

REPORT NUMBER: 214D-CAL-20-005

RESEARCH MOVING DEFORMABLE BARRIER SIDE IMPACT TEST

**Hyundai Motor Manufacturing Alabama, LLC
2020 Hyundai Santa Fe
SUV**

NHTSA No: R20204201

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



March 7, 2024

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, ROOM W43-410
WASHINGTON, D.C. 20590**

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Date: March 7, 2024

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Date: March 7, 2024

FINAL REPORT ACCEPTANCE BY OCWS:

Division Chief, Structures and Restraints Research
NHTSA, Office of Crashworthiness Standards

Date: _____

COTR, Structures and Restraints Research
NHTSA, Office of Crashworthiness Standards

Date: _____

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15. Supplementary Notes																																																	
16. Abstract A 48/24, (52.90 kph / 32.87 mph), 90° Moving Deformable Barrier NCAP Side Impact Test was conducted on the subject 2020 Hyundai Santa Fe 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 12, 2020. The impact velocity of the Moving Deformable Barrier (MDB) was 52.96 km/h, and the ambient temperature at the struck (driver's) side of the target vehicle at the time of impact was 21°C. The target vehicle's maximum post-test static crush was 174mm located at level 2. The test vehicle's occupant performance data is as follows: <table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th colspan="2">Driver ATD (ES-2re)</th> </tr> <tr> <th>Units</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₃₆)</td> <td>N/A</td> <td>28.90</td> </tr> <tr> <td>Brain Injury Criterion (BrIC)</td> <td>N/A</td> <td>0.38</td> </tr> <tr> <td>Maximum Shoulder Force</td> <td>N</td> <td>1084.87</td> </tr> <tr> <td>Maximum Thoracic Rib Deflection</td> <td>mm</td> <td>16.13</td> </tr> <tr> <td>Combined Abdominal Force</td> <td>N</td> <td>342.83</td> </tr> <tr> <td>Pubic Symphysis Force</td> <td>N</td> <td>-981.04</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th colspan="2">Passenger ATD (SID-IIs)</th> </tr> <tr> <th>Units</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₃₆)</td> <td>N/A</td> <td>109.76</td> </tr> <tr> <td>Brain Injury Criterion (BrIC)</td> <td>N/A</td> <td>0.57</td> </tr> <tr> <td>Maximum Thoracic Rib Deflection</td> <td>mm</td> <td>8.64</td> </tr> <tr> <td>Maximum Abdominal Rib Deflection</td> <td>mm</td> <td>30.75</td> </tr> <tr> <td>Lower Spine Acceleration</td> <td>G</td> <td>39.03</td> </tr> <tr> <td>Total Pelvic Force (sum of acetabular and iliac forces)</td> <td>N</td> <td>2455.25</td> </tr> </tbody> </table>				Measurement Description	Driver ATD (ES-2re)		Units	Result	Head Injury Criteria (HIC ₃₆)	N/A	28.90	Brain Injury Criterion (BrIC)	N/A	0.38	Maximum Shoulder Force	N	1084.87	Maximum Thoracic Rib Deflection	mm	16.13	Combined Abdominal Force	N	342.83	Pubic Symphysis Force	N	-981.04	Measurement Description	Passenger ATD (SID-IIs)		Units	Result	Head Injury Criteria (HIC ₃₆)	N/A	109.76	Brain Injury Criterion (BrIC)	N/A	0.57	Maximum Thoracic Rib Deflection	mm	8.64	Maximum Abdominal Rib Deflection	mm	30.75	Lower Spine Acceleration	G	39.03	Total Pelvic Force (sum of acetabular and iliac forces)	N	2455.25
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* 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.		18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division, NPO-411 1200 New Jersey Ave. SE Washington, D.C. 20590																																															
17. Key Words Side Impact MDB ES-2re SID-IIs	19. Security Class. (of this report) UNCLASSIFIED	20. Security Class. (of this page) UNCLASSIFIED	21. No. of Pages 194 22. Price																																														

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1	Test Purpose and Procedure	1-1
2	Summary of Test Results	2-1
3	Occupant and Vehicle Information	3-1
<u>Data Sheet</u>		<u>Page</u>
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	3-12
4	Dummy Lateral Clearance Dimensions	3-13
5	Camera and Instrumentation Data	3-14
6	Test Vehicle Accelerometer Locations	3-15
7	MDB Accelerometer Locations	3-17
8	Post-Test Observations	3-18
9	MDB Summary of Results	3-20
10	Test Vehicle Profile Measurements	3-21
11	Test Vehicle Exterior Crush Measurements	3-22
12	MDB Exterior Static Crush Measurements	3-25
13	Vehicle and MDB Damage Profile Distances	3-26
14	FMVSS No. 301 Static Rollover Results	3-27
15	Dummy/Vehicle Temperature and Humidity Stabilization Data	3-28
<u>Appendix</u>		<u>Page</u>
A	Photographs	A-1
B	Vehicle and Dummy Response Data Plots	B-1
C	Dummy Configuration and Performance Verification Data	C-1
D	Test Equipment and Instrumentation Calibration Data	D-1
E	Seating Procedure Worksheets and Plots	E-1

SECTION 1

TEST PURPOSE AND PROCEDURE

This moving deformable barrier side impact test is part of the Federal Motor Vehicle Safety Standard 214 Side Impact Protection Program. It was conducted for the National Highway Traffic Safety Administration (NHTSA), under contract number DTNH22-14-D-00359L by Calspan Corporation. The purpose of this test was to evaluate side impact protection in a 2020 Hyundai Santa Fe SUV. The side impact test was conducted in accordance with the latest 214 Test Procedure (TP-214D-09, dated September, 2012)."

SECTION 2

SUMMARY OF TEST RESULTS

A 2020 Hyundai Santa Fe 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 52.96 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 12, 2020. 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 September 2012. 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)

Head CG tri-axial accelerometer

Head angular rate sensor

Upper and lower neck load cells

Shoulder load cell

Upper (T1), middle (T4), and lower spine (T12) tri-axial accelerometers

Lumbar load cell

Pelvic tri-axial accelerometers

Pubic load cell

PASSENGER ATD (SID-IIs)

Primary and redundant head CG tri-axial accelerometers

Head angular rate sensor

Chest upper rib, middle rib, and lower rib y-axis displacement potentiometers

Abdomen upper rib and lower rib y-axis displacement potentiometers

Upper (T1) and 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. Appendix E contains the seating procedure worksheets and plots.

DUMMY INJURY VALUES

Measurement Description	Driver ATD (ES-2re)	
	Units	Result
Head Injury Criteria (HIC36)		28.90
Brain Injury Criterion (BrIC)		0.38
Maximum Shoulder Force	N	1084.87
Maximum Thoracic Rib Deflection	mm	16.13
Combined Abdominal Force	N	342.83
Pubic Symphysis Force	N	-981.04

Measurement Description	Passenger ATD (SID-IIs)	
	Units	Result
Head Injury Criteria (HIC36)		109.76
Brain Injury Criterion (BrIC)		0.57
Maximum Thoracic Rib Deflection	mm	8.64
Maximum Abdominal Rib Deflection	mm	30.75
Lower Spine Acceleration	G	39.03
Total Pelvic Force (sum of acetabular and iliac forces)	N	2455.25

SUPPLEMENTAL RESTRAINT INFORMATION

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

GENERAL COMMENTS:

1. P1 serial number – F034
2. P4 serial number – 303

Data Anomalies:

The following channel was questionable for

- Rear Floorpan X Acceleration, Exceeded calibration range at 43.2 ms
- Rear Floorpan Y Acceleration, Questionable data after 55 ms
- Left Front Door - Mid Centerline Accel Y, Exceeded calibration range at 32.6 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 System 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. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	R20204201	Traction Control System (TCS)	Yes
Model Year	2020	Auto-Leveling System	No
Make	Hyundai	Automatic Door Locks (ADL)	Yes
Model	Santa Fe	Power Window Auto-Reverse	No
Body Style	SUV	Other Optional Feature	N/A
VIN	5NMS23AD2LH255369	Driver Front Air bag	Yes
Body Color	Green	Driver Curtain Air bag	Yes
Odometer Reading (km/mi)	60 miles	Driver Head/Torso Air bag	No
Engine Displacement (L)	2.4	Driver Torso Air bag	No
Type/No. Cylinders	I4	Driver Torso/Pelvis Air bag	Yes
Engine Placement	Transverse	Driver Pelvis Air bag	No
Transmission Type	Automatic	Driver Knee Air bag	No
Transmission Speeds	8-speed	Rear Pass. Curtain Air bag	Yes
Overdrive	Yes	Rear Pass. Head/Torso Air bag	No
Final Drive	Front Wheel Drive	Rear Pass. Torso Air bag	No
Roof Rack	No	Rear Pass. Torso/Pelvis Air bag	No
Sunroof/T-Top	No	Rear Pass. Pelvis Air bag	No
Running Boards	No	Driver Seat Belt Pretensioners	Yes
Tilt Steering Wheel	Yes	Rear Pass. Seat Belt Pretensioners	No
Power Seats	No	Driver Load Limiter	Yes
Anti-Lock Brakes (ABS)	Yes	Rear Pass. Load Limiter	No
		Other Safety Restraint	-

Does owner's manual provide instructions to turn off automatic door locks?

Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Manufacturing Alabama, LLC	GVWR (kg)	2210
Date of Manufacture	Jul/22/20	GAWR Front (kg)	1300
Vehicle Type	MPV	GAWR Rear (kg)	1395

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3	-	5	
Capacity Weight (VCW) (kg)				480	(A)
DSC X 68.04 kg				340.2	(B)
Cargo Weight (RCLW) (kg)				136	(A-B)

VEHICLE SEAT TYPE

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

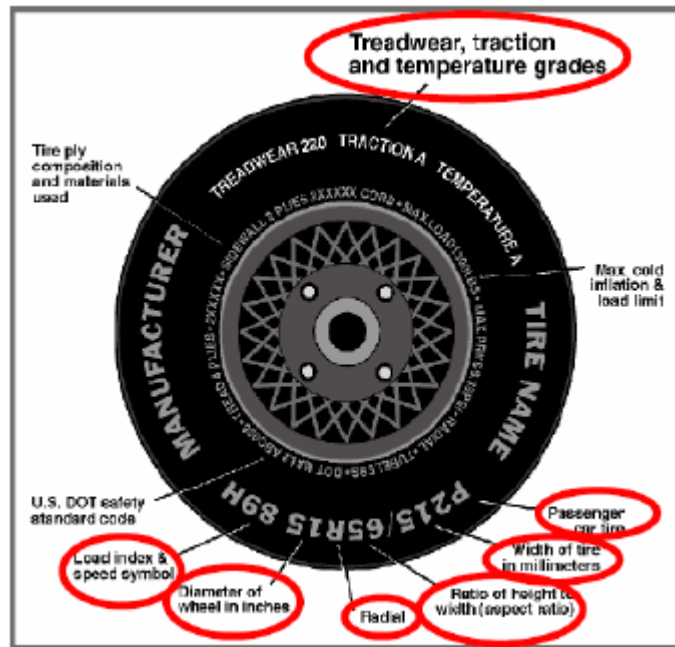
DATA SHEET NO. 1 ... (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

VEHICLE TIRE INFORMATION

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



TIRE SIDEWALL INFORMATION

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	240	240
Recommended Tire Size	235/65R17	235/65R17
Tire Size on Vehicle	235/65R17	235/65R17
Tire Manufacturer	Hankook	Hankook
Tire Model	DynaPro HP2	DynaPro HP2
Treadwear	540	540
Traction	A	A
Temperature Grade	A	A
Load Index/Speed Symbol	104H	104H
Tire Material	Rubber	Rubber

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

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

TIRE PRESSURES

	Units	LF	RF	LR	RR
As Delivered	kPa	245	250	252	243
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	Requirement	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	490	356		505	459		528	481	
Right	kg	450	361		493	456		453	456	
Ratio	%	57	43		52	48		51	49	
Totals	kg	940	717	1657	998	915	1913	981	937	1918

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value	
Total Delivered Weight (UVW)	kg	1657	(A)
Sum of Actual Weight of 1 ES2re and 1 P572 ATD (SID-IIs)	kg	127	(B)
Rated Cargo / Luggage Weight (RCLW)	kg	136	(C)
Calculated Target Vehicle Test Weight (TVTW)	kg	1920	(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)? ☒ Yes ☐ No

TEST VEHICLE ATTITUDES AND CG

Measurement Description	Units	Fully Loaded	As Tested	Meets Requirement**
LF	mm	864	855	Yes
RF	mm	877	868	Yes
RR	mm	874	867	Yes
LR	mm	863	861	Yes
Vehicle CG (Aft of Front Axle)	mm	1351	1323	
Vehicle CG (Left+)/Right(-) from Longitudinal Centerline)	mm	43	7	

*** 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:	<u>2020 Hyundai Santa Fe SUV</u>	NHTSA No.:	<u>R20204201</u>
Test Program:	<u>Research Side MDB Impact Test</u>	Test Date:	<u>11/12/2020</u>

WEIGHT OF BALLAST AND VEHICLE COMPONENTS REMOVED TO MEET TVTW

Component Description	Weight (kg)
Trunk Carpeting	8
Jack	3
Tail Light	1
Ballast / Equipment Added	84.3

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

Test Vehicle: <u>2020 Hyundai Santa Fe SUV</u>	NHTSA No.: <u>R20204201</u>	
Test Program: <u>Research Side MDB Impact Test</u>	Test Date: <u>11/12/2020</u>	

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 passengers' seats should be set to the rear-most, lowest, mid-angle position.

SCRL ANGLE RANGE

Seat	SCRL (°)		
	Max	Min	Mid
Driver Seat	13.5	10.9	12.2
Front Passenger Seat	Not Adjustable		
Front Center Seat*			
Struck Side Rear Seat	Fixed	Fixed	Fixed
Non-Struck Side Rear Seat	Fixed	Fixed	Fixed
Rear Center Seat*	Fixed	Fixed	Fixed

**if applicable*

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	12.2	29	Max	-	-	-
			Mid	24	29	34
			Min	-	-	-
Front Passenger Seat	Not Adjustable		Max	-	-	-
			Mid	-	-	-
			Min	-	-	-
Front Center Seat*	N/A	N/A	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 SYSTEM DATA

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

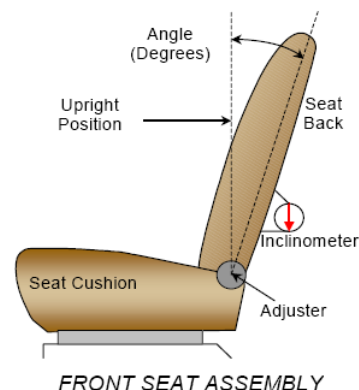
SEAT FORE / AFT POSITION

Seat	Total Fore / Aft Travel		Test Position from Forwardmost Position	
	mm	Detents*	mm	Detent*
Driver Seat	240	38 (0-37)	120	19
Front Passenger Seat	240	38 (0-37)	120	19
Front Center Seat*	N/A	N/A	N/A	N/A
Struck Side Rear Seat	FIXED	FIXED	FIXED	FIXED
Non-Struck Side Rear Seat	FIXED	FIXED	FIXED	FIXED
Rear Center Seat*	FIXED	FIXED	FIXED	FIXED

**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.



Seat	Total Seat Back Angle Range		Test Position from Most Upright	
	Degrees	Detents*	Degrees	Detents*
Driver Seat w/ Seated Dummy	64.6	N/A	0.5	9
Front Passenger Seat	66.1	N/A	0.5	9
Front Center Seat*	N/A	N/A	N/A	N/A
Struck Side Rear Seat w/ Seated Dummy	21.8	5 (0-4)	4.5	0
Non-Struck Side Rear Seat	21.5	5 (0-4)	4.5	0
Rear Center Seat*	21.8	5 (0-4)	4.5	0

**if applicable*

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

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

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.

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

HEAD RESTRAINT ADJUSTMENT

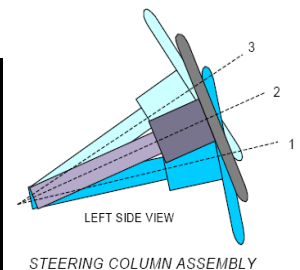
The driver's head restraint is adjusted to the highest and most full forward in-use position. The struck-side rear passenger's head restraint is adjusted to the lowest and most full forward in-use position.

	Total # of Positions	Placed in Position #
Driver Seat	7 (0-6)	Uppermost
Rear Seat	3 (0-2)	Lowest

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.

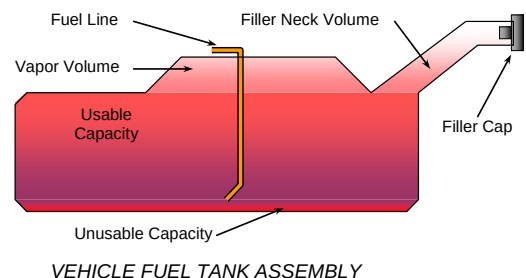
	Degrees	Fore/Aft Position (mm)
Lowermost – Position 1	22.1	
Geometric Center – Position 2	25.2	
Uppermost – Position 3	27.2	
Telescoping Steering Wheel Travel		60
Test Position	25.2	30



FUEL PUMP

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

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



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

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020

FUEL TANK CAPACITY

	Liters
Usable Capacity of "Standard Tank" (see Form No. 1)	N/A
Usable Capacity of "Optional Tank" (see Form No. 1)	N/A
Usable Capacity of Standard Tank (see Owner's Manual)	71
Usable Capacity of Optional Tank (see Owner's Manual)	N/A
93% of Usable Capacity	66.03
Actual Amount of Solvent Used in Test	66.03
1/3 of Usable Capacity	23.67

Is the Actual Amount of Solvent Used in the test equal to 93% $\pm$ 1% of the Usable Capacity stated in Form No. 1? ☒ Yes ☐ No

Table 1 ES-2re Instrumentation Data - Serial No. F034

Test Vehicle: 2020 Hyundai Santa Fe SUV

NHTSA No.: R20204201

Test Program: Research Side MDB Impact Test

Test Date: 11/12/2020

	Nomenclature	Units	Source	Max	Max Time	Min	Min Time
Head	Head CG X Acceleration	g	CFC1000	6.86	14.65	-7.45	75.80
	Head CG Y Acceleration	g	CFC1000	20.38	36.45	-4.30	287.10
	Head CG Z Acceleration	g	CFC1000	9.32	18.00	-9.45	75.20
	Head Resultant Acceleration	g	Compute	20.64	36.40		
	36 ms HIC		Compute	28.90			
	15 ms HIC		Compute	21.69			
	Head Resultant Acceleration, 3 ms Clip	g	CFC1000	18.88			
	Head CG X Angular Rate	deg/s	CFC60	885.74	61.05	-276.00	177.10
	Head CG Y Angular Rate	deg/s	CFC60	411.76	115.85	-310.21	66.90
	Head CG Z Angular Rate	deg/s	CFC60	662.13	79.40	-517.31	46.30
	Head CG Resultant Angular Rate	deg/s	CFC60	987.86			
	Brain Injury Criteria (BrIC)		Compute	0.38			
Neck	Upper Neck Tension	N	CFC1000	259.63	16.75		
	Upper Neck Compression	N	CFC1000			-545.19	74.80
	Upper Neck Resultant Force	N	CFC1000	1015.87	68.80		
	Upper Neck Resultant Moment	Nm	CFC600	25.33	65.40		
Shoulder	Shoulder Y Force	N	CFC600	1084.87	23.90	-335.72	86.75
	Shoulder Resultant Force	N	CFC600	1295.50			
Chest	Thorax Rib Upper Y Deflection	mm	CFC180	5.40	31.80	-3.03	17.95
	Thorax Rib Middle Y Deflection	mm	CFC180	7.98	52.75	-1.02	19.65
	Thorax Rib Lower Y Deflection	mm	CFC180	16.13	54.65	-0.00	-44.90
	Thorax Rib Max. Deflection	mm	CFC180	16.13			
	Thorax Rib Avg. Deflection	mm	CFC180	9.83			
Abdomen	Abdomen Front Y Force	N	CFC600	80.88	92.30	-25.94	14.20
	Abdomen Middle Y Force	N	CFC600	105.60	45.75	-2.91	12.20
	Abdomen Rear Y Force	N	CFC600	224.65	52.65	-6.39	257.35
	Combined Abdominal Force	N	Compute	342.83			
Spine	Lower Spine T12 Y Force	N	CFC600	631.34	68.35	-190.64	242.00
	Lower Spine T12 X Moment	Nm	CFC600	38.68	191.05	-48.62	26.55
	Lower Spine T12 Resultant Acceleration	g	CFC180	18.07	51.95		
Pelvis	Lumbar Y Force	N	CFC600	1122.03	52.85	-267.72	214.70
	Lumbar Z Force	N	CFC600	878.22	19.70	-786.41	93.80
	Lumbar X Moment	Nm	CFC600	67.24	54.55	-10.89	30.85
	Pubic Symphysis Y Force	N	CFC600	115.46	144.60	-981.04	57.40
	Pelvis Resultant Acceleration	g	CFC1000	27.56			
	Anomalies None						

Table 2 SID-IIs Instrumentation Data - Serial No. 303

Test Vehicle: 2020 Hyundai Santa Fe SUV

NHTSA No.:

R20204201

Test Program: Research Side MDB Impact Test

Test Date:

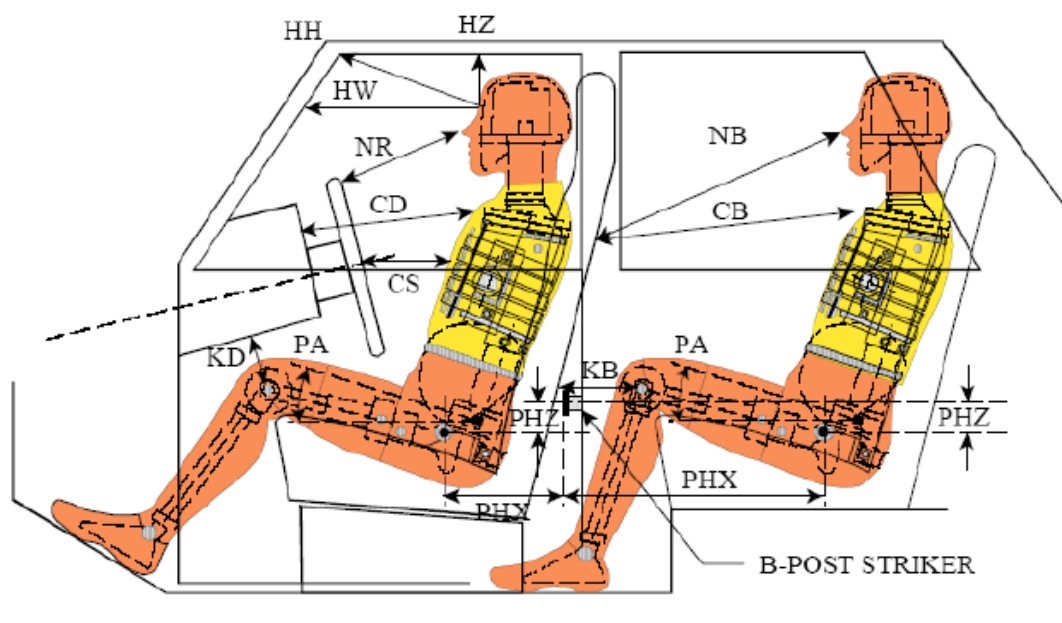
11/12/2020

	Nomenclature	Units	Source	Max	MaxTime	Min	MinTime
Head	Head CG X Acceleration	g	CFC1000	7.07	71.70	-8.36	44.05
	Head CG Y Acceleration	g	CFC1000	29.33	66.75	-4.68	143.50
	Head CG Z Acceleration	g	CFC1000	2.51	255.00	-17.62	70.85
	Head Resultant Acceleration	g	Compute	33.24			
	36 ms HIC		Compute	109.76			
	15 ms HIC		Compute	75.75			
	Head Resultant Acceleration, 3ms Clip	g	Compute	32.31			
	Head CG X Angular Rate	deg/s	CFC60	905.31	56.75	-622.35	88.15
	Head CG Y Angular Rate	deg/s	CFC60	321.64	55.05	-511.19	202.85
	Head CG Z Angular Rate	deg/s	CFC60	1197.24	153.25	-1025.52	239.20
	Head CG Resultant Angular Rate	deg/s	CFC60	1337.78	57.45		
	Brain Injury Criteria (BrIC)		Compute	0.57			
Neck	Neck Tension	N	CFC1000	128.04	43.30		
	Neck Compression	N	CFC1000			-787.72	73.65
	Neck Resultant Force	N	CFC1000	853.00	73.65	0.07	-38.15
	Neck Resultant Moment	Nm	CFC600	39.46	69.05	0.00	2.00
Shoulder	Shoulder Y Force	N	CFC600	946.82	67.45	-104.99	96.05
	Shoulder Left Resultant Force	N	CFC600	996.63	67.80	0.04	-13.85
	Shoulder Deflection	mm	CFC600	15.30	72.60	-0.50	223.15
Chest	Thorax Rib Upper Y Deflection	mm	CFC600	8.64	67.20	-0.64	93.75
	Thorax Rib Middle Y Deflection	mm	CFC600	4.87	58.80	-1.47	91.40
	Thorax Rib Lower Y Deflection	mm	CFC600	7.76	60.15	-1.32	90.15
	Thorax Rib Max. Deflection	mm	CFC600	8.64			
	Thorax Rib Avg. Deflection	mm	CFC600	7.09			
Abdomen	Abdomen Rib Upper Deflection	mm	CFC600	30.75	61.95	-0.04	42.25
	Abdomen Rib Lower Deflection	mm	CFC600	25.03	62.10	-0.00	14.25
	Abdomen Rib Max. Deflection	mm	CFC600	30.75			
	Abdomen Rib Avg. Deflection	mm	CFC600	27.89			
Spine	T12 Resultant Acceleration	g	CFC180	39.03	56.70	0.00	-35.85
	T1 Resultant Acceleration	g	CFC180	42.49	63.90	0.01	-28.75
Iliac	Iliac Left Force	N	CFC600	62.91	65.95	-149.49	50.50
Acetabulum	Acetabulum Left Force	N	CFC600	2530.66	53.40	-34.44	133.50
Pelvis	Pelvis Resultant Acceleration	g	CFC1000	47.73	52.35	0.00	-2.00
	Combined Pelvic Left Force	N	CFC600	2455.25	53.45	-103.76	115.70
	Pubic Symphysis Y Force	N	CFC600	106.31	38.95	-666.62	57.70
Lumbar	Lumbar Resultant Force	N	CFC600	1176.40	57.50	0.09	-33.45
	Lumbar Resultant Moment	Nm	CFC600	75.18	58.55	0.00	-9.75
	Anomalies: None						

DATA SHEET NO. 3 DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020



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

DUMMY LONGITUDINAL CLEARANCE DIMENSION INFORMATION

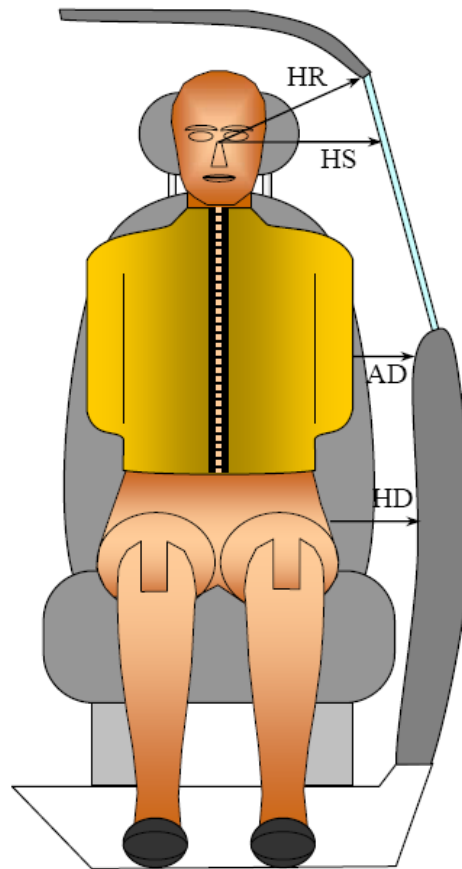
Driver Code	Pass. Code	Description	Driver (Serial No. F034)		Passenger (Serial No.303)	
			Length (mm)	Angle	Length (mm)	Angle
HH		Header to Header	390			
HW		Header to Windshield	653			
HZ	HZ	Head to Roof Liner	185		311	
NR	NB	Nose to Rim/Seat Back	448		613	
CD	CB	Chest to Dash/Seat Back	552		621	
CS		Chest to Steering Wheel	346			
KD(L)/KDA(L)°	KB(L)/KBA(L)°	Left Knee to Dash/Seat Back	179	20.2	340	0
KD(R)/KDA(R)°	KB(R)/KBA(R)°	Right Knee to Dash/Seat Back	188	17.8	343	0.3
PAX°	PAX°	Pelvic Tilt Angle X		18.1		20.4
	PAY°	Pelvic Tilt Angle Y				0.2
PHX	PHX	Hip Point to Striker (X-Axis)	176		250	
PHZ	PHZ	Hip Point to Striker (Z-Axis)	251		212	

*See Appendix A for digital tilt sensor angle photographs

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020



FRONT VIEW OF DUMMY

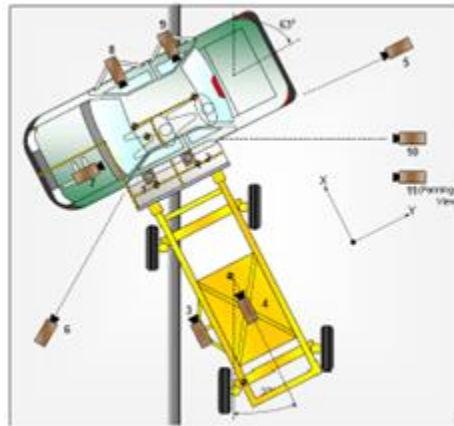
DUMMY LATERAL CLEARANCE DIMENSION INFORMATION

Code	Measurement Description	Units	Driver (Serial No. F034)	Passenger (Serial No. 303)
HR	Head to Side Header	mm	214	270
HS	Head to Side Window	mm	343	360
AD	Arm to Door	mm	112	156
HD	Hip Point to Door	mm	184	198

DATA SHEET NO. 5
CAMERA AND INSTRUMENTATION DATA

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020



CAMERA LOCATIONS AND DATA

No.	Camera View	Coordinates (mm)			Lens Length (mm)	Operating Frame Rate (fps)
		X	Y	Z		
1	Overhead Overall	0	0	-8136	12.5	1000
2	Overhead Close-up	0	0	-8128	28	1000
3	Impact Point Close-up (MDB)				25	1000
4	Centerline of Impact (MDB)				8	1000
5	Right Side View	0	-8000	-1352	24	1000
6	Left Side View	-2250	6405	-1303	24	1000
7	Front Seat Occupant – Frontal View (OB)				25	1000
8	Front Seat Occupant – Side View (OB)				12.5	1000
9	Rear Passenger - Side View (OB)				12.5	60
10	Real Time Coverage				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 normally

INSTRUMENTATION

Driver Dummy Channels	45
Passenger Dummy Channels	46
Vehicle Structure Accelerometers	37
MDB Accelerometers	7
Total	135

DATA SHEET NO. 6
VEHICLE ACCELEROMETER DATA

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020

TEST VEHICLE ACCELEROMETER LOCATIONS

No.	Accelerometer Location	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2,503	-64	60
2	Vehicle CG ARS	2,526	-62	59
3	Right Sill at Front Seat	2,888	724	126
4	Right Sill at Rear Seat	1,818	719	109
5	Left Side Sill at Front Seat	2,876	-712	129
6	Left Side Sill at Rear Seat	1,825	-716	114
7	Left Front Door - Mid Centerline	2,719	-797	-238
8	Left Front Door - Mid Rear	2,427	-767	-248
9	Left Front Door - Upper Centerline	2,693	-781	-541
10	Left Rear Door - Mid Rear	1,512	-786	-279
11	Left Rear Door - Upper Centerline	1,725	-760	-578
12	Left Lower A-Pillar	2,273	-754	-240
13	Left Middle A-Pillar	2,244	-741	-540
14	Left Lower B-Pillar	3,301	-717	-104
15	Left Middle B-Pillar	3,232	-719	-619
16	Front Seat Track	2,372	-600	92
17	Left Rear Seat Structure	1,895	-575	41
18	Right Rear Occupant Compartment	2,115	407	193
19	Engine Block Top	4,039	163	-320
20	Floorpan Above Rear Axle	170	9	-96
21	Rear Deck	170	9	-96
22	Rear Deck ARS	168	-39	-96

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

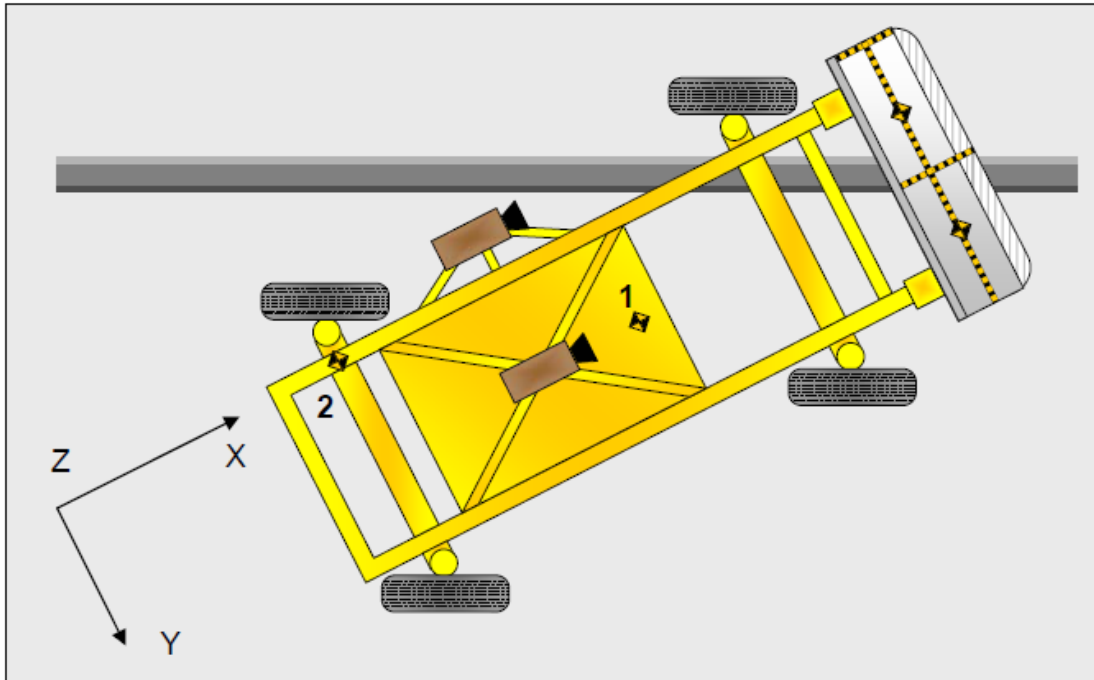
DATA SHEET NO. 6 (CONTINUED)
VEHICLE ACCELEROMETER DATA

Loc. No	Description	Axes	Units	Peak Values			
				Max	Time (ms)	Min	Time (ms)
1	Vehicle CG	X	g	2.36	52.05	-8.53	11.00
	Vehicle CG	Y	g	24.95	8.15	-1.99	77.15
	Vehicle CG	Z	g	3.45	11.55	-9.58	50.45
2	Vehicle CG Angular Rate	X	°/s	84.38	182.50	-234.50	9.35
	Vehicle CG Angular Rate	Y	°/s	33.97	-50.00	-11.62	268.20
	Vehicle CG Angular Rate	Z	°/s	15.20	-50.00	-62.53	236.75
3	Right Sill at Front Seat	X	g	2.60	54.55	-7.14	13.10
	Right Sill at Front Seat	Y	g	24.12	8.55	-2.39	72.10
	Right Sill at Front Seat	Z	g	5.33	63.65	-9.64	11.10
4	Right Sill at Rear Seat	X	g	3.34	53.80	-4.80	12.35
	Right Sill at Rear Seat	Y	g	26.96	8.55	-2.12	134.15
	Right Sill at Rear Seat	Z	g	3.07	62.80	-7.51	21.35
5	Left Sill at Front Door	Y	g	26.78	6.25	-2.35	134.05
6	Left Sill at Rear Door	Y	g	33.00	8.90	-3.35	13.40
7	Left Front Door Mid Centerline	Y	g	89.08	25.35	-88.75	32.75
8	Left Front Door Mid Rear	Y	g	71.52	24.90	-28.89	10.85
9	Left Front Door Upper Centerline	Y	g	86.68	12.80	-28.52	7.80
10	Left Rear Door Mid Rear	Y	g	129.79	20.50	-65.97	28.40
11	Left Rear Door Upper Centerline	Y	g	94.83	14.05	-46.34	21.70
12	Left A-Pillar Lower	Y	g	20.55	3.85	-3.41	31.50
13	Left A-Pillar Middle	Y	g	17.35	11.25	-2.02	249.75
14	Left B-Pillar Lower	Y	g	62.70	6.45	-12.27	11.30
15	Left B-Pillar Middle	Y	g	54.33	9.35	-13.56	14.65
16	Front Seat Track	Y	g	25.72	8.55	-2.91	50.05
17	Rear Seat Track or Structure	Y	g	23.11	7.80	-1.79	103.25
18	Right Rear Occ. Compartment	Y	g	26.10	8.35	-2.33	73.30
19	Engine Block	X	g	6.38	39.90	-13.25	26.75
	Engine Block	Y	g	25.71	21.35	-5.25	103.10
20	Rear Floorpan Above Axle	X	g	34.78	48.25	-44.87	43.00
	Rear Floorpan Above Axle	Y	g	2049.92	60.60	-99.50	47.80
	Rear Floorpan Above Axle	Z	g	10.63	11.70	-22.53	42.80
21	Rear Deck	X	g	3.94	52.20	-8.16	22.85
	Rear Deck	Y	g	24.67	10.75	-3.51	100.25
	Rear Deck	Z	g	5.60	44.45	-4.36	49.75
22	Rear Deck Angular Velocity	X	°/s	178.47	103.90	-250.61	21.95
	Rear Deck Angular Velocity	Y	°/s	116.22	20.65	-157.64	13.20
	Rear Deck Angular Velocity	Z	°/s	38.82	10.45	-68.67	53.80

DATA SHEET NO. 7
MDB ACCELEROMETER LOCATIONS

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020



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)

Loc. No	Description	Axes	Units	Peak Values			
				Max	Time (ms)	Min	Time (ms)
1	MDB CG	X	g	1.41	96.35	-19.88	33.55
	MDB CG	Y	g	0.50	61.05	-5.69	29.25
	MDB CG	Z	g	26.26	54.65	-13.69	26.70
2	MDB Rear	X	g	1.97	88.35	-22.46	36.20
	MDB Rear	Y	g	4.49	28.00	-3.85	300.00

DATA SHEET NO. 8
POST-TEST OBSERVATIONS

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020

TEST DUMMY INFORMATION AND CONTACT POINTS

Dummy Body Part	Front Seat Dummy (ES-2re)	Rear Seat Dummy (SID-IIs)
Face	None	Curtain Airbag
Top of Head	Curtain Airbag, Side Header,	Curtain Airbag
Left Side of Head	Curtain Airbag, Side Header	Curtain Airbag
Back of Head	Curtain Airbag, Side Header, Headrest	Curtain Airbag, Headrest
Left Shoulder	Curtain Airbag, Torso/Pelvis Airbag	Rear Passenger Door
Upper Torso	Torso/Pelvis Airbag, Seatback	Rear Passenger Door
Lower Torso	Seatback	Rear Passenger Door
Left Hip	Torso/Pelvis Airbag, Seatback, Seatpan	Rear Passenger Door
Left Knee	Driver Door	Rear Passenger Door

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

*Tailgate opened during impact but is still operational.

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	B-Pillar Buckled
Sill Separation	None
Windshield Damage	None
Side Window Damage	Rear Window Loose
Other Notable Effects	None

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

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Struck Side Driver		Struck Side Rear Passenger	
	Mounted	Deployed	Mounted	Deployed
Frontal Air bag	Yes	No		
Knee Air bag	No	N/A		
Side Air bag 1 - Curtain	Yes	Yes	Yes	Yes
Side Air bag 2 - Torso/Pelvis Air bag	Yes	Yes	No	N/A
Seat Belt Pretensioner	Yes	Yes	No	N/A
Seat Belt Load Limiter	Yes	Yes	No	N/A
Other				

IMPACT POINT LOCATION DATA

Measured Parameter	Units	Tolerance	Value
Vehicle Wheel Base	mm		2766
Vertical Impact Reference Line (Aft of Front Axle - Intended Impact Point)	mm		443
Actual Impact Point (Aft of Frontal Axle)	mm		450
Horizontal Offset (+ forward / - rearward)	mm	+/- 50 of Intended Impact Point	-7
Vertical Offset (+ down / - up)	mm	+/- 20 of Intended Impact Point	7

DATA SHEET NO. 9
MDB SUMMARY OF RESULTS

Test Vehicle: 2020 Hyundai Santa Fe SUV
Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
Test Date: 11/12/2020

MDB SPECIFICATIONS

Measurement Description	Length (mm)
Overall Width of Framework Carriage	1,250
Overall Length Including Honeycomb Frame	4,120
Wheelbase of Framework Carriage	2,600
CG Location of Front Axle	1,123

MDB WEIGHTS

	Units	Front Axle	Rear Axle	Total
Left	kg	396	291.5	690.0
Right	kg	377.5	301	677.5
Ratio	%	56.6%	43.4%	100.0%
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	52.10 to 53.70	52.96
Trap No. 2 Velocity (Redundant)	km/h	52.10 to 53.70	52.93
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

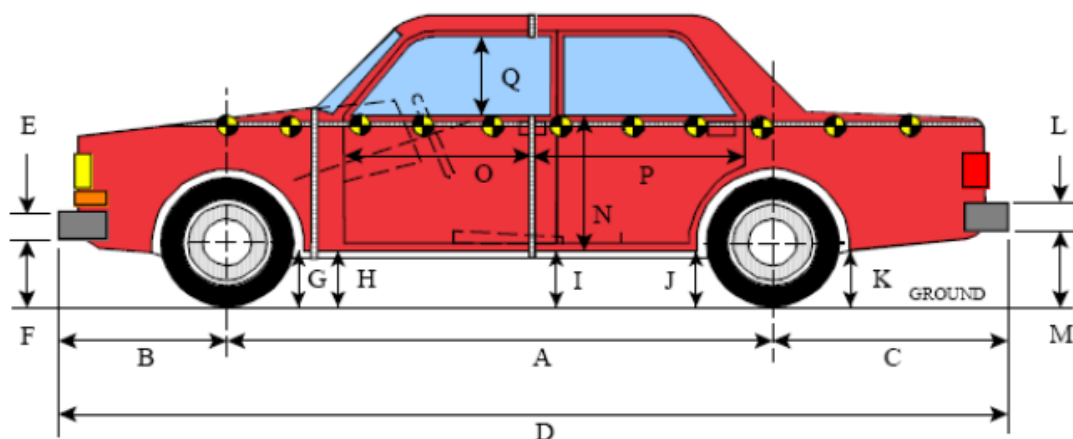
MAXIMUM STATIC CRUSH OF HONEYCOMB IMPACT FACE

Vertical Location			From Centerline		Maximum Crush (mm)
Row	Description	Height (mm)	Distance (mm)	Direction	
A	Center of Bumper	432	800	Left	193
B	Top of Bumper	533	800	Left	119
C	Mid-Level	686	800	Left	111
D	Top of Stack	813	800	Left	129

DATA SHEET NO. 10
TEST VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020



LEFT SIDE VIEW

All MEASUREMENTS IN (mm) WITH TOLERANCE OF ± 3 mm

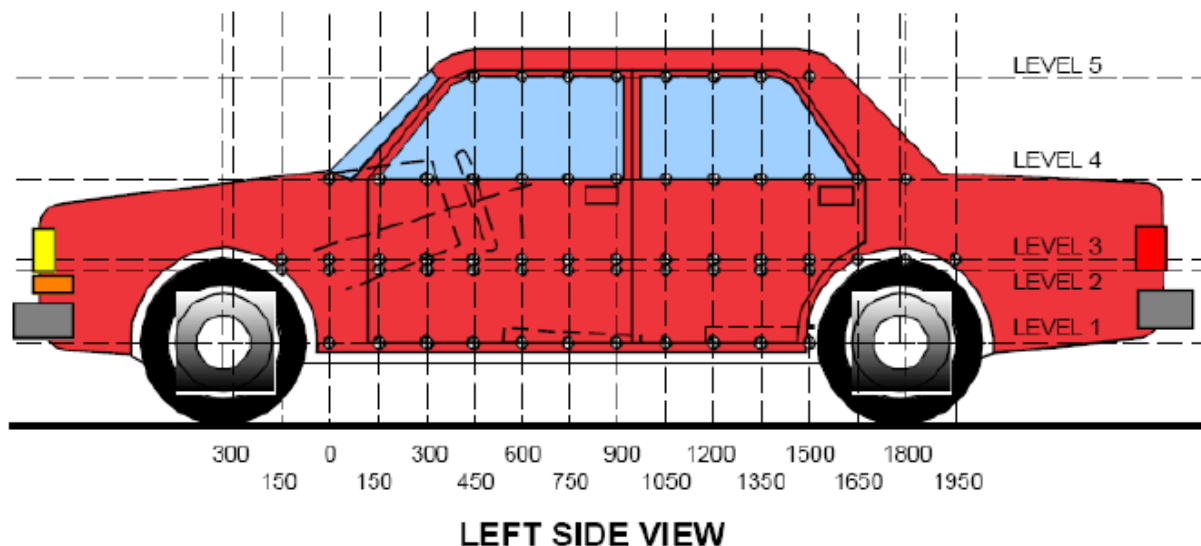
VEHICLE PRE- AND POST-TEST MEASUREMENT INFORMATION

Code	Description	Pre-Test	Post-Test	Difference
A	Wheelbase	2766	2765	-1
B	Front Axle to FSOV	941	942	1
C	Rear Axle to RSOV	1051	1049	-2
D	Total Length at Centerline	4756	4756	0
E	Front Bumper Thickness	125	125	0
F	Front Bumper Bottom to Ground	432	428	-4
G	Sill Height at Front Wheel Well	238	238	0
H	Sill Height at Front Door Leading Edge	228	230	2
I	Sill Height at B Pillar	231	234	3
J1	Sill Height at Rear Wheel Well	238	239	1
J2	Pinch Weld Height at Rear Wheel Well	231	230	-1
K	Sill Height Aft of Rear Wheel Well	250	249	-1
L	Rear Bumper Thickness	118	112	-6
M	Rear Bumper Bottom to Ground	391	398	7
N	Sill Height to Window Bottom of Front Window Sill	911	802	-109
O	Front Door Leading Edge to Impact CL	734	735	1
P	Rear Door Trailing Edge to Impact CL	1383	1353	-30
Q	Front Window Opening	445	457	12
R	Right Side Length	4698	4699	1
S	Left Side Length	4694	4691	-3
T	Maximum Vehicle Width	1887	1769	-118

DATA SHEET NO. 11
TEST VEHICLE EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020



MAXIMUM EXTERIOR CRUSH MEASUREMENTS

Level	Measurement Description	Units	Height Above Ground	Maximum Exterior Static Crush	Distance from Impact
1	Sill Top	mm	400	81	1200
2	Driver Hip Point	mm	702	174	1650
3	Mid-Door	mm	779	170	1200
4	Window Sill	mm	1106	45	1200
5	Window Top	mm	1618	4	1650

*window top level bent outward from original position

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: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

EXTERIOR CRUSH MEASUREMENTS AT EACH LEVEL

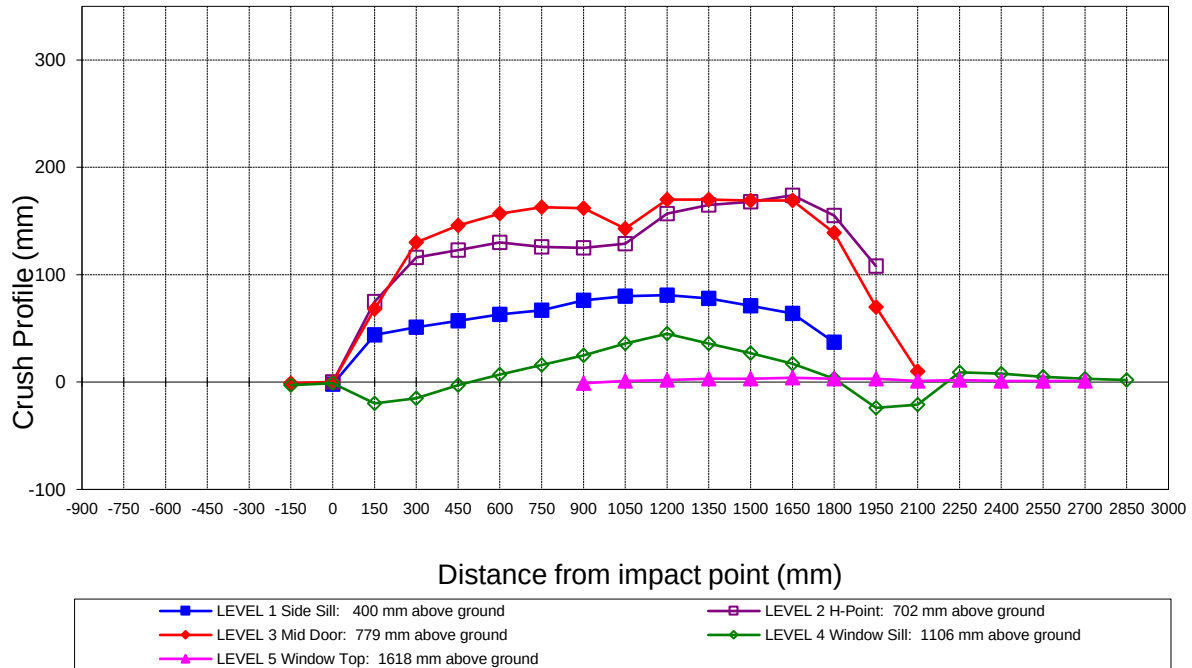
	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-900															
-750															
-600															
-450															
-300															
-150			946	812				947	815				-1	-3	
0	921	943	943	823		923	943	943	824		-2	0	0	-1	
150	923	937	938	829		879	862	870	849		44	75	68	-20	
300	932	931	937	841		881	815	807	856		51	116	130	-15	
450	936	930	938	864		879	807	792	867		57	123	146	-3	
600	938	930	938	880		875	800	781	873		63	130	157	7	
750	938	929	938	890		871	803	775	874		67	126	163	16	
900	936	927	938	892	610	860	802	776	867	611	76	125	162	25	-1
1050	936	924	936	893	622	856	795	793	857	621	80	129	143	36	1
1200	935	923	934	892	626	854	766	764	847	624	81	157	170	45	2
1350	932	922	930	890	627	854	757	760	854	624	78	165	170	36	3
1500	928	923	930	888	627	857	755	761	861	624	71	168	169	27	3
1650	924	931	934	885	626	860	757	765	868	622	64	174	169	17	4
1800	920	942	942	883	623	883	787	803	880	620	37	155	139	3	3
1950		946	947	873	620		838	877	897	617	--	108	70	-24	3
2100			950	898	614			940	919	613			10	-21	1
2250				889	609				880	607				9	2
2400				892	601				884	600				8	1
2550				889	589				884	588				5	1
2700				877	570				874	569				3	1
2850				859					857					2	
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: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

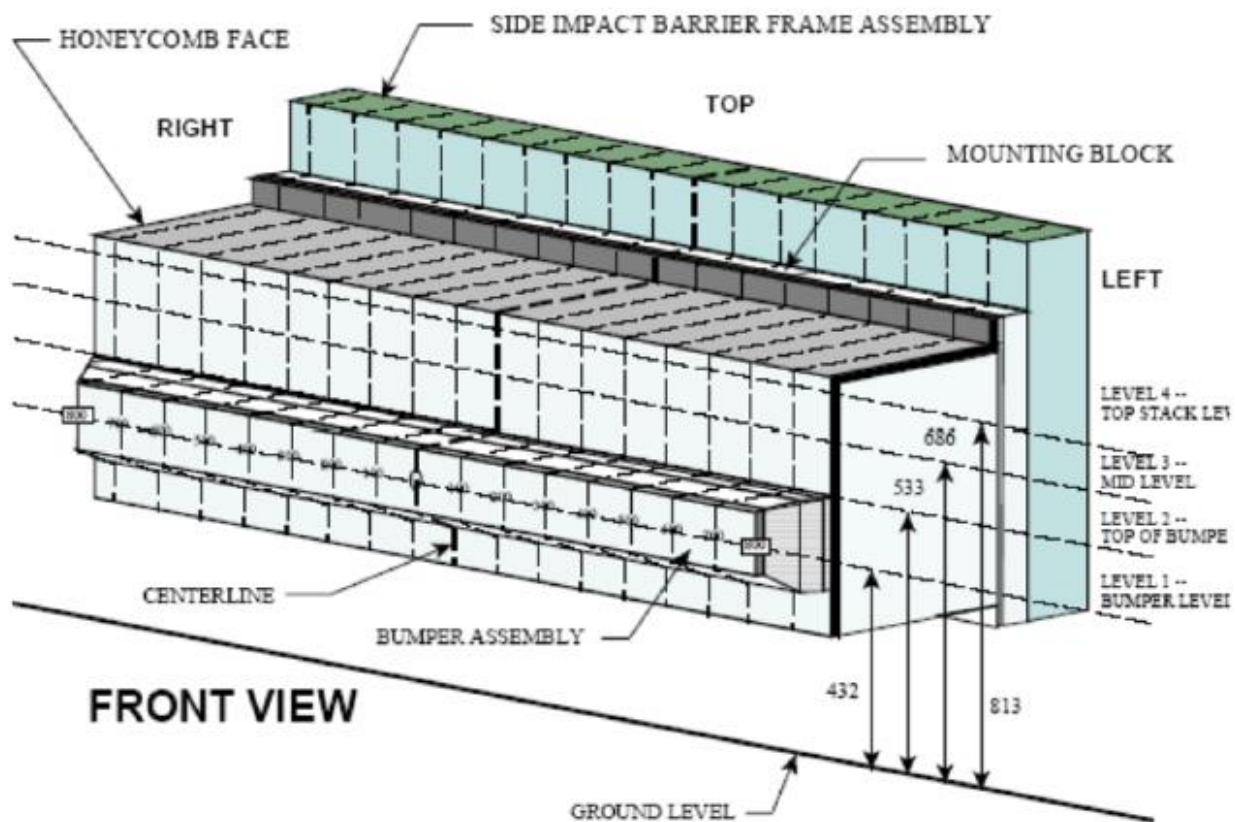


Vehicle Exterior Crush Measurements - Visual Representation

DATA SHEET NO. 12
MDB EXTERIOR STATIC CRUSH MEASUREMENTS

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020



NOTE: Dimensions are shown in millimeters, mm

DEFORMABLE BARRIER STATIC CRUSH

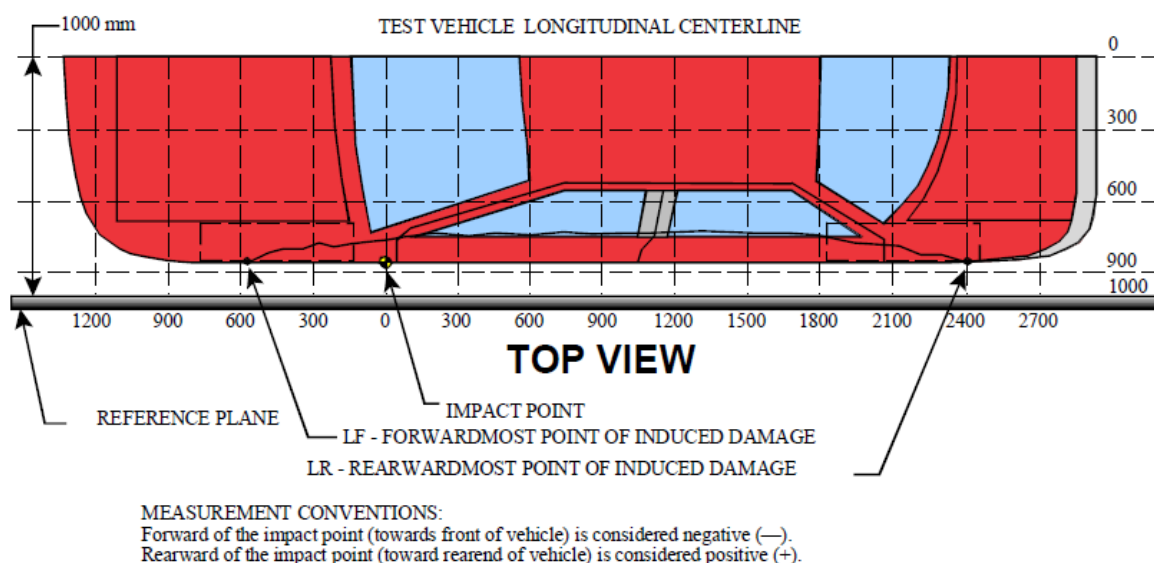
Stack Level	Distance Right of Center								C/L	Distance Left of Center							
	800	700	600	500	400	300	200	100		0	100	200	300	400	500	600	700
1	164	165	166	168	170	171	172	174	177	172	174	176	178	181	183	185	193
2	71	74	76	77	78	79	88	81	77	78	80	85	87	89	91	94	119
3	29	19	14	13	16	20	29	41	37	35	30	29	28	33	44	61	111
4	43	29	21	17	17	22	37	36	33	41	44	44	42	44	56	71	129

DATA SHEET NO. 13
VEHICLE AND MDB DAMAGE PROFILE DISTANCES

Test Vehicle: 2020 Hyundai Santa Fe SUV
 Test Program: Research Side MDB Impact Test

NHTSA No.: R20204201
 Test Date: 11/12/2020

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



VEHICLE DAMAGE PROFILE DISTANCES

DPD	Distance From Impact Point (mm)	Level	Post-Test (mm)	Pre-Test (mm)	Crush (mm)
1	-150	3	53	54	-1
2	300	3	193	63	130
3	750	3	225	62	163
4	1200	3	236	66	170
5	1650	3	235	66	169
6	2100	3	60	50	10

MDB DAMAGE PROFILE DISTANCES

DPD	Distance From Center of MDB	Level	Post-Test (mm)*
1	800 mm left of center	1	193
2	480 mm left of center	1	180
3	160 mm left of center	1	173
4	160 mm right of center	1	173
5	480 mm right of center	1	169
6	800 mm right of center	1	164

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

Test Vehicle: 2020 Hyundai Santa Fe SUV NHTSA No.: R20204201
Test Program: Research Side MDB Impact Test Test Date: 11/12/2020

Test Time: 12:08 PM 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./minute)
- D. Spillage Details: No Spillage Occurred

FMVSS NO. 301 STATIC ROLLOVER DATA



ROLLOVER SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	-	300	N/A
90° to 180°	-	300	N/A
180° to 270°	-	300	N/A
270° to 360°	-	300	N/A

FMVSS NO. 301 ROLLOVER SPILLAGE TABLE

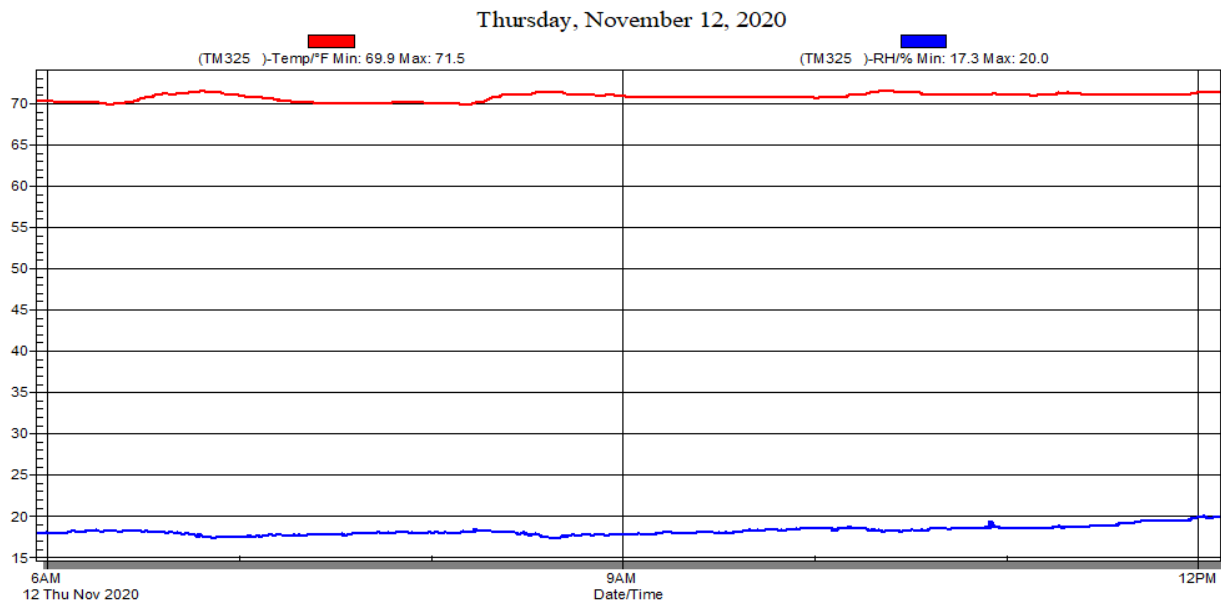
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eighth Minute
0° to 90°	0	0	0	
90° to 180°	0	0	0	
180° to 270°	0	0	0	
270° to 360°	0	0	0	

ROLLOVER SOLVENT SPILLAGE LOCATION TABLE

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

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

Test Vehicle:	<u>2020 Hyundai Santa Fe SUV</u>	NHTSA No.:	<u>R20204201</u>
Test Program:	<u>Research Side MDB Impact Test</u>	Test Date:	<u>11/12/2020</u>



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

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Fig.	Description	Page
1	As-Delivered Right Front 3/4 View of Test Vehicle	A-6
2	As-Delivered Left Rear 3/4 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 3/4 View of Test Vehicle	A-8
6	Post-Test Left Front 3/4 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 3/4 View of Test Vehicle	A-10
10	Post-Test Left Rear 3/4 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-36
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-37
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-38
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-39
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-40

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-41
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-42
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-43
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-44
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-45
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-46
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-47
83	Post-Test View of Fuel Filler Cap or Fuel Filler Neck	A-47
84	Pre-Test Front View of MDB Impactor Face	A-48
85	Post-Test Front View of MDB Impactor Face	A-48
86	Pre-Test Top View of MDB Impactor Face	A-49
87	Post-Test Top View of MDB Impactor Face	A-49
88	Pre-Test Left Side View of MDB Impactor Face	A-50
89	Post-Test Left Side View of MDB Impactor Face	A-50
90	Pre-Test Right Side View of MDB Impactor Face	A-51
91	Post-Test Right Side View of MDB Impactor Face	A-51
92	Close-Up View of Vehicle's Certification Label	A-52
93	Close-Up View of Vehicle's Tire Information Placard or Label	A-52
94	Pre-Test Ballast View	A-53
95	Post-Test Primary and Redundant Speed Trap Read-Out	A-53
96	FMVSS No. 301 Static Rollover 0 Degrees	A-54
97	FMVSS No. 301 Static Rollover 90 Degrees	A-54
98	FMVSS No. 301 Static Rollover 180 Degrees	A-55
99	FMVSS No. 301 Static Rollover 270 Degrees	A-55
100	FMVSS No. 301 Static Rollover 360 Degrees	A-56
101	Impact Event	A-56
102	Monroney Label	A-57
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-58

Fig.	Description	Page
105	Pre-Test Head Tilt Sensor View for ES-2re	A-58
106	Pre-Test Pelvis Tilt Sensor View for ES-2re	A-59
107	Pre-Test Head Tilt Sensor View for SID-IIs	A-59
108	Pre-Test Pelvic Tilt Sensor View for SID-IIs	A-60



Figure A-1: As-Delivered Right Front 3/4 View of Test Vehicle



Figure A-2: As-Delivered Left Rear 3/4 View of Test Vehicle



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

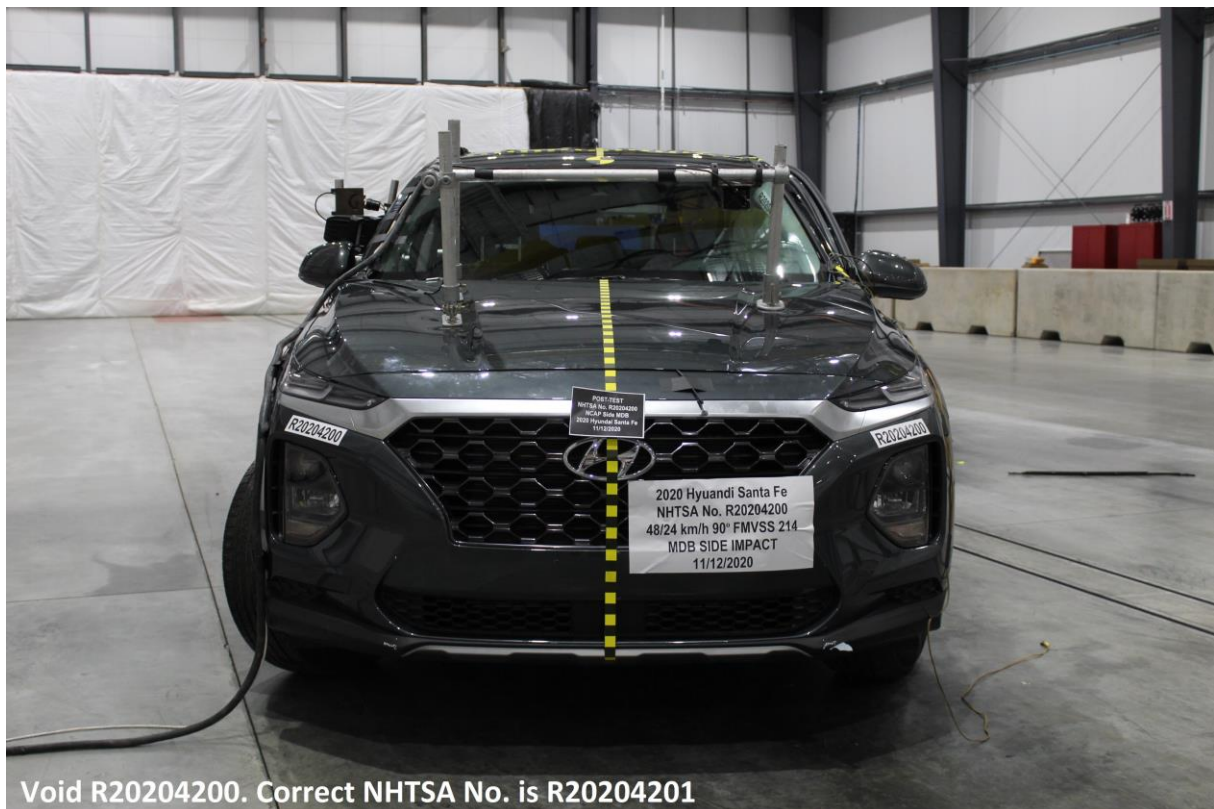


Figure A-4: Post-Test Frontal View of Test Vehicle



Void R20204200. Correct NHTSA No. is R20204201

Figure A-5: Pre-Test Left Front $\frac{3}{4}$ View of Test Vehicle



Void R20204200. Correct NHTSA No. is R20204201

Figure A-6: Post-Test Left Front $\frac{3}{4}$ View of Test Vehicle



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

Figure A-9: Pre-Test Left Rear $\frac{3}{4}$ View of Test Vehicle



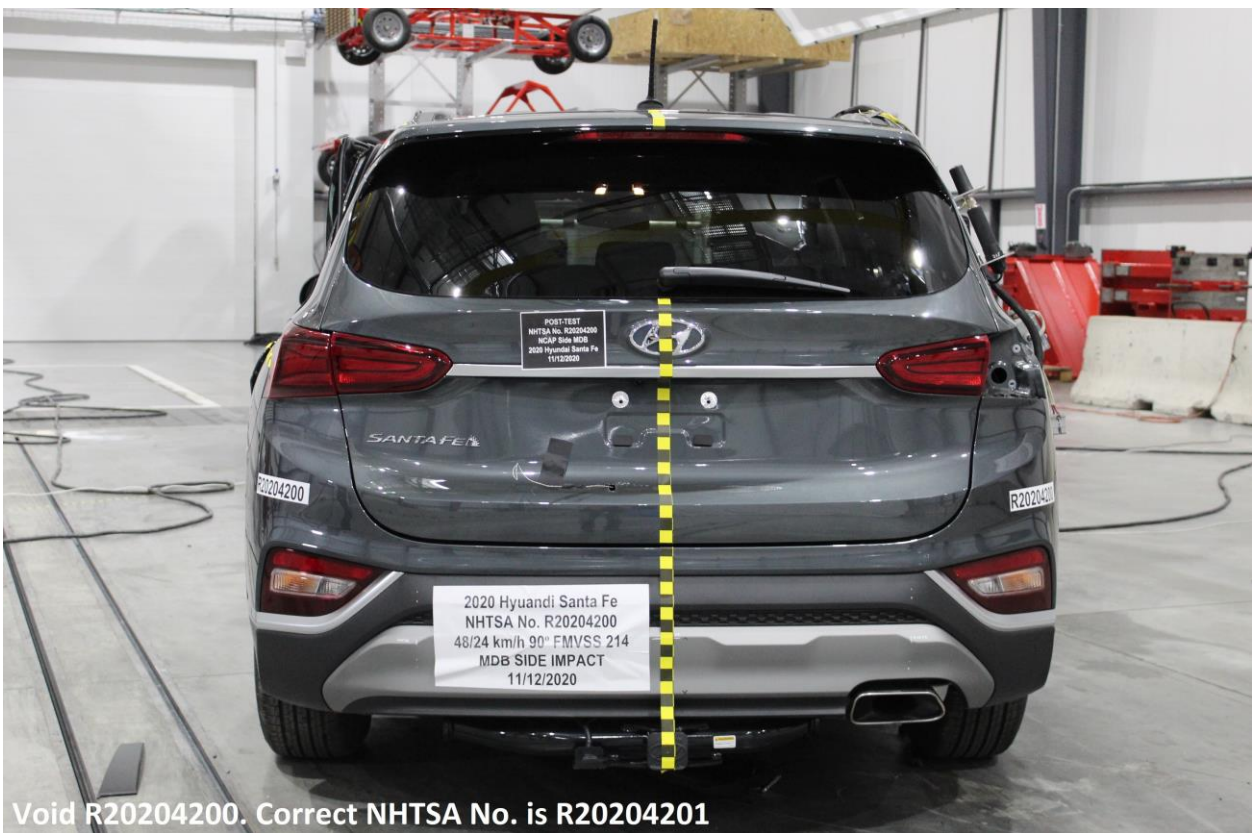
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Figure A-10: Post-Test Left Rear $\frac{3}{4}$ View of Test Vehicle



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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

Void R20204200. Correct NHTSA No. is R20204201



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

Void R20204200. Correct NHTSA No. is R20204201



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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



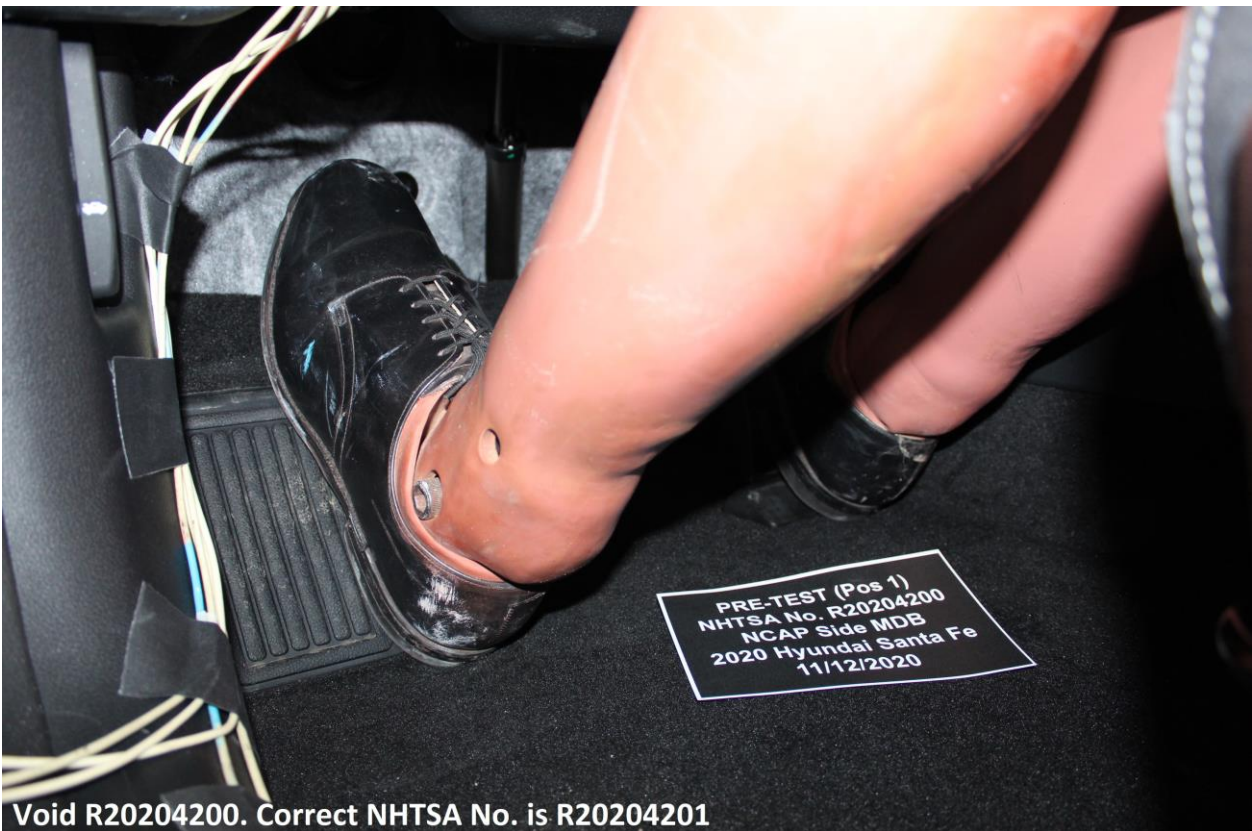
Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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

