REPORT NUMBER: SINCAP-CAL-24-013

NEW CAR ASSESSMENT PROGRAM (NCAP)
MOVING DEFORMABLE BARRIER SIDE IMPACT TEST

Hyundai Motor Manufacturing Alabama, LLC
2024 Hyundai Santa Fe
5 Door SUV

NHTSA No: M20244202

PREPARED BY:
CALSPAN CORPORATION
P.O. BOX 400
BUFFALO, NEW YORK 14225

January 7, 2025

FINAL REPORT

PREPARED FOR:
U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
OFFICE OF CRASHWORTHINESS STANDARDS
MAIL CODE: NRM-110
1200 NEW JERSEY AVE SE
WASHINGTON, D.C. 20590

This final test report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, in response to Contract Number 693JJ920D000016.

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof.

If trade or manufacturers' names or products are mentioned it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared by: Alexander Rudniski Date: January 7, 2025
Alexander Rudniski, Test Engineer

Approved by: Vanessa Hansen Date: January 7, 2025
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: _____

TECHNICAL REPORT DOCUMENTATION PAGE

1. *Report No.*	2. *Government Accession No.*	3. *Recipient's Catalog No.*
SINCAP-CAL-24-013		

4. Title and Subtitle Final Report of New Car Assessment Program Side Impact MDB Testing & FMVSS 305 Indicant Testing of a 2024 Hyundai Santa Fe 5 Door SUV NHTSA No.: M20244202	***5. Report Date*** January 7, 2025 ***6. Performing Organization Code*** CAL
7. Author(s) Alexander Rudniski, Test Engineer Vanessa Hansen, Operations Manager	***8. Performing Organization Report No.*** CAL-DOT-2024-013
9. Performing Organization Name and Address Calspan Corporation Transportation Test Operations P.O. Box 400 Buffalo, New York 14225	***10. Work Unit No.*** ***11. Contract or Grant No.*** 693JJ920D000016
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards (NRM-110) 1200 New Jersey Ave., SE Washington, D.C. 20590	***13. Type of Report and Period Covered:*** Final Test Report November 21, 2024 - January 7, 2025 ***14. Sponsoring Agency Code*** NRM-110

15. Supplementary Notes

16. Abstract

A 55/28, (61.90kph / 38.5 mph), 90° Moving Deformable Barrier NCAP Side Impact Test was conducted on the subject 2024 Hyundai Santa Fe 5 Door SUV in accordance with the specifications of the Office of Crashworthiness Standards Test Procedure for the generation of consumer information on vehicle side crash protection. This test was conducted at Calspan Corporation's Transportation Test Operations facility in Buffalo, New York on November 21, 2024.

The impact velocity of the Moving Deformable Barrier (MDB) was 62.16 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 185 mm located at level 3. The test vehicle's occupant performance data is as follows:

Measurement Description	Driver ATD (ES-2re)		
	Units	IARV	Result
Head Injury Criteria (HIC36)		1000	21.261
Maximum Thorax Rib Deflection	mm	44	14.465
Total Abdominal Force	N	2500	379.834
Pubic Symphysis Force	N	6000	901.362
Lower Spine (T12) Resultant Acceleration	G	82*	16.758

Measurement Description	Passenger ATD (SID-IIs)		
	Units	IARV	Result
Head Injury Criteria (HIC36)		1000	60.419
Maximum Thorax Rib Deflection	mm	38*	13.194
Lower Spine (T12) Resultant Acceleration	G	82	32.178
Total Pelvic Force (sum of acetabular and iliac forces)	N	5525	1175.489
Maximum Abdominal Rib Deflection	mm	45*	14.560

**Proposed IARV*

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.

17. Key Words	***18. Distribution Statement***
New Car Assessment Program (NCAP) Side Impact MDB ES-2re SID-IIs	Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division, NPO-411 1200 New Jersey Ave. SE Washington, D.C. 20590

19. Security Class. (of this report)	***20. Security Class. (of this page)***	***21. No. of Pages***	***22. Price***
UNCLASSIFIED	UNCLASSIFIED	222	

TABLE OF CONTENTS

Section		Page
1	Test Purpose and Procedure	1-1
2	Summary of Test Results	2-1
3	Occupant and Vehicle Information	3-1

Data Sheet		Page
1	General Test and Vehicle Parameter Data	3-2
2	Seat, Seat Belt, Steering Wheel Adjustment and Fuel System Data	3-6
3	Dummy Longitudinal Clearance Dimensions	3-10
4	Dummy Lateral Clearance Dimensions	3-11
5	Camera and Instrumentation Data	3-12
6	Test Vehicle Accelerometer Location	3-13
7	MDB Accelerometer Locations	3-14
8	Post-Test Observations	3-15
9	MDB Summary of Results	3-17
10	Test Vehicle Profile Measurements	3-18
11	Test Vehicle Exterior Crush Measurements	3-19
12	MDB Exterior Static Crush Measurements	3-22
13	Vehicle and MDB Damage Profile Distances	3-23
14	FMVSS No. 301 Static Rollover Results	3-24
15	Dummy / Vehicle Temperature and Humidity Stabilization Data	3-25
305-1	General Test and Vehicle Parameter Data for Indicant FMVSS No. 305 Testing	3-26
305-2	Pre-Impact Data for Indicant FMVSS No. 305 Testing	3-27
305-3	Pre-Impact Electrical Isolation Measurements and Calculations for Indicant FMVSS No. 305 Testing	3-28
305-4	Post-Impact Data for Indicant FMVSS No. 305 Testing	3-29
305-5	Static Rollover Test Data for Indicant FMVSS No. 305 Testing	3-30

Appendix		Page
A	Photographs	A-1
B	Vehicle and Dummy Response Data Traces	B-1
C	Dummy Configuration and Performance Verification Data	C-1
D	Test Equipment and Instrumentation Calibration Data	D-1

SECTION 1

TEST PURPOSE AND PROCEDURE

This moving deformable barrier side impact test is part of the MY 2024 New Car Assessment Program Side Impact Test Program, sponsored by the National Highway Traffic Safety Administration (NHTSA), under contract number 693JJ920D000016. The purpose of this test is to generate comparative side impact performance in a 2024 Hyundai Santa Fe 5 Door SUV. The side impact test was conducted in accordance with the Office of Crashworthiness Standard's Laboratory Test Procedure dated March 2020.

SECTION 2
SUMMARY OF TEST RESULTS

A 2024 Hyundai Santa Fe 5 Door SUV was impacted on the left (driver's) side by a Moving Deformable Barrier (MDB) which was moving forward in a 27° crabbed position to the tow road guidance system at a velocity of 62.16 km/h. The target vehicle was stationary and was positioned at an angle of 63° to the line of forward motion. The side impact test was conducted by the Calspan Corporation's Transportation Test Operations Center in Buffalo, New York on November 21, 2024. Pre-test and post-test photographs of the test vehicle, the MDB and the dummies (ES-2re and SID-IIs) are included in this report.

Dummies were placed in the driver and left rear designated seating positions according to instructions specified in the OCWS Side Impact Laboratory Test Procedure, dated March 2020. The side impact event was documented by 9 high-speed and 2 real-time cameras. Camera locations are included in this report.

The Dummies were instrumented in the following manner:

DRIVER ATD (ES-2re)
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
Pubic symphysis y-axis load cell

PASSENGER ATD (SID-IIs)
Primary and redundant head CG tri-axial accelerometers
Chest upper rib, middle rib, and lower rib y-axis displacement potentiometers
Abdomen upper rib and lower rib y-axis displacement potentiometers
Lower spine (T12) tri-axial accelerometers
Acetabulum and iliac wing y-axis load cells

Appendix B contains the vehicle and dummy response data. Dummy configuration and performance verification data can be found in Appendix C of this report. Appendix D of this report contains the test equipment and instrumentation calibration data.

DUMMY INJURY VALUES

Measurement Description	Driver ATD (ES-2re)		
	Units	IARV	Result
Head Injury Criteria (HIC36)		1000	21.261
Maximum Thorax Rib Deflection	mm	44	14.465
Total Abdominal Force	N	2500	379.834
Pubic Symphysis Force	N	6000	901.362
Lower Spine (T12) Resultant Acceleration	G	82*	16.758

Measurement Description	Passenger ATD (SID-IIs)		
	Units	IARV	Result
Head Injury Criteria (HIC36)		1000	60.419
Maximum Thorax Rib Deflection	mm	38*	13.194
Lower Spine (T12) Resultant Acceleration	G	82	32.178
Total Pelvic Force (sum of acetabular and iliac forces)	N	5525	1175.489
Maximum Abdominal Rib Deflection	mm	45*	14.560

*Proposed IARV

SUPPLEMENTAL RESTRAINT INFORMATION

Restraint Type	Left Front (Driver) Occupant Location 1		Left Rear (Passenger) Occupant Location 4	
	Mounted	Deployed	Mounted	Deployed
Front Airbag	Yes	No		
Knee Airbag	Yes	No		
Side Airbag 1 - Curtain	Yes	Yes	Yes	Yes
Side Airbag 2 - Torso/Pelvis Airbag	Yes	Yes	Yes	Yes
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes	Yes	Yes	Yes
Other				

GENERAL COMMENTS:

1. P1 serial number – F033
2. P4 serial number – DG8012

Data Anomalies:

The following channel was questionable for:

- Left B-Pillar Lower Y Acceleration, Exceeded calibration range at 10.8 ms
- Left B-Pillar Middle Y Acceleration, Exceeded calibration range at 10.7 ms

SECTION 3

OCCUPANT AND VEHICLE INFORMATION

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, Seat Belt, Steering Wheel Adjustment and Fuel Systems Data

Data Sheet No. 3 - Dummy Longitudinal Clearance Dimensions

Data Sheet No. 4 - Dummy Lateral Clearance Dimensions

Data Sheet No. 5 - Camera and Instrumentation Data

Data Sheet No. 6 - Test Vehicle Accelerometer Locations

Data Sheet No. 7- MDB Accelerometer Locations

Data Sheet No. 8 - Post-Test Observations

Data Sheet No. 9 - MDB Summary of Results

Data Sheet No. 10 - Test Vehicle Profile Measurements

Data Sheet No. 11 - Test Vehicle Exterior Crush Measurements

Data Sheet No. 12 - MDB Exterior Static Crush Measurements

Data Sheet No. 13 - Vehicle and MDB Damage Profile Distances

Data Sheet No. 14 - FMVSS No. 301 Static Rollover Results

Data Sheet No. 15 - Dummy / Vehicle Temperature and Humidity Stabilization Data

Data Sheet No. 305-1 - General Test and Parameter Data for Indicant FMVSS No. 305 Testing

Data Sheet No. 305-2 - Pre-Impact Data for Indicant FMVSS No. 305 Testing

Data Sheet No. 305-3 - Pre-Impact Electrical Isolation Measurements and Calculations for Indicant FMVSS No. 305 Testing

Data Sheet No. 305-4 - Post-Impact Data for Indicant FMVSS No. 305 Testing

Data Sheet No. 305-5 - Static Rollover Test Data for Indicant FMVSS No. 305 Testing

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV
NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test
Test Date: 11/21/2024

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20244202
Model Year	2024
Make	Hyundai
Model	Santa Fe Hybrid
Body Style	SUV
VIN	5NMP24G15RH007540
Body Color	Rockwood Green Pearl
Odometer Reading (km/mi)	57 mi
Engine Displacement (L)	1.6
Type / No. Cylinders	I4
Engine Placement	Transverse
Transmission Type	Automatic
Transmission Speeds	6-speed
Overdrive	Yes
Final Drive	Front Wheel Drive
Roof Rack	No
Sunroof / T-Top	No
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	Yes
Anti-Lock Brakes (ABS)	Yes

Traction Control System (TCS)	Yes
Auto-Leveling System	No
Automatic Door Locks (ADL)	Yes
Power Window Auto-Reverse	Yes
Other Optional Feature	N/A
Driver Front 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	Yes
Rear Pass. Curtain Airbag	Yes
Rear Pass. Head / Torso Airbag	No
Rear Pass. Torso Airbag	No
Rear Pass. Torso / Pelvis Airbag	Yes
Rear Pass. Pelvis Airbag	No
Driver Seat Belt Pretensioner	Yes
Rear Pass. Seat Belt Pretensioner	Yes
Driver Load Limiter	Yes
Rear Pass. Load Limiter	Yes
Other Safety Restraint	N/A

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

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Manufacturing Alabama, LLC
Date of Manufacture	May/15/24
Vehicle Type	MPV

GVWR (KG)	2565
GAWR Front (KG)	1340
GAWR Rear (KG)	1410

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3	2	7	
Vehicle Capacity Weight (VCW) (kg)				480	(A)
DSC x 68.0 kg				476	(B)
Cargo Weight (RCLW) (kg)				4	(A-B)

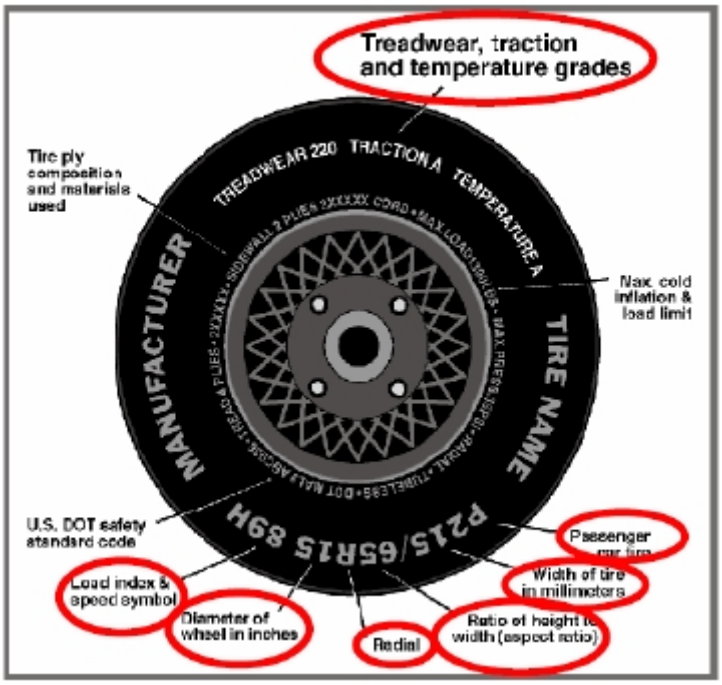
VEHICLE SEAT TYPE

Seating Location	Type Of Seat Pan				Type Of Seat Back		
	Bucket	Bench	Split Bench	Contour	Fixed	Adjustable	
						W/ Lever	W/ Knob
Front	X						X
Rear or Second Row Seat			X			X	
Third Row Seat		X			X		

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

Collected for year, make, model, & VIN, all 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	235/60R18	235/60R18
Tire Size on Vehicle	235/60R18	235/60R18
Tire Manufacturer	Goodyear	Goodyear
Tire Model	Assurance	Assurance
Treadwear	540	540
Traction	A	A
Temperature Grades	A	A
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	2 Polyester, 2 Steel, 1 Polyamide	2 Polyester, 2 Steel, 1 Polyamide
Load Index / Speed Symbol	103H	103H
Tire Material	Rubber	Rubber
DOT Safety Code Left	1PL45JDTR1524	1PL45JDTR1324
DOT Safety Code Right	1PL45JDTR1524	1PL45JDTR1524

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

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV | NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test | Test Date: 11/21/2024

TIRE PRESSURES

	Units	LF	RF	LR	RR
As Delivered	kPa	214	209	212	197
Tire Placard	kPa	240	240	240	240
Owner's Manual	kPa	240	240	240	240
As Tested	kPa	240	240	240	240

MDB TIRE SPECIFICATIONS

	Units	Requirements	LF	RF	LR	RR
Tire Size		P205/75R15	P205/75R15	P205/75R15	P205/75R15	P205/75R15
Tire Pressure	kPa	200 ± 21	207	207	207	207

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)			Fully Loaded		
		Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	kg	571	434		578	489		623	490	
Right	kg	542	423		563	464		548	441.5	
Ratio	%	56.5	43.5		54.5	45.5		55.7	44.3	
Totals	kg	1113	857	1970	1141	953	2094	1171	931.5	2102.5

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total As Delivered Weight (UVW)	kg	1970	(A)
Sum of Actual Weight of 1 ES2re and 1 P572 ATD (SID-IIs)	kg	127	(B)
Rated Cargo / Luggage Weight (RCLW)	kg	4	(C)
Calculated Vehicle Target Weight (TVTW)	kg	2101	(A+B+C)

Does the measured As Test Vehicle Weight lie within the required weight range

(i.e. Calculated Test Vehicle Target Weight – 4.5 kg to – 9 kg)? [X] **Yes** [ ] **No**

TEST VEHICLE ATTITUDES AND CG

Measurement Description	Units	Fully Loaded	As Tested	Meets Rqmt***
LF	mm	842	841	Yes
RF	mm	846	845	Yes
RR	mm	867	859	Yes
LR	mm	863	855	Yes
Vehicle CG (Aft of Front Axle)	mm	1248	1282	
Vehicle CG (Left (+) / Right (-) from Longitudinal Centerline)	mm	48	16	

****The "As Tested" vehicle attitude measurements must be equal to or within ± 10mm of the "Fully Loaded" vehicle attitude measurements at each wheel well. Indicate "Yes" or "No" for "Meets Requirements".*

Test height adjustable suspension setting, if applicable: N/A

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

WEIGHT OF BALLAST AND VEHICLE COMPONENTS REMOVED TO MEET TVTW

Component Description	Weight (kg)
Air pump kit	2
Truck carpeting & Plastics	8
Ballast / Equipment Added	11.3

TEST SURFACE MARKINGS

	Distance from 63° Impact Location Line (mm)
Fore 25 mm target	245
Aft 25 mm target	248
Pre-Impact Angle Line	235

Parallel Track Target	X Location (mm)	Y Location (mm)
A	0	0
B	2955	1555
C	2955	3355
D	0	3000

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

SEAT POSITIONING

The driver's seat, front center seat (if applicable), and right front passenger's seat should be set to the mid-track, lowest, mid-angle position. The struck-side rear passenger's seat, rear center seat, and non-struck side rear passenger's seats should be set to the rear-most, lowest, mid-angle position.

SCRL ANGLE RANGE

Seat	SCRL(°)		
	Max	Min	Mid
Driver Seat	19.6	10.6	15.1
Front Passenger Seat	12.1	10.7	11.4
Front Center Seat			
Struck Side Rear Seat	Fixed	Fixed	Fixed
Non-Struck Side Rear Seat	Fixed	Fixed	Fixed
Rear Center Seat	Fixed	Fixed	Fixed

SEAT HEIGHT AND ANGLE

Seat	As Tested SCRL Angle (Mid) (°)	As Tested SCRP Height (mm)	SCRP Height Position	SCRP Height (mm)		
				Rearmost	Mid-Fore / Aft	Forward-Most
Driver Seat	15.1	10	Max	69	74	79
			Mid	36	42	47
			Min	6	10	14
Front Passenger Seat	11.4	17	Max	-	-	-
			Mid	-	-	-
			Min	12	17	23
Front Center Seat*			Max			
			Mid			
			Min			
Struck Side Rear Seat	Fixed	Fixed	Max			
			Mid			
			Min			
Non-Struck Side Rear Seat	Fixed	Fixed	Max			
			Mid			
			Min			
Rear Center Seat*	Fixed	Fixed	Max			
			Mid			
			Min			

**If applicable*

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

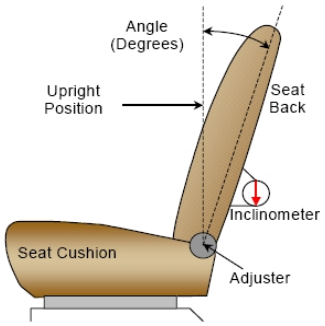
SEAT FORE / AFT POSITION

Seat	Total Fore / Aft Travel		Test Position from Forwardmost Position	
	mm	Detents*	mm	Detents*
Driver Seat	220	Power	110	Power
Front Passenger Seat	240	37 (0-36)	123	18
Front Center Seat				
Struck Side Rear Seat	140	15 (0-14)	0	14
Non-Struck Side Rear Seat	140	15 (0-14)	0	14
Rear Center Seat	140	15 (0-14)	0	14

**if applicable*

SEAT BACK ANGLE ADJUSTMENT

The driver's seat back is positioned to the manufacturer's designated design angle. The front center and front passenger's seat backs are positioned in a similar manner as the driver's seat back. The struck side rear seat back is positioned such that the dummy's head is level. The rear center and non-struck side rear outboard seat backs are positioned in a similar manner as the struck-side rear seat back.



FRONT SEAT ASSEMBLY

Seat	Total Seat Back Angle Range		Test Position from Most Upright	
	Degrees	Detents*	Degrees	Detents*
Driver Seat w/ Seated Dummy	64.2	Power	0.5	Power
Front Passenger Seat	63.9	31 (0-30)	0.4	9
Front Center Seat*				
Struck Side Rear Seat w/ Seated Dummy	22.1	12 (0-11)	2.2	0
Non-Struck Side Rear Seat	22.1	12 (0-11)	2.2	0
Rear Center Seat*	22.1	12 (0-11)	2.2	0

**if applicable*

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

SEAT BELT ANCHORAGE ADJUSTMENT

Seat belt anchorages are adjusted in accordance with the information provided by the manufacturer on Form No. 1. For this test zero is defined as the uppermost position.

Seat	Total # of Positions	Placed in Position #
Driver Seat	4 (0-3)	0
Rear Seat	Fixed	Fixed

HEAD RESTRAINT ADJUSTMENT

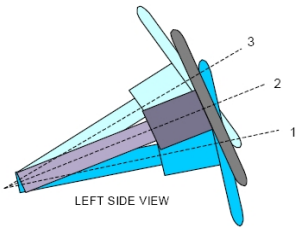
The driver's head restraint is adjusted to the highest and most full forward in-use position. The struck-side rear passenger's head restraint is adjusted to the lowest and most full forward in-use position.

Seat	Total # of Positions	Placed in Position #
Driver Seat	6 (0-6)	Uppermost
Rear Seat	4 (0-4)	Lowermost

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the center of its geometric locus it describes when it moves through its full range of motion.

	Degrees	Fore / Aft Position (mm)
Lowermost - Position No. 1	26.3	
Geometric center - Position No. 2	28.7	
Uppermost - Position No. 3	31.0	
Telescoping Steering Wheel Travel		56
Test Position	28.7	28

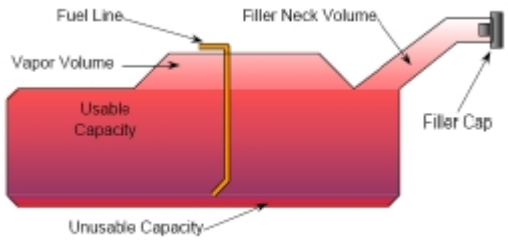


STEERING COLUMN ASSEMBLY

FUEL PUMP

Describe the fuel pump type, details about how it operates, and the location of the fuel filler neck

The vehicle is an gas-electric hybrid vehicle. The fuel filler port is located on the left rear of the vehicle.



VEHICLE FUEL TANK ASSEMBLY

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

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

FUEL TANK CAPACITY

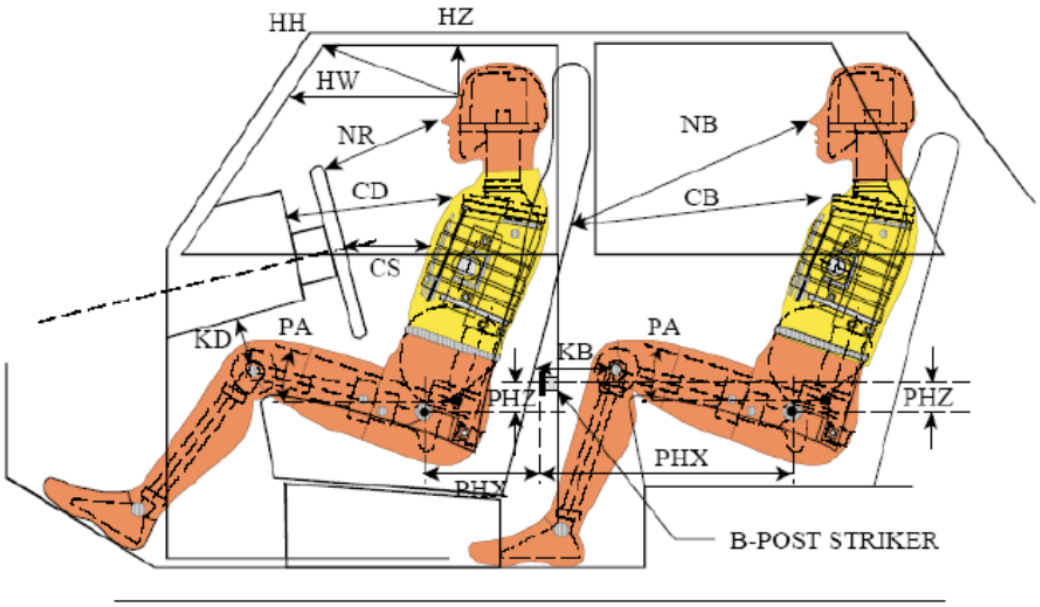
Description	Liters
Usable Capacity of “Standard Tank” (see Form No. 1)	67.0
Usable Capacity of “Optional Tank” (see Form No. 1)	N/A
Usable Capacity of “Standard Tank” (see Owner’s Manual)	67.0
Usable Capacity of “Optional Tank” (see Owner’s Manual)	N/A
93% of Usable Capacity	62.3
Actual Amount of Solvent Used in Test	62.3
1/3 of Usable Capacity	22.3

Is the Actual Amount of Solvent Used in the test equal to 93% ±1% of the Usable Capacity stated in Form No. 1? [X] **Yes** [ ] **No** [ ] **N/A**

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

DUMMY LONGITUDINAL CLEARANCE DIMENSION INFORMATION



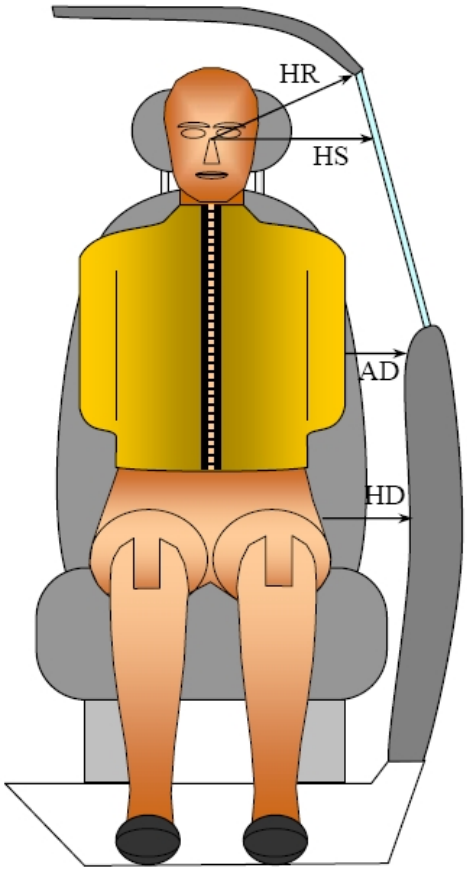
LEFT SIDE VIEW

NOTE: 2-DOOR VEHICLE SHOWN. REAR DUMMY PHX & PHZ MEASUREMENTS FOR A 4-DOOR VEHICLE WOULD USE THE C-POST STRIKER AS A REFERENCE POINT

Driver Code	Pass. Code	Description	Driver (Serial No. F033)		Left Rear Passenger (Serial No. DG8012)	
			Length (mm)	Angle (°)	Length (mm)	Angle (°)
HH		Header to Header	434			
HW		Header to Windshield	726			
HZ	HZ	Head to Roof Liner	238		357	
NR	NB	Nose to Rim/Seat Back	448		569	
CD	CB	Chest to Dash/Seat Back	677		556	
CS		Chest to Steering Wheel	400			
KD(L)/KDA(L)°	KB(L)/KBA(L)°	Left Knee to Dash/Seat Back	218	25.7	310	9.0
KD(R)/KDA(R)°	KB(R)/KBA(R)°	Right Knee to Dash/Seat Back	188	25.1	308	10.0
PAX°	PAX°	Pelvic Tilt Angle X		21.6		22.1
	PAY°	Pelvic Tilt Angle Y				0.2
PHX	PHX	Hip Point to Striker (X-Axis)	155		241	
PHZ	PHZ	Hip Point to Striker (Z-Axis)	288		193	

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



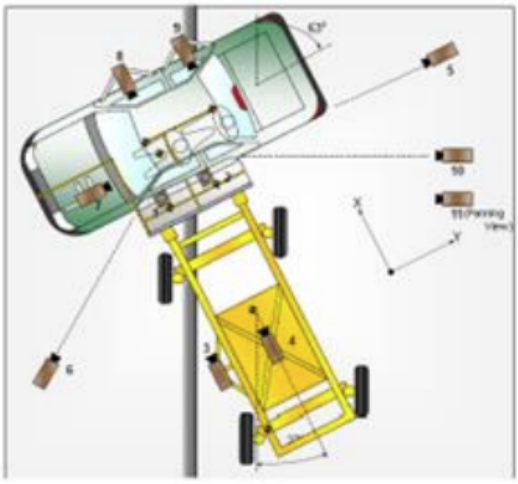
FRONT VIEW OF DUMMY

DUMMY LATERAL CLEARANCE DIMENSION INFORMATION

Code	Measurement Description	Units	Driver (Serial No. F033)	Left Rear Passenger (Serial No. DG8012)
HR	Head to Side Header	mm	262	322
HS	Head to Side Window	mm	388	409
AD	Arm to Door	mm	117	193
HD	Hip Point to Door	mm	178	195

DATA SHEET NO. 5
CAMERA AND INSTRUMENTATION DATA

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV
NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test
Test Date: 11/21/2024



CAMERA LOCATIONS AND DATA

No.	Camera View	Location (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Overhead Overall	0	-518	-9220	12.5	1000
2	Overhead Close-up	0	0	-9220	28	1000
3	Left Impact Point (MDB)	-1470	0	-847	25	1000
4	Side Overall (MDB)	-1140	878	-1587	8	1000
5	Rear	464	8656	-1453	28	1000
6	Left Front	-3323	-5326	-1412	24	1000
7	Driver Front (OB)				25	1000
8	Driver Side (OB)				12.5	1000
9	Passenger Side (OB)				12.5	1000
10	Real-time Left Rear				Zoom	60
11	Real-time In Run				Zoom	60

Notes: *Reference: Impact Point projected to Ground*
+X = To Front of MDB, +Y = To Right of MDB, +Z = Down
** All measurements accurate to ± 6 mm.*

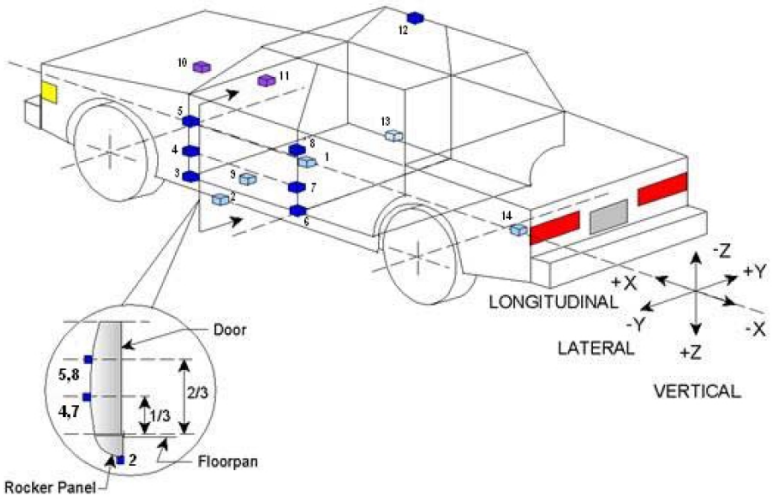
If applicable, explain why camera(s) did not operate as intended: All cameras operated as intended.

INSTRUMENTATION

Description	Number of Channels
Driver Dummy Channels	16
Passenger Dummy Channels	16
Vehicle Structure Accelerometers	23
MDB Accelerometers	7
Total	62

DATA SHEET NO. 6
TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



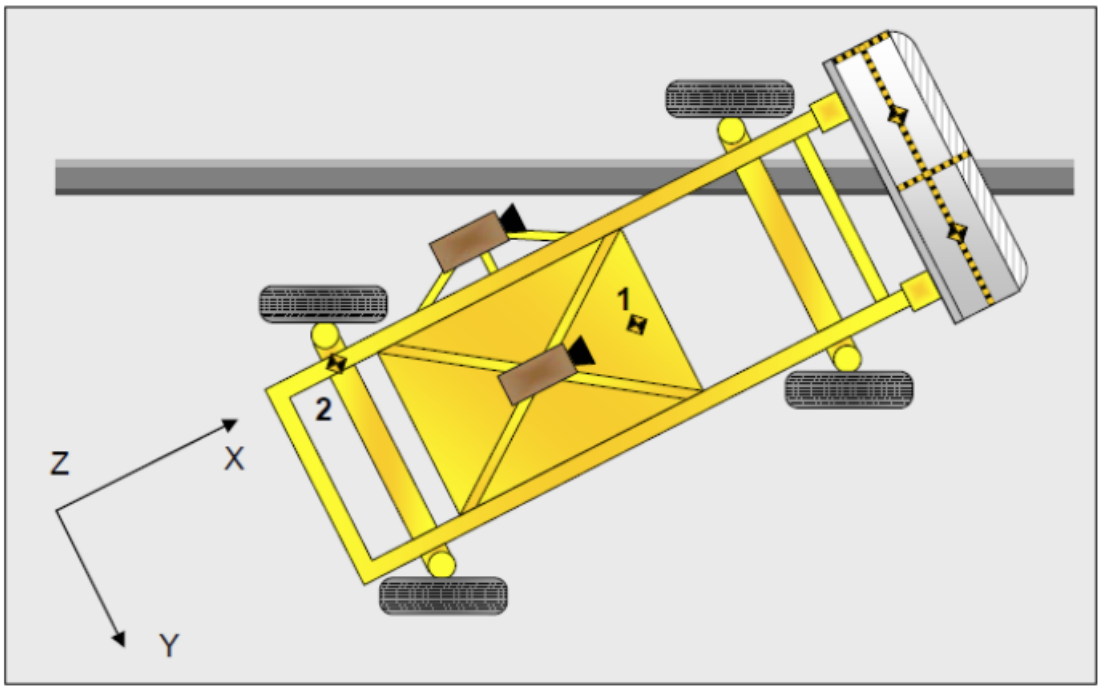
TEST VEHICLE ACCELEROMETER LOCATIONS

No.	Accelerometer Location	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2238	-6	3
2	Right Sill at Front Seat	2980	676	-7
3	Right Sill at Rear Seat	2014	677	-9
4	Left Sill at Front Door	2961	-674	-6
5	Left Sill at Rear Door	2019	-680	-18
6	A-Post Lower	3421	-641	-255
7	A-Post Middle	3293	-698	-748
8	B-Post Lower	2329	-701	-330
9	B-Post Middle	2291	-702	-741
10	Front Seat Track	2646	-587	-30
11	Rear Seat Structure	1987	-350	-29
12	Rt. Rear Occ. Compartment	2278	350	47
13	Engine Block	4066	212	-491
14	Rear Above Axle	503	38	-139

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

DATA SHEET NO. 7
MDB ACCELEROMETER LOCATIONS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



MDB ACCELEROMETER LOCATIONS

No.	Accelerometer Location	Coordinates (mm)		
		X	Y	Z
1	MDB CG	1859	0	-330
2	MDB Rear	386	-660	-660

Reference: *X – Face of MDB (+forward)*
Y – MDB centerline (+ to right)
Z – Ground plane (+down)

Width between left and right contact switches (mm): 1410

DATA SHEET NO. 8
POST-TEST OBSERVATIONS

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV | NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test | Test Date: 11/21/2024

TEST DUMMY INFORMATION AND CONTACT POINTS

Description	Front Seat Dummy (ES-2re)	Rear Seat Dummy (SID-IIs)
Face	Curtain Airbag	None
Top of Head	Curtain Airbag & Header	Curtain Airbag
Left Side of Head	Curtain Airbag	Curtain Airbag
Back of Head	Curtain Airbag, Header, & Head Restraint	Curtain Airbag & Headrest
Left Shoulder	Torso/Pelvic Airbag	Seatback & Torso/Pelvic Airbag
Upper Torso	Seatback	Seatback
Lower Torso	Seatback	Seatback & Torso/Pelvic Airbag
Left Hip	Seatpan & Torso/Pelvic Airbag	Seatpan & Torso/Pelvic Airbag
Left Knee	Door Trim	Door Trim

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
Seat Back Movement from Initial Position	No	No	No	No
Seat Back Collapse	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	None
Side Window Damage	None
Other Notable Effects	None

DATA SHEET NO. 8 … (CONTINUED)
POST-TEST OBSERVATIONS

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test Test Date: 11/21/2024

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

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

IMPACT POINT LOCATION DATA

Measured Parameter	Units	Tolerance	Value
Vehicle Wheel Base	mm		2816
Vertical Impact Reference Line (Aft of Front Axle - Intended Impact Point)	mm		468
Actual Impact Point (Aft of Frontal Axle)	mm		475
Horizontal Offset (+ forward / - rearward)	mm	+/- 50 of Intended Impact Point	-7
Vertical Offset (+ down / - up)	mm	+/- 20 of Intended Impact Point	-4

DATA SHEET NO. 9
MDB SUMMARY OF RESULTS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

MDB SPECIFICATIONS

Measurement Description	Length (mm)
Overall Width of Framework Carriage	1250
Overall Length Including Honeycomb Frame	4120
Wheelbase of Framework Carriage	2591
CG Location of Front Axle	1122

MDB WEIGHTS

	Units	Front Axle	Rear Axle	Total
Left	kg	396	291.5	687.5
Right	kg	377.5	301	678.5
Ratio	%	56.6	43.4	100
Totals	kg	773.5	592.5	1366

SPEED AND ANGLE AT IMPACT DATA

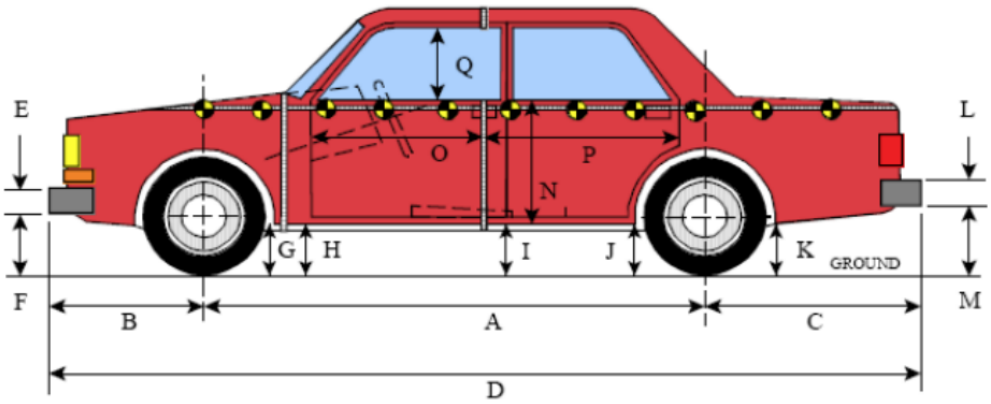
Measured Parameter	Units	Requirement	Value
Trap No. 1 Velocity (Primary)	km/h	61.10 to 62.70	62.16
Trap No. 2 Velocity (Redundant)	km/h	61.10 to 62.70	62.18
MDB CL to Target Vehicle CL	degrees	88.5 to 91.5	90.0
MDB Forward Line of Motion to Target Vehicle CL	degrees	62.5 to 63.5	63.0
MDB Crabbed angle to MDB Forward Line of Motion	degrees	26.0 to 28.0	27.0

MAXIMUM STATIC CRUSH OF HONEYCOMB IMPACT FACE

Vertical Location			From Centerline		Maximum Crush (mm)
Row	Description	Height (mm)	Distance (mm)	Direction	
A	Center of Bumper	432	800	Right	243
B	Top of Bumper	533	100	Right	178
C	Mid-Level	686	200	Right	157
D	Top of Stack	813	800	Left	152

DATA SHEET NO. 10
TEST VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



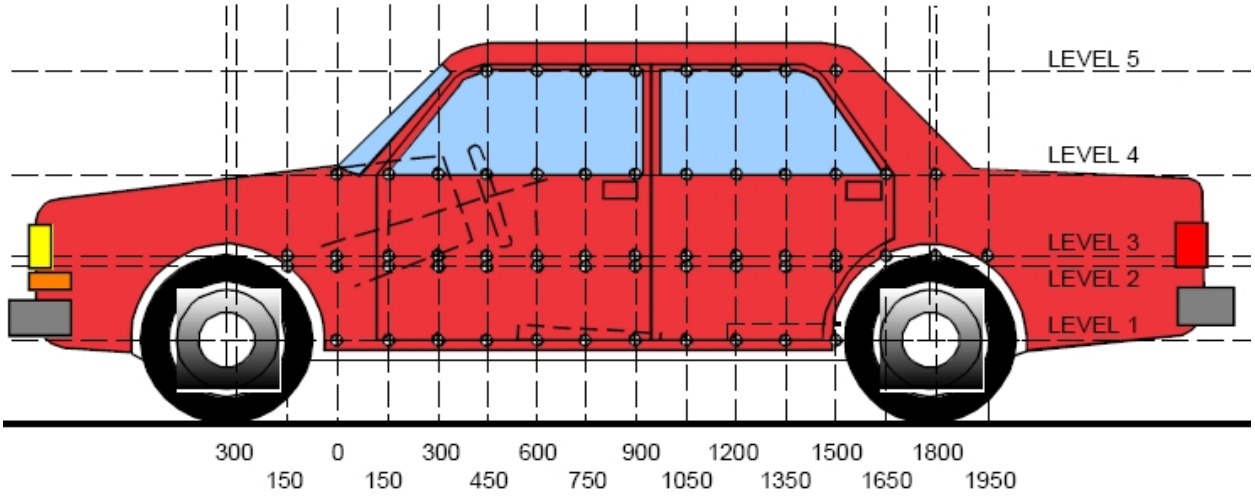
LEFT SIDE VIEW
All MEASUREMENTS IN (mm) WITH TOLERANCE OF ± 3mm

VEHICLE PRE- AND POST-TEST MEASUREMENT INFORMATION

Code.	Measurement Description	Pre-Test	Post-Test	Change
A	Wheelbase	2816	2814	-2
B	Front Axle to FSOV	929	933	4
C	Rear Axle to RSOV	1098	1095	-3
D2	Total Length at Centerline	4843	4842	-1
E	Front Bumper Thickness	114	114	0
F	Front Bumper Bottom to Ground	477	478	1
G	Sill Height at Front Wheel Well	252	261	9
H	Sill Height at Front Door Leading Edge	251	261	10
I	Sill Height at B Pillar	256	260	4
J1	Sill Height at Rear Wheel Well	255	256	1
J2	Pinch Weld Height at Rear Wheel Well	241	248	7
K	Sill Height Aft of Rear Wheel Well	270	275	5
L	Rear Bumper Thickness	148	148	0
M	Rear Bumper Bottom to Ground	476	490	14
N	Sill Height to Bottom of Front Window Sill	920	905	-15
O	Front Door Leading Edge to Impact CL	780	774	-6
P	Rear Door Trailing Edge to Impact CL	1365	1351	-14
Q	Front Window Opening	429	426	-3
R	Right Side Length	4754	4754	0
S	Left Side Length	4751	4749	-2
T	Vehicle Width at B-Pillars	1902	1783	-119
U	Front Wheel Track Width	1642	1648	6
V	Rear Wheel Track Width	1652	1645	-7

DATA SHEET NO.11
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



LEFT SIDE VIEW

MAXIMUM EXTERIOR CRUSH MEASUREMENTS

Level	Measurement Description	Units	Height Above Ground	Maximum Exterior Static Crush	Distance from Impact
1	Sill Top	mm	420	63	1200
2	Occupant H-Point	mm	709	173	1650
3	Mid-Door	mm	774	185	1650
4	Window Sill	mm	1138	43	1350
5	Window Top	mm	1665	3	1350

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.11 … (CONTINUED)
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test Test Date: 11/21/2024

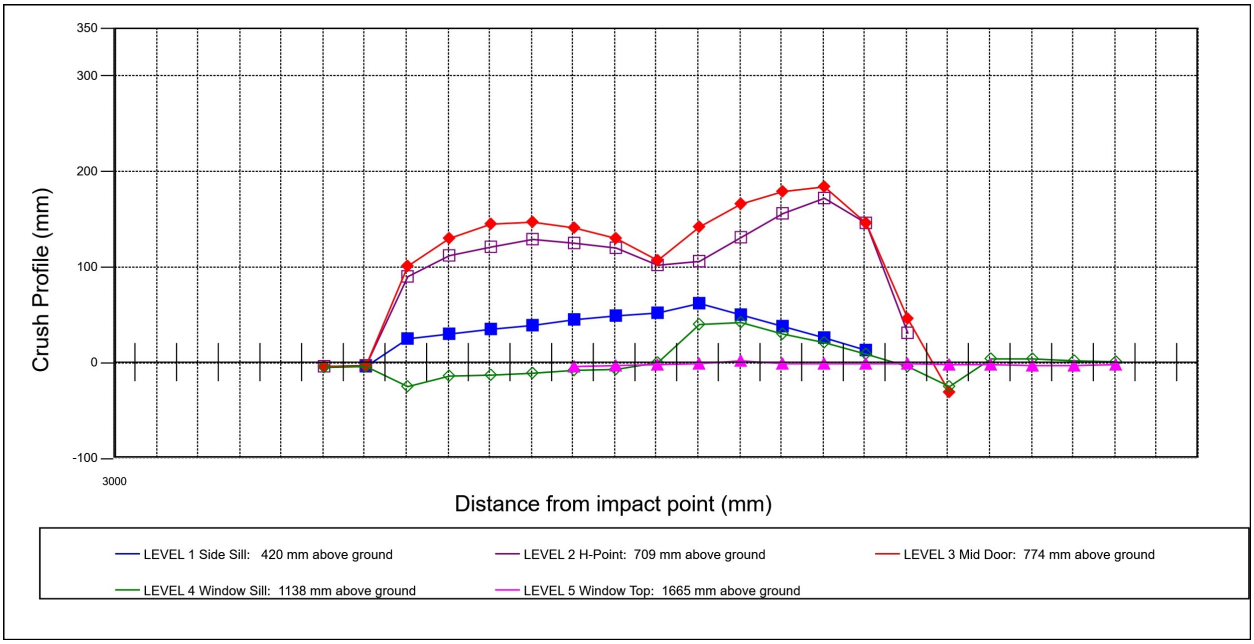
EXTERIOR CRUSH MEASUREMENTS AT EACH LEVEL

	Pre-Test					Post-Test					Crush				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-900															
-750															
-600															
-450															
-300															
-150		950	951	844			953	954	848			-3	-3	-4	
0	935	952	952	866		938	954	953	869		-3	-2	-1	-3	
150	935	944	944	879		909	853	842	903		26	91	102	-24	
300	936	947	946	890		905	834	815	903		31	113	131	-13	
450	936	948	948	895		900	826	802	907		36	122	146	-12	
600	937	950	950	899		897	820	802	909		40	130	148	-10	
750	937	951	951	903	658	891	825	809	910	661	46	126	142	-7	-3
900	937	952	952	906	672	887	831	821	912	674	50	121	131	-6	-2
1050	938	952	953	908	674	885	849	845	907	675	53	103	108	1	-1
1200	935	950	951	909	675	872	843	808	868	675	63	107	143	41	0
1350	933	949	949	909	675	882	817	782	866	672	51	132	167	43	3
1500	931	947	947	908	674	892	790	767	877	674	39	157	180	31	0
1650	928	945	945	908	672	901	772	760	886	672	27	173	185	22	0
1800	926	950	947	906	670	912	803	800	896	670	14	147	147	10	0
1950		952	952	893	667		920	905	896	667		32	47	-3	0
2100			952	897	663			982	921	664			-30	-24	-1
2250				892	659				887	660				5	-1
2400				886	653				881	655				5	-2
2550				879	646				876	648				3	-2
2700				872	638				870	639				2	-1
2850															
3000															

NOTE: *Pre-test measurements are taken when the vehicle is in the "As Tested" weight condition.*
Vehicle measurements forward of the vertical impact reference line are negative.
The crush profile grid is established prior to test based on an estimated impact point.

DATA SHEET NO.11 … (CONTINUED)
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

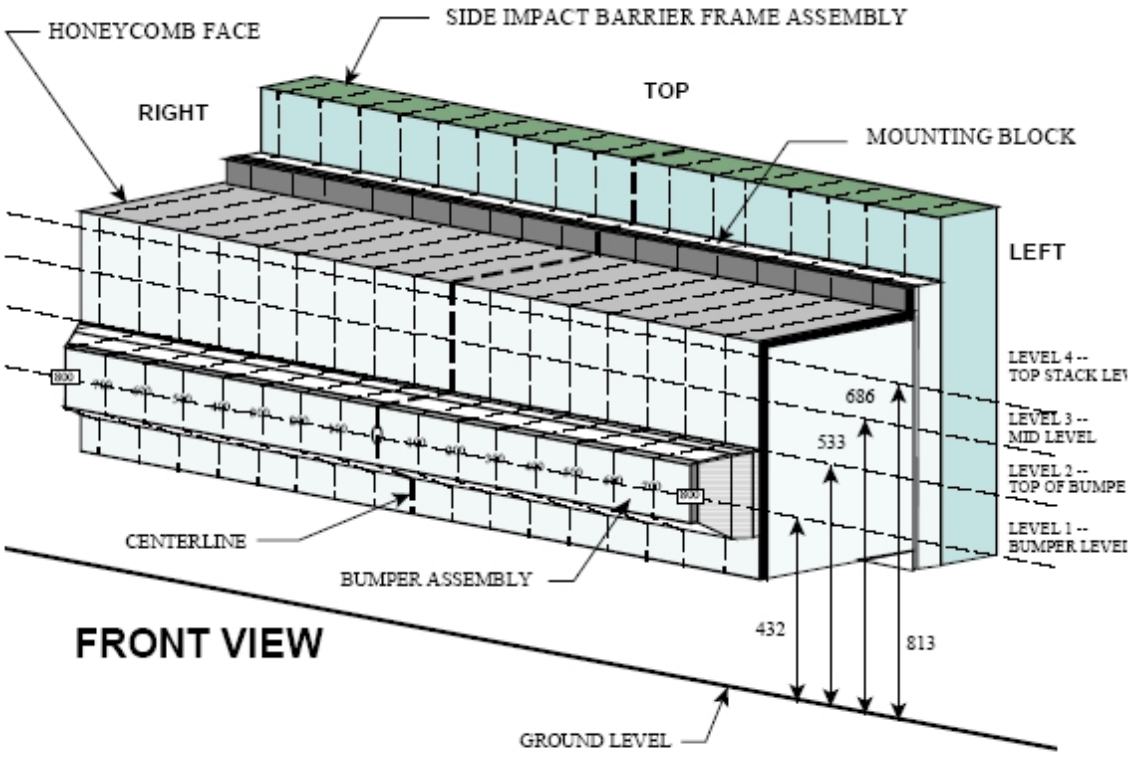
Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



Vehicle Exterior Crush Measurements - Visual Representation

DATA SHEET NO.12
MDB EXTERIOR STATIC CRUSH MEASUREMENTS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



NOTE: Dimensions are shown in millimeters, mm

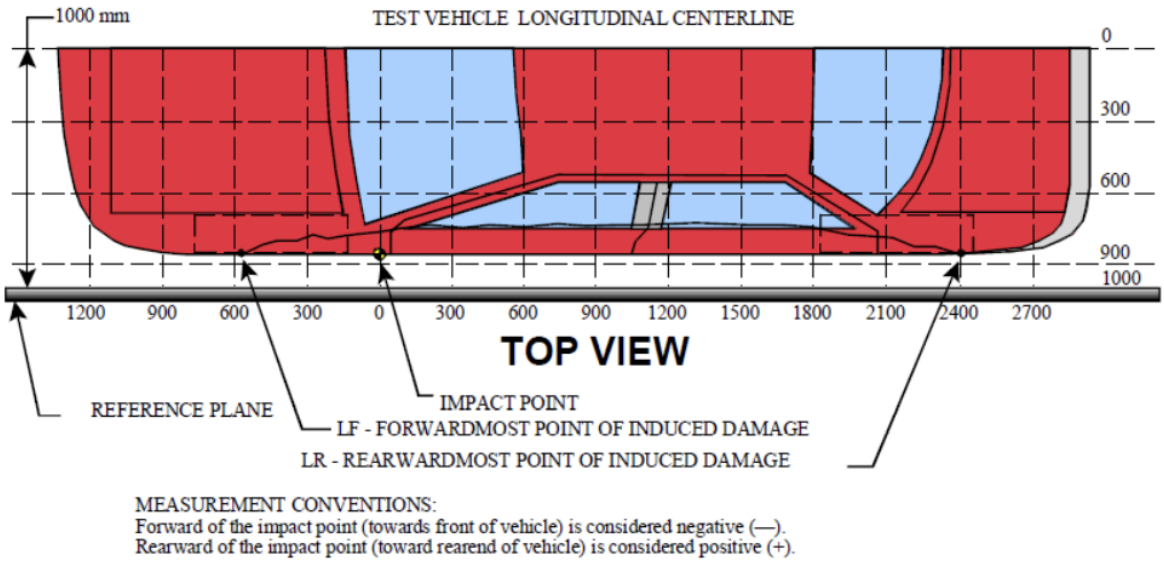
DEFORMABLE BARRIER STATIC CRUSH

Stack Level	Distance Right of Center								C/L	Distance Left of Center							
	800	700	600	500	400	300	200	100	0	100	200	300	400	500	600	700	800
1	243	240	241	241	242	242	243	243	241	232	230	229	228	228	227	227	234
2	165	166	167	166	166	168	173	178	169	152	148	147	147	147	147	149	160
3	93	92	98	108	123	135	157	141	117	105	95	88	86	95	100	118	144
4	92	84	73	75	85	110	143	148	124	113	107	93	95	102	114	131	152

DATA SHEET NO.13
VEHICLE AND MDB DAMAGE PROFILE DISTANCE

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

For guidance regarding damage profile distance measurements, please refer to the latest version of the *NHTSA Test Reference Guide, Volume 1: Vehicle Tests.*



MEASUREMENT CONVENTIONS:
Forward of the impact point (towards front of vehicle) is considered negative (—).
Rearward of the impact point (toward rearend of vehicle) is considered positive (+).

VEHICLE DAMAGE PROFILE DISTANCES

DPD	Distance From Impact Point (mm)	Level	Post-Test (mm)	Pre-Test (mm)	Crush (mm)
1	-150	3	46	49	-3
2	300	3	185	54	131
3	750	3	191	49	142
4	1200	3	192	49	143
5	1650	3	240	55	185
6	2100	3	18	48	-30

MDB DAMAGE PROFILE DISTANCES

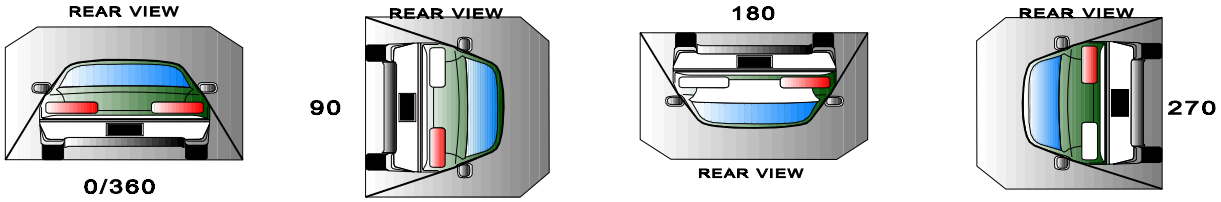
DPD	Distance From Center of MDB (mm)	Level	Post-Test (mm)	Pre-Test (mm)	Crush (mm)
1	800 mm left of center	1	271	505	-234
2	480 mm left of center	1	286	514	-228
3	160 mm left of center	1	283	514	-231
4	160 mm right of center	1	270	513	-243
5	480 mm right of center	1	272	513	-241
6	800 mm right of center	1	258	501	-243

DATA SHEET NO.14
FMVSS NO.301 STATIC ROLLOVER RESULTS

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024
Test Time:	11:10 AM	Temperature:	21 °C

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

D. Spillage Detail: None



ROLLOVER SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	69	300	369
90° to 180°	68	300	368
180° to 270°	66	300	366
270° to 360°	64	300	364

FMVSS 301 SPILLAGE TABLE

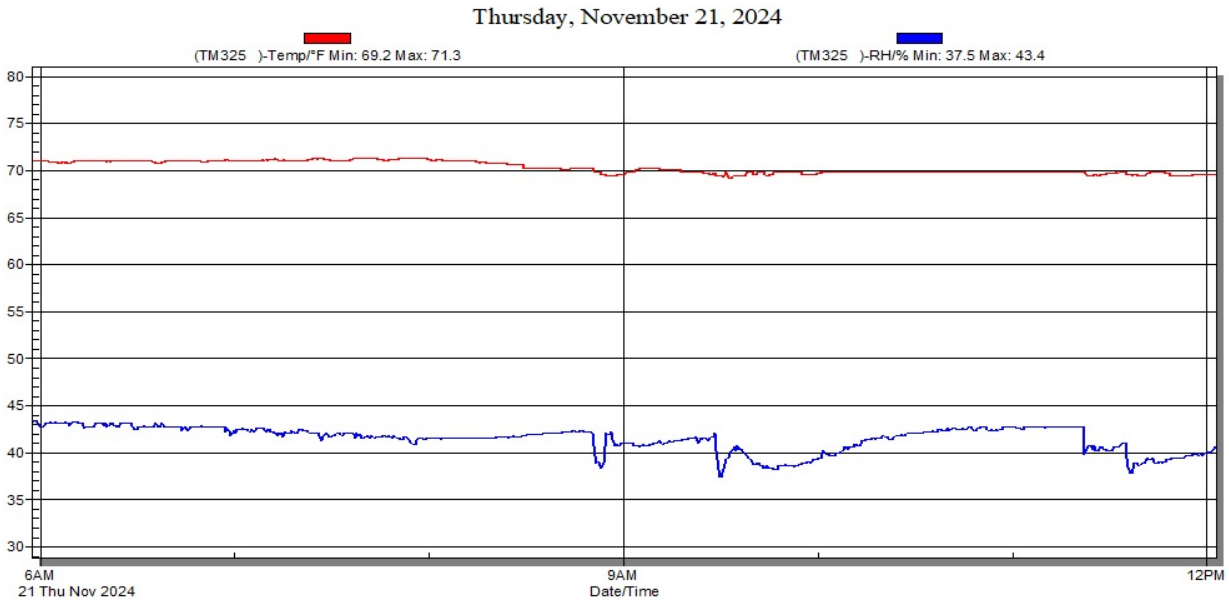
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° to 90°	0	0	0	
90° to 180°	0	0	0	
180° to 270°	0	0	0	
270° to 360°	0	0	0	

SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° to 90°	No Spillage Occurred
90° to 180°	No Spillage Occurred
180° to 270°	No Spillage Occurred
270° to 360°	No Spillage Occurred

DATA SHEET NO. 15
DUMMY / VEHICLE TEMPERATURE AND HUMIDITY STABILIZATION DATA

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024



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

DATA SHEET NO. 305-1
GENERAL TEST AND VEHICLE PARAMETER DATA FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test Test Date: 11/21/2024

ELECTRIC VEHICLE PROPULSION SYSTEM

Measured Parameter	Value
Type of Electric Vehicle (Electric/Gas-Electric Hybrid/Fuel Cell-Electric Hybrid)	Gas-Electric Hybrid
Propulsion Battery Type	Lithium-Ion Battery
Nominal Voltage (Volts)	270
Is this Vehicle equipped with an Automatic Propulsion Battery Disconnect?	Yes
Physical Location of Automatic Propulsion Battery Disconnect, if applicable	Underfloor
Auxiliary Battery Type	N/A

PROPULSION BATTERY SYSTEM DATA (COTR SUPPLIED)

Measured Parameter	Value
Electrolyte Fluid Type	Liquid
Electrolyte Fluid Specific Gravity	1.225 g/cm3
Electrolyte Fluid Kinematic Viscosity (centistokes)	0.65cp
Electrolyte Fluid Color	Clear
Propulsion Battery Coolant Type, Color and Specific Gravity (if applicable)	Air
Location of Battery Modules (Inside or Outside of Passenger Compartment?)	Outside Passenger Compartment

PROPULSION BATTERY STATE OF CHARGE

Measured Parameter	Units	Value
For all battery types: Voltage Range corresponding to **useable energy** of the battery:		
Minimum State of Charge	V	
Maximum State of Charge	V	
95% of Maximum	V	
Test Voltage *	V	
For batteries that are rechargeable ONLY by an energy source on the vehicle: Voltage range corresponding to **useable energy** of the battery:		
Minimum State of Charge	V	180
Maximum State of Charge	V	309.6
95% of Maximum	V	294.12
Test Voltage *	V	260.1

* *For all battery types-No less than 95% of Maximum Operating Voltage; for batteries that are rechargeable ONLY by an energy source on the vehicle-maximum practicable state of charge within normal operating range.*

DATA SHEET NO. 305-2
PRE-IMPACT DATA FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

VEHICLE CHASSIS GROUND PT(S) LOCATION(S) & PROPULSION BATTERY SYSTEM

Measured Parameter	Value
Details of Vehicle Chassis Ground Points & Locations	Ground point is located underneath the vehicle on the vehicle body
Details of Propulsion Battery Components	No details provided by Manufacturer

DATA SHEET NO. 305-3
PRE-IMPACT ELECTRICAL ISOLATION MEASUREMENTS AND CALCULATIONS FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

VOLTMETER INFORMATION

Measured Parameter	Units	Value
Make & Model		Fluke 1587
Serial No.		51800115
Internal Impedance Value	MΩ	10
Resolution	V	0.001
Last Calibration Date		06/20/2024

NOTES:

- *The voltmeter used in this test shall measure DC values and have an internal impedance of at least 10 M Ω*
- *An oscilloscope meeting the above requirements may need to be used to adequately measure voltage in some vehicles.*

PROPULSION BATTERY VOLTAGE, RESISTANCE & ELECTRICAL ISOLATION MEASUREMENTS & CALCULATIONS

Measured Parameter	Symbol	Units	Value
Normal operating voltage range specified by the manufacturer	V_b	V	180-309.6
Propulsion Battery Voltage: (ready to drive position)	V_b	V	260.1
Propulsion Battery to Vehicle Chassis	V_1	V	80.4
Propulsion Battery to Vehicle Chassis	V_2	V	193.5
Propulsion Battery to Vehicle Chassis Across Known Resistor	R_o	Ω	200,000
Propulsion Battery to Vehicle Chassis with R_o installed	V_1'	V	25.5
Propulsion Battery to Vehicle Chassis with R_o installed	V_2'	V	25.7
$R_{i1}= R_o*(1+V_2/V_1)*[(V_1-V_1')/V_1']$	R_{i1}	Ω	1,466,892
$R_{i2}= R_o*(1+V_1/V_2)*[(V_2-V_2')/V_2']$	R_{i2}	Ω	1,848,417
Lesser value of R_{i1} and R_{i2}	R_i	Ω	1,466,892
Electrical Isolation Value (Minimum E.I. Value is 500 Ω/V)	R_i/V_b	Ω/V	5,640

Is the Electrical Isolation Value ≥ 500 Ω/V (Yes/No)? [X] Yes [ ] No (Fail)

NOTES:

- *The measurement shall be made with the propulsion battery connected to the vehicle propulsion system, and the vehicle in the "ready-to-drive" (propulsion motor(s) activated) position.*
- *If the voltage measurement is not at the voltage or within the normal operating voltage range specified by the manufacturer, the battery must be charged.*
- *The known resistance Ro (in Ohms) should be approximately 500 times the nominal operating voltage of the vehicle (in volts) per SAE J1766*
- *If measured voltage is zero and results in a division by zero, record "Zero Volts." This "zero voltage" condition is considered as being compliant*

DATA SHEET NO. 305-4
POST-IMPACT DATA FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle:	2024 Hyundai Santa Fe 5 Door SUV	NHTSA No.:	M20244202
Test Program:	NCAP Side MDB Impact Test	Test Date:	11/21/2024

VOLTMETER INFORMATION

Measured Parameter	Units	Value
Make & Model		Fluke 1587
Serial No.		51800115
Internal Impedance Value	MΩ	10
Resolution	V	0.001
Last Calibration Date		06/20/2024

NOTES:

- *The voltmeter used in this test shall measure DC values and have an internal impedance of at least 10 M Ω*
- *An oscilloscope meeting the above requirements may need to be used to adequately measure voltage in some vehicles.*

ELECTRICAL ISOLATION MEASUREMENTS & IMPACT CALCULATIONS

Parameter	Value	Units		Value		Value	
V_b =	4.8	V	Time:	1	Minutes	7	Seconds
V_1 =	1.1	V	Time:	1	Minutes	11	Seconds
V_2 =	5.2	V	Time:	1	Minutes	16	Seconds
R_o =	200,000	Ω					
V_1' =	0.0	V	Time:	1	Minutes	36	Seconds
V_2' =	0.2	V	Time:	1	Minutes	38	Seconds
R_{i1} =	Zero Volts	Ω	Time:	1	Minutes	36	Seconds
R_{i2} =	6,057,692	Ω	Time:	1	Minutes	38	Seconds
R_i =	6,057,692	Ω/V	Time:	1	Minutes	38	Seconds
R_i/V_b =	1,262,019	Ω/V	Time:	1	Minutes	38	Seconds

Is the Electrical Isolation Value ≥ 500 Ω/V (Yes/No)?	X	Yes		No (Fail)

NOTES:

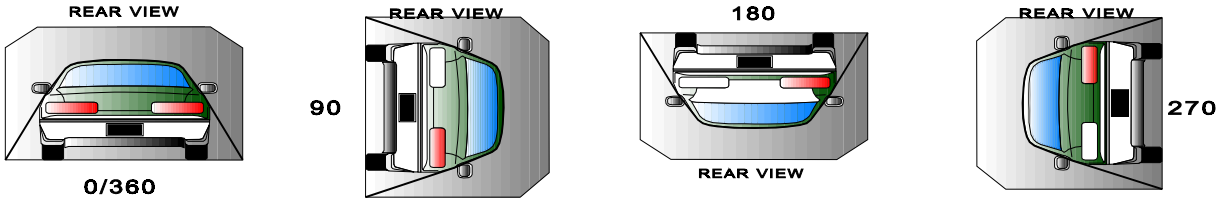
- *$R_{i1}= R_o*(1+V_2/V_1)*[(V_1-V_1')/V_1']$, $R_{i2}= R_o*(1+V_1/V_2)*[(V_2-V_2')/V_2']$, R_i = Lesser value of R_{i1} and R_{i2}*
- *If measured voltage is zero and results in a division by zero, record "Zero Volts." This "zero voltage" condition is considered as being compliant*
- *Minimum Electrical Isolation Value is 500 Ω/V*

PROPULSION BATTERY SYSTEM COMPONENTS

Measured Parameter	Comments	Passed	Failed
Propulsion Battery Module movement within the passenger compartment	None	X	
Intrusion of an outside Propulsion Battery Component into the passenger compartment	None	X	
Is propulsion battery electrolyte spillage visible in the passenger compartment?	None	X	

DATA SHEET NO. 305-5
STATIC ROLLOVER TEST DATA FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV
NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test
Test Date: 11/21/2024



Rear View

DETERMINATION OF PROPULSION BATTERY ELECTROLYTE COLLECTION TIME PERIOD

Rollover Stage	Rotation Time (spec. 1 -3 min)		FMVSS 301 Hold Time	Total Time		Next Whole Minute Interval
	Minutes	Seconds	Minutes	Minutes	Seconds	Minutes
0° to 90°	1	9	5	6	9	7
90° to 180°	1	8	5	6	8	7
180° to 270°	1	6	5	6	6	7
270° to 360°	1	4	5	6	4	7

ACTUAL TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE

Rollover Stage	Propulsion Battery Electrolyte Spillage	Units	Spillage Location
0° to 90°	0	Liters	No Spillage Occurred
90° to 180°	0	Liters	No Spillage Occurred
180° to 270°	0	Liters	No Spillage Occurred
270° to 360°	0	Liters	No Spillage Occurred
Total Spillage	0	Liters	No Spillage Occurred

** FMVSS 305 Requirements: Maximum allowable propulsion battery electrolyte spillage is **5.0 Liters***

Is the total spillage of propulsion battery electrolyte greater than 5.0 Liters? [ ] Yes (Fail) [X] No

Is propulsion battery electrolyte spillage visible in the passenger compartment? [ ] Yes (Fail) [X] No

VOLTMETER INFORMATION

Measured Parameter	Units	Value
Make & Model		Fluke 1587
Serial No.		51800115
Internal Impedance Value	MΩ	10
Resolution	V	0.001
Last Calibration Date		06/20/2024

NOTES:

- *The voltmeter used in this test shall measure DC values and have an internal impedance of at least 10 M Ω*
- *An oscilloscope meeting the above requirements may need to be used to adequately measure voltage in some vehicles.*

DATA SHEET NO. 305-5
STATIC ROLLOVER TEST DATA FOR INDICANT FMVSS NO. 305 TESTING (CONT'D)

Test Vehicle: 2024 Hyundai Santa Fe 5 Door SUV NHTSA No.: M20244202
Test Program: NCAP Side MDB Impact Test Test Date: 11/21/2024

ELECTRICAL ISOLATION MEASUREMENTS & CALCULATIONS

Parameter	Rollover Stage	Value	Units	R_o=150,600 Ω	Minutes	Seconds
V_b =	90°	4.9	V	Time:	7	18
	180°	4.9	V		15	53
	270°	4.8	V		22	8
	360°	4.4	V		28	19
V_1 =	90°	0.9	V	Time:	7	28
	180°	2.2	V		16	2
	270°	2.2	V		22	19
	360°	2.0	V		28	29
V_2 =	90°	4.6	V	Time:	7	33
	180°	2.5	V		16	8
	270°	2.5	V		22	26
	360°	2.3	V		28	34
V_1' =	90°	0.1	V	Time:	7	38
	180°	0.1	V		16	15
	270°	0.1	V		22	31
	360°	0.1	V		28	41
V_2' =	90°	0.3	V	Time:	7	43
	180°	0.1	V		16	22
	270°	0.1	V		22	39
	360°	0.1	V		28	48
R_{i1} =	90°	9,777,778	Ω	Time:	7	38
	180°	8,972,727	Ω		16	15
	270°	8,972,727	Ω		22	31
	360°	8,170,000	Ω		28	41
R_{i2} =	90°	3,427,536	Ω	Time:	7	43
	180°	9,024,000	Ω		16	22
	270°	9,024,000	Ω		22	39
	360°	8,226,087	Ω		28	48
R_i =	90°	3,427,536	Ω/V	Time:	7	43
	180°	8,972,727	Ω/V		16	15
	270°	8,972,727	Ω/V		22	31
	360°	8,170,000	Ω/V		28	41
R_i/V_b =	90°	699,497	Ω/V	Time:	7	43
	180°	1,831,169	Ω/V		16	15
	270°	1,869,318	Ω/V		22	31
	360°	1,856,818	Ω/V		28	41

Is the Electrical Isolation Value ≥ 500 Ω/V (Yes/No)? [X] Yes [ ] No (Fail)

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Fig.	Description	Page
1	As-Delivered Right Front ¾ View of Test Vehicle	A-6
2	As-Delivered Left Rear ¾ View of Test Vehicle	A-6
3	Pre-Test Frontal View of Test Vehicle	A-7
4	Post-Test Frontal View of Test Vehicle	A-7
5	Pre-Test Left Front ¾ View of Test Vehicle	A-8
6	Post-Test Left Front ¾ View of Test Vehicle	A-8
7	Pre-Test Left Side View of Test Vehicle	A-9
8	Post-Test Left Side View of Test Vehicle	A-9
9	Pre-Test Left Rear ¾ View of Test Vehicle	A-10
10	Post-Test Left Rear ¾ View of Test Vehicle	A-10
11	Pre-Test Rear View of Test Vehicle	A-11
12	Post-Test Rear Side View of Test Vehicle	A-11
13	Pre-Test Right Side View of Test Vehicle	A-12
14	Post-Test Right Side View of Test Vehicle	A-12
15	Pre-Test Overhead View of Test Area	A-13
16	Post-Test Overhead View of Test Area	A-13
17	Pre-Test Left Side View of MDB Positioned Against Side of Test Vehicle	A-14
18	Pre-Test Right Side View of MDB Positioned Against Side of Test Vehicle	A-14
19	Pre-Test Close-Up View of Impact Point Target	A-15
20	Post-Test Close-Up View of Impact Point Target	A-15
21	Pre-Test Left Front Door Latch Close-Up	A-16
22	Post-Test Left Front Door Latch Close-Up	A-16
23	Pre-Test Left Rear Door Latch Close-Up	A-17
24	Post-Test Left Rear Door Latch Close-Up	A-17
25	Pre-Test Front Close-up View of Driver Dummy	A-18
26	Post-Test Front Close-up View of Driver Dummy	A-18
27	Pre-Test Left Side View of Driver Dummy Showing Belt and Chalking	A-19
28	Pre-Test Left Side View of Driver Dummy Shoulder and Door Top View	A-19
29	Post-Test Left Side View of Driver Dummy Shoulder and Door Top View	A-20
30	Pre-Test Frontal View of Driver Seat Back Prior to Dummy Positioning	A-20
31	Pre-Test Frontal View of Driver Dummy Head and Shoulders in Relation to Head Restraint	A-21
32	Pre-Test Frontal View of Driver Seat Pan Prior to Dummy Positioning	A-21
33	Pre-Test Overhead View of Driver Dummy Thighs on Seat Pan	A-22
34	Pre-Test Placement of Driver Dummy’s Feet	A-22

Fig.	Description	Page
35	Pre-Test View of Belt Anchorage for Driver Dummy	A-23
36	Pre-Test Left Side View of Steering Wheel	A-23
37	View of Disengaged Parking Brake	A-24
38	Pre-Test View of Parking Brake	A-24
39	Pre-Test Close-Up Left Side View of Driver Seat Track	A-25
40	Pre-Test Close-Up Left Side View of Driver Seat Back	A-25
41	Pre-Test Close-Up View of Driver Seat Back or Head Restraint	A-26
42	Pre-Test Driver Dummy and Door Clearance View	A-26
43	Post-Test Driver Dummy and Door Clearance View	A-27
44	Pre-Test Right Side View of Driver Dummy and Front Seat of Occupant Compartment	A-27
45	Post-Test Right Side View of Driver Dummy and Front Seat of Occupant Compartment	A-28
46	Pre-Test Driver Inner Door Panel View	A-28
47	Post-Test Driver Inner Door Panel View	A-29
48	Post-Test Driver Dummy Close-Up Head Contact with Vehicle View	A-29
49	Post-Test Driver Dummy Close-Up Head Contact with Side Air Bag View	A-30
50	Post-Test Driver Dummy Close-Up Torso Contact with Vehicle Interior View	A-30
51	Post-Test Driver Dummy Close-Up Torso Contact with Side Air Bag View	A-31
52	Post-Test Driver Dummy Close-Up Pelvis Contact View	A-31
53	Post-Test Driver Dummy Close-Up Pelvis Contact with Side Air Bag View	A-32
54	Post-Test Driver Dummy Close-Up Knee Contact View	A-32
55	Pre-Test Left Side View of Rear Passenger Dummy Showing Belt and Chalking	A-33
56	Pre-Test Left Side View of Rear Passenger Dummy Shoulder and Door Top View	A-33
57	Post-Test Left Side View of Rear Passenger Dummy Shoulder and Door Top View	A-34
58	Pre-Test Frontal View of Rear Passenger Seat Back Prior to Dummy Positioning	A-34
59	Pre-Test Frontal View of Rear Passenger Dummy Head and Shoulders in Relation to Head Restraint	A-35
60	Pre-Test Overhead View of Rear Passenger Seat Pan Prior to Dummy Positioning	A-35
61	Pre-Test Overhead View of Rear Passenger Dummy Thighs on Seat Pan	A-36
62	Pre-Test View of Rear Passenger Dummy’s Neck Showing Position of Adjustable Neck Bracket	A-36
63	Pre-Test View of Rear Passenger Dummy’s Head Showing Dummy’s Head is Level	A-37
64	Pre-Test Placement of Rear Passenger Dummy’s Feet	A-37
65	Pre-Test View of Belt Anchorage for Rear Passenger Dummy	A-38
66	Pre-Test Close-Up Left Side View of Rear Passenger Seat Track	A-38
67	Pre-Test Close-Up Left Side View of Rear Passenger Seat Back	A-39
68	Pre-Test Close-Up View of Rear Passenger Seat Back or Head Restraint	A-39

Fig.	Description	Page
69	Pre-Test Rear Passenger Dummy and Door Clearance View	A-40
70	Post-Test Rear Passenger Dummy and Door Clearance View	A-40
71	Pre-Test Right Side View of Rear Passenger Dummy and Rear Seat Occupant Compartment	A-41
72	Post-Test Right Side View of Rear Passenger Dummy and Rear Seat Occupant Compartment	A-41
73	Pre-Test Rear Passenger Inner Door Panel View	A-42
74	Post-Test Rear Passenger Inner Door Panel View Showing Rear Passenger Dummy Contact Locations	A-42
75	Post-Test Rear Passenger Dummy Close-Up Head Contact with Vehicle View	A-43
76	Post-Test Rear Passenger Dummy Close-Up Head Contact with Side Air Bag View	A-43
77	Post-Test Rear Passenger Dummy Close-Up Torso Contact with Vehicle Interior View	A-44
78	Post-Test Rear Passenger Dummy Close-Up Torso Contact with Side Air Bag View	A-44
79	Post-Test Rear Passenger Dummy Close-Up Pelvis Contact View	A-45
80	Post-Test Rear Passenger Dummy Close-Up Pelvis Contact with Side Air Bag View	A-45
81	Post-Test Rear Passenger Dummy Close-Up Knee Contact View	A-46
82	Pre-Test View of Fuel Filler Cap or Fuel Filler Neck	A-46
83	Post-Test View of Fuel Filler Cap or Fuel Filler Neck	A-47
84	Pre-Test Front View of MDB Impactor Face	A-47
85	Post-Test Front View of MDB Impactor Face	A-48
86	Pre-Test Top View of MDB Impactor Face	A-48
87	Post-Test Top View of MDB Impactor Face	A-49
88	Pre-Test Left Side View of MDB Impactor Face	A-49
89	Post-Test Left Side View of MDB Impactor Face	A-50
90	Pre-Test Right Side View of MDB Impactor Face	A-50
91	Post-Test Right Side View of MDB Impactor Face	A-51
92	Close-Up View of Vehicle’s Certification Label	A-51
93	Close-Up View of Vehicle’s Tire Information Placard or Label	A-52
94	Pre-Test Ballast View	A-52
95	Post-Test Primary and Redundant Speed Trap Read-Out	A-53
96	FMVSS No. 301 Static Rollover 0 Degrees	A-53
97	FMVSS No. 301 Static Rollover 90 Degrees	A-54
98	FMVSS No. 301 Static Rollover 180 Degrees	A-54
99	FMVSS No. 301 Static Rollover 270 Degrees	A-55
100	FMVSS No. 301 Static Rollover 360 Degrees	A-55
101	Impact Event	A-56
102	Monroney Label	A-56
103	Driver Head Restraint Use and Adjustment Information from Vehicle Owner’s Manual	A-57
104	Left Rear Passenger Head Restraint Use and Adjustment Information from Vehicle Owner’s Manual	A-57

Fig.	Description	Page
305-1	Auxiliary Power Module Warning Label	A-58
305-2	Power Inverter Warning Label	A-58
305-3	First Responder Warning Label	A-59
305-4	First Responder Warning Label Location	A-59
305-5	Other Vehicle Label(s) Related to Electrical Propulsion System	A-60
305-6	Manual High Voltage Service Disconnect in Place	A-60
305-7	Manual High Voltage Service Disconnect Removed (Plug)	A-61
305-8	Manual High Voltage Service Disconnect Removed (Location where removed)	A-61
305-9	Pre-Impact View of Propulsion Battery	A-62
305-10	Post-Impact Front View of Propulsion Battery	A-62
305-11	Post-Impact Rear View of Propulsion Battery (if any part of it is visible)	A-63
305-12	Pre-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules	A-63
305-13	Post-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules	A-64
305-14	Pre-Impact View of Propulsion Battery Module(s)	A-64
305-15	Post-Impact View of Propulsion Battery Module(s)	A-65
305-16	Pre-Impact View of Electric Propulsion Drive	A-65
305-17	Post-Impact View of Electric Propulsion Drive	A-66
305-18	Pre-Impact View of High Voltage Interconnect(s)	A-66
305-19	Pre-Impact View Propulsion Venting System(s)	A-67
305-20	Pre-Impact View of Other Visible Electric Propulsion Components	A-67
305-21	Pre-Impact View of Ground Lead Attached	A-68
305-22	Pre-Impact View of High Voltage Leads Attached	A-68
305-23	Pre-Impact Close-Up View of High Voltage Leads Attached	A-69
305-24	Pre-Impact View of Installed Test Interface Port	A-69
305-25	Post-Impact View of Installed Test Interface Port	A-70
305-26	Pre-Impact View of Other Test Devices	A-70
305-27	Post-Impact View of Other Test Devices	A-71
305-28	FMVSS No. 305 Static Rollover 90 Degrees	A-71
305-29	FMVSS No. 305 Static Rollover 180 Degrees	A-72
305-30	FMVSS No. 305 Static Rollover 270 Degrees	A-72
305-31	FMVSS No. 305 Static Rollover 360 Degrees	A-73
305-32	Pre-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery	A-73
305-33	Post-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery	A-74
305-34	Post-Impact Propulsion Battery System Mounting and/or Intrusion Failure(s)	A-74
305-35	Post-Impact View of Battery Component Intrusion	A-75
305-36	Post-Impact View of Battery Module Movement or Retention Loss	A-75
305-37	Post-Impact View of Propulsion Battery Electrolyte Spillage Location (Prior to static roll)	A-76
305-38	Post-Impact View of Propulsion Battery Electrolyte Spillage Location (After static roll)	A-76



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



Figure A-2: As Delivered Left Rear ¾ View of Test Vehicle



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



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



Figure A-5: Pre-Test Left Front ¾ View of Test Vehicle



Figure A-6: Post-Test Left Front ¾ View of Test Vehicle



Figure A-7: Pre-Test Left Side View of Test Vehicle



Figure A-8: Post-Test Left Side View of Test Vehicle



Figure A-9: Pre-Test Left Rear ¾ View of Test Vehicle



Figure A-10: Post-Test Left Rear ¾ View of Test Vehicle



Figure A-11: Pre-Test Rear View of Test Vehicle



Figure A-12: Post-Test Rear Side View of Test Vehicle



Figure A-13: Pre-Test Right Side View of Test Vehicle



Figure A-14: Post-Test Right Side View of Test Vehicle

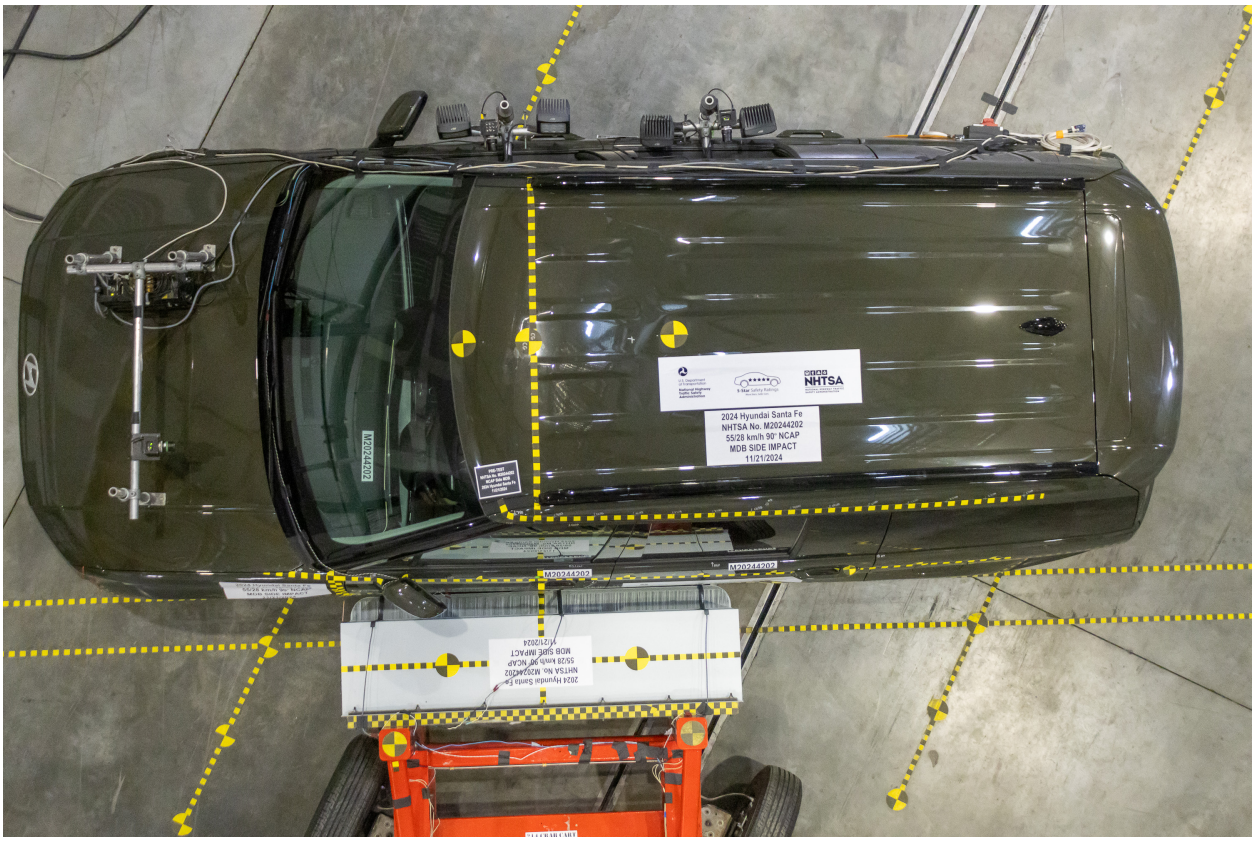


Figure A-15: Pre-Test Overhead View of Test Area

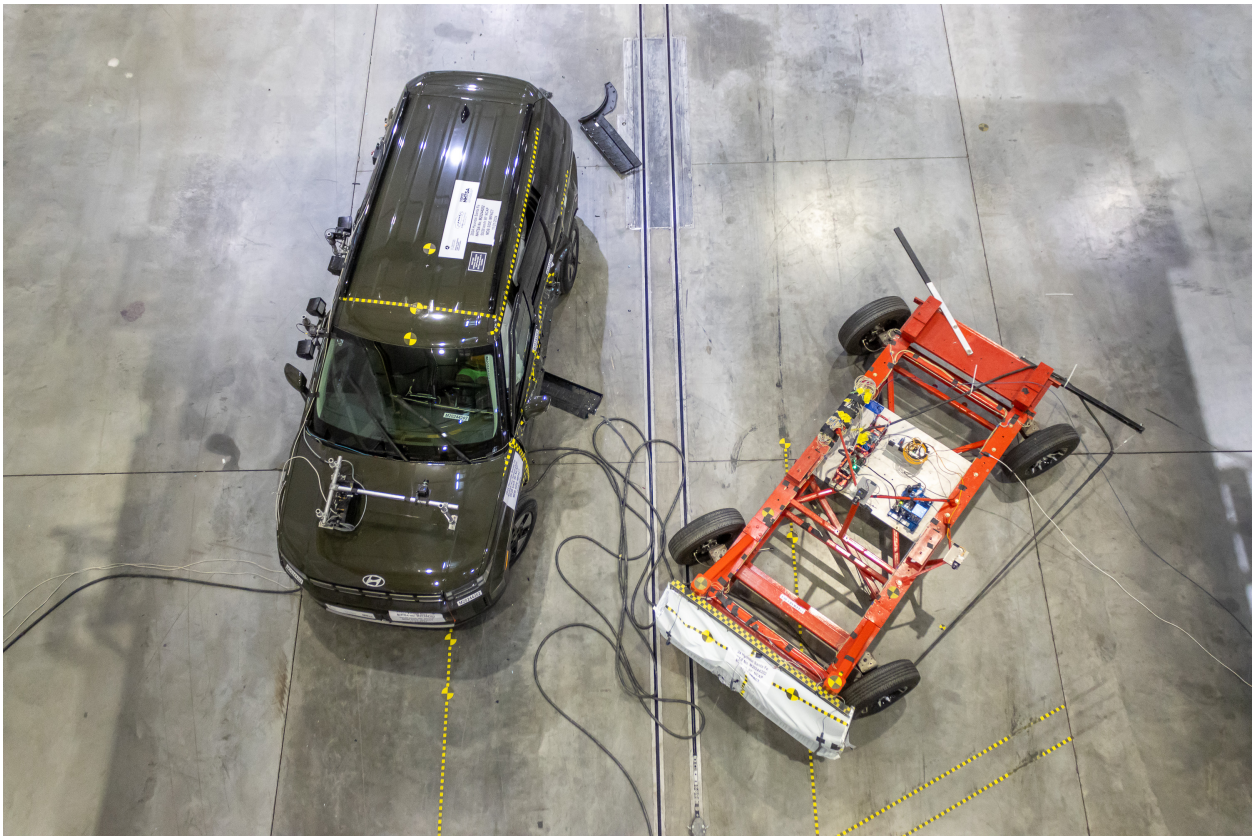


Figure A-16: Post-Test Overhead View of Test Area



Figure A-17: Pre-Test Left Side View of MDB Positioned Against Side of Test Vehicle



