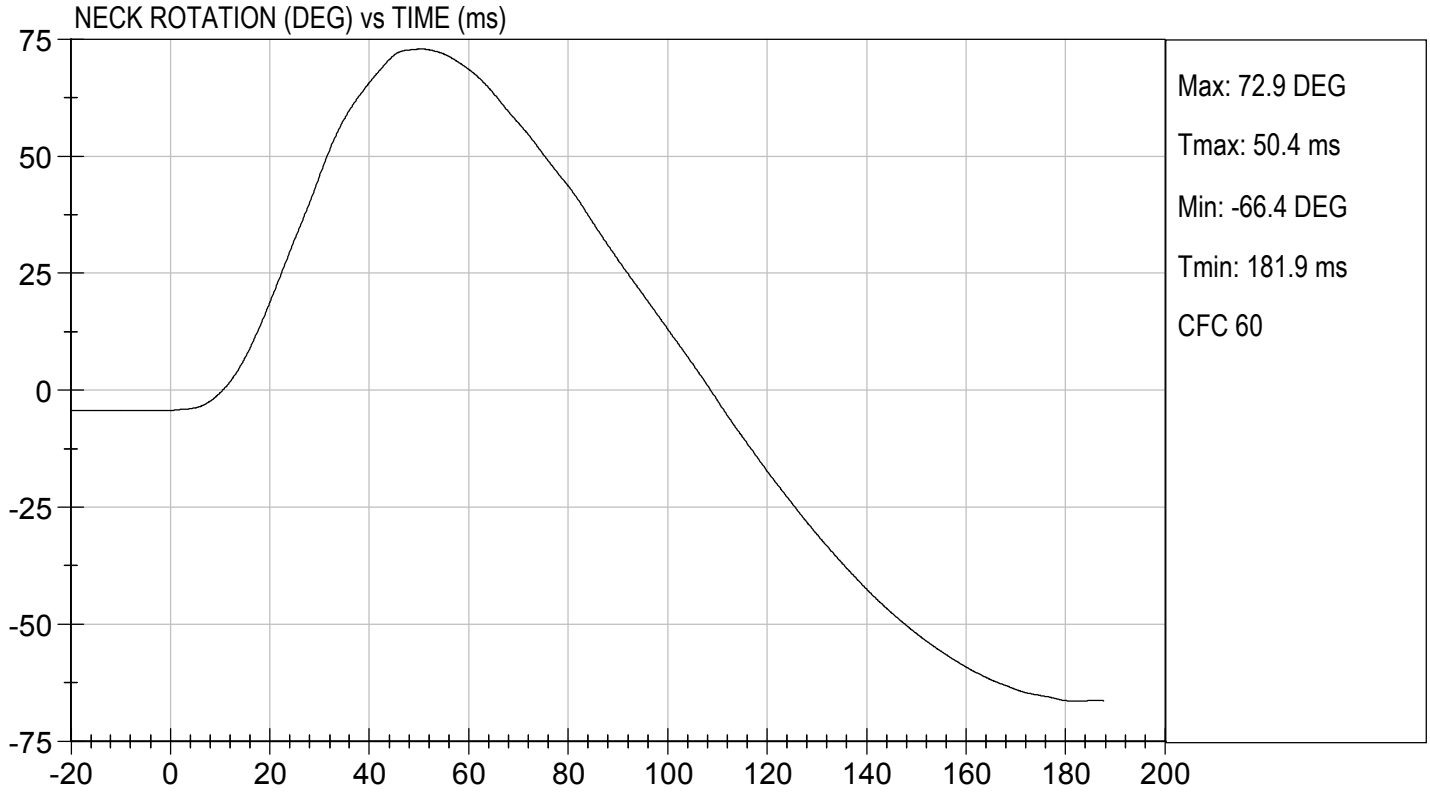
02/01/2021
Test Date

Approved By

TEST DESC: NECK FLEXION
VELOCITY: 18.32 ft/s, 5.58 m/s

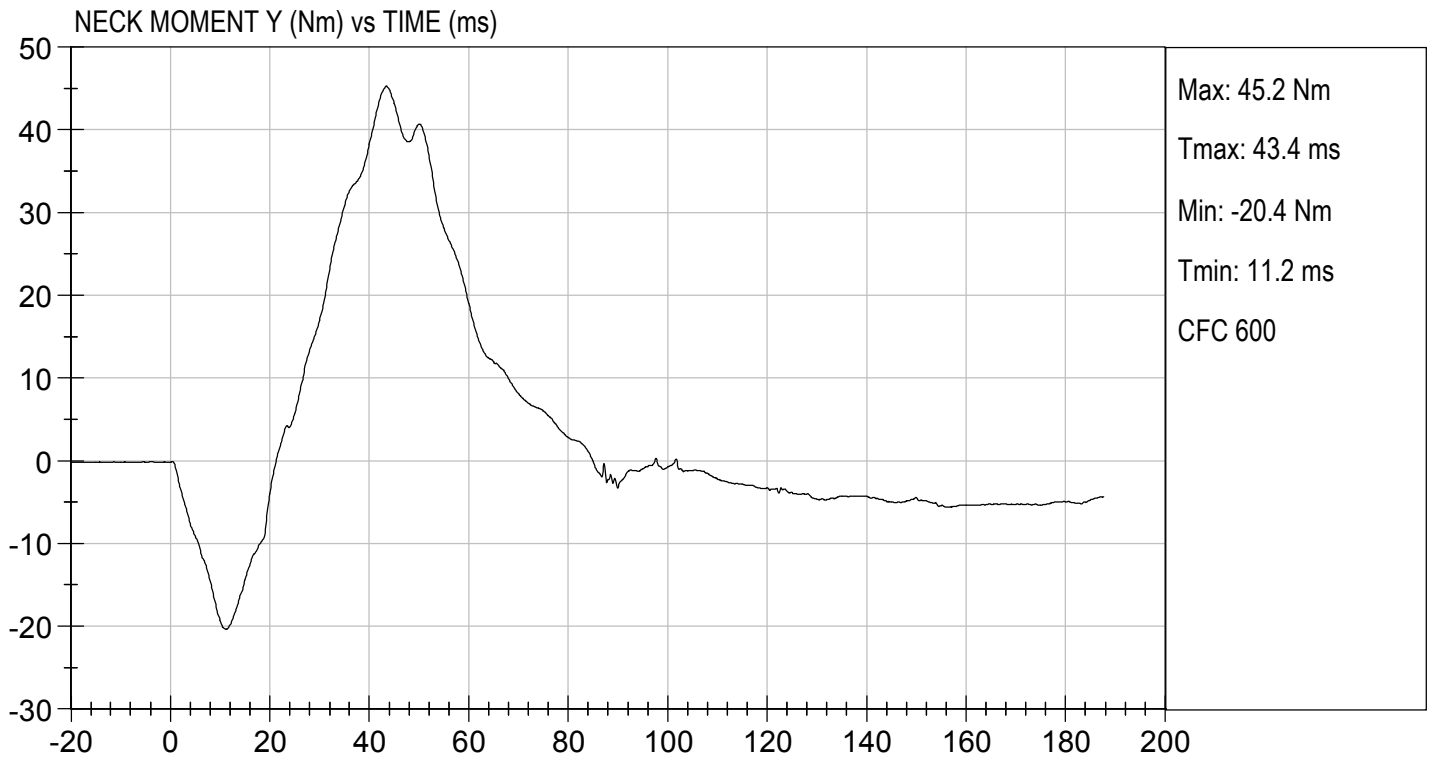
TEST DATE: 02/01/2021
TEST #: D210232





TEST DESC: NECK FLEXION
VELOCITY: 18.32 ft/s, 5.58 m/s

TEST DATE: 02/01/2021
TEST #: D210232



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210233

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity		%	10 to 70	24	Pass
Pendulum Speed		m/s	3.55 to 3.75	3.71	Pass
Pendulum Velocity	6 ms	m/s	1.0 to 1.4	1.4	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	-44.0	Pass
Negative Moment - Time Curve Decay to -10 Nm		ms	60.0 to 80.0	68	Pass
			Overall Test Results		Pass