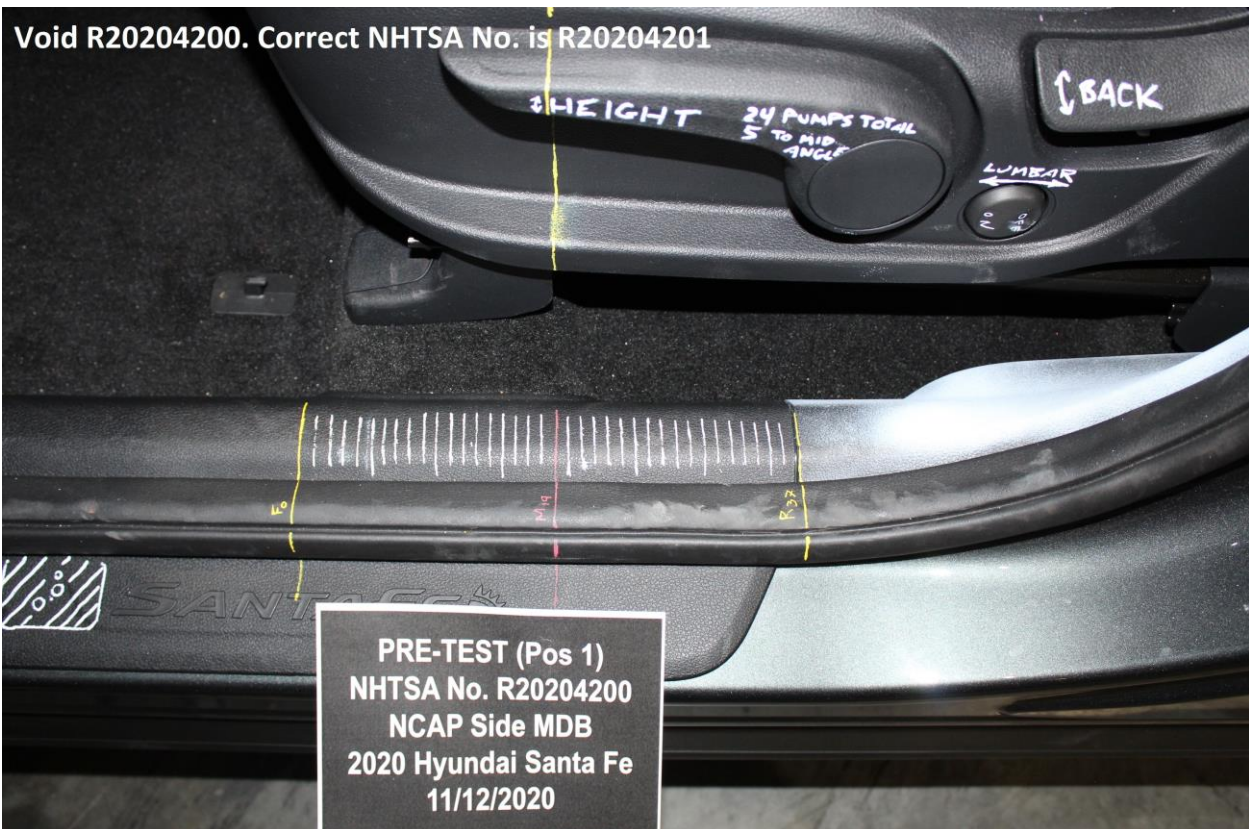


Figure A-39: Pre-test Close-Up Left Side View of Driver Seat Track

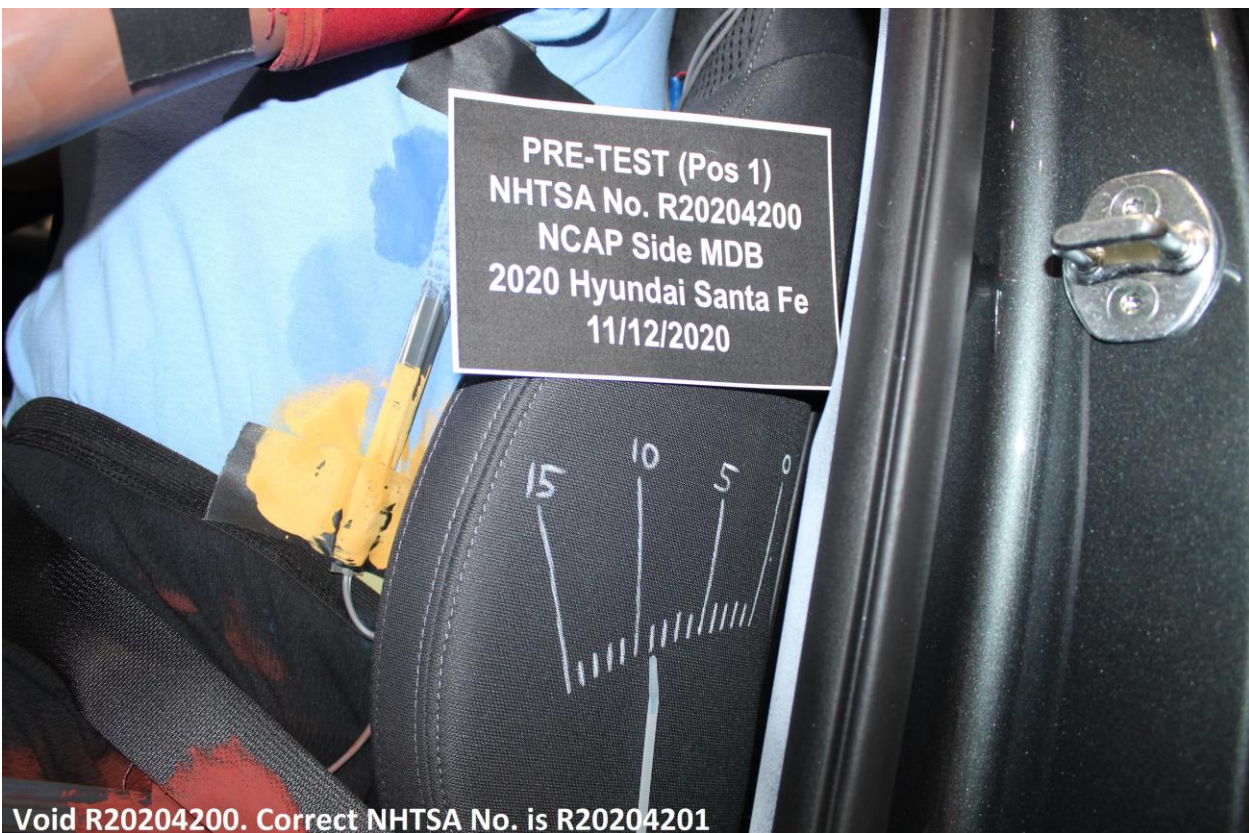


Figure A-40: Pre-Test Close-Up Left Side View of Driver Seat Back



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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Figure A-47: Post-Test Driver Inner Door Panel View Showing Driver Dummy Contact Locations



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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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

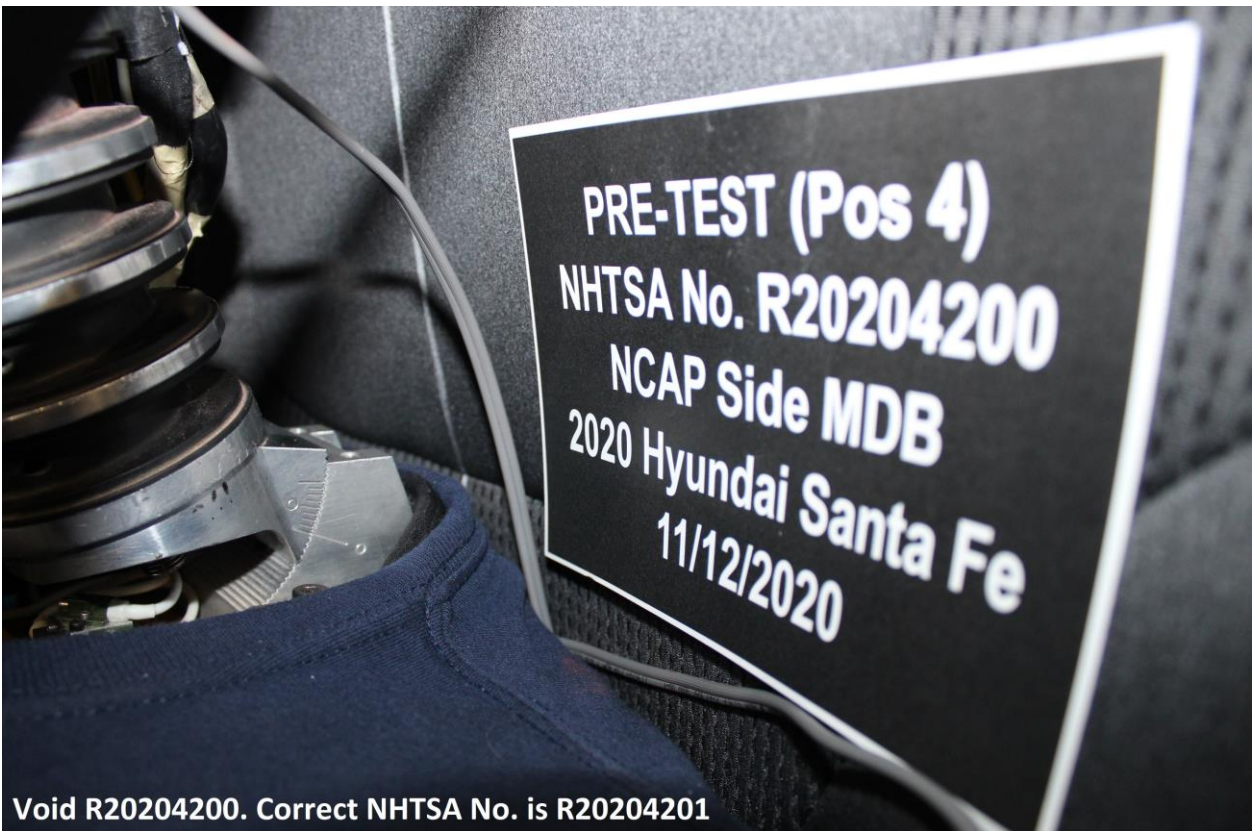


Figure A-60: Pre-Test Overhead View of Rear Passenger Seat Pan Prior to Dummy Positioning



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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

Void R20204200. Correct NHTSA No. is R20204201

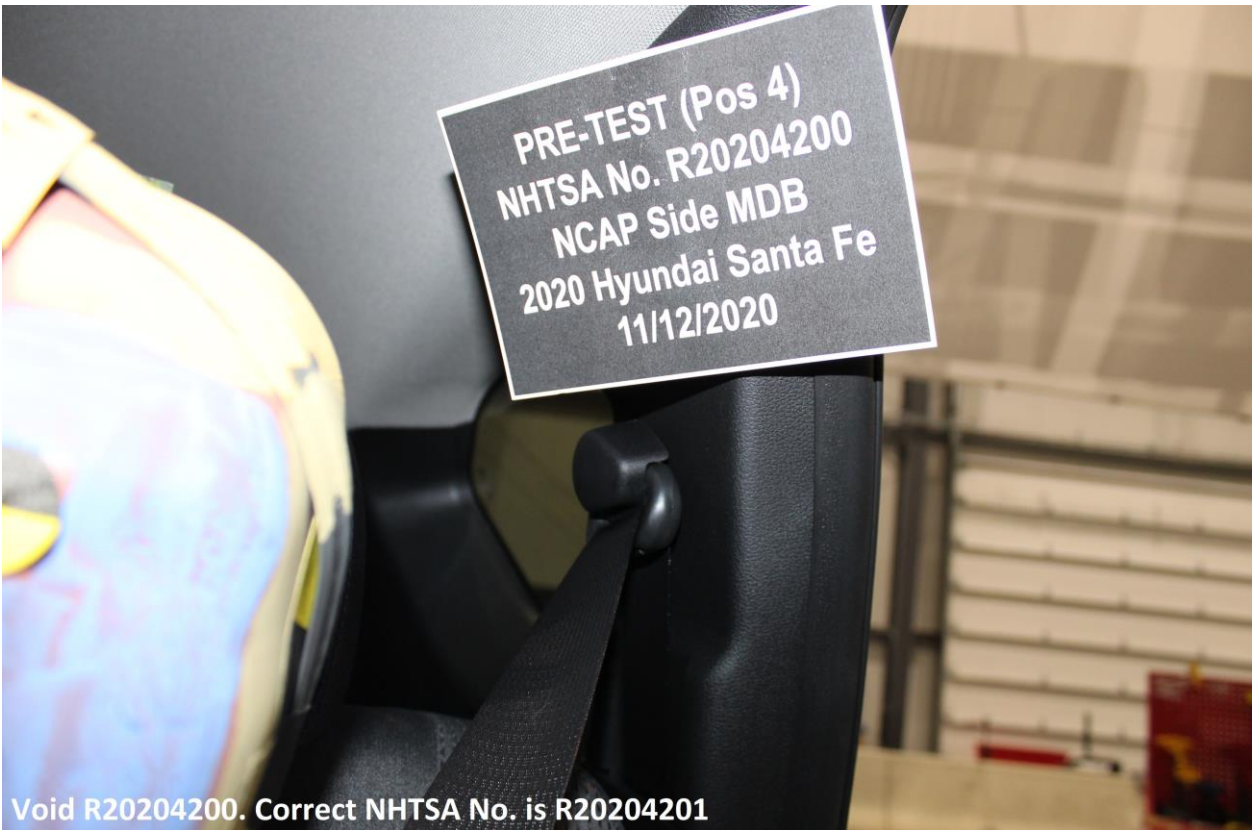


Figure A-63: Pre-Test View of Rear Passenger Dummy's Head Showing Dummy's Head is Level

Void R20204200. Correct NHTSA No. is R20204201



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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No. is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



Void R20204200. Correct NHTSA No is R20204201

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



R20204201

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

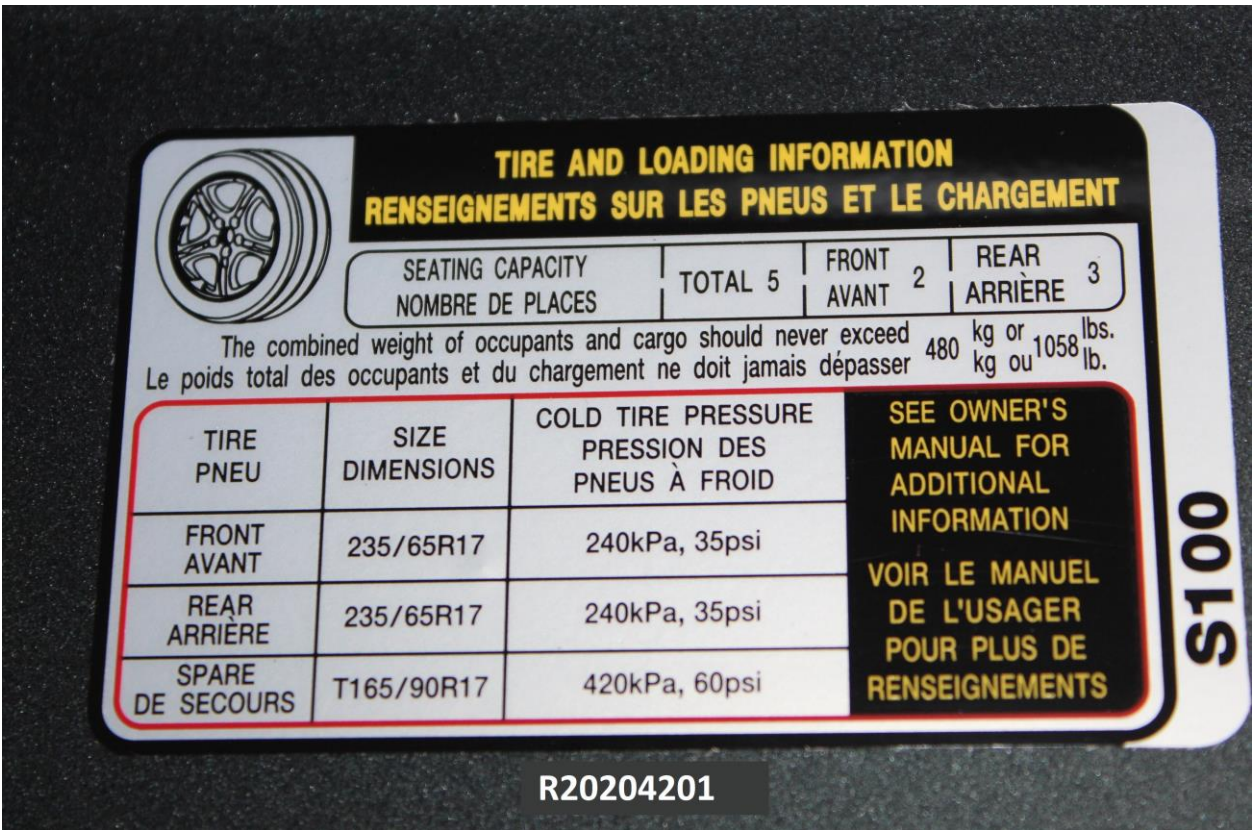


Figure A-93: Close-Up View of Vehicle's Tire Information Placard or Label

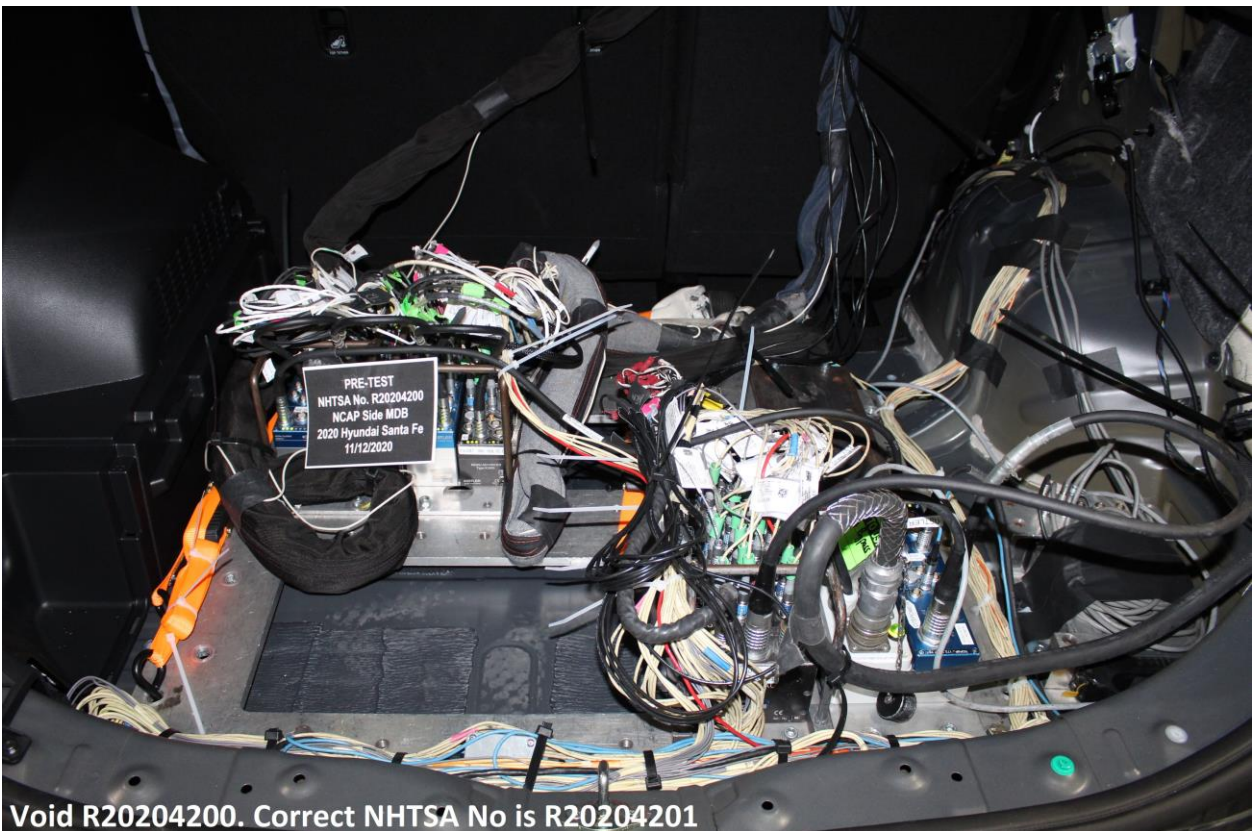


Figure A-94: Pre-Test Ballast View

Void R20204200. Correct NHTSA No is R20204201



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

Photo Not Applicable

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

Photo Not Applicable

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

Photo Not Applicable

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

Photo Not Applicable

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

Photo Not Applicable

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



Void R20204200. Correct NHTSA No is R20204201

Figure A-101: Impact Event

HYUNDAI

2020 SANTA FE SE 2.4 FWD

EPA DOT

SOLD TO: W1034
RACINE HYUNDAI
13013 WASHINGTON AVE
MOUNT PLEASANT WI 53177

SHIPPED TO: W1034

VIN: SNMS23AD2LH255369
MODEL: 64412F45
ENGINE: G4KJL059484
PORT OF ENTRY: MA
EXTERIOR COLOR: RAINFOREST
INTERIOR/SEAT COLOR: BLACK/BLACK
TRANSPORT: TRUCK
ACCESSORY WEIGHT: 72 lbs./ 33 kgs.
EMISSIONS: This vehicle is certified to meet emission requirements in all 50 states

GOVERNMENT 5-STAR SAFETY RATINGS

This vehicle has not been rated by the government for overall vehicle score, frontal crash, side crash or rollover risk.

Source: National Highway Traffic Safety Administration (NHTSA).
www.safercar.gov or 1-888-327-4236

Fuel Economy and Environment

Fuel Economy

25 MPG
combined city/hwy

22 MPG
city

29 MPG
highway

4.0 gallons per 100 miles

You spend \$500 more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost \$1,600

Fuel Economy & Greenhouse Gas Rating (smaller is better)

5 (Best)

Smog Rating (smaller is better)

5 (Best)

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs \$7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at \$2.79 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fuel economy.gov
Calculate personalized estimates and compare vehicles

STANDARD FEATURES:

AMERICA'S BEST WARRANTY:

- 5-year/50,000-mile New Vehicle Warranty*
- 10-year/100,000-mile Powertrain Warranty*
- 7-year/Unlimited-mile A/C performance Warranty*
- 5-year/Unlimited-mile Roadside Assistance
- *limited warranties, see dealer for details

ADVANCED SAFETY TECHNOLOGY

- Forward Collision-Avoidance Assist
- High Beam Assist: Rear Occupant Alert
- Lane Keeping Assist: Driver Attention Warning
- Smart Cruise Control with Stop & Go
- Rear View Monitor

POWERTRAIN TECHNOLOGY

- 2.4L Gasoline Direct Injection (GDI) 4-Cylinder Engine
- 8-speed Automatic Transmission with SHIFTRONIC®
- Electronic Parking Brake: Hillstart Assist Control (HSA) & Go (HSA)

EXTERIOR

- 17" Alloy Wheels and 235/65R17 Tires
- LED Daytime Running Lights and Accent Lights
- Automatic Headlights and Chrome Accent Front Grille
- Solar Front Glass & Privacy Rear Glass
- Variable Intermittent Front Windshield Wipers
- Acoustic Laminated Windshield

COMFORT & CONVENIENCE

- Keyless Entry System with Illuminated Ignition
- Cloth Seats
- 6-way Manual Driver Seat plus 2-way lumbar support
- 60/40 Split 2nd Row Fold-flat Seats with Recline
- Power Doors and Windows with Driver's Auto-Down-Up
- Air Conditioning with Cabin Air Filter and Rear Air Vents
- Tilt & Telescoping Steering Wheel w/ Audio/Cruise/Phone Ctrls
- Illuminated Vanity Mirrors with Extensions
- Cargo Area Underfloor Storage
- 7" Display Audio with Android Auto (TM) & Apple CarPlay (TM)
- AM/FM/MP3 Audio System: 12V Power Outlets
- Dual Front and Rear USB Outlets (1x Power/Data, 3x Power)
- Bluetooth® Hands-free with Wireless Audio Streaming
- Multi-information Display
- Full Tank of Fuel

ADDED FEATURES:

- Cargo Net
- Cargo Tray
- Cargo Cover
- First Aid Kit
- Tire Hitch
- All Season Floor Liners

Manufacturer's Suggested Retail Price: **\$26,275.00**

Inland Freight & Handling: **\$1,140.00**

Total Price: \$28,410.00

PARTS CONTENT INFORMATION

FOR VEHICLE IN THIS CARLINE:

U.S./CANADIAN PARTS CONTENT: 35 %

MAJOR SOURCES OF FOREIGN PARTS CONTENT: KOREA: 54 %

Note: Parts content does not include final assembly, distribution, or other non-parts costs.

FOR THIS VEHICLE:

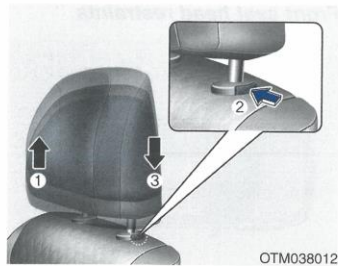
FINAL ASSEMBLY POINT: MONTGOMERY, ALABAMA U.S.A.

COUNTRY OF ORIGIN:

ENGINE: U.S.A.

TRANSMISSION: U.S.A.

Figure A-102: Monroney Label



OTM038012

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:

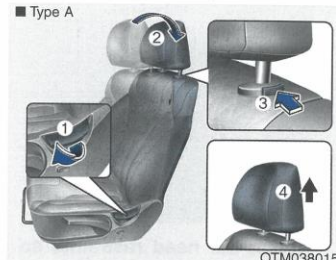
1. Push and hold the release button (2) on the head restraint support.
2. Lower the head restraint to the desired position (3).



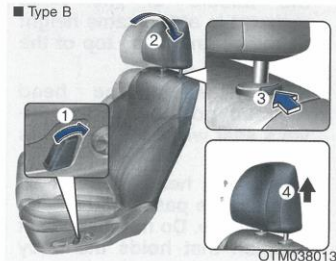
OLF034015

NOTICE

If you recline the seatback towards the front with the head restraint and seat cushion raised, the head restraint may come in contact with the sunvisor or other parts of the vehicle.



OTM038015



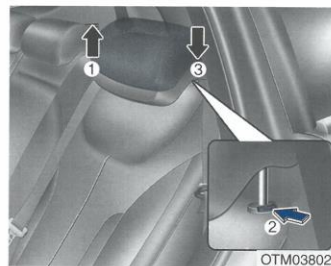
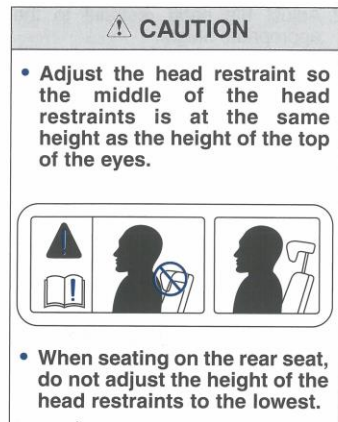
OTM038013

Removal/Reinstallation

To remove the head restraint:

1. Recline the seatback (2) rearward using the seatback angle lever/switch (1).

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



OTM038023

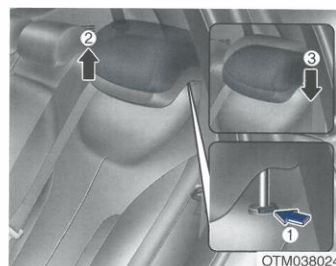
Adjusting the height up and down

To raise the head restraint:

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

To lower the head restraint:

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



OTM038024

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 the head restraint up (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-Rear Restraints Not Adjustable

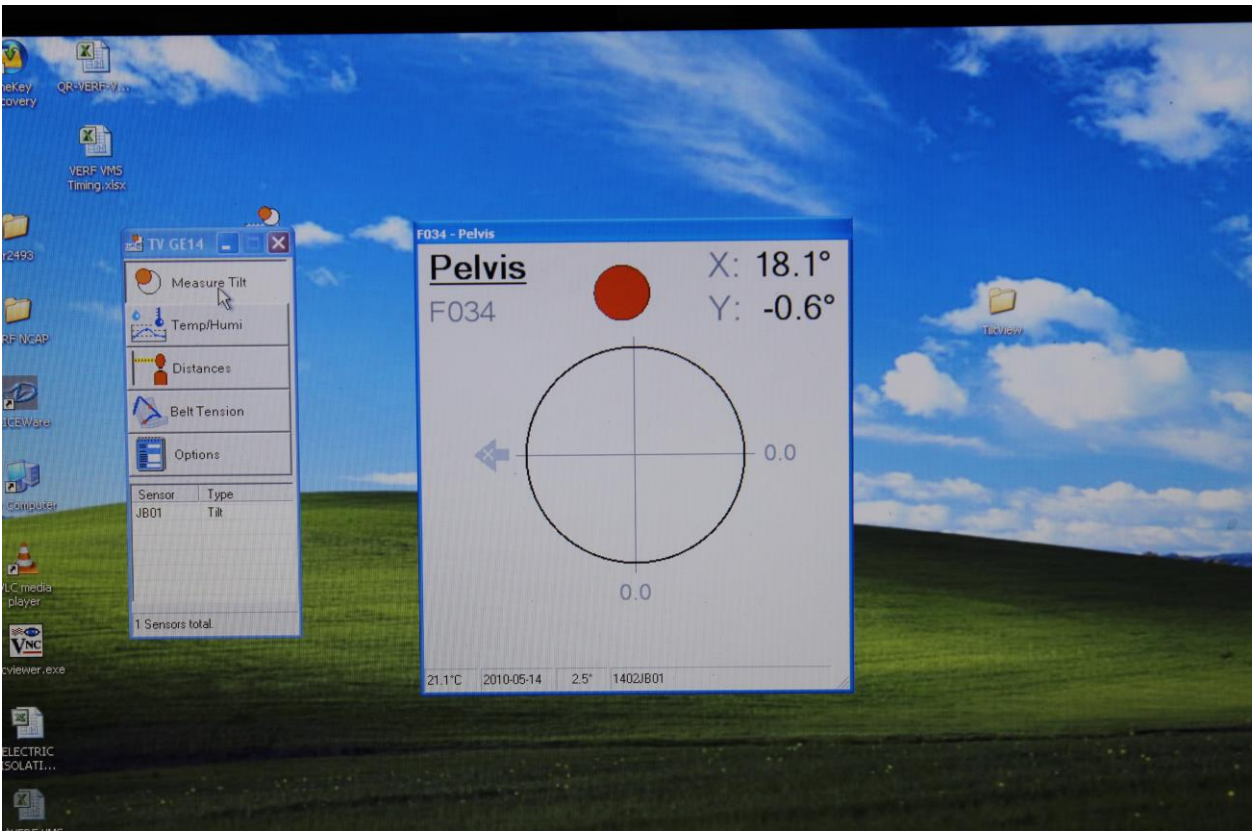


Figure A-105: Pre-Test Head Tilt Sensor View for ES-2re

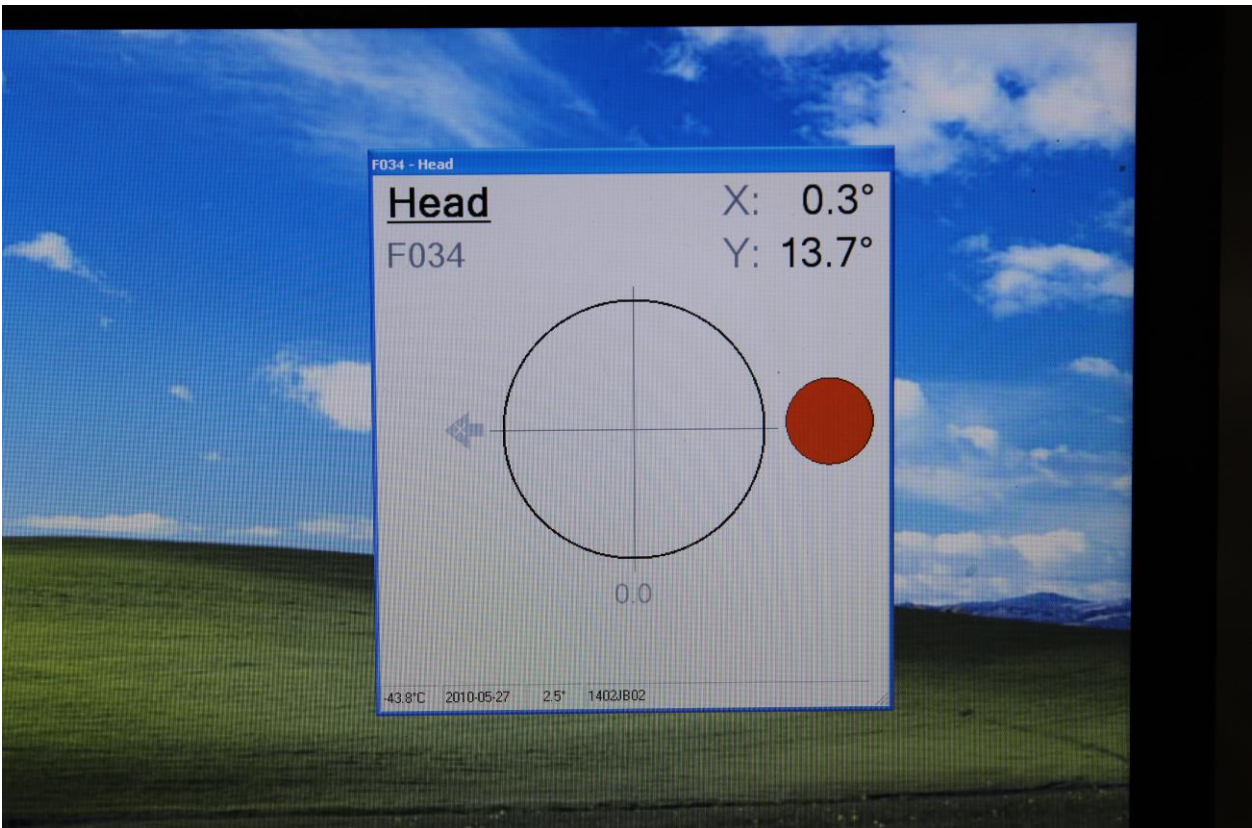


Figure A-106: Pre-Test Pelvis Tilt Sensor View for ES-2re

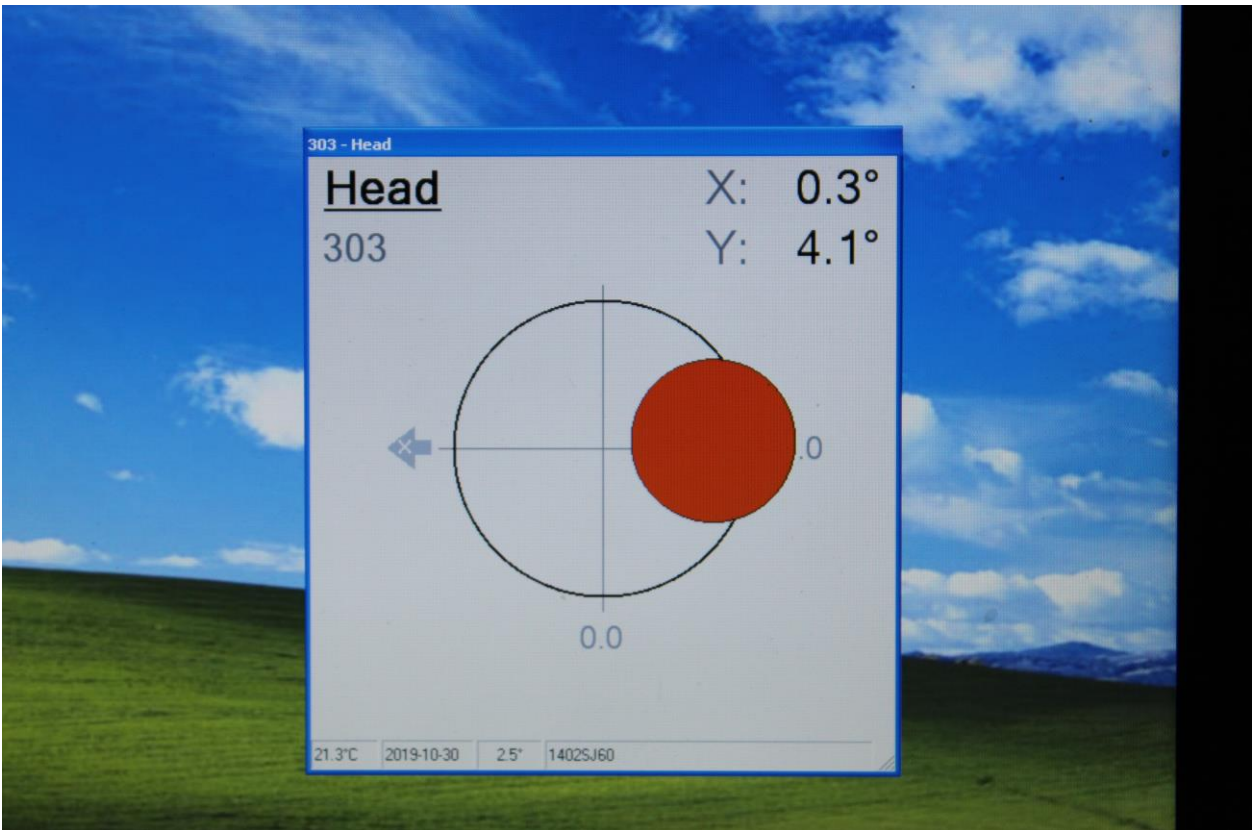


Figure A-107: Pre-Test Head Tilt Sensor View for SID-IIs

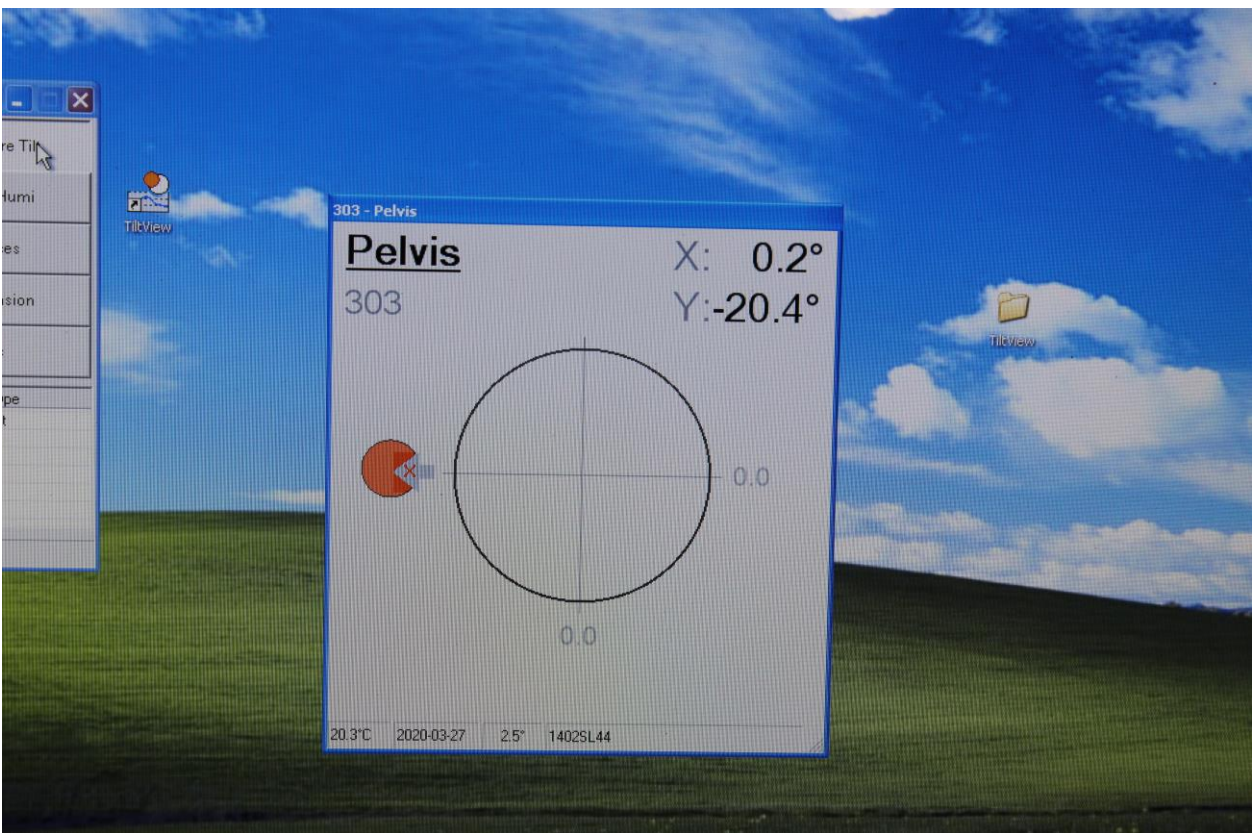


Figure A-108: Pre-Test Pelvis Tilt Sensor View for SID-IIs

Data Traces
VEHICLE & DUMMY RESPONSE DATA TRACES

Table of Data Plots

No.	Description	Page
1	ES-2re Head (X) Acceleration vs. Time	B-6
2	ES-2re Head (Y) Acceleration vs. Time	B-6
3	ES-2re Head (Z) Acceleration vs. Time	B-6
4	ES-2re Head Resultant Acceleration vs. Time	B-6
5	ES-2re Head (X) Redundant Acceleration vs. Time	B-7
6	ES-2re Head (Y) Redundant Acceleration vs. Time	B-7
7	ES-2re Head (Z) Redundant Acceleration vs. Time	B-7
8	ES-2re Head Resultant Redundant Acceleration vs. Time	B-7
9	ES-2re Head (X) Angular Velocity vs. Time	B-8
10	ES-2re Head (Y) Angular Velocity vs. Time	B-8
11	ES-2re Head (Z) Angular Velocity vs. Time	B-8
12	ES-2re Head Resultant Angular Velocity vs. Time	B-8
13	ES-2re Neck (X) Force vs. Time	B-9
14	ES-2re Neck (Y) Force vs. Time	B-9
15	ES-2re Neck (Z) Force vs. Time	B-9
16	ES-2re Neck Resultant Force vs. Time	B-9
17	ES-2re Neck (X) Moment vs. Time	B-10
18	ES-2re Neck (Y) Moment vs. Time	B-10
19	ES-2re Neck (Z) Moment vs. Time	B-10
20	ES-2re Neck Resultant Moment vs. Time	B-10
21	ES-2re Shoulder (X) Force vs. Time	B-11
22	ES-2re Shoulder (Y) Force vs. Time	B-11
23	ES-2re Shoulder (Z) Force vs. Time	B-11
24	ES-2re Shoulder Resultant Force vs. Time	B-11
25	ES-2re Upper Spine (T1) Acceleration (X) vs. Time	B-12
26	ES-2re Upper Spine (T1) Acceleration (Y) vs. Time	B-12
27	ES-2re Upper Spine (T1) Acceleration (Z) vs. Time	B-12
28	ES-2re Upper Spine (T1) Resultant Acceleration vs. Time	B-12
29	ES-2re Lower Spine (T12) Acceleration (X) vs. Time	B-13
30	ES-2re Lower Spine (T12) Acceleration (Y) vs. Time	B-13
31	ES-2re Lower Spine (T12) Acceleration (Z) vs. Time	B-13
32	ES-2re Lower Spine (T12) Resultant Acceleration vs. Time	B-13
33	ES-2re Lower Spine (T12) Force (X) vs. Time	B-14
34	ES-2re Lower Spine (T12) Force (Y) vs. Time	B-14
35	ES-2re Lower Spine (T12) Moment (X) vs. Time	B-14
36	ES-2re Lower Spine (T12) Moment (Y) vs. Time	B-14
37	ES-2re Upper Thorax Rib Deflection (Y) vs. Time	B-15
38	ES-2re Middle Thorax Rib Deflection (Y) vs. Time	B-15
39	ES-2re Lower Thorax Rib Deflection (Y) vs. Time	B-15
40	ES-2re Upper Thorax Rib Deflection Rate vs. Time	B-15
41	ES-2re Middle Thorax Rib Deflection Rate vs. Time	B-16
42	ES-2re Lower Thorax Rib Deflection Rate vs. Time	B-16
43	ES-2re Front Abdomen Force (Y) vs. Time	B-16
44	ES-2re Middle Abdomen Force (Y) vs. Time	B-16
45	ES-2re Rear Abdomen Force (Y) vs. Time	B-17
46	ES-2re Sum of Abdomen Forces vs. Time	B-17
47	ES-2re Lumbar (Y) Force vs. Time	B-17
48	ES-2re Lumbar (Z) Force vs. Time	B-17
49	ES-2re Lumbar (X) Moment vs. Time	B-18
50	ES-2re Pubic Symphysis Force (Y) vs. Time	B-18
51	ES-2re Pelvic (X) Acceleration vs. Time	B-18
52	ES-2re Pelvic (Y) Acceleration vs. Time	B-18

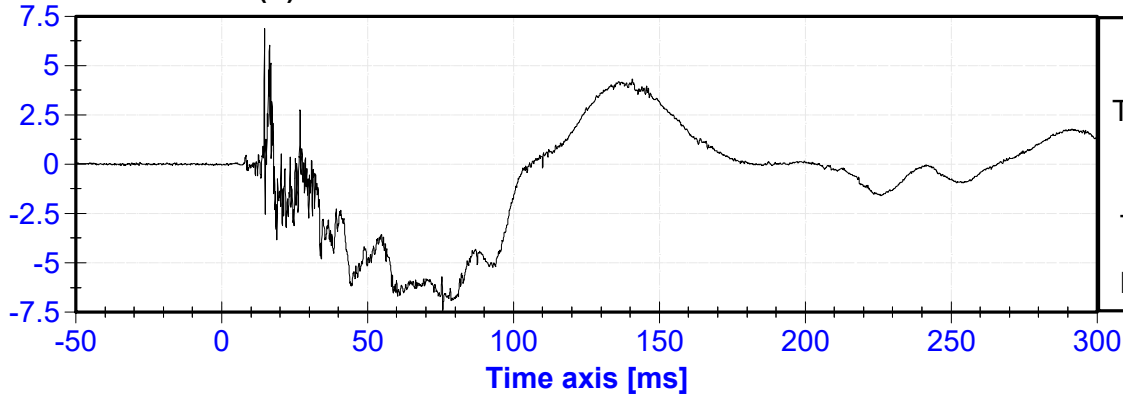
53	ES-2re Pelvic (Z) Acceleration vs. Time	B-19
54	ES-2re Pelvic Resultant Acceleration vs. Time	B-19
55	ES-2re Head Contact vs. Time	B-19
56	ES-2re Shoulder Contact vs. Time	B-19
57	ES-2re Thorax Contact vs. Time	B-20
58	ES-2re Pelvis Contact vs. Time	B-20
59	SID-IIs Head (X) Acceleration vs. Time	B-20
60	SID-IIs Head (Y) Acceleration vs. Time	B-20
61	SID-IIs Head (Z) Acceleration vs. Time	B-21
62	SID-IIs Head Resultant Acceleration vs. Time	B-21
63	SID-IIs Head (X) Redundant Acceleration vs. Time	B-21
64	SID-IIs Head (Y) Redundant Acceleration vs. Time	B-21
65	SID-IIs Head (Z) Redundant Acceleration vs. Time	B-22
66	SID-IIs Head Resultant Redundant Acceleration vs. Time	B-22
67	SID-IIs Head (X) Angular Velocity vs. Time	B-22
68	SID-IIs Head (Y) Angular Velocity vs. Time	B-22
69	SID-IIs Head (Z) Angular Velocity vs. Time	B-23
70	SID-IIs Head Resultant Angular Velocity vs. Time	B-23
71	SID-IIs Neck (X) Force vs. Time	B-23
72	SID-IIs Neck (Y) Force vs. Time	B-23
73	SID-IIs Neck (Z) Force vs. Time	B-24
74	SID-IIs Neck Resultant Force vs. Time	B-24
75	SID-IIs Neck (X) Moment vs. Time	B-24
76	SID-IIs Neck (Y) Moment vs. Time	B-24
77	SID-IIs Neck (Z) Moment vs. Time	B-25
78	SID-IIs Neck Resultant Moment vs. Time	B-25
79	SID-IIs Shoulder (X) Force vs. Time	B-25
80	SID-IIs Shoulder (Y) Force vs. Time	B-25
81	SID-IIs Shoulder (Z) Force vs. Time	B-26
82	SID-IIs Shoulder Resultant Force vs. Time	B-26
83	SID-IIs Upper Spine (T1) Acceleration (X) vs. Time	B-26
84	SID-IIs Upper Spine (T1) Acceleration (Y) vs. Time	B-26
85	SID-IIs Upper Spine (T1) Acceleration (Z) vs. Time	B-27
86	SID-IIs Upper Spine (T1) Resultant Acceleration vs. Time	B-27
87	SID-IIs Lower Spine (T12) Acceleration (X) vs. Time	B-27
88	SID-IIs Lower Spine (T12) Acceleration (Y) vs. Time	B-27
89	SID-IIs Lower Spine (T12) Acceleration (Z) vs. Time	B-28
90	SID-IIs Lower Spine (T12) Resultant Acceleration vs. Time	B-28
91	SID-IIs Shoulder Rib Deflection (Y) vs. Time	B-28
92	SID-IIs Upper Thorax Rib Deflection (Y) vs. Time	B-28
93	SID-IIs Middle Thorax Rib Deflection (Y) vs. Time	B-29
94	SID-IIs Lower Thorax Rib Deflection (Y) vs. Time	B-29
95	SID-IIs Abdomen Upper Rib Deflection (Y) vs. Time	B-29
96	SID-IIs Abdomen Lower Rib Deflection (Y) vs. Time	B-29
97	SID-IIs Acetabulum Force vs. Time	B-30
98	SID-IIs Iliac Force vs. Time	B-30
99	SID-IIs Sum of Iliac and Acetabulum Forces vs. Time	B-30
100	SID-IIs Lumbar (X) Force vs. Time	B-30
101	SID-IIs Lumbar (Y) Force vs. Time	B-31
102	SID-IIs Lumbar (Z) Force vs. Time	B-31
103	SID-IIs Lumbar Resultant Force vs. Time	B-31
104	SID-IIs Lumbar (X) Moment vs. Time	B-31

105	SID-IIs Lumbar (Y) Moment vs. Time	B-32
106	SID-IIs Lumbar (Z) Moment vs. Time	B-32
107	SID-IIs Lumbar Resultant Moment vs. Time	B-32
108	SID-IIs Pubic Symphysis Force (Y) vs. Time	B-32
109	SID-IIs Pelvic (X) Acceleration vs. Time	B-33
110	SID-IIs Pelvic (Y) Acceleration vs. Time	B-33
111	SID-IIs Pelvic (Z) Acceleration vs. Time	B-33
112	SID-IIs Pelvic Resultant Acceleration vs. Time	B-33
113	SID-IIs Head Contact vs. Time	B-34
114	SID-IIs Shoulder Contact vs. Time	B-34
115	SID-IIs Thorax Contact vs. Time	B-34
116	SID-IIs Pelvis Contact vs. Time	B-34
117	Vehicle CG (X) Acceleration vs. Time	B-35
118	Vehicle CG (Y) Acceleration vs. Time	B-35
119	Vehicle CG (Z) Acceleration vs. Time	B-35
120	Vehicle CG (X) Angular Velocity vs. Time	B-35
121	Vehicle CG (Y) Angular Velocity vs. Time	B-36
122	Vehicle CG (Z) Angular Velocity vs. Time	B-36
123	Right Sill at Front Seat (X) Acceleration vs. Time	B-36
124	Right Sill at Front Seat (Y) Acceleration vs. Time	B-36
125	Right Sill at Front Seat (Z) Acceleration vs. Time	B-37
126	Right Sill at Rear Seat (X) Acceleration vs. Time	B-37
127	Right Sill at Rear Seat (Y) Acceleration vs. Time	B-37
128	Right Sill at Rear Seat (Z) Acceleration vs. Time	B-37
129	Left Sill at Front Seat (Y) Acceleration vs. Time.	B-38
130	Left Sill at Rear Seat (Y) Acceleration vs. Time	B-38
131	Left A-Pillar Lower (Y) Acceleration vs. Time	B-38
132	Left A-Pillar Middle (Y) Acceleration vs. Time	B-38
133	Left B-Pillar Lower (Y) Acceleration vs. Time	B-39
134	Left B-Pillar Middle (Y) Acceleration vs. Time	B-39
135	Front Seat Track (Y) Acceleration vs. Time	B-39
136	Rear Seat Track or Structure (Y) Acceleration vs. Time	B-39
137	Right Rear Occ. Compartment (Y) Acceleration vs. Time	B-40
138	Engine Block Top (X) Acceleration vs. Time	B-40
139	Engine Block Top (Y) Acceleration vs. Time	B-40
140	Rear Floorpan Above Axle (X) Acceleration vs. Time	B-40
141	Rear Floorpan Above Axle (Y) Acceleration vs. Time	B-41
142	Rear Floorpan Above Axle (Z) Acceleration vs. Time	B-41
143	Rear Deck (X) Acceleration vs. Time	B-41
144	Rear Deck (Y) Acceleration vs. Time	B-41
145	Rear Deck (Z) Acceleration vs. Time	B-42
146	Rear Deck (X) Angular Velocity vs. Time	B-42
147	Rear Deck (Y) Angular Velocity vs. Time	B-42
148	Rear Deck (Z) Angular Velocity vs. Time	B-42
149	Left Front Door Mid Centerline (Y) Acceleration vs. Time	B-43
150	Left Front Door Mid Rear (Y) Acceleration vs. Time	B-43
151	Left Front Door Upper Centerline (Y) Acceleration vs. Time	B-43
152	Left Rear Door Mid Rear (Y) Acceleration vs. Time	B-43
153	Left Rear Door Upper Centerline (Y) Acceleration vs. Time	B-44
154	MDB Center of Gravity (X) Acceleration vs. Time	B-44
155	MDB Center of Gravity (Y) Acceleration vs. Time	B-44
156	MDB Center of Gravity (Z) Acceleration vs. Time	B-44

157	MDB Rear (X) Acceleration vs. Time	B-45
158	MDB Rear (Y) Acceleration vs. Time	B-45
159	Left MDB Contact vs. Time	B-45
160	Right MDB Contact vs. Time	B-45

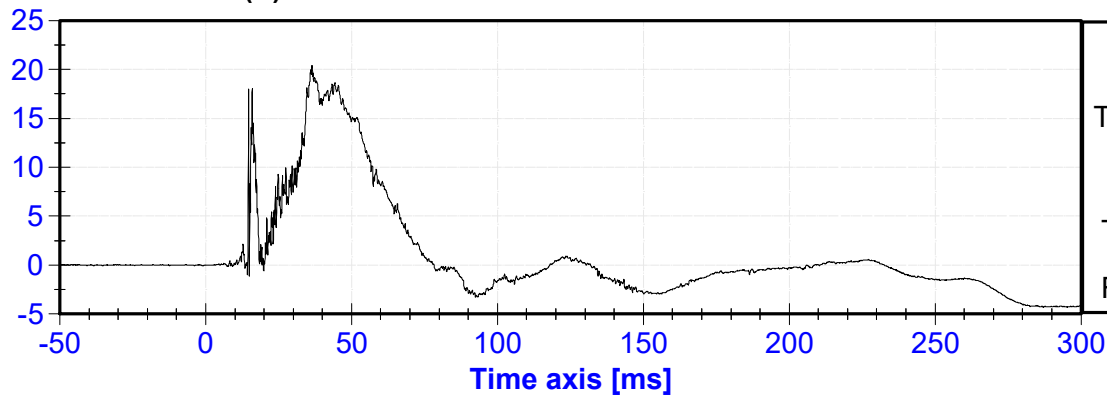
ACCELERATION [g's]

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



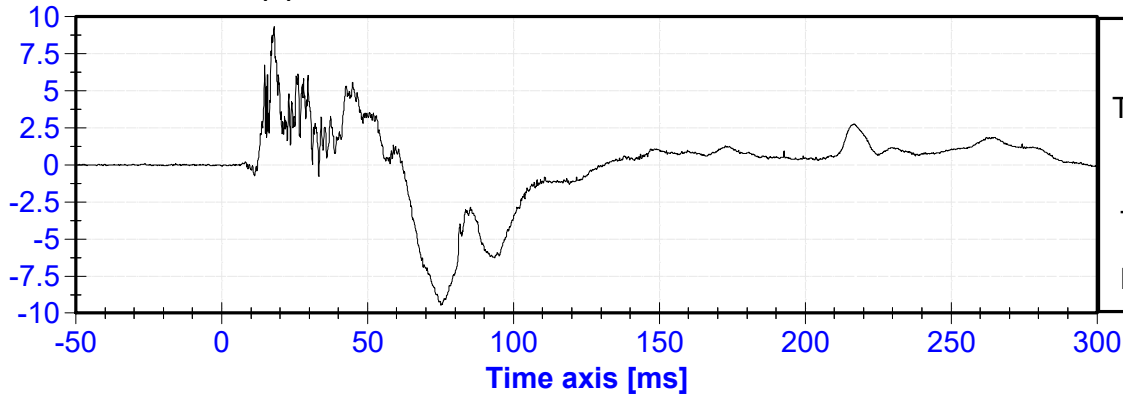
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ES-2re Head (Y) Acceleration vs. Time



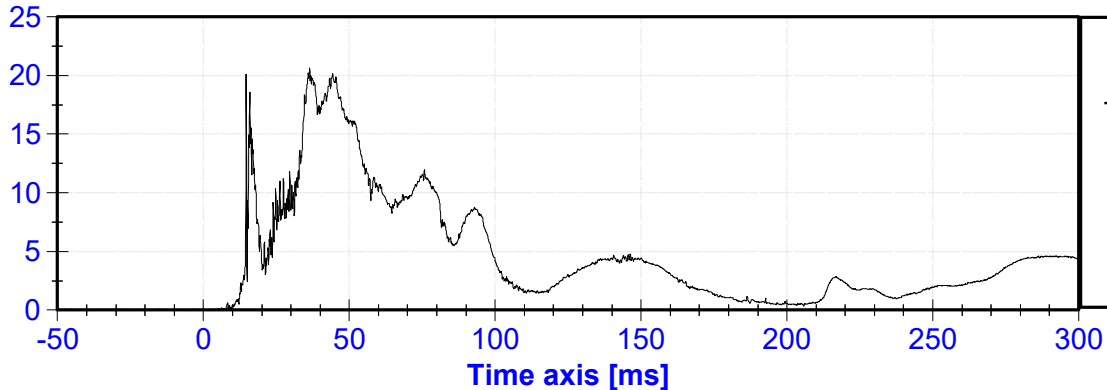
ACCELERATION [g's]

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



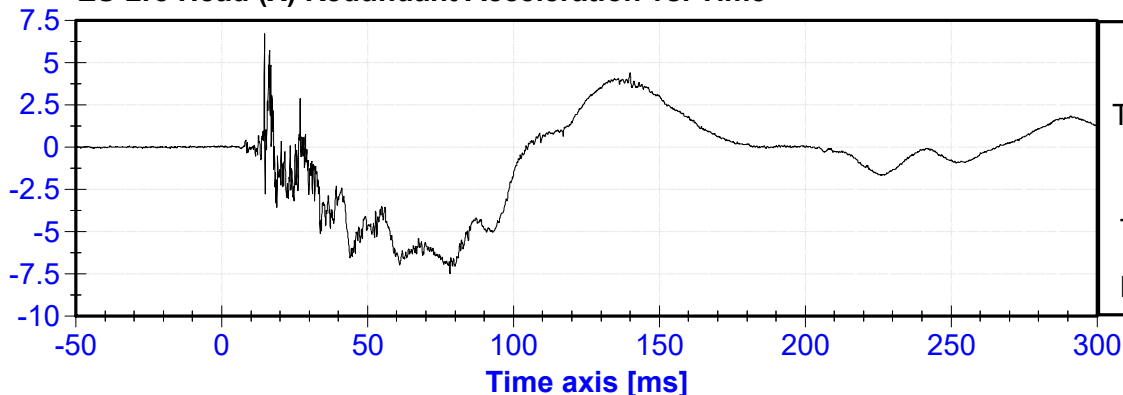
ACCELERATION [g's]

ES-2re Head Resultant Acceleration vs. Time



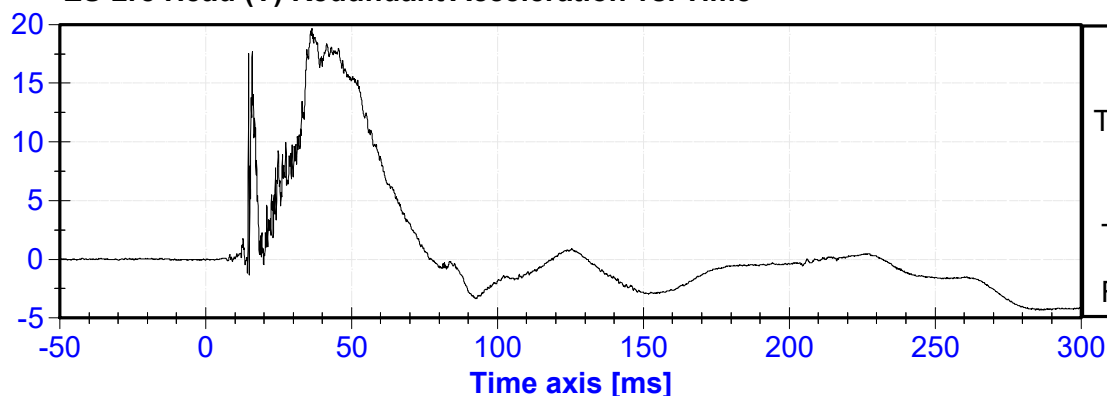
ACCELERATION [g's]

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



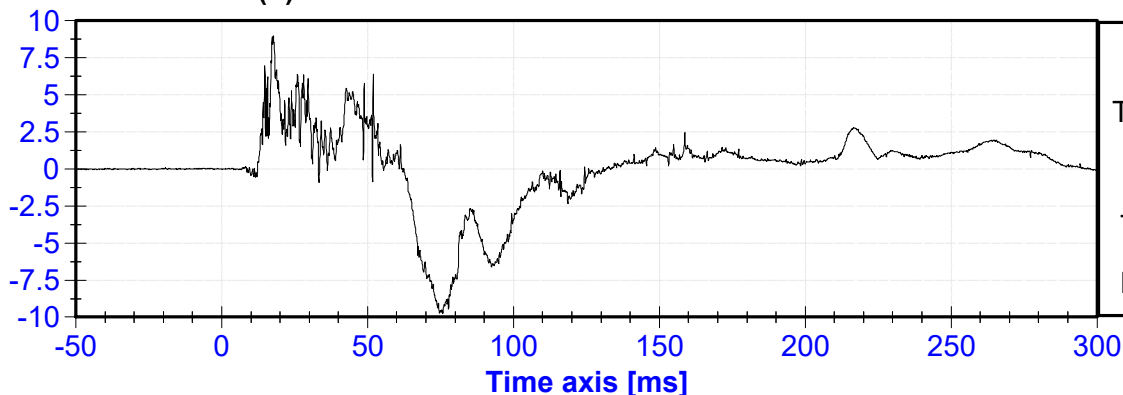
ACCELERATION [g's]

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



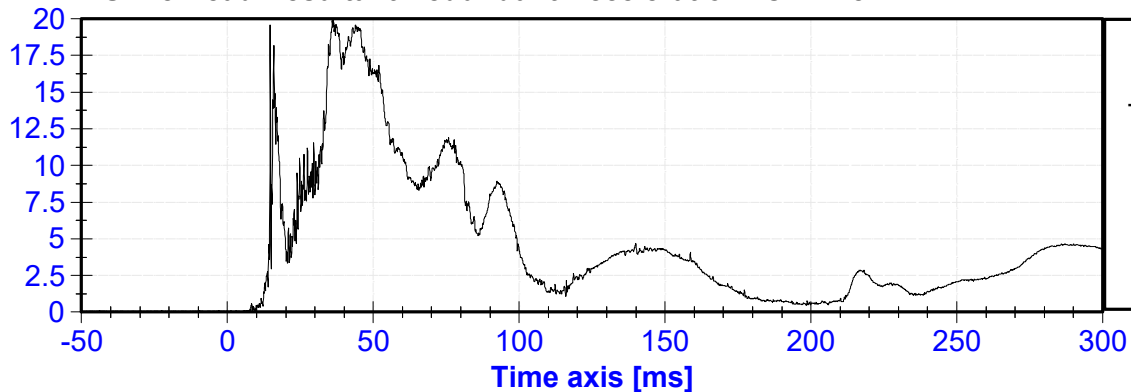
ACCELERATION [G's]

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



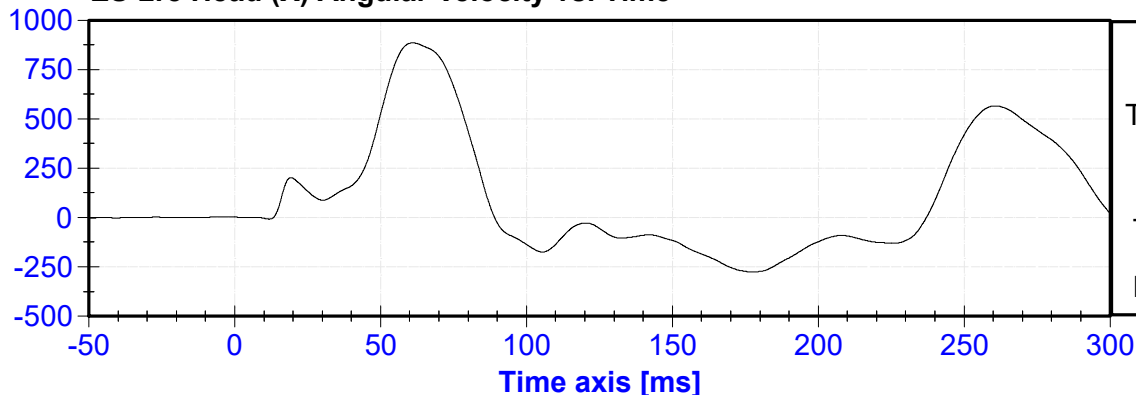
ACCELERATION [g's]

ES-2re Head Resultant Redundant Acceleration vs. Time



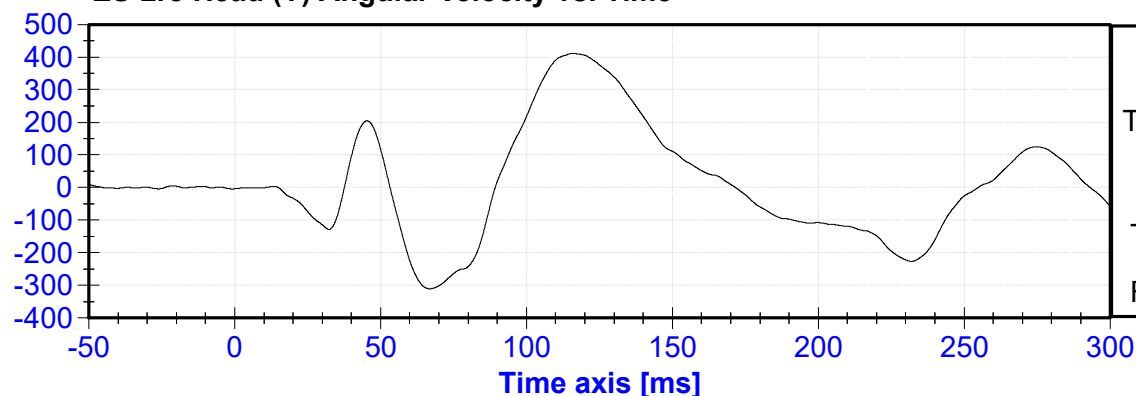
ES-2re Head (X) Angular Velocity vs. Time

ANGULAR VEL [deg/s]



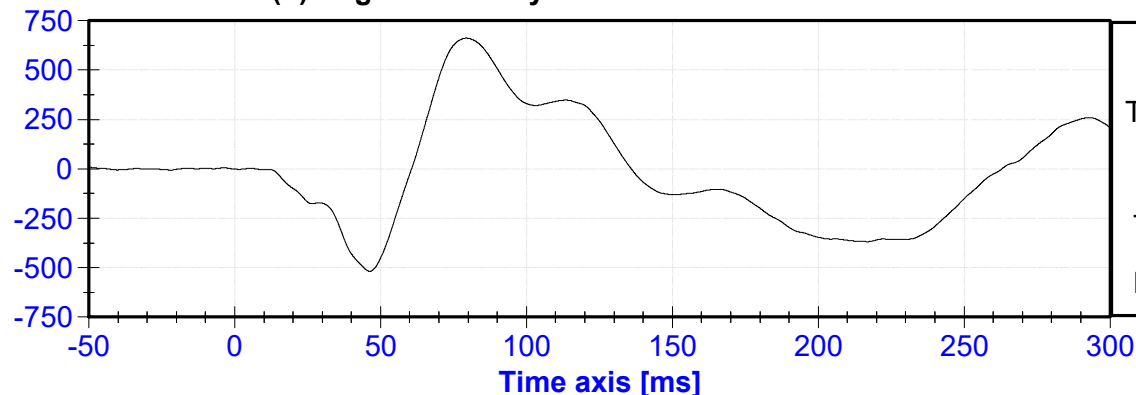
ES-2re Head (Y) Angular Velocity vs. Time

ANGULAR VEL [deg/s]



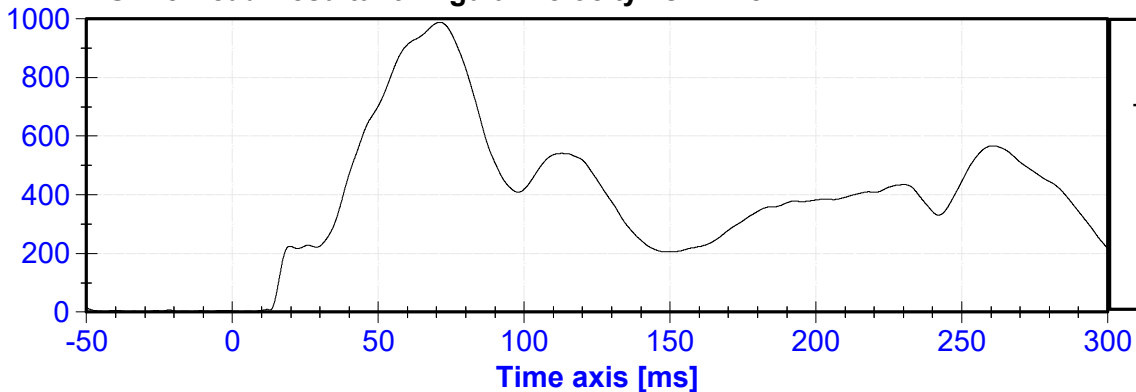
ES-2re Head (Z) Angular Velocity vs. Time