Figure A-18: Pre-Test Right Side View of MDB Positioned Against Side of Test Vehicle



Figure A-19: Pre-Test Close-Up View of Impact Point Target



Figure A-20: Post-Test Close-Up View of Impact Point Target



Figure A-21: Pre-Test Left Front Door Latch Close-Up



Figure A-22: Post-Test Left Front Door Latch Close-Up



Figure A-23: Pre-Test Left Rear Door Latch Close-Up



Figure A-24: Post-Test Left Rear Door Latch Close-Up



Figure A-25: Pre-Test Front Close-up View of Driver Dummy



Figure A-26: Post-Test Front Close-up View of Driver Dummy



Figure A-27: Pre-Test Left Side View of Driver Dummy Showing Belt and Chalking



Figure A-28: Pre-Test Left Side View of Driver Dummy Shoulder and Door Top View



Figure A-29: Post-Test Left Side View of Driver Dummy Shoulder and Door Top View



Figure A-30: Pre-Test Frontal View of Driver Seat Back Prior to Dummy Positioning



Figure A-31: Pre-Test Frontal View of Driver Dummy Head and Shoulders in Relation to Head Restraint



Figure A-32: Pre-Test Frontal View of Driver Seat Pan Prior to Dummy Positioning



Figure A-33: Pre-Test Overhead View of Driver Dummy Thighs on Seat Pan



Figure A-34: Pre-Test Placement of Driver Dummy's Feet



Figure A-35: Pre-Test View of Belt Anchorage for Driver Dummy



Figure A-36: Pre-Test Left Side View of Steering Wheel

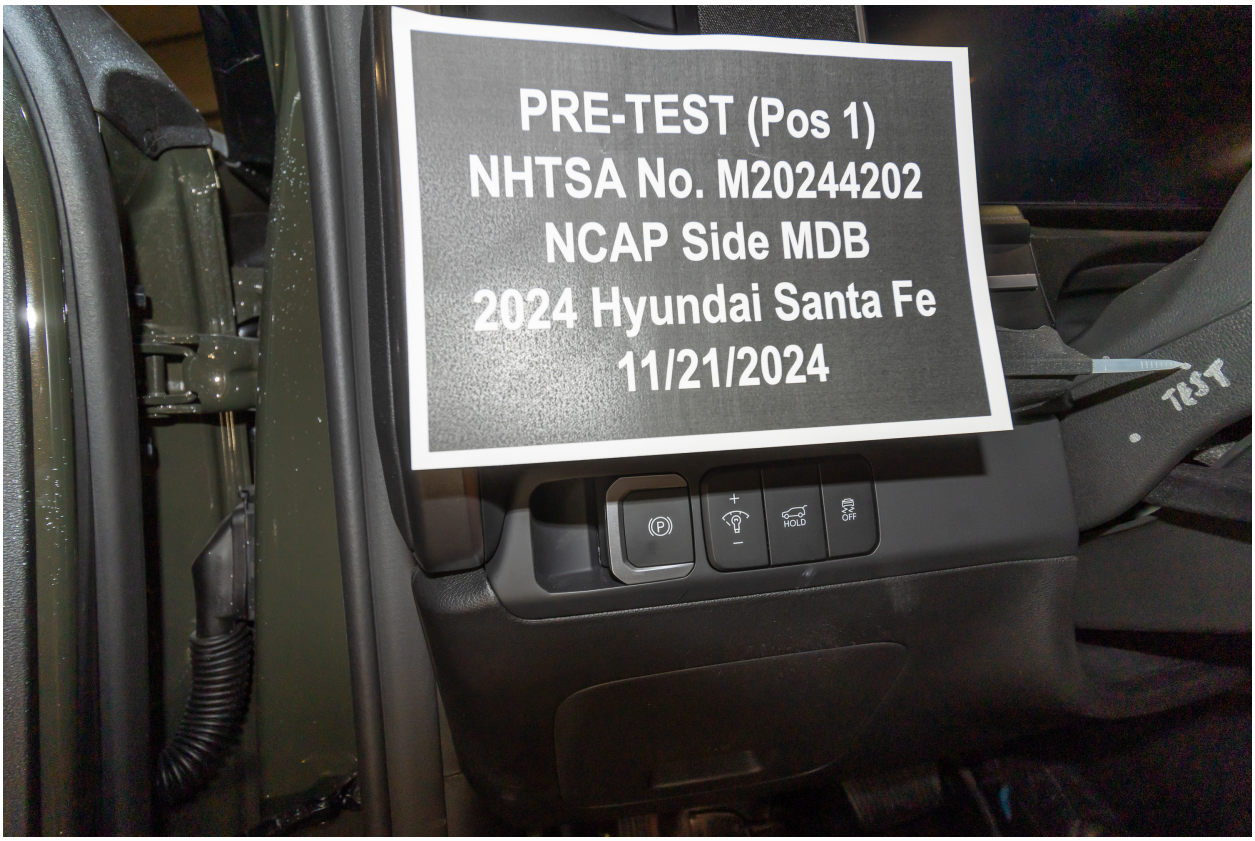


Figure A-37: View of Disengaged Parking Brake



Figure A-38: Pre-Test View of Parking Brake



Figure A-39: Pre-Test Close-Up Left Side View of Driver Seat Track



Figure A-40: Pre-Test Close-Up Left Side View of Driver Seat Back



Figure A-41: Pre-Test Close-Up View of Driver Seat Back or Head Restraint



Figure A-42: Pre-Test Driver Dummy and Door Clearance View



Figure A-43: Post-Test Driver Dummy and Door Clearance View



Figure A-44: Pre-Test Right Side View of Driver Dummy and Front Seat of Occupant Compartment



Figure A-45: Post-Test Right Side View of Driver Dummy and Front Seat of Occupant Compartment



Figure A-46: Pre-Test Driver Inner Door Panel View



Figure A-47: Post-Test Driver Inner Door Panel View



Figure A-48: Post-Test Driver Dummy Close-Up Head Contact with Vehicle View



Figure A-49: Post-Test Driver Dummy Close-Up Head Contact with Side Air Bag View



Figure A-50: Post-Test Driver Dummy Close-Up Torso Contact with Vehicle Interior View



Figure A-51: Post-Test Driver Dummy Close-Up Torso Contact with Side Air Bag View



Figure A-52: Post-Test Driver Dummy Close-Up Pelvis Contact View



Figure A-53: Post-Test Driver Dummy Close-Up Pelvis Contact with Side Air Bag View



Figure A-54: Post-Test Driver Dummy Close-Up Knee Contact View



Figure A-55: Pre-Test Left Side View of Rear Passenger Dummy Showing Belt and Chalking



Figure A-56: Pre-Test Left Side View of Rear Passenger Dummy Shoulder and Door Top View



Figure A-57: Post-Test Left Side View of Rear Passenger Dummy Shoulder and Door Top View



Figure A-58: Pre-Test Frontal View of Rear Passenger Seat Back Prior to Dummy Positioning



Figure A-59: Pre-Test Frontal View of Rear Passenger Dummy Head and Shoulders in Relation to Head Restraint



Figure A-60: Pre-Test Overhead View of Rear Passenger Seat Pan Prior to Dummy Positioning



Figure A-61: Pre-Test Overhead View of Rear Passenger Dummy Thighs on Seat Pan

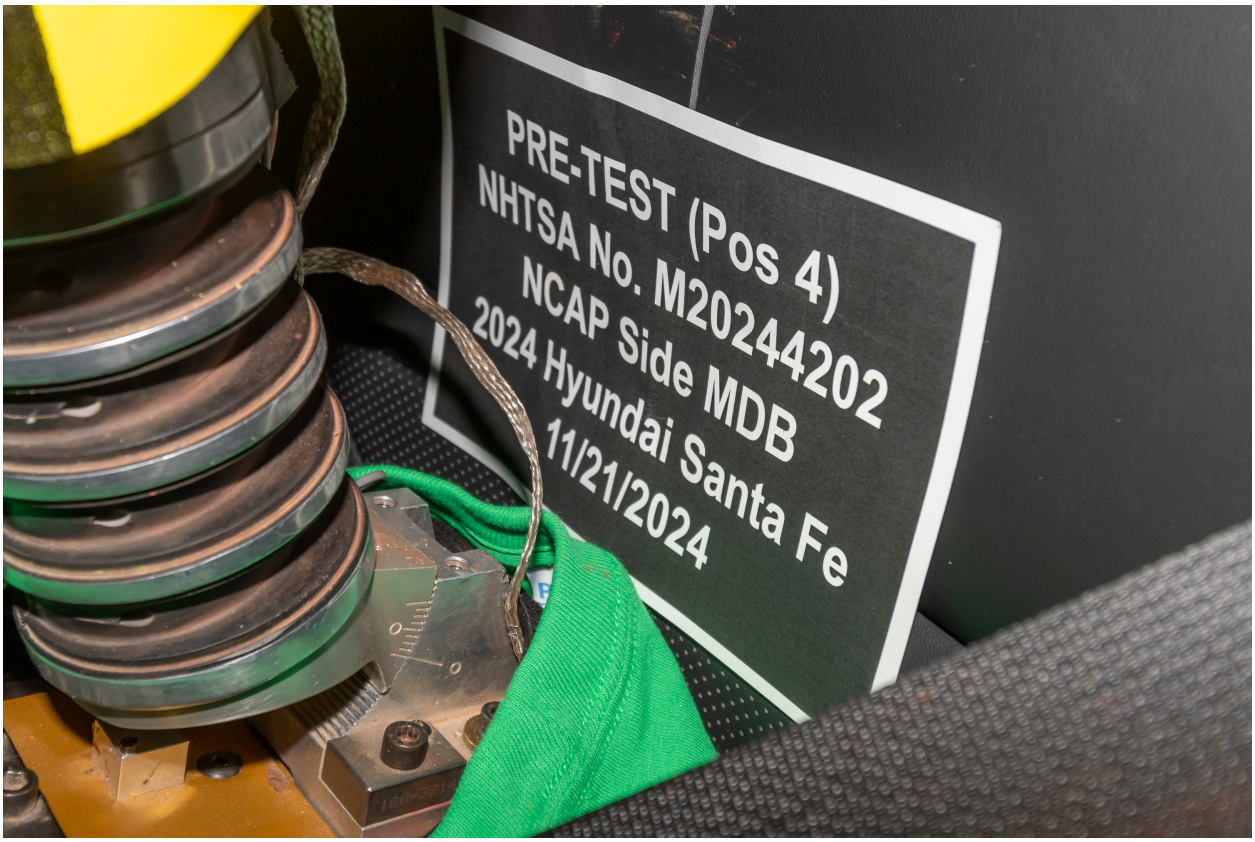


Figure A-62: Pre-Test View of Rear Passenger Dummy's Neck Showing Position of Adjustable Neck Bracket



Figure A-63: Pre-Test View of Rear Passenger Dummy's Head Showing Dummy's Head is Level



Figure A-64: Pre-Test Placement of Rear Passenger Dummy's Feet



Figure A-65: Pre-Test View of Belt Anchorage for Rear Passenger Dummy



Figure A-66: Pre-Test Close-Up Left Side View of Rear Passenger Seat Track

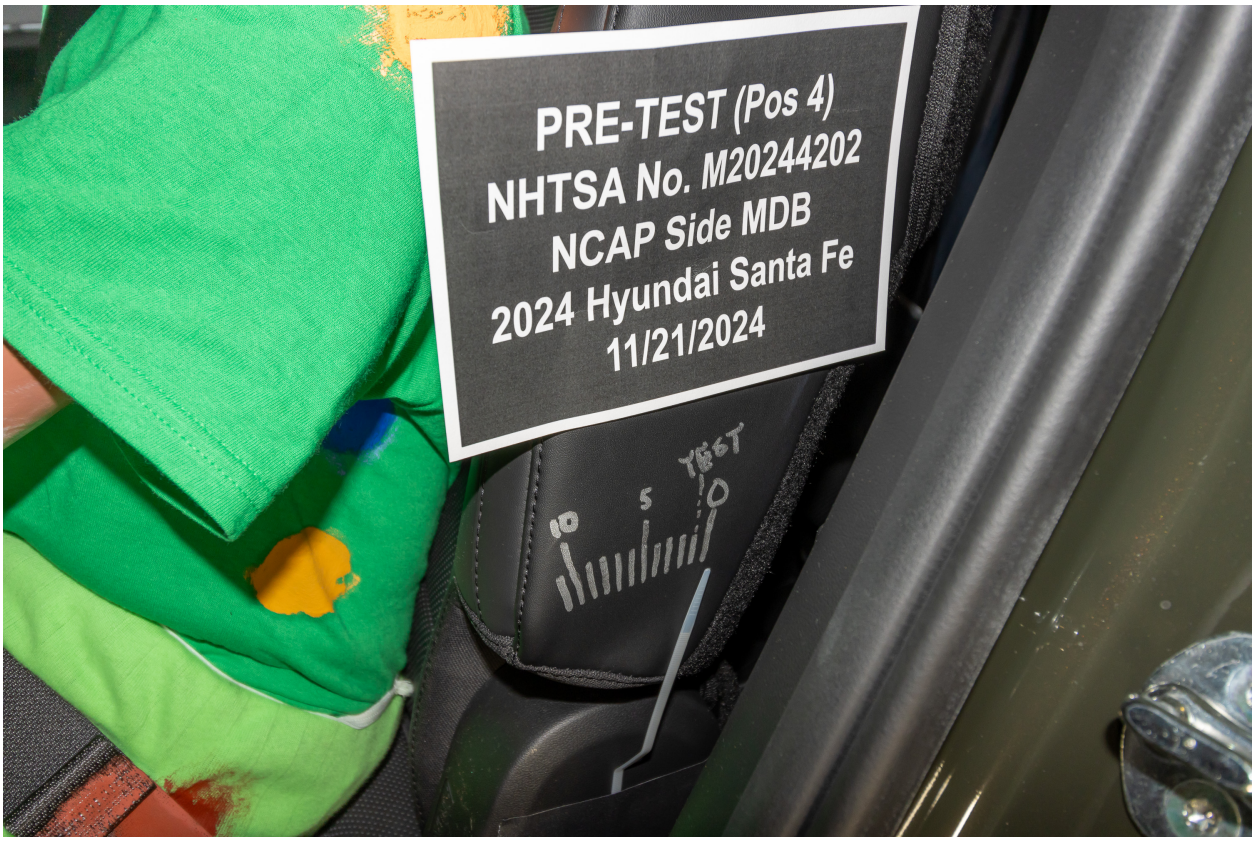


Figure A-67: Pre-Test Close-Up Left Side View of Rear Passenger Seat Back

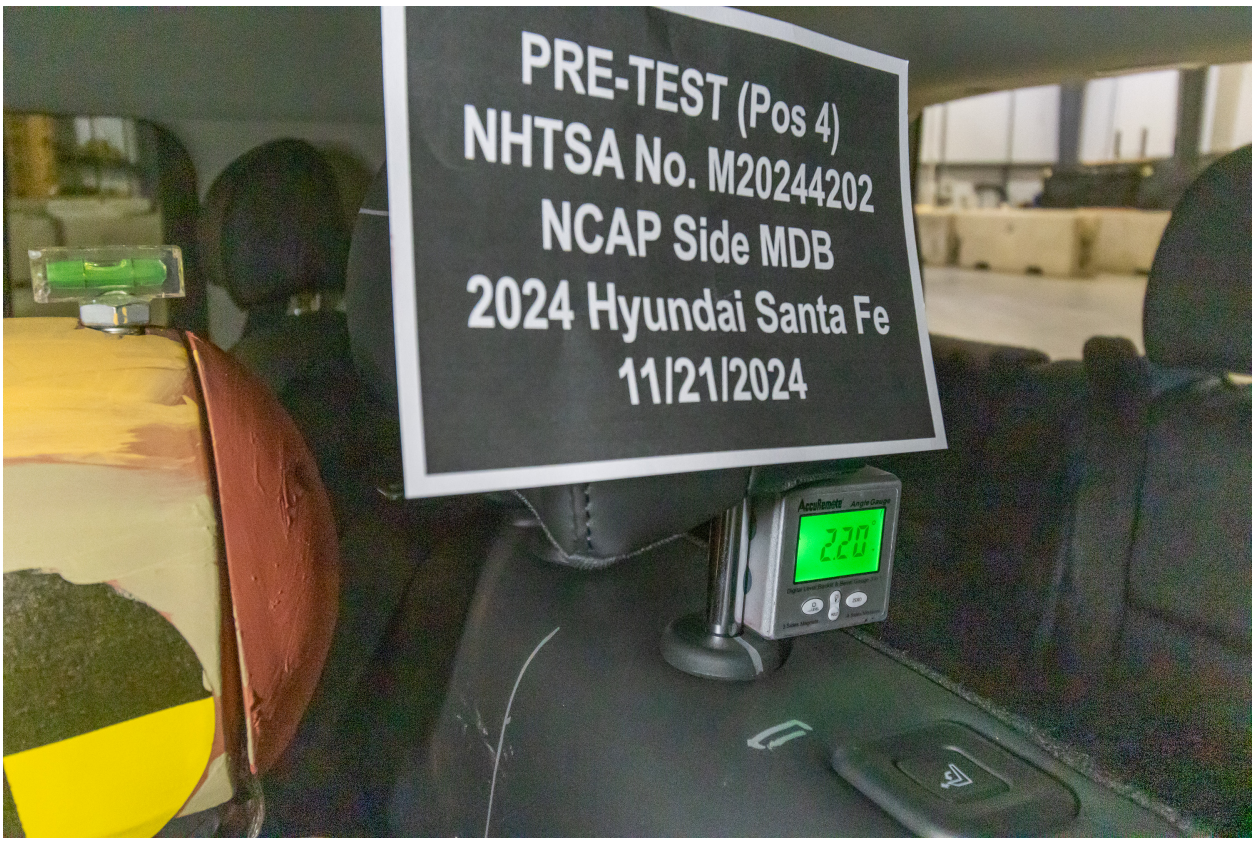


Figure A-68: Pre-Test Close-Up View of Rear Passenger Seat Back or Head Restraint



Figure A-69: Pre-Test Rear Passenger Dummy and Door Clearance View

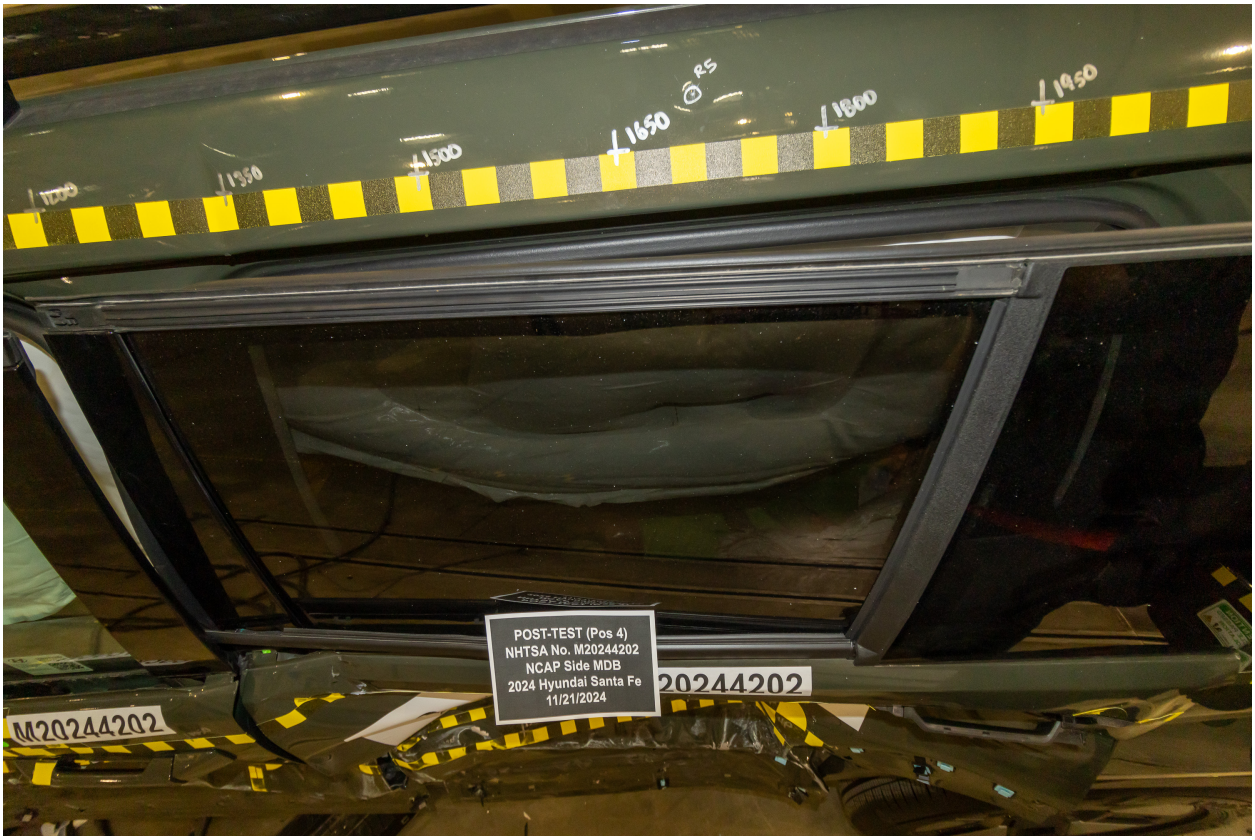


Figure A-70: Post-Test Rear Passenger Dummy and Door Clearance View



Figure A-71: Pre-Test Right Side View of Rear Passenger Dummy and Rear Seat Occupant Compartment



Figure A-72: Post-Test Right Side View of Rear Passenger Dummy and Rear Seat Occupant Compartment



Figure A-73: Pre-Test Rear Passenger Inner Door Panel View

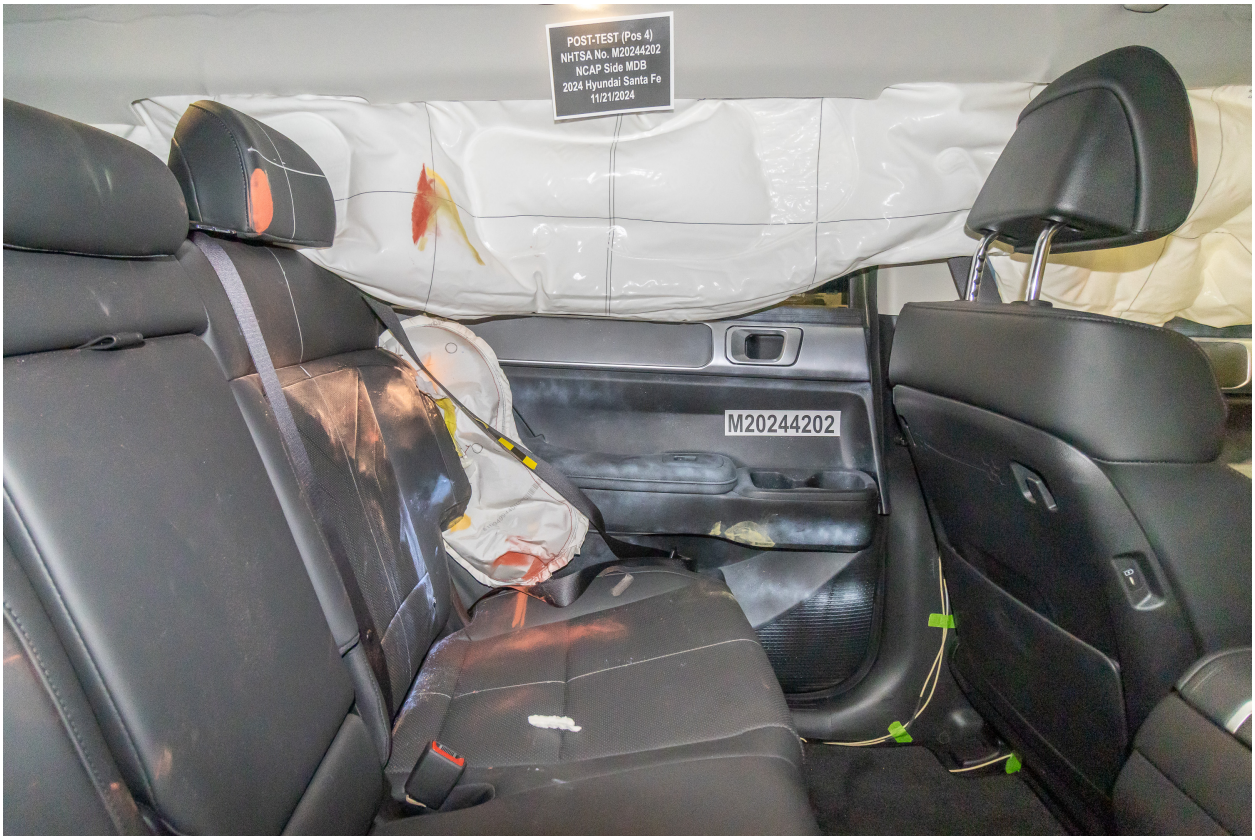


Figure A-74: Post-Test Rear Passenger Inner Door Panel View Showing Rear Passenger Dummy Contact Locations



Figure A-75: Post-Test Rear Passenger Dummy Close-Up Head Contact with Vehicle View



Figure A-76: Post-Test Rear Passenger Dummy Close-Up Head Contact with Side Air Bag View



Figure A-77: Post-Test Rear Passenger Dummy Close-Up Torso Contact with Vehicle Interior View



Figure A-78: Post-Test Rear Passenger Dummy Close-Up Torso Contact with Side Air Bag View



Figure A-79: Post-Test Rear Passenger Dummy Close-Up Pelvis Contact View



Figure A-80: Post-Test Rear Passenger Dummy Close-Up Pelvis Contact with Side Air Bag View



Figure A-81: Post-Test Rear Passenger Dummy Close-Up Knee Contact View



Figure A-82: Pre-Test View of Fuel Filler Cap or Fuel Filler Neck



Figure A-83: Post-Test View of Fuel Filler Cap or Fuel Filler Neck



Figure A-84: Pre-Test Front View of MDB Impactor Face



Figure A-85: Post-Test Front View of MDB Impactor Face

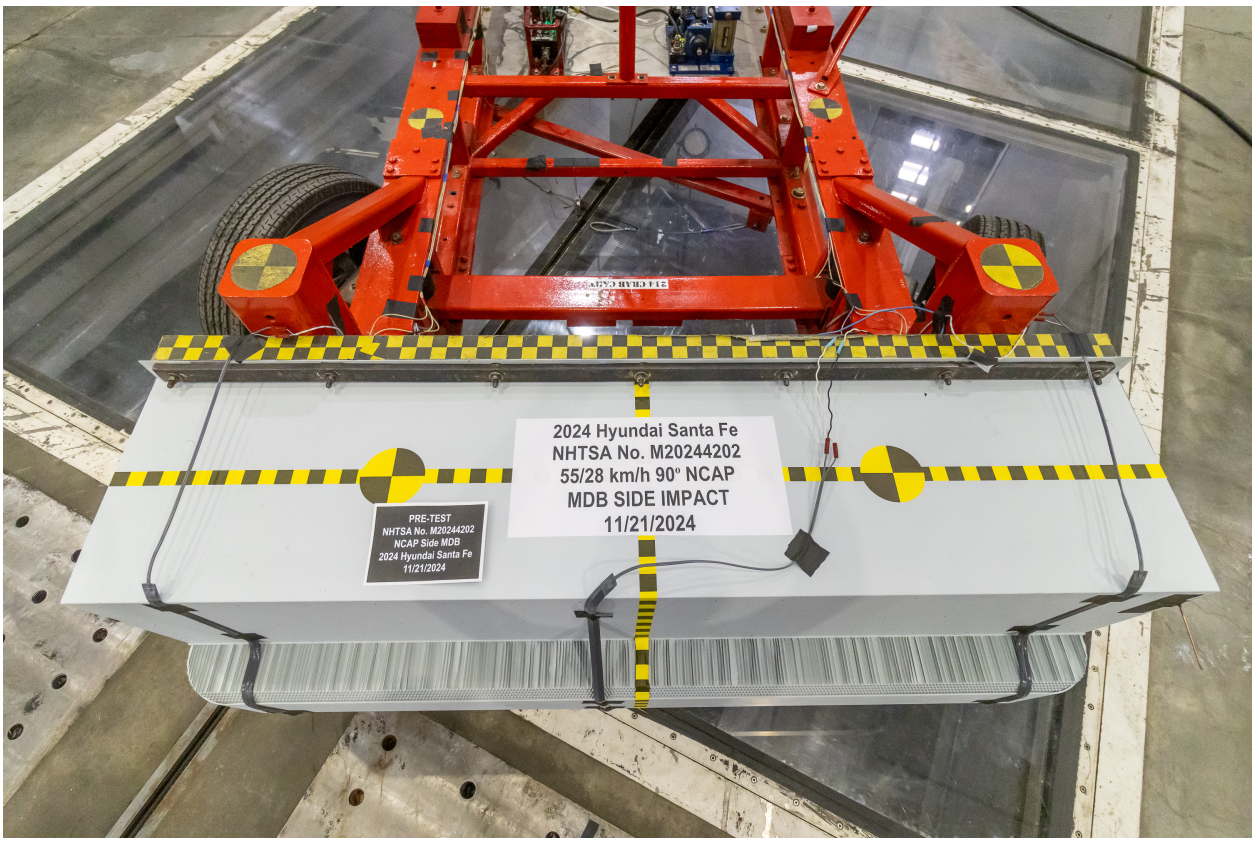


Figure A-86: Pre-Test Top View of MDB Impactor Face



Figure A-87: Post-Test Top View of MDB Impactor Face



Figure A-88: Pre-Test Left Side View of MDB Impactor Face



Figure A-89: Post-Test Left Side View of MDB Impactor Face

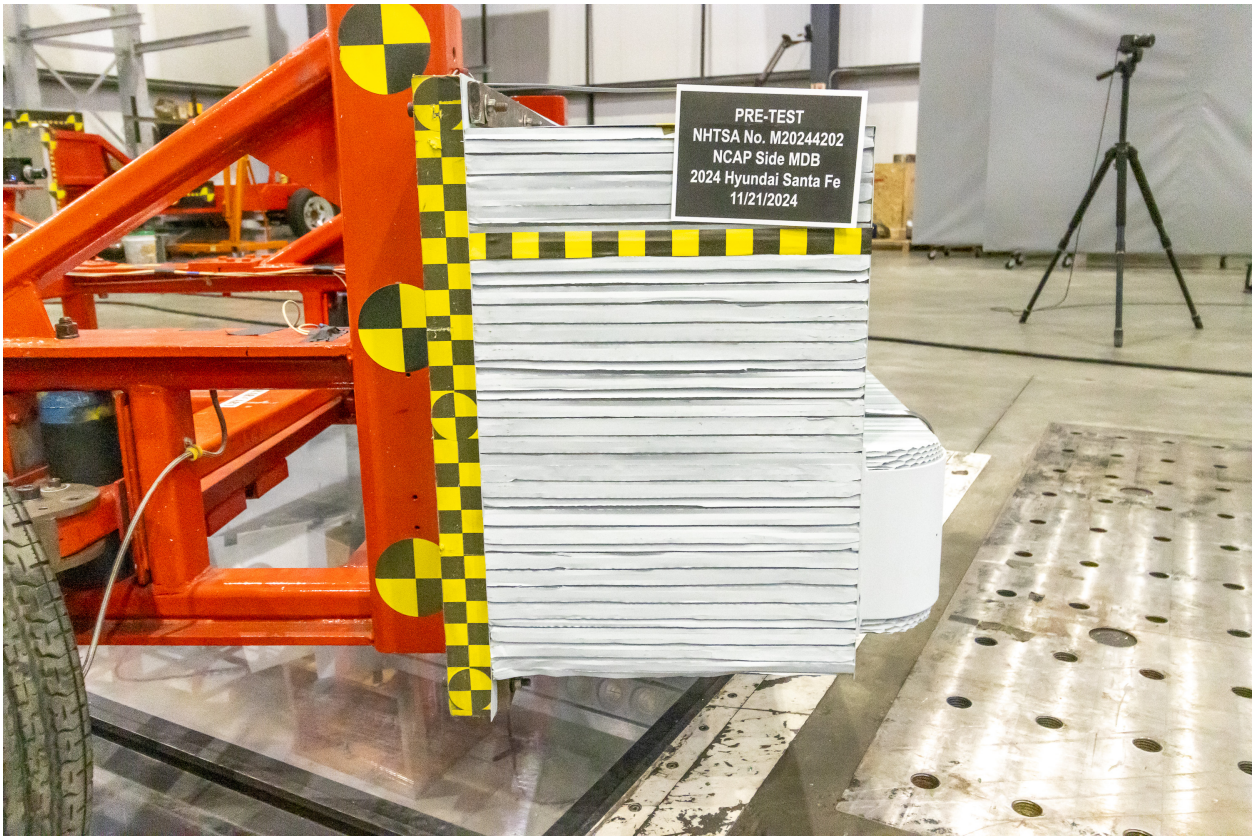


Figure A-90: Pre-Test Right Side View of MDB Impactor Face



Figure A-91: Post-Test Right Side View of MDB Impactor Face

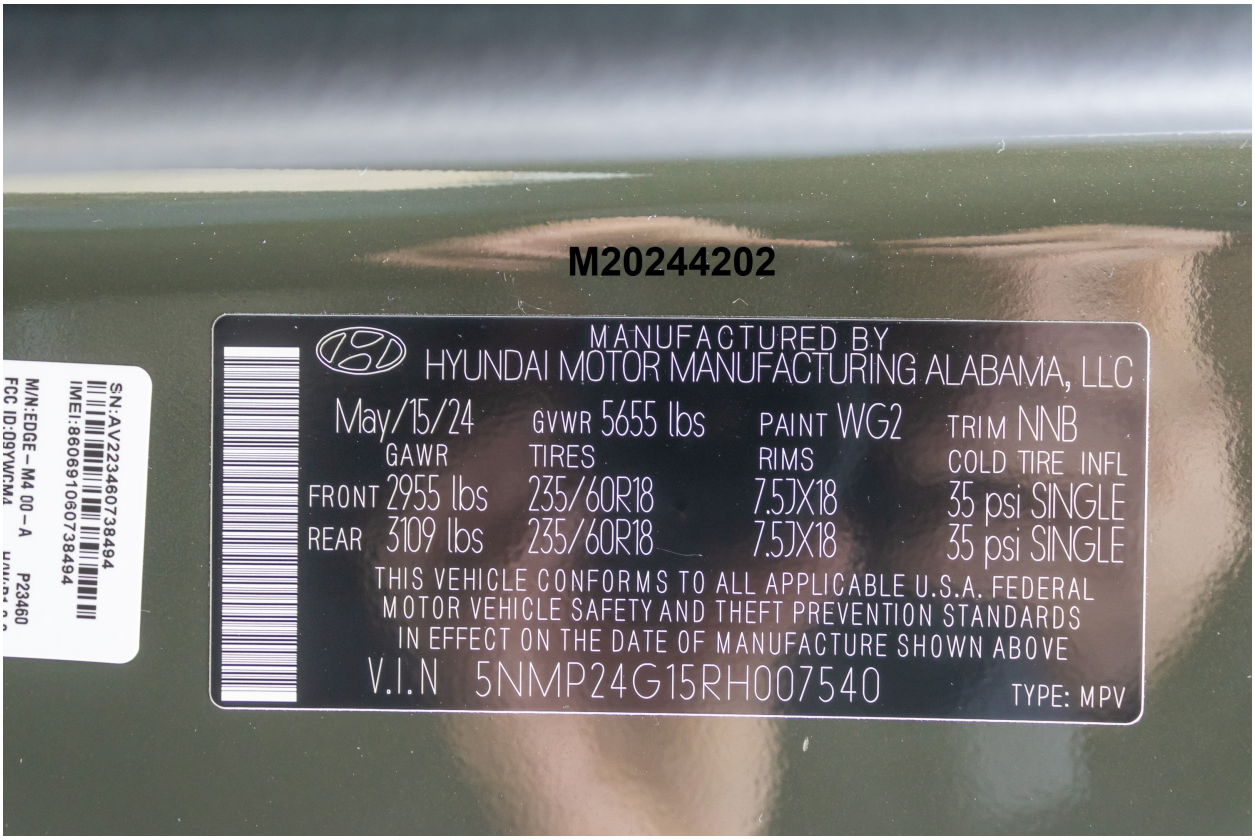


Figure A-92: Close-Up View of Vehicle's Certification Label



Figure A-93: Close-Up View of Vehicle's Tire Information Placard or Label



Figure A-94: Pre-Test Ballast View



Figure A-95: Post-Test Primary and Redundant Speed Trap Read-Out



Figure A-96: FMVSS No. 301 Static Rollover 0 Degrees



Figure A-97: FMVSS No. 301 Static Rollover 90 Degrees

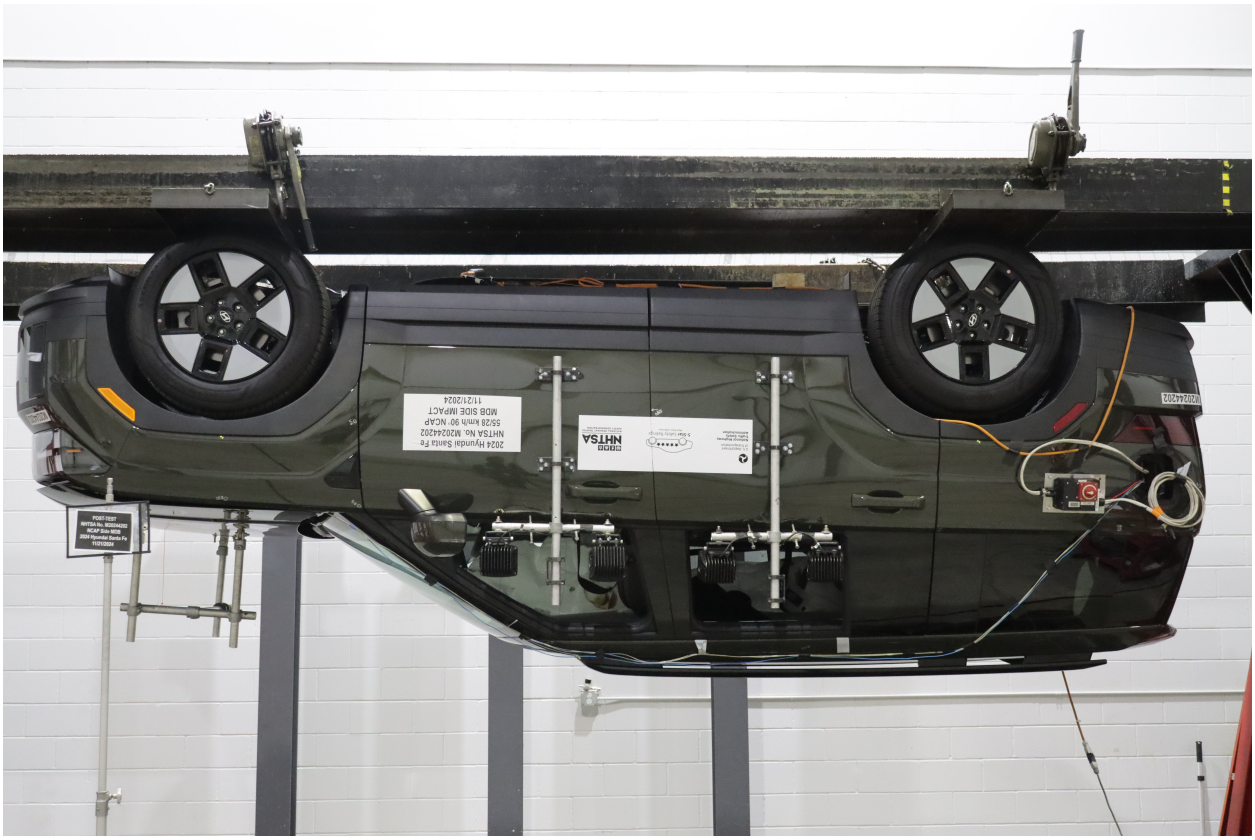


Figure A-98: FMVSS No. 301 Static Rollover 180 Degrees

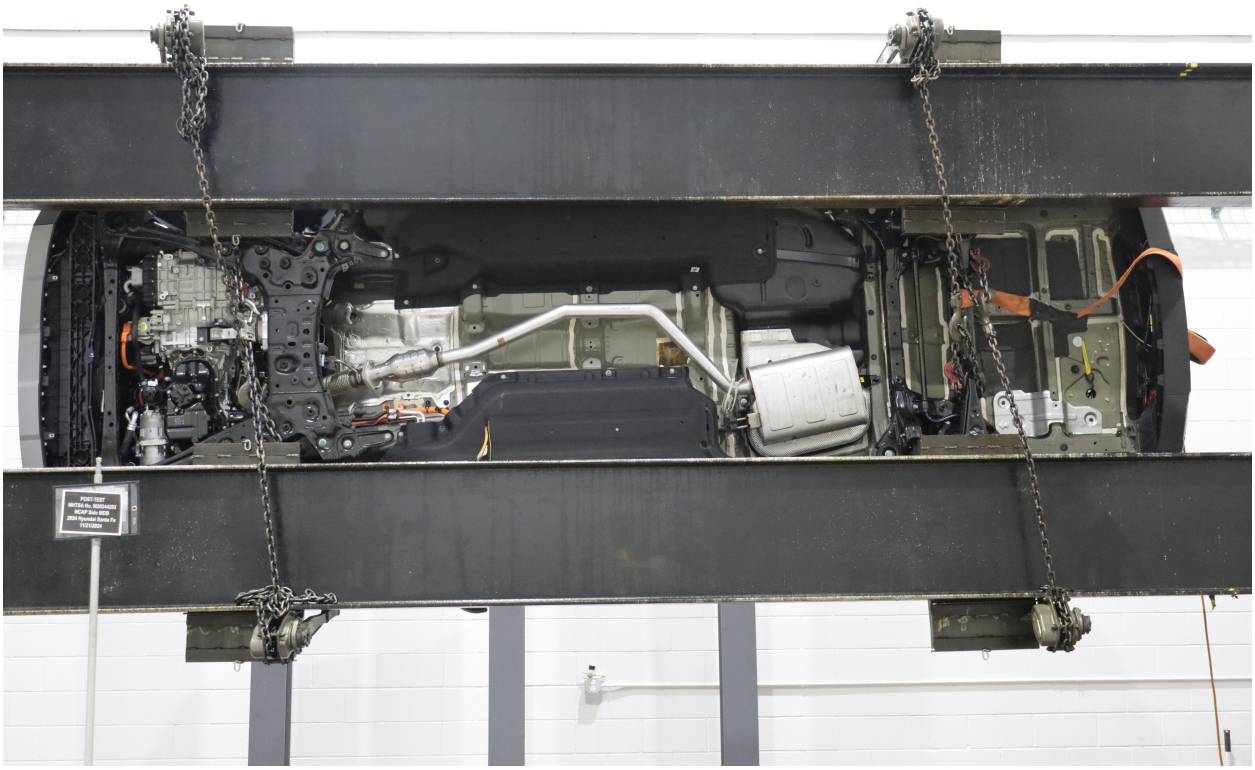


Figure A-99: FMVSS No. 301 Static Rollover 270 Degrees



Figure A-100: FMVSS No. 301 Static Rollover 360 Degrees



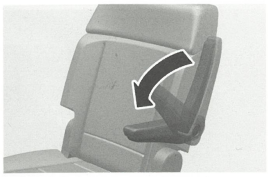
Figure A-101: Impact Event



Figure A-102: Monroney Label

Armrest (2nd row seat)

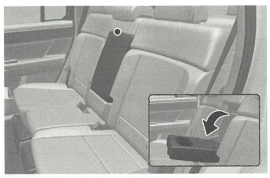
6-seater



To adjust the armrest to a desired angle:

Lift the armrest to slightly above the highest position, then lower it to the lowest position, then lift the armrest to position it to the desired angle.

7-seater



The armrest is located in the center of the rear seat. Pull the armrest down from the seatback to use it.

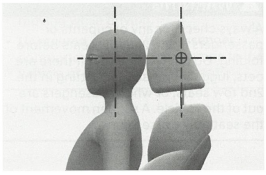
Head Restraints

The vehicle's front and rear seats have adjustable head restraints. The head restraints are designed to help protect passengers from whiplash and other neck and spinal injuries during a collision, especially a rear impact collision. When there are no occupants in the rear seats, adjust the rear head restraints to the lowest height to improve the driver's visibility.

⚠ WARNING

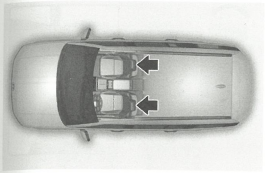
To help reduce, the risk of serious injury or death in a crash, take the following precautions when adjusting your head restraints:

- Always adjust the head restraints properly for all passengers BEFORE starting the vehicle.
- Never let anyone ride in a seat with the head restraints removed or reversed.
- Adjust the head restraints so that the middle of the head restraint is at the same height as the top of the eyes.



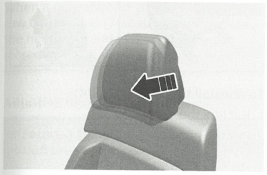
- Never adjust the driver's head restraint when the vehicle is moving.
- Make sure the head restraint is locked in place after adjustment.

Front seat head restraints



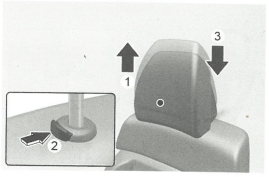
The driver's and front passenger's seats are equipped with adjustable head restraint for the passengers safety and comfort.

Forward and rearward adjustment



The head restraint may be adjusted forward to 3 different positions by pulling the head restraint forward to the desired detent. To adjust the head restraint to it's furthest rearwards position, pull it fully forward to the farthest position and release it.

Adjusting the height up and down



To raise the head restraint:

1. Pull it up to the desired position (1).

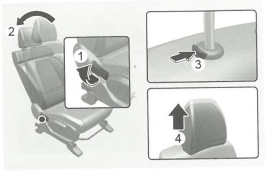
To lower the head restraint:

1. Press and hold the release button (2) on the head restraint support.
2. Lower the head restraint to the desired position (3).

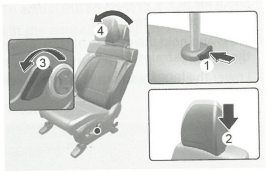
Figure A-103: Driver Head Restraint Use and Adjustment Information from Vehicle Owner's Manual

Removal/Reinstallation

Manual



Auto



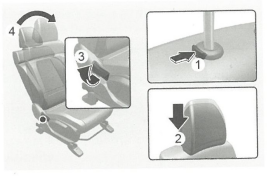
To remove the head restraint:

1. Recline the seatback (2) with the seatback angle lever or switch (1).
2. Raise the head restraint as far as it can go.
3. Press the head restraint release button (3) while pulling the head restraint up (4).

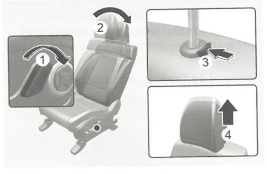
⚠ WARNING

Never allow anyone to travel in a seat with the head restraint removed.

Manual



Auto



To reinstall the head restraint:

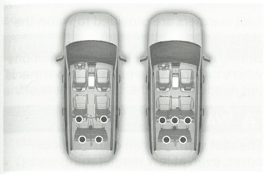
1. Recline the seatback.
2. Put the head restraint poles (2) into the holes while pressing the release button (1).
3. Adjust the head restraint to the appropriate height.
4. Return the seatback (4) with the seatback angle lever or switch (3).

⚠ WARNING

Always make sure the head restraint is locked in place and properly adjusted for the passenger.

Rear seat head restraint

6, 7-seater

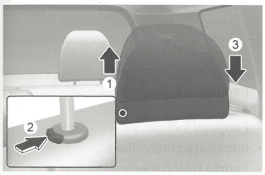


The rear seats are equipped with head restraint in all the seating positions for the passenger's safety and comfort.

⚠ WARNING

When a passenger is sitting on the 2nd row center seat (7-seater), always raise the head restraints above the lowest stored position.

Adjusting the height up and down



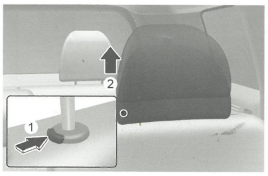
To raise the head restraint:

1. Pull it up to the desired position (1).

To lower the head restraint:

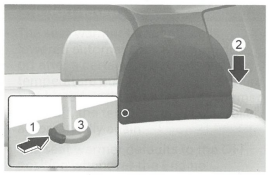
1. Press and hold the release button (2) on the head restraint support.
2. Lower the head restraint to the desired position (3).

Removal/Reinstallation



To remove the head restraint:

1. Raise the head restraint as far as it can go.
2. Press the head restraint release button (1) while pulling up the head restraint (2).



To reinstall the head restraint:

1. Put the head restraint poles into the holes (3) while pressing the release button (1).
2. Adjust the head restraint to the appropriate height.

Figure A-104: Left Rear Passenger Head Restraint Use and Adjustment Information from Vehicle Owner's Manual



Figure 305-1: Auxiliary Power Module Warning Label

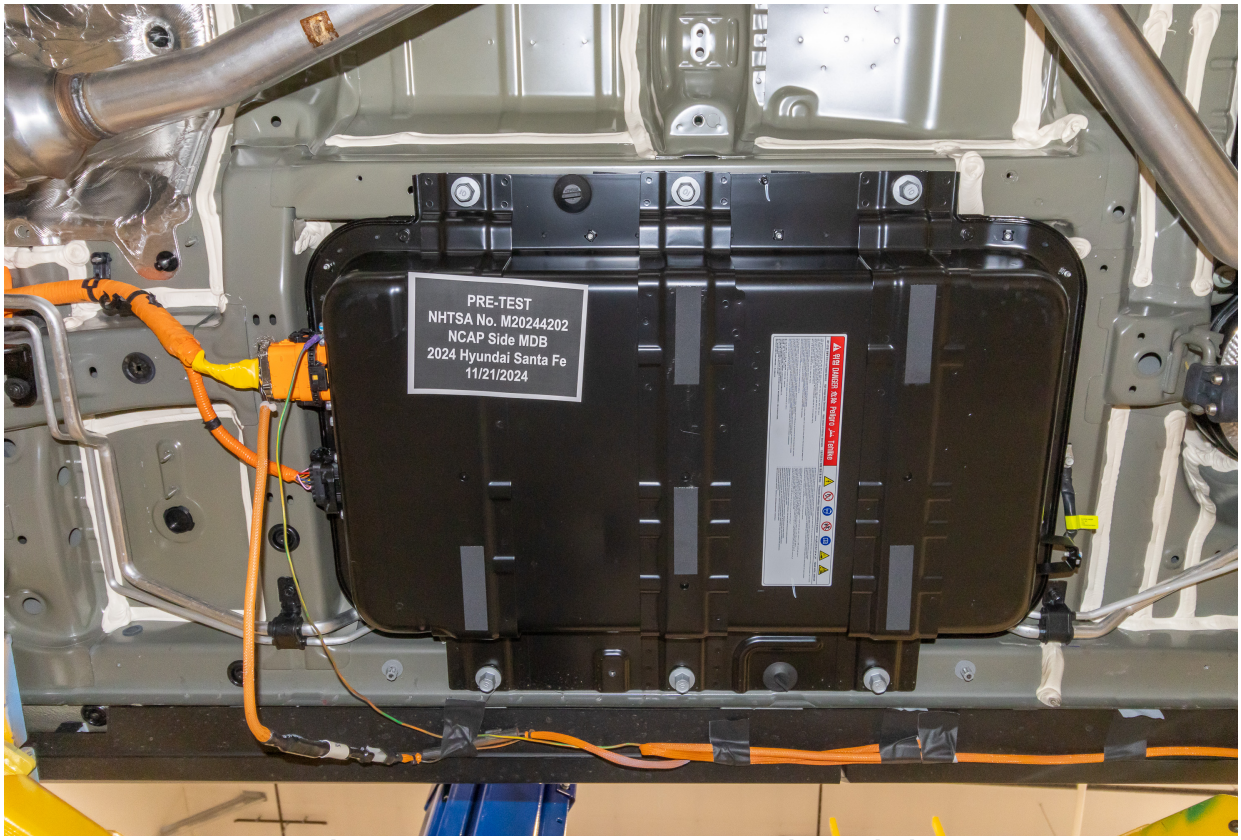


Figure 305-2: Power Inverter Warning Label



Figure 305-3 First Responder Warning Label



Figure 305-4: First Responder Warning Label Location



Figure 305-5: Other Vehicle Label(s) Related to Electrical Propulsion System



Figure 305-6: Manual High Voltage Service Disconnect in Place



Figure 305-7: Manual High Voltage Service Disconnect Removed (Plug)



Figure 305-8: Manual High Voltage Service Disconnect Removed (Location where removed)

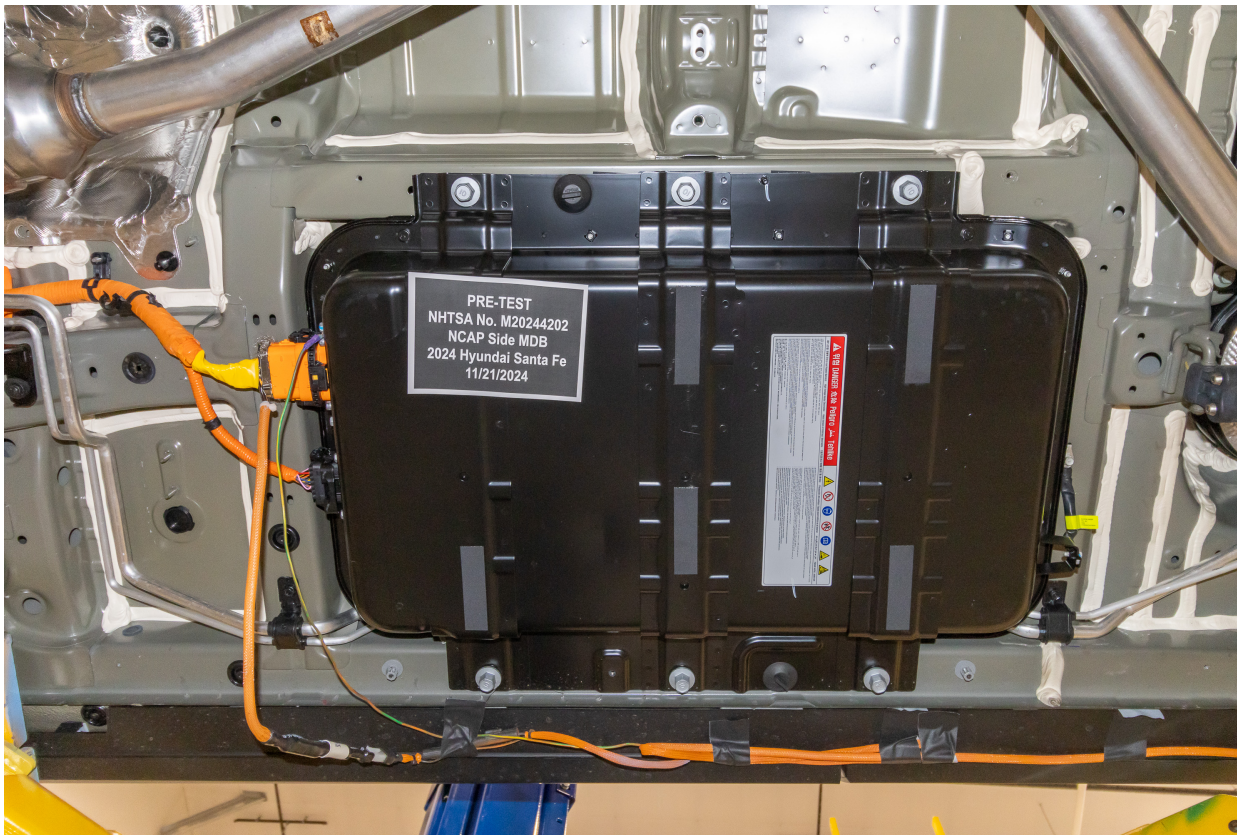


Figure 305-9: Pre-Impact View of Propulsion Battery



Figure 305-10: Post-Impact Front View of Propulsion Battery



Figure 305-11: Post-Impact Rear View of Propulsion Battery (if any part of it is visible)

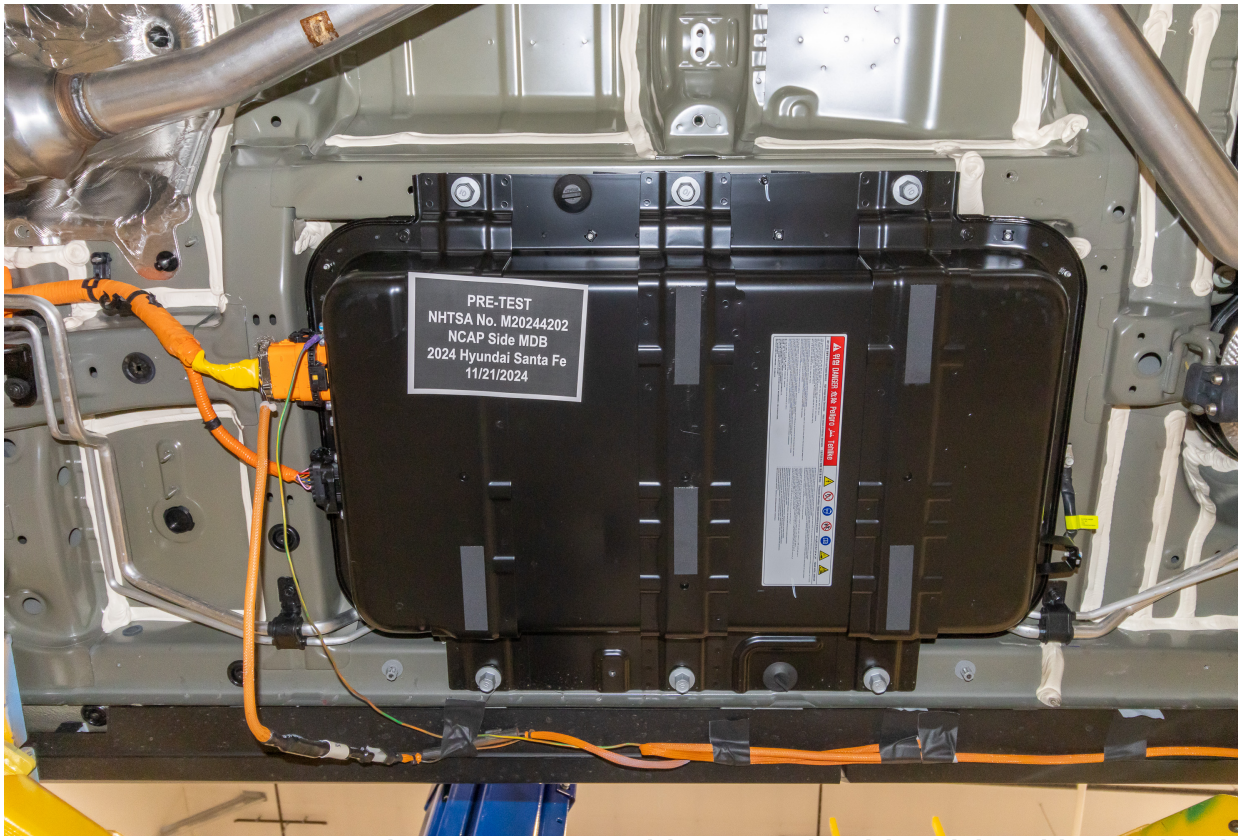


Figure 305-12: Pre-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

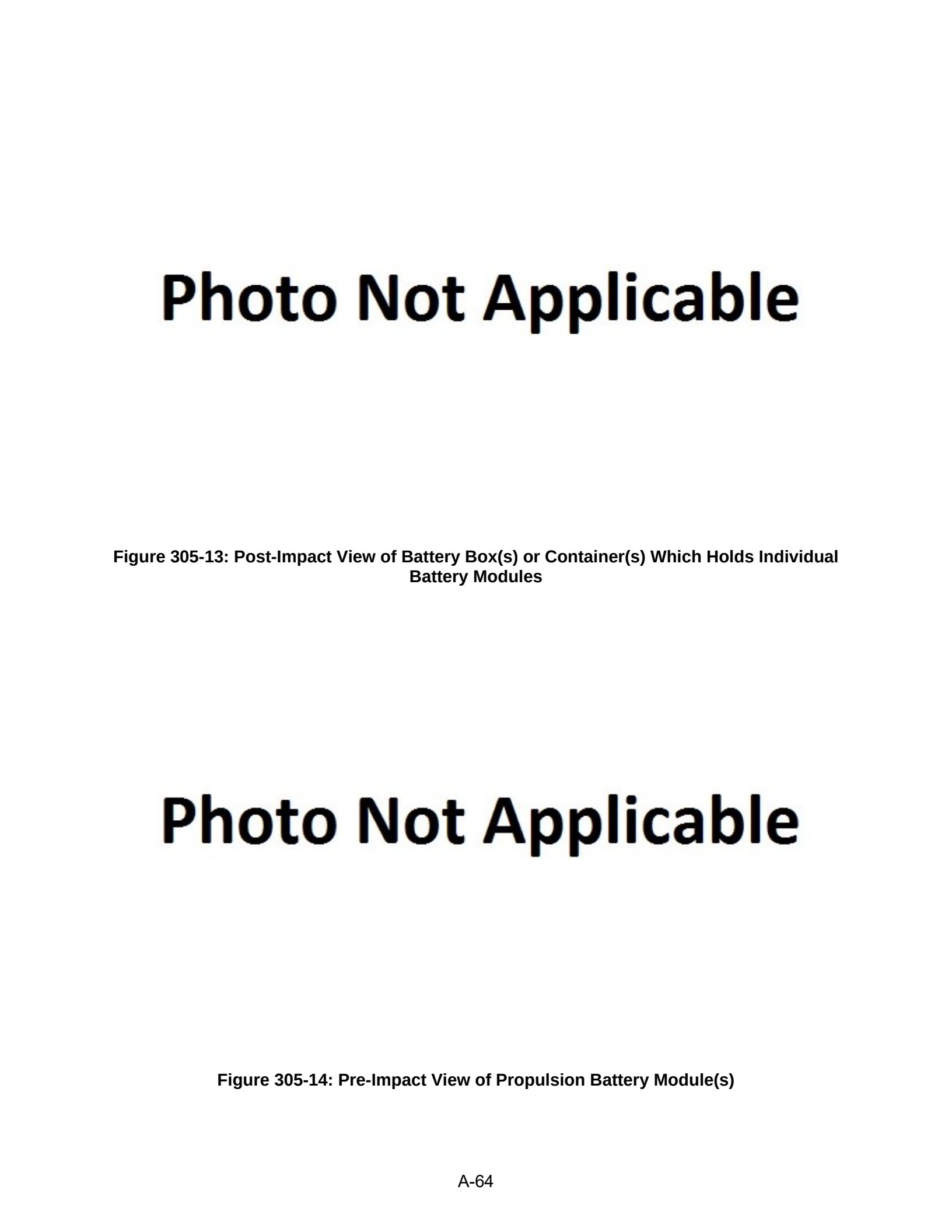


Figure 305-13: Post-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

Figure 305-14: Pre-Impact View of Propulsion Battery Module(s)

Photo Not Applicable

Figure 305-15: Post-Impact View of Propulsion Battery Module(s)



Figure 305-16: Pre-Impact View of Electric Propulsion Drive

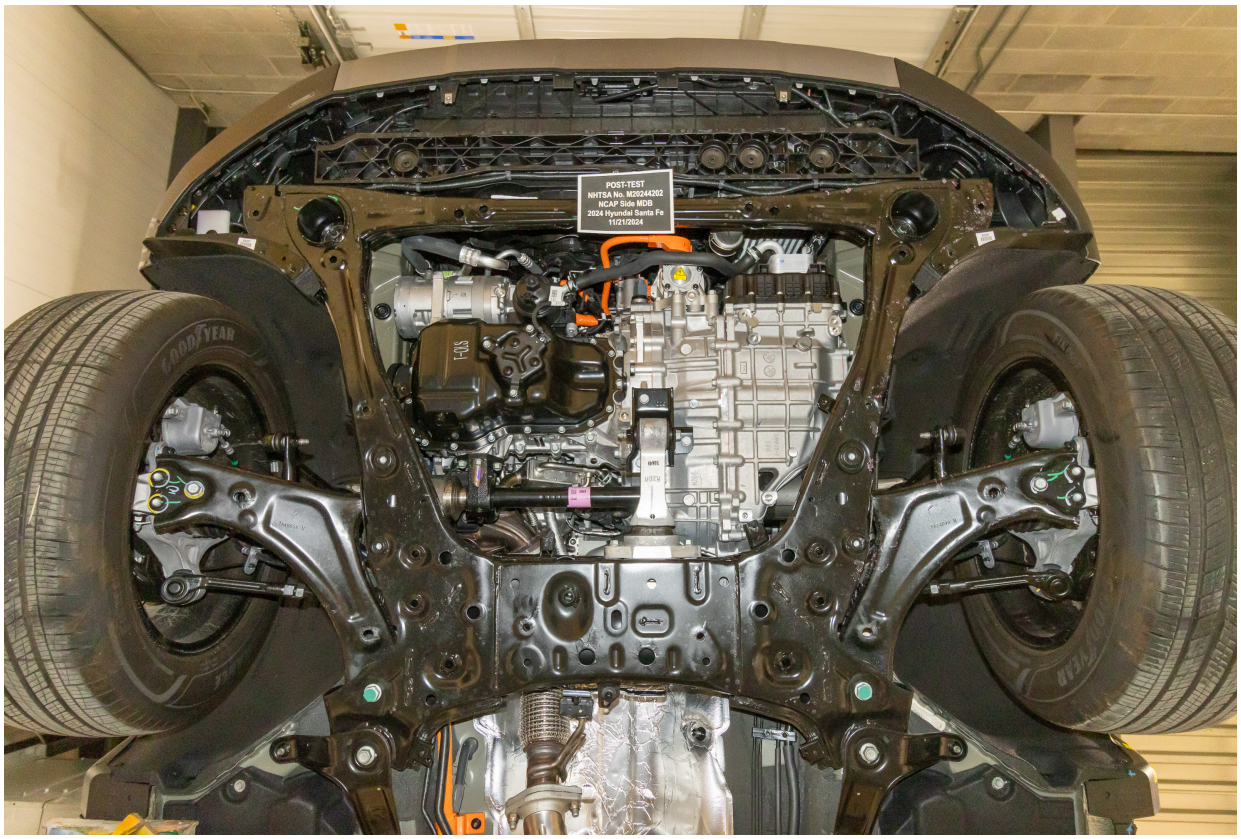


Figure 305-17: Post-Impact View of Electric Propulsion Drive



Figure 305-18: Pre-Impact View of High Voltage Interconnect(s)

Photo Not Applicable

Figure 305-19: Pre-Impact View Propulsion Venting System(s)



Figure 305-20: Pre-Impact View of Other Visible Electric Propulsion Components



Figure 305-21: Pre-Impact View of Ground Lead Attached

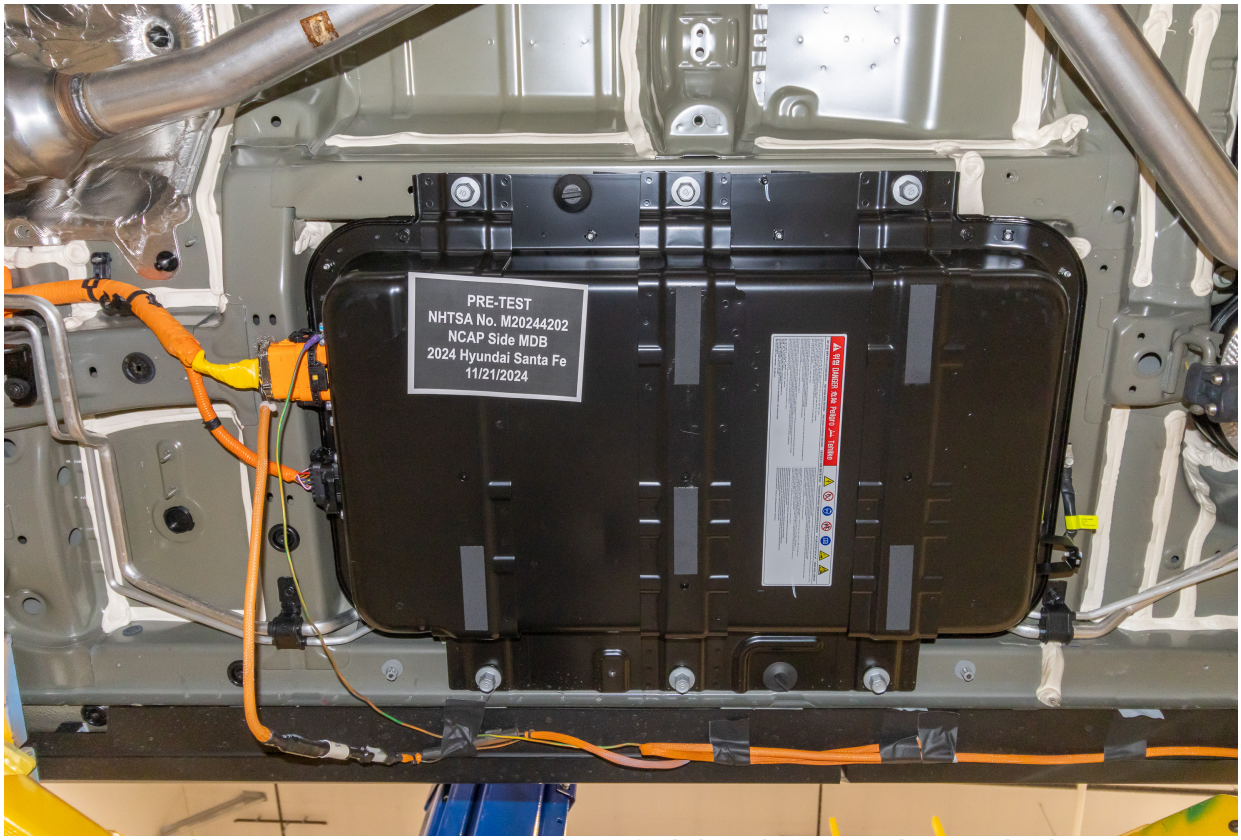


Figure 305-22: Pre-Impact View of High Voltage Leads Attached



Figure 305-23: Pre-Impact Close-Up View of High Voltage Leads Attached



Figure 305-24: Pre-Impact View of Installed Test Interface Port

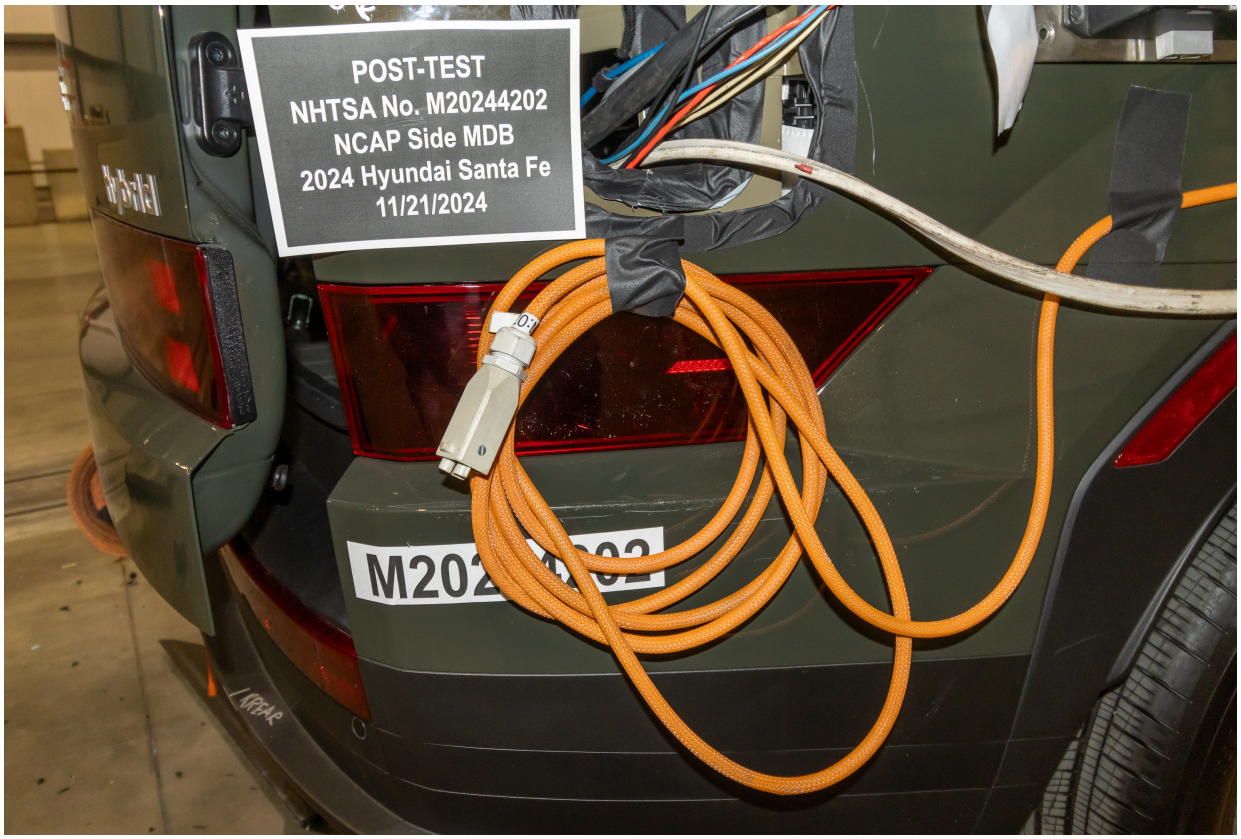


Figure 305-25: Post-Impact View of Installed Test Interface Port

Photo Not Applicable

Figure 305-26: Pre-Impact View of Other Test Devices

Photo Not Applicable

Figure 305-27: Post-Impact View of Other Test Devices



Figure 305-28: FMVSS No. 305 Static Rollover 90 Degrees

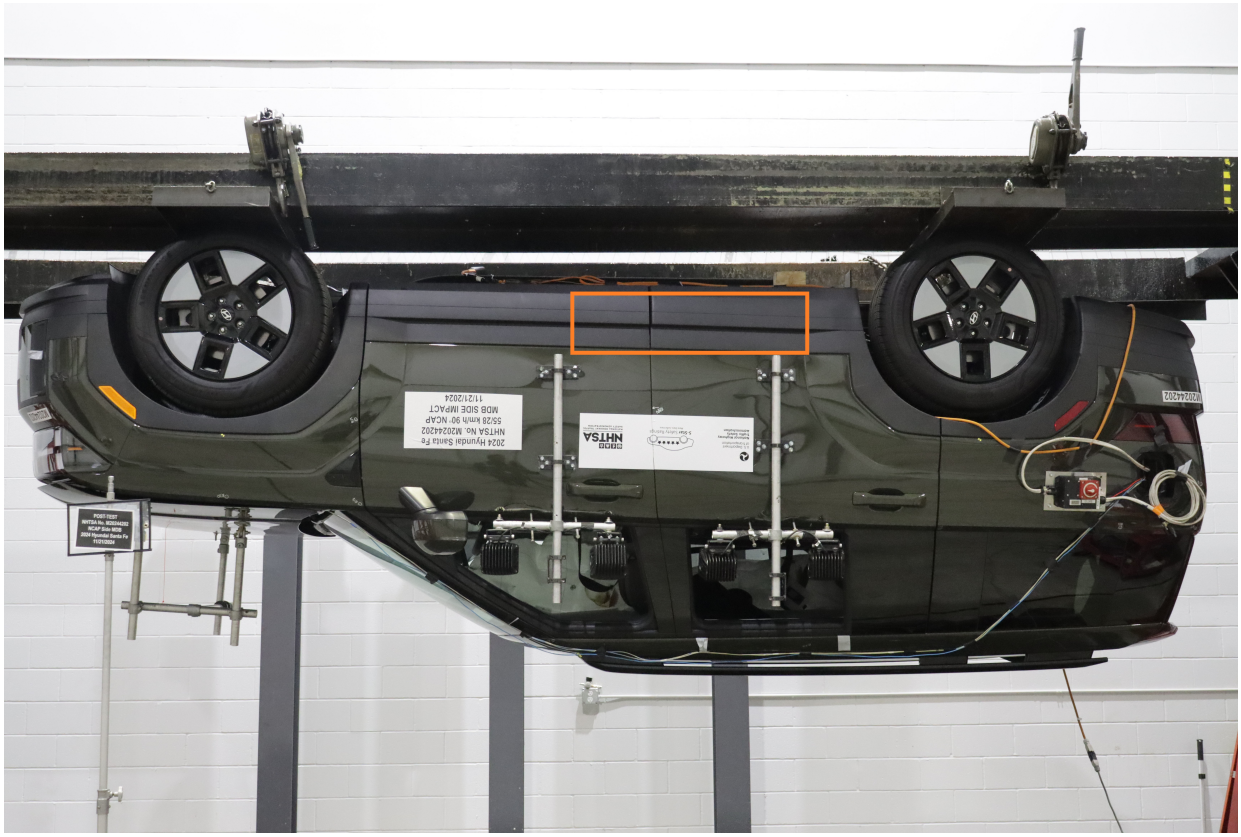


Figure 305-29: FMVSS No. 305 Static Rollover 180 Degrees

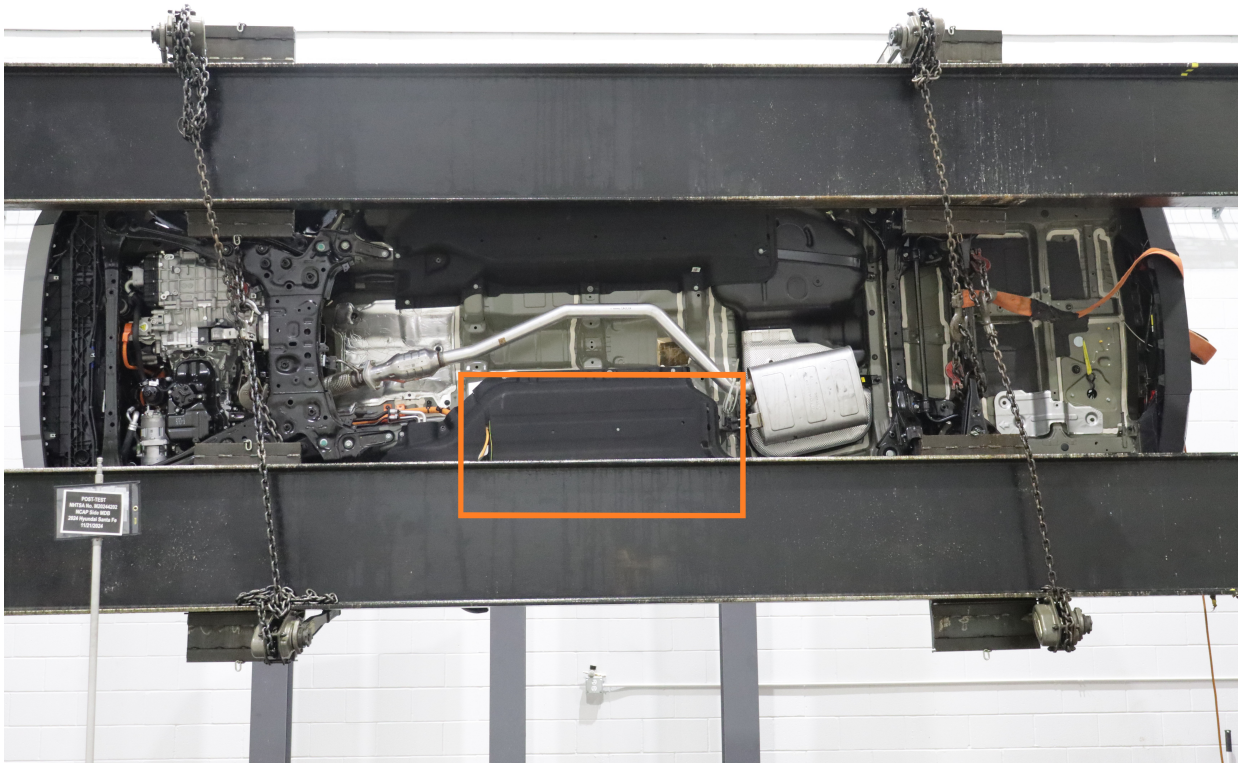


Figure 305-30: FMVSS No. 305 Static Rollover 270 Degrees

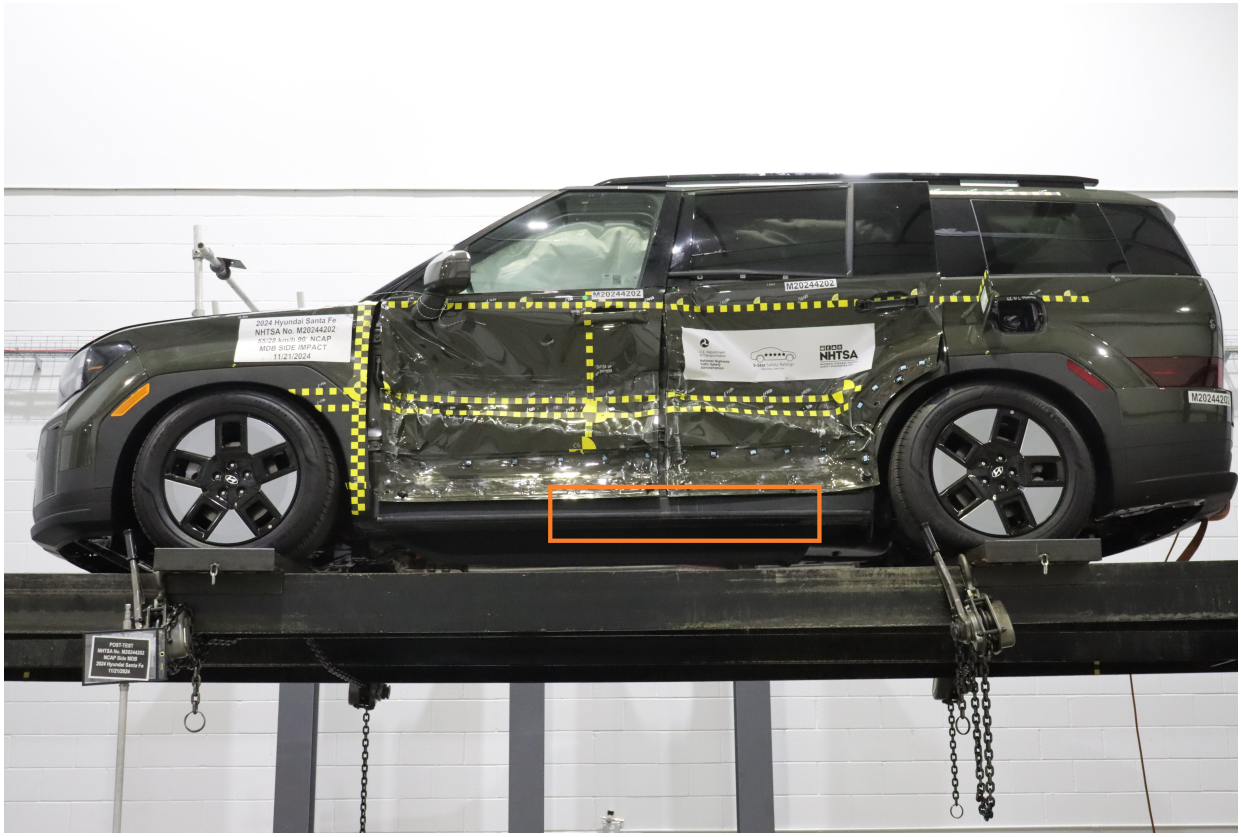


Figure 305-31: FMVSS No. 305 Static Rollover 360 Degrees



Figure 305-32: Pre-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery



Figure 305-33: Post-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery

Photo Not Applicable

Figure 305-34: Post-Impact Propulsion Battery System Mounting and-or Intrusion Failure(s)

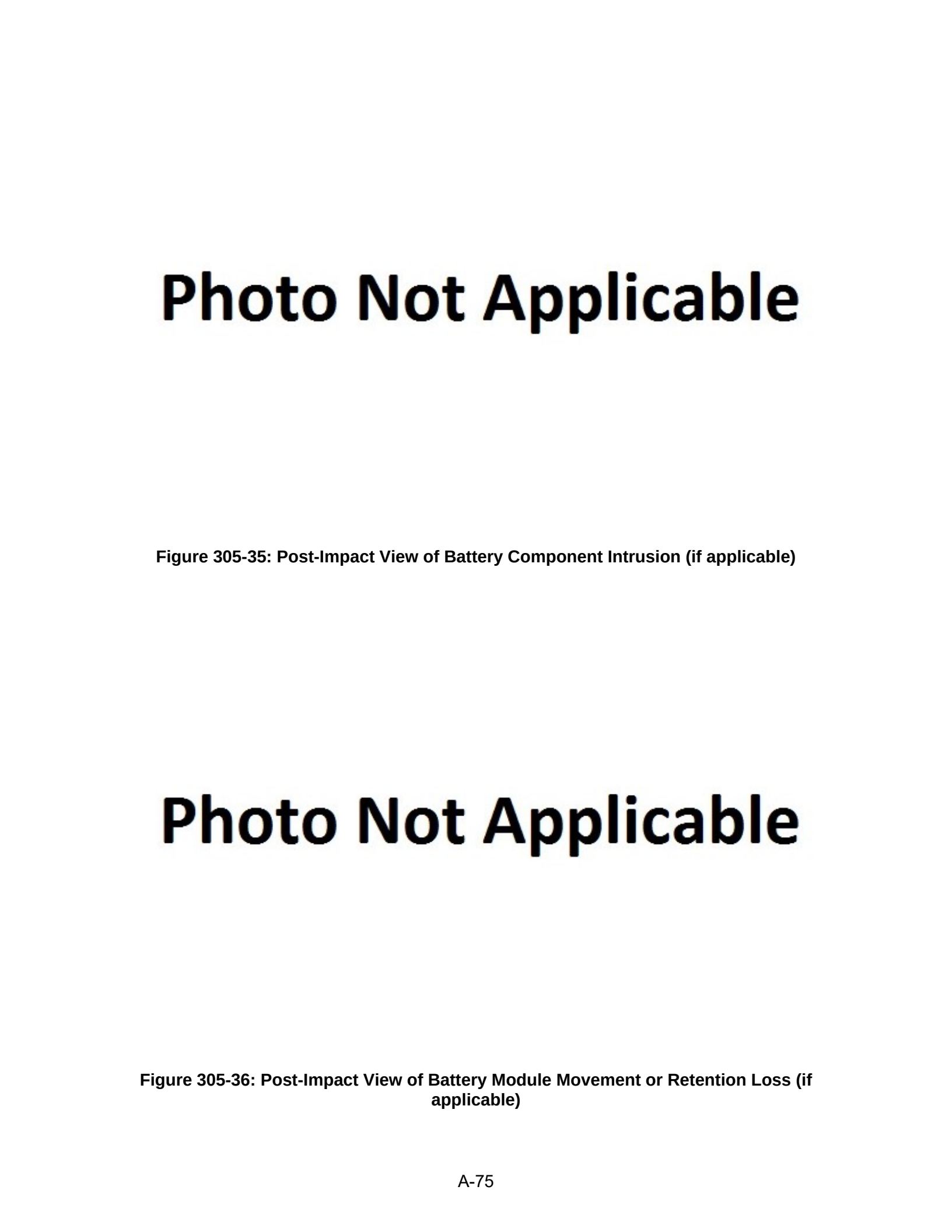


Figure 305-35: Post-Impact View of Battery Component Intrusion (if applicable)

Figure 305-36: Post-Impact View of Battery Module Movement or Retention Loss (if applicable)



Figure 305-37: Post-Impact View of Propulsion Battery Electrolyte Spillage Location (Prior to static roll)

Figure 305-38: Post-Impact View of Propulsion Battery Electrolyte Spillage Location (After static roll)

