mga research corporation

REPORT NUMBER: TWG-MGA-2018-001

SIDE AIRBAG OUT-OF-POSITION INJURY
TECHNICAL WORKING GROUP

BAYERISCHE MOTOREN WERKE AG
2018 BMW X1 sDrive28i 5-Door SUV
NHTSA No.: M20184102TWG2

Test Date: September 24, 2018

Final Report Date: April 1, 2019

FINAL REPORT

PREPARED BY:
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Approval Date: April 1, 2019

FINAL REPORT ACCEPTANCE BY:

_____

Date: _____

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

TECHNICAL REPORT DOCUMENTATION PAGE

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7. Author(s) Ben Fischer, Project Engineer		*8. Performing Organization Report No.* TWG-MGA-2018-001
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12. Sponsoring Agency Name and Address United States Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards (NRM-110) 1200 New Jersey Ave, SE, Room W43-410 Washington, DC 20590		*13. Type of Report and Period Covered:* Final Test Report September 24, 2018 to April 1, 2019 *14. Sponsoring Agency Code* NRM-110
15. Supplementary Notes		

16. Abstract

A Side Airbag Out-of-Position Injury evaluation was conducted on the subject 2018 BMW X1 Drive28i 5-Door SUV 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 September 24, 2018.

Injury Summary (3-Year-Old Out-Of-Position)

HIC15	Maximum Chest Displacement (mm)	Maximum Chest Displacement Rate m/s)	Nij (NTF)	Nij (NTE)	Nij (NCF)	Nij (NCE)
27.657			0.15	0.07	0.83	0.13

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 e-mail: tis@nhtsa.dot.gov FAX: 202-493-2833	
19. Security Classification of Report Unclassified	*20. Security Classification of Page* Unclassified	*21. No. of Pages* 63	22. Price

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SECTION 1
PURPOSE AND SUMMARY OF TEST

PURPOSE

The purpose of this test was to obtain data in a static out-of-position side air bag deployment. These data constitute part of the general consumer information collected by Alpha Technology Associate, Inc.

SUMMARY

The effects of both a curtain and torso airbag deployment in a 2018 BMW X1 sDrive28i 5-Door SUV 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 September 24, 2018. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Three high-speed cameras (1000 fps) were used to document the side airbag deployment event. The following camera locations were used:

- Left Side Through Removed Driver Door
- Front Through Windshield
- Left Side ¾ View Through Windshield

One Hybrid III 3-Year-Old child dummy (Serial Number 082) was placed in the right front passenger seat lying on the seat 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 15 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:

- Torso/pelvis airbag to top and left side of head

The Hybrid III 3-Year-Old child dummy was placed in the right front passenger 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 was aligned with the vertical centerline of the side airbag module. The door/side trim did not interfere with the placement of the dummy's head. No foam blocks were placed under the dummy's legs.

The dummy's skullcap seam was taped 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 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1

TEST SUMMARY

	Test Data	Description
Seating Position	P2	Right Front Seating Position
Test	3.3.3.4*	Lying Child Dummy
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 / 082	Child Dummy

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

Number of Data Channels	15
Number of Airbag Channels	4
Number of High-Speed Video	3

Visible Dummy Contact Points	
Head Contact	Torso/Pelvis Airbag to Top and Left Side of Head
Left Shoulder Contact	None
Left Torso Contact	None
Left Pelvis Contact	None

DATA SHEET NO. 2

TEST VEHICLE INFORMATION

Please note that this vehicle had previously been tested in an NCAP Side Impact on December 1, 2017.

TEST VEHICLE INFORMATION

Manufacturer	BMW
Model	X1 sDrive28i
Body Style	5-Door SUV
NHTSA No.	M20184102TWG2
VIN	WBXHU7C31J5H40320
Color	Sunset Orange Metallic
Delivery Date	11/6/2017
Odometer Reading	61 miles
Dealer	-
Transmission	Automatic
Final Drive	FWD
Number of Cylinders	4
Engine Displacement	2.0 L
Engine Placement	Lateral
Automatic Door Lock (ADL)	Yes
Owner's Manual Details Instructions on Disabling ADLs	Yes
Bucket Seats	Yes

TEST VEHICLE OPTIONS

Driver Front Airbag	Yes
Driver Side Curtain Airbag	Yes
Driver Side Torso Airbag	No
Driver Side Torso/Pelvis Airbag	Yes
Rear Pass. Side Curtain Airbag	Yes
Rear Pass. Side Torso Airbag	No
Rear Pass. Side Torso/Pelvis Airbag	No
Force Limiter	Yes
Pretensioner	Yes
Power Steering	Yes
Power Door Locks	Yes
Tilt Wheel	Yes
Air Conditioning	Yes
Anti-lock Brakes	Yes
Traction Control	Yes
All-Wheel Drive	No
Power Seats	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	BAYERISCHE MOTOREN WERKE AG
Date of Manufacture	09/17

GVWR (kg)	2075
GAWR Front (kg)	1090
GAWR Rear (kg)	1035

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Split Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				408
Cargo Wt. (RCLW) (kg)				68

DATA SHEET NO. 3

DUMMY POSITIONING IN VEHICLE

Measurement		Value
Seat Position (from forward-most)		190 of 190mm
Seat Height Position		Lowest Height
Placed in Position No. 2		-
Seat Back Angle (at seatback centerline)	SA (°)	23.0
Top of Curtain Airbag Module to Head/Neck Junction	AN (mm)	907
Top of Seat Airbag Module to Head/Neck Junction	AN (mm)	380
Head CG to Door Panel	HD (mm)	80
Head to Seat Back Centerline	HSC (mm)	230
Chest to Dash	CD (mm)	674
Chest to Seatback	CS (mm)	181
Right Arm to Seat Back Centerline	RACL (mm)	-
Left Arm to Seat Back Centerline	LACL (mm)	-
Right Arm to Door Panel	RA (mm)	199
Left Arm to Door Panel	LA (mm)	215
Knee to Knee	KK (mm)	91
Toe to Toe	TT (mm)	80
Right Knee to Seat Cushion Centerline	KSCR (mm)	310
Left Knee to Seat Cushion Centerline	KSCL (mm)	324
Right Toe to Seat Cushion Centerline	TSCR (mm)	600
Left Toe to Seat Cushion Centerline	TSCL (mm)	614
Nose to Front Seatback	ND (mm)	670
Nose to Seatback	NS (mm)	145
Top of Head to Headliner	HH (mm)	740

DATA SHEET NO. 4

DUMMY INJURY CRITERIA VALUES

NHTSA No. M20184102TWG2

		Position No. 2			
DESCRIPTION	UNIT	MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Head X	g	12.4	21.8	-21.5	12.5
Head Y	g	44.0	12.4	-17.8	25.4
Head Z	g	27.1	11.5	-7.2	48.6
Head Resultant	g	52.3	12.4		
Upper Neck Fx	N	195.3	15.4	-119.1	30.3
Upper Neck Fy	N	79.8	36.3	-226.8	15.9
Upper Neck Fz	N	33.0	252.3	1366.0	15.7
Upper Neck F Resultant	N	1397.4	15.7		
Upper Neck Mx	Nm	7.0	30.8	-5.1	20.3
Upper Neck My	Nm	14.3	18.4	-1.7	133.9
Upper Neck Mz	Nm	1.5	284.6	-4.5	31.1
Upper Neck M Resultant	Nm	14.9	19.2		
Lower Neck Fx	N	154.2	19.5	-57.7	32.9
Lower Neck Fy	N	38.0	36.3	-132.4	16.6
Lower Neck Fz	N	30.4	257.3	-1322.0	15.7
Lower Neck F Resultant	N	1331.8	15.7		
Lower Neck Mx	Nm	14.1	36.6	-18.2	17.1
Lower Neck My	Nm	13.5	33.5	-6.5	16.9
Lower Neck Mz	Nm	1.5	284.0	-3.2	30.9
Lower Neck M Resultant	Nm	19.4	17.1		

DATA SHEET NO. 4 (continued)

DUMMY INJURY CRITERIA VALUES

NHTSA No. M20184102TWG2

Head Injury Summary (3-Year-Old Out-Of-Position)

	HEAD INJURY CRITERIA (HIC)					
	HIC15			HIC36		
ATD position	HIC	T^1 (msec)	T^2 (msec)	HIC	T^1 (msec)	T^2 (msec)
No. 082 Right Front	27.657	9.3	14.8	30.904	9.1	29.6

Neck Injury Summary (3-Year-Old Out-Of-Position)

	Nij	Time (msec)	Z Force (N) (CFC 600)	X Force (N) (CFC 600)	Y Moment (N-m) (CFC 600)
Ntf	0.15	39.0	8.4	-6.9	9.7
Nte	0.07	133.9	9.1	20.6	-1.7
Ncf	0.83	16.1	-1357.3	188.5	13.3
Nce	0.13	10.1	-264.4	28.0	0.0
Peak Tension (CFC1000)		**33.0 N**	**Peak Compression (CFC 1000)**		**-1366.0 N**

Critical Values

Nij Intercepts				Peak Limits	
Tension (CVt)	2120 N	Extension (mCVe)	27 N-m	Tension	1130 N
Compression (CVc)	2120 N	Flexion (mCVf)	68 N-m	Compression	1380 N

APPENDIX A

PHOTOGRAPHS

TABLE OF 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

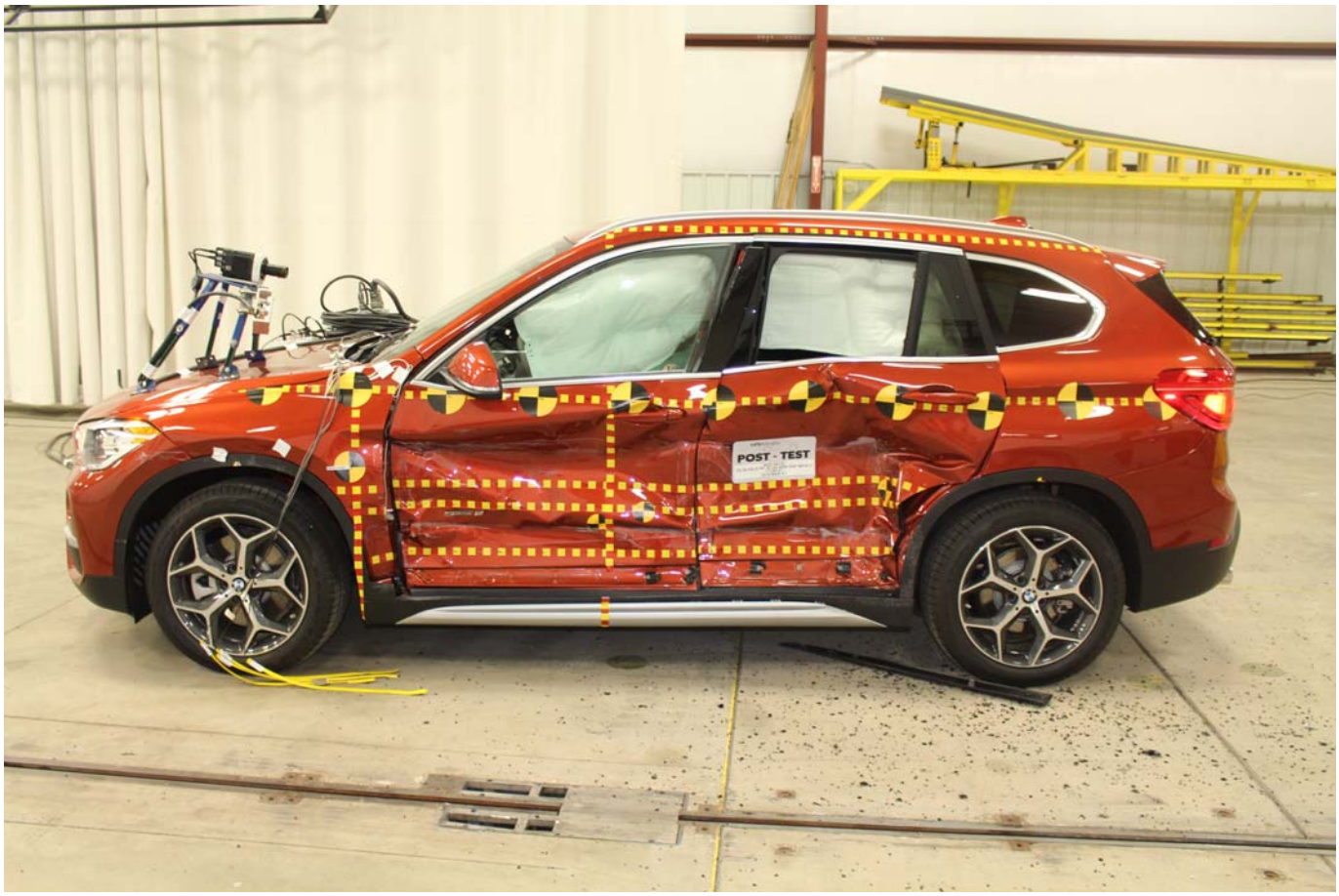


Photo No. 004 - Post-Test Vehicle Left Side View

Photo No. 005 - Pre-Test 3-Year-Old Child Dummy Left Side View

Photo No. 006 - Post-Test 3-Year-Old Child Dummy Left Side View

Photo No. 007 - Pre-Test 3-Year-Old Child Dummy Left Side Close-Up View

Photo No. 008 - Post-Test 3-Year-Old Child Dummy Left Side Close-Up View

Photo No. 009 - Pre-Test 3-Year-Old Child Dummy Left Three-Quarter Front View

Photo No. 010 - Post-Test 3-Year-Old Child Dummy Left Three-Quarter Front View

Photo No. 011 - Pre-Test 3-Year-Old Child Dummy Left Three-Quarter Front Close-Up View

Photo No. 012 - Post-Test 3-Year-Old Child Dummy Left Three-Quarter Front Close-Up View

Photo No. 013 - Pre-Test 3-Year-Old Child Dummy Front View

Photo No. 014 - Post-Test 3-Year-Old Child Dummy Front View

Photo No. 015 - Pre-Test 3-Year-Old Child Dummy Front Close-Up View

Photo No. 016 - Post-Test 3-Year-Old Child Dummy Front Close-Up View

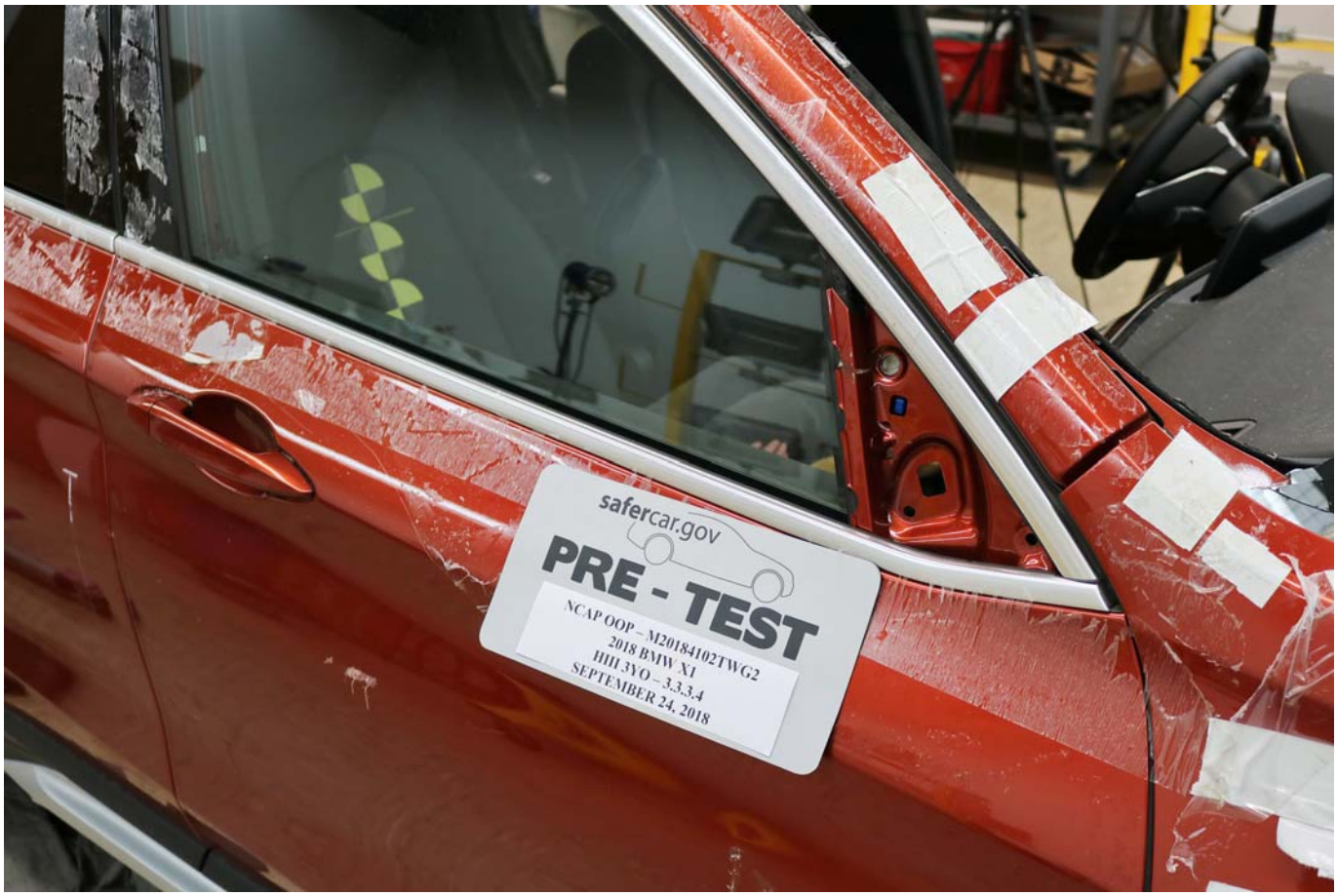


Photo No. 017 - Pre-Test 3-Year-Old Child Dummy Right Three-Quarter Front View

Photo No. 018 - Post-Test 3-Year-Old Child Dummy Right Three-Quarter Front View

Photo No. 019 - Pre-Test 3-Year-Old Child Dummy Right Side View

Photo No. 020 - Post-Test 3-Year-Old Child Dummy Right Side View

Photo No. 021 - Post-Test 3-Year-Old Child 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

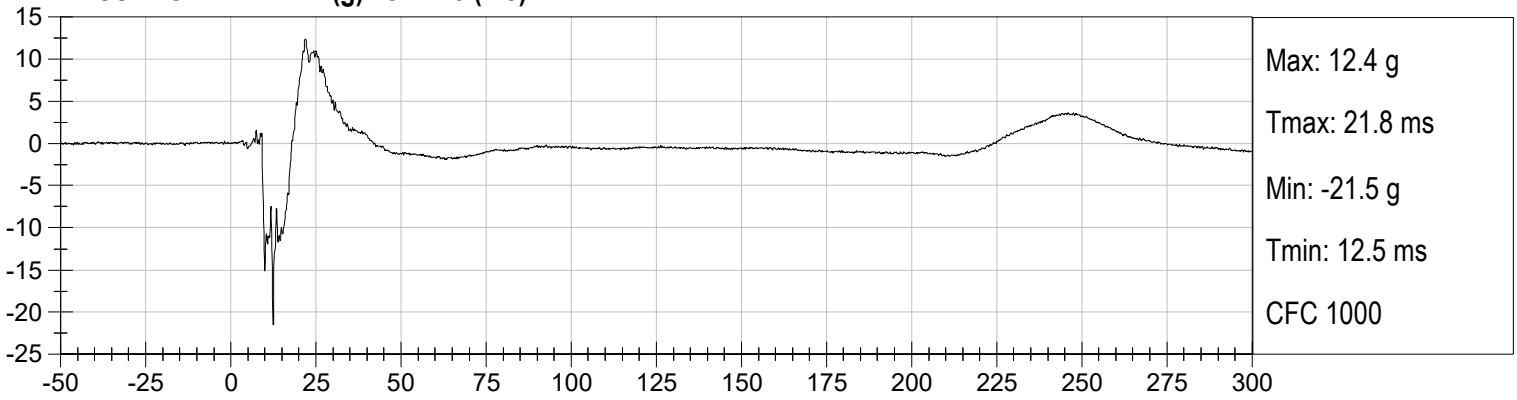
Photo No. 025 - Post-Test Curtain Airbag Right Side View (Door Open)

APPENDIX B

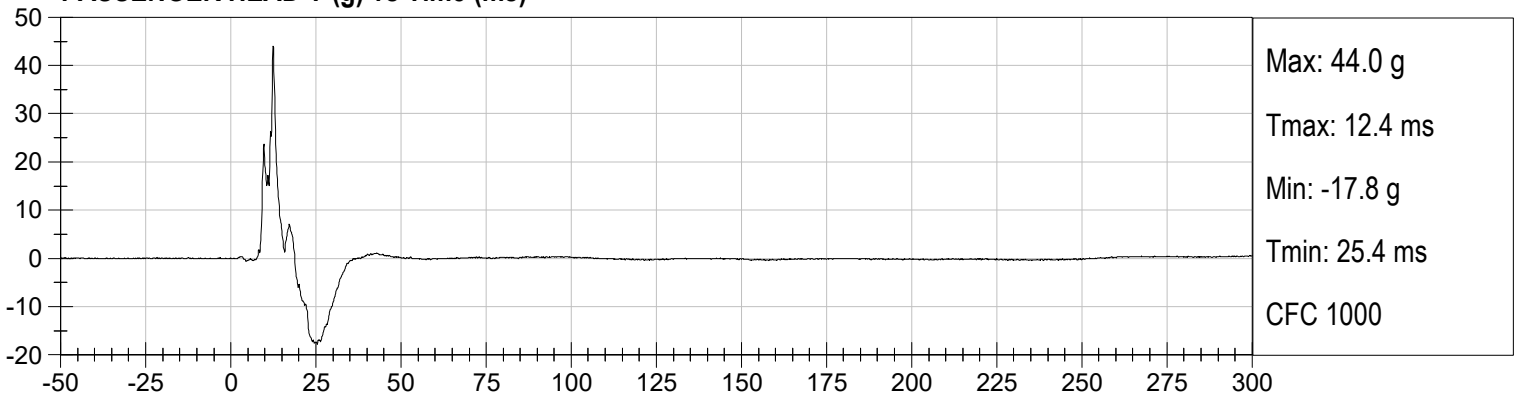
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