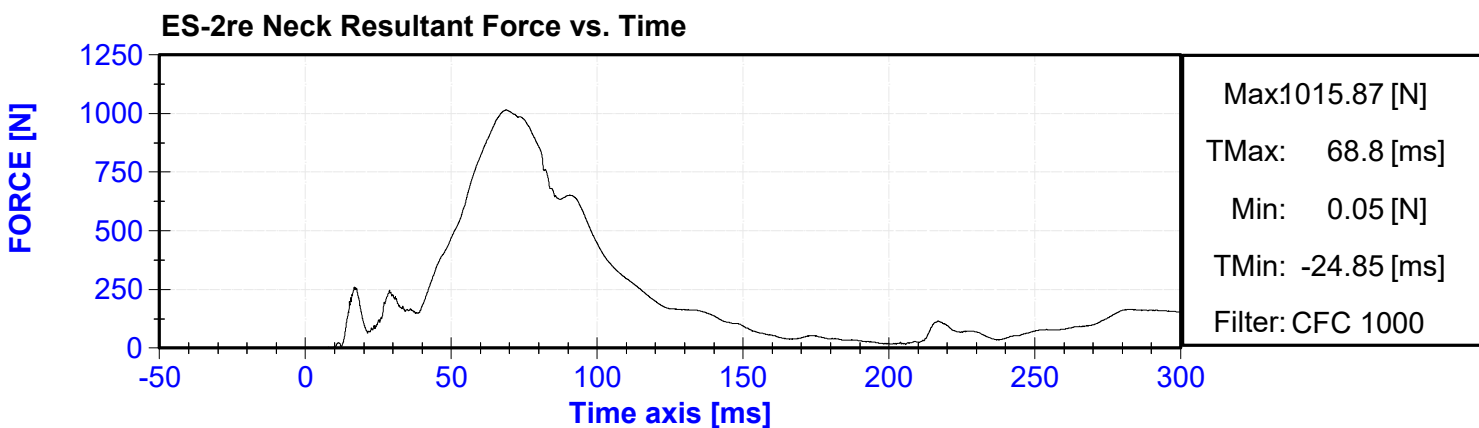
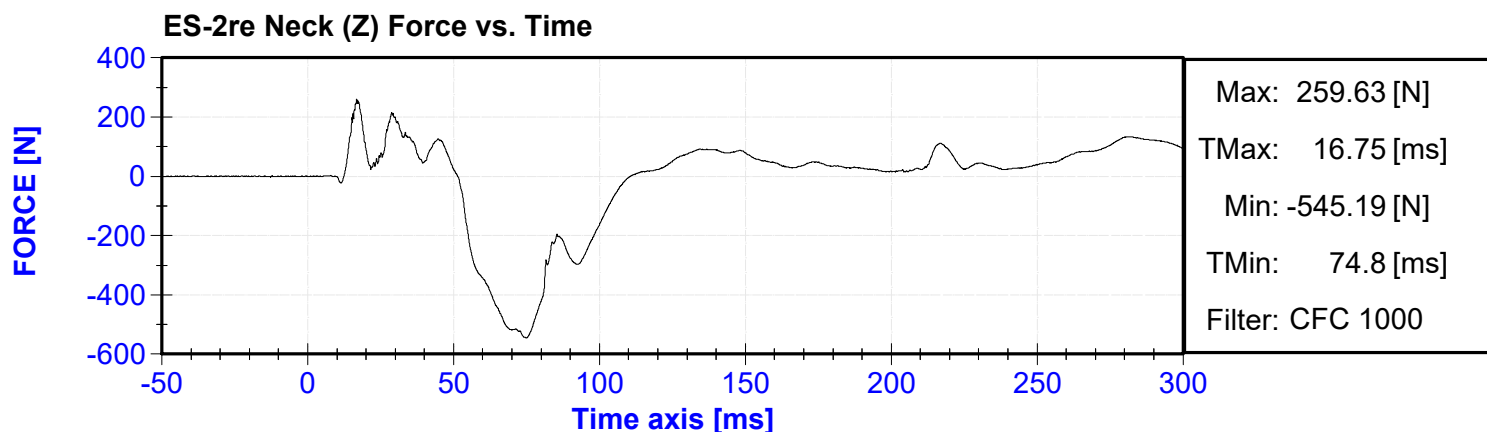
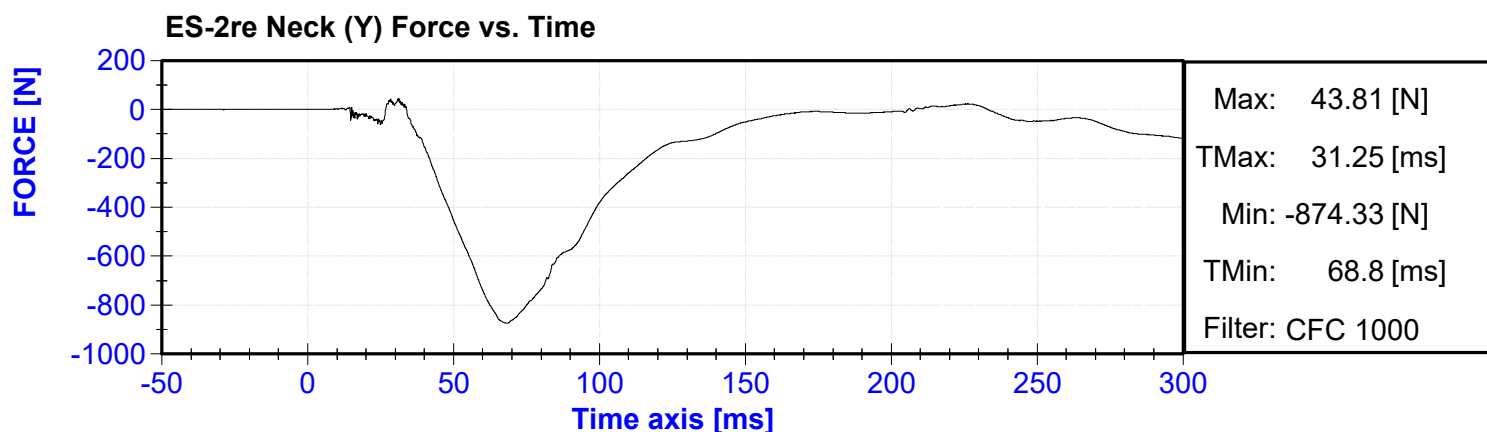
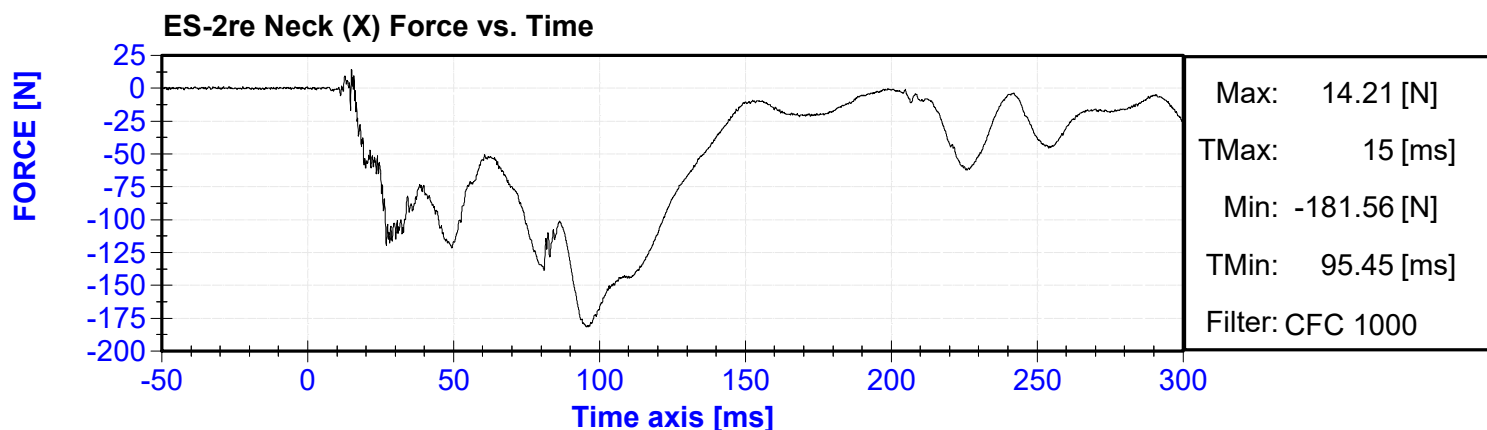
ANGULAR VEL [deg/s]

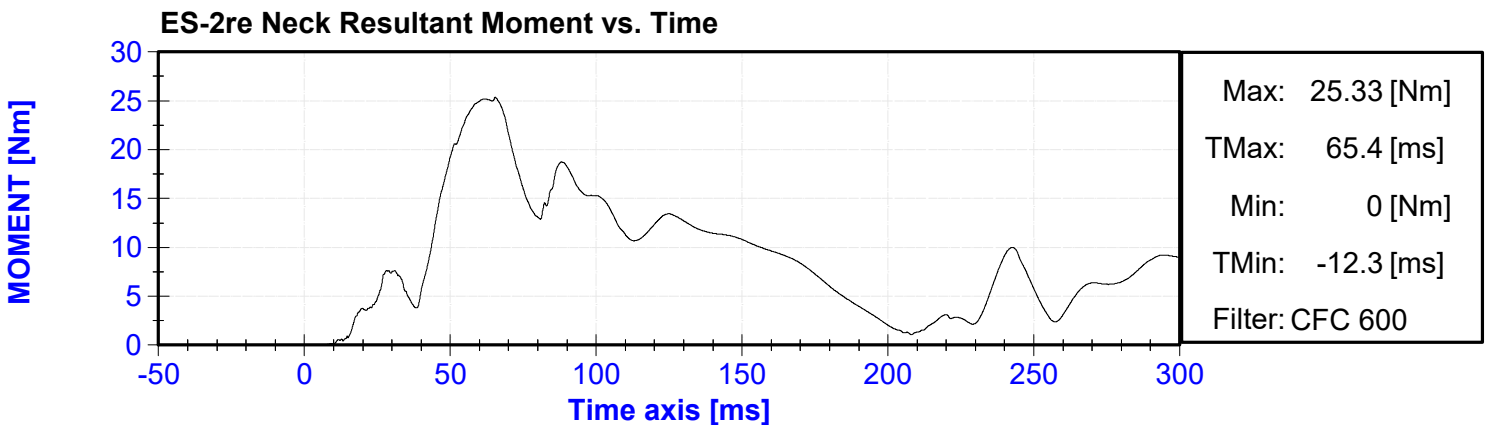
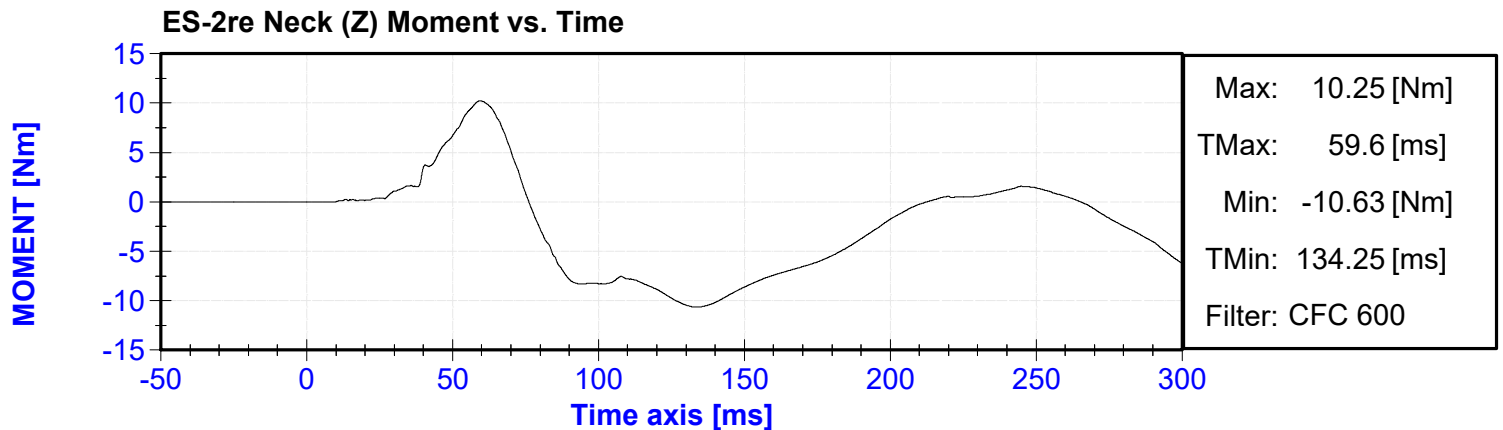
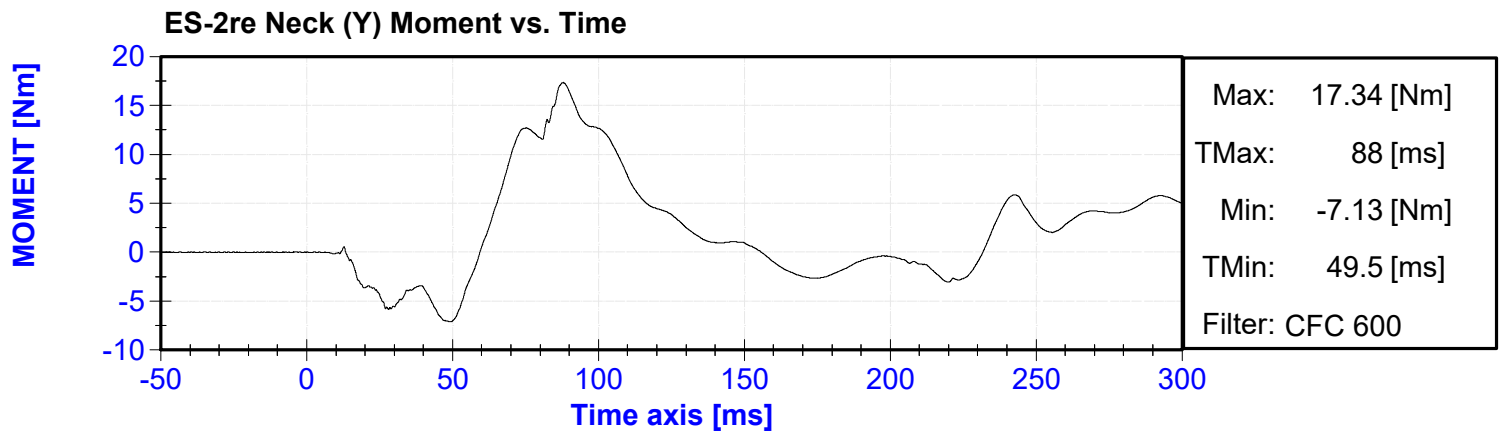
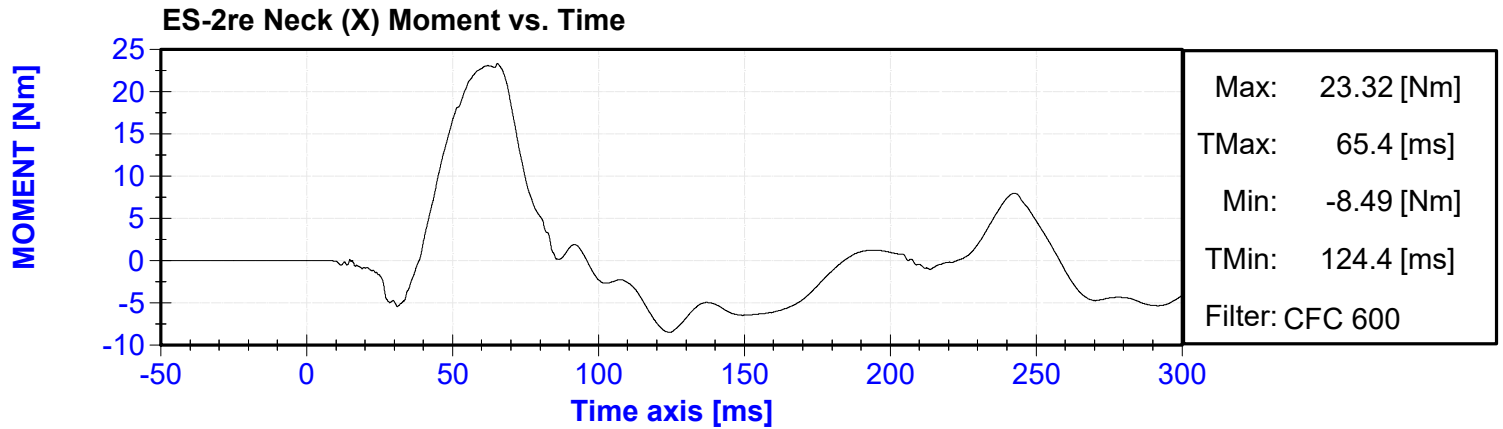


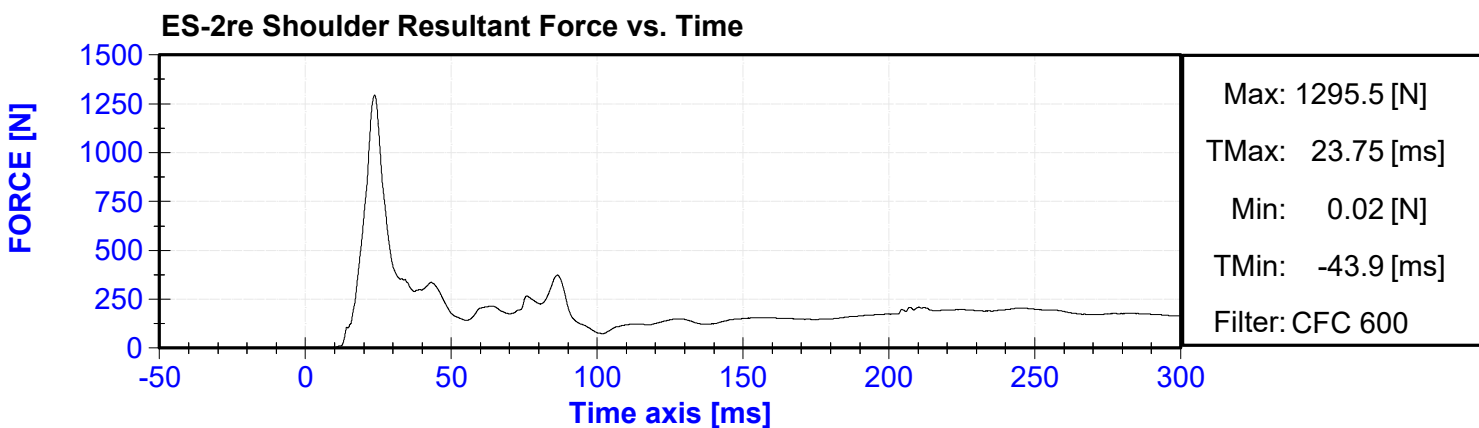
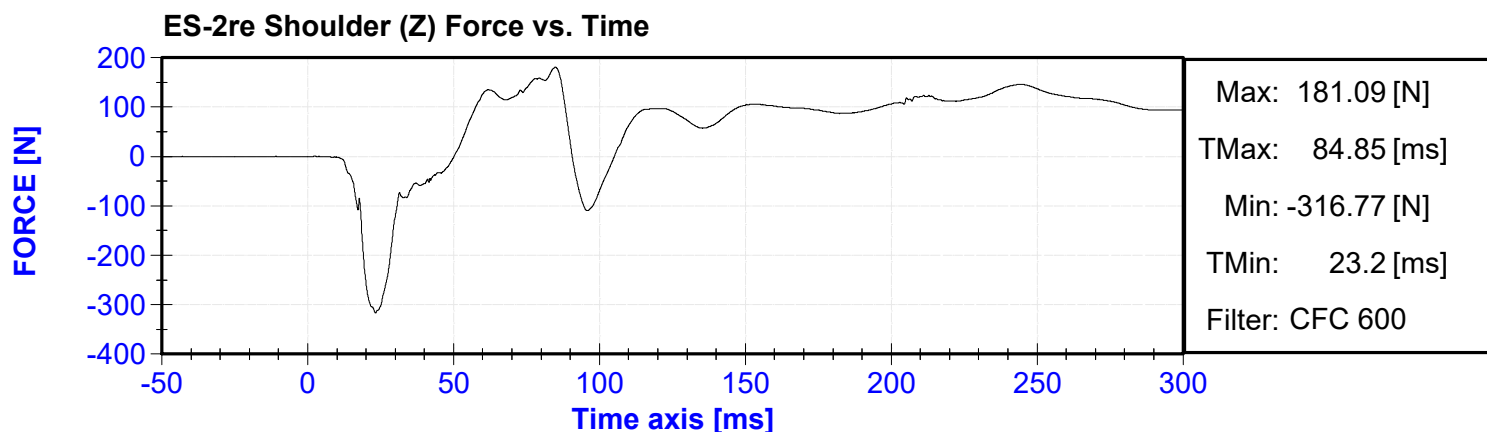
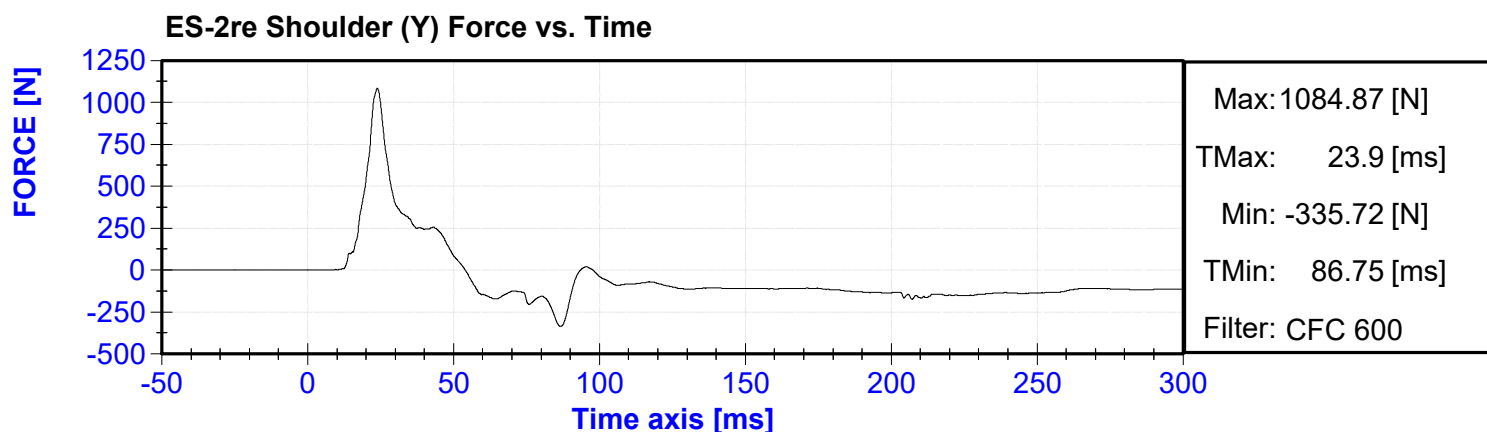
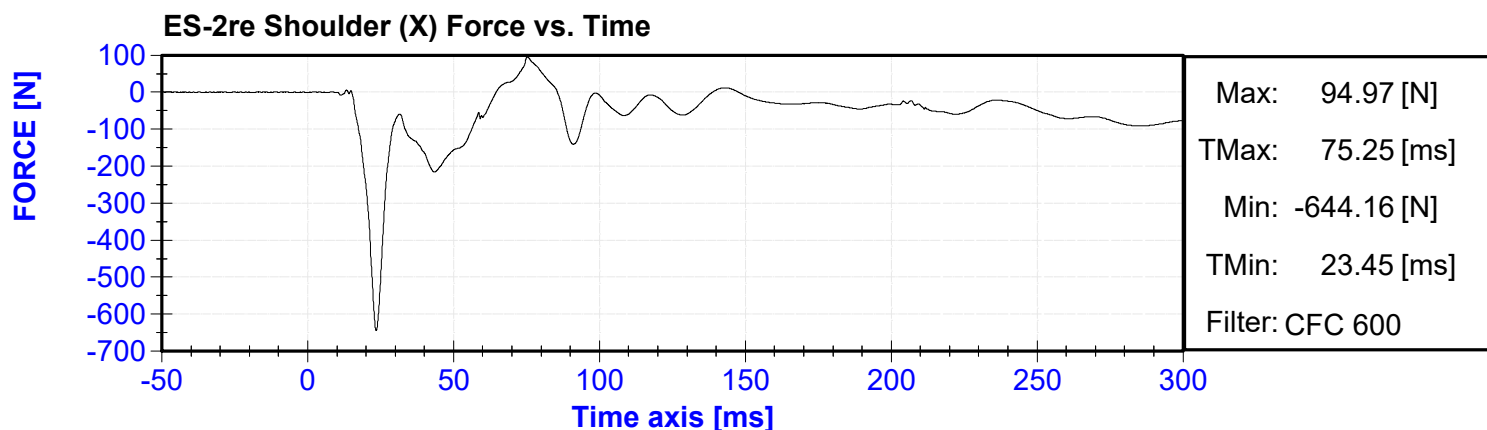
ES-2re Head Resultant Angular Velocity vs. Time

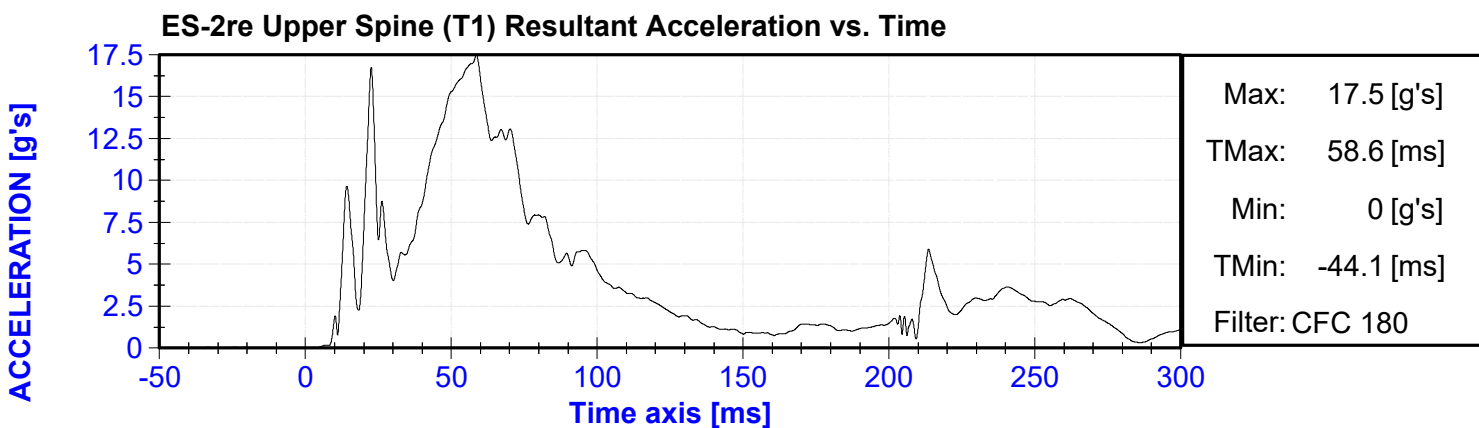
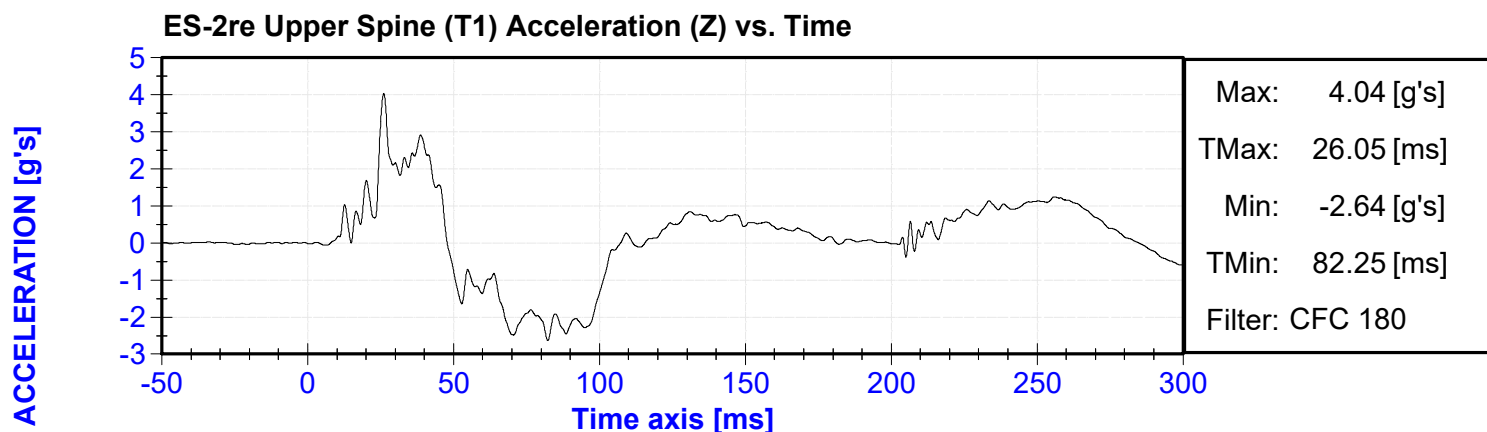
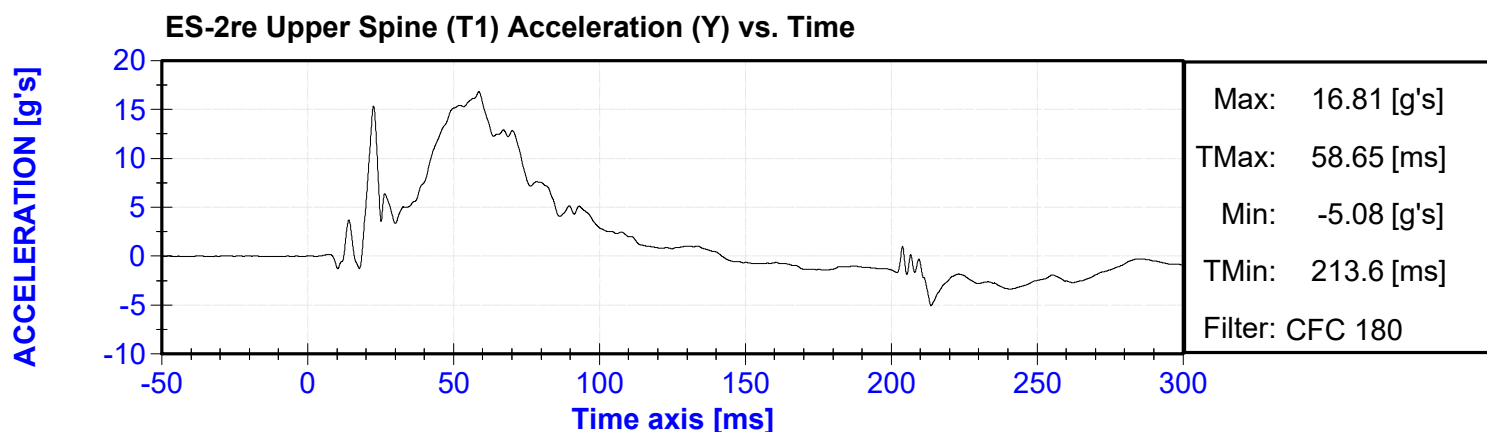
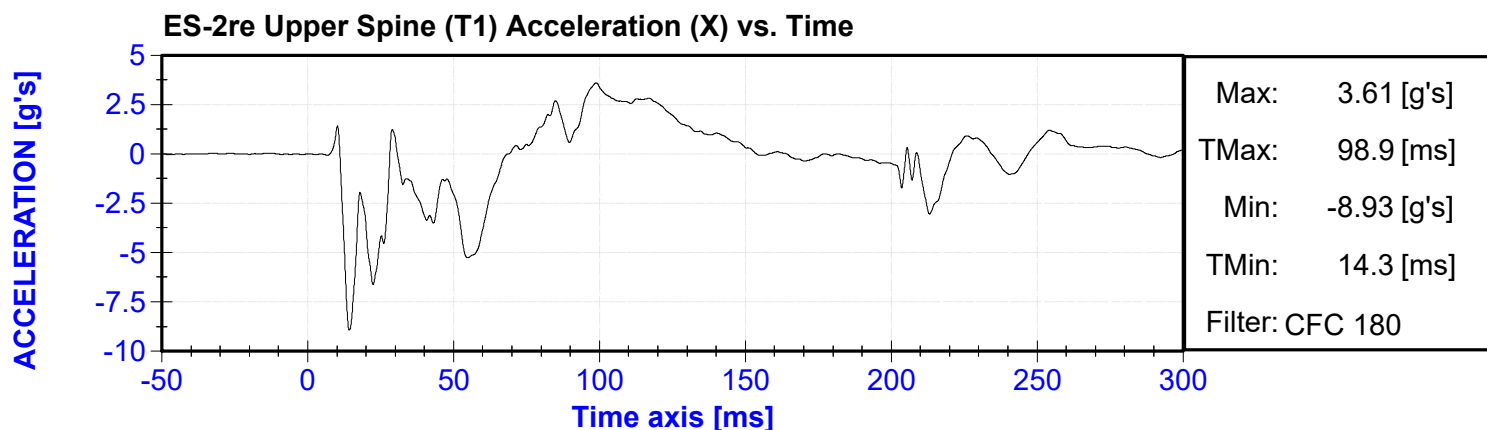
ANGULAR VEL [deg/s]





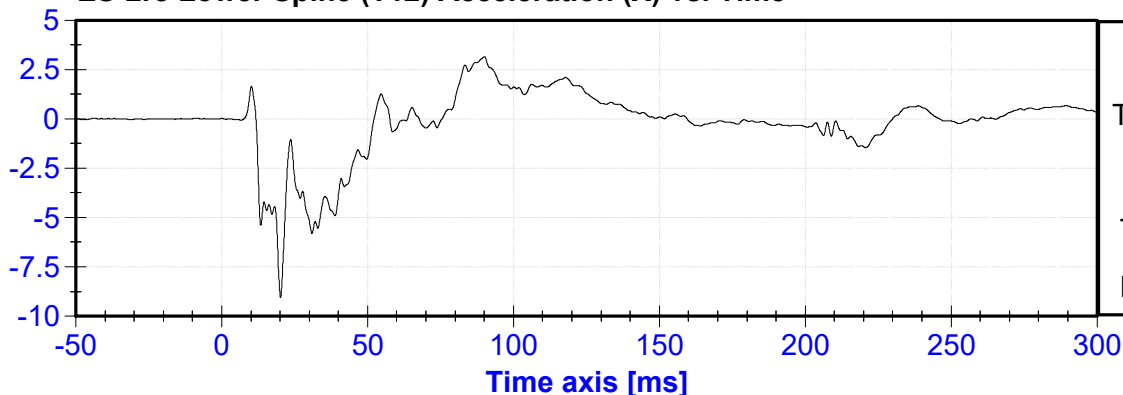






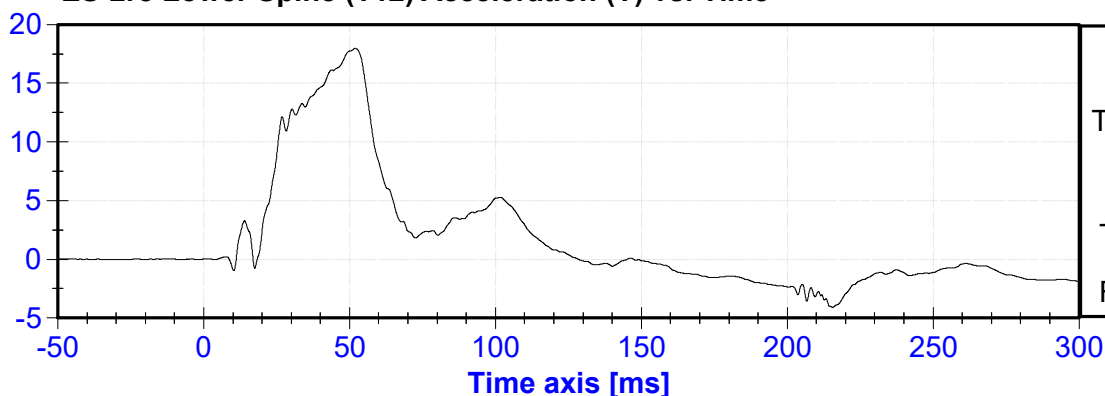
ACCELERATION [G's]

ES-2re Lower Spine (T12) Acceleration (X) vs. Time



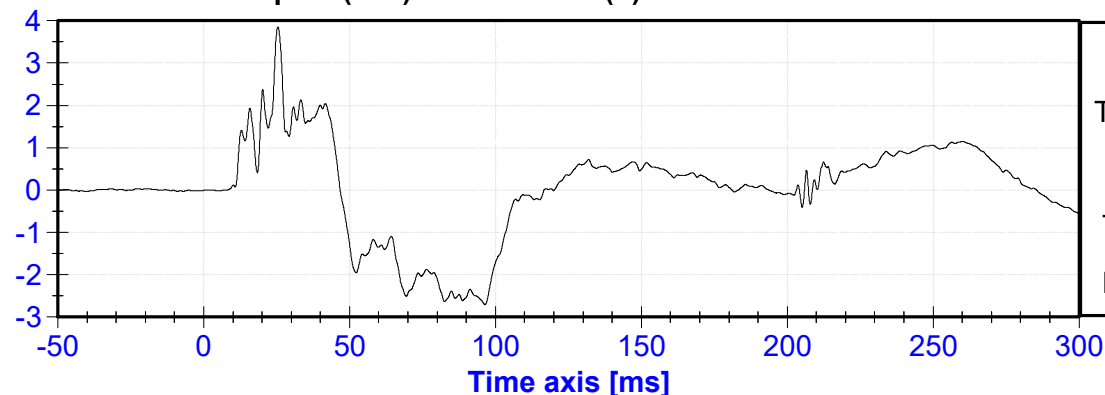
ACCELERATION [g's]

ES-2re Lower Spine (T12) Acceleration (Y) vs. Time



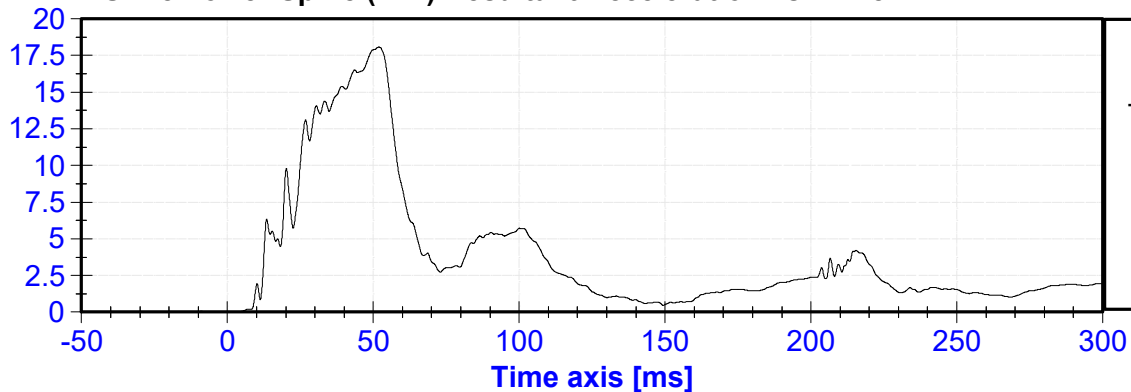
ACCELERATION [g's]

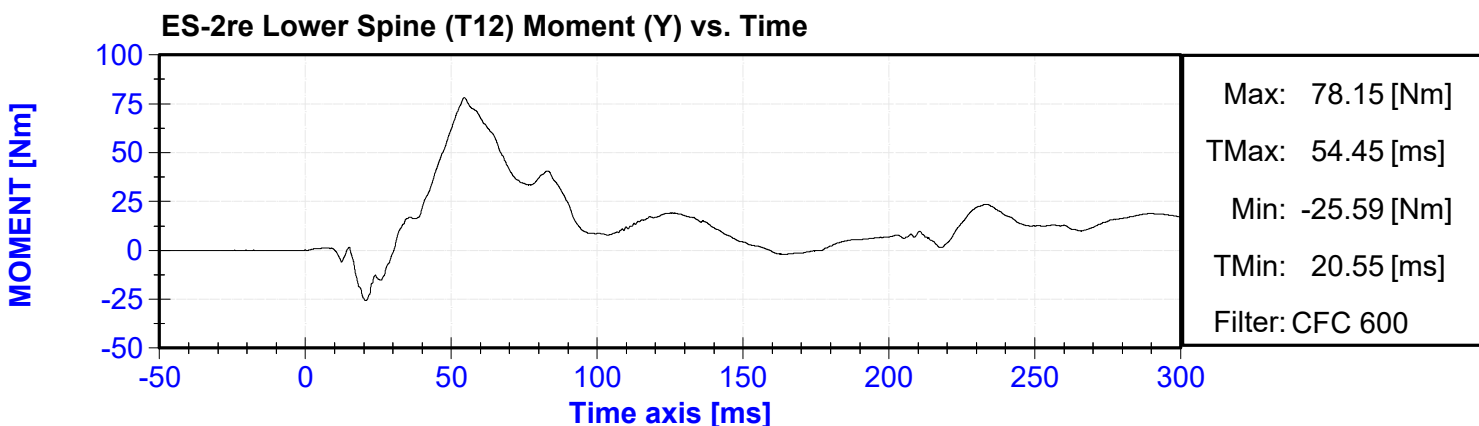
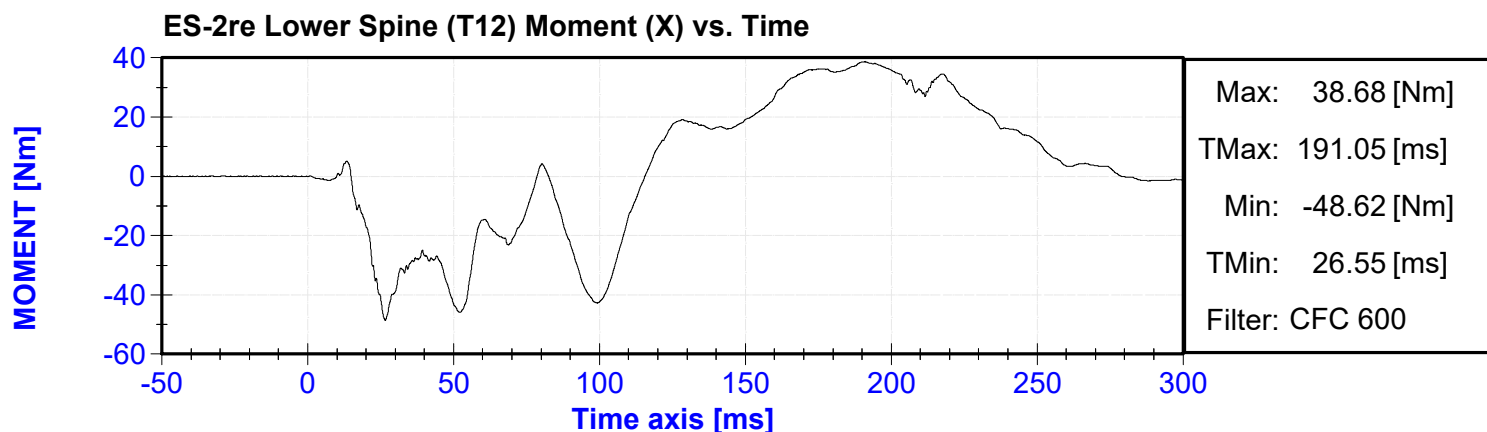
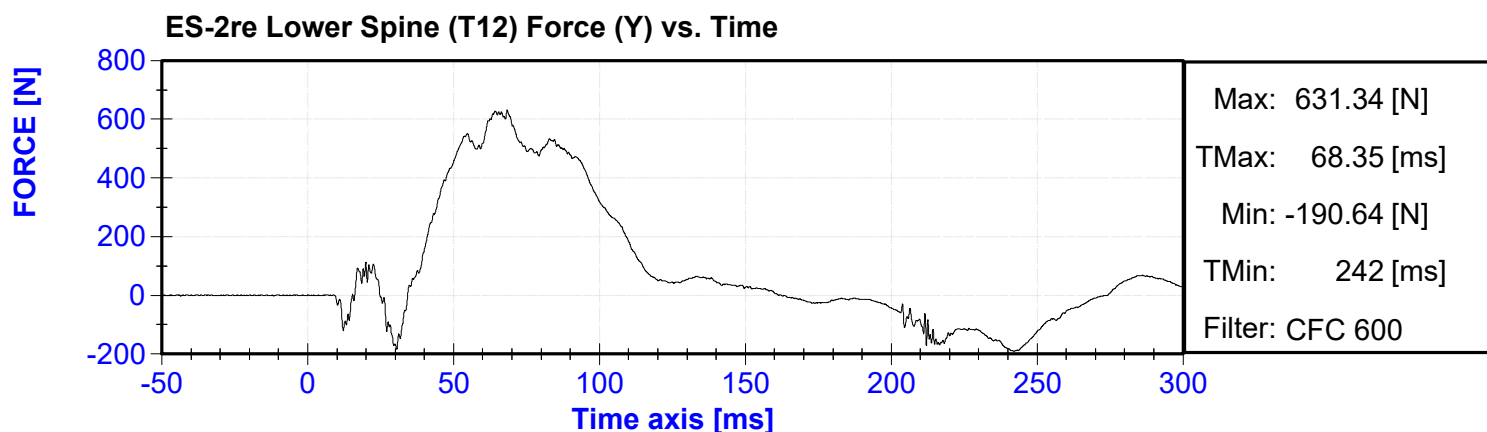
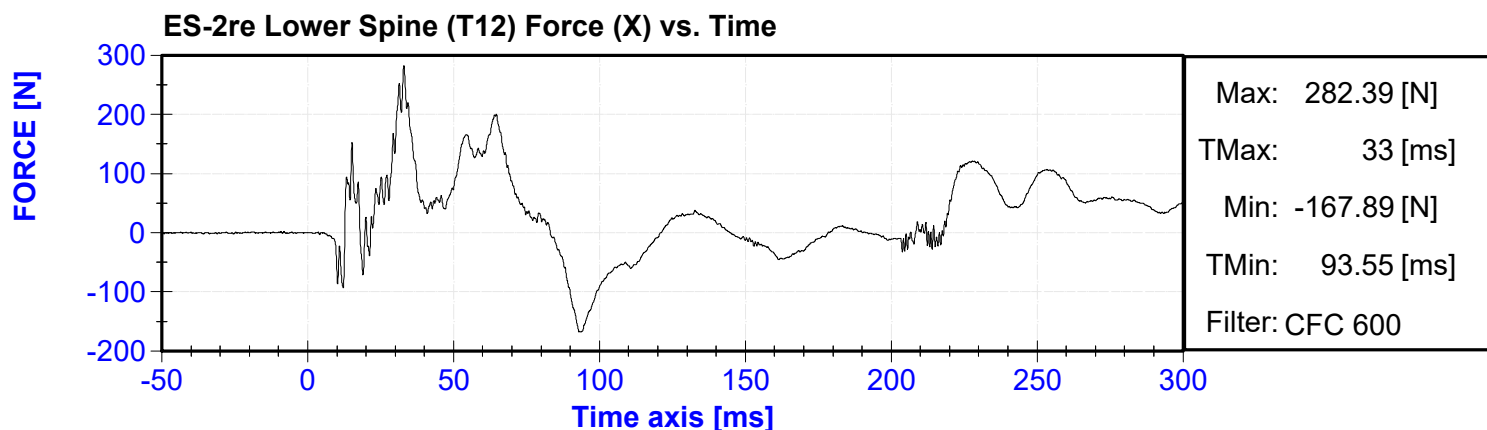
ES-2re Lower Spine (T12) Acceleration (Z) vs. Time

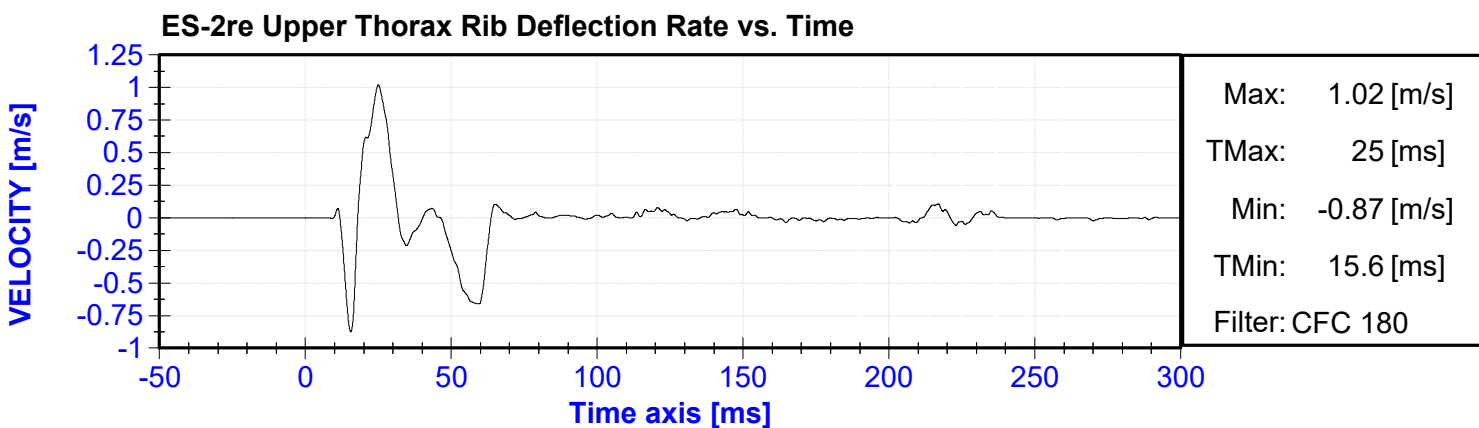
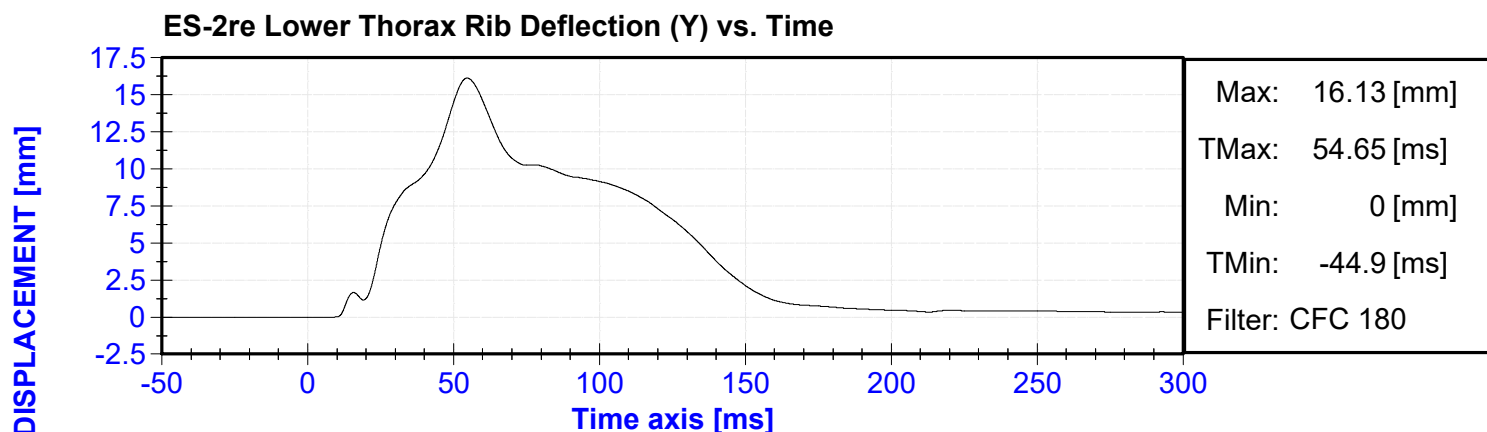
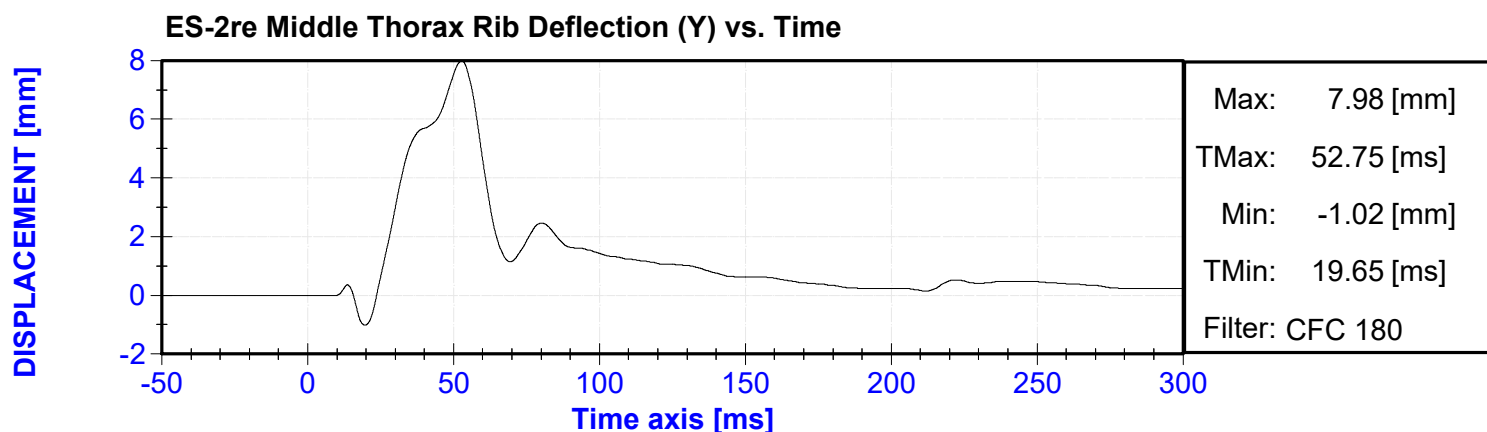
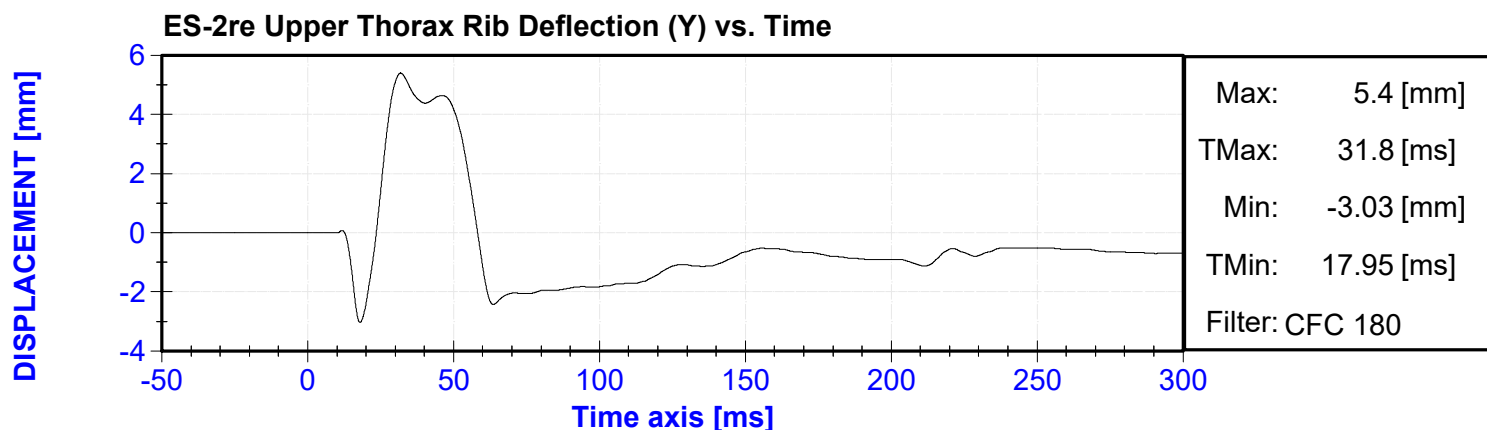


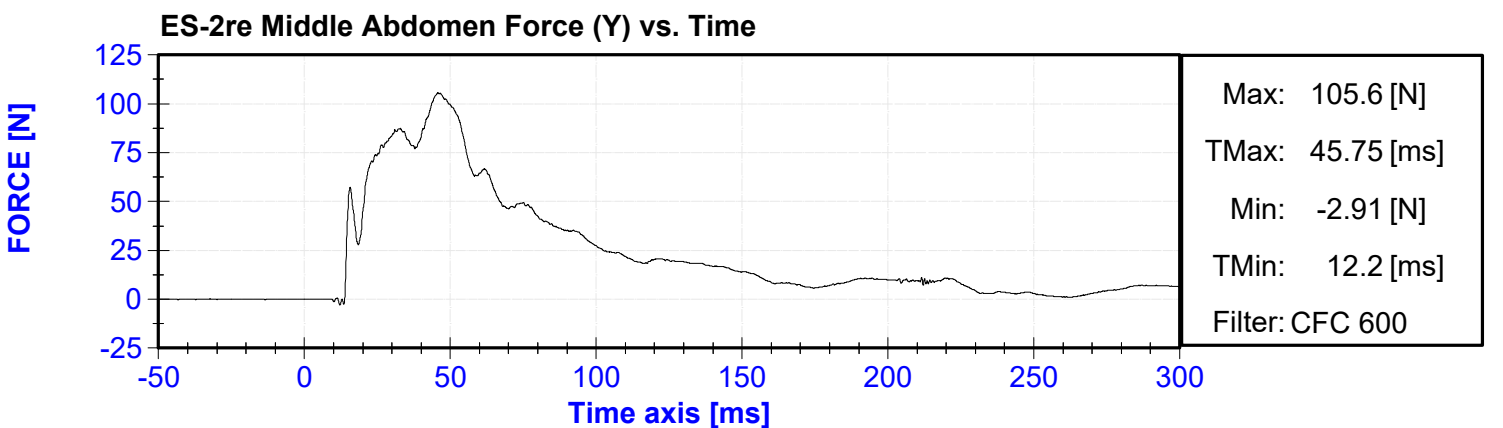
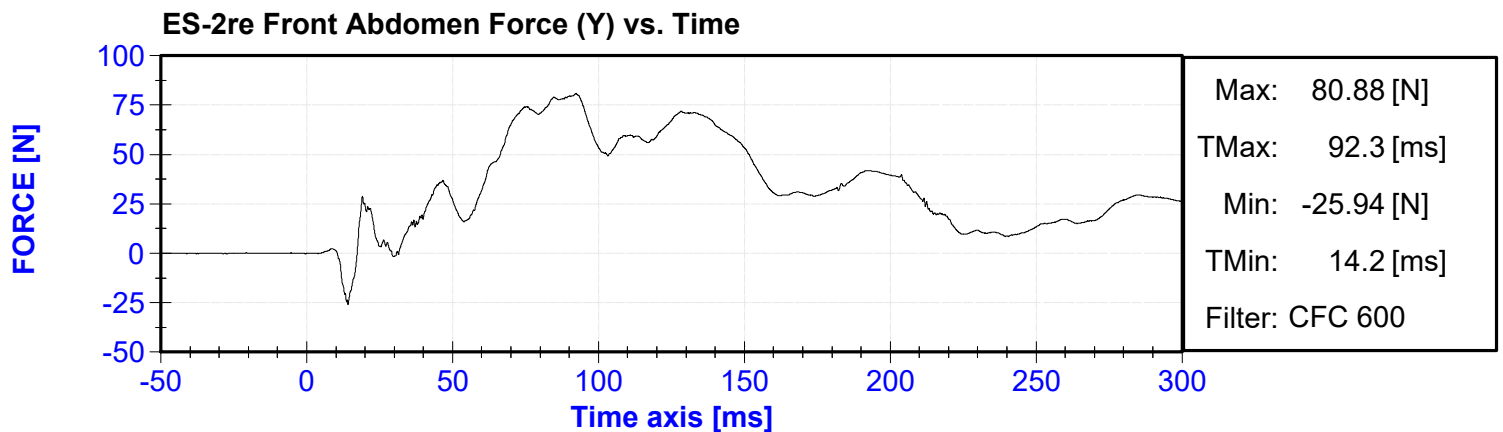
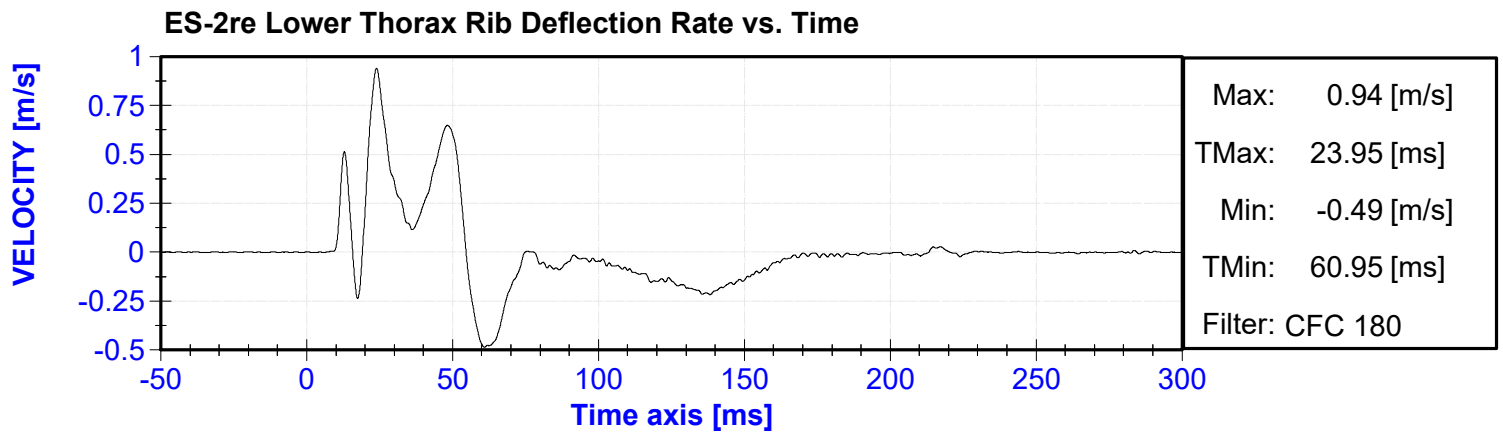
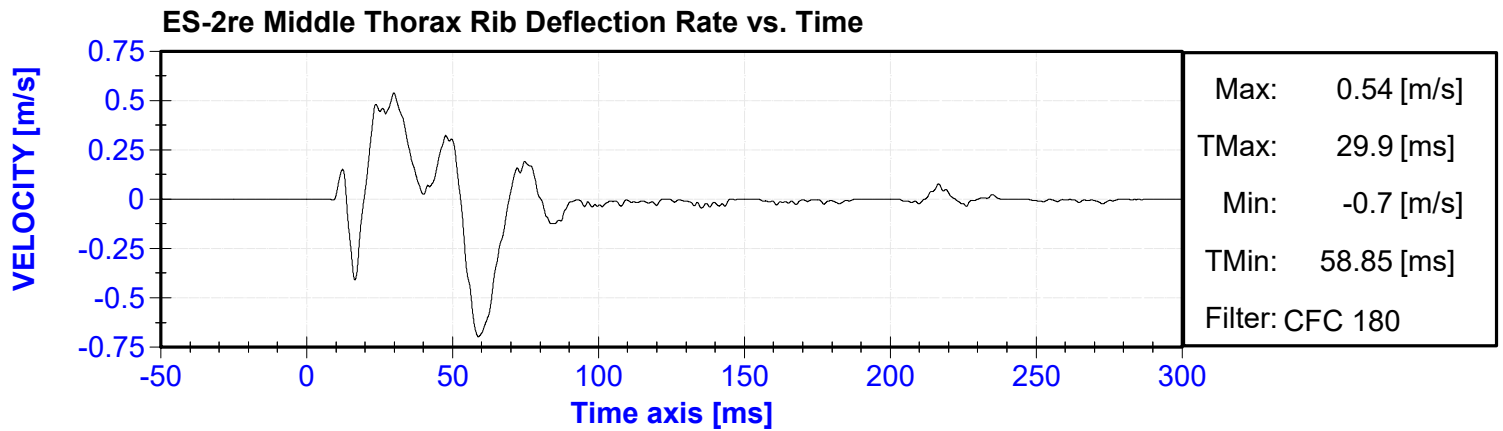
ACCELERATION [g's]

ES-2re Lower Spine (T12) Resultant Acceleration vs. Time

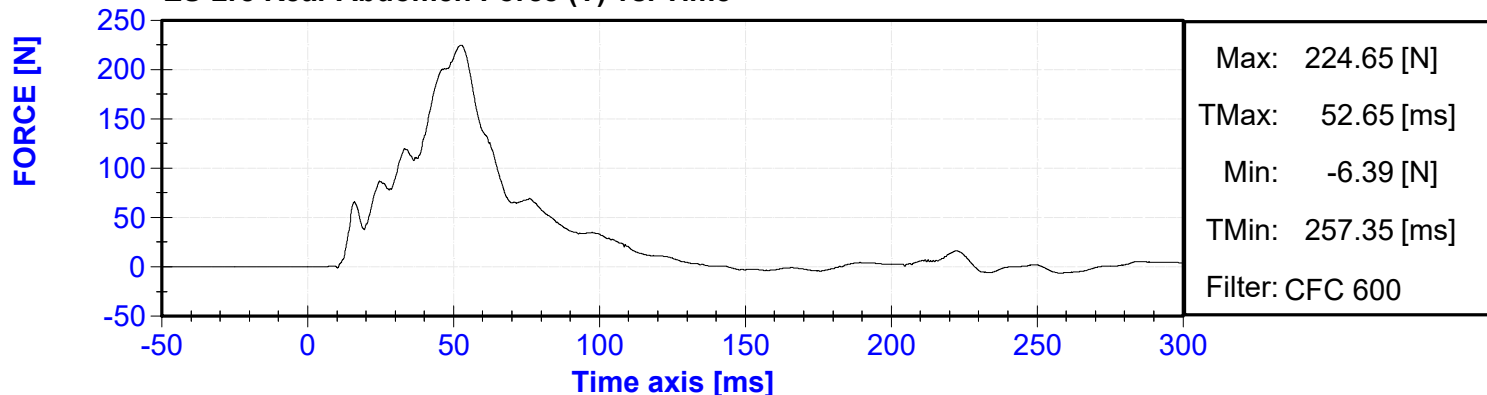




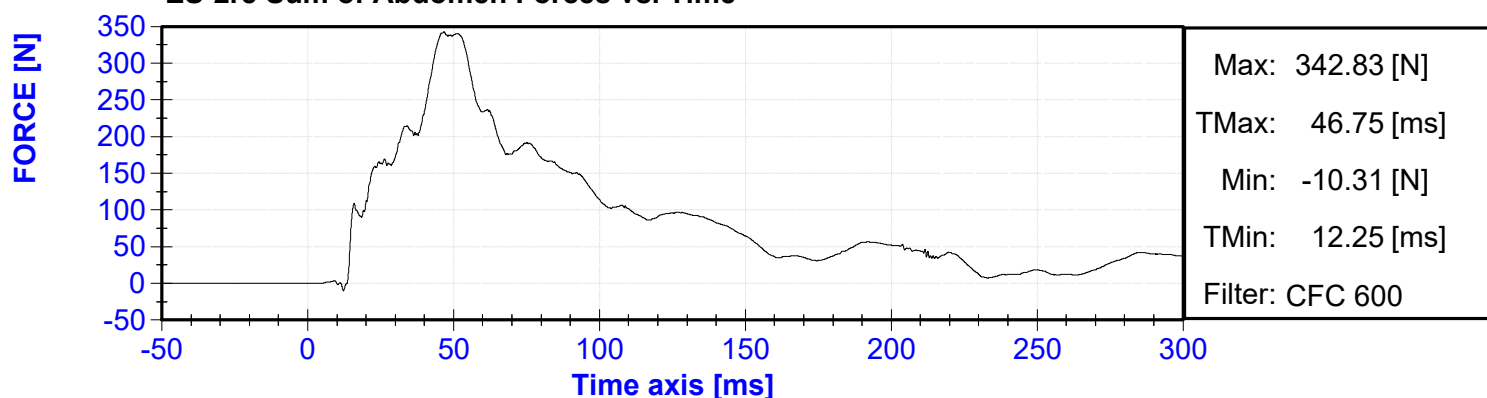




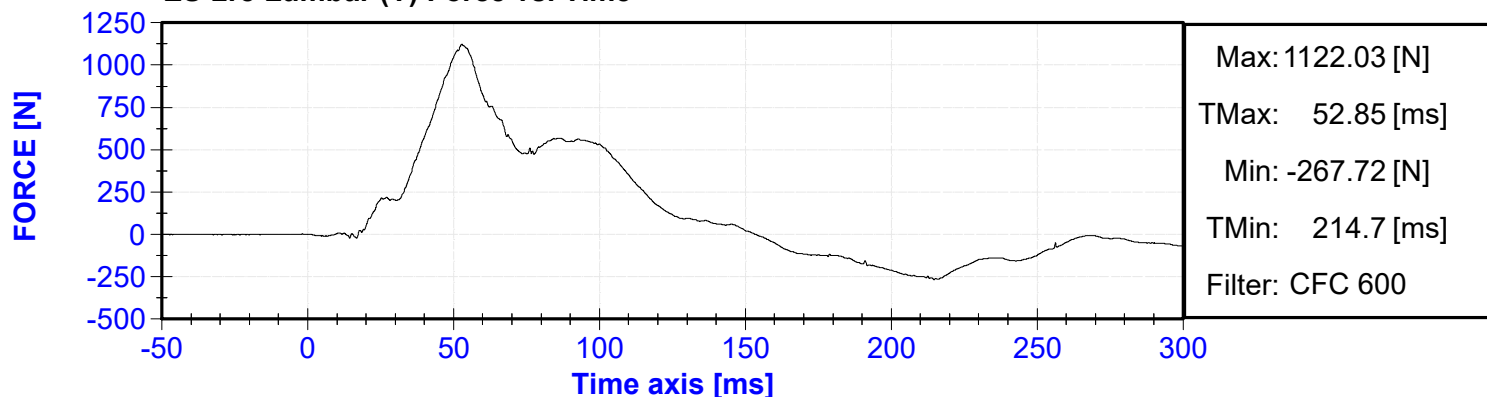
ES-2re Rear Abdomen Force (Y) vs. Time



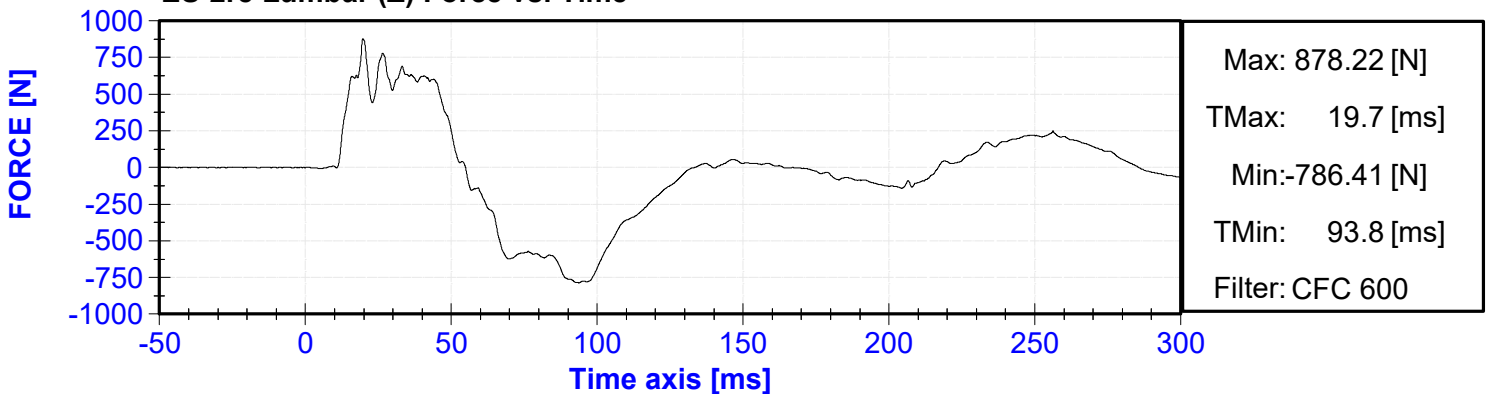
ES-2re Sum of Abdomen Forces vs. Time

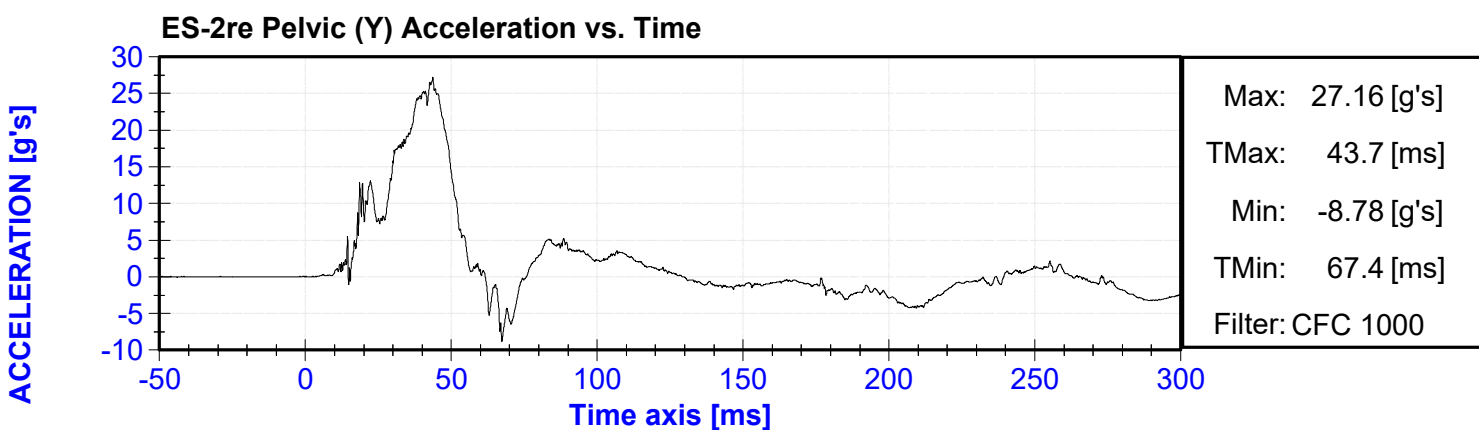
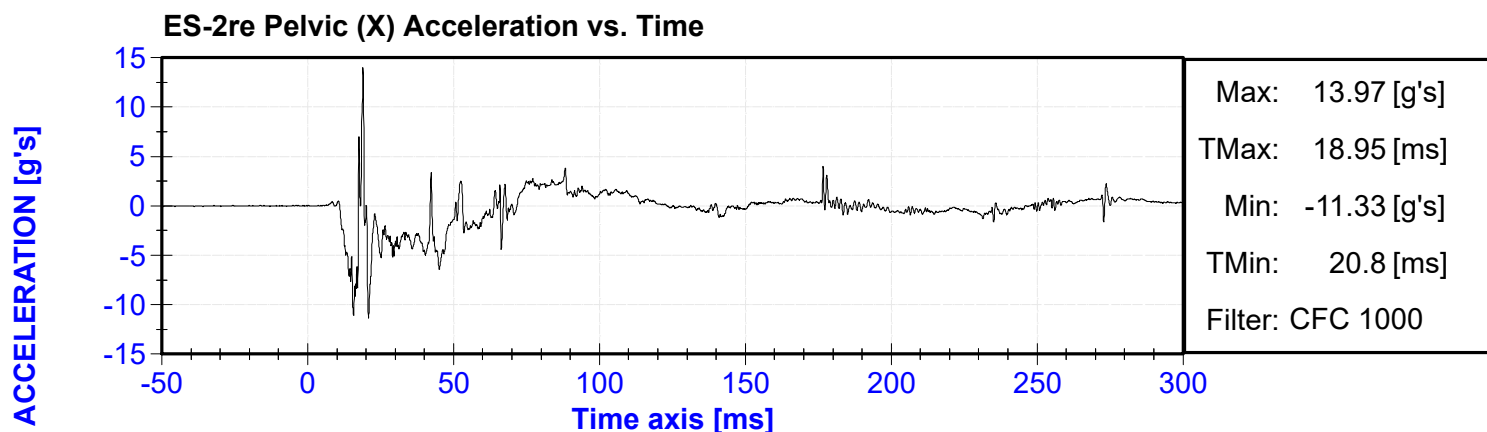
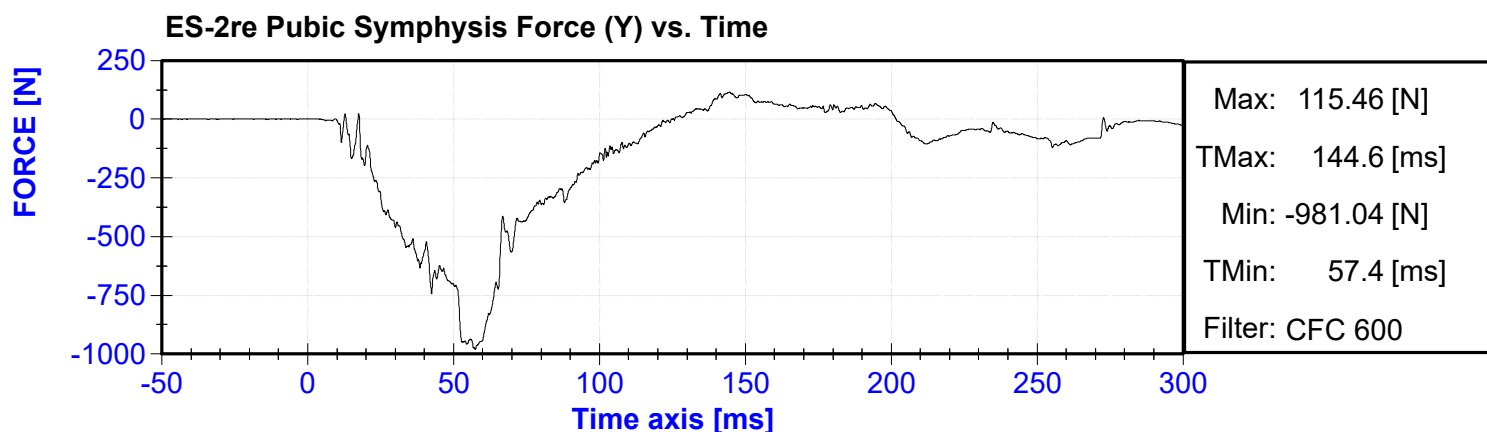
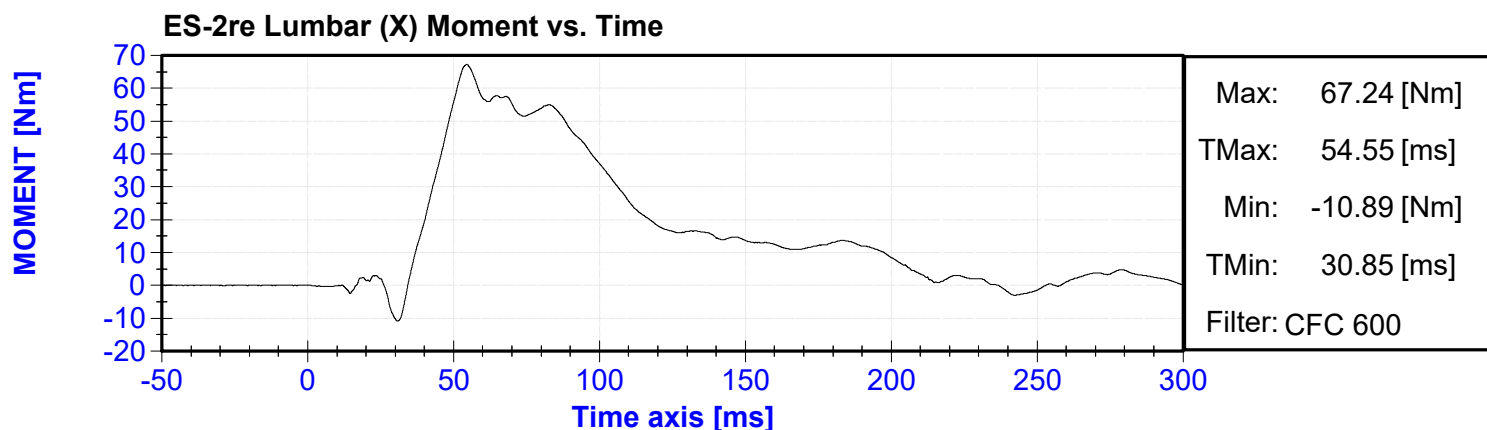