APPENDIX B
VEHICLE AND DUMMY RESPONSE DATA TRACES

Table of Data Plots
Driver Dummy Instrumentation Plots

Fig.	Description	Page
Plot 1	Driver Head Acceleration (X) Primary vs. Time	B-5
Plot 2	Driver Head Acceleration (Y) Primary vs. Time	B-5
Plot 3	Driver Head Acceleration (Z) Primary vs. Time	B-5
Plot 4	Driver Head Resultant Acceleration Primary vs. Time	B-5
Plot 5	Driver Upper Thorax Rib Deflection (Y) vs. Time	B-6
Plot 6	Driver Middle Thorax Rib Deflection (Y) vs. Time	B-6
Plot 7	Driver Lower Thorax Rib Deflection (Y) vs. Time	B-6
Plot 8	Driver Thorax Rib Deflection Maximum vs. Time	B-6
Plot 9	Driver Anterior Abdominal Force (Y) vs. Time	B-7
Plot 10	Driver Middle Abdominal Force (Y) vs. Time	B-7
Plot 11	Driver Posterior Abdominal Force (Y) vs. Time	B-7
Plot 12	Driver Total Abdominal Force (Y) vs. Time	B-7
Plot 13	Driver Pubic Symphysis Force (Y) vs. Time	B-8
Plot 14	Passenger Head Acceleration (X) vs. Time Primary	B-8
Plot 15	Passenger Head Acceleration (Y) vs. Time Primary	B-8
Plot 16	Passenger Head Acceleration (Z) vs. Time Primary	B-8
Plot 17	Passenger Head Resultant Acceleration Primary vs. Time	B-9
Plot 18	Passenger Lower Spine T12 Acceleration (X) vs. Time	B-9
Plot 19	Passenger Lower Spine T12 Acceleration (Y) vs. Time	B-9
Plot 20	Passenger Lower Spine T12 Acceleration (Z) vs. Time	B-9
Plot 21	Passenger Lower Spine T12 Resultant Acceleration vs. Time	B-10
Plot 22	Passenger Iliac Force on Impact Side (Y) vs. Time	B-10
Plot 23	Passenger Acetabulum Force on Impact Side (Y) vs. Time	B-10
Plot 24	Passenger Total Pelvic Force on Impact Side (Y) vs. Time	B-10

The following additional dummy and vehicle response data can be obtained from the Research and Development section of the NHTSA website. The website can be found at www.NHTSA.gov

Additional Driver & Passenger Dummy Instrumentation Data

Driver Lower Spine T12 Acceleration (X)
Driver Lower Spine T12 Acceleration (Y)
Driver Lower Spine T12 Acceleration (Z)
Passenger Upper Thorax Rib Deflection (Y)
Passenger Middle Thorax Rib Deflection (Y)
Passenger Lower Thorax Rib Deflection (Y)
Passenger Upper Abdomen Rib Deflection (Y)
Passenger Lower Abdomen Rib Deflection (Y)
Driver Head Acceleration Redundant (X)
Driver Head Acceleration Redundant (Y)
Driver Head Acceleration Redundant (Z)
Passenger Head Acceleration Redundant (X)
Passenger Head Acceleration Redundant (Y)
Passenger Head Acceleration Redundant (Z)

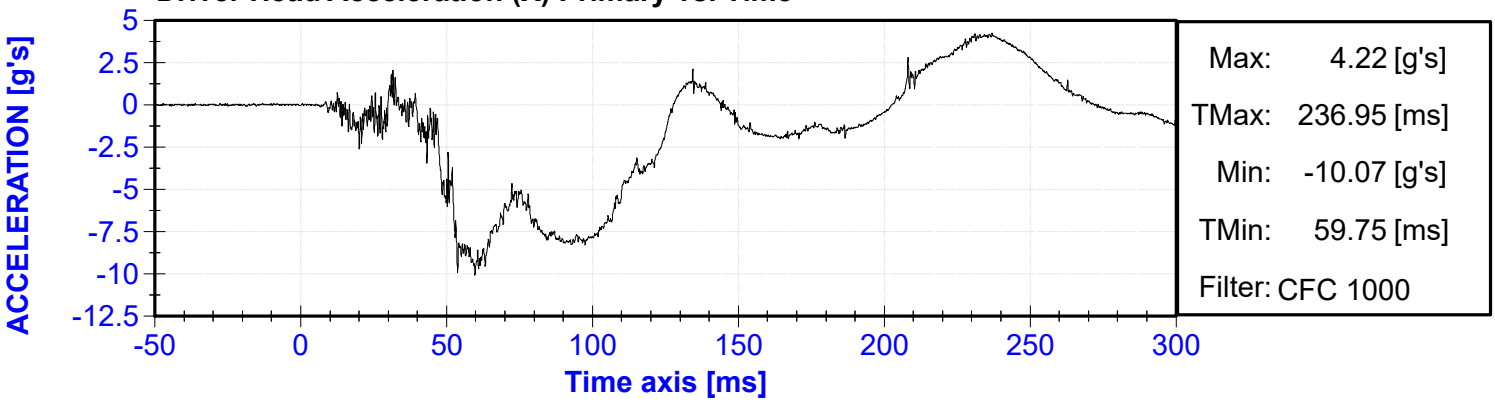
Vehicle Instrumentation Data

Vehicle Center of Gravity Acceleration (X)
Vehicle Center of Gravity Acceleration (Y)
Vehicle Center of Gravity Acceleration (Z)
Right Side Sill at Front Seat Acceleration (X)
Right Side Sill at Front Seat Acceleration (Y)
Right Side Sill at Front Seat Acceleration (Z)
Right Side Sill at Rear Seat Acceleration (X)
Right Side Sill at Rear Seat Acceleration (Y)
Right Side Sill at Rear Seat Acceleration (Z)
Left Side Sill at Front Seat Acceleration (Y)
Left Side Sill at Rear Seat Acceleration (Y)
Lower A-Post Acceleration (Y)
Middle A-Post Acceleration (Y)
Lower B-Post Acceleration (Y)
Middle B-Post Acceleration (Y)
Front Seat Track Acceleration (Y)
Rear Seat Structure Acceleration (Y)
Right Rear Occupant Compartment Acceleration (Y)
Engine Block (X)
Engine Block (Y)
Rear Floorpan Above Axle Acceleration (X)
Rear Floorpan Above Axle Acceleration (Y)
Rear Floorpan Above Axle Acceleration (Z)

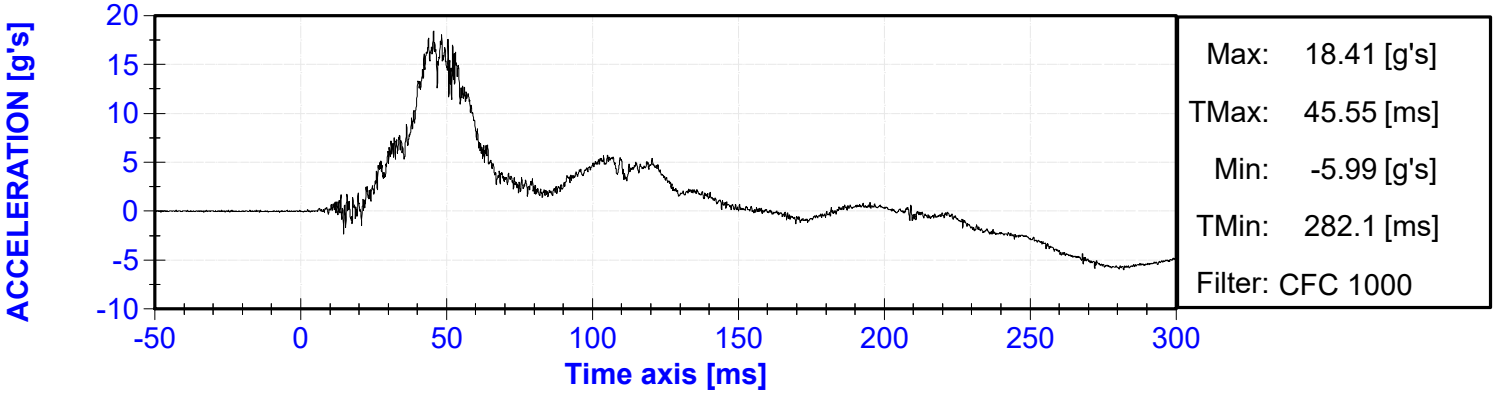
MDB Instrumentation Data

MDB Center of Gravity Acceleration (X)
MDB Center of Gravity Acceleration (Y)
MDB Center of Gravity Acceleration (Z)
MDB Rear Acceleration (X)
MDB Rear Acceleration (Y)
Left MDB Contact Switch
Right MDB Contact Switch

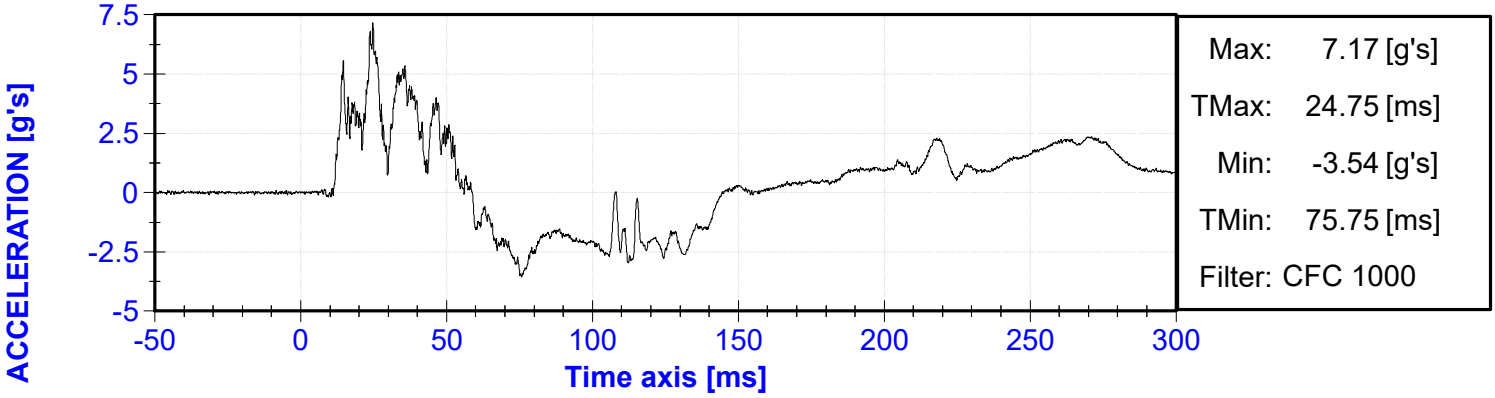
Driver Head Acceleration (X) Primary vs. Time



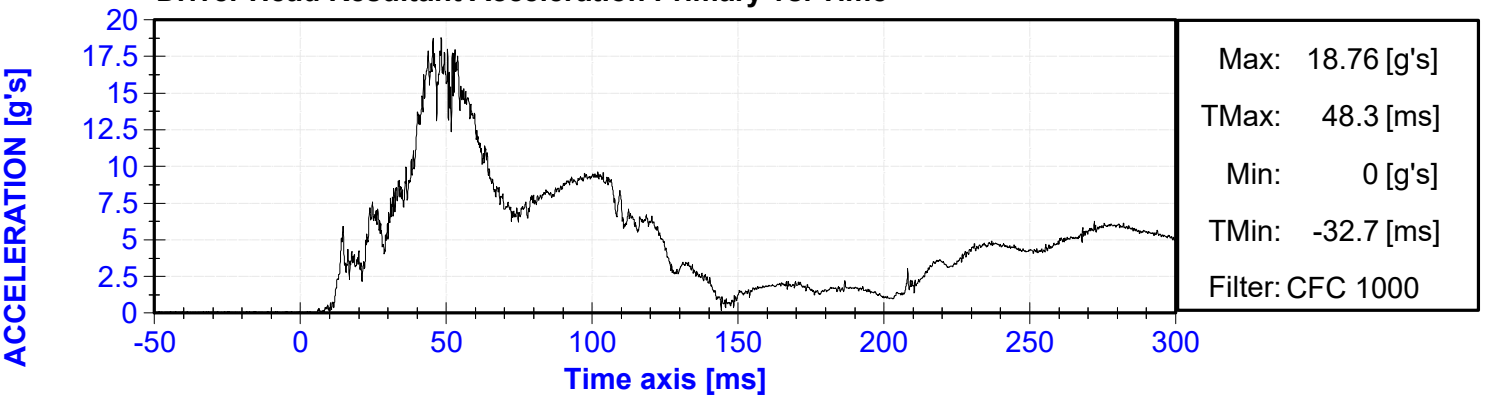
Driver Head Acceleration (Y) Primary vs. Time



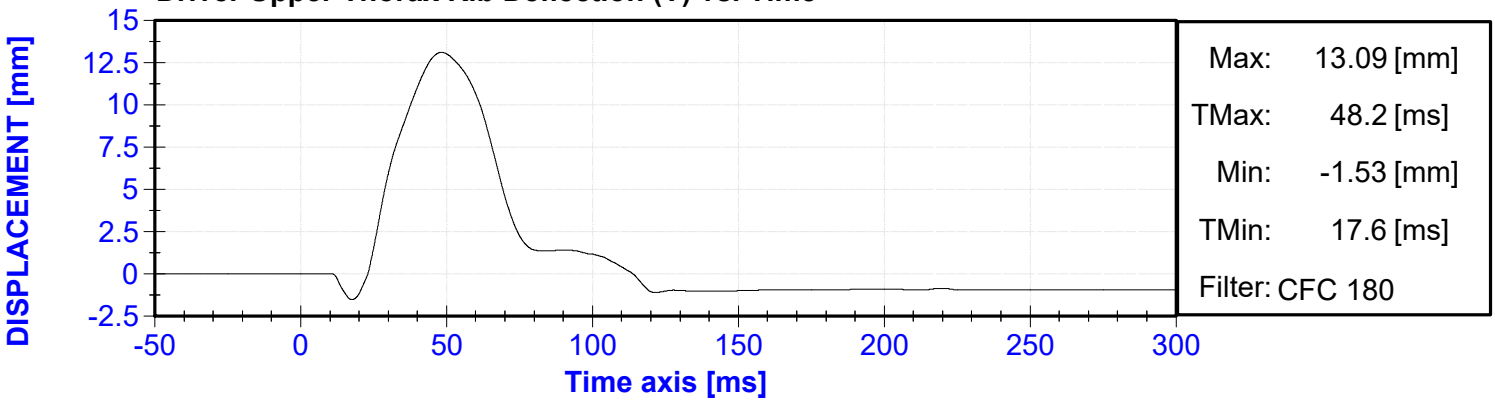
Driver Head Acceleration (Z) Primary vs. Time



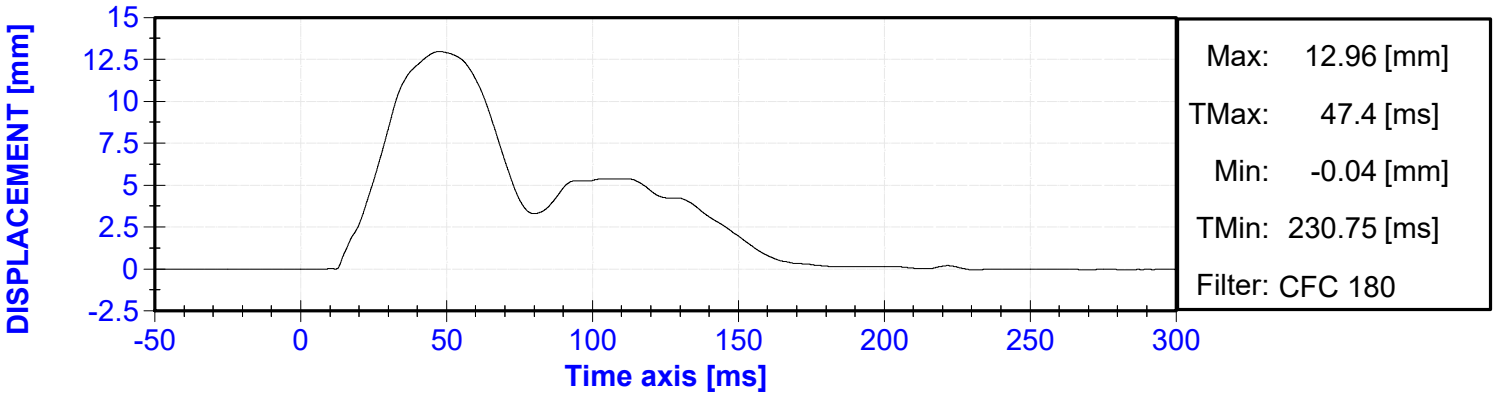
Driver Head Resultant Acceleration Primary vs. Time



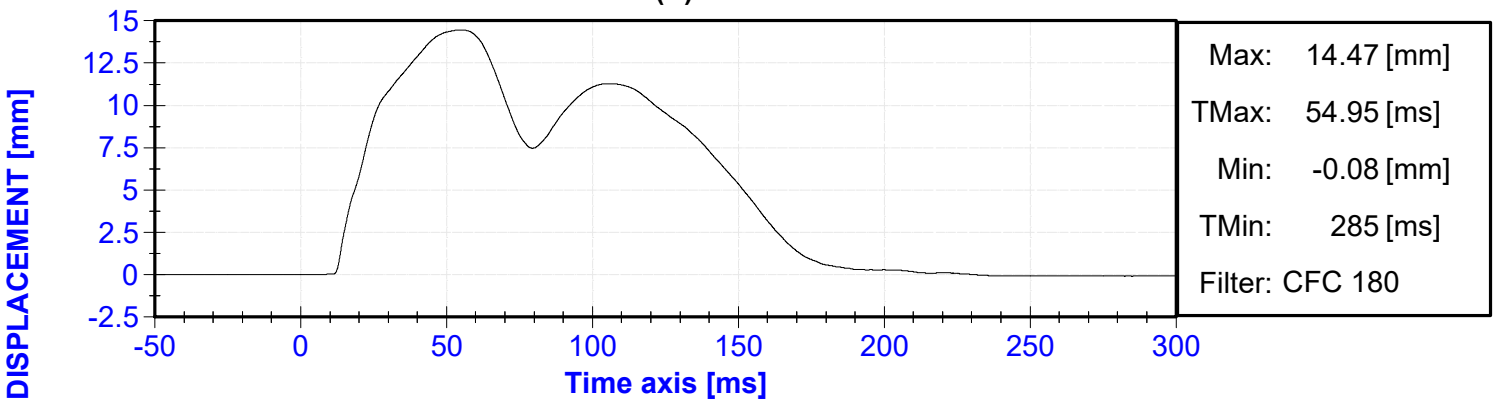
Driver Upper Thorax Rib Deflection (Y) vs. Time



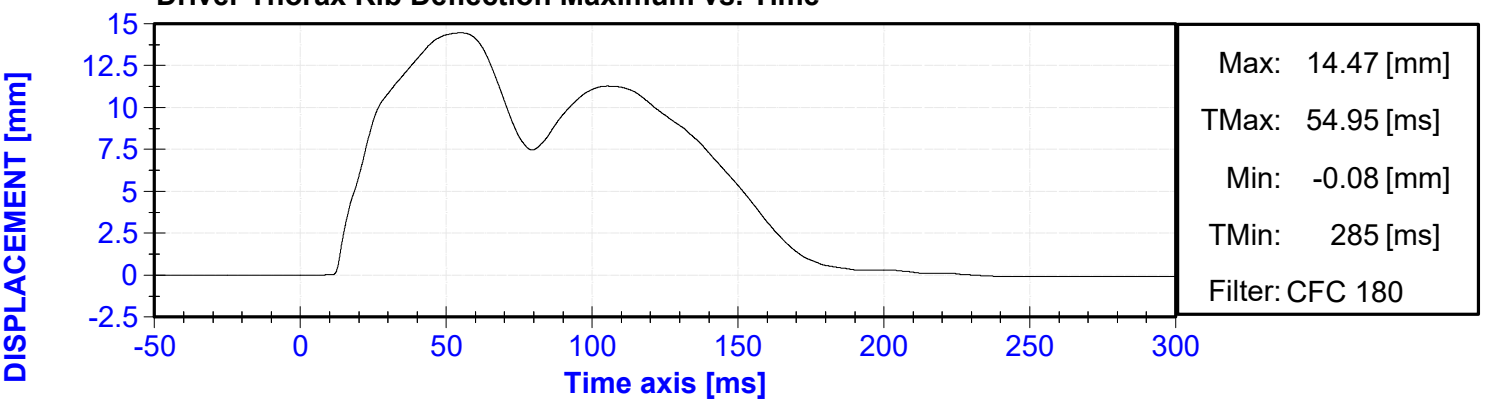
Driver Middle Thorax Rib Deflection (Y) vs. Time



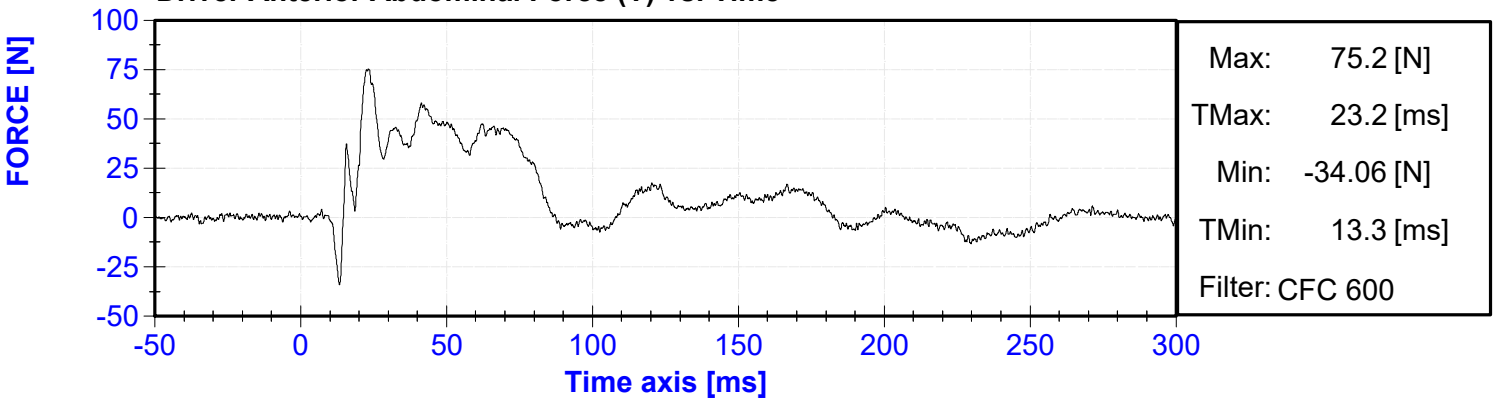
Driver Lower Thorax Rib Deflection (Y) vs. Time



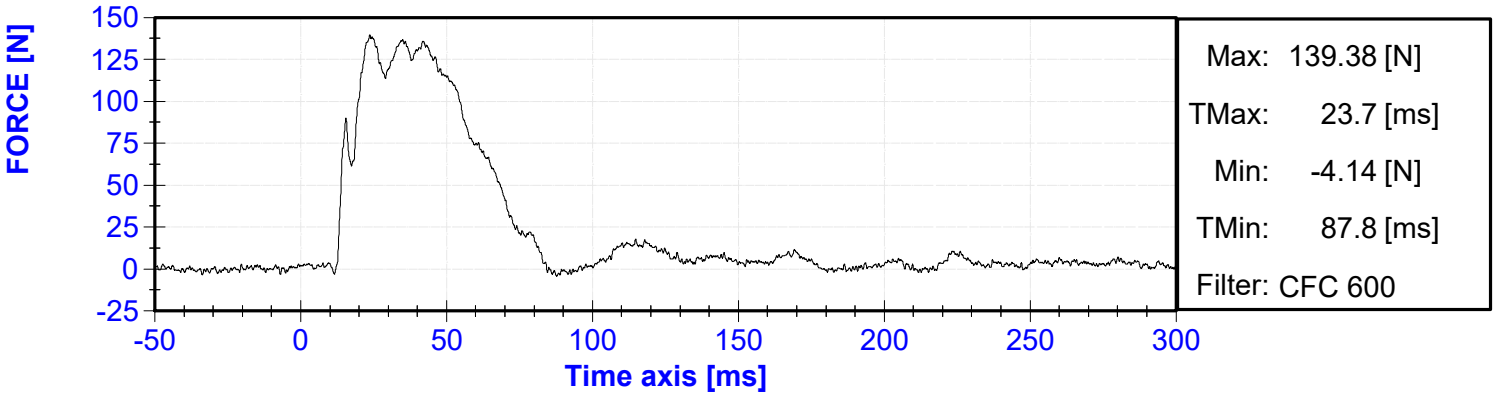
Driver Thorax Rib Deflection Maximum vs. Time



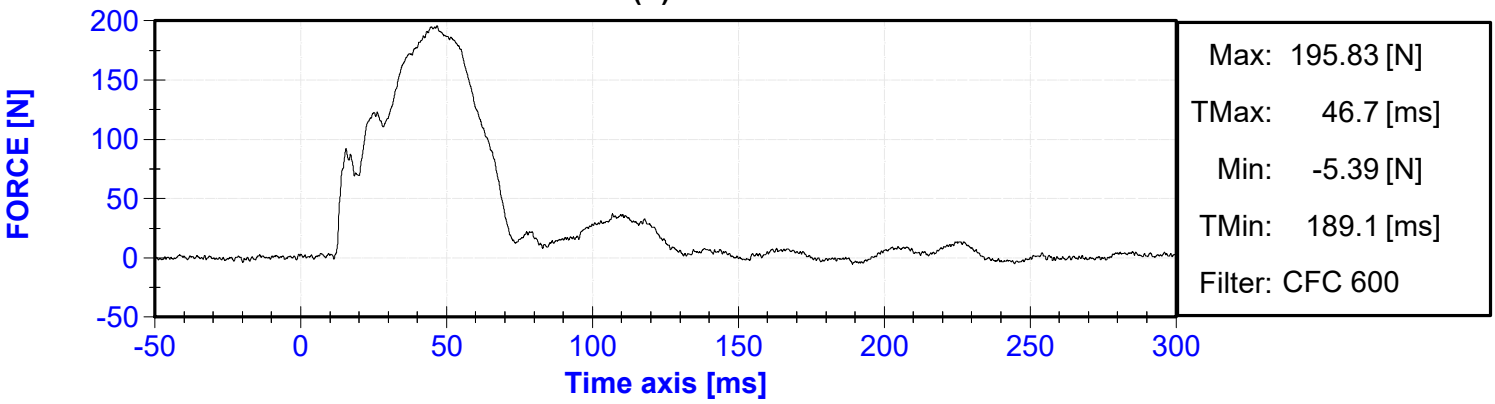
Driver Anterior Abdominal Force (Y) vs. Time



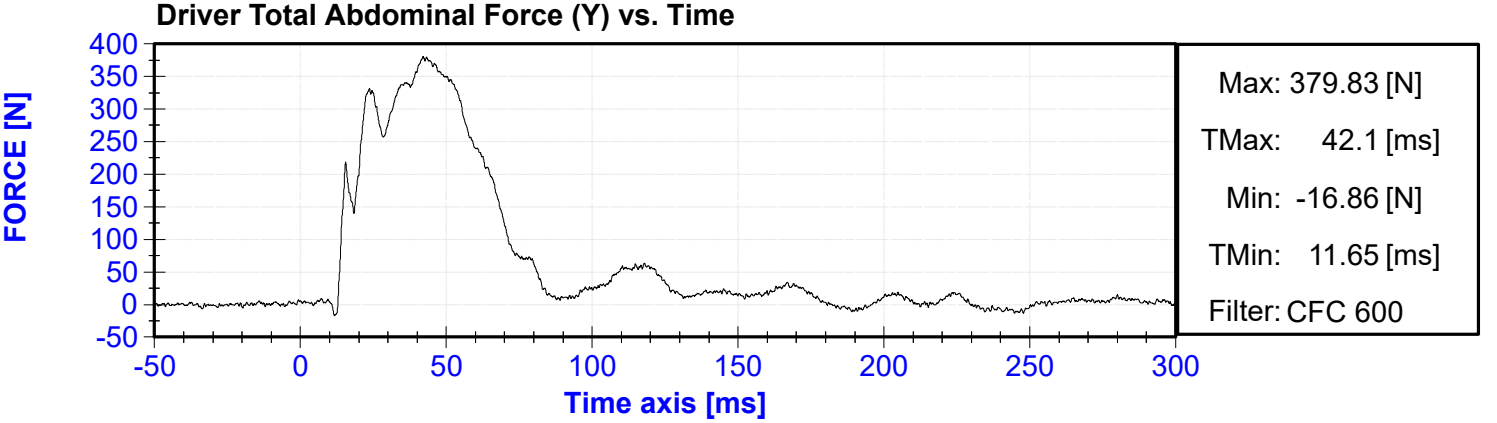
Driver Middle Abdominal Force (Y) vs. Time

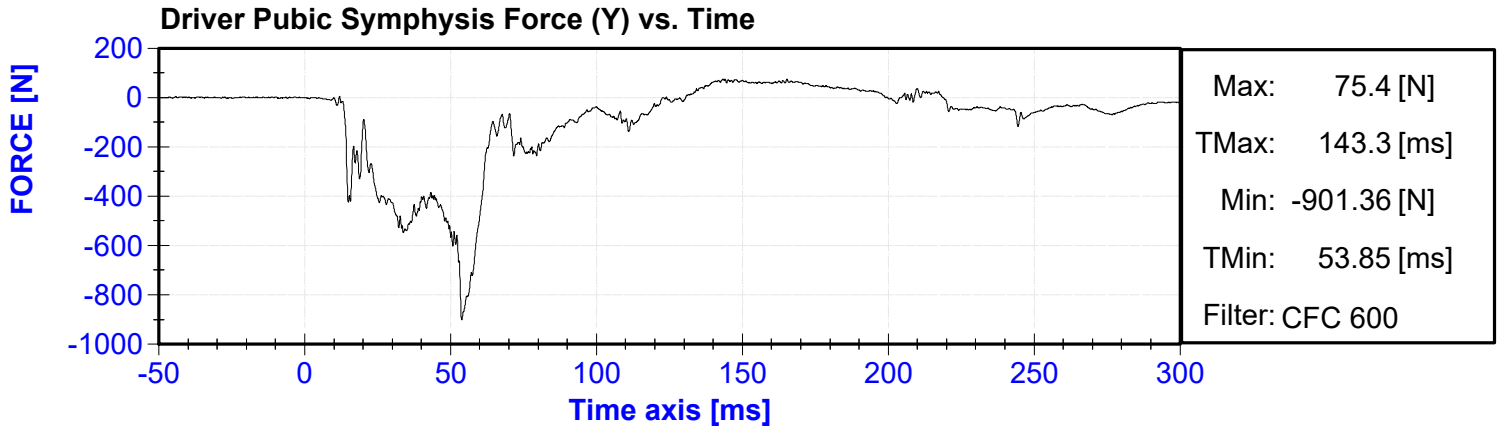


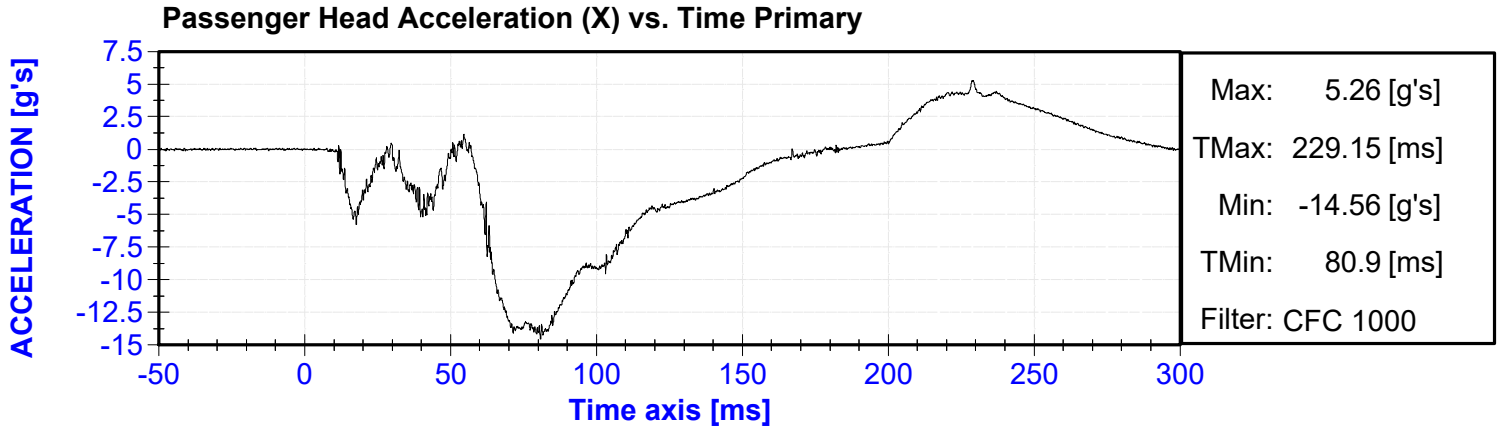
Driver Posterior Abdominal Force (Y) vs. Time

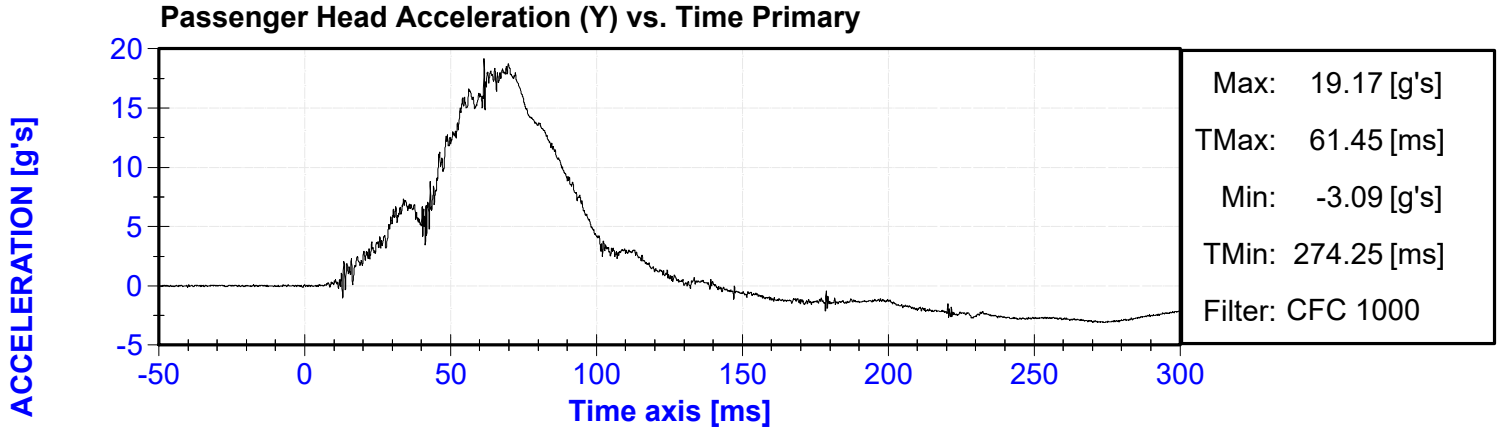


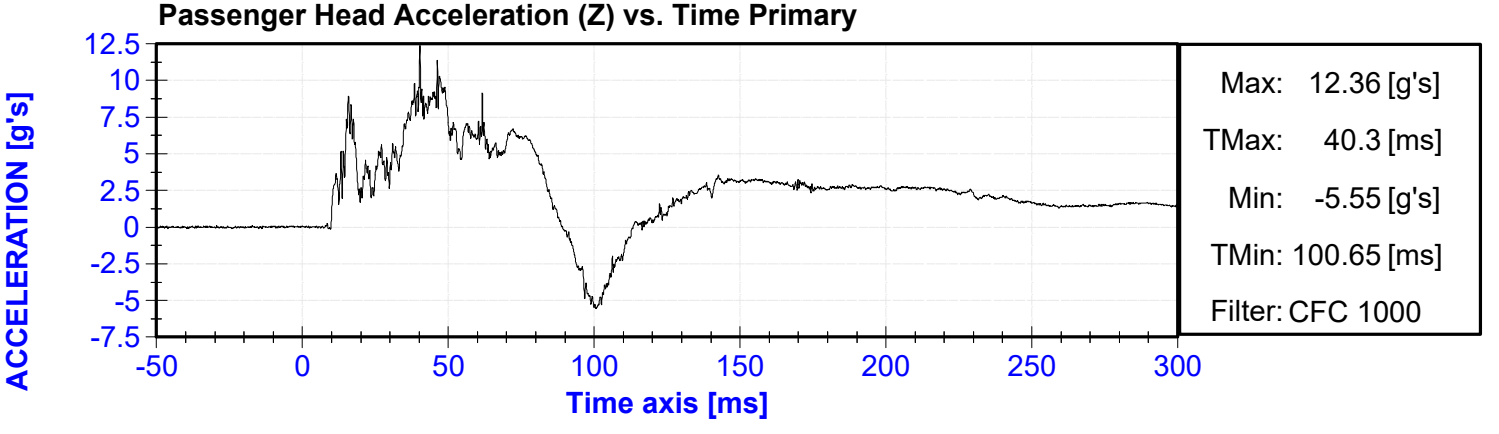
Driver Total Abdominal Force (Y) vs. Time



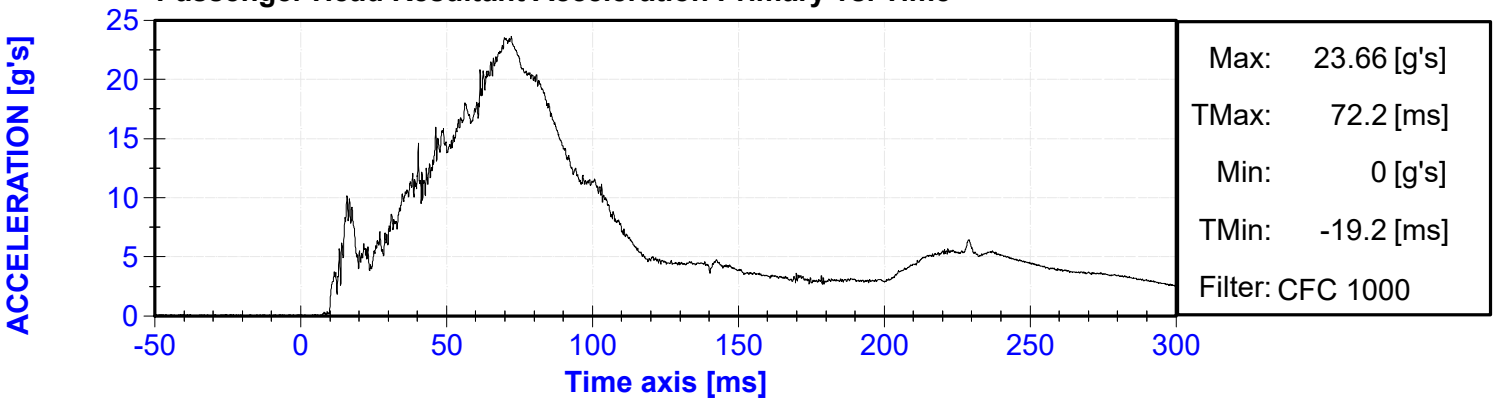

Driver Pubic Symphysis Force (Y) vs. Time
FORCE [N]
200
0
-200
-400
-600
-800
-1000
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 75.4 [N]
TMax: 143.3 [ms]
Min: -901.36 [N]
TMin: 53.85 [ms]
Filter: CFC 600


Passenger Head Acceleration (X) vs. Time Primary
ACCELERATION [g's]
7.5
5
2.5
0
-2.5
-5
-7.5
-10
-12.5
-15
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 5.26 [g's]
TMax: 229.15 [ms]
Min: -14.56 [g's]
TMin: 80.9 [ms]
Filter: CFC 1000

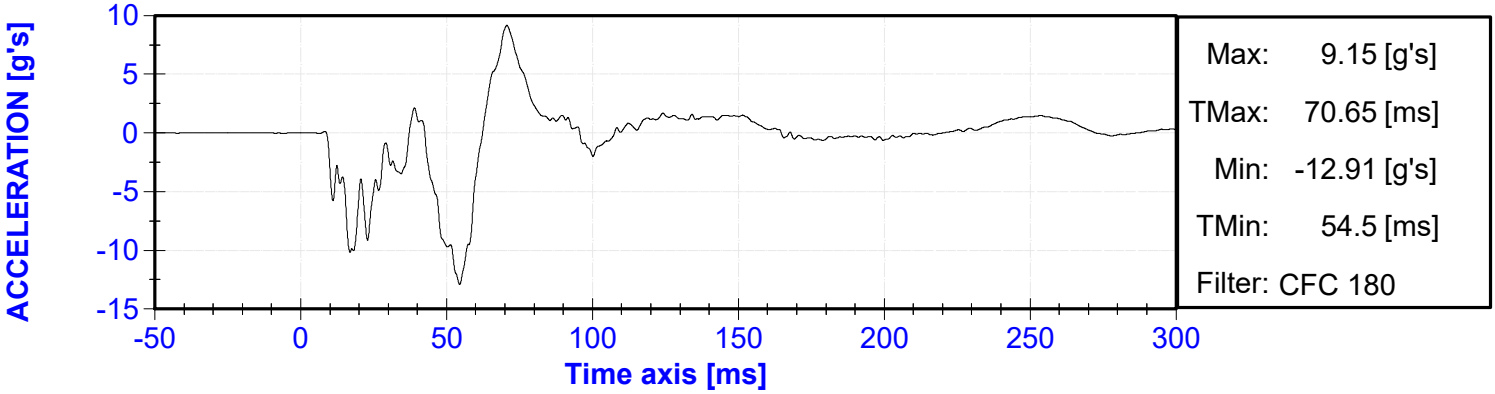

Passenger Head Acceleration (Y) vs. Time Primary
ACCELERATION [g's]
20
15
10
5
0
-5
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 19.17 [g's]
TMax: 61.45 [ms]
Min: -3.09 [g's]
TMin: 274.25 [ms]
Filter: CFC 1000


Passenger Head Acceleration (Z) vs. Time Primary
ACCELERATION [g's]
12.5
10
7.5
5
2.5
0
-2.5
-5
-7.5
-50
0
50
100
150
200
250
300
Time axis [ms]
Max: 12.36 [g's]
TMax: 40.3 [ms]
Min: -5.55 [g's]
TMin: 100.65 [ms]
Filter: CFC 1000

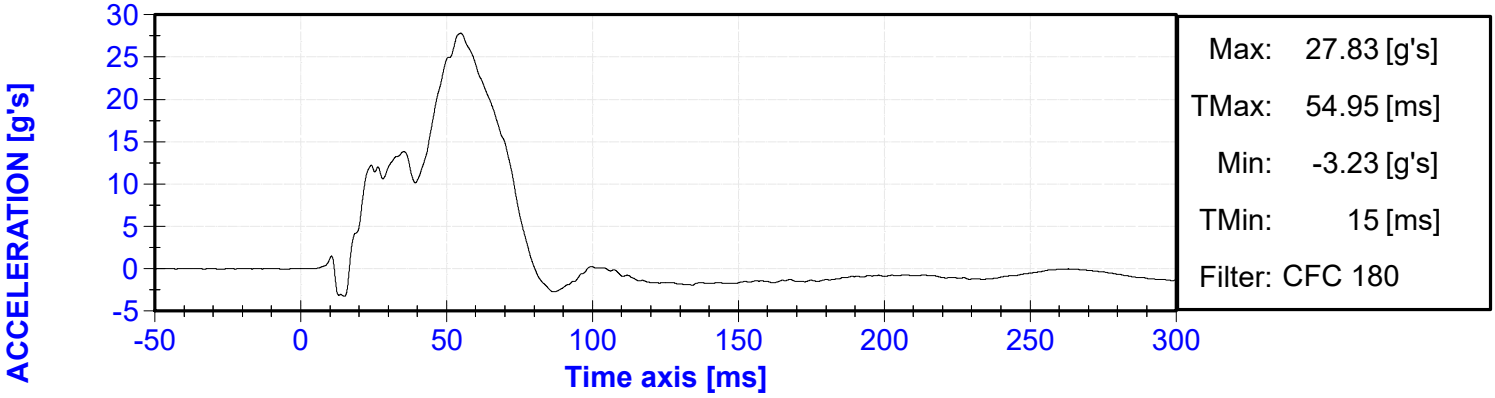
Passenger Head Resultant Acceleration Primary vs. Time



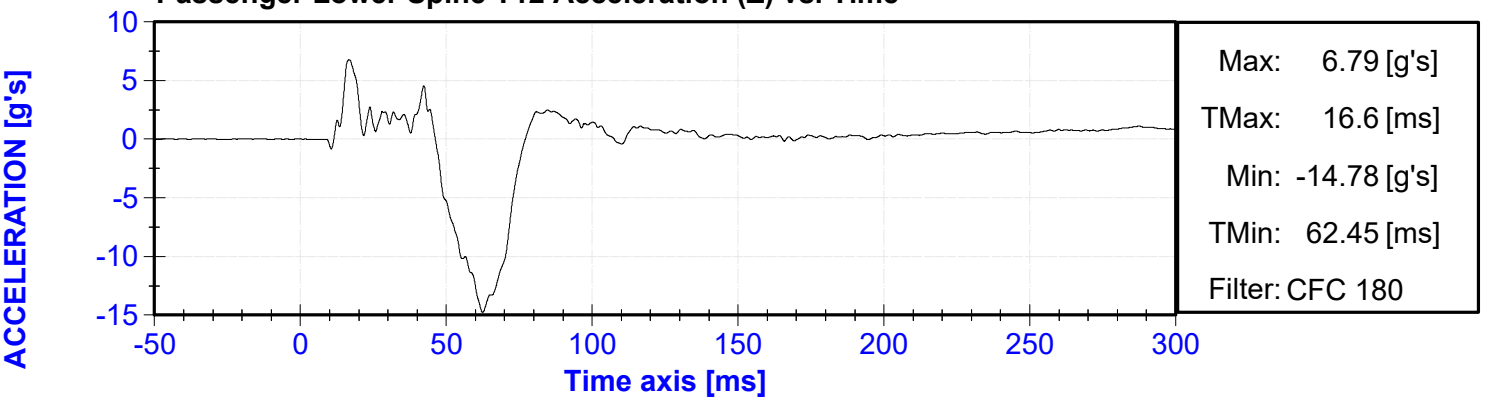
Passenger Lower Spine T12 Acceleration (X) vs. Time



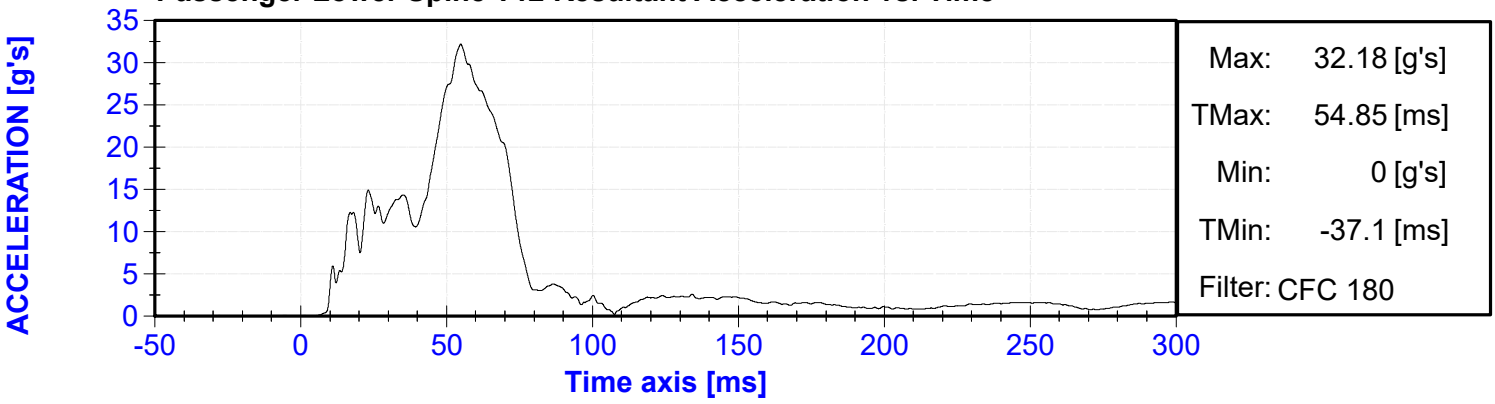
Passenger Lower Spine T12 Acceleration (Y) vs. Time



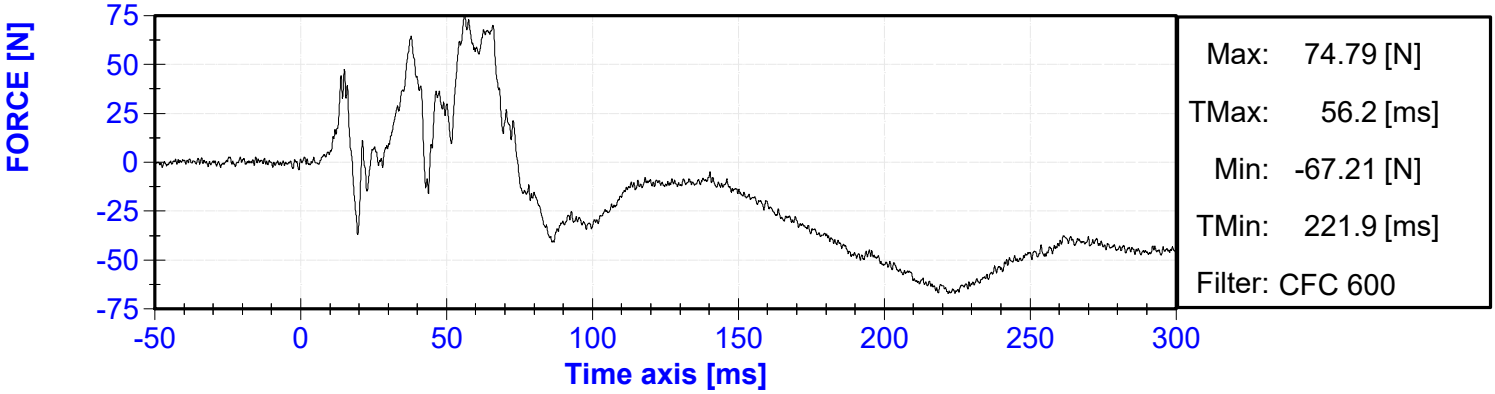
Passenger Lower Spine T12 Acceleration (Z) vs. Time



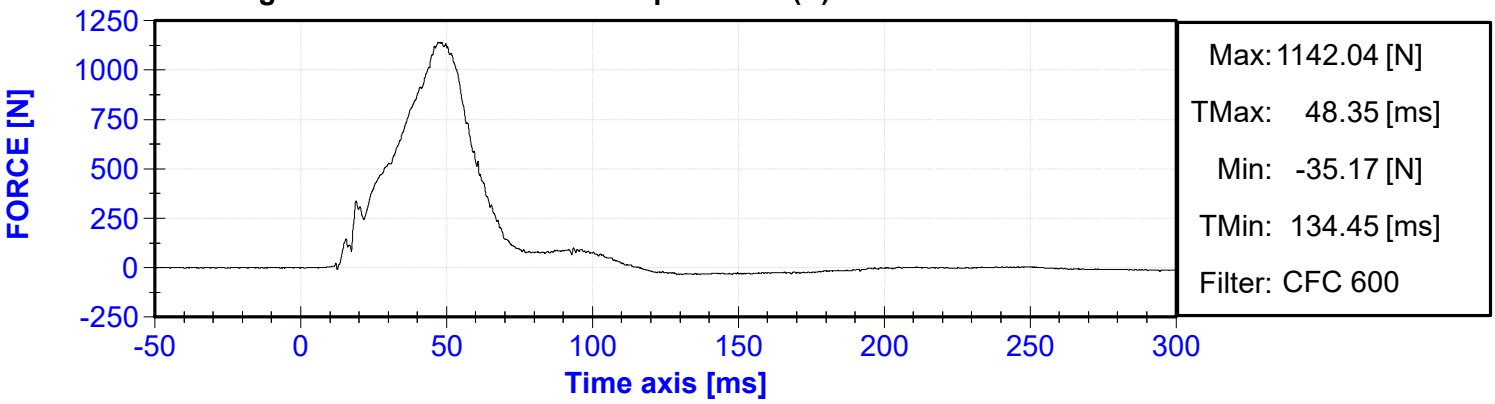
Passenger Lower Spine T12 Resultant Acceleration vs. Time



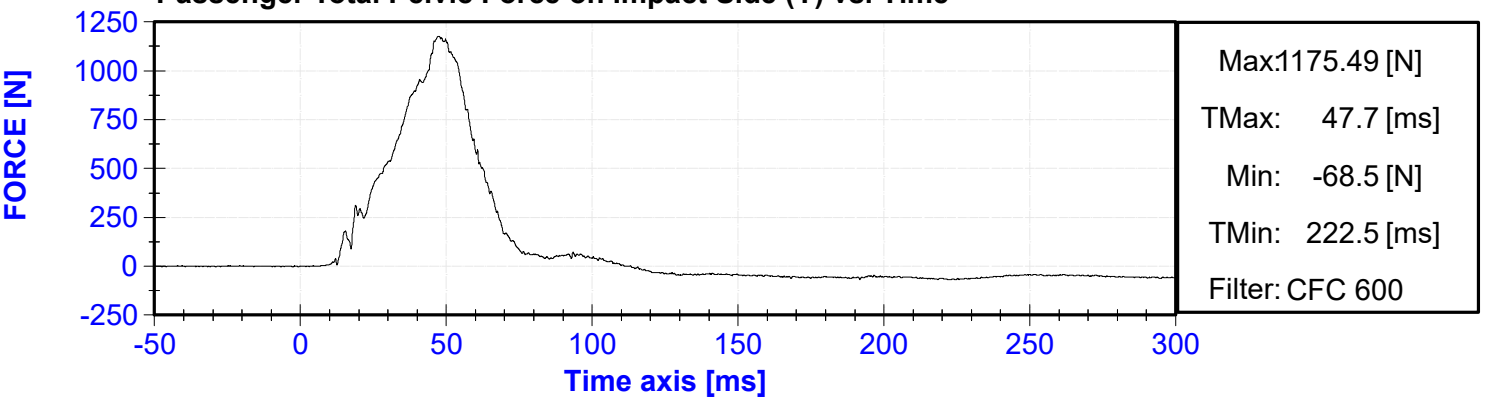
Passenger Iliac Force on Impact Side (Y) vs. Time



Passenger Acetabulum Force on Impact Side (Y) vs. Time



Passenger Total Pelvic Force on Impact Side (Y) vs. Time



APPENDIX C

DUMMY CONFIGURATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

EUROSID 2 (ES-2RE) MALE – DRIVER ATD

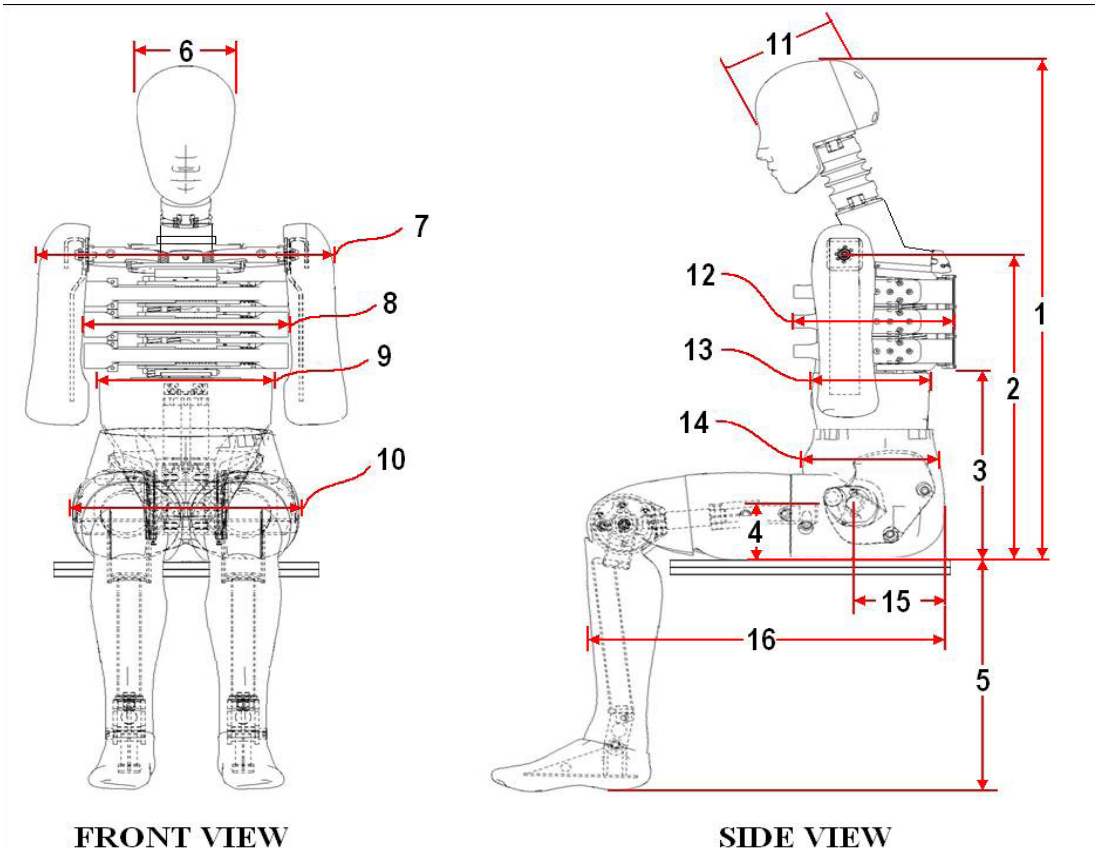
SERIAL NO:F033

(CONFIGURED FOR LEFT SIDE IMPACT)

External Measurements - EuroSID-2re

Technician: J. Rios Date: 11/19/2024

Dummy Serial Number: F033



FRONT VIEW SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	903	Pass
2	Seat to Shoulder Joint	558	572	562	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	349	Pass
4	Seat to Hip Joint (center of bolt)	97	103	102	Pass
5	Sole to Seat, Sitting	333	451	395	Pass
6	Head Width	152	158	155	Pass
7	Shoulder/Arm Width	461	479	462	Pass
8	Thorax Width	322	332	325	Pass
9	Abdomen Width	273	287	281	Pass
10	Pelvis Lap Width	359	373	366	Pass
11	Head Depth	196	206	201	Pass
12	Thorax Depth	262	272	268	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	154	Pass
16	Back of Buttocks to Front Knee	597	615	609	Pass

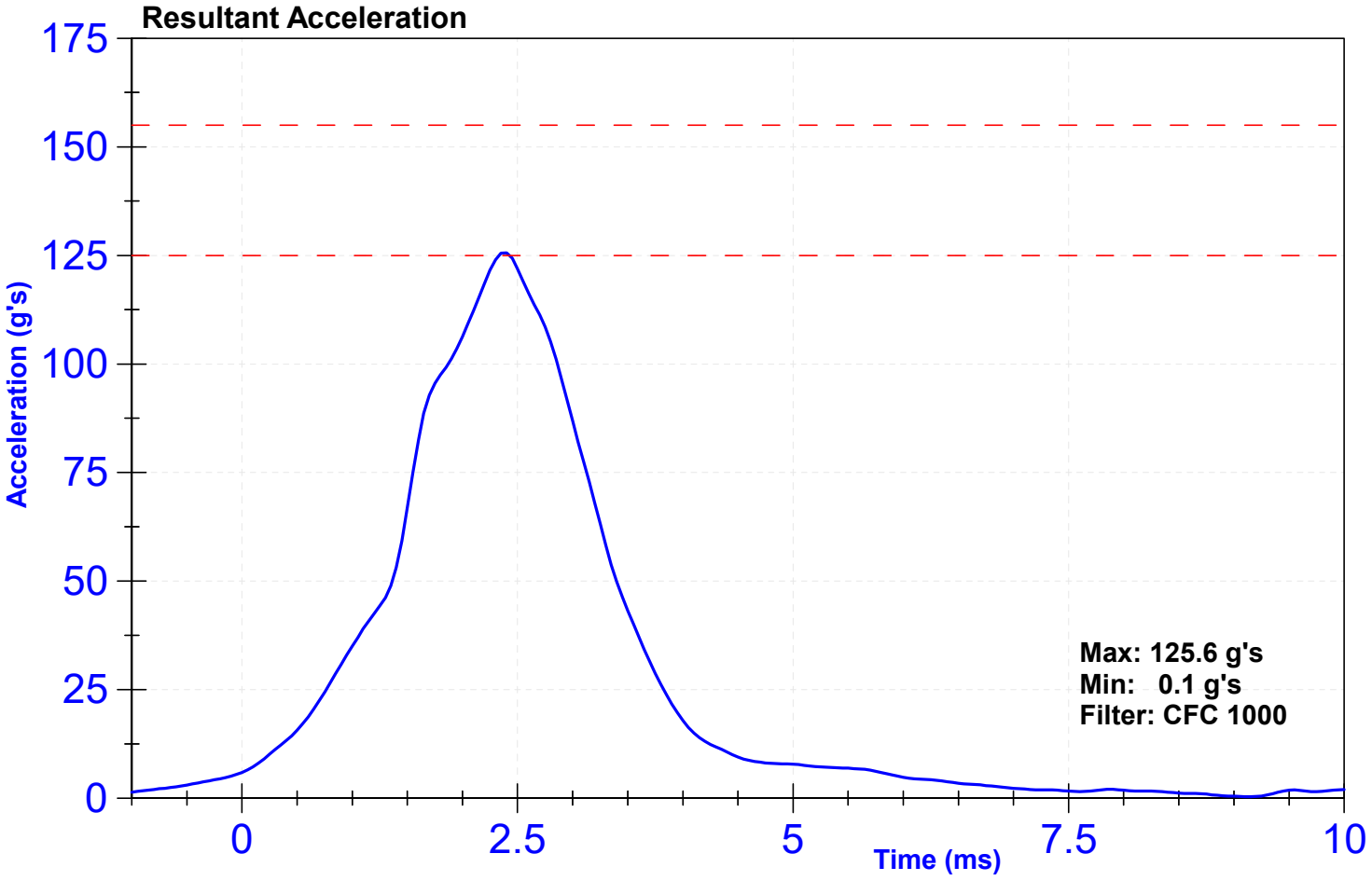
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

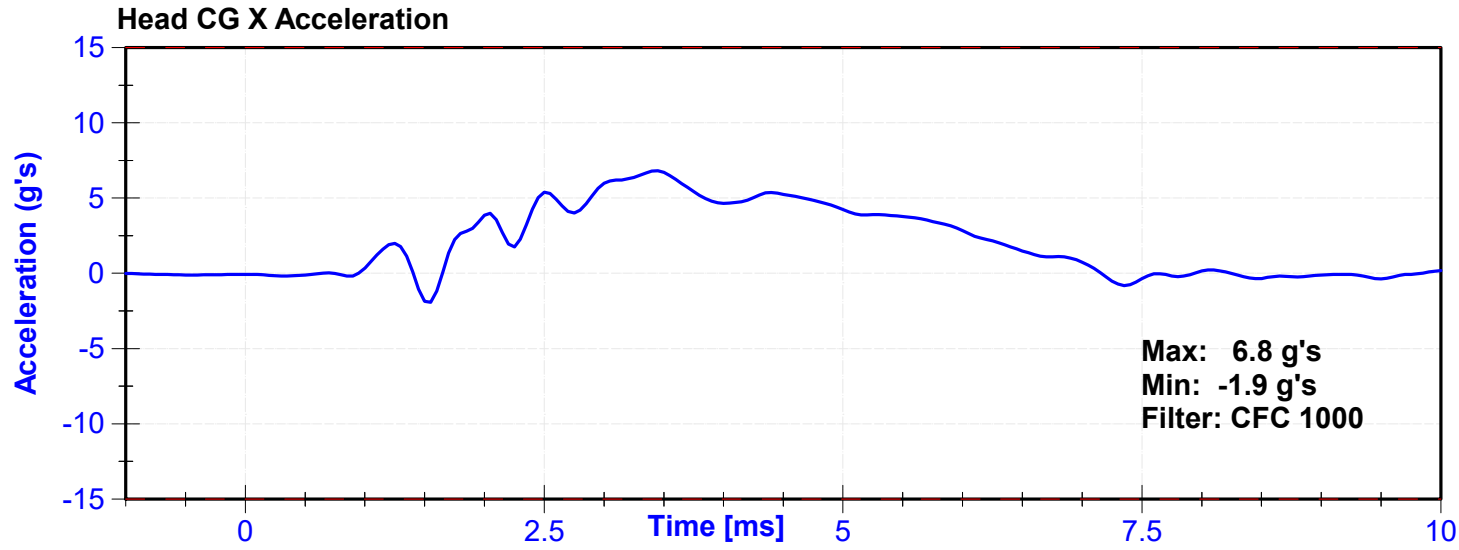
Results

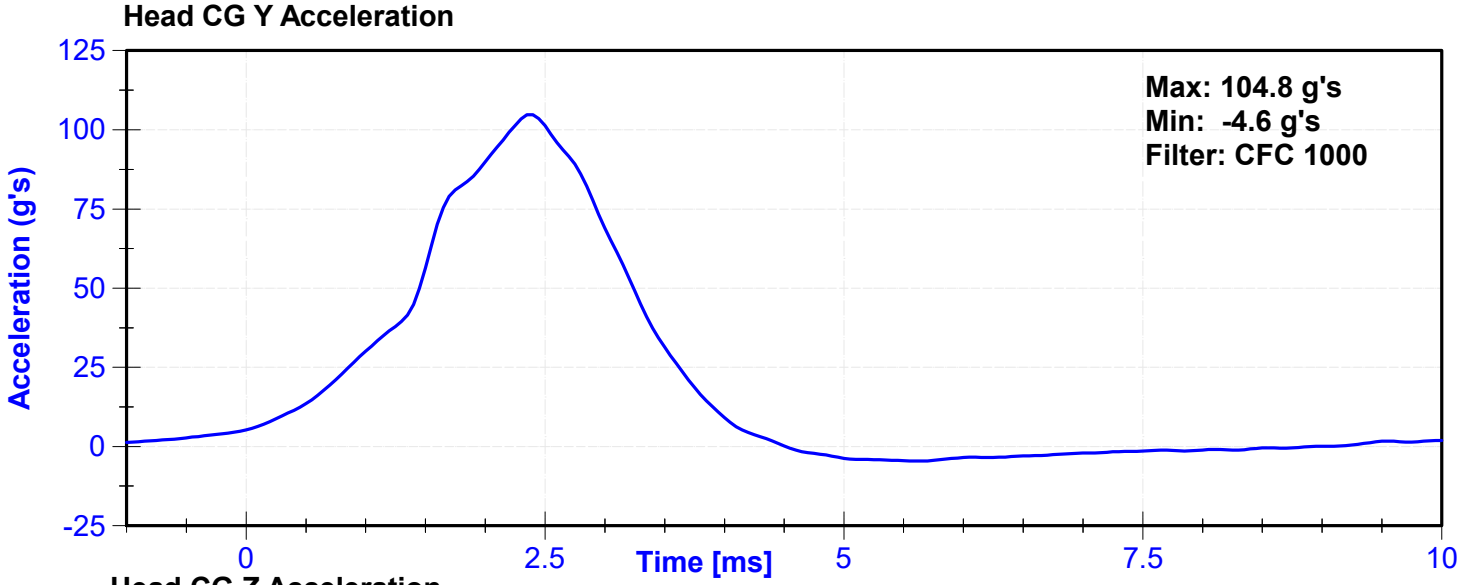
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Resultant Acceleration	125	155	g's	125.6	Pass
Oscillation	0	15	%	3.62	Pass
Fore-Aft Acceleration	-15	15	g's	6.8	Pass

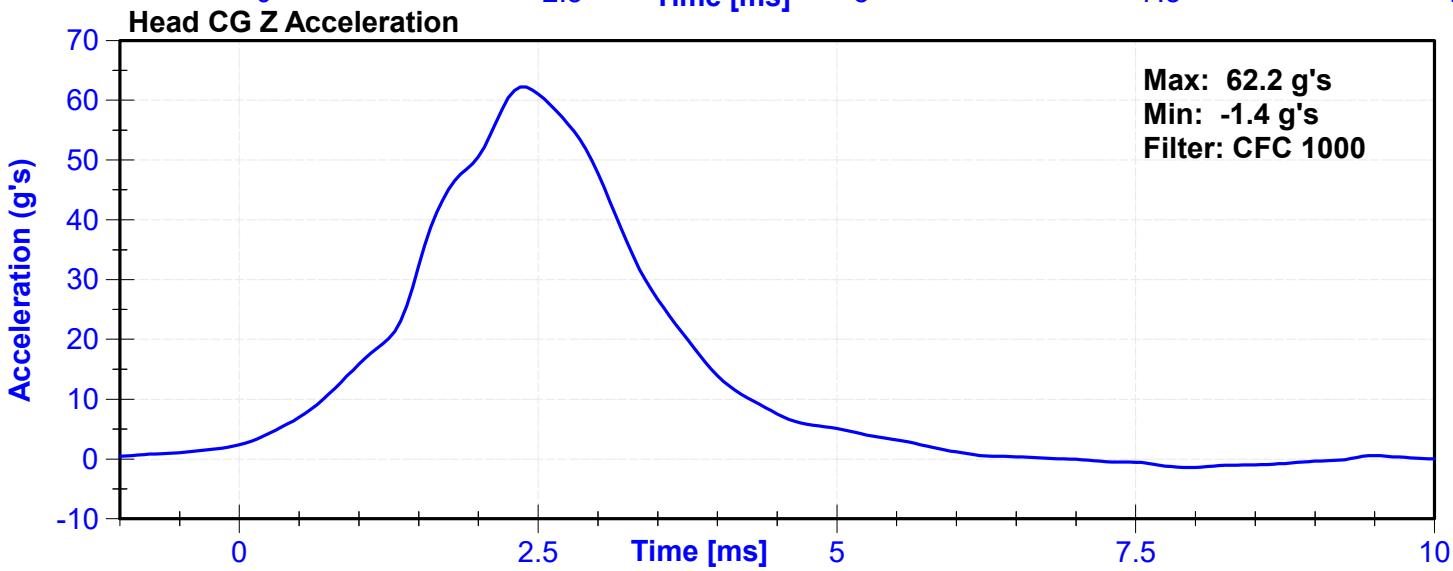
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P63861	10/17/2024	4/15/2025
Y Accelerometer	Endevco	P49216	10/17/2024	4/15/2025
Z Accelerometer	Endevco	P51303	10/17/2024	4/15/2025




Head CG X Acceleration
Acceleration (g's)
15
10
5
0
-5
-10
-15
0
2.5
Time [ms]
5
7.5
10
Max: 6.8 g's
Min: -1.9 g's
Filter: CFC 1000


Head CG Y Acceleration
Acceleration (g's)
125
100
75
50
25
0
-25
0
2.5
Time [ms]
5
7.5
10
Max: 104.8 g's
Min: -4.6 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
70
60
50
40
30
20
10
0
-10
0
2.5
Time [ms]
5
7.5
10
Max: 62.2 g's
Min: -1.4 g's
Filter: CFC 1000

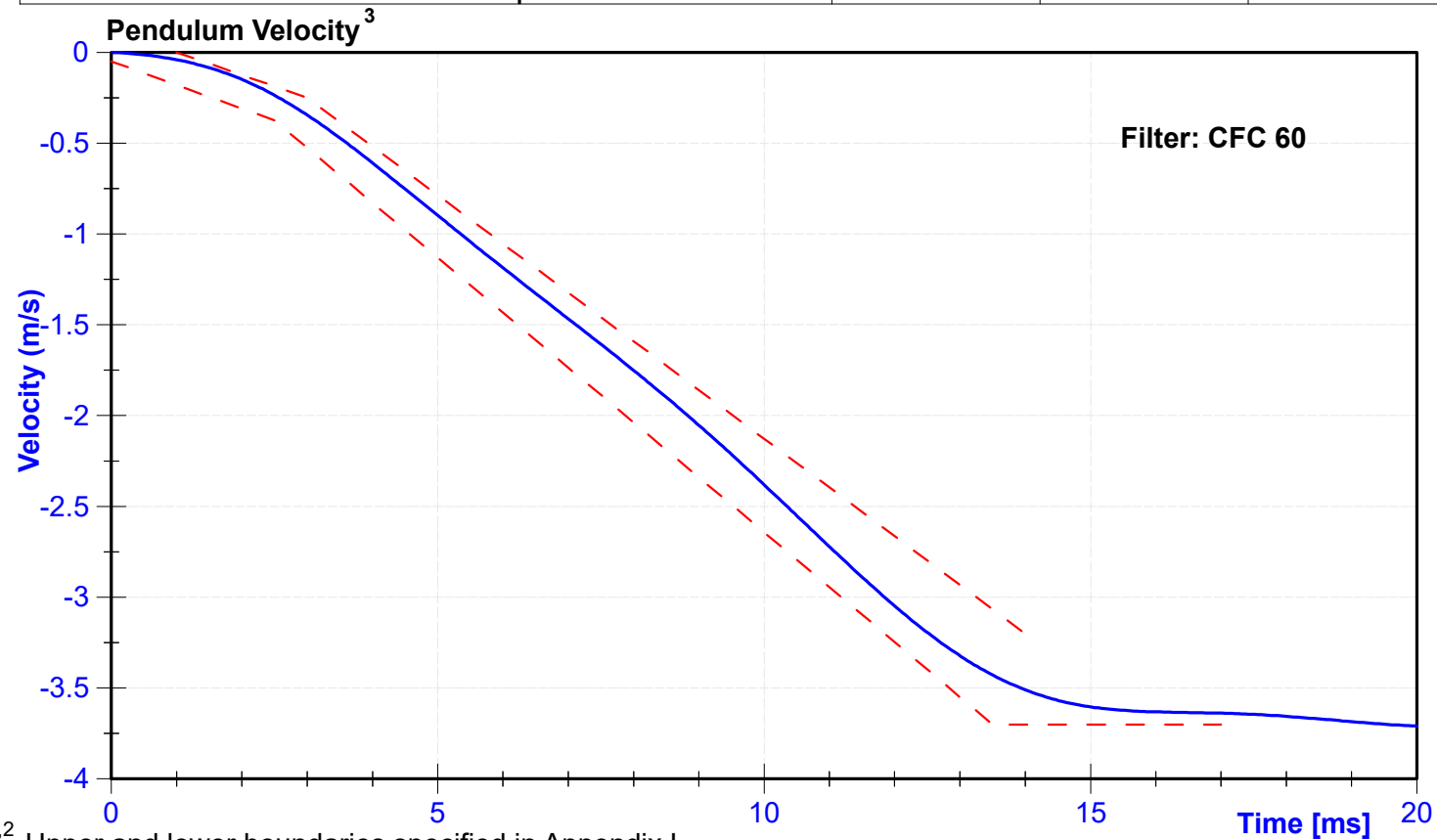
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

Results

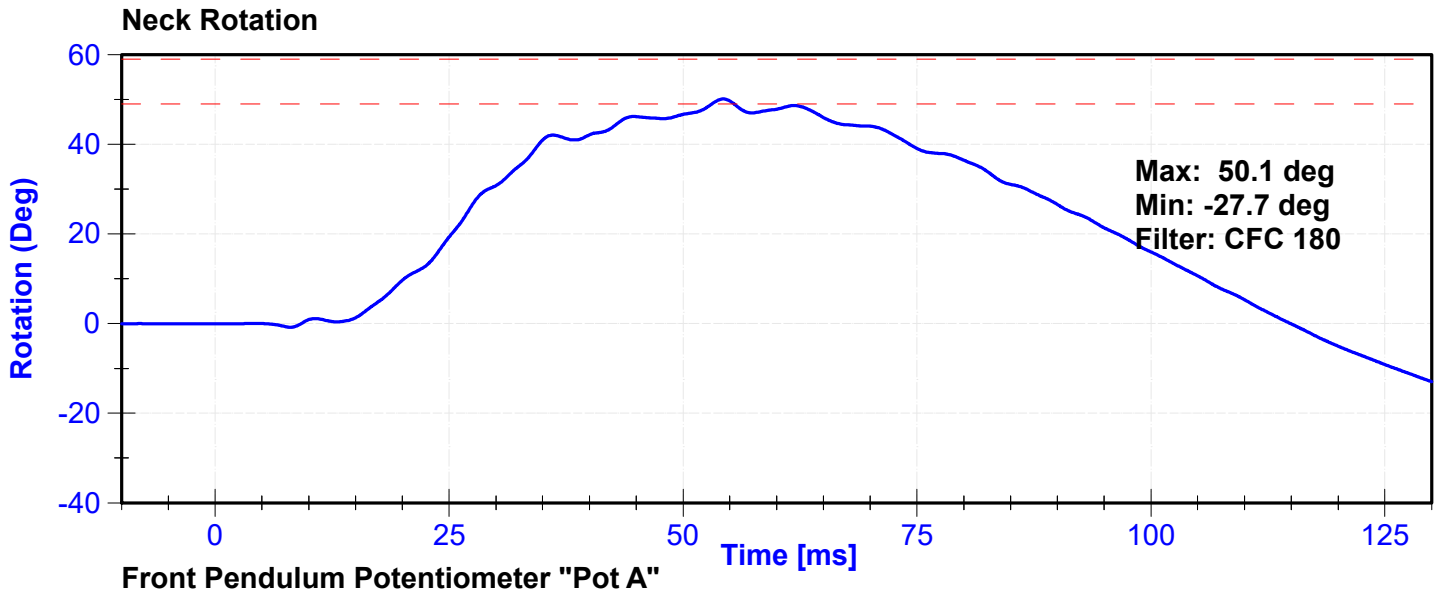
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.8	Pass
Humidity	10	70	%	34	Pass
Velocity	3.3	3.5	m/s	3.42	Pass
Lateral Neck Rotation	49	59	deg	50.1	Pass
Time at Maximum Rotation	54	66	ms	54.3	Pass
Time of Rotation Decay from Maximum	53	88	ms	60.6	Pass
Pendulum Velocity Overall Corridor	Lower Boundary[1]	Upper Boundary[2]	m/s	See Plot[3]	Pass

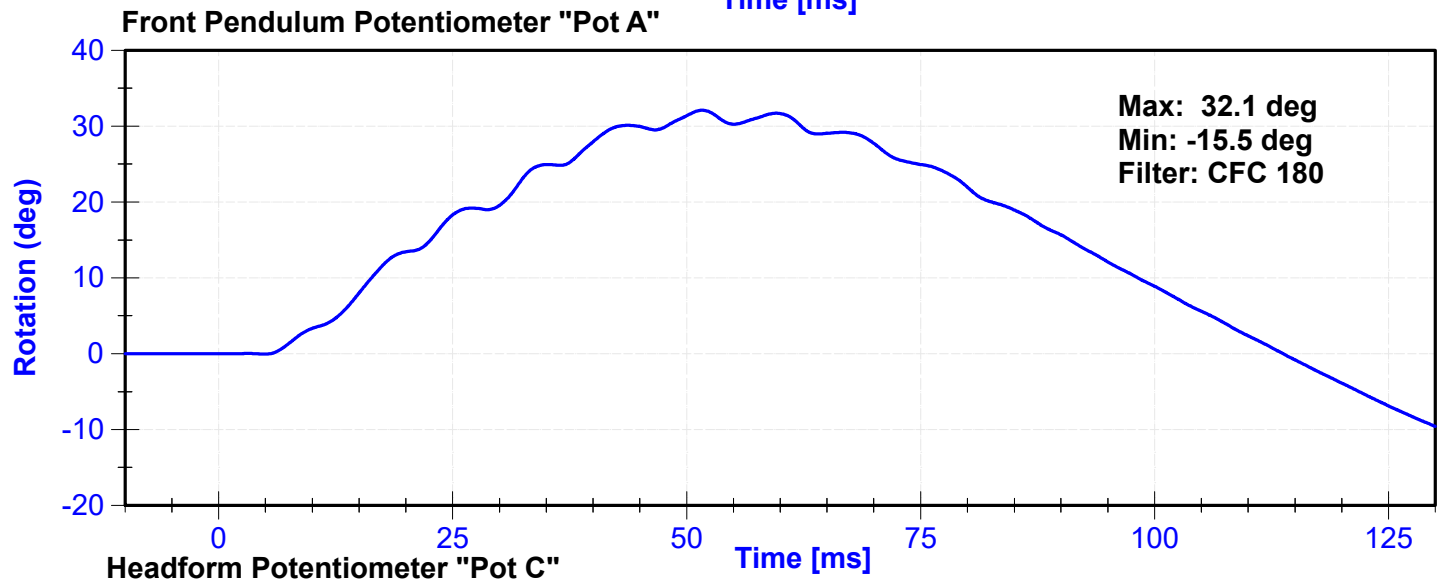
Transducer Calibrations

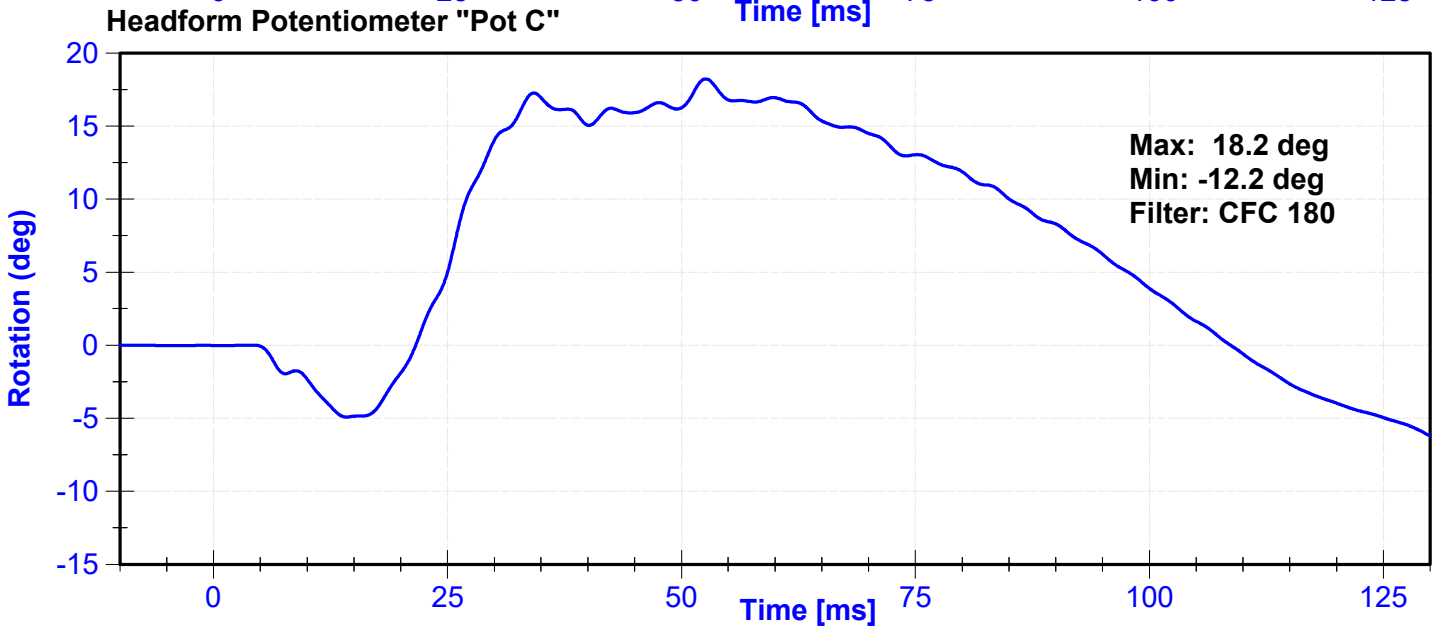
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16650	11/1/2024	11/1/2025
Front Pendulum Potentiometer	Sfernice	2247	9/13/2024	9/13/2025
Headform Potentiometer	Sfernice	095	9/13/2024	9/13/2025



[1,2] Upper and lower boundaries specified in Appendix I


Neck Rotation
Rotation (Deg)
60
40
20
0
-20
-40
0
25
50
75
100
125
Time [ms]
Max: 50.1 deg
Min: -27.7 deg
Filter: CFC 180


Front Pendulum Potentiometer "Pot A"
Rotation (deg)
40
30
20
10
0
-10
-20
0
25
50
75
100
125
Time [ms]
Max: 32.1 deg
Min: -15.5 deg
Filter: CFC 180


Headform Potentiometer "Pot C"
Rotation (deg)
20
15
10
5
0
-5
-10
-15
0
25
50
75
100
125
Time [ms]
Max: 18.2 deg
Min: -12.2 deg
Filter: CFC 180

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

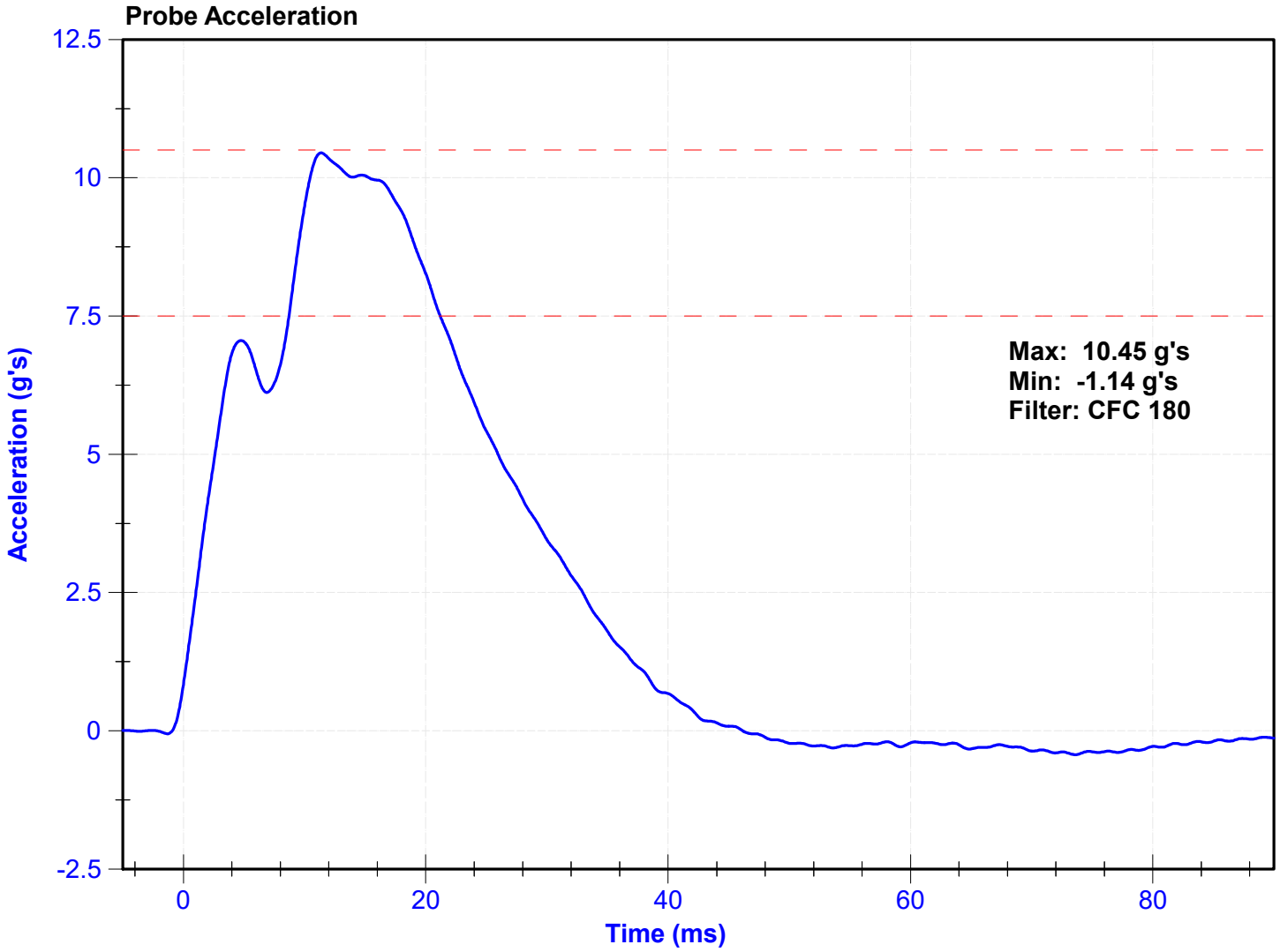
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.28	Pass
Probe Acceleration	7.5	10.5	g's	10.45	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18599	9/13/2024	3/12/2025