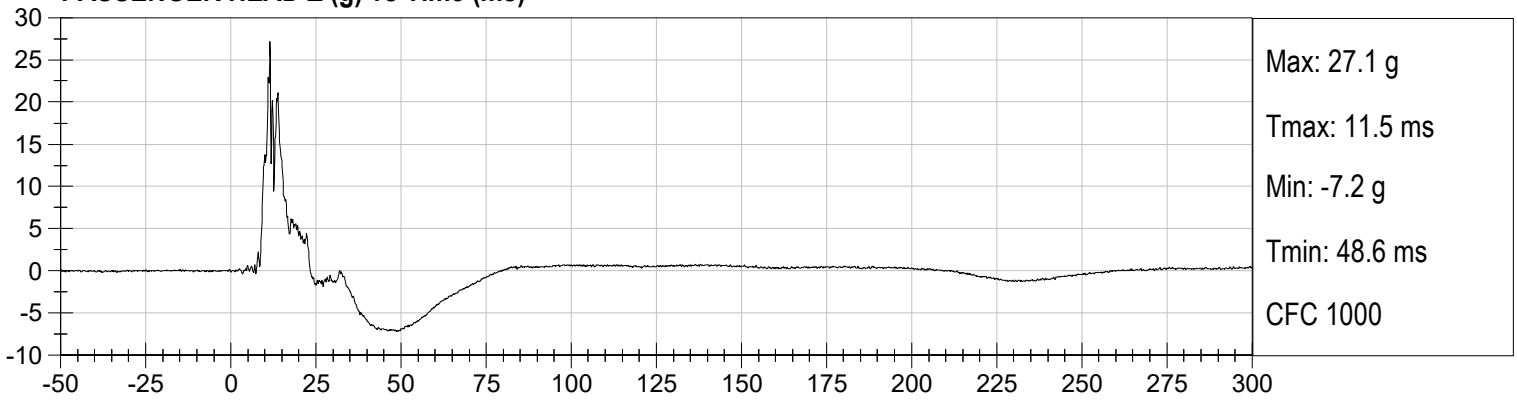
PASSENGER HEAD X (g) vs Time (ms)



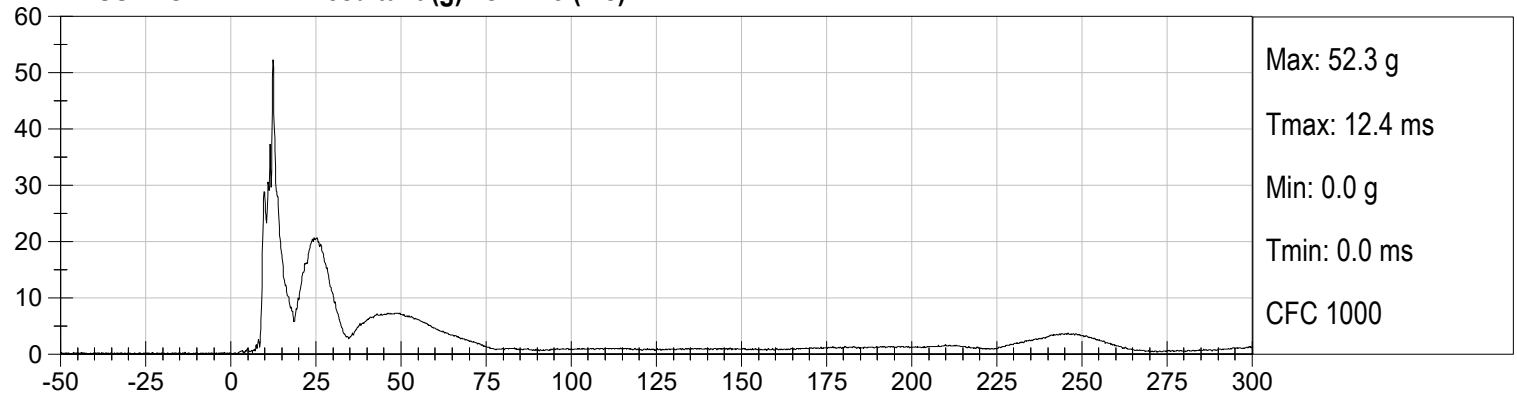
PASSENGER HEAD Y (g) vs Time (ms)



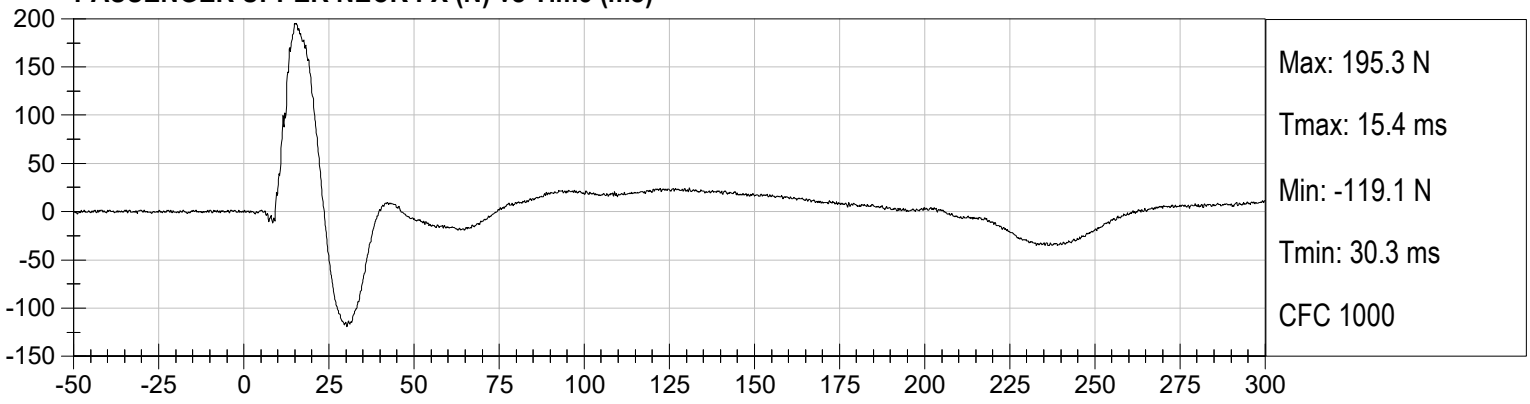
PASSENGER HEAD Z (g) vs Time (ms)



PASSENGER HEAD Resultant (g) vs Time (ms)



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



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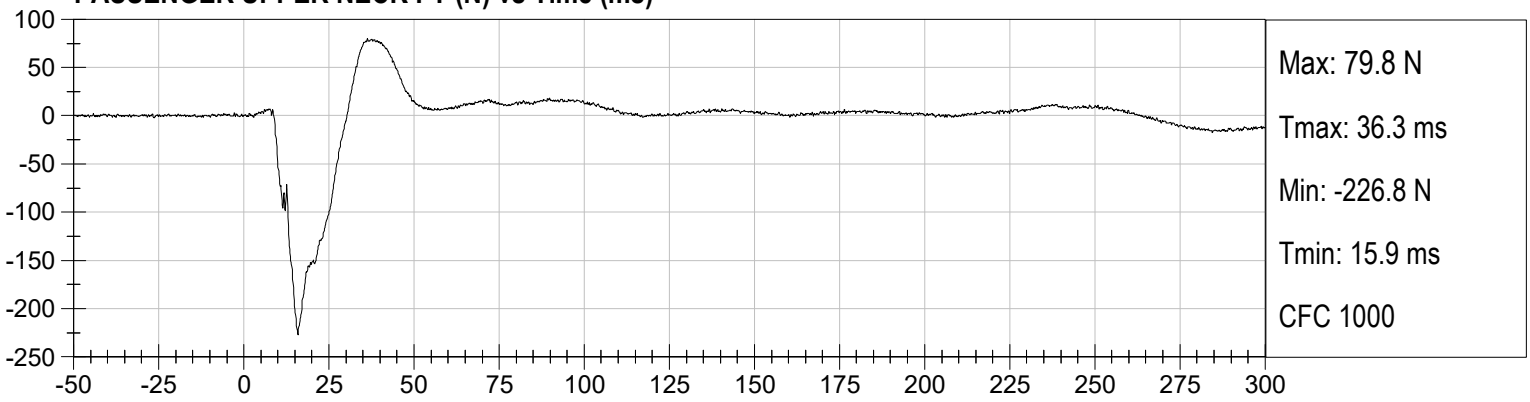
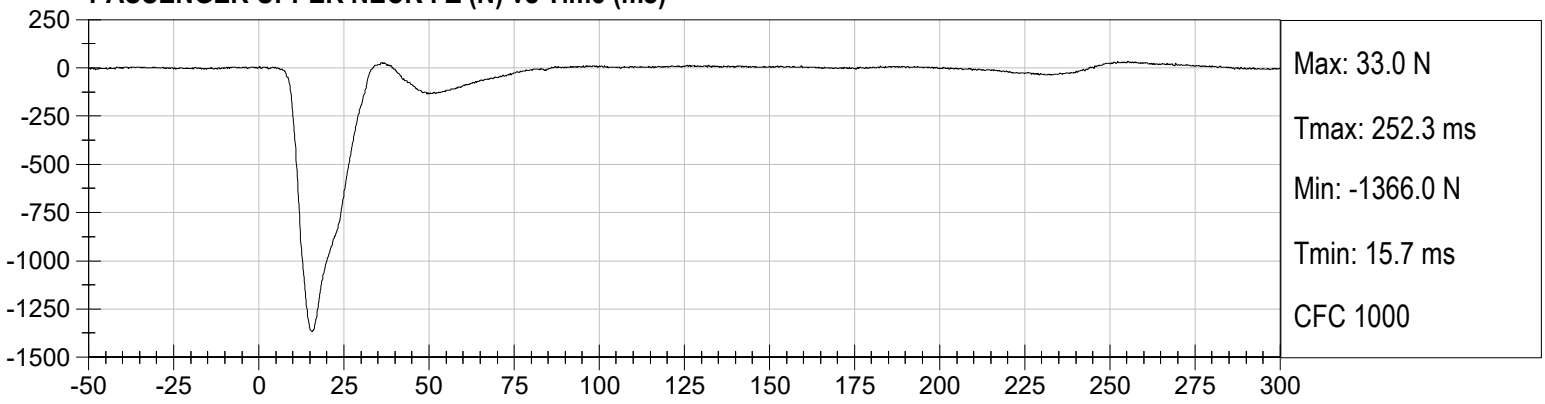
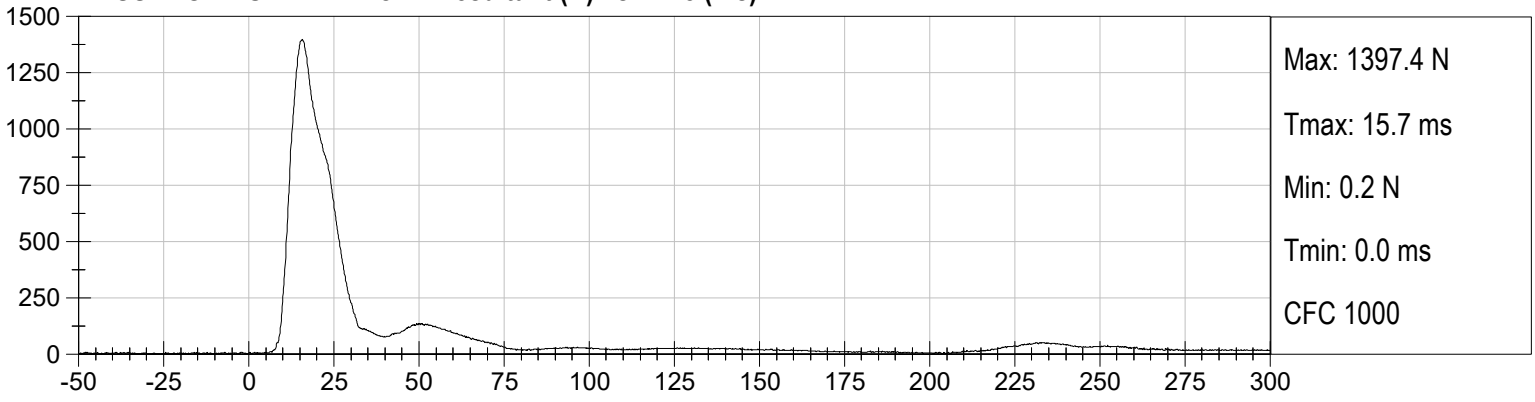


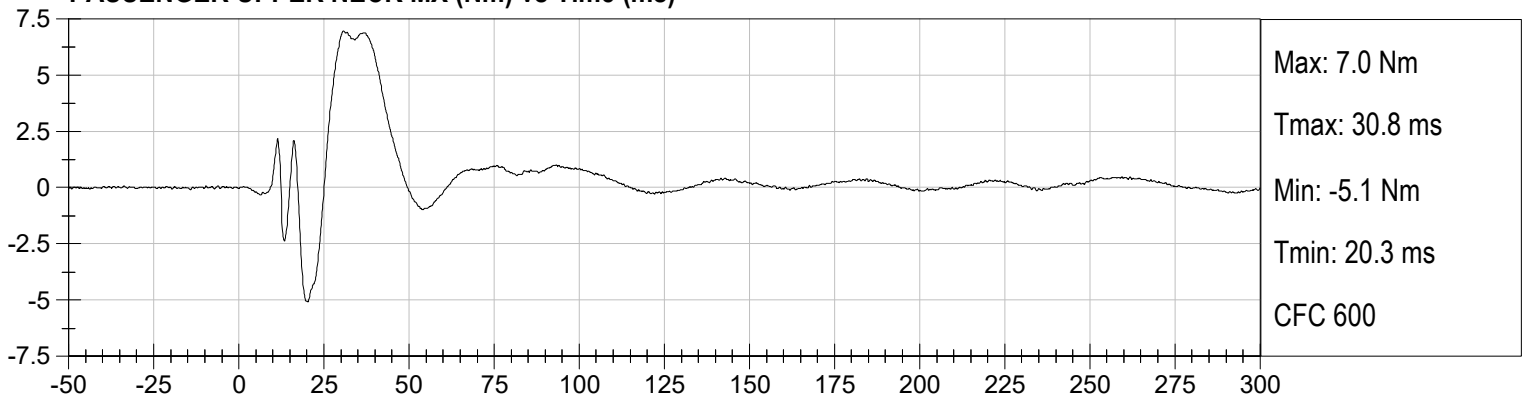
PASSENGER UPPER NECK FZ (N) vs Time (ms)



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



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



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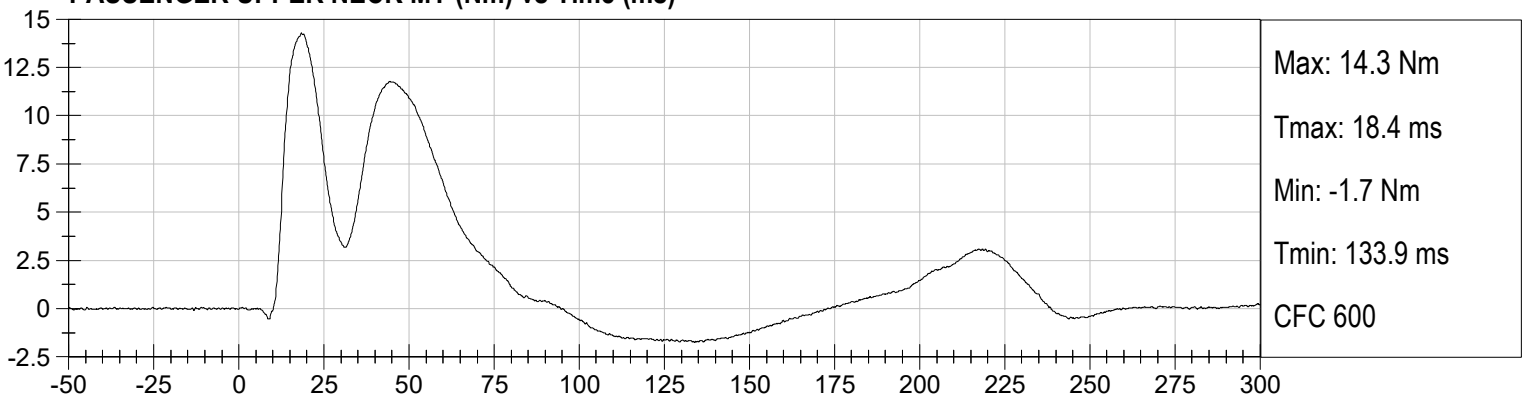

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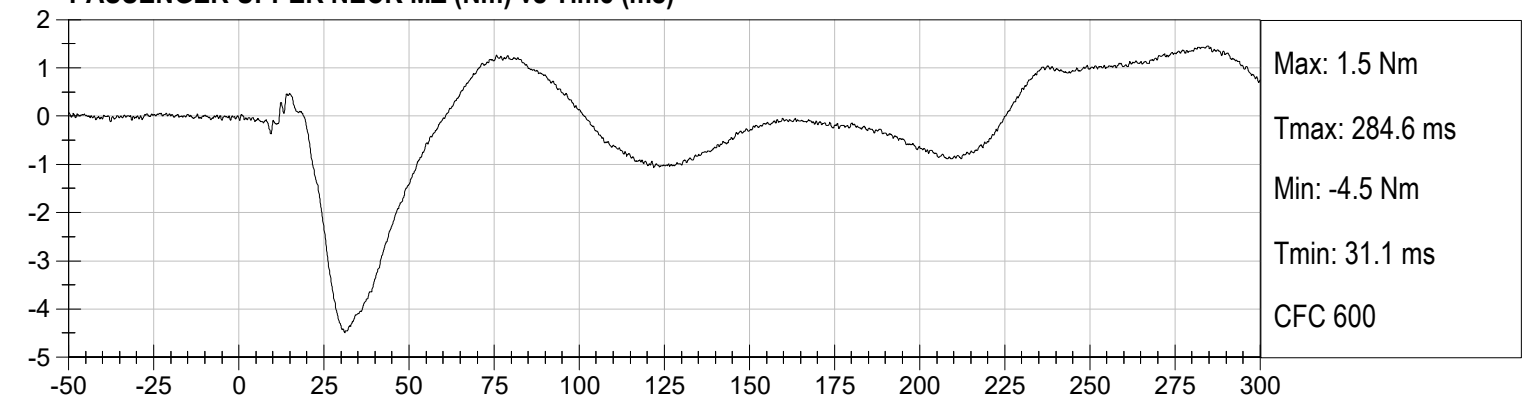
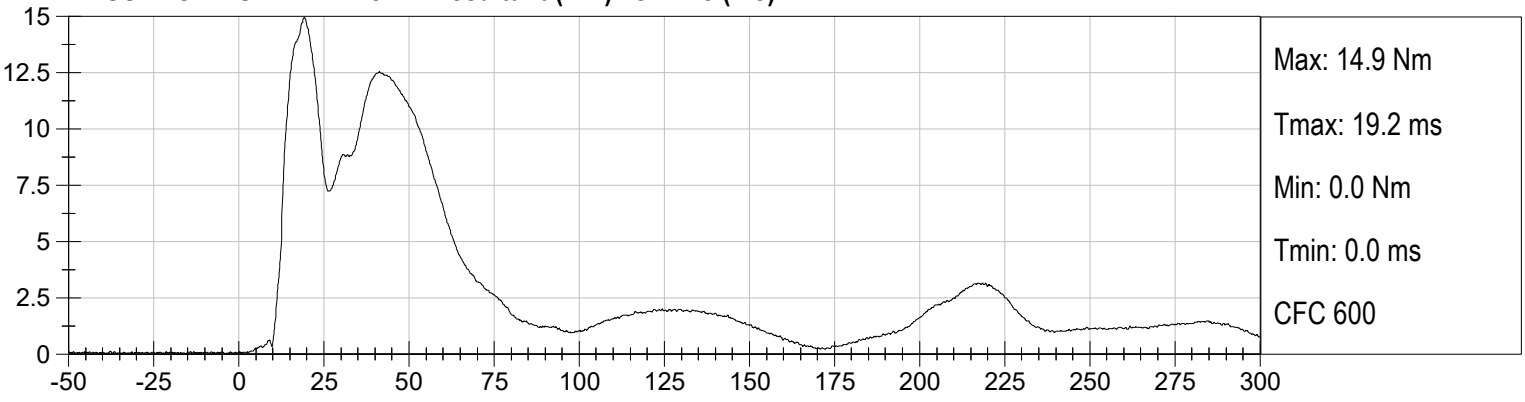
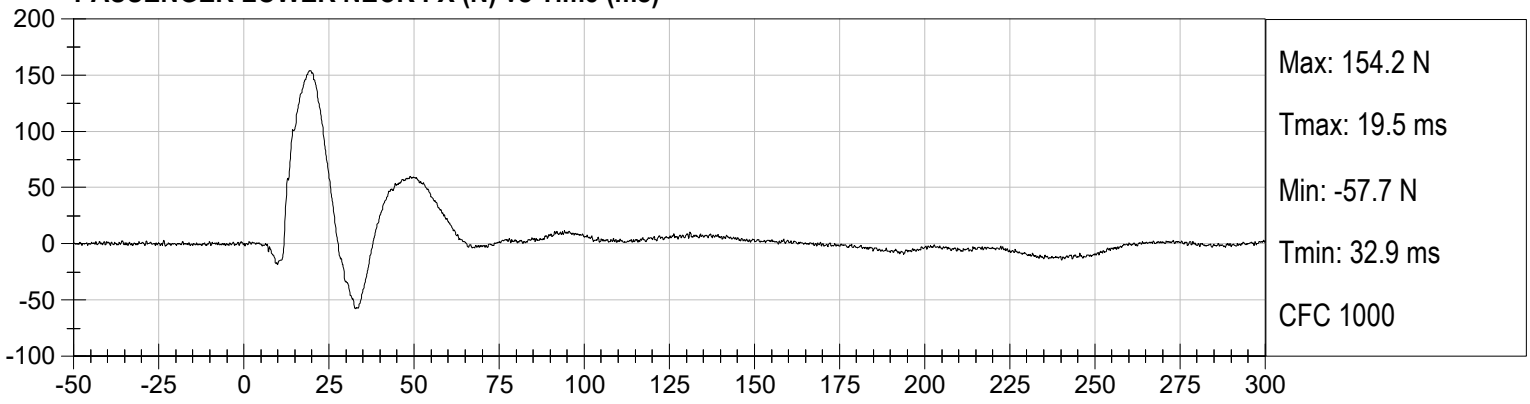


