REPORT NUMBER: NCAP-CAL-21-009

NEW CAR ASSESSMENT PROGRAM (NCAP)
FRONTAL BARRIER IMPACT TEST

Ford Motor Co.
2022 Ford Bronco
Four Door SUV

NHTSA No: M20220215

PREPARED BY:
CALSPAN CORPORATION
P.O. BOX 400
BUFFALO, NEW YORK 14224

June 3, 2022

FINAL REPORT

PREPARED FOR:
U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
OFFICE OF CRASHWORTHINESS STANDARDS
1200 NEW JERSEY AVE SE, ROOM W43-410
WASHINGTON, D.C. 20590

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Prepared by: Matthew Pronko Date: June 3, 2022
Matthew Pronko, Test Engineer

Approved by: Vanessa Hansen Date: June 3, 2022
Vanessa Hansen, Operations Manager

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date: _____

_____
COTR, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

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9. Performing Organization Name and Address Calspan Corporation Transportation Test Operations P.O. Box 400 Buffalo, New York 104625		***10. Work Unit No.*** ***11. Contract or Grant No.*** 693JJ919D000005
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15. Supplementary Notes		

16. Abstract

A 56.30 km/h (35 mph), NCAP frontal rigid barrier impact test was conducted on a 2022 Ford Bronco four door SUV in accordance with the specifications of the Office of Crashworthiness Standards Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing. This test was conducted to obtain data related to FMVSS Nos. 208, 212, 219 (partial), 301, and 305 performance. The test was conducted at Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on March 16, 2022.

The impact velocity of the vehicle was 56.38 km/h, and the ambient temperature at the barrier face at the time of impact was 21°C. The target vehicle post-test maximum crush was 513 mm at C3 to the left side of the front bumper. The test vehicle's occupant performance data is as follows:

Measurement Description	Units	Driver ATD (Serial No. 142)		Passenger ATD (Serial No. 137)	
		Threshold	Result	Threshold	Result
Head Injury Criteria (HIC_{15})		700	119.867	700	286.512
Maximum Chest Compression	mm	63	-31.368	52	-11.097
Nij		1	0.280	1	0.286
Neck Tension	N	4,170	1621.104	2,620	703.776
Neck Compression	N	4,000	-57.765	2,520	-433.932
Left Femur Force	N	10,008	-1832.427	6,805	-2048.803
Right Femur Force	N	10,008	-589.745	6,805	-625.399

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Form DOT F1700.7 (8-69)

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SECTION 1

PURPOSE AND SUMMARY OF TEST

PURPOSE

This 56.3 km/h frontal barrier impact test is part of the Vehicle Barrier Impact Testing Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. 693JJ919D000005. The purpose of this test was to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

The 56.3 km/h frontal barrier impact test was conducted in accordance with the Office of Crashworthiness Standards Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing.

SUMMARY

A load cell barrier consisting of 128 load cells was impacted by a 2022 Ford Bronco four door SUV at a velocity of 56.38 km/h. The test was performed at Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on March 16, 2022. Pre- and post-test photographs of the vehicle and dummies to document the test can be found in Appendix A. One real-time camera and 16 high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in Data Sheet 6 of this report.

One Part 572E, 50th percentile male anthropomorphic test device (ATD), was placed in the driver seating position and one Part 572O 5th percentile female ATD was placed in the right-front passenger seating position according to dummy placement instructions specified in the Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing. Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometers, upper neck transducers, femur load cells, and lower leg instrumentation. No Seat belt load cells were installed on the driver's and passenger's lap and shoulder belts per OEM instruction. The driver (position 1) ATD (Serial No. 142) and the right-front passenger (position 2) ATD (Serial No. 137) were qualified prior to this test. Certification details, along with instrumentation calibration data, can be found in Appendix C of this report.

The 486 channels of data were recorded on an on-board data acquisition system. Appendix B contains the vehicle, load cell barrier and dummy response data traces.

There was 100 percent windshield retention and no intrusion into the protected zone of the windshield during the event. There was a total of 0.0 grams of stoddard solvent leakage after the event or during any phase of the static rollover. The maximum static crush of the vehicle was 513 mm and both driver and passenger side doors remained closed during the impact event and were operable after the impact.

The driver's visible contact points were as follows: The driver's head contacted the frontal airbag and then the head restraint. The upper torso contacted the frontal airbag. Both knees contacted the knee bolster.

The passenger's visible contact points were as follows: The passenger's head contacted the frontal airbag and then the head restraint. The upper torso contacted the frontal airbag. Both knees contacted the glove box.

The occupant data is summarized below.

ATD Position	HIC_{15}	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (Gs)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50^{th})	119.867	0.280	1621.104	-57.765	37.303	-31.368	-1832.427	-589.745
Passenger (5^{th})	286.512	0.286	703.776	-433.932	37.214	-11.097	-2048.803	-625.399

GENERAL COMMENTS:

1. P1 (Driver) serial number - 142
2. P2 (Passenger) serial number - 137
3. No seatbelt load cells were used per OEM instruction

Data Anomalies:

- Engine Bottom X Acceleration, Exceeded calibration range at 12.2 ms 33.2 ms 36.8 ms

SECTION 2

OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

This section contains information reporting for the following Data Sheets:

Data Sheet No. 1 – General Test and Vehicle Parameter Data

Data Sheet No. 2 – Seat Adjustment, Fuel System, and Steering Wheel Data

Data Sheet No. 3 – Dummy Longitudinal Clearance Dimensions

Data Sheet No. 4 – Dummy Lateral Clearance Dimensions

Data Sheet No. 5 – Seat Belt Positioning Data

Data Sheet No. 6 – High-Speed Camera Locations and Data

Data Sheet No. 7 – Vehicle Accelerometer Locations

Data Sheet No. 8 – Photographic Reference Target Locations

Data Sheet No. 9 – Load Cell Locations on Fixed Barrier

Data Sheet No. 10 – Test Vehicle Summary of Results

Data Sheet No. 11 – Post-Test Observations

Data Sheet No. 12 – Vehicle Profile Measurements

Data Sheet No. 13 – Accident Investigation Division Data

Data Sheet No. 14 – Vehicle Intrusion Measurements

Data Sheet No. 15 – Summary of Indicant FMVSS No. 212 and FMVSS No. 219 (Partial)

Data Sheet No. 16 – FMVSS 301 Barrier Impact and Static Rollover Results

Data Sheet No. 17 – Dummy/Vehicle Temperature Stabilization Chart

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20220215
Model Year	2022
Make	Ford
Model	Bronco
Body Style	SUV
VIN	1FMDE5BH0NLA99018
Body Color	Blue
Odometer Reading (km /mi)	8.2 miles
Engine Displacement (L)	2.3
Type / No. Cylinders	I4
Engine Placement	Inline
Transmission Type	Manual
Transmission Speeds	7-Speed
Overdrive	Yes
Final Drive	All Wheel Drive
Roof Rack	No
Sunroof / T-Top	No – Soft top
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	No
Anti-Lock Brakes (ABS)	Yes
Automatic Door Locks (ADLs)	Yes

Traction Control System (TCS)	Yes
Power Steering	Yes
Power Window Auto-Reverse	No
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
Front Pass. Frontal Airbag	Yes
Front Pass. Curtain Airbag	Yes
Front Pass. Head/Torso Airbag	No
Front Pass. Torso Airbag	No
Front Pass. Torso/Pelvis Airbag	Yes
Front Pass. Pelvis Airbag	No
Front Pass. Knee Airbag	No
Driver Pretensioner	Yes
Driver Load Limiter	Yes
Front Pass. Pretensioner	Yes
Front Pass. Load Limiter	Yes
Other –	N/A

Does owner's manual provide instructions to turn off automatic door locks?	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Ford Motor Co.
Date of Manufacture	02/22

GVWR (kg)	2685
GAWR Front (kg)	1402
GAWR Rear (kg)	1393

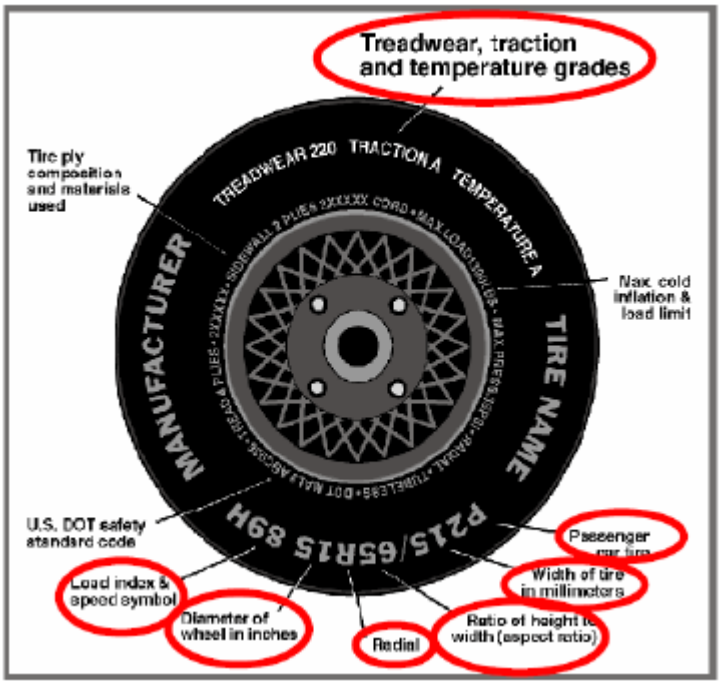
VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench	N/A	
Number of Occupants	2	3	N/A	5
Capacity Wt. (VCW) (kg)				642
Cargo Wt. (RCLW) (kg)				136

DATA SHEET NO. 1 … (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

Collect items circled in red, tire manufacturer, and tire name.



VEHICLE TIRE INFORMATION

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	240	240
Recommended Tire Size	255/75R17	255/75R17
Tire Size on Vehicle	255/75R17	255/75R17
Tire Manufacturer	Bridgestone	Bridgestone
Tire Model	Dueler	Dueler
Treadwear	400	400
Traction	B	B
Temperature Grades	B	B
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	2 Polyester, 2 steel, 1 Nylon	2 Polyester, 2 steel, 1 Nylon
Load Index / Speed Symbol	15T	15T
Tire Material	Rubber	Rubber
DOT Safety Code Left	1VNORRHD15221	1VNORRHD15221
DOT Safety Code Right	1VNORRHD15221	1VNORRHD15221

DATA SHEET NO. 1 … (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

TEST VEHICLE WEIGHTS

	Units	As Delivered Weights (UVW)			As Tested Weights (ATW)		
		Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total
Left	kg	564	455.5		612	563	
Right	kg	568	453		584	555	
Ratio	%	55.5	44.5		51.7	48.3	
Totals	kg	1132	908.5	2040.5	1196	1118	2314

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total Delivered Weight (UVW)	kg	2040.5	(A)
Weight of 1 P572E ATD & 1 P572O ATD	kg	142	(B)
Rated Cargo / Luggage Weight (RCLW)	kg	136	(C)
Calculated Vehicle Target Weight (TVTW)	kg	2318.5	(A+B+C)

TEST VEHICLE ATTITUDES AND CG

Condition	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	1025	1020	1045	1044	1314
As Tested	mm	1005	1007	1006	1006	1426
Post-Test	mm	1053	1028	995	1001	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2952
Total Vehicle Length at Left Side	mm	4509
Total Vehicle Length at Centerline	mm	4557
Total Vehicle Length at Right Side	mm	4509
Weight of Ballast in Cargo Area	kg	100
Weight of Vehicle Components Removed	kg	25
Amount of Stoddard Solvent in Fuel Tank	L	74.4

LIST OF COMPONENTS REMOVED TO MEET TEST WEIGHT:

Trunk carpeting, jack, tail light, rear row headrests, trunk trim, rear door panels, left rear tow hook, Rear speakers

DATA SHEET NO.1 … (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

TARGET VEHICLE STRUCTURAL MEASUREMENT

No.	Description	Pre-Test
1	Total Length	4557
2	Total Width	1783
3*	Bumper Top Height	675
4*	Bumper Bottom Height	521
5*	Longitudinal Member Top Height	476
6	Distance Between Longitudinal Members	8
7	Longitudinal Member Width	14
8*	Engine Top Height	848
9*	Engine Bottom Height	849
10	Engine and Gearbox Width	197
11	Front Bumper-Engine Distance	589
12*	Front Shock Absorber Fixing Height	624
13*	Bonnet Leading Edge Height	1118
14	Front Shock Absorber Fixing Width	830
15	Front Bumper – Front Axle Distance	781
16	Front Axle – A Pillar Distance	696
17	A-Pillar – B-Pillar Distance	1067
18	B-Pillar – Rear Axle Distance	1190
19	B-Pillar – C-Pillar Distance	892
20*	Roof Sill Bottom Height	1715
21*	Roof Sill Top Height	1812
22*	Floor Sill Bottom Height	557
23*	Floor Sill Top Height	587

*Height Measurements are taken from the ground
Note: All measurements are in millimeters

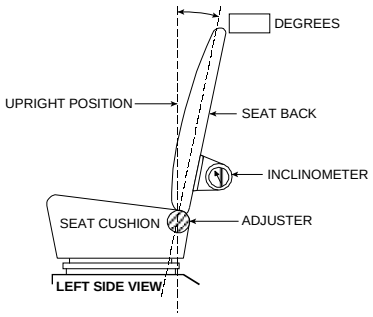
DATA SHEET NO. 2
SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

NOMINAL DESIGN RIDING POSITION

The driver's seat back was set to the manufacturer's designated angle. The passenger's seat back was positioned in a similar manner as the driver's seat back. Seat back angles are measured at the headrest post bezel using a digital inclinometer.

Seating Position	Degrees
Driver Seat Back Angle	3.2
Passenger Seat Back Angle	3.0



FRONT SEAT ASSEMBLY

SEAT FORE / AFT POSITIONS

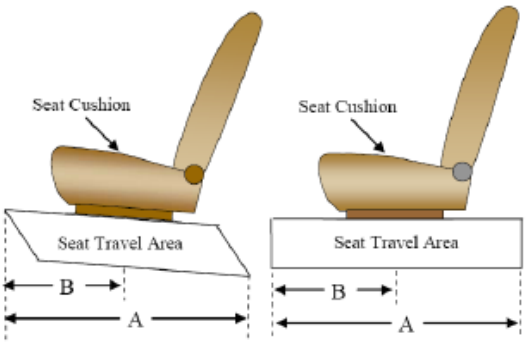
The driver's seat was positioned at the mid-point of fore/aft travel at its lowest position. The passenger's seat was positioned at the most forward position of fore/aft travel. Zero is defined as the forward most position.

Seating Position	Total Fore / Aft Travel	Placed in Position #
Driver Seat	26 (0-25)	10
Passenger Seat	26 (0-25)	0

SEAT BELT UPPER ANCHORAGE

The driver's seat belt anchorage was positioned according to the manufacturer's designated positioning for a 50th percentile adult male ATD. The passenger's seat belt anchorage was positioned according to the manufacturer's designated positioning for a 5th percentile adult female ATD. For this test zero is defined as the uppermost position.

Seating Position	Total # of Positions	Placed in Position #
Driver Seat	Fixed	Fixed
Passenger Seat	Fixed	Fixed



DATA SHEET NO. 2 … (CONTINUED)
SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

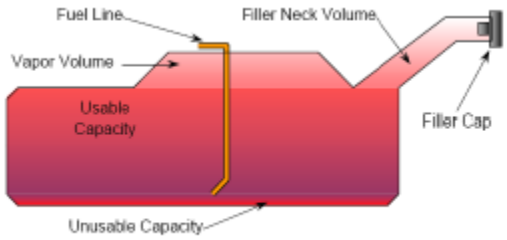
Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

FUEL TANK CAPACITY

Description	Liters
Usable Capacity of "Standard Tank"	85.17
Usable Capacity of "Optional Tank"	N/A
92%-94% of Usable Capacity	78.3 – 80
Actual Amount of Solvent Used	79.2
1/3 of Usable Capacity	28.39

FUEL PUMP

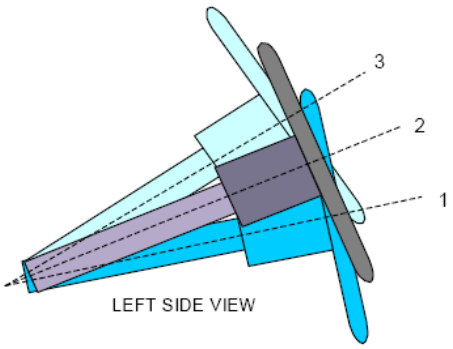
The vehicle is equipped with an electric fuel pump. The fuel filler neck is on the left side of the vehicle. The pump creates positive pressure in the fuel lines, pushing the gasoline to the engine. See form 1 for more information.



VEHICLE FUEL TANK ASSEMBLY

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. For angular measurements, a digital inclinometer was used to measure a plate which was placed across the steering wheel rim. A tape measure was used to measure the telescoping steering wheel travel.



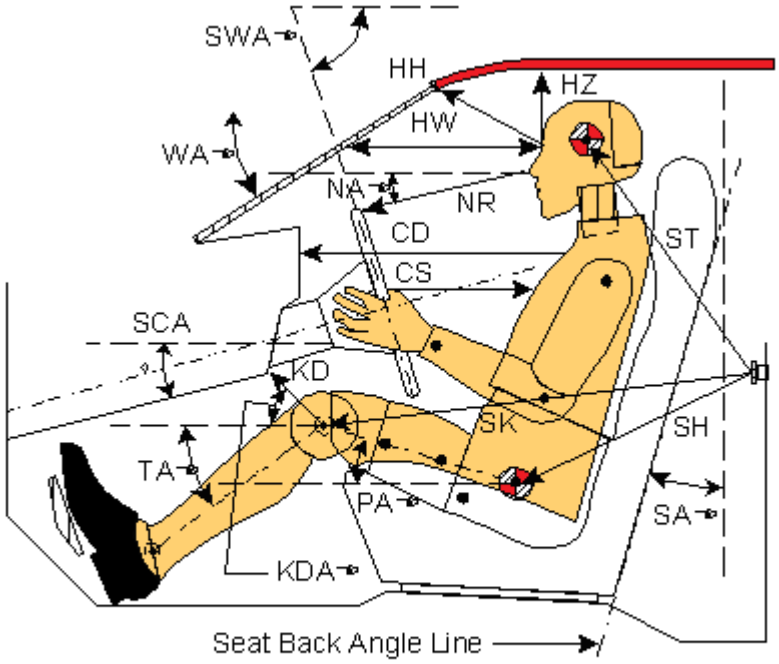
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITIONS

Description	Degrees	Fore / Aft Position (mm)
Lowermost position No. 1	19.4	
Geometric center position No. 2	22.2	
Uppermost position No. 3	24.9	
Telescoping Steering Wheel Travel		70
Test Position	22.2	35

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2022 Ford Bronco four door SUV
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: M20220215
Test Date: 3/16/2022

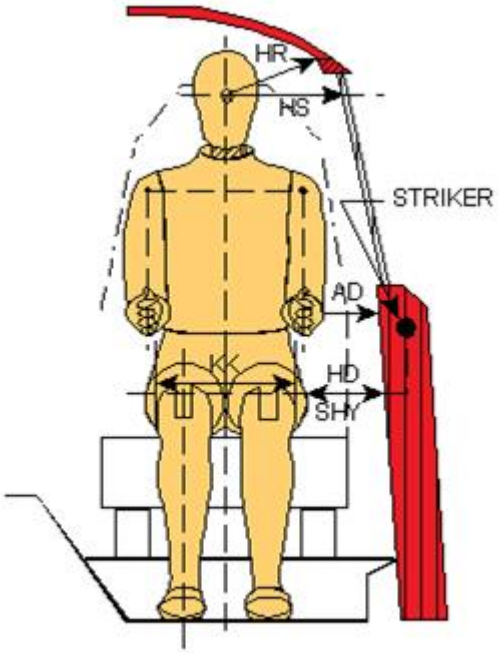


Left Side View

Code	Measurement Description	Driver (SN: 142)		Passenger (SN: 137)	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		51.4		
SWA°	Steering Wheel Angle		22.3		
SCA°	Steering Column Angle		67.7		
SA°	Seat Back Angle (on headrest post)		3.2		30
HZ	Head to Roof (Z)	321	90	400	90
HH	Head to Header	580	15.9	515	27.3
HW	Head to Windshield	695	0	623	0
NR	Nose to Rim / Dash	396	11.6	367	11.3
CD	Chest to Dash	528		360	
CS	Chest to Steering Hub	305	2.4		
RA	Rim to Abdomen	203	0		
KDL	Left Knee to Dash	171	19.4	110	28.9
KDR	Right Knee to Dash	179	8.0	104	35.4
	Pelvic Angle		23.2		19.4
TA°	Tibia Angle		34.6		45.2
SK	Striker to Knee	566	0.8	670	2.4
ST	Striker to Head	563	79.6	523	66.5
SH	Striker to H-Point	220	37.8	382	15.4

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2022 Ford Bronco four door SUV
NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test
Test Date: 3/16/2022

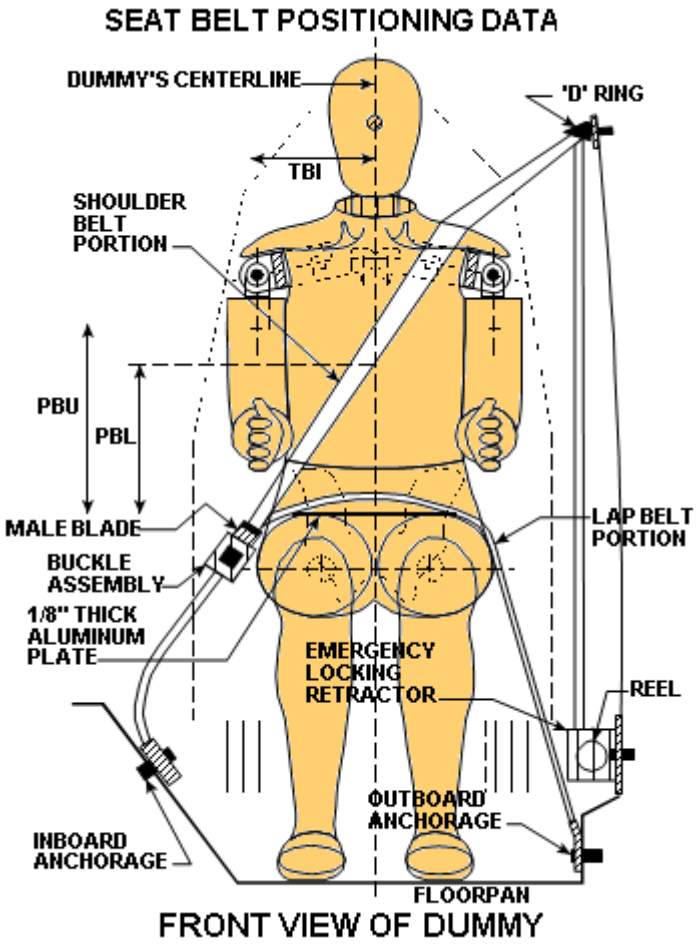


Front View

Code	Description	Driver (mm)	Passenger (mm)
AD	Arm to Door	114	85
HD	H-Point to Door	153	172
HR	Head to Side Header	221	290
HS	Head to Side Window	336	376
KK	Knee to Knee	298	210
SHY	Striker to H-Point (Y Direction)	215	240
AA	Ankle to Ankle	328	164

DATA SHEET NO. 5
SEAT BELT POSITIONING DATA

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022



SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU — Top surface of reference to belt upper edge	mm	304	275
PBL — Top surface of reference to belt lower edge	mm	222	185

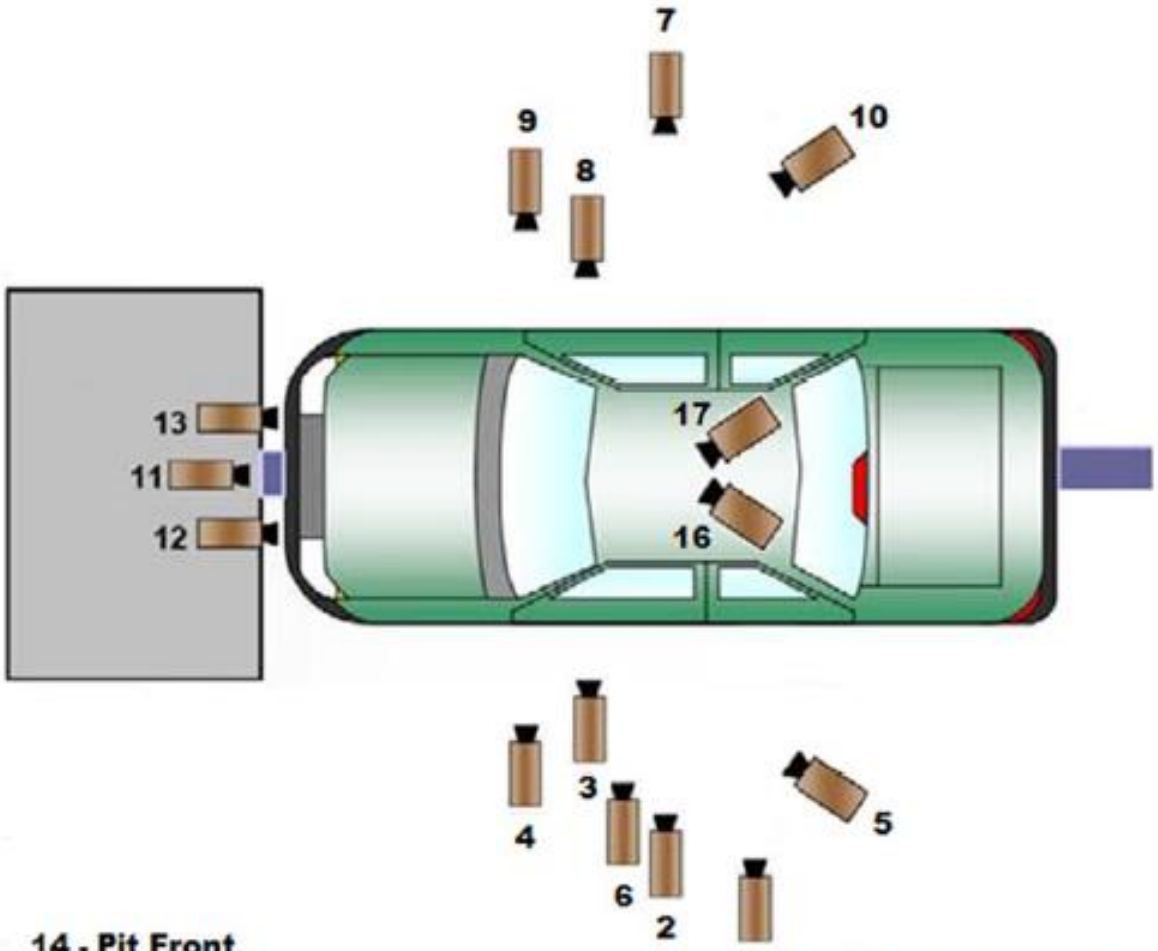
BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder belt length as measured on ATD	mm	828	885
Lap Belt Length as measured on ATD	mm	613	650
Remainder of belt on reel	mm	909	815
Total belt length for continuous webbing systems	mm	2350	2350

DATA SHEET NO. 6
HIGH-SPEED CAMERA LOCATIONS AND DATA

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

CAMERA POSITIONS FOR FRONTAL IMPACTS



DATA SHEET NO. 6 … (CONTINUED)
HIGH-SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

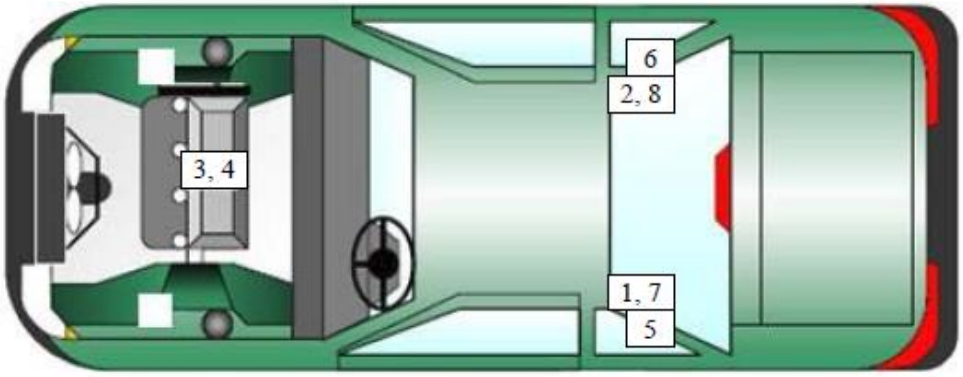
CAMERA LOCATIONS

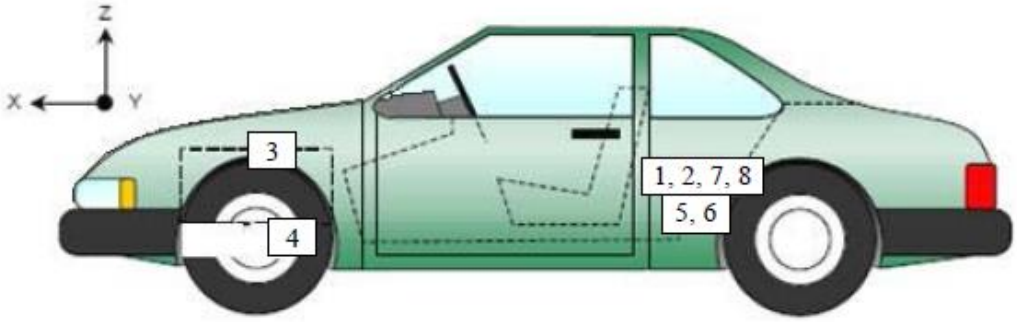
No.	Camera View	Location (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Overall					60
2	Left Overall	-2090	-7822	-1422	24	1000
3	Driver Close-Up	-1376	-7270	-1566	50	1000
4	Left Front Half	-1159	-6712	-1439	28	1000
5	Left Angle	-4444	-4946	-2554	50	1000
6	Steering Column	-1679	-8487	-2376	75	1000
7	Right Overall	-2086	8155	-1408	24	1000
8	Passenger Close-Up	-1373	7555	-1588	50	1000
9	Right Front Half	-1096	6813	-1428	28	1000
10	Right Angle	-4468	4910	-2560	50	1000
11	Windshield	1145	0	-3471	12.5	1000
12	Driver Windshield	820	-345	-2397	25	1000
13	Passenger Windshield	820	-415	-2397	25	1000
14	Pit Front	-1424	0	2746	12.5	1000
15	Pit Rear	-2894	0	2795	12.5	1000
16	Onboard Driver Airbag (Optional)				8	1000
17	Onboard Passenger Airbag (Optional)				8	1000

** COORDINATES:* *+X = forward of impact plane*
+Y = right of monorail center
+Z = into ground

DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Accelerometer – X Direction	1562	-294	-127
2	Right Rear Accelerometer – X Direction	1546	376	-126
3	Engine Top X	3792	-57	-557
4	Engine Bottom X	3593	-66	129
5	Left Rear Accelerometer – Z Direction	1562	-294	-127
6	Right Rear Accelerometer – Z Direction	1546	376	-126
7	Left Rear Accelerometer – X Direction Redundant	1561	-293	-127
8	Right Rear Accelerometer – X Direction Redundant	1546	376	-126

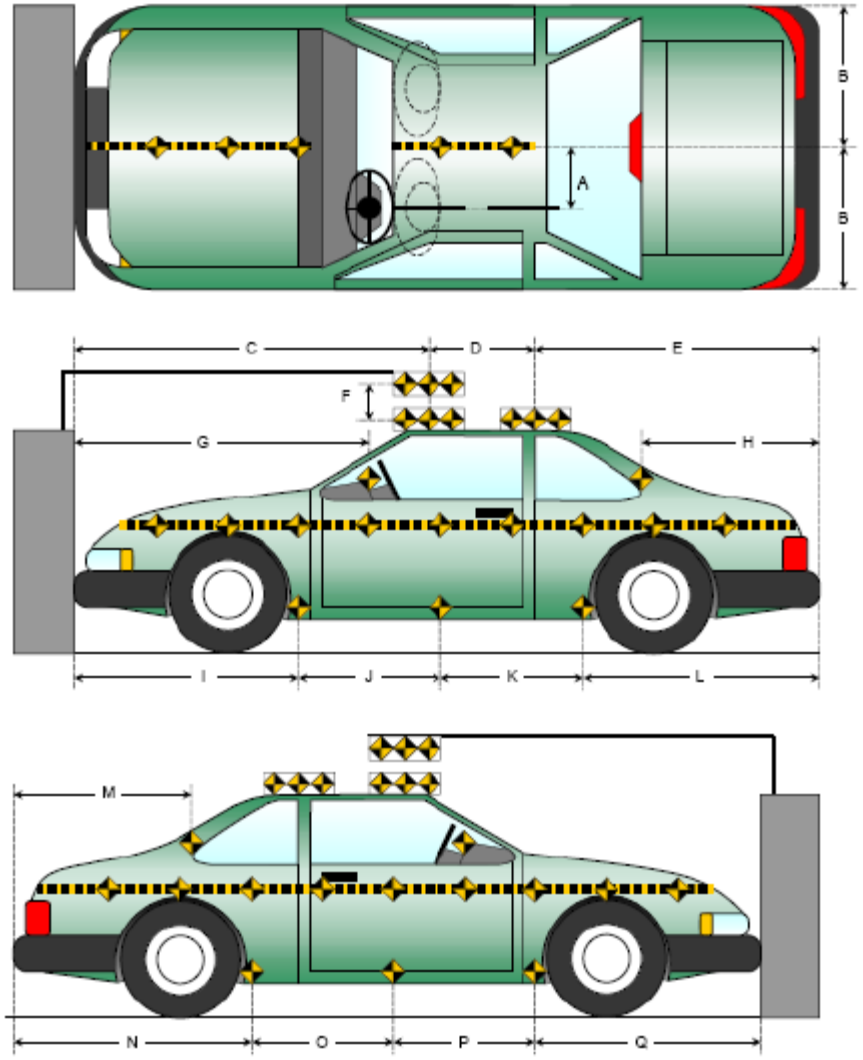
Reference Points:
X – Rear Surface of Vehicle (+ forward)
Y – Vehicle Centerline (+ to right)
Z – Ground Plane (+ down)

DATA SHEET NO. 8
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2022 Ford Bronco four door SUV
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: M20220215
Test Date: 3/16/2022

Item	Value
A	386
B	892
C	2594
D	609
E	1354
F	210
G	1758
H	1064
I	1405
J	852
K	850
L	1450
M	1066
N	1448
O	855
P	850
Q	1404

All units in millimeters



DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

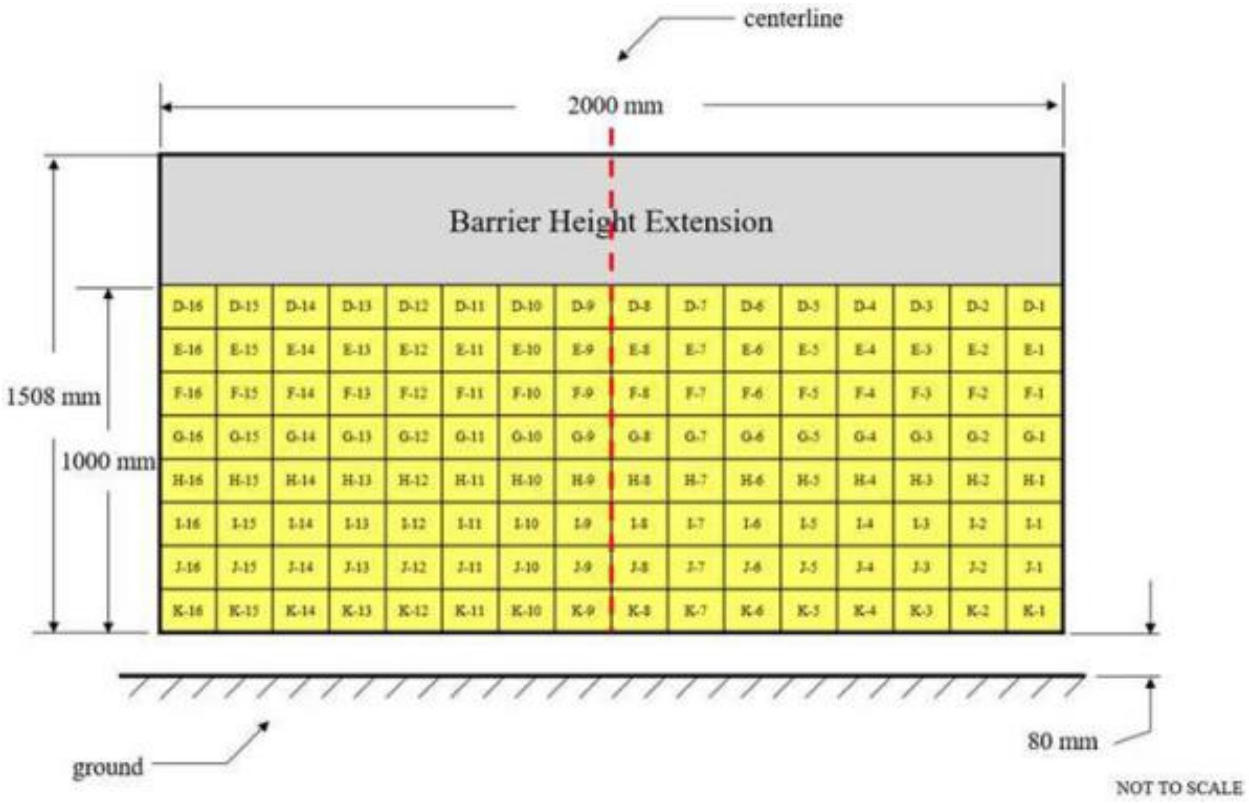


Figure 1 - Load Cell Locations on a 128-Load Cell Barrier with Plywood Height Extension*
Please note above diagram is not actual representation of load cell barrier used.

DATA SHEET NO. 10
TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

INSTRUMENTATION

Instrumentation	Number of Channels Collected
Driver Dummy Accelerometers	47
Passenger Dummy Accelerometers	47
Vehicle Structure Accelerometers	8
Load Cell Barrier	384
Total	486

CAMERA COVERAGE

Type of Camera	Number Used in this Test
High-Speed Vehicle Onboard	2
High-Speed Offboard	14
Real-Time Panning	1
Total	17

DATA SHEET NO. 11
POST-TEST OBSERVATIONS

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Passenger
Dummy Type / Serial No.	P572E 50th Male / 142	P5720 5th Female / 137
Head Contact	Frontal Airbag & Headrest	Frontal Airbag & Headrest
Upper Torso Contact	Frontal Airbag	Frontal Airbag
Lower Torso Contact	None	None
Left Knee Contact	Knee Bolster	Glove Box
Right Knee Contact	Knee Bolster	Glove Box

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Passenger	Other
Locked / Unlocked Doors	Locked	Locked	
Front Door Opening	Closed & Operational	Closed & Operational	
Rear Door Opening	Closed & Operational	Closed & Operational	
Trunk/Hatch/Tailgate Opening			Closed & Operational
Seat Track Shift (mm)	0	0	
Seat Back Movement from Initial Position	None	None	

**NOTE: Indicate "No", "N/A, or "Yes" described

POST-TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	Minor Cracks throughout
Window Damage	None
Other	Dashboard upper partially detached

VEHICLE REBOUND FROM BARRIER

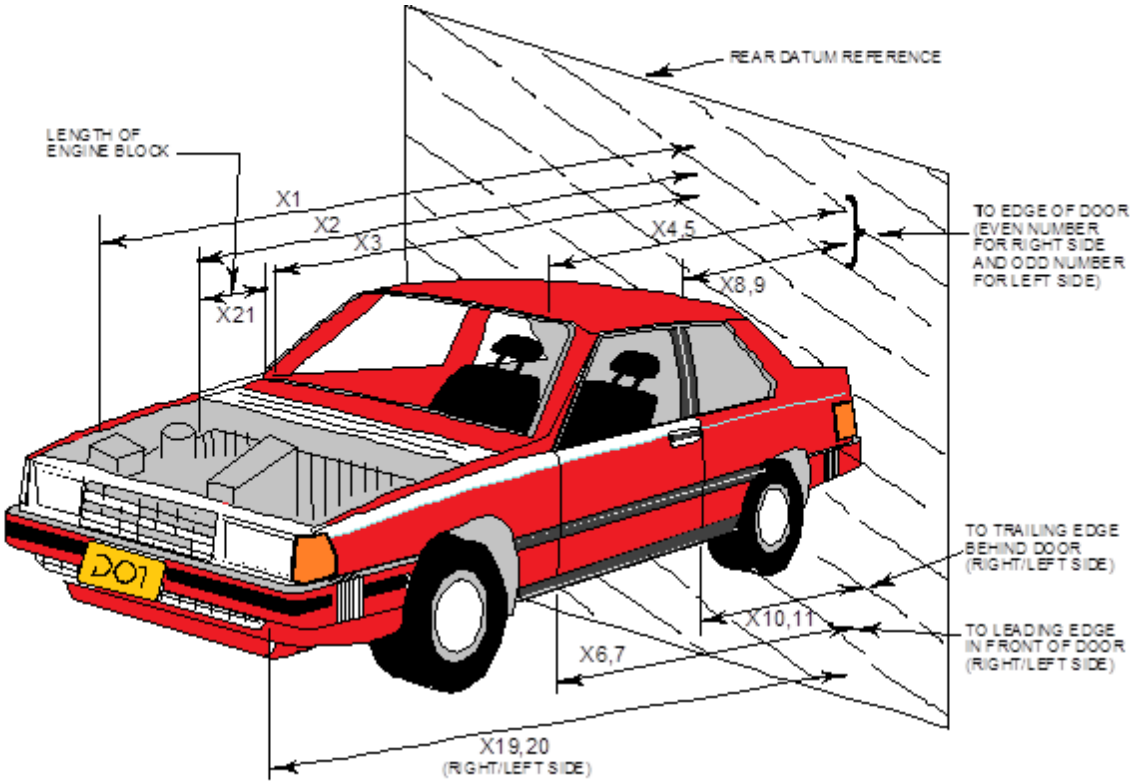
Measured Parameter	Units	Value
Left Side	mm	565
Center	mm	570
Right Side	mm	529
Average	mm	555

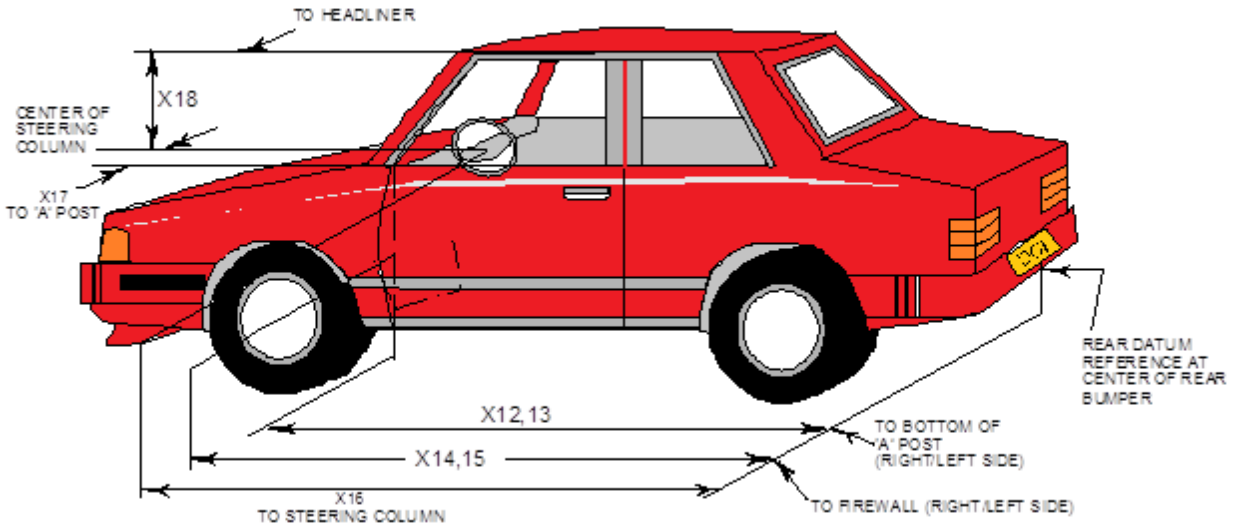
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Driver		Passenger	
	Installed	Deployed	Installed	Deployed
Front Airbag	Yes	Yes	Yes	Yes
Side Airbag 1 - Curtain	Yes	No	Yes	No
Side Airbag 2 - Torso/Pelvis Airbag	Yes	No	Yes	No
Knee Airbag	No	N/A	No	N/A
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes	Yes	Yes	Yes
Other				

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022





DATA SHEET NO. 12 … (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

No.	Measurement Description	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	4557	4050	-507
2	Rear Surface of Vehicle (RSOV) to Front of Engine	3968	3742	-226
3	RSOV to Firewall	3372	3271	-101
4	RSOV to Upper Leading Edge of Right Door	3074	3074	0
5	RSOV to Upper Leading Edge of Left Door	3073	3070	-3
6	RSOV to Lower Leading Edge of Right Door	3054	3057	3
7	RSOV to Lower Leading Edge of Left Door	3052	3053	1
8	RSOV to Upper Trailing Edge of Right Door	2016	2018	2
9	RSOV to Upper Trailing Edge of Left Door	2015	2013	-2
10	RSOV to Lower Trailing Edge of Right Door	2025	2028	3
11	RSOV to Lower Trailing Edge of Left Door	2026	2027	1
12	RSOV to Bottom of “A” Post of Right Side	3044	3045	1
13	RSOV to Bottom of “A” Post of Left Side	3049	3035	-14
14	RSOV to Firewall, Right Side	3455	3435	-20
15	RSOV to Firewall, Left Side	3448	3425	-23
16	RSOV to Steering Column	2628	2705	77
17	Center of Steering Column to “A” Post	254	249	-5
18	Center of Steering Column to Headliner	447	486	39
19	RSOV to Right Side of Front Bumper	4559	4071	-488
20	RSOV to Left Side of Front Bumper	4559	4073	-486
21	Length of Engine Block	520	520	0
RD	RSOV to Right Side of Dash Panel	2810	2808	-2
CD	RSOV to Center of Dash Panel	2767	2748	-19
LD	RSOV to Left Side of Dash Panel	2810	2803	-7

*UR= Unrecoverable data point
All Dimensions in mm

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

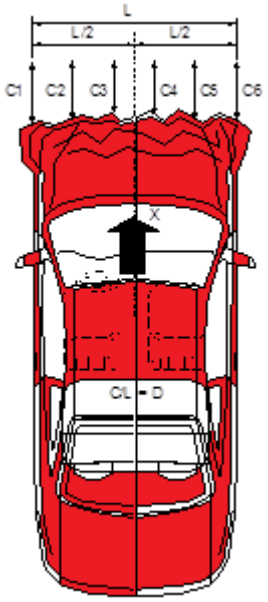
Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

VEHICLE INFORMATION

VIN:	1FMDE5BH0NLA99018	Wheelbase (mm):	2952
Vehicle Size Category:	MPV	Test Weight (kg):	2314

ACCELEROMETER DATA

Accelerometer Locations:	Please See Data Sheet No. 7
Cal. Procedure / Interval:	Calspan Procedure / 6 month
Integration Algorithm:	Trapezoidal
Linearity:	> 99%
Impact Velocity (km/h):	56.38
Velocity Change (km/h):	62.77
Time of Separation (ms):	152



CRUSH PROFILE

Collision Deformation Classification:	12FDEW3
Midpoint of Damage:	C3
Damage Region Length (mm):	1642
Impact Mode:	Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush Zone 1 at Left Side	mm	4458	4057	401
C2	Crush Zone 2 at Left Side	mm	4542	4060	482
C3	Crush Zone 3 at Left Side	mm	4556	4043	513
C4	Crush Zone 4 at Right Side	mm	4556	4045	511
C5	Crush Zone 5 at Right Side	mm	4541	4054	487
C6	Crush Zone 6 at Right Side	mm	4458	4029	429
L	C1 to C6	mm	1651	1642	9

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

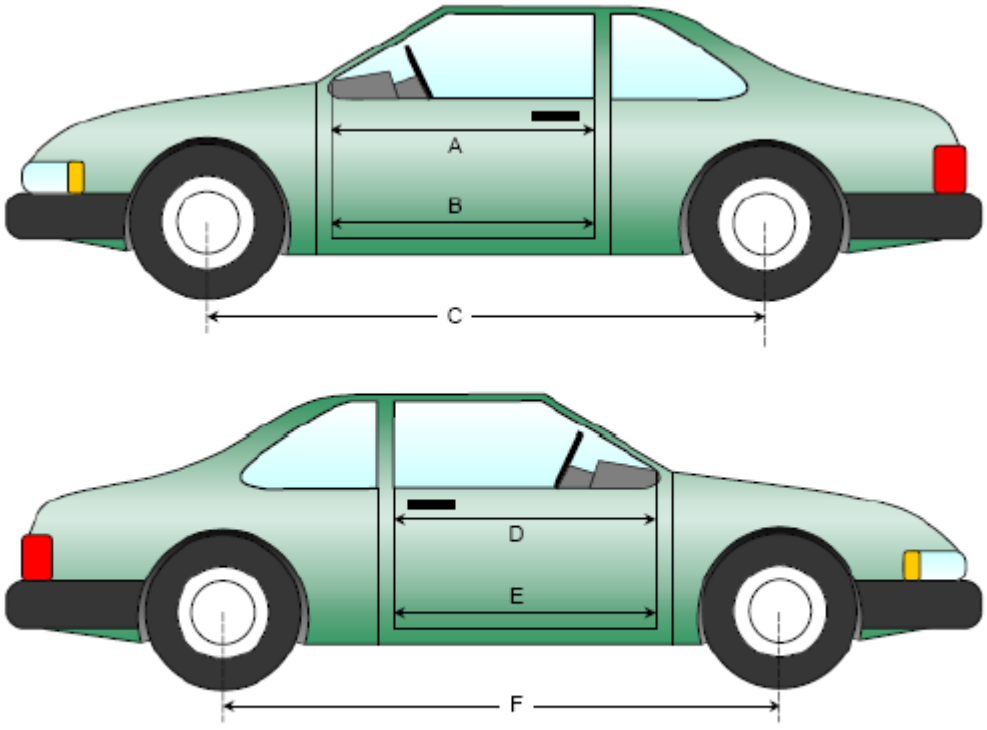
Test Vehicle: 2022 Ford Bronco four door SUV
NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test
Test Date: 3/16/2022

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	937	937	0
B	Left Side Lower	mm	794	794	0
D	Right Side Upper	mm	938	938	0
E	Right Side Lower	mm	796	795	-1

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2952	2869	-83
F	Right Side Wheelbase	mm	2952	2868	-84



Left & Right Side Views

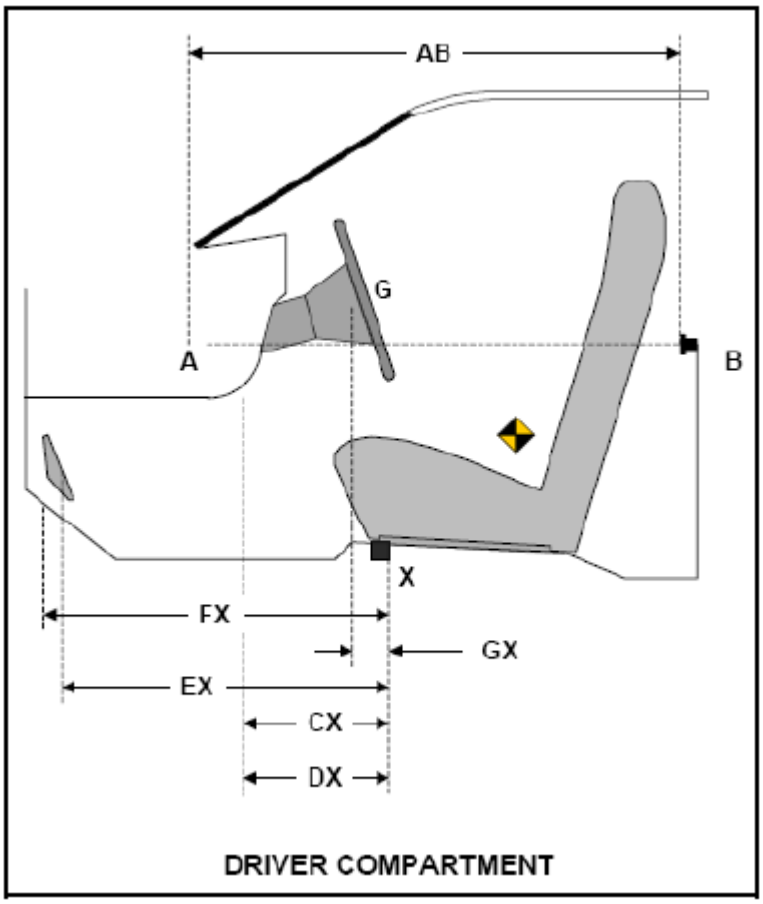
DATA SHEET NO.14 … (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	755	755	0
CX	Left Knee Bolster to X	mm	338	320	-18
DX	Right Knee Bolster to X	mm	331	335	4
EX	Brake Pedal to X	mm	588	533	-55
FX	Foot Rest to X	mm	616	614	-2
GX	Center of Steering Column Wheel Hub to X	mm	84	160	76

X = Front of Seat Track (Stationary)



DATA SHEET NO. 15
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA

Test Vehicle: 2022 Ford Bronco four door SUV NHTSA No.: M20220215
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/16/2022

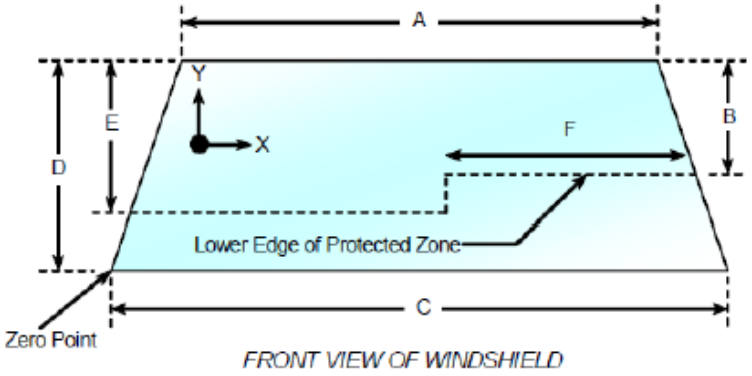
Windshield Mounting Details: A 0.8 mm trim surrounds the top and side of windshield while a plastic shroud is on the bottom.

The standard requires that the post-test retention measurement be a minimum of 75% of the pre-test total periphery measurement for vehicles not equipped with occupant passive restraints and 50% for each side of the windshield for vehicles which are equipped with occupant passive restraints.

Temperature of windshield molding during test: 21 ° C

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% Retention
Left Side	1894.5	1894.5	100
Right Side	1894.5	1894.5	100
Total	3789	3789	100



FRONT VIEW OF WINDSHIELD

Item	Units	Value
A	mm	1313
B	mm	289
C	mm	1456
D	mm	510
E	mm	284
F	mm	565

AREAS OF PROTECTED ZONE FAILURES

A. *Provide coordinates of the area that the protected zone was penetrated more than .25 inches by a vehicle component other than one that is normally in contact with the windshield.*
- No Penetration

X	Y

B. *Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component.*
- No Penetration

X	Y

DATA SHEET NO. 15 … (CONTINUED)
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Temperature at Time of Impact: 21 ° C Test Time: 2:53 PM

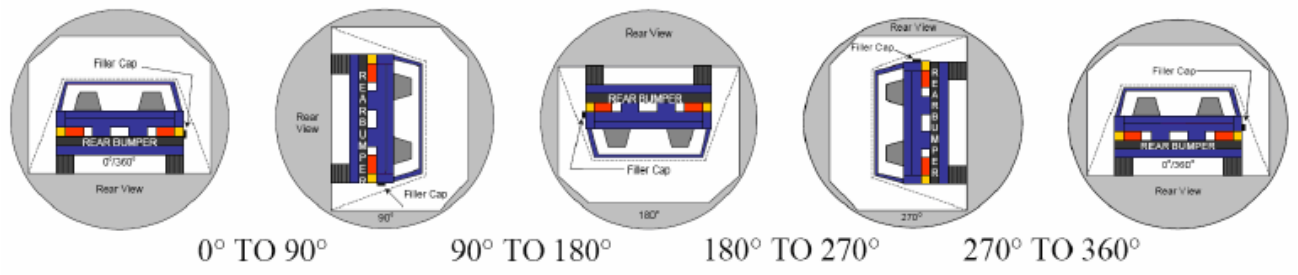
STODDARD SOLVENT SPILLAGE MEASUREMENTS

A. From impact until vehicle motion ceases: (Maximum allowable is 1 oz.)	0	oz.
B. For the 5-minute period after motion ceases: (Maximum allowable is 5 oz.)	0	oz.
C. For the following 25 minutes: (Maximum allowable is 1 oz./minute)	0	oz.

D. Spillage: No Spillage Occurred

DATA SHEET NO. 16
FMVSS 301 STATIC ROLLOVER RESULTS

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022



1. The specified fixture rollover rate for each 90°of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).
3. Details of Stoddard Solvent Spillage: No Spillage Occurred

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	69	300	369
90° to 180°	64	300	364
180° to 270°	64	300	364
270° to 360°	67	300	367

FMVSS 301 SPILLAGE TABLE

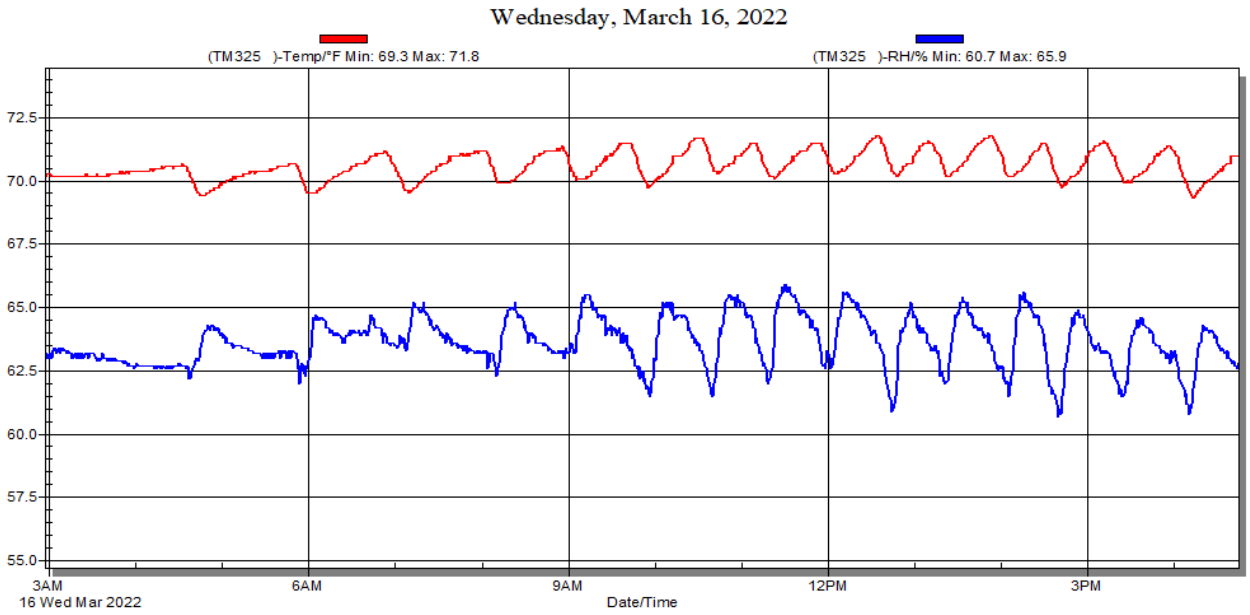
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° to 90°	0	0	0	
90° to 180°	0	0	0	
180° to 270°	0	0	0	
270° to 360°	0	0	0	

SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° to 90°	None
90° to 180°	None
180° to 270°	None
270° to 360°	None

DATA SHEET NO. 17
DUMMY / VEHICLE TEMPERATURE STABILIZATION CHART

Test Vehicle:	2022 Ford Bronco four door SUV	NHTSA No.:	M20220215
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/16/2022



Temperature and Humidity Stabilization Chart/Data for Dummies and Test Vehicle

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

[1]**NOTE**: *The underbody views should include the following vehicle components: fuel pump, fuel lines, sender unit, fuel tank filler pipe and any other visible system components.*