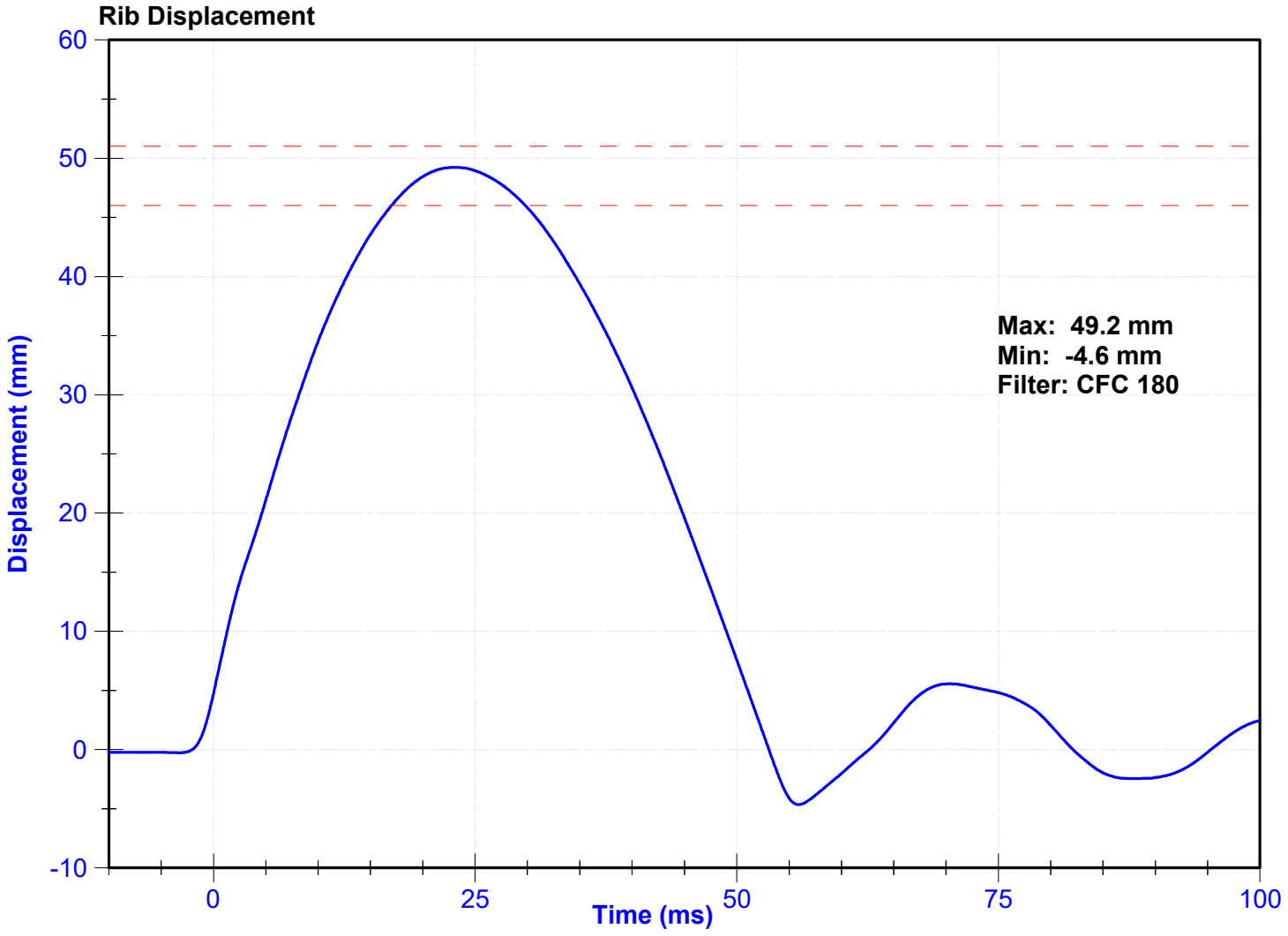
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	49.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025



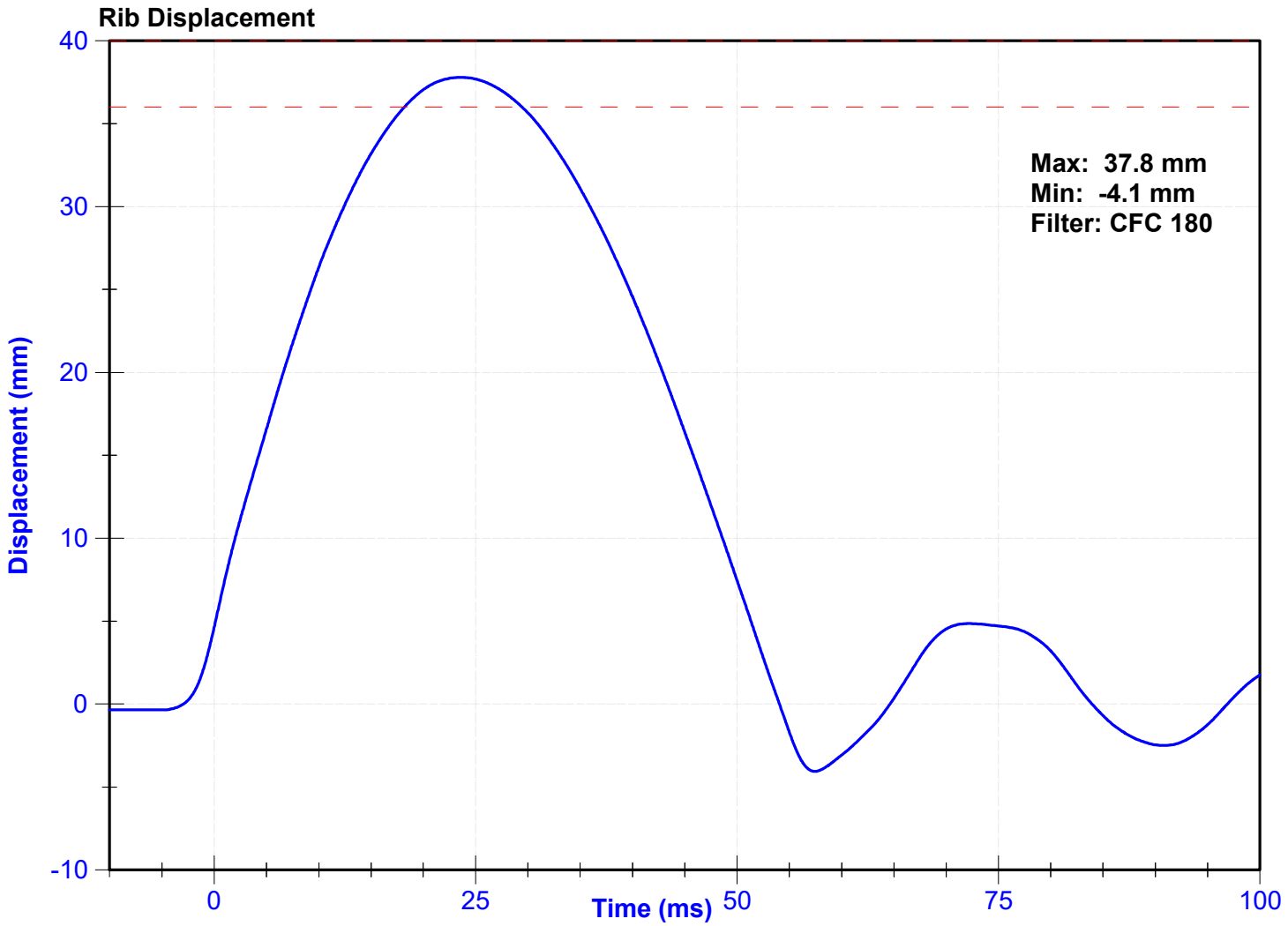
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	37.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025



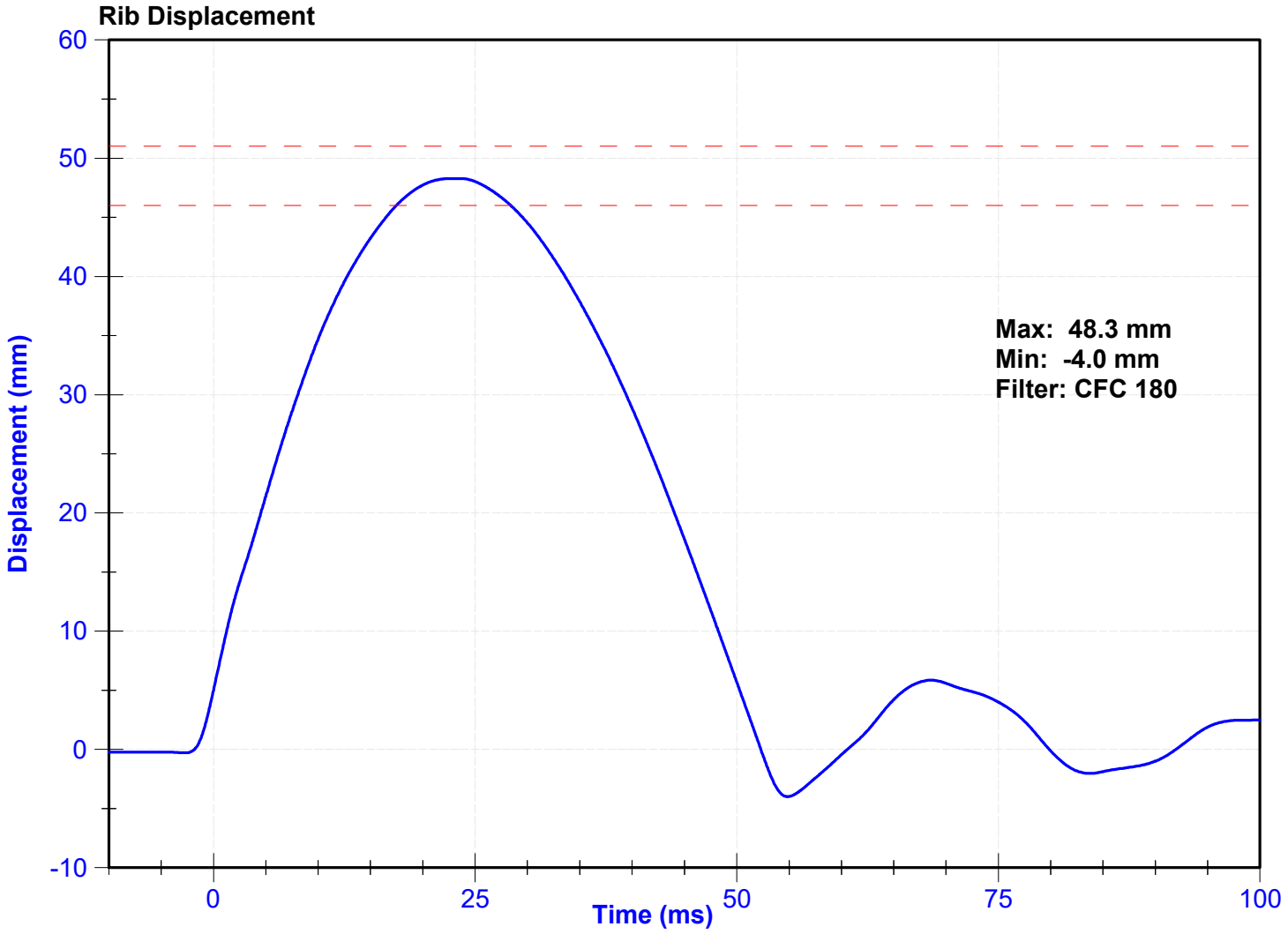
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	48.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025



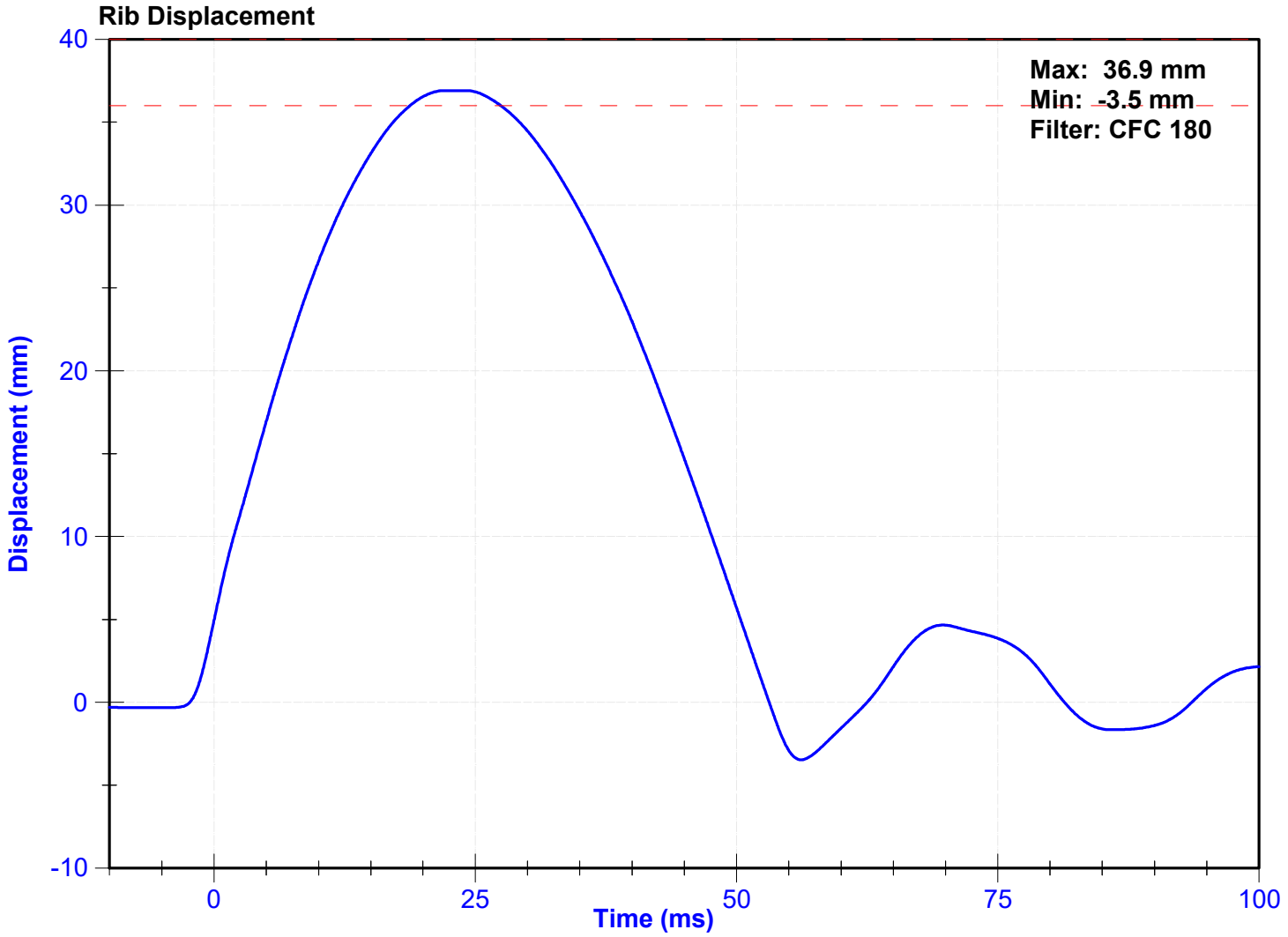
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	36.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025



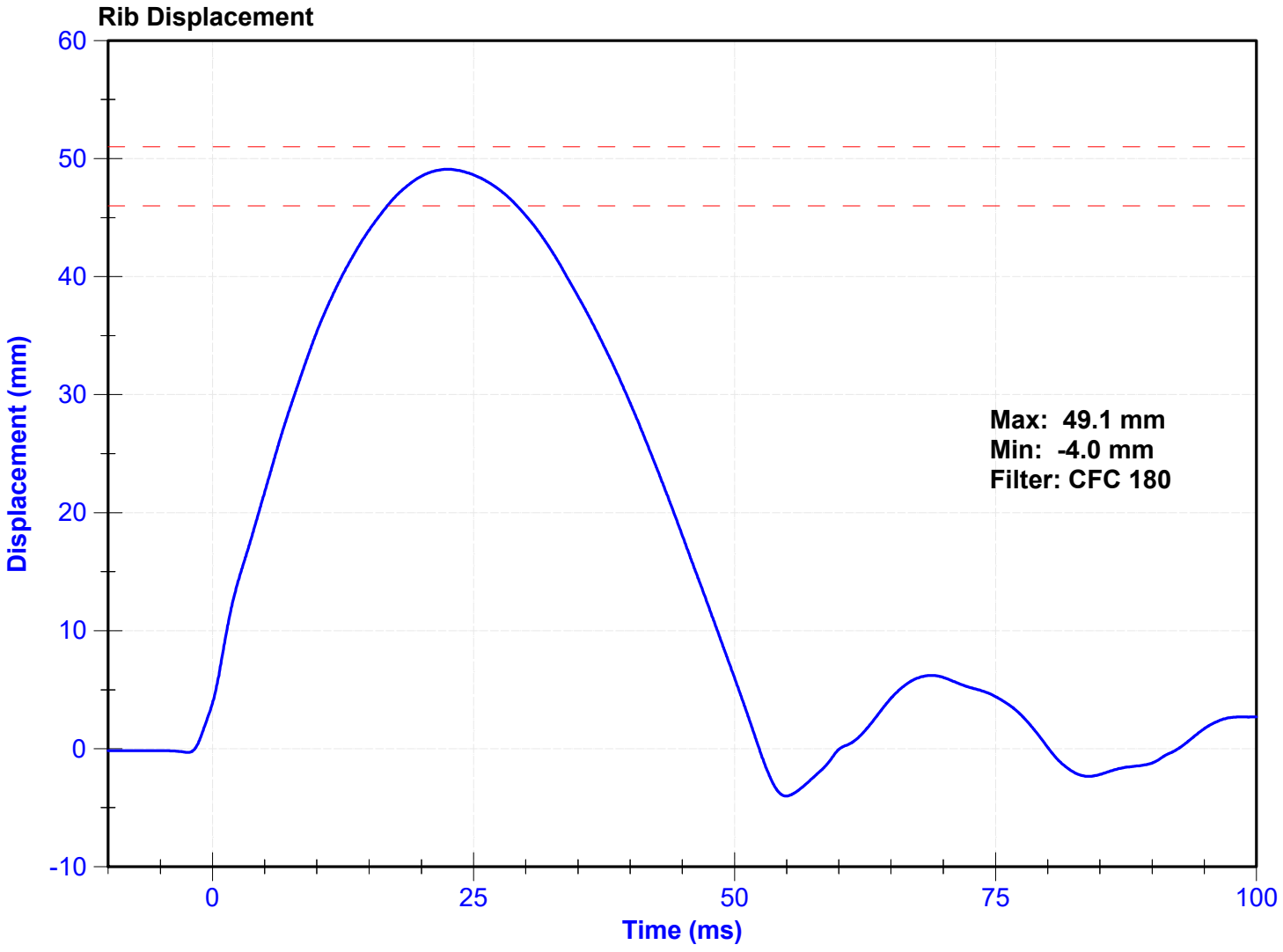
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	49.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	178GFE	10/16/2024	4/16/2025



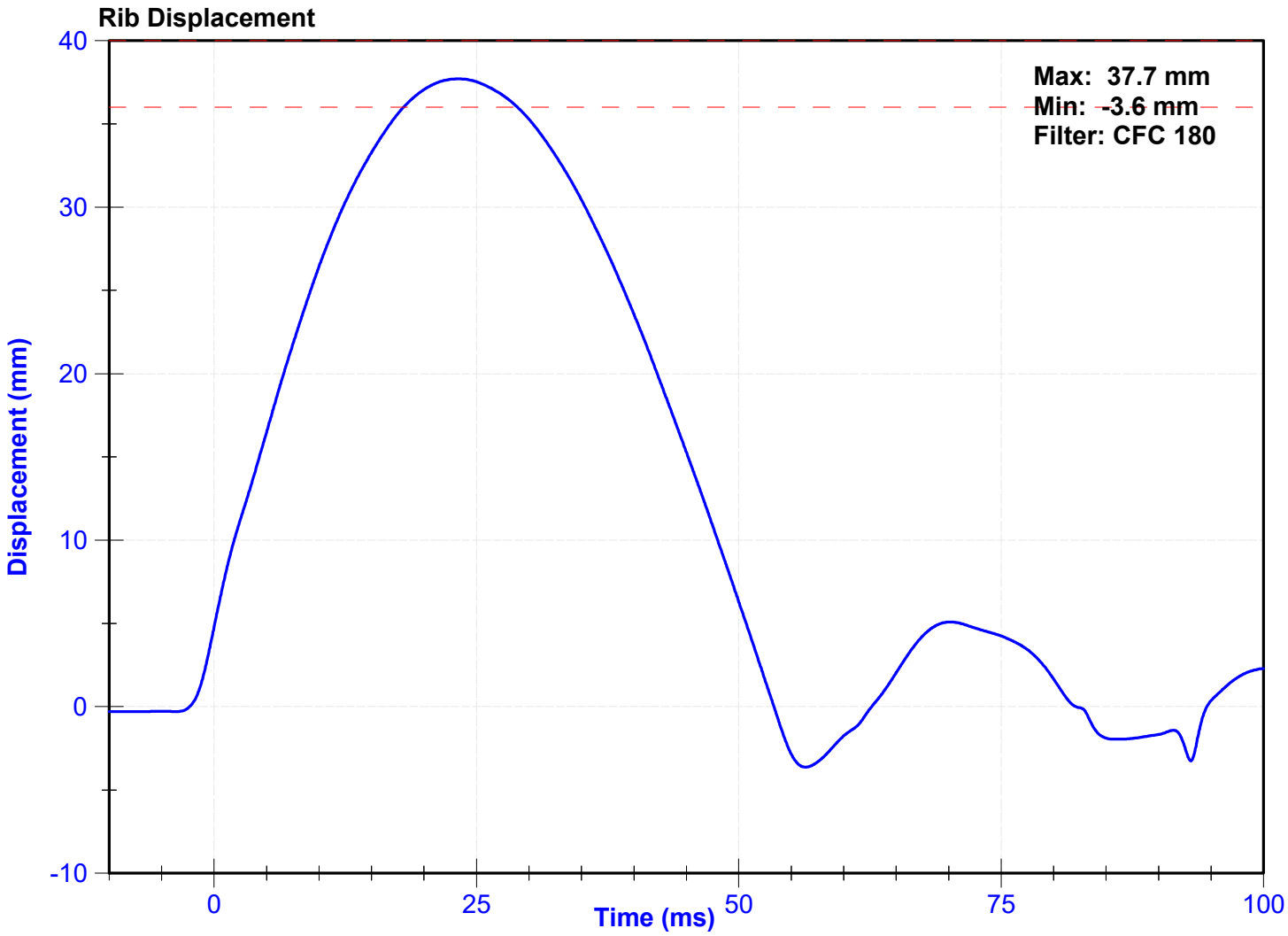
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	37.7	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	178GFE	10/16/2024	4/16/2025



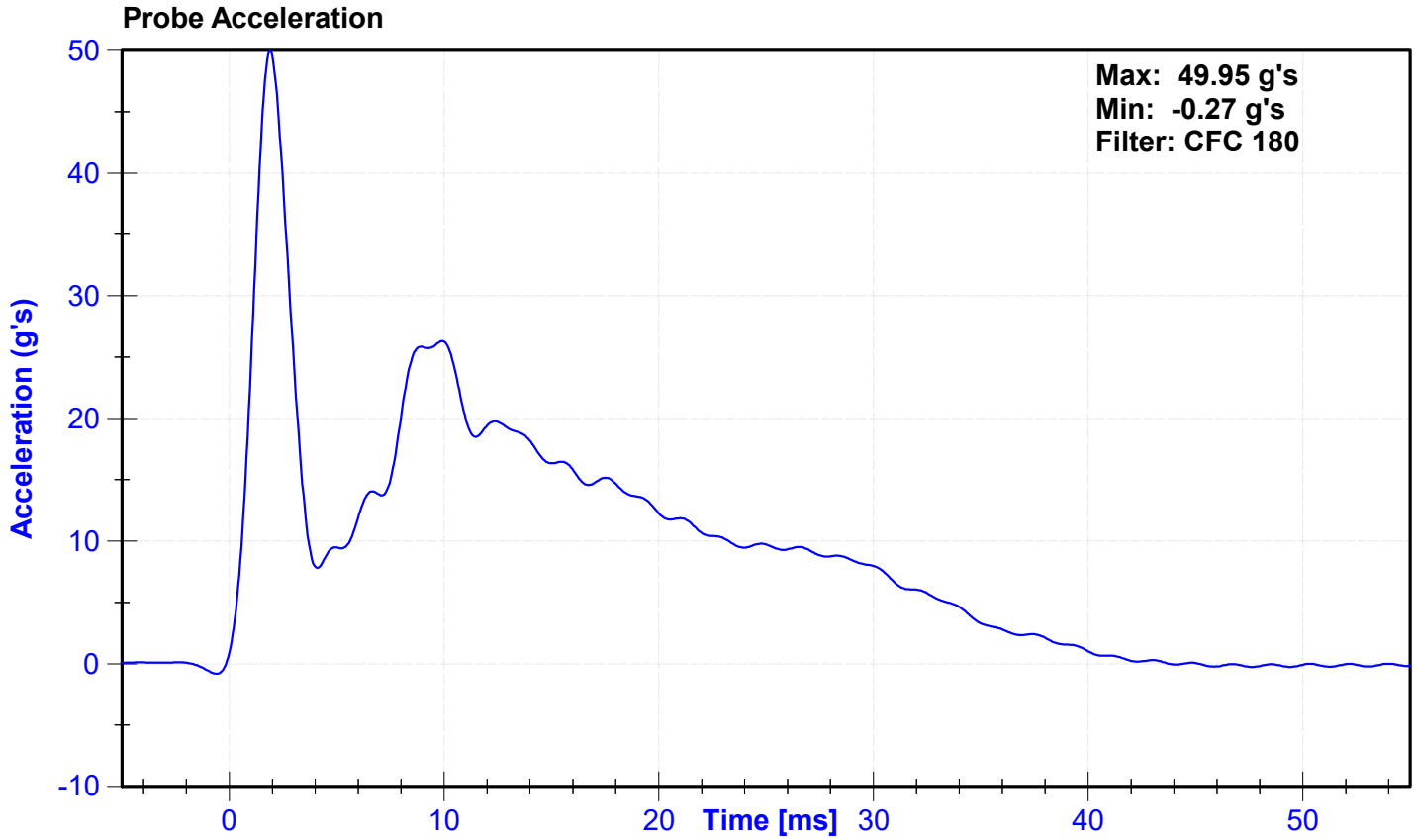
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

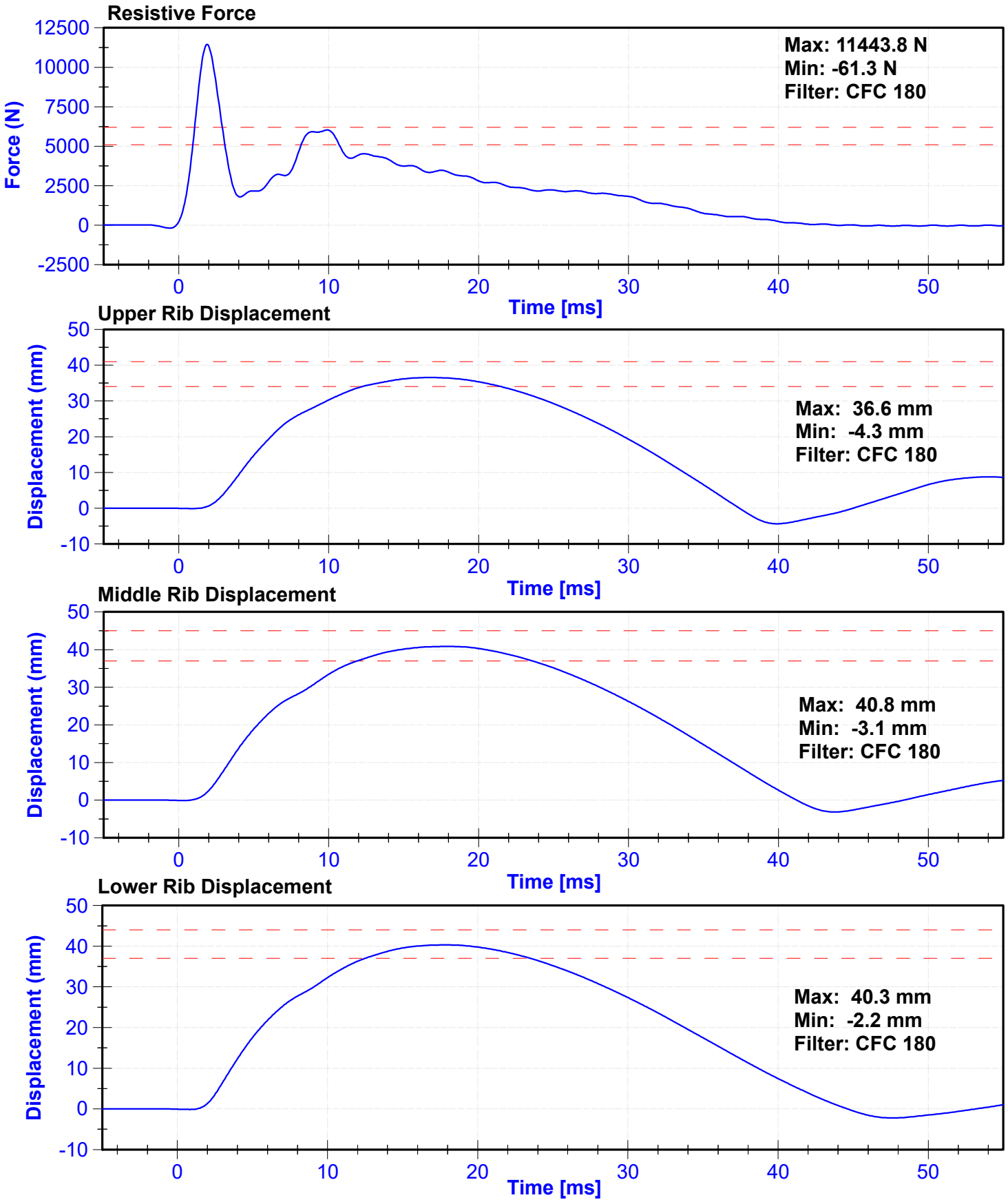
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	5.4	5.6	m/s	5.54	Pass
Resistive Force after 6ms	5100	6200	N	6027.2	Pass
Upper Thorax Rib Deflection	34	41	mm	36.6	Pass
Mid Thorax Rib Deflection	37	45	mm	40.8	Pass
Lower Thorax Rib Deflection	37	44	mm	40.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Upper Thorax Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Honeywell	184GFE	11/19/2024	5/20/2025




Resistive Force
Force (N)
Max: 11443.8 N
Min: -61.3 N
Filter: CFC 180
Time [ms]
Upper Rib Displacement
Displacement (mm)
Max: 36.6 mm
Min: -4.3 mm
Filter: CFC 180
Time [ms]
Middle Rib Displacement
Displacement (mm)
Max: 40.8 mm
Min: -3.1 mm
Filter: CFC 180
Time [ms]
Lower Rib Displacement
Displacement (mm)
Max: 40.3 mm
Min: -2.2 mm
Filter: CFC 180
Time [ms]

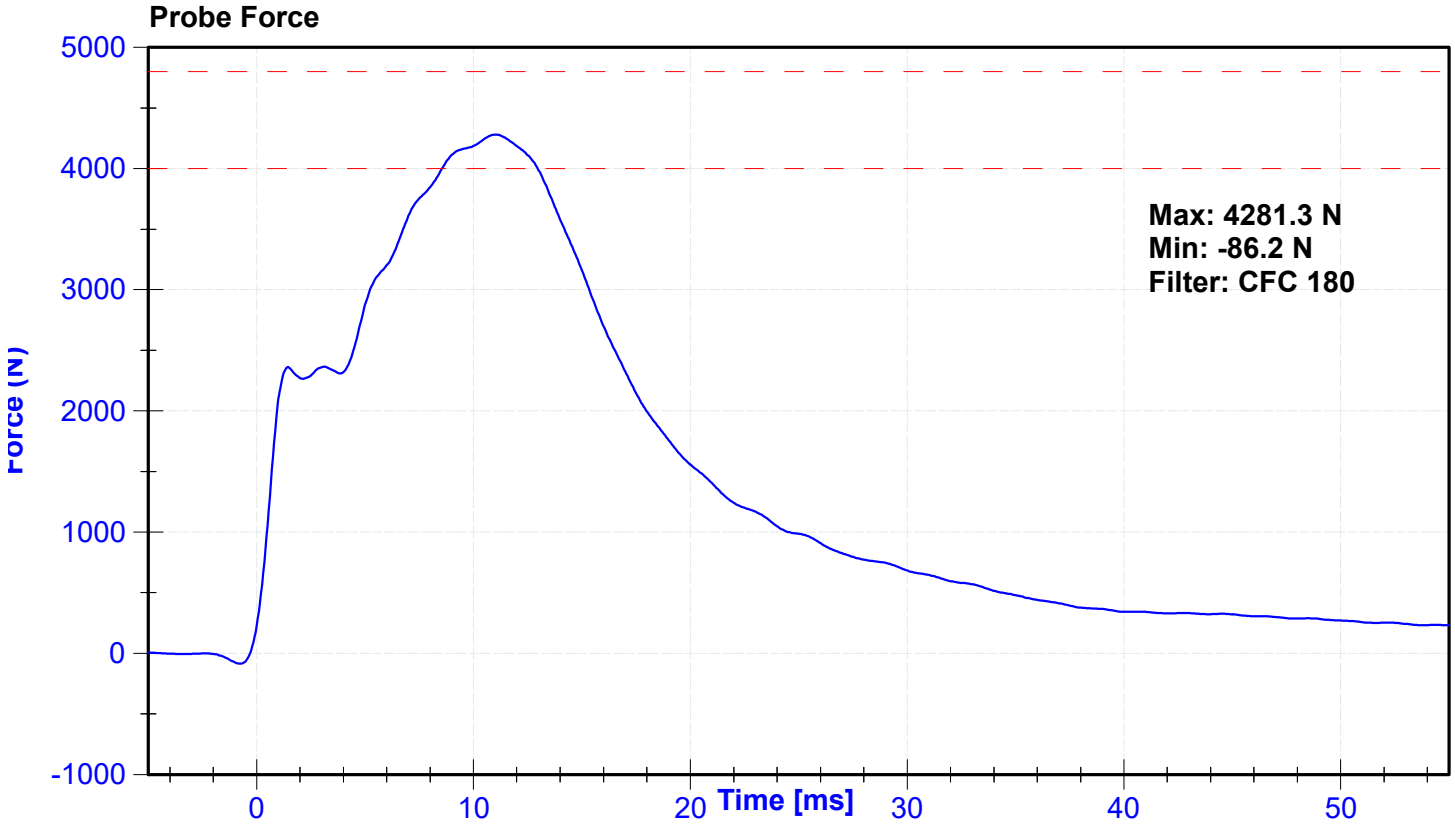
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

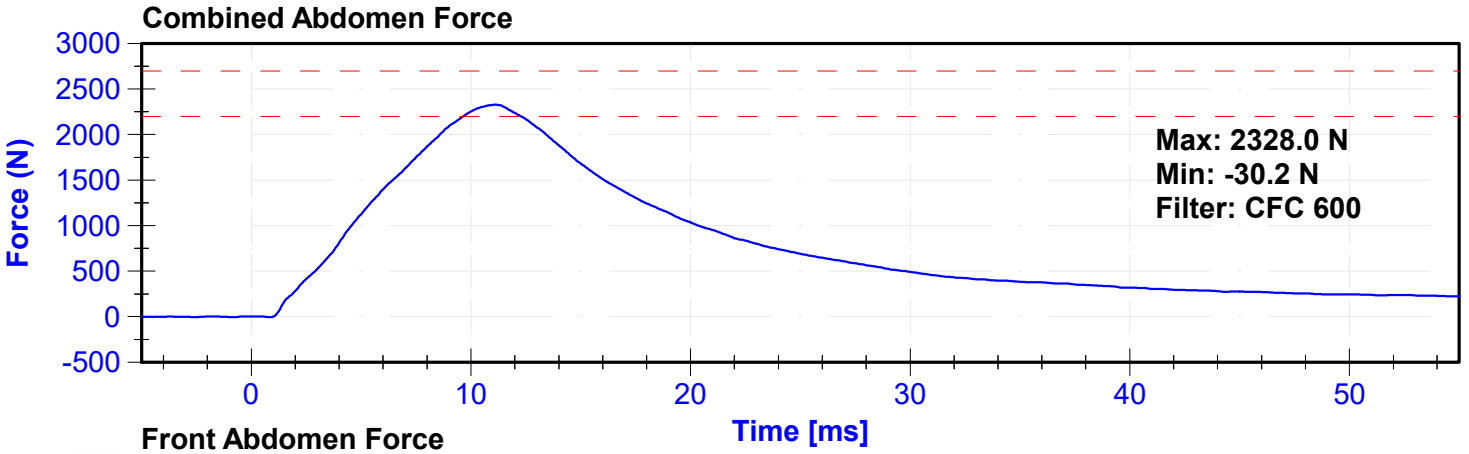
Results

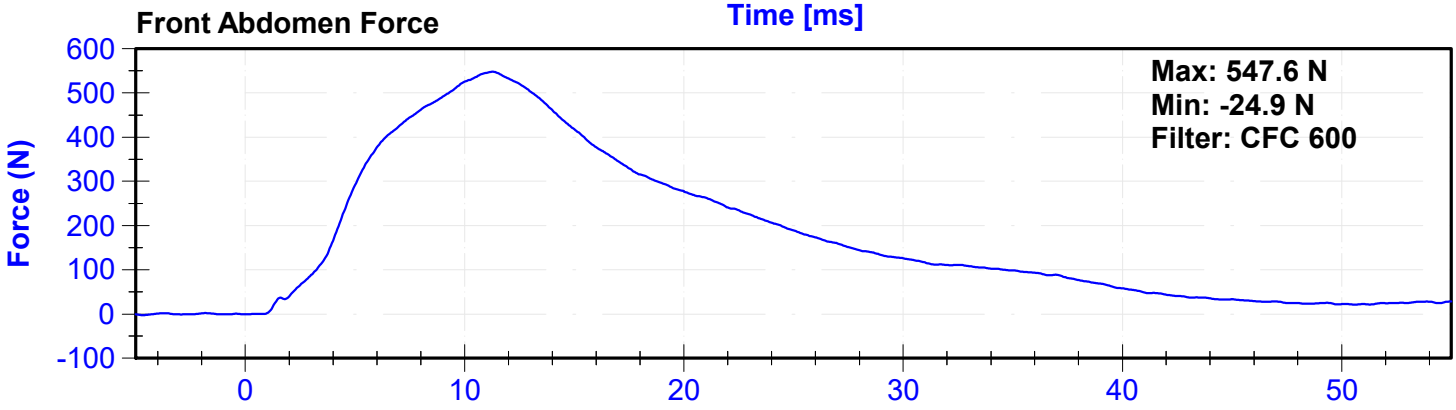
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	3.9	4.1	m/s	4.02	Pass
Combined Abdomen Force	2200	2700	N	2328.0	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	11.10	Pass
Resistive Probe Force	4000	4800	N	4281.3	Pass
Time at Peak Resistive Force	10.6	13.0	ms	11.00	Pass

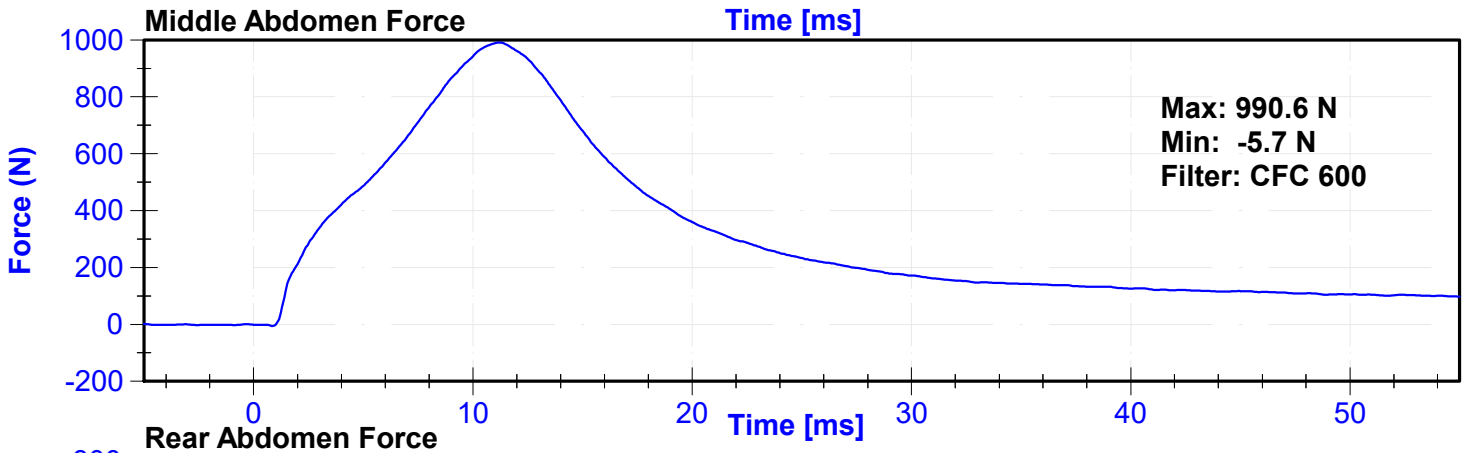
Transducer Calibrations

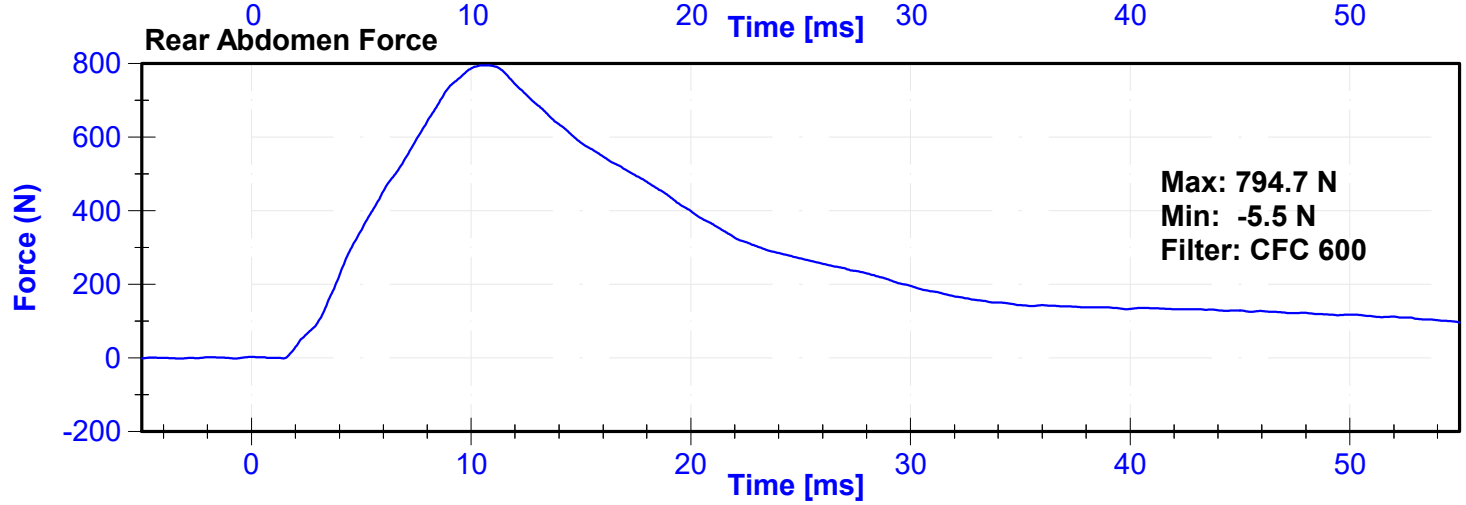
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Front Abdomen Load Cell	Denton	1523	10/28/2024	10/28/2025
Middle Abdomen Load Cell	Denton	1524	10/28/2024	10/28/2025
Rear Abdomen Load Cell	Denton	1530	10/28/2024	10/28/2025




Combined Abdomen Force
Force (N)
3000
2500
2000
1500
1000
500
0
-500
0
10
20
30
40
50
Time [ms]
Max: 2328.0 N
Min: -30.2 N
Filter: CFC 600


Front Abdomen Force
Force (N)
600
500
400
300
200
100
0
-100
0
10
20
30
40
50
Time [ms]
Max: 547.6 N
Min: -24.9 N
Filter: CFC 600


Middle Abdomen Force
Force (N)
1000
800
600
400
200
0
-200
0
10
20
30
40
50
Time [ms]
Max: 990.6 N
Min: -5.7 N
Filter: CFC 600


Rear Abdomen Force
Force (N)
800
600
400
200
0
-200
0
10
20
30
40
50
Time [ms]
Max: 794.7 N
Min: -5.5 N
Filter: CFC 600

ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

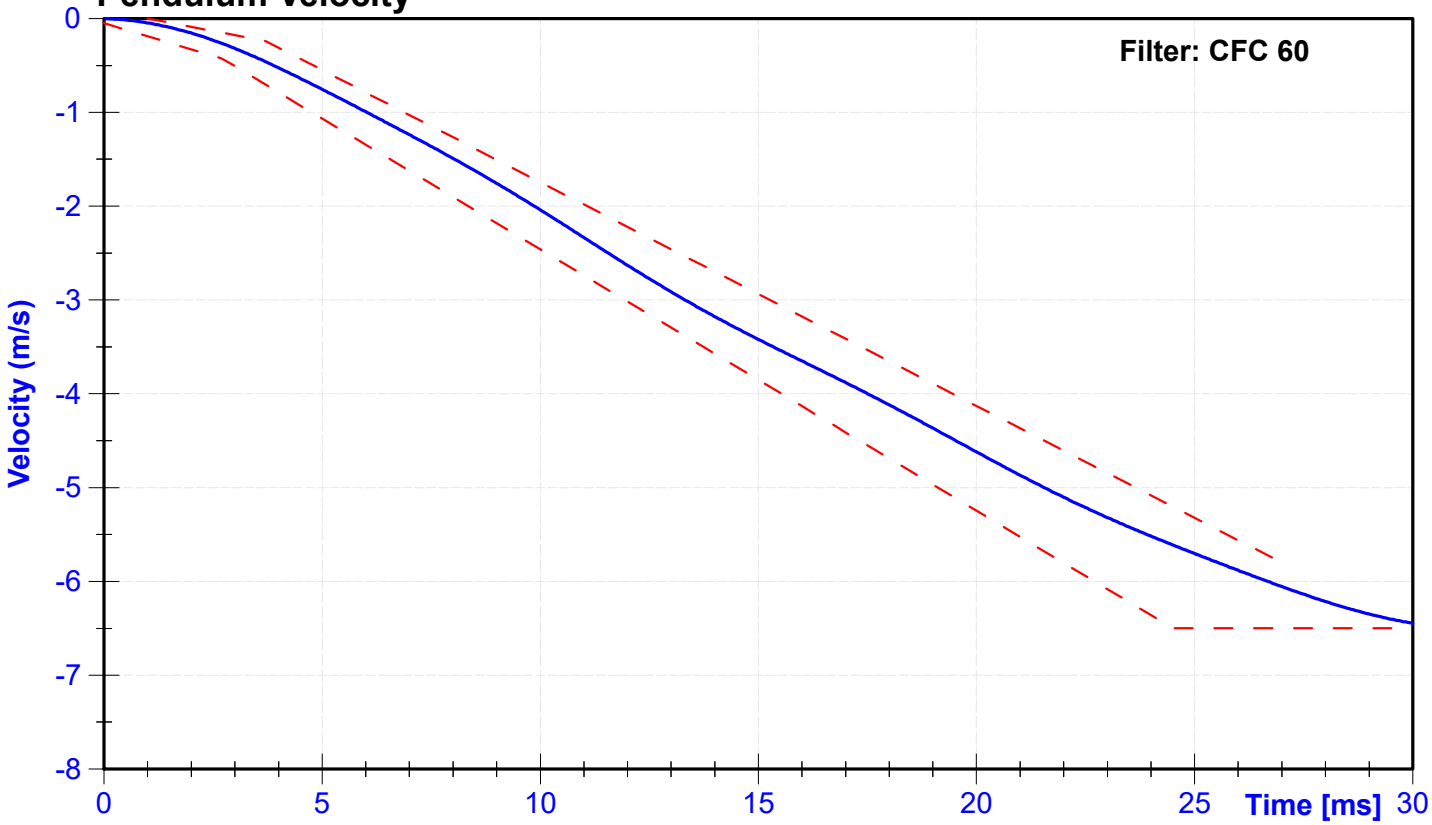
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.8	Pass
Humidity	10	70	%	34	Pass
Velocity	5.95	6.15	m/s	6.127	Pass
Lateral Spine Rotation	45	55	deg	47.8	Pass
Time at Maximum Rotation	39	53	ms	43.1	Pass
Time of Decay to Zero Degrees	37	57	ms	38.2	Pass
Pendulum Velocity Overall Corridor	Lower Boundary[1]	Upper Boundary[2]	m/s	See Plot[3]	Pass

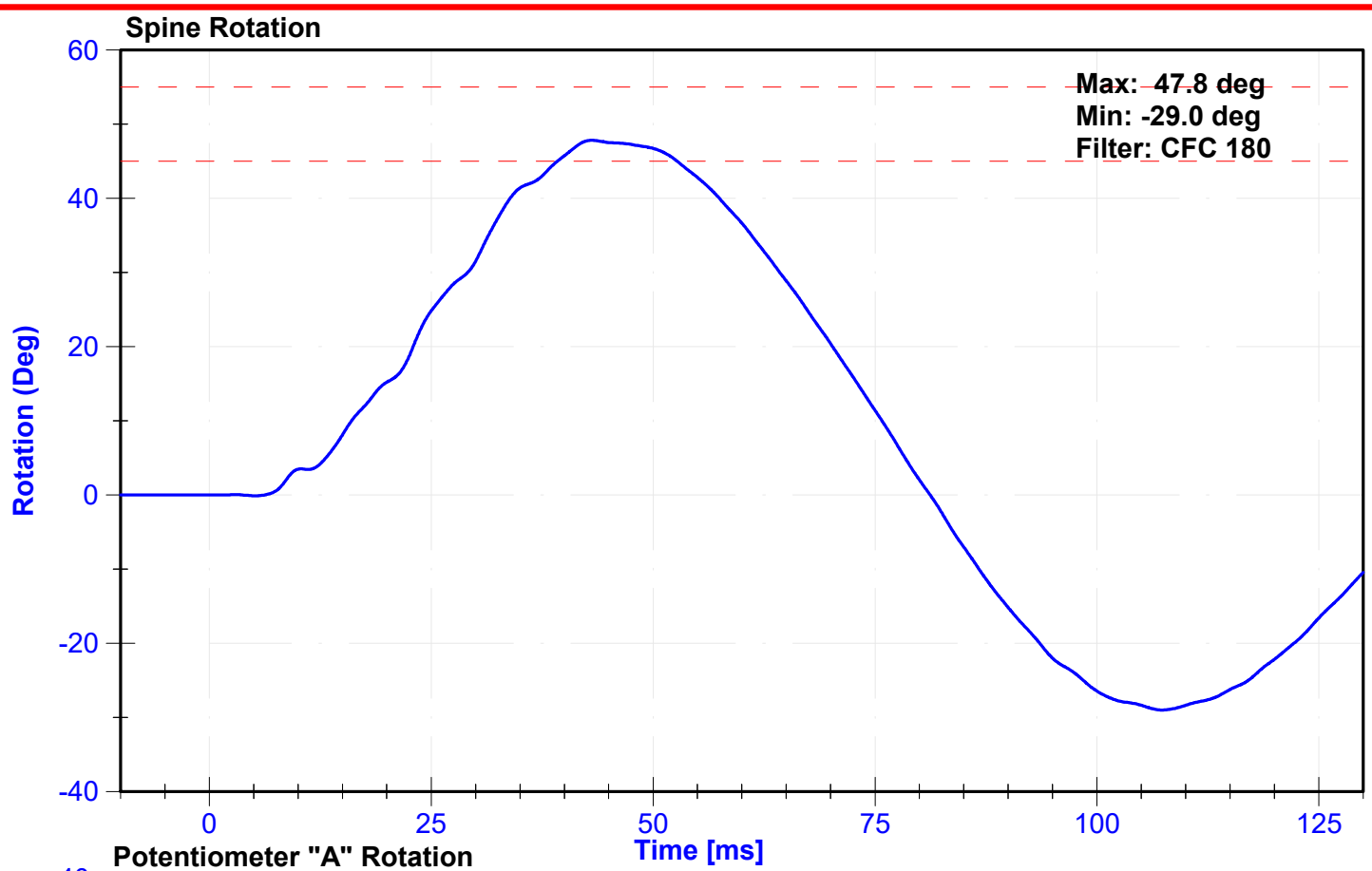
Transducer Calibrations

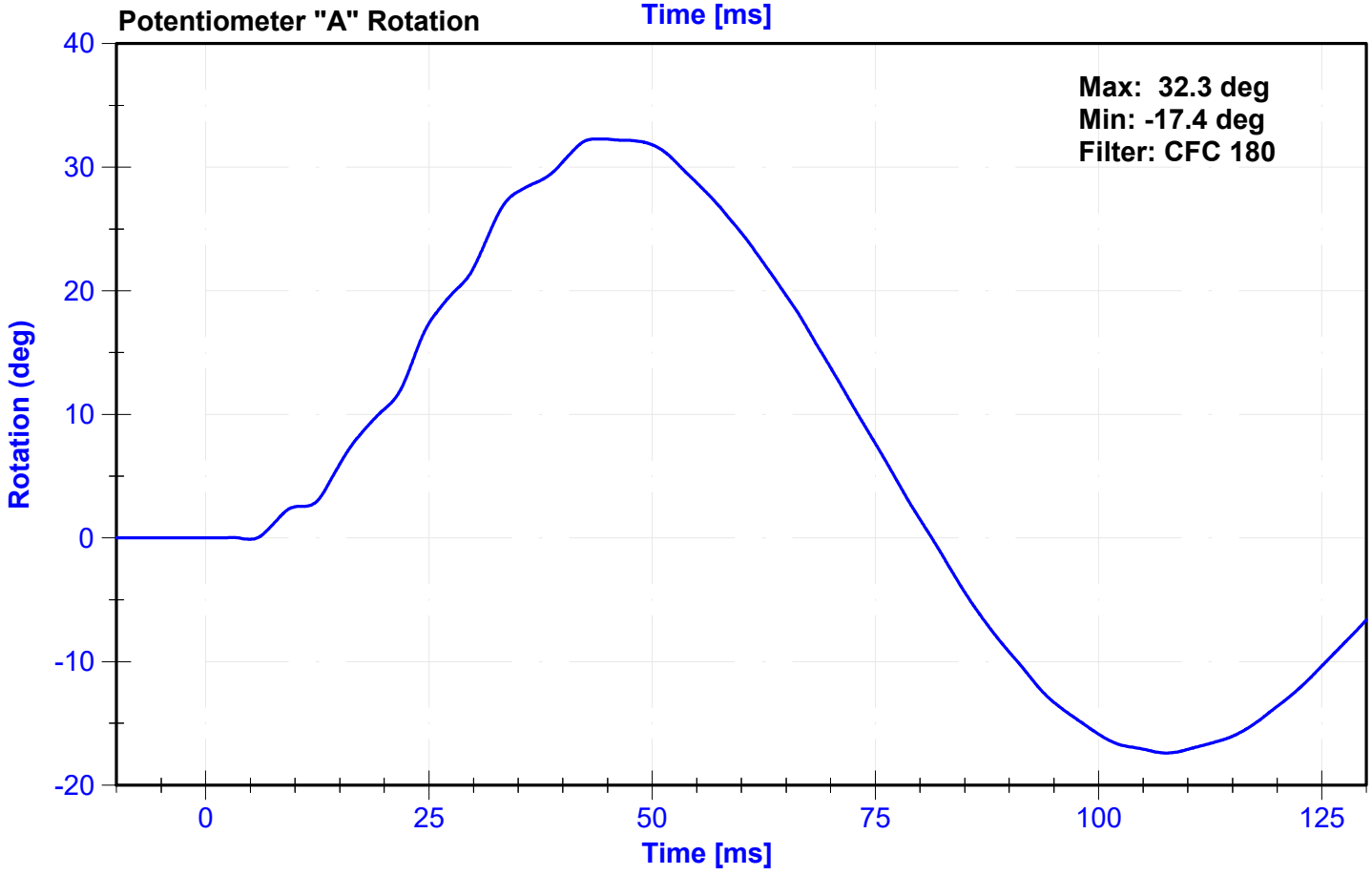
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16650	11/1/2024	11/1/2025
Pendulum "A" Potentiometer	Sfernice	2247	9/13/2024	9/13/2025
Condyle "B" Potentiometer	Sfernice	095	9/13/2024	9/13/2025

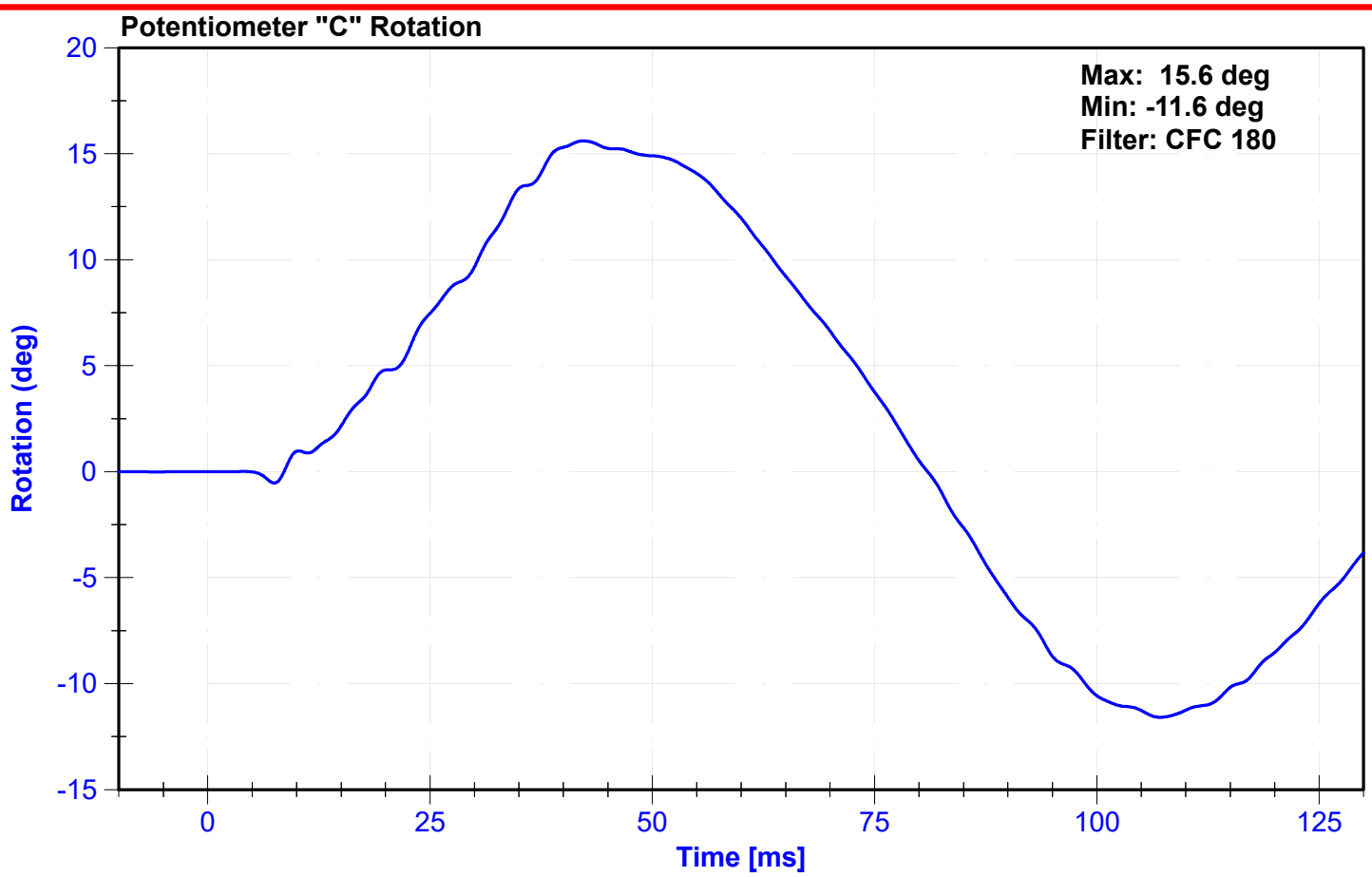
Pendulum Velocity[3]



[1,2] Upper and lower boundaries specified in Appendix I


Spine Rotation
Max: 47.8 deg
Min: -29.0 deg
Filter: CFC 180
Rotation (Deg)
60
40
20
0
-20
-40
0
25
50
75
100
125
Time [ms]


Potentiometer "A" Rotation
Max: 32.3 deg
Min: -17.4 deg
Filter: CFC 180
Rotation (deg)
40
30
20
10
0
-10
-20
0
25
50
75
100
125
Time [ms]



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

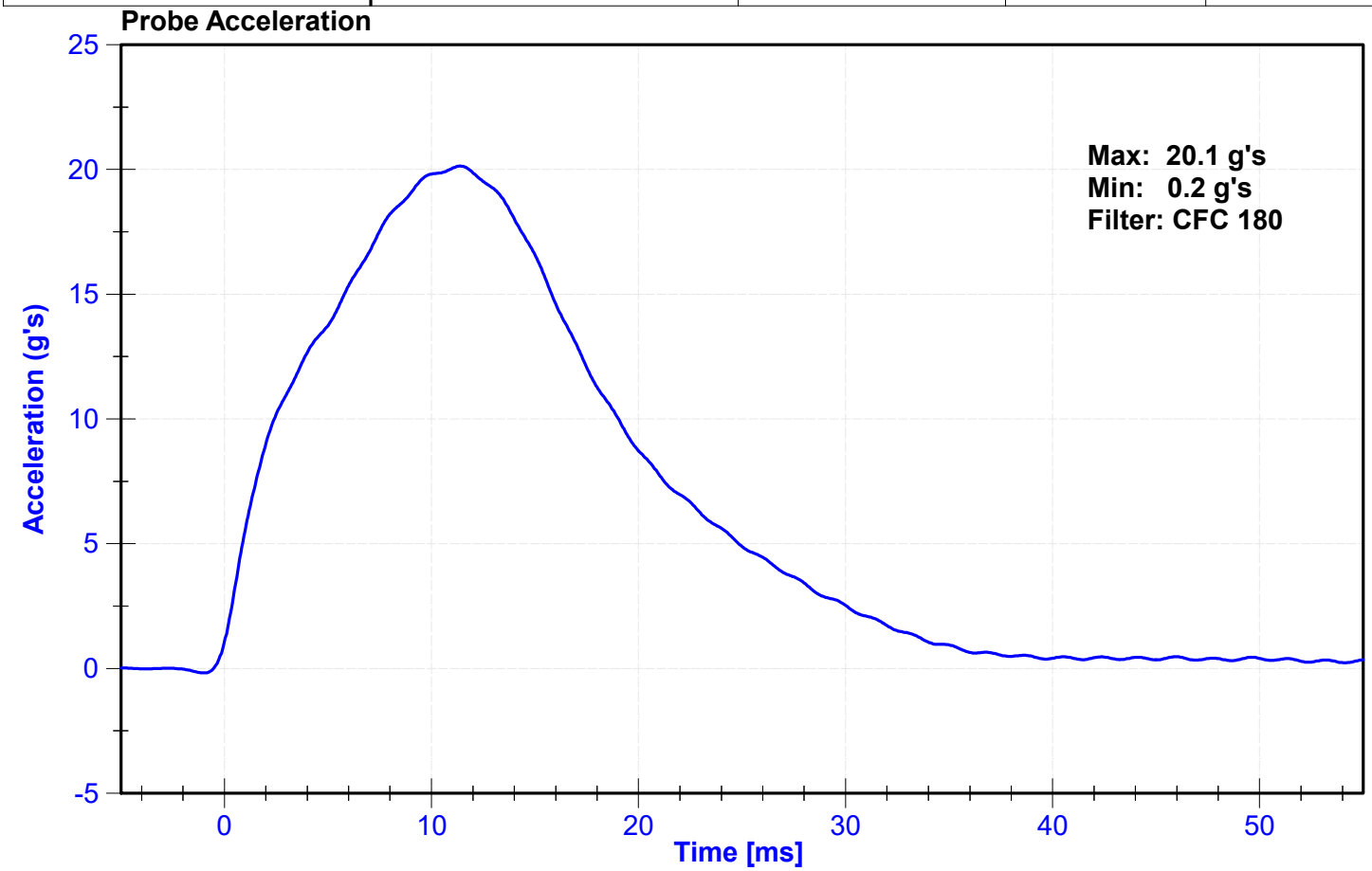
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

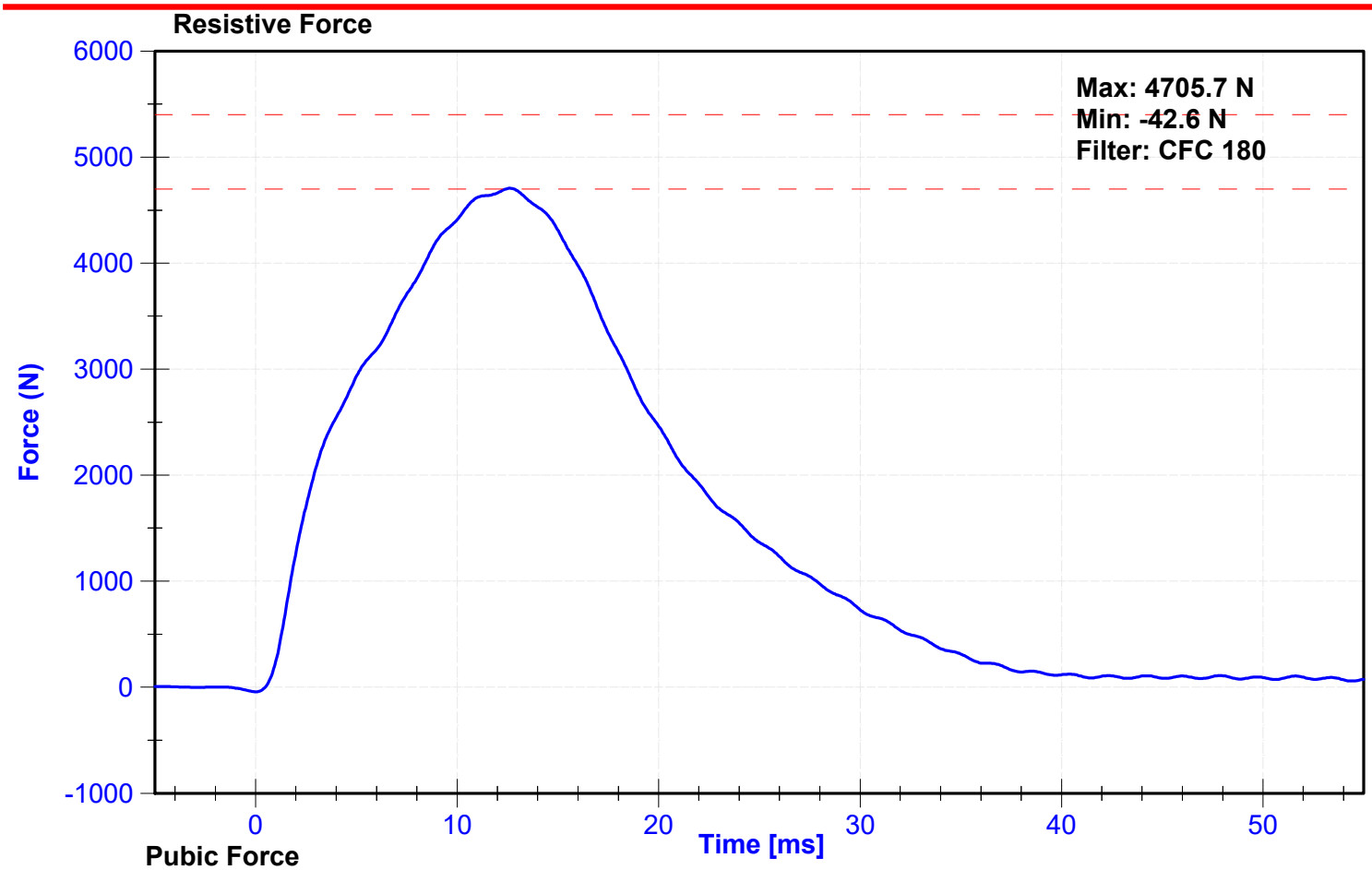
Results

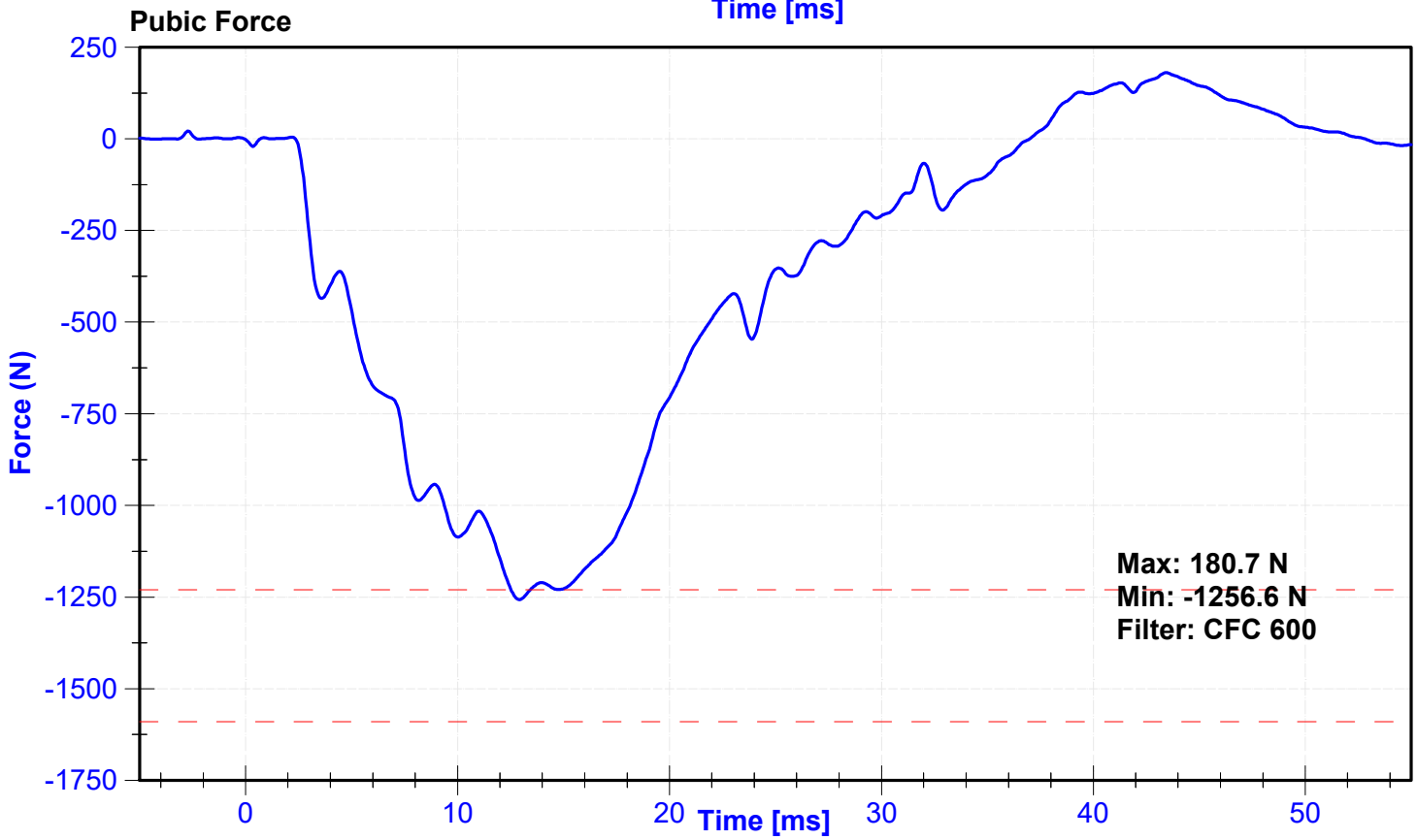
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.28	Pass
Resistive Force	4700	5400	N	4705.7	Pass
Time at Peak Resistive Force	11.8	16.1	ms	12.63	Pass
Pubic Force	-1590	-1230	N	-1256.6	Pass
Time at Peak Pubic Force	12.2	17.0	ms	12.92	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Pubic Load Cell	Denton	458-FY	10/28/2024	10/28/2025




Resistive Force
Max: 4705.7 N
Min: -42.6 N
Filter: CFC 180
Force (N)
6000
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]


Pubic Force
Max: 180.7 N
Min: -1256.6 N
Filter: CFC 600
Force (N)
250
0
-250
-500
-750
-1000
-1250
-1500
-1750
0
10
20
30
40
50
Time [ms]

CALIBRATION TEST RESULTS

PRE-TEST

SID-IIS 5TH PERCENTILE FEMALE – PASSENGER ATD

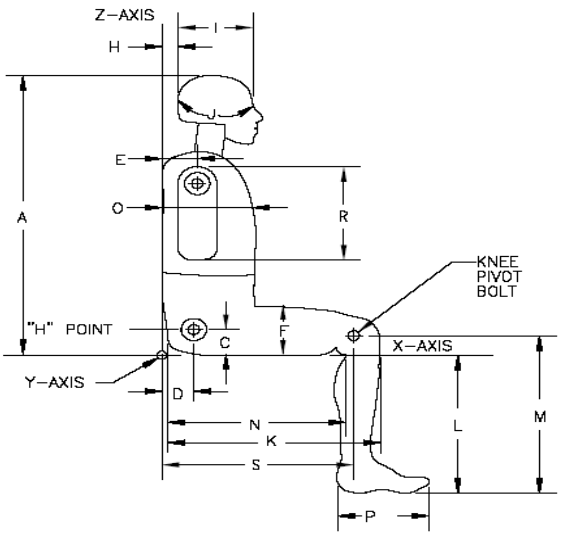
SERIAL NO:DG8012

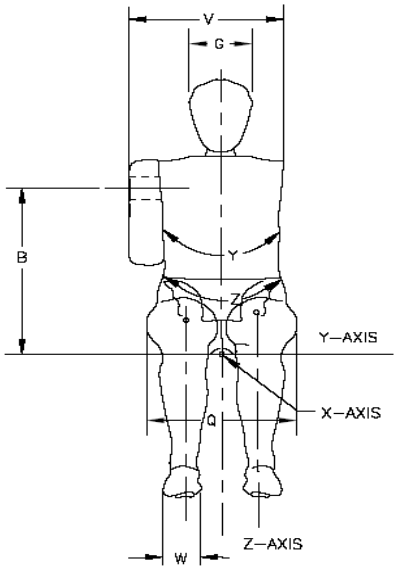
(CONFIGURED FOR LEFT SIDE IMPACT)

External Measurements - SID-IIs

Technician: J. Rios Date: 11/20/2024

Dummy Serial Number: DG8012





Symbol	Description	Specification (mm)		Result (mm)	Pass/Fail
A	Sitting Height	772	788	773	Pass
B	Shoulder Pivot Height	437	453	439	Pass
C	H-point Height	79	89	85	Pass
D	H-point from seatback	141	151	142	Pass
E	Shoulder Pivot from Backline	97	107	102	Pass
F	Thigh Clearance	119	135	122	Pass
G	Head Breadth	140	148	142	Pass
H	Head Back from Backline	40	46	44	Pass
I	Head Depth	178	188	184	Pass
J	Head Circumference	541	551	550	Pass
K	Buttock to Knee Length	514	540	519	Pass
L	Popliteal Height	343	369	351	Pass
M	Knee Pivot to floor height	392	409	402	Pass
N	Buttock Popliteal Length	416	442	427	Pass
O	Chest Depth w/o jacket	195	211	200	Pass
P	Foot Length	216	232	226	Pass
Q	Hip Breadth (w/pelvic plugs)	313	323	318	Pass
R	Arm Length	249	259	254	Pass
S	Knee Joint to seatback	477	493	481	Pass
V	Shoulder Width	341	357	352	Pass
W	Foot Width	78	94	87	Pass
Y	Chest Circumference w/jacket	851	881	873	Pass
Z	Waist Circumference	761	791	781	Pass

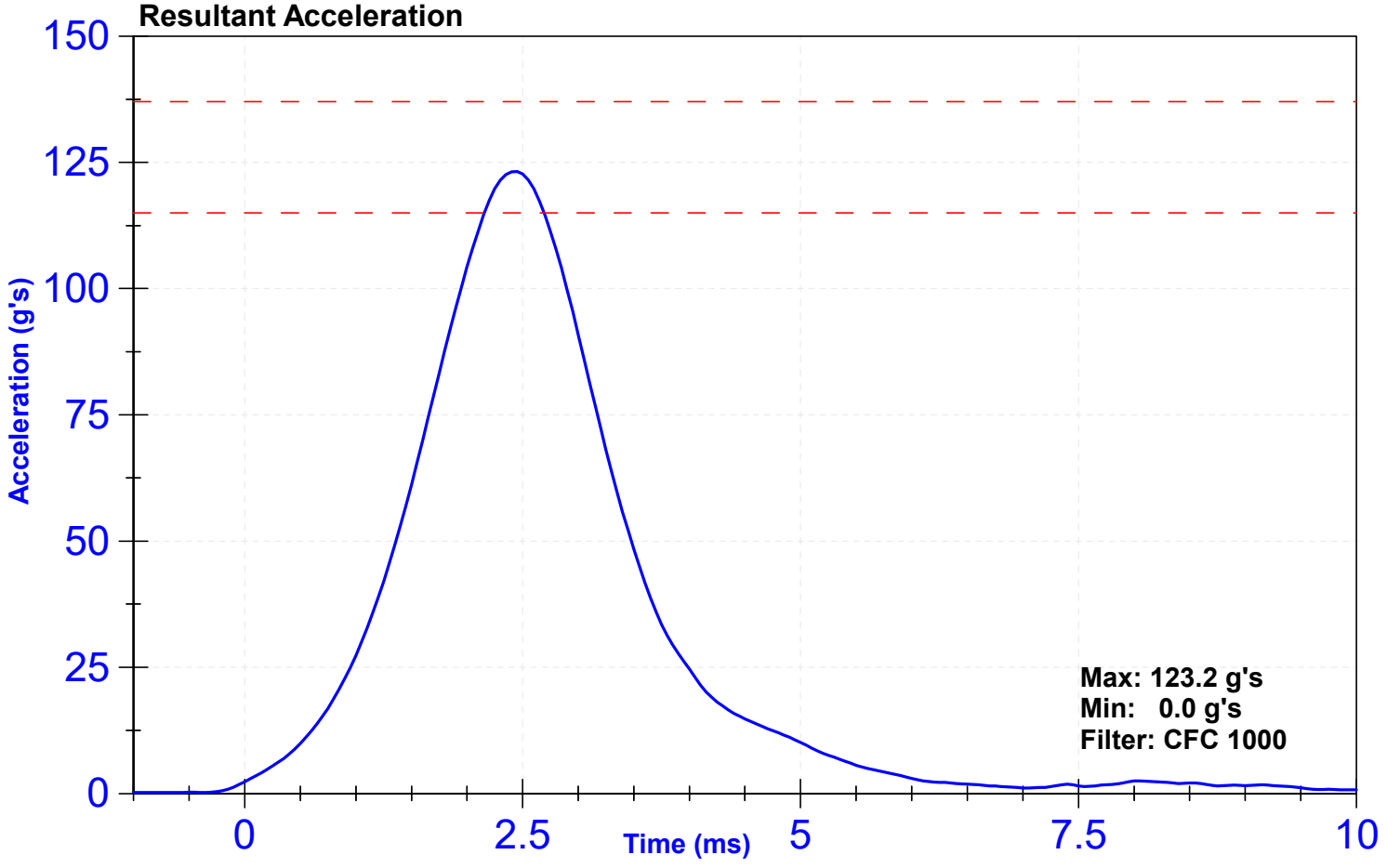
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

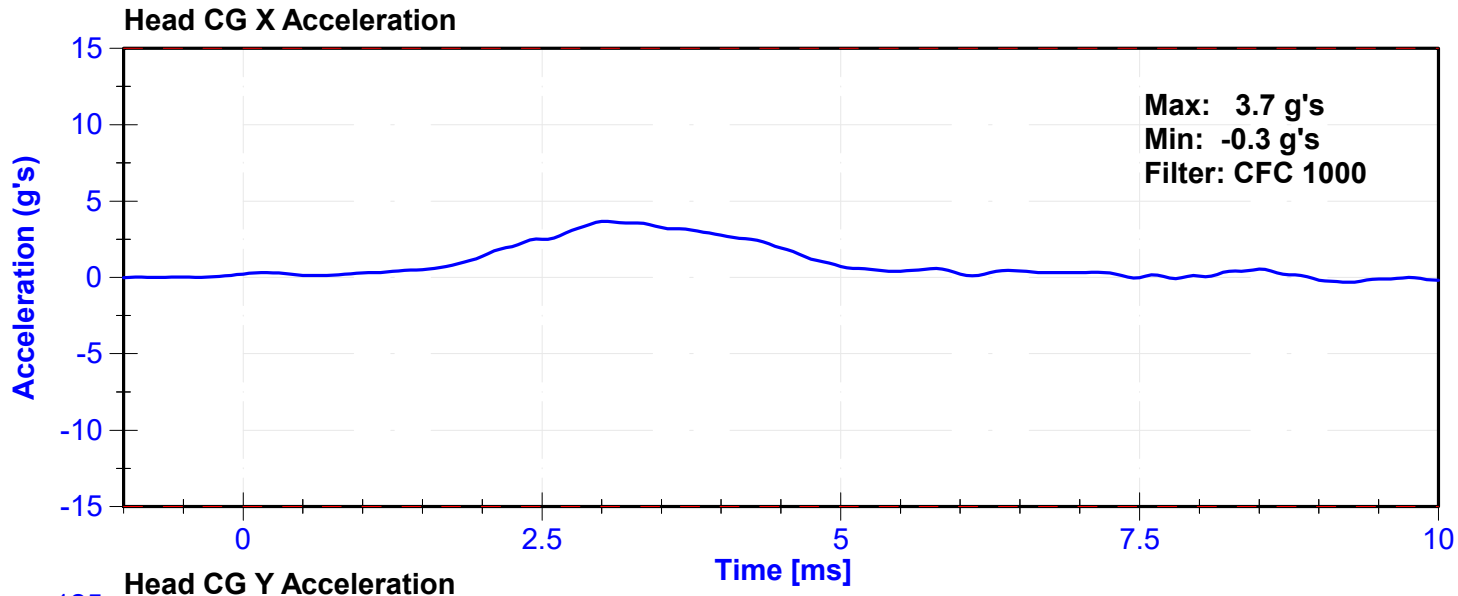
Results

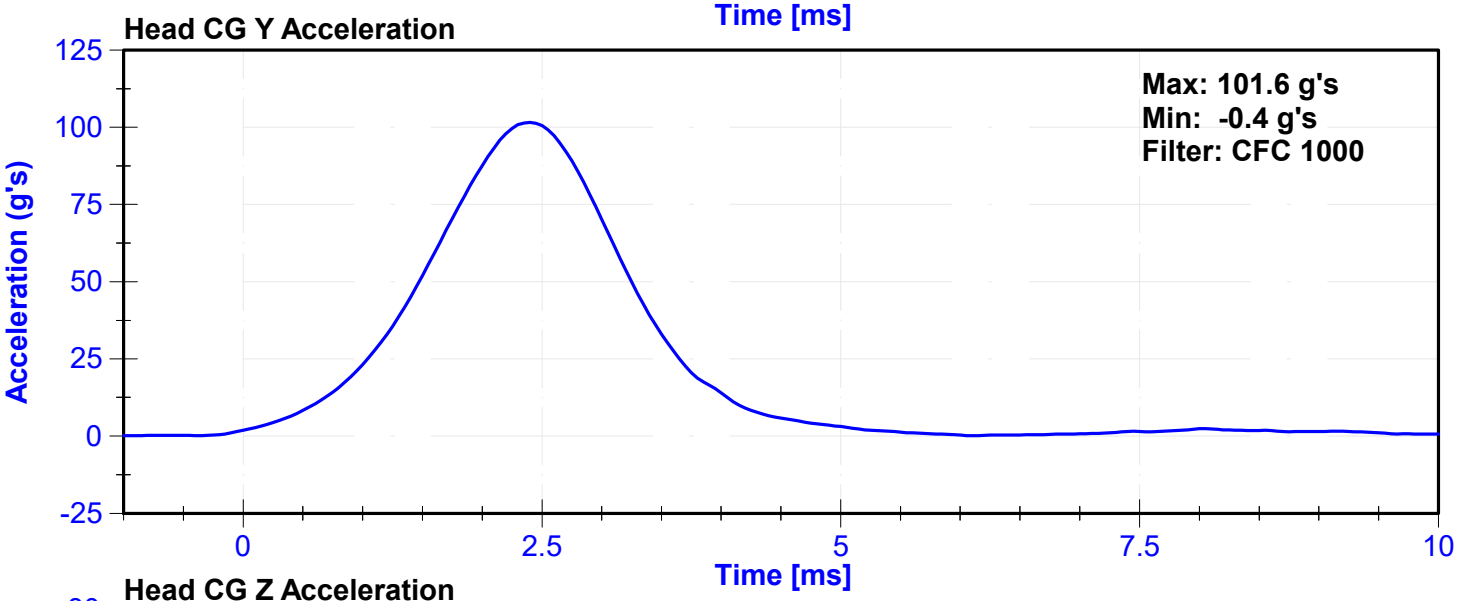
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.7	Pass
Humidity	10	70	%	31	Pass
Resultant Acceleration	115	137	g's	123.2	Pass
Oscillation	0	15	%	2.0	Pass
Fore-Aft Acceleration	-15	15	g's	3.7	Pass

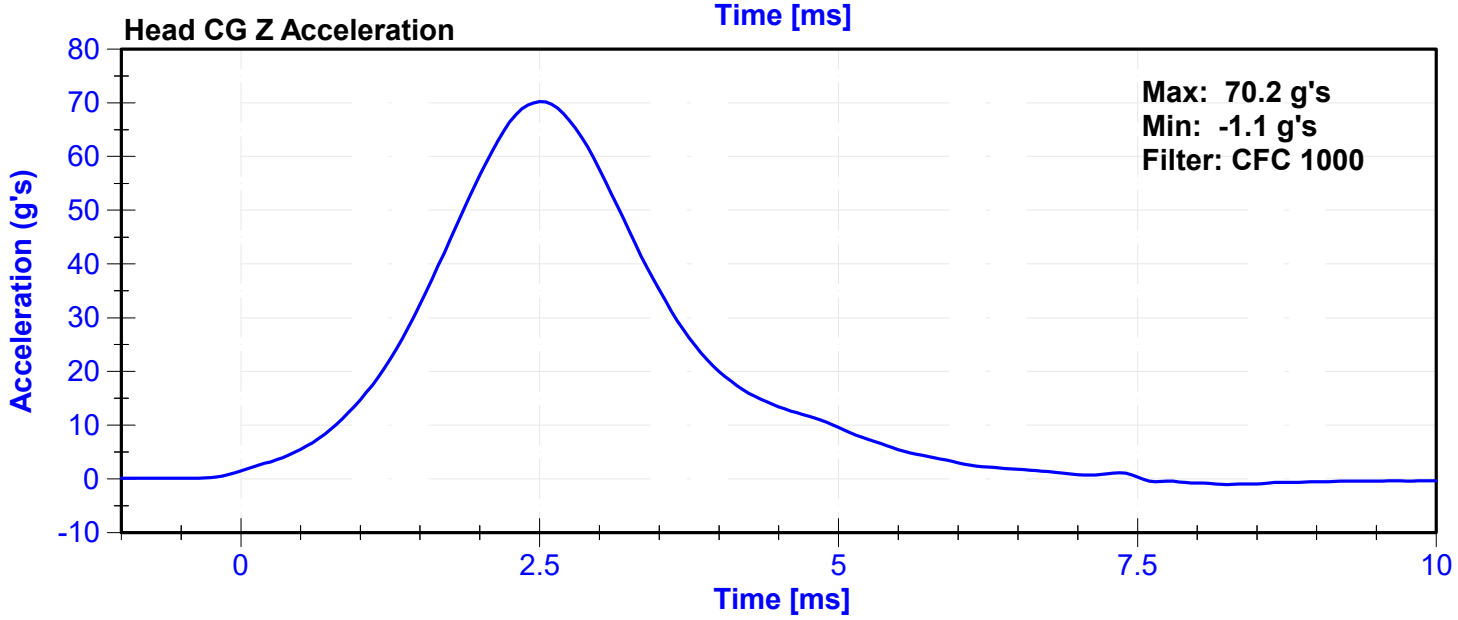
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibratio Date	Calibratio Due Date
X Accelerometer	Endevco	T21184	10/17/2024	4/15/2025
Y Accelerometer	Endevco	T31030	10/17/2024	4/15/2025
Z Accelerometer	Endevco	P83319	10/17/2024	4/15/2025




