REPORT NUMBER: TWG-CAL-20-03

NEW CAR ASSESSMENT PROGRAM (NCAP)
SIDE AIRBAG OUT-OF-POSITION TEST

Ford Motor Company
2020 Ford Transit
Wagon

NHTSA NUMBER: M20200206TWG2

PREPARED BY:
CALSPAN CORPORATION
4455 Genesee St.
BUFFALO, NEW YORK 14225

July 9, 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

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Prepared By: Matthew Pronko

Matthew Pronko, Test Engineer

Approved By: Vanessa Hansen

Vanessa Hansen, Operations Program Manager

Approval Date: July 9, 2021

FINAL REPORT ACCEPTANCE BY OCWS:

Accepted By: _____

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

Date: _____

Accepted By: _____

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

Date: _____

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16. Abstract

A side air bag out of position test was conducted on the subject 2020 Ford Transit Wagon in accordance with the specifications of the Office of Crashworthiness Standards SAB OOP NCAP Laboratory Test Procedure for the generation of consumer information on vehicle side air bag protection. The test was conducted at the Calspan Corporation Test Facility in Buffalo, New York, on August 6, 2020.

The curtain and torso side air bags were deployed and responses were measured on a Hybrid III 6 Year Old. Three high-speed cameras recorded the event. The ambient temperature at the time of air bag deployment was 21 °C

Section 3.3.3.4 – Hybrid III 6-Year-Old – Right Front Passenger Seat			
Measurement Description	**Units**	**IARV**	**Result**
Head Injury Criteria (HIC15)		723	0.75
Nij		1.0	0.147
Upper Neck Tension	N	1490	123.320
Upper Neck Compression	N	1820	-236.695
Maximum Chest Compression	mm	N/A	N/A
Maximum Chest Compression Rate	m/s	N/A	N/A

17. KEY Words: New Car Assessment Program (NCAP) Side Air Bag Out-of-Position (OOP) Technical Working Group (TWG)	18. Distribution Statement Copies of this report are available from the following: National Highway Traffic Safety Administration Technical Information Services 1200 New Jersey Ave, SE Washington, DC 20590 Email: tis@nhtsa.dot.gov FAX: 202-493-2833

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SECTION 1

PURPOSE AND PROCEDURE OF TEST:

1.1 PURPOSE

The purpose of this test was to obtain data from a static out-of-position side air bag deployment using a vehicle that had previously undergone a New Car Assessment Program (NCAP) sponsored frontal barrier impact test requested by the National Highway Traffic Safety Administration (NHTSA). This test was performed under NHTSA contract No. 693JJ919F000146.

SECTION 2

SUMMARY OF TEST RESULTS

The effects of both a seat-mounted side airbag and a curtain airbag deployment in a 2020 Ford Transit Wagon on an out-of-position Hybrid III 6-Year-Old ATD were evaluated. The test was performed by Calspan on August 6, 2020. Pre-and post-test photographs of the vehicle and ATD can be found in Appendix A.

The vehicle has previously undergone crash testing as part of the NCAP program. After conducting the crash test and before conducting the air bag deployment test, the vehicle was inspected for damage. The vehicle was found to be in good condition to undergo the air bag deployment test.

Four high-speed digital cameras were used to document the airbag deployment event. High-speed images were recorded at rates of 1000 frames per second. Cameras were placed perpendicular to the right-front passenger seat centerline, oblique, and through the passenger window to capture the deployment event from various positions.

The Hybrid III 6-Year-Old anthropomorphic test device (ATD) was placed in the right front passenger seat, inboard facing, with the head aligned with the path of the roof-rail mounted airbag module. This placement followed the ATD placement instructions in the NCAP Laboratory Test Procedure as well as 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). This orientation complies with section 3.3.5.1 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.

The Hybrid III 6-Year-Old ATD was instrumented with head x, y and z accelerometers, a six-axis upper neck load cell, and a six-axis lower neck load cell. During the air bag deployment event, a total of 22 channels of data were recorded using an on-board data acquisition system. Appendix B contains the ATD response data traces and Appendix C contains the instrumentation list and calibration information. Appendix D contains the dummy's pre-test qualification performance verification data.

No Injury Reference Values were exceeded during the test. The occupant data is summarized below:

Measurement Description	Units	Hybrid III 6-Year-Old	
		IARV	Result
Head Injury Criteria (HIC15)		723	0.75
Nij		1.0	0.147
Upper Neck Tension	N	1490	123.320
Upper Neck Compression	N	1820	-236.695

SECTION 3
DATA SHEETS

DATA SHEET NO. 1
TEST SUMMARY

Test Vehicle:	2020 Ford Transit Wagon	NHTSA No.:	M20200206TWG2
Test Program:	TWG 3.3.5.1	Test Date:	8/6/2020

TEST CONFIGURATION INFORMATION

Seating Position:	P2	Position 2 – Right Front Passenger
Test:	3.3.5.1	Inboard Facing 6YO on Booster Block
Airbag: 1	Curtain	Curtain
Airbag: 2	Seat/Torso	Torso/Pelvic
Booster Block:	Foam	300 mm x 450 mm x 75 mm with density 40-80 g/l
ATD Type/Serial No.:	6YO	Hybrid III 6YO Serial No:158
Vehicle	Ford	Transit Wagon
Previous Crash Test	NCAP	NCAP Frontal – NHTSA No. M20200206

EQUIPMENT INFORMATION

Number of Data Channels	22
Number of High Speed Video Cameras	4
Number of Real Time Video Cameras	0

VISIBLE DUMMY CONTACT POINTS

Head Contact:	Curtain Airbag
Upper Torso Contact:	Curtain Airbag & Torso/Pelvic Airbag
Lower Torso Contact:	Curtain Airbag, Torso/Pelvic Airbag & Dashboard
Knee Contact:	Seat Pan
Foot Contact:	None

DATA SHEET NO. 2
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Ford Transit Wagon NHTSA No.: M20200206TWG2
Test Program: TWG 3.3.5.1 Test Date: 8/6/2020

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20200206TWG2
Model Year	2020
Make	Ford
Model	Transit
Body Style	Wagon
VIN	1FBAX2Y87LKA00516
Body Color	Silver
Odometer Reading (km /mi)	147.2
Engine Displacement (L)	3.5
Type / No. Cylinders	V6
Engine Placement	Inline
Transmission Type	Automatic
Transmission Speeds	10-Speed
Overdrive	Yes
Final Drive	Rear Wheel Drive
Roof Rack	No
Sunroof / T-Top	No
Running Boards	Yes
Tilt Steering Wheel	Yes
Power Seats	No
Anti-Lock Brakes (ABS)	Yes

Traction Control System (TCS)	Yes
Auto-Leveling System	No
Automatic Door Locks (ADLs)	Yes
Power Window Auto-Reverse	No
Other Optional Feature	-
Driver Frontal Airbag	Yes
Driver Curtain Airbag	Yes
Driver Head/Torso Airbag	No
Driver Torso Airbag	No
Driver Torso/Pelvis Airbag	Yes
Driver Pelvis Airbag	No
Driver Knee Airbag	No
Rear Pass. Curtain Airbag	Yes
Rear Pass. Head/Torso Airbag	No
Rear Pass. Torso Airbag	No
Rear Pass. Torso/Pelvis Airbag	No
Rear Pass. Pelvis Airbag	No
Driver Pretensioner	Yes
Rear Pass. Pretensioner	No
Driver Load Limiter	Yes
Rear Pass. Load Limiter	No
Other Safety Restraint	-

DATA FROM CERTIFICATION LABEL

Manufactured By	Ford Motor Co.
Date of Manufacture	10/19
Vehicle Type	BUS

GVWR (kg)	4196
GAWR Front (kg)	1873
GAWR Rear (kg)	2622

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Fourth	Total	
Designated Seating Capacity (DSC)	2	3	3	4	12	
Capacity Wt. (VCW) (kg)					1405	(A)
DSC x 68.04 (kg)					816.48	(B)
Cargo Wt. (RCLW) (kg)					588.52	(A-B)

VEHICLE SEAT TYPE

Seating Location	Type of Seat Pan				Type of Seatback		
	Bucket	Bench	Split Bench	Contoured	Fixed	Adjustable w/lever	Adjustable w/knob
Front Seat	X					X	
Rear or Second Row		X			X		
Third Row			X		X		

DATA SHEET NO. 3
SEAT ADJUSTMENT DATA

Test Vehicle:	2020 Ford Transit Wagon	NHTSA No.:	M20200206TWG2
Test Program:	TWG 3.3.5.1	Test Date:	8/6/2020

VEHICLE SEAT FORE / AFT POSITION

Seat Location	Total Fore / Aft Travel		Test Position from Forwardmost Position	
	mm	Detents*	mm	Detent*
Front Right	248	37 (0-36)	0	0 (Forwardmost)
Rear Right	N/A	N/A	N/A	N/A

TWG Seat Fore/Aft Guideline Reference	
Seat Fore/Aft Position Per TWG Guidelines	Adjust the seat track position to minimize the vertical distance between the dummy's head and the roof-rail module and to maximize the cushion to head interaction.
Reason for Deviation from TWG Guidelines	No deviation from TWG Guidelines

VEHICLE SEAT FORE / AFT POSITION

Seat Location	Total Seat Back Angle Range		Test Position from Most Upright (Vertical)	
	Degrees	Detents*	Degrees	Detents*
Front Right	-	-	1.7	23
Rear Right	N/A	N/A	N/A	N/A

TWG Seat Back Guideline Reference	
OEM Seat Back Angle Design Position	+1.5 Degrees
Method of Measuring Seat Back Angle Position	Headrest Post
Seat Back Angle Position Per TWG Guidelines	+1.7 Degrees
Reason for Deviation from TWG Guidelines	No Deviation from TWG Guidelines

VEHICLE SEAT HEIGHT ADJUSTMENT

Seat Location	Total Height Adjustment Range		Test Position from Lowermost Position	
	mm	Detents*	mm	Detent*
Front Right	N/A	N/A	Not Adjustable	N/A
Rear Right	N/A	N/A	N/A	N/A

TWG Seat Back Guideline Reference	
Seat Height Position Per TWG Guidelines	Seat is adjusted to its highest position
Reason for Deviation from TWG Guidelines	No Deviation from TWG guidelines

DATA SHEET NO. 4
DUMMY SETUP AND POSITIONING DATA

Test Vehicle:	2020 Ford Transit Wagon	NHTSA No.:	M20200206TWG2
Test Program:	TWG 3.3.5.1	Test Date:	8/6/2020

DUMMY INFORMATION

ATD Type:	Hybrid III 6-Year-Old
Serial Number:	158
Qualification Date:	July 23, 2020
Qualification Type:	Full Qualification
Clothing:	Cotton knit shirt and pants
Other ATD Prep:	Skullcap seam was taped with 4mm wide electrical tape and the ATD's head was cleaned with alcohol and dusted with baby powder.
ATD Temperature:	21° C

DUMMY POSITIONING INFORMATION

TWG Setup Instructions:	Place the dummy with its arms hanging at its sides on the foam block facing inboard with its legs extended. Adjust the seat track position forward to minimize the vertical distance between the dummy's head and the roof-rail module and to maximize the cushion to head interaction. Keeping the head in its neutral orientation, slide the dummy's pelvis outboard until the dummy's back contacts the door trim panel or armrest and the center of gravity of the head is centered in the deployment trajectory of the airbag. It may be necessary to tilt the dummy outboard in order to achieve proper alignment of the head. A vertical plane through the centerline of the dummy's shoulder bolts should be parallel to the vehicle centerline. Bend the dummy's arms at the elbow until the fingers just touch the booster seat.
Actual Setup:	The dummy was placed with its arms hanging at its sides on the foam block facing inboard with its legs extended. The seat track position was moved to the full forward position to minimize the vertical distance between the dummy's head and the roof-rail module and to maximize the cushion to head interaction. Keeping the head in its neutral orientation, the dummy's pelvis was slid outboard until the dummy's back contacted the armrest and the center of gravity of the head is centered in the deployment trajectory of the airbag. A vertical plane through the centerline of the dummy's shoulder bolts was established parallel to the vehicle centerline. The dummy's arms were bent at the elbow until the fingers initially touched the booster seat.

DATA SHEET NO. 5
DUMMY INJURY CRITERIA DATA

Test Vehicle: 2020 Ford Transit Wagon NHTSA No.: M20200206TWG2
Test Program: TWG 3.3.5.1 Test Date: 8/6/2020

RECORDED DATA – MINIMUMS AND MAXIMUMS

Channel	Units	Max	Time (ms)	Min	Time (ms)
V1P2 Head x [CFC_1000]	g's	2.65	22.00	-2.15	8.05
V1P2 Head y [CFC_1000]	g's	6.78	14.25	-2.09	253.80
V1P2 Head z [CFC_1000]	g's	4.04	11.70	-6.74	13.30
V1P2 Headform Resultant [CFC_1000]	g's	9.55	14.30	0.00	-17.45
V1P2 Upper Neck Mocy [CFC_600]	Nm	3.37	22.55	-5.17	88.40
V1P2 Upper Neck Ntf [CFC_600]	-	0.06	21.15	0.00	-50.00
V1P2 Upper Neck Nte [CFC_600]	-	0.15	88.20	0.00	-49.90
V1P2 Upper Neck Ncf [CFC_600]	-	0.10	15.45	0.00	-50.00
V1P2 Upper Neck Nce [CFC_600]	-	0.05	13.15	0.00	-50.00
V1P2 Upper Neck Nij [CFC_600]	-	0.15	88.20	0.00	-28.95
V1P2 Upper Neck Fx [CFC_1000]	N	36.97	66.80	-40.25	26.50
V1P2 Upper neck Fy [CFC_1000]	N	141.50	15.25	-63.32	254.55
V1P2 Upper neck Fz [CFC_1000]	N	123.32	11.65	-236.69	14.95
V1P2 Neck Force Resultant [CFC_1000]	N	271.75	14.95	0.09	-10.35
V1P2 Upper Neck Mx [CFC_600]	Nm	8.62	24.75	-14.38	14.35
V1P2 Upper Neck My [CFC_600]	Nm	3.33	21.40	-4.63	88.45
V1P2 Upper Neck Mz [CFC_600]	Nm	3.46	16.60	-2.79	65.75
V1P2 Neck Moment Resultant [CFC_600]	Nm	14.65	14.35	0.00	-28.75
V1P2 Lower Neck Fx F [CFC_1000]	N	44.23	16.45	-84.63	29.60
V1P2 Lower Neck Fy F [CFC_1000]	N	177.41	13.30	-86.89	239.20
V1P2 Lower Neck Fz F [CFC_1000]	N	143.05	11.35	-291.15	14.85
V1P2 Lower Neck Force Resultant [CFC_1000]	N	338.55	14.80	0.04	-23.25
V1P2 Lower Neck Mx F [CFC_600]	Nm	16.86	38.45	-14.01	255.05
V1P2 Lower Neck My F [CFC_600]	Nm	10.29	14.60	-9.61	69.10
V1P2 Lower Neck Mz F [CFC_600]	Nm	8.85	29.55	-4.35	254.90
V1P2 Lower Neck Moment Resultant [CFC_600]	Nm	18.96	29.50	0.00	-0.25
Curtain Airbag Volts	V	15.15	1.15	-0.00	40.00
Torso/Pelvis Airbag Volts	V	15.62	0.30	-0.00	-19.80
Front Center Airbag Volts	V	-	-	-	-
Curtain Airbag Current	A	19.94	6.85	-0.00	114.00
Torso/Pelvis Airbag Current	A	6.43	0.25	-0.03	38.45
Front Center Airbag Current	A	-	-	-	-

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

Test Vehicle: 2020 Ford Transit Wagon NHTSA No.: M20200206TWG2
Test Program: TWG 3.3.5.1 Test Date: 8/6/2020

HEAD INJURY SUMMARY

H15	T1 (ms)	T2 (ms)	HIC36	T1 (ms)	T2 (ms)
0.75	12.45	18.10	N/A	N/A	N/A

NECK INJURY SUMMARY

Injury Criteria	Units	Value	Time(ms)
Upper Neck NTF		0.056	21.150
Upper Neck NTE		0.147	88.200
Upper Neck NCF		0.101	15.450
Upper Neck NCE		0.054	13.150
Peak Tension	N	123.320	11.65
Peak Compression	N	-236.695	14.95

CHEST INJURY SUMMARY

Injury Criteria	Units	Value	Time(ms)
Chest/Rib Deflection	mm	N/A	N/A
Deflection Rate[1]	m/s	N/A	N/A

[1](Describe deflection rate calculation method)

RESEARCH INJURY SUMMARY

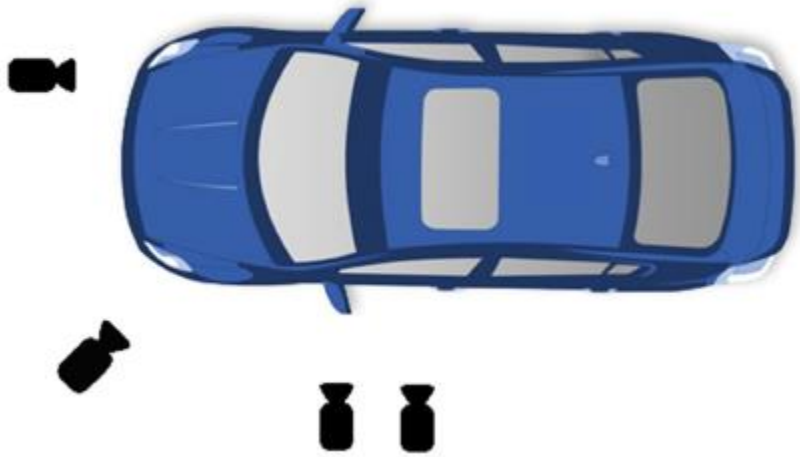
Research Injury Criteria	Units	Value	Time(ms)
Upper Neck Lateral Moment	Nm	-14.38	14.35
Upper Neck Twist Moment	Nm	3.46	16.60
Lower Neck Flexion Moment	Nm	10.29	14.60
Lower Neck Extension Moment	Nm	-9.61	69.10
Lower Neck Lateral Moment	Nm	16.86	38.45
Lower Neck Twist Moment	Nm	8.85	29.55
Lower Neck Tension	N	143.05	11.35
Lower Neck Compression	N	-291.15	14.85
Spine Acceleration	G	NA	NA

Note: These injury criteria are only monitored and not considered pass/fail

DATA SHEET NO. 6
CAMERA SETUP AND DESCRIPTION

Test Vehicle:	2020 Ford Transit Wagon	NHTSA No.:	M20200206TWG2
Test Program:	TWG 3.3.5.1	Test Date:	8/6/2020

CAMERA SETUP DIAGRAM FOR SAB OOP TESTS



CAMERA LOCATIONS

No.	Camera View	Coordinates (mm)			Lens Length (mm)	Speed (fps)
		X	Y	Z		
1	Left View	-1549	1583	-2005	12.5	1000
2	Oblique View	773	-1226	-2016	50	1000
3	Front View	-1234	-1057	-1685	24	1000
4	Real Time (Optional)	-690	604	-1742	12.5	1000