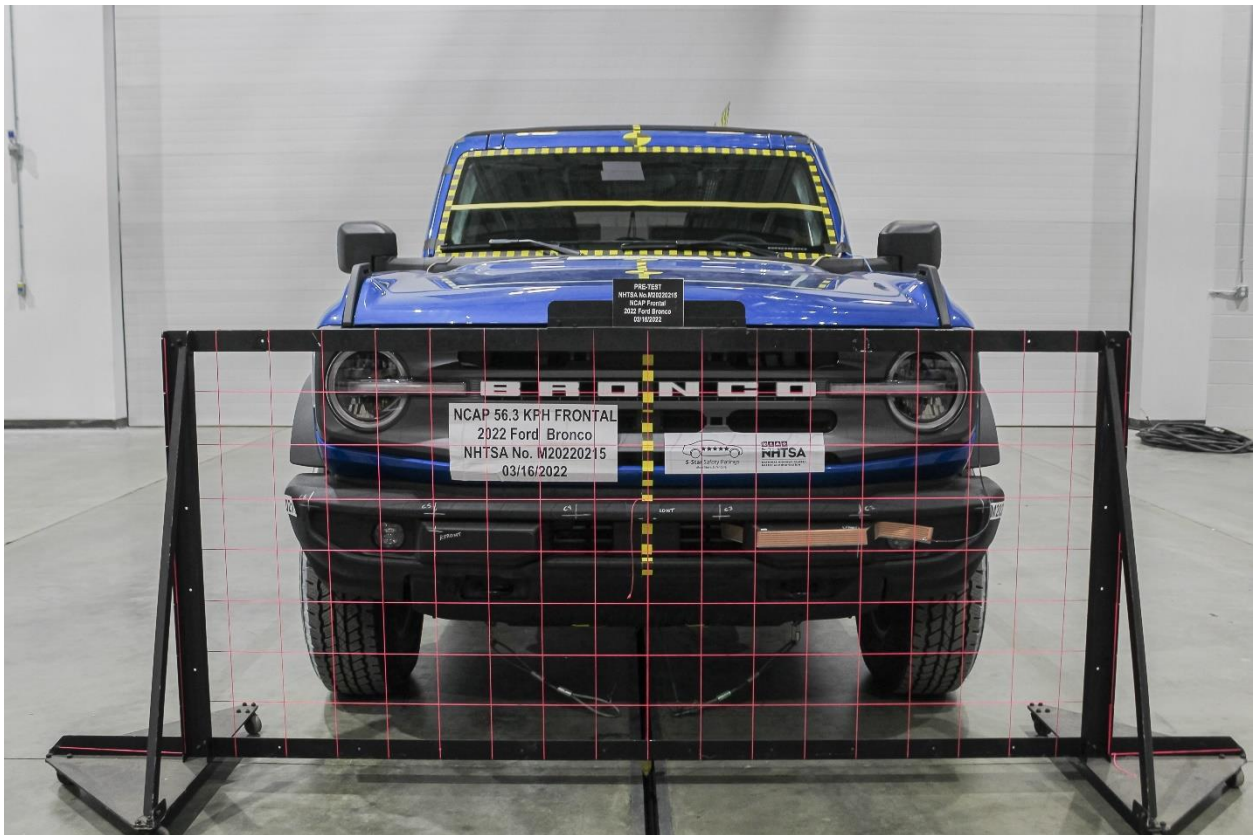


Figure A-1: Load Cell Location

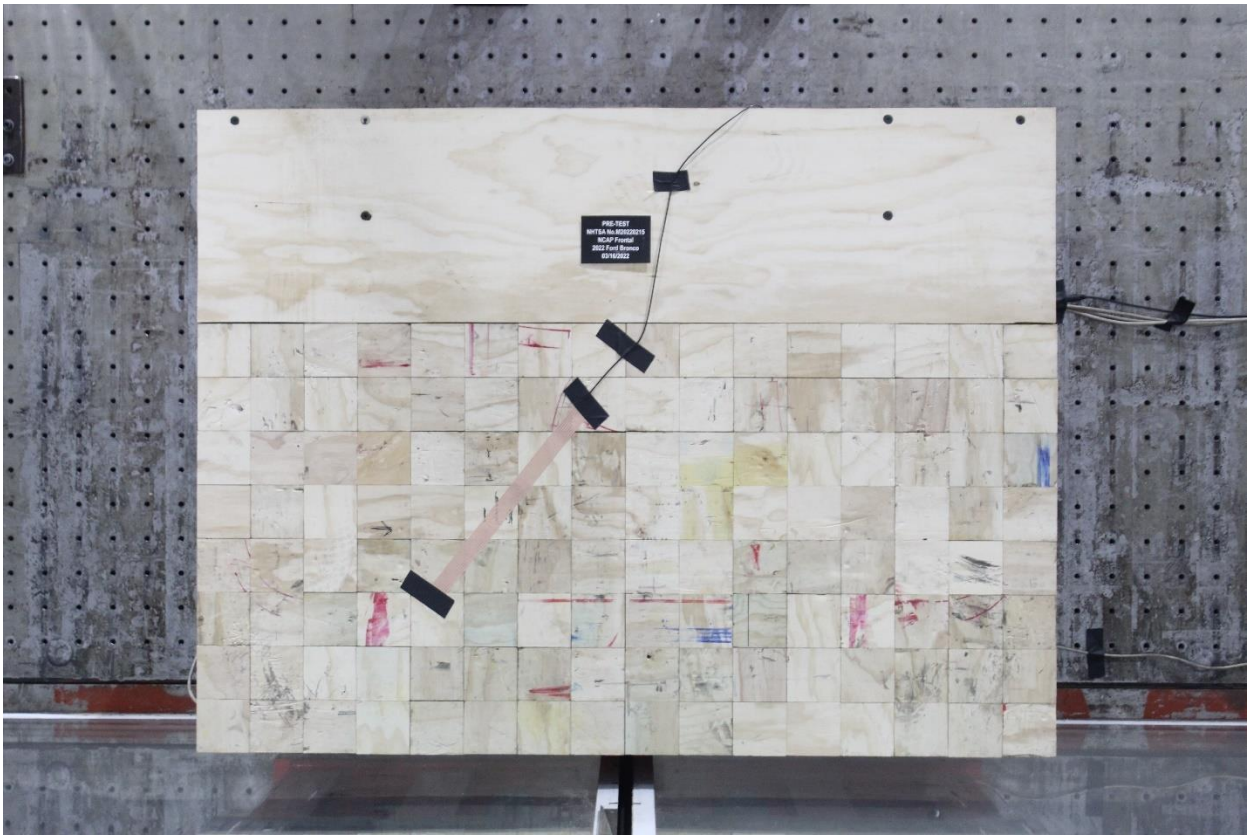


Figure A-2: Pre-Test Load Cell Wall

Figure A-3: Post-Test Load Cell Wall

Figure A-4: Manufacturer's Label

Figure A-5: Tire Placard

Figure A-6: 2022 Ford Bronco Frontal As Delivered

Figure A-7: Left Rear 3-4 View, As Received

Figure A-8: Pre-Test Front View of Test Vehicle

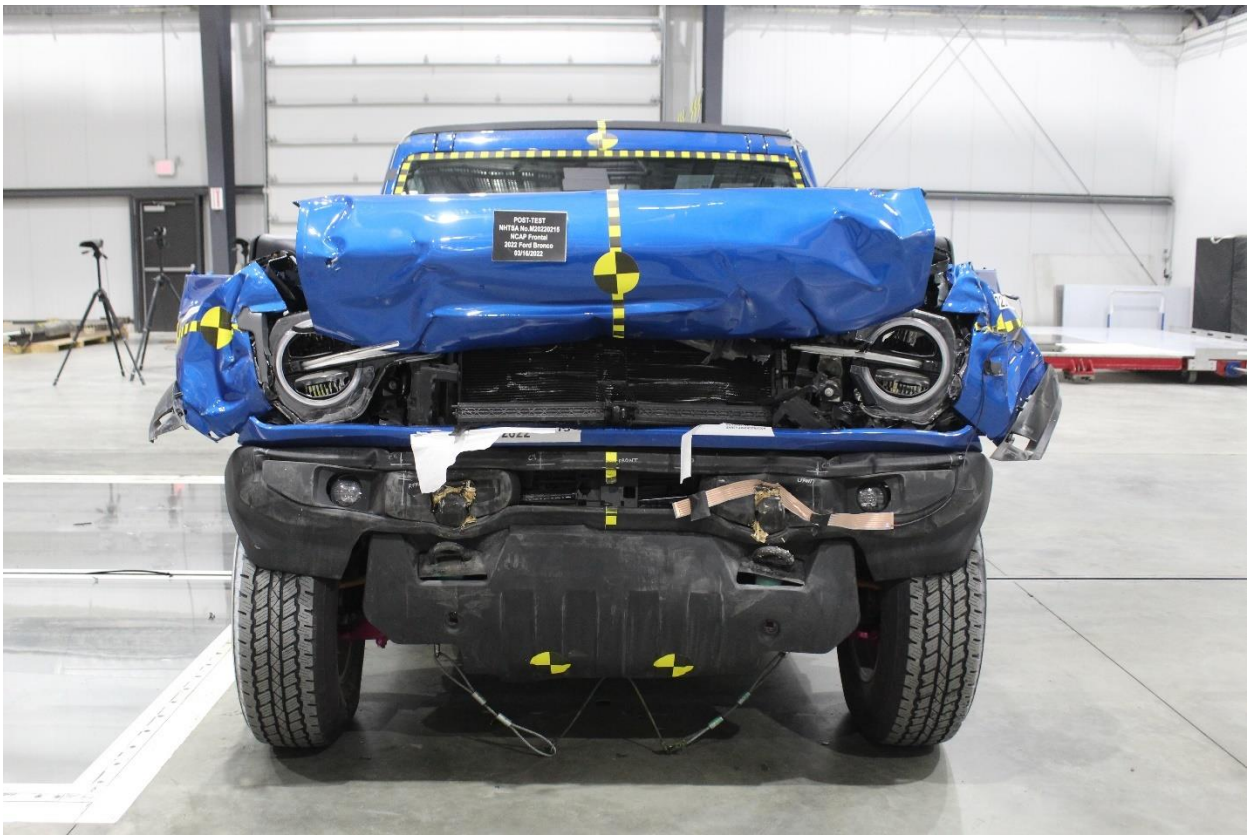


Figure A-9: Post-Test Front View of Test Vehicle

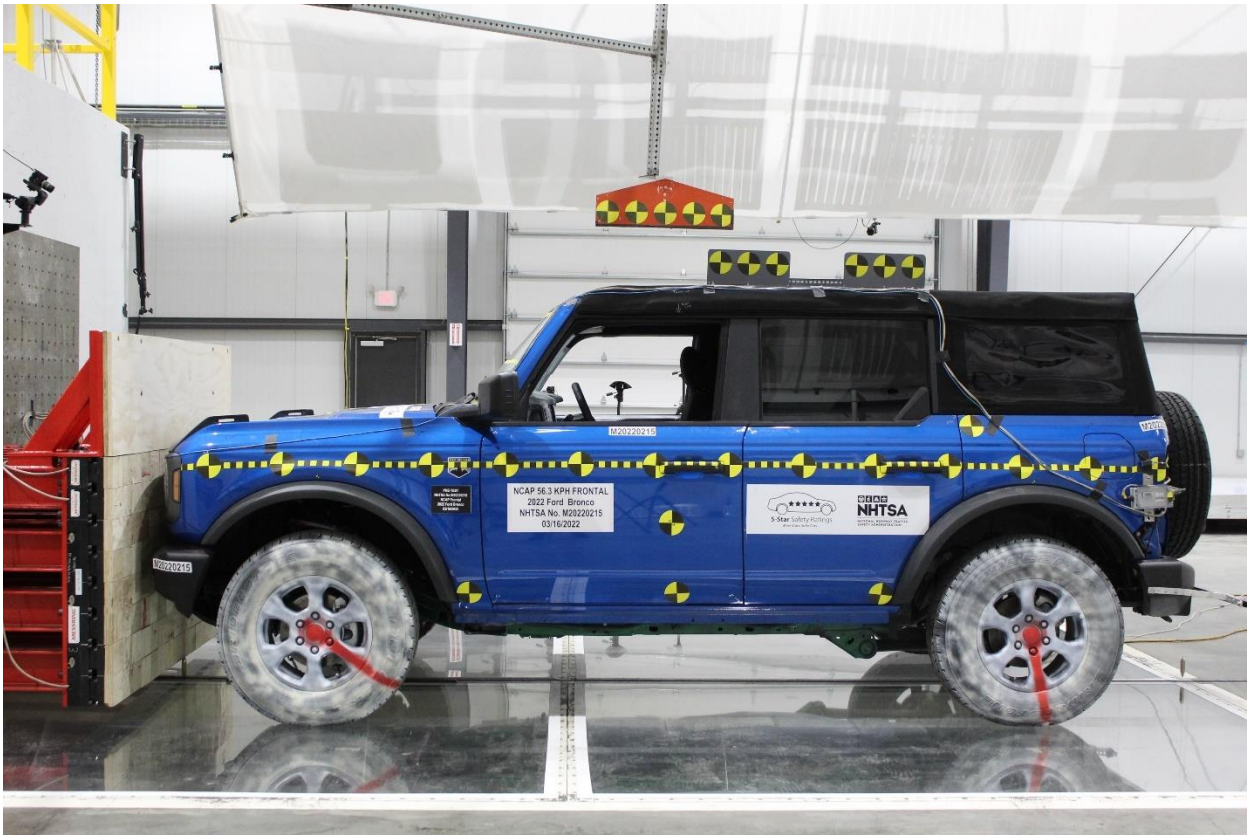


Figure A-10: Pre-Test Left View of Test Vehicle

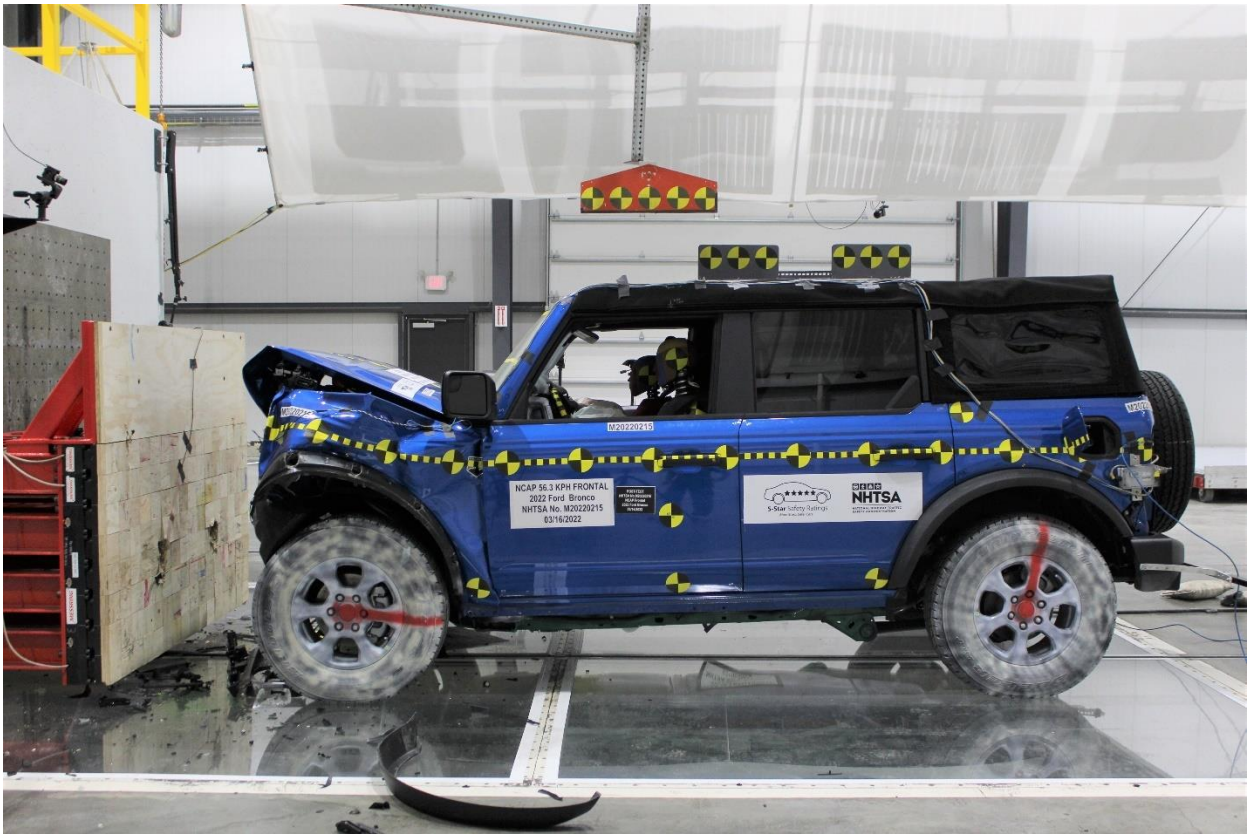


Figure A-11: Post-Test Left View of Test Vehicle

Figure A-12: Pre-Test Right View of Test Vehicle

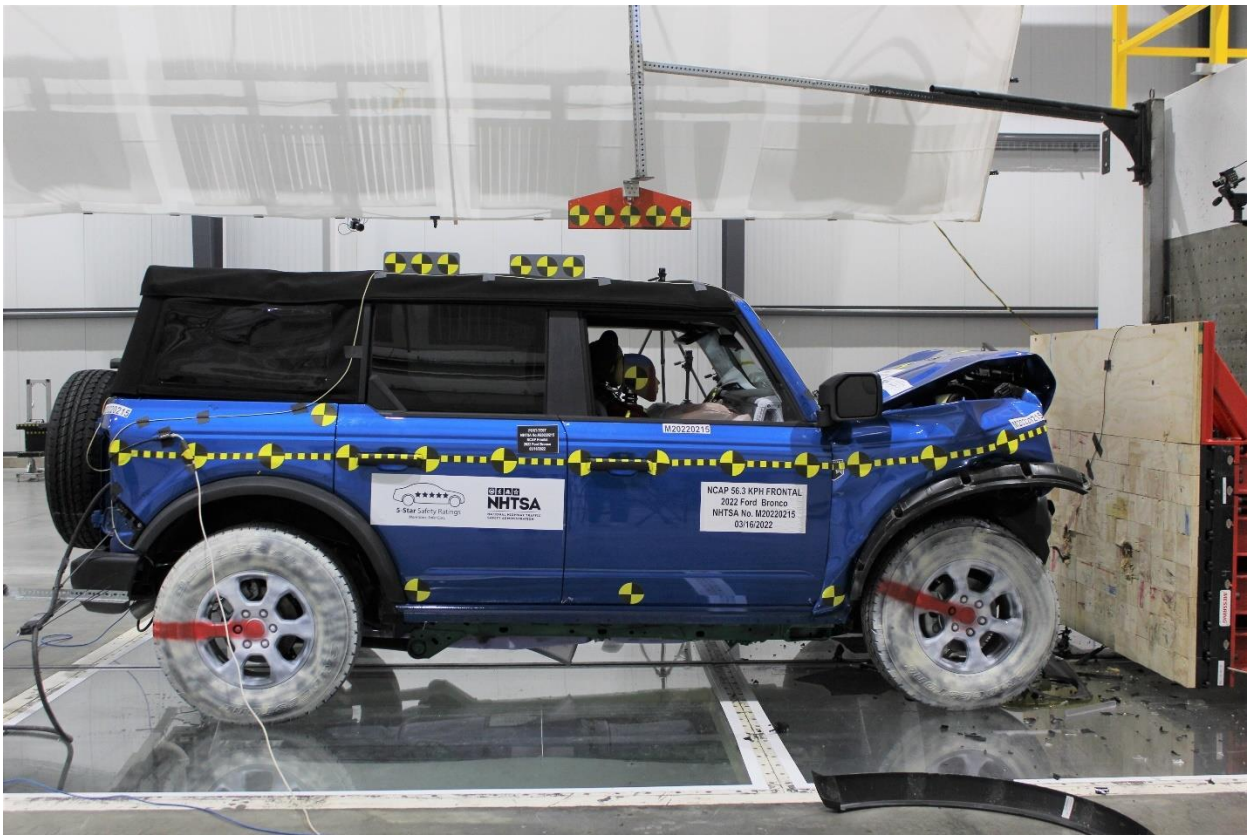


Figure A-13: Post-Test Right View of Test Vehicle

Figure A-14: Pre-Test Right Front 3-4 View

Figure A-15: Post-Test Right Front 3-4 View

Figure A-16: Pre-Test Left Rear 3-4 View

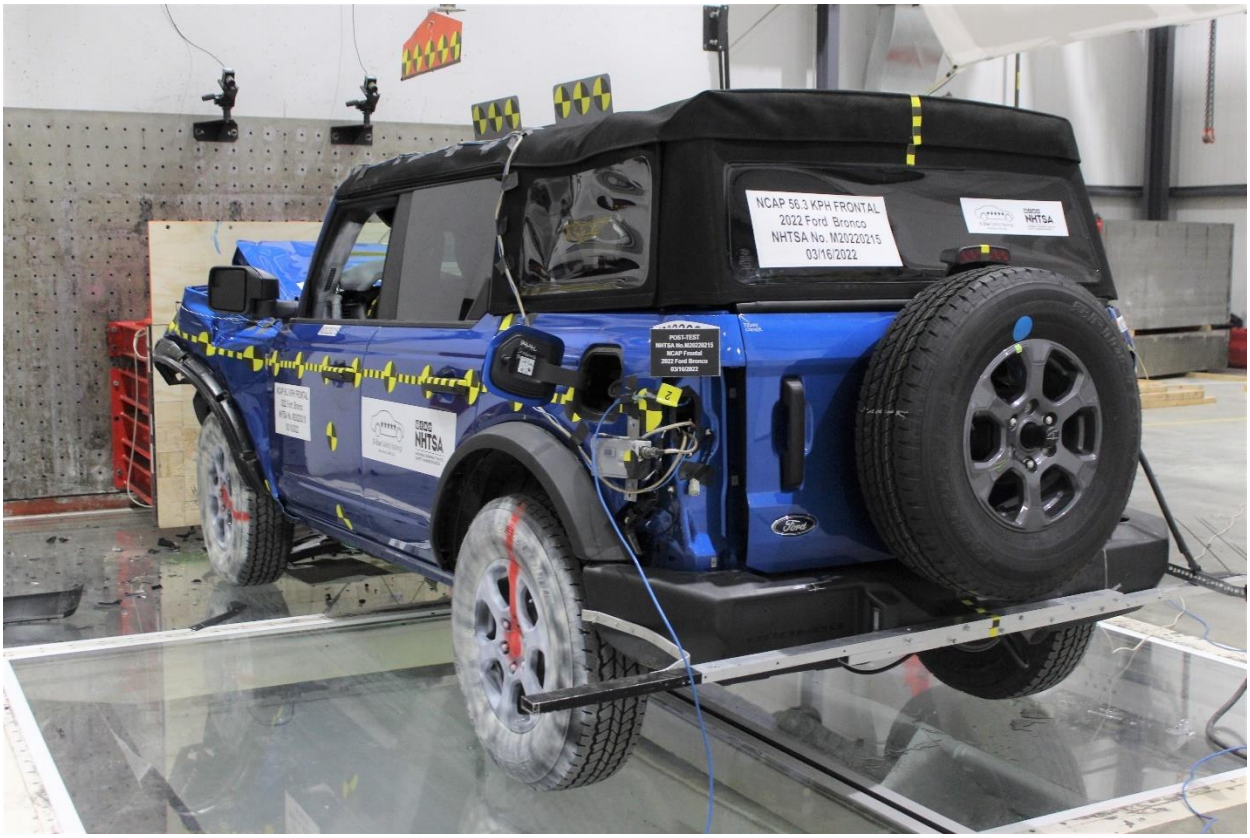


Figure A-17: Post-Test Left Rear 3-4 View

Figure A-18: Pre-Test Windshield View

Figure A-19: Post-Test Windshield View

Photo Not Available

Figure A-20: Pre-Test Engine Compartment View

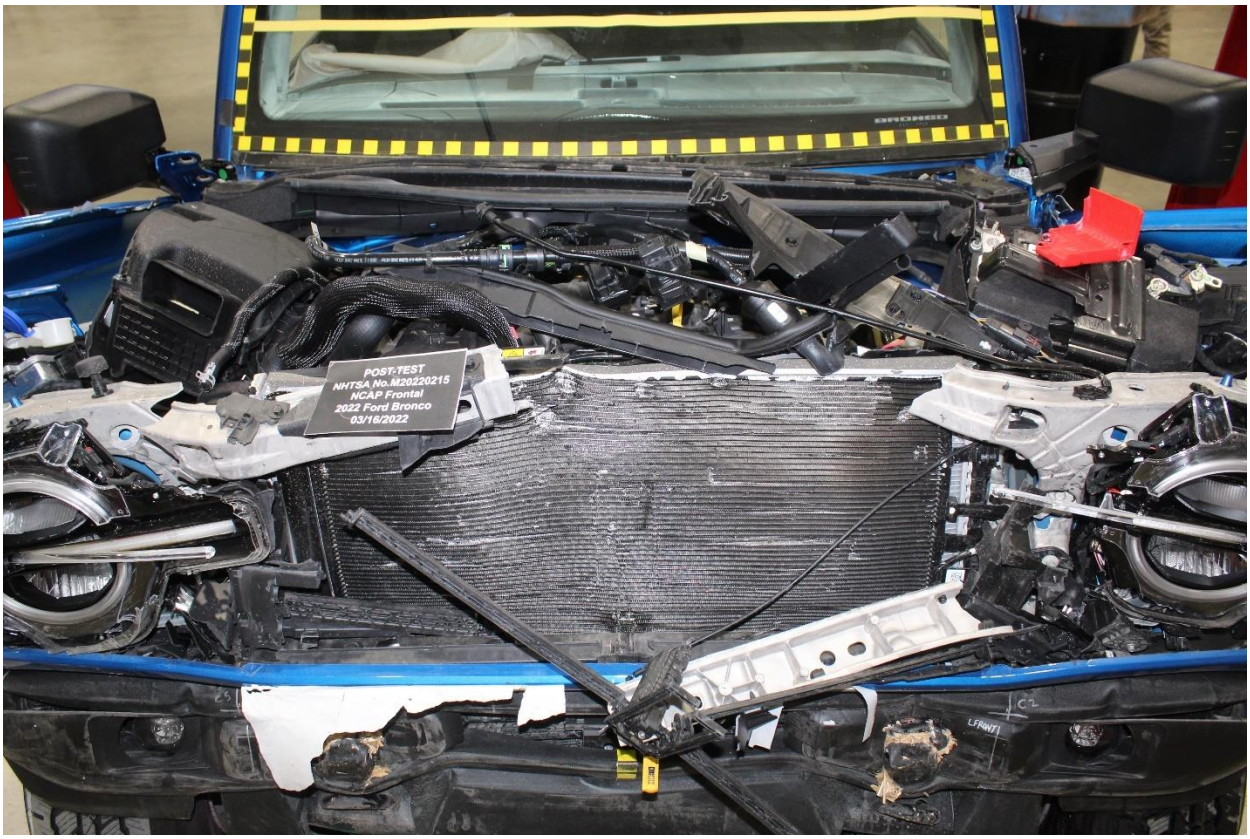


Figure A-21: Post-Test Engine Compartment View

Figure A-22: Pre-Test Fuel Filler Cap View

Figure A-23: Post-Test Fuel Filler Cap View

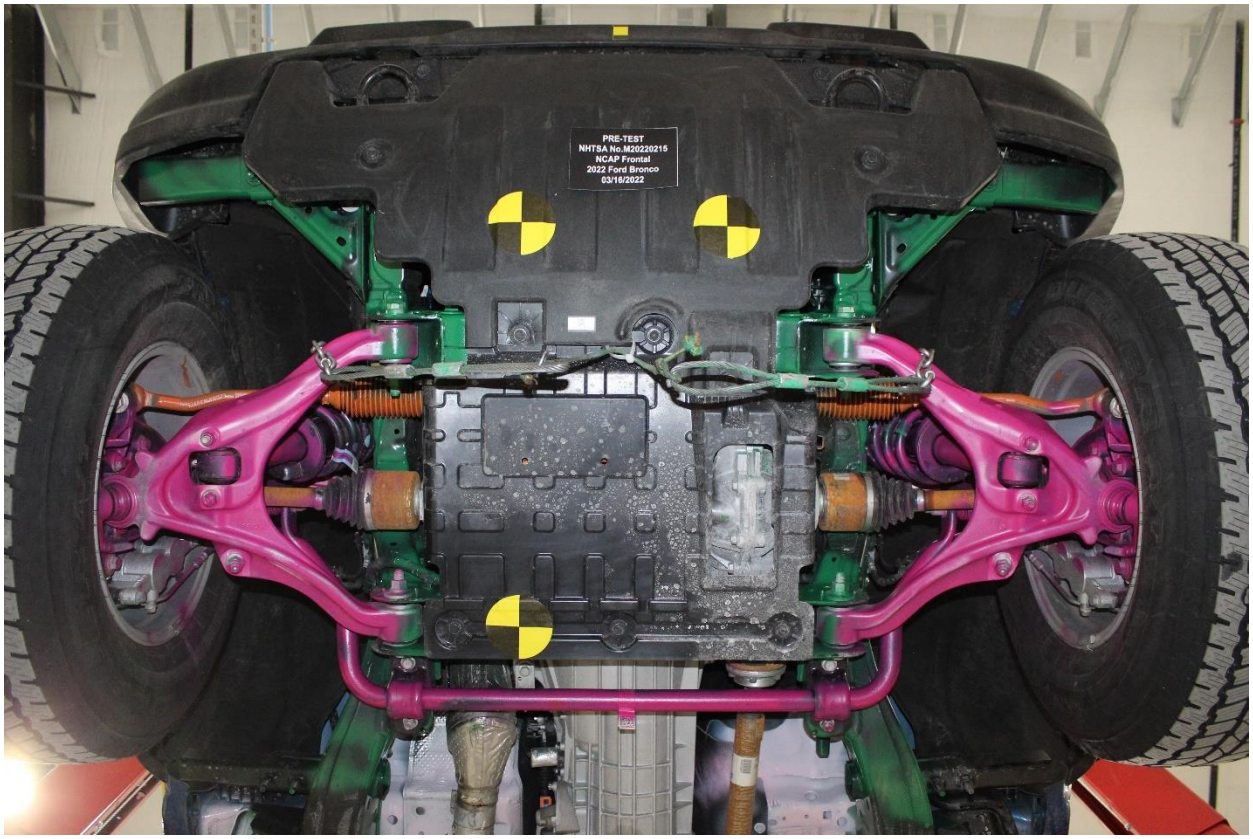


Figure A-24: Pre-Test Front Underbody View

Figure A-25: Post-Test Front Underbody View

Figure A-26: Pre-Test Rear Underbody View

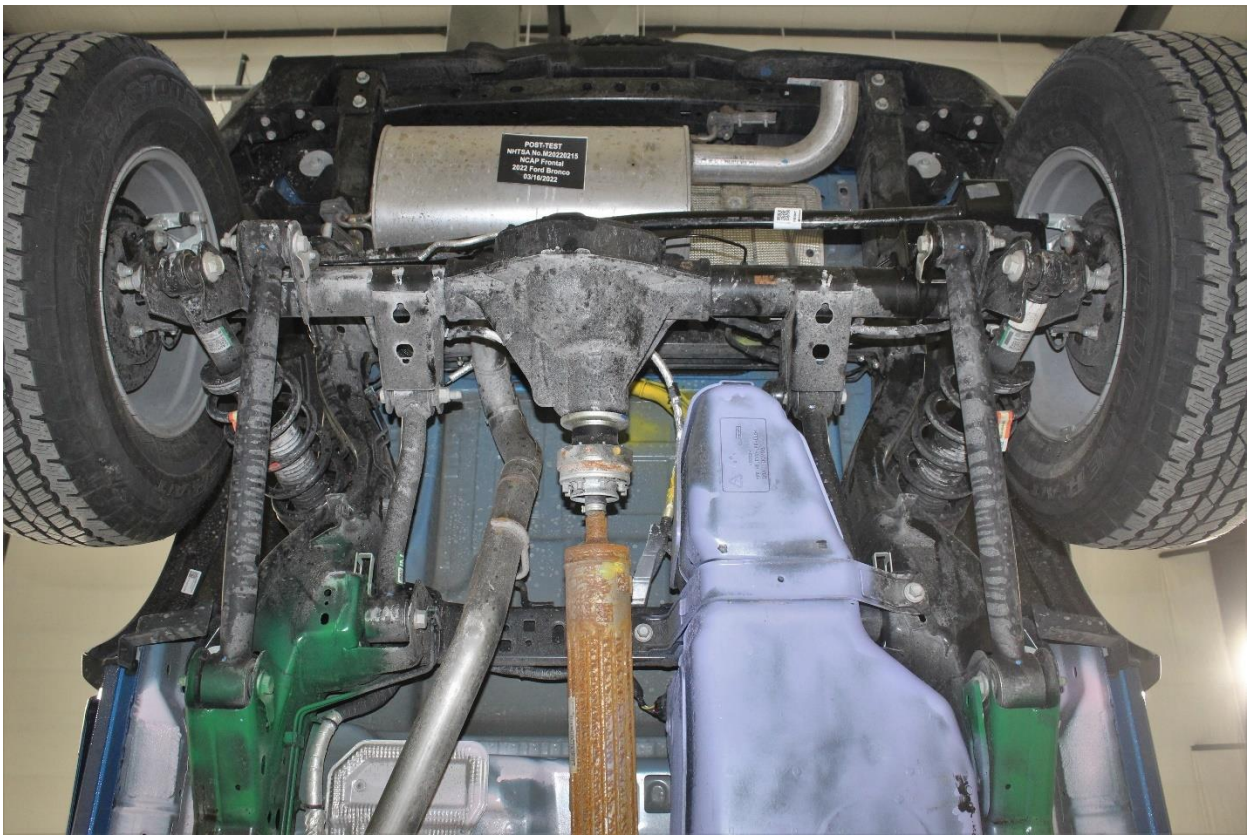


Figure A-27: Post-Test Rear Underbody View

Figure A-28: Pre-Test Dummy Cable Routing

Figure A-29: Post-Test Dummy Cable Routing

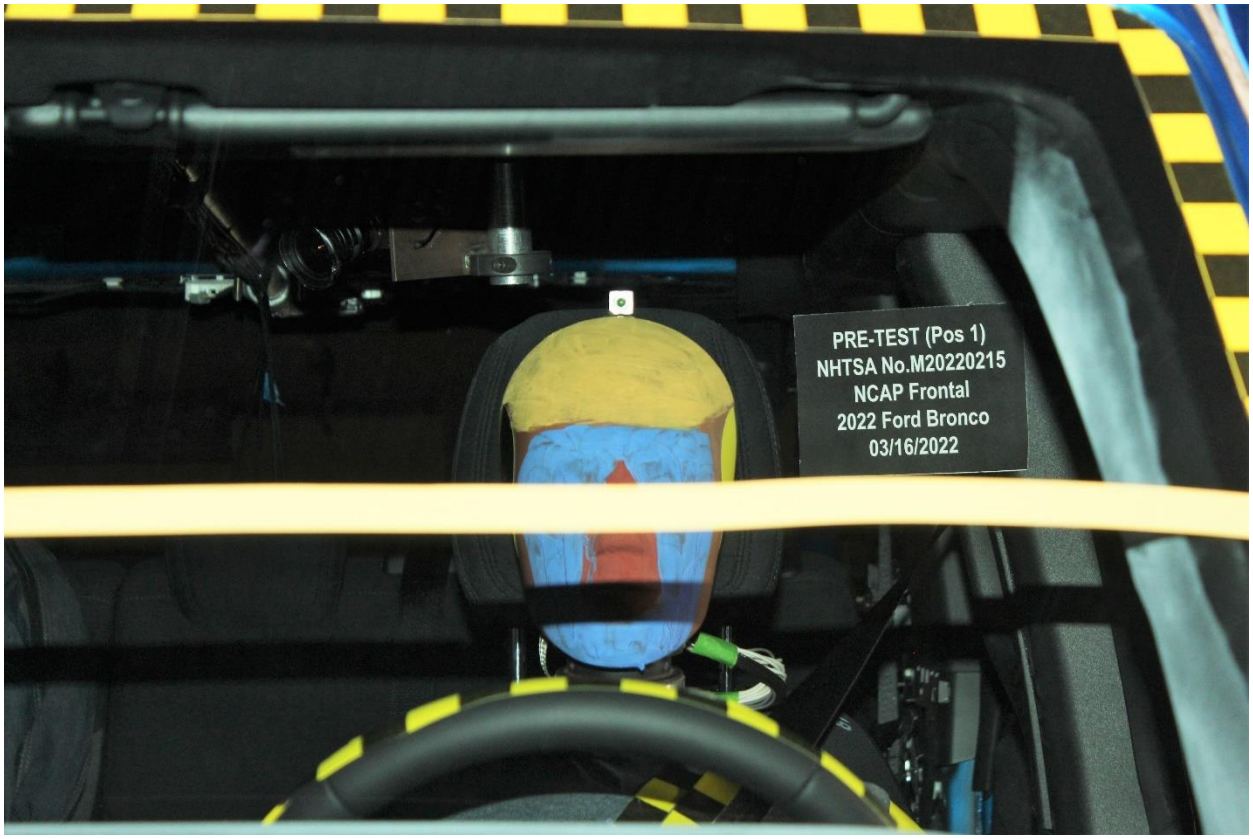


Figure A-30: Pre-Test Driver Dummy Front View

Figure A-31: Post-Test Driver Dummy Front View

Figure A-32: Pre-Test Driver Dummy Window View

Figure A-33: Post-Test Driver Dummy Window View

Figure A-34: Pre-Test Driver Dummy and Vehicle Interior View

Figure A-35: Post-Test Driver Dummy and Vehicle Interior View

Figure A-36: Pre-Test Driver's Seat Fore-Aft Markings

Figure A-37: Post-Test Driver's Seat Fore-Aft Markings

Figure A-38: Pre-Test View of Belt Anchorage for Driver Dummy

Figure A-39: Post-Test View of Belt Anchorage for Driver Dummy

Figure A-40: Pre-Test View of Belt Buckle and Latch Plate for Driver Dummy

Figure A-41: Post-Test View of Belt Buckle and Latch Plate for Driver Dummy

Figure A-42: Pre-Test Driver Dummy Feet

Figure A-43: Post-Test Driver Dummy Feet

Figure A-44: Pre-Test Driver's Side Knee Bolster

Figure A-45: Post-Test Driver's Side Knee Bolster

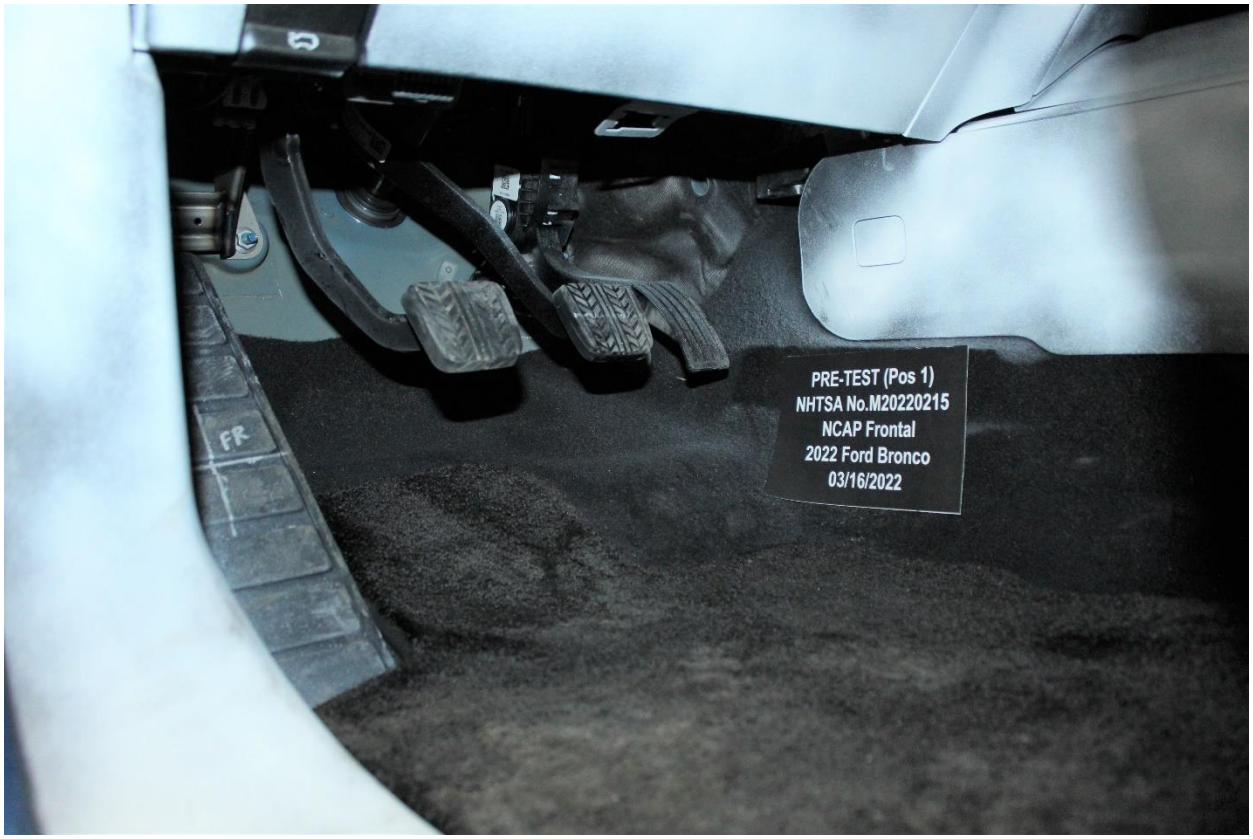


Figure A-46: Pre-Test Driver's Side Floorpan

Figure A-47: Post-Test Driver's Side Floorpan

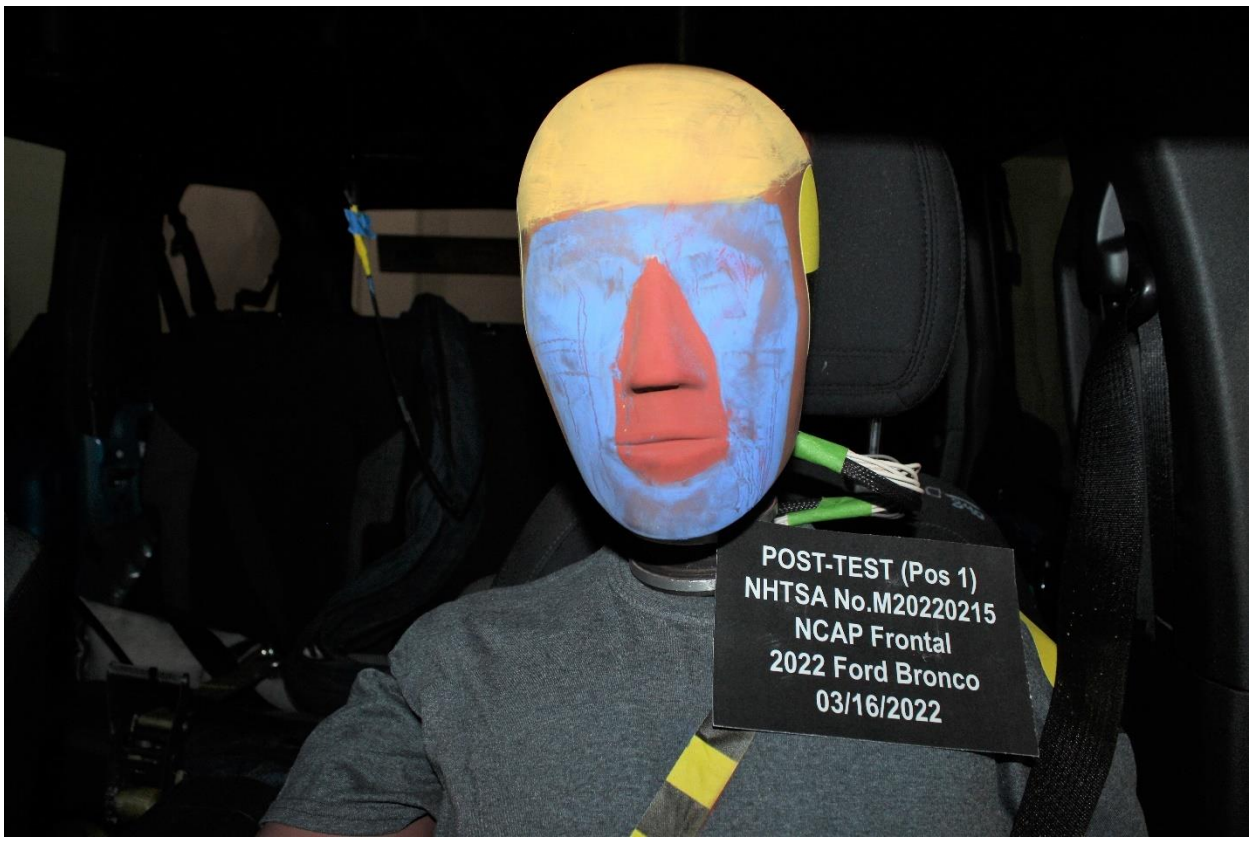


Figure A-48: Post-Test Driver Dummy Face

Figure A-49: Post-Test Driver Dummy Contact With Airbag

Figure A-50: Post-Test Driver Dummy Contact With Headrest

Figure A-51: Pre-Test View of the Steering Wheel

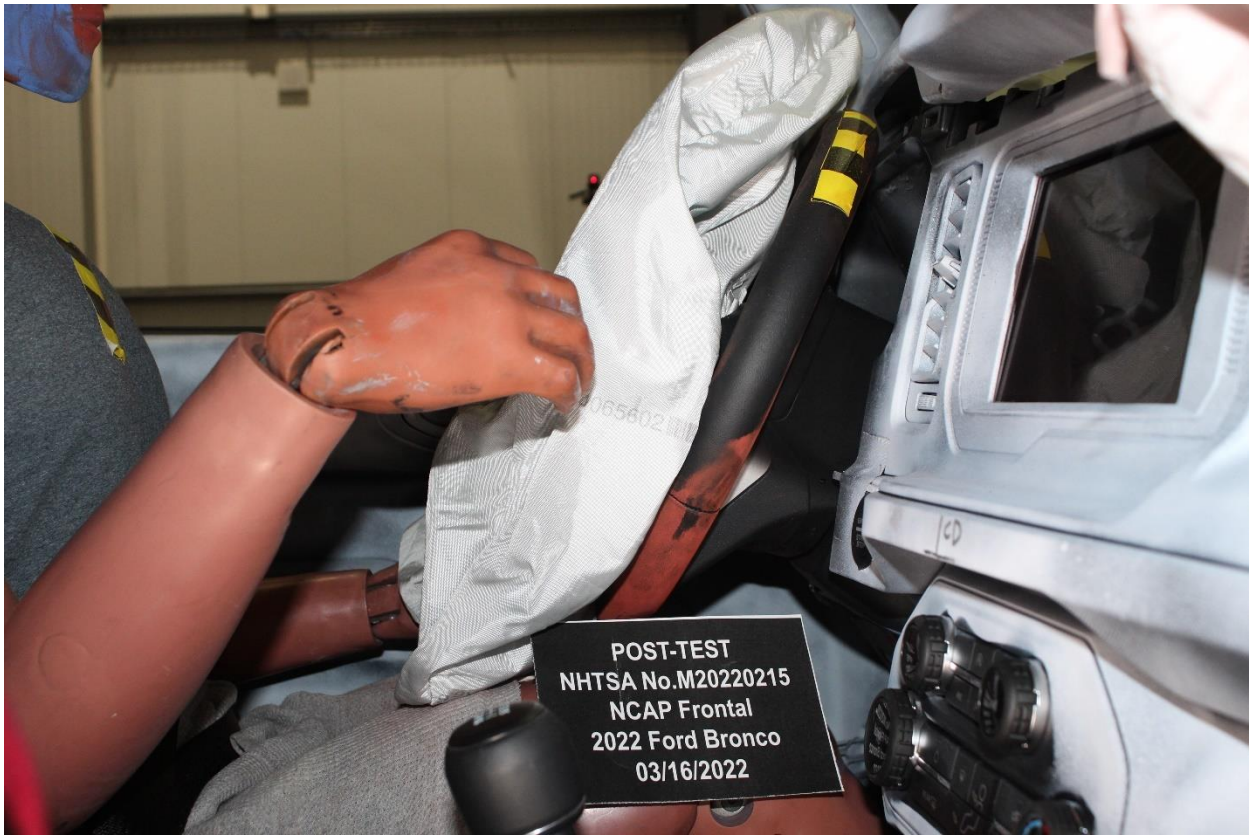


Figure A-52: Post-Test View of the Steering Wheel

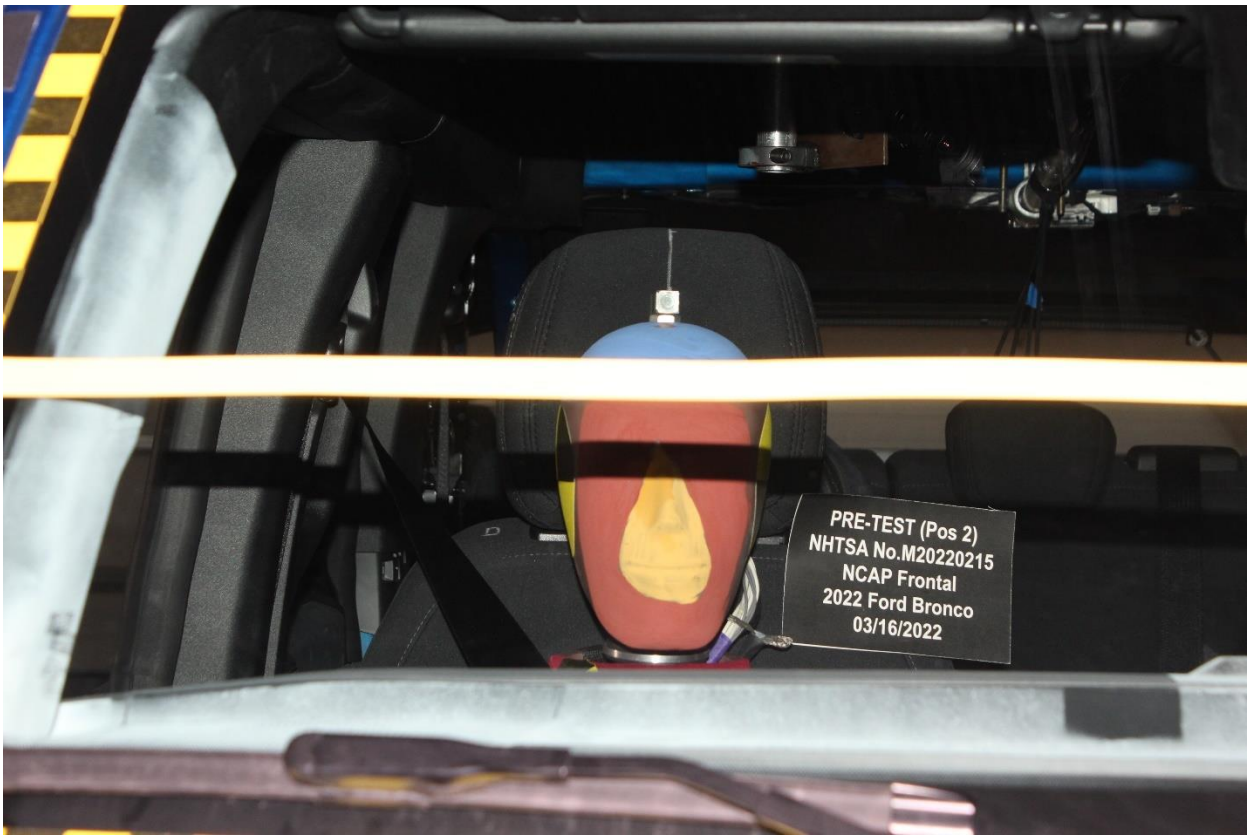


Figure A-53: Pre-Test Passenger Dummy Front View

Figure A-54: Post-Test Passenger Dummy Front View

Figure A-55: Pre-Test Passenger Dummy Window View

Figure A-56: Post-Test Passenger Dummy Window View

Figure A-57: Pre-Test Passenger Dummy and Vehicle Interior View

Figure A-58: Post-Test Passenger Dummy and Vehicle Interior View

Figure A-59: Pre-Test Passenger's Seat Fore-Aft Markings

Figure A-60: Post-Test Passenger's Seat Fore-Aft Markings

Figure A-61: Pre-Test View of Belt Anchorage for Passenger Dummy

Figure A-62: Post-Test View of Belt Anchorage for Passenger Dummy

Figure A-63: Pre-Test View of Belt Buckle and Latch Plate for Passenger Dummy

Figure A-64: Post-Test View of Belt Buckle and Latch Plate for Passenger Dummy

Figure A-65: Pre-Test Passenger Dummy Feet

Figure A-66: Post-Test Passenger Dummy Feet

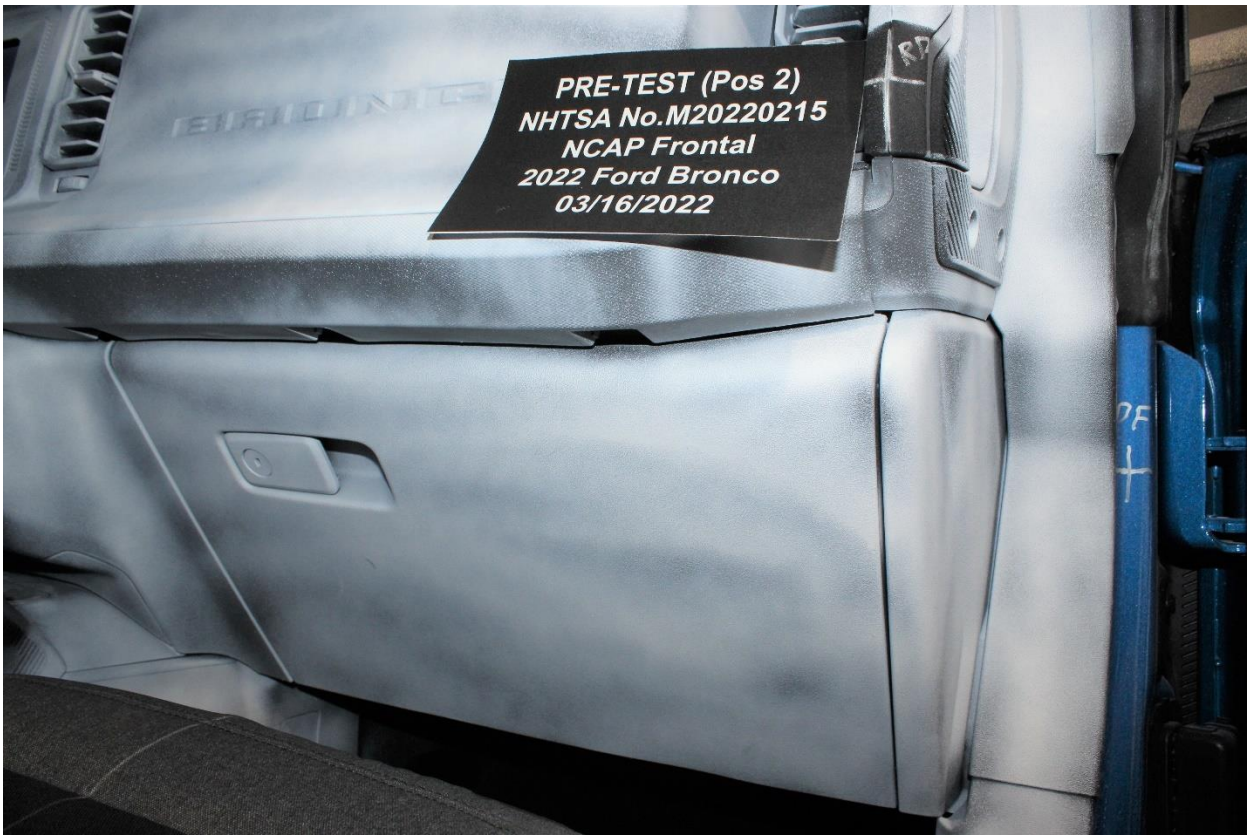


Figure A-67: Pre-Test Passenger's Side Knee Bolster

Figure A-68: Post-Test Passenger's Side Knee Bolster

Figure A-69: Pre-Test Passenger's Side Floorpan

Figure A-70: Post-Test Passenger's Side Floorpan

Figure A-71: Post-Test Passenger Dummy Face

Figure A-72: Post-Test Passenger Dummy Contact With Airbag

Figure A-73: Post-Test Passenger Dummy Contact With Headrest

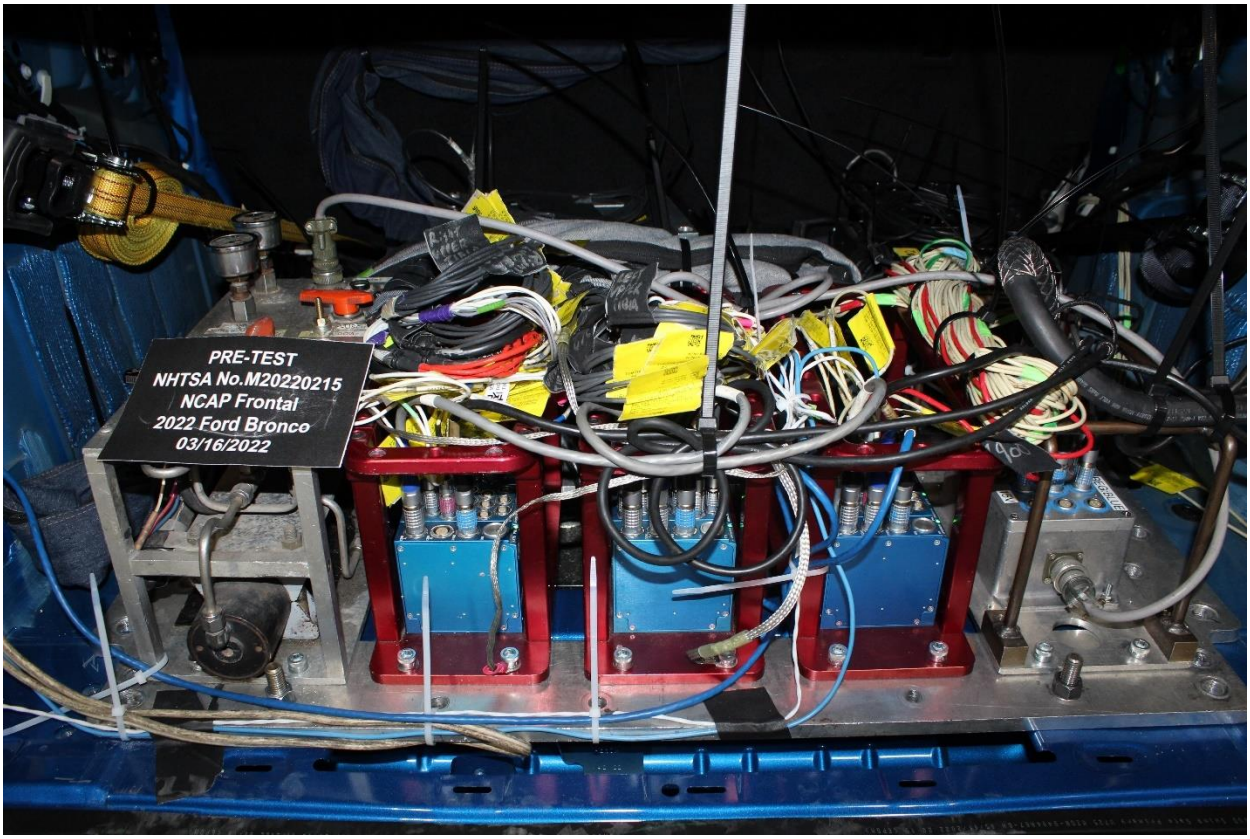


Figure A-74: Photograph of Ballast Installed in Vehicle

Photo Not Applicable

Figure A-75: Post-Test Stoddard Solvent Spillage Location View, If Required

Figure A-76: Post-Test Speed Trap Read-Out

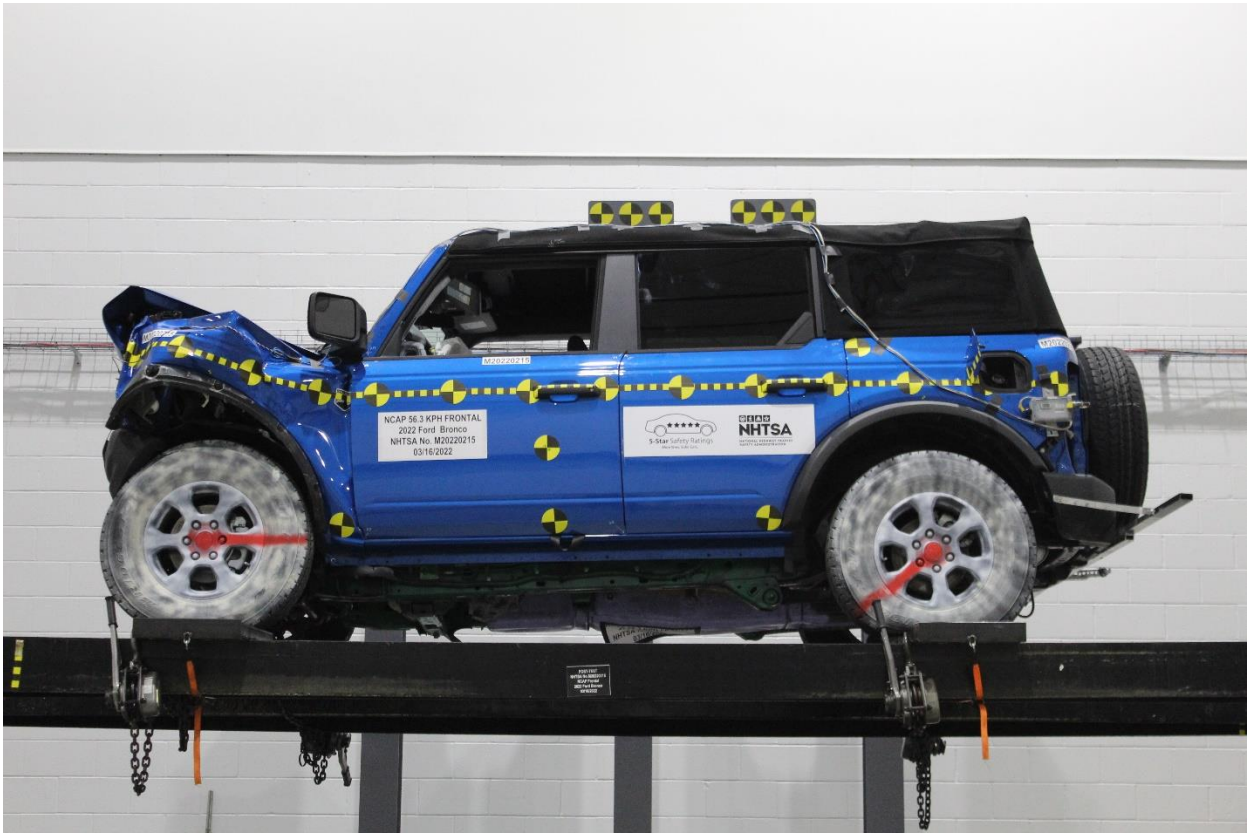


Figure A-77: Vehicle at 0º on Static Rollover Device

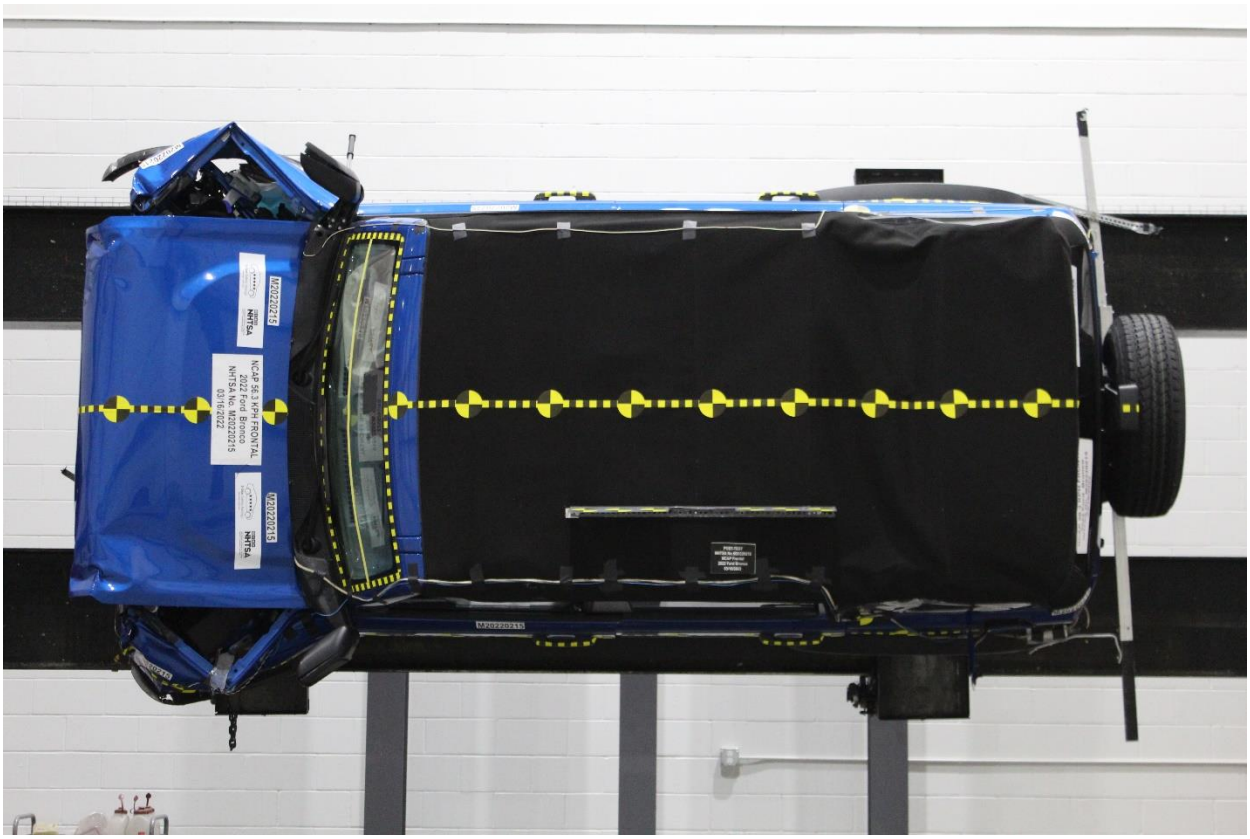


Figure A-78: Vehicle at 90º on Static Rollover Device

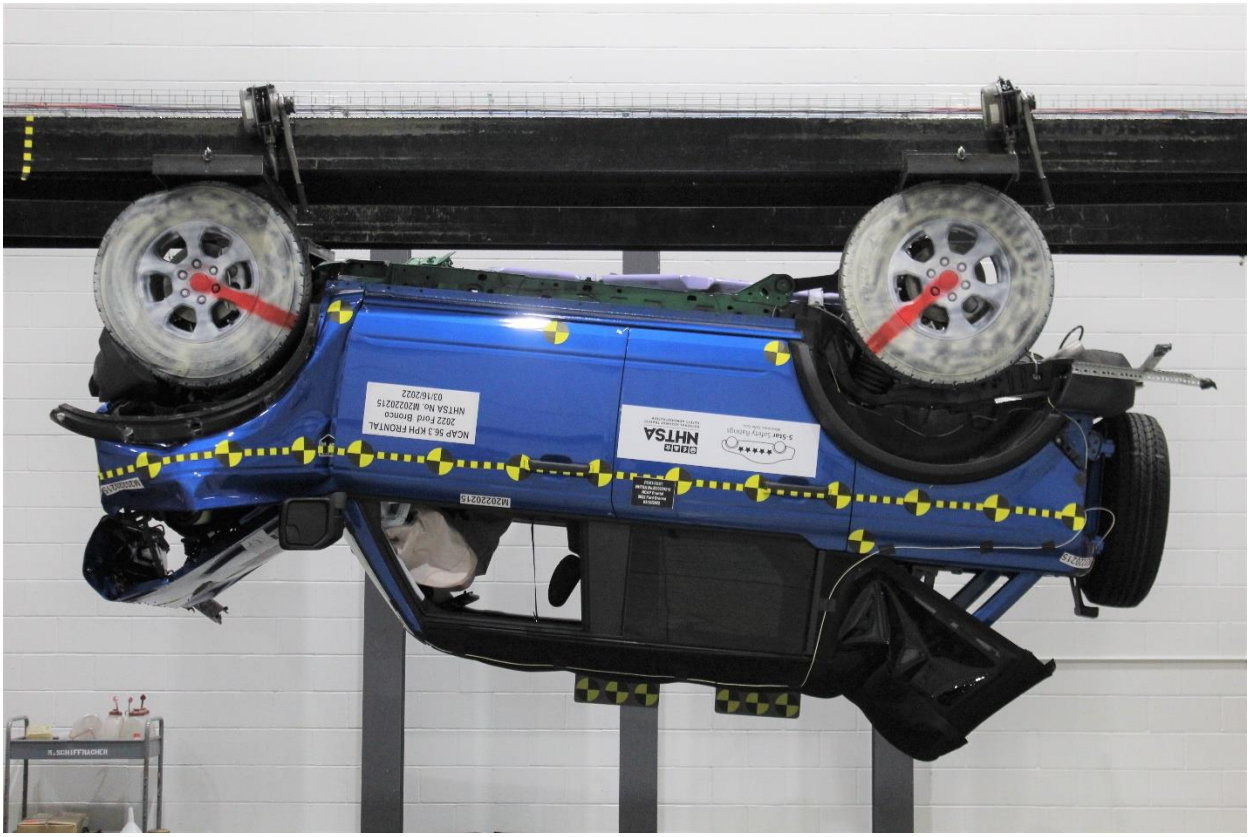


Figure A-79: Vehicle at 180º on Static Rollover Device

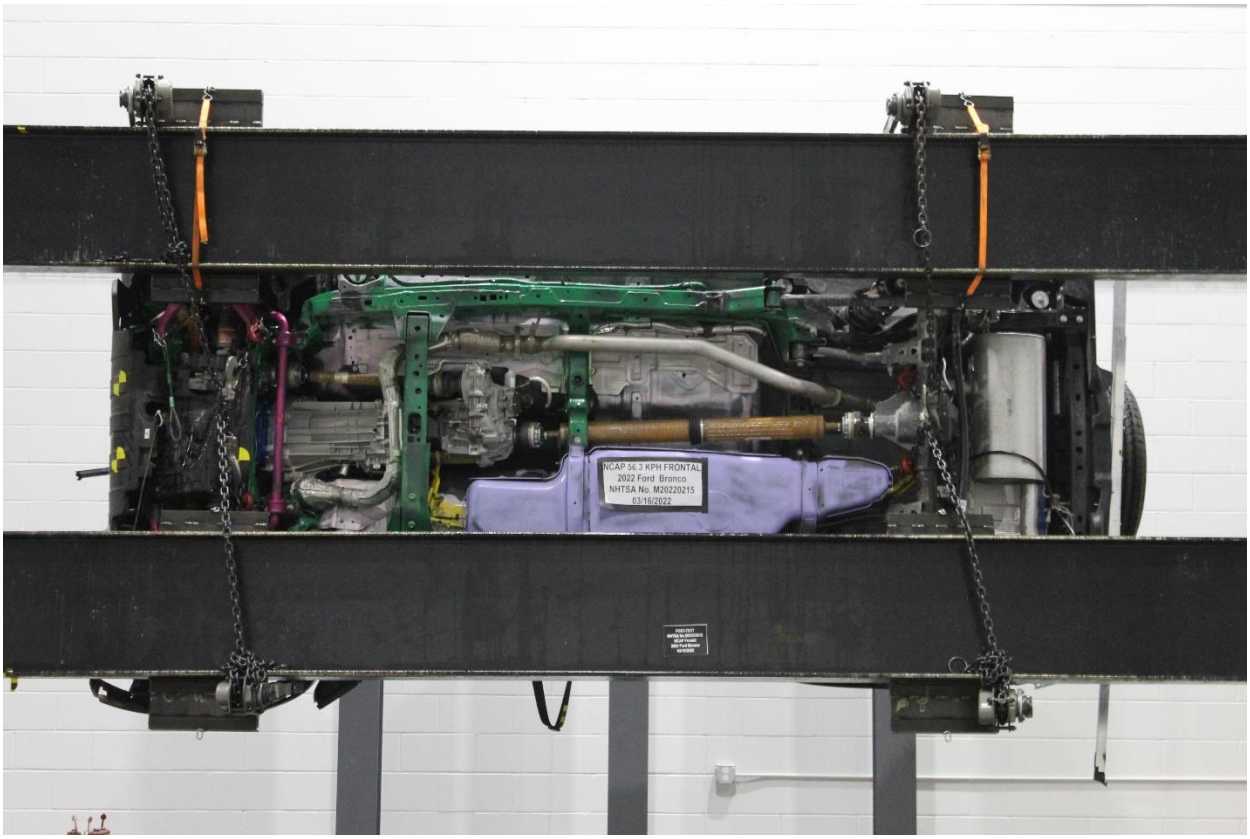


Figure A-80: Vehicle at 270º on Static Rollover Device

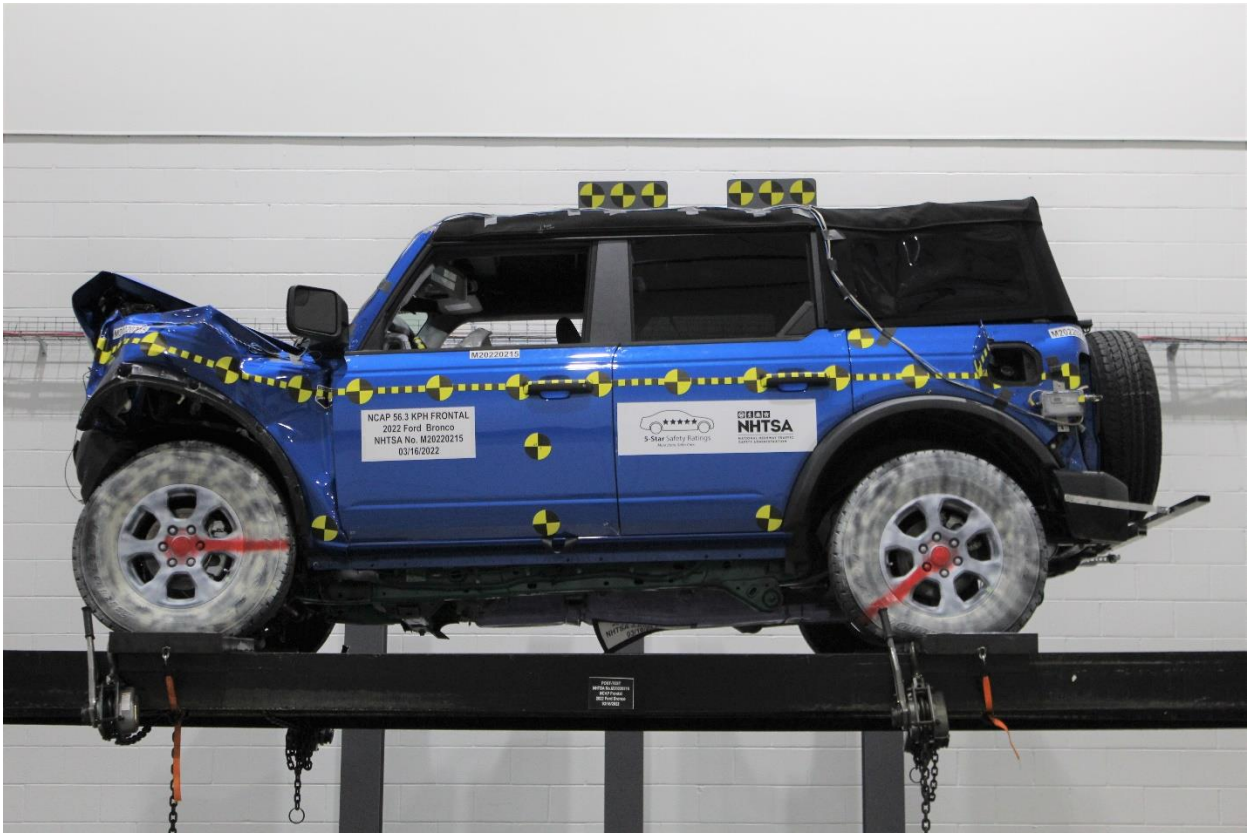


Figure A-81: Vehicle at 360º on Static Rollover Device

Figure A-82: 2022 Ford Bronco Frontal Impact Event

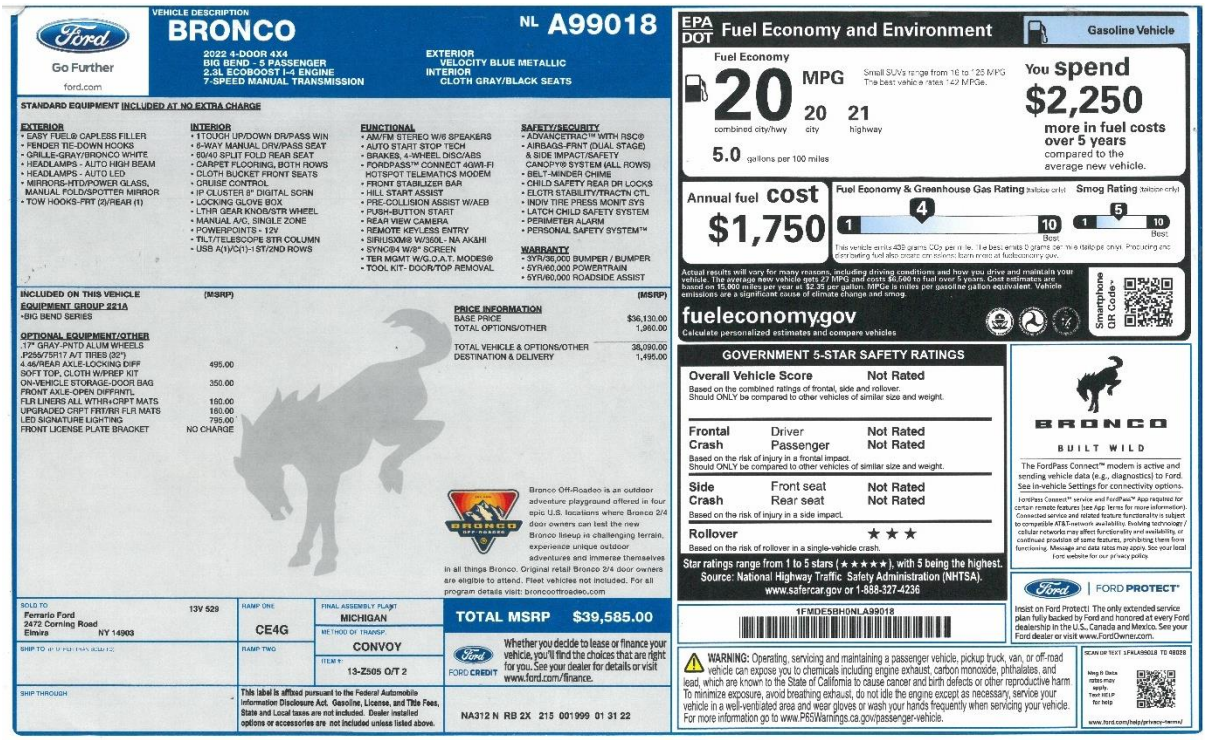


Figure A-83: Monroney Label Photograph

APPENDIX B
VEHICLE & DUMMY RESPONSE DATA TRACES

Table of Data Plots

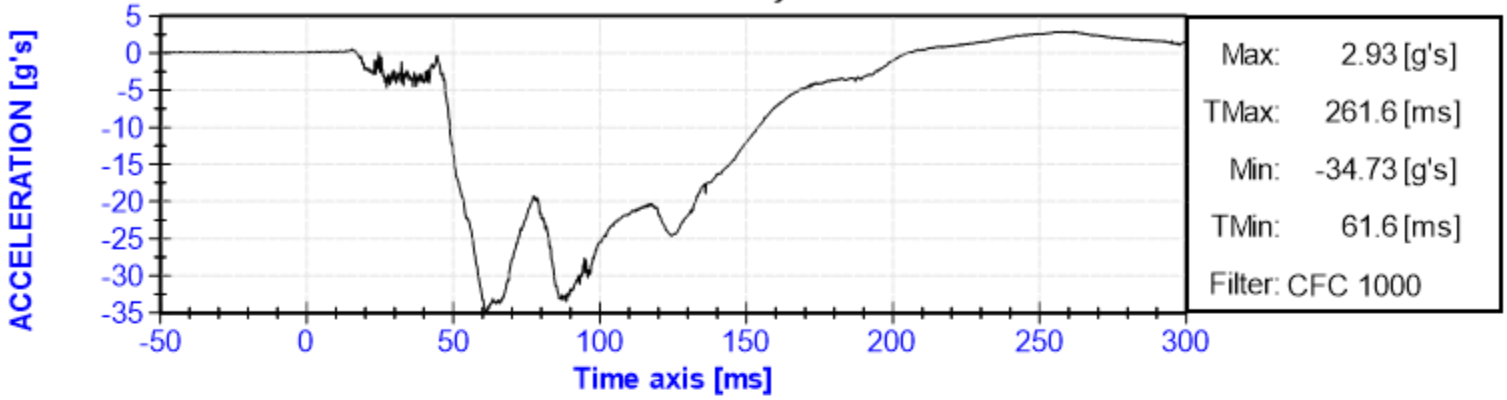
The following additional dummy and vehicle response data can be found in the R&D section of the NHTSA website at www.NHTSA.gov