Head CG X Acceleration
Max: 3.7 g's
Min: -0.3 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]


Head CG Y Acceleration
Max: 101.6 g's
Min: -0.4 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]


Head CG Z Acceleration
Max: 70.2 g's
Min: -1.1 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]

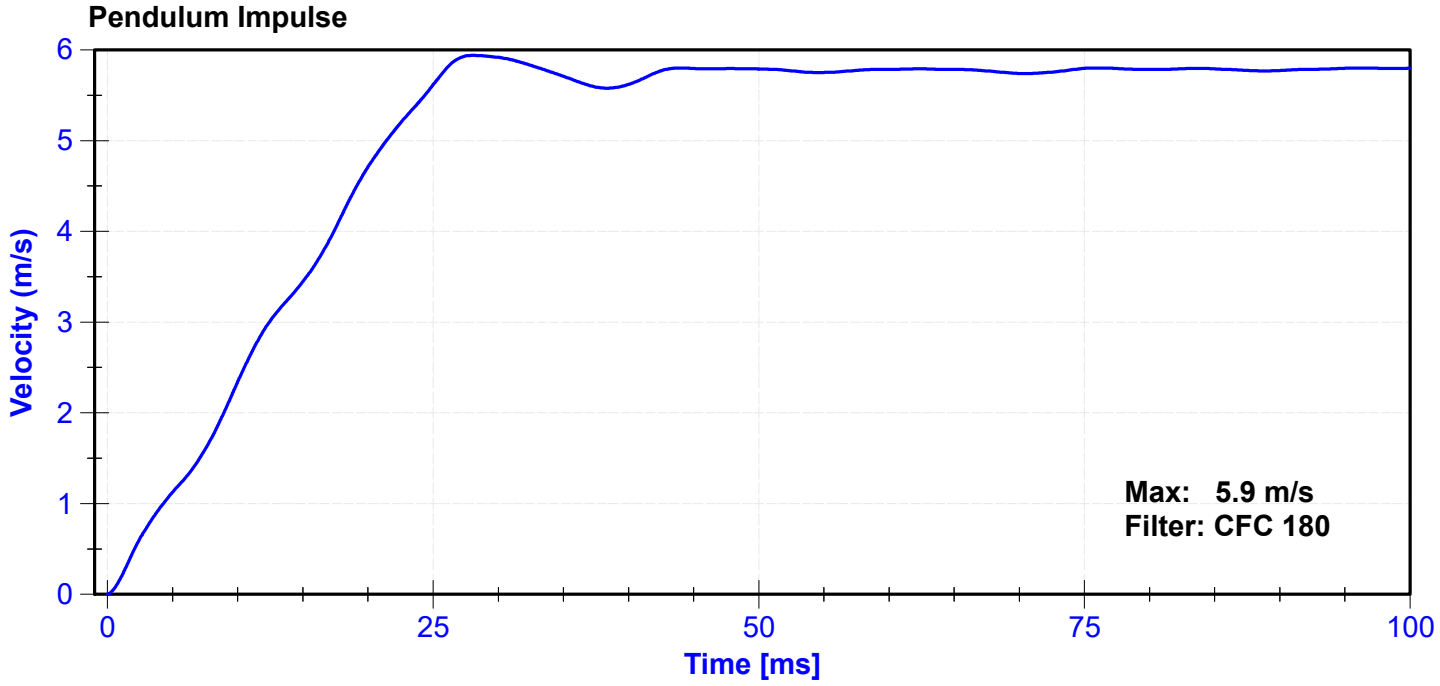
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

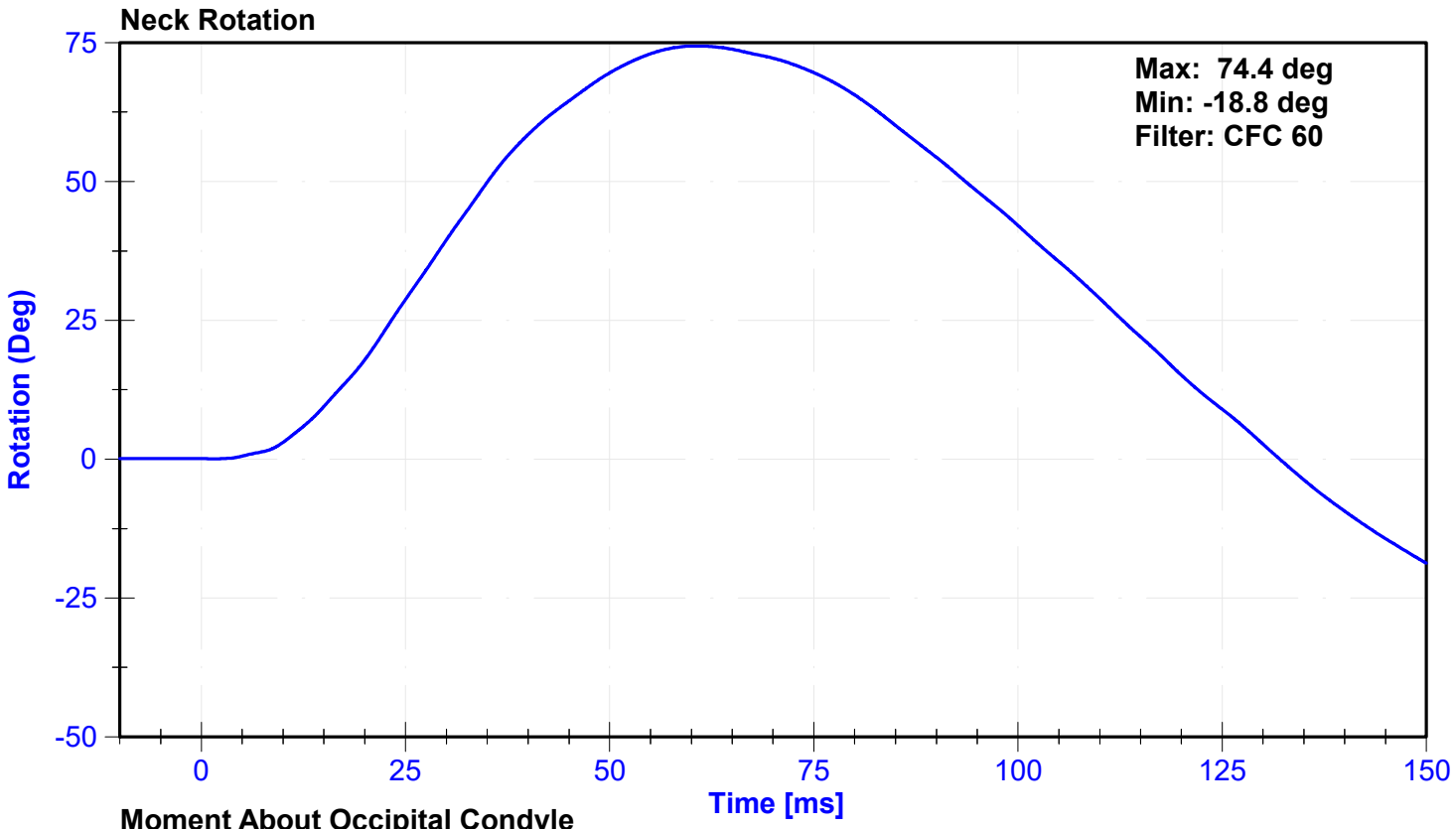
Results

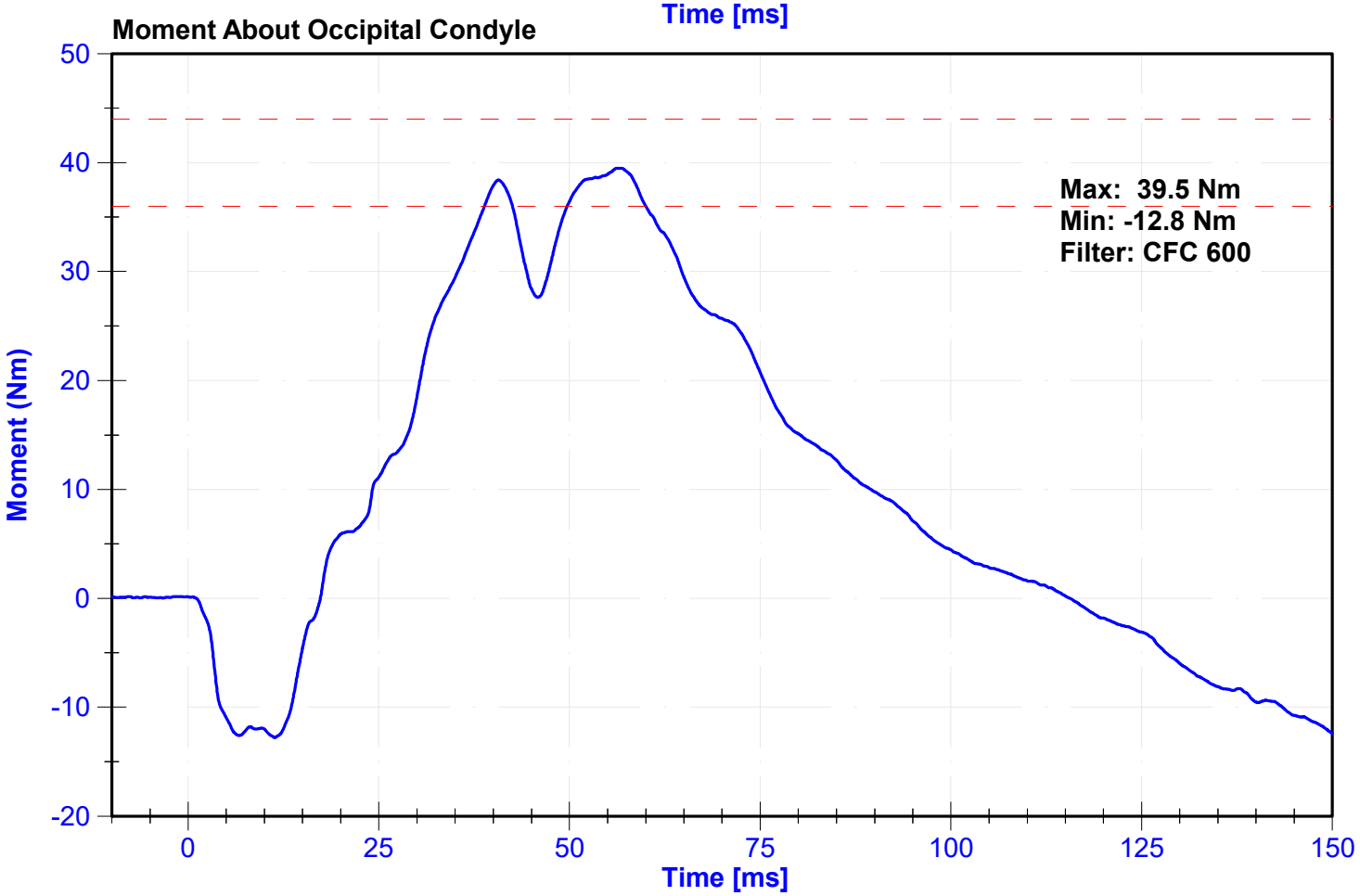
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.8	Pass
Humidity	10	70	%	32	Pass
Velocity	5.51	5.63	m/s	5.567	Pass
Pendulum Impulse at 10ms	2.2	2.8	m/s	2.35	Pass
Pendulum Impulse at 15ms	3.3	4.1	m/s	3.45	Pass
Pendulum Impulse at 20ms	4.4	5.4	m/s	4.71	Pass
Pendulum Impulse at 25ms	5.4	6.1	m/s	5.61	Pass
Pendulum Impulse from 25 to 100ms	5.5	6.2	m/s	5.94	Pass
Neck Rotation	71	81	deg	74.4	Pass
Time at Maximum Rotation	50	70	ms	60.6	Pass
Moment about the OC	36	44	Nm	39.5	Pass
Moment Decay to 0 Nm	102	126	ms	115.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231C-750	11/1/2024	11/1/2025
Pendulum Potentiometer	Servo	4961	9/23/2024	9/23/2025
Condyle Potentiometer	Servo	DS185	9/23/2024	9/23/2025
Upper Neck Load Cell	Denton	1716A_2187-FY	12/5/2023	12/4/2024




Neck Rotation
Max: 74.4 deg
Min: -18.8 deg
Filter: CFC 60
Rotation (Deg)
75
50
25
0
-25
-50
0
25
50
75
100
125
150
Time [ms]


Moment About Occipital Condyle
Max: 39.5 Nm
Min: -12.8 Nm
Filter: CFC 600
Moment (Nm)
50
40
30
20
10
0
-10
-20
0
25
50
75
100
125
150
Time [ms]

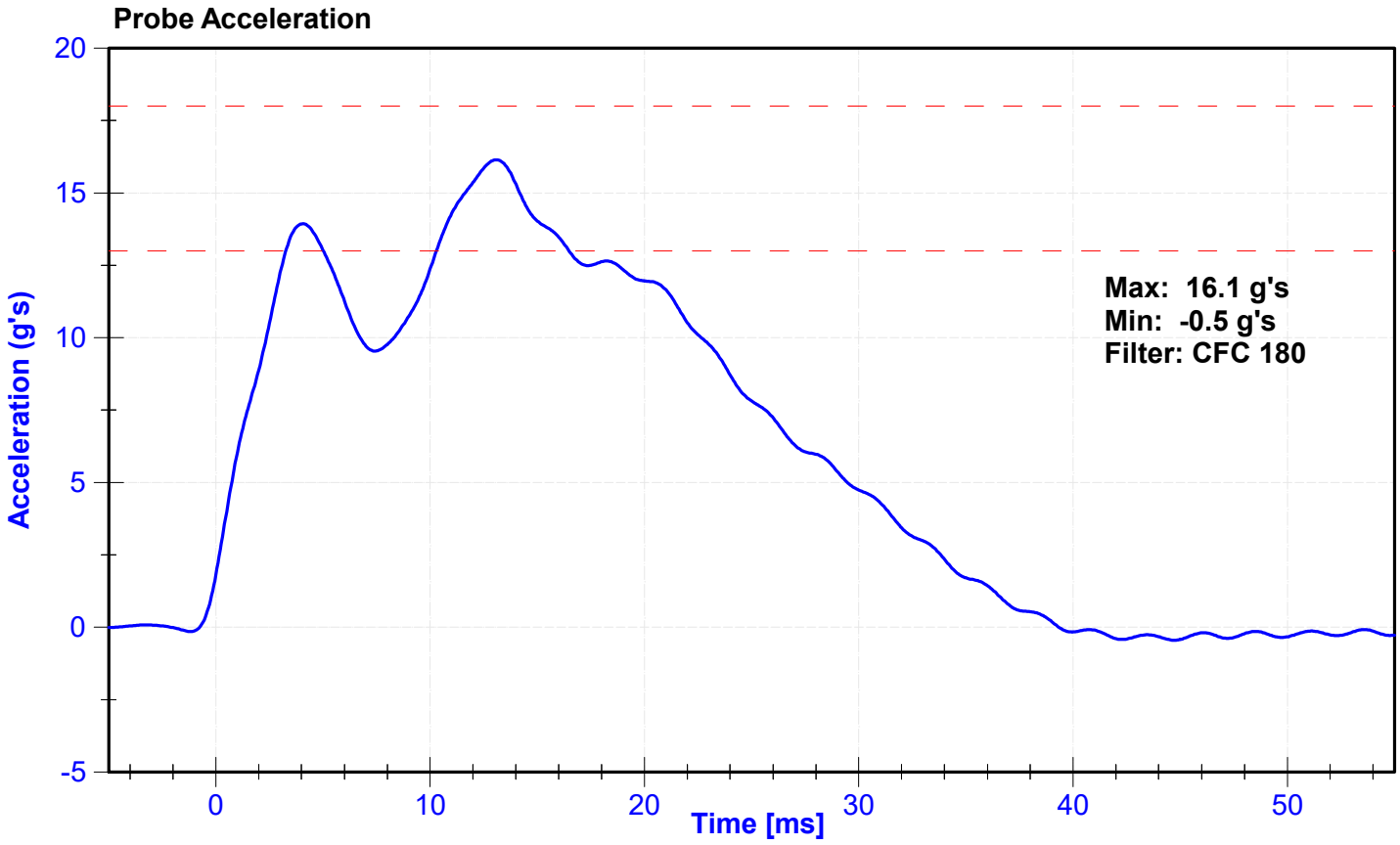
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

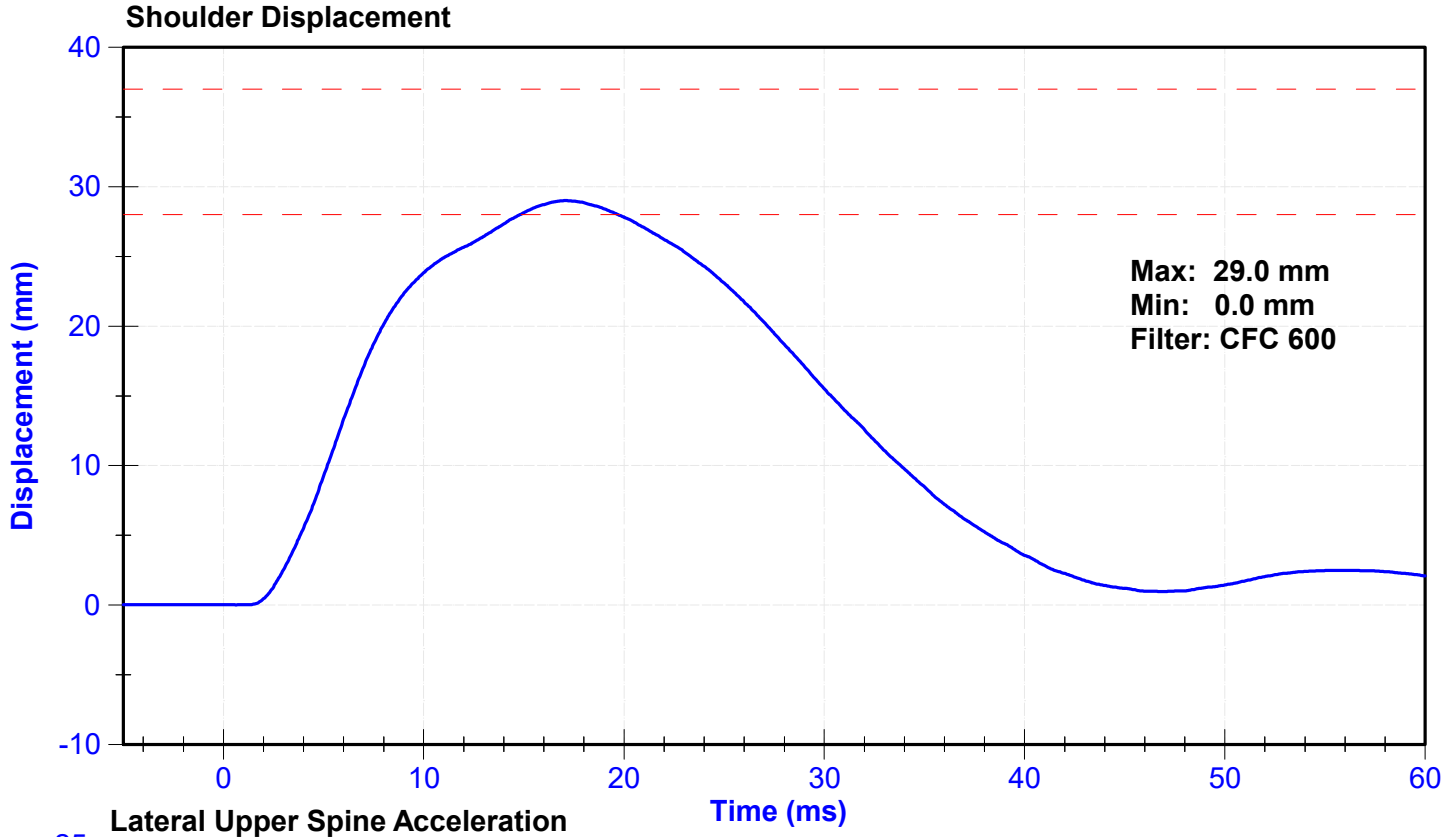
Results

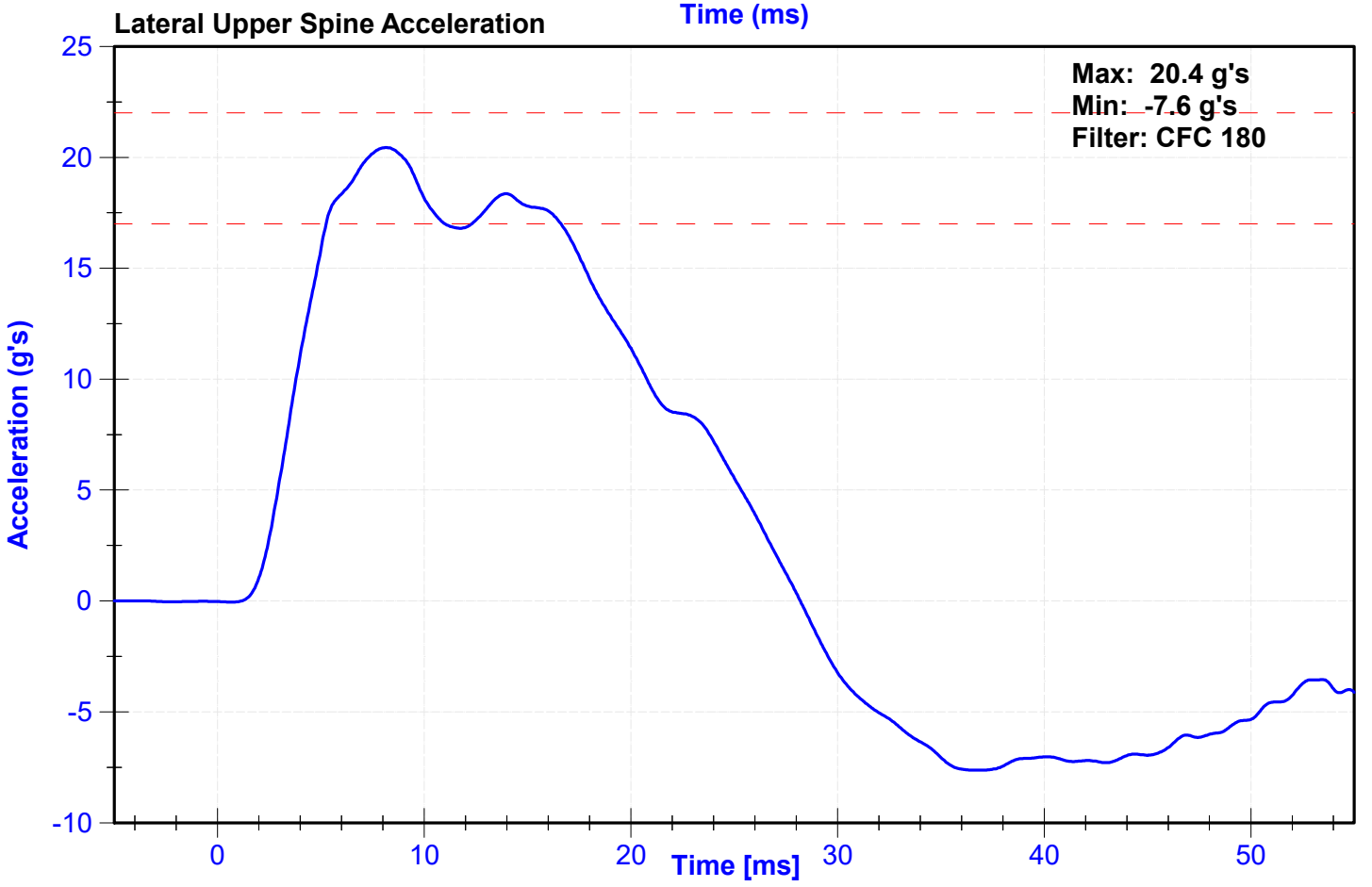
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.29	Pass
Probe Acceleration	13	18	g's	16.1	Pass
Shoulder Deflection	28	37	mm	29.0	Pass
Lateral Upper Spine Acceleration	17	22	g's	20.4	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Shoulder Potentiometer	Servo	1274GFE	10/16/2024	4/16/2025
Upper Spine Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025




Shoulder Displacement
Displacement (mm)
Time (ms)
Max: 29.0 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 20.4 g's
Min: -7.6 g's
Filter: CFC 180

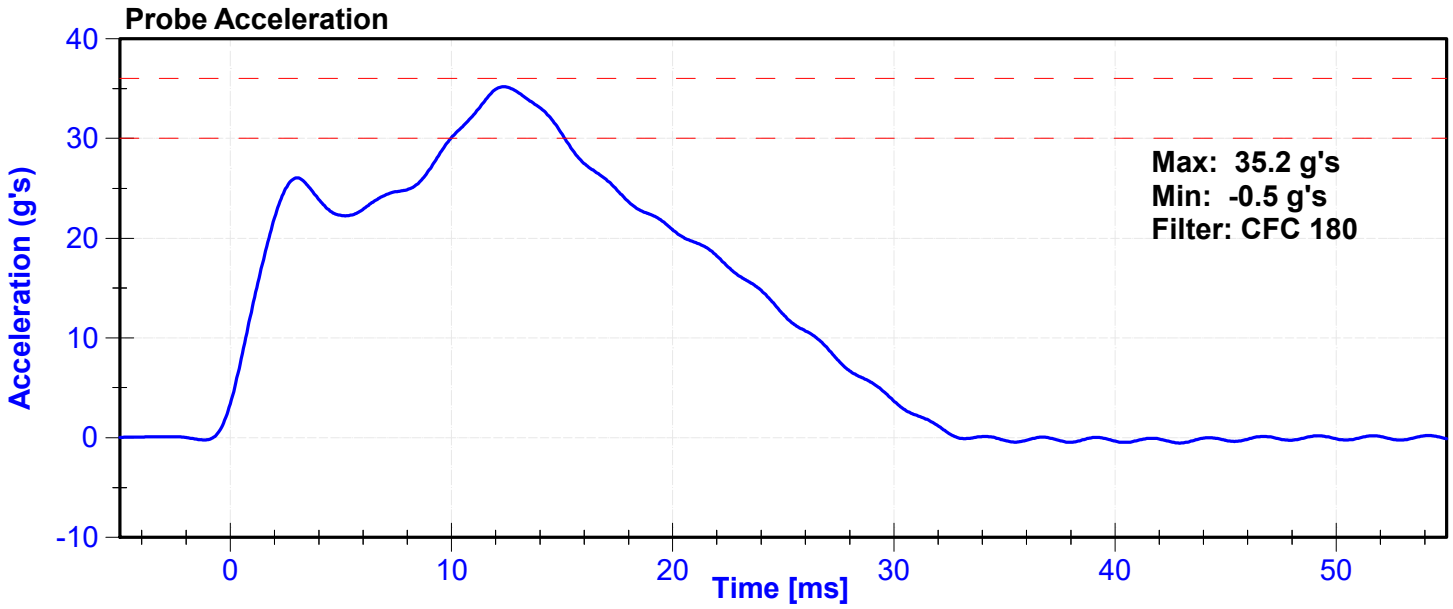
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

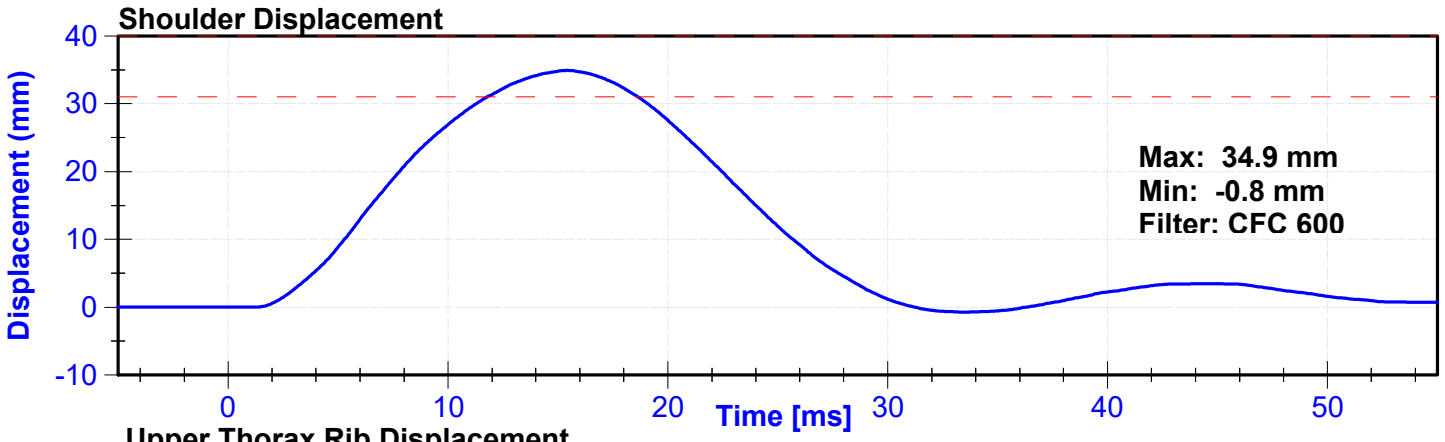
Results

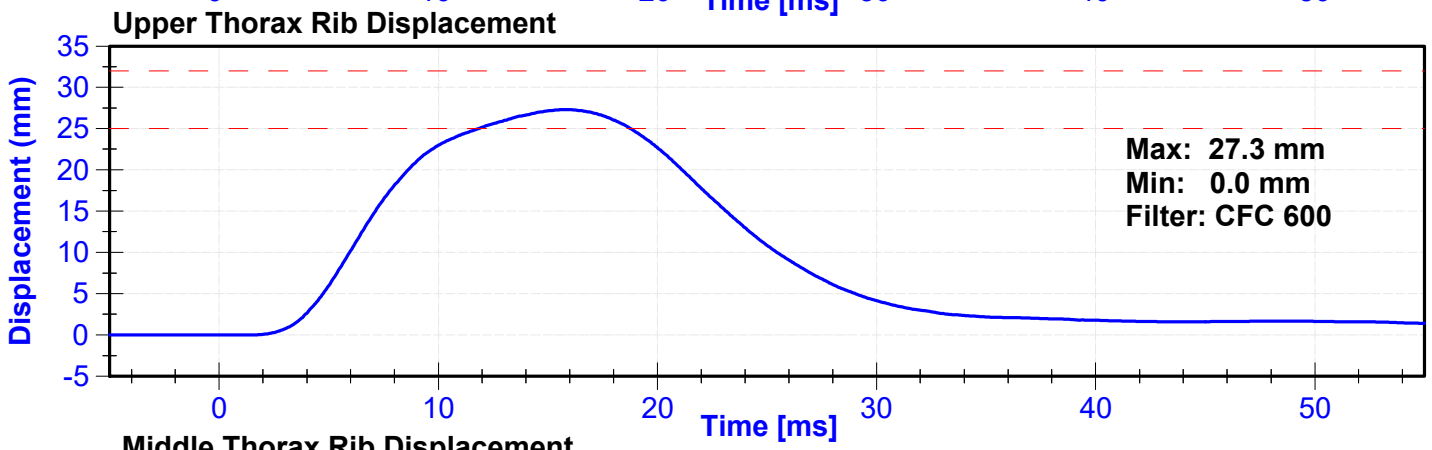
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	6.6	6.8	m/s	6.68	Pass
Probe Acceleration after 5 ms	30	36	g's	35.2	Pass
Lateral Upper Spine Acceleration	34	43	g's	38.6	Pass
Lateral Lower Spine Acceleration	29	37	g's	34.1	Pass
Shoulder Deflection	31	40	mm	34.9	Pass
Upper Thorax Rib Deflection	25	32	mm	27.3	Pass
Mid Thorax Rib Deflection	30	36	mm	30.7	Pass
Lower Thorax Rib Deflection	32	38	mm	32.9	Pass

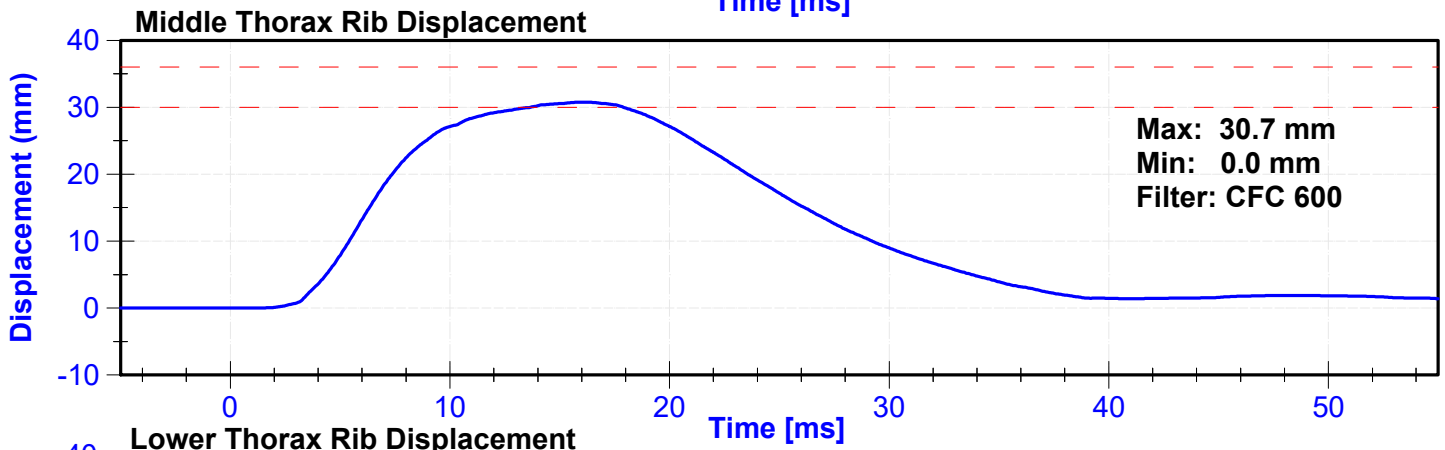
Transducer Calibrations

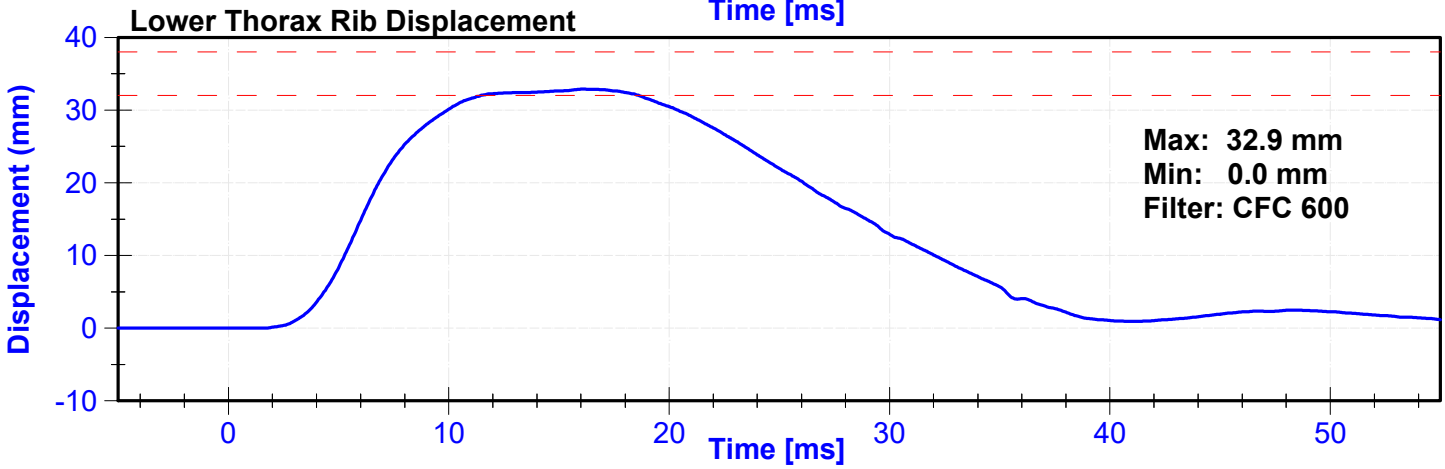
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Upper Spine T1 Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025
Upper Spine T12 Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Shoulder Potentiometer	Servo	1274GFE	10/16/2024	4/16/2025
Upper Thorax Rib Potentiometer	Servo	1199GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Servo	1246GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Servo	011GFE	10/16/2024	4/16/2025

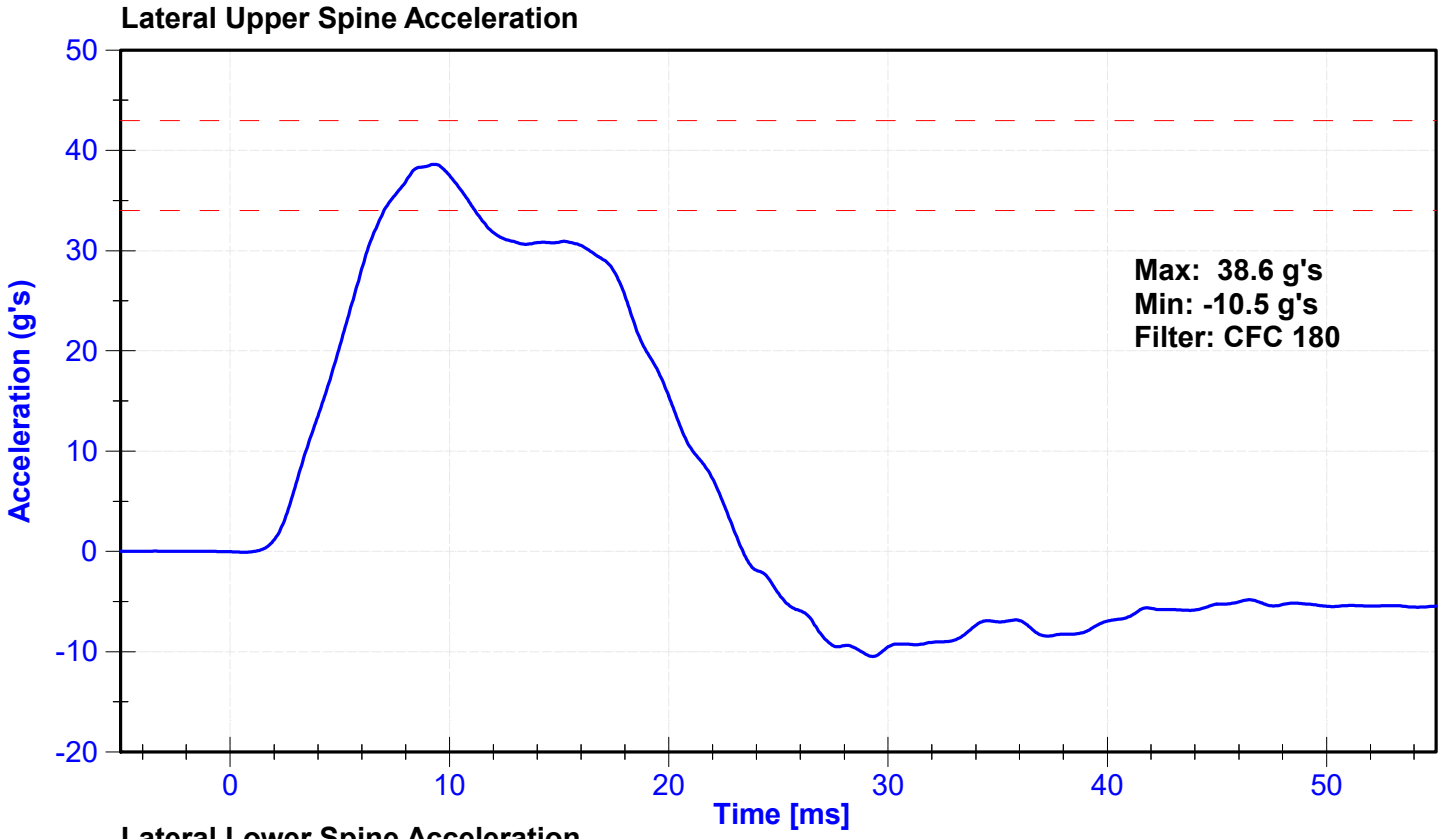


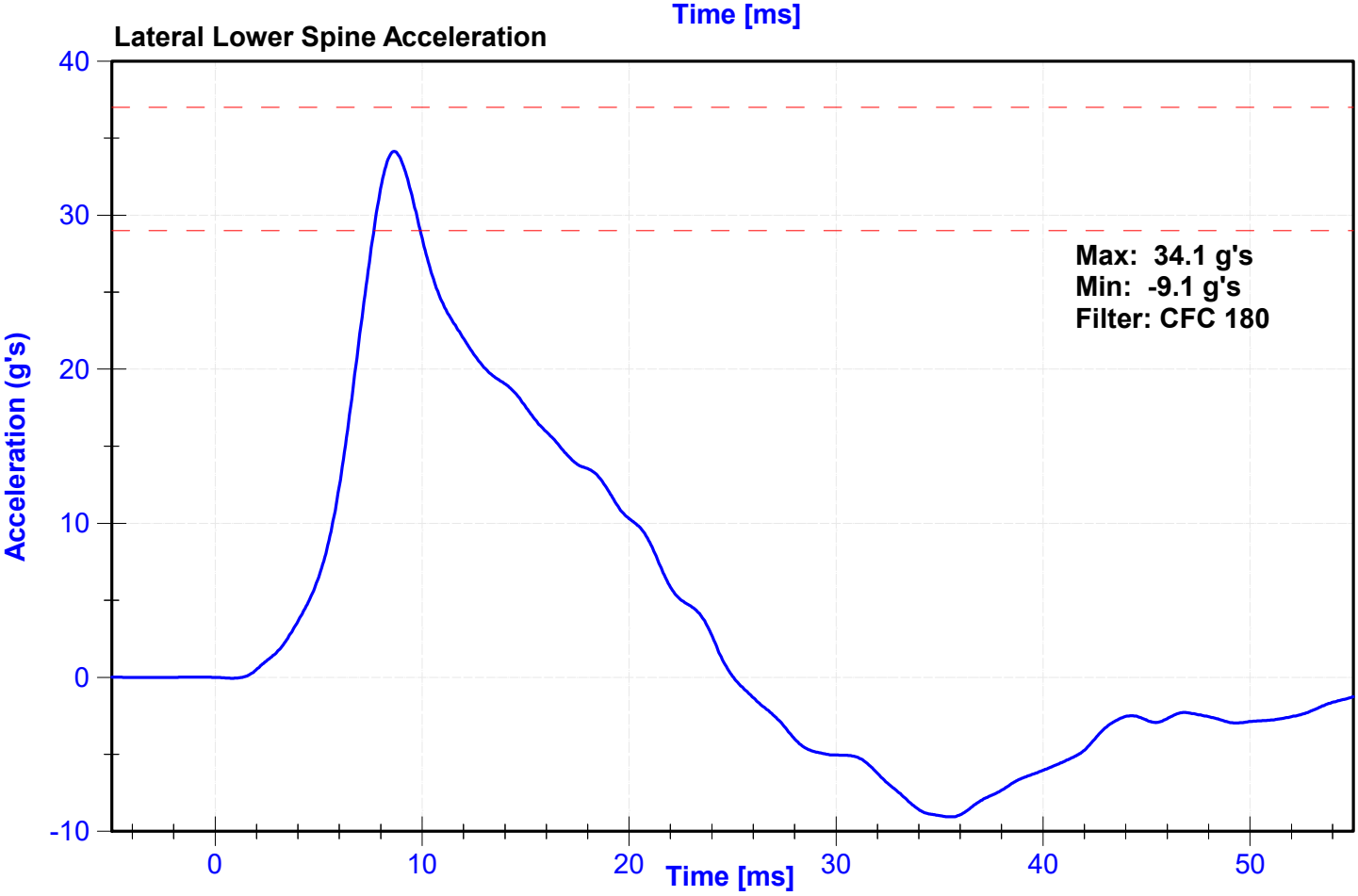

Shoulder Displacement
Displacement (mm)
Time [ms]
Max: 34.9 mm
Min: -0.8 mm
Filter: CFC 600


Upper Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 27.3 mm
Min: 0.0 mm
Filter: CFC 600


Middle Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 30.7 mm
Min: 0.0 mm
Filter: CFC 600


Lower Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 32.9 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 38.6 g's
Min: -10.5 g's
Filter: CFC 180


Lateral Lower Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 34.1 g's
Min: -9.1 g's
Filter: CFC 180

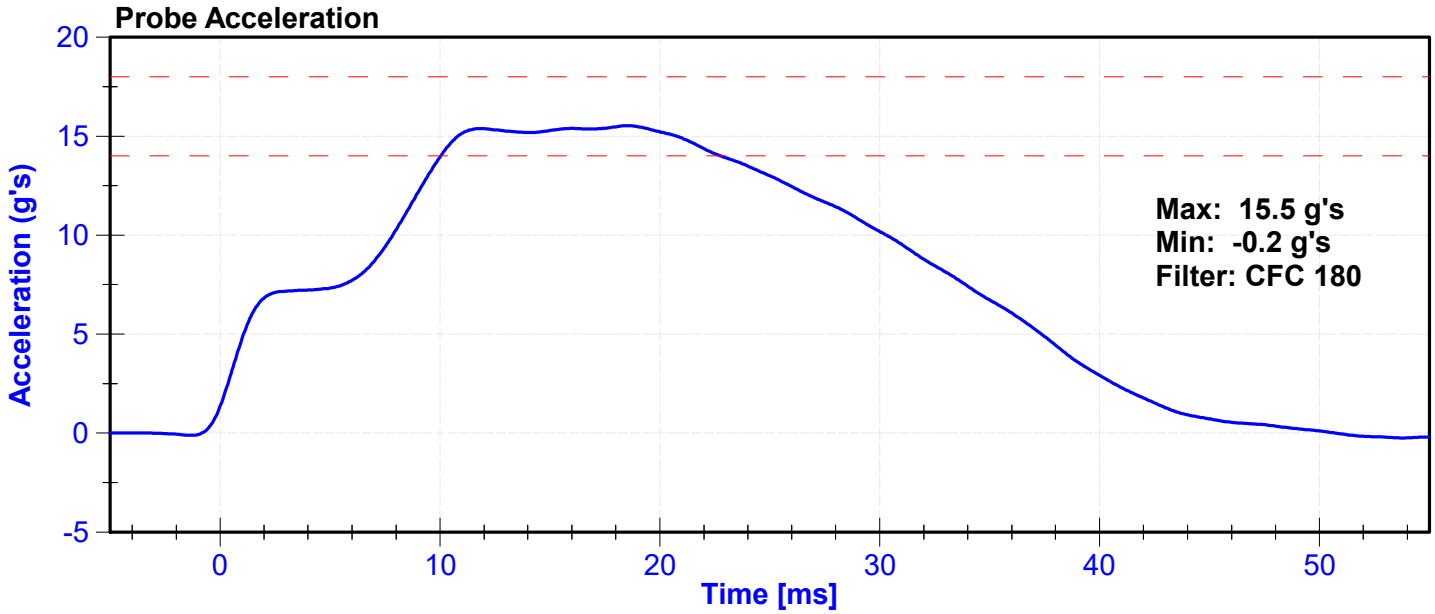
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

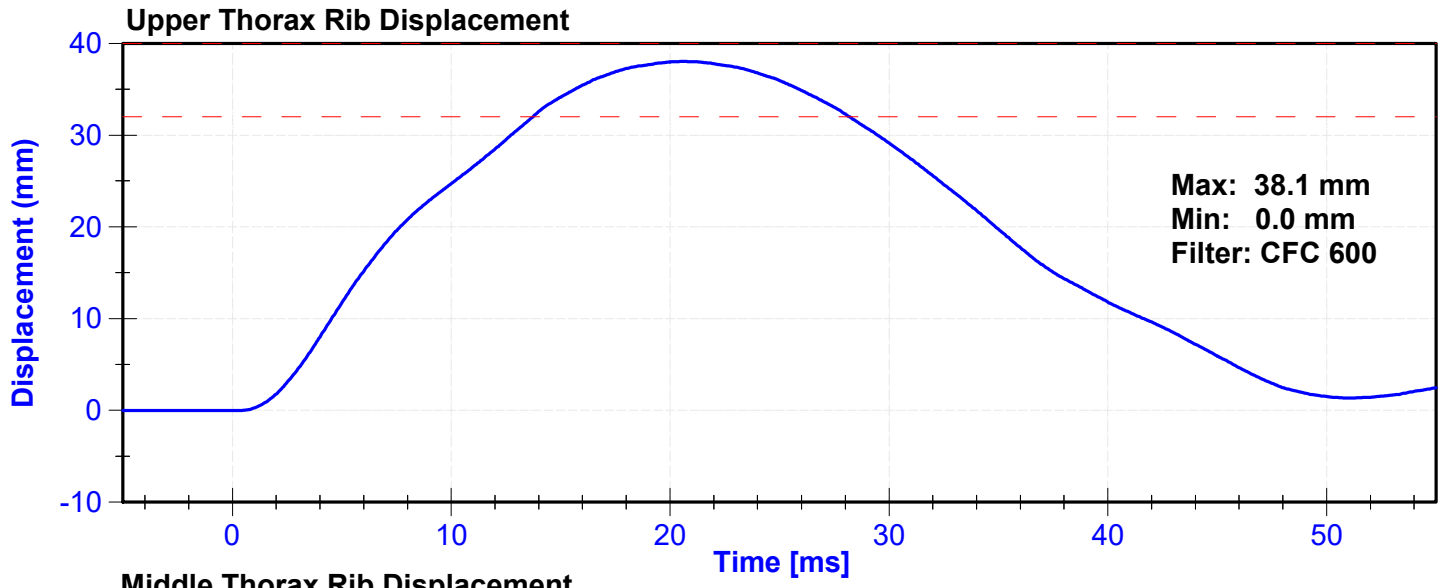
Results

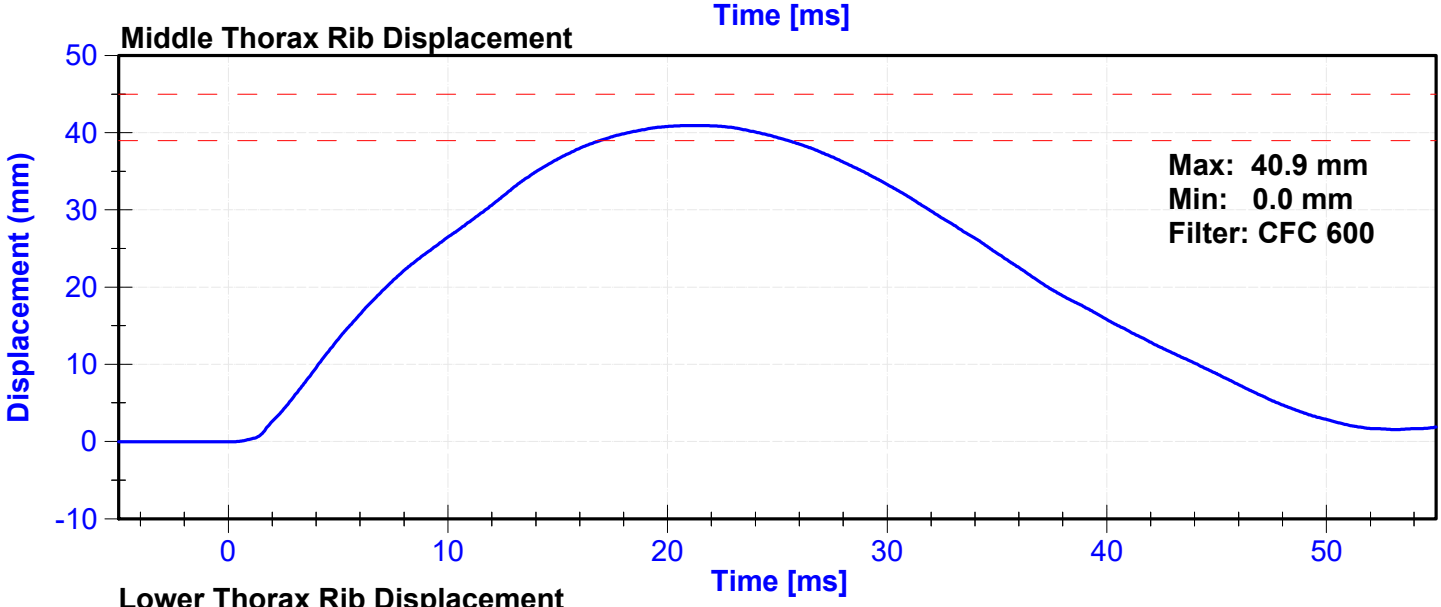
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.27	Pass
Probe Acceleration	14	18	g's	15.5	Pass
Lateral Upper Spine Acceleration	13	17	g's	14.6	Pass
Lateral Lower Spine Acceleration	7	11	g's	9.1	Pass
Upper Thorax Rib Deflection	32	40	mm	38.1	Pass
Middle Thorax Rib Deflection	39	45	mm	40.9	Pass
Lower Thorax Rib Deflection	35	43	mm	37.1	Pass

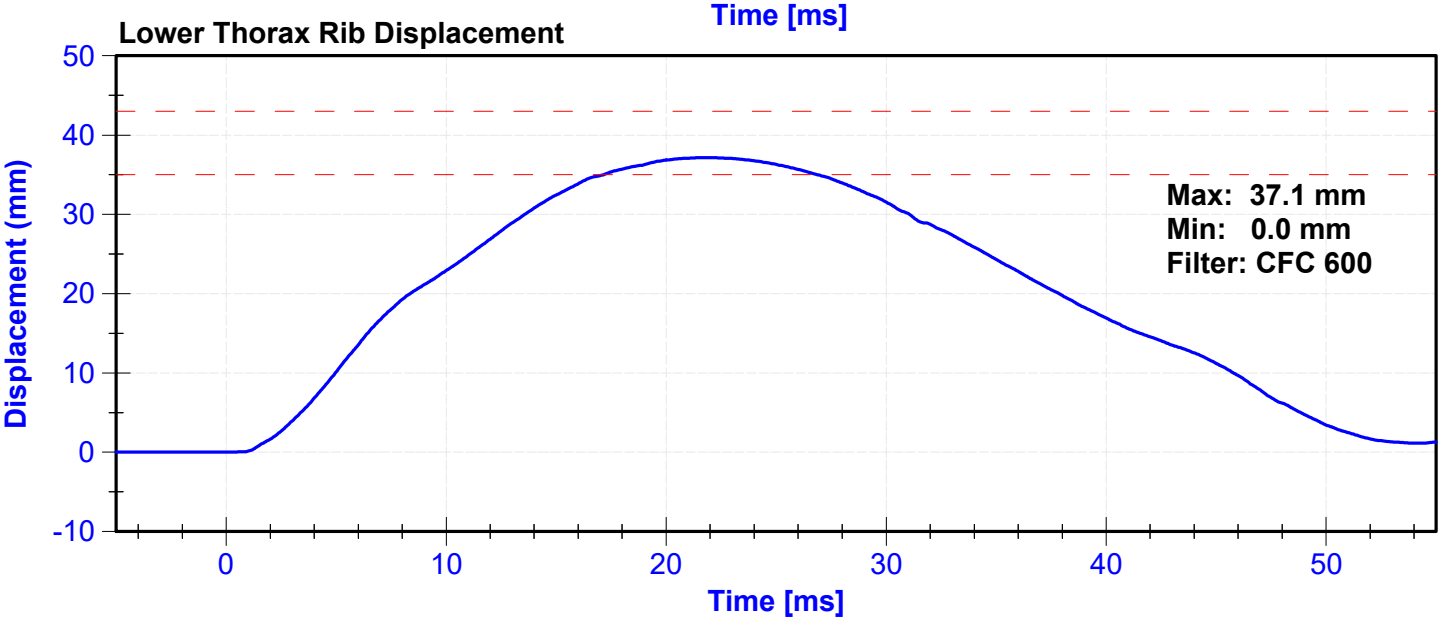
Transducer Calibrations

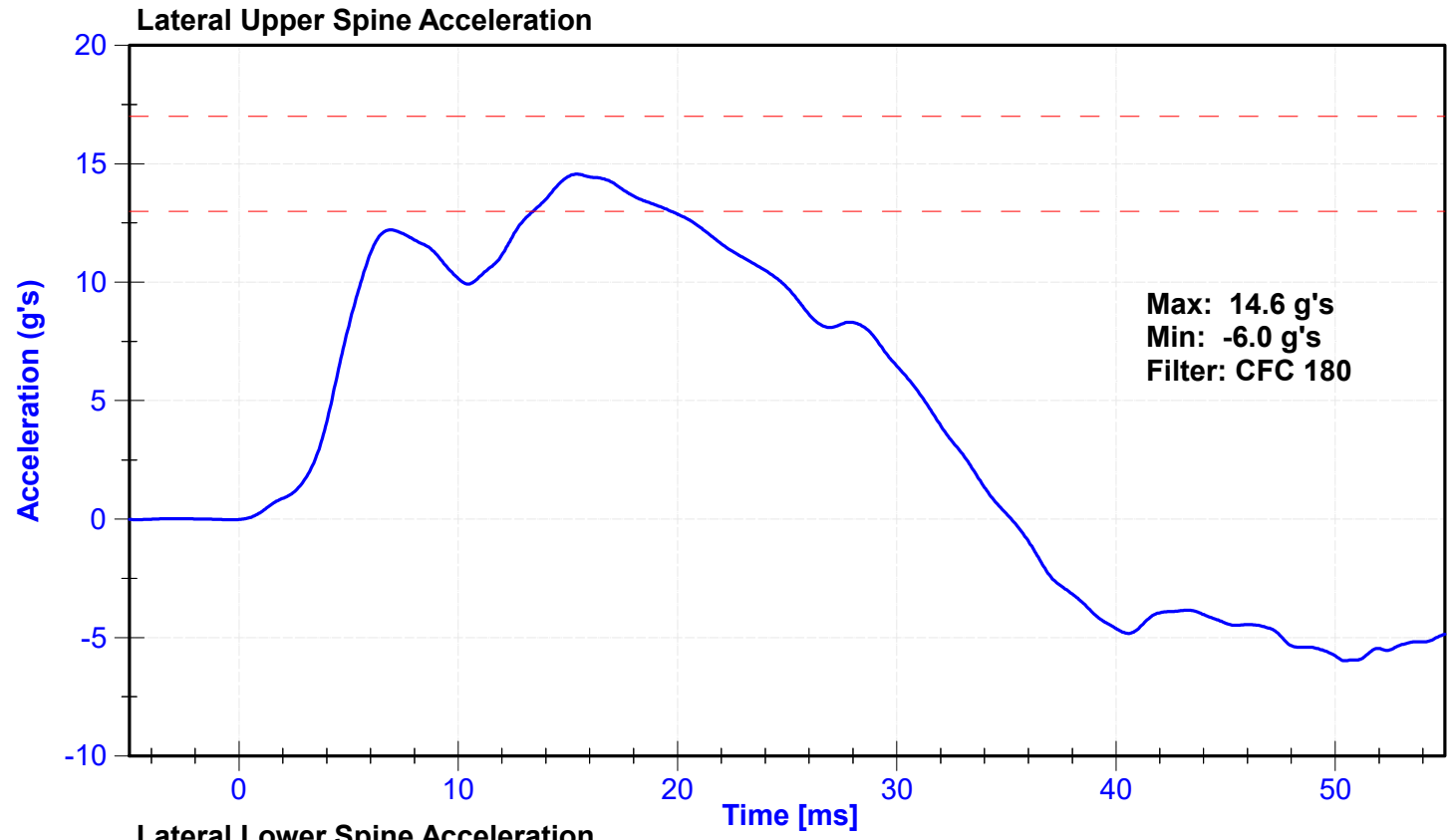
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Upper Spine Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025
Lower Spine Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Upper Thorax Rib Potentiometer	Servo	1199GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Servo	1246GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Servo	011GFE	10/16/2024	4/16/2025

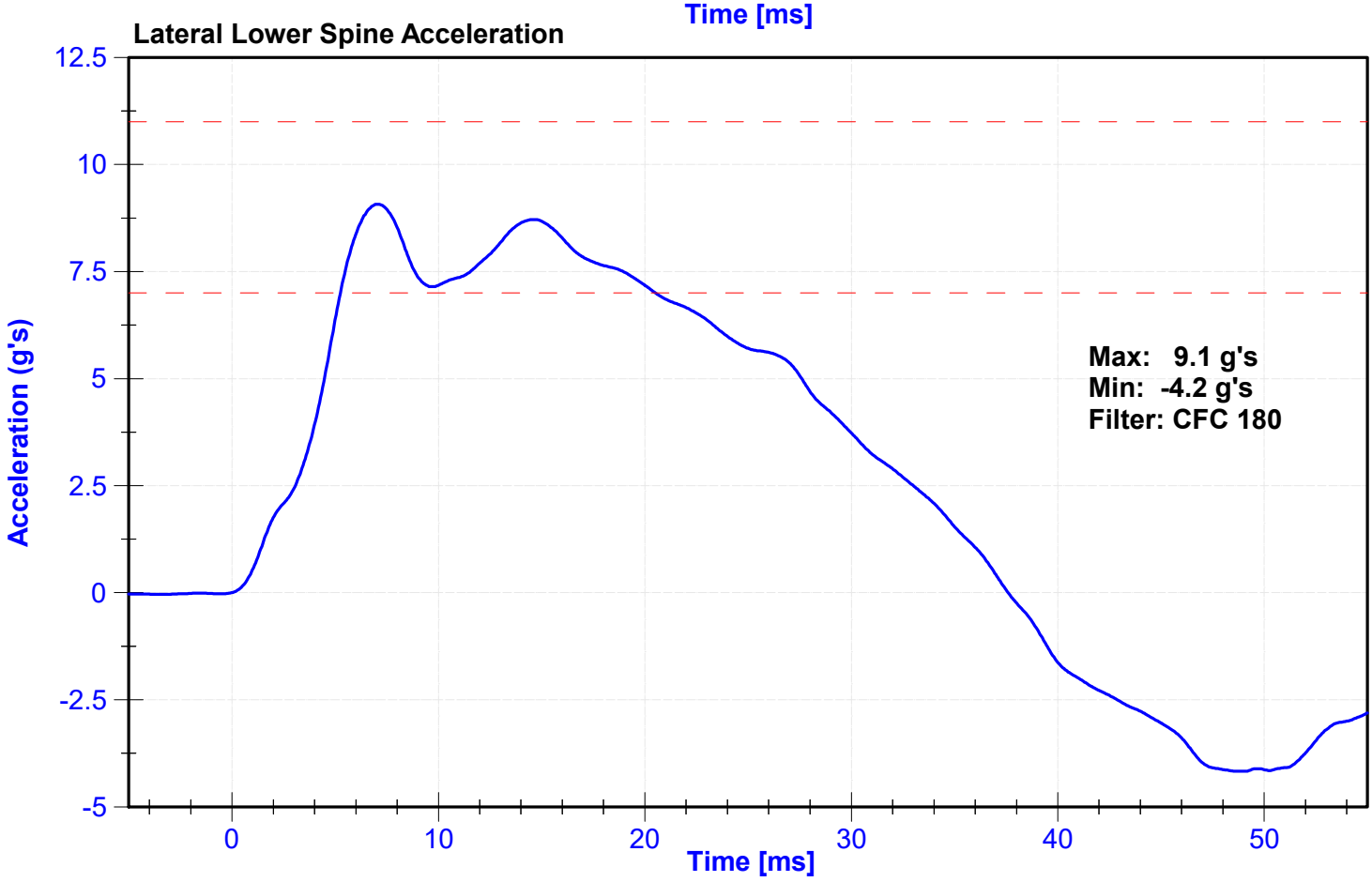



Upper Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 38.1 mm
Min: 0.0 mm
Filter: CFC 600


Middle Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 40.9 mm
Min: 0.0 mm
Filter: CFC 600


Lower Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 37.1 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 14.6 g's
Min: -6.0 g's
Filter: CFC 180


Lateral Lower Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 9.1 g's
Min: -4.2 g's
Filter: CFC 180

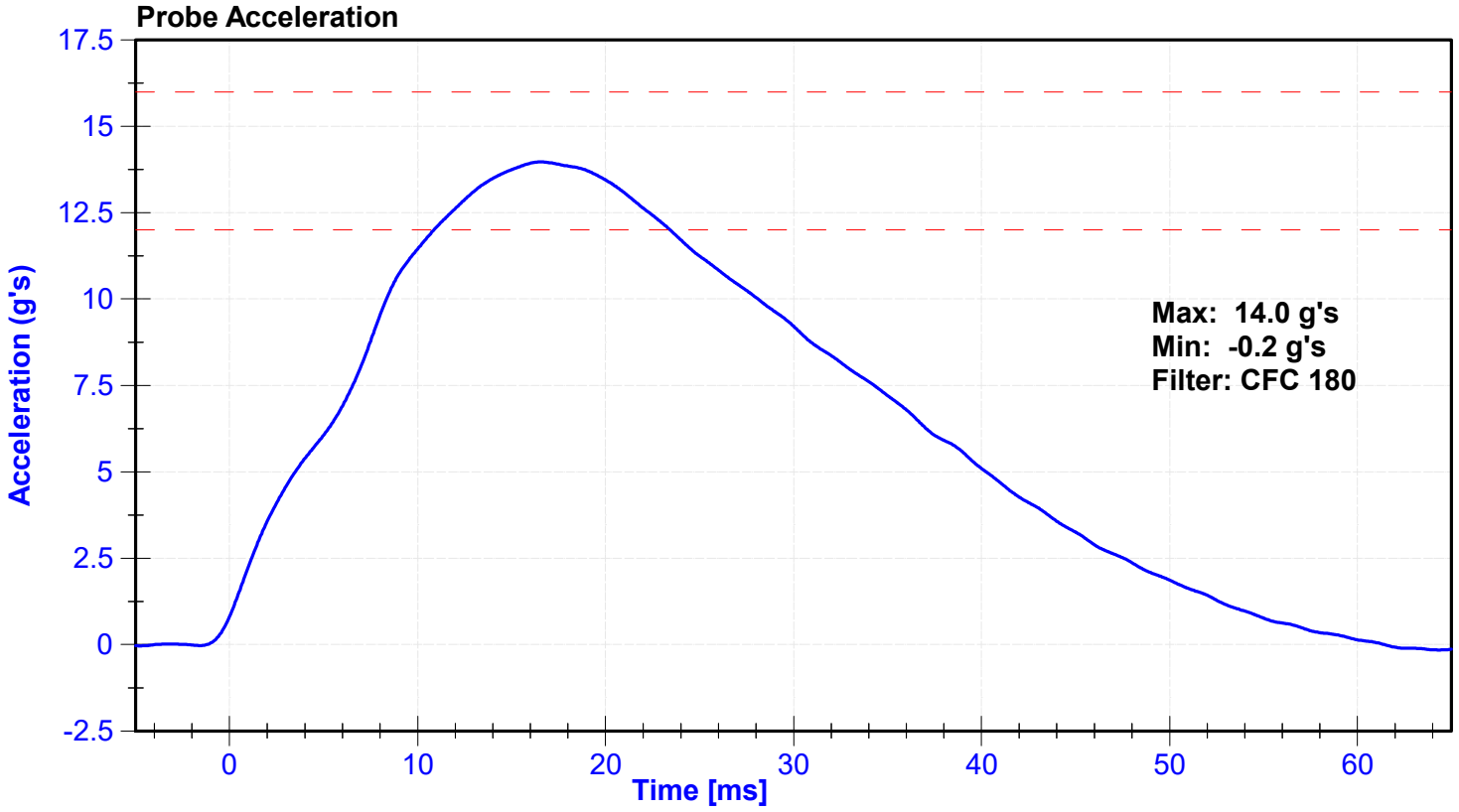
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

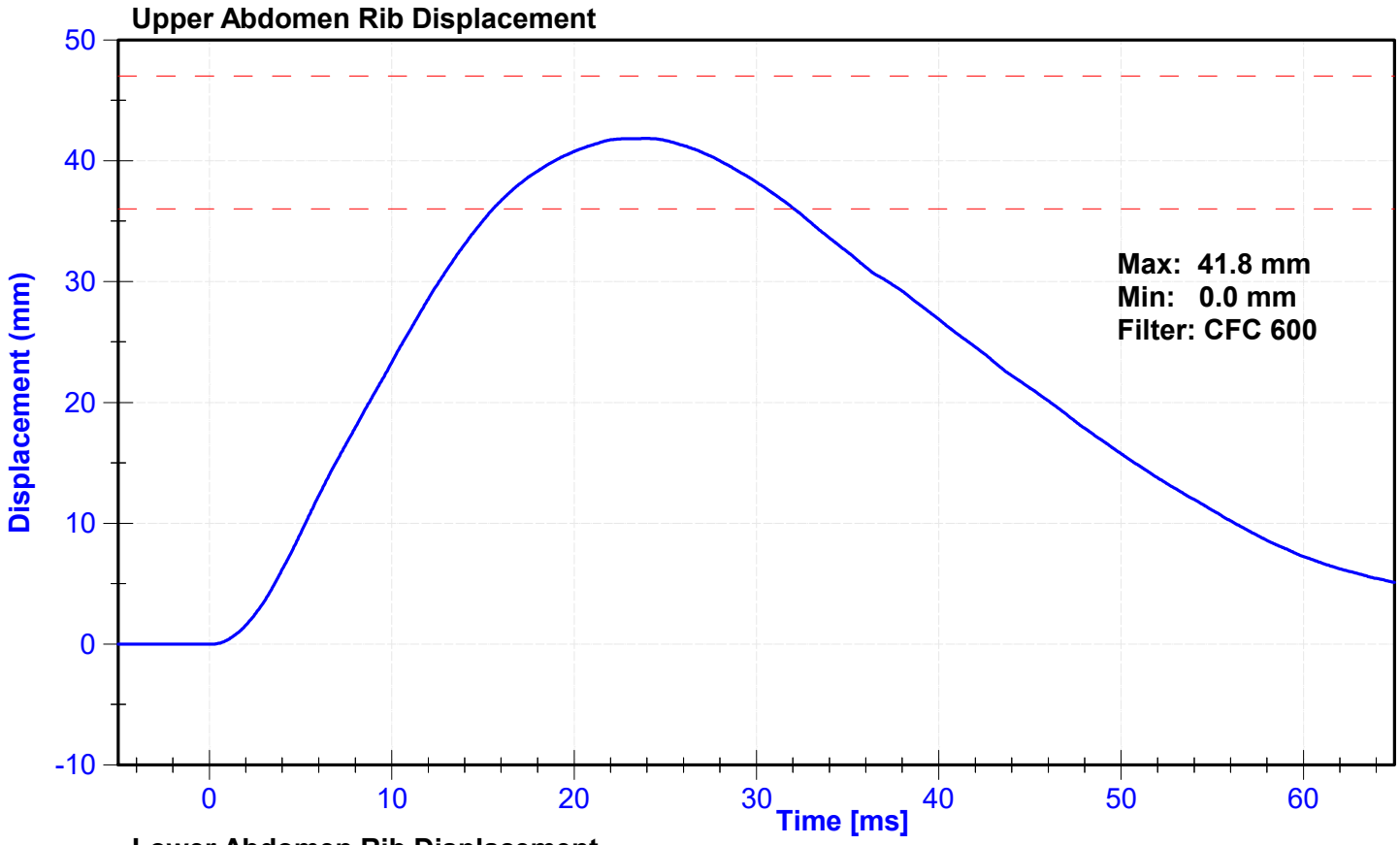
Results

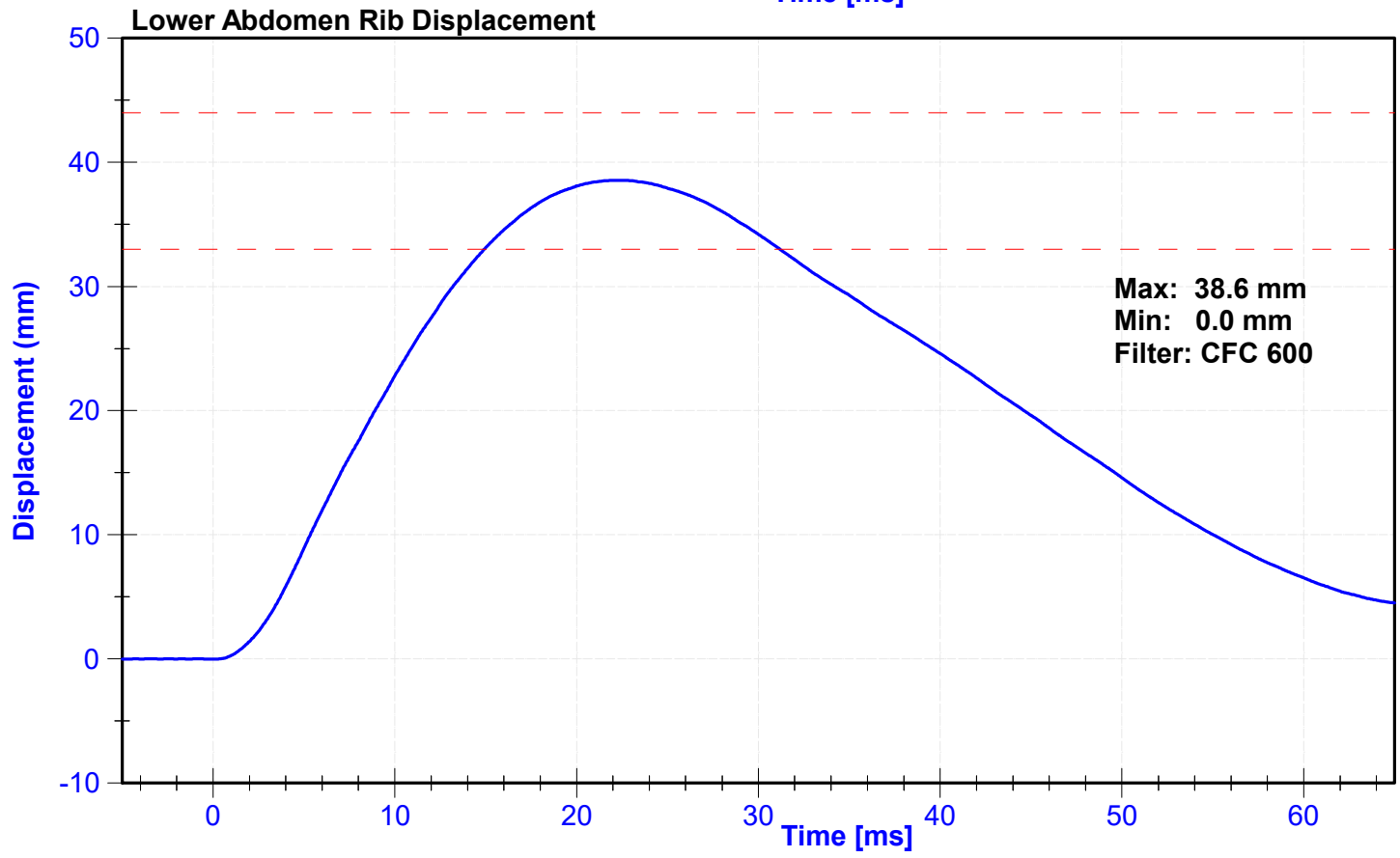
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.28	Pass
Probe Acceleration	12	16	g's	14.0	Pass
Lateral Lower Spine Acceleration	9	14	g's	10.1	Pass
Upper Abdomen Rib Deflection	36	47	mm	41.8	Pass
Lower Abdomen Rib Deflection	33	44	mm	38.6	Pass

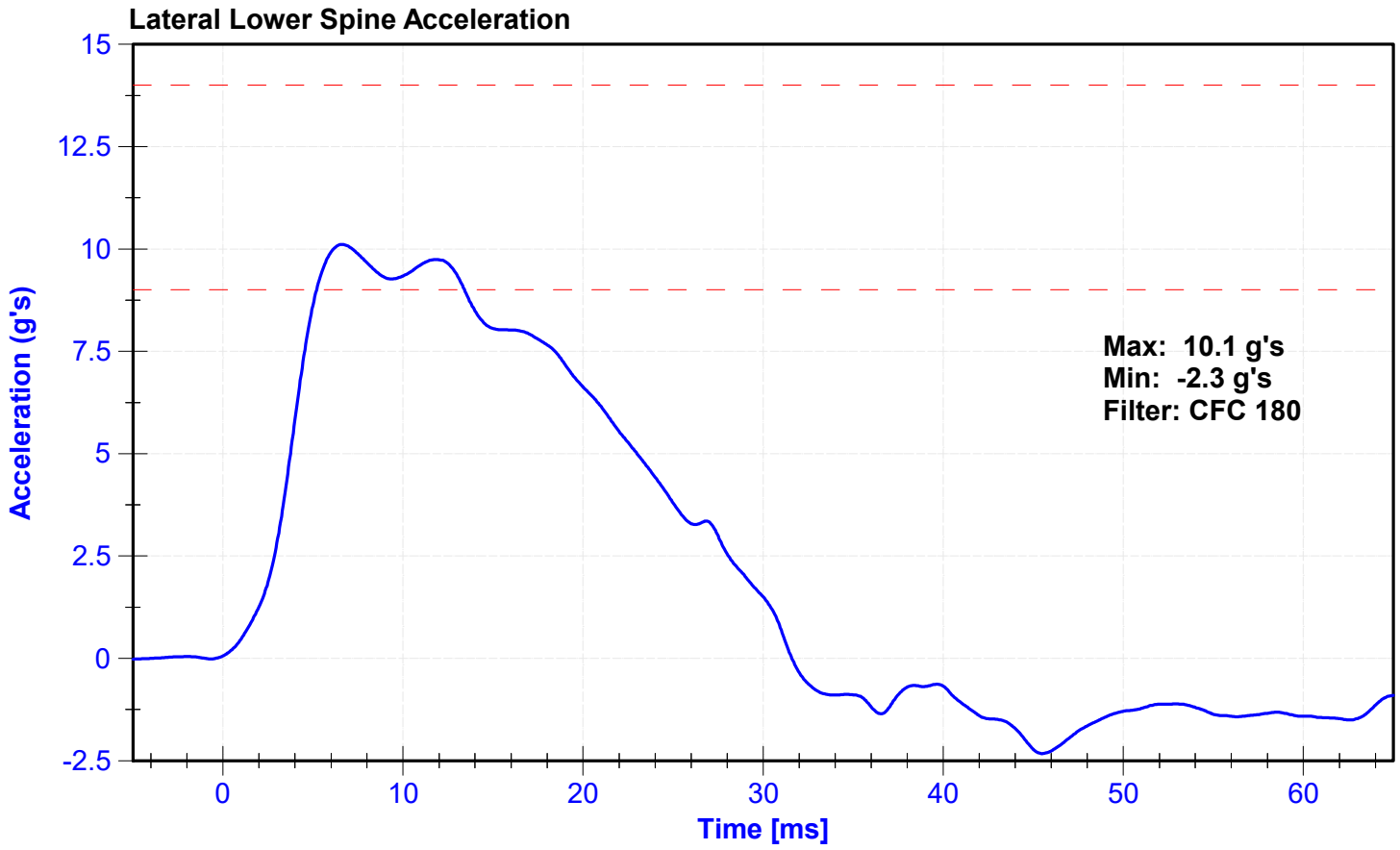
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Lower Spine Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Upper Abdomen Rib Potentiometer	Servo	008GFE	10/16/2024	4/16/2025
Lower Abdomen Rib Potentiometer	Servo	046GFE	10/16/2024	4/16/2025




Upper Abdomen Rib Displacement
Displacement (mm)
Time [ms]
Max: 41.8 mm
Min: 0.0 mm
Filter: CFC 600


Lower Abdomen Rib Displacement
Displacement (mm)
Time [ms]
Max: 38.6 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Lower Spine Acceleration
Acceleration (g's)
15
12.5
10
7.5
5
2.5
0
-2.5
0
10
20
30
40
50
60
Time [ms]
Max: 10.1 g's
Min: -2.3 g's
Filter: CFC 180

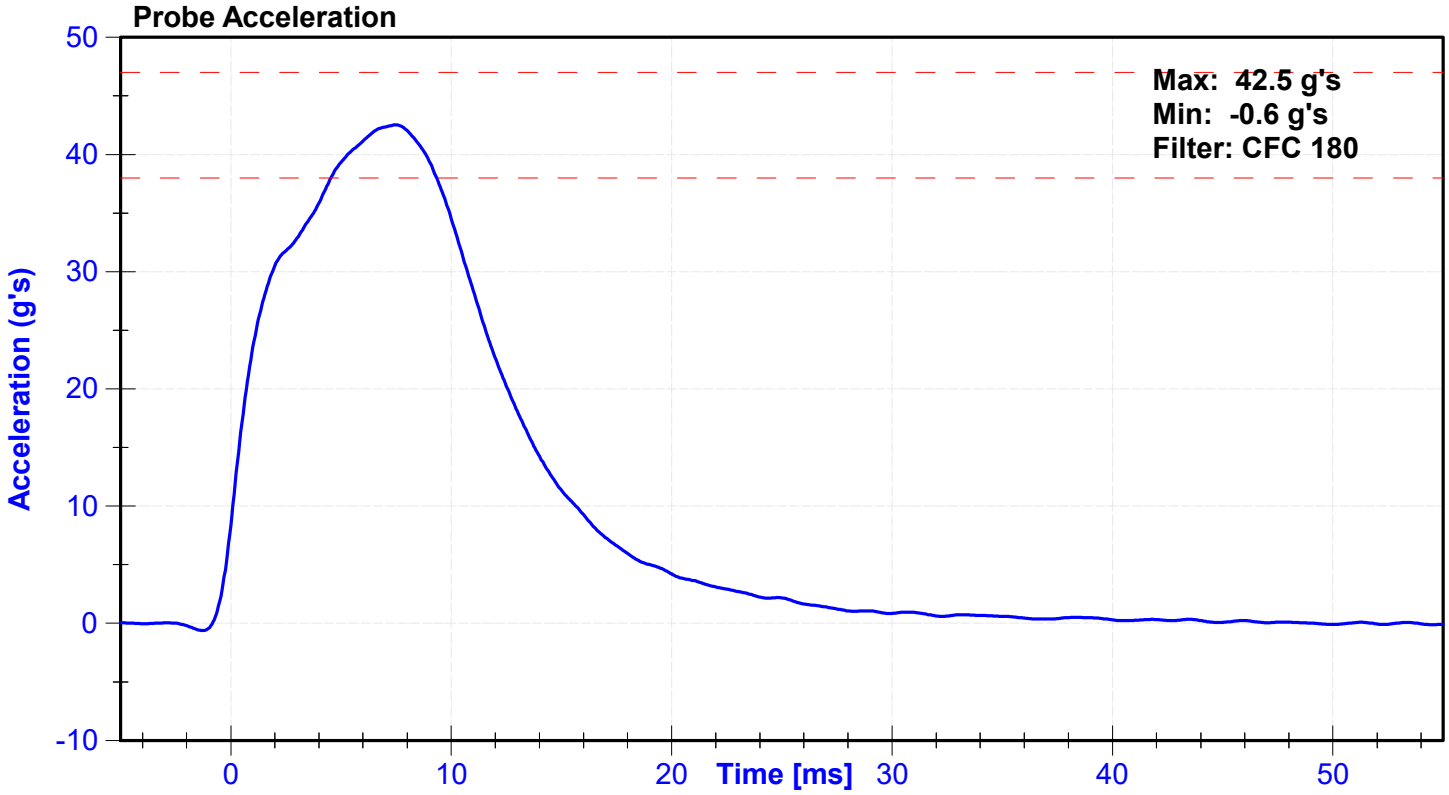
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

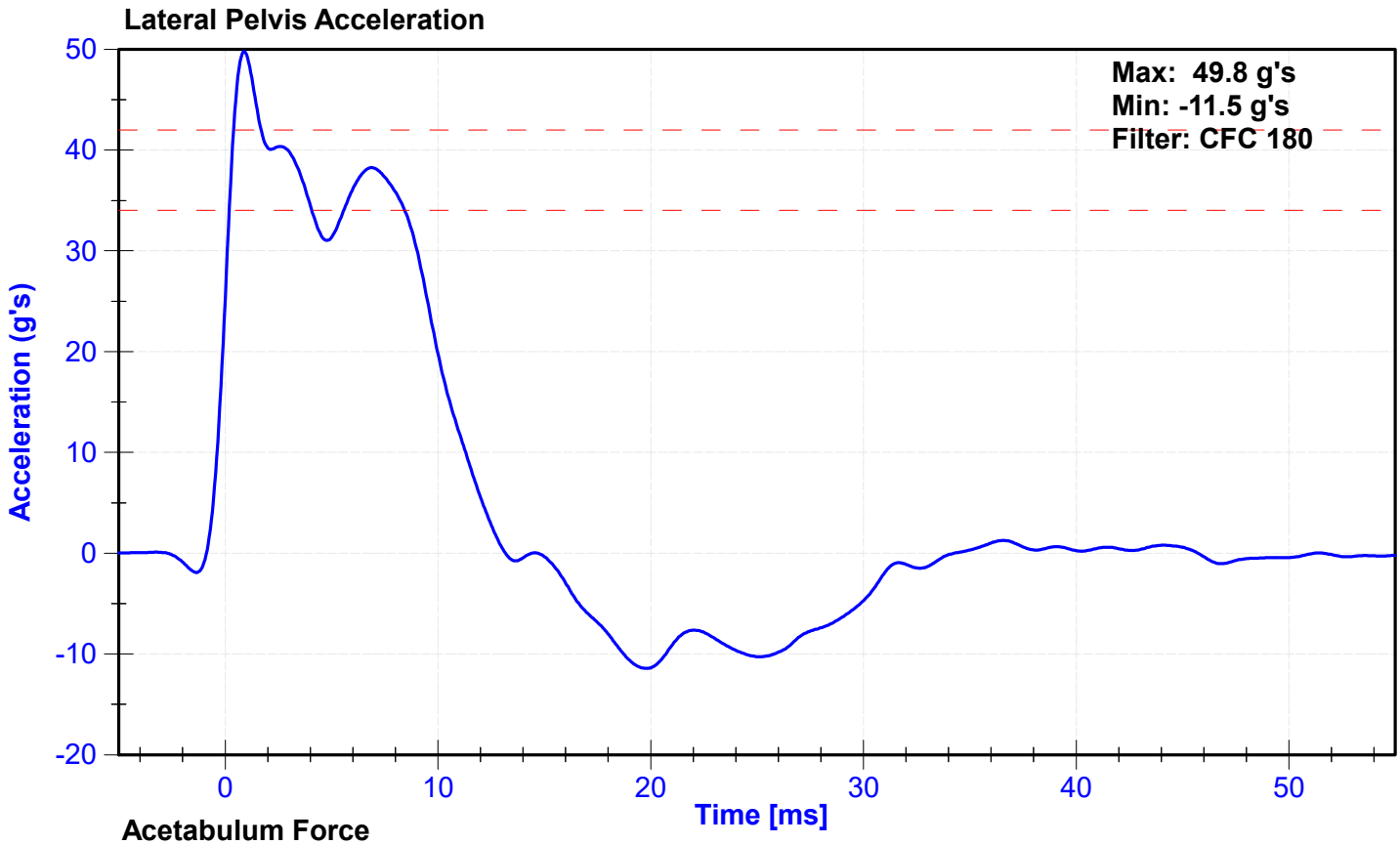
Results

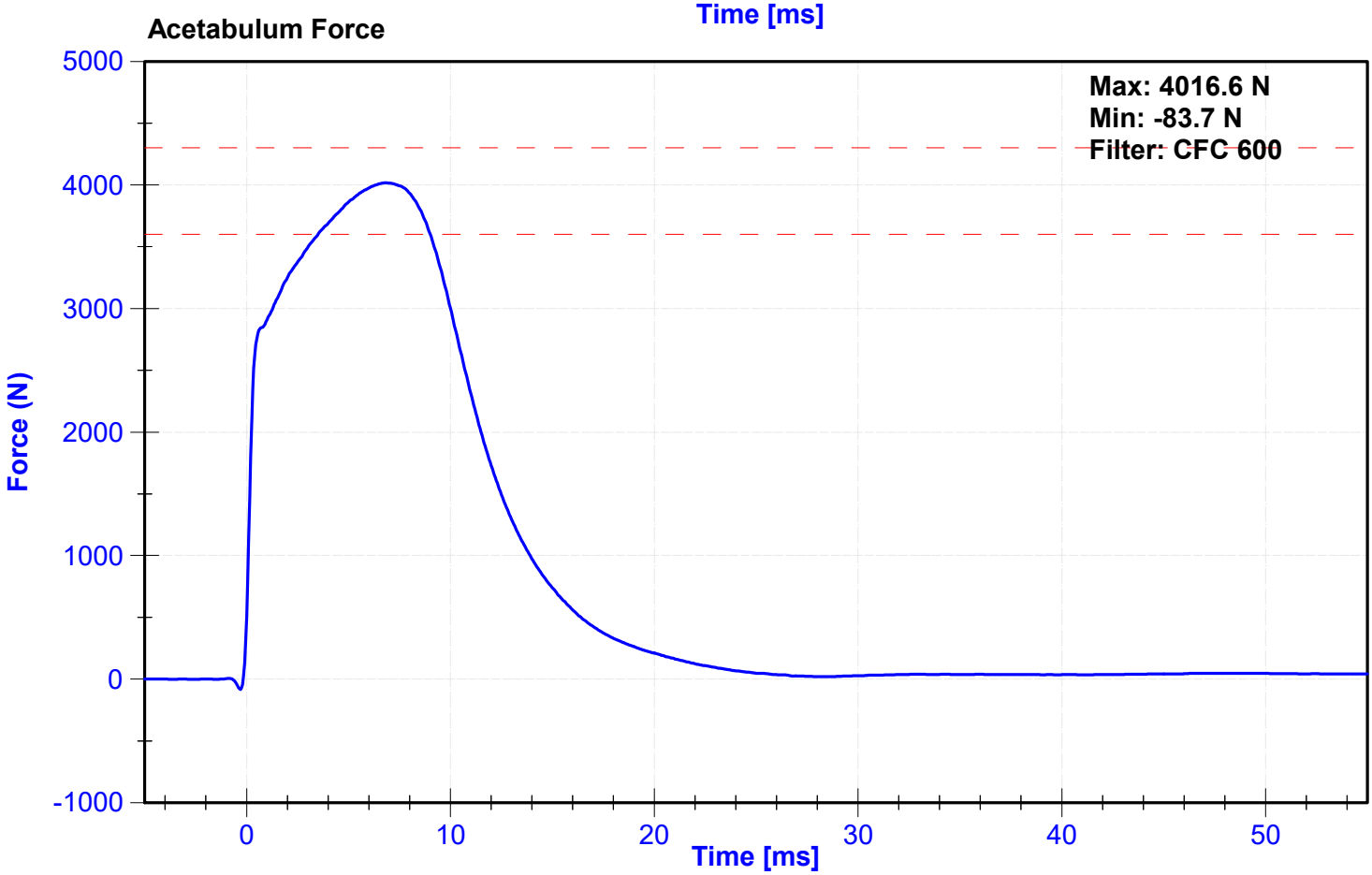
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	6.6	6.8	m/s	6.67	Pass
Probe Acceleration	38	47	g's	42.5	Pass
Lateral Pelvis Acceleration after 6ms	34	42	g's	38.2	Pass
Acetabulum Force	3600	4300	N	4016.6	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Pelvis Y Accelerometer	Endevco	T20860	10/17/2024	4/15/2025
Acetabulum Load Cell	Denton	270-FY	9/16/2024	9/16/2025
Certification Plug	SACO			N/A
Crash Test Plug	SACO			N/A