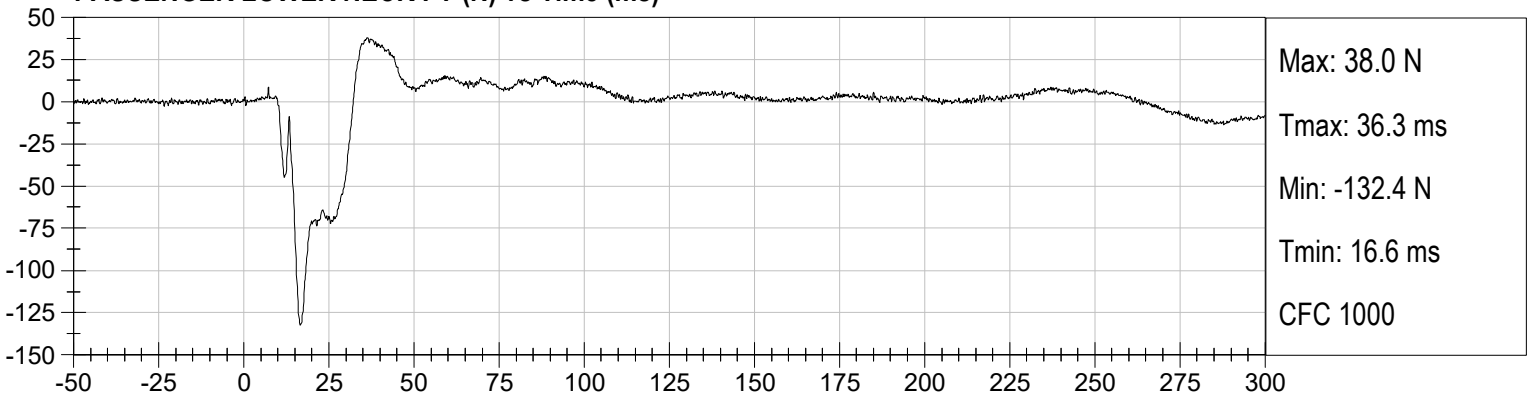
PASSENGER UPPER NECK MResultant (Nm) vs Time (ms)



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



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



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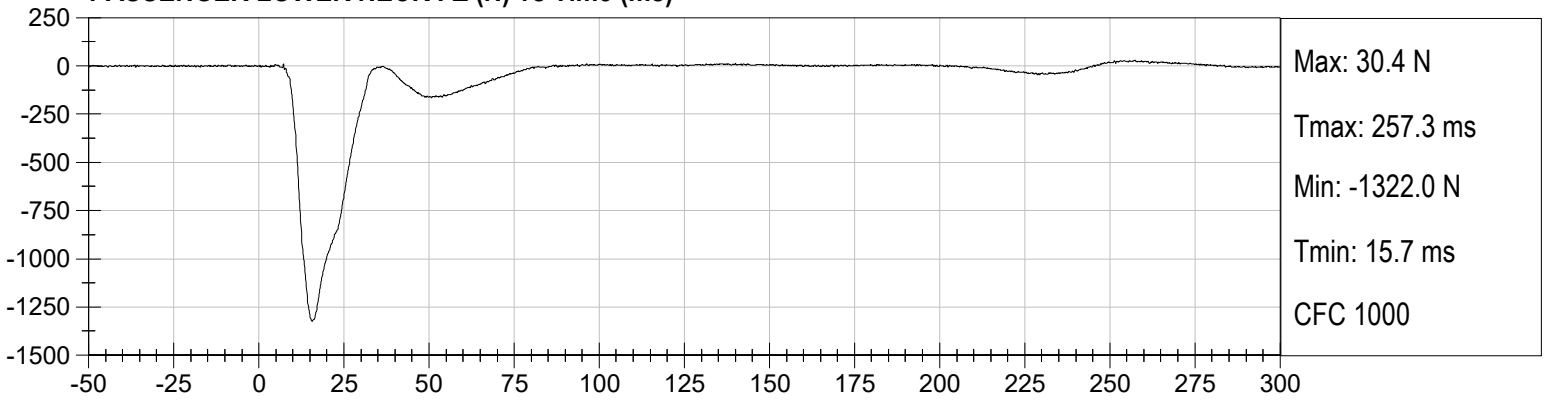
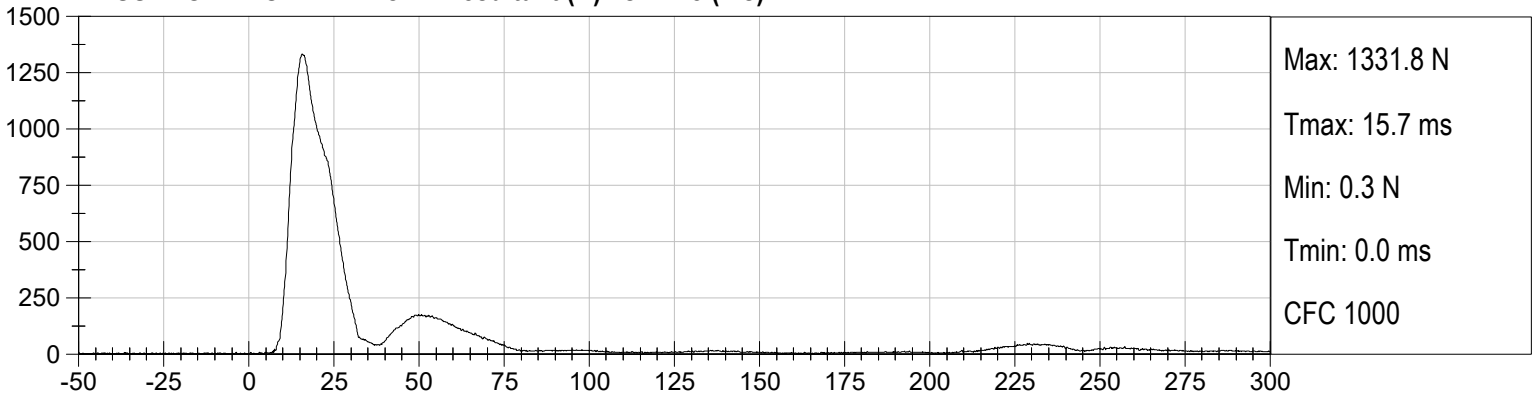
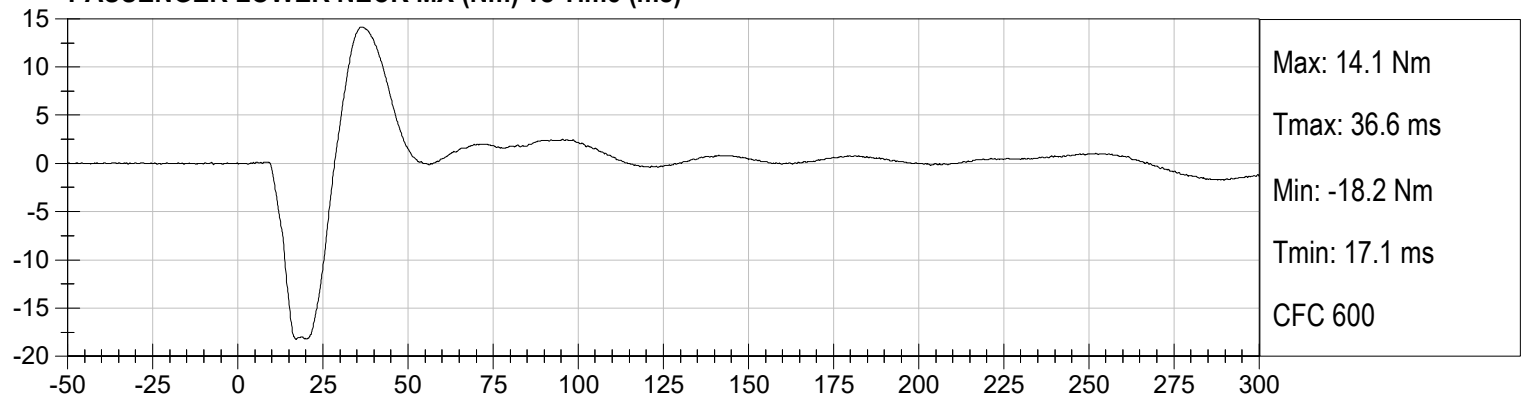


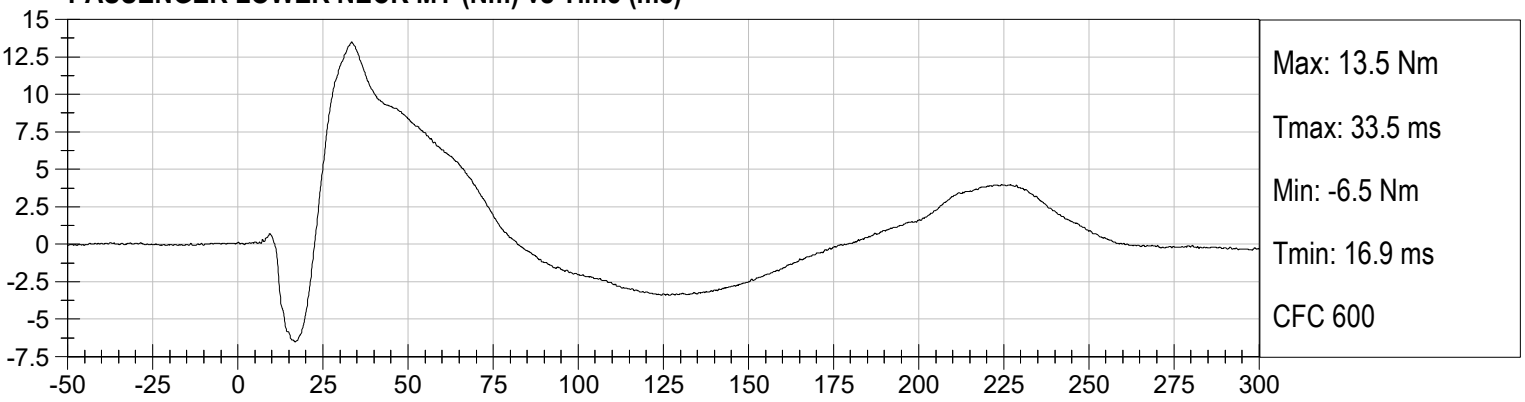
PASSENGER LOWER NECK FResultant (N) vs Time (ms)



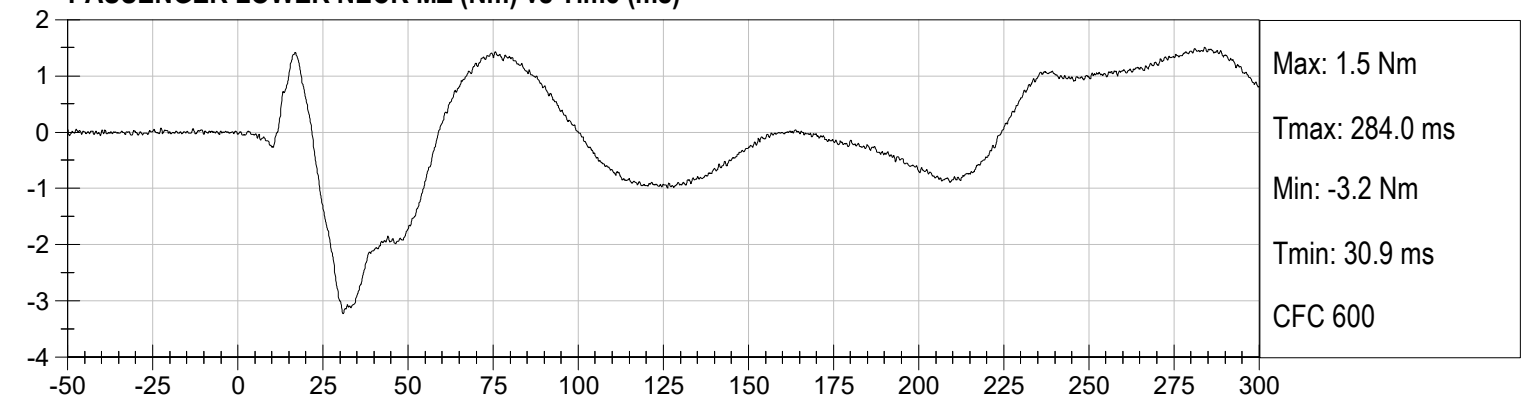
PASSENGER LOWER NECK MX (Nm) vs Time (ms)



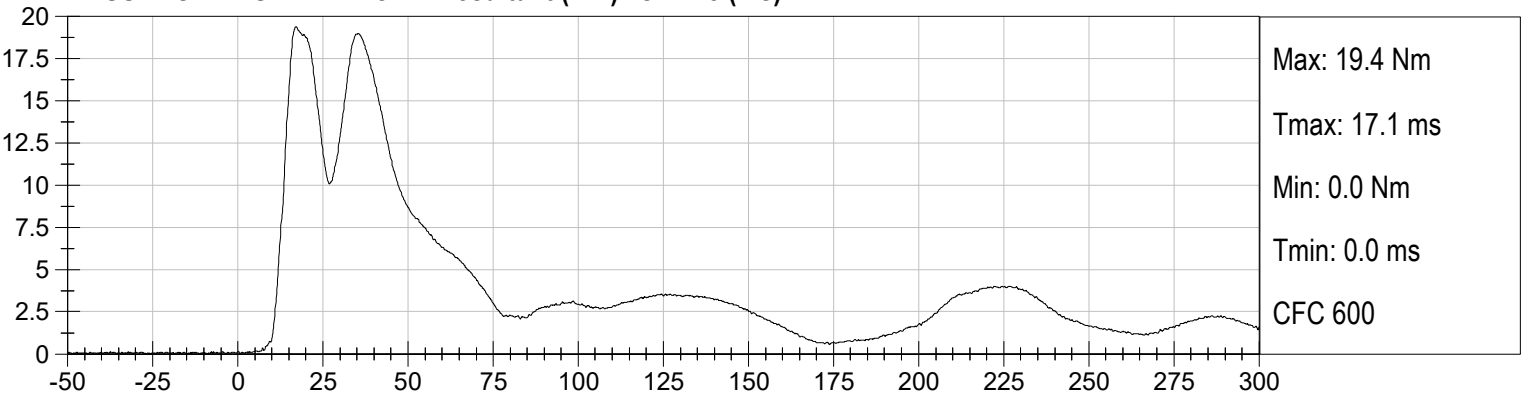
PASSENGER LOWER NECK MY (Nm) vs Time (ms)



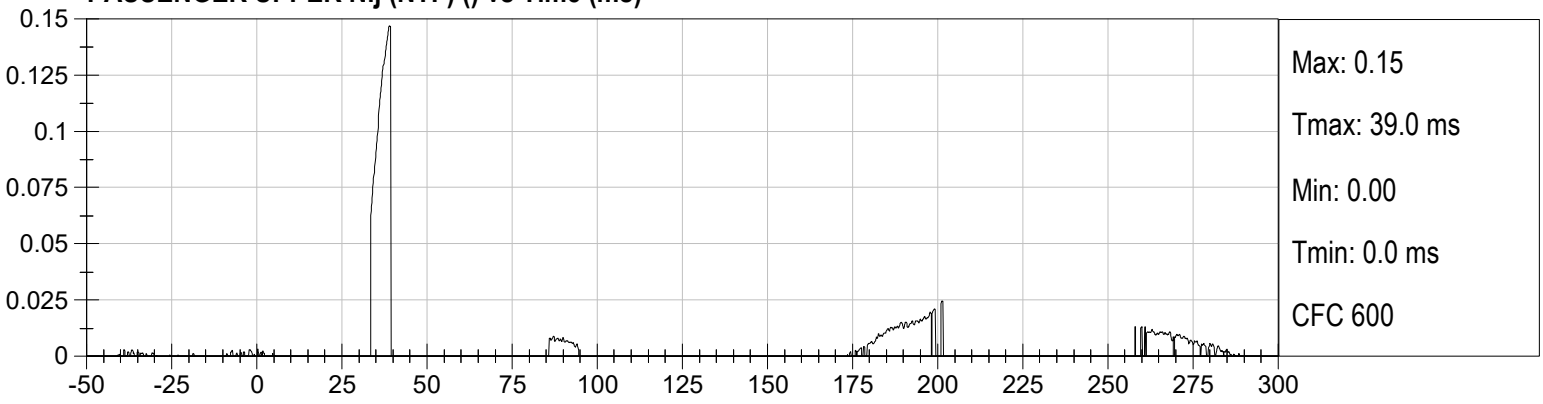
PASSENGER LOWER NECK MZ (Nm) vs Time (ms)



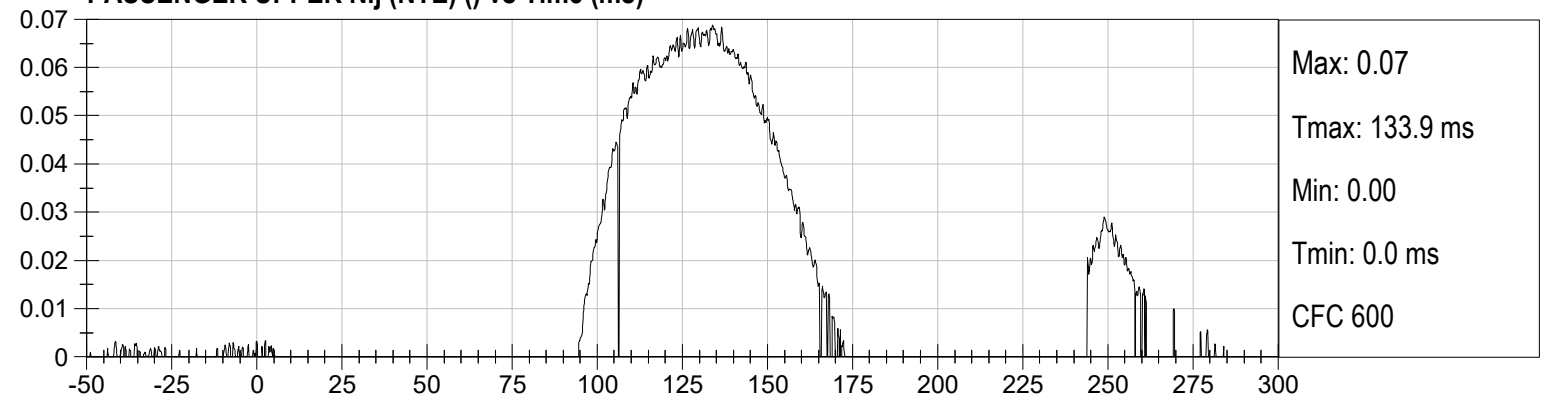
PASSENGER LOWER NECK MResultant (Nm) vs Time (ms)



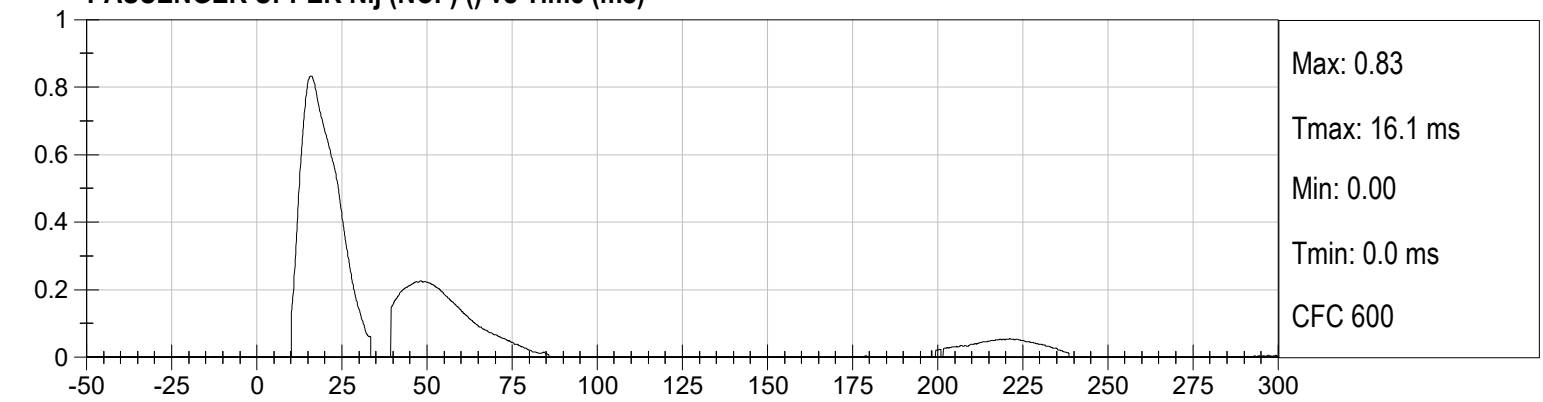
PASSENGER UPPER Nij (NTF) () vs Time (ms)