Reference:

+X = To Forward of vehicle
+Y = To Right of vehicle
+Z = Down into ground

Appendix A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Figure A-1: Right Front ¾ View of Test Vehicle As Delivered

Figure A-2: Vehicle Certification Label

Figure A-3: Pre-Test Vehicle Left Side View

Figure A-4: Post-Test Vehicle Left Side View

Figure A-5: Pre-Test Vehicle Location of Airbag 1

Figure A-6: Pre-Test Vehicle Location of Airbag 2

Figure A-7: Pre-Test Vehicle Location of Airbag 3

Figure A-8: Pre-Test Vehicle Seat Back Angle

Figure A-9: Pre-Test Dummy Left Side View

Figure A-10: Post-Test Dummy Left Side View

Figure A-11: Pre-Test Dummy Left Side Close-up View

Figure A-12: Post-Test Dummy Left Side Close-up View

Figure A-13: Pre-Test Dummy Left ¾ Front View

Figure A-14: Post-Test Dummy Left ¾ View

Figure A-15: Pre-Test Dummy Left ¾ Close-up View

Figure A-16: Post-Test Dummy Left ¾ Close-up View

Figure A-17: Pre-Test Dummy Front View

Figure A-18: Post-Test Dummy Front View

Figure A-19: Pre-Test Dummy Front Close-up View

Figure A-20: Post-Test Dummy Front Close-up View

Figure A-21: Pre-Test Dummy Right ¾ Front View

Figure A-22: Post-Test Dummy Right ¾ Front View

Figure A-23: Pre-Test Dummy Right Side View

Figure A-24: Post-Test Dummy Right Side View

Figure A-25: Post-Test Dummy Right Side View (Door Open)

Figure A-26: Post-Test Curtain Air Bag Left Side View

Figure A-27: Post-Test Curtain Air Bag Left ¾ Front View

Figure A-28: Post-Test Curtain Air Bag Front View

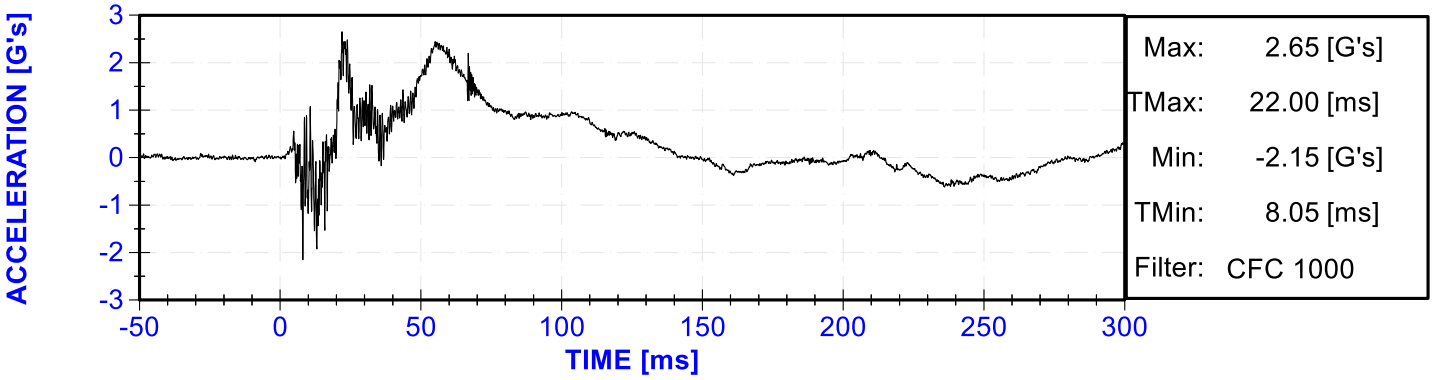
Figure A-29: Post-Test Curtain Air Bag Right Side View (Door Open)

APPENDIX B

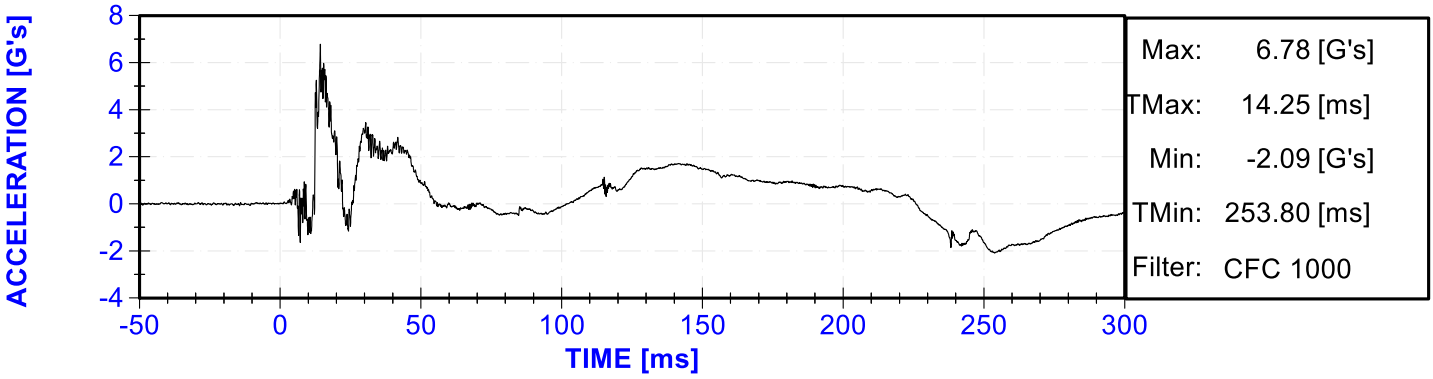
DUMMY RESPONSE DATA PLOTS

Table of Data Plots

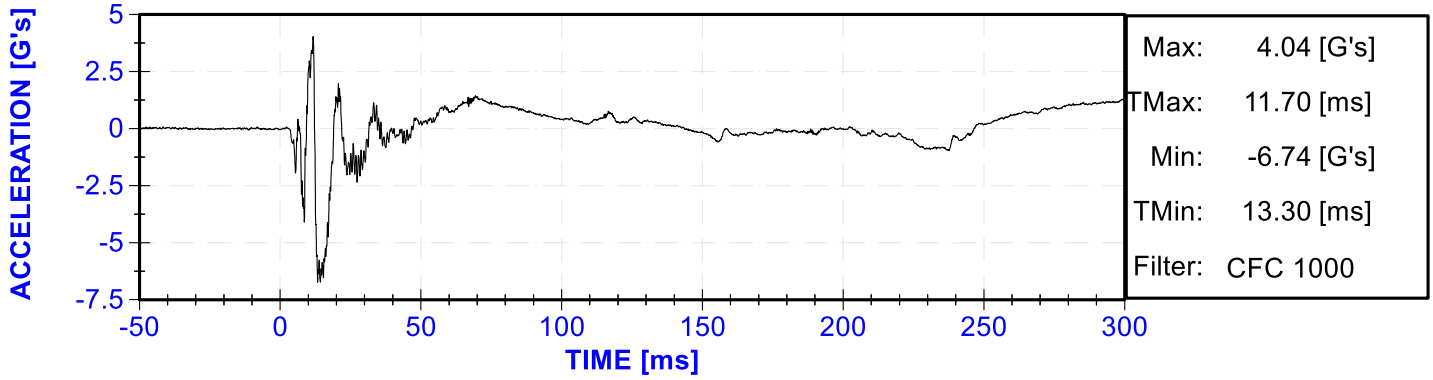
Head CG X Acceleration



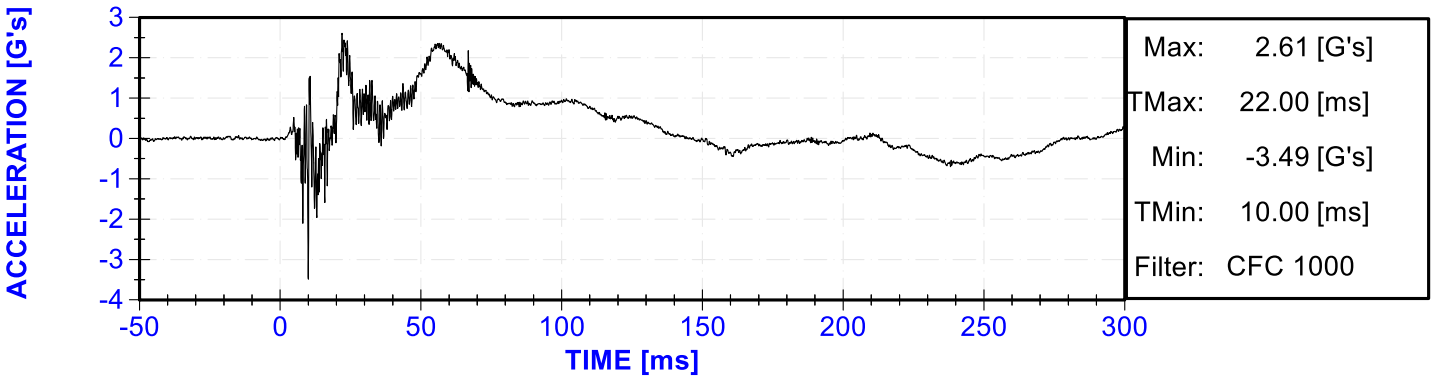
Head CG Y Acceleration

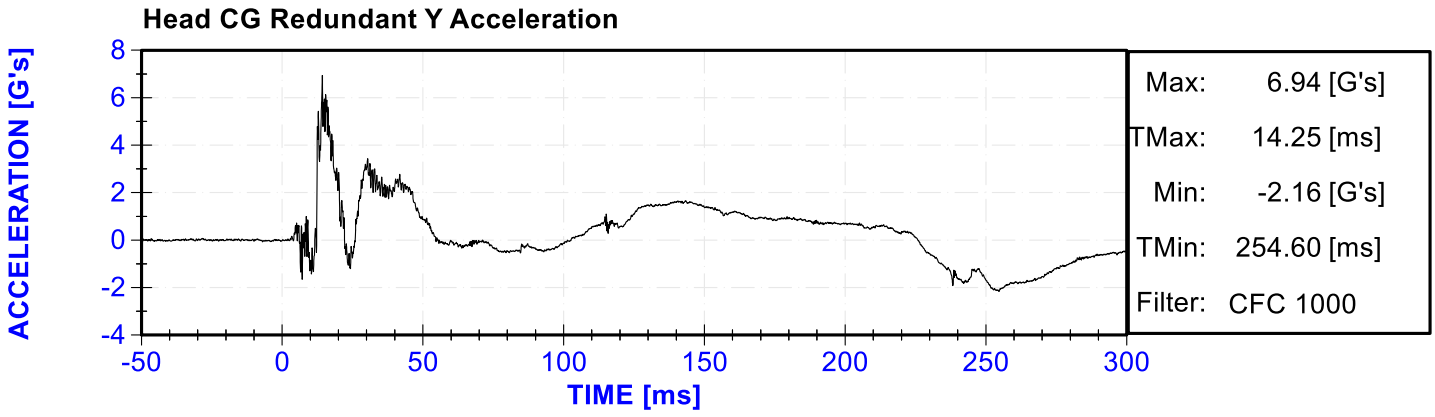


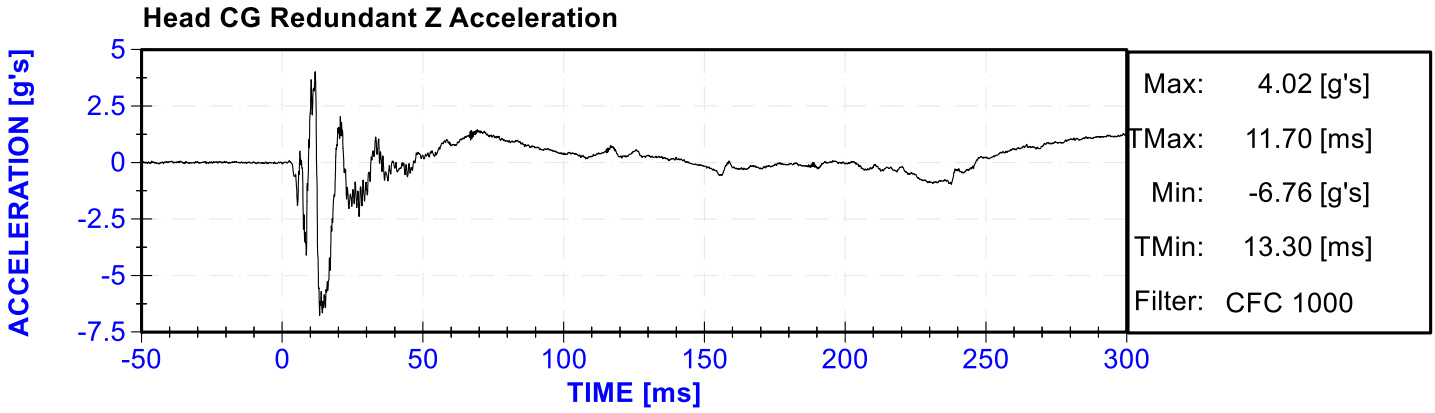
Head CG Z Acceleration

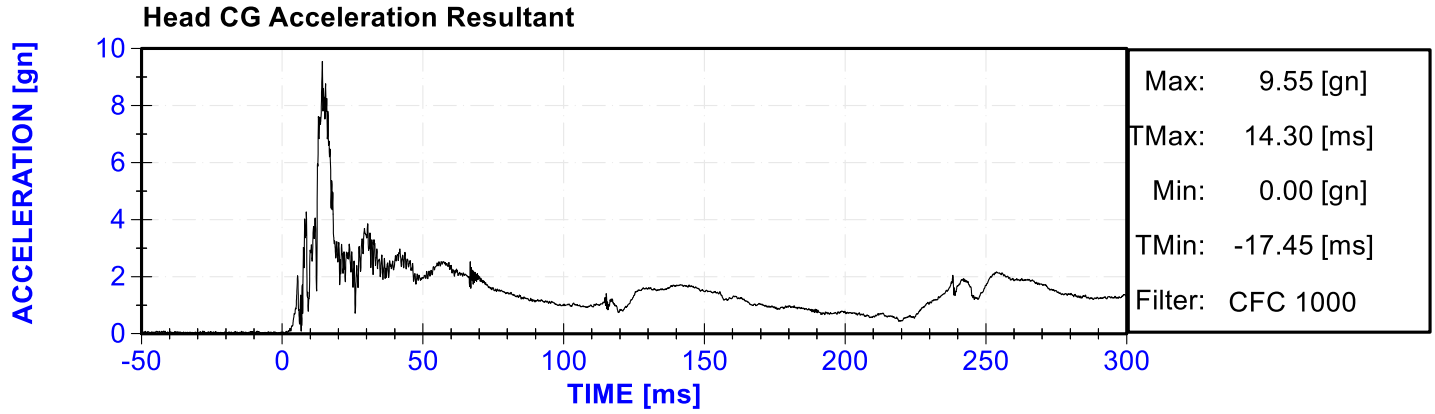


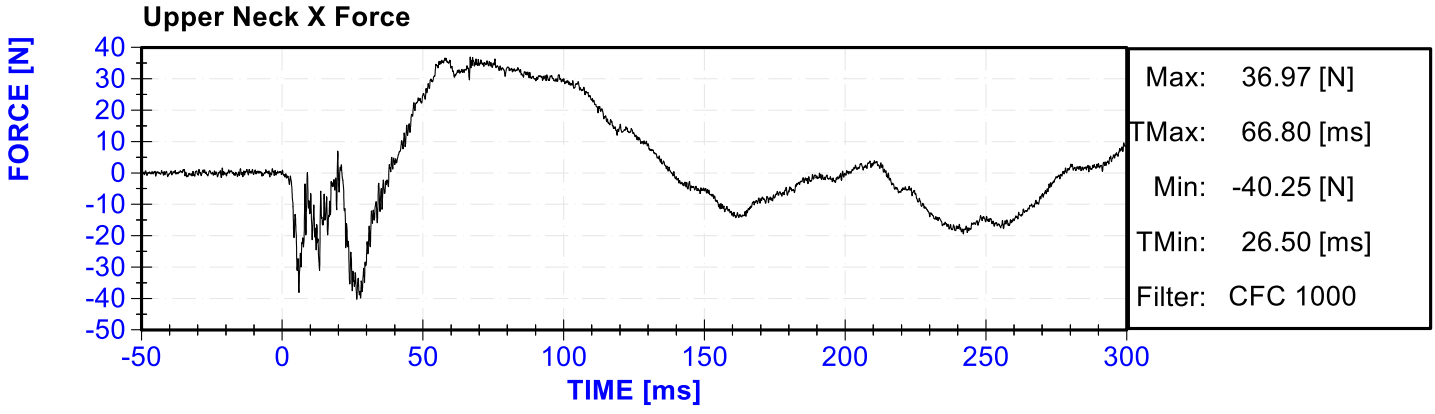
Head CG Redundant X Acceleration

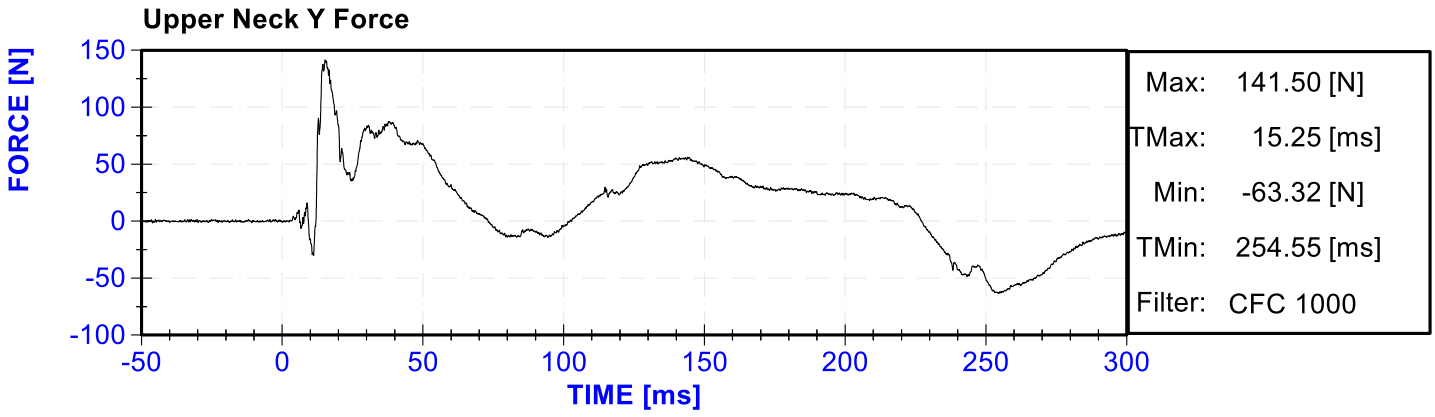


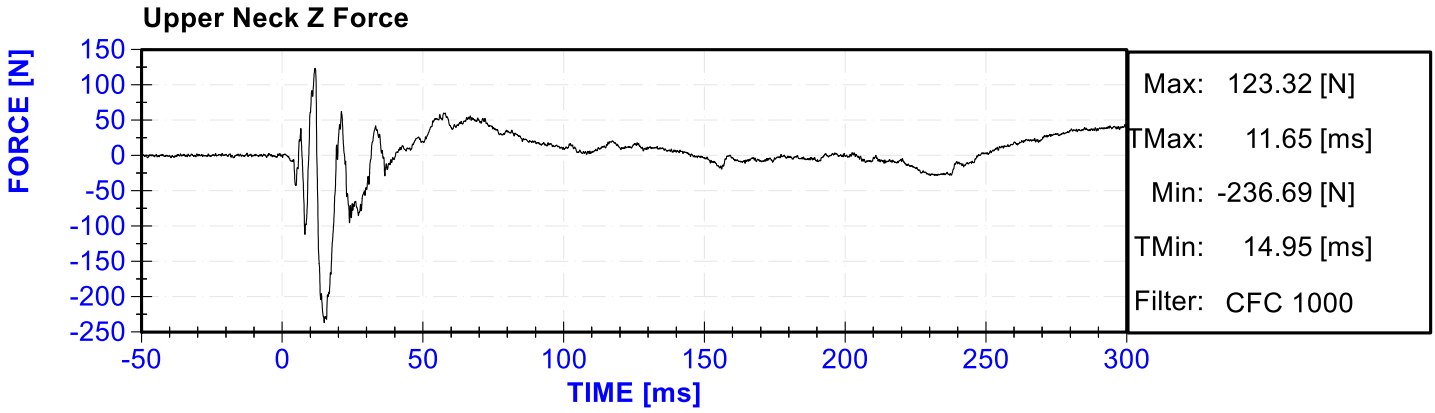

Head CG Redundant Y Acceleration
ACCELERATION [G's]
TIME [ms]
Max: 6.94 [G's]
TMax: 14.25 [ms]
Min: -2.16 [G's]
TMin: 254.60 [ms]
Filter: CFC 1000