Lateral Pelvis Acceleration
Max: 49.8 g's
Min: -11.5 g's
Filter: CFC 180
Acceleration (g's)
50
40
30
20
10
0
-10
-20
0
10
20
30
40
50
Time [ms]


Acetabulum Force
Max: 4016.6 N
Min: -83.7 N
Filter: CFC 600
Force (N)
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]

SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16737
Test Number 23537
Report Number 23594
Test Date 7/22/2022 1:00:03 PM

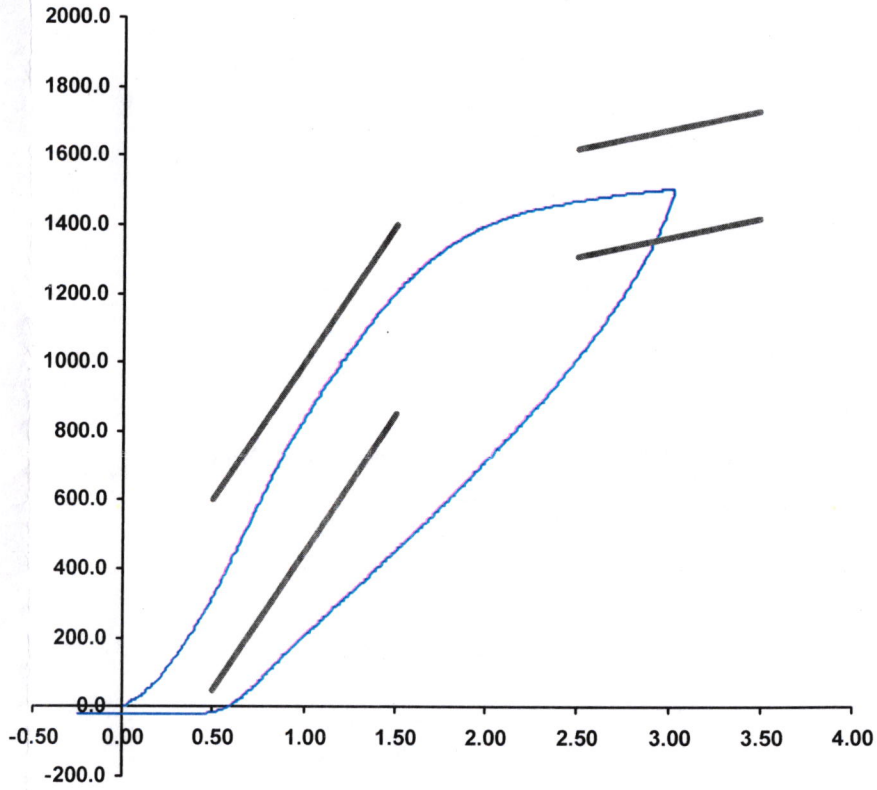
	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	325	50	600
Force @ 1.5 mm (N)	1,208	850	1,400
Force @ 2.5 mm (N)	1,470	1,306	1,618
Force @ 3.0 mm (N)	1,503	1,361	1,673

Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
NON IMPACT 11-20-24 D6801Z

Force (-N) vs Extension (-mm)



Operator

Part Number 180-4450

Template No 107 22-Jul-22
SACO Research

By : DC Date : 7/22/22

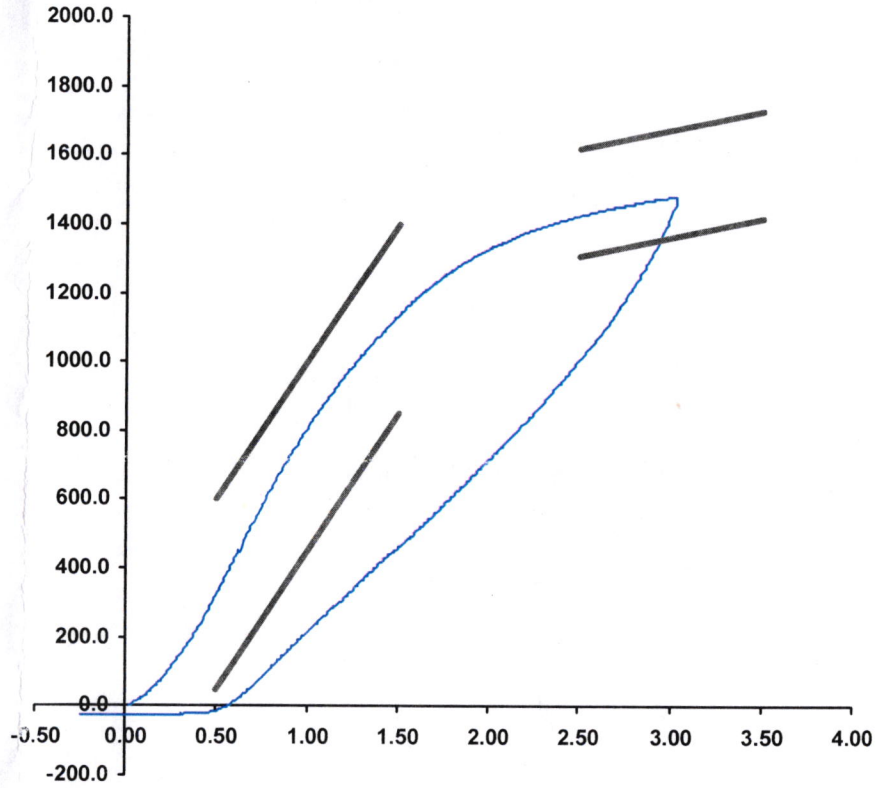
SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16659
Test Number 23435
Report Number 23492
Test Date 7/21/2022 11:43:47 AM

	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	329	50	600
Force @ 1.5 mm (N)	1,140	850	1,400
Force @ 2.5 mm (N)	1,426	1,306	1,618
Force @ 3.0 mm (N)	1,481	1,361	1,673

Force (-N) vs Extension (-mm)



Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
IMPACT PLUG 11-20-24 DG8012

Operator

Part Number 180-4450

Template No 107 21-Jul-22
SACO Research

By : DC Date : 7/21/22

SACO Research 41735 Elm St, #401 Murrieta, CA 92562 Tel 310-694-2082 FAX

SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16738
Test Number 23538
Report Number 23595
Test Date 7/22/2022 1:02:32 PM

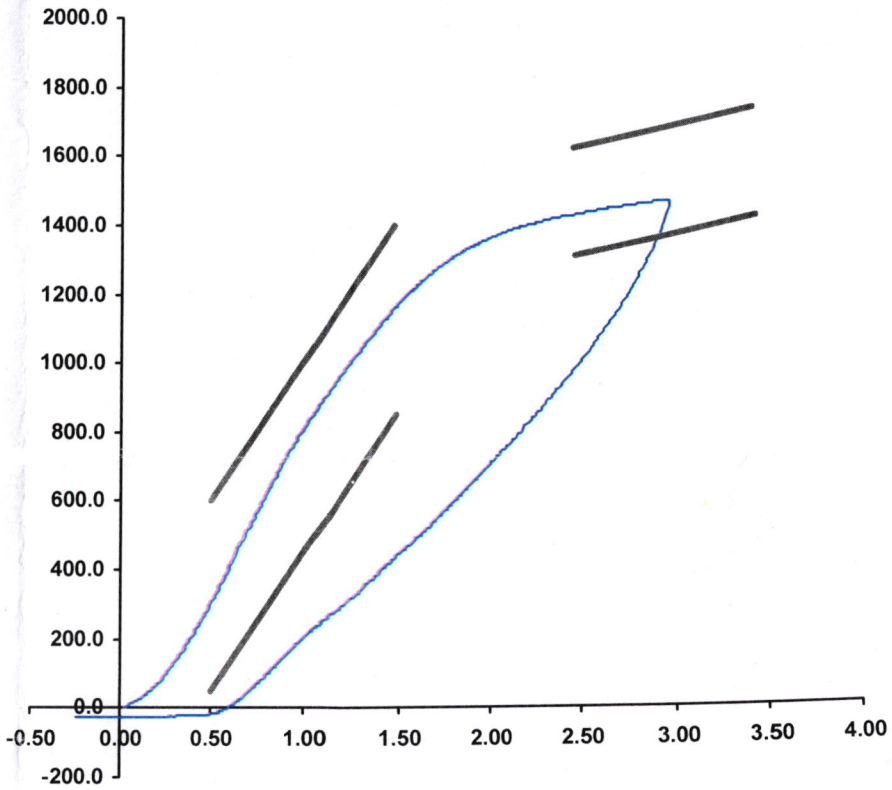
	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	312	50	600
Force @ 1.5 mm (N)	1,165	850	1,400
Force @ 2.5 mm (N)	1,426	1,306	1,618
Force @ 3.0 mm (N)	1,465	1,361	1,673

Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
Cert plug 11-20-~~24~~ 24 DG80L2

Force (-N) vs Extension (-mm)



Operator

Part Number 180-4450

Template No 107 22-Jul-22
SACO Research

By : DC Date : 7/22/22

SACO Research 41735 Elm St, #401 Murrieta, CA 92562 Tel 310-694-2082 FAX

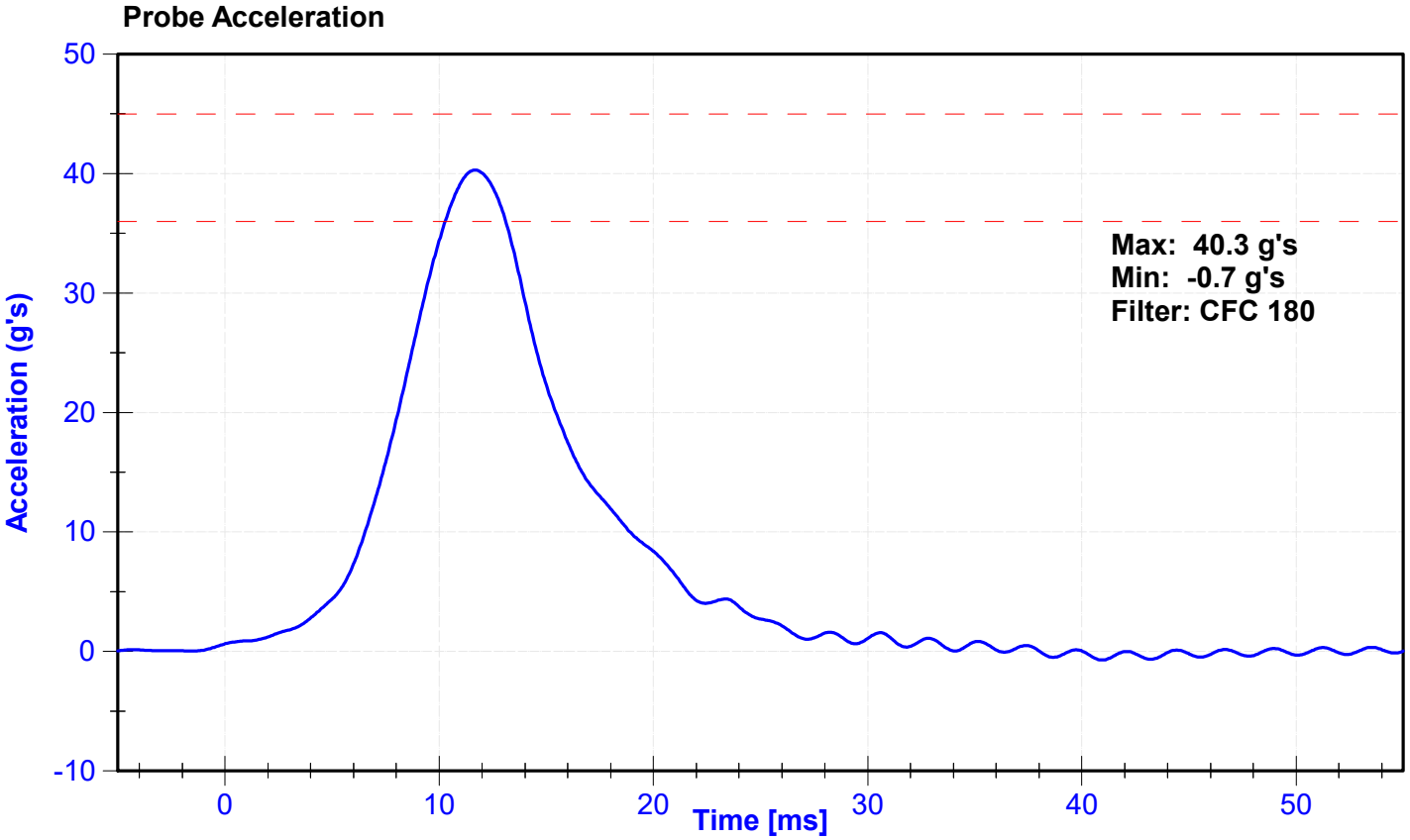
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	C. Mantell

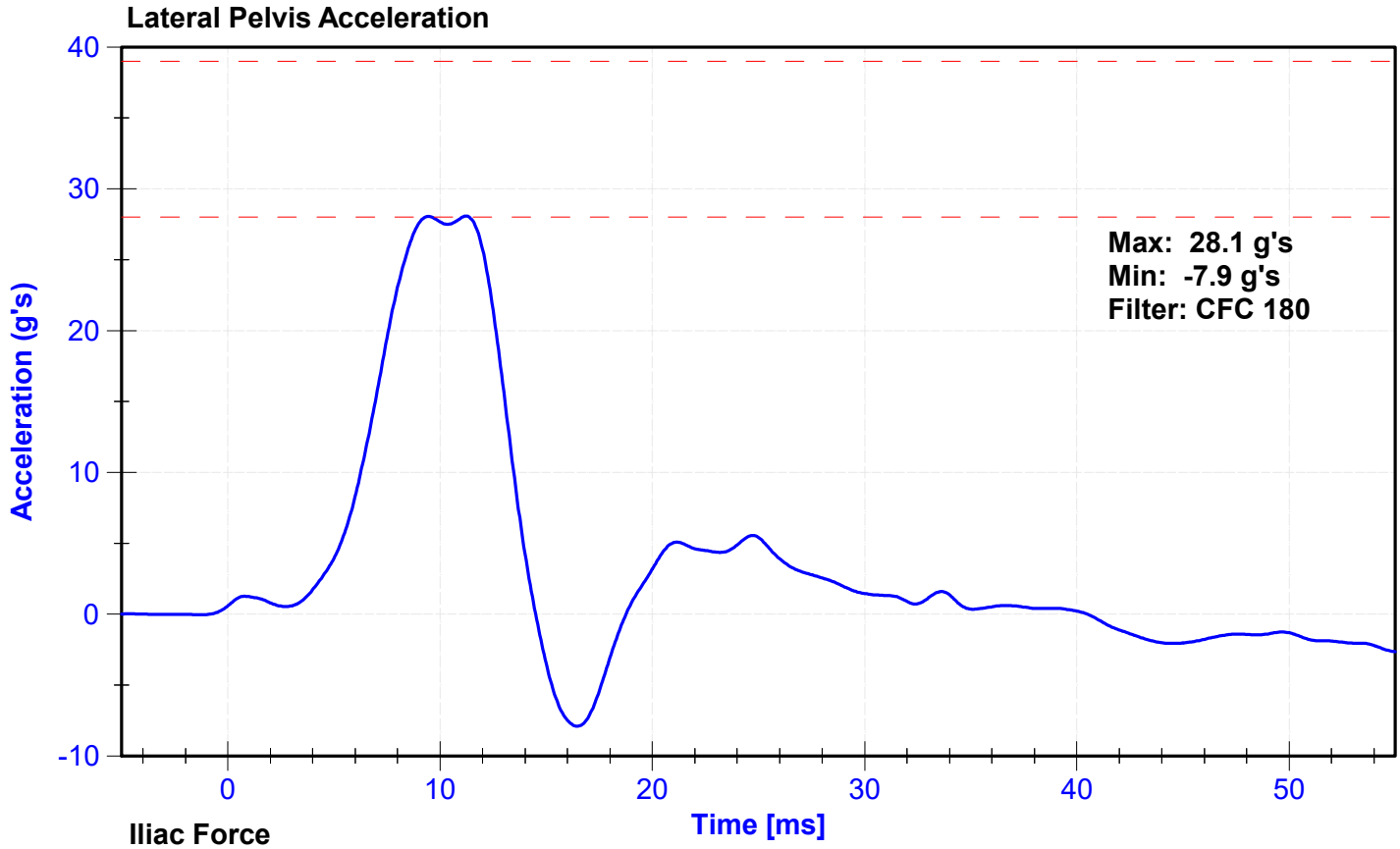
Results

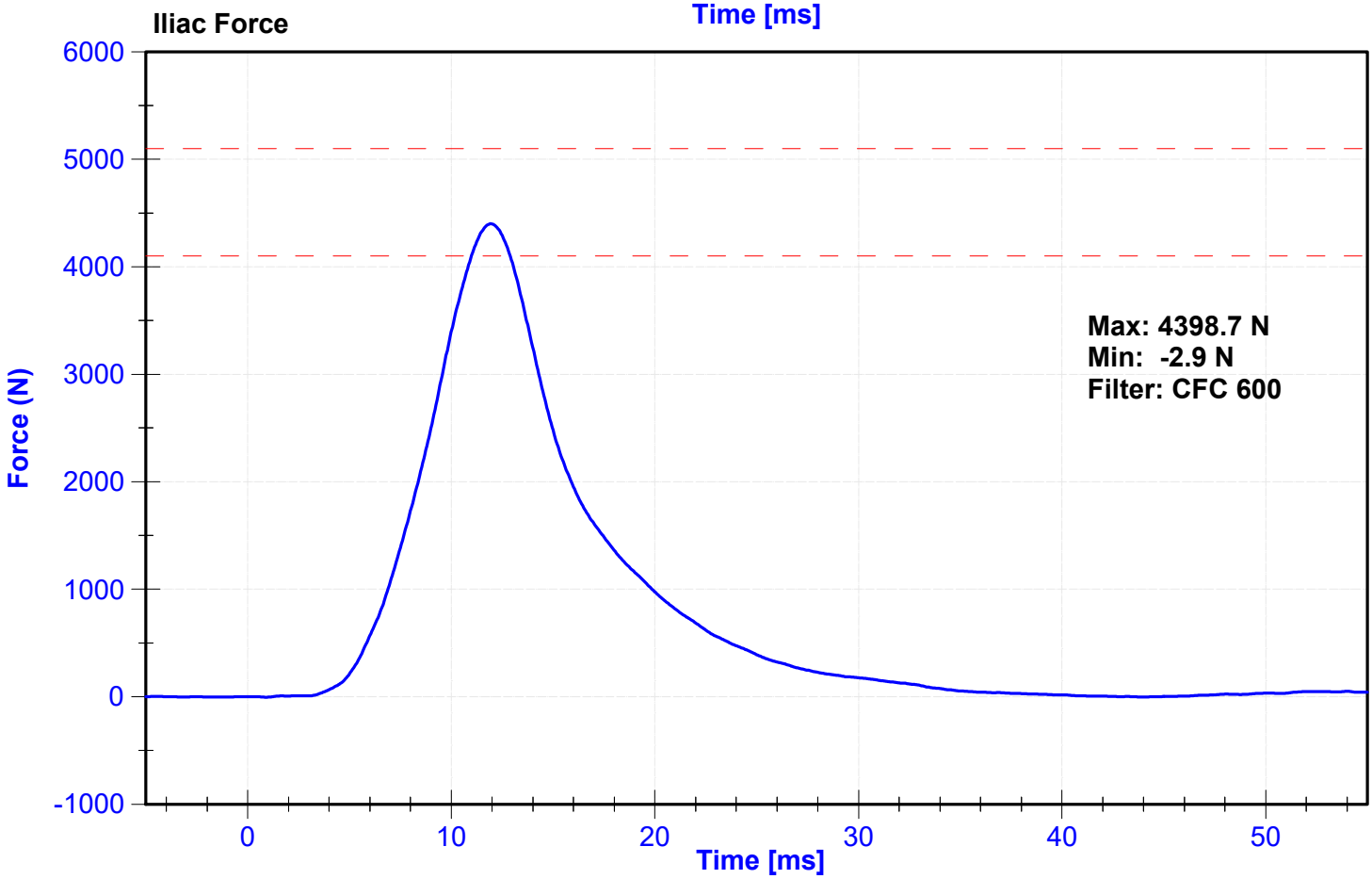
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.26	Pass
Probe Acceleration	36	45	g's	40.3	Pass
Lateral Pelvis Acceleration	28	39	g's	28.1	Pass
Iliac Force	4100	5100	N	4398.7	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Pelvis Y Accelerometer	Endevco	T20860	10/17/2024	4/15/2025
Iliac Load Cell	Denton	321	9/16/2024	9/16/2025




Lateral Pelvis Acceleration
Acceleration (g's)
40
30
20
10
0
-10
0
10
20
30
40
50
Time [ms]
Max: 28.1 g's
Min: -7.9 g's
Filter: CFC 180


Iliac Force
Force (N)
6000
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]
Max: 4398.7 N
Min: -2.9 N
Filter: CFC 600

CALIBRATION TEST RESULTS

POST-TEST

EUROSID 2 (ES-2RE) MALE – DRIVER ATD

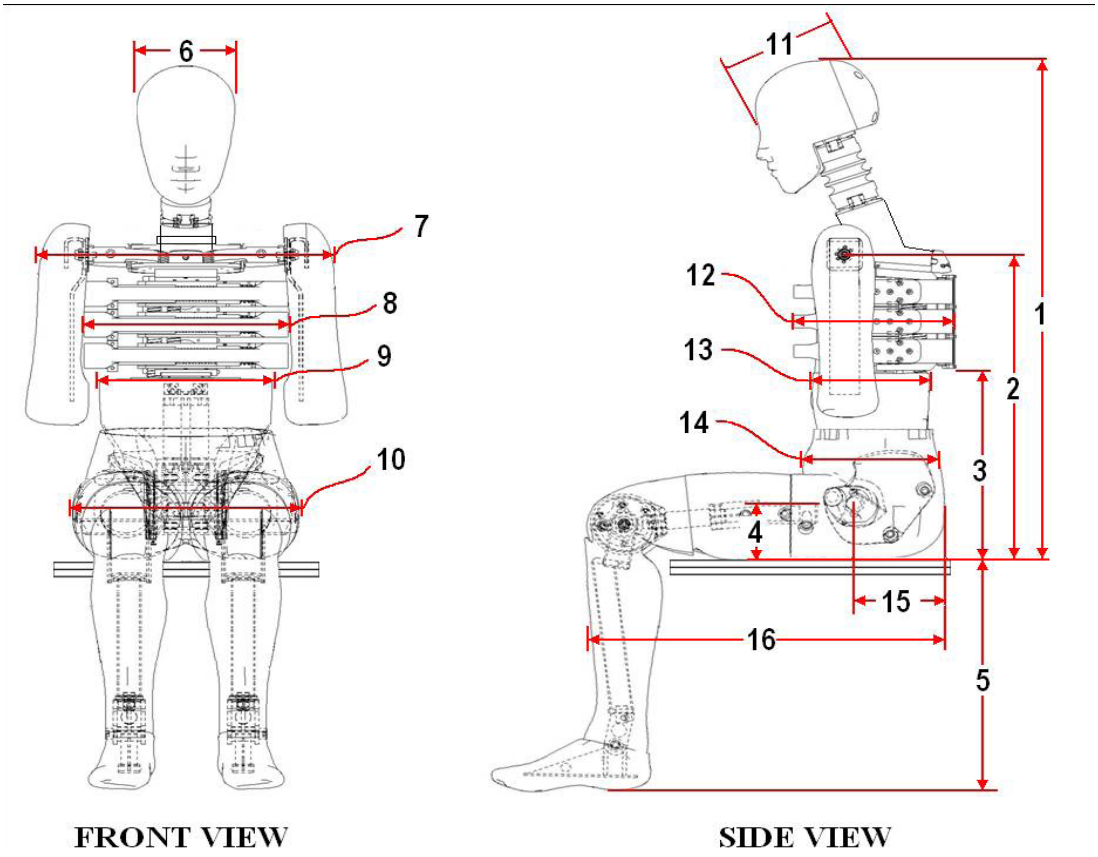
SERIAL NO:F033

(CONFIGURED FOR LEFT SIDE IMPACT)

External Measurements - EuroSID-2re

Technician: J. Rios Date: 11/23/2024

Dummy Serial Number: F033



FRONT VIEW SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	906	Pass
2	Seat to Shoulder Joint	558	572	559	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	351	Pass
4	Seat to Hip Joint (center of bolt)	97	103	101	Pass
5	Sole to Seat, Sitting	333	451	402	Pass
6	Head Width	152	158	153	Pass
7	Shoulder/Arm Width	461	479	468	Pass
8	Thorax Width	322	332	325	Pass
9	Abdomen Width	273	287	283	Pass
10	Pelvis Lap Width	359	373	363	Pass
11	Head Depth	196	206	201	Pass
12	Thorax Depth	262	272	269	Pass
13	Abdomen Depth	194	204	197	Pass
14	Pelvis Depth	235	245	242	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	154	Pass
16	Back of Buttocks to Front Knee	597	615	607	Pass

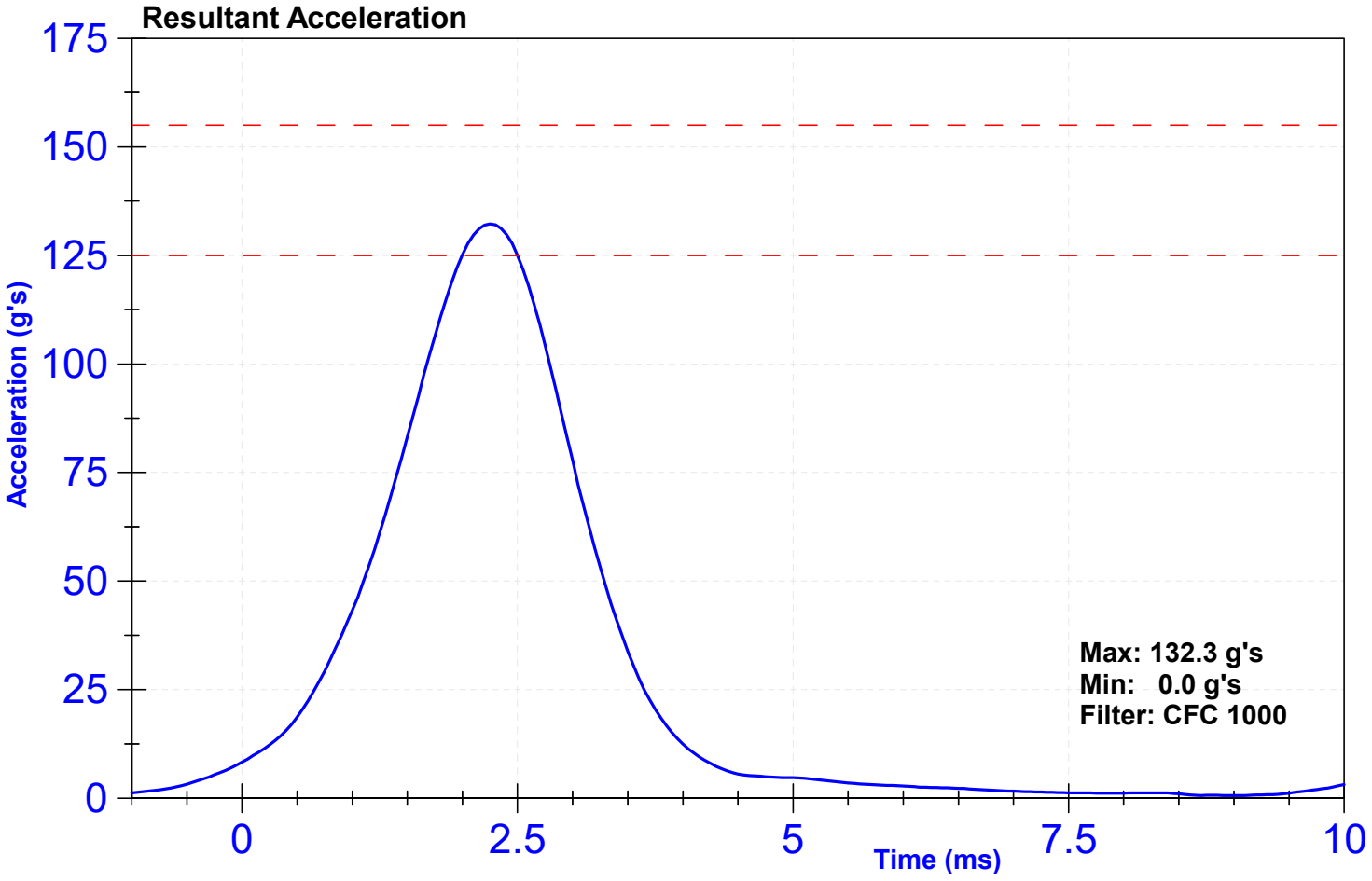
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C. Mantell

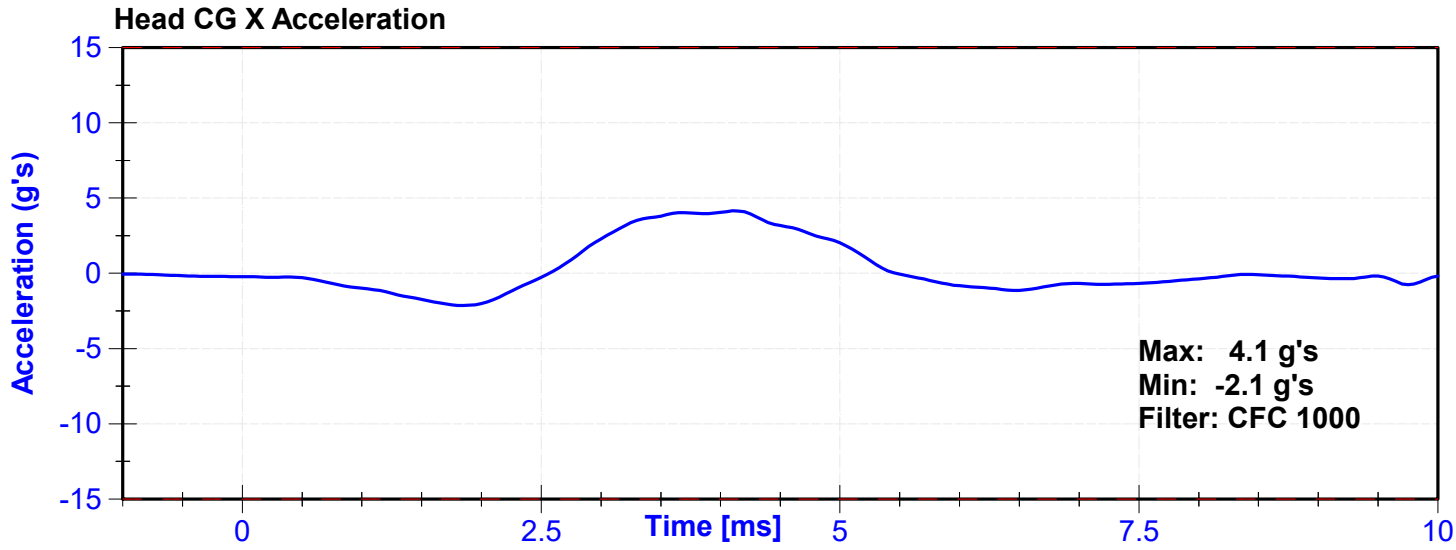
Results

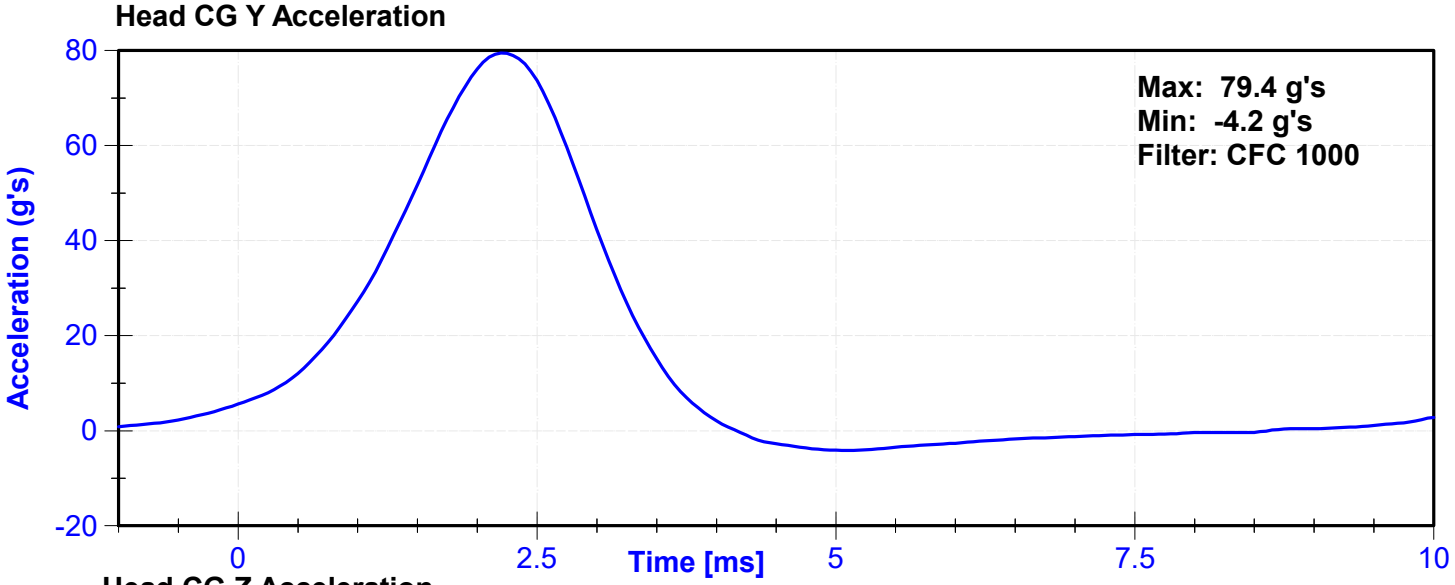
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Resultant Acceleration	125	155	g's	132.3	Pass
Oscillation	0	15	%	2.85	Pass
Fore-Aft Acceleration	-15	15	g's	4.1	Pass

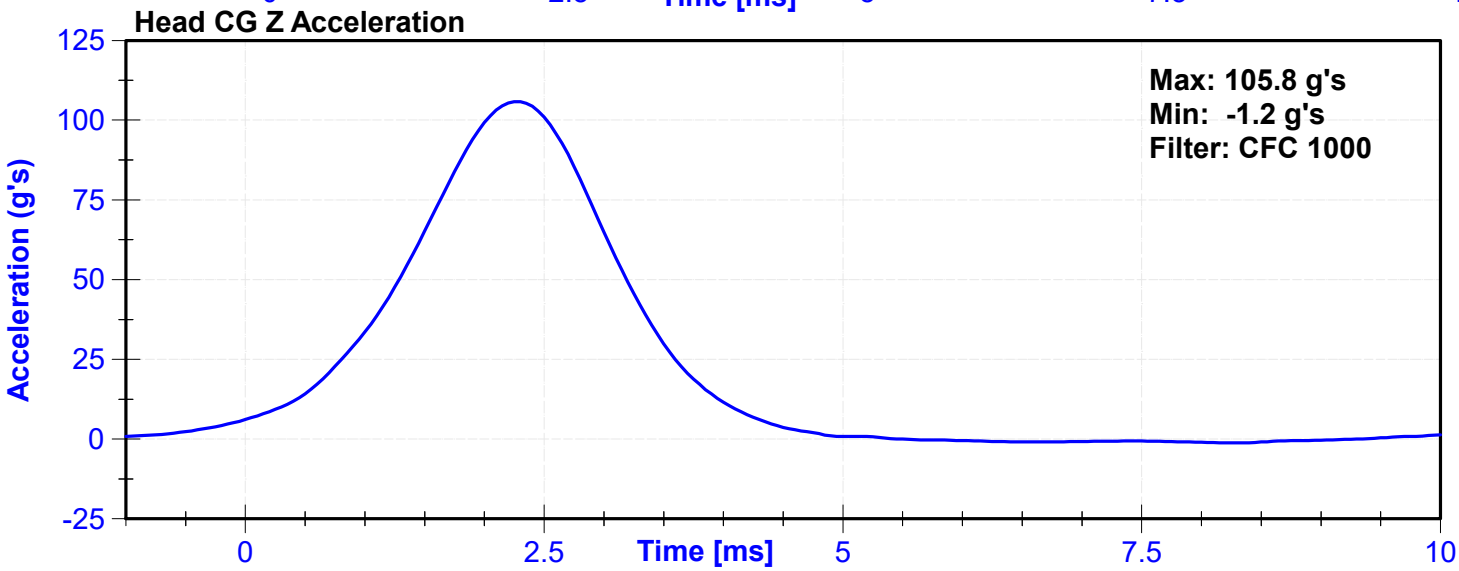
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco	P63861	10/17/2024	4/15/2025
Y Accelerometer	Endevco	P49216	10/17/2024	4/15/2025
Z Accelerometer	Endevco	P51303	10/17/2024	4/15/2025




Head CG X Acceleration
Acceleration (g's)
15
10
5
0
-5
-10
-15
0
2.5
Time [ms]
5
7.5
10
Max: 4.1 g's
Min: -2.1 g's
Filter: CFC 1000


Head CG Y Acceleration
Acceleration (g's)
80
60
40
20
0
-20
0
2.5
Time [ms]
5
7.5
10
Max: 79.4 g's
Min: -4.2 g's
Filter: CFC 1000


Head CG Z Acceleration
Acceleration (g's)
125
100
75
50
25
0
-25
0
2.5
Time [ms]
5
7.5
10
Max: 105.8 g's
Min: -1.2 g's
Filter: CFC 1000

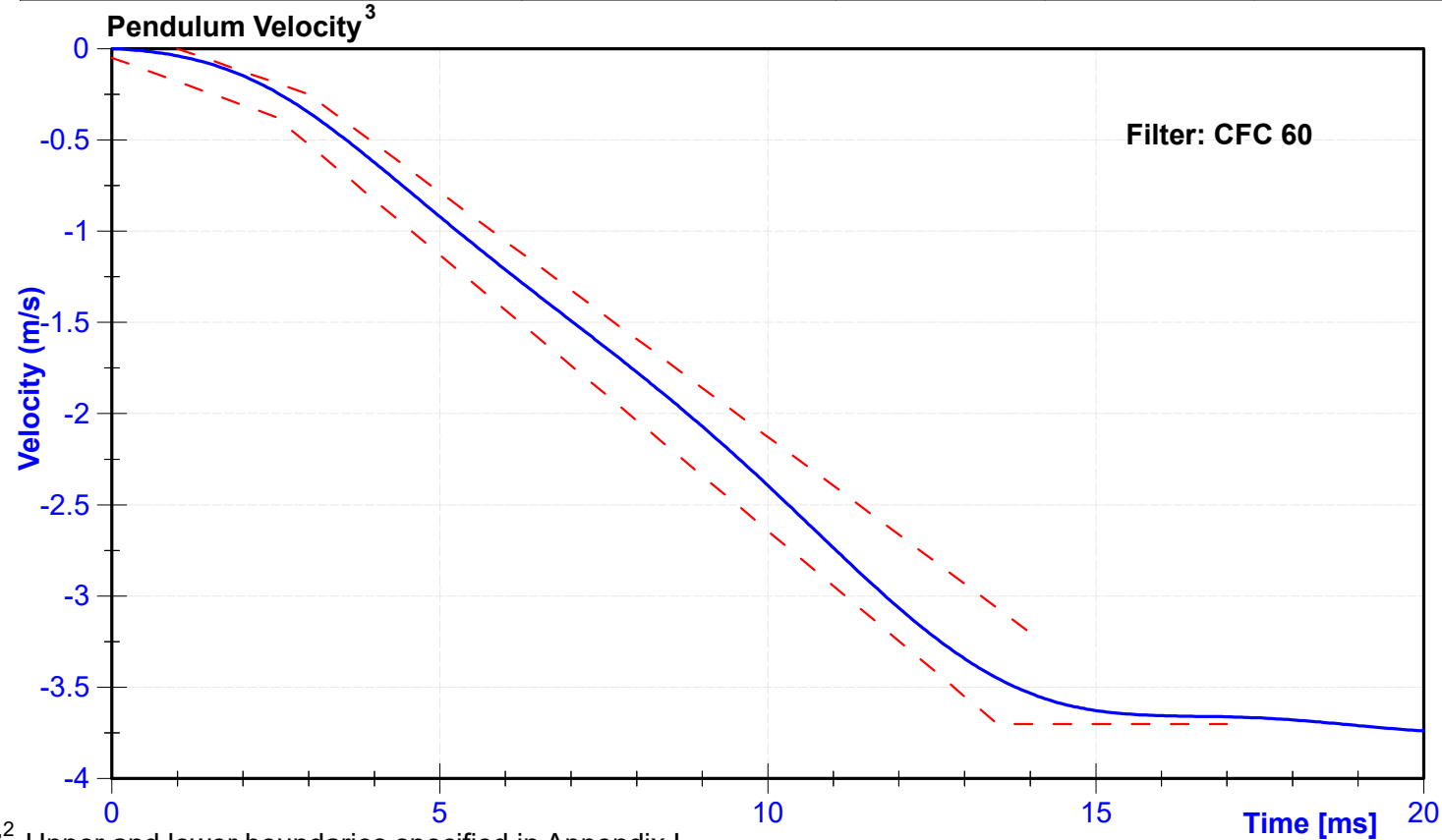
ATD Manufacturer	Humanetics	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

Results

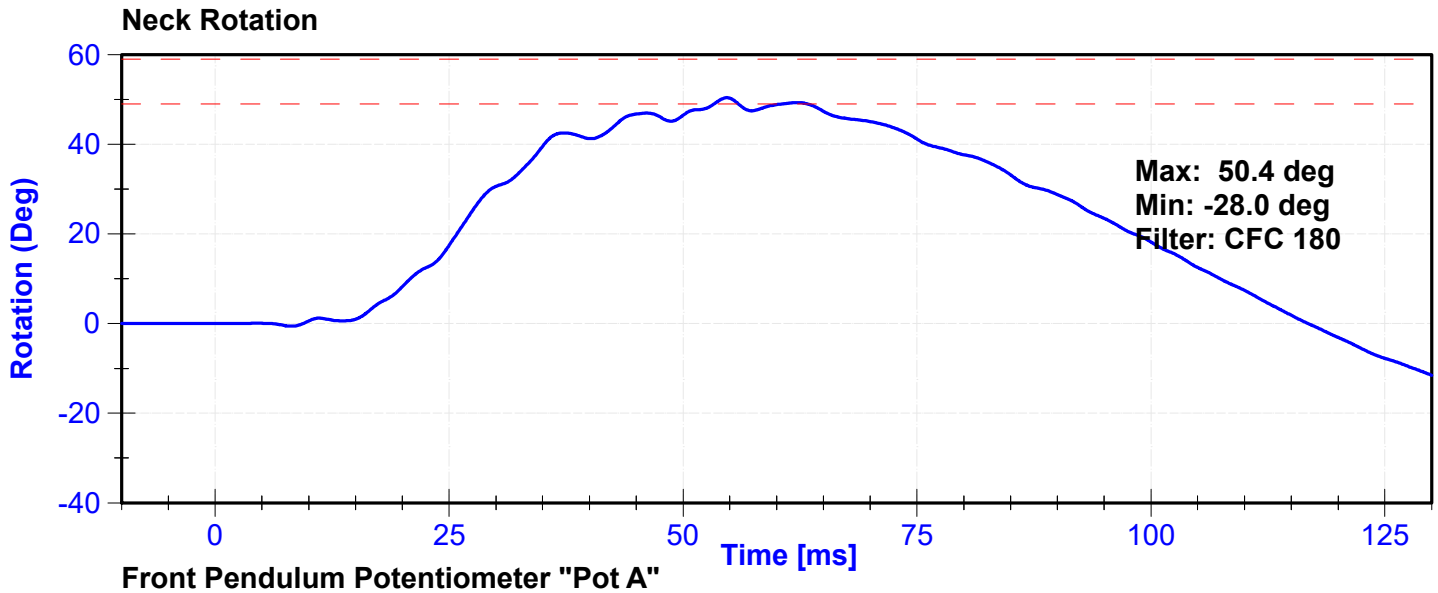
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	35	Pass
Velocity	3.3	3.5	m/s	3.45	Pass
Lateral Neck Rotation	49	59	deg	50.4	Pass
Time at Maximum Rotation	54	66	ms	54.7	Pass
Time of Rotation Decay from Maximum	53	88	ms	62.1	Pass
Pendulum Velocity Overall Corridor	Lower Boundary[1]	Upper Boundary[2]	m/s	See Plot[3]	Pass

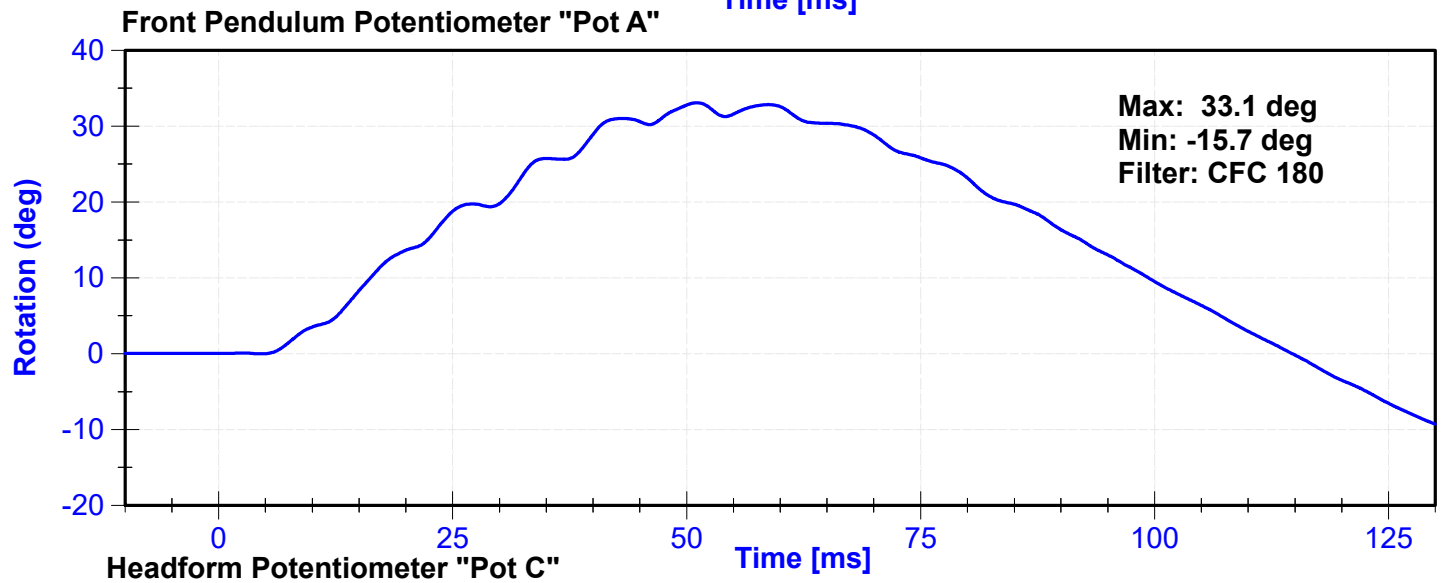
Transducer Calibrations

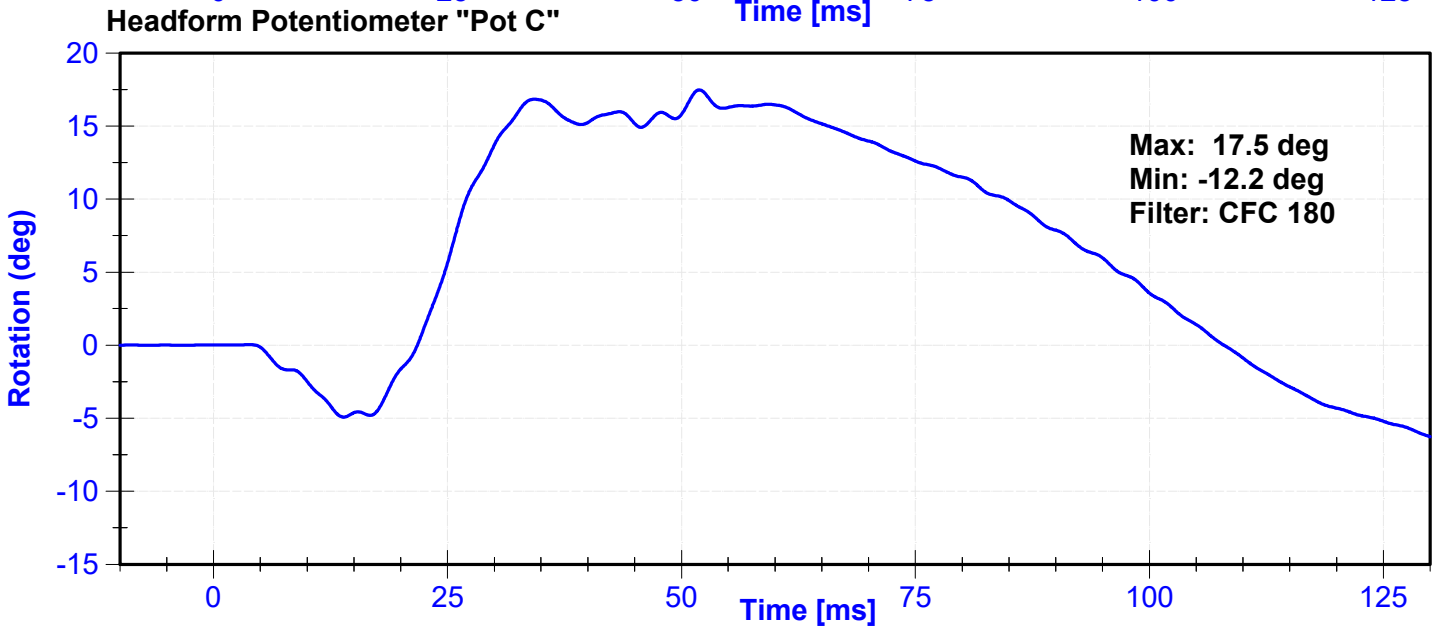
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16650	11/1/2024	11/1/2025
Front Pendulum Potentiometer	Sfernice	2247	9/13/2024	9/13/2025
Headform Potentiometer	Sfernice	095	9/13/2024	9/13/2025



[1,2] Upper and lower boundaries specified in Appendix I


Neck Rotation
Rotation (Deg)
60
40
20
0
-20
-40
0
25
50
75
100
125
Time [ms]
Max: 50.4 deg
Min: -28.0 deg
Filter: CFC 180


Front Pendulum Potentiometer "Pot A"
Rotation (deg)
40
30
20
10
0
-10
-20
0
25
50
75
100
125
Time [ms]
Max: 33.1 deg
Min: -15.7 deg
Filter: CFC 180


Headform Potentiometer "Pot C"
Rotation (deg)
20
15
10
5
0
-5
-10
-15
0
25
50
75
100
125
Time [ms]
Max: 17.5 deg
Min: -12.2 deg
Filter: CFC 180

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

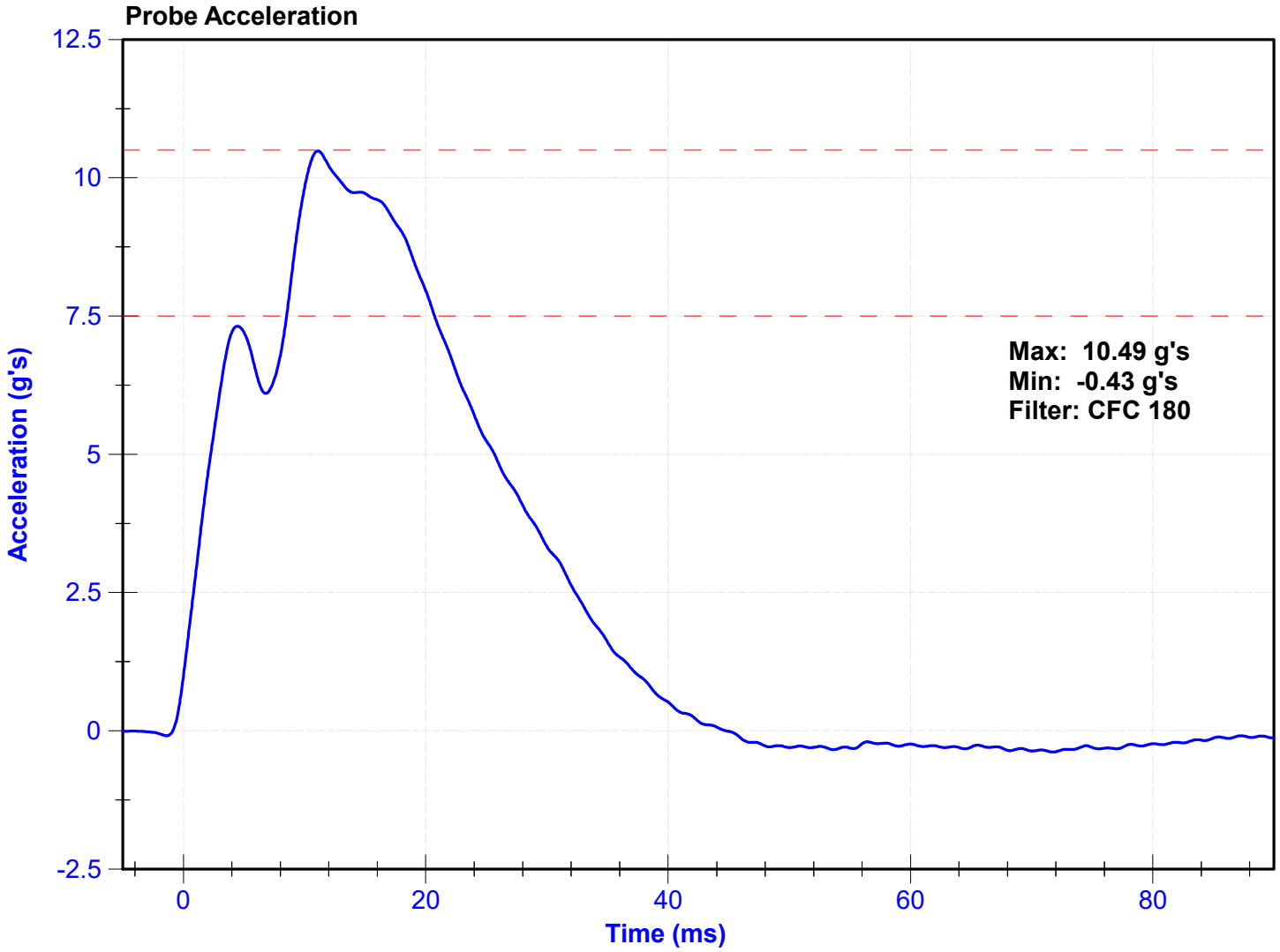
ATD Manufacturer	FTSS	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.29	Pass
Probe Acceleration	7.5	10.5	g's	10.49	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18599	9/13/2024	3/12/2025



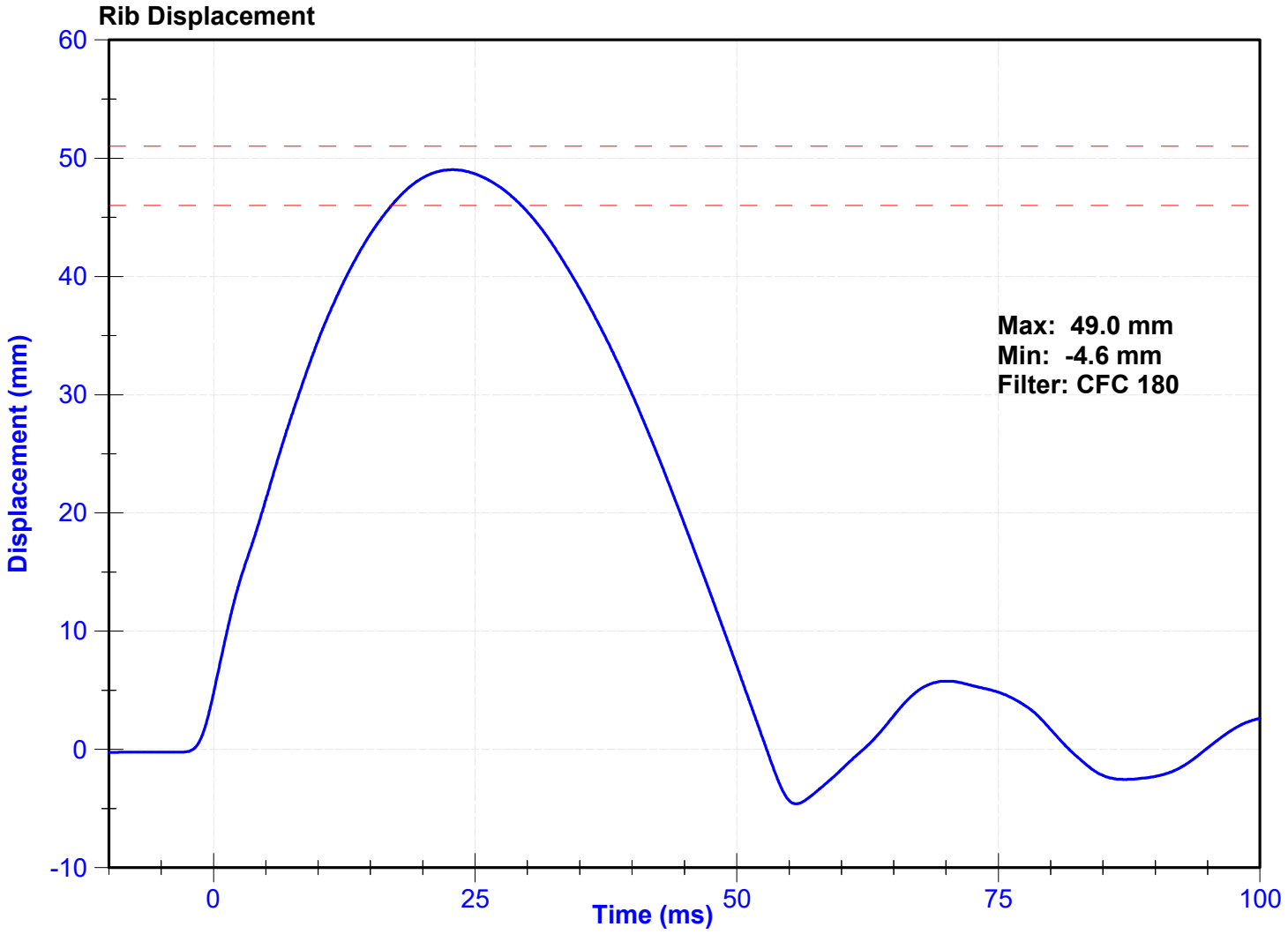
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	49.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025



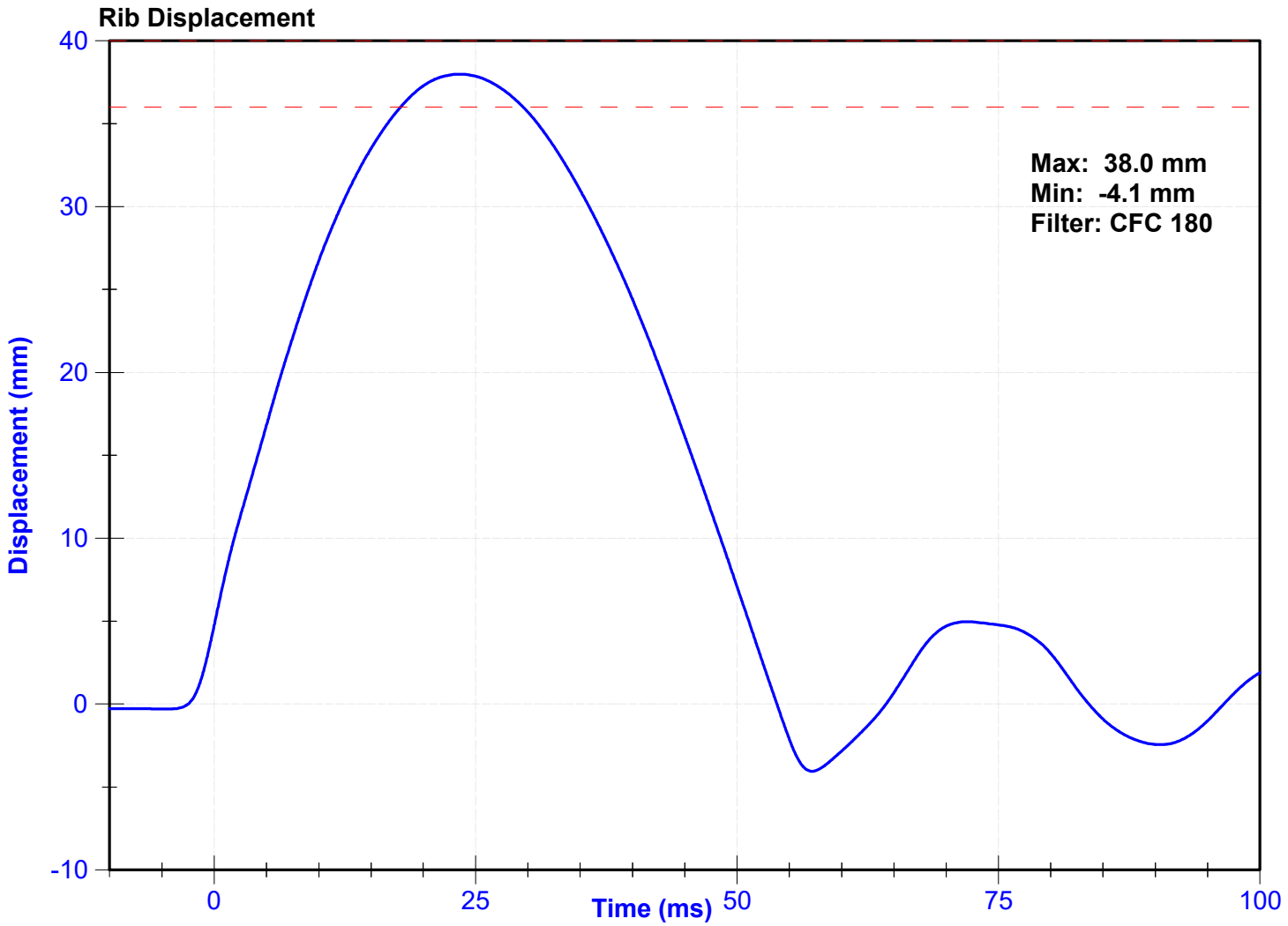
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	38.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025



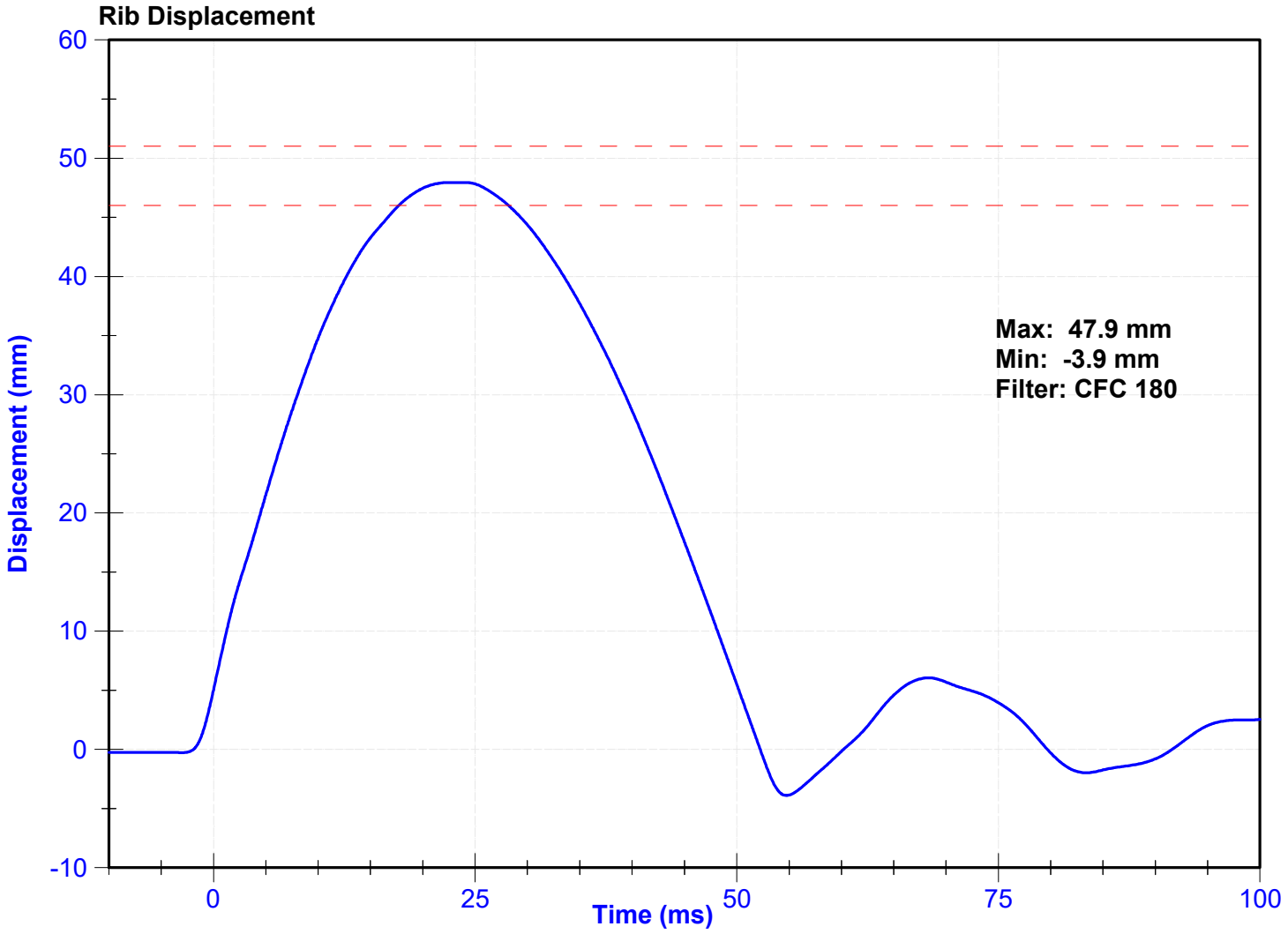
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	47.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025



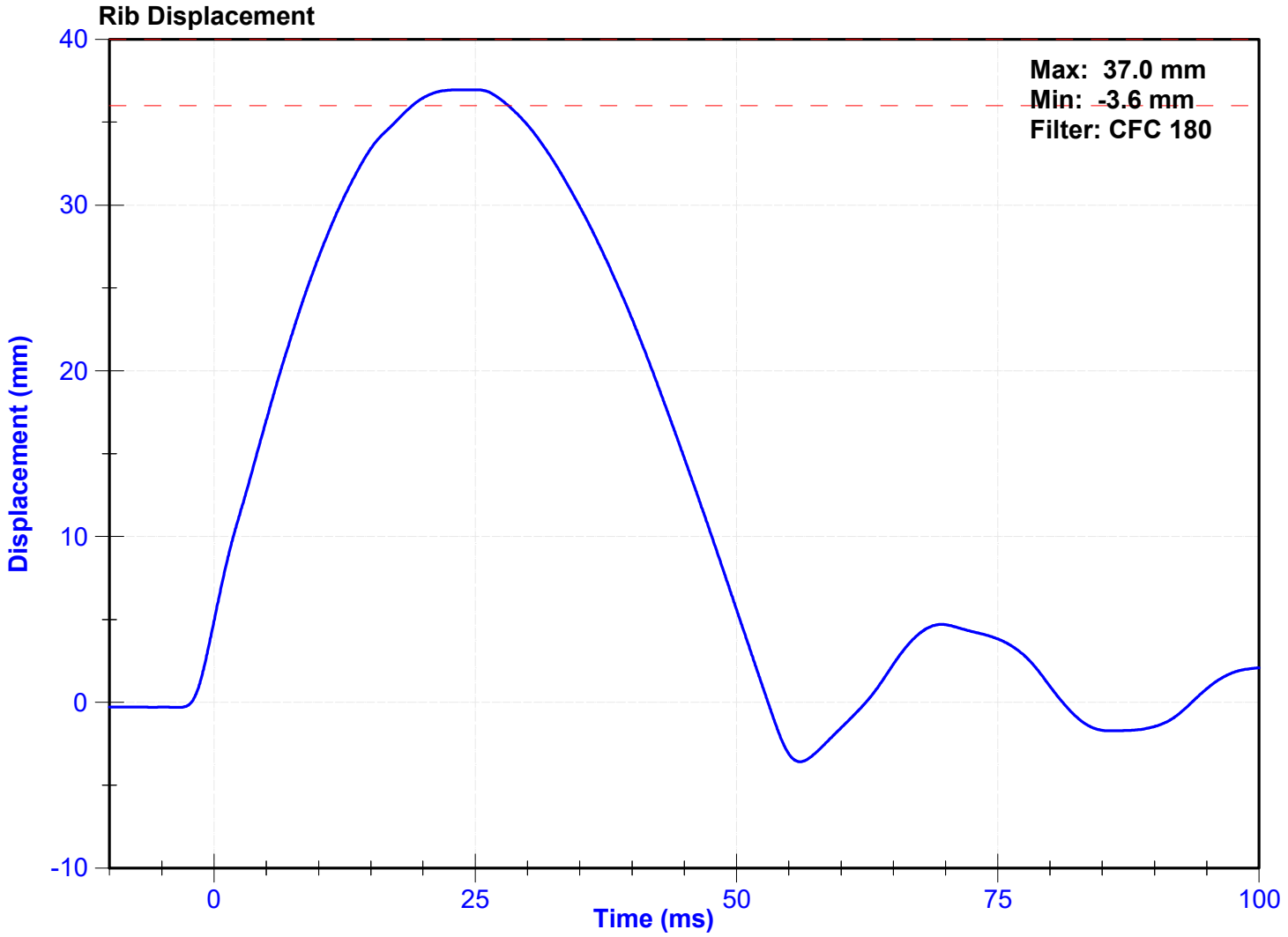
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	37.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025



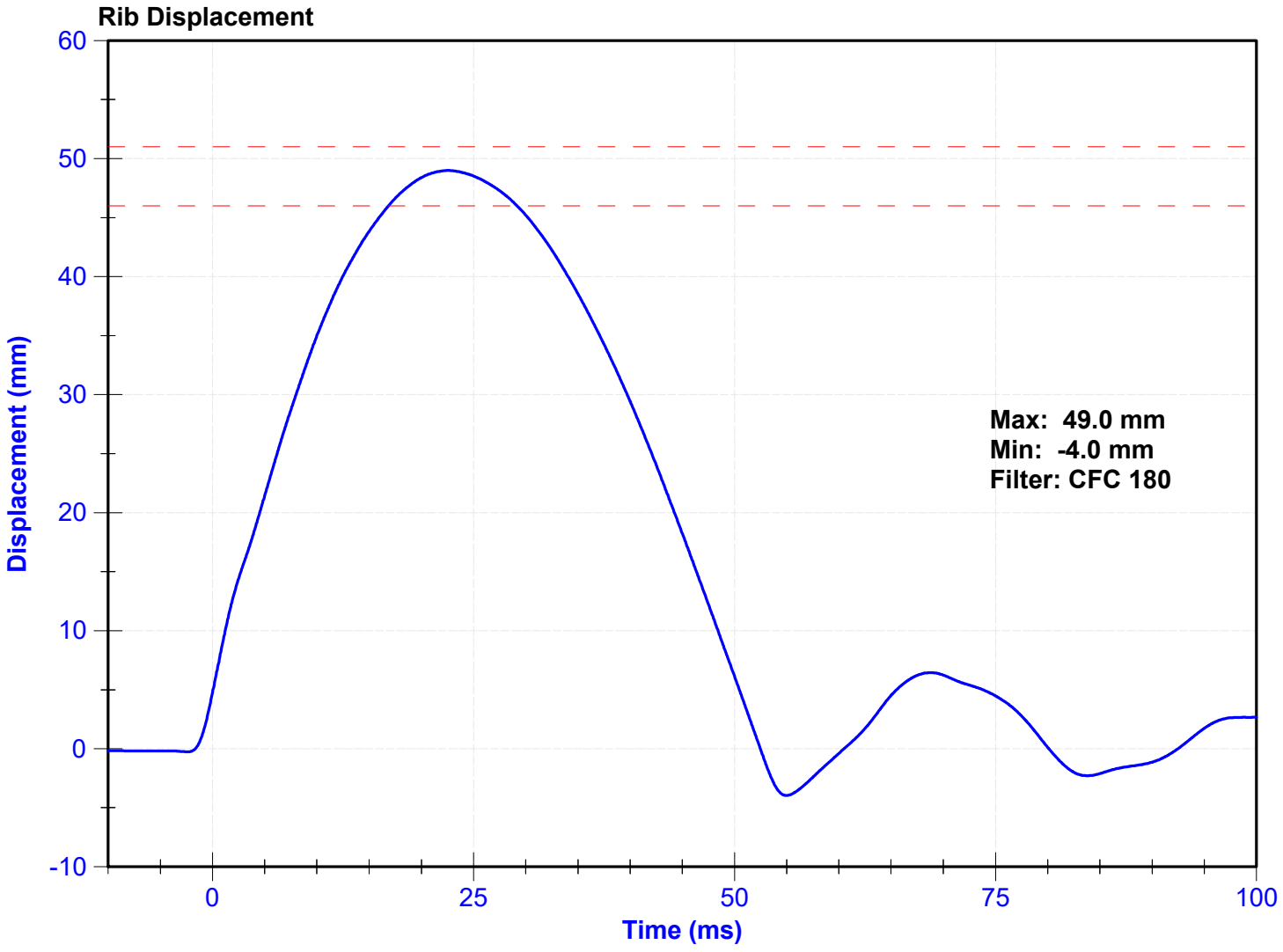
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	46	51	mm	49.0	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	184GFE	11/19/2024	5/20/2025



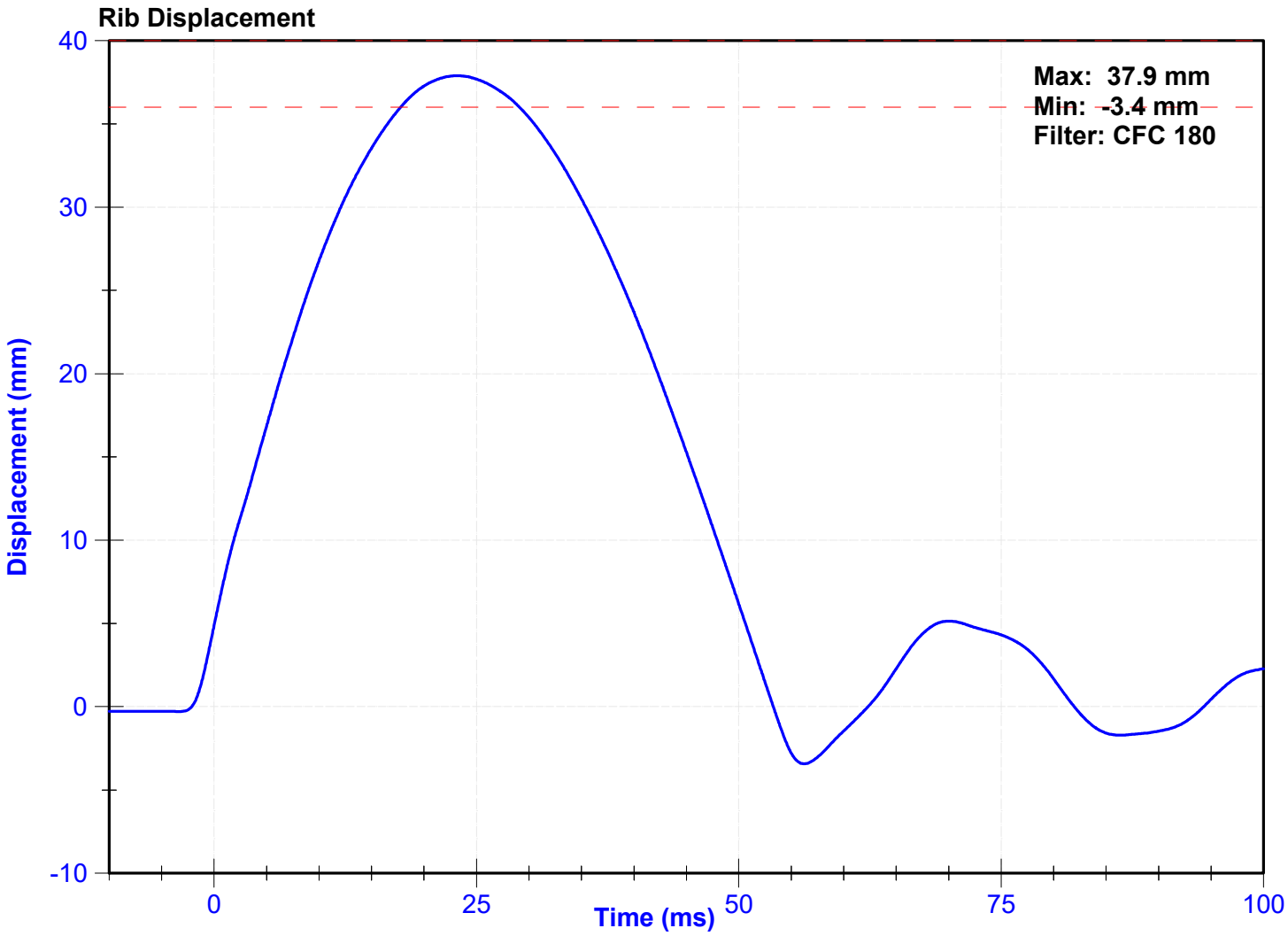
ATD Manufacturer	FTSS	Test Technician	J.Kinderman
ATD Serial Number	F033	Laboratory Supervisor	C.Mantell

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	21.2	Pass
Humidity	10	70	%	39	Pass
Rib Displacement	36	40	mm	37.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell	184GFE	11/19/2024	5/20/2025



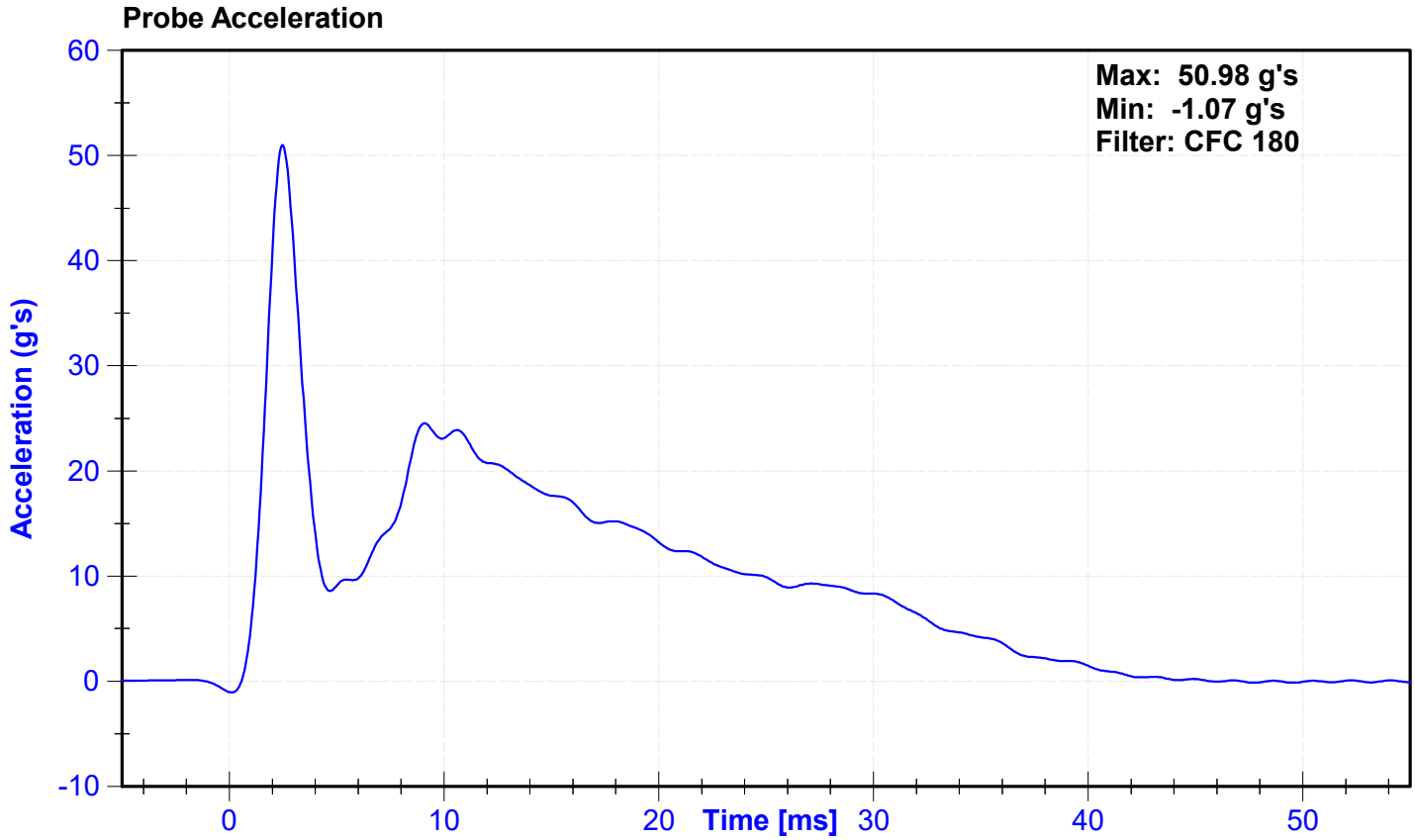
ATD Manufacturer	FTSS	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

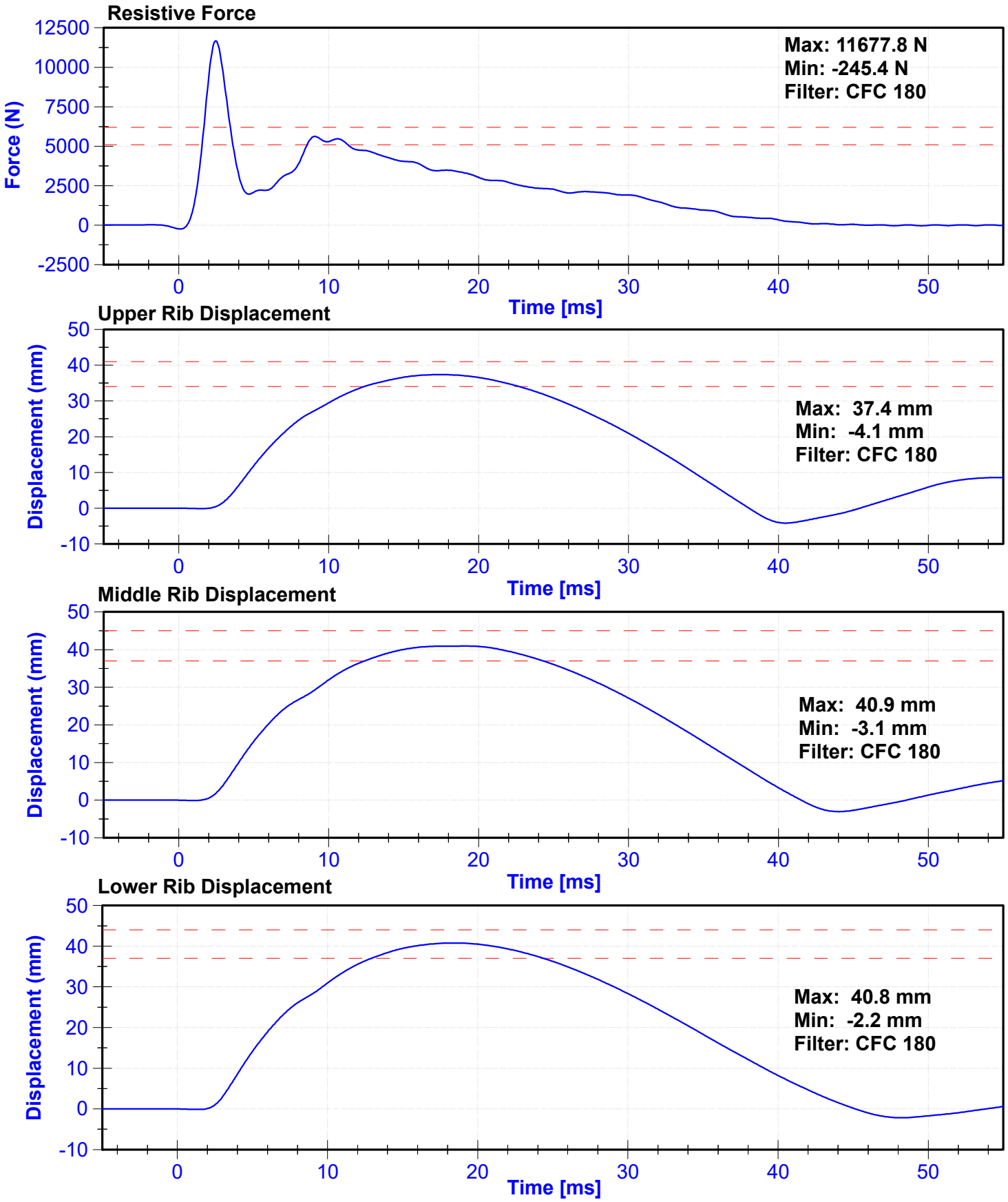
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	5.4	5.6	m/s	5.55	Pass
Resistive Force after 6ms	5100	6200	N	5619.4	Pass
Upper Thorax Rib Deflection	34	41	mm	37.4	Pass
Mid Thorax Rib Deflection	37	45	mm	40.9	Pass
Lower Thorax Rib Deflection	37	44	mm	40.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Upper Thorax Rib Potentiometer	Honeywell	179GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Honeywell	185GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Honeywell	184GFE	11/19/2024	5/20/2025