Driver Head X Acceleration Redundant
Driver Head Y Acceleration Redundant
Driver Head Z Acceleration Redundant
Driver Upper Neck Force Y
Driver Upper Neck Moment X
Driver Upper Neck Moment Z
Driver Chest X Acceleration Redundant
Driver Chest Y Acceleration Redundant
Driver Chest Z Acceleration Redundant
Driver Pelvis X
Driver Pelvis Y
Driver Pelvis Z
Driver Left Femur Redundant
Driver Right Femur Redundant
Driver Left Upper Tibia Moment X
Driver Left Upper Tibia Moment Y

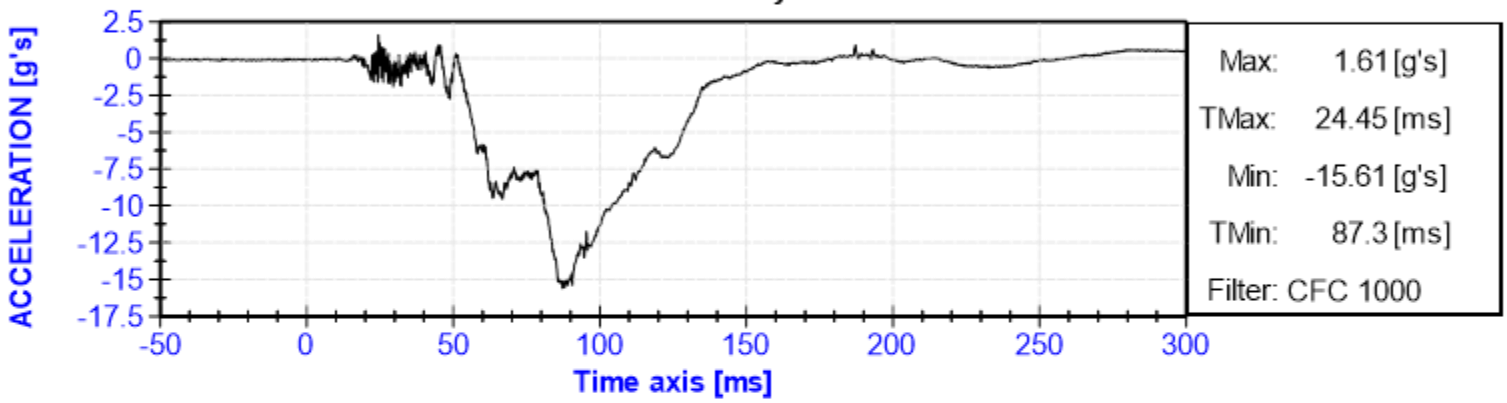
Driver Left Upper Tibia Force Z
Driver Left Lower Tibia Moment X
Driver Left Lower Tibia Moment Y
Driver Left Lower Tibia Force Z
Driver Right Upper Tibia Moment X
Driver Right Upper Tibia Moment Y
Driver Right Upper Tibia Force Z
Driver Right Lower Tibia Moment X
Driver Right Lower Tibia Moment Y
Driver Right Lower Tibia Force Z
Driver Left Foot Fore Z
Driver Left Foot Aft X
Driver Left Foot Aft Z
Driver Right Foot Fore Z
Driver Right Foot Aft X
Driver Right Foot Aft Z
Driver Shoulder Belt Force
Driver Lap Belt Force
Driver Head Angular Velocity X
Driver Head Angular Velocity Y
Driver Head Angular Velocity Z
Passenger Head X Acceleration Redundant
Passenger Head Y Acceleration Redundant
Passenger Head Z Acceleration Redundant
Passenger Upper Neck Force X
Passenger Upper Neck Force Z
Passenger Upper Neck Moment Y
Passenger Chest X Acceleration Redundant
Passenger Chest Y Acceleration Redundant
Passenger Chest Z Acceleration Redundant
Passenger Pelvis X
Passenger Pelvis Y
Passenger Pelvis Z
Passenger Left Femur Redundant
Passenger Right Femur Redundant
Passenger Left Upper Tibia Moment X
Passenger Left Upper Tibia Moment Y
Passenger Left Upper Tibia Force Z
Passenger Left Lower Tibia Moment X
Passenger Left Lower Tibia Moment Y
Passenger Left Lower Tibia Force Z
Passenger Right Upper Tibia Moment X
Passenger Right Upper Tibia Moment Y
Passenger Right Upper Tibia Force Z
Passenger Right Lower Tibia Moment X
Passenger Right Lower Tibia Moment Y
Passenger Right Lower Tibia Force Z
Passenger Left Foot Fore Z
Passenger Left Foot Aft X
Passenger Left Foot Aft Z

Passenger Right Food Fore Z
Passenger Right Foot Aft X
Passenger Right Foot Aft Z
Passenger Shoulder Belt Force
Passenger Lap Belt Force
Passenger Head Angular Velocity X
Passenger Head Angular Velocity Y
Passenger Head Angular Velocity Z
Left Rear Seat Crossmember X
Left Rear Seat Crossmember Z
Right Rear Seat Crossmember X
Right Rear Seat Crossmember Z
Left Rear Seat Crossmember X Redundant
Right Rear Seat Crossmember X Redundant
Vehicle Engine Top X
Vehicle Engine Bottom X
Load Cell Barrier Forces and Moments

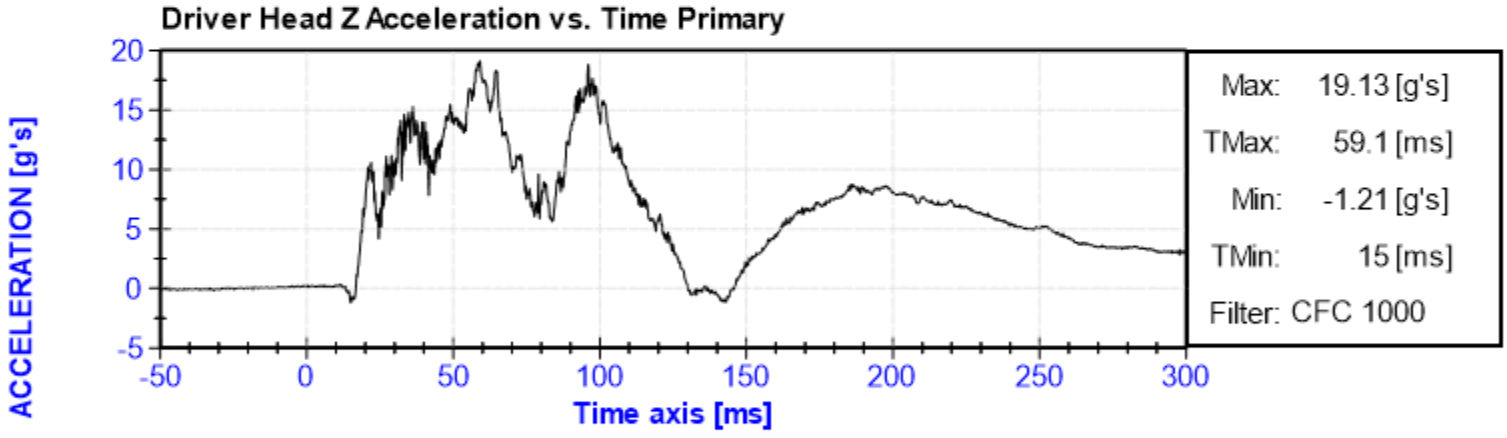
Driver Head X Acceleration vs. Time Primary



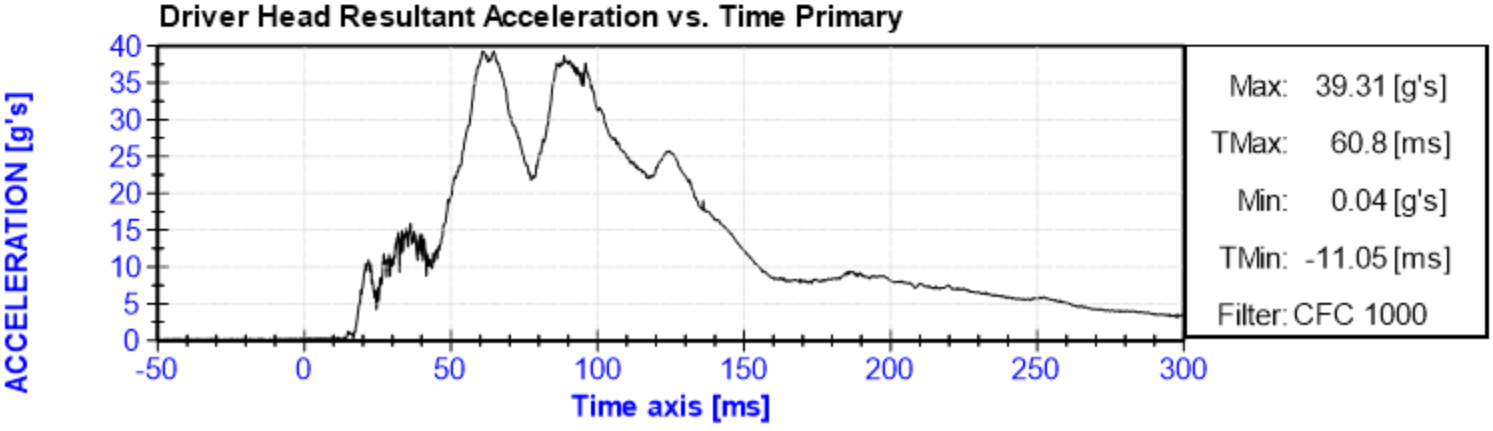
Driver Head Y Acceleration vs. Time Primary



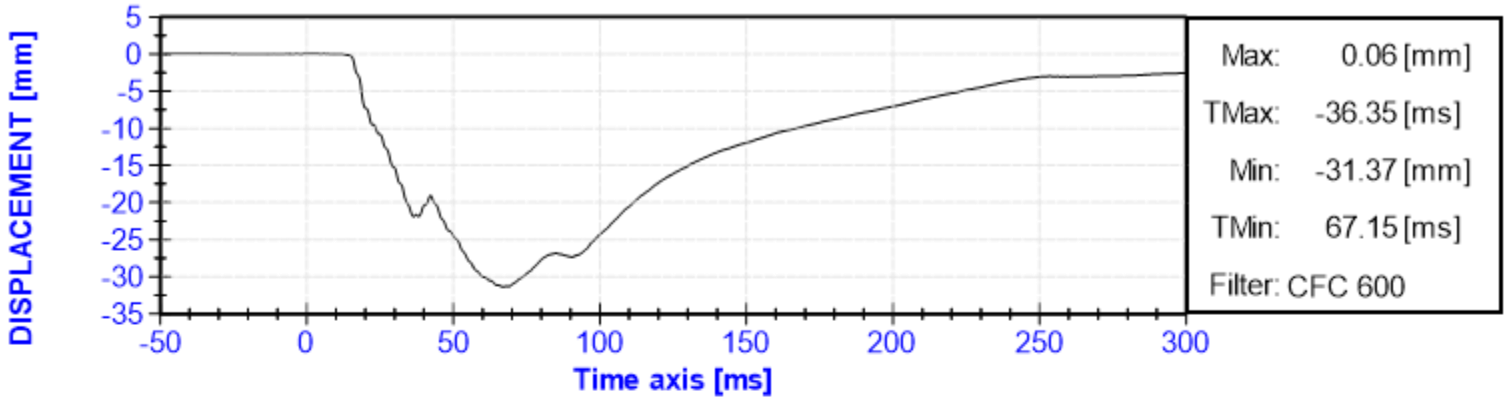
Driver Head Z Acceleration vs. Time Primary



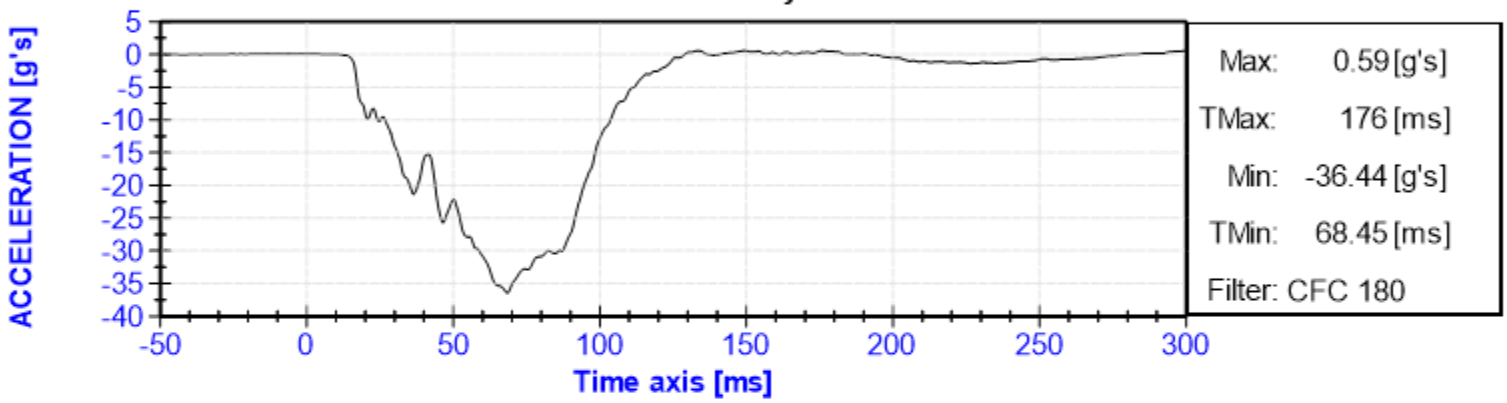
Driver Head Resultant Acceleration vs. Time Primary



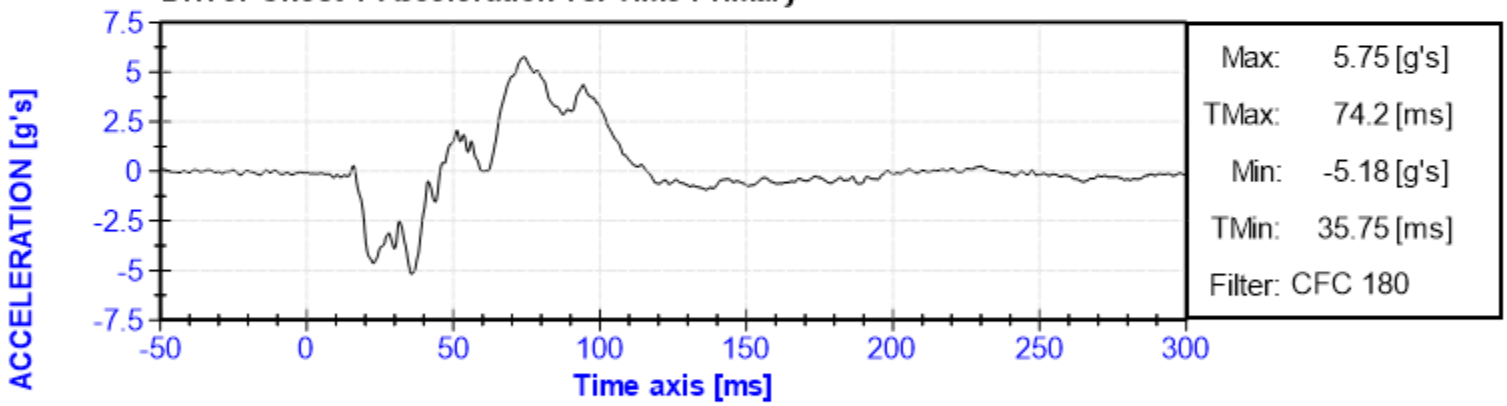
Driver Chest X Deflection vs. Time



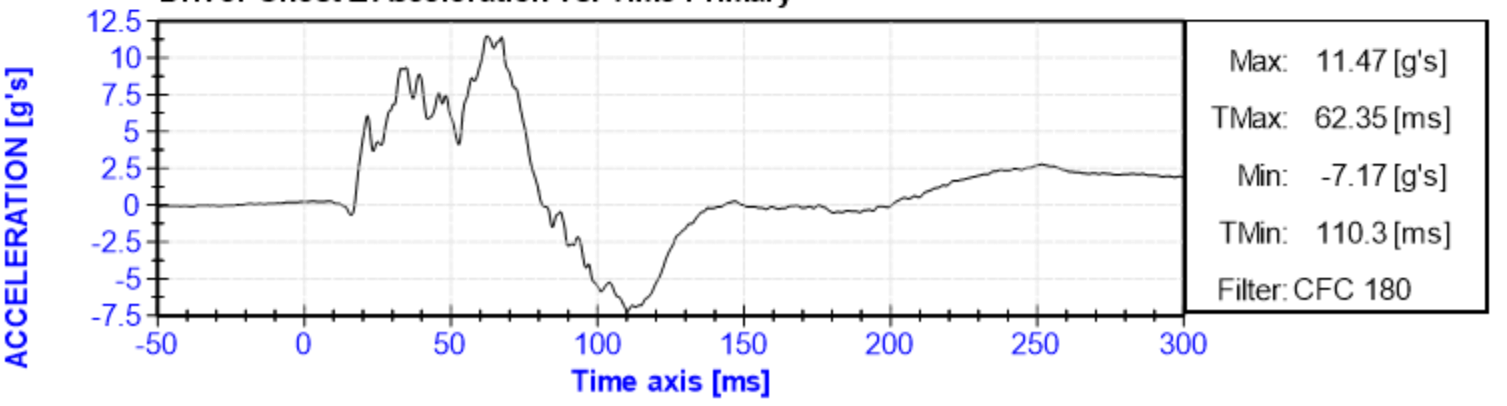
Driver Chest X Acceleration vs. Time Primary



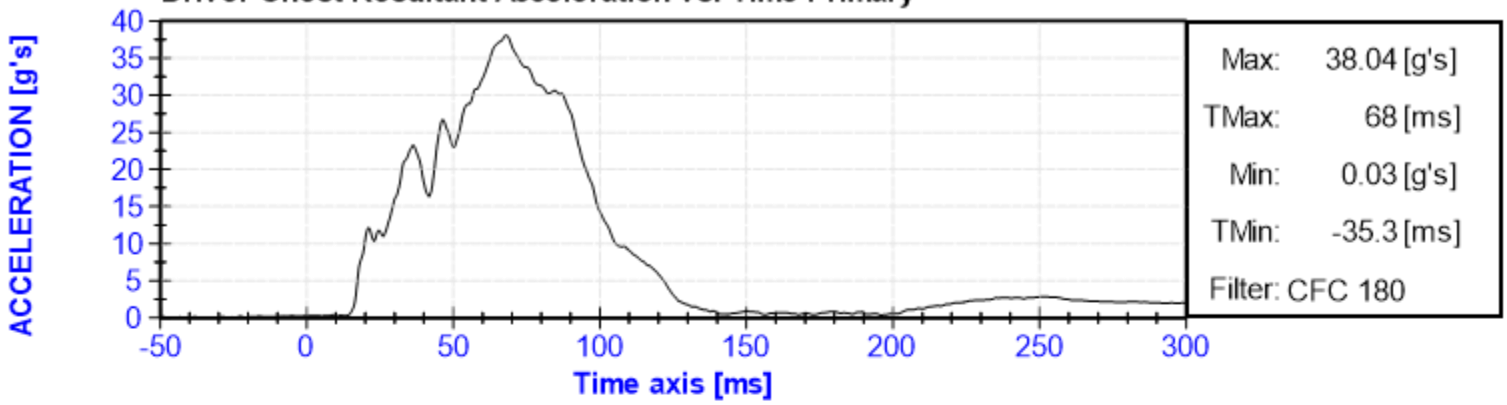
Driver Chest Y Acceleration vs. Time Primary



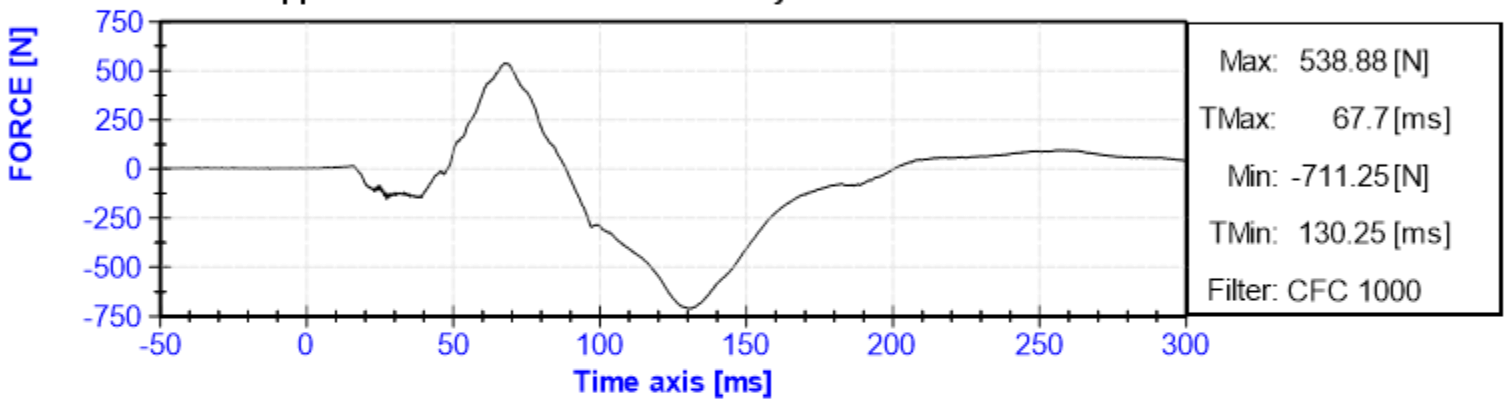
Driver Chest Z Acceleration vs. Time Primary



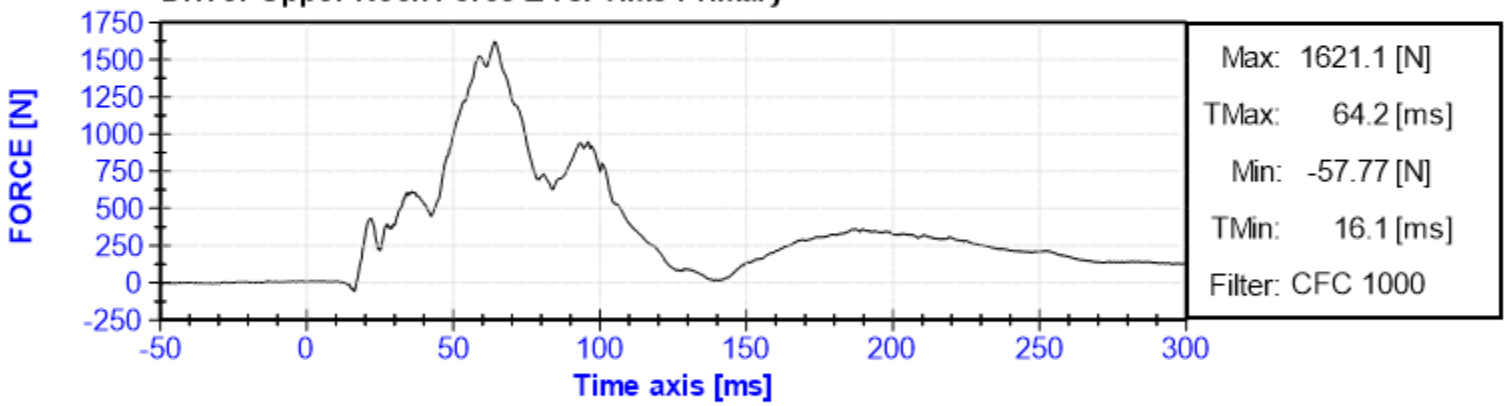
Driver Chest Resultant Acceleration vs. Time Primary



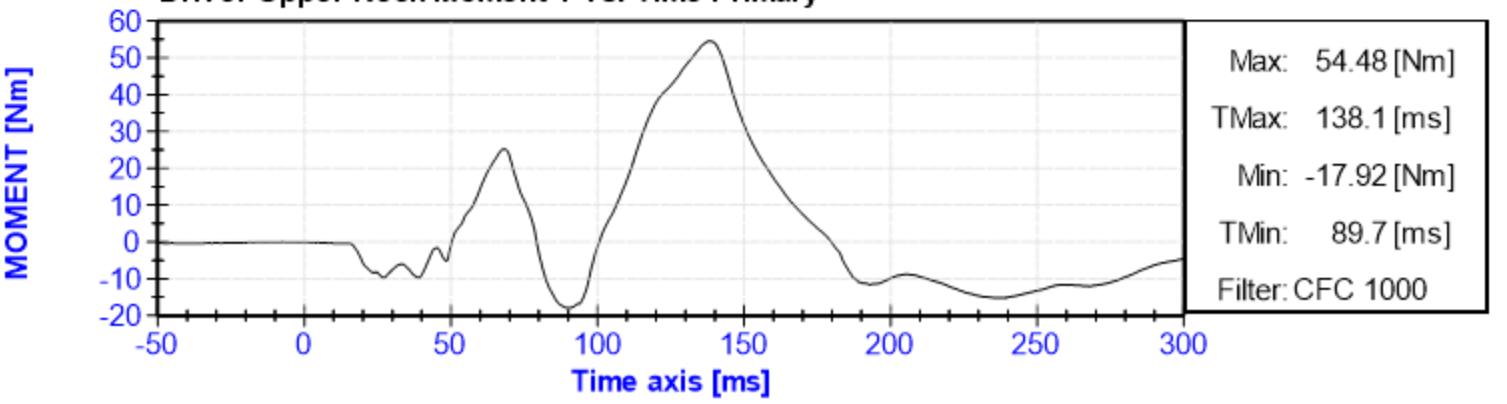
Driver Upper Neck Force X vs. Time Primary

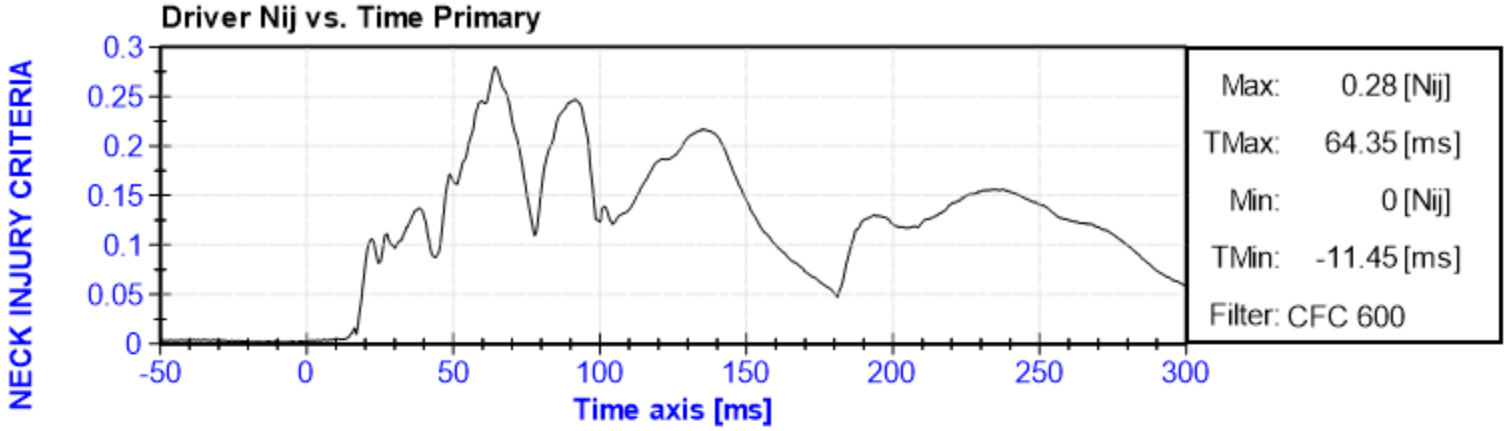


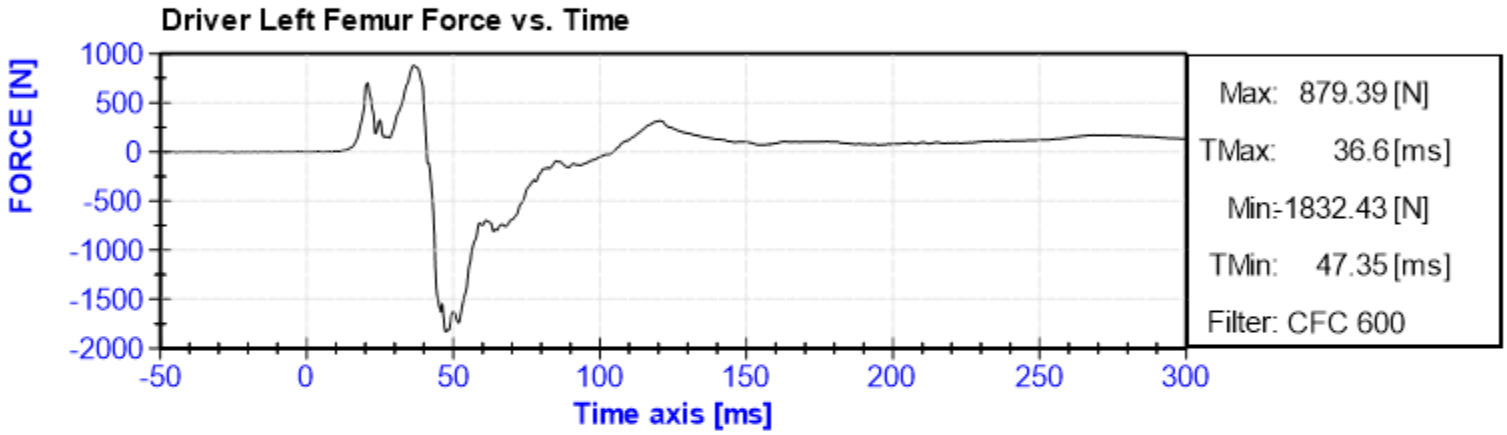
Driver Upper Neck Force Z vs. Time Primary

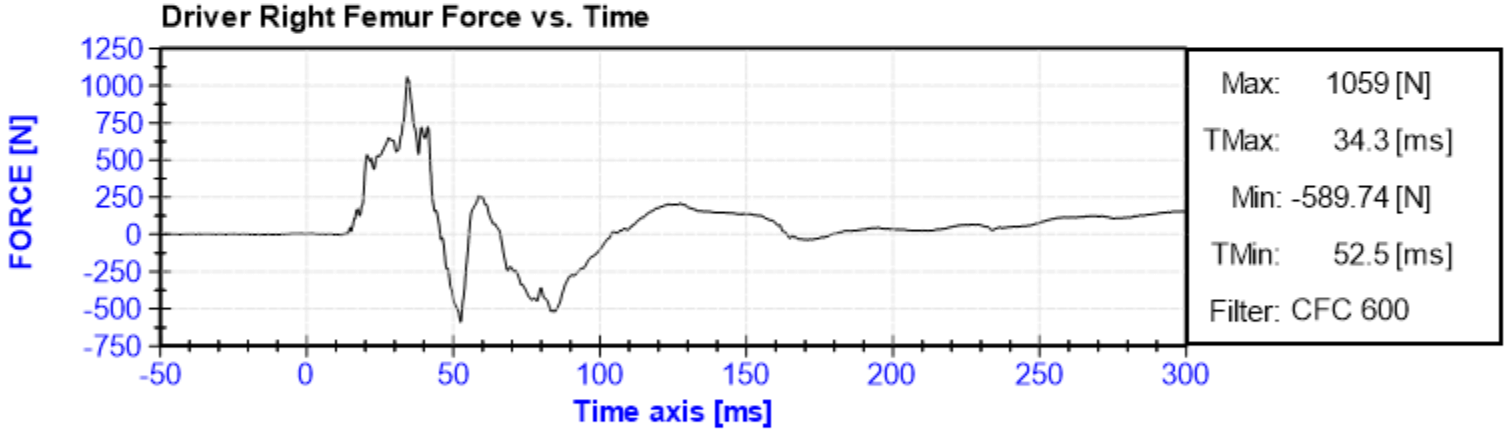


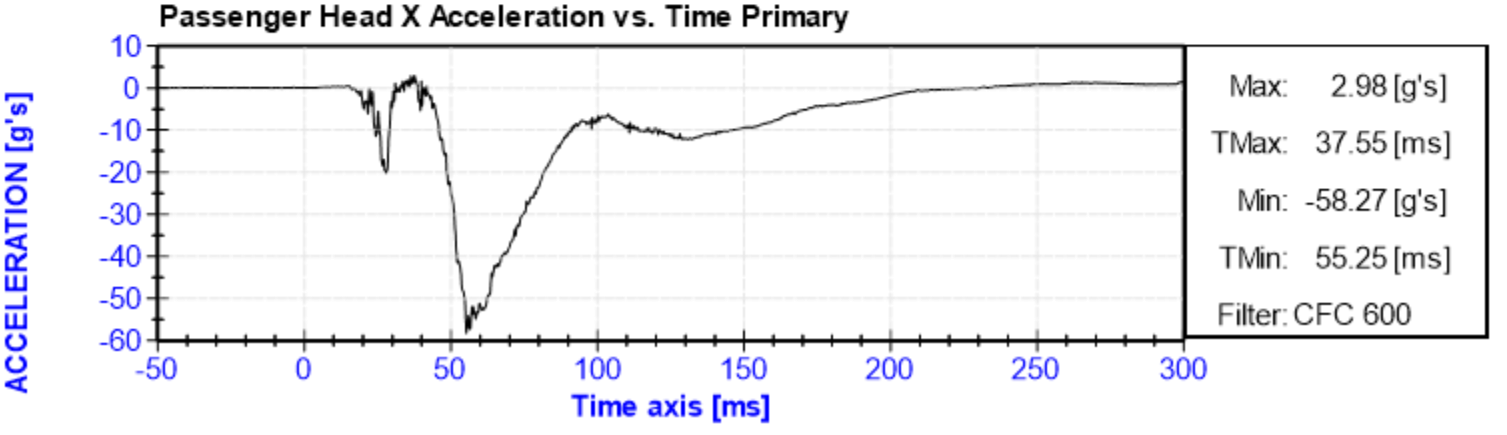
Driver Upper Neck Moment Y vs. Time Primary



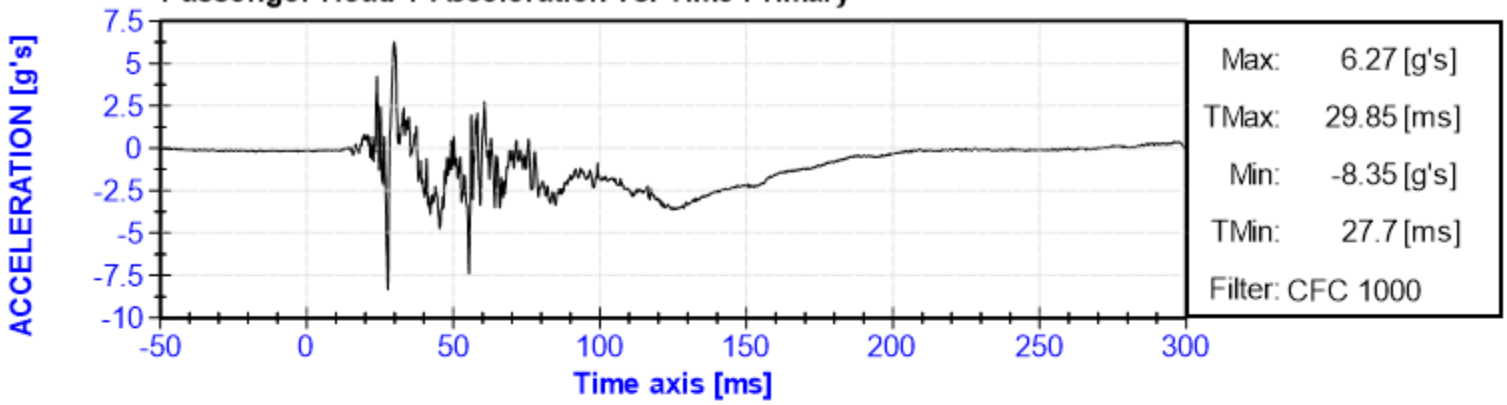

Driver Nij vs. Time Primary
NECK INJURY CRITERIA
0.3
0.25
0.2
0.15
0.1
0.05
0
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 0.28 [Nij]
TMax: 64.35 [ms]
Min: 0 [Nij]
TMin: -11.45 [ms]
Filter: CFC 600


Driver Left Femur Force vs. Time
FORCE [N]
1000
500
0
-500
-1000
-1500
-2000
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 879.39 [N]
TMax: 36.6 [ms]
Min: -1832.43 [N]
TMin: 47.35 [ms]
Filter: CFC 600

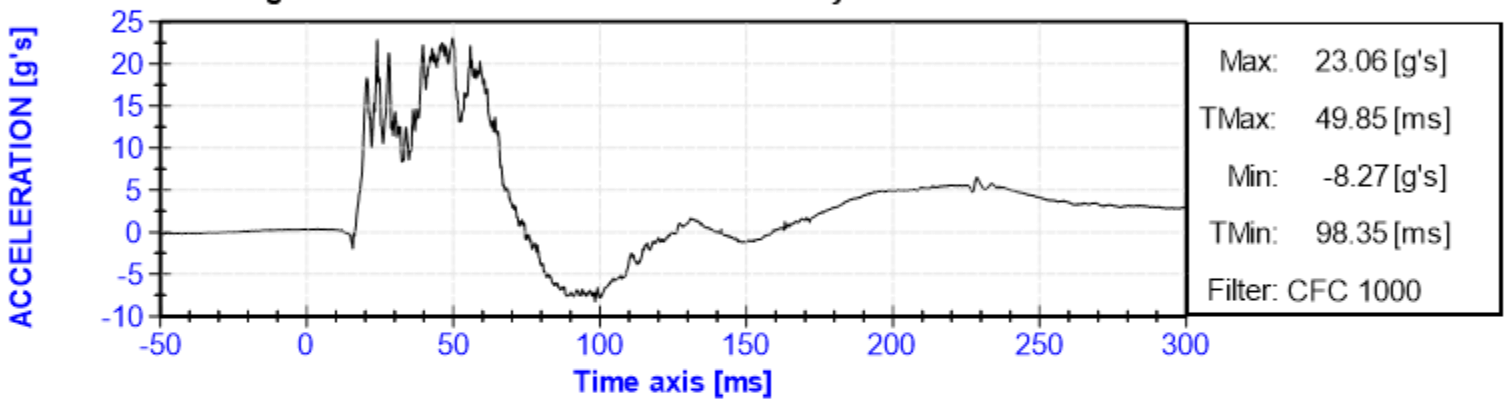

Driver Right Femur Force vs. Time
FORCE [N]
1250
1000
750
500
250
0
-250
-500
-750
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 1059 [N]
TMax: 34.3 [ms]
Min: -589.74 [N]
TMin: 52.5 [ms]
Filter: CFC 600


Passenger Head X Acceleration vs. Time Primary
ACCELERATION [g's]
10
0
-10
-20
-30
-40
-50
-60
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 2.98 [g's]
TMax: 37.55 [ms]
Min: -58.27 [g's]
TMin: 55.25 [ms]
Filter: CFC 600

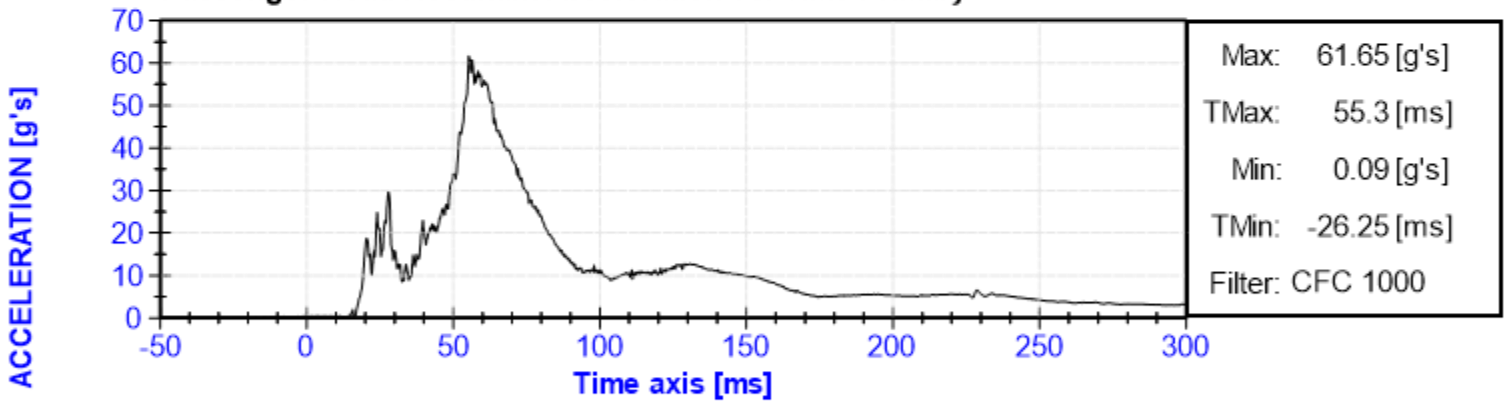
Passenger Head Y Acceleration vs. Time Primary



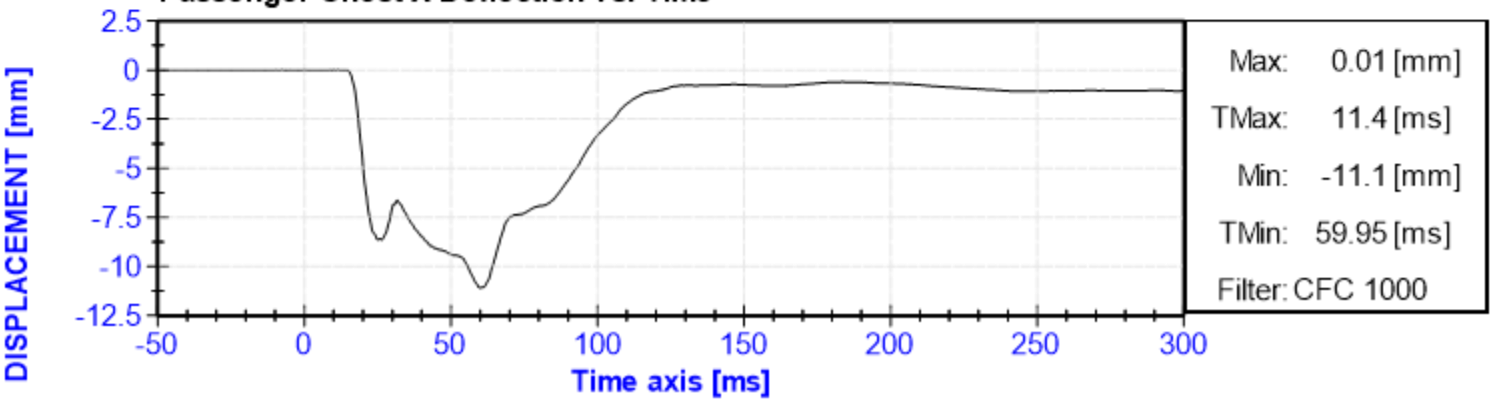
Passenger Head Z Acceleration vs. Time Primary



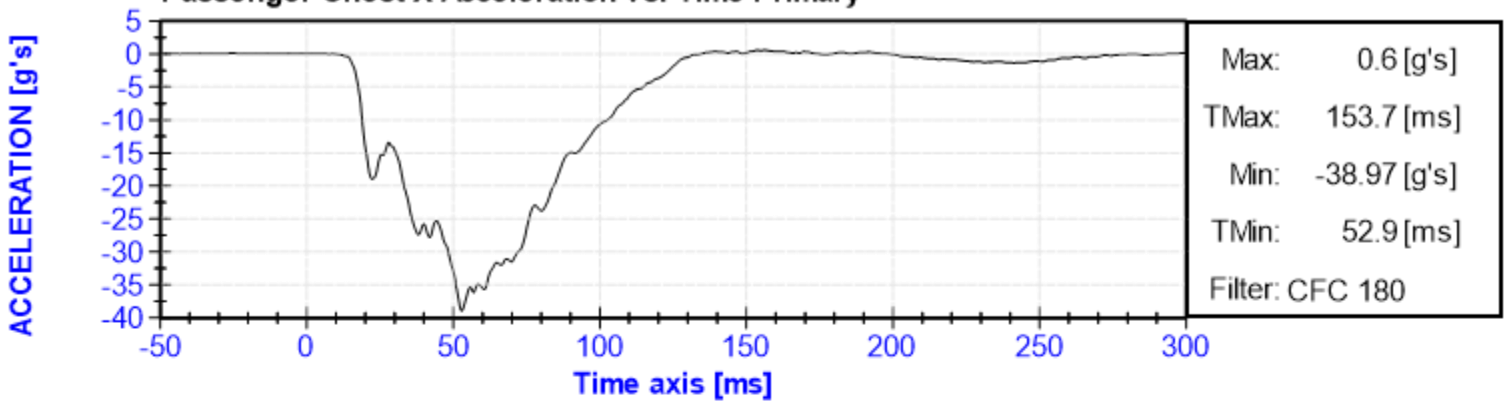
Passenger Head Resultant Acceleration vs. Time Primary



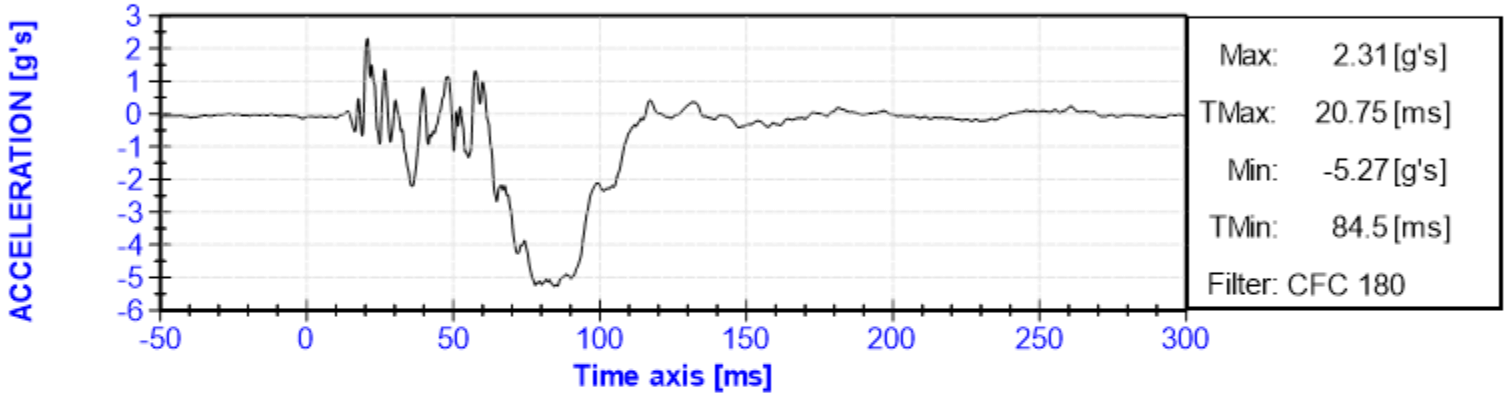
Passenger Chest X Deflection vs. Time



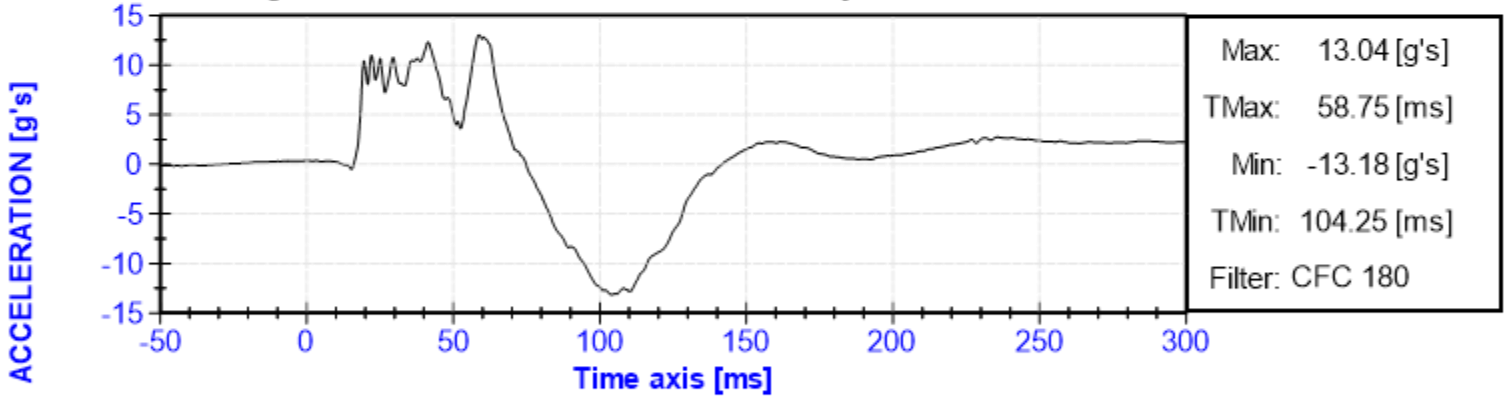
Passenger Chest X Acceleration vs. Time Primary



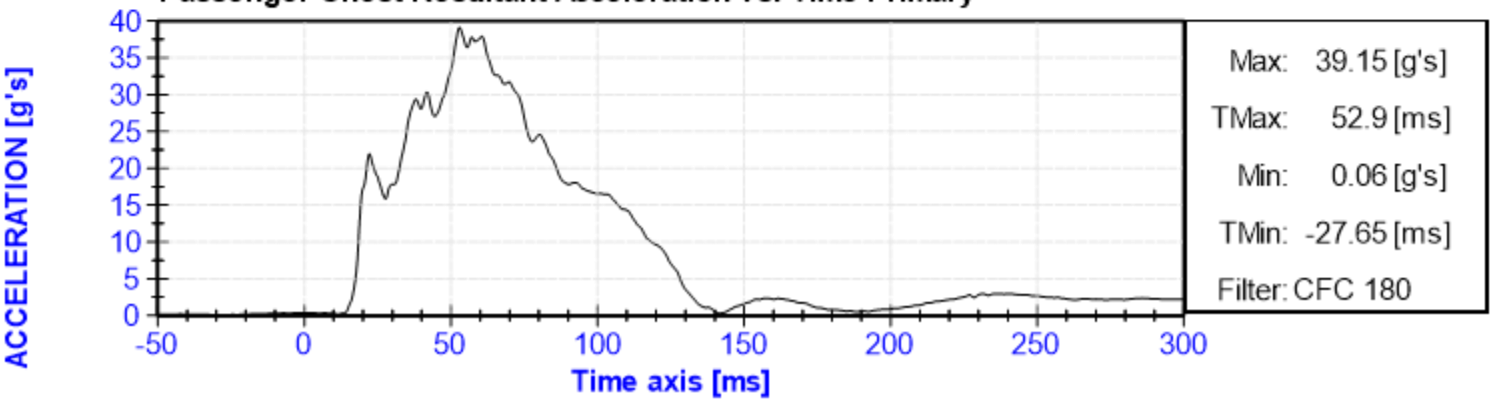
Passenger Chest Y Acceleration vs. Time Primary

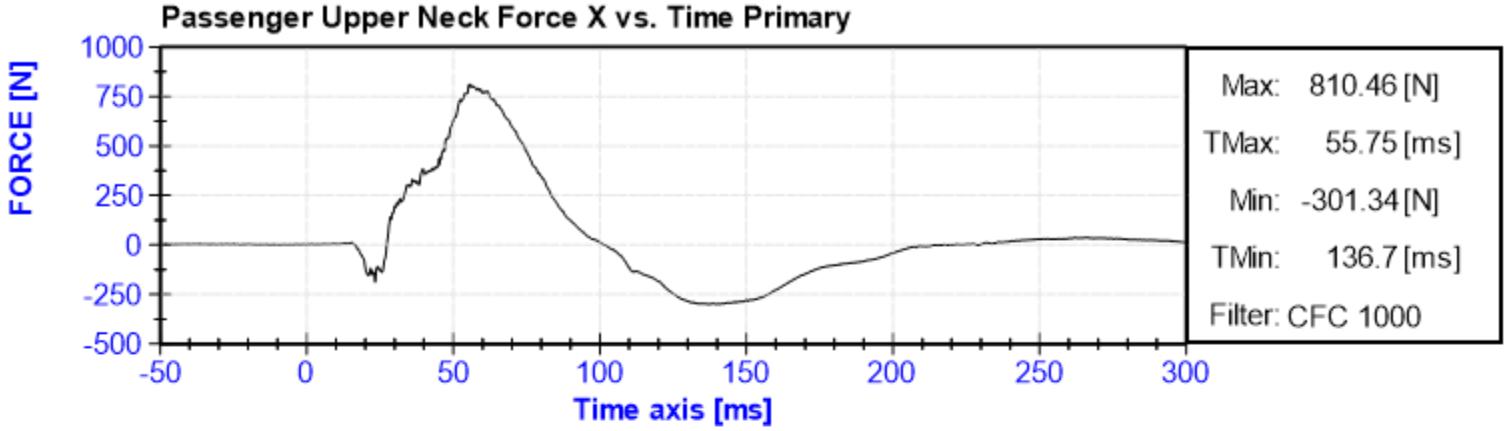


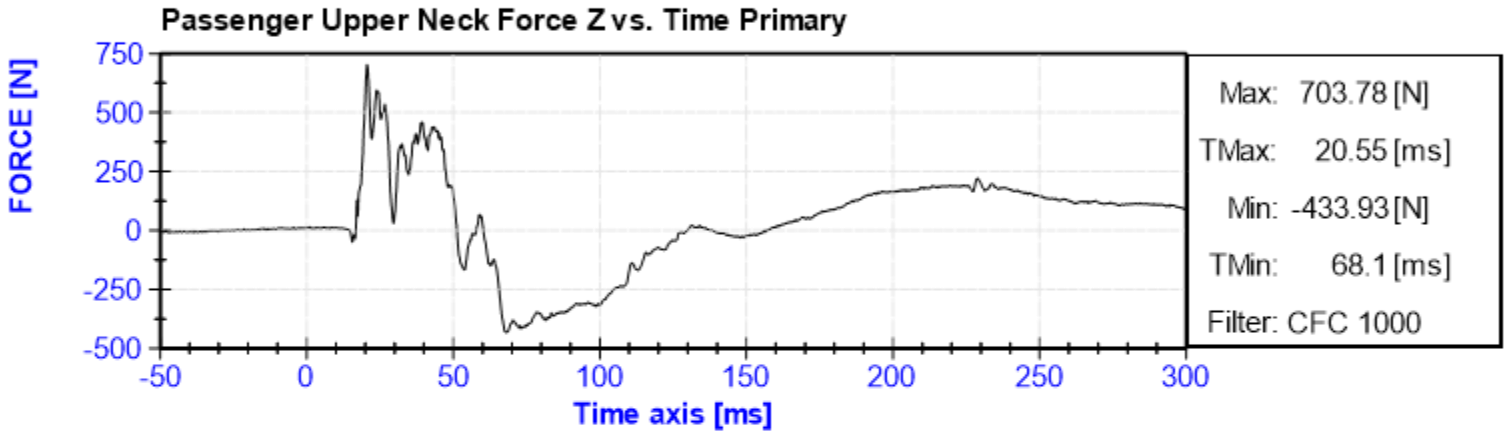
Passenger Chest Z Acceleration vs. Time Primary

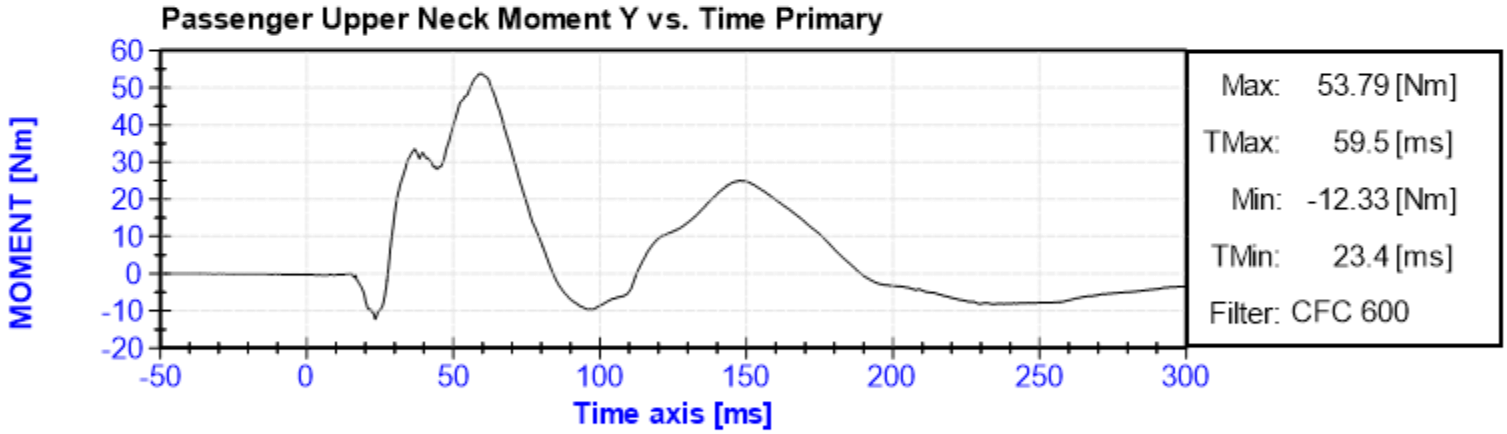


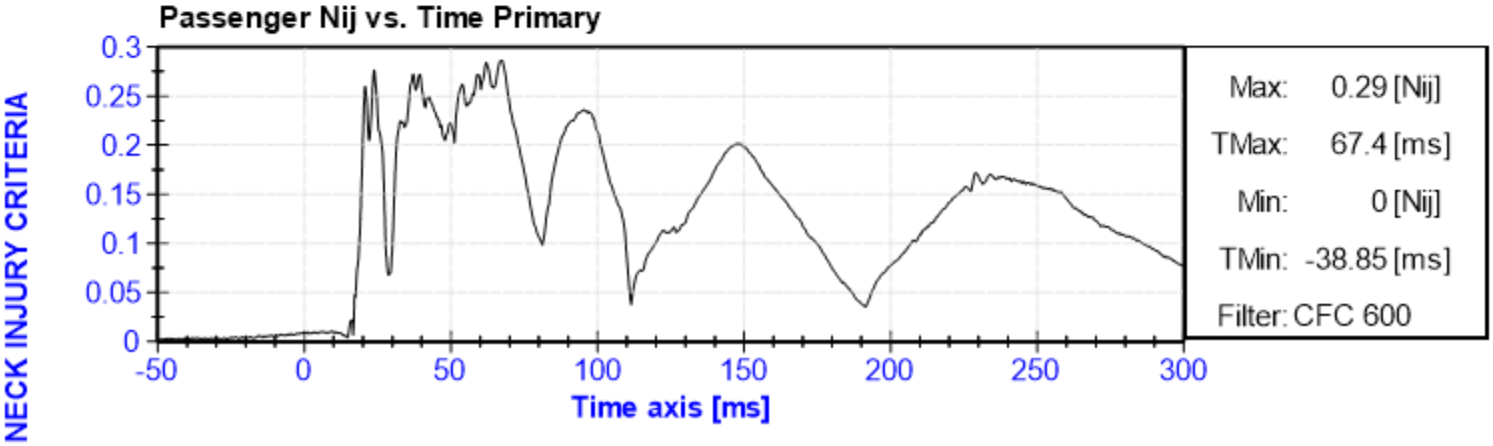
Passenger Chest Resultant Acceleration vs. Time Primary

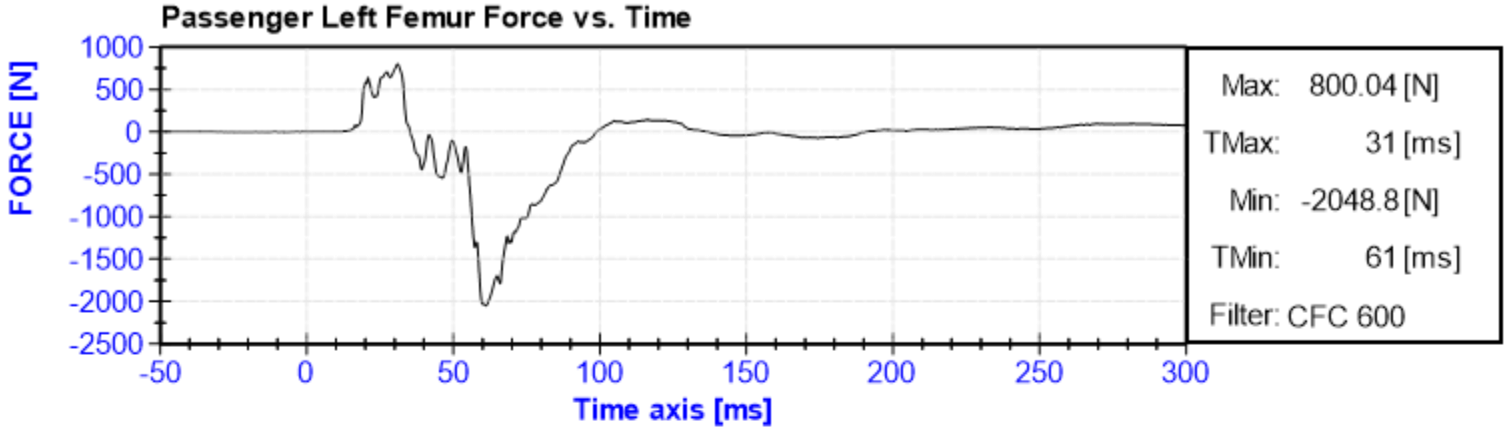


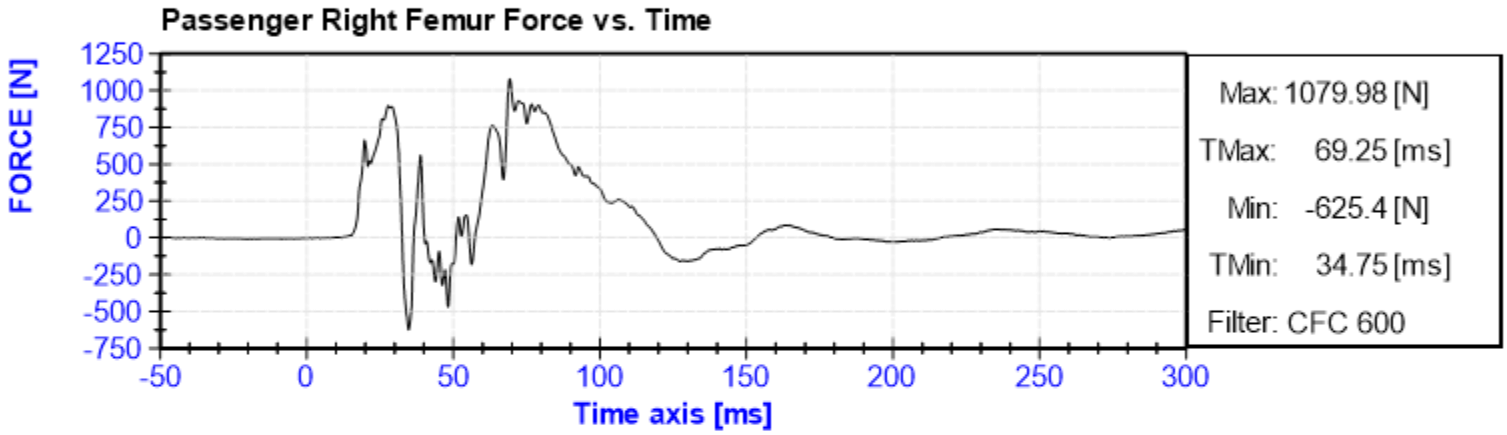

Passenger Upper Neck Force X vs. Time Primary
FORCE [N]
1000
750
500
250
0
-250
-500
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 810.46 [N]
TMax: 55.75 [ms]
Min: -301.34 [N]
TMin: 136.7 [ms]
Filter: CFC 1000


Passenger Upper Neck Force Z vs. Time Primary
FORCE [N]
750
500
250
0
-250
-500
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 703.78 [N]
TMax: 20.55 [ms]
Min: -433.93 [N]
TMin: 68.1 [ms]
Filter: CFC 1000


Passenger Upper Neck Moment Y vs. Time Primary
MOMENT [Nm]
60
50
40
30
20
10
0
-10
-20
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 53.79 [Nm]
TMax: 59.5 [ms]
Min: -12.33 [Nm]
TMin: 23.4 [ms]
Filter: CFC 600


Passenger Nij vs. Time Primary
NECK INJURY CRITERIA
0.3
0.25
0.2
0.15
0.1
0.05
0
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 0.29 [Nij]
TMax: 67.4 [ms]
Min: 0 [Nij]
TMin: -38.85 [ms]
Filter: CFC 600


Passenger Left Femur Force vs. Time
FORCE [N]
1000
500
0
-500
-1000
-1500
-2000
-2500
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 800.04 [N]
TMax: 31 [ms]
Min: -2048.8 [N]
TMin: 61 [ms]
Filter: CFC 600


Passenger Right Femur Force vs. Time
FORCE [N]
1250
1000
750
500
250
0
-250
-500
-750
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 1079.98 [N]
TMax: 69.25 [ms]
Min: -625.4 [N]
TMin: 34.75 [ms]
Filter: CFC 600

APPENDIX C

DUMMY CALIBRATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

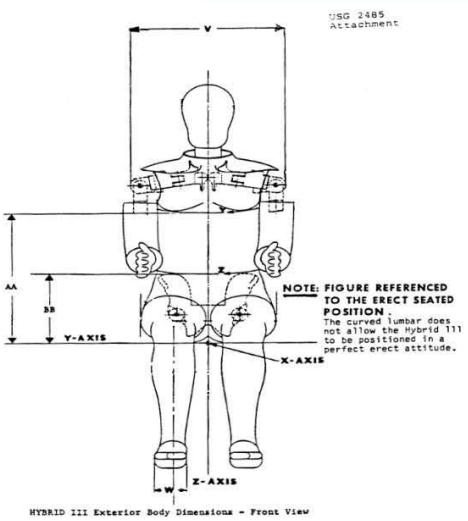
HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

SERIAL NO: 142

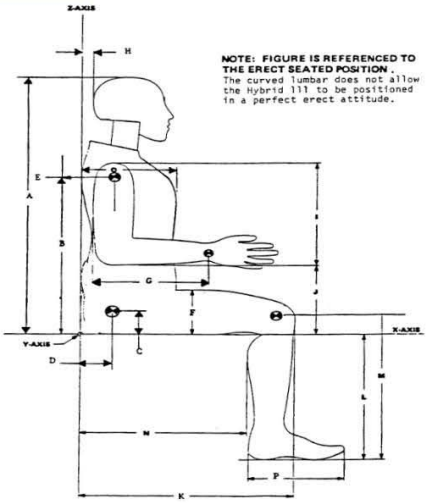
External Measurements - Hybrid 3 - 50th Male

Technician: K. Brogan Date: 02/11/2022

Dummy Serial Number: 142



HYBRID III Exterior Body Dimensions - Front View



HYBRID III Exterior Body Dimensions - Side View

Symbol	Description	Specification (in)		Result (in)	Pass/Fail
A	Sitting Height	34.6	35.0	34.8	Pass
B	Shoulder Pivot Height	19.9	20.5	20.3	Pass
C	H-Point Height	3.3	3.5	3.4	Pass
D	H-Point from Backline	5.3	5.5	5.4	Pass
E	Shoulder Pivot from Backline	3.3	3.7	3.5	Pass
F	Thigh Clearance	5.5	6.1	5.8	Pass
G	Back of Elbow to Wrist Pivot	11.4	12.0	11.7	Pass
H	Head Back to Backline	1.6	1.8	1.7	Pass
I	Shoulder to Elbow Length	13.0	13.6	13.4	Pass
J	Elbow Rest Height	7.5	8.3	8.1	Pass
K	Buttock to Knee Length	22.8	23.8	23.2	Pass
L	Popliteal Height	16.9	17.9	17.2	Pass
M	Knee Pivot Height	19.1	19.7	19.4	Pass
N	Buttock Popliteal Length	17.8	18.8	18.3	Pass
O	Chest Depth without Jacket	8.4	9.0	8.8	Pass
P	Foot Length (right)	9.9	10.5	10.1	Pass
V	Shoulder Breadth	16.3	17.2	16.8	Pass
W	Foot Breadth	3.6	4.2	3.8	Pass
Y	Chest Circumference with Jacket	38.2	39.4	39.0	Pass
Z	Waist Circumference	32.9	34.1	33.7	Pass
AA	Reference Location (Chest Circumference)	16.9	17.1	17.0	Pass
BB	Reference Location (Waist Circumference)	8.9	9.1	9.0	Pass

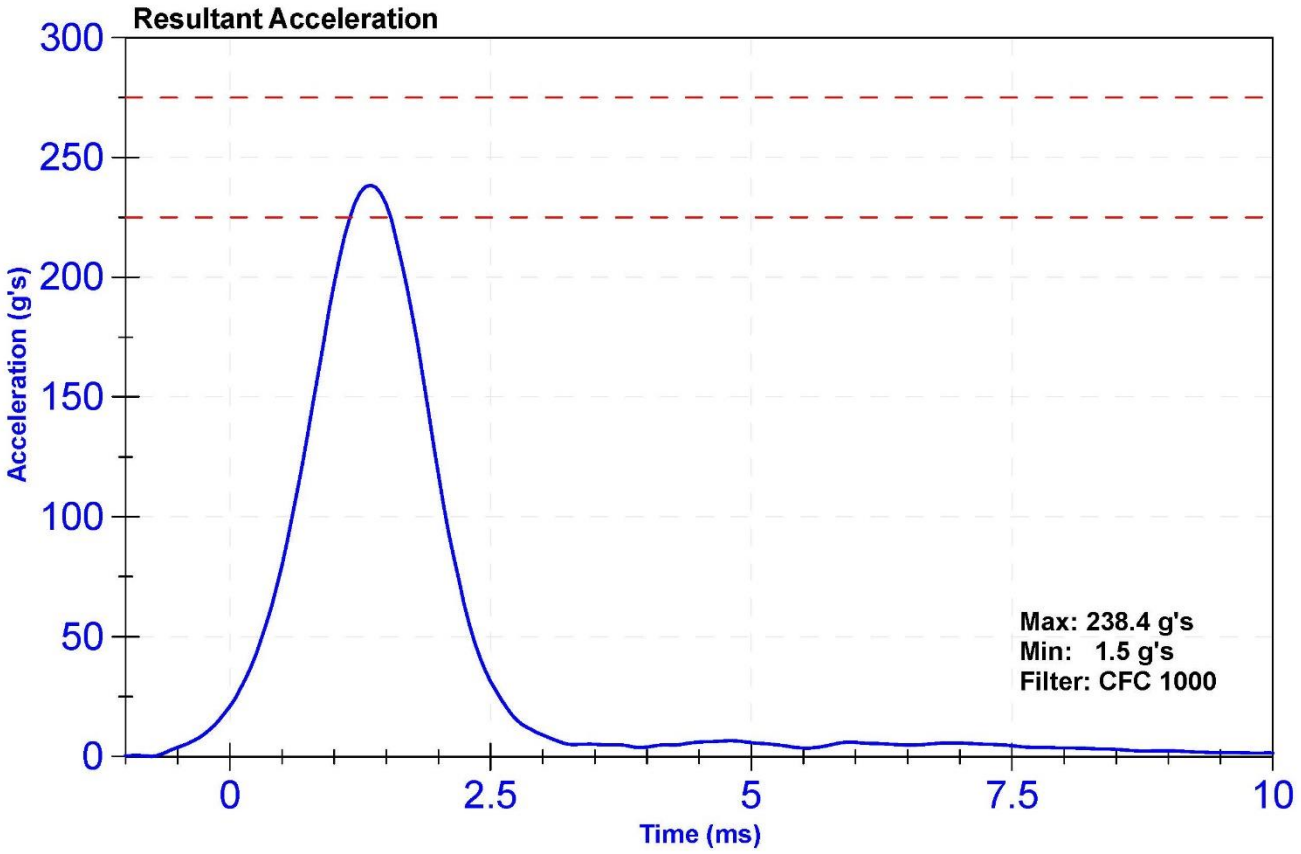
ATD Manufacturer	Humanetics	Test Technician	D.Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