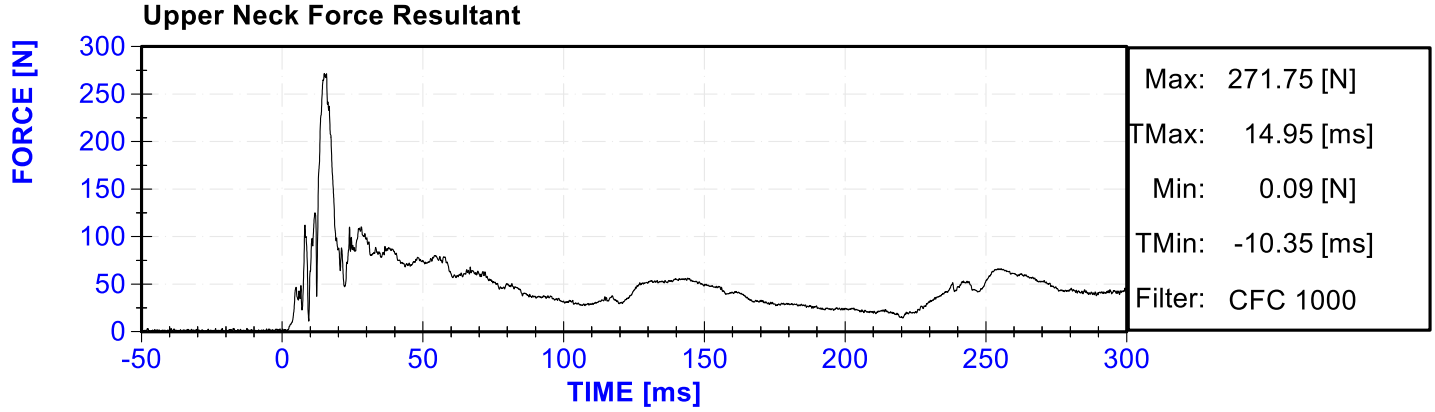

Head CG Redundant Z Acceleration
ACCELERATION [g's]
TIME [ms]
Max: 4.02 [g's]
TMax: 11.70 [ms]
Min: -6.76 [g's]
TMin: 13.30 [ms]
Filter: CFC 1000

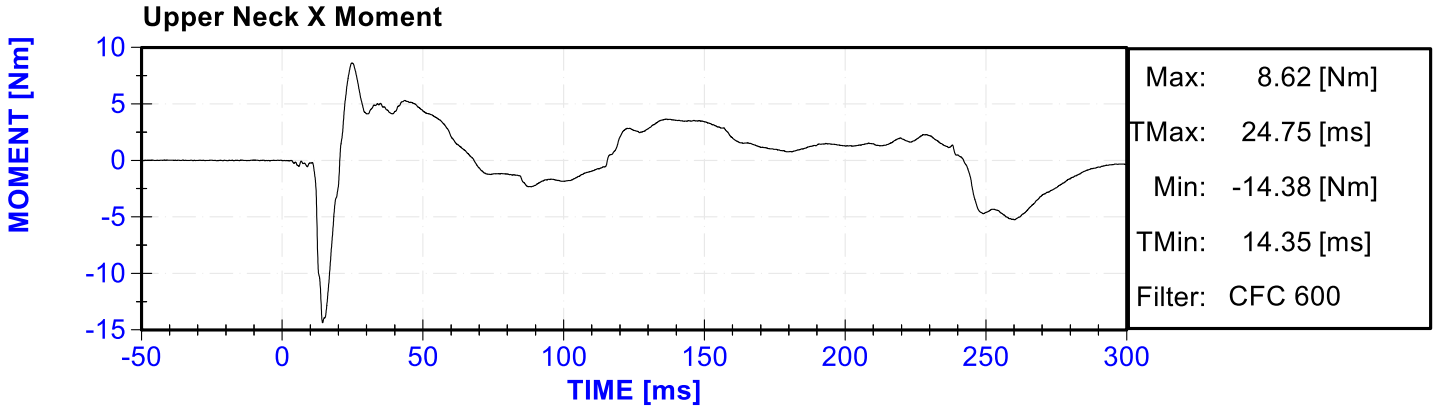

Head CG Acceleration Resultant
ACCELERATION [gn]
TIME [ms]
Max: 9.55 [gn]
TMax: 14.30 [ms]
Min: 0.00 [gn]
TMin: -17.45 [ms]
Filter: CFC 1000

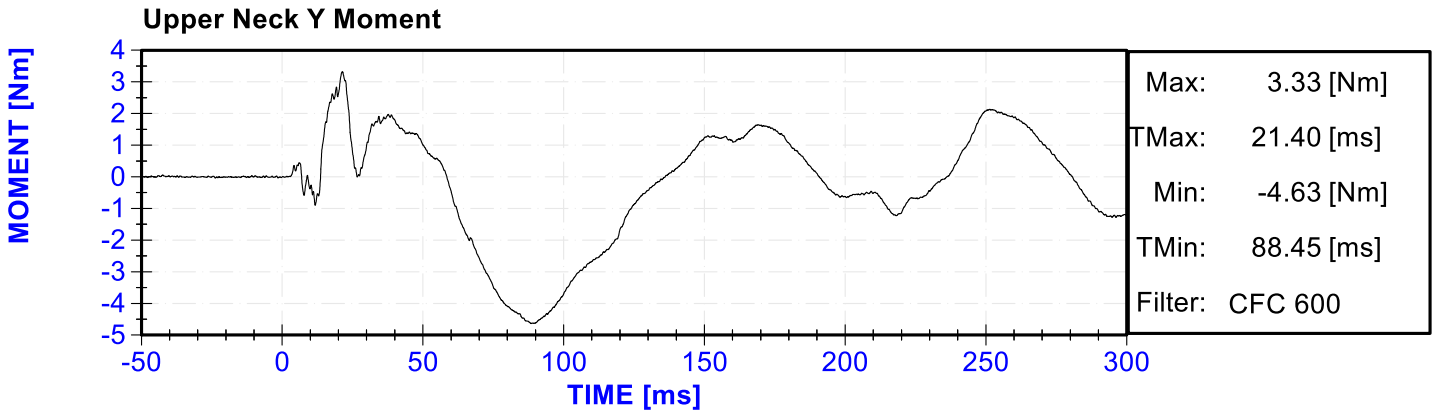

Upper Neck X Force
FORCE [N]
TIME [ms]
Max: 36.97 [N]
TMax: 66.80 [ms]
Min: -40.25 [N]
TMin: 26.50 [ms]
Filter: CFC 1000

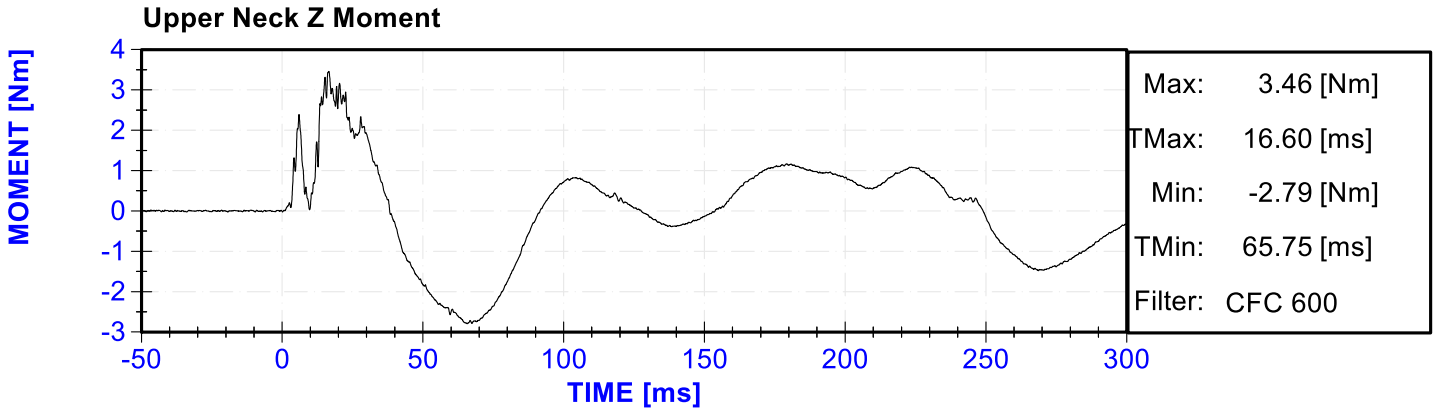

Upper Neck Y Force
FORCE [N]
TIME [ms]
Max: 141.50 [N]
TMax: 15.25 [ms]
Min: -63.32 [N]
TMin: 254.55 [ms]
Filter: CFC 1000

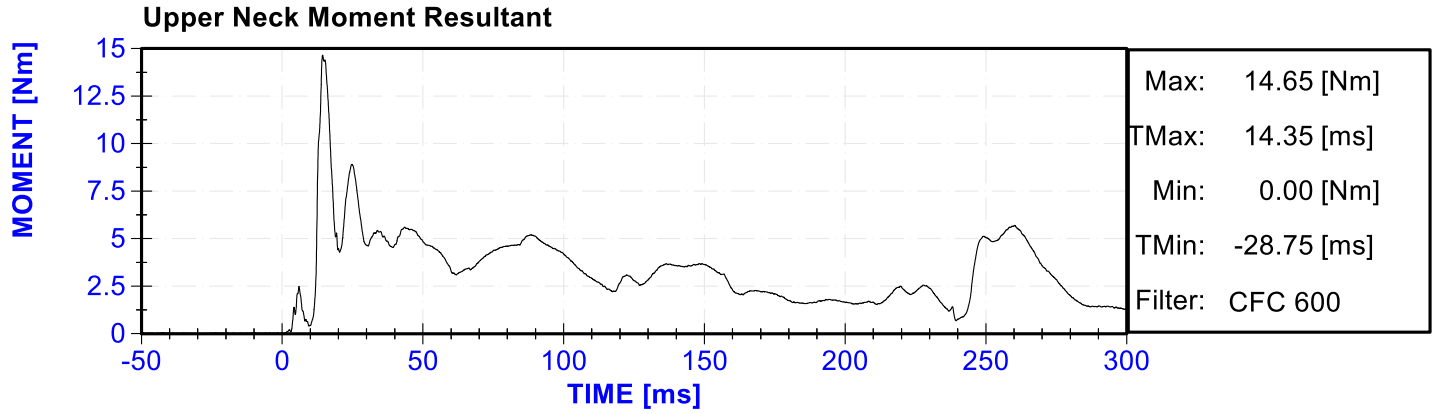

Upper Neck Z Force
FORCE [N]
TIME [ms]
Max: 123.32 [N]
TMax: 11.65 [ms]
Min: -236.69 [N]
TMin: 14.95 [ms]
Filter: CFC 1000

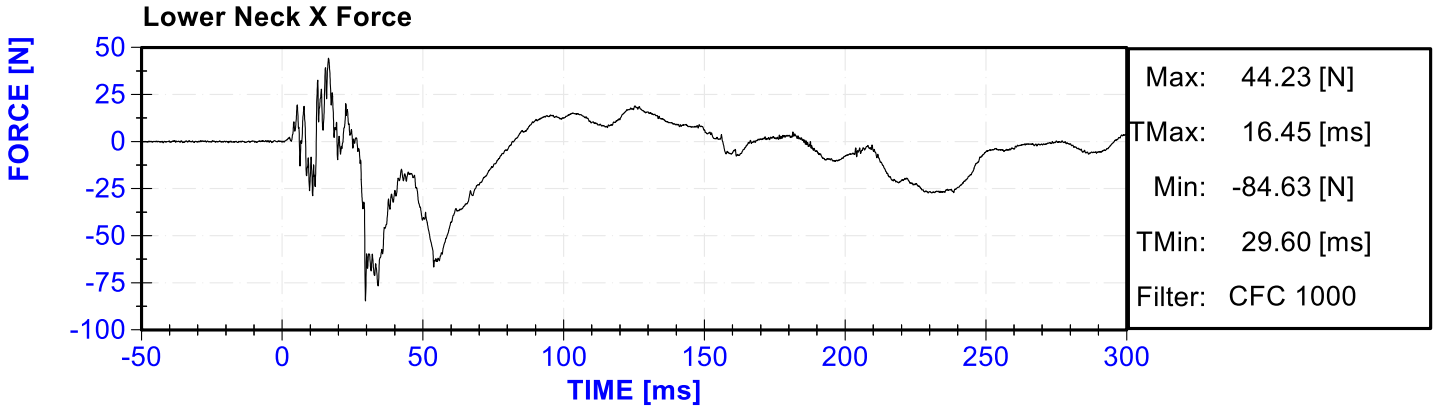

Upper Neck Force Resultant
FORCE [N]
TIME [ms]
Max: 271.75 [N]
TMax: 14.95 [ms]
Min: 0.09 [N]
TMin: -10.35 [ms]
Filter: CFC 1000

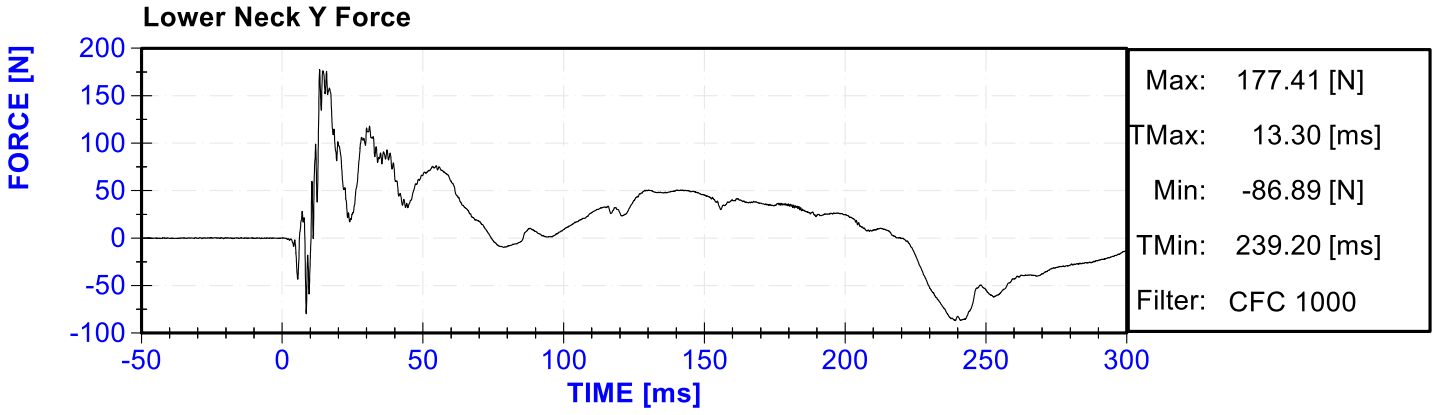

Upper Neck X Moment
MOMENT [Nm]
TIME [ms]
Max: 8.62 [Nm]
TMax: 24.75 [ms]
Min: -14.38 [Nm]
TMin: 14.35 [ms]
Filter: CFC 600

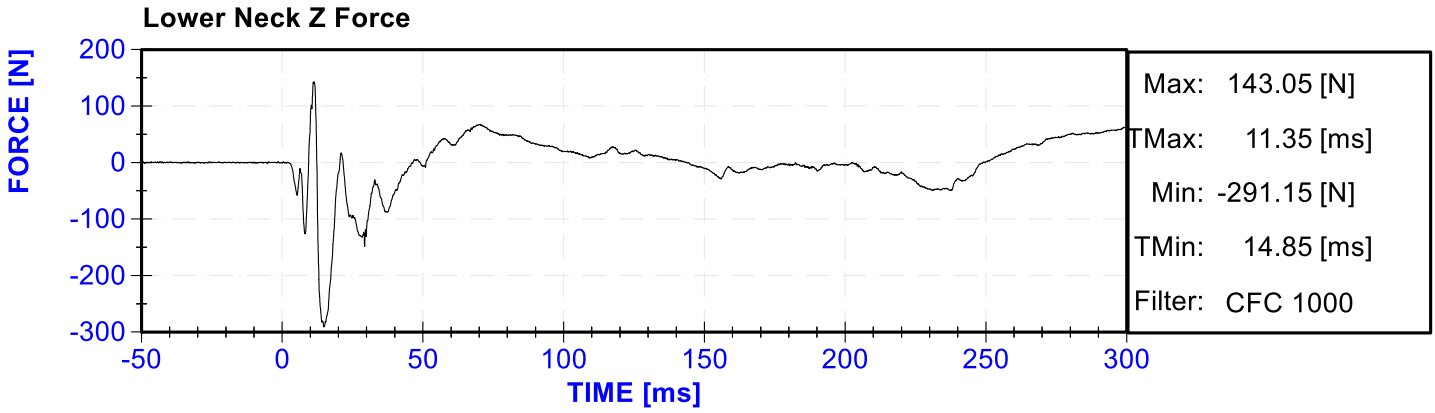

Upper Neck Y Moment
MOMENT [Nm]
TIME [ms]
Max: 3.33 [Nm]
TMax: 21.40 [ms]
Min: -4.63 [Nm]
TMin: 88.45 [ms]
Filter: CFC 600

