

REPORT NUMBER: R&D-CAL-12-004

**MOVING BARRIER TO VEHICLE CRASH TEST IN SUPPORT OF NHTSA'S
FRONTAL OBLIQUE OFFSET PROGRAM
RESEARCH MOVING DEFORMABLE BARRIER INTO LEFT FRONT OF A**

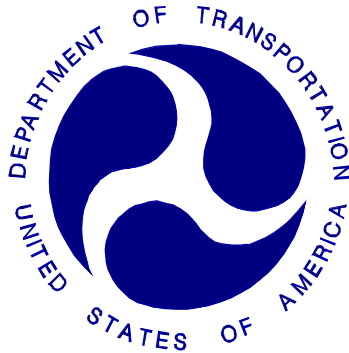
2013 HYUNDAI ELANTRA

90.1KPH, 15 DEGREE ANGLE, 35% OVERLAP

TEST DATE: 12/10/2012

NHTSA No: RD4200

**CALSPAN CORPORATION
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FINAL REPORT SUBMITTED:

March 4, 2015

PREPARED FOR:

**U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Vehicle safety Research
1200 New Jersey Ave, SE
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FINAL REPORT ACCEPTANCE BY VEHICLE SAFETY RESEARCH, OFFICE OF
STRUCTURAL AND RESTRAINTS RESEARCH DIVISION
:

Date: _____

TOM, Vehicle Crash Testing
NHTSA, Office of Structures and Restraints Research

Date: _____

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16. Abstract A test was conducted in accordance with Task Order 0001 of Contract DTNH22-10-D-00155. The Test consisted of a Research Moving Deformable Barrier (RMDB) traveling at a target speed of 90.12 kph into a stationary 2013 Hyundai Elantra. The struck vehicle was positioned 15 degrees relative to the moving barrier and impacted 35% of the left side of the vehicle. The test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), 301, and foot well intrusion performance. The test was conducted at the Calspan Corporation's Transportation Test Operation's facility in Buffalo, New York on December 10, 2012. The RMDB impact velocity was 90.09 kph and the ambient temperature at the test vehicle at the time of impact was 21°C. The target vehicle post-test maximum crush was 465 mm. The test vehicle's performance was as follows: <table border="1"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th rowspan="2">Units</th> <th colspan="2">Driver ATD</th> <th colspan="2">Pass. ATD</th> </tr> <tr> <th>Threshold</th> <th>Result</th> <th>Threshold</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₁₅)</td> <td>N/A</td> <td>700</td> <td>344.00</td> <td>700</td> <td>950.92</td> </tr> <tr> <td>Maximum Chest Compression</td> <td>mm</td> <td>63</td> <td>-53.23</td> <td>63</td> <td>-38.55</td> </tr> <tr> <td>Neck Injury Criteria (Nij)</td> <td>N/A</td> <td>1</td> <td>0.32</td> <td>1</td> <td>0.44</td> </tr> <tr> <td>Neck Tension</td> <td>N</td> <td>4,170</td> <td>2047.77</td> <td>4,170</td> <td>1470.66</td> </tr> <tr> <td>Neck Compression</td> <td>N</td> <td>4,000</td> <td>-486.81</td> <td>4,000</td> <td>-752.46</td> </tr> <tr> <td>Left Femur Force</td> <td>N</td> <td>10,008</td> <td>-4195.80</td> <td>10,008</td> <td>-4783.51</td> </tr> <tr> <td>Right Femur Force</td> <td>N</td> <td>10,008</td> <td>-6201.89</td> <td>10,008</td> <td>-417.16</td> </tr> </tbody> </table>					Measurement Description	Units	Driver ATD		Pass. ATD		Threshold	Result	Threshold	Result	Head Injury Criteria (HIC ₁₅)	N/A	700	344.00	700	950.92	Maximum Chest Compression	mm	63	-53.23	63	-38.55	Neck Injury Criteria (Nij)	N/A	1	0.32	1	0.44	Neck Tension	N	4,170	2047.77	4,170	1470.66	Neck Compression	N	4,000	-486.81	4,000	-752.46	Left Femur Force	N	10,008	-4195.80	10,008	-4783.51	Right Femur Force	N	10,008	-6201.89	10,008	-417.16
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 Test Date: 12/10/2012

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SECTION 1
PURPOSE OF TEST

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

This 90.12 kph (56 mph) Research Moving Deformable Barrier (RMDB) into a vehicle test is part of the Frontal Offset Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-10-D-00155. The purpose of this test is to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

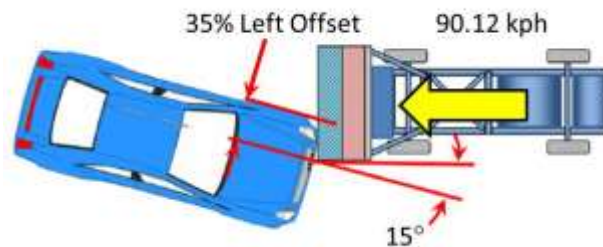
This test was conducted in accordance with the instructions set forth by NHTSA in which the vehicle was placed at a 15° angle, 35% offset relative to the RMDB as outlined in Task Order (TO-1) DTNH22-10-D00155. Data was obtained indicant of Federal Motor Vehicle Safety Standard FMVSS 208-Occupant Crash Protection, FMVSS 212 – Windshield Mounting, FMVSS 219 (partial) – Windshield Zone Intrusion, and FMVSS 301 – Fuel System Integrity, in addition to the requirements of TO-1 of DTNH22-10-D-00155.

SECTION 2 SUMMARY OF TEST

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

A 2013 Hyundai Elantra Four Door Sedan was impacted on the left front corner by a Research Moving Deformable Barrier (RMDB). This test vehicle was stationary and positioned at a target angle of 15° and at a target offset of 35% to the forward line of motion of the RMDB. The RMDB was towed down the test track in a full forward direction, without any crabbing, and at the targeted impact velocity of 90.12 kph (56.0 mph) into the test vehicle. The test vehicle's mass was 1,589.5 kg (3,504.2 lbs), and the RMDB's mass was 2490.7 kg (5491 lbs). The test was conducted by Calspan Corporation on December 10, 2012.



The test was documented by one (1) real time and fourteen (14) high-speed video cameras. Camera locations and other pertinent data are located in Data Sheet No. 6 of this report. Pre and post – test photographs of the test vehicle, RMDB, and test setup were taken using a digital still camera. Photographic documentation of the test is presented in Appendix A of this report.

One 50% adult male THOR-NT with MOD KIT (TK) Anthropomorphic Test Device (ATD) (Serial No. 007) was seated in the left, front (P1 -Driver's) seating position and one 50% adult male THOR-NT with MOD KIT (TK) ATD (Serial No. 016) was seated in the right front passenger seating position (P2). The THOR TK driver and passenger were positioned according to instructions specified in laboratory test procedures FMVSS 208-14, "Occupant Crash Protection", TP208-14, July 27, 2006.

The driver was restrained with a 3 – point seat belt, a frontal airbag, a curtain airbag, and a torso airbag. The passenger was restrained with a 3 – point seat belt, and a frontal airbag. The passenger's curtain and torso airbags were disabled.

CRASH VEHICLE SUMMARY

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

Two hundred and thirty (230) channels of data from the two ATD's, test vehicle and RMDB were collected using Kayser – Threde and DTS data acquisition systems. Appendix B contains dummy data plots, as well as vehicle and RMDB response data plots.

There was 82.1% total windshield retention, with 64.2% and 100% retention on the left and right sides, respectively. There appeared to be no intrusion into the protected zone of the windshield during any portion of the impact event. The maximum static crush of the vehicle was 465 mm at C1 to the left of the vehicle's centerline. The maximum crush of the structural bumper beam was 544 mm at B1, to the left of the vehicle's centerline. Additional information pertaining to static crush measurements can be found on Data Sheet No.12 of this report.

All four vehicle doors remained closed and latched during the test. The left front door was deformed as a result of the impact causing it to be non-operational. The remaining doors all remained operational after the test.

Structure observations include the following:

- Driver's side A-Pillar buckled rearward. Resulting in separation between the top of the door and roof sill. (See Photo No.061 in Appendix A)
- Windshield cracked throughout with no penetration in the protected zone.
- Hood remained latched during the impact event, however bent upwards exposing the engine compartment.

The Driver ATD's visible contact points were:

- Head Contact: Frontal airbag, curtain airbag, head liner (visor), and Driver's seat back
- Torso Contact: Frontal airbag, torso airbag, and Driver's side door.
- Knee Contact: Knee bolster

The Passenger ATD's visible contact points were:

- Head Contact: Frontal airbag & center dash panel
- Torso Contact: Frontal airbag & center dash panel
- Knee Contact: Glove Box

CRASH VEHICLE SUMMARY

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

Primary Impact Data

Measured Parameter	Units	Value
RMDB Velocity at Impact	kph	90.09
RMDB Test Weight	kg	2490.7
RMDB Maximum Static Crush	mm	274
Vehicle Test Weight	kg	1589.5
Actual Vehicle Angle	degrees	15
Vehicle Maximum Static Crush	mm	465
Vertical Offset from Target Point (+ down / - up)*	mm	0
Lateral Offset from Target Point (+ left / - right)*	mm	-12
Number of Data Channels		230
Number of Real-Time Cameras		1
Number of High-Speed Cameras		14

*Offsets are in relation to the vehicle coordinate system.

Dummy Contacts

	Driver	Picture Ref.	Passenger	Picture Ref.
Dummy Type	50% Male, Thor 007		50% Male, Thor 016	
Head Contact	Frontal Airbag, Curtain Airbag, Head Liner & Seat Back	A49-A51	Frontal Airbag & Center Dash Panel	A70-A72
Upper Torso Contact	Frontal Airbag, Torso Airbag & Driver's Door	NA	Frontal Airbag & Center Dash Panel	NA
Lower Torso Contact	None	NA	None	NA
Left Knee Contact	Knee Bolster	A28	Glove Box	A52
Right Knee Contact	Knee Bolster	A28	Glove Box	A52

Data Anomalies:

- V2P1 ANKL RY had a questionable min at 56ms
- V2P2 FMRL FX had noise spikes throughout the data
- V2P2 FMRL FY had noise spikes throughout the data
- V2P2 ANKL RX was questionable
- V2P2 ANKL RY was questionable
- V2P2 FOTL AZ failed
- V2P2 TBRL MY had noise spikes at 225 & 247ms
- V2P2 ANKR RX was questionable
- V2P2 ANKR RY was questionable

PRELIMINARY INJURY SUMMARY: Driver

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200
 Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Driver: Thor Serial No. 007 Injury Summary

	Nomenclature	Units	Source	Max	Min
Head	Head CG X	g	1000	5.84	-45.71
	Head CG Y	g	1000	97.99	-3.59
	Head CG Z	g	1000	43.98	-3.41
	Head Resultant	g	Compute	108.31	
	36 ms HIC		Compute	716.56	
	15 ms HIC		Compute	344.00	
	Head Resultant CG Acceleration, 3 ms Clip	g	Compute	66.61	
	Head Rotational Velocity X	deg/s	60	832.65	-2053.74
	Head Rotational Velocity Y	deg/s	60	1064.02	-2099.47
	Head Rotational Velocity Z	deg/s	60	1712.40	-464.35
	Head Rotational Velocity Resultant	deg/s	Compute	3034.33	
	Brain Injury Criteria		Compute	1.10	
Neck	UNLC Transferred to OC, Neck System, FX	N	1000	265.90	-810.00
	UNLC Neck System Tension, FZ	N	1000	2047.77	
	UNLC Neck System Compression, FZ	N	1000		-486.81
	UNLC Transferred to OC, Neck System Flexion, MY	N-m	Thortest	0.71	
	UNLC Transferred to OC, Neck System Extension, MY	N-m	Thortest		-14.32
	NIJ		Compute	0.32	
	On head acting through total neck section, FX	N	Thortest	259.50	-506.44
	On head acting through total neck section, FY	N	Thortest	612.30	-178.16
	On head acting through total neck section, FZ	N	Thortest	2143.14	-76.26
	On head acting through total neck section, MX	N-m	Thortest	37.98	-41.61
	On head acting through total neck section, MY	N-m	Thortest	28.95	-26.01
	On head acting through total neck section, MZ	N-m	Thortest	4.24	-22.82
	On head acting through O.C. joint only, FX	N	Thortest	311.47	-791.48
	On head acting through O.C. joint only, FZ	N	Thortest	2019.99	-491.27
	On head acting through O.C. joint only, MY	N-m	Thortest	0.71	-14.32
Chest	Upper Left IR-TRACC X - deflection	mm	Thortest	0.49	-21.75
	Upper Left IR-TRACC Y - deflection	mm	Thortest	8.96	-4.83
	Upper Left IR-TRACC Z - deflection	mm	Thortest	10.66	-17.05
	Upper Left IR-TRACC D - deflection	mm	Thortest	0.31	-19.62
	Upper Right IR-TRACC X - deflection	mm	Thortest	0.56	-39.17
	Upper Right IR-TRACC Y - deflection	mm	Thortest	10.40	-5.68
	Upper Right IR-TRACC Z - deflection	mm	Thortest	6.89	-23.14
	Upper Right IR-TRACC D - deflection	mm	Thortest	0.11	-37.50
	Lower Left IR-TRACC X - deflection	mm	Thortest	9.63	-4.41
	Lower Left IR-TRACC Y - deflection	mm	Thortest	6.43	-13.75

PRELIMINARY INJURY SUMMARY: Driver

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200

Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Driver: Thor Serial No. 007 Injury Summary

	Nomenclature	Units	Source	Max	Min
Chest (Con't)	Lower Left IR-TRACC Z - deflection	mm	Thortest	11.19	-10.48
	Lower Left IR-TRACC D - deflection	mm	Thortest	9.63	-5.46
	Lower Right IR-TRACC X - deflection	mm	Thortest	3.95	-54.35
	Lower Right IR-TRACC Y - deflection	mm	Thortest	2.46	-15.87
	Lower Right IR-TRACC Z - deflection	mm	Thortest	4.25	-15.30
	Lower Right IR-TRACC D - deflection	mm	Thortest	3.83	-53.23
	Chest CG Acceleration, 3 ms clip	g	Compute	45.83	
Abdomen	Lower Left IR-TRACC X - deflection	mm	Thortest	0.51	-68.62
	Lower Left IR-TRACC Y - deflection	mm	Thortest	1.33	-23.64
	Lower Left IR-TRACC Z - deflection	mm	Thortest	20.11	-5.26
	Lower Left IR-TRACC D - deflection	mm	Thortest	0.52	-69.90
	Left Viscous Criterion Based on X - deflection		Compute	3.67	
	Lower Right IR-TRACC X - deflection	mm	Thortest	0.89	-59.56
	Lower Right IR-TRACC Y - deflection	mm	Thortest	7.00	-11.36
	Lower Right IR-TRACC Z - deflection	mm	Thortest	28.70	-0.56
	Lower Right IR-TRACC D - deflection	mm	Thortest	0.95	-63.29
	Right Viscous Criterion Based on X - deflection		Compute	3.34	
Spine	Upper Spine (T1) AX	g	180	6.36	-51.49
	Upper Spine (T1) AY	g	180	18.32	-11.95
	Upper Spine (T1) AZ	g	180	41.26	-9.21
	Upper Spine (T1) Resultant	g	Compute	61.14	
	Middle Spine (T6) AX	g	180	13.71	-50.97
	Middle Spine (T6) AY	g	180	27.22	-5.46
	Middle Spine (T6) AZ	g	180	8.36	-15.46
	Middle Spine (T6) Resultant	g	Compute	51.74	
Pelvis	Pelvis CG Resultant Acceleration	g	Compute	91.39	
Acetabulum	Left FX force	N	600	1832.65	-1071.07
	Left FY force	N	600	344.32	-1487.63
	Left FZ force	N	600	1764.11	-1615.44
	Left Acetabulum Resultant	N	Compute	2288.65	
	Right FX force	N	600	710.89	-1875.63
	Right FY force	N	600	315.96	-2745.42
	Right FZ force	N	600	1612.08	-211.93
	Right Acetabulum Resultant	N	Compute	3365.57	
Anomalies None					

PRELIMINARY INJURY SUMMARY: Driver Legs

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200
 Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Driver: Thor Serial No. 007 Injury Summary

	Nomenclature	Units	Source	Max	Min
Knee	Left Knee Displacement, DX	mm	180	1.97	-8.65
	Right Knee Displacement, DX	mm	180	2.54	-10.87
Femur	Left Femur Force, FZ	N	600	835.65	-4195.80
	Left Femur Moment, MX	N-m	600	26.61	-266.06
	Left Femur Moment, MY	N-m	600	61.83	-132.88
	Left Femur Res (MX / MY only, not MZ)	N-m	Compute	266.09	
	Right Femur Force, FZ	N	600	474.98	-6201.89
	Right Femur Moment, MX	N-m	600	122.62	-269.90
	Right Femur Moment, MY	N-m	600	125.65	-13.98
	Right Femur Res (MX / MY only, not MZ)	N-m	Compute	281.70	
	Left Upper Tibia, FZ	N	600	53.04	-1991.28
	Left Upper Tibia, MY	N-m	600	81.12	-77.75
Tibia	Left Upper Tibia, Index		Compute	0.58	
	Right Upper Tibia, FZ	N	600	660.52	-2294.88
	Right Upper Tibia, MY	N-m	600	85.92	-75.29
	Right Upper Tibia, Index		Compute	0.59	
	Left Lower Tibia, FZ	N	600	1.64	-4332.77
	Left Lower Tibia, MY	N-m	600	74.91	-73.10
	Left Lower Tibia, Index		Compute	0.81	
	Right Lower Tibia, FZ	N	600	538.11	-3346.11
	Right Lower Tibia, MY	N-m	600	71.38	-118.91
	Right Lower Tibia, Index		Compute	0.72	
Ankle	Left Ankle Rotation, RX	Deg	180	31.24	-9.82
	Left Ankle Rotation, RY	Deg	180	37.90	-12.02
	Right Ankle Rotation, RX	Deg	180	4.13	-30.37
	Right Ankle Rotation, RY	Deg	180	0.58	-35.24
Anomalies					
None					

PRELIMINARY INJURY SUMMARY: Right Front Passenger

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200
 Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Right Front Passenger: Thor Serial No. 016 Injury Summary

	Nomenclature	Units	Source	Max	Min
Head	Head CG X	g	1000	110.17	-19.42
	Head CG Y	g	1000	149.35	-2.76
	Head CG Z	g	1000	48.97	-1.23
	Head Resultant	g	Compute	190.33	
	36 ms HIC		Compute	950.92	
	15 ms HIC		Compute	950.92	
	Head Resultant CG Acceleration, 3 ms Clip	g	Compute	114.85	
	Head Rotational Velocity X	deg/s	60	390.59	-2085.29
	Head Rotational Velocity Y	deg/s	60	1611.94	-1230.26
	Head Rotational Velocity Z	deg/s	60	3390.68	-2139.86
	Head Rotational Velocity Resultant	deg/s	Compute	3860.73	
	Brain Injury Criteria		Compute	1.57	
	Neck	UNLC Transferred to OC, Neck System, FX	N	1000	1129.82
UNLC Neck System Tension, FZ		N	1000	1470.66	
UNLC Neck System Compression, FZ		N	1000		-752.47
UNLC Transferred to OC, Neck System Flexion, MY		N-m	Thortest	15.00	
UNLC Transferred to OC, Neck System Extension, MY		N-m	Thortest		-4.06
NIJ			Compute	0.50	
On head acting through total neck section, FX		N	Thortest	1356.40	-140.84
On head acting through total neck section, FY		N	Thortest	992.52	-94.25
On head acting through total neck section, FZ		N	Thortest	1663.08	-429.01
On head acting through total neck section, MX		N-m	Thortest	21.32	-38.60
On head acting through total neck section, MY		N-m	Thortest	12.73	-11.60
On head acting through total neck section, MZ		N-m	Thortest	19.78	-44.56
On head acting through O.C. joint only, FX		N	Thortest	1252.67	-101.13
On head acting through O.C. joint only, FZ		N	Thortest	1400.92	-764.23
On head acting through O.C. joint only, MY		N-m	Thortest	15.00	-4.06
Chest	Upper Left IR-TRACC X - deflection	mm	Thortest	0.12	-30.73
	Upper Left IR-TRACC Y - deflection	mm	Thortest	5.59	-14.03
	Upper Left IR-TRACC Z - deflection	mm	Thortest	12.95	-13.93
	Upper Left IR-TRACC D - deflection	mm	Thortest	0.12	-31.43
	Upper Right IR-TRACC X - deflection	mm	Thortest	0.26	-34.03
	Upper Right IR-TRACC Y - deflection	mm	Thortest	6.33	-13.39
	Upper Right IR-TRACC Z - deflection	mm	Thortest	13.30	-6.61
	Upper Right IR-TRACC D - deflection	mm	Thortest	0.25	-33.35
	Lower Left IR-TRACC X - deflection	mm	Thortest	9.19	-39.75
	Lower Left IR-TRACC Y - deflection	mm	Thortest	11.70	-1.79

PRELIMINARY INJURY SUMMARY: Right Front Passenger

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200
 Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Right Front Passenger: Thor Serial No. 016 Injury Summary

	Nomenclature	Units	Source	Max	Min
Chest (Con't)	Lower Left IR-TRACC Z - deflection	mm	Thortest	11.64	-8.82
	Lower Left IR-TRACC D - deflection	mm	Thortest	10.90	-38.55
	Lower Right IR-TRACC X - deflection	mm	Thortest	12.56	-14.88
	Lower Right IR-TRACC Y - deflection	mm	Thortest	7.08	-18.60
	Lower Right IR-TRACC Z - deflection	mm	Thortest	6.72	-14.79
	Lower Right IR-TRACC D - deflection	mm	Thortest	13.71	-11.64
	Chest CG Acceleration, 3 ms clip	g	Compute	35.48	
Abdomen	Lower Left IR-TRACC X - deflection	mm	Thortest	1.53	-63.76
	Lower Left IR-TRACC Y - deflection	mm	Thortest	13.08	-5.91
	Lower Left IR-TRACC Z - deflection	mm	Thortest	19.41	-8.90
	Lower Left IR-TRACC D - deflection	mm	Thortest	1.54	-62.89
	Left Viscous Criterion Based on X - deflection		Compute	4.10	
	Lower Right IR-TRACC X - deflection	mm	Thortest	5.20	-47.82
	Lower Right IR-TRACC Y - deflection	mm	Thortest	16.07	-0.23
	Lower Right IR-TRACC Z - deflection	mm	Thortest	14.01	-8.97
	Lower Right IR-TRACC D - deflection	mm	Thortest	6.08	-48.03
	Right Viscous Criterion Based on X - deflection		Compute	6.93	
Spine	Upper Spine (T1) AX	g	180	5.59	-28.51
	Upper Spine (T1) AY	g	180	44.73	-5.21
	Upper Spine (T1) AZ	g	180	29.24	-0.98
	Upper Spine (T1) Resultant	g	Compute	47.94	
	Middle Spine (T6) AX	g	180	3.09	-31.82
	Middle Spine (T6) AY	g	180	19.95	-1.33
	Middle Spine (T6) AZ	g	180	10.61	-9.96
	Middle Spine (T6) Resultant	g	Compute	35.98	
Pelvis	Pelvis CG Resultant Acceleration	g	Compute	81.82	
Acetabulum	Left FX force	N	600	23.13	-3608.36
	Left FY force	N	600	2057.42	-688.62
	Left FZ force	N	600	295.52	-1936.99
	Left Acetabulum Resultant	N	Compute	3993.78	
	Right FX force	N	600	2766.29	-2352.70
	Right FY force	N	600	653.22	-1898.73
	Right FZ force	N	600	1434.59	-1240.67
	Right Acetabulum Resultant	N	Compute	3224.27	
Anomalies None					

PRELIMINARY INJURY SUMMARY: Right Front Passenger Legs

Test Vehicle: 2013 Hyundai Elantra - Four Door Sedan NHTSA No.: RD4200
 Test Program: Research and Development Left Oblique Offset Test Date: 12/10/2012

Right Front Passenger: Thor Serial No. 016 Injury Summary

	Nomenclature	Units	Source	Max	Min
Knee	Left Knee Displacement, DX	mm	180	1.91	-5.27
	Right Knee Displacement, DX	mm	180	1.88	-0.38
Femur	Left Femur Force, FZ	N	600	1249.35 ⁽¹⁾	-4783.51 ⁽¹⁾
	Left Femur Moment, MX	N-m	600	119.49	-122.43
	Left Femur Moment, MY	N-m	600	105.68	-79.14
	Left Femur Res (MX / MY only, not MZ)	N-m	Compute	140.34 ⁽¹⁾	
	Right Femur Force, FZ	N	600	980.53	-417.16
	Right Femur Moment, MX	N-m	600	122.21	-195.02
	Right Femur Moment, MY	N-m	600	158.99	-125.28
	Right Femur Res (MX / MY only, not MZ)	N-m	Compute	220.94	
Tibia	Left Upper Tibia, FZ	N	600	150.61	-2330.50
	Left Upper Tibia, MY	N-m	600	64.05	-83.76
	Left Upper Tibia, Index		Compute	0.76	
	Right Upper Tibia, FZ	N	600	227.99	-2235.15
	Right Upper Tibia, MY	N-m	600	65.69	-116.73
	Right Upper Tibia, Index		Compute	1.08	
	Left Lower Tibia, FZ	N	600	110.32	-2871.06
	Left Lower Tibia, MY	N-m	600	40.54	-96.90
	Left Lower Tibia, Index		Compute	0.61	
	Right Lower Tibia, FZ	N	600	164.93	-3104.57
	Right Lower Tibia, MY	N-m	600	26.11 ⁽²⁾	-135.40 ⁽²⁾
	Right Lower Tibia, Index		Compute	0.93 ⁽²⁾	
Ankle	Left Ankle Rotation, RX	Deg	180	57.84 ⁽³⁾	-99.88 ⁽³⁾
	Left Ankle Rotation, RY	Deg	180	-2.97 ⁽⁴⁾	-34.87 ⁽⁴⁾
	Right Ankle Rotation, RX	Deg	180	30.65	-23.70
	Right Ankle Rotation, RY	Deg	180	-14.54	-48.21

Anomalies

- (1) Questionable spikes throughout
- (2) Questionable spikes at 225 and 247 ms
- (3) Channel failed
- (4) Channel failed

SECTION 3 DATA SHEETS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

Data Sheet No.		Page No.
1	General Test and Vehicle Parameter Data	3-2
2	Seat Adjustment, Fuel System, and Steering Wheel	3-6
3	Dummy Longitudinal Clearance Dimensions	3-8
4	Dummy Lateral Clearance Dimensions	3-10
5	Seat Belt Positioning Data	3-11
6	High-Speed Camera Locations and Data	3-12
7	Vehicle Instrumentation Data	3-15
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15	Summary of FMVSS 212, 219 (Partial), and 301 Data	3-47
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16	FMVSS 301 Static Rollover Results	3-49
17	Dummy / Vehicle Temperature Stabilization	3-50

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

VEHICLE INFORMATION

NHTSA No.	RD4200
Model Year	2013
Make	Hyundai
Model	Elantra
Body Style	Four Door Sedan
VIN	5NPDH4AE9DH208432
Body Color	Light gray/silver
Odometer Reading (km/mi)	19 / 12
Engine Displacement. (L)	1.8
Type/No. Cylinders	I4
Engine Placement	Transverse
Transmission Type	Automatic
Transmission Speeds	6-Speed
Overdrive	Yes
Final Drive	Front Wheel Drive
Roof Rack	No
Sunroof/T-Top	No
Running Boards	No
Tilt Steering Wheel	Yes
Power Seats	No
Anti-Lock Brakes (ABS)	Yes
All-Wheel Drive (AWD)	No
Traction Control System (TCS)	Yes

VEHICLE OPTIONS

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

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

No

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Manufacturing Alabama, LLC
Date of Manufacture	08/12

GVWR (kg)	1720
GAWR Front (kg)	940
GAWR Rear (kg)	800

VEHICLE SEATING AND WEIGHT CAPACITY

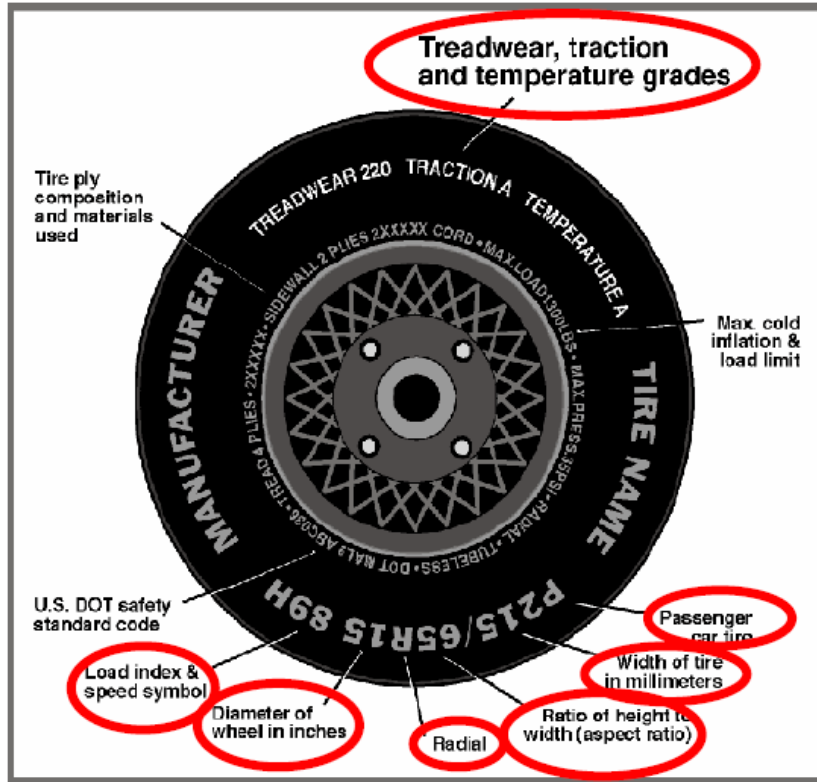
Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench	--	
Number of Occupants	2	3	--	5
Capacity Wt. (VCW) (kg)				385.00
Cargo Wt. (RCLW) (kg)				44.80

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

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



Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	220	220
Recommended Tire Size	P205/55R16	P205/55R16
Tire Size on Vehicle	P205/55R16	P205/55R16
Tire Manufacturer	Hankook	Hankook
Tire Model	Optimo H426	Optimo H426
Treadwear	440	440
Traction	A	A
Temperature Grades	A	A
Tire Plies Sidewall	1 Polyester	1 Polyester
Tire Plies Body	2 Steel, 1 Polyester, 1 Nylon	2 Steel, 1 Polyester, 1 Nylon
Load Index/Speed Symbol	89H	89H
Tire Material	Rubber	Rubber
DOT Safety Code Right	5MBCDLH	5MBCDLH
DOT Safety Code Left	5MBCDLH	5MBCDLH

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW) (Axle)			As Tested (ATW) (Axle)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	391.5	249		428.5	380.5	
Right	kg	384	232		419.5	361	
Ratio	%	61.7%	38.3%		53.4%	46.6%	
Totals	kg	775.5	481.0	1,256.5	848.0	741.5	1589.5

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1,256.50
Weight of 2 P572E ATDs	kg	190.51
Rated Cargo/Luggage Weight (RCLW)	kg	44.80
Calculated Vehicle Target Weight (TVTW)	kg	1,482.81

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	683	684	684	693	1034
As Tested	mm	665	671	633	642	1260
Post Test	mm	697	668	577	627	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2702
Total Vehicle Length at Left Side	mm	4370
Total Vehicle Length at Centerline	mm	4534
Total Vehicle Length at Right Side	mm	4370
Weight of Ballast in Cargo Area	kg	0
Weight of Vehicle Components Removed	kg	0
Amount of Stoddard Solvent in Fuel Tank	L	44.7

LIST OF COMPONENTS REMOVED TO MEET TEST WEIGHT:

No components were removed in order to meet the required test weight.

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

TARGET VEHICLE STRUCTURAL MEASUREMENT

	Elements		Pre-Test
1	Total Length	mm	4534
2	Total Width	mm	1770
3	Bumper Top Height	mm	2211
4	Bumper Bottom Height	mm	2320
5	Longitudinal Member Top Height	mm	2213
6	Distance Between Longitudinal Members	mm	1051
7	Longitudinal Member Width	mm	73
8	Engine Top Height	mm	1874
9	Engine Bottom Height	mm	2523
10	Engine and Gearbox Width	mm	593
11	Front Bumper-Engine Distance	mm	421
12	Front Shock Absorber Fixing Height	mm	1879
13	Bonnet Leading Edge Height	mm	2068
14	Front Shock Absorber Fixing Width	mm	1249
15	Front Bumper – Front Axle Distance	mm	860
16	Front Axle – A Pillar Distance	mm	451
17	A-Pillar – B-Pillar Distance	mm	1147
18	B-Pillar – Rear Axle Distance	mm	1105
19	B-Pillar – C-Pillar Distance	mm	958
20	Roof Sill Bottom Height	mm	1315
21	Roof Sill Top Height	mm	1419
22	Floor Sill Bottom Height	mm	279
23	Floor Sill Top Height	mm	374

Note: Height measurements are in reference to the ground.

DATA SHEET NO. 2

SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

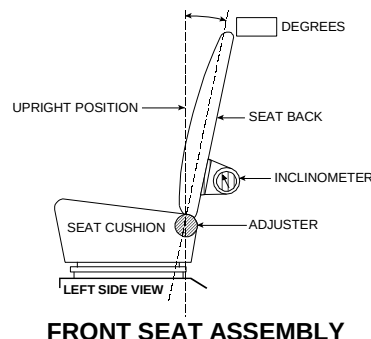
NHTSA No.: RD4200
 Test Date: 12/10/2012

NORMAL DESIGN RIDING POSITION

For adjustable driver and passenger seat backs. Please describe how to position the inclinometer to measure the seat back angle. Include description of the location of the adjustment latch detent, if applicable.

Driver seat: The driver seat back was positioned according to the Nominal Design Riding position listed in FORM 1

Passenger Seat: The passenger seat back was positioned to allow for a zero head angle of the passenger dummy



	Deg.
Driver Seat Back Angle	5.1
Passenger Seat Back Angle	4.0

SEAT FORE/AFT POSITIONS

Describe the method used of determining seat fore/aft positions.

The driver's seat was positioned at the mid-point of fore/aft travel.

The passenger's seat was positioned at the most forward position of fore/aft travel.

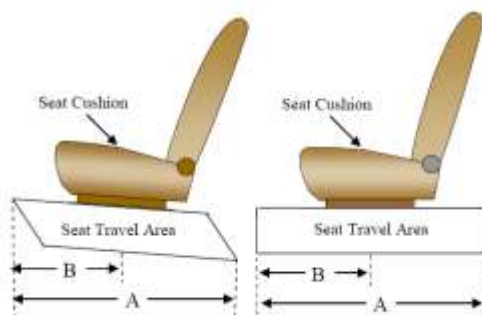
	Total Fore/Aft Travel	Placed in Position #
Driver Seat	266	10
Passenger Seat	220	11

SEAT BELT UPPER ANCHORAGES

Describe the method of positioning seat belt upper anchorages. Belt anchorages were moved along the full range of motion, and marked on the B-Pillar to their respective possible positions.

Photographic evidence can be found in Appendix A of this report. Zero is defined as the upper-most position.

	Total # of Positions	Placed in Position #
Driver Seat	4	0 - uppermost
Passenger Seat	4	0 - uppermost



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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

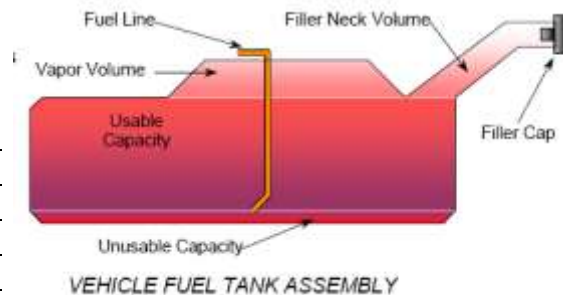
FUEL TANK CAPACITY

	Liters
Usable Capacity of "Standard Tank"	48.1
Usable Capacity of "Optional Tank"	
93% of Usable Capacity	44.7
Actual Amount of Solvent Used	44.7
1/3 of Usable Capacity	15.9

FUEL PUMP

Describe the fuel system - what type of fuel pump, details about how it operates, etc.

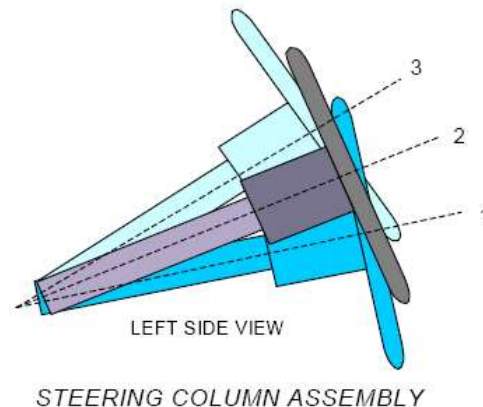
Fuel evacuated according to the specifications provided by the manufacturer in Form 1. Electric fuel pump operates when the ignition is in the 'on' position and the engine is running. The fuel filler neck is located above the left rear wheel.



STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. Describe how this measurement was taken.

The steering wheel was adjusted to the midpoint of tilt angle range and the midpoint of the telescoping travel (if applicable)



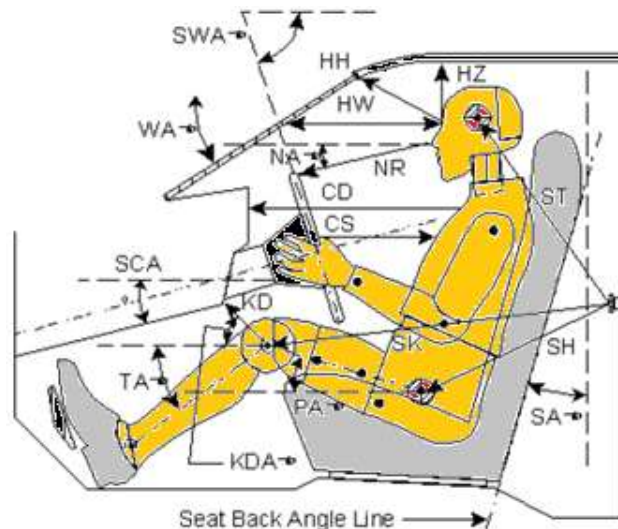
STEERING COLUMN POSITIONS

	Tilt (degrees)	Fore/Aft Position (mm)
Lowermost position No. 1	20.8	
Geometric center position No. 2	23.0	
Uppermost position No. 3	25.2	
Telescoping Steering Wheel Travel		38
Test Position	23.0	19

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Code	Measurement Description	Driver (Serial # Thor 007)		Passenger (Serial # Thor 016)	
		Length (mm)	Angle(°)	Length (mm)	Angle (°)
WA°	Windshield Angle		23.1		
SWA°	Steering Wheel Angle		23.4		
SCA°	Steering Column Angle		66.6		
SA°	Seat Back Angle (on headrest post)		5.2		4.4
HZ	Head to Roof (Z)	184	90.0	174	90.0
HH	Head to Header	426	16.2	436	14.2
HW	Head to Windshield	720	0.0	747	0.0
NR	Nose to Rim	522	11.2	763	-30.1
CD	Chest to Dash	589		641	
CS	Chest to Steering Hub	406	-3.1		
RA	Rim to Abdomen	228	-7.2		
KDL	Left Knee to Dash	180	28.4	175	33.7
KDR	Right Knee to Dash	151	27.8	182	27.6
PA°	Pelvic Angle		-24.2		21.4
TA°	Tibia Angle		-37.0		-32.6
SK	Striker to Knee	607	-12.6	611	-14.1
ST	Striker to Head	15	88.0	3	89.6
SH	Striker to H-Point	202	-51.3	196	-53.1
HAX°	Head Angle (X)		0.1		-0.4
HAY°	Head Angle (Y)		0.3		-0.2
NAX°	Neck Angle (X)		4.9		
NAY°	Neck Angle (Y)		0.4		
TAX°	T6 Angle (X)		-0.5		5.5
TAY°	T6 Angle (Y)		25.7		0.1
LAX°	Lumbar Angle (X)		21.0		0.0
LAY°	Lumbar Angle (Y)		0.4		20.8

DATA SHEET NO.3 (CONTINUED)
DUMMY CMM MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

Description	Units	Driver			Passenger		
		X	Y	Z	X	Y	Z
Striker	mm	928	-769	582	929	771	580
Head CG	mm	977	-432	162	965	422	150
Bridge of Nose	mm	1075	-356	165	1060	344	153
Tip of Nose	mm	1075	-356	203	1060	347	195
Shoulder Bolt	mm	1017	-544	403	1018	545	412
Tip of Chin	mm	1073	-356	284	1057	345	278
H-Point	mm	1164	-555	842	1158	554	851
Left Knee	mm	1569	-543	726	1573	280	744
Right Knee	mm	1584	-295	723	1574	517	749
Left Ankle	mm	1910	-585	966	1928	278	967
Right Ankle	mm	1915	-264	972	1932	517	964
Left Heel	mm	1941	-579	1097	1926	249	1100
Right Heel	mm	1913	-232	1084	1919	491	1103
Outboard Seat Anchor Bolt	mm	1453	-592	1041	1453	596	1042
Outboard Head Restraint Post	mm	824	-430	325	825	431	323
Top of Head Restraint	mm	868	-358	56	870	346	60
Center of Steering Wheel	mm	1516	-362	458			

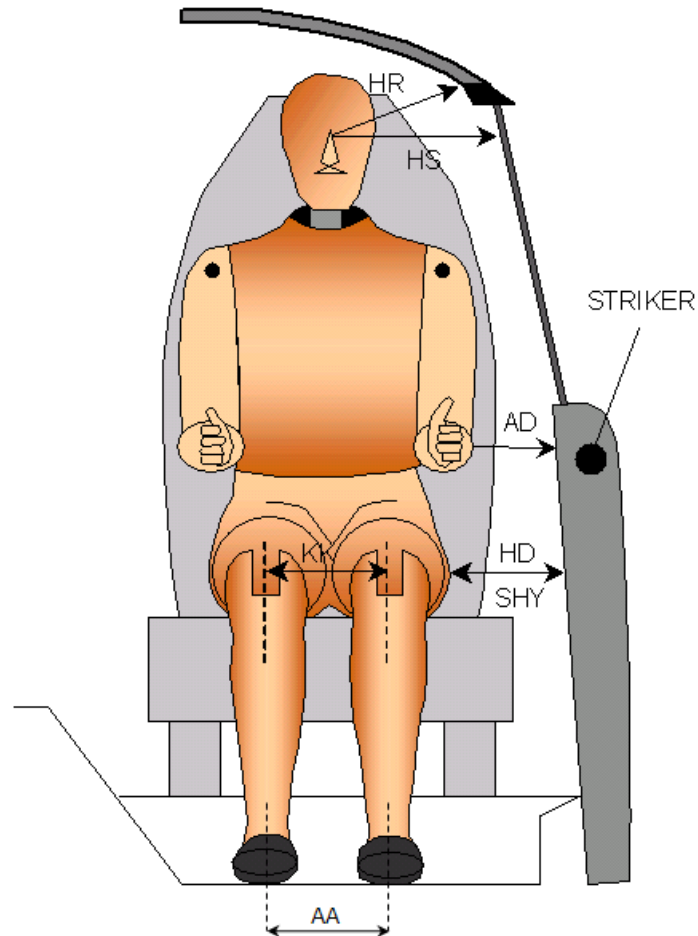
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

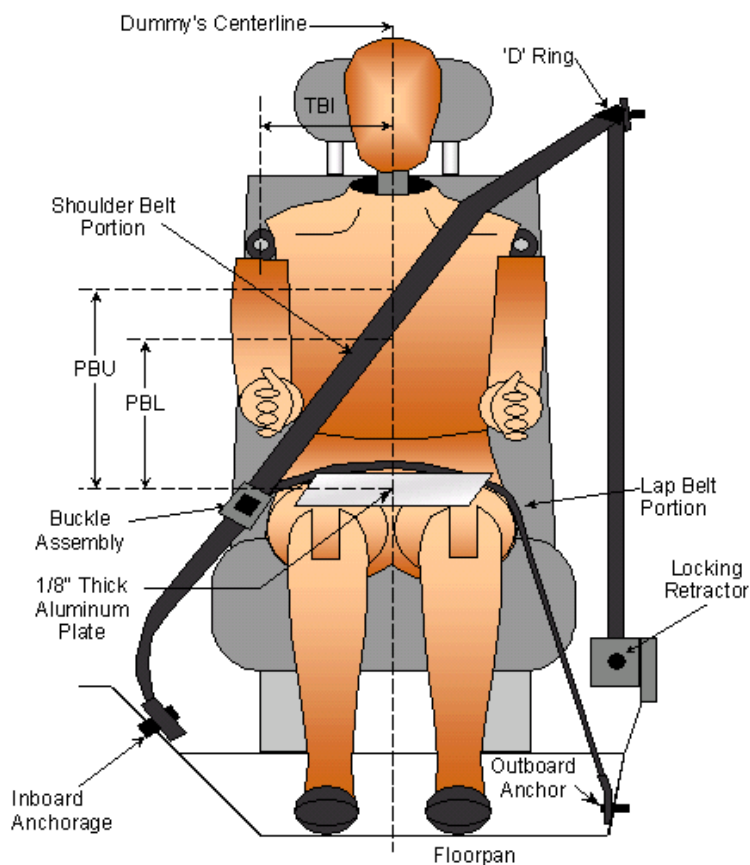


Code	Description	Units	Driver	Passenger
AD	Arm to Door	mm	133	43
HD	H-Point to Door	mm	130	132
HR	Head to Side Header	mm	219	223
HS	Head to Side Window	mm	346	351
KK	Knee to Knee	mm	270	274
SHY	Striker to H-Point (Y Direction)	mm	225	225
AA	Ankle to Ankle	mm	330	248

DATA SHEET NO. 5 SEAT BELT POSITIONING DATA

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU — Top surface of reference to belt upper edge	mm	390	390
PBL — Top surface of reference to belt lower edge	mm	315	315

BELT LENGTH DATA

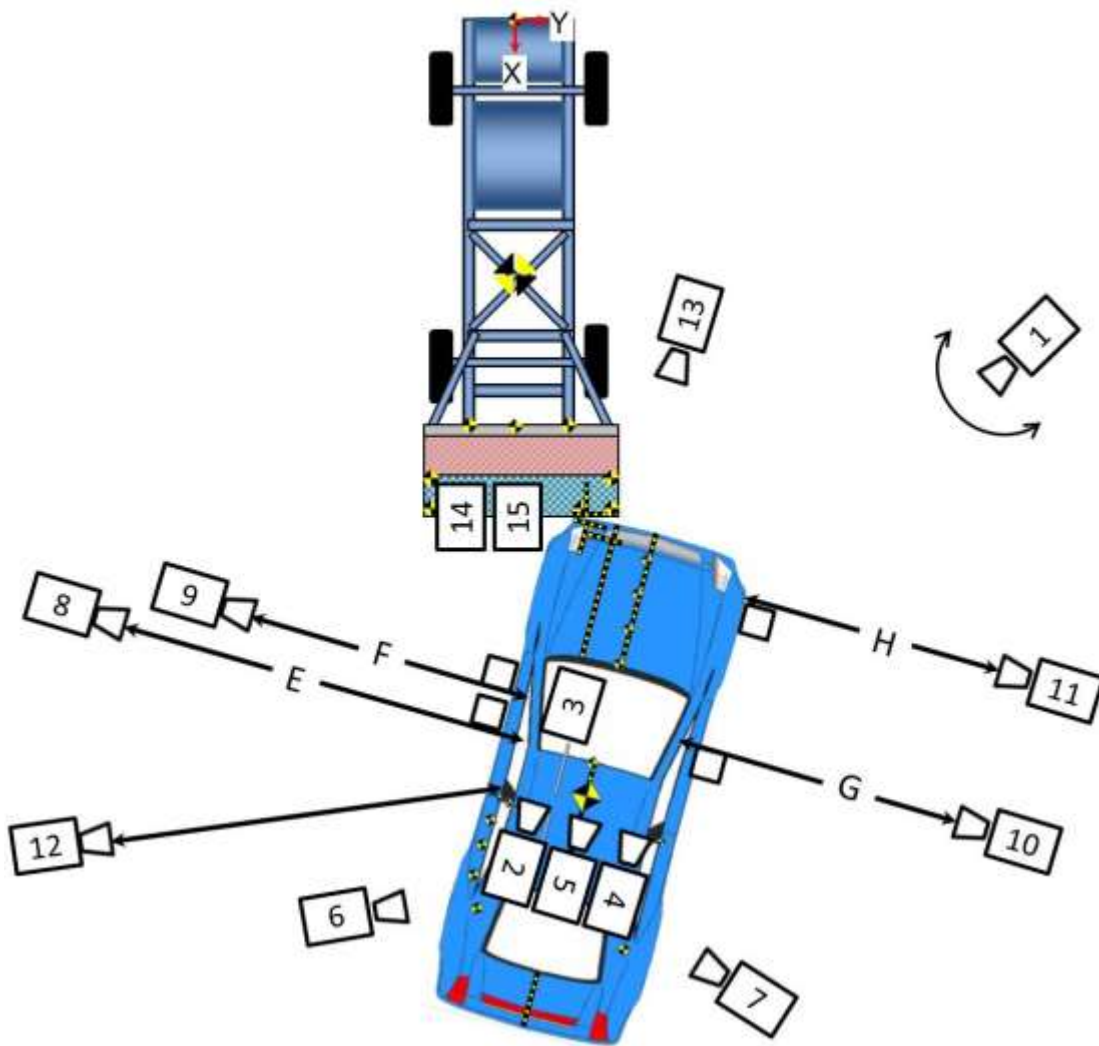
Measurement Description	Units	Driver	Passenger
Shoulder belt length as measured on ATD	mm	850	875
Lap Belt Length as measured on ATD	mm	640	650
Remainder of belt on reel	mm	710	675
Total belt length for continuous webbing systems	mm	2,200	2,200

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

HORIZONTAL LOCATION



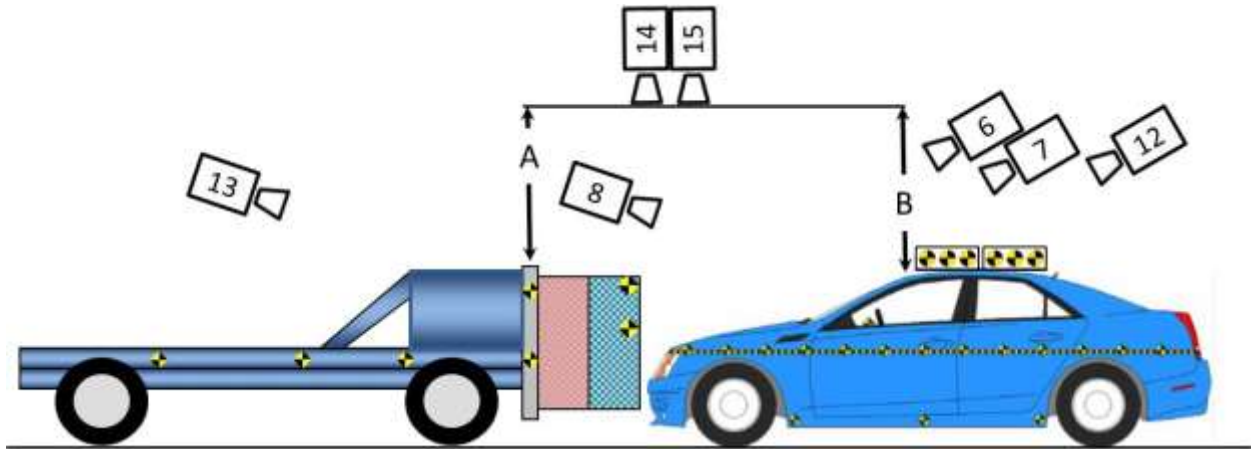
E	mm	9829
F	mm	6091
G	mm	8649
H	mm	8700

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

VERTICAL LOCATION



A	mm	4117
B	mm	3875

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

CAMERA LOCATIONS

No.	Camera View	Location (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Side	--	--	--	Zoom	30
2	Onboard Passenger Movement	8072	714	1208	12.5	500
3	Onboard Driver Lower Leg	6282	-560	227	6.5	500
4	Onboard Driver Movement	8002	120	1208	12.5	500
5	Onboard Centerline	8020	-427	1208	12.5	500
6	Driver Interaction	7969	-4120	3355	24	1000
7	Passenger Interaction	11891	8324	2551	50	1000
8	Target Vehicle Left Side Perpendicular (High)	5135	9582	3252	24-70	1000
9	Target Vehicle Driver Motion	6109	6046	1349	24	1000
10	Target Vehicle Passenger Motion	9102	9643	1936	50	1000
11	Target Vehicle Right Side	8873	10225	1958	24	1000
12	Target Vehicle Left Side (High)	10486	8397	3177	28-70	1000
13	RMDB/Target Vehicle Interaction	3957	1563	2017	13	1000
14	Close-up Impact Point	4935	878	4704	28	1000
15	Overall Impact	6427	616	5294	14	1000

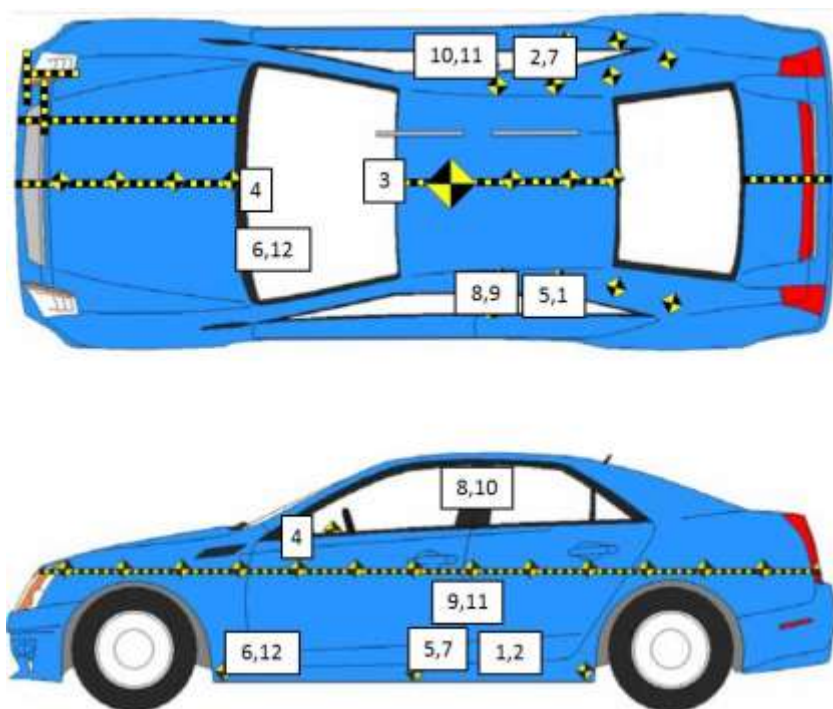
Reference Point: Center most rearward point of the RMDB when in contact with the target vehicle:

- +X – From back of RMDB to front of RMDB
- +Y – Right of monorail center
- +Z – Up from ground

DATA SHEET NO. 7 **VEHICLE INSTRUMENTATION DATA**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Axes	Units	Measurements (mm)		
				X	Y	Z
1	Left Rear Sill	X,Y	mm	761	-632	1108
2	Right Rear Sill	X,Y	mm	786	632	1112
3	Vehicle CG	X,Y,Z	mm	1346	30	936
4	Instrument Panel	X	mm	1683	-20	601
5	Driver Seat Track	X,Y,Z	mm	1019	-528	1123
6	Behind Brake Pedal	X,Y,Z	mm	2227	-400	930
7	Passenger Seat Track	X,Y,Z	mm	1052	519	1112

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO. 7 (CONTINUED)
VEHICLE INSTRUMENTATION DATA

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

VEHICLE INSTRUMENTATION DATA

Loc.	Description	Axes	Units	Positive Direction		Negative Direction	
				Max	Time (ms)	Max	Time (ms)
1	Left Rear Sill	X	g	1.40	103.35	-48.10	32.05
		Y	g	48.64	23.75	-24.50	39.15
2	Right Rear Sill	X	g	30.45	187.35	-66.12	157.70
		Y	g	126.64	156.40	-83.04	114.45
3	Vehicle CG	X	g	1.94	112.95	-37.20	25.90
		Y	g	41.44	26.30	-10.13	50.05
		Z	g	31.50	50.45	-22.27	72.20
4	Instrument Panel	X	g	32.53	80.35	-57.22	50.45
5	Driver Seat Track	X	g	1.47	112.35	-45.49	31.95
		Y	g	33.63	26.45	-3.13	75.45
		Z	g	30.61	44.75	-30.90	36.65
6	Behind Brake Pedal	X	g	27.22	11.75	-59.85	15.00
		Y	g	94.56	25.35	-9.83	56.25
		Z	g	35.88	32.30	-23.93	60.65
7	Passenger Seat Track	X	g	2.28	79.25	-43.75	26.20
		Y	g	34.72	26.75	-3.76	68.35
		Z	g	14.39	35.50	-21.90	45.70
8	Driver Shoulder Belt		N	5,118.56	58.40	-79.09	148.00
9	Driver Lap Belt		N	8,142.61	52.70	-52.04	191.55
10	Passenger Shoulder Belt		N	4,478.50	41.90	-18.69	158.20
11	Passenger Lap Belt		N	9,345.75	52.05	-30.68	257.40
12	Driver Floor Pan String Pot		mm	0.07	0.90	-32.29	78.40

TIME TO FIRE RESTRAINT TIMING

Loc.	Description	Axes	Units	Time to Fire (ms)
1	Driver Air Bag Squib 1	*	V	12.6
2	Driver Air Bag Squib 2	*	V	59.4
3	Driver Curtain Airbag	*	V	34.4
4	Driver Torso Airbag	*	V	35.1
5	Driver Knee Airbag	*	V	Not Applicable
6	Driver Pretensioner	*	V	11.7
7	Passenger Air Bag Squib 1	*	V	12.6
8	Passenger Air Bag Squib 2	*	V	23.2
9	Passenger Curtain Airbag	*	V	Disabled
10	Passenger Torso Airbag	*	V	Disabled
11	Passenger Knee Airbag	*	V	Not Applicable
12	Passenger Pretensioner	*	V	11.7

* The measurement indicates the time the voltage changed

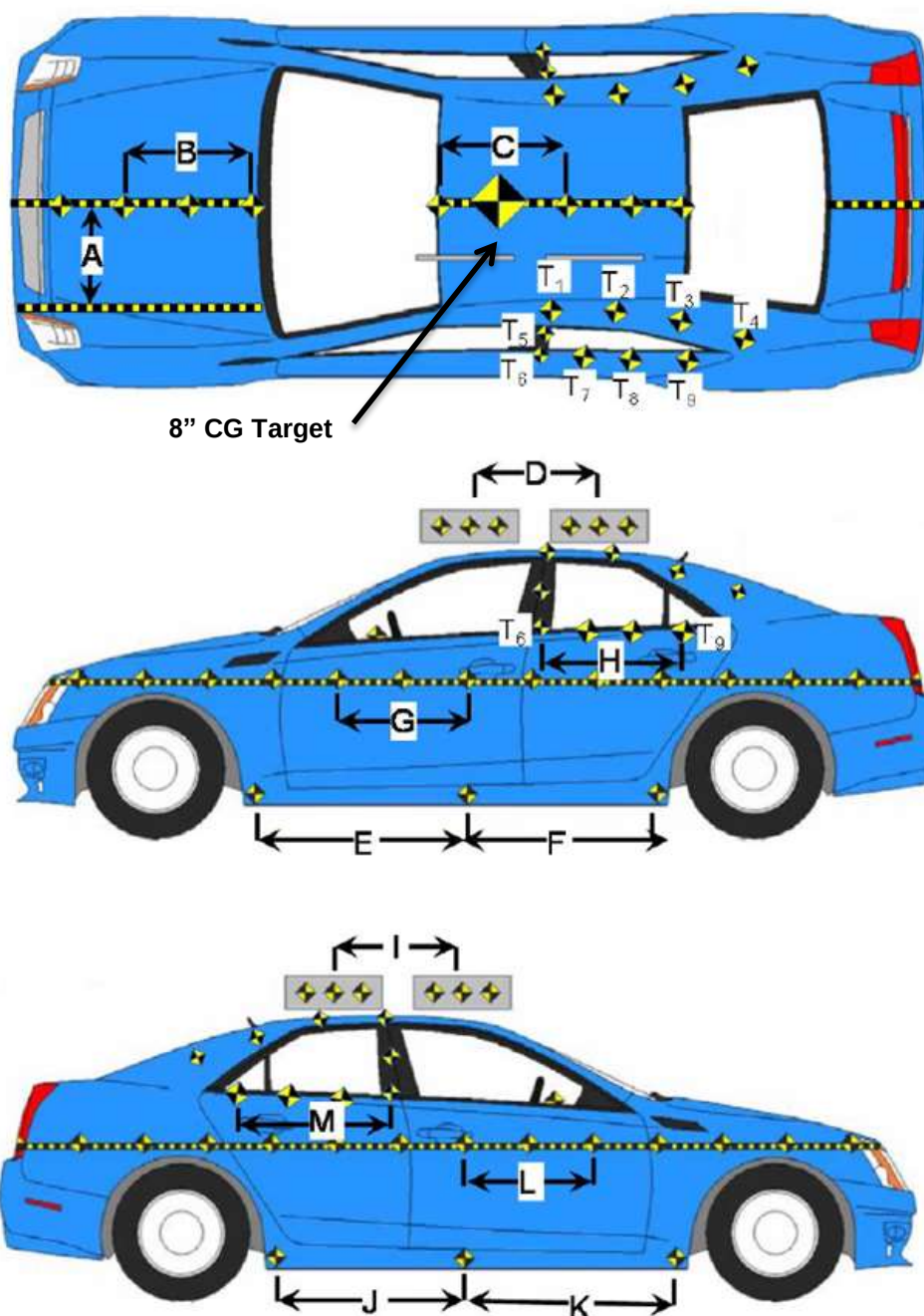
DATA SHEET NO. 8 **PHOTOGRAPHIC REFERENCE TARGET LOCATIONS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

Item	Units	Value
A	mm	267
B	mm	1220
C	mm	1220
D	mm	612
E	mm	894
F	mm	903
G	mm	1220
H	mm	960
I	mm	612
J	mm	902
K	mm	901
L	mm	1220
M	mm	960

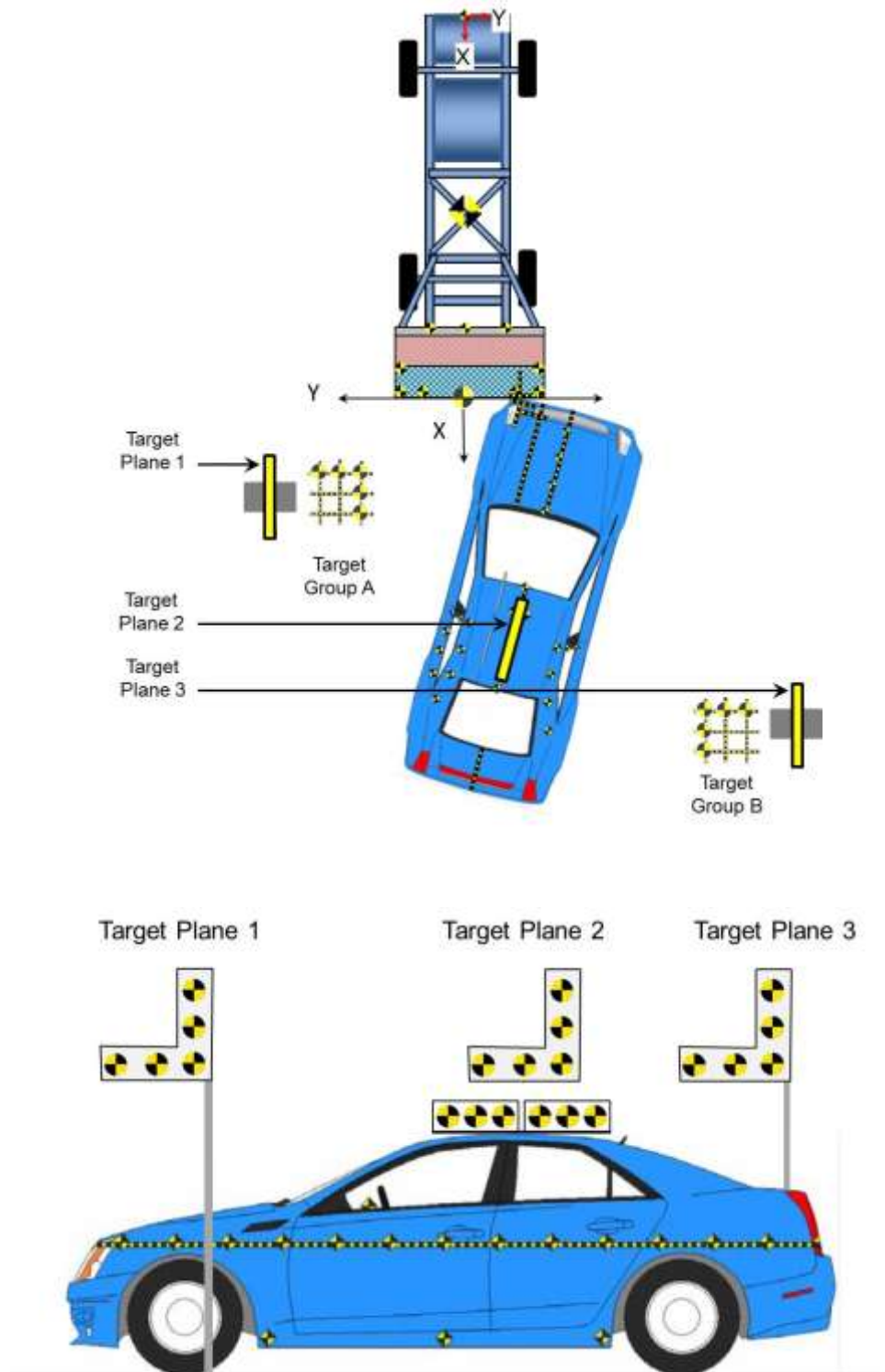
Note: All 6" targets on the centerline of the hood and roof are 610mm apart



DATA SHEET NO. 8 (CONTINUED)
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

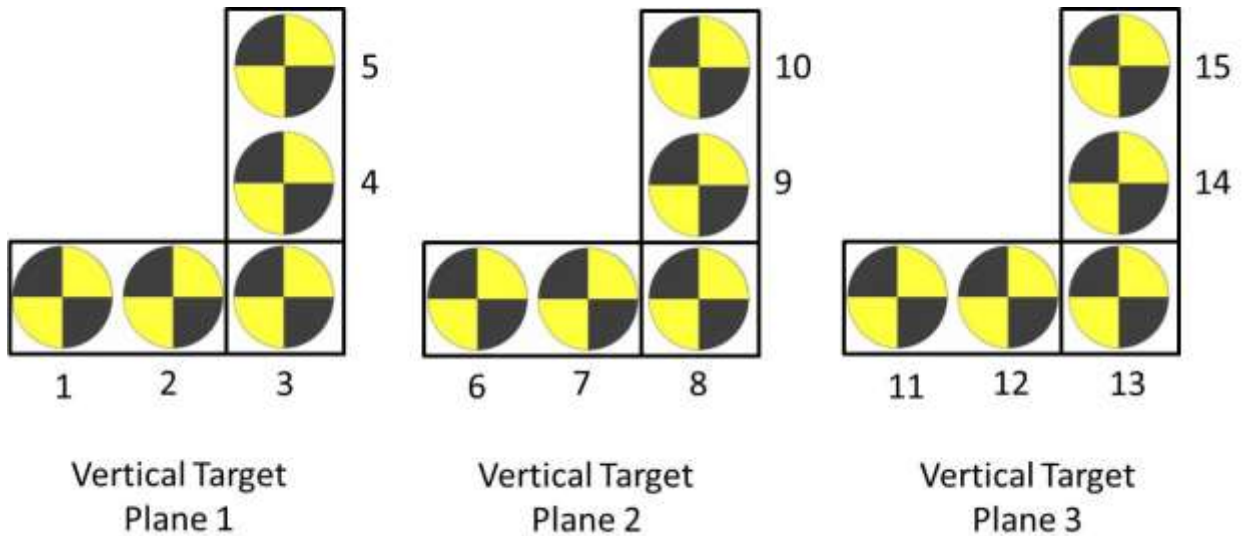
NHTSA No.: RD4200
Test Date: 12/10/2012



DATA SHEET NO. 8 (CONTINUED)
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Target	Units	X	Y	Z
1	mm	5035	3020	1650
2	mm	5340	3020	1650
3	mm	5645	3020	1650
4	mm	5645	3020	1955
5	mm	5645	3020	2260
6*	mm	1121	-388	-344
7*	mm	817	-390	-350
8*	mm	514	-391	-360
9*	mm	518	-391	-665
10*	mm	530	-389	-970
11	mm	7760	3110	1665
12	mm	8065	3110	1665
13	mm	8370	3110	1665
14	mm	8370	3110	1970
15	mm	8370	3110	2275

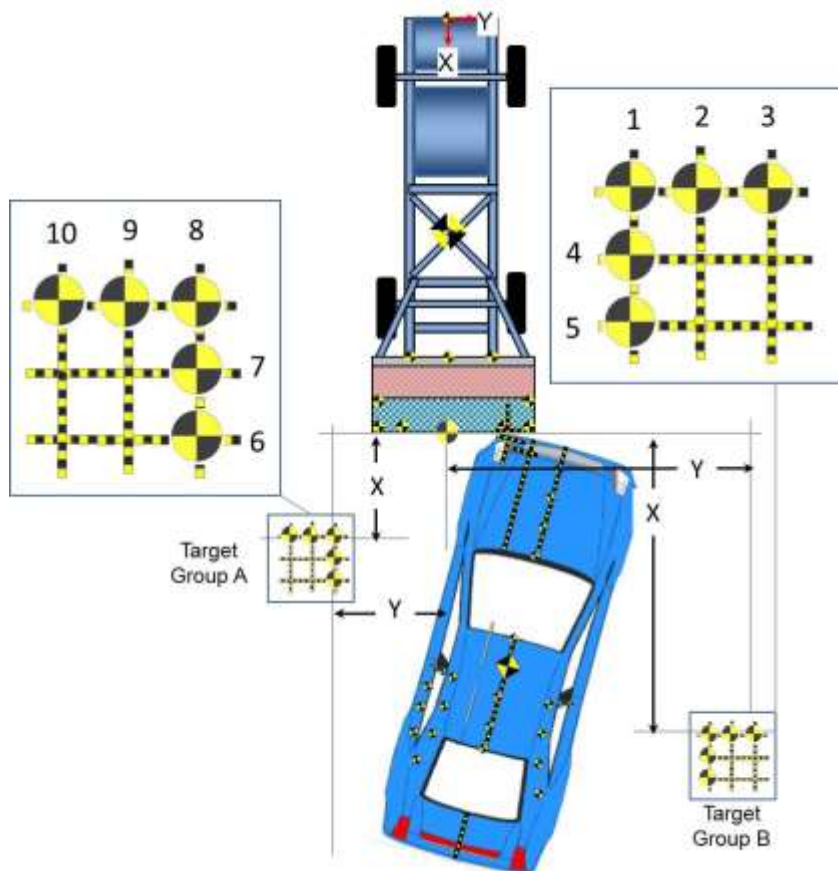
***NOTE:**

- Targets 6-10 are in reference to the vehicle coordinate system
- Targets 1-5 and Targets 11-15 are in reference to the global coordinate system, which references the back of the RMBD.

DATA SHEET NO. 8 (CONTINUED)
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



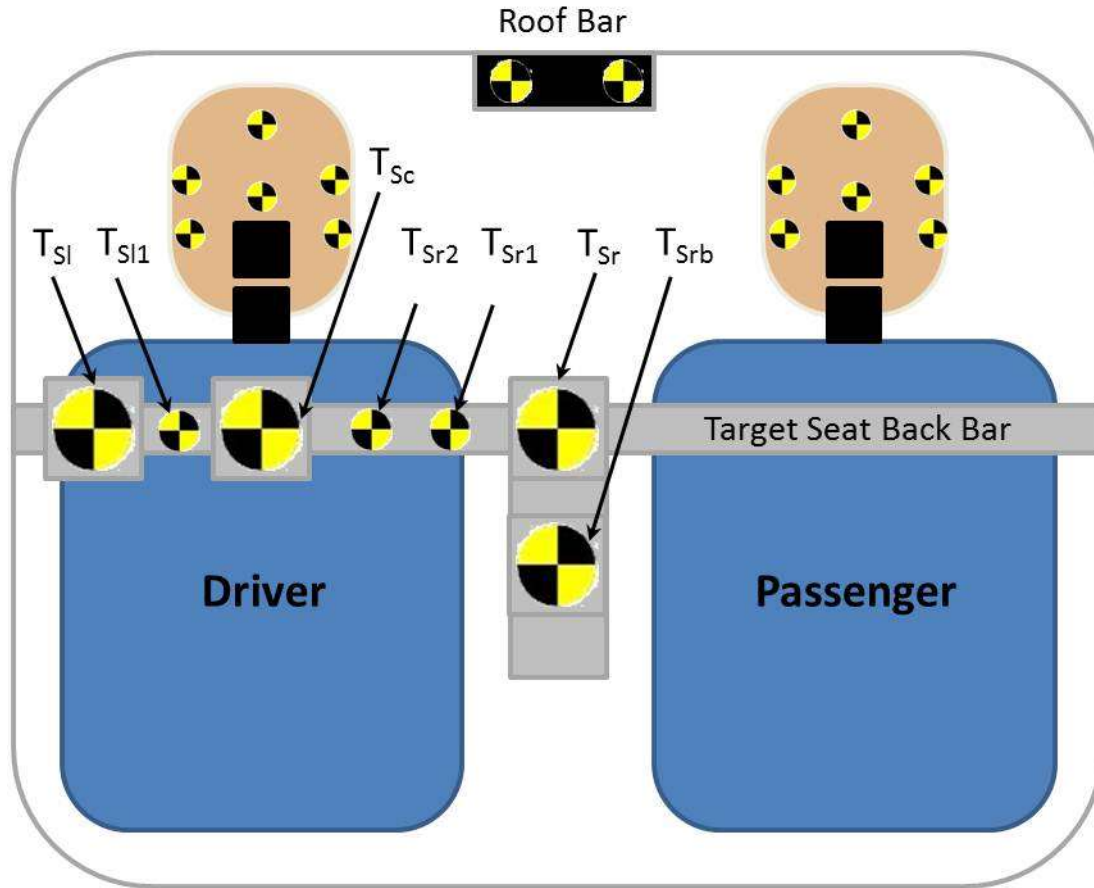
Target	Units	X	Y
1	mm	3198	1820
2	mm	3198	2122
3	mm	3198	2425
4	mm	3500	1820
5	mm	3803	1820
6	mm	1678	615
7	mm	1382	615
8	mm	1068	615
9	mm	1068	923
10	mm	1068	1916

Note: Target Locations are in reference to the front center of RMDB

DATA SHEET NO. 8 (CONTINUED)
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Point	Pre-Test		
	X	Y	Z
TSrb	663	-4	532
TSr	658	-1	381
TSr1	670	-120	412
TSr2	670	-239	409
TSc	661	-360	380
TSil1	671	-478	411
TSI	663	-606	382
TRoof Driver	1463	-66	93
TRoof Passenger	1460	60	90

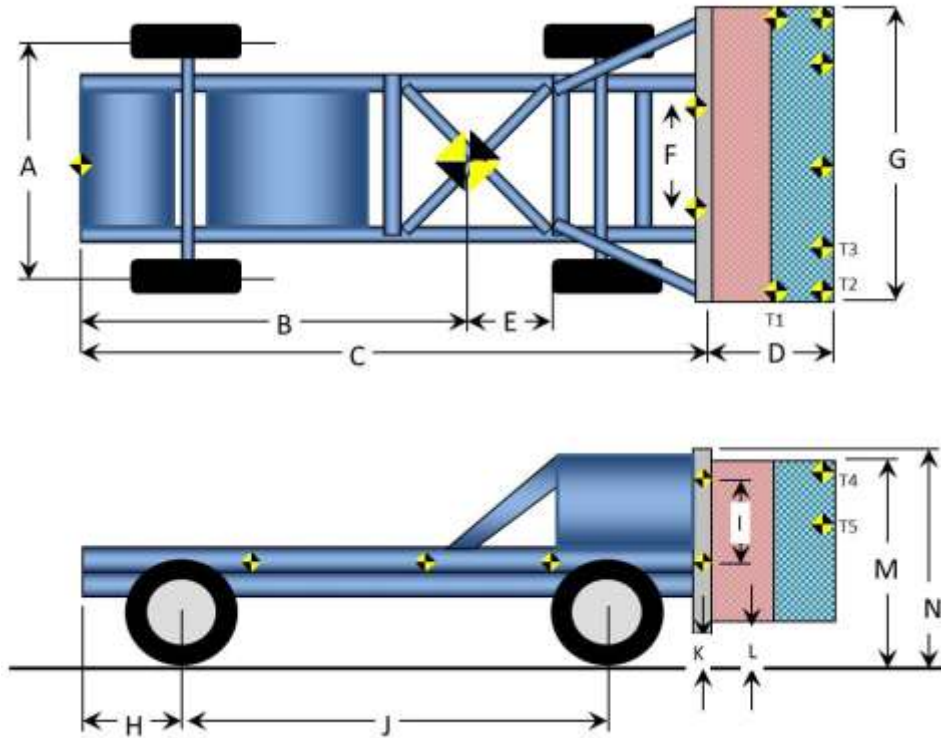
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO. 8 (CONTINUED)
RMDB PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



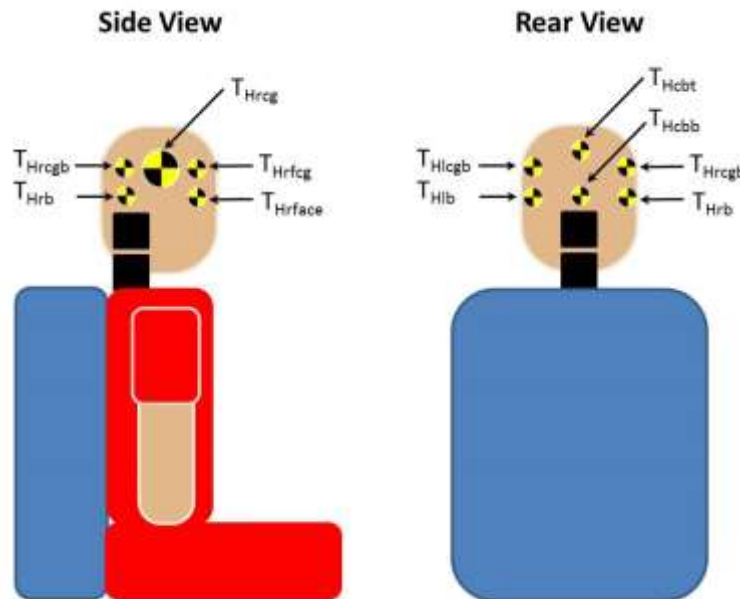
Item	Units	Value	Item	Units	Value
A	mm	1930	H	mm	800
B	mm	2451	I	mm	500
C	mm	3995	J	mm	2555
D	mm	605	K	mm	77
E	mm	904	L	mm	71
F	mm	1123	M	mm	1024
G	mm	2205	N	mm	1177

	Units	Front Axle	Rear Axle	Total
Left	kg	802.0	453.6	1255.6
Right	kg	807.4	427.7	1235.1
Ratio	%	65	35	100
Total	kg	1609.4	881.3	2490.7
CG Aft of Front Axle	mm			904

DATA SHEET NO. 8 (CONTINUED)
DUMMY PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Driver Dummy Head Targets (THOR007)

Measurement	Units	Value
Distance between T _{Hrcg} & T _{Hrfcg}	mm	50
Distance between T _{Hrcg} & T _{Hrcgb}	mm	40
Distance between T _{Hrcgb} & T _{Hrb}	mm	70
Distance between T _{Hrfcg} & T _{Hrfce}	mm	70
Distance between T _{Hlcb} & T _{Hlcbg}	mm	50
Distance between T _{Hlcb} & T _{Hlcbg}	mm	40
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbt} & T _{Hlcb}	mm	67

Passenger Dummy Head Targets (THOR016)

Measurement	Units	Value
Distance between T _{Hrcg} & T _{Hrfcg}	mm	50
Distance between T _{Hrcg} & T _{Hrcgb}	mm	40
Distance between T _{Hrcgb} & T _{Hrb}	mm	70
Distance between T _{Hrfcg} & T _{Hrfce}	mm	70
Distance between T _{Hlcb} & T _{Hlcbg}	mm	50
Distance between T _{Hlcb} & T _{Hlcbg}	mm	40
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbg} & T _{Hlcb}	mm	70
Distance between T _{Hlcbt} & T _{Hlcb}	mm	67

DATA SHEET NO. 9
TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

INSTRUMENTATION

Instrumentation	Number of Channels Collected
Driver Dummy Accelerometers	93
Passenger Dummy Accelerometers	93
Vehicle Structure Accelerometers	38
RMDB Cart Accelerometers	6
Total	230

CAMERA COVERAGE

Type of Camera	Number Used in this Test
High-Speed Vehicle Onboard	4
High-Speed Off-board	10
Real-Time Panning	1
Total	15

DATA SHEET NO. 10 - POST TEST OBSERVATIONS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Right Front Passenger
Dummy Type/Serial No.	THOR 007	THOR 016
Lower Leg Type	THOR LOWER LEG LX	THOR LOWER LEG LX
Lower Leg Serial No.	LX036 / LX037	LX018 / LX019
Head Contact	Frontal Airbag, Curtain Airbag, Head Liner & Seat back	Frontal Airbag & Center Dash Panel
Upper Torso Contact	Frontal Airbag, Torso Airbag & Driver's Door	Frontal Airbag & Center Dash Panel
Lower Torso Contact	None	None
Left Knee Contact	Knee Bolster	Glove Box
Right Knee Contact	Knee Bolster	Glove Box

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Right Front Passenger
Locked/Unlocked Doors	Locked	Locked
Front Door Opening	Jammed Closed	Closed & Operational
Rear Door Opening	Closed & Operational	Closed & Operational
Seat Track Shift (mm)	0	0
Seat Back Failure	No	No
Glazing Damage	None	None

POST TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions	Photo Taken (Y/N)
Pillar Performance	Driver's A-Pillar buckled causing minor separation between the door and vehicle.	Y
Windshield Damage	Cracked throughout & wiper blade penetrated the non-protected zone.	Y
Window Damage	None	Y
Other Notable Effects	None	--

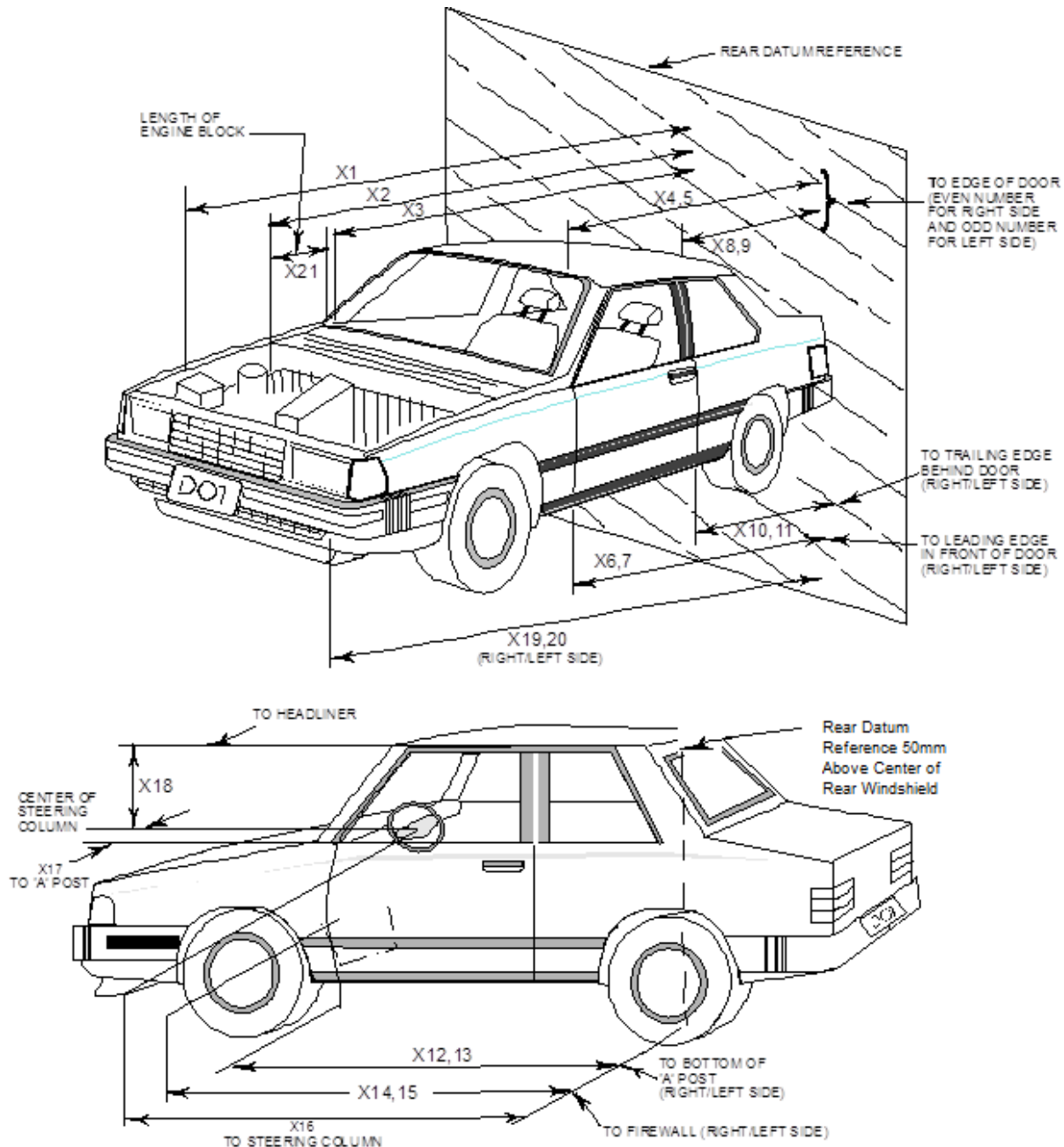
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Driver (Occupant 1)		Right Front Passenger (Occupant 2)	
	Installed	Deployed	Installed	Deployed
Front Airbag	Yes	Yes	Yes	Yes
Curtain Airbag	Yes	Yes	Yes	Disabled
Torso Airbag	Yes	Yes	Yes	Disabled
Knee Airbag	No	NA	No	NA
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes	Yes	Yes	Yes
Other				

DATA SHEET NO. 11 **VEHICLE PROFILE MEASUREMENTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



DATA SHEET NO. 11 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	mm	3320	3048	272
2	Rear Surface of Vehicle (RSOV) to Front of Engine	mm	2899	2743	156
3	RSOV to Firewall	mm	2393	2307	86
4	RSOV to Upper Leading Edge of Right Door	mm	2012	2011	1
5	RSOV to Upper Leading Edge of Left Door	mm	2013	1998	15
6	RSOV to Lower Leading Edge of Right Door	mm	1997	1995	2
7	RSOV to Lower Leading Edge of Left Door	mm	1998	1980	18
8	RSOV to Upper Trailing Edge of Right Door	mm	872	871	1
9	RSOV to Upper Trailing Edge of Left Door	mm	871	856	15
10	RSOV to Lower Trailing Edge of Right Door	mm	889	887	2
11	RSOV to Lower Trailing Edge of Left Door	mm	887	871	16
12	RSOV to Bottom of "A" Post of Right Side	mm	2224	2221	3
13	RSOV to Bottom of "A" Post of Left Side	mm	2218	2155	63
14	RSOV to Firewall, Right Side	mm	2500	2494	6
15	RSOV to Firewall, Left Side	mm	2502	2266	236
16	RSOV to Steering Column	mm	1516	1497	19
17	Center of Steering Column to "A" Post	mm	275	227	48
18	Center of Steering Column to Headliner	mm	397	382	15
19	RSOV to Right Side of Front Bumper	mm	3226	3215	11
20	RSOV to Left Side of Front Bumper	mm	3223	2768	455
21	Length of Engine Block	mm	424	458	-34
RD	RSOV to Right Side of Dash Panel	mm	1696	1697	-1
CD	RSOV to Center of Dash Panel	mm	1782	1733	49
LD	RSOV to Left Side of Dash Panel	mm	1694	1649	45

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO. 12
ACCIDENT INVESTIGATION DIVISION DATA

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

VEHICLE INFORMATION

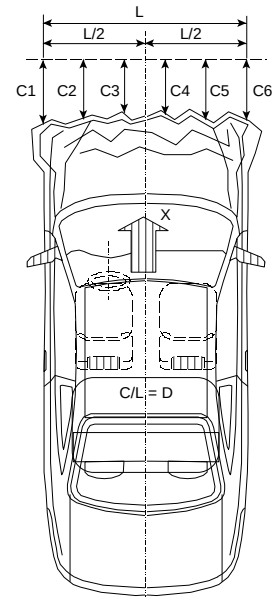
VIN: 5NPDH4AE9DH208432 Wheelbase (mm): 2702
Vehicle Size Category: Four Door Sedan Test Weight (kg): 1589.5

ACCELEROMETER DATA

Accelerometer Locations: As Described in Data Sheet No. 7
Cal. Procedure/Interval: Calspan Procedure / 6 month
Integration Algorithm: Trapezoidal
Linearity: > 99%
Impact Velocity (kph): 90.09
Velocity Change (kph): 90.09

CRUSH PROFILE

Collision Deformation Classification: 11FYEW5
Midpoint of Damage: C2
Damage Region Length (mm): 1005
Impact Mode: Frontal 15° Angle, 35% Left Offset



Crush Measurements: Bumper Cover

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	3206	2741	465
C2	Crush zone 2 at left side	mm	3287	2877	410
C3	Crush zone 3 at left side	mm	3313	2992	321
C4	Crush zone 4 at right side	mm	3314	3092	222
C5	Crush zone 5 at right side	mm	3291	3170	121
C6	Crush zone 6 at right side	mm	3209	3194	15
L	C1 to C6	mm	1005	907	98

Crush Measurements: Bumper Cover Removed

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
B1	Bumper Beam 1 at left side	mm	3105	2562	-544
B2	Bumper Beam 2 at left side	mm	3156	2664	-492
B3	Bumper Beam 3 at left side	mm	3189	2737	-452
B4	Bumper Beam 4 at left side	mm	3209	2842	-367
B5	Bumper Beam 5 at right side	mm	3215	2933	-282
B6	Bumper Beam 6 at right side	mm	3209	3013	-196
B7	Bumper Beam 7 at right side	mm	3189	3083	-106
B8	Bumper Beam 8 at right side	mm	3156	3139	-17
B9	Bumper Beam 9 at right side	mm	3106	3176	70
L	B1 to B9	mm	1273	1095	178

DATA SHEET NO. 13
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

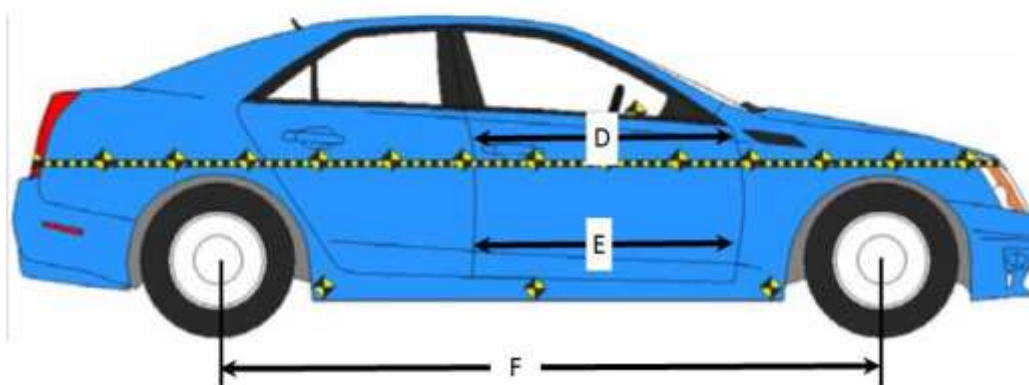
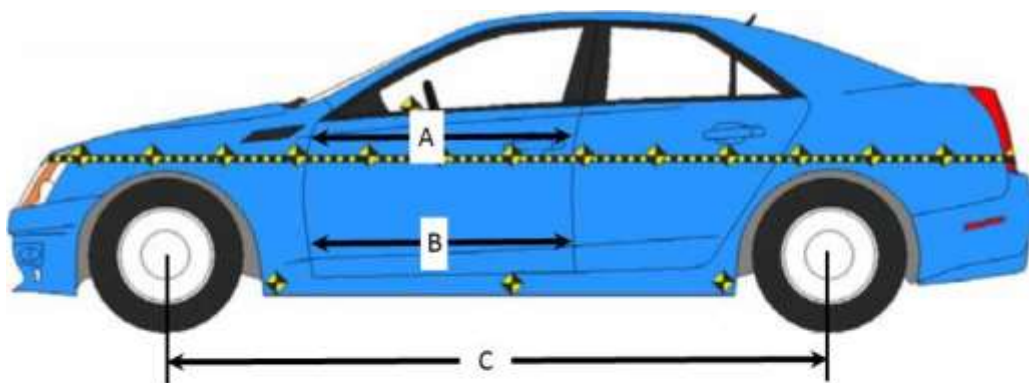
NHTSA No.: RD4200
 Test Date: 12/10/2012

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1047	1009	-38
B	Left Side Lower	mm	959	939	-20
D	Right Side Upper	mm	1048	1046	-2
E	Right Side Lower	mm	953	952	-1

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2702	2482	-220
F	Right Side Wheelbase	mm	2702	2743	41



DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

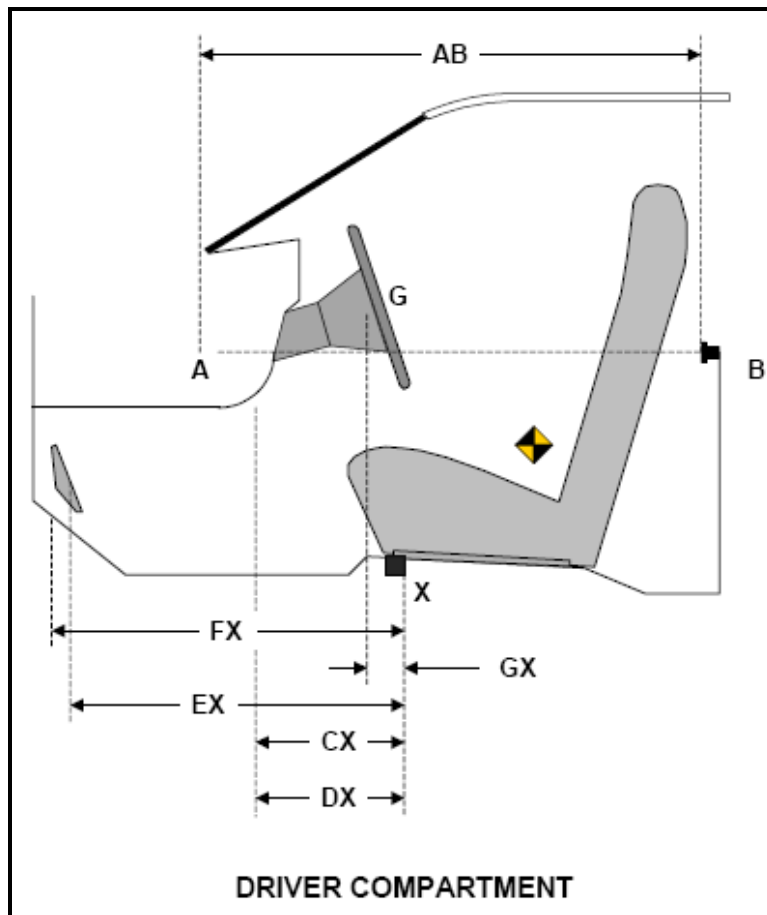
Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	893	883	-10
CX	Left Knee Bolster to X	mm	267	231	-36
DX	Right Knee Bolster to X	mm	251	225	-27
EX	Brake Pedal to X	mm	558	559	1
FX	Foot Rest to X	mm	588	532	-56
GX	Center of Steering Column Wheel Hub to X	mm	63	50	-13

X = Front of Seat Track (Stationary)



DATA SHEET NO.13 (CONTINUED) **VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

DRIVER SIDE DOOR SILL INTRUSIONS



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
1	1965	-744	916	1942	-727	903	-23	17	-13
2	1970	-737	841	1935	-731	827	-35	6	-14
3	1969	-733	766	1924	-736	755	-45	-3	-11
4	1974	-730	465	1938	-748	463	-36	-18	-2
5	1957	-721	393	1931	-738	388	-26	-17	-5
6	1890	-705	318	1877	-716	305	-13	-11	-13
7	1812	-745	1036	1807	-714	1040	-5	31	4
8	1663	-746	1037	1660	-717	1037	-3	29	0
9	1510	-746	1036	1508	-721	1033	-2	25	-3
10	1883	-752	1028	1878	-717	1025	-5	35	-3
11	1940	-753	985	1927	-724	975	-13	29	-10
12	1971	-729	666	1923	-740	657	-48	-11	-9
13	1972	-729	565	1925	-746	560	-47	-17	-5
14	1817	-710	256	1817	-714	231	0	-4	-25
15	1738	-699	220	1738	-705	202	0	-6	-18
16	1660	-687	185	1661	-692	168	1	-5	-17

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
17	1581	-675	152	1582	-679	136	1	-4	-16
18	1502	-663	122	1502	-665	107	0	-2	-15
19	1420	-652	94	1421	-652	80	1	0	-14
20	1339	-641	71	1339	-642	59	0	-1	-12
21	1256	-633	52	1256	-633	43	0	0	-9
22	1174	-626	38	1174	-626	30	0	0	-8
23	1087	-620	26	1086	-620	19	-1	0	-7
24	1002	-616	19	1000	-616	13	-2	0	-6
25	918	-614	15	917	-614	10	-1	0	-5
26	830	-610	12	828	-611	8	-2	-1	-4
27	1440	-745	1035	1438	-722	1031	-2	23	-4
28	1370	-745	1033	1368	-723	1030	-2	22	-3
29	1302	-745	1032	1300	-725	1030	-2	20	-2
30	1235	-746	1024	1232	-727	1021	-3	19	-3
31	1170	-746	1003	1167	-729	1001	-3	17	-2
32	1110	-746	970	1108	-730	968	-2	16	-2

Note: See Appendix D for detailed procedure on how to measure the required door sill intrusions.