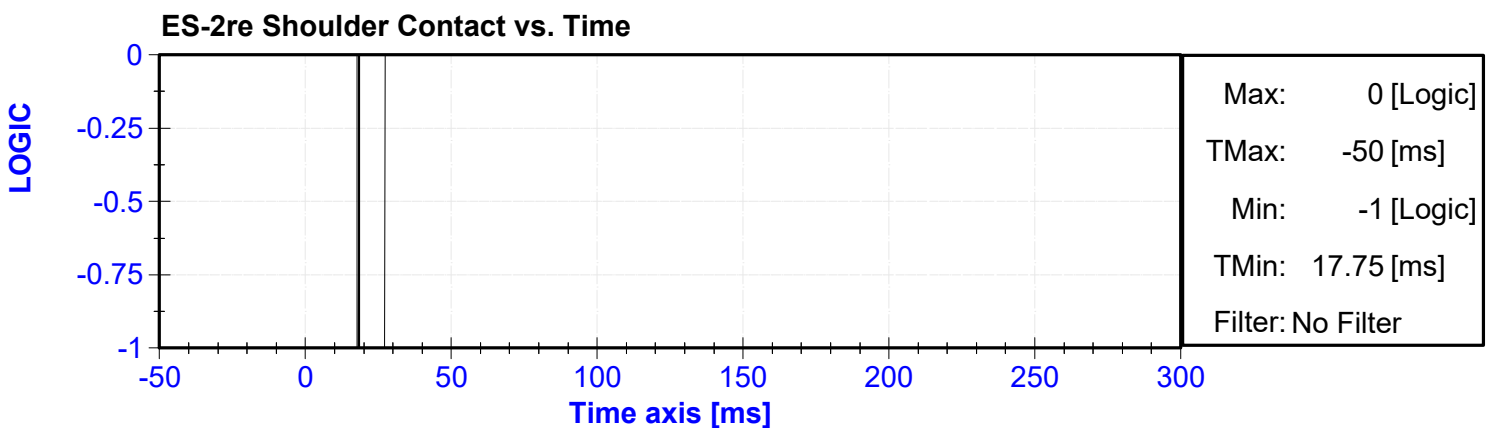
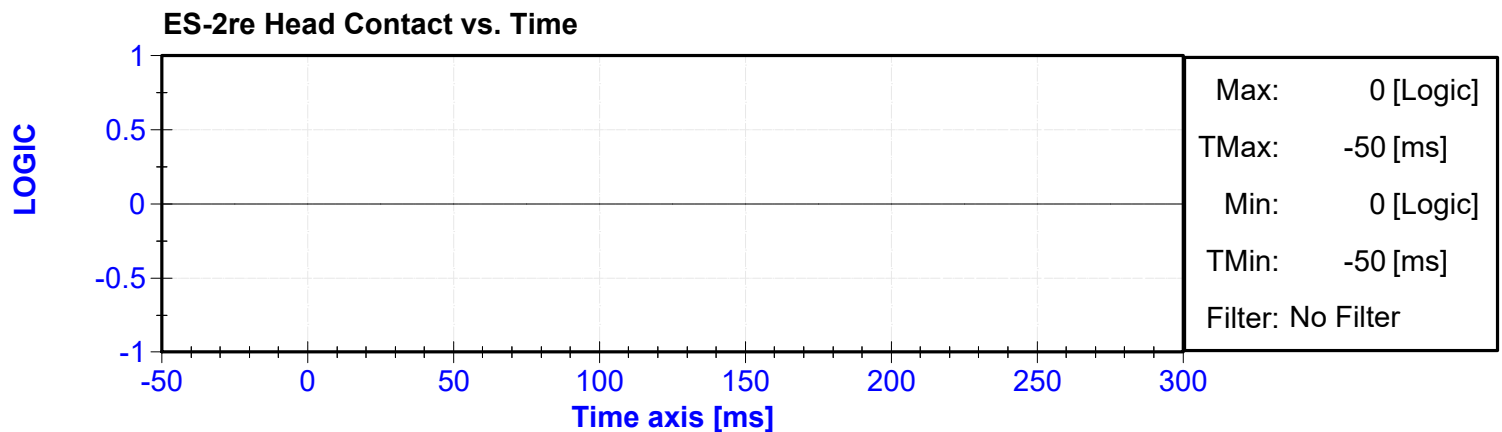
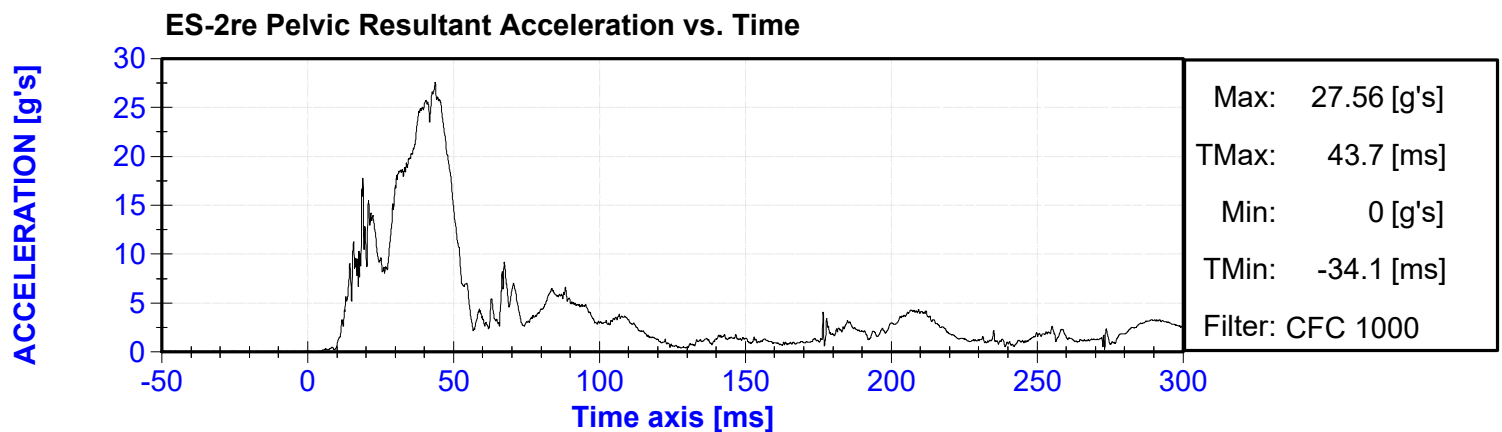
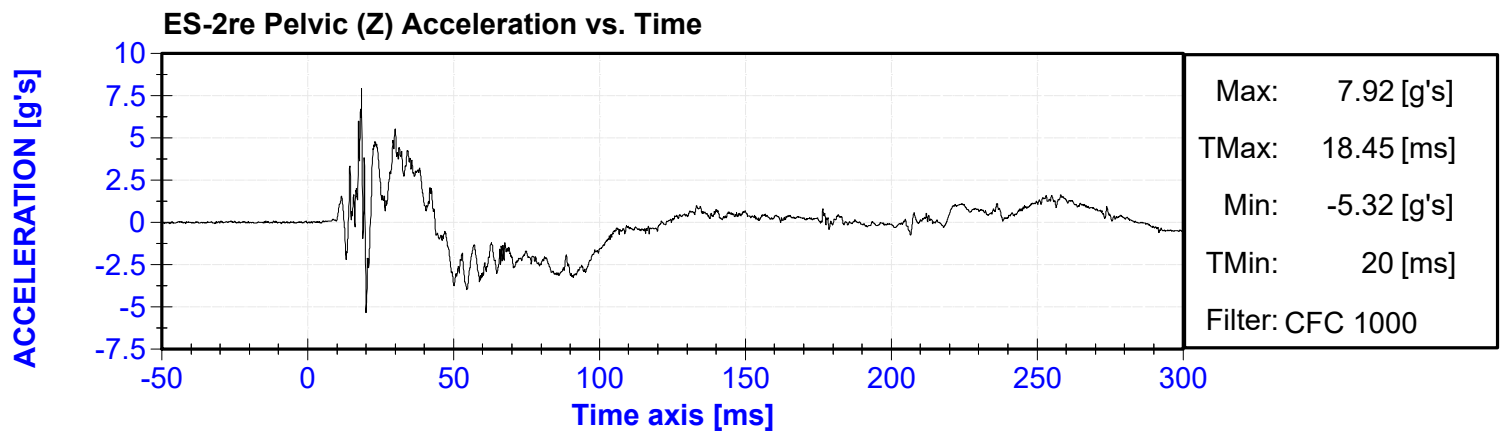
ES-2re Lumbar (Y) Force vs. Time

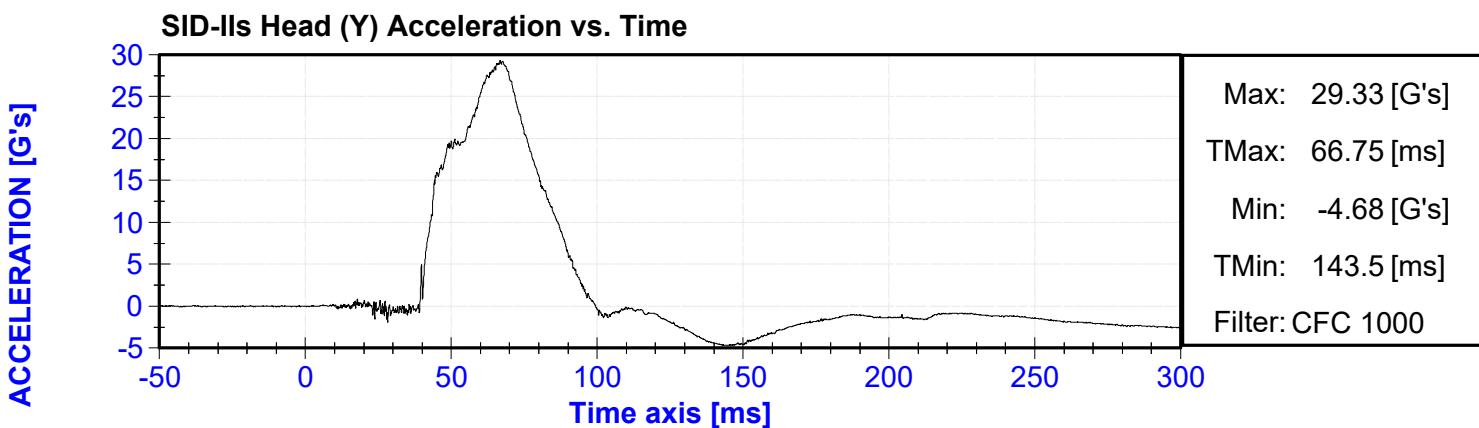
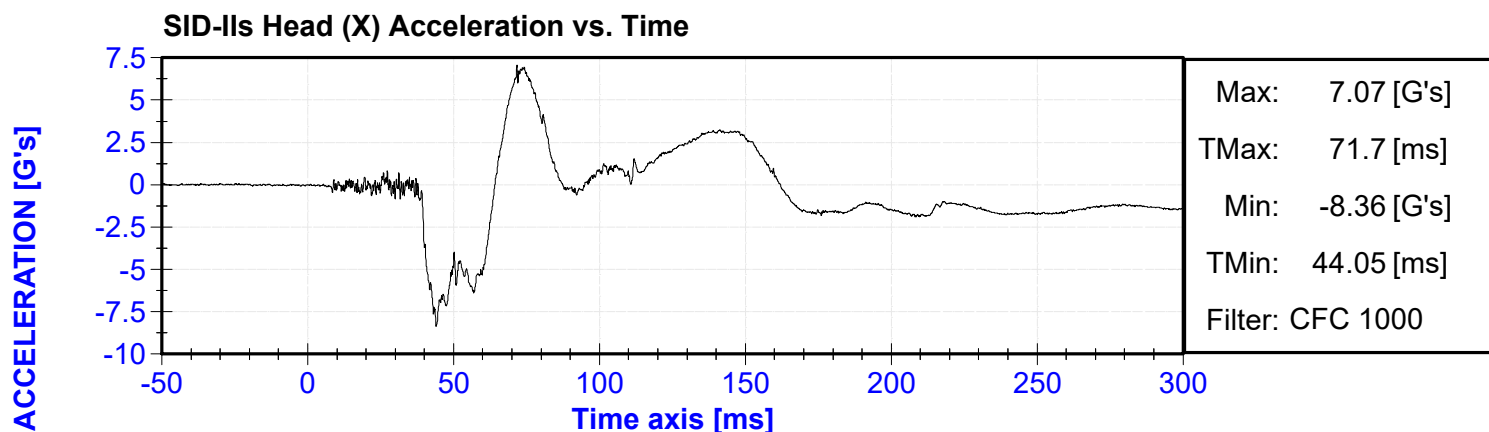
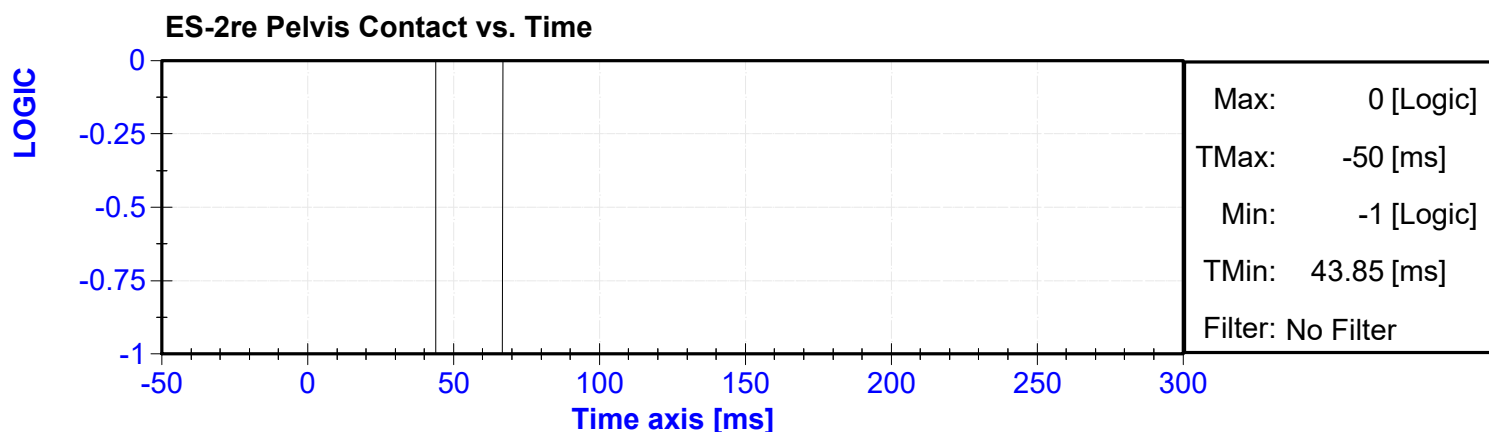
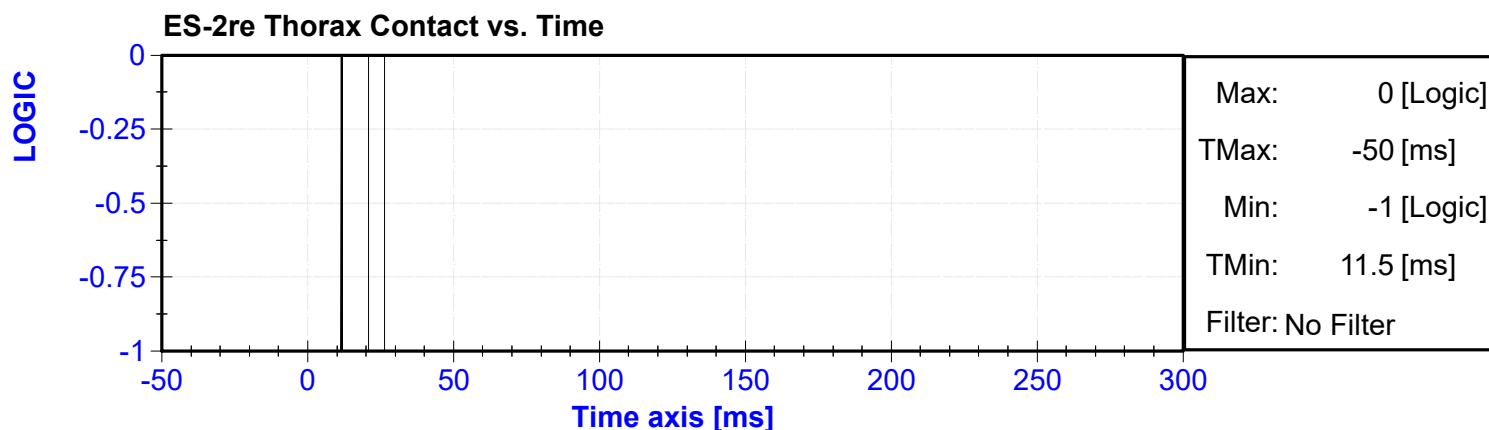


ES-2re Lumbar (Z) Force vs. Time



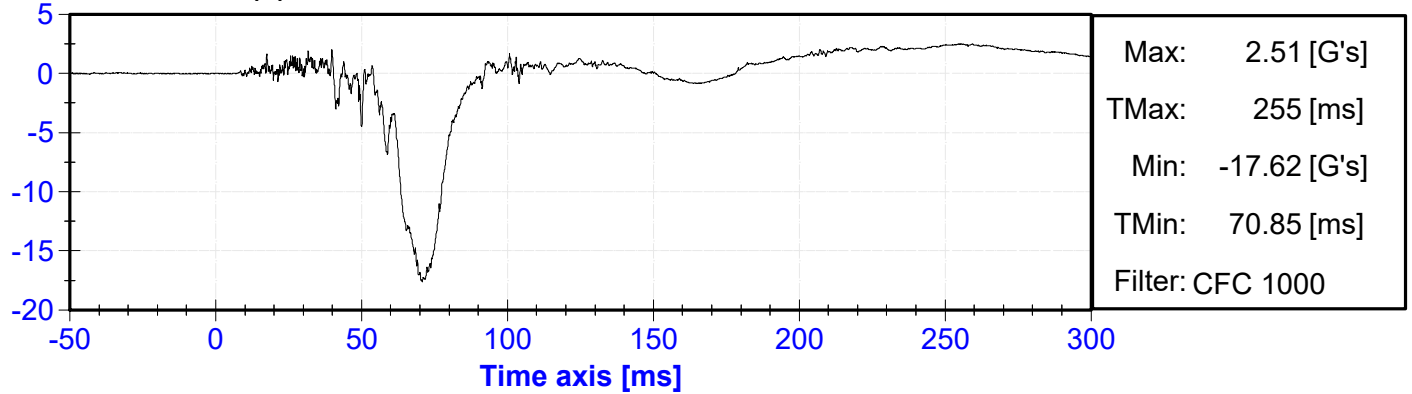






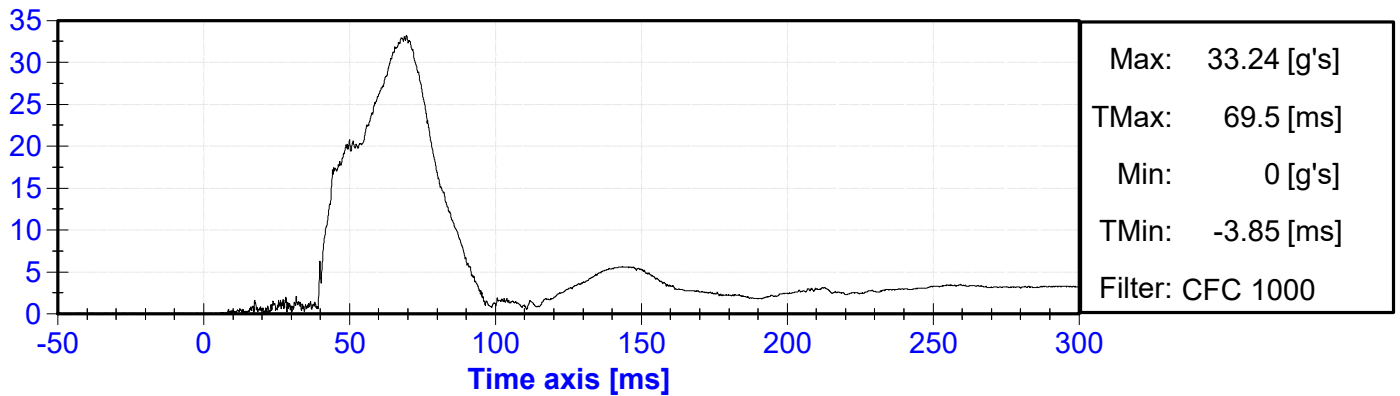
ACCELERATION [G's]

SID-Ils Head (Z) Acceleration vs. Time



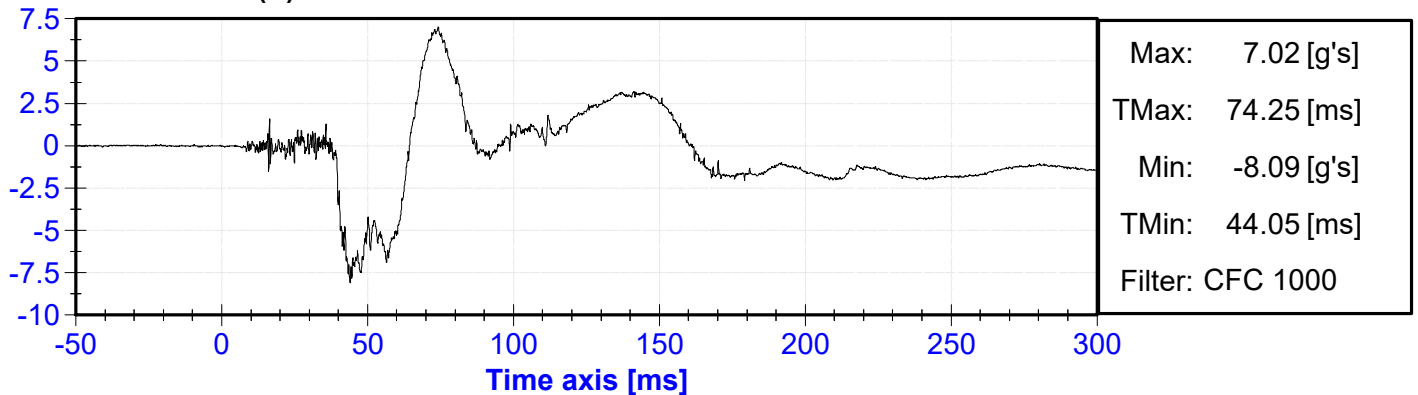
ACCELERATION [g's]

SID-Ils Head Resultant Acceleration vs. Time



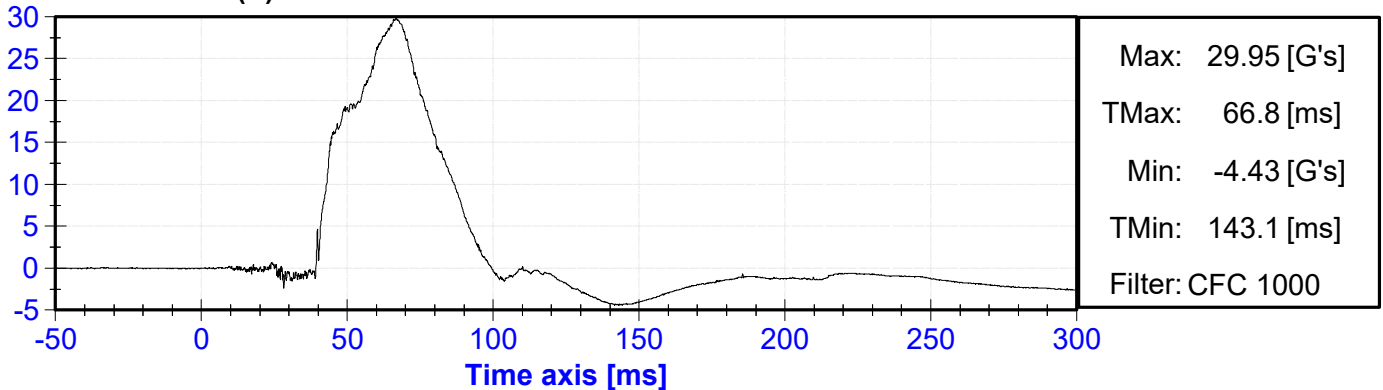
ACCELERATION [g's]

SID-Ils Head (X) Redundant Acceleration vs. Time



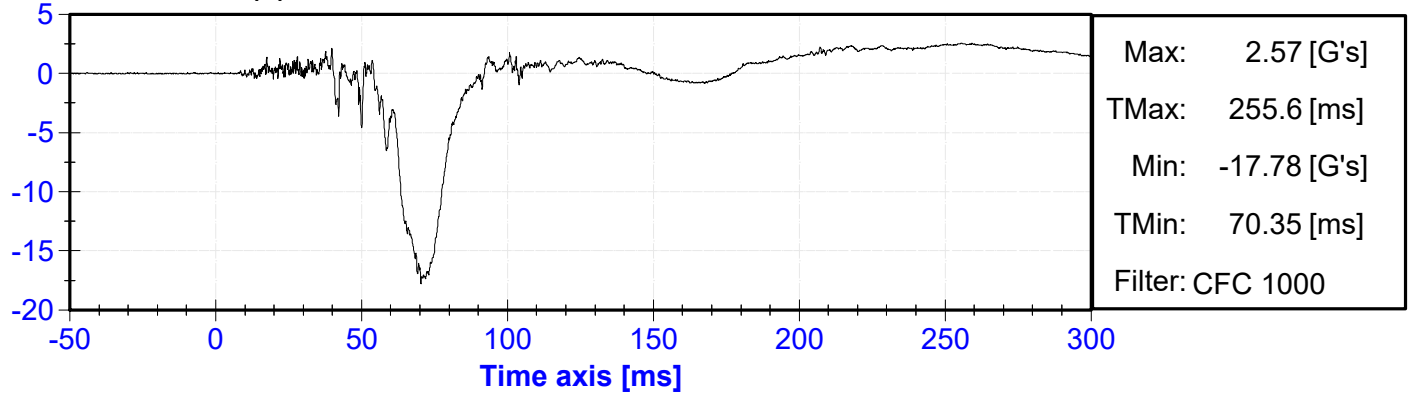
ACCELERATION [G's]

SID-Ils Head (Y) Redundant Acceleration vs. Time



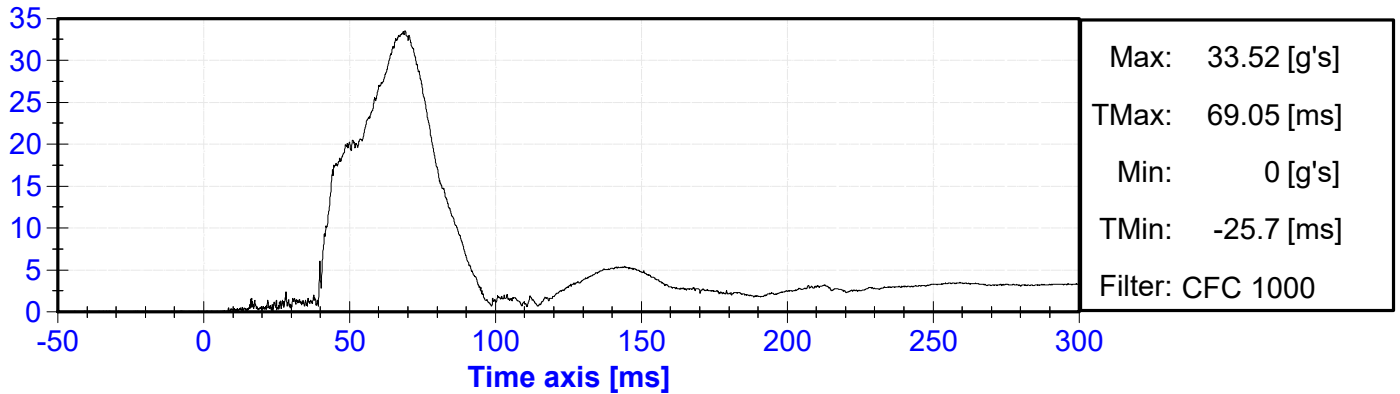
ACCELERATION [G's]

SID-IIs Head (Z) Redundant Acceleration vs. Time



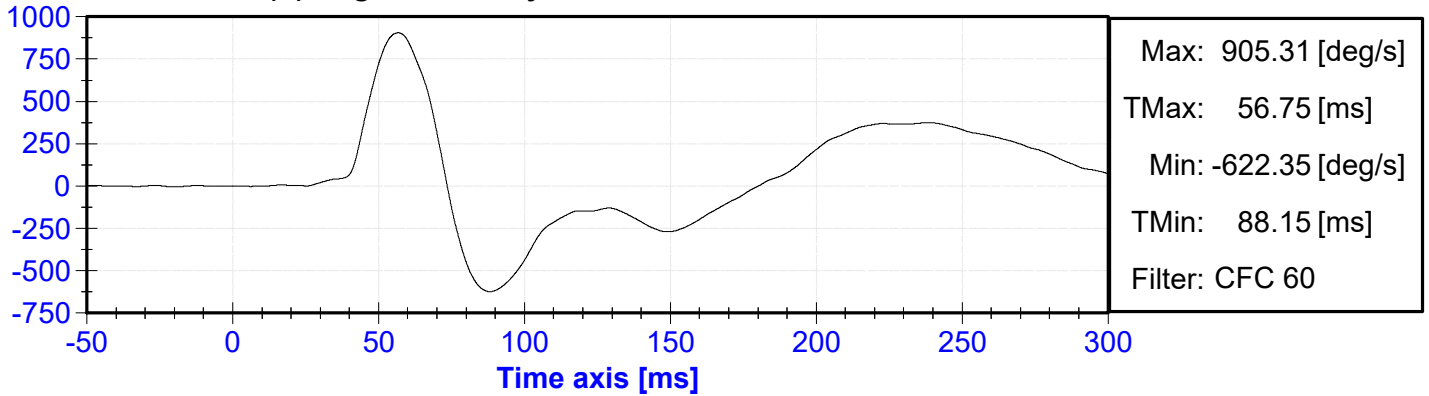
ACCELERATION [g's]

SID-IIs Head Resultant Redundant Acceleration vs. Time



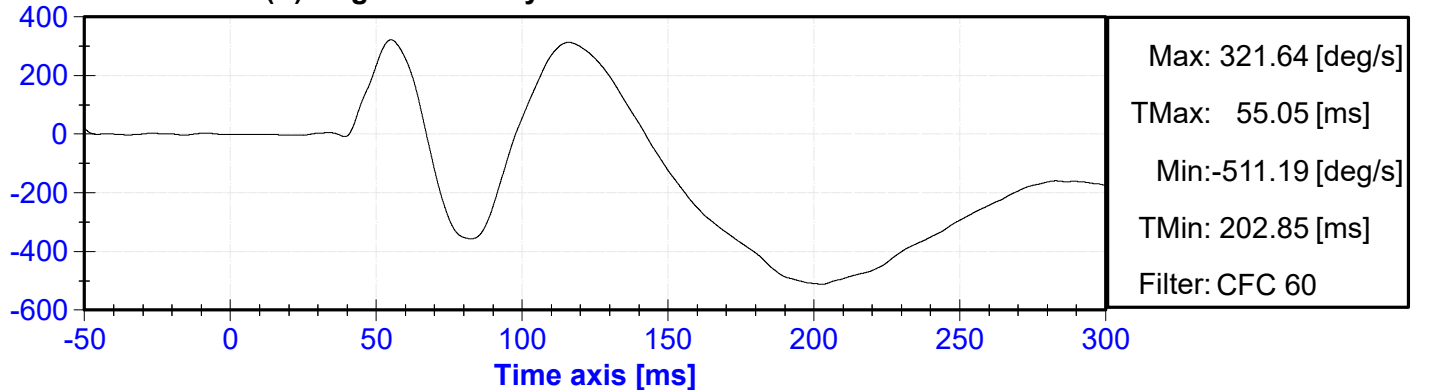
ANGULAR VEL [deg/s]

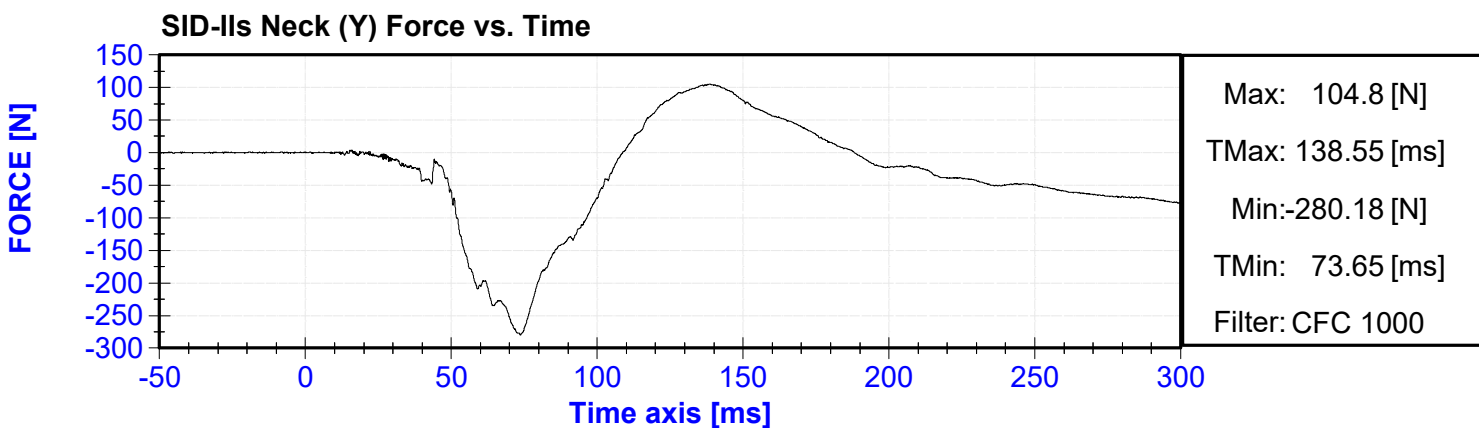
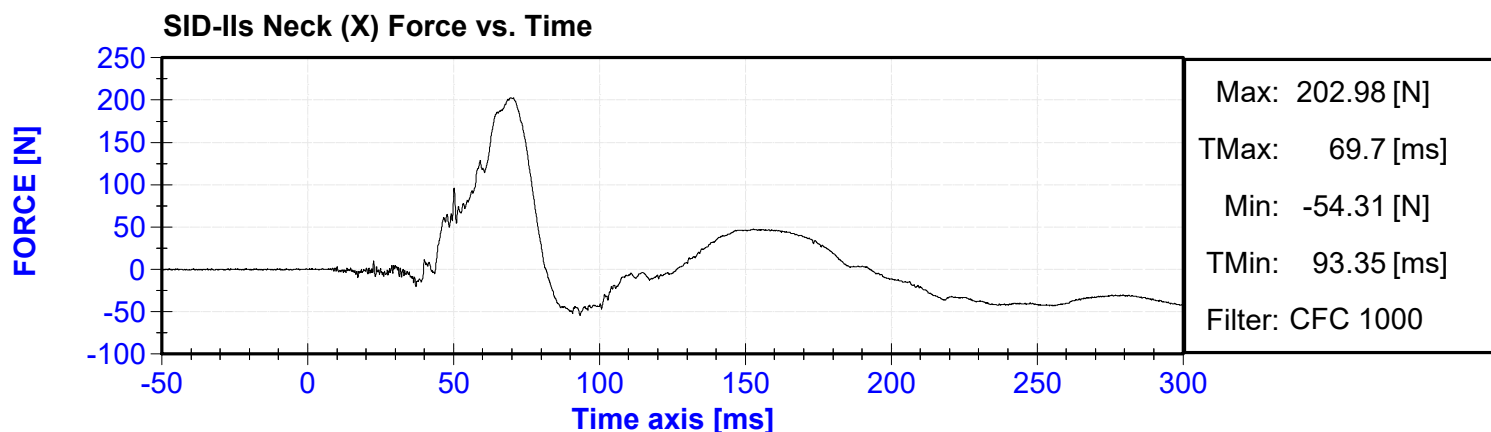
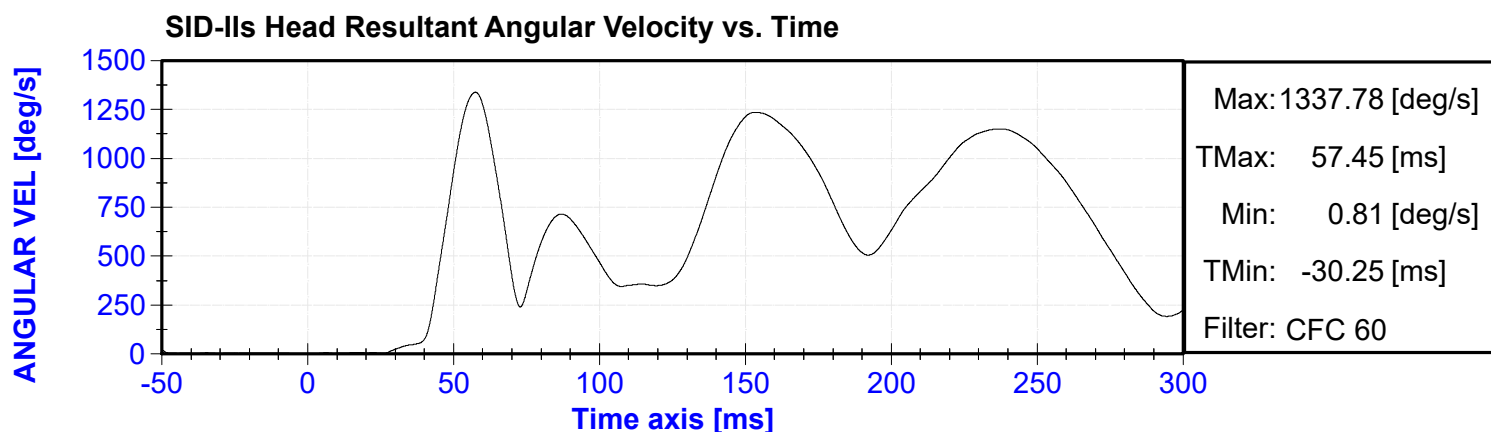
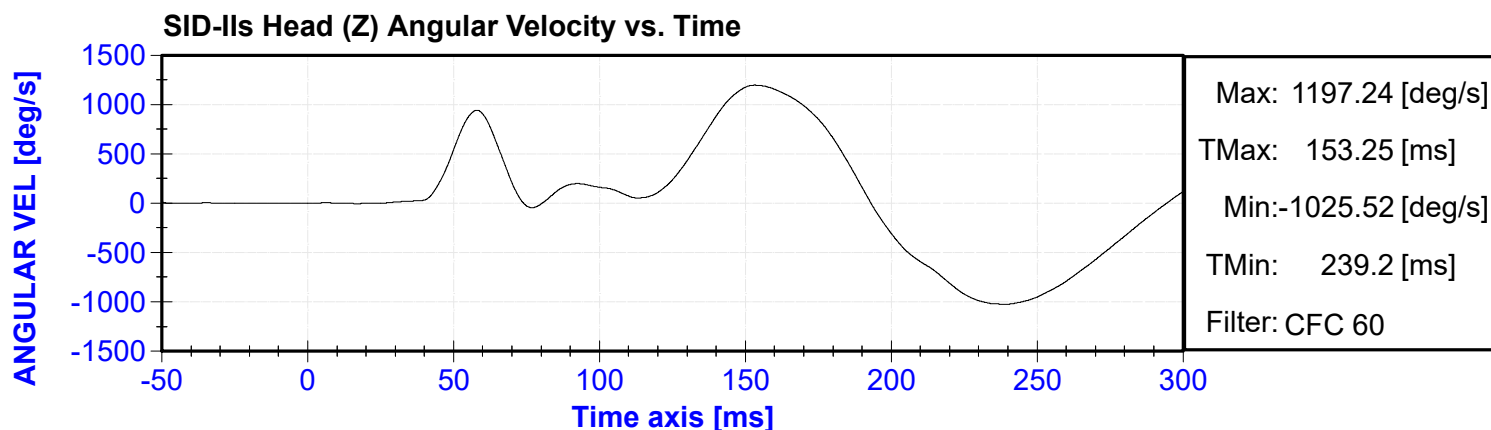
SID-IIs Head (X) Angular Velocity vs. Time

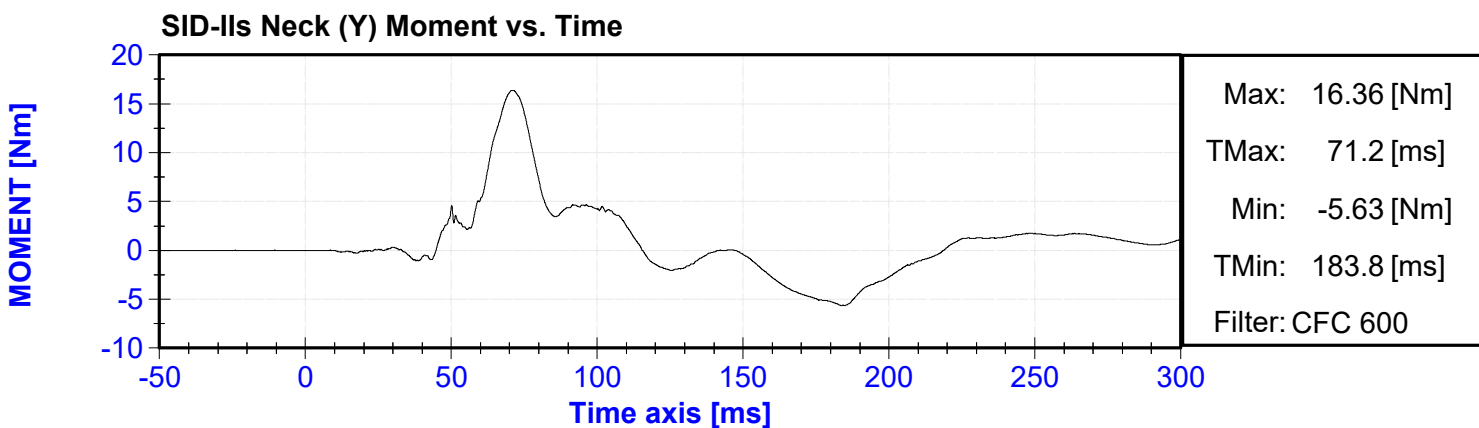
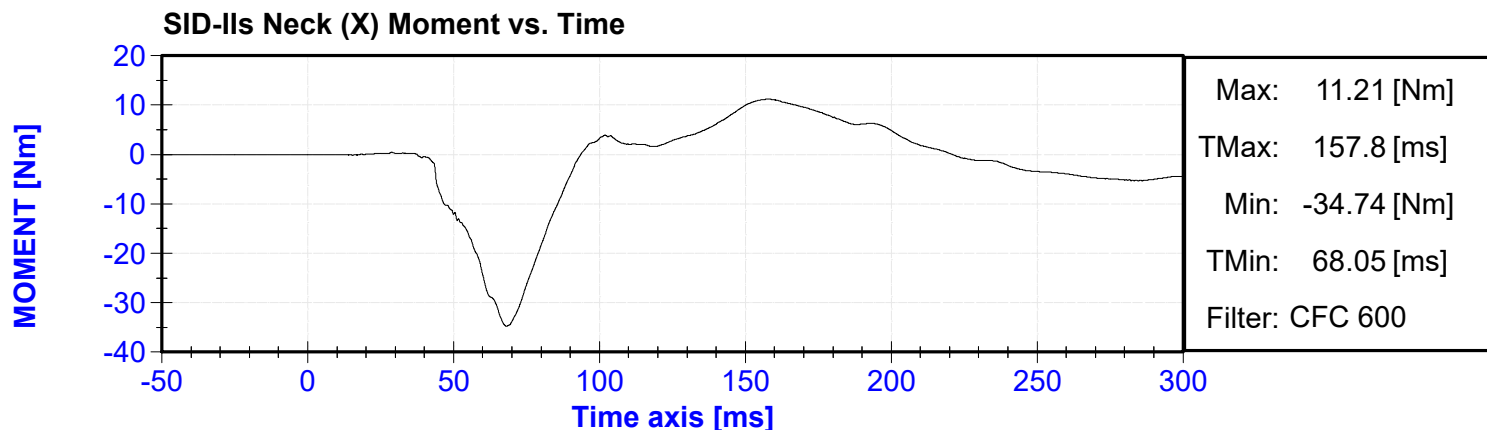
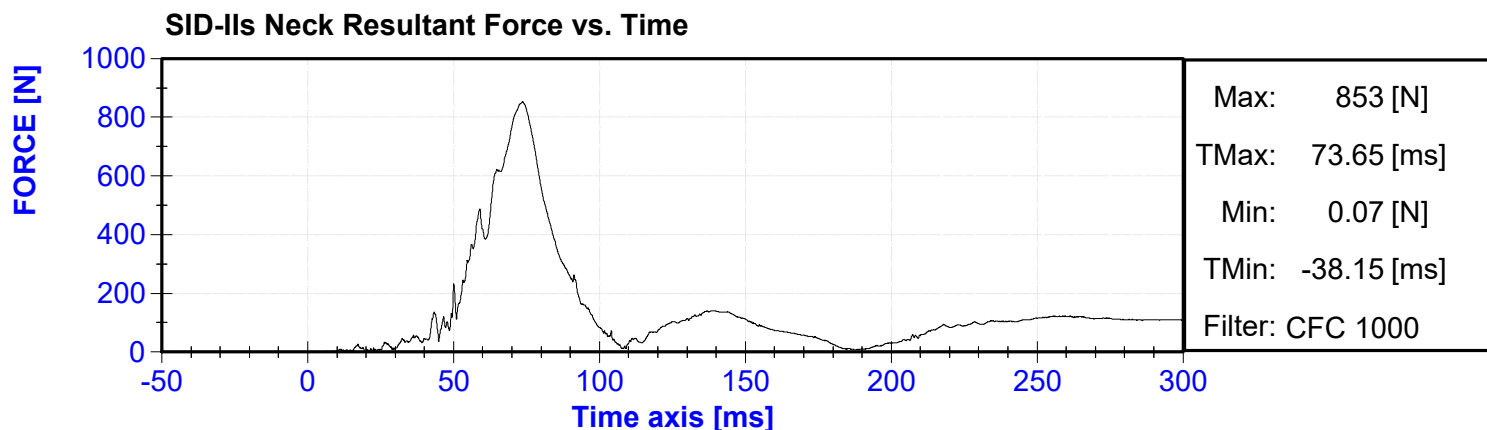
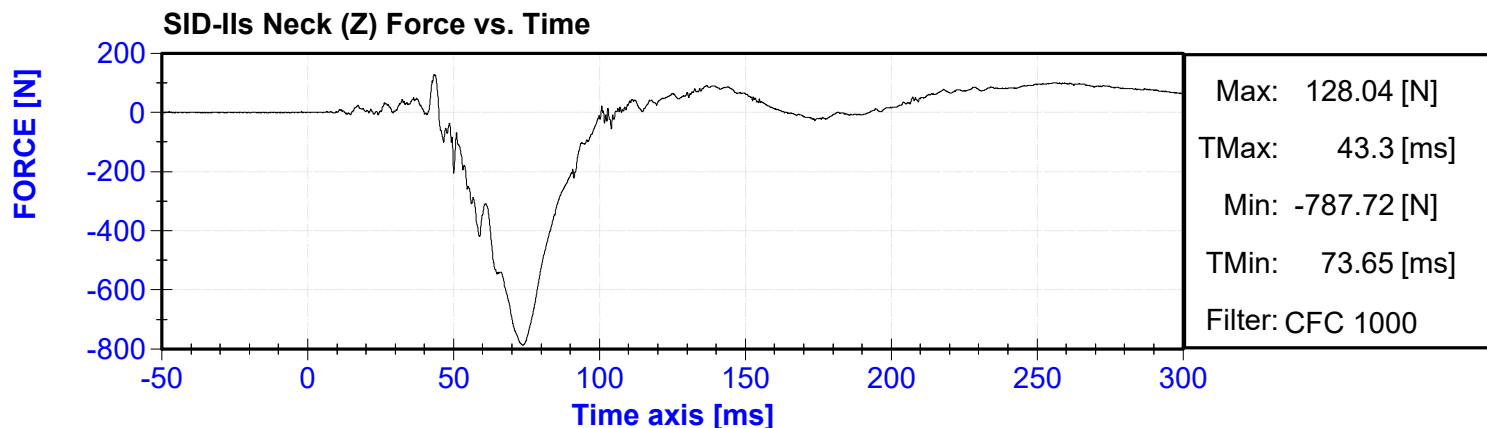


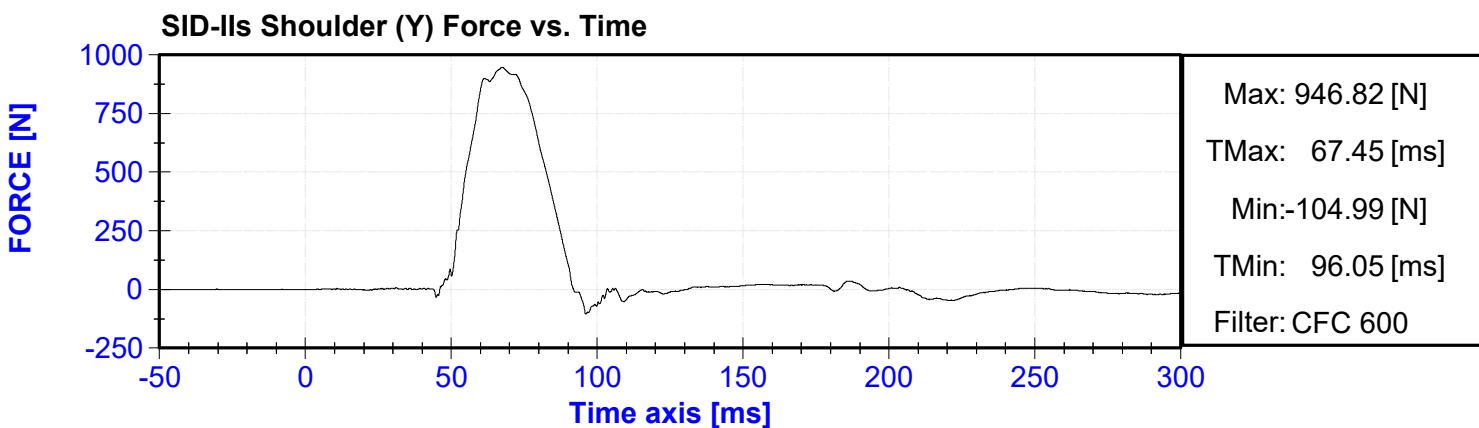
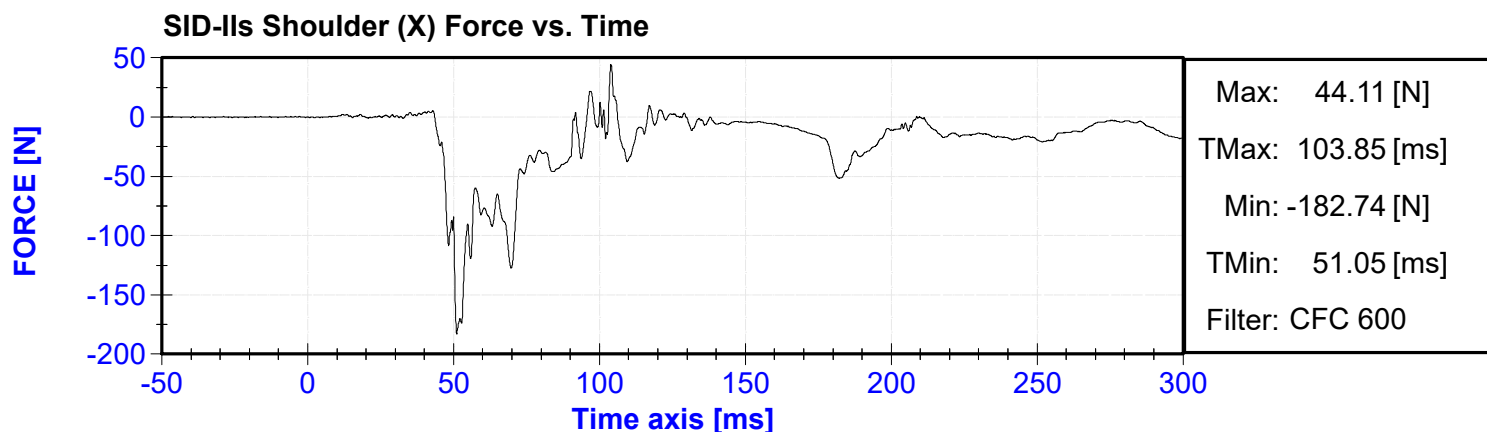
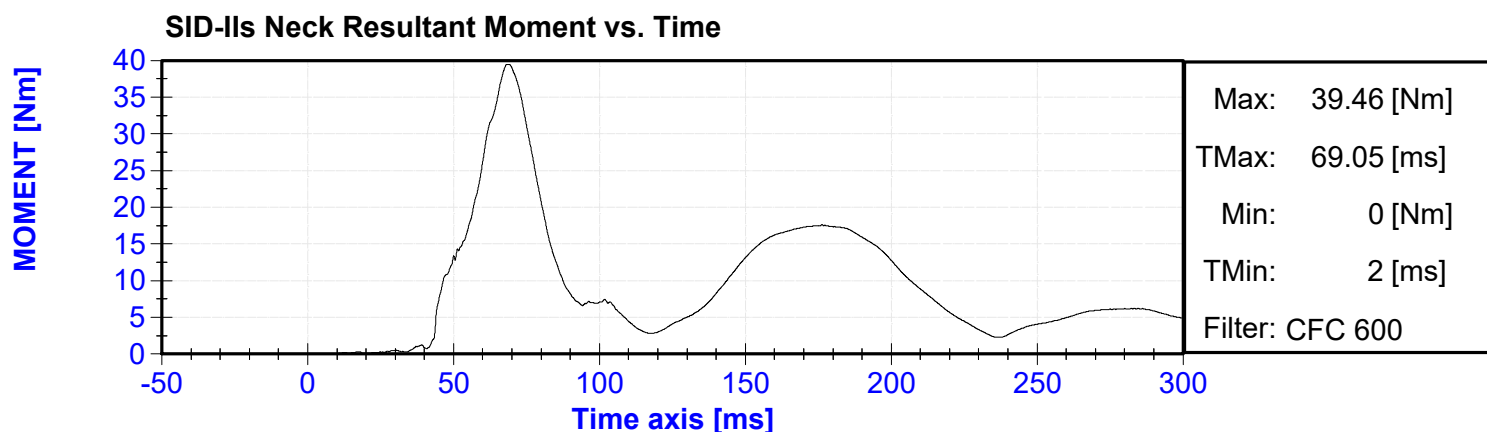
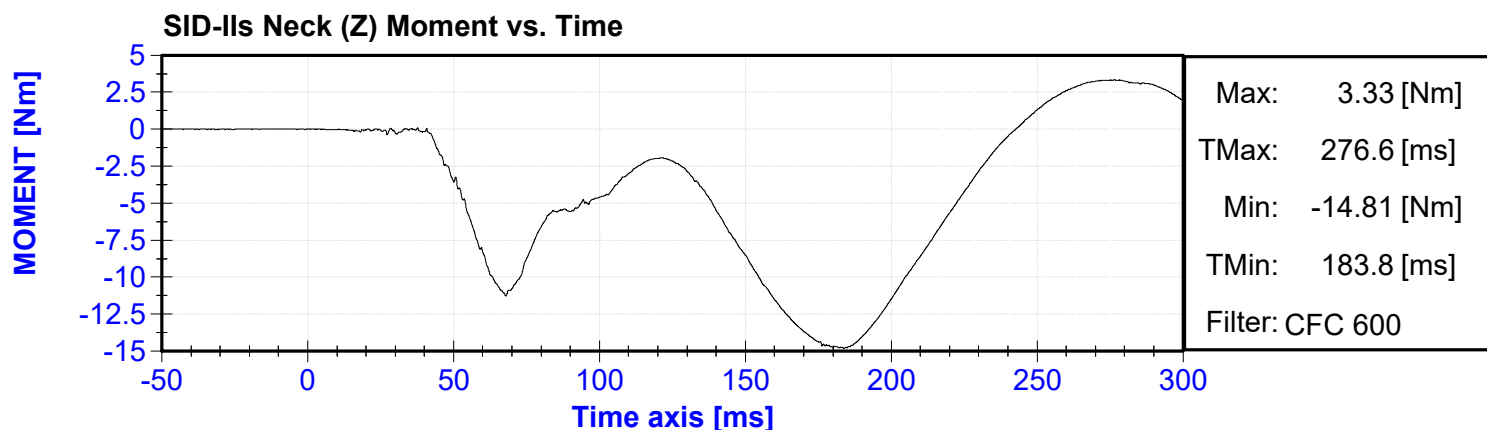
ANGULAR VEL [deg/s]

SID-IIs Head (Y) Angular Velocity vs. Time

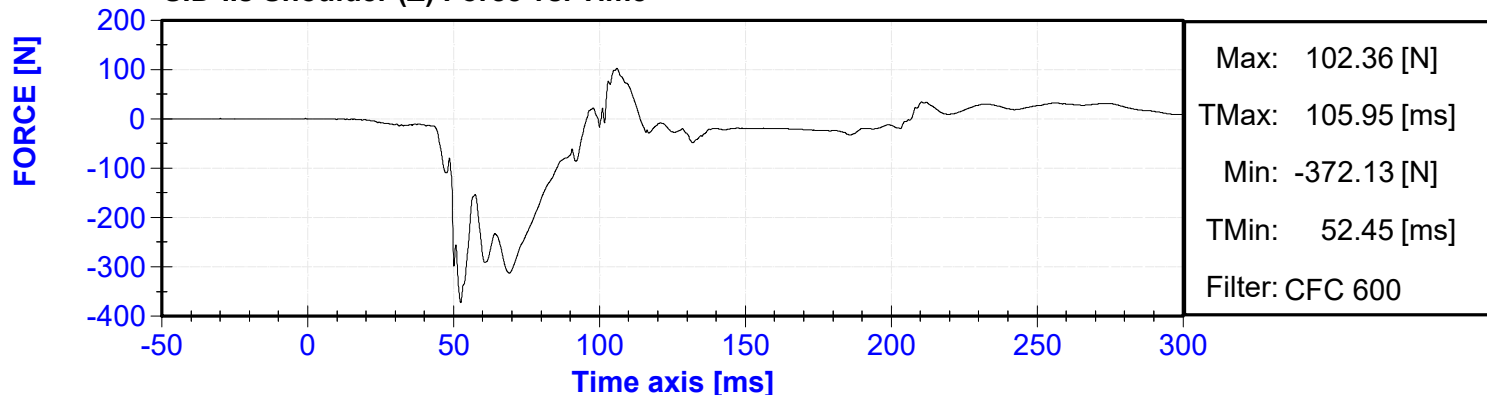




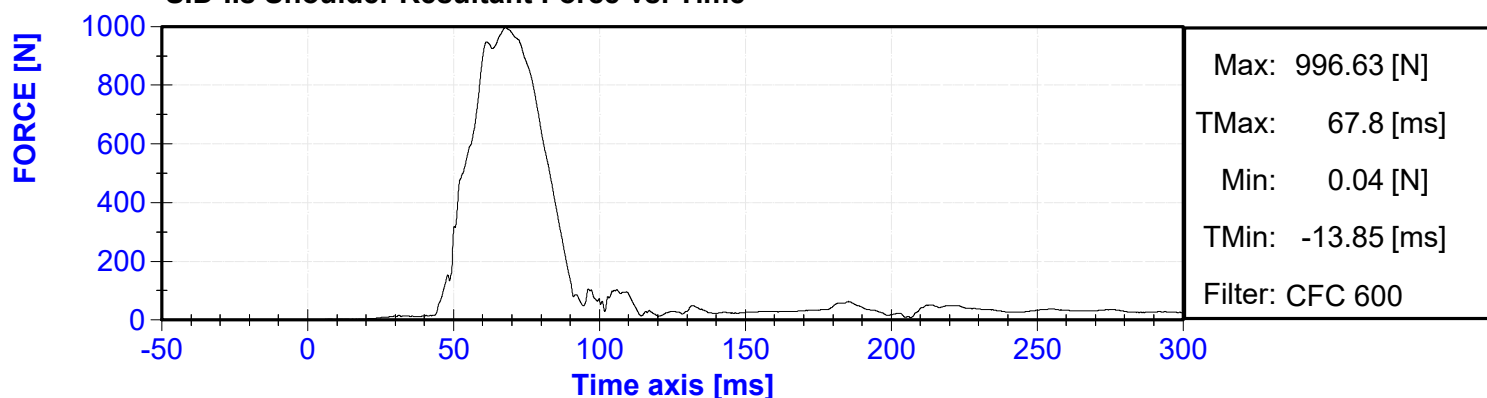




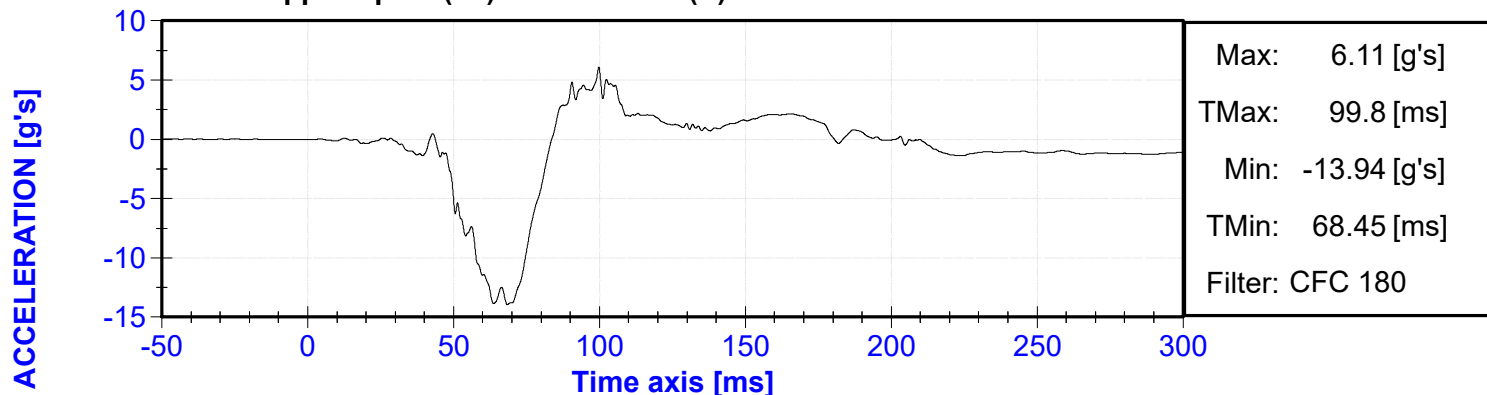
SID-IIs Shoulder (Z) Force vs. Time



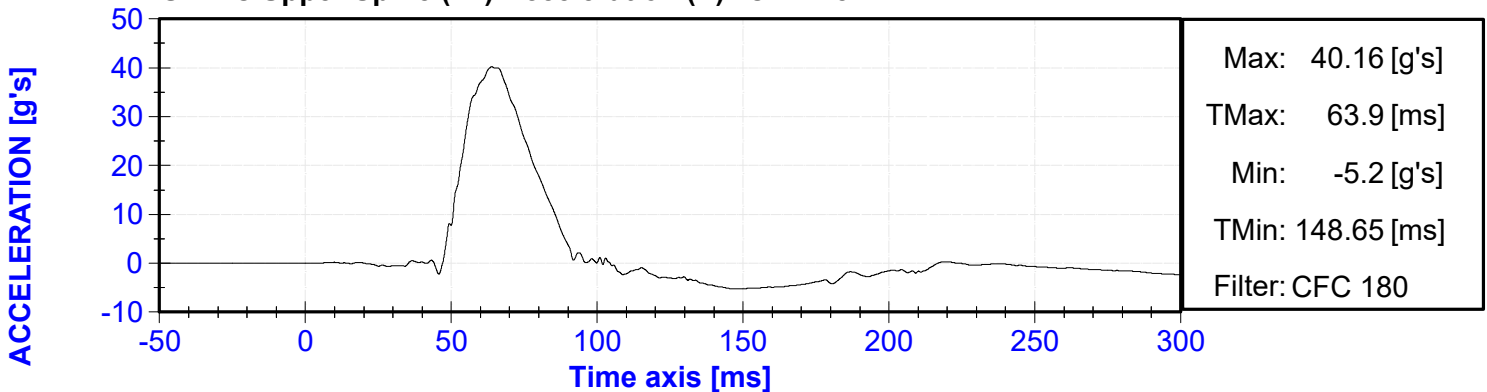
SID-IIs Shoulder Resultant Force vs. Time



SID-IIs Upper Spine (T1) Acceleration (X) vs. Time

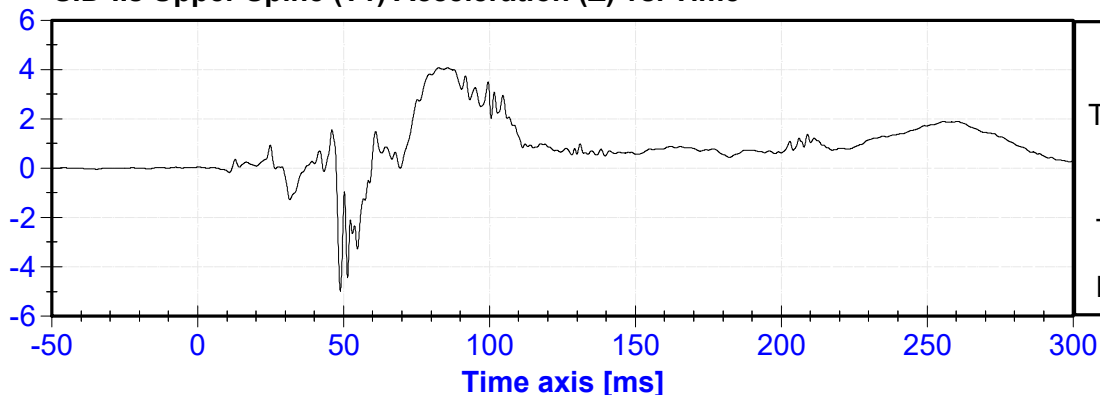


SID-IIs Upper Spine (T1) Acceleration (Y) vs. Time



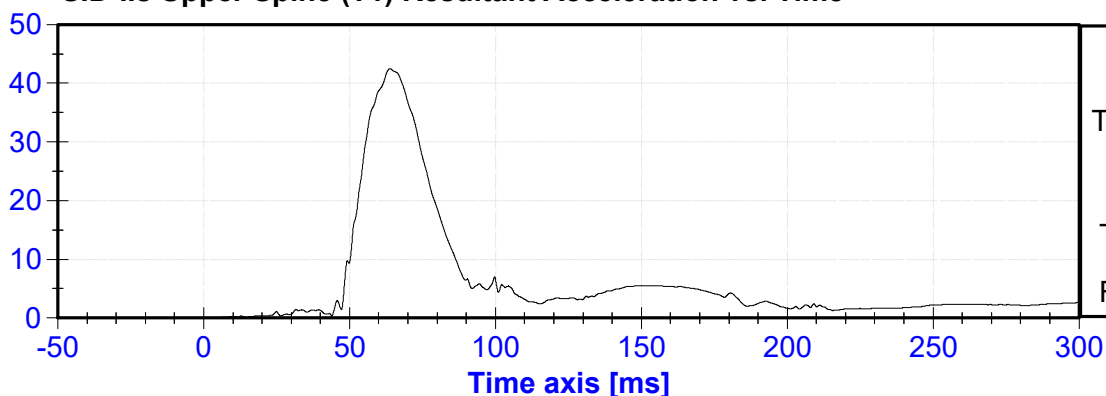
ACCELERATION [g's]

SID-IIs Upper Spine (T1) Acceleration (Z) vs. Time



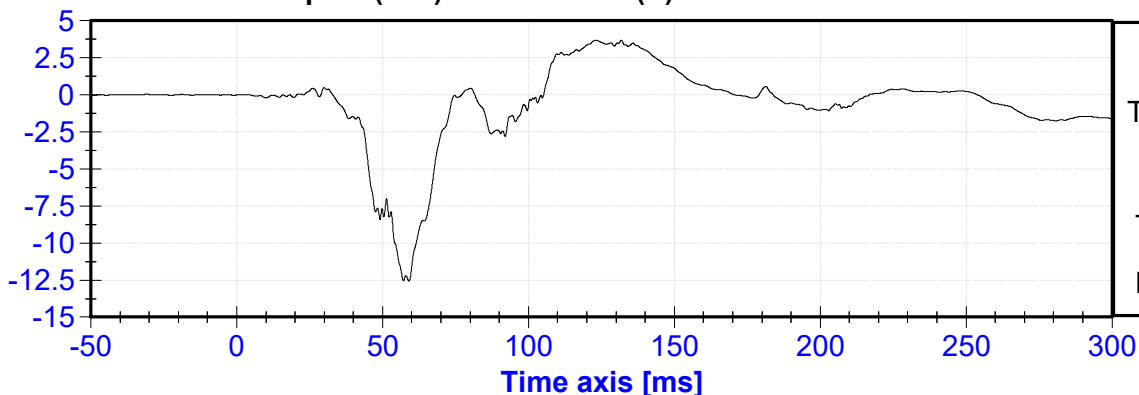
ACCELERATION [g's]