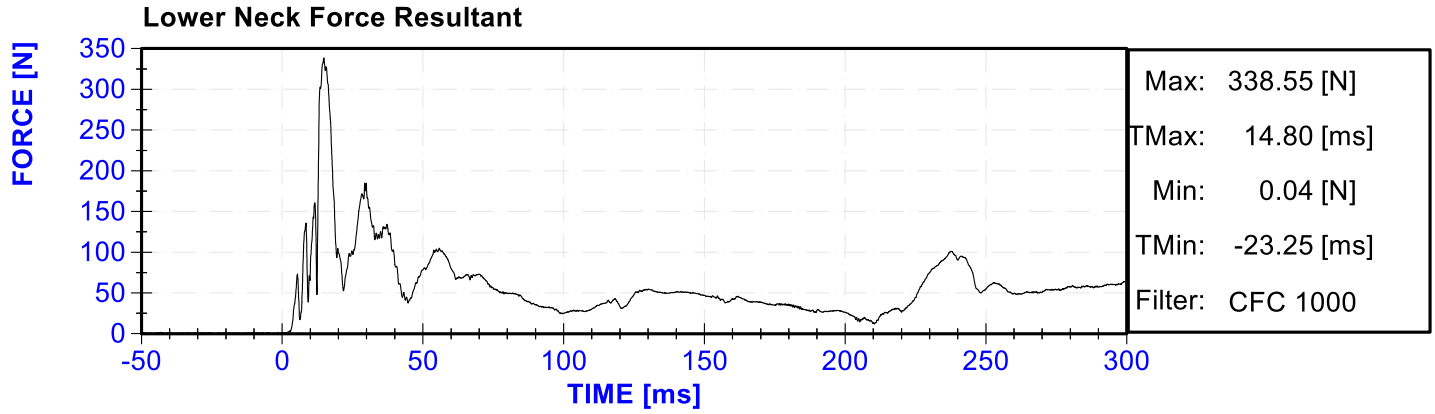

Upper Neck Z Moment
MOMENT [Nm]
TIME [ms]
Max: 3.46 [Nm]
TMax: 16.60 [ms]
Min: -2.79 [Nm]
TMin: 65.75 [ms]
Filter: CFC 600

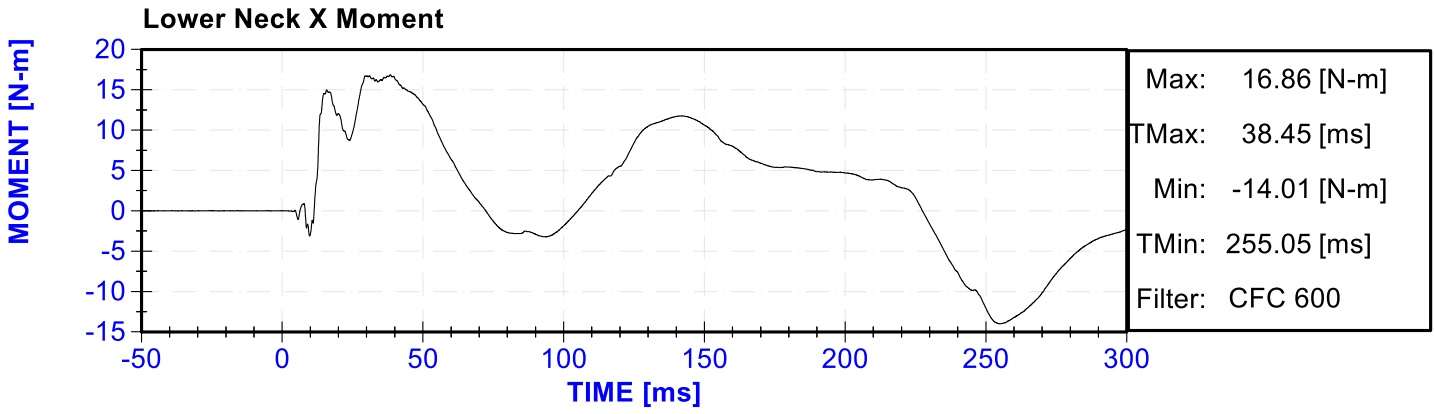

Upper Neck Moment Resultant
MOMENT [Nm]
TIME [ms]
Max: 14.65 [Nm]
TMax: 14.35 [ms]
Min: 0.00 [Nm]
TMin: -28.75 [ms]
Filter: CFC 600


Lower Neck X Force
FORCE [N]
TIME [ms]
Max: 44.23 [N]
TMax: 16.45 [ms]
Min: -84.63 [N]
TMin: 29.60 [ms]
Filter: CFC 1000

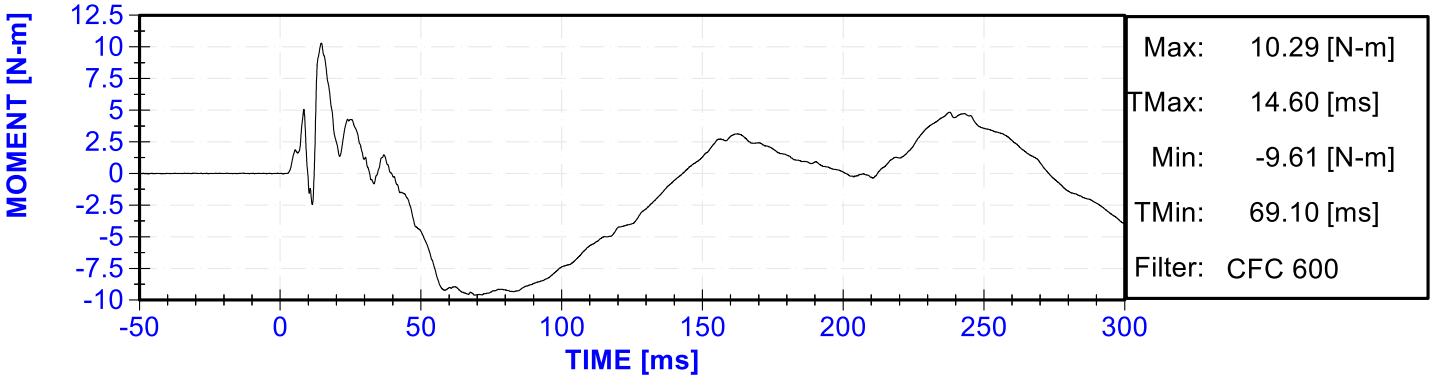

Lower Neck Y Force
FORCE [N]
TIME [ms]
Max: 177.41 [N]
TMax: 13.30 [ms]
Min: -86.89 [N]
TMin: 239.20 [ms]
Filter: CFC 1000


Lower Neck Z Force
FORCE [N]
TIME [ms]
Max: 143.05 [N]
TMax: 11.35 [ms]
Min: -291.15 [N]
TMin: 14.85 [ms]
Filter: CFC 1000

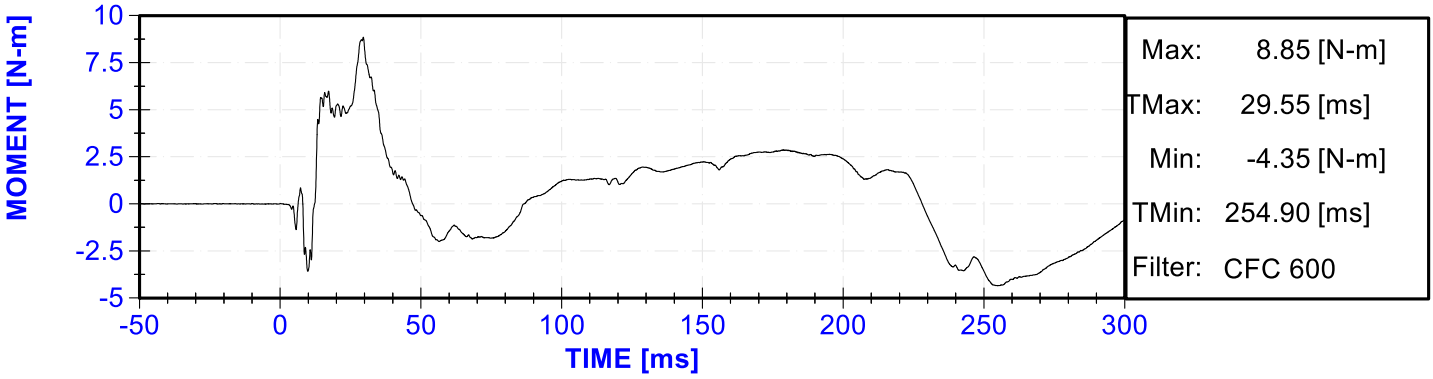

Lower Neck Force Resultant
FORCE [N]
TIME [ms]
Max: 338.55 [N]
TMax: 14.80 [ms]
Min: 0.04 [N]
TMin: -23.25 [ms]
Filter: CFC 1000


Lower Neck X Moment
MOMENT [N-m]
TIME [ms]
Max: 16.86 [N-m]
TMax: 38.45 [ms]
Min: -14.01 [N-m]
TMin: 255.05 [ms]
Filter: CFC 600

