

REPORT NUMBER: 214P-CAL-24-013

**SAFETY COMPLIANCE TESTING FOR FMVSS 214
DYNAMIC SIDE IMPACT PROTECTION
RIGID POLE TEST**

**Alfa Romeo
2024 Alfa Romeo Tonale TI
5 Door SUV**

NHTSA No: C20240303

**PREPARED BY:
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May 13, 2024

FINAL REPORT

**PREPARED FOR:
U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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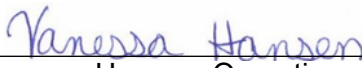
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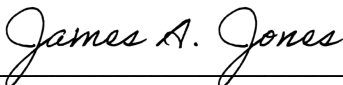
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16. Abstract A 31.00 km/h (19.3 mph), 75° oblique compliance test was conducted on the subject 2024 Alfa Romeo Tonale TI 5 Door SUV in accordance with the specifications of the Office of Vehicle Safety Compliance TP-214P-01 for the determination of FMVSS No.214 Side Impact Protection compliance. This test was conducted at Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on April 16, 2024. The impact velocity of the vehicle was 31.01 km/h, and the ambient temperature at the struck (driver's) side of the target vehicle was 21°C. The target vehicle's maximum post-test static crush was 345 mm located at level 3. The test vehicle's occupant performance data is as follows: <table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th colspan="3">Driver ATD (ES-2re)</th> </tr> <tr> <th>Units</th> <th>IARV</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC36)</td> <td></td> <td>1000</td> <td>435.349</td> </tr> <tr> <td>Maximum Thoracic Rib Deflection</td> <td>mm</td> <td>44</td> <td>26.977</td> </tr> <tr> <td>Total Abdominal Force</td> <td>N</td> <td>2500</td> <td>899.347</td> </tr> <tr> <td>Pubic Symphysis Force</td> <td>N</td> <td>6000</td> <td>1898.027</td> </tr> </tbody> </table> The two doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite doors did not open during the side impact event.						Measurement Description	Driver ATD (ES-2re)			Units	IARV	Result	Head Injury Criteria (HIC36)		1000	435.349	Maximum Thoracic Rib Deflection	mm	44	26.977	Total Abdominal Force	N	2500	899.347	Pubic Symphysis Force	N	6000	1898.027
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SECTION 1

PURPOSE AND SUMMARY OF TEST

PURPOSE

This side impact test was conducted as part of the FY 2024 FMVSS 214 Side Impact Protection Compliance Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. 693JJ923D000043. The purpose of this test was to evaluate side impact protection in a 2024 Alfa Romeo Tonale TI 5 Door SUV. The side impact test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure, TP-214P-01 dated September 2012.

SUMMARY

A rigid pole side impact test was conducted on a 2024 Alfa Romeo Tonale TI 5 Door SUV. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.01 km/h. The test was conducted by Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on April 16, 2024. Pre-test and post-test photographs of the test vehicle and side impact dummy (ES2re) are included in Appendix I of this report.

One Part 572U (ES-2re) dummy was placed in the driver designated seating position according to instructions specified in the TP-214P-01 Test Procedure, dated September 2012. The side impact event was documented by nine High Speed Cameras and one real time camera.

The ES2re male dummy was instrumented accordingly:

- Primary and redundant head CG tri-axial accelerometers
- Chest upper rib, middle rib, and lower rib y-axis displacement potentiometers
- Abdomen forward, middle, and rear y-axis load cells
- Lower spine (T12) tri-axial accelerometers
- Public symphysis y-axis load cell

Appendix II contains the dummy response data. Dummy configuration and performance verification data can be found in Appendix IV of this report. Appendix V identifies all serial numbers, manufacturers, and calibration dates for test equipment, dummy sensors, potentiometers, and load cells used to collect data during the test.

Injury readings for the ES2re dummy were recorded as follows:

INJURY READINGS

Measurement Description	Driver ATD (ES2re)		
	Units	IARV	Result
Head Injury Criteria (HIC36)		1000	435.349
Upper Rib Deflection	mm	44	25.069
Mid Rib Deflection	mm	44	24.274
Lower Rib Deflection	mm	44	26.977
Abdominal Load (front)	N		266.780
Abdominal Load (mid)	N		283.648
Abdominal Load (rear)	N		354.704
Total Abdominal Force	N	2500	899.347
Pubic Symphysis Force	N	6000	1898.027

SECTION 2
OCCUPANT AND VEHICLE INFORMATION

This section contains information reporting for the following Data Sheets:

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DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
 Test Facility: Calspan

NHTSA No.: C20240303
 Test Date: 04/16/2024

TEST VEHICLE INFORMATION AND OPTIONS

Make	Alfa Romeo	Anti-Lock Brakes (ABS)	Yes
Model	Tonale TI	All-Wheel Drive (AWD)	Yes
Body Style	SUV	Traction Control System (TCS)	Yes
VIN	ZASPATCW0R3039314	Electric Stability Control (ECS)	Yes
Body Color	Blue	Curtain Airbags	Yes
Engine Displacement (L)	1.3	Torso Airbags – Front Seats	Yes
Type / No. Cylinders	I4 Turbo PHEV	Torso Airbags – Rear Seats	No
Engine Placement	Transverse	Combination/Head Torso Bag	No
Transmission Type	Automatic	Pelvic Airbag – Front Seats	No
Transmission Speeds	6-Speed	Pelvis Airbag – Rear Seats	No
Overdrive	Yes	Knee Airbag – Driver	Yes
Final Drive	All Wheel Drive	Knee Airbag – Front Passenger	No
Odometer Reading (mi)	751	Seat Belt Pretensioners – Front Seats	Yes
		Seat Belt Pretensioners – Rear Seats	No
		Seat Belt Load Limiter – Front Seats	Yes
		Seat Belt Load Limiter – Rear Seats	No
		Tire Pressure Monitoring System (TPMS)	Yes
		Tilt Steering Wheel	Yes
		Automatic Door Locks (ADL)	Yes
		Power Window Auto-reverse	Yes
		Power Seats	Yes
		Other Safety Restraint	N/A

DATA FROM CERTIFICATION LABEL

Manufactured By	Alfa Romeo	GVWR (kg)	2420
Date of Manufacture	23/05	GVWR Front (kg)	1220
Vehicle Type	MPV	GVWR Rear (kg)	1285

VEHICLE SEATING AND WEIGHT CAPACITY DATA

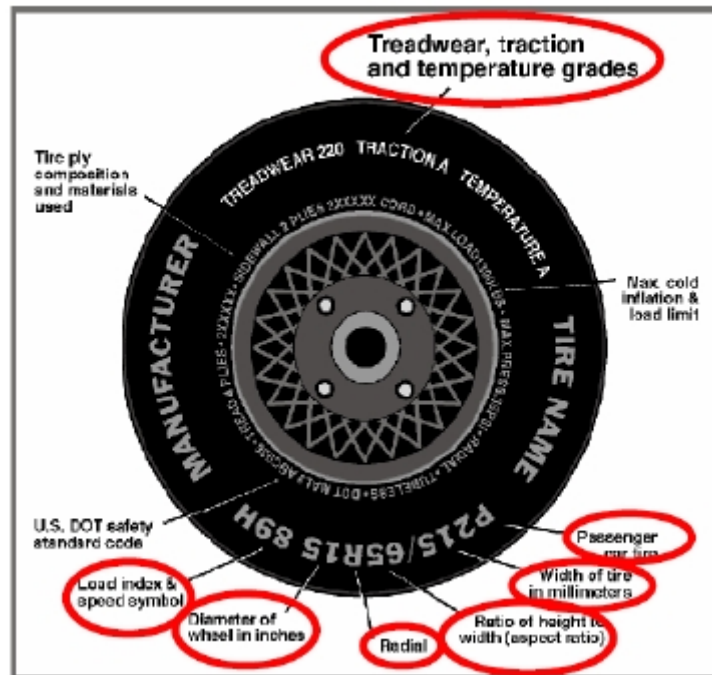
Measured Parameter	Front	Rear	Third	Total
Type of Seats (Bench or Bucket)	Bucket	Split Bench	N/A	
Designated Seating Capacity (DSC)	2	3	N/A	5
Capacity Weight (VCW) (kg)				567
Cargo Weight (RCLW) (kg)				136

DATA SHEET NO. 2 VEHICLE TIRE INFORMATION

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

Collected for year, make, model, & VIN, all items circled in red, tire manufacturer and tire name



VEHICLE TIRE INFORMATION

Tire Placard	Front	Rear
Recommended Cold Pressure (kPa)	240	240
Recommended Tire Size	225/55R18	225/55R18
Tire Sidewall	Front	Rear
Maximum Tire Pressure (kPa)	350	350
Tire Size on Vehicle	225/55R18	225/55R18
Tire Manufacturer Model	Goodyear	Goodyear
Tire Name	Eagle Sport	Eagle Sport
Tire Type	Sport	Sport
Tire Width	225	225
Aspect Ratio	Yes	Yes
Radial	Yes	Yes
Wheel Diameter	18"	18"
Load Index / Speed Symbol	98V	98V
Treadwear	560	560
Traction Grade	A	A
Temperature Grades	A	A

DATA SHEET NO. 3
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

TIRE PRESSURES

	Units	LF	RF	LR	RR
As Delivered	kPa	282	290	243	242
Tire Placard	kPa	240	240	240	240

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			Fully Loaded			As Tested		
		Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	kg	513	455		544	552		565	517	
Right	kg	500	431		506	515		538	487	
Ratio	%	53.3	46.7		49.6	50.4		52.3	47.7	
Totals	kg	1013	886	1899	1050	1067	2117	1103	1004	2107

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total As Delivered Weight (UVW)	kg	1899	(A)
Weight of Test Dummy	kg	81	(B)
Rated Cargo / Luggage Weight (RCLW)	kg	136	(C)
Calculated Vehicle Target Weight (TVTW)	kg	2116	(A+B+C)

TEST VEHICLE ATTITUDES AND CG

Measurement Description	Units	As Delivered	Fully Loaded	As Tested
Driver Door Sill Angle	Deg	-0.25	-0.95	-0.35
Front Passenger Sill Angle	Deg	-0.75	-0.10	-0.10
Front Bumper-Line Angle	Deg	-0.20	-0.25	-0.25
Rear Bumper-Line Angle	Deg	-3.10	+3.15	+3.15

ND = Nose Down (-), NU = Nose Up (+), LD = Left Down (-), LU = Left Up (+)

CALCULATION OF VERTICAL IMPACT REFERENCE LINE

Measured Parameter	Units	Value
Test Vehicle Wheelbase	mm	2630
Vertical Impact Reference Line Aft of Front Axle	mm	1270

WEIGHT OF BALLAST AND VEHICLE COMPONENTS REMOVED TO MEET TVTW

Component Description	Weight (kg)
Trunk Carpeting	8
Spare Tire	5
Right Passenger Rear Window	3
Ballast (if any)	79

DATA SHEET NO. 4
SEAT AND SEAT BELT ANCHORAGE ADJUSTMENT DATA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

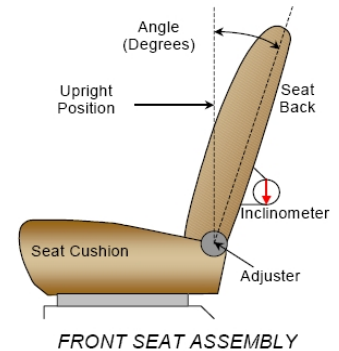
NHTSA No.: C20240303
Test Date: 04/16/2024

SEAT BACK ANGLE ADJUSTMENT

The driver and passenger seat backs are positioned to the manufacturer's designated angle provided in the Form1.

	Units	Seat Back Angle
Driver Seat	degrees	1.7
Front Passenger Seat	degrees	1.7

*Measurement taken on headrest post



SEAT HEIGHT AND ANGLE

Seat	As Tested SCRL Angle (Mid) (°)	SCR P Height Position	SCR P Height (mm)		
			Rearmost	Mid-Fore / Aft	Forward-Most
Driver Seat	18.2	Max	58	64	71
		Mid	32	39	44
		Min	5	12	18
Front Passenger Seat	20.2	Max	61	66	70
		Mid	32	38	44
		Min	3	10	16

SEAT FORE / AFT POSITION

Seat	Total Fore / Aft Travel		Placed in Position #	
	mm	Detents*	mm	Detents*
Driver Seat	299	Power	184	Power
Front Passenger Seat	297	Power	184	Power

SEAT BELT ANCHORAGE ADJUSTMENT

Seat	Total # of Positions	Placed in Position #
Driver Seat	5 (0-4)	Uppermost

HEAD RESTRAINT ADJUSTMENT

Seat	Total # of Positions	Placed in Position #
Driver Seat	5 (0-4)	Uppermost

DATA SHEET NO. 5 FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

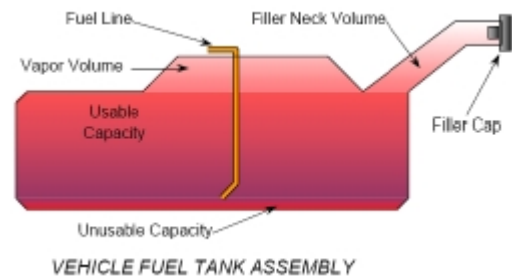
FUEL TANK CAPACITY DATA

Description	Liters
Usable Capacity of (Form No.1)	42.39
Usable Capacity of (Owner's Manual)	42.39
92 - 94% of Usable Capacity	39.0 - 39.8
Actual Amount of Solvent Used in Test	39.4

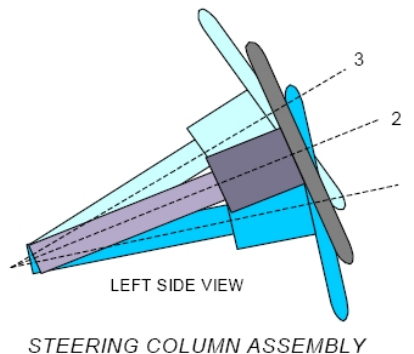
FUEL PUMP

Describe the operation of the fuel pump.

The vehicle is equipped with an electric fuel pump. The fuel filler neck is on the right 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.



STEERING COLUMN POSITIONS

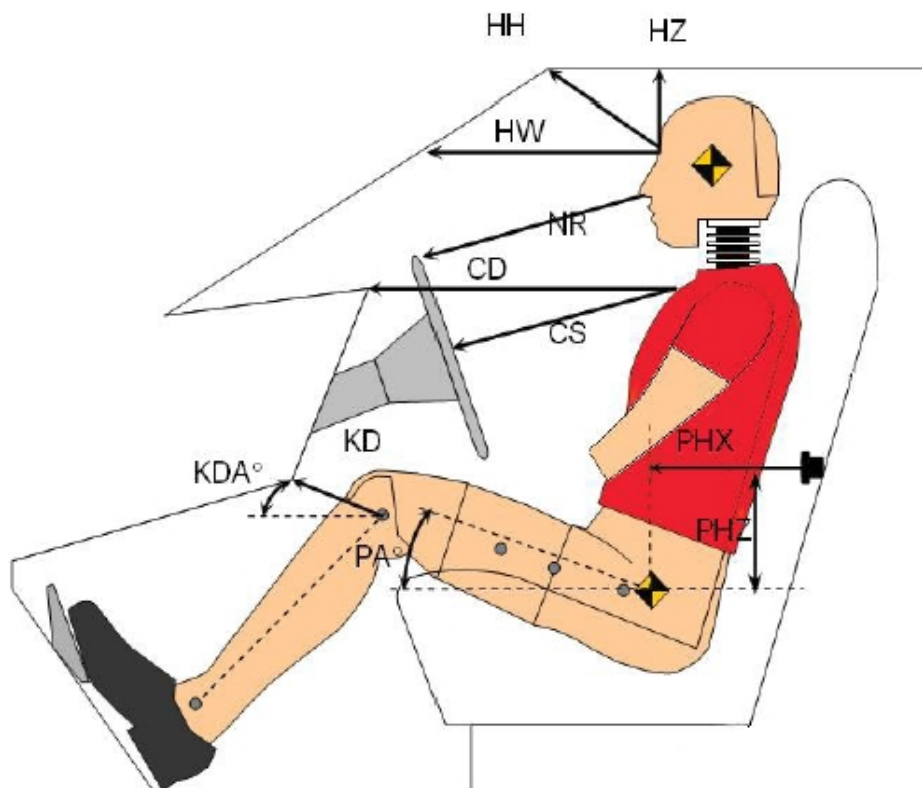


	Degrees	Fore / Aft Position (mm)
Lowermost - Position No. 1	23.6	
Geometric center - Position No. 2	26.3	
Uppermost - Position No. 3	28.9	
Telescoping Steering Wheel Travel		50
Test Position	26.3	25

DATA SHEET NO. 6
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
 Test Facility: Calspan

NHTSA No.: C20240303
 Test Date: 04/16/2024



Left Side View

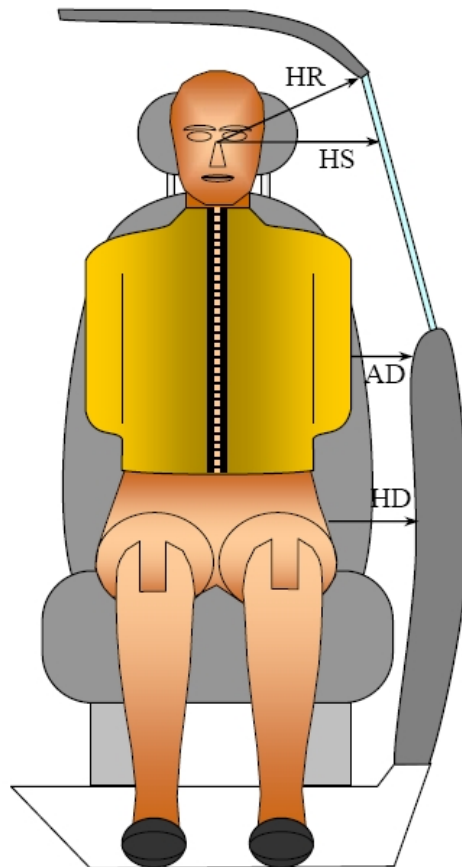
DUMMY LONGITUDINAL CLEARANCE DIMENSION INFORMATION

Driver Code	Description	Driver	
		Length (mm)	Angle (°)
HH	Head to Header	410	
HW	Head to Windshield	661	
HZ	Head to Roof Liner	194	
NR	Nose to Rim	465	
CD	Chest to Dash	629	
CS	Chest to Steering Wheel	385	
KD(L) / KDA(L)°	Left Knee to Dash	208	25.3
KD(R) / KDA(R)°	Right Knee to Dash	200	26.7
PAX°	Pelvic Tilt Angle (X-Axis)		23.4
PAY°	Pelvic Tilt Angle (Y-Axis)		0.8
PHX	Hip Point to Striker (X-Axis)	157	
PHZ	Hip Point to Striker (Z-Axis)	124	

DATA SHEET NO. 7
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024



FRONT VIEW OF DUMMY

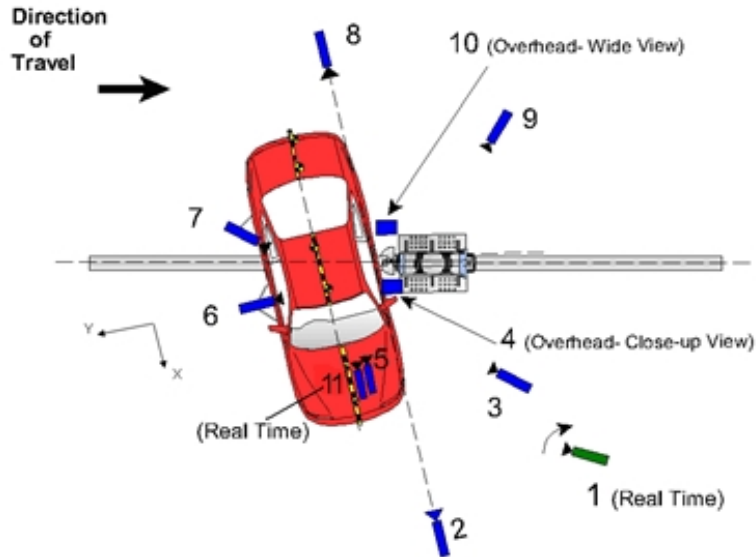
DUMMY LATERAL CLEARANCE DIMENSION INFORMATION

Code	Measurement Description	Units	Driver
HR	Head to Side Header	mm	222
HS	Head to Side Window	mm	353
AD	Arm to Door	mm	116
HD	H-Point to Door	mm	161

DATA SHEET NO. 8 LOCATION OF CAMERA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024



CAMERA LOCATIONS AND DATA

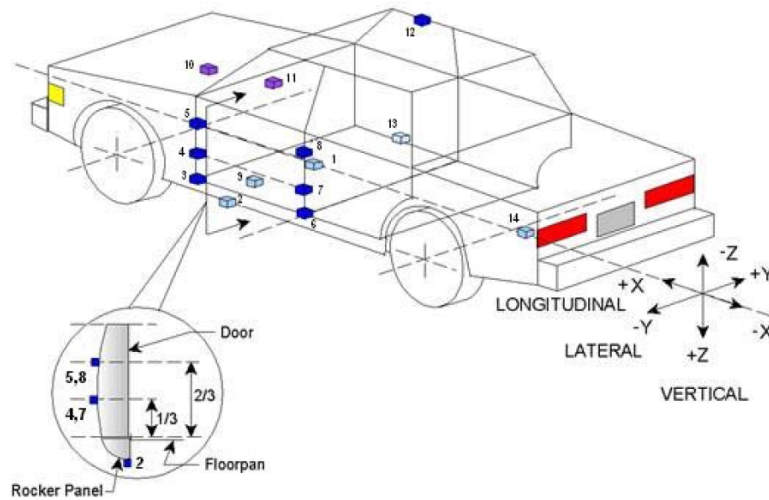
No.	Camera View	Coordinates (mm)			Lens Length (mm)	Operating Frame Rate (fps)
		X	Y	Z		
1	Real-time (24 - 30 fps) pan view of impact				Zoom	60
2	Front ground level - impact view	7804	0	-1464	28	1000
3	Impact side 45° - forward pole view	4642	-811	-1513	24	1000
4	Overhead Close-up view of impact	0	0	-9375	28	1000
5	Onboard - dummy front view					1000
6	Onboard - dummy side view					1000
7	Onboard - dummy rear oblique view					1000
8	Rear ground level - impact view	-8021	0	-1454	28	1000
9	Impact side 45° - rearward pole view	-3973	-3211	-1488	24	1000
10	Overhead wide - view of impact	0	0	-9375	12.5	1000

Notes: Reference - From Point of Impact for X and Y; from Ground for Z
+X = Forward of vehicle, +Y = Right of vehicle, +Z = Down
* All measurements accurate to ± 6 mm. Vehicle is at a 75° angle to the rigid pole.

DATA SHEET NO. 9 **TEST VEHICLE ACCELEROMETER LOCATIONS**

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024



TEST VEHICLE ACCELEROMETER LOCATIONS

No.	Accelerometer Location	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2531	-7	805
2	Left Floor Sill	2738	-600	393
3	A-Pillar Sill	3025	-594	410
4	A-Pillar Low	3059	-596	648
5	A-Pillar Mid	2957	-626	1163
6	B-Pillar Sill	2053	-652	482
7	B-Pillar Low	1997	-662	835
8	B-Pillar Mid	1974	-641	1101
9	Seat	2122	-560	397
10	Engine	3773	293	916
11	Firewall	3509	56	989
12	Roof	2265	614	1573
13	Right Floor Sill	2733	603	429
14	Rear Deck	550	-4	551

Reference: X – Rear surface of vehicle (+ forward)
Y – Vehicle centerline (+ to right)
Z – Ground plane (+ down)

DATA SHEET NO. 10
TEST VEHICLE ACCELEROMETER DATA SUMMARY

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

Loc. No	Description	Axes	Units	Positive Direction		Negative Direction	
				Max	Time (ms)	Max	Time (ms)
1	Vehicle CG	X	g	22.09	81.25	-24.07	86.15
	Vehicle CG	Y	g	68.89	39.45	-30.36	84.80
	Vehicle CG	Z	g	16.12	38.50	-22.20	71.80
	Vehicle CG Resultant	N/A	g	71.34	39.35	0.03	-11.70
2	Floor Sill (Left)	Y	g	35.14	44.45	-27.78	49.65
3	A Pillar Sill	Y	g	41.56	44.30	-22.94	52.00
4	A Pillar Low	Y	g	28.08	24.75	-12.95	15.65
5	A Pillar Mid	Y	g	65.94	15.20	-30.07	59.25
6	B Pillar Sill	Y	g	57.97	31.00	-39.26	50.40
7	B Pillar Low	Y	g	72.13	14.05	-88.92	17.80
8	B Pillar Mid	Y	g	81.16	17.00	-118.26	13.55
9	Seat	Y	g	103.28	29.75	-25.86	49.10
10	Engine Top	X	g	11.66	143.70	-22.28	38.75
	Engine Top	Y	g	13.15	43.35	-7.11	205.40
11	Firewall	Y	g	14.31	42.40	-2.82	46.95
12	Roof	Y	g	51.31	38.45	-28.15	50.55
13	Floor Sill (Right)	Y	g	15.22	28.15	-1.38	264.85
14	Rear Deck	X	g	5.15	33.90	-8.29	52.90
	Rear Deck	Y	g	21.18	42.95	-3.14	192.60

DATA SHEET NO. 11
DUMMY INJURY RESPONSE DATA
(Subpart U, ES-2re)

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV

NHTSA No.: C20240303

Test Facility: Calspan

Test Date: 04/16/2024

Dummy Serial No. D037

Description	Axes	Positive Direction		Negative Direction	
		Max	Time (ms)	Max	Time (ms)
HEAD ACCELERATION (g)					
Longitudinal	X	3.98	76.30	-18.17	53.80
Lateral	Y	66.68	56.60	-16.92	99.40
Vertical	Z	12.80	46.85	-2.21	142.95
Resultant	N/A	69.01	56.60		
HIC36 (t1, t2)	N/A	435.35		t1 = 47.55	t2 = 67.45
THORAX DEFLECTION (mm)					
Upper Rib	Y	25.07	51.75	-7.02	22.55
Middle Rib	Y	24.27	51.60	-1.08	92.30
Lower Rib	Y	26.98	50.20	0.00	-2.85
ABDOMINAL FORCES (N)					
Front	Y	266.78	45.20	-11.92	245.75
Middle	Y	283.65	44.90	-2.97	-35.80
Rear	Y	354.70	43.25	-3.81	148.55
SUM	N/A	899.35	45.15		
PELVIS FORCES (N)					
Pubic Symphysis	Y	7.94	174.80	-1898.03	59.50

Reference: Positive Direction - Longitudinal (X) = forward
 - Lateral (Y) = to right
 - Vertical (Z) = down

DATA SHEET NO. 12
POST-TEST OBSERVATIONS

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

IMPACT POINT DATA

Measured Parameter	Units	Value
Vertical Impact Ref Line - Aft of Front Axle, Intended Impact Pt	mm	1270
Actual Impact Point - Aft of Front Axle	mm	1270
Difference	mm	2

TEST DUMMY INFORMATION AND CONTACT POINTS

Dummy Body Part	Driver Seat Dummy (ES2-re)
Head Contact	Curtain Airbag & Headrest
Upper Torso Contact	Seatback & Torso/Pelvis Airbag
Lower Torso Contact	Seatback
Left Knee Contact	None
Right Knee Contact	Left Knee

POST-TEST DOOR PERFORMANCE

Description	Struck Side		Non-Struck Side		Rear Hatch/Other
	Front	Rear	Front	Rear	
Remained Closed and Operational	No	No	Yes	Yes	Yes
Total Separation from Vehicle at Hinges or Latches	No	No	No	No	No
Latch or Hinge Systems Pulled Out of Their Anchorages	No	No	No	No	No
Disengaged from Latched Position	No	No	No	No	No
Latch Separated from Striker	No	No	No	No	No
Jammed Shut	Yes	Yes	No	No	No
If Door Opened at Striker, Width of Opening at Striker (mm)	0	0	0	0	0

POST-TEST SEAT PERFORMANCE

Description	Struck Side		Non-Struck Side	
	Front	Rear	Front	Rear
Seat Movement Along Seat Track	No	No	No	No
Seat Disengagement from Floor Pan	No	No	No	No

POST-TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Pillar Performance	A-Pillar, B-Pillar & C-Pillar Buckled
Sill Separation	None
Windshield Damage	Cracks throughout with separation along driver's A-Pillar
Side Window Damage	Driver window shattered during impact event
Other Notable Effects	Roof separated from side rail along drive door on impact side

DATA SHEET NO. 12 ... (CONTINUED)
POST-TEST OBSERVATIONS

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

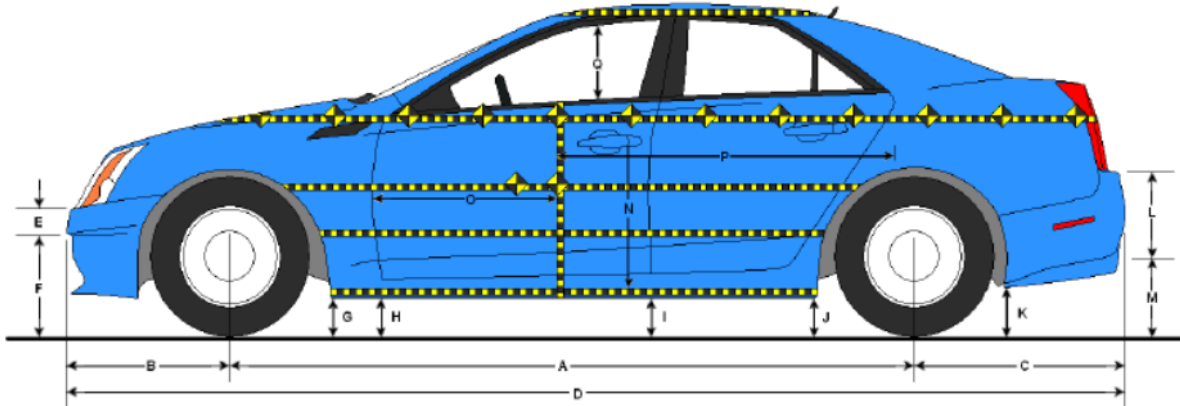
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Struck Side Front Occupant	
	Mounted	Deployed
Front Airbag	Yes	No
Knee Airbag	Yes	No
Curtain Airbag	Yes	Yes
Side Airbag 2 - Torso/Pelvis Airbag	Yes	Yes
Seat Belt Pretensioner	Yes	Yes
Seat Belt Load Limiter	Yes	Yes
Other		

DATA SHEET NO. 13
VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
 Test Facility: Calspan

NHTSA No.: C20240303
 Test Date: 04/16/2024



LEFT SIDE VIEW

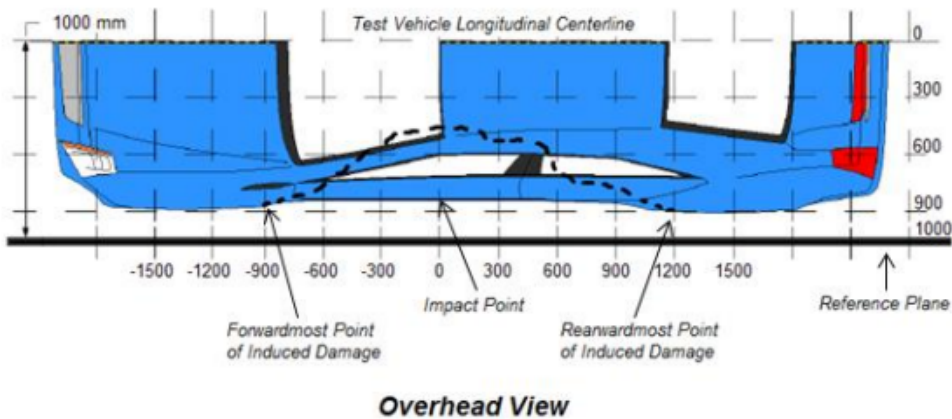
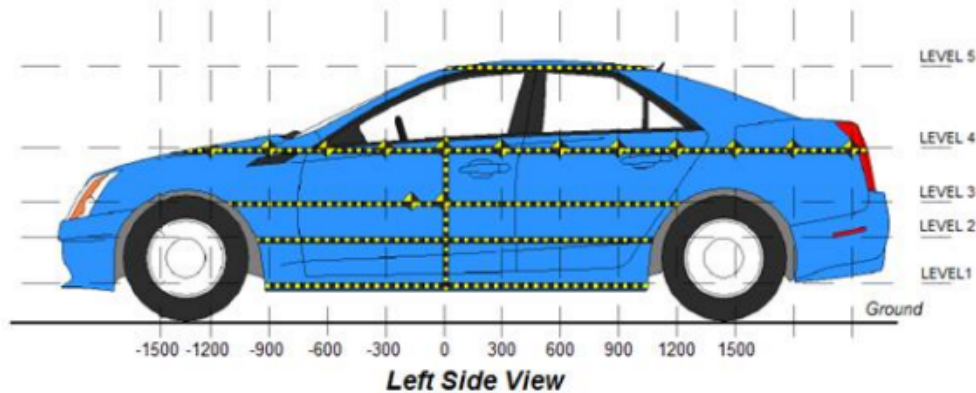
VEHICLE PRE- AND POST-TEST MEASUREMENT INFORMATION

No.	Measurement Description	Pre-Test	Post-Test	Difference
A	Vehicle Wheelbase	2630	2593	-37
B	Front Axle to FSOV	947	971	24
C	Rear Axle to RSOV	946	937	-9
D	Total Vehicle Length at Centerline	4523	4501	-22
E	Front Bumper Thickness	115	115	0
F	Front Bumper Bottom to Ground	504	520	16
G	Sill Height at Front Wheel Well	246	246	0
H	Sill Height at Front Door Leading Edge	248	268	20
I	Sill Height at B Pillar	248	266	18
J1	Sill Height at Rear Wheel Well	254	287	33
J2	Pinch Weld Height at Rear Wheel Well	256	264	8
K	Sill Height Aft of Rear Wheel Well	257	267	10
L	Rear Bumper Thickness	137	137	0
M	Rear Bumper Bottom to Ground	475	477	2
N	Sill Height to Window Bottom Sill	846	853	7
O	Front Door Leading Edge to Impact CL	788	728	-60
P	Rear Door Trailing Edge to Impact CL	1250	1177	-74
Q	Front Window Opening	397	393	-4
R	Right Side Length	4337	4334	-3
S	Left Side Length	4335	4300	-35
T	Vehicle Width at B-Pillars	1817	1662	-155

DATA SHEET NO. 14 **TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS**

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
 Test Facility: Calspan

NHTSA No.: C20240303
 Test Date: 04/16/2024



MAXIMUM EXTERIOR CRUSH MEASUREMENTS

Level	Measurement Description	Units	Height Above Ground	Maximum Exterior Static Crush	Distance from Impact
1	Sill Top	mm	401	291	0
2	Occupant H-Point	mm	662	342	0
3	Mid-Door	mm	793	345	0
4	Window Sill	mm	1078	289	0
5	Window Top	mm	1543	106	0

NOTE: The above measurements should be taken along the vertical impact reference line. Vehicle measurements forward of the vertical impact reference line are negative.

DATA SHEET NO. 14
VEHICLE EXTERIOR CRUSH MEASUREMENTS (CONTINUED)

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
 Test Facility: Calspan

NHTSA No.: C20240303
 Test Date: 04/16/2024

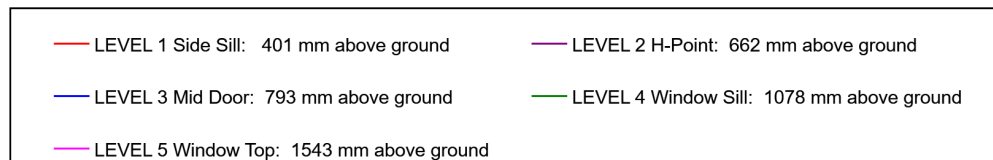
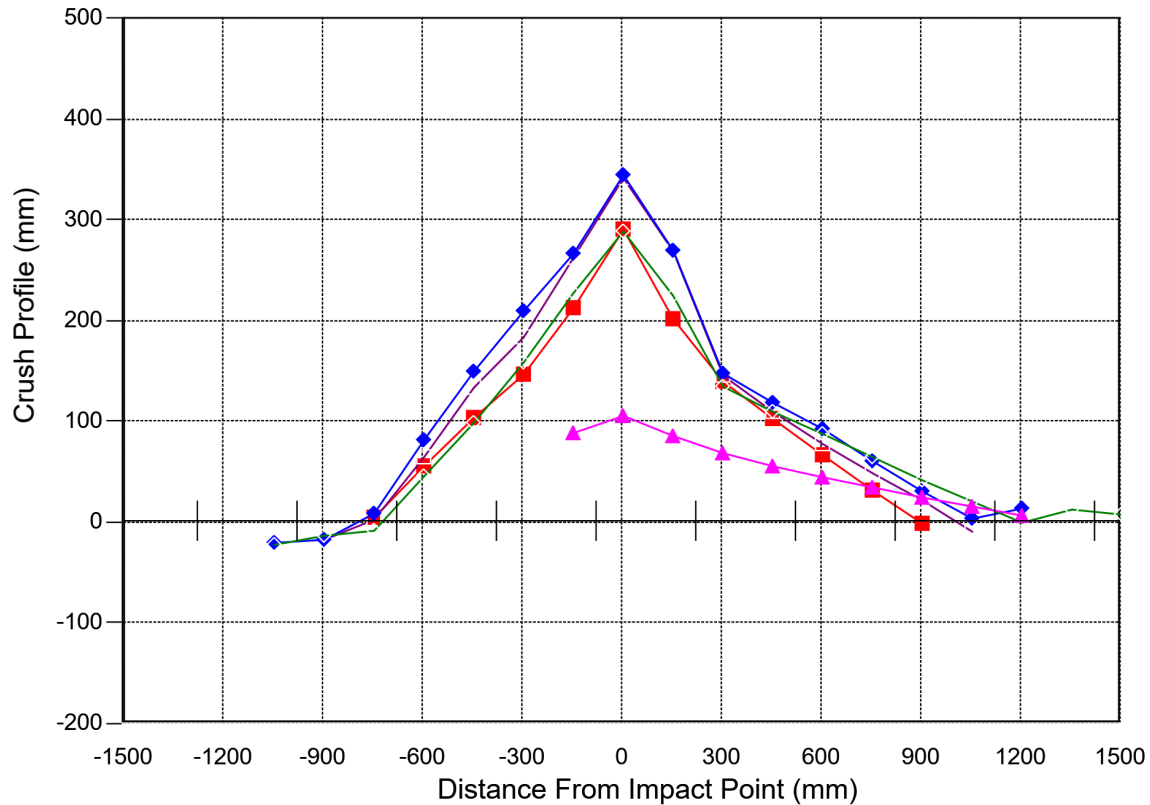
EXTERIOR CRUSH MEASUREMENTS AT EACH LEVEL

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1500															
-1350															
-1200															
-1050			919	769				939	791				-20	-22	
-900		913	916	795			930	933	808			-17	-17	-13	
-750	892	910	913	813		887	907	904	821		5	3	9	-8	
-600	878	907	914	829		822	842	832	783		56	65	82	46	
-450	873	906	913	840		769	772	763	741		104	134	150	99	
-300	868	904	911	847		721	720	701	688		147	184	210	159	
-150	863	903	909	851	599	650	640	642	623	510	213	263	267	228	89
0	860	901	906	856	616	569	559	561	567	510	291	342	345	289	106
150	860	901	903	859	623	658	632	633	634	537	202	269	270	225	86
300	863	900	901	860	623	723	754	753	725	554	140	146	148	135	69
450	864	900	898	861	620	761	790	779	751	564	103	110	119	110	56
600	870	900	895	861	613	803	822	802	773	568	67	78	93	88	45
750	887	904	895	859	601	855	855	834	794	566	32	49	61	65	35
900	902	914	903	856	585	903	892	872	814	560	-1	22	31	42	25
1050		919	917	853	558		928	913	832	542		-9	4	21	16
1200			919	849	528			905	849	521			14	0	7
1350				841					828					13	
1500				832					824					8	

DATA SHEET NO. 14
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS (CONTINUED)

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024



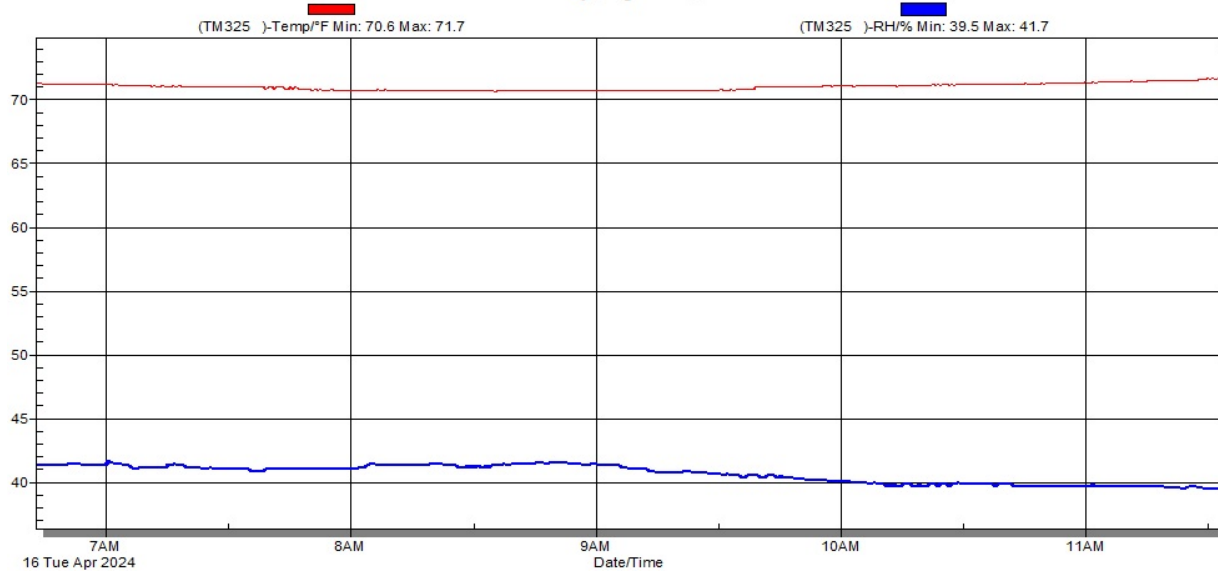
Vehicle Exterior Crush Measurements - Visual Representation

DATA SHEET NO. 16
DUMMY / VEHICLE TEMPERATURE AND HUMIDITY STABILIZATION DATA

Test Vehicle: 2024 Alfa Romeo Tonale TI 5 Door SUV
Test Facility: Calspan

NHTSA No.: C20240303
Test Date: 04/16/2024

Tuesday, April 16, 2024



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

APPENDIX I
PHOTOGRAPHS

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23	Post-Test $\frac{3}{4}$ Rear View of Impact Zone	I-14
24	Post-Test Close-Up View of Impact Point Target	I-14
25	Close-Up View of Vehicle's Certification Label	I-15
26	Close-Up View of Vehicle's Tire Placard Label	I-15



Figure A-1: Pre-Test Frontal View of Test Vehicle



Figure A-2: Post Test Frontal View of Test Vehicle



Figure A-3: Pre-Test Rear View of Test Vehicle



Figure A-4: Post-Test Rear View of Test Vehicle

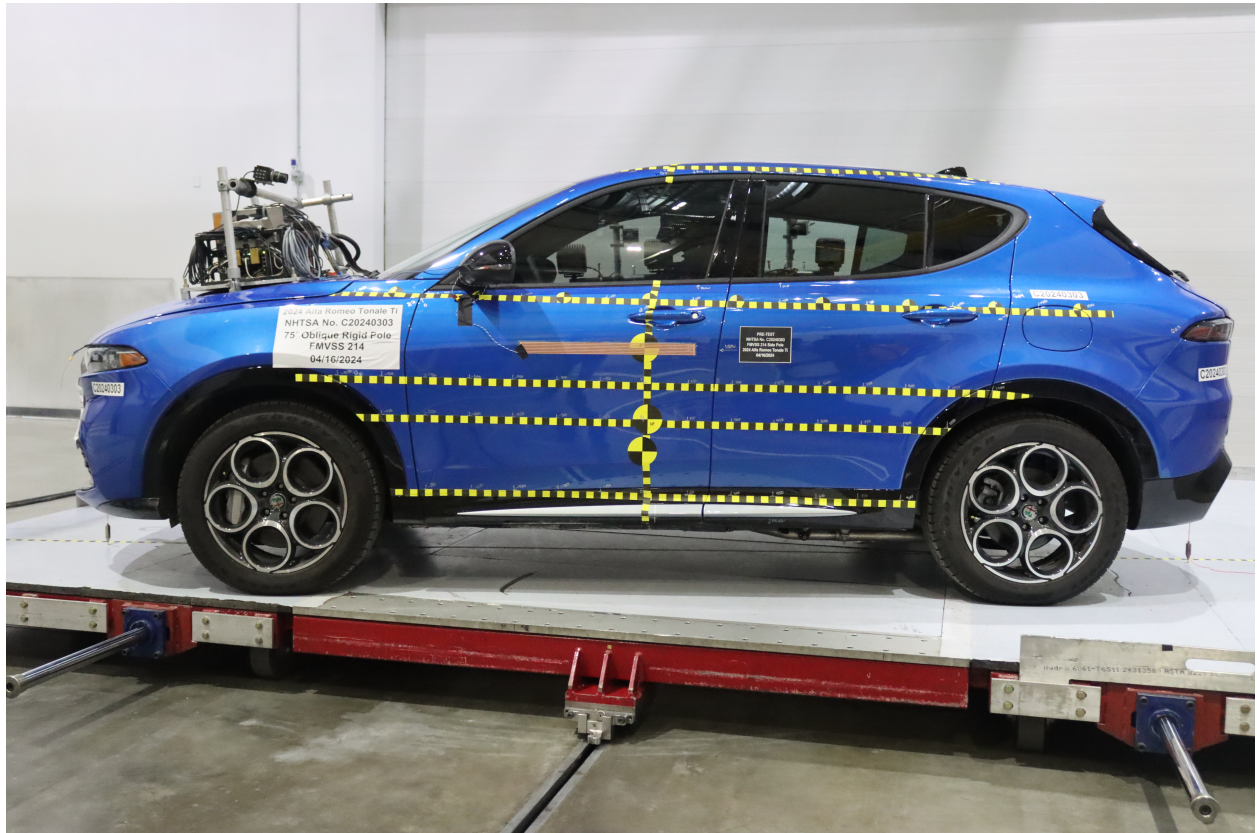


Figure A-5: Pre-Test Impacted Side View of Test Vehicle



Figure A-6: Post-Test Impacted Side View of Test Vehicle



Figure A-7: Pre-Test Left $\frac{3}{4}$ Front View of Vehicle and Pole



Figure A-8: Pre-Test Left $\frac{3}{4}$ Rear View of Vehicle and Pole



Figure A-9: Pre-Test Overhead View of Test Vehicle



Figure A-10: Post-Test Overhead View of Test Vehicle



Figure A-11: Pre-Test Dummy Through Opposite Window



Figure A-12: Post-Test Dummy Through Opposite Window



Figure A-13: Pre-Test Close-Up of Dummy with Door Closed (Impact Side)