Brian Roach

Laboratory Technician

02/01/2021

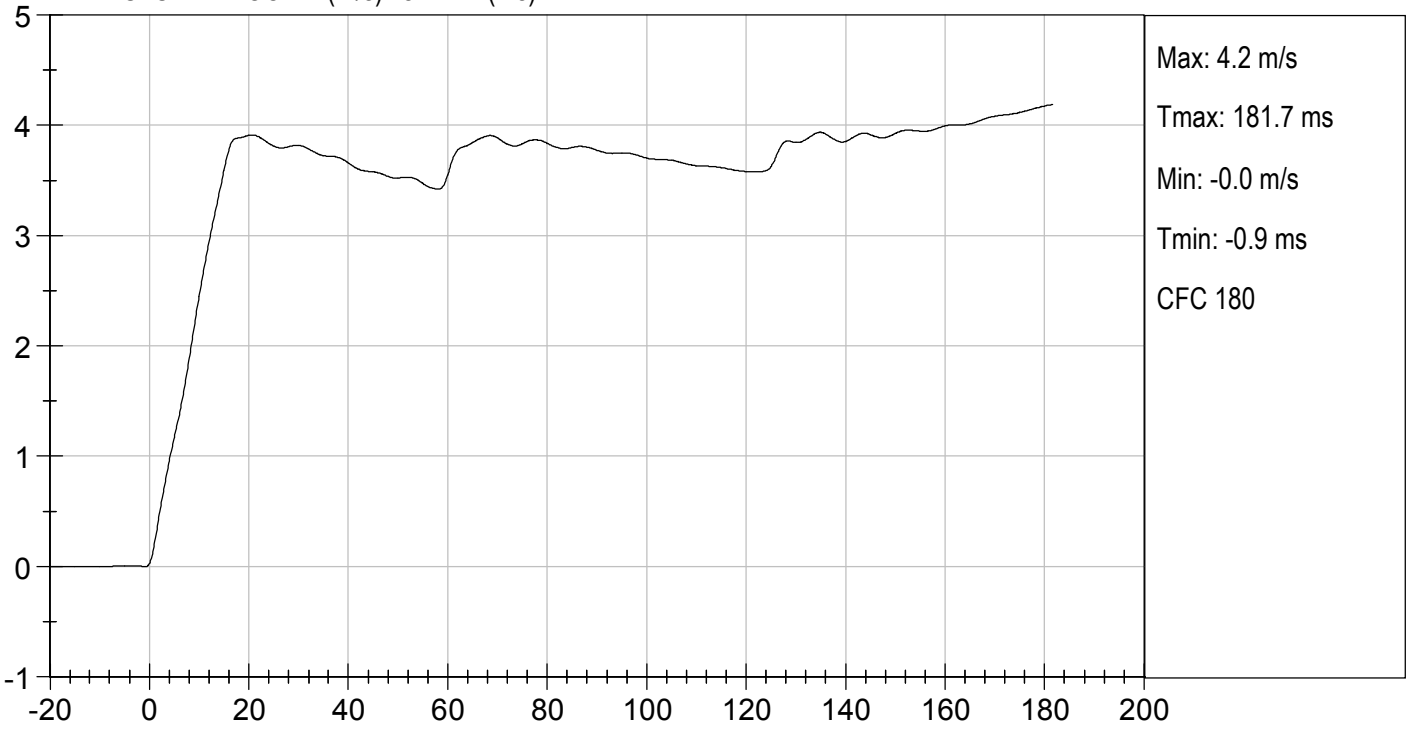
Test Date

Approved By

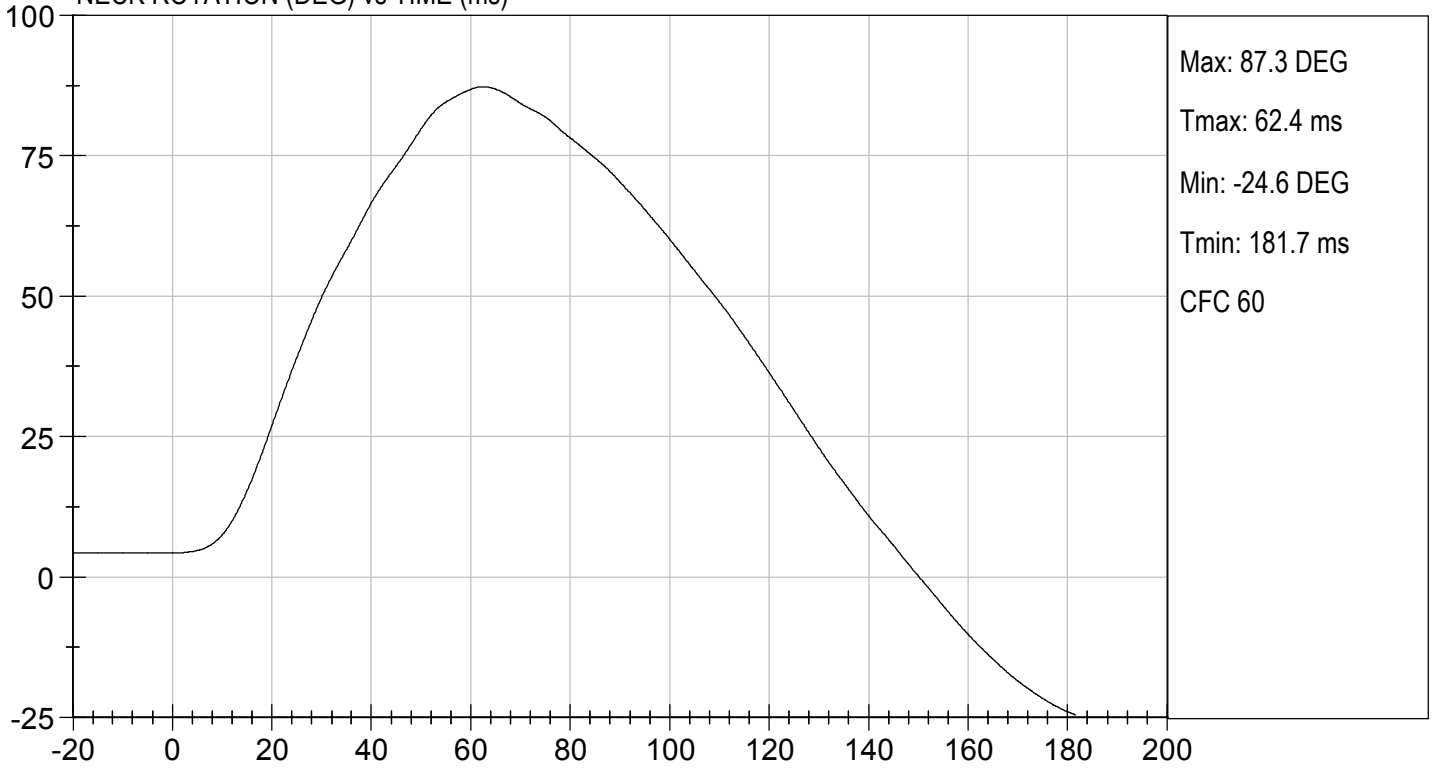
TEST DESC: NECK EXTENSION
VELOCITY: 12.17 ft/s, 3.71 m/s

TEST DATE: 02/01/2021
TEST #: D210233

PENDULUM VELOCITY (m/s) vs TIME (ms)

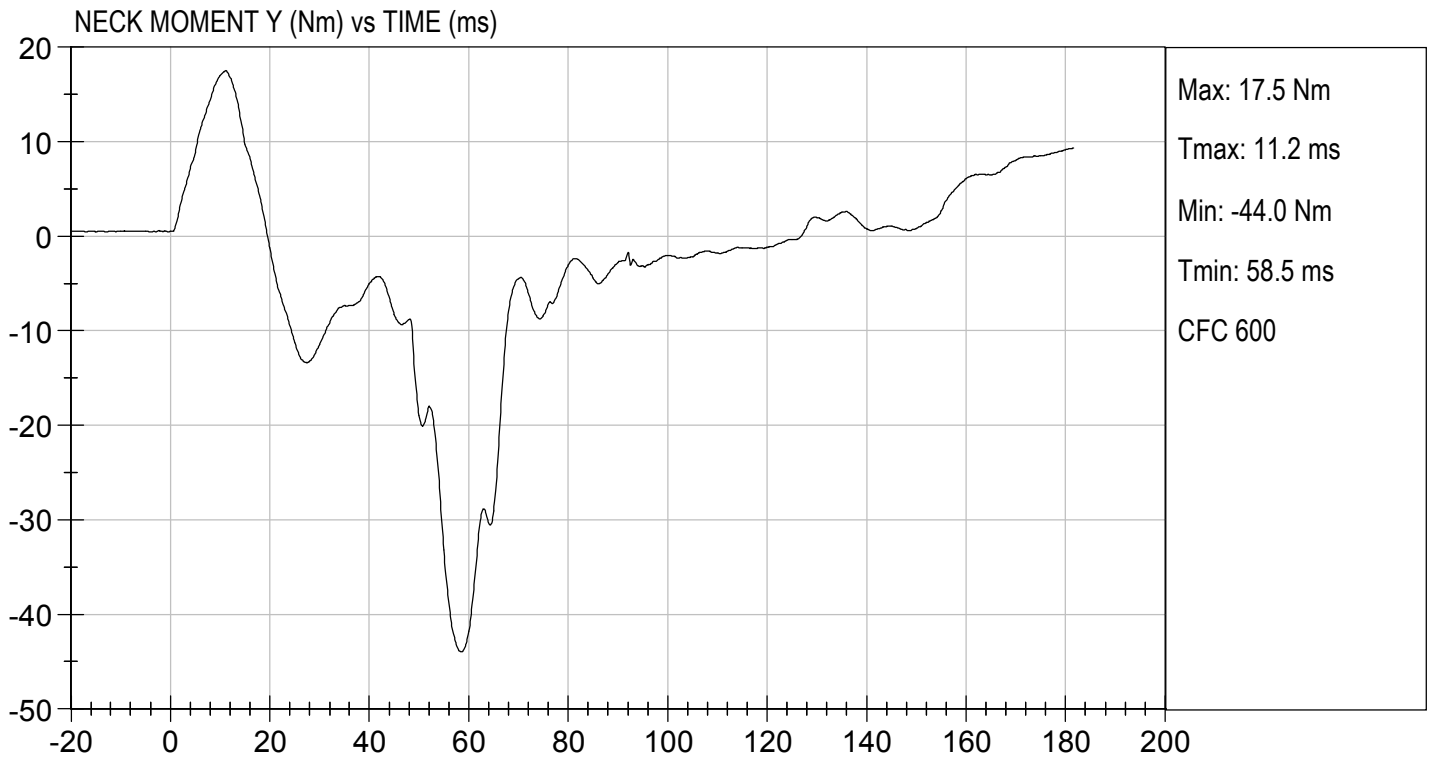


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 02/01/2021
TEST #: D210233



MGA RESEARCH CORPORATION

THORAX IMPACT TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210234

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	24	Pass
Probe Velocity	m/s	5.9 to 6.1	5.98	Pass
Peak Deflection	mm	32 to 38	36.7	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	720	Pass
Internal Hysteresis	%	65 to 85	72.0	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	770	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