DATA SHEET NO.13 (CONTINUED) **VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

PASSENGER SIDE DOOR SILL INTRUSIONS



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
1	1963	746	916	1962	774	916	-1	28	0
2	1972	741	841	1971	767	840	-1	26	-1
3	1970	736	767	1968	761	766	-2	25	-1
4	1974	730	466	1971	752	465	-3	22	-1
5	1960	724	391	1956	744	390	-4	20	-1
6	1893	707	317	1890	723	317	-3	16	0
7	1811	749	1034	1811	774	1032	0	25	-2
8	1661	750	1034	1661	772	1033	0	22	-1
9	1512	749	1033	1511	769	1032	-1	20	-1
10	1880	752	1025	1879	778	1023	-1	26	-2
11	1936	753	984	1935	780	982	-1	27	-2
12	1973	732	668	1971	756	667	-2	24	-1
13	1975	733	567	1972	756	566	-3	23	-1
14	1836	715	262	1833	727	261	-3	12	-1
15	1757	703	225	1754	713	224	-3	10	-1
16	1678	692	190	1676	698	189	-2	6	-1

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

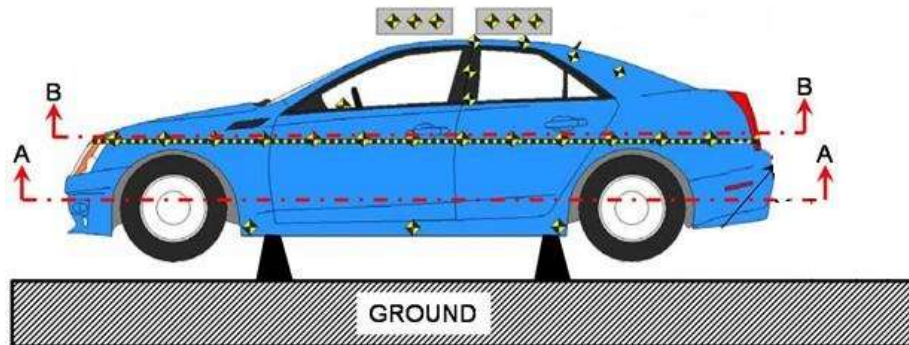
Point	Pre-Test			Post-Test			Difference		
	X	Y	Z	X	Y	Z	X	Y	Z
17	1599	680	156	1597	683	156	-2	3	0
18	1519	668	125	1519	667	125	0	-1	0
19	1436	656	97	1437	653	96	1	-3	-1
20	1353	646	72	1352	643	72	-1	-3	0
21	1268	636	53	1268	635	54	0	-1	1
22	1183	629	38	1182	628	39	-1	-1	1
23	1093	624	25	1094	623	27	1	-1	2
24	1007	620	18	1007	619	19	0	-1	1
25	918	618	14	919	617	15	1	-1	1
26	831	615	10	831	614	12	0	-1	2
27	1440	749	1032	1440	767	1031	0	18	-1
28	1374	749	1032	1373	766	1031	-1	17	-1
29	1308	750	1032	1307	765	1030	-1	15	-2
30	1241	749	1025	1240	764	1024	-1	15	-1
31	1179	750	1006	1178	763	1005	-1	13	-1
32	1119	750	975	1118	761	974	-1	11	-1

Note: See Appendix D for detailed procedure on how to measure the required door sill intrusions.

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

VEHICLE EXTERIOR CRUSH PROFILE
SECTION A-A

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
1	2807	-872	886	1	2068	-840	884
2	2866	-858	885	2	2226	-802	884
3	2921	-838	884	3	2433	-756	884
4	2955	-808	885	4	2518	-767	884
5	3118	-644	884	5	2545	-674	885
6	3174	-562	882	6	2530	-612	884
7	3206	-508	882	7	2644	-429	883
8	3239	-432	883	8	2725	-348	885
9	3281	-338	885	9	2742	-312	885
10	3298	-267	885	10	2740	-230	884
11	3311	-159	887	11	2782	-133	884
12	3317	-45	886	12	2873	-24	884
13	3316	72	885	13	2954	104	885
14	3308	192	886	14	3010	233	883
15	3298	274	886	15	3079	251	884
16	3275	357	884	16	3098	316	885
17	3246	422	884	17	3063	546	885
18	3213	490	886	18	2898	696	884
19	3184	549	885	19	2798	831	884
20	3146	607	882	20	2667	891	885
21	3085	676	882	21	2551	903	885
22	2957	808	883	22	2374	908	885
23	2918	844	883	23	2107	906	884
24	2865	860	883	24	1963	907	885
25	2808	875	885	25	1722	897	884

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

VEHICLE EXTERIOR CRUSH PROFILE
SECTION A-A (Continued)

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
26	2108	887	885	26	1523	893	885
27	1946	877	886	27	1344	889	885
28	1787	873	886	28	1158	886	885
29	1609	873	885	29	1026	883	885
30	1447	873	886	30	903	881	885
31	1247	873	886	31	762	879	885
32	1065	873	885	32	558	878	885
33	903	873	885	33	375	880	885
34	832	873	885	34	211	888	885
35	674	873	886	35	123	888	884
36	505	874	887	36	-578	878	884
37	320	879	886	37	-658	864	885
38	114	889	887	38	-745	849	884
39	-588	881	887	39	-825	832	884
40	-687	867	886	40	-905	799	884
41	-784	850	885	41	-992	743	885
42	-858	830	884	42	-1058	676	884
43	-964	771	885	43	-1101	608	884
44	-1034	705	884	44	-1142	508	884
45	-1091	622	883	45	-1171	399	885
46	-1130	537	884	46	-1196	245	884
47	-1158	445	884	47	-1206	86	885
48	-1195	242	885	48	-1194	-242	885
49	-1204	93	886	49	-1175	-370	884
50	-1203	-128	888	50	-1134	-518	885
51	-1190	-276	883	51	-1087	-621	884
52	-1181	-402	890	52	-994	-740	884
53	-1139	-500	886	53	-851	-826	884
54	-1110	-574	885	54	-737	-852	884
55	-1068	-651	885	55	-599	-874	884
56	-1002	-732	885	56	108	-881	885
57	-935	-784	884	57	273	-871	884
58	-877	-815	884	58	467	-863	884
59	-823	-834	885	59	762	-860	885
60	-764	-847	884	60	949	-862	885
61	-713	-856	884	61	1147	-861	884
62	-663	-864	885	62	1390	-862	884
63	-575	-876	885	63	1733	-865	884
64	110	-884	886	64	1943	-861	884
65	213	-880	884	65	2007	-866	884
66	357	-872	884	66	2049	-842	884

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

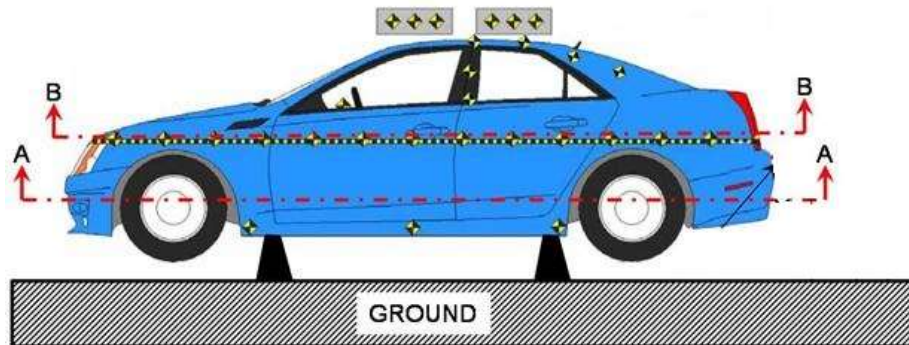
VEHICLE EXTERIOR CRUSH PROFILE
SECTION A-A (Continued)

Point	Pre-Test		
	X	Y	Z
67	540	-869	885
68	747	-868	886
69	966	-869	884
70	1145	-869	884
71	1354	-869	885
72	1554	-869	885
73	1688	-869	885
74	1847	-870	884
75	2011	-879	884
76	2106	-883	883
77	2807	-872	886

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

VEHICLE EXTERIOR CRUSH PROFILE
SECTION B-B

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
1	2082	-858	617	1	2044	-801	618
2	2193	-865	617	2	2114	-819	618
3	2312	-878	617	3	2163	-772	618
4	2420	-881	618	4	2224	-757	619
5	2500	-877	617	5	2298	-678	618
6	2590	-862	617	6	2348	-604	618
7	2699	-821	617	7	2450	-548	618
8	2815	-791	618	8	2616	-410	618
9	2905	-757	619	9	2658	-227	619
10	2972	-697	618	10	2736	-117	618
11	3015	-636	618	11	2849	32	618
12	3050	-547	620	12	2924	155	618
13	3071	-465	615	13	2970	273	618
14	3103	-347	618	14	3000	373	618
15	3129	-240	617	15	3006	454	618
16	3149	-102	617	16	2695	741	619
17	3156	-3	619	17	2679	862	618
18	3149	135	618	18	2525	890	619
19	3130	256	618	19	2372	865	618
20	3106	372	620	20	2231	881	619
21	3081	460	619	21	2117	883	618
22	3047	554	618	22	2068	886	618
23	3012	645	619	23	2017	886	618
24	2967	704	618	24	1815	889	618
25	2904	758	619	25	1639	889	619

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

VEHICLE EXTERIOR CRUSH PROFILE
SECTION B-B (Continued)

Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
26	2837	787	618	26	1442	887	618
27	2752	802	619	27	1253	886	619
28	2635	850	618	28	1095	886	619
29	2521	878	617	29	983	885	619
30	2404	883	619	30	796	883	618
31	2258	876	620	31	582	880	619
32	2071	860	618	32	429	878	618
33	2019	858	618	33	160	874	619
34	1815	866	620	34	-20	878	618
35	1636	868	620	35	-136	884	618
36	1450	871	619	36	-136	885	618
37	1254	874	619	37	-193	885	619
38	1063	877	618	38	-352	876	618
39	908	879	619	39	-612	834	618
40	701	878	618	40	-783	821	619
41	529	878	619	41	-898	800	619
42	348	876	619	42	-951	769	619
43	207	875	619	43	-1028	657	618
44	64	875	619	44	-1078	530	619
45	-134	887	617	45	-1108	367	618
46	-166	888	619	46	-1119	147	619
47	-223	888	619	47	-1122	-1	618
48	-298	887	619	48	-1118	-176	618
49	-383	884	620	49	-1116	-298	618
50	-466	877	620	50	-1099	-412	618
51	-548	861	620	51	-1082	-515	618
52	-631	843	619	52	-1037	-634	619
53	-710	829	619	53	-969	-748	619
54	-746	824	620	54	-908	-788	618
55	-811	815	618	55	-783	-812	618
56	-885	802	619	56	-606	-843	619
57	-953	772	619	57	-441	-875	619
58	-996	721	618	58	-273	-881	618
59	-1030	658	616	59	-194	-881	618
60	-1071	557	617	60	-147	-879	619
61	-1084	469	622	61	-79	-875	618
62	-1107	368	619	62	96	-869	619
63	-1113	271	619	63	280	-869	618
64	-1119	127	620	64	533	-870	618
65	-1121	25	619	65	742	-869	618
66	-1117	-191	619	66	876	-868	618
67	-1113	-266	618	67	1016	-876	618

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

VEHICLE EXTERIOR CRUSH PROFILE
SECTION B-B (Continued)

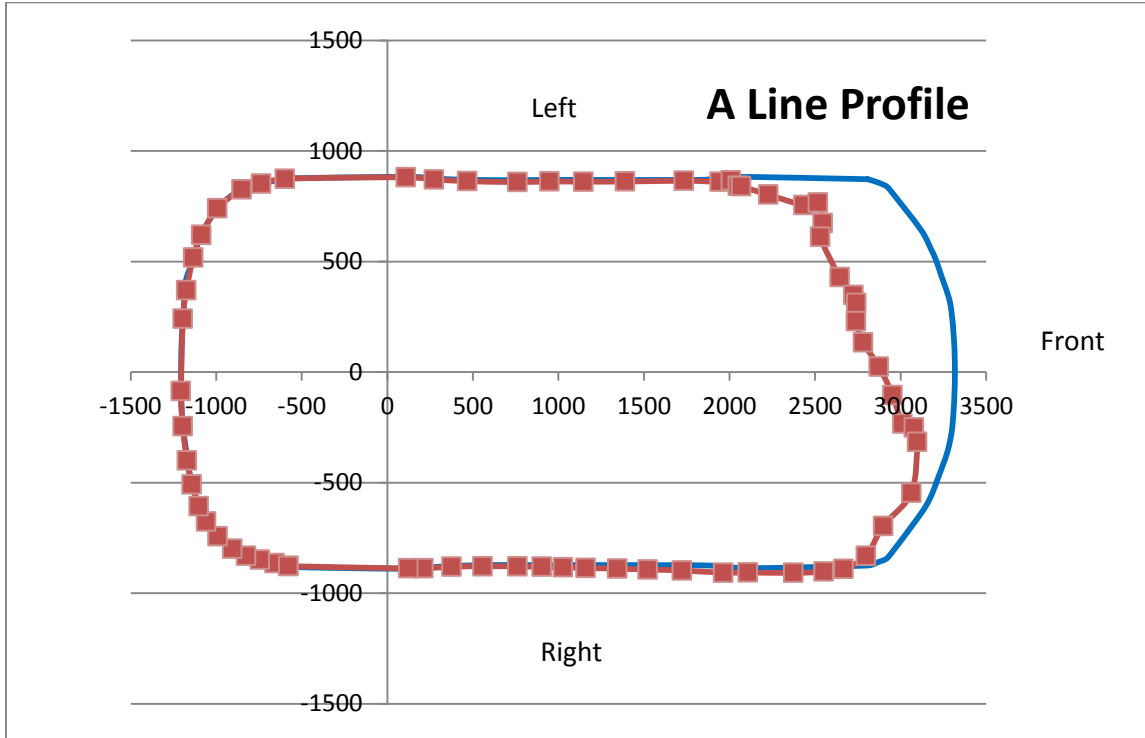
Point	Pre-Test			Point	Post-Test		
	X	Y	Z		X	Y	Z
68	-1109	-359	619	68	1183	-877	618
69	-1087	-455	619	69	1363	-877	618
70	-1080	-521	619	70	1638	-877	619
71	-1049	-607	619	71	1749	-877	619
72	-1025	-660	619	72	1888	-872	619
73	-983	-729	618	73	1981	-867	618
74	-939	-775	618	74	2010	-840	618
75	-876	-797	619				
76	-765	-814	621				
77	-650	-834	619				
78	-532	-858	619				
79	-321	-881	621				
80	-189	-881	619				
81	-146	-880	618				
82	-13	-872	620				
83	191	-869	619				
84	382	-871	620				
85	552	-873	619				
86	751	-874	619				
87	877	-873	620				
88	998	-874	620				
89	1120	-873	619				
90	1256	-871	619				
91	1371	-869	620				
92	1504	-867	619				
93	1687	-865	619				
94	1817	-863	618				
95	1957	-857	618				
96	2053	-855	617				
97	2082	-858	617				

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

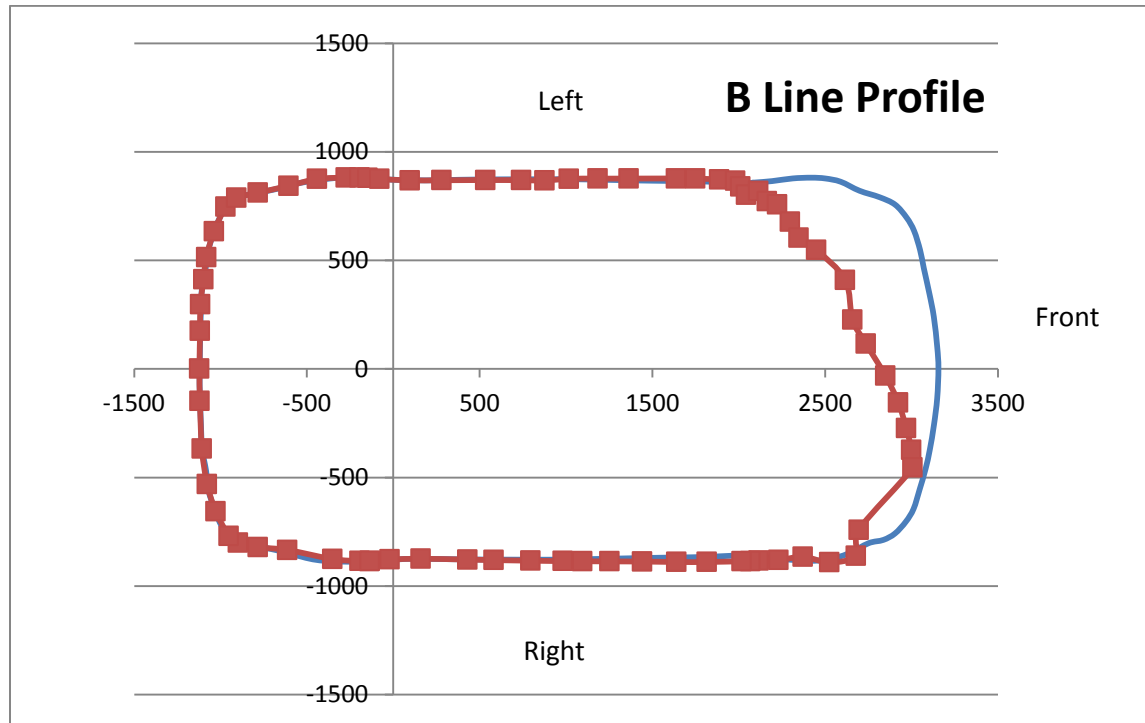
Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

VEHICLE EXTERIOR CRUSH PROFILE
SECTION A-A



SECTION B-B



DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



STRUCTURAL BUMPER BEAM POINTS

	Point	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
		X	Y	Z	X	Y	Z	X	Y	Z
Redundant Structural Bumper Beam	B10	3107	-638	860	2554	-498	646	-553	140	-214
	B11	3163	-486	858	2660	-383	646	-503	103	-212
	B12	3195	-326	859	2736	-251	669	-459	75	-190
	B13	3217	-162	858	2845	-127	680	-372	35	-178
	B14	3221	2	858	2935	9	703	-286	7	-155
	B15	3214	166	858	3016	149	728	-198	-17	-130
	B16	3195	328	858	3085	295	757	-110	-33	-101
	B17	3163	488	858	3143	444	788	-20	-44	-70
	B18	3106	638	860	3174	596	825	68	-42	-35
Center Structural Bumper Beam	B1	3105	-636	885	2562	-505	667	-543	131	-218
	B2	3156	-483	884	2664	-388	671	-492	95	-213
	B3	3189	-326	883	2737	-254	694	-452	72	-189
	B4	3209	-161	882	2842	-128	706	-367	33	-176
	B5	3215	3	883	2933	6	727	-282	3	-156
	B6	3209	165	882	3013	145	752	-196	-20	-130
	B7	3189	328	884	3083	290	783	-106	-38	-101
	B8	3156	487	882	3139	440	812	-17	-47	-70
	B9	3106	637	884	3176	590	847	70	-47	-37
Upper Radiator Support	1	3042	-458	652	2541	-274	511	-501	184	-141
	2	3035	-347	621	2578	-170	475	-457	177	-146
	3	3024	-232	616	2653	-88	466	-371	144	-150
	4	3032	-118	620	2742	-10	455	-290	108	-165
	5	3020	-2	619	2782	97	475	-238	99	-144
	6	3032	114	619	2840	194	504	-192	80	-115
	7	3028	229	623	2884	295	538	-144	66	-85
	8	3031	343	617	2934	395	558	-97	52	-59
	9	3043	457	649	2995	484	607	-48	27	-42

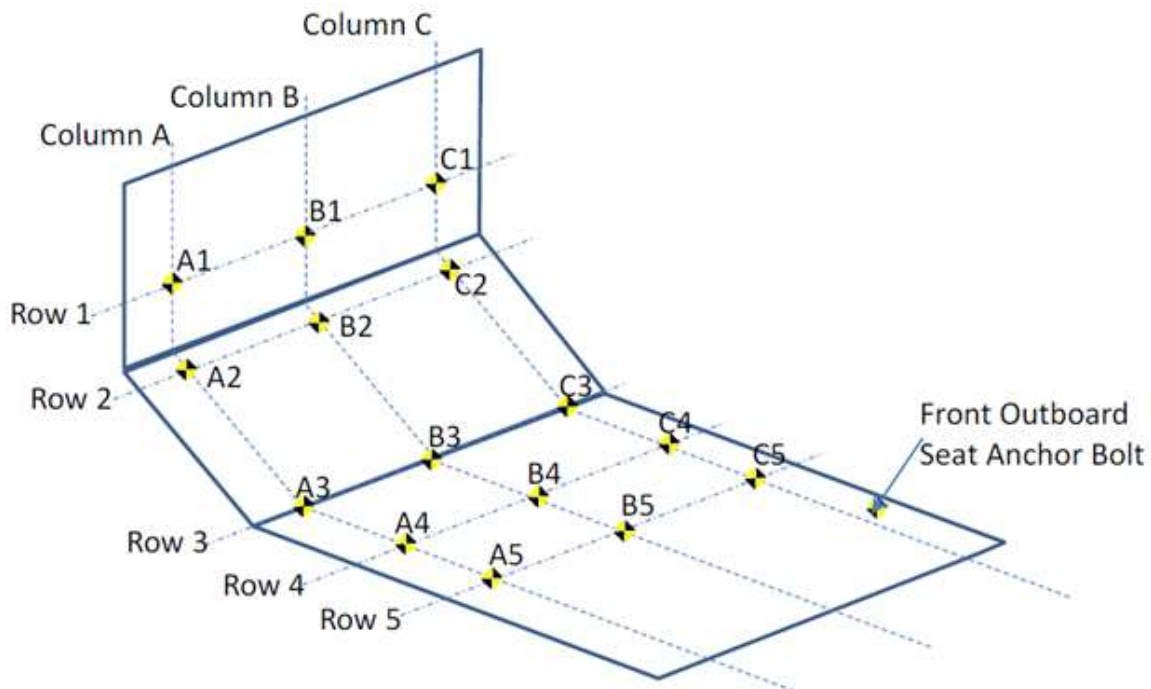
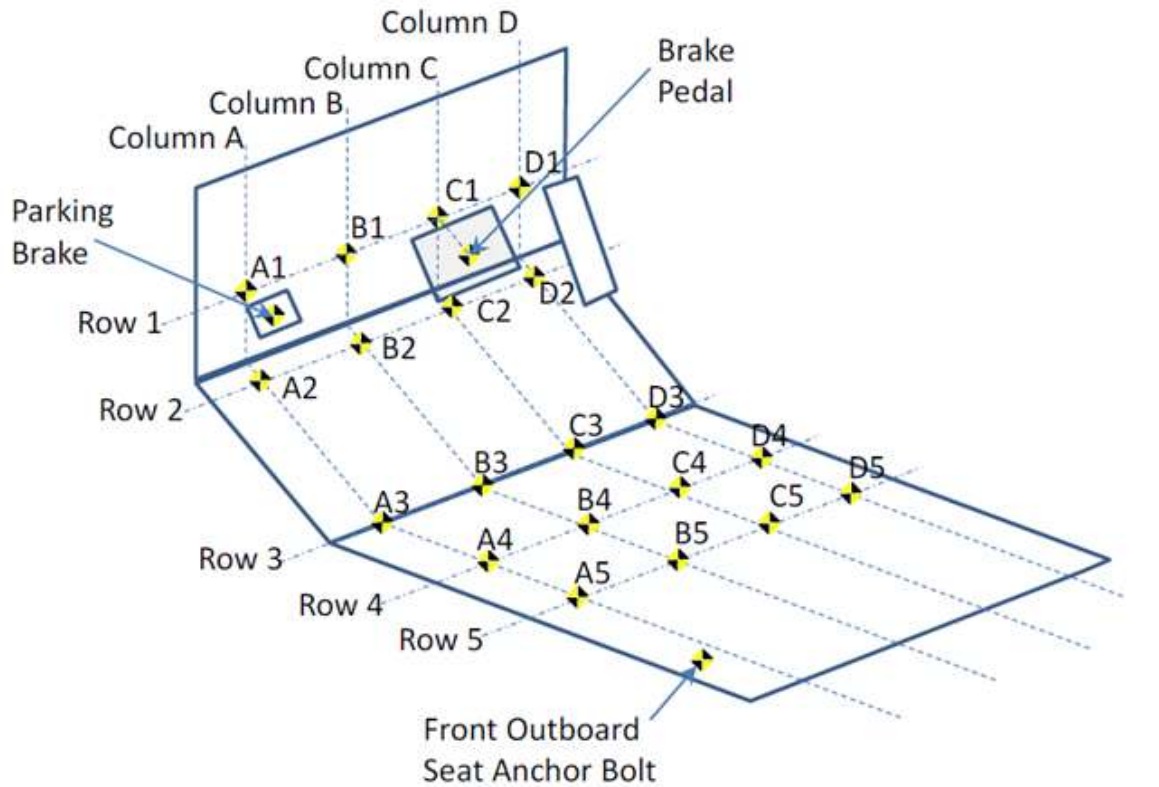
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO.13 (CONTINUED) **VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



Note: See Appendix D for toe pan measuring procedure

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

DRIVER FLOOR PAN MEASUREMENTS

Intrusion Location	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
	X	Y	Z	X	Y	Z	X	Y	Z
A1	2101	-575	916	2016	-522	915	-85	53	0
B1	2221	-476	913	2092	-396	881	-129	80	-32
C1	2222	-324	916	2107	-254	896	-115	70	-20
D1	2219	-173	917	2159	-129	898	-60	44	-19
A2	2062	-576	999	2041	-533	1003	-21	43	5
B2	2183	-475	999	2120	-421	953	-63	54	-46
C2	2205	-328	998	2127	-274	968	-78	53	-30
D2	2185	-176	1002	2153	-138	978	-33	39	-24
A3	1966	-576	1116	1960	-537	1109	-6	39	-8
B3	1966	-475	1117	1955	-436	1105	-12	39	-11
C3	1968	-327	1122	1949	-289	1111	-19	37	-11
D3	1966	-175	1084	1944	-134	1081	-22	41	-2
A4	1920	-576	1133	1911	-538	1124	-8	38	-9
B4	1919	-475	1129	1907	-438	1122	-11	37	-8
C4	1917	-325	1130	1902	-288	1129	-15	37	-1
D4	1916	-176	1132	1904	-141	1137	-12	35	5
A5	1867	-575	1136	1859	-539	1128	-8	36	-8
B5	1867	-475	1135	1855	-439	1131	-12	35	-3
C5	1870	-328	1137	1856	-293	1137	-14	34	1
D5	1868	-174	1136	1857	-142	1137	-11	32	1
Brake Pedal	2011	-325	917	2006	-307	901	-5	19	-16
Driver IP Left	1720	-513	633	1677	-502	631	-42	12	-2
Driver IP Right	1704	-212	633	1671	-197	628	-33	14	-6
DOLP	1705	-611	617	1661	-597	612	-44	13	-5
Steering Column	1516	-362	458	1497	-403	435	-19	-41	-22
Front Outboard Bolt	1453	-590	1044	1446	-572	1041	-6	18	-3

Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO.13 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

PASSENGER FLOOR PAN MEASUREMENTS

Intrusion Location	Pre-Test (mm)			Post-Test (mm)			Difference (mm)		
	X	Y	Z	X	Y	Z	X	Y	Z
A1	2227	205	917	2210	236	906	-17	31	-12
B1	2230	353	916	2223	384	910	-7	30	-6
C1	2186	507	916	2186	538	912	0	31	-4
A2	2180	206	1000	2172	236	990	-8	30	-9
B2	2182	358	999	2179	385	997	-2	27	-2
C2	2169	504	1000	2169	535	995	0	31	-5
A3	1967	207	1122	1971	240	1137	5	34	15
B3	1968	355	1118	1972	385	1124	4	29	6
C3	1969	505	1118	1969	534	1116	1	29	-2
A4	1915	206	1131	1927	236	1135	12	30	4
B4	1918	355	1129	1921	384	1131	3	29	2
C4	1916	506	1131	1916	534	1129	0	28	-2
A5	1866	205	1133	1871	234	1121	5	29	-12
B5	1867	357	1135	1871	386	1137	4	28	2
C5	1868	505	1136	1868	533	1133	0	28	-3
Pass IP Left	1710	205	651	1713	213	654	4	9	2
Pass IP Right	1736	505	654	1738	515	670	2	10	16
PORP	1707	605	616	1705	618	637	-2	12	22
Front Outboard Bolt	1453	595	1043	1454	614	1041	0	19	-2

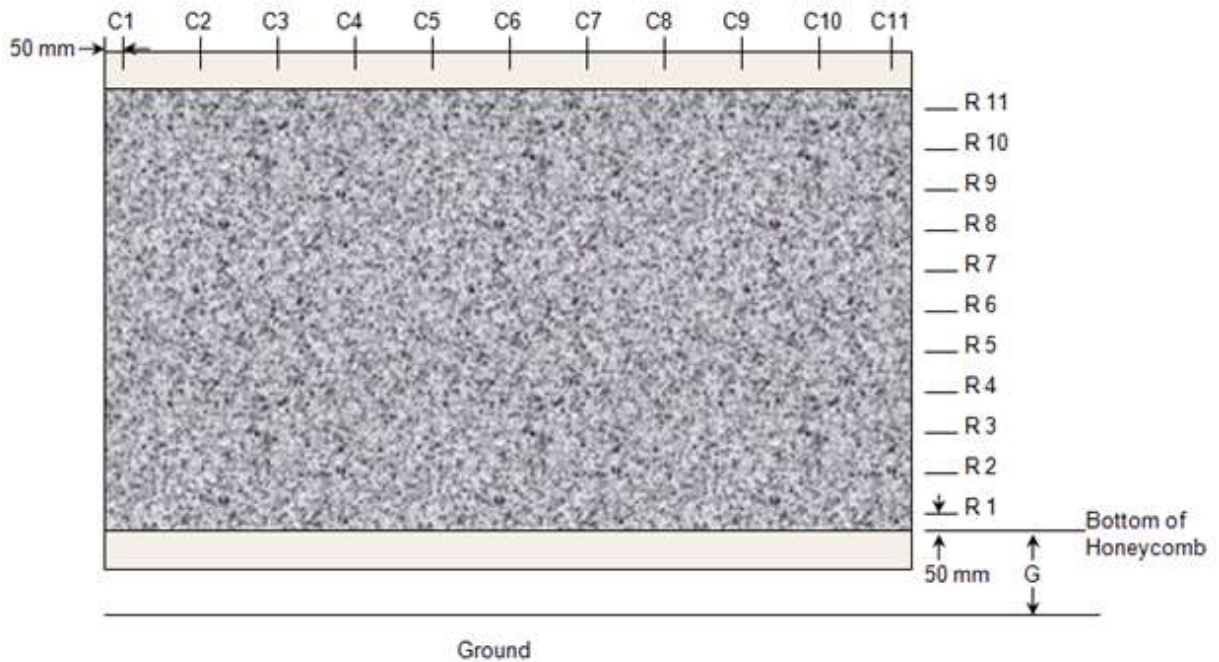
Reference point: 50mm above the center of the rear windshield (See appendix D for procedure to create coordinate system).

- +X – From the rear of the vehicle to the front of the vehicle
- +Y – From the left side of the vehicle to the right side of the vehicle
- +Z – From the top of the vehicle to the bottom of the vehicle

DATA SHEET NO.14 **RMDB CRUSH MEASUREMENTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
		50 mm	260 mm	470 mm	680 mm	890 mm	1100 mm	1310 mm	1520 mm	1730 mm	1940 mm	2150 mm
R11	910mm	0.4	2.0	2.5	2.5	3.2	3.8	3.9	4.0	4.4	7.0	12.0
R10	824mm	-0.1	0.1	0.2	0.5	0.8	1.3	1.8	3.1	16.0	14.8	39.2
R9	738mm	-0.3	-0.6	-0.3	0.0	0.1	0.9	1.4	20.0	15.2	31.9	76.4
R8	652mm	-0.7	-0.9	-0.7	-0.1	0.2	0.7	3.9	33.6	33.2	56.9	116.3
R7	566mm	-1.3	-1.7	-1.1	-0.6	-0.1	0.5	1.8	31.8	40.2	111.3	164.9
R6	480mm	-1.7	-1.9	-1.4	-1.0	-0.2	0.2	1.3	12.8	89.2	179.1	213.9
R5	384mm	-1.8	-2.2	-1.9	-1.0	-0.3	0.3	13.5	41.3	101.7	230.0	263.7
R4	308mm	-2.4	-2.3	-1.9	-1.1	-0.4	0.2	38.0	86.1	101.2	247.2	274.0
R3	222mm	-2.7	-2.7	-2.1	-1.1	-0.6	0.2	59.2	132.3	110.9	234.7	251.1
R2	136mm	-3.5	-3.0	-2.0	-1.1	-0.5	0.3	74.9	149.6	80.2	213.0	240.2
R1	50mm	-3.7	-3.0	-0.8	-0.9	*	*	69.1	154.9	58.0	149.3	199.7

*Barrier was cut to accommodate the rail, therefore these points were un-measurable.

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012

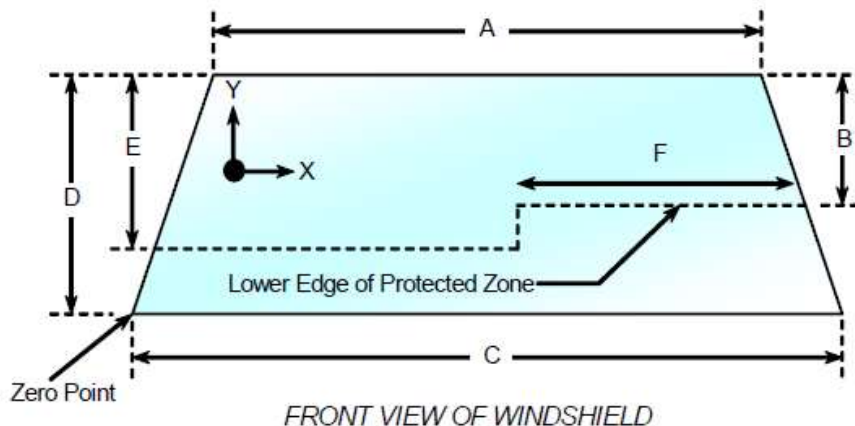
Please provide windshield mounting details. A 0.8 mm trim surrounds the top and side of windshield while a plastic shroud is on the bottom.

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

Temperature of windshield molding during test: 21°C

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% Retention
Left Side	2222	1427	64.2%
Right Side	2222	2222	100%
Total	4444	3649	82.1%



Item	Units	Value
A	mm	1210
B	mm	560
C	mm	1420
D	mm	907
E	mm	560
F	mm	302

AREAS OF PROTECTED ZONE FAILURES

A. Provide coordinates of the area that the protected zone was penetrated more than .25 inches by a vehicle component other than one that is normally in contact with the windshield.

X	Y

B. Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component.

X	Y

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

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Ambient Temperature of Test Vehicle at Time of Impact: 21° C

Test Time: 12:38 PM

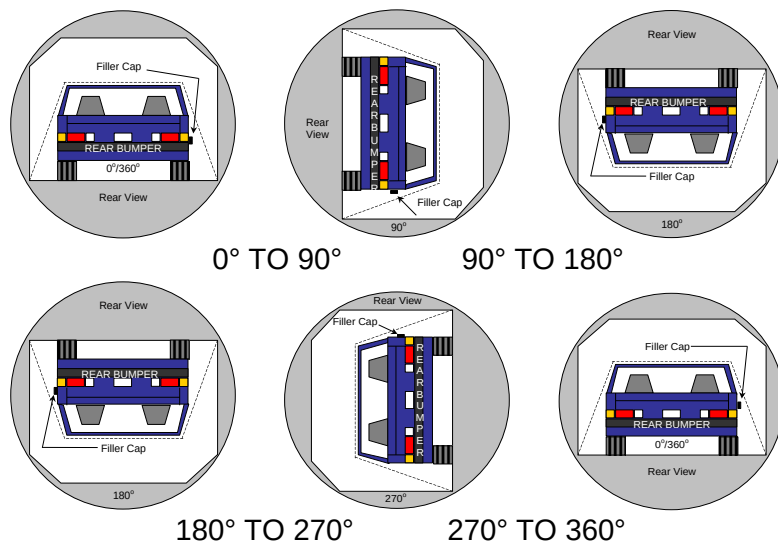
Stoddard Solvent Spillage Measurements

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

DATA SHEET NO. 16 **FMVSS 301 STATIC ROLLOVER RESULTS**

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
 Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
 Test Date: 12/10/2012



1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.

2. The position hold time at each position is 300 seconds (minimum).

3. Details of Stoddard Solvent spillage: None

SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	74	300	374
90° to 180°	67	300	367
180° to 270°	61	300	361
270° to 360°	68	300	368

FMVSS 301 SPILLAGE TABLE

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

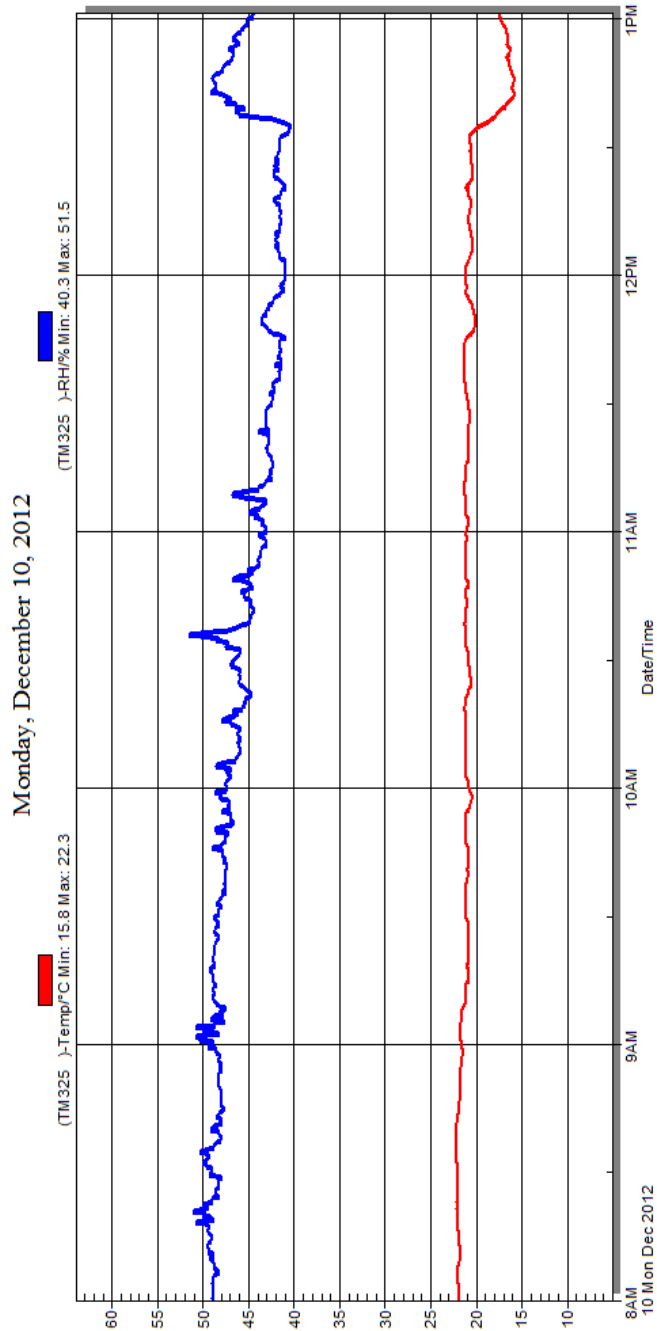
SOLVENT SPILLAGE LOCATION TABLE

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

DATA SHEET NO. 17
DUMMY/VEHICLE TEMPERATURE STABILIZATION

Test Vehicle: 2013 Hyundai Elantra Four Door Sedan
Test Program: R&D 90.1kph, 15° angle, 35% offset

NHTSA No.: RD4200
Test Date: 12/10/2012



Temperature Stabilization Chart/Data

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No. 001 As Delivered Right Front 3-4 View of Test Vehicle



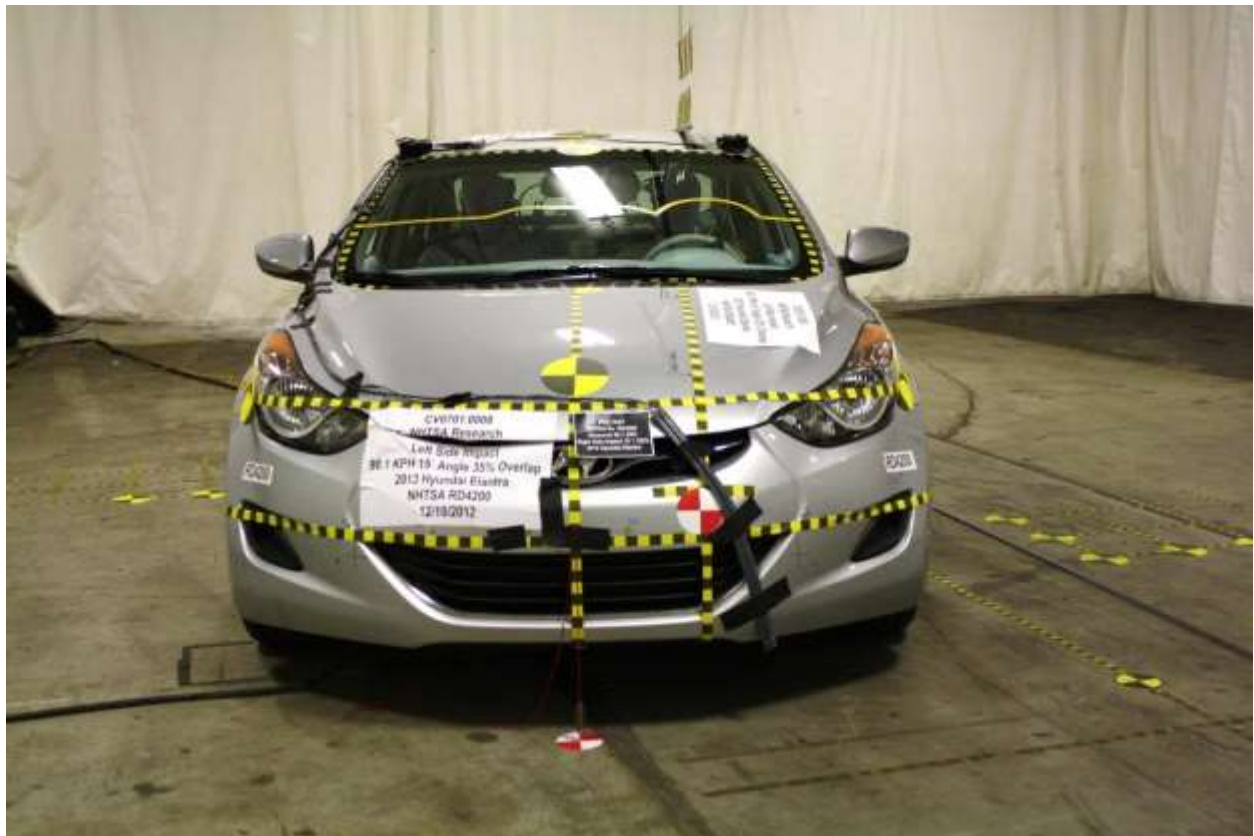
No. 002 As Delivered Left Rear 3-4 View of Test Vehicle



No. 003 Test Vehicle Certification Label



No. 004 Test Vehicle Tire Placard



No. 005 Pre-Test Front View of Test Vehicle



No. 006 Post-Test Front View of Test Vehicle



No. 007 Pre-Test Left Front 3-4 View of Test Vehicle



No. 008 Post-Test Left Front 3-4 View of Test Vehicle



No. 009 Pre-Test Left Side View of Test Vehicle



No. 010 Post-Test Left Side View of Test Vehicle



No. 011 Pre-Test Left Rear 3-4 View of Test Vehicle



No. 012 Post-Test Left Rear 3-4 View of Test Vehicle



No. 013 Pre-Test Rear View of Test Vehicle



No. 014 Post-Test Rear View of Test Vehicle



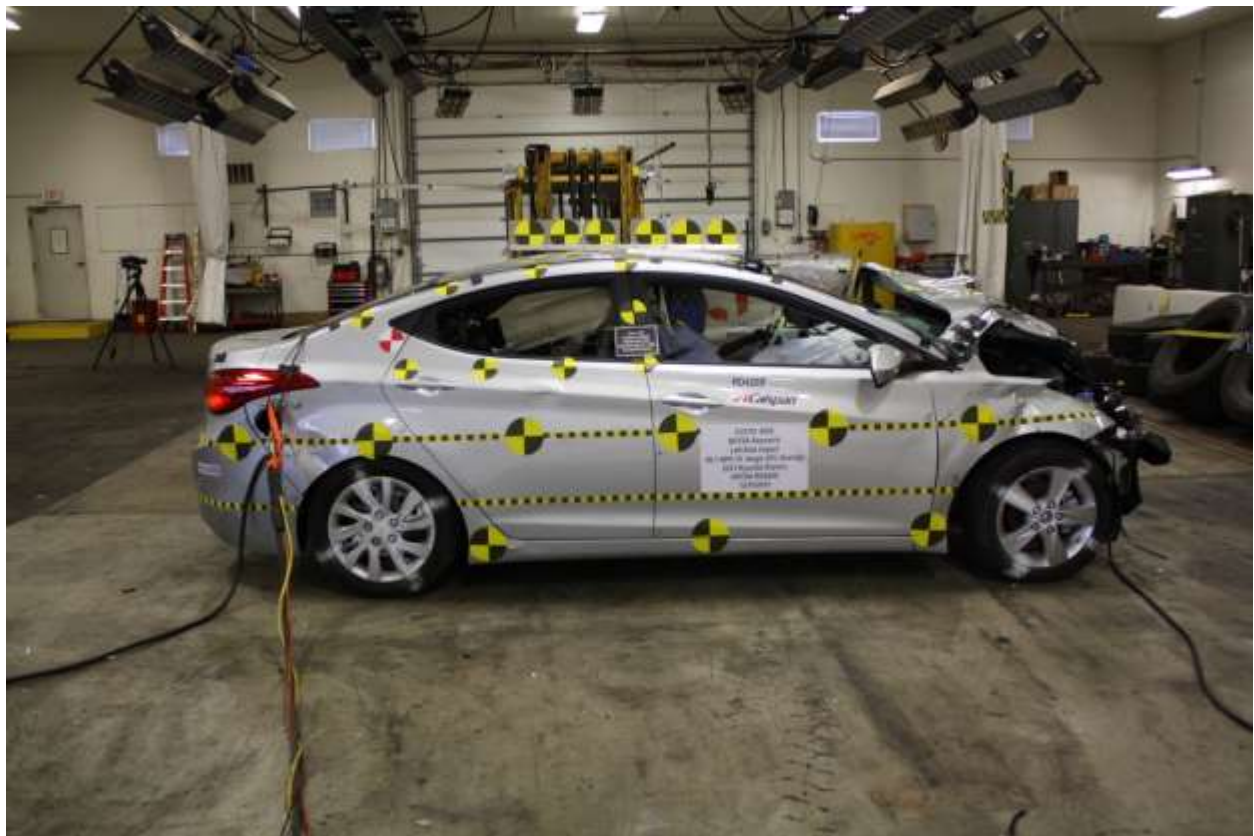
No. 015 Pre-Test Right Rear 3-4 View of Test Vehicle



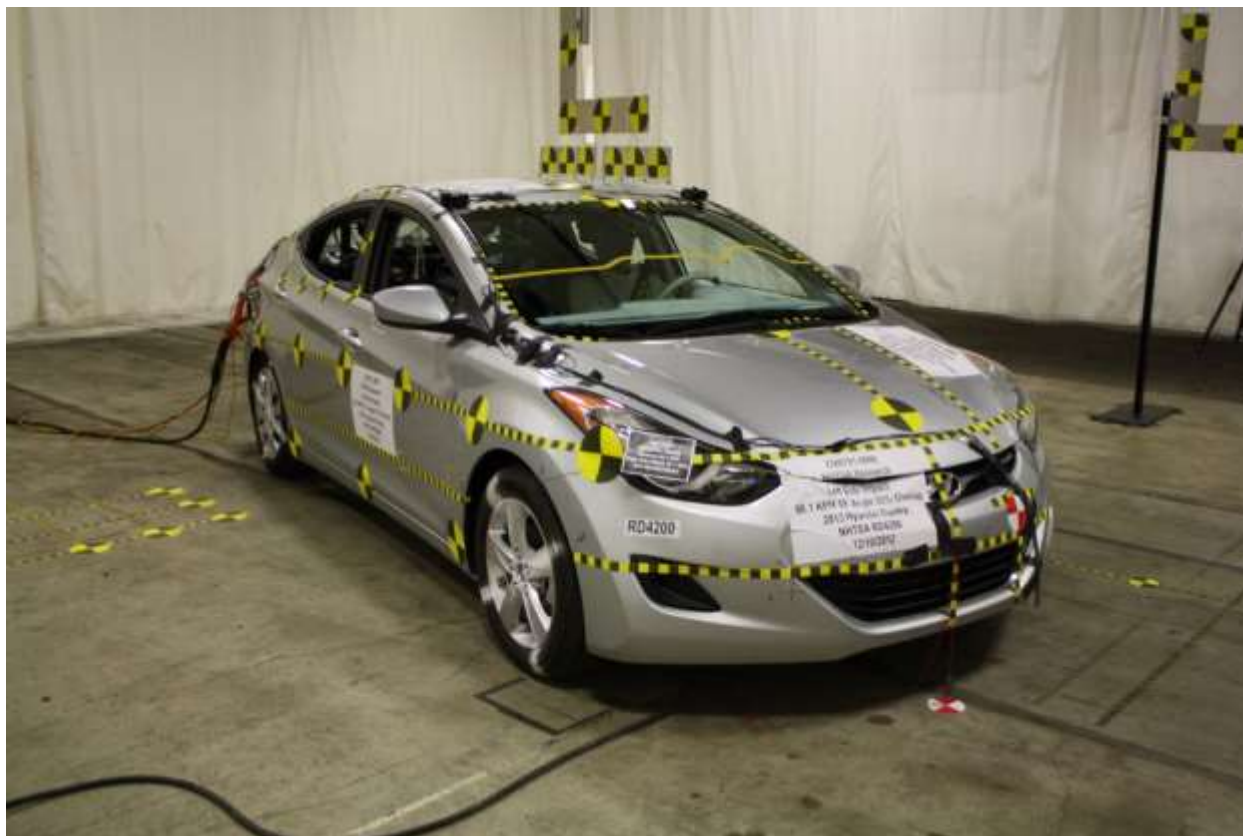
No. 016 Post-Test Right Rear 3-4 View of Test Vehicle



No. 017 Pre-Test Right Side View of Test Vehicle



No. 018 Post-Test Right Side View of Test Vehicle



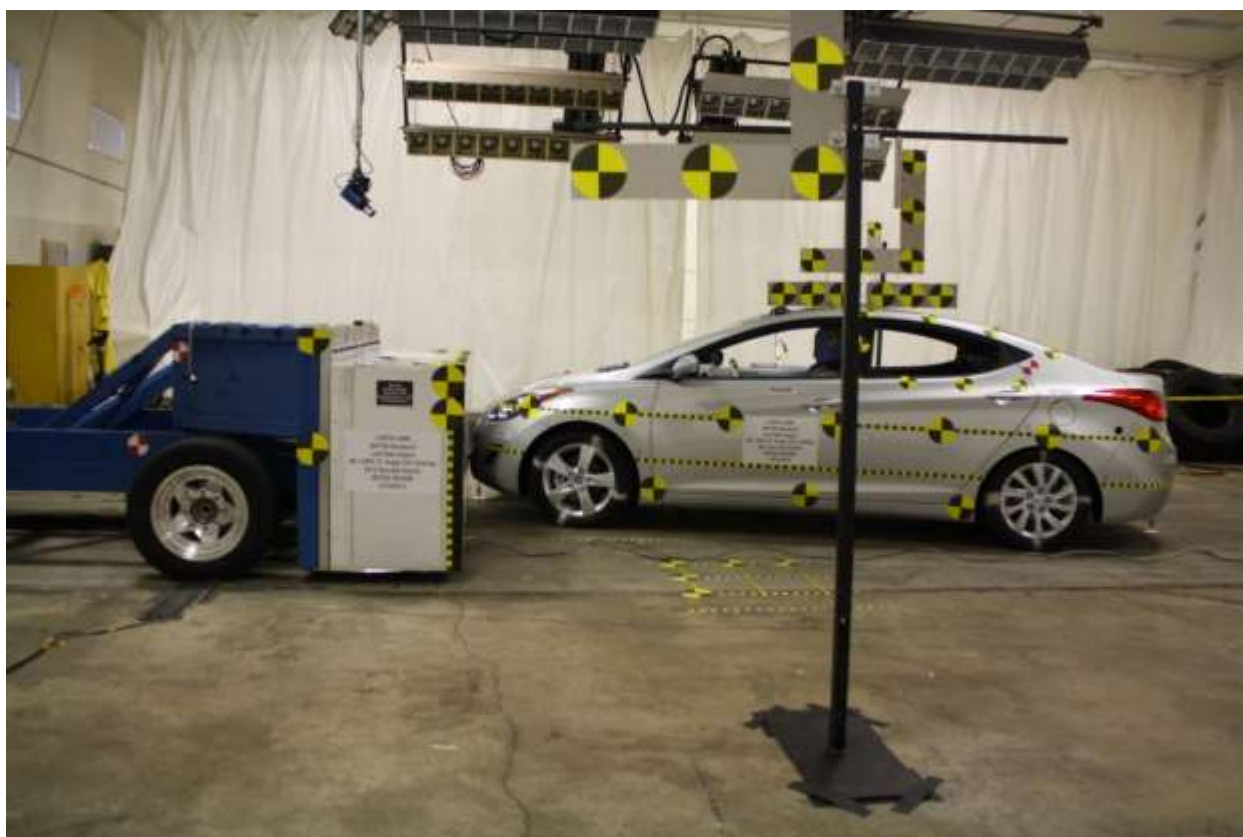
No. 019 Pre-Test Right Front 3-4 View of Test Vehicle



No. 020 Post-Test Right Front 3-4 View of Test Vehicle



No. 023 Pre-Test Left Side View of RMDB against target vehicle at ideal Impact Point



No. 024 Pre-Test Right Side View of RMDB against target vehicle at ideal Impact Point

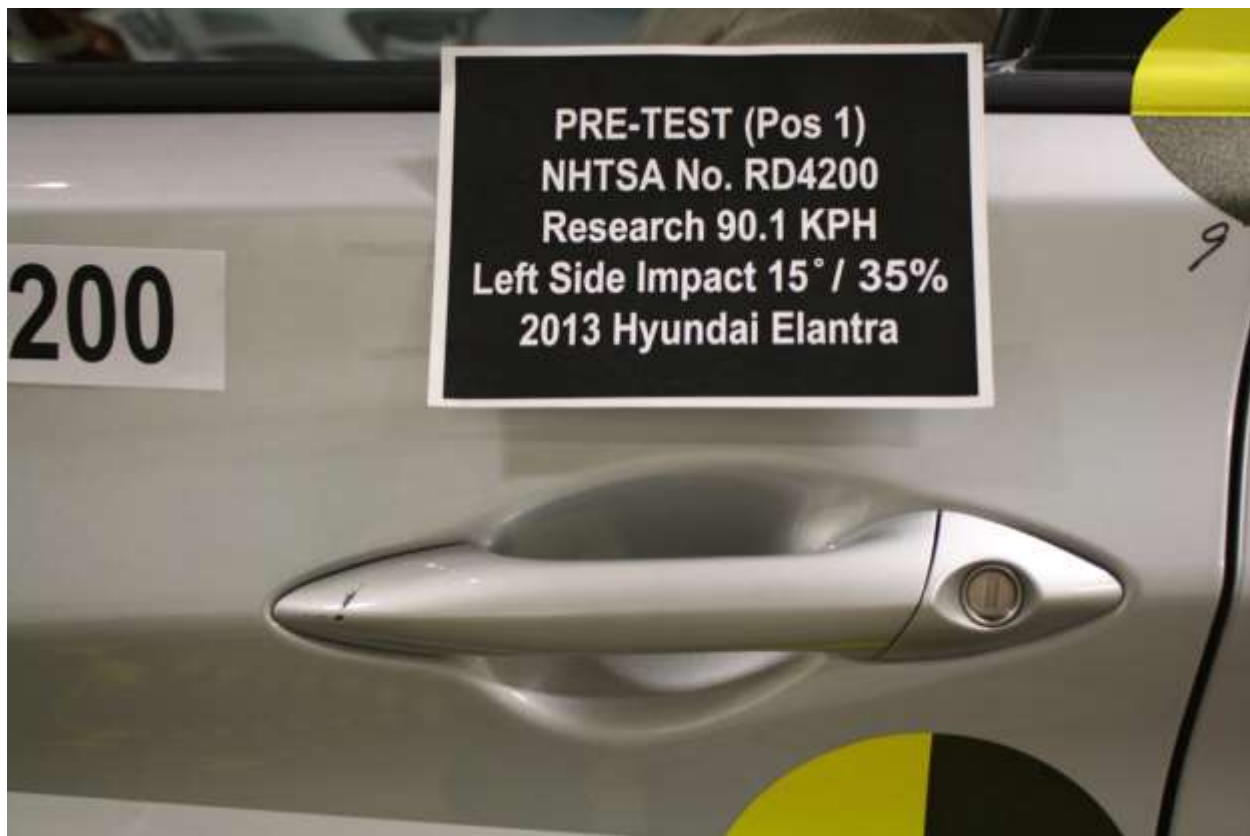


No. 025 Pre-Test Close-up View of Impact Point

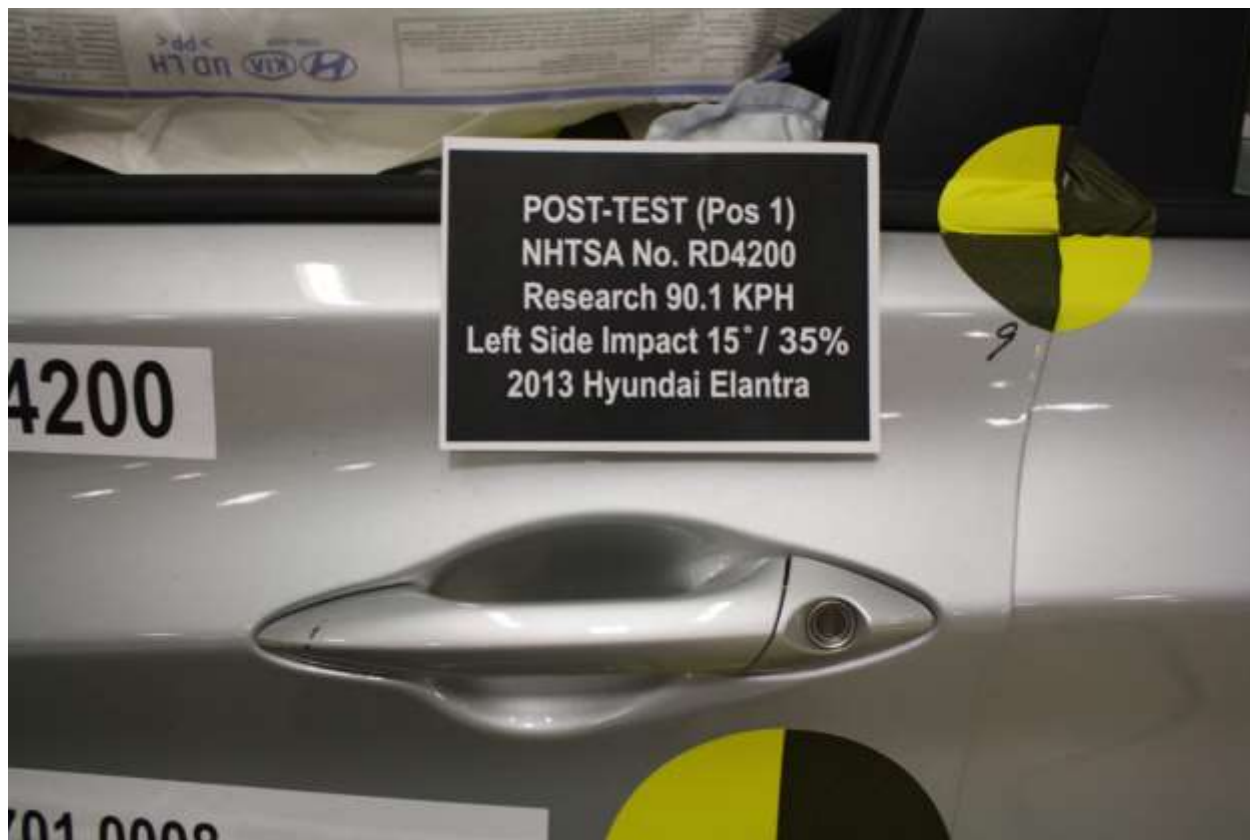


No. 026 Post-Test Close-up View of Impact Point





No. 028 Pre-Test Close-up View of Driver Door Latch



No. 029 Post-Test Close-up View of Driver Door Latch



No. 030 Pre-Test Close-up View of Passenger Door Latch



No. 031 Post-Test Close-up View of Passenger Door Latch



No. 032 Pre-Test Windshield View



No. 033 Post-Test Windshield View



No. 034 Pre-Test View of Driver Inner Door Panel



No. 035 Post-Test View of Driver Inner Door Panel



No. 036 Pre-Test View of Passenger Inner Door Panel



No. 037 Post-Test View of Passenger Inner Door Panel



No. 038 Pre-Test Overall View of Driver Knee Bolsters



No. 039 Post-Test Overall View of Driver Knee Bolsters



No. 040 Pre-Test Left Side View of Driver Knee Bolsters



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No. 042 Pre-Test Right Side View of Driver Knee Bolsters



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No. 044 Pre-Test View of Driver Floor pan at Left sill level, w/carpet



No. 045 Post-Test View of Driver Floor pan at Left sill level, w/carpet



No. 046 Pre-Test View of Driver Floor pan at Mid seat level, w/carpet



No. 047 Post-Test view of Driver Floor pan at Mid seat level, w/carpet



No. 048 Pre-Test View of Driver Floor pan at Left sill level, w/o carpet



No. 049 Post-Test View of Driver Floor pan at Left sill level, w/o carpet



No. 050 Pre-Test View of Driver Floor pan at Mid seat level, w/o carpet



No. 051 Post-Test view of Driver Floor pan at Mid seat level, w/o carpet



No. 052 Pre-Test Driver Front Windshield View



No. 053 Post-Test Driver Front Windshield View



No. 054 Pre-Test Left Side View of Driver and Interior



No. 055 Post-Test Left Side View of Driver and Interior



No. 056 Pre-Test Left Side Driver Window View



No. 057 Post-Test Left Side Driver Window View



No. 058 Pre-Test Right Side View of Driver and Interior



No. 059 Post-Test Right Side View of Driver and Interior



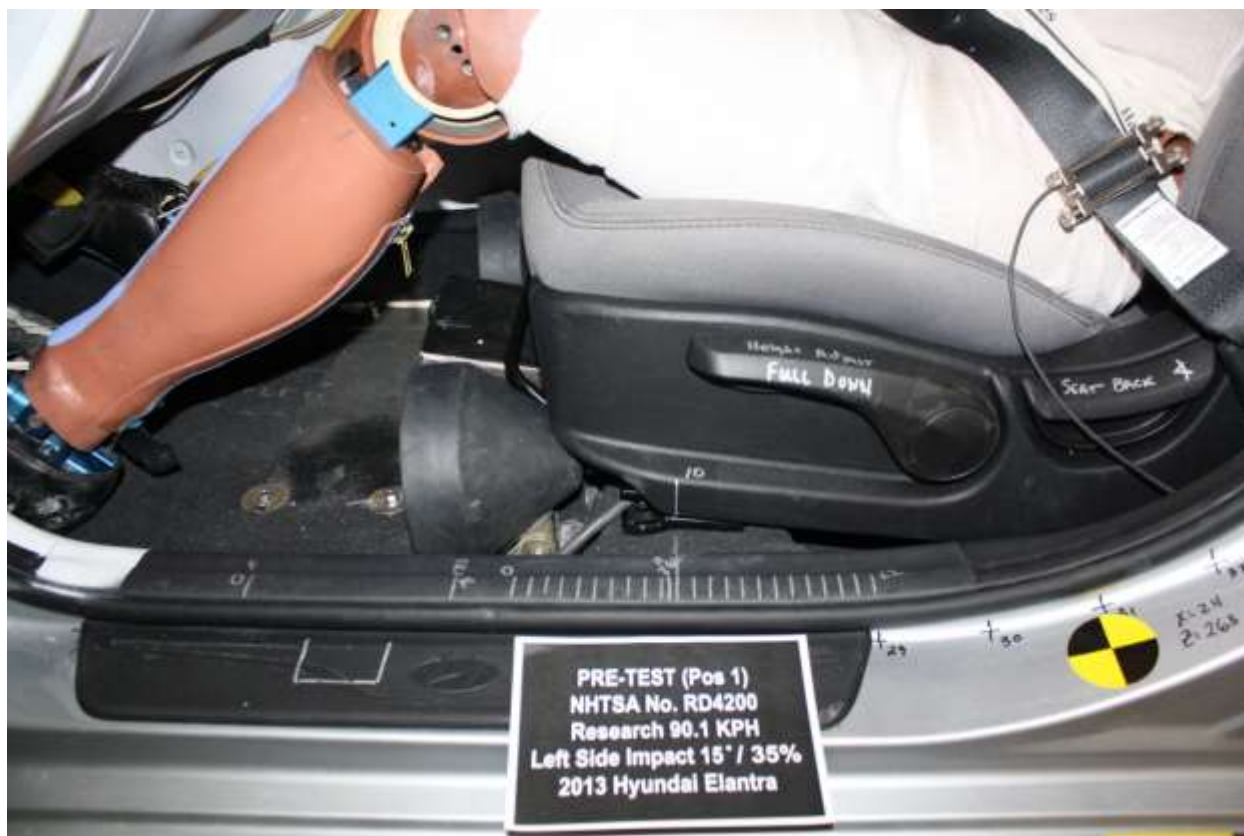
No. 060 Pre-Test View of Driver Door Clearance



No. 061 Post-Test View of Driver Door Clearance



No. 062 Pre-Test View of Parking Brake



No. 063 Pre-Test Driver Seat Fore Aft Markings



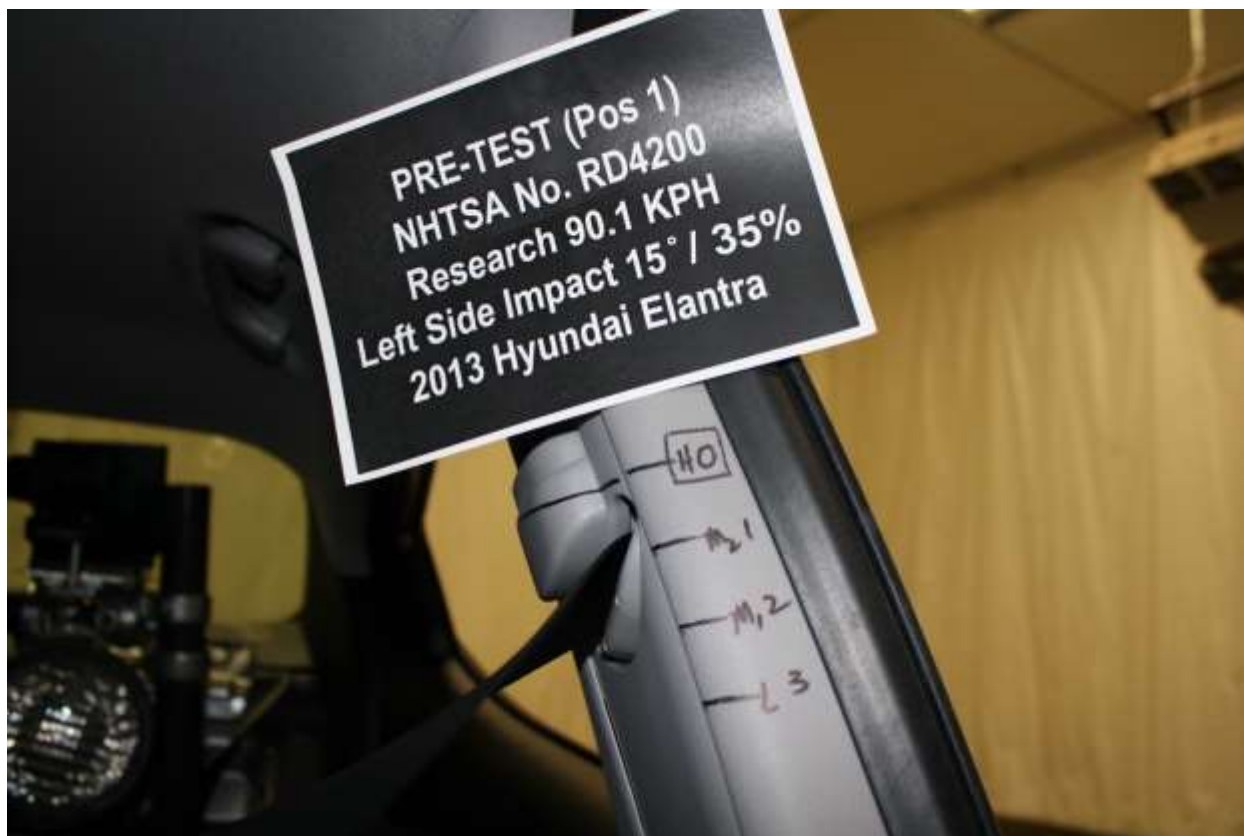
No. 064 Post-Test Driver Seat Fore Aft Markings



No. 065 Pre-Test Driver Seat Back Markings



No. 066 Pre-Test Overhead View of Driver Thighs on Seat



No. 067 Pre-Test Driver Adjustable D-Ring



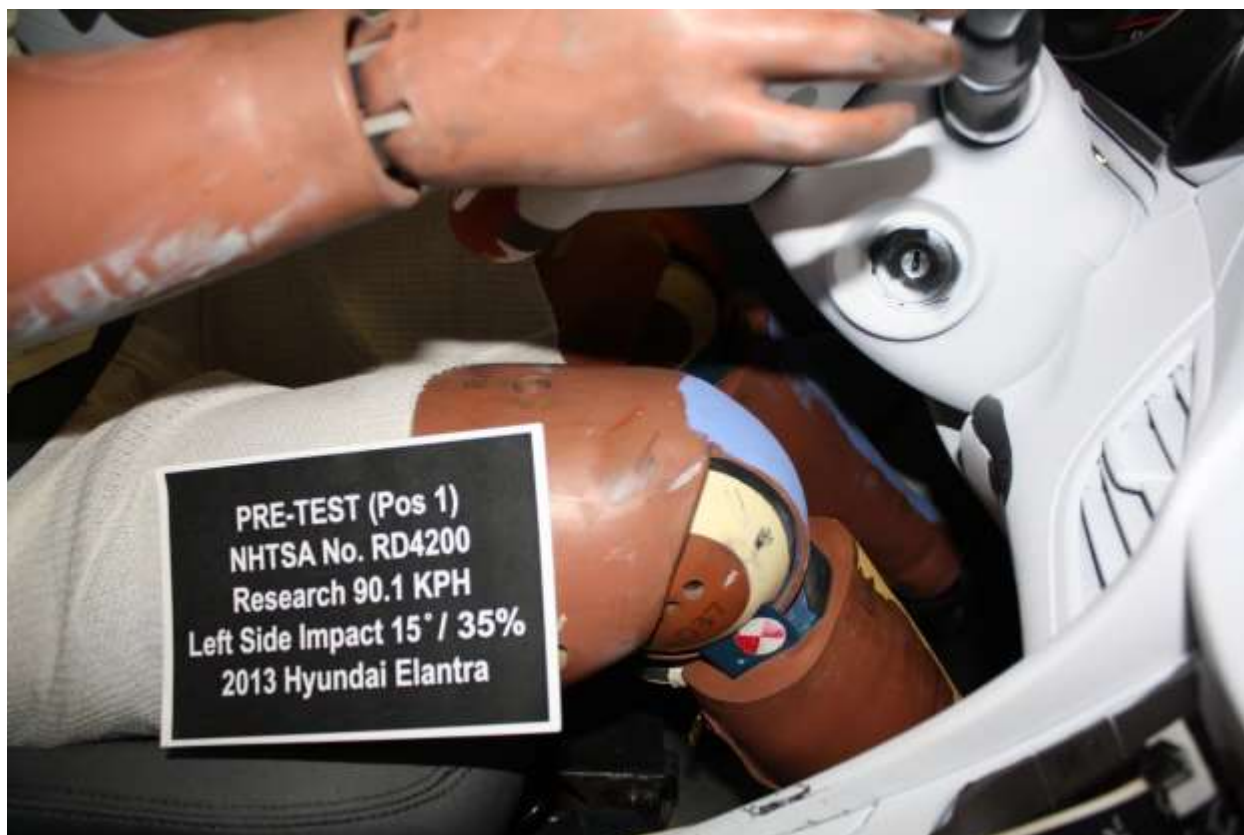
No. 068 Post-Test Driver Adjustable D-Ring



No. 069 Pre-Test Driver Feet



No. 070 Post-Test Driver Feet



No. 071 Pre-Test View of Driver Right Knee and Bolster



No. 072 Post-Test View of Driver Right Knee and Bolster



No. 073 Pre-Test View of Driver Left Knee and Bolster



No. 074 Post-Test View of Driver Left Knee and Bolster



No. 075 Pre-Test View of Driver Abdomen



No. 076 Post-Test View of Driver Abdomen



No. 077 Pre-Test Left Side View of Steering Wheel set position



No. 078 Post-Test Left Side View of Steering Wheel set position



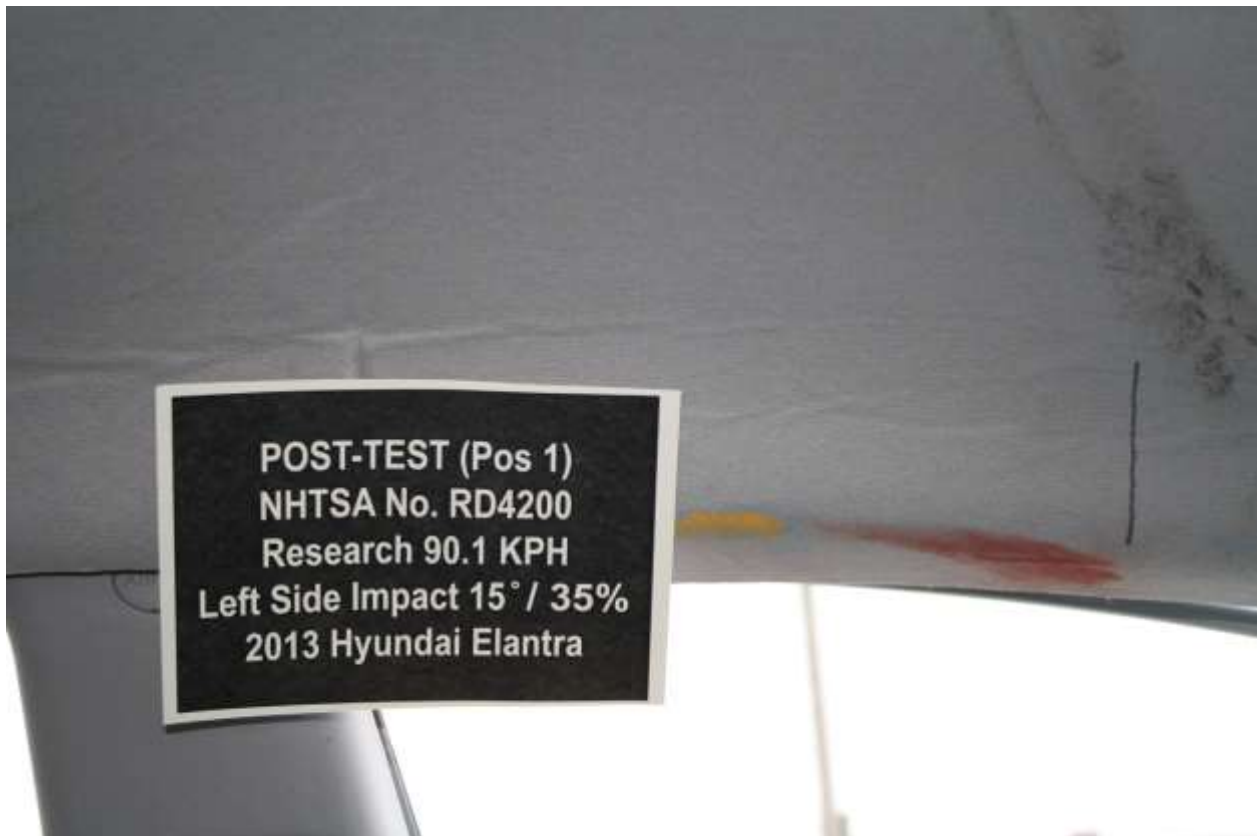
No. 079 Post-Test View of Driver Head Contact with Front Airbag



No. 080 Post-Test View of Driver Head Contact with Curtain Airbag



No. 081 Post-Test View of Driver Head Contact with Vehicle Interior – A



No. 081a Post-Test View of Driver Head Contact with Vehicle Interior - B

Photo Not Applicable

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No. 082 Pre-Test Overall View of Passenger Knee Bolsters



No. 083 Post-Test Overall View of Passenger Knee Bolsters



No. 084 Pre-Test Left Side View of Passenger Knee Bolsters



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No. 088 Pre-Test View of Passenger Floor pan at Left sill level, w/carpet



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No. 099 Post-Test Left Side Passenger and Interior View



No. 100 Pre-Test Right Side Passenger Window View



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No. 102 Pre-Test Right Side Passenger and Interior View



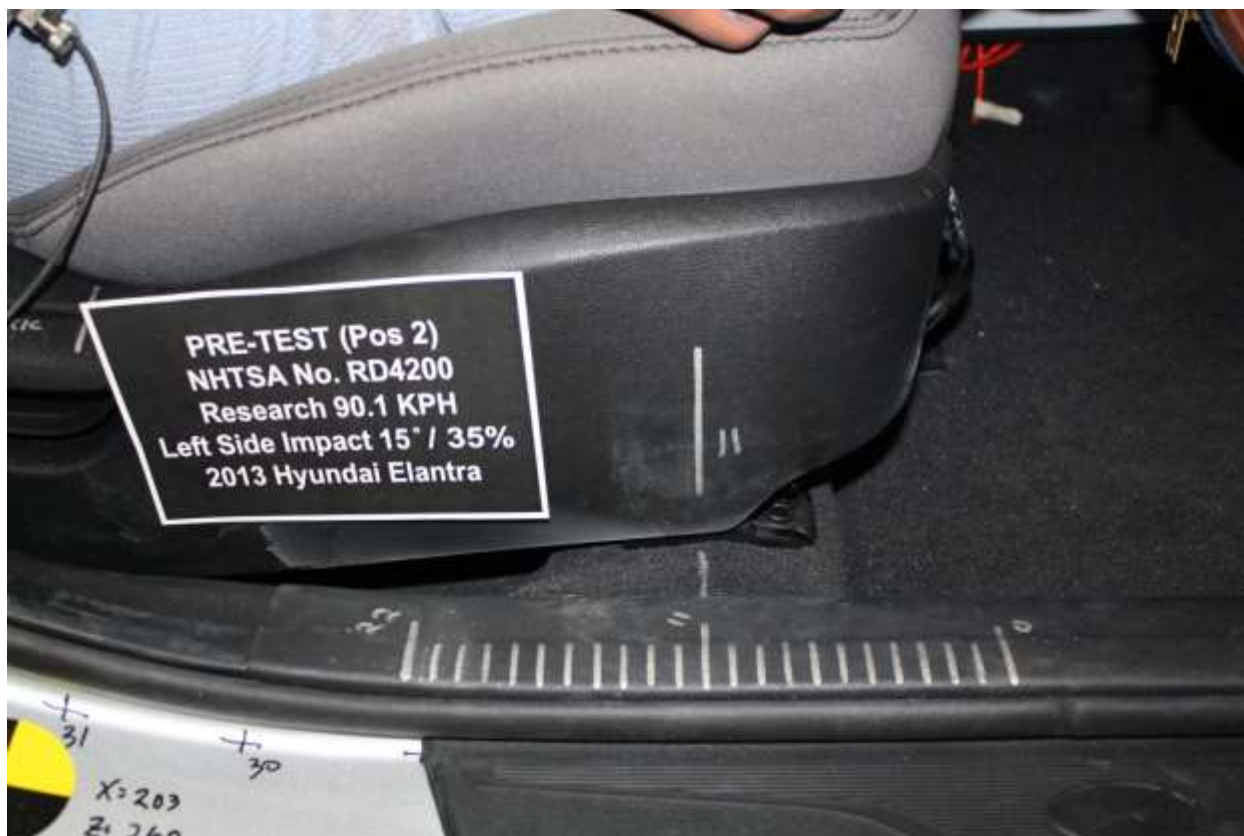
No. 103 Post-Test Right Side Passenger and Interior View



No. 104 Pre-Test View of Passenger Door Clearance



No. 105 Post-Test View of Passenger Door Clearance



No. 106 Pre-Test Passenger Seat Fore-Aft Markings



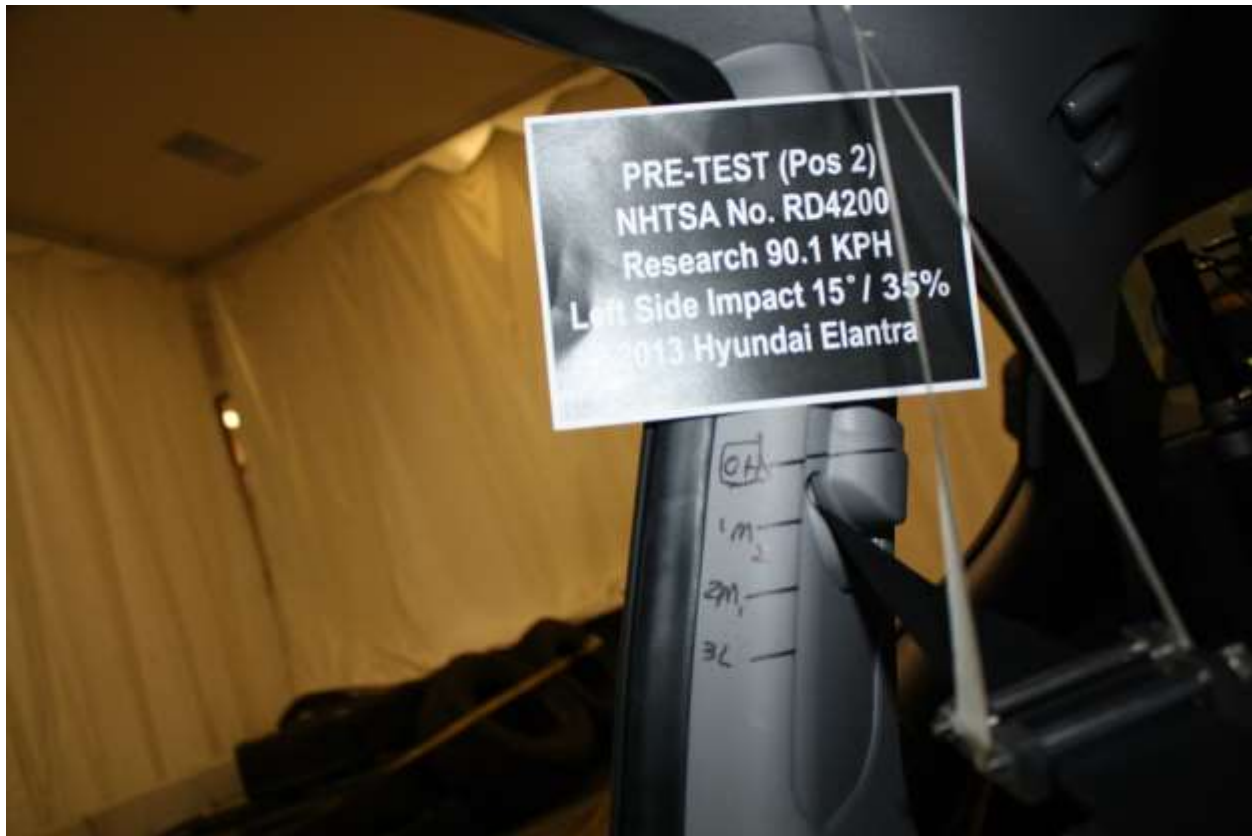
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No. 109 Pre-Test Overhead View of Passenger Thighs on seat