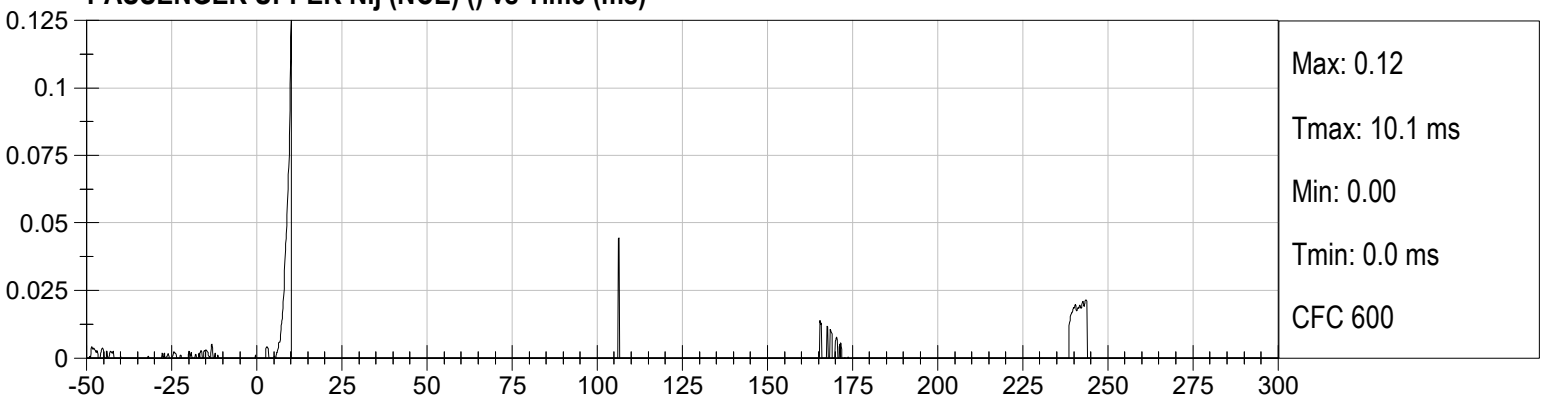
PASSENGER UPPER Nij (NTE) () vs Time (ms)



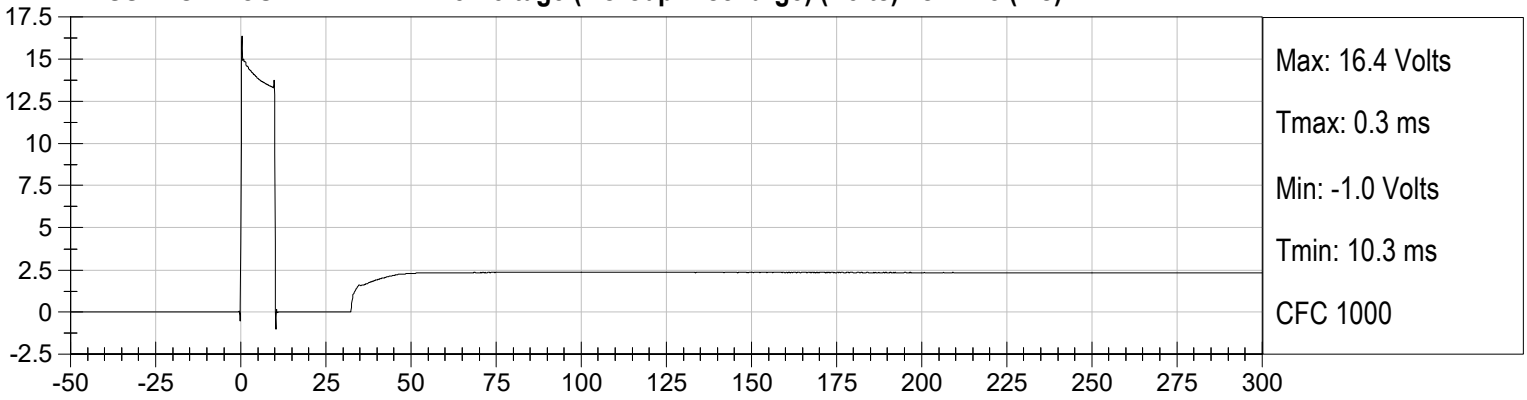
PASSENGER UPPER Nij (NCF) () vs Time (ms)



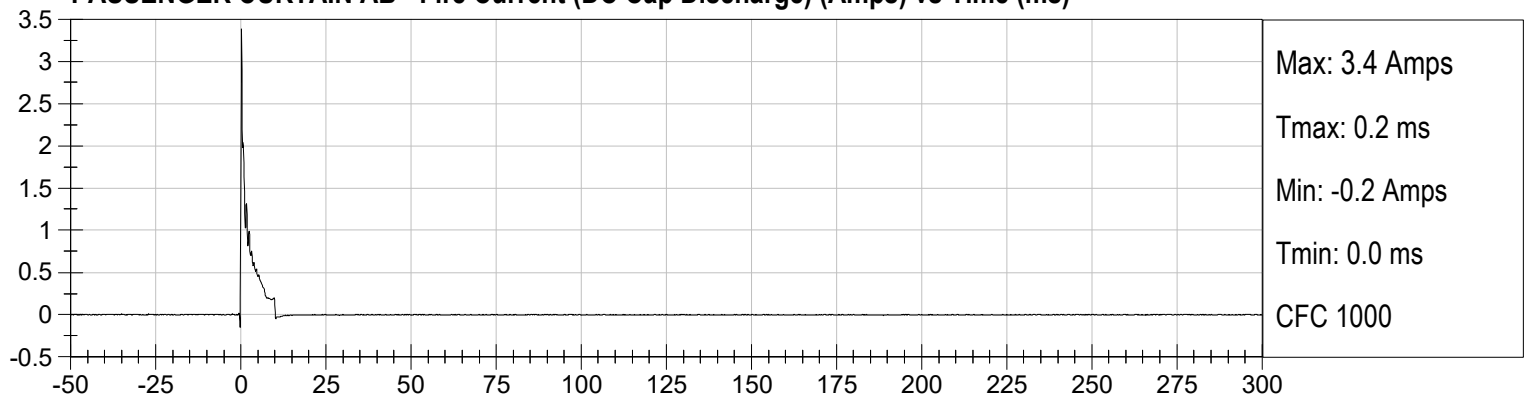
PASSENGER UPPER Nij (NCE) () vs Time (ms)



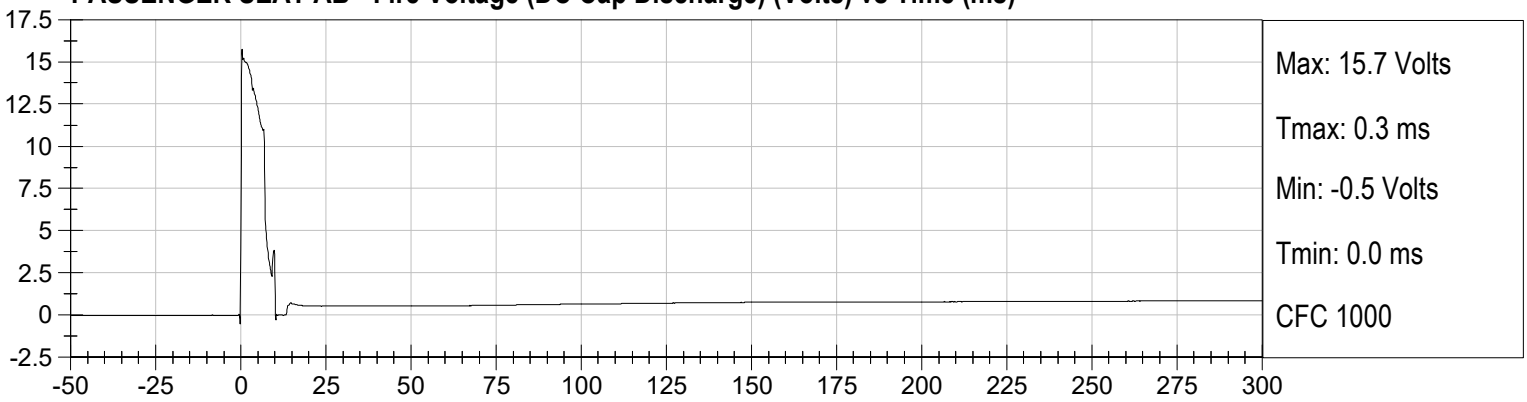
PASSENGER CURTAIN AB - Fire Voltage (DC Cap Discharge) (Volts) vs Time (ms)



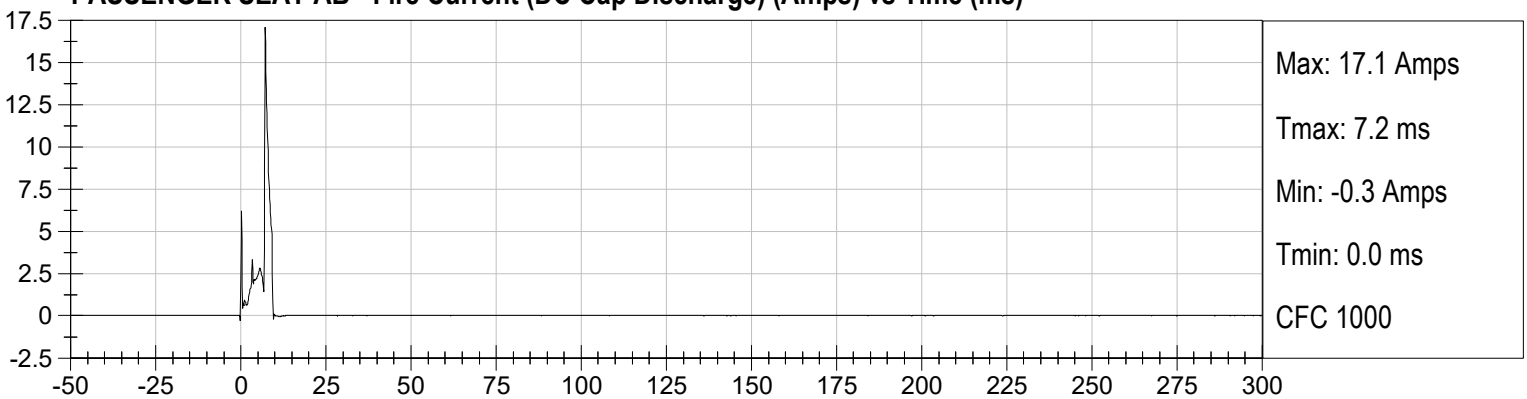
PASSENGER CURTAIN AB - Fire Current (DC Cap Discharge) (Amps) vs Time (ms)



PASSENGER SEAT AB - Fire Voltage (DC Cap Discharge) (Volts) vs Time (ms)



PASSENGER SEAT AB - Fire Current (DC Cap Discharge) (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:** D182481

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	46	Pass
Peak Resultant Acceleration	G's	250 to 280	254	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-14.5	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