SID-IIs Upper Spine (T1) Resultant Acceleration vs. Time



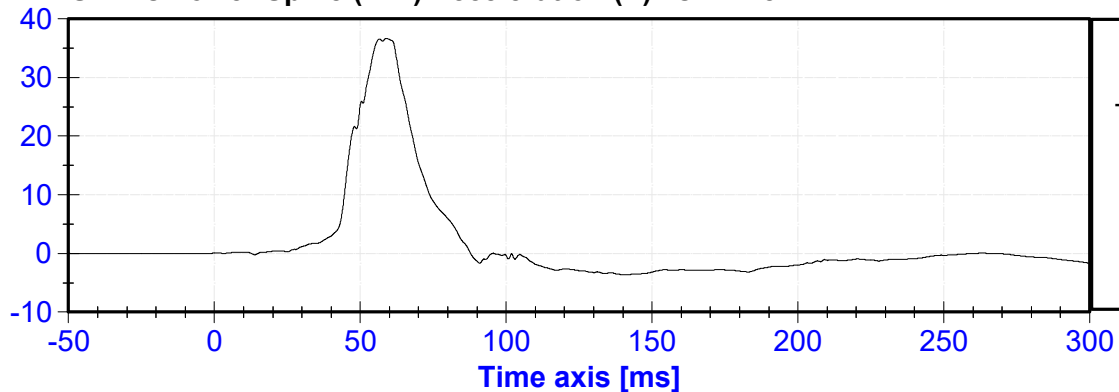
ACCELERATION [g's]

SID-IIs Lower Spine (T12) Acceleration (X) vs. Time



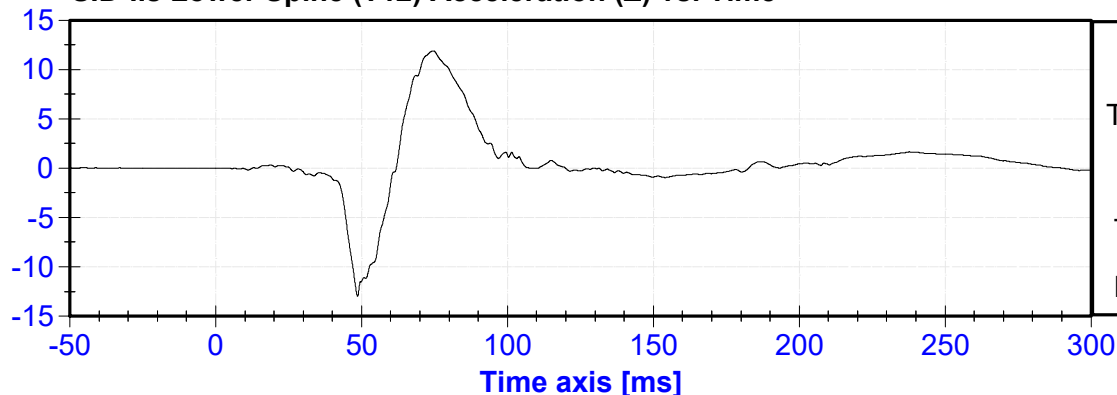
ACCELERATION [g's]

SID-IIs Lower Spine (T12) Acceleration (Y) vs. Time



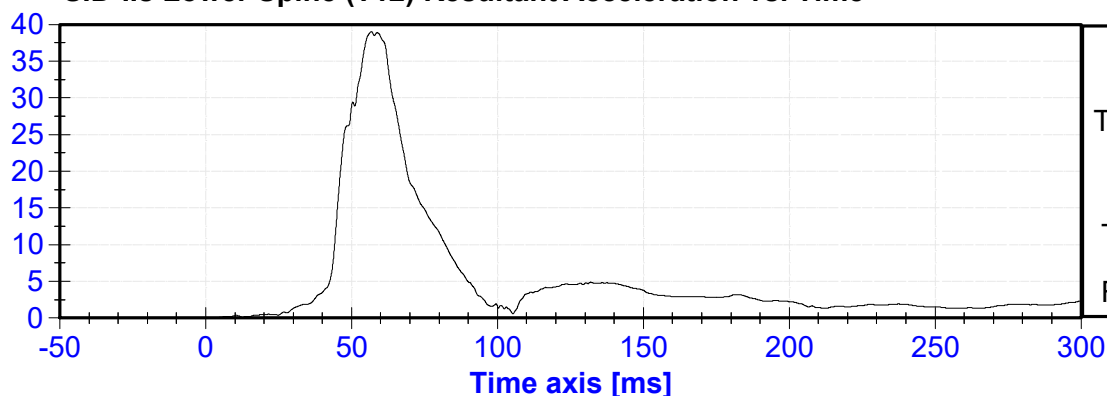
SID-IIs Lower Spine (T12) Acceleration (Z) vs. Time

ACCELERATION [g's]



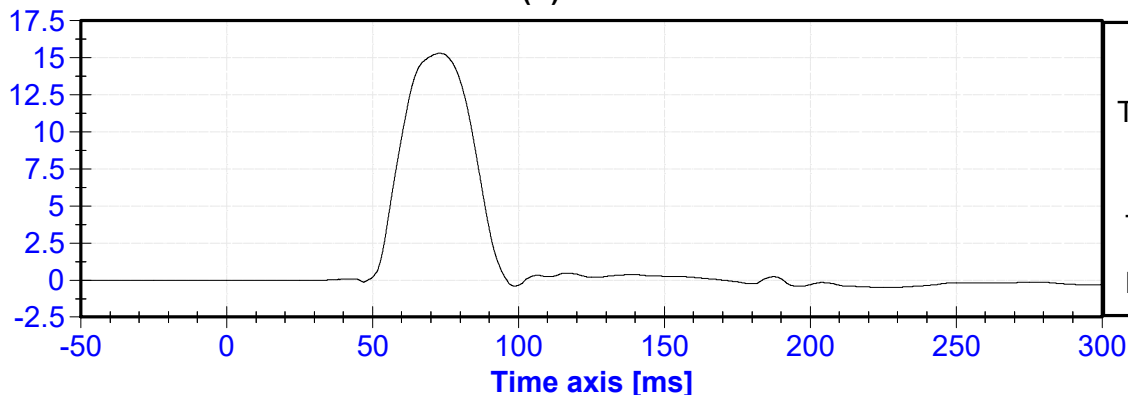
SID-IIs Lower Spine (T12) Resultant Acceleration vs. Time

ACCELERATION [g's]



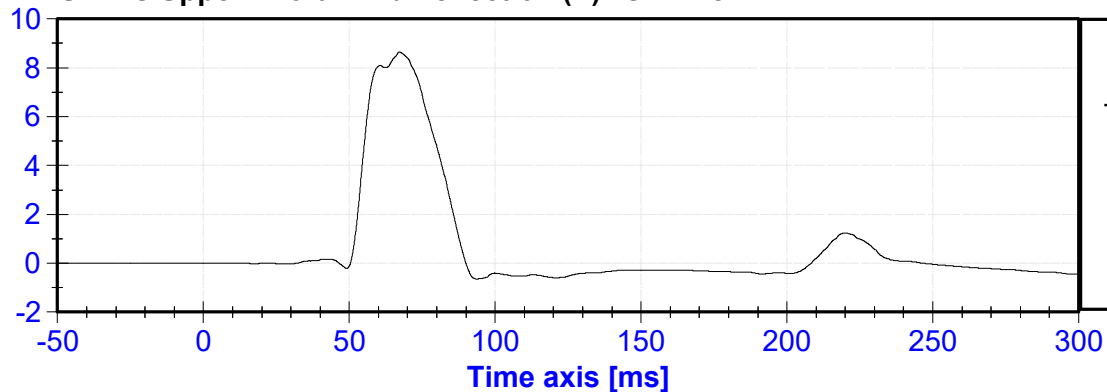
SID-IIs Shoulder Rib Deflection (Y) vs. Time

DISPLACEMENT [mm]



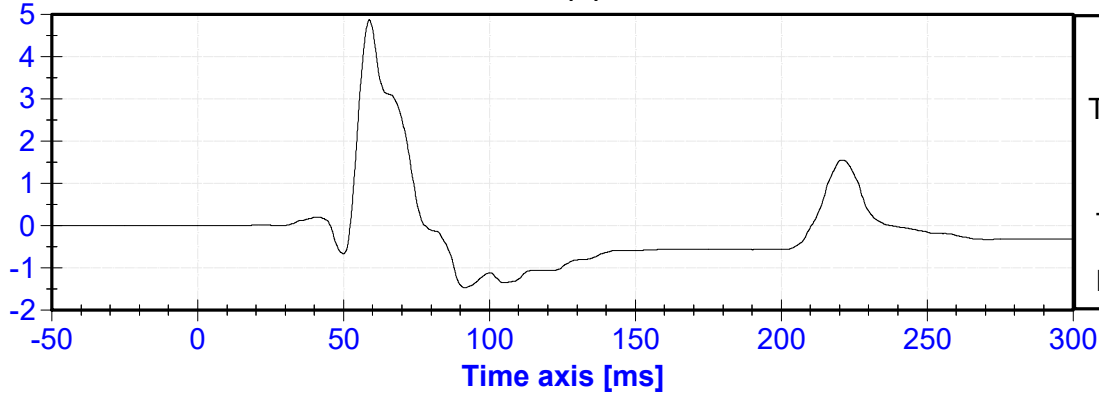
SID-IIs Upper Thorax Rib Deflection (Y) vs. Time

DISPLACEMENT [mm]



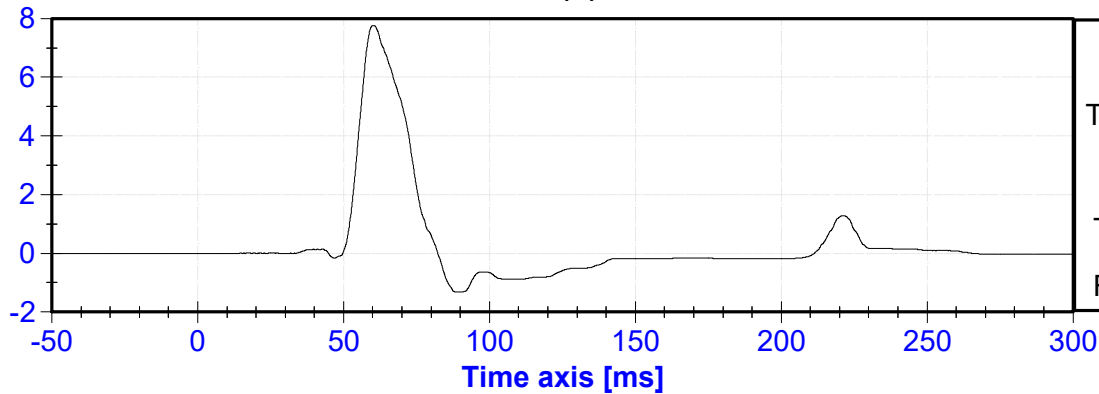
SID-IIs Middle Thorax Rib Deflection (Y) vs. Time

DISPLACEMENT [mm]



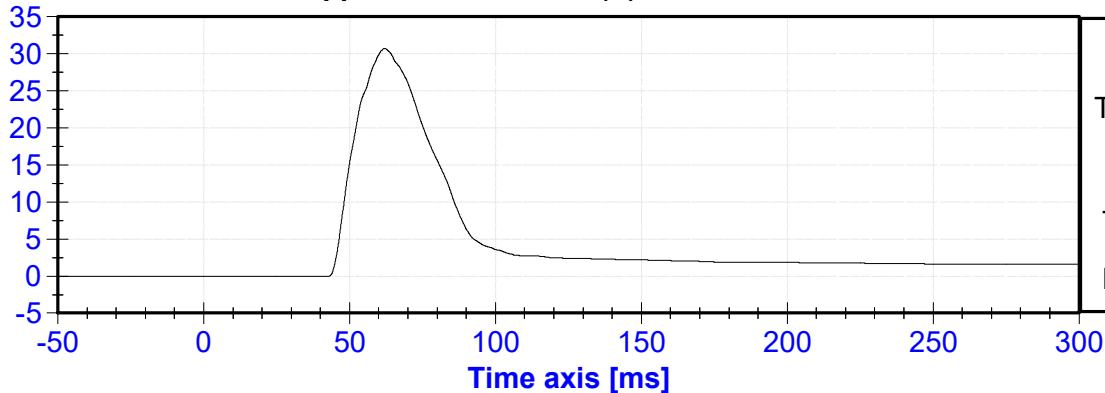
SID-IIs Lower Thorax Rib Deflection (Y) vs. Time

DISPLACEMENT [mm]



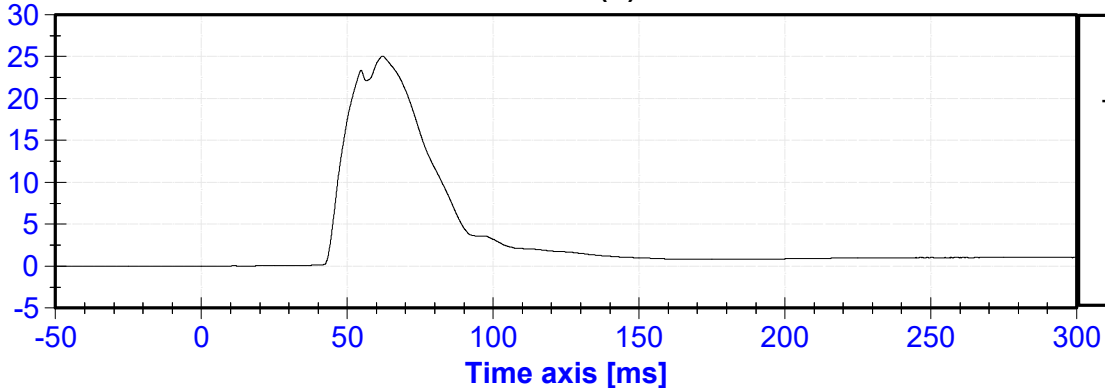
SID-IIs Abdomen Upper Rib Deflection (Y) vs. Time

DISPLACEMENT [mm]

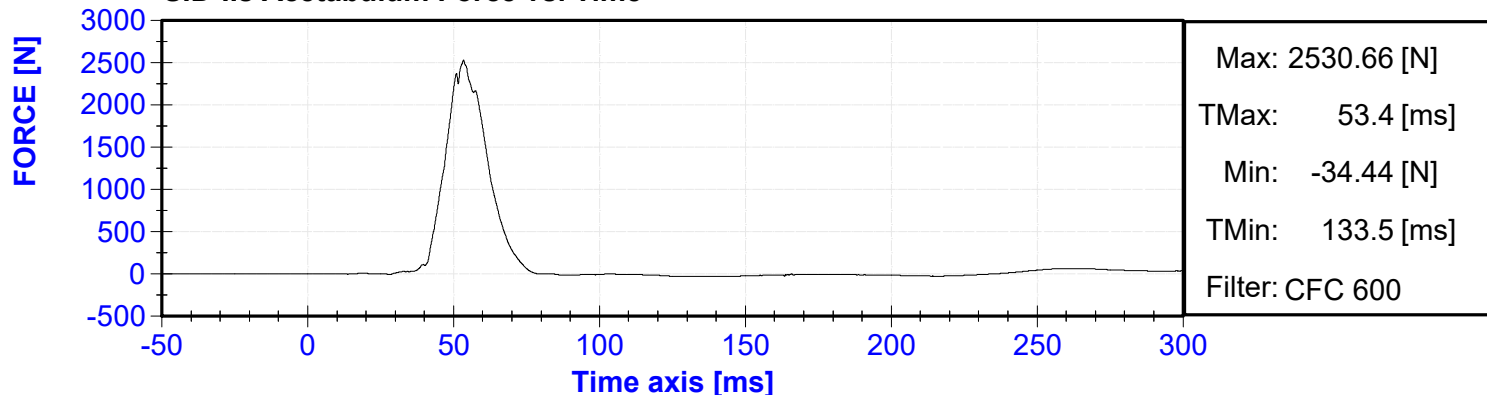


SID-IIs Abdomen Lower Rib Deflection (Y) vs. Time

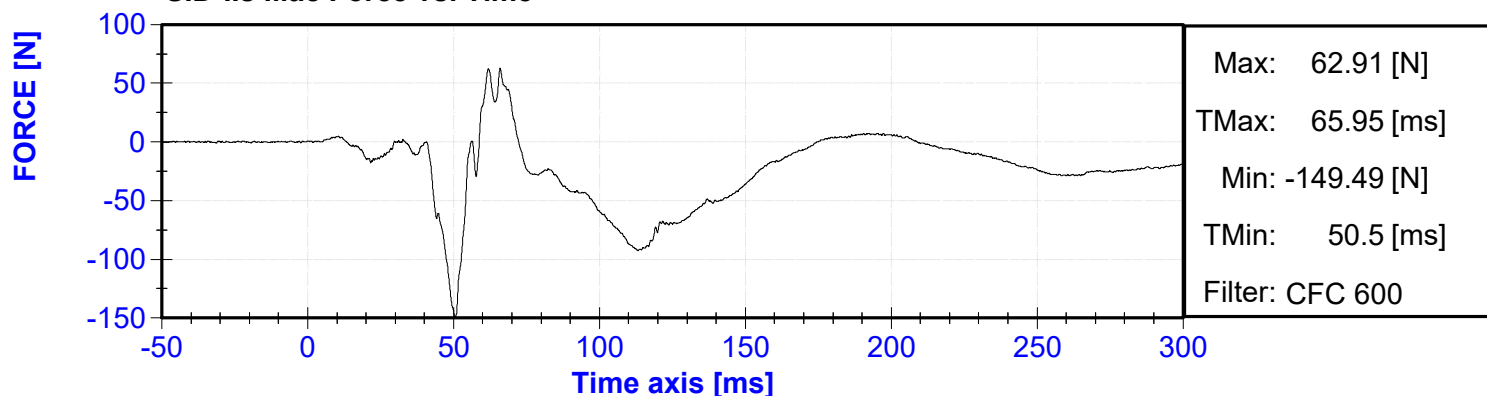
DISPLACEMENT [mm]



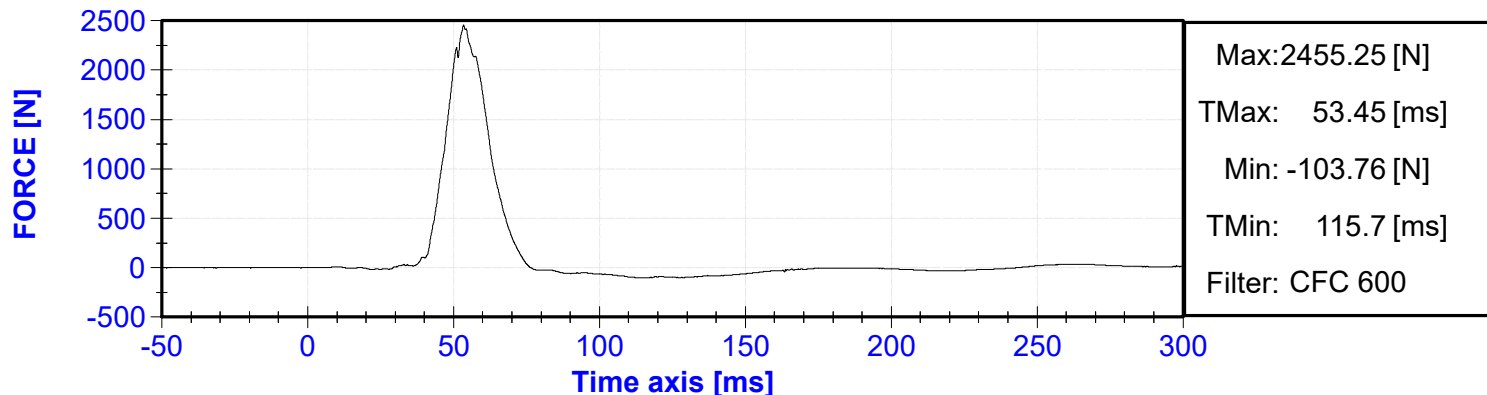
SID-Ils Acetabulum Force vs. Time



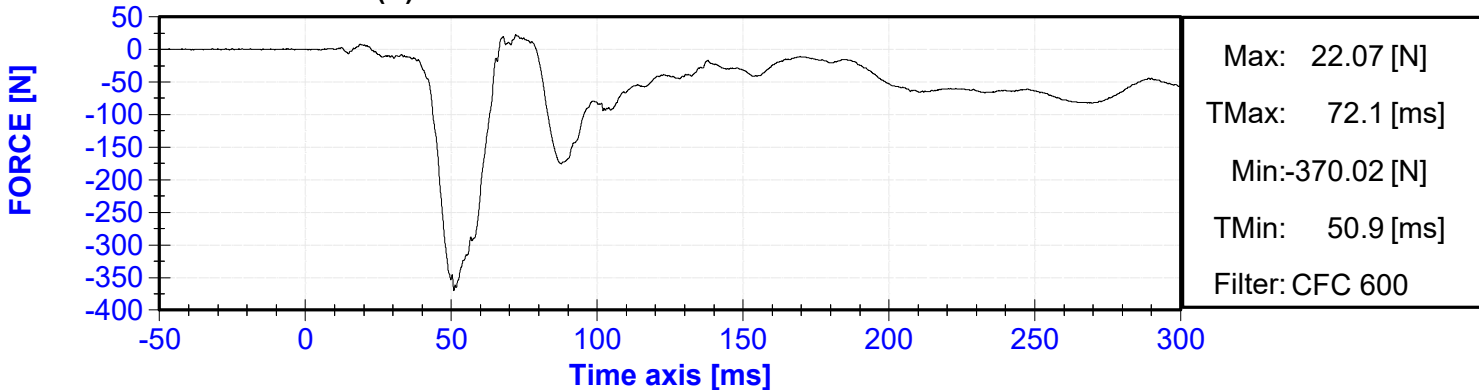
SID-Ils Iliac Force vs. Time



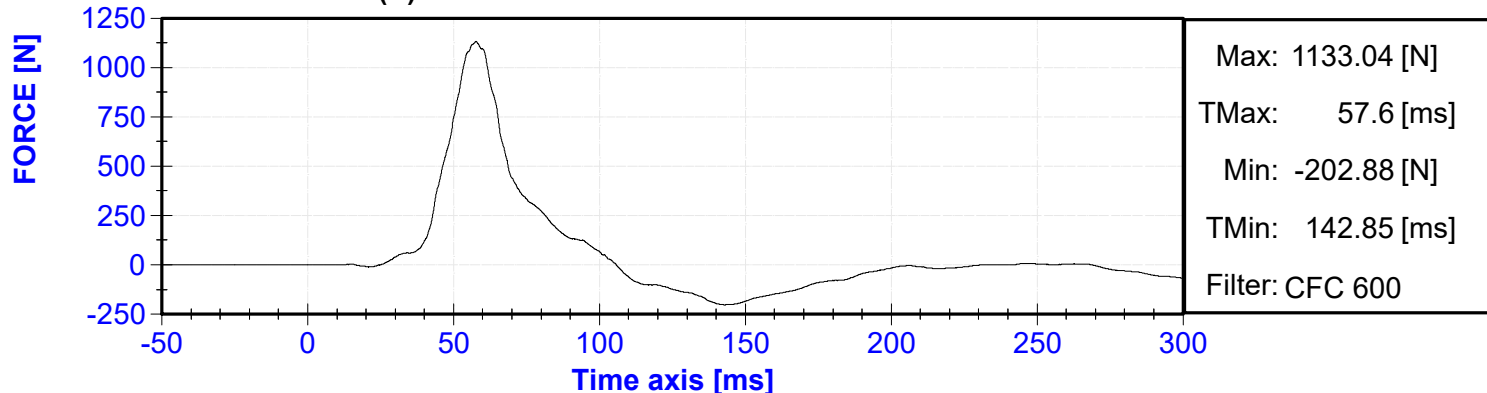
SID-Ils Sum of Iliac and Acetabulum Forces vs. Time



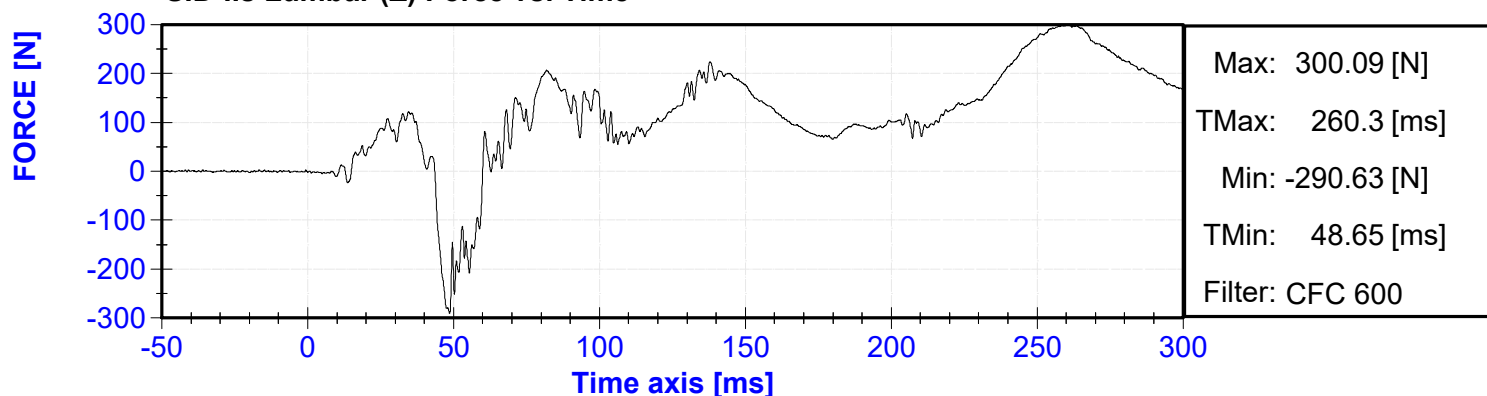
SID-Ils Lumbar (X) Force vs. Time



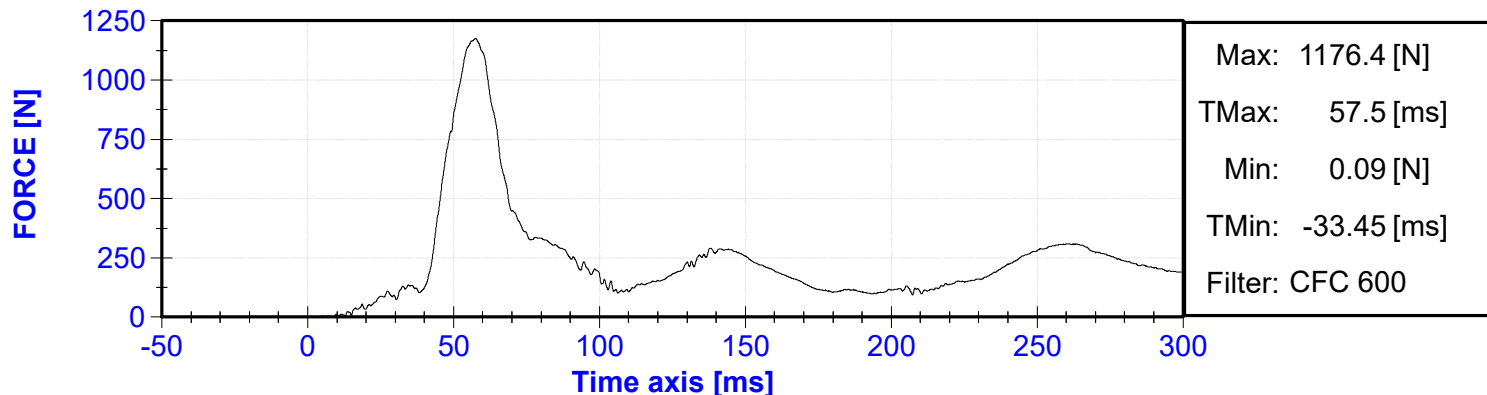
SID-IIs Lumbar (Y) Force vs. Time



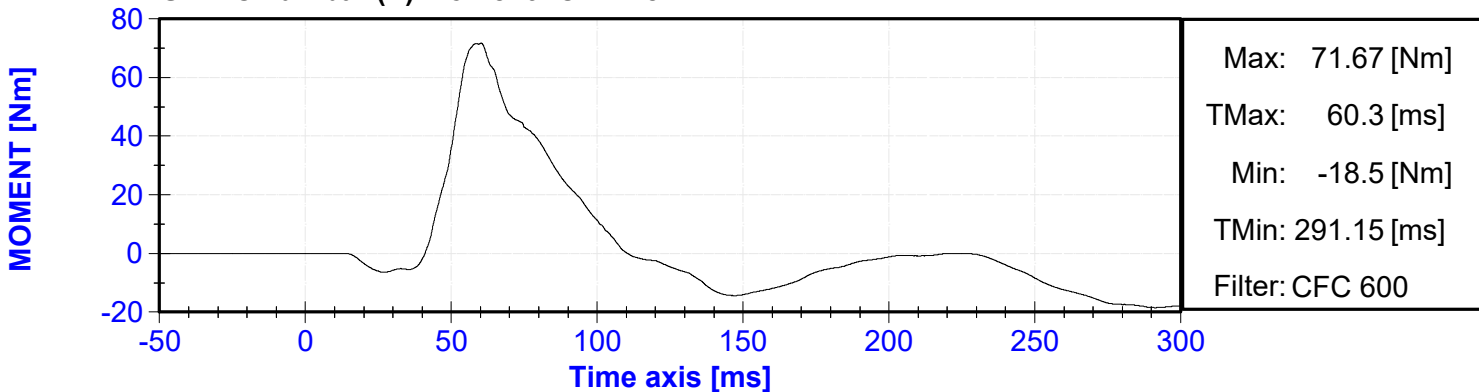
SID-IIs Lumbar (Z) Force vs. Time

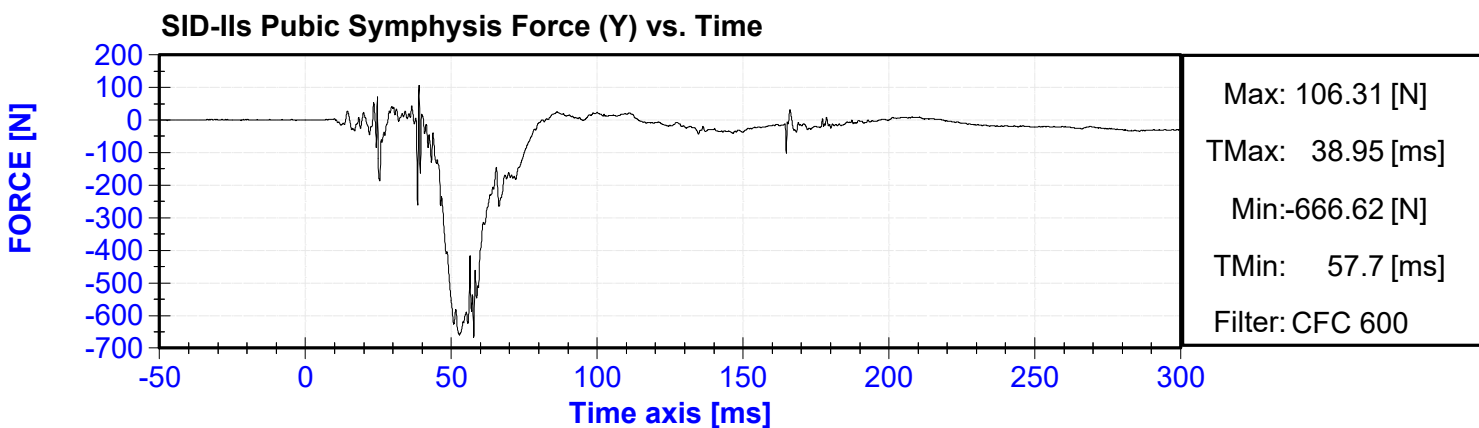
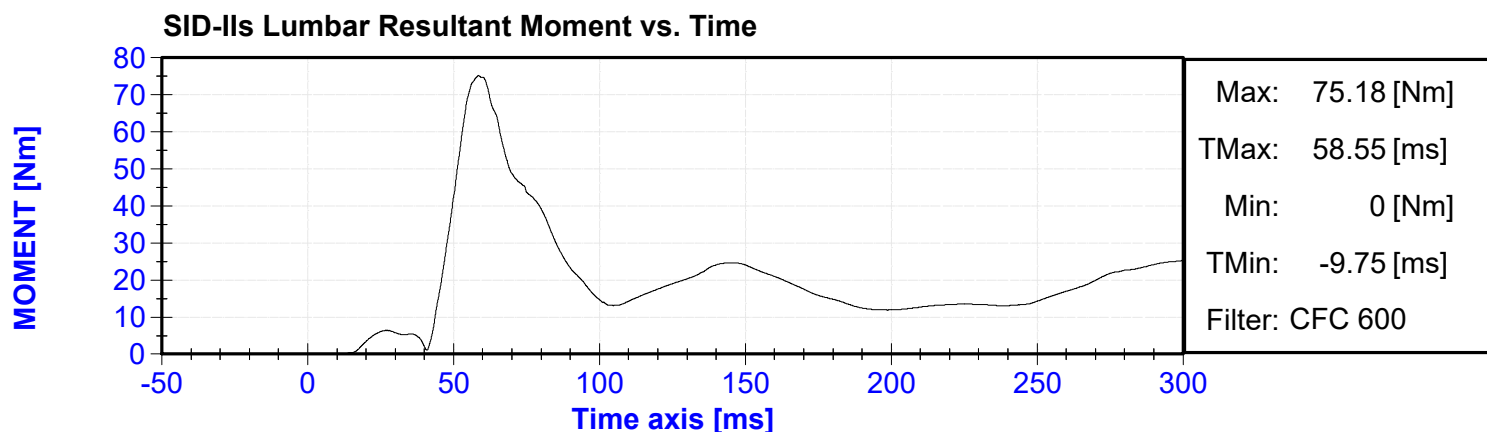
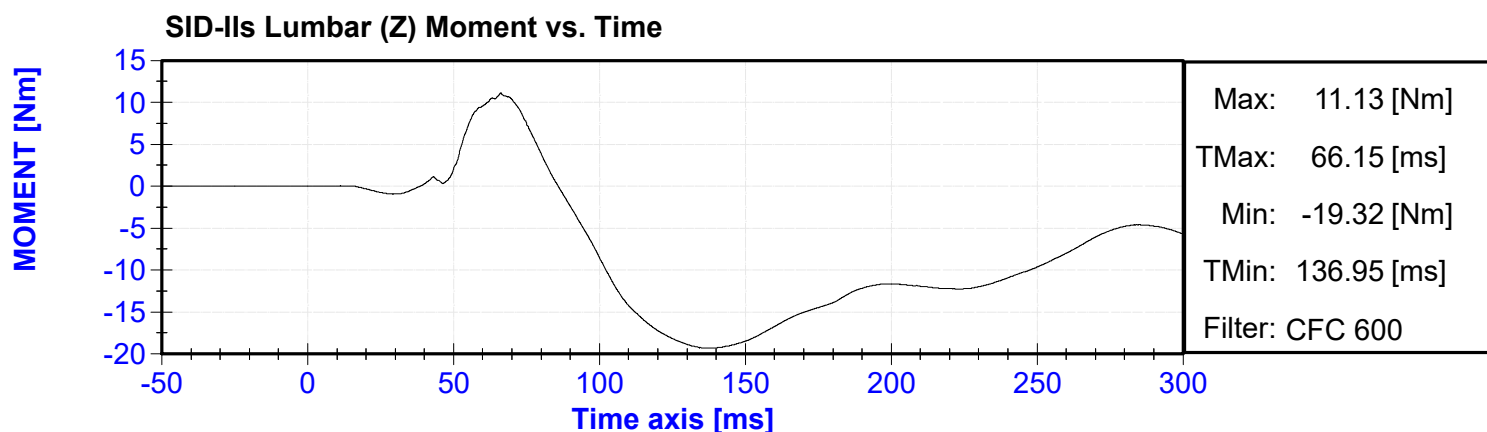
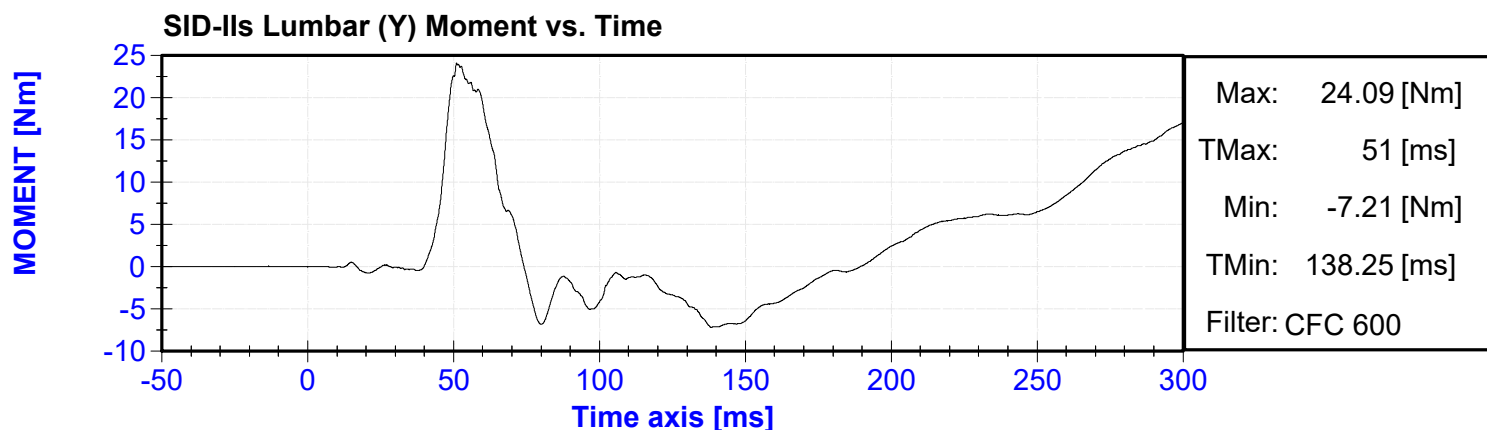


SID-IIs Lumbar Resultant Force vs. Time



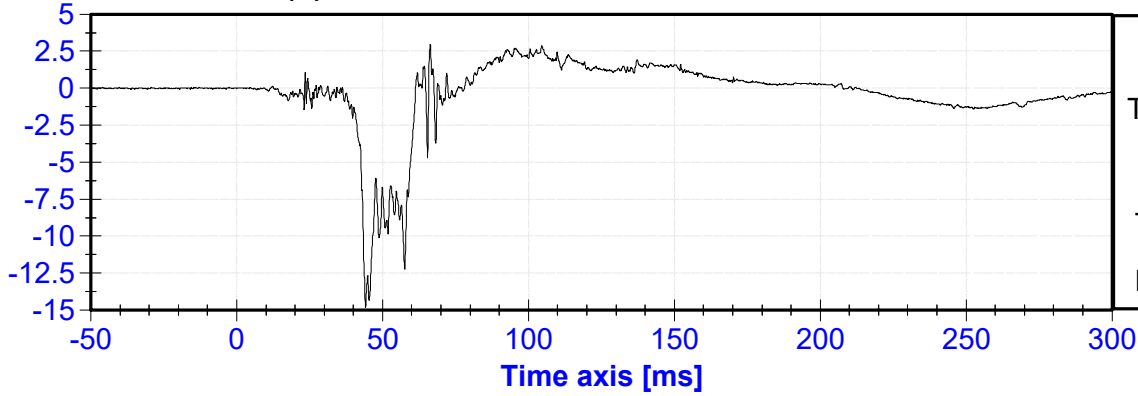
SID-IIs Lumbar (X) Moment vs. Time





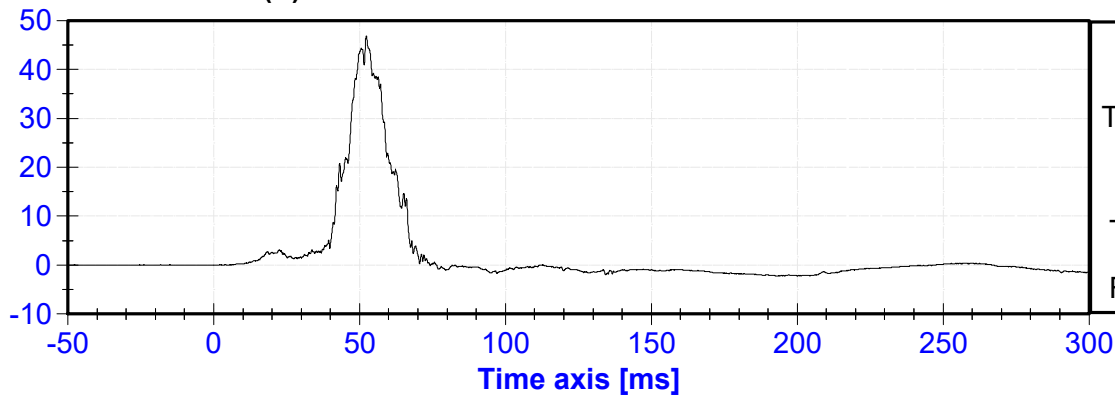
ACCELERATION [g's]

SID-IIs Pelvic (X) Acceleration vs. Time



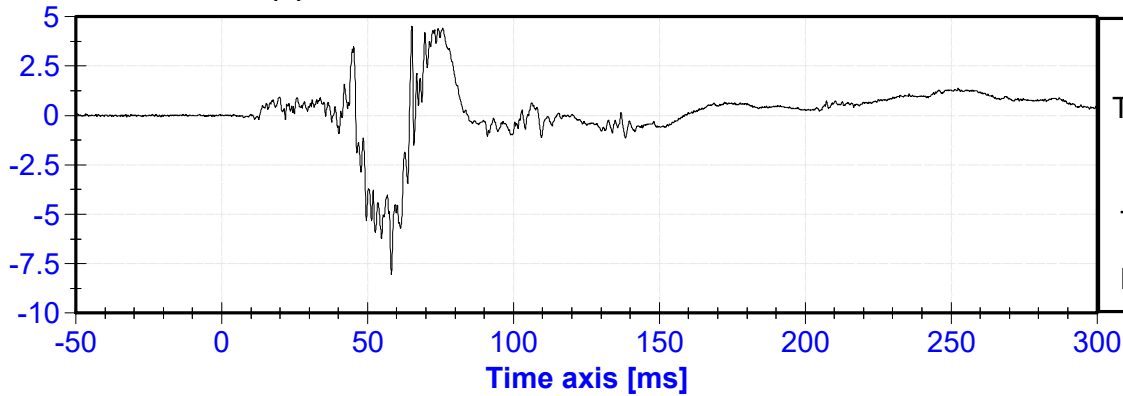
ACCELERATION [g's]

SID-IIs Pelvic (Y) Acceleration vs. Time



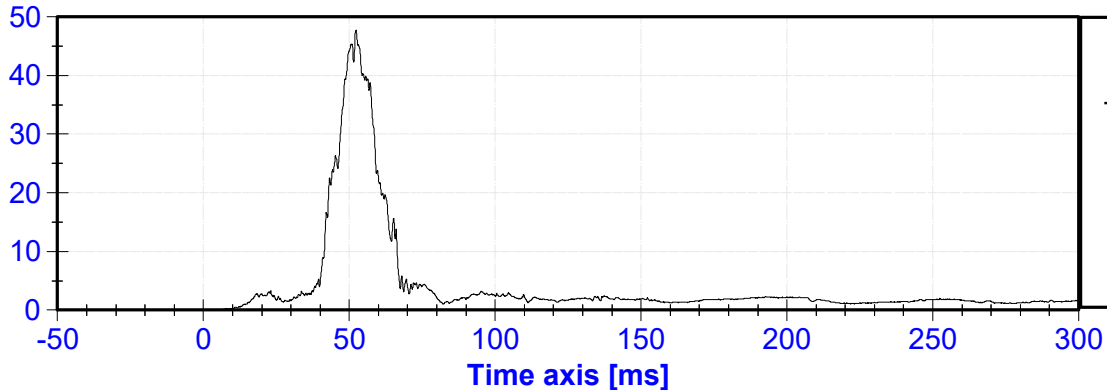
ACCELERATION [g's]

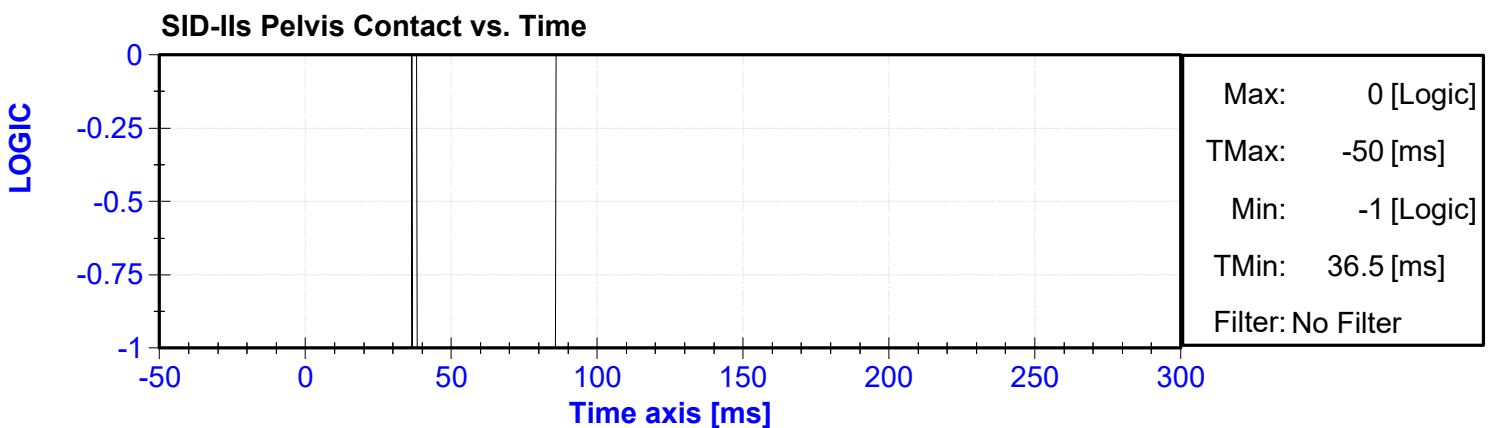
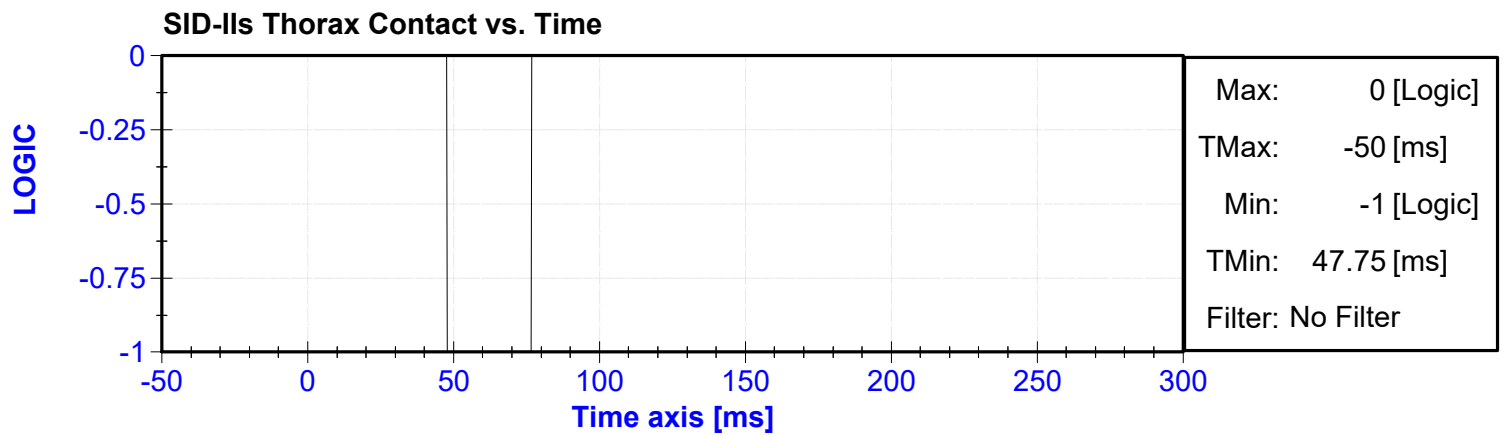
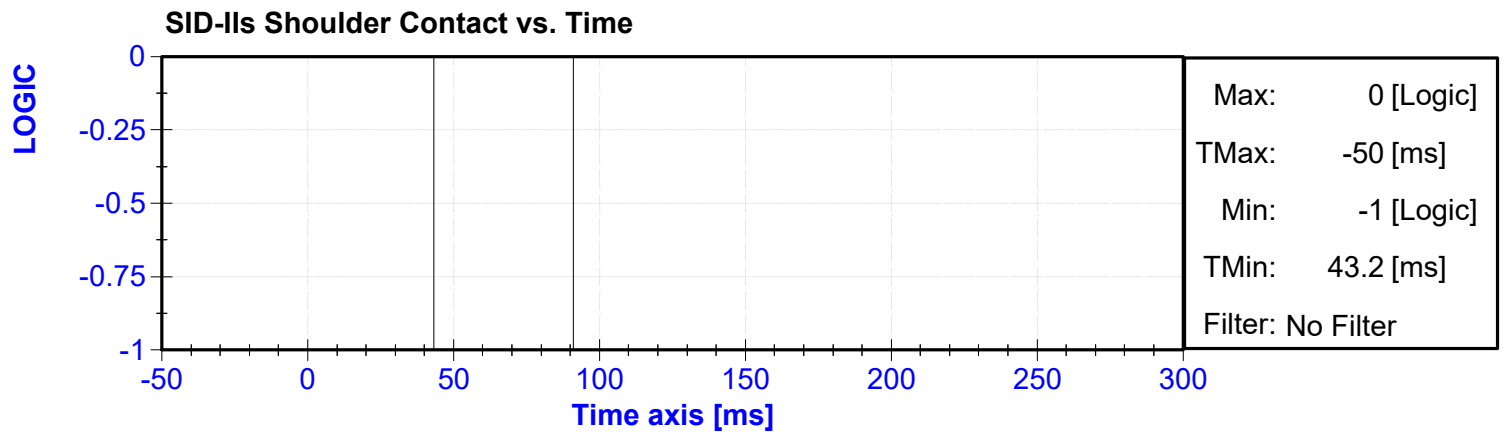
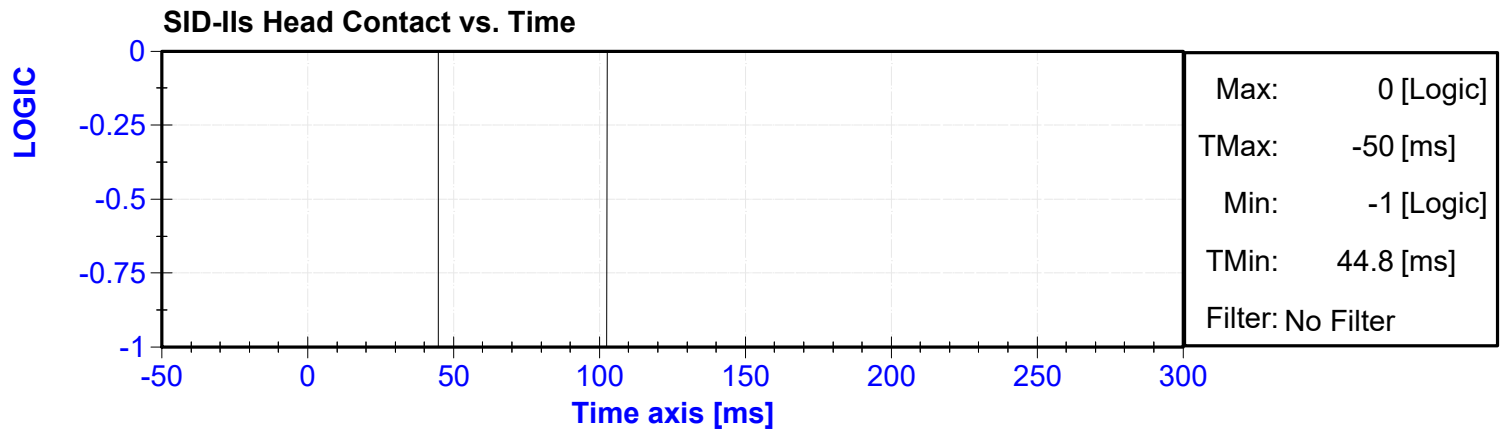
SID-IIs Pelvic (Z) Acceleration vs. Time

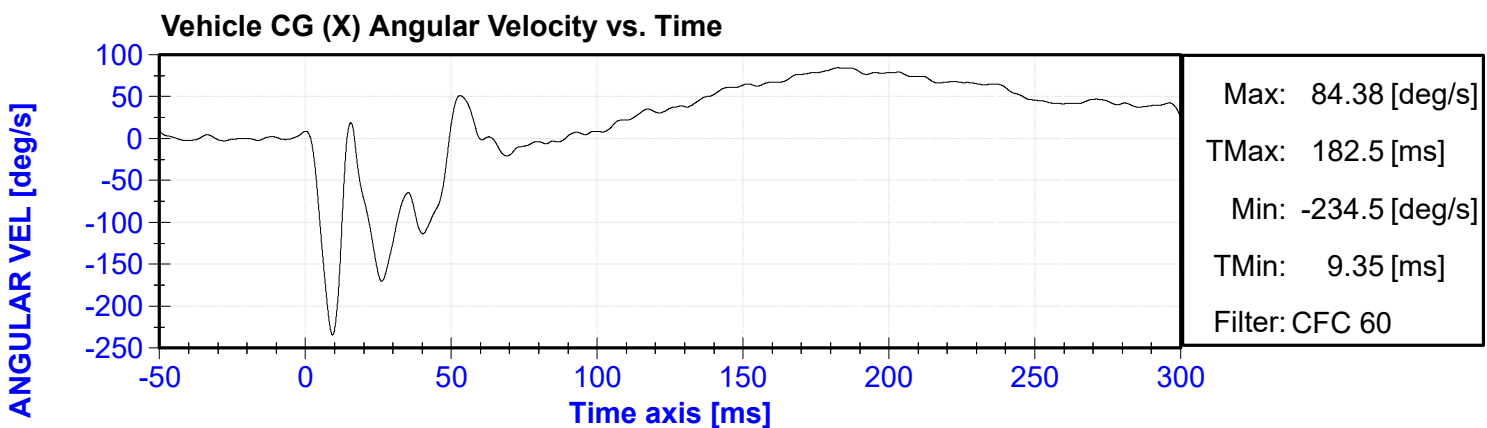
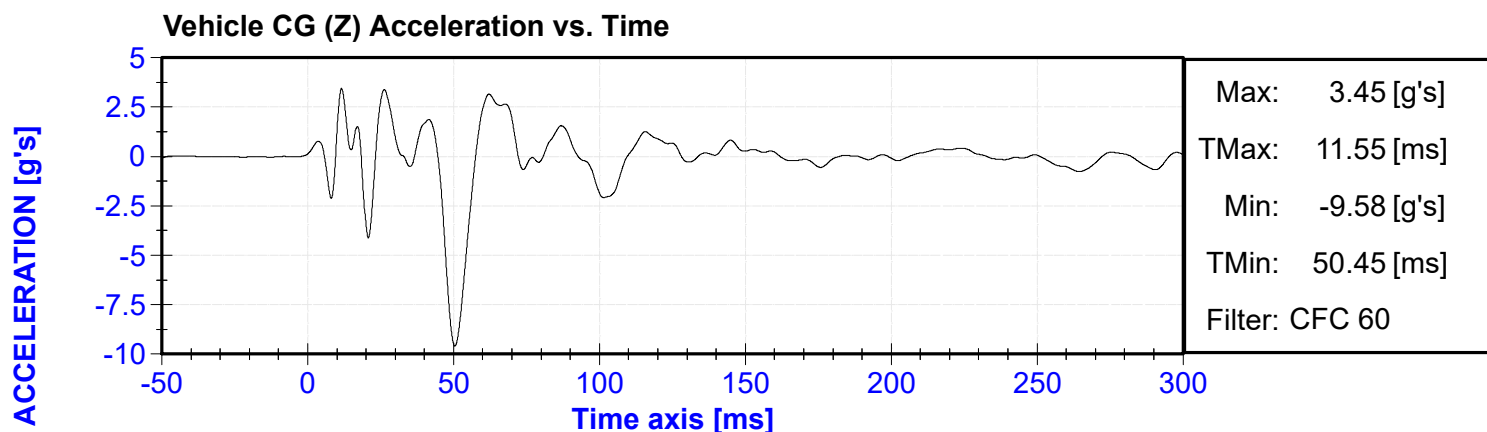
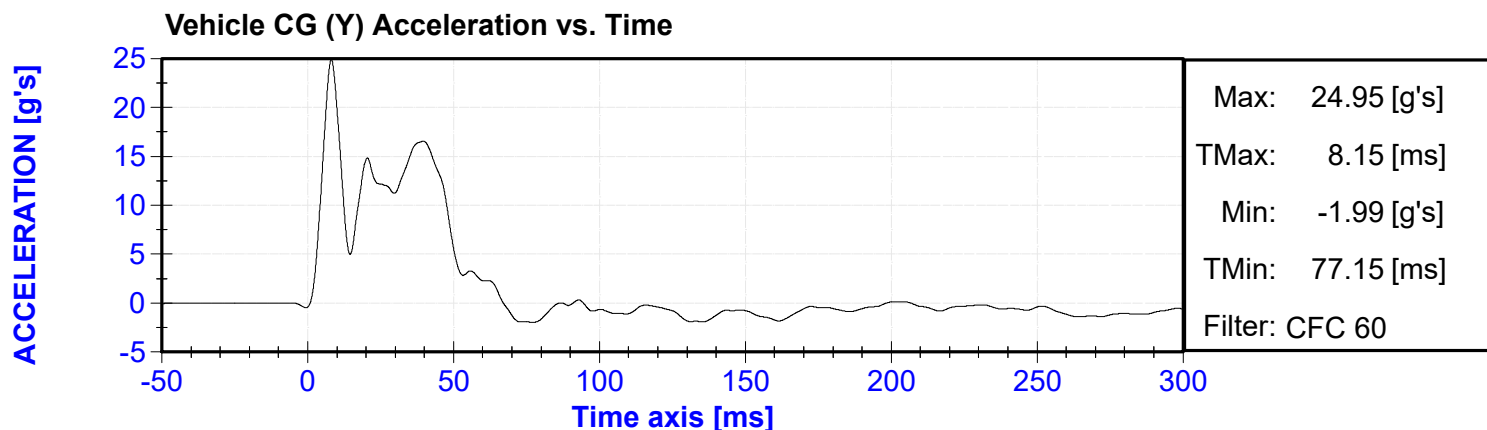
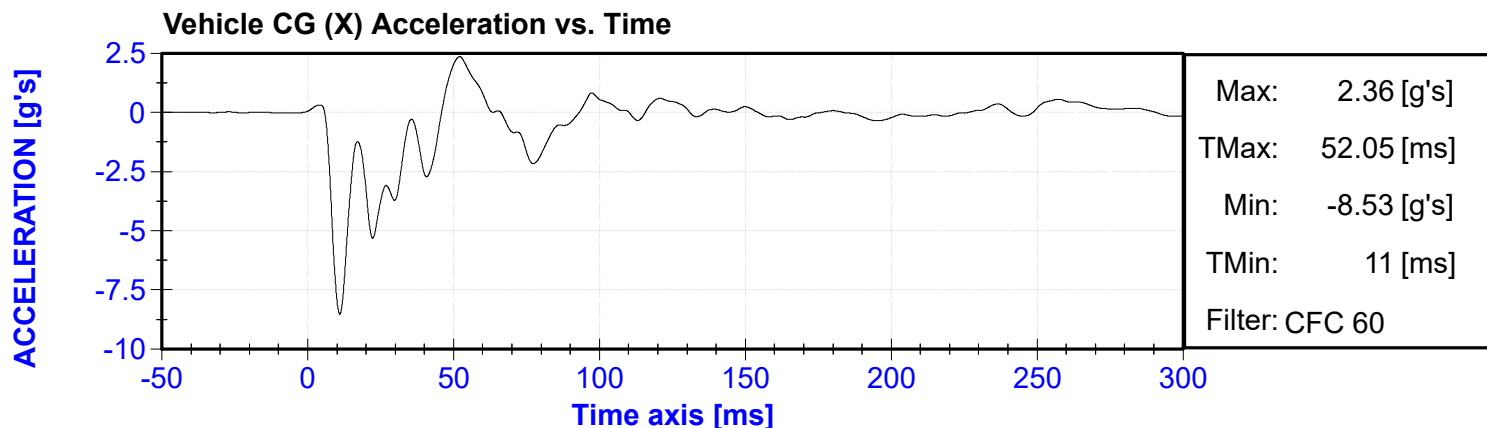


ACCELERATION [g's]

SID-IIs Pelvic Resultant Acceleration vs. Time

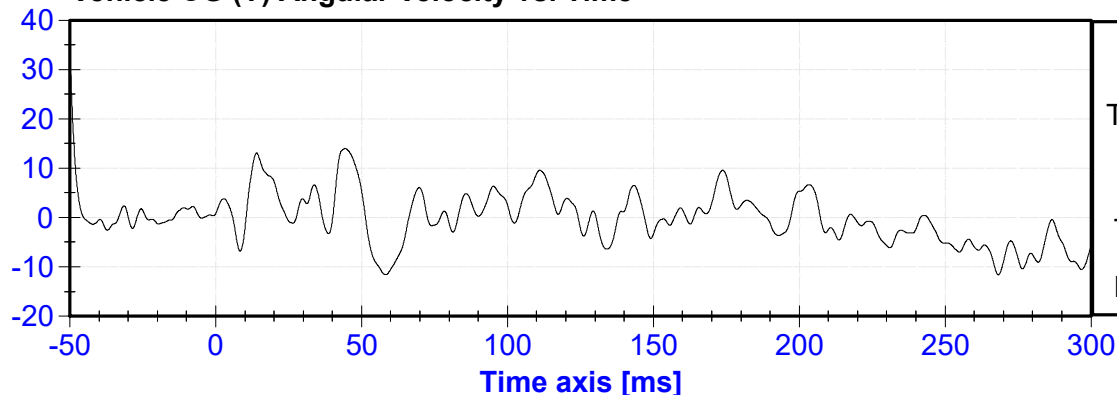






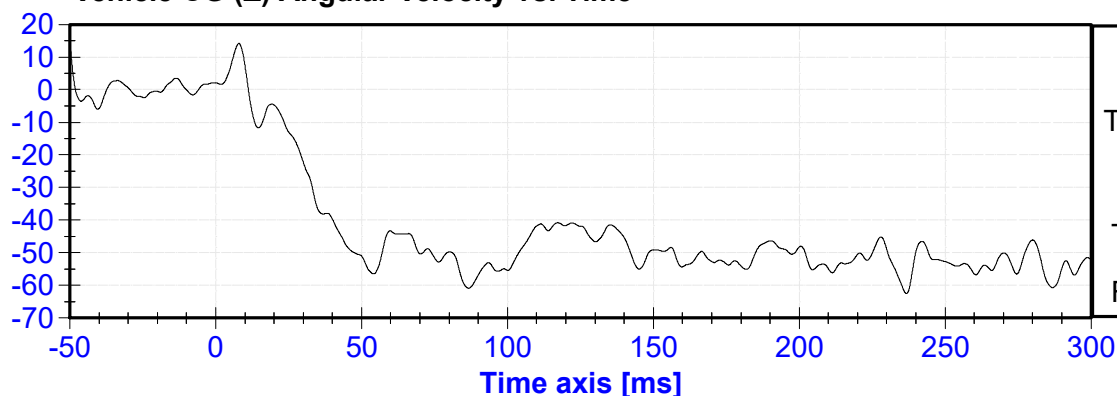
ANGULAR VEL [deg/s]

Vehicle CG (Y) Angular Velocity vs. Time



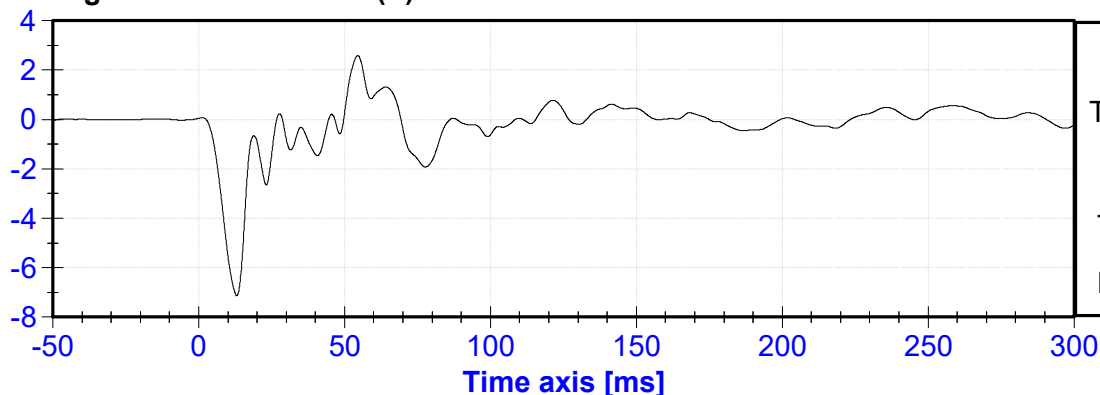
ANGULAR VEL [deg/s]

Vehicle CG (Z) Angular Velocity vs. Time



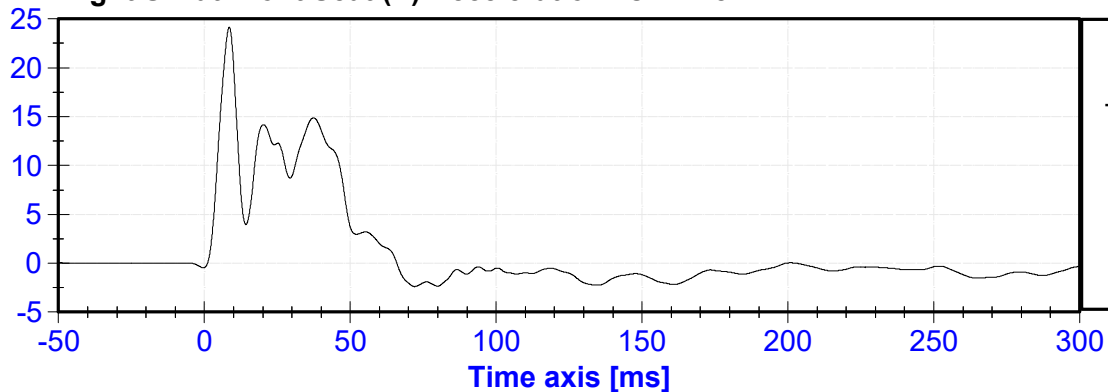
ACCELERATION [g's]

Right Sill at Front Seat (X) Acceleration vs. Time



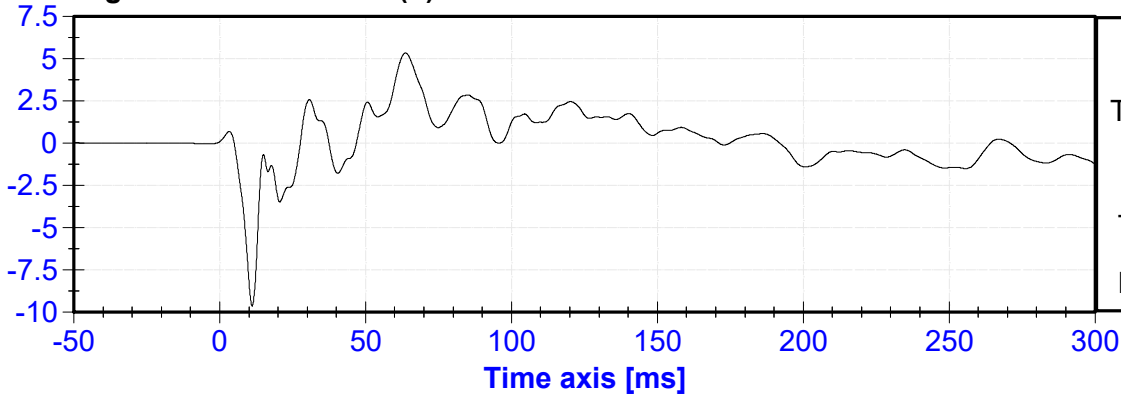
ACCELERATION [g's]

Right Sill at Front Seat (Y) Acceleration vs. Time



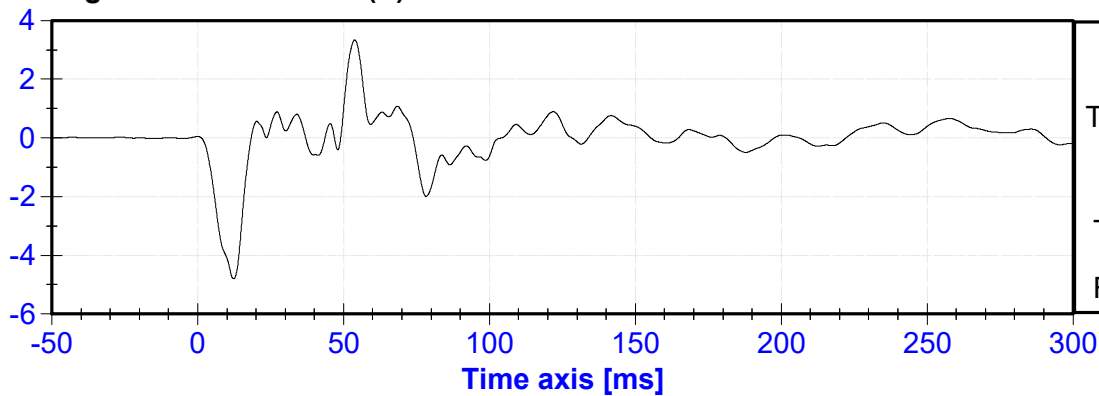
ACCELERATION [g's]

Right Sill at Front Seat (Z) Acceleration vs. Time



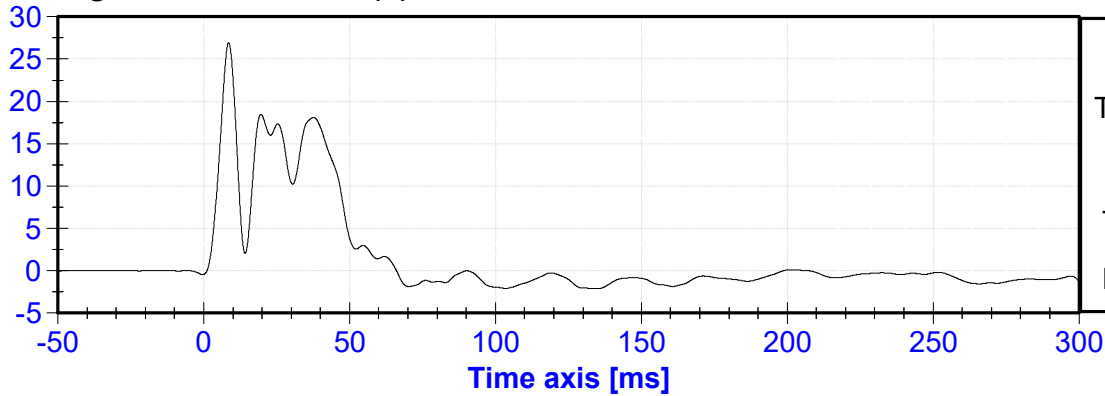
ACCELERATION [g's]

Right Sill at Rear Seat (X) Acceleration vs. Time



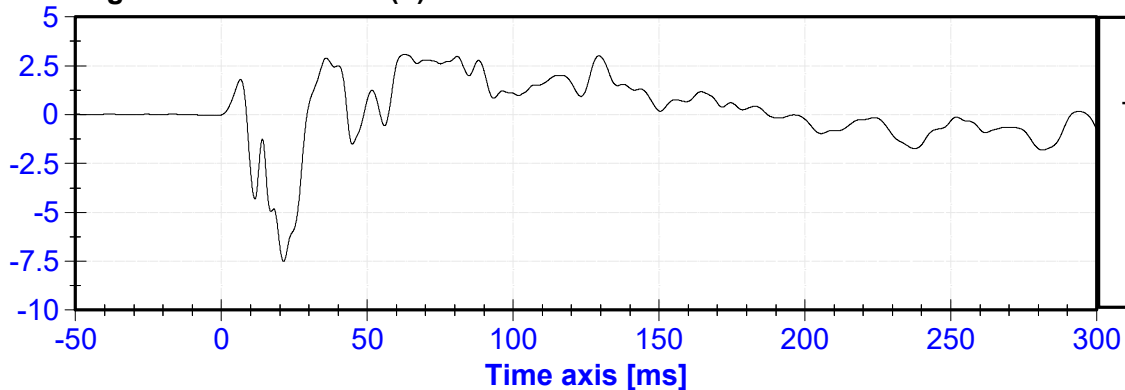
ACCELERATION [g's]

Right Sill at Rear Seat (Y) Acceleration vs. Time



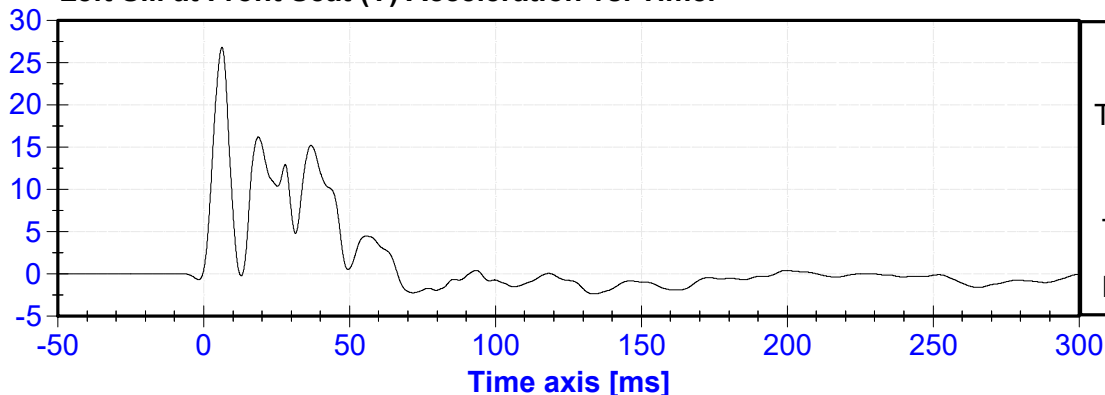
ACCELERATION [g's]

Right Sill at Rear Seat (Z) Acceleration vs. Time



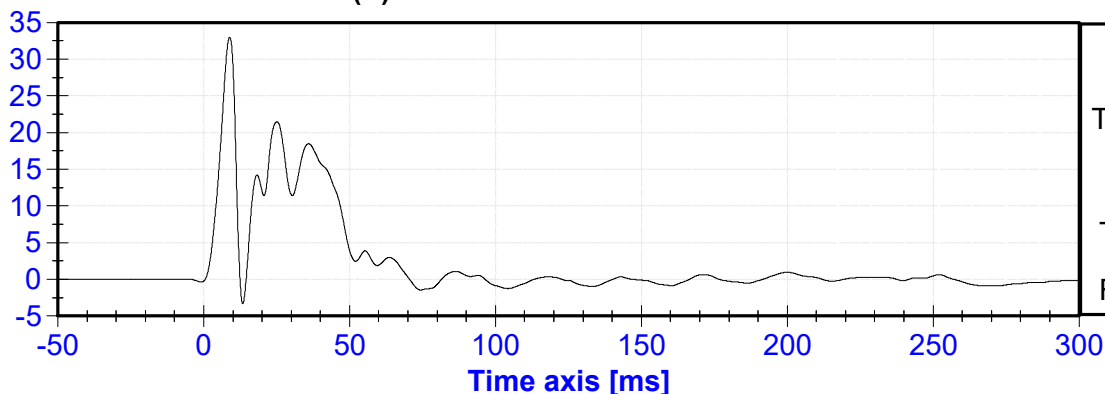
Left Sill at Front Seat (Y) Acceleration vs. Time.