Figure A-14: Post-Test Close-Up of Dummy with Door Closed (Impact Side)



Figure A-15: Pre-Test Dummy with Door Open



Figure A-16: Pre-Test Dummy Shoulder and Door Top View



Figure A-17: Post-Test Dummy Shoulder and Door Top View



Figure A-18: Pre-Test Interior of Front Door Closed (through opposite window)



Figure A-19: Post-Test Interior of Front Door Showing Dummy Impact Locations

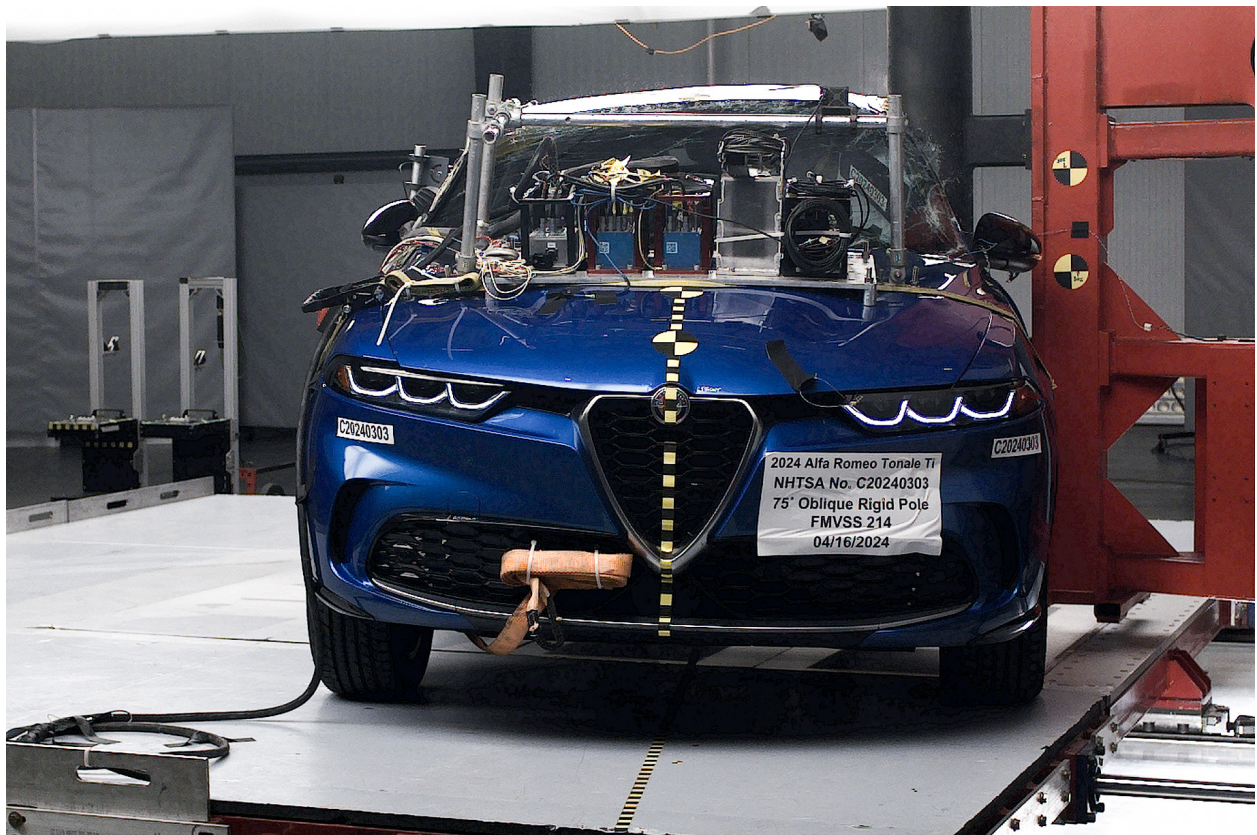


Figure A-20: Impact Event



Figure A-21: Post-Test Impact Zone Close-Up View



Figure A-22: Post-Test $\frac{3}{4}$ Front View of Impact Zone



Figure A-23: Post-Test ¾ Rear View of Impact Zone



Figure A-24: Post-Test Close-Up View of Impact Point Target



Figure A-25: Close-Up View of Vehicle's Certification Label



Figure A-26: Close-Up View of Vehicle's Tire Placard Label

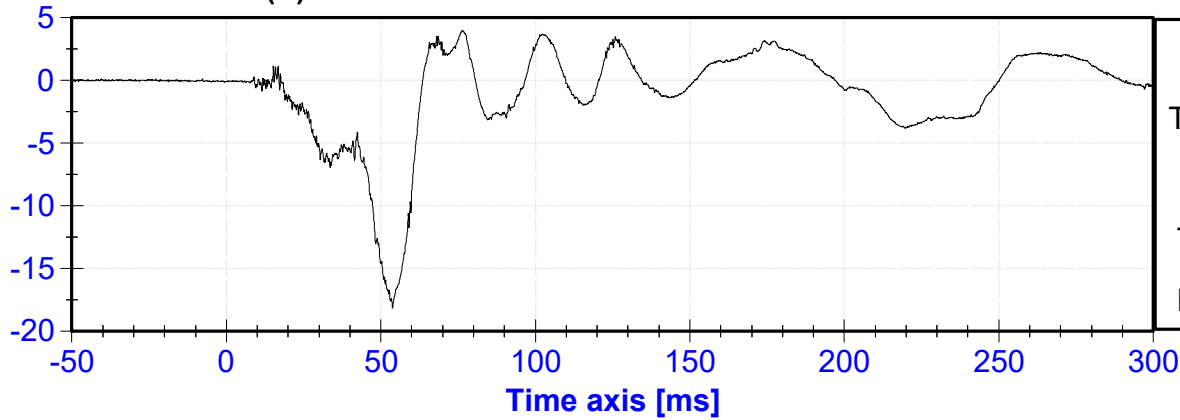
APPENDIX II

ES-2re DUMMY RESPONSE DATA TRACES

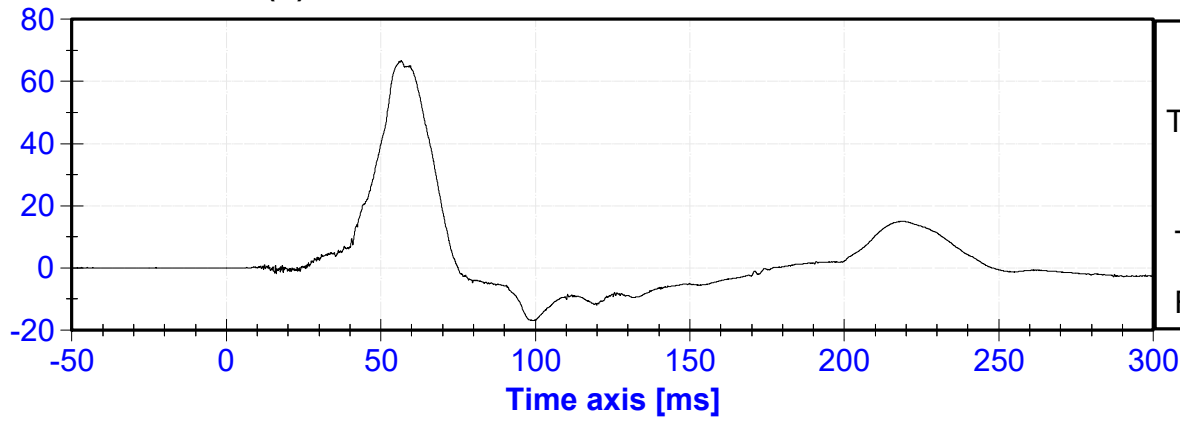
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17	ES-2re Sum of Abdomen Forces vs. Time	II-7
18	ES-2re Pubic Symphysis Force (Y) vs. Time	II-7

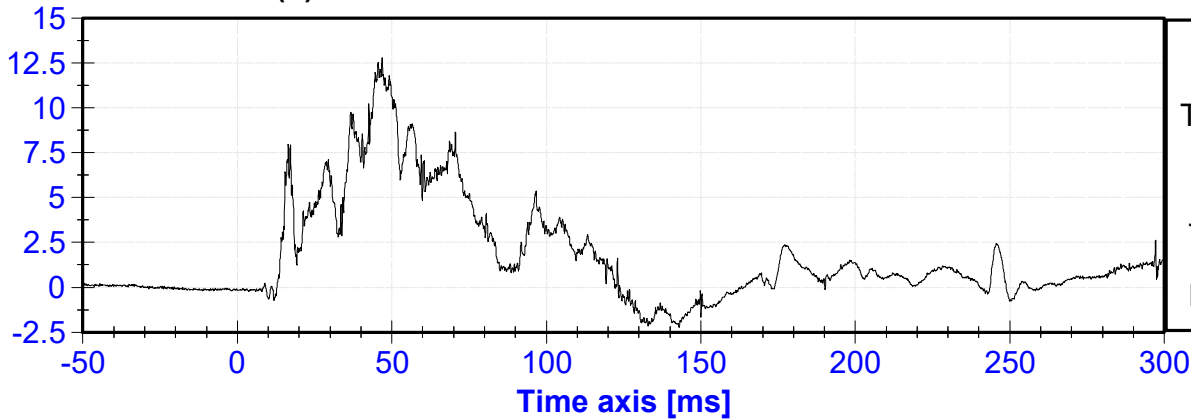
ES-2re Head (X) Acceleration vs. Time



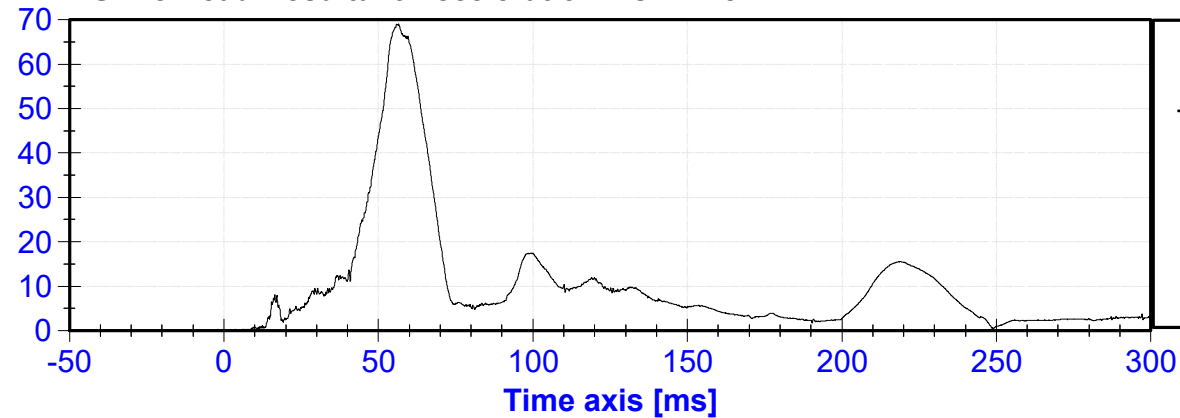
ES-2re Head (Y) Acceleration vs. Time



ES-2re Head (Z) Acceleration vs. Time

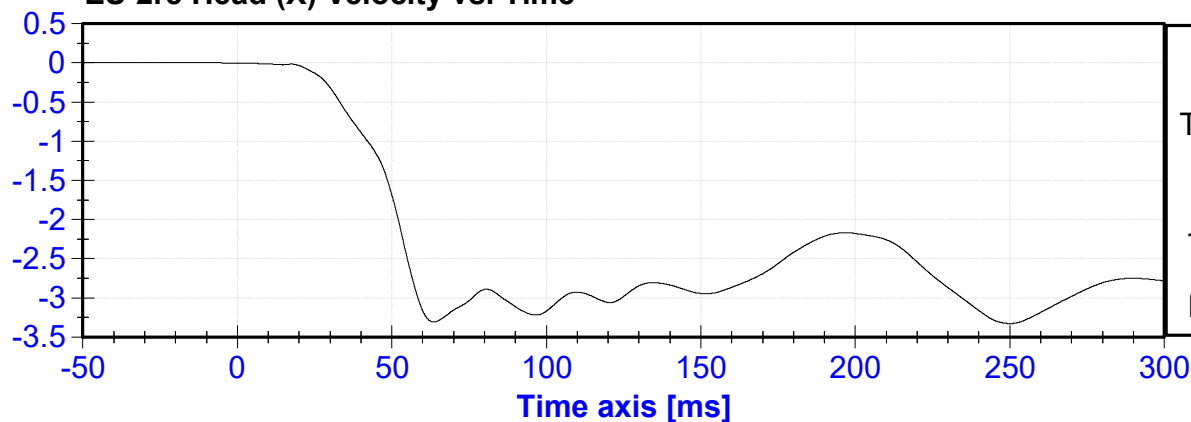


ES-2re Head Resultant Acceleration vs. Time



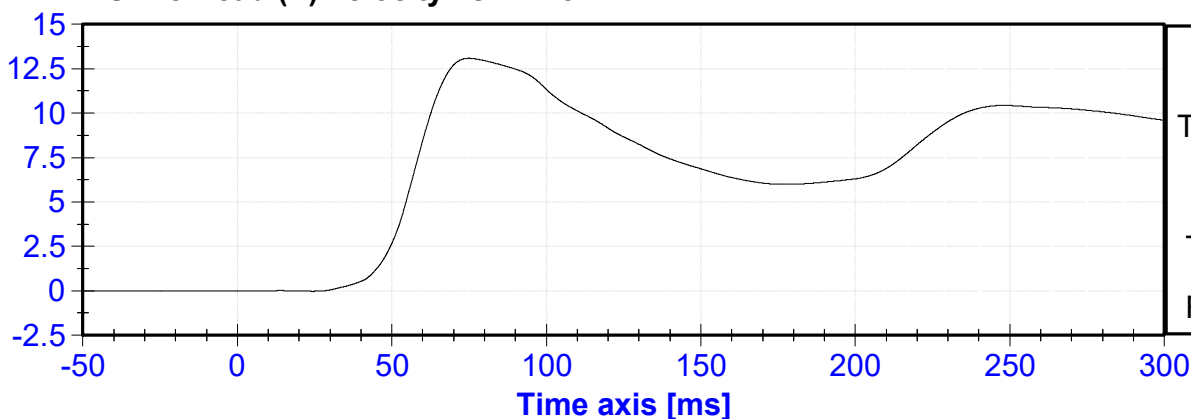
ES-2re Head (X) Velocity vs. Time

VELOCITY [m/s]



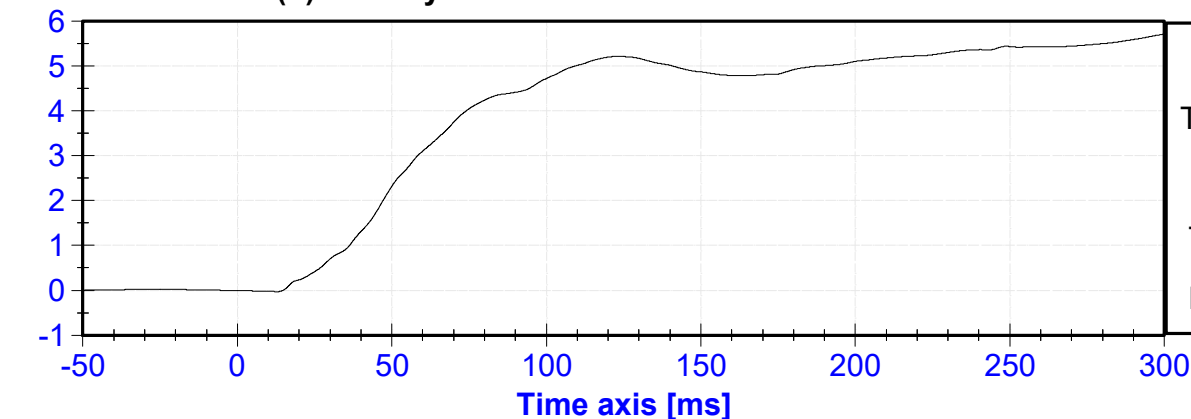
ES-2re Head (Y) Velocity vs. Time

VELOCITY [m/s]



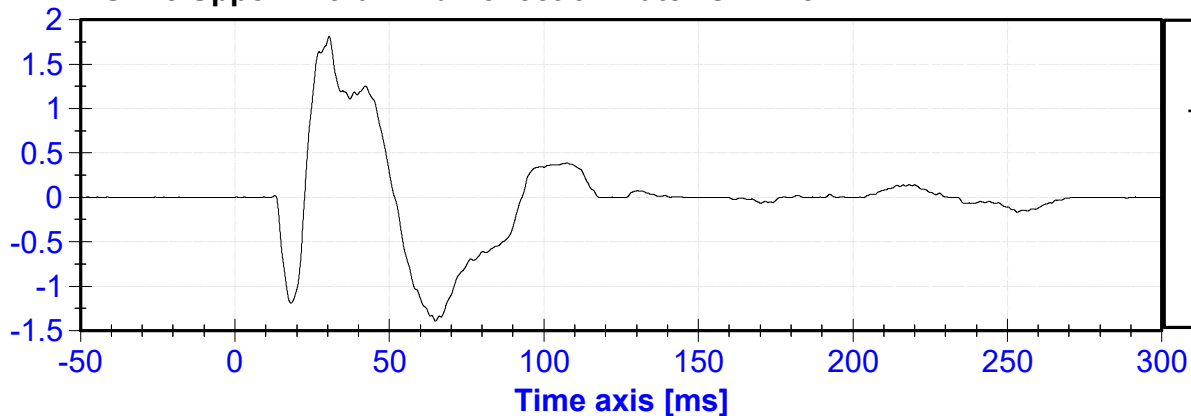
ES-2re Head (Z) Velocity vs. Time

VELOCITY [m/s]

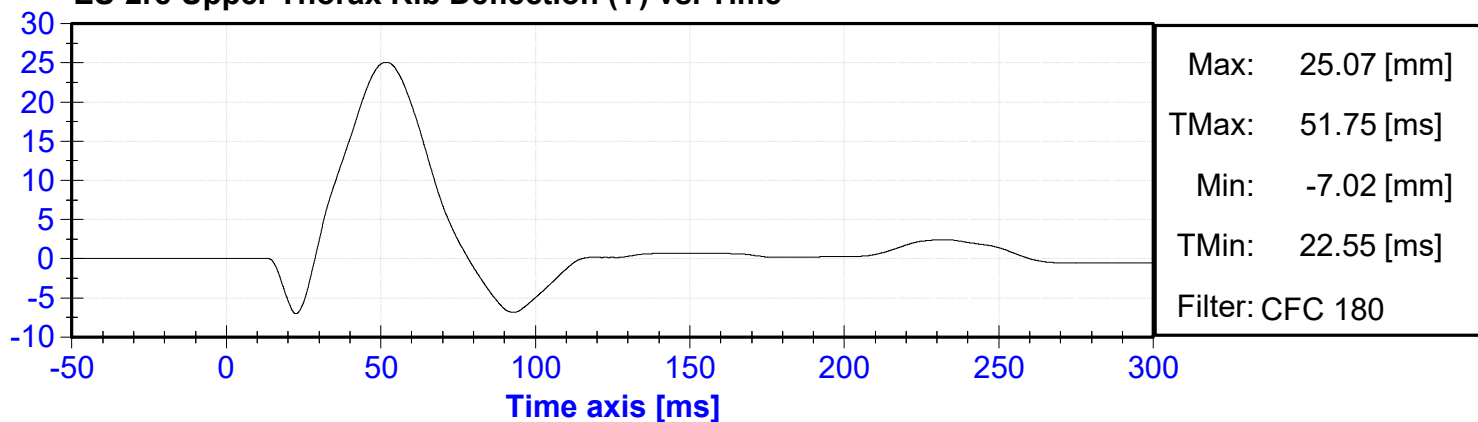


ES-2re Upper Thorax Rib Deflection Rate vs. Time

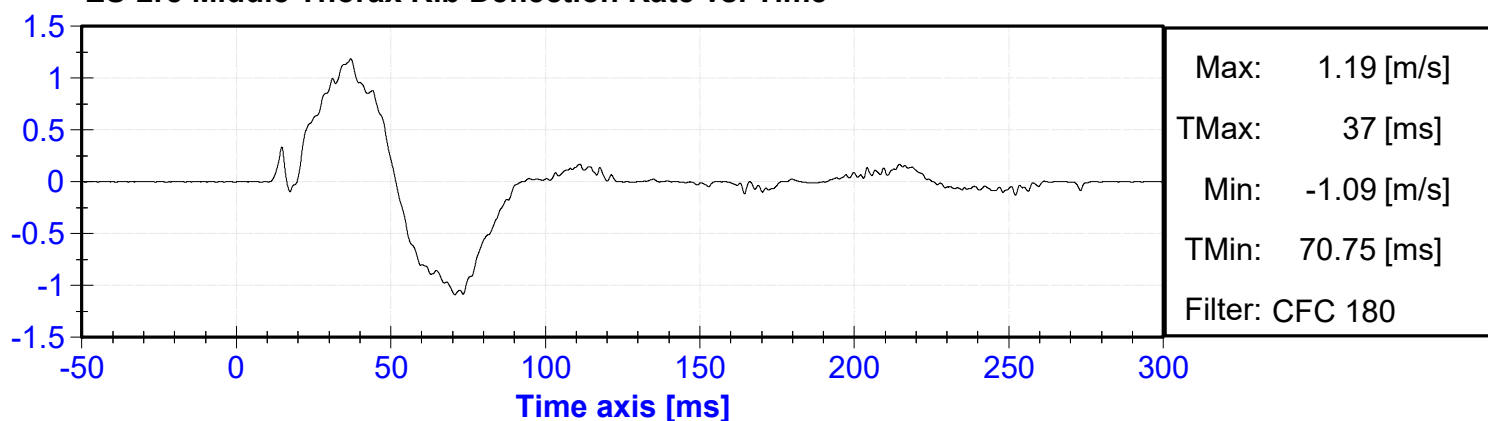
VELOCITY [m/s]



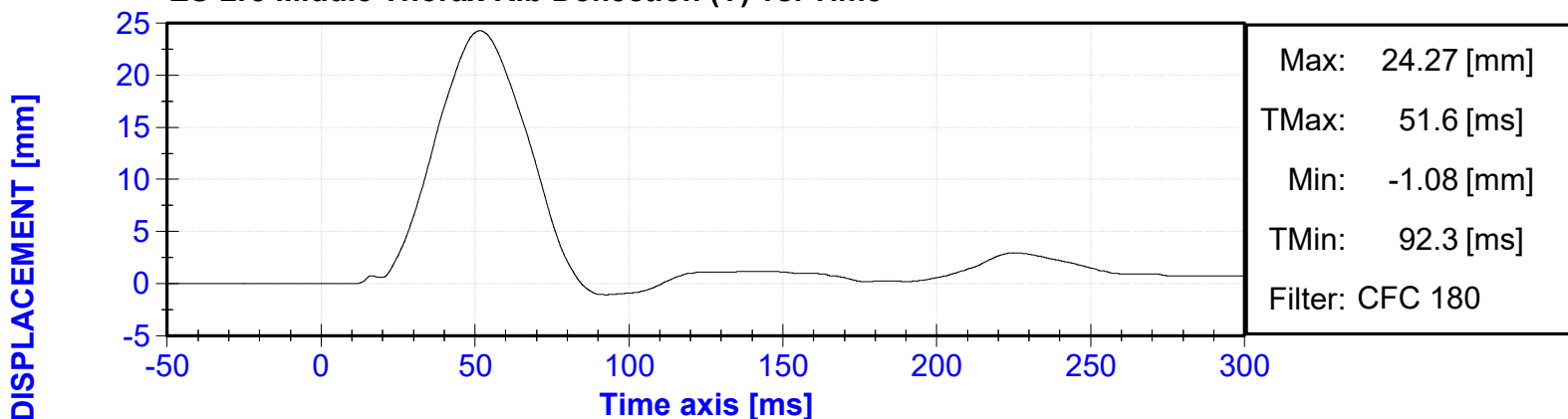
ES-2re Upper Thorax Rib Deflection (Y) vs. Time



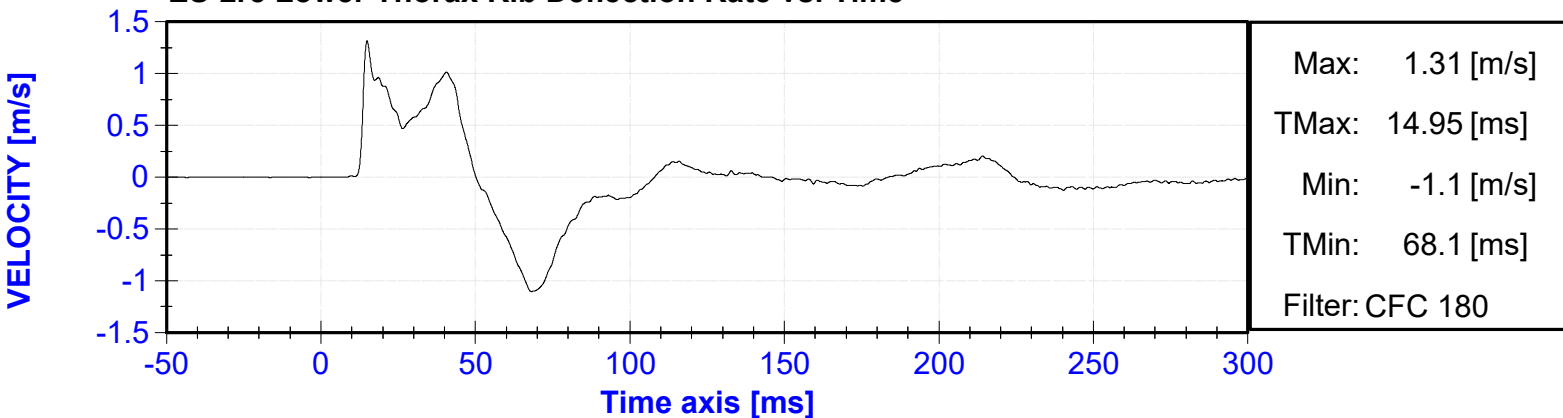
ES-2re Middle Thorax Rib Deflection Rate vs. Time



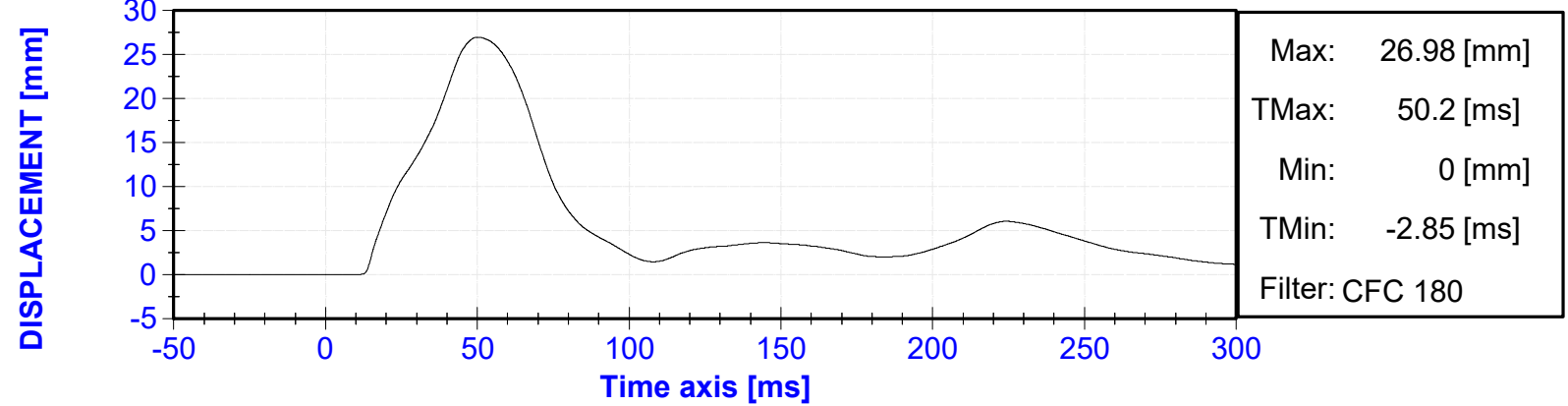
ES-2re Middle Thorax Rib Deflection (Y) vs. Time



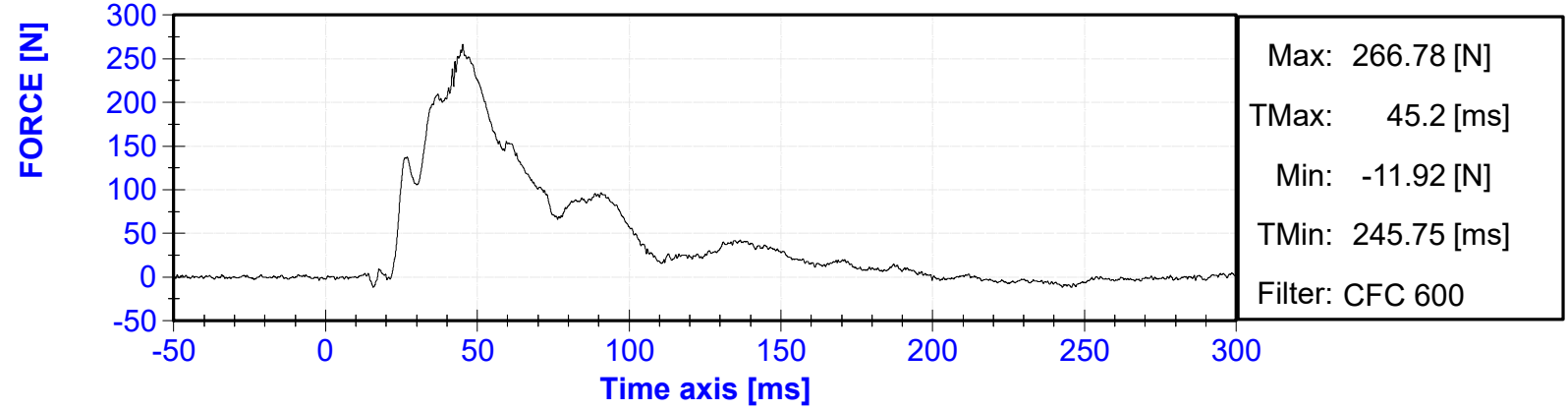
ES-2re Lower Thorax Rib Deflection Rate vs. Time



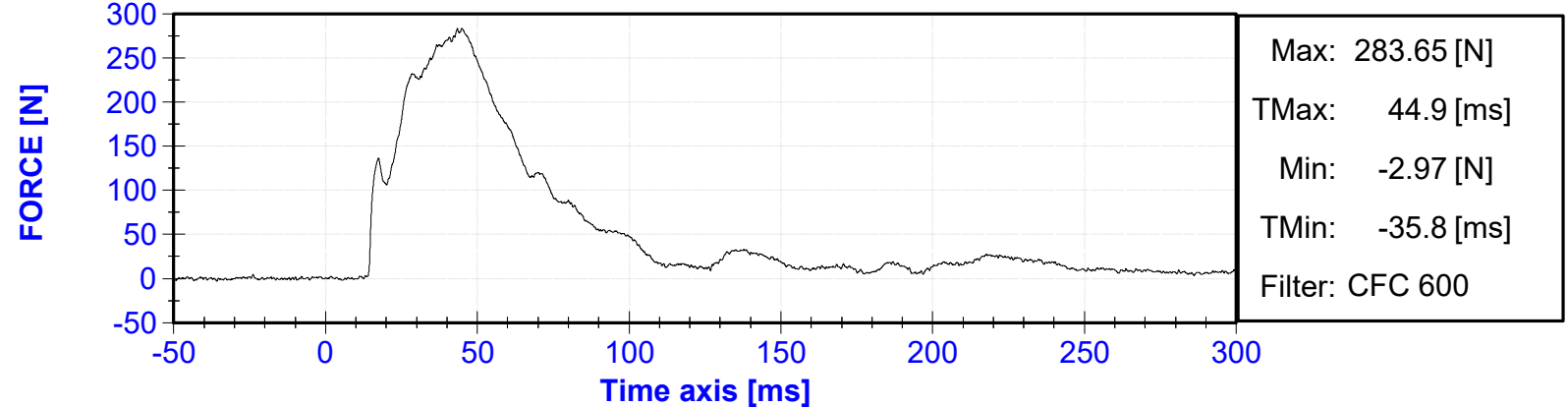
ES-2re Lower Thorax Rib Deflection (Y) vs. Time



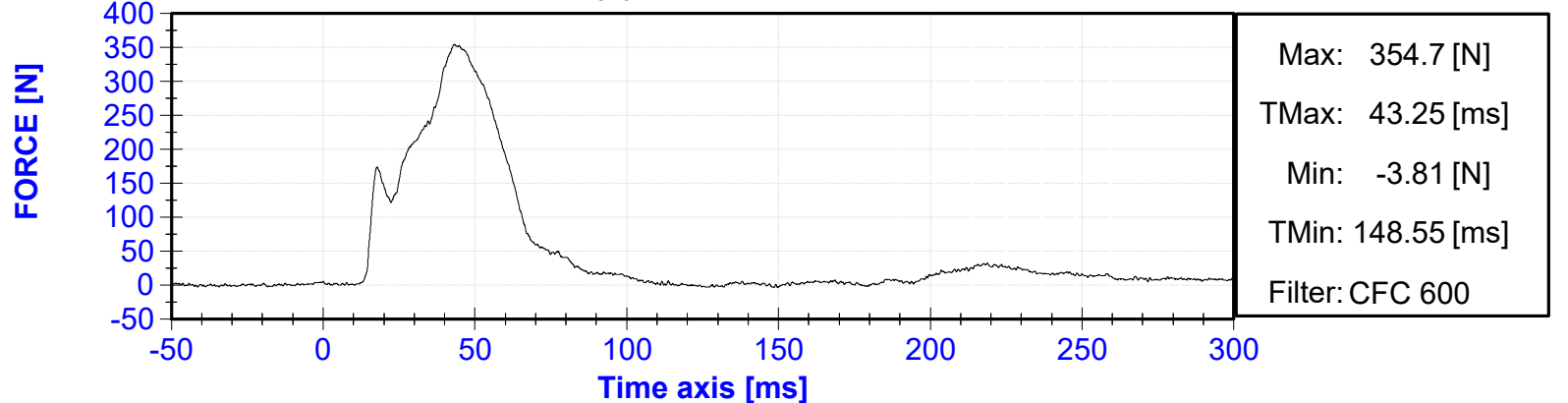
ES-2re Front Abdomen Force (Y) vs. Time



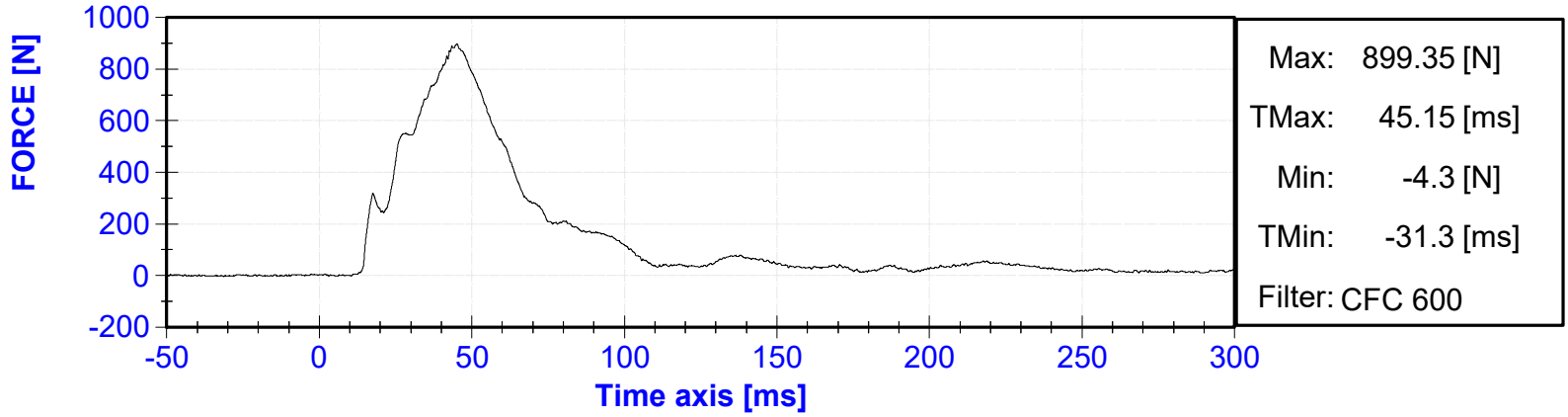
ES-2re Middle Abdomen Force (Y) vs. Time



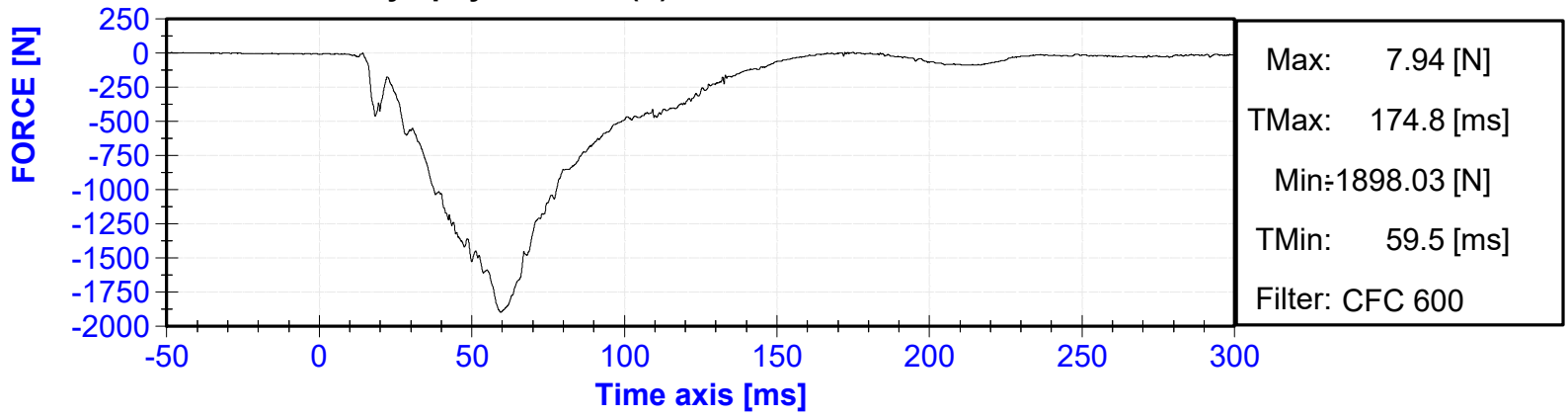
ES-2re Rear Abdomen Force (Y) vs. Time



ES-2re Sum of Abdomen Forces vs. Time



ES-2re Pubic Symphysis Force (Y) vs. Time



APPENDIX III

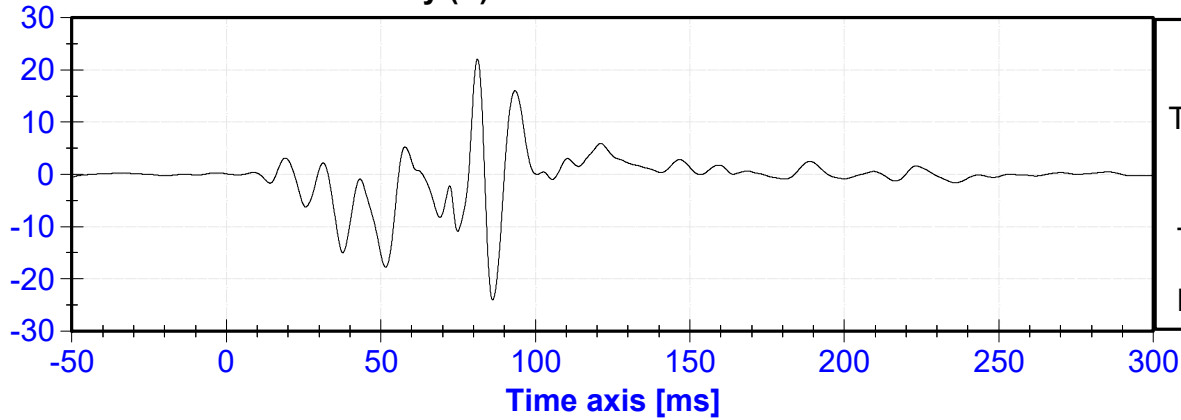
VEHICLE ACCELEROMETER RESPONSE DATA

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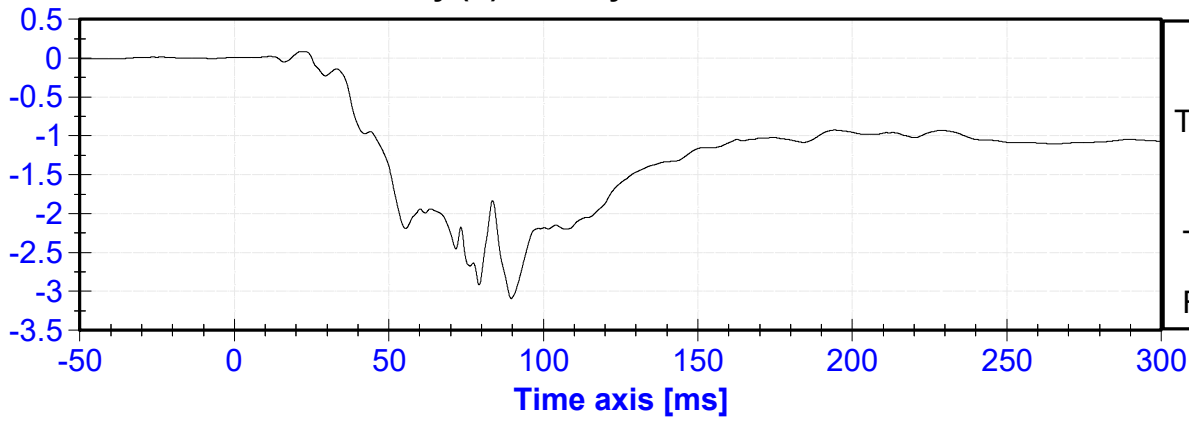
Vehicle Center of Gravity (X) Acceleration vs. Time

ACCELERATION [g's]



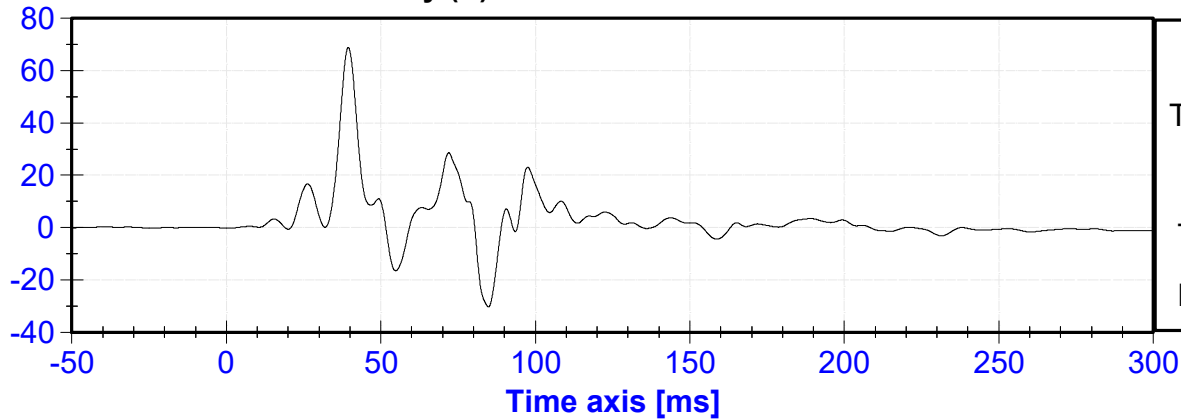
Vehicle Center of Gravity (X) Velocity vs. Time

VELOCITY [m/s]



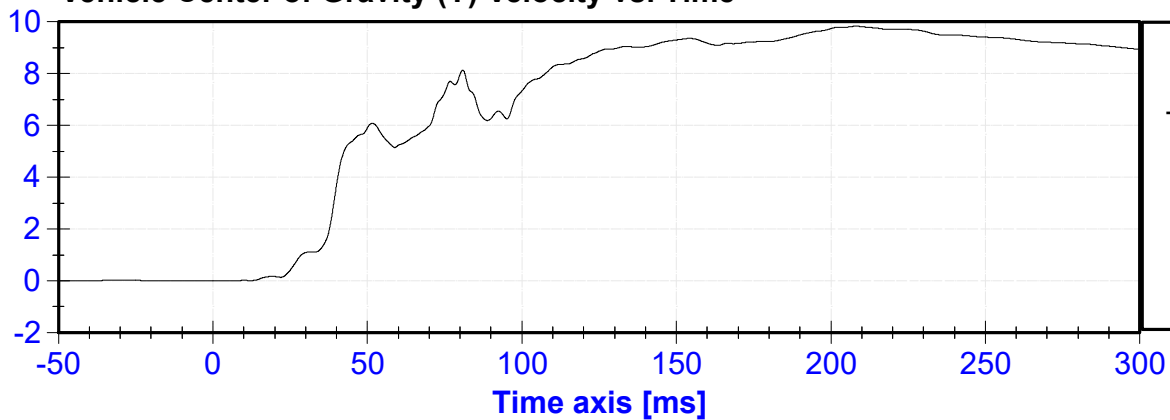
Vehicle Center of Gravity (Y) Acceleration vs. Time