08/15/2018

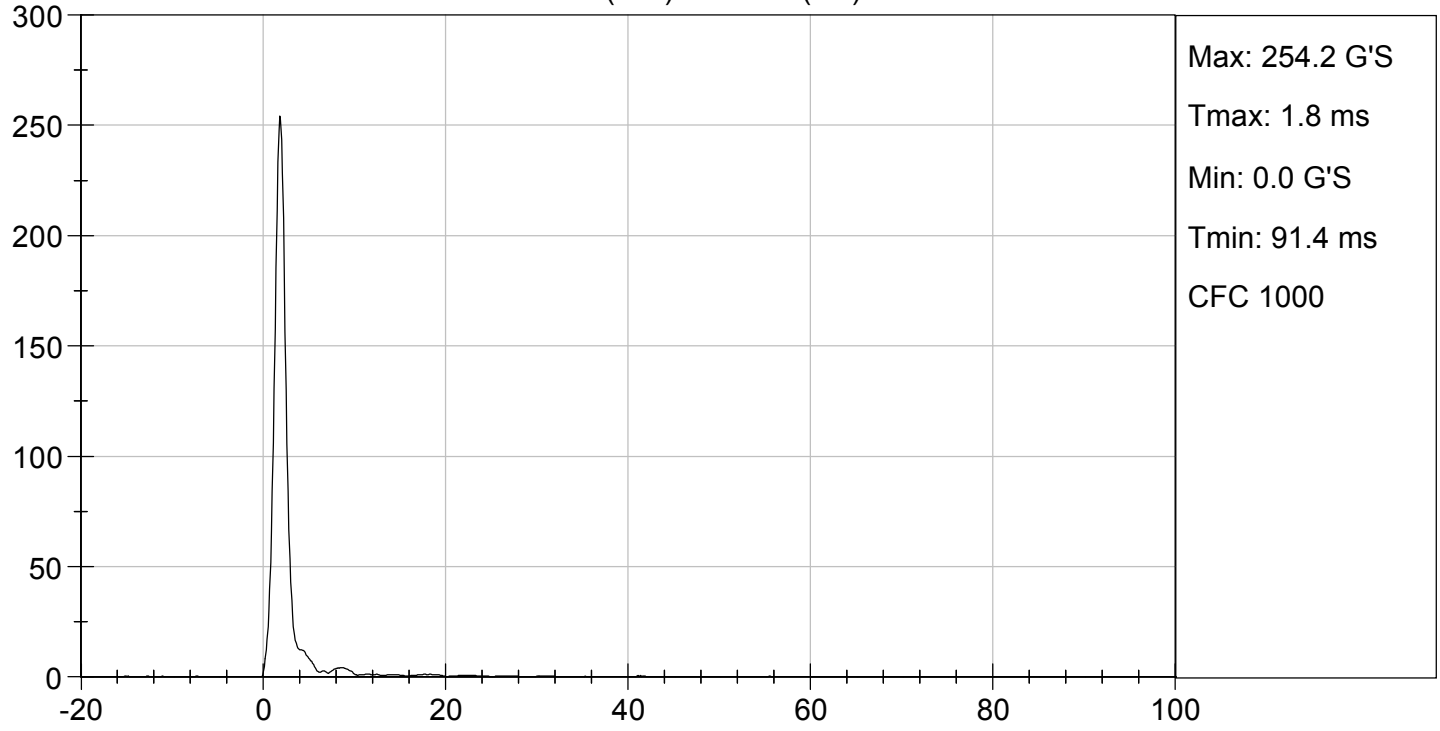
Test Date

Approved By

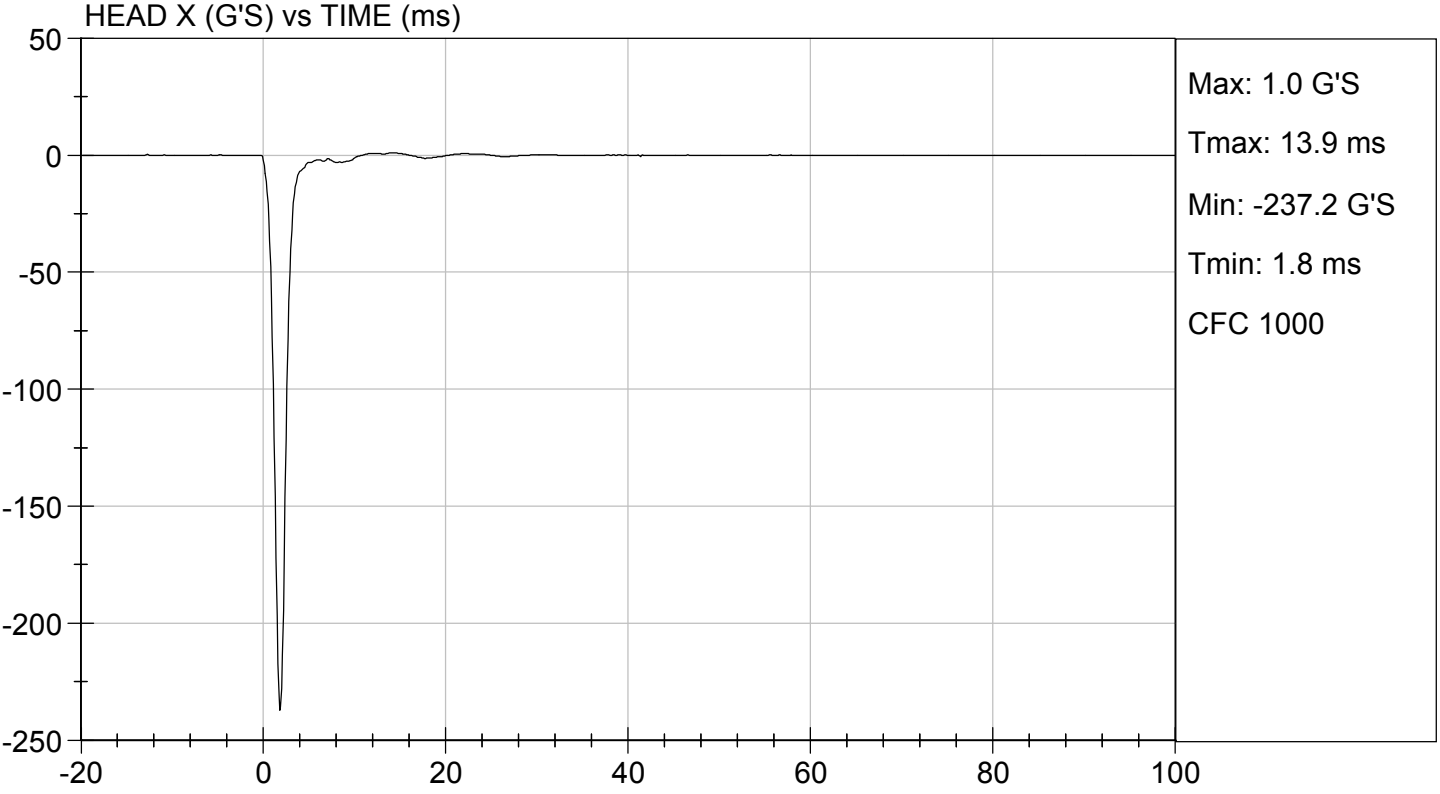
TEST DESC: HEAD DROP

TEST DATE: 08/15/2018
TEST #: D182481

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

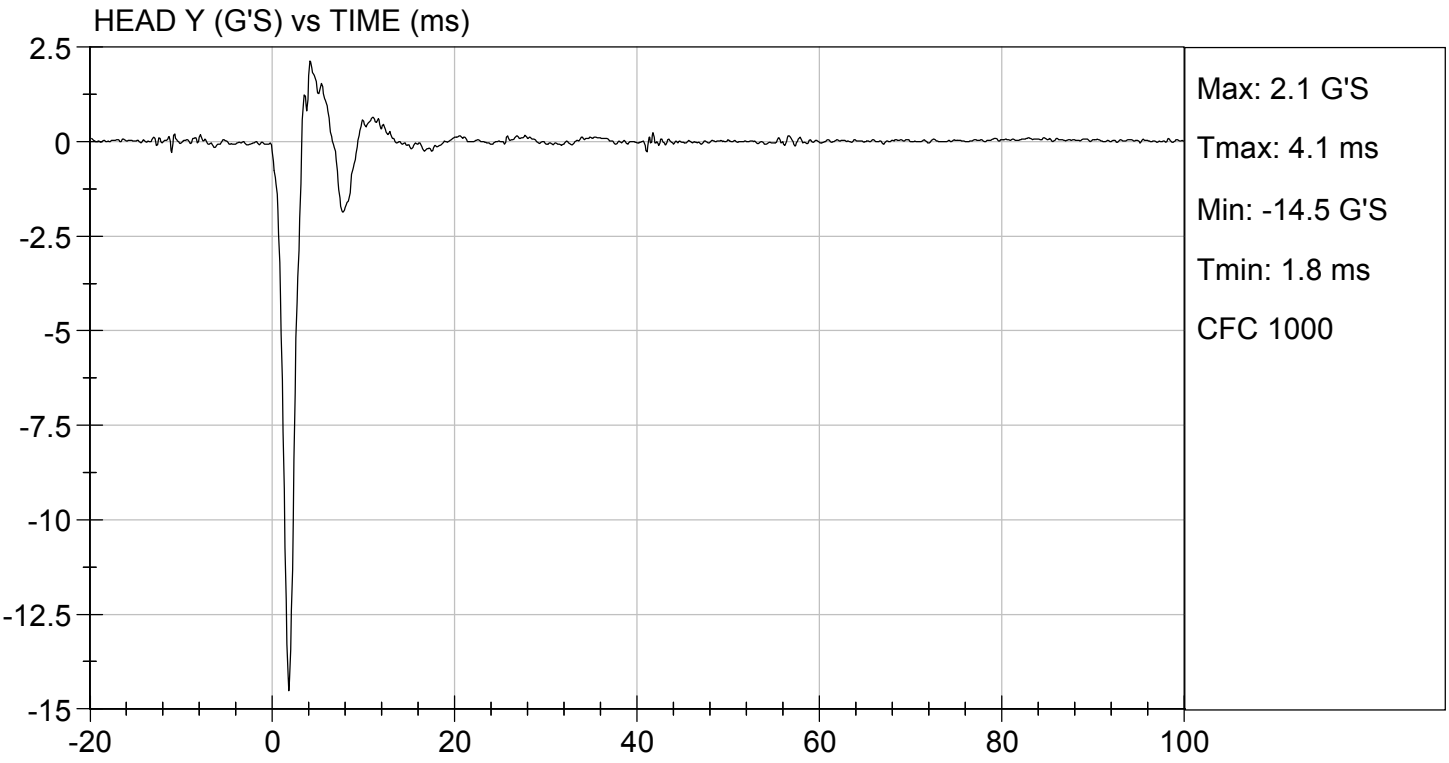


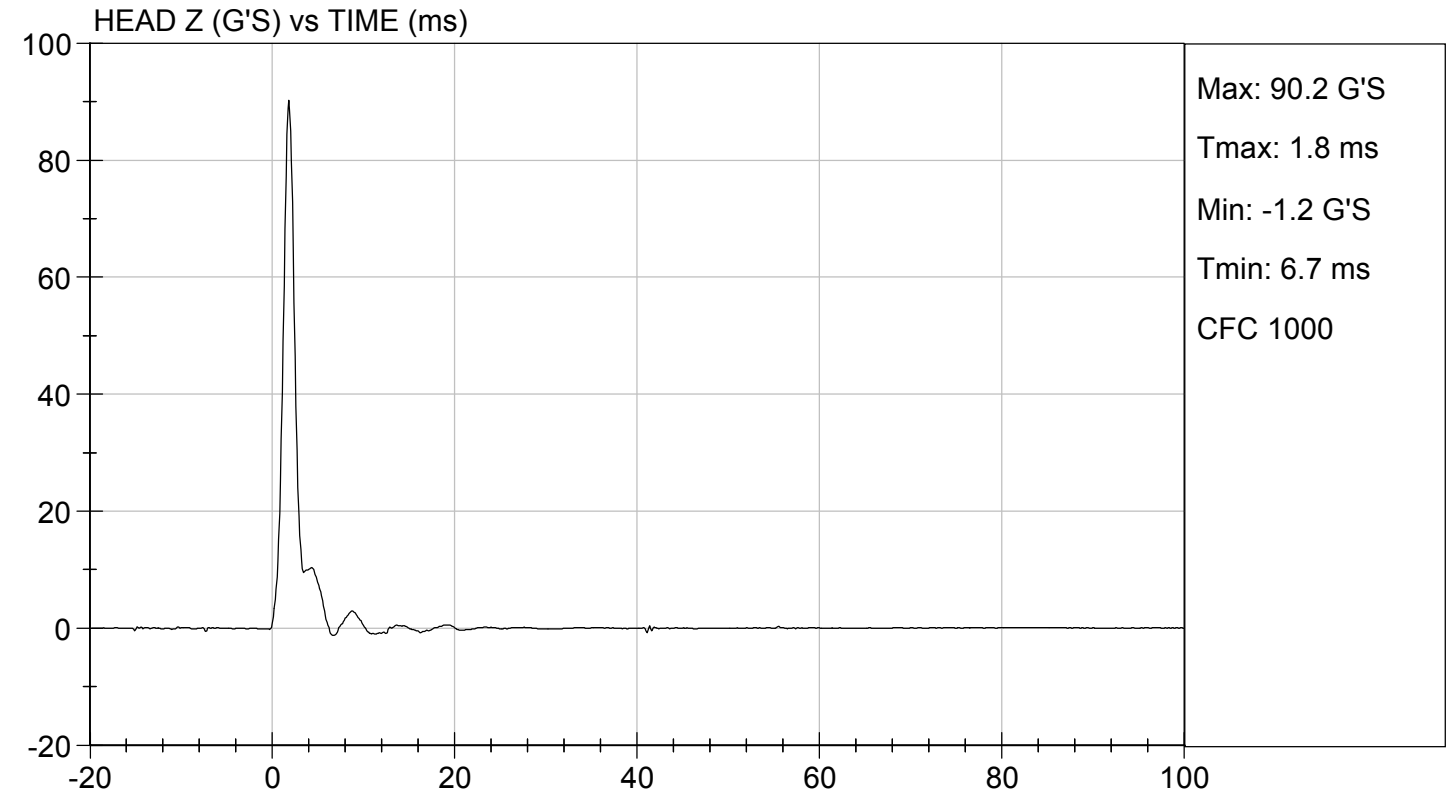
HEAD X (G'S) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 08/15/2018
TEST #: D182481





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D182482

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	50	Pass
Pendulum Speed		m/s	5.40 to 5.60	5.52	Pass
Pendulum Velocity	10 msec	m/s	2.0 to 2.7	2.6	Pass
	15 msec	m/s	3.0 to 4.0	3.7	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	46.2	Pass
Positive Moment - Time Curve Decay to 10 Nm		msec	60.0 to 80.0	69	Pass
			Overall Test Results		Pass

Brian Roach

Laboratory Technician

08/16/2018

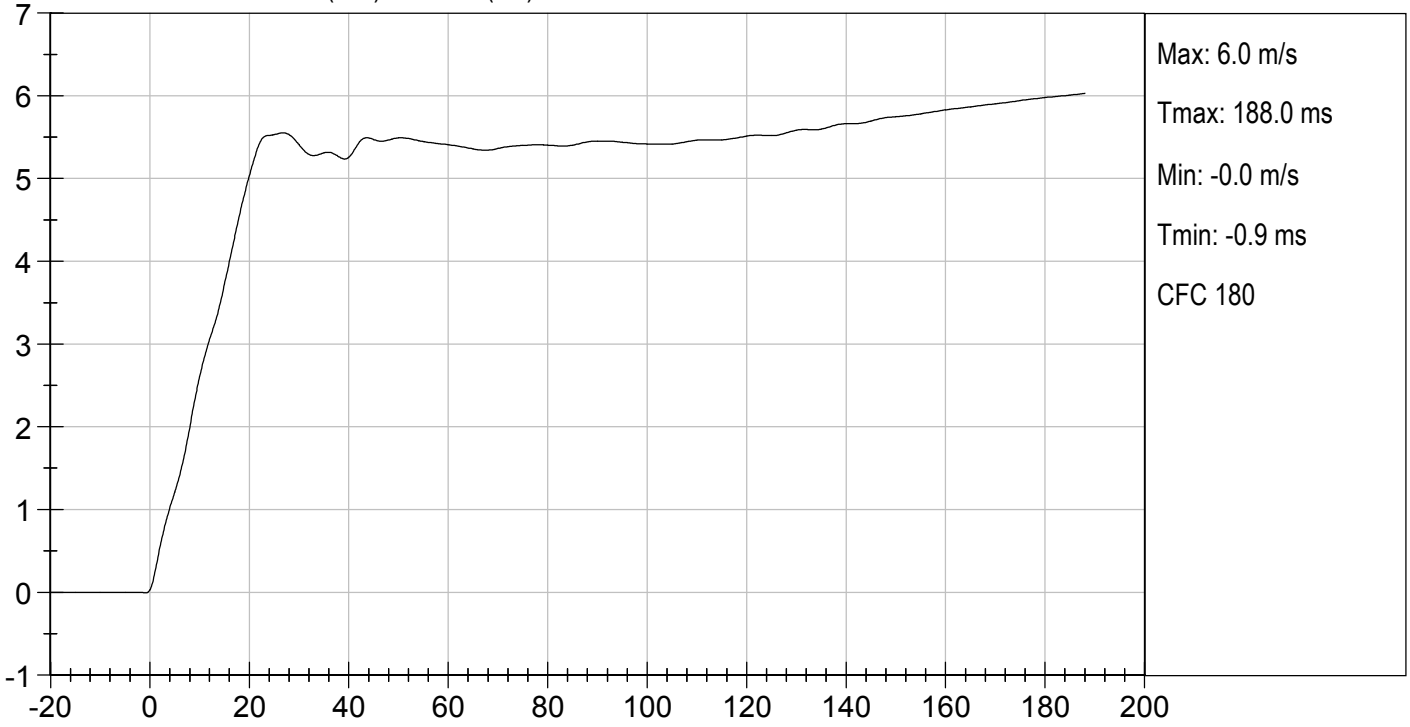
Test Date

Approved By

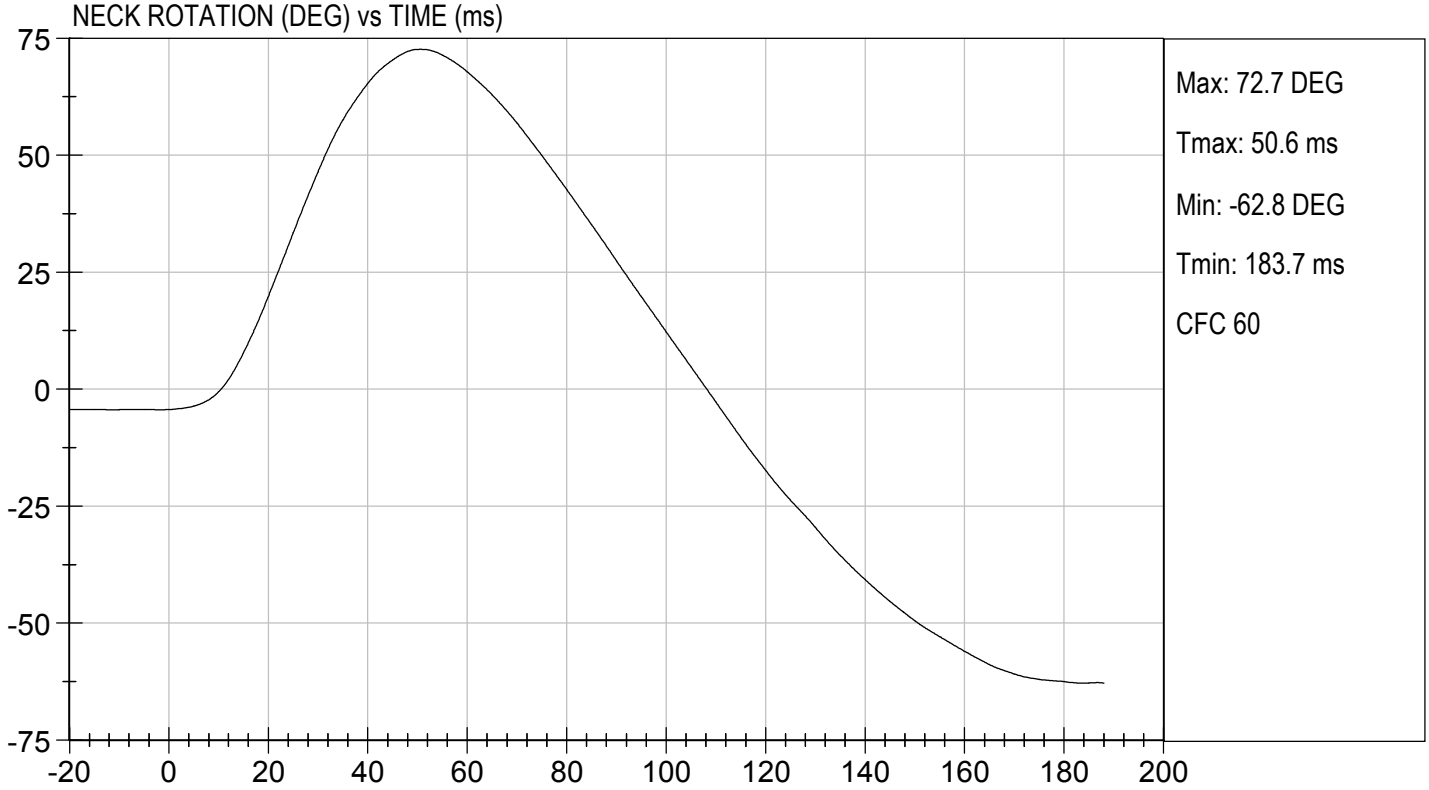
TEST DESC: NECK FLEXION
VELOCITY: 18.12 ft/s, 5.52 m/s

TEST DATE: 08/16/2018
TEST #: D182482

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

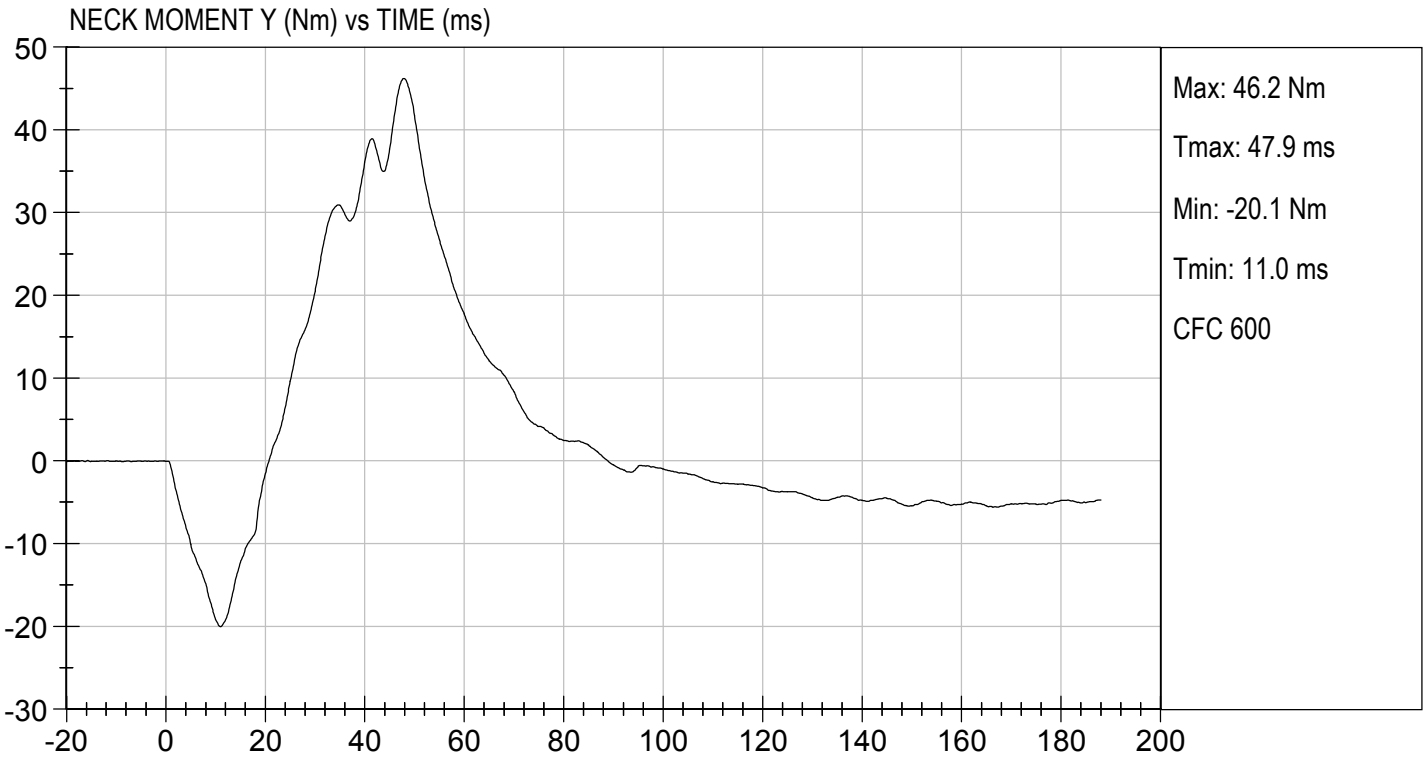


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK FLEXION
VELOCITY: 18.12 ft/s, 5.52 m/s

TEST DATE: 08/16/2018
TEST #: D182482



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D182483

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	50	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	3.3	Pass
D Plane Rotation		deg	83 to 93	88	Pass
Peak Moment within Deflection Corridor		Nm	-53.3 to -43.7	-44.4	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

08/16/2018

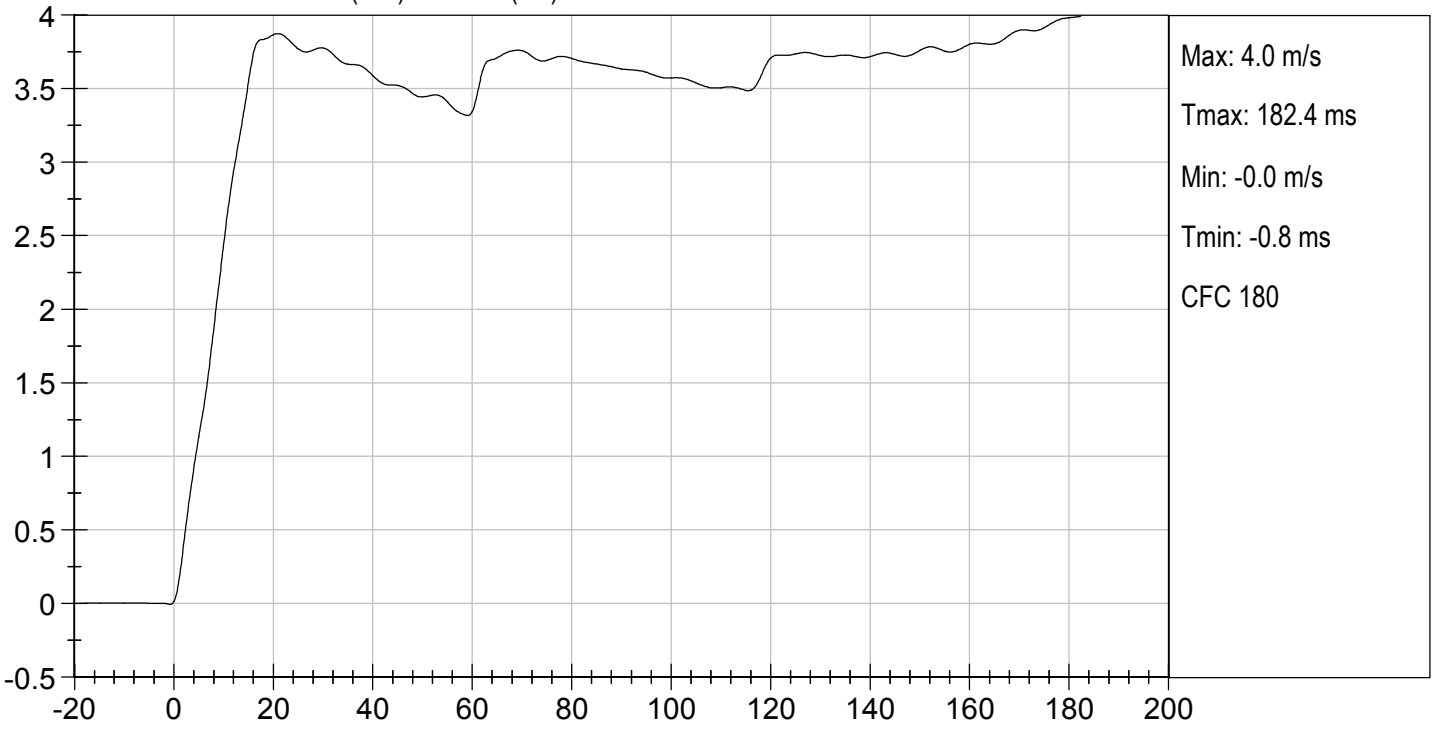
Test Date

Approved By

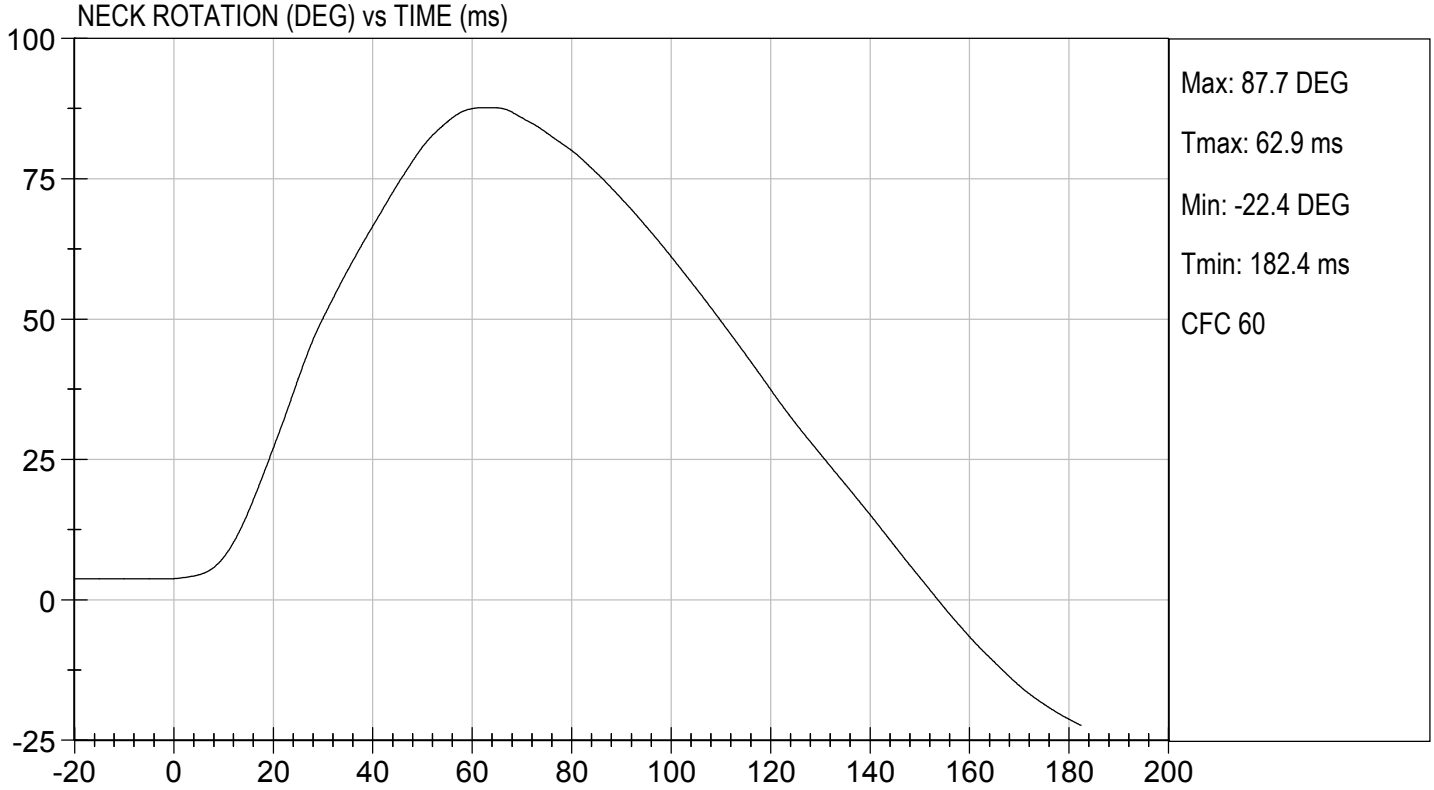
TEST DESC: NECK EXTENSION
VELOCITY: 12.17 ft/s, 3.71 m/s