Resistive Force
Force (N)
12500
10000
7500
5000
2500
0
-2500
Max: 11677.8 N
Min: -245.4 N
Filter: CFC 180
0
10
20
30
40
50
Time [ms]
Upper Rib Displacement
Displacement (mm)
50
40
30
20
10
0
-10
Max: 37.4 mm
Min: -4.1 mm
Filter: CFC 180
Time [ms]
Middle Rib Displacement
Max: 40.9 mm
Min: -3.1 mm
Filter: CFC 180
Time [ms]
Lower Rib Displacement
Max: 40.8 mm
Min: -2.2 mm
Filter: CFC 180
Time [ms]

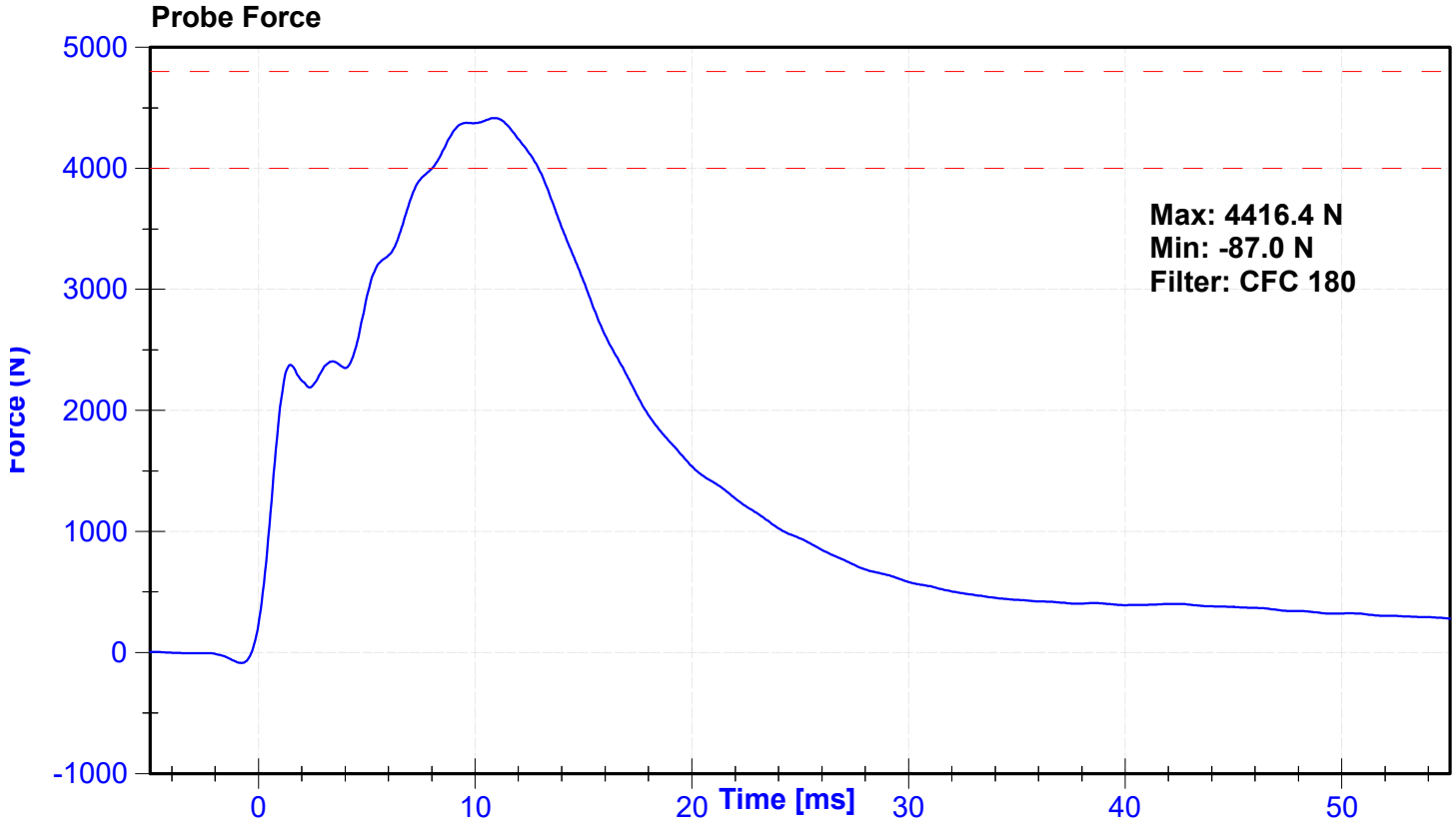
ATD Manufacturer	FTSS	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

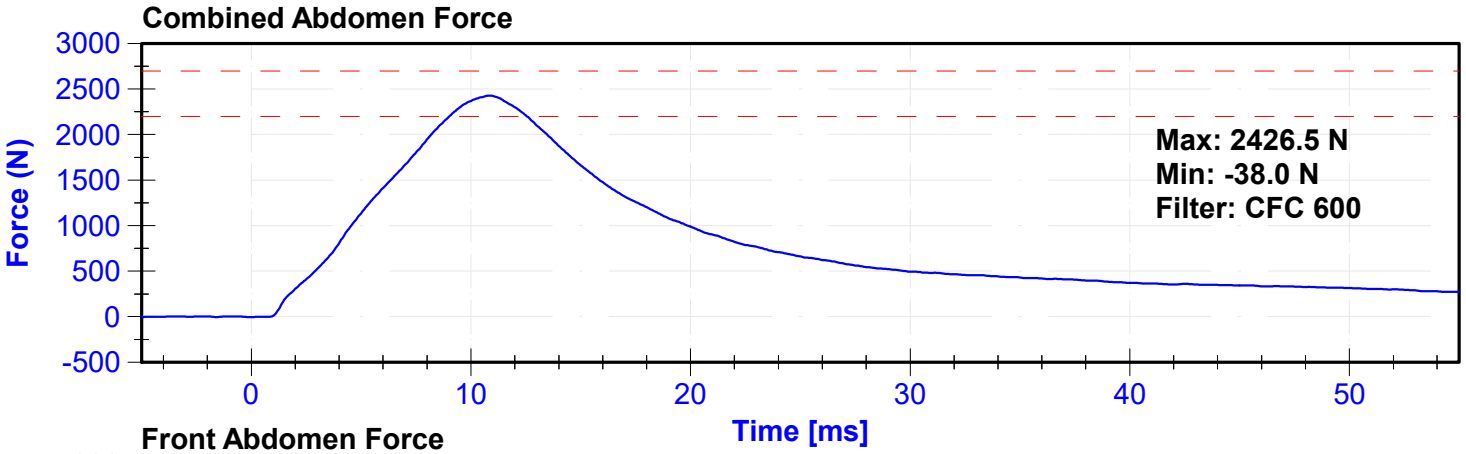
Results

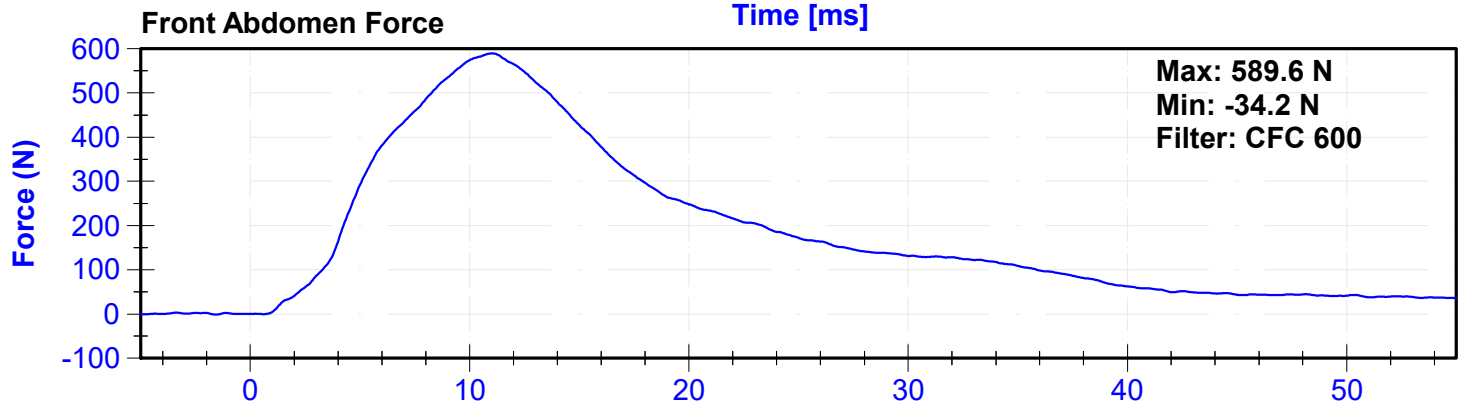
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	3.9	4.1	m/s	4.03	Pass
Combined Abdomen Force	2200	2700	N	2426.5	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	10.85	Pass
Resistive Probe Force	4000	4800	N	4416.4	Pass
Time at Peak Resistive Force	10.6	13.0	ms	10.90	Pass

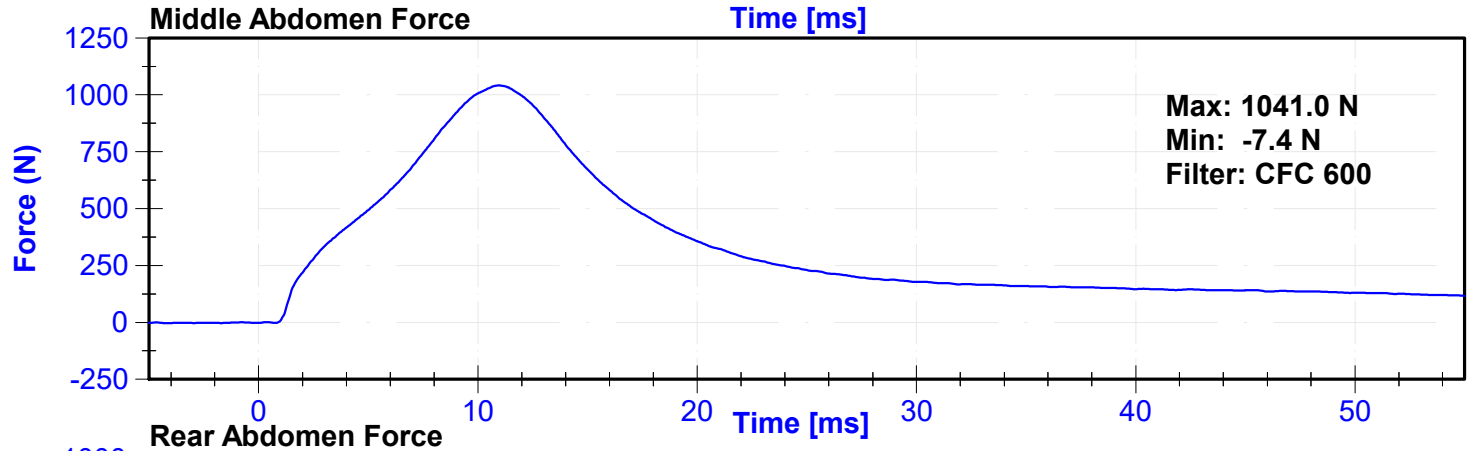
Transducer Calibrations

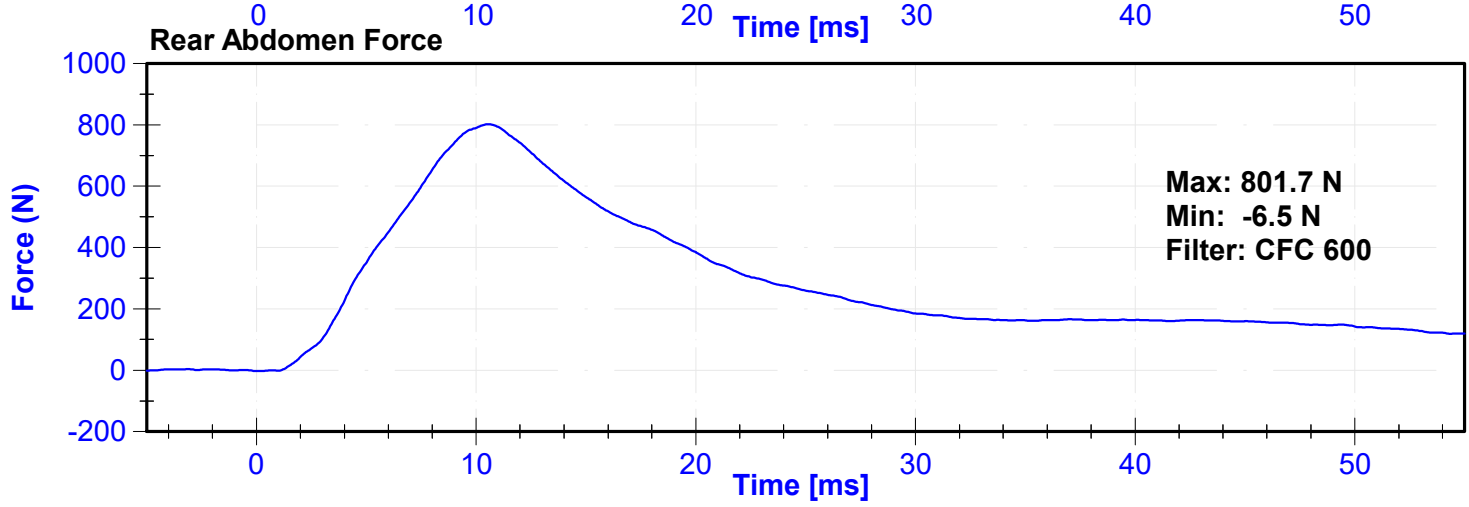
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Front Abdomen Load Cell	Denton	1523	10/28/2024	10/28/2025
Middle Abdomen Load Cell	Denton	1524	10/28/2024	10/28/2025
Rear Abdomen Load Cell	Denton	1530	10/28/2024	10/28/2025




Combined Abdomen Force
Force (N)
3000
2500
2000
1500
1000
500
0
-500
0
10
20
30
40
50
Time [ms]
Max: 2426.5 N
Min: -38.0 N
Filter: CFC 600


Front Abdomen Force
Force (N)
600
500
400
300
200
100
0
-100
0
10
20
30
40
50
Time [ms]
Max: 589.6 N
Min: -34.2 N
Filter: CFC 600


Middle Abdomen Force
Force (N)
1250
1000
750
500
250
0
-250
0
10
20
30
40
50
Time [ms]
Max: 1041.0 N
Min: -7.4 N
Filter: CFC 600


Rear Abdomen Force
Force (N)
1000
800
600
400
200
0
-200
0
10
20
30
40
50
Time [ms]
Max: 801.7 N
Min: -6.5 N
Filter: CFC 600

ATD Manufacturer	Humanetics	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

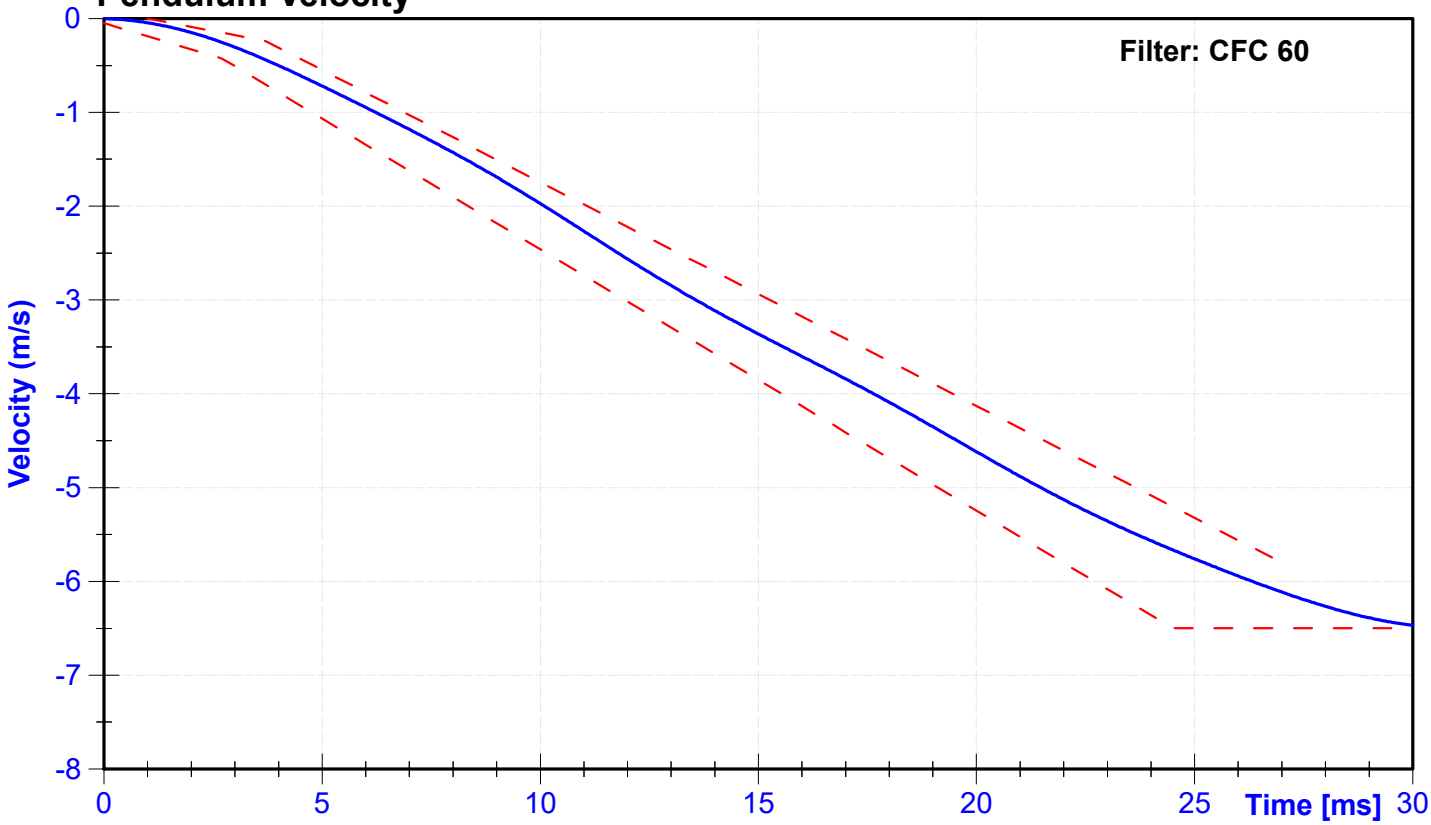
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	35	Pass
Velocity	5.95	6.15	m/s	6.150	Pass
Lateral Spine Rotation	45	55	deg	46.3	Pass
Time at Maximum Rotation	39	53	ms	42.7	Pass
Time of Decay to Zero Degrees	37	57	ms	37.7	Pass
Pendulum Velocity Overall Corridor	Lower Boundary[1]	Upper Boundary[2]	m/s	See Plot[3]	Pass

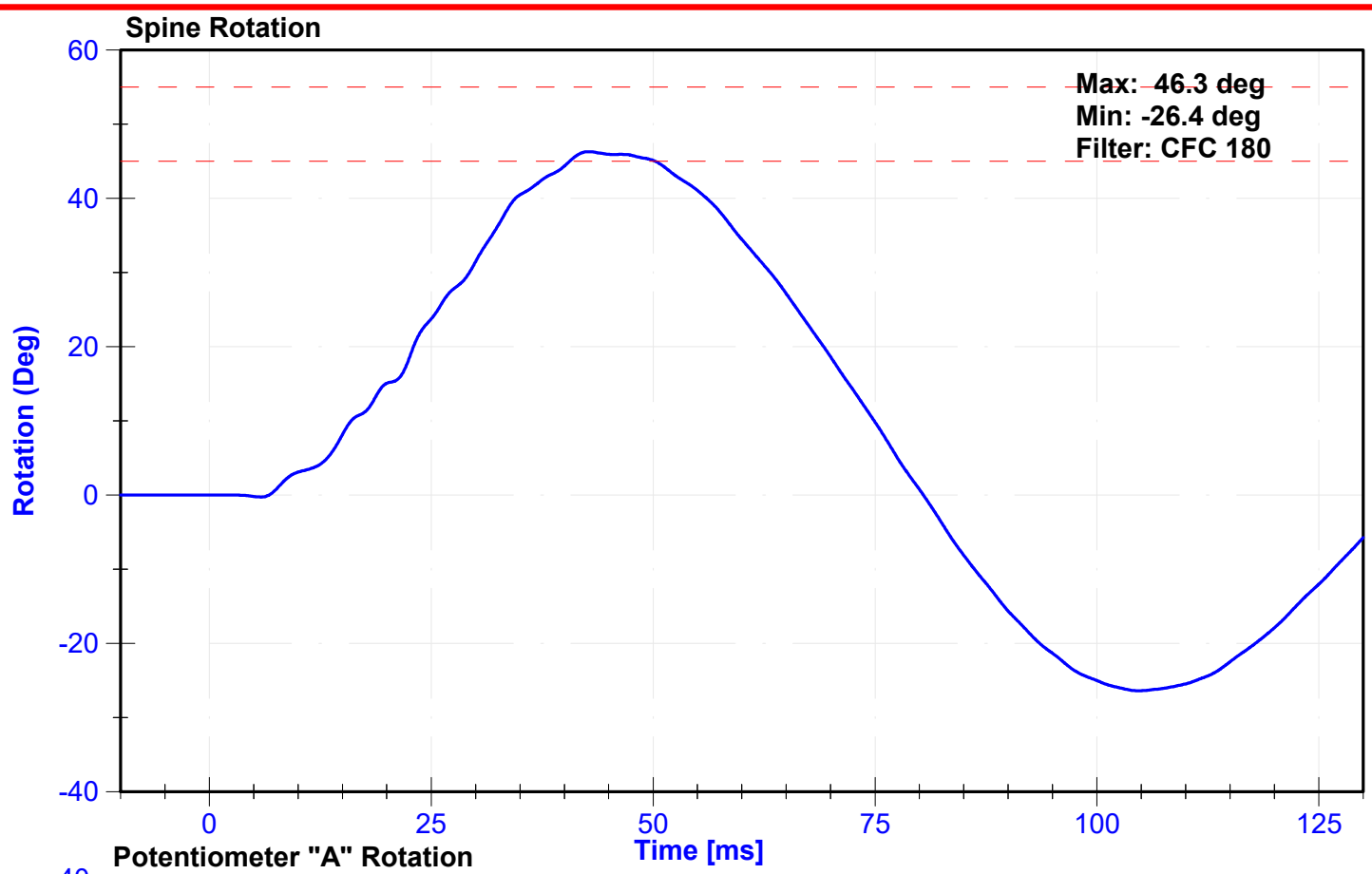
Transducer Calibrations

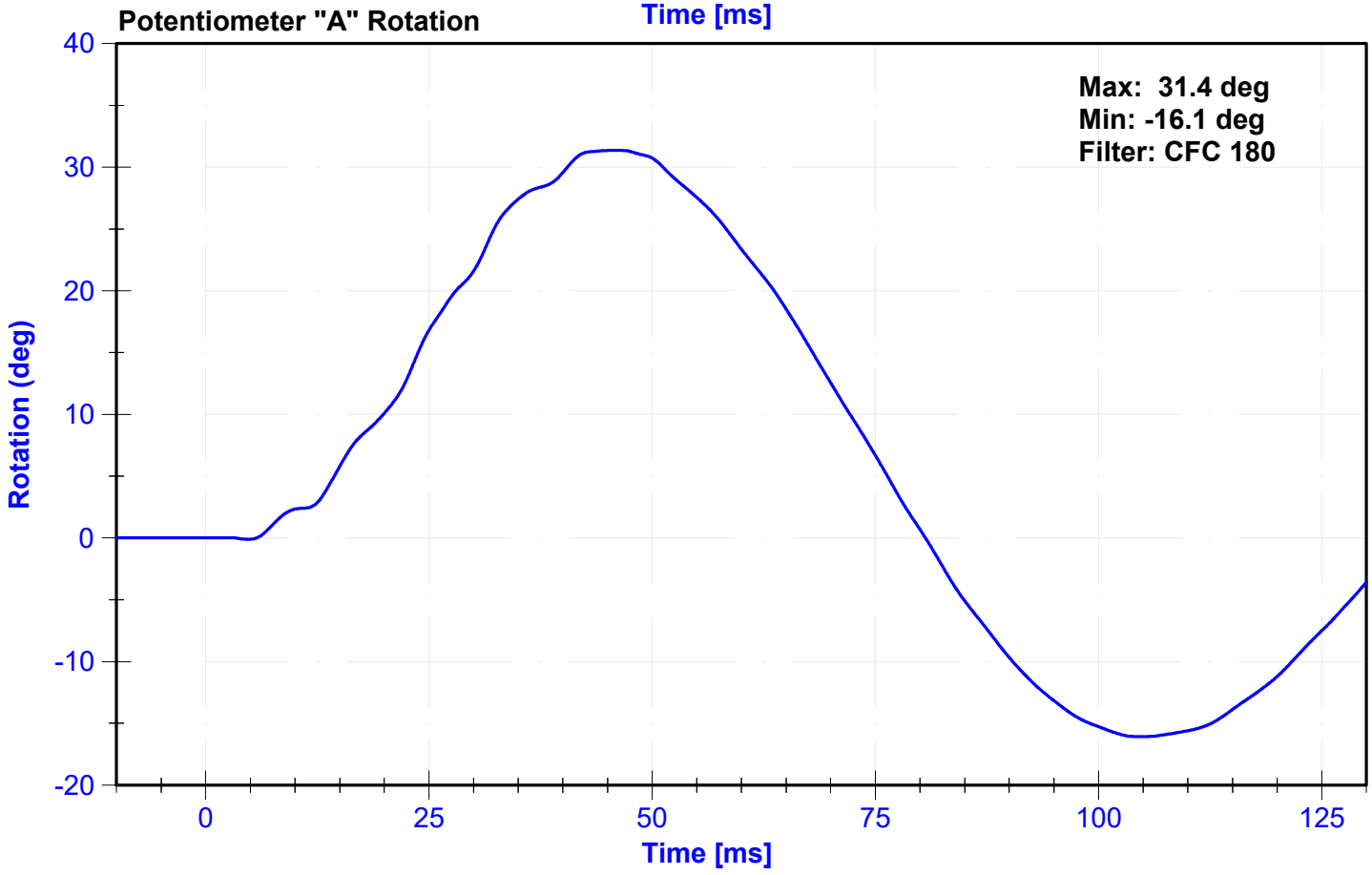
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	C16650	11/1/2024	11/1/2025
Pendulum "A" Potentiometer	Sfernice	2247	9/13/2024	9/13/2025
Condyle "B" Potentiometer	Sfernice	095	9/13/2024	9/13/2025

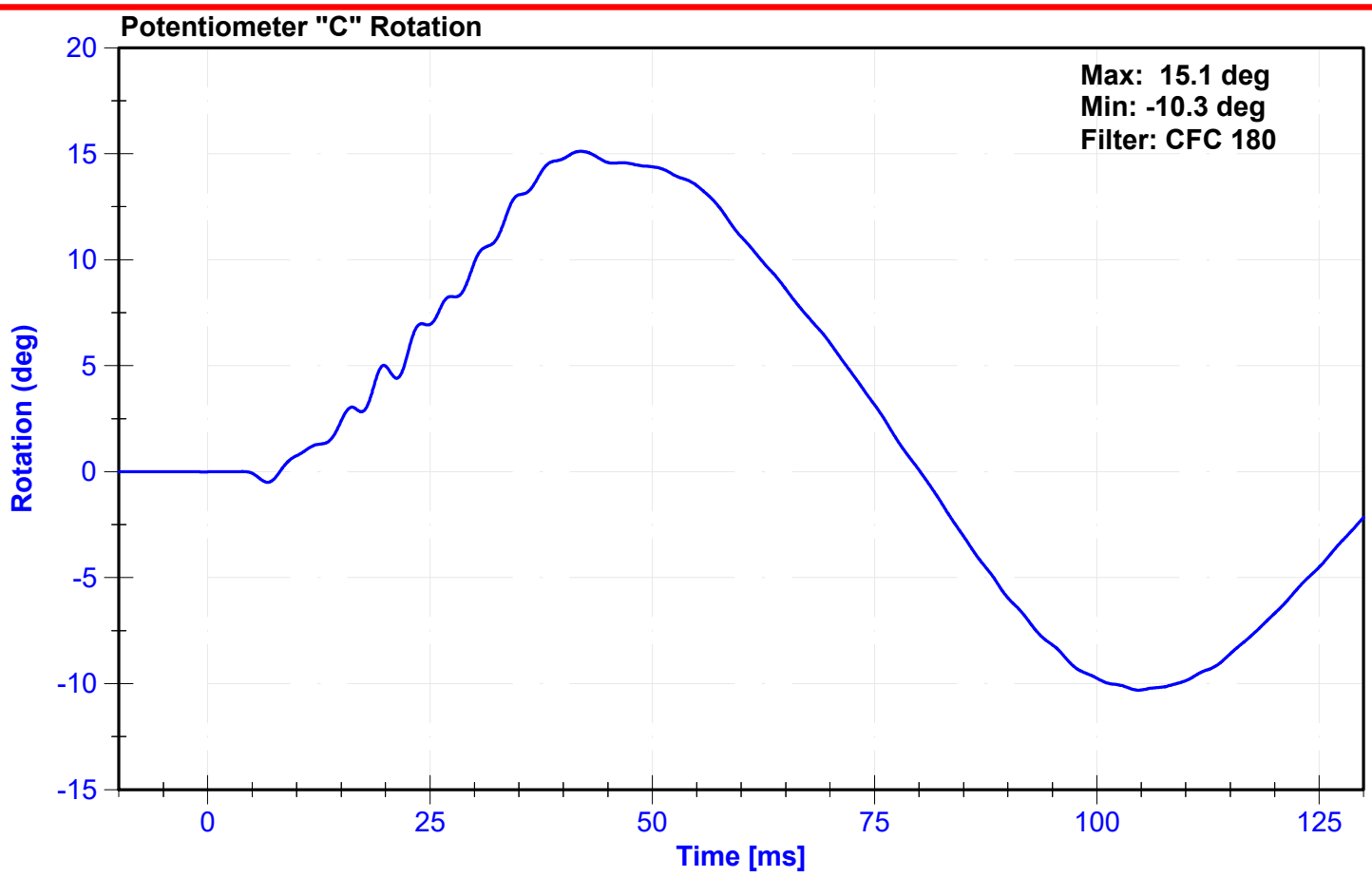
Pendulum Velocity[3]



[1,2] Upper and lower boundaries specified in Appendix I


Spine Rotation
Max: 46.3 deg
Min: -26.4 deg
Filter: CFC 180
Rotation (Deg)
60
40
20
0
-20
-40
0
25
50
75
100
125
Time [ms]


Potentiometer "A" Rotation
Max: 31.4 deg
Min: -16.1 deg
Filter: CFC 180
Rotation (deg)
40
30
20
10
0
-10
-20
0
25
50
75
100
125
Time [ms]



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

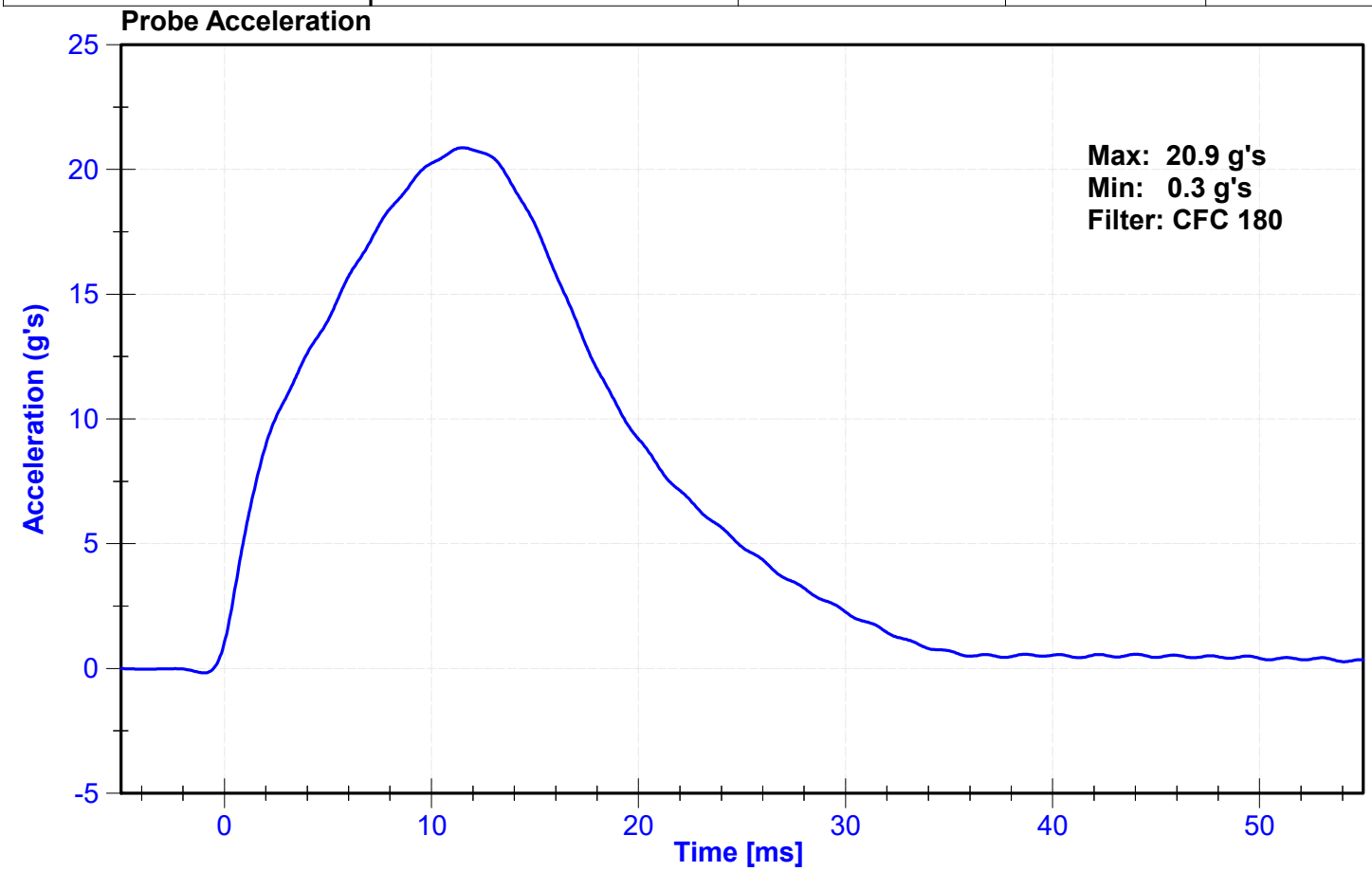
ATD Manufacturer	FTSS	Test Technician	E.Andruczyk
ATD Serial Number	F033	Laboratory Supervisor	J.Kinderman

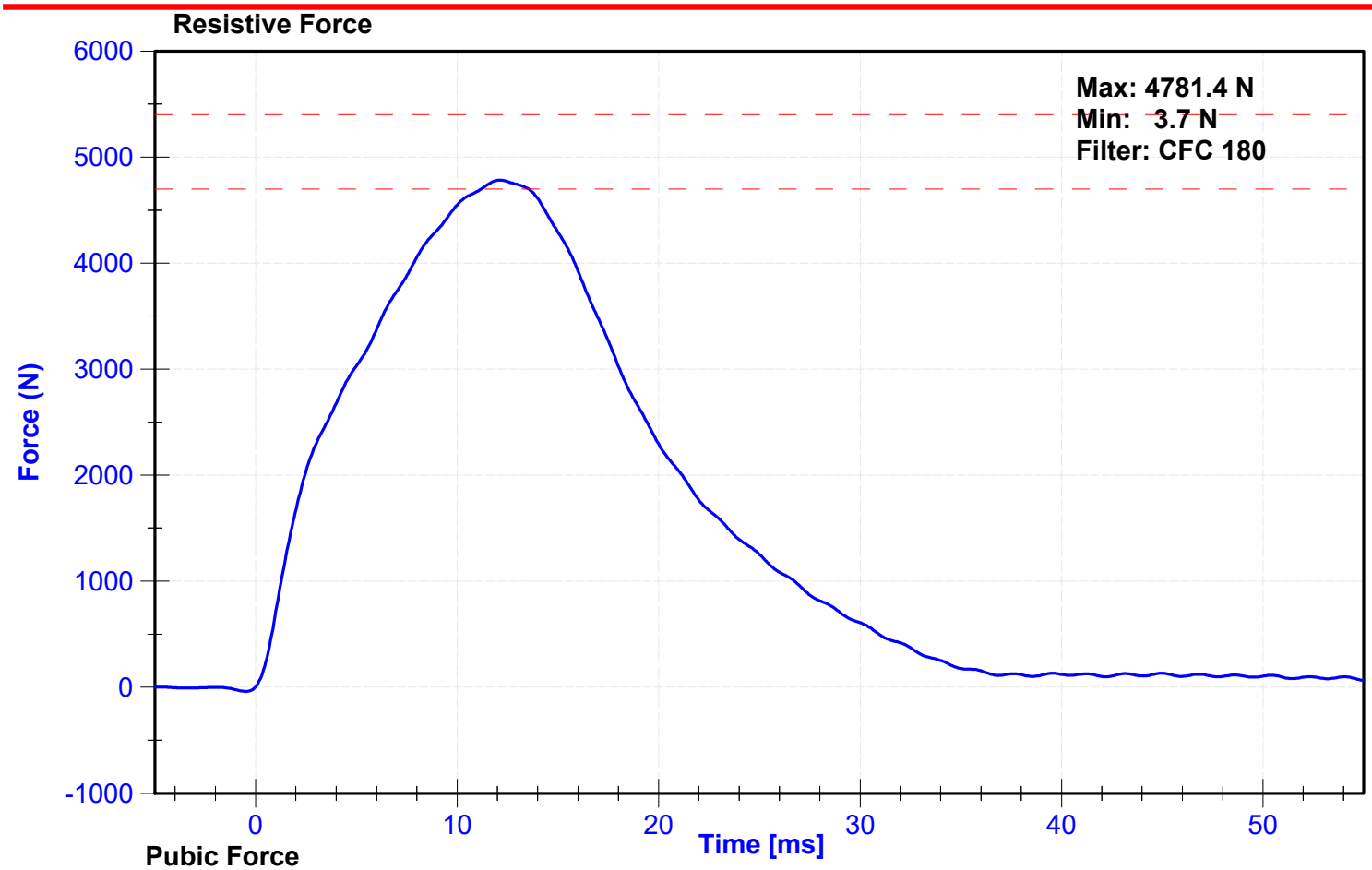
Results

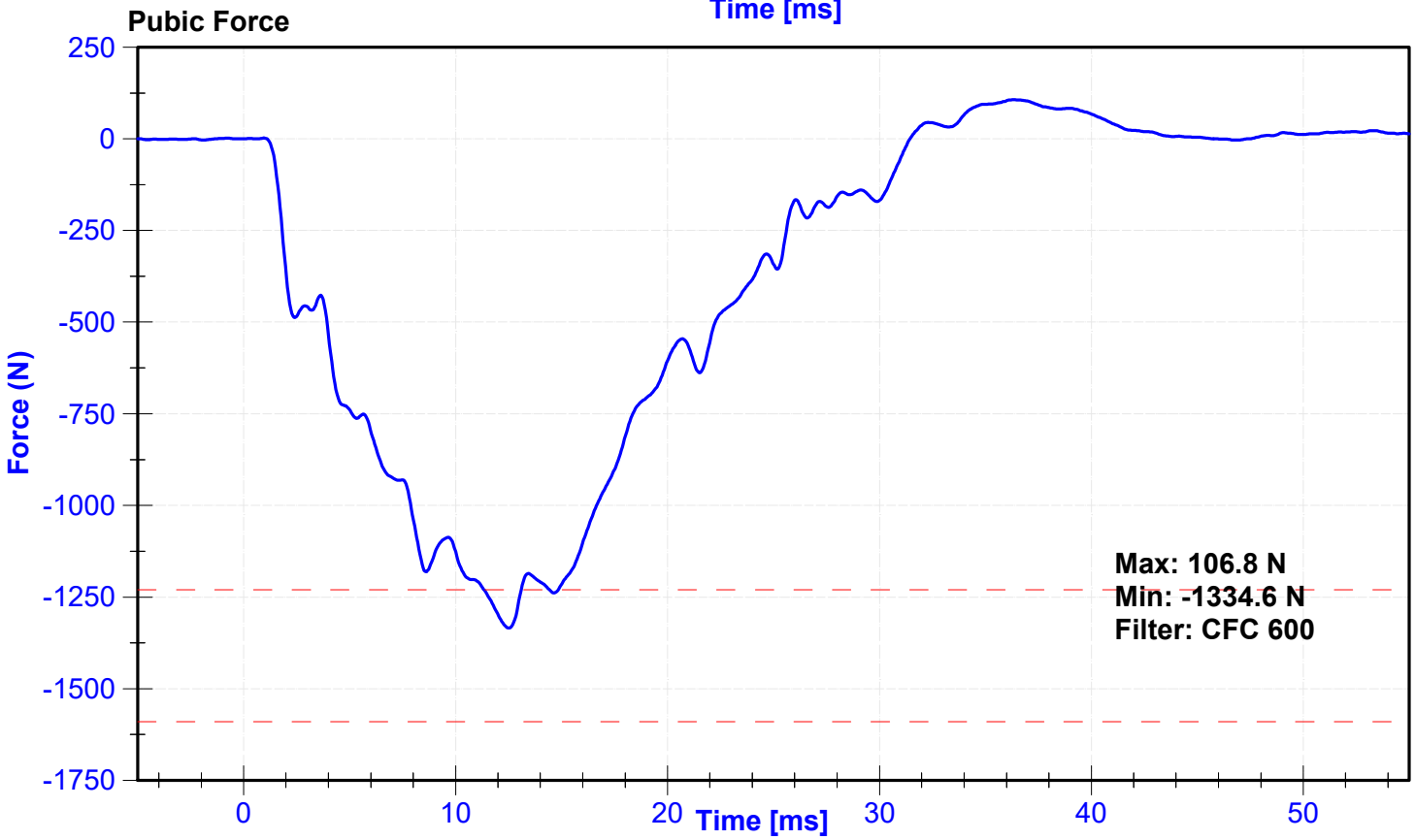
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.6	Pass
Humidity	10	70	%	28	Pass
Velocity	4.2	4.4	m/s	4.29	Pass
Resistive Force	4700	5400	N	4781.4	Pass
Time at Peak Resistive Force	11.8	16.1	ms	12.12	Pass
Pubic Force	-1590	-1230	N	-1334.6	Pass
Time at Peak Pubic Force	12.2	17.0	ms	12.53	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18599	9/13/2024	3/12/2025
Pubic Load Cell	Denton	458-FY	10/28/2024	10/28/2025




Resistive Force
Max: 4781.4 N
Min: 3.7 N
Filter: CFC 180
Force (N)
Time [ms]
6000
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50


Pubic Force
Max: 106.8 N
Min: -1334.6 N
Filter: CFC 600
Force (N)
Time [ms]
250
0
-250
-500
-750
-1000
-1250
-1500
-1750
0
10
20
30
40
50

CALIBRATION TEST RESULTS

POST-TEST

SID-IIS 5TH PERCENTILE FEMALE – PASSENGER ATD

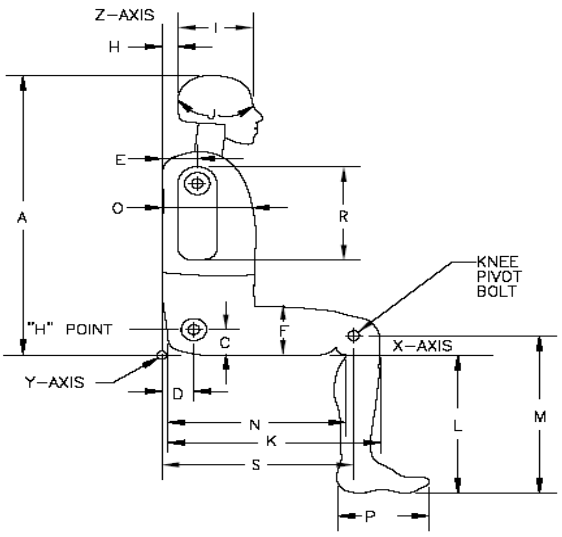
SERIAL NO:DG8012

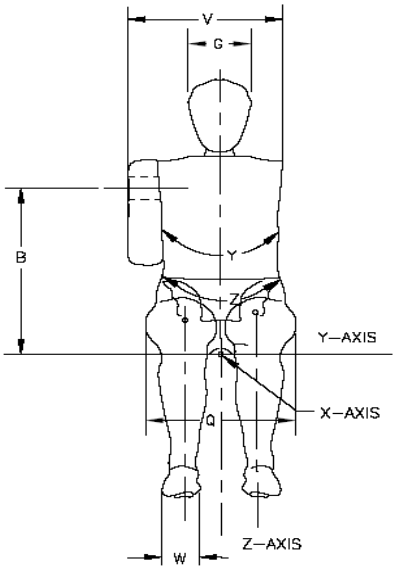
(CONFIGURED FOR LEFT SIDE IMPACT)

External Measurements - SID-IIs

Technician: J. Rios Date: 11/22/2024

Dummy Serial Number: DG8012





Symbol	Description	Specification (mm)		Result (mm)	Pass/Fail
A	Sitting Height	772	788	781	Pass
B	Shoulder Pivot Height	437	453	444	Pass
C	H-point Height	79	89	85	Pass
D	H-point from seatback	141	151	147	Pass
E	Shoulder Pivot from Backline	97	107	102	Pass
F	Thigh Clearance	119	135	125	Pass
G	Head Breadth	140	148	142	Pass
H	Head Back from Backline	40	46	43	Pass
I	Head Depth	178	188	183	Pass
J	Head Circumference	541	551	550	Pass
K	Buttock to Knee Length	514	540	522	Pass
L	Popliteal Height	343	369	352	Pass
M	Knee Pivot to floor height	392	409	402	Pass
N	Buttock Popliteal Length	416	442	431	Pass
O	Chest Depth w/o jacket	195	211	204	Pass
P	Foot Length	216	232	226	Pass
Q	Hip Breadth (w/pelvic plugs)	313	323	319	Pass
R	Arm Length	249	259	256	Pass
S	Knee Joint to seatback	477	493	483	Pass
V	Shoulder Width	341	357	352	Pass
W	Foot Width	78	94	85	Pass
Y	Chest Circumference w/jacket	851	881	873	Pass
Z	Waist Circumference	761	791	783	Pass

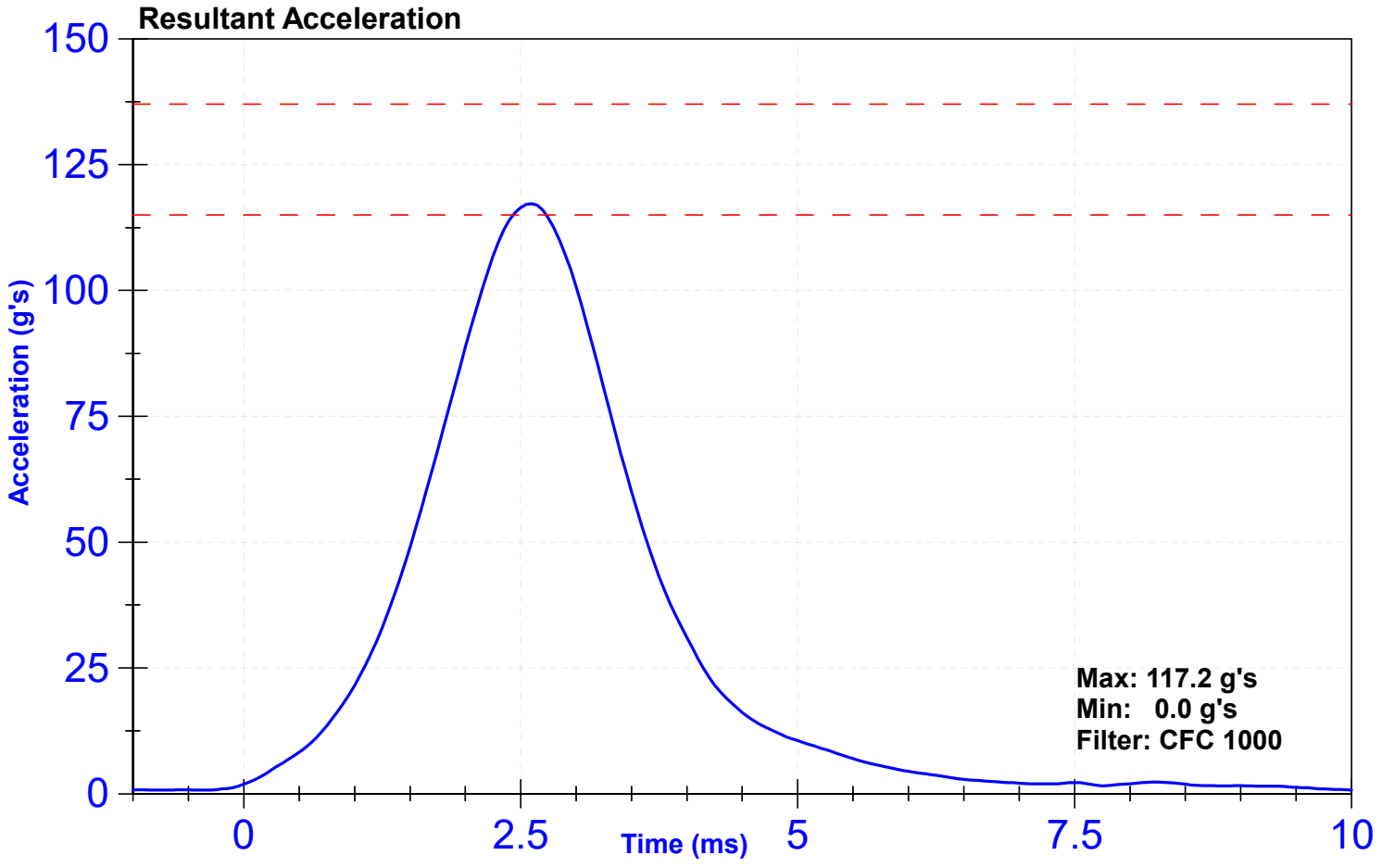
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

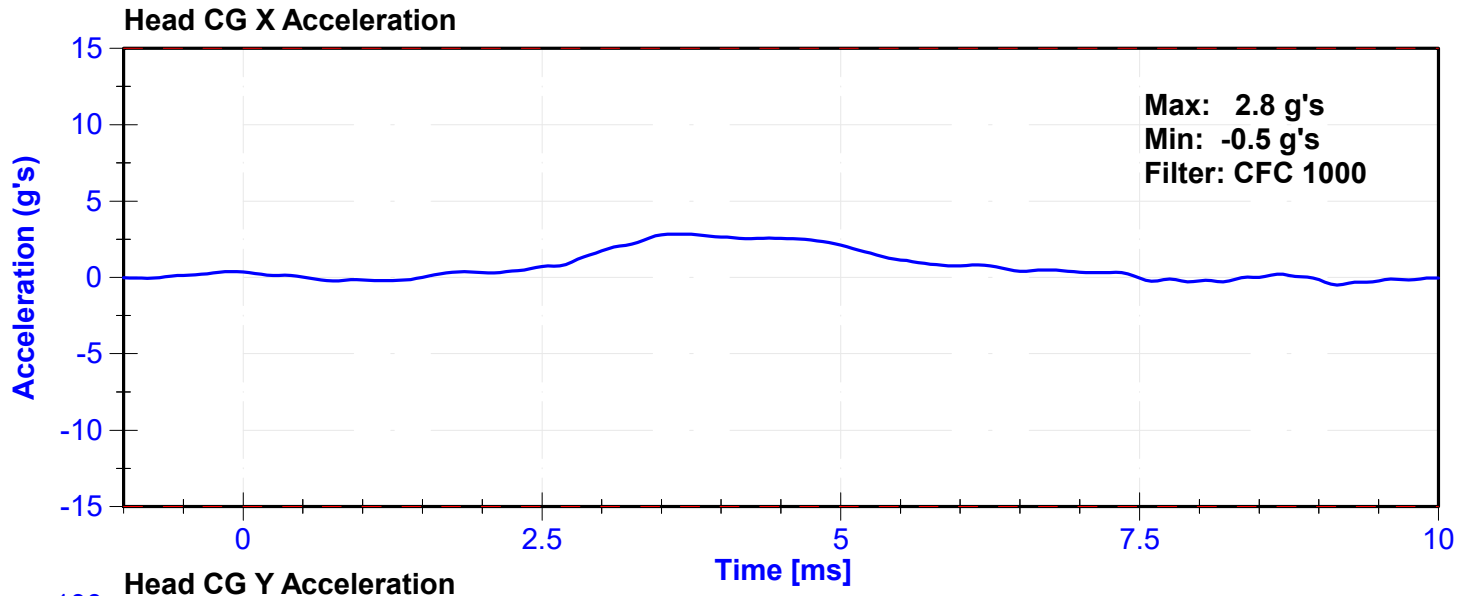
Results

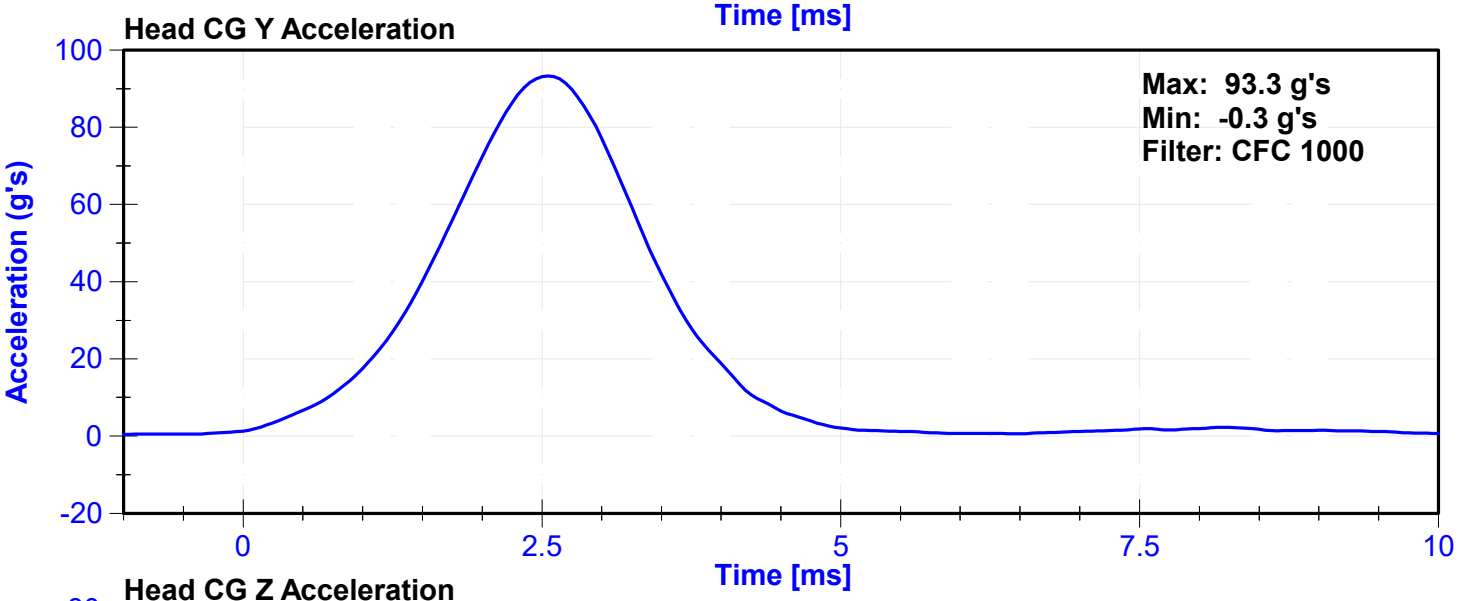
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.7	Pass
Humidity	10	70	%	31	Pass
Resultant Acceleration	115	137	g's	117.2	Pass
Oscillation	0	15	%	1.9	Pass
Fore-Aft Acceleration	-15	15	g's	2.8	Pass

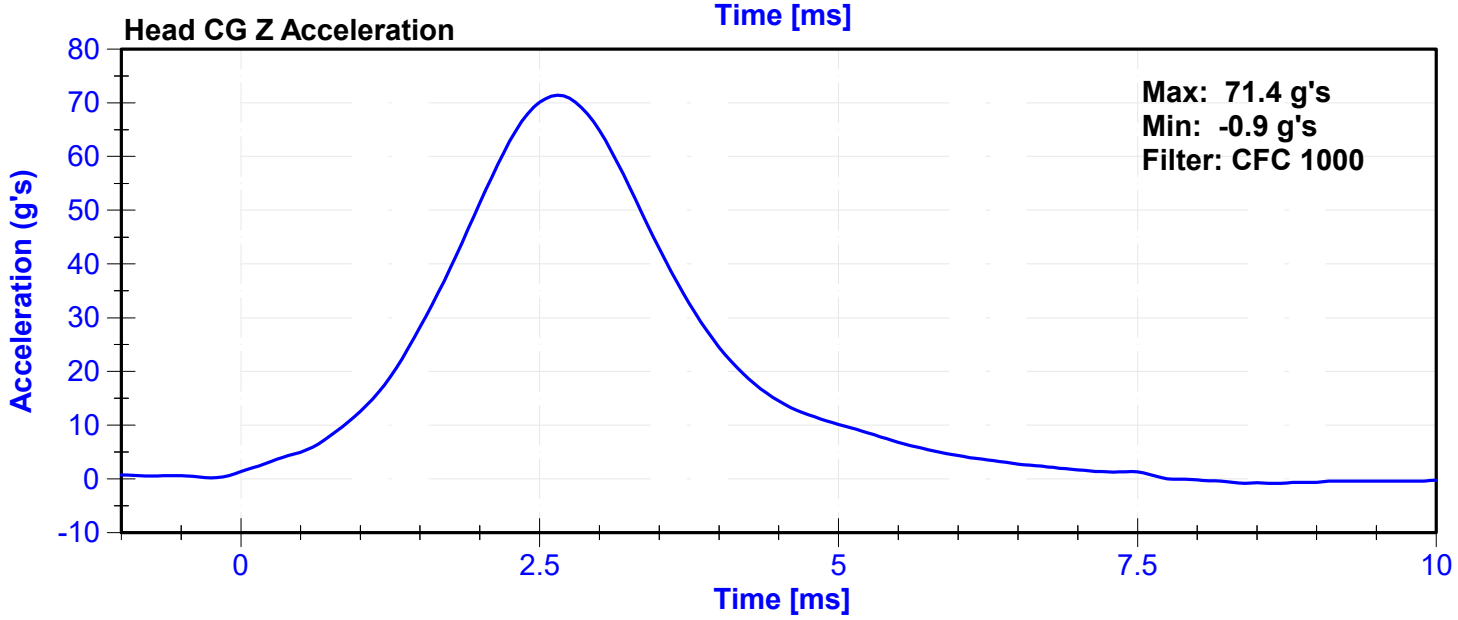
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibratio Date	Calibratio Due Date
X Accelerometer	Endevco	T21184	10/17/2024	4/15/2025
Y Accelerometer	Endevco	T31030	10/17/2024	4/15/2025
Z Accelerometer	Endevco	P83319	10/17/2024	4/15/2025




Head CG X Acceleration
Max: 2.8 g's
Min: -0.5 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]


Head CG Y Acceleration
Max: 93.3 g's
Min: -0.3 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]


Head CG Z Acceleration
Max: 71.4 g's
Min: -0.9 g's
Filter: CFC 1000
Acceleration (g's)
Time [ms]

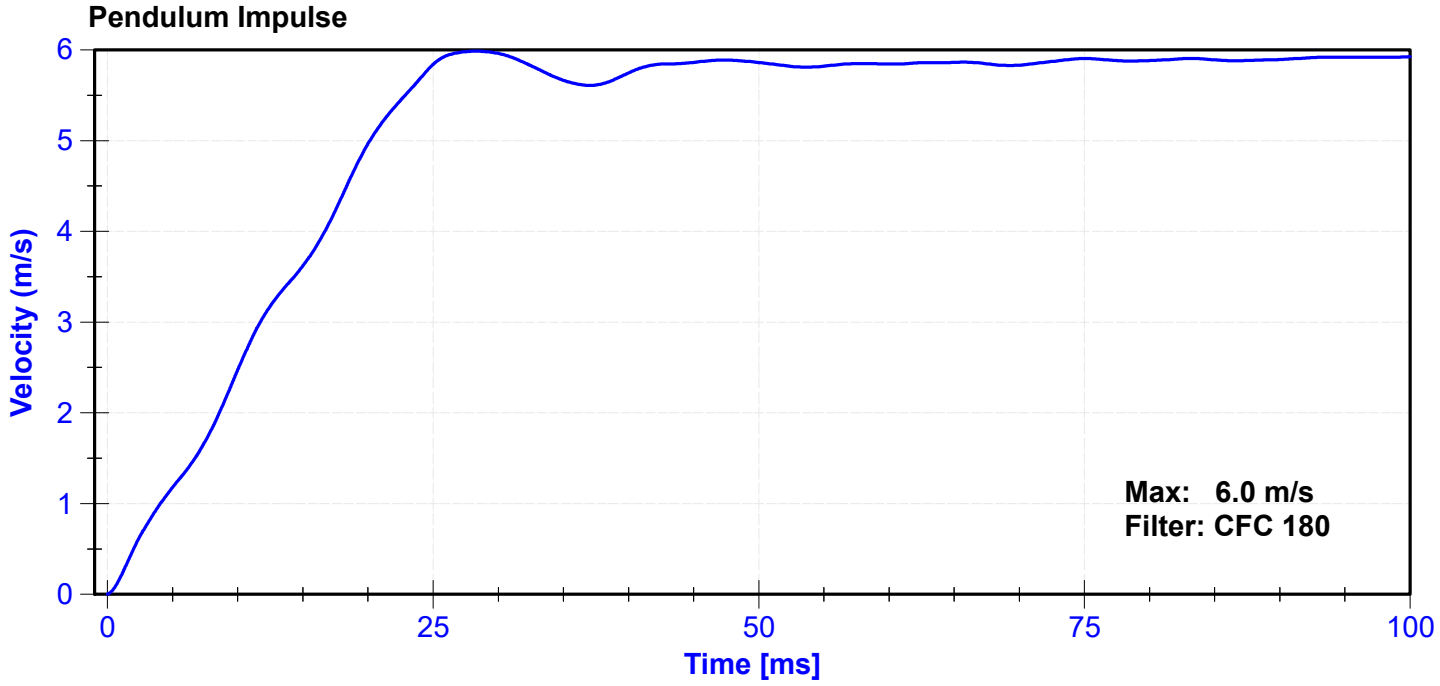
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

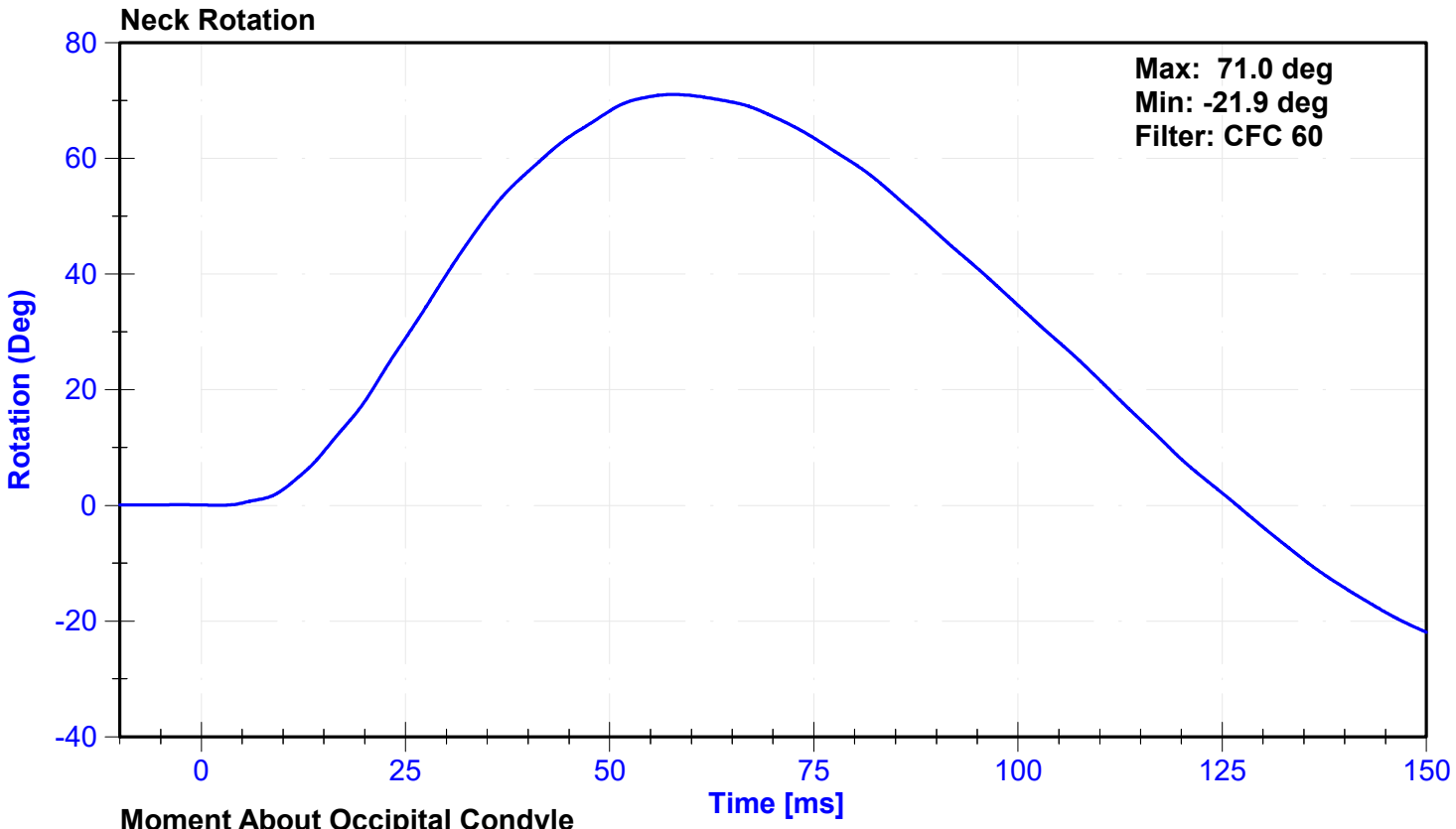
Results

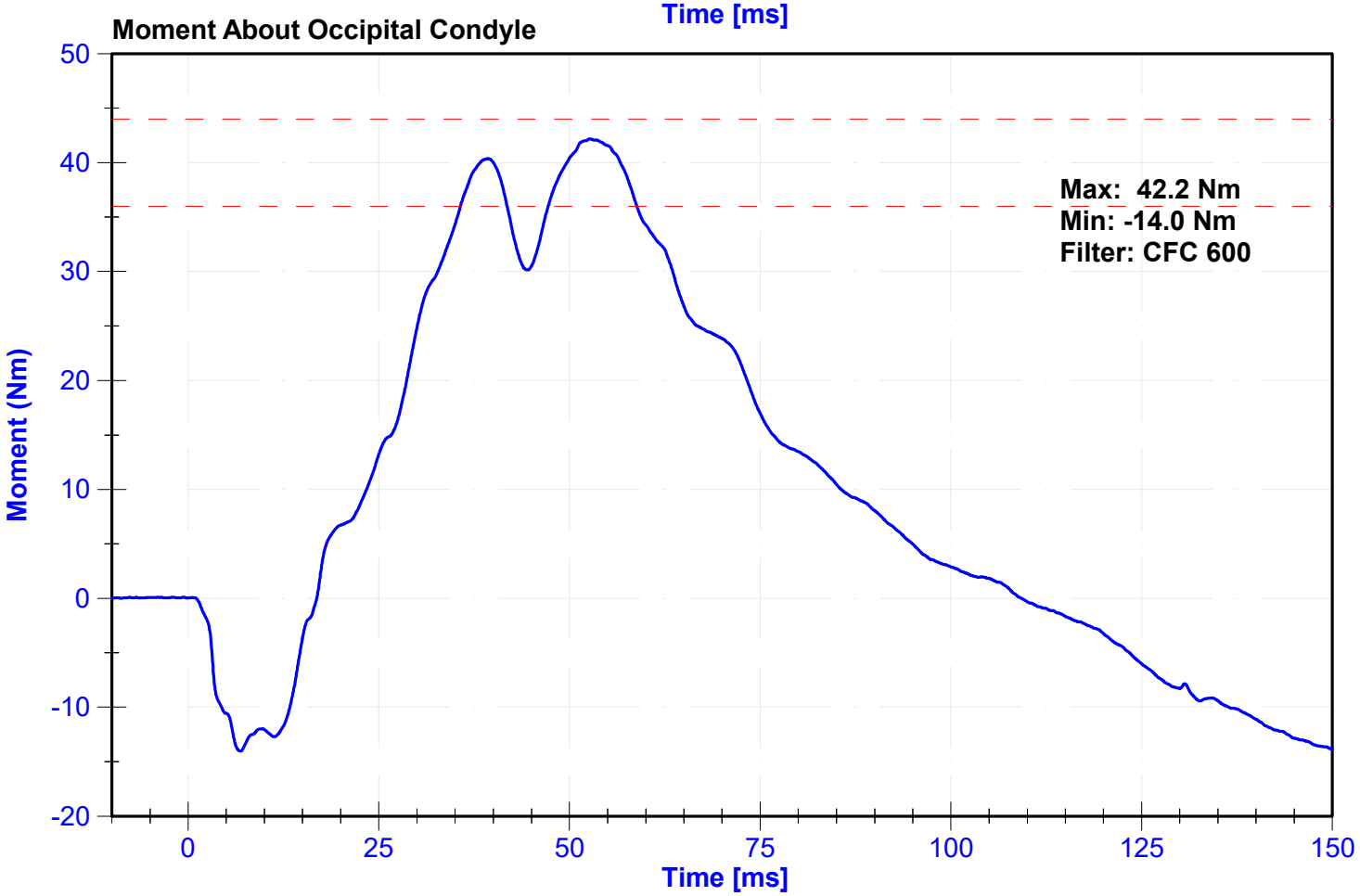
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.7	Pass
Humidity	10	70	%	35	Pass
Velocity	5.51	5.63	m/s	5.580	Pass
Pendulum Impulse at 10ms	2.2	2.8	m/s	2.48	Pass
Pendulum Impulse at 15ms	3.3	4.1	m/s	3.62	Pass
Pendulum Impulse at 20ms	4.4	5.4	m/s	4.97	Pass
Pendulum Impulse at 25ms	5.4	6.1	m/s	5.84	Pass
Pendulum Impulse from 25 to 100ms	5.5	6.2	m/s	5.98	Pass
Neck Rotation	71	81	deg	71.0	Pass
Time at Maximum Rotation	50	70	ms	57.7	Pass
Moment about the OC	36	44	Nm	42.2	Pass
Moment Decay to 0 Nm	102	126	ms	109.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	7231C-750	11/1/2024	11/1/2025
Pendulum Potentiometer	Servo	4961	9/23/2024	9/23/2025
Condyle Potentiometer	Servo	DS185	9/23/2024	9/23/2025
Upper Neck Load Cell	Denton	1716A_2187-FY	12/5/2023	12/4/2024




Neck Rotation
Max: 71.0 deg
Min: -21.9 deg
Filter: CFC 60
Rotation (Deg)
80
60
40
20
0
-20
-40
0
25
50
75
100
125
150
Time [ms]


Moment About Occipital Condyle
Max: 42.2 Nm
Min: -14.0 Nm
Filter: CFC 600
Moment (Nm)
50
40
30
20
10
0
-10
-20
0
25
50
75
100
125
150
Time [ms]

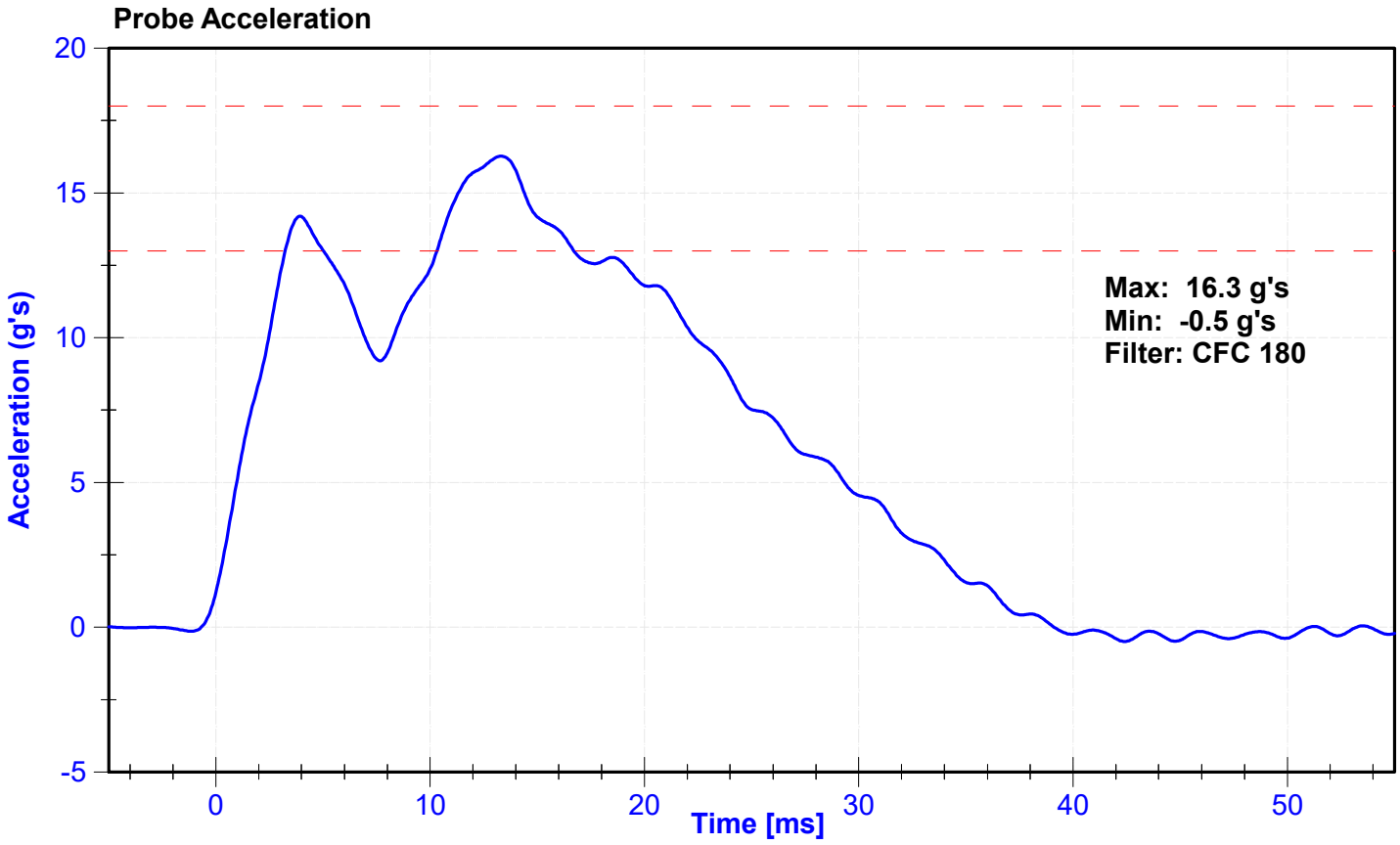
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

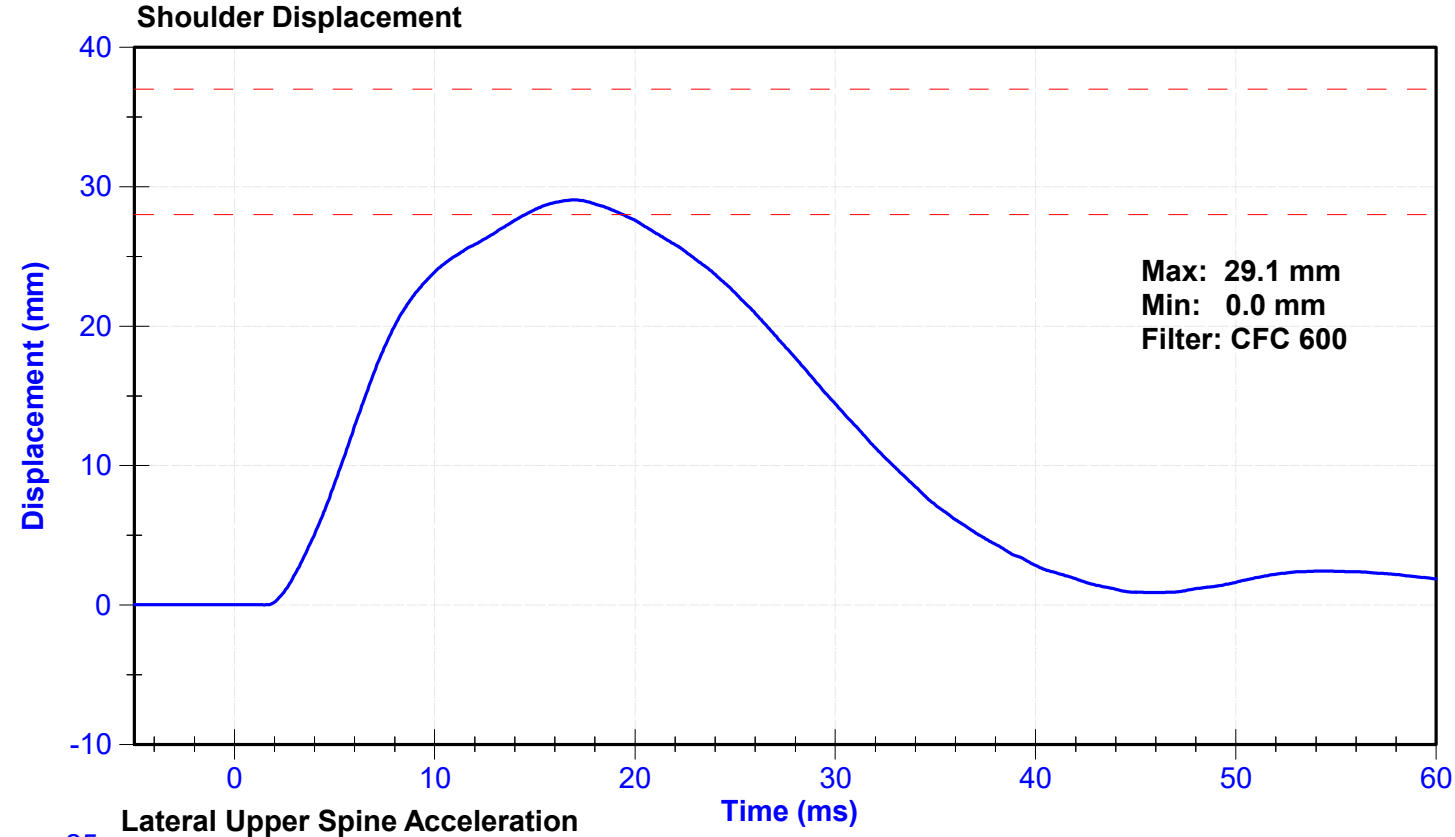
Results

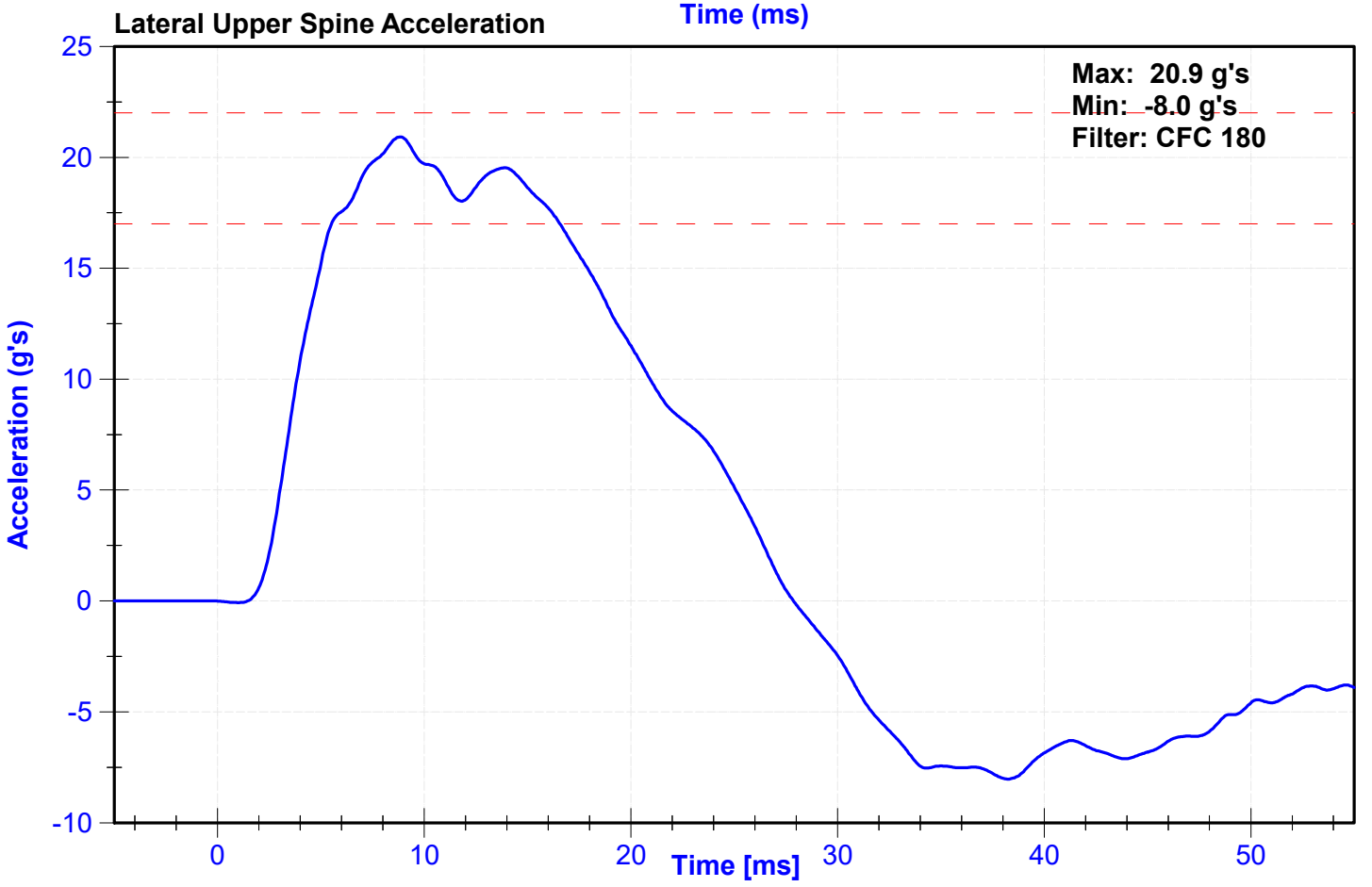
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.29	Pass
Probe Acceleration	13	18	g's	16.3	Pass
Shoulder Deflection	28	37	mm	29.1	Pass
Lateral Upper Spine Acceleration	17	22	g's	20.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Shoulder Potentiometer	Servo	1274GFE	10/16/2024	4/16/2025
Upper Spine Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025




Shoulder Displacement
Displacement (mm)
Time (ms)
Max: 29.1 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 20.9 g's
Min: -8.0 g's
Filter: CFC 180

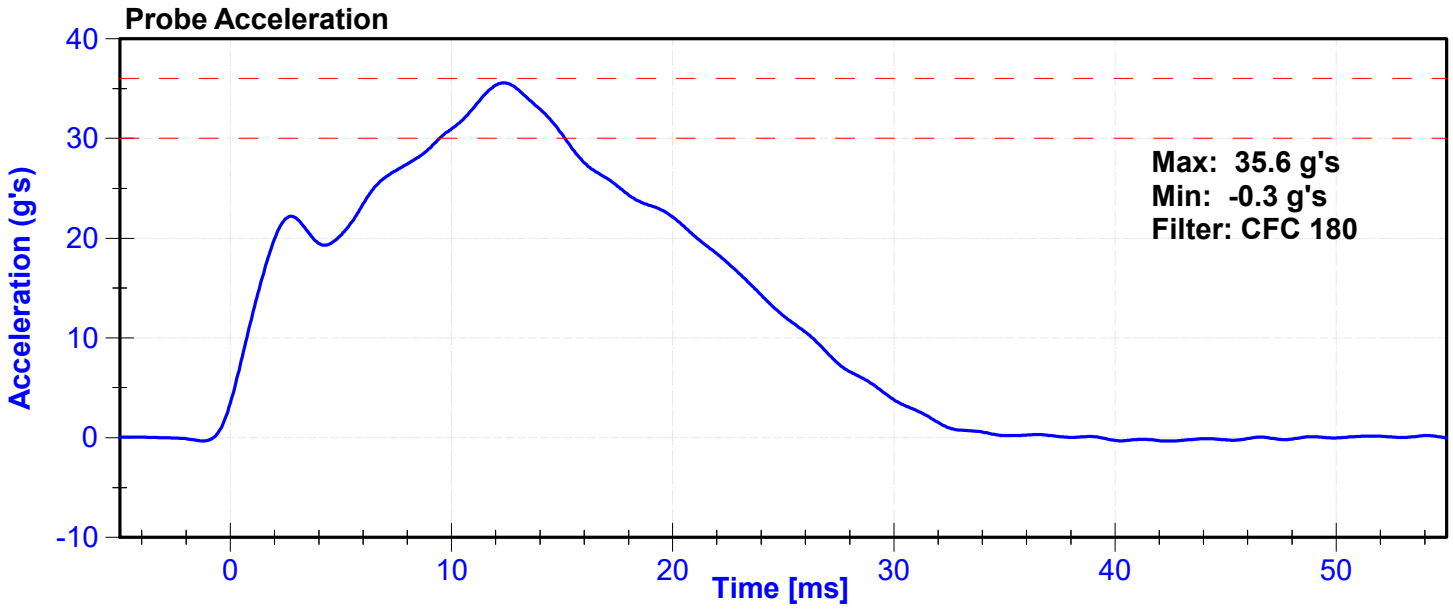
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

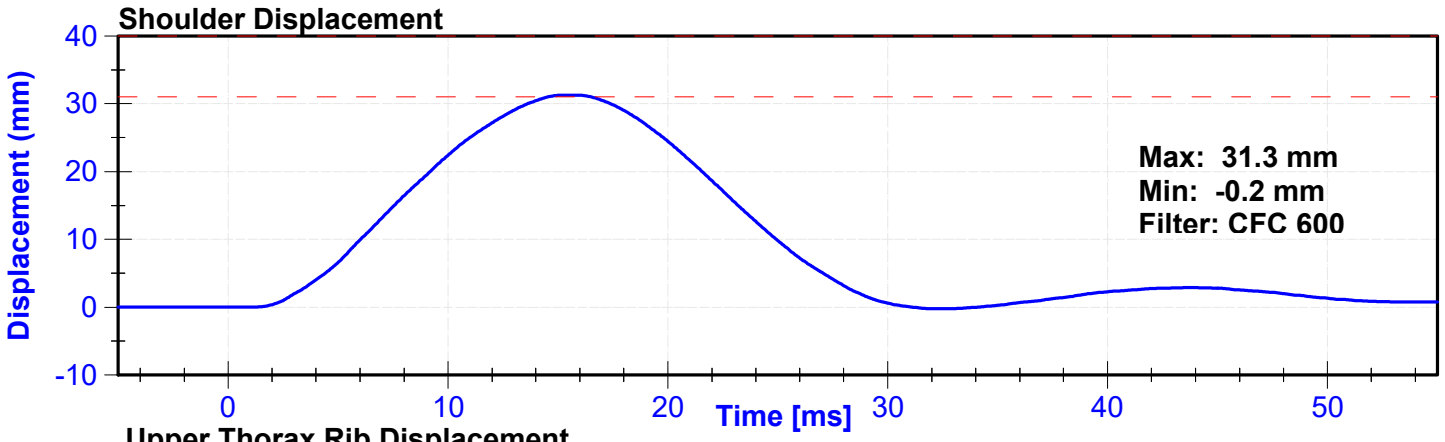
Results

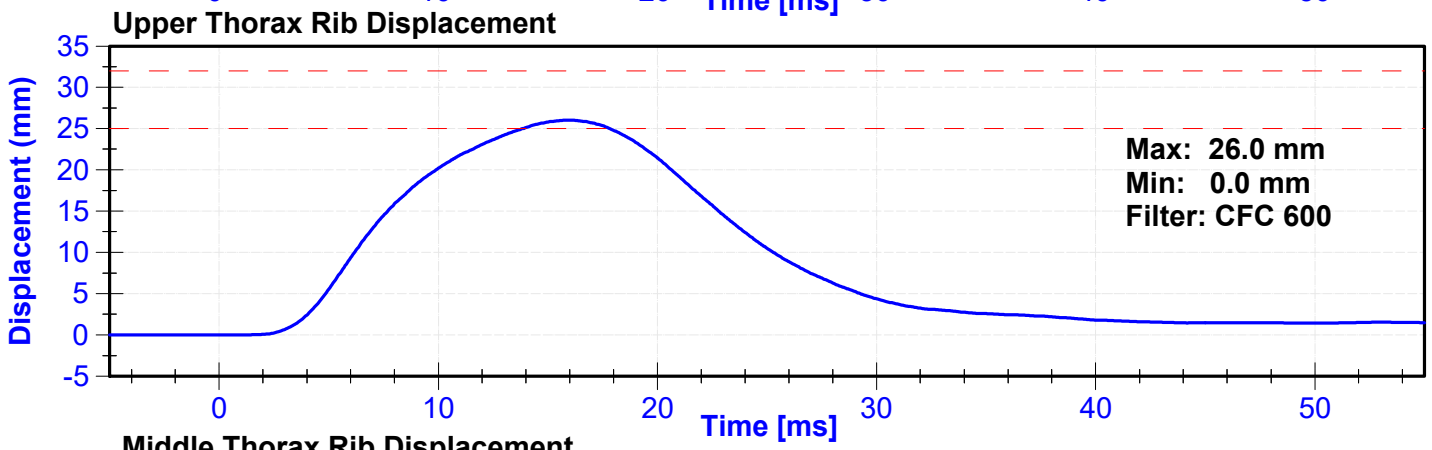
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	6.6	6.8	m/s	6.67	Pass
Probe Acceleration after 5 ms	30	36	g's	35.6	Pass
Lateral Upper Spine Acceleration	34	43	g's	38.9	Pass
Lateral Lower Spine Acceleration	29	37	g's	32.9	Pass
Shoulder Deflection	31	40	mm	31.3	Pass
Upper Thorax Rib Deflection	25	32	mm	26.0	Pass
Mid Thorax Rib Deflection	30	36	mm	31.5	Pass
Lower Thorax Rib Deflection	32	38	mm	35.6	Pass