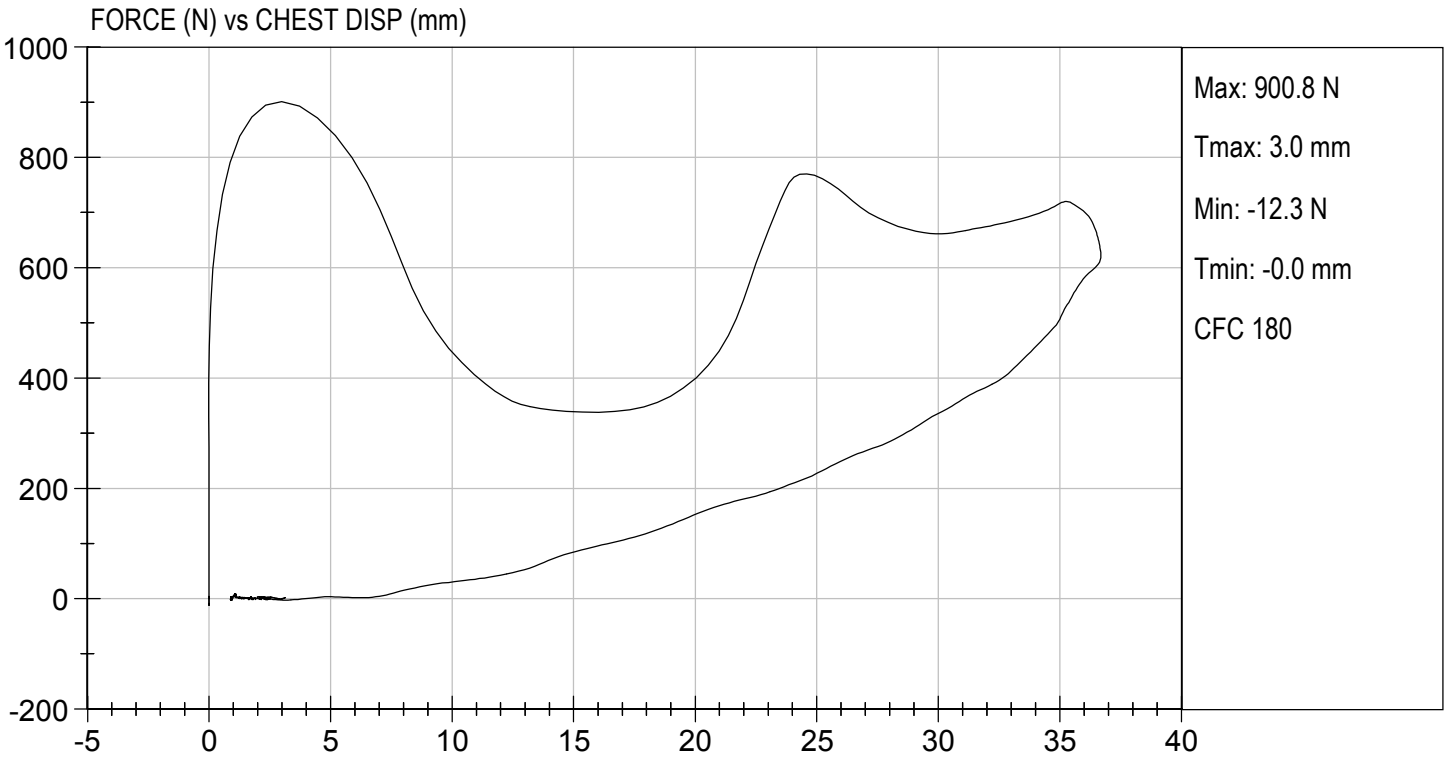
02/02/2021

Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 19.61 ft/s, 5.98 m/s

TEST DATE: 02/02/2021
TEST #: D210234



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 3 YEAR OLD

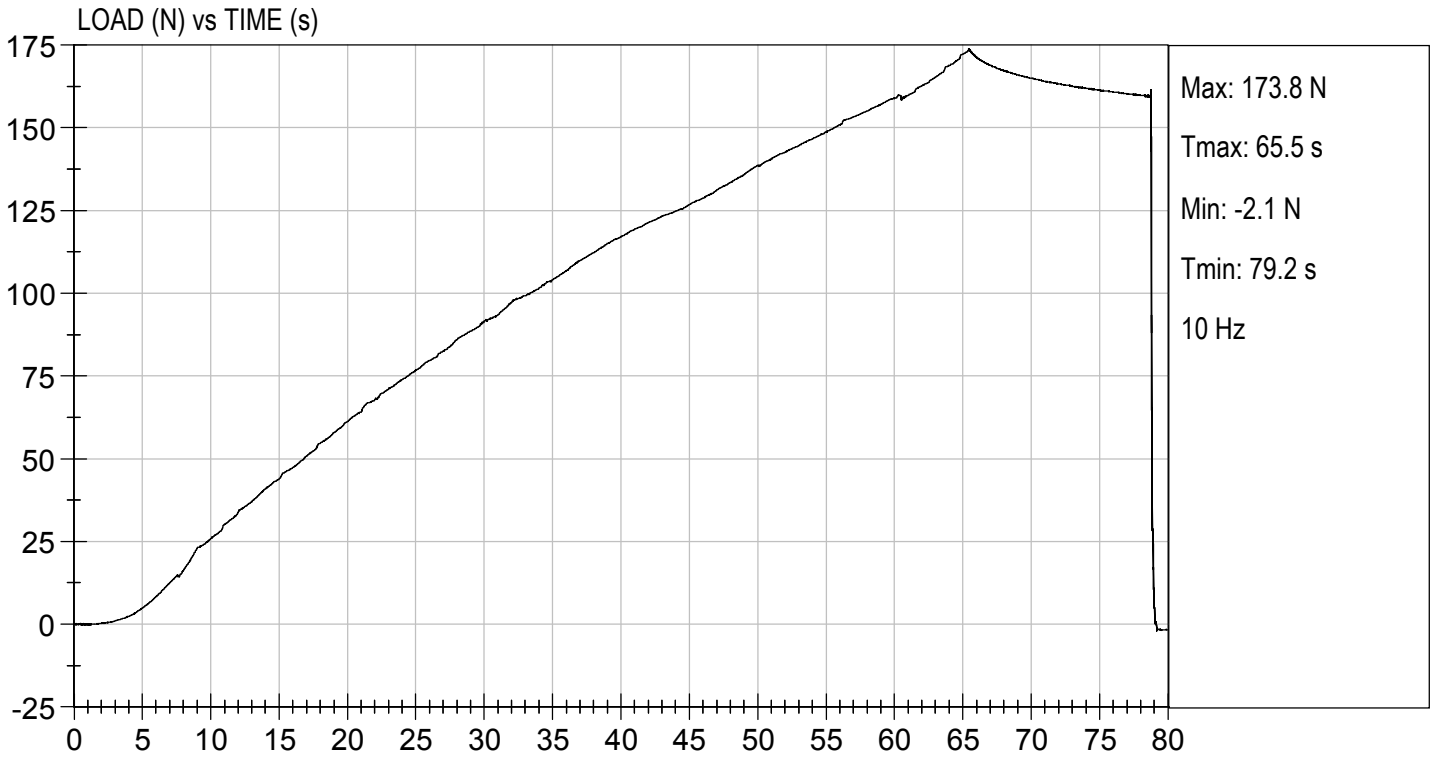
ATD Serial No: 082 **Test I.D:** D210237

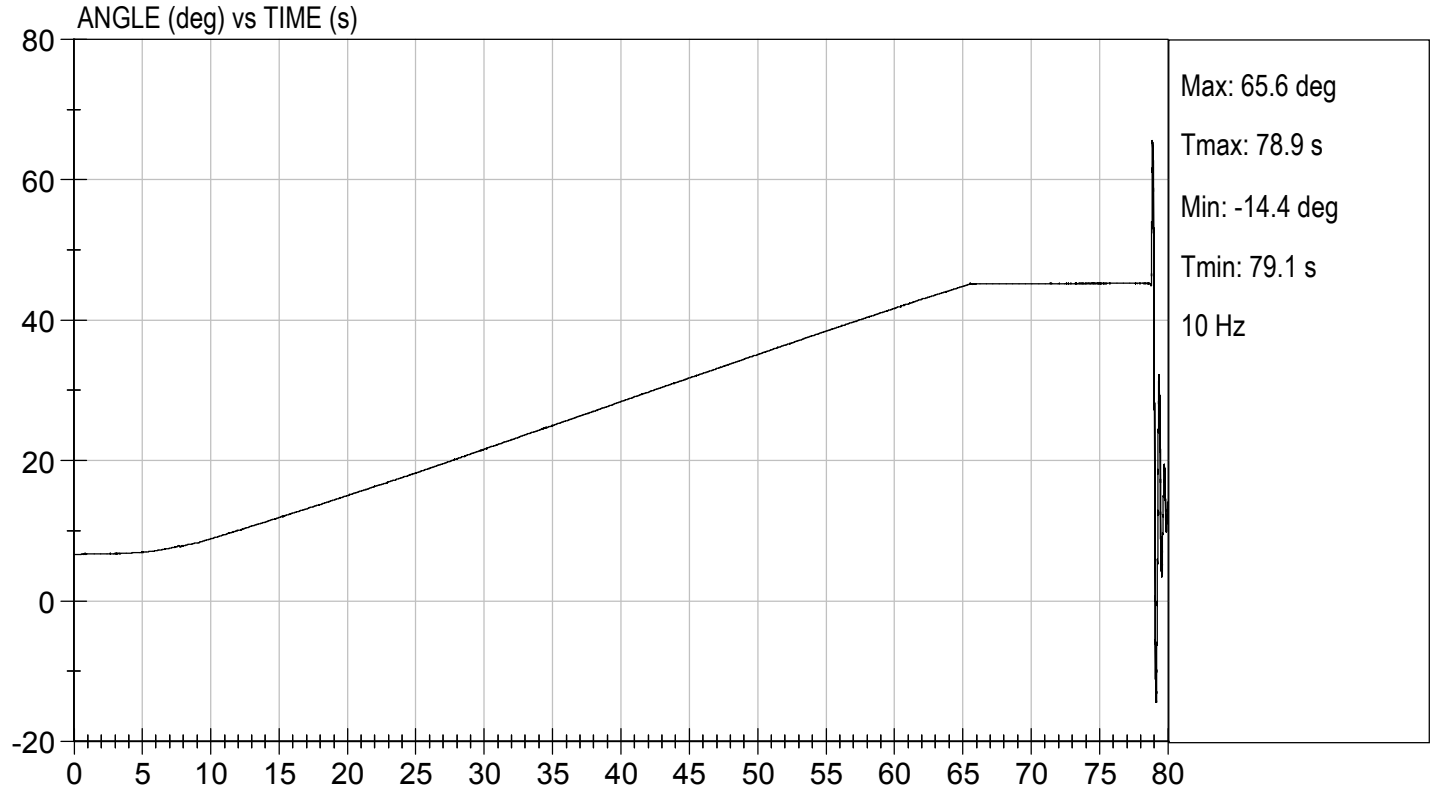
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Initial Angle	deg	0 to 15	7	Pass
Return Angle	deg	-10 to 10	5	Pass
Force at 45 deg	N	130 to 180	174	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
		Overall Test Results		Pass