No. 110 Pre-Test Passenger Adjustable D-ring



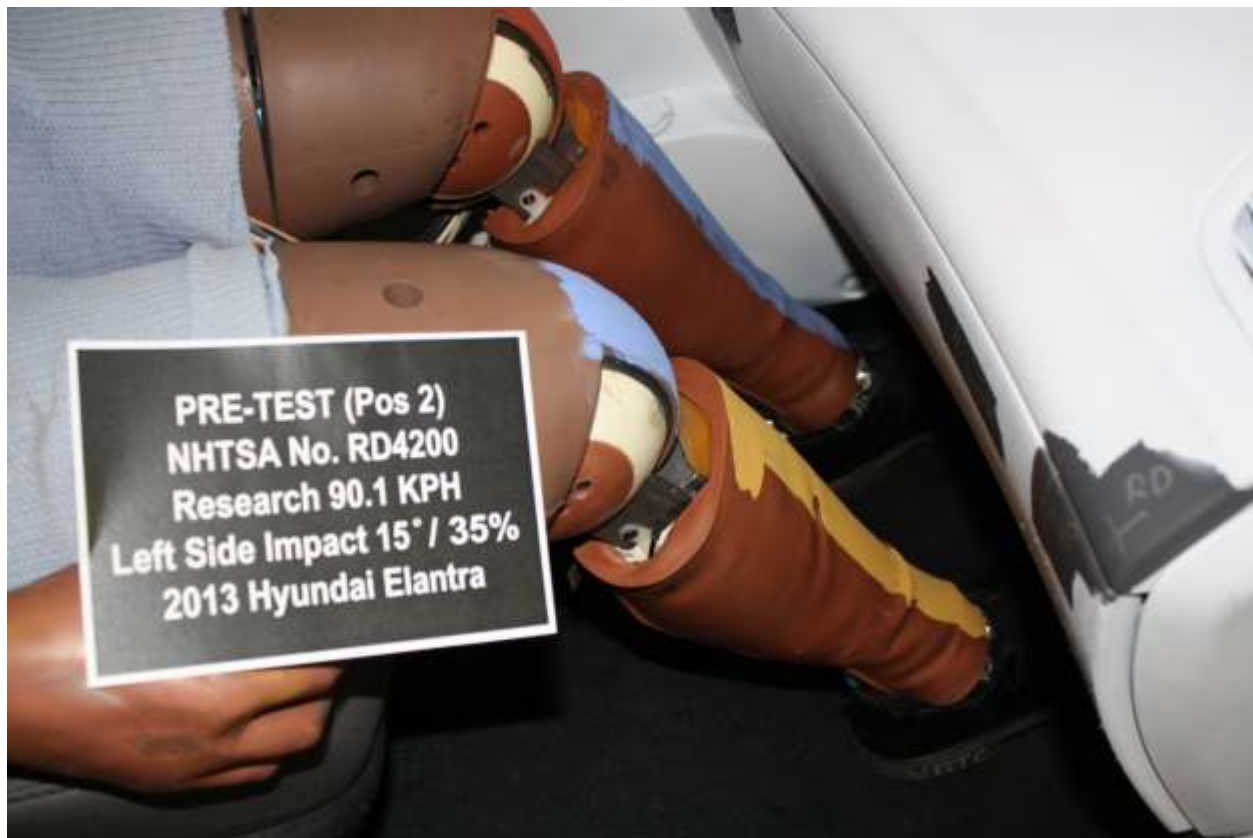
No. 111 Post-Test Passenger Adjustable D-ring



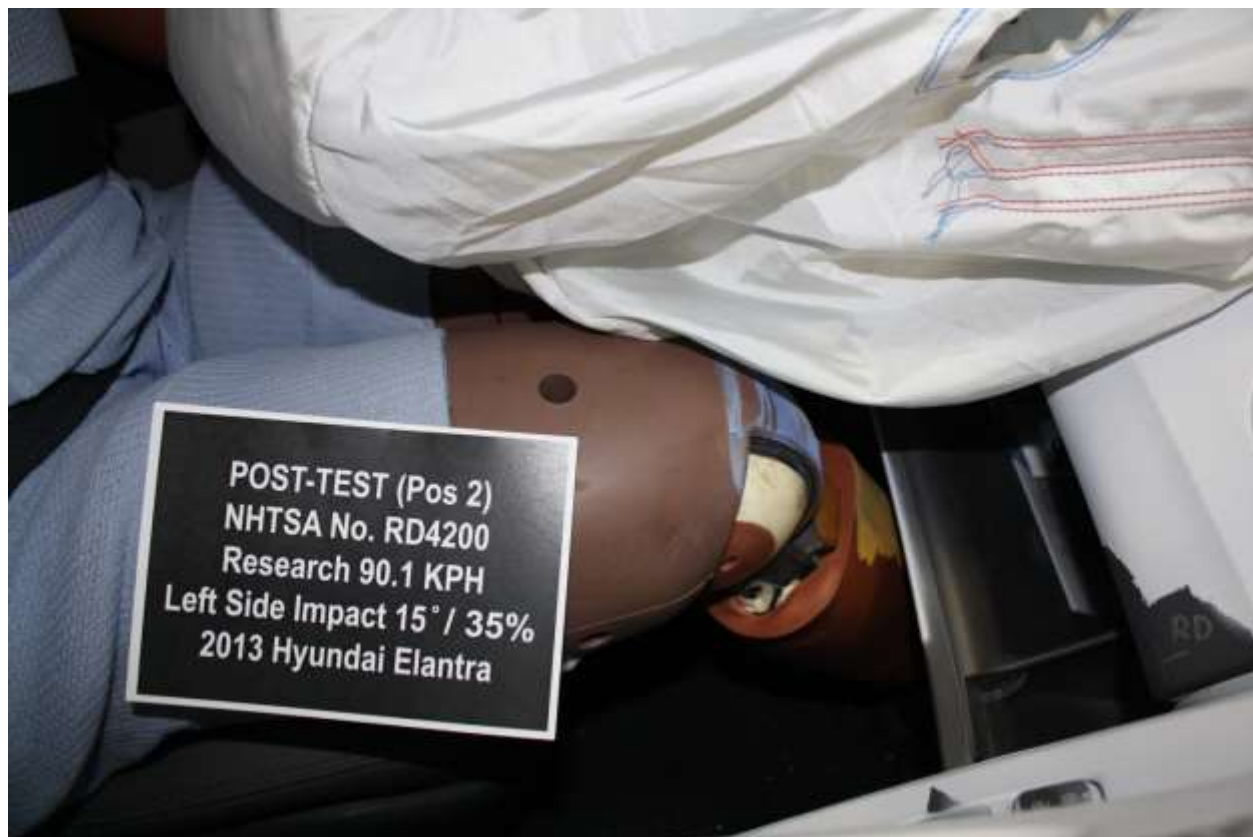
No. 112 Pre-Test View of Passenger Feet



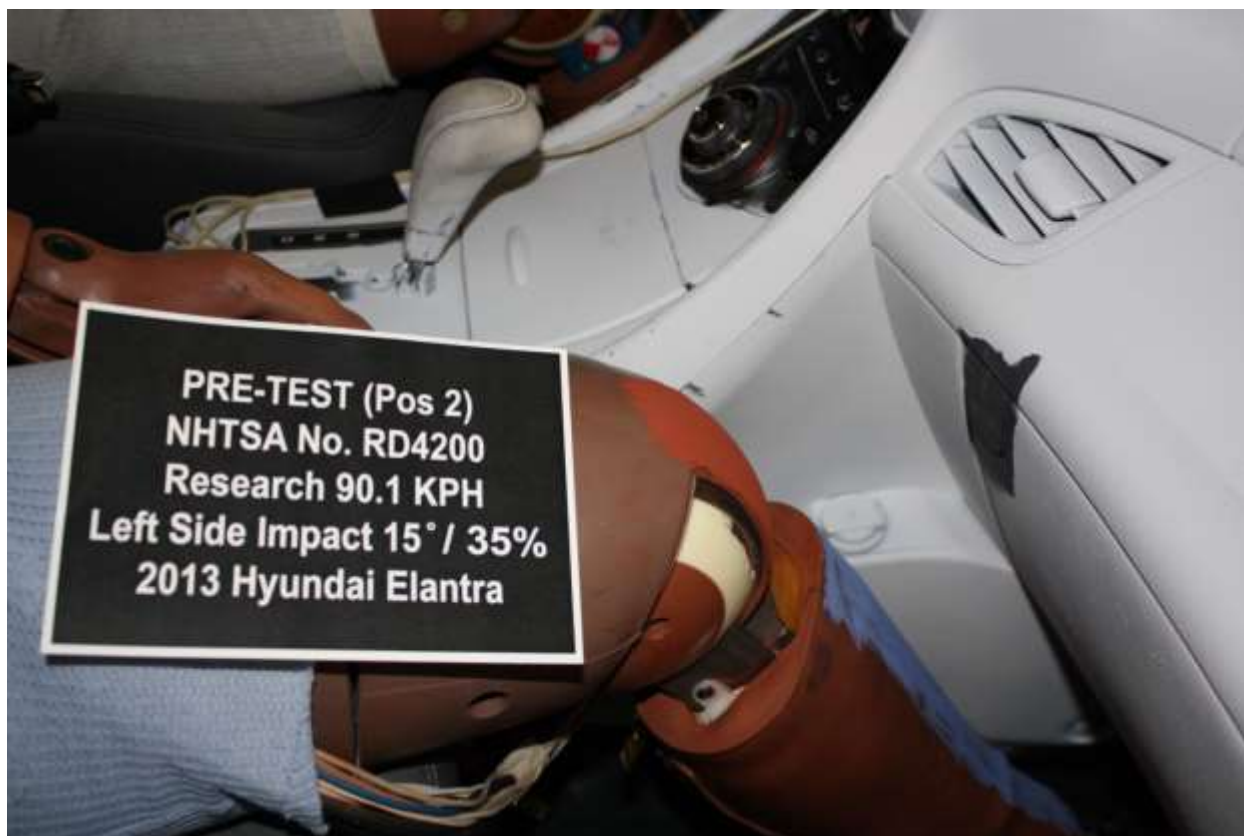
No. 113 Post-Test View of Passenger Feet



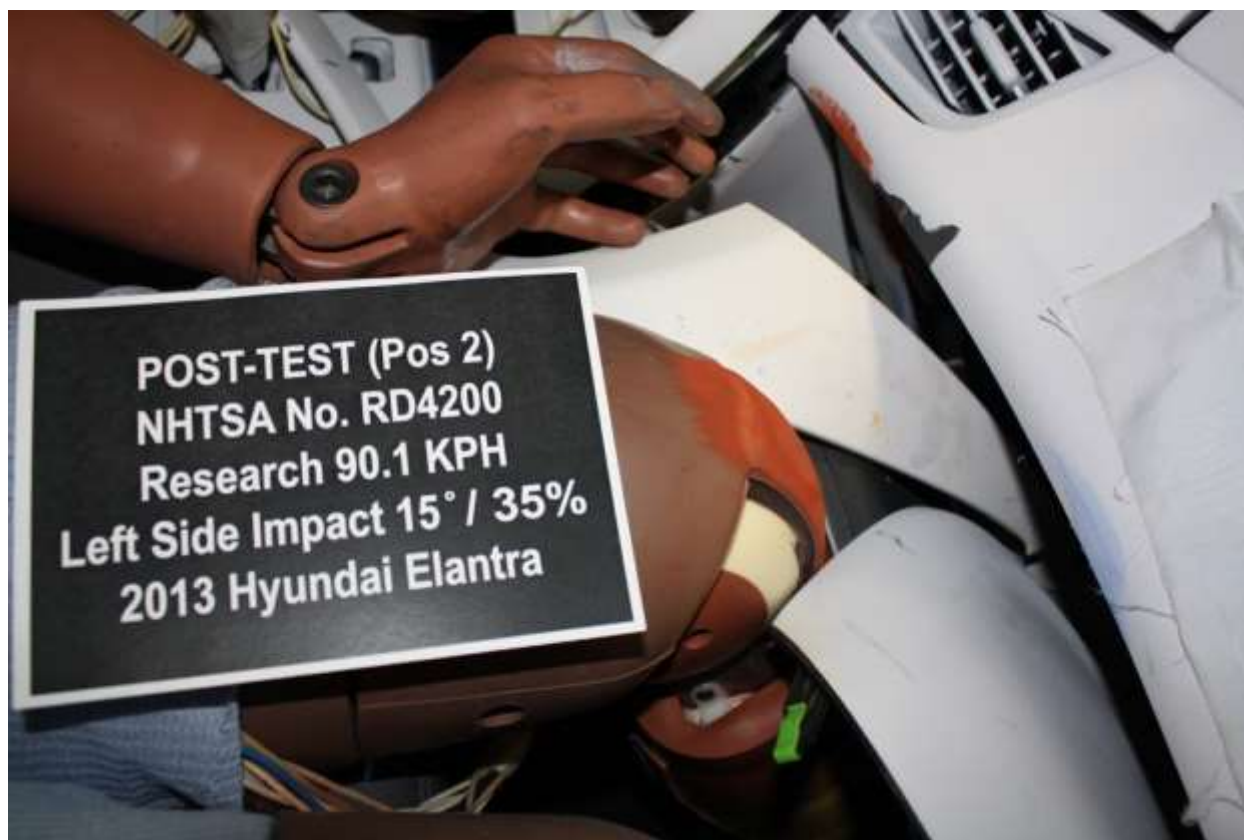
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No. 116 Pre-Test View of Passenger Left Knee and Bolster



No. 117 Post-Test View of Passenger Left Knee and Bolster



No. 118 Pre-Test View of Passenger Abdomen



No. 119 Post-Test View of Passenger Abdomen



No. 120 Post-Test View of Passenger Head contact with Airbag – Front

Photo Not Applicable

No. 120a Post-Test View of Passenger Head contact with Airbag - Curtain



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Photo Not Applicable

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No. 123 Pre-Test Ballast Locations



No. 124 Post-Test Speed Trap Readout



No. 125 Pre-Test View of Fuel Filler Cap



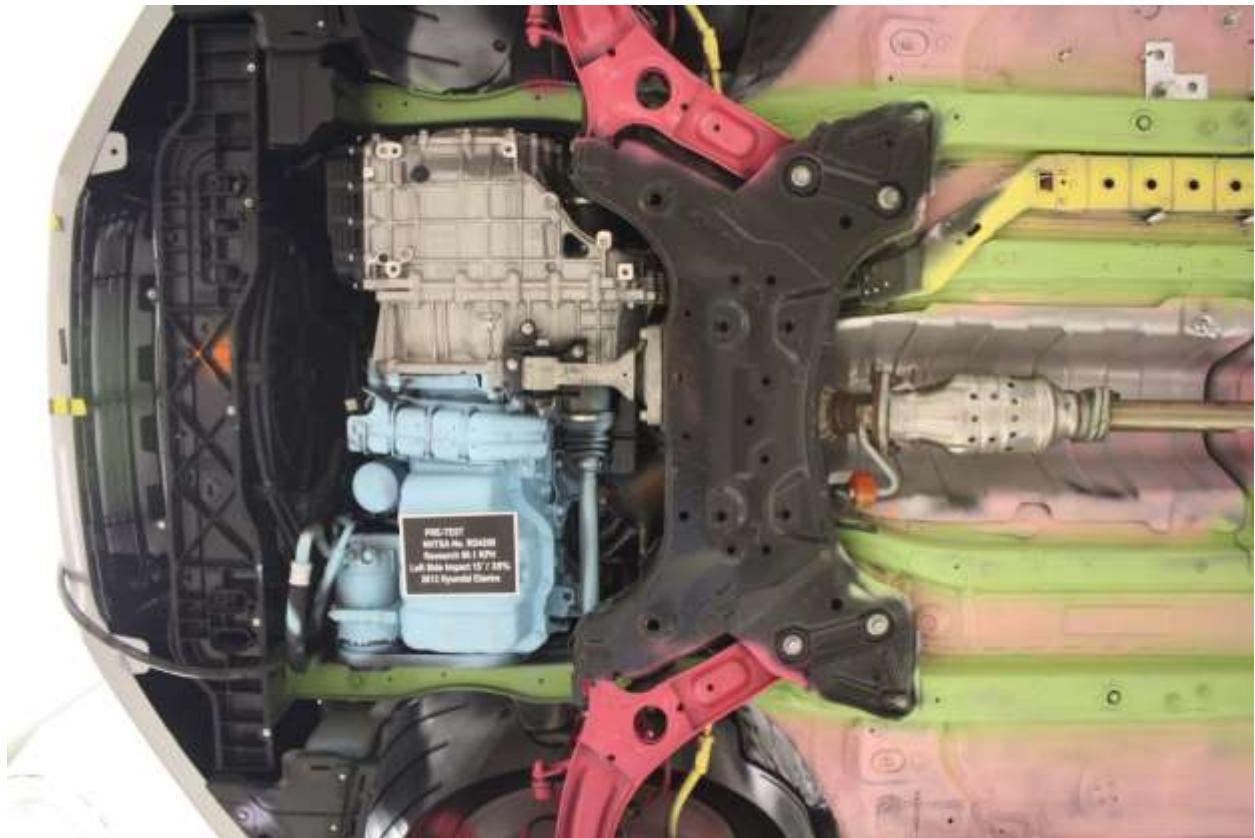
No. 126 Post-Test View of Fuel Filler Cap



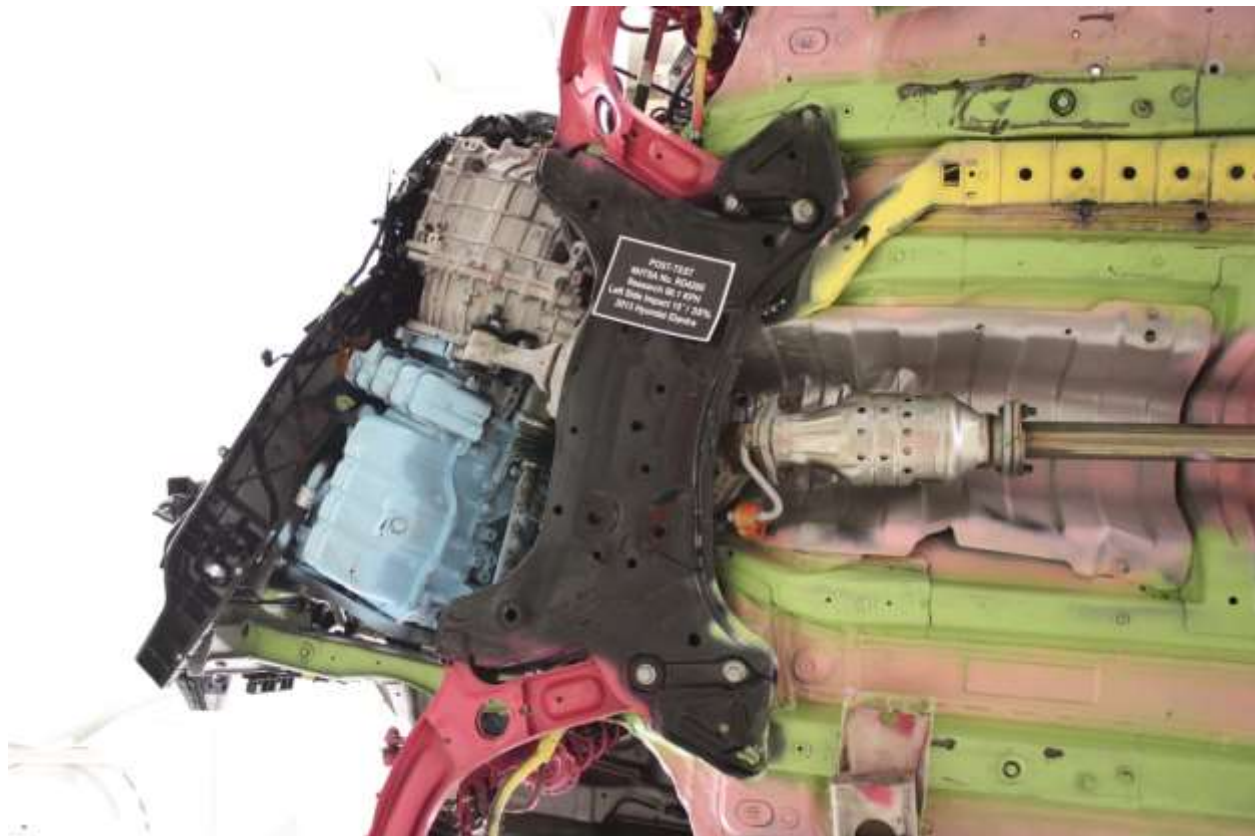
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No. 165 Post-Test Right Side View of RMDB



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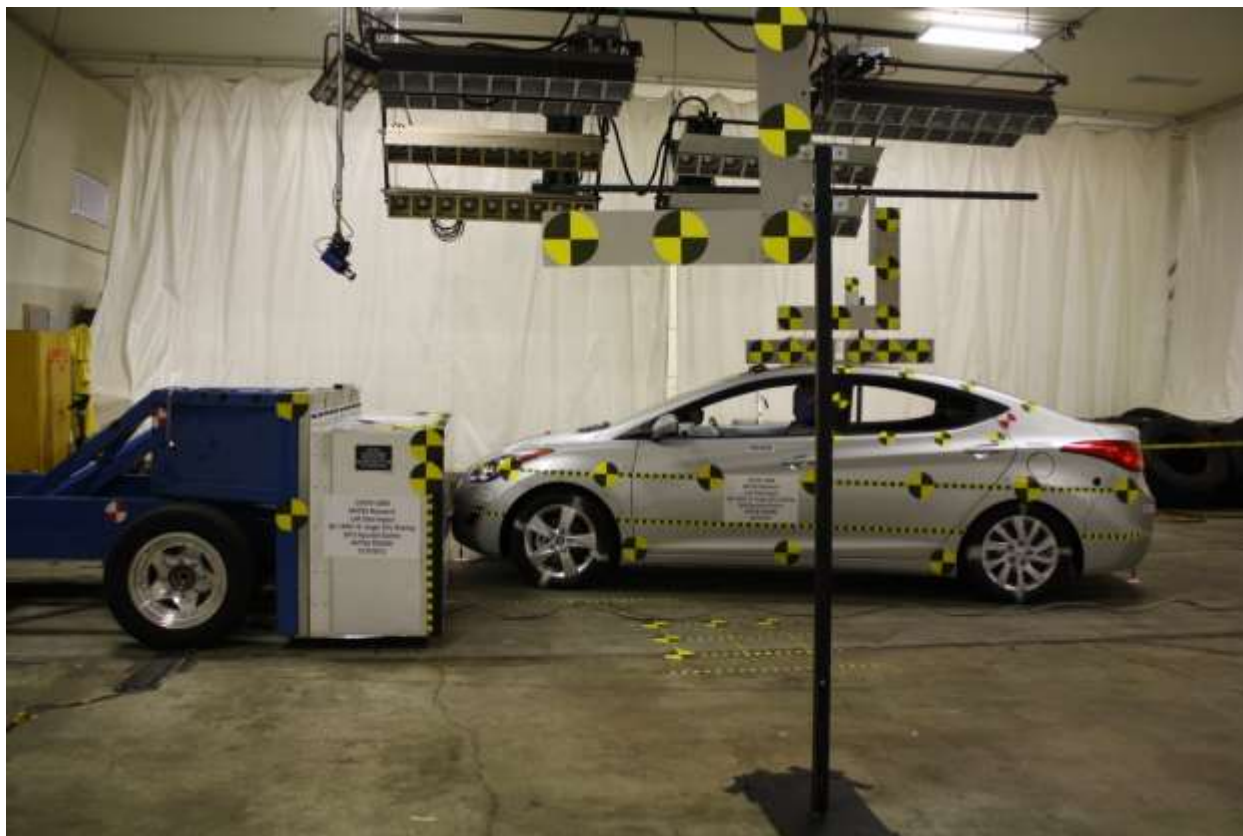
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No. 169 Post-Test Front View of RMDB



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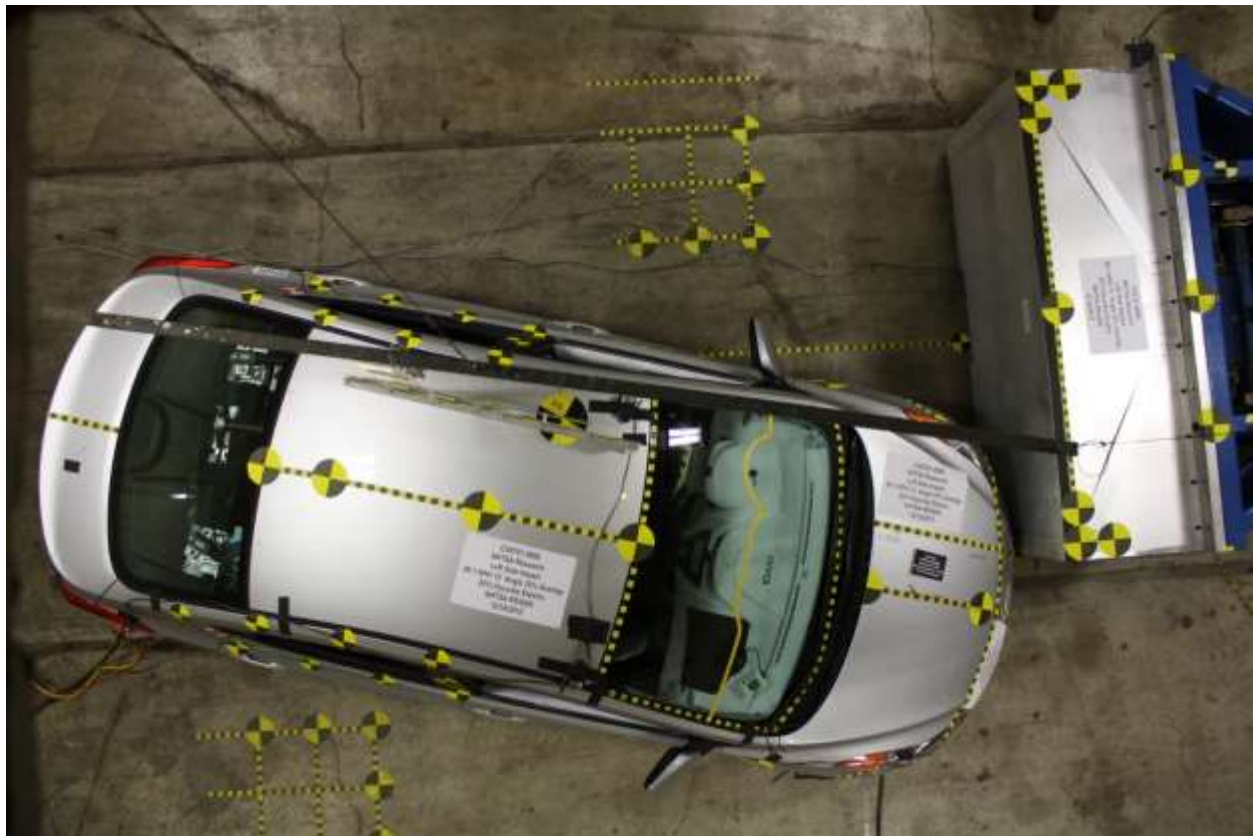
No. 171 Post-Test RMDB & Vehicle, Right Side



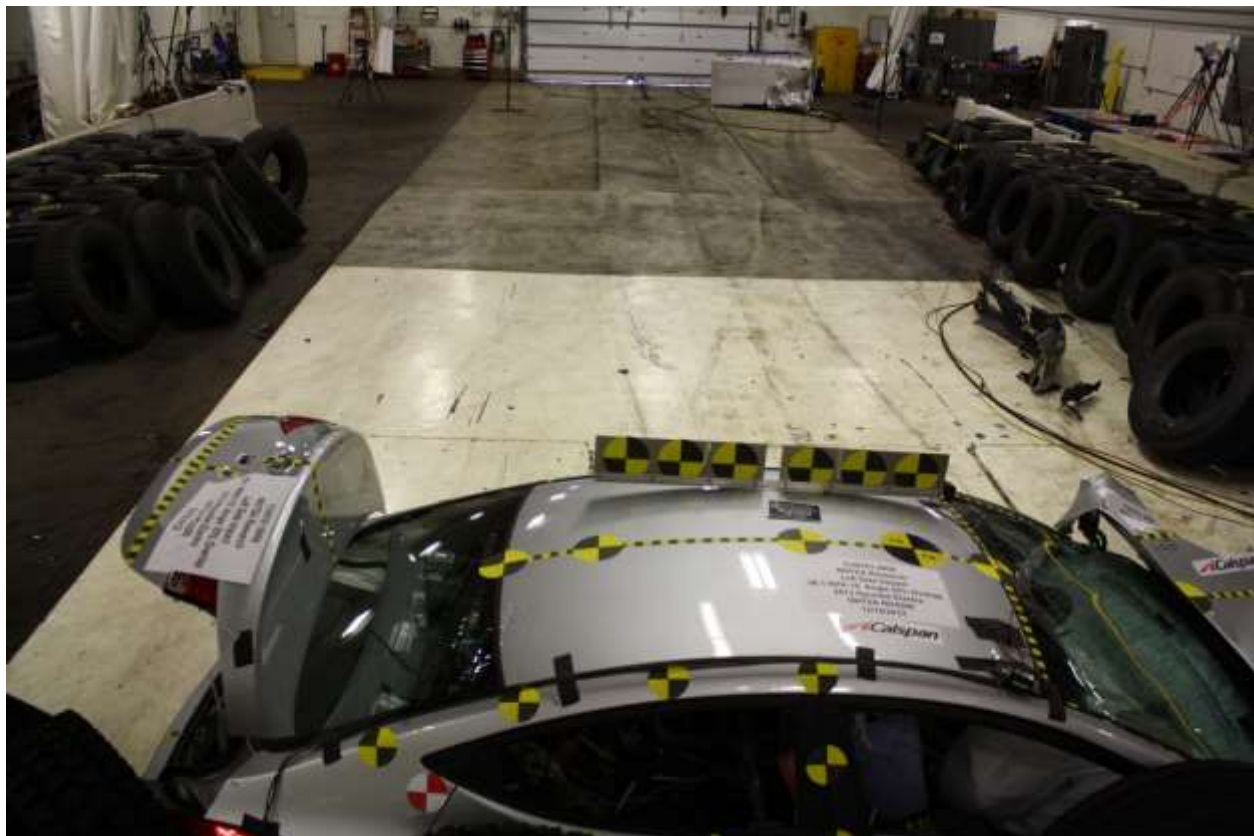
No. 172 Pre-Test RMDB & Vehicle, Left Side

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No. 174 Pre-Test RMDB & Vehicle, Top View



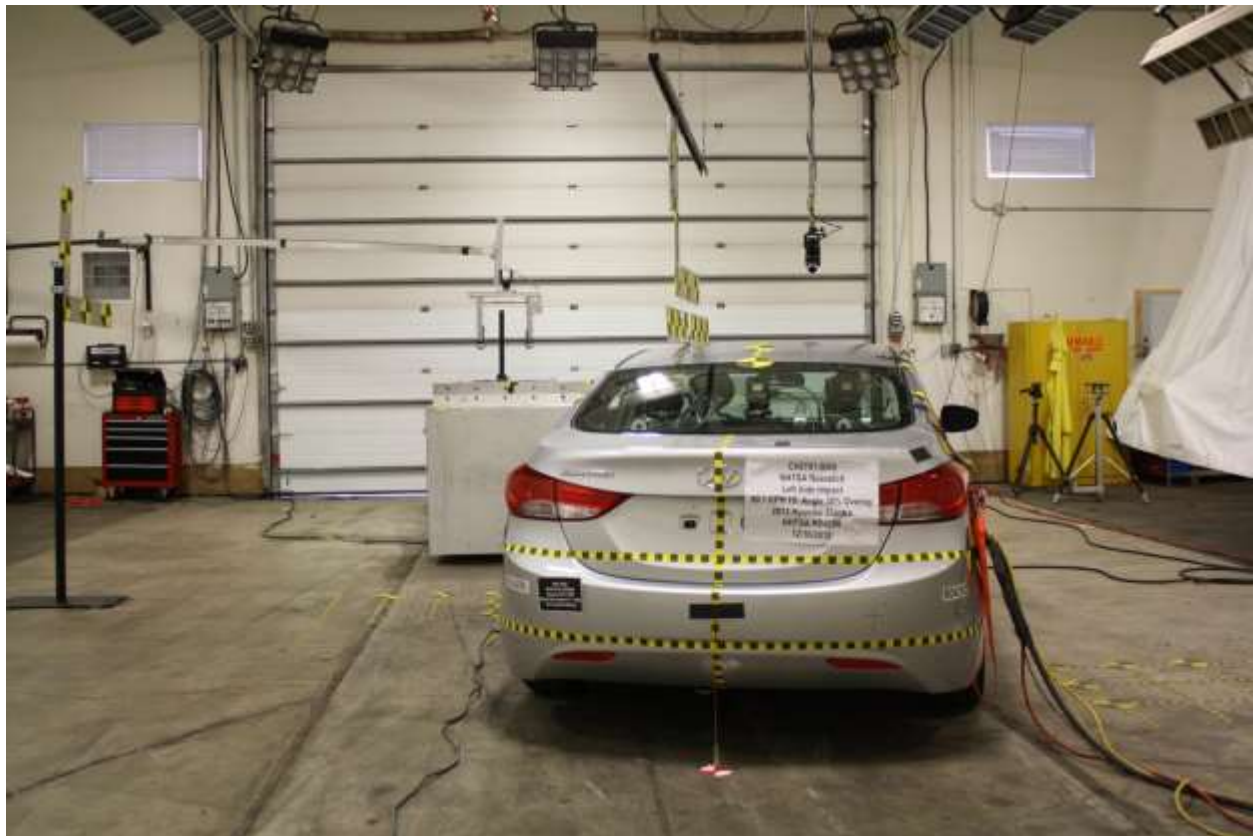
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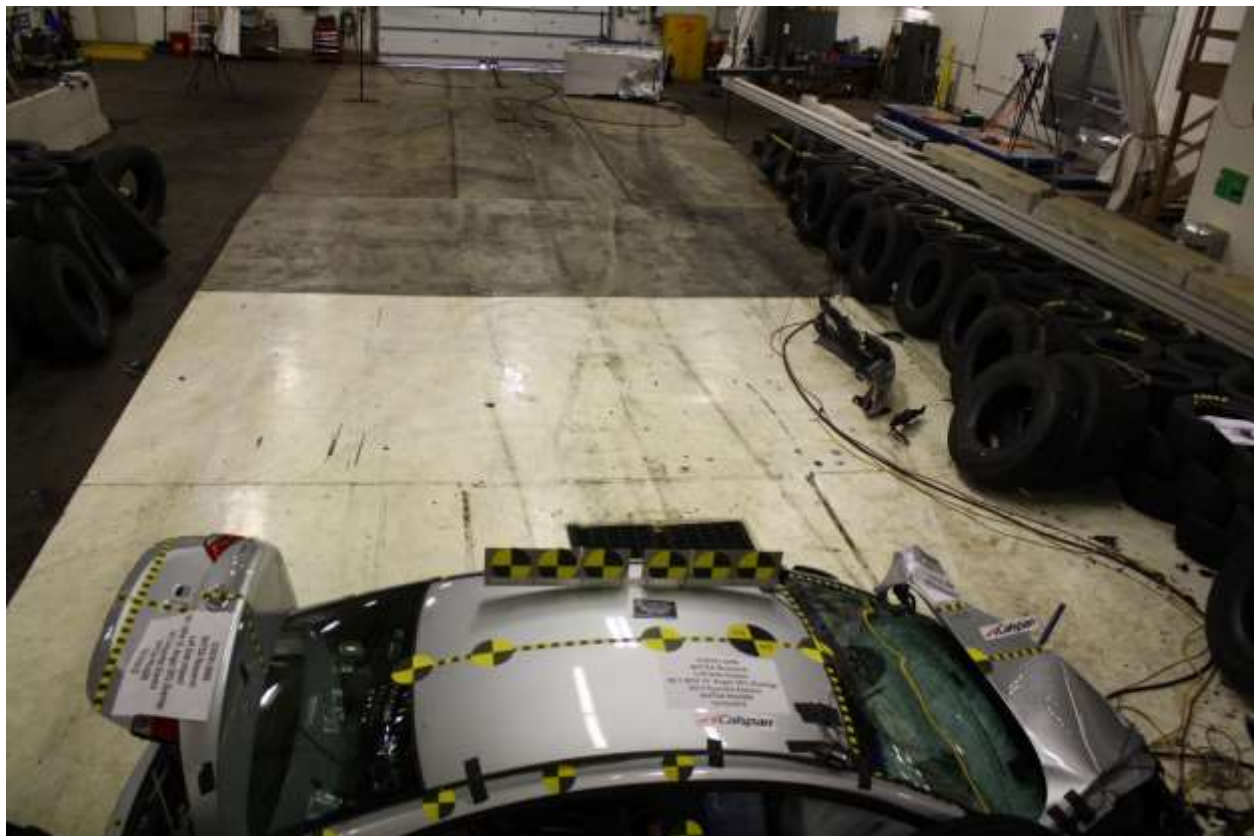
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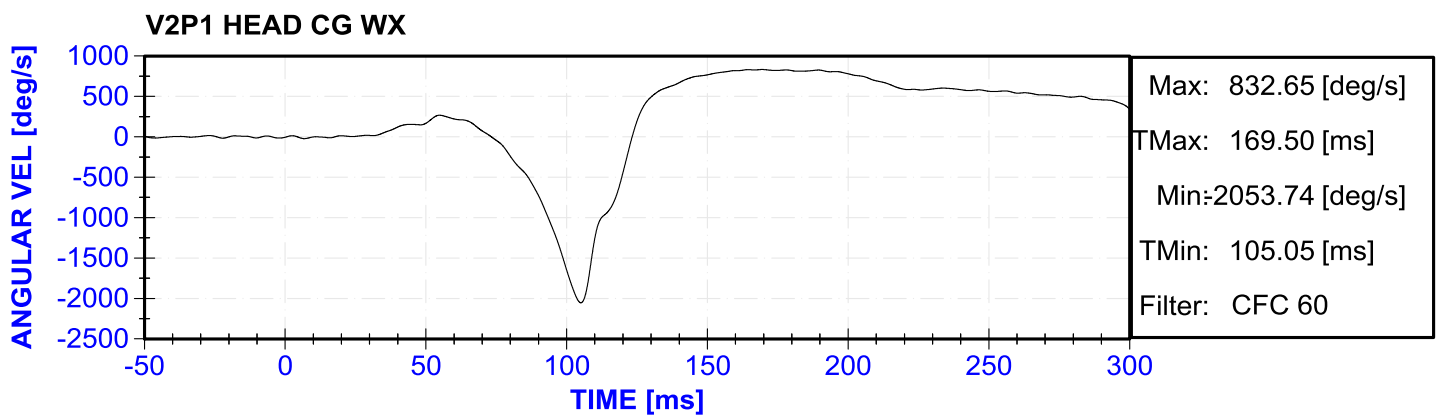
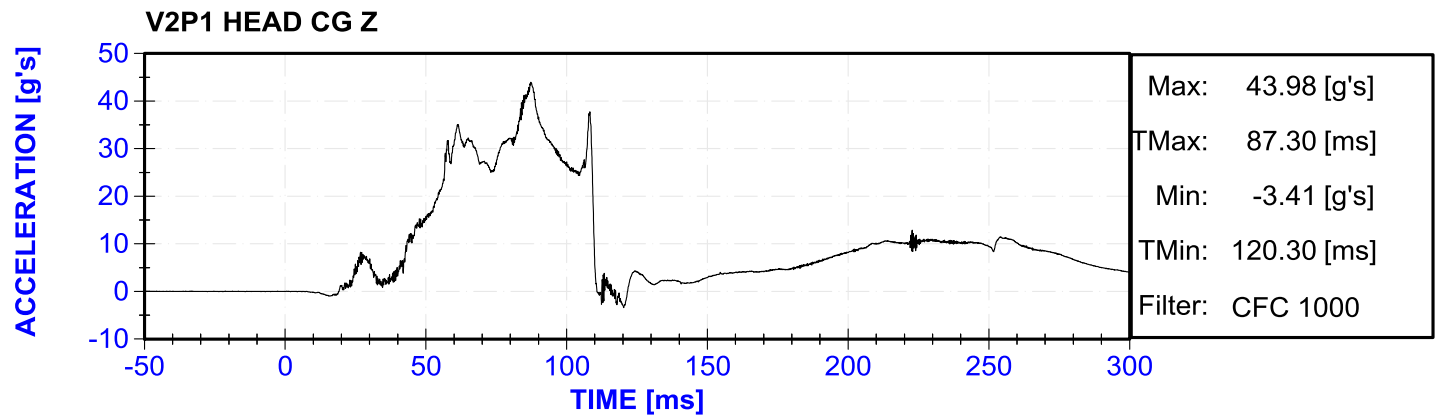
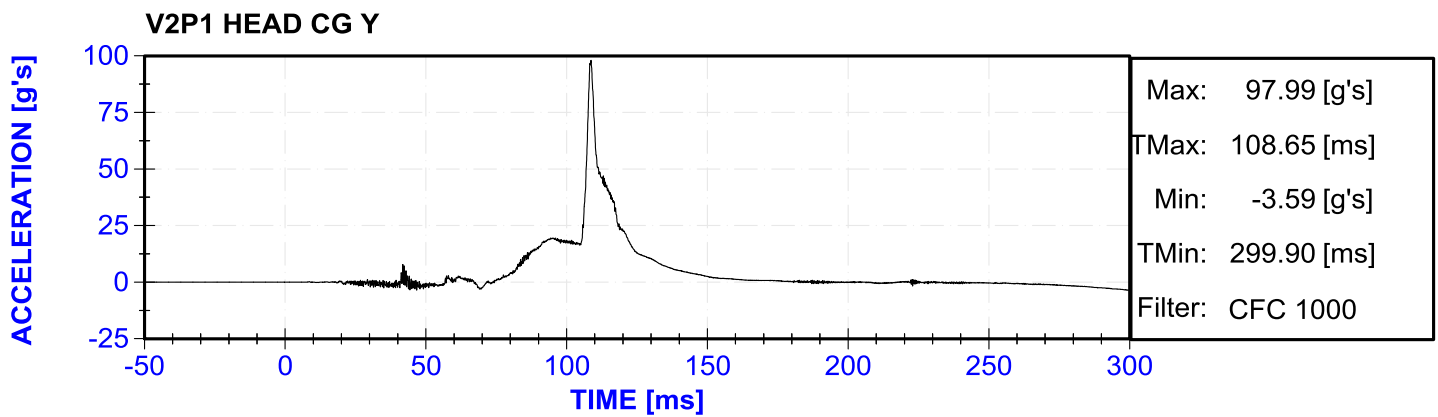
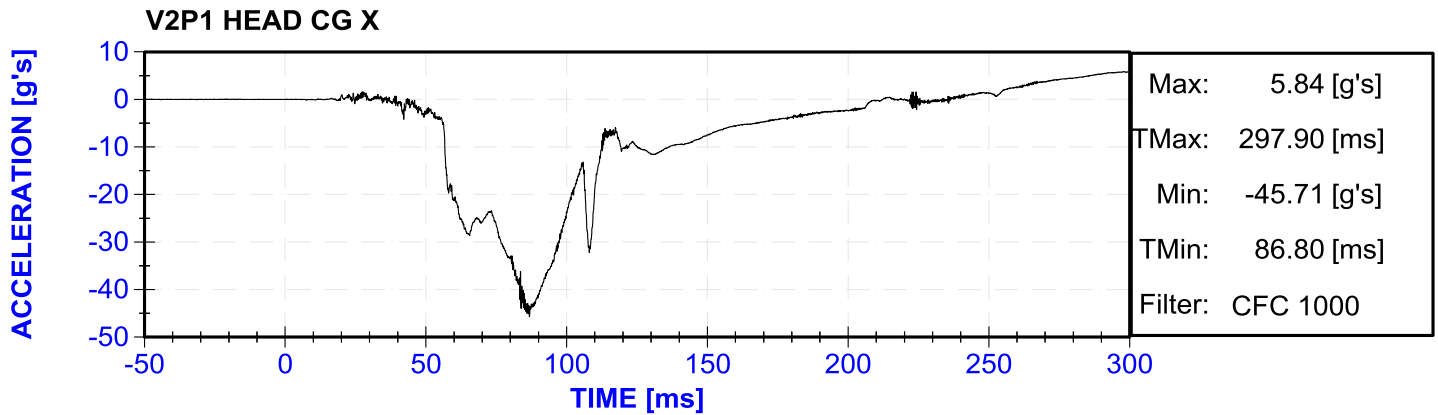
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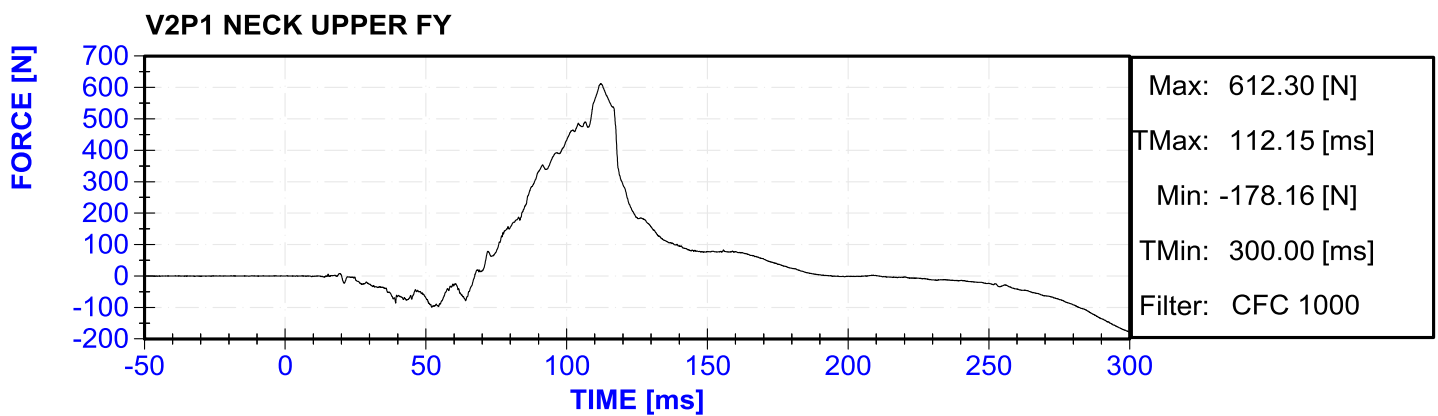
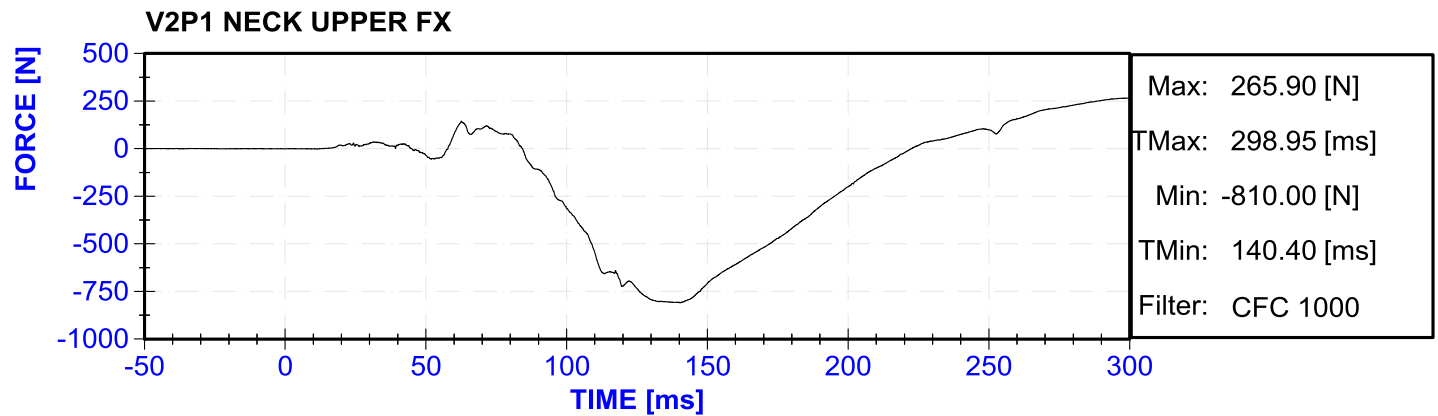
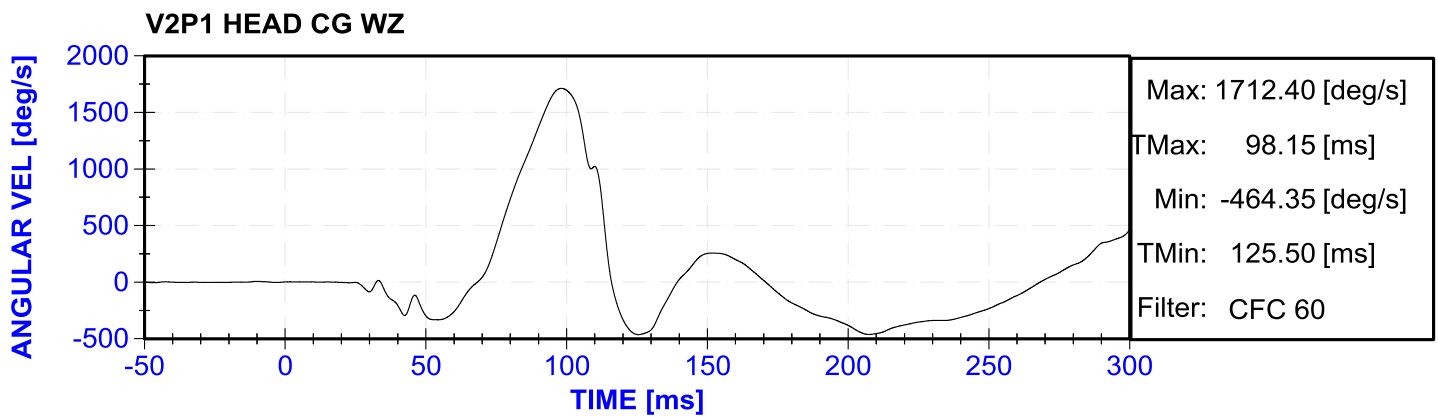
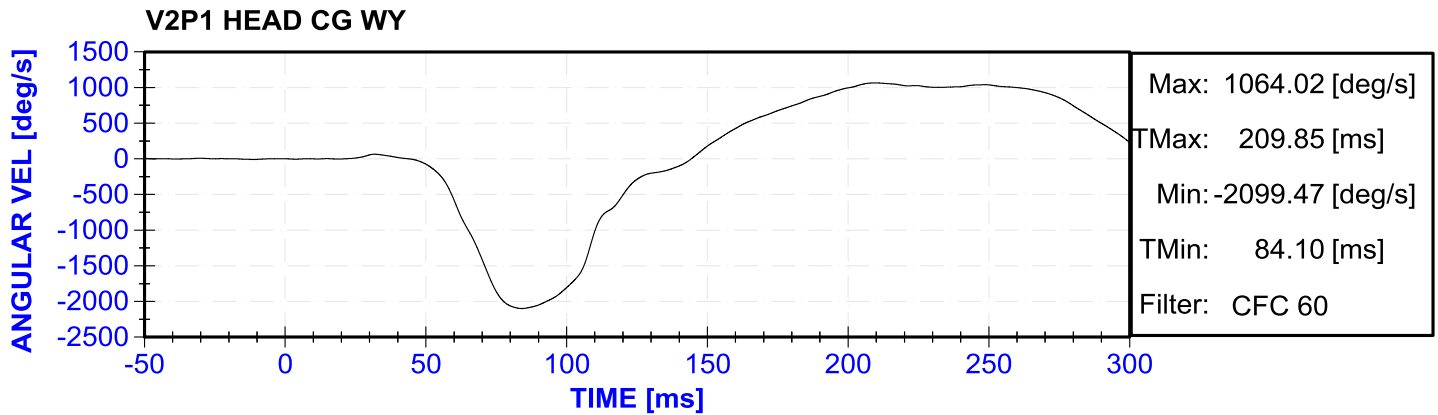
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Plot 160	V2P2 LEFT FEMUR MX	B-47
Plot 161	V2P2 LEFT FEMUR MY	B-48
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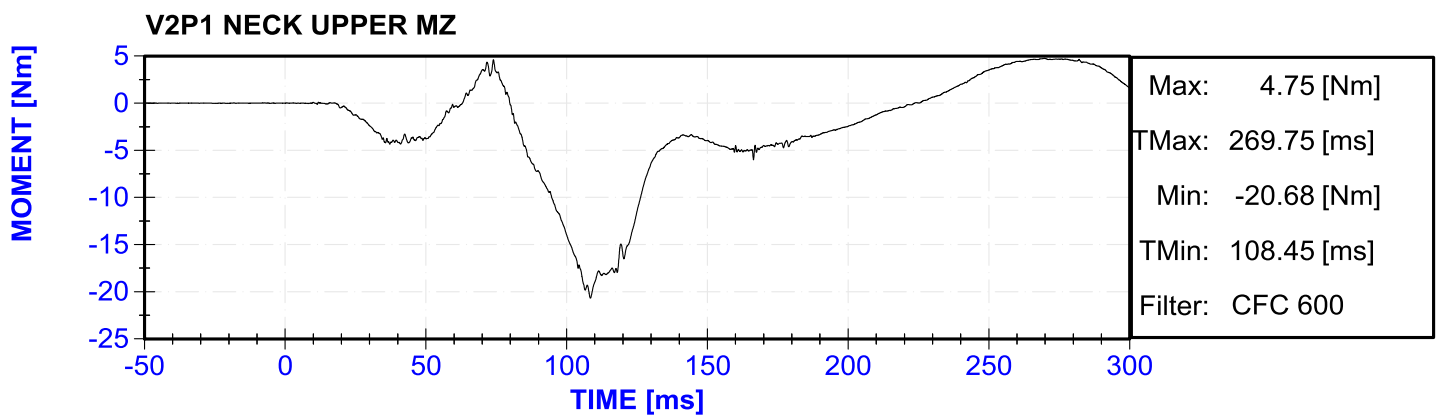
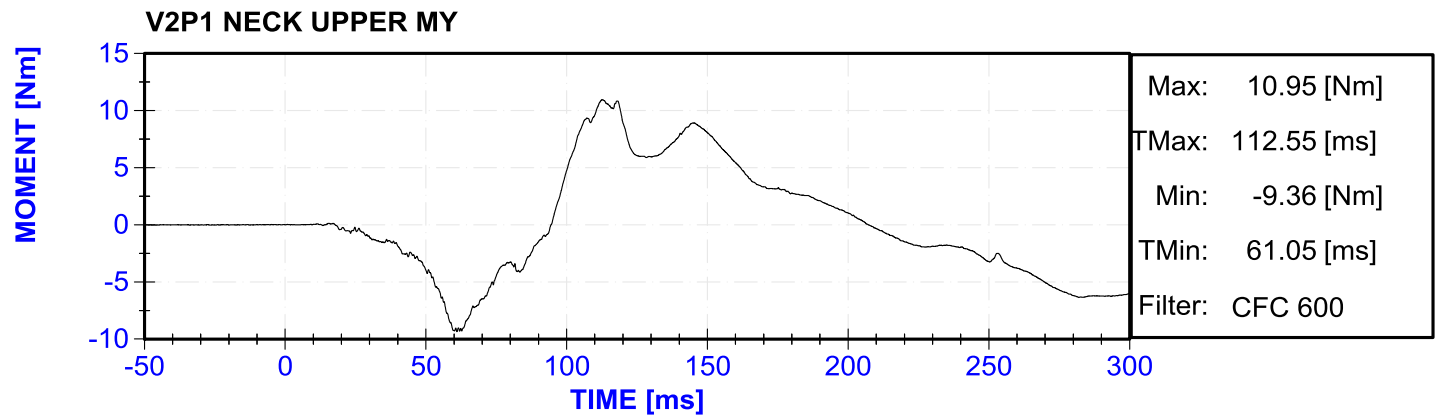
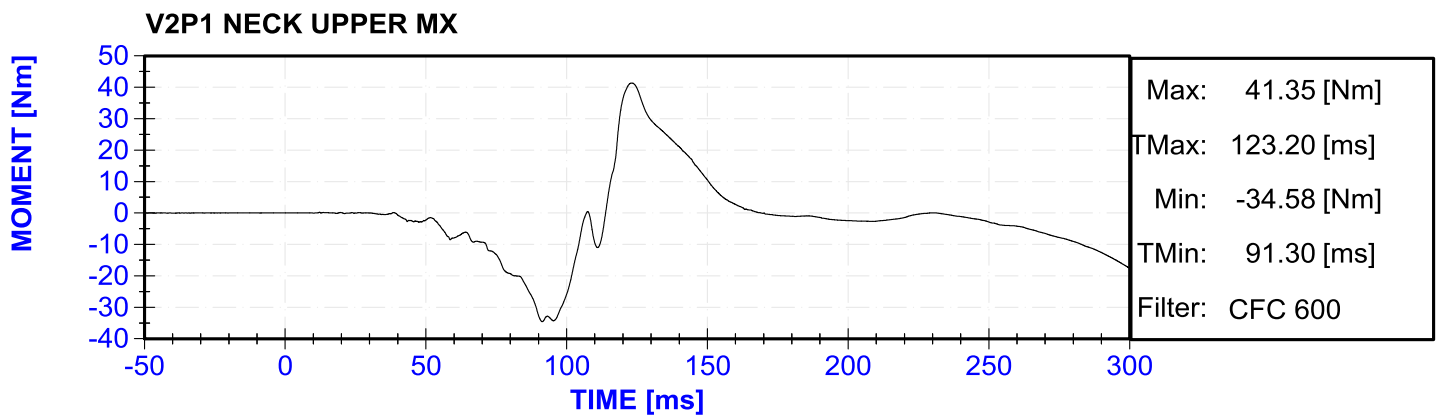
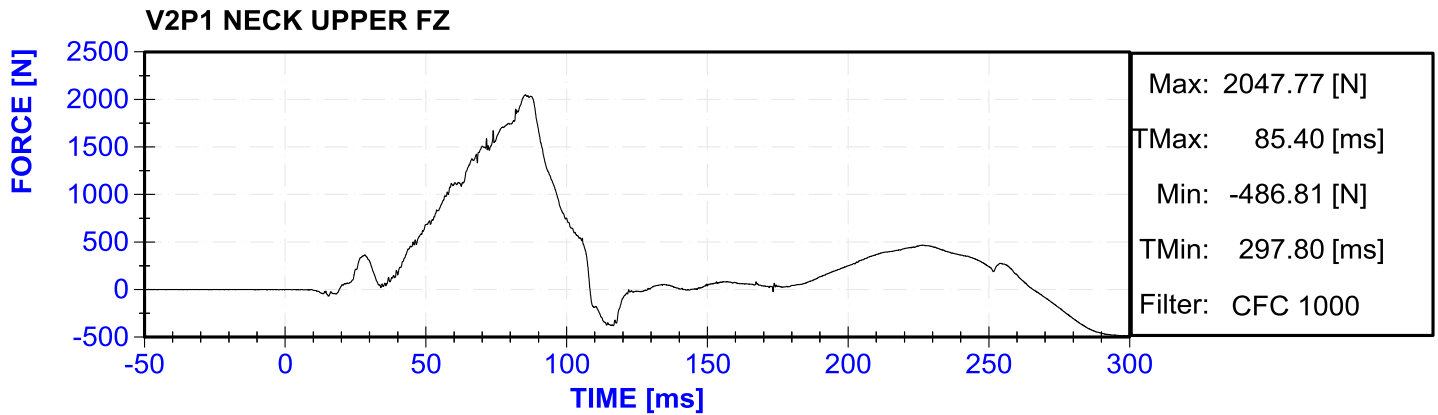
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Plot 174	V2P2 TIBIA LEFT LOWER MX	B-51
Plot 175	V2P2 TIBIA LEFT LOWER MY	B-51
Plot 176	V2P2 ANKLE LEFT POT RX	B-51
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Plot 183	V2P2 TIBIA RIGHT LOWER FZ	B-53
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Plot 186	V2P2 ANKLE RIGHT POT RX	B-54
Plot 187	V2P2 ANKLE RIGHT POT RY	B-54
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Plot 228	V1 REAR C/L AX	B-64
Plot 229	V1 REAR C/L AY	B-65
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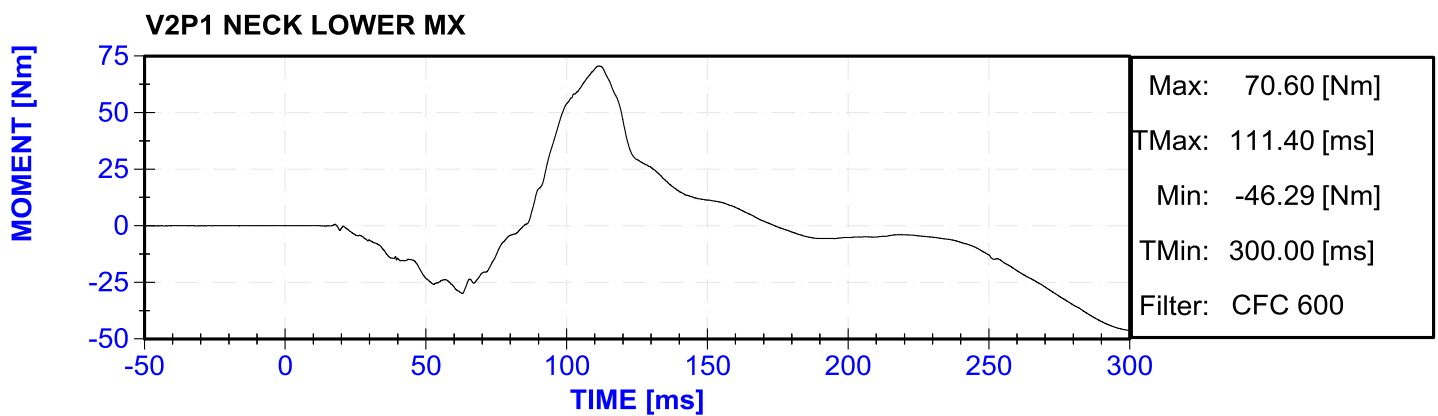
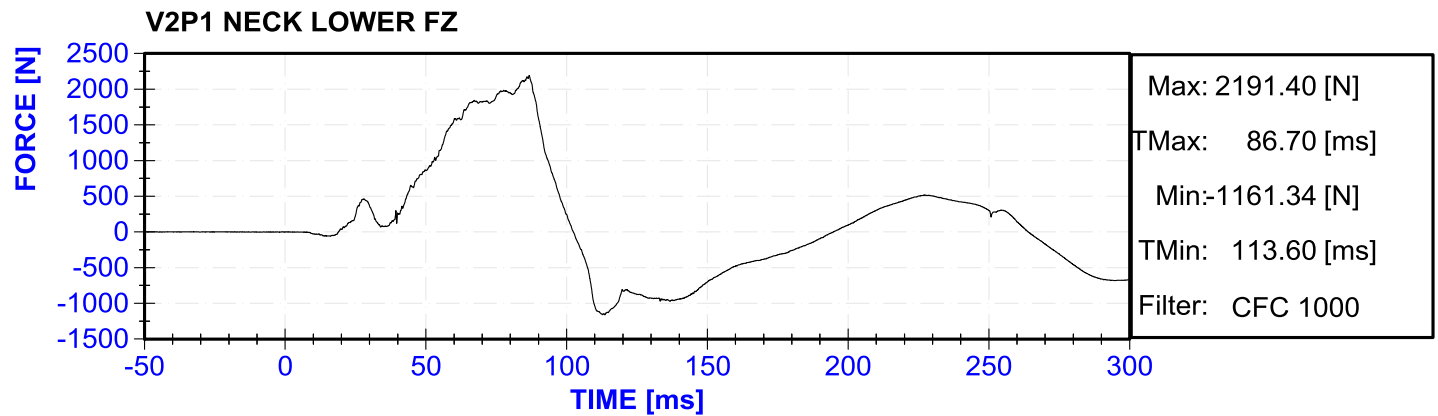
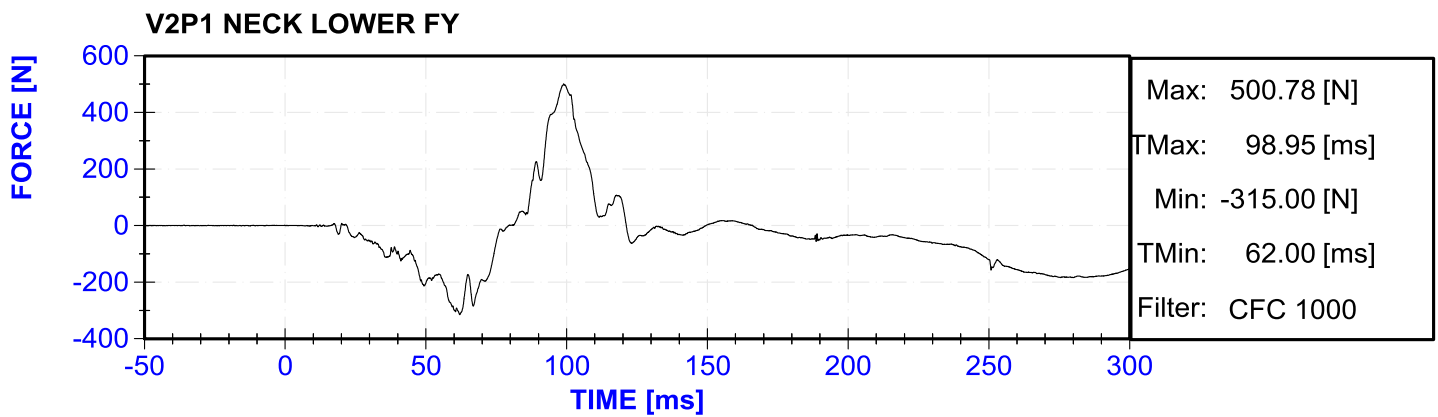
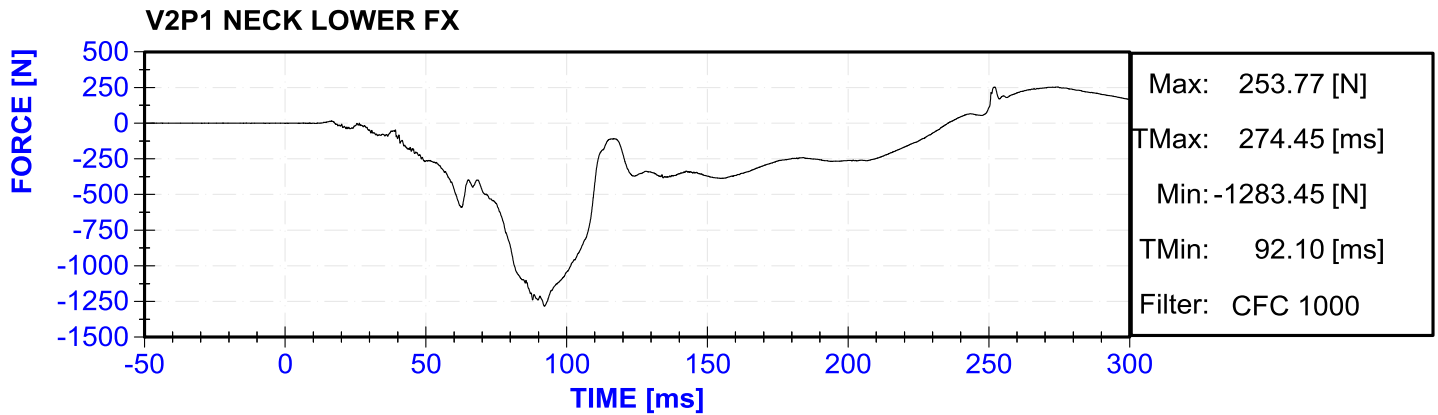
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Plot 282	V2P2 CHEST LOWER LEFT Y [CFC_180]	B-78
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Plot 287	V2P2 CHEST LOWER RIGHT Z [CFC_180]	B-79
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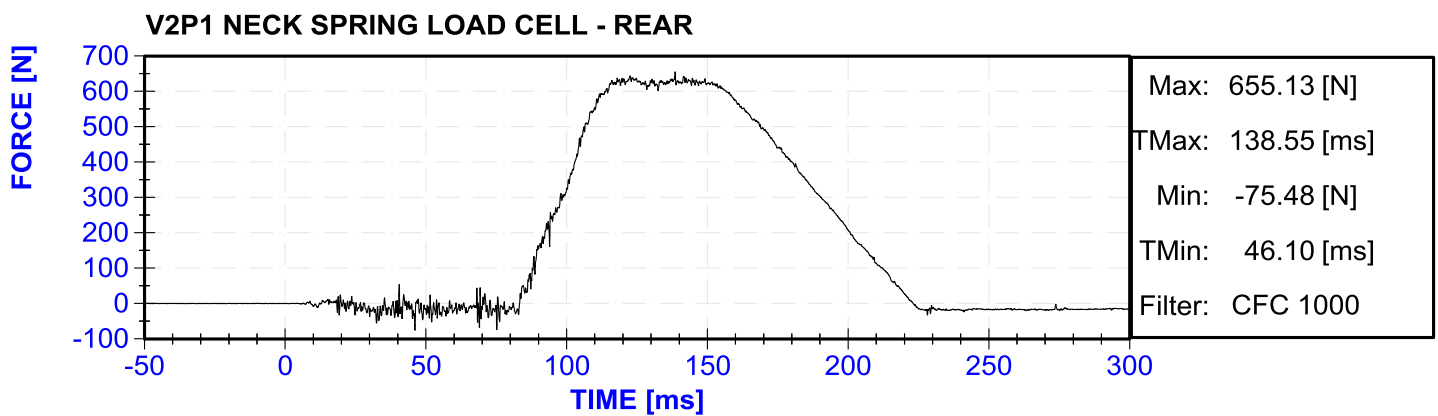
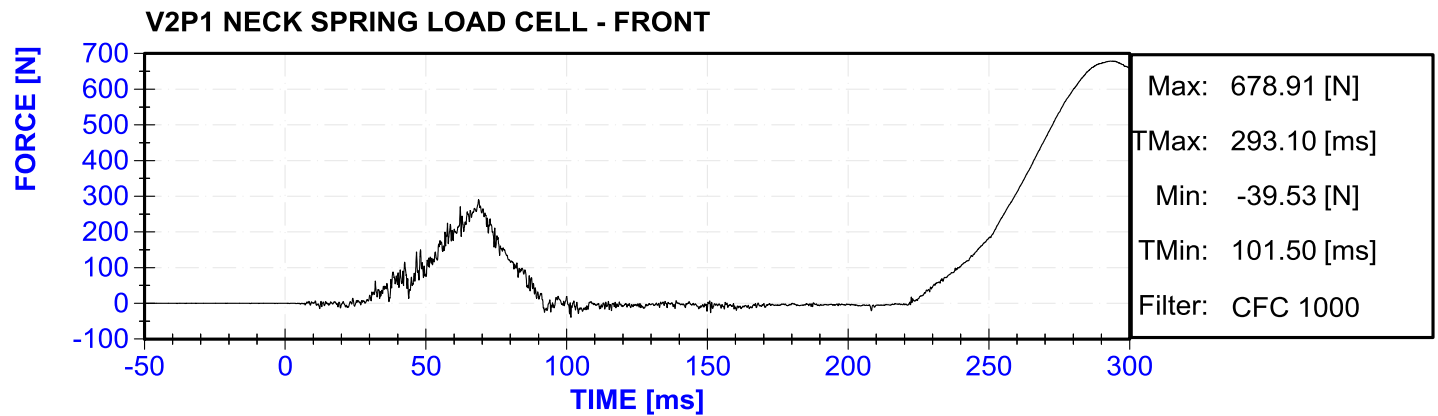
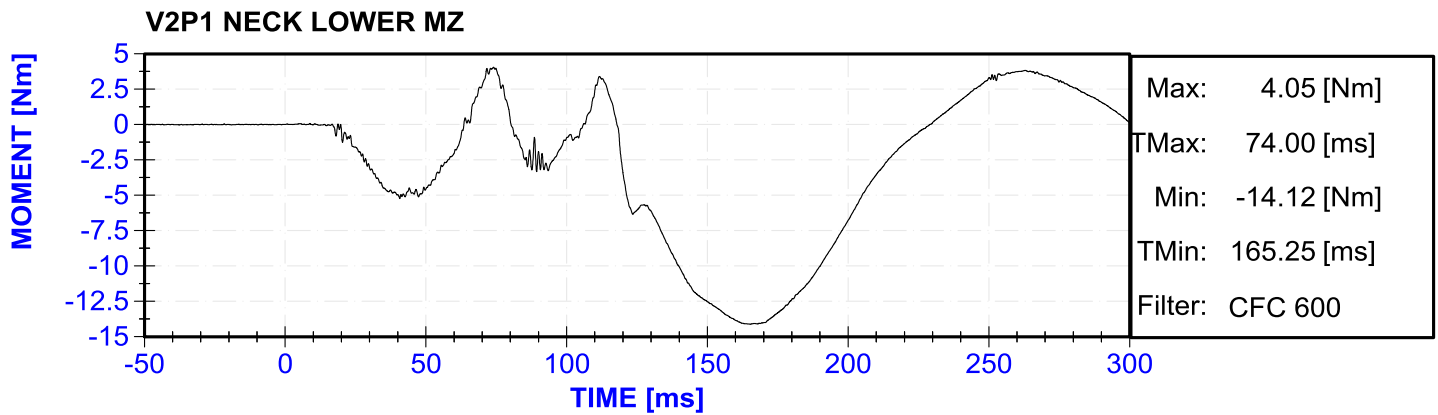
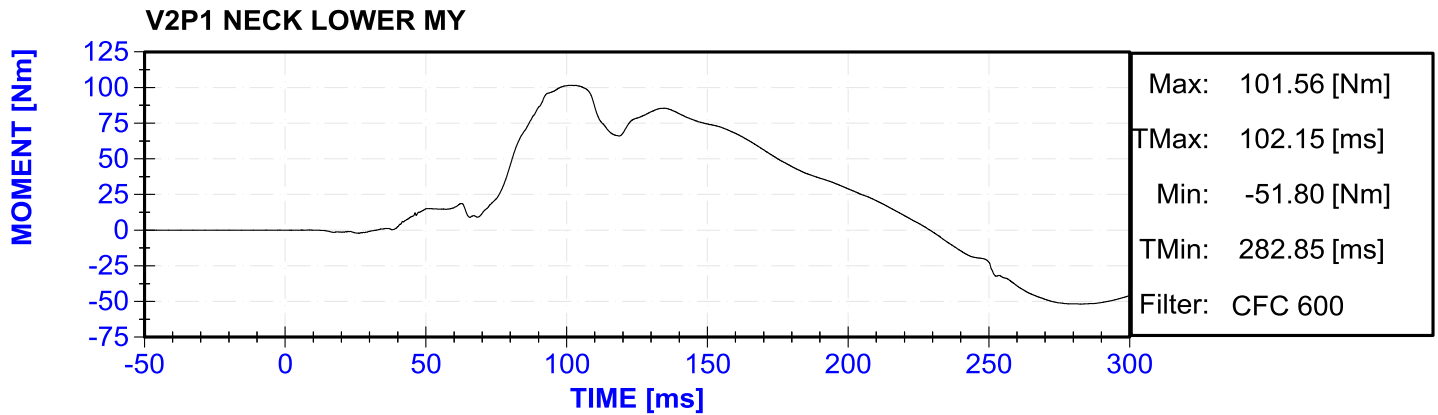
Plot 289	V2P2 ABDOMEN LEFT LOWER X [CFC_180]	B-80
Plot 290	V2P2 ABDOMEN LEFT LOWER Y [CFC_180]	B-80
Plot 291	V2P2 ABDOMEN LEFT LOWER Z [CFC_180]	B-80
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Plot 294	V2P2 ABDOMEN RIGHT LOWER Y [CFC_180]	B-81
Plot 295	V2P2 ABDOMEN RIGHT LOWER Z [CFC_180]	B-81
Plot 296	V2P2 ABDOMEN RIGHT LOWER D [CFC_180]	B-81

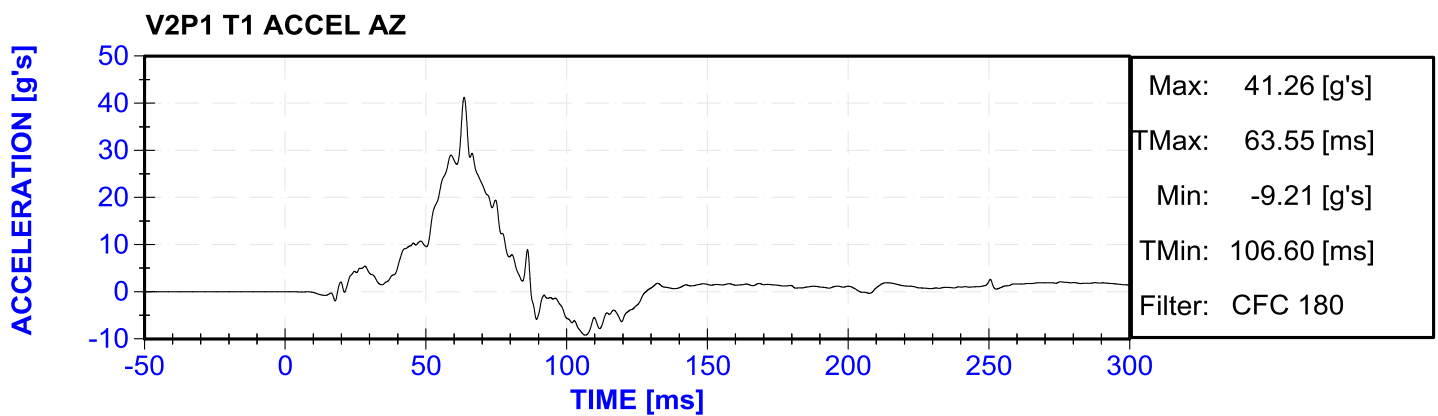
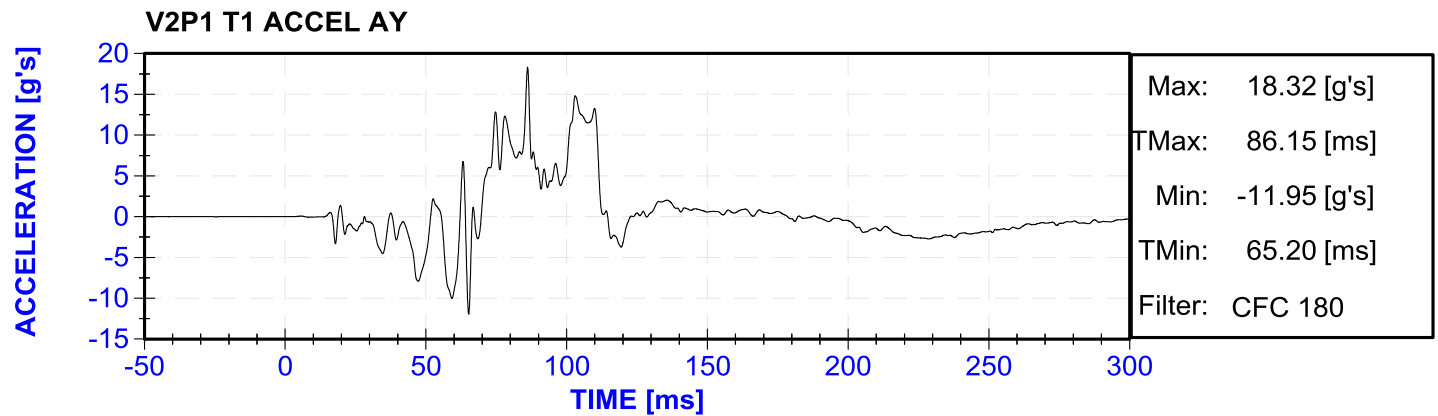
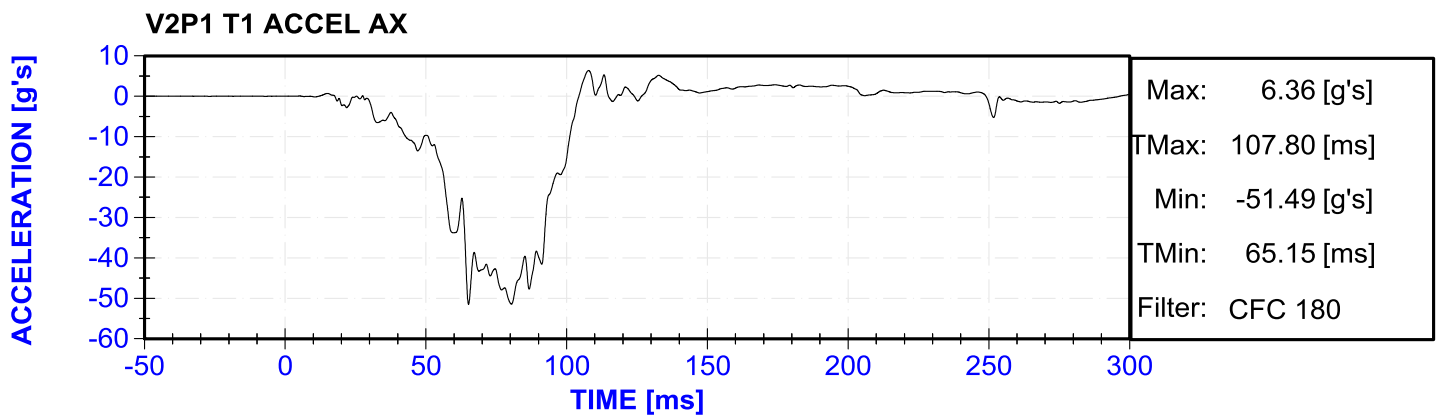
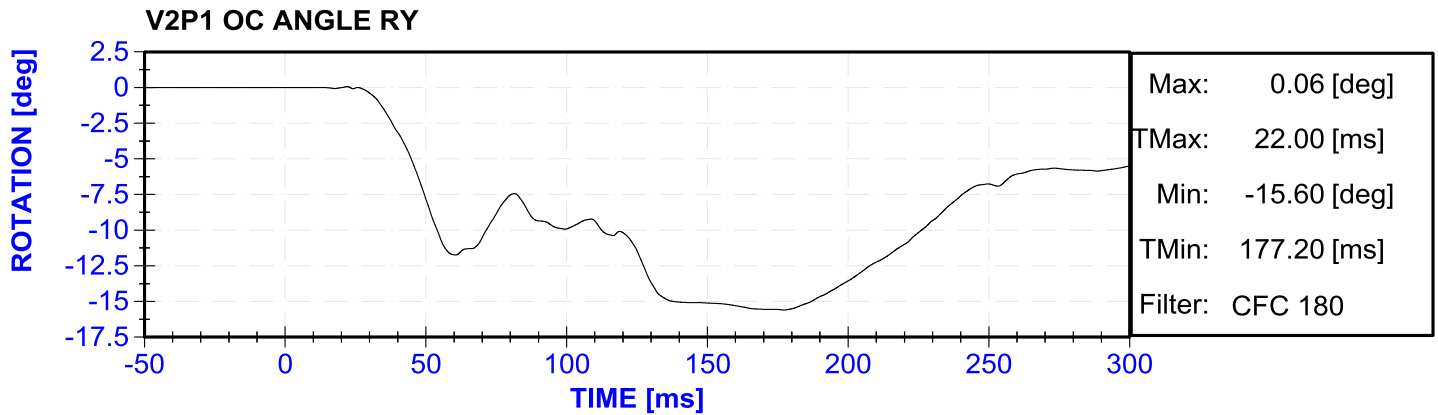


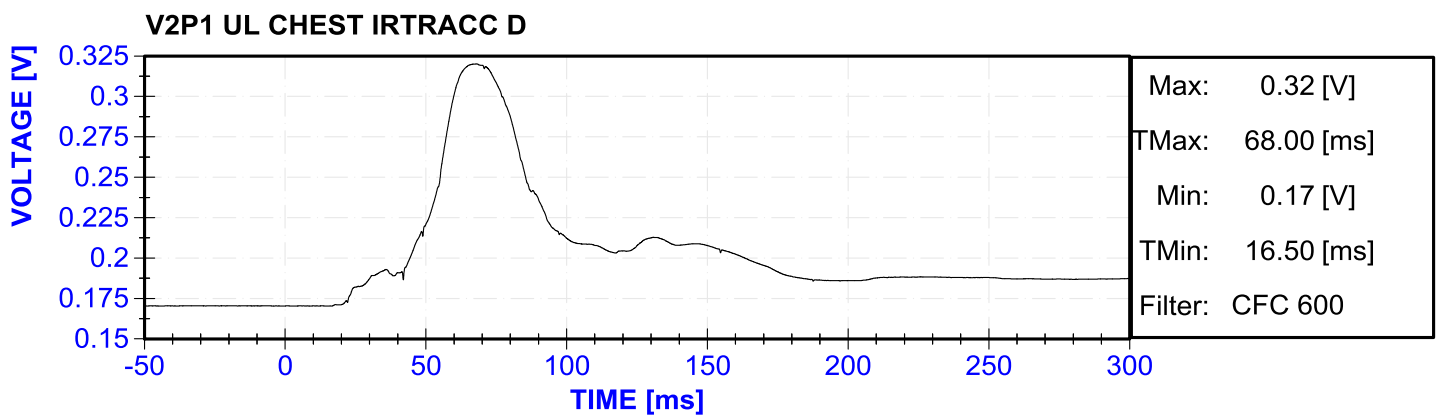
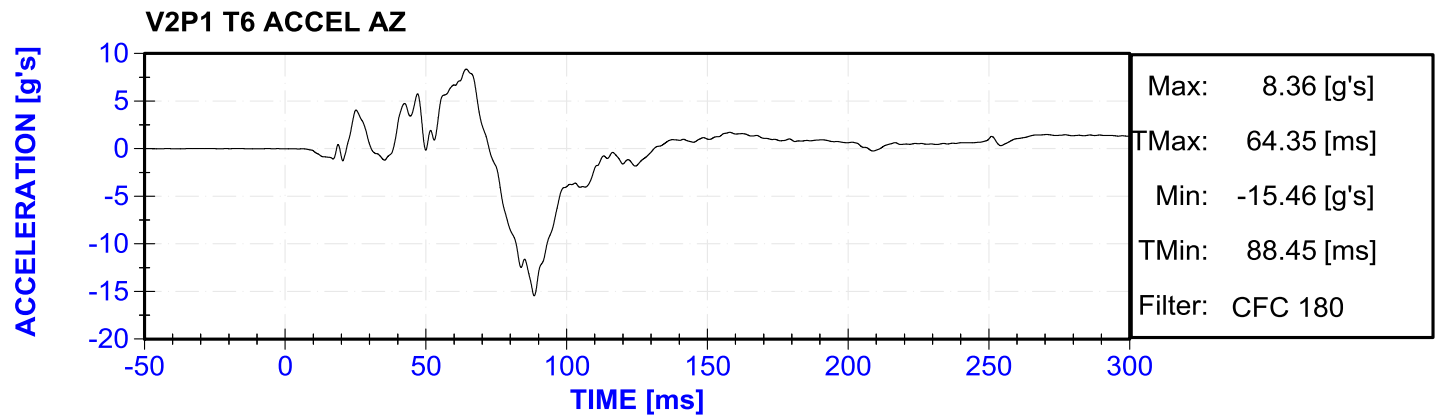
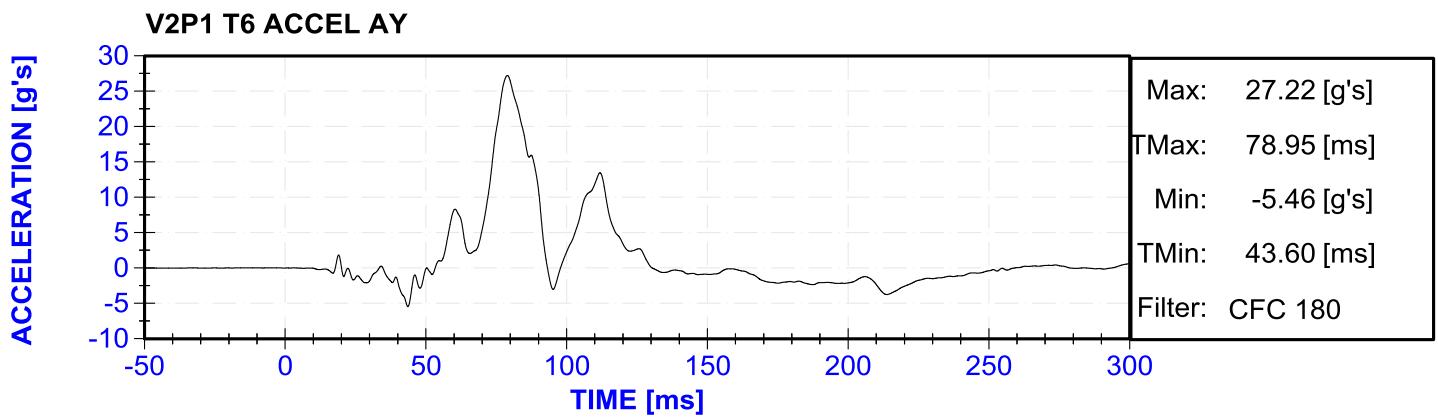
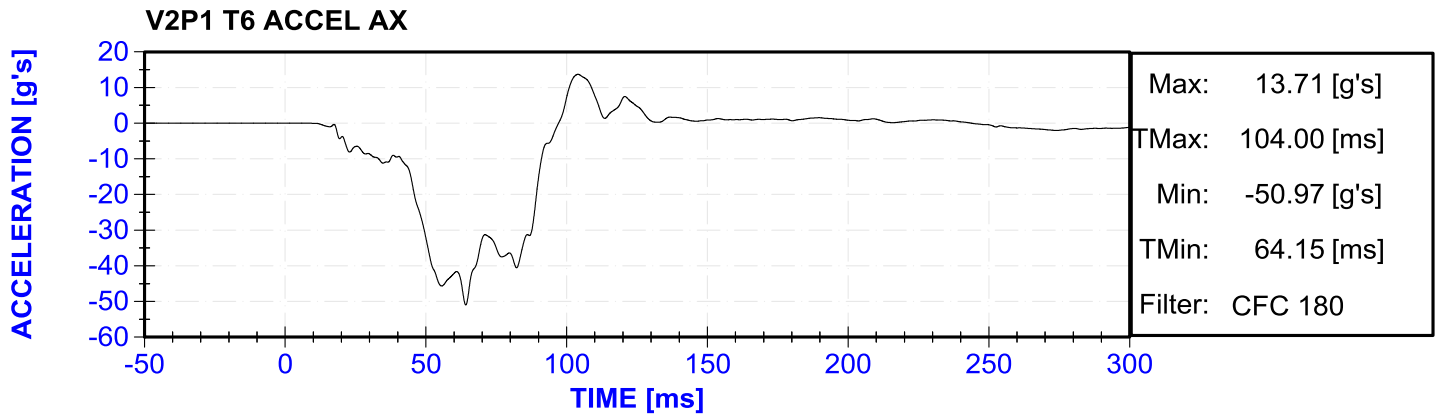