ACCELERATION [g's]



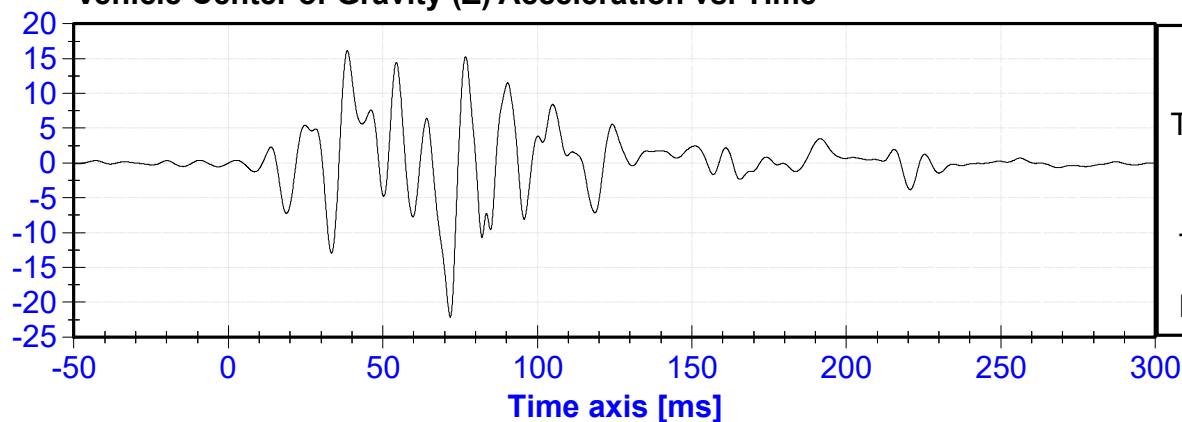
Vehicle Center of Gravity (Y) Velocity vs. Time

VELOCITY [m/s]



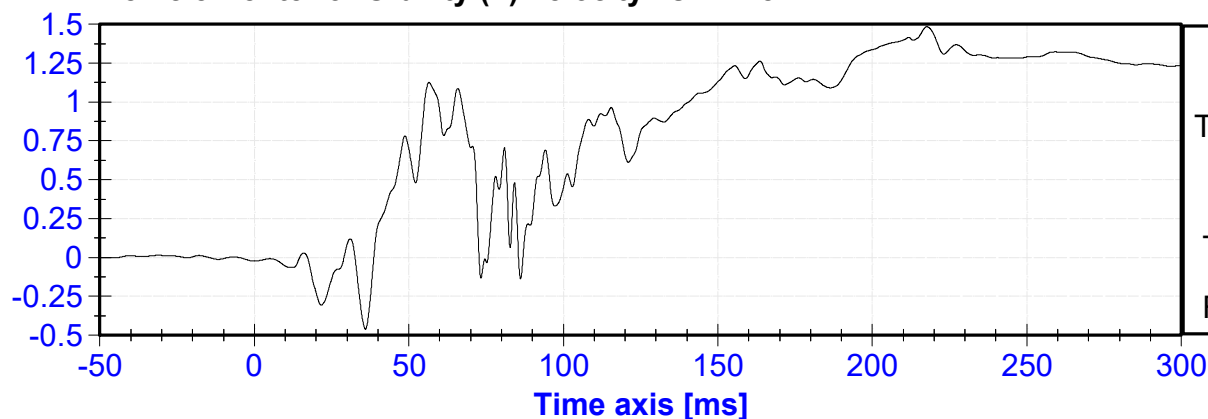
Vehicle Center of Gravity (Z) Acceleration vs. Time

ACCELERATION [g's]



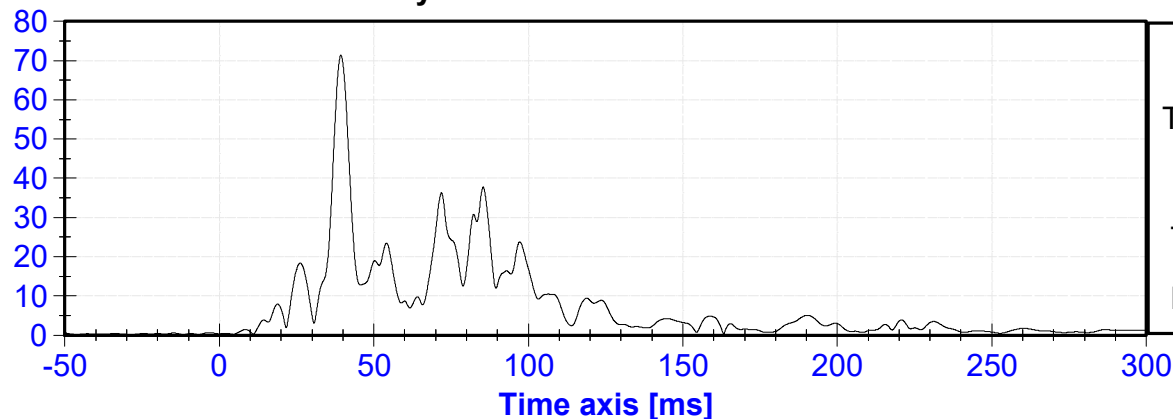
Vehicle Center of Gravity (Z) Velocity vs. Time

VELOCITY [m/s]



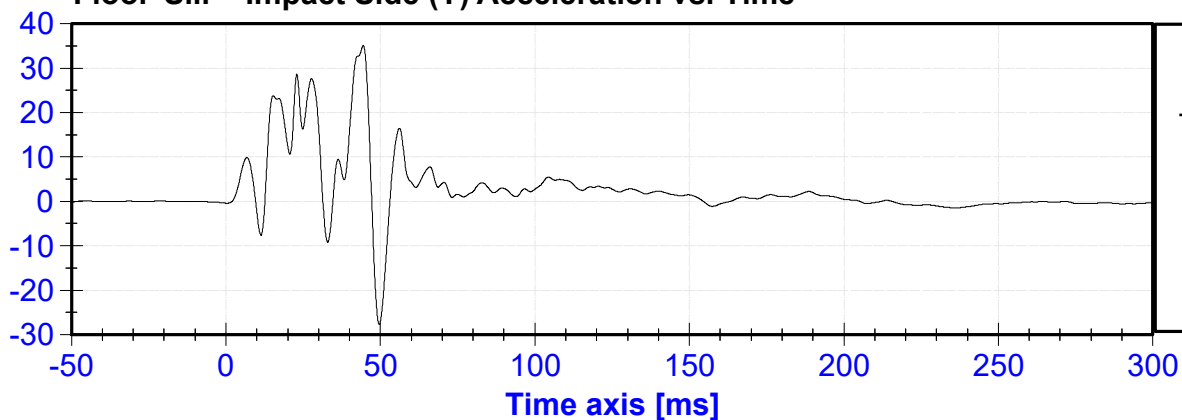
Vehicle Center of Gravity Resultant Acceleration vs. Time

ACCELERATION [g's]



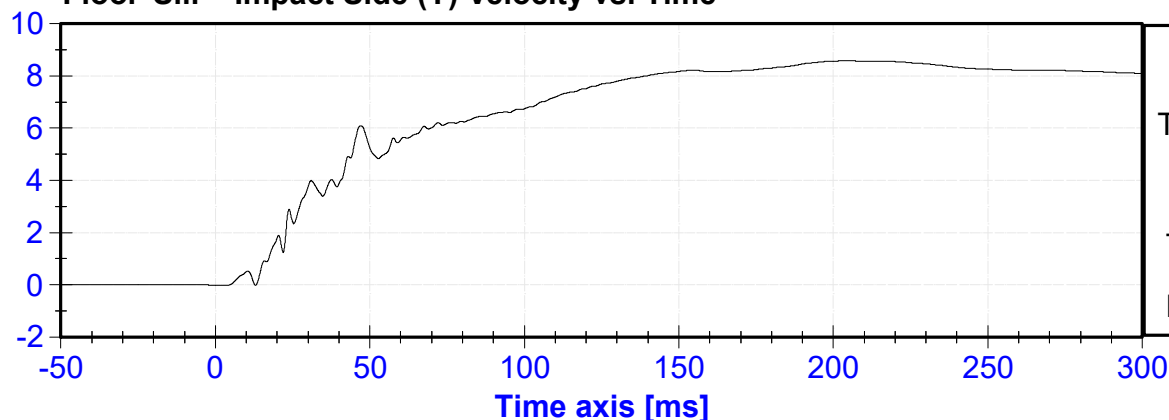
Floor Sill – Impact Side (Y) Acceleration vs. Time

ACCELERATION [g's]



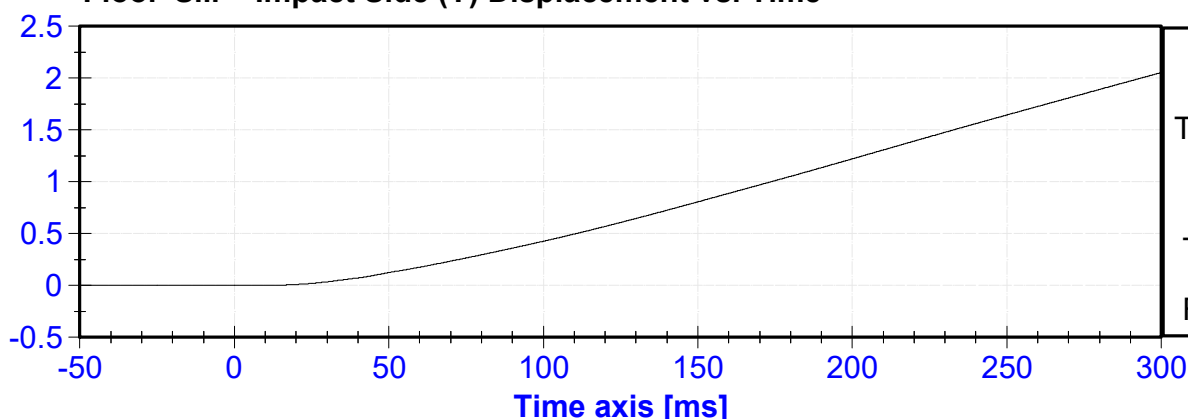
Floor Sill – Impact Side (Y) Velocity vs. Time

VELOCITY [m/s]



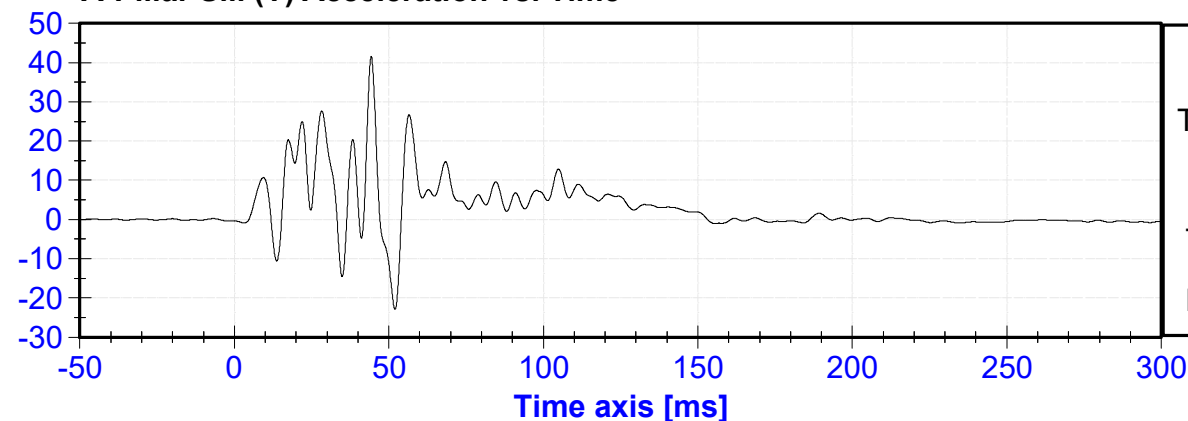
Floor Sill – Impact Side (Y) Displacement vs. Time

DISPLACEMENT [m]



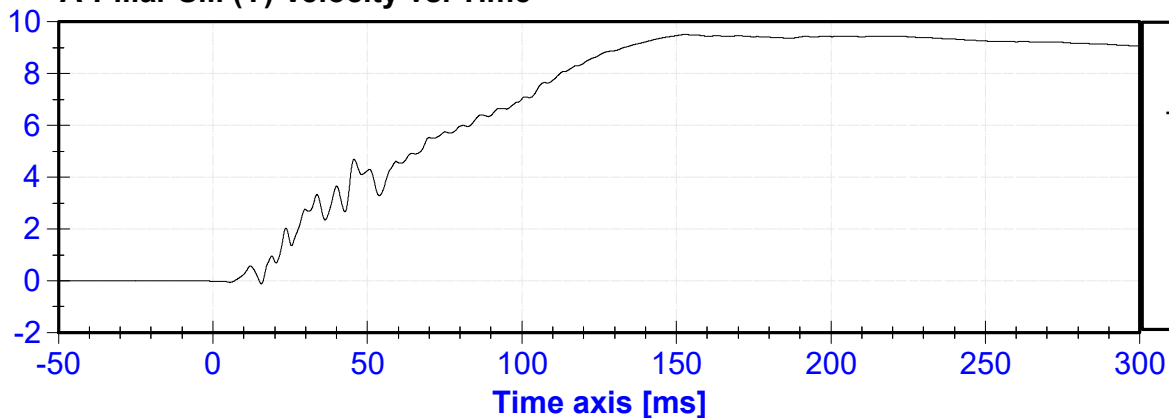
A-Pillar Sill (Y) Acceleration vs. Time

ACCELERATION [g's]

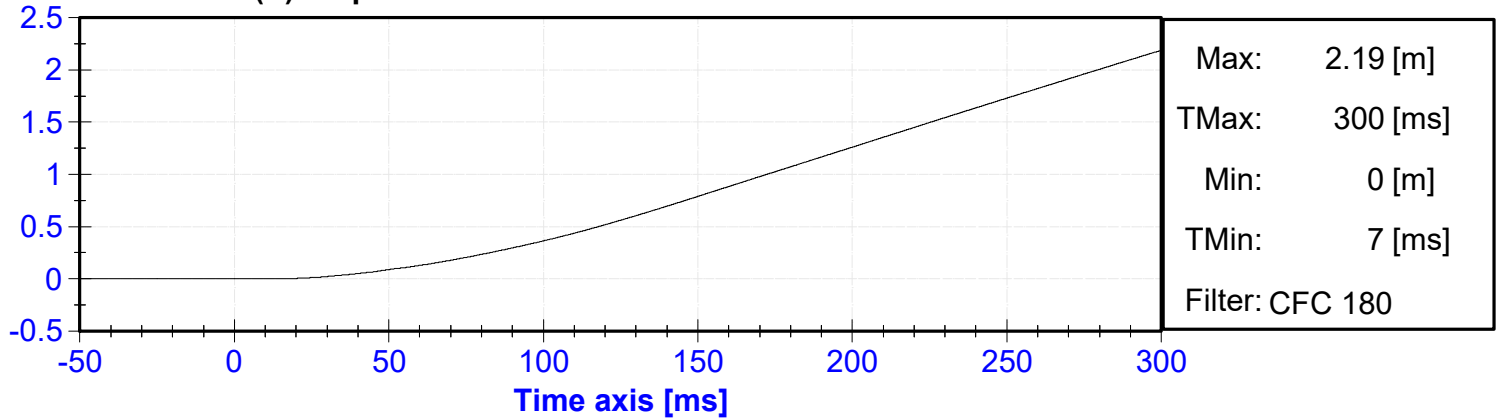


A-Pillar Sill (Y) Velocity vs. Time

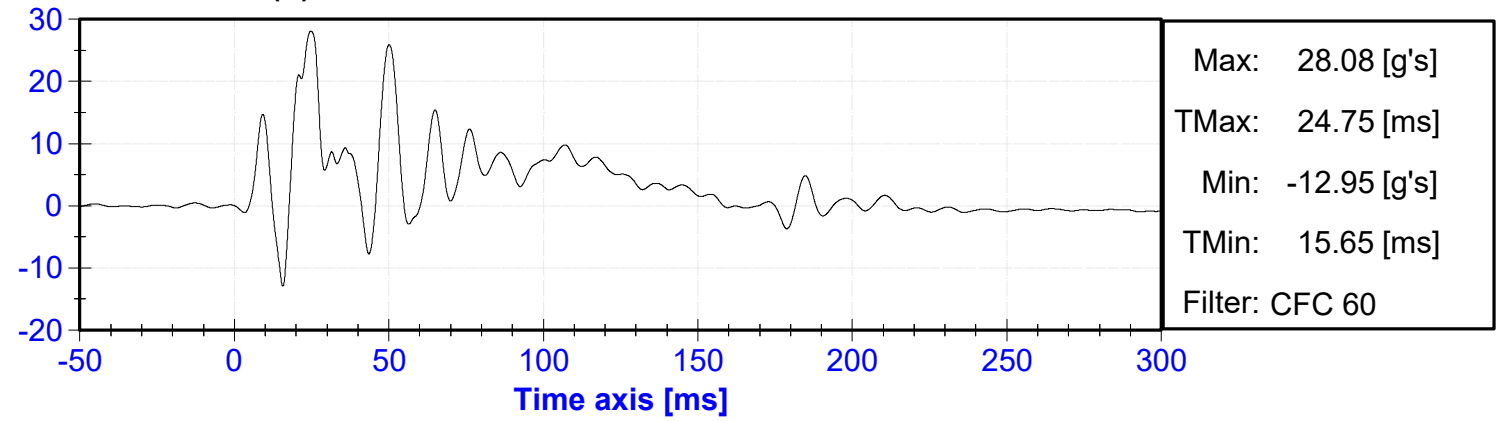
VELOCITY [m/s]



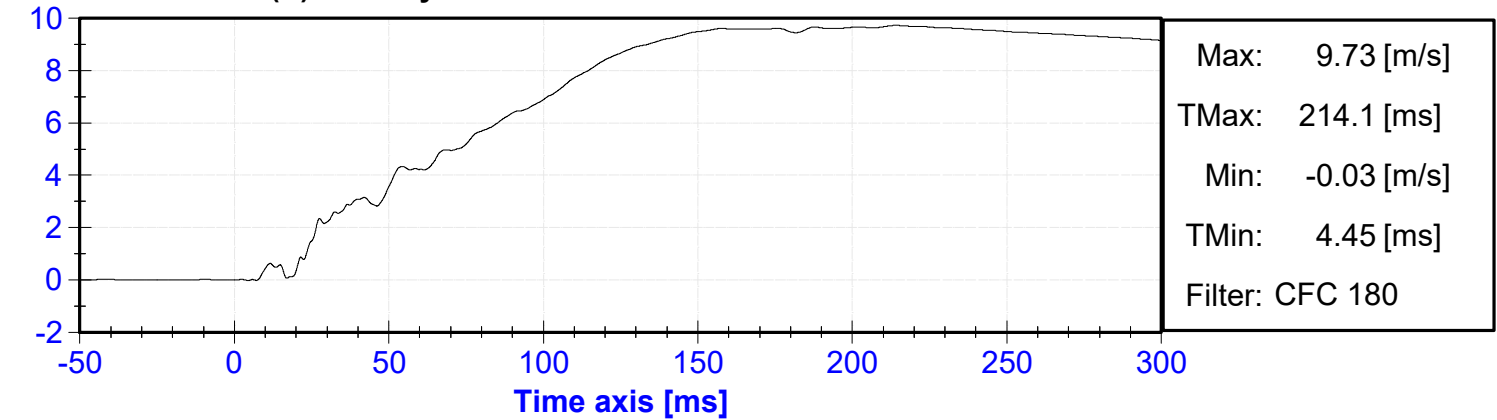
A-Pillar Sill (Y) Displacement vs. Time



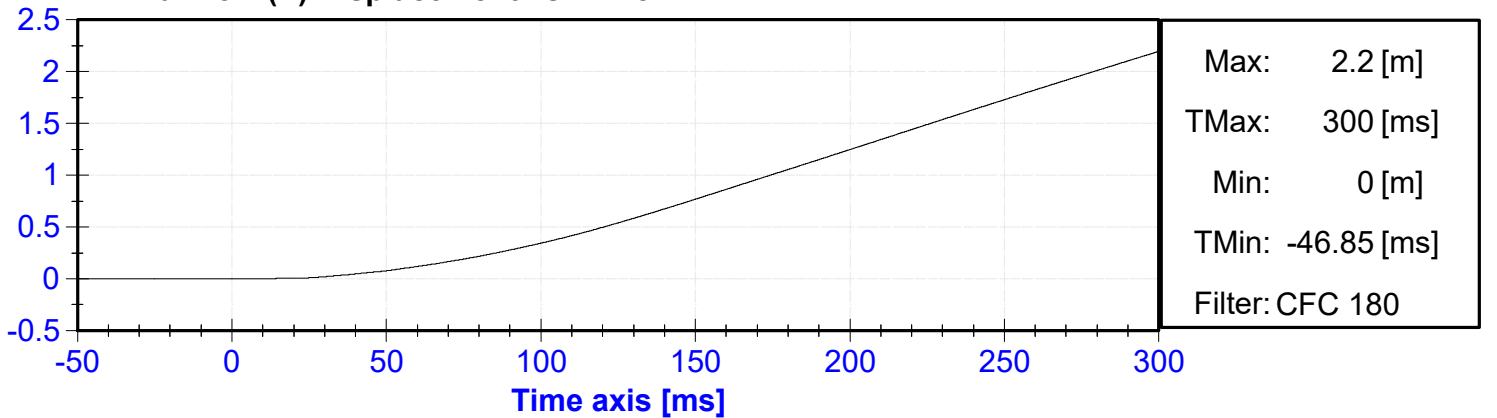
A-Pillar Low (Y) Acceleration vs. Time



A-Pillar Low (Y) Velocity vs. Time

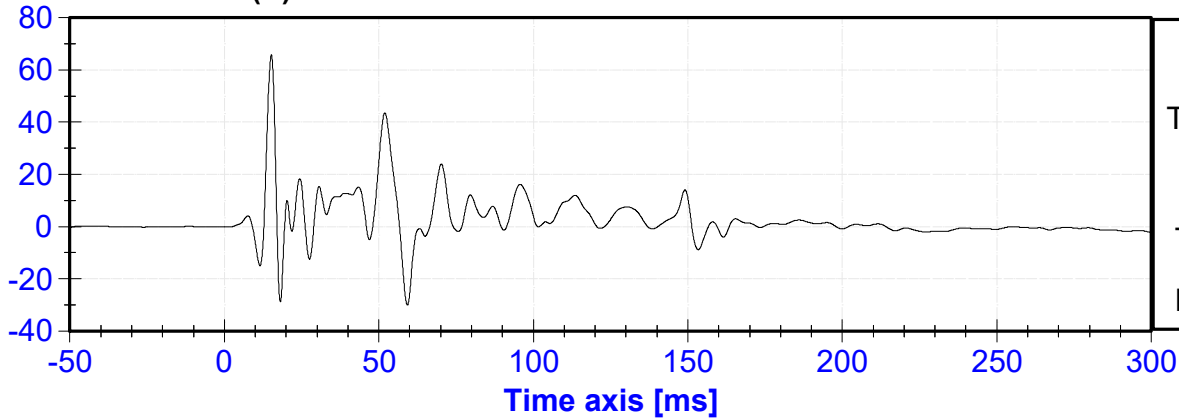


A-Pillar Low (Y) Displacement vs. Time



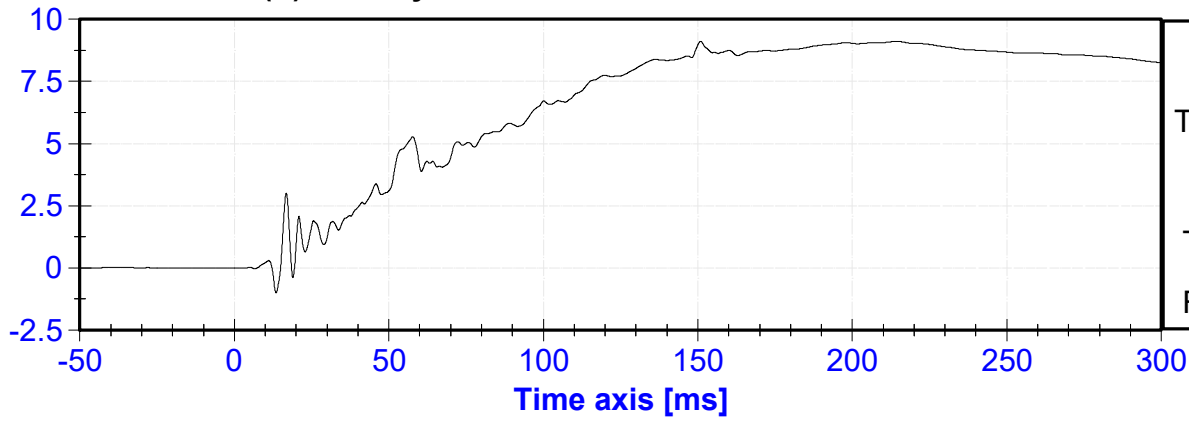
A-Pillar Mid (Y) Acceleration vs. Time

ACCELERATION [g's]



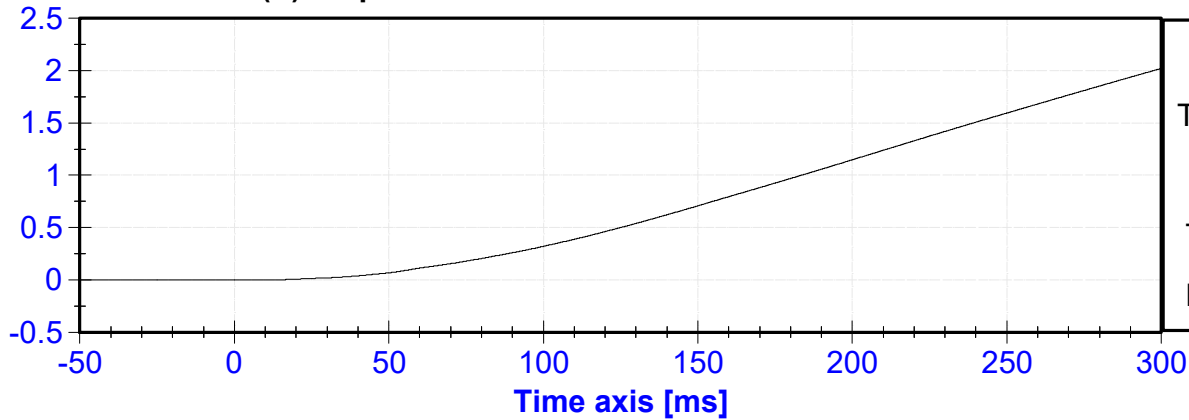
A-Pillar Mid (Y) Velocity vs. Time

VELOCITY [m/s]



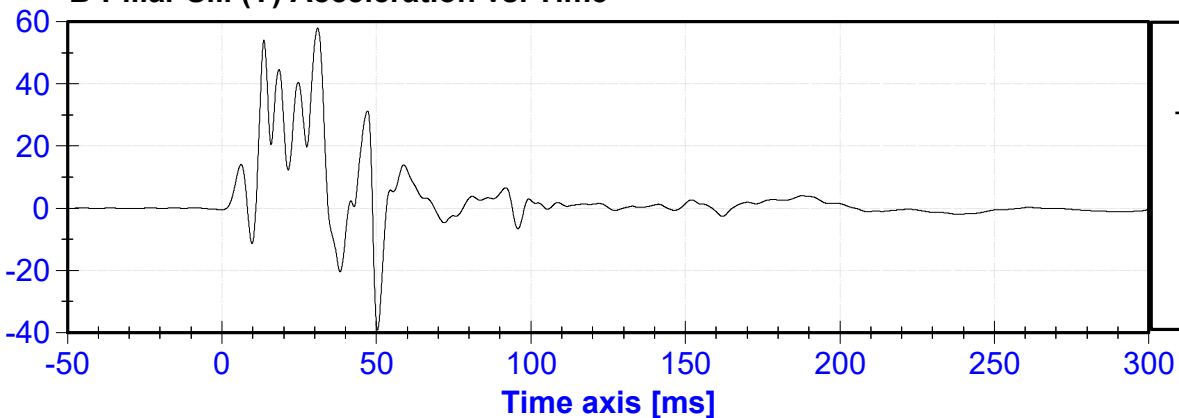
A-Pillar Mid (Y) Displacement vs. Time

DISPLACEMENT [m]



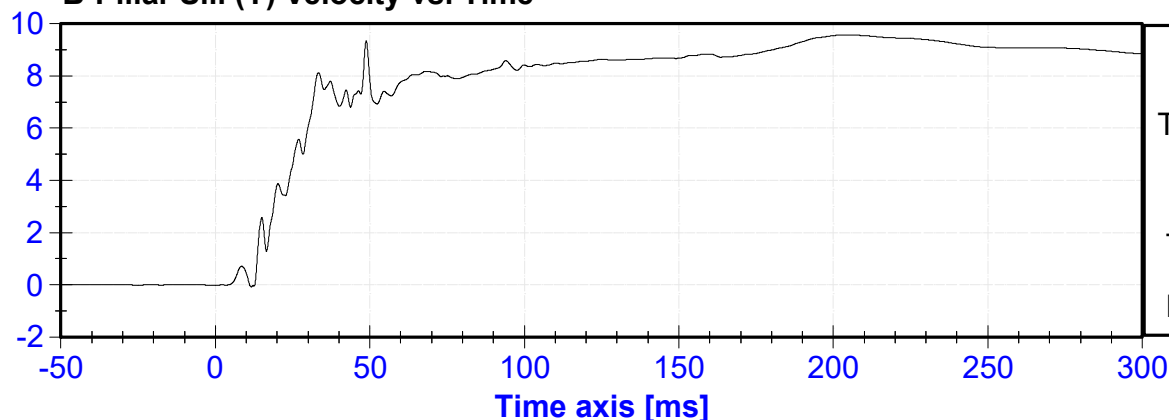
B-Pillar Sill (Y) Acceleration vs. Time

ACCELERATION [g's]



B-Pillar Sill (Y) Velocity vs. Time

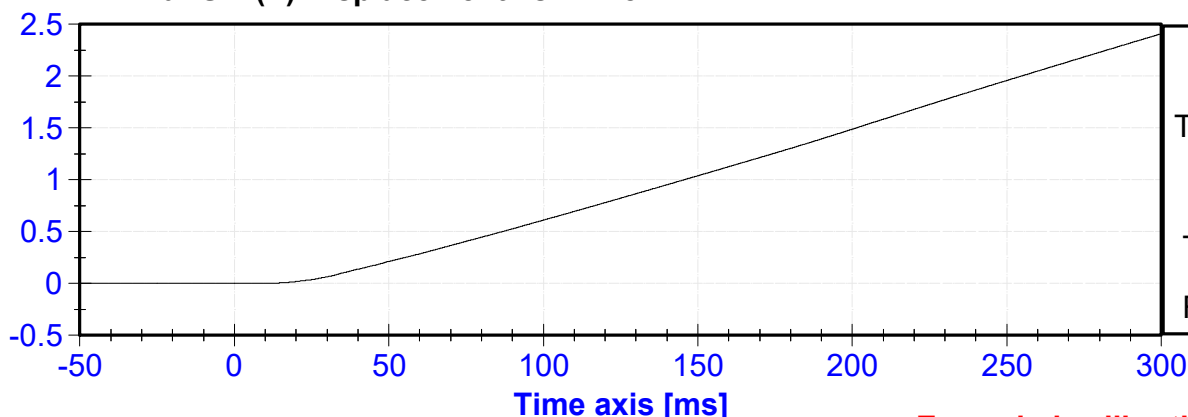
VELOCITY [m/s]



Max: 9.58 [m/s]
TMax: 206.65 [ms]
Min: -0.08 [m/s]
TMin: 11.6 [ms]
Filter: CFC 180

B-Pillar Sill (Y) Displacement vs. Time

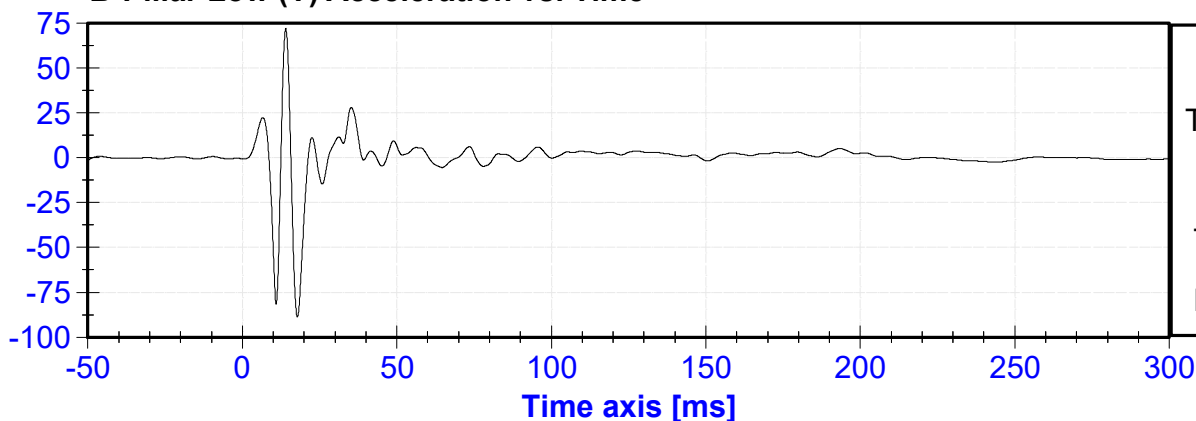
DISPLACEMENT [m]



Max: 2.41 [m]
TMax: 300 [ms]
Min: 0 [m]
TMin: 4.35 [ms]
Filter: CFC 180

B-Pillar Low (Y) Acceleration vs. Time

ACCELERATION [g's]

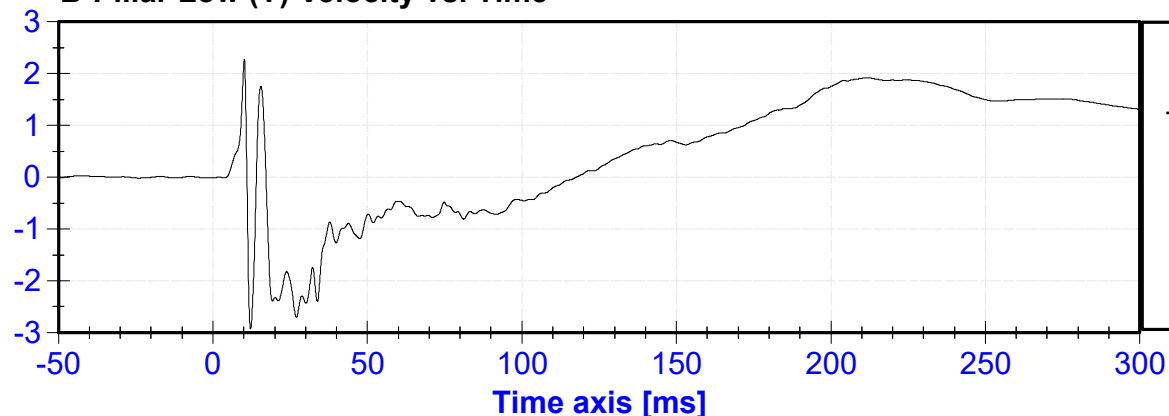


Max: 72.13 [g's]
TMax: 14.05 [ms]
Min: -88.92 [g's]
TMin: 17.8 [ms]
Filter: CFC 60

Exceeded calibration range at 10.1 ms

B-Pillar Low (Y) Velocity vs. Time

VELOCITY [m/s]

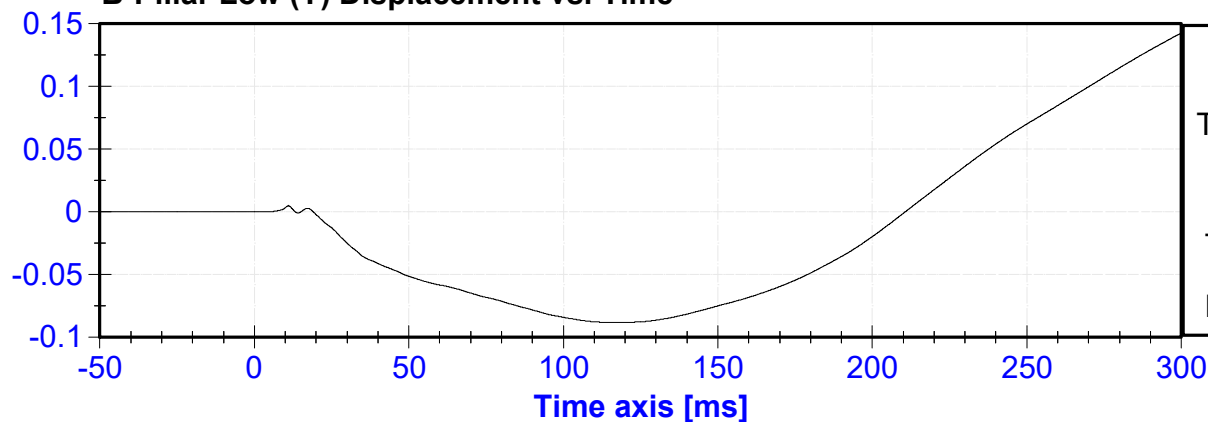


Max: 2.28 [m/s]
TMax: 10.2 [ms]
Min: -2.93 [m/s]
TMin: 12.2 [ms]
Filter: CFC 180

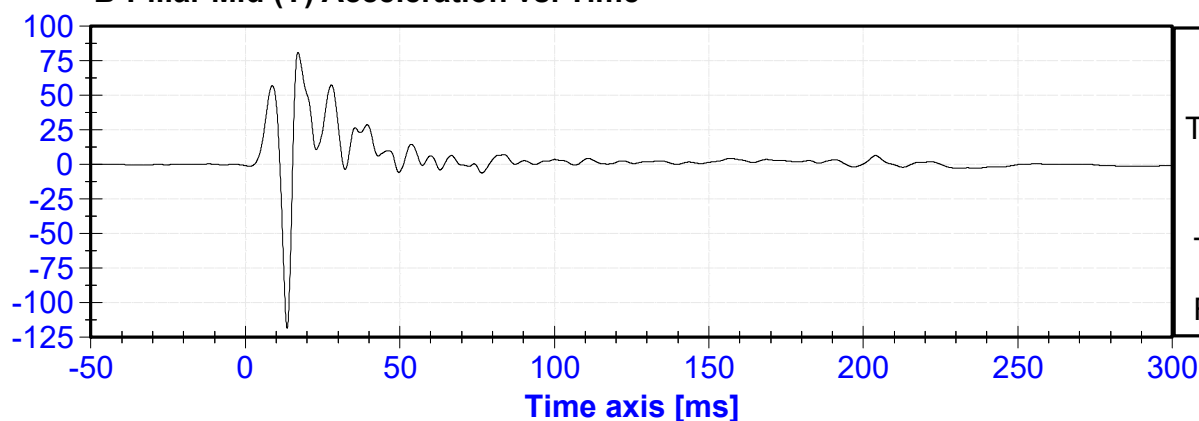
Exceeded calibration range at 10.1 ms

Exceeded calibration range at 10.1 ms

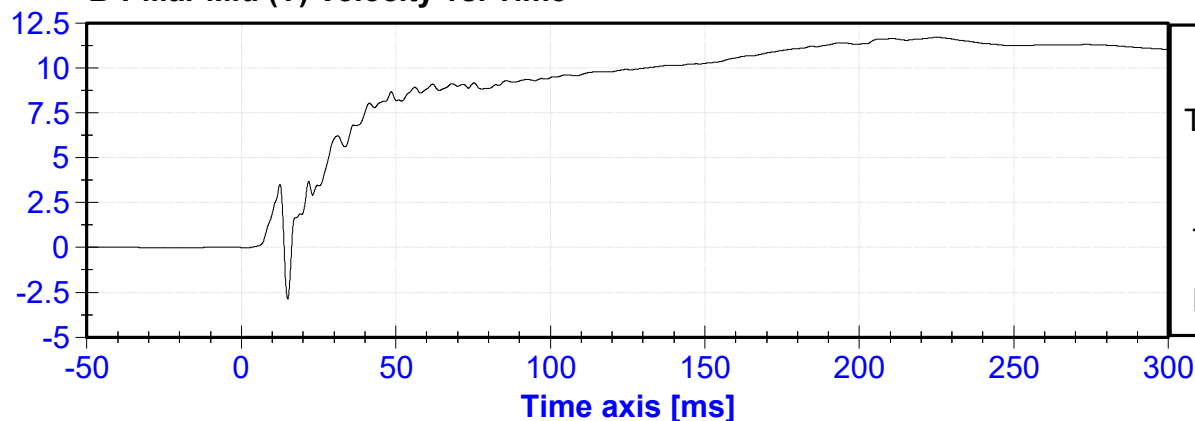
B-Pillar Low (Y) Displacement vs. Time



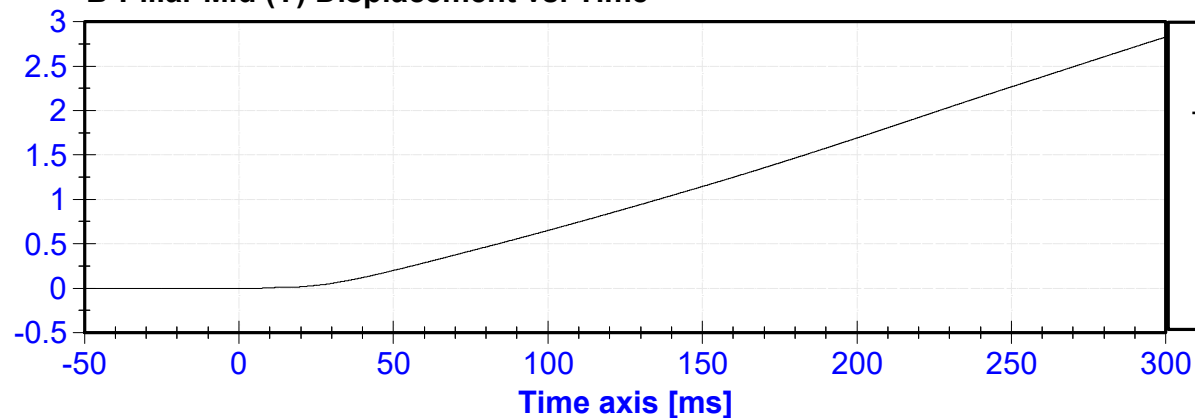
B-Pillar Mid (Y) Acceleration vs. Time



B-Pillar Mid (Y) Velocity vs. Time

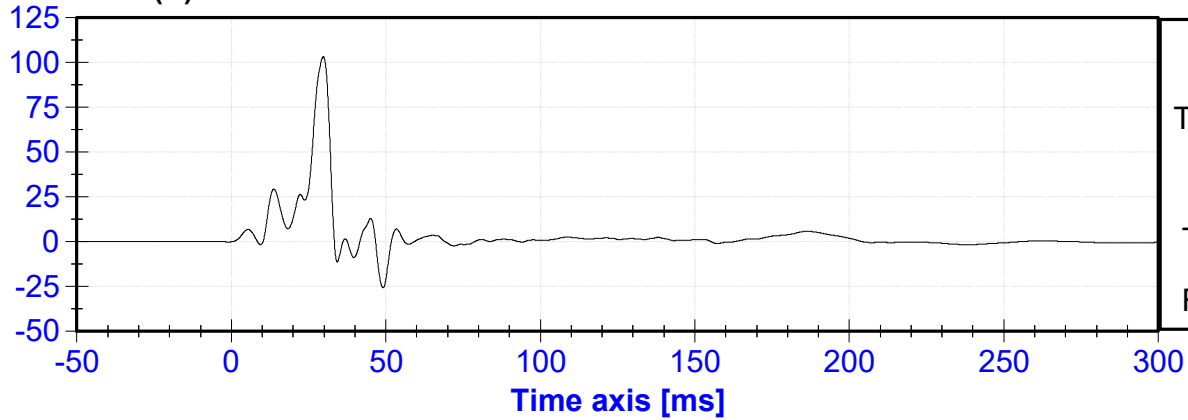


B-Pillar Mid (Y) Displacement vs. Time



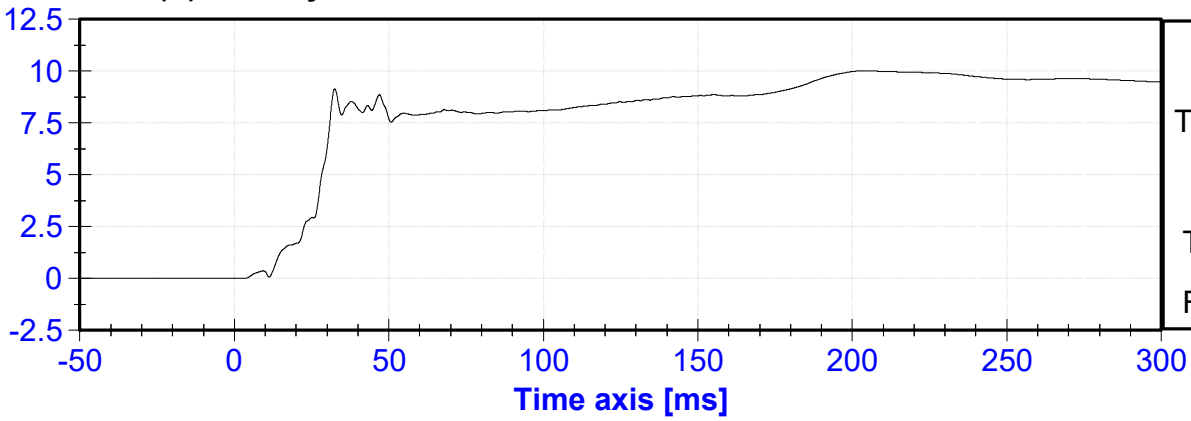
Seat (Y) Acceleration vs. Time

ACCELERATION [g's]