TEST DATE: 08/16/2018
TEST #: D182483

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

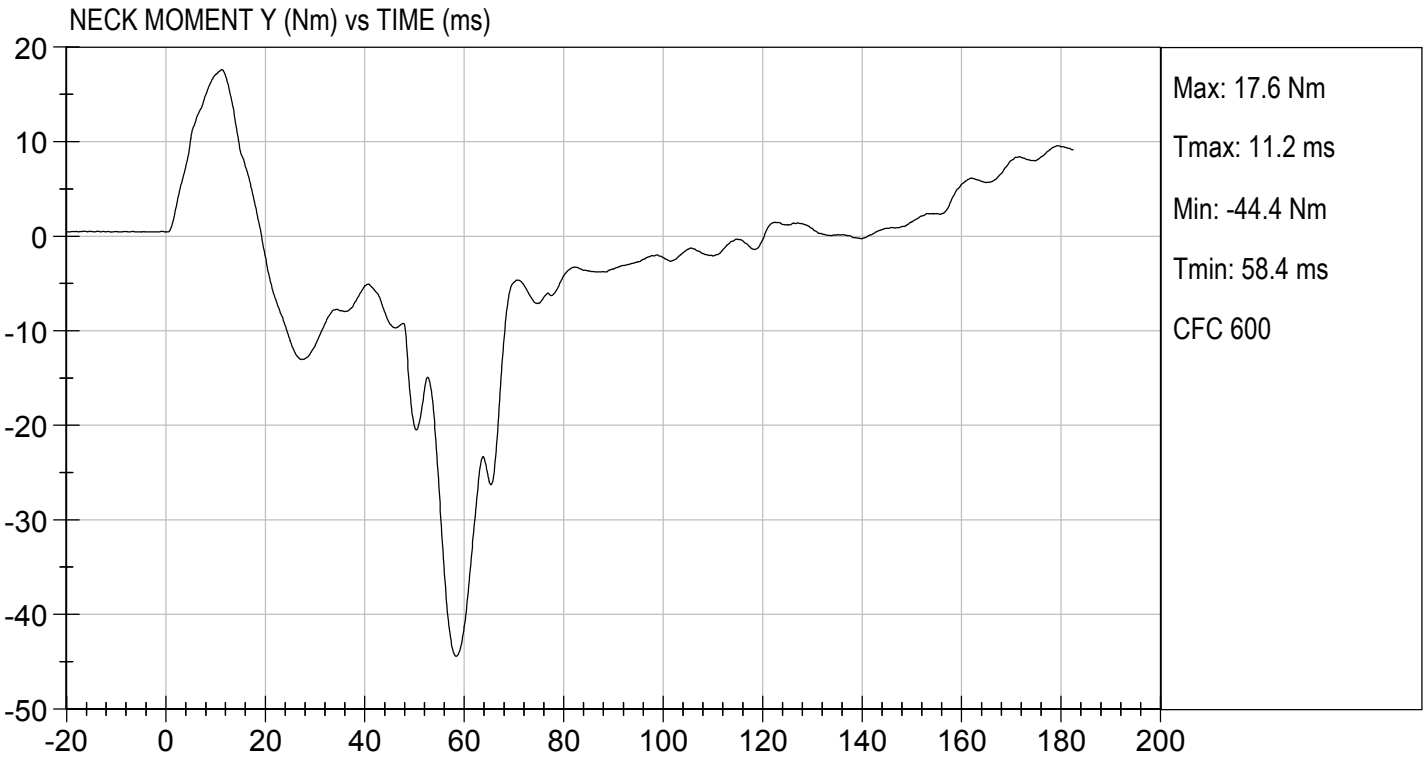


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 08/16/2018
TEST #: D182483



MGA RESEARCH CORPORATION

THORAX IMPACT TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D182484

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	46	Pass
Probe Velocity	m/s	5.9 to 6.1	6.05	Pass
Peak Deflection	mm	32 to 38	34.1	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	693	Pass
Internal Hysteresis	%	65 to 85	72.9	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	746	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

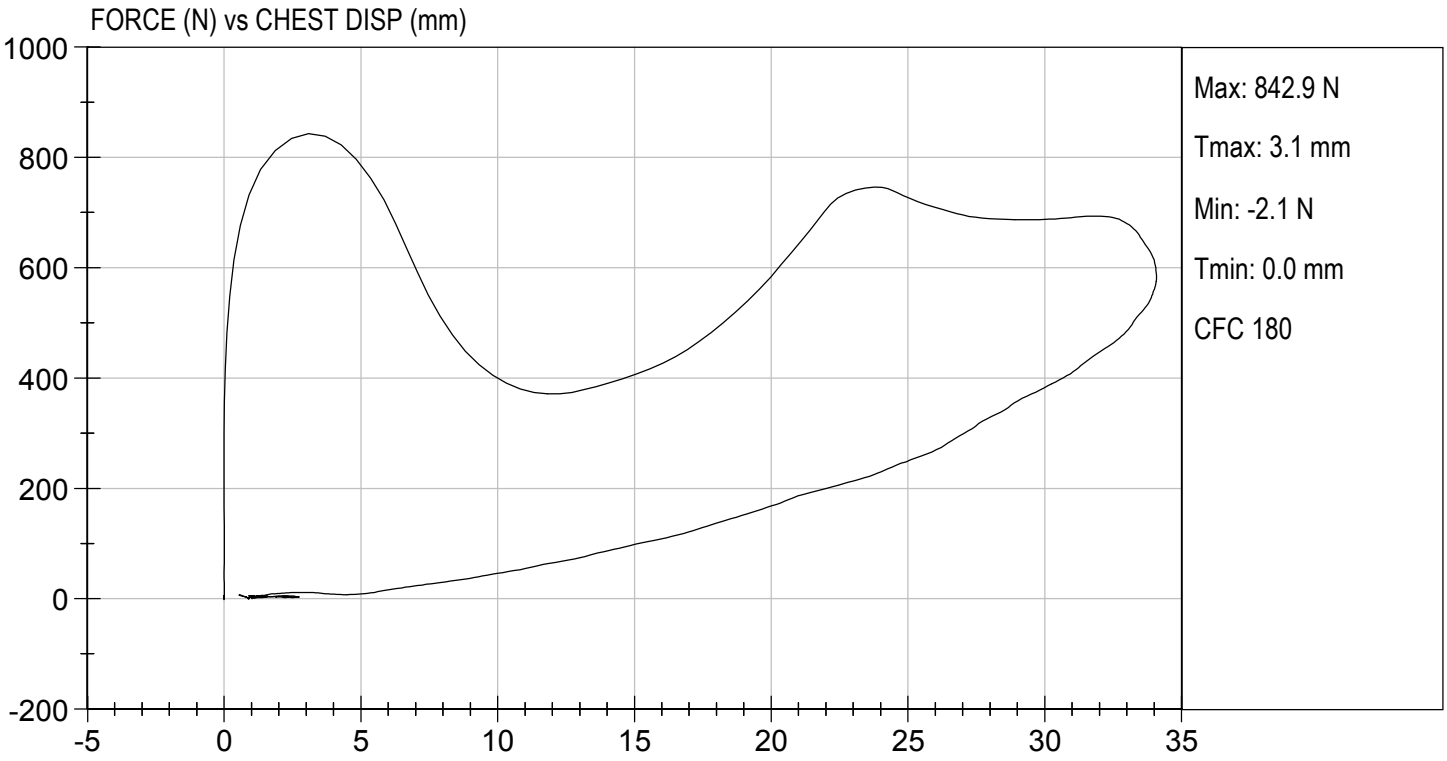
08/14/2018

Test Date

Approved By

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

TEST DATE: 08/14/2018
TEST #: D182484



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D182487

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	49	Pass
Initial Angle	deg	0 to 15	5	Pass
Return Angle	deg	-10 to 10	5	Pass
Force at 45 deg	N	130 to 180	171	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.9	Pass
		Overall Test Results		Pass

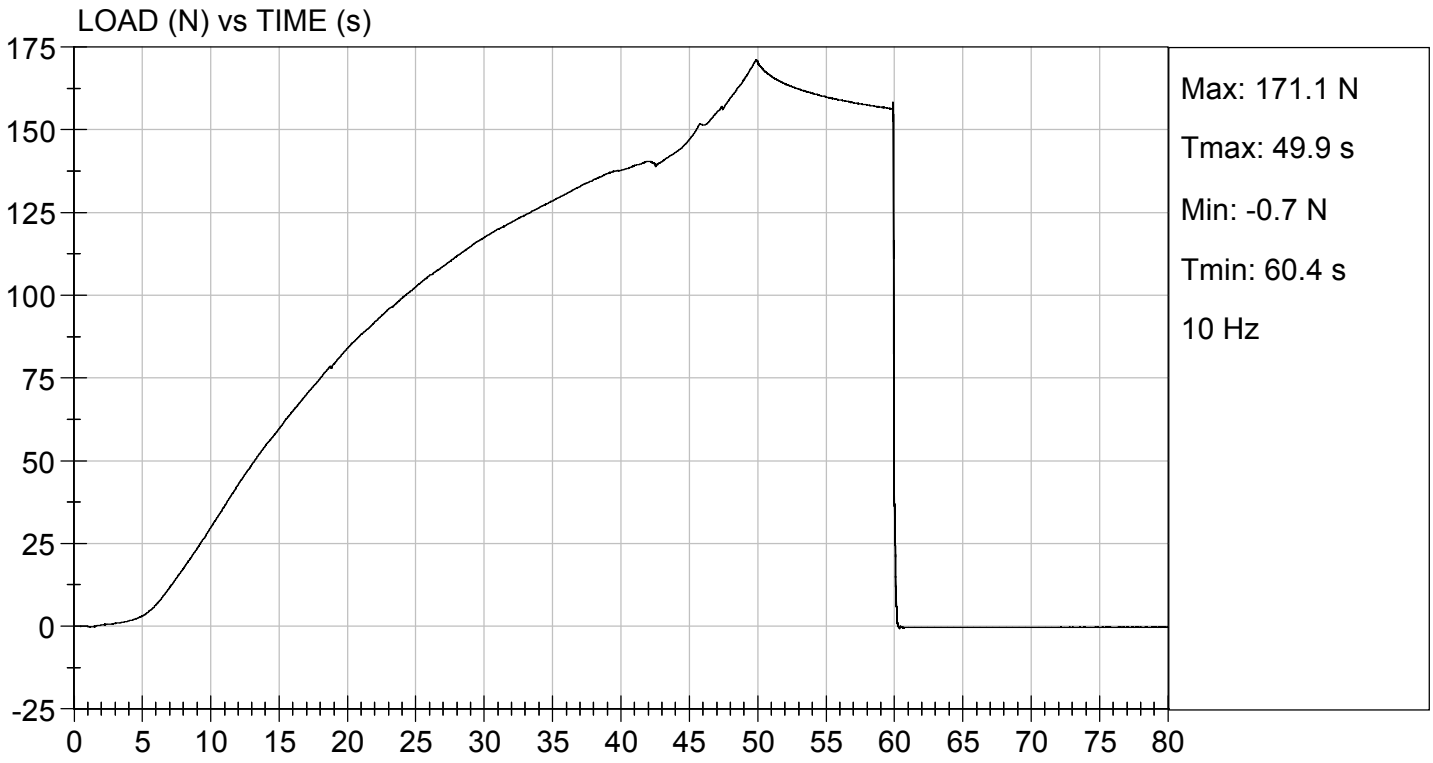
Brian Roach

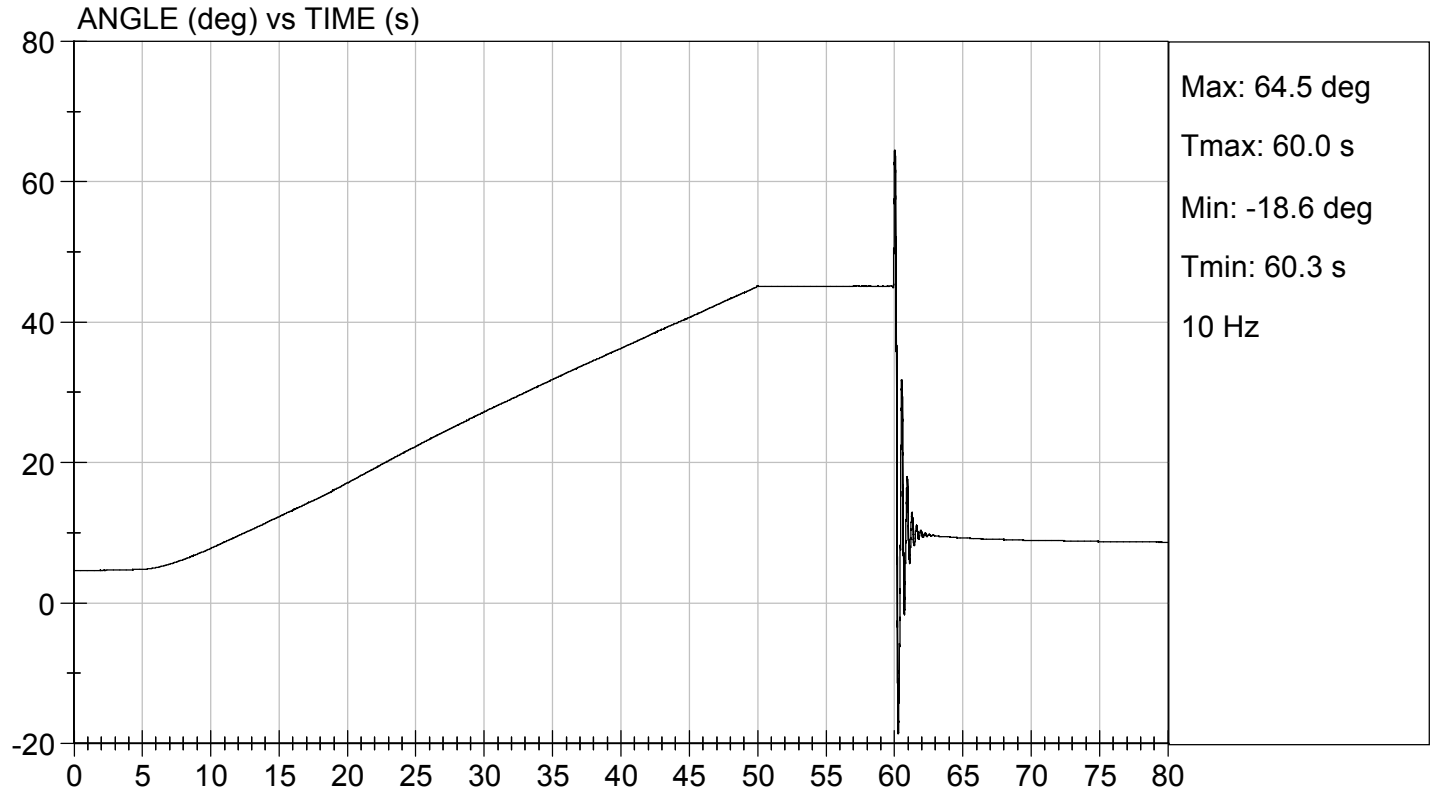
Laboratory Technician

08/16/2018

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: 171.1 N
Tmax: 49.9 s
Min: -0.7 N
Tmin: 60.4 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: 64.5 deg
Tmax: 60.0 s
Min: -18.6 deg
Tmin: 60.3 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:** D183041

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	251	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-4.0	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