ACCELERATION [g's]



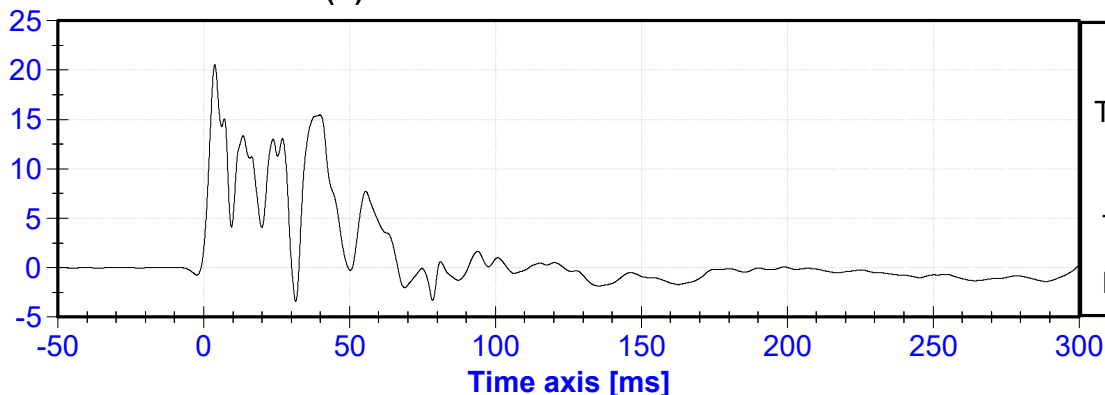
Left Sill at Rear Seat (Y) Acceleration vs. Time

ACCELERATION [g's]



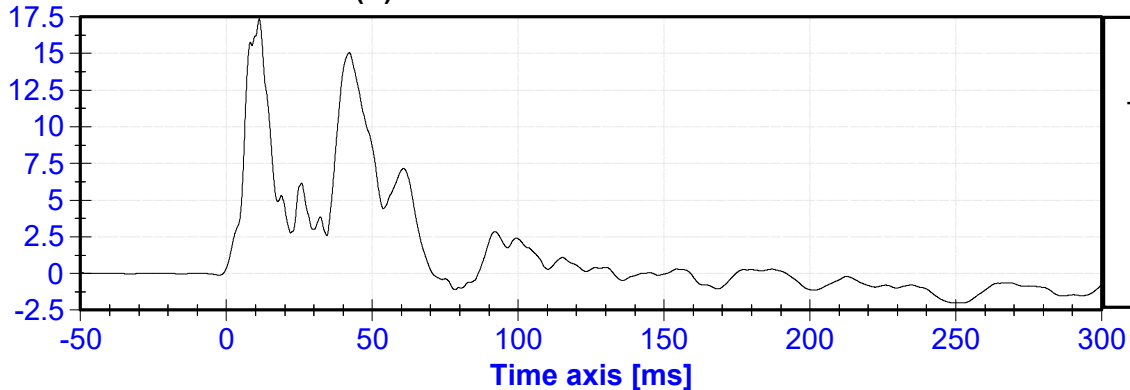
Left A-Pillar Lower (Y) Acceleration vs. Time

ACCELERATION [g's]



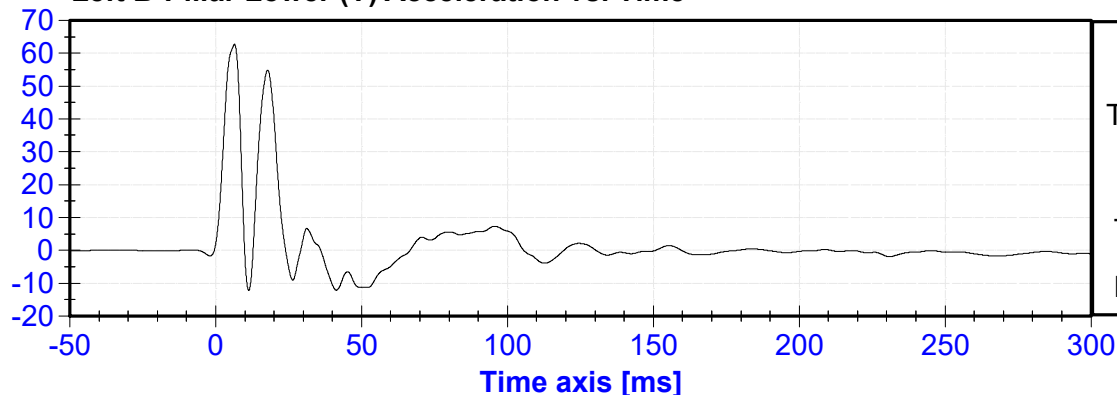
Left A-Pillar Middle (Y) Acceleration vs. Time

ACCELERATION [g's]



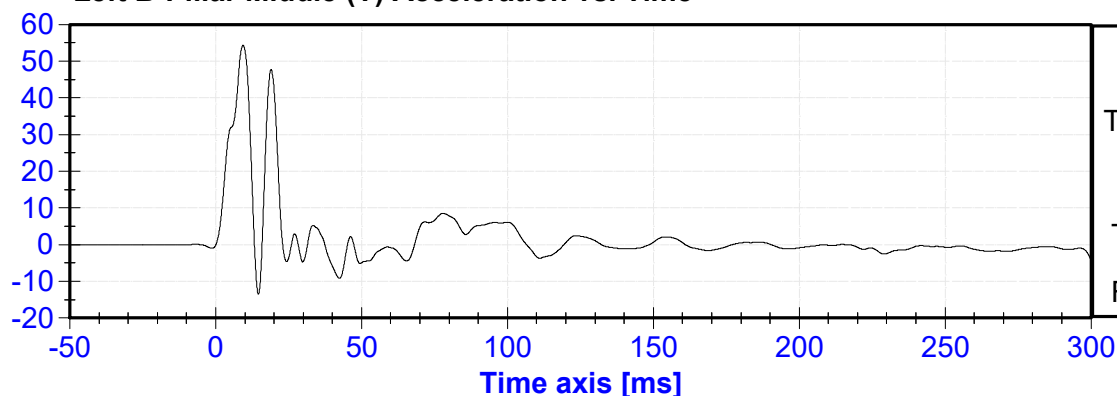
ACCELERATION [g's]

Left B-Pillar Lower (Y) Acceleration vs. Time



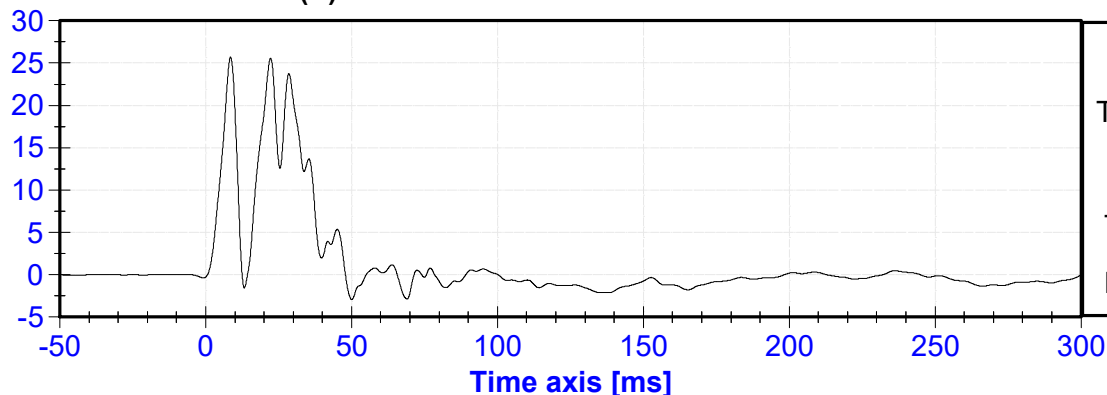
ACCELERATION [g's]

Left B-Pillar Middle (Y) Acceleration vs. Time



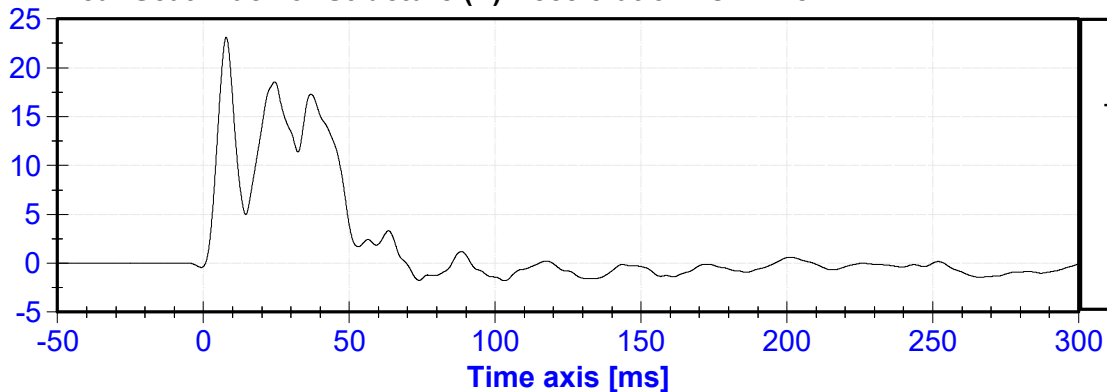
ACCELERATION [g's]

Front Seat Track (Y) Acceleration vs. Time



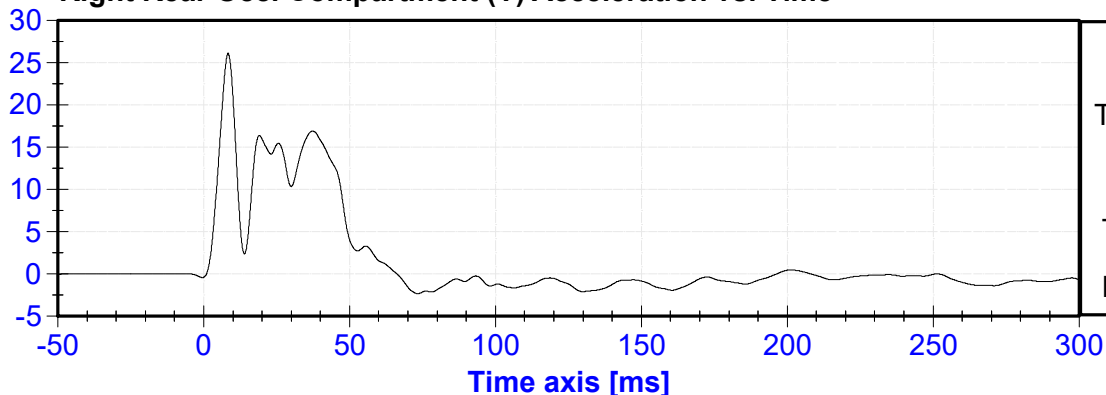
ACCELERATION [g's]

Rear Seat Track or Structure (Y) Acceleration vs. Time



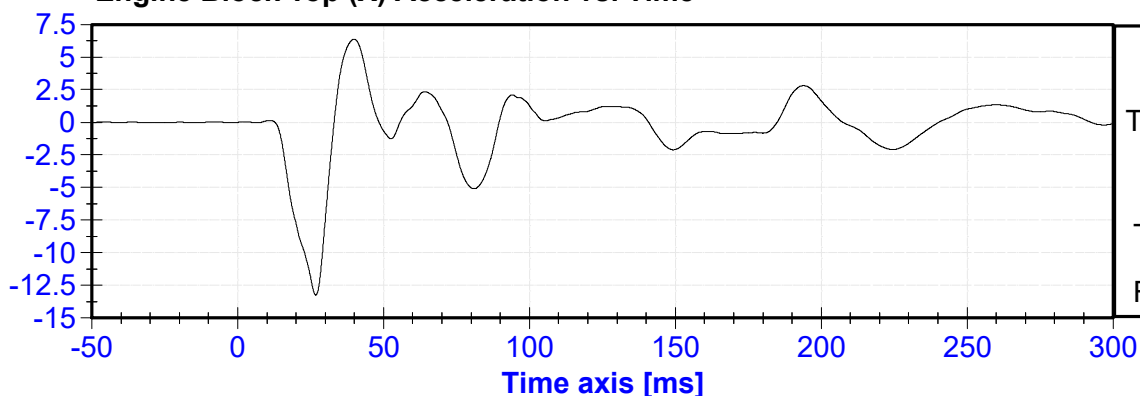
Right Rear Occ. Compartment (Y) Acceleration vs. Time

ACCELERATION [g's]



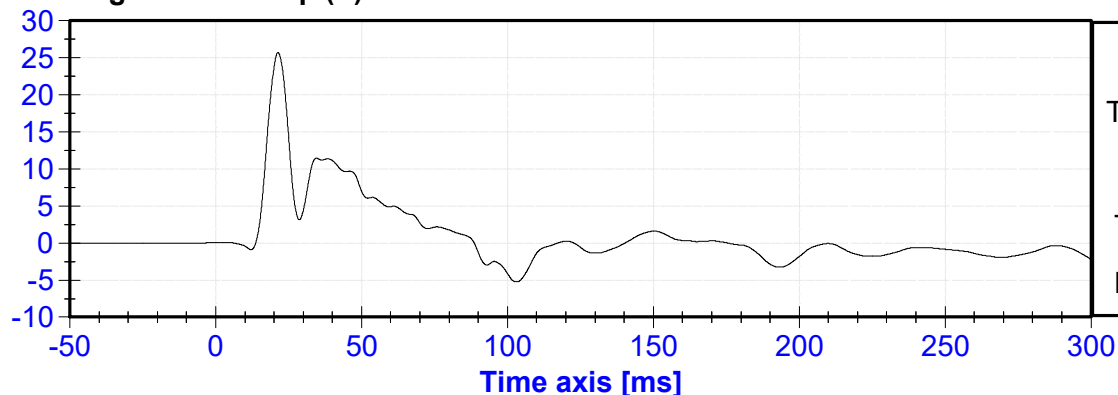
Engine Block Top (X) Acceleration vs. Time

ACCELERATION [g's]



Engine Block Top (Y) Acceleration vs. Time

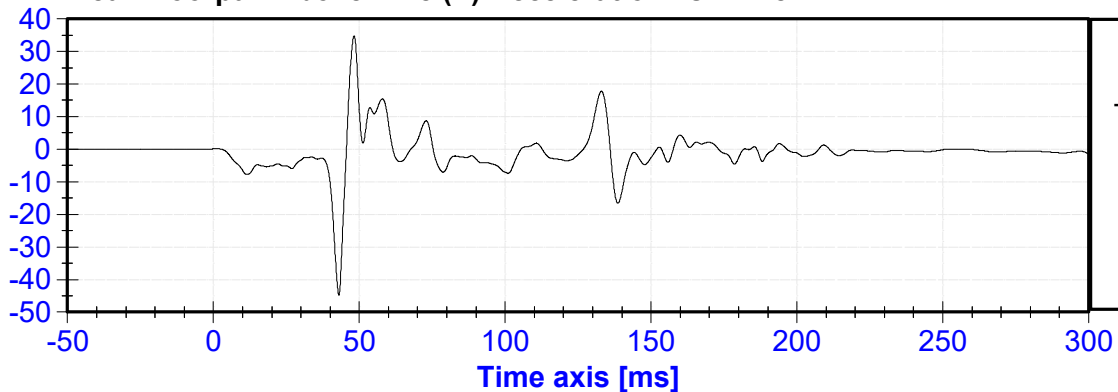
ACCELERATION [g's]



Rear Floorpan Above Axle (X) Acceleration vs. Time

Exceeded calibration range at 43.2 ms

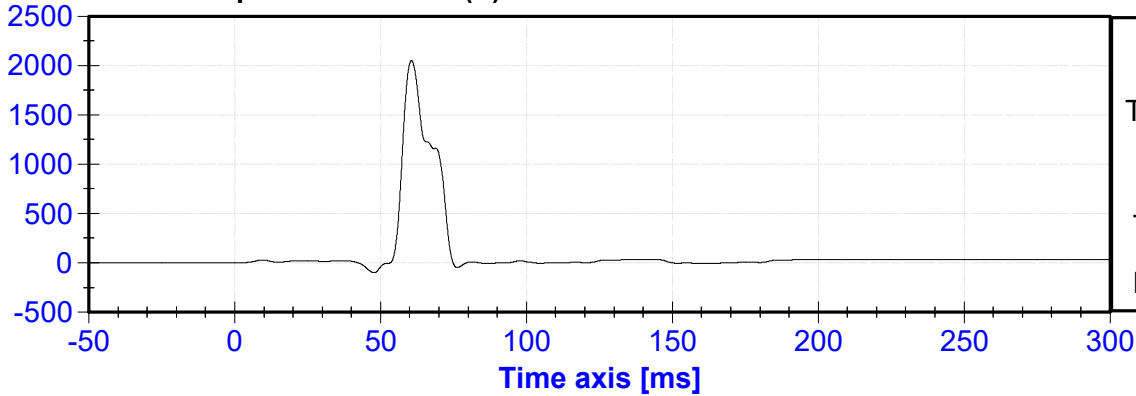
ACCELERATION [g's]



Questionable data after 55 ms

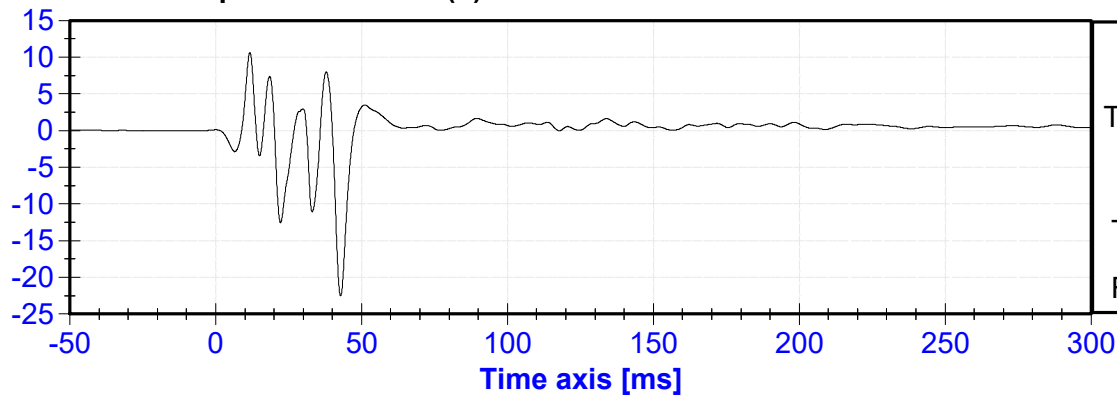
ACCELERATION [g's]

Rear Floorpan Above Axle (Y) Acceleration vs. Time



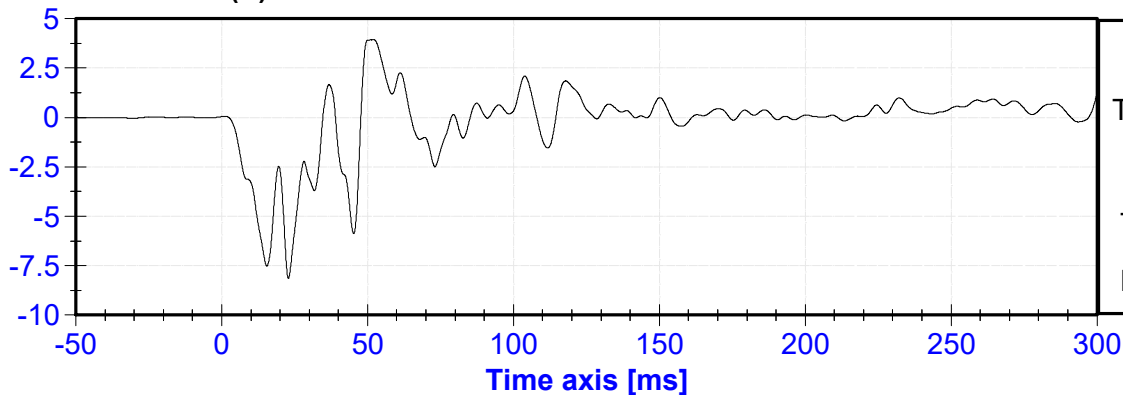
ACCELERATION [g's]

Rear Floorpan Above Axle (Z) Acceleration vs. Time



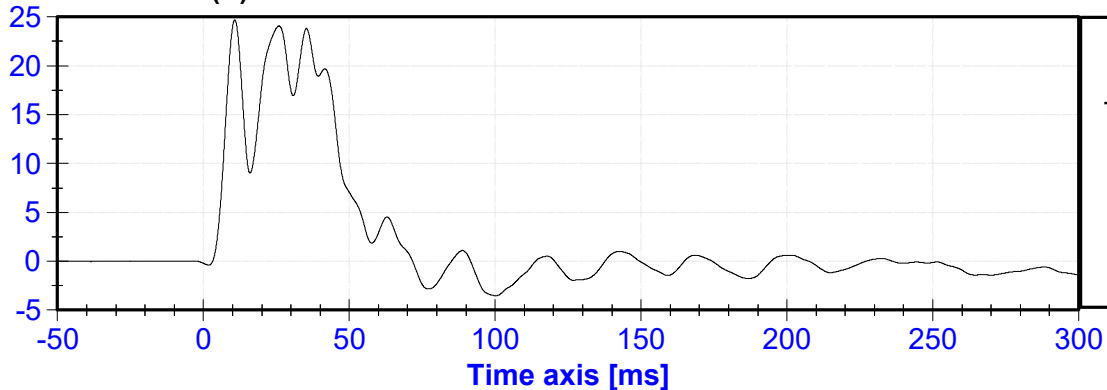
ACCELERATION [g's]

Rear Deck (X) Acceleration vs. Time



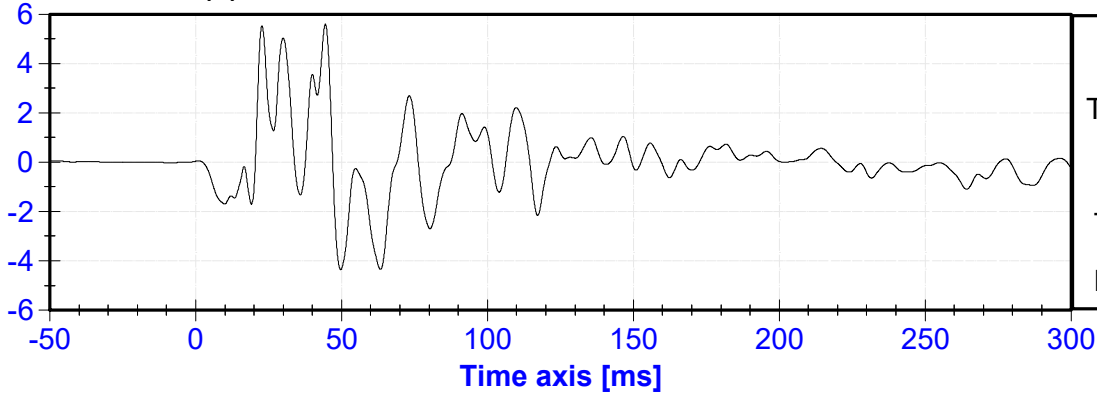
ACCELERATION [g's]

Rear Deck (Y) Acceleration vs. Time



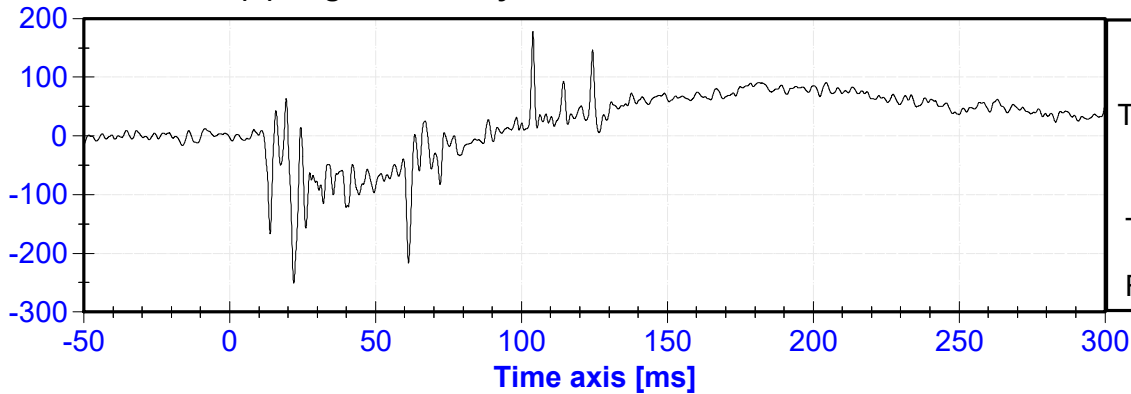
ACCELERATION [g's]

Rear Deck (Z) Acceleration vs. Time



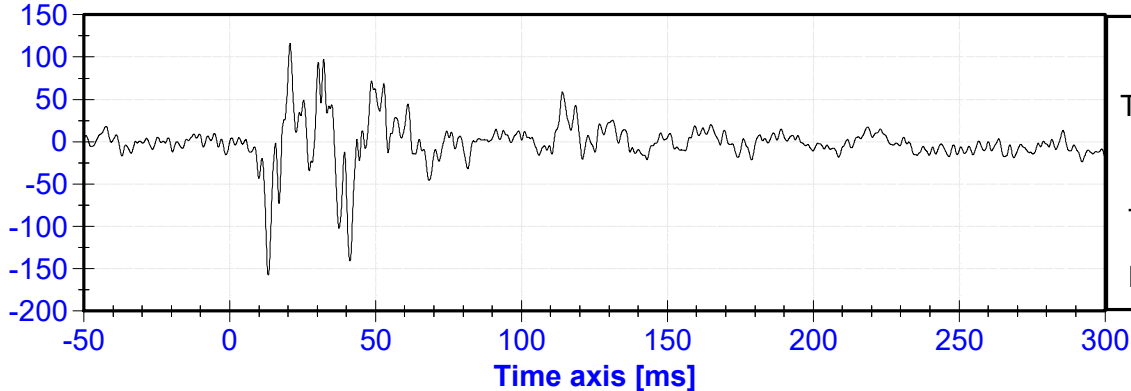
ANGULAR VEL [deg/s]

Rear Deck (X) Angular Velocity vs. Time



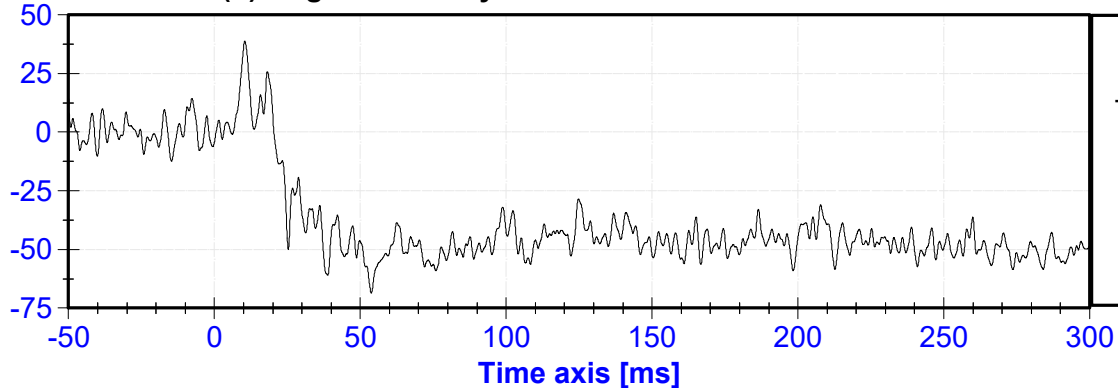
ANGULAR VEL [deg/s]

Rear Deck (Y) Angular Velocity vs. Time



ANGULAR VEL [deg/s]

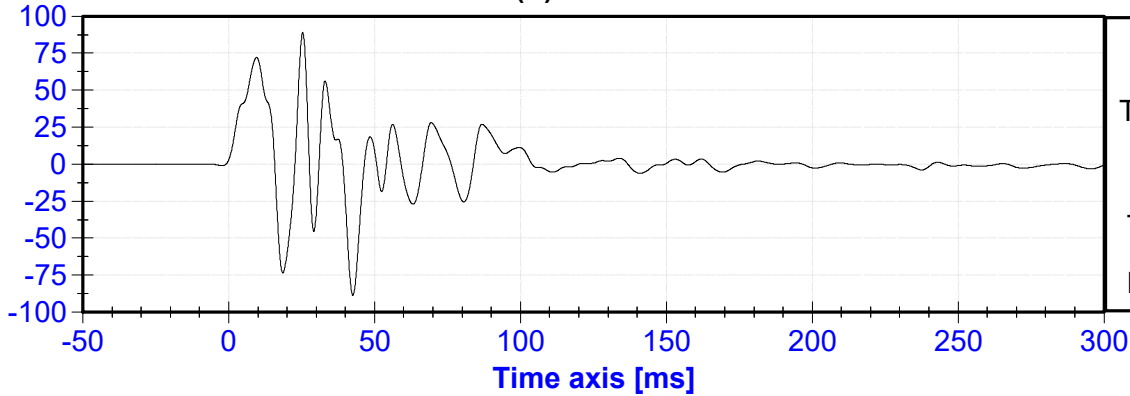
Rear Deck (Z) Angular Velocity vs. Time



Exceeded calibration range at 32.6 ms

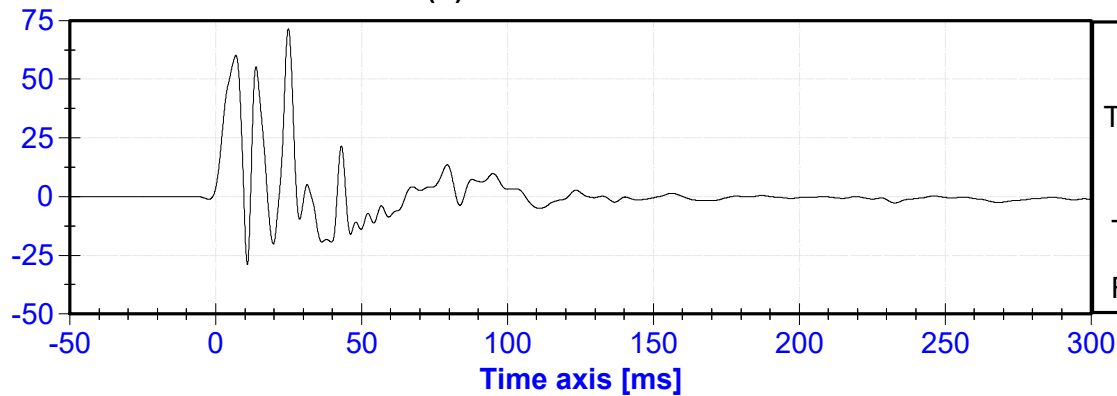
ACCELERATION [g's]

Left Front Door Mid Centerline (Y) Acceleration vs. Time



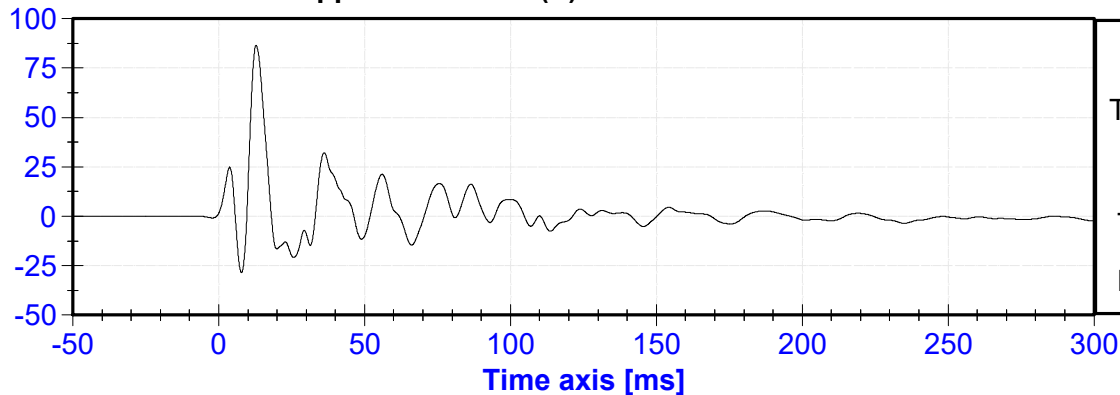
ACCELERATION [g's]

Left Front Door Mid Rear (Y) Acceleration vs. Time



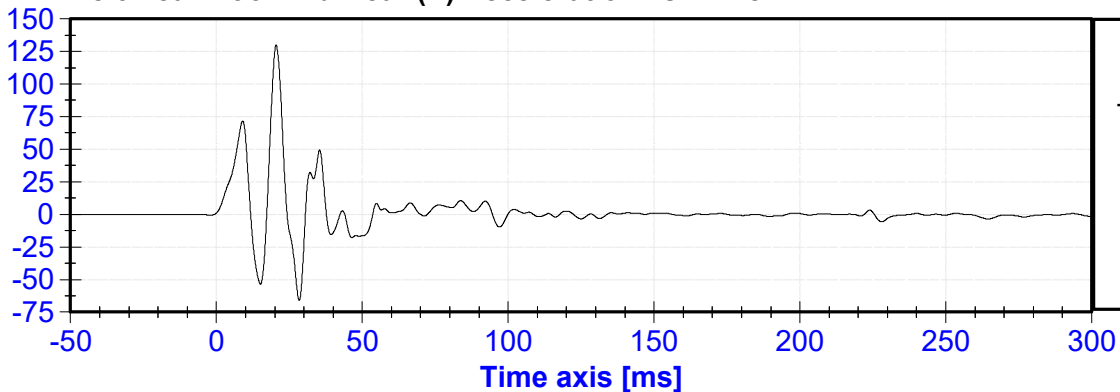
ACCELERATION [g's]

Left Front Door Upper Centerline (Y) Acceleration vs. Time



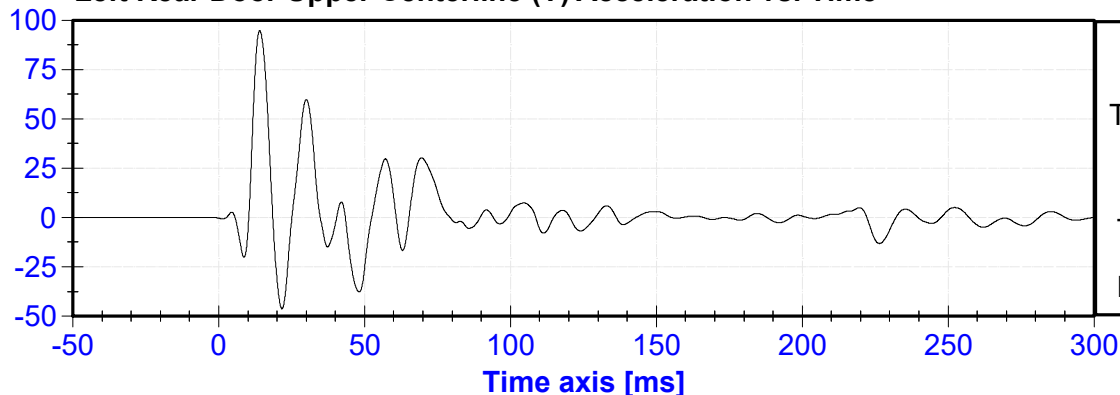
ACCELERATION [g's]

Left Rear Door Mid Rear (Y) Acceleration vs. Time



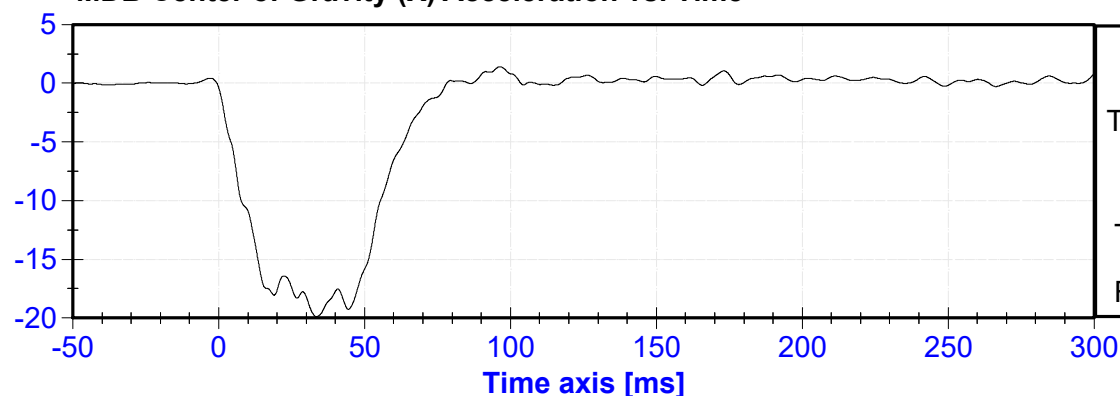
Left Rear Door Upper Centerline (Y) Acceleration vs. Time

ACCELERATION [g's]



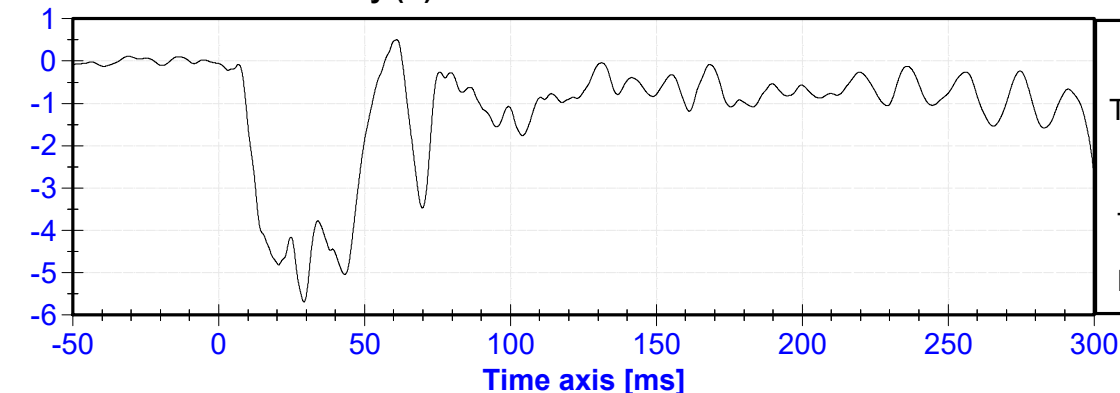
MDB Center of Gravity (X) Acceleration vs. Time

ACCELERATION [g's]



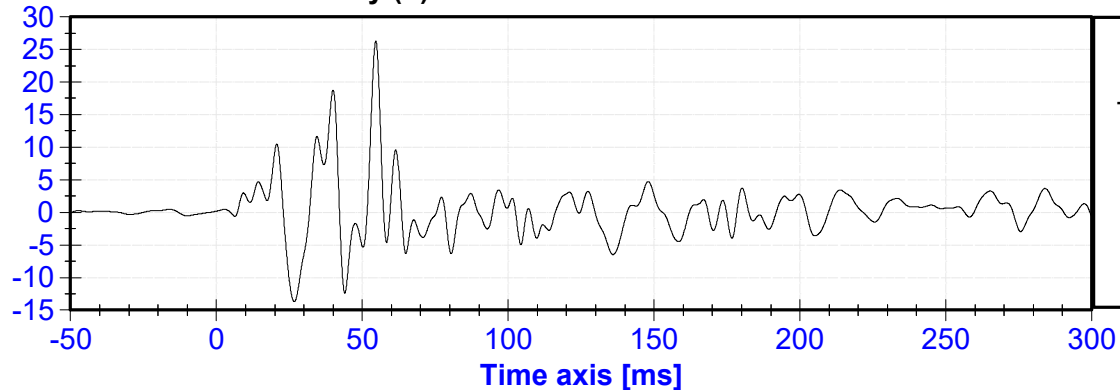
MDB Center of Gravity (Y) Acceleration vs. Time

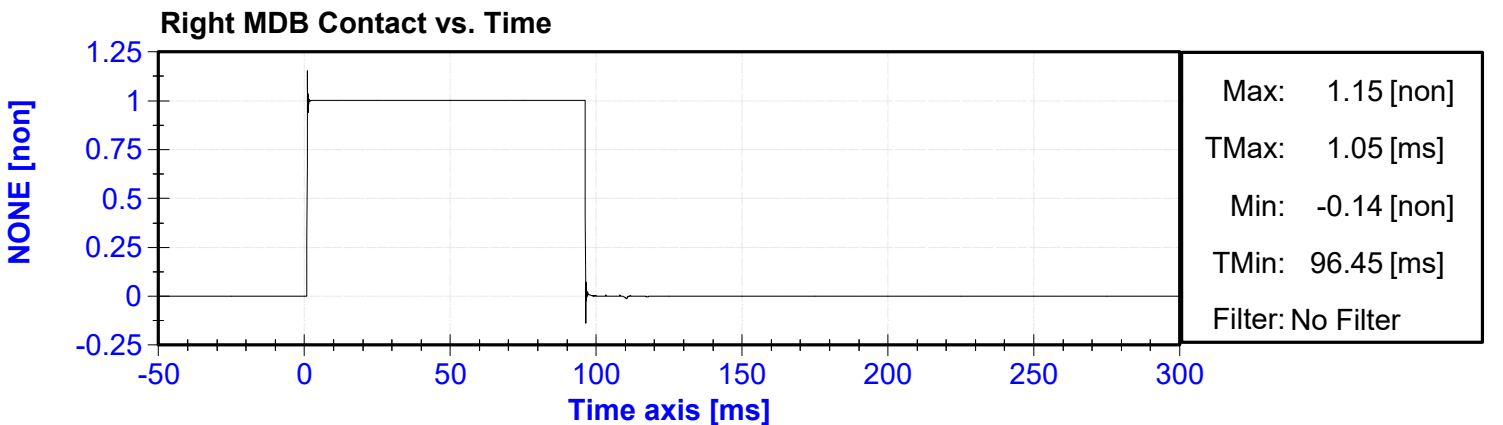
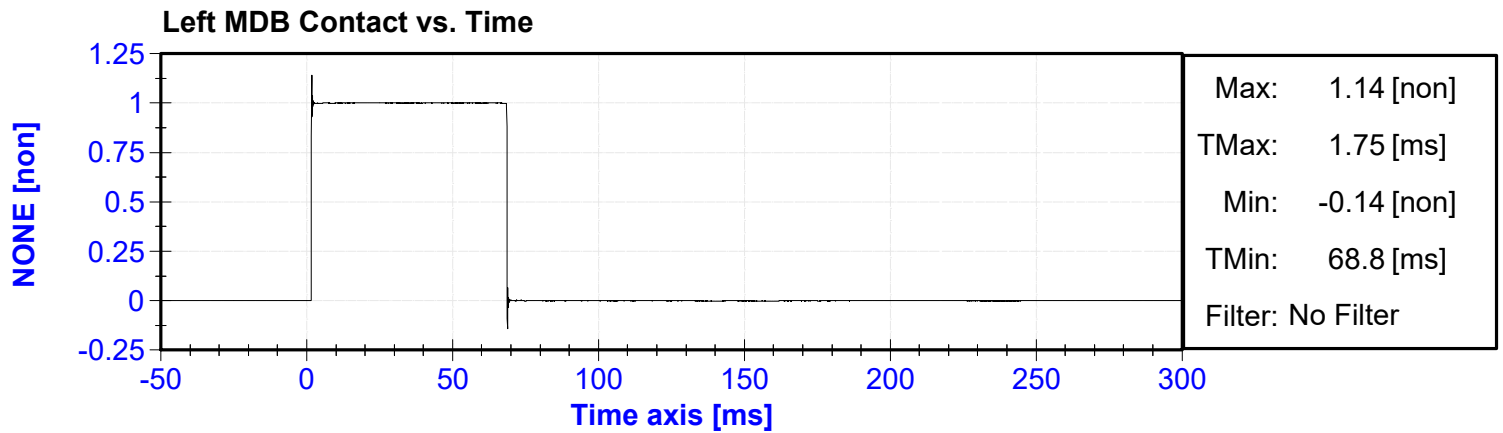
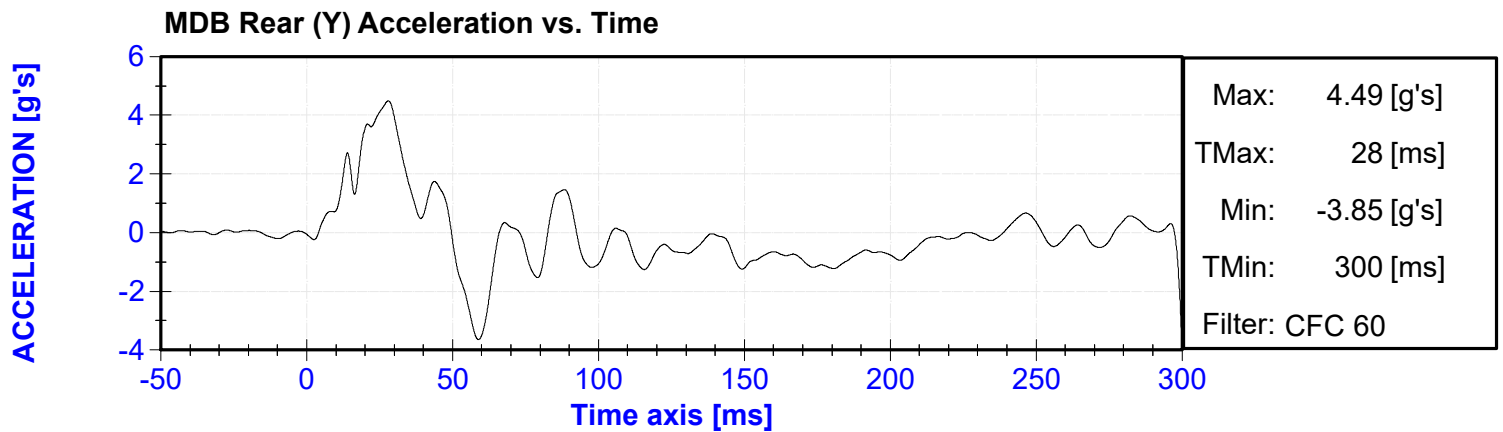
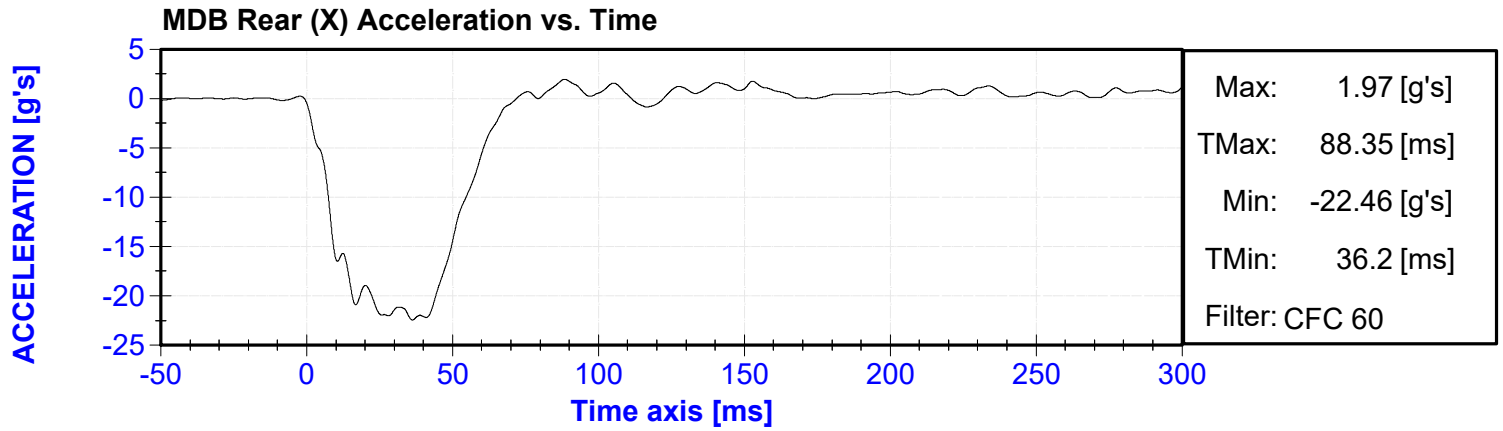
ACCELERATION [g's]



MDB Center of Gravity (Z) Acceleration vs. Time

ACCELERATION [g's]





APPENDIX C

DUMMY PERFORMANCE CALIBRATION TEST DATA

CALIBRATION TEST RESULTS

PRE-TEST

EUROSID 2 (ES-2RE) MALE – DRIVER ATD

SERIAL NO: F034

(CONFIGURED FOR LEFT SIDE IMPACT)

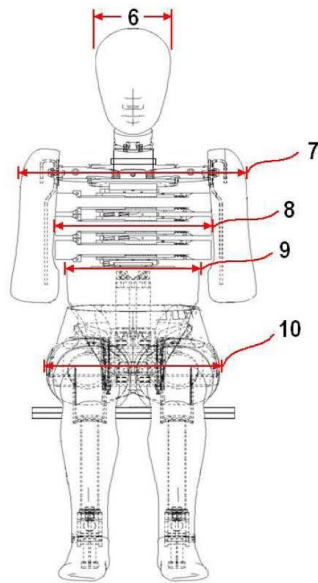


External Measurements - EuroSID-2re

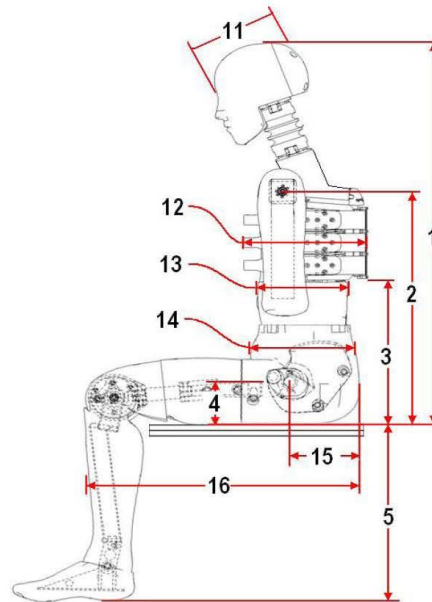
Technician: K. Dutton

Date: 10/28/2020

Dummy Serial Number: F034



FRONT VIEW



SIDE VIEW

Dim. No.	Description	Specification (mm)		Result (mm)	Pass/Fail
1	Sitting Height	900	918	911	Pass
2	Seat to Shoulder Joint	558	572	569	Pass
3	Seat to Lower Face of Thoracic Spine Box	346	356	352	Pass
4	Seat to Hip Joint (center of bolt)	97	103	100	Pass
5	Sole to Seat, Sitting	333	451	421	Pass
6	Head Width	152	158	154	Pass
7	Shoulder/Arm Width	461	479	470	Pass
8	Thorax Width	322	332	329	Pass
9	Abdomen Width	273	287	285	Pass
10	Pelvis Lap Width	359	373	367	Pass
11	Head Depth	196	206	202	Pass
12	Thorax Depth	262	272	268	Pass
13	Abdomen Depth	194	204	202	Pass
14	Pelvis Depth	235	245	240	Pass
15	Back of Buttocks to Hip Joint (center of bolt)	150	160	156	Pass
16	Back of Buttocks to Front Knee	597	615	609	Pass

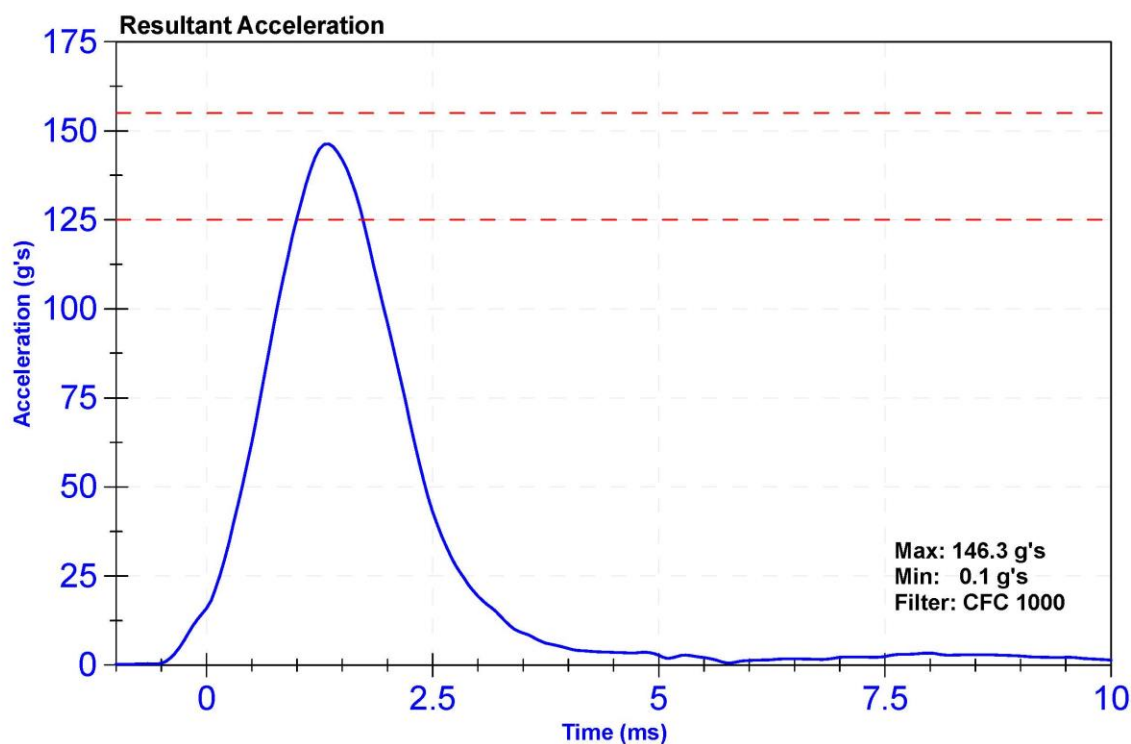
ATD Manufacturer	FTSS	Test Technician	M. Dudek
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

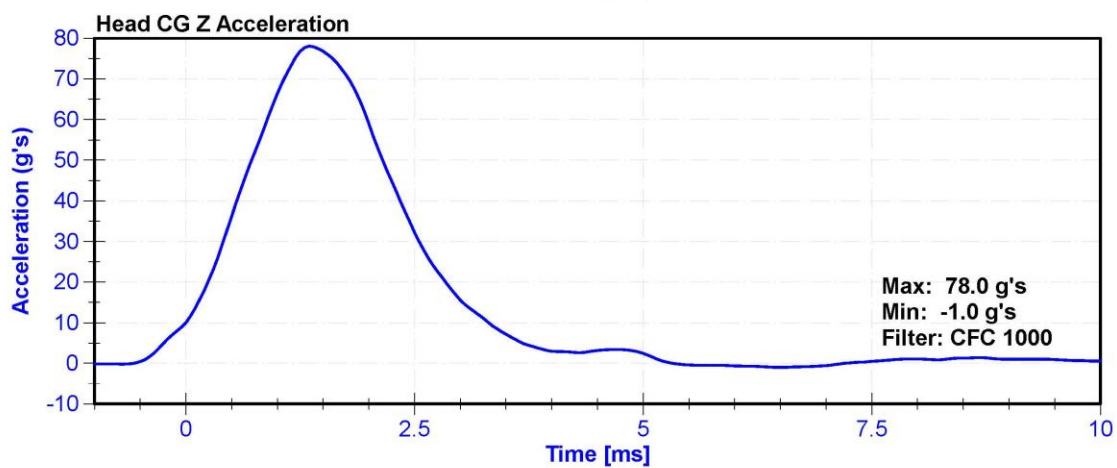
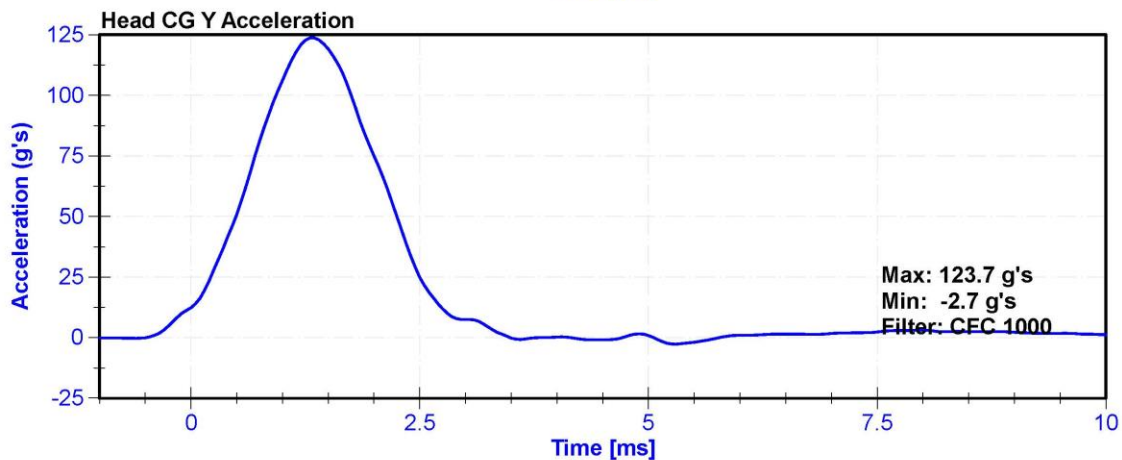
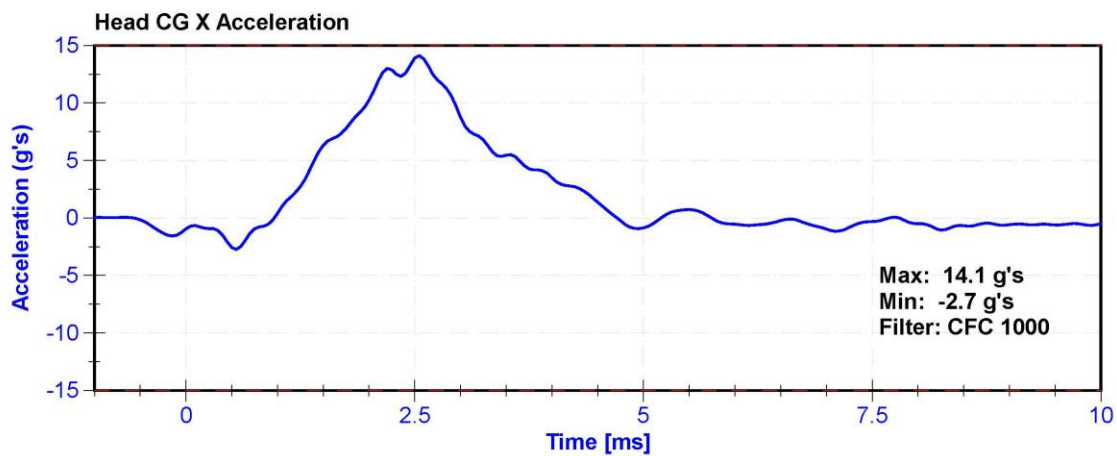
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	44.8	Pass
Resultant Acceleration	125	155	g's	146.3	Pass
Oscillation	0	15	%	2.46	Pass
Fore-Aft Acceleration	-15	15	g's	14.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	Endevco 7264C	P51884	9/22/2020	3/23/2021
Y Accelerometer	Endevco 7264C	P73161	9/22/2020	3/23/2021
Z Accelerometer	Endevco 7264C	P79588	9/22/2020	3/23/2021





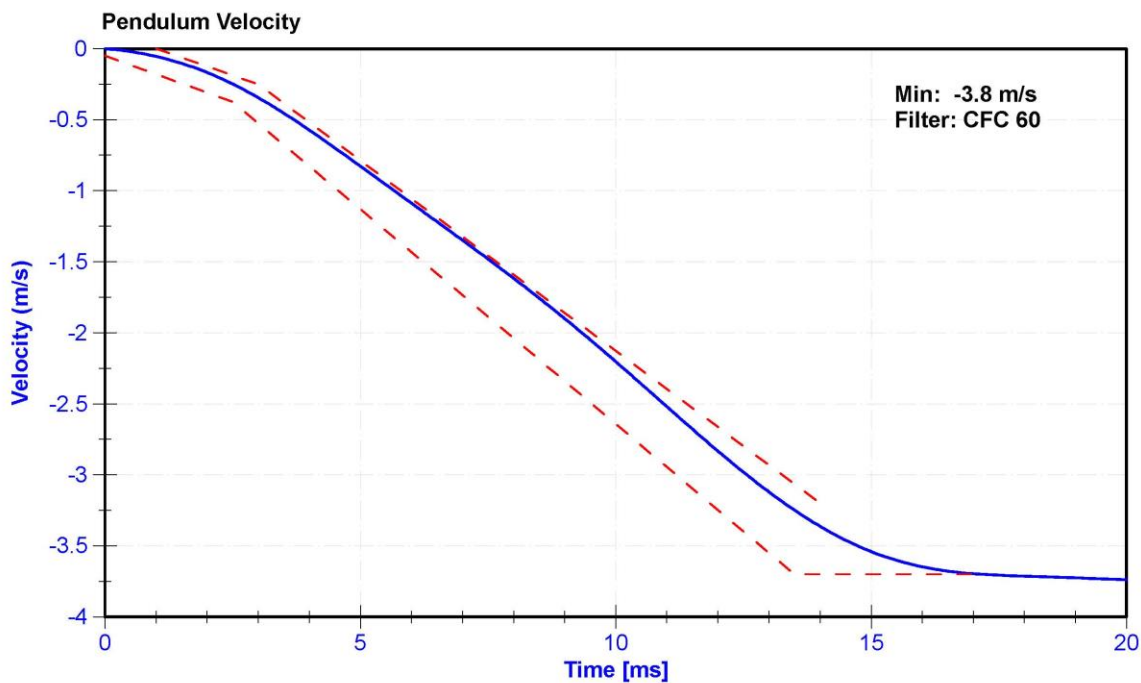
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

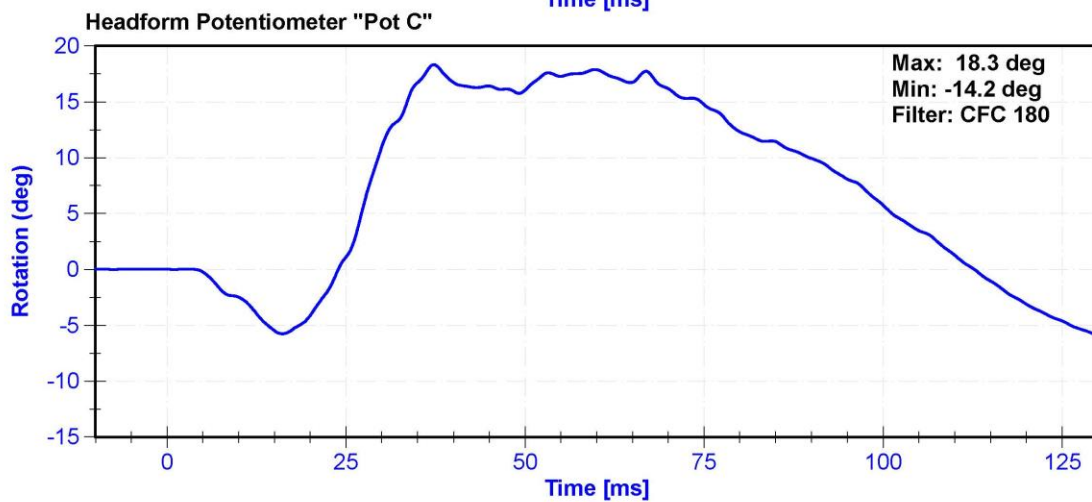
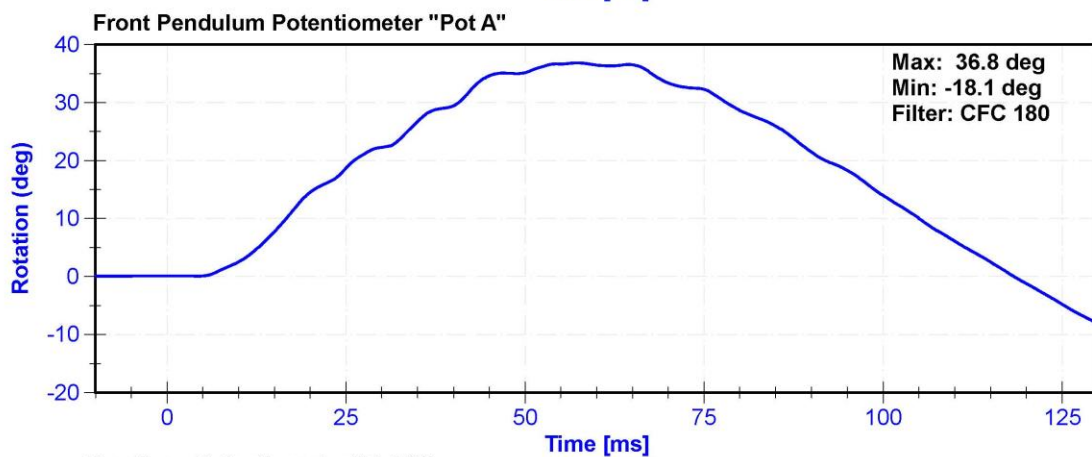
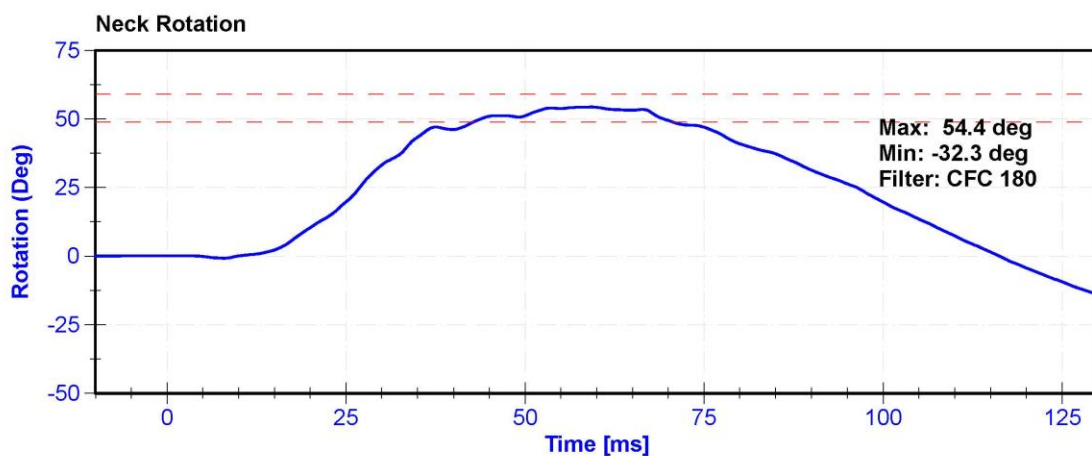
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.3	Pass
Humidity	10	70	%	31.2	Pass
Velocity	3.3	3.5	m/s	3.40	Pass
Lateral Neck Rotation	49	59	deg	54.4	Pass
Time at Maximum Rotation	54	66	ms	59.3	Pass
Time of Rotation Decay from Maximum	53	88	ms	56.9	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-C16503	2/6/2020	2/5/2021
Front Pendulum Potentiometer	SP22G	DS-094	8/18/2020	8/18/2021
Headform Potentiometer	SP22G	DS-095	8/18/2020	8/18/2021





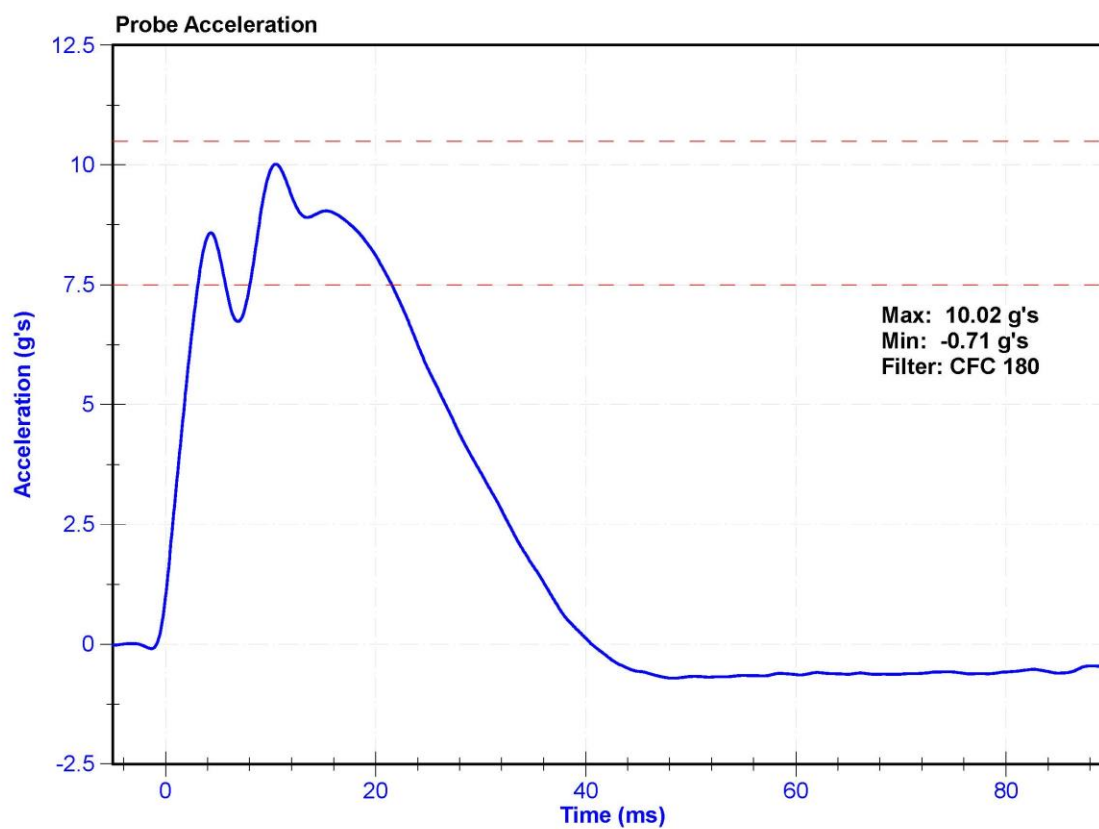
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	40.0	Pass
Velocity	4.2	4.4	m/s	4.40	Pass
Probe Acceleration	7.5	10.5	g's	10.02	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A279031	5/8/2020	5/8/2021