Brian Roach
Laboratory Technician

02/02/2021
Test Date

Approved By


LOAD (N) vs TIME (s)
175
150
125
100
75
50
25
0
-25
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Max: 173.8 N
Tmax: 65.5 s
Min: -2.1 N
Tmin: 79.2 s
10 Hz


ANGLE (deg) vs TIME (s)
80
60
40
20
0
-20
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Max: 65.6 deg
Tmax: 78.9 s
Min: -14.4 deg
Tmin: 79.1 s
10 Hz

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:** D210471

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	24	Pass
Peak Resultant Acceleration	G's	250 to 280	271	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-6.3	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

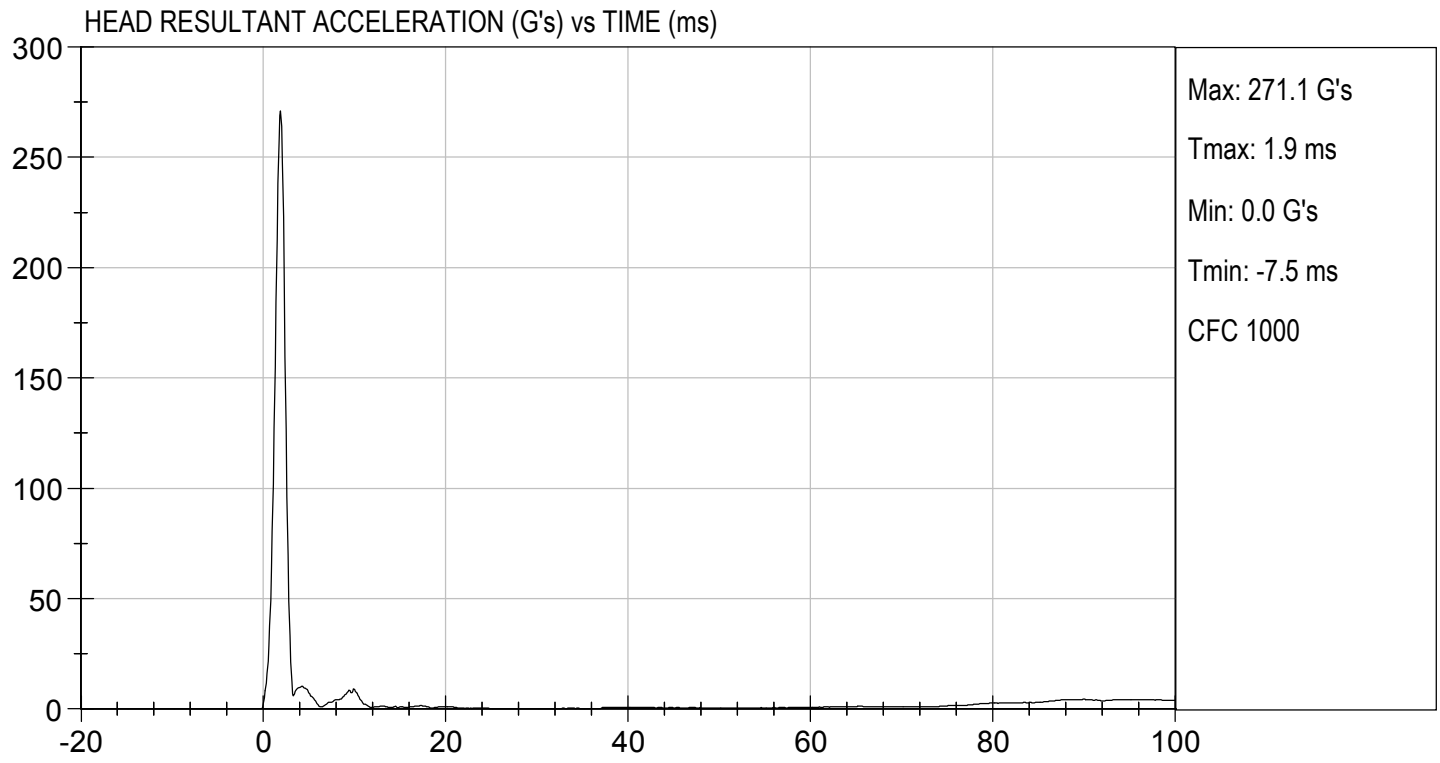
02/23/2021

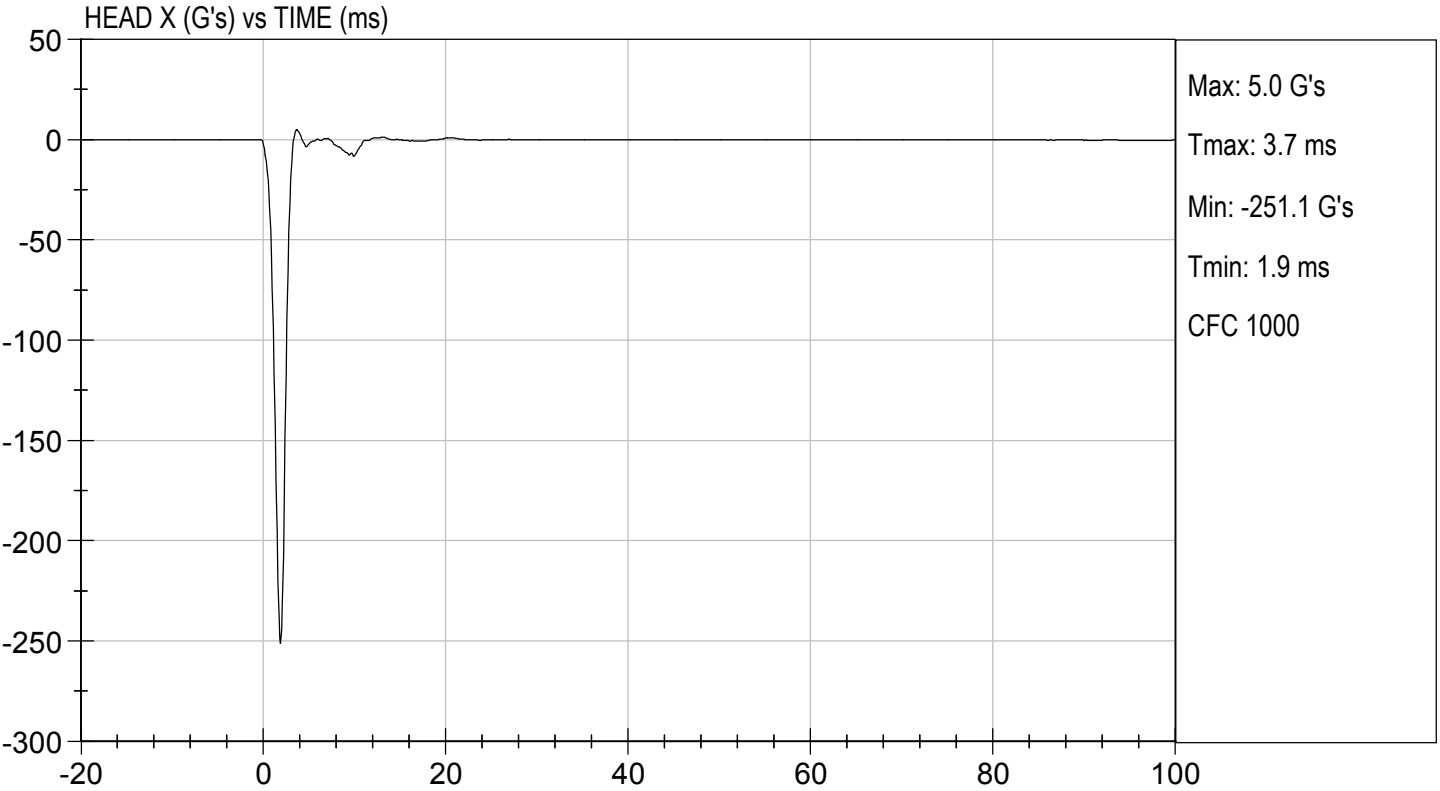
Test Date

Approved By

TEST DESC: HEAD DROP

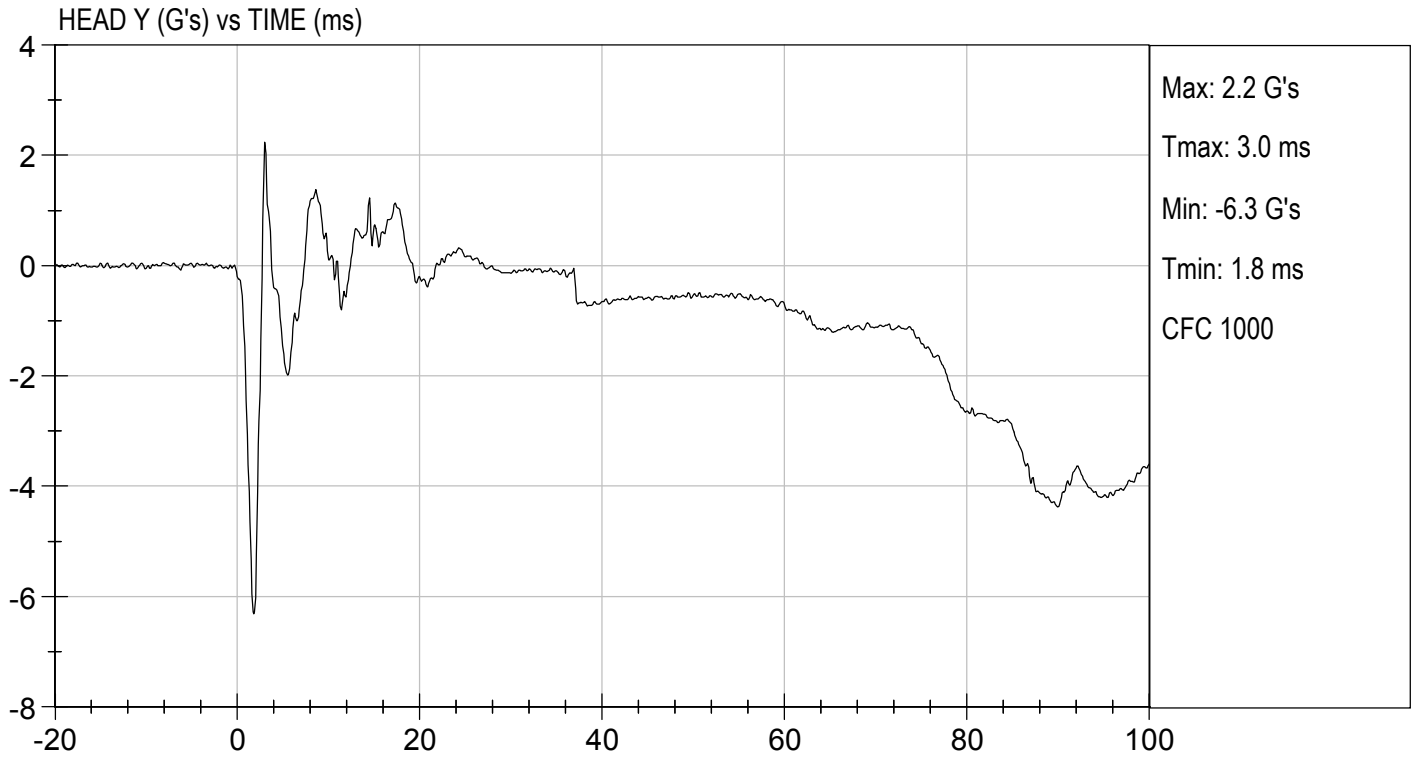
TEST DATE: 02/23/2021
TEST #: D210471

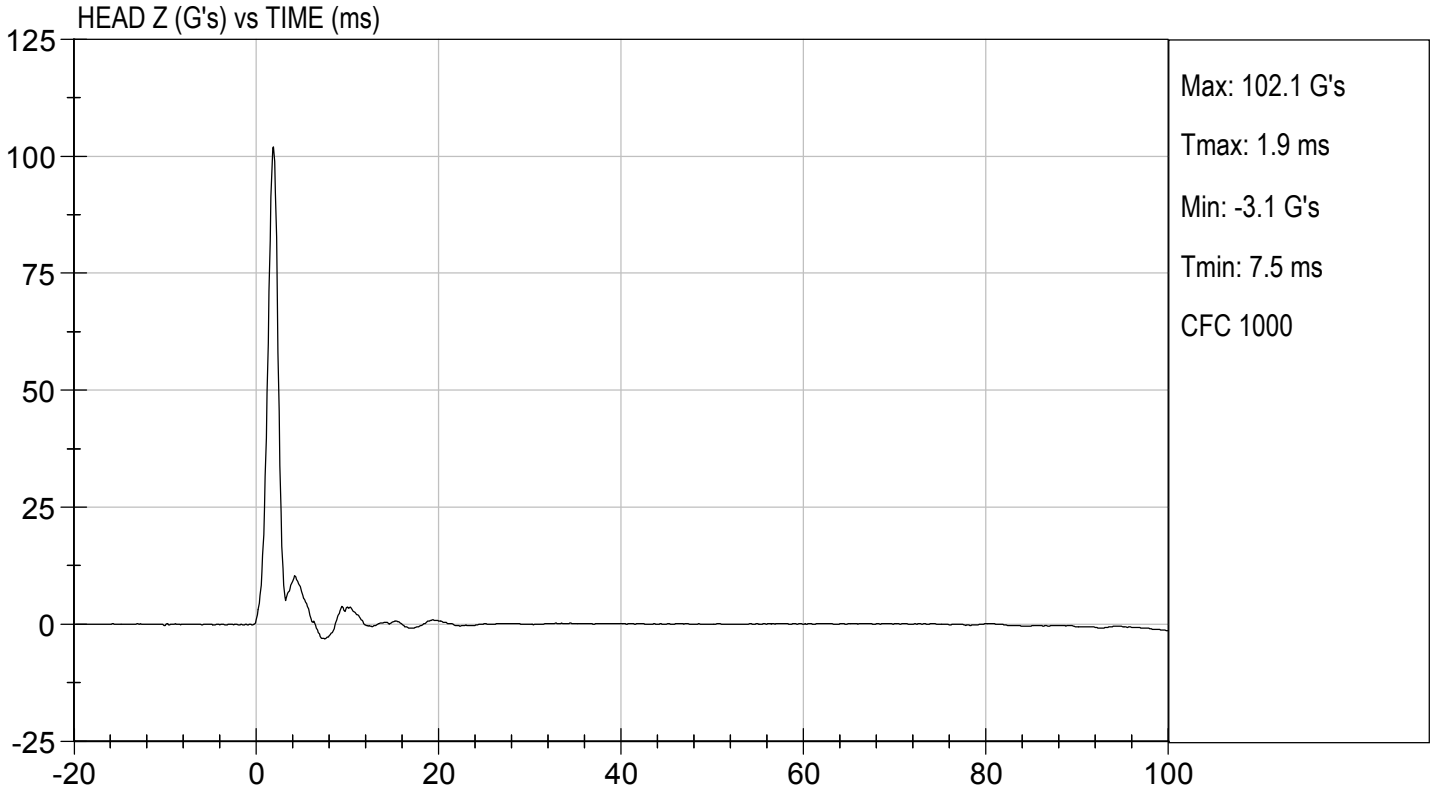




TEST DESC: HEAD DROP

TEST DATE: 02/23/2021
TEST #: D210471





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210472

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	22	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	42.6	Pass
Positive Moment - Time Curve Decay to 10 Nm		msec	60.0 to 80.0	67	Pass
			Overall Test Results		Pass