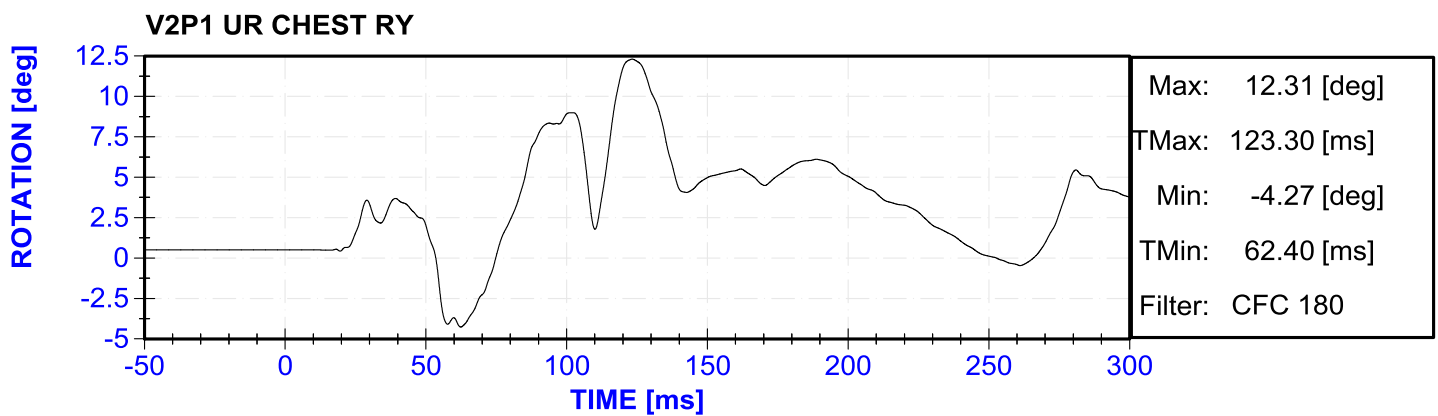
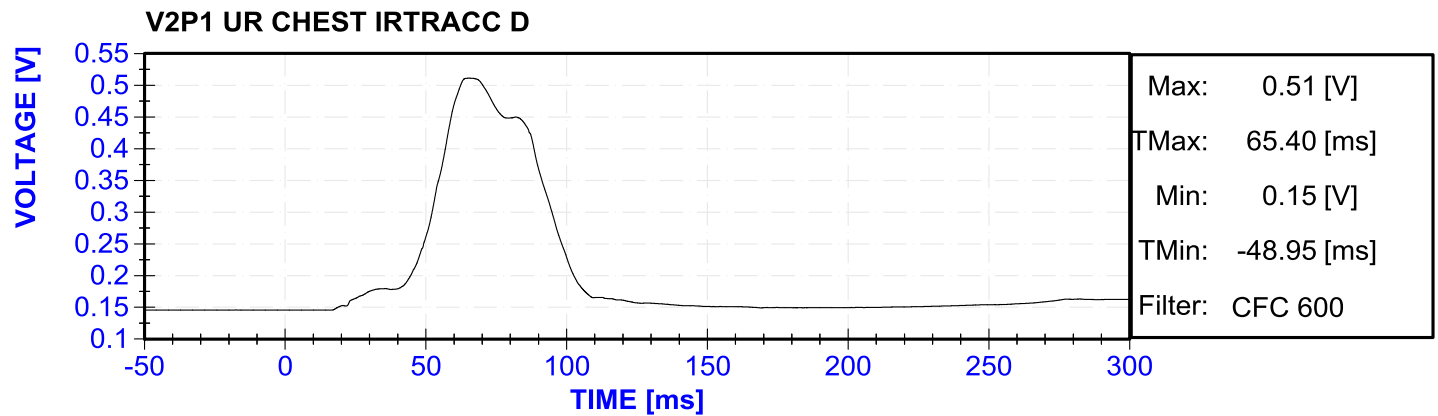
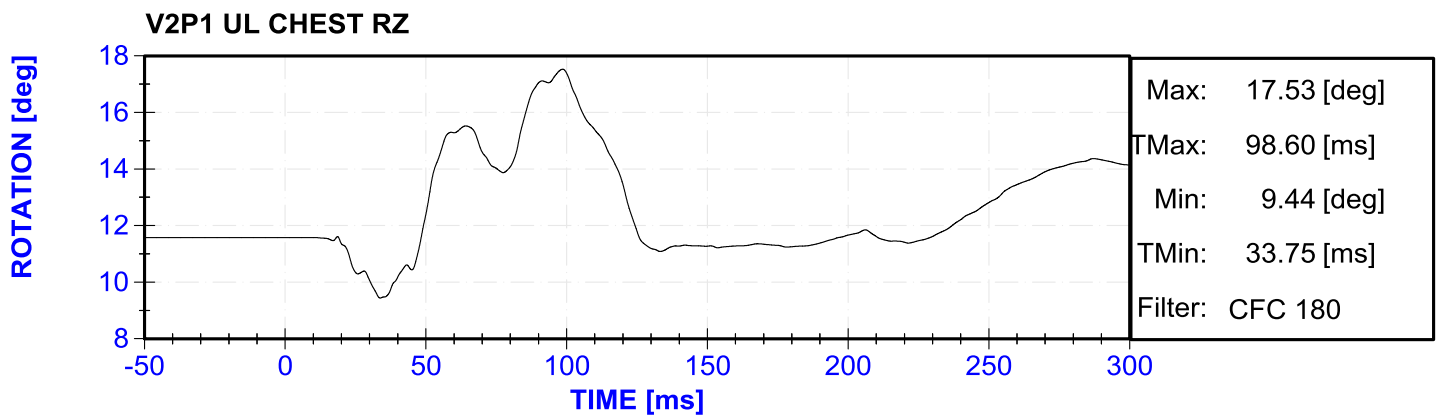
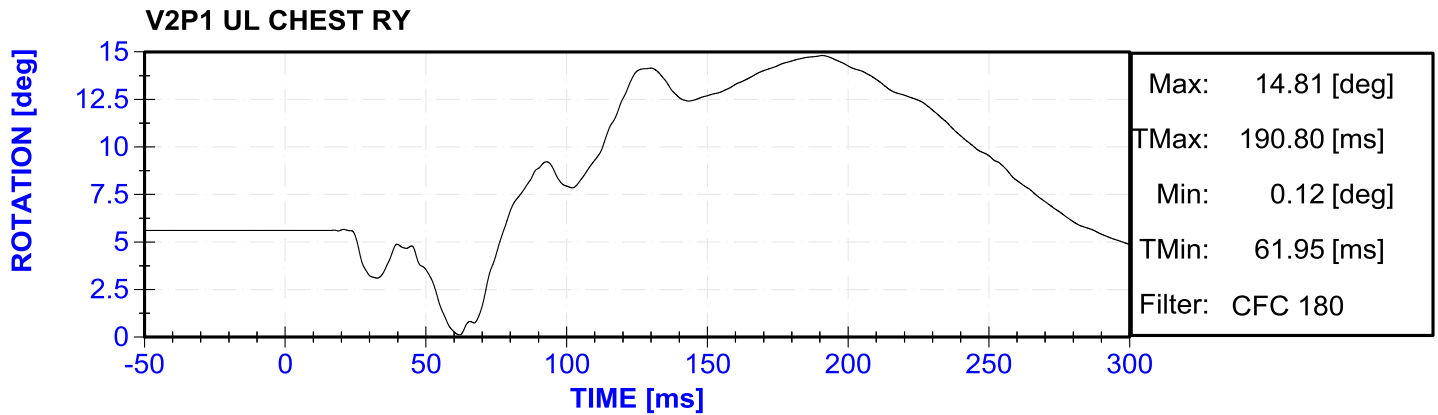


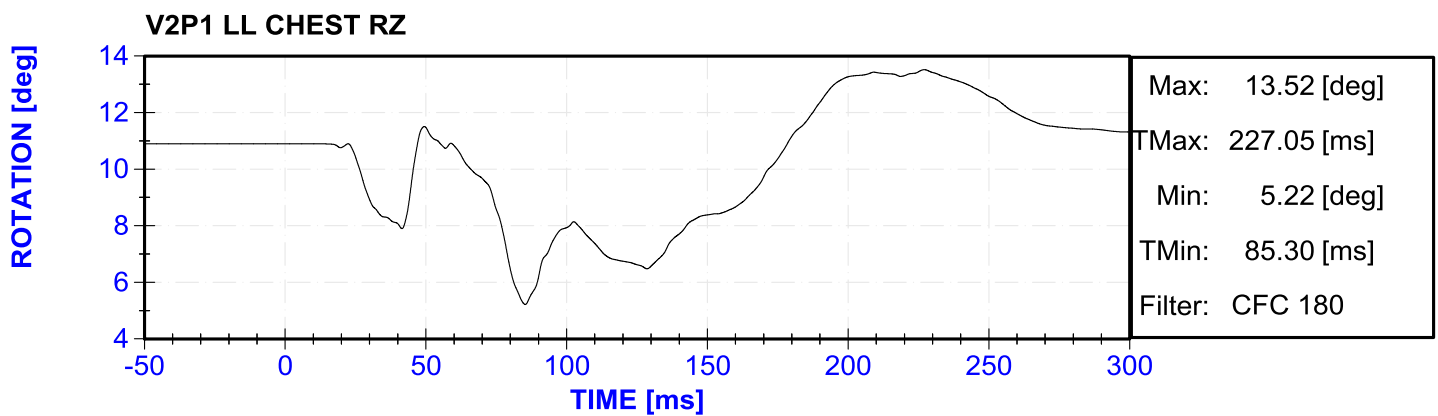
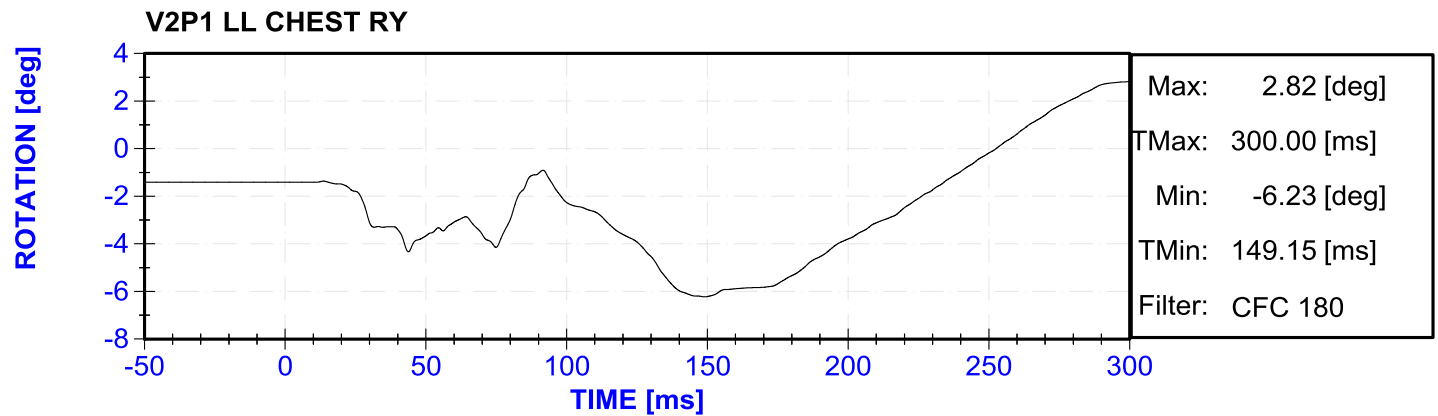
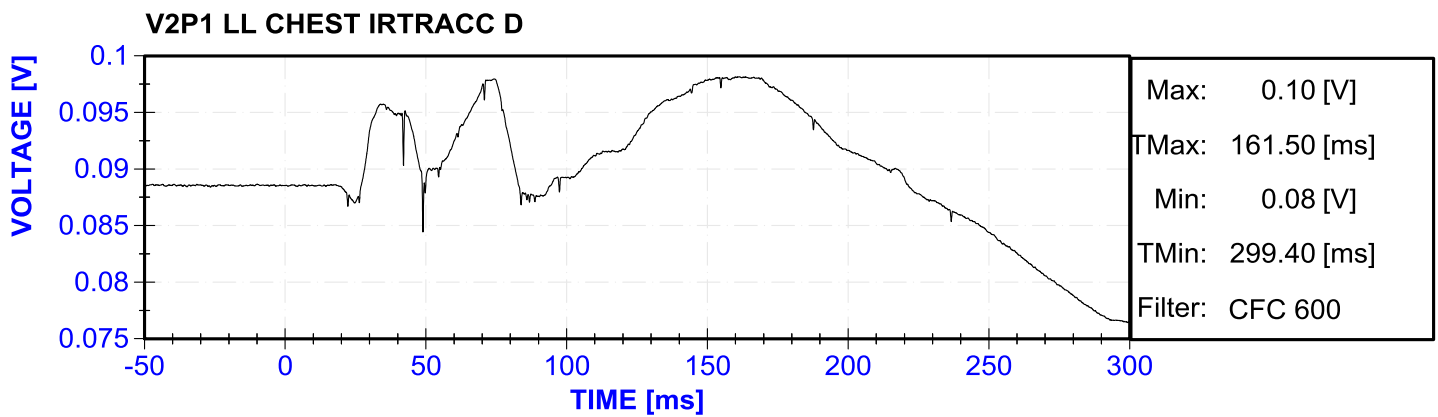
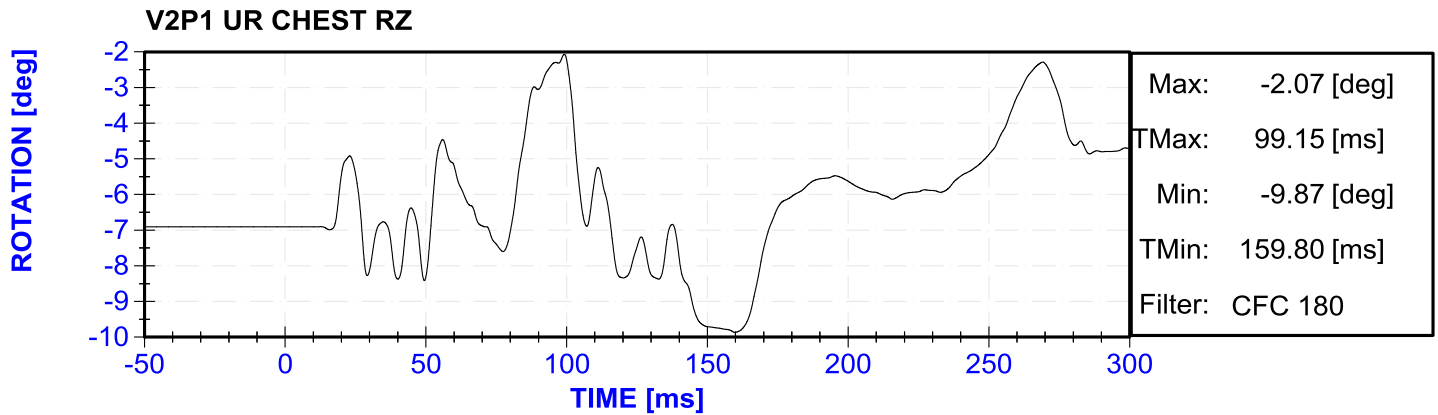




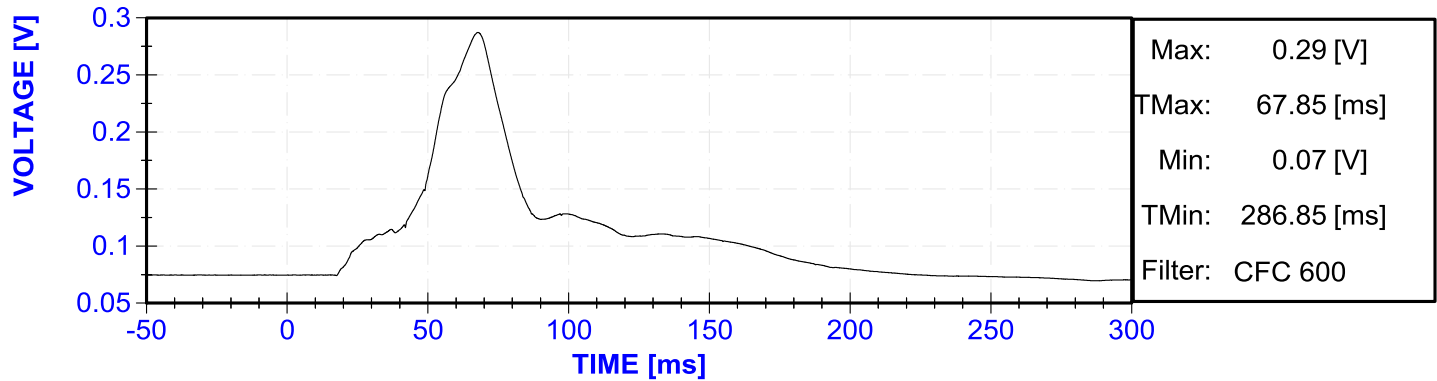




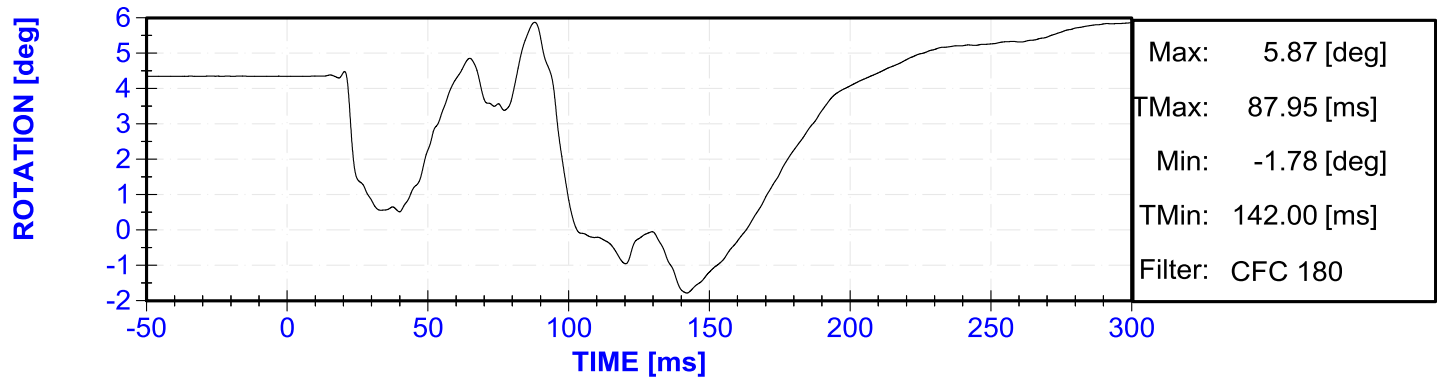




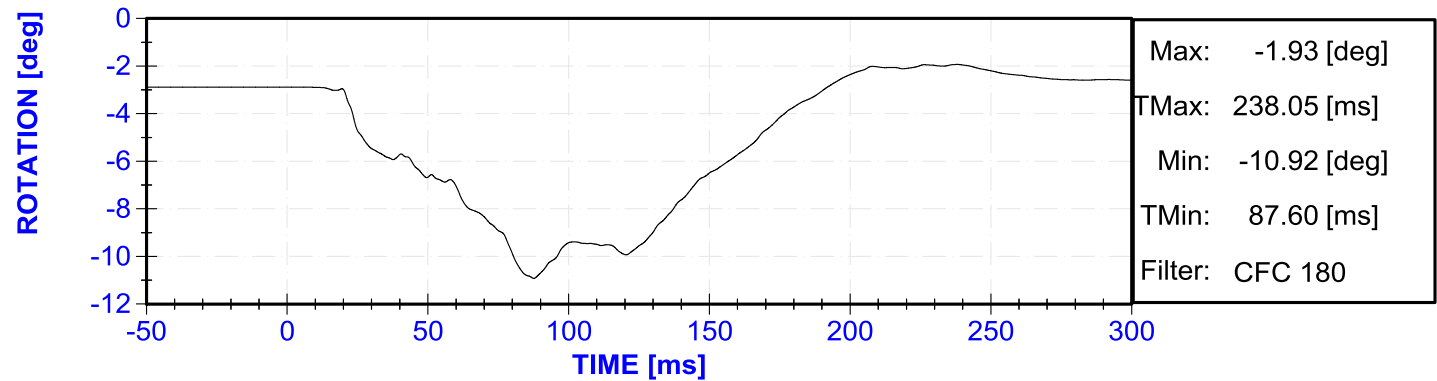
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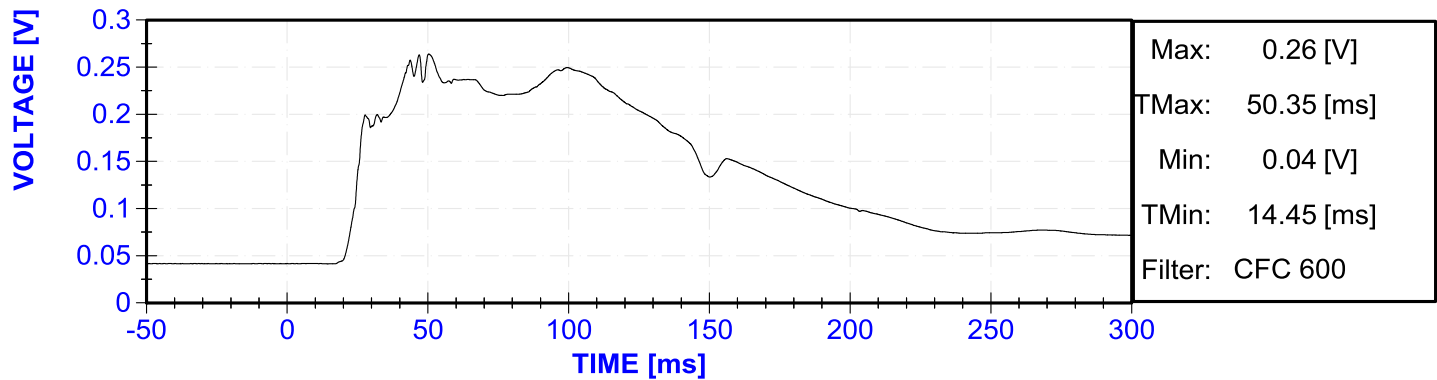
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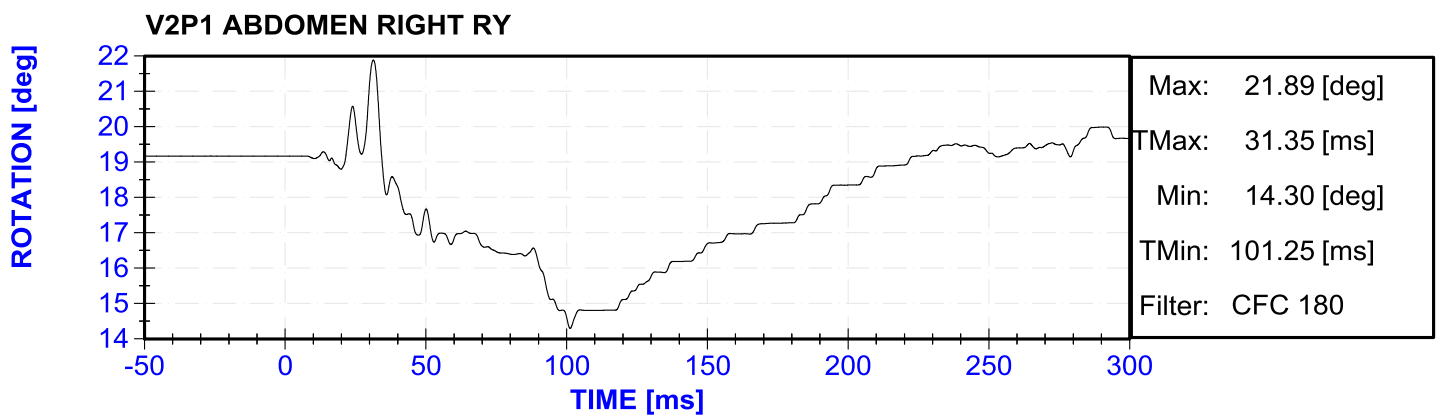
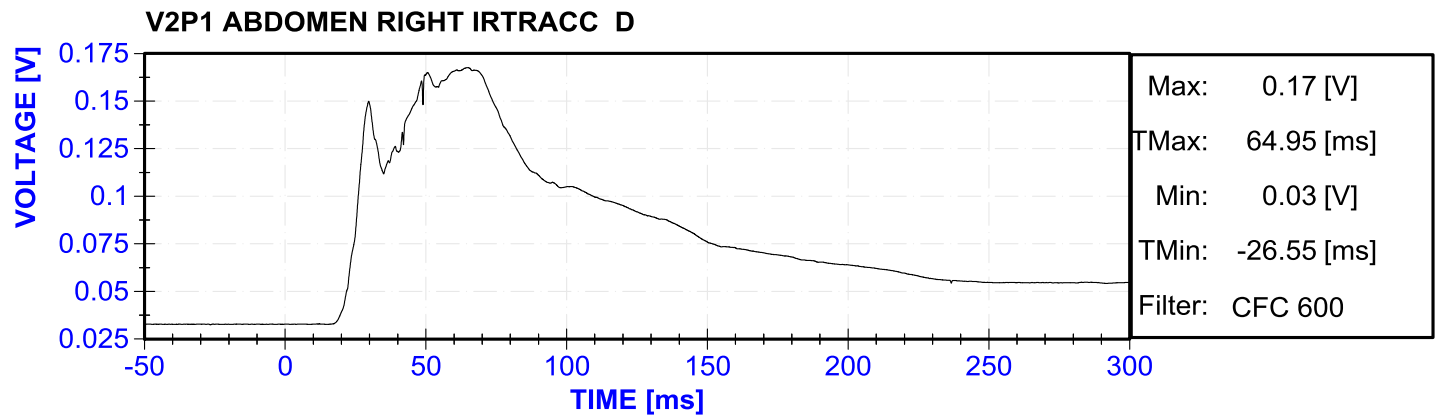
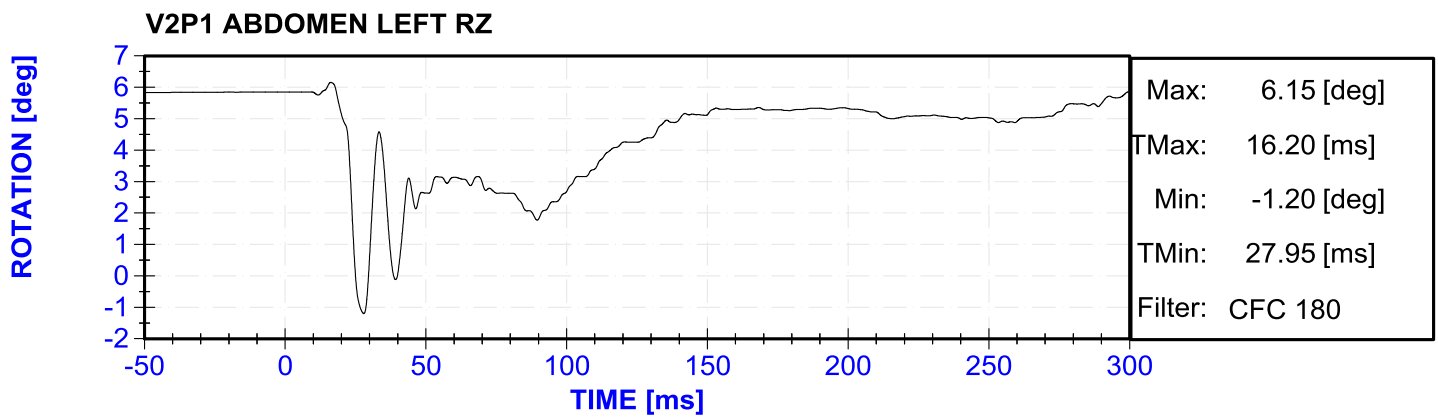
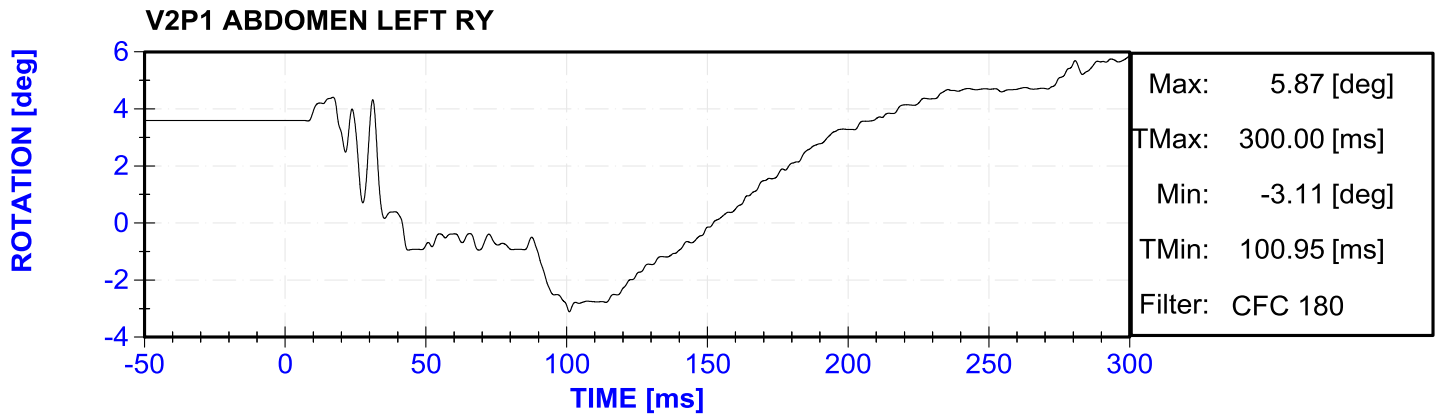


V2P1 LR CHEST RZ

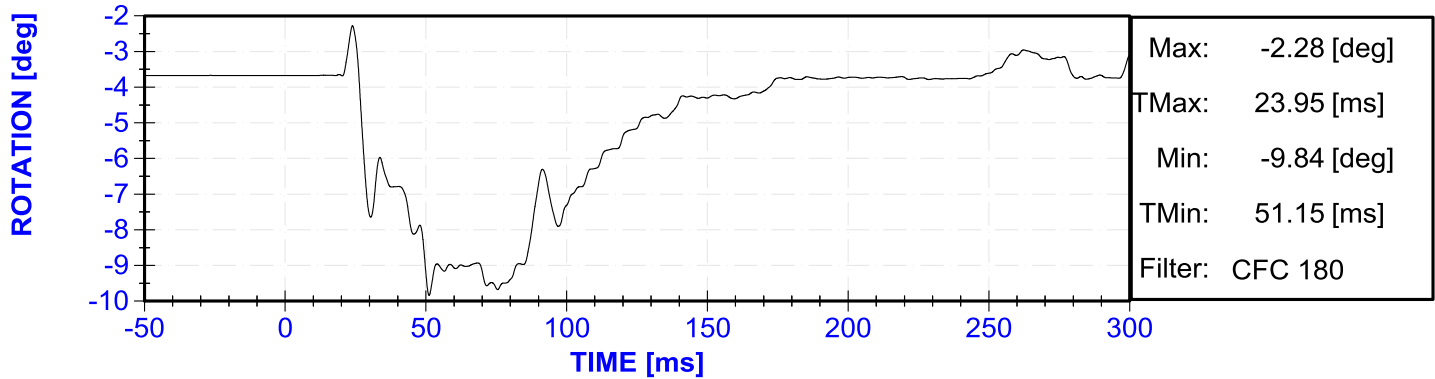


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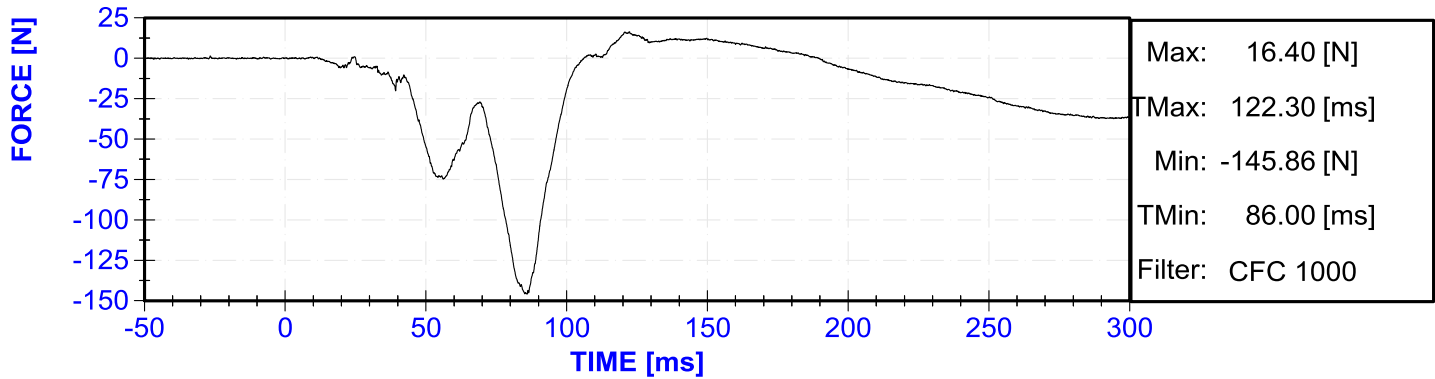




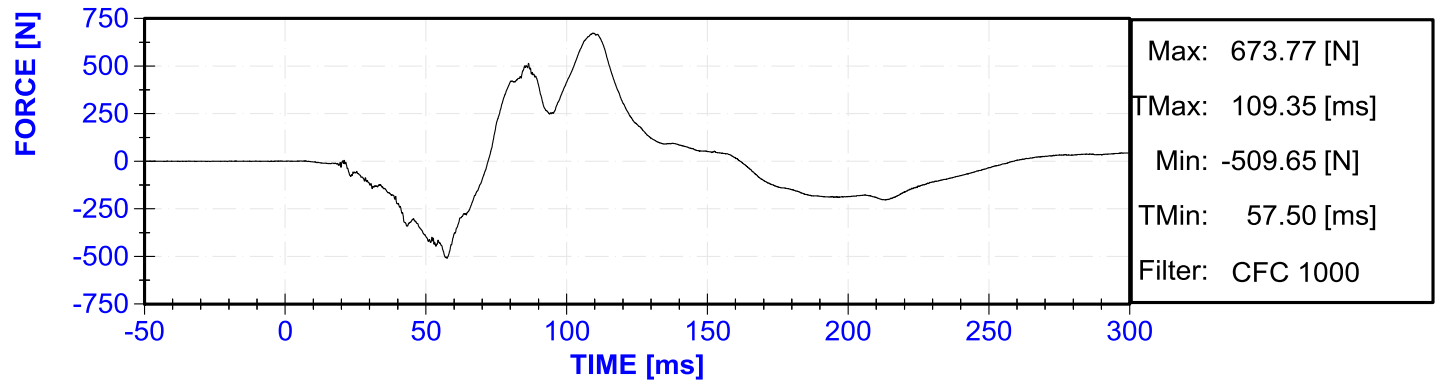
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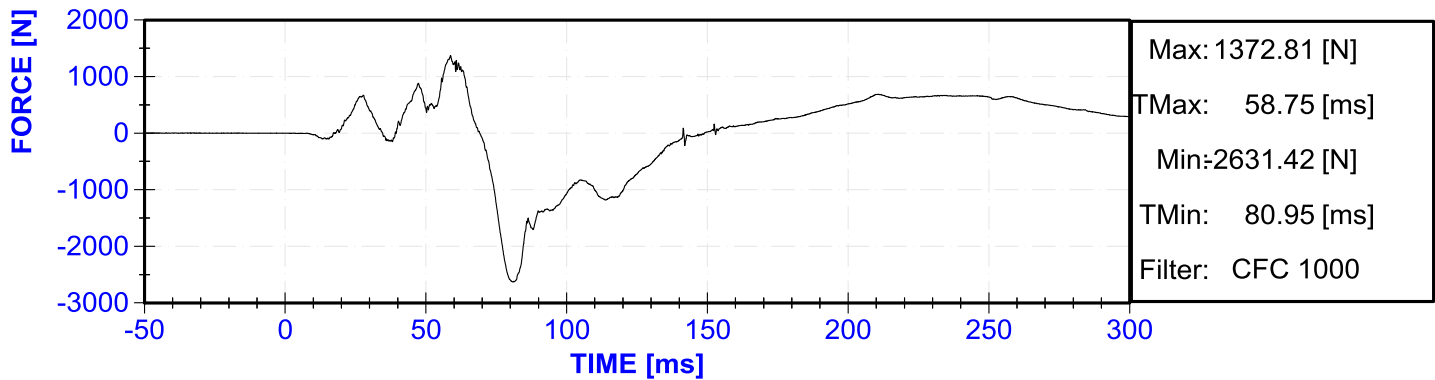
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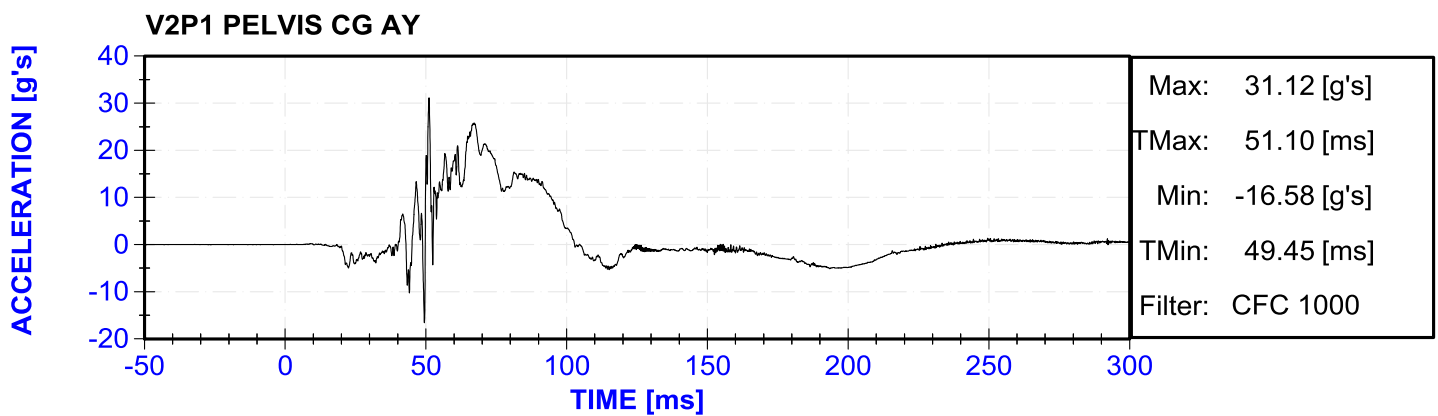
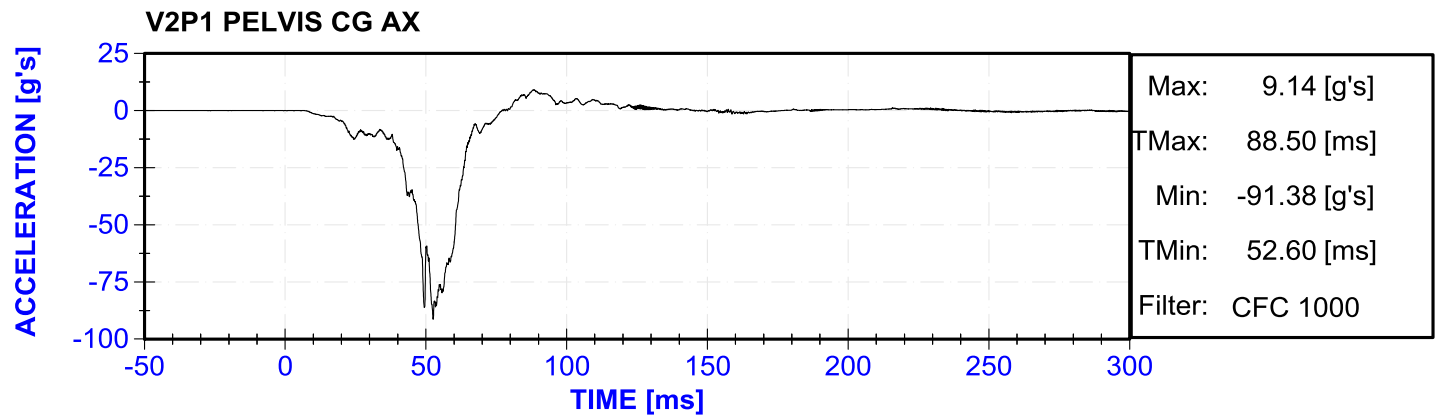
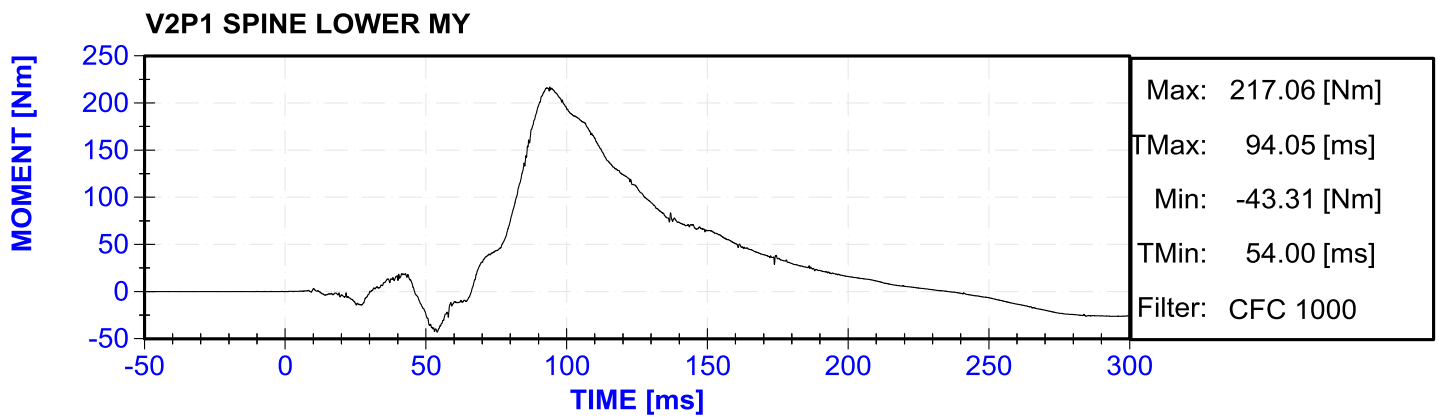
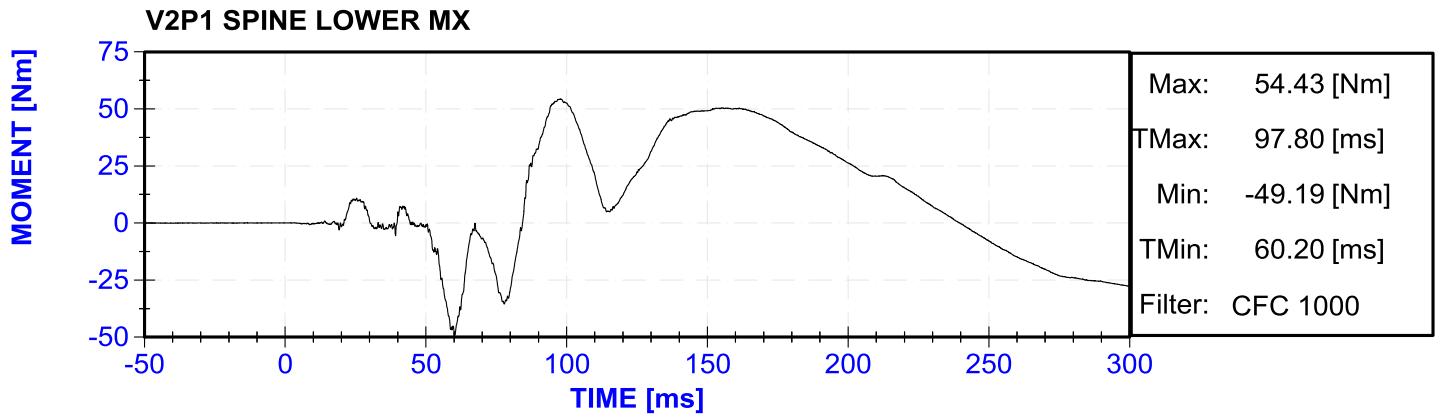


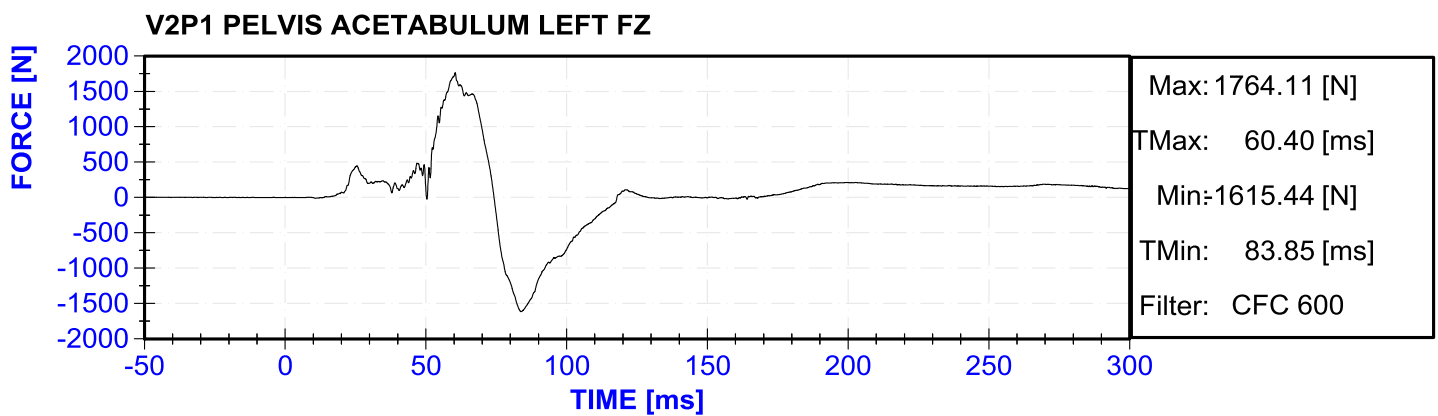
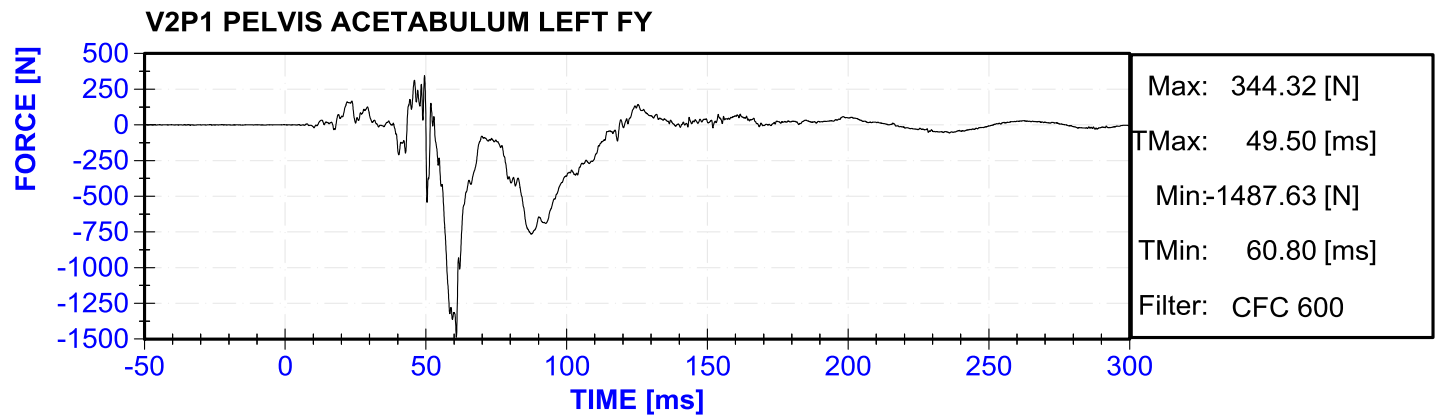
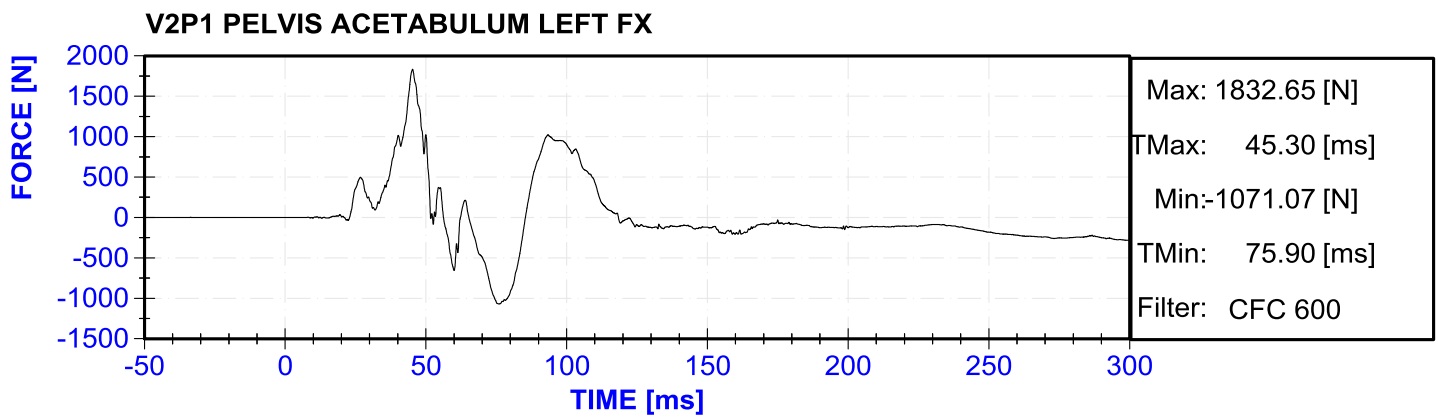
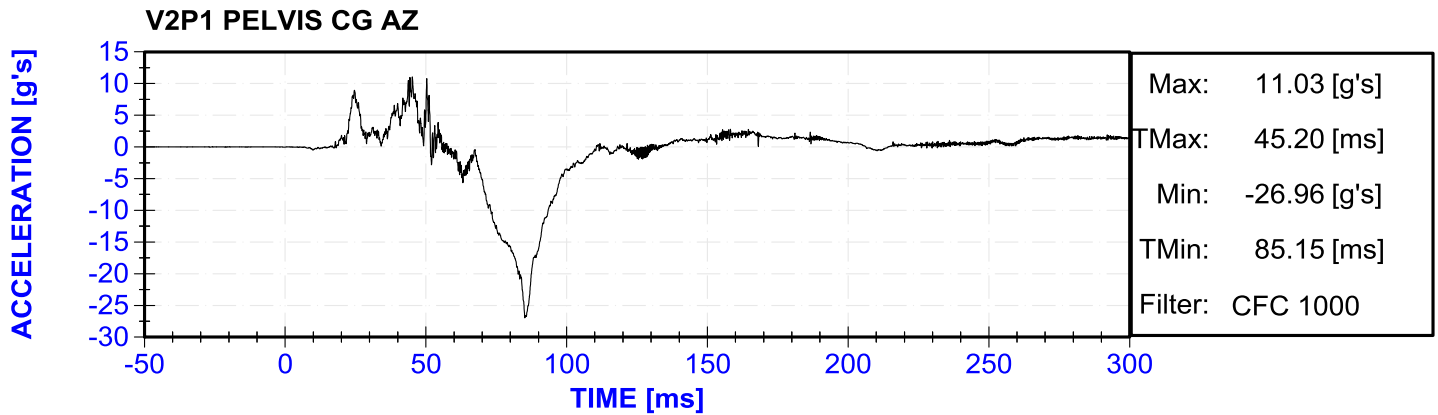
V2P1 SPINE LOWER FY



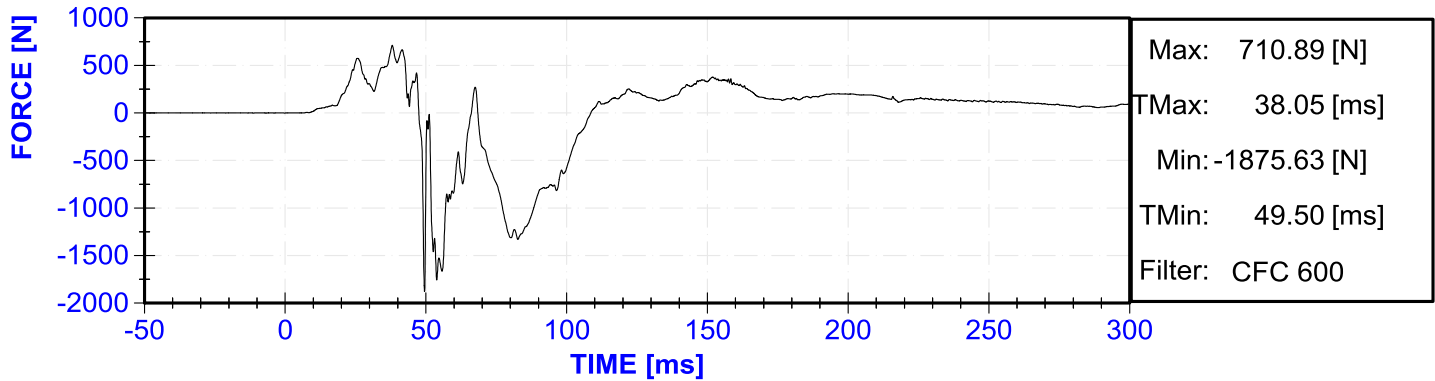
V2P1 SPINE LOWER FZ



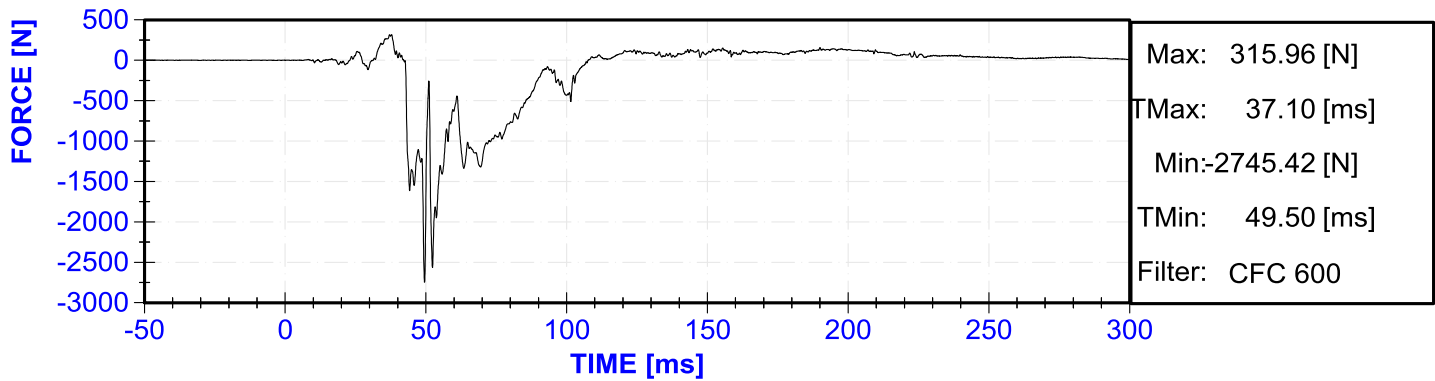




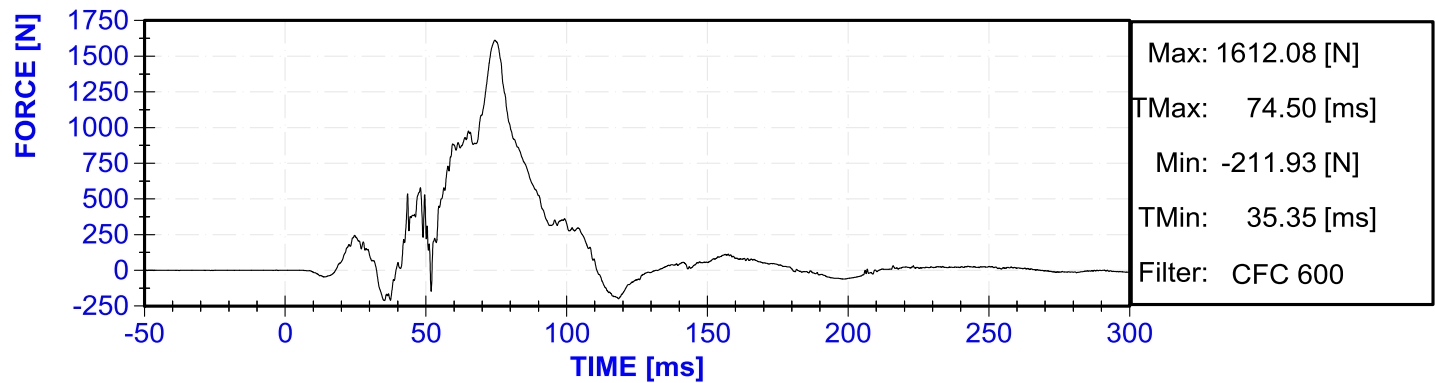
V2P1 PELVIS ACETABULUM RIGHT FX



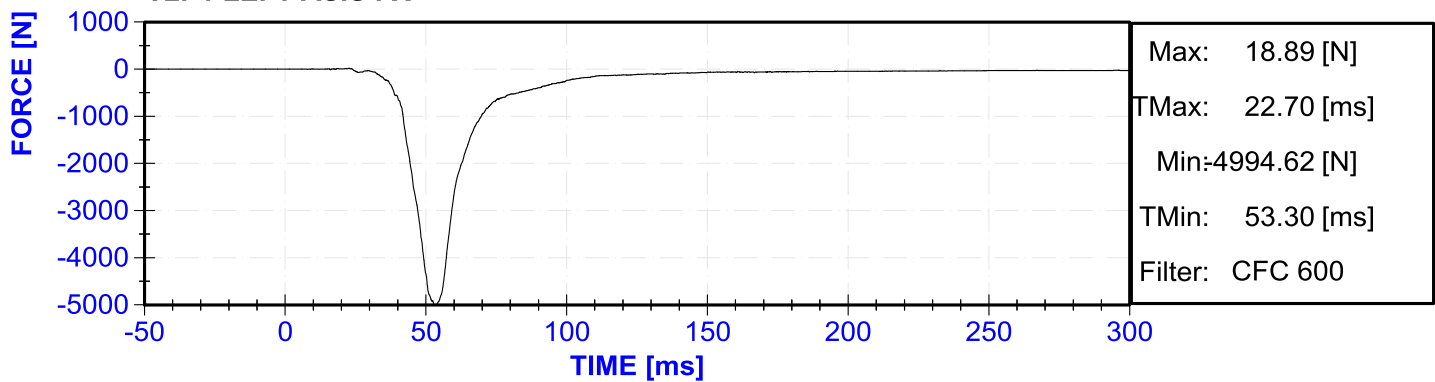
V2P1 PELVIS ACETABULUM RIGHT FY

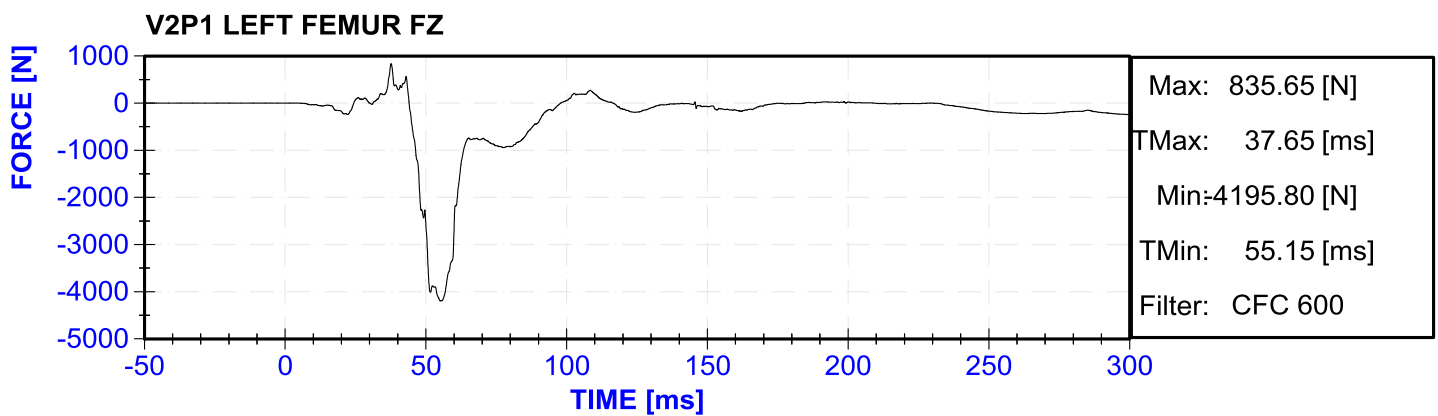
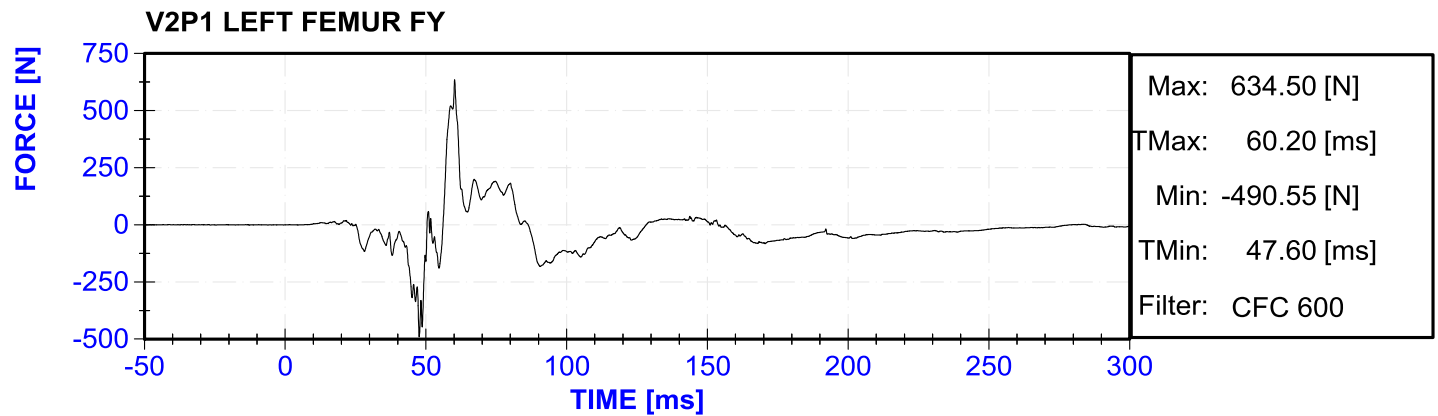
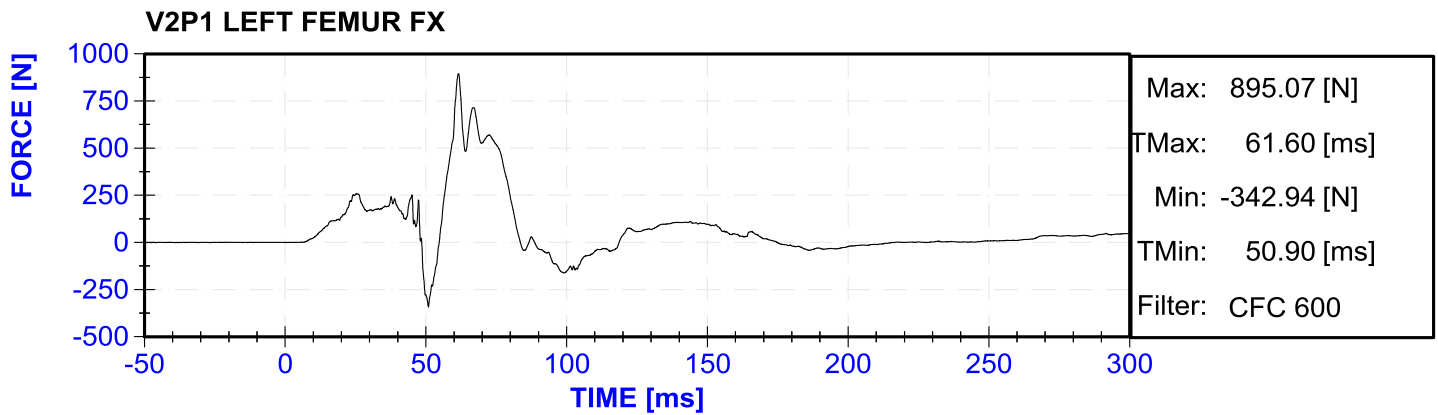
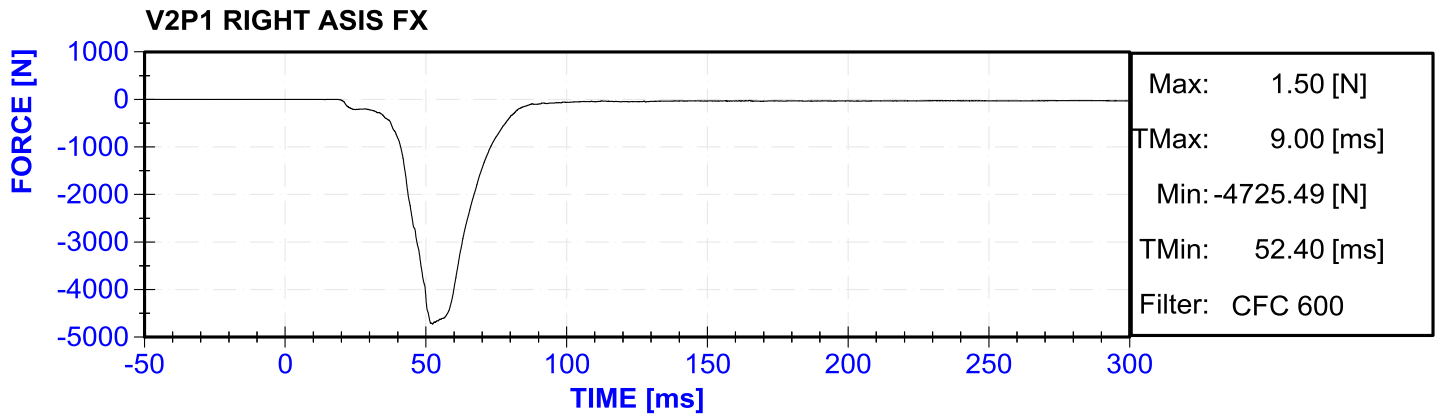


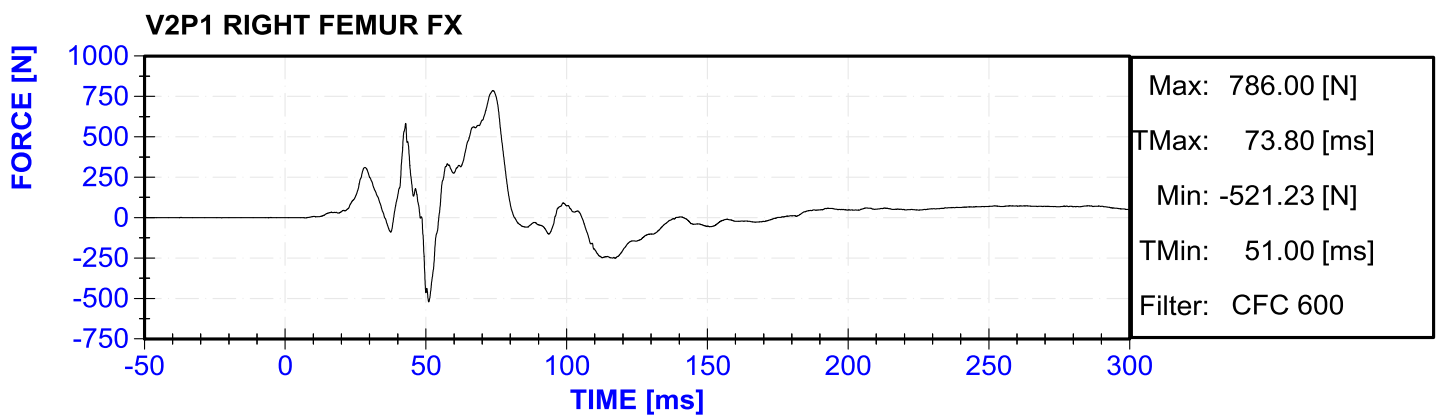
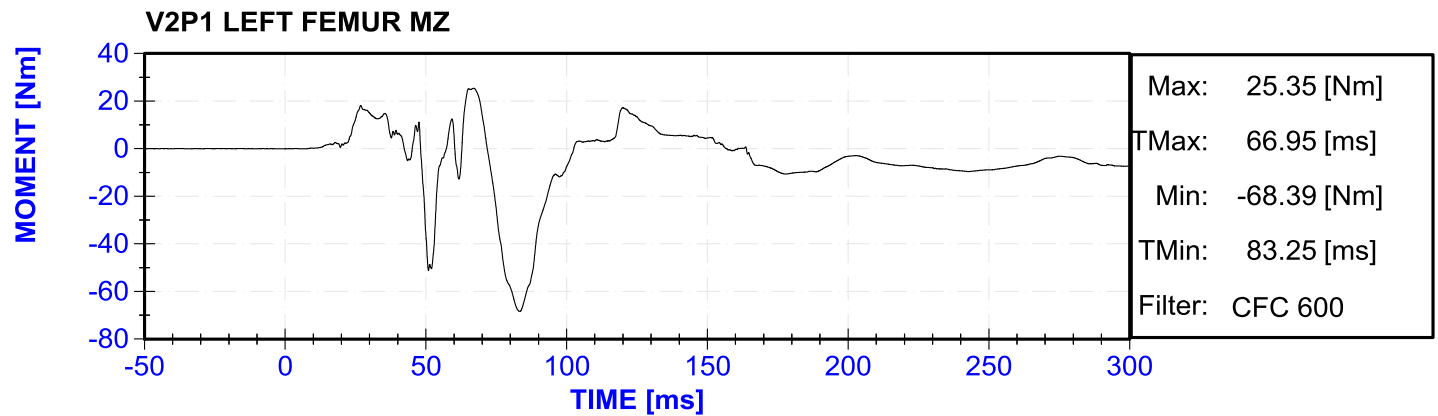
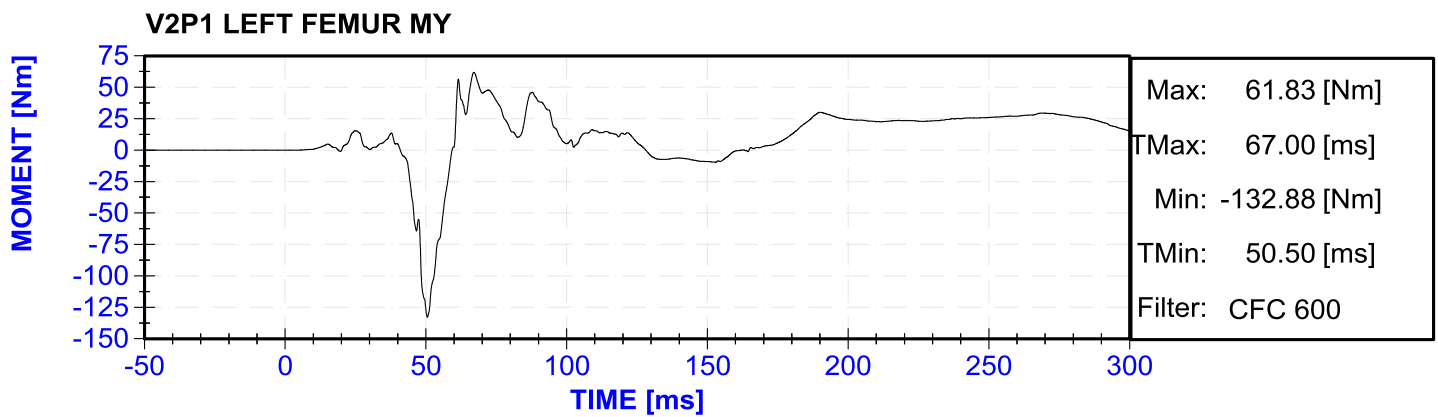
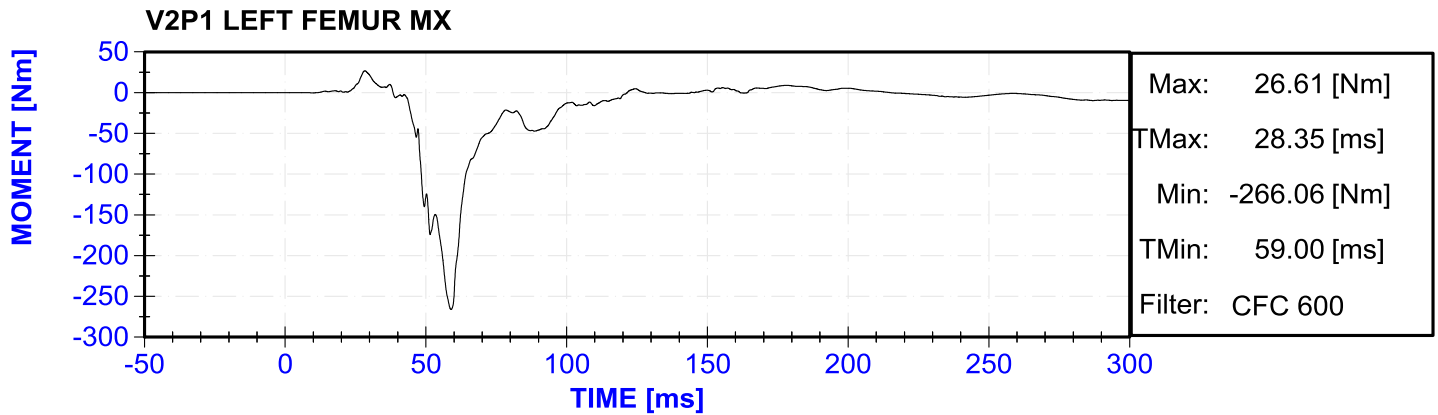
V2P1 PELVIS ACETABULUM RIGHT FZ

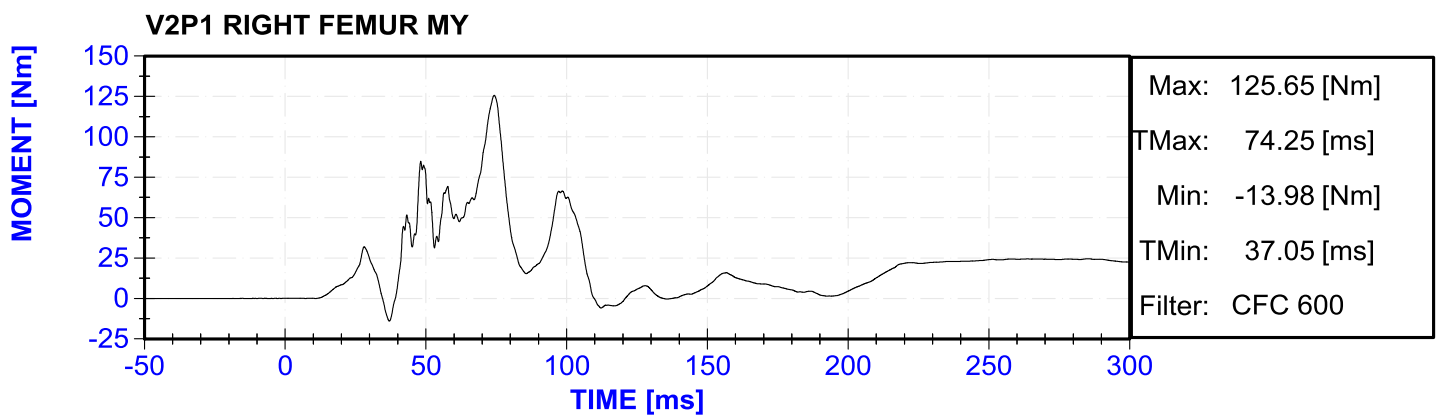
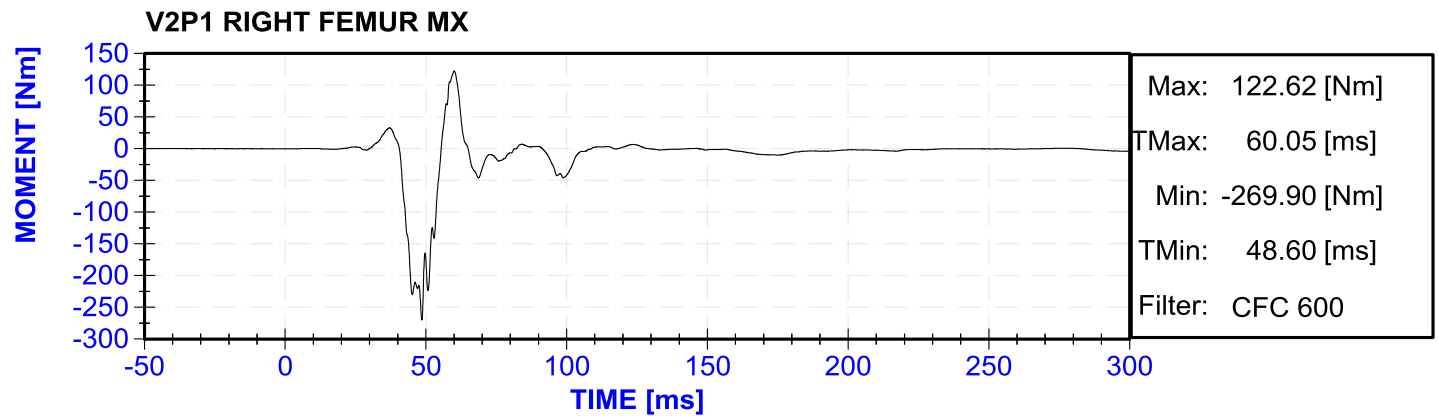
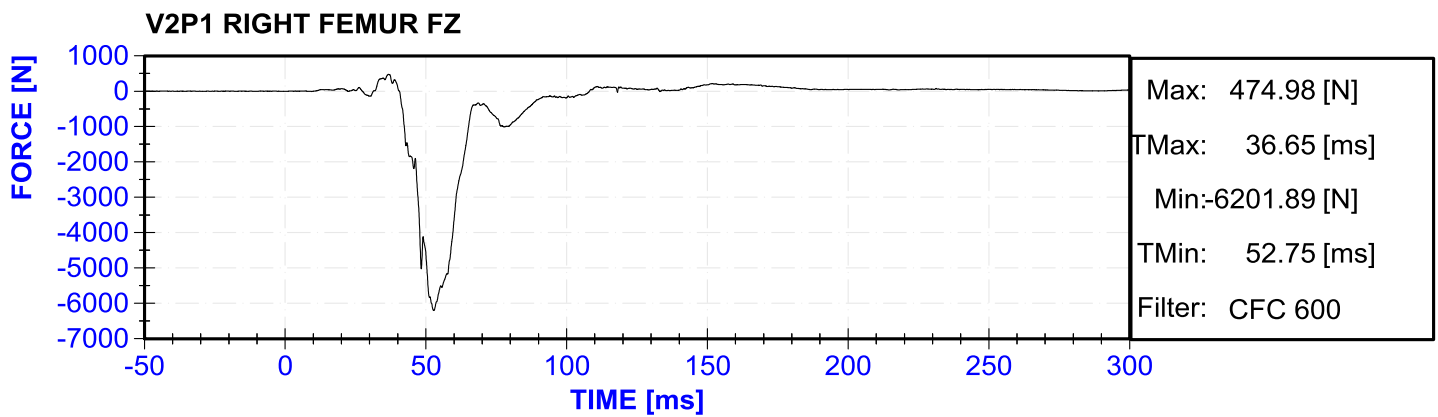
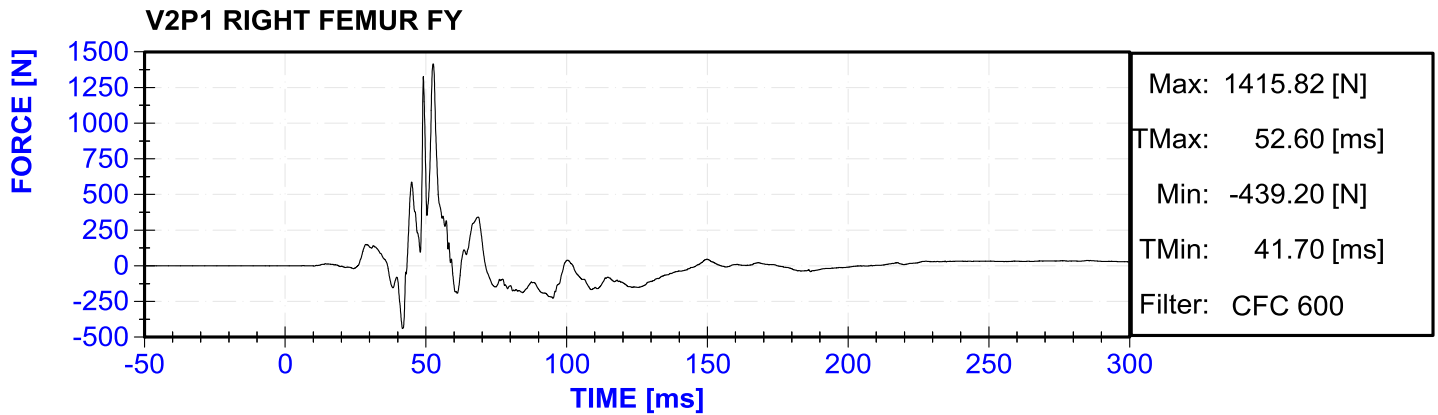


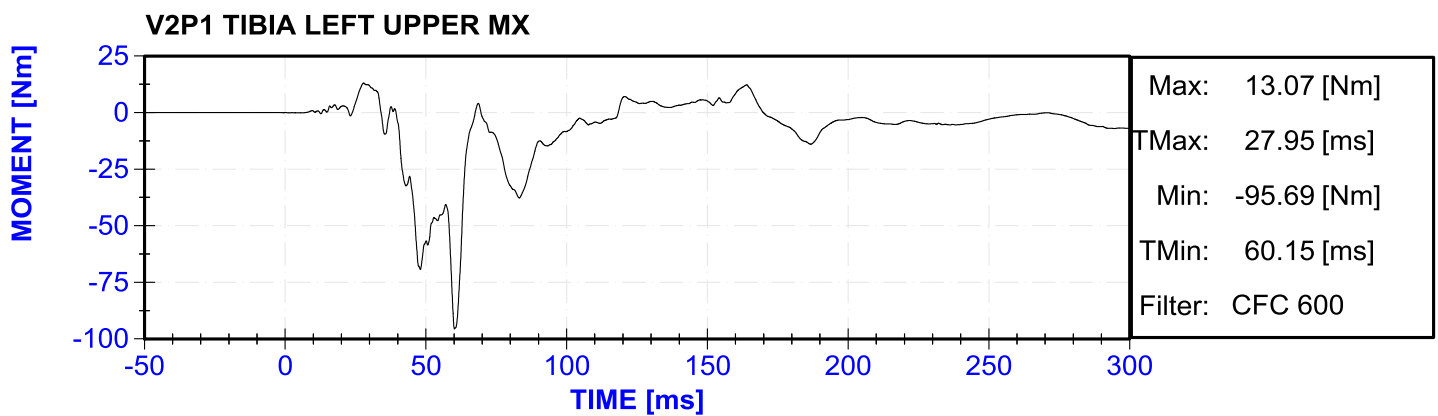
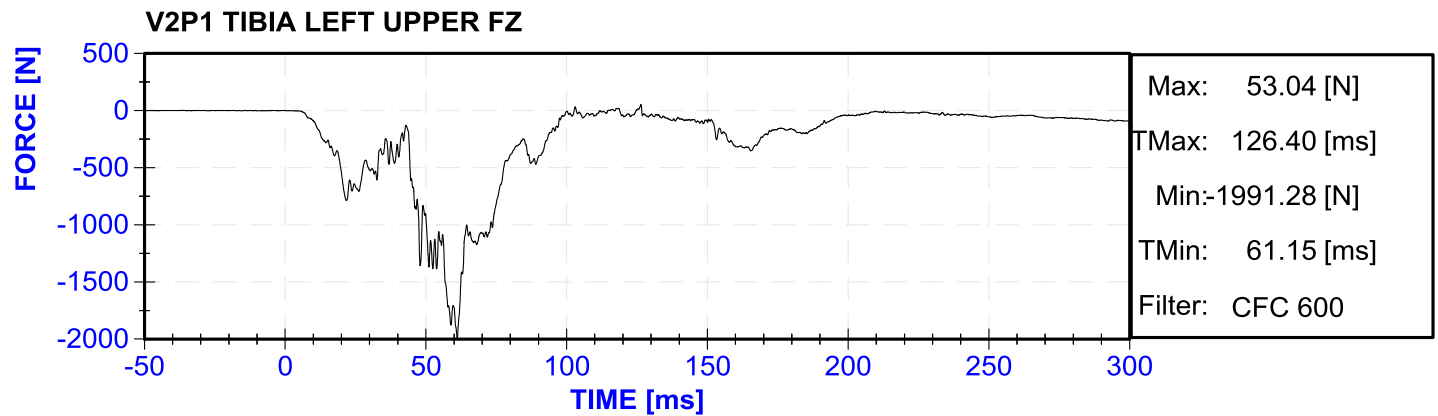
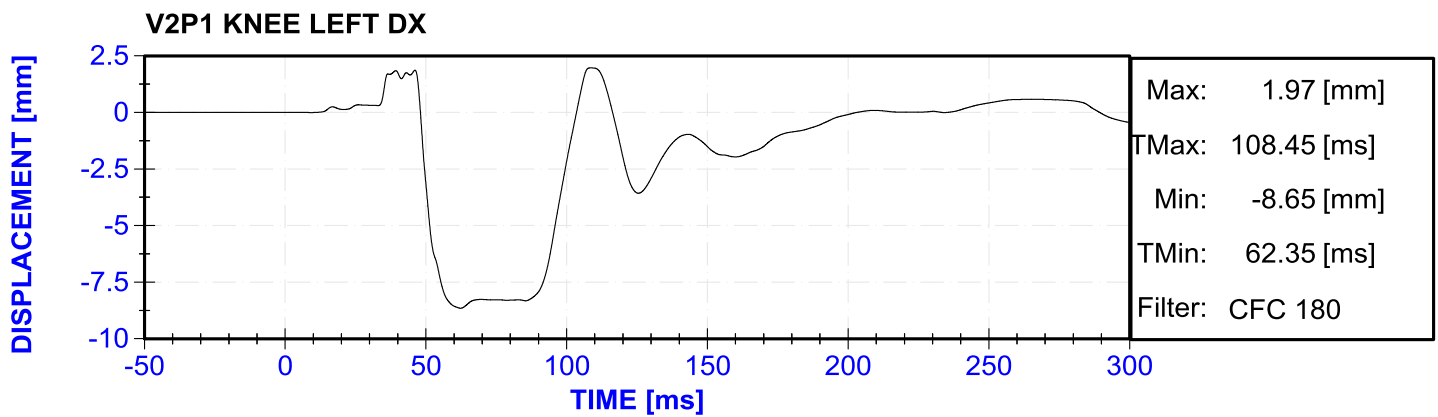
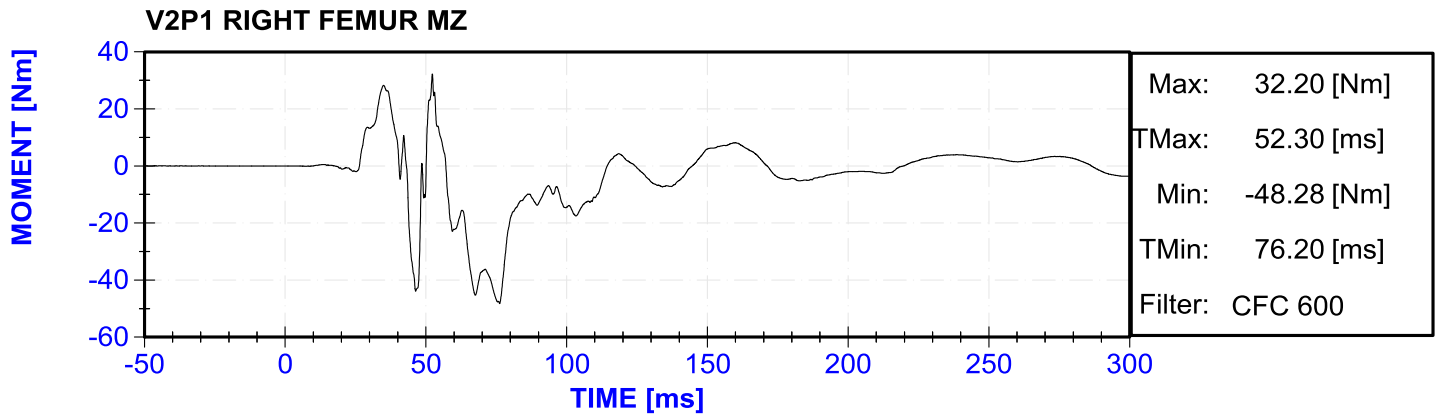
V2P1 LEFT ASIS FX