10/09/2018

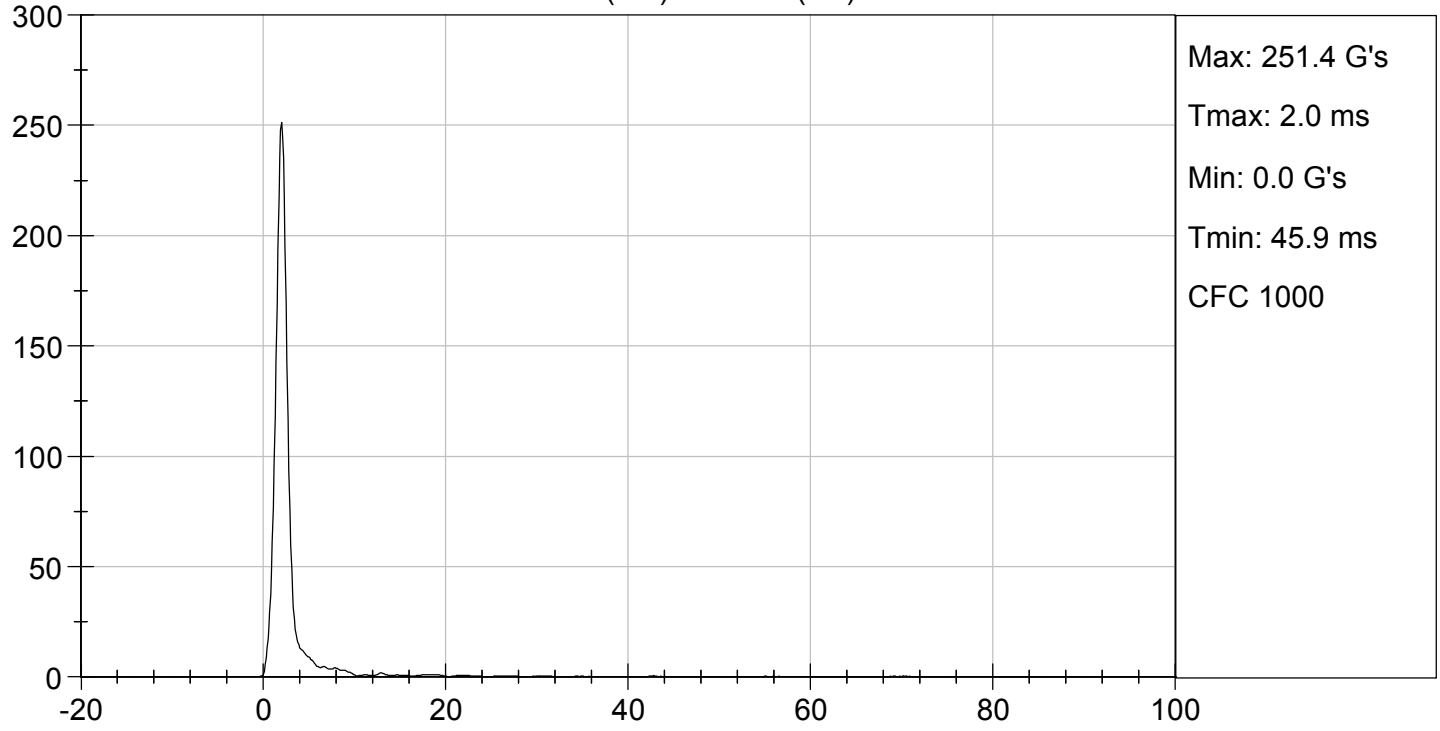
Test Date

Approved By

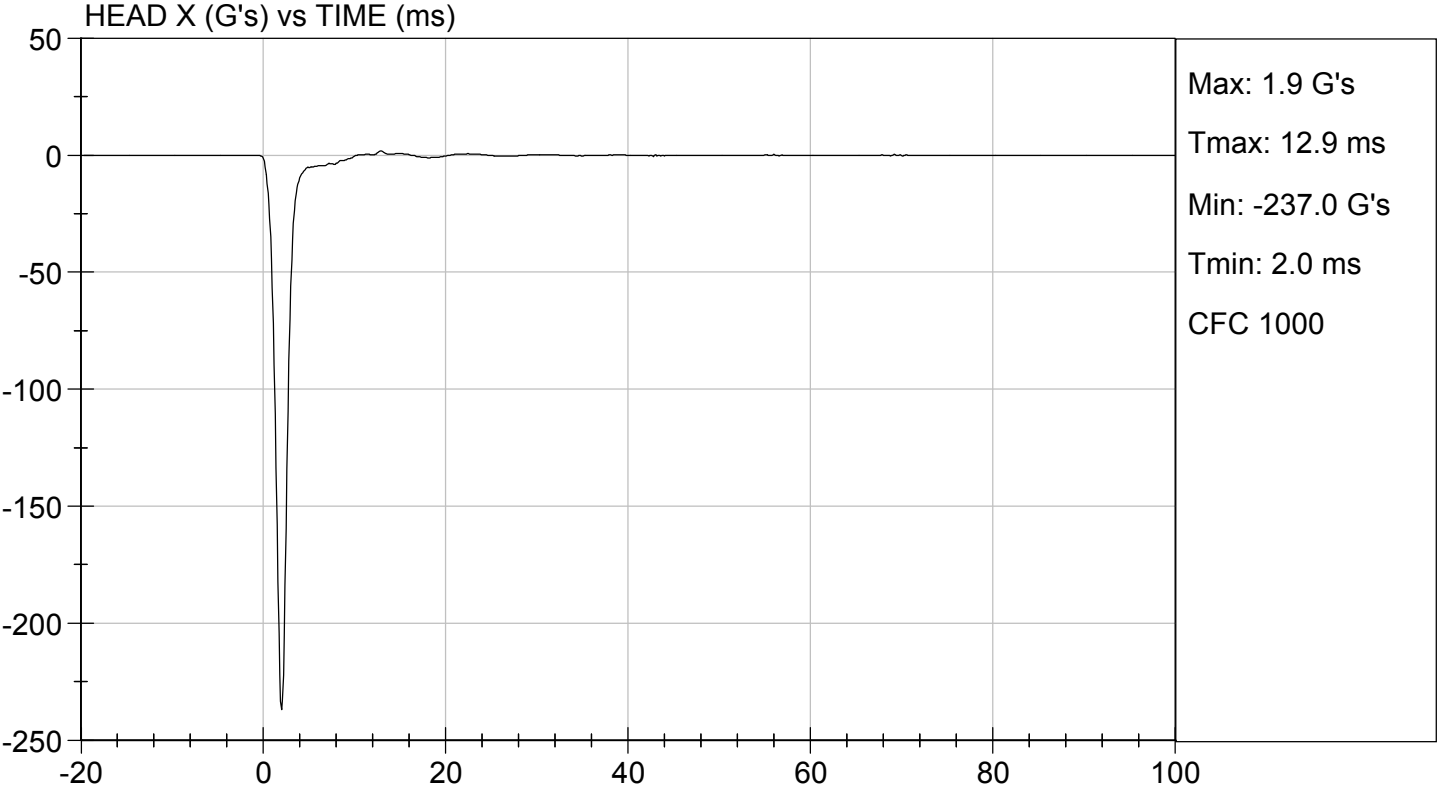
TEST DESC: HEAD DROP

TEST DATE: 10/09/2018
TEST #: D183041

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

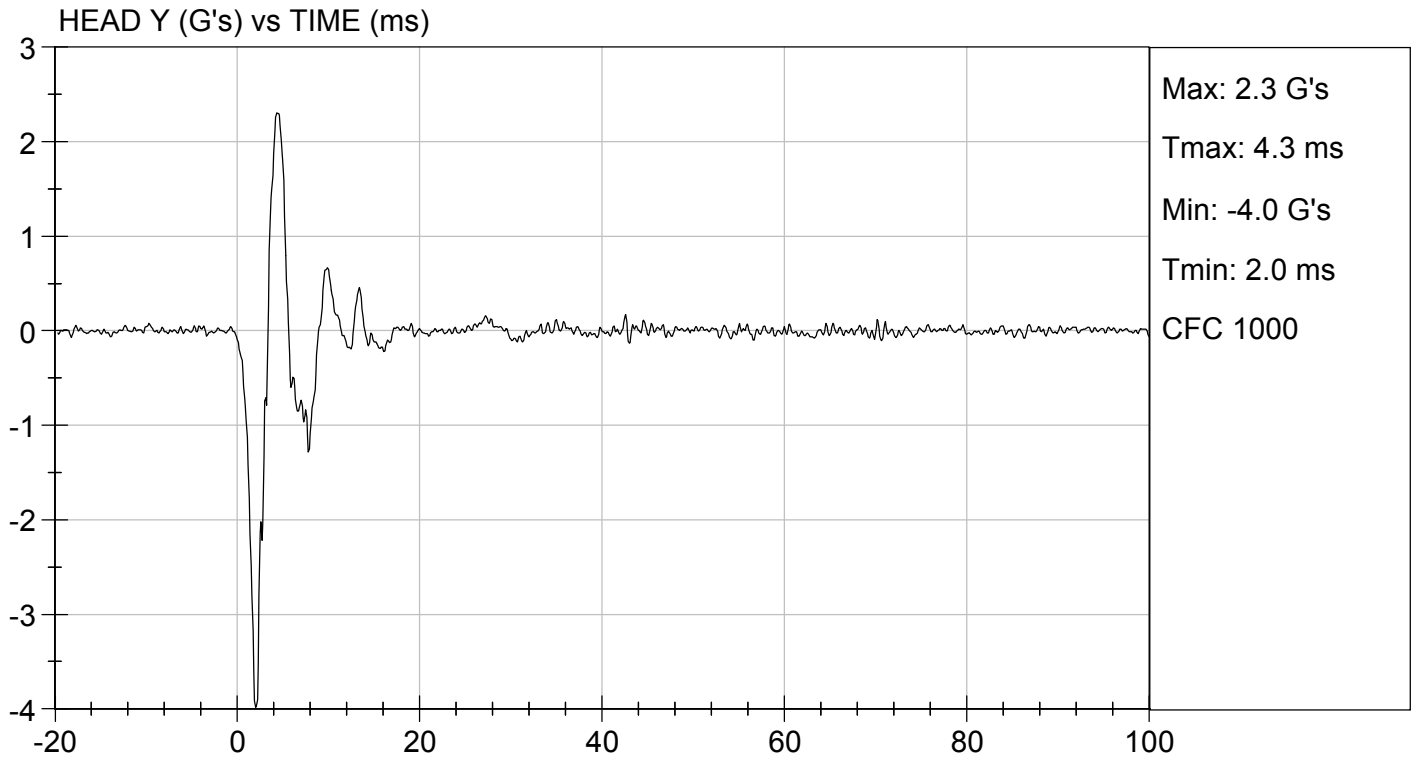


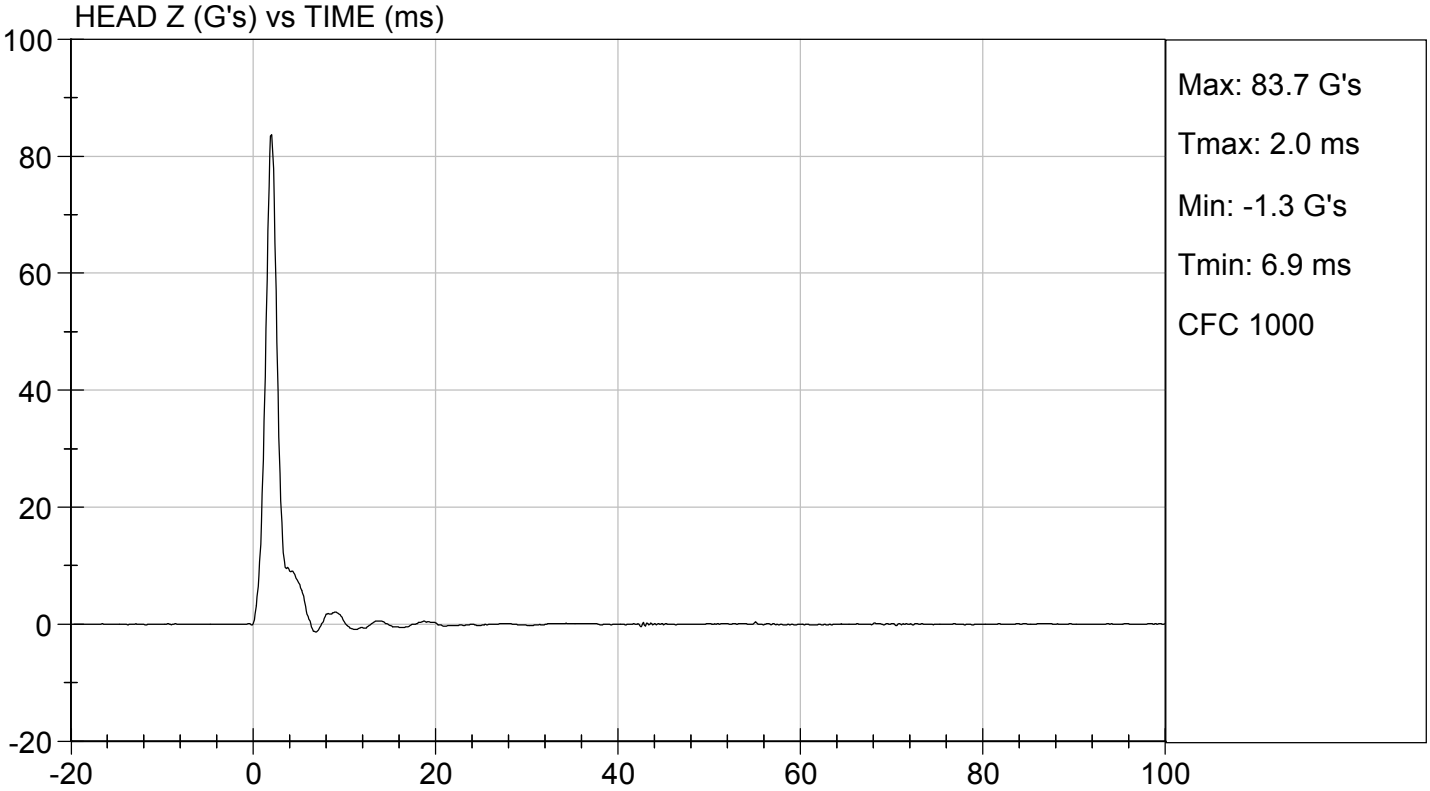
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 10/09/2018
TEST #: D183041





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D183042

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	51	Pass
Pendulum Speed		m/s	5.40 to 5.60	5.52	Pass
Pendulum Velocity	10 msec	m/s	2.0 to 2.7	2.7	Pass
	15 msec	m/s	3.0 to 4.0	3.9	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	44.1	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

10/10/2018

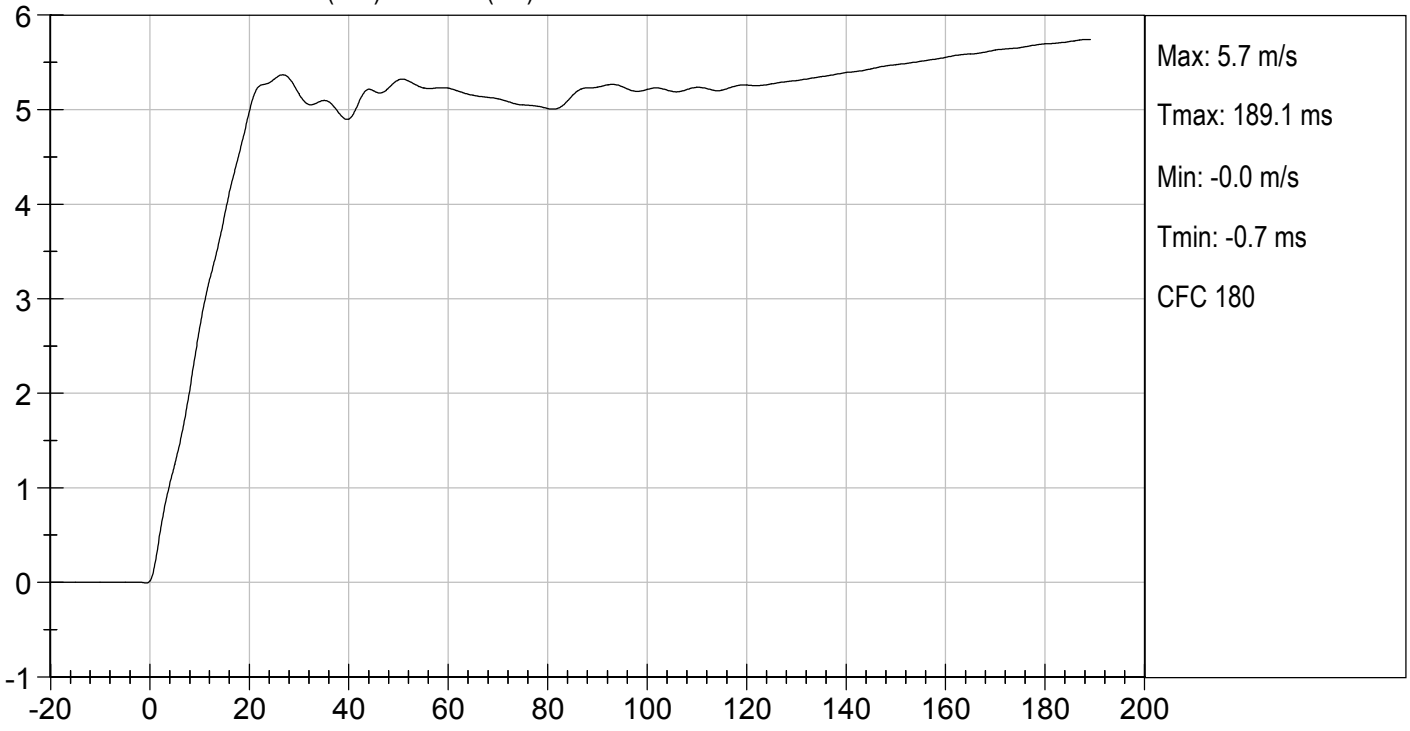
Test Date

Approved By

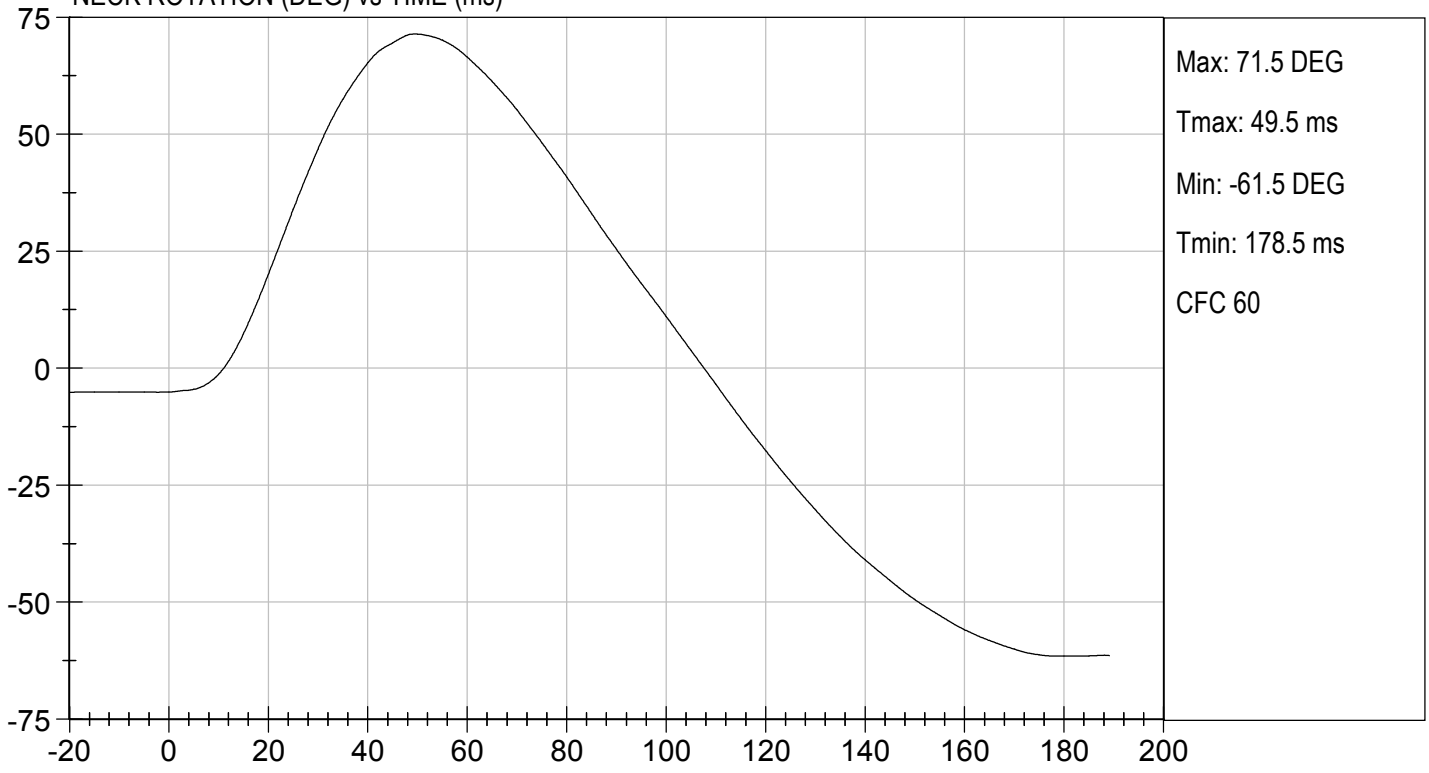
TEST DESC: NECK FLEXION
VELOCITY: 18.12 ft/s, 5.52 m/s

TEST DATE: 10/10/2018
TEST #: D183042

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

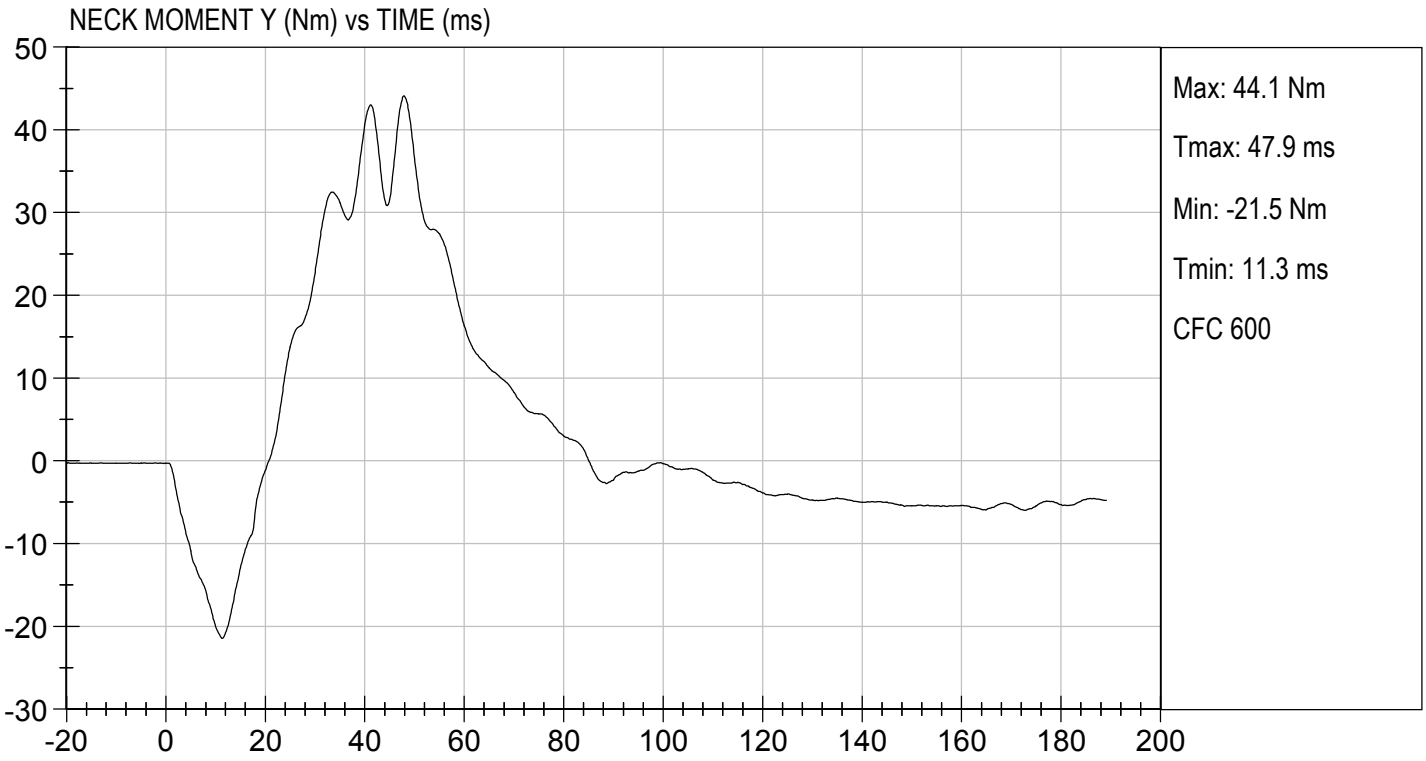


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK FLEXION
VELOCITY: 18.12 ft/s, 5.52 m/s

TEST DATE: 10/10/2018
TEST #: D183042



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D183043

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	51	Pass
Pendulum Speed		m/s	3.55 to 3.75	3.63	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	3.3	Pass
D Plane Rotation		deg	83 to 93	88	Pass
Peak Moment within Deflection Corridor		Nm	-53.3 to -43.7	-44.2	Pass
Negative Moment - Time Curve Decay to -10 Nm		ms	60.0 to 80.0	65	Pass
			Overall Test Results		Pass