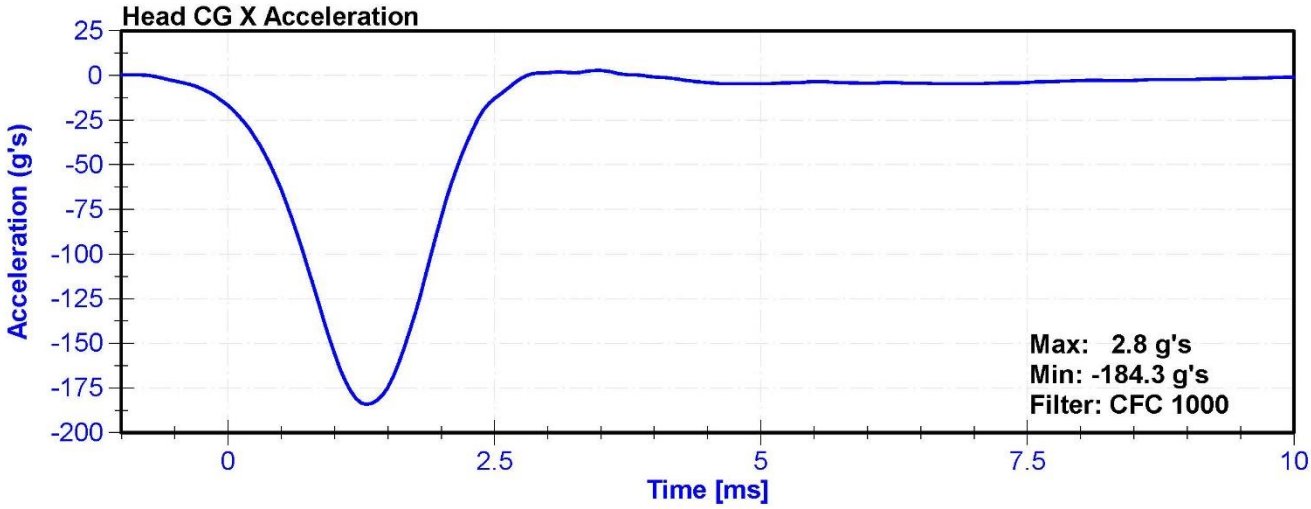
Results

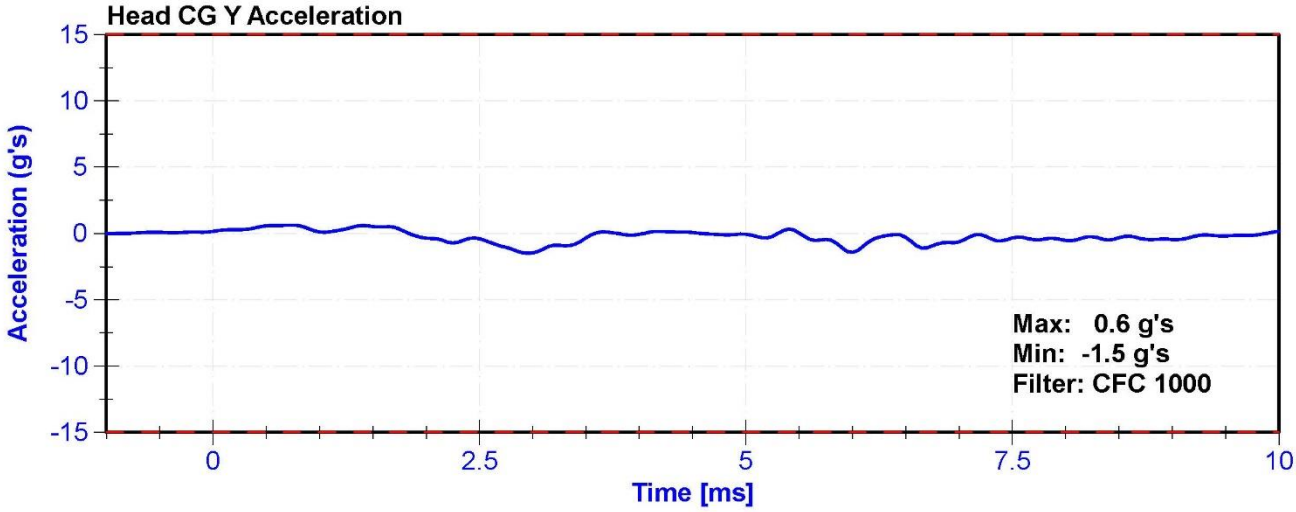
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.6	Pass
Humidity	10	70	%	36	Pass
Resultant Acceleration	225	275	g's	238.4	Pass
Oscillation	0	10	%	2.7	Pass
Lateral Acceleration	-15	15	g's	-1.5	Pass

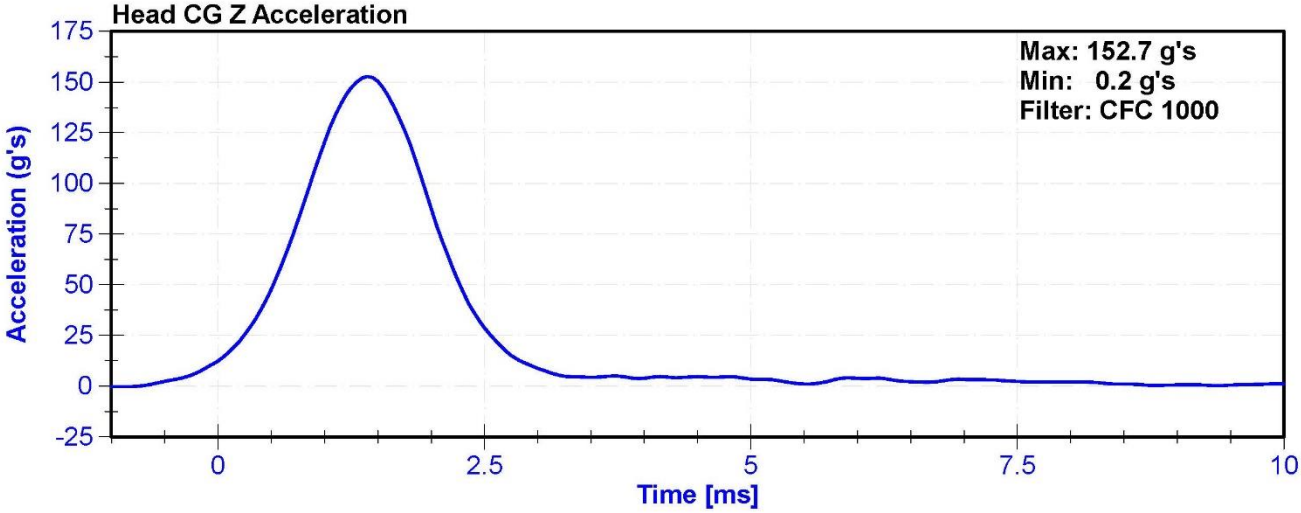
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P51681	11/16/2021	5/15/2022
Y Accelerometer	Endevco	P64151	11/16/2021	5/15/2022
Z Accelerometer	Endevco	P52114	11/16/2021	5/15/2022




Head CG X Acceleration
Acceleration (g's)
25
0
-25
-50
-75
-100
-125
-150
-175
-200
0
2.5
5
7.5
10
Time [ms]
Max: 2.8 g's
Min: -184.3 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: 0.6 g's
Min: -1.5 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
175
150
125
100
75
50
25
0
-25
0
2.5
5
7.5
10
Time [ms]
Max: 152.7 g's
Min: 0.2 g's
Filter: CFC 1000

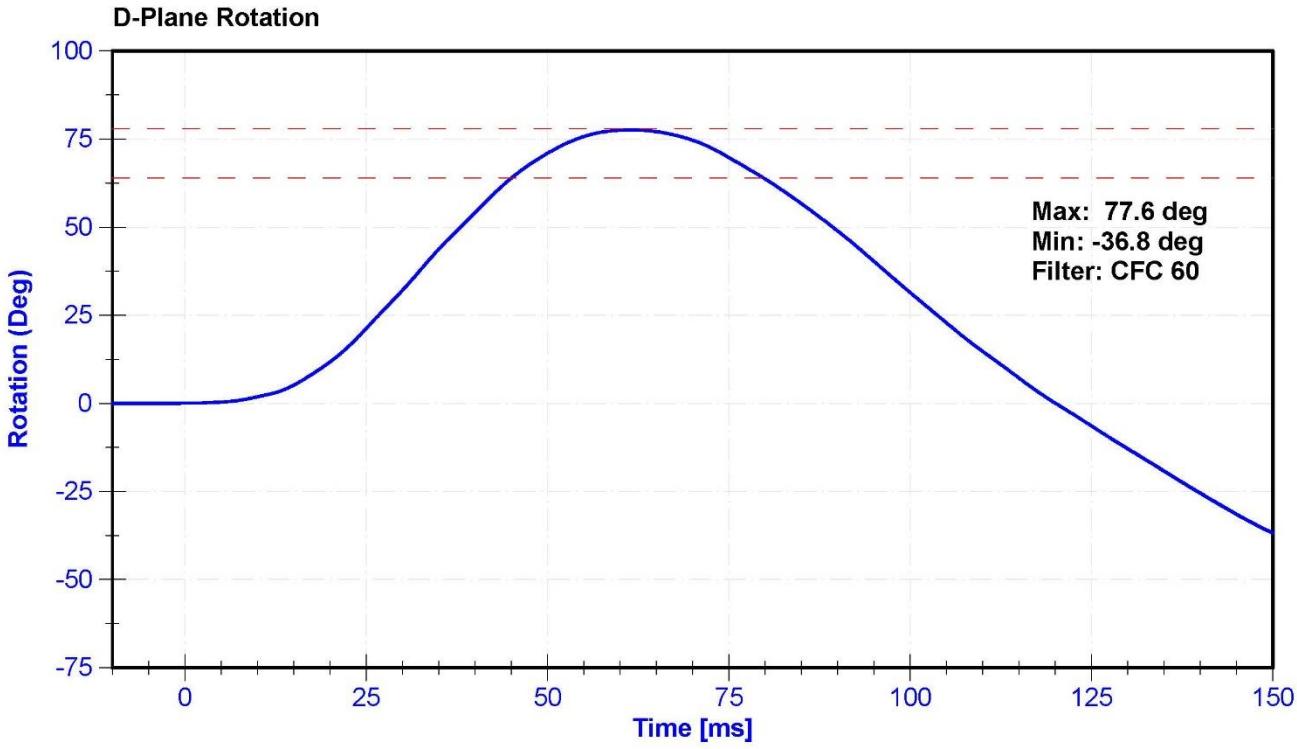
ATD Manufacturer	Humanetics	Test Technician	D. Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

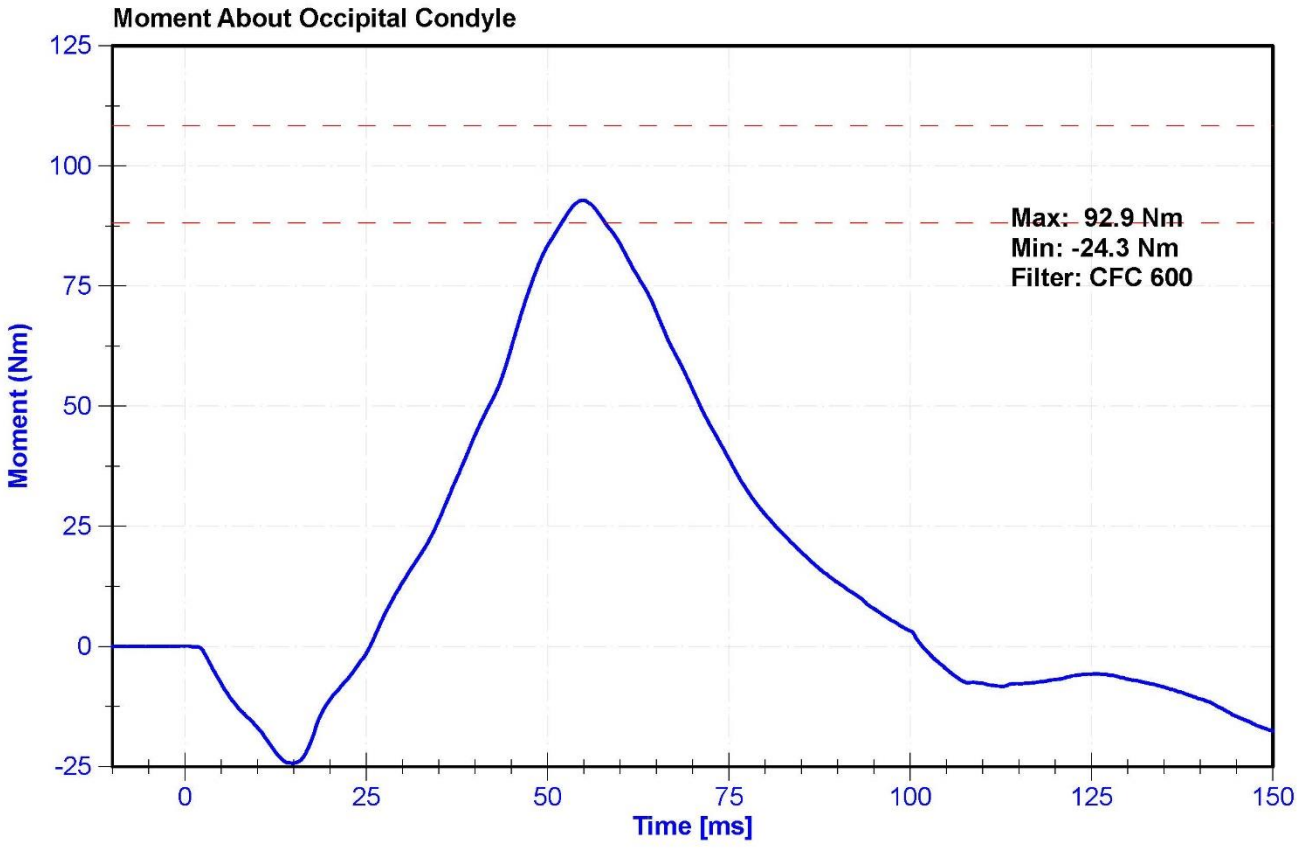
Results

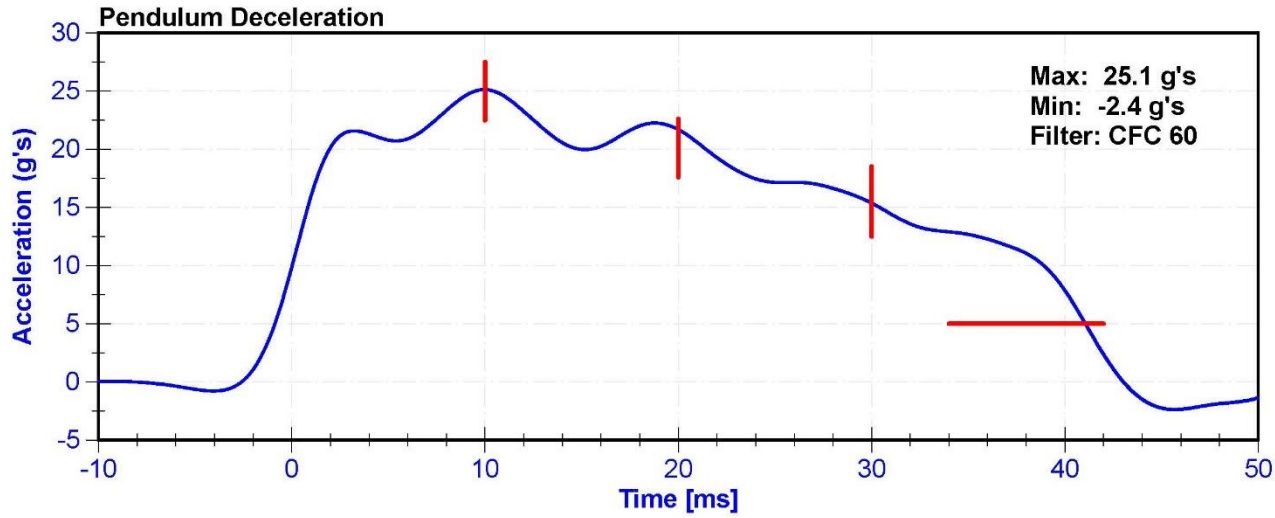
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	36	Pass
Velocity	6.89	7.13	m/s	6.964	Pass
Pendulum Deceleration at 10ms	22.5	27.5	g's	25.13	Pass
Pendulum Deceleration at 20ms	17.6	22.6	g's	21.69	Pass
Pendulum Deceleration at 30ms	12.5	18.5	g's	15.37	Pass
Max. Pendulum Deceleration After 30ms	0	29	g's	25.1	Pass
Pendulum Deceleration Time to 5 g's	34	42	ms	41.1	Pass
Maximum D Plane Rotation	64	78	deg	77.6	Pass
Time to Maximum Rotation	57	64	ms	61.5	Pass
Rotation Decay to Zero	113	127	ms	120.0	Pass
Moment About Occipital Condyle	88.1	108.4	Nm	92.86	Pass
Time to Maximum Moment	47	58	ms	54.9	Pass
Moment Decay to Zero	97	107	ms	101.7	Pass

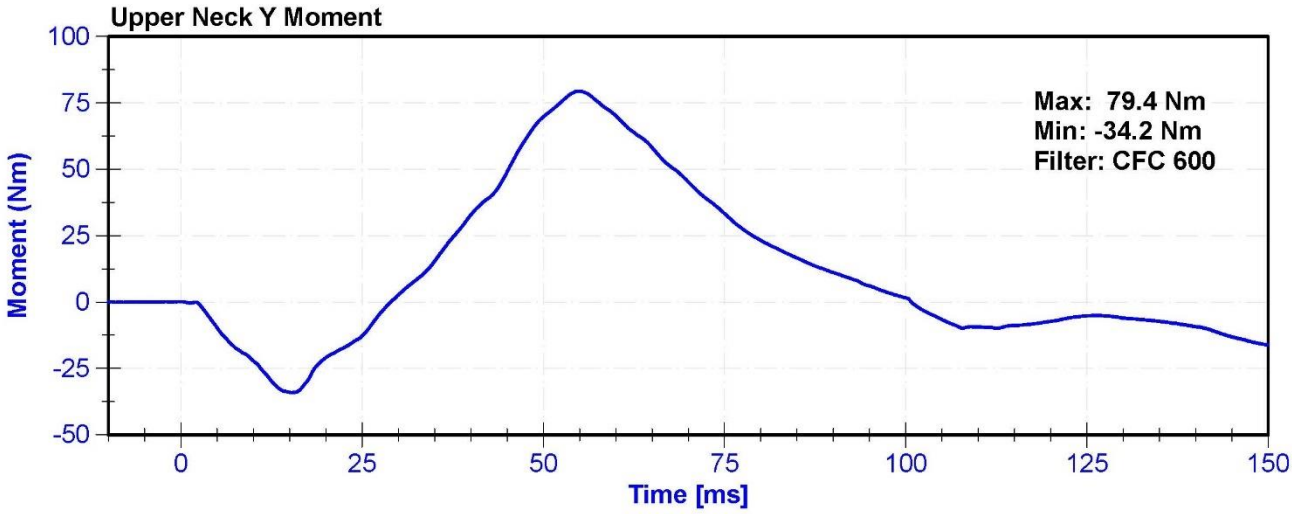
Transducer Calibrations

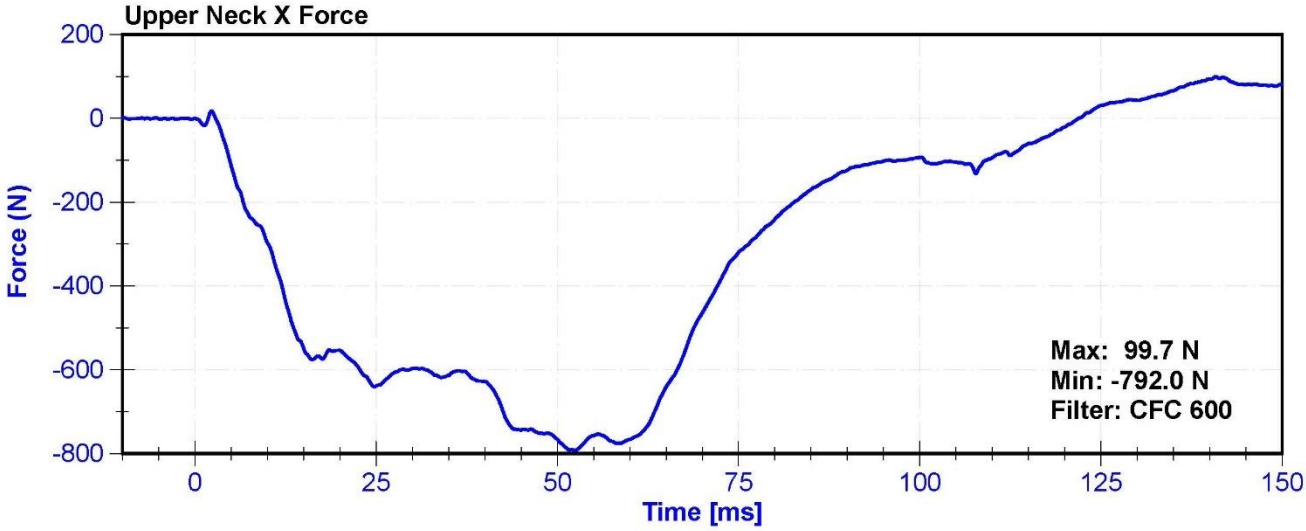
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231CT	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	FTSS	280-FX	9/14/2021	9/14/2022


D-Plane Rotation
Rotation (Deg)
100
75
50
25
0
-25
-50
-75
0
25
50
75
100
125
150
Time [ms]
Max: 77.6 deg
Min: -36.8 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
125
100
75
50
25
0
-25
0
25
50
75
100
125
150
Time [ms]
Max: 92.9 Nm
Min: -24.3 Nm
Filter: CFC 600


Pendulum Deceleration
Acceleration (g's)
Time [ms]
Max: 25.1 g's
Min: -2.4 g's
Filter: CFC 60


Upper Neck Y Moment
Moment (Nm)
Time [ms]
Max: 79.4 Nm
Min: -34.2 Nm
Filter: CFC 600


Upper Neck X Force
Force (N)
Time [ms]
Max: 99.7 N
Min: -792.0 N
Filter: CFC 600

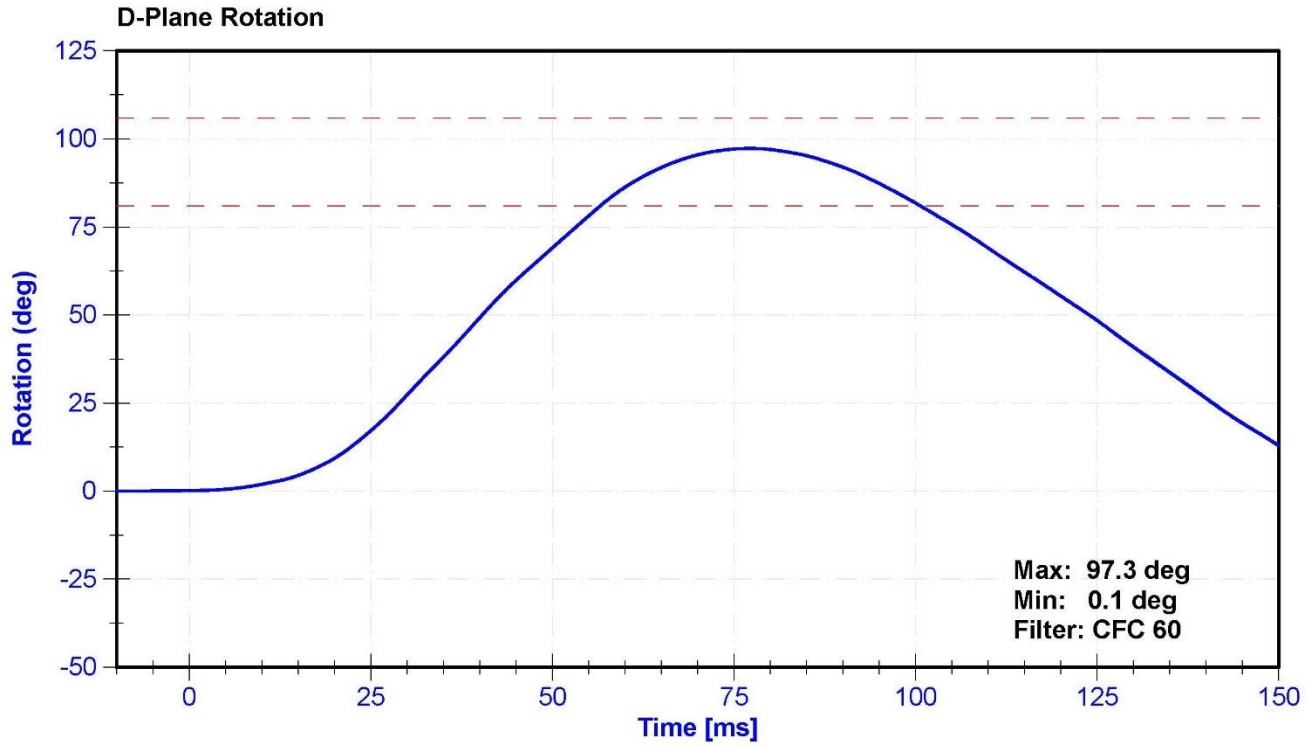
ATD Manufacturer	Humanetics	Test Technician	D. Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

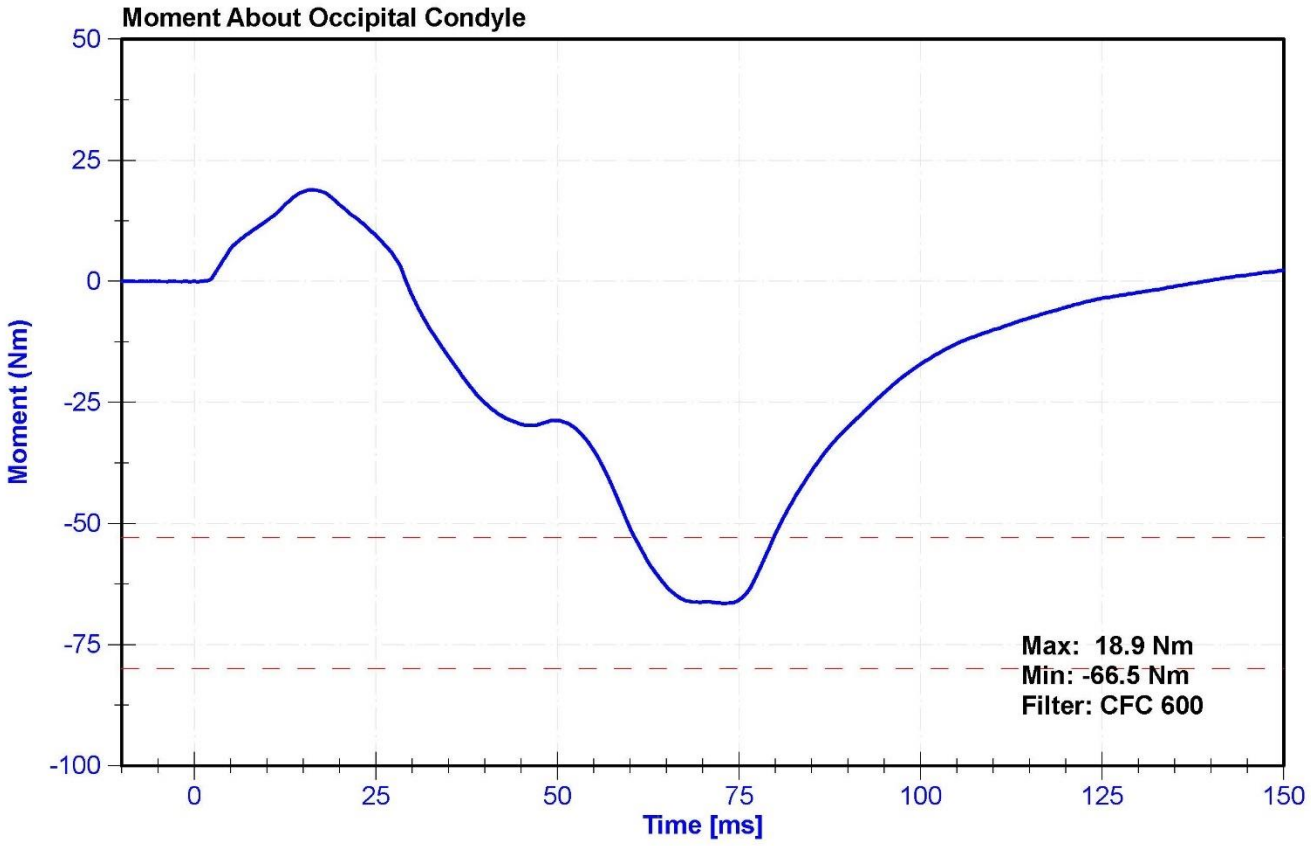
Results

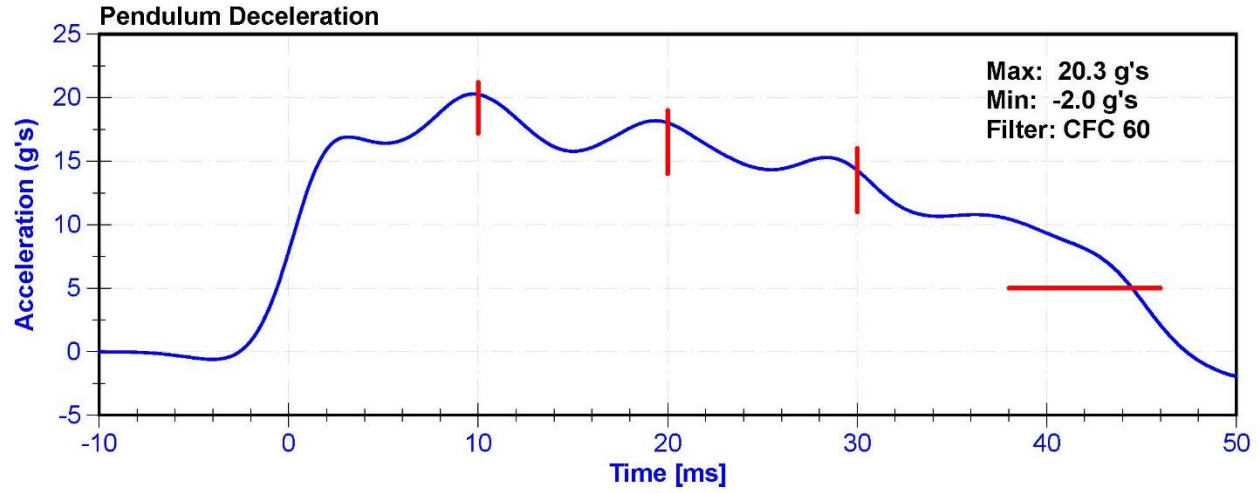
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	36	Pass
Velocity	5.94	6.19	m/s	6.049	Pass
Pendulum Deceleration at 10ms	17.2	21.2	g's	20.25	Pass
Pendulum Deceleration at 20ms	14	19	g's	18.0	Pass
Pendulum Deceleration at 30ms	11	16	g's	14.3	Pass
Max. Pendulum Deceleration After 30ms	0	22	g's	20.3	Pass
Pendulum Deceleration Time to 5 g's	38	46	ms	44.6	Pass
Maximum D Plane Rotation	81	106	deg	97.3	Pass
Time to Maximum Rotation	72	82	ms	77.3	Pass
Rotation Decay to Zero	147	174	ms	159.8	Pass
Minimum Moment About OC	-80	-52.9	Nm	-66.53	Pass
Time to Minimum Moment	65	79	ms	73.0	Pass
Moment Decay to Zero	120	148	ms	139.3	Pass

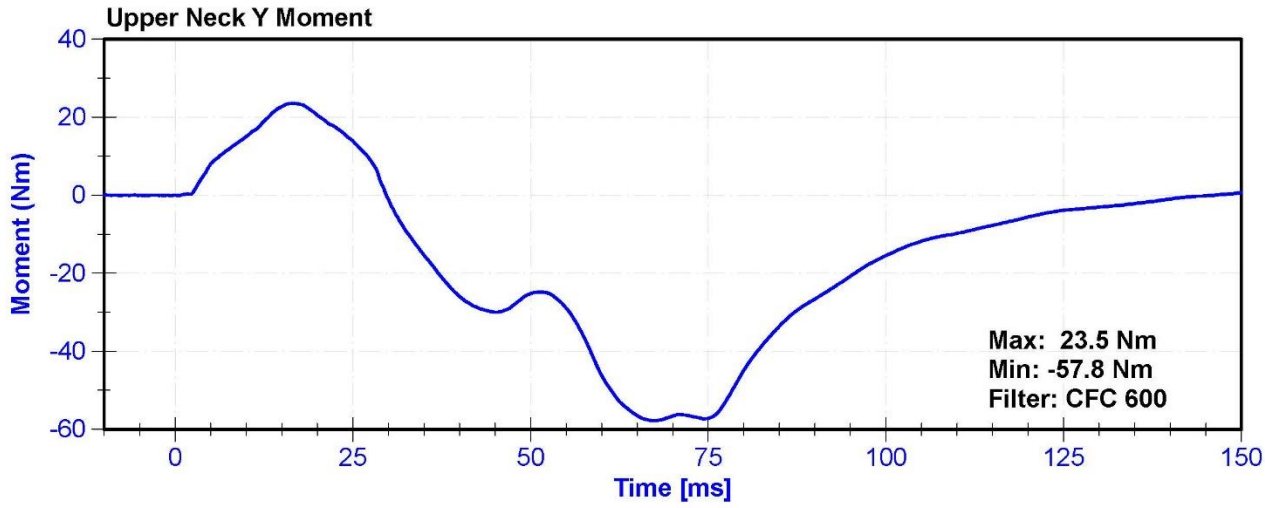
Transducer Calibrations

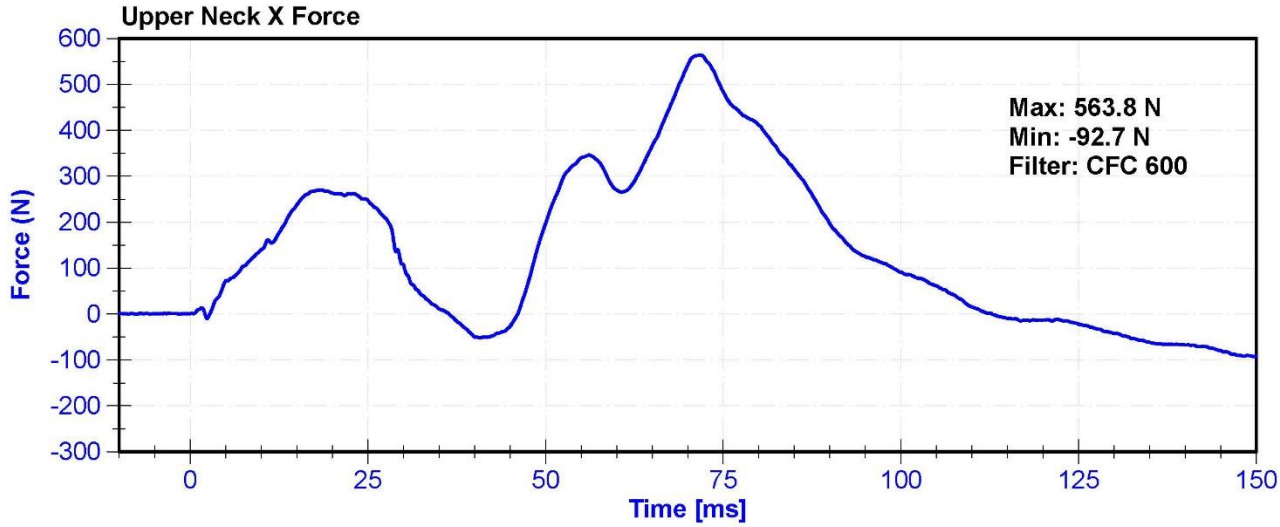
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	FTSS	280-FX	9/14/2021	9/14/2022


D-Plane Rotation
Rotation (deg)
125
100
75
50
25
0
-25
-50
0
25
50
75
100
125
150
Time [ms]
Max: 97.3 deg
Min: 0.1 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
50
25
0
-25
-50
-75
-100
0
25
50
75
100
125
150
Time [ms]
Max: 18.9 Nm
Min: -66.5 Nm
Filter: CFC 600


Pendulum Deceleration
Max: 20.3 g's
Min: -2.0 g's
Filter: CFC 60
Acceleration (g's)
25
20
15
10
5
0
-5
-10
0
10
20
30
40
50
Time [ms]


Upper Neck Y Moment
Max: 23.5 Nm
Min: -57.8 Nm
Filter: CFC 600
Moment (Nm)
40
20
0
-20
-40
-60
0
25
50
75
100
125
150
Time [ms]


Upper Neck X Force
Max: 563.8 N
Min: -92.7 N
Filter: CFC 600
Force (N)
600
500
400
300
200
100
0
-100
-200
-300
0
25
50
75
100
125
150
Time [ms]

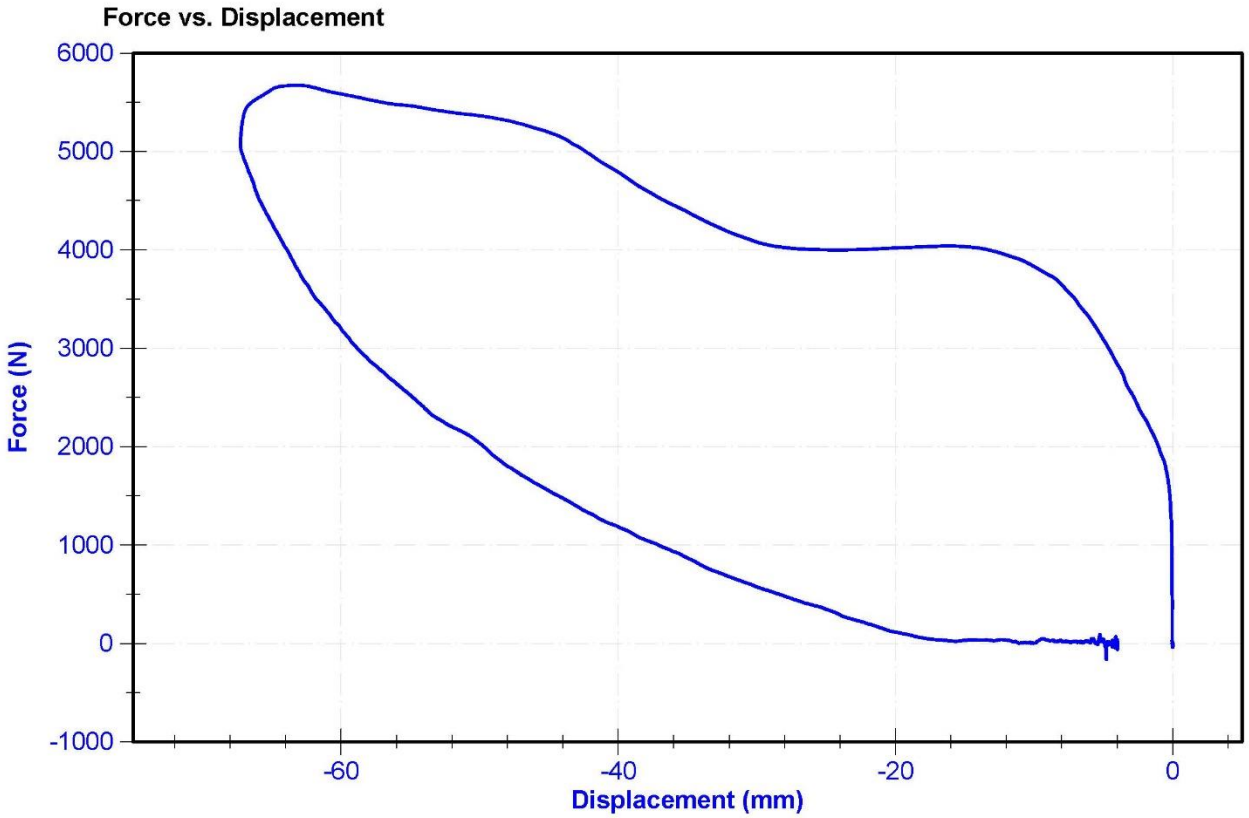
ATD Manufacturer	Humanetics	Test Technician	D. Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

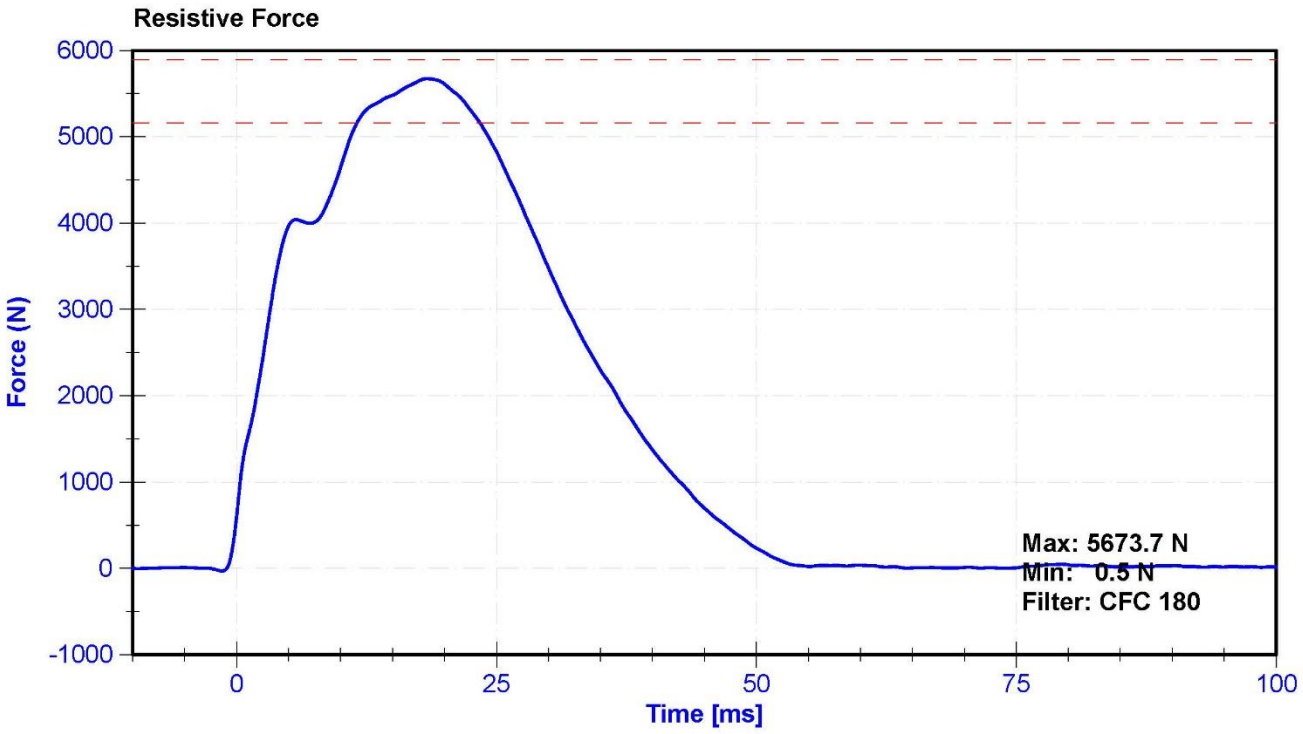
Results

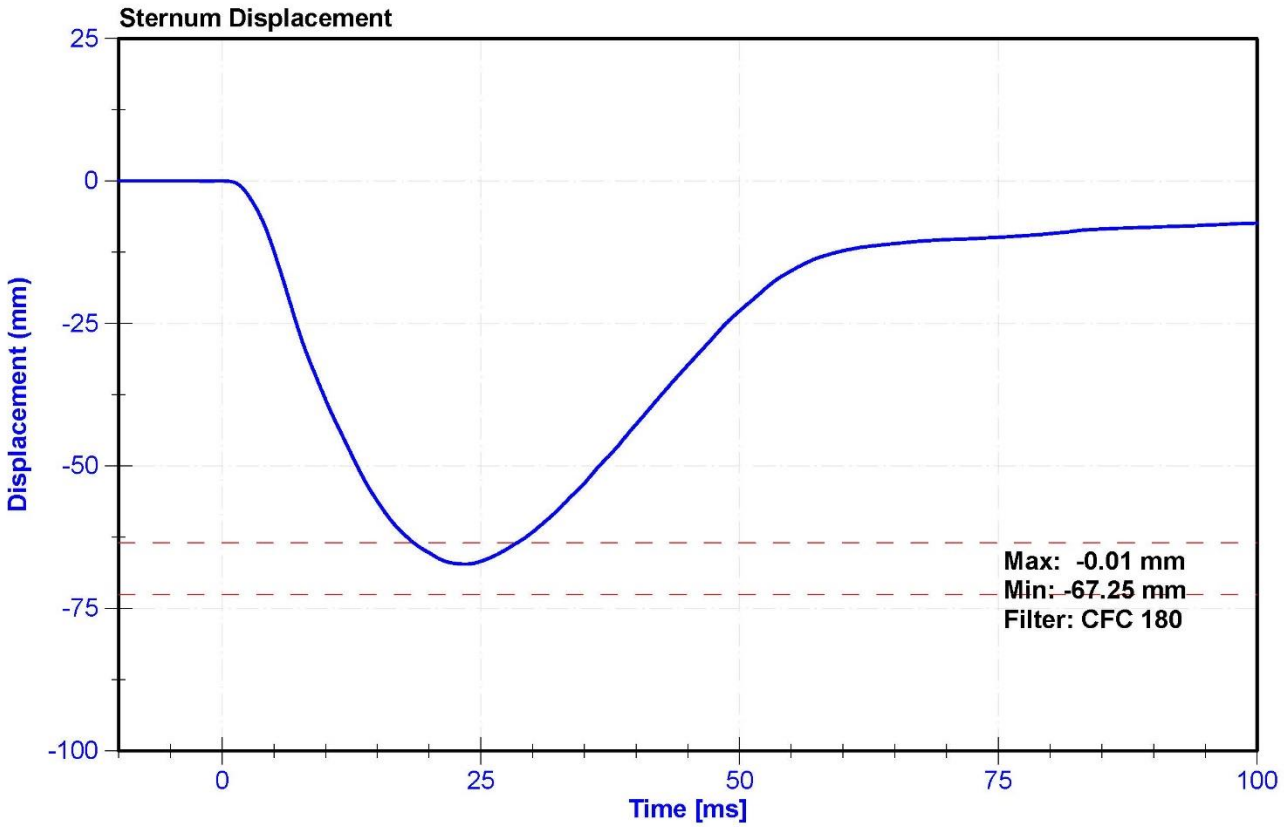
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	27.4	Pass
Velocity	6.59	6.83	m/s	6.718	Pass
Chest Displacement	-72.6	-63.5	mm	-67.25	Pass
Resistive Force	5160	5894	N	5673.7	Pass
Hysteresis	65	85	%	72.5	Pass

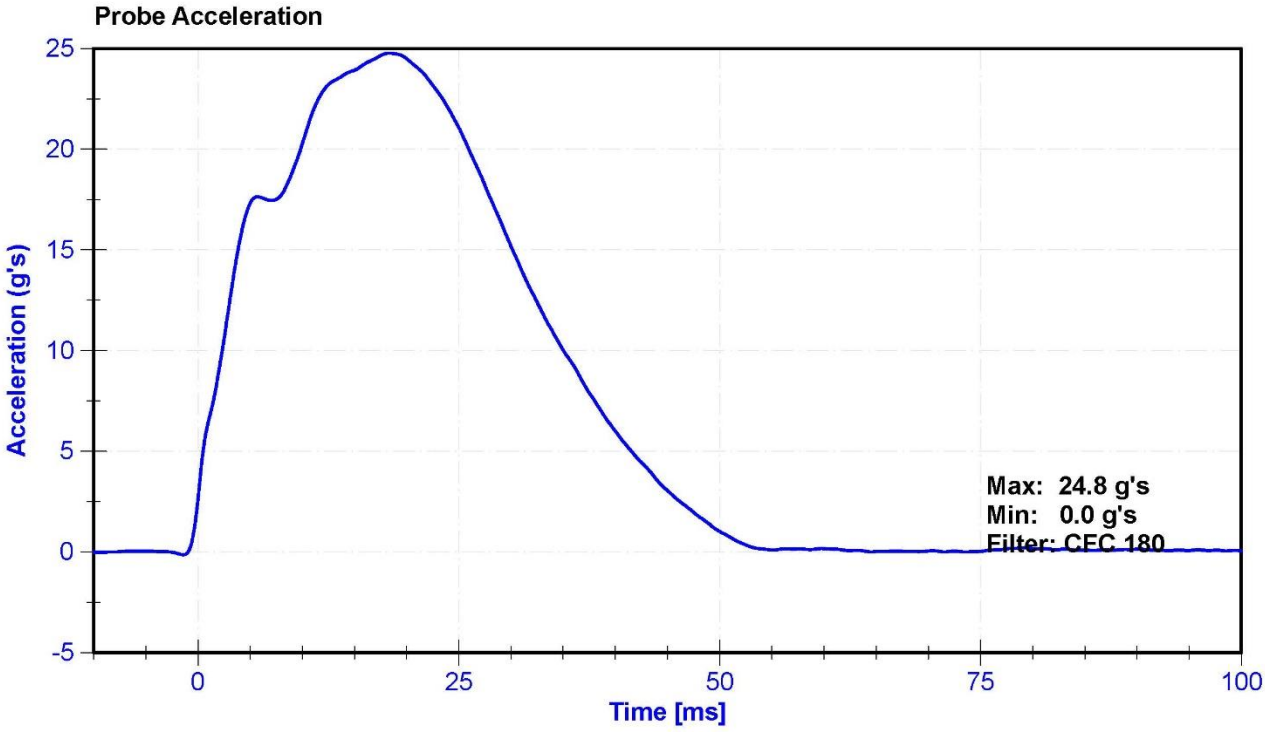
Transducer Calibrations

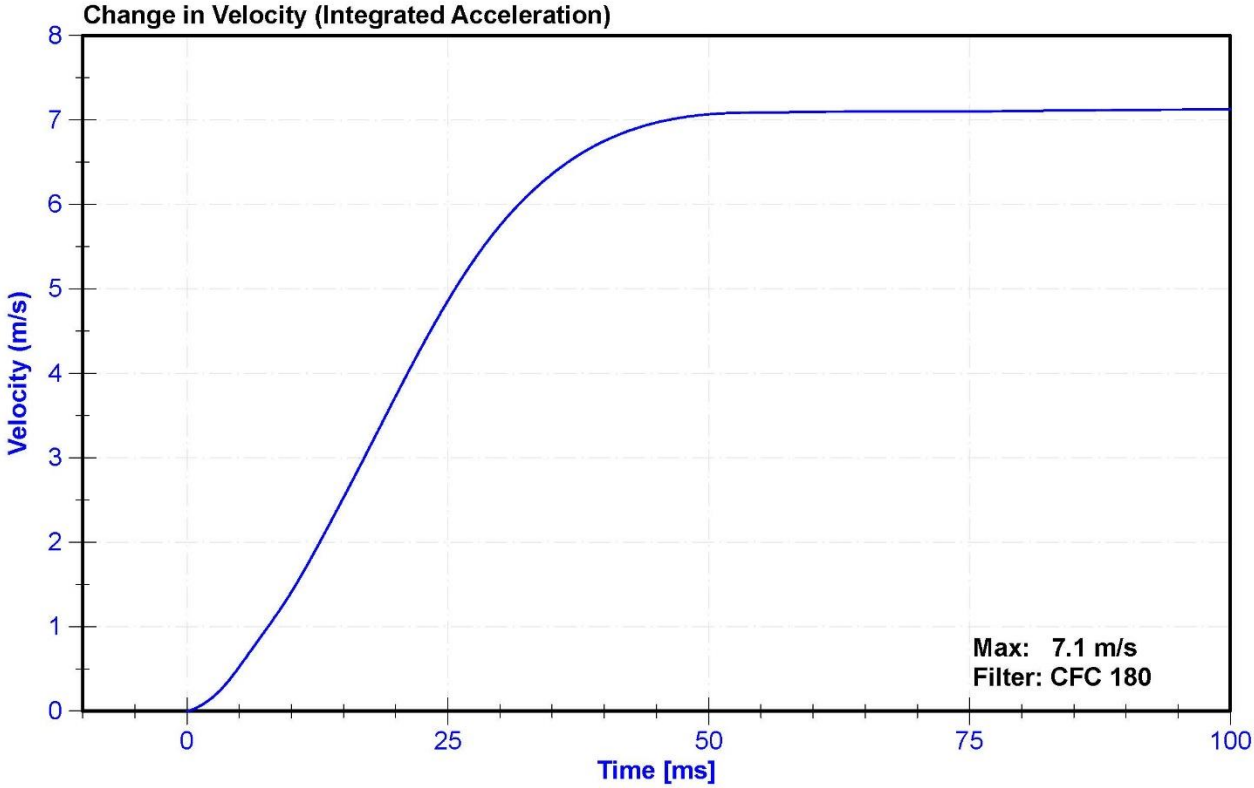
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022
Chest Potentiometer	Servo	142GFE	11/16/2021	5/17/2022




Resistive Force
Force (N)
6000
5000
4000
3000
2000
1000
0
-1000
0
25
50
75
100
Time [ms]
Max: 5673.7 N
Min: 0.5 N
Filter: CFC 180


Sternum Displacement
Displacement (mm)
25
0
-25
-50
-75
-100
0
25
50
75
100
Time [ms]
Max: -0.01 mm
Min: -67.25 mm
Filter: CFC 180


Probe Acceleration
Acceleration (g's)
25
20
15
10
5
0
-5
0
25
50
75
100
Time [ms]
Max: 24.8 g's
Min: 0.0 g's
Filter: CFC 180


Change in Velocity (Integrated Acceleration)
Velocity (m/s)
8
7
6
5
4
3
2
1
0
0
25
50
75
100
Time [ms]
Max: 7.1 m/s
Filter: CFC 180

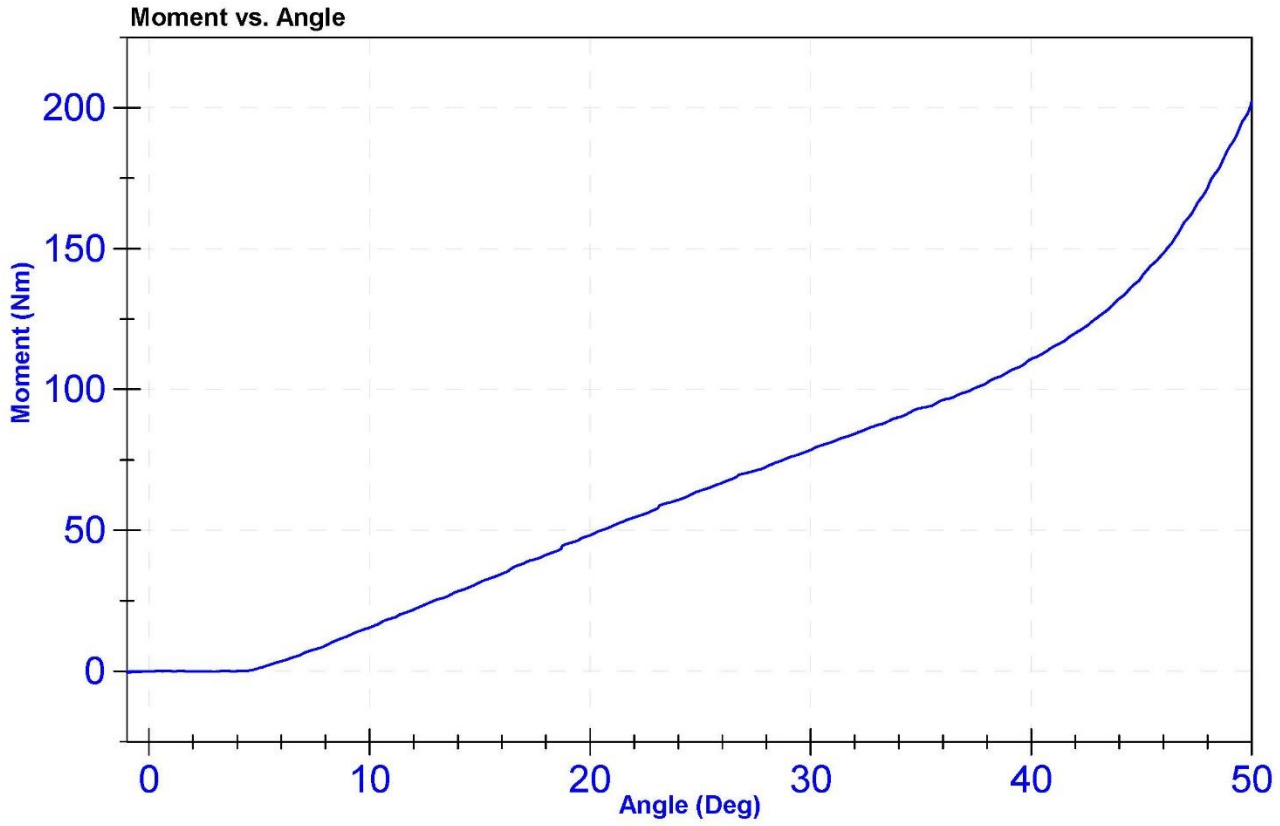
ATD Manufacturer	Humanetics	Test Technician	D. Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.4	Pass
Humidity	10	70	%	23.2	Pass
Average Velocity	5	10	deg/s	7.3	Pass
Angle at 203Nm	40	50	deg	50.0	Pass
Moment at 30 degrees	0	94.9	Nm	78.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	NOVALUE	DS-0008		
Load Cell	Key Trans 2301-02	LC-115 My	2021-08-13	2022-08-13



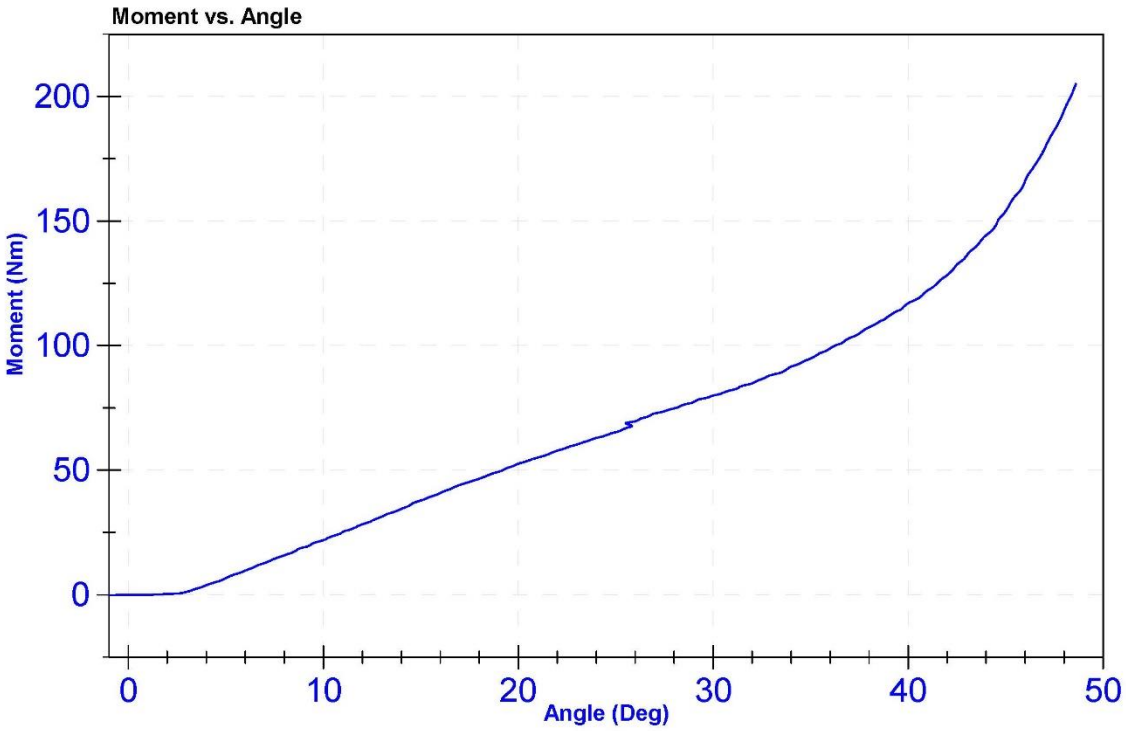
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.4	Pass
Humidity	10	70	%	23.2	Pass
Average Velocity	5	10	deg/s	7.3	Pass
Angle at 203Nm	40	50	deg	48.5	Pass
Moment at 30 degrees	0	94.9	Nm	79.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	NOVALUE	DS-0008		
Load Cell	Key Trans 2301-02	LC-115 My	2021-08-13	2022-08-13



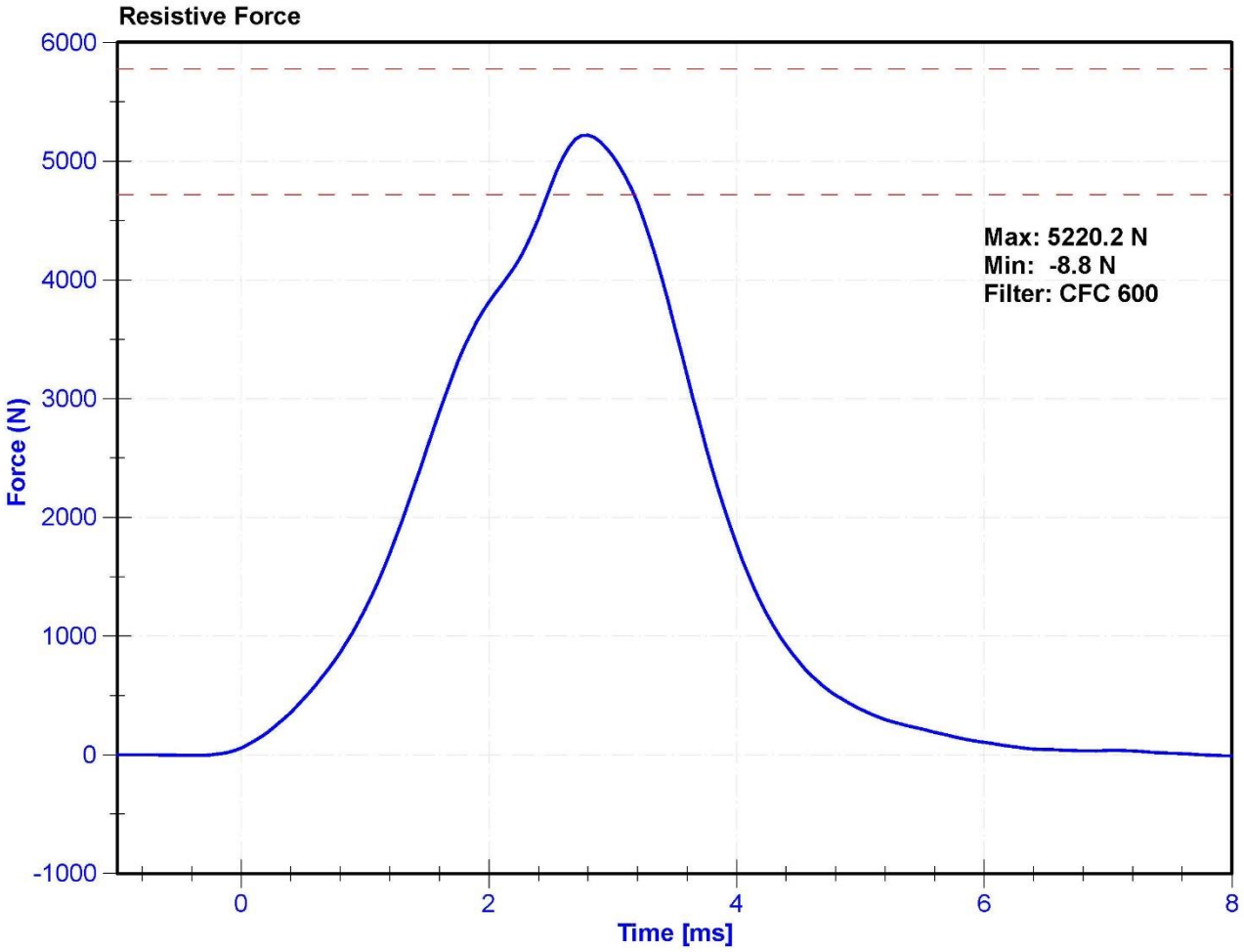
ATD Manufacturer	Humanetics	Test Technician	D. Reinhard
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

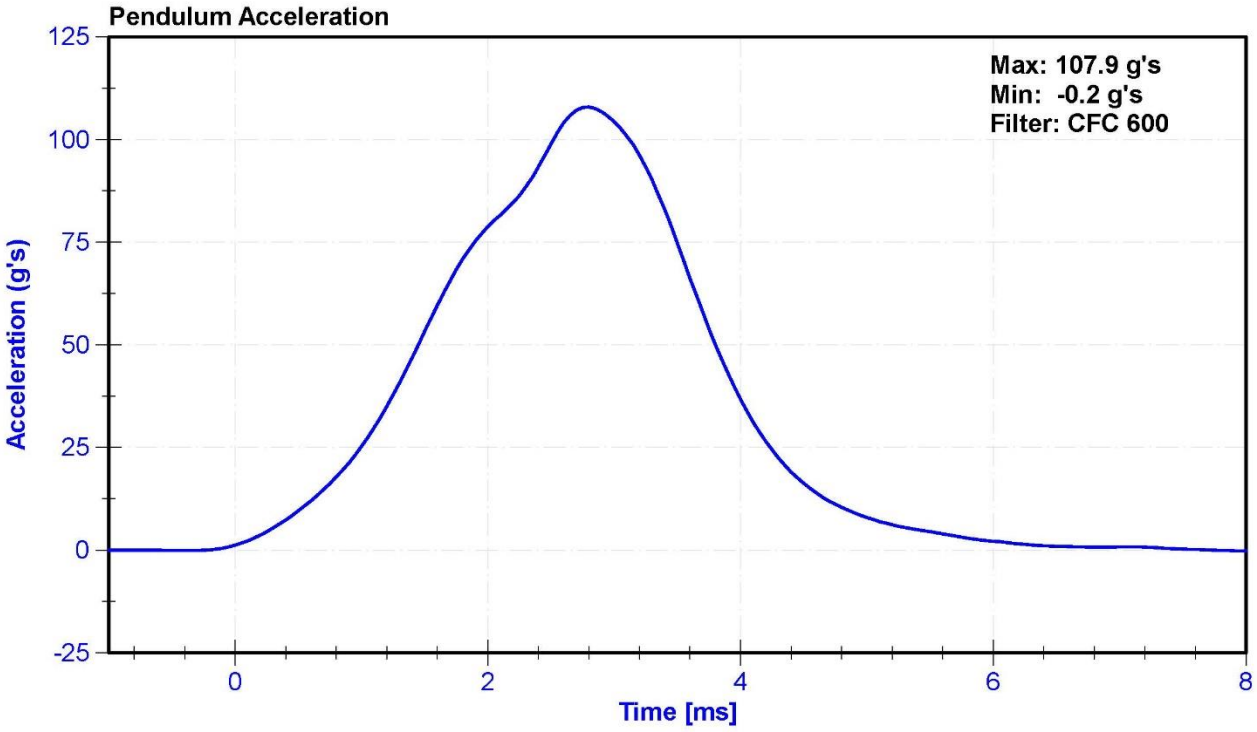
Results

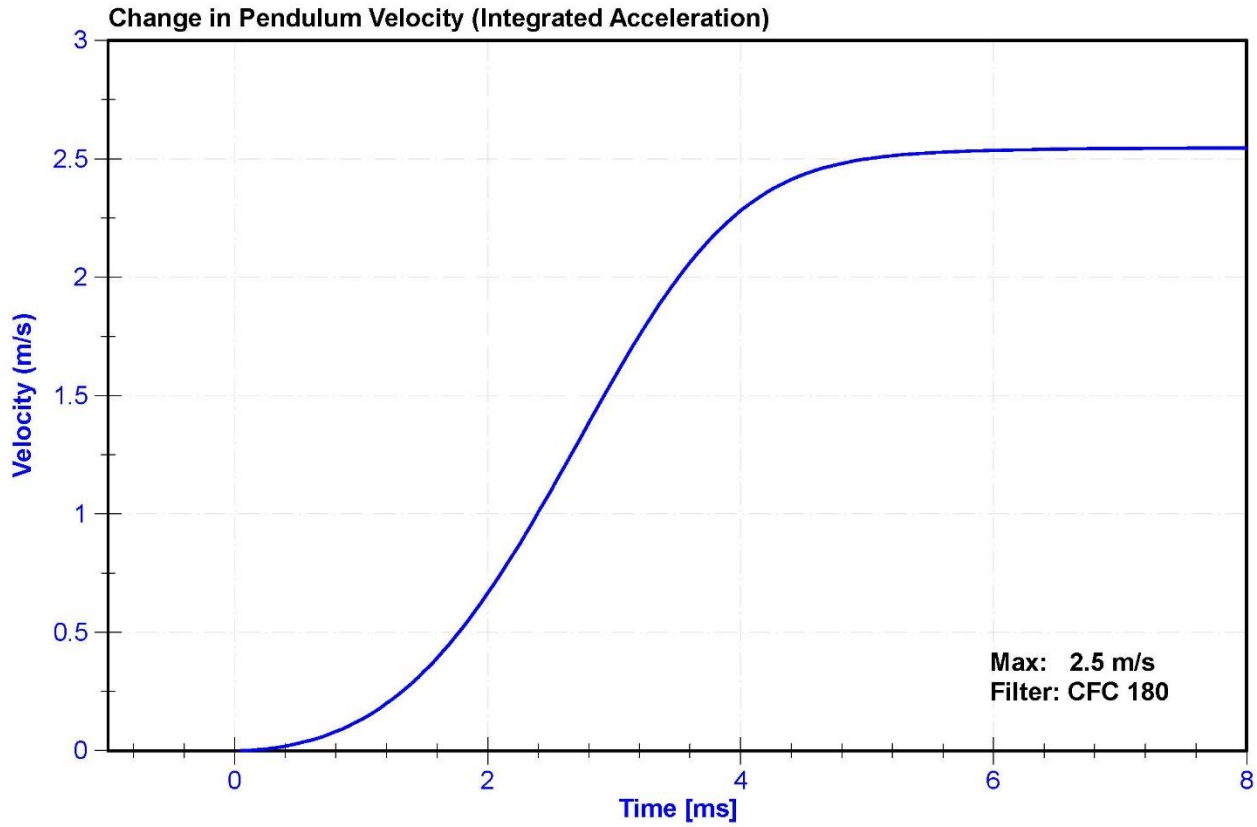
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.6	Pass
Humidity	10	70	%	27	Pass
Velocity	2.07	2.13	m/s	2.114	Pass
Maximum Resistive Force	4720	5780	N	5220.2	Pass