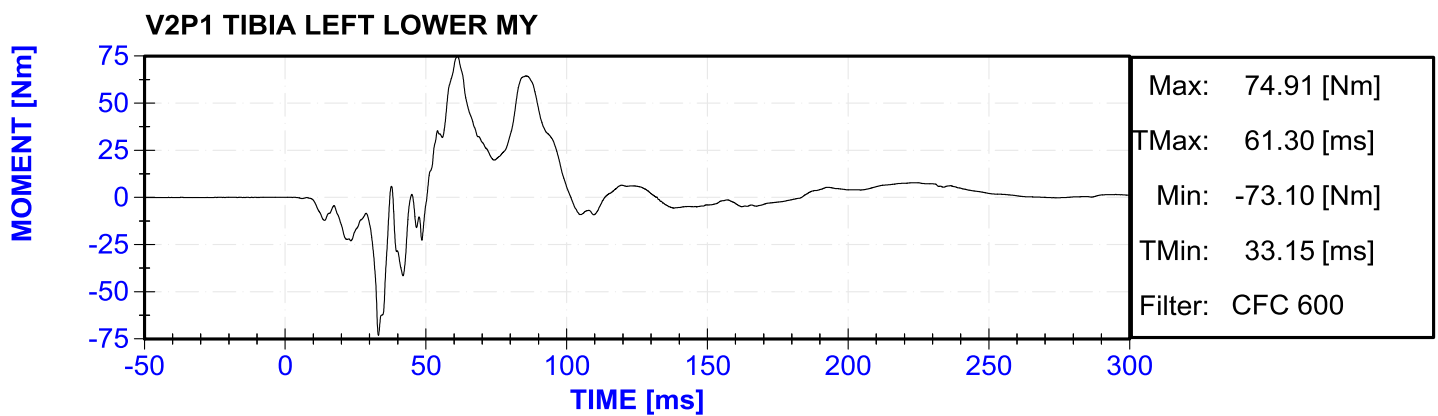
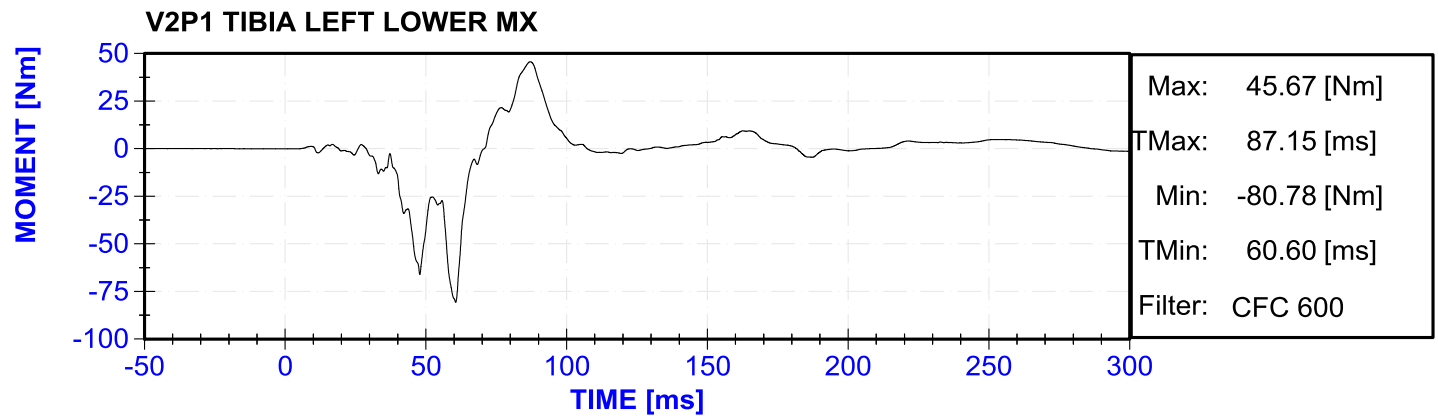
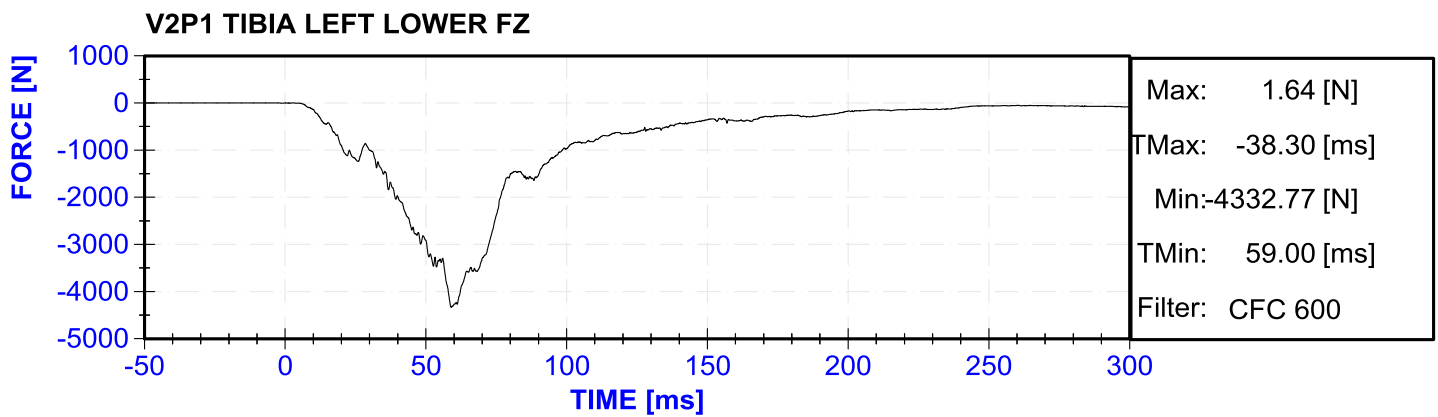
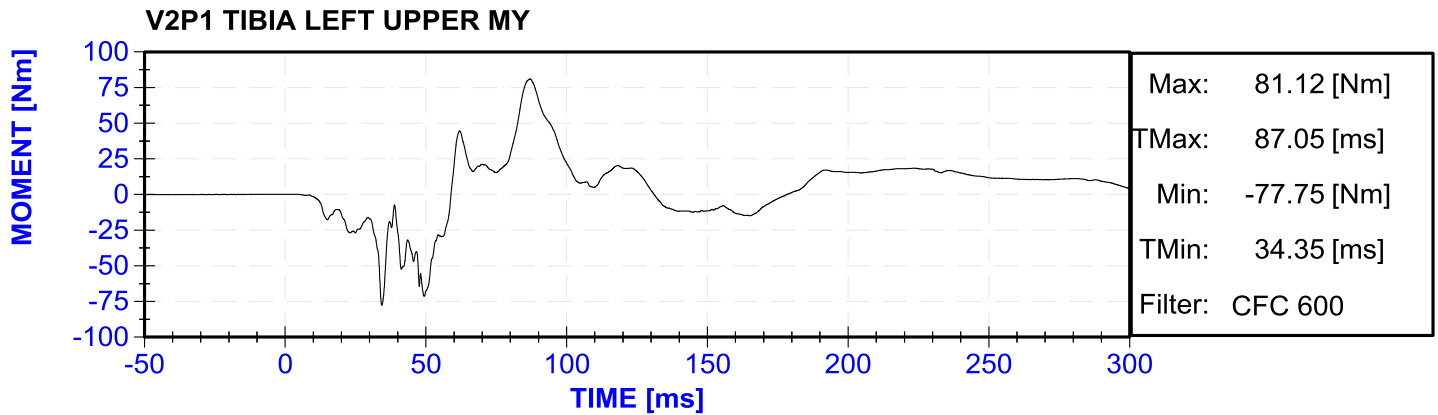


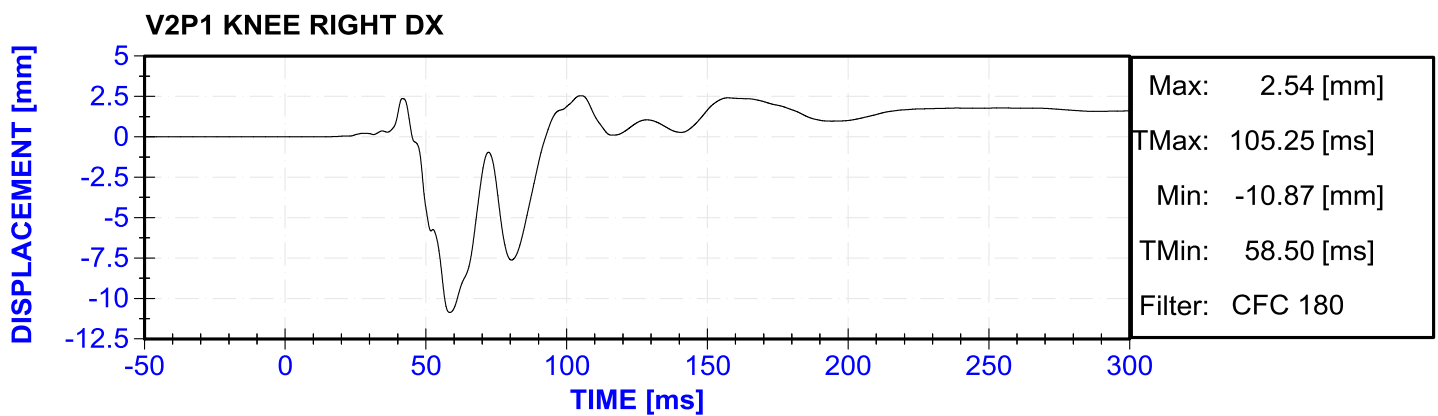
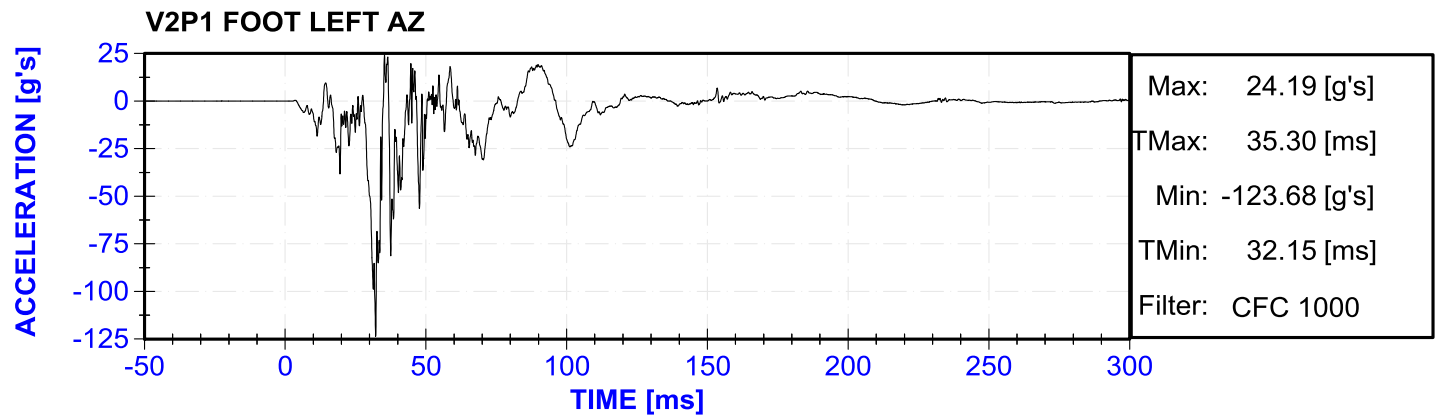
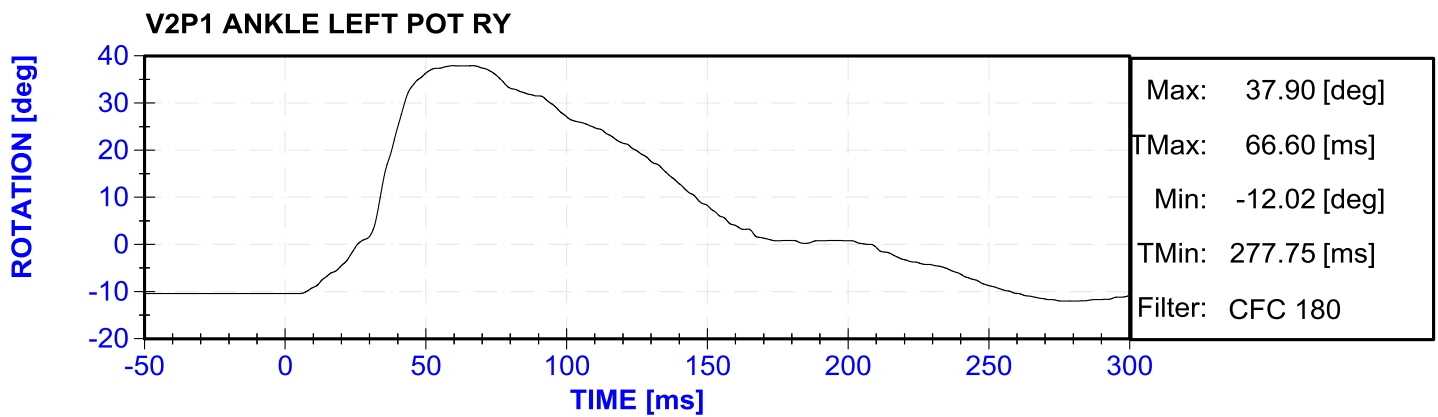
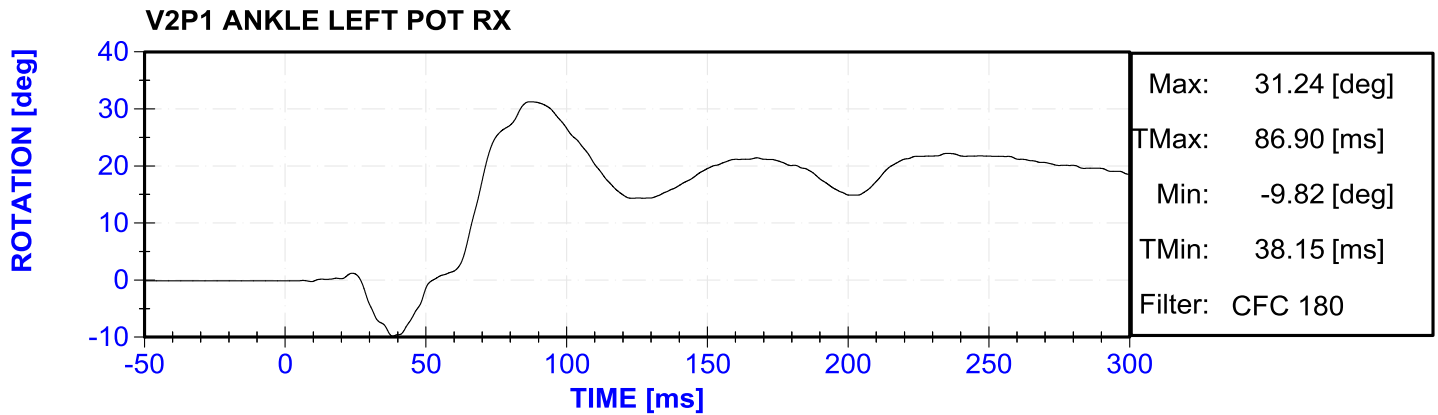


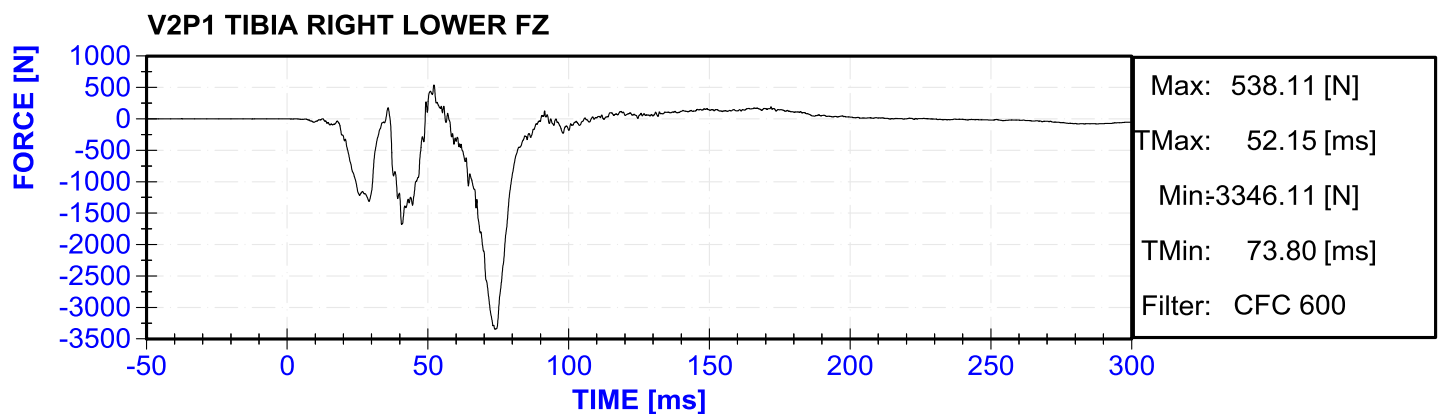
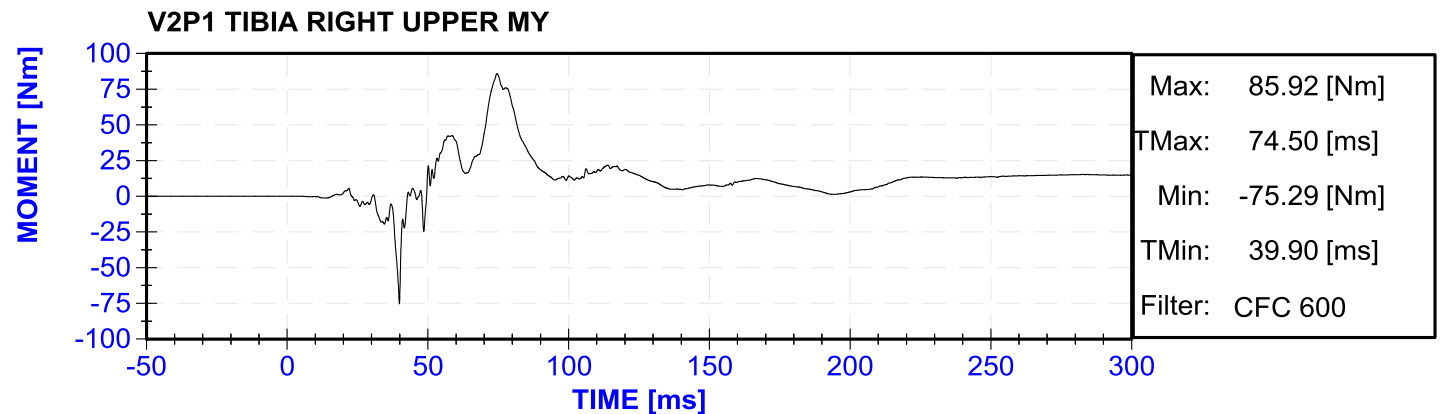
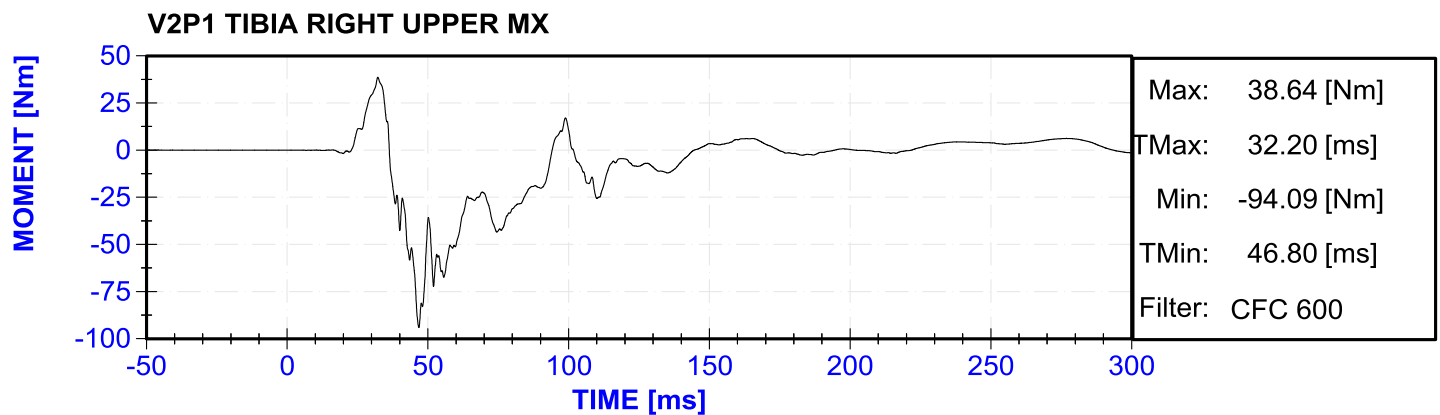
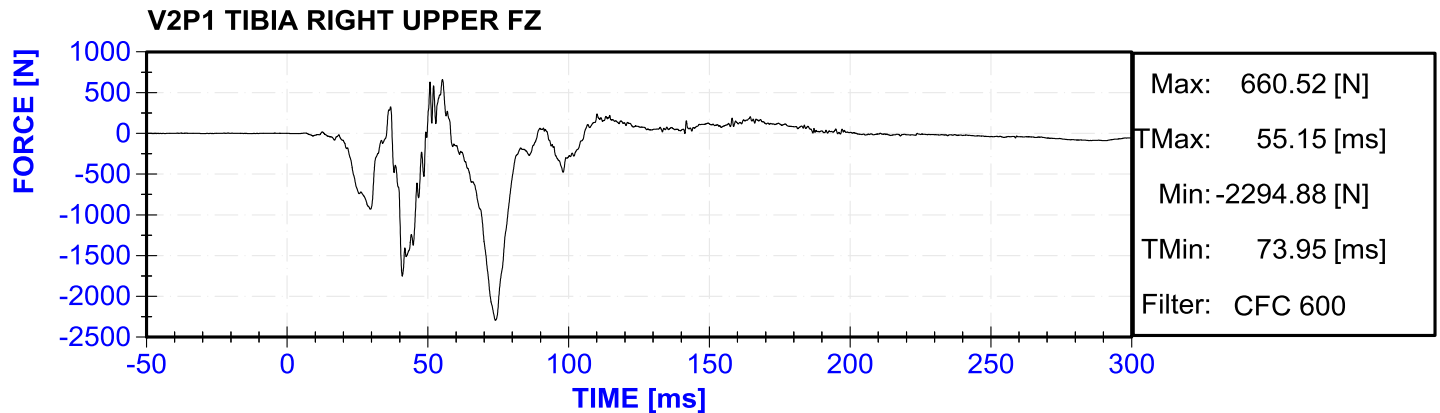


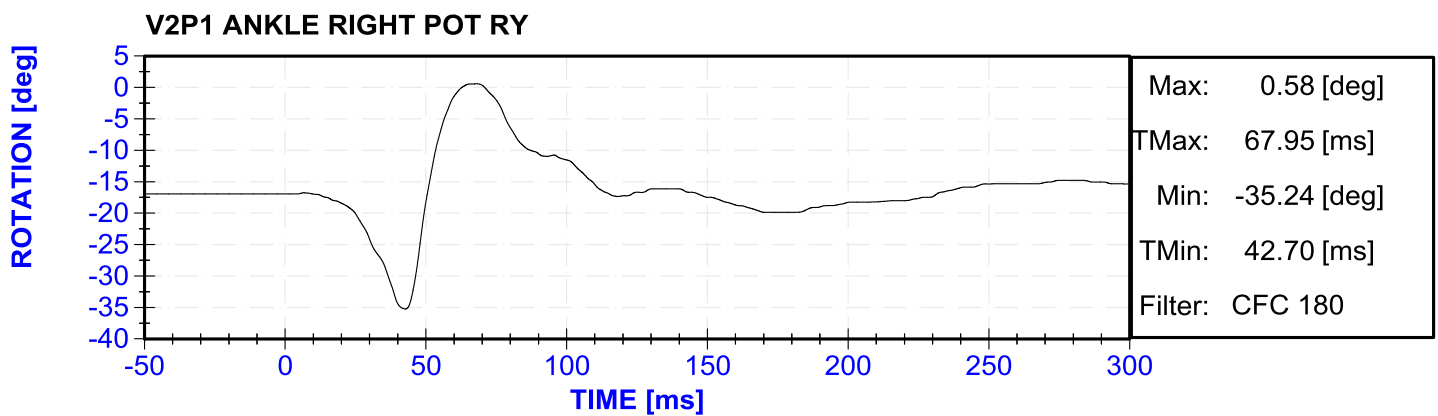
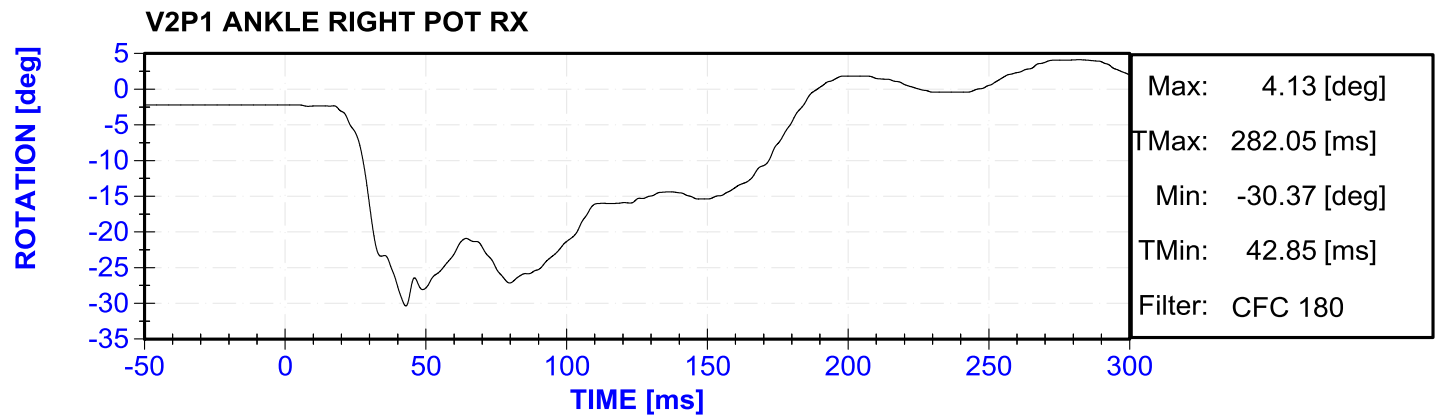
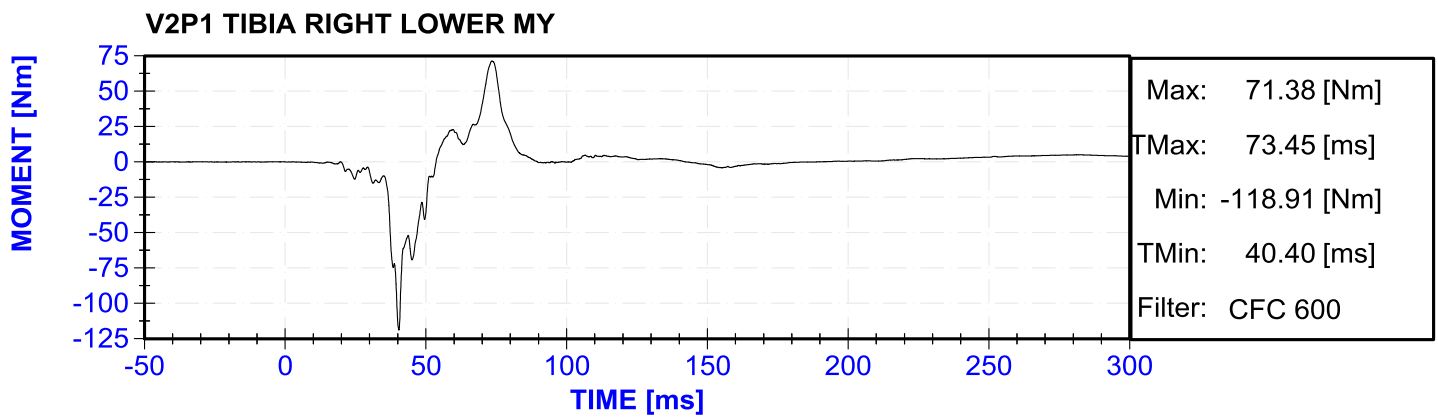
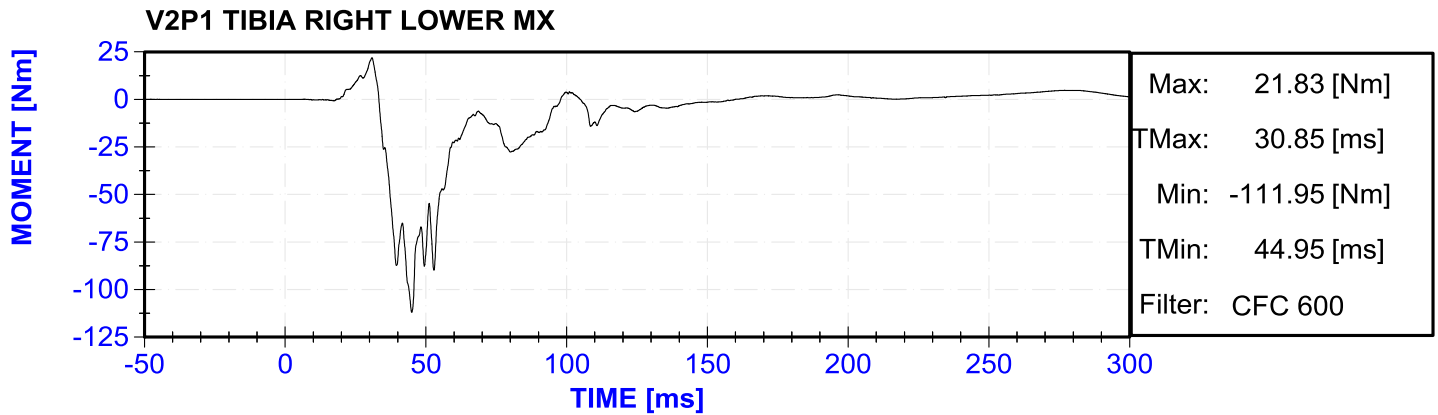


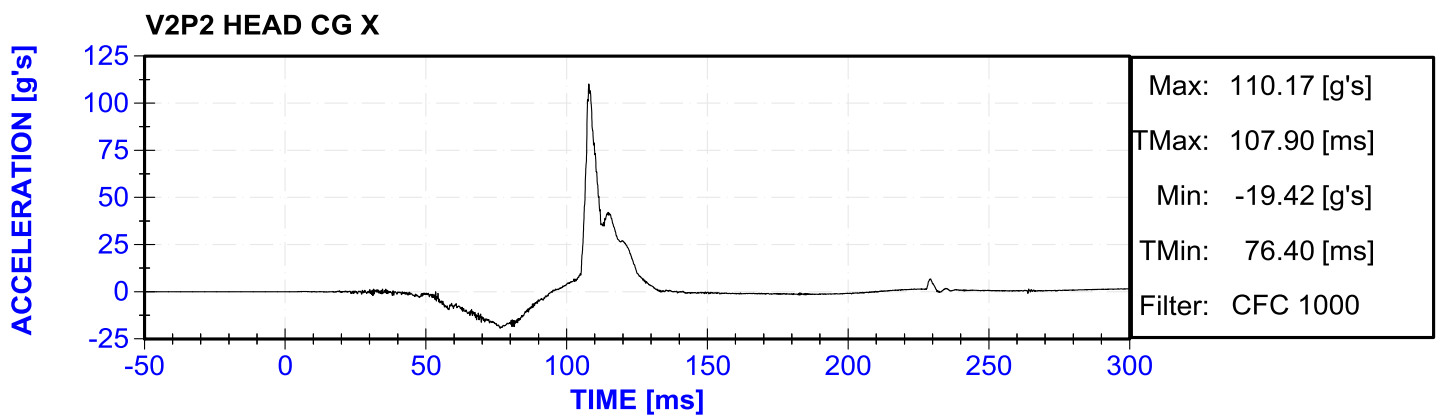
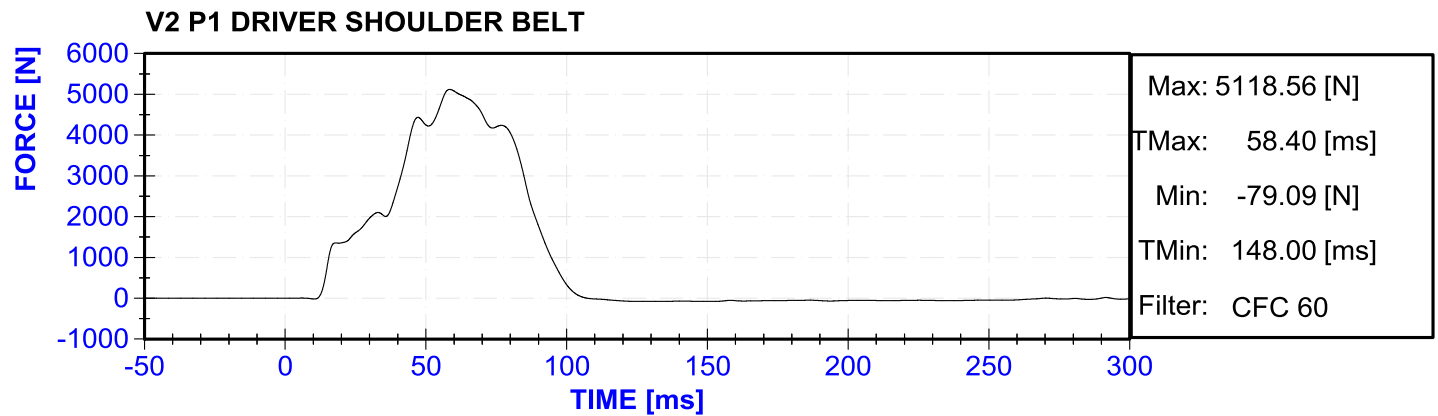
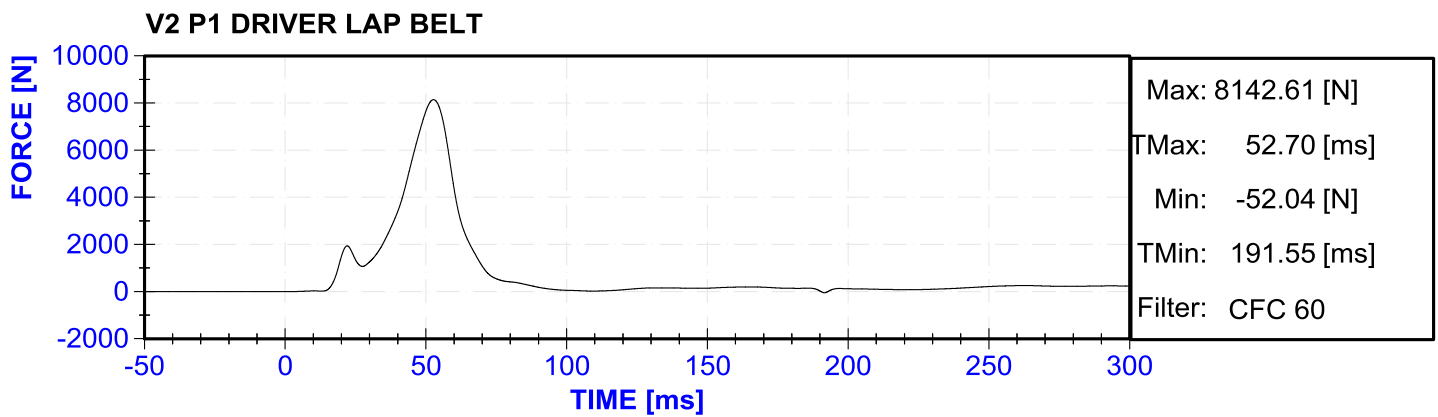
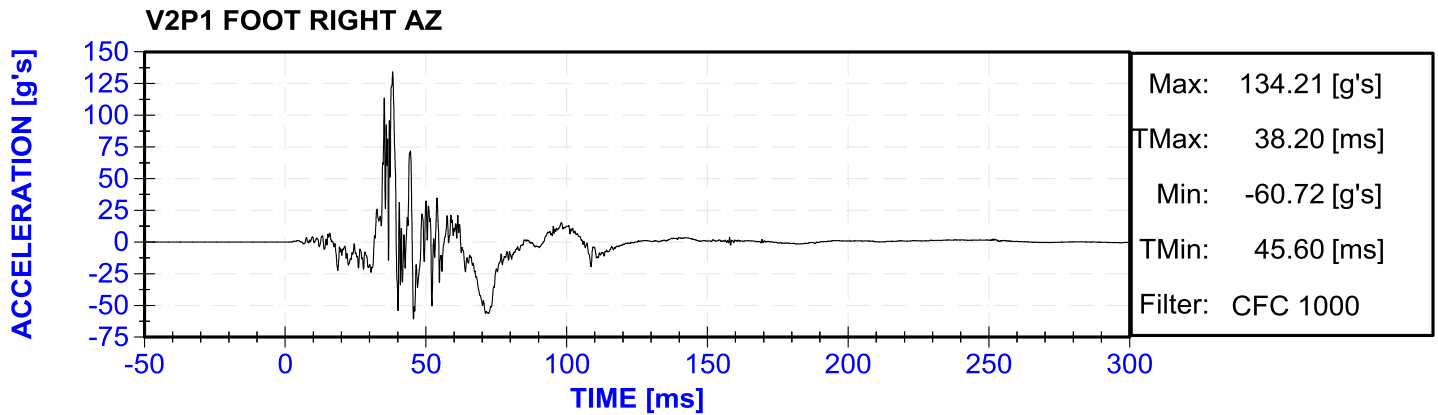


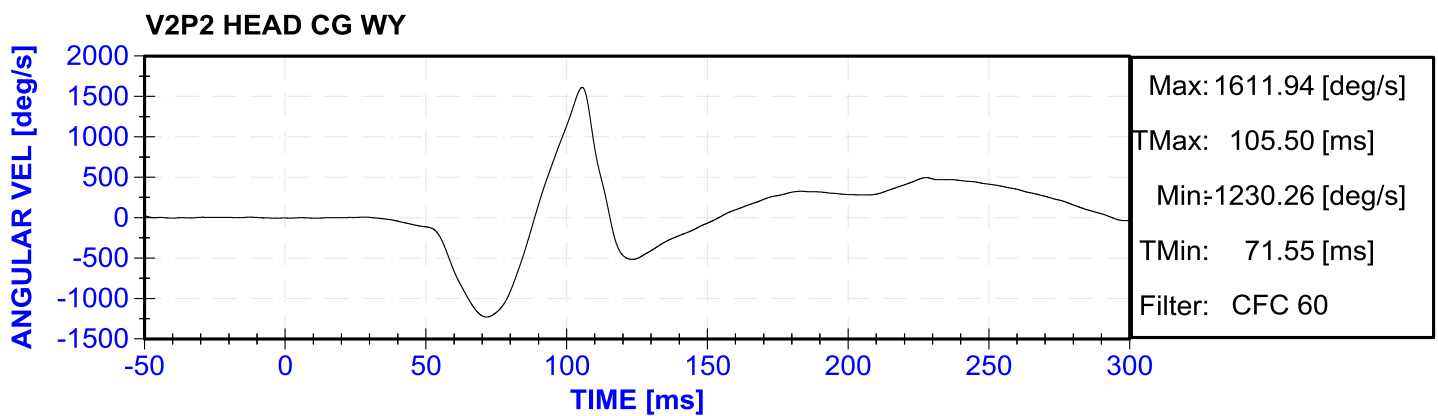
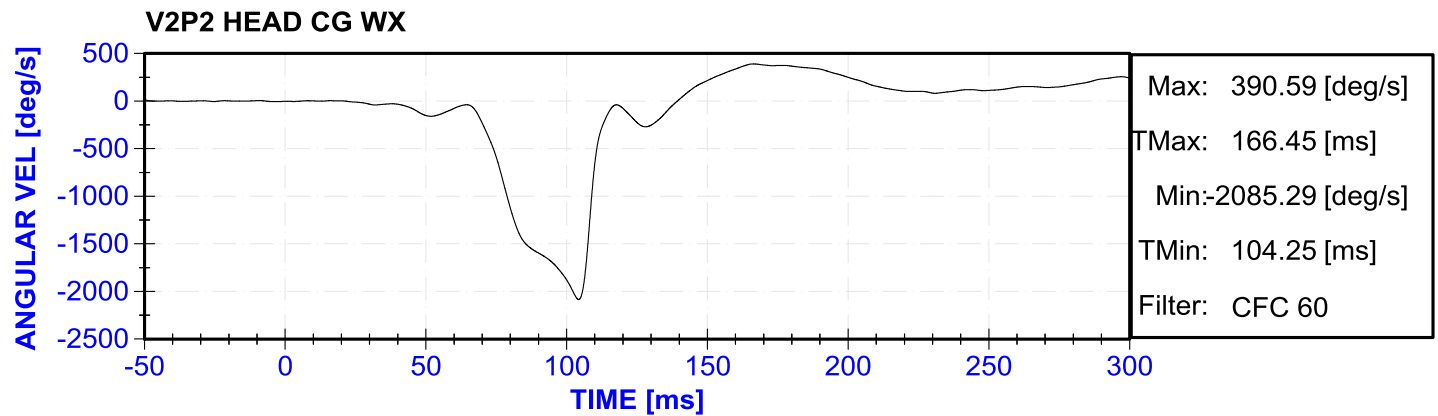
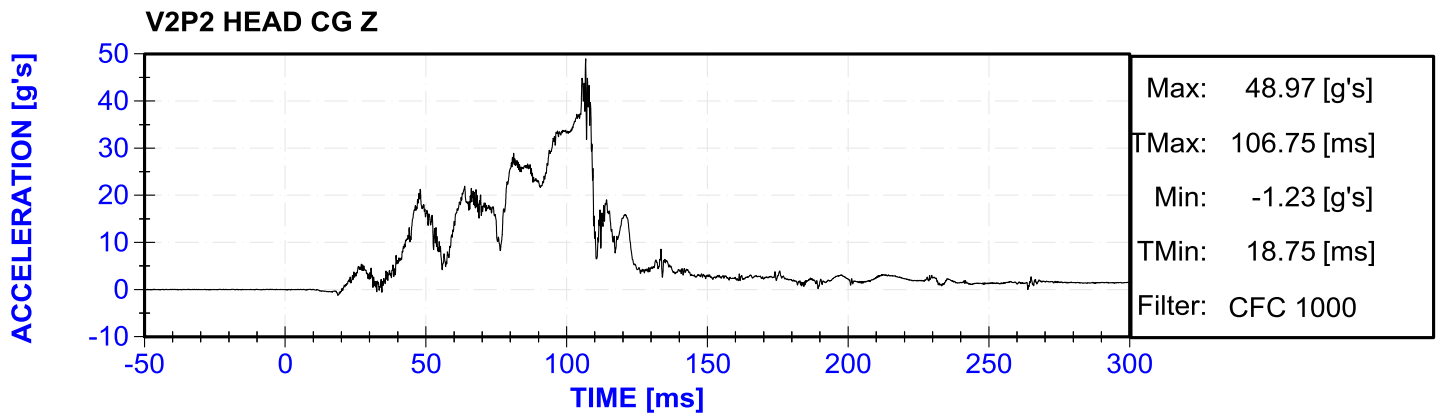
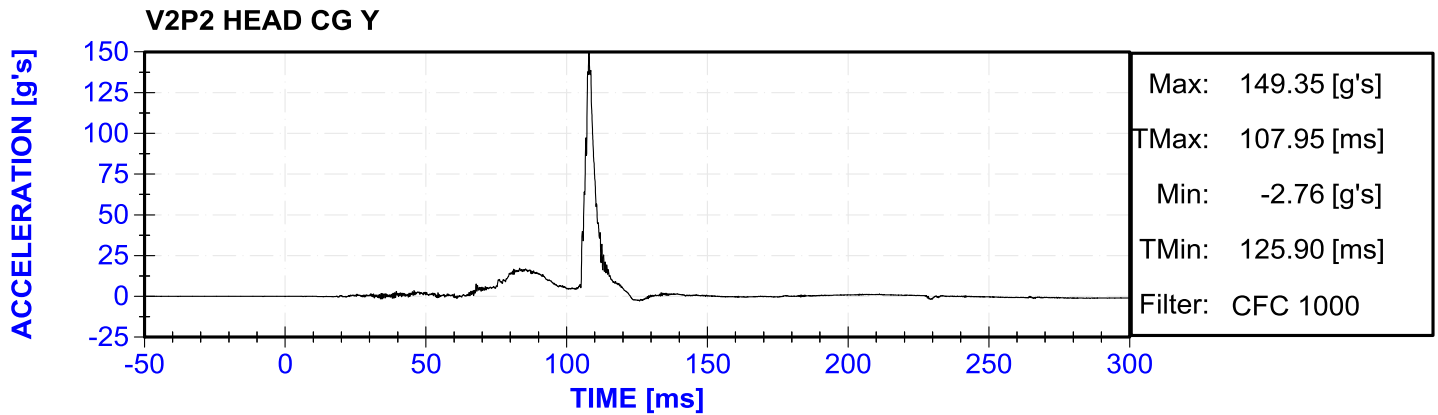


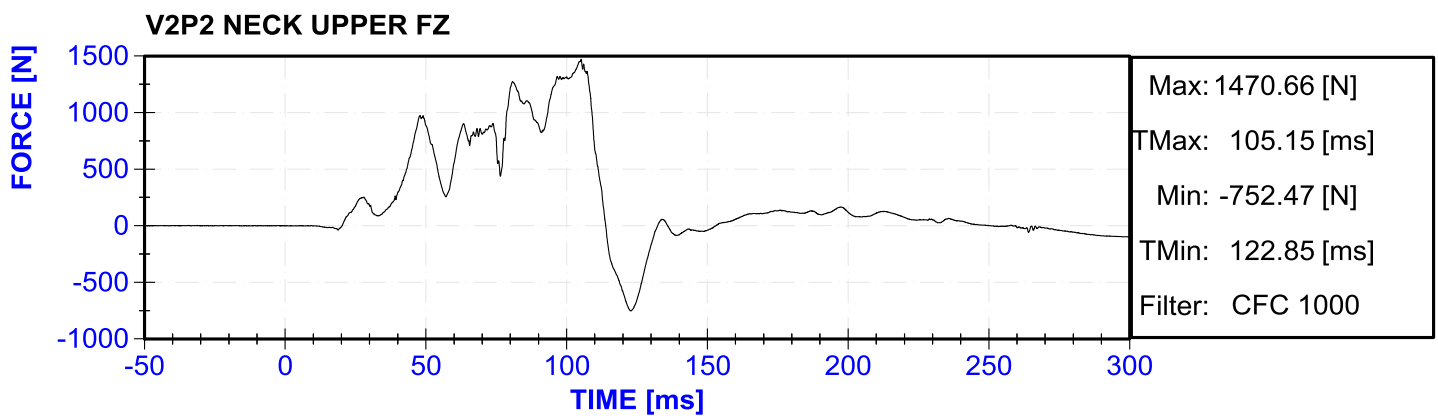
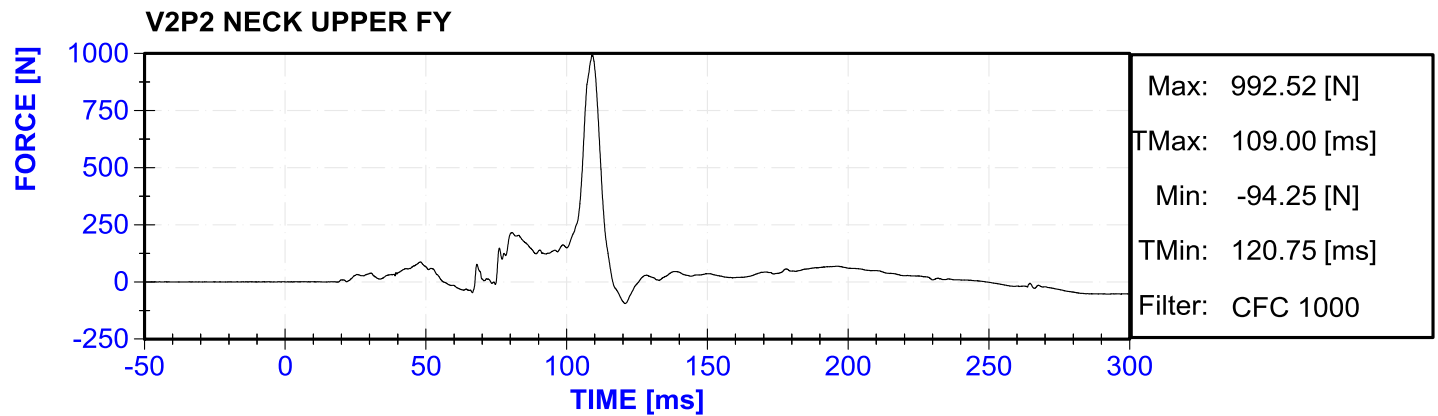
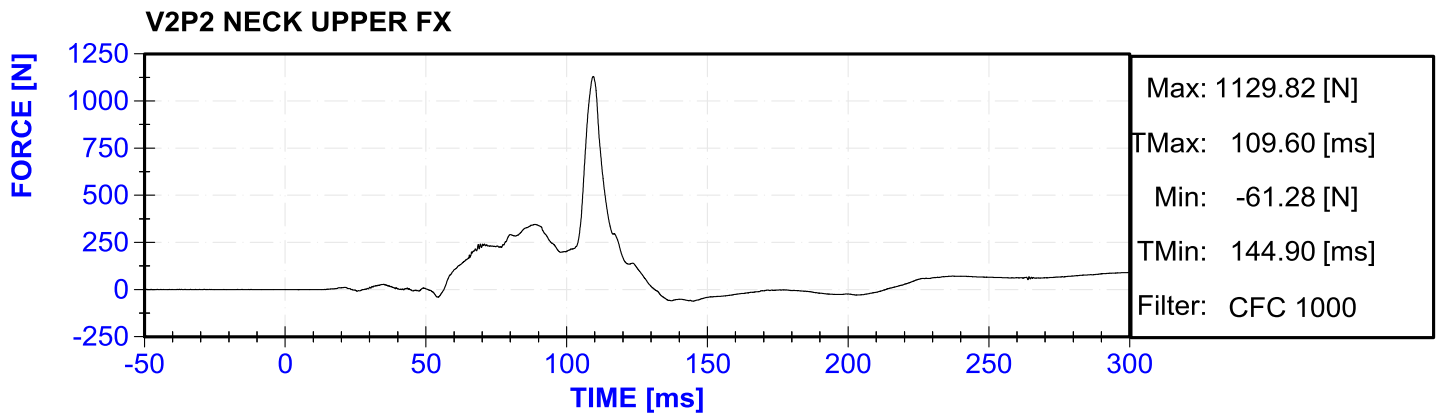
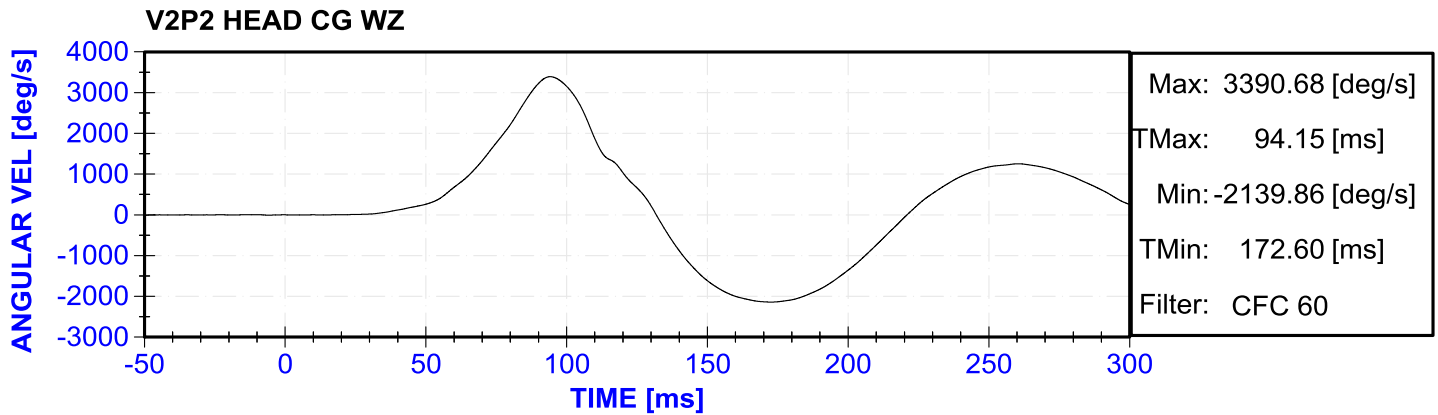


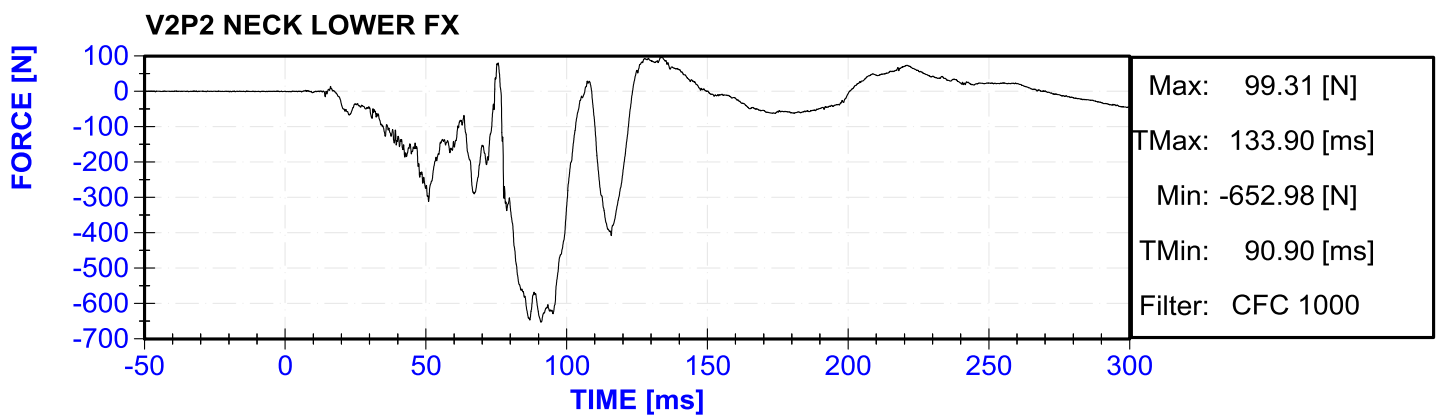
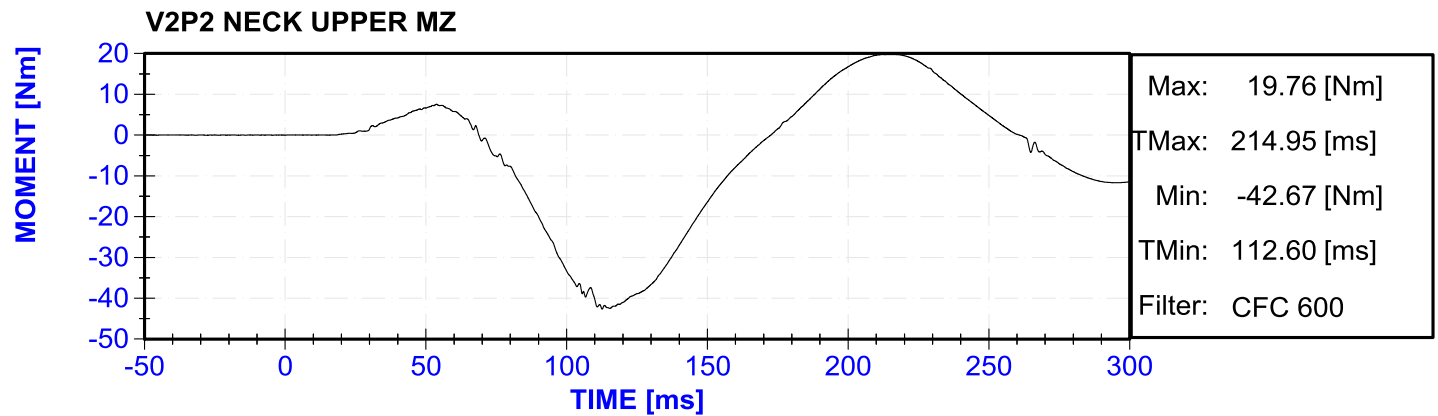
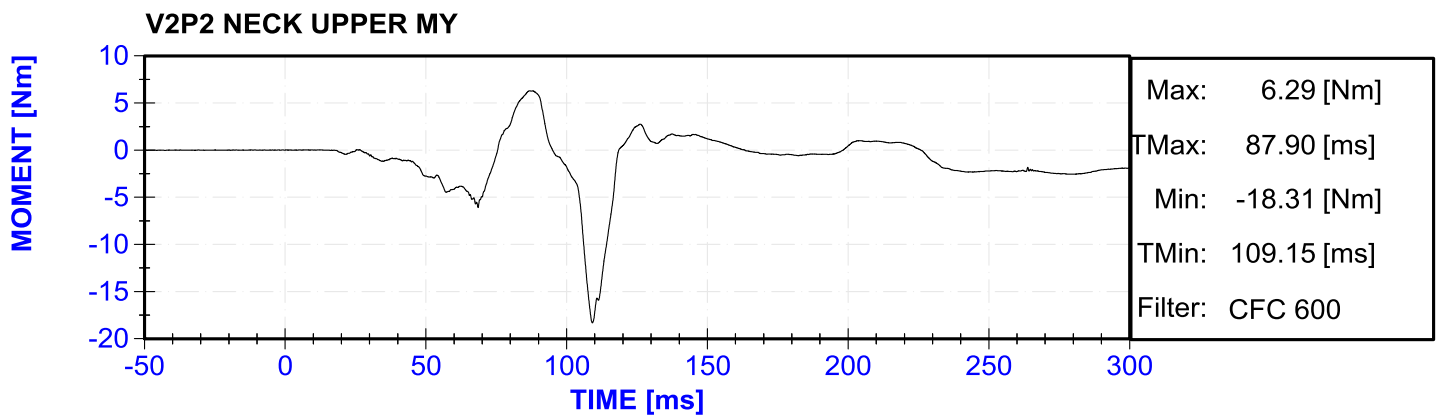
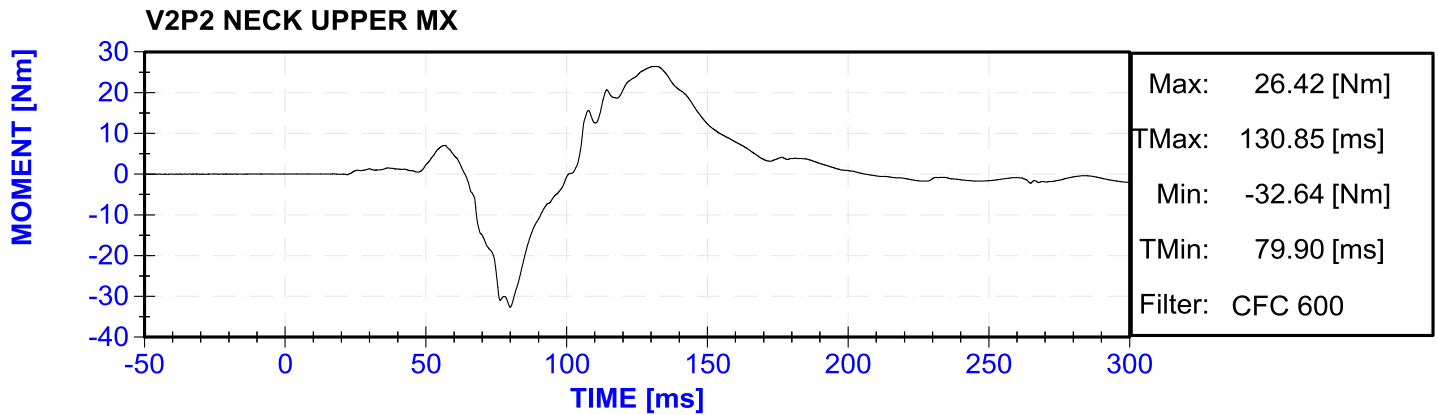


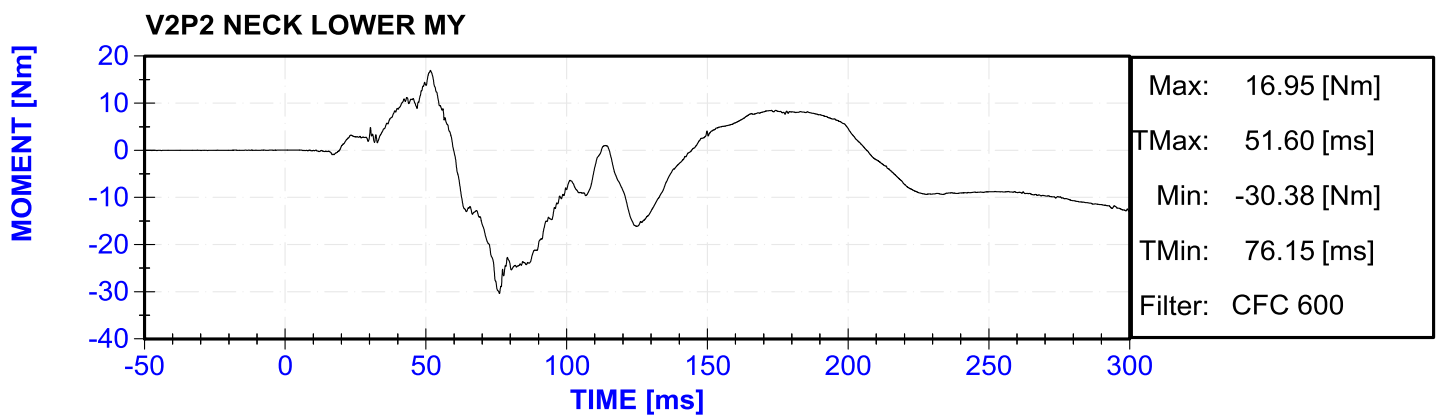
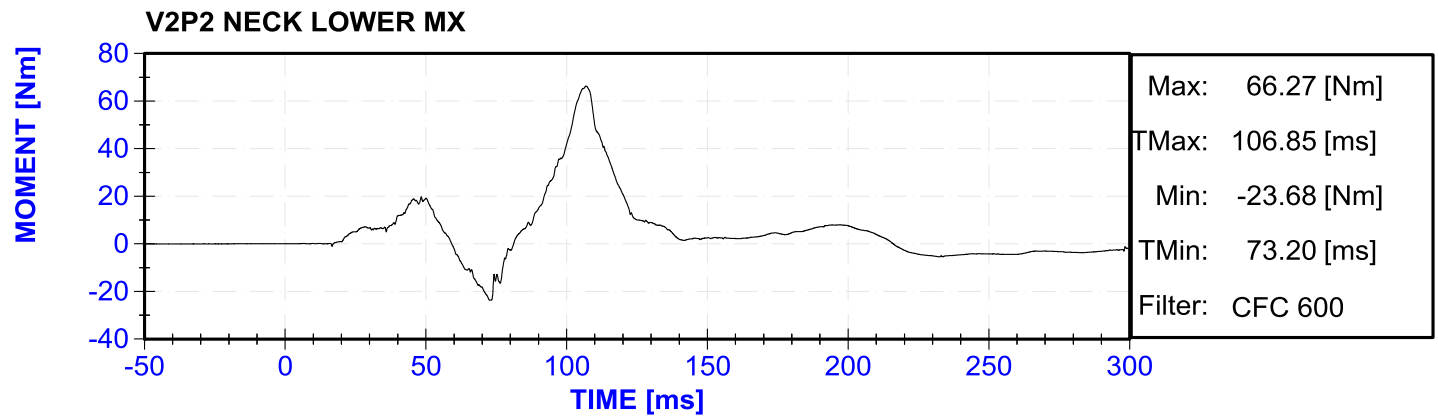
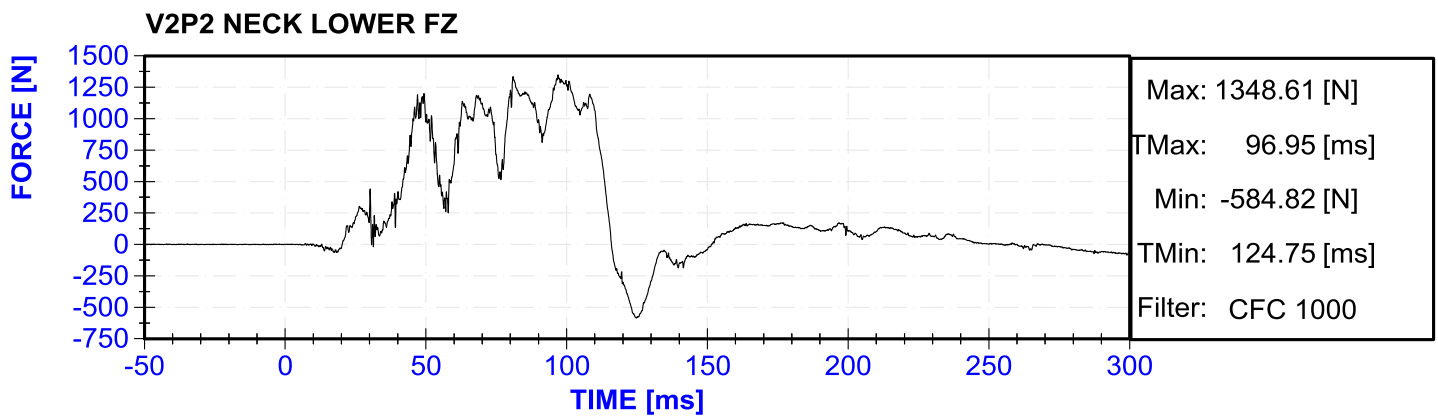
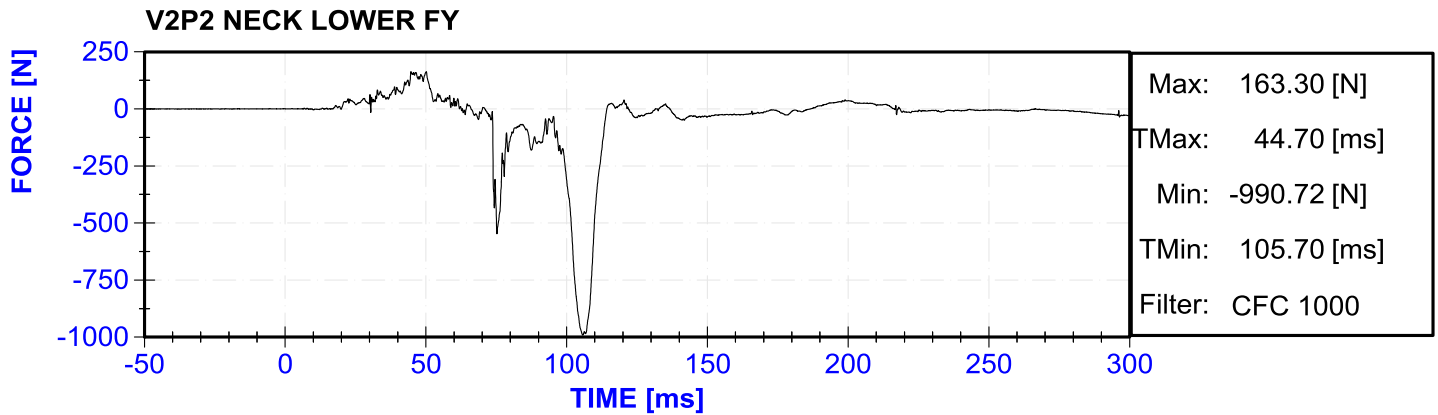


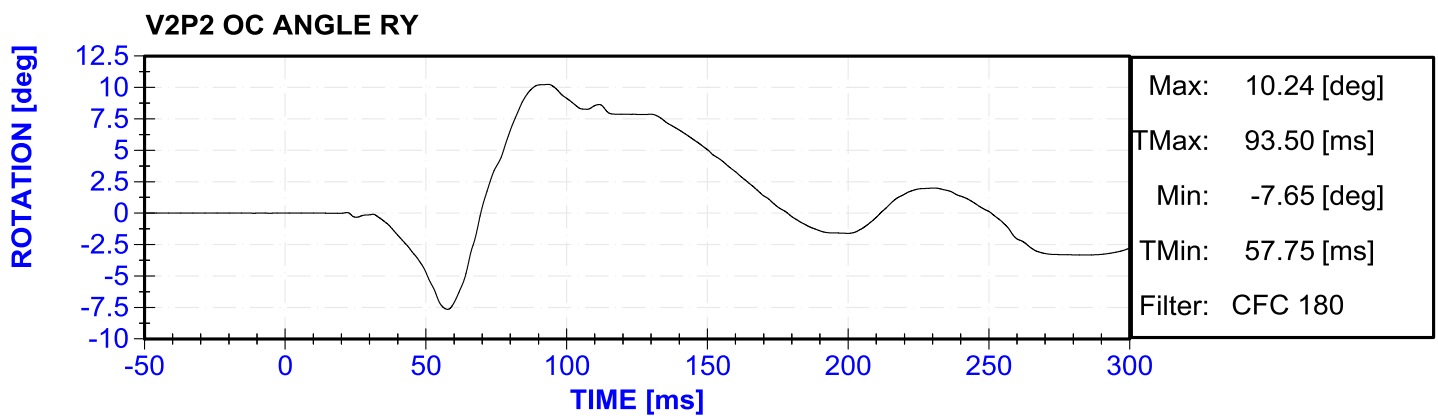
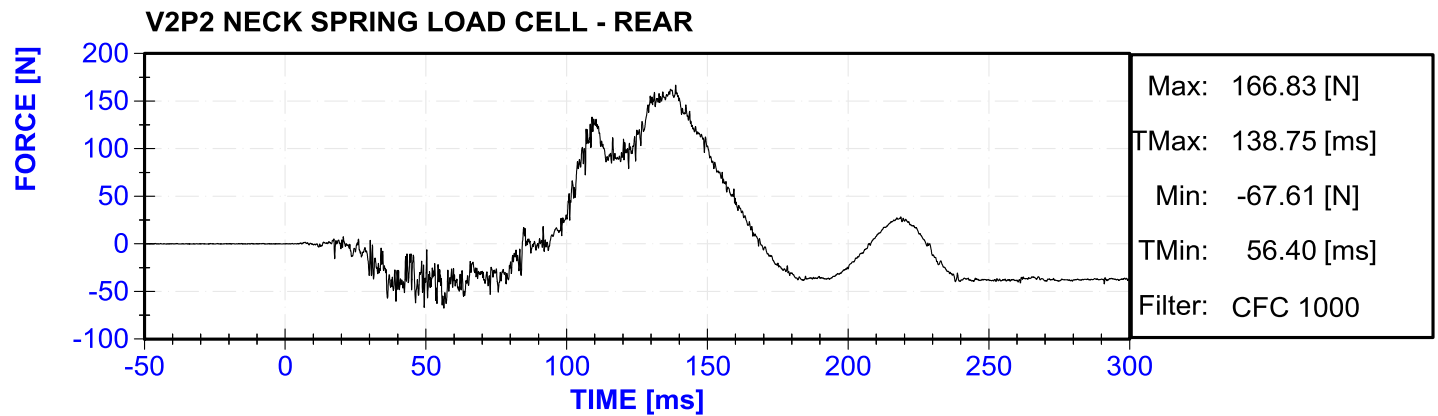
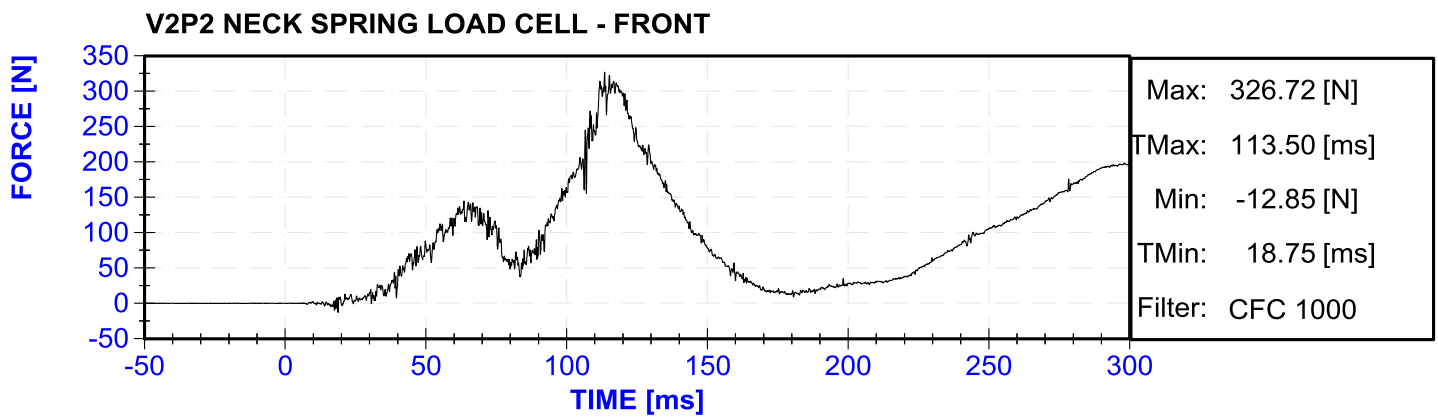
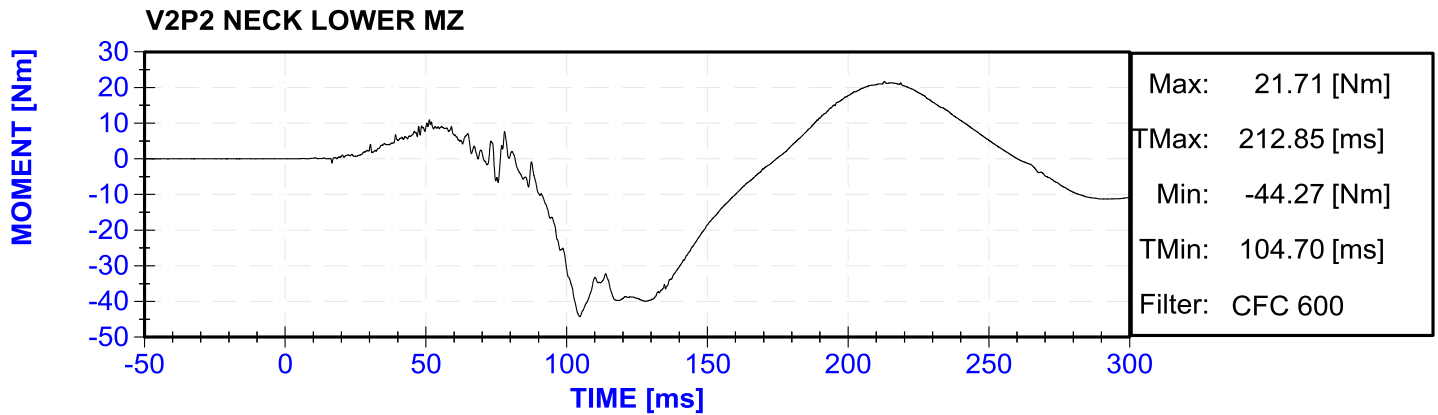


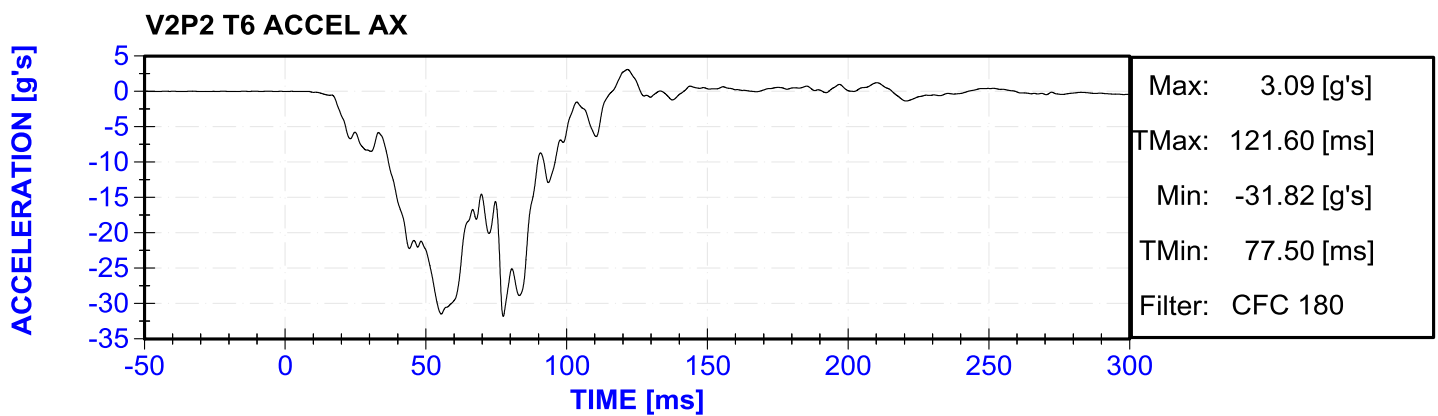
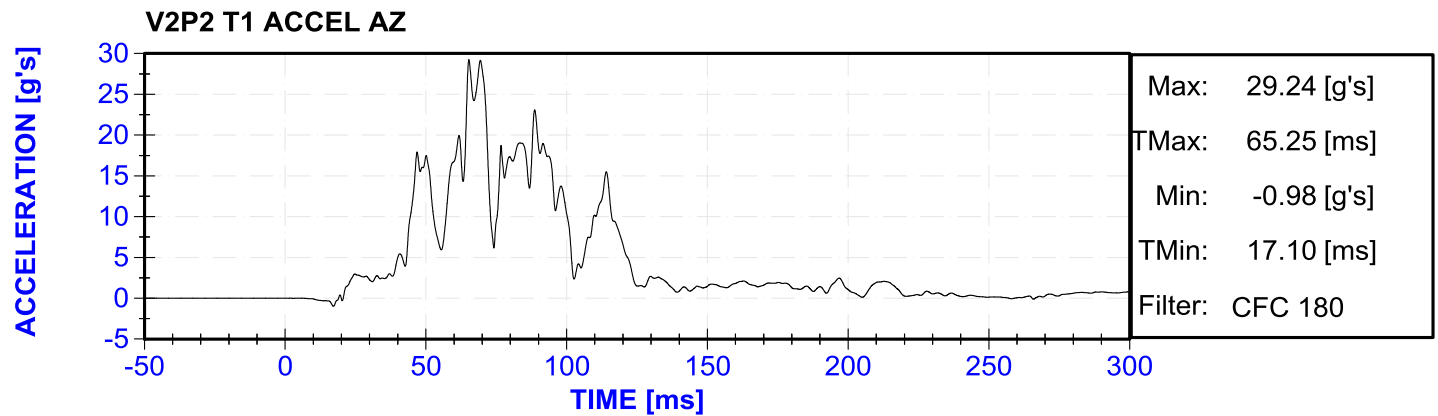
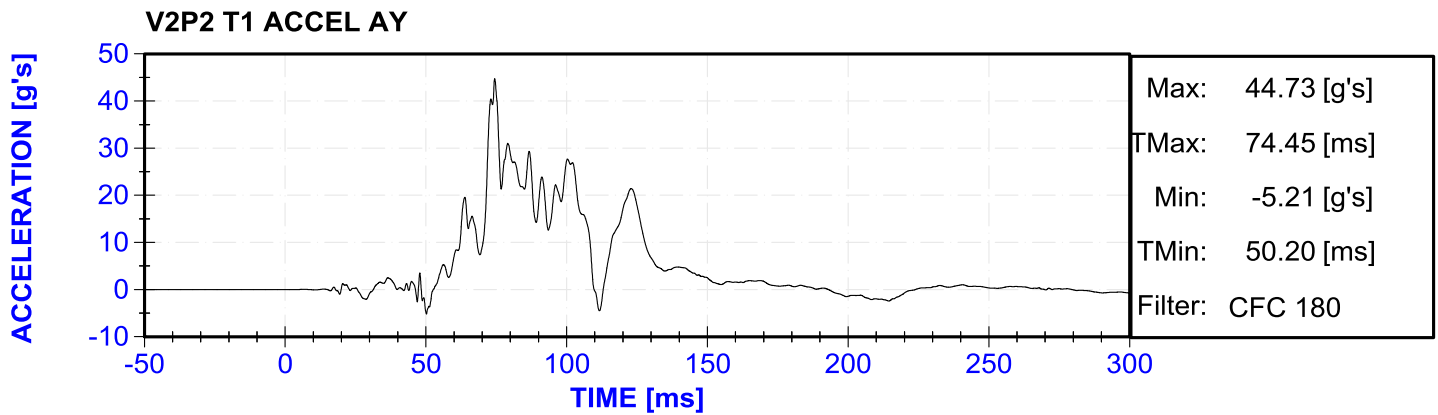
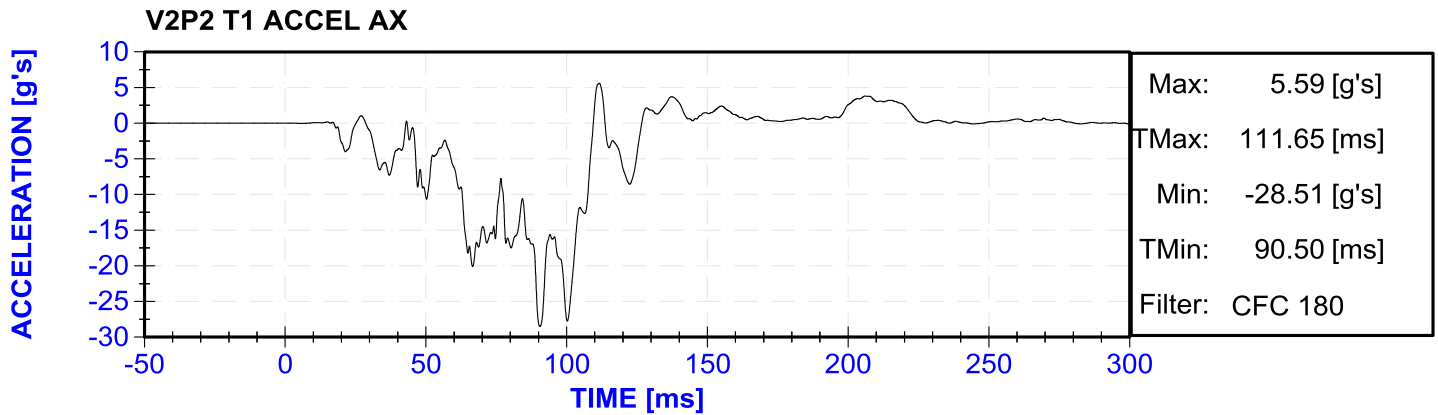


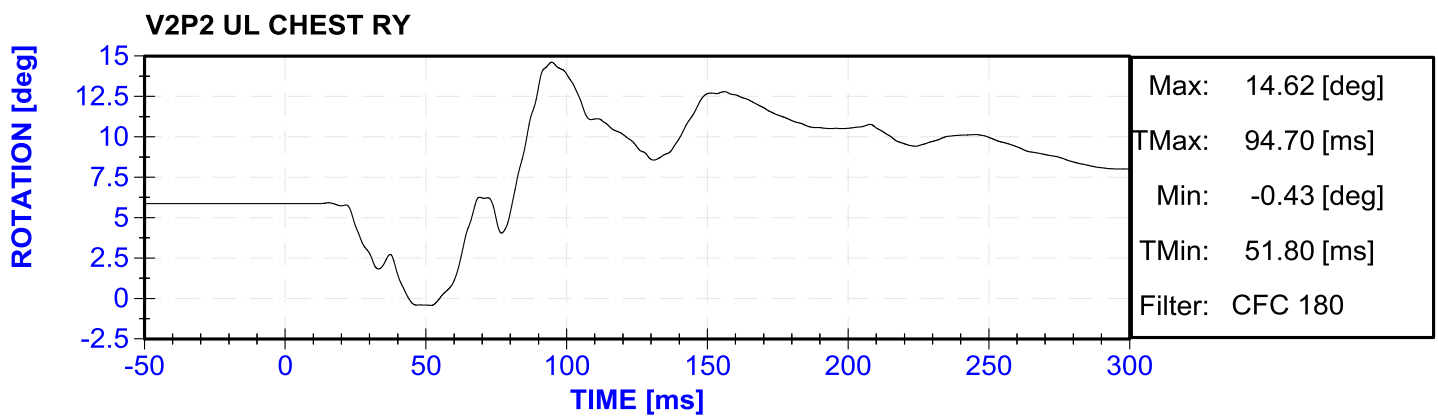
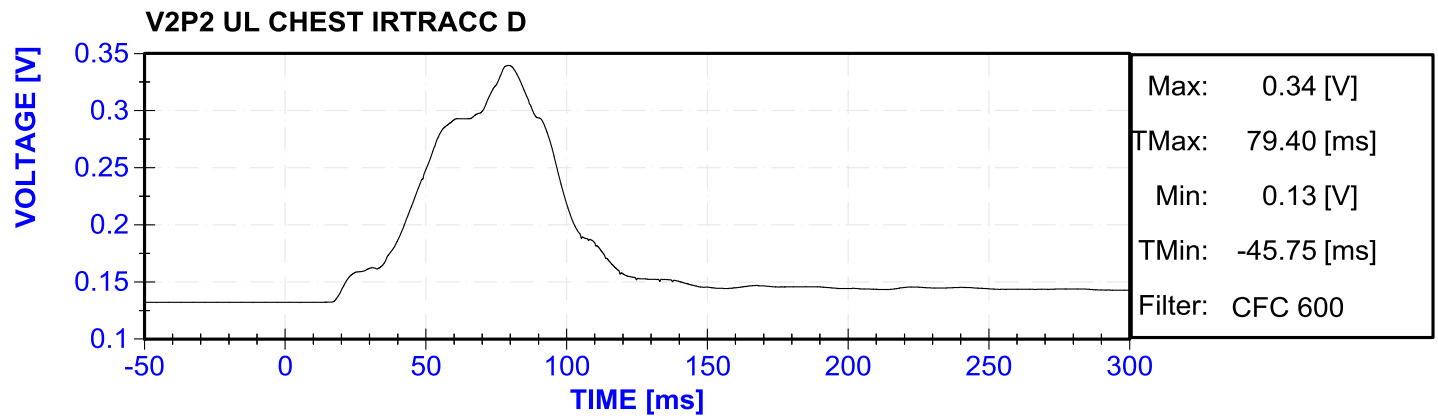
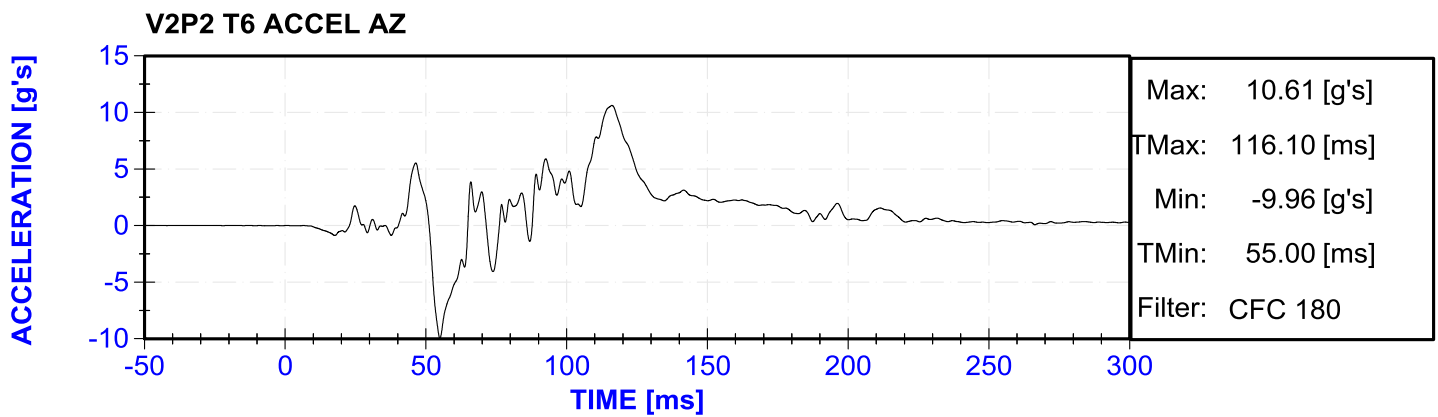
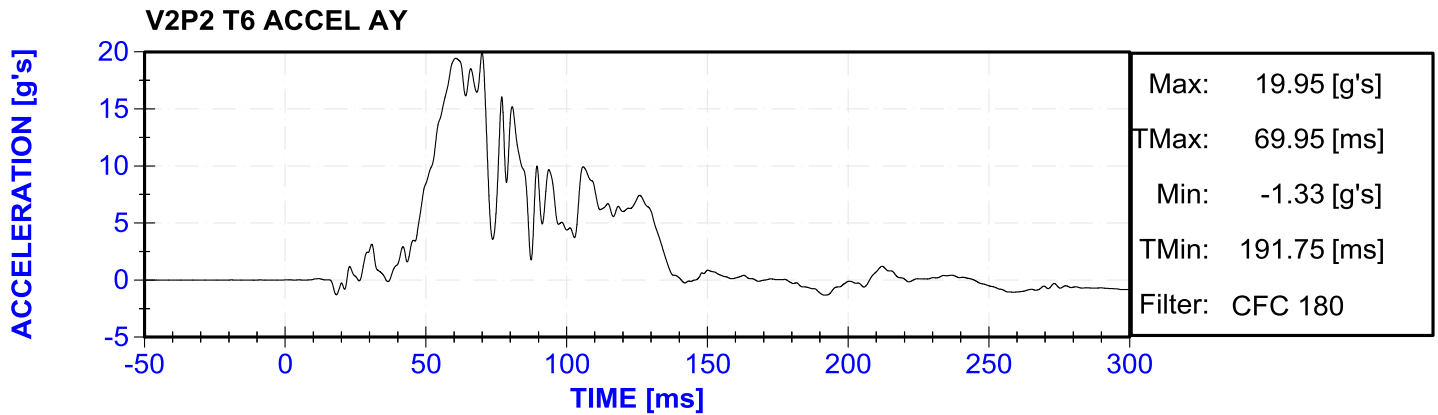