Brian Roach

Laboratory Technician

10/10/2018

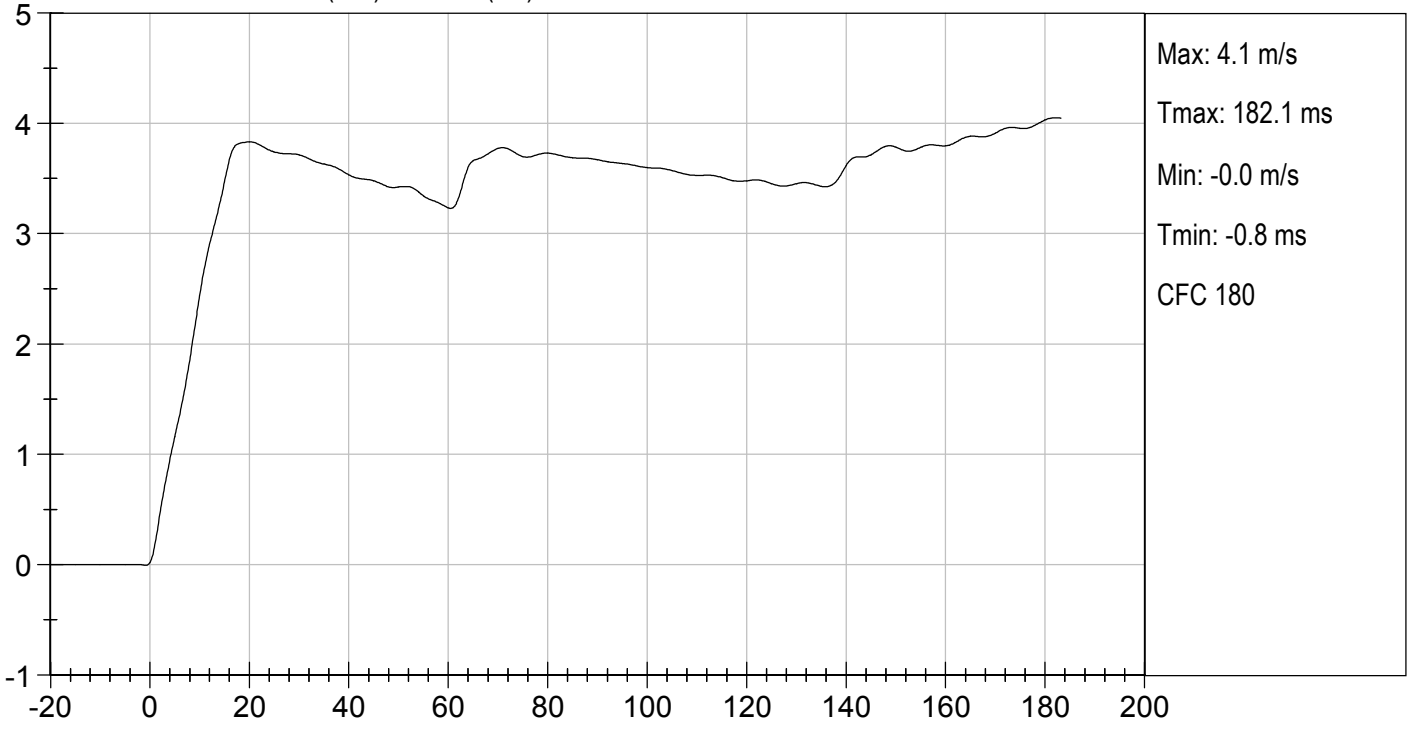
Test Date

Approved By

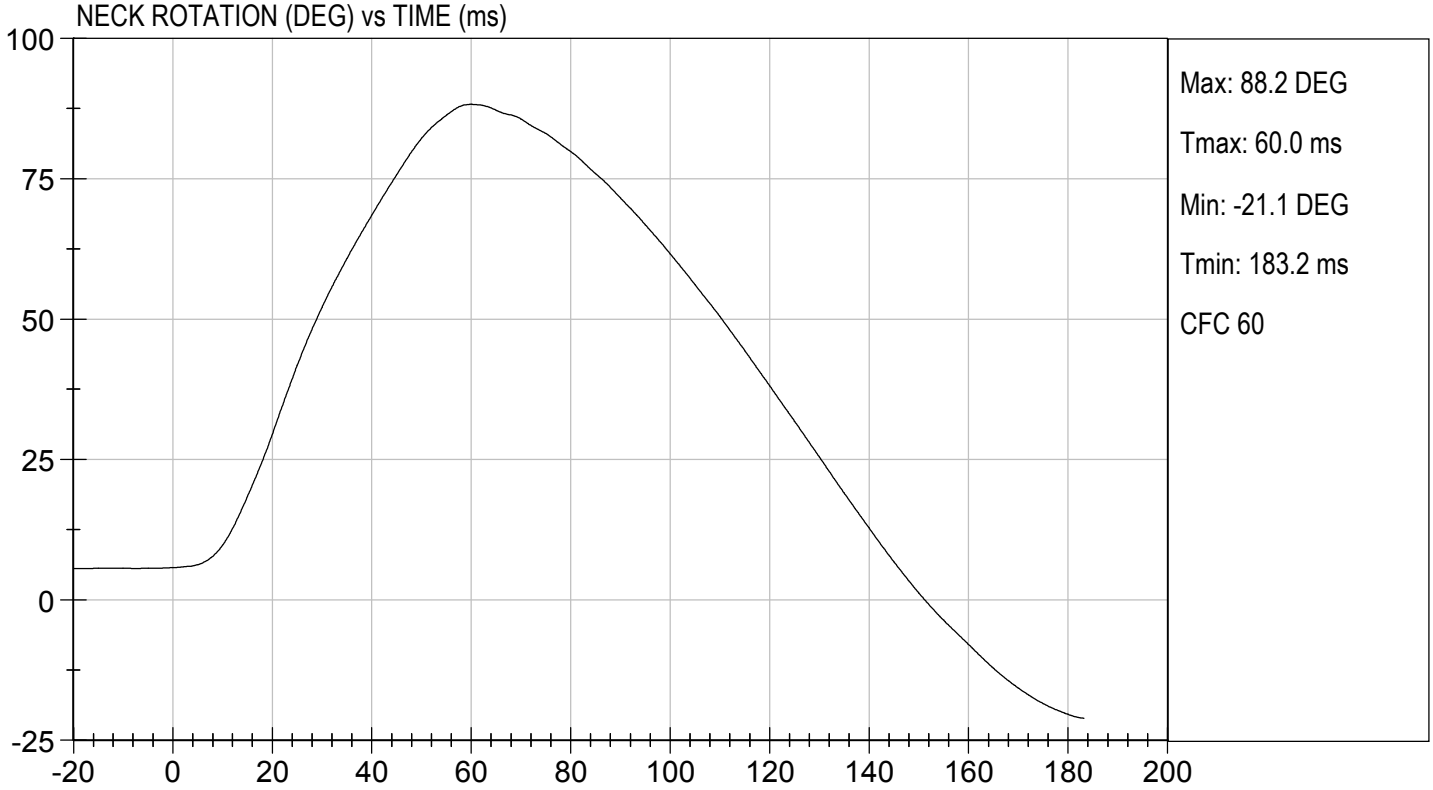
TEST DESC: NECK EXTENSION
VELOCITY: 11.90 ft/s, 3.63 m/s

TEST DATE: 10/10/2018
TEST #: D183043

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

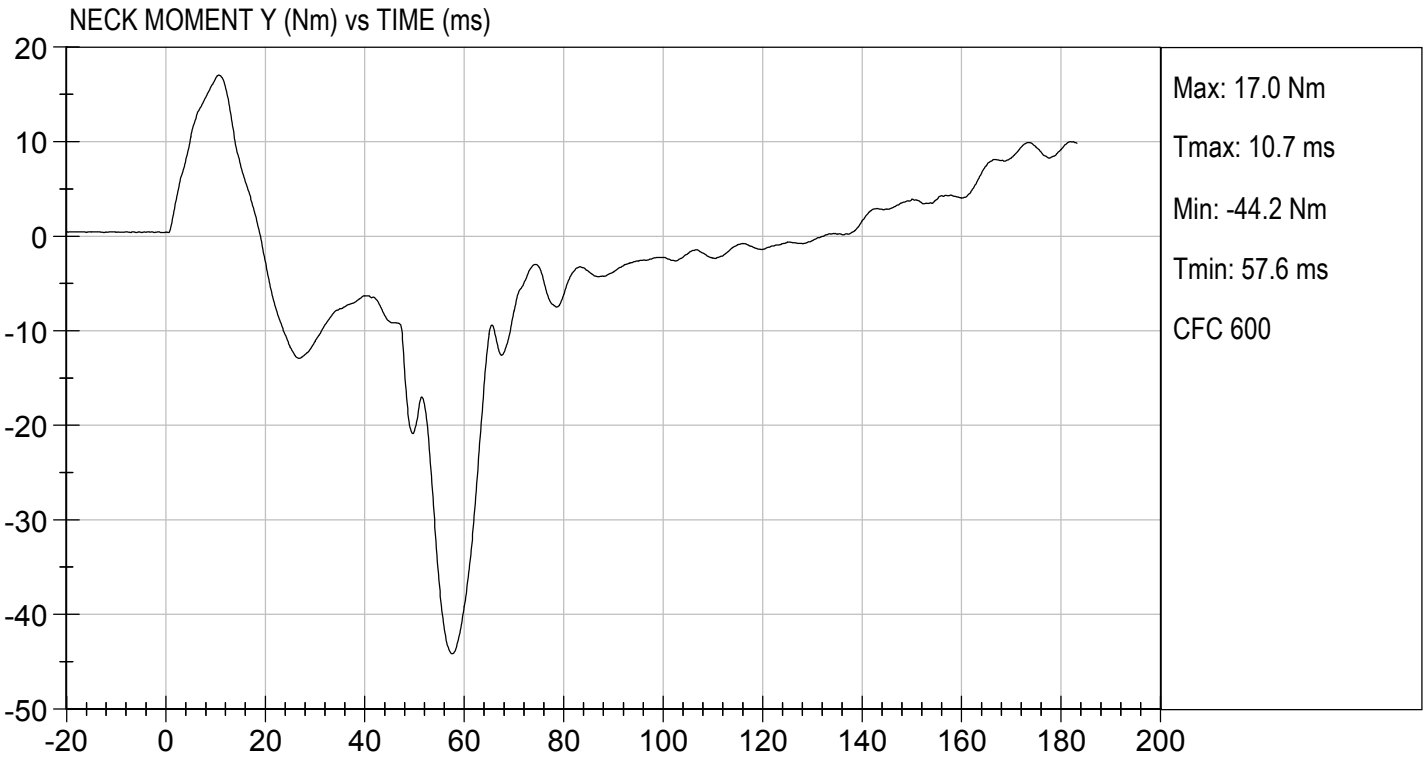


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK EXTENSION
VELOCITY: 11.90 ft/s, 3.63 m/s

TEST DATE: 10/10/2018
TEST #: D183043



MGA RESEARCH CORPORATION

THORAX IMPACT TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D183044

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	51	Pass
Probe Velocity	m/s	5.9 to 6.1	5.98	Pass
Peak Deflection	mm	32 to 38	34.4	Pass
Peak Resistive Force w/in Deflection Corridor	N	680 to 810	724	Pass
Internal Hysteresis	%	65 to 85	72.2	Pass
Max Force 12.5 mm - 32 mm Deflection	N	<= 910	752	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

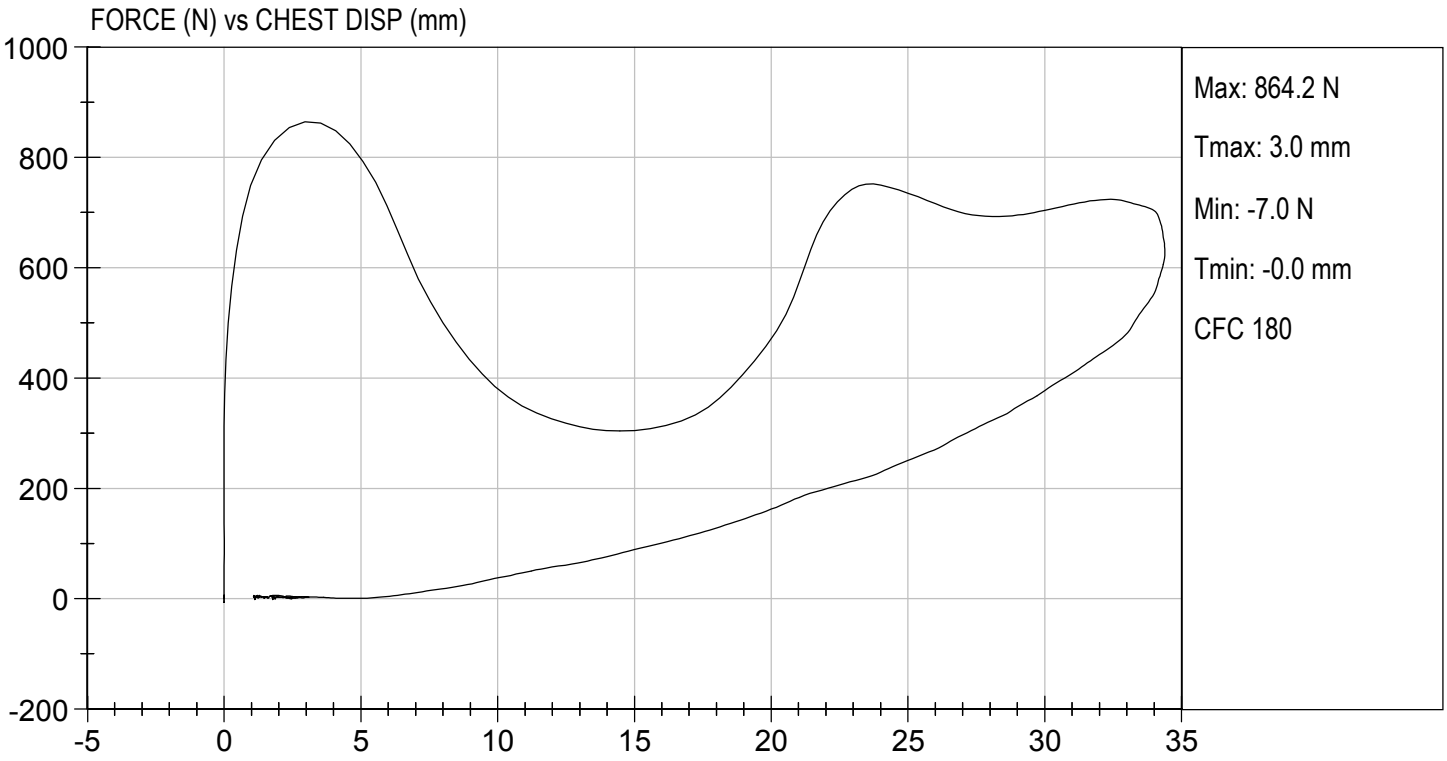
10/10/2018

Test Date

Approved By

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

TEST DATE: 10/10/2018
TEST #: D183044



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 3 YEAR OLD

ATD Serial No: 082 **Test I.D:** D183047

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	52	Pass
Initial Angle	deg	0 to 15	3	Pass
Return Angle	deg	-10 to 10	3	Pass
Force at 45 deg	N	130 to 180	176	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	1.0	Pass
		Overall Test Results		Pass

Brian Roach

Laboratory Technician

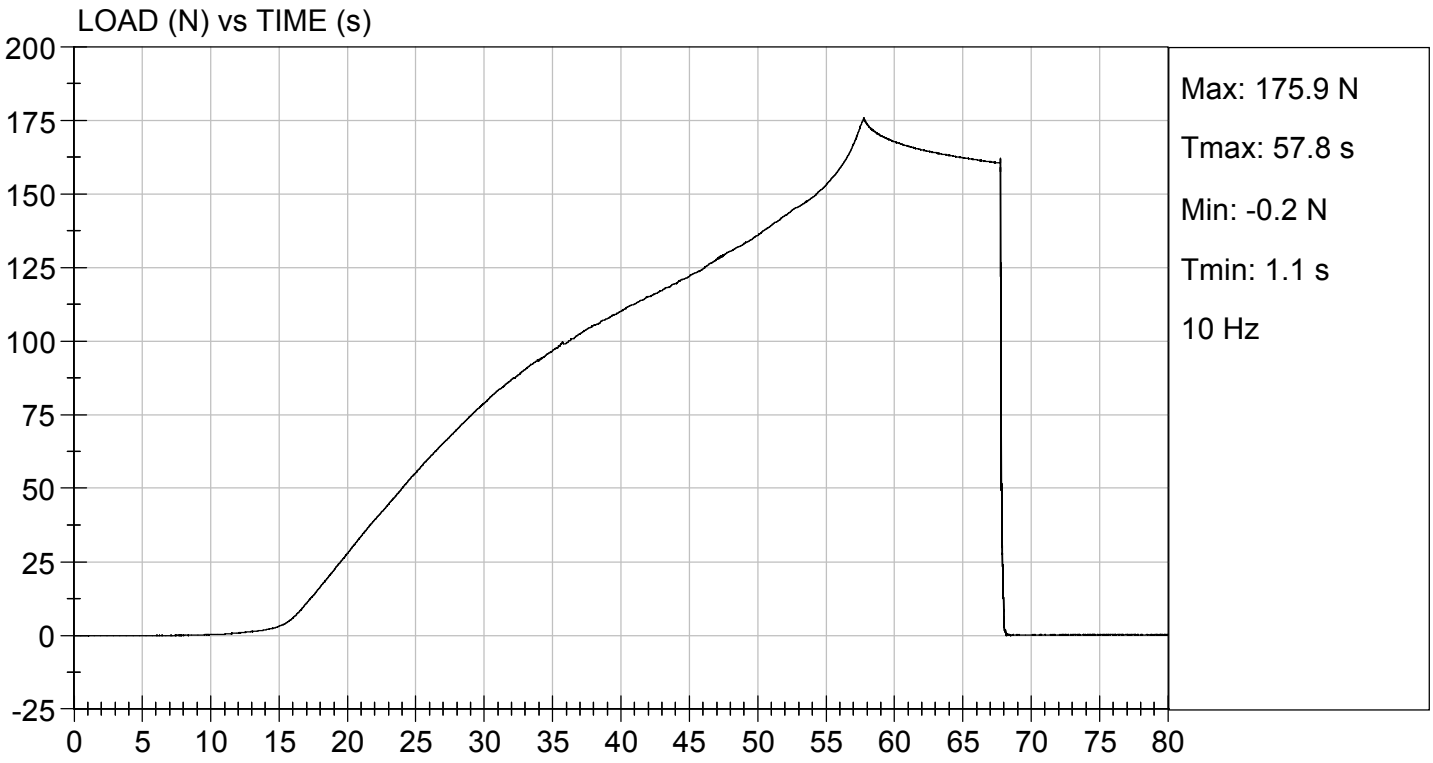
10/10/2018

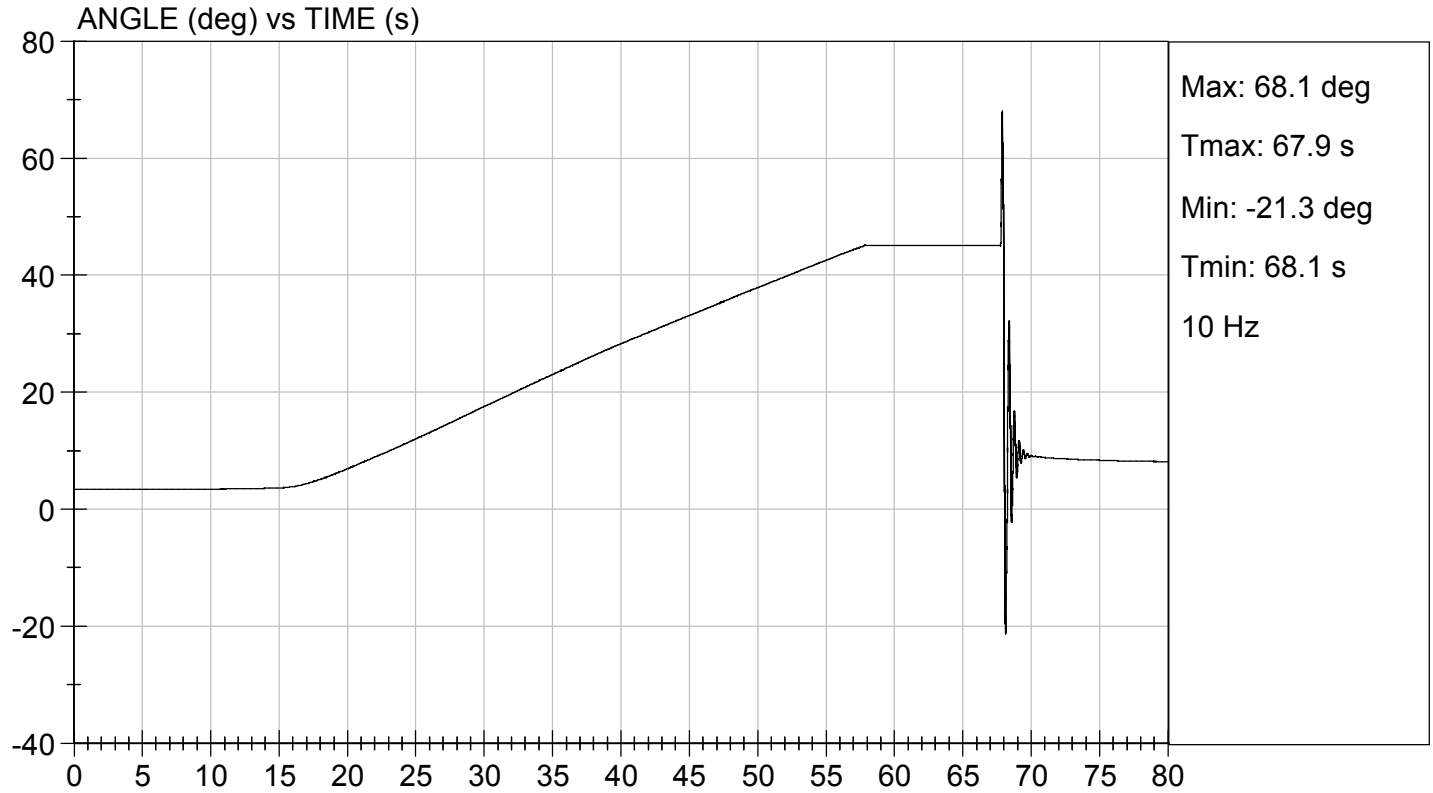
Test Date

Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 10/10/2018
TEST #: D183047





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	P88333	Endevco	09/18/18
	Y	P88334	Endevco	09/18/18
	Z	P88335	Endevco	09/18/18
Upper Neck Load Cell		NG124	FTSS	08/02/18
Lower Neck Load Cell		NG249	Denton	08/02/18
Chest Accelerometers	X	P86724	Endevco	07/30/18
	Y	P86725	Endevco	07/30/18
	Z	P86726	Endevco	07/30/18
Chest Potentiometer		082	Servo	08/02/18
Upper Sternum Accelerometer	X	P88302	Endevco	05/24/18
Lower Sternum Accelerometer	X	P88303	Endevco	09/20/18
Upper Spine Accelerometers	X	P79639	Endevco	09/19/18
	Y	P79640	Endevco	09/19/18
	Z	P79641	Endevco	09/19/18
Lower Spine Accelerometers	X	P84445	Endevco	09/19/18
	Y	P84449	Endevco	09/19/18
	Z	P88720	Endevco	09/19/18