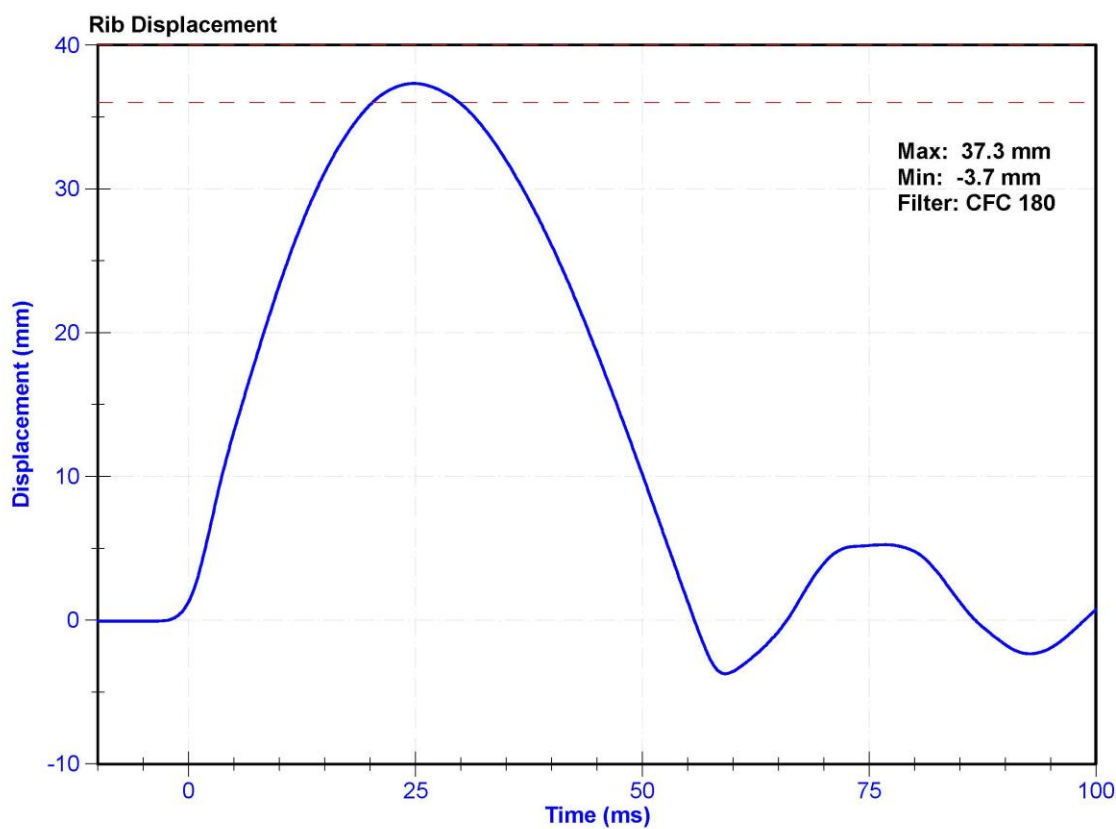
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.3	Pass
Humidity	10	70	%	32.1	Pass
Rib Displacement	36	40	mm	37.3	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-183GFE	10/8/2020	4/8/2021



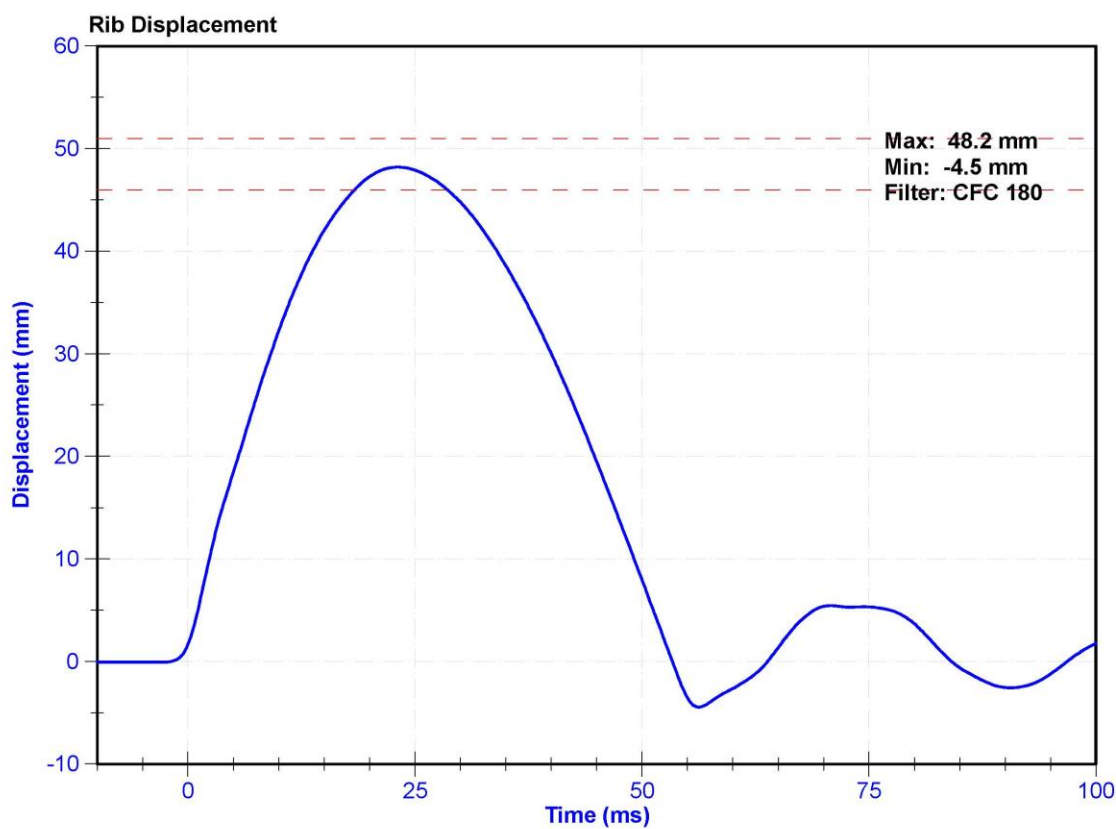
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.9	Pass
Humidity	10	70	%	32.4	Pass
Rib Displacement	46	51	mm	48.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-183GFE	10/8/2020	4/8/2021



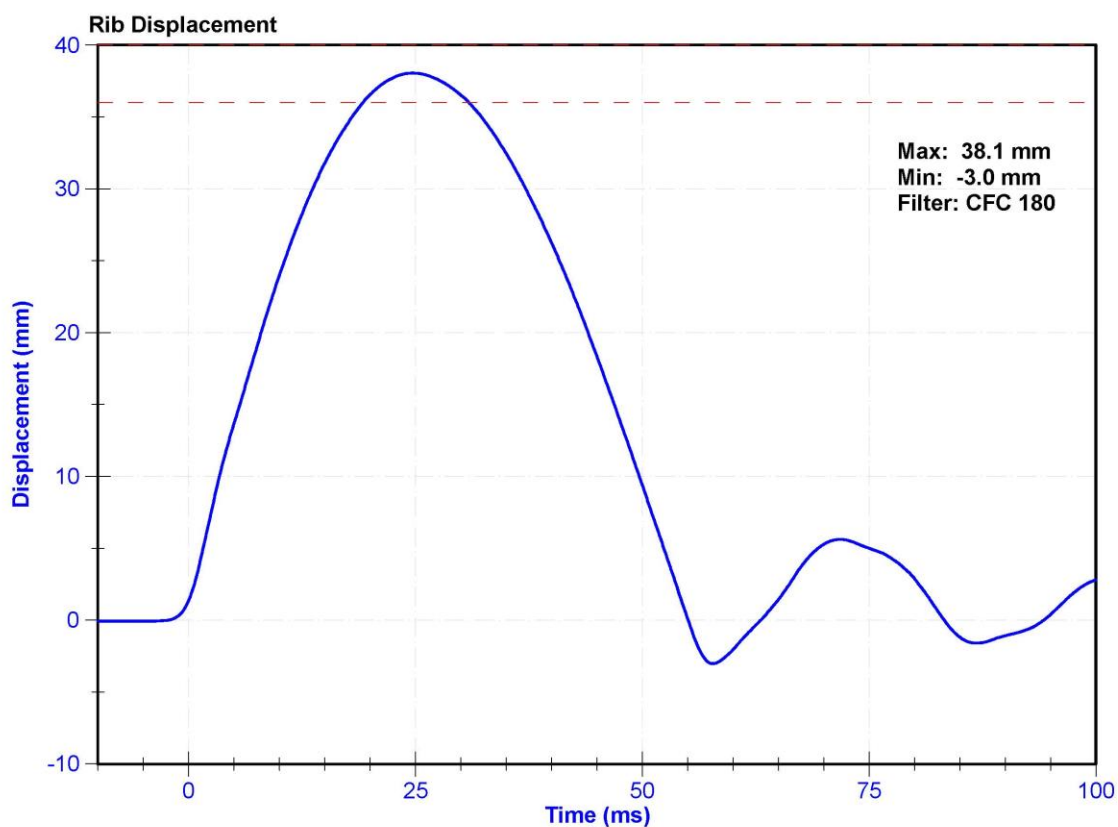
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	32.4	Pass
Rib Displacement	36	40	mm	38.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-184GFE	10/8/2020	4/8/2021



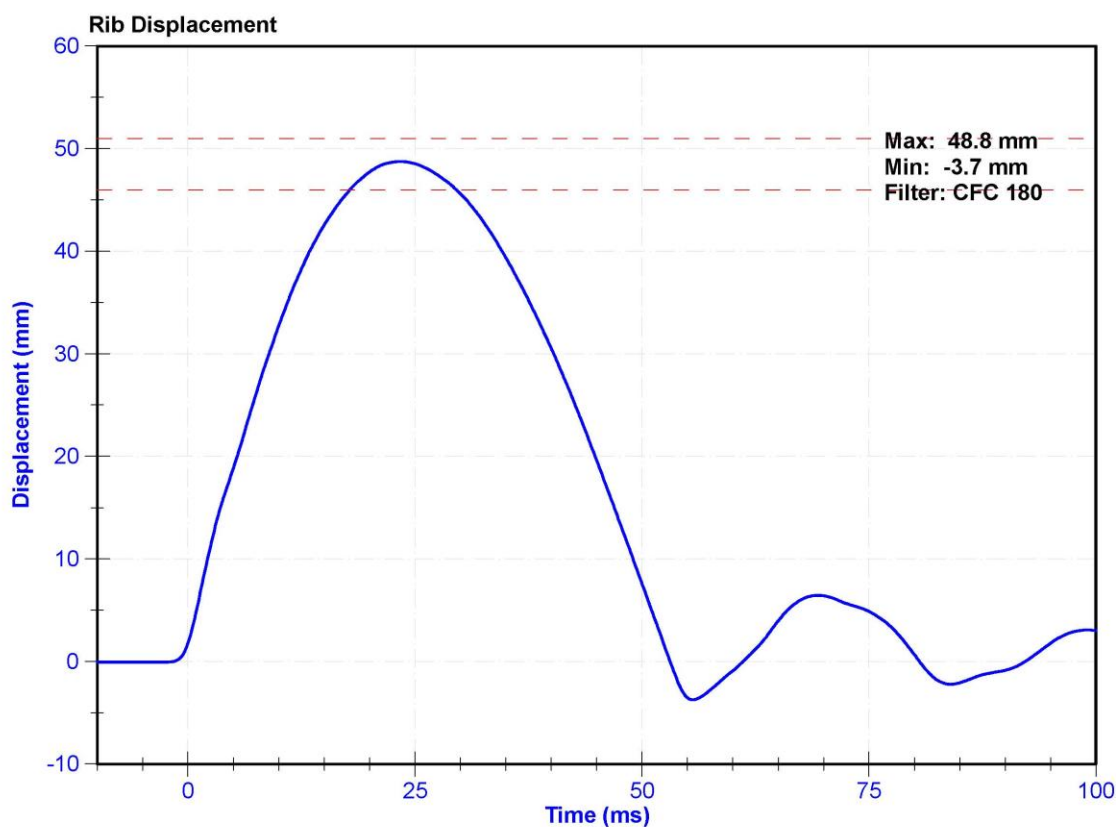
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	32.4	Pass
Rib Displacement	46	51	mm	48.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-184GFE	10/8/2020	4/8/2021



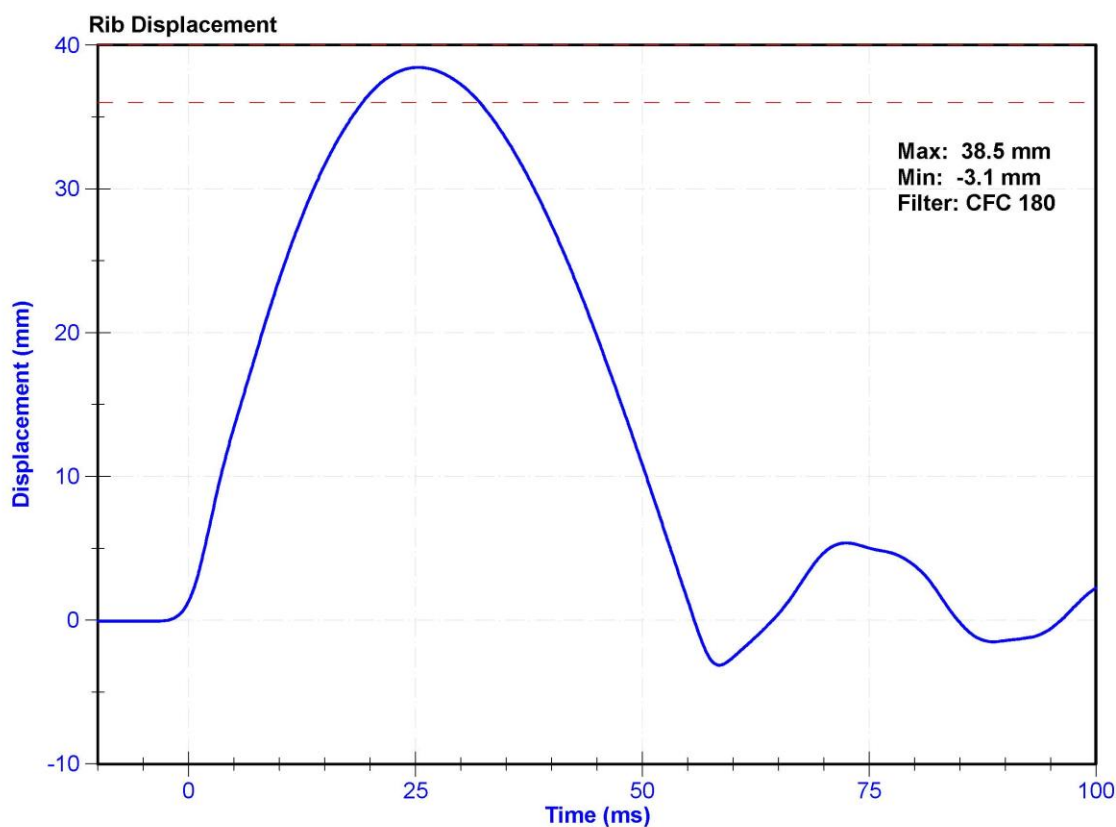
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	32.4	Pass
Rib Displacement	36	40	mm	38.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-182GFE	10/8/2020	4/8/2021



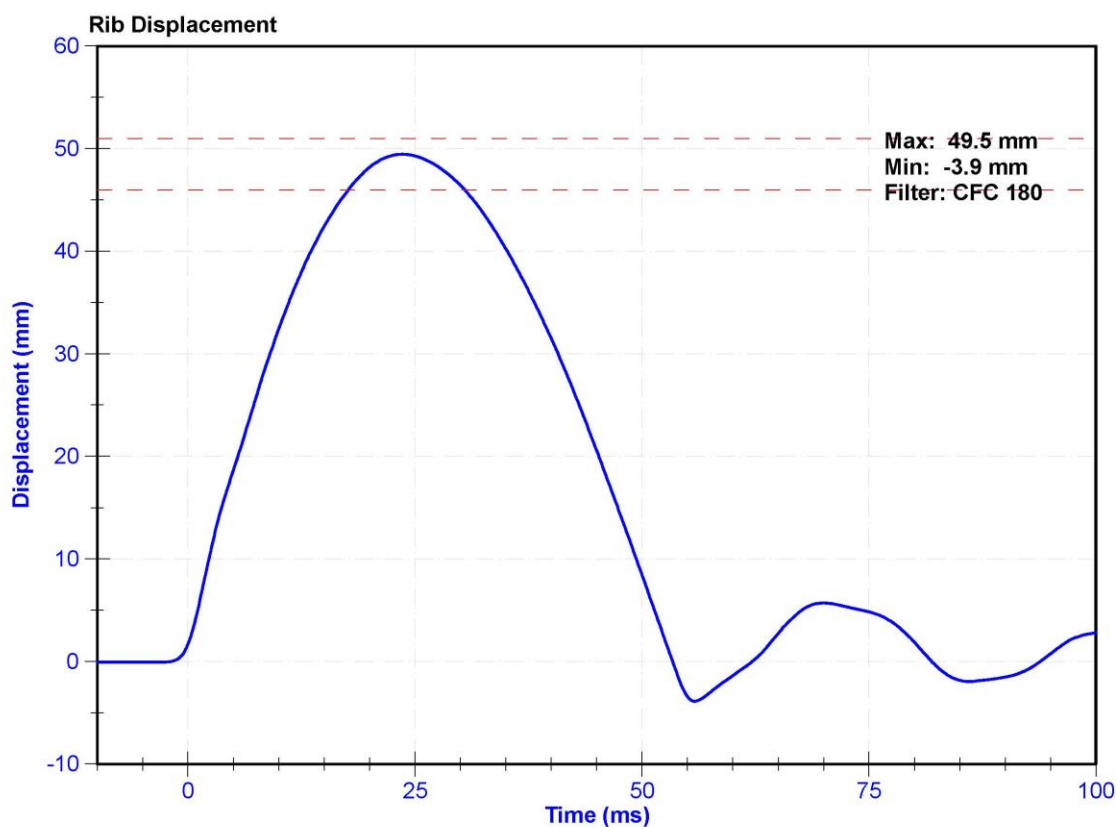
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	32.4	Pass
Rib Displacement	46	51	mm	49.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Rib Potentiometer	Honeywell MLT-38000203	DS-182GFE	10/8/2020	4/8/2021



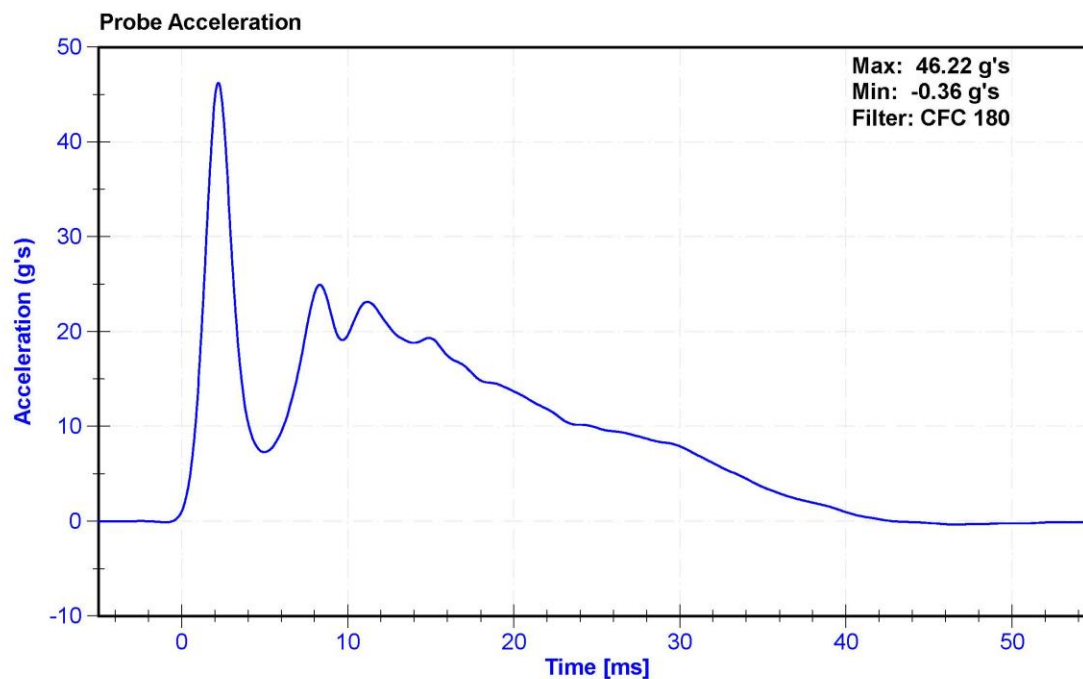
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

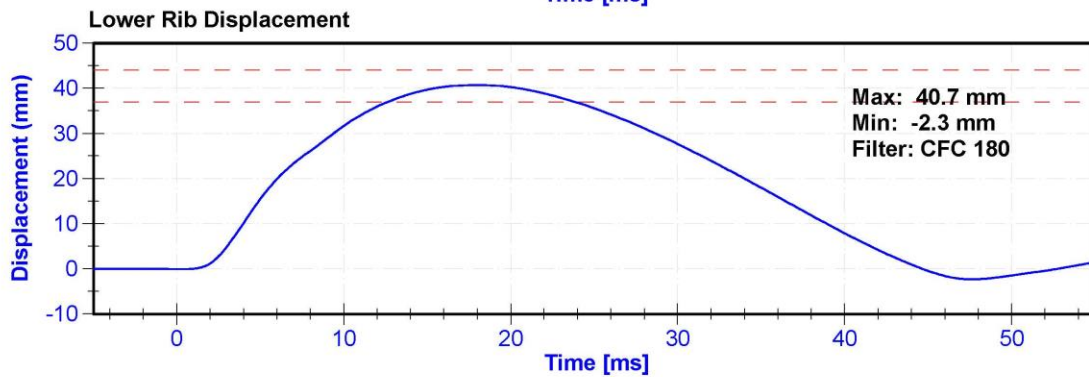
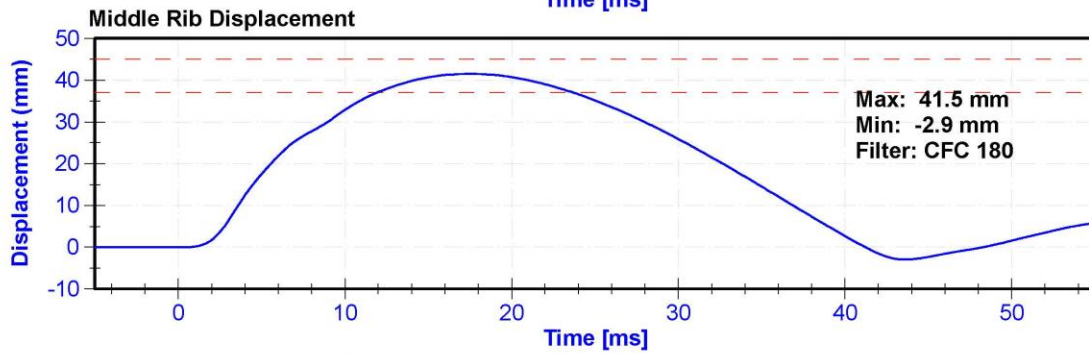
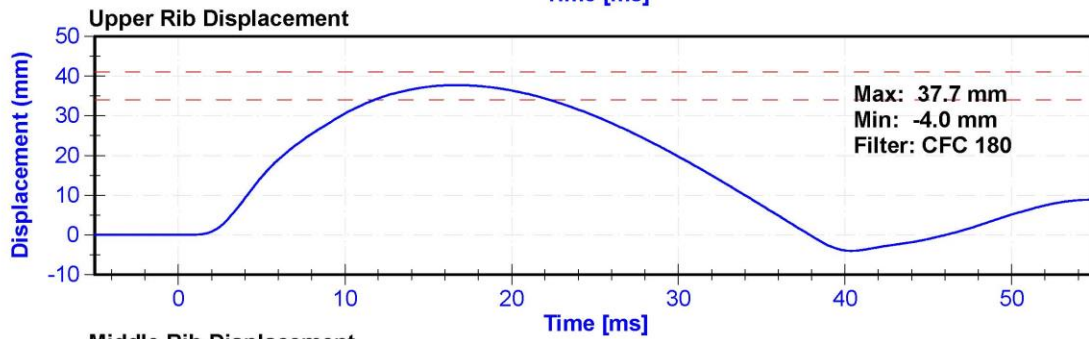
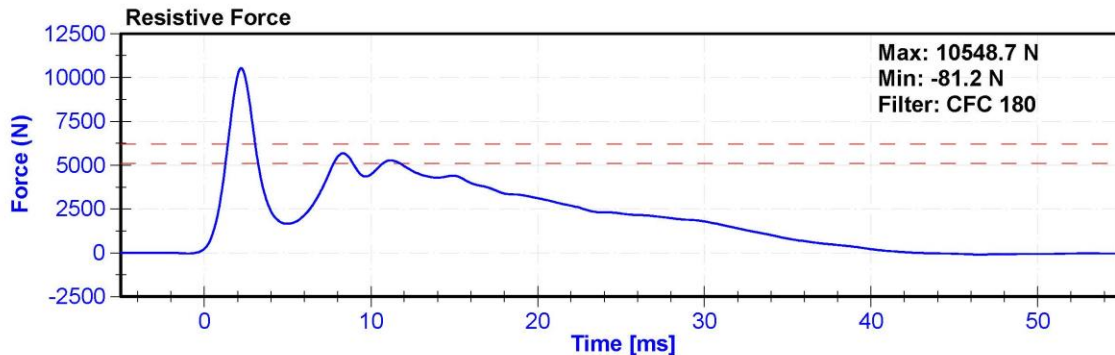
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	43.0	Pass
Velocity	5.4	5.6	m/s	5.40	Pass
Resistive Force after 6ms	5100	6200	N	5690.0	Pass
Upper Thorax Rib Deflection	34	41	mm	37.7	Pass
Mid Thorax Rib Deflection	37	45	mm	41.5	Pass
Lower Thorax Rib Deflection	37	44	mm	40.7	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A279031	5/8/2020	5/8/2021
Upper Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-183GFE	10/8/2020	4/8/2021
Middle Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-184GFE	10/8/2020	4/8/2021
Lower Thorax Rib Potentiometer	Honeywell MLT-38000203	DS-182GFE	10/8/2020	4/8/2021





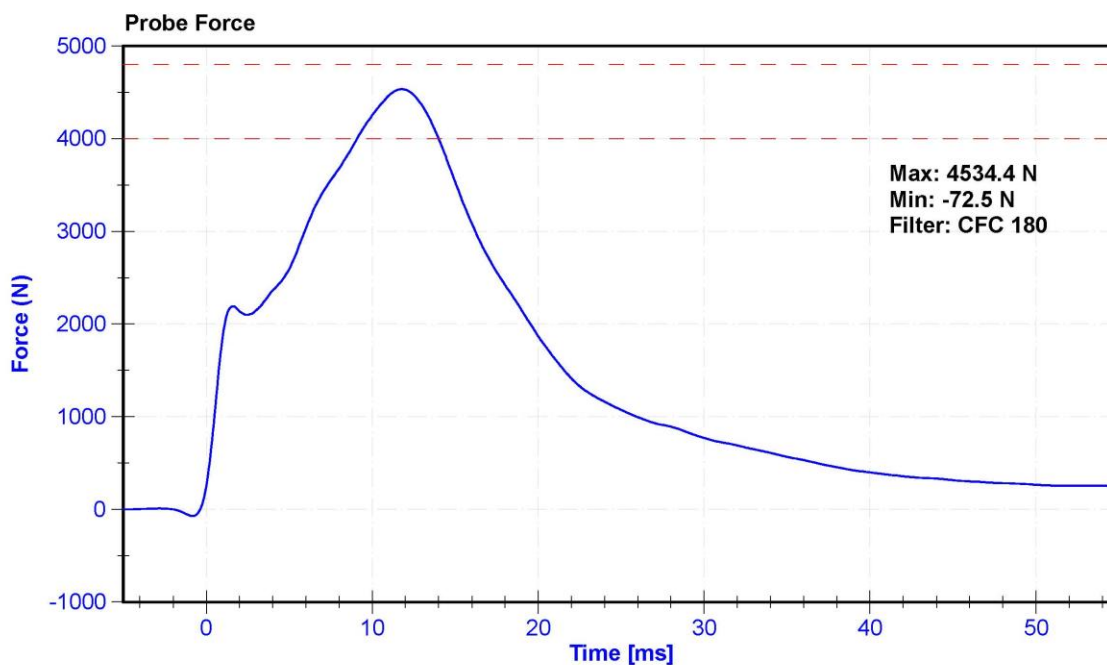
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	F034	Laboratory Supervisor	K.Brogan

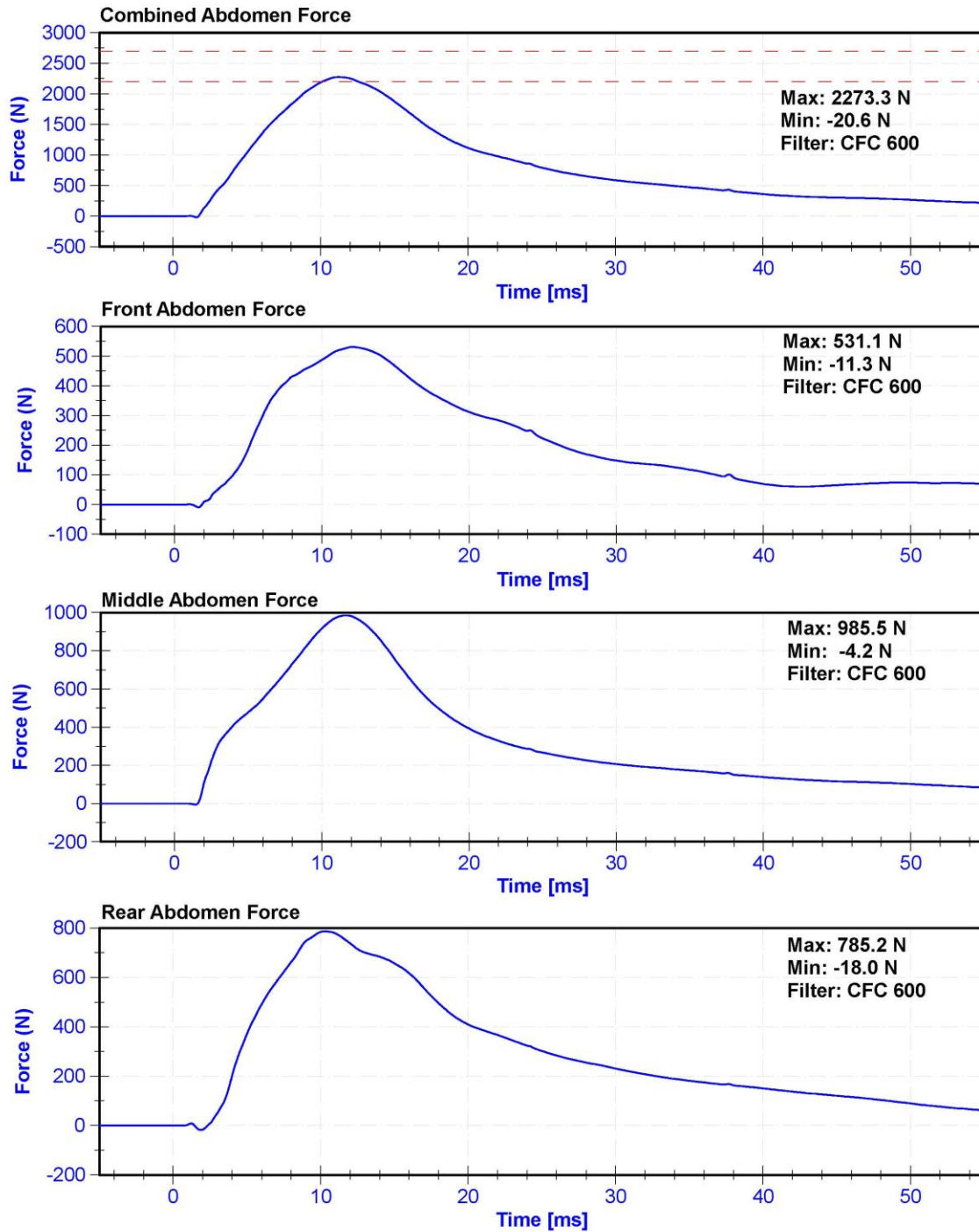
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	43	Pass
Velocity	3.9	4.1	m/s	4.05	Pass
Combined Abdomen Force	2200	2700	N	2273.3	Pass
Time at Peak Abdomen Force	10.0	12.3	ms	11.20	Pass
Resistive Probe Force	4000	4800	N	4534.4	Pass
Time at Peak Resistive Force	10.6	13.0	ms	11.80	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A279031	5/8/2020	5/8/2021
Front Abdomen Load Cell	DENTON 2631J	LC-1524	3/19/2020	3/19/2021
Middle Abdomen Load Cell	DENTON 2631J	LC-1523	3/19/2020	3/19/2021
Rear Abdomen Load Cell	DENTON 2631J	LC-1530	3/19/2020	3/19/2021







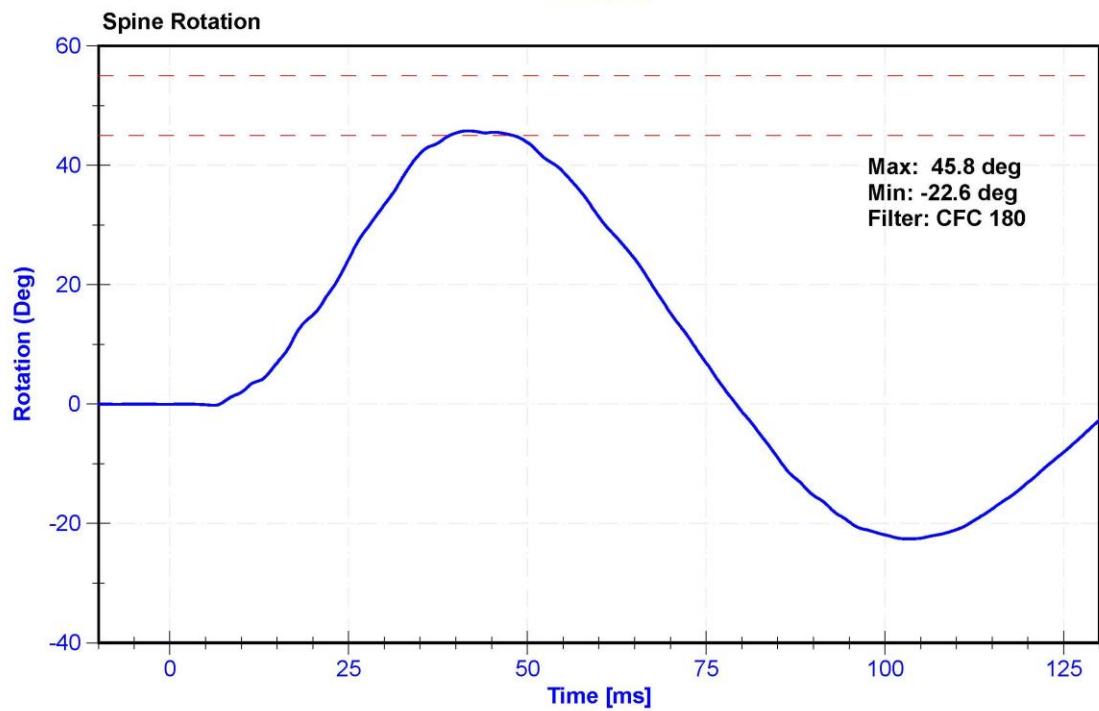
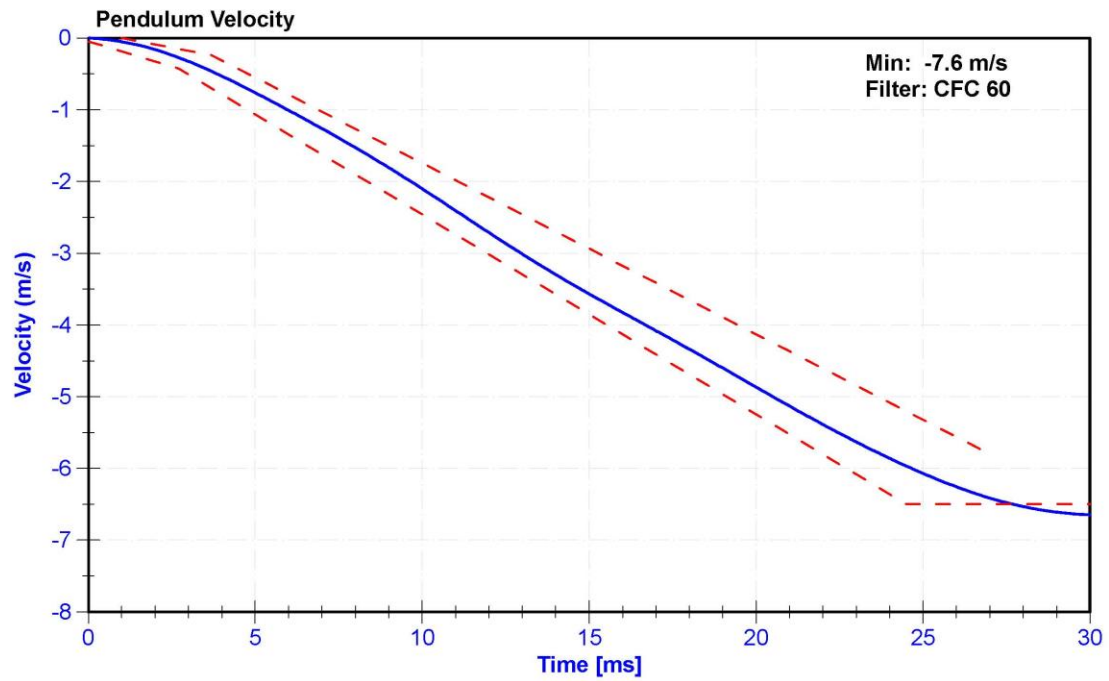
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

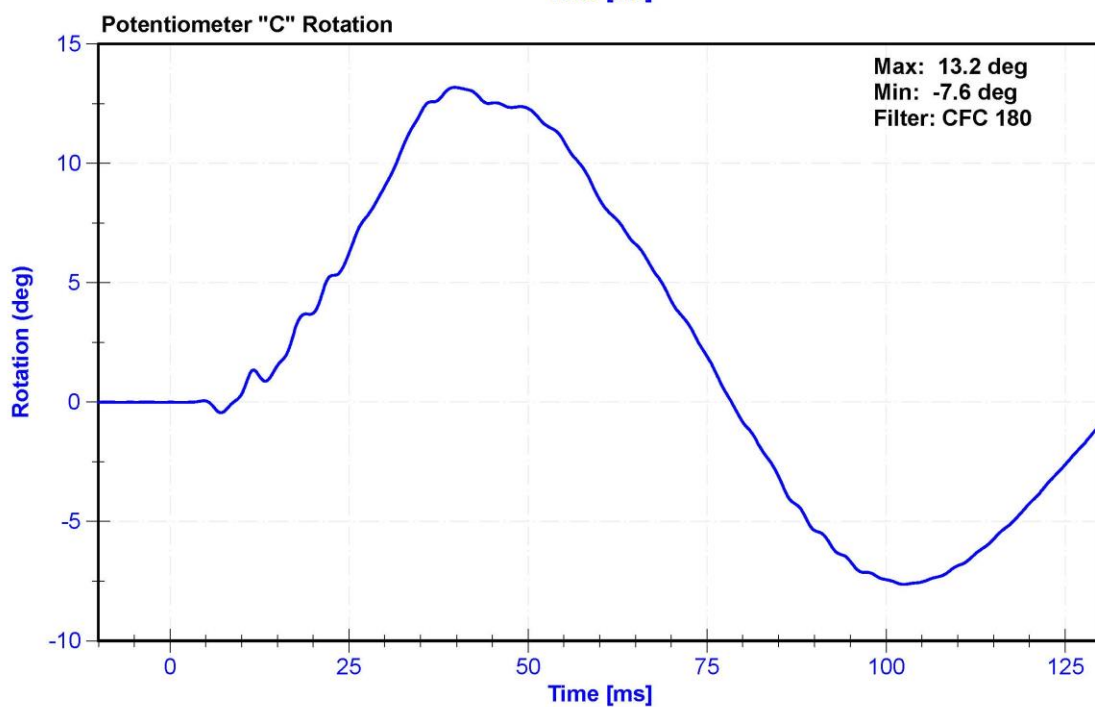
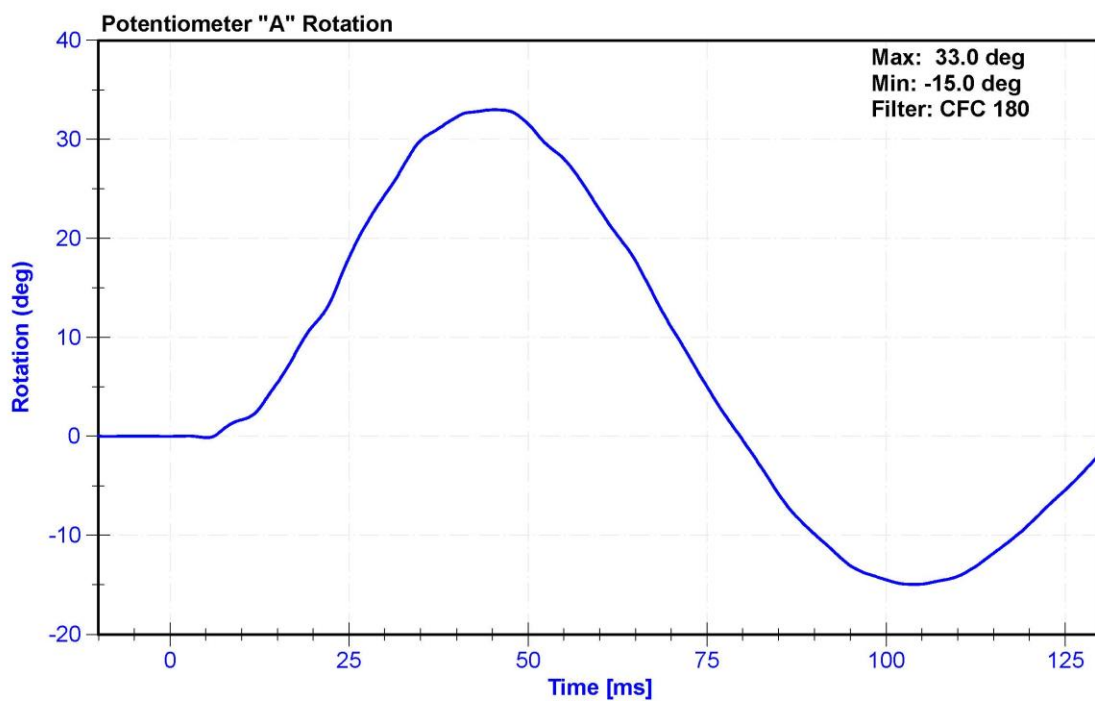
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.6	Pass
Humidity	10	70	%	32.4	Pass
Velocity	5.95	6.15	m/s	6.088	Pass
Lateral Spine Rotation	45	55	deg	45.8	Pass
Time at Maximum Rotation	39	53	ms	41.7	Pass
Time of Decay to Zero Degrees	37	57	ms	37.6	Pass
Pulse within Corridor?	-	-	-		

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-C16503 Striker	2/6/2020	2/5/2021
Pendulum "A" Potentiometer	SP22G	DS-094	8/18/2020	8/18/2021
Condyle "B" Potentiometer	SP22G	DS-095	8/18/2020	8/18/2021





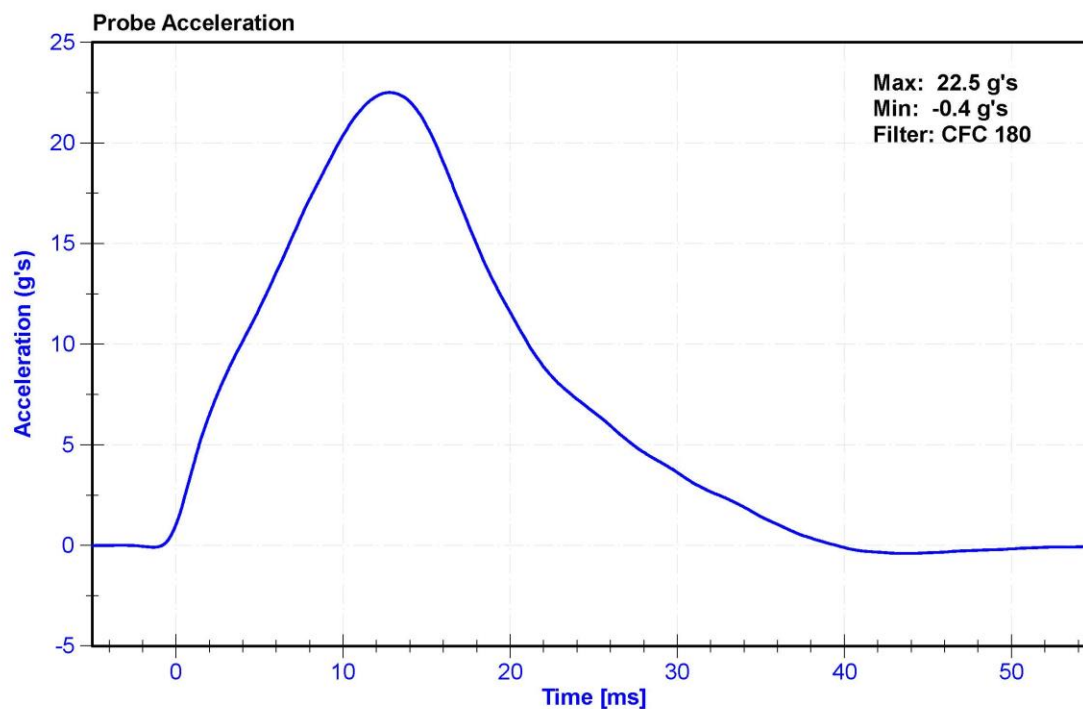
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	F034	Laboratory Supervisor	K. Brogan

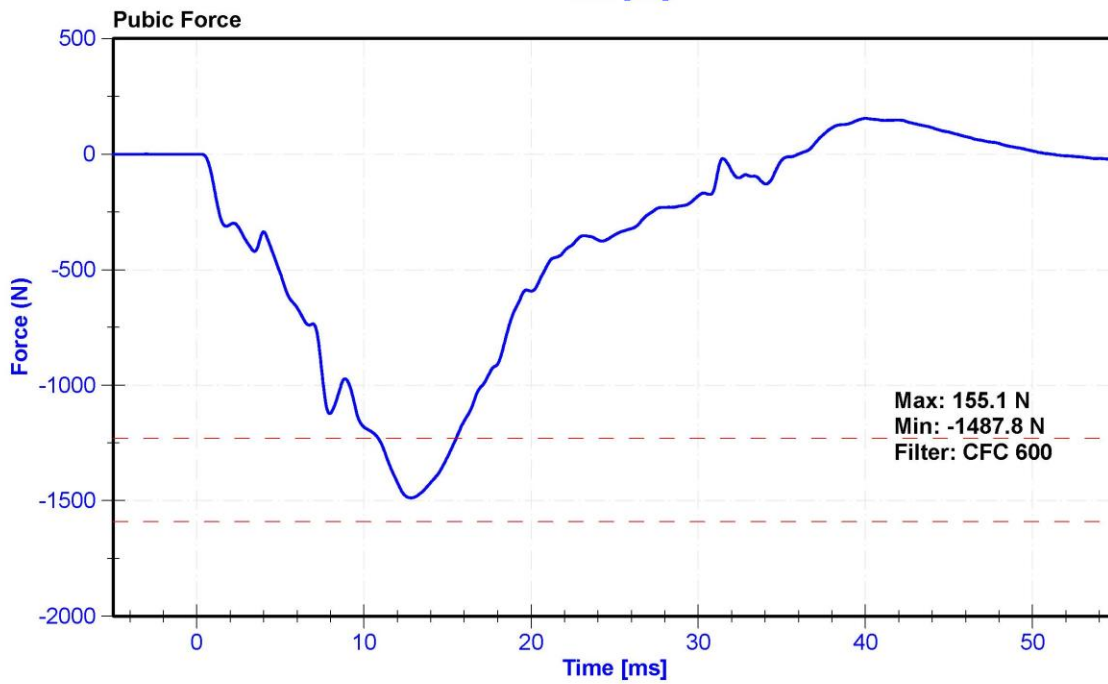
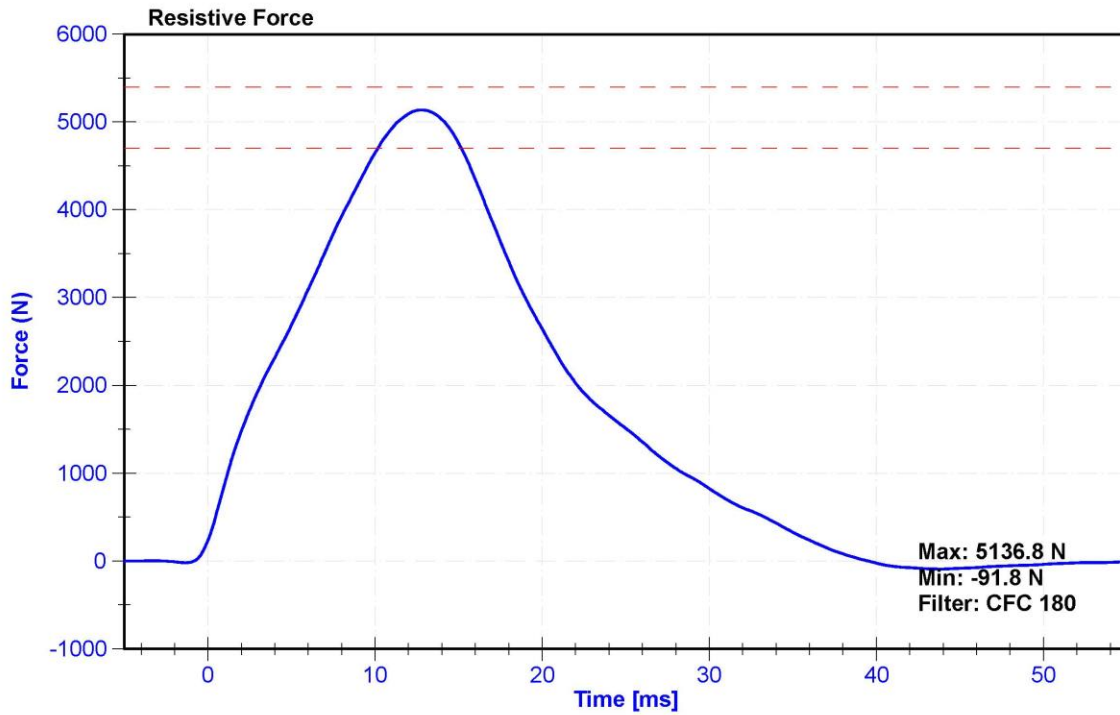
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.6	Pass
Humidity	10	70	%	37.6	Pass
Velocity	4.2	4.4	m/s	4.35	Pass
Resistive Force	4700	5400	N	5136.8	Pass
Time at Peak Resistive Force	11.8	16.1	ms	12.80	Pass
Pubic Force	-1590	-1230	N	-1487.8	Pass
Time at Peak Pubic Force	12.2	17.0	ms	12.80	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A279031	5/8/2020	5/8/2021
Pubic Load Cell	Denton 3096JFL	30960459GFE	3/19/2020	3/19/2021





CALIBRATION TEST RESULTS

PRE-TEST

SID-IIS 5TH PERCENTILE FEMALE - PASSENGER ATD

SERIAL No: 303

(CONFIGURED FOR LEFT SIDE IMPACT)

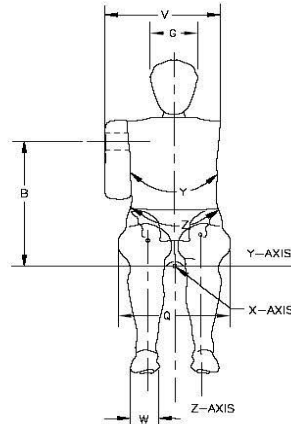
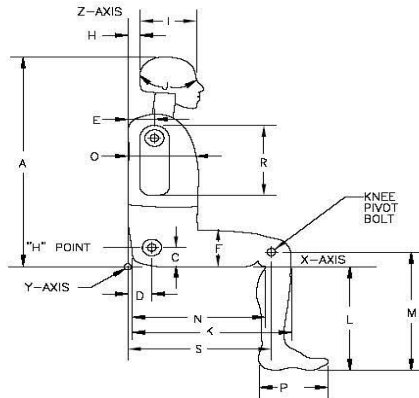


External Measurements - SID-IIs

Technician: K. Dutton

Date: 10/28/2020

Dummy Serial Number: 303



Symbol	Description	Specification (mm)		Result (mm)	Pass/Fail
A	Sitting Height	772	788	780	Pass
B	Shoulder Pivot Height	437	453	449	Pass
C	H-point Height	79	89	85	Pass
D	H-point from seatback	141	151	144	Pass
E	Shoulder Pivot from Backline	97	107	103	Pass
F	Thigh Clearance	119	135	128	Pass
G	Head Breadth	140	148	144	Pass
H	Head Back from Backline	40	46	42	Pass
I	Head Depth	178	188	181	Pass
J	Head Circumference	541	551	546	Pass
K	Buttock to Knee Length	514	540	530	Pass
L	Popliteal Height	343	369	358	Pass
M	Knee Pivot to floor height	392	409	404	Pass
N	Buttock Popliteal Length	416	442	436	Pass
O	Chest Depth w/o jacket	195	211	204	Pass
P	Foot Length	216	232	222	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	488	Pass
V	Shoulder Width	341	357	349	Pass
W	Foot Width	78	94	85	Pass
Y	Chest Circumference w/jacket	851	881	868	Pass
Z	Waist Circumference	761	791	772	Pass

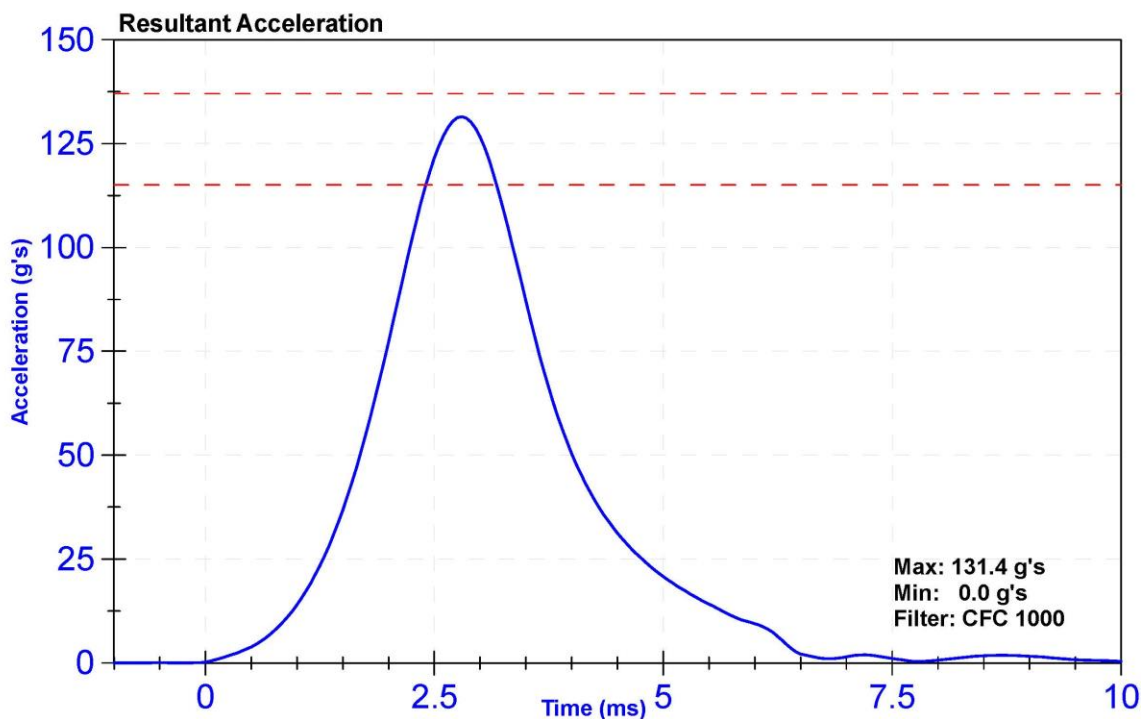
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

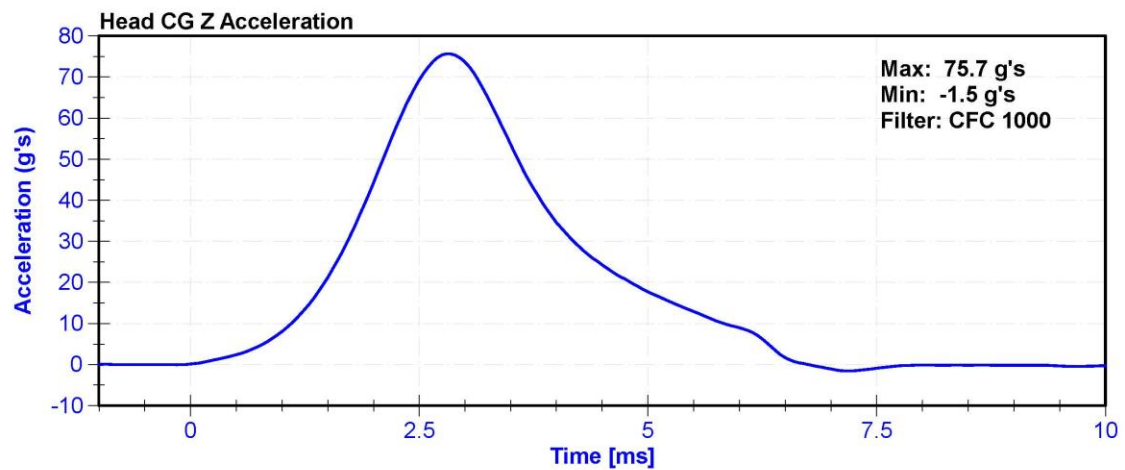
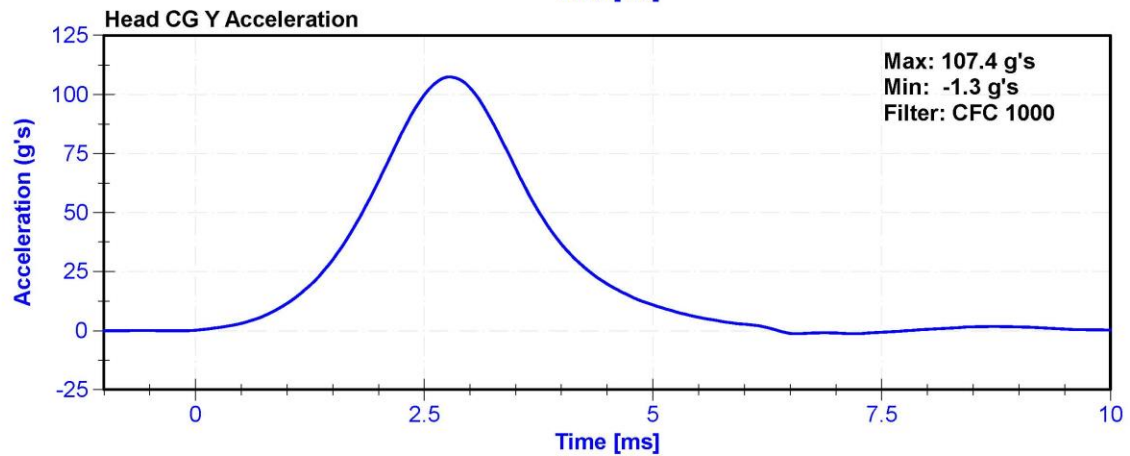
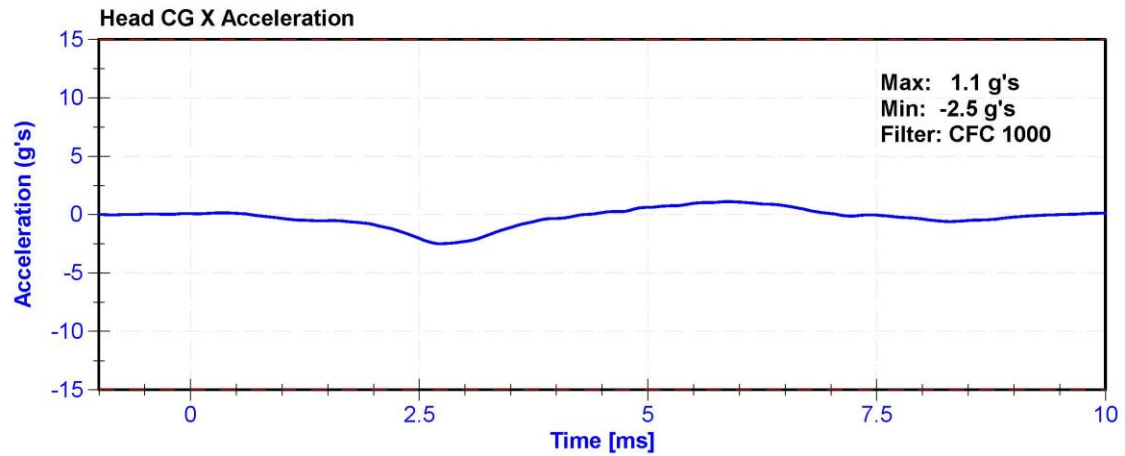
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	42	Pass
Resultant Acceleration	115	137	g's	131.4	Pass
Oscillation	0	15	%	1.5	Pass
Fore-Aft Acceleration	-15	15	g's	-2.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
X Accelerometer	ENDEVCO 7264CT	AC-P83431	9/18/2020	3/19/2021
Y Accelerometer	ENDEVCO 7264CT	AC-P75158	9/18/2020	3/19/2021
Z Accelerometer	ENDEVCO 7264CT	AC-P68077	9/18/2020	3/19/2021





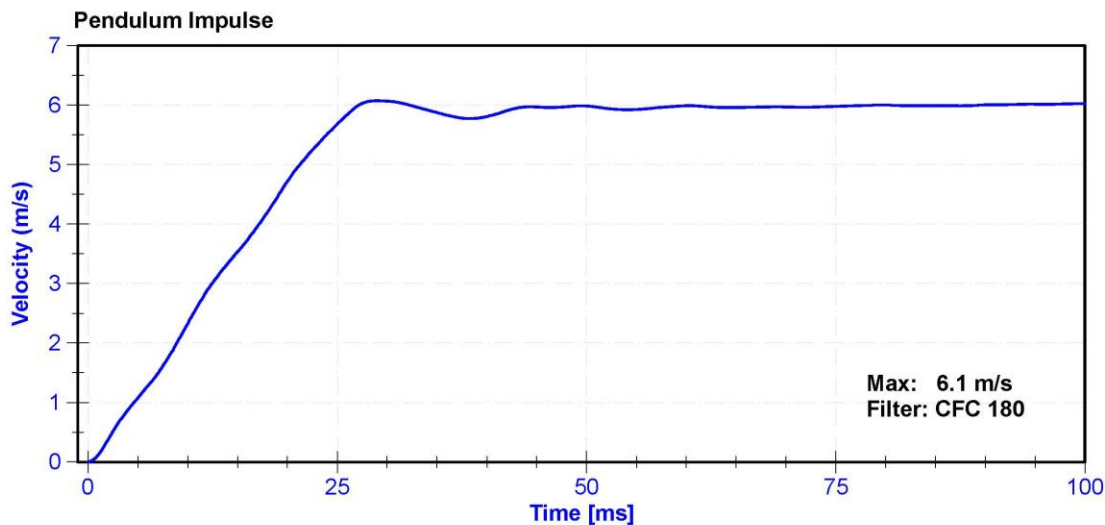
ATD Manufacturer	FTSS	Test Technician	E. Helenbrook
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

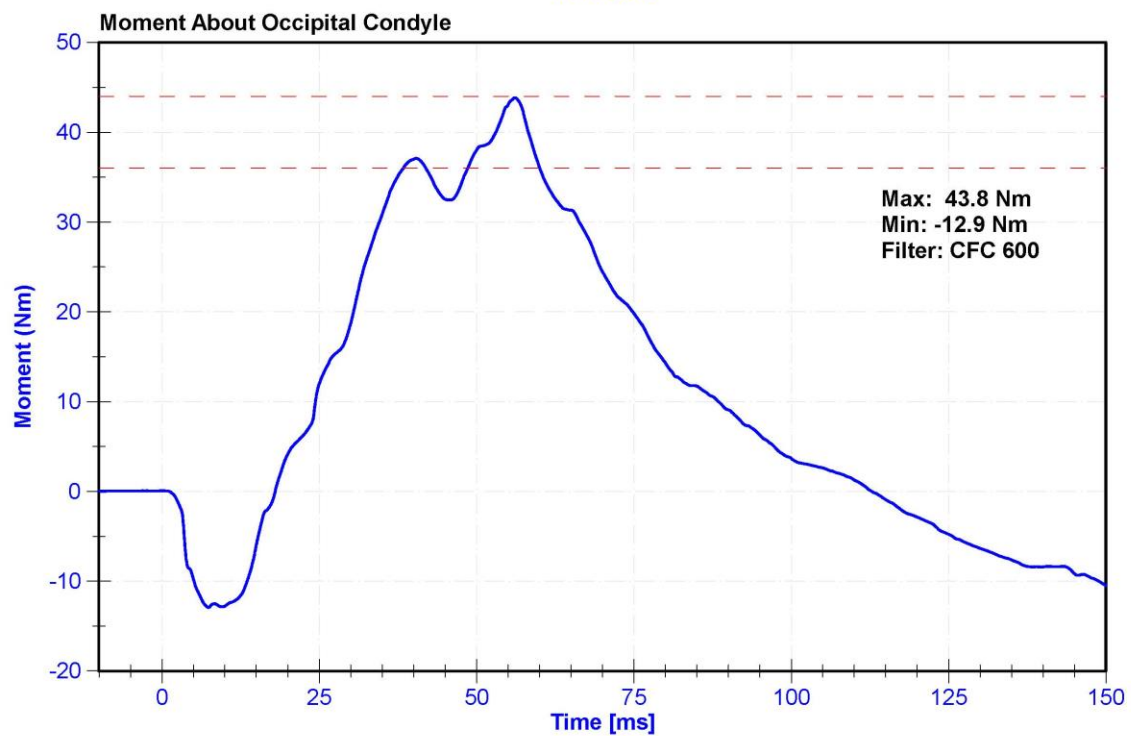
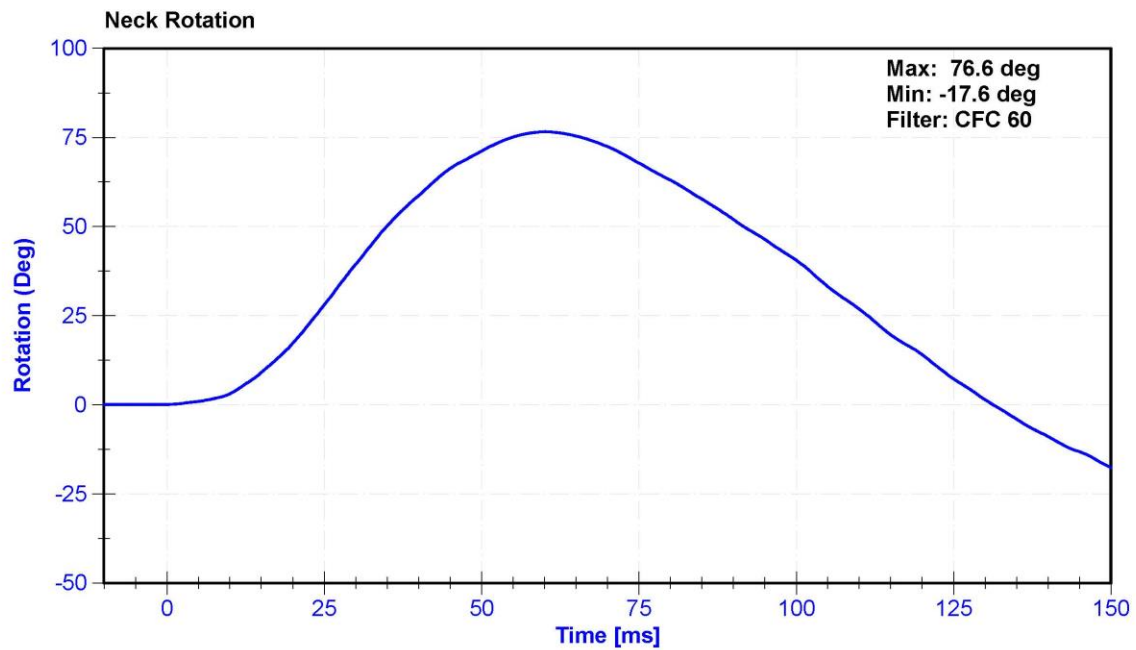
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	21.5	Pass
Humidity	10	70	%	32.4	Pass
Velocity	5.51	5.63	m/s	5.584	Pass
Pendulum Impulse at 10ms	2.2	2.8	m/s	2.33	Pass
Pendulum Impulse at 15ms	3.3	4.1	m/s	3.53	Pass
Pendulum Impulse at 20ms	4.4	5.4	m/s	4.72	Pass
Pendulum Impulse at 25ms	5.4	6.1	m/s	5.68	Pass
Pendulum Impulse from 25 to 100ms	5.5	6.2	m/s	6.07	Pass
Neck Rotation	71	81	deg	76.6	Pass
Time at Maximum Rotation	50	70	ms	60.1	Pass
Moment about the OC	36	44	Nm	43.8	Pass
Moment Decay to 0 Nm	102	126	ms	112.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	ENDEVCO 7231CT	AC-C16503 Striker	2/6/2020	2/5/2021
Pendulum Potentiometer	Denton 78051-342	DS-184Pend	11/4/2019	11/3/2020
Condyle Potentiometer	Denton 78051-342	DS-185Pend	11/4/2019	11/3/2020
Upper Neck Load Cell	Denton 1716	17162019 FY	3/18/2020	3/18/2021





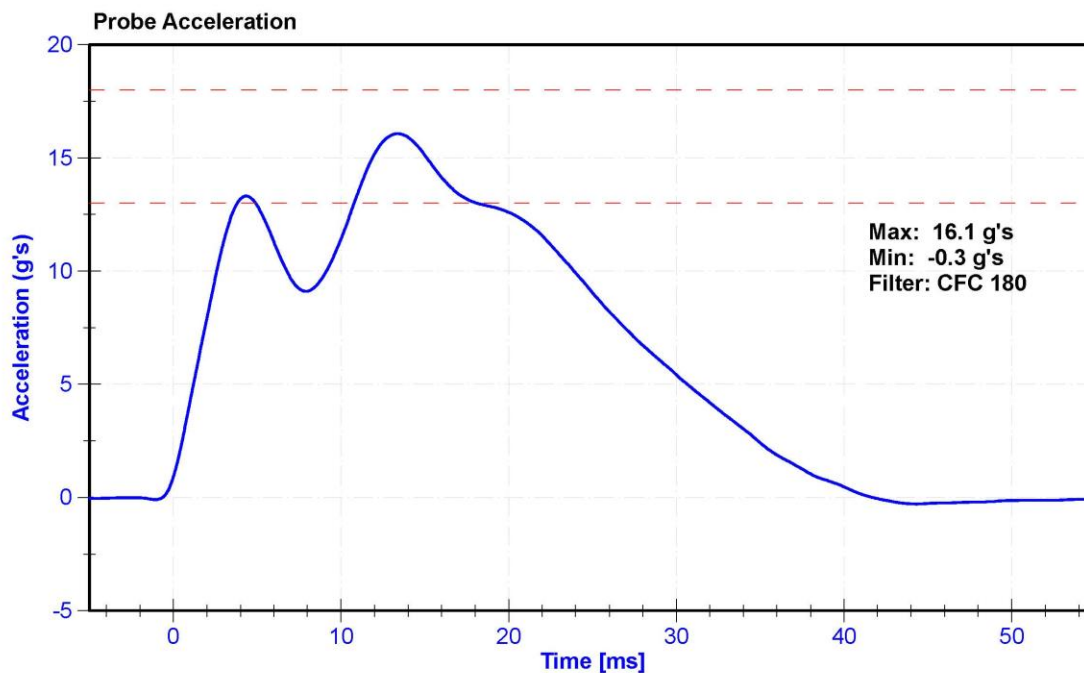
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