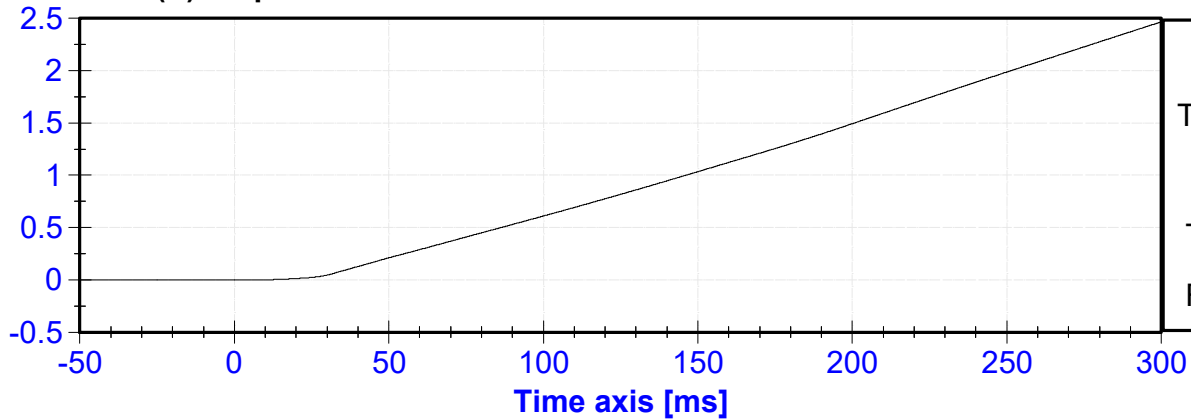
Seat (Y) Velocity vs. Time

VELOCITY [m/s]



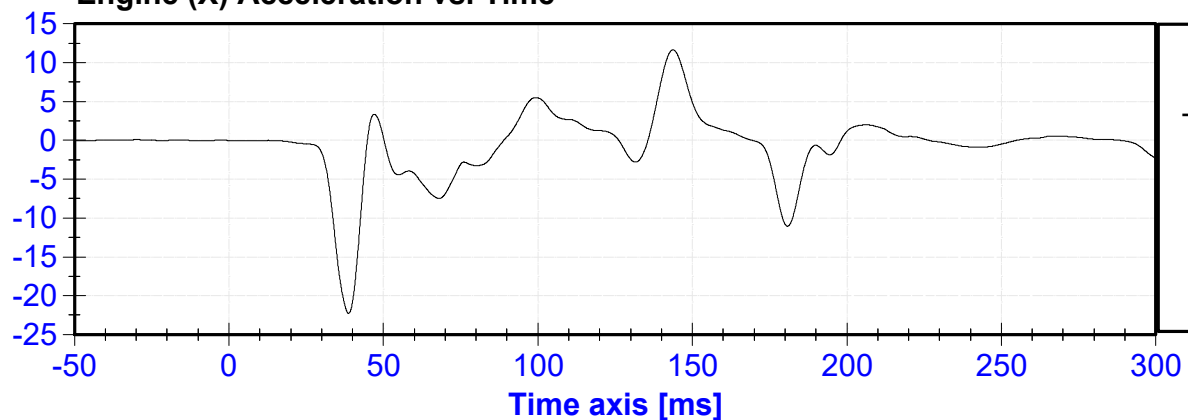
Seat (Y) Displacement vs. Time

DISPLACEMENT [m]



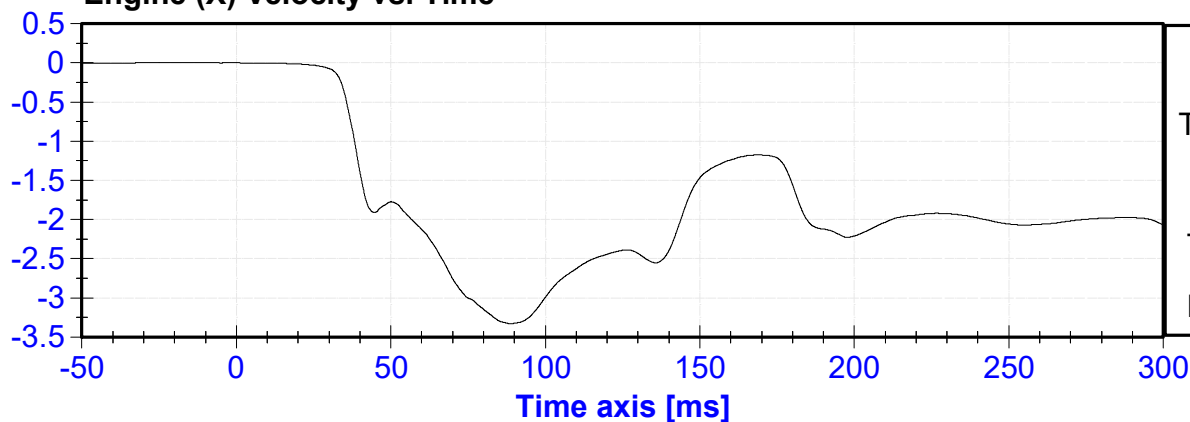
Engine (X) Acceleration vs. Time

ACCELERATION [g's]



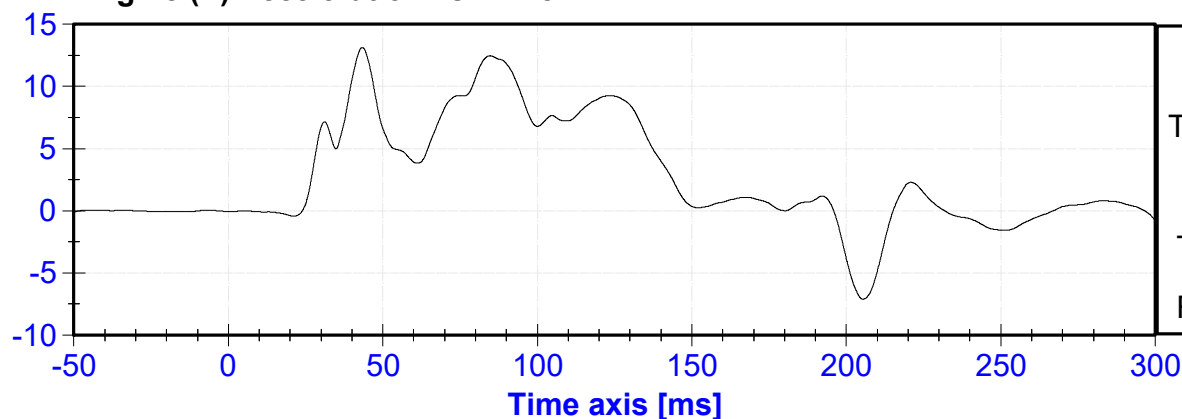
Engine (X) Velocity vs. Time

VELOCITY [m/s]



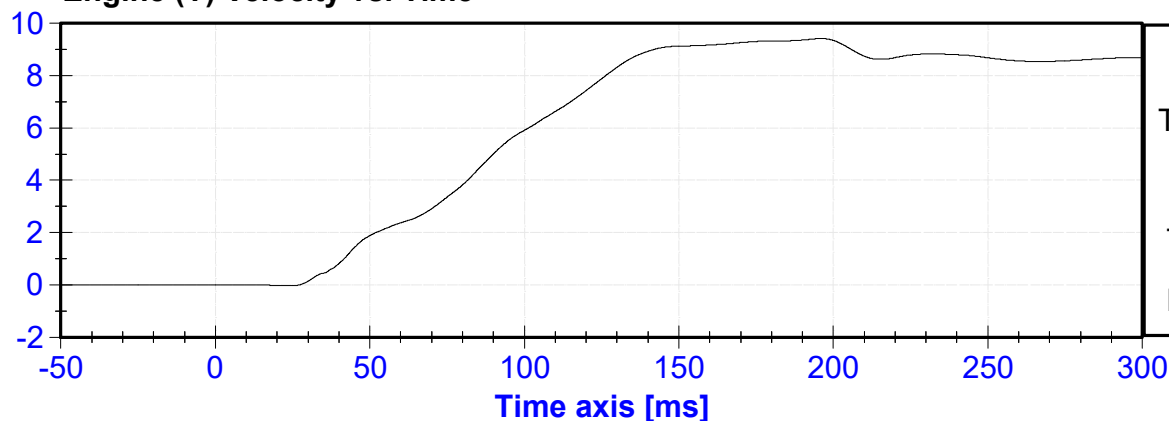
Engine (Y) Acceleration vs. Time

ACCELERATION [g's]



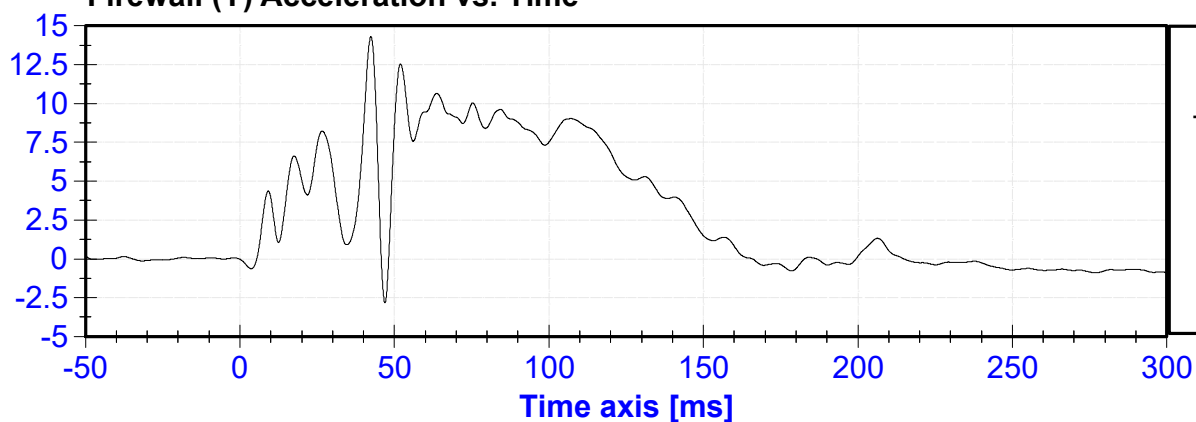
Engine (Y) Velocity vs. Time

VELOCITY [m/s]



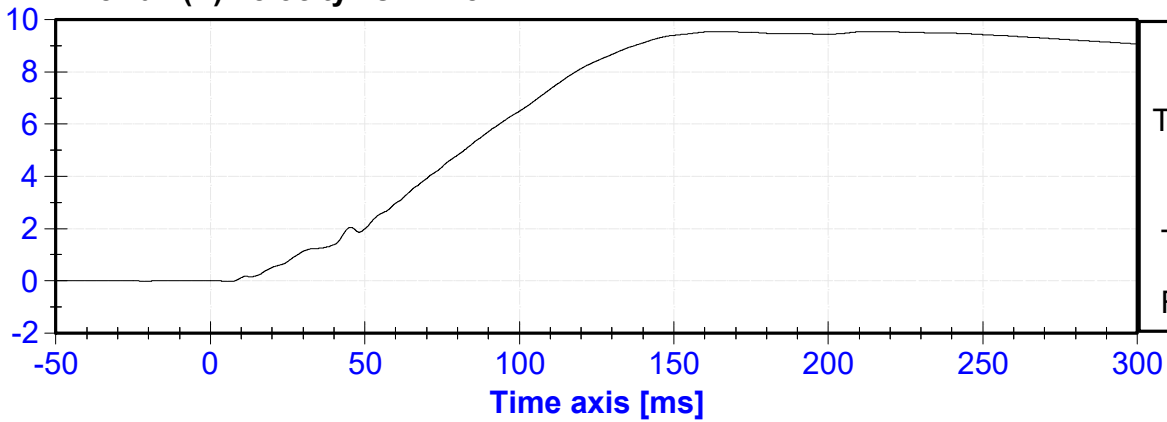
Firewall (Y) Acceleration vs. Time

ACCELERATION [g's]



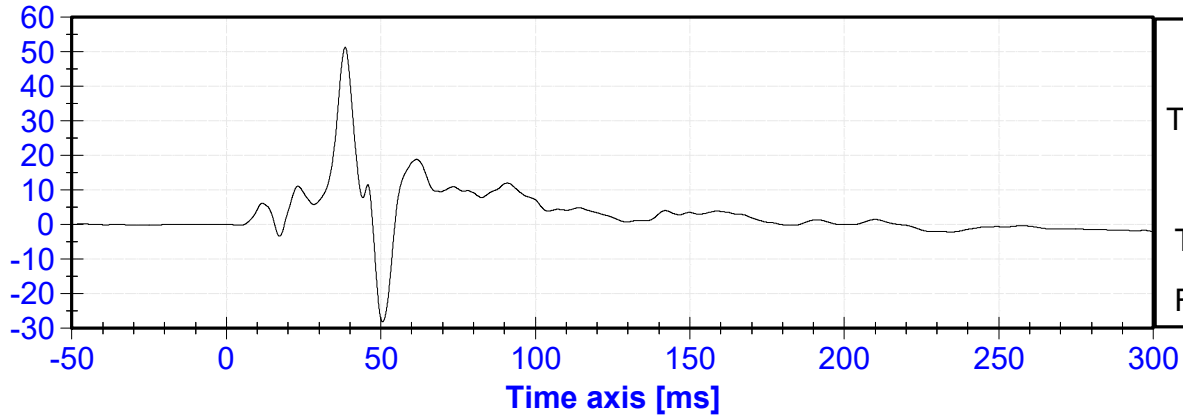
Firewall (Y) Velocity vs. Time

VELOCITY [m/s]



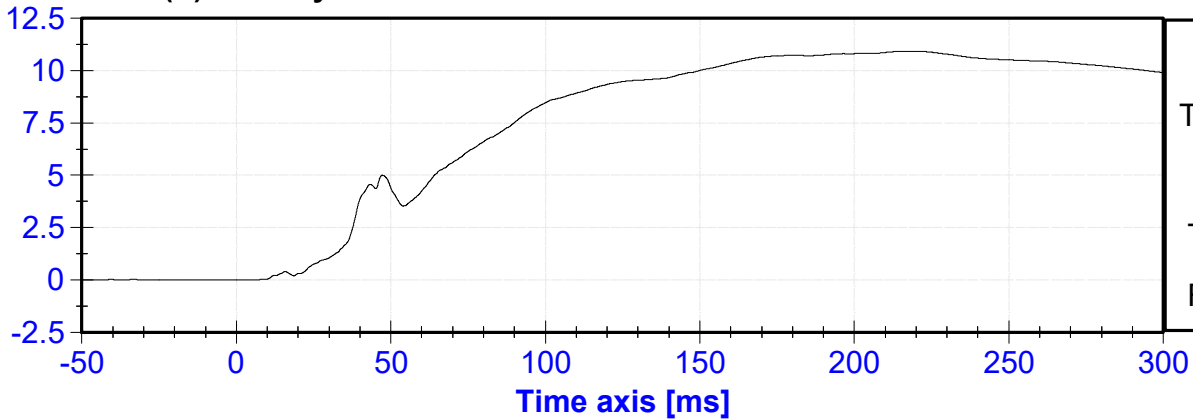
Roof (Y) Acceleration vs. Time

ACCELERATION [g's]



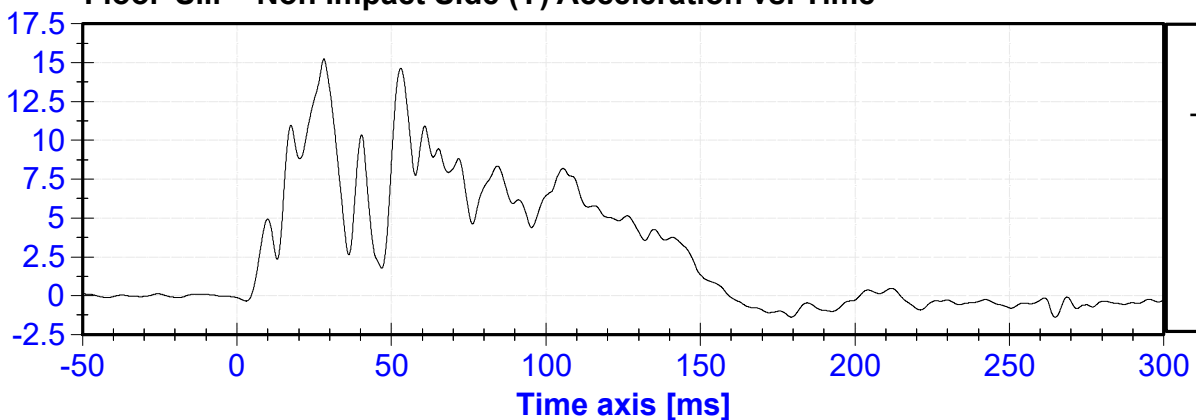
Roof (Y) Velocity vs. Time

VELOCITY [m/s]



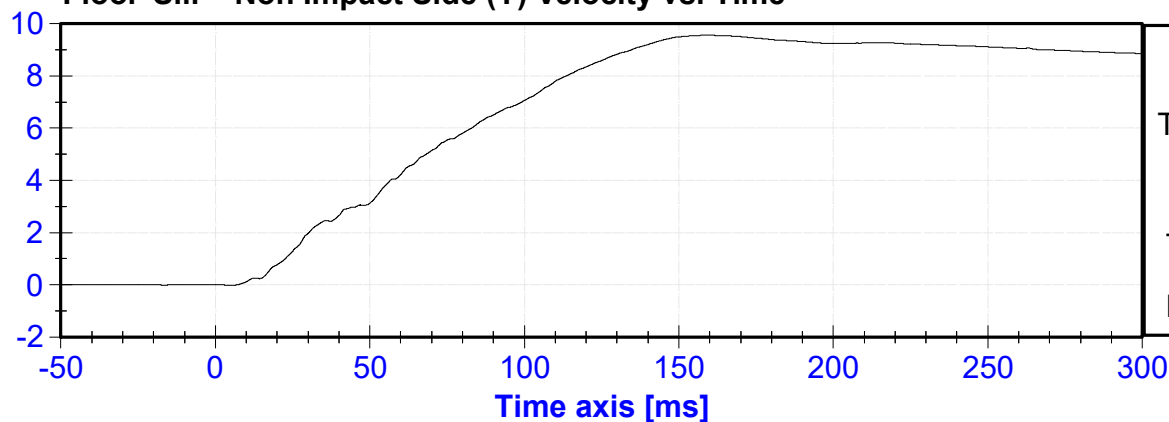
Floor Sill – Non Impact Side (Y) Acceleration vs. Time

ACCELERATION [g's]



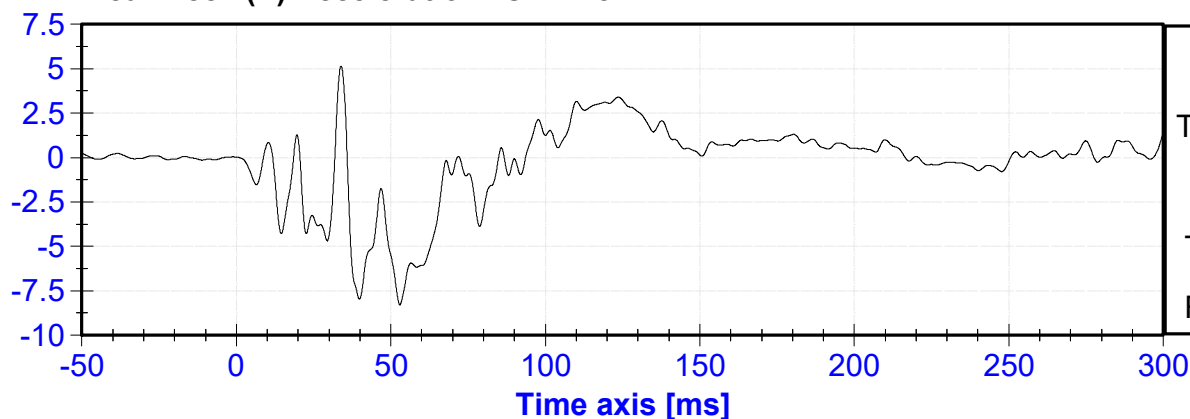
Floor Sill – Non Impact Side (Y) Velocity vs. Time

VELOCITY [m/s]



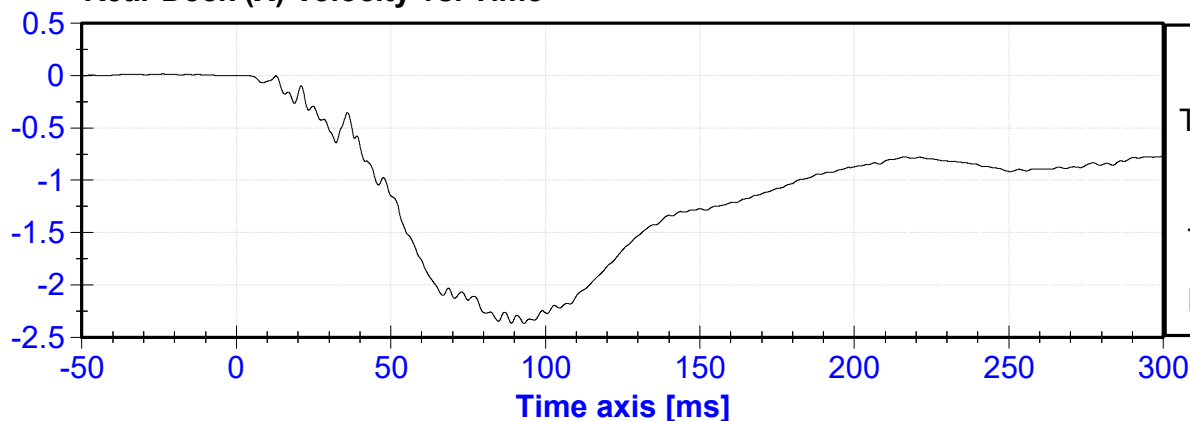
Rear Deck (X) Acceleration vs. Time

ACCELERATION [g's]



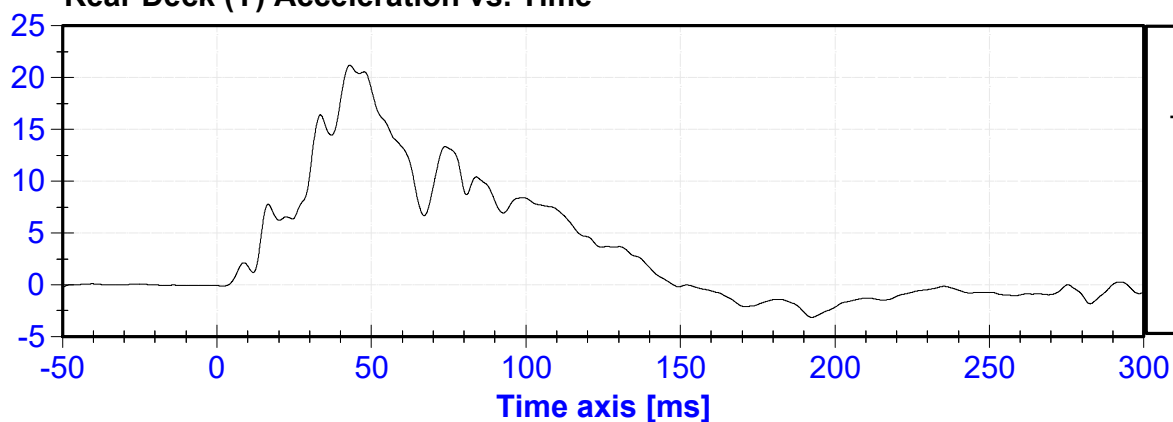
Rear Deck (X) Velocity vs. Time

VELOCITY [m/s]

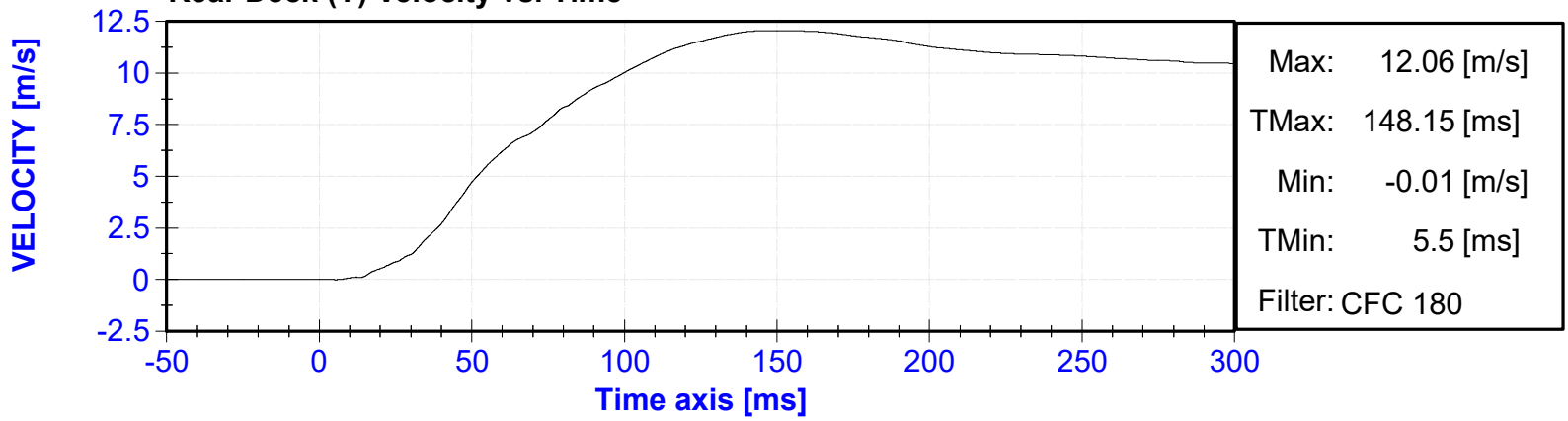


Rear Deck (Y) Acceleration vs. Time

ACCELERATION [g's]



Rear Deck (Y) Velocity vs. Time



APPENDIX IV

PRE-TEST DUMMY PERFORMANCE CALIBRATION TEST DATA

(Subpart U, ES-2re)

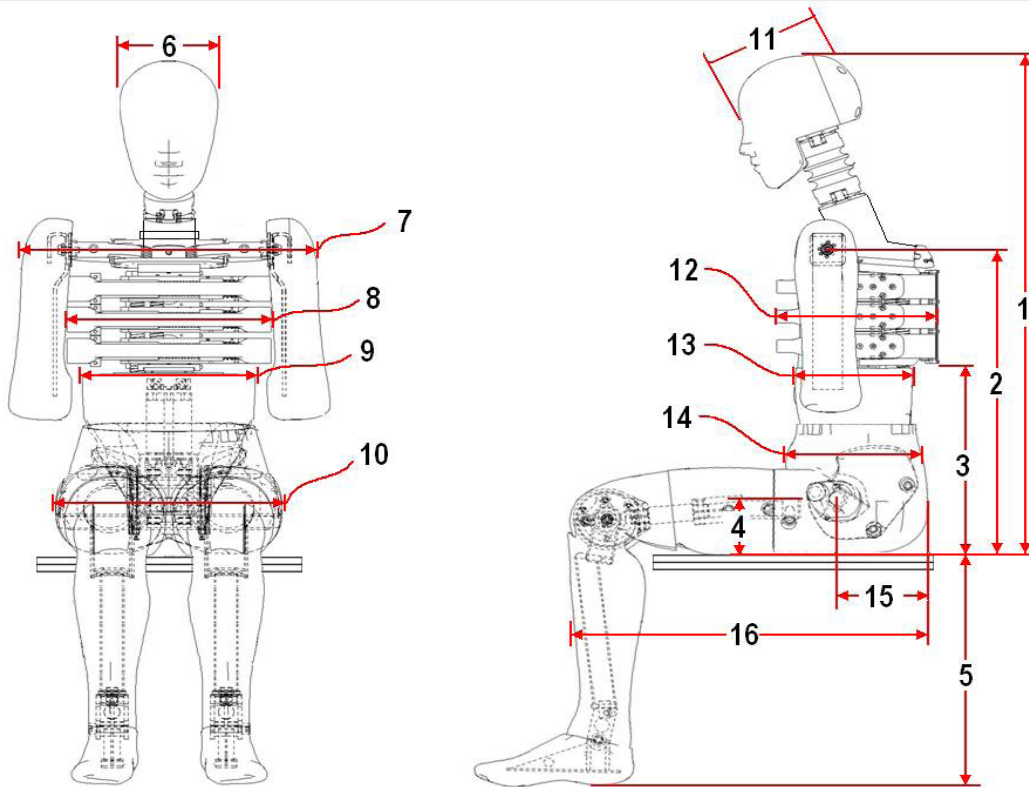


External Measurements - EuroSID-2re

Technician: T. Roseman

Date: 4/8/2024

Dummy Serial Number: D037



FRONT VIEW

SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	910	Pass
2	Seat to Shoulder Joint	558	572	562	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	353	Pass
4	Seat to Hip Joint (center of bolt)	97	103	101	Pass
5	Sole to Seat, Sitting	333	451	421	Pass
6	Head Width	152	158	154	Pass
7	Shoulder/Arm Width	461	479	472	Pass
8	Thorax Width	322	332	330	Pass
9	Abdomen Width	273	287	282	Pass
10	Pelvis Lap Width	359	373	362	Pass
11	Head Depth	196	206	199	Pass
12	Thorax Depth	262	272	267	Pass
13	Abdomen Depth	194	204	197	Pass
14	Pelvis Depth	235	245	239	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	155	Pass
16	Back of Buttocks to Front Knee	597	615	605	Pass

ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

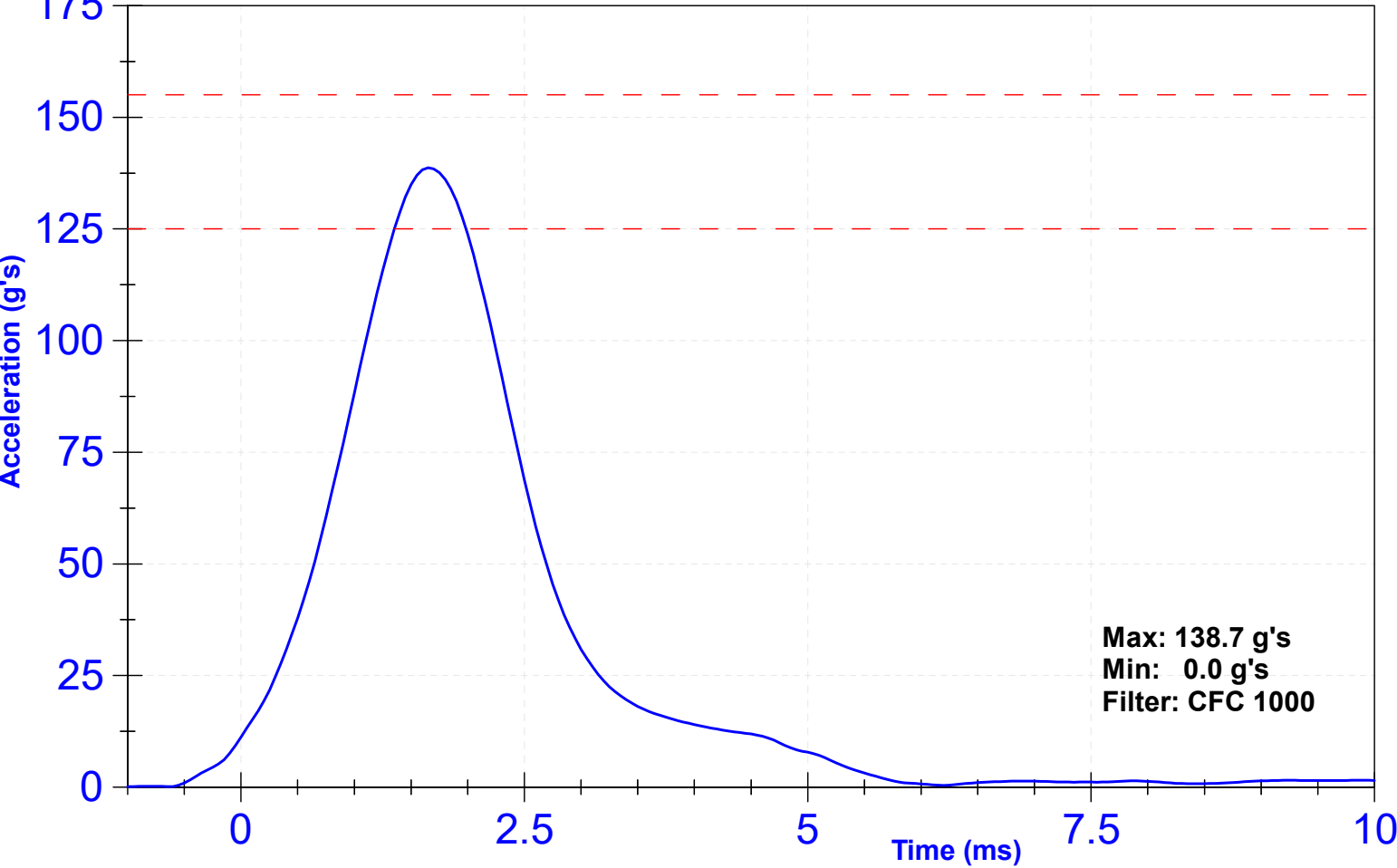
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Resultant Acceleration	125	155	g's	138.7	Pass
Oscillation	0	15	%	1.12	Pass
Fore-Aft Acceleration	-15	15	g's	5.2	Pass

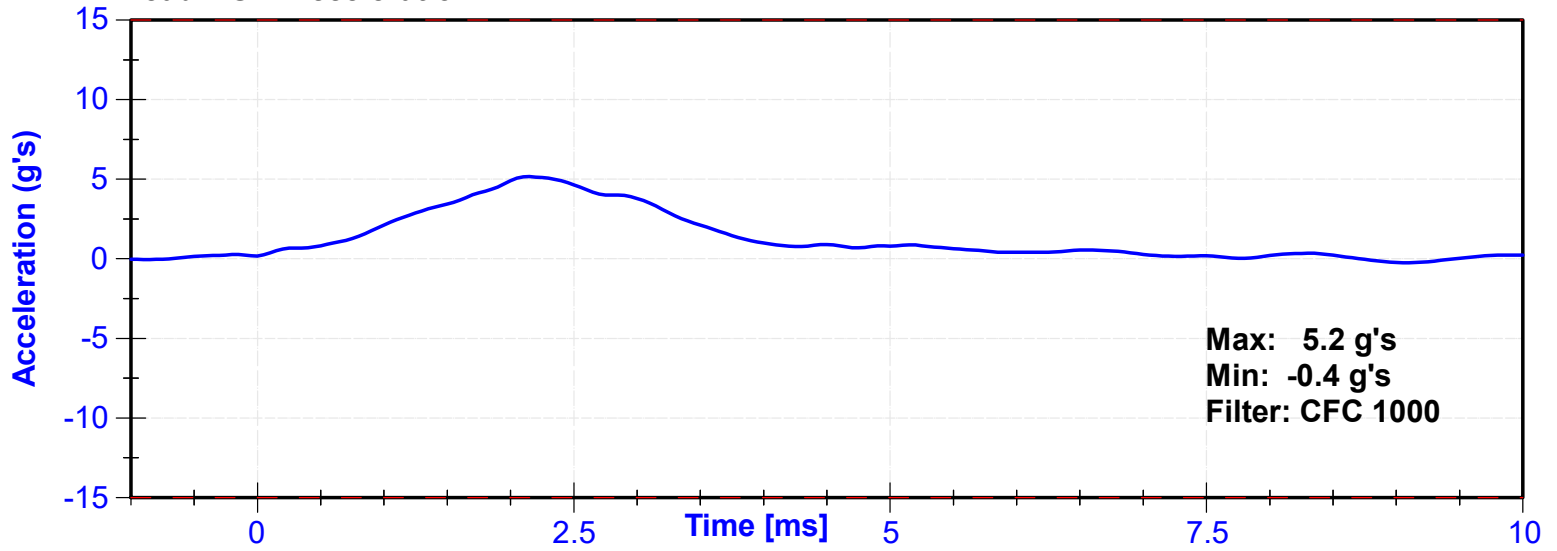
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	T21724	2/1/2024	7/30/2024
Y Accelerometer	Endevco	T22281	2/1/2024	7/30/2024
Z Accelerometer	Endevco	T26050	2/1/2024	7/30/2024

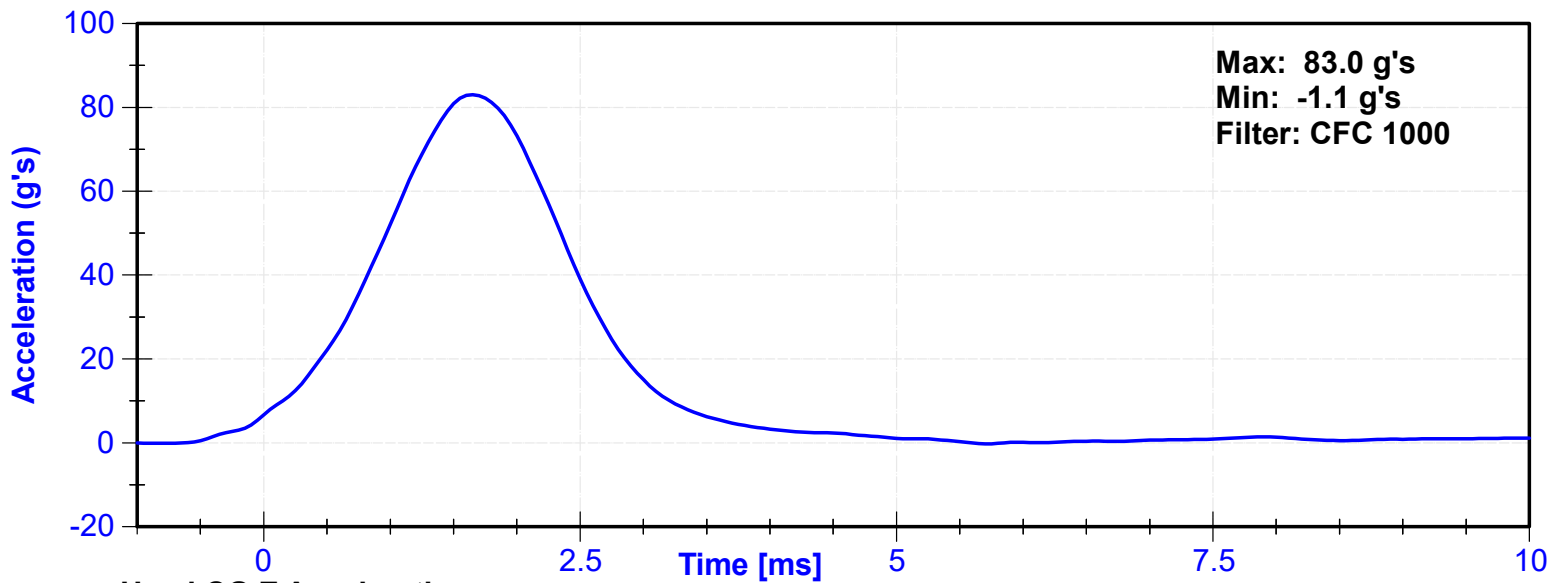
Resultant Acceleration



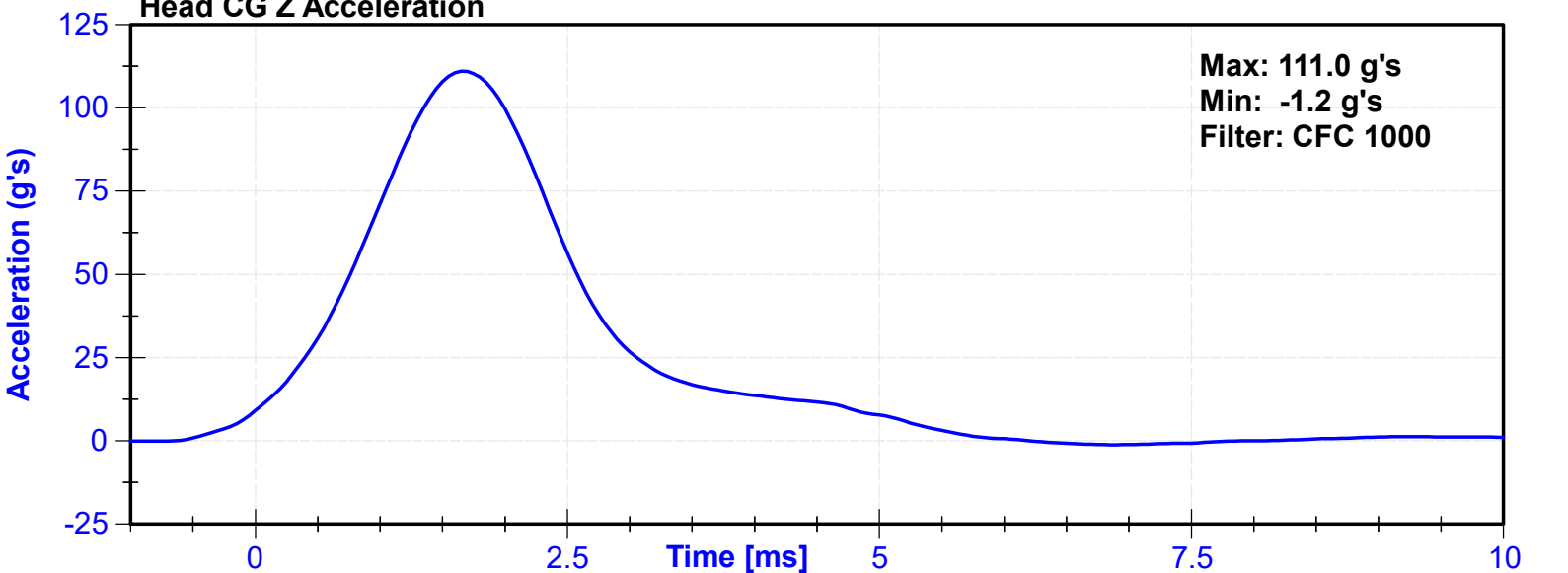
Head CG X Acceleration



Head CG Y Acceleration



Head CG Z Acceleration



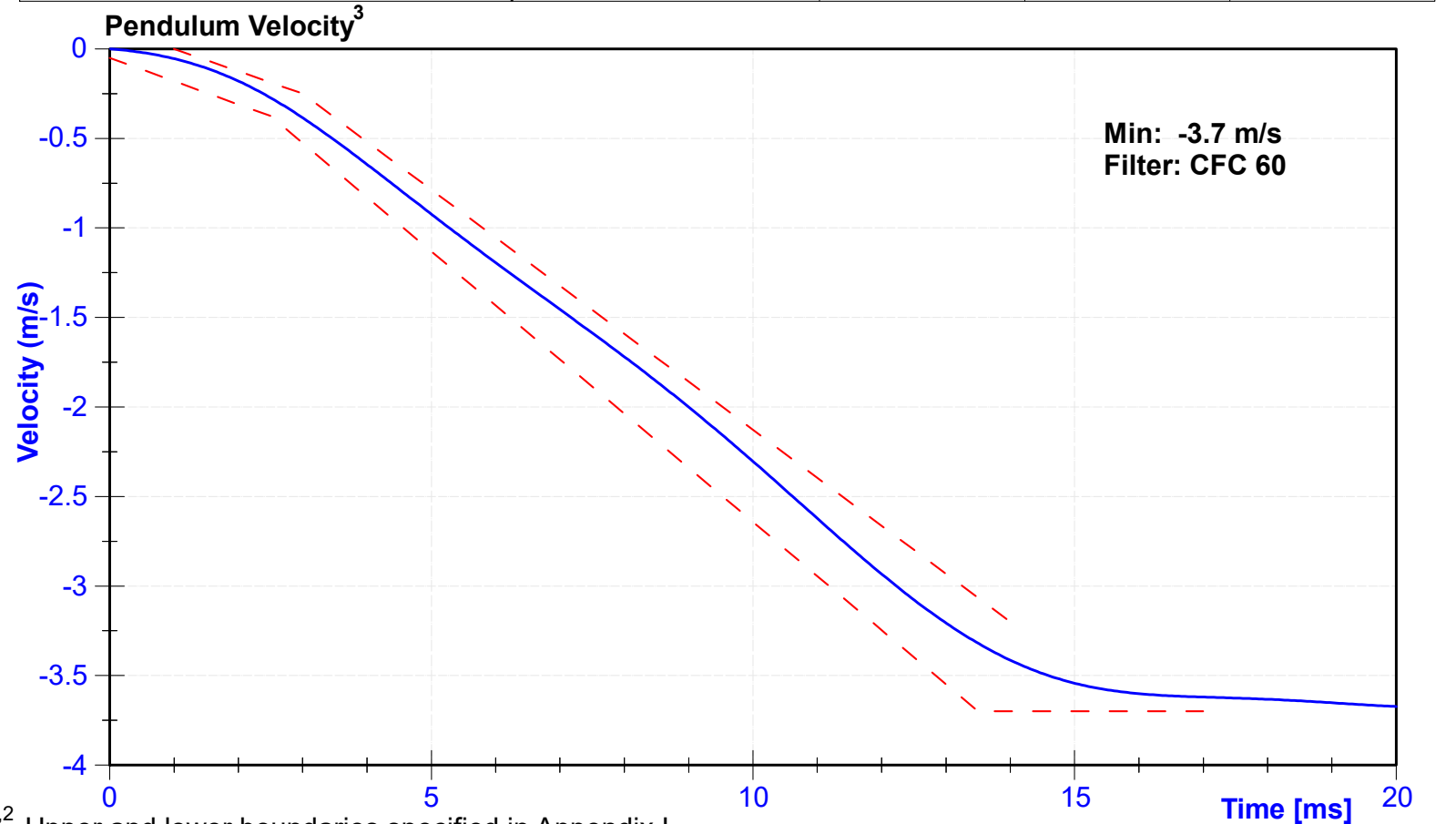
ATD Manufacturer	Denton	Test Technician	J. Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