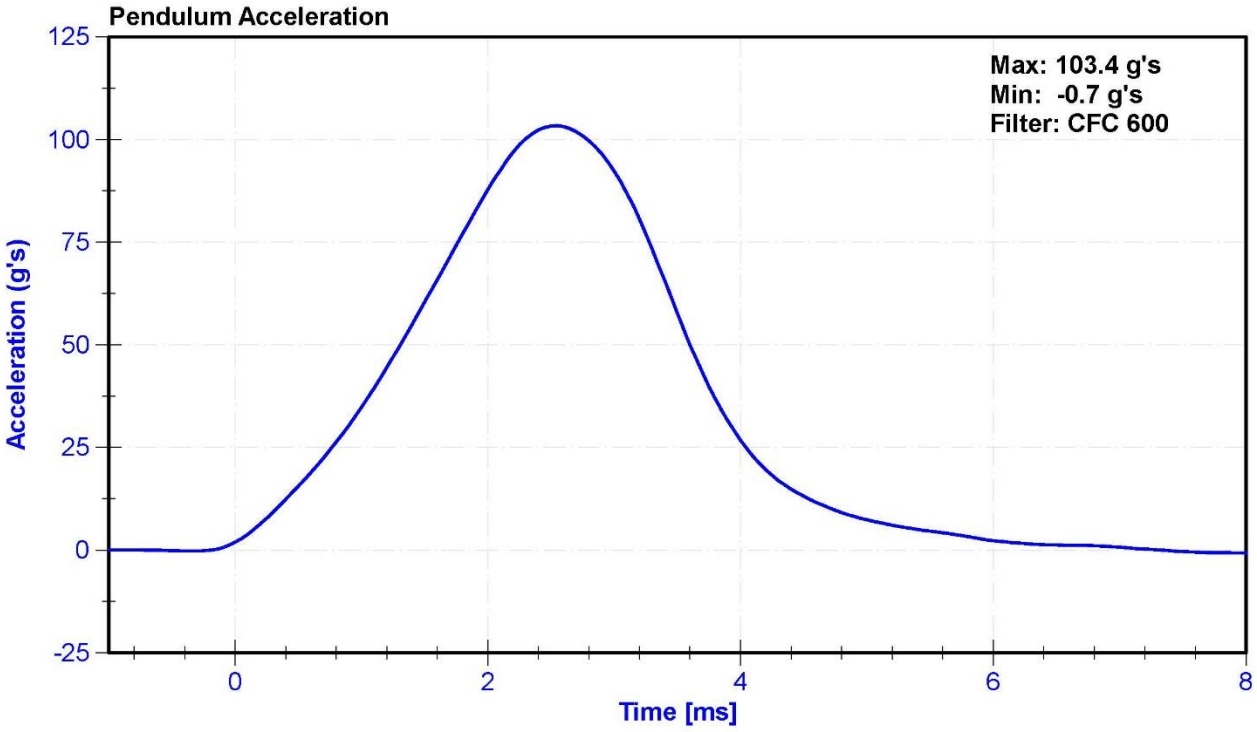
Transducer Calibrations

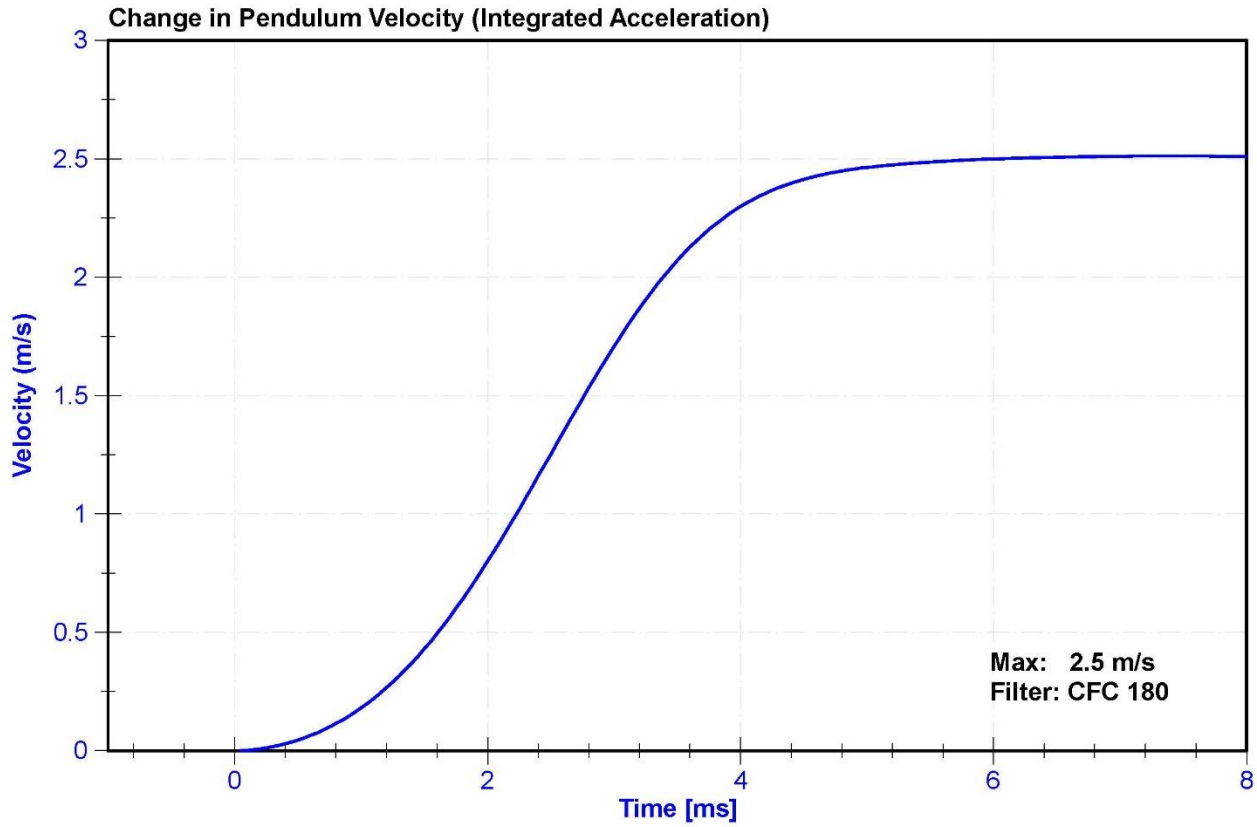
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	T25885	10/25/2021	4/23/2022

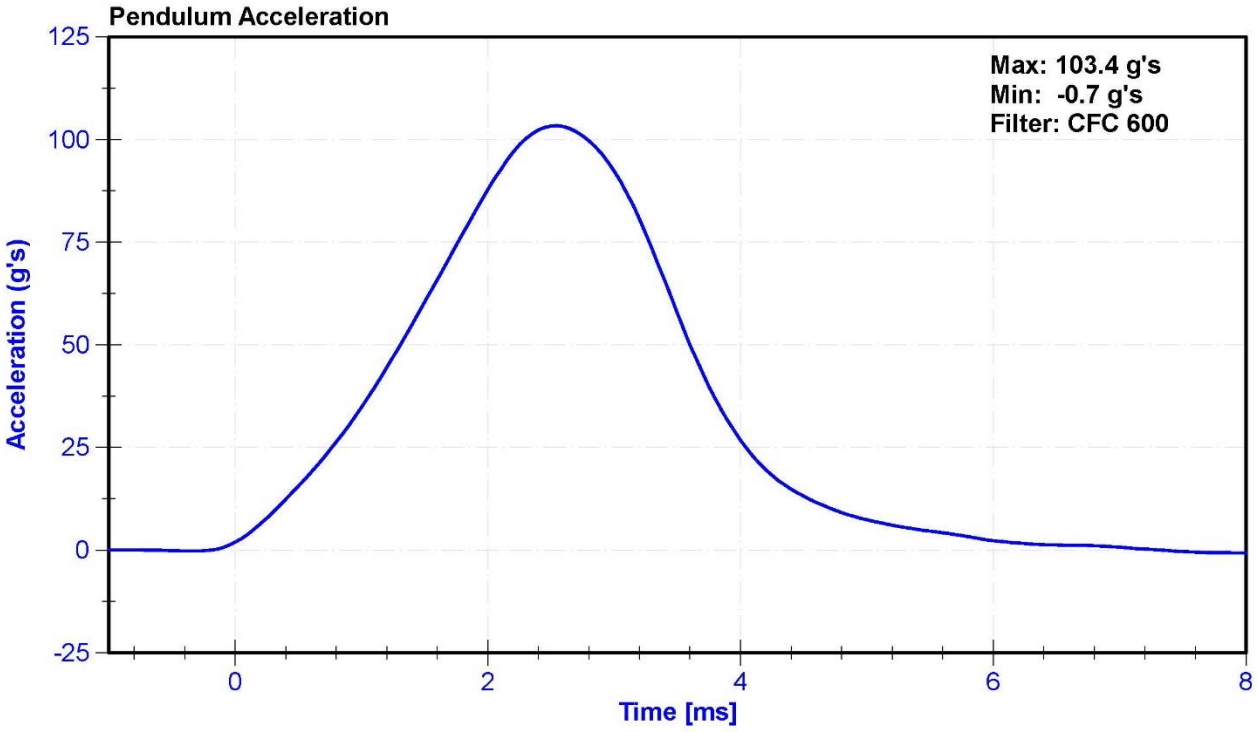


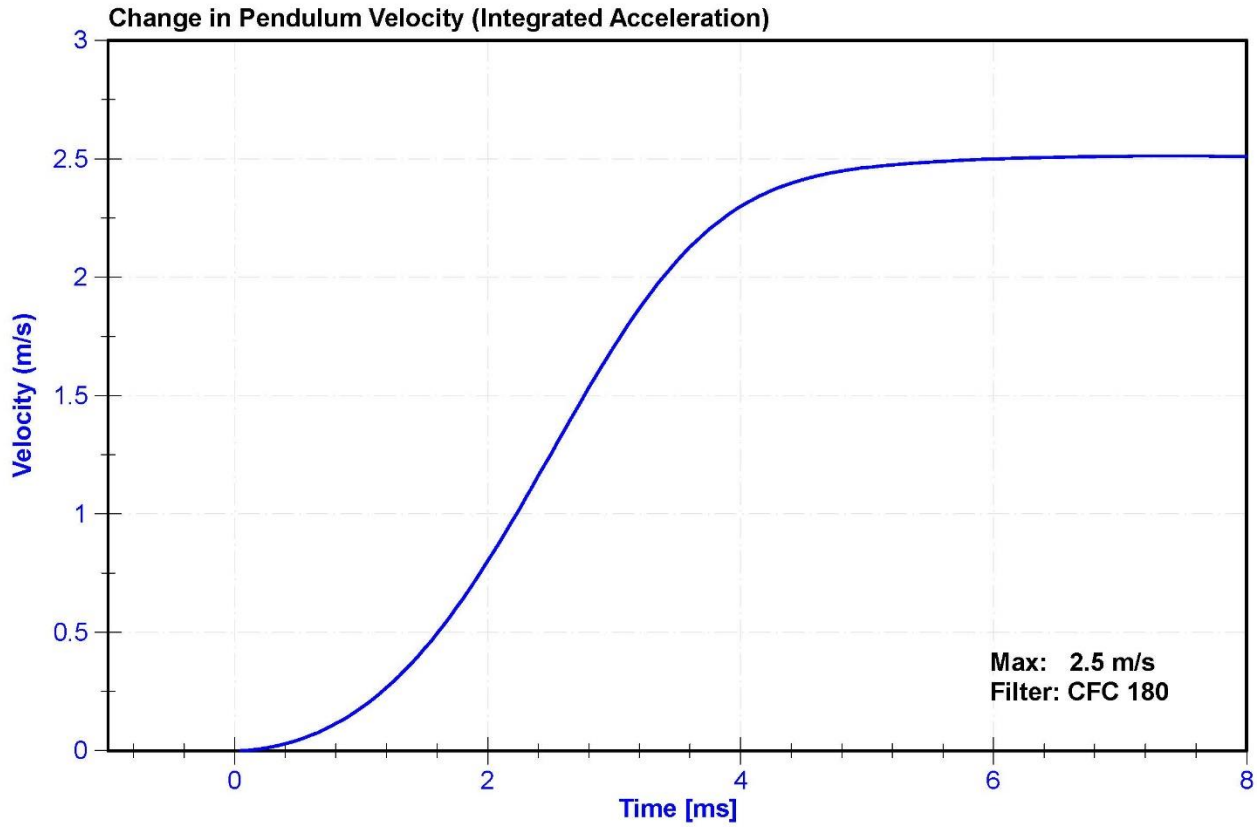

Pendulum Acceleration
Max: 107.9 g's
Min: -0.2 g's
Filter: CFC 600
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]


Change in Pendulum Velocity (Integrated Acceleration)
Max: 2.5 m/s
Filter: CFC 180
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]


Pendulum Acceleration
Max: 103.4 g's
Min: -0.7 g's
Filter: CFC 600
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]


Change in Pendulum Velocity (Integrated Acceleration)
Max: 2.5 m/s
Filter: CFC 180
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]


Pendulum Acceleration
Max: 103.4 g's
Min: -0.7 g's
Filter: CFC 600
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]


Change in Pendulum Velocity (Integrated Acceleration)
Max: 2.5 m/s
Filter: CFC 180
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]

CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 5TH PERCENTILE - PASSENGER ATD

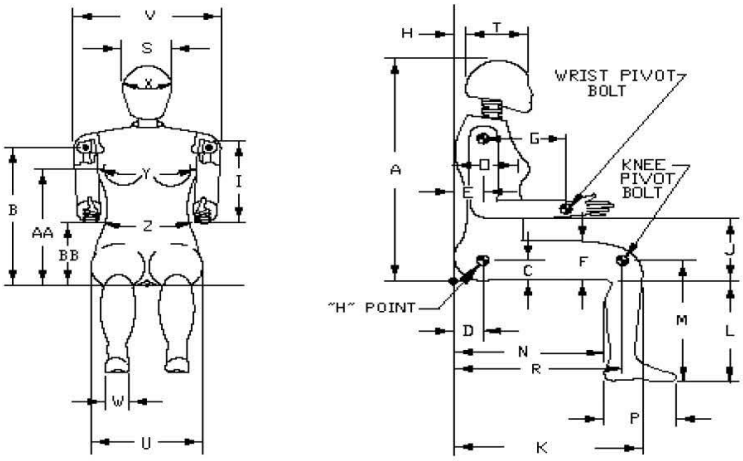
SERIAL NO: 137

Calspan

External Measurements - Hybrid 3 - 5th Female

Technician: K. Brogan Date: 02/11/2021

Dummy Serial Number: 137



Symbol	Description	Specification (mm)		Result (mm)	Pass/Fail
A	Sitting Height	775	800	790	Pass
B	Shoulder Pivot Height	432	457	445	Pass
C	H-Point Height	81	86	83	Pass
D	H-Point from Backline	145	150	147	Pass
E	Shoulder Pivot from Backline	69	84	78	Pass
F	Thigh Clearance	119	135	125	Pass
G	Back of Elbow to Wrist Pivot	244	259	250	Pass
H	Head Back to Backline	43	48	45	Pass
I	Shoulder to Elbow Length	277	297	290	Pass
J	Elbow Rest Height	183	203	195	Pass
K	Buttock to Knee Length	521	546	541	Pass
L	Popliteal Height	356	376	365	Pass
M	Knee Pivot Height	394	419	412	Pass
N	Buttock Popliteal Length	414	439	425	Pass
O	Chest Depth without Jacket	175	191	181	Pass
P	Foot Length (right)	219	234	228	Pass
R	Buttock To Knee Pivot Length	457	483	466	Pass
S	Head Breadth	137	147	141	Pass
T	Head Depth	178	188	180	Pass
U	Hip Breadth	300	315	310	Pass
V	Shoulder Breadth	351	366	359	Pass
W	Foot Breadth	79	94	85	Pass
X	Head Circumference	528	549	540	Pass
Y	Chest Circumference with Jacket	851	881	874	Pass
Z	Waist Circumference	460	790	650	Pass
AA	Reference Location (Chest Circumference)	333	358	345	Pass
BB	Reference Location (Waist Circumference)	160	170	165	Pass

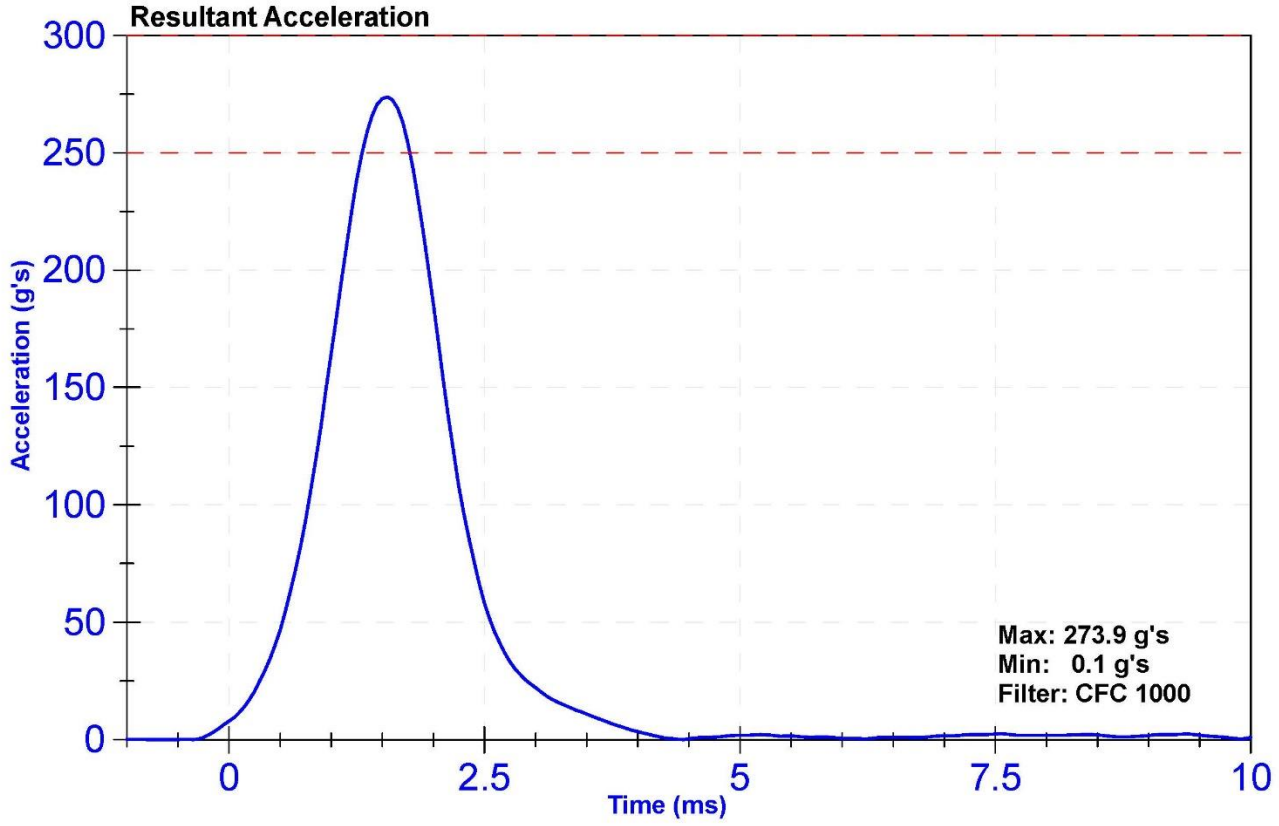
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

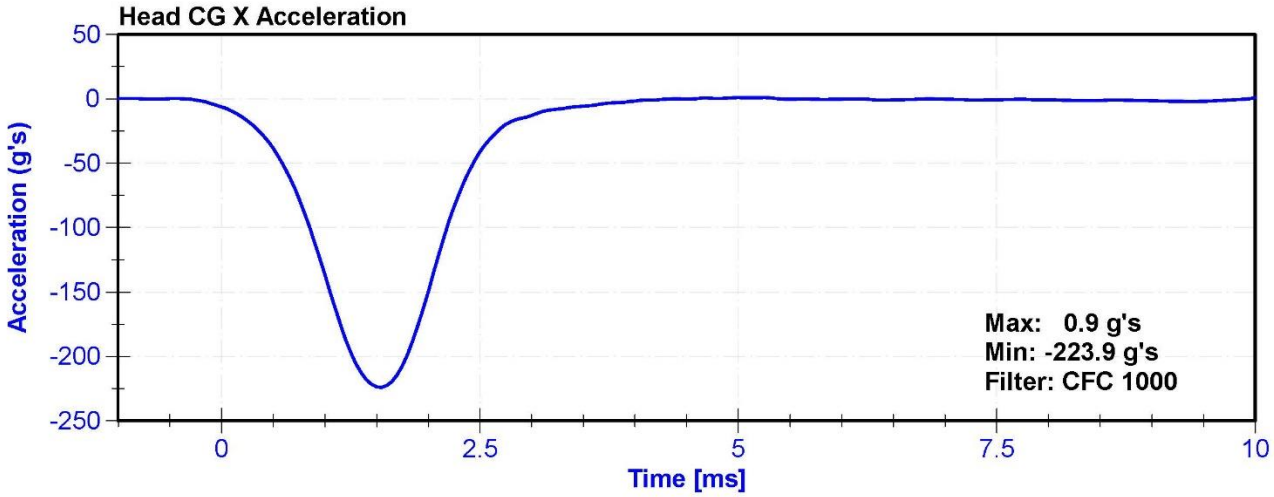
Results

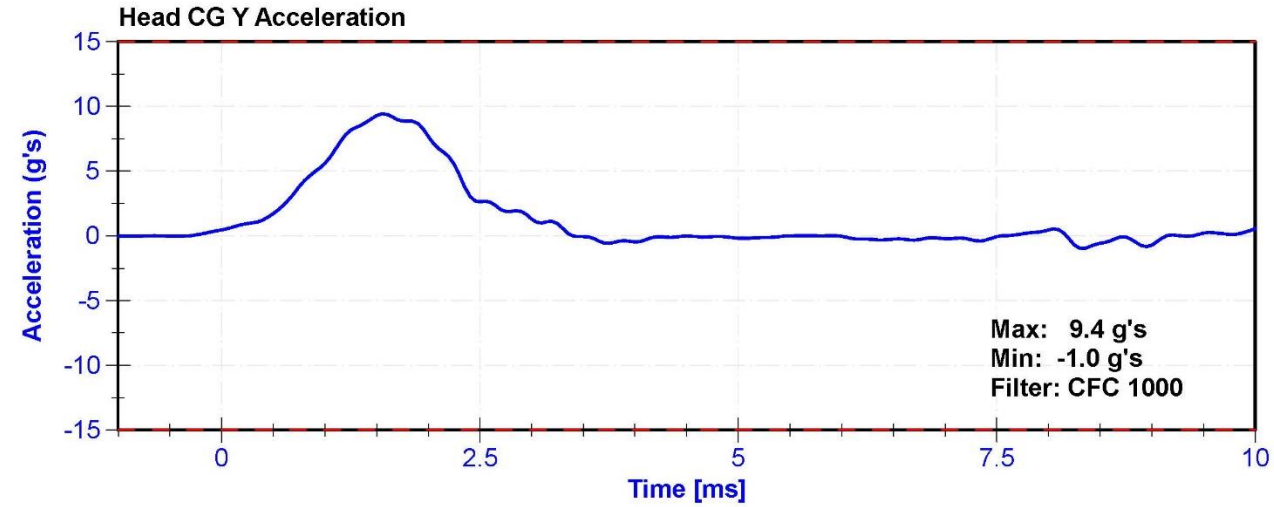
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.6	Pass
Humidity	10	70	%	23.6	Pass
Resultant Acceleration	250	300	g's	273.9	Pass
Oscillation	0	10	%	1.9	Pass
Lateral Acceleration	-15	15	g's	9.4	Pass

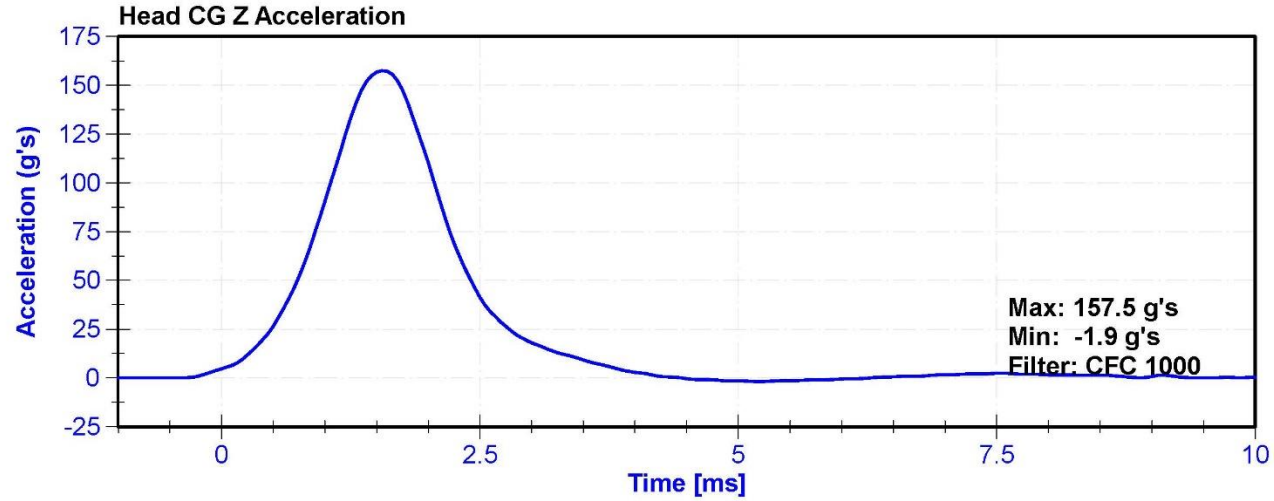
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P79417	2/1/2022	7/31/2022
Y Accelerometer	Endevco	P83335	2/1/2022	7/31/2022
Z Accelerometer	Endevco	P64149	2/1/2022	7/31/2022




Head CG X Acceleration
Acceleration (g's)
50
0
-50
-100
-150
-200
-250
0
2.5
5
7.5
10
Time [ms]
Max: 0.9 g's
Min: -223.9 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: 9.4 g's
Min: -1.0 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
175
150
125
100
75
50
25
0
-25
0
2.5
5
7.5
10
Time [ms]
Max: 157.5 g's
Min: -1.9 g's
Filter: CFC 1000

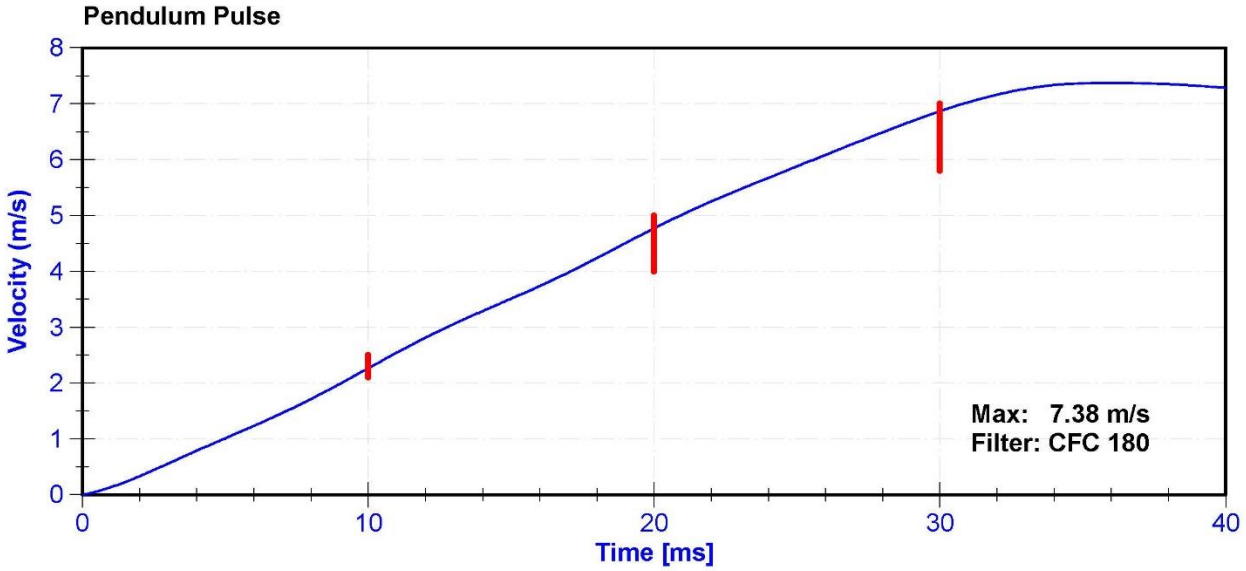
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

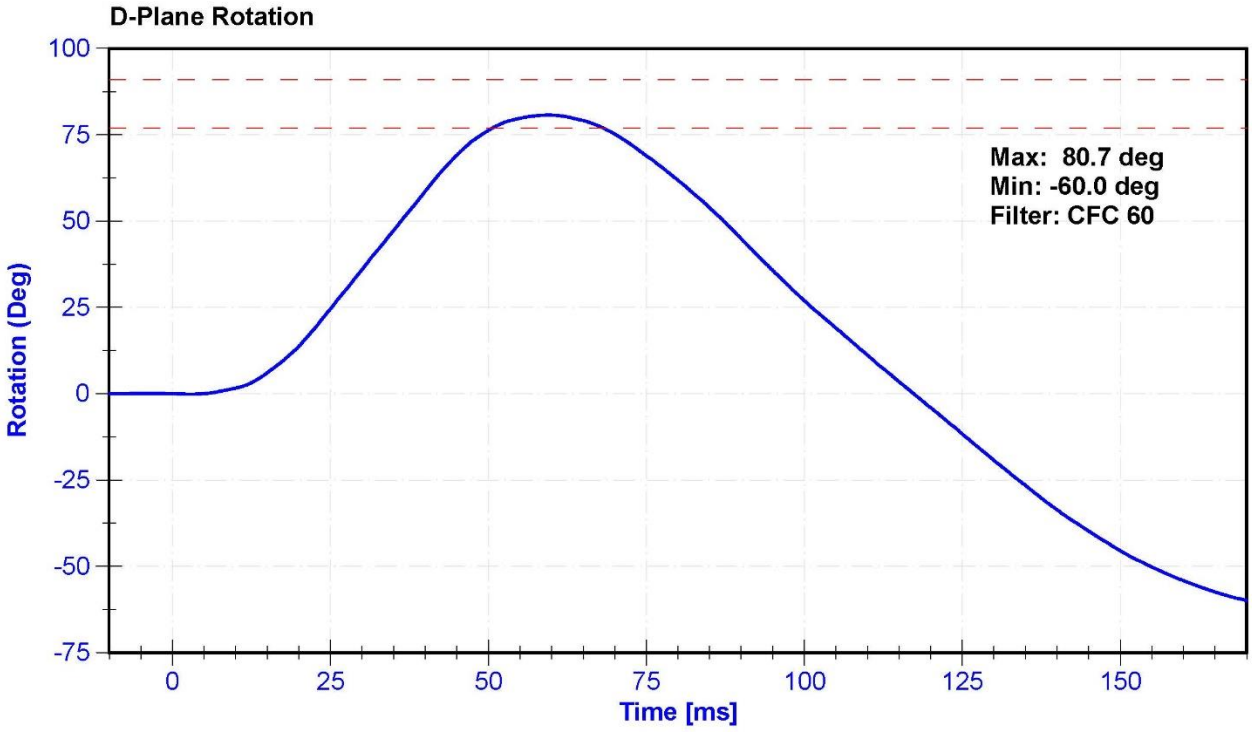
Results

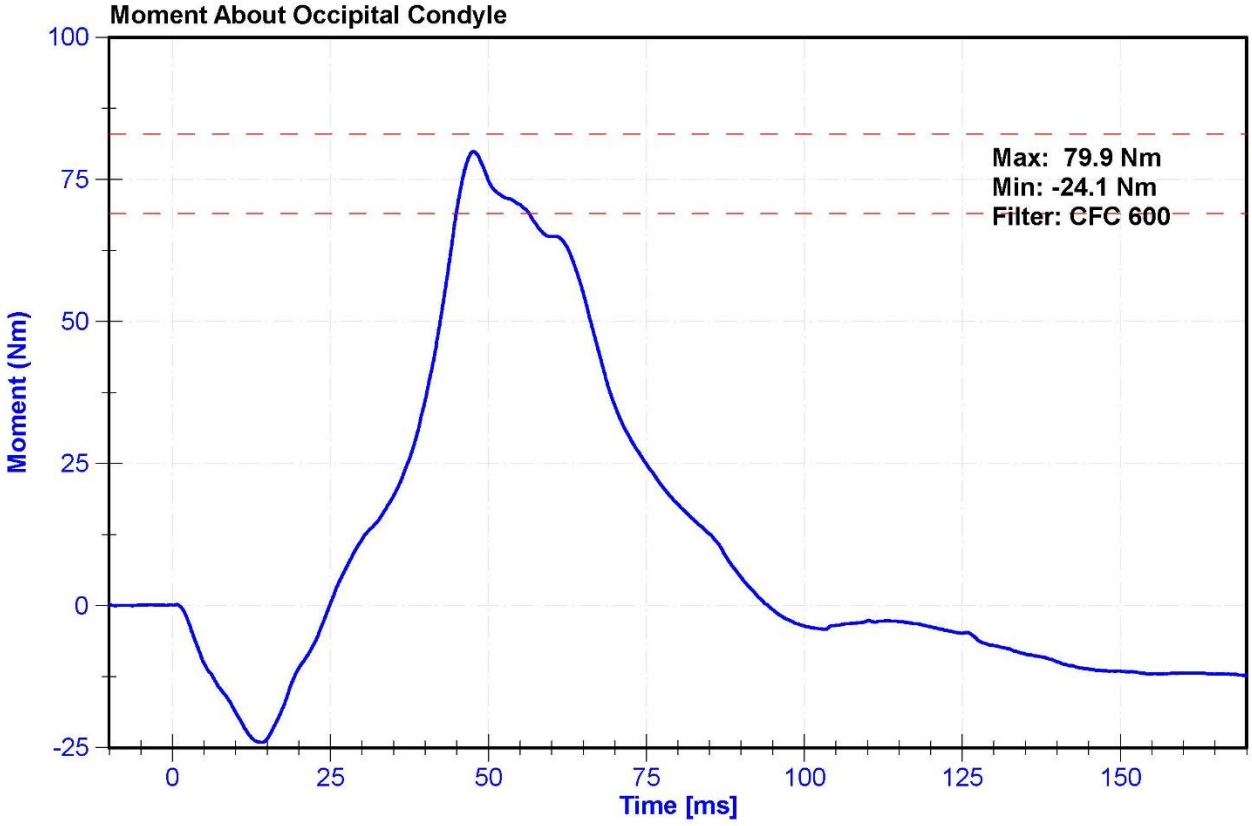
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	22.8	Pass
Velocity	6.89	7.13	m/s	7.023	Pass
Pendulum Impulse at 10ms	2.1	2.5	m/s	2.26	Pass
Pendulum Impulse at 20ms	4.0	5.0	m/s	4.77	Pass
Pendulum Impulse at 30ms	5.8	7.0	m/s	6.87	Pass
Max D Plane Rotation	77	91	deg	80.7	Pass
Max Moment During Rotation Interval	69	83	Nm	79.9	Pass
Moment Decay to 10.0 Nm	80	100	ms	86.9	Pass

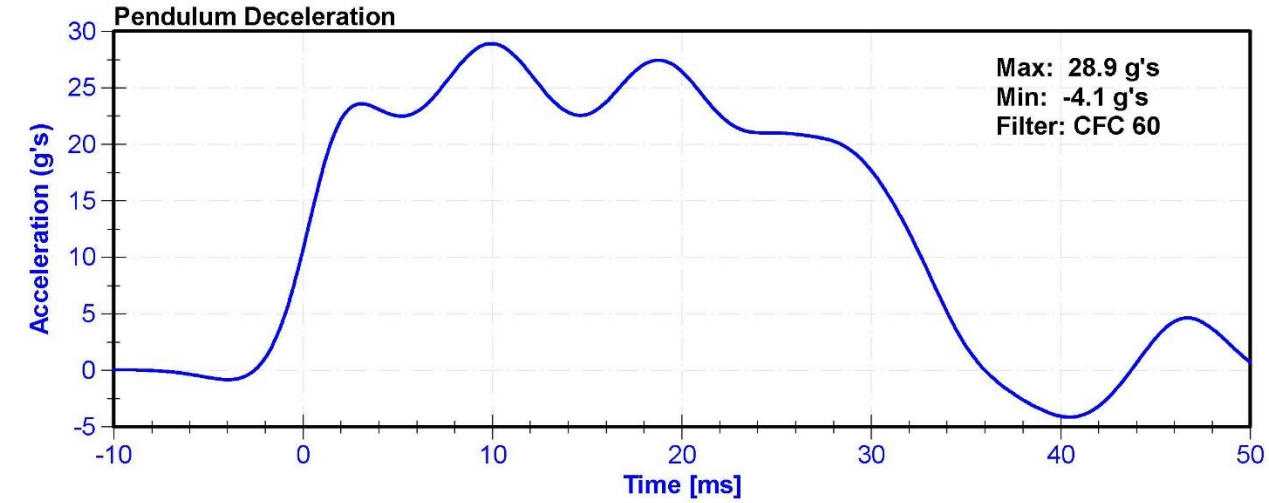
Transducer Calibrations

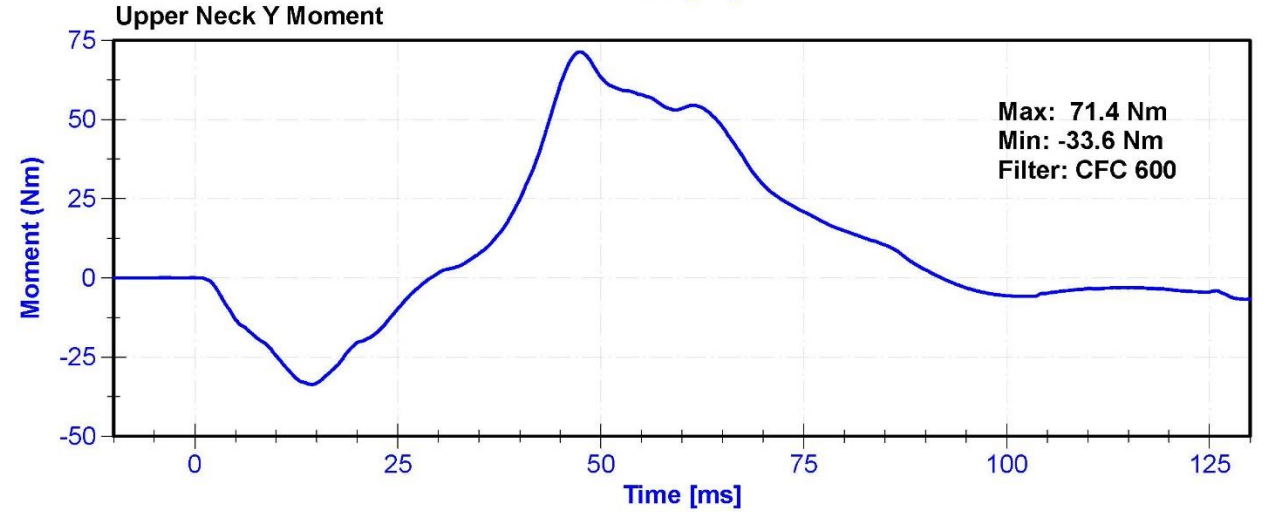
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231CT	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	Denton	2184-FX	6/24/2021	6/24/2022

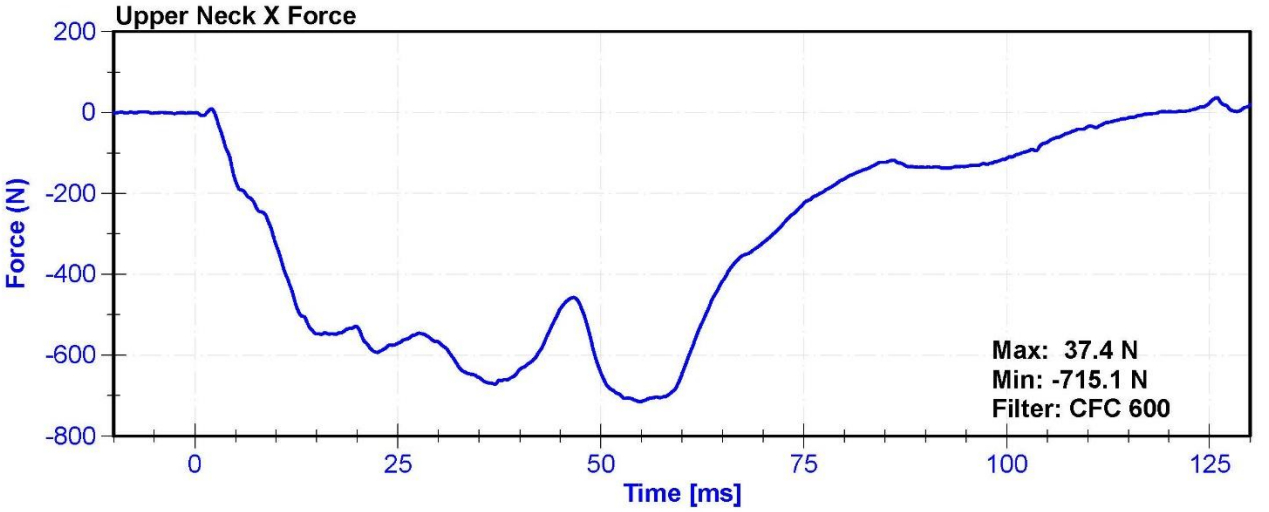



D-Plane Rotation
Max: 80.7 deg
Min: -60.0 deg
Filter: CFC 60
Rotation (Deg)
100
75
50
25
0
-25
-50
-75
0
25
50
75
100
125
150
Time [ms]


Moment About Occipital Condyle
Max: 79.9 Nm
Min: -24.1 Nm
Filter: CFC 600
Moment (Nm)
100
75
50
25
0
-25
0
25
50
75
100
125
150
Time [ms]


Pendulum Deceleration
Acceleration (g's)
Time [ms]
Max: 28.9 g's
Min: -4.1 g's
Filter: CFC 60


Upper Neck Y Moment
Moment (Nm)
Time [ms]
Max: 71.4 Nm
Min: -33.6 Nm
Filter: CFC 600


Upper Neck X Force
Force (N)
Time [ms]
Max: 37.4 N
Min: -715.1 N
Filter: CFC 600

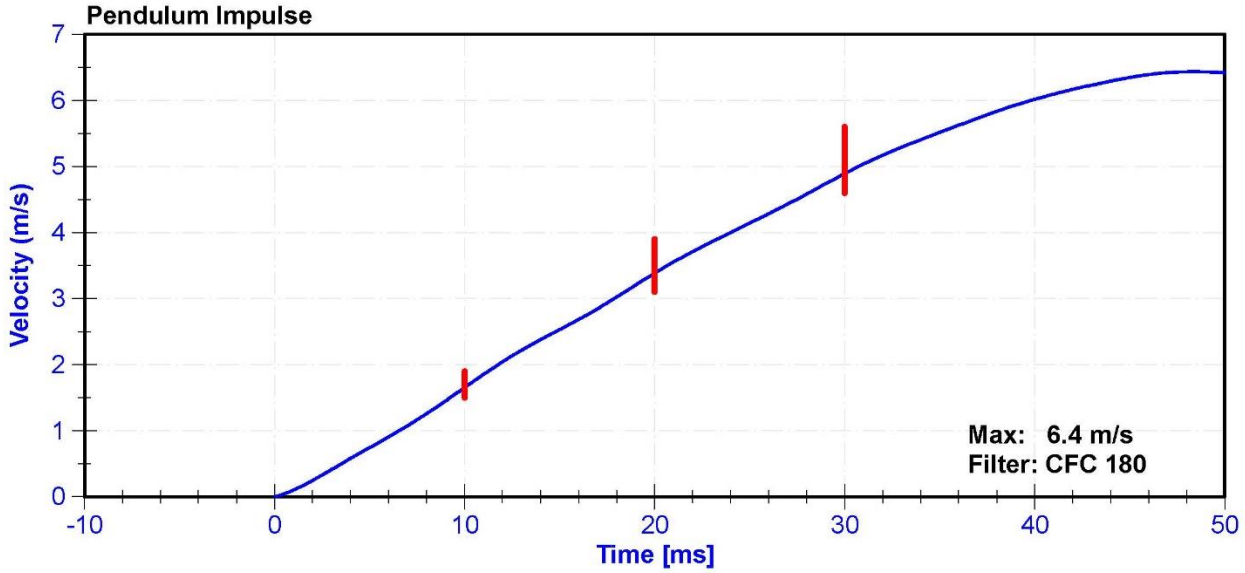
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

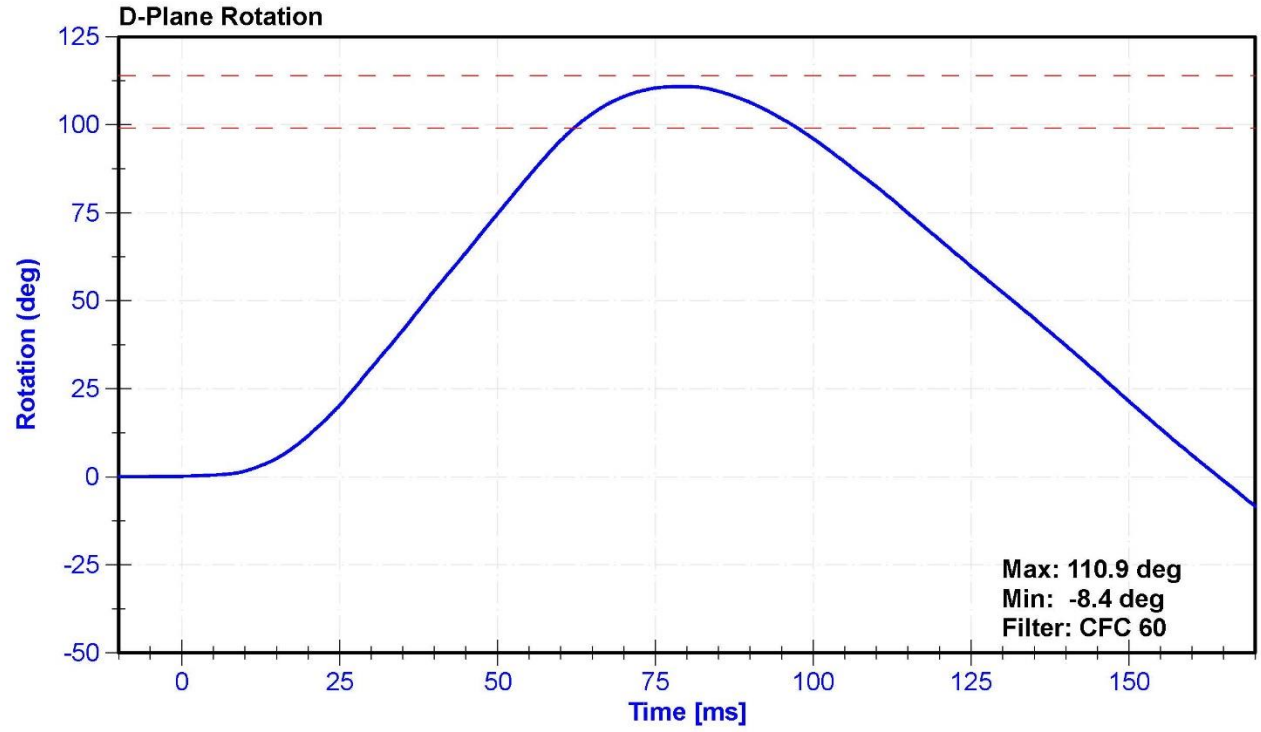
Results

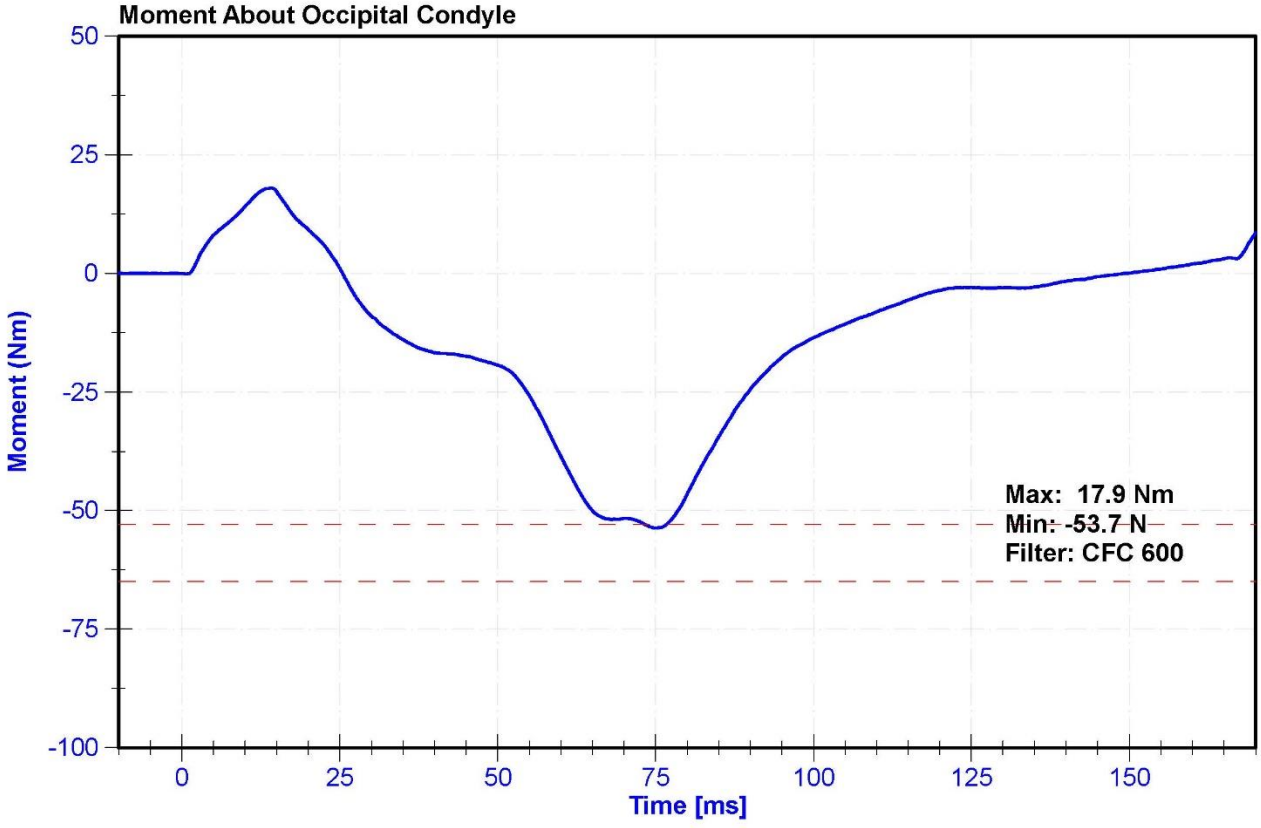
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	22.8	Pass
Velocity	5.95	6.19	m/s	6.136	Pass
Pendulum Impulse at 10ms	1.5	1.9	m/s	1.65	Pass
Pendulum Impulse at 20ms	3.1	3.9	m/s	3.39	Pass
Pendulum Impulse at 30ms	4.6	5.6	m/s	4.89	Pass
D Plane Rotation	99	114	deg	110.9	Pass
Moment During Rotation Interval	-65	-53	Nm	-53.7	Pass
Moment Decay to -10Nm	94	114	ms	106.3	Pass

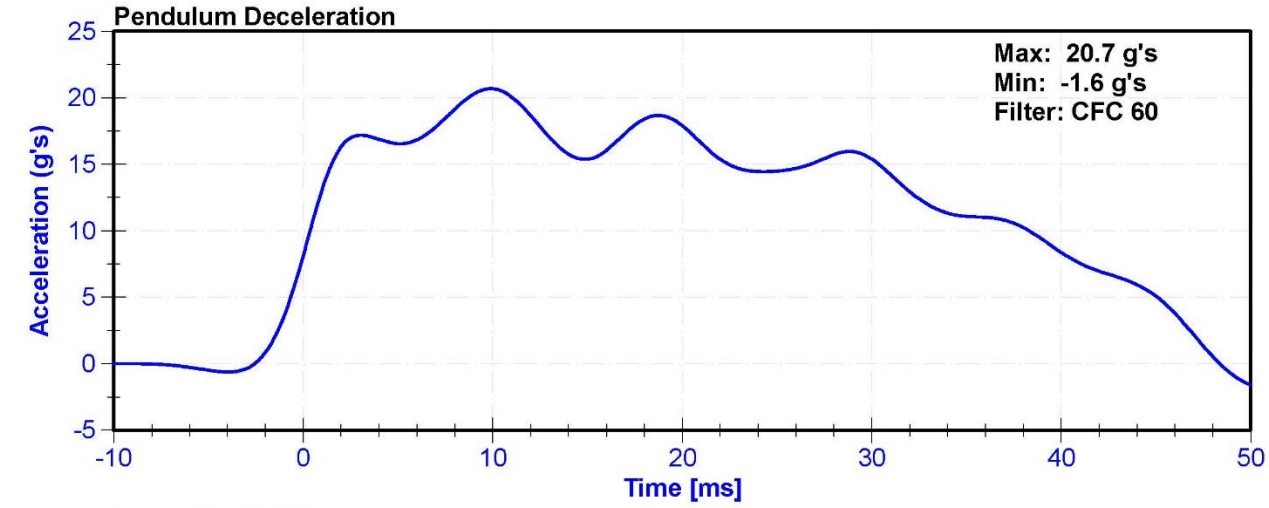
Transducer Calibrations

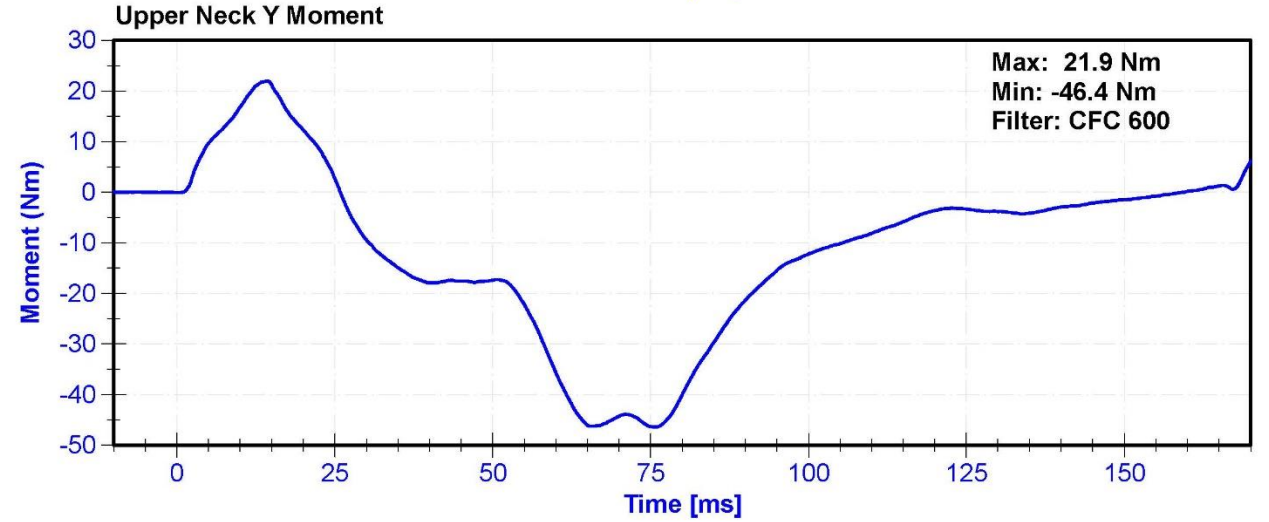
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	Denton	2184-FX	6/24/2021	6/24/2022

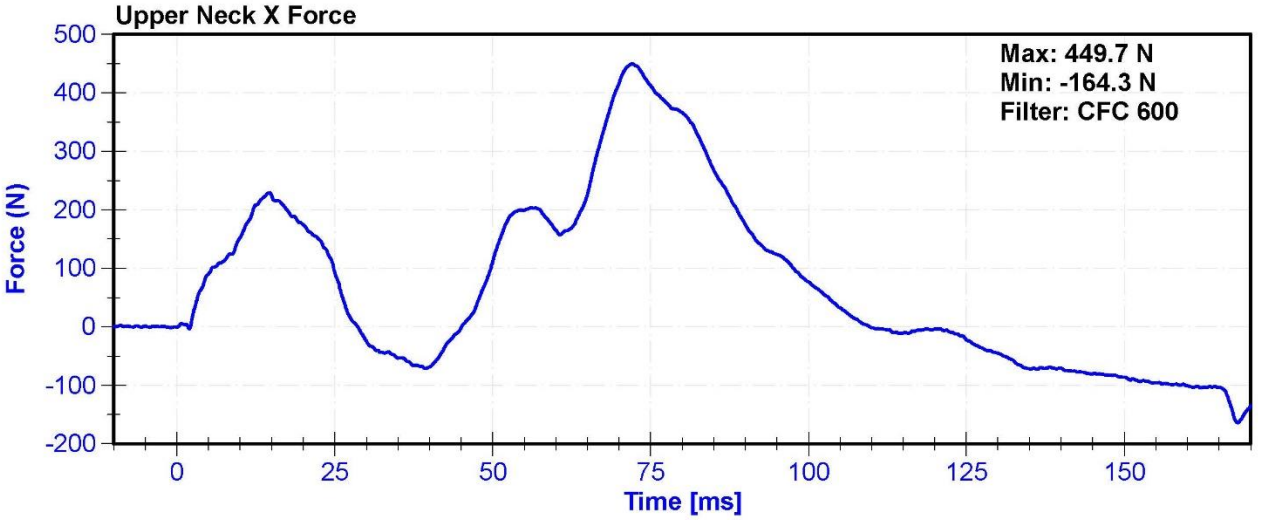



D-Plane Rotation
Rotation (deg)
125
100
75
50
25
0
-25
-50
0
25
50
75
100
125
150
Time [ms]
Max: 110.9 deg
Min: -8.4 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
50
25
0
-25
-50
-75
-100
0
25
50
75
100
125
150
Time [ms]
Max: 17.9 Nm
Min: -53.7 N
Filter: CFC 600


Pendulum Deceleration
Max: 20.7 g's
Min: -1.6 g's
Filter: CFC 60
Acceleration (g's)
25
20
15
10
5
0
-5
-10
0
10
20
30
40
50
Time [ms]


Upper Neck Y Moment
Max: 21.9 Nm
Min: -46.4 Nm
Filter: CFC 600
Moment (Nm)
30
20
10
0
-10
-20
-30
-40
-50
0
25
50
75
100
125
150
Time [ms]


Upper Neck X Force
Max: 449.7 N
Min: -164.3 N
Filter: CFC 600
Force (N)
500
400
300
200
100
0
-100
-200
0
25
50
75
100
125
150
Time [ms]

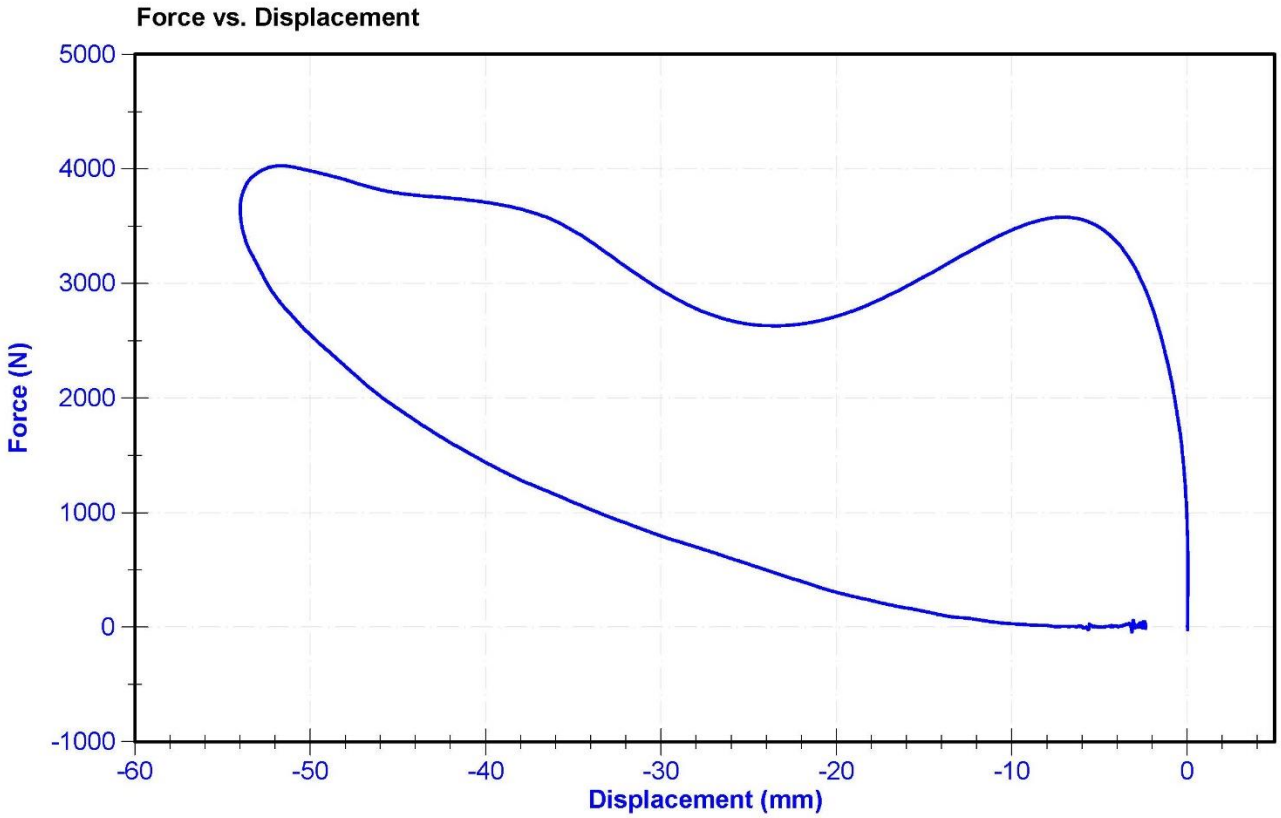
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

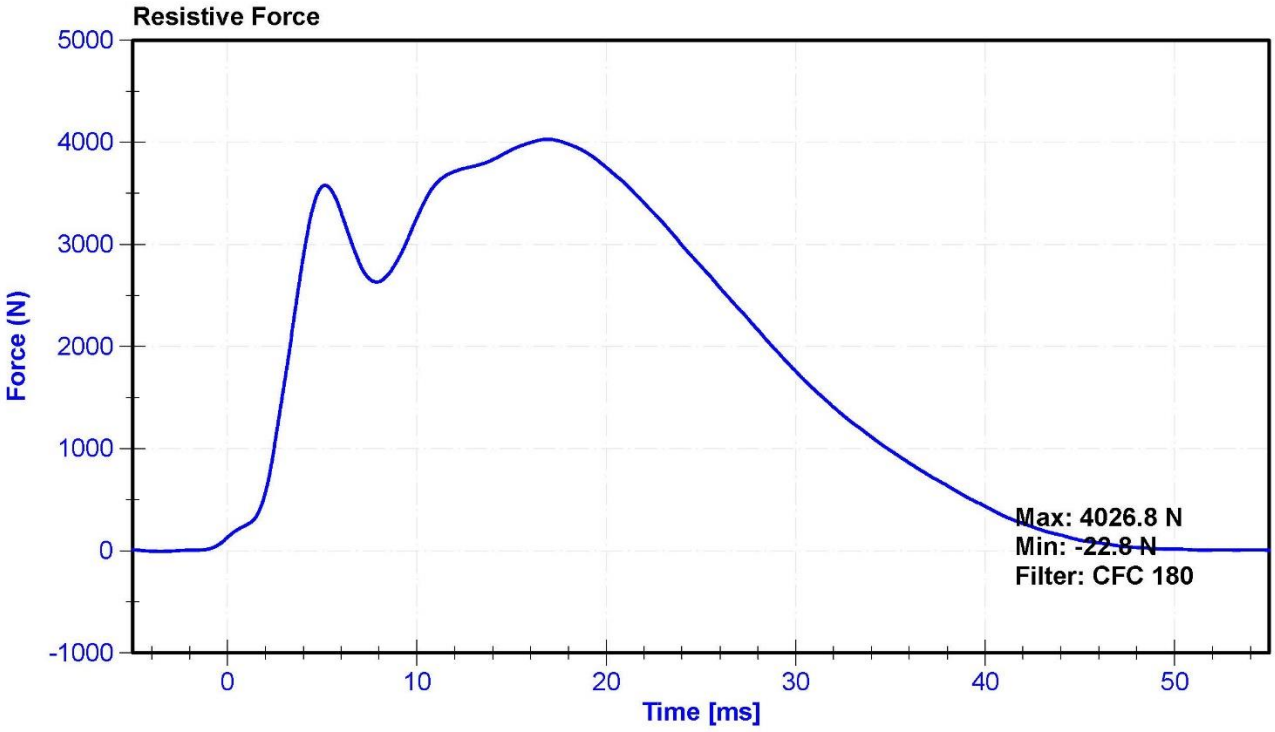
Results

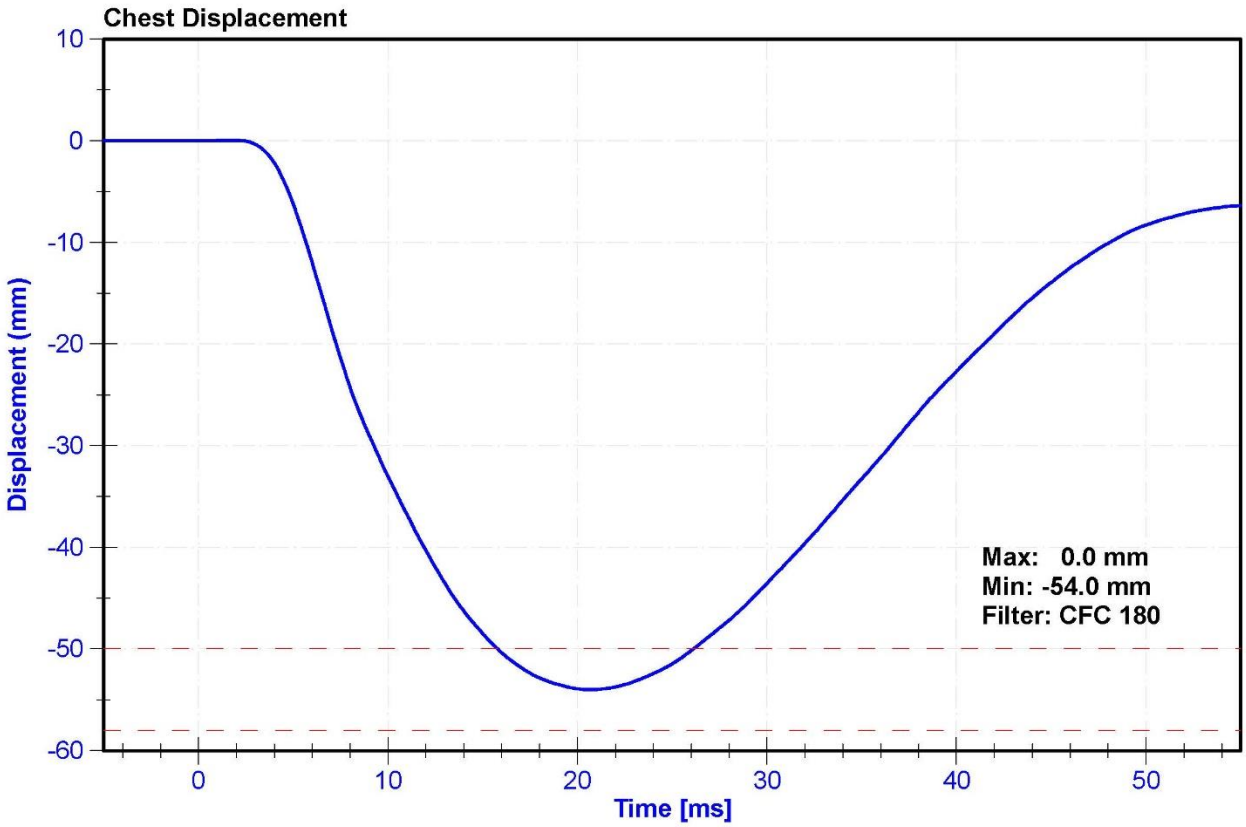
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	22.8	Pass
Velocity	6.59	6.83	m/s	6.733	Pass
Chest Deflection	-58	-50	mm	-54.0	Pass
Maximum Resistive Force (50 to 58mm)	3900	4400	N	4026.8	Pass
Maximum Resistive Force (18 to 50mm)	0	4600	N	3980.8	Pass
Hysteresis	69	85	%	72.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022
Chest Potentiometer	Servo	0720	10/28/2021	4/28/2022




Resistive Force
Force (N)
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]
Max: 4026.8 N
Min: -22.8 N
Filter: CFC 180


Chest Displacement
Displacement (mm)
10
0
-10
-20
-30
-40
-50
-60
0
10
20
30
40
50
Time [ms]
Max: 0.0 mm
Min: -54.0 mm
Filter: CFC 180