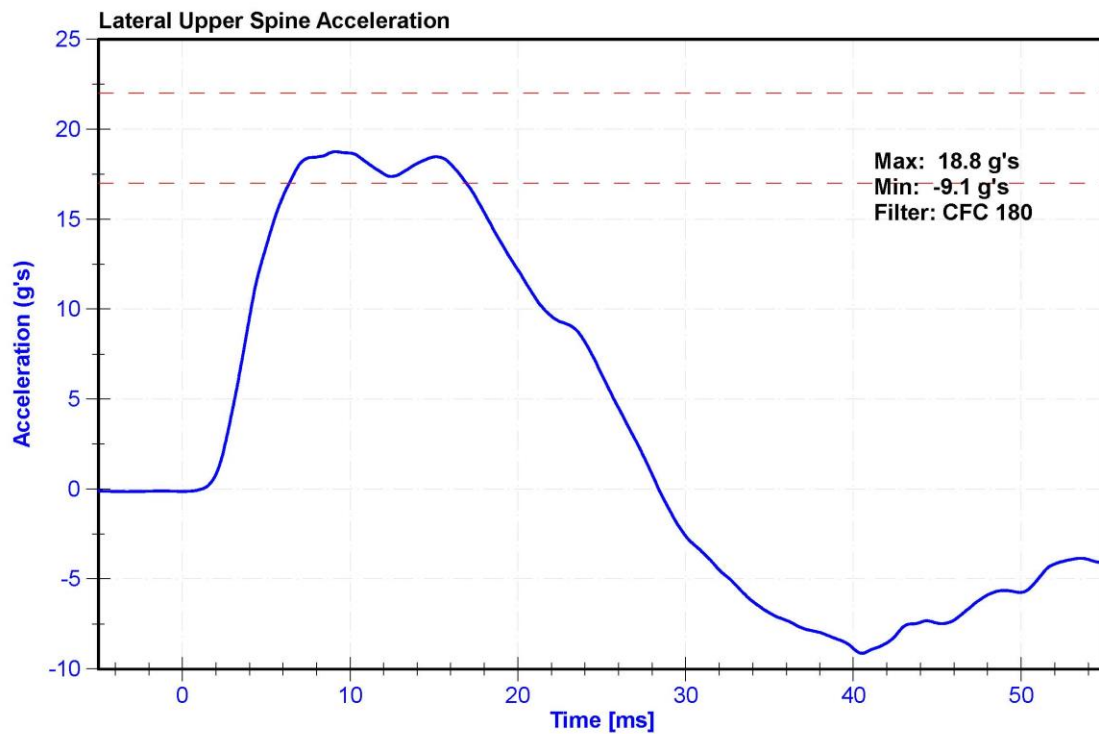
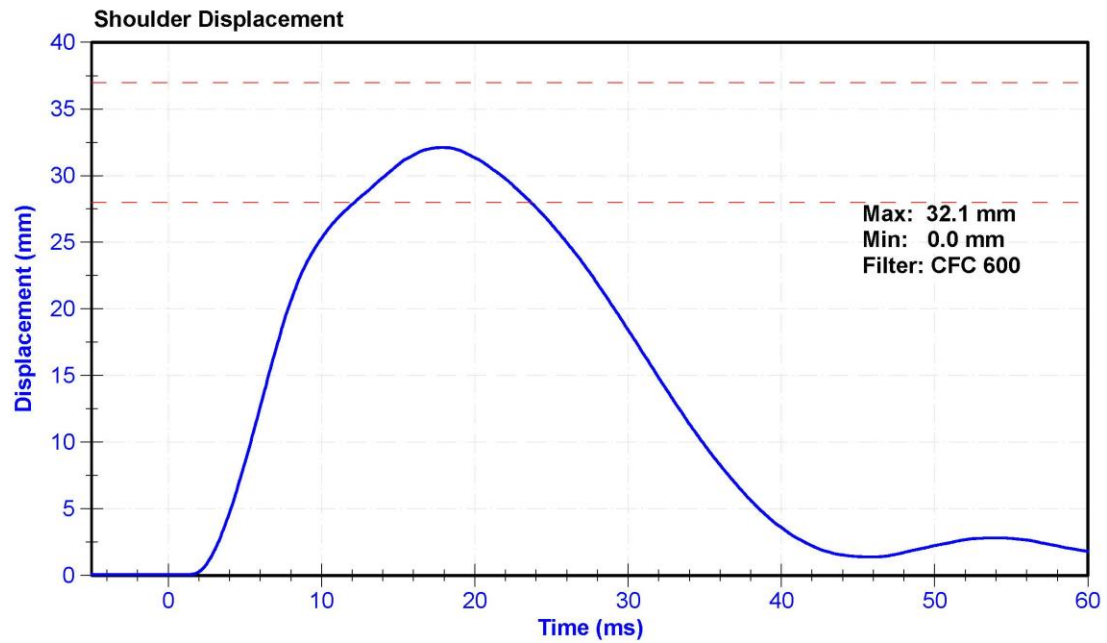
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	36	Pass
Velocity	4.2	4.4	m/s	4.31	Pass
Probe Acceleration	13	18	g's	16.1	Pass
Shoulder Deflection	28	37	mm	32.1	Pass
Lateral Upper Spine Acceleration	17	22	g's	18.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Shoulder Potentiometer	Servo 08TC1-3787	DS-030GFE	9/14/2020	3/15/2021
Upper Spine Y Accelerometer	Endevco 7264C	T20816	9/18/2020	3/19/2021





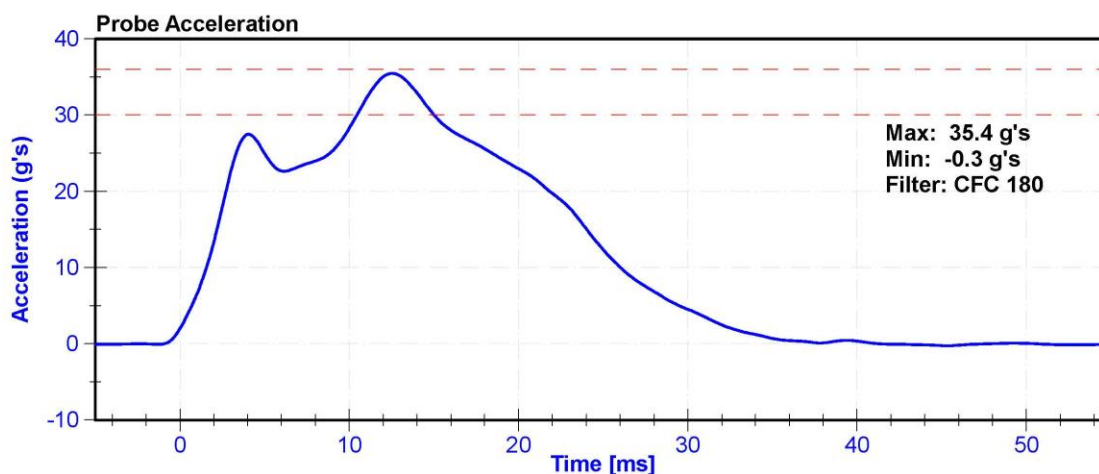
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

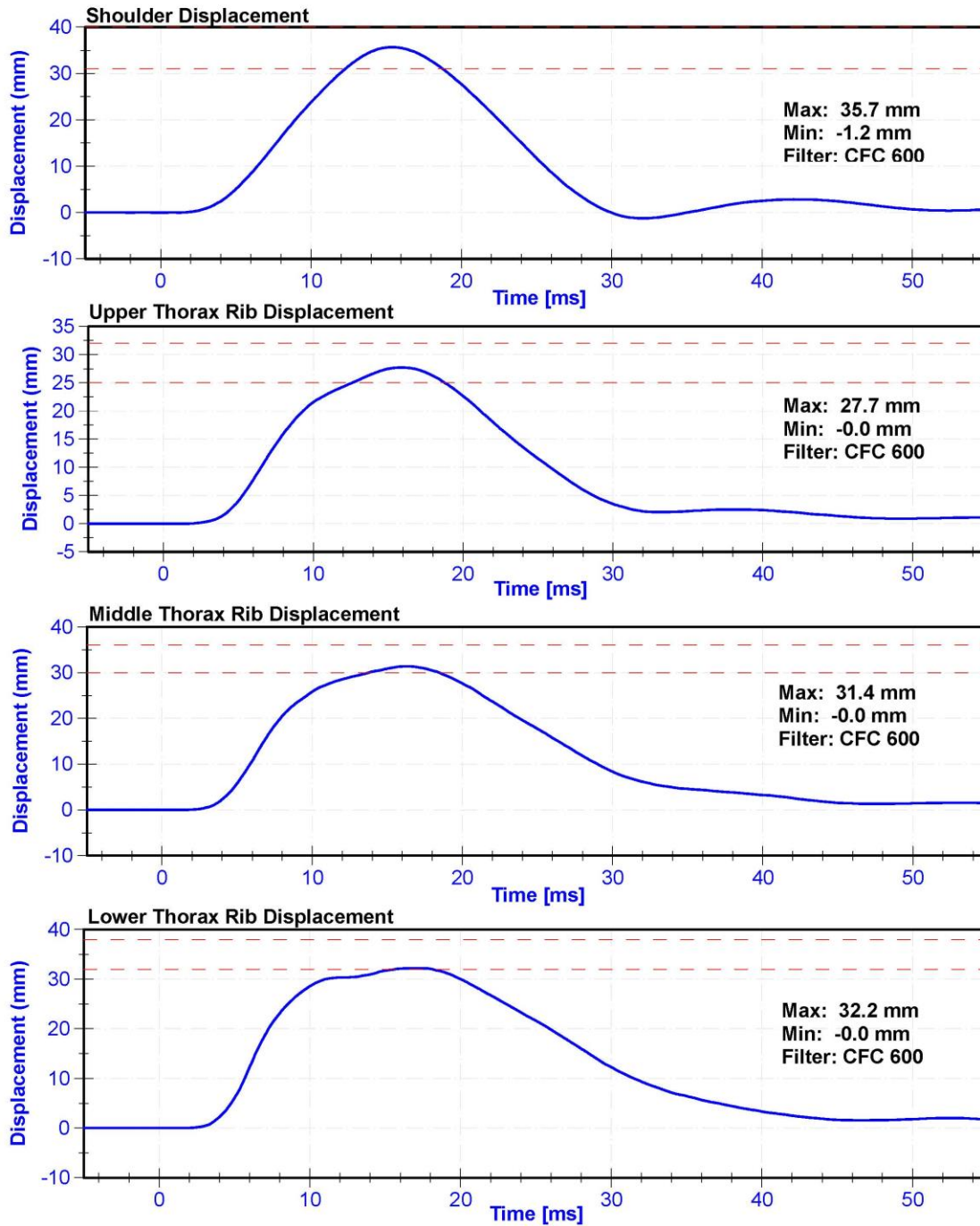
Results

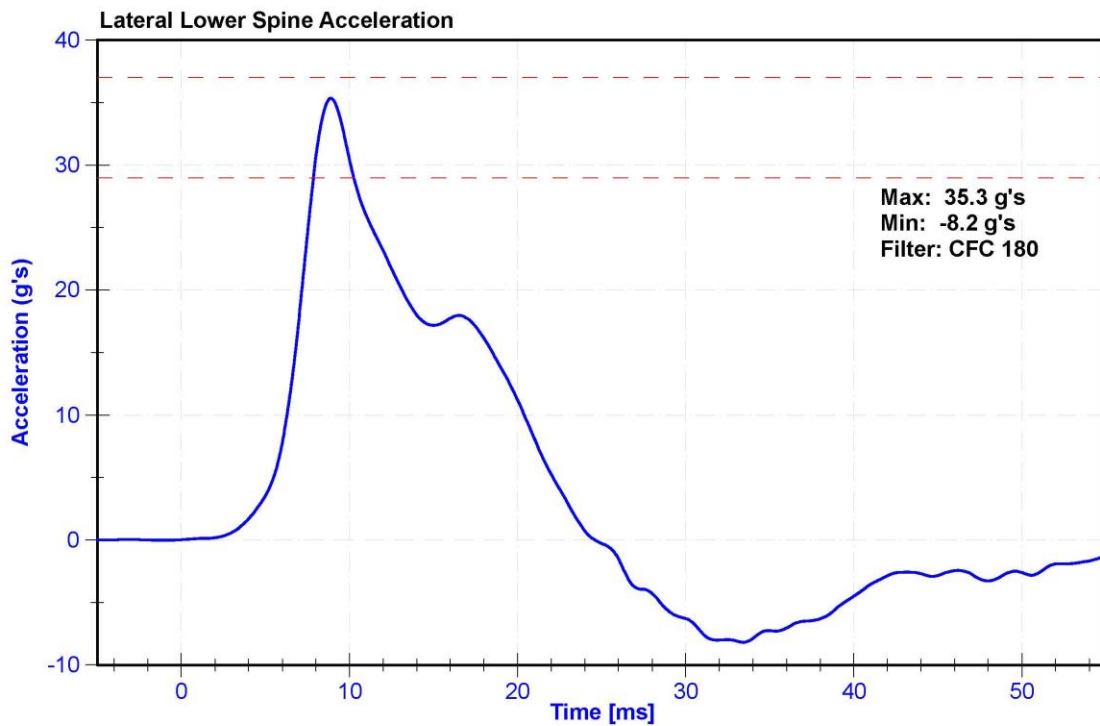
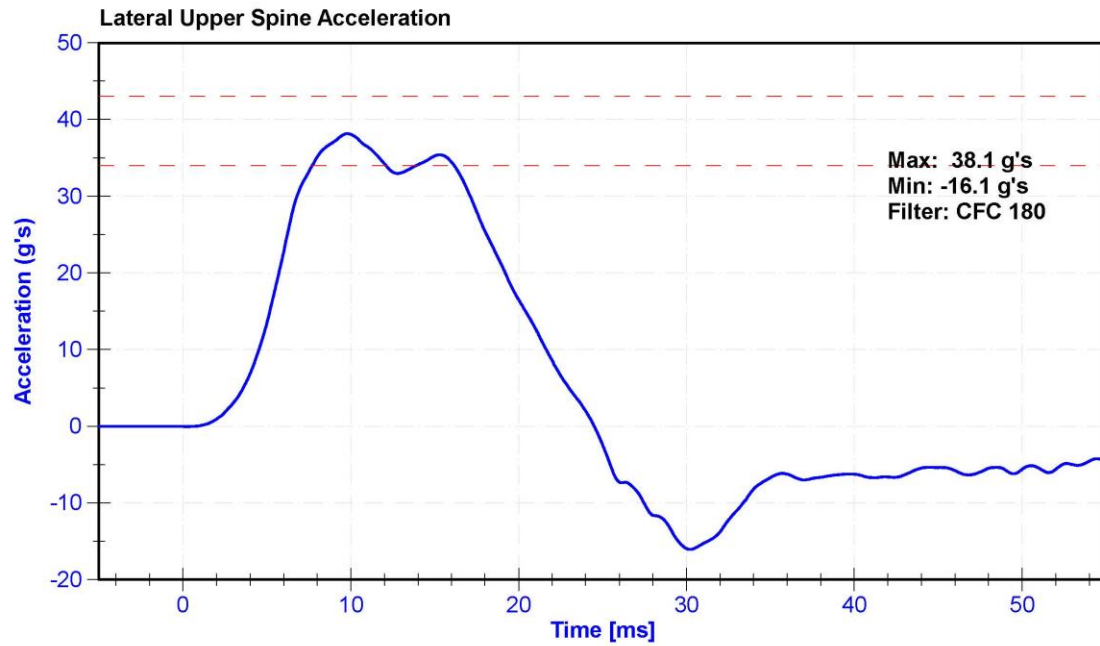
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.7	Pass
Humidity	10	70	%	36.0	Pass
Velocity	6.6	6.8	m/s	6.66	Pass
Probe Acceleration after 5 ms	30	36	g's	35.4	Pass
Lateral Upper Spine Acceleration	34	43	g's	38.1	Pass
Lateral Lower Spine Acceleration	29	37	g's	35.3	Pass
Shoulder Deflection	31	40	mm	35.7	Pass
Upper Thorax Rib Deflection	25	32	mm	27.7	Pass
Mid Thorax Rib Deflection	30	36	mm	31.4	Pass
Lower Thorax Rib Deflection	32	38	mm	32.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Upper Spine T1 Y Accelerometer	Endevco 7264C	T20816	9/18/2020	3/19/2021
Upper Spine T12 Y Accelerometer	Endevco 7264C	P84353	9/18/2020	3/19/2021
Shoulder Potentiometer	Servo 08TC1-3787	DS-030GFE	9/14/2020	3/15/2021
Upper Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1199GFE	6/1/2020	11/30/2020
Middle Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1246GFE	6/1/2020	11/30/2020
Lower Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1256GFE	6/1/2020	11/30/2020







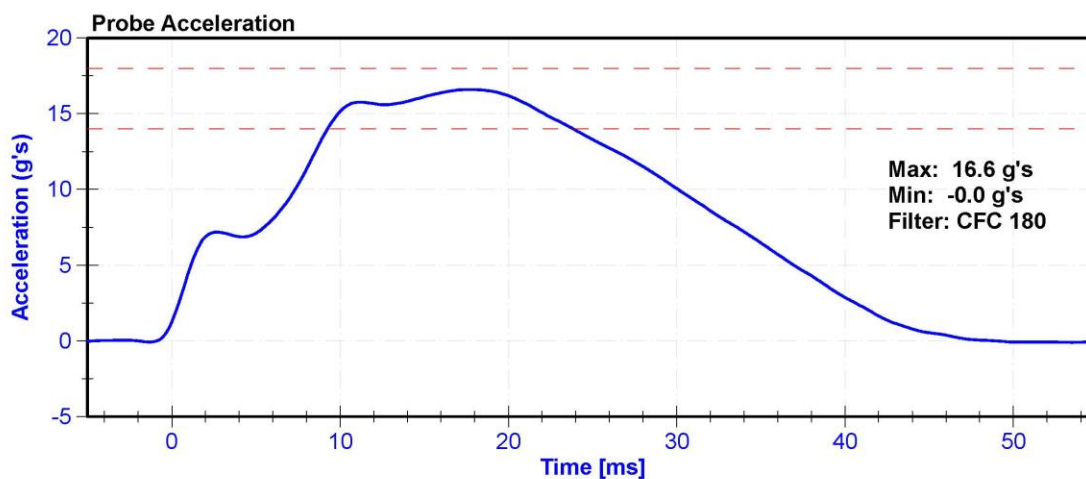
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

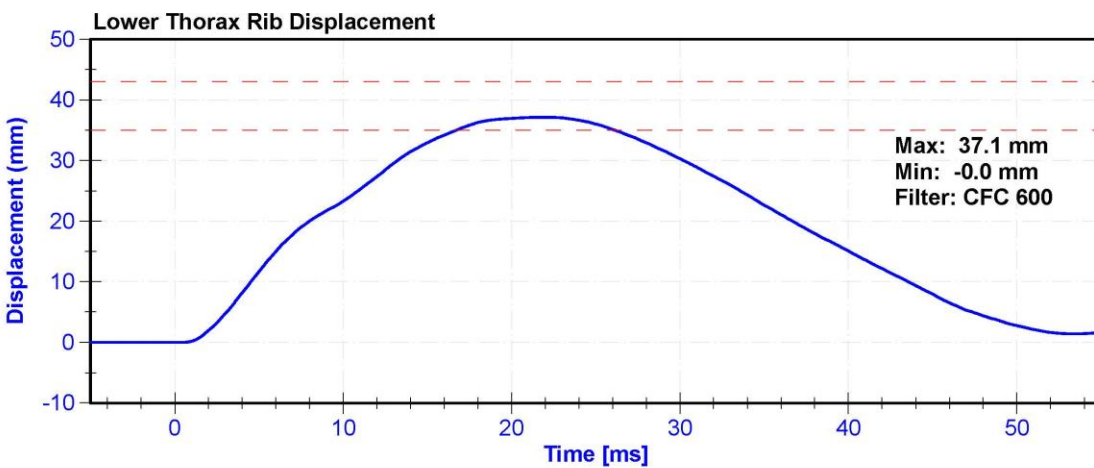
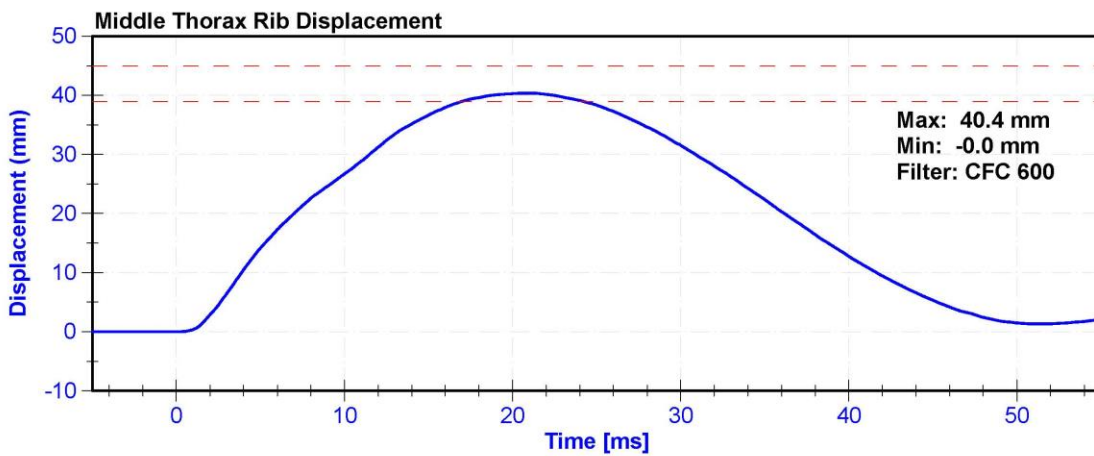
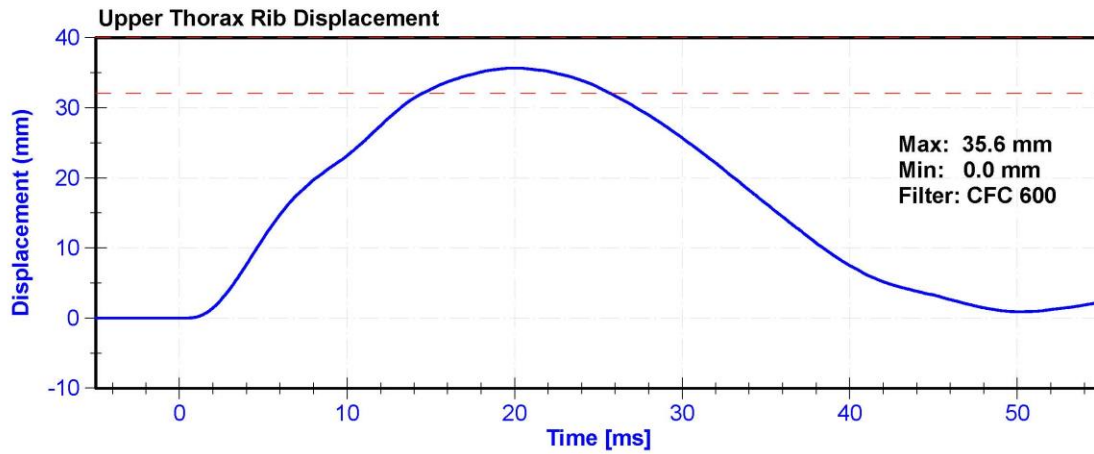
Results

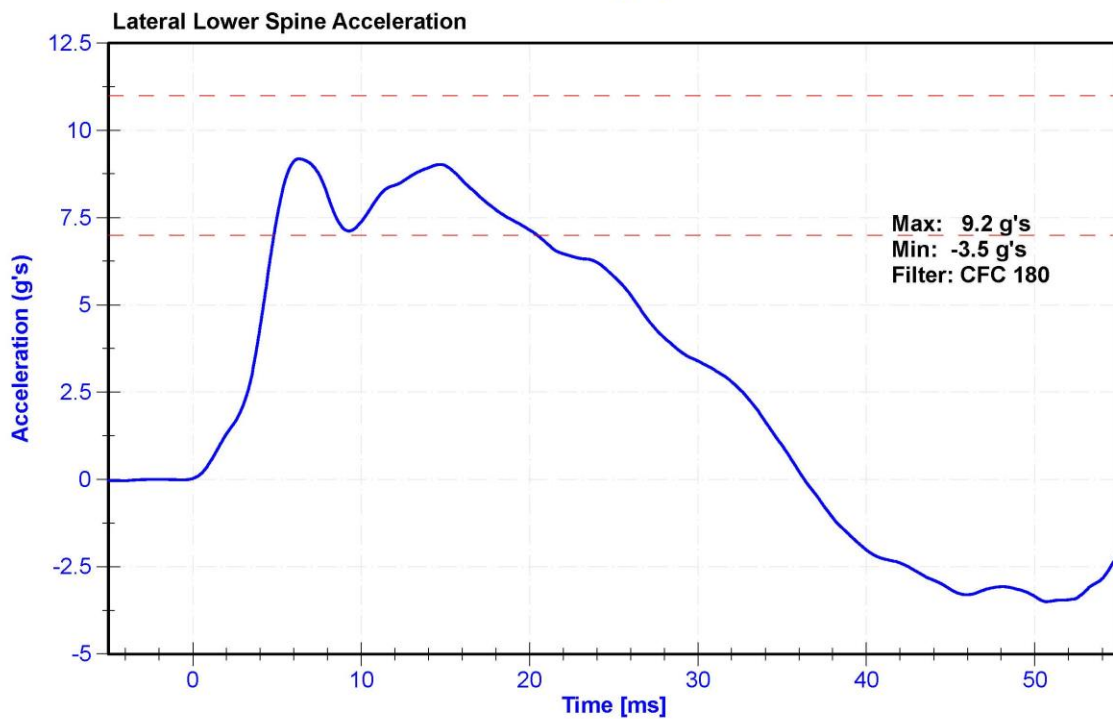
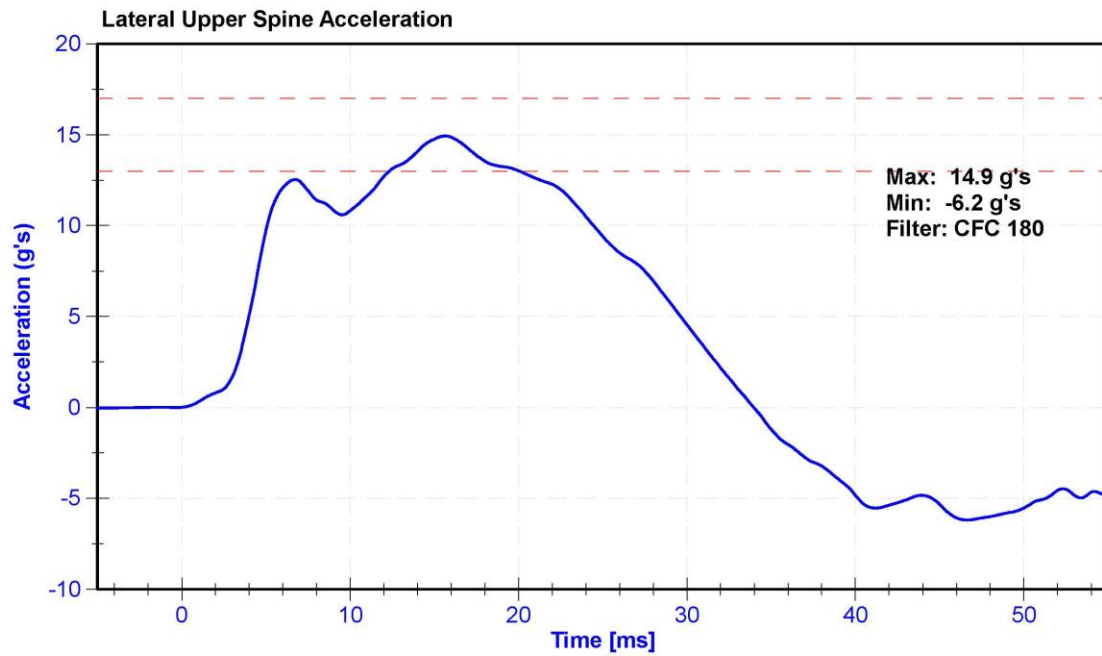
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.9	Pass
Humidity	10	70	%	36	Pass
Velocity	4.2	4.4	m/s	4.34	Pass
Probe Acceleration	14	18	g's	16.6	Pass
Lateral Upper Spine Acceleration	13	17	g's	14.9	Pass
Lateral Lower Spine Acceleration	7	11	g's	9.2	Pass
Upper Thorax Rib Deflection	32	40	mm	35.6	Pass
Middle Thorax Rib Deflection	39	45	mm	40.4	Pass
Lower Thorax Rib Deflection	35	43	mm	37.1	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Upper Spine Y Accelerometer	Endevco 7264C	T20816	9/18/2020	3/19/2021
Lower Spine Y Accelerometer	Endevco 7264C	P84353	9/18/2020	3/19/2021
Upper Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1199GFE	6/1/2020	11/30/2020
Middle Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1246GFE	6/1/2020	11/30/2020
Lower Thorax Rib Potentiometer	Servo 08CT1-3725	DS-1256GFE	6/1/2020	11/30/2020







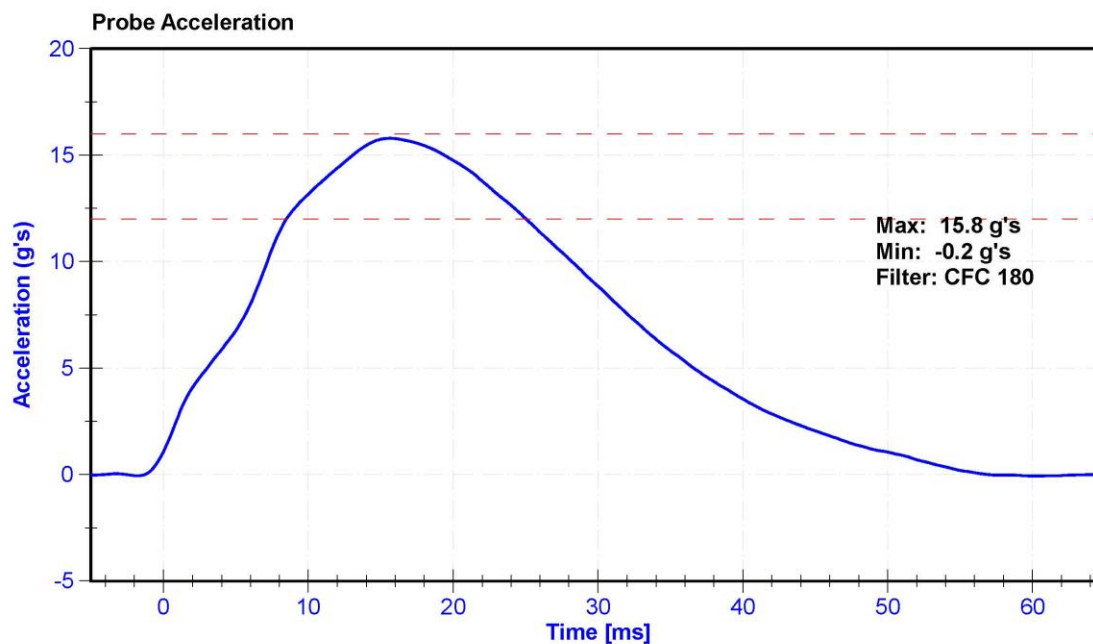
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

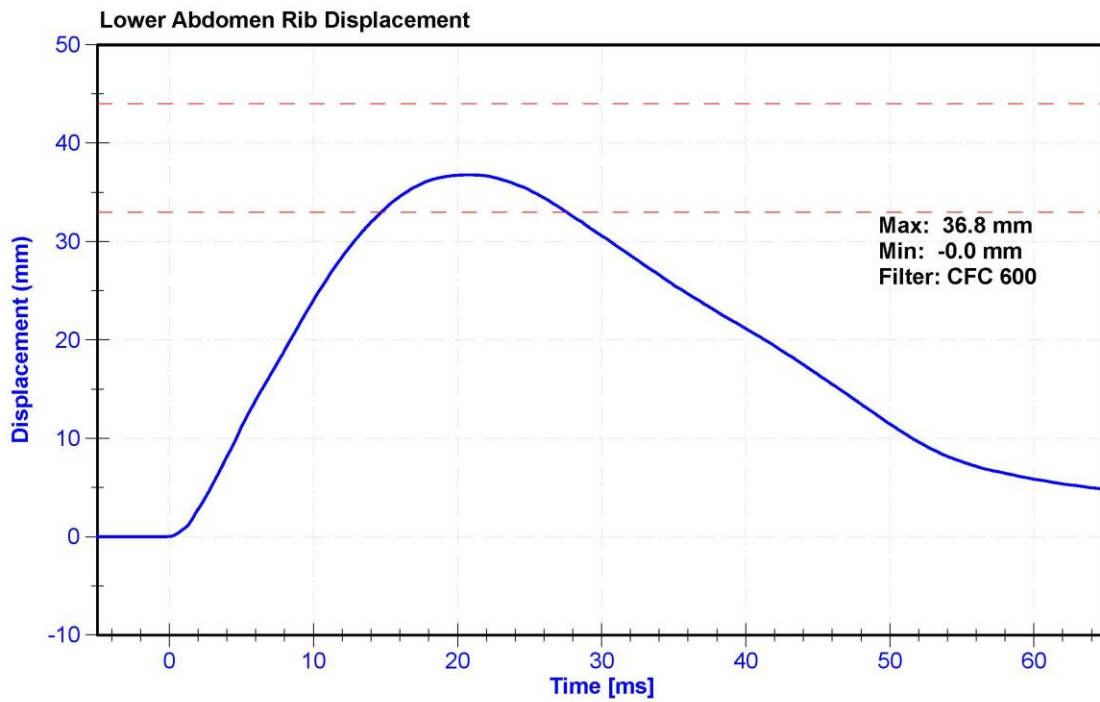
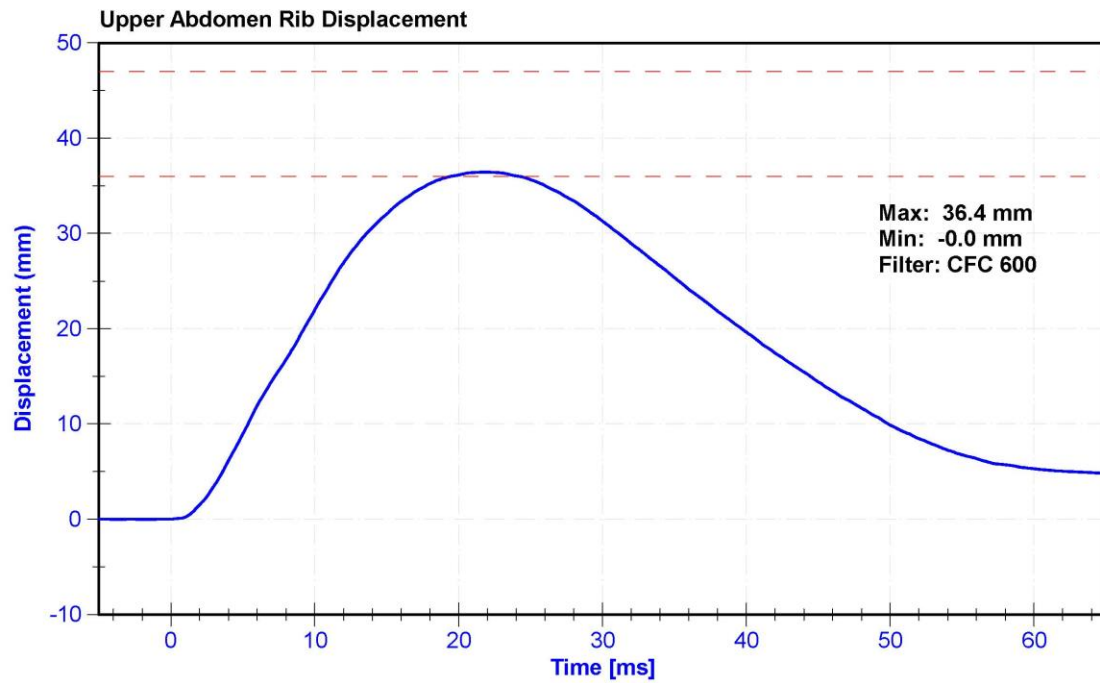
Results

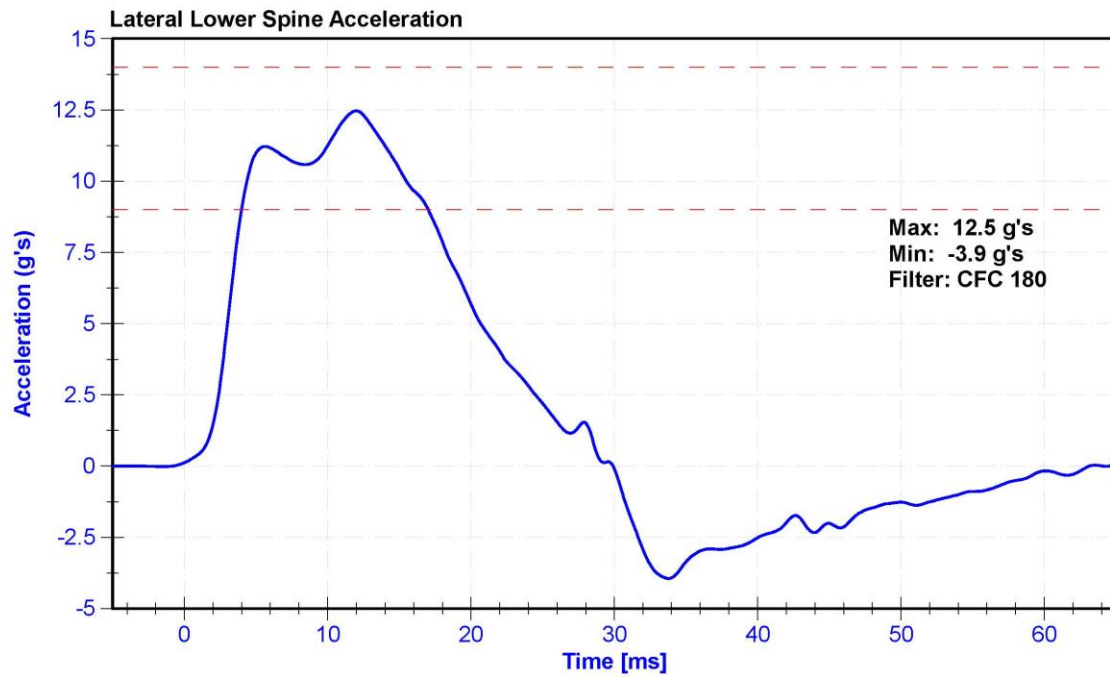
Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	37.0	Pass
Velocity	4.2	4.4	m/s	4.34	Pass
Probe Acceleration	12	16	g's	15.8	Pass
Lateral Lower Spine Acceleration	9	14	g's	12.5	Pass
Upper Abdomen Rib Deflection	36	47	mm	36.4	Pass
Lower Abdomen Rib Deflection	33	44	mm	36.8	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Probe Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Lower Spine Y Accelerometer	Endevco 7264C	P84353	9/18/2020	3/19/2021
Upper Abdomen Rib Potentiometer	Servo 08CT1-3725	DS-1274GFE	6/1/2020	11/30/2020
Lower Abdomen Rib Potentiometer	Servo 08CT1-3745	DS-2316GFE	5/28/2020	11/26/2020







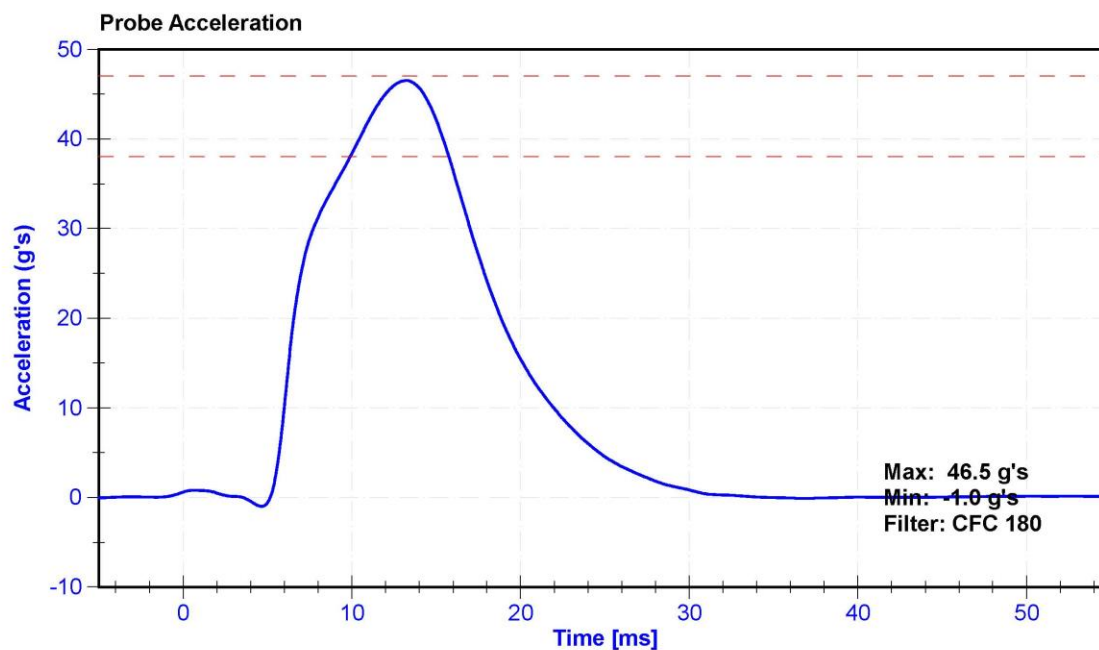
ATD Manufacturer	FTSS	Test Technician	D.Reinhard
ATD Serial Number	303	Laboratory Supervisor	K. Brogan

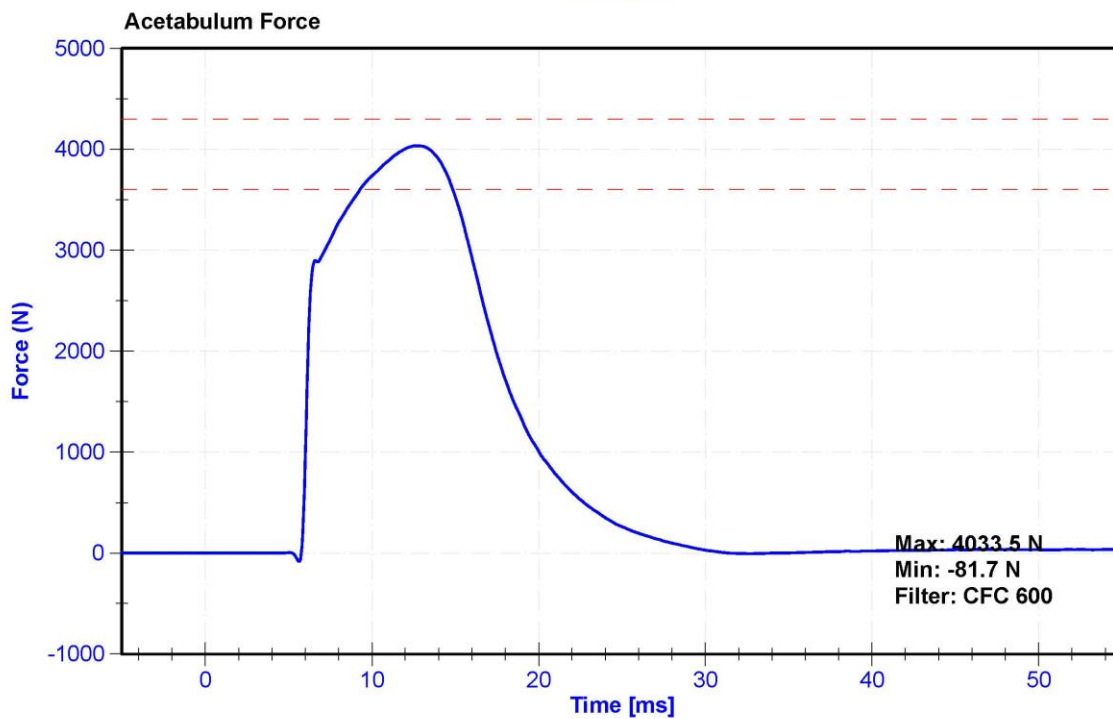
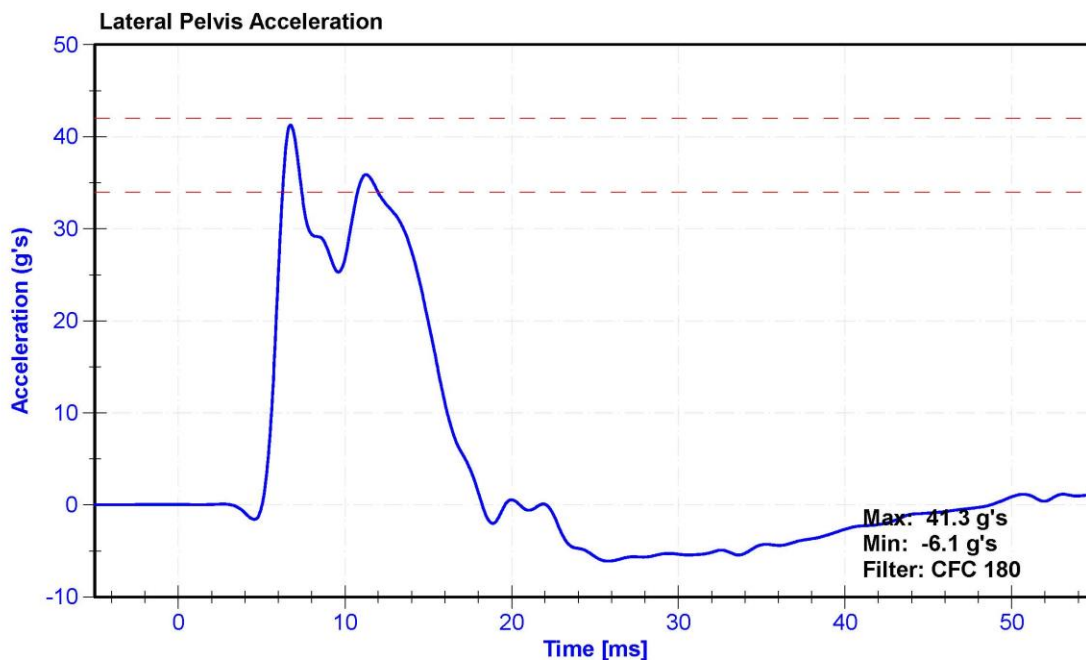
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.9	Pass
Humidity	10	70	%	37	Pass
Velocity	6.6	6.8	m/s	6.66	Pass
Probe Acceleration	38	47	g's	46.5	Pass
Lateral Pelvis Acceleration after 6ms	34	42	g's	41.3	Pass
Acetabulum Force	3600	4300	N	4033.5	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Pelvis Y Accelerometer	Endevco 7264C	P58744	9/18/2020	3/19/2021
Acetabulum Load Cell	Denton 3249J	LC-276Fy	7/23/2020	7/23/2021
Certification Plug	SACO	13534	9/23/2019	N/A
Crash Test Plug	SACO	13479	9/23/2019	N/A







SID-Its Pelvis Plug Certification Test

Plug S/N 13392

Test Number 11034

Report Number 11072

Test Date 9/19/2019 12:23:36 PM

Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	281.90	600.00
Force @ 1.5 mm (N)	1,204.05	1,400.00
Force @ 2.5 mm (N)	1,445.78	1,618.00
Force @ 3.0 mm (N)	1,475.50	1,673.00

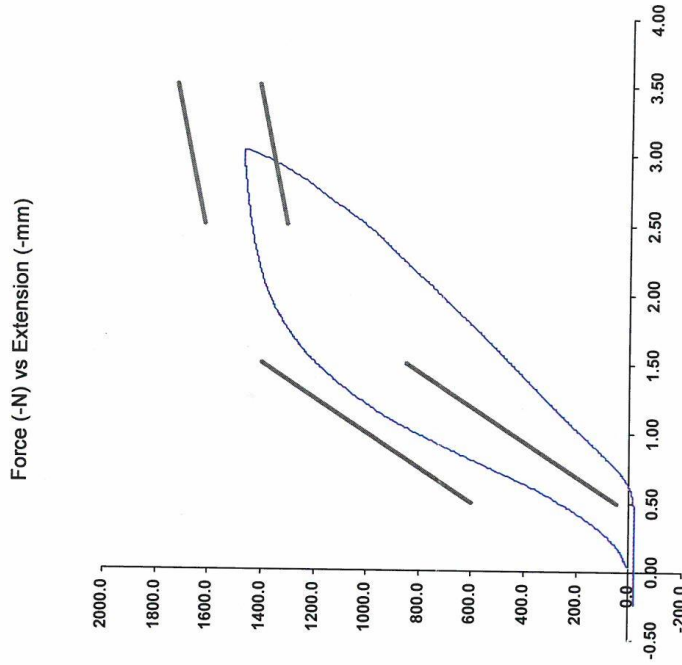
Testing Machine STM-20 5965541

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:



Operator	Part Number 180-4450
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Template No 107	19-Sep-19
SACO Research	

By : *DC* Date : 9/19/2019

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



SID-11s Pelvis Plug Certification Test

Plug S/N 13534

Test Number 11178

Report Number 11216

Test Date 9/23/2019 11:44:46 AM

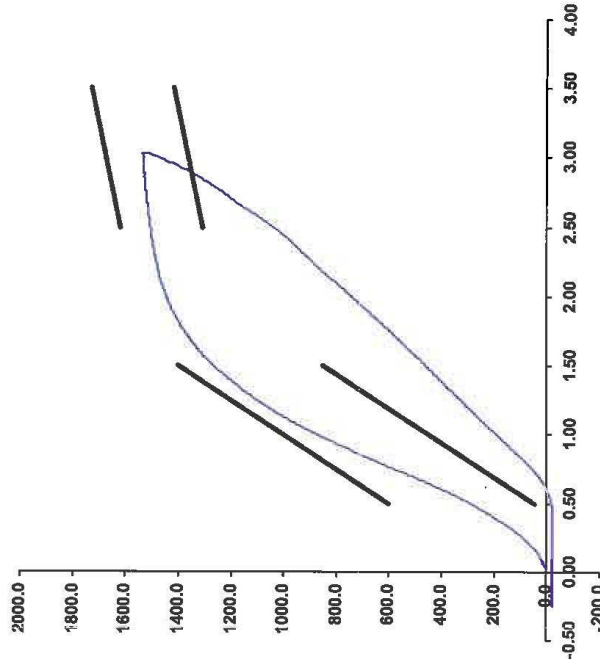
Test Results	Spec Min	Spec Max
Force @ 0.5 mm (N)	50.00	600.00
Force @ 1.5 mm (N)	850.00	1,400.00
Force @ 2.5 mm (N)	1,308.00	1,618.00
Force @ 3.0 mm (N)	1,361.00	1,673.00

Testing Machine STM-20 5965542
 Load Cell S/N (F1360947), Units (LBS 1000
 Crosshead Speed (mm / min) or Rate 12.7
 Extension or Position Measured by XHD_100 (XHD100)

Notes:

303
 Cefl
 10/28/2020

Force (-N) vs Extension (-mm)



Operator
 Part Number 180-4450

Template No 107 23-Sep-19
 SACO Research

By: DC Date: 9/23/2019
 SACO Research 41735 Elm St, #401 Murieta, CA 92562 Tel 310-694-2082 FAX

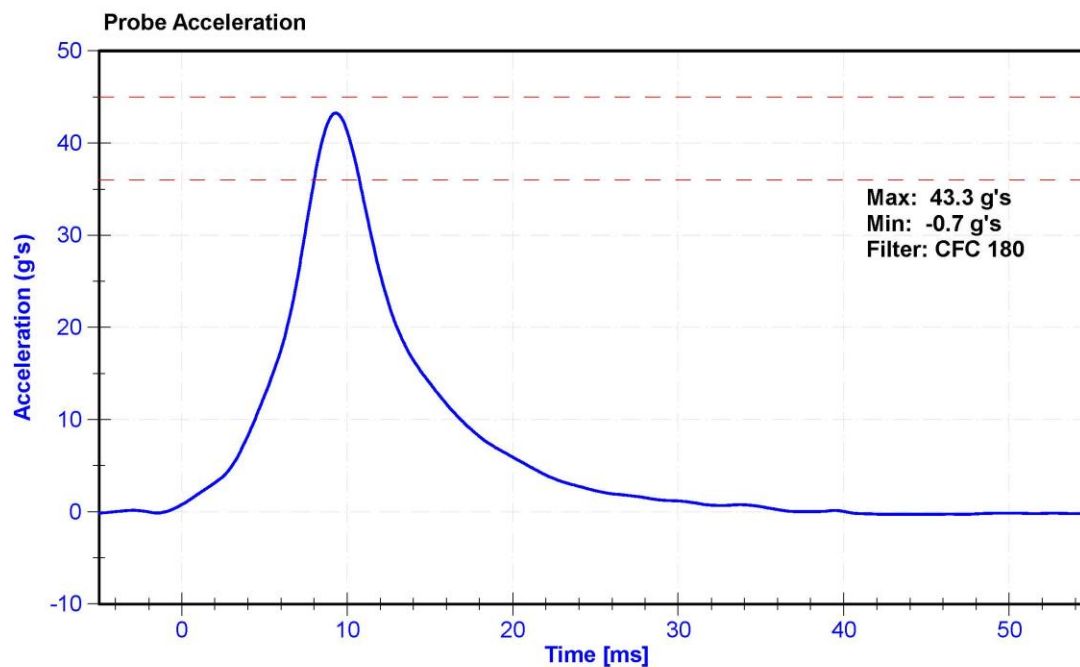
ATD Manufacturer	FTSS	Test Technician	K. Brogan
ATD Serial Number	303	Laboratory Supervisor	D.Reinhard

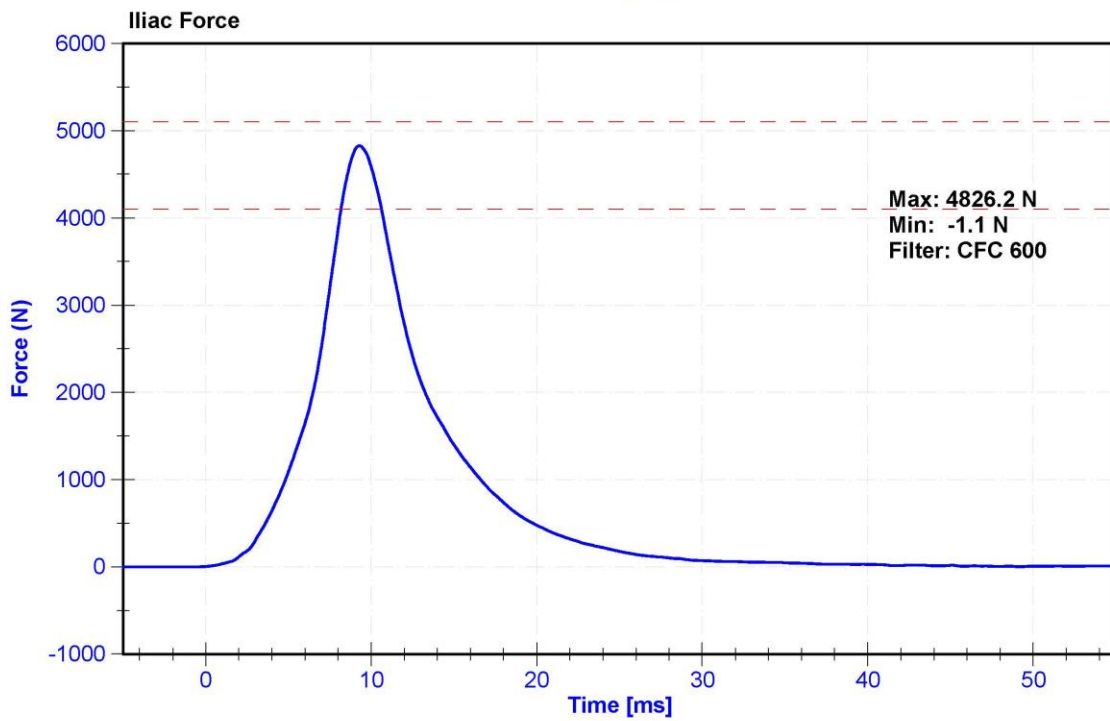
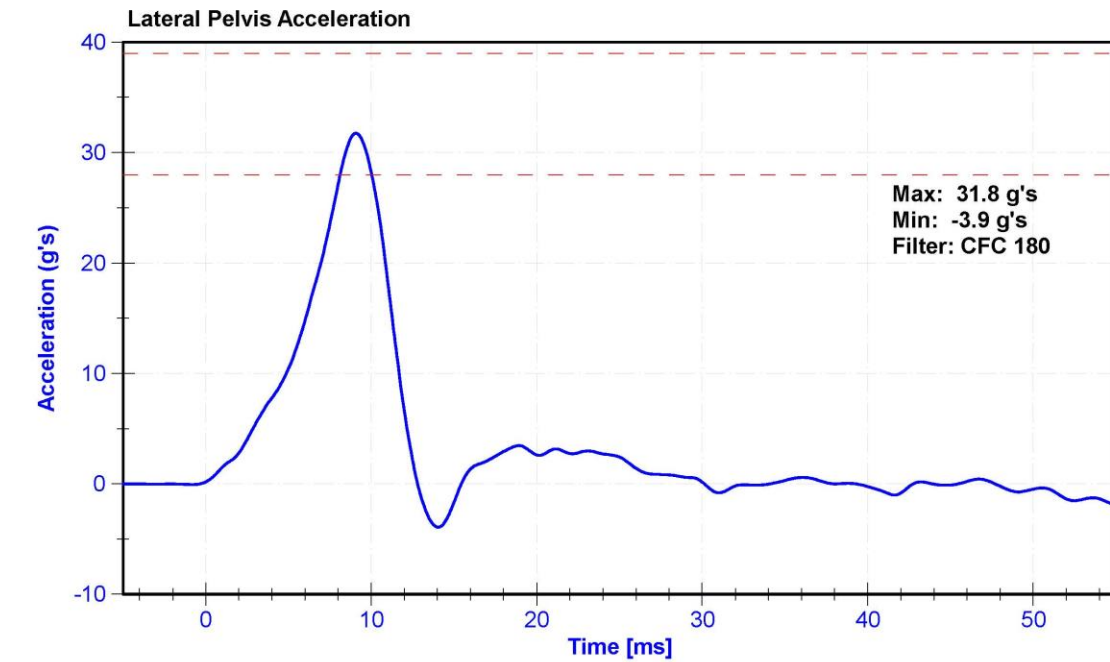
Results

Test Parameter	Minimum Specification	Maximum Specification	Unit	Result	Pass/Fail
Temperature	20.6	22.2	°C	20.8	Pass
Humidity	10	70	%	37.0	Pass
Velocity	4.2	4.4	m/s	4.23	Pass
Probe Acceleration	36	45	g's	43.3	Pass
Lateral Pelvis Acceleration	28	39	g's	31.8	Pass
Iliac Force	4100	5100	N	4826.2	Pass

Transducer Calibrations

Channel	Manufacturer	Serial Number	Calibration Date	Calibration Due Date
Pendulum Accelerometer	MSI 64C-2000	A286228	1/29/2020	1/28/2021
Pelvis Y Accelerometer	Endevco 7264C	P58744	9/18/2020	3/19/2021
Iliac Load Cell	DENTON 3228J	LC-280Fy	7/23/2020	7/23/2021





APPENDIX D

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

TABLE 1 – Dummy Instrumentation (ES-2re)

			ES-2re S/N F034		
			Serial Number	Manufacturer	Calibration Date
Head	Primary Accelerometers	X	P51884	Endevco	9/22/2020
		Y	P73161	Endevco	9/22/2020
		Z	P79588	Endevco	9/22/2020
	Redundant Accelerometers	X	P74963	Endevco	9/22/2020
		Y	P58864	Endevco	9/22/2020
		Z	AC-P52030	Endevco	5/15/2020
	Angular Rate Sensors	X	ARS-7553 GFE	DTS	2/21/2020
		Y	ARS-14908GFE	DTS	2/21/2020
		Z	ARS-14909GFE	DTS	2/21/2020
Upper Neck Load Cell	Forces	X	40850139 GFE Fx	Denton	5/8/2020
		Y	40850139 GFE Fy	Denton	5/8/2020
		Z	40850139 GFE Fz	Denton	5/8/2020
	Moments	X	40850139 GFE Mx	Denton	5/8/2020
		Y	40850139 GFE My	Denton	5/8/2020
		Z	40850139 GFE Mz	Denton	5/8/2020
Shoulder Load Cell	Forces	X	31550145 GFE FX	Denton	10/9/2020
		Y	31550145 GFE FY	Denton	10/9/2020
		Z	31550145 GFE FZ	Denton	10/9/2020
Thorax Rib Displacement Potentiometers	Upper	Y	DS-183GFE	Honeywell	10/8/2020
	Middle	Y	DS-184GFE	Honeywell	10/8/2020
	Lower	Y	DS-182GFE	Honeywell	10/8/2020
Abdomen Load Cells	Forward	Y	LC-1524	Denton	3/19/2020
	Middle	Y	LC-1523	Denton	3/19/2020
	Rear	Y	LC-1530	Denton	3/19/2020
Spine	Upper (T1) Accelerometers	X	T21176	Endevco	5/22/2020
		Y	T20906	Endevco	5/22/2020
		Z	P82326	Endevco	5/22/2020
	Lower (T12) Accelerometers	X	P52981	Endevco	9/22/2020
		Y	P67430	Endevco	9/22/2020
		Z	P51986	Endevco	9/22/2020
	Forces	X	42840162 GFE FX	Denton	6/19/2020
		Y	42840162 GFE FY	Denton	6/19/2020
	Moments	X	42840162 GFE MX	Denton	6/19/2020
		Y	42840162 GFE MY	Denton	6/19/2020
Lumbar Spine	Forces	Y	4130104 GFE FY	Denton	7/14/2020
		Z	4130104 GFE FZ	Denton	7/14/2020
	Moment	X	4130104 GFE MX	Denton	7/14/2020
Pelvis	Pubic Symphysis Load Cell	Y	30960459GFE	Denton	3/19/2020
	Accelerometers	X	P79591	Endevco	9/22/2020
		Y	P63840	Endevco	9/22/2020
		Z	P52012	Endevco	9/22/2020

TABLE 2 – Dummy Instrumentation (SID-IIs)

			SID-IIs S/N <u>303</u>			
			Serial Number	Manufacturer	Calibration Date	
Head	Primary Accelerometers	X	AC-P83431	Endevco	9/18/2020	
		Y	AC-P75158	Endevco	9/18/2020	
		Z	AC-P68077	Endevco	9/18/2020	
	Redundant Accelerometers	X	T20849	Endevco	9/22/2020	
		Y	AC-P52046	Endevco	9/18/2020	
		Z	AC-P52020	Endevco	9/18/2020	
	Angular Rate Sensors	X	ARS11335	DTS	8/4/2020	
		Y	ARS11059GFE	DTS	8/4/2020	
		Z	ARS14934GFE	DTS	8/4/2020	
Upper Neck Load Cell	Forces	X	17162187-FX	Denton	8/12/2020	
		Y	17162187-FY	Denton	8/12/2020	
		Z	17162187-FZ	Denton	8/12/2020	
	Moments	X	17162187-MX	Denton	8/12/2020	
		Y	17162187-MY	Denton	8/12/2020	
		Z	17162187-MZ	Denton	8/12/2020	
Shoulder Load Cell	Forces	X	IF-3440110 GFE Fx	FTSS	8/12/2020	
		Y	IF-3440110 GFE Fy	FTSS	8/12/2020	
		Z	IF-3440110 GFE Fz	FTSS	8/12/2020	
Displacement Potentiometers	Shoulder Rib		Y	DS-030GFE	Servo	9/14/2020
	Thoracic Rib	Upper	Y	DS-1199GFE	Servo	6/1/2020
		Middle	Y	DS-1246GFE	Servo	6/1/2020
		Lower	Y	DS-1256GFE	Servo	6/1/2020
	Abdominal Rib	Upper	Y	DS-1274GFE	Servo	6/1/2020
		Lower	Y	DS-2316GFE	Servo	5/28/2020
Spine	Upper (T1) Accelerometers	X	P64149	Endevco	9/18/2020	
		Y	T20816	Endevco	9/18/2020	
		Z	P82183	Endevco	9/18/2020	
	Lower (T12) Accelerometers	X	P75156	Endevco	9/18/2020	
		Y	P84353	Endevco	9/18/2020	
		Z	T21144	Endevco	9/18/2020	
Lumbar Spine	Forces	X	IF-4140107 GFE Fx	Humanetics	8/28/2020	
		Y	IF-4140107 GFE Fy	Humanetics	8/28/2020	
		Z	IF-4140107 GFE Fz	Humanetics	8/28/2020	
	Moments	X	IF-4140107 GFE Mx	Humanetics	8/28/2020	
		Y	IF-4140107 GFE My	Humanetics	8/28/2020	
		Z	IF-4140107 GFE Mz	Humanetics	8/28/2020	
Pelvis	Pubic Symphysis Load Cell	Y	31680139 GFE Fy	Denton	1/8/2020	
	Accelerometers	X	P52071	Endevco	9/18/2020	
		Y	P58744	Endevco	9/18/2020	
		Z	T20880	Endevco	10/30/2020	
		Acetabulum Load Cell		Y	LC-276Fy	Denton
Iliac Wing Load Cell		Y	LC-280Fy	Denton	7/23/2020	
Pelvis Plug (struck side)			13392	SACO	9/19/2019	
Pelvis Plug (non-struck side)			-	-	-	

TABLE 3 – Vehicle Instrumentation

Vehicle Instrumentation			Serial Number	Manufacturer	Calibration Date
1	Vehicle Center of Gravity	X	A352327	MSI	9/25/2020
		Y	A352337	MSI	9/25/2020
		Z	A352365	MSI	9/24/2020
2	Vehicle Center of Gravity Angular Rate	X	ARS-6440	DTS	4/14/2020
		Y	ARS17707	DTS	7/23/2020
		Z	ARS17708	DTS	7/23/2020
3	Right Sill at Front Seat	X	A283599	MSI	7/14/2020
		Y	A284225	MSI	7/14/2020
		Z	A284904	MSI	7/14/2020
4	Right Sill at Rear Seat	X	A262056	MSI	7/22/2020
		Y	A280976	MSI	7/15/2020
		Z	A284344	MSI	7/14/2020
5	Left Sill at Front Door	Y	A284396	MSI	7/15/2020
6	Left Sill at Rear Door	Y	A280899	MSI	10/19/2020
7	Left Front Door Mid Centerline	Y	A282659	MSI	7/14/2020
8	Left Front Door Mid Rear	Y	A335460	MSI	10/17/2020
9	Left Front Door Upper Centerline	Y	A335431	MSI	10/17/2020
10	Left Rear Door Mid Rear	Y	A284257	MSI	7/17/2020
11	Left Rear Door Upper Centerline	Y	A290927	MSI	10/21/2020
12	Left A-Pillar Lower	Y	A280338	MSI	7/15/2020
13	Left A-Pillar Middle	Y	A279985	MSI	7/23/2020
14	Left B-Pillar Lower	Y	A315948	MSI	10/21/2020
15	Left B-Pillar Middle	Y	A315745	MSI	7/24/2020
16	Front Seat Track	Y	A280174	MSI	7/14/2020
17	Rear Seat Track or Structure	Y	A284350	MSI	7/14/2020
18	Right Rear Occ. Compartment	Y	A282718	MSI	7/15/2020
19	Engine Block	X	A280835	MSI	7/22/2020
		Y	A280854	MSI	6/25/2020
20	Rear Floorpan Above Axle	X	A284222	MSI	10/17/2020
		Y	A284244	MSI	10/17/2020
		Z	A284379	MSI	10/17/2020
21	Rear Deck	X	A290911	MSI	10/17/2020
		Y	A290932	MSI	10/17/2020
		Z	A290942	MSI	10/17/2020
22	Rear Deck Angular Velocity	X	ARS0758	DTS	2/20/2020
		Y	ARS10590	DTS	6/9/2020
		Z	ARS-14957GFE	DTS	2/21/2020

TABLE 4 – MDB Instrumentation

MDB Instrumentation		Serial Number	Manufacturer	Calibration Date
MDB CG Acceleration	X	A315087	MSI	5/16/2020
	Y	A315096	MSI	5/17/2020
	Z	A315733	MSI	5/17/2020
MDB Rear Acceleration	X	1201-1000_A315983	Measurement Specialties	10/5/2020
	Y	1201-1000_A290947	Measurement Specialties	10/5/2020

APPENDIX E

Seating Procedure Worksheets and Plots

Driver ES-2re Seating Worksheet

Vehicle	2020 Hyundai Santa Fe		Technician	Vanessa Hansen	
VIN #	5NMS23AD2LH255369		Position		
ATD	ES2re		Date	11/12/2020	
Test #	R20204201				
SCRL Angle	Max	13.5	ES-2re Tilt Sensors	X	Y
	Min -	10.9	Head	0°±2	0.3
	Difference	2.6			
	/2	1.3	T6	0°±2	N/A
	Min +	1.3			
	Mid Angle	12.2	Pelvis	0°±2	18.1
					-0.6
Seat Back Angle	W/Level *		HEAD REST POST		FINAL HEAD REST
Seat Pan Angle	W/Level *		ANGLE	0.5	POST ANGLE
					2.5
Pelvis Angle	ES-2re 0° +/-2.5°		Manual Inclinometer		
				Tilt Sensor	
Collected Points					
Name	Meas X	Meas Y	Meas Z		
SBU -	2,308.01	-816.385	-421.79		
SBL -	2,311.11	-818.392	-390.841		
STRIKER -	2,340.29	-818.081	-410.873		
FOSB -					
FISB -					
ROSB -					
RISB -					
PCP - (Pedal Center Point)					
RHP - (Right Heel Point)					
LHP - (Left Heel Point)					
S0 -	2,842.56	-391.024	-536.174		
TS -	2,941.11	-390.343	-699.403		
BS -	2,773.26	-391.356	-360.606		
SC1 -	3,065.42	-491.413	-401.288		
OSCAR H-POINT -	2,514.30	-584.117	-156.051		
DR PROJECTED WSID H-POINT AT MID-POSITION -					
DRIVER STP 15.27 MID-POSITION -					
DRIVER STP STEP 18.6 TRIAL 1 -					
DR PROJECTED WSID H-POINT STEP 18.6.2 TRIAL 1 -					
DRIVER STP STEP 18.6 TRIAL 2 -					
DR PROJECTED WSID H-POINT STEP 18.6.2 TRIAL 2 -					
DRIVER STP STEP 18.6 TRIAL 3 -					
DR PROJECTED WSID H-POINT STEP 18.6.2 TRIAL 3 -					
RHDCG -	2,395.41	-321.692	-868.467		
3DLHCG -					
LHDCG -	2,394.09	-474.705	-859.461		
BON -	2,483.98	-390.367	-843.215		
TN -	2,494.82	-390.128	-800.166		
TC -	2,458.22	-390.687	-733.291		
SHLD R1 -	2,379.44	-391.815	-636.079		
THX R1 -	2,488.33	-391.145	-595.413		
THX R2 -	2,517.38	-389.545	-533.185		
THX R3 -	2,531.92	-390.087	-488.458		
ABD R1 -	2,534.92	-390.84	-428.107		
ABD R2 -					
TPS -	2,577.44	-390.069	-298.534		
C1 -	2,480.14	-389.35	-607.143		
C2 -	2,525.58	-390.105	-536.993		
C3 -	2,560.47	-392.292	-360.355		
SHT -	2,393.37	-623.493	-596.858		
E1 -	2,601.22	-656.461	-470.508		
P1 -					
H-POINT -	2,516.64	-510.799	-160.027		
H-POINT 2 -	2,517.31	-562.206	-159.213		
OK -	2,912.47	-562.681	-238.174		
IK -	2,916.37	-307.577	-234.133		
OA -	3,202.92	-576.293	54.669		
IA -	3,203.33	-262.162	46.76		
OH -	3,233.84	-536.523	165.462		
IH -	3,235.61	-209.575	156.656		
OP -					
R -	2,484.75	-390.26	-1,030.72		
H -	2,844.72	-389.35	-979.54		
W1 -	3,113.86	-389.83	-843.851		
W1 - Outside	3,128.22	-390.495	-843.985		
W2 - Outside	3,388.15	-388.237	-695.269		
D1 -	3,121.35	-389.195	-607.965		
D2 -	3,111.67	-561.917	-239.176		
D3 -	3,116.32	-304.849	-234.423		
HRP -	2,484.33	-550.576	-976.907		
HSP -	2,484.28	-737.209	-843.986		
ADP -	2,602.15	-776.137	-470.873		
HDP -	2,516.54	-742.039	-160.353		

Calculated Measurements					
Name	Cal X	Cal Y	Cal Z	Cal 3D Distance	Deg
HZ -			188		
HH -				386	
HW -	630				
NR -				458	
CD -				641	
CS -	317				
CBS -	213				
IKD -				199.9638195	
OKD -				199	
HR -				209	
HS -		347			
AD -		120			
HD -		231			
HLHL -				327	
KK -				255	
SH -				434	
HRA -					
H-POINT TOOL ANGLE -					Missing P1
TORSO ANGLE -					9.9
WINDSHIELD ANGLE -					60.2

Rear Passenger SIDIIS Seating Worksheet

Vehicle	2020 Hyundai Santa FE	Technician	Vanessa Hansen
VIN #	5NMS23AD2LH255369	Position	
ATD	SID2s	Date	11/12/2020
SEATING #	Rear Passenger (P4)		

Seat Back Angle	W/Level °	HEAD REST		FINAL HEAD REST	
Seat Pan Angle	W/Level °	POST ANGLE	4.5	POST ANGLE	4.5
head x = 0.3 y = 4.1					
Pelvis Angle = x=0.2 Y= -20.4		Manual Inclinometer			

Collected Points				
Name	Meas X	Meas Y	Meas Z	
SBU -	1,275.87	-810.359	-395.897	
SBL -	1,295.05	-812.474	-370.479	
STRIKER -	1,310.74	-812.346	-402.497	
FOSB -				
FISB -				
ROSB -				
RISB -				
RHP -				
LHP -				
OSCAR H-POINT -				
LHDCG -	1,405.37	-445.817	-756.92	
BON -	1,491.47	-370.659	-770.707	
TN -	1,514.87	-370.483	-742.505	
TC -	1,503.80	-370.646	-664.84	
C1 -	1,507.22	-370.594	-538.887	
SHT -	1,398.04	-582.352	-522.484	
E1 -	1,534.45	-604.37	-444.868	
P1 -	1,481.66	-675.256	-209.776	
H-POINT -	1,561.18	-474.141	-189.947	
H-POINT 2 -	1,561.34	-540.766	-188.974	
OK -	1,895.74	-481.437	-247.136	
IK -	1,892.96	-318.661	-245.685	
OA -	2,033.96	-466.154	66.646	
IA -	2,034.23	-293.893	65.913	
OH -	1,964.96	-453.677	152.155	
IH -	1,966.43	-280.706	139.939	
OP -	1,208.33	-462.101	-736.696	
R -	1,492.17	-371.621	-1,081.84	
SB -	2,127.22	-371.67	-539.471	
KBL -	2,232.50	-480.244	-246.73	
KBR -	2,226.52	-320.856	-249.376	
HRP -	1,491.88	-534.985	-997.176	
HSP -	1,492.38	-760.775	-771.312	
ADP -	1,533.12	-764.441	-446.021	
HDP -	1,556.23	-734.811	-197.652	
Calculated Measurements				
Name	Cal X	Cal Y	Cal Z	Cal 3D Distance
HZ -			311	
NB -				645
CB -				620
IKB -				334
OKB -				337
HR -				280
HS -		390		
AD -		160		
HD -		261		
HLHL -				173.408
KK -				163
SH -				438
HRA -				N/A
H-POINT TOOL ANGLE -				14.0
TORSO ANGLE -				49.7
SEATBACK ANGLE -				19.8