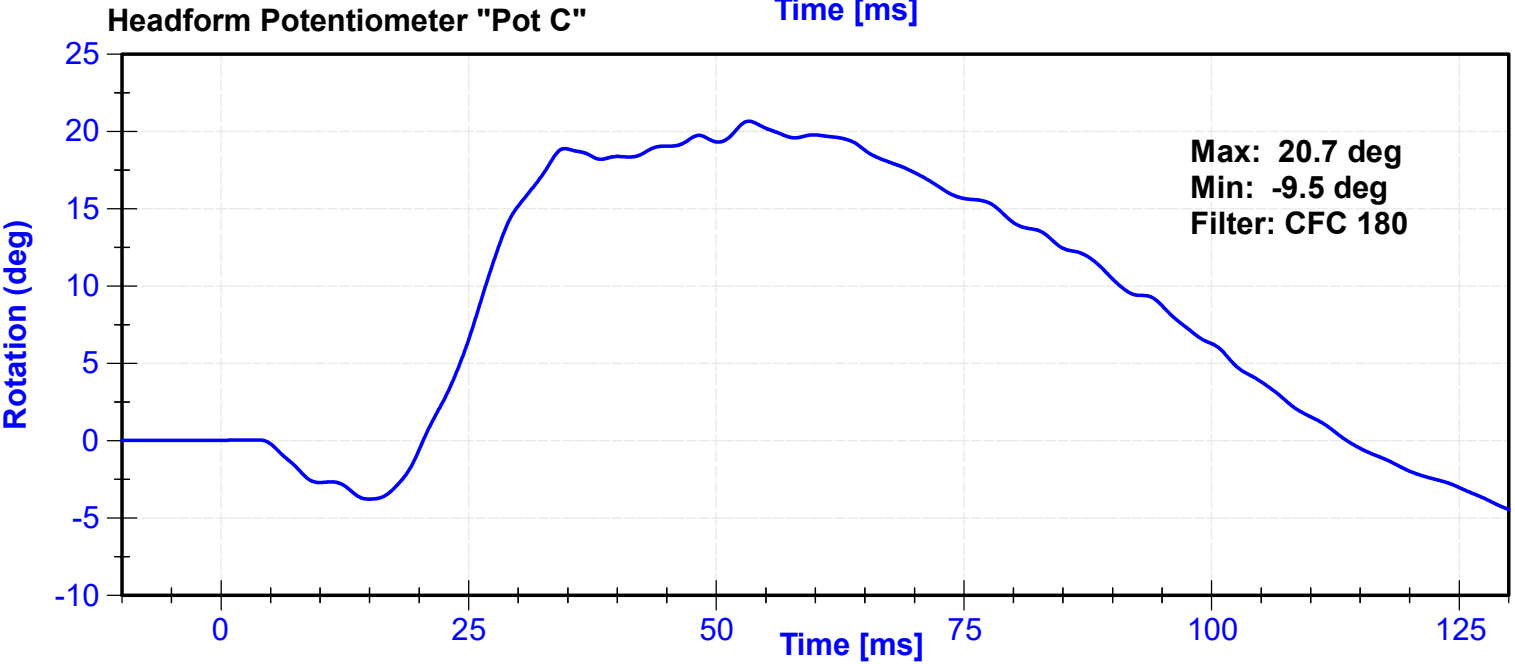
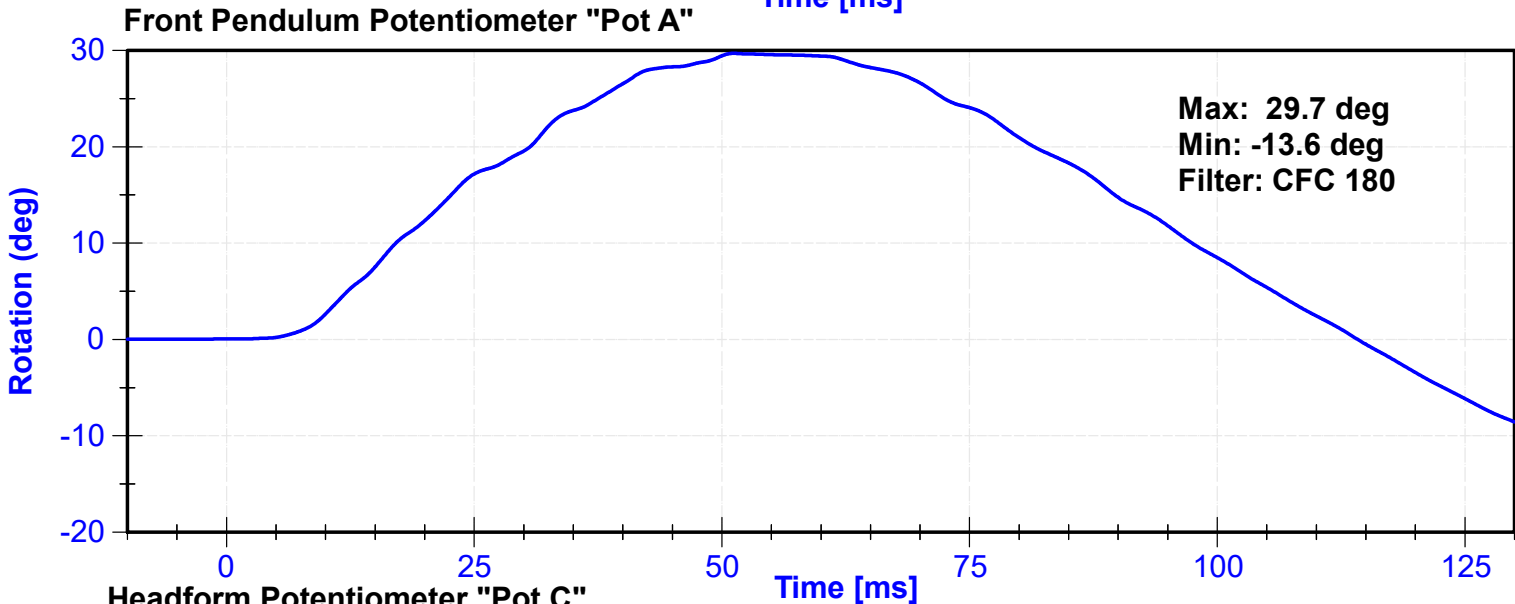
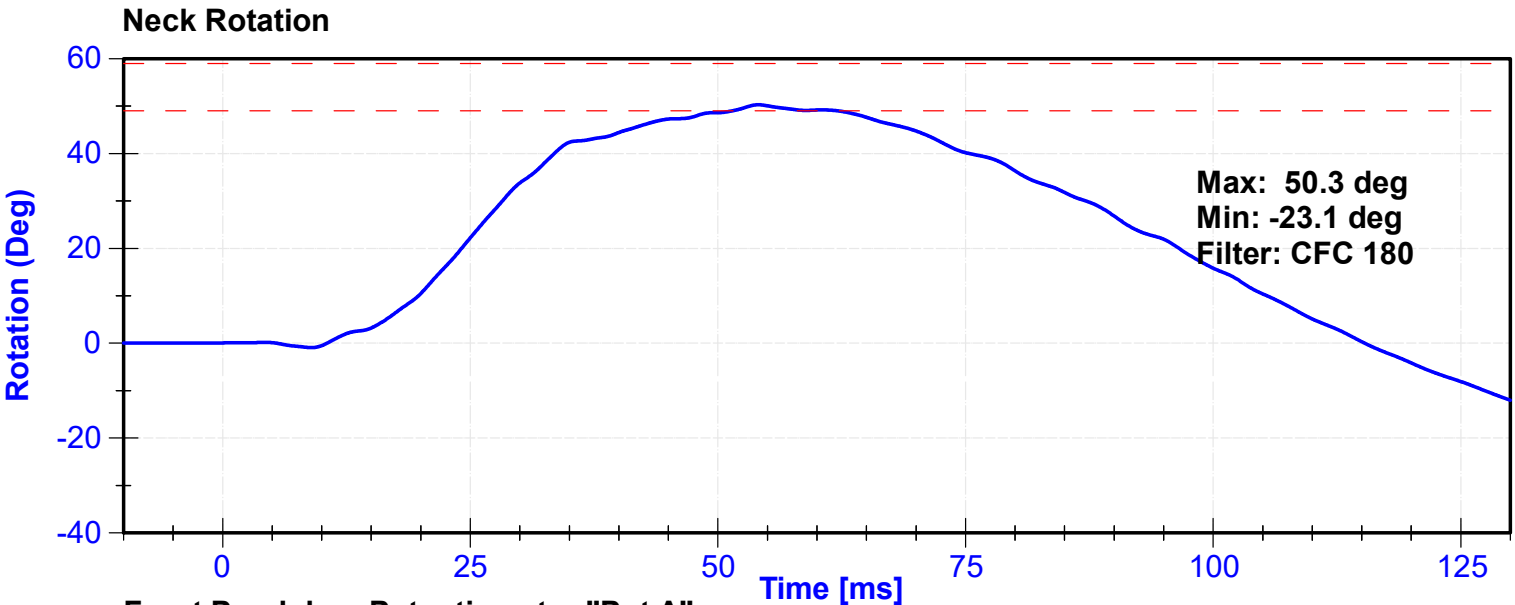
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	35	Pass
Velocity	3.3	3.5	m/s	3.39	Pass
Lateral Neck Rotation	49	59	deg	50.3	Pass
Time at Maximum Rotation	54	66	ms	54.1	Pass
Time of Rotation Decay from Maximum	53	88	ms	61.2	Pass
Pendulum Velocity Overall Corridor	Lower Boundary ¹	Upper Boundary ²	m/s	See Plot ³	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/31/2023	4/28/2024
Front Pendulum Potentiometer	Sfernice	2247	12/5/2023	12/4/2024
Headform Potentiometer	Sfernice	095	9/29/2023	9/28/2024





Appendix I

² Upper Boundary Corridor		¹ Lower Boundary Corridor	
Time (ms)	Velocity (m/s)	Time (ms)	Velocity (m/s)
1.0	0.00	0.0	-0.05
3.0	-0.25	2.5	-0.375
14.0	-3.20	13.5	-3.7
		17.0	-3.7

ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

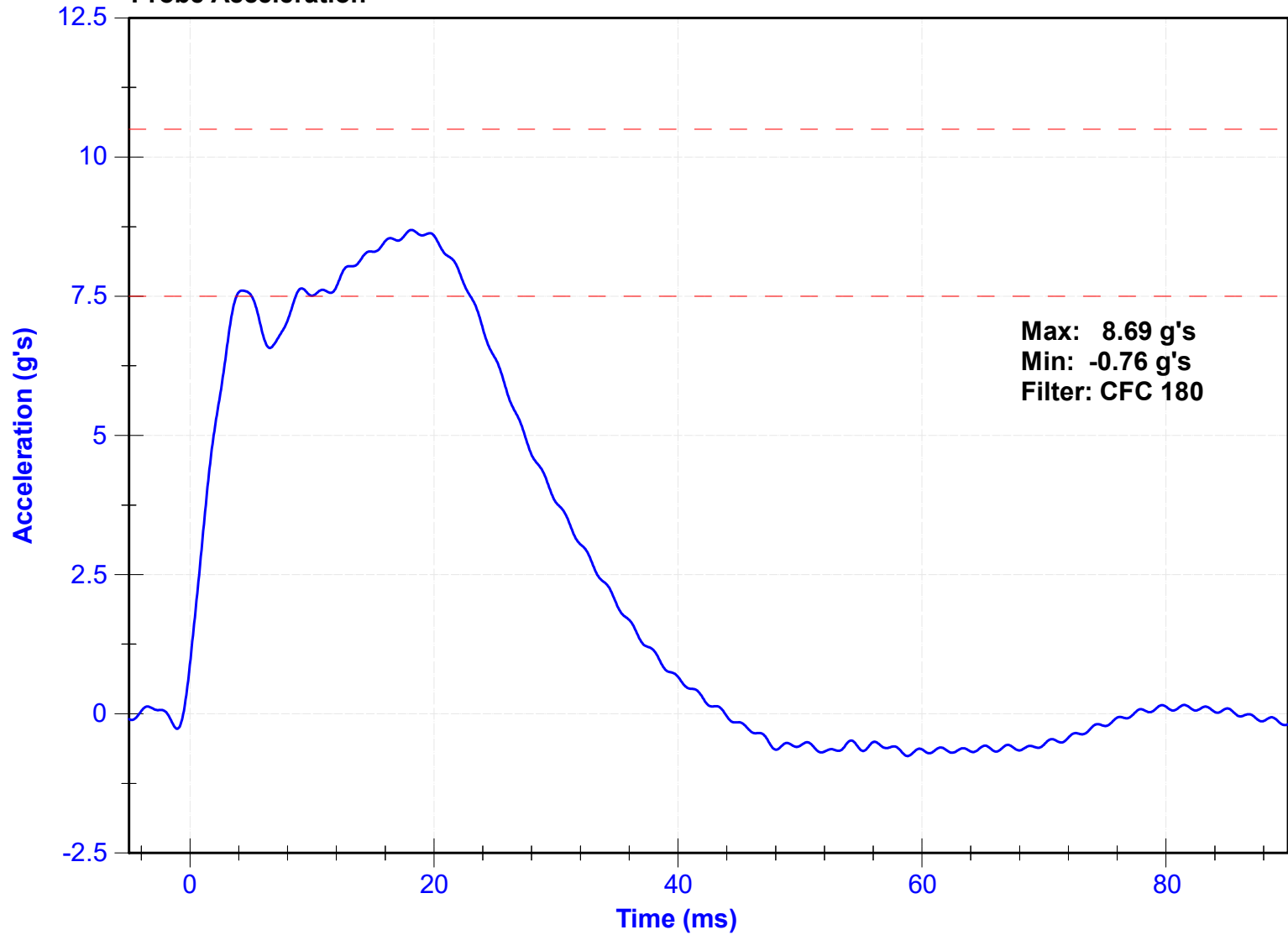
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.24	Pass
Probe Acceleration	7.5	10.5	g's	8.69	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18587	11/20/2023	11/19/2024

Probe Acceleration



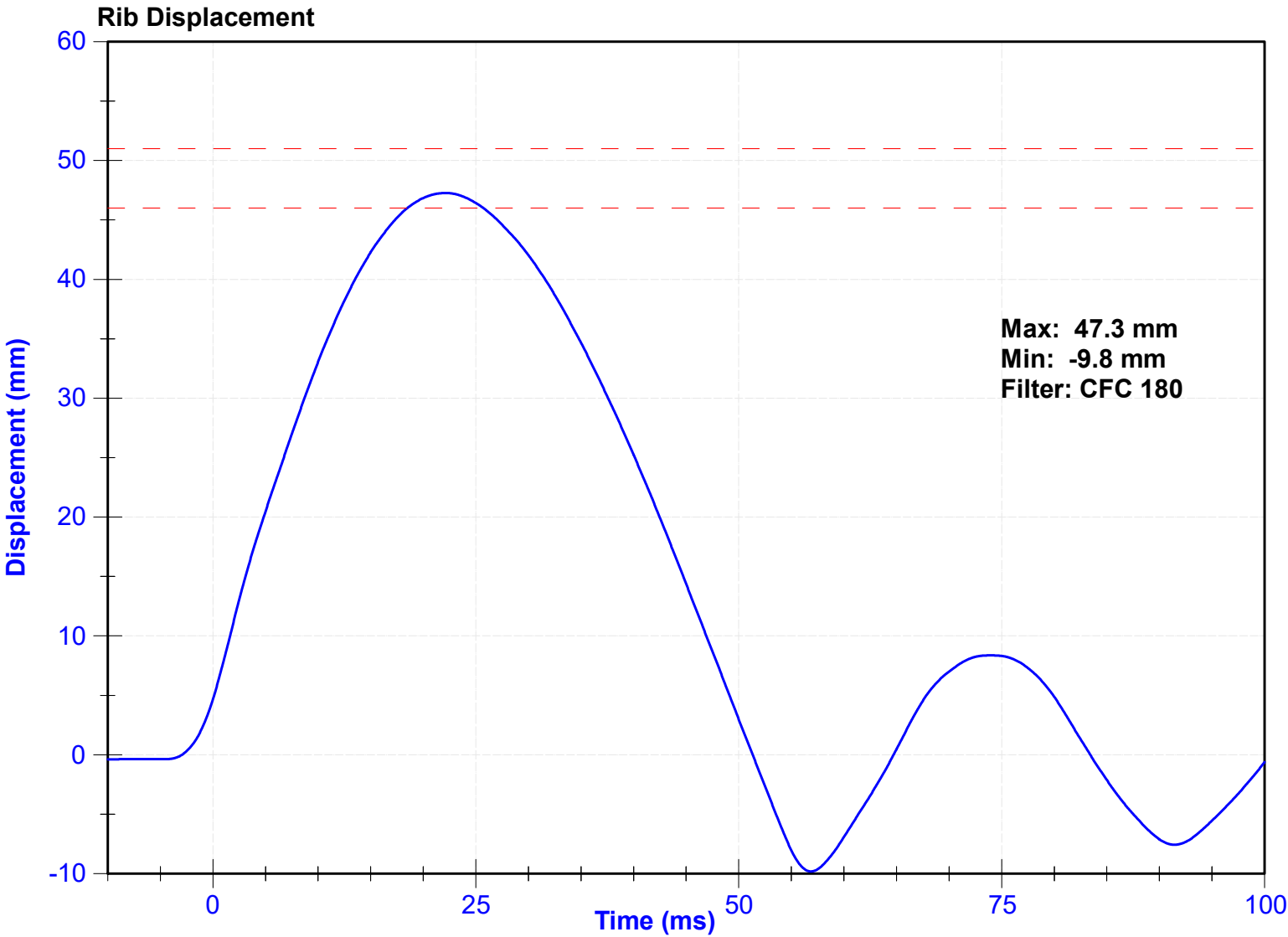
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	46	51	mm	47.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024



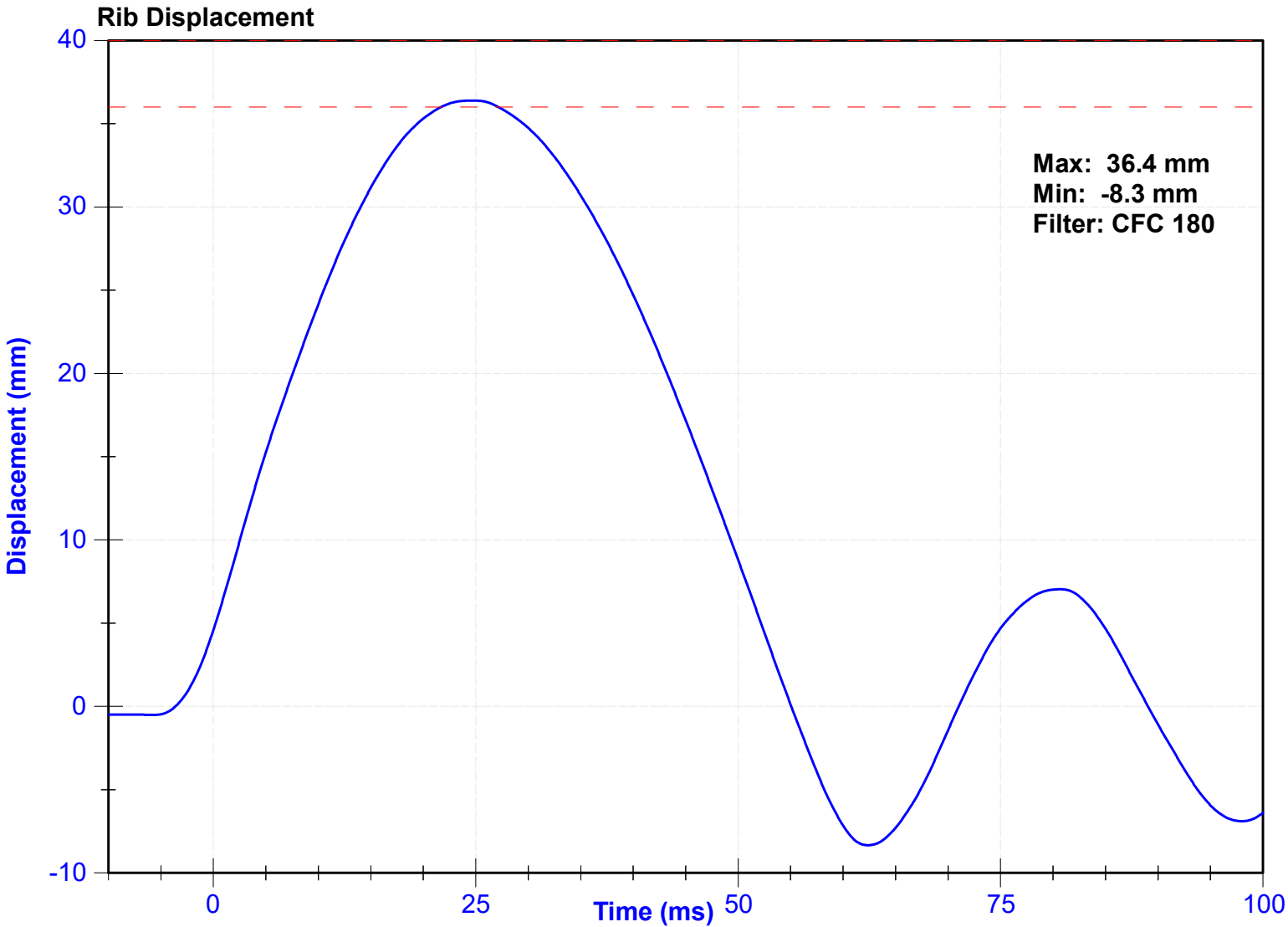
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	36	40	mm	36.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024



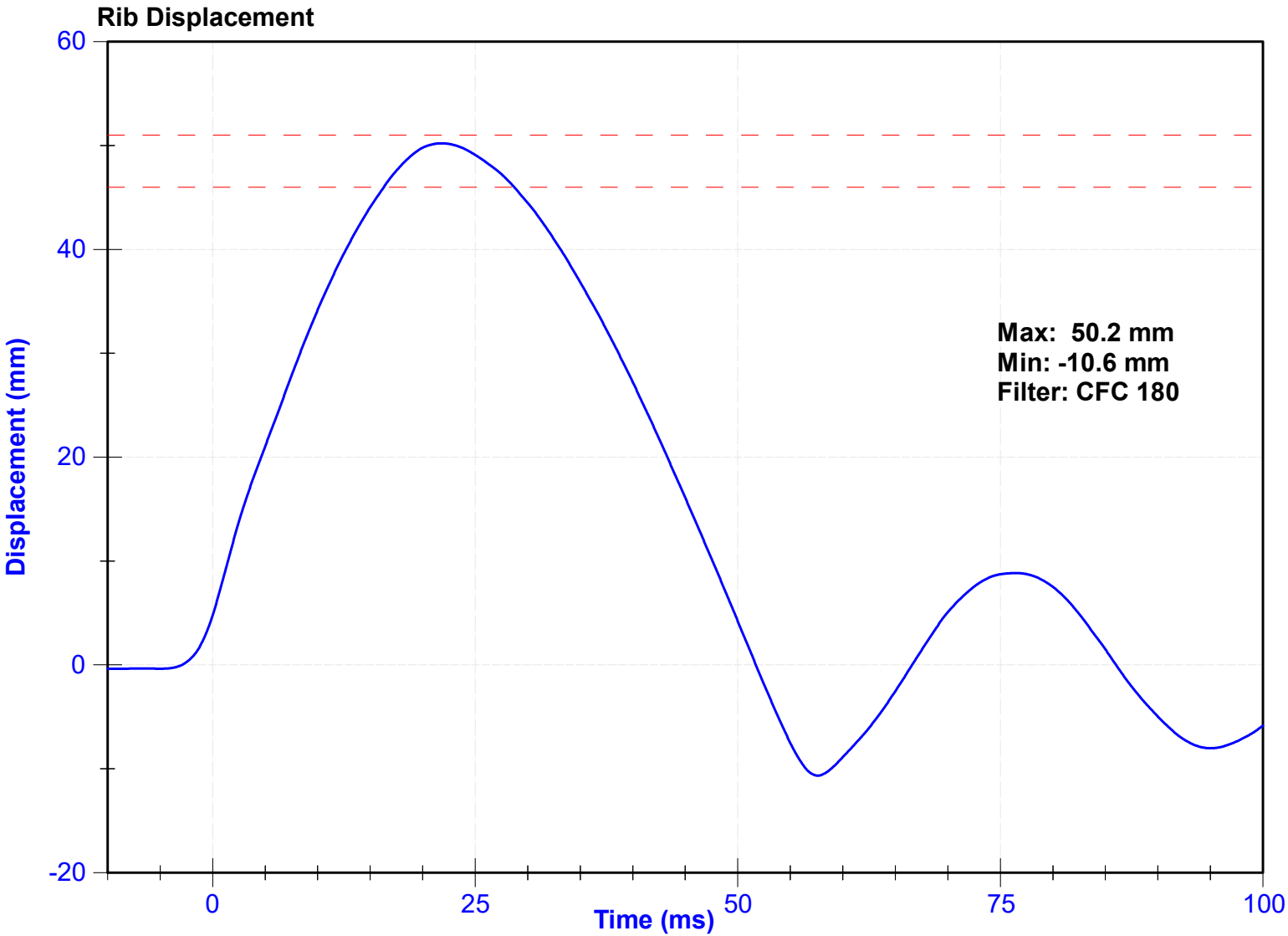
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	46	51	mm	50.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024



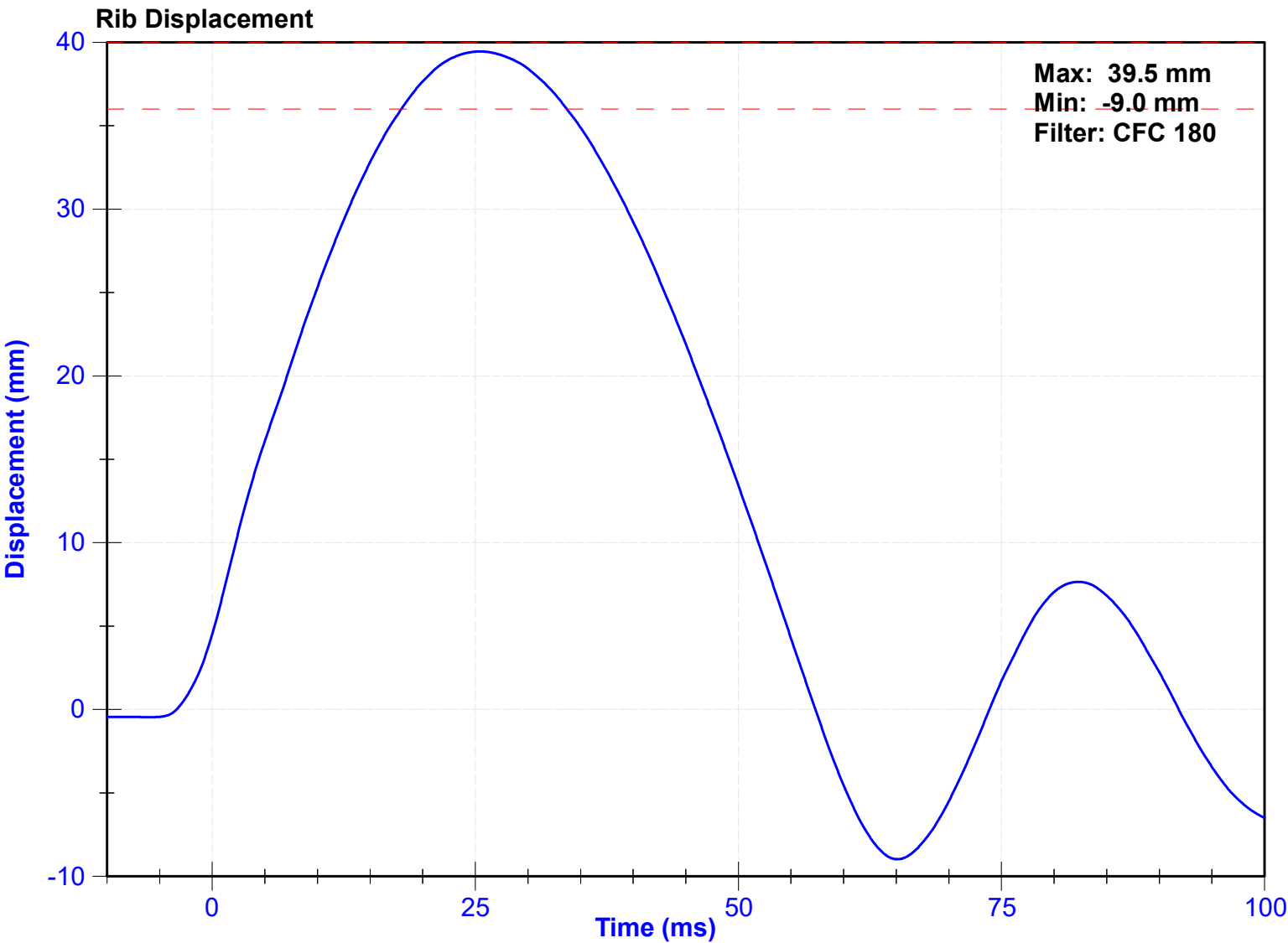
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	36	40	mm	39.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024



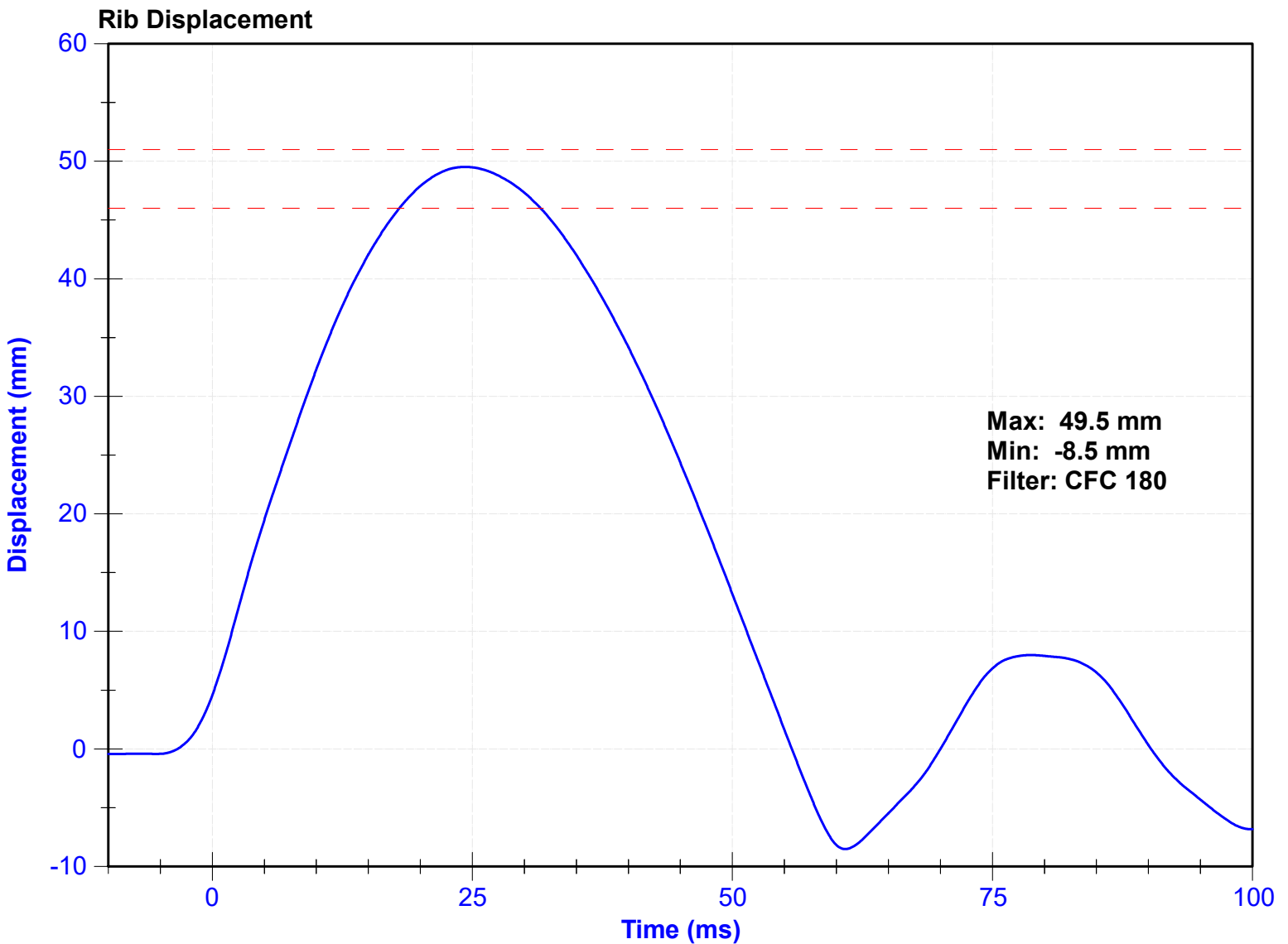
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	46	51	mm	49.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024



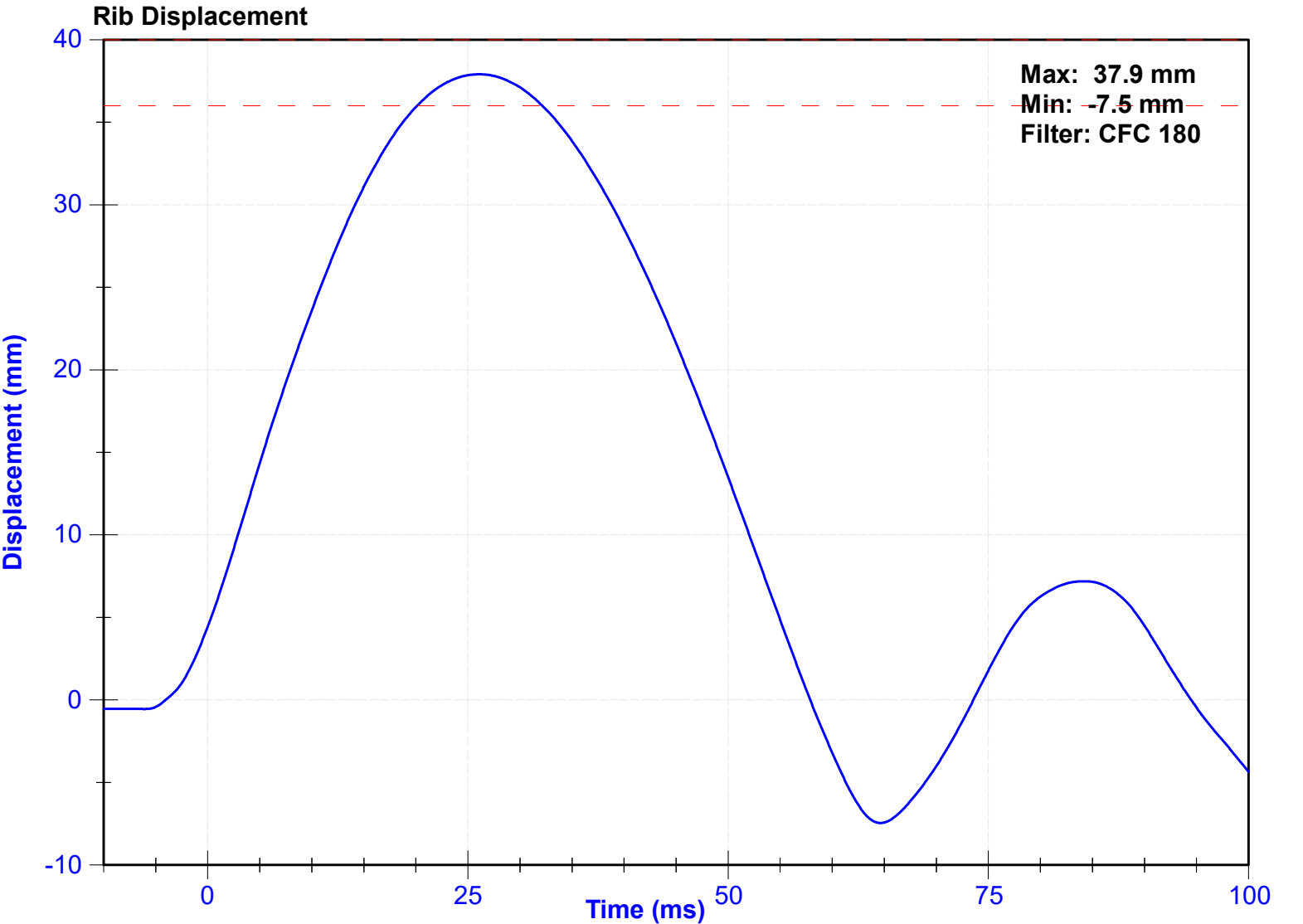
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	22	Pass
Rib Displacement	36	40	mm	37.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024



ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

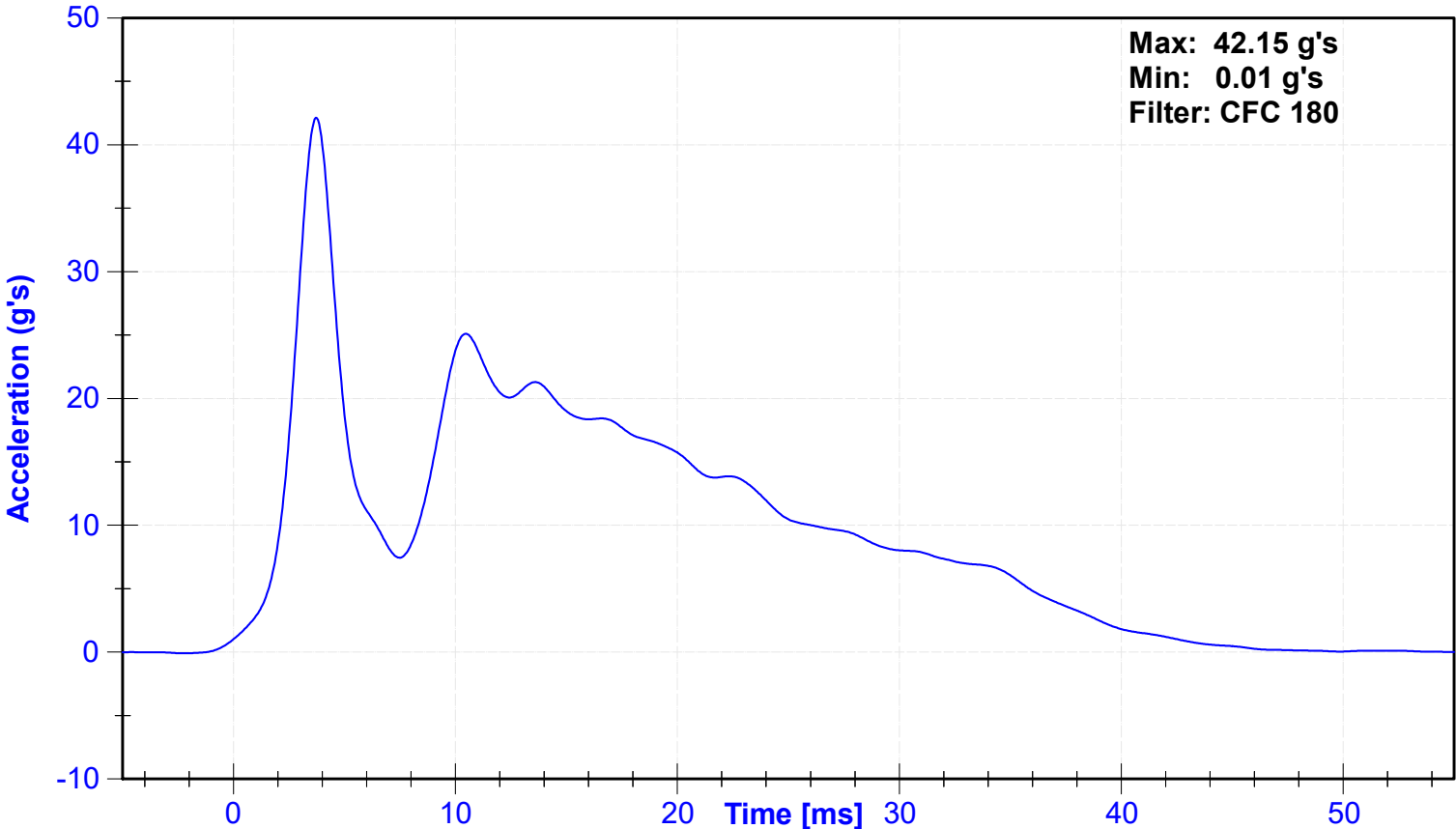
Results

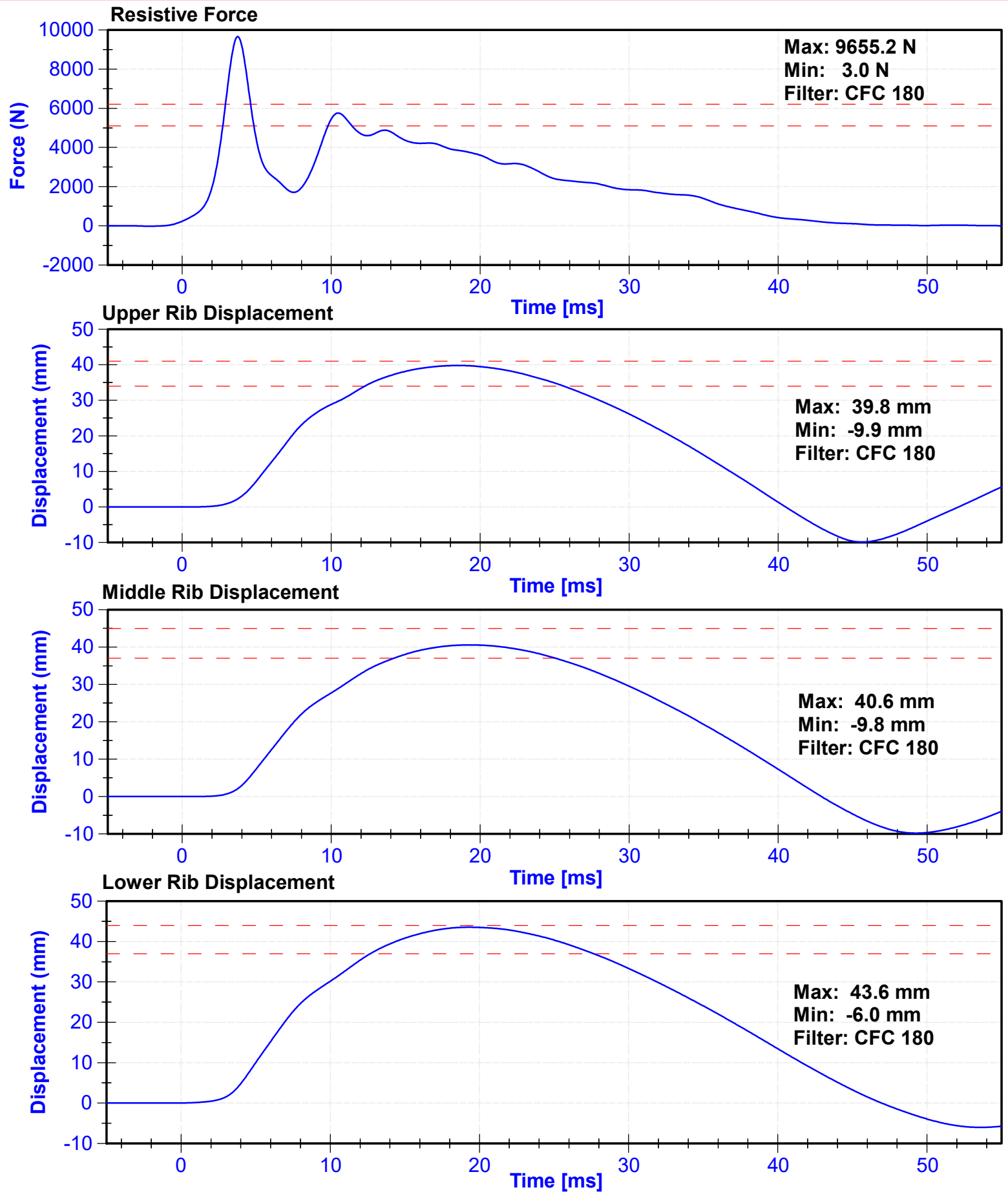
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21	Pass
Humidity	10	70	%	28	Pass
Velocity	5.4	5.6	m/s	5.45	Pass
Resistive Force after 6ms	5100	6200	N	5752.6	Pass
Upper Thorax Rib Deflection	34	41	mm	39.8	Pass
Mid Thorax Rib Deflection	37	45	mm	40.6	Pass
Lower Thorax Rib Deflection	37	44	mm	43.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Upper Thorax Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024
Middle Thorax Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024
Lower Thorax Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024