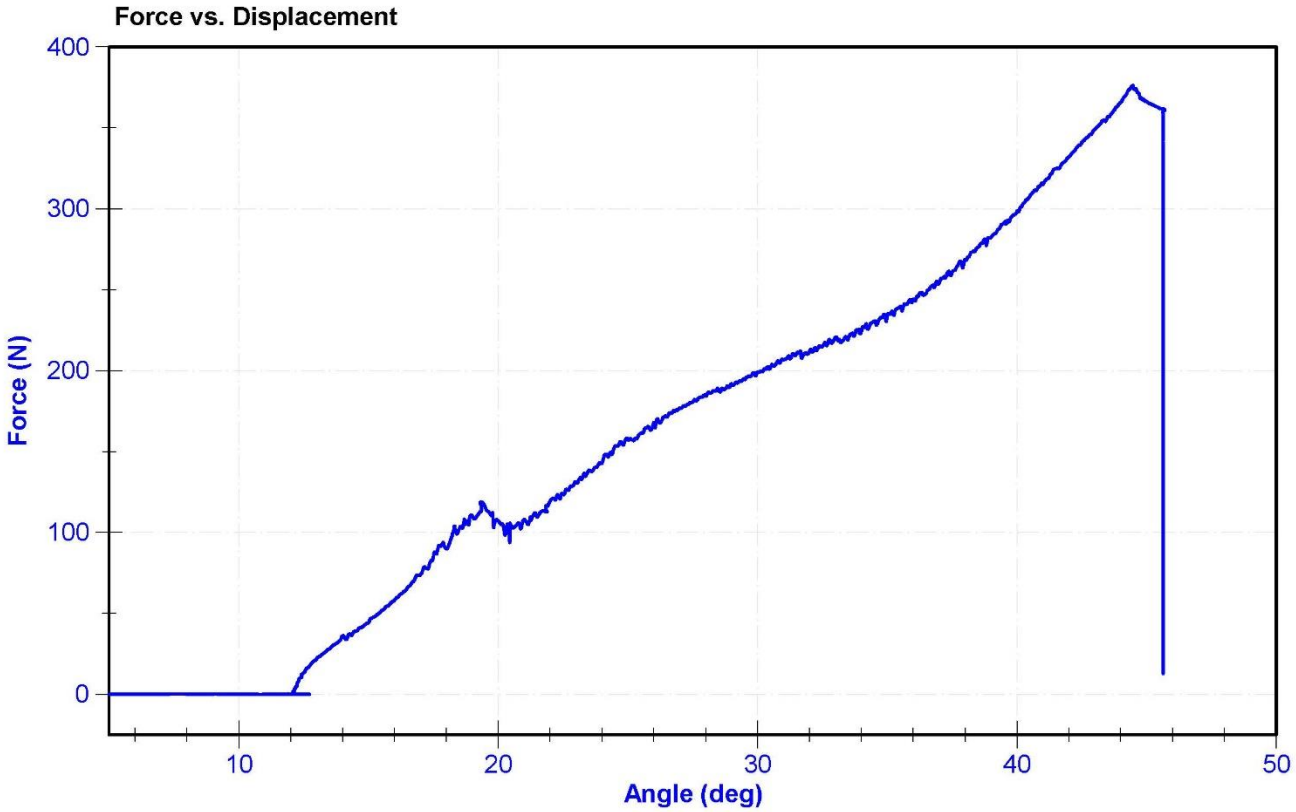
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

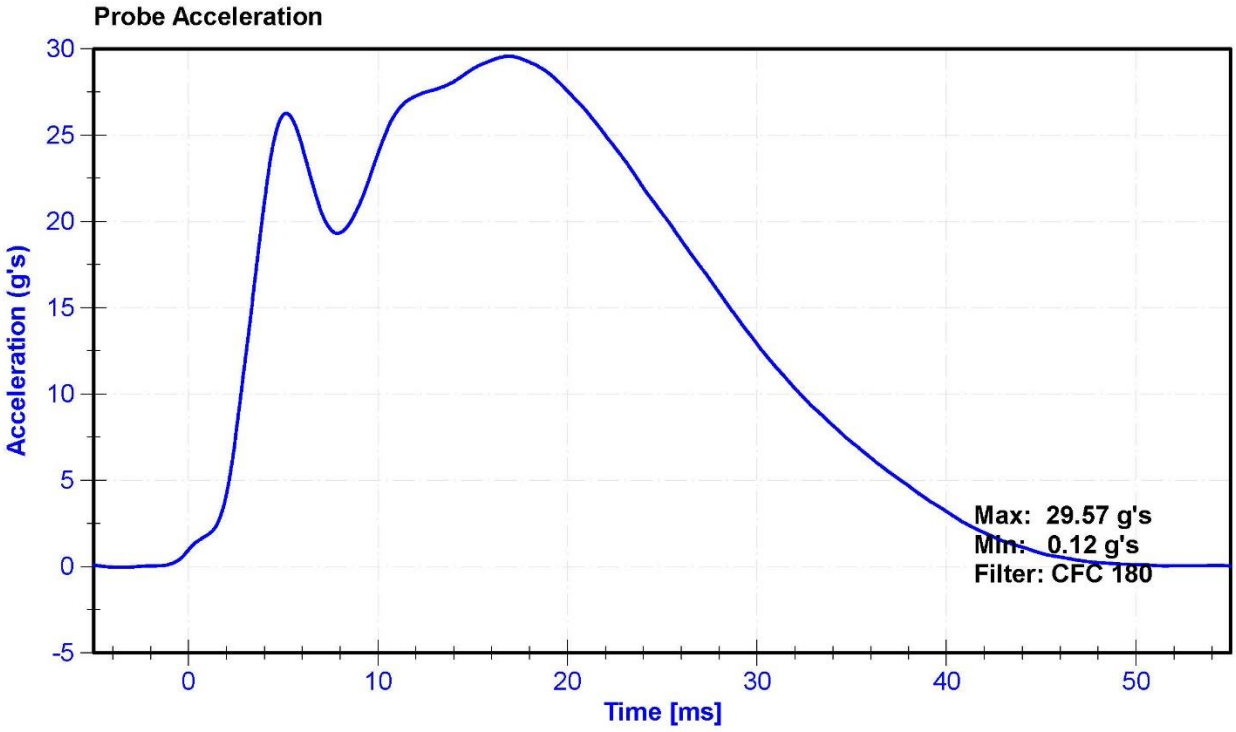
Results

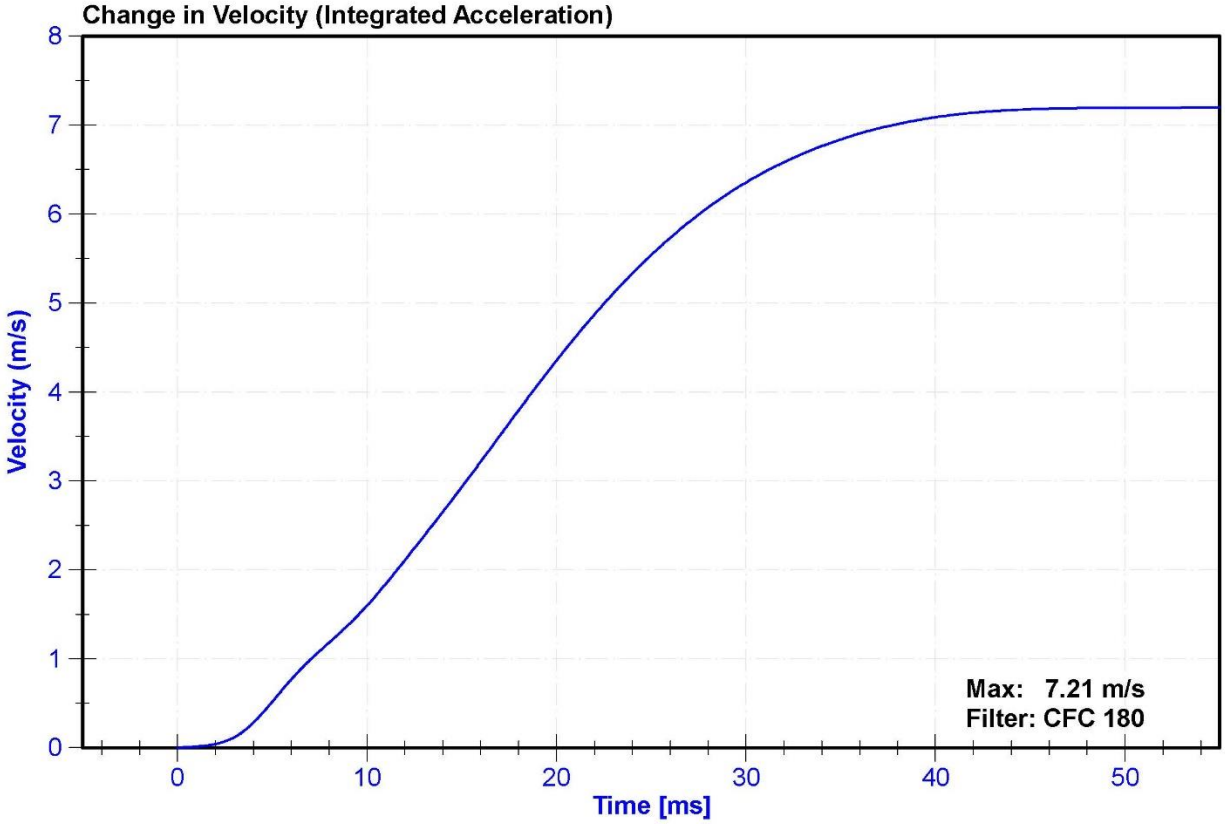
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.6	25.6	ºC	20.6	Pass
Humidity	10	70	%	23.6	Pass
Initial Angle	0	20	deg	11.8	Pass
Force at 45 Degrees	320	390	N	376.2	Pass
Return Angle Relative to Initial	0	8	deg	3.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	Rieker	DS-1905226	2021-11-01	2022-11-01
Load Cell	Interface	1134516	2021-08-27	2022-08-27




Probe Acceleration
Acceleration (g's)
30
25
20
15
10
5
0
-5
0
10
20
30
40
50
Time [ms]
Max: 29.57 g's
Min: 0.12 g's
Filter: CFC 180


Change in Velocity (Integrated Acceleration)
Velocity (m/s)
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
Time [ms]
Max: 7.21 m/s
Filter: CFC 180

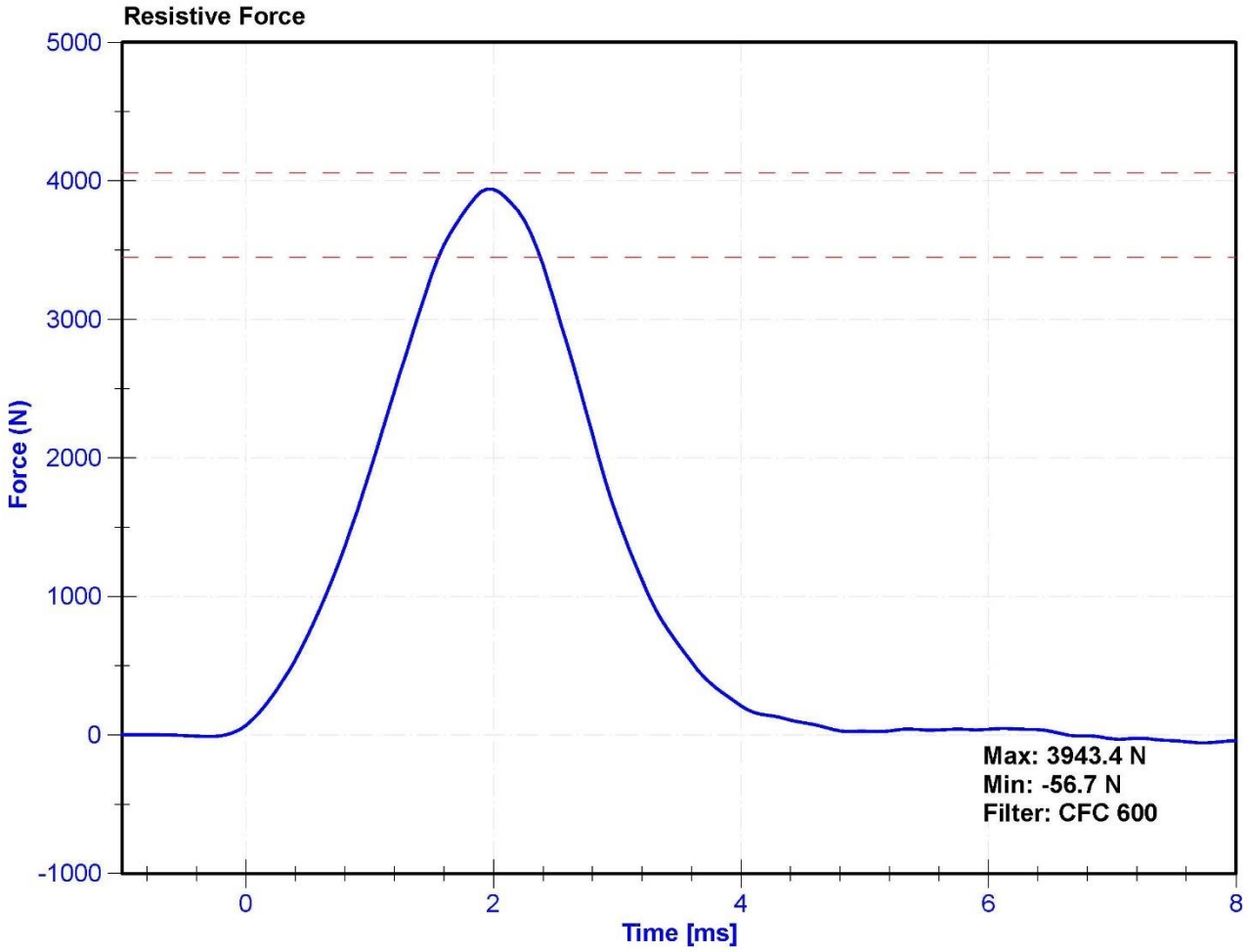
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

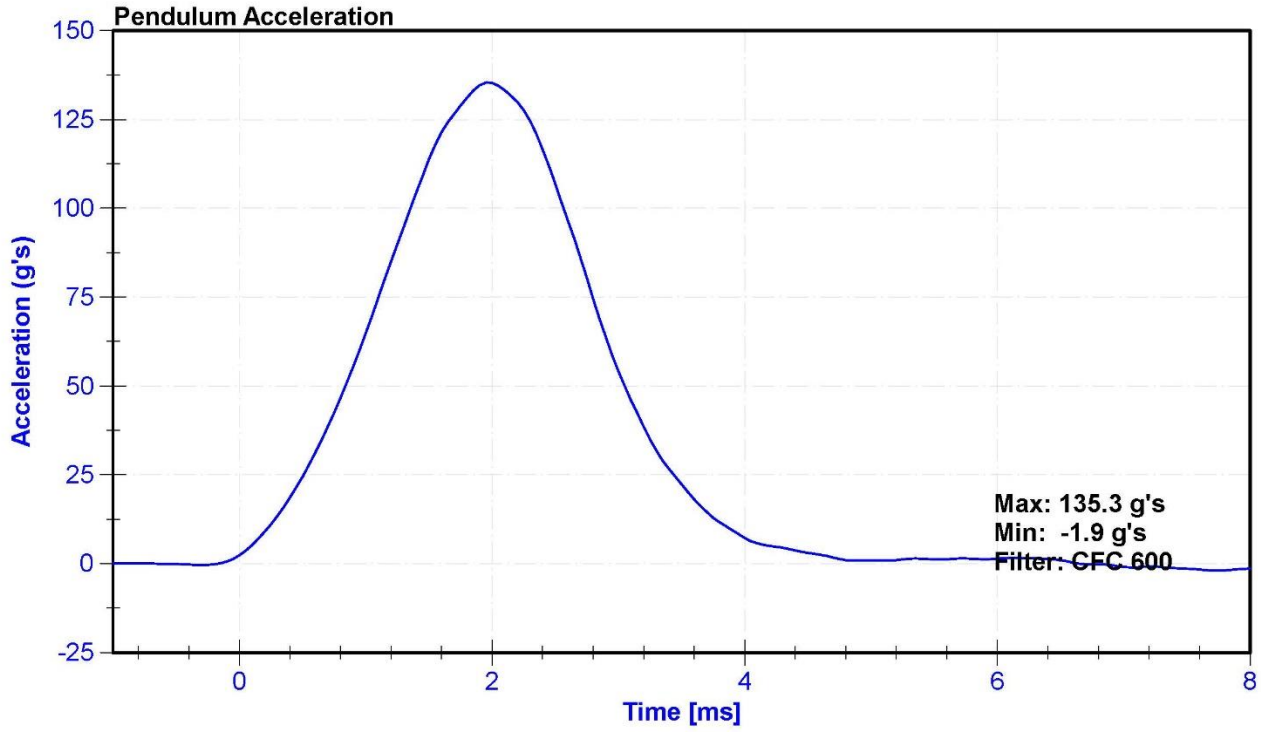
Results

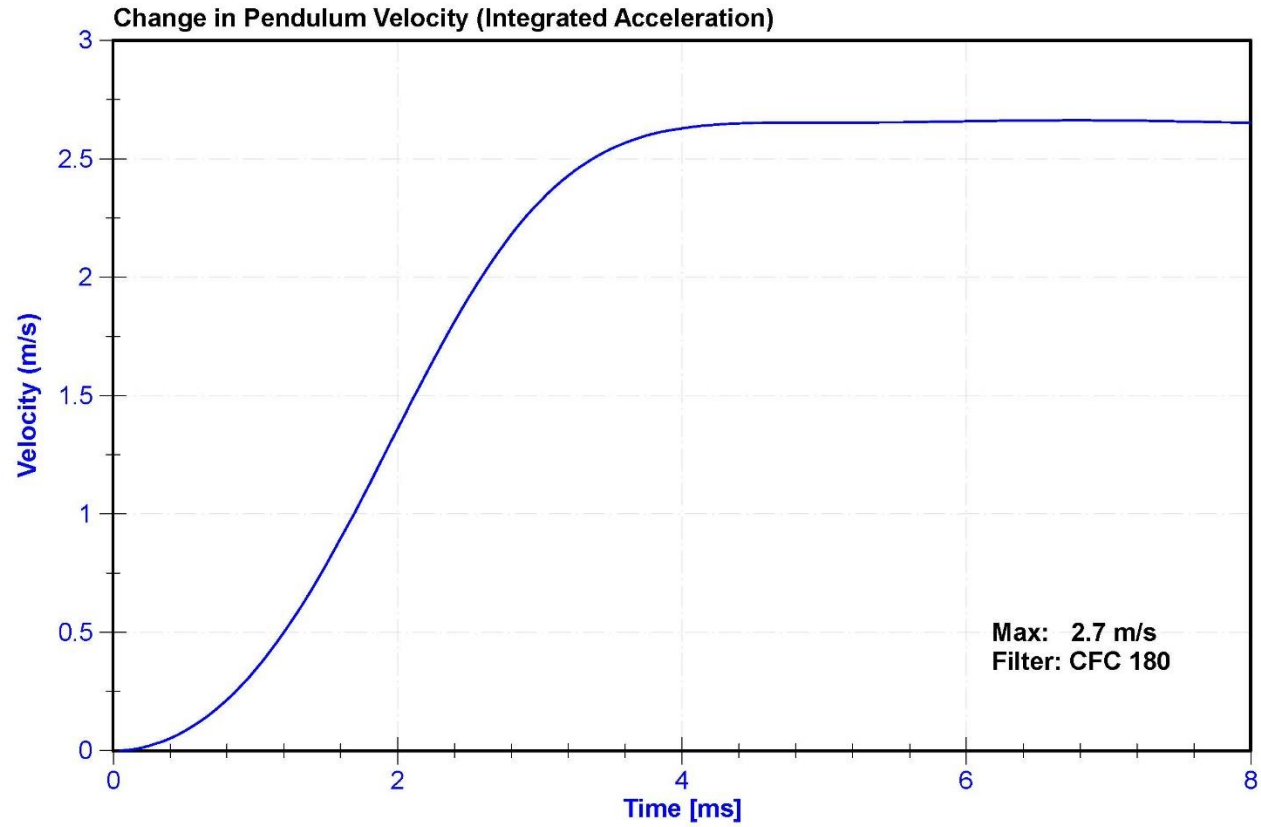
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.6	Pass
Humidity	10	70	%	24	Pass
Velocity	2.07	2.13	m/s	2.092	Pass
Resistive Force	3450	4060	N	3943.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	T25885	10/25/2021	4/23/2022




Pendulum Acceleration
Acceleration (g's)
150
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]
Max: 135.3 g's
Min: -1.9 g's
Filter: CFC 600


Change in Pendulum Velocity (Integrated Acceleration)
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]
Max: 2.7 m/s
Filter: CFC 180

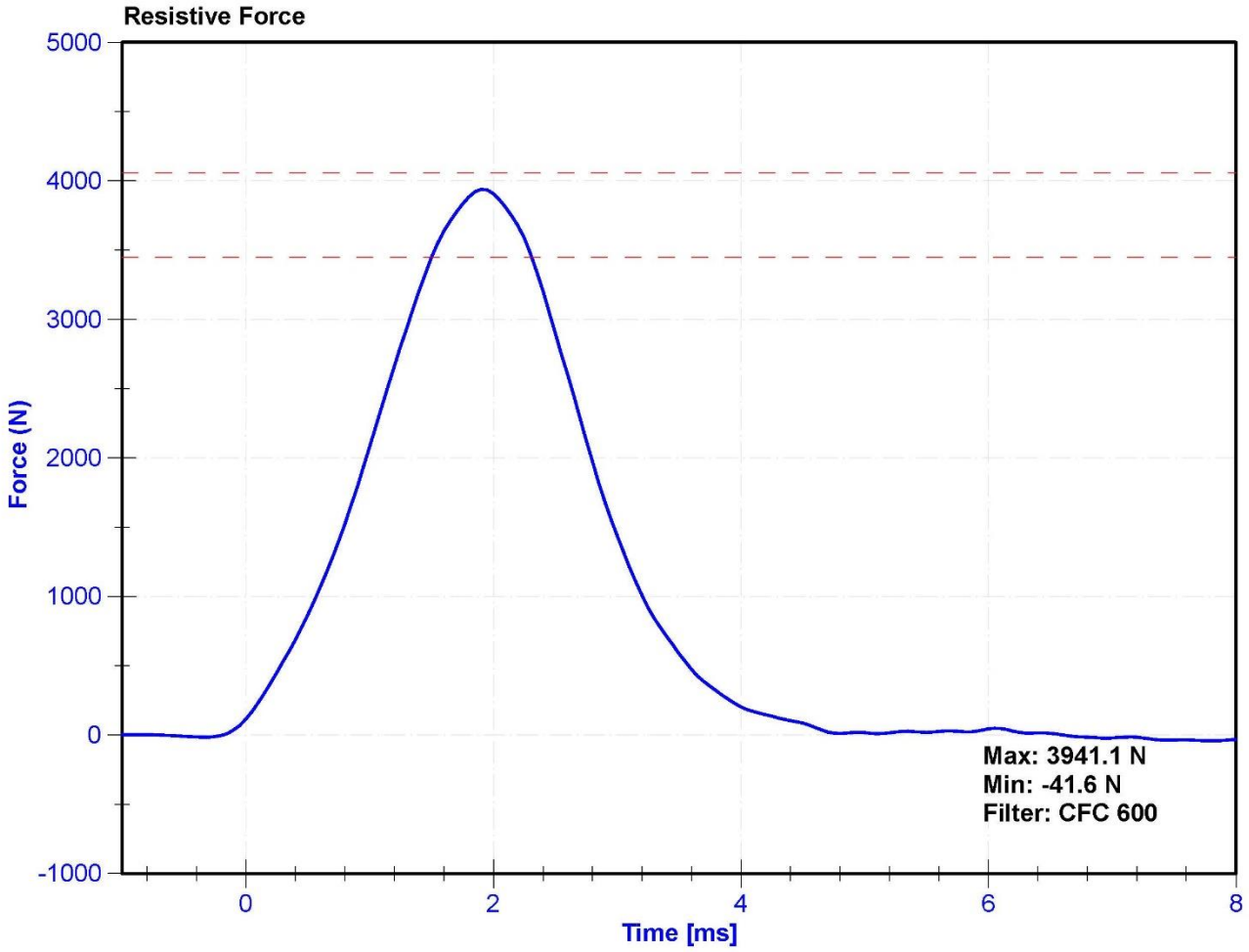
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

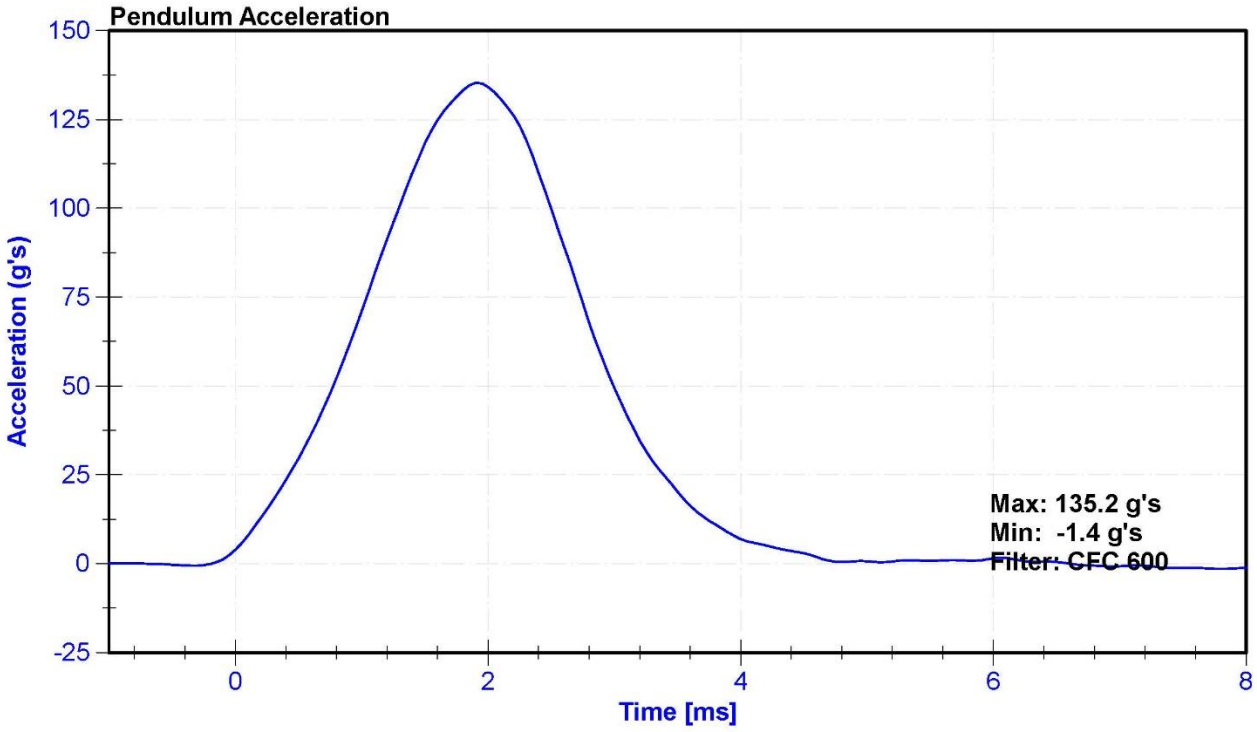
Results

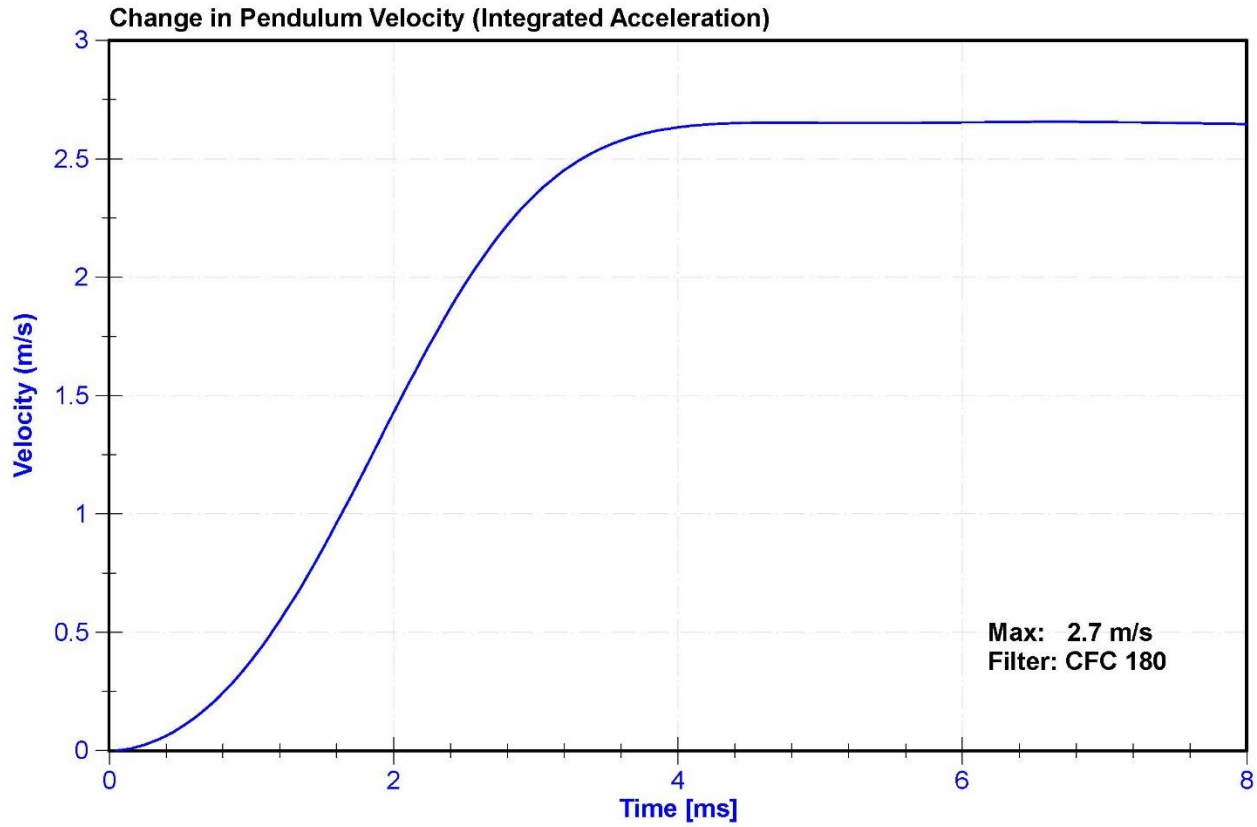
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	20.6	Pass
Humidity	10	70	%	24	Pass
Velocity	2.07	2.13	m/s	2.091	Pass
Resistive Force	3450	4060	N	3941.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	T25885	10/25/2021	4/23/2022




Pendulum Acceleration
Acceleration (g's)
150
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]
Max: 135.2 g's
Min: -1.4 g's
Filter: CFC 600


Change in Pendulum Velocity (Integrated Acceleration)
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]
Max: 2.7 m/s
Filter: CFC 180

CALIBRATION TEST RESULTS

POST-TEST

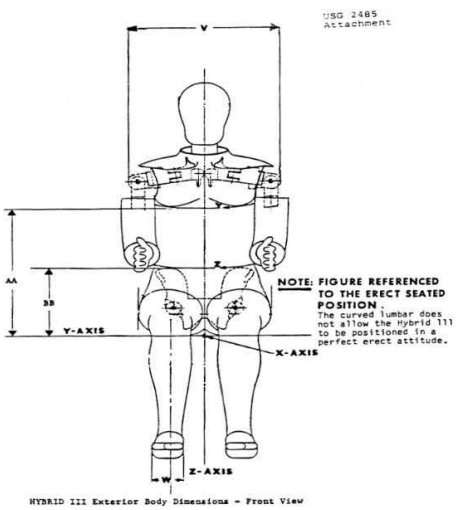
HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

SERIAL NO: 142

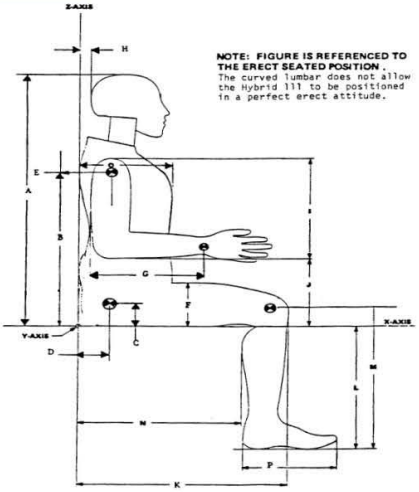
External Measurements - Hybrid 3 - 50th Male

Technician: K. Brogan Date: 03/19/2022

Dummy Serial Number: 142



HYBRID III Exterior Body Dimensions - Front View



HYBRID III Exterior Body Dimensions - Side View

Symbol	Description	Specification (in)		Result (in)	Pass/Fail
A	Sitting Height	34.6	35.0	34.8	Pass
B	Shoulder Pivot Height	19.9	20.5	20.2	Pass
C	H-Point Height	3.3	3.5	3.4	Pass
D	H-Point from Backline	5.3	5.5	5.4	Pass
E	Shoulder Pivot from Backline	3.3	3.7	3.5	Pass
F	Thigh Clearance	5.5	6.1	5.8	Pass
G	Back of Elbow to Wrist Pivot	11.4	12.0	11.8	Pass
H	Head Back to Backline	1.6	1.8	1.7	Pass
I	Shoulder to Elbow Length	13.0	13.6	13.5	Pass
J	Elbow Rest Height	7.5	8.3	8.1	Pass
K	Buttock to Knee Length	22.8	23.8	23.2	Pass
L	Popliteal Height	16.9	17.9	17.2	Pass
M	Knee Pivot Height	19.1	19.7	19.4	Pass
N	Buttock Popliteal Length	17.8	18.8	18.3	Pass
O	Chest Depth without Jacket	8.4	9.0	8.8	Pass
P	Foot Length (right)	9.9	10.5	10.2	Pass
V	Shoulder Breadth	16.3	17.2	16.8	Pass
W	Foot Breadth	3.6	4.2	3.8	Pass
Y	Chest Circumference with Jacket	38.2	39.4	39.0	Pass
Z	Waist Circumference	32.9	34.1	33.5	Pass
AA	Reference Location (Chest Circumference)	16.9	17.1	17.0	Pass
BB	Reference Location (Waist Circumference)	8.9	9.1	9.0	Pass

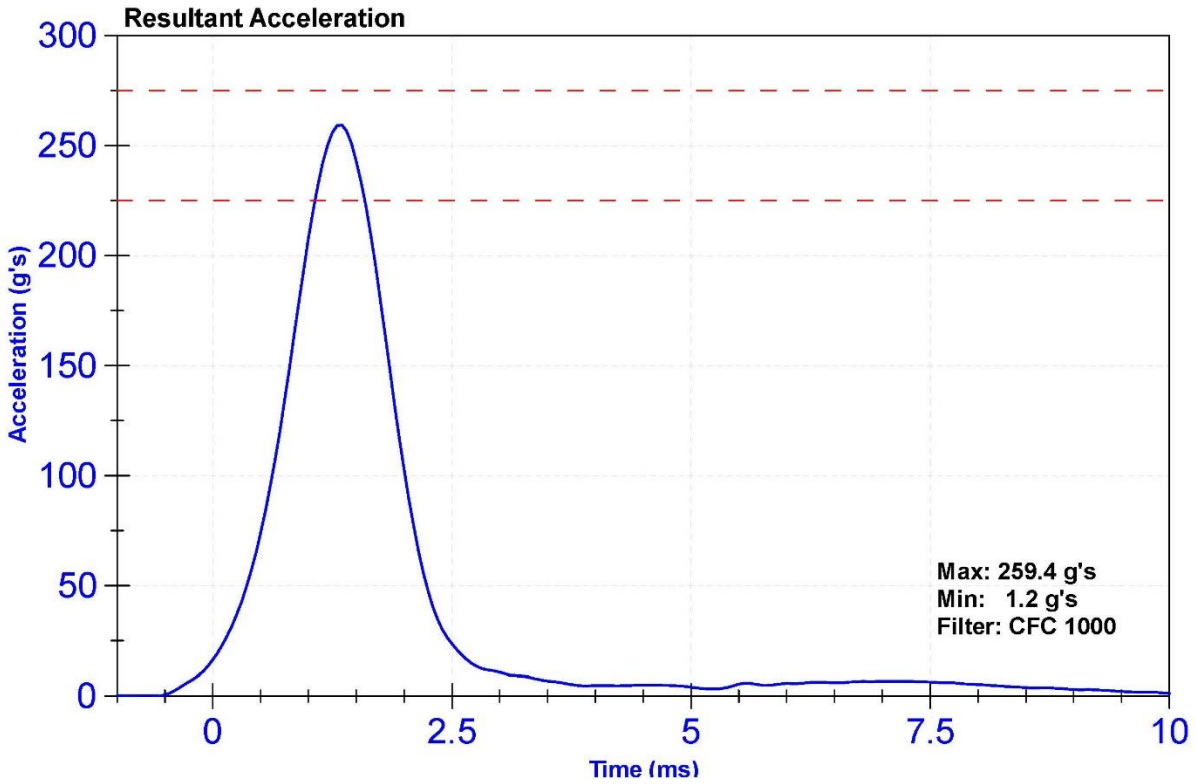
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

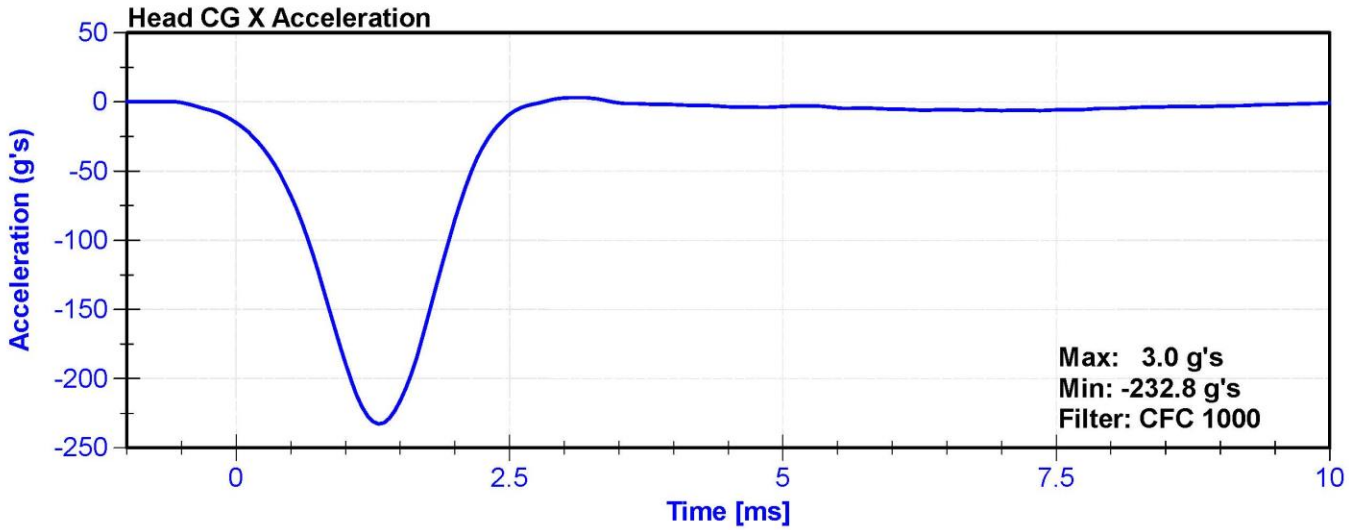
Results

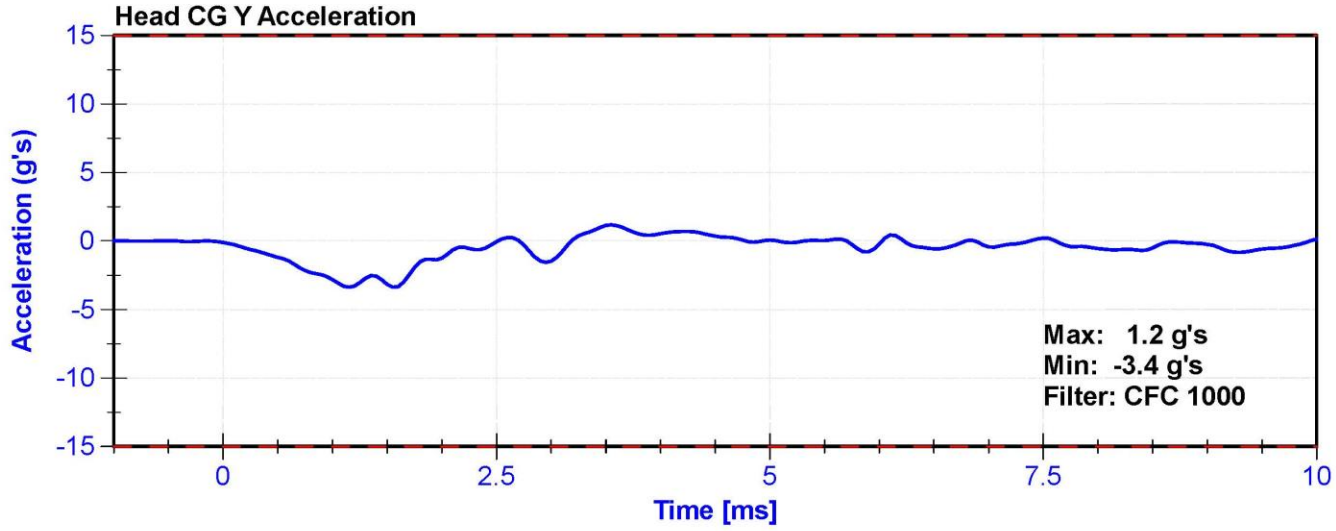
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Resultant Acceleration	225	275	g's	259.4	Pass
Oscillation	0	10	%	2.6	Pass
Lateral Acceleration	-15	15	g's	-3.4	Pass

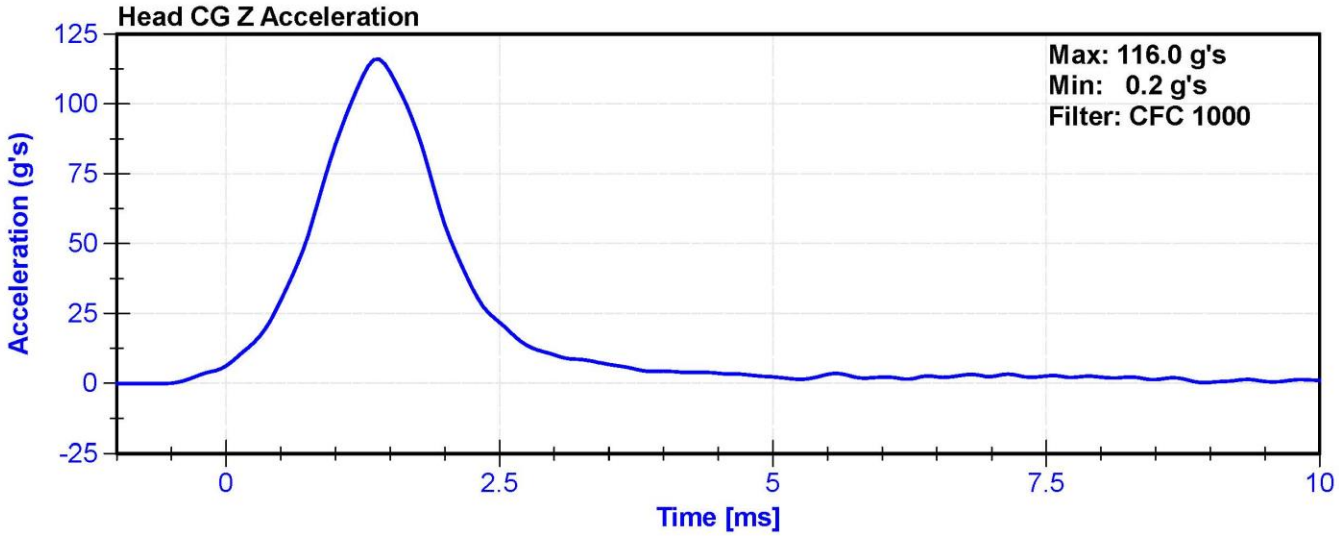
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P51681	11/16/2021	5/15/2022
Y Accelerometer	Endevco	P64151	11/16/2021	5/15/2022
Z Accelerometer	Endevco	P52114	11/16/2021	5/15/2022




Head CG X Acceleration
Acceleration (g's)
50
0
-50
-100
-150
-200
-250
0
2.5
5
7.5
10
Time [ms]
Max: 3.0 g's
Min: -232.8 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: 1.2 g's
Min: -3.4 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
125
100
75
50
25
0
-25
0
2.5
5
7.5
10
Time [ms]
Max: 116.0 g's
Min: 0.2 g's
Filter: CFC 1000

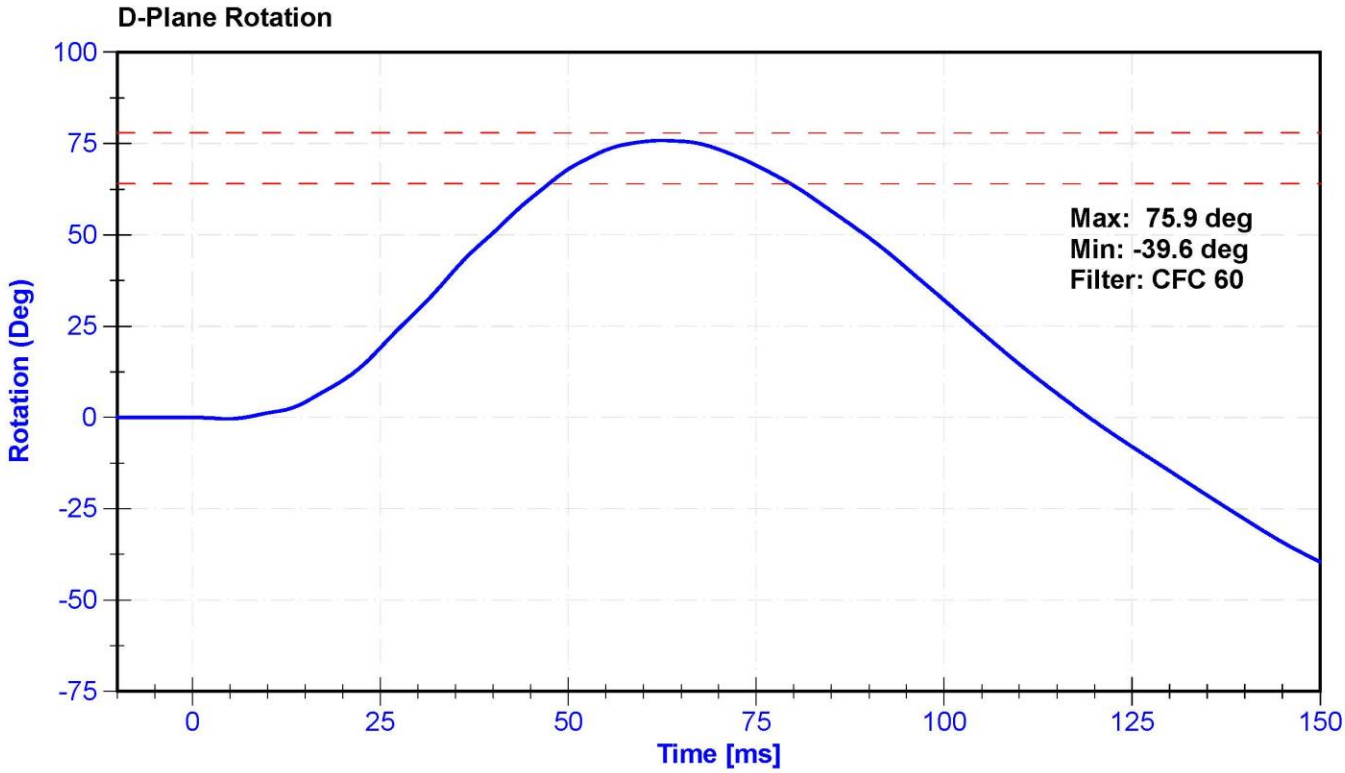
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

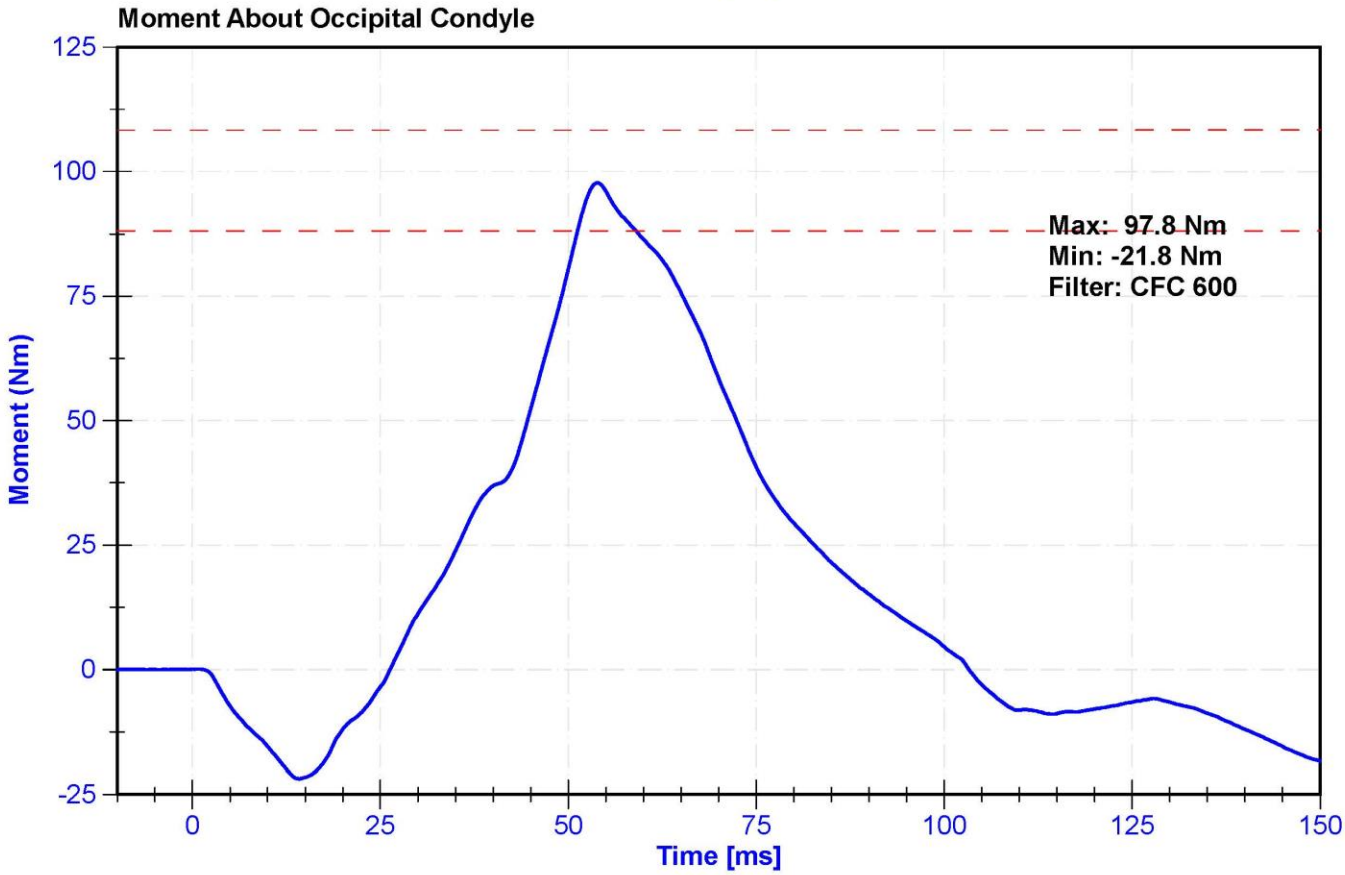
Results

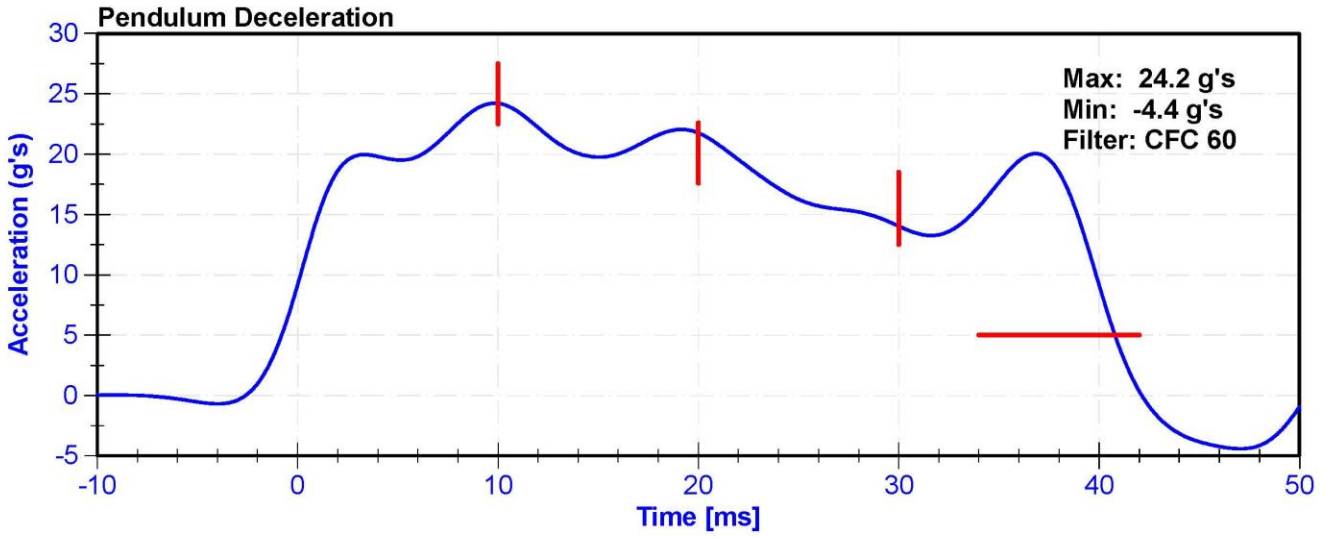
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Velocity	6.89	7.13	m/s	6.970	Pass
Pendulum Deceleration at 10ms	22.5	27.5	g's	24.21	Pass
Pendulum Deceleration at 20ms	17.6	22.6	g's	21.76	Pass
Pendulum Deceleration at 30ms	12.5	18.5	g's	14.03	Pass
Max. Pendulum Deceleration After 30ms	0	29	g's	24.2	Pass
Pendulum Deceleration Time to 5 g's	34	42	ms	40.8	Pass
Maximum D Plane Rotation	64	78	deg	75.9	Pass
Time to Maximum Rotation	57	64	ms	62.7	Pass
Rotation Decay to Zero	113	127	ms	119.3	Pass
Moment About Occipital Condyle	88.1	108.4	Nm	97.79	Pass
Time to Maximum Moment	47	58	ms	53.9	Pass
Moment Decay to Zero	97	107	ms	103.3	Pass

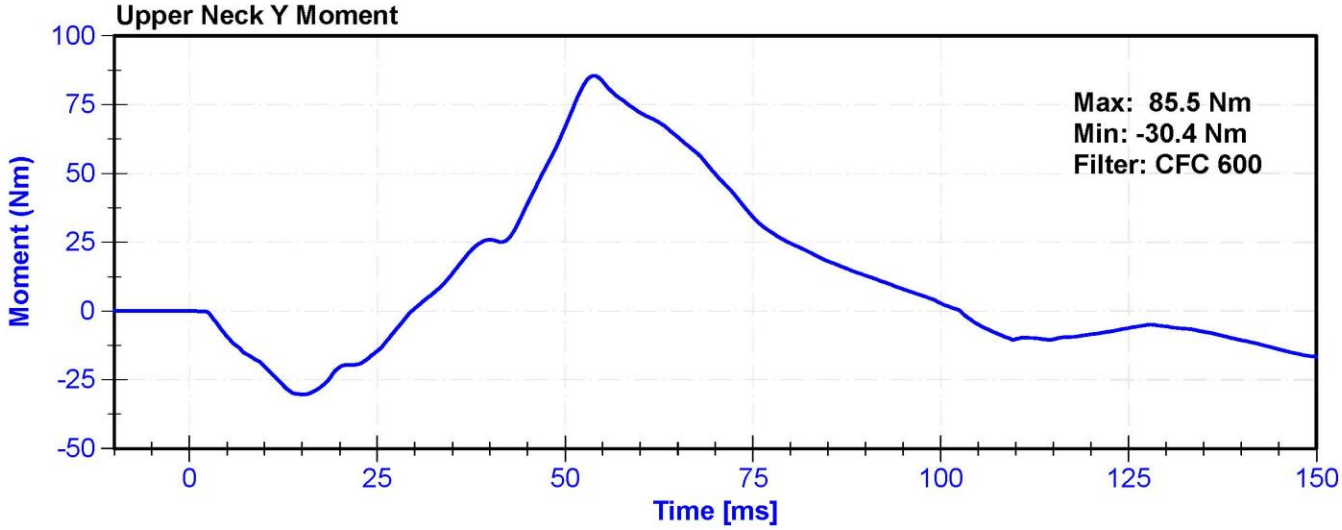
Transducer Calibrations

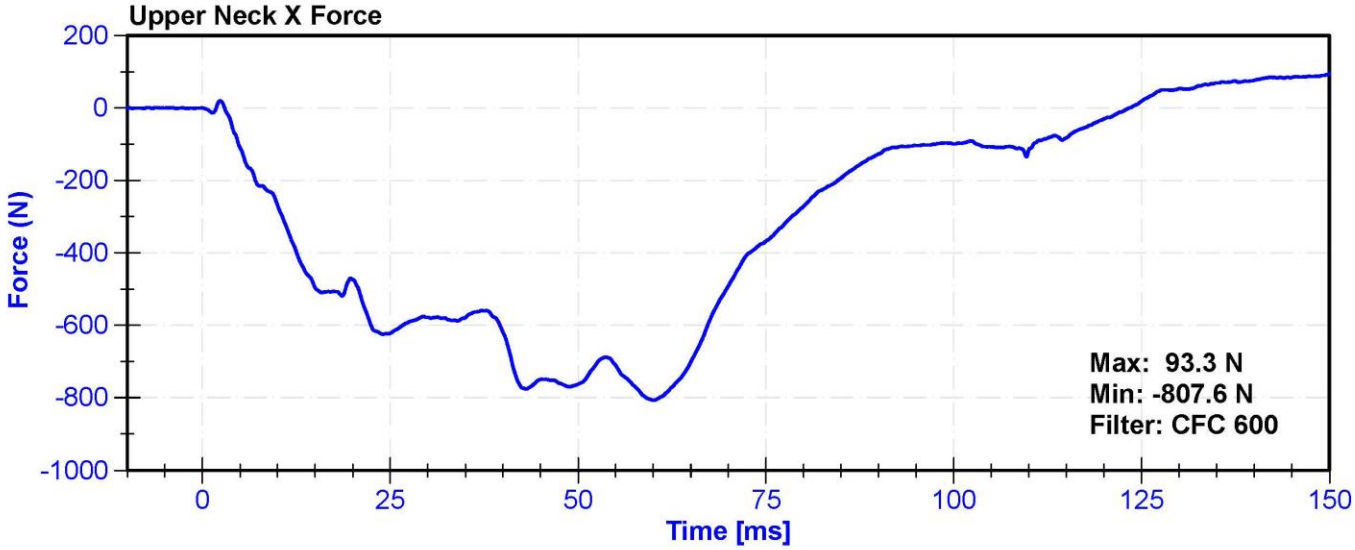
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231CT	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	FTSS	280-FX	9/14/2021	9/14/2022


D-Plane Rotation
Rotation (Deg)
100
75
50
25
0
-25
-50
-75
0
25
50
75
100
125
150
Time [ms]
Max: 75.9 deg
Min: -39.6 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
125
100
75
50
25
0
-25
0
25
50
75
100
125
150
Time [ms]
Max: 97.8 Nm
Min: -21.8 Nm
Filter: CFC 600


Pendulum Deceleration
Acceleration (g's)
Time [ms]
Max: 24.2 g's
Min: -4.4 g's
Filter: CFC 60


Upper Neck Y Moment
Moment (Nm)
Time [ms]
Max: 85.5 Nm
Min: -30.4 Nm
Filter: CFC 600


Upper Neck X Force
Force (N)
Time [ms]
Max: 93.3 N
Min: -807.6 N
Filter: CFC 600

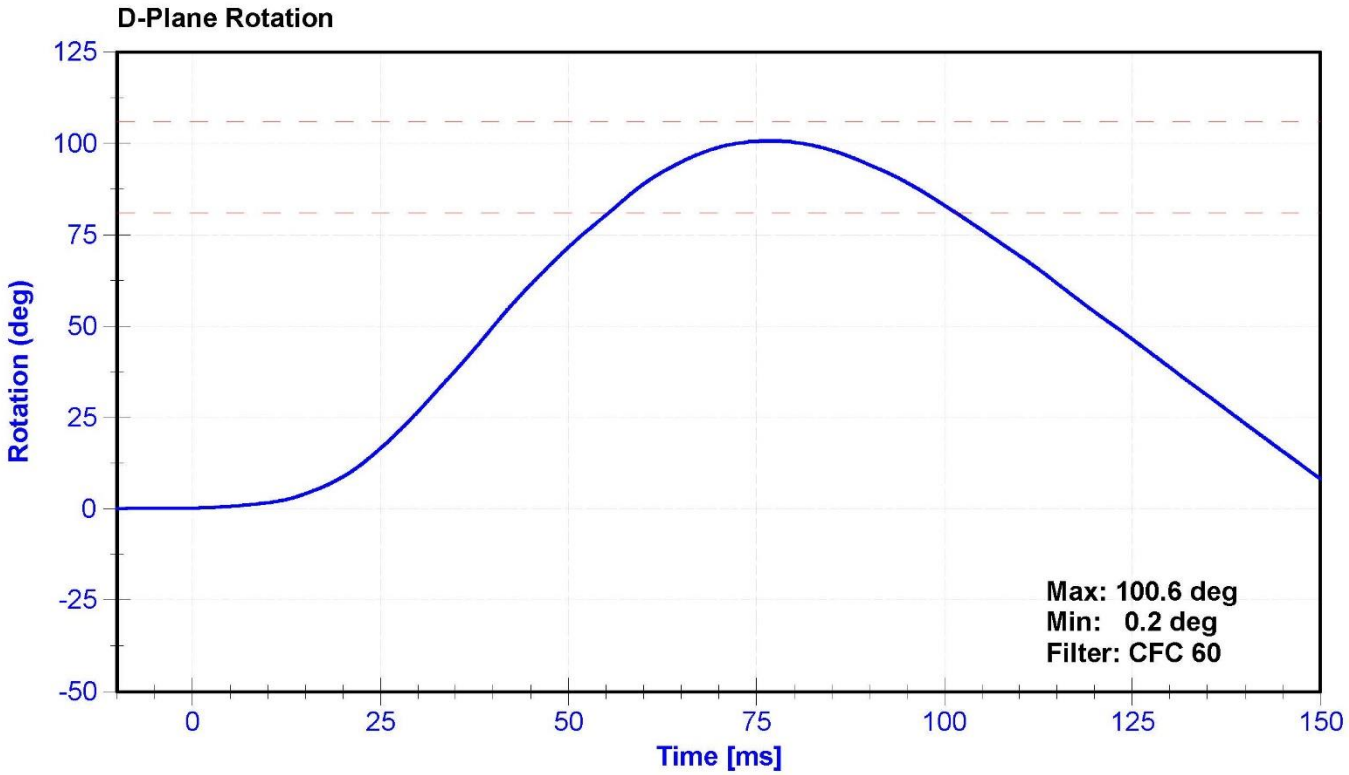
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

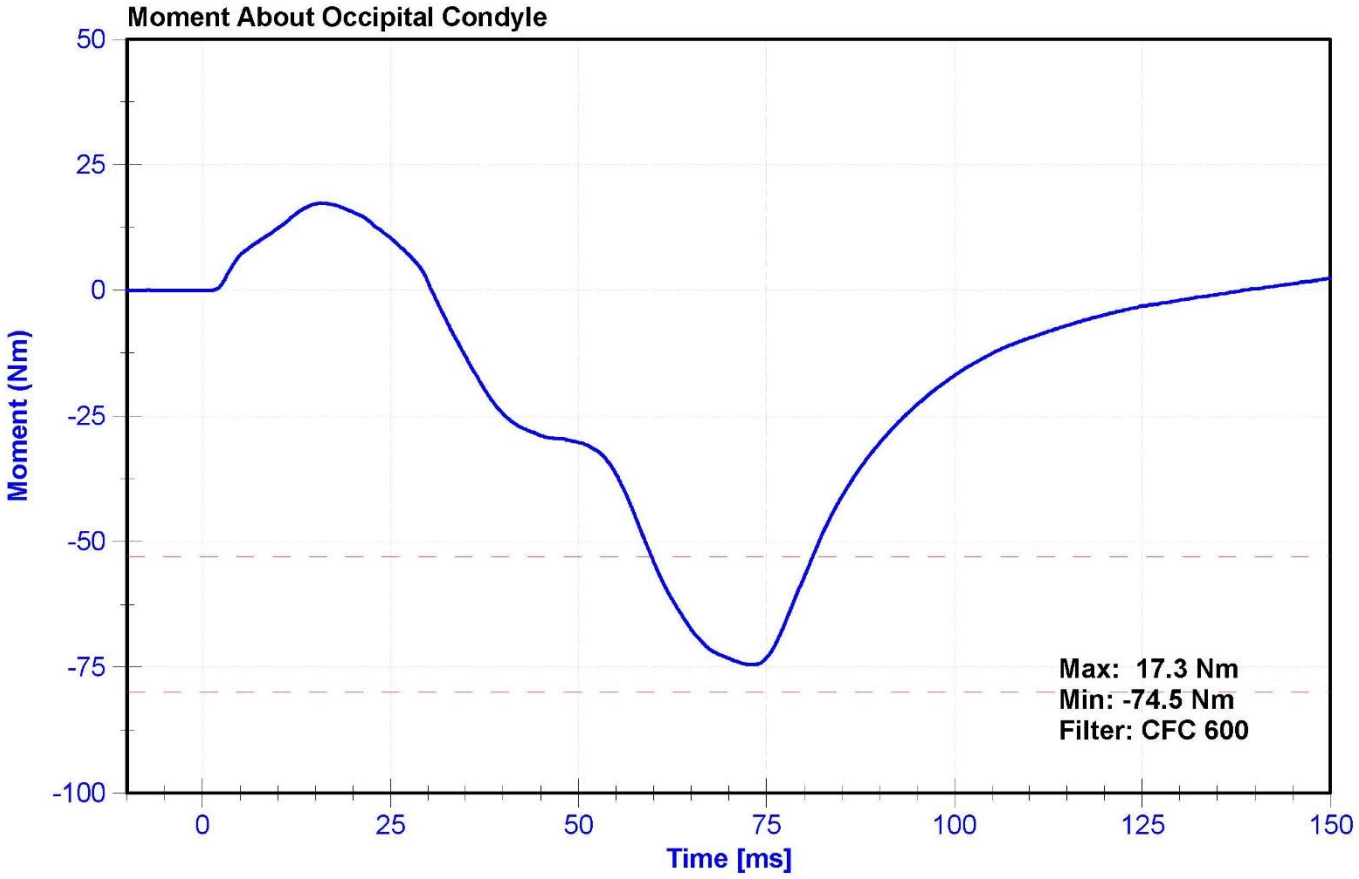
Results

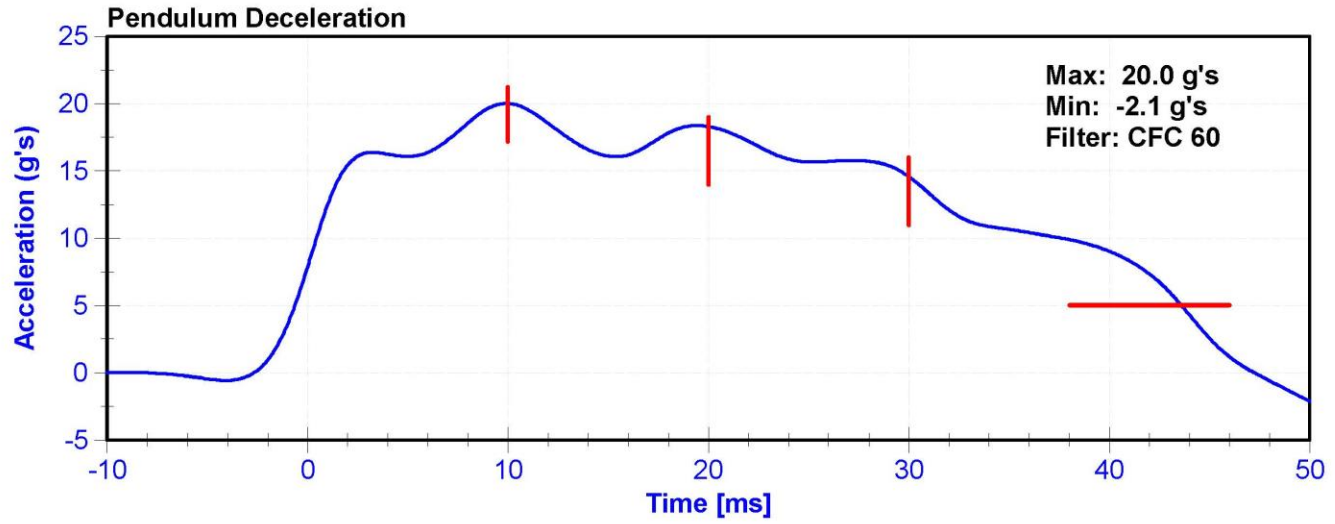
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Velocity	5.94	6.19	m/s	6.054	Pass
Pendulum Deceleration at 10ms	17.2	21.2	g's	20.01	Pass
Pendulum Deceleration at 20ms	14	19	g's	18.3	Pass
Pendulum Deceleration at 30ms	11	16	g's	14.6	Pass
Max. Pendulum Deceleration After 30ms	0	22	g's	20.0	Pass
Pendulum Deceleration Time to 5 g's	38	46	ms	43.6	Pass
Maximum D Plane Rotation	81	106	deg	100.6	Pass
Time to Maximum Rotation	72	82	ms	76.9	Pass
Rotation Decay to Zero	147	174	ms	155.7	Pass
Minimum Moment About OC	-80	-52.9	Nm	-74.45	Pass
Time to Minimum Moment	65	79	ms	73.1	Pass
Moment Decay to Zero	120	148	ms	138.3	Pass