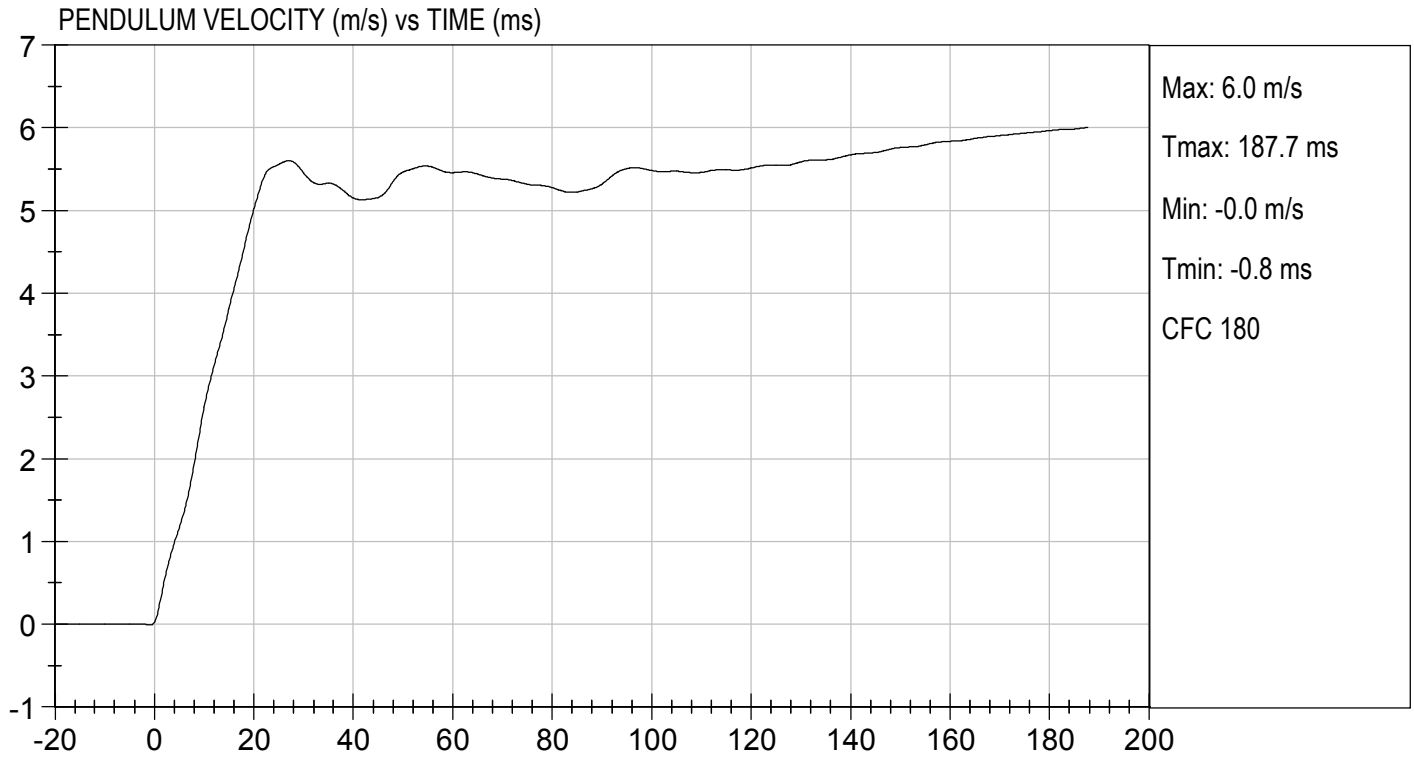
Brian Roach
Laboratory Technician

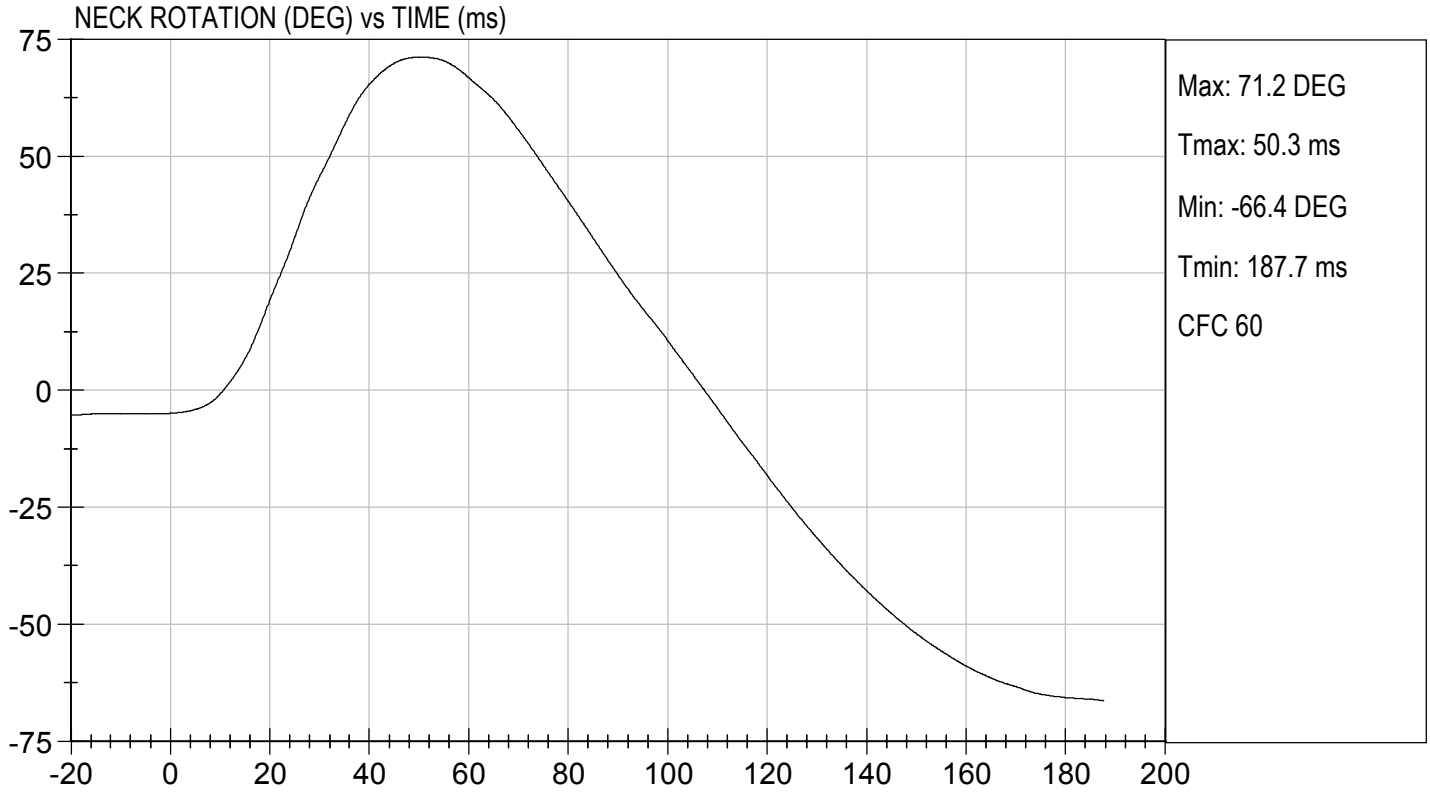
02/22/2021
Test Date

Approved By

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

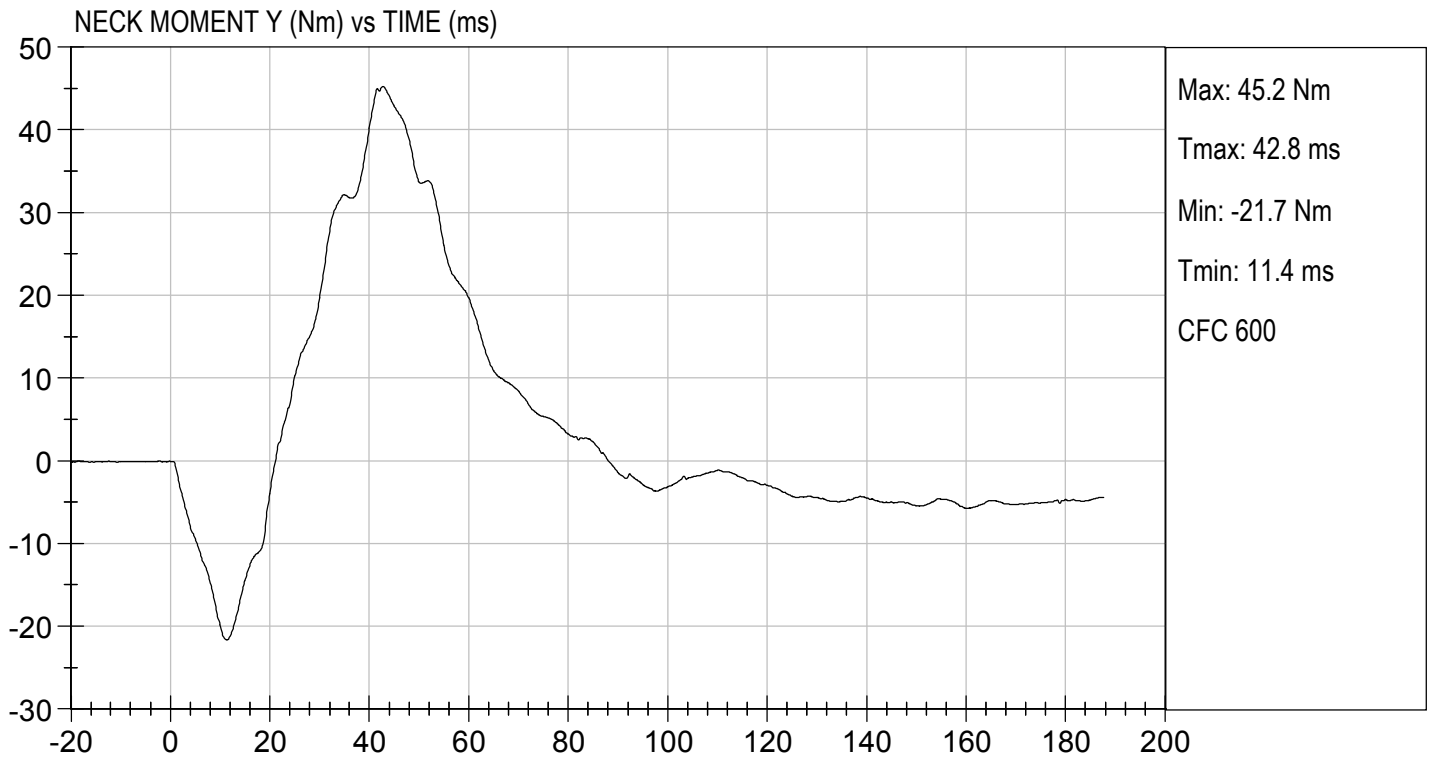
TEST DATE: 02/22/2021
TEST #: D210472





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

TEST DATE: 02/22/2021
TEST #: D210472



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210473

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	22	Pass
Pendulum Speed		m/s	3.55 to 3.75	3.73	Pass
Pendulum Velocity	6 ms	m/s	1.0 to 1.4	1.3	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	68	Pass
			Overall Test Results		Pass