Probe Acceleration





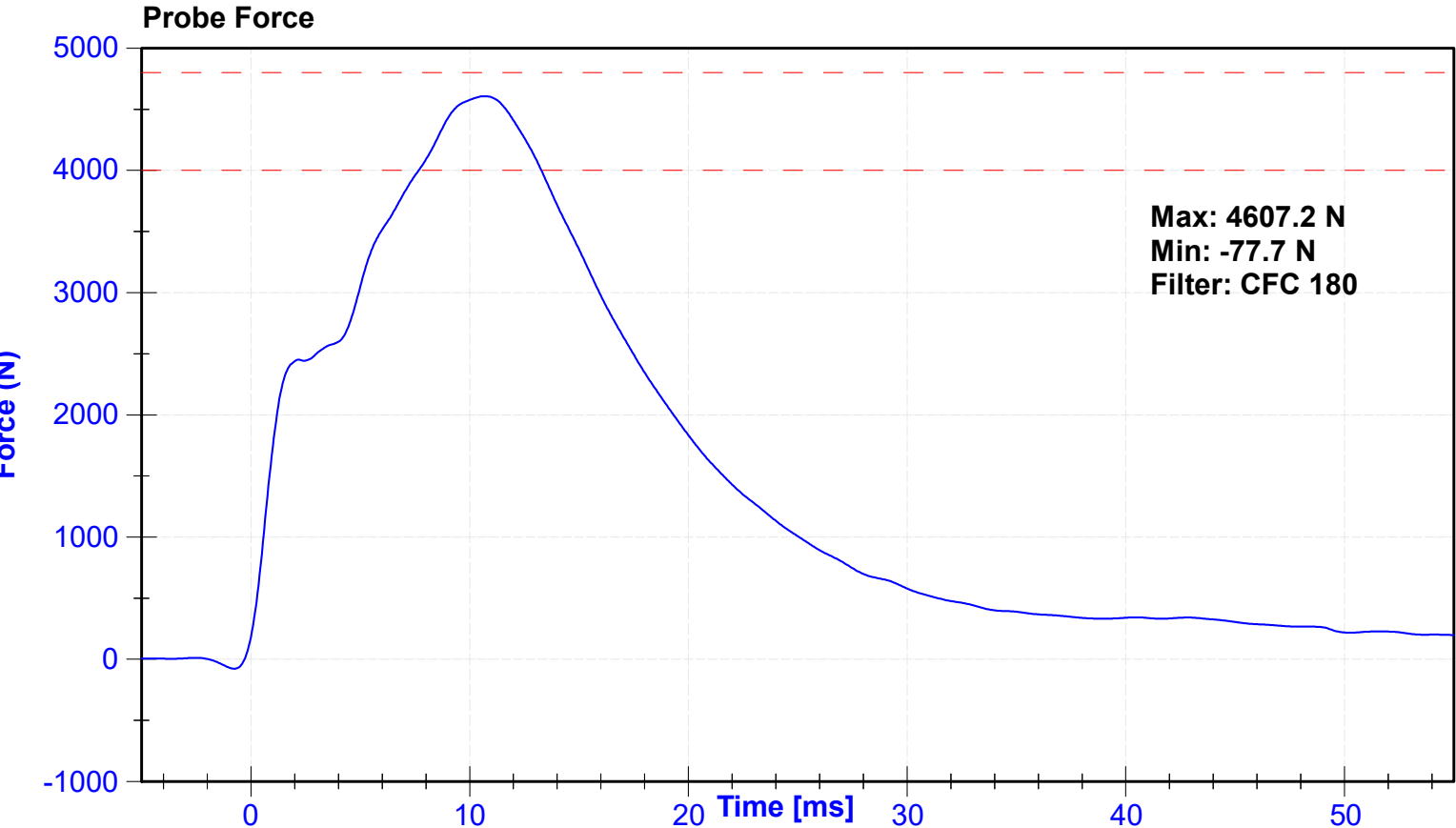
ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

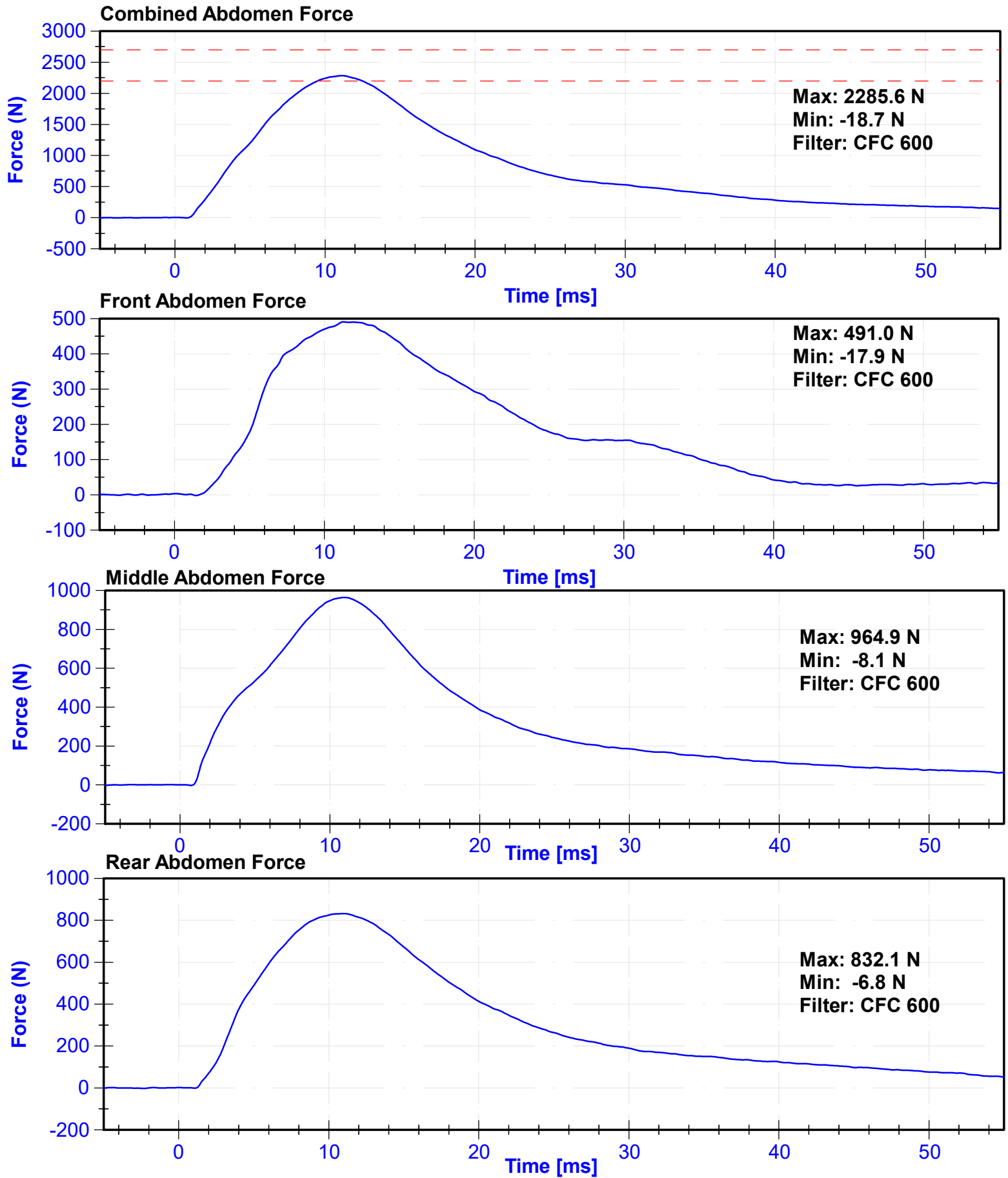
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21	Pass
Humidity	10	70	%	28	Pass
Velocity	3.9	4.1	m/s	3.94	Pass
Combined Abdomen Force	2200	2700	N	2285.6	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	11.10	Pass
Resistive Probe Force	4000	4800	N	4607.2	Pass
Time at Peak Resistive Force	10.6	13.0	ms	10.67	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Front Abdomen Load Cell	Denton	1440	8/8/2023	8/7/2024
Middle Abdomen Load Cell	Denton	1525	8/8/2023	8/7/2024
Rear Abdomen Load Cell	Denton	1528	8/8/2023	8/7/2024





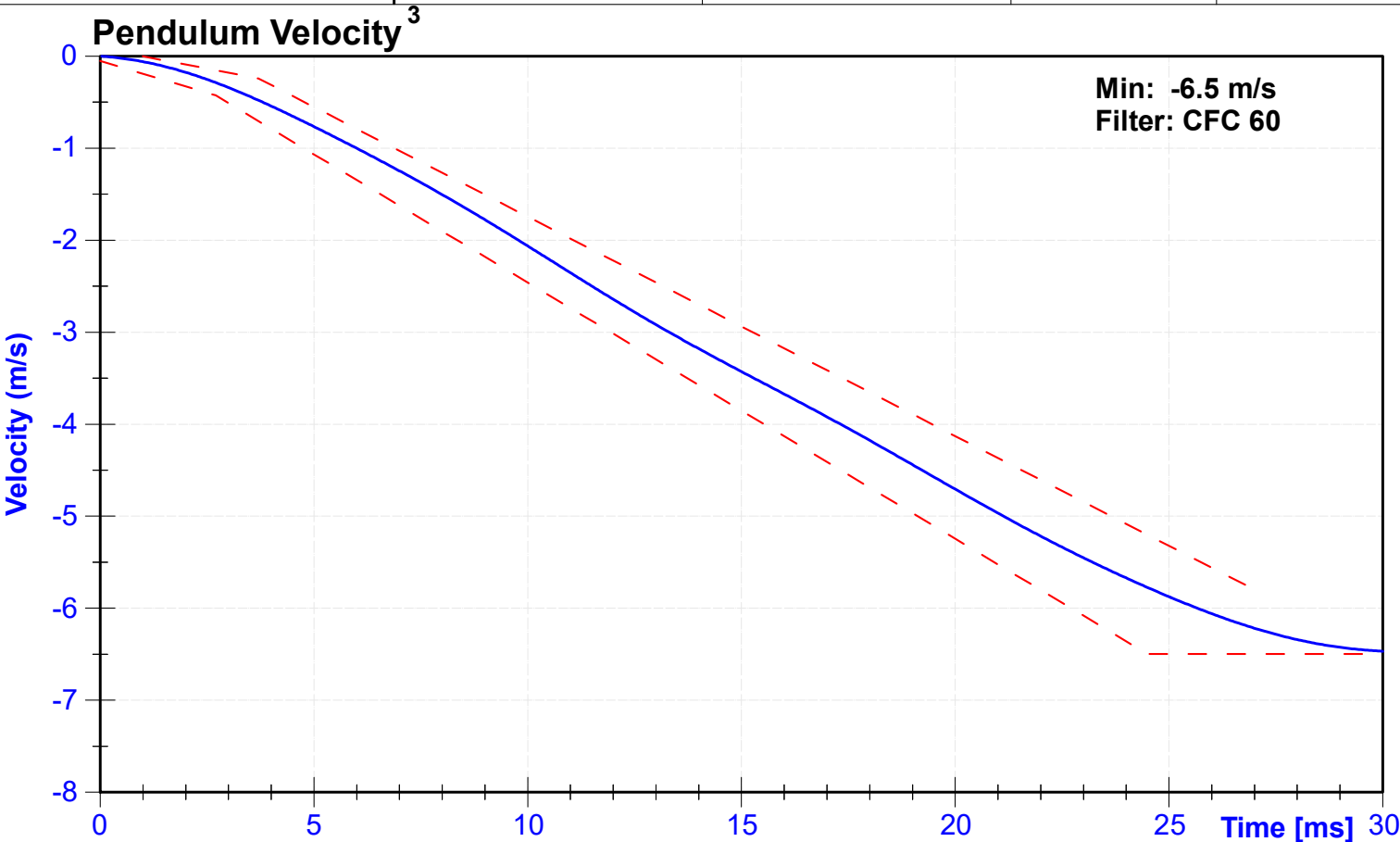
ATD Manufacturer	Denton	Test Technician	J. Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

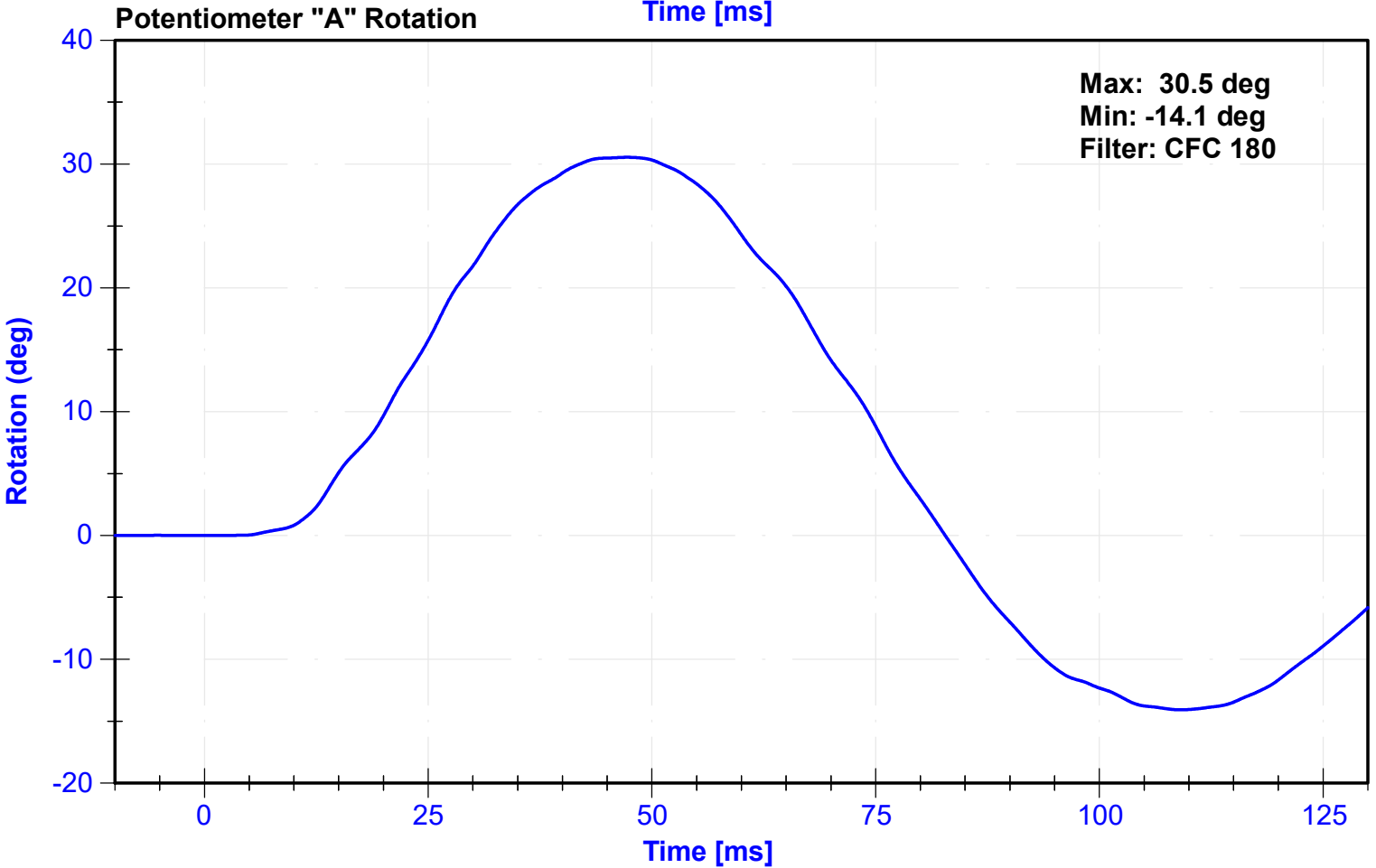
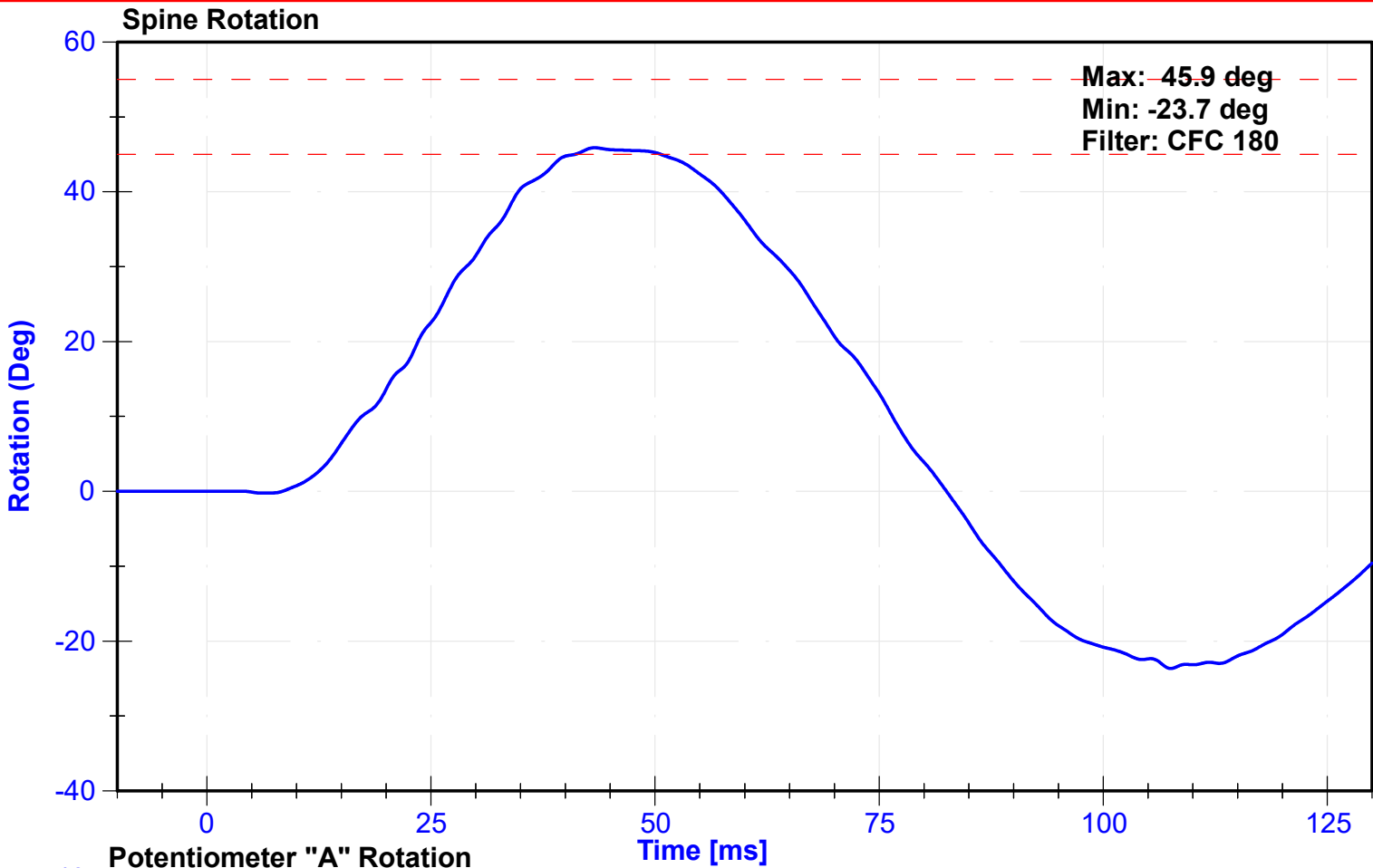
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.1	Pass
Humidity	10	70	%	35	Pass
Velocity	5.95	6.15	m/s	6.035	Pass
Lateral Spine Rotation	45	55	deg	45.9	Pass
Time at Maximum Rotation	39	53	ms	43.2	Pass
Time of Decay to Zero Degrees	37	57	ms	39.3	Pass
Pendulum Velocity Overall Corridor	Lower Boundary ¹	Upper Boundary ²	m/s	See Plot ³	Pass

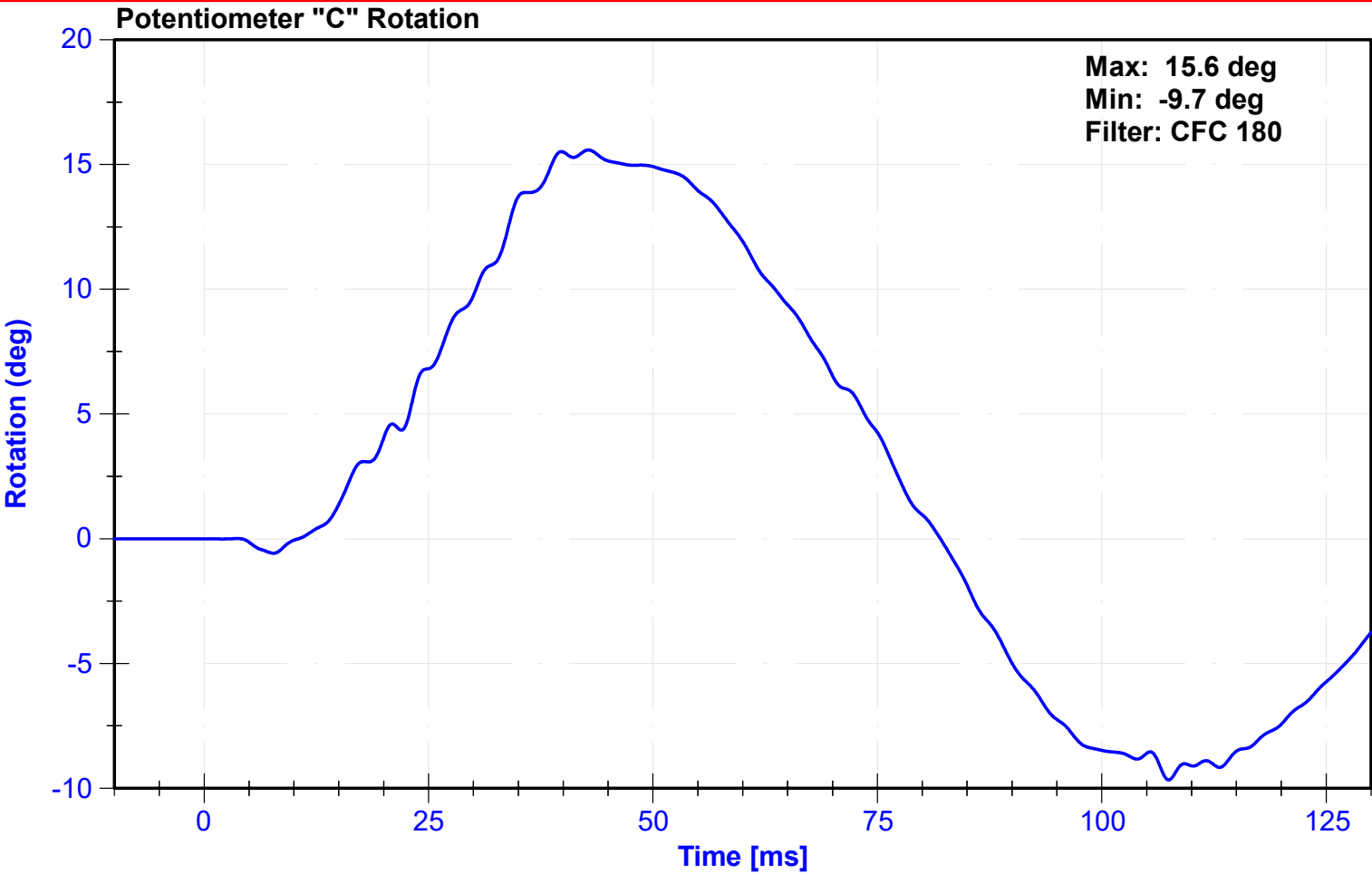
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/31/2023	4/28/2024
Pendulum "A" Potentiometer	Sfernice	2247	12/5/2023	12/4/2024
Condyle "B" Potentiometer	Sfernice	095	9/29/2023	9/28/2024



^{1,2} Upper and lower boundaries specified in Appendix I
IV-19





Appendix I

² Upper Boundary Corridor		¹ Lower Boundary Corridor	
Time (ms)	Velocity (m/s)	Time (ms)	Velocity (m/s)
1.0	0.00	0.0	-0.05
3.7	-0.24	2.7	-0.425
27.0	-5.80	24.5	-6.5
		30.0	-6.5

ATD Manufacturer	Denton	Test Technician	J.Kinderman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

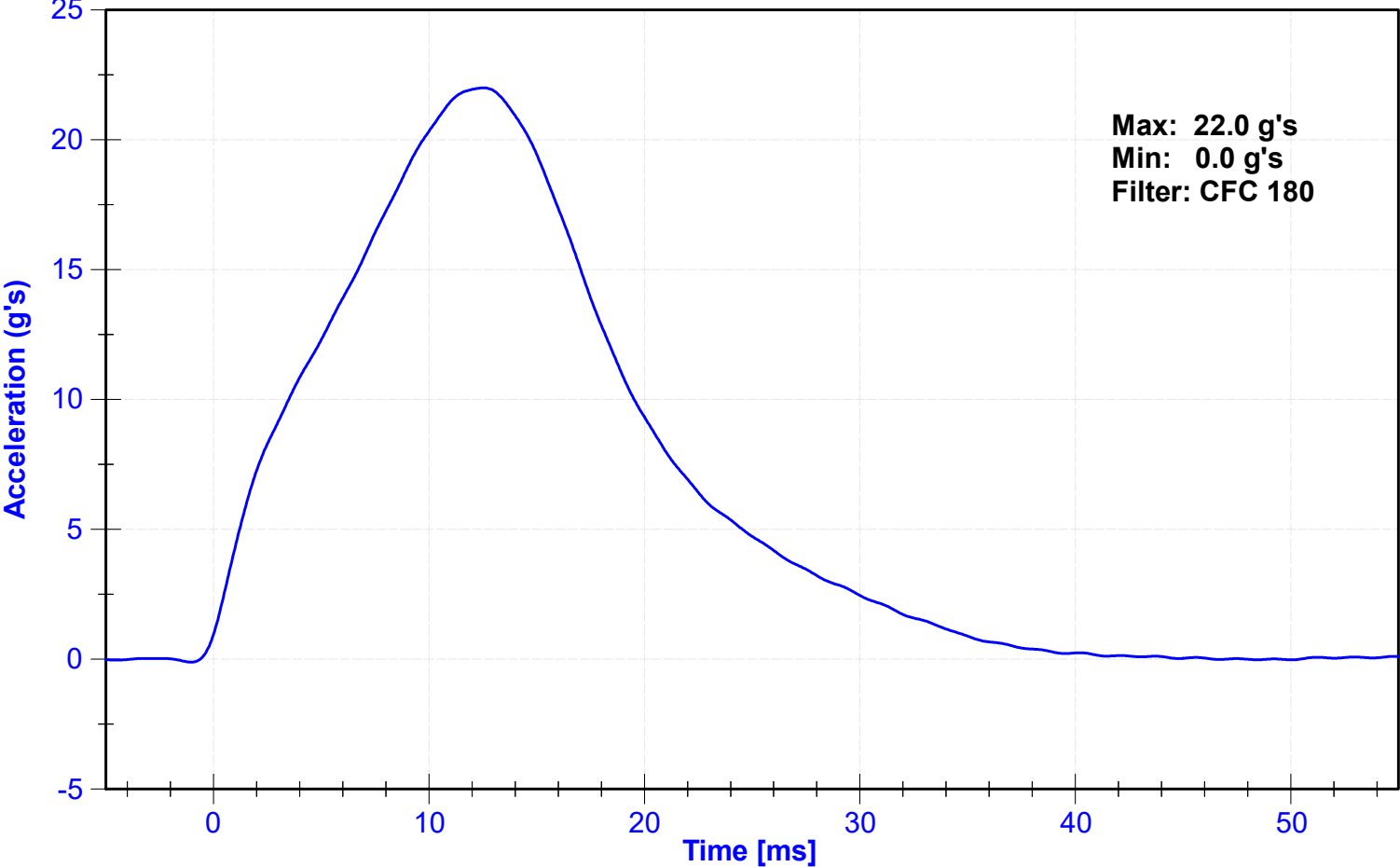
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.26	Pass
Resistive Force	4700	5400	N	5038.5	Pass
Time at Peak Resistive Force	11.8	16.1	ms	12.50	Pass
Pubic Force	-1590	-1230	N	-1532.8	Pass
Time at Peak Pubic Force	12.2	17.0	ms	13.80	Pass

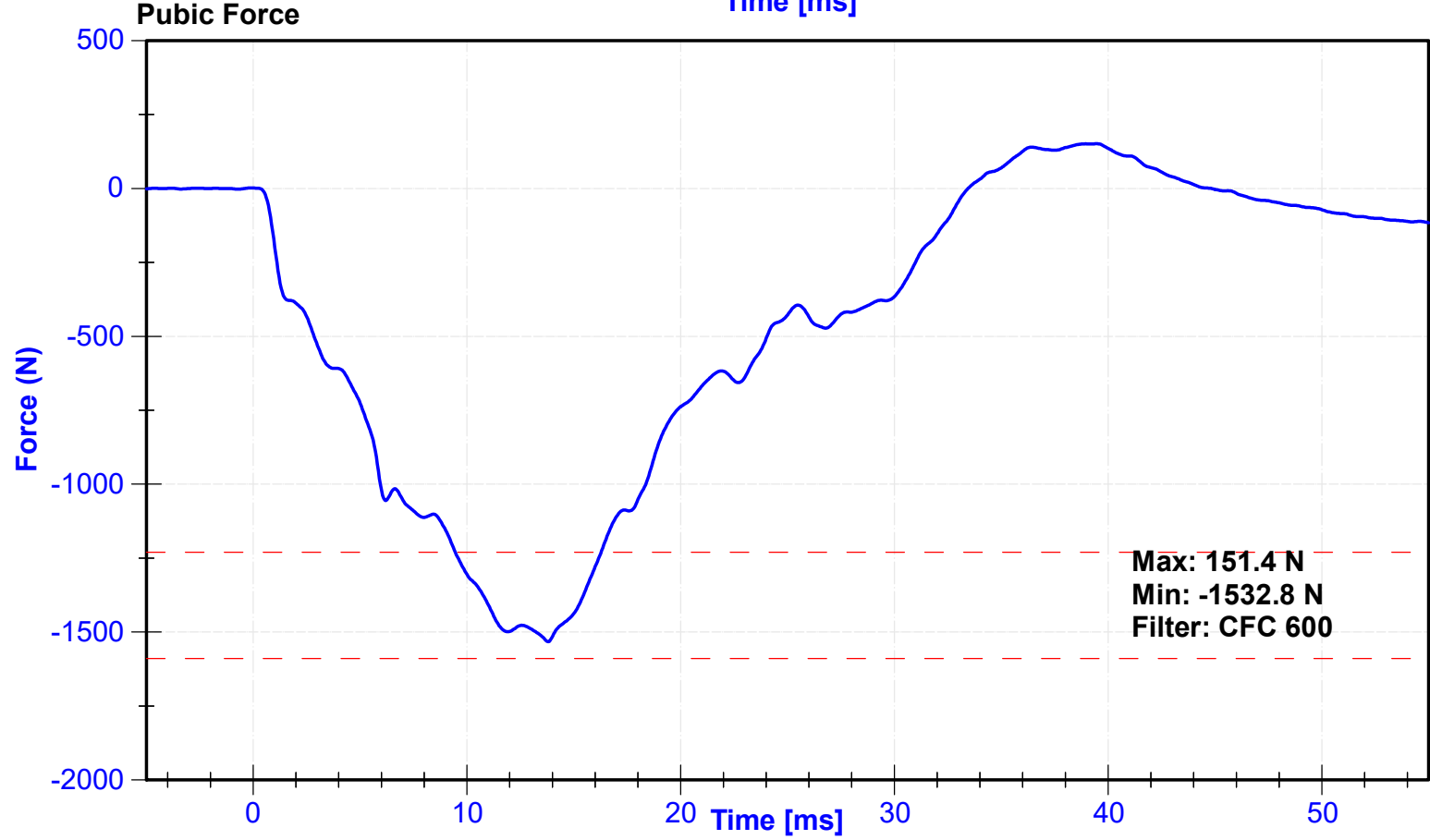
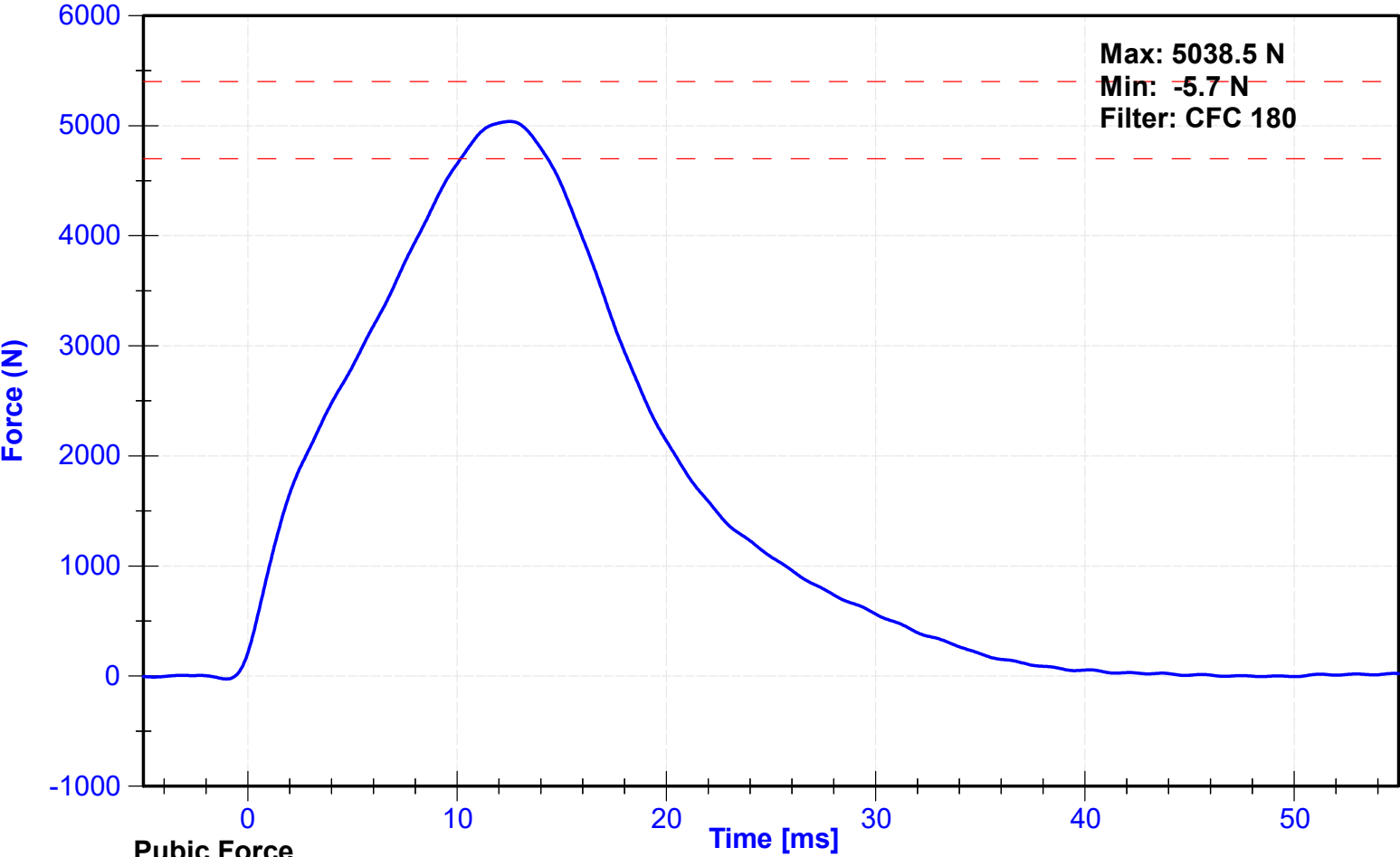
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Pubic Load Cell	Denton	456-FY	8/8/2023	8/7/2024

Probe Acceleration



Resistive Force



POST-TEST DUMMY PERFORMANCE CALIBRATION TEST DATA
(Subpart U, ES-2re)

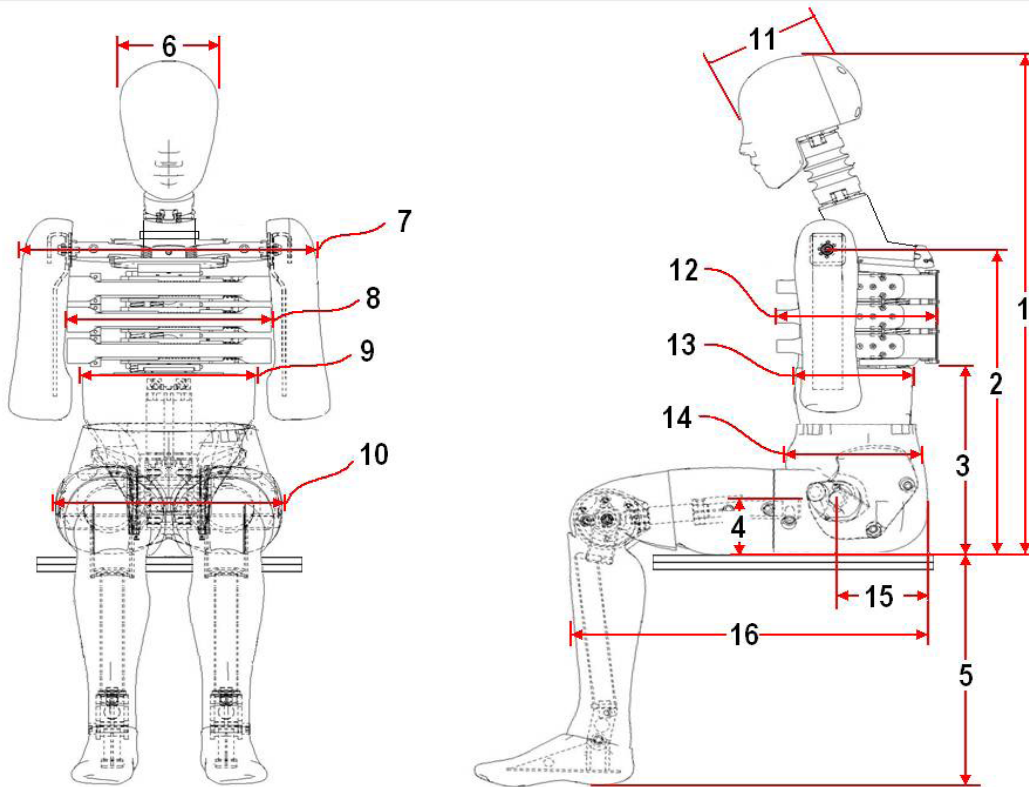


External Measurements - EuroSID-2re

Technician: T. Roseman

Date: 4/22/2024

Dummy Serial Number: D037



FRONT VIEW

SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	910	Pass
2	Seat to Shoulder Joint	558	572	562	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	354	Pass
4	Seat to Hip Joint (center of bolt)	97	103	101	Pass
5	Sole to Seat, Sitting	333	451	421	Pass
6	Head Width	152	158	155	Pass
7	Shoulder/Arm Width	461	479	472	Pass
8	Thorax Width	322	332	330	Pass
9	Abdomen Width	273	287	283	Pass
10	Pelvis Lap Width	359	373	362	Pass
11	Head Depth	196	206	199	Pass
12	Thorax Depth	262	272	267	Pass
13	Abdomen Depth	194	204	198	Pass
14	Pelvis Depth	235	245	239	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	155	Pass
16	Back of Buttocks to Front Knee	597	615	607	Pass

ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

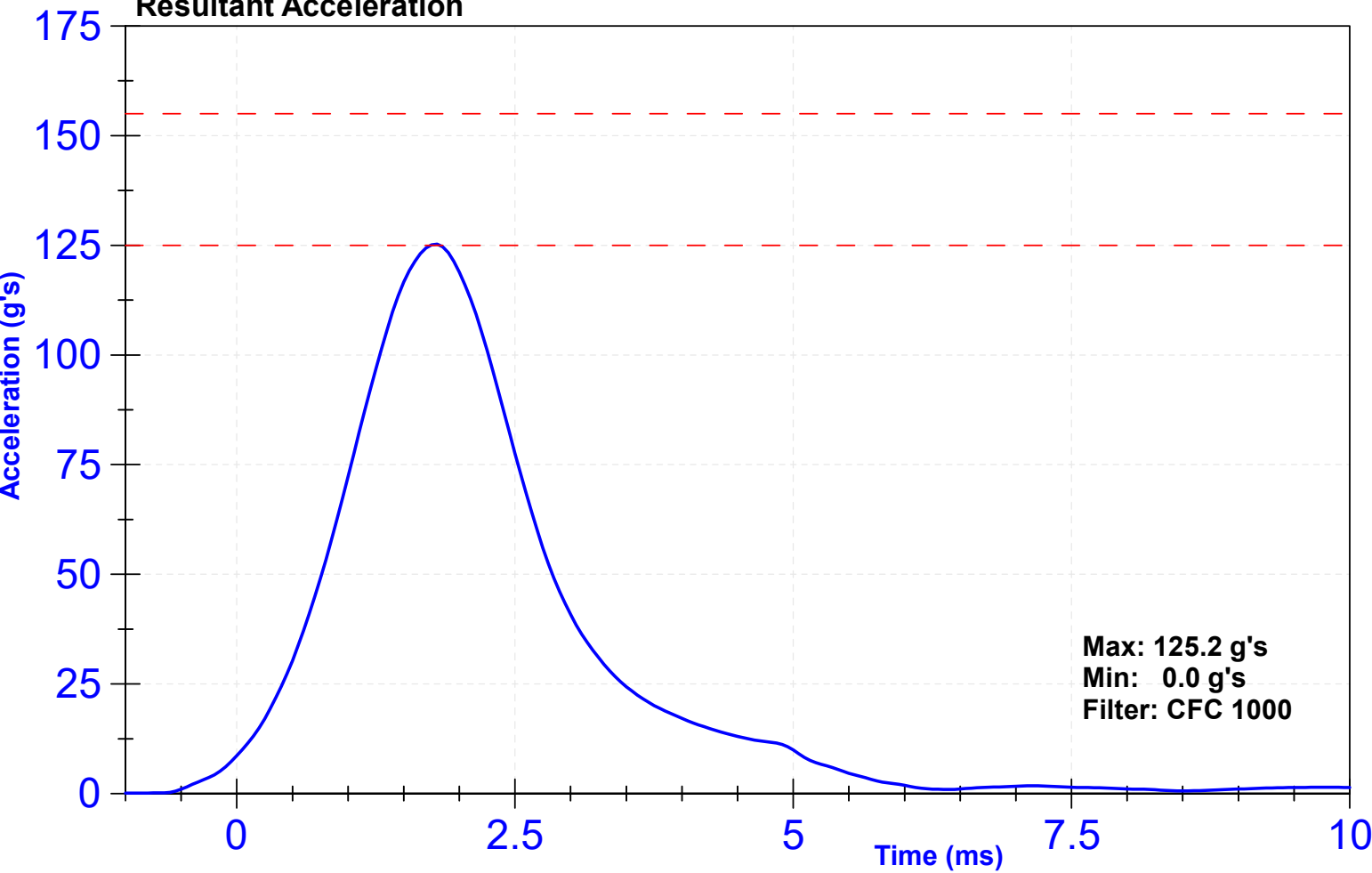
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	33.1	Pass
Resultant Acceleration	125	155	g's	125.2	Pass
Oscillation	0	15	%	1.43	Pass
Fore-Aft Acceleration	-15	15	g's	9.3	Pass

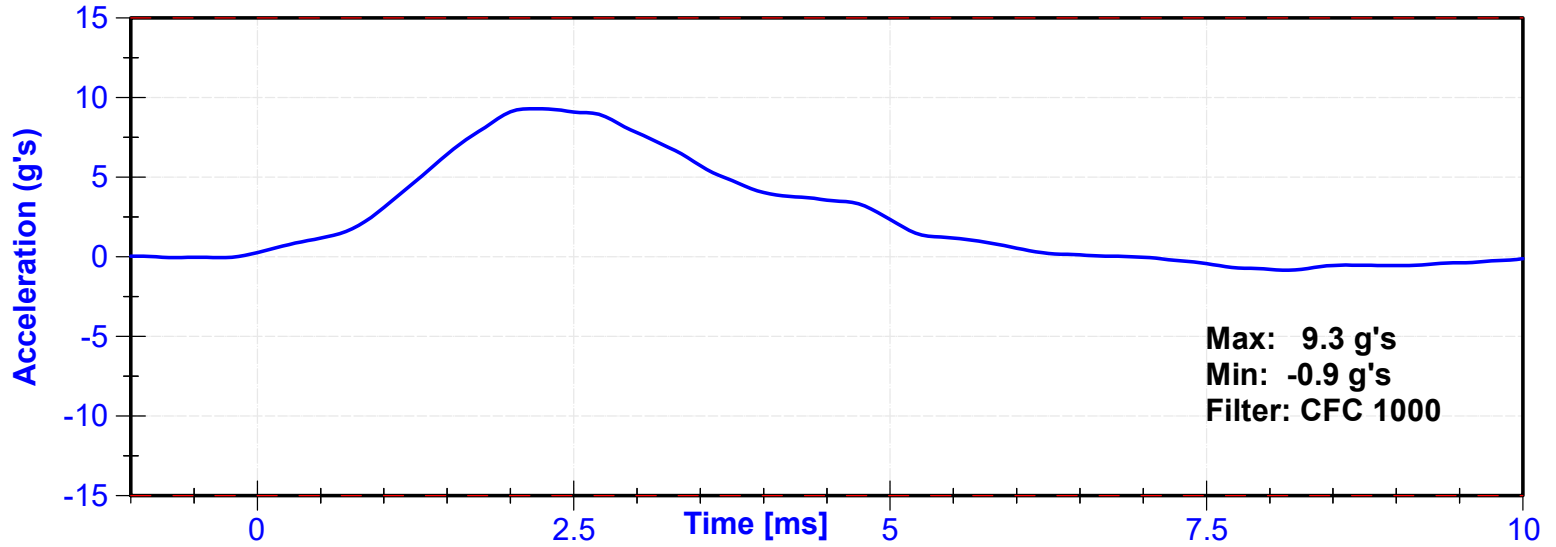
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	T21724	2/1/2024	7/30/2024
Y Accelerometer	Endevco	T22281	2/1/2024	7/30/2024
Z Accelerometer	Endevco	T26050	2/1/2024	7/30/2024