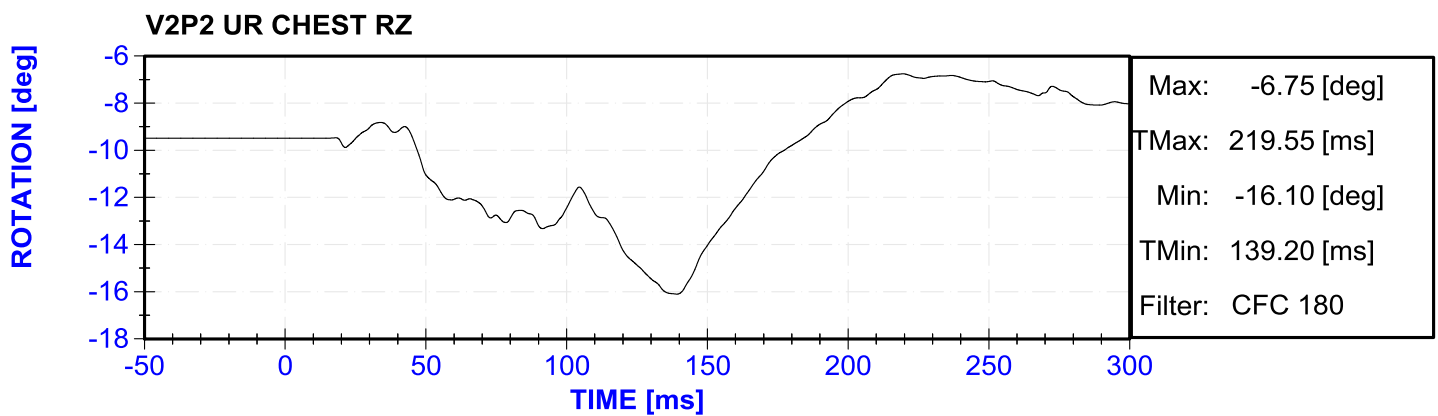
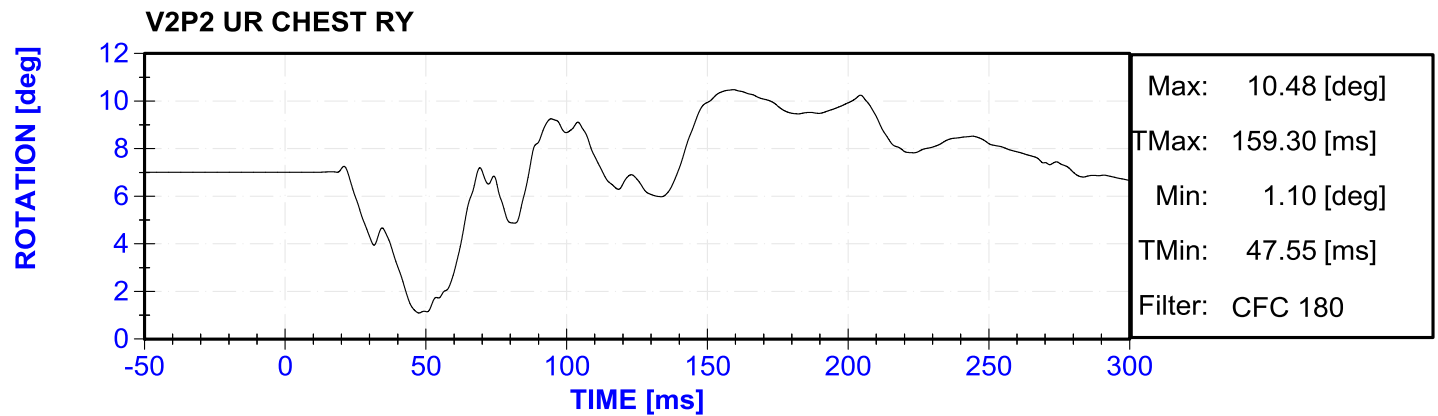
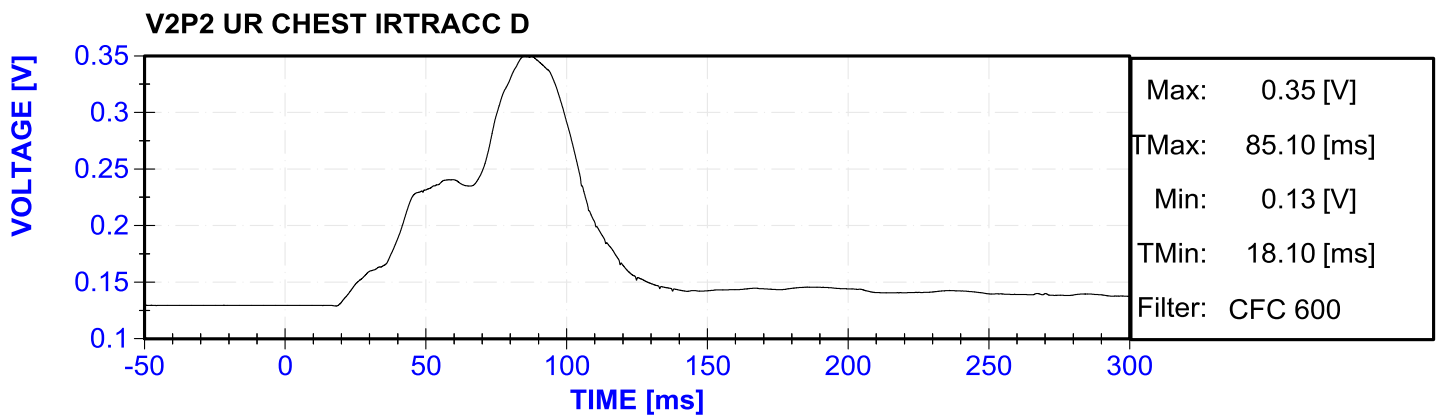
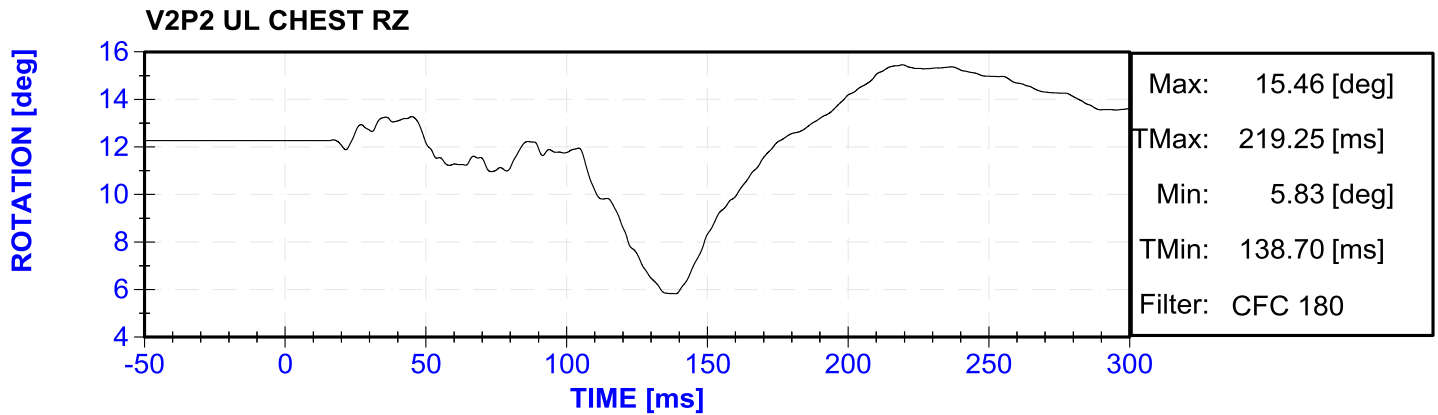


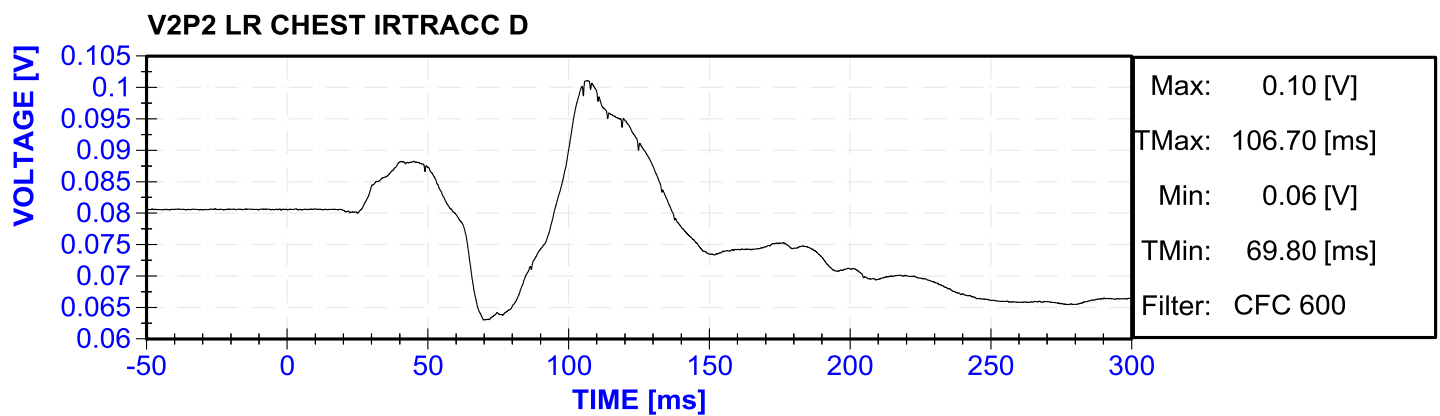
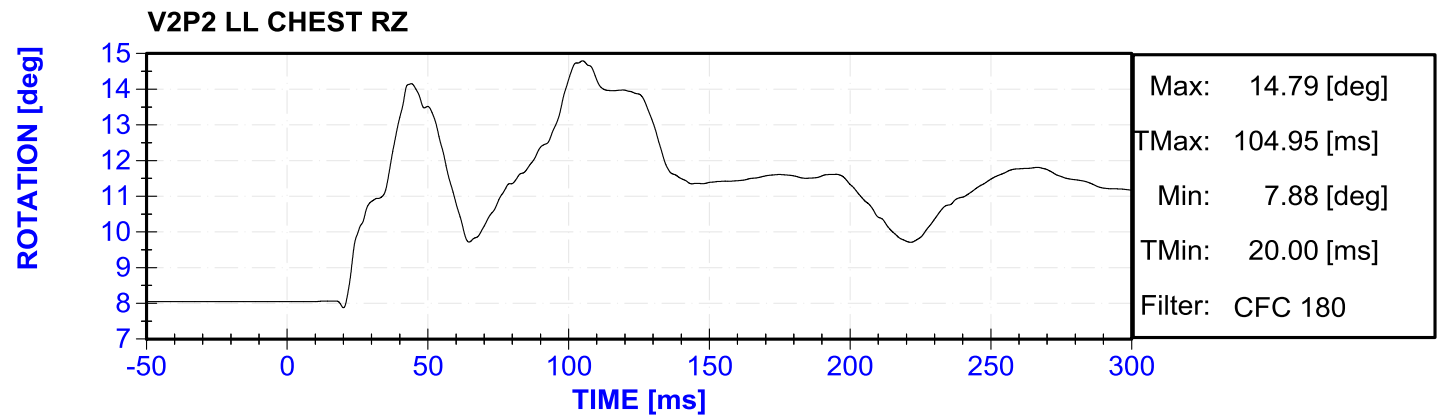
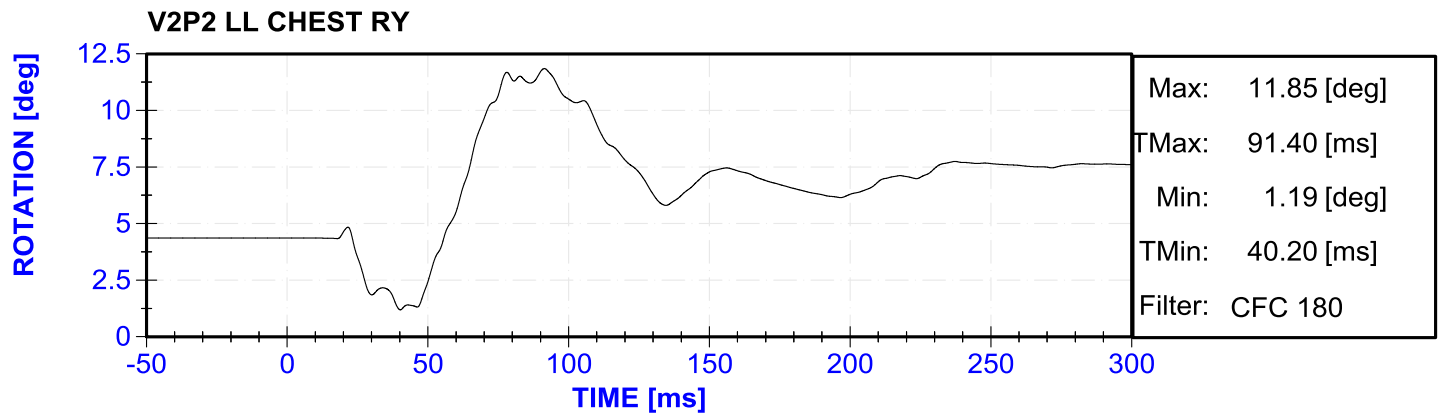
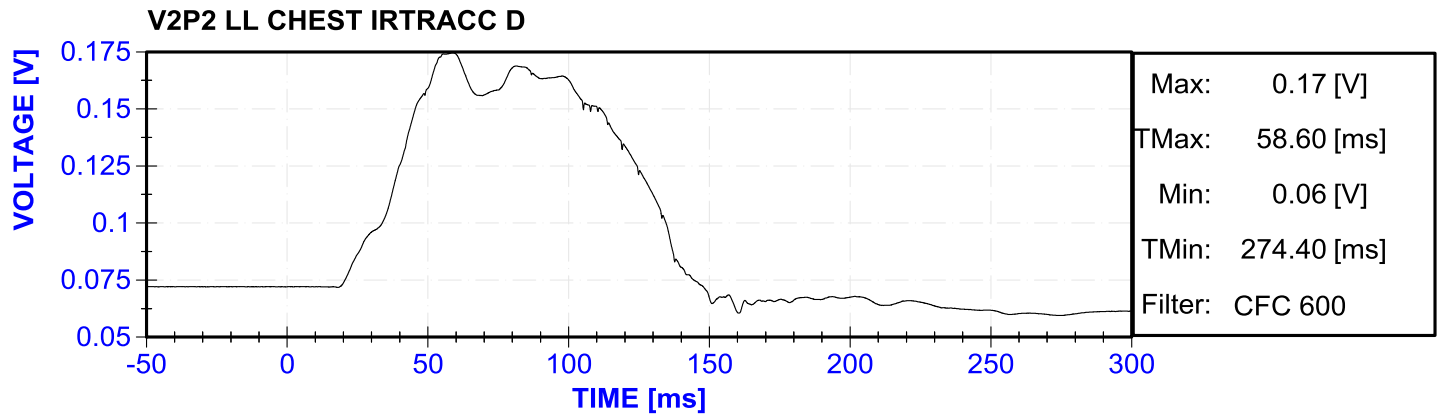


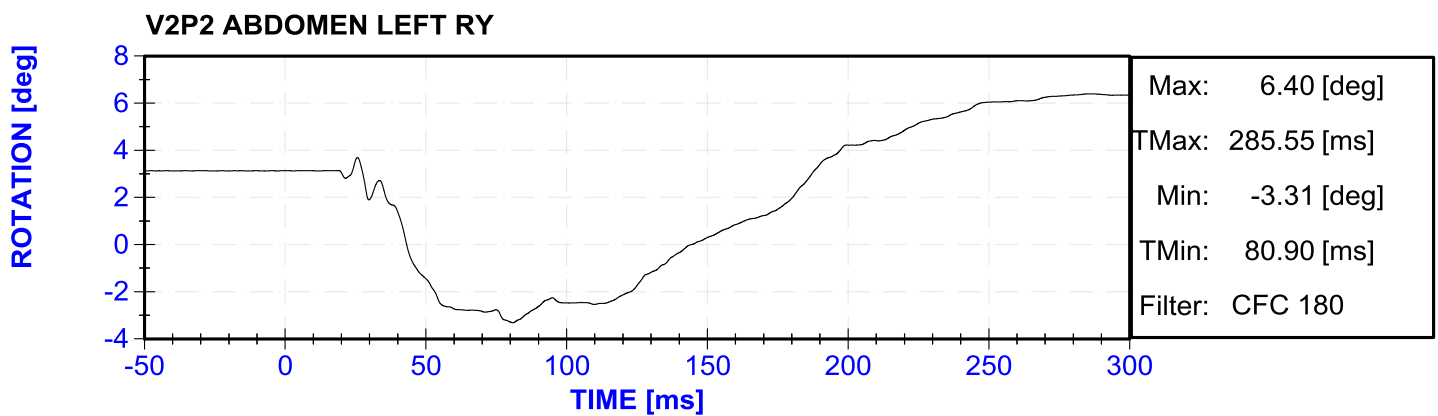
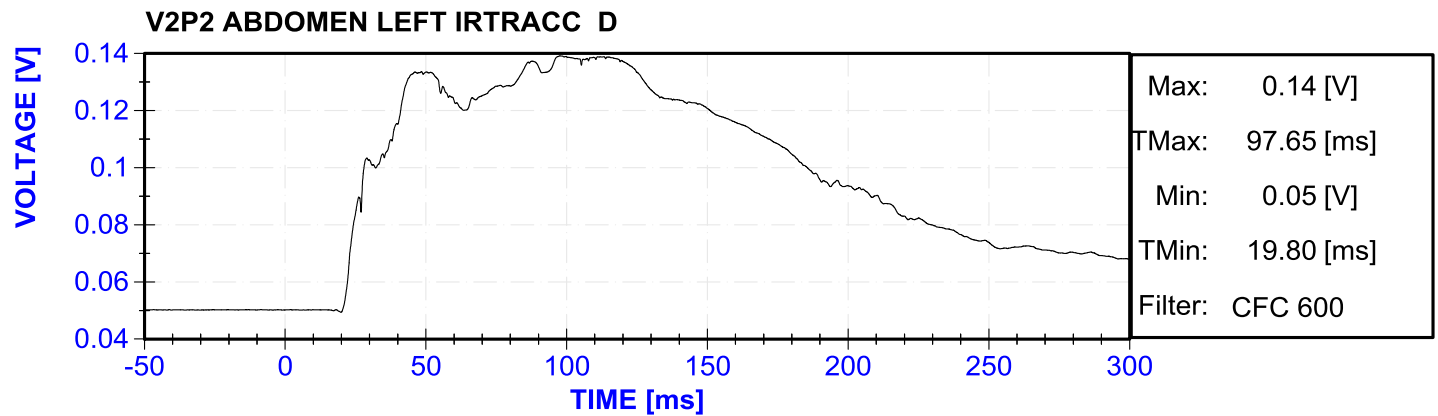
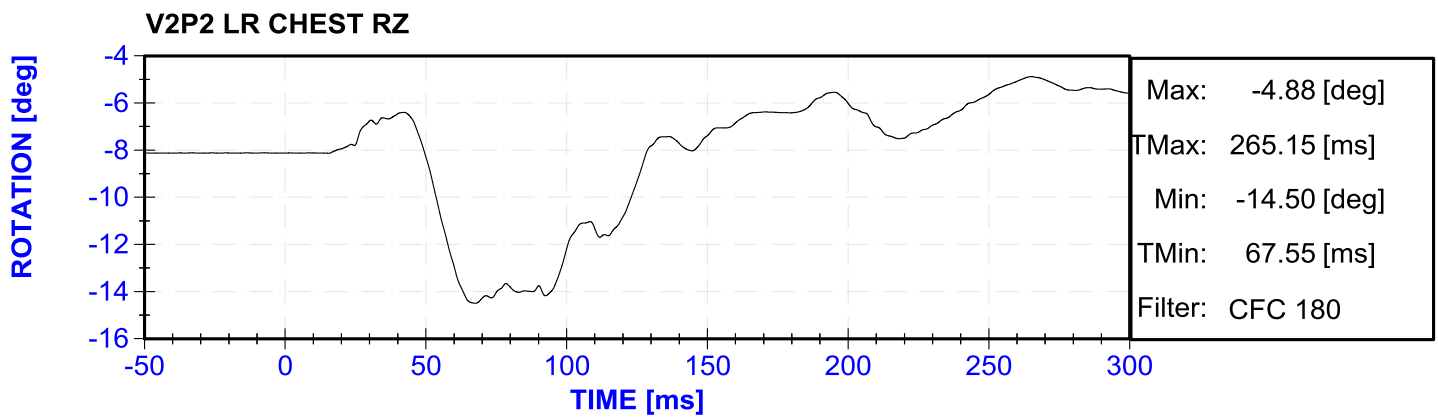
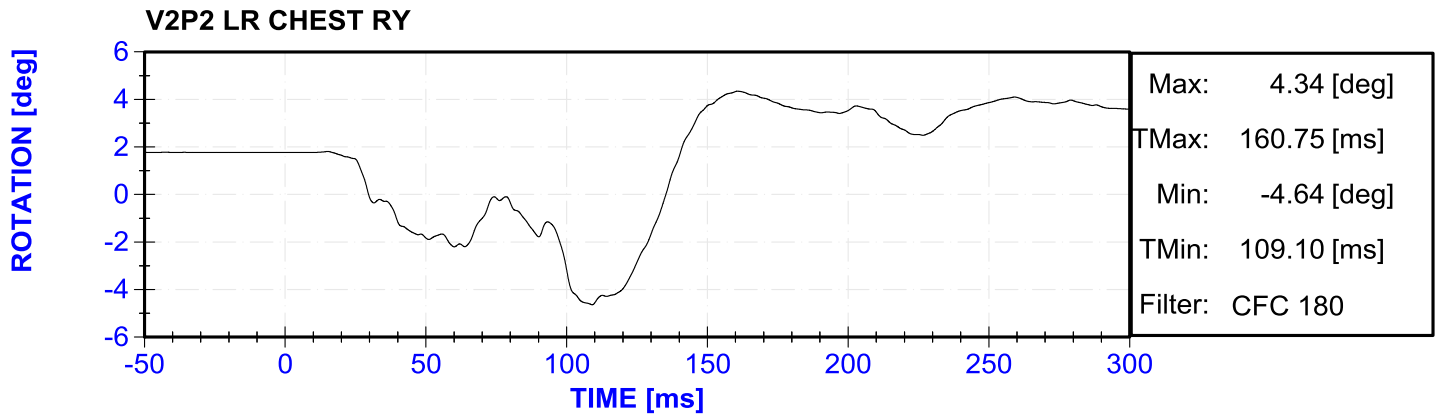


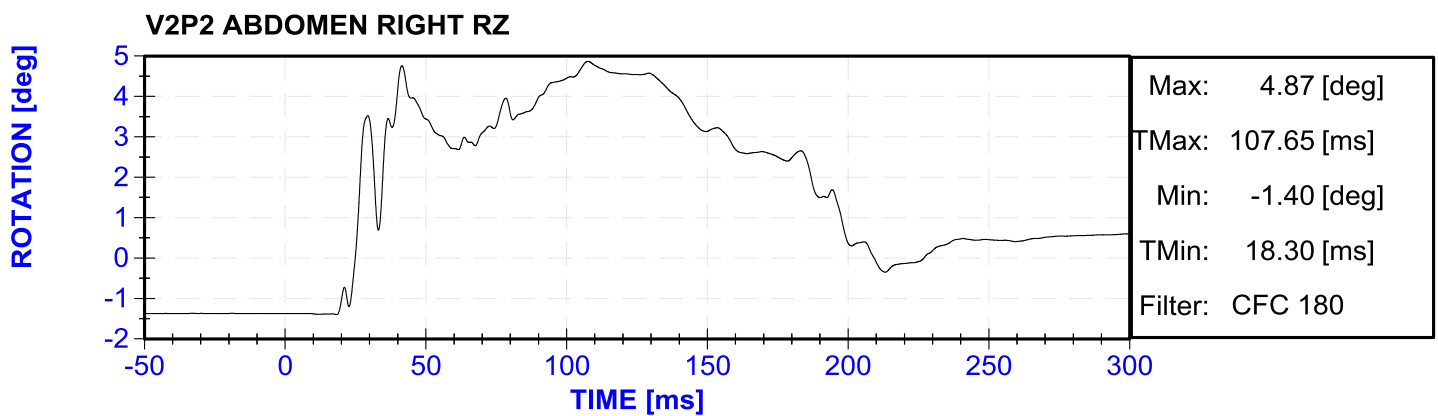
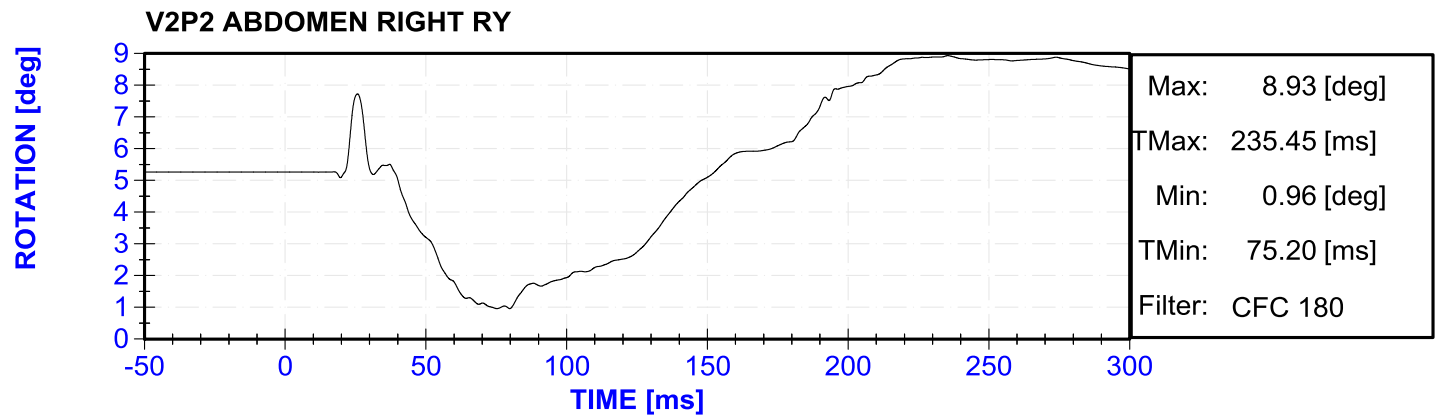
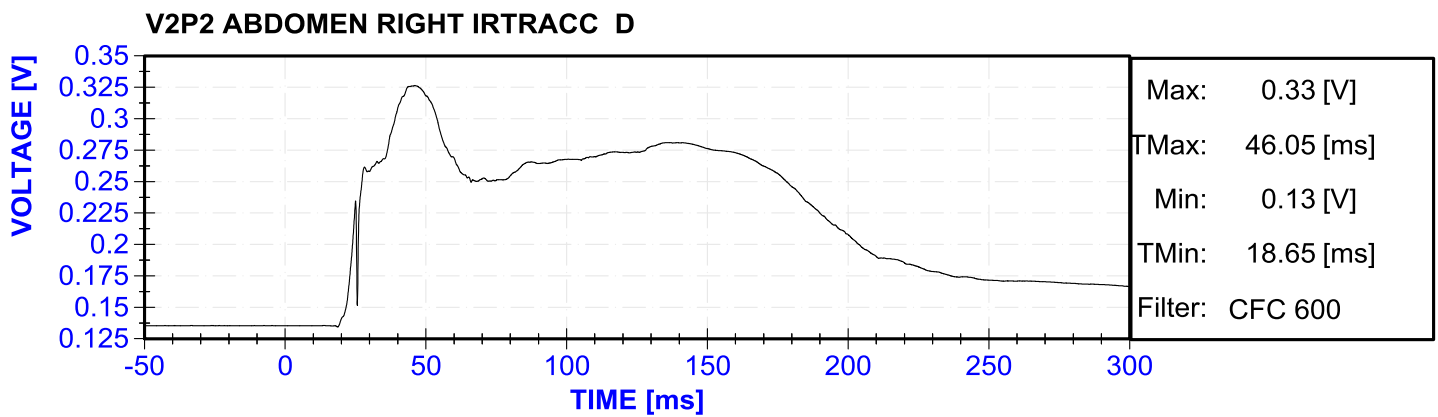
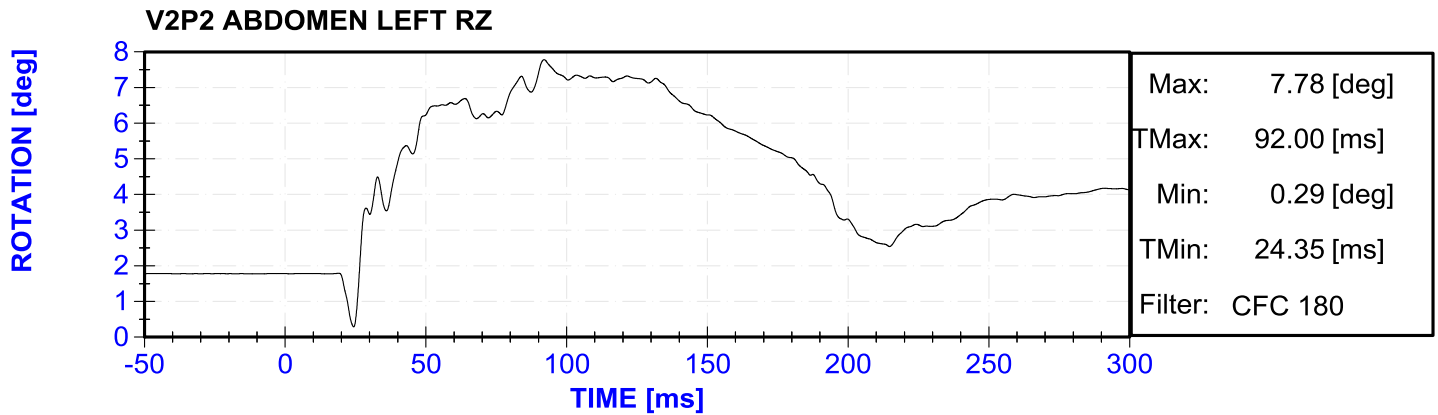


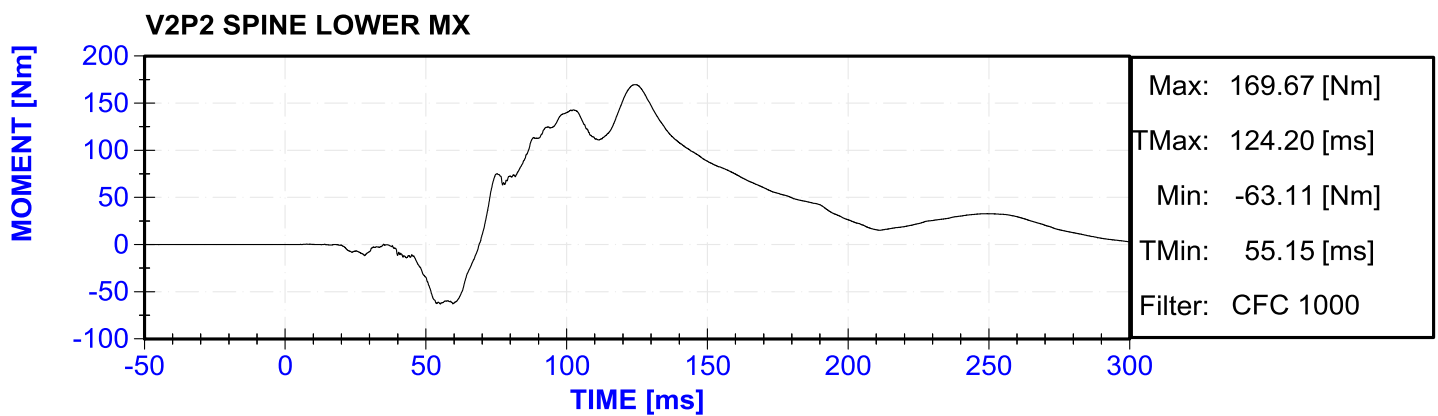
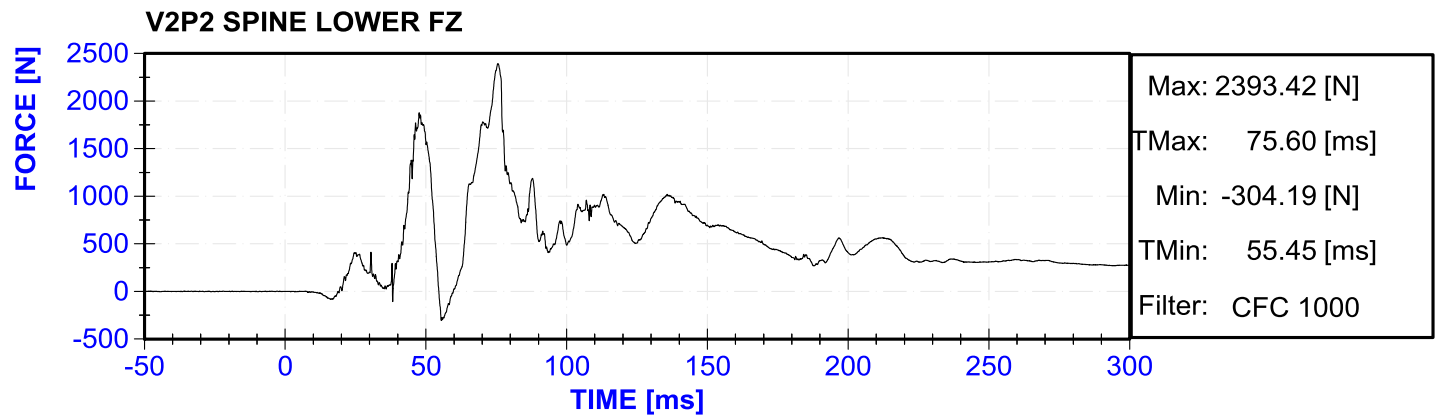
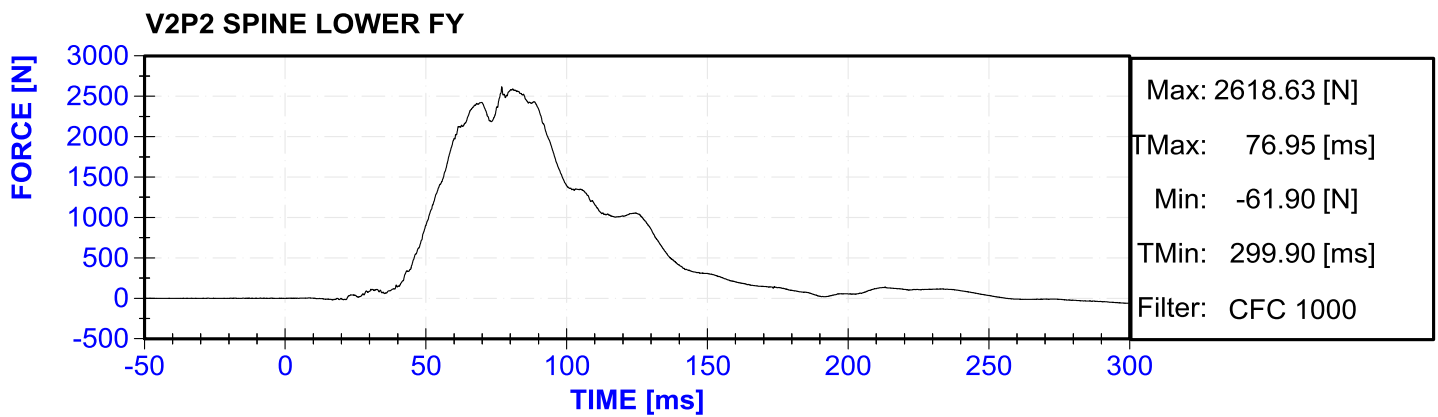
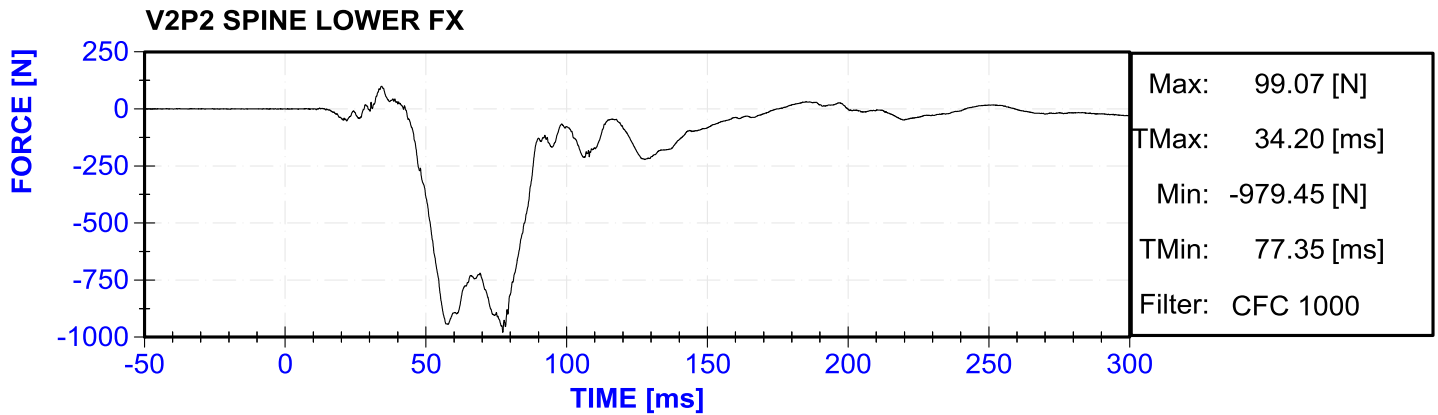


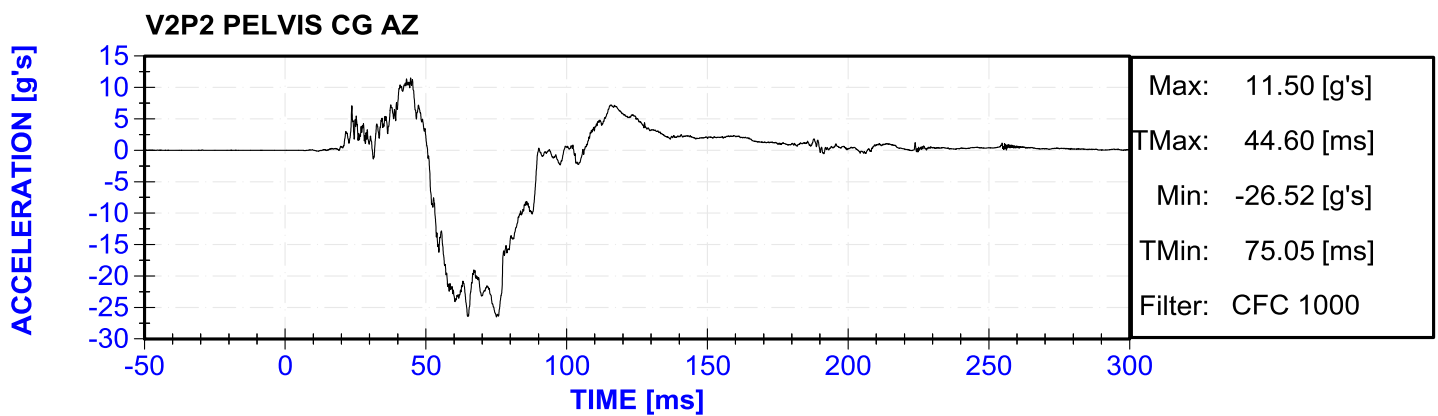
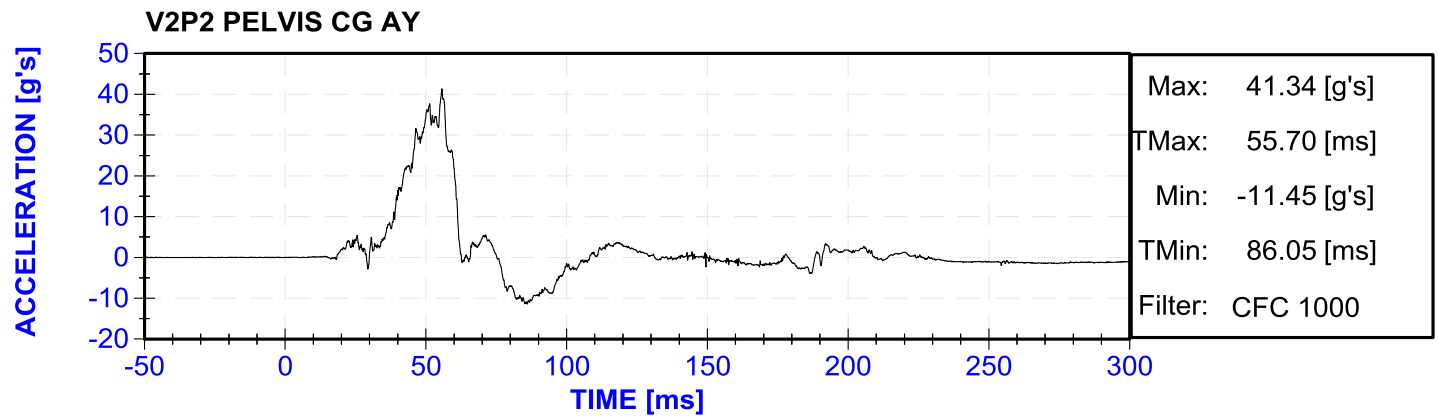
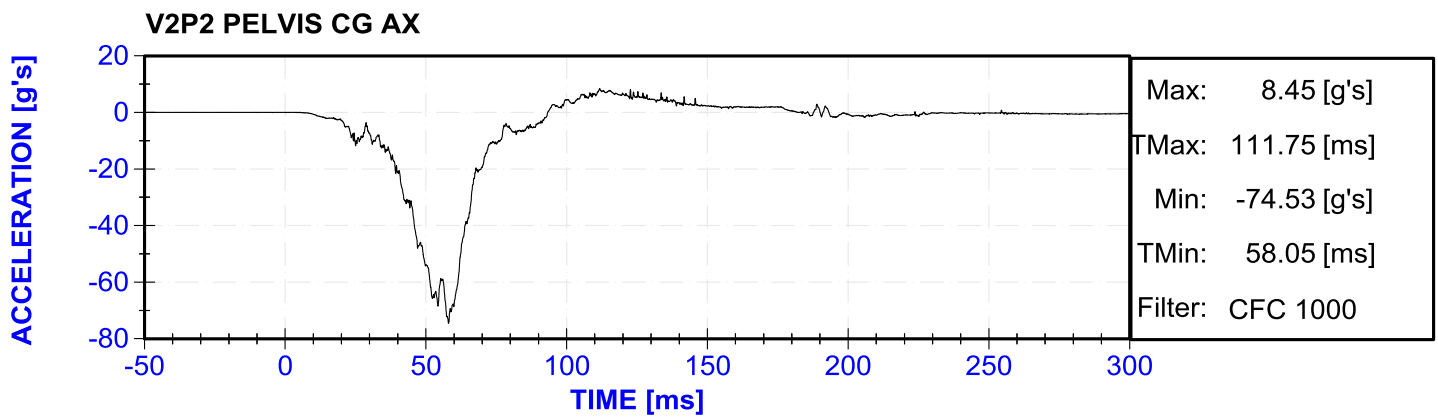
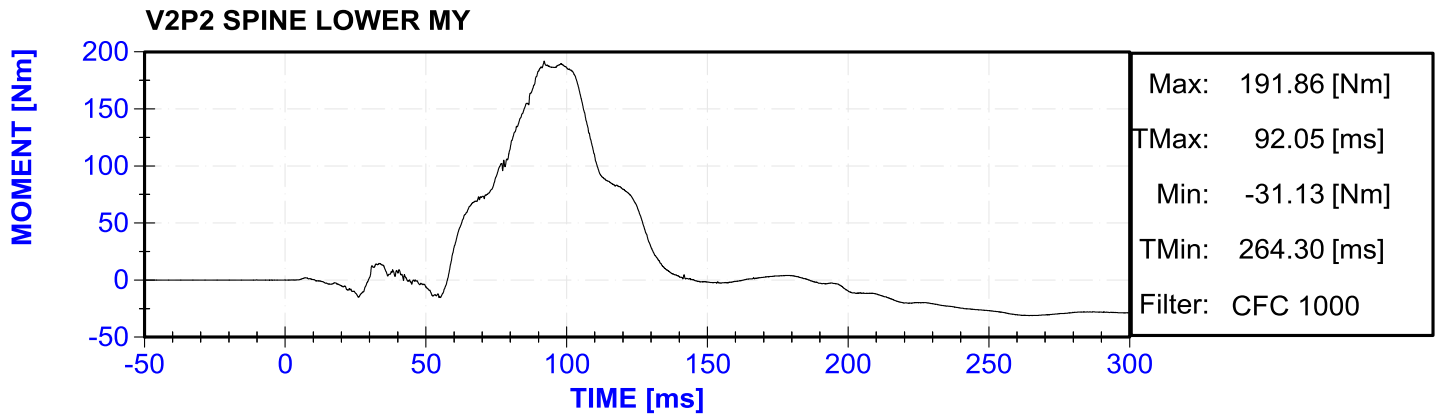


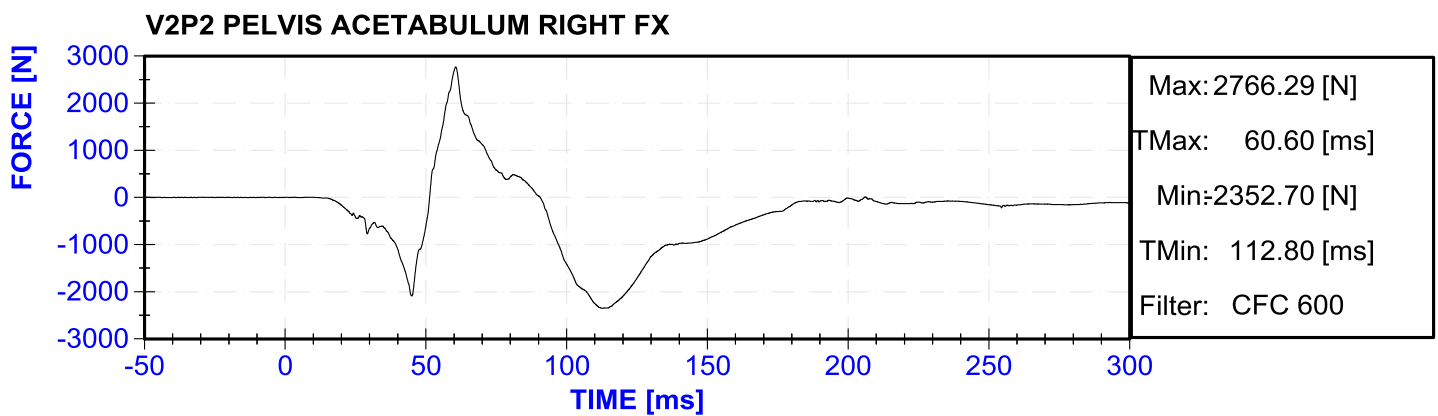
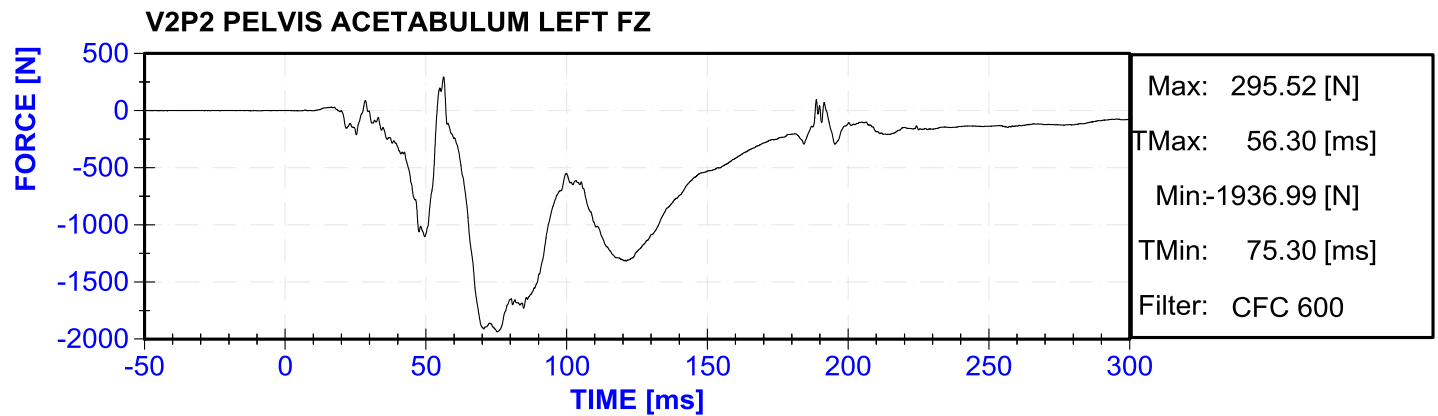
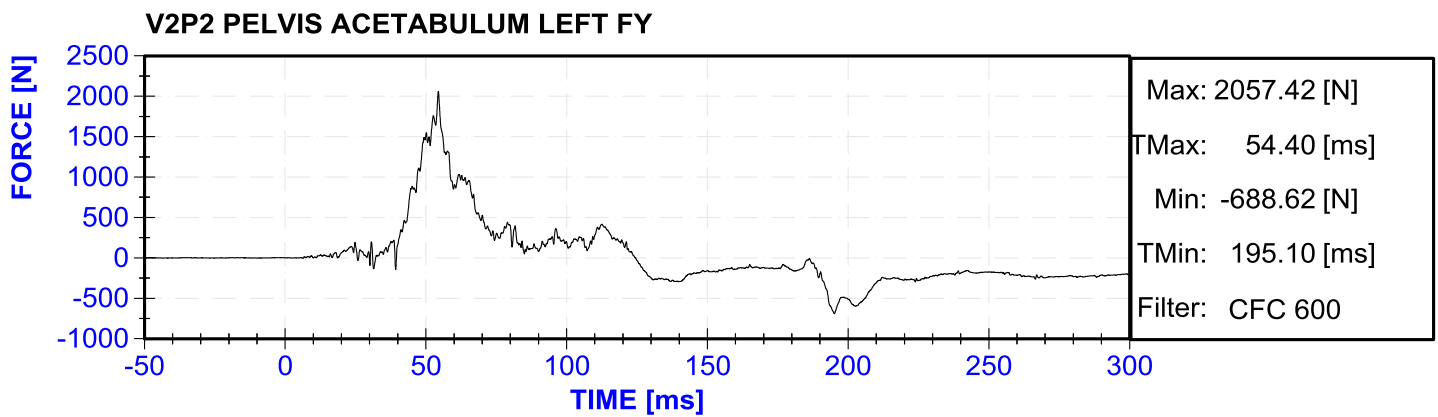
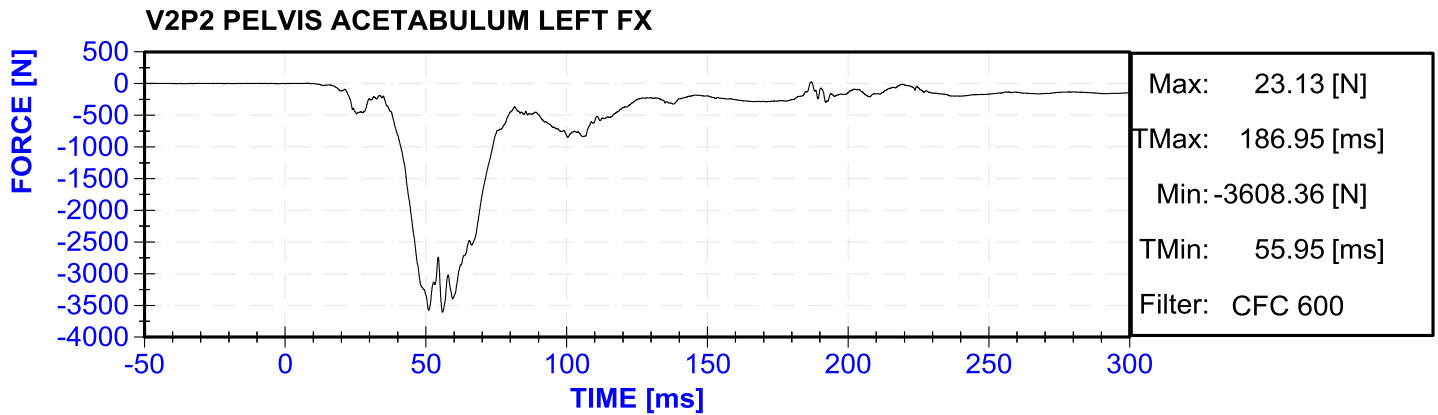




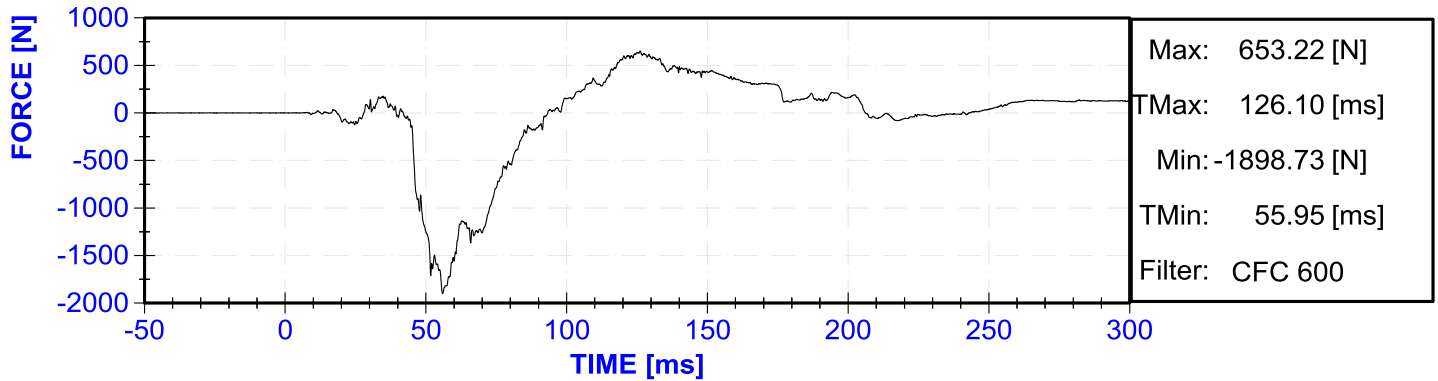




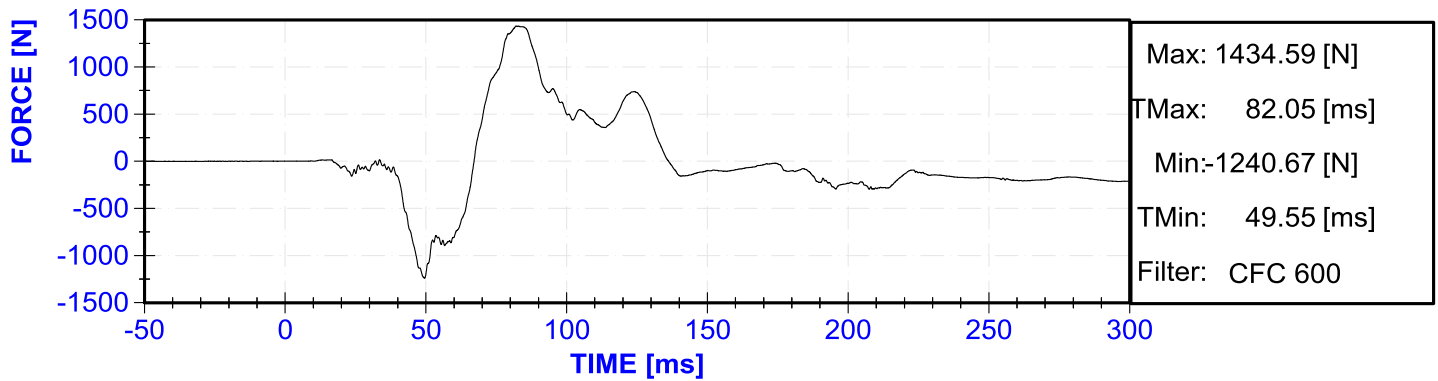




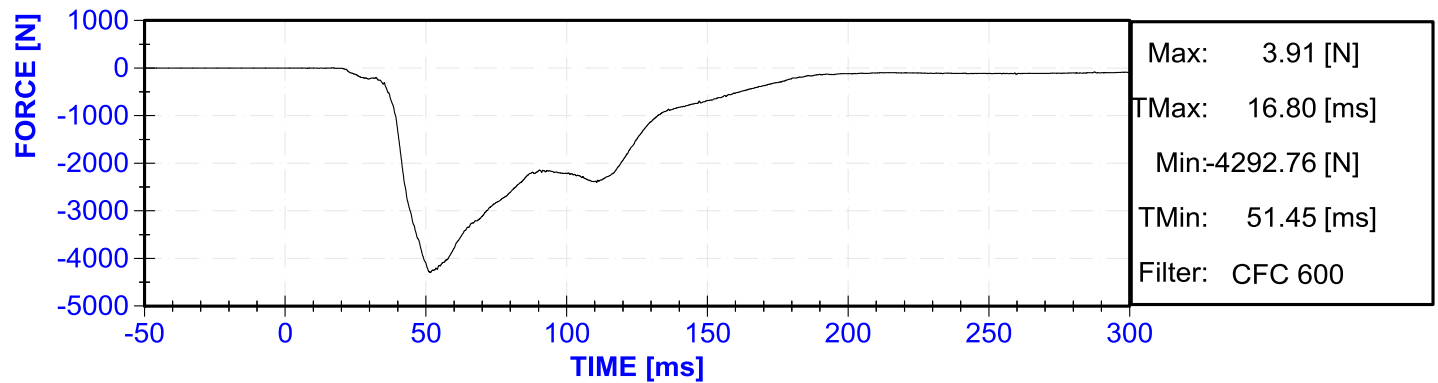
V2P2 PELVIS ACETABULUM RIGHT FY



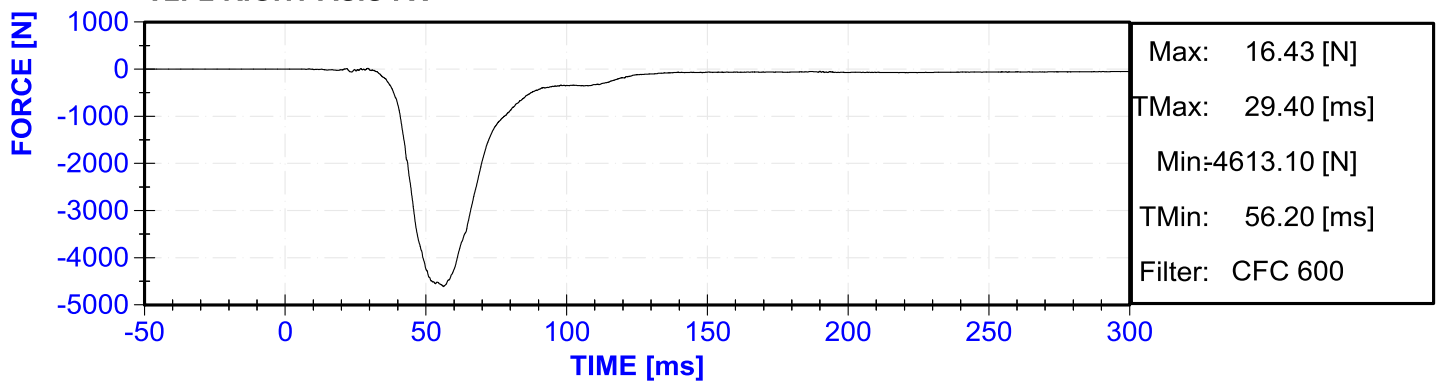
V2P2 PELVIS ACETABULUM RIGHT FZ

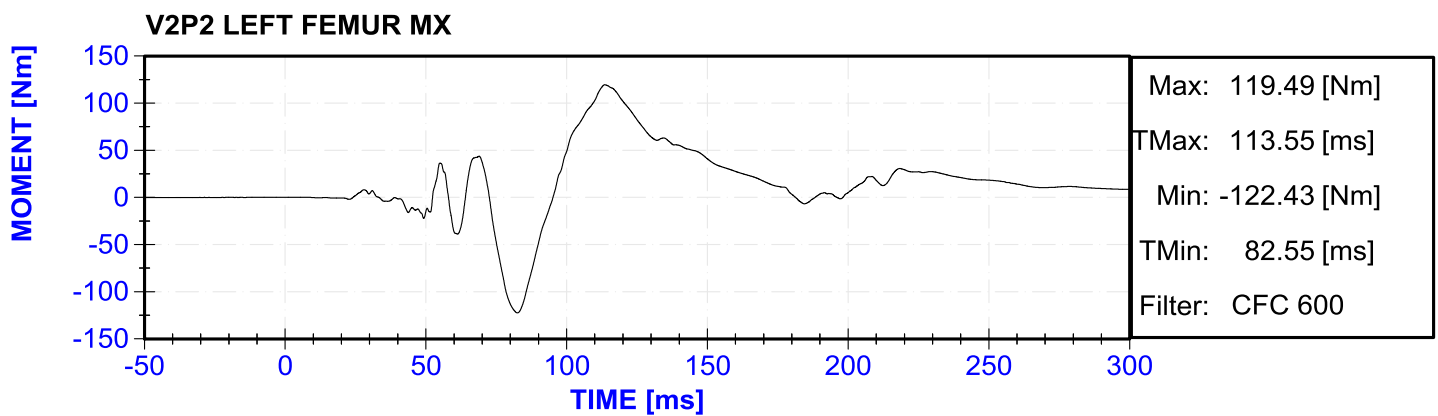
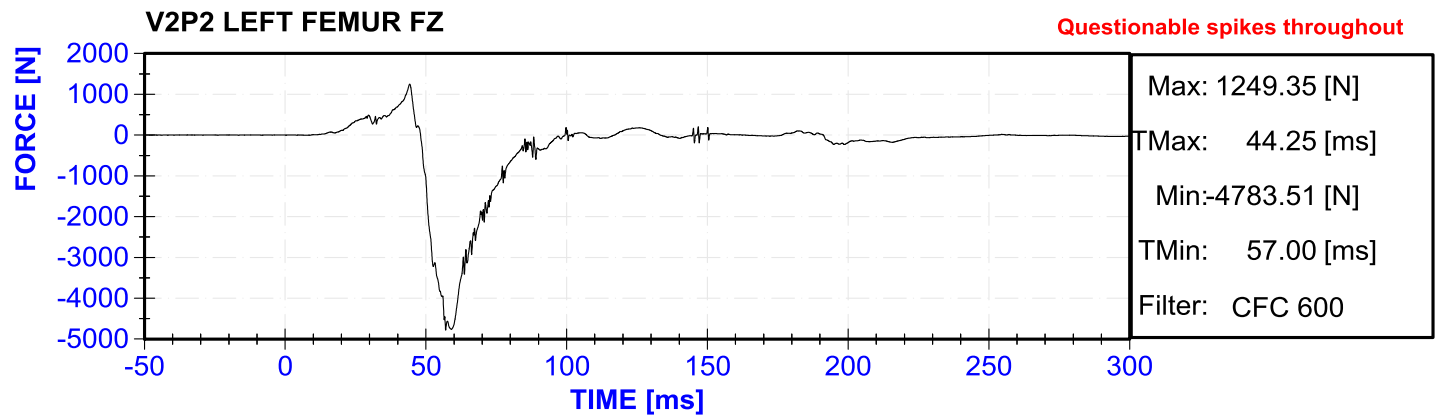
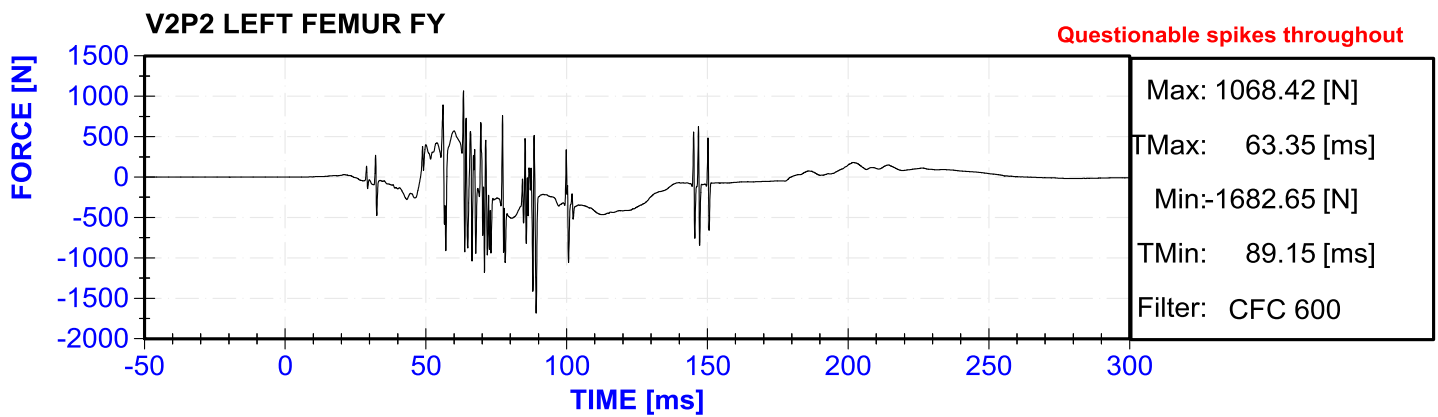
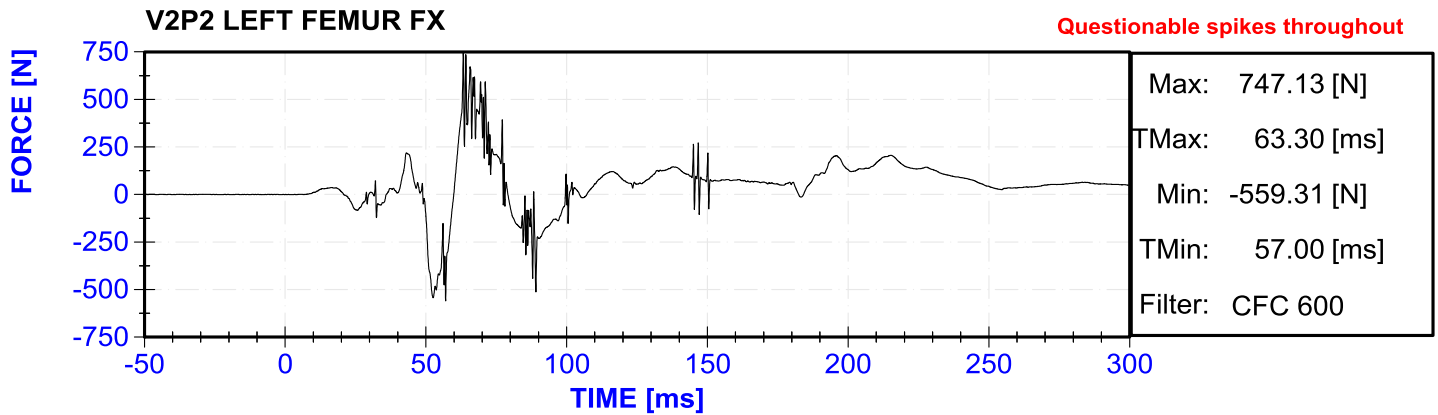


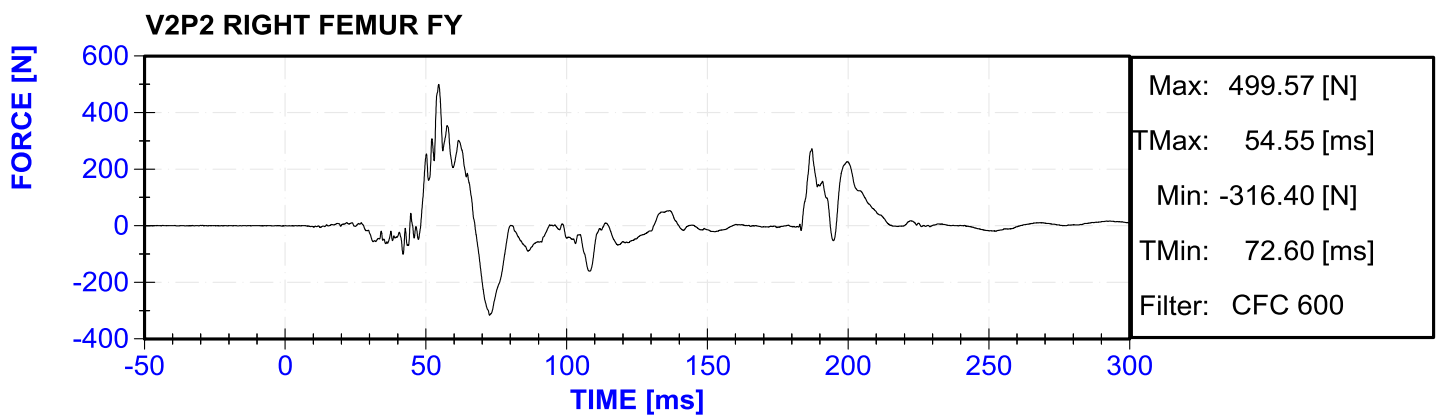
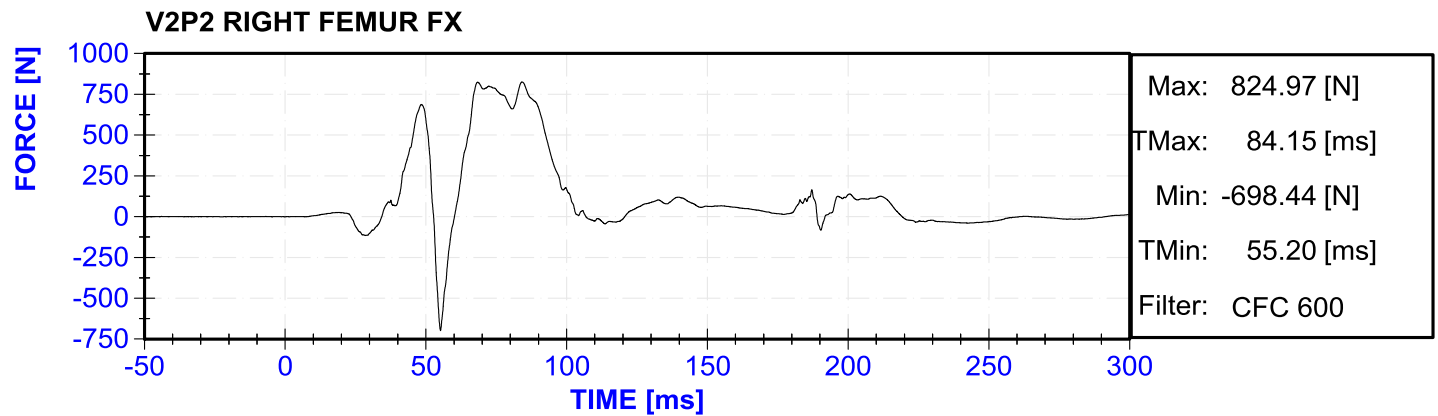
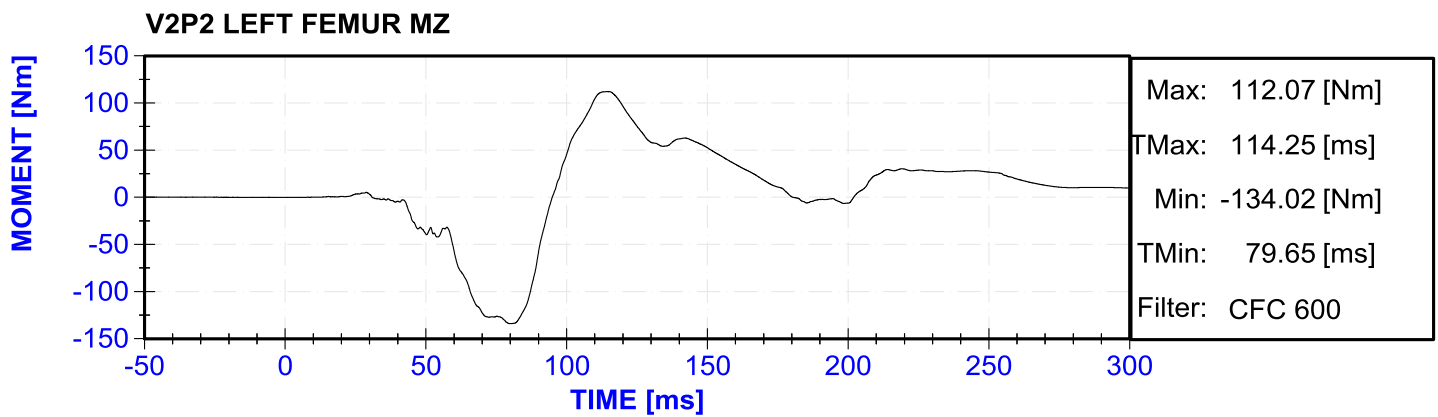
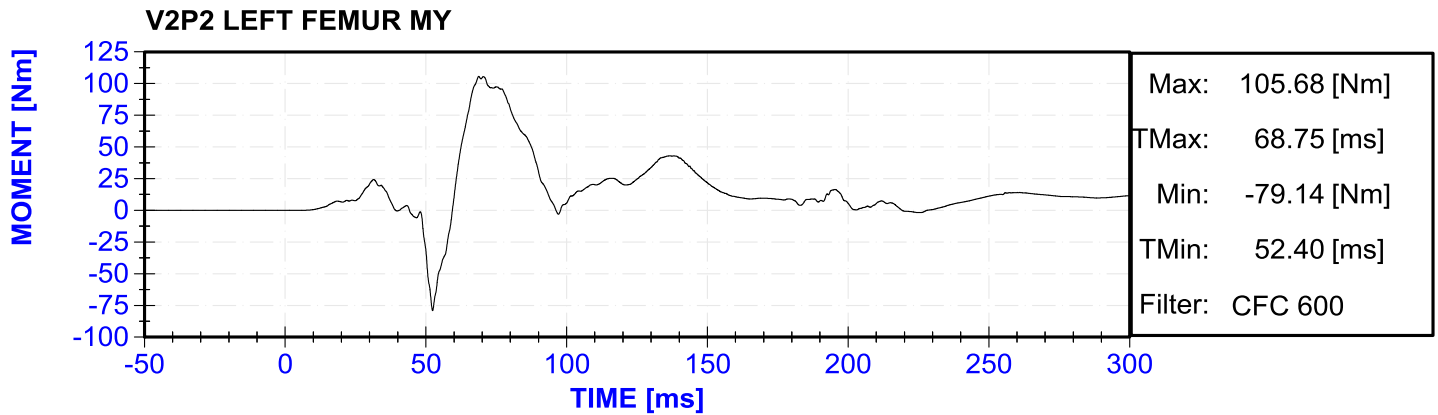
V2P2 LEFT ASIS FX

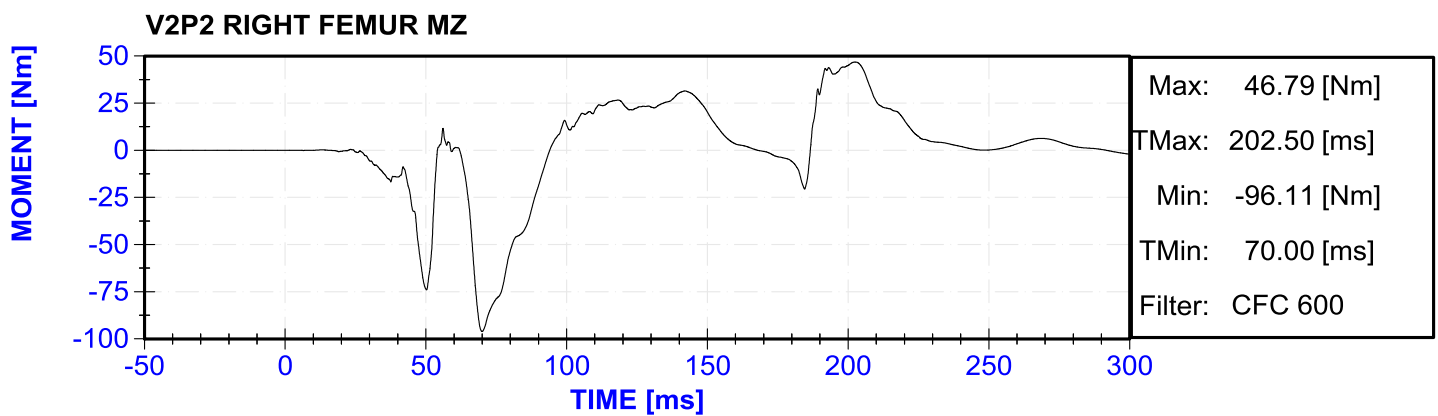
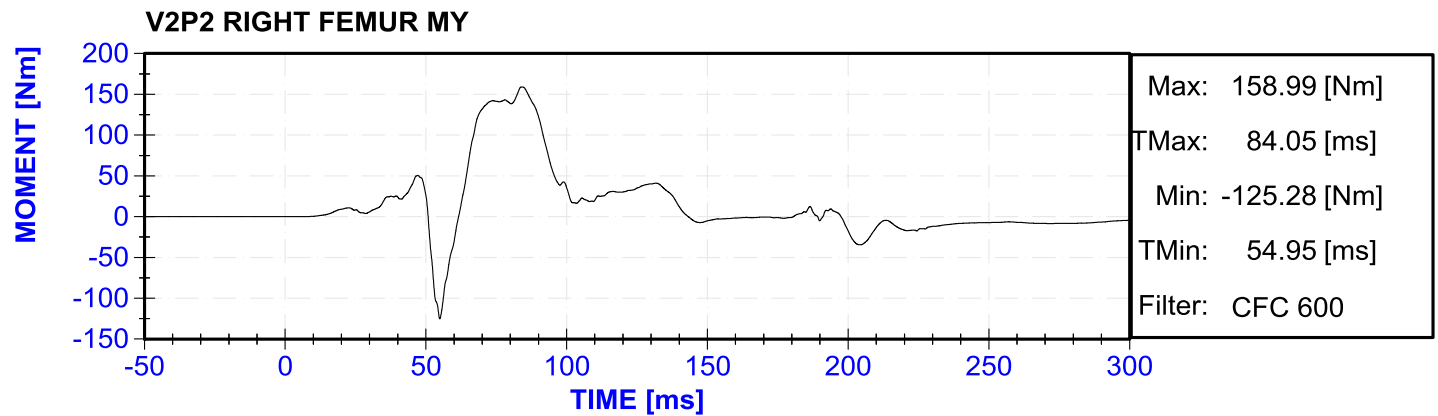
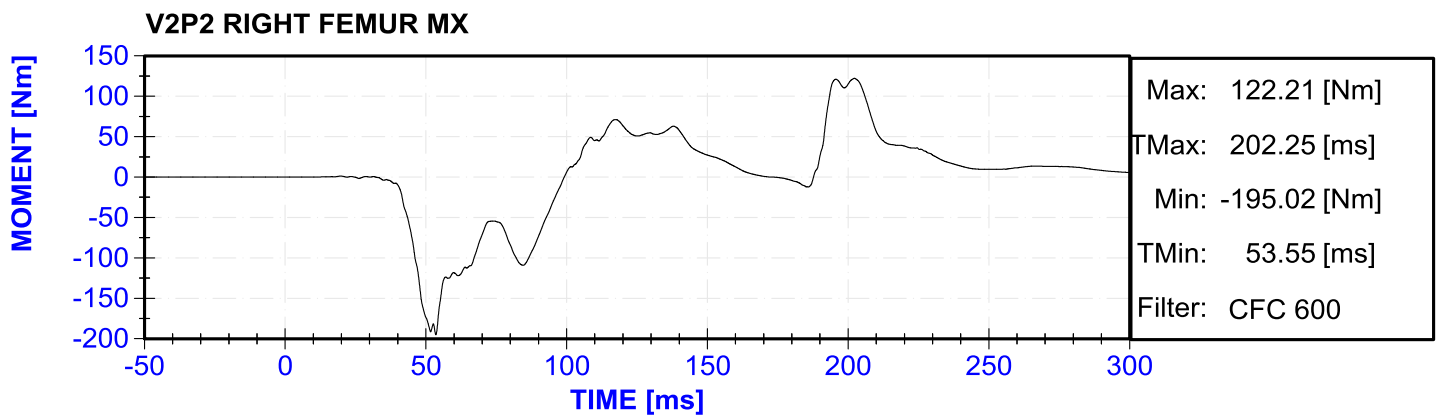
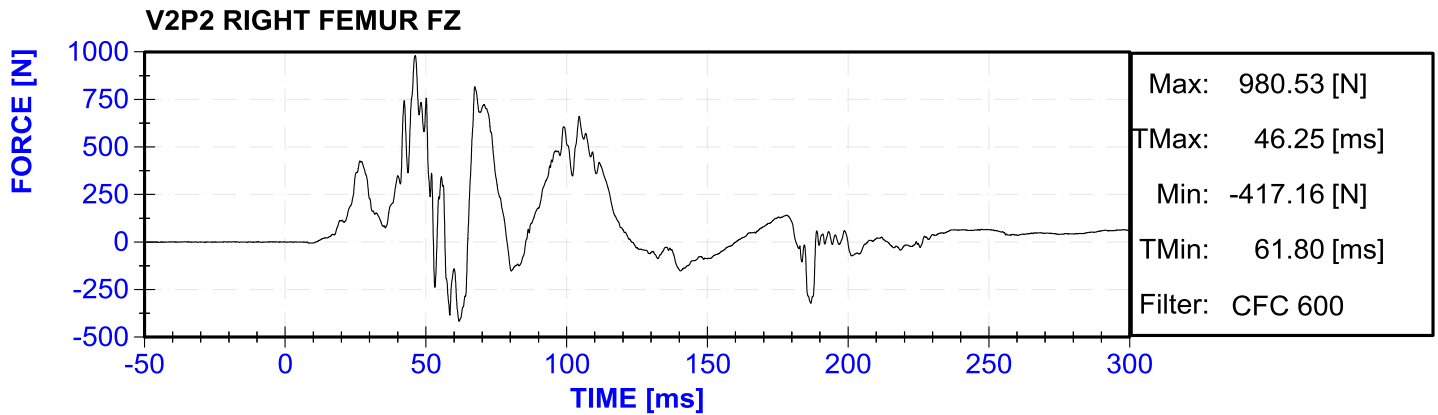


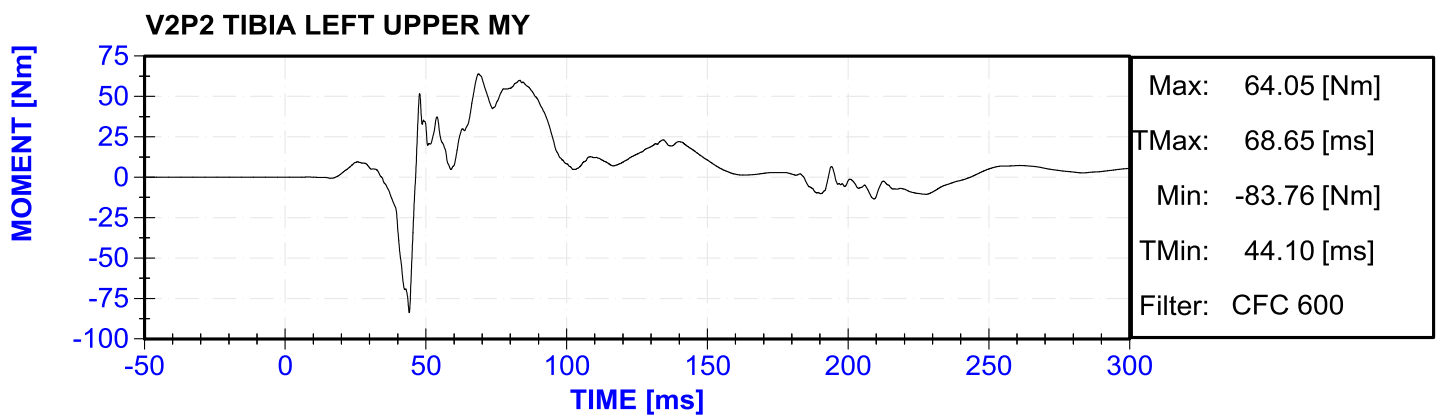
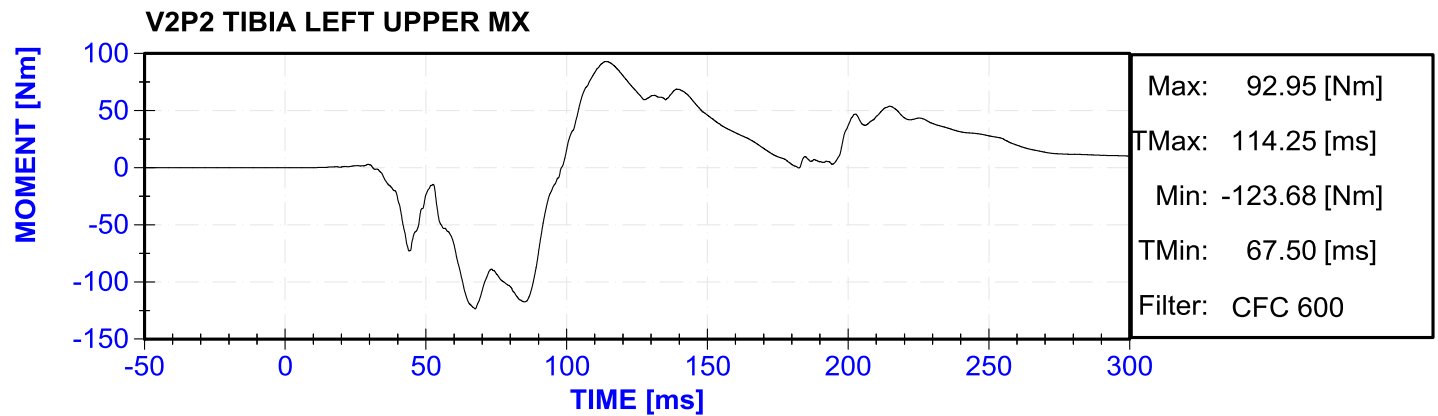
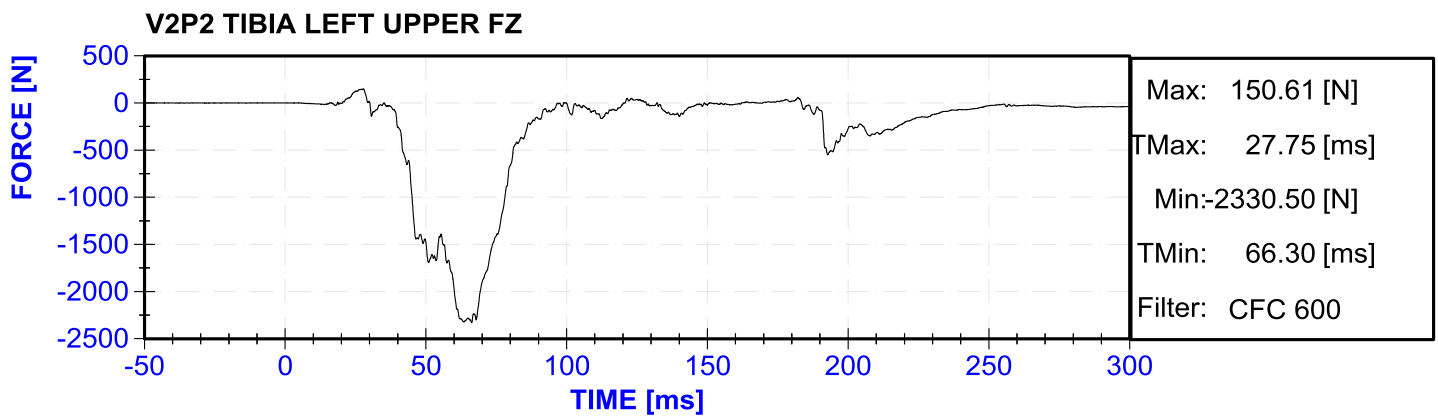
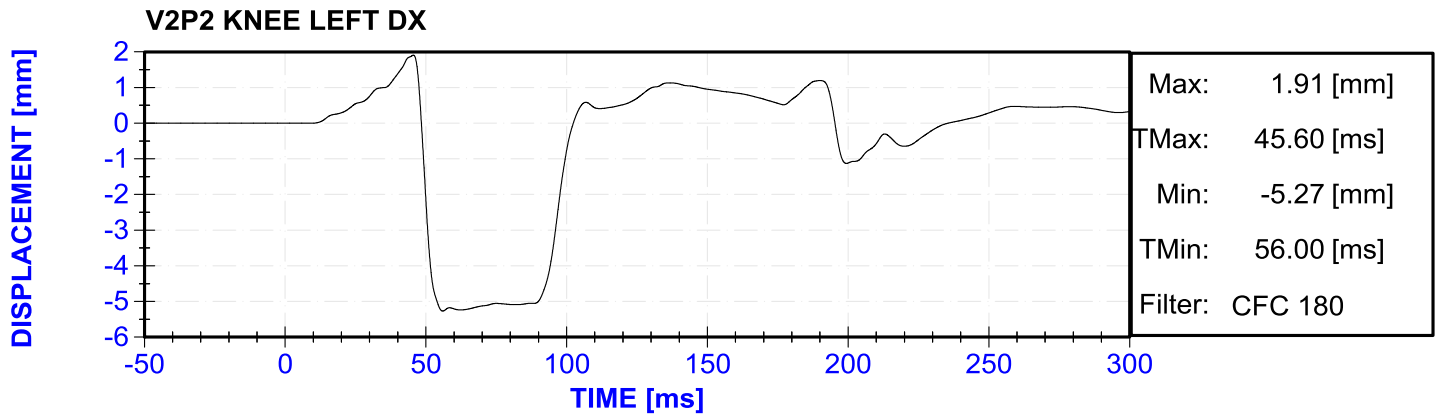
V2P2 RIGHT ASIS FX

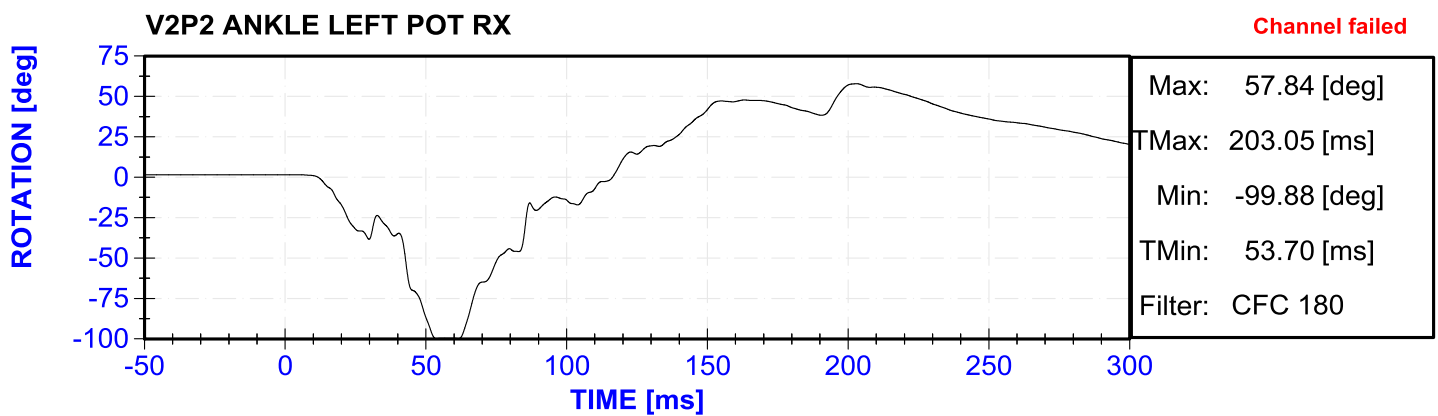
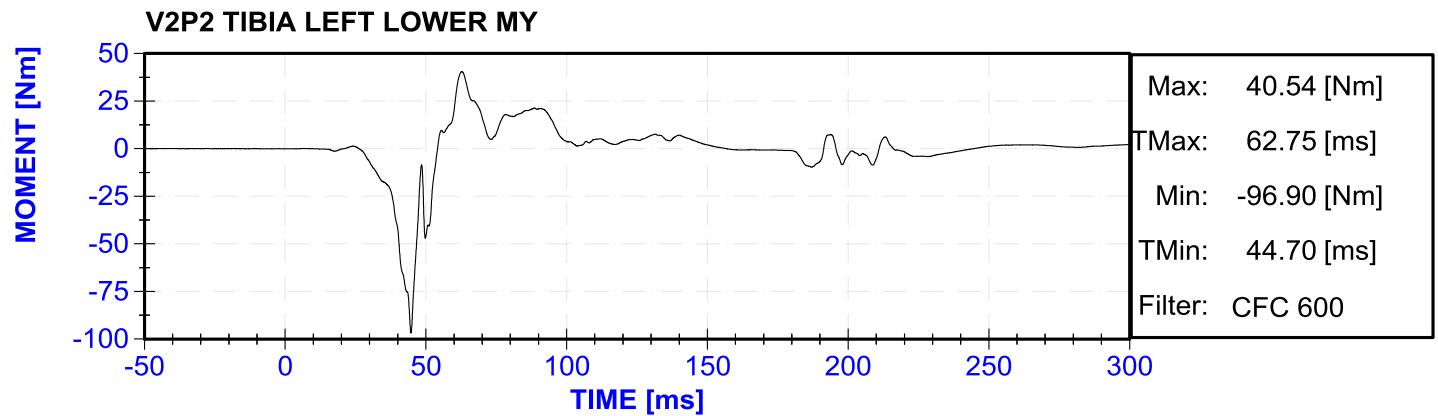
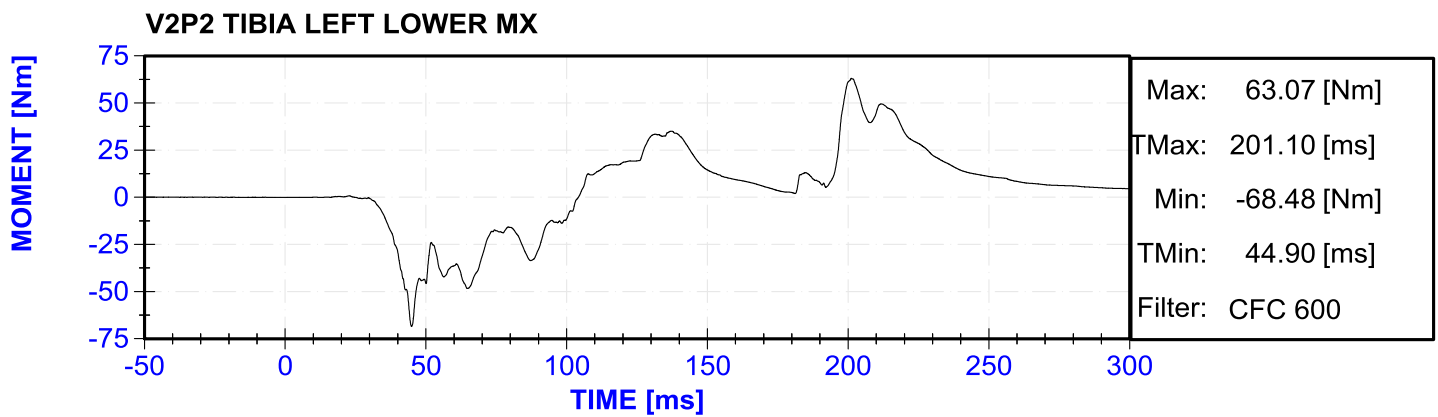
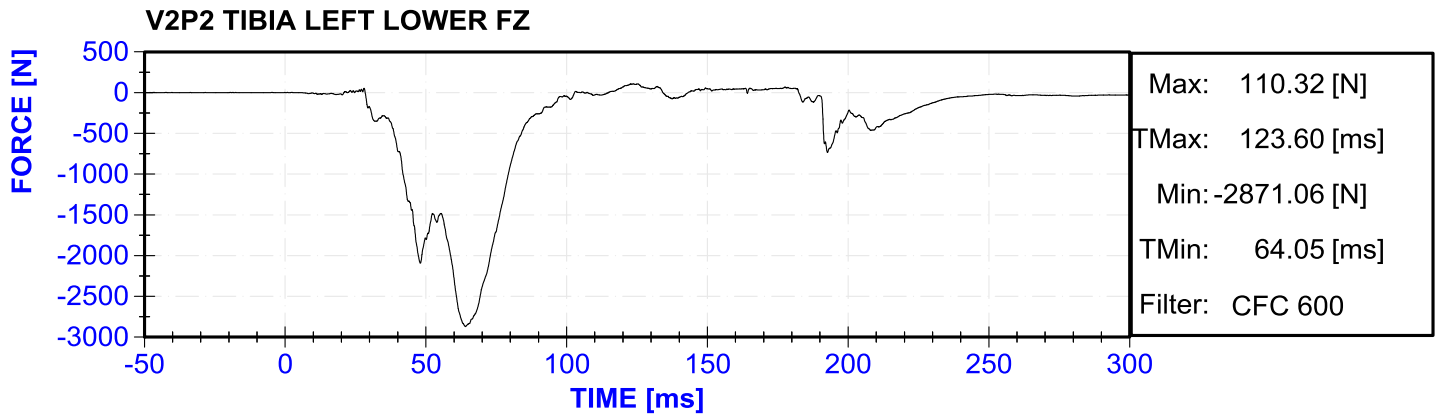