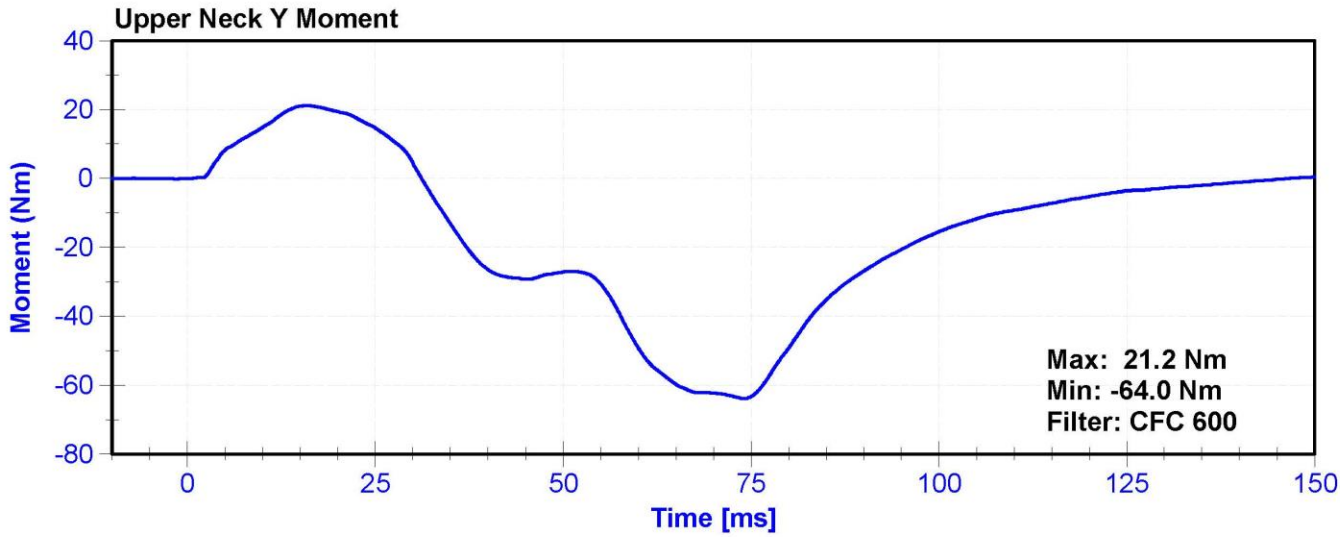
Transducer Calibrations

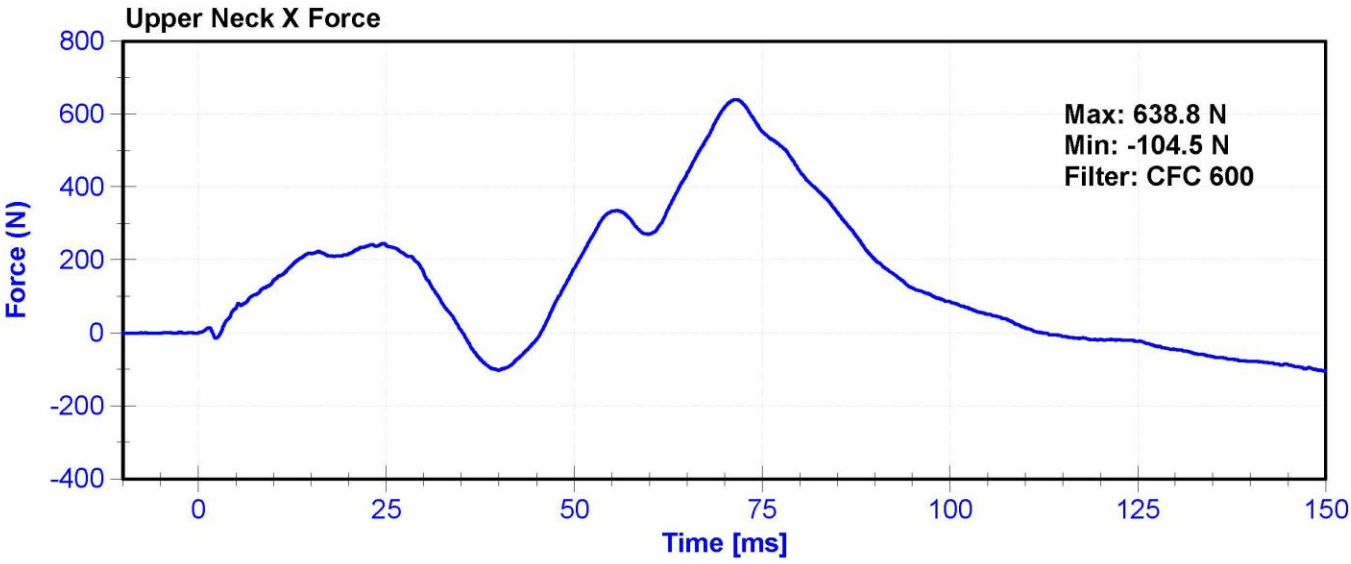
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	FTSS	280-FX	9/14/2021	9/14/2022


D-Plane Rotation
Rotation (deg)
125
100
75
50
25
0
-25
-50
0
25
50
75
100
125
150
Time [ms]
Max: 100.6 deg
Min: 0.2 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
50
25
0
-25
-50
-75
-100
0
25
50
75
100
125
150
Time [ms]
Max: 17.3 Nm
Min: -74.5 Nm
Filter: CFC 600


Pendulum Deceleration
Max: 20.0 g's
Min: -2.1 g's
Filter: CFC 60
Acceleration (g's)
Time [ms]


Upper Neck Y Moment
Max: 21.2 Nm
Min: -64.0 Nm
Filter: CFC 600
Moment (Nm)
Time [ms]


Upper Neck X Force
Max: 638.8 N
Min: -104.5 N
Filter: CFC 600
Force (N)
Time [ms]

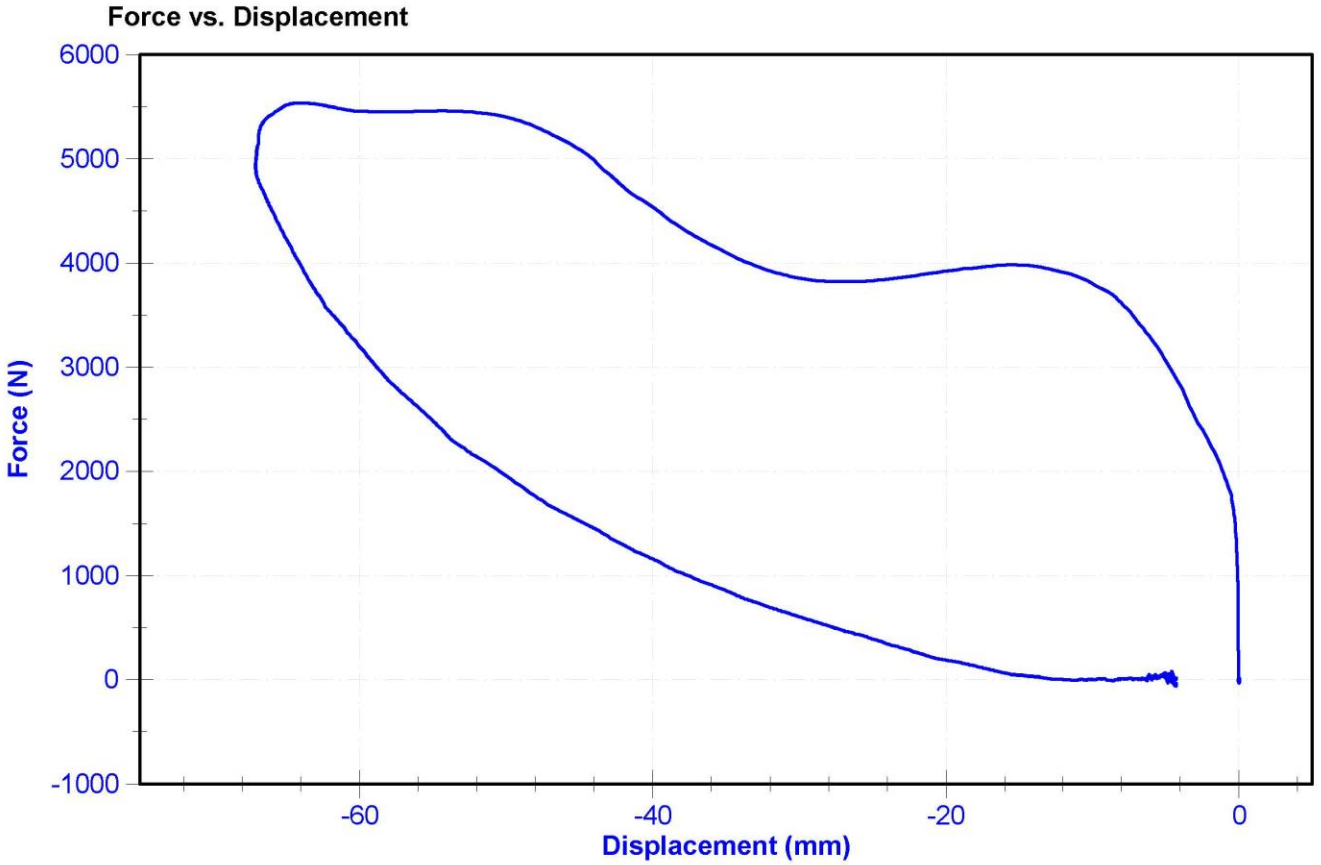
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

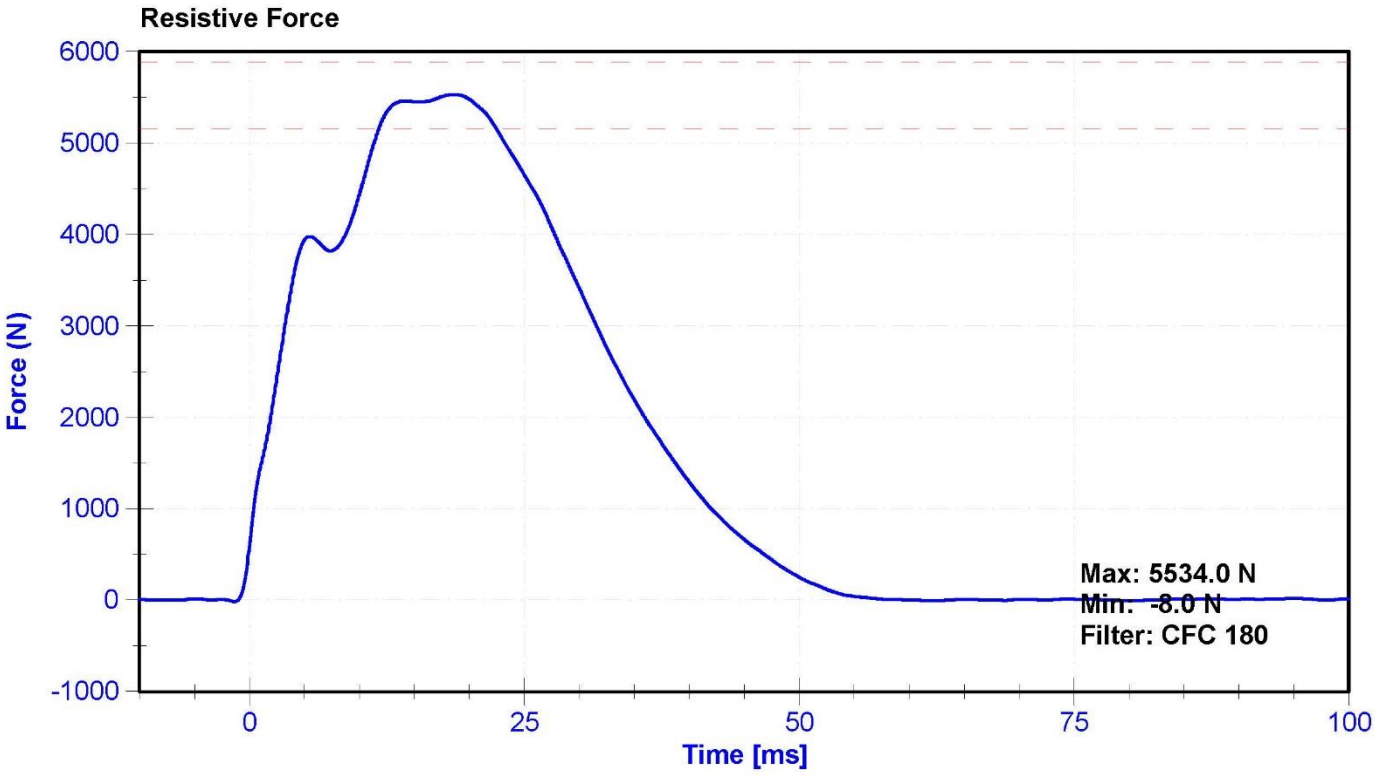
Results

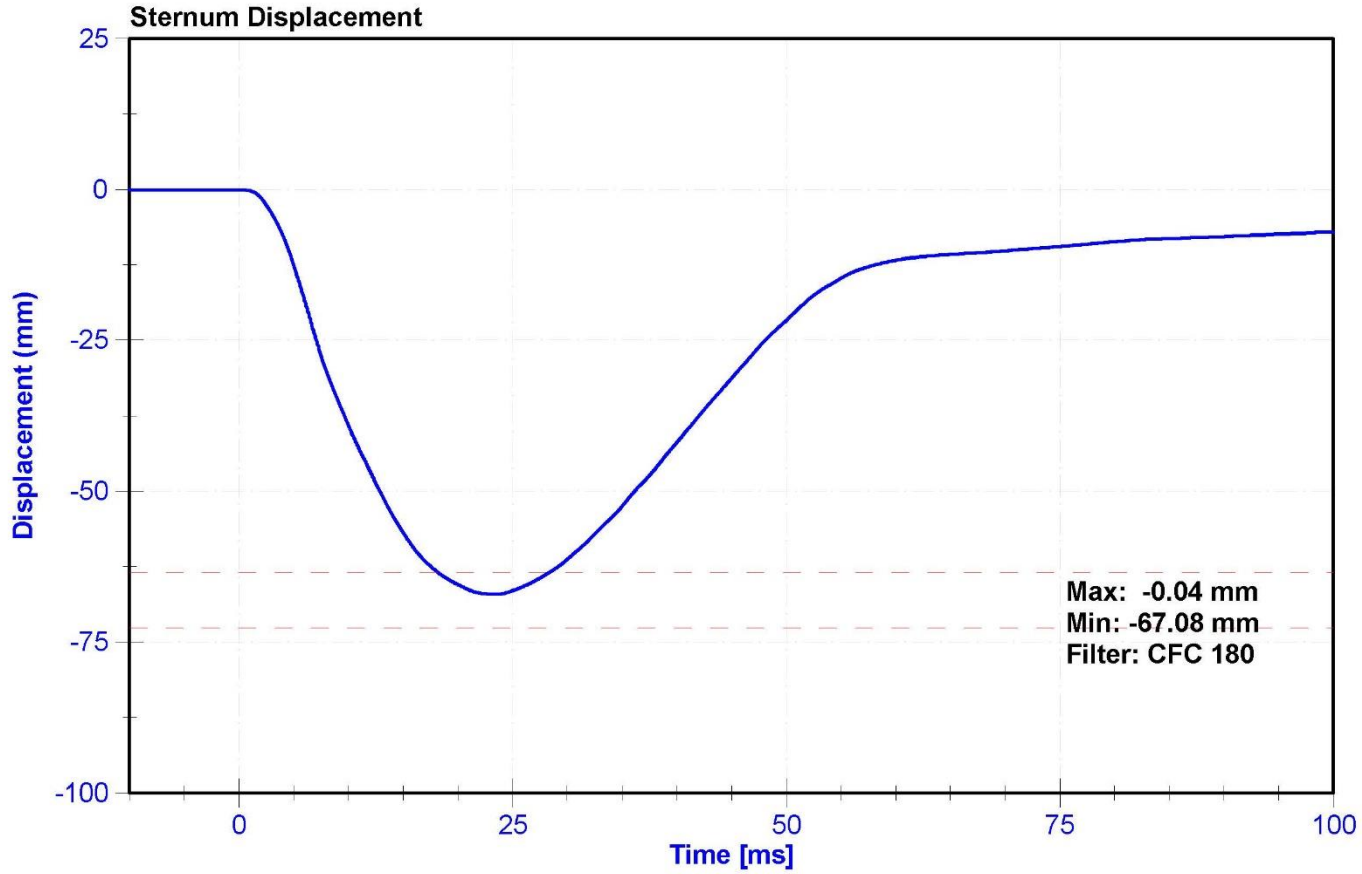
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	30.3	Pass
Velocity	6.59	6.83	m/s	6.670	Pass
Chest Displacement	-72.6	-63.5	mm	-67.08	Pass
Resistive Force	5160	5894	N	5534.0	Pass
Hysteresis	65	85	%	72.1	Pass

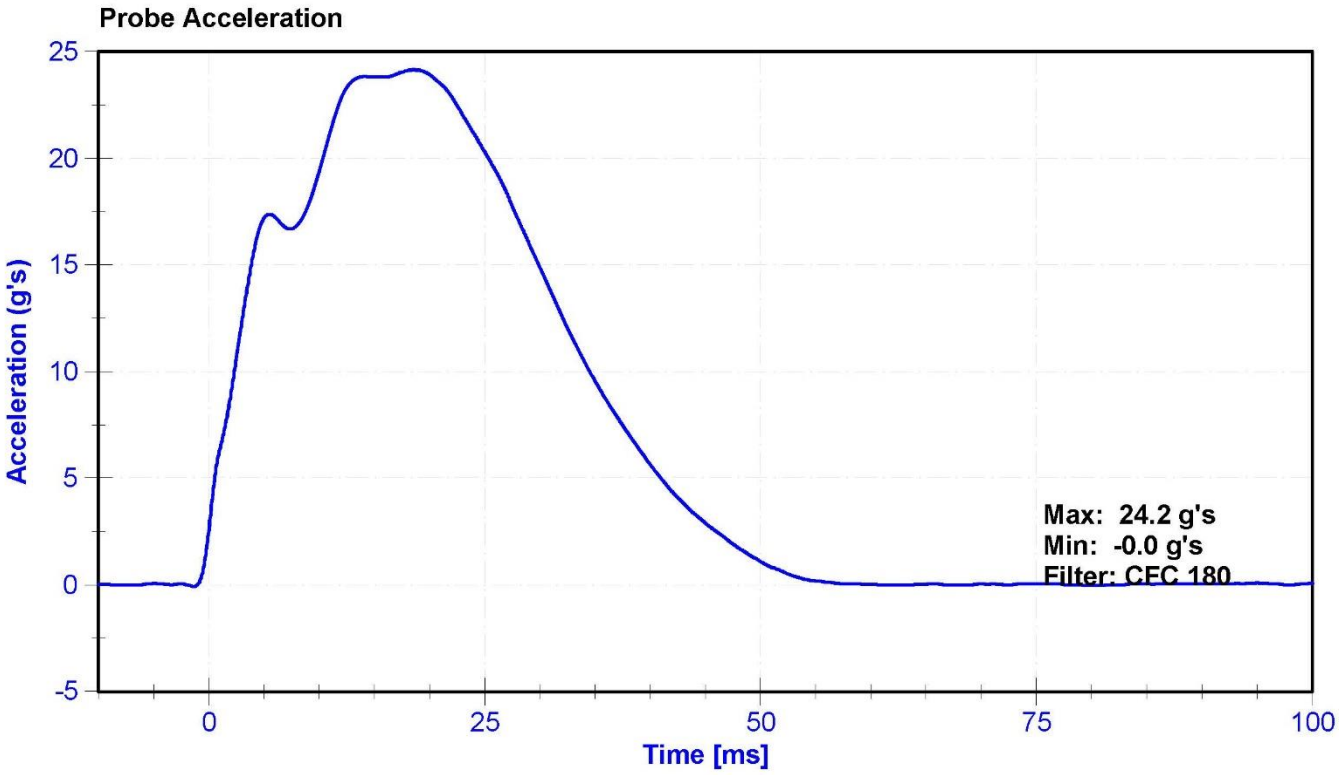
Transducer Calibrations

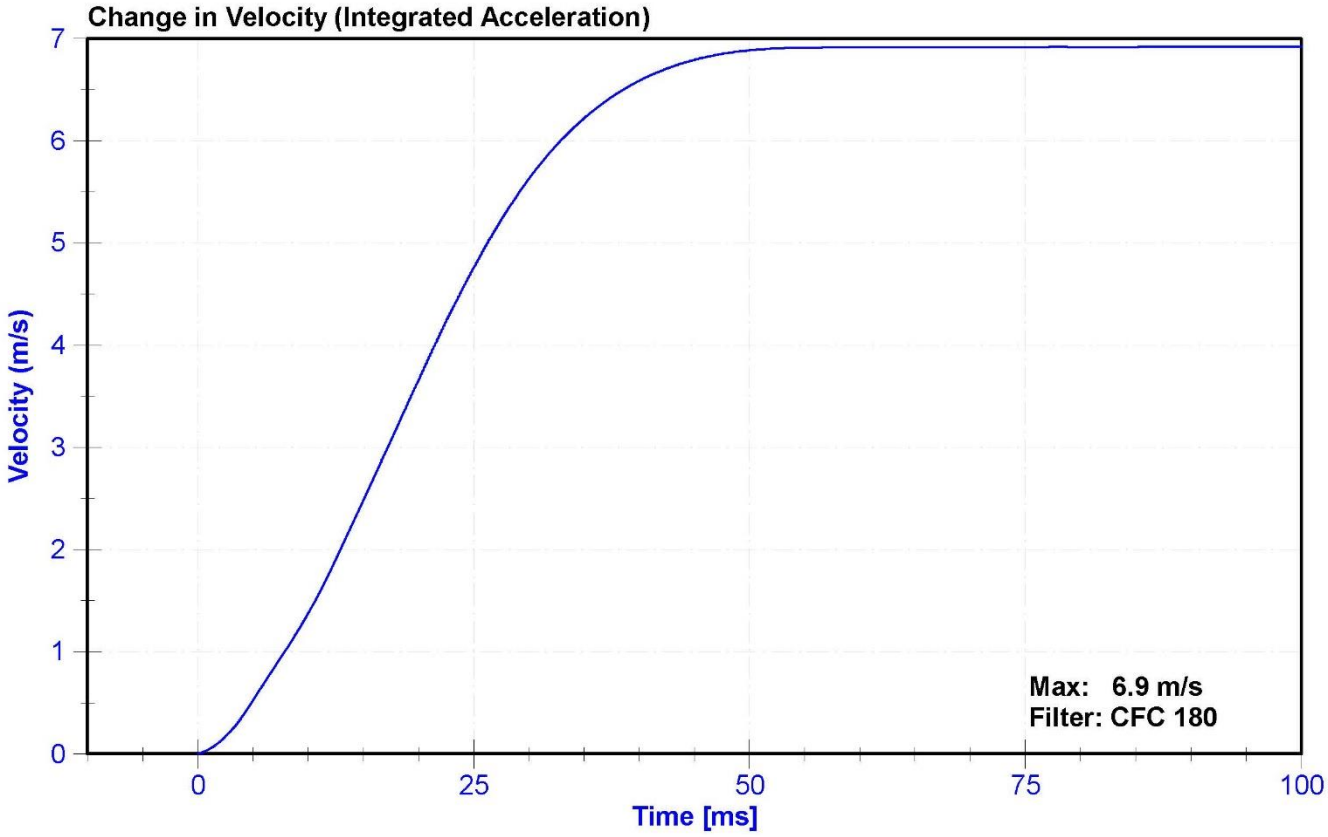
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022
Chest Potentiometer	Servo	142GFE	11/16/2021	5/17/2022




Resistive Force
6000
5000
4000
3000
2000
1000
0
-1000
Force (N)
0
25
50
75
100
Time [ms]
Max: 5534.0 N
Min: -8.0 N
Filter: CFC 180


Sternum Displacement
25
0
-25
-50
-75
-100
Displacement (mm)
0
25
50
75
100
Time [ms]
Max: -0.04 mm
Min: -67.08 mm
Filter: CFC 180


Probe Acceleration
Acceleration (g's)
25
20
15
10
5
0
-5
0
25
50
75
100
Time [ms]
Max: 24.2 g's
Min: -0.0 g's
Filter: CFC 180


Change in Velocity (Integrated Acceleration)
Velocity (m/s)
7
6
5
4
3
2
1
0
0
25
50
75
100
Time [ms]
Max: 6.9 m/s
Filter: CFC 180

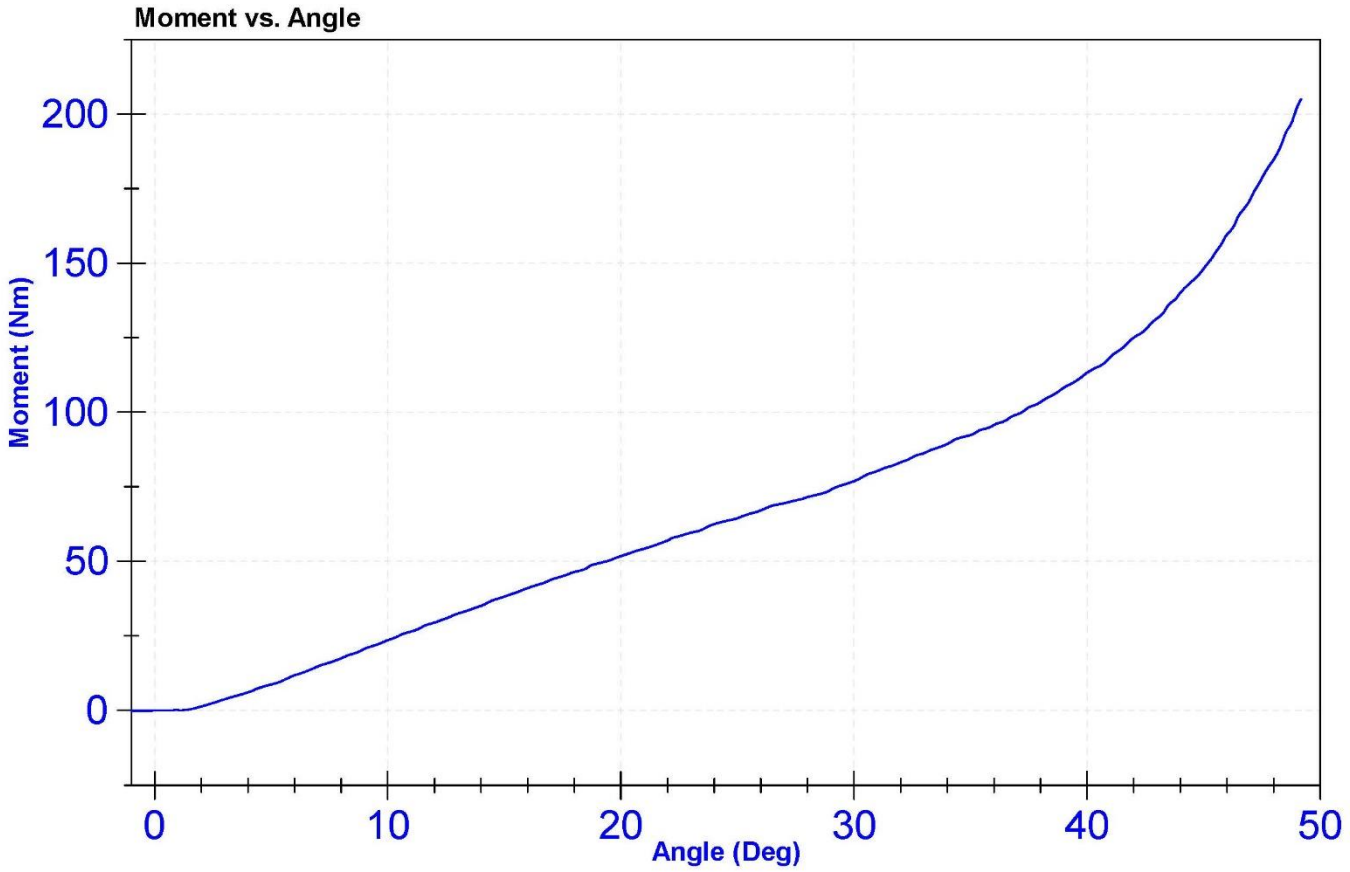
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Average Velocity	5	10	deg/s	7.6	Pass
Angle at 203Nm	40	50	deg	49.0	Pass
Moment at 30 degrees	0	94.9	Nm	76.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	NOVALUE	DS-0008		
Load Cell	Key Trans 2301-02	LC-115 My	2021-08-13	2022-08-13



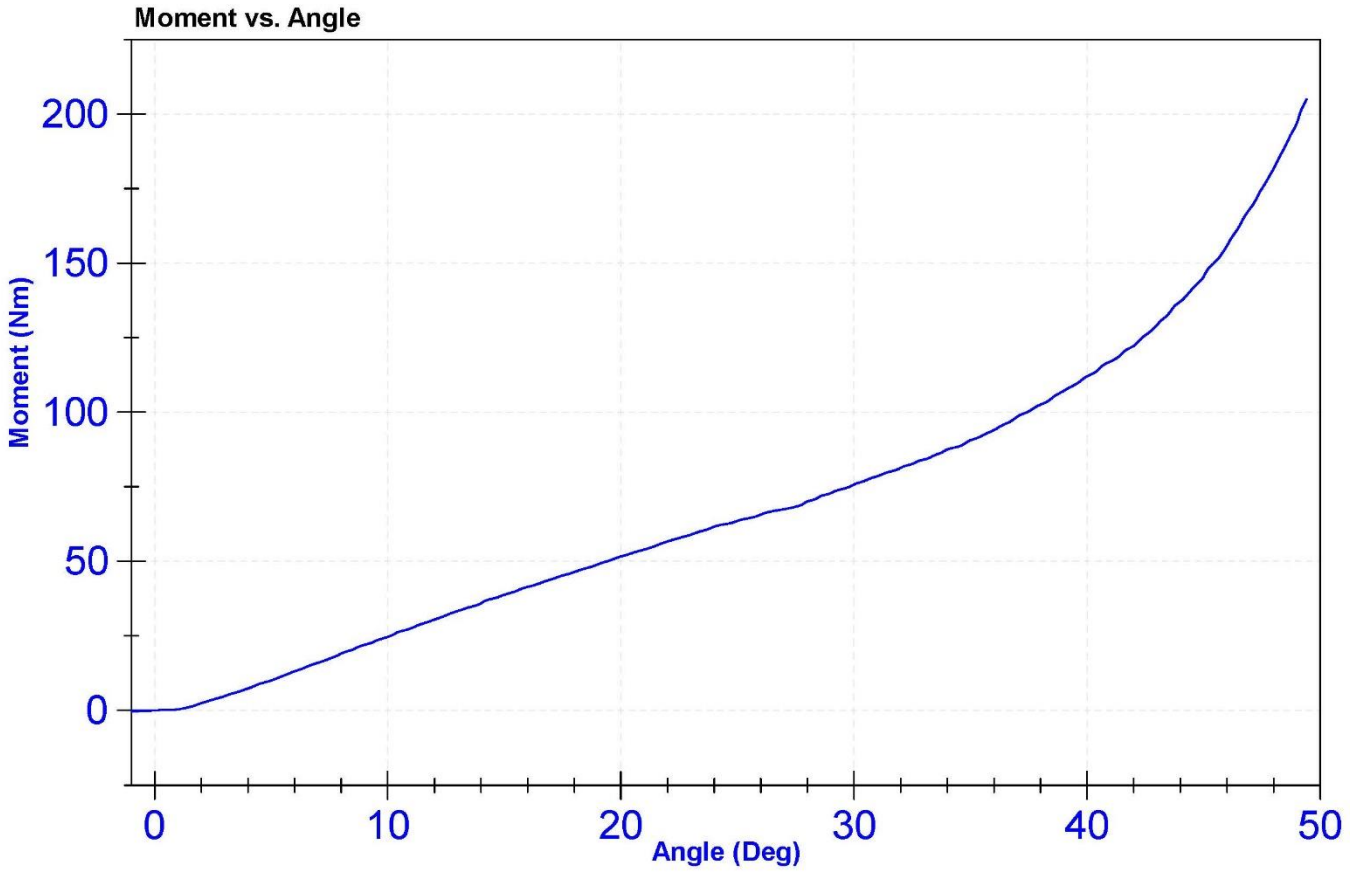
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Average Velocity	5	10	deg/s	7.7	Pass
Angle at 203Nm	40	50	deg	49.3	Pass
Moment at 30 degrees	0	94.9	Nm	75.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	NOVALUE	DS-0008		
Load Cell	Key Trans 2301-02	LC-115 My	2021-08-13	2022-08-13



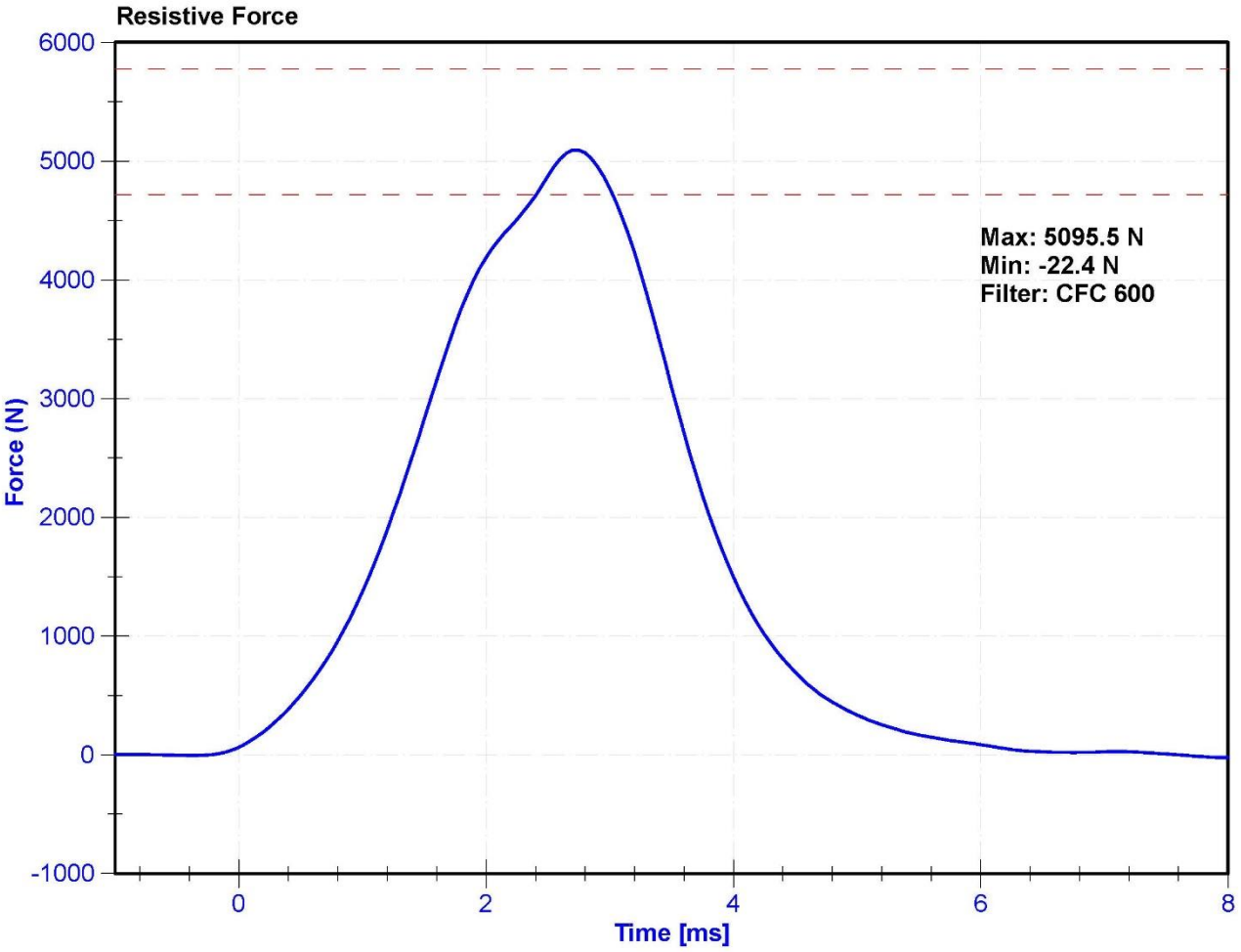
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

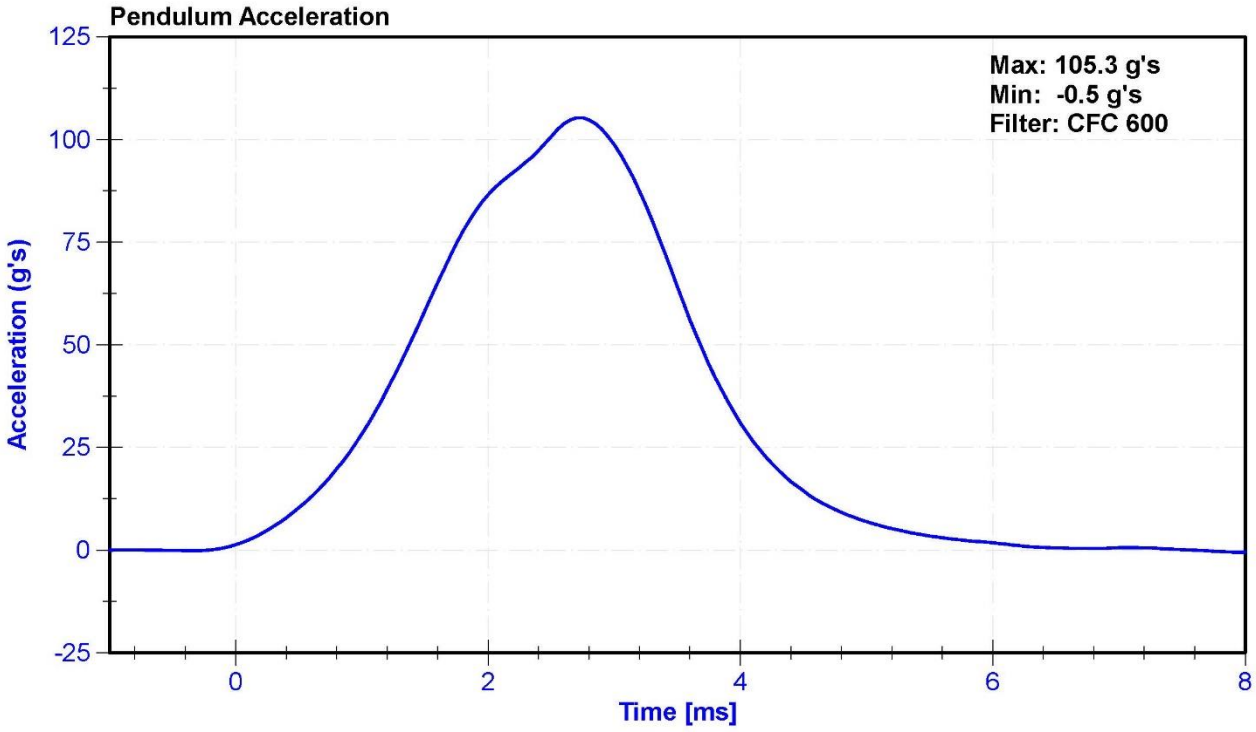
Results

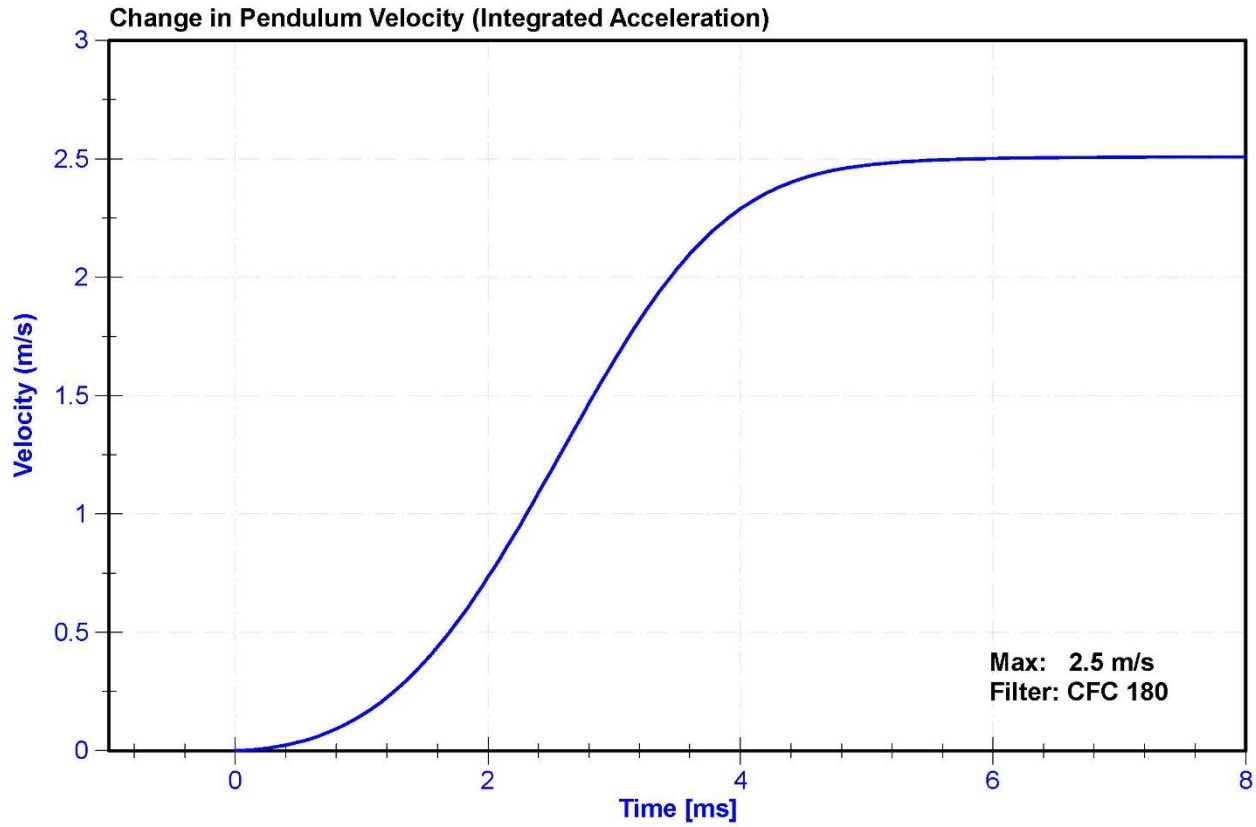
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.0	Pass
Humidity	10	70	%	30.3	Pass
Velocity	2.07	2.13	m/s	2.072	Pass
Maximum Resistive Force	4720	5780	N	5095.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022




Pendulum Acceleration
Max: 105.3 g's
Min: -0.5 g's
Filter: CFC 600
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]


Change in Pendulum Velocity (Integrated Acceleration)
Max: 2.5 m/s
Filter: CFC 180
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]

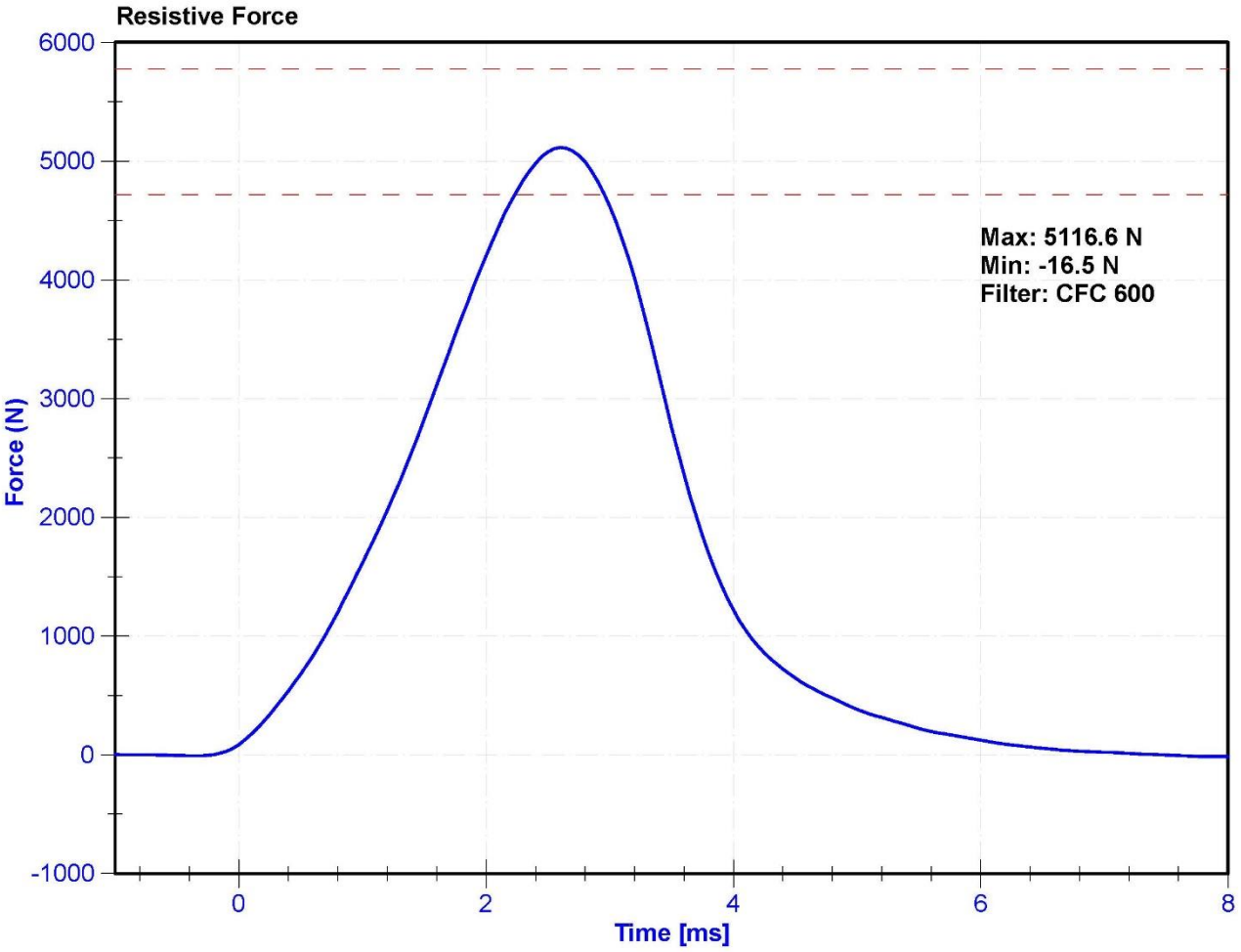
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

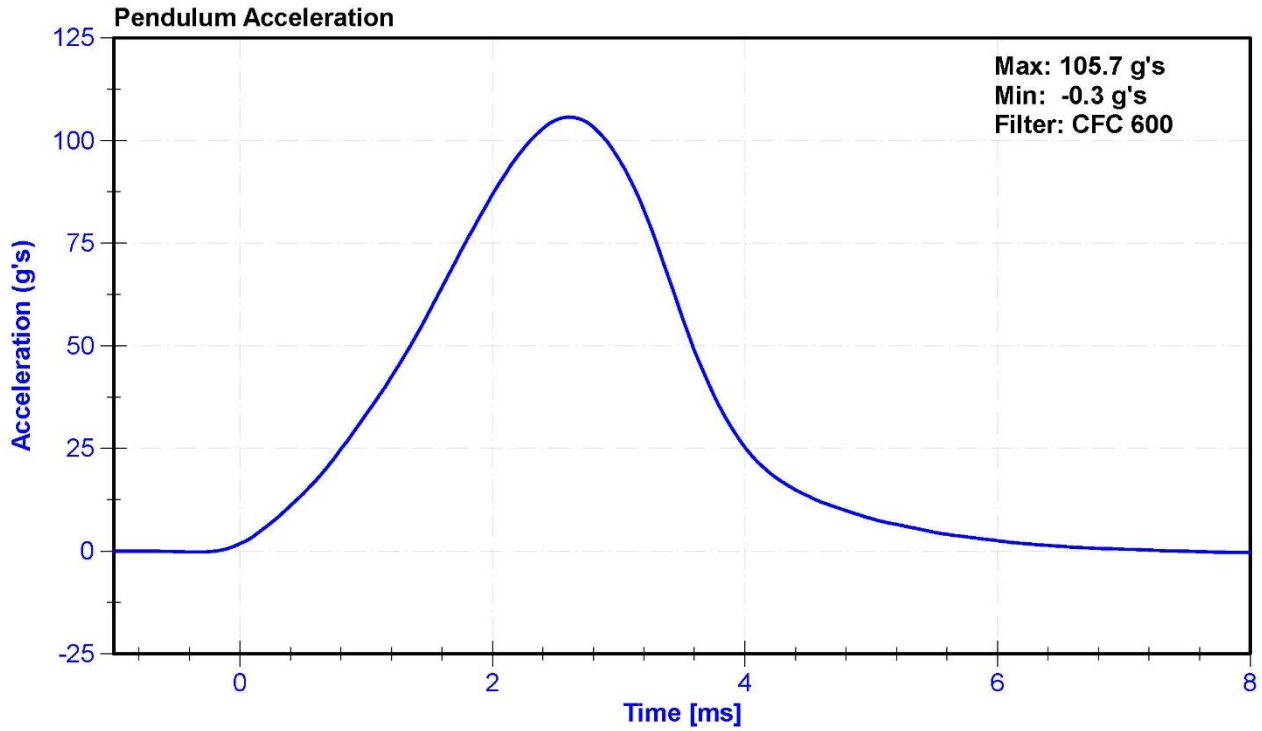
Results

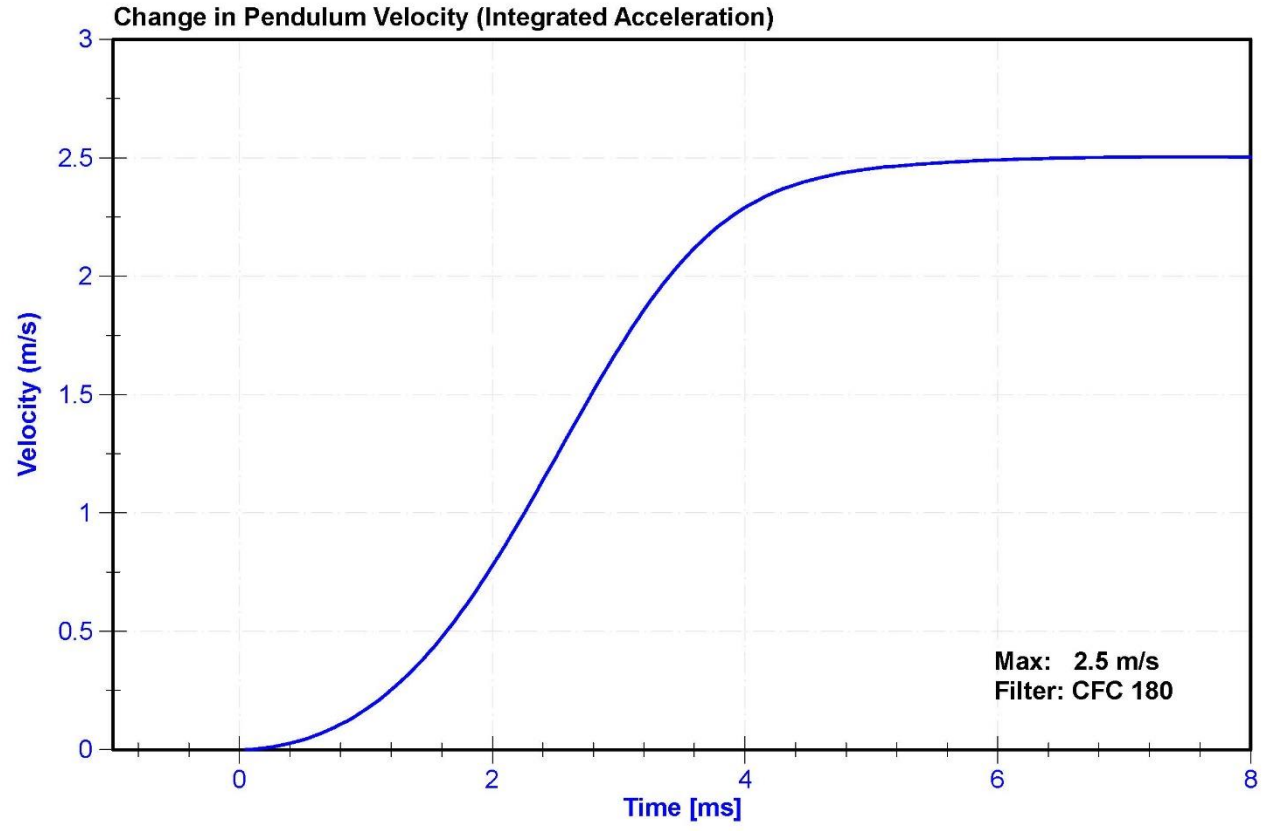
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.0	Pass
Humidity	10	70	%	30.3	Pass
Velocity	2.07	2.13	m/s	2.073	Pass
Maximum Resistive Force	4720	5780	N	5116.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022




Pendulum Acceleration
Max: 105.7 g's
Min: -0.3 g's
Filter: CFC 600
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]


Change in Pendulum Velocity (Integrated Acceleration)
Max: 2.5 m/s
Filter: CFC 180
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]

CALIBRATION TEST RESULTS

POST-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

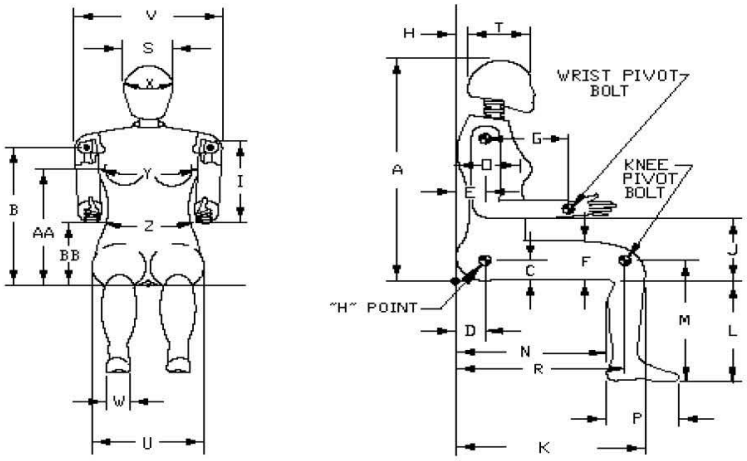
SERIAL NO: 137

Calspan

External Measurements - Hybrid 3 - 5th Female

Technician: K. Brogan Date: 03/19/2021

Dummy Serial Number: 137



Symbol	Description	Specification (mm)		Result (mm)	Pass/Fail
A	Sitting Height	775	800	790	Pass
B	Shoulder Pivot Height	432	457	445	Pass
C	H-Point Height	81	86	84	Pass
D	H-Point from Backline	145	150	147	Pass
E	Shoulder Pivot from Backline	69	84	76	Pass
F	Thigh Clearance	119	135	125	Pass
G	Back of Elbow to Wrist Pivot	244	259	250	Pass
H	Head Back to Backline	43	48	45	Pass
I	Shoulder to Elbow Length	277	297	290	Pass
J	Elbow Rest Height	183	203	195	Pass
K	Buttock to Knee Length	521	546	535	Pass
L	Popliteal Height	356	376	365	Pass
M	Knee Pivot Height	394	419	410	Pass
N	Buttock Popliteal Length	414	439	425	Pass
O	Chest Depth without Jacket	175	191	182	Pass
P	Foot Length (right)	219	234	228	Pass
R	Buttock To Knee Pivot Length	457	483	466	Pass
S	Head Breadth	137	147	141	Pass
T	Head Depth	178	188	180	Pass
U	Hip Breadth	300	315	310	Pass
V	Shoulder Breadth	351	366	359	Pass
W	Foot Breadth	79	94	85	Pass
X	Head Circumference	528	549	540	Pass
Y	Chest Circumference with Jacket	851	881	865	Pass
Z	Waist Circumference	460	790	650	Pass
AA	Reference Location (Chest Circumference)	333	358	345	Pass
BB	Reference Location (Waist Circumference)	160	170	165	Pass

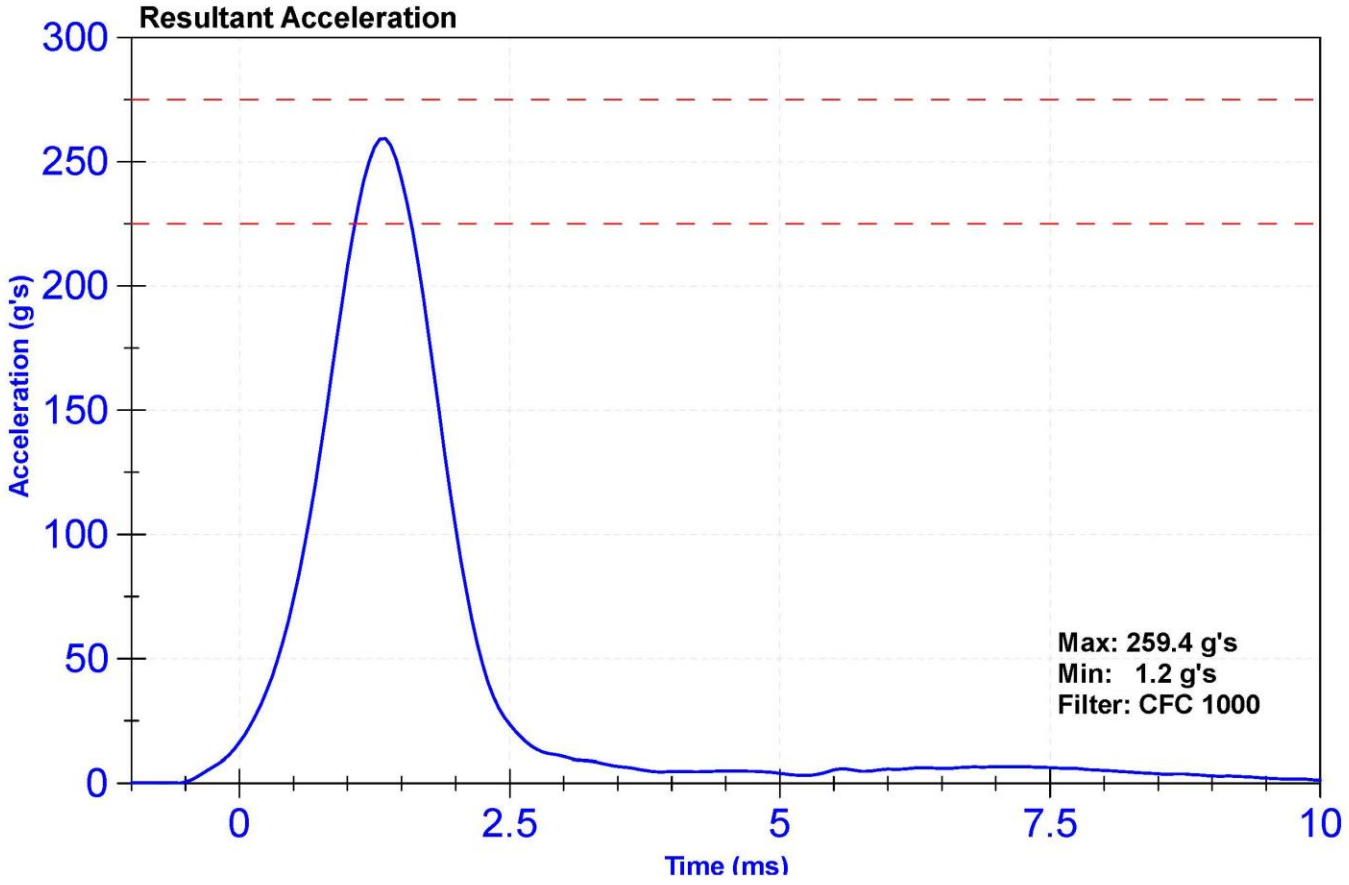
ATD Manufacturer	Humanetics	Test Technician	B. Kirchner
ATD Serial Number	142	Laboratory Supervisor	K. Brogan

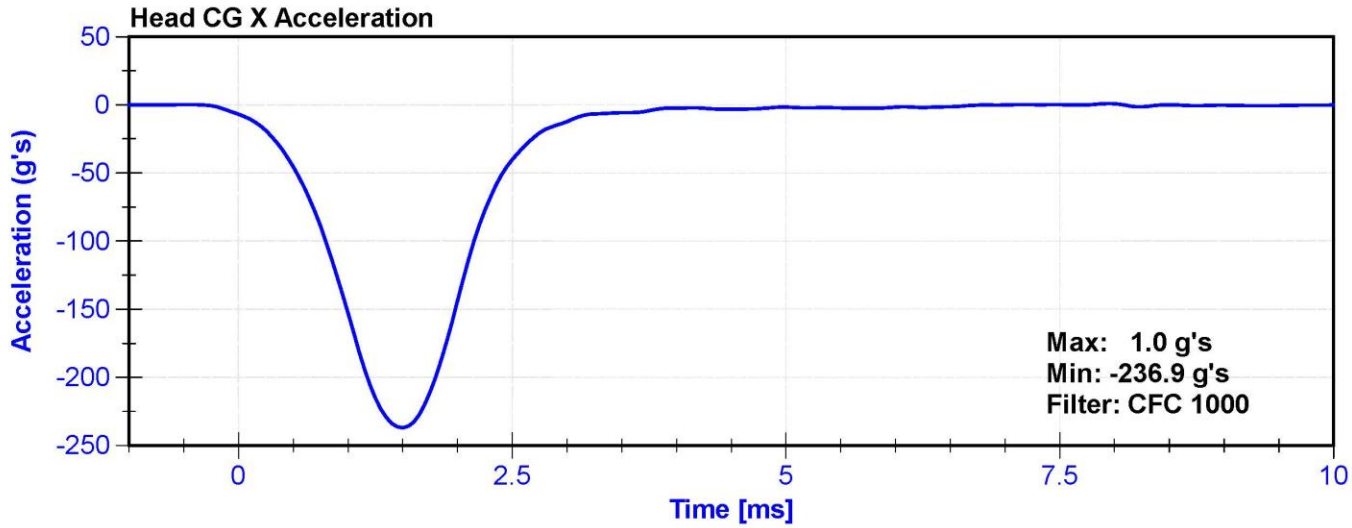
Results

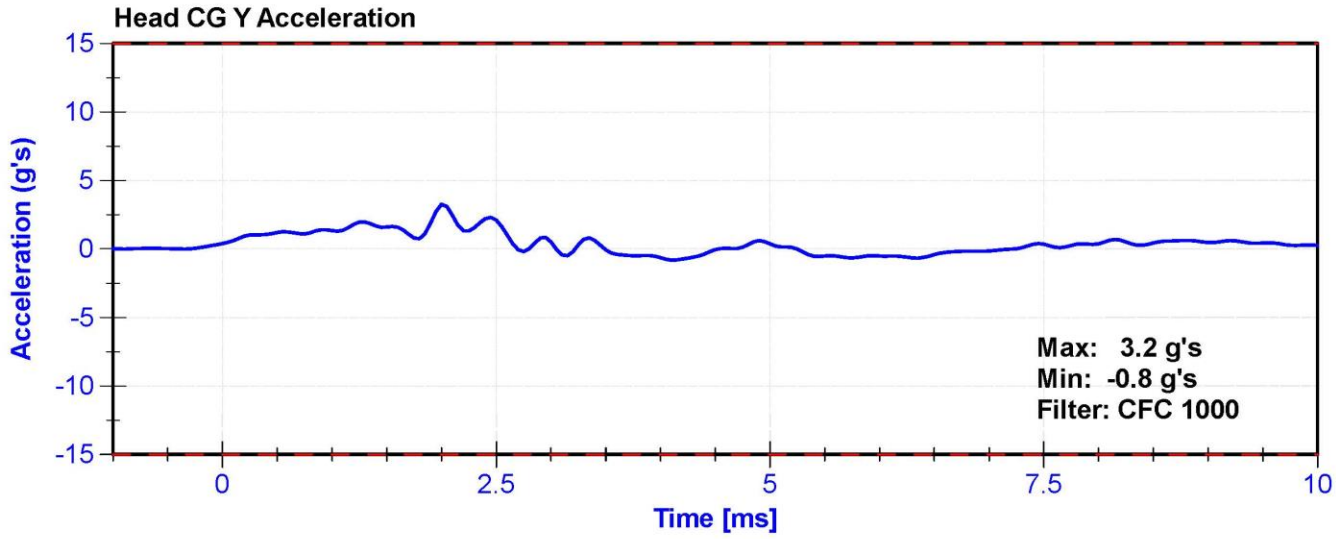
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	32.3	Pass
Resultant Acceleration	225	275	g's	259.4	Pass
Oscillation	0	10	%	2.6	Pass
Lateral Acceleration	-15	15	g's	-3.4	Pass

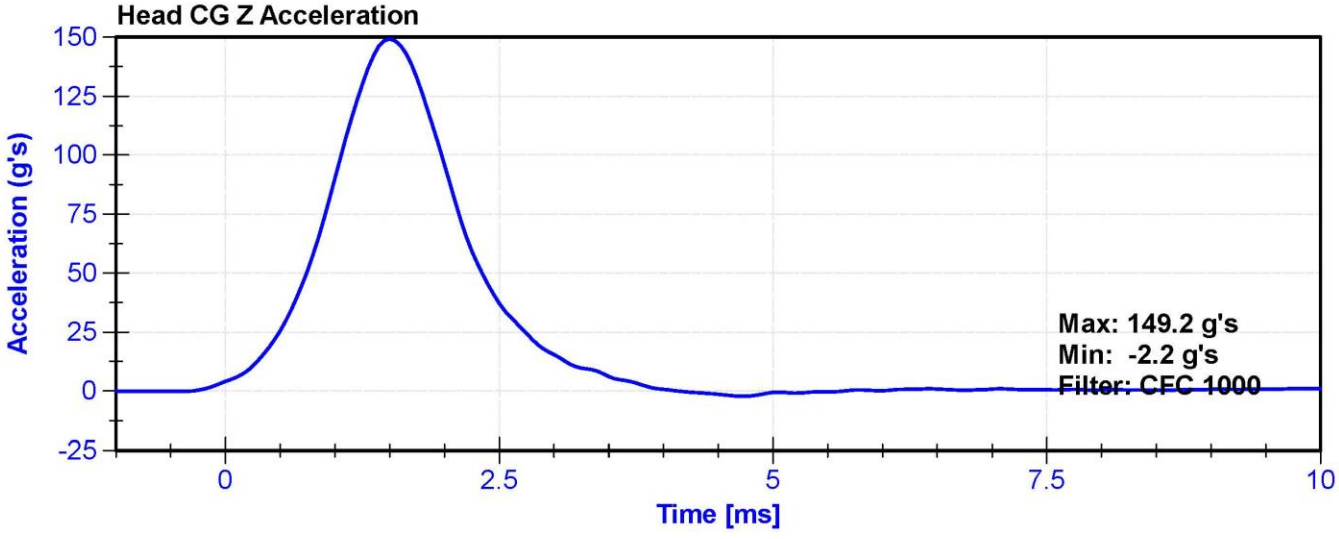
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P51681	11/16/2021	5/15/2022
Y Accelerometer	Endevco	P64151	11/16/2021	5/15/2022
Z Accelerometer	Endevco	P52114	11/16/2021	5/15/2022




Head CG X Acceleration
Acceleration (g's)
50
0
-50
-100
-150
-200
-250
0
2.5
5
7.5
10
Time [ms]
Max: 1.0 g's
Min: -236.9 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: 3.2 g's
Min: -0.8 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
150
125
100
75
50
25
0
-25
0
2.5
5
7.5
10
Time [ms]
Max: 149.2 g's
Min: -2.2 g's
Filter: CFC 1000

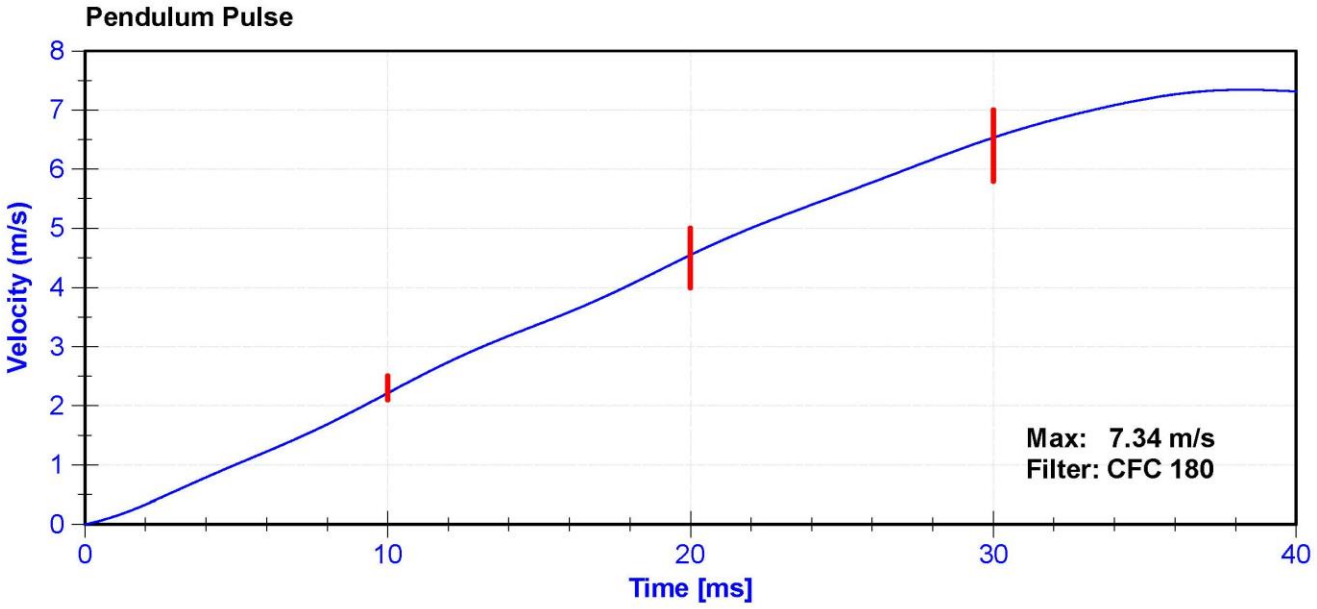
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