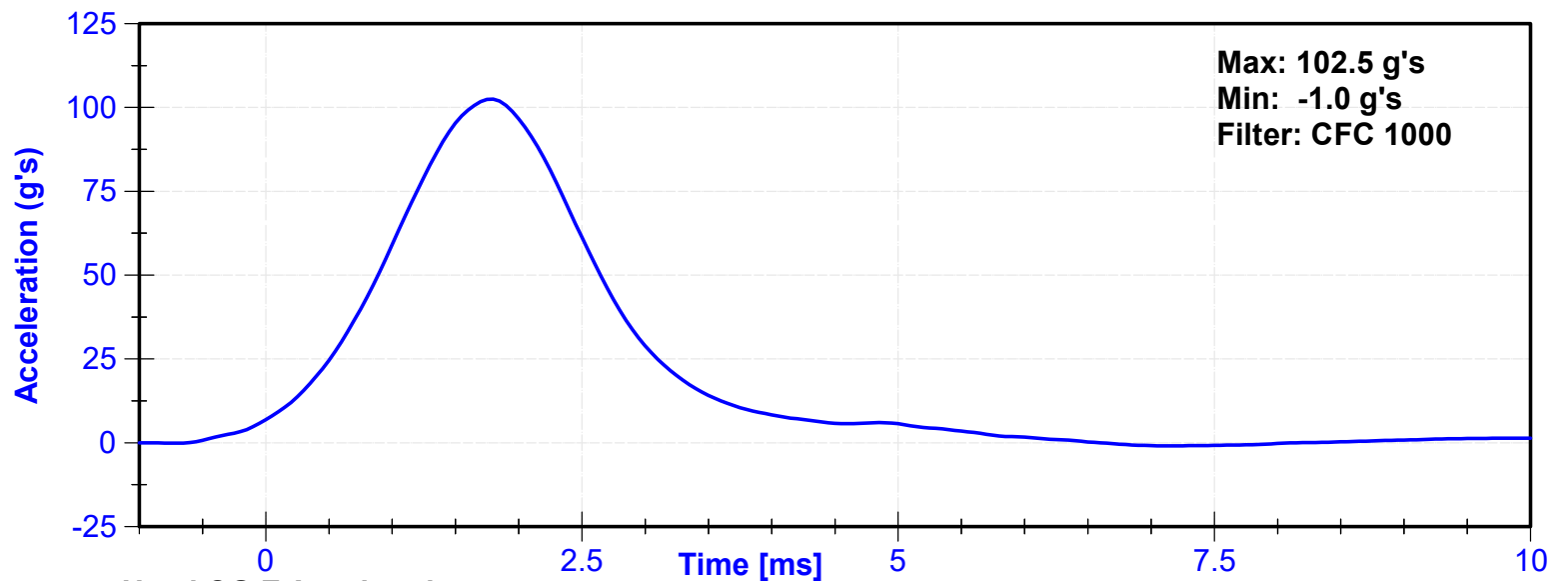
Resultant Acceleration



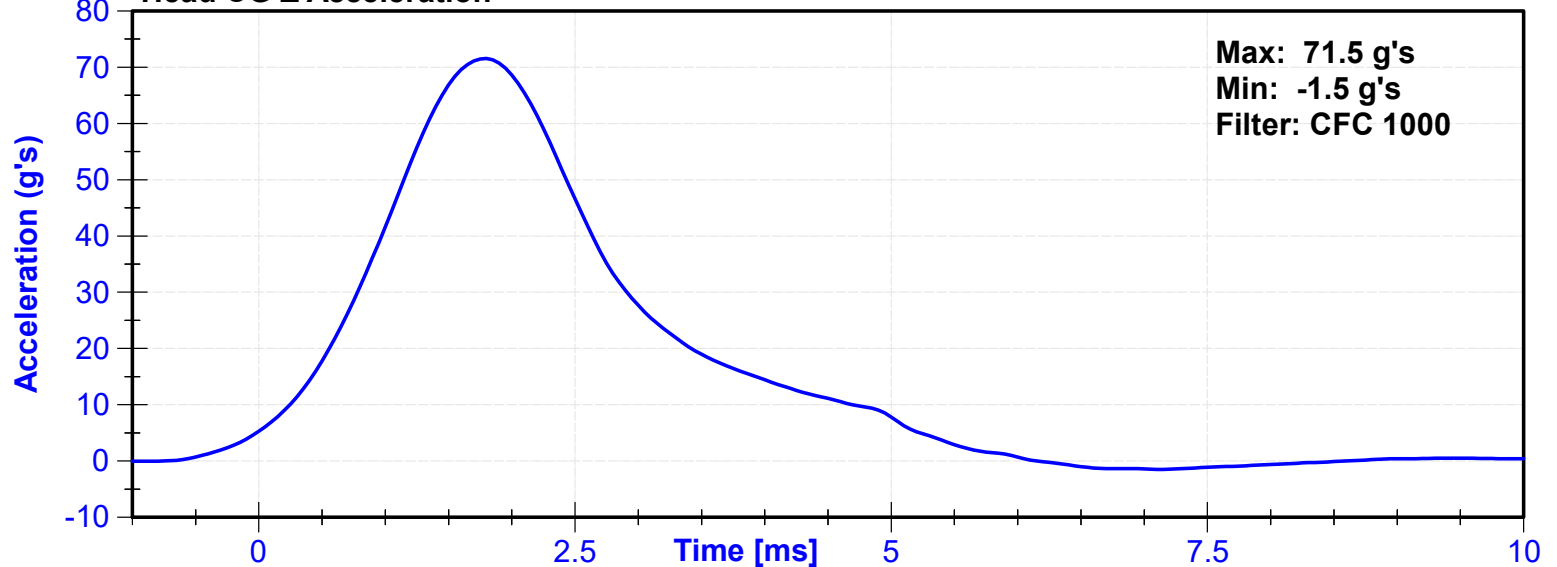
Head CG X Acceleration



Head CG Y Acceleration



Head CG Z Acceleration



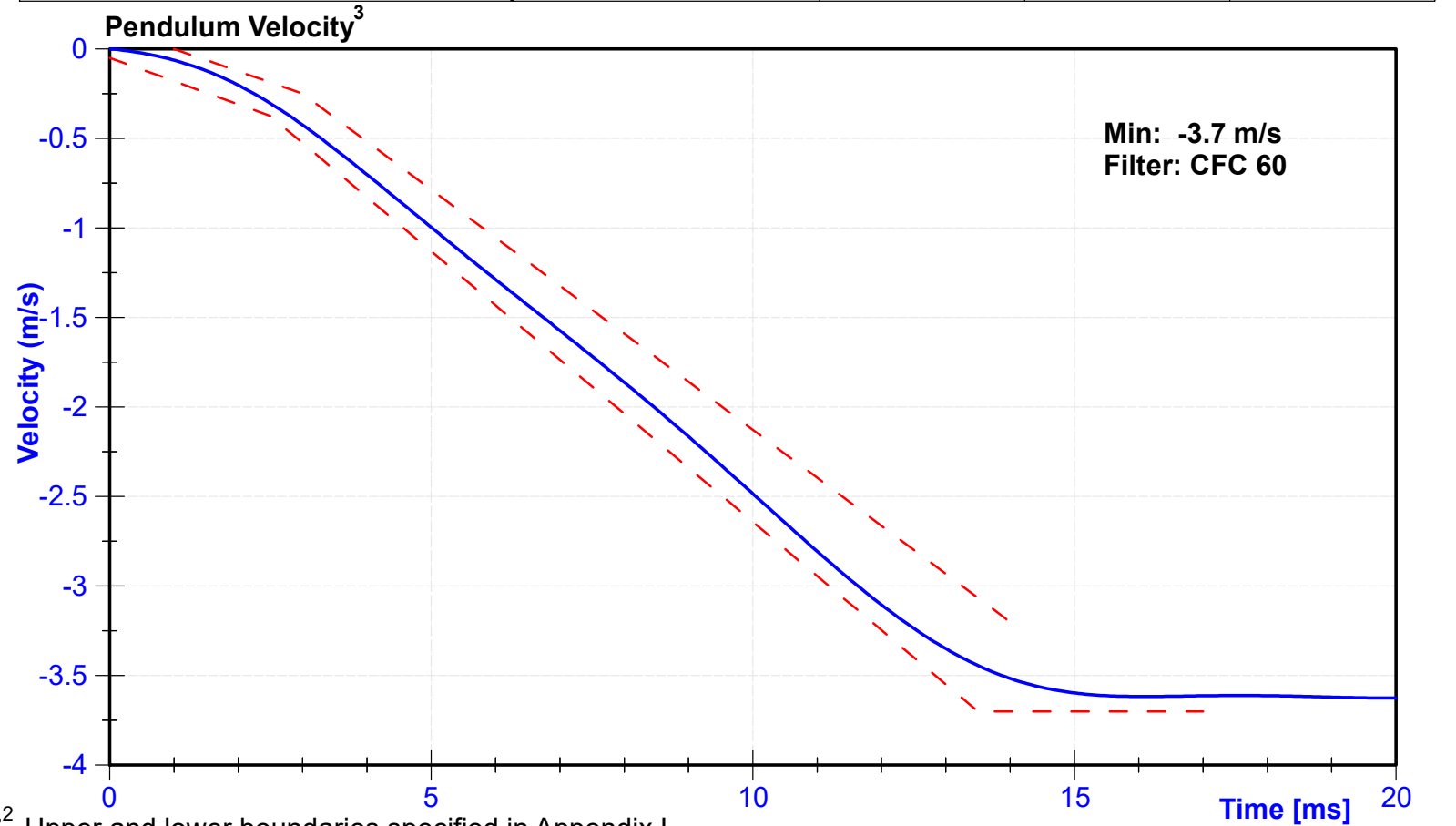
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

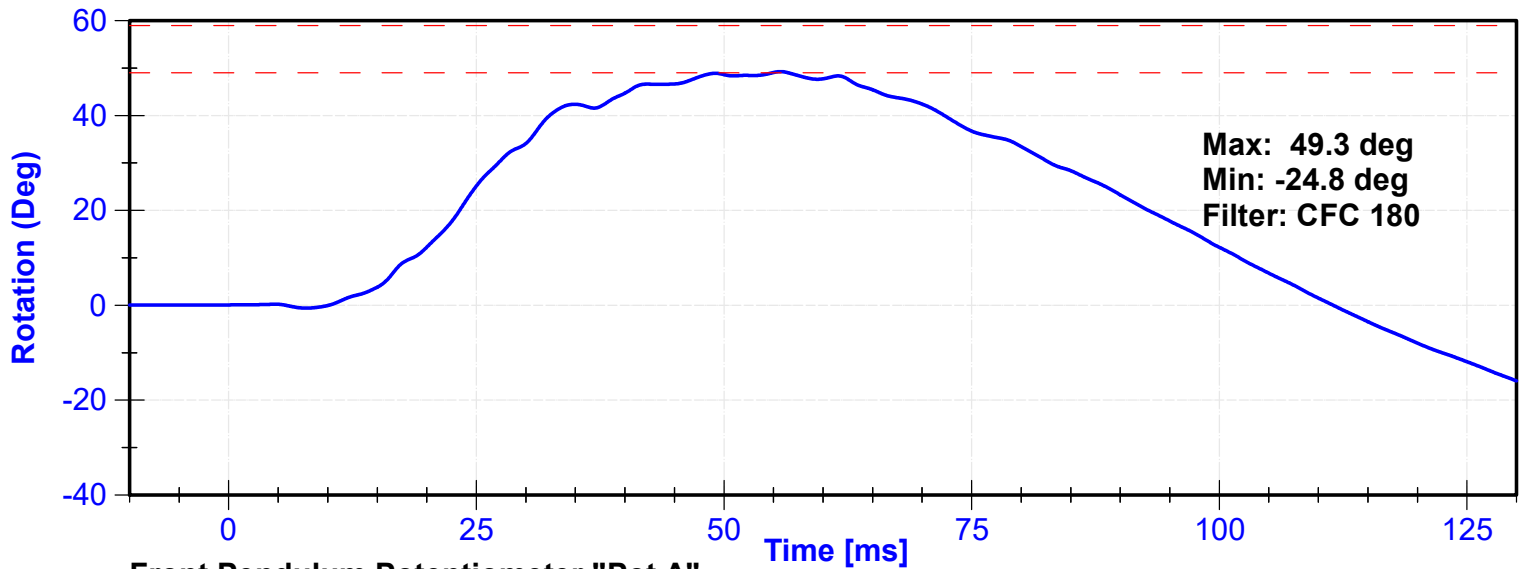
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.2	Pass
Humidity	10	70	%	32	Pass
Velocity	3.3	3.5	m/s	3.42	Pass
Lateral Neck Rotation	49	59	deg	49.3	Pass
Time at Maximum Rotation	54	66	ms	55.7	Pass
Time of Rotation Decay from Maximum	53	88	ms	55.8	Pass
Pendulum Velocity Overall Corridor	Lower Boundary ¹	Upper Boundary ²	m/s	See Plot ³	Pass

Transducer Calibrations

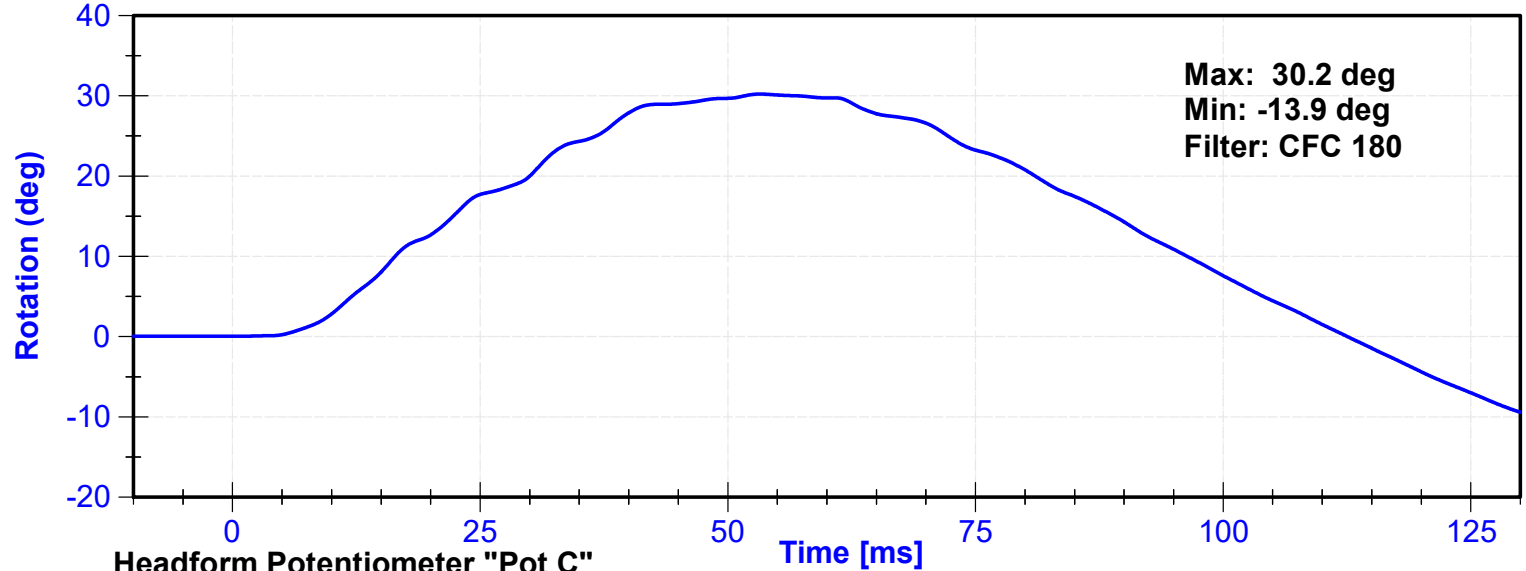
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/31/2023	4/28/2024
Front Pendulum Potentiometer	Sfernice	2247	12/5/2023	12/4/2024
Headform Potentiometer	Sfernice	095	9/29/2023	9/28/2024



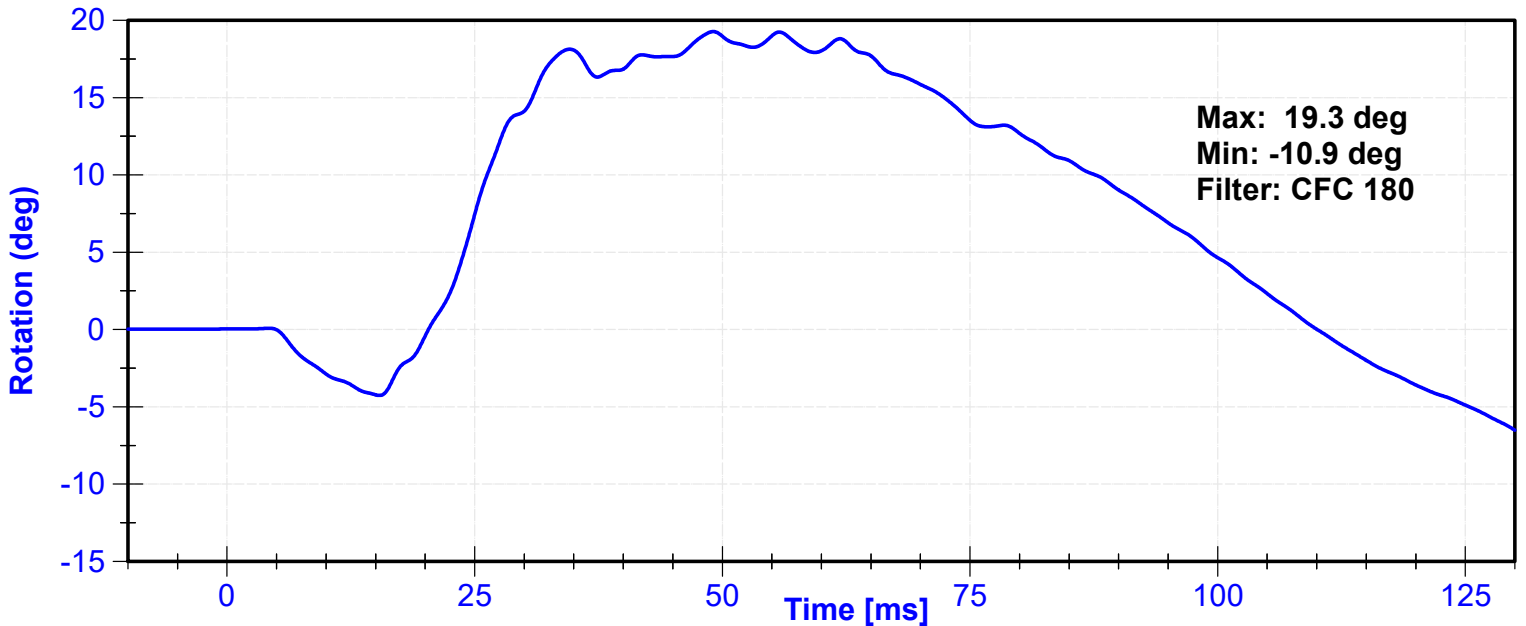
Neck Rotation



Front Pendulum Potentiometer "Pot A"



Headform Potentiometer "Pot C"



Appendix I

² Upper Boundary Corridor		¹ Lower Boundary Corridor	
Time (ms)	Velocity (m/s)	Time (ms)	Velocity (m/s)
1.0	0.00	0.0	-0.05
3.0	-0.25	2.5	-0.375
14.0	-3.20	13.5	-3.7
		17.0	-3.7

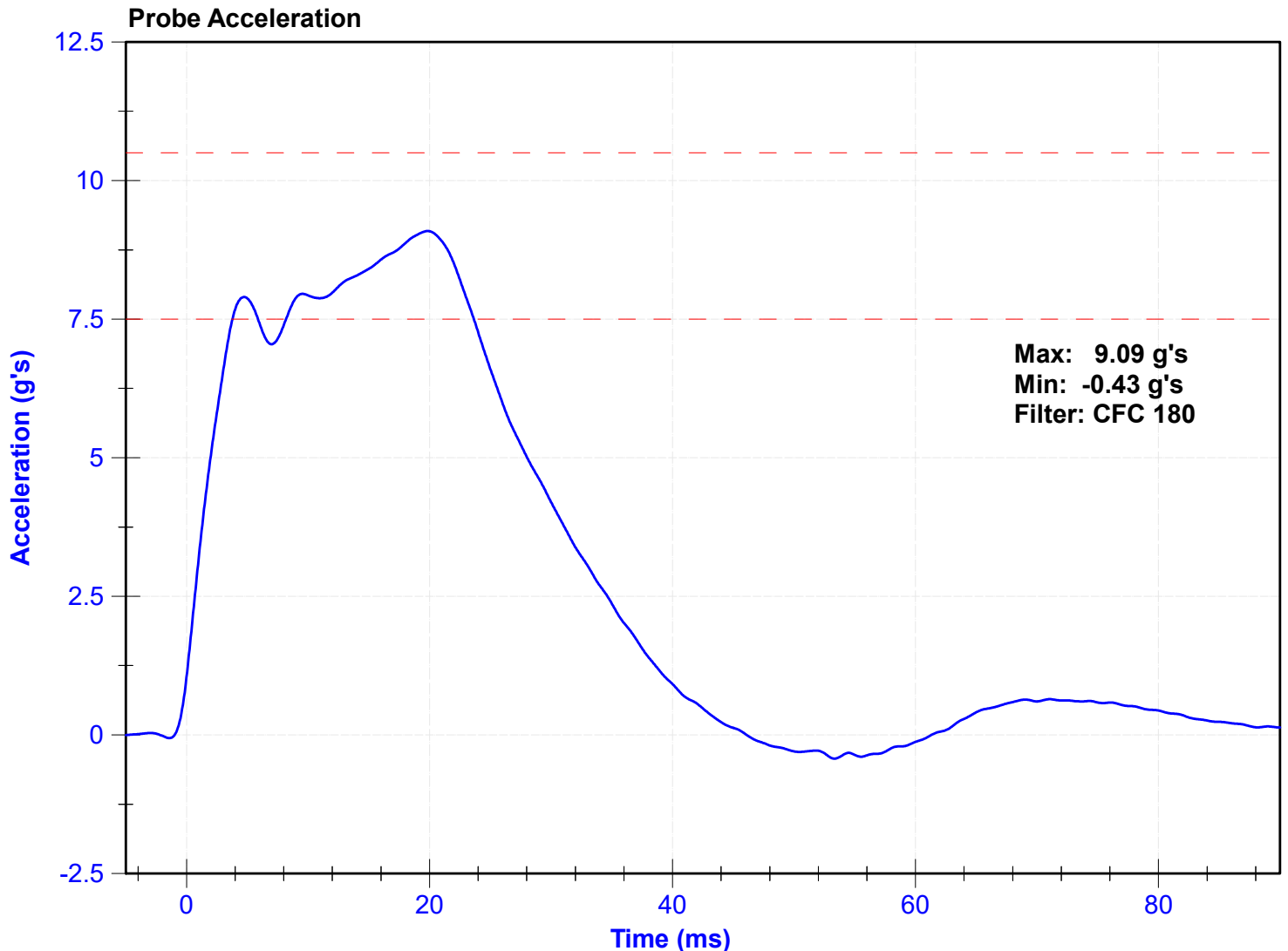
ATD Manufacturer	Denton	Test Technician	J. Rios
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	27	Pass
Velocity	4.2	4.4	m/s	4.23	Pass
Probe Acceleration	7.5	10.5	g's	9.09	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18587	11/20/2023	11/19/2024



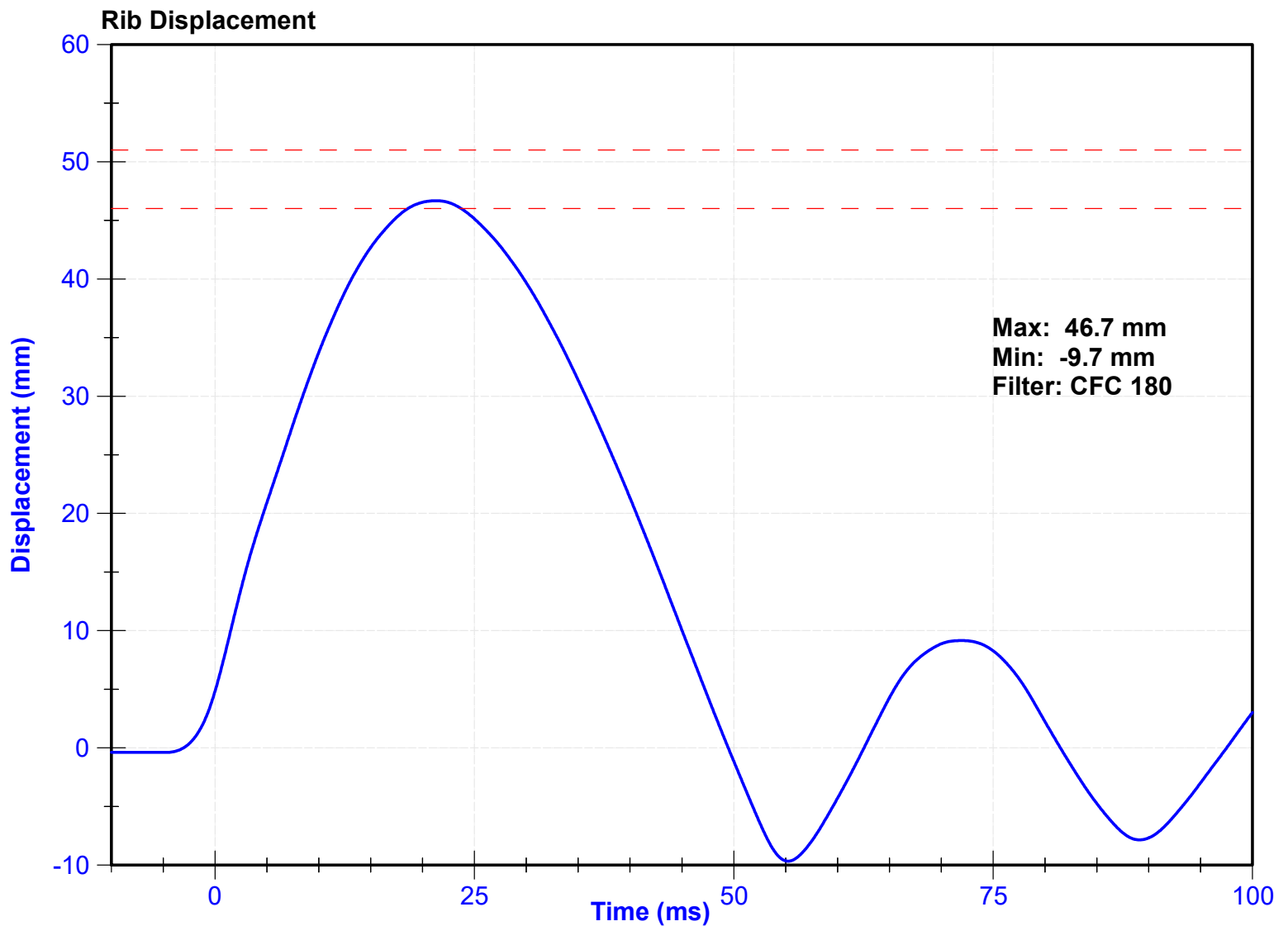
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	46	51	mm	46.7	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024



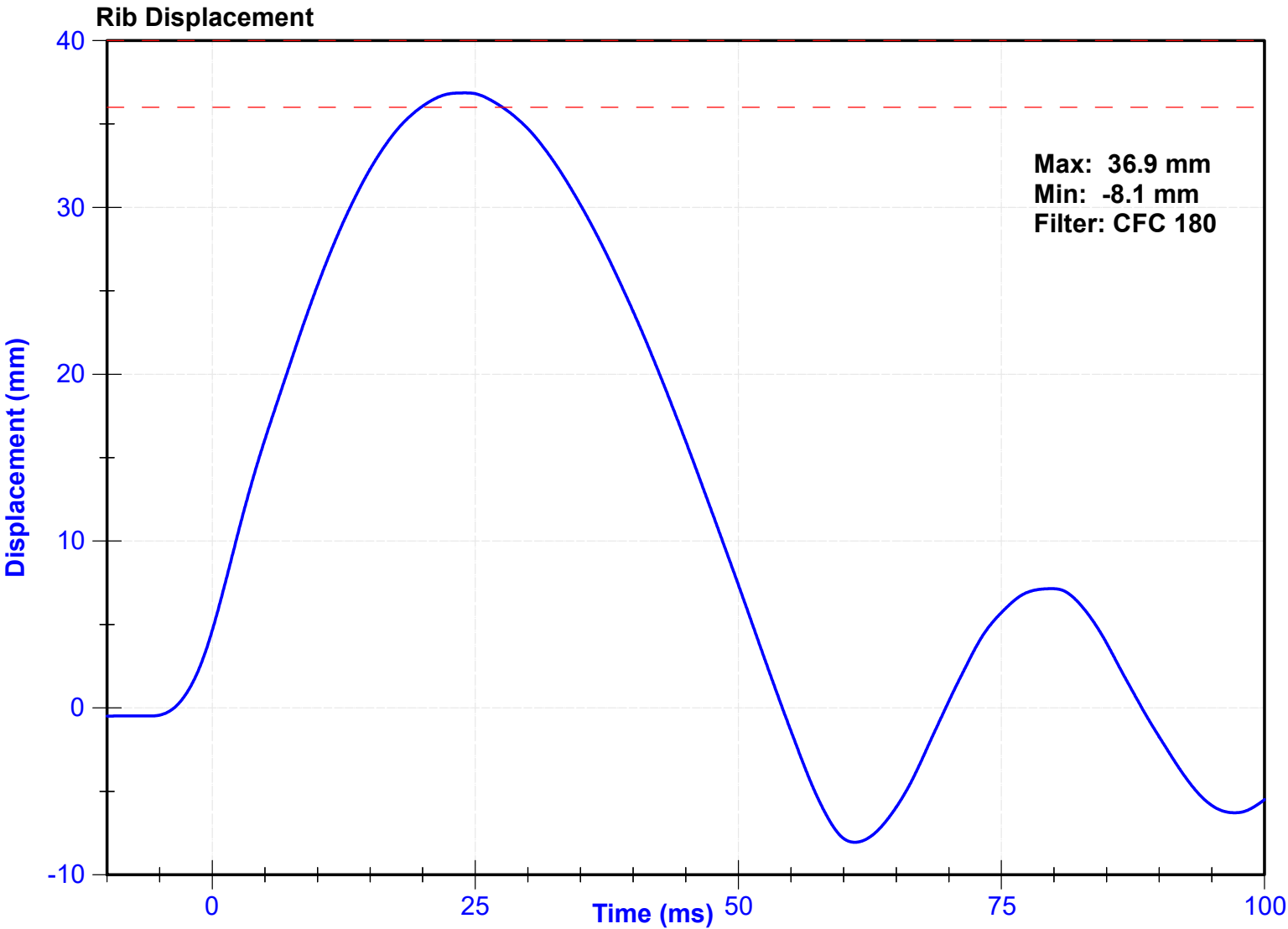
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	36	40	mm	36.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024



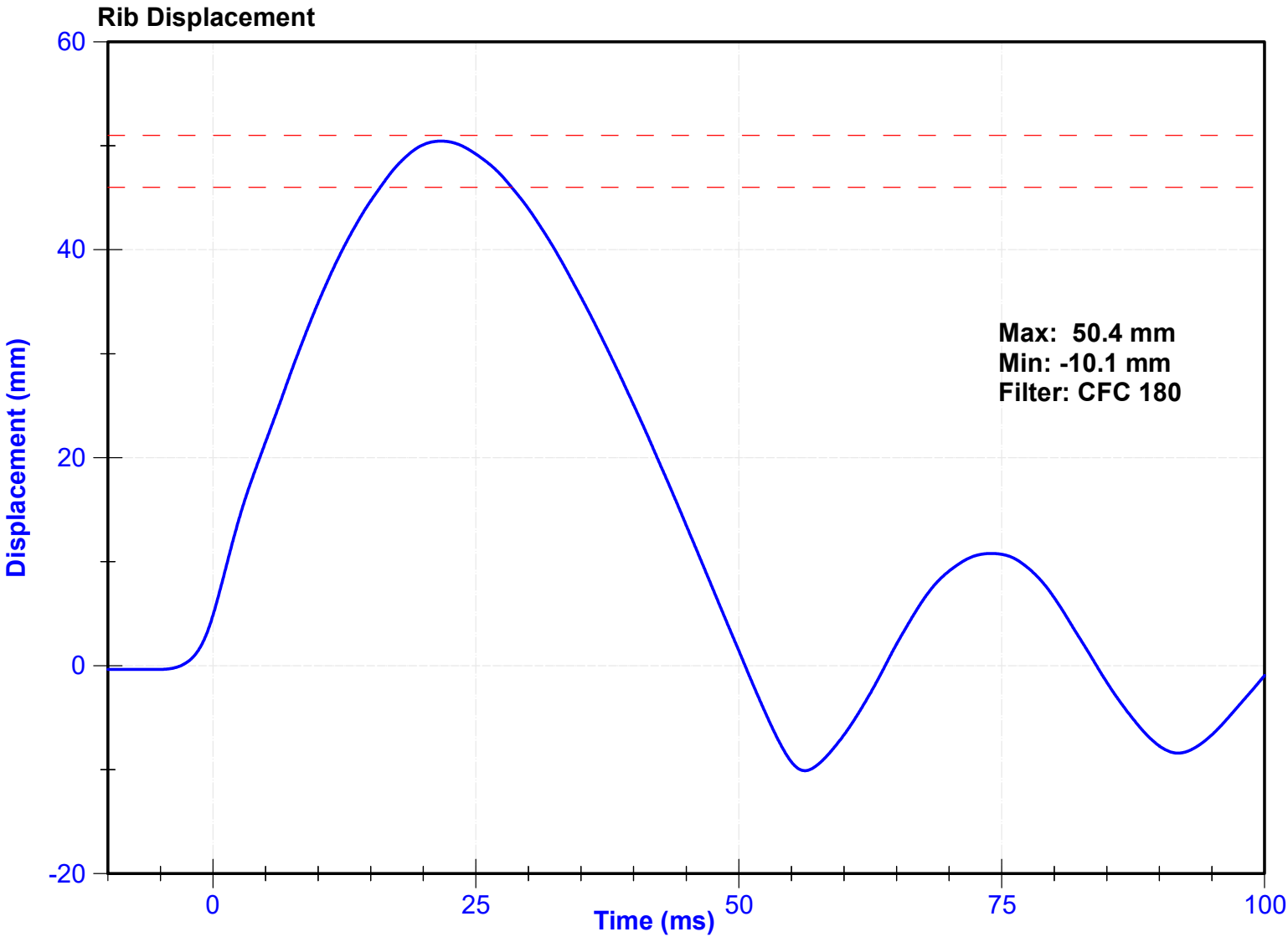
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	46	51	mm	50.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024



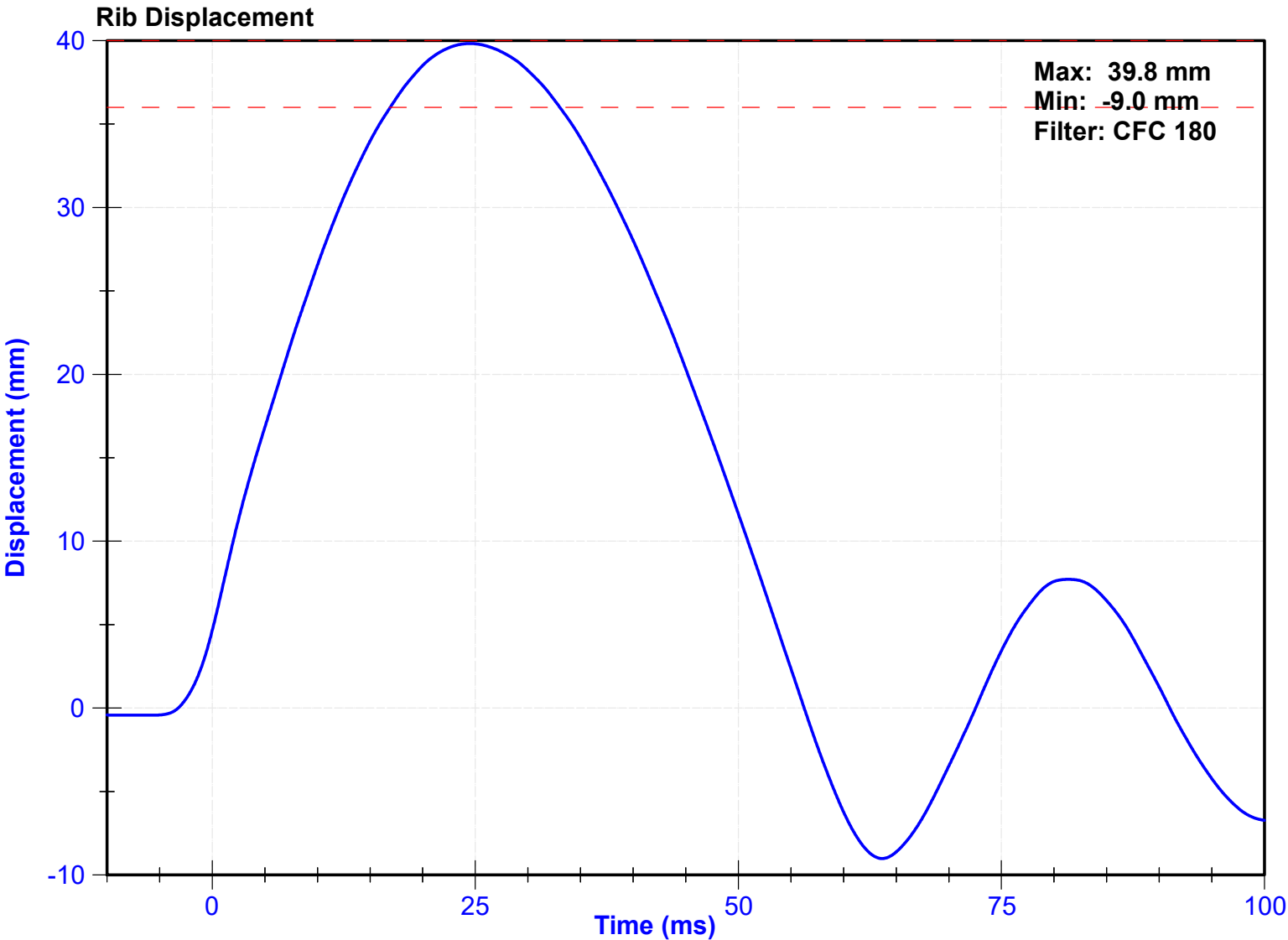
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	36	40	mm	39.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024



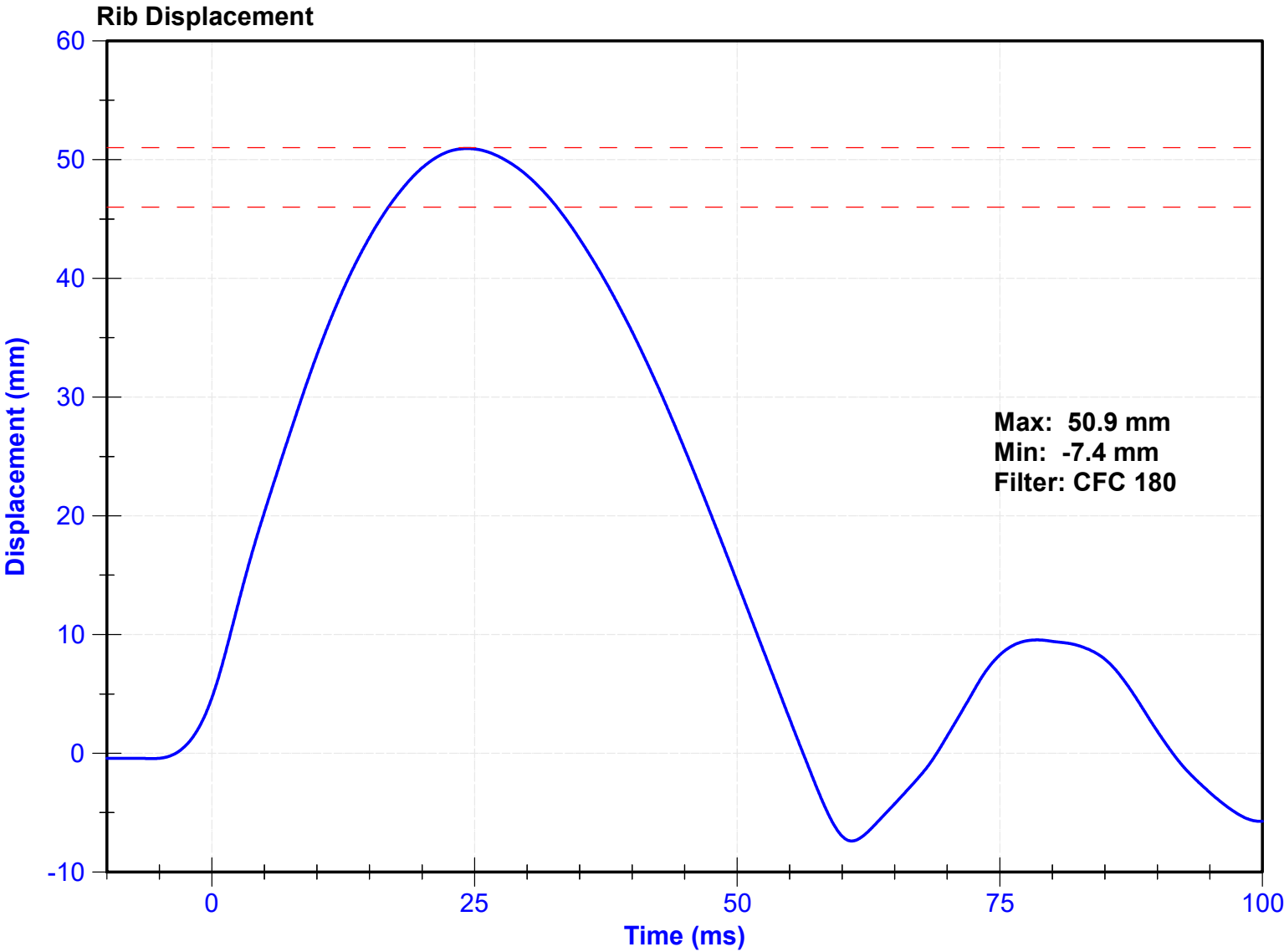
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	46	51	mm	50.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024



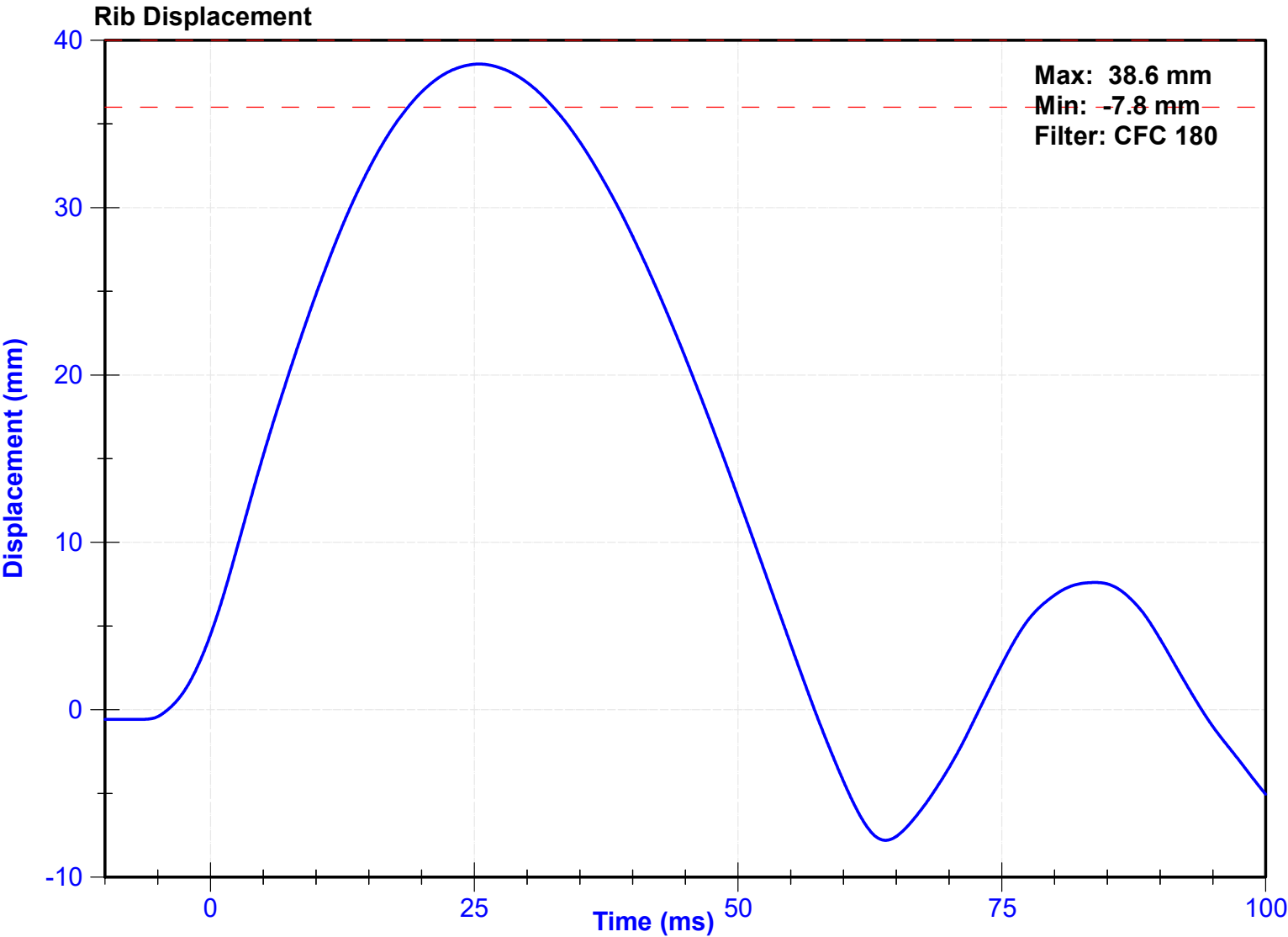
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	44	Pass
Rib Displacement	36	40	mm	38.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024



ATD Manufacturer	Denton	Test Technician	J. Rios
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