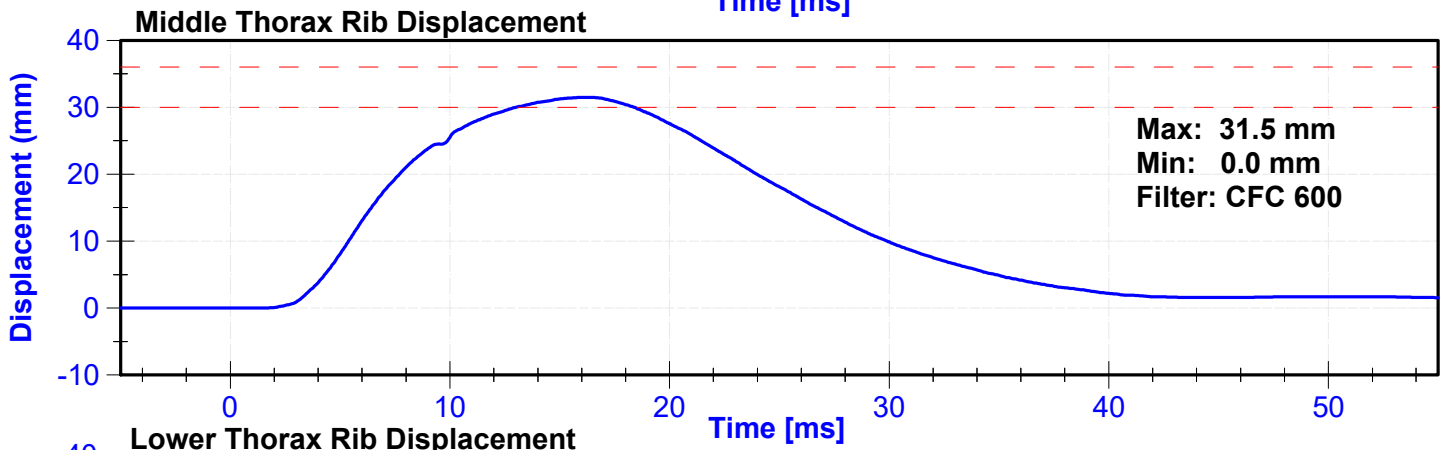
Transducer Calibrations

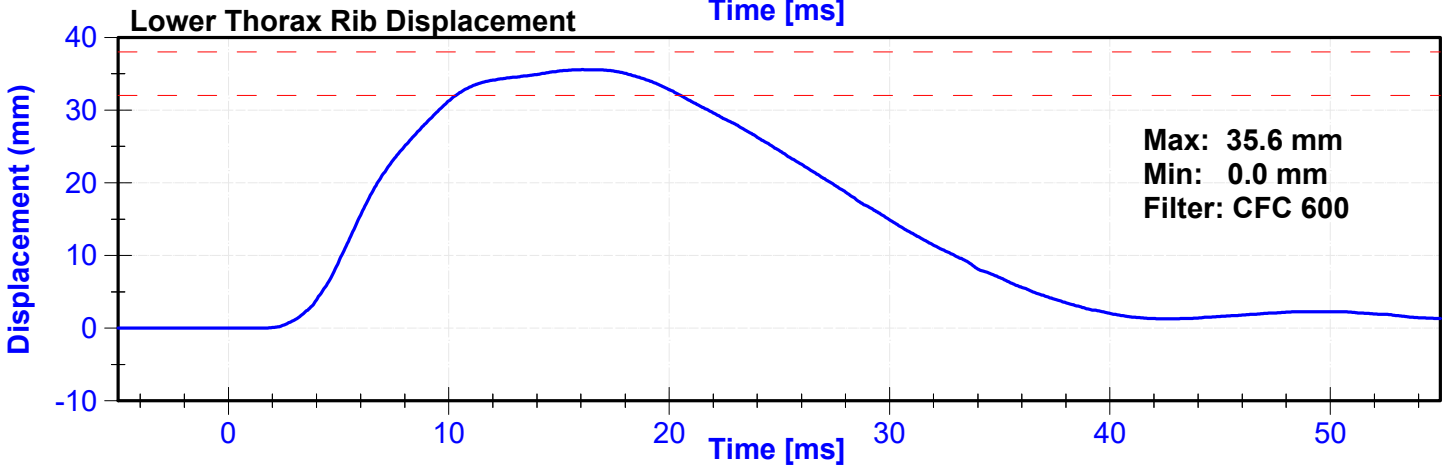
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Upper Spine T1 Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025
Upper Spine T12 Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Shoulder Potentiometer	Servo	1274GFE	10/16/2024	4/16/2025
Upper Thorax Rib Potentiometer	Servo	1199GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Servo	1246GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Servo	011GFE	10/16/2024	4/16/2025

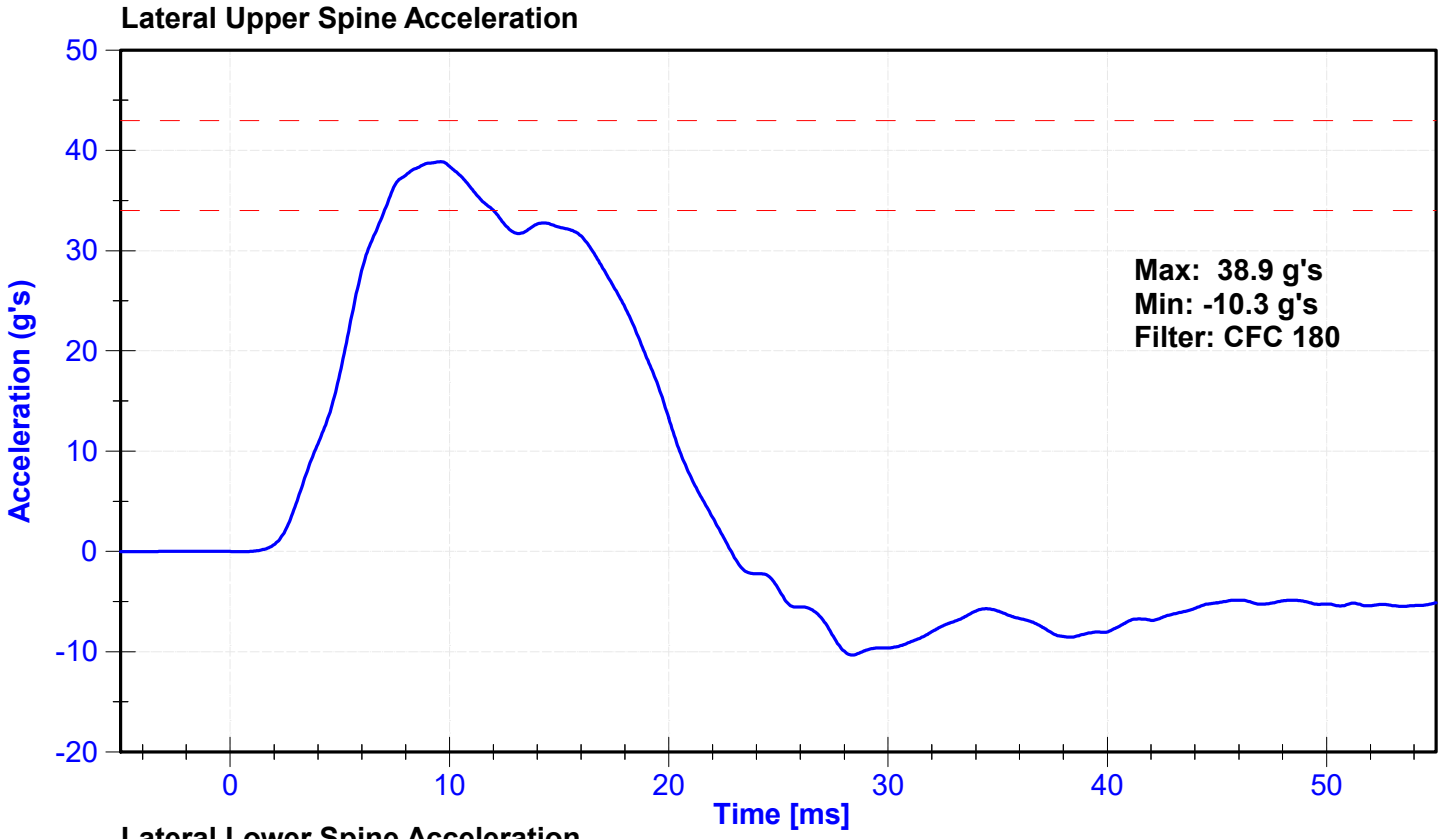


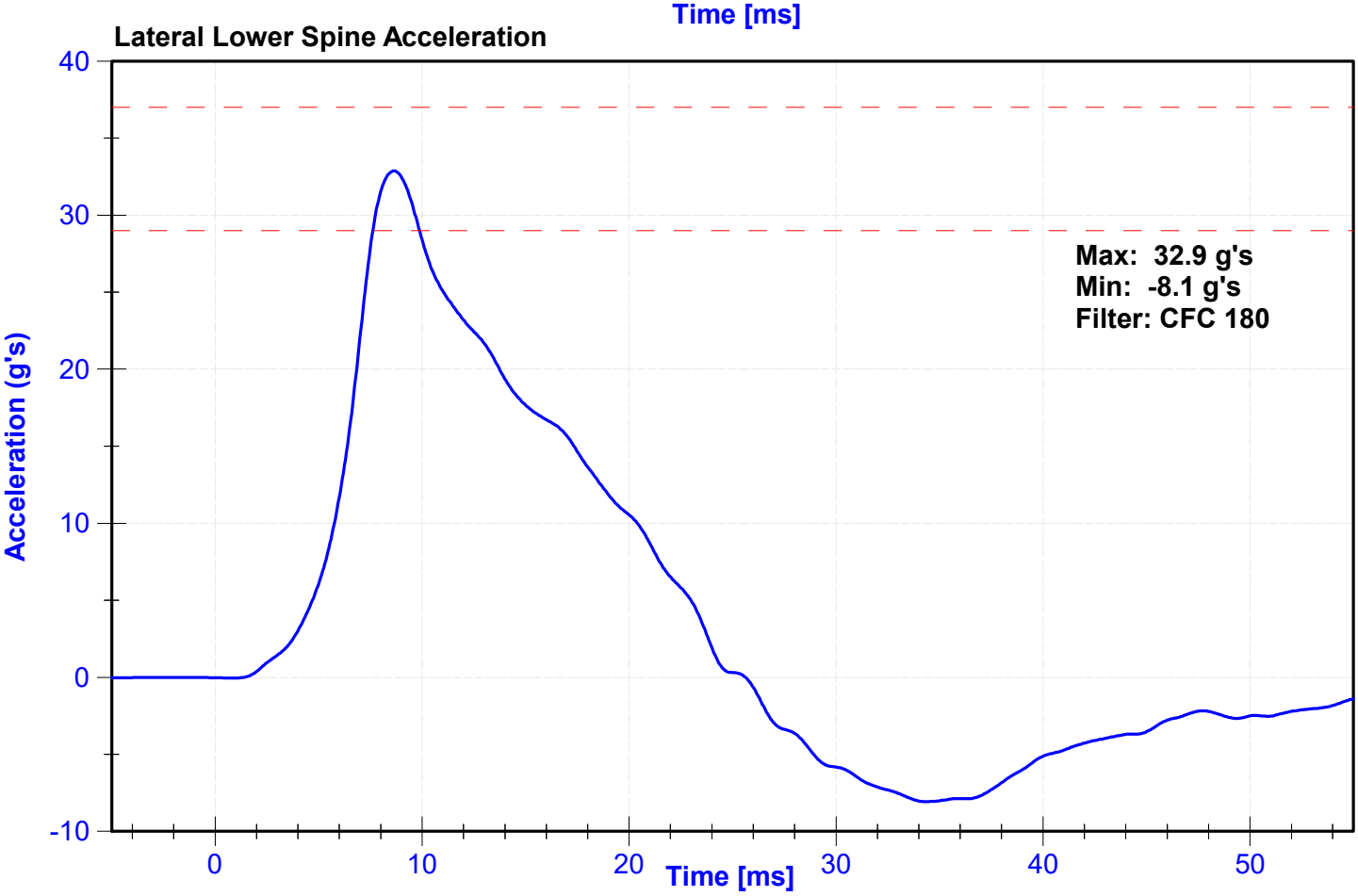

Shoulder Displacement
Displacement (mm)
Time [ms]
Max: 31.3 mm
Min: -0.2 mm
Filter: CFC 600


Upper Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 26.0 mm
Min: 0.0 mm
Filter: CFC 600


Middle Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 31.5 mm
Min: 0.0 mm
Filter: CFC 600


Lower Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 35.6 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 38.9 g's
Min: -10.3 g's
Filter: CFC 180


Lateral Lower Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 32.9 g's
Min: -8.1 g's
Filter: CFC 180

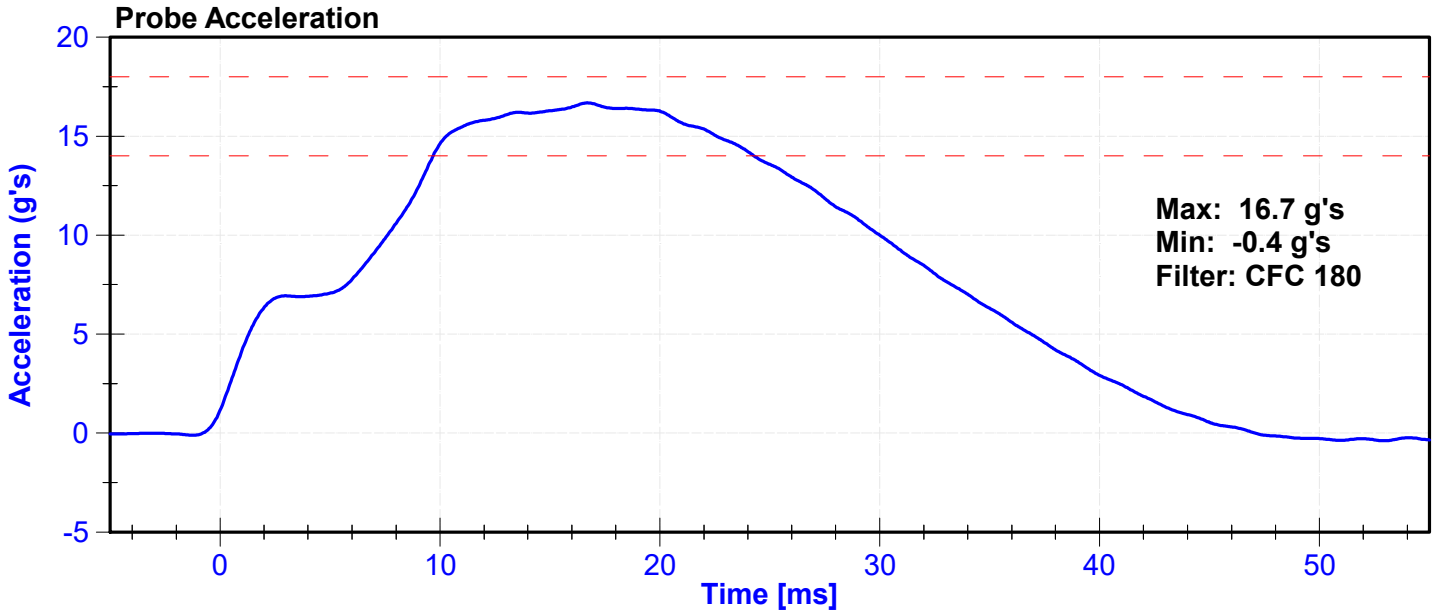
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

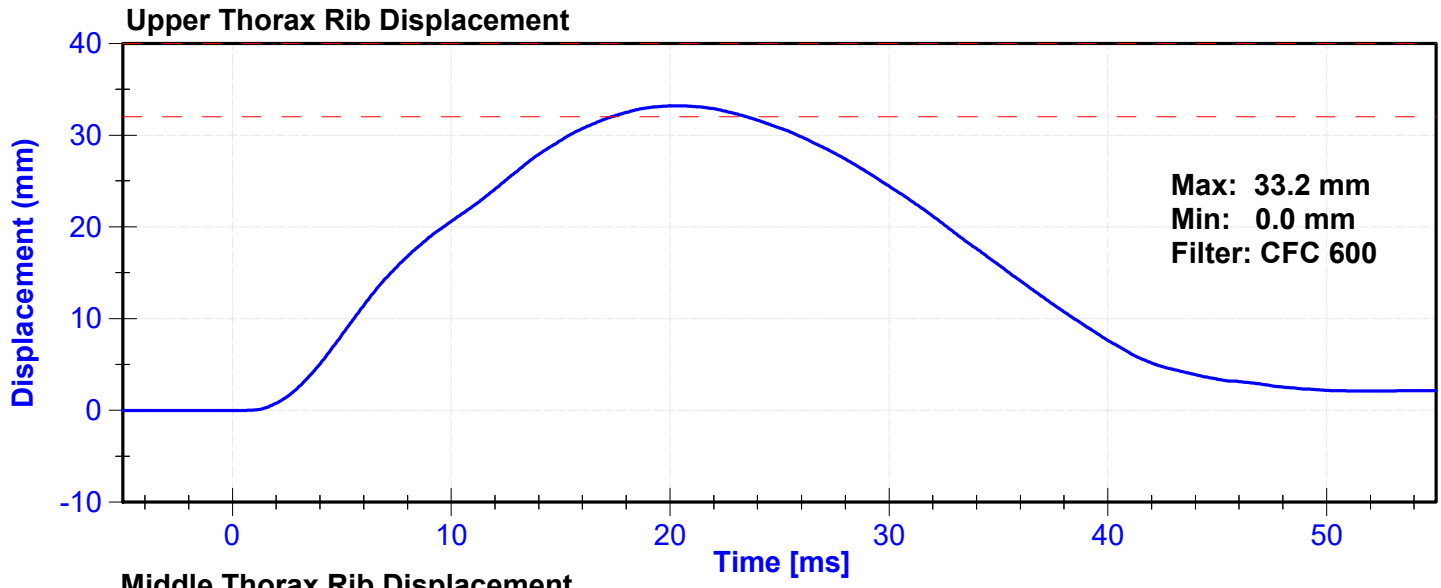
Results

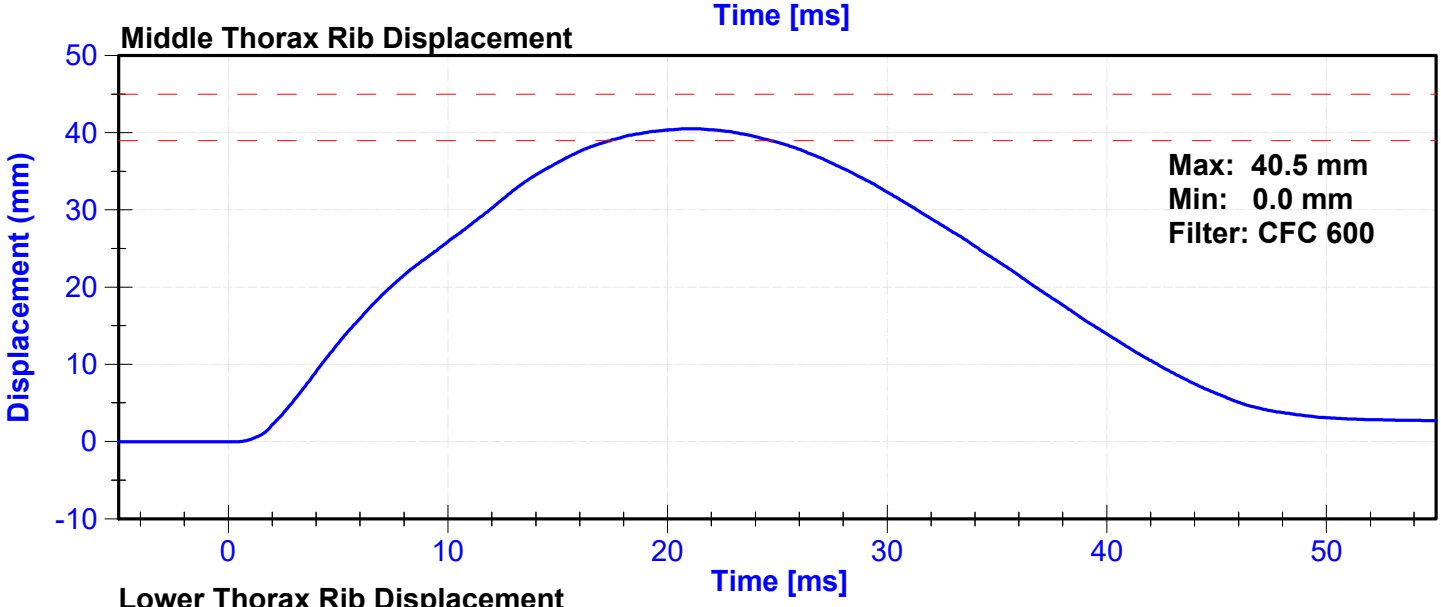
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.30	Pass
Probe Acceleration	14	18	g's	16.7	Pass
Lateral Upper Spine Acceleration	13	17	g's	15.0	Pass
Lateral Lower Spine Acceleration	7	11	g's	9.9	Pass
Upper Thorax Rib Deflection	32	40	mm	33.2	Pass
Middle Thorax Rib Deflection	39	45	mm	40.5	Pass
Lower Thorax Rib Deflection	35	43	mm	40.5	Pass

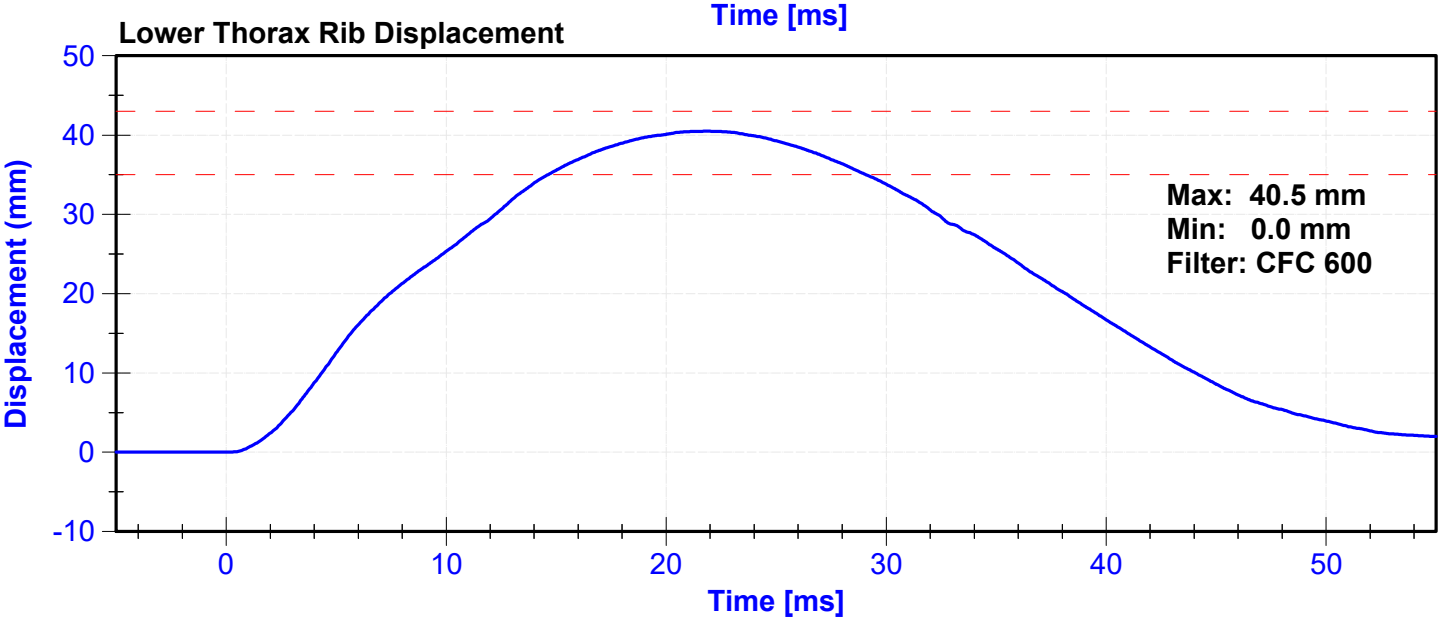
Transducer Calibrations

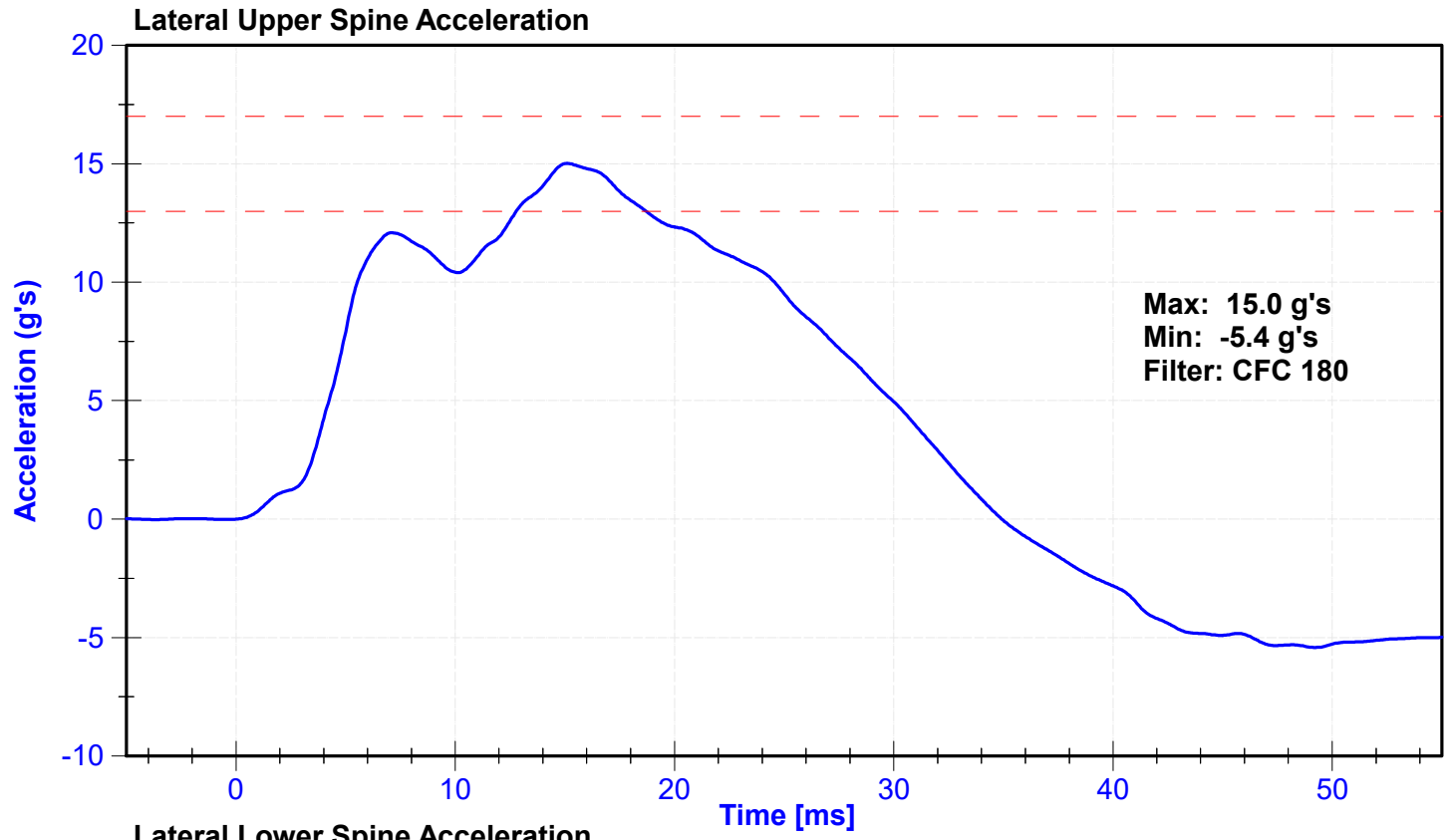
Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Upper Spine Y Accelerometer	Endevco	P64148	10/17/2024	4/15/2025
Lower Spine Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Upper Thorax Rib Potentiometer	Servo	1199GFE	10/16/2024	4/16/2025
Middle Thorax Rib Potentiometer	Servo	1246GFE	10/16/2024	4/16/2025
Lower Thorax Rib Potentiometer	Servo	011GFE	10/16/2024	4/16/2025

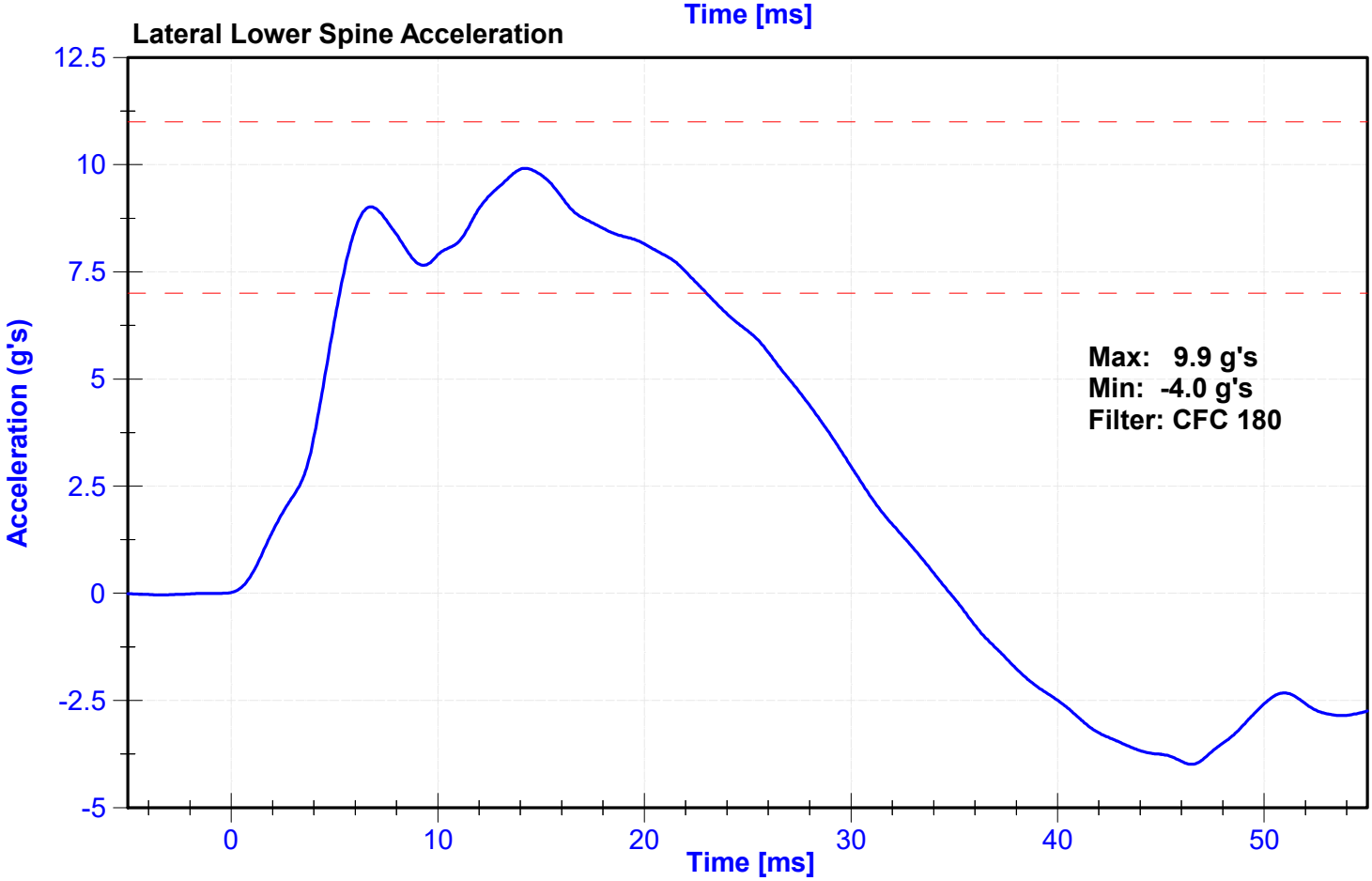



Upper Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 33.2 mm
Min: 0.0 mm
Filter: CFC 600


Middle Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 40.5 mm
Min: 0.0 mm
Filter: CFC 600


Lower Thorax Rib Displacement
Displacement (mm)
Time [ms]
Max: 40.5 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Upper Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 15.0 g's
Min: -5.4 g's
Filter: CFC 180


Lateral Lower Spine Acceleration
Acceleration (g's)
Time [ms]
Max: 9.9 g's
Min: -4.0 g's
Filter: CFC 180

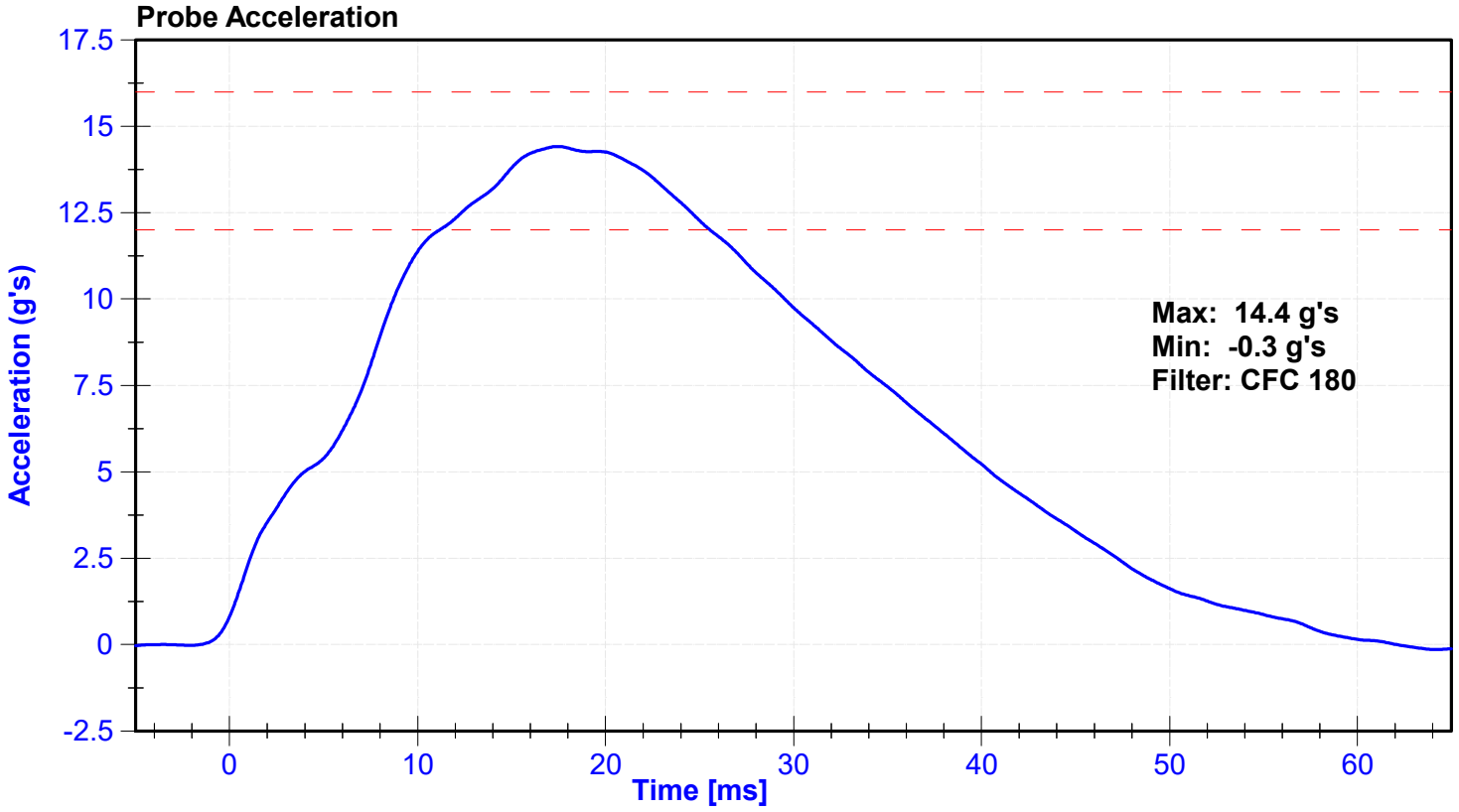
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

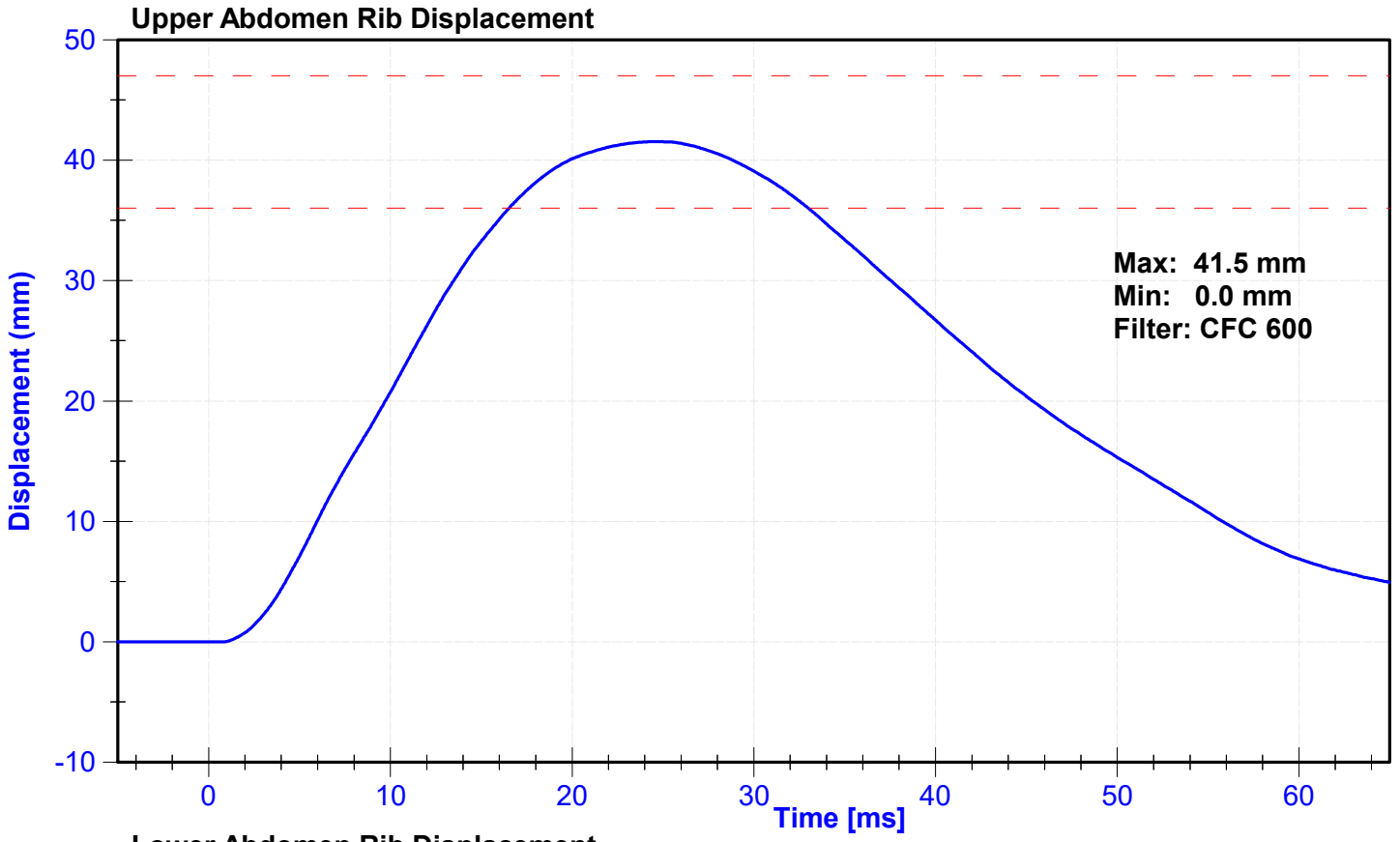
Results

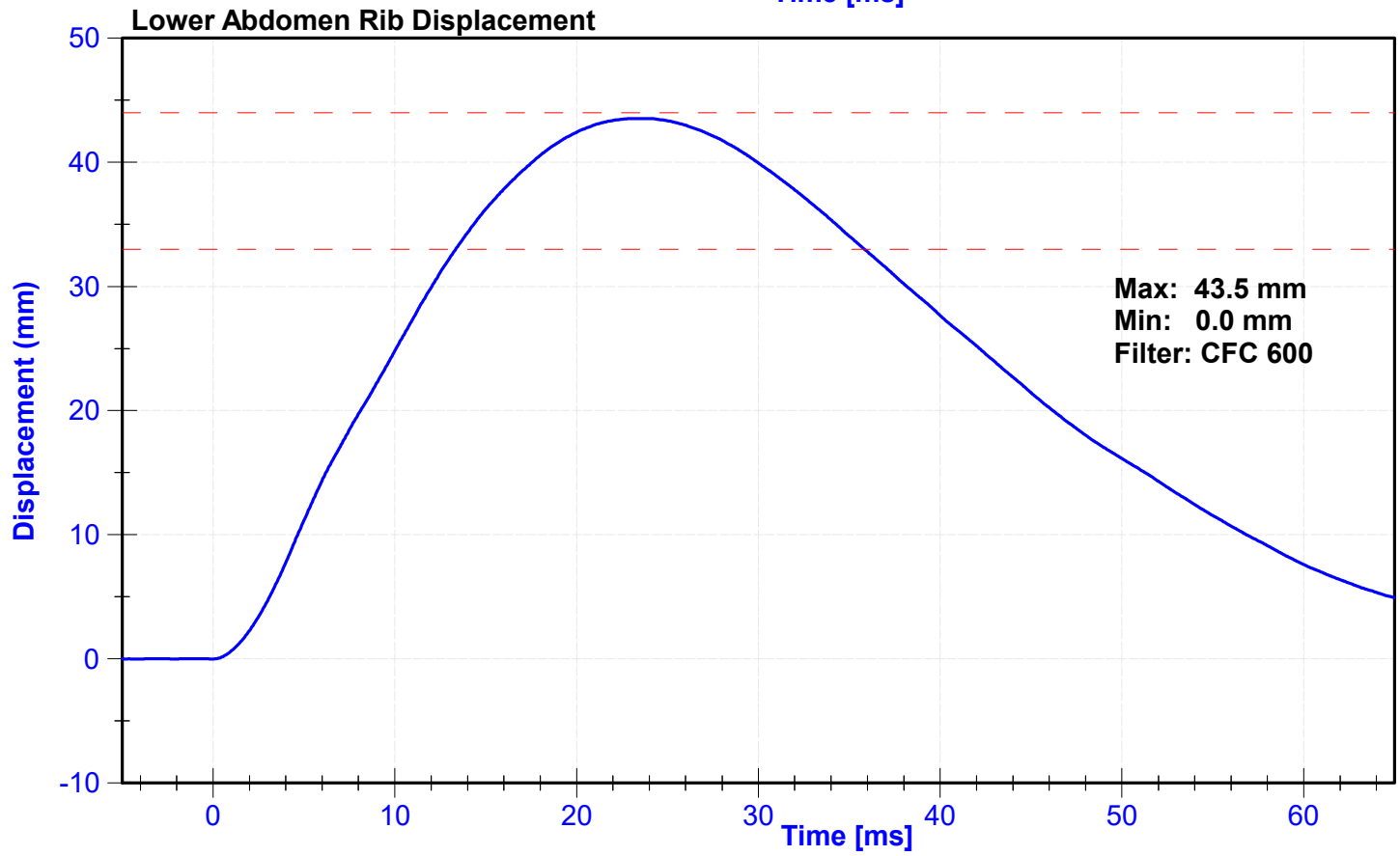
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.30	Pass
Probe Acceleration	12	16	g's	14.4	Pass
Lateral Lower Spine Acceleration	9	14	g's	10.2	Pass
Upper Abdomen Rib Deflection	36	47	mm	41.5	Pass
Lower Abdomen Rib Deflection	33	44	mm	43.5	Pass

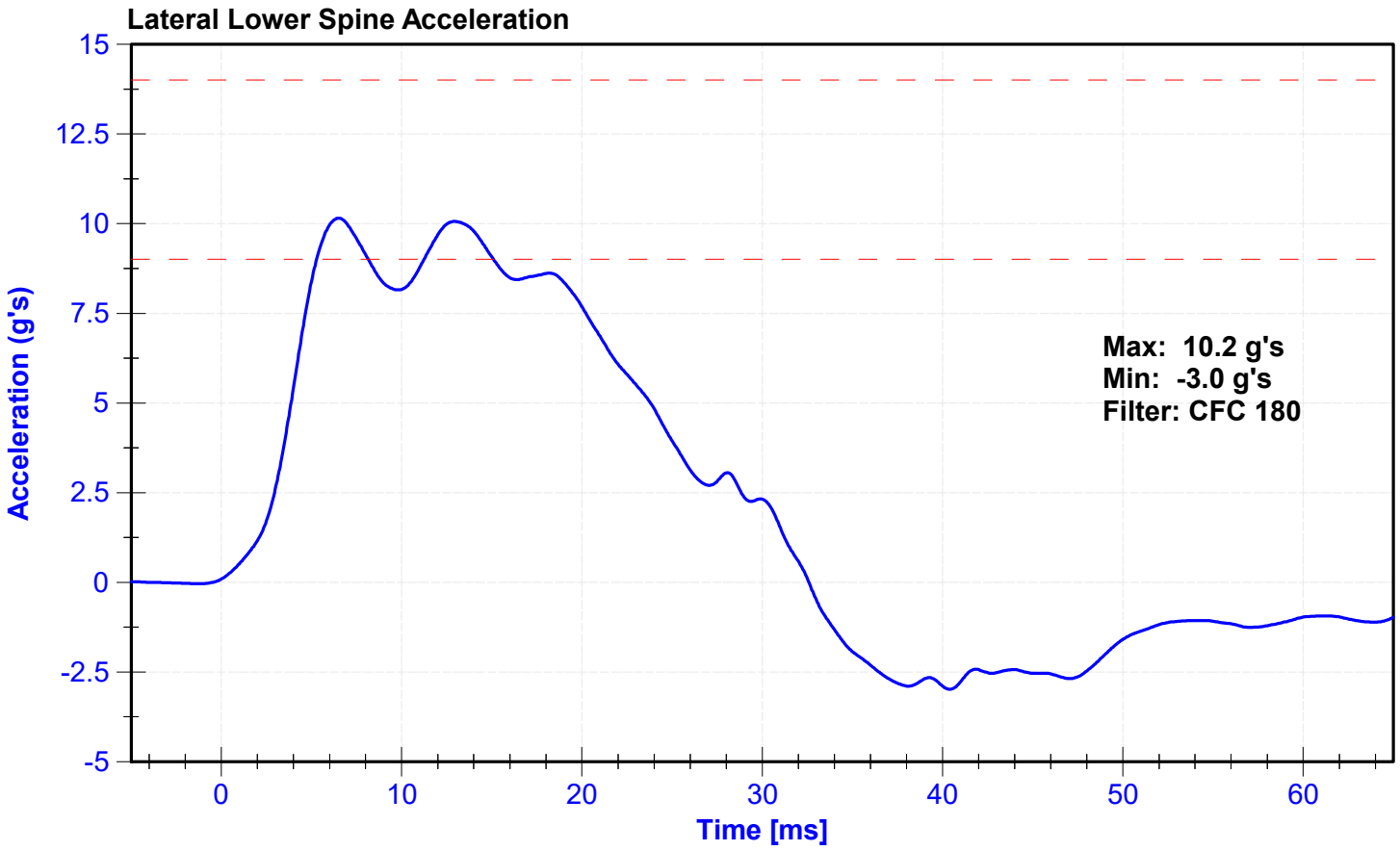
Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Lower Spine Y Accelerometer	Endevco	P51327	10/17/2024	4/15/2025
Upper Abdomen Rib Potentiometer	Servo	008GFE	10/16/2024	4/16/2025
Lower Abdomen Rib Potentiometer	Servo	046GFE	10/16/2024	4/16/2025




Upper Abdomen Rib Displacement
Displacement (mm)
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
Time [ms]
Max: 41.5 mm
Min: 0.0 mm
Filter: CFC 600


Lower Abdomen Rib Displacement
Displacement (mm)
50
40
30
20
10
0
-10
0
10
20
30
40
50
60
Time [ms]
Max: 43.5 mm
Min: 0.0 mm
Filter: CFC 600


Lateral Lower Spine Acceleration
Acceleration (g's)
15
12.5
10
7.5
5
2.5
0
-2.5
-5
0
10
20
30
40
50
60
Time [ms]
Max: 10.2 g's
Min: -3.0 g's
Filter: CFC 180

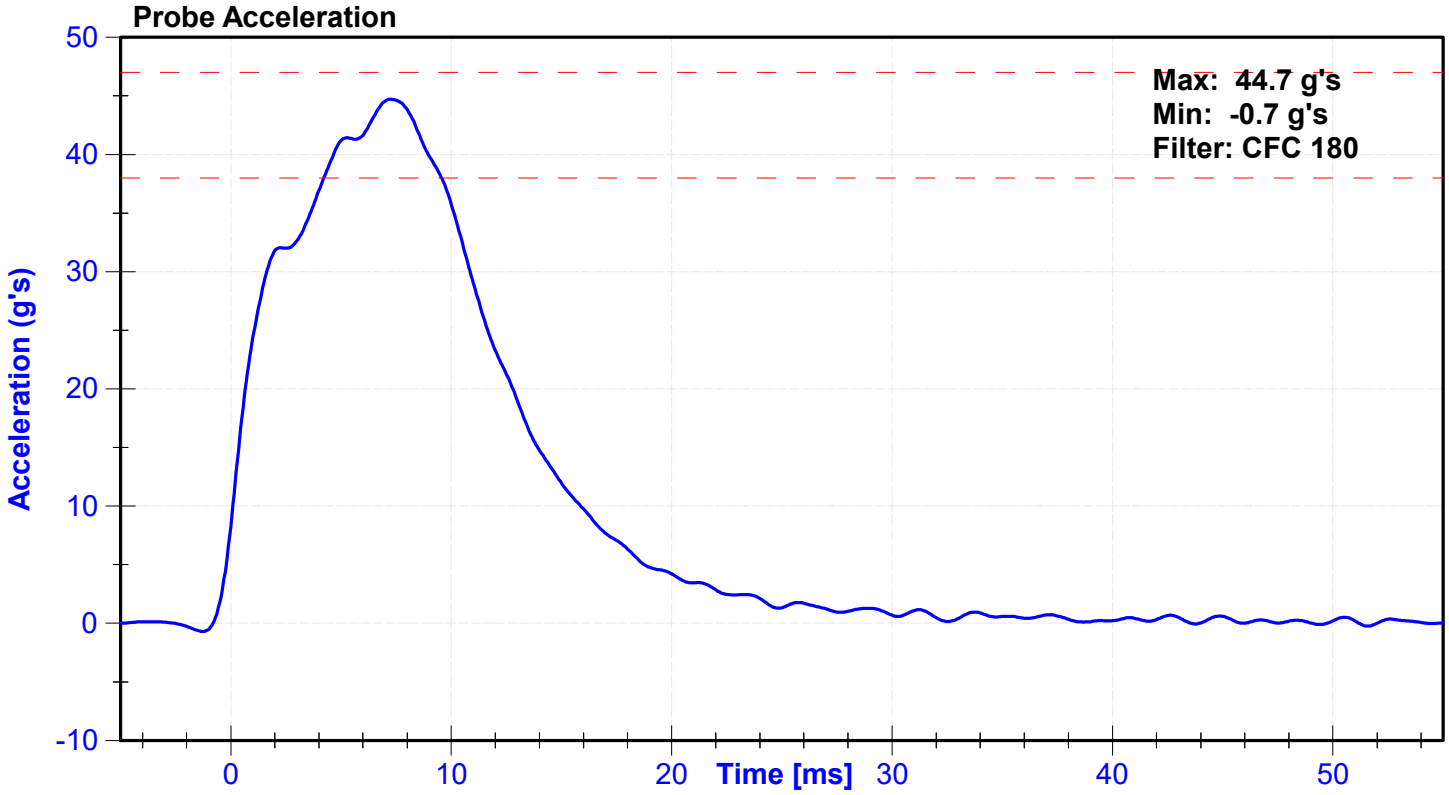
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

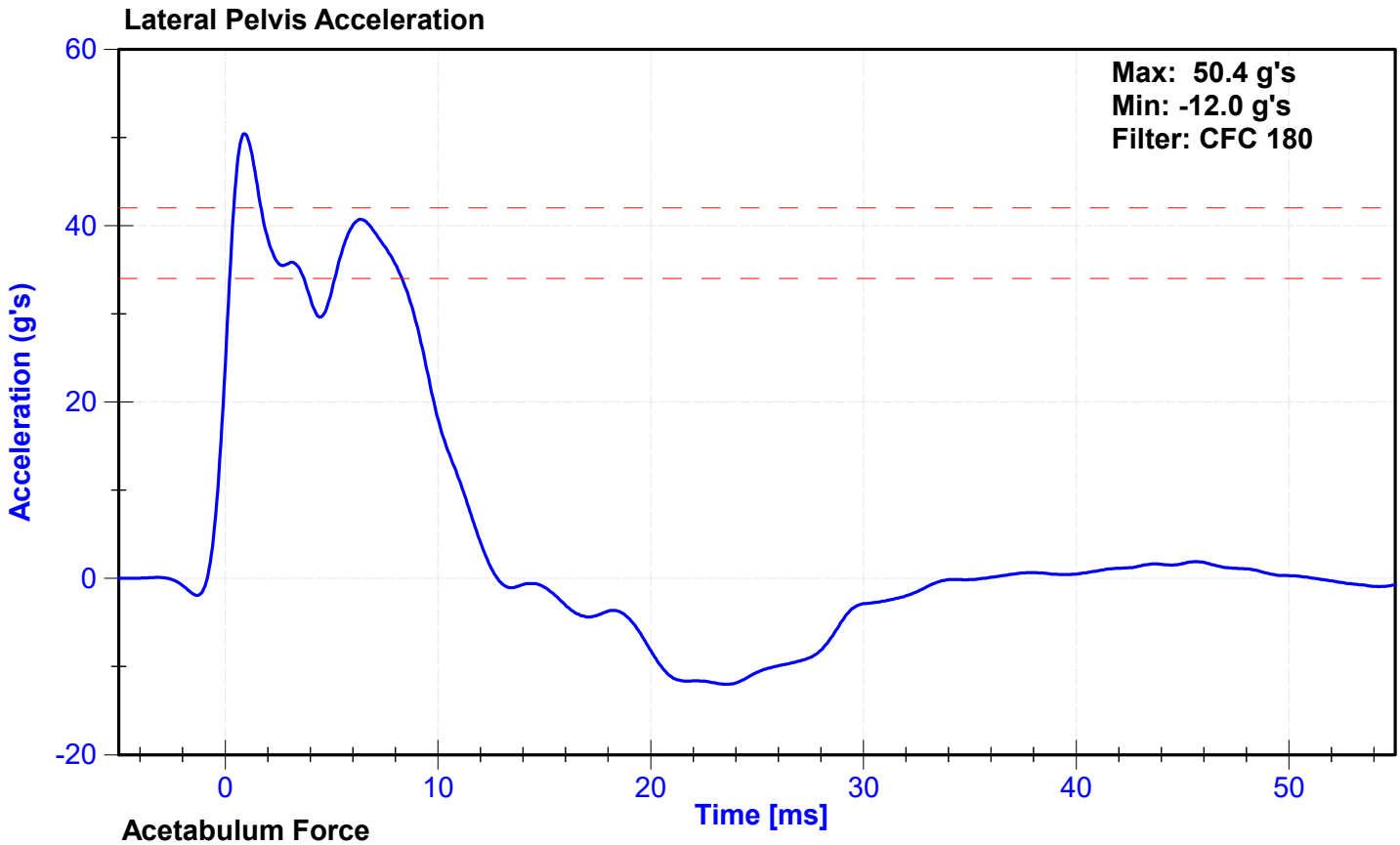
Results

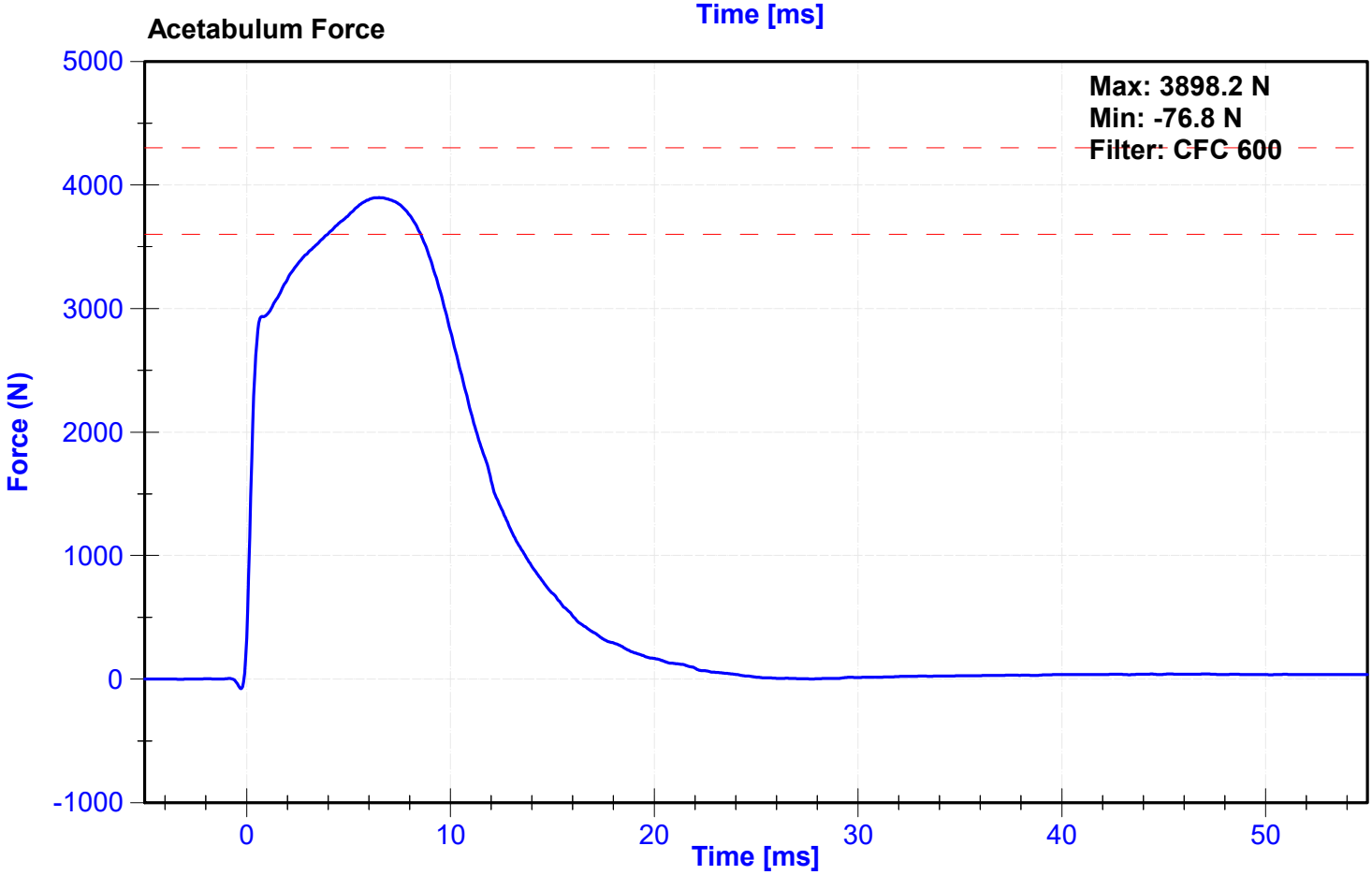
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	6.6	6.8	m/s	6.67	Pass
Probe Acceleration	38	47	g's	44.7	Pass
Lateral Pelvis Acceleration after 6ms	34	42	g's	40.7	Pass
Acetabulum Force	3600	4300	N	3898.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Pelvis Y Accelerometer	Endevco	T20860	10/17/2024	4/15/2025
Acetabulum Load Cell	Denton	270-FY	9/16/2024	9/16/2025
Certification Plug	SACO			N/A
Crash Test Plug	SACO			N/A




Lateral Pelvis Acceleration
Max: 50.4 g's
Min: -12.0 g's
Filter: CFC 180
Acceleration (g's)
60
40
20
0
-20
0
10
20
30
40
50
Time [ms]


Acetabulum Force
Max: 3898.2 N
Min: -76.8 N
Filter: CFC 600
Force (N)
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]

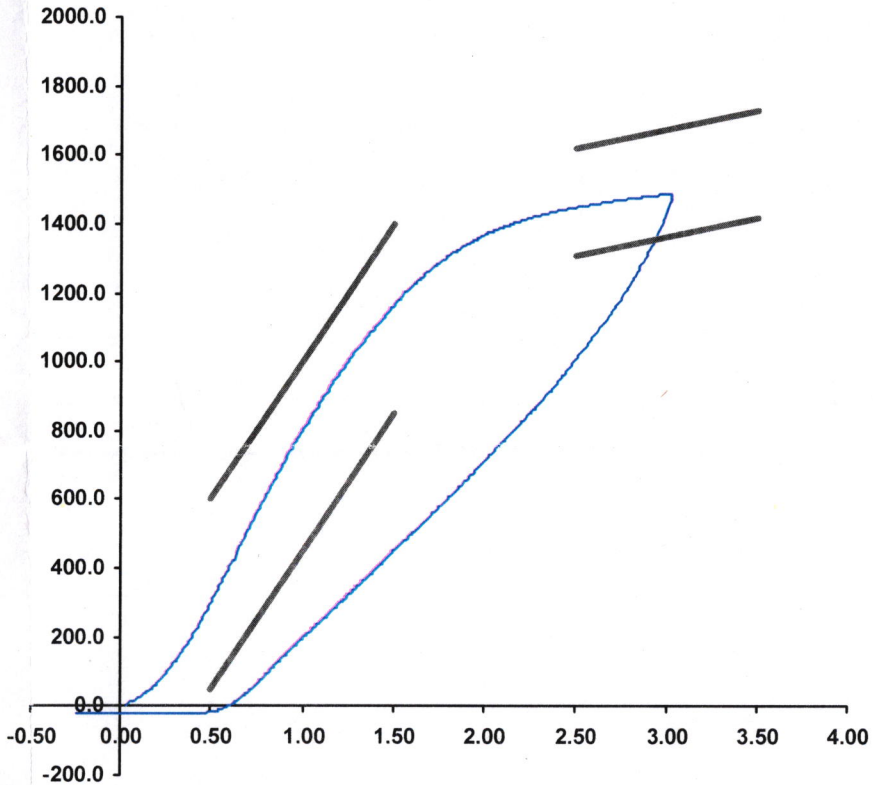
SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16732
Test Number 23532
Report Number 23589
Test Date 7/22/2022 12:49:50 PM

	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	305	50	600
Force @ 1.5 mm (N)	1,169	850	1,400
Force @ 2.5 mm (N)	1,449	1,306	1,618
Force @ 3.0 mm (N)	1,486	1,361	1,673

Force (-N) vs Extension (-mm)



Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
Cert Plug 11-21-24 DG8072

Operator

Part Number 180-4450

Template No 107 22-Jul-22
SACO Research

By : DC Date : 7/22/22

SACO Research 41735 Elm St, #401 Murrieta, CA 92562 Tel 310-694-2082 FAX

SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16759
Test Number 23562
Report Number 23619
Test Date 7/22/2022 1:51:22 PM

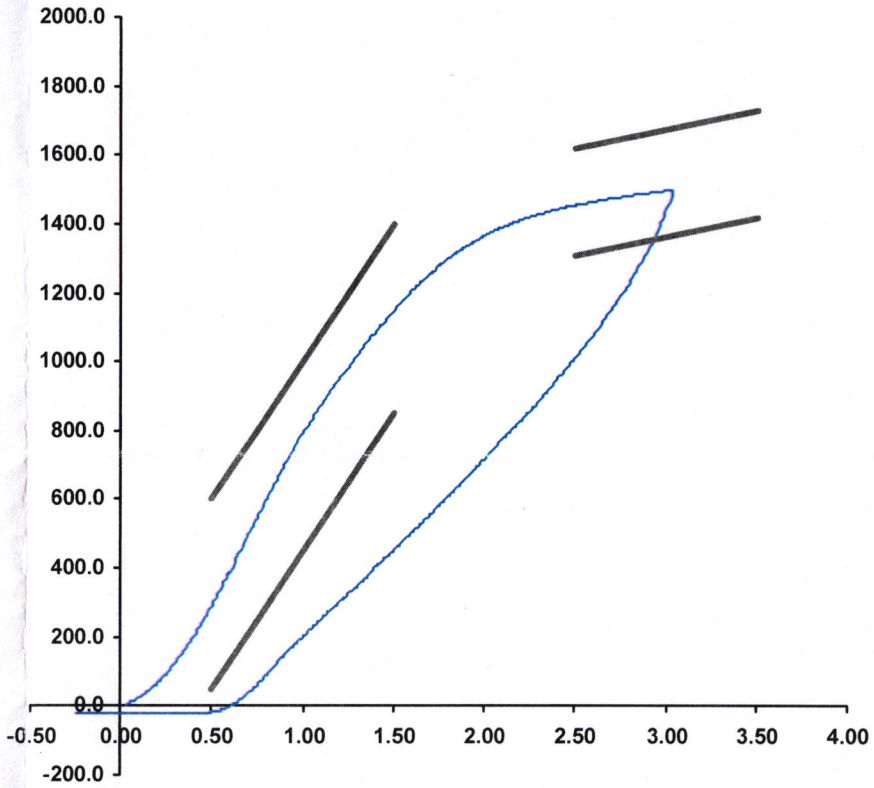
	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	292	50	600
Force @ 1.5 mm (N)	1,151	850	1,400
Force @ 2.5 mm (N)	1,455	1,306	1,618
Force @ 3.0 mm (N)	1,496	1,361	1,673

Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
NON - IMPACT 11-21-24 DG8012

Force (-N) vs Extension (-mm)



Operator

Part Number 180-4450

Template No 107 22-Jul-22
SACO Research

By : DC Date : 7/22/22

SACO Research 41735 Elm St, #401 Murrieta, CA 92562 Tel 310-694-2082 FAX

C-90

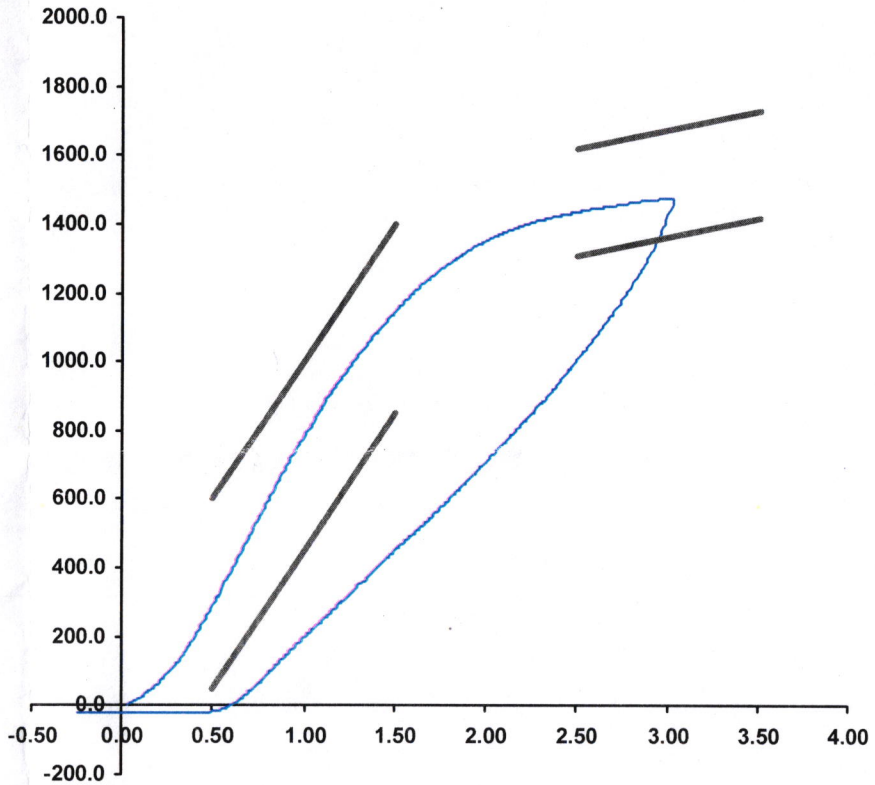
SACO RESEARCH

SID-IIs Pelvis Plug Certification Test

Plug S/N 16692
Test Number 23492
Report Number 23549
Test Date 7/22/2022 10:57:41 AM

	Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	297	50	600
Force @ 1.5 mm (N)	1,145	850	1,400
Force @ 2.5 mm (N)	1,436	1,306	1,618
Force @ 3.0 mm (N)	1,475	1,361	1,673

Force (-N) vs Extension (-mm)



Testing Machine STM-20 5965542
Load Cell S/N (FI360947), Units (LBS) 1000

Crosshead Speed (mm / min) or Rate 12.7
Extension or Position Measured by XHD_100 (XHD100)

Notes:
IMPACT 11-21-24 DG8012

Operator

Part Number 180-4450

Template No 107 22-Jul-22
SACO Research

By : DC Date : 7/22/22

SACO Research 41735 Elm St, #401 Murrieta, CA 92562 Tel 310-694-2082 FAX

C-91

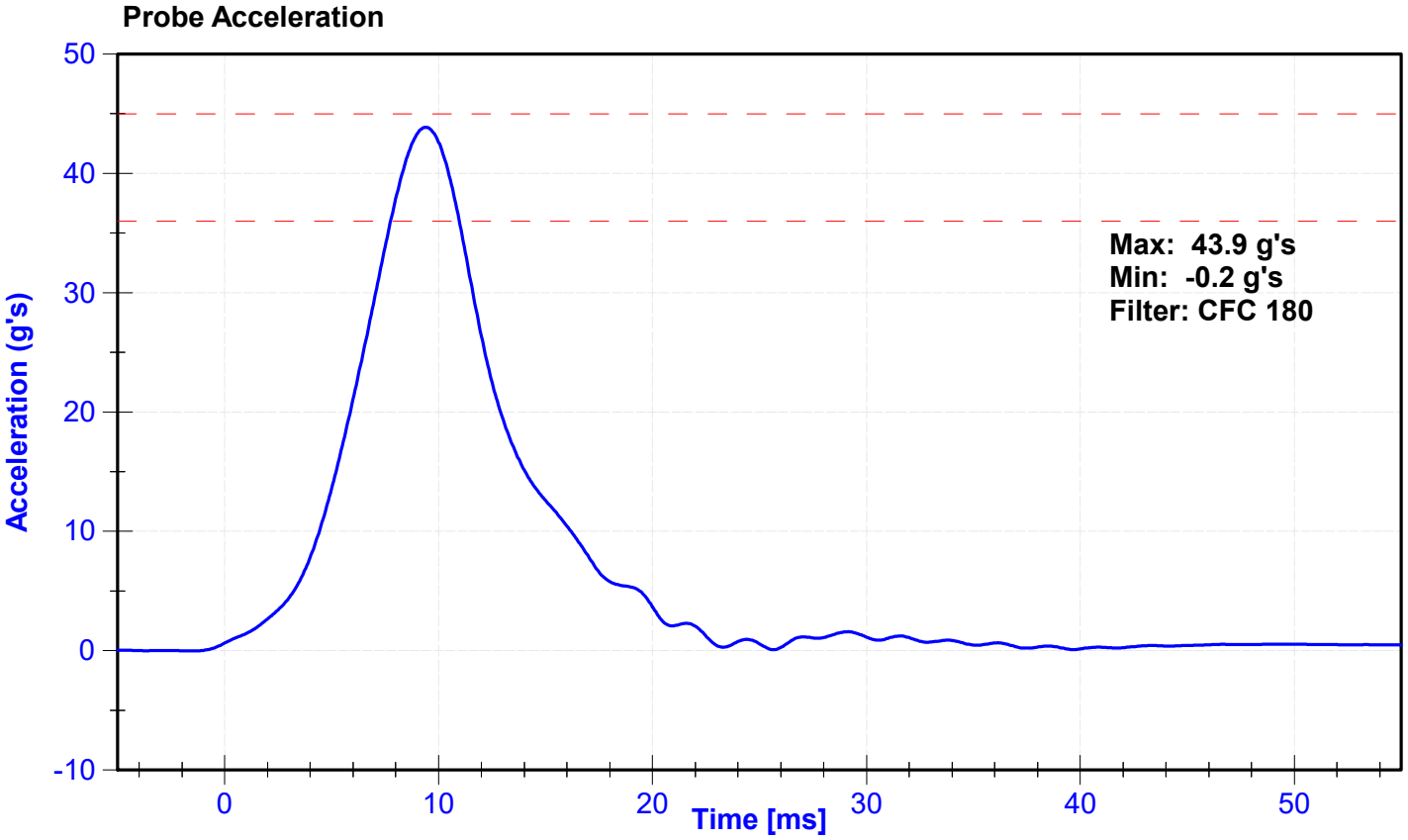
ATD Manufacturer	FTSS	Test Technician	J. Rios
ATD Serial Number	DG8012	Laboratory Supervisor	J. Kinderman

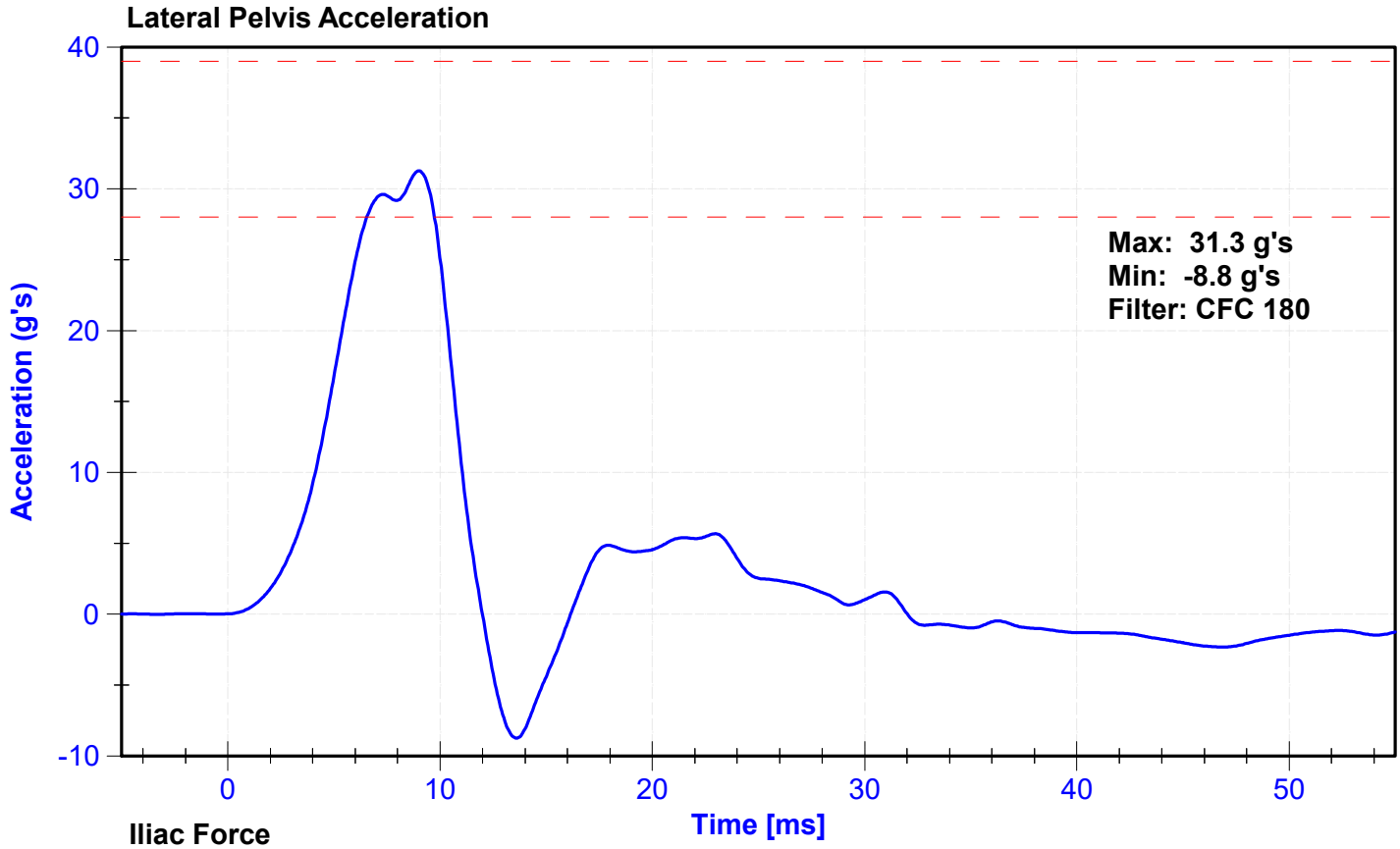
Results

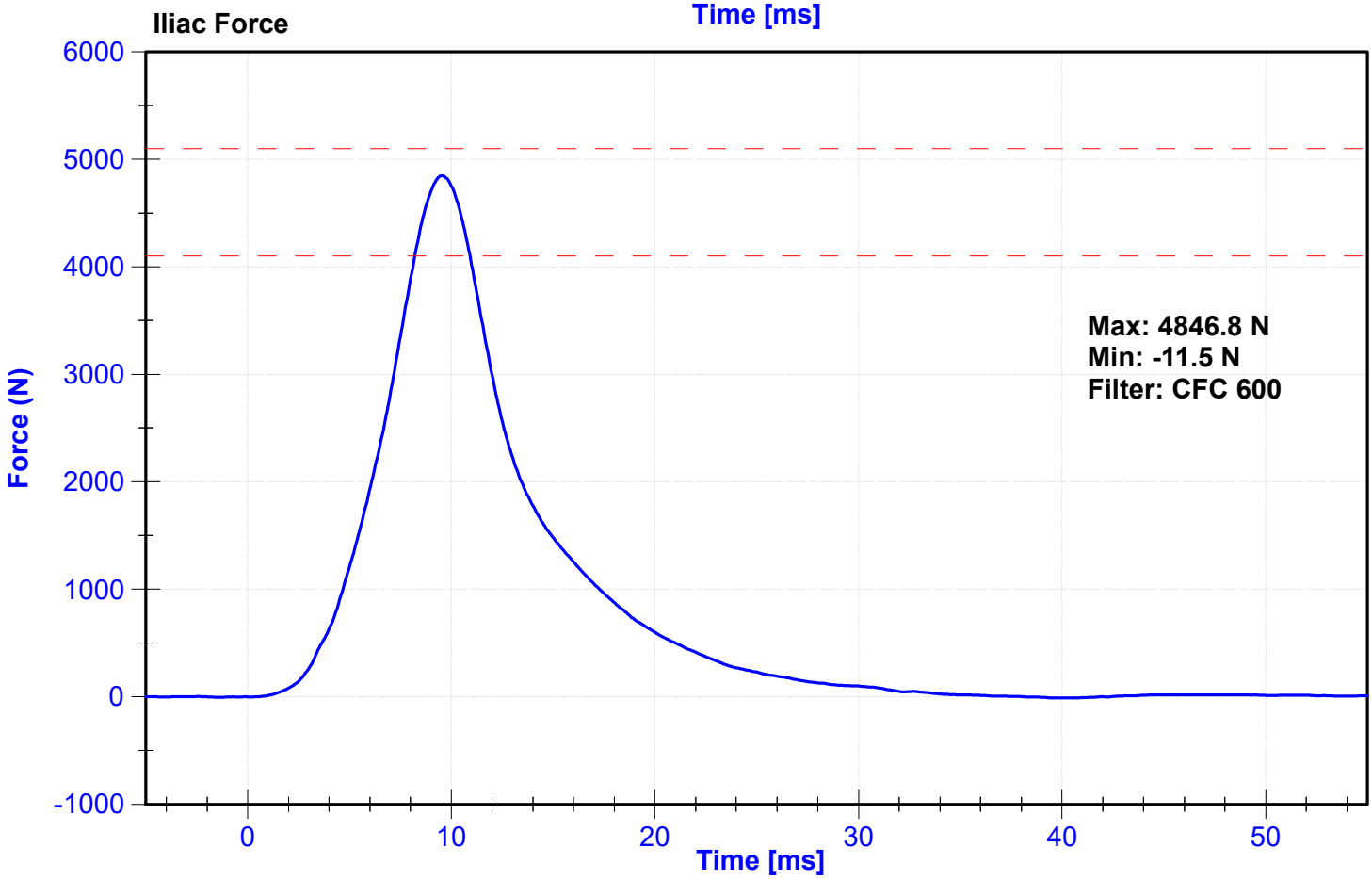
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	ºC	20.9	Pass
Humidity	10	70	%	33	Pass
Velocity	4.2	4.4	m/s	4.29	Pass
Probe Acceleration	36	45	g's	43.9	Pass
Lateral Pelvis Acceleration	28	39	g's	31.3	Pass
Iliac Force	4100	5100	N	4846.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	Endevco	18527	8/2/2024	1/29/2025
Pelvis Y Accelerometer	Endevco	T20860	10/17/2024	4/15/2025
Iliac Load Cell	Denton	321	9/16/2024	9/16/2025




Lateral Pelvis Acceleration
Acceleration (g's)
40
30
20
10
0
-10
0
10
20
30
40
50
Time [ms]
Max: 31.3 g's
Min: -8.8 g's
Filter: CFC 180


Iliac Force
Force (N)
6000
5000
4000
3000
2000
1000
0
-1000
0
10
20
30
40
50
Time [ms]
Max: 4846.8 N
Min: -11.5 N
Filter: CFC 600

APPENDIX D

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

TABLE 1 – Dummy Instrumentation (ES-2re)

			ES-2re S/N _F033__		
			Serial Number	**Manufacturer**	**Calibration Date**
Head Accelerometers	Primary	X	P63861	Endevco	10/17/2024
		Y	P49216	Endevco	10/17/2024
		Z	P51303	Endevco	10/17/2024
	Redundant	X	P58868	Endevco	10/17/2024
		Y	P59020	Endevco	10/17/2024
		Z	P52132	Endevco	10/17/2024
Thorax Rib Displacement Potentiometers	Upper	Y	179GFE	Honeywell	10/16/2024
	Middle	Y	185GFE	Honeywell	10/16/2024
	Lower	Y	184GFE	Honeywell	11/19/2024
Abdomen Load Cells	Forward	Y	1523	Denton	10/28/2024
	Middle	Y	1524	Denton	10/28/2024
	Rear	Y	1530	Denton	10/28/2024
Lower Spine Accelerometers (T12)		X	P35790	Endevco	10/17/2024
		Y	T31029	Endevco	10/17/2024
		Z	P52033	Endevco	10/17/2024
Pubic Symphysis Load Cell		Y	458-FY	Denton	10/28/2024

TABLE 2 – Dummy Instrumentation (SID-IIs)

				SID-IIs S/N __DG8012__		
				Serial Number	**Manufacturer**	**Calibration Date**
Head Accelerometers		Primary	X	T21184	Endevco	10/17/2024
			Y	T31030	Endevco	10/17/2024
			Z	P83319	Endevco	10/17/2024
		Redundant	X	T21354	Endevco	10/17/2024
			Y	P52155	Endevco	10/17/2024
			Z	P83322	Endevco	10/17/2024
Displacement Potentiometers	Thoracic Rib	Upper	Y	1199GFE	Servo	10/16/2024
		Middle	Y	1246GFE	Servo	10/16/2024
		Lower	Y	011GFE	Servo	10/16/2024
	Abdominal Rib	Upper	Y	008GFE	Servo	10/16/2024
		Lower	Y	046GFE	Servo	10/16/2024
Lower Spine Accelerometers (T12)			X	P71272	Endevco	10/17/2024
			Y	P51327	Endevco	10/17/2024
			Z	P52067	Endevco	10/17/2024
Acetabulum Load Cell			Y	270-FY	Denton	09/16/2024
Iliac Wing Load Cell			Y	321	Denton	09/16/2024
Pelvis Plug (struck side)				16659	SACO	07/21/2022
Pelvis Plug (non-struck side)				16737	SACO	07/22/2022

TABLE 3 – Vehicle Instrumentation

Vehicle Instrumentation			Serial Number	Manufacturer	Calibration Date
1	Vehicle Center of Gravity	X	G24030	Endevco	10/15/2024
	Vehicle Center of Gravity	Y	G24952	Endevco	10/15/2024
	Vehicle Center of Gravity	Z	G25274	Endevco	10/15/2024
2	Right Sill at Front Seat	X	G25233	Endevco	09/09/2024
	Right Sill at Front Seat	Y	G25372	Endevco	09/09/2024
	Right Sill at Front Seat	Z	G25373	Endevco	09/09/2024
3	Right Sill at Rear Seat	X	G25262	Endevco	07/18/2024
	Right Sill at Rear Seat	Y	G25263	Endevco	07/18/2024
	Right Sill at Rear Seat	Z	G25264	Endevco	07/18/2024
4	Left Sill at Front Door	Y	G23853	Endevco	10/15/2024
5	Left Sill at Rear Door	Y	A431245	Measurement Specialties	09/18/2024
6	Left A-Post Lower	Y	G22815	Endevco	10/15/2024
7	Left A-Post Middle	Y	G25258	Endevco	07/17/2024
8	Left B-Post Lower	Y	A290919	Measurement Specialties	09/18/2024
9	Left B-Post Middle	Y	A413571	Measurement Specialties	10/11/2024
10	Front Seat Track	Y	G25253	Endevco	07/16/2024
11	Rear Seat Track or Structure	Y	A350993	Measurement Specialties	10/14/2024
12	Right Rear Occ. Compartment	Y	A413599	Measurement Specialties	09/09/2024
13	Engine Block	X	A335480	Measurement Specialties	07/30/2024
	Engine Block	Y	A352412	Measurement Specialties	07/30/2024
14	Rear Floorpan Above Axle	X	G22196	Endevco	10/02/2024
	Rear Floorpan Above Axle	Y	A315800	Measurement Specialties	10/02/2024
	Rear Floorpan Above Axle	Z	A398671	Measurement Specialties	10/02/2024

TABLE 4 – MDB Instrumentation

MDB Instrumentation		Serial Number	Manufacturer	Calibration Date
MDB Center of Gravity	X	A374299	Measurement Specialties	08/01/2024
MDB Center of Gravity	Y	A399983	Measurement Specialties	08/01/2024
MDB Center of Gravity	Z	G23881	Endevco	08/01/2024
Left Frame at Rear Axle Centerline	X	A372851	Measurement Specialties	08/01/2024
Left Frame at Rear Axle Centerline	Y	A413581	Measurement Specialties	08/01/2024