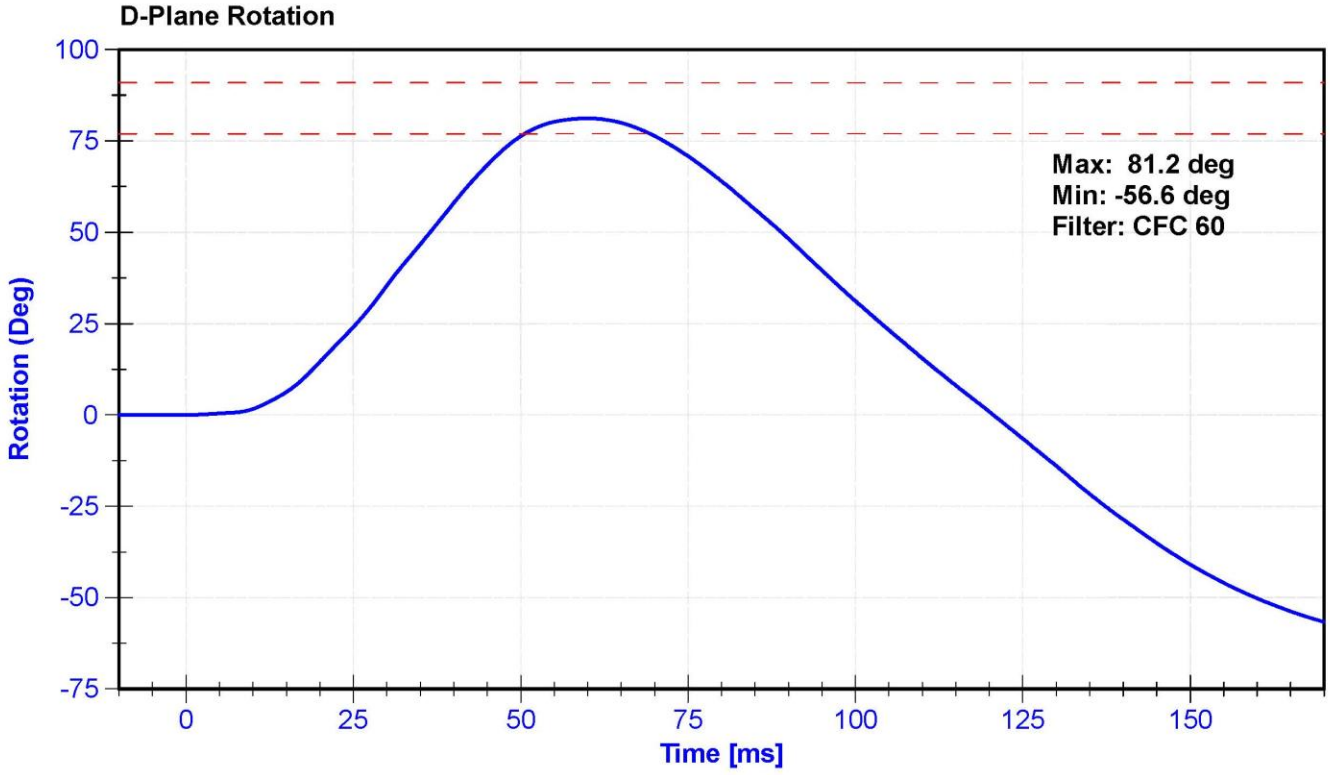
Results

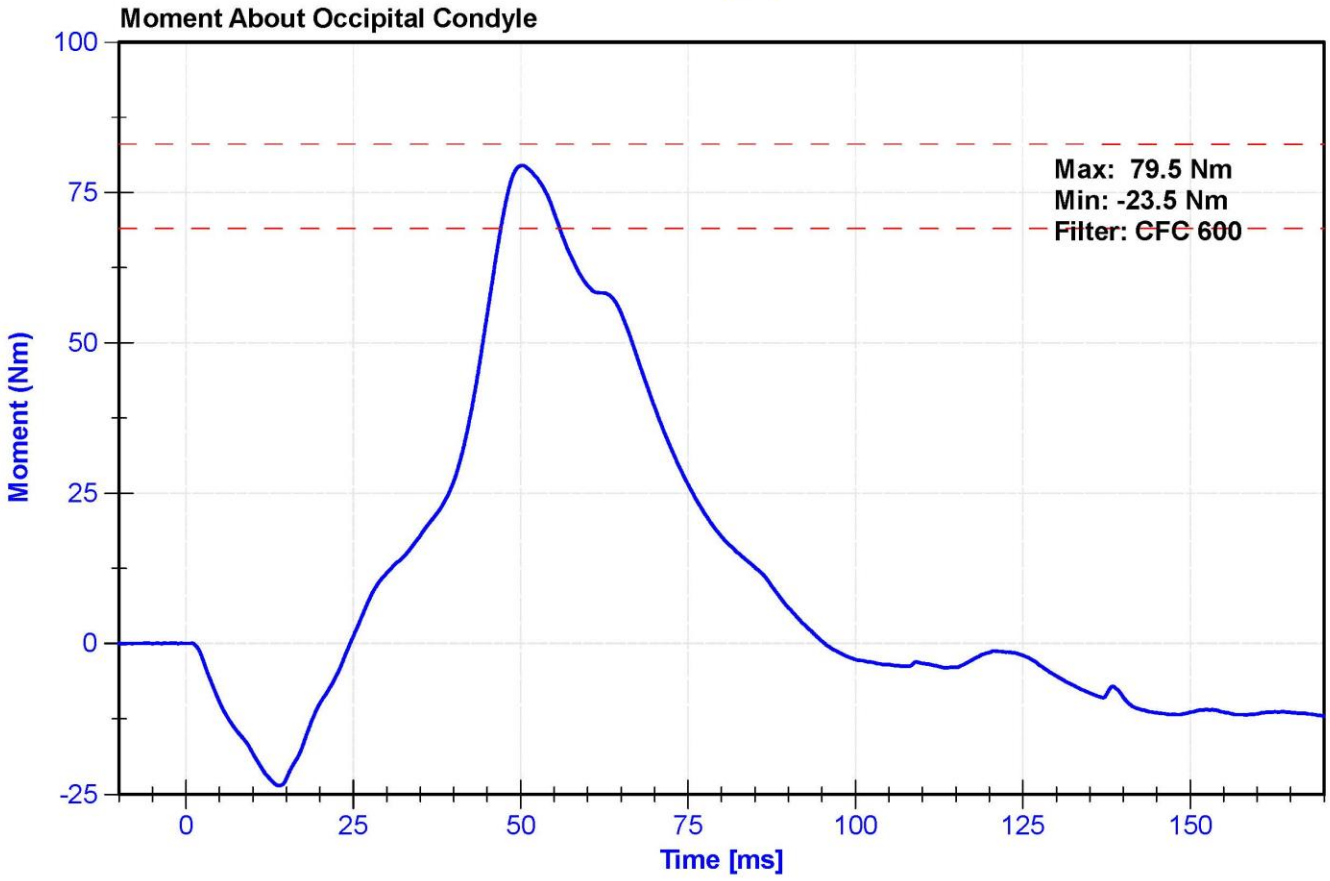
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	33.5	Pass
Velocity	6.89	7.13	m/s	7.031	Pass
Pendulum Impulse at 10ms	2.1	2.5	m/s	2.21	Pass
Pendulum Impulse at 20ms	4.0	5.0	m/s	4.55	Pass
Pendulum Impulse at 30ms	5.8	7.0	m/s	6.53	Pass
Max D Plane Rotation	77	91	deg	81.2	Pass
Max Moment During Rotation Interval	69	83	Nm	79.5	Pass
Moment Decay to 10.0 Nm	80	100	ms	87.3	Pass

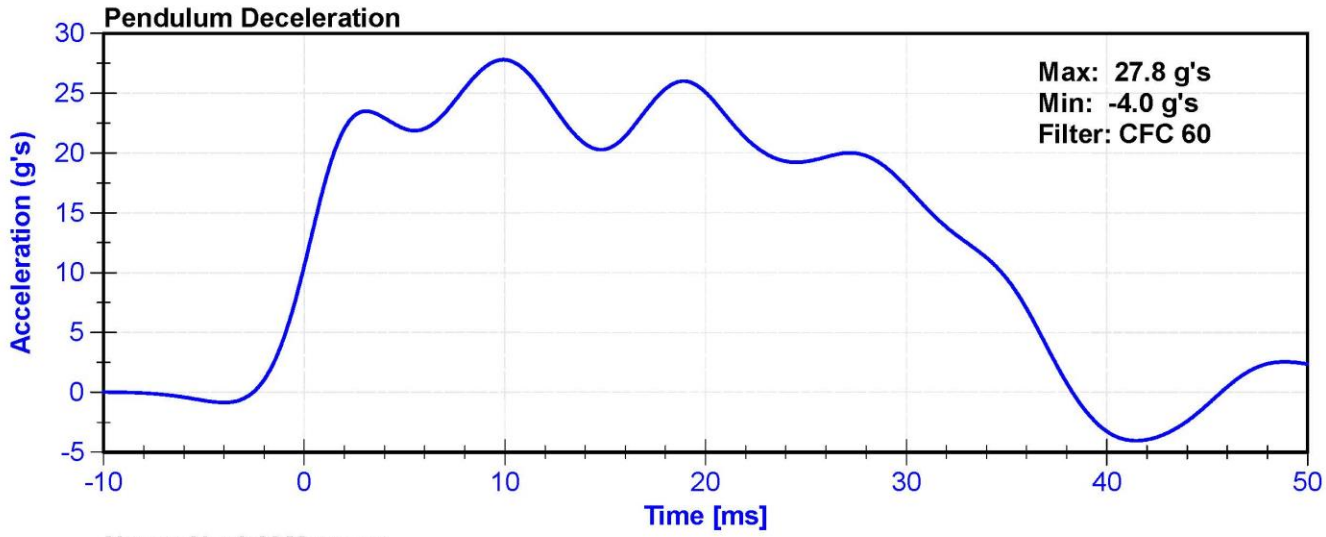
Transducer Calibrations

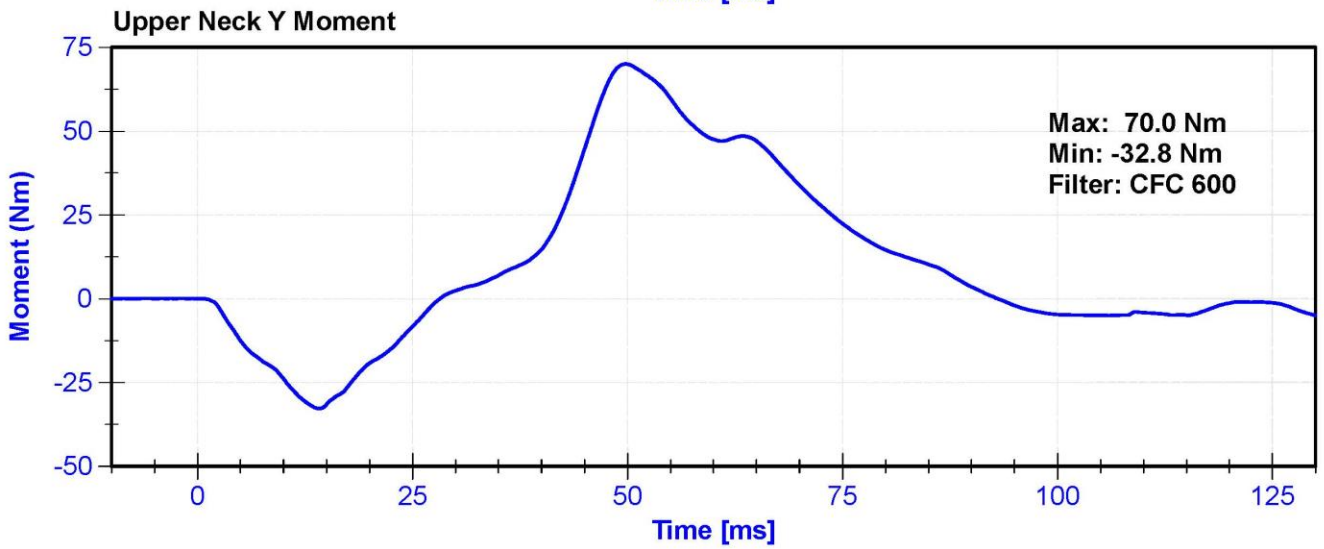
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231CT	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	Denton	1805-FX	6/17/2021	6/17/2022

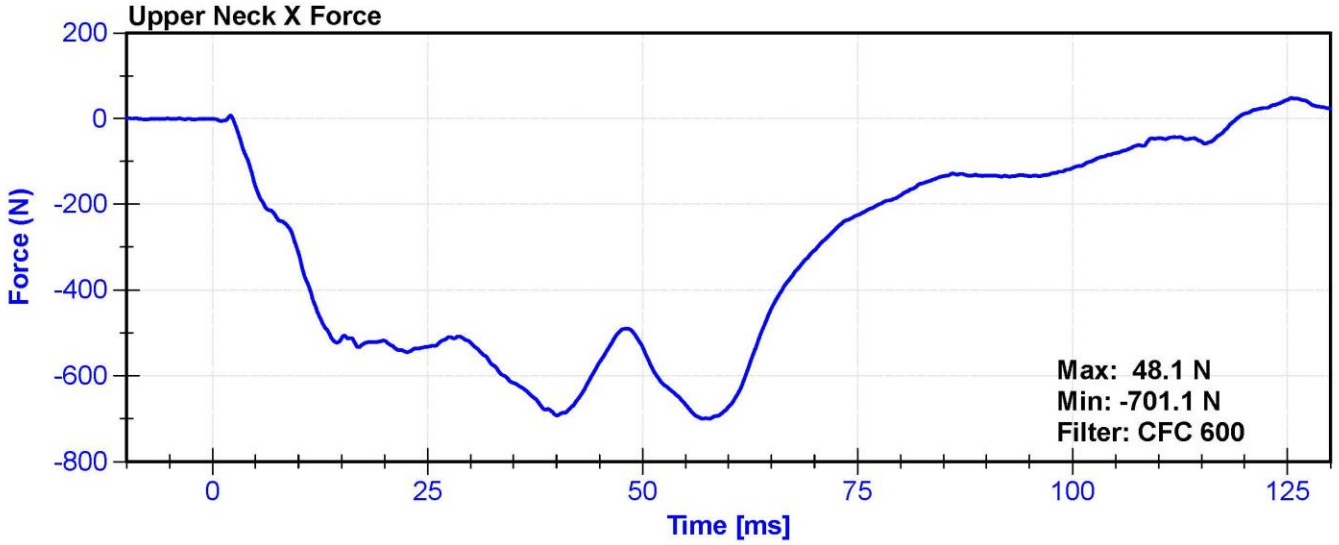



D-Plane Rotation
Max: 81.2 deg
Min: -56.6 deg
Filter: CFC 60
Rotation (Deg)
Time [ms]
100
75
50
25
0
-25
-50
-75
0
25
50
75
100
125
150


Moment About Occipital Condyle
Max: 79.5 Nm
Min: -23.5 Nm
Filter: CFC 600
Moment (Nm)
Time [ms]
100
75
50
25
0
-25
0
25
50
75
100
125
150


Pendulum Deceleration
Max: 27.8 g's
Min: -4.0 g's
Filter: CFC 60
Acceleration (g's)
Time [ms]


Upper Neck Y Moment
Max: 70.0 Nm
Min: -32.8 Nm
Filter: CFC 600
Moment (Nm)
Time [ms]


Upper Neck X Force
Max: 48.1 N
Min: -701.1 N
Filter: CFC 600
Force (N)
Time [ms]

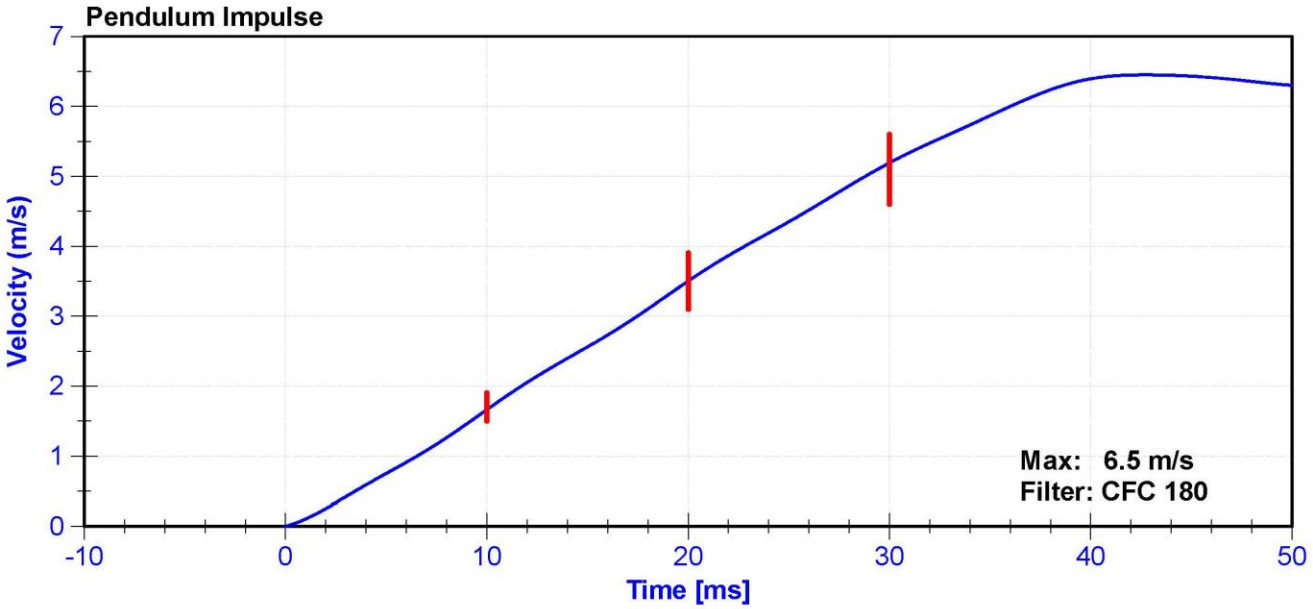
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

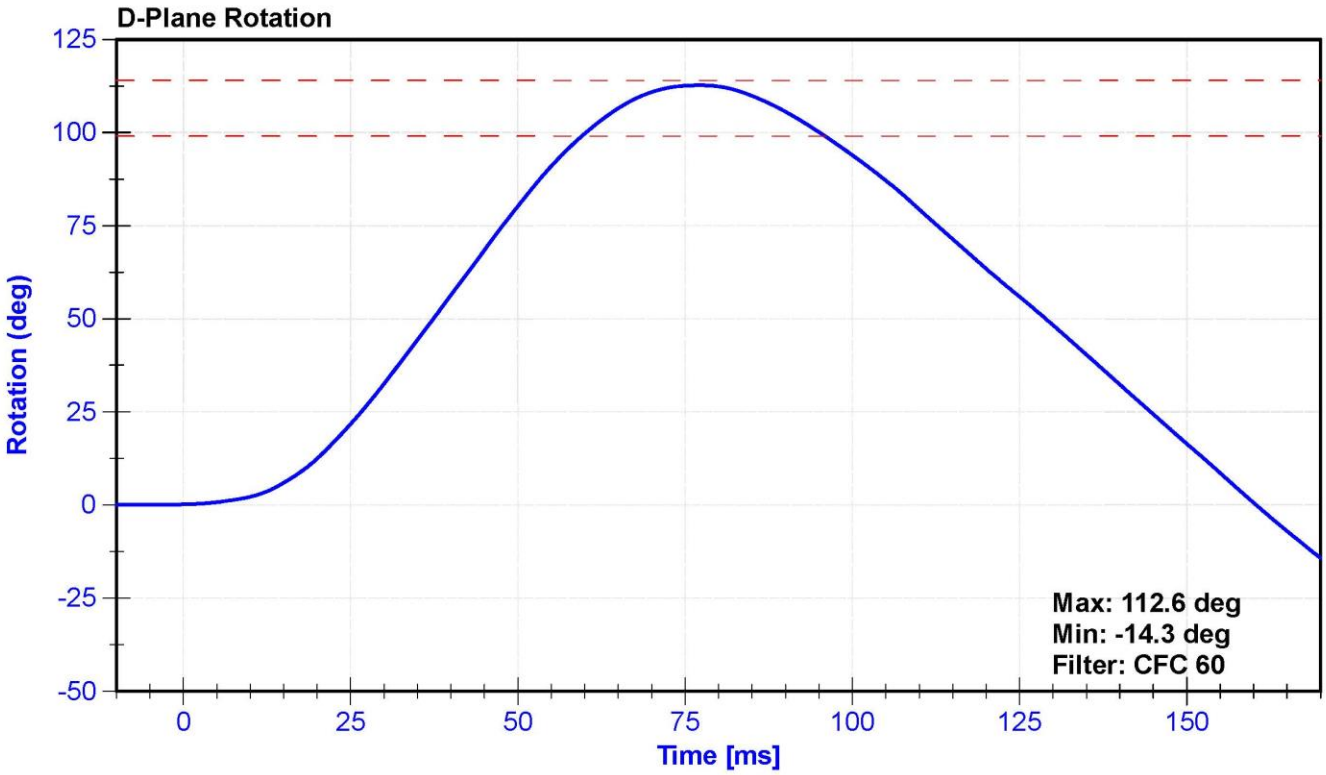
Results

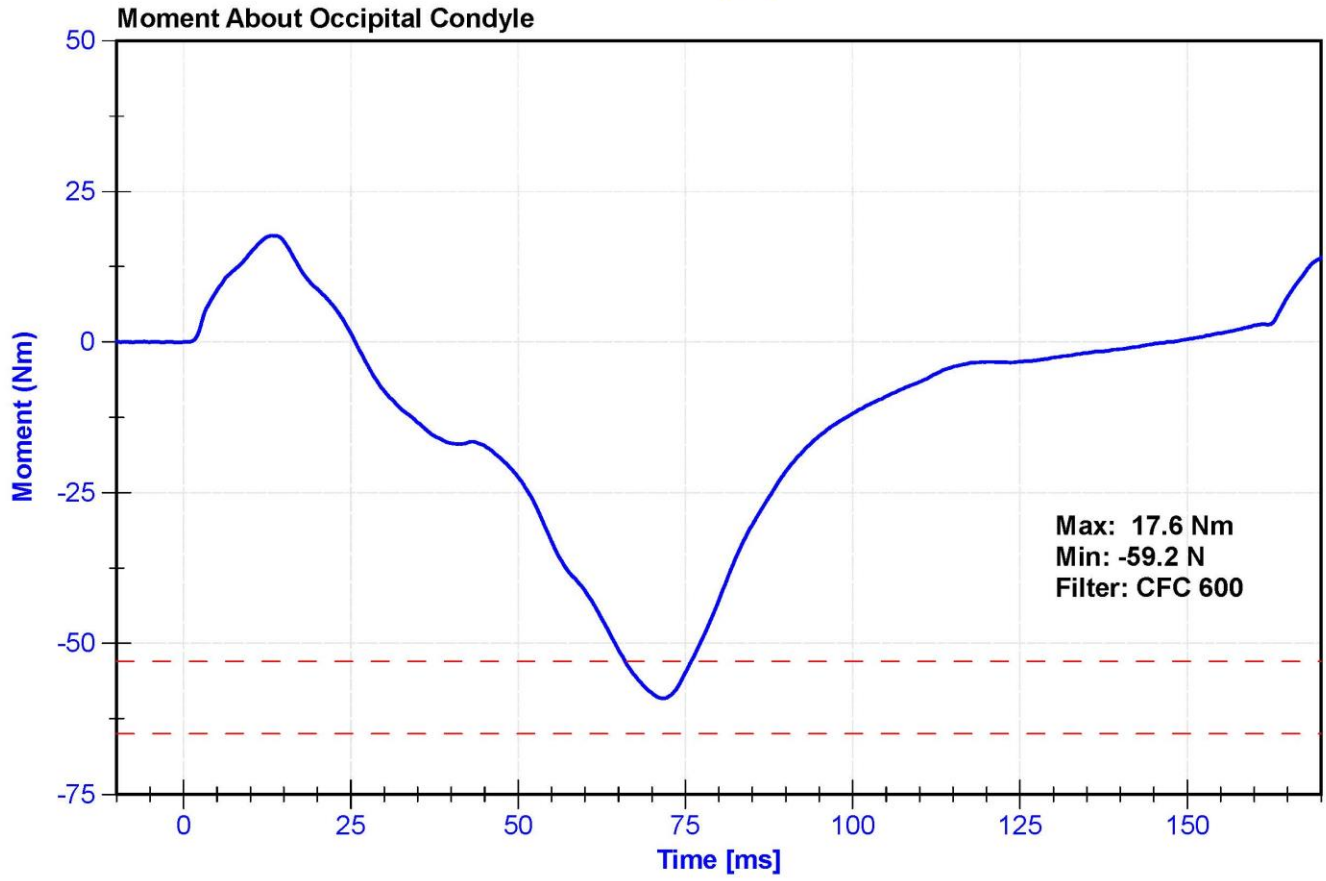
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.3	Pass
Humidity	10	70	%	33.5	Pass
Velocity	5.95	6.19	m/s	6.141	Pass
Pendulum Impulse at 10ms	1.5	1.9	m/s	1.66	Pass
Pendulum Impulse at 20ms	3.1	3.9	m/s	3.50	Pass
Pendulum Impulse at 30ms	4.6	5.6	m/s	5.19	Pass
D Plane Rotation	99	114	deg	112.6	Pass
Moment During Rotation Interval	-65	-53	Nm	-59.2	Pass
Moment Decay to -10Nm	94	114	ms	103.2	Pass

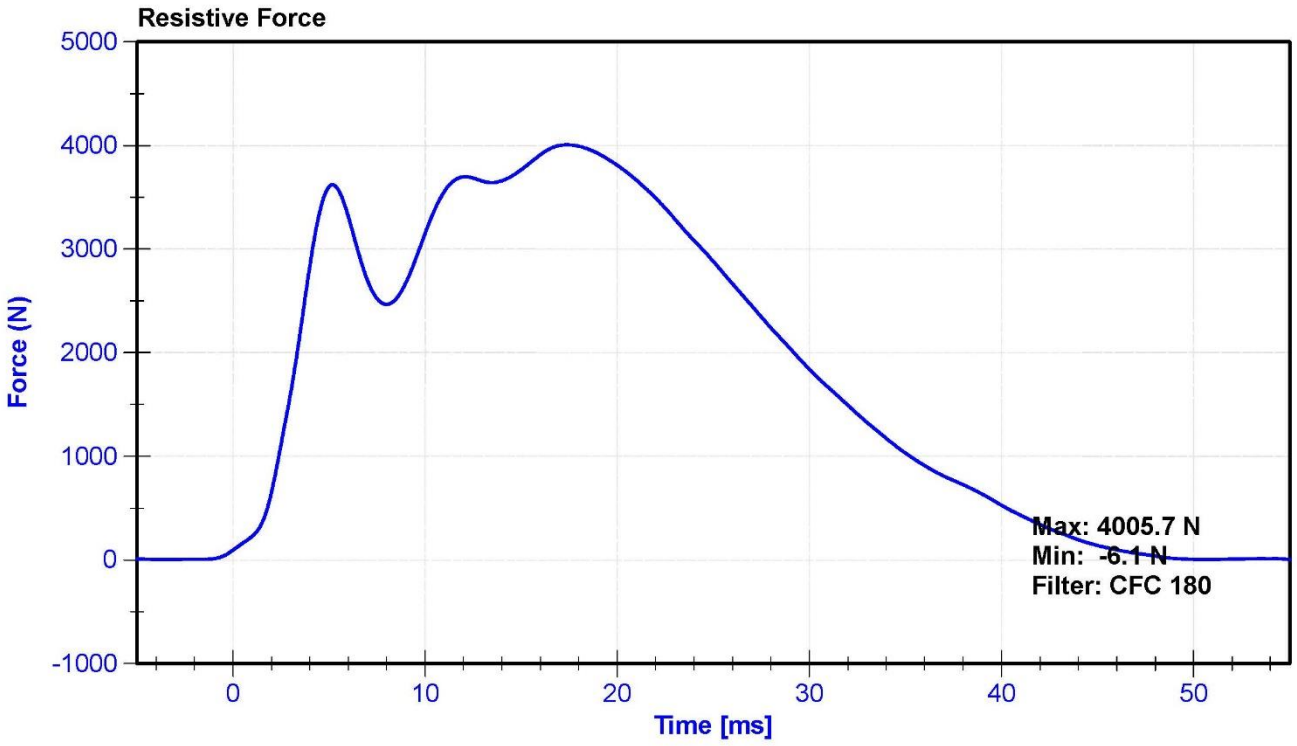
Transducer Calibrations

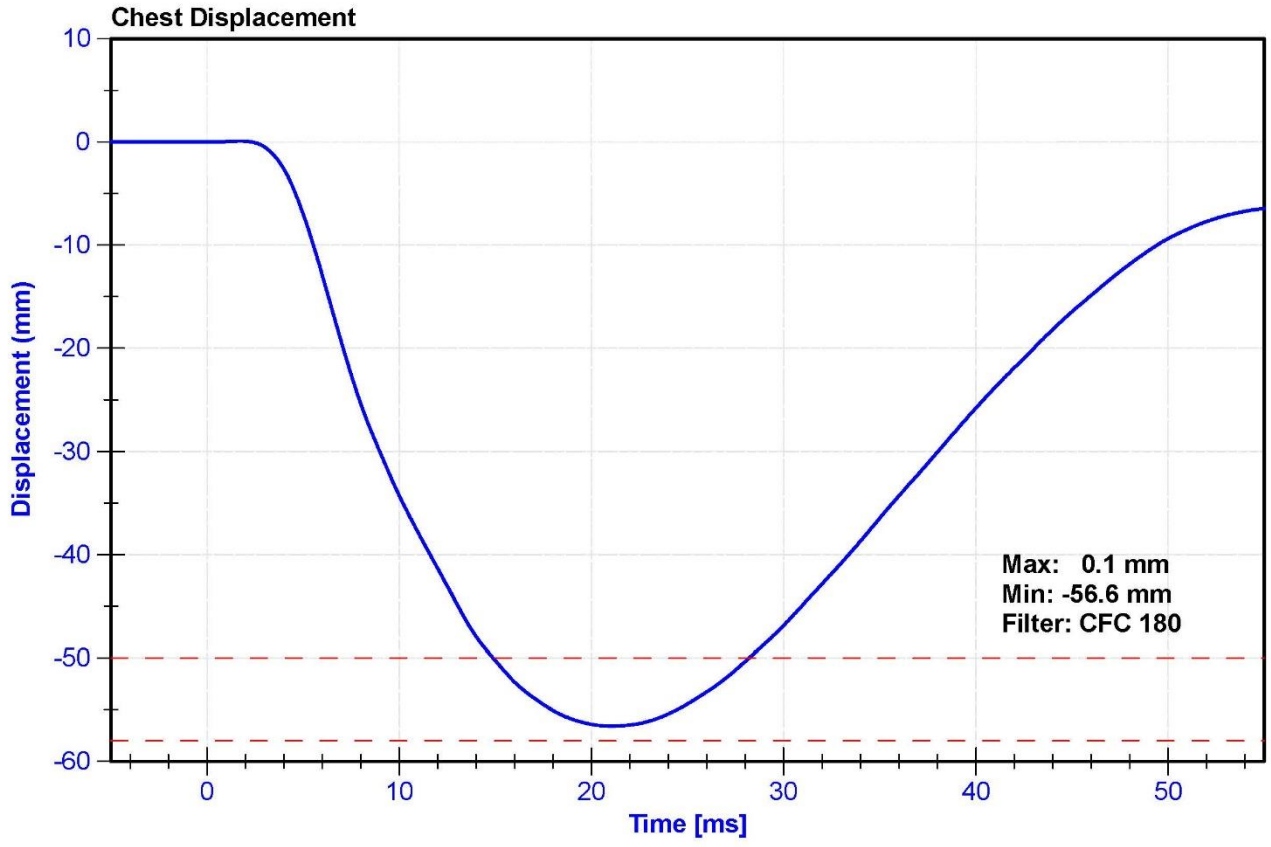
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/28/2021	10/28/2022
Pendulum Potentiometer	ETI	LABPOT1	5/7/2021	5/7/2022
Condyle Potentiometer	ETI	LABPOT2	5/7/2021	5/7/2022
Upper Neck Load Cell	Denton	1805-FX	6/17/2021	6/17/2022

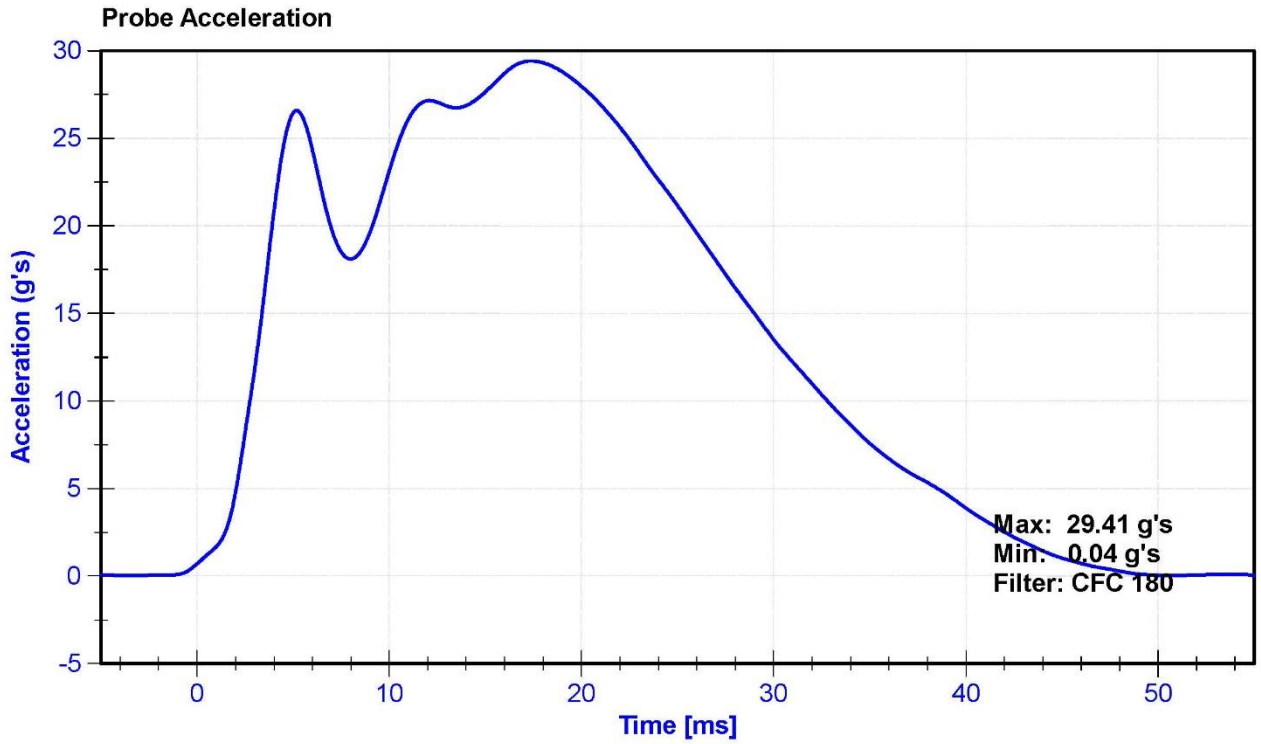


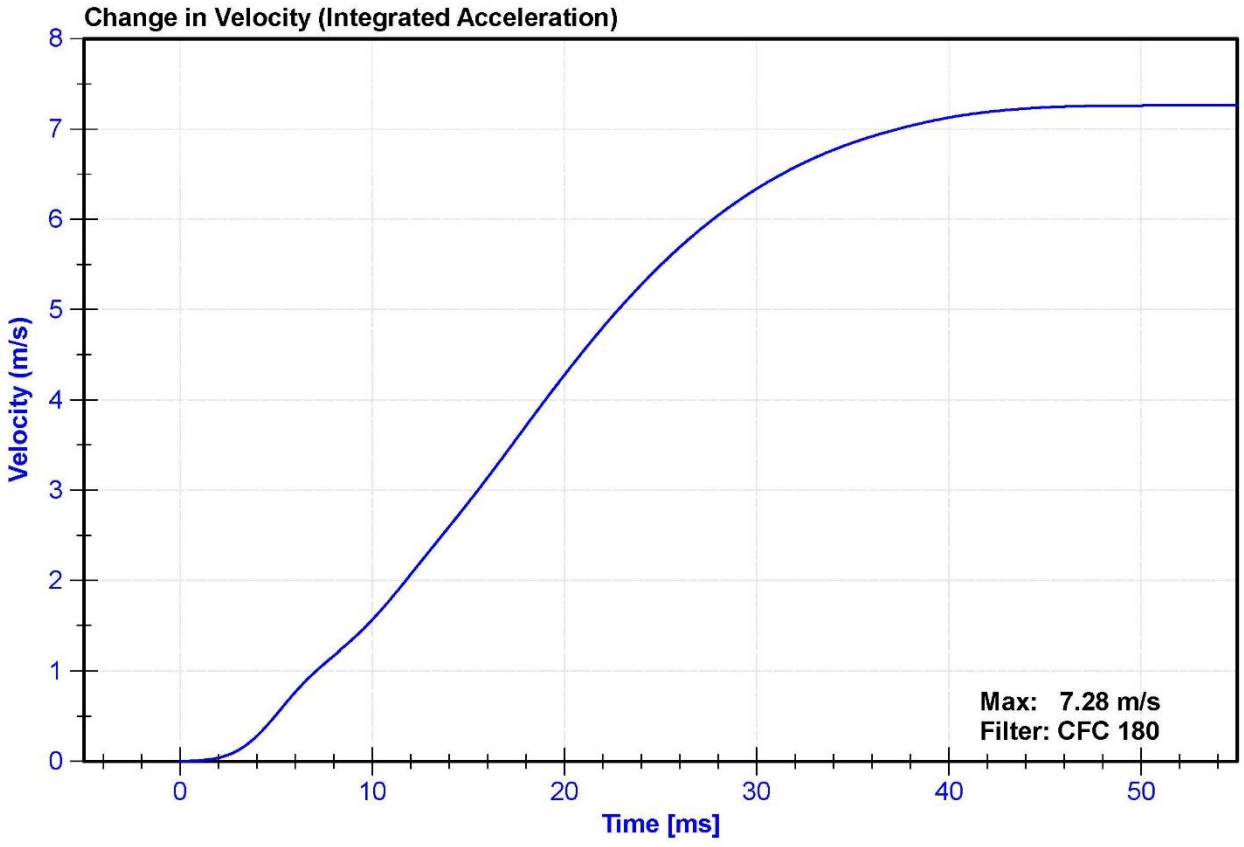

D-Plane Rotation
Rotation (deg)
125
100
75
50
25
0
-25
-50
0
25
50
75
100
125
150
Time [ms]
Max: 112.6 deg
Min: -14.3 deg
Filter: CFC 60


Moment About Occipital Condyle
Moment (Nm)
50
25
0
-25
-50
-75
0
25
50
75
100
125
150
Time [ms]
Max: 17.6 Nm
Min: -59.2 N
Filter: CFC 600


Resistive Force
Force (N)
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]
Max: 4005.7 N
Min: -6.1 N
Filter: CFC 180


Chest Displacement
Displacement (mm)
10
0
-10
-20
-30
-40
-50
-60
0
10
20
30
40
50
Time [ms]
Max: 0.1 mm
Min: -56.6 mm
Filter: CFC 180


Probe Acceleration
Acceleration (g's)
30
25
20
15
10
5
0
-5
0
10
20
30
40
50
Time [ms]
Max: 29.41 g's
Min: 0.04 g's
Filter: CFC 180


Change in Velocity (Integrated Acceleration)
Velocity (m/s)
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
Time [ms]
Max: 7.28 m/s
Filter: CFC 180

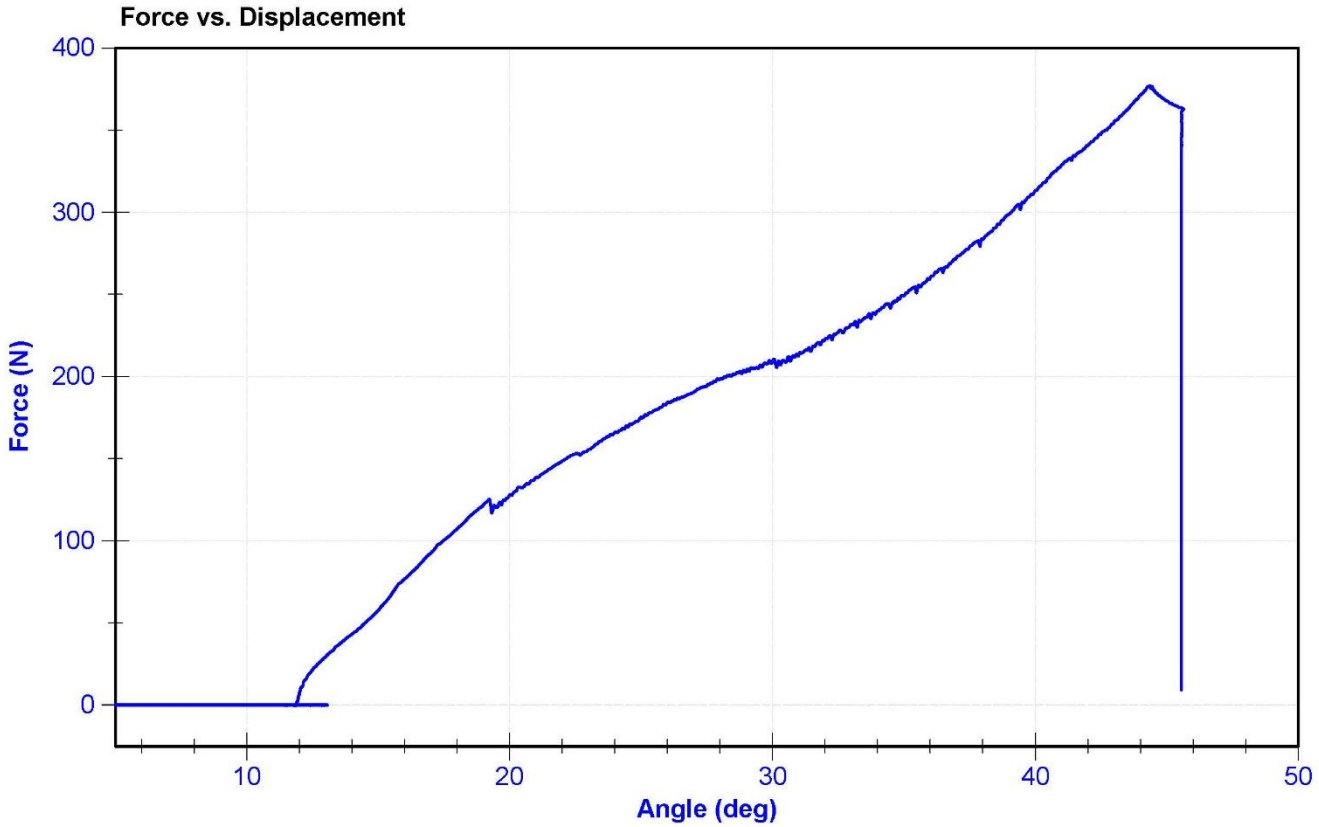
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.6	25.6	ºC	21.0	Pass
Humidity	10	70	%	30.3	Pass
Initial Angle	0	20	deg	11.8	Pass
Force at 45 Degrees	320	390	N	377.0	Pass
Return Angle Relative to Initial	0	8	deg	3.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Potentiometer	Rieker	DS-1905226	2021-11-01	2022-11-01
Load Cell	Interface	1134516	2021-08-27	2022-08-27



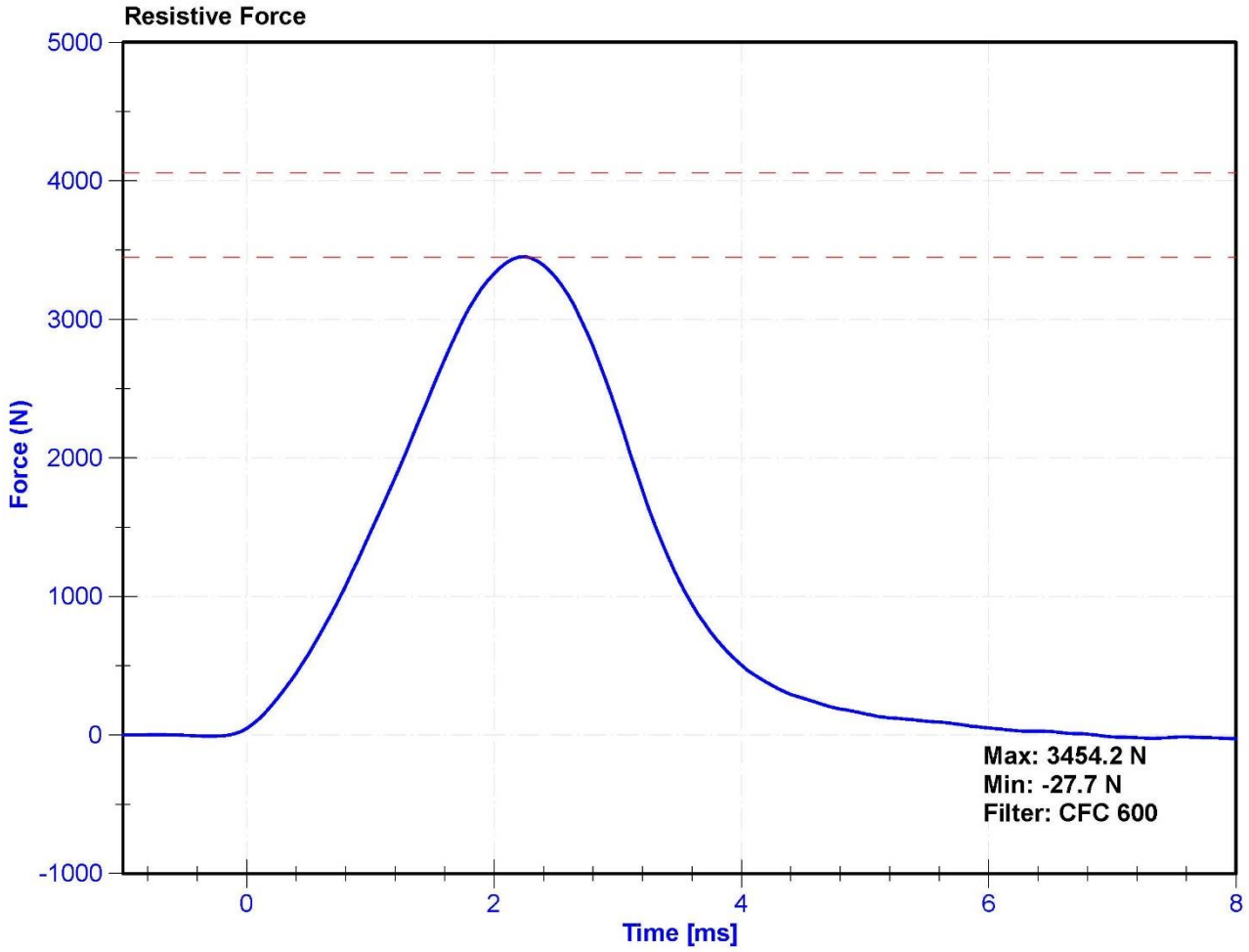
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

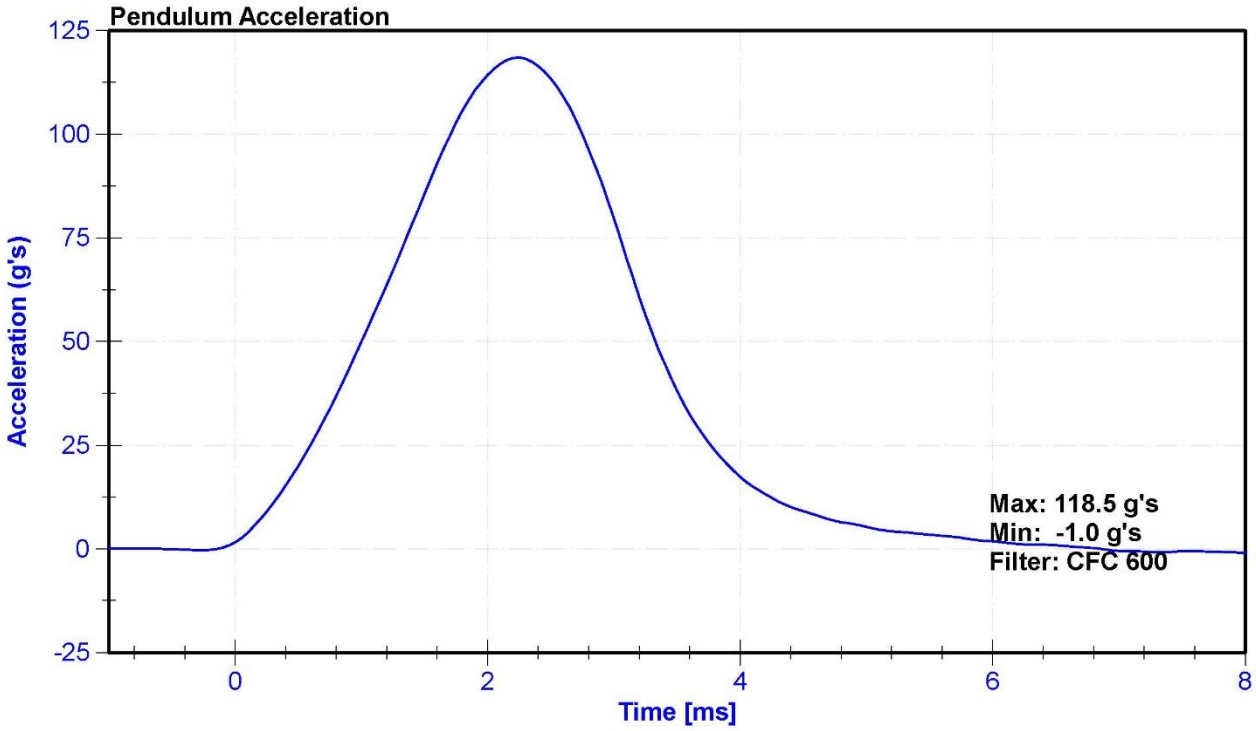
Results

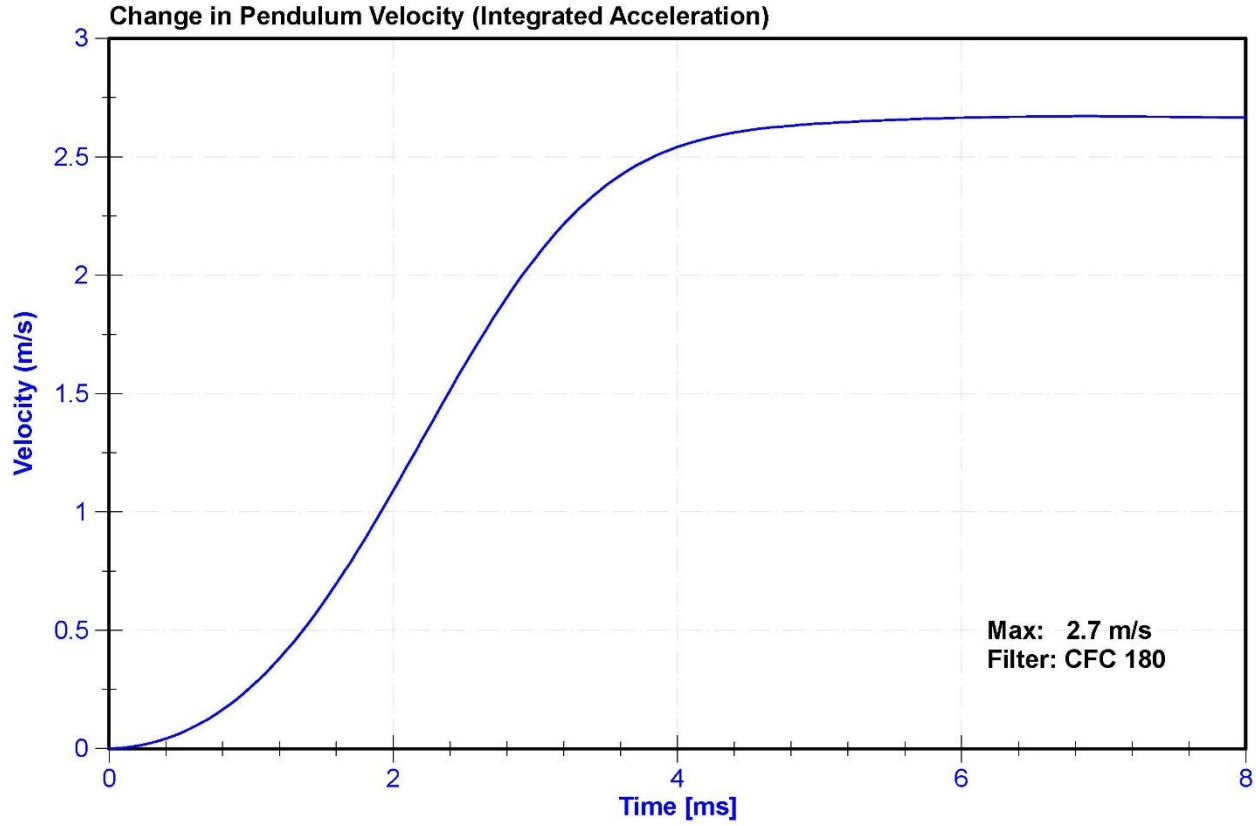
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.0	Pass
Humidity	10	70	%	30.3	Pass
Velocity	2.07	2.13	m/s	2.111	Pass
Resistive Force	3450	4060	N	3454.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022




Pendulum Acceleration
Acceleration (g's)
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]
Max: 118.5 g's
Min: -1.0 g's
Filter: CFC 600


Change in Pendulum Velocity (Integrated Acceleration)
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]
Max: 2.7 m/s
Filter: CFC 180

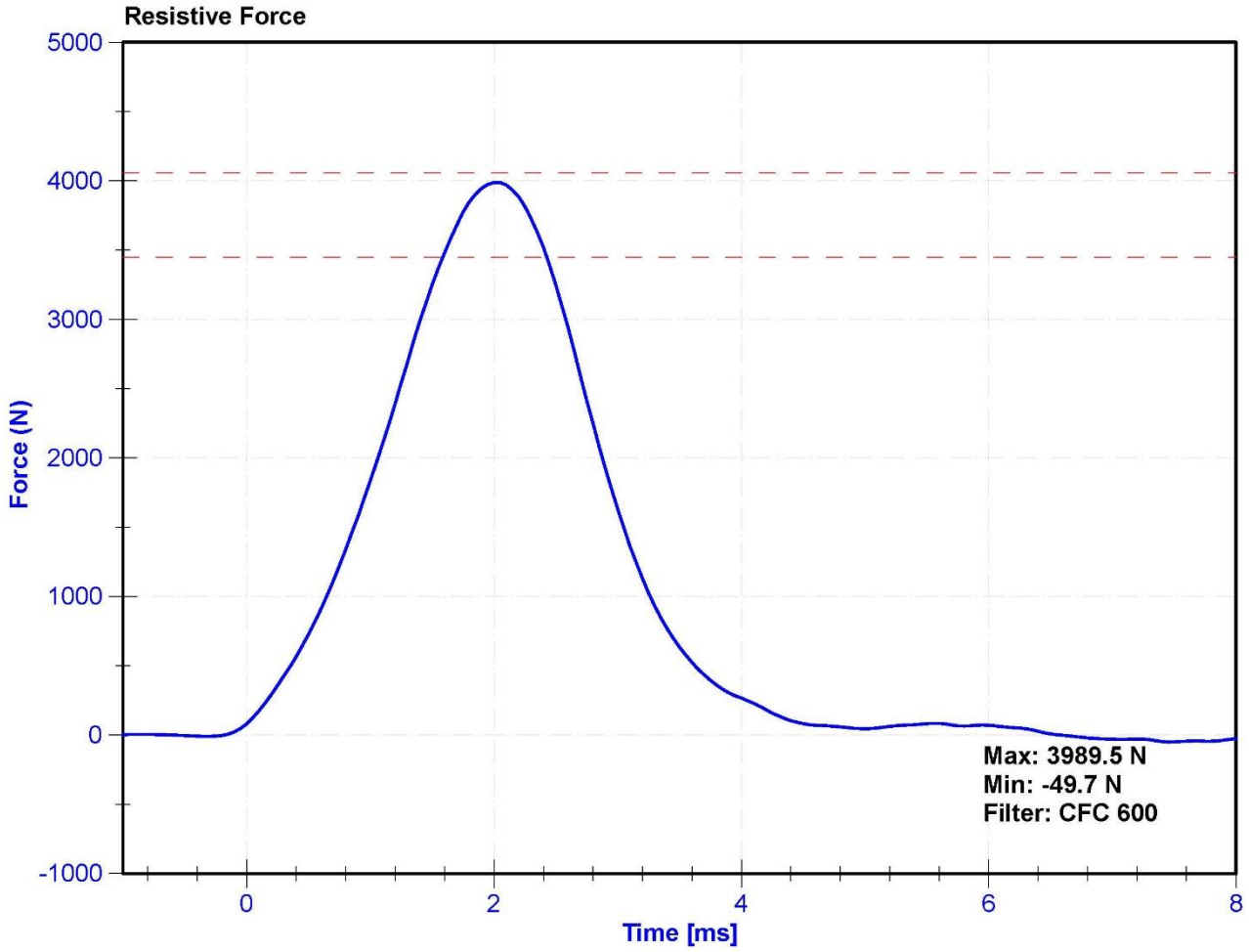
ATD Manufacturer	Humanetics	Test Technician	T. Roseman
ATD Serial Number	137	Laboratory Supervisor	K. Brogan

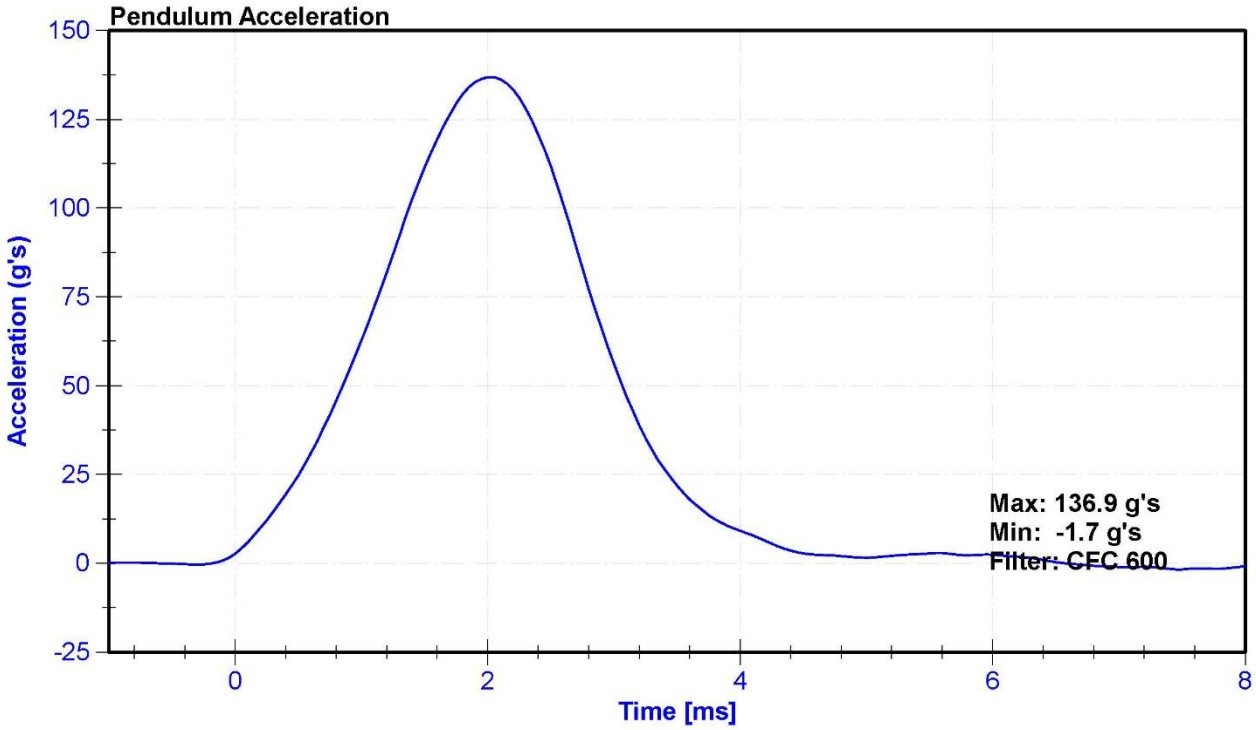
Results

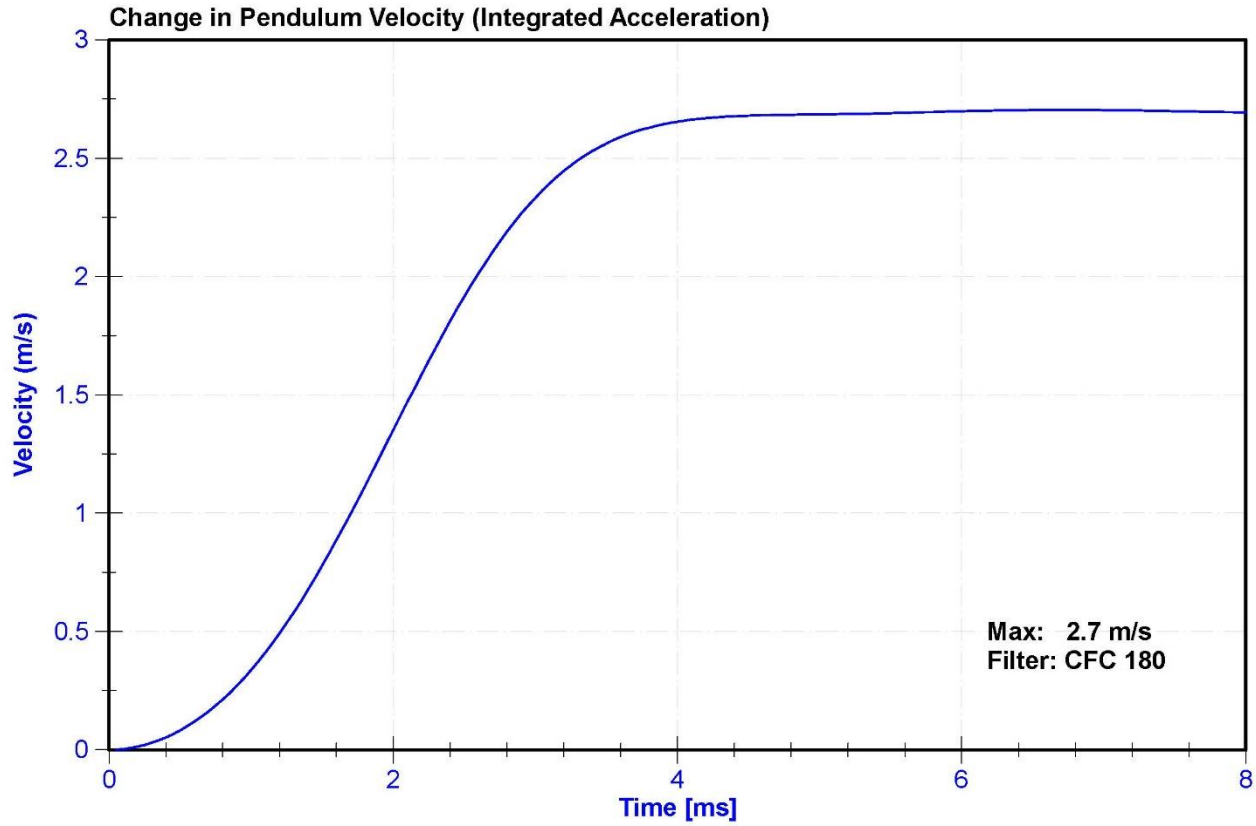
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	18.9	25.6	ºC	21.6	Pass
Humidity	10	70	%	33.5	Pass
Velocity	2.07	2.13	m/s	2.126	Pass
Resistive Force	3450	4060	N	3989.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	P51736	10/25/2021	4/23/2022




Pendulum Acceleration
Acceleration (g's)
150
125
100
75
50
25
0
-25
0
2
4
6
8
Time [ms]
Max: 136.9 g's
Min: -1.7 g's
Filter: CFC 600


Change in Pendulum Velocity (Integrated Acceleration)
Velocity (m/s)
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Time [ms]
Max: 2.7 m/s
Filter: CFC 180

APPENDIX D

DUMMY CALIBRATION AND PERFORMANCE VERIFICATION DATA

Table 1 – Driver Dummy Instrumentation

Instrumentation		Axis/ Location	Hybrid III 50th S/N: 142		
			Serial Number	Manufacturer	Calibration Date
Head Accelerometers	Primary	X	7264C-2000-TZ-2_P51681	Endevco	11/16/2021
		Y	7264C-2000-TZ-2_P64151	Endevco	11/16/2021
		Z	7264C-2000-TZ-2_P52114	Endevco	11/16/2021
	Redundant	X	7264C-2000-TZ-2_P58833	Endevco	11/16/2021
		Y	7264C-2000-TZ-2_P58905	Endevco	11/16/2021
		Z	7264C-2000-TZ-2_P63996	Endevco	11/16/2021
Head Angular Rate Sensors		X	ARS PRO-8K_7589	DTS ARS PRO-8K	8/9/2021
		Y	ARS PRO-8K_7370	DTS ARS PRO-8K	8/9/2021
		Z	ARS PRO-18K_13095	DTS ARS PRO-18K	8/9/2021
Upper Neck Load Cell		FX, Fy, Fz MX,MY, MZ	IF-205_280-FX	FTSS IF-205-FX	9/14/2021
Chest Accelerometers	Primary	X	7264C-2000-TZ-2_P51991	Endevco	11/16/2021
		Y	7264C-2000-TZ-2_P80337	Endevco	1/14/2022
		Z	7264C-2000-TZ-2_P49185	Endevco	11/16/2021
	Redundant	X	7264C-2000-TZ-2_P68059	Endevco	11/16/2021
		Y	7264C-2000-TZ-2_P51713	Endevco	11/16/2021
		Z	7264C-2000-TZ-2_P78824	Endevco	11/16/2021
Chest Potentiometer		X	JDK 6209-2038_142GFE	Servo JDK 6209-2038	11/16/2021
Pelvis Accelerometer		X	7264C-2000-TZ-2_P58800	Endevco	11/16/2021
		Y	7264C-2000-TZ-2_P52157	Endevco	11/16/2021
		Z	7264C-2000-TZ-2_P52156	Endevco	11/16/2021
Femur Load Cells - Left	Primary	Z	3821JLN2_DT0998-FZ1	Denton	6/30/2021
	Redundant	Z	3821JLN2_DT0998-FZ2	Denton	6/30/2021
Femur Load Cells - Right	Primary	Z	3821JTF_117-FZ1	Denton	9/14/2021
	Redundant	Z	3821JTF_117-FZ2	Denton	9/14/2021
Tibia Load Cells - Left	Upper	MX, MY, FZ	3643_371-FZ	Denton	7/30/2021
	Lower	MX, MY, FZ	3644JFL_673-FZ	Denton	7/30/2021
Tibia Load Cells – Right	Upper	MX, MY, FZ	3643_361-FZ	Denton	7/30/2021
	Lower	MX, MY, FZ	3644_362-FZ	Denton	7/30/2021
Foot Accelerometers - Left	Rear	X	7264C-2000-TZ-2_P82756	Endevco	11/16/2021
	Front	Z	7264C-2000-TZ-2_P51872	Endevco	11/16/2021
Foot Accelerometers - Right	Rear	X	7264C-2000-TZ-2_P49195	Endevco	11/16/2021
	Front	Z	7264C-2000-TZ-2_P58779	Endevco	11/16/2021
Seat belt Load Cells	Lap		NA	NA	11/2/2019
	Shoulder		NA	NA	11/2/2019

Table 2 – Front Passenger Dummy Instrumentation

Instrumentation		Axis/Location	Hybrid III 5th S/N: 137		
			Serial Number	Manufacturer	Calibration Date
Head Accelerometers	Primary	X	7264C-2000-TZ-2_P79417	Endevco	2/1/2022
		Y	7264C-2000-TZ-2_P83335	Endevco	2/1/2022
		Z	7264C-2000-TZ-2_P64149	Endevco	2/1/2022
	Redundant	X	7264C-2000-TZ-2_P52008	Endevco	2/1/2022
		Y	7264C-2000-TZ-2_P52045	Endevco	2/1/2022
		Z	7264C-2000-TZ-2_P74774	Endevco	2/1/2022
Head Angular Rate Sensors		X	ARS PRO-8K_4718	DTS ARS PRO-18K	8/9/2021
		Y	ARS PRO-8K_7603	DTS ARS PRO-8K	8/9/2021
		Z	ARS PRO-8K_7521	DTS ARS PRO-8K	8/9/2021
Upper Neck Load Cell		FX, Fy, Fz MX,MY, MZ	1716ATF_2184-FX	Denton	6/24/2021
Chest Accelerometers	Primary	X	7264C-2000-TZ-2_T21142	Endevco	2/1/2022
		Y	7264C-2000-TZ-2_P83346	Endevco	2/1/2022
		Z	7264C-2000-TZ-2_P49190	Endevco	2/1/2022
	Redundant	X	7264C-2000-TZ-2_P58794	Endevco	2/1/2022
		Y	7264C-2000-TZ-2_P79602	Endevco	2/1/2022
		Z	7264C-2000-TZ-2_T11253	Endevco	2/1/2022
Chest Potentiometer		X	14CBI-3615_0720	Servo 14CBI	10/28/2021
Pelvis Accelerometer		X	7264C-2000-TZ-2_P58735	Endevco	1/31/2022
		Y	7264C-2000-TZ-2_P77587	Endevco	1/31/2022
		Z	7264C-2000-TZ-2_P51285	Endevco	1/31/2022
Femur Load Cells - Left	Primary	Z	3821JTF_119-FZ1	Denton	6/30/2021
	Redundant	Z	3821JTF_119-FZ2	Denton	6/30/2021
Femur Load Cells - Right	Primary	Z	3821JTF_109-FZ1	Denton	6/30/2021
	Redundant	Z	3821JTF_109-FZ2	Denton	6/30/2021
Tibia Load Cells - Left	Upper	MX, MY, FZ	3643_406-FZ	Denton	7/30/2021
	Lower	MX, MY, FZ	3644_360-FZ	Denton	7/30/2021
Tibia Load Cells – Right	Upper	MX, MY, FZ	3643_476-FZ	Denton	7/30/2021
	Lower	MX, MY, FZ	3644_359-FZ	Denton	7/30/2021
Foot Accelerometers - Left	Rear	X	7264C-2000-TZ-2_P78959	Endevco	1/31/2022
	Front	Z	7264C-2000-TZ-2_P83418	Endevco	1/31/2022
Foot Accelerometers - Right	Rear	X	7264C-2000-TZ-2_P83428	Endevco	1/31/2022
	Front	Z	7264C-2000-TZ-2_P80265	Endevco	1/31/2022
Seat belt Load Cells	Lap		NA	NA	5/4/2019
	Shoulder		NA	NA	5/4/2019

Table 3 – Vehicle Instrumentation

Instrumentation			Axis	Serial Number	Manufacturer	Calibration Date
Crossmember/Rear Seat Accelerometers	Left	Primary	X	1201-1000_A197003	Measurement Specialties	11/10/2021
			Z	1201-1000_A374291	Measurement Specialties	11/10/2021
		Redundant	X	1201-1000_A372831	Measurement Specialties	11/10/2021
	Right	Primary	X	1201-1000_A284258	Measurement Specialties	12/30/2021
			Z	1201-1000_A374221	Measurement Specialties	12/30/2021
		Redundant	X	1201-1000_A315823	Measurement Specialties	12/30/2021
Engine Accelerometers	Top		X	1201-1000_A374301	Measurement Specialties	11/12/2021
	Bottom		X	1201-1000_A271900	Measurement Specialties	12/29/2021