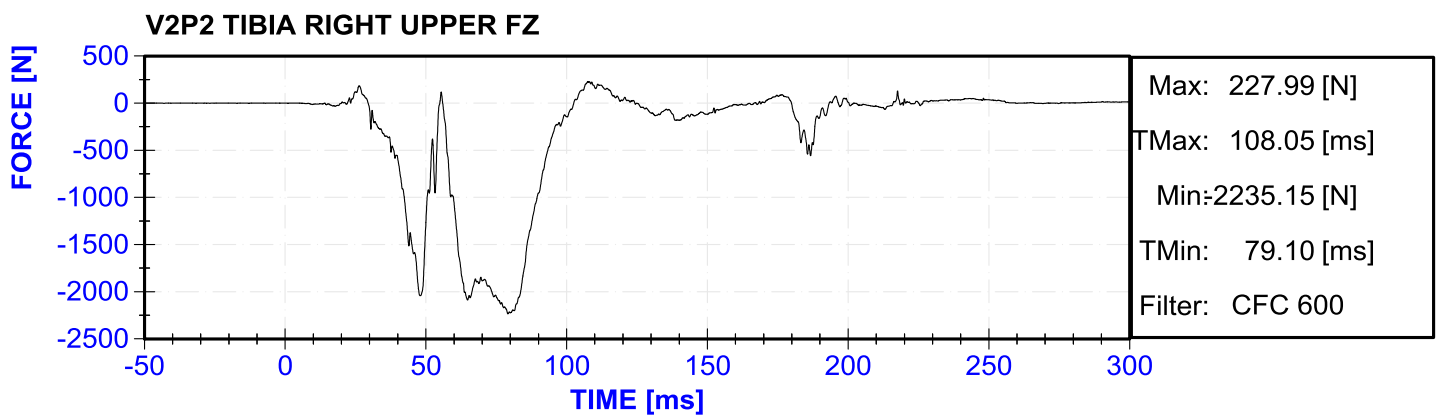
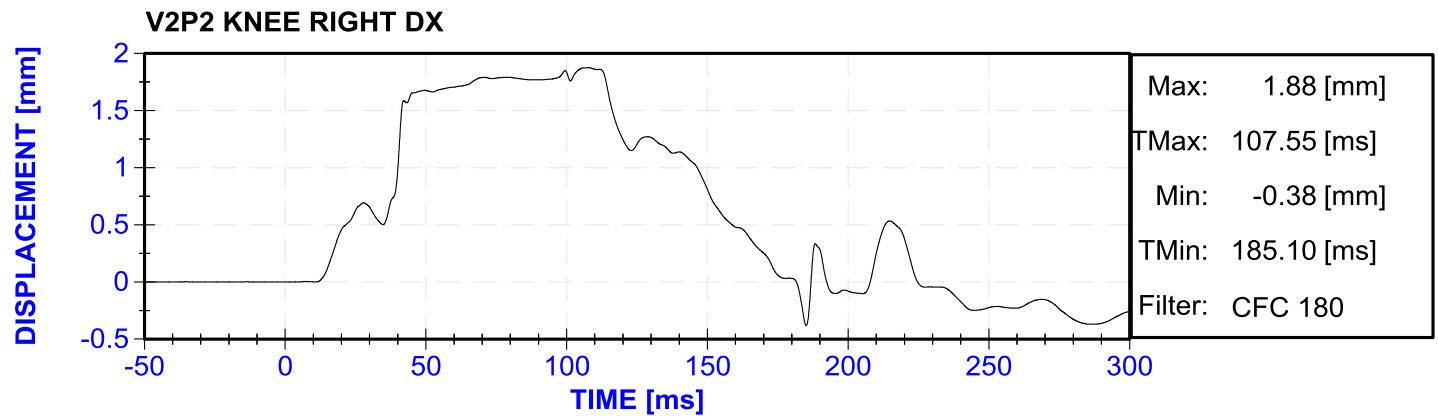
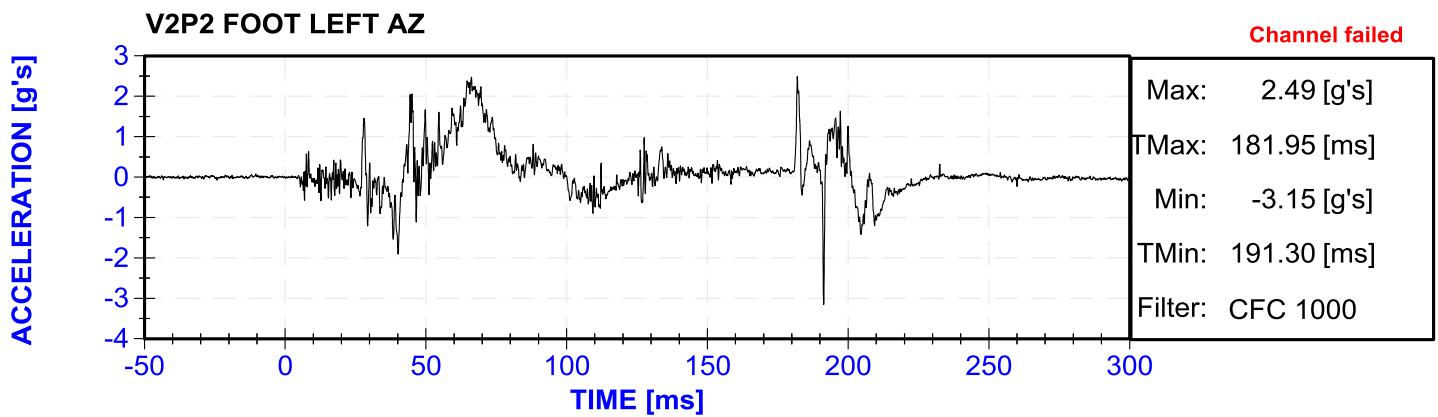
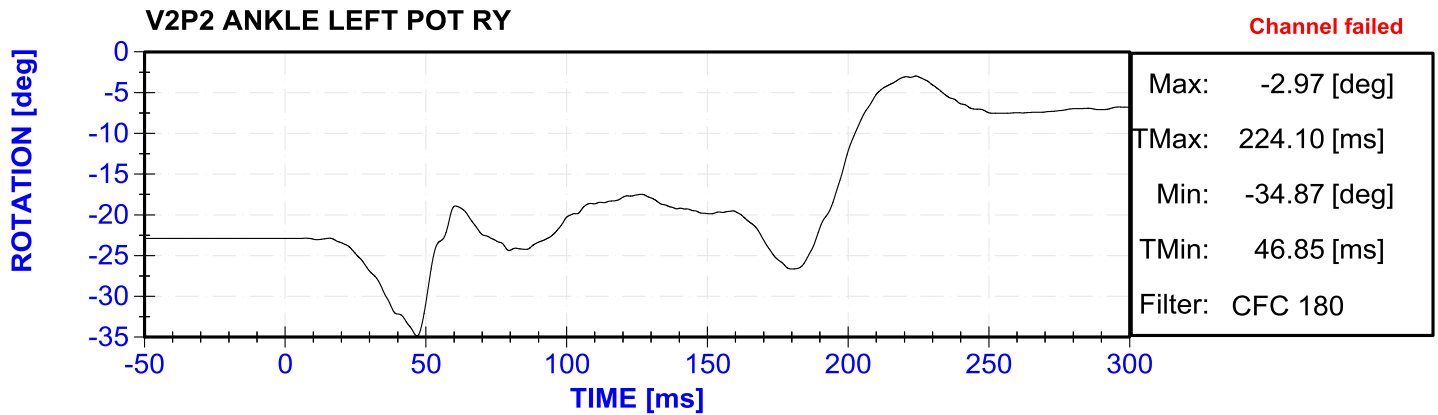


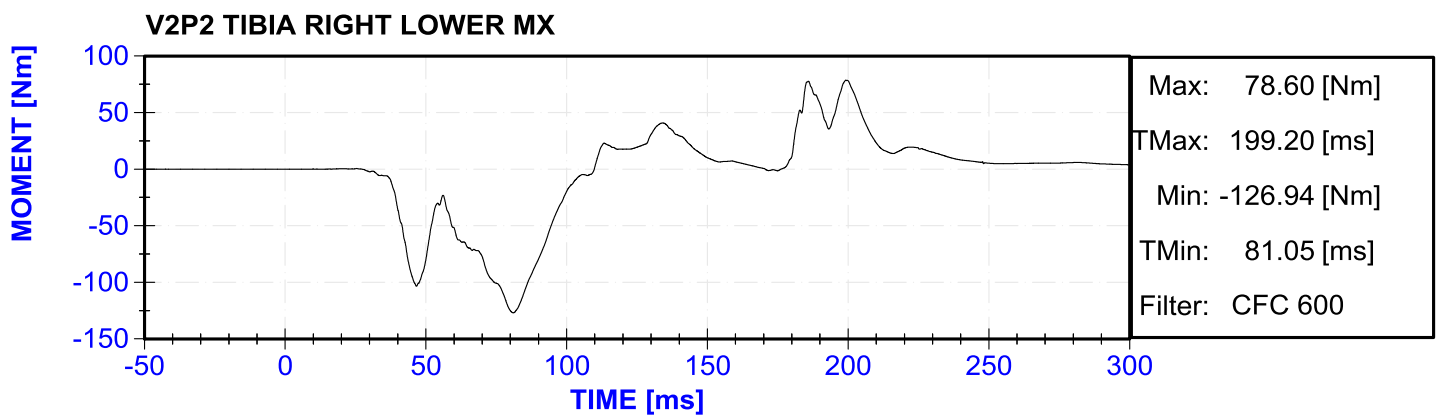
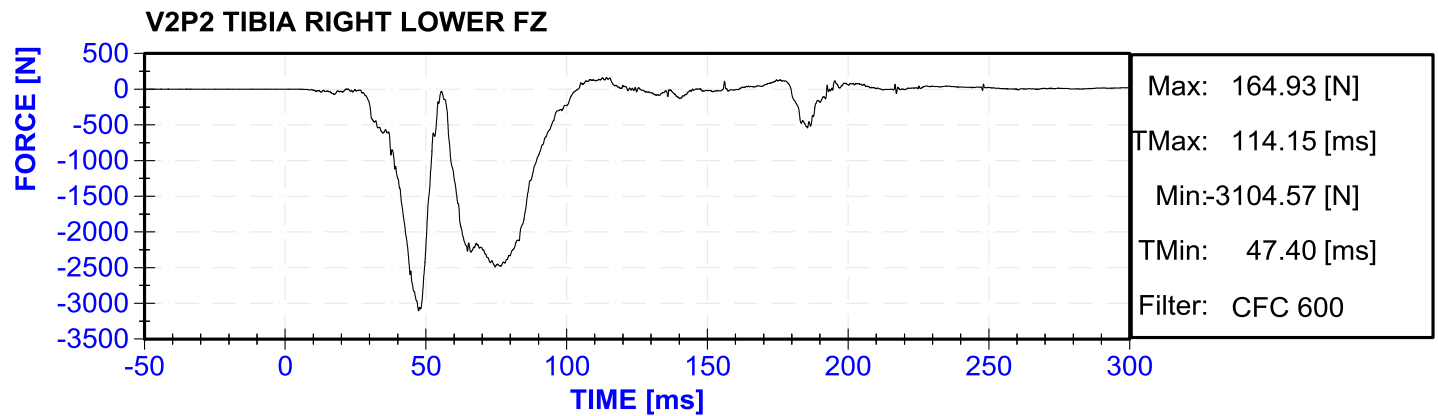
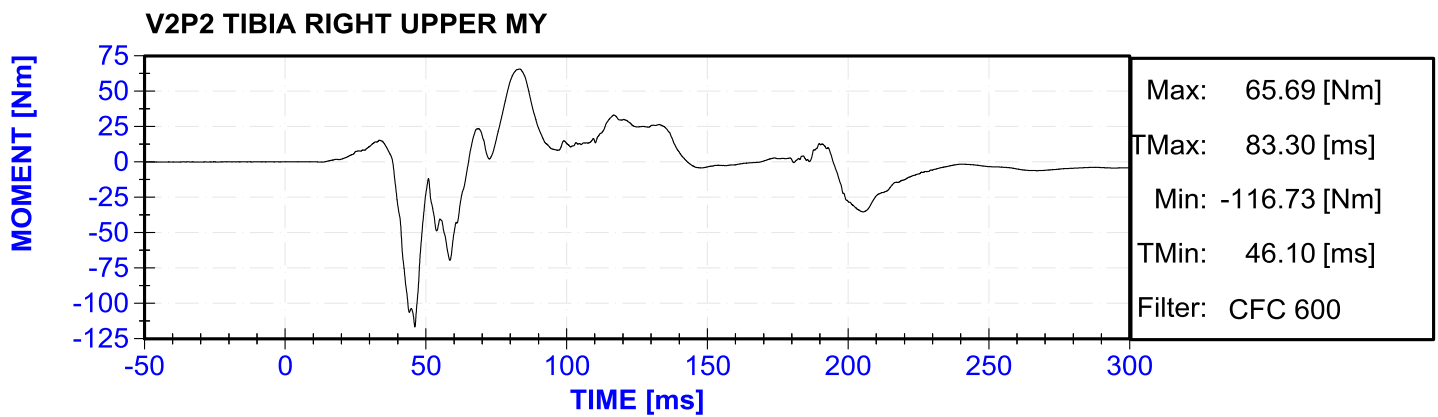
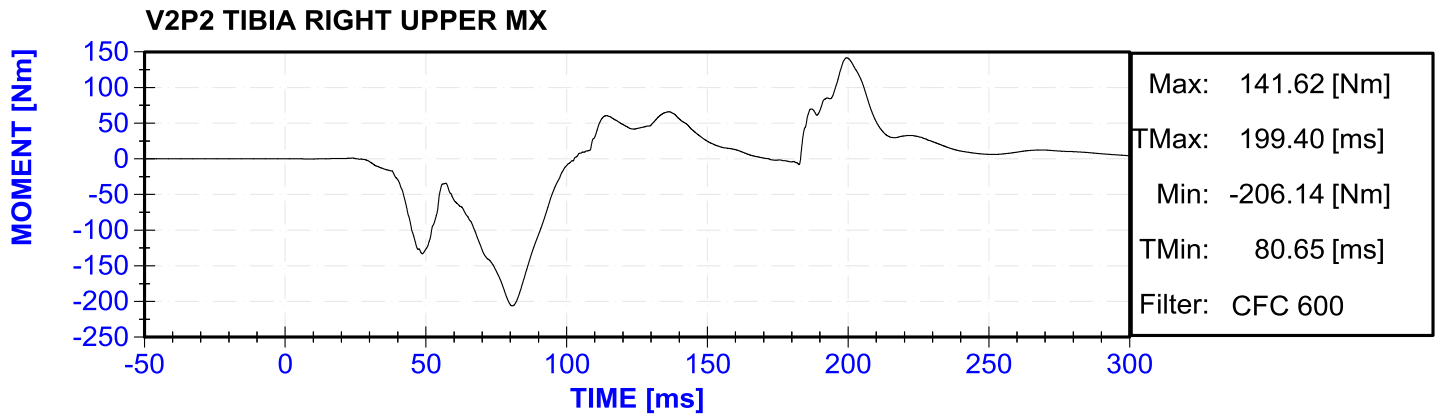


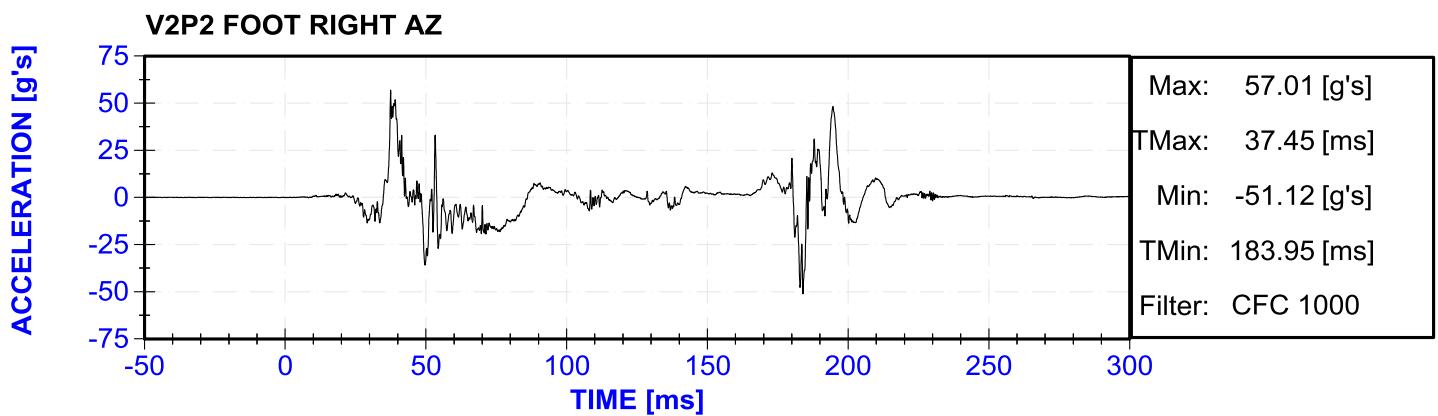
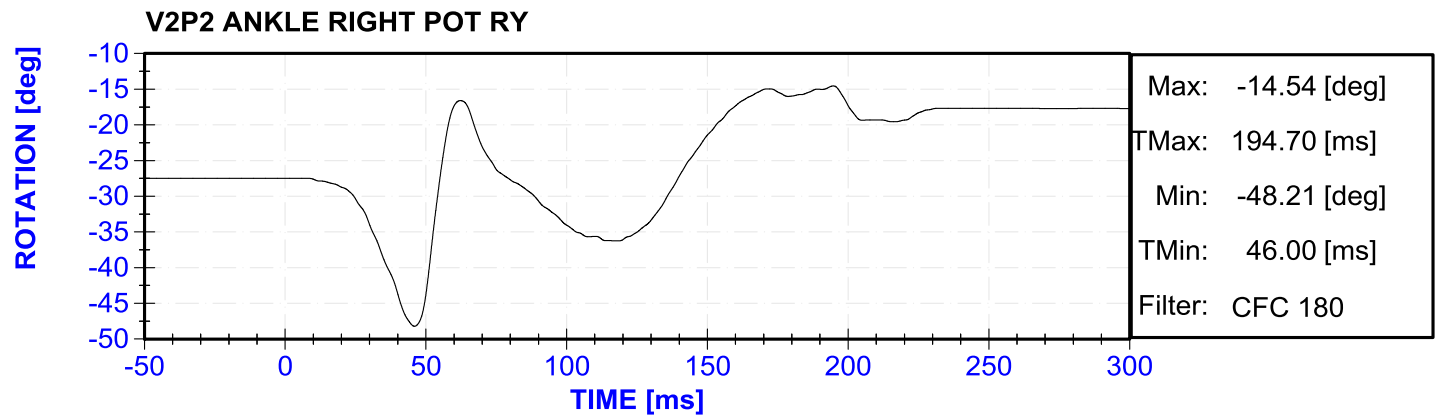
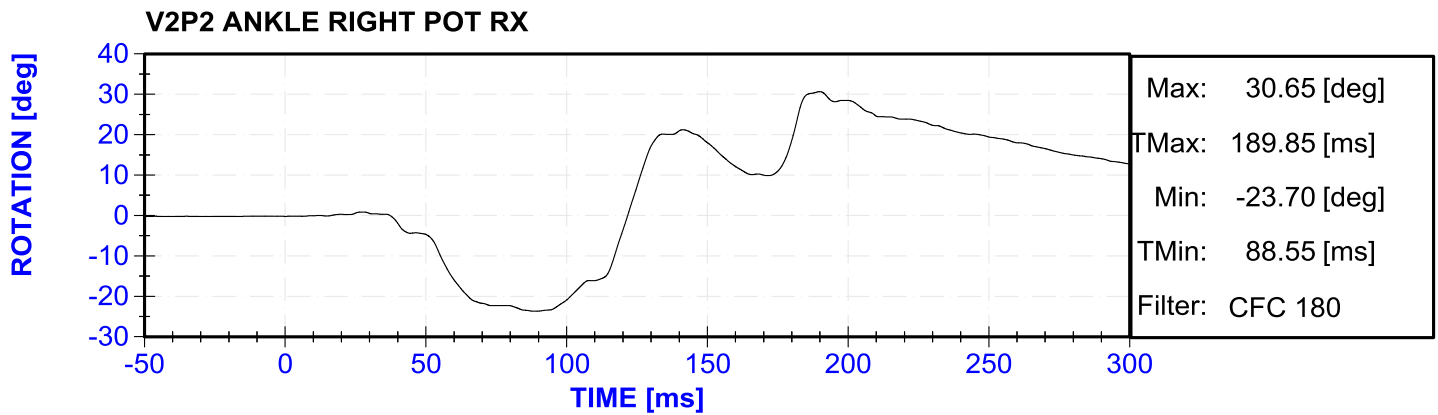
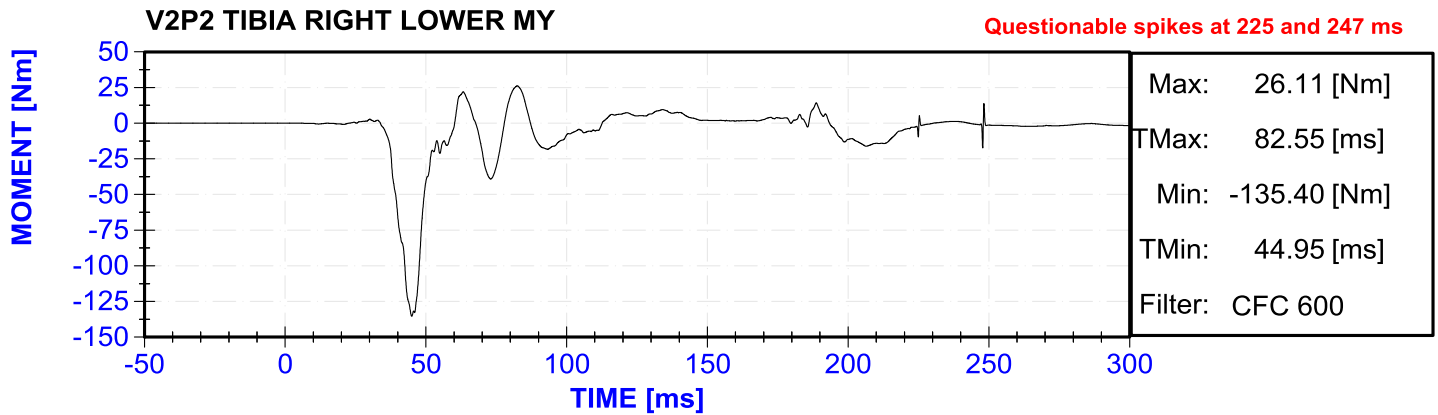




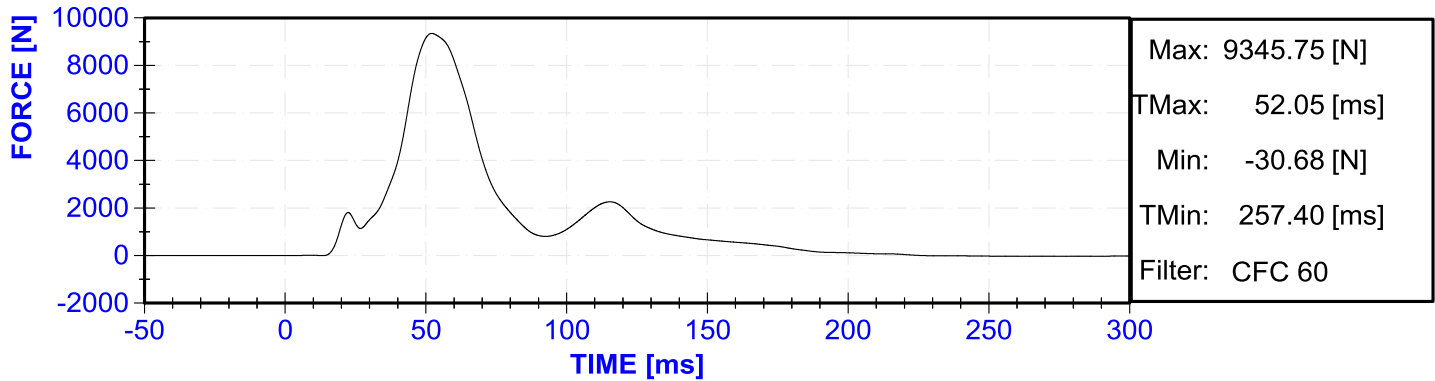




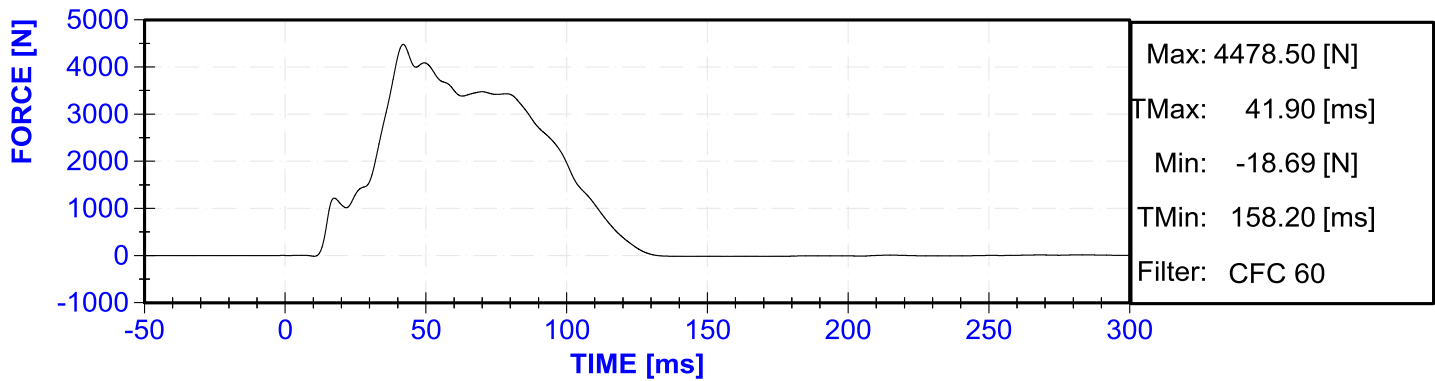




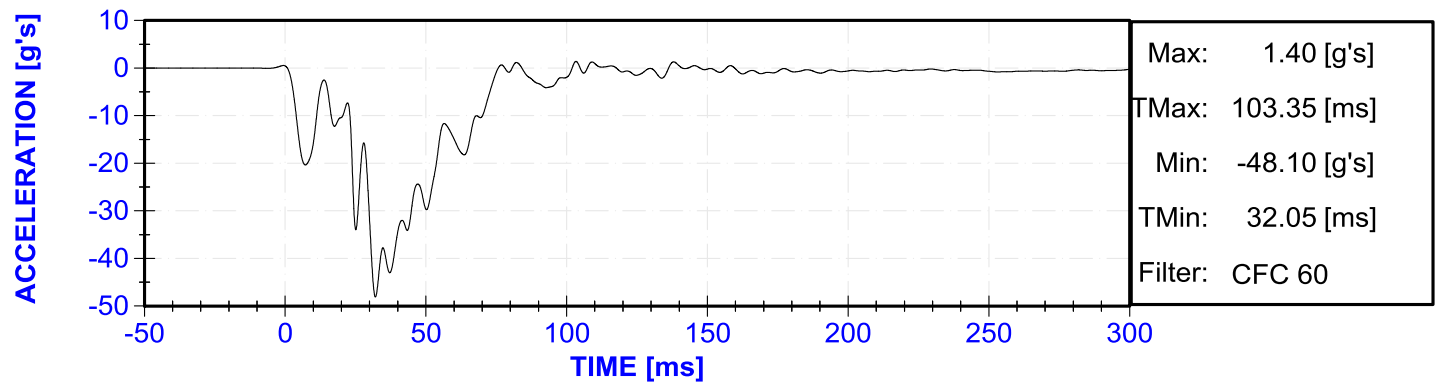
V2 P2 PASSENGER LAP BELT



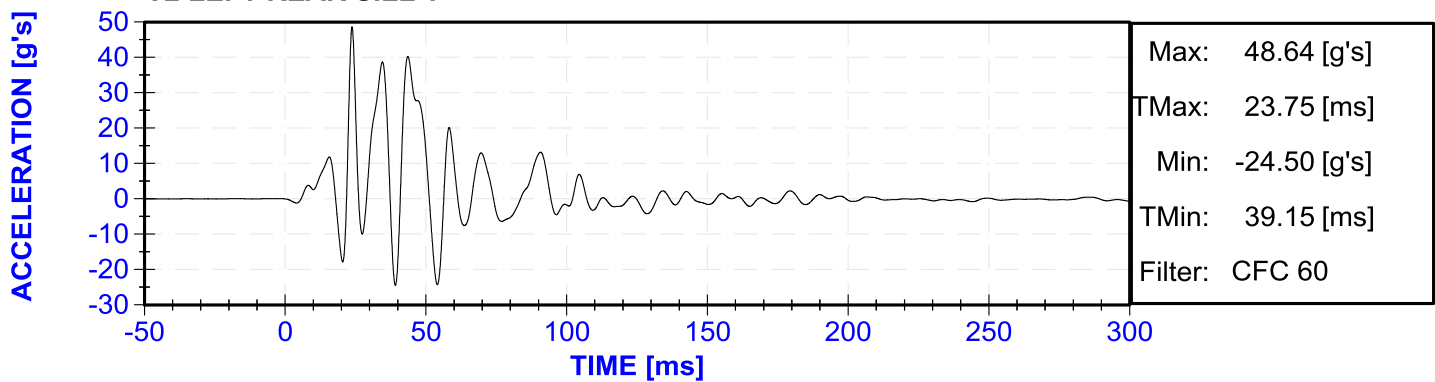
V2 P2 PASSENGER SHOULDER BELT

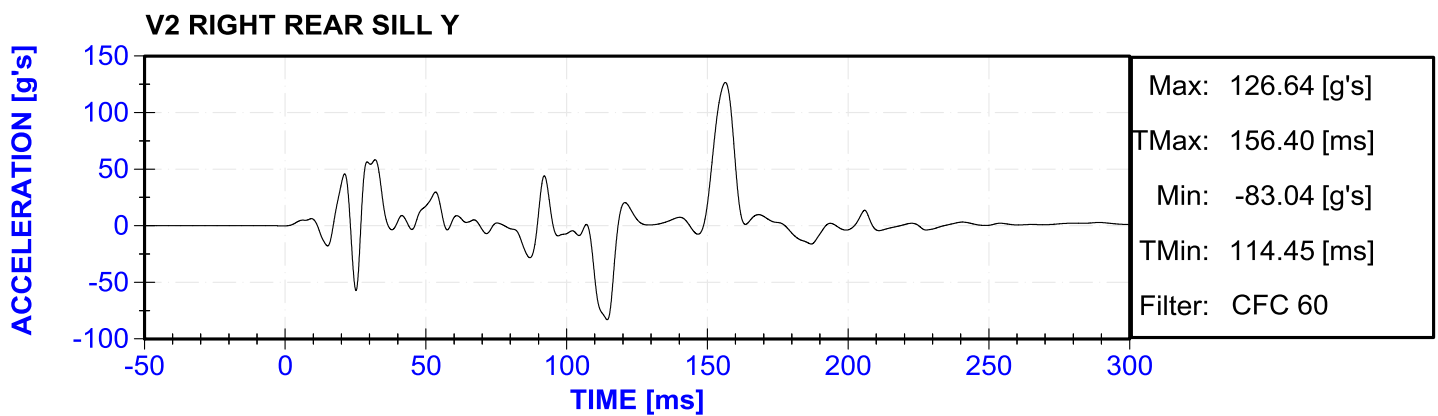
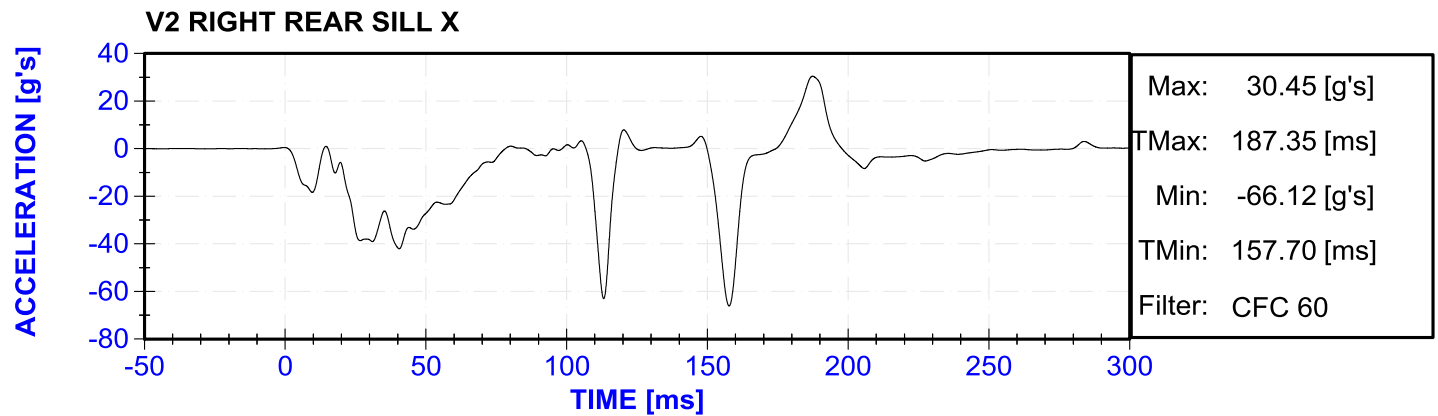
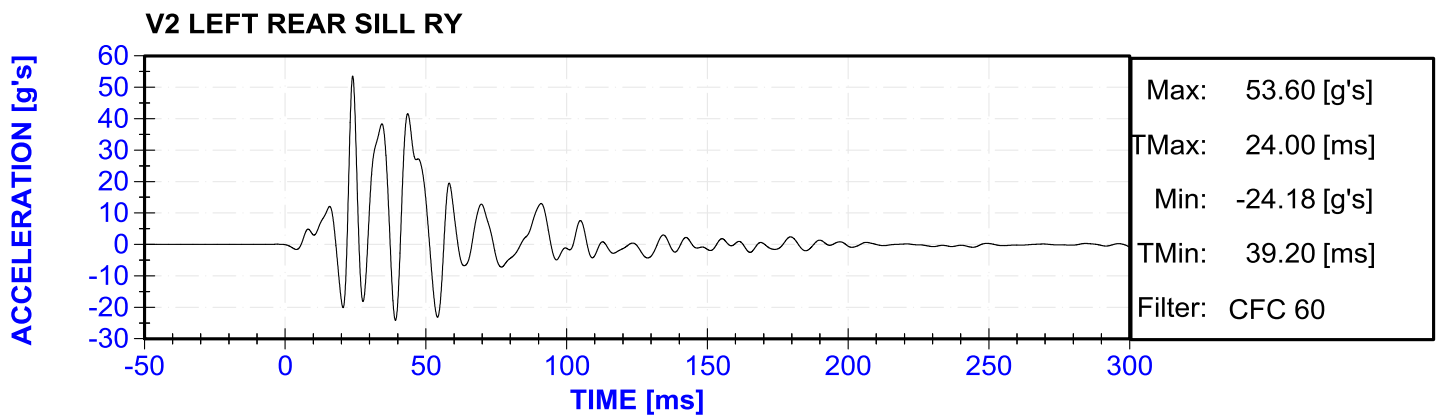
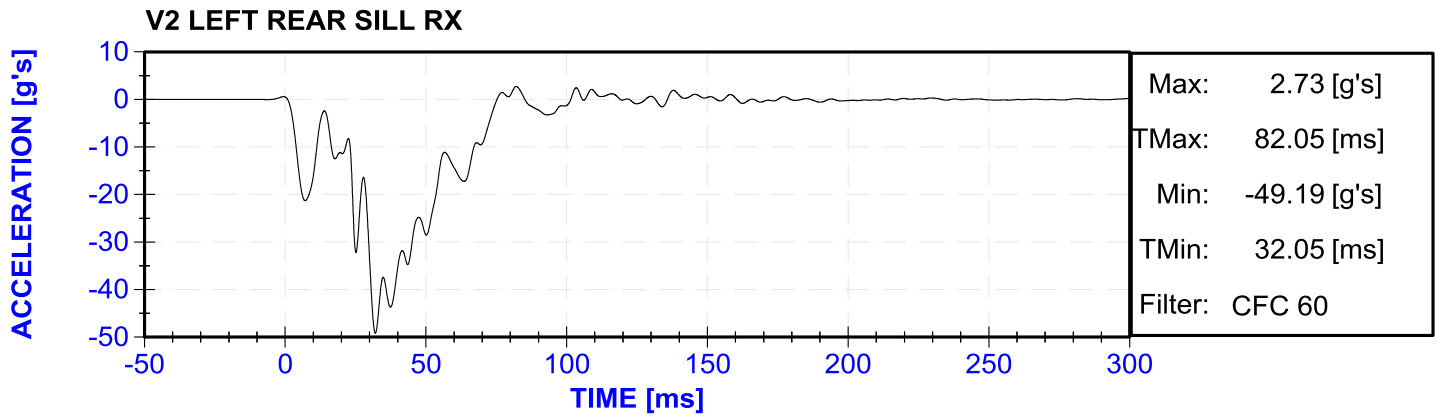


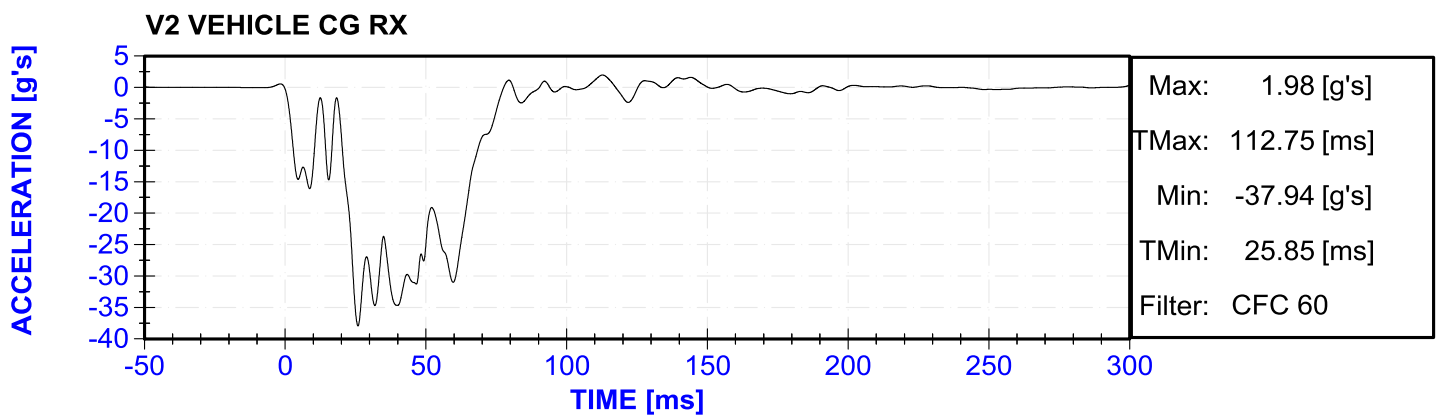
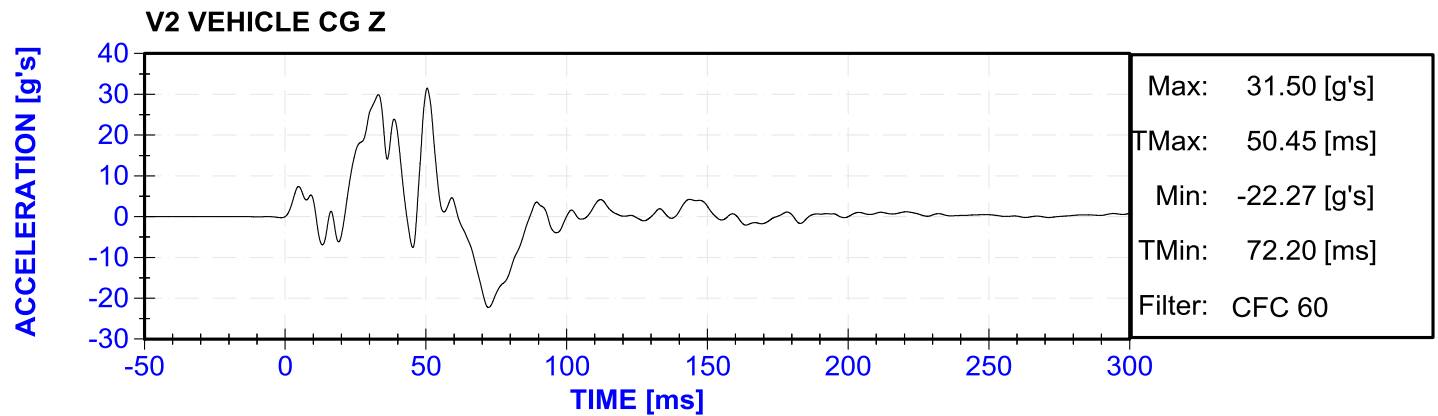
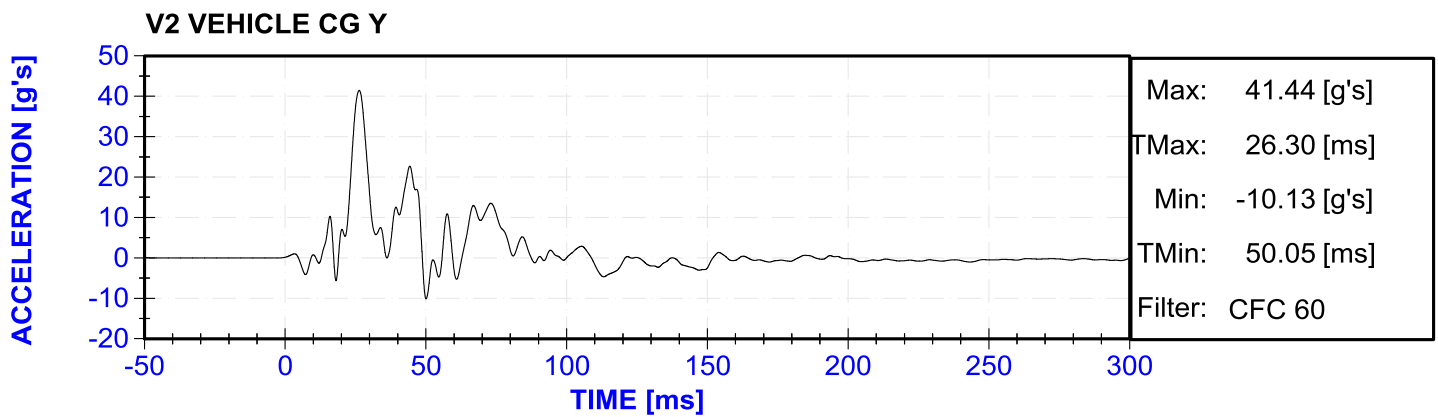
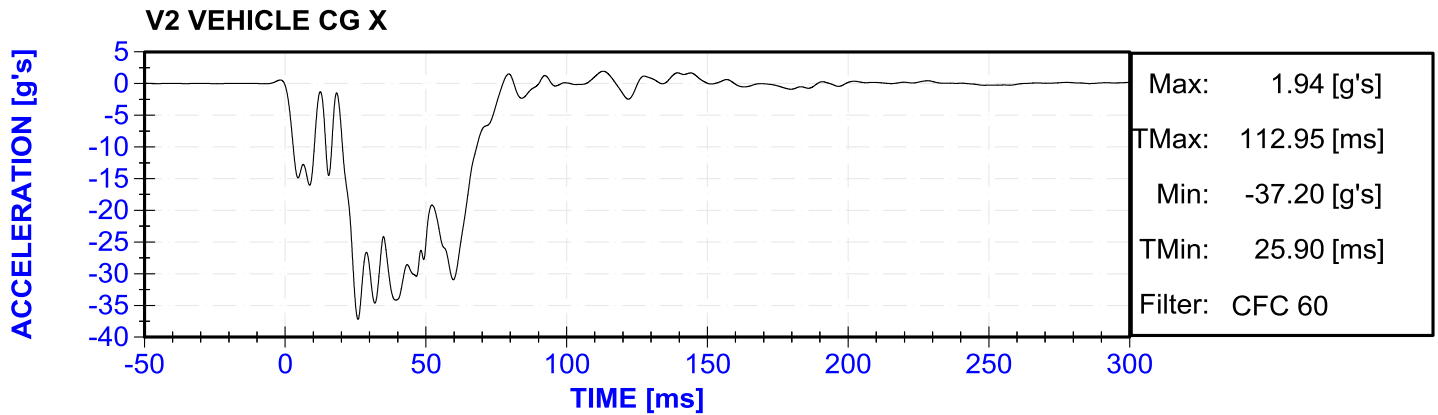
V2 LEFT REAR SILL X

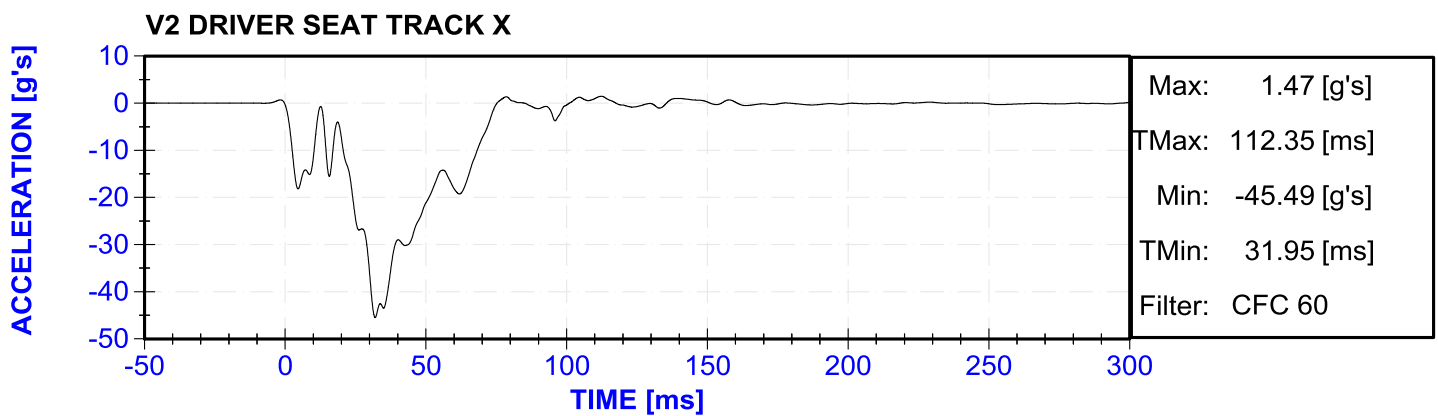
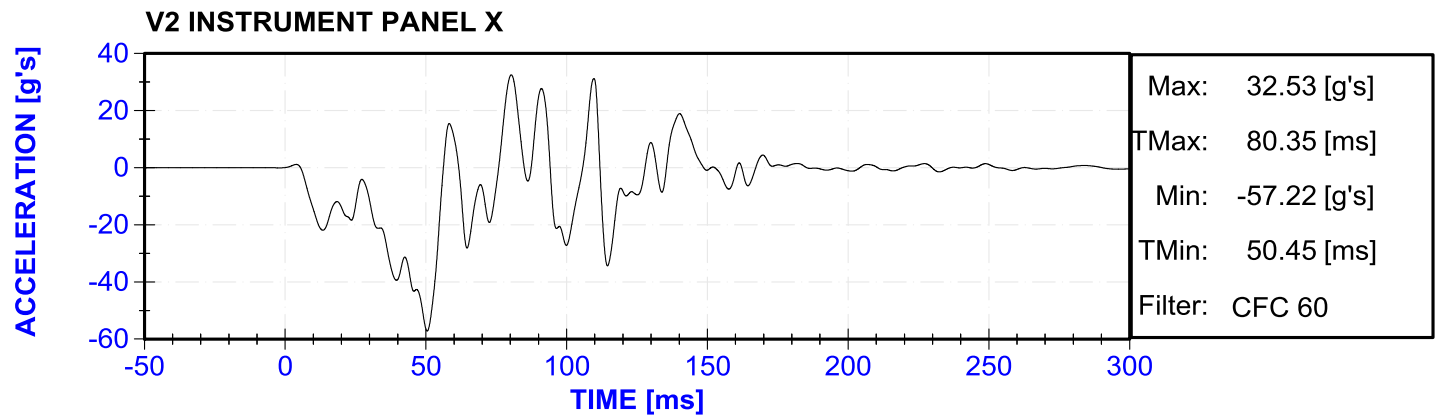
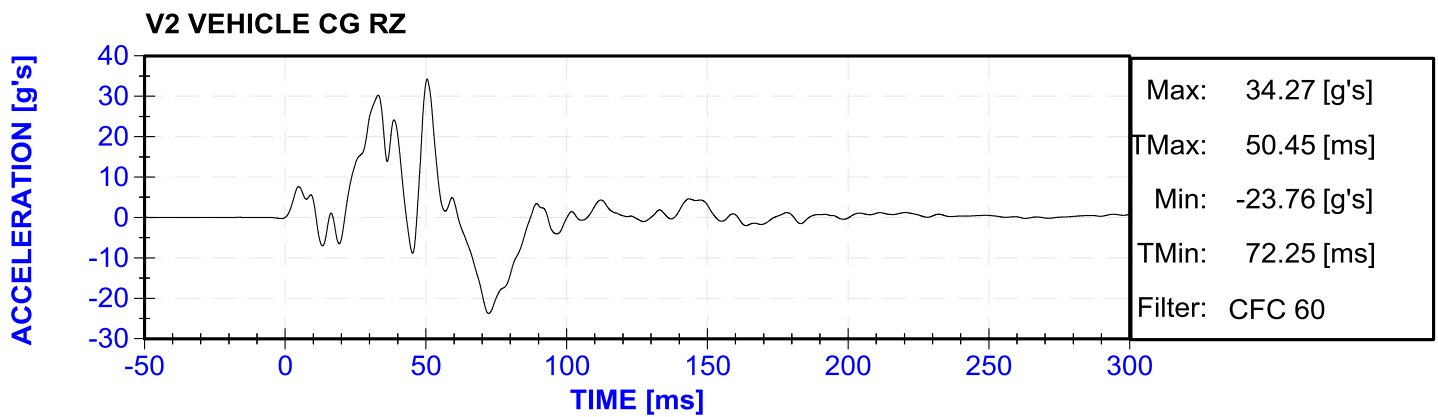
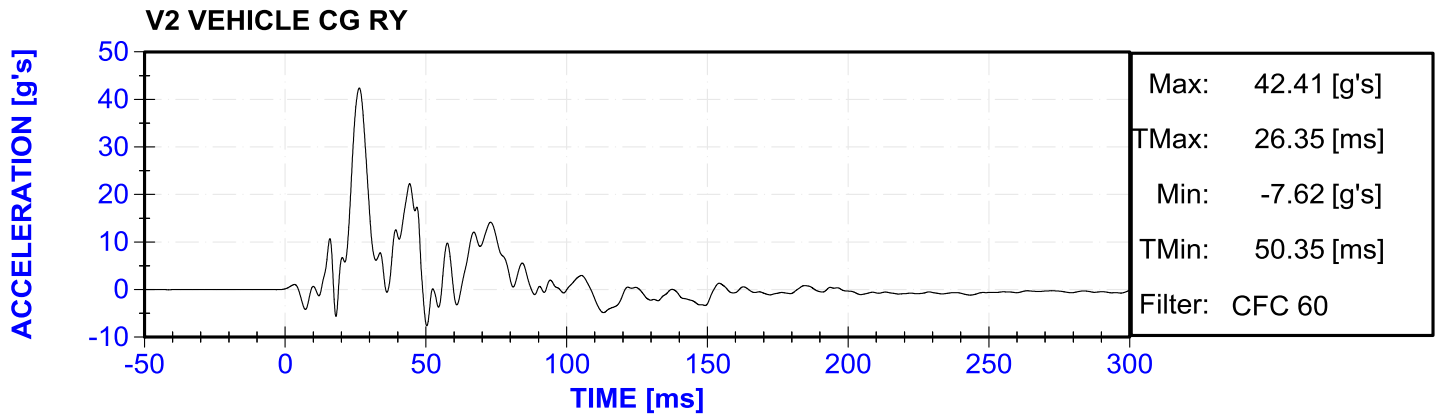


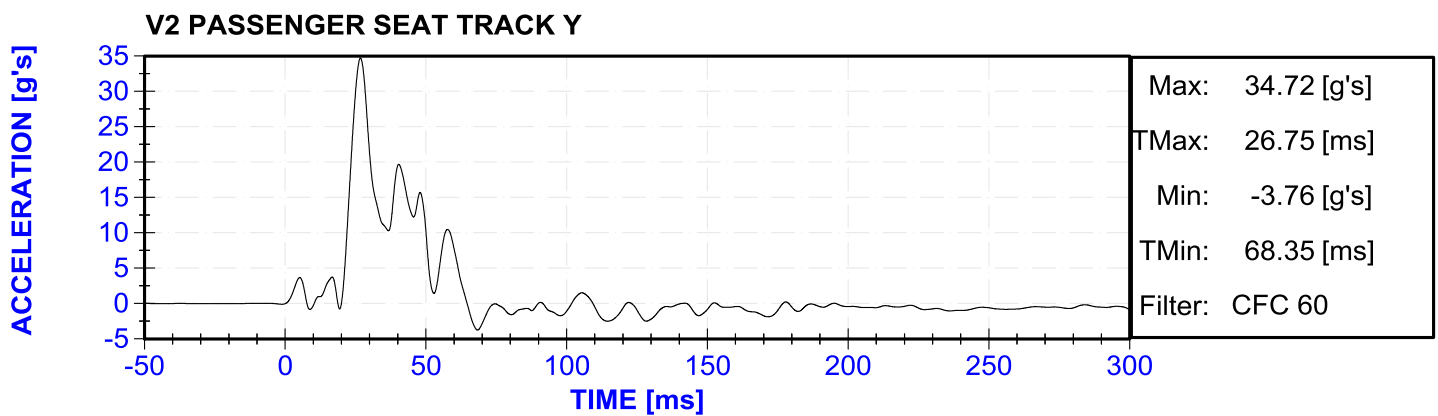
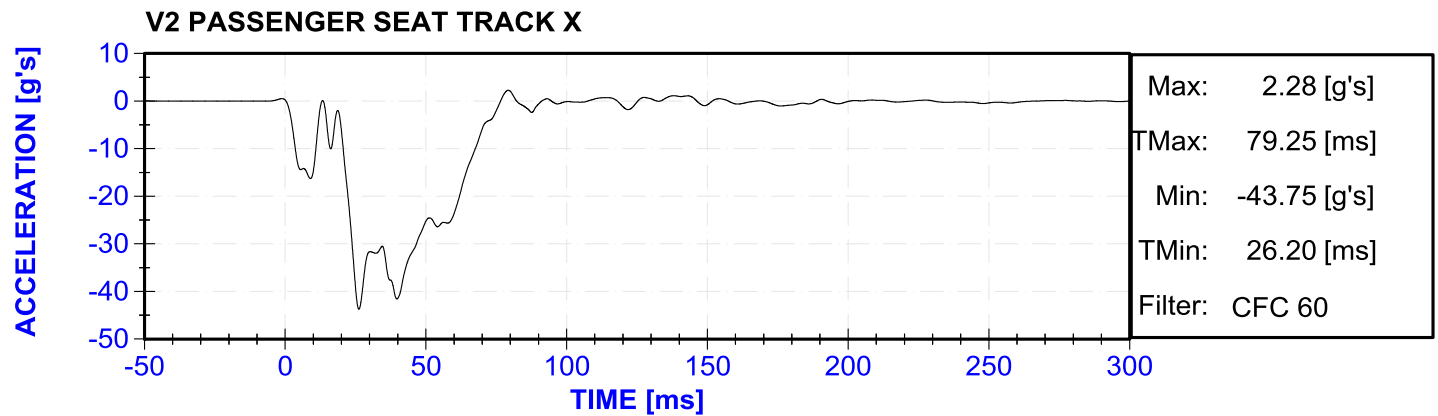
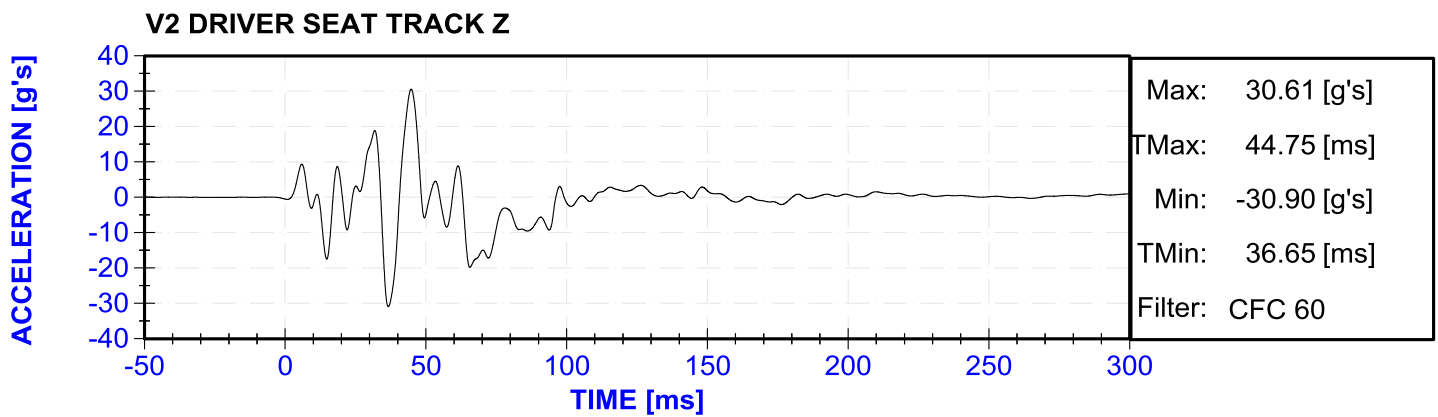
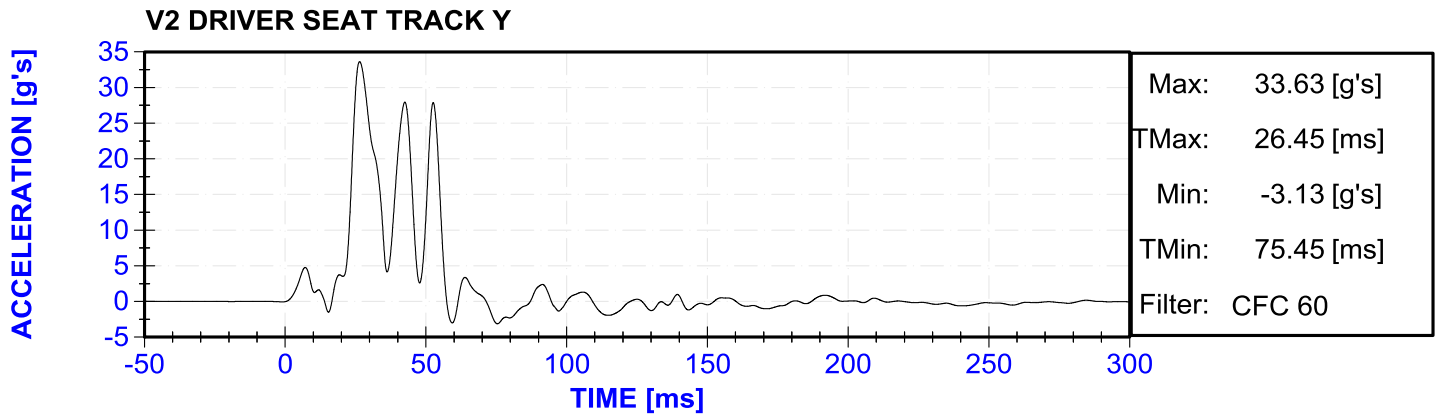
V2 LEFT REAR SILL Y



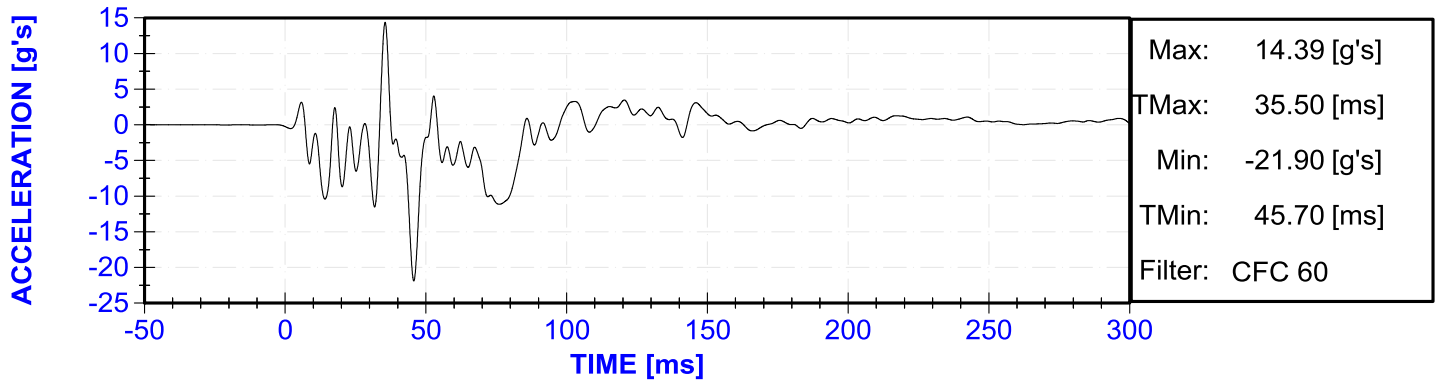




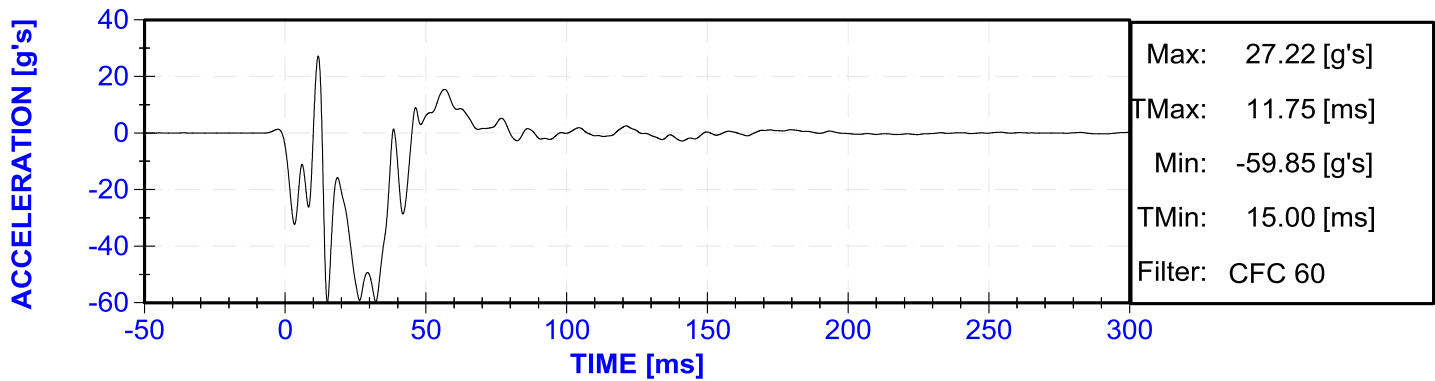




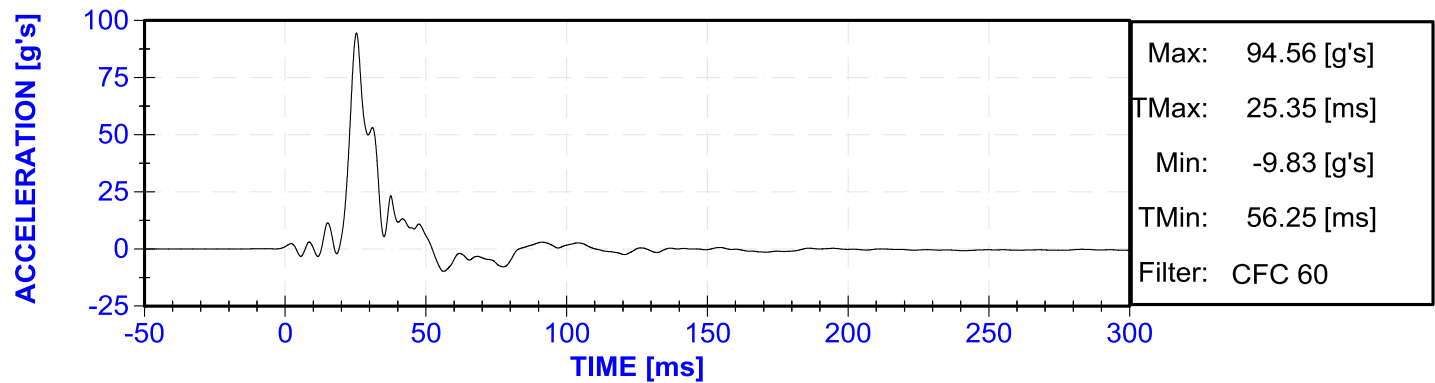
V2 PASSENGER SEAT TRACK Z



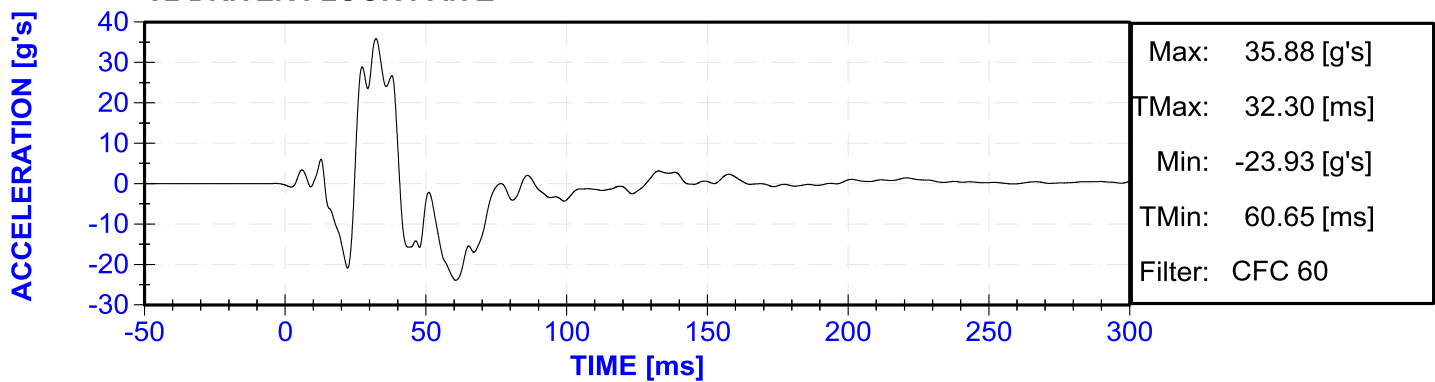
V2 DRIVER FLOOR PAN X

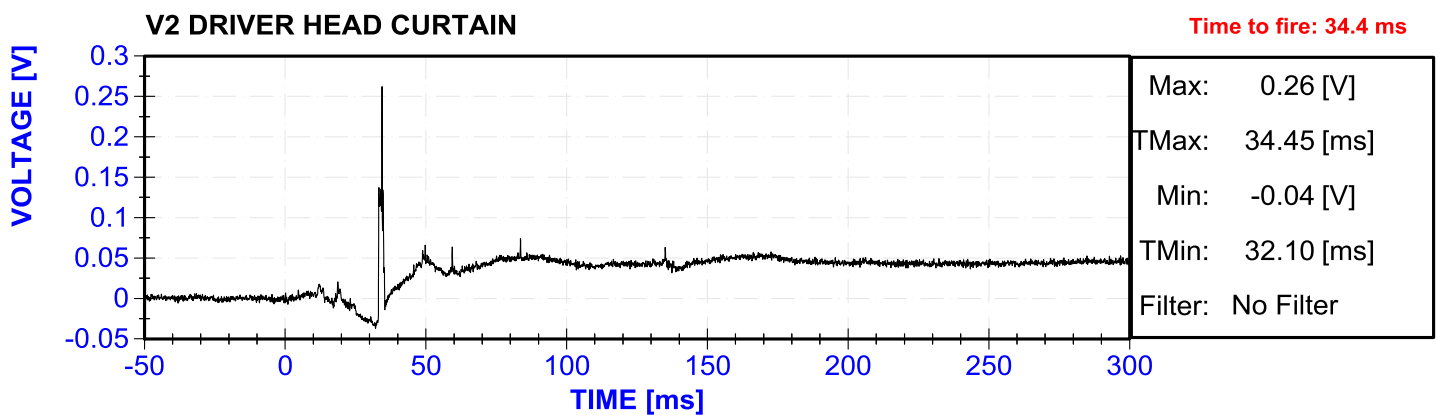
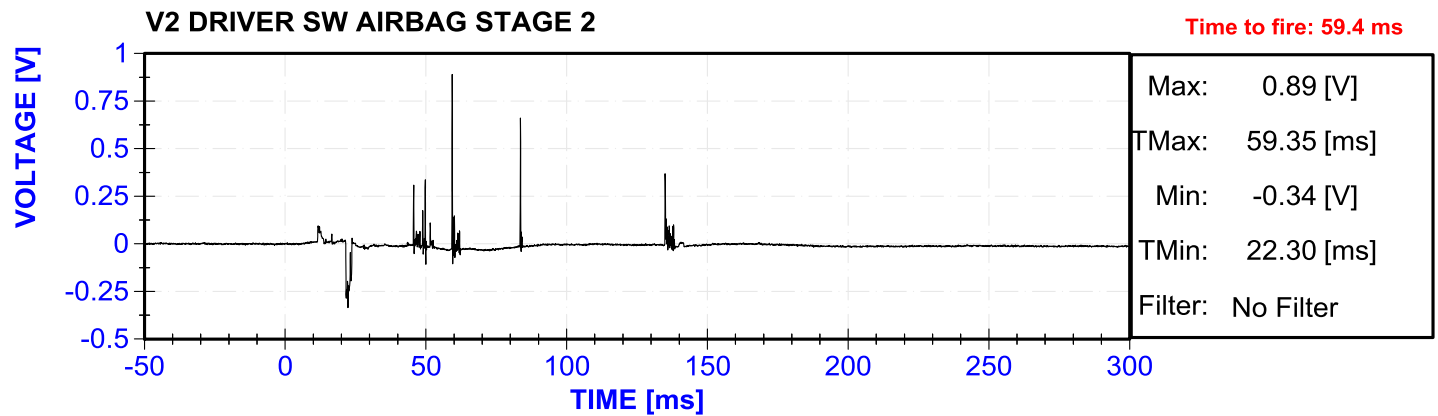
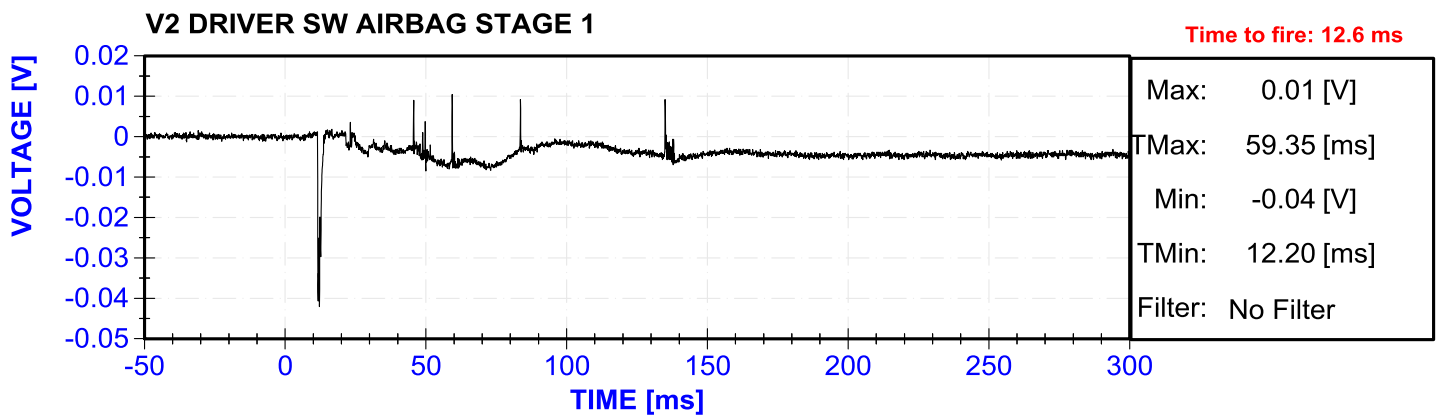
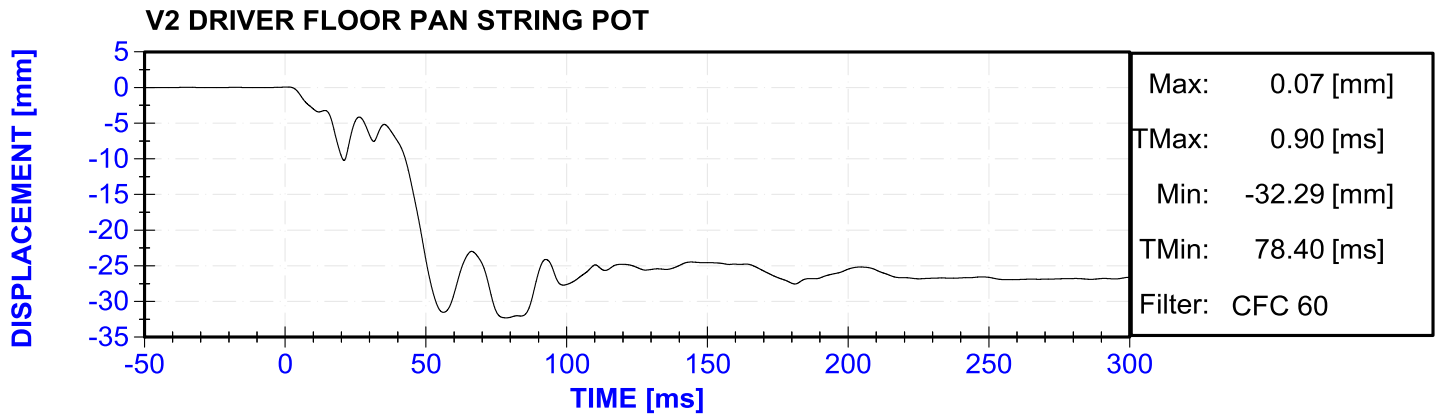


V2 DRIVER FLOOR PAN Y



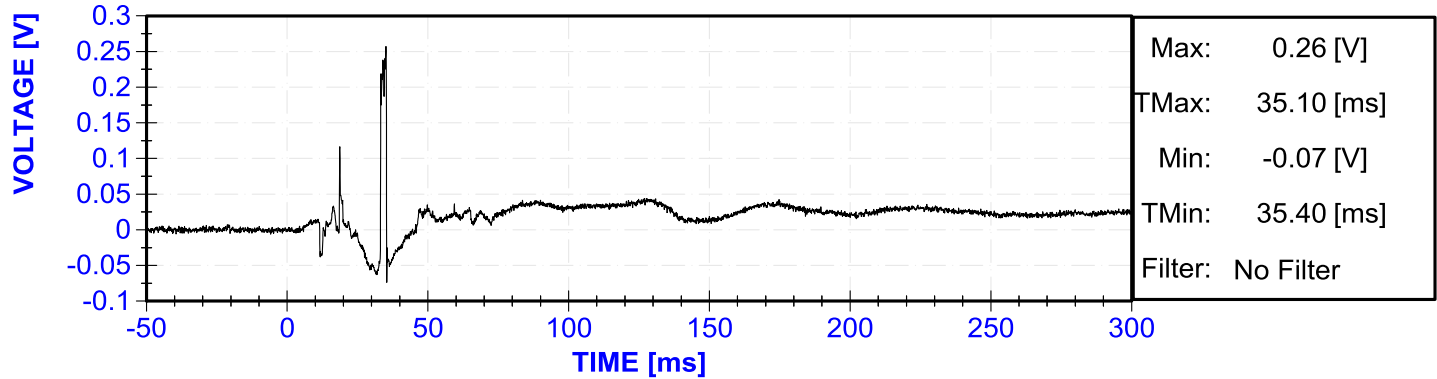
V2 DRIVER FLOOR PAN Z





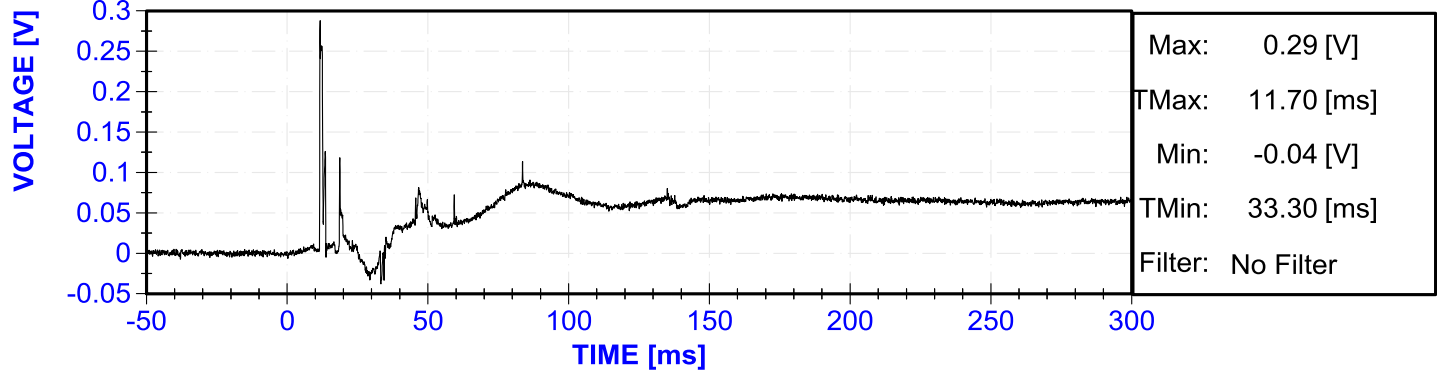
V2 DRIVER SEAT HEAD/TORSO/PELVIS

Time to fire: 35.1 ms



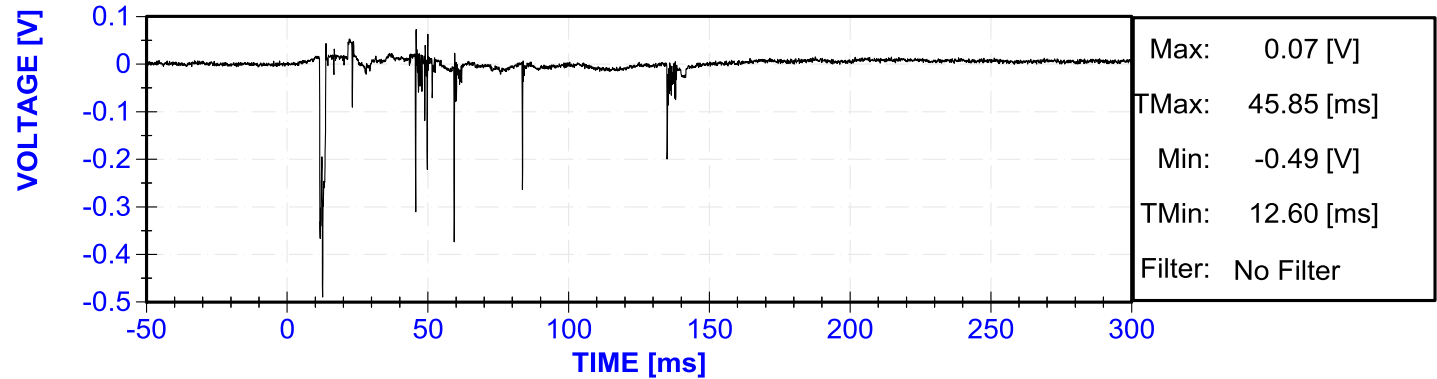
V2 DRIVER TORSO BELT PRETENSIONER

Time to fire: 11.7 ms



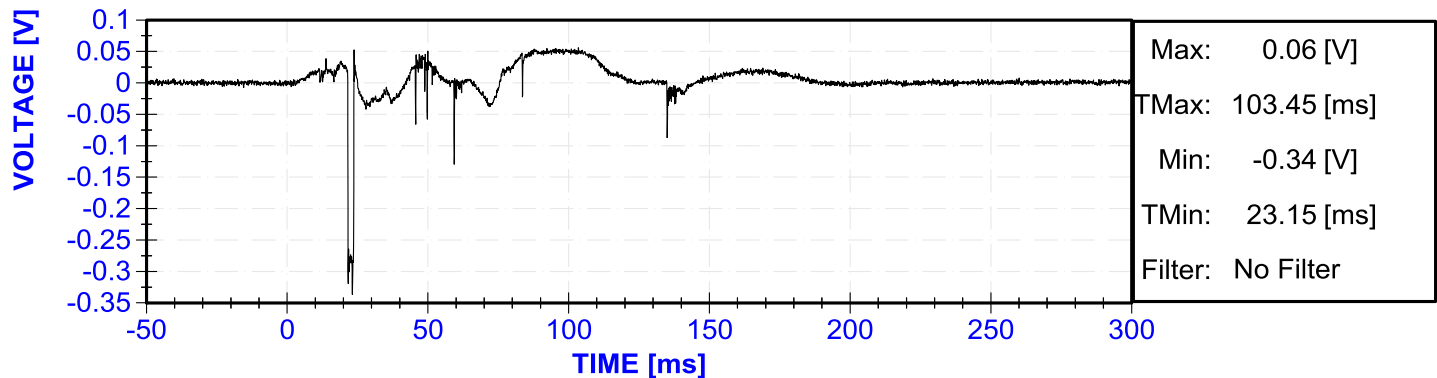
V2 PASSENGER FRT AIRBAG STAGE 1

Time to fire: 12.6 ms



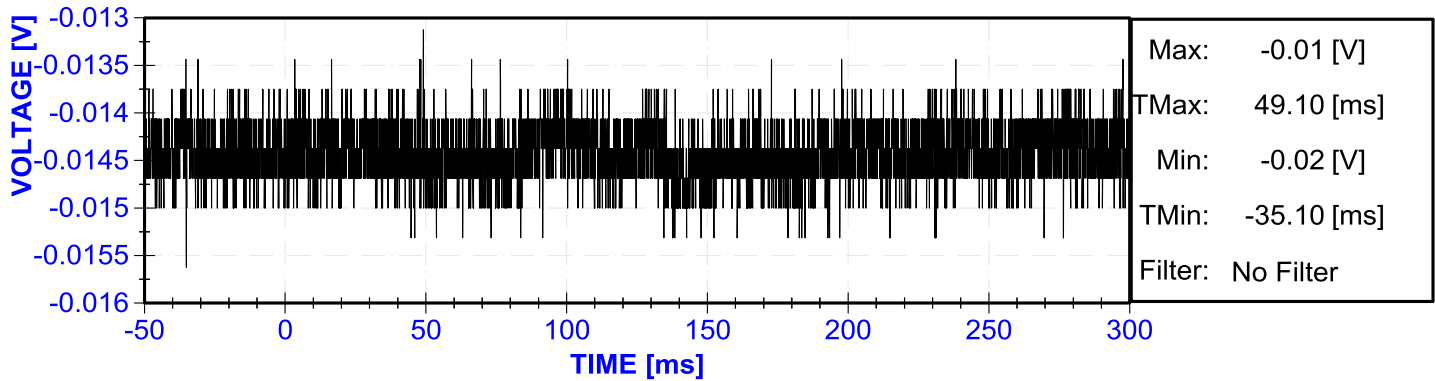
V2 PASSENGER FRT AIRBAG STAGE 2

Time to fire: 23.2 ms



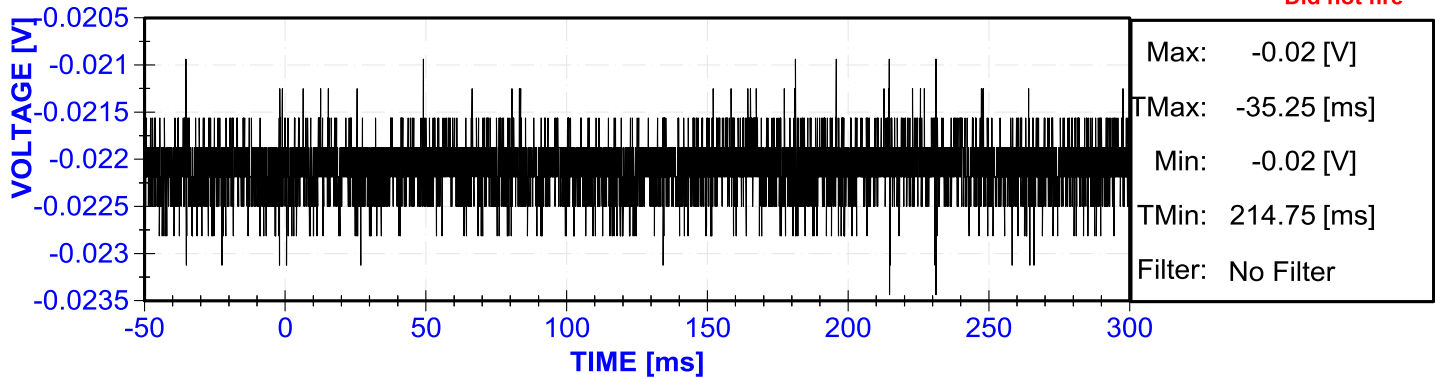
V2 PASSENGER HEAD CURTAIN

Did not fire



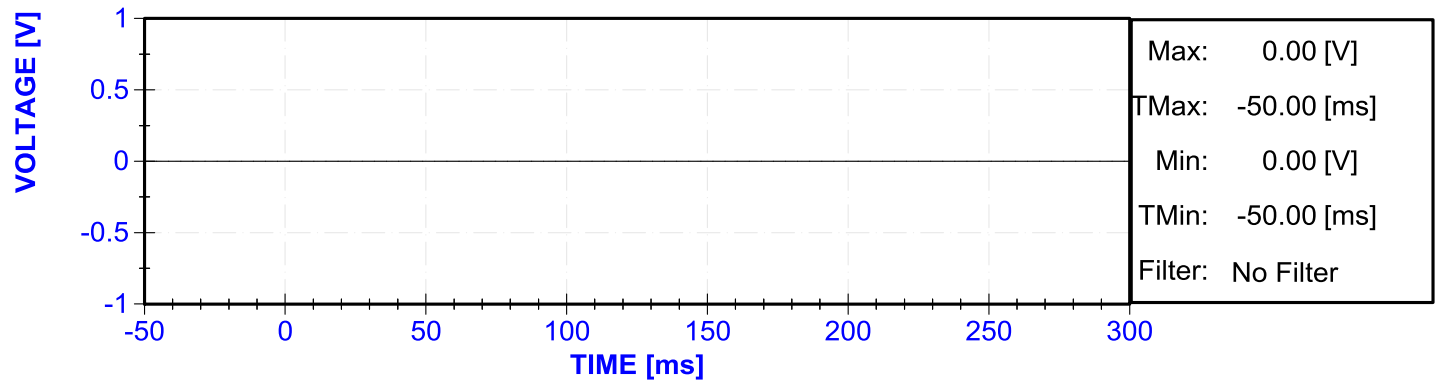
V2 PASSENGER HEAD/TORSO/PELVIS

Did not fire



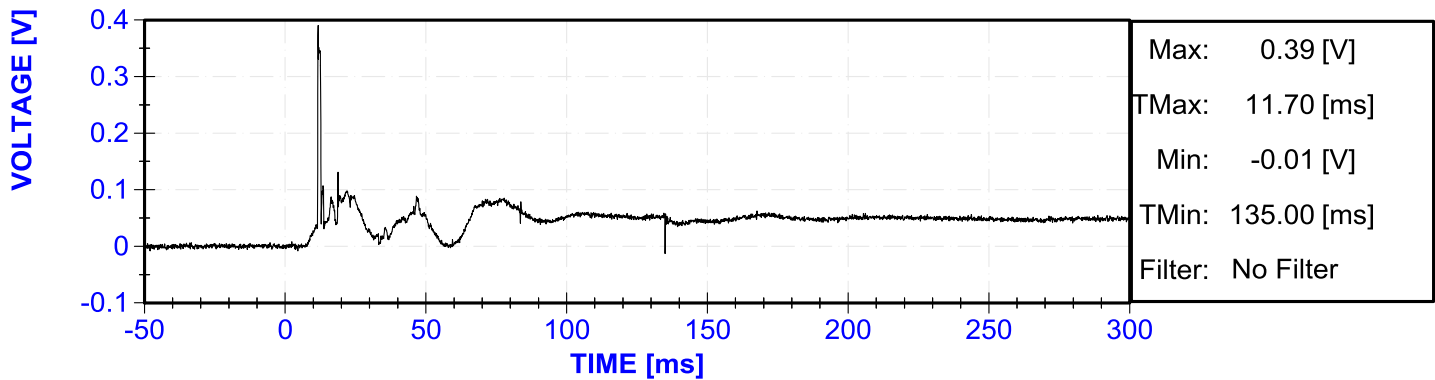
V2 PASSENGER KNEE

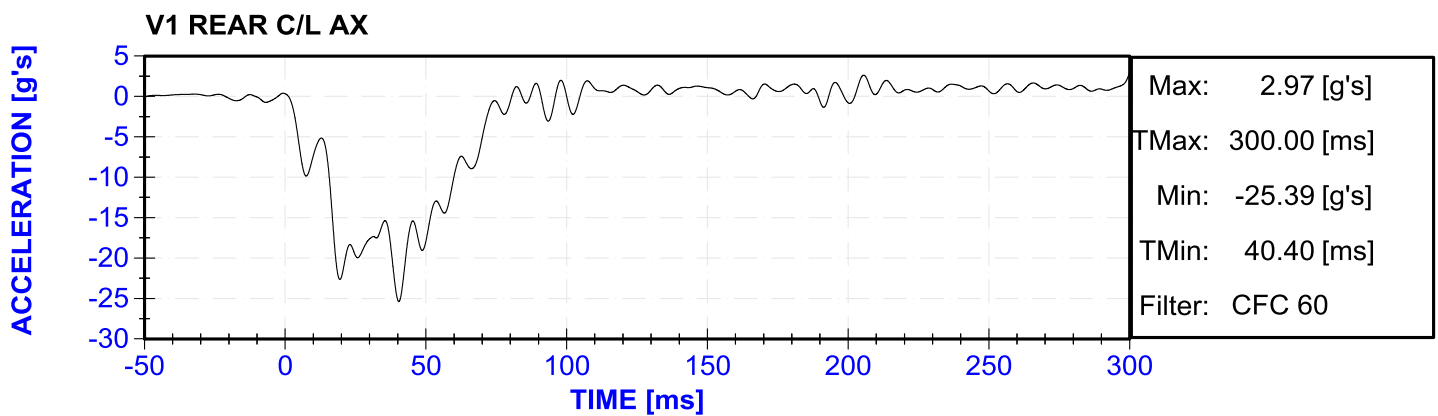
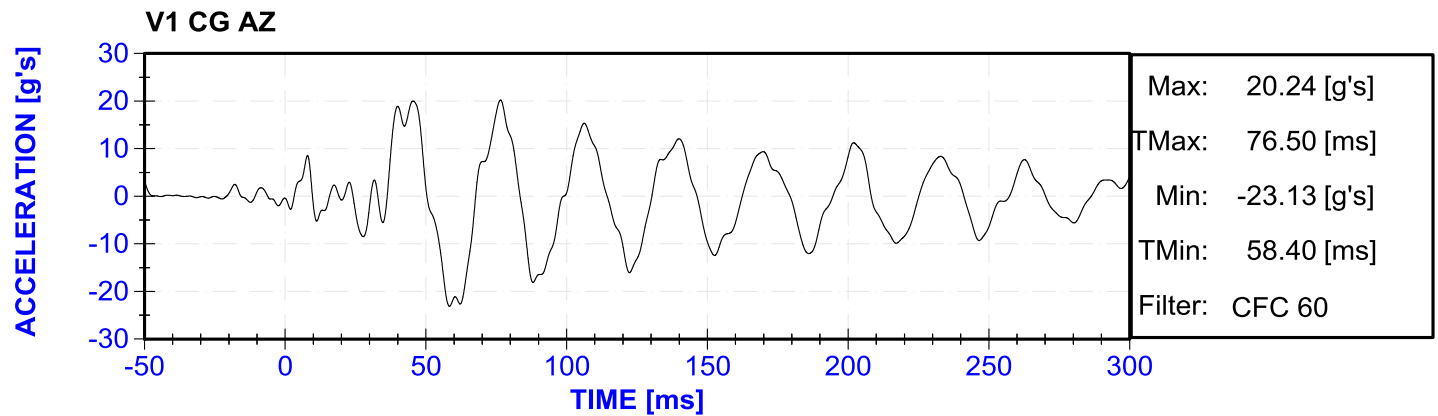
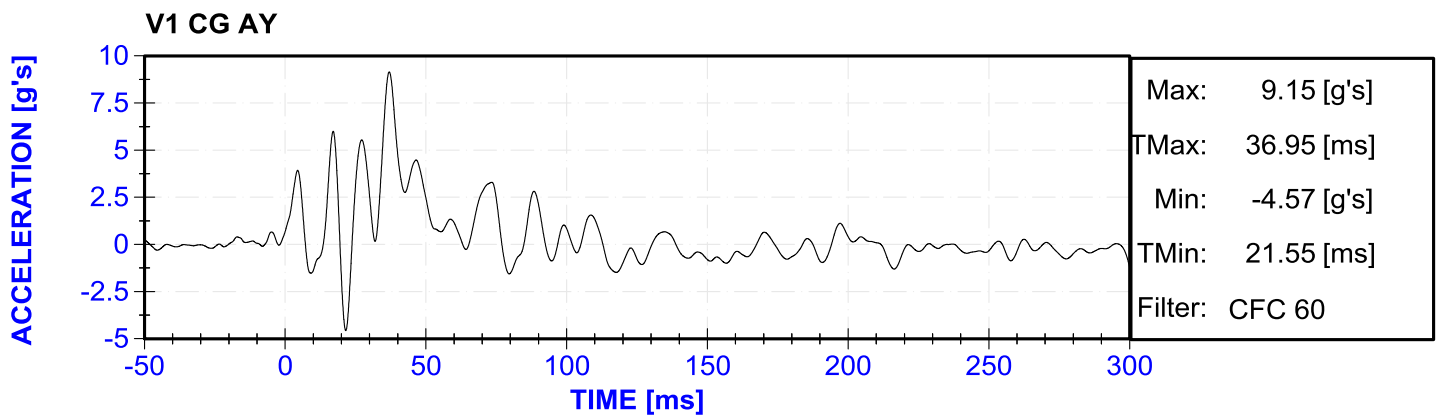
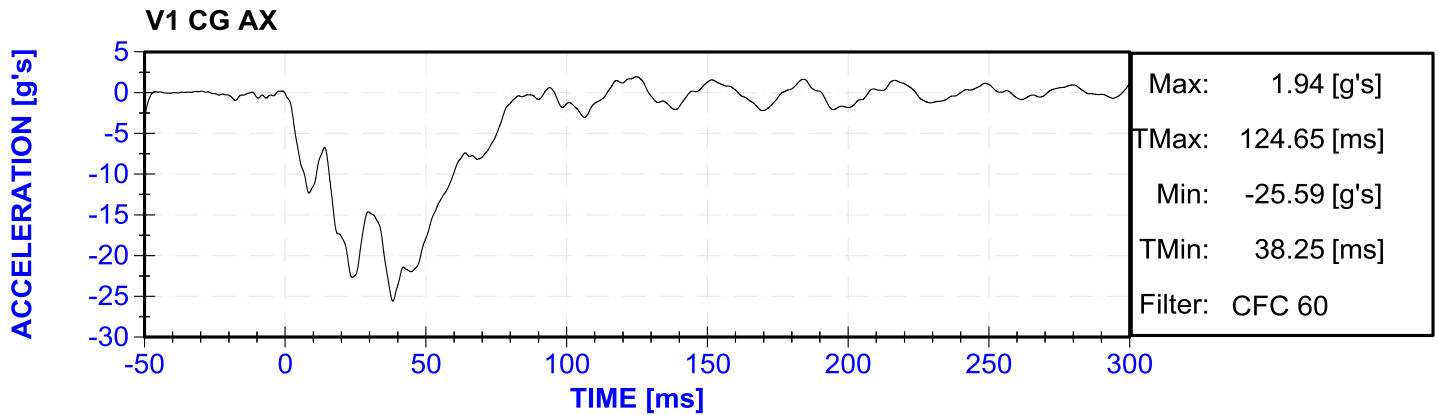
Not monitored