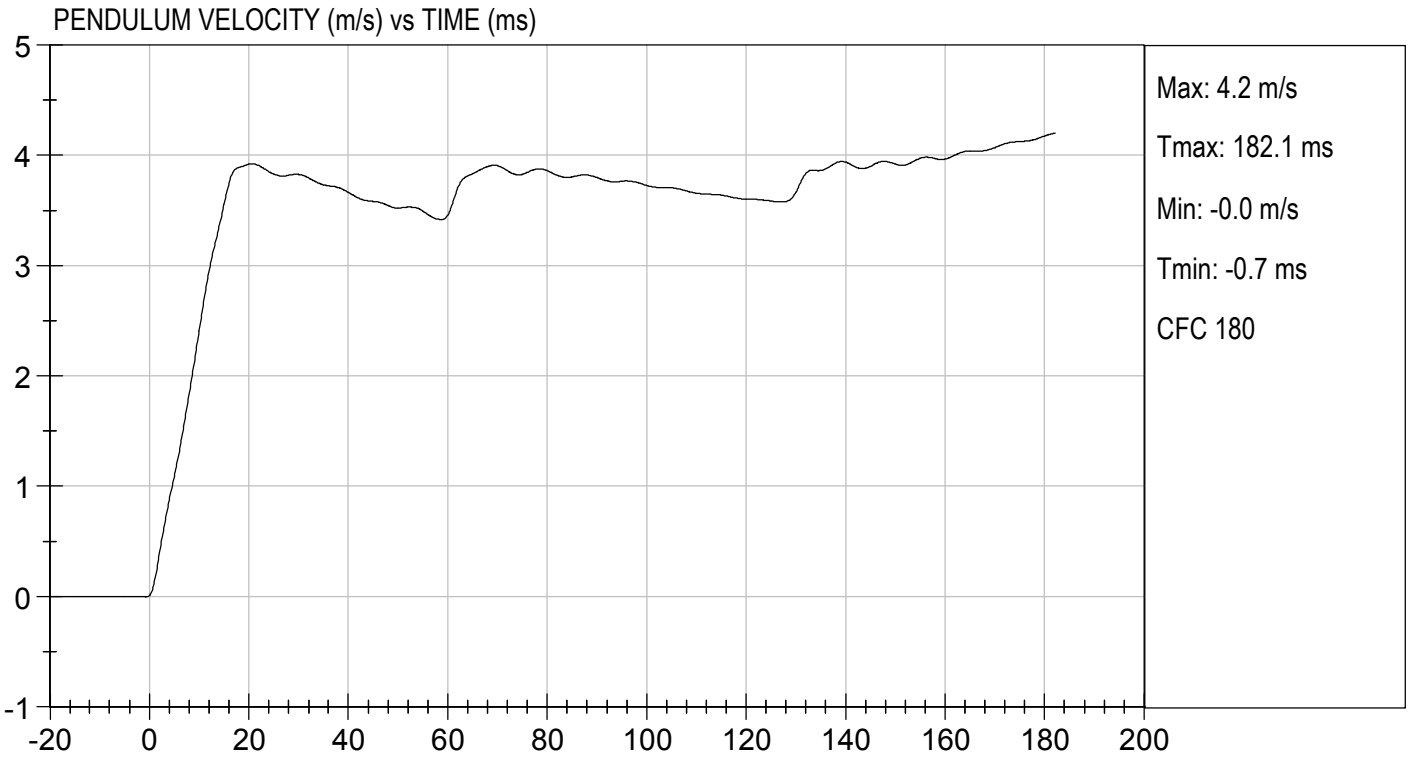
Brian Roach
Laboratory Technician

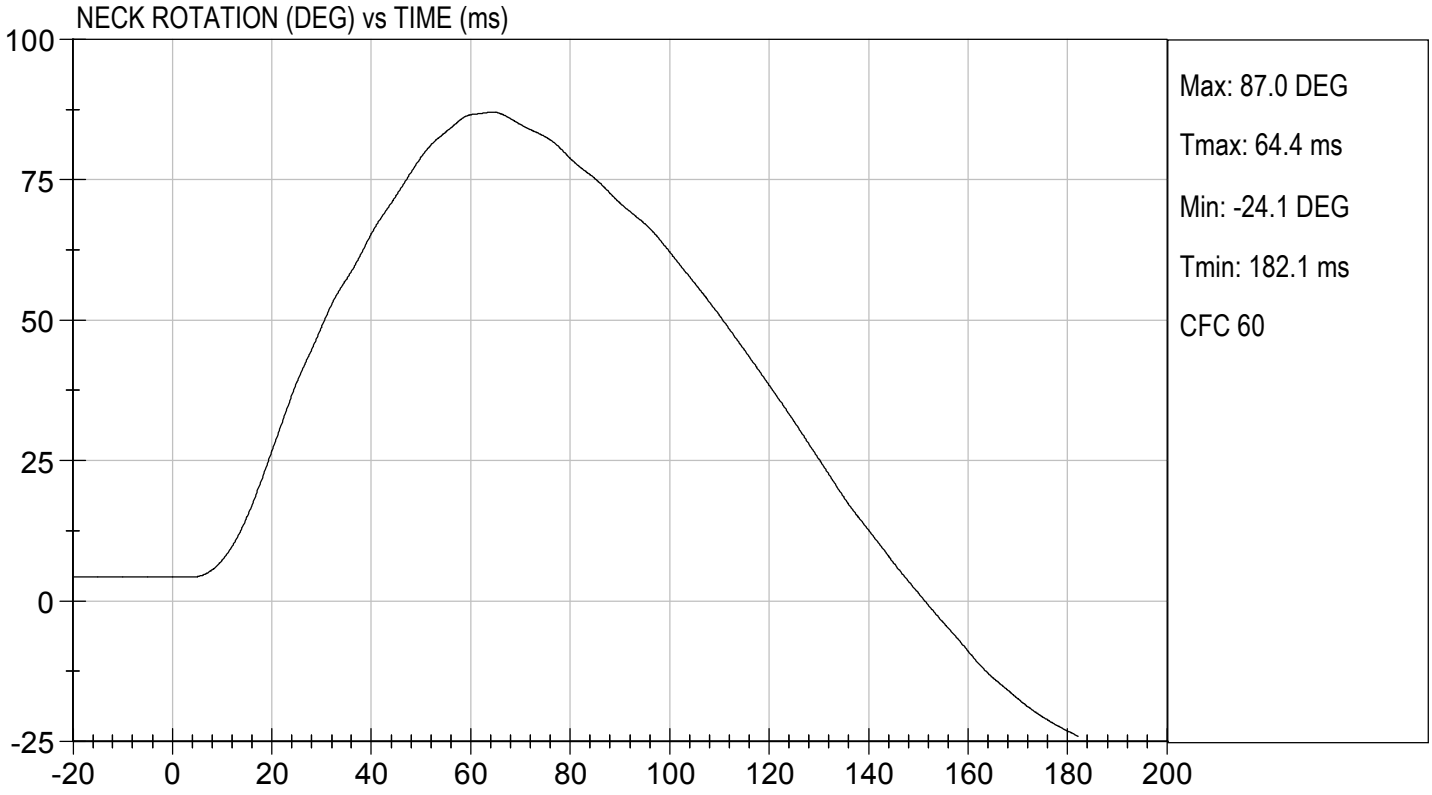
02/22/2021
Test Date

Approved By

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

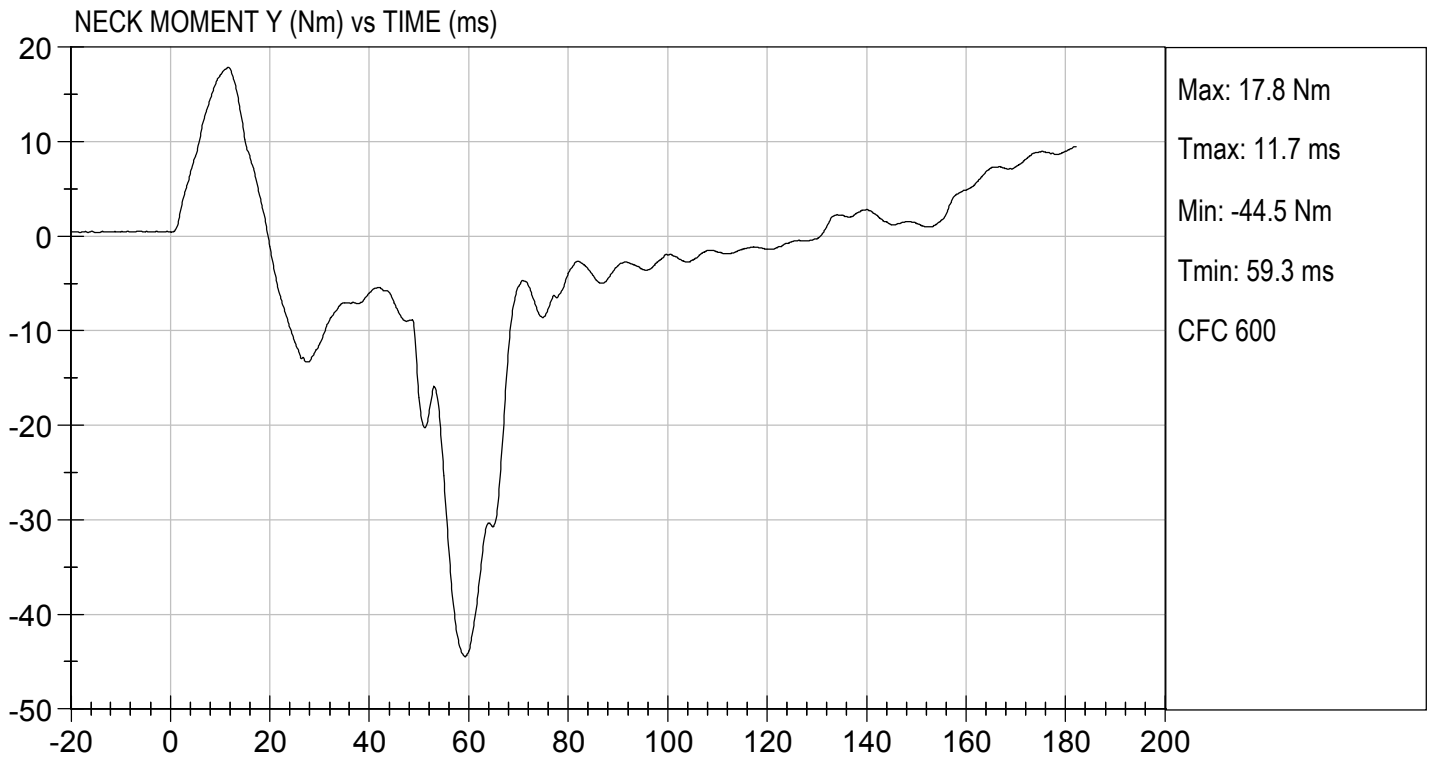
TEST DATE: 02/22/2021
TEST #: D210473





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

TEST DATE: 02/22/2021
TEST #: D210473



MGA RESEARCH CORPORATION

THORAX IMPACT TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D210474

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	22	Pass
Probe Velocity	m/s	5.9 to 6.1	5.98	Pass
Peak Deflection	mm	32 to 38	35.8	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	738	Pass
Internal Hysteresis	%	65 to 85	74.4	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	773	Pass
		Overall Test Results		Pass