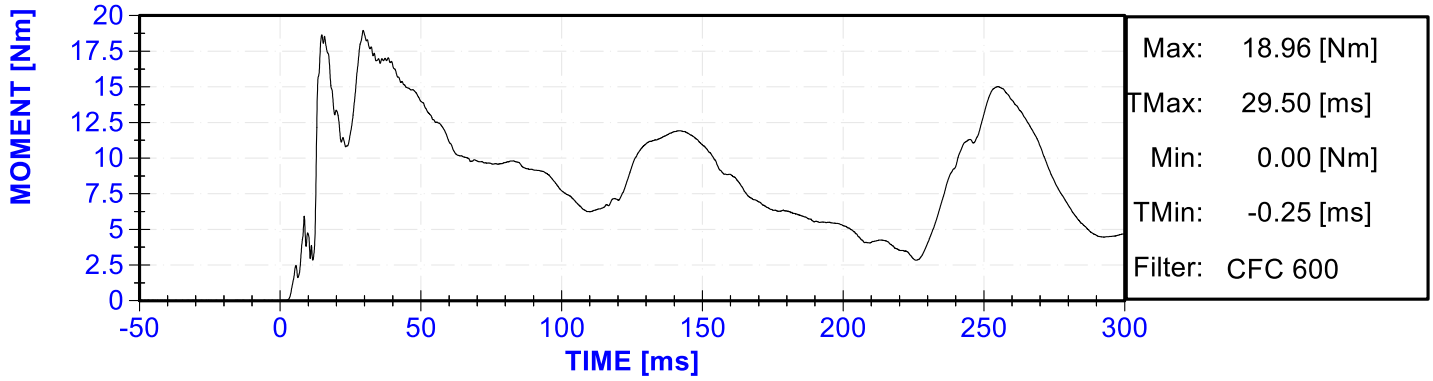
Lower Neck Y Moment



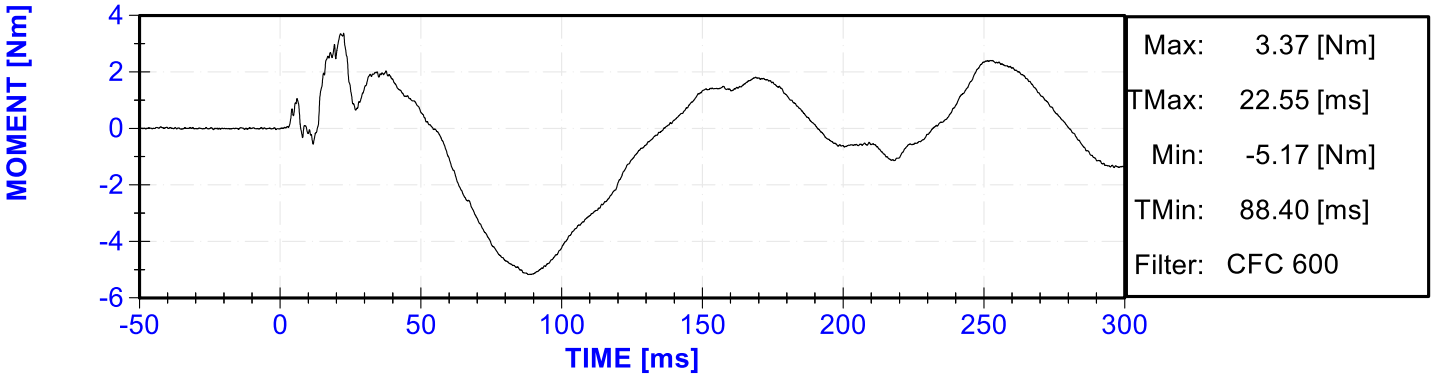
Lower Neck Z Moment



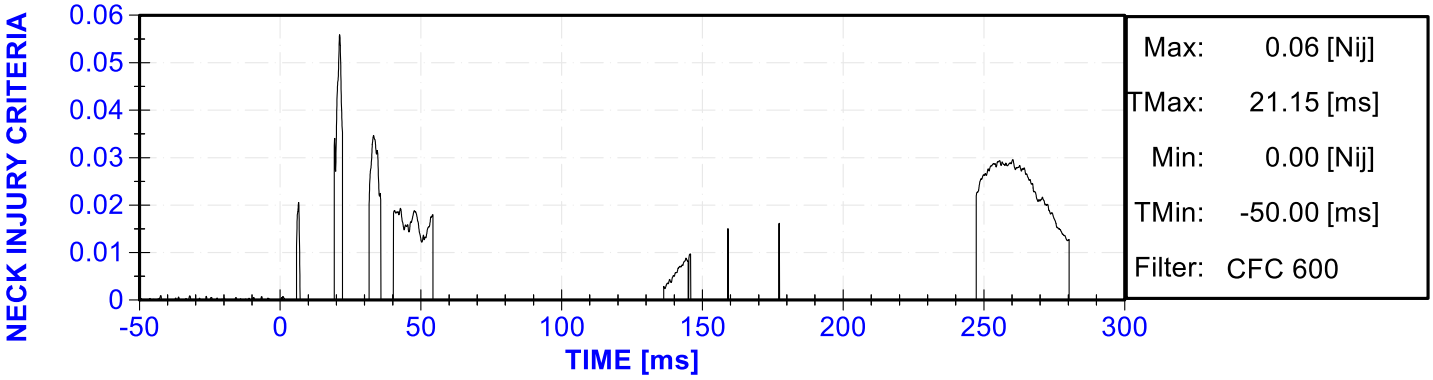
Lower Neck Moment Resultant



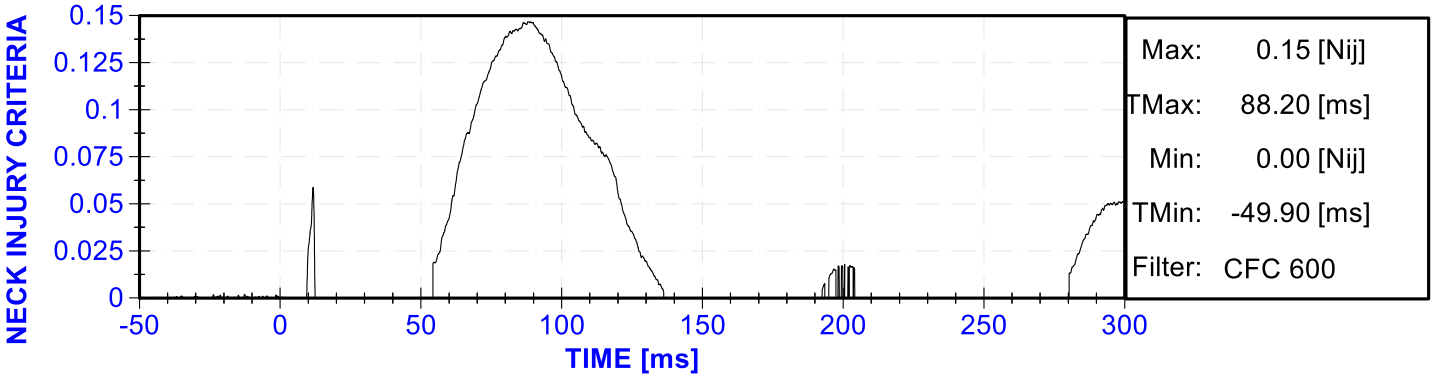
Total Moment about the OC



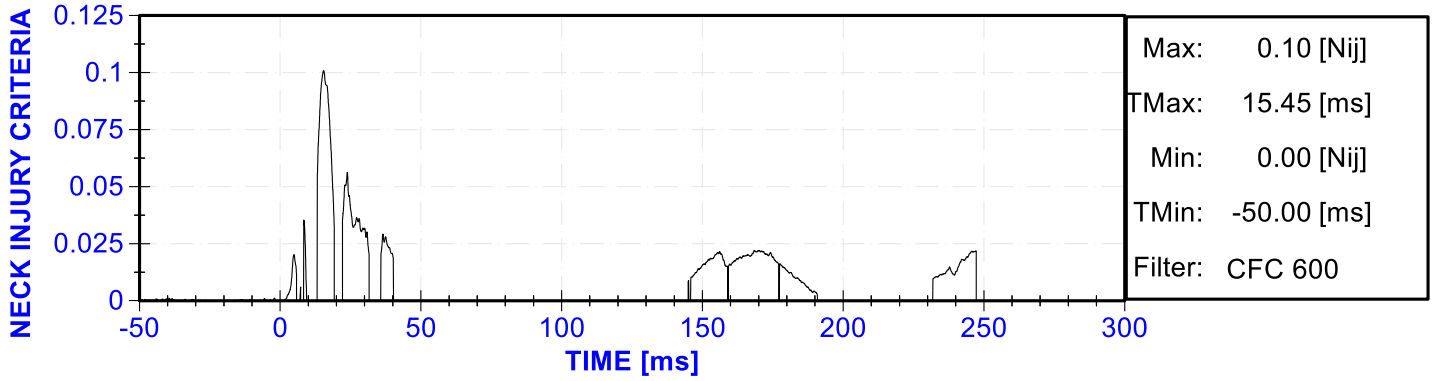
Neck Tension-Flexion Injury



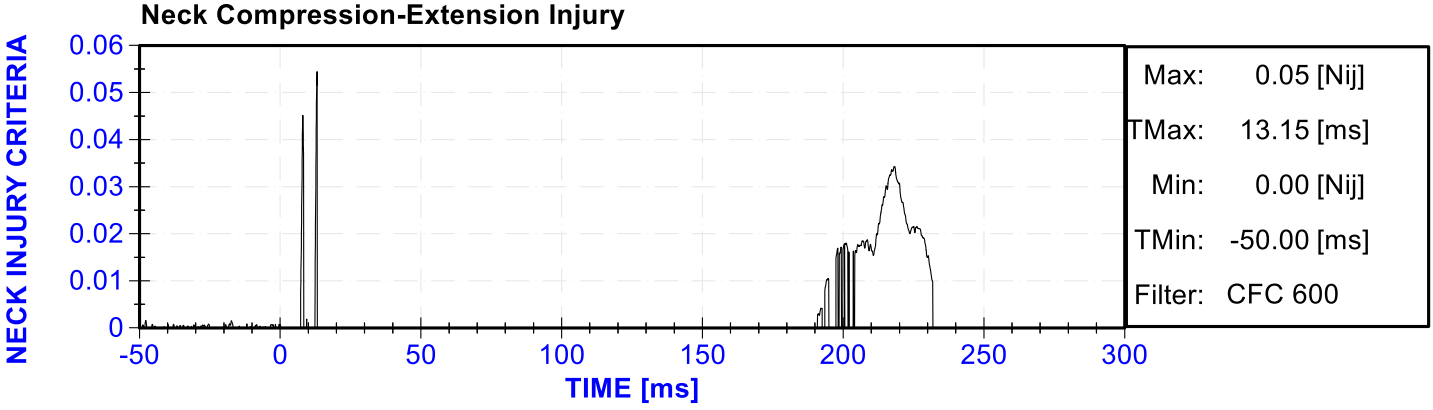
Neck Tension-Extension Injury



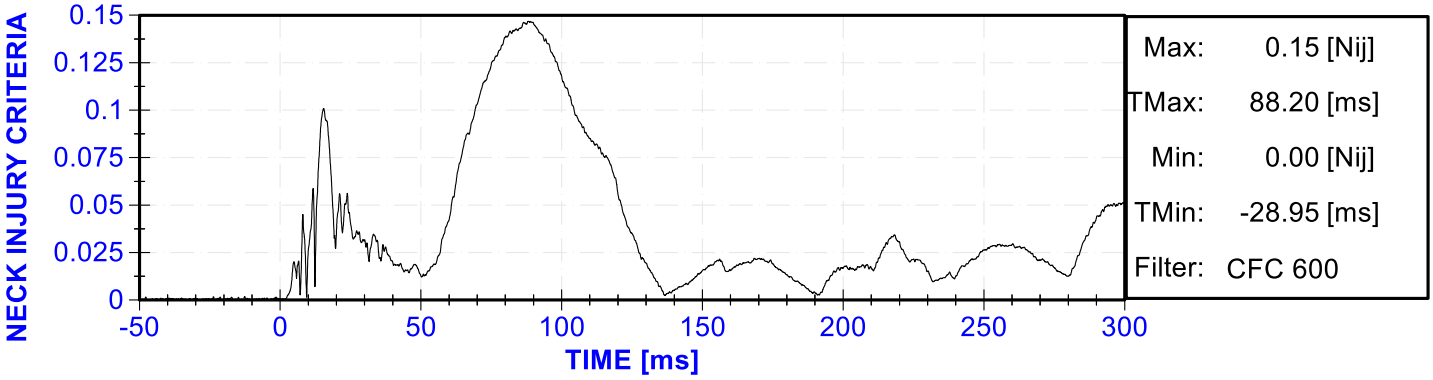
Neck Compression-Flexion Injury



Neck Compression-Extension Injury

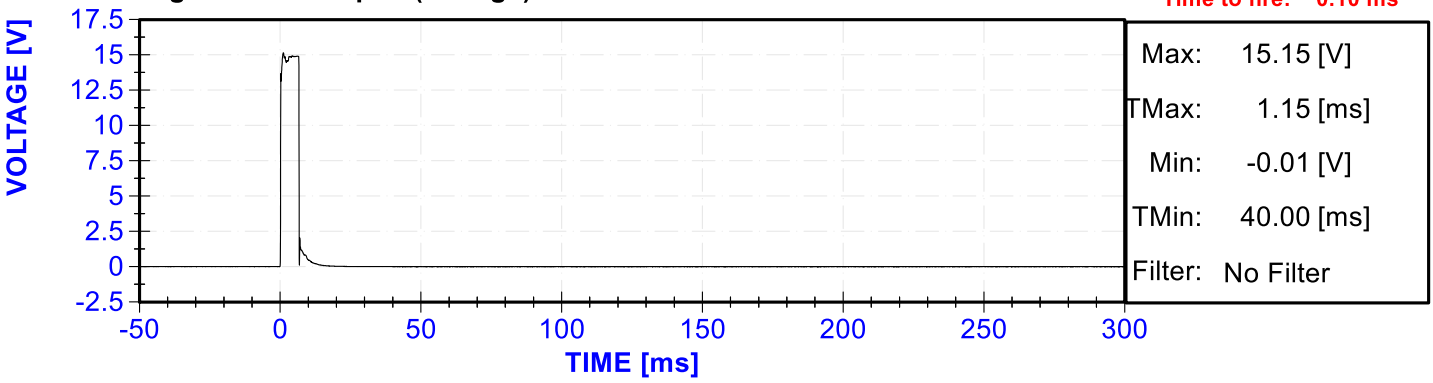


Total Neck Injury



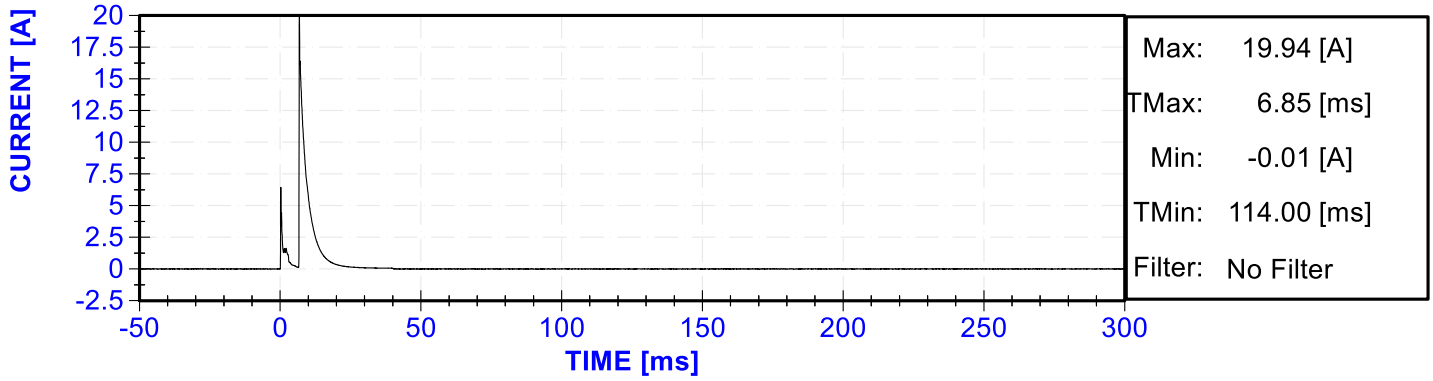
Right Curtain Squib (Voltage)

Time to fire: 0.10 ms



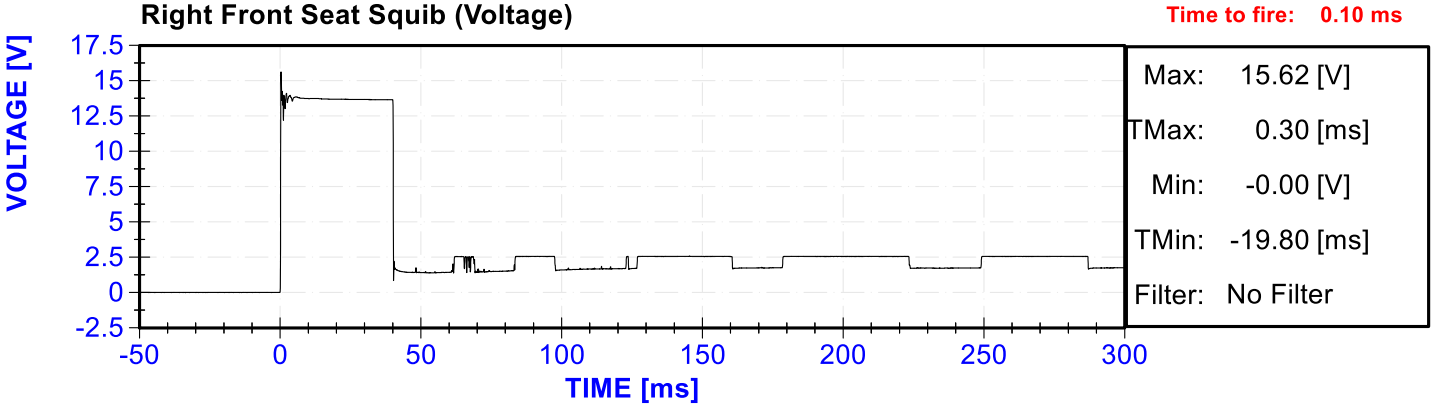
Right Curtain Squib (Current)

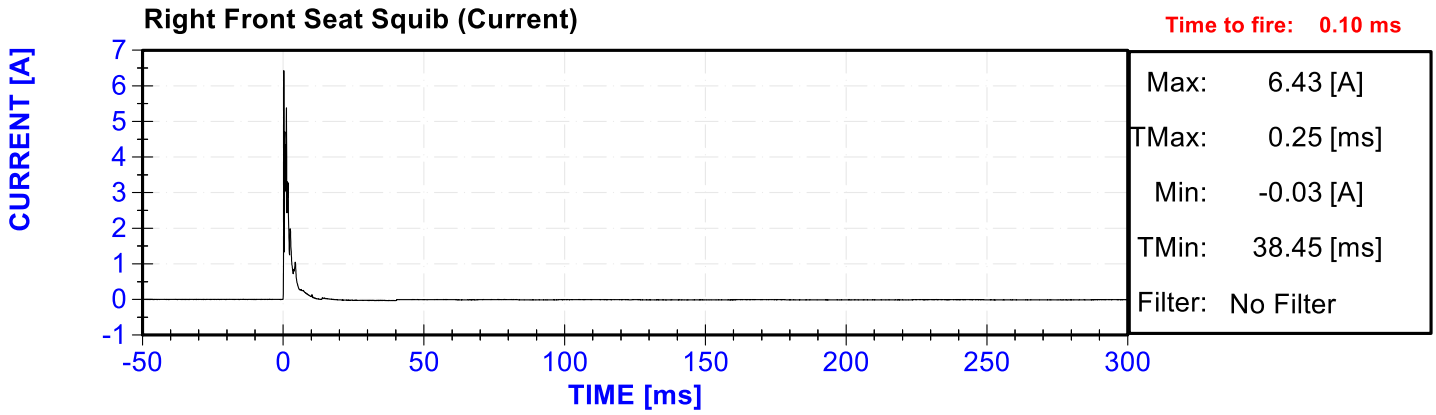
Time to fire: 0.10 ms



Right Front Seat Squib (Voltage)

Time to fire: 0.10 ms




Right Front Seat Squib (Current)
Time to fire: 0.10 ms
CURRENT [A]
7
6
5
4
3
2
1
0
-1
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 6.43 [A]
TMax: 0.25 [ms]
Min: -0.03 [A]
TMin: 38.45 [ms]
Filter: No Filter

APPENDIX C

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation

	POSITION #2 (Passenger) SERIAL NO.: 158			
	SERIAL NUMBER	**MANUFACTURER**	**CALIBRATION DATE**	**CALIBRATION DUE DATE**
Head X Acceleration	AC-P52128	Endevco 7264C	7/20/2020	1/18/2021
Head Y Acceleration	AC-P83340	ENDEVCO 7264CT	7/20/2020	1/18/2021
Head Z Acceleration	AC-P51684	ENDEVCO 7264CT	7/20/2020	1/18/2021
Head Redundant X Acceleration	P58788	ENDEVCO 7264	7/24/2020	1/22/2021
Head Redundant Y Acceleration	P52014	ENDEVCO 7264	7/24/2020	1/22/2021
Head Redundant Z Acceleration	P74792	Endevco 7264C-2KTZ-2-300	7/24/2020	1/22/2021
Upper Neck X Force	LC-851 Fx	FTSS 1716	7/9/2020	7/9/2021
Upper Neck Y Force	LC-851 Fy	FTSS 1716	7/9/2020	7/9/2021
Upper Neck Z Force	LC-851 Fz	FTSS 1716	7/9/2020	7/9/2021
Upper Neck X Moment	LC-851 Mx	FTSS 1716	7/9/2020	7/9/2021
Upper Neck Y Moment	LC-851 My	FTSS 1716	7/9/2020	7/9/2021
Upper Neck Z Moment	LC-851 Mz	FTSS 1716	7/9/2020	7/9/2021
Lower Neck X Force	LC-179 Fx Lower Neck	Denton 2430	7/16/2020	7/16/2021
Lower Neck Y Force	LC-179 Fy Lower Neck	Denton 2430	7/16/2020	7/16/2021
Lower Neck Z Force	LC-179 Fz Lower Neck	Denton 2430	7/16/2020	7/16/2021
Lower Neck X Moment	LC-179 Mx Lower Neck	Denton 2430	7/16/2020	7/16/2021
Lower Neck Y Moment	LC-179 My Lower Neck	Denton 2430	7/16/2020	7/16/2021
Lower Neck Z Moment	LC-179 Mz Lower Neck	Denton 2430	7/16/2020	7/16/2021
Curtain Bag Voltage	ABF018 (Voltage)	-	-	-
Curtain Bag Current	ABF018 (Current)	-	-	-
Seat/Torso Bag Voltage	ABF008 (Voltage)	-	-	-
Seat/Torso Bag Current	ABF008 (Current)	-	-	-

APPENDIX D

DUMMY QUALIFICATION DATA

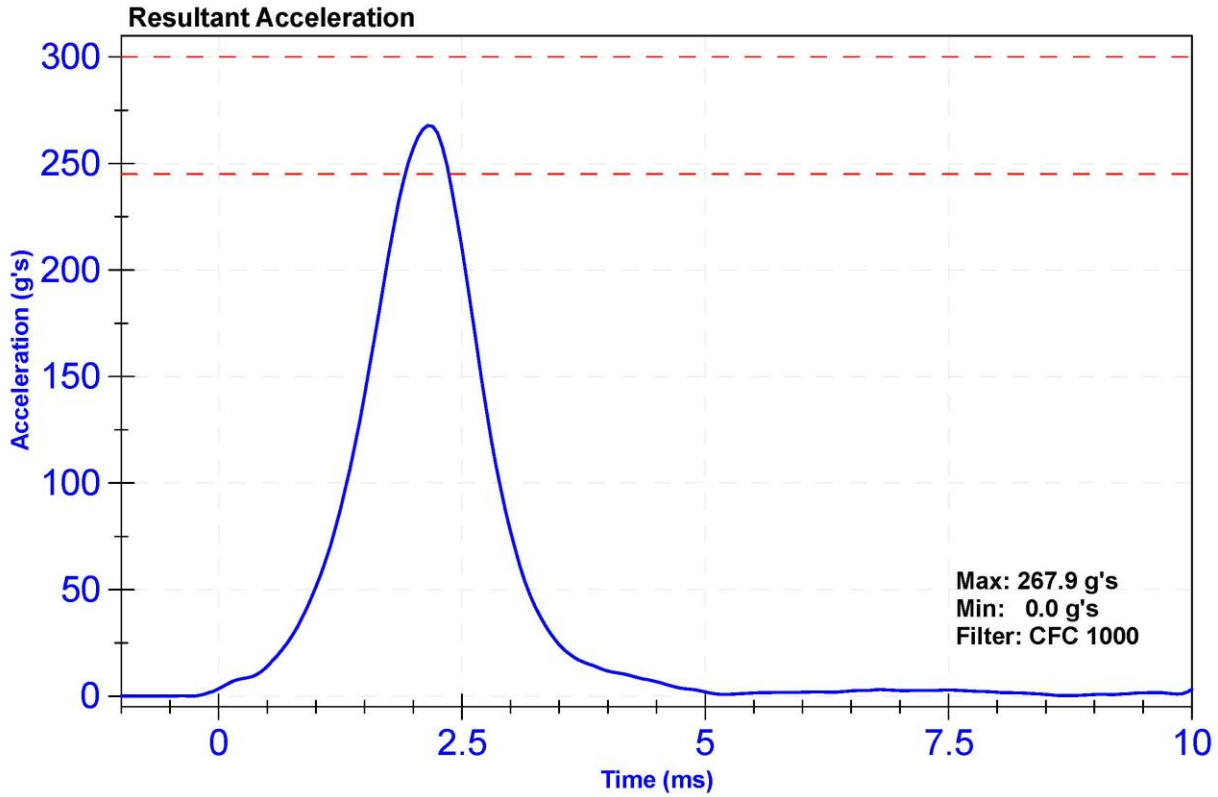
ATD Manufacturer	FTSS	Test Technician	J.Cowell
ATD Serial Number	158 GFE	Laboratory Supervisor	W.Horn