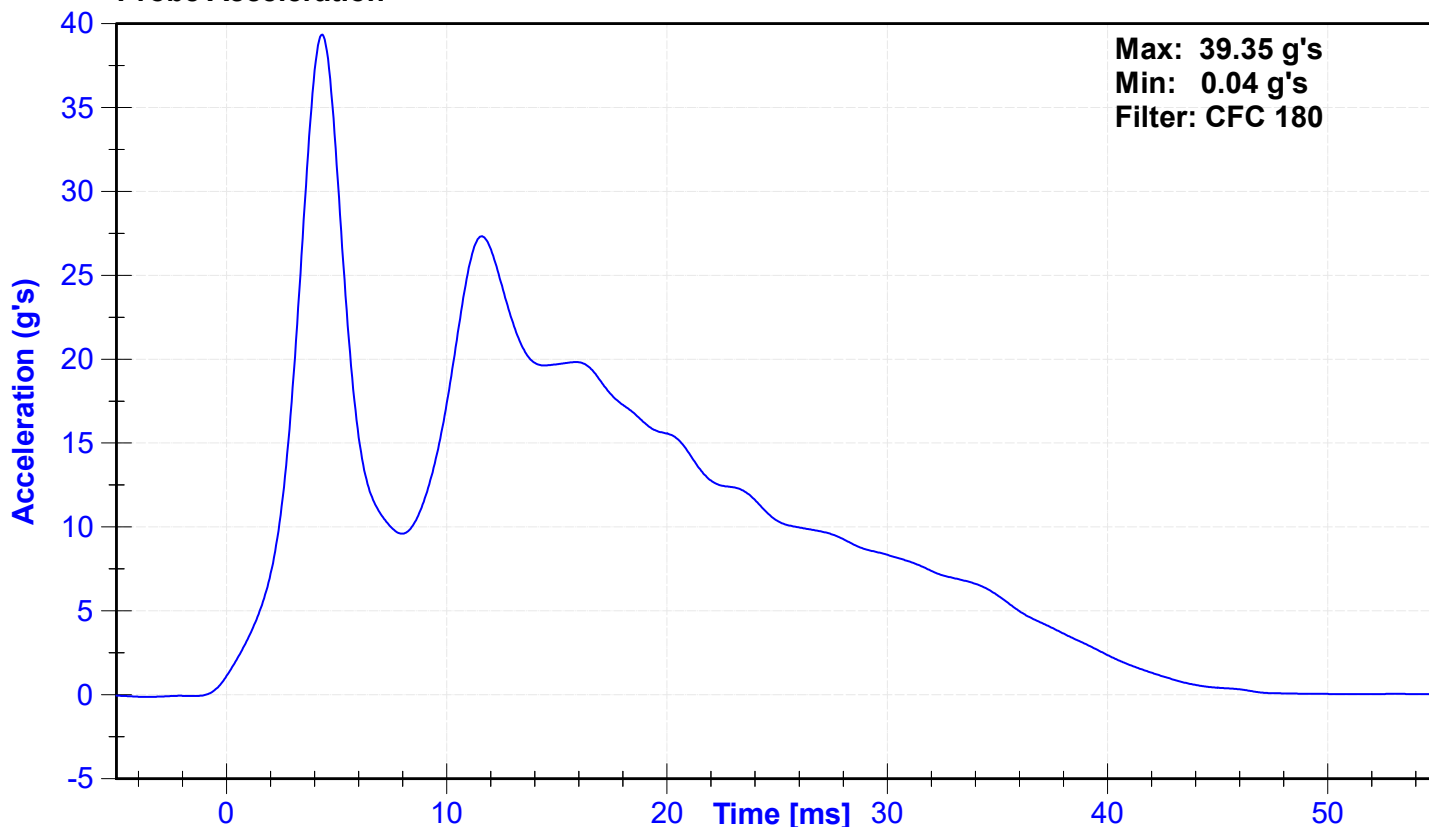
Results

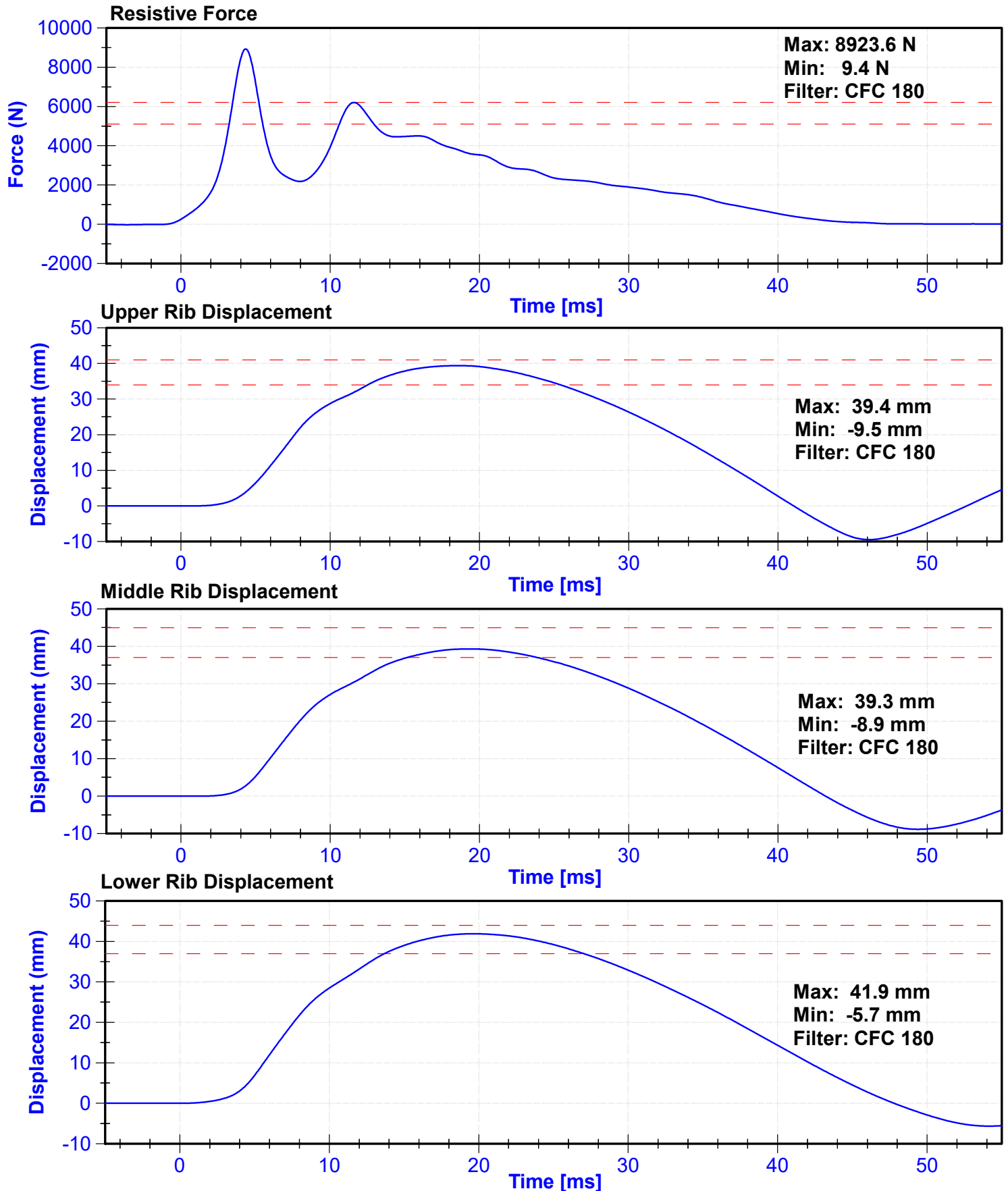
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	27	Pass
Velocity	5.4	5.6	m/s	5.53	Pass
Resistive Force after 6ms	5100	6200	N	6198.5	Pass
Upper Thorax Rib Deflection	34	41	mm	39.4	Pass
Mid Thorax Rib Deflection	37	45	mm	39.3	Pass
Lower Thorax Rib Deflection	37	44	mm	41.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Upper Thorax Rib Potentiometer	Honeywell	0552-01	1/31/2024	7/31/2024
Middle Thorax Rib Potentiometer	Honeywell	807	1/31/2024	7/31/2024
Lower Thorax Rib Potentiometer	Honeywell	0552-03	1/31/2024	7/31/2024

Probe Acceleration





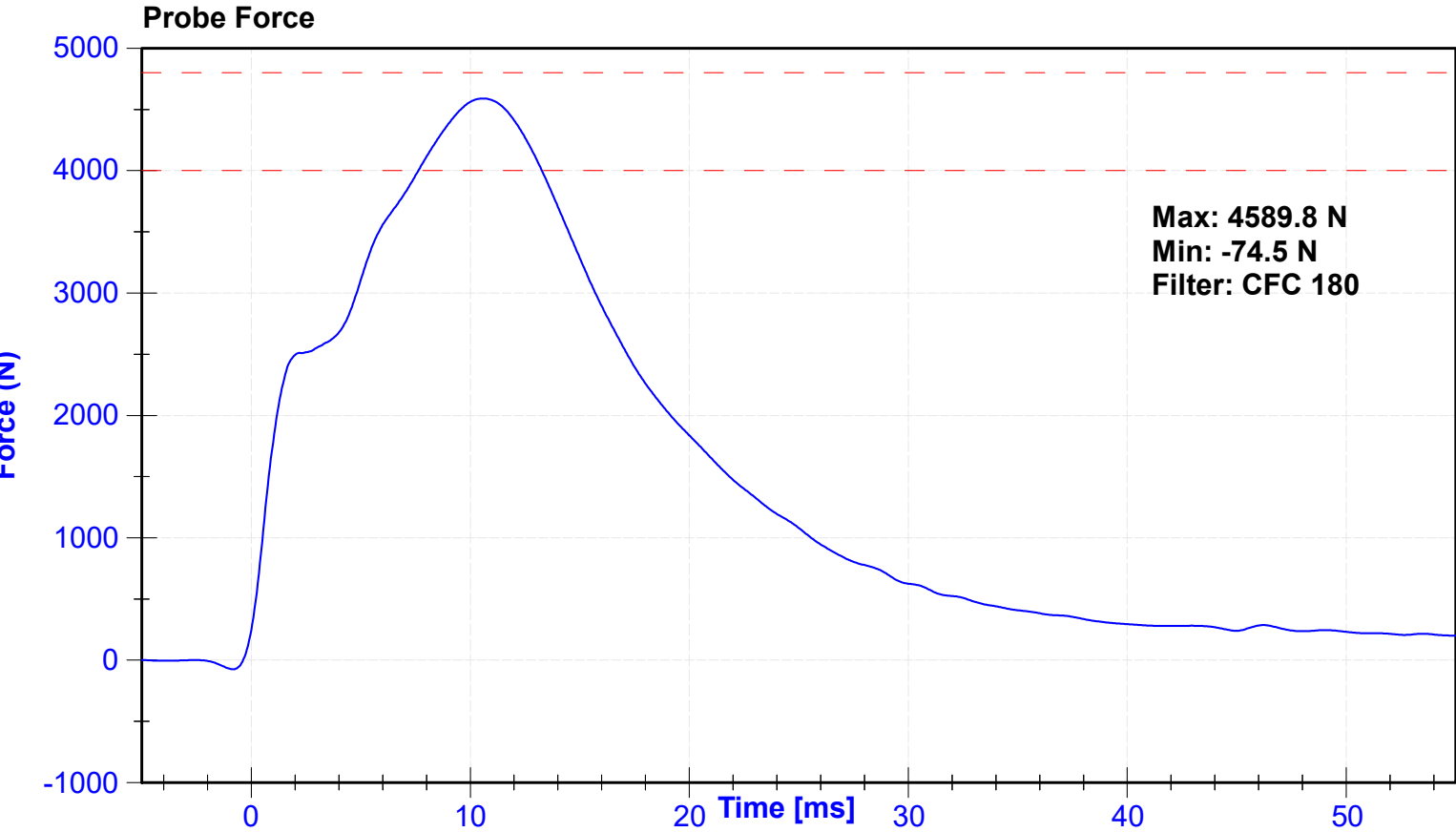
ATD Manufacturer	Denton	Test Technician	J. Rios
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

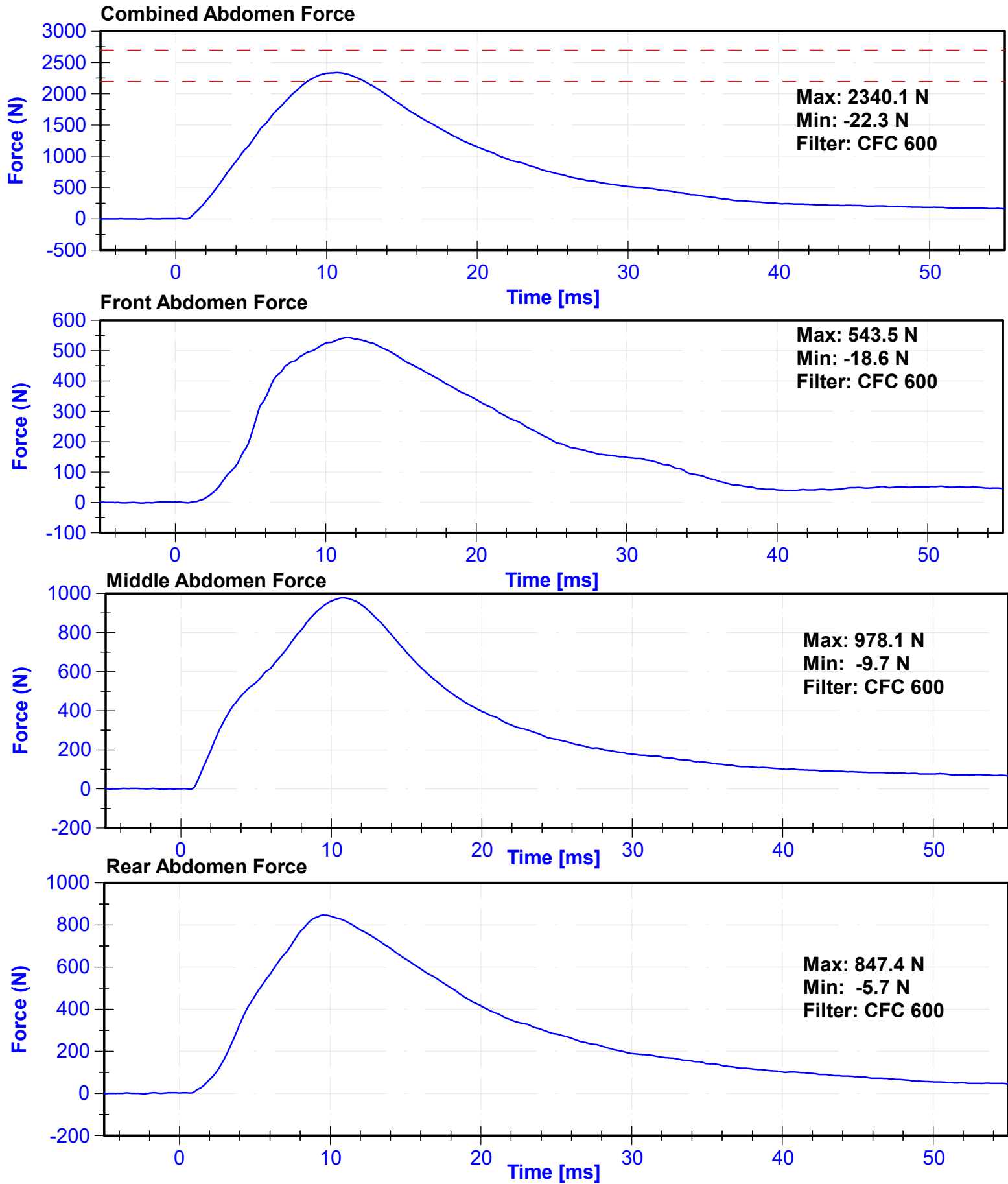
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	27	Pass
Velocity	3.9	4.1	m/s	3.99	Pass
Combined Abdomen Force	2200	2700	N	2340.1	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	10.70	Pass
Resistive Probe Force	4000	4800	N	4589.8	Pass
Time at Peak Resistive Force	10.6	13.0	ms	10.60	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Front Abdomen Load Cell	Denton	1440	8/8/2023	8/7/2024
Middle Abdomen Load Cell	Denton	1525	8/8/2023	8/7/2024
Rear Abdomen Load Cell	Denton	1528	8/8/2023	8/7/2024





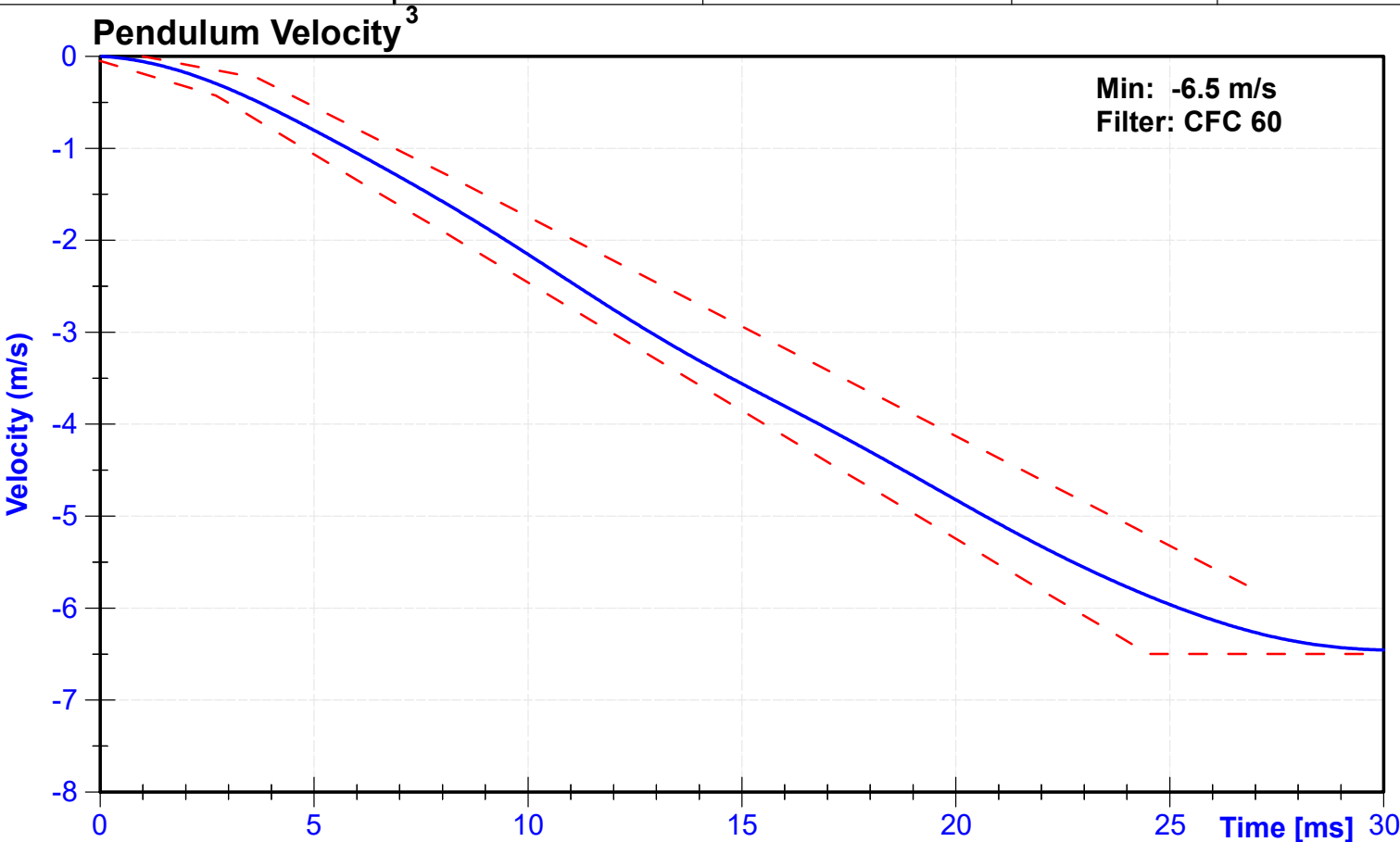
ATD Manufacturer	Denton	Test Technician	T. Roseman
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

Results

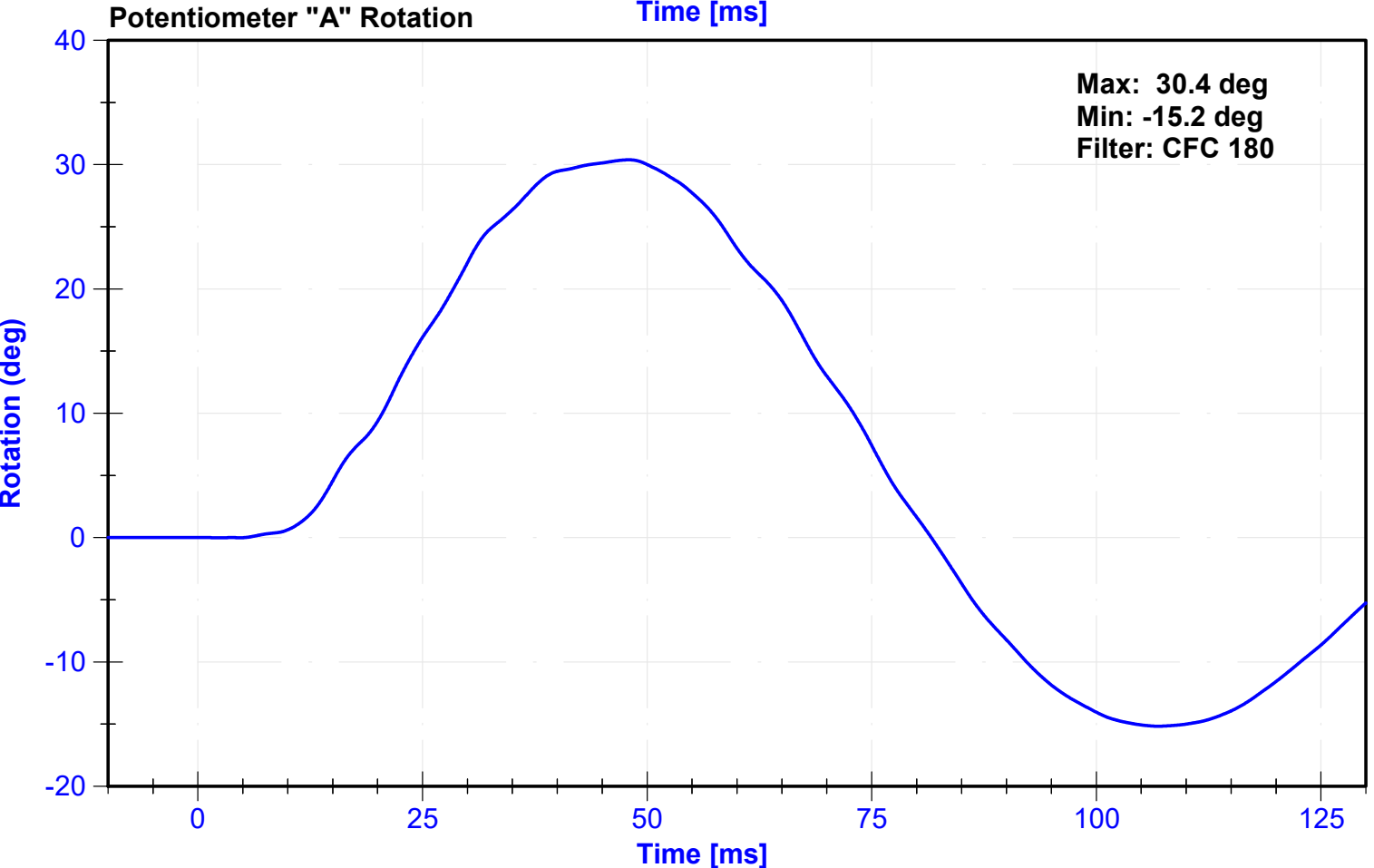
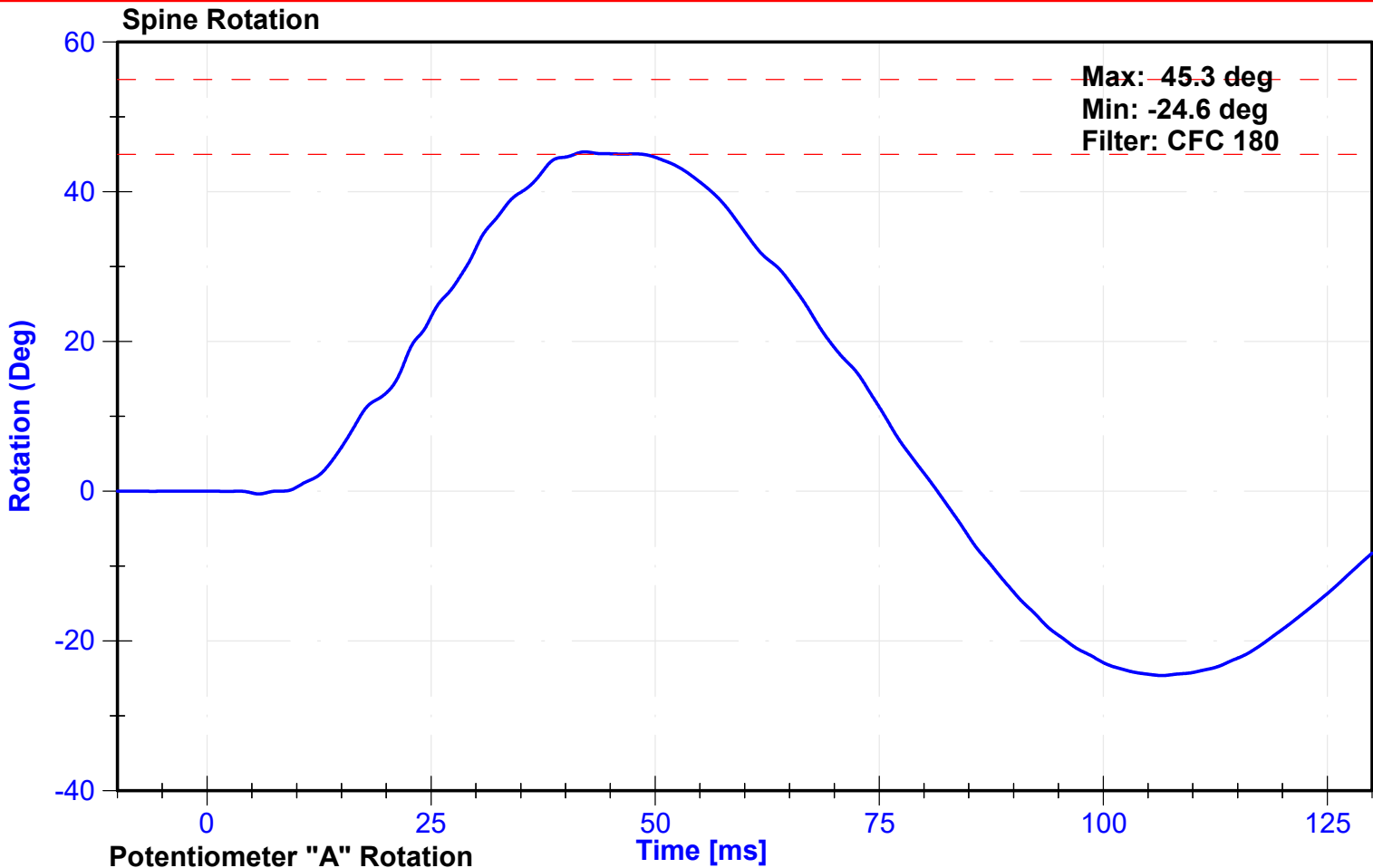
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.2	Pass
Humidity	10	70	%	32	Pass
Velocity	5.95	6.15	m/s	6.011	Pass
Lateral Spine Rotation	45	55	deg	45.3	Pass
Time at Maximum Rotation	39	53	ms	42.1	Pass
Time of Decay to Zero Degrees	37	57	ms	39.4	Pass
Pendulum Velocity Overall Corridor	Lower Boundary ¹	Upper Boundary ²	m/s	See Plot ³	Pass

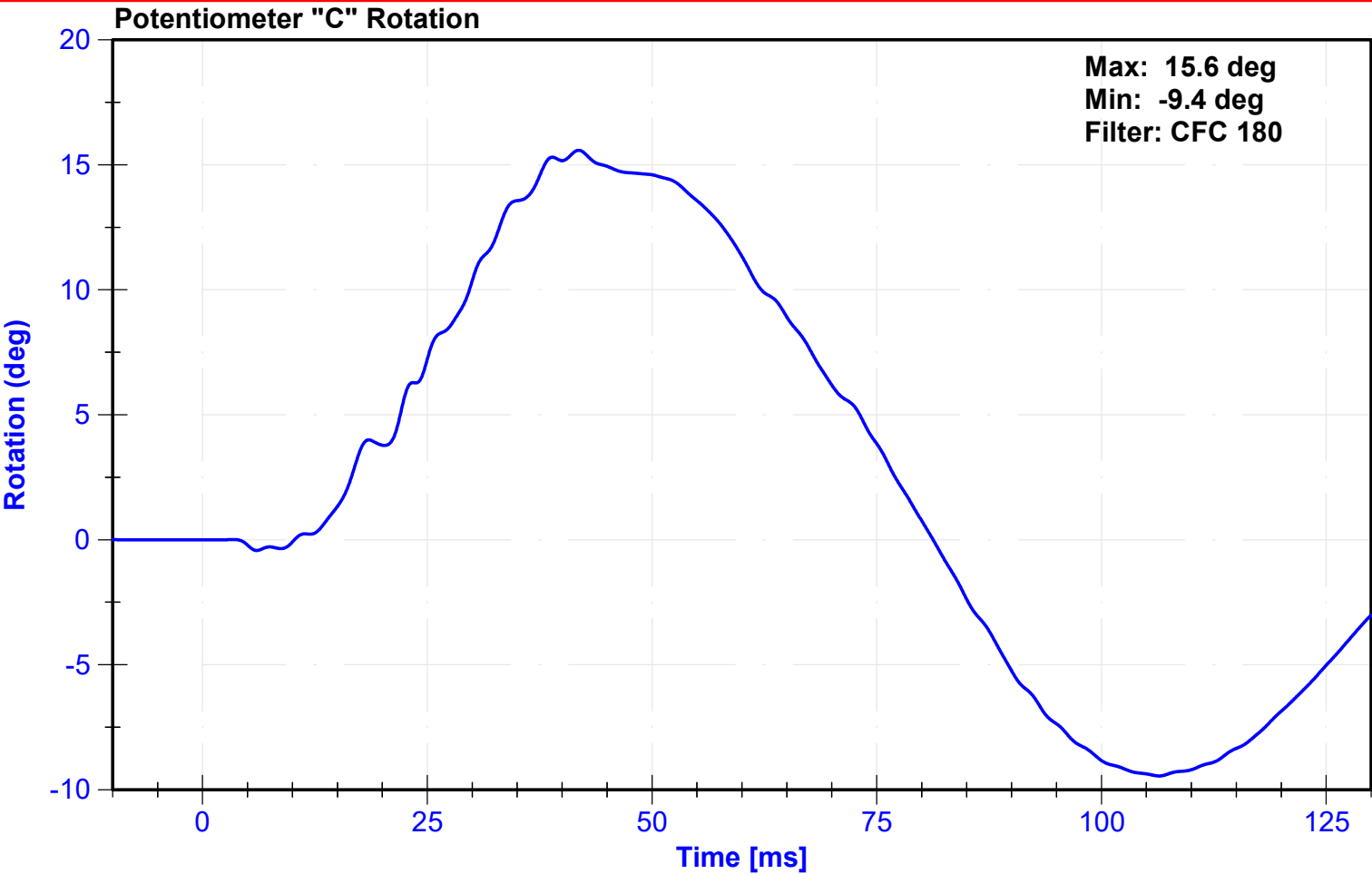
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16503	10/31/2023	4/28/2024
Pendulum "A" Potentiometer	Sfernice	2247	12/5/2023	12/4/2024
Condyle "B" Potentiometer	Sfernice	095	9/29/2023	9/28/2024



^{1,2} Upper and lower boundaries specified in Appendix I
IV-42





Appendix I

² Upper Boundary Corridor		¹ Lower Boundary Corridor	
Time (ms)	Velocity (m/s)	Time (ms)	Velocity (m/s)
1.0	0.00	0.0	-0.05
3.7	-0.24	2.7	-0.425
27.0	-5.80	24.5	-6.5
		30.0	-6.5

ATD Manufacturer	Denton	Test Technician	J. Rios
ATD Serial Number	D037	Laboratory Supervisor	C. Mantell

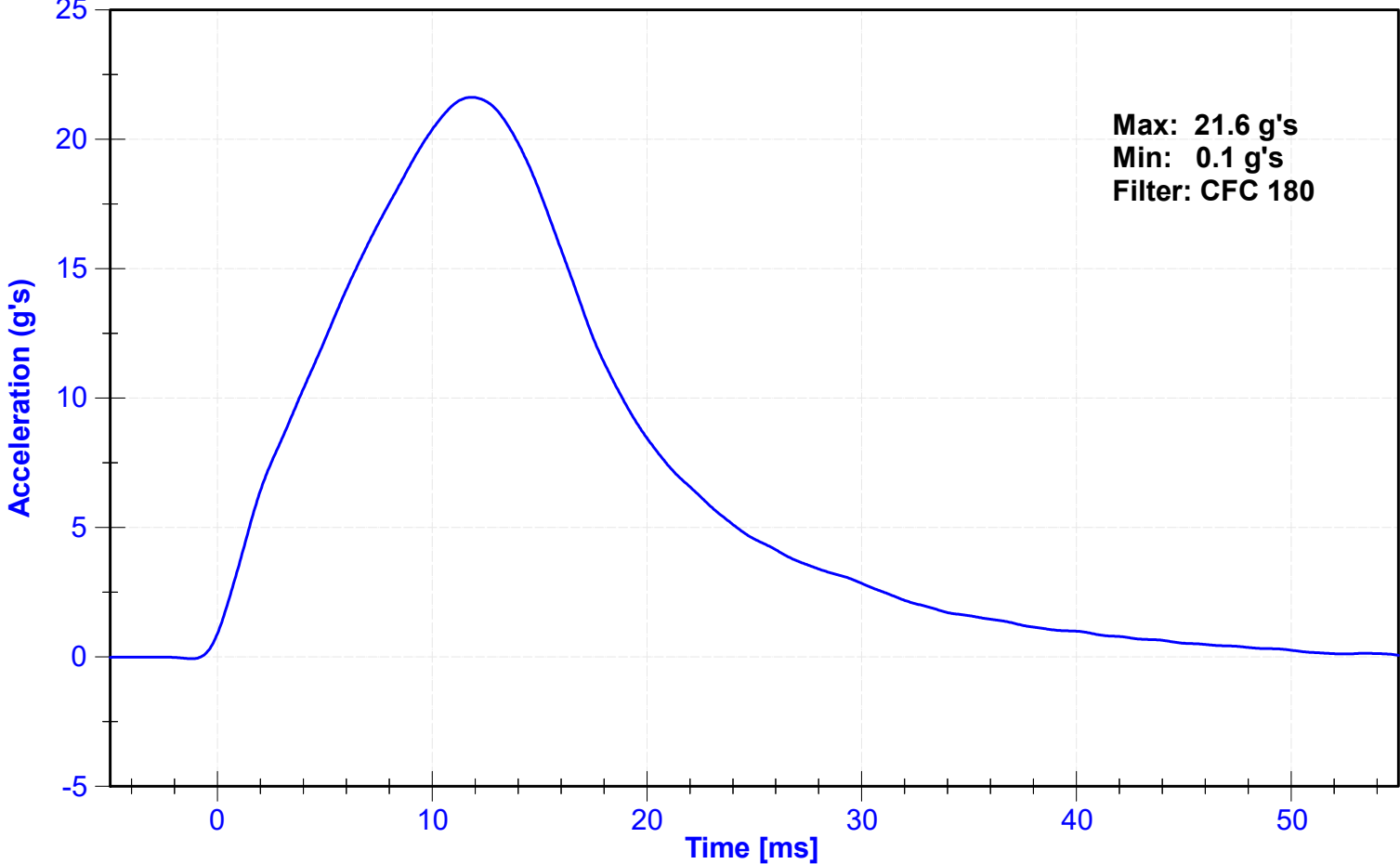
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	27	Pass
Velocity	4.2	4.4	m/s	4.28	Pass
Resistive Force	4700	5400	N	4952.4	Pass
Time at Peak Resistive Force	11.8	16.1	ms	11.85	Pass
Pubic Force	-1590	-1230	N	-1409.6	Pass
Time at Peak Pubic Force	12.2	17.0	ms	12.50	Pass

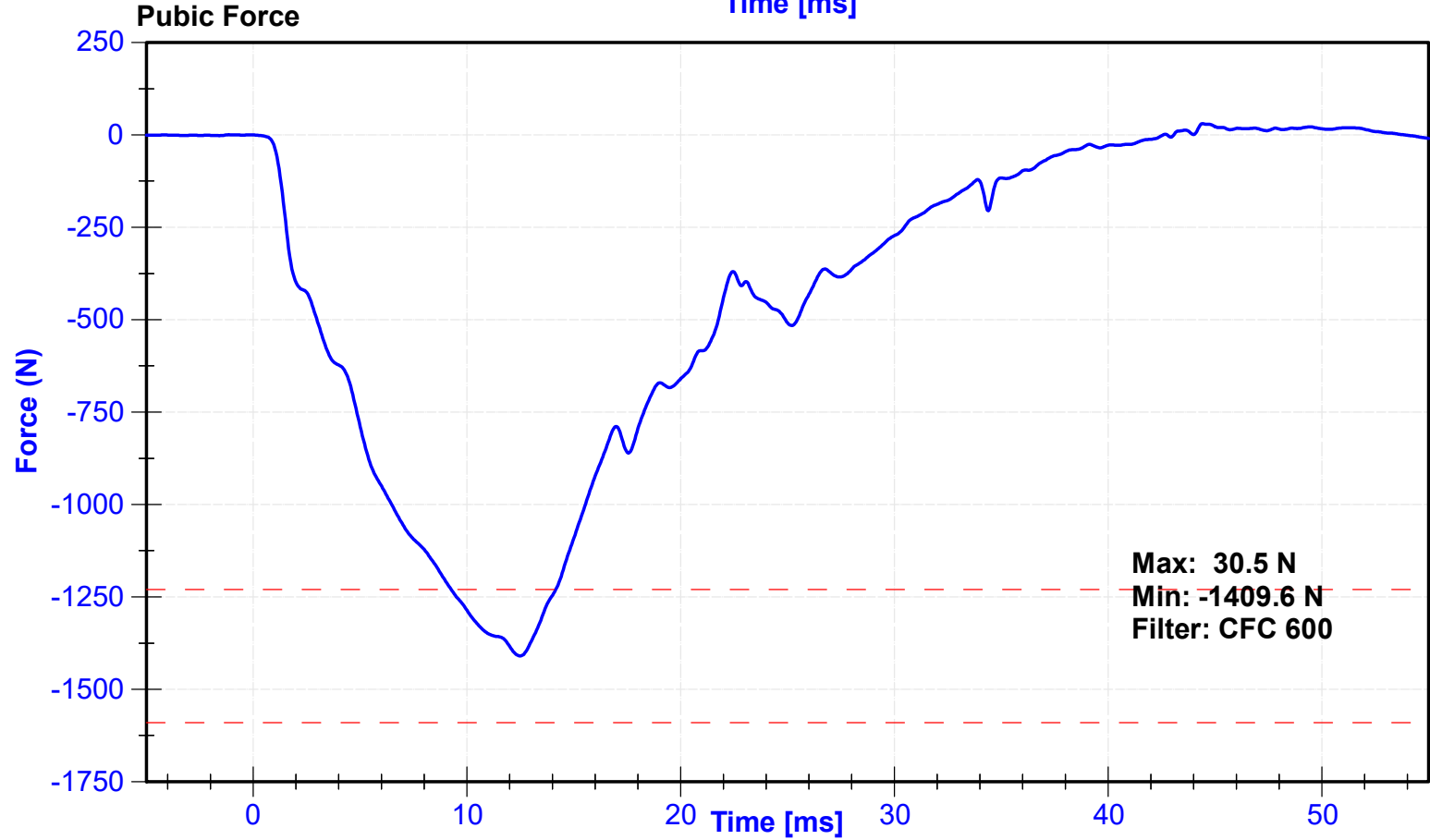
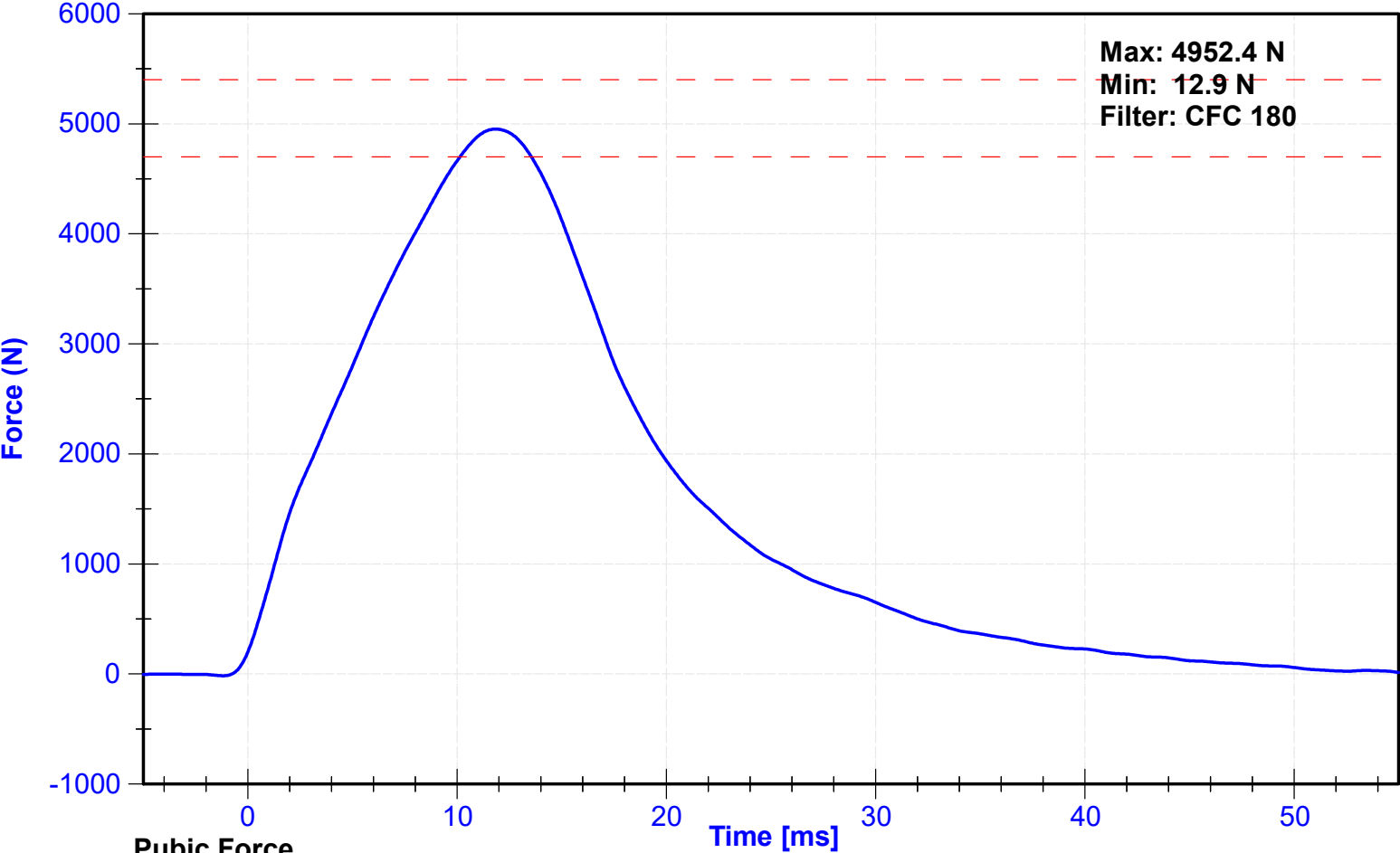
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18587	11/20/2023	11/19/2024
Pubic Load Cell	Denton	456-FY	8/8/2023	8/7/2024

Probe Acceleration



Resistive Force



APPENDIX V

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation (ES-2re)

			ES-2re S/N _D037		
			Serial Number	Manufacturer	Calibration Date
Head Accelerometers	Primary	X	T21724	Endevco	02/01/2024
		Y	T22281	Endevco	02/01/2024
		Z	T26050	Endevco	02/01/2024
	Redundant	X	T21682	Endevco	02/01/2024
		Y	T25989	Endevco	02/01/2024
		Z	T25864	Endevco	02/01/2024
Thorax Rib Displacement Potentiometers	Upper	Y	0552-01	Honeywell	01/31/2024
	Middle	Y	807	Honeywell	01/31/2024
	Lower	Y	0552-03	Honeywell	01/31/2024
Abdomen Load Cells	Forward	Y	1440	Denton	08/08/2023
	Middle	Y	1525	Denton	08/08/2023
	Rear	Y	1528	Denton	08/08/2023
Lower Spine Accelerometers (T12)		X	P71278	Endevco	02/01/2024
		Y	18595	Endevco	04/04/2024
		Z	18509	Endevco	04/04/2024
Pubic Symphysis Load Cell		Y	456-FY	Denton	08/08/2023

Table 2 – Vehicle Instrumentation

Vehicle Instrumentation		Serial Number	Manufacturer	Calibration Date
Vehicle Center of Gravity	X	A262920	Measurement Specialties	03/15/2024
Vehicle Center of Gravity	Y	A315742	Measurement Specialties	03/15/2024
Vehicle Center of Gravity	Z	A315882	Measurement Specialties	03/15/2024
Left Floor Sill	Y	G24636	Endevco	11/30/2023
A-Pillar Sill	Y	A284376	Measurement Specialties	02/05/2024
A-Pillar Low	Y	A413578	Measurement Specialties	02/13/2024
A-Pillar Mid	Y	A370951	Measurement Specialties	02/15/2024
B-Pillar Sill	Y	G22439	Endevco	02/05/2024
B-Pillar Low	Y	A352316	Measurement Specialties	11/17/2023
B-Pillar Mid	Y	A315841	Measurement Specialties	02/16/2024
Driver Seat	Y	G24330	Endevco	11/09/2023
Engine Top	X	G22805	Endevco	01/25/2024
Engine Top	Y	G22812	Endevco	01/25/2024
Firewall	Y	G24959	Endevco	01/10/2024
Right Roof	Y	G24315	Endevco	11/09/2023
Right Floor Sill	Y	A315740	Measurement Specialties	02/16/2024
Rear Floorpan	X	G24319	Endevco	11/10/2023
Rear Floorpan	Y	G24623	Endevco	11/29/2023