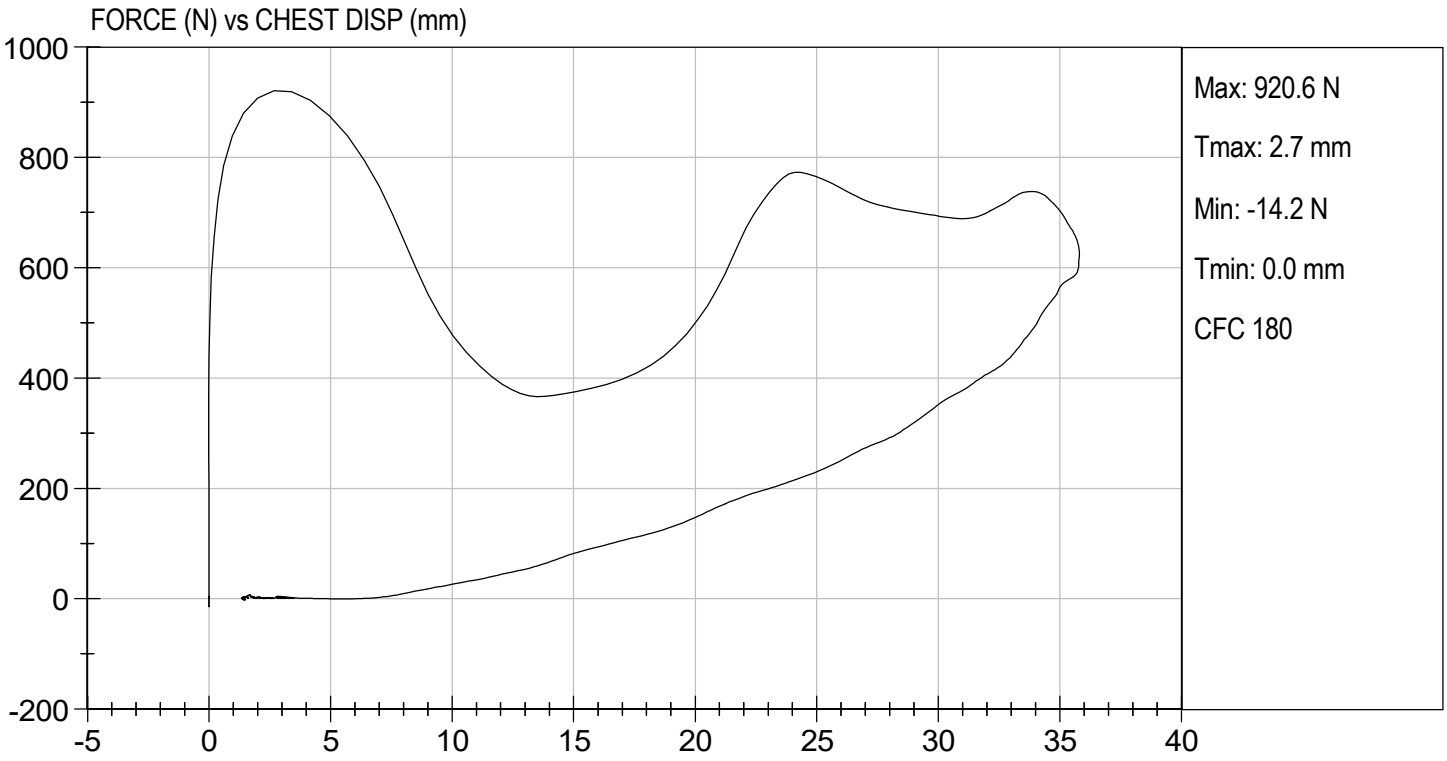
Brian Roach
Laboratory Technician

02/22/2021
Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 19.61 ft/s, 5.98 m/s

TEST DATE: 02/22/2021
TEST #: D210474



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 3 YEAR OLD

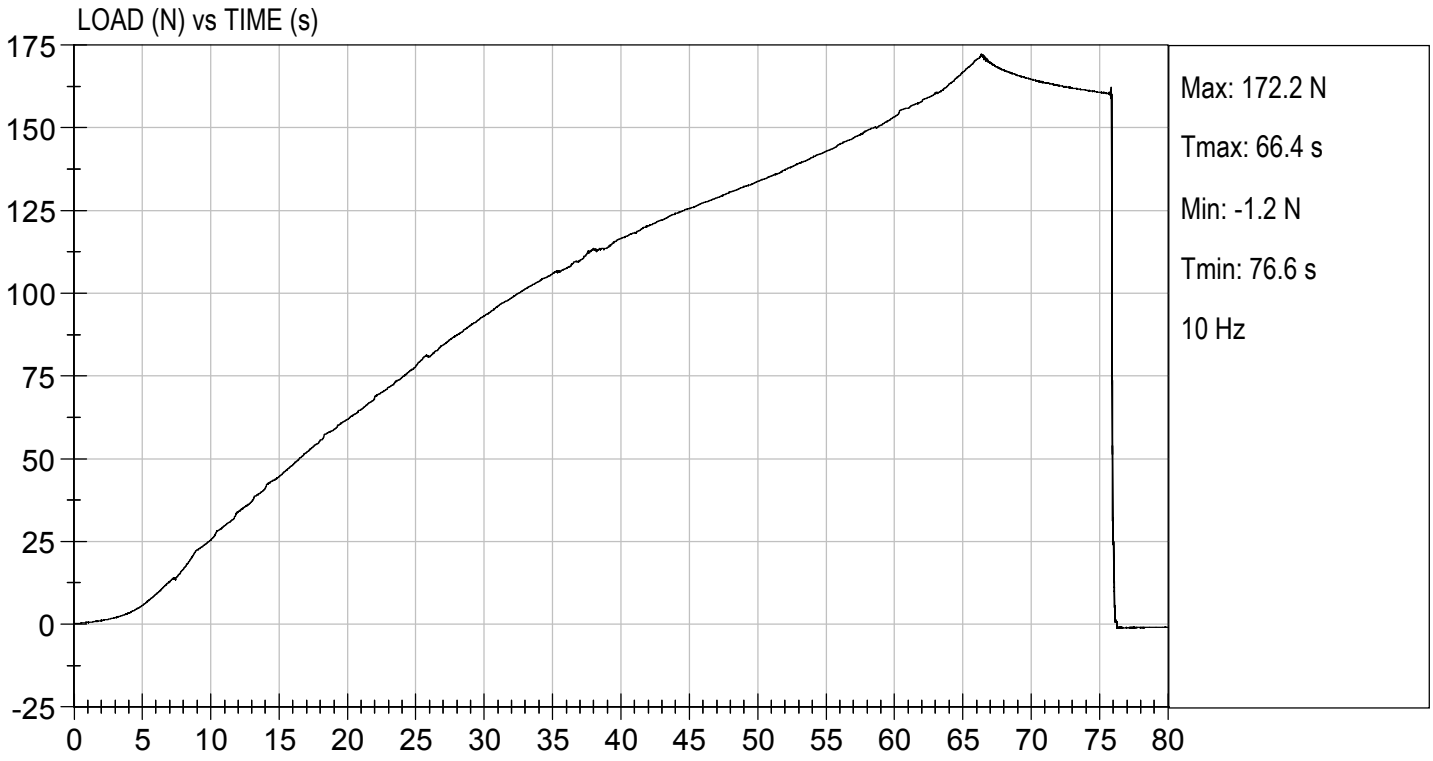
ATD Serial No: 082 **Test I.D:** D210477

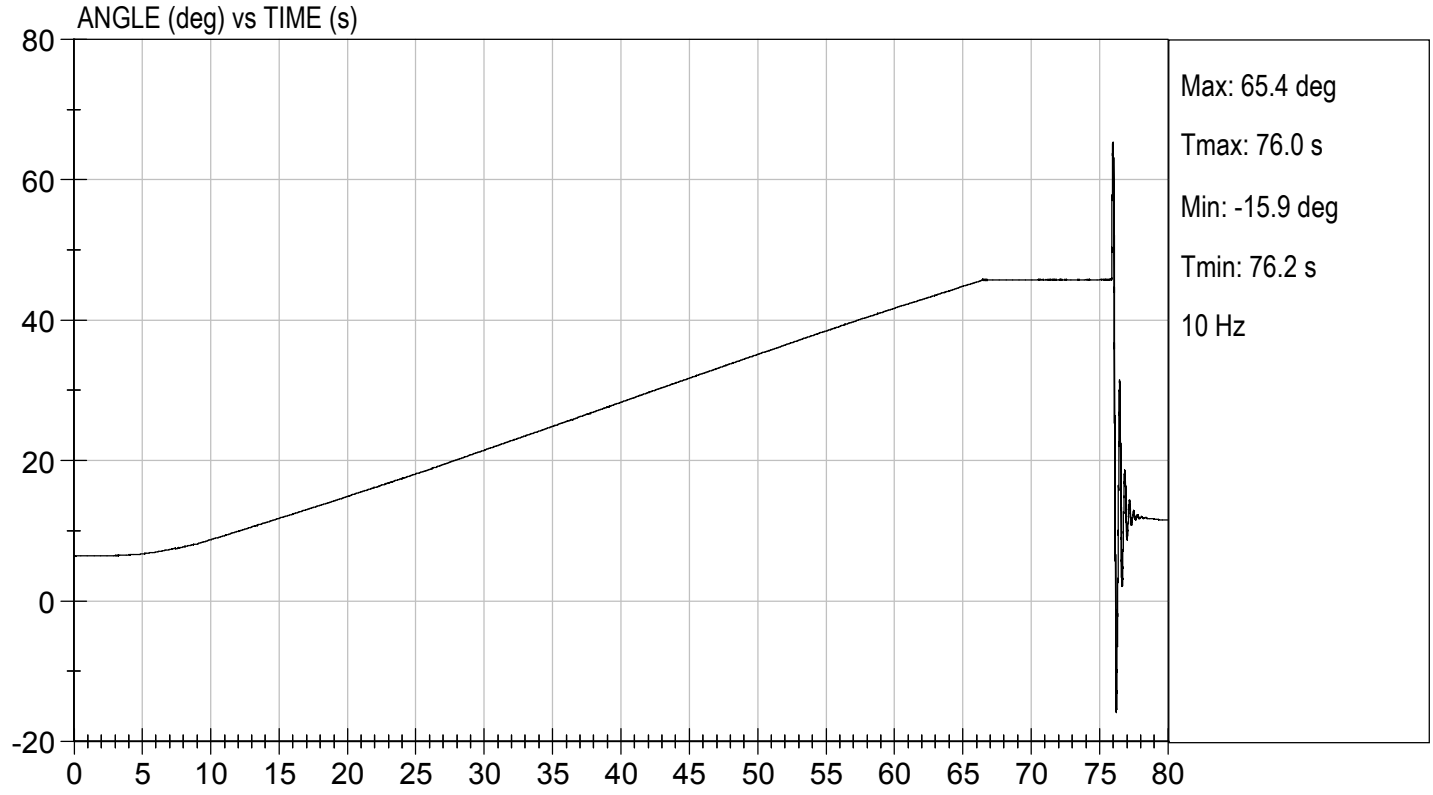
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Initial Angle	deg	0 to 15	6	Pass
Return Angle	deg	-10 to 10	4	Pass
Force at 45 deg	N	130 to 180	172	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
		Overall Test Results		Pass

Brian Roach
Laboratory Technician

02/22/2021
Test Date

Approved By


LOAD (N) vs TIME (s)
175
150
125
100
75
50
25
0
-25
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Max: 172.2 N
Tmax: 66.4 s
Min: -1.2 N
Tmin: 76.6 s
10 Hz


ANGLE (deg) vs TIME (s)
80
60
40
20
0
-20
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Max: 65.4 deg
Tmax: 76.0 s
Min: -15.9 deg
Tmin: 76.2 s
10 Hz

APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation

		HIII 3YO S/N 082		
		Serial Number	Manufacturer	Calibration Date
Head CG Accelerometers	X	P96870	Endevco	09/28/2020
	Y	P97374	Endevco	09/28/2020
	Z	P97383	Endevco	09/28/2020
Upper Neck Load Cell		NG249	Denton	07/17/2020
Lower Neck Load Cell		NG124	Denton	07/17/2020