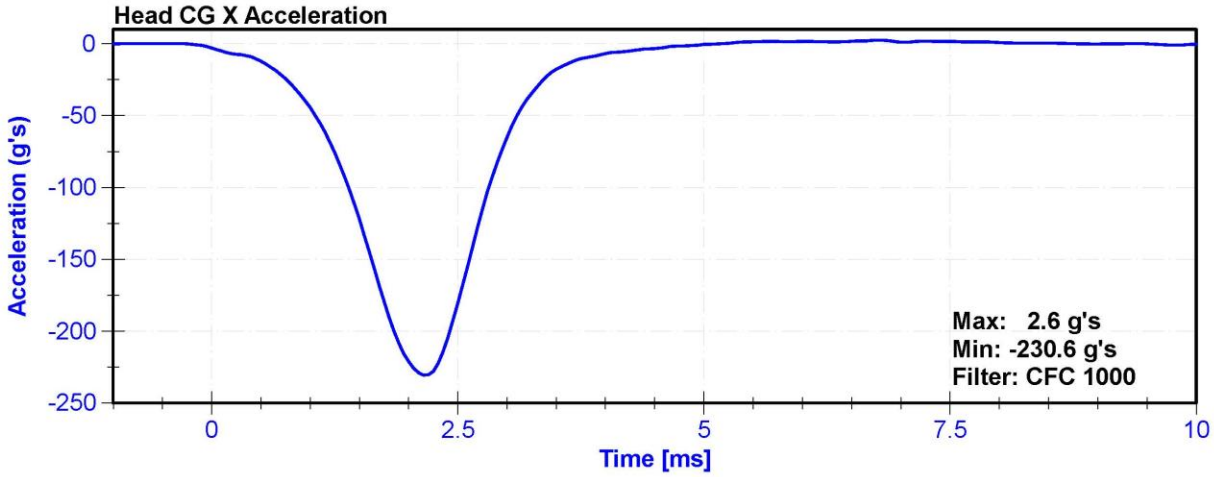
Results

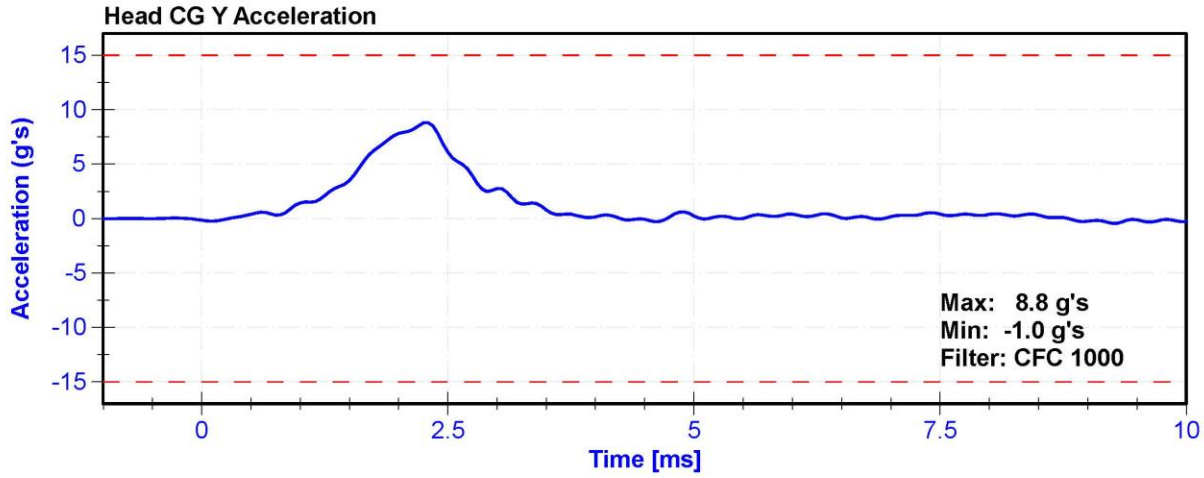
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	60.6	Pass
Resultant Acceleration	245	300	g's	267.9	Pass
Oscillation	0	10	%	1.6	Pass
Lateral Acceleration	-15	15	g's	8.8	Pass

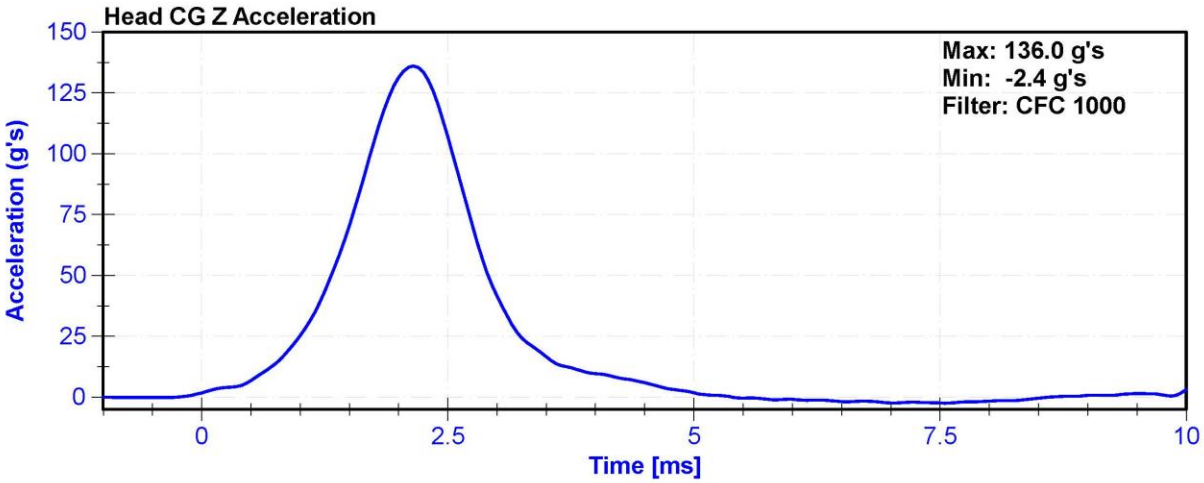
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco 7264C	AC-P52128	7/20/2020	1/18/2021
Y Accelerometer	ENDEVCO 7264CT	AC-P83340	7/20/2020	1/18/2021
Z Accelerometer	ENDEVCO 7264CT	AC-P51684	7/20/2020	1/18/2021




Head CG X Acceleration
Acceleration (g's)
0
-50
-100
-150
-200
-250
0
2.5
5
7.5
10
Time [ms]
Max: 2.6 g's
Min: -230.6 g's
Filter: CFC 1000


Head CG Y Acceleration
Acceleration (g's)
15
10
5
0
-5
-10
-15
0
2.5
5
7.5
10
Time [ms]
Max: 8.8 g's
Min: -1.0 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
150
125
100
75
50
25
0
0
2.5
5
7.5
10
Time [ms]
Max: 136.0 g's
Min: -2.4 g's
Filter: CFC 1000

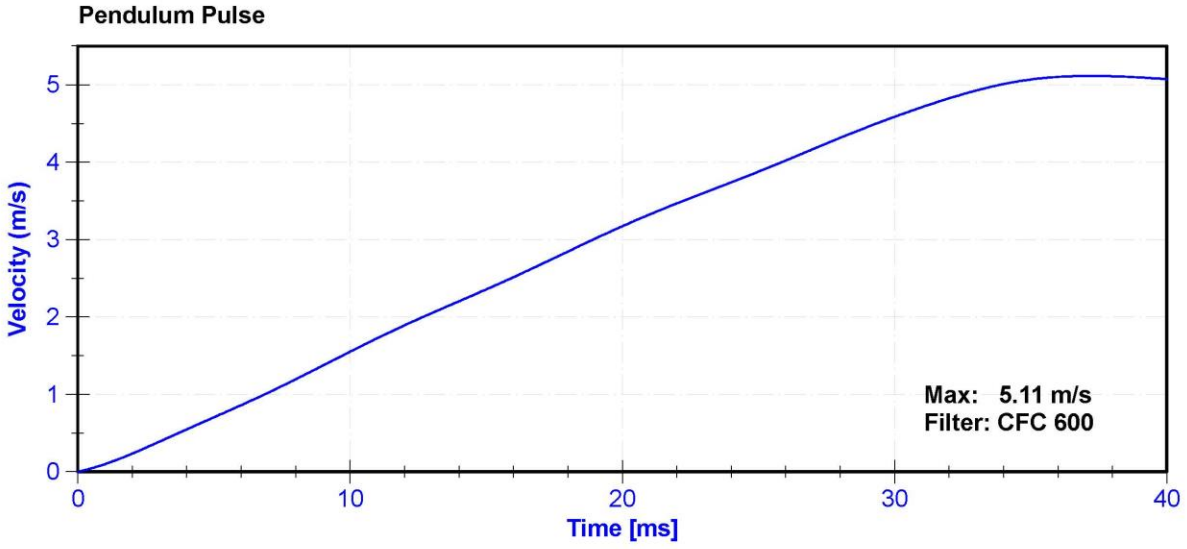
ATD Manufacturer	FTSS	Test Technician	MH
ATD Serial Number	158	Laboratory Supervisor	MB

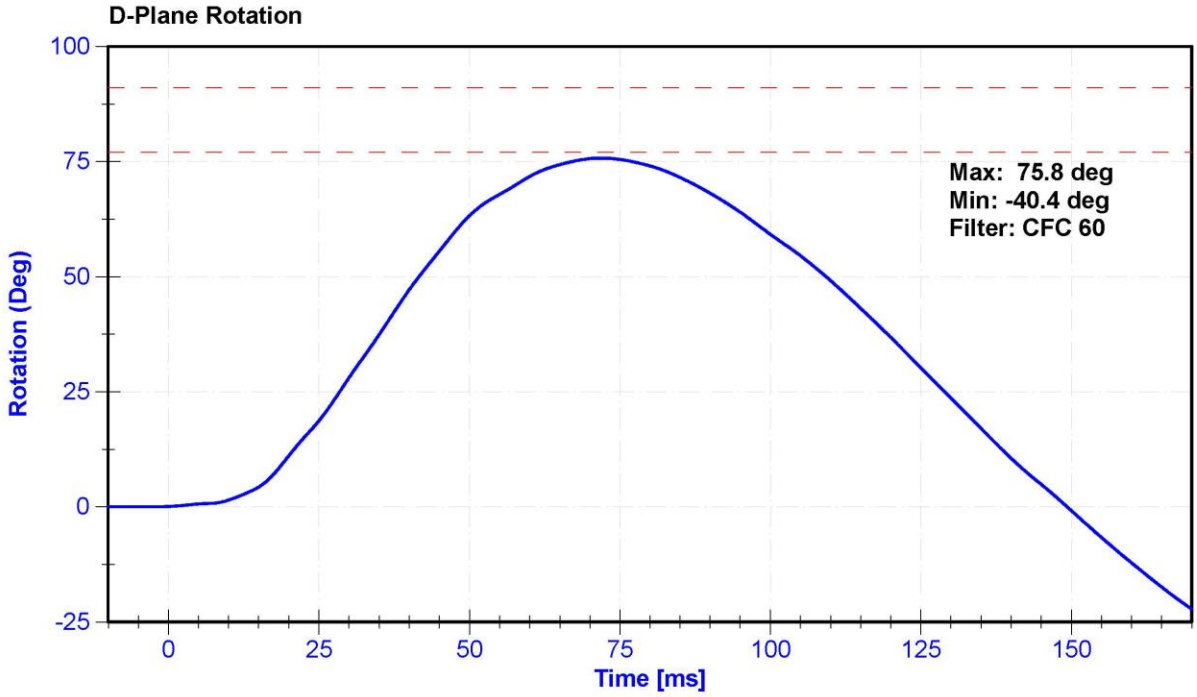
Results

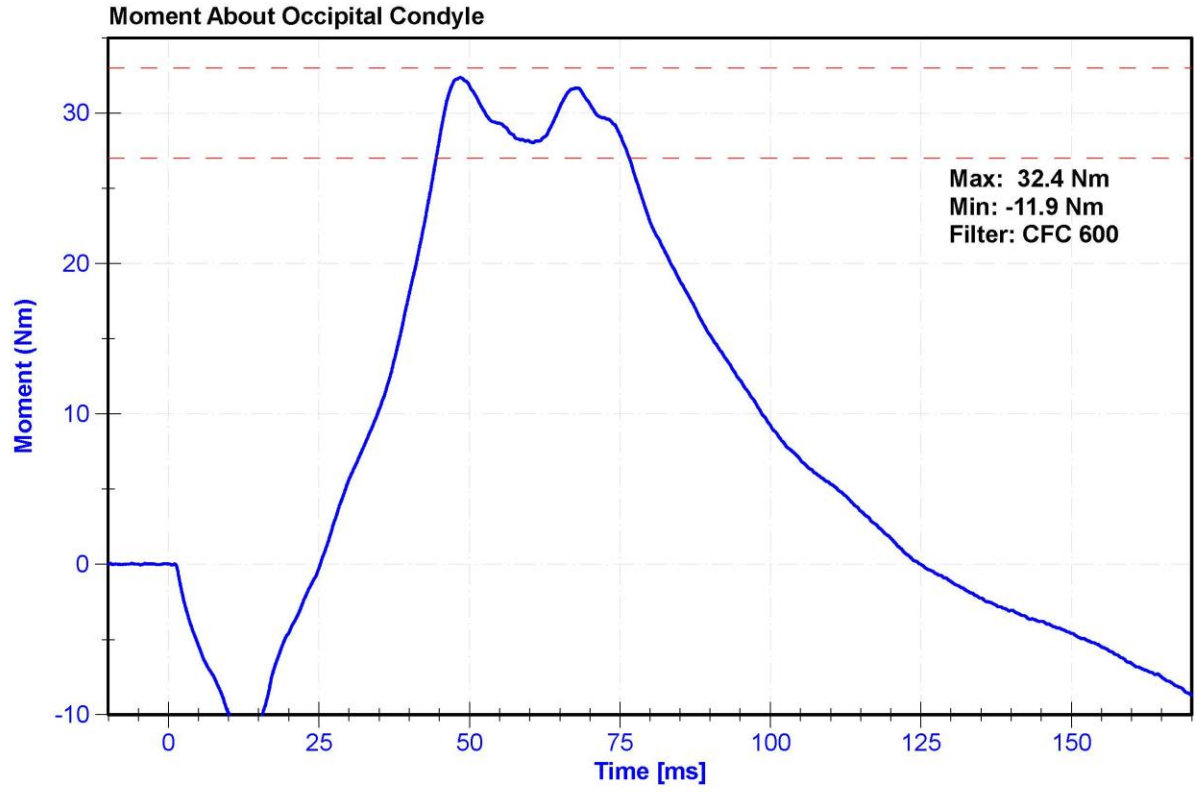
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.7	Pass
Humidity	10	70	%	55	Pass
Velocity	4.83	5.07	m/s	4.869	Pass
Pendulum Impulse at 10ms	1.2	1.6	m/s	1.55	Pass
Pendulum Impulse at 20ms	2.4	3.4	m/s	3.17	Pass
Pendulum Impulse at 30ms	3.8	5.0	m/s	4.59	Pass
D Plane Rotation	74	92	deg	75.8	Pass
Moment During Rotation Interval	27	33	Nm	32.4	Pass
Moment Decay to 10.0 Nm	103	123	ms	111.2	Pass

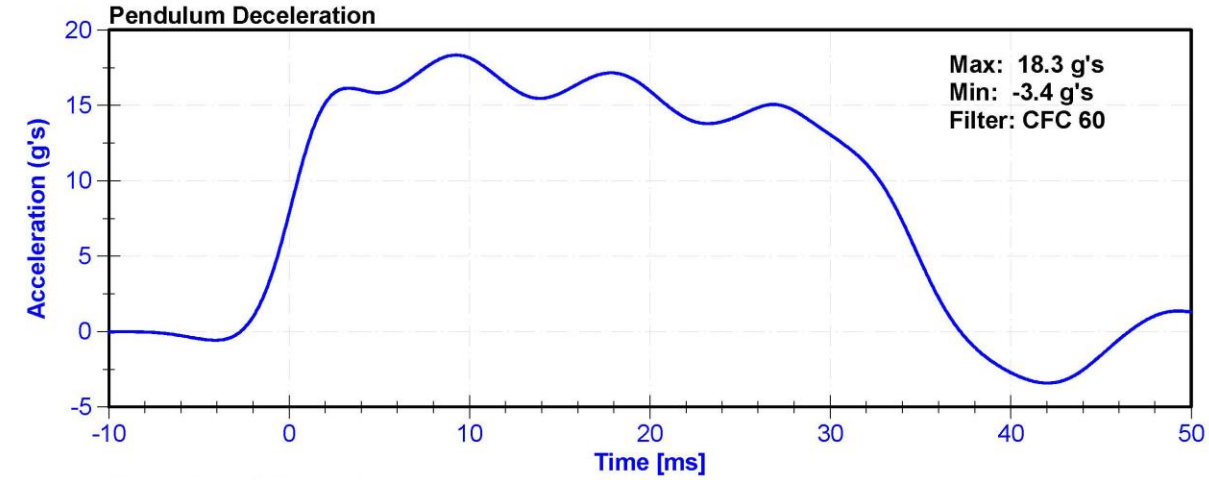
Transducer Calibrations

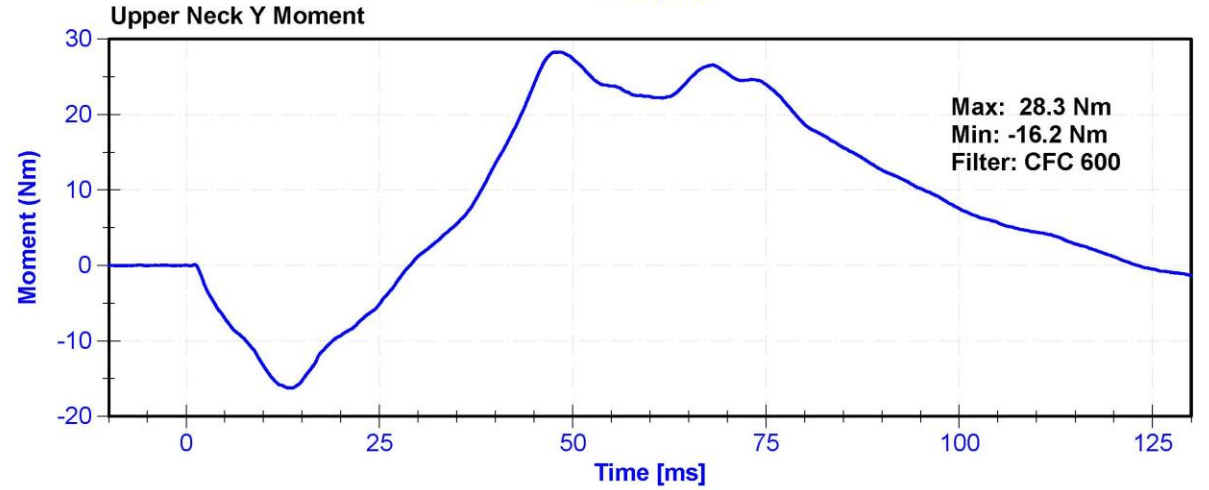
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	C16687	7/21/2020	7/21/2021
Pendulum Potentiometer	ETI SP22G	PENDPOT	10/24/2019	10/23/2020
Condyle Potentiometer	ETI SP22G	CONDPOT	10/24/2019	10/23/2020
Upper Neck Load Cell	Humanetics	1716A-851	7/10/2020	7/10/2021

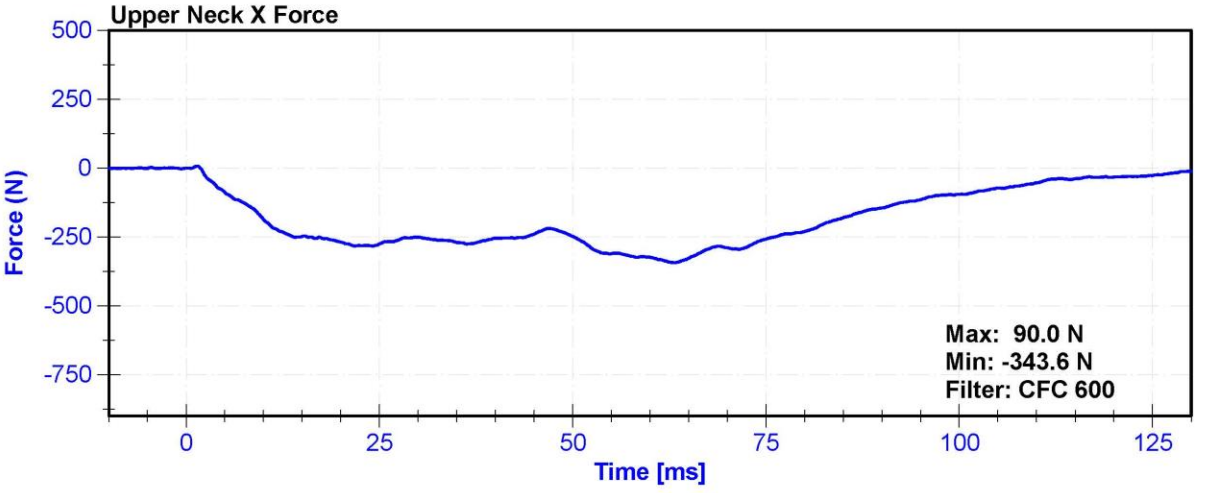



D-Plane Rotation
Rotation (Deg)
Time [ms]
Max: 75.8 deg
Min: -40.4 deg
Filter: CFC 60
100
75
50
25
0
-25
0
25
50
75
100
125
150