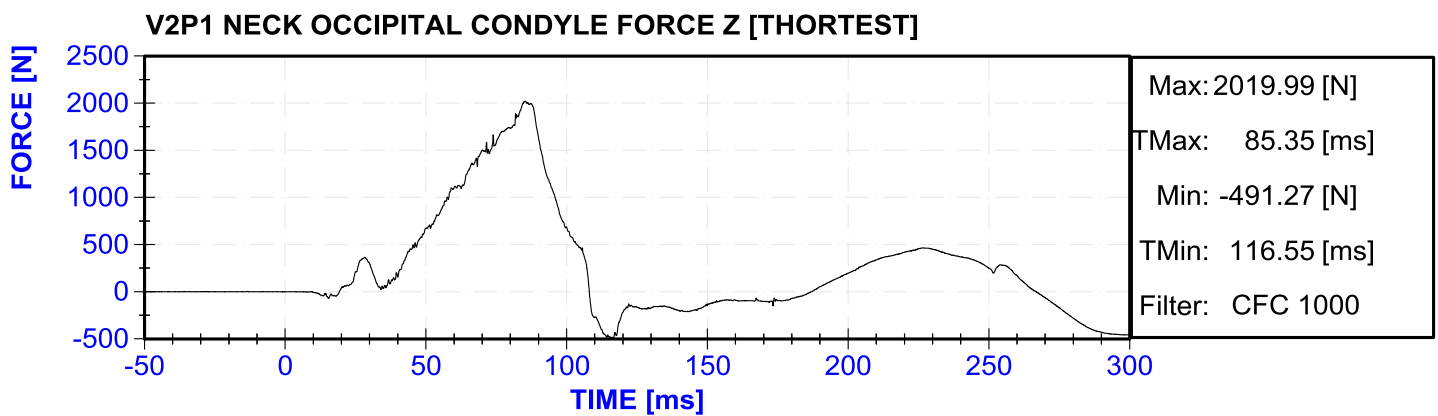
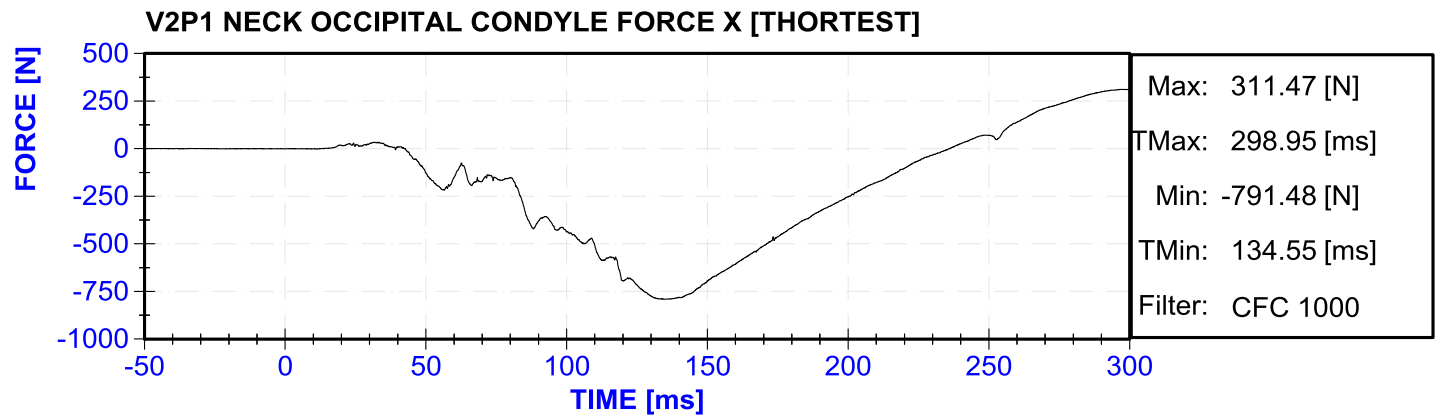
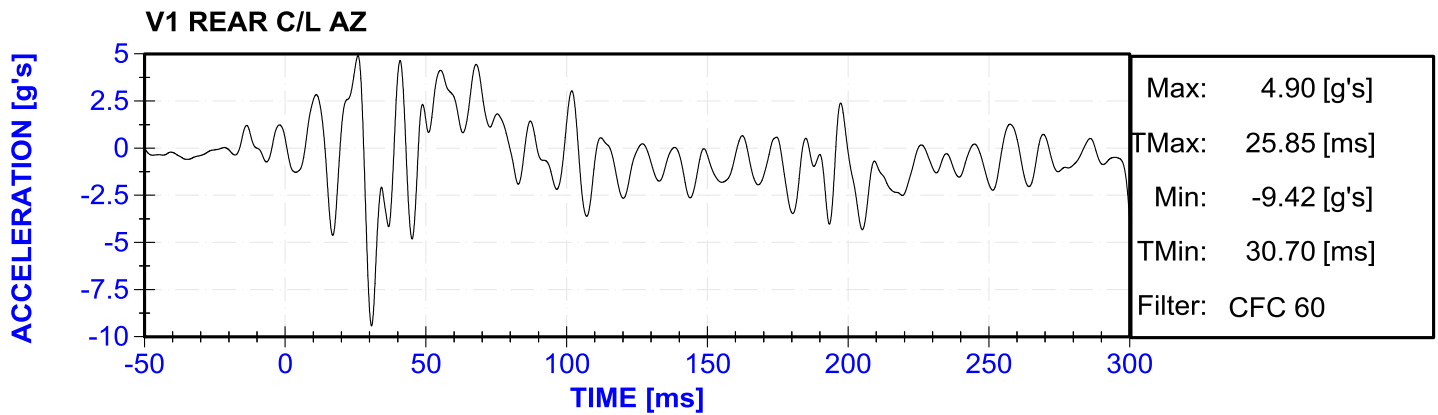
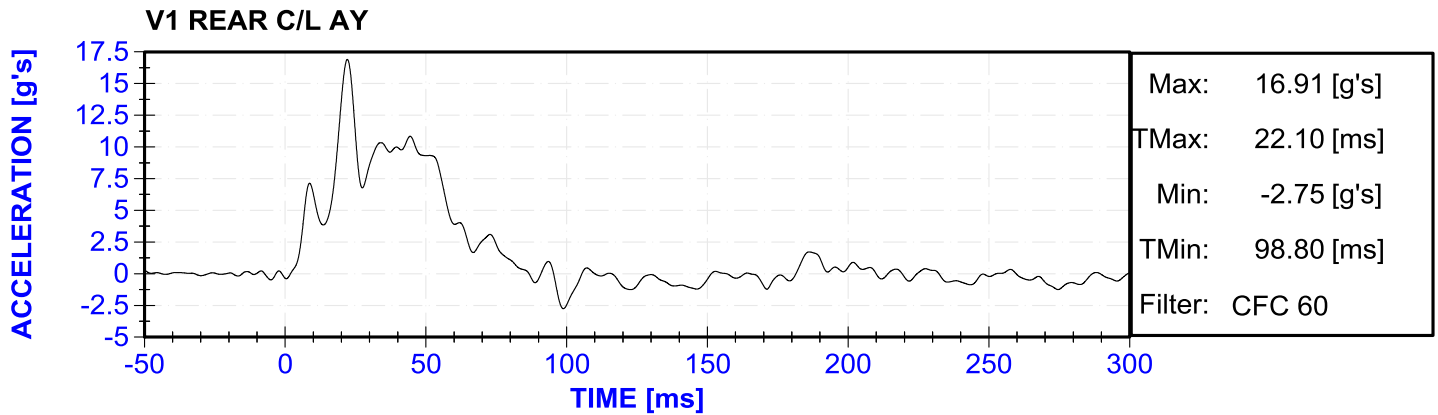


V2 PASSENGER TORSO BELT PRETENSIONER

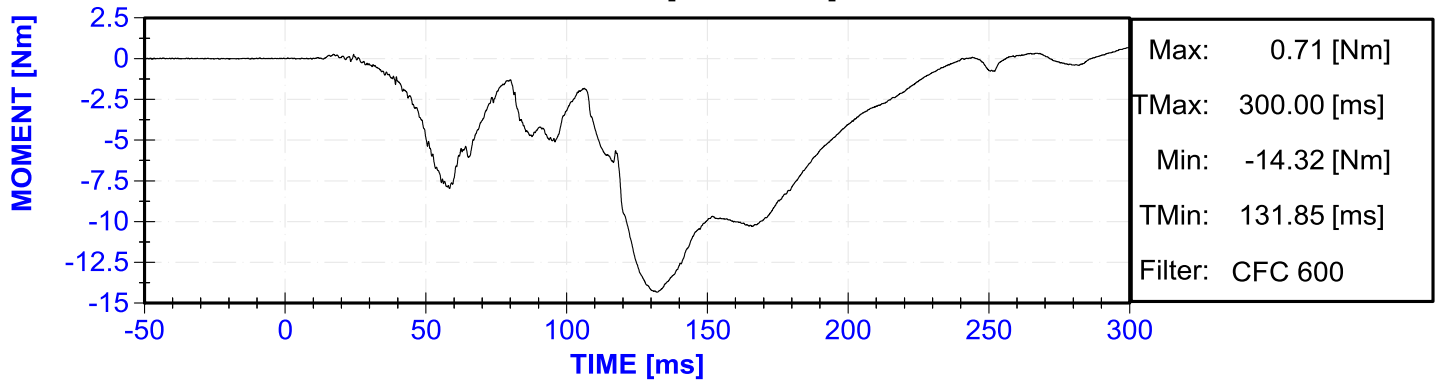
Time to fire: 11.7 ms



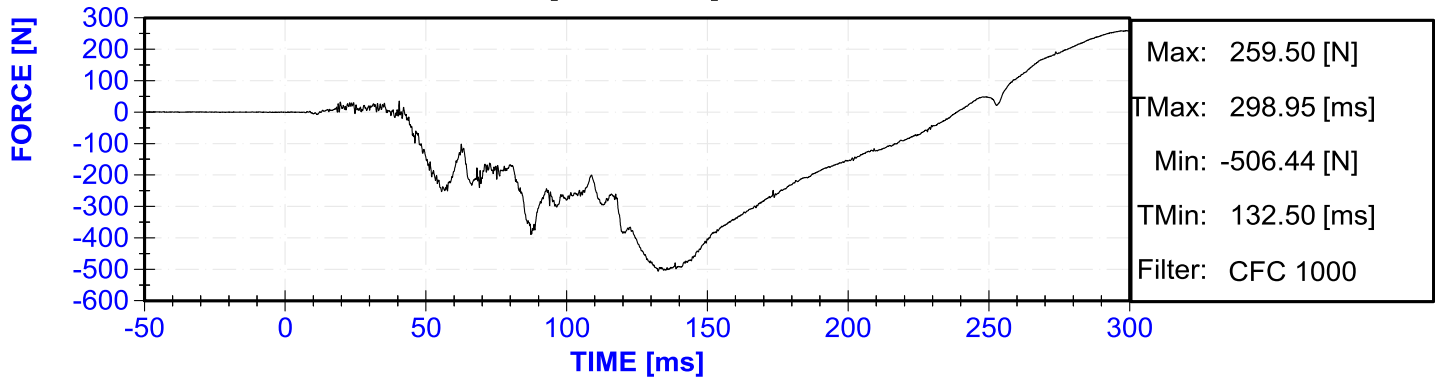




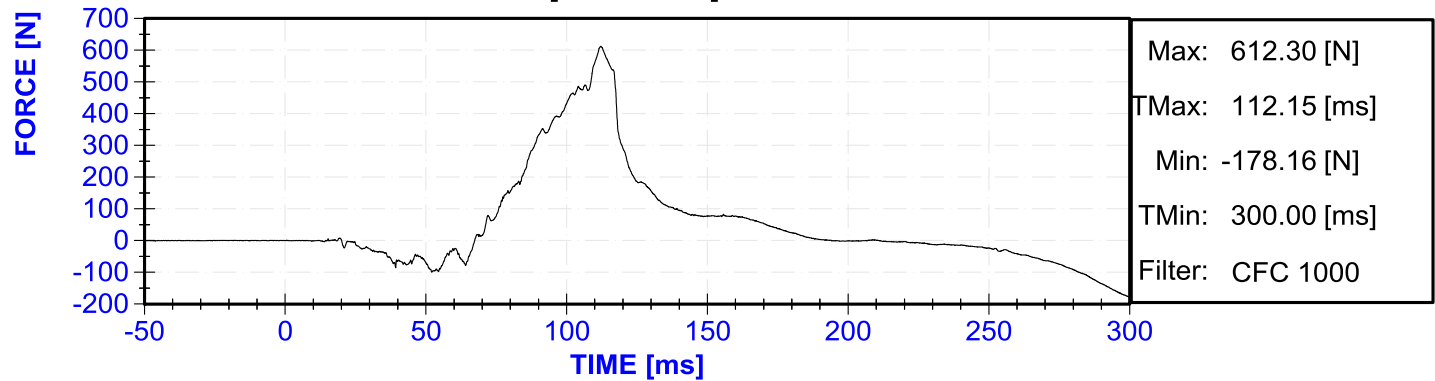
V2P1 NECK OCCIPITAL CONDYLE MY [THORTEST]



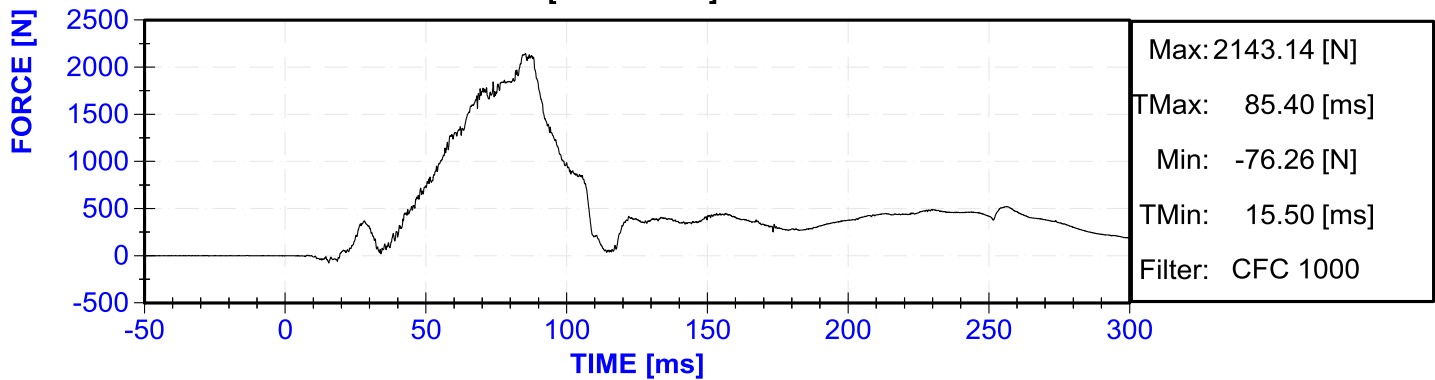
V2P1 NECK UPPER FORCE X [THORTEST]

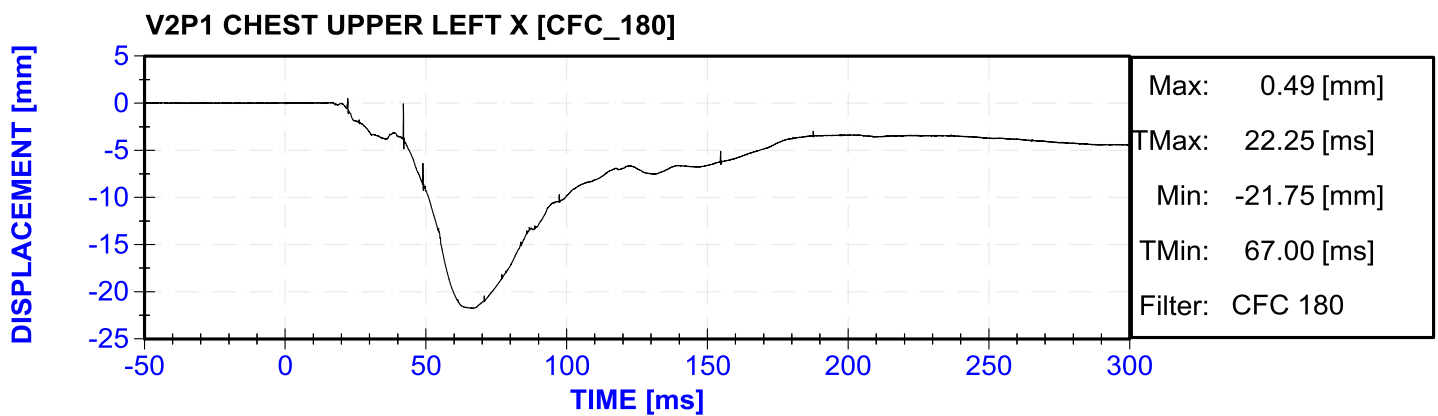
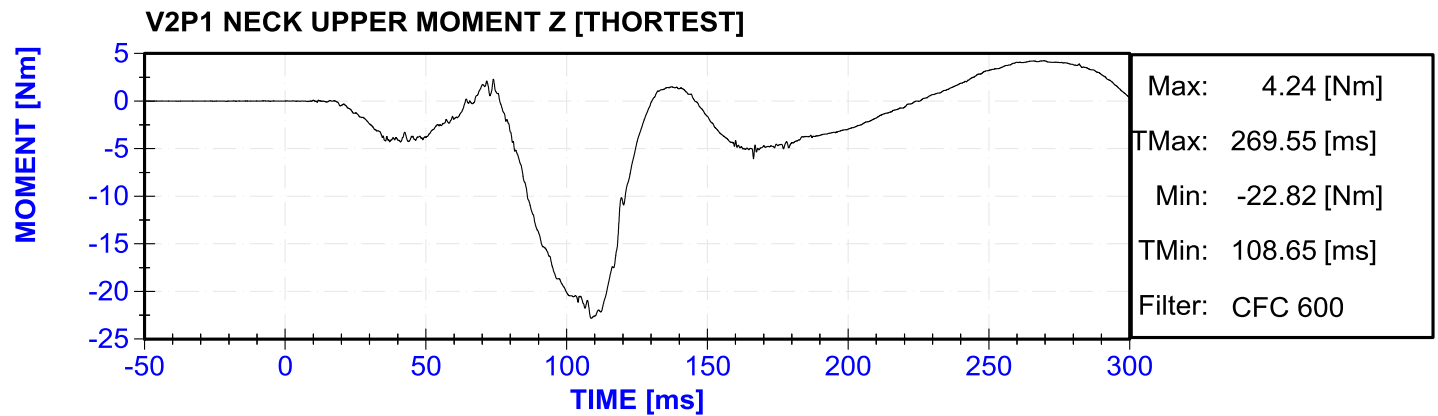
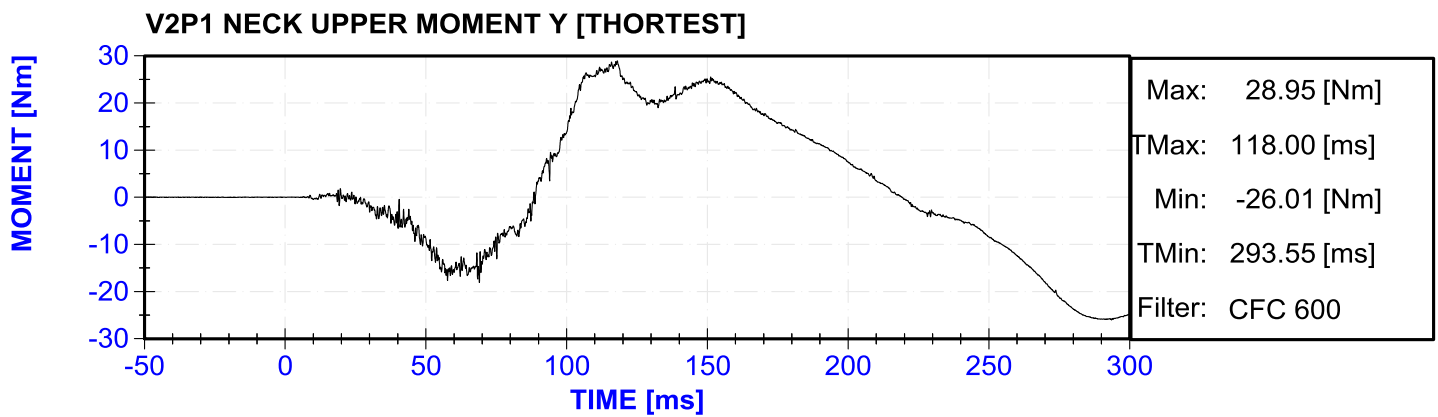
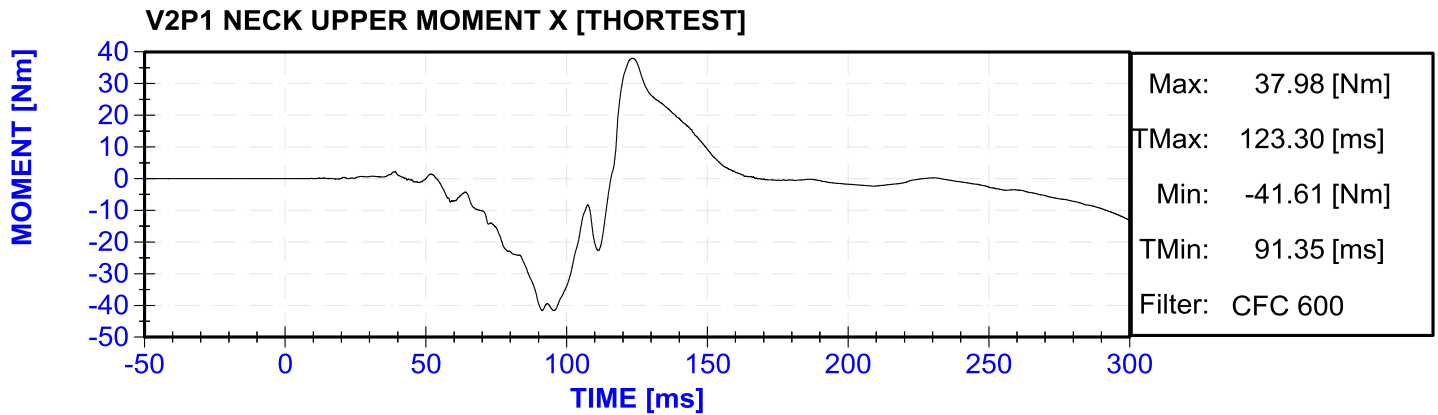


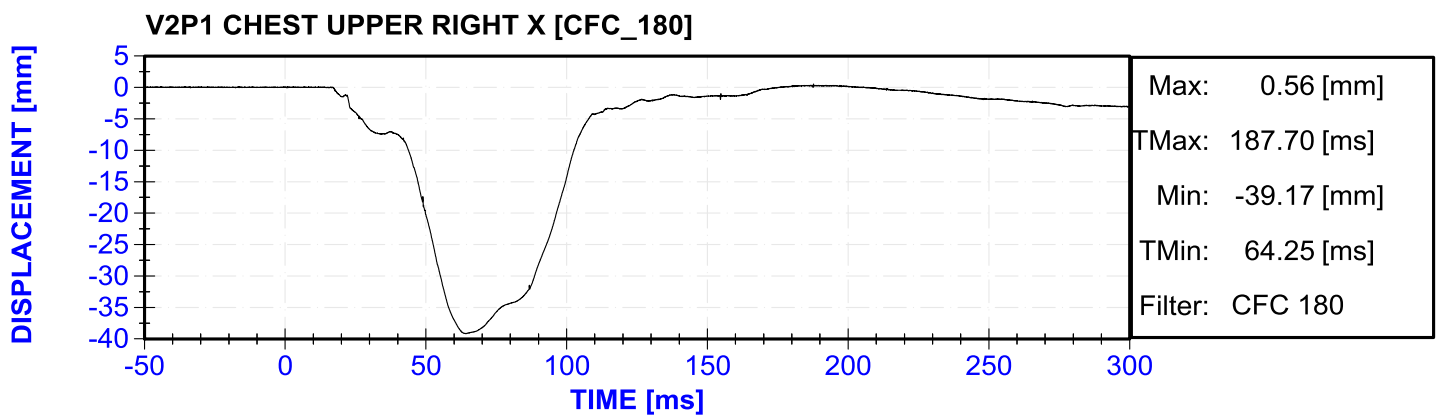
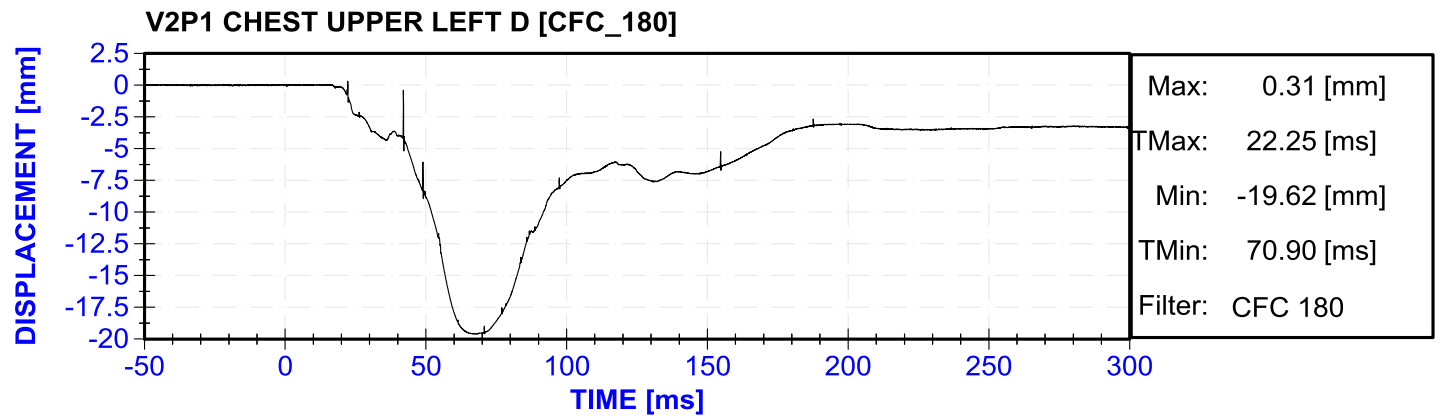
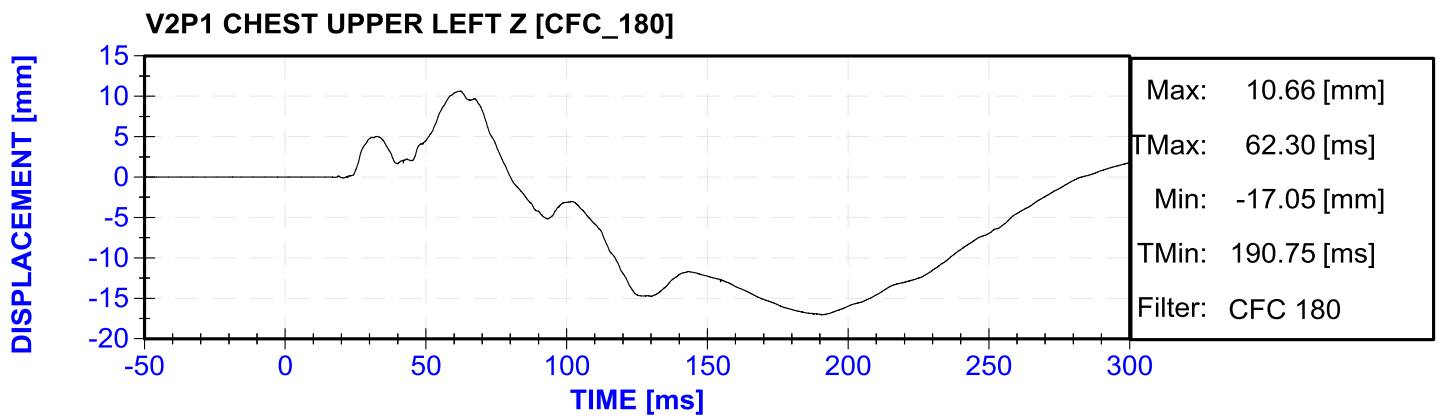
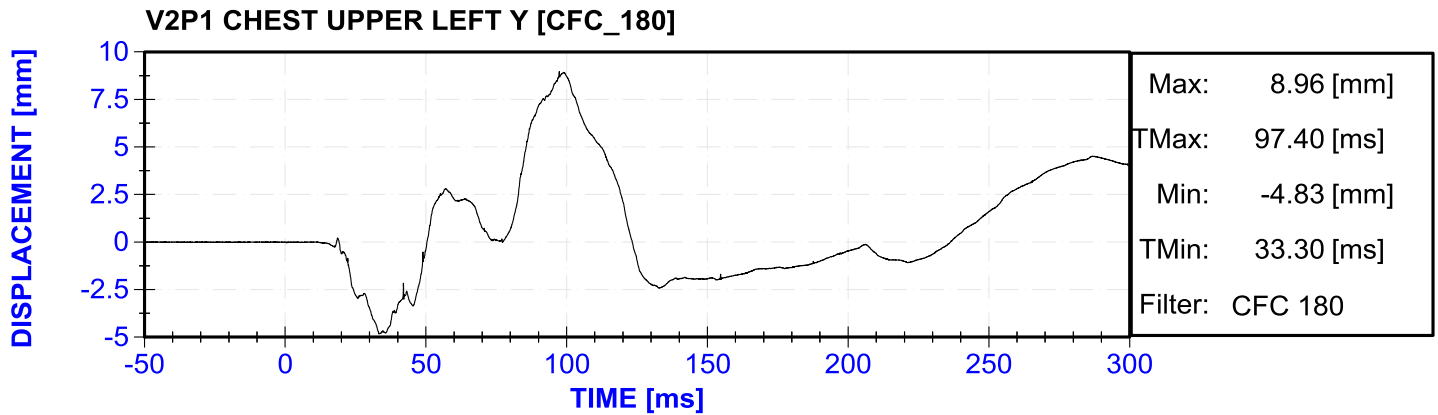
V2P1 NECK UPPER FORCE Y [THORTEST]

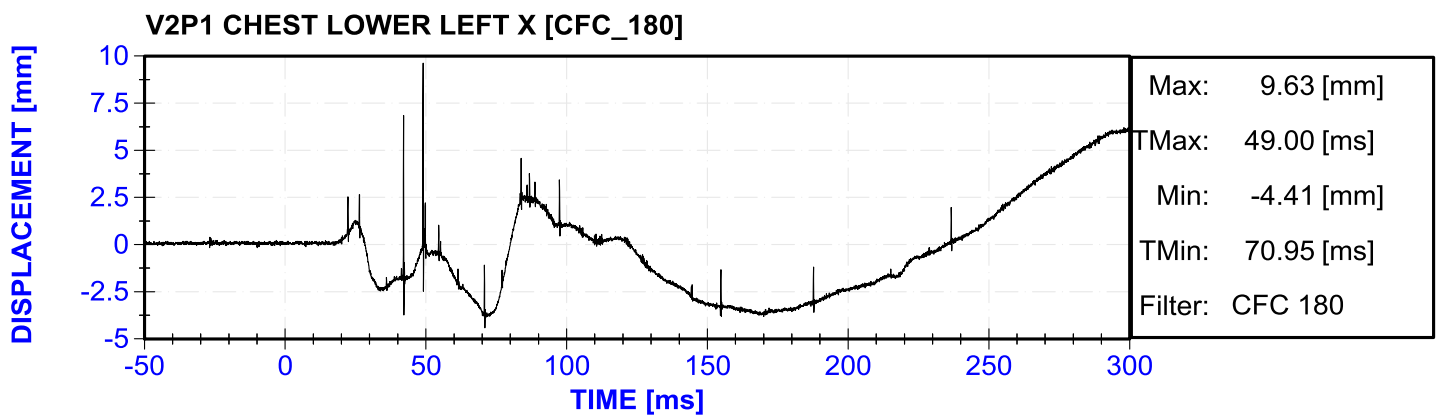
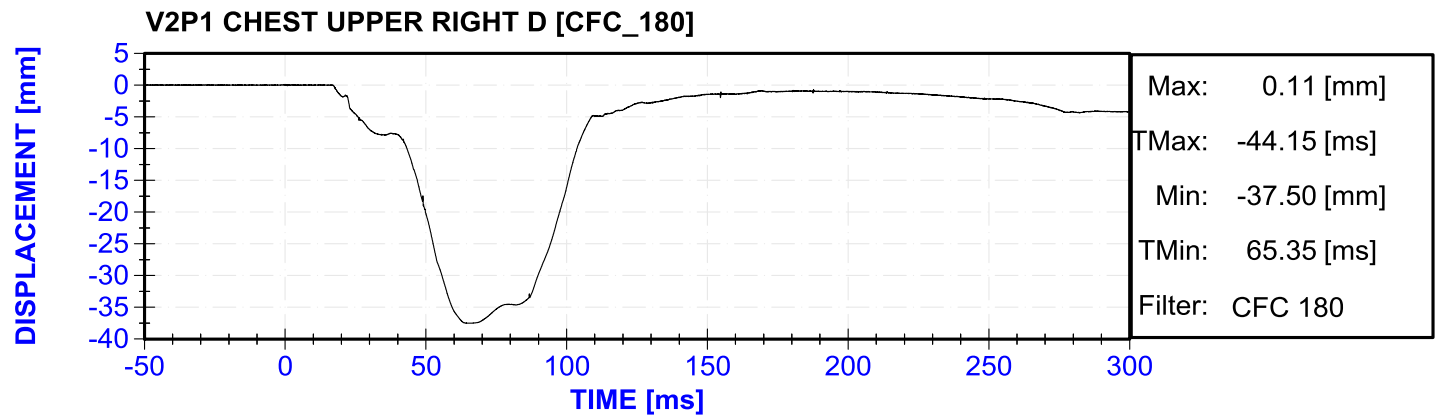
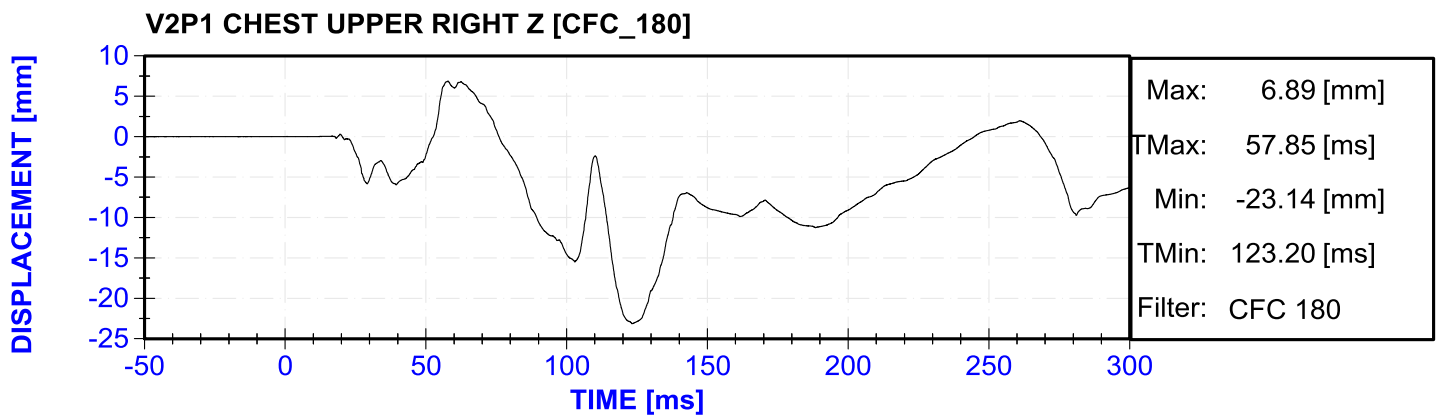
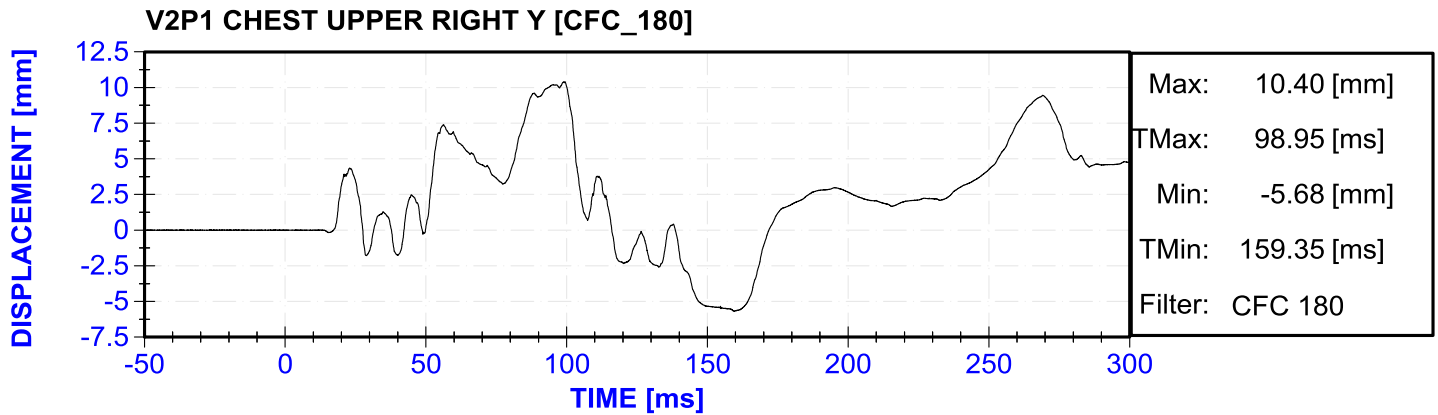


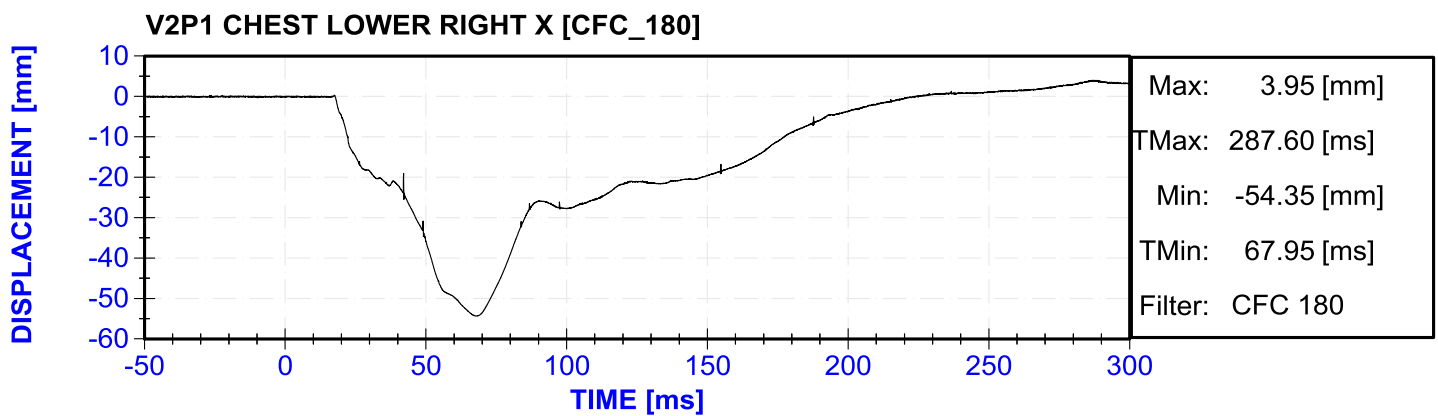
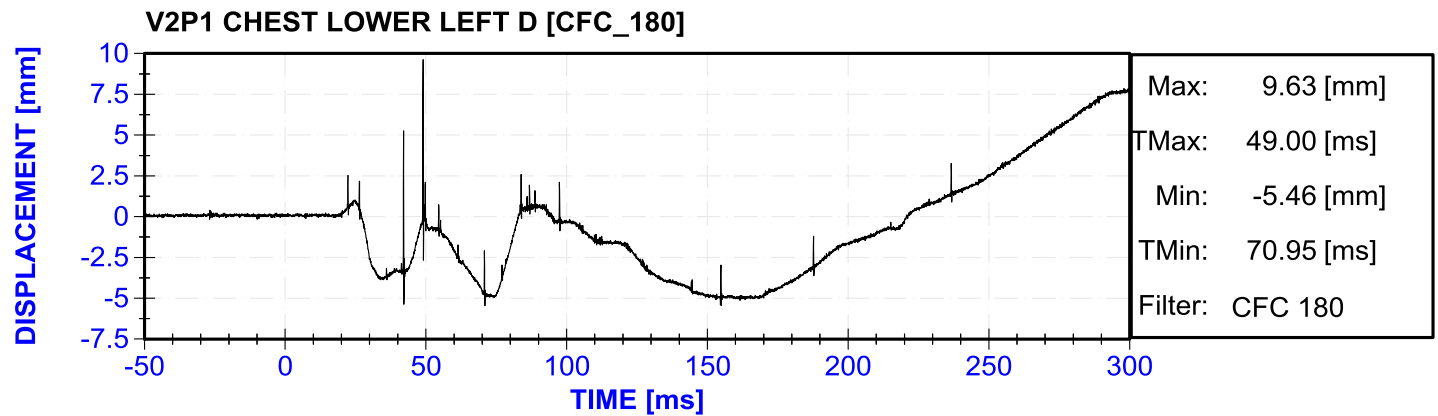
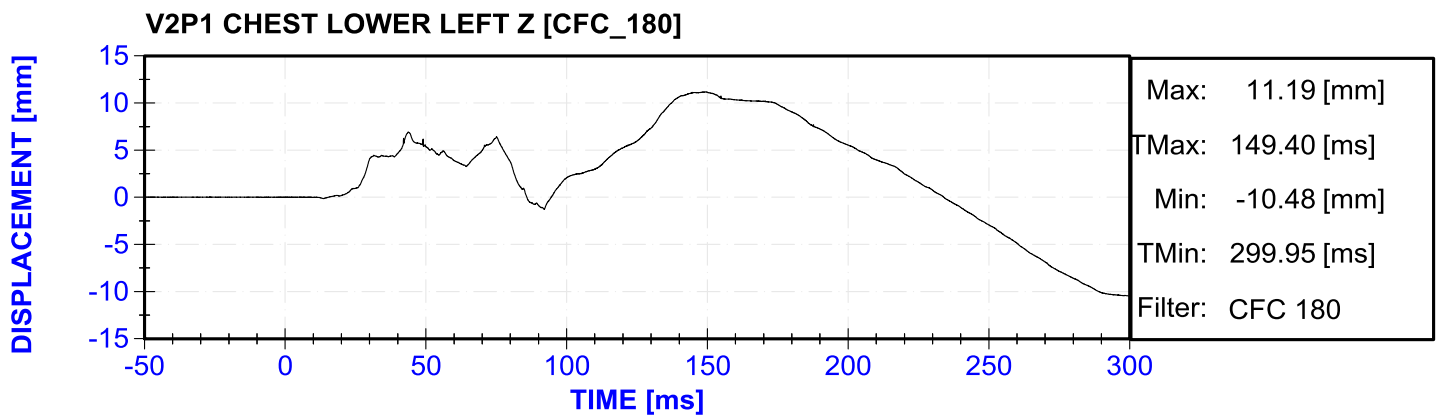
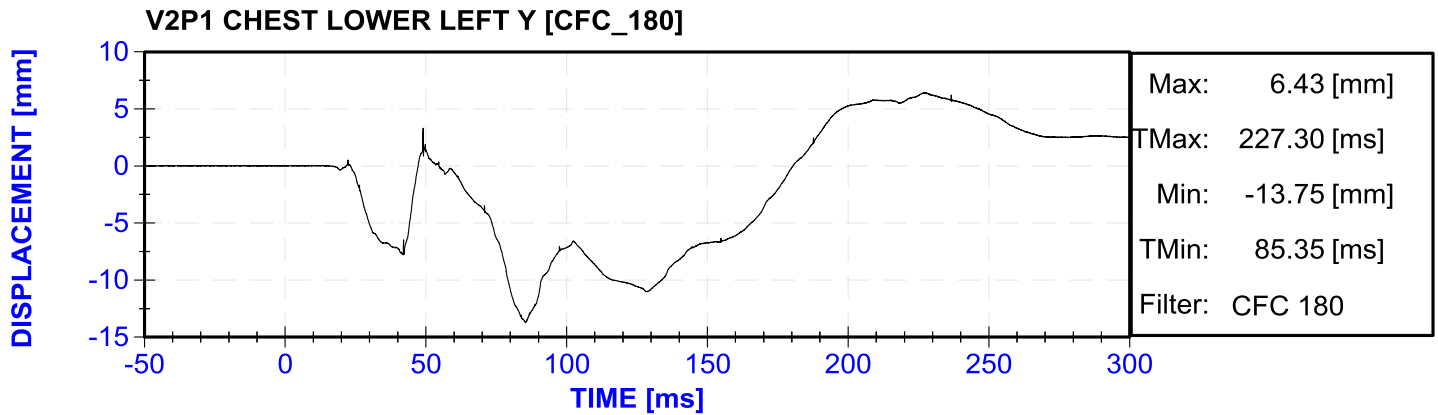
V2P1 NECK UPPER FORCE Z [THORTEST]

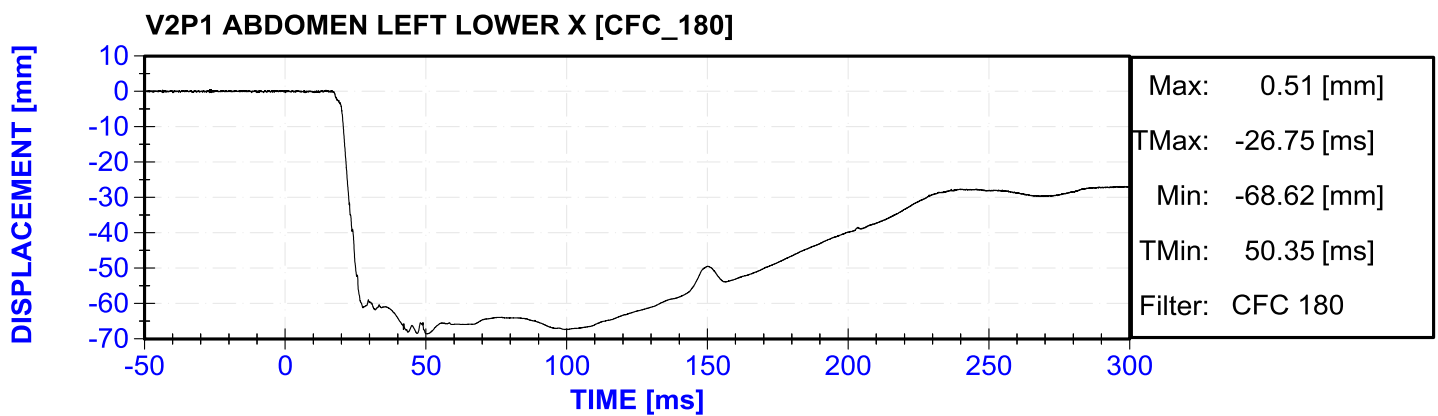
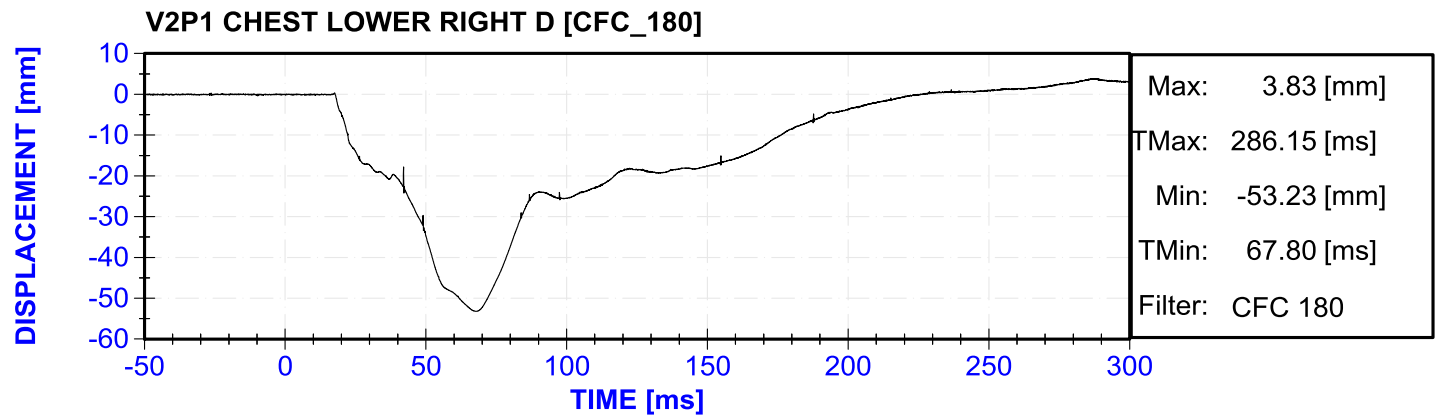
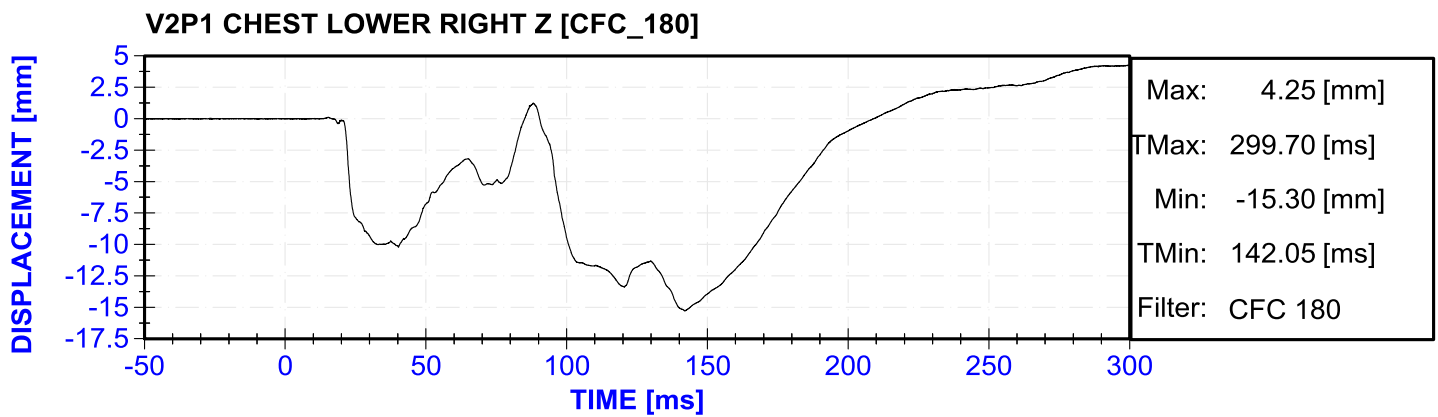
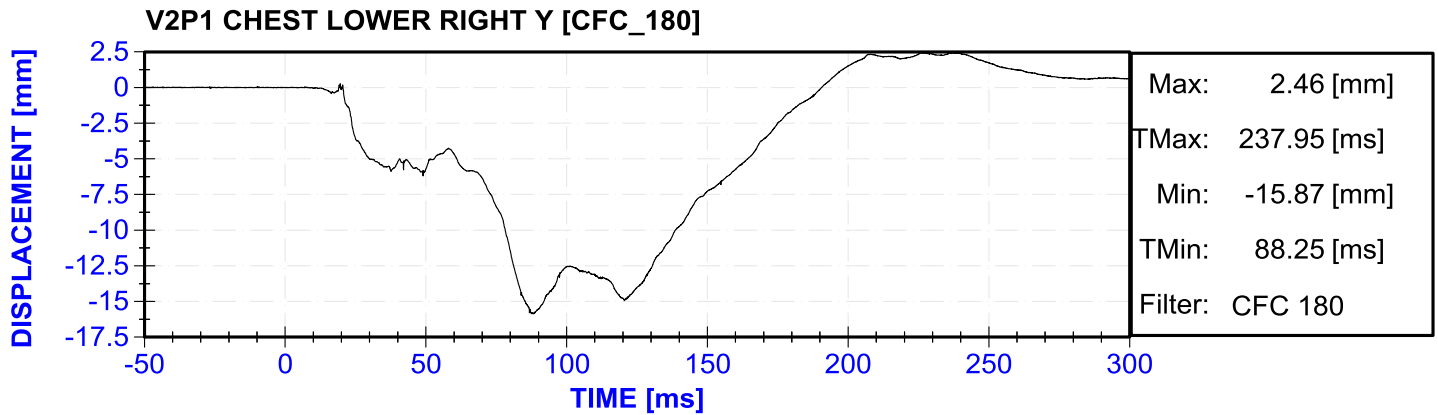


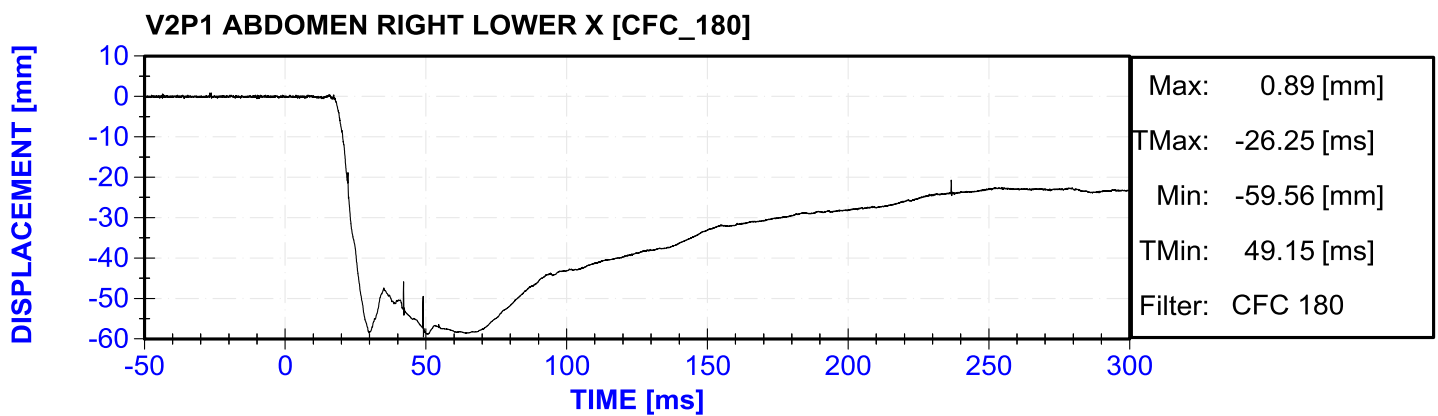
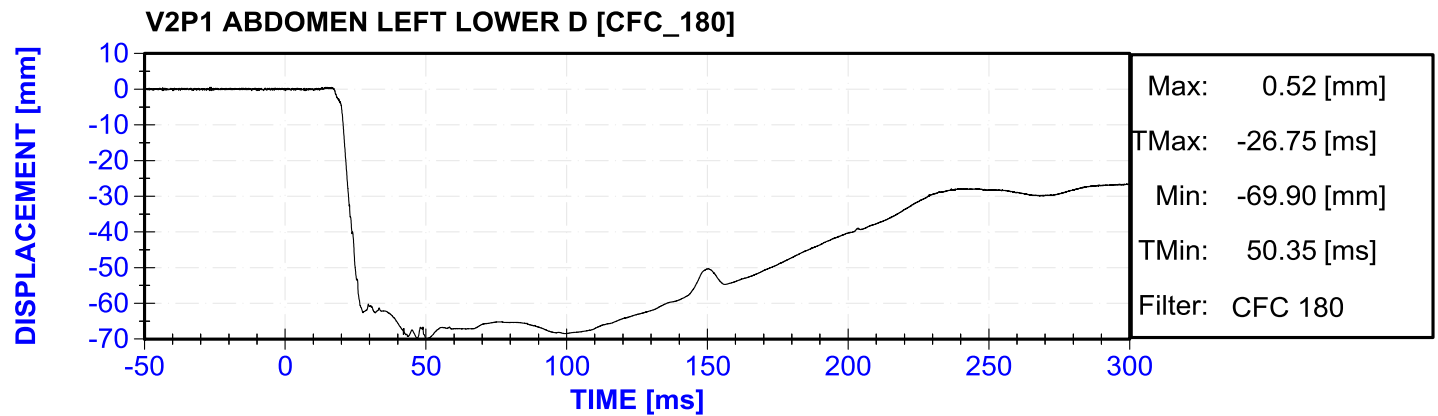
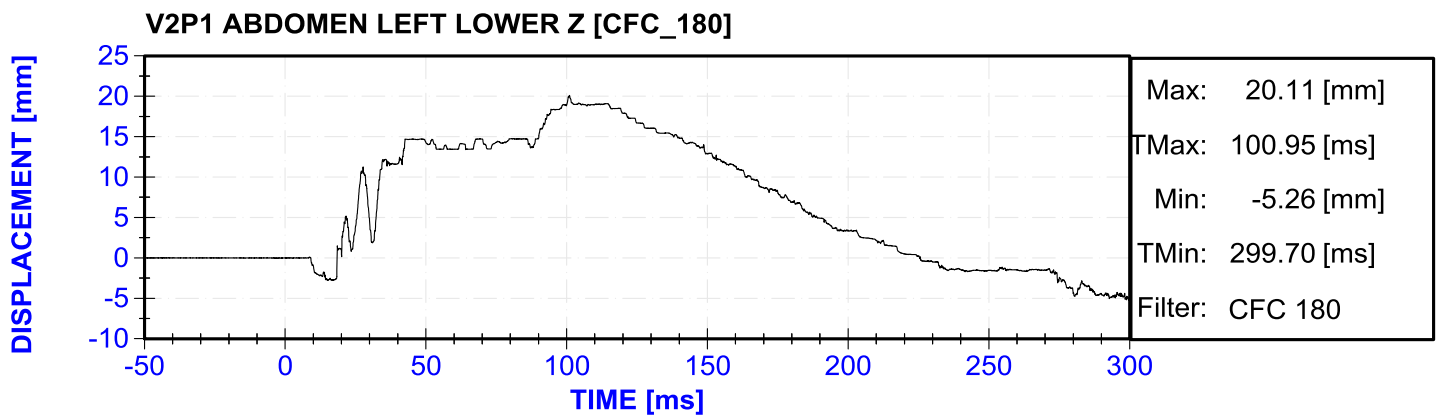
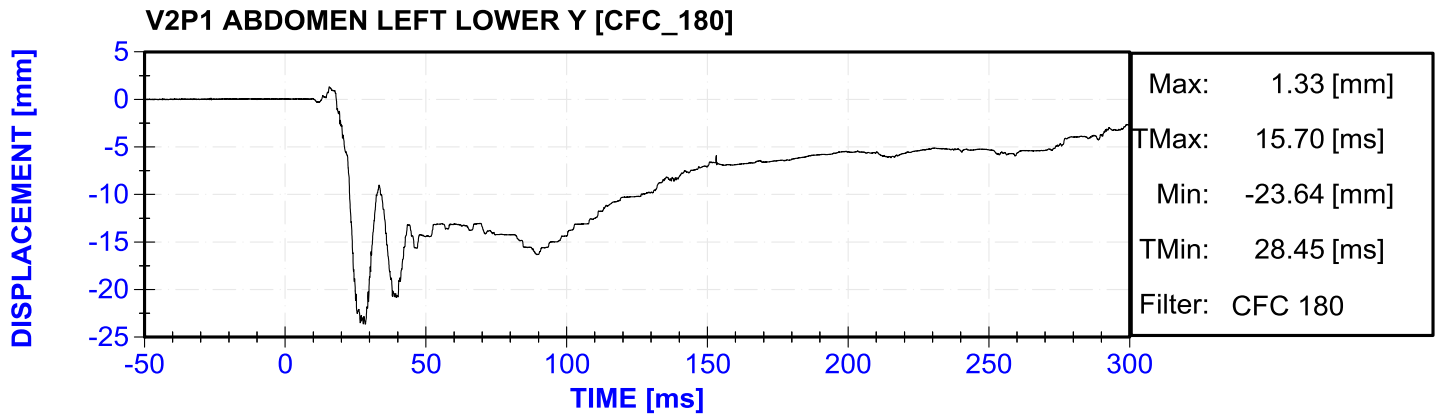


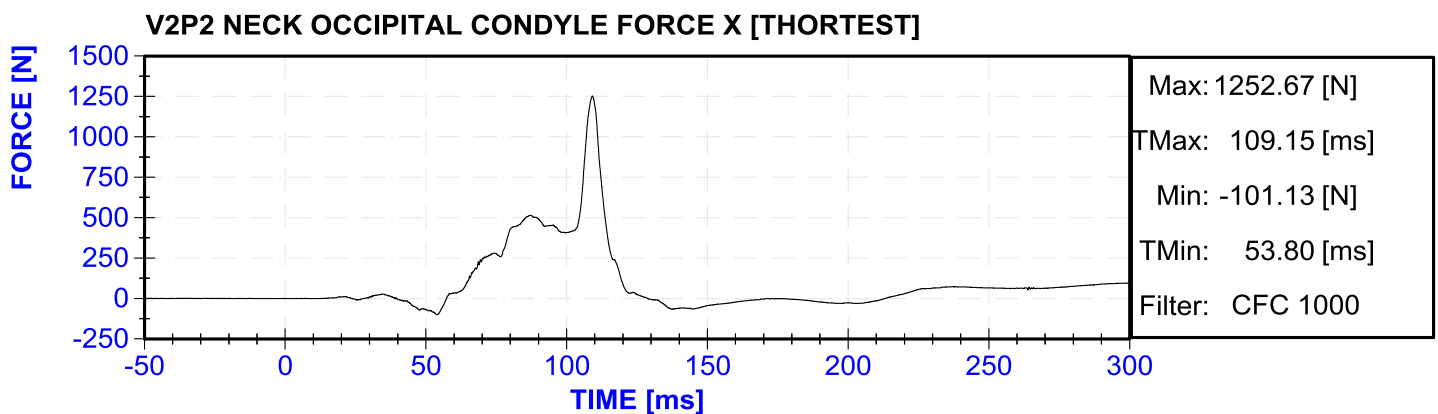
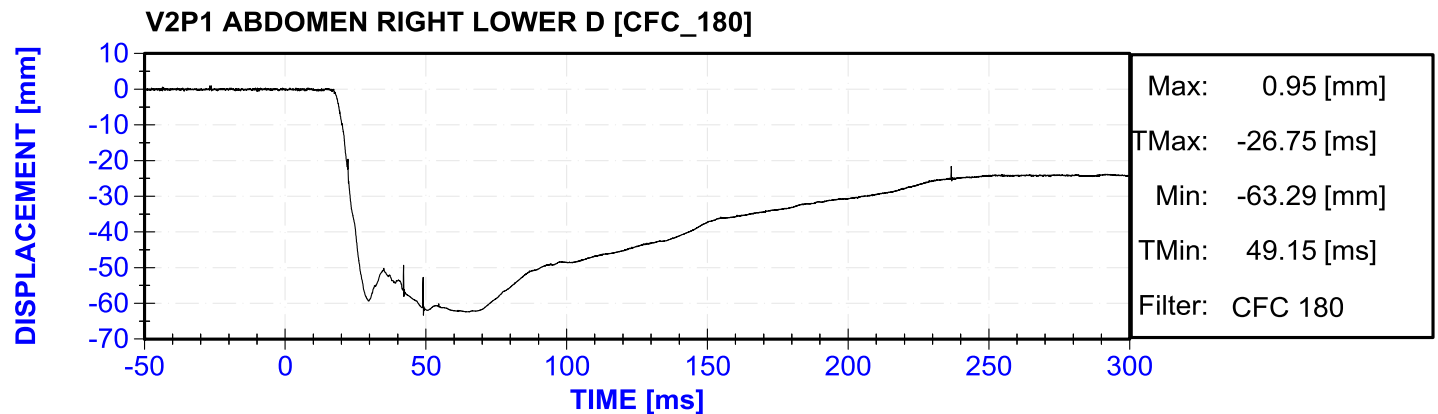
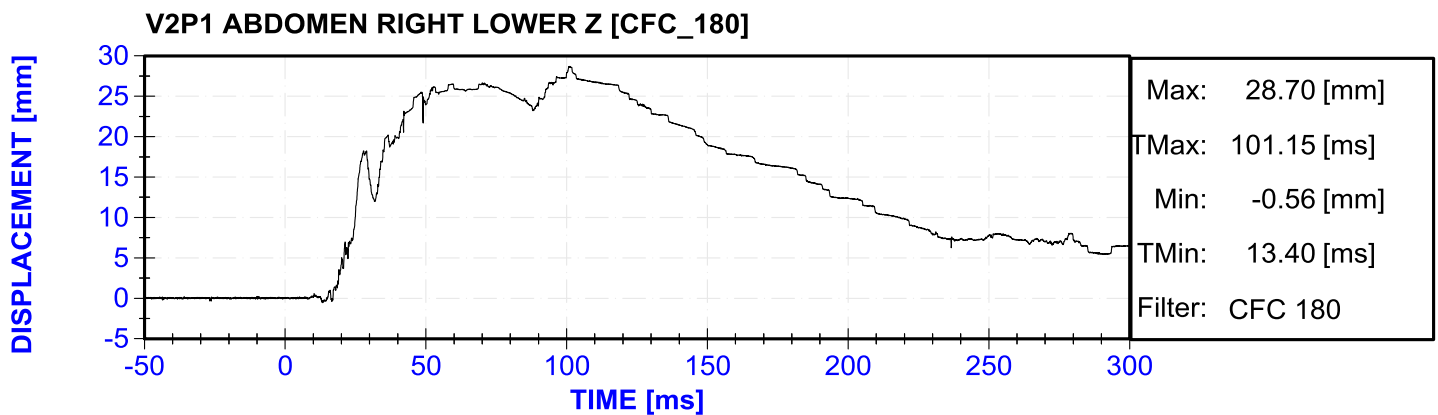
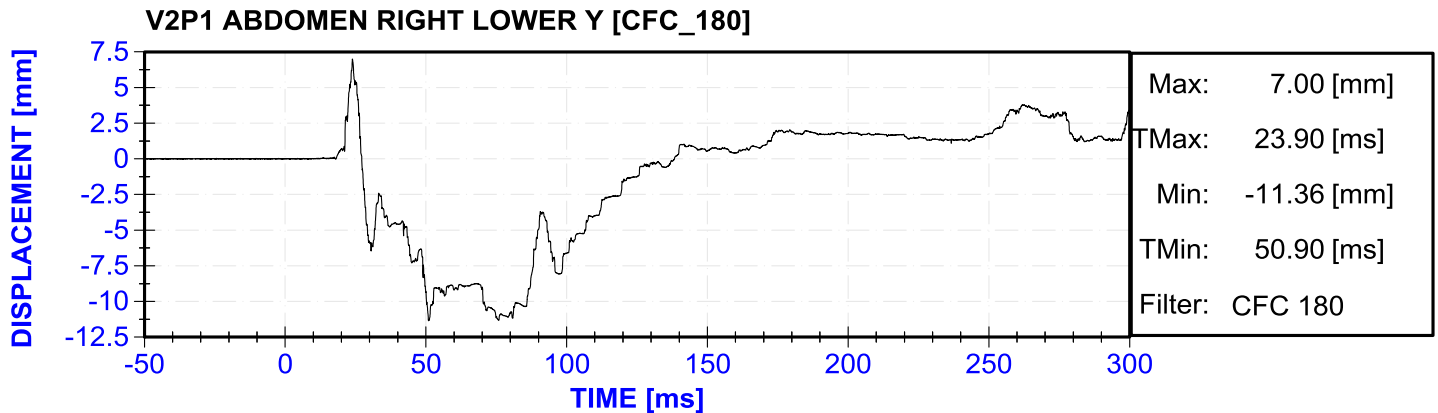




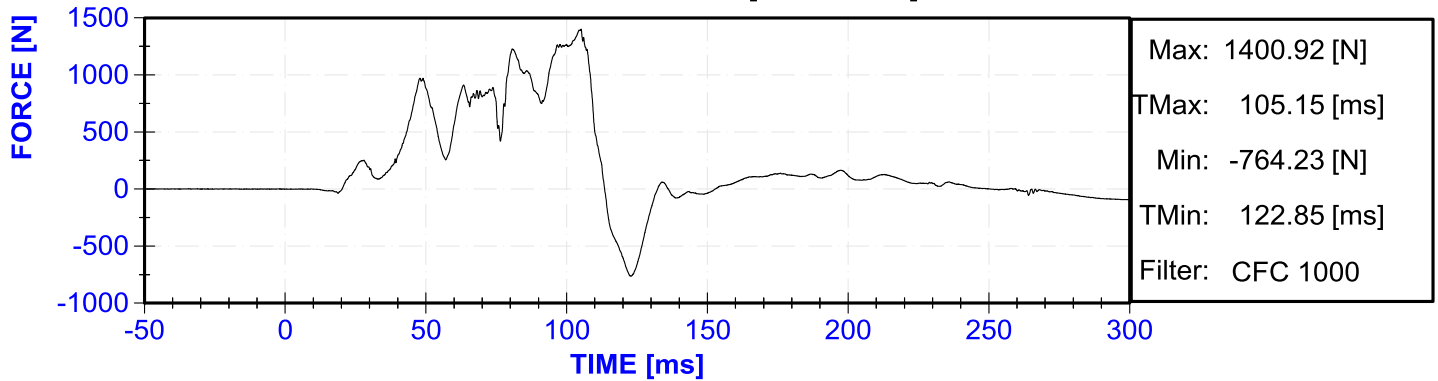




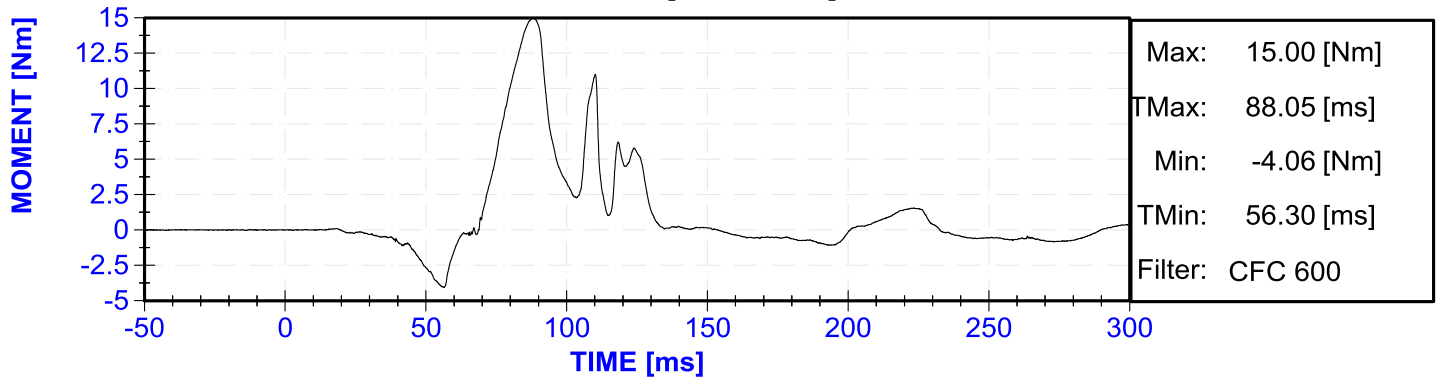




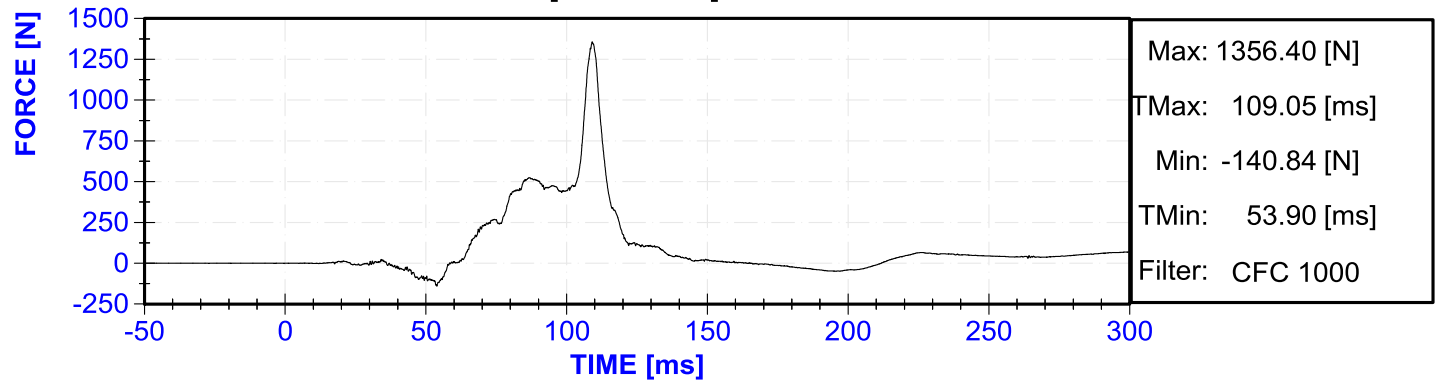
V2P2 NECK OCCIPITAL CONDYLE FORCE Z [THORTEST]



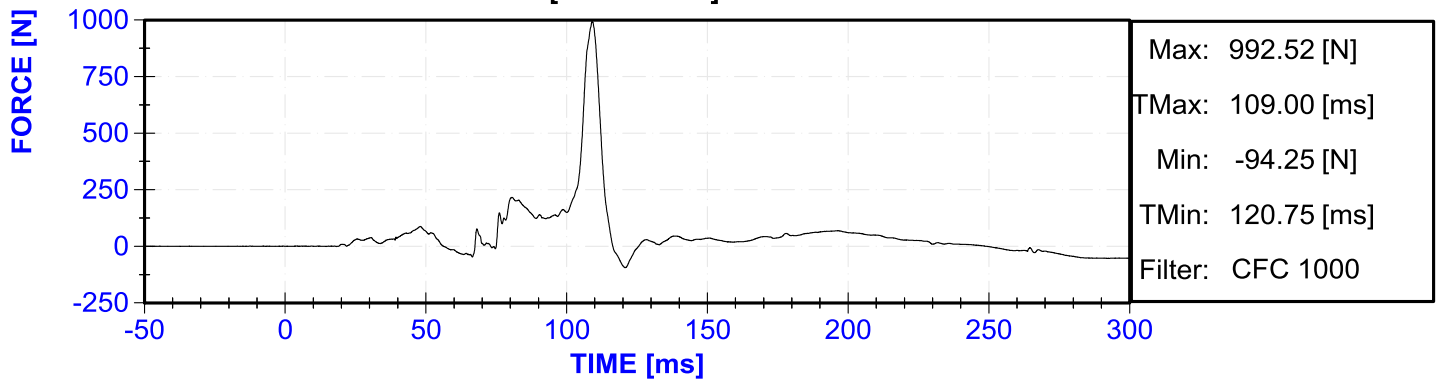
V2P2 NECK OCCIPITAL CONDYLE MY [THORTEST]

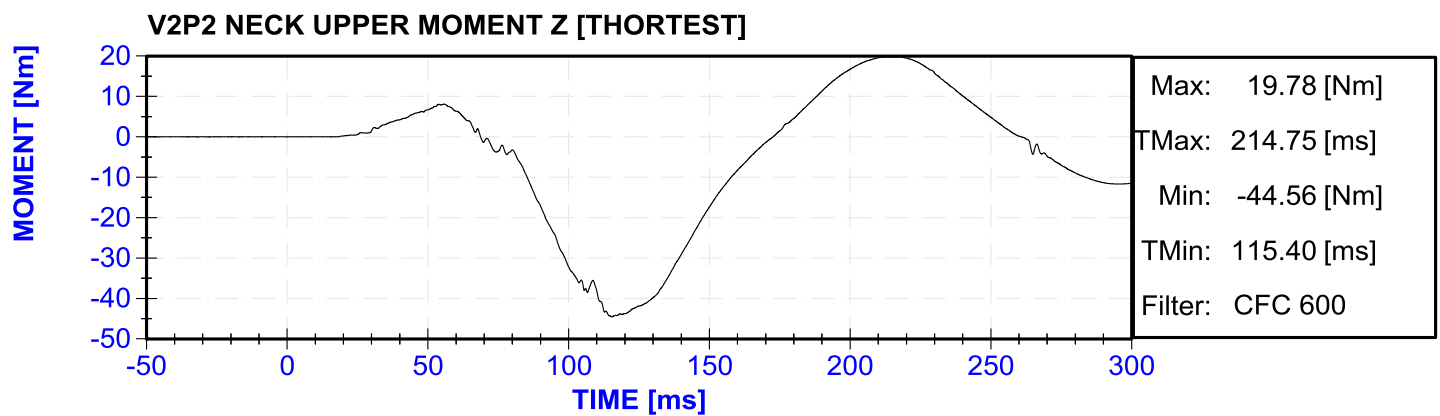
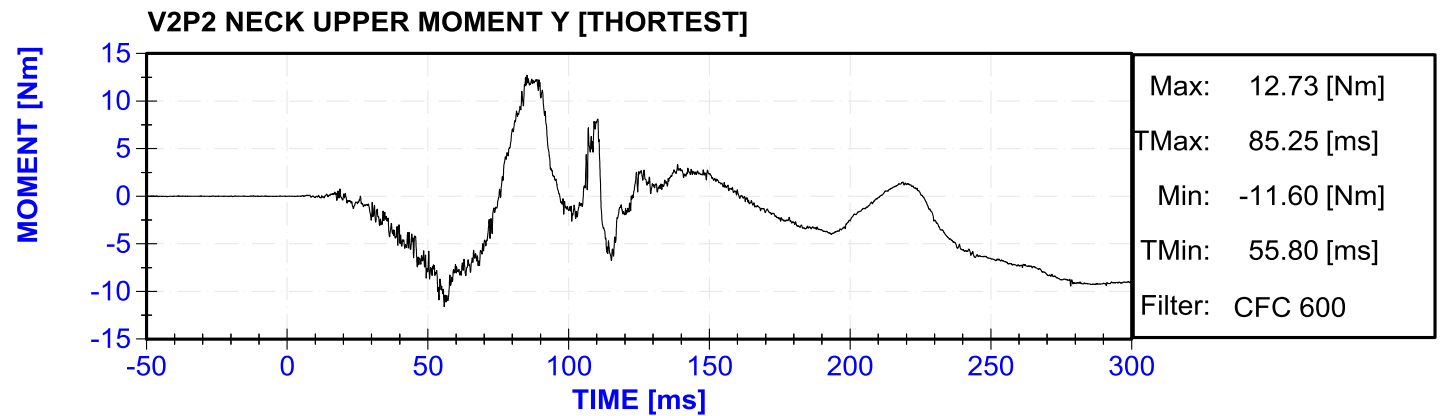
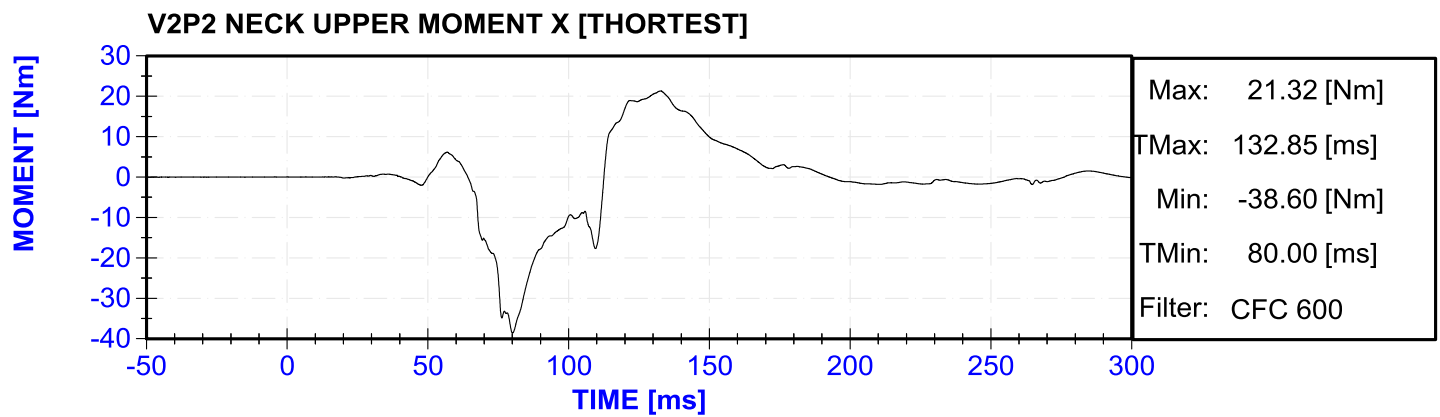
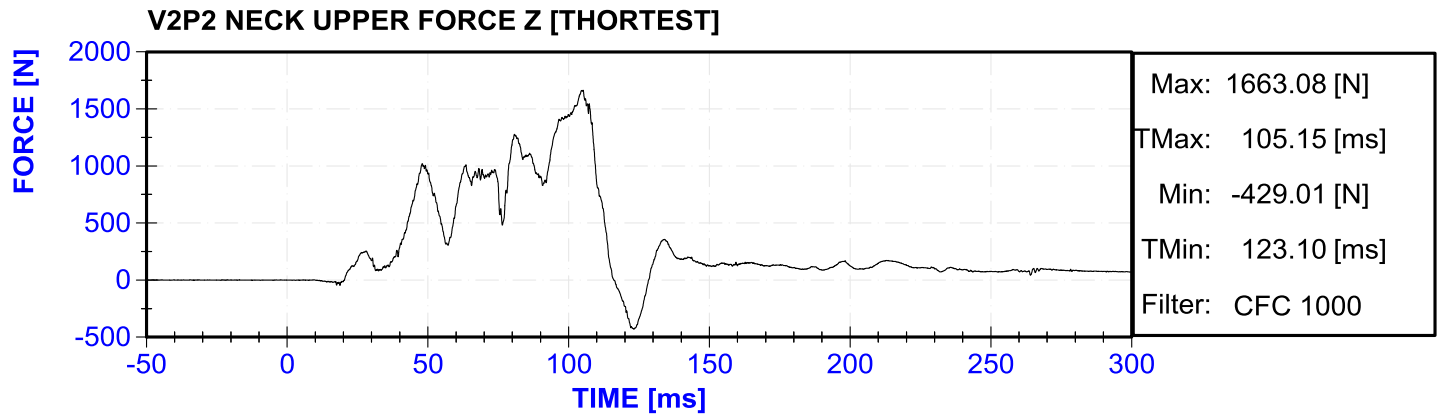


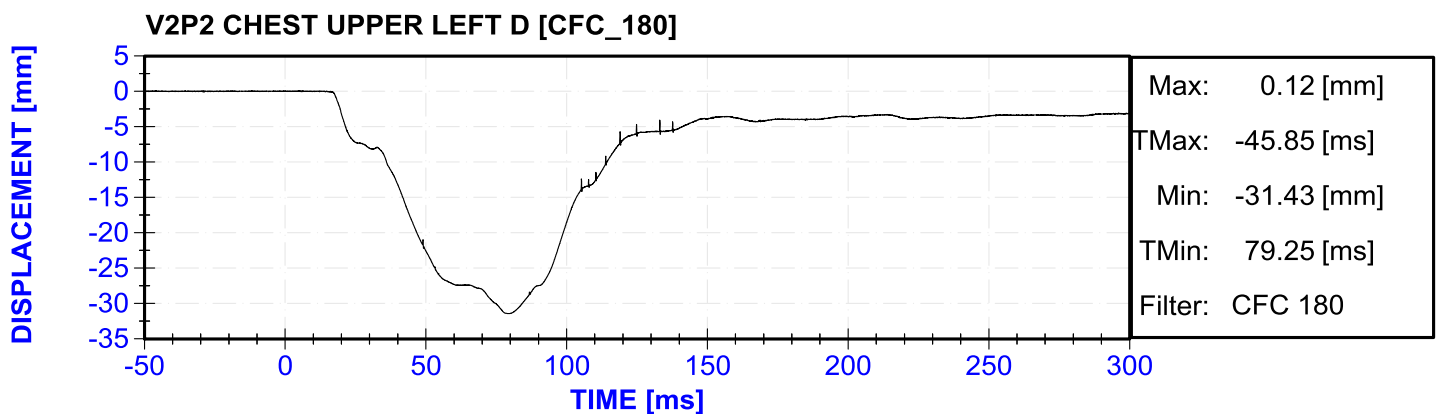