Moment About Occipital Condyle
Moment (Nm)
Time [ms]
Max: 32.4 Nm
Min: -11.9 Nm
Filter: CFC 600
30
20
10
0
-10
0
25
50
75
100
125
150


Pendulum Deceleration
Acceleration (g's)
Time [ms]
Max: 18.3 g's
Min: -3.4 g's
Filter: CFC 60


Upper Neck Y Moment
Moment (Nm)
Time [ms]
Max: 28.3 Nm
Min: -16.2 Nm
Filter: CFC 600


Upper Neck X Force
Force (N)
Time [ms]
Max: 90.0 N
Min: -343.6 N
Filter: CFC 600

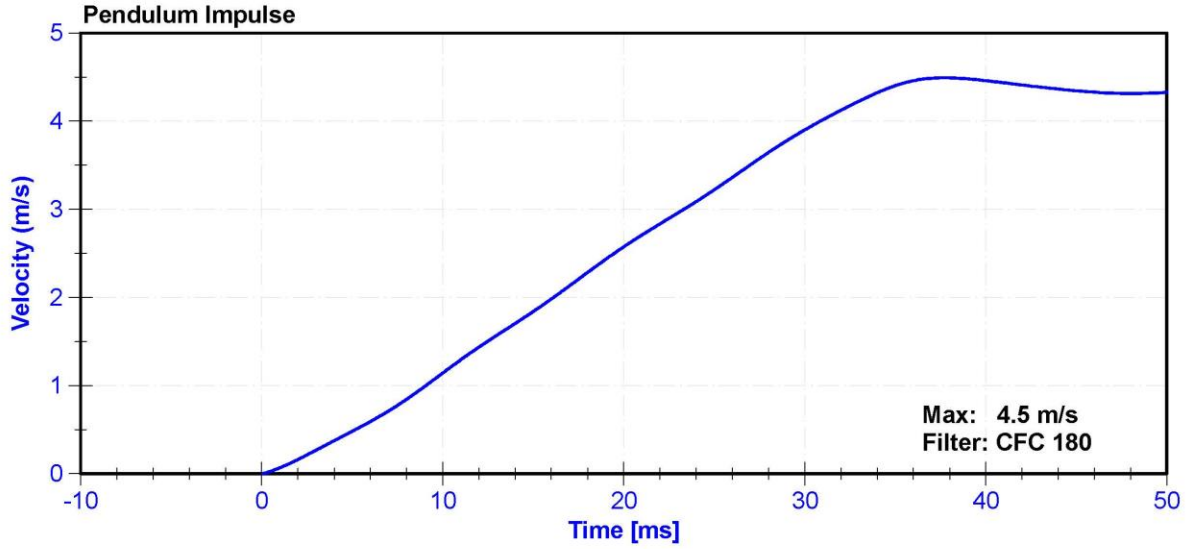
ATD Manufacturer	FTSS	Test Technician	MH
ATD Serial Number	158	Laboratory Supervisor	MB

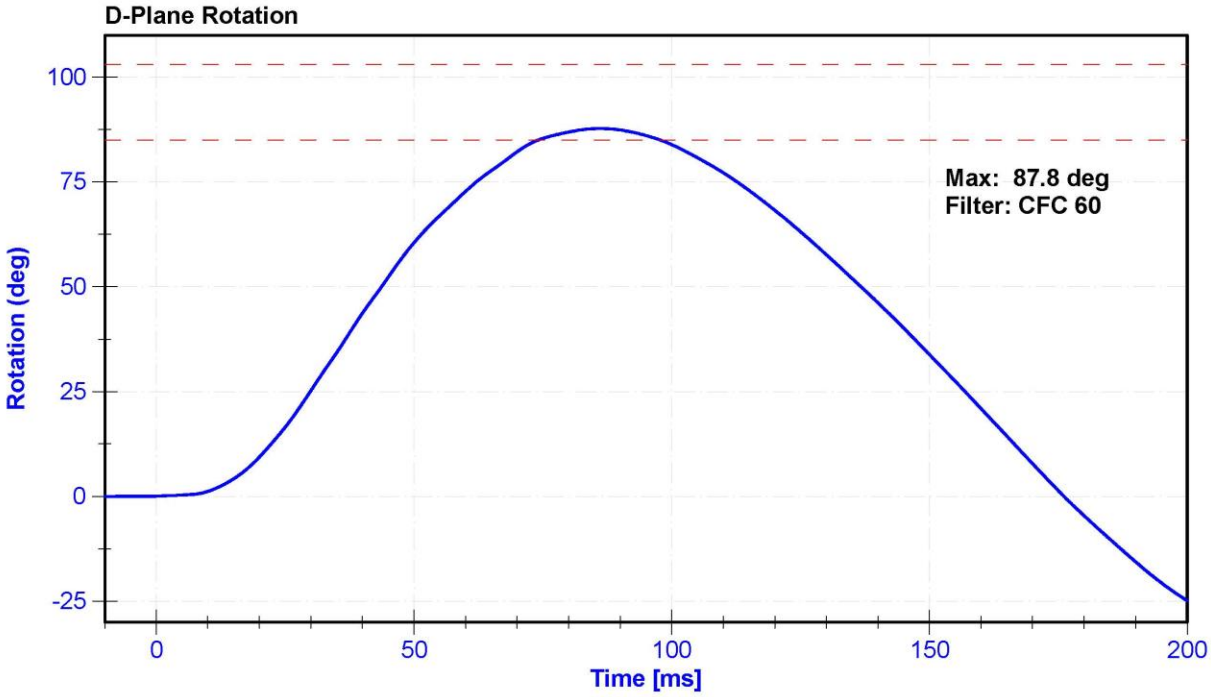
Results

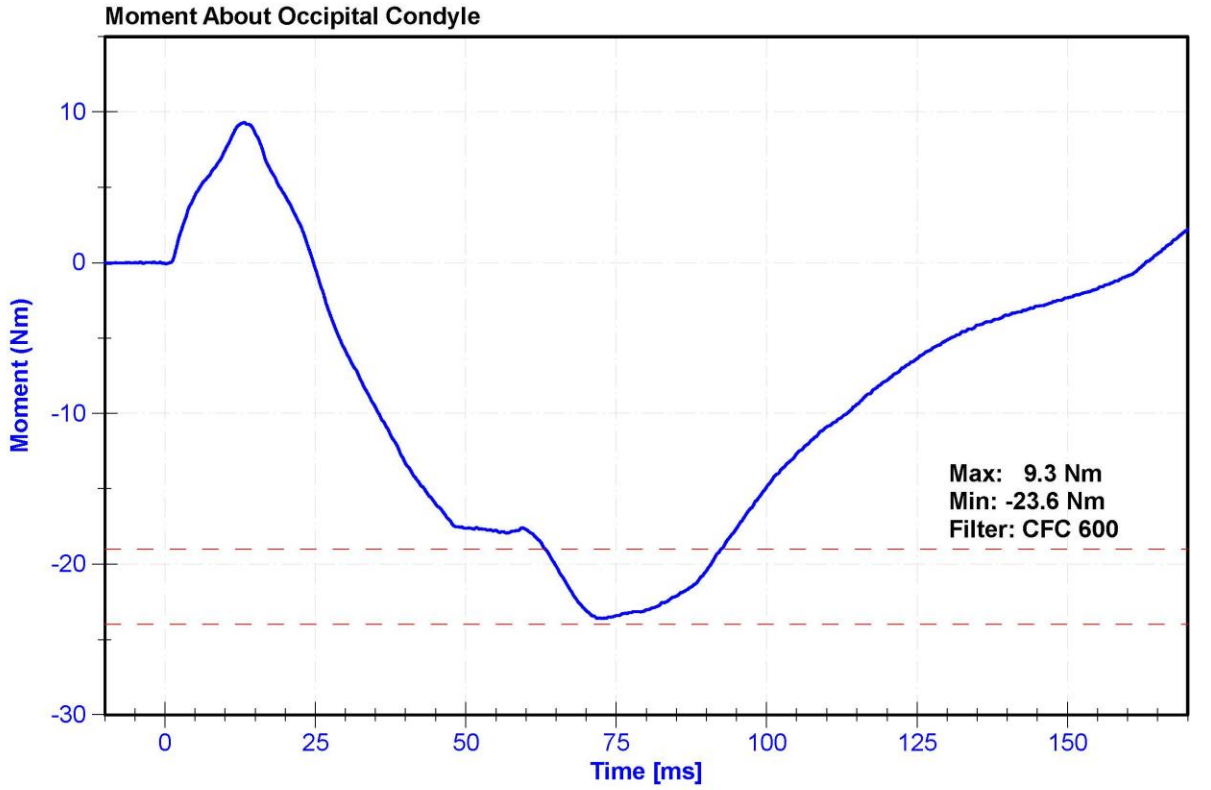
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.7	Pass
Humidity	10	70	%	54.6	Pass
Velocity	4.18	4.42	m/s	4.29	Pass
Pendulum Impulse at 10ms	1.0	1.4	m/s	1.14	Pass
Pendulum Impulse at 20ms	2.2	3.0	m/s	2.58	Pass
Pendulum Impulse at 30ms	3.2	4.2	m/s	3.90	Pass
D Plane Rotation	85	103	deg	87.8	Pass
Moment During Rotation Interval	-24	-19	Nm	-23.6	Pass
Moment Decay to -5Nm	123	147	ms	130.6	Pass

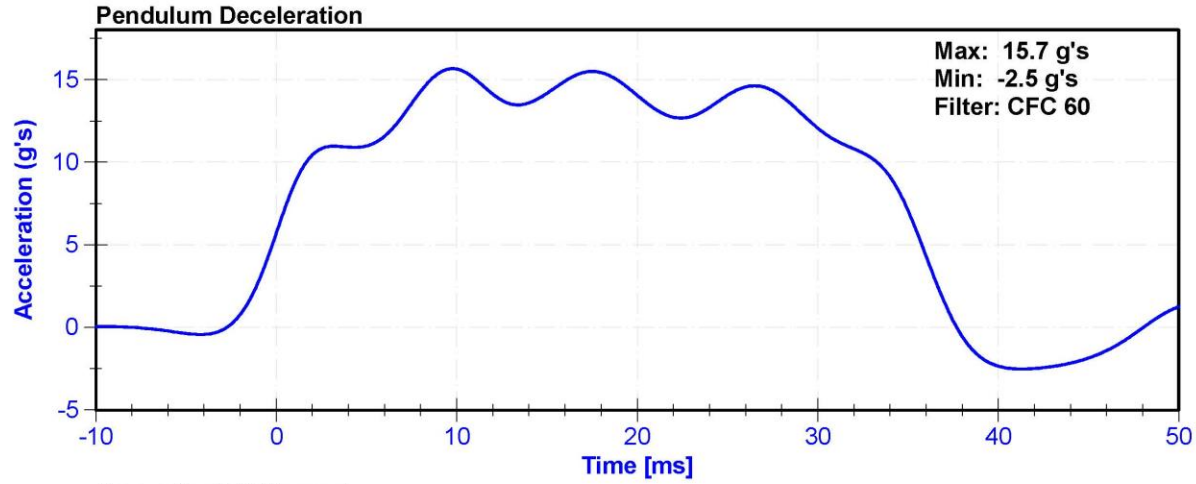
Transducer Calibrations

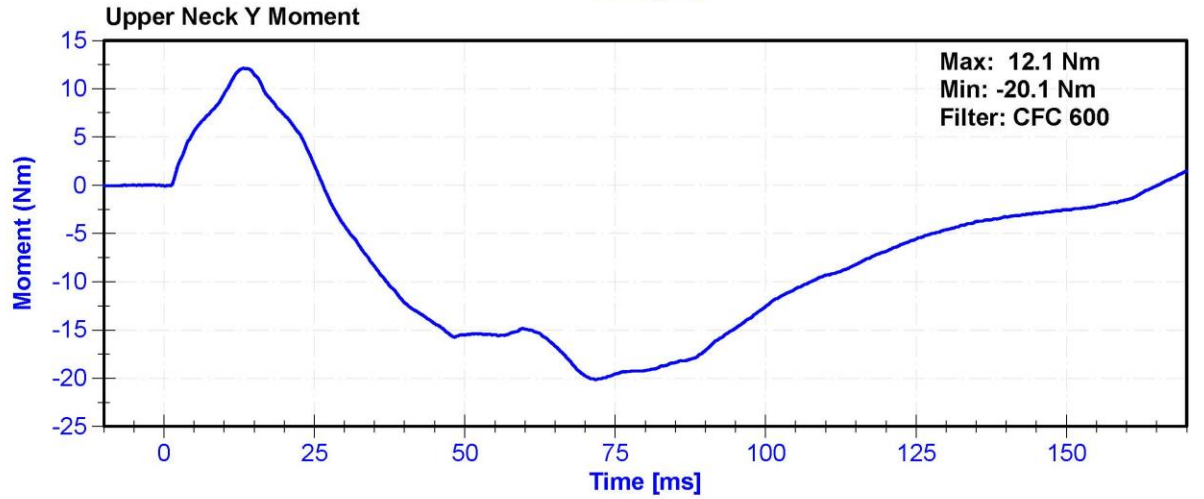
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	C16687	7/21/2020	7/21/2021
Pendulum Potentiometer	ETI SP22G	PENDPOT	10/24/2019	10/23/2020
Condyle Potentiometer	ETI SP22G	CONDPOT	10/24/2019	10/23/2020
Upper Neck Load Cell	Humanetics	1716-851	7/10/2020	7/10/2021

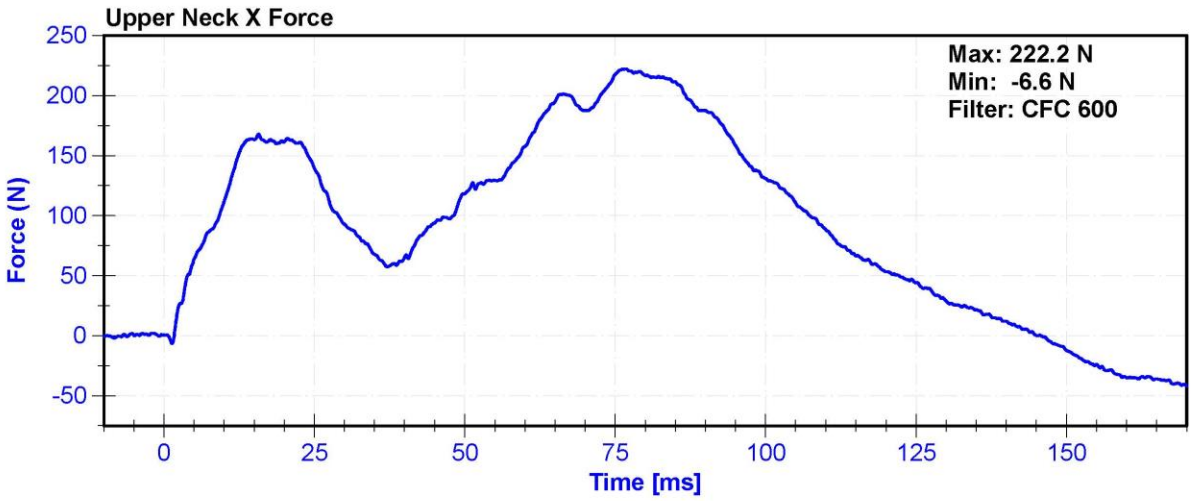



D-Plane Rotation
Rotation (deg)
100
75
50
25
0
-25
0
50
100
150
200
Time [ms]
Max: 87.8 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
10
0
-10
-20
-30
0
25
50
75
100
125
150
Time [ms]
Max: 9.3 Nm
Min: -23.6 Nm
Filter: CFC 600


Pendulum Deceleration
Max: 15.7 g's
Min: -2.5 g's
Filter: CFC 60
Acceleration (g's)
15
10
5
0
-5
-10
0
10
20
30
40
50
Time [ms]


Upper Neck Y Moment
Max: 12.1 Nm
Min: -20.1 Nm
Filter: CFC 600
Moment (Nm)
15
10
5
0
-5
-10
-15
-20
-25
0
25
50
75
100
125
150
Time [ms]


Upper Neck X Force
Max: 222.2 N
Min: -6.6 N
Filter: CFC 600
Force (N)
250
200
150
100
50
0
-50
0
25
50
75
100
125
150
Time [ms]

Calspan

TORSO FLEXION TEST – Hybrid III – 6 Year Old

Based on the Code of Federal Regulations (CFR) Title 49 Part 572

Dummy Serial Number 158

Technician M. Hartung Test Date 9/30/2020

Test attempt no. 1 Pass ✓ Fail ___

✓ 1) It has been at least 30 minutes since the last torso flexion test.
✓ N/A, ONLY one torso flexion test performed

✓ 2) The test fixture conforms to the specifications in the CFR.

✓ 3) The assembled dummy is used
✓ with lower legs
___ without lower legs

✓ 4) The dummy assembly soaked at a temperature between 18.9°C and 25.6°C and at a relative humidity from 10% to 70% for a period of at least four (4) hours prior to this test.

Record the temperature: 22.1
Record the humidity: 54.9

✓ 5) Secure the pelvis to the fixture at the pelvis instrument cavity rear face by threading 2 bolts into the available threaded attachment holes. Tighten the mountings so the pelvic lumbar joining surface is horizontal ± 1°.

✓ 6) Attach the loading adapter bracket to the upper spine box of the dummy as shown on the second page.

✓ 7) Flex the dummy forward and back 3 times such that the angle reference plane moves between 0° and 30° with respect to the vertical transverse plane.

✓ 8) Support the dummy such that the angle reference plane is at or near 0° (vertical with respect to the vertical transverse plane).

✓ 9) Wait at least 30 minutes before continuing.

✓ 10) Remove all external support that was implemented in step 9 above and wait 2 minutes.

✓ 11) Measure the initial orientation angle of the torso reference plane of the seated, unsupported dummy and record on the results chart.

✓ 12) Apply a tension force in the midsagittal plane to the pull cable at any upper torso deflection rate between 0.5° and 1.5° per second, until the angle reference plane is at 45° ± 0.5° of flexion relative to the vertical transverse plane.

✓ 13) Maintain angle reference plane at 45° ± 0.5° of flexion for 10 seconds

✓ 14) Quickly release the force applied to the attachment bracket.

✓ 15) Measure the reference plane angle between 3 and 4 minutes and record on the chart.

16) Process the data and complete the following table:

Torso Flexion Results

Parameter	Specification		Result	Pass	Fail
	Minimum	Maximum			
Initial Angle		22°	13.2	✓	
Force at 45°	147 N	200 N	191.9	✓	
Final Angle	Initial -8°	Initial +8°	18.0	✓	

17) Select the outcome:

__All results passed and the report is saved on Calspan's server

__Not all results passed

Variable to change for next test:

_____

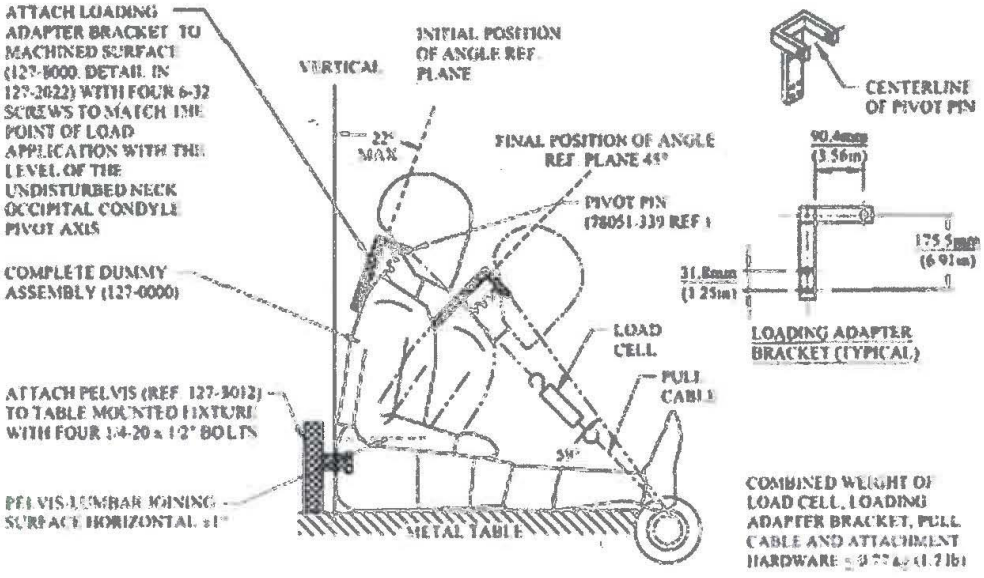
_____

_____

_____

Signature

7/30/2020
Date



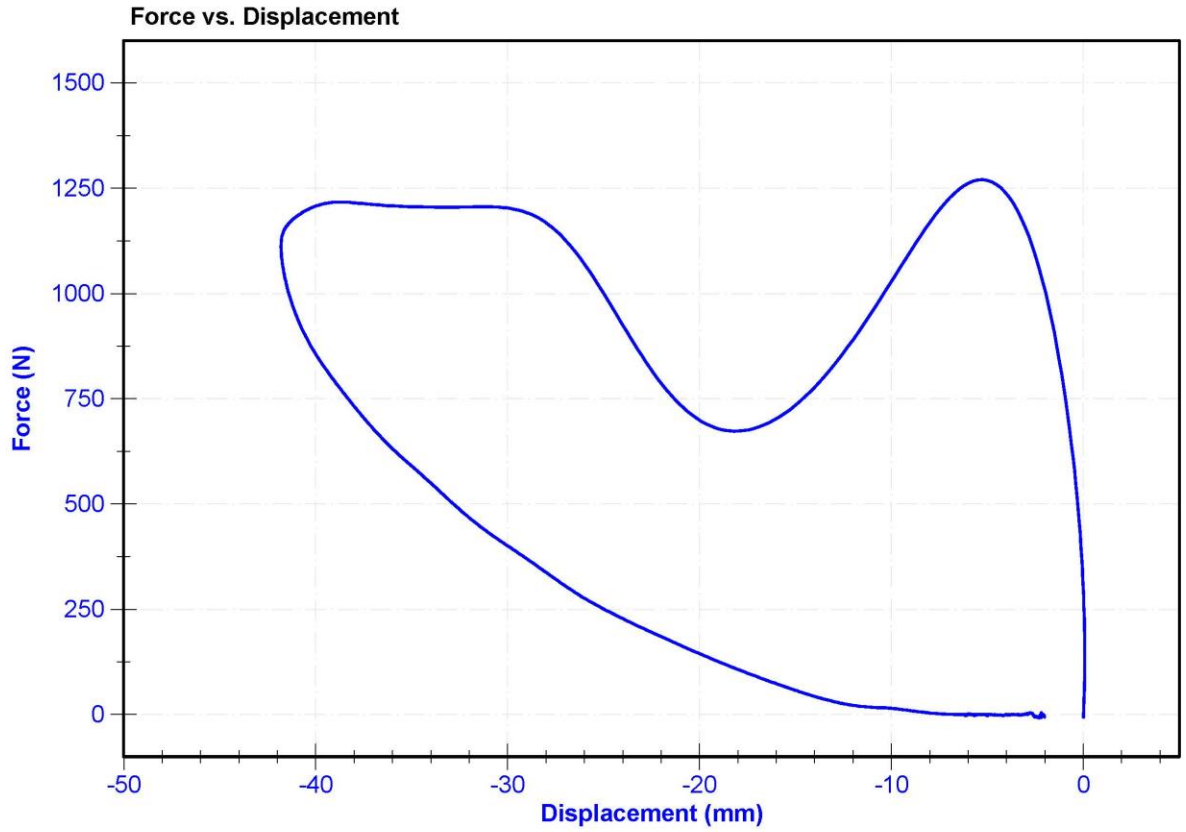
ATD Manufacturer	FTSS	Test Technician	M.Hartung
ATD Serial Number	158	Laboratory Supervisor	W. Horn

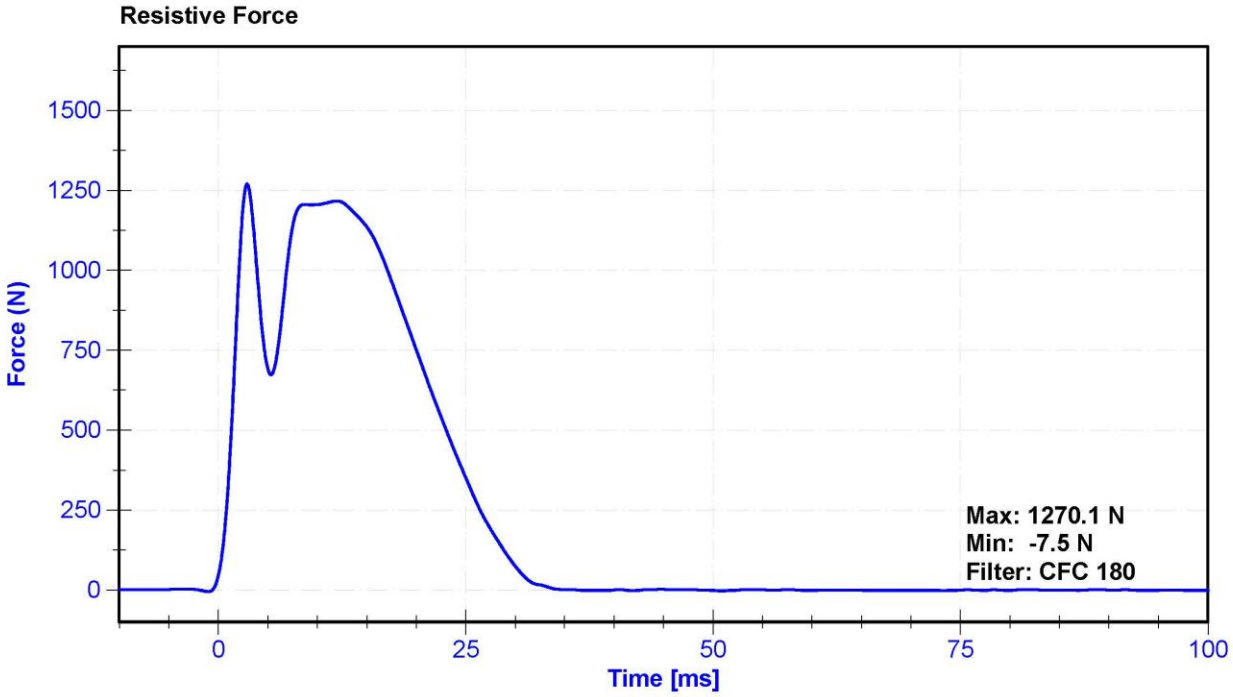
Results

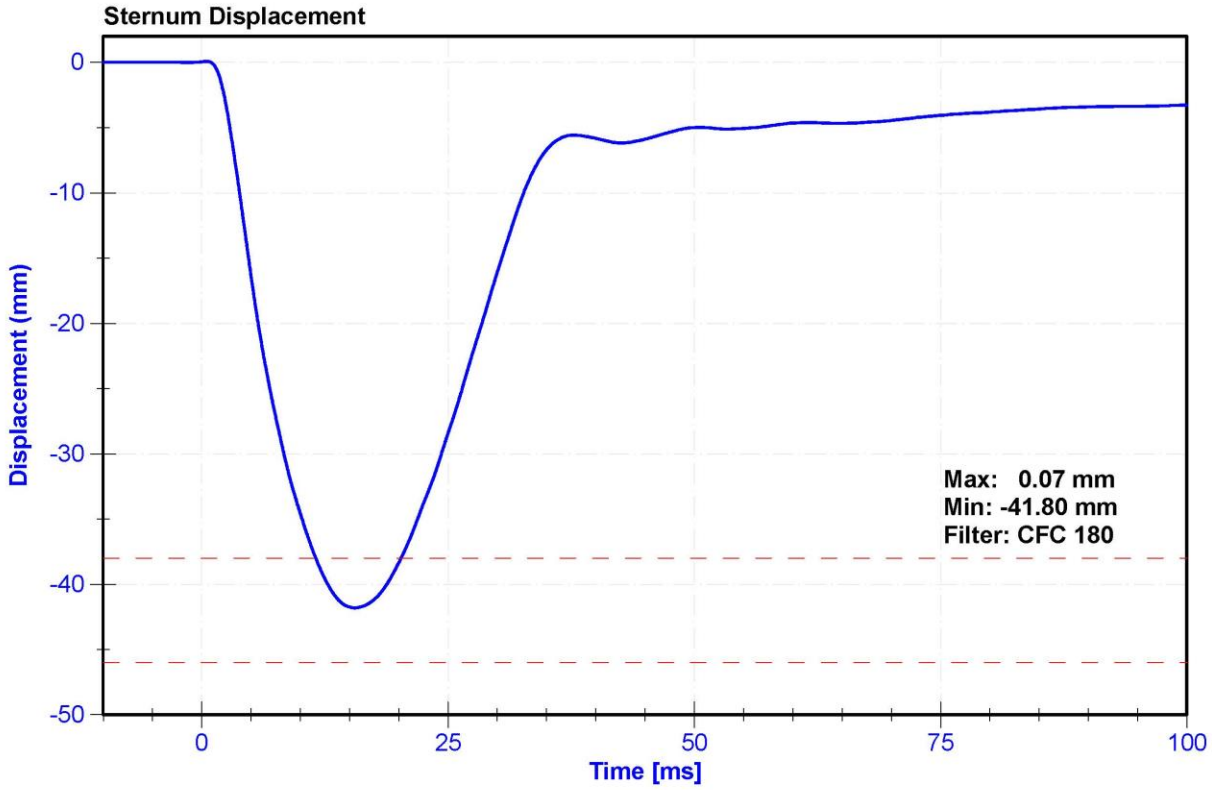
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	22.2	Pass
Humidity	10	70	%	49.4	Pass
Velocity	6.59	6.83	m/s	6.63	Pass
Chest Displacement	-46	-38	mm	-41.80	Pass
Max Force from -38 to -46 mm	1150	1380	N	1216.82	Pass
Max Force from -12.5 to -38 mm	0	1500	N	1215.24	Pass
Hysteresis	65	85	%	74.3	Pass

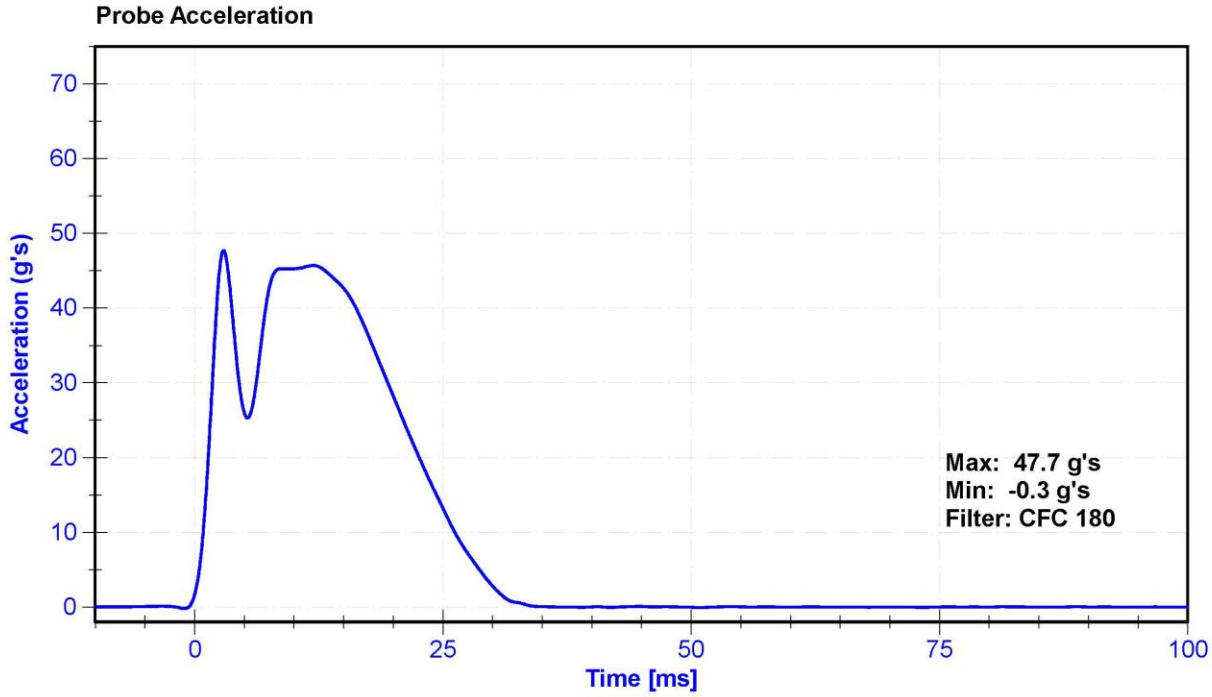
Transducer Calibrations

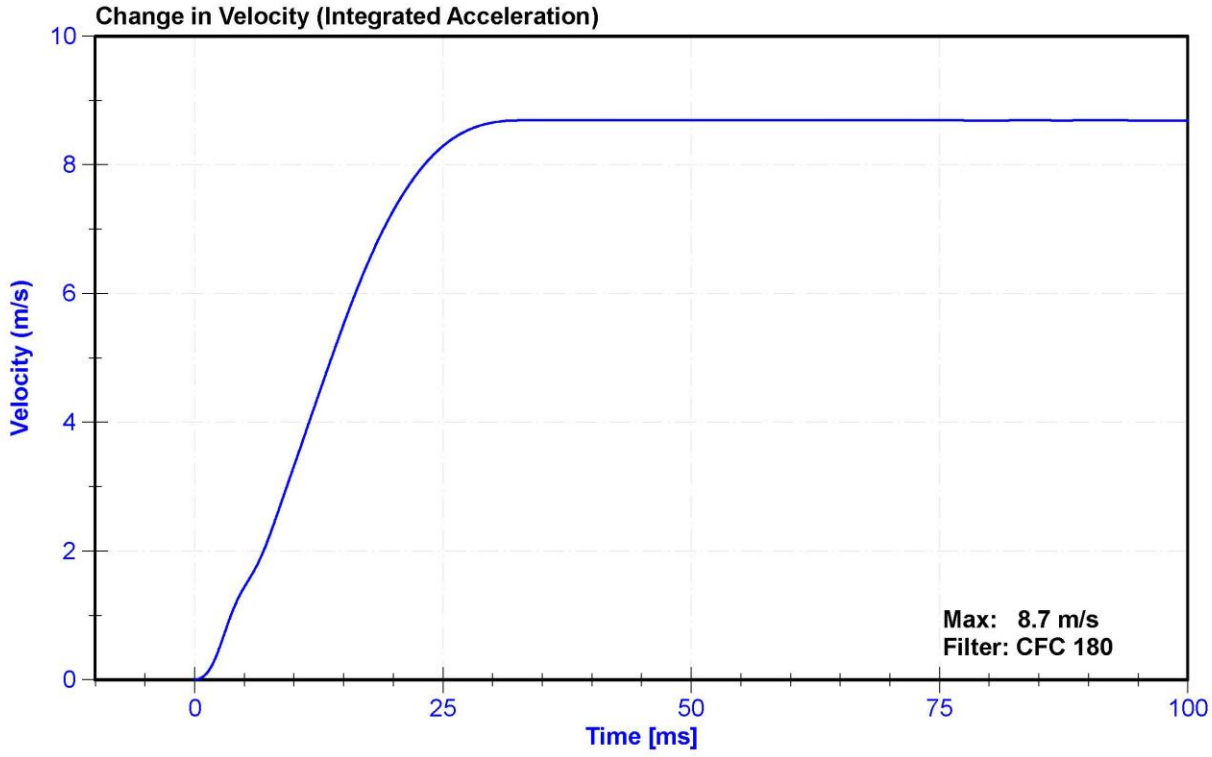
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7264CT	AC-P18743	3/18/2020	3/18/2021
Chest Potentiometer	Servo 14CB1	DS-CST158	2/16/2020	8/16/2020




Resistive Force
1500
1250
1000
750
500
250
0
Force (N)
0
25
50
75
100
Time [ms]
Max: 1270.1 N
Min: -7.5 N
Filter: CFC 180


Sternum Displacement
0
-10
-20
-30
-40
-50
Displacement (mm)
0
25
50
75
100
Time [ms]
Max: 0.07 mm
Min: -41.80 mm
Filter: CFC 180


Probe Acceleration
Acceleration (g's)
70
60
50
40
30
20
10
0
0
25
50
75
100
Time [ms]
Max: 47.7 g's
Min: -0.3 g's
Filter: CFC 180


Change in Velocity (Integrated Acceleration)
Velocity (m/s)
10
8
6
4
2
0
0
25
50
75
100
Time [ms]
Max: 8.7 m/s
Filter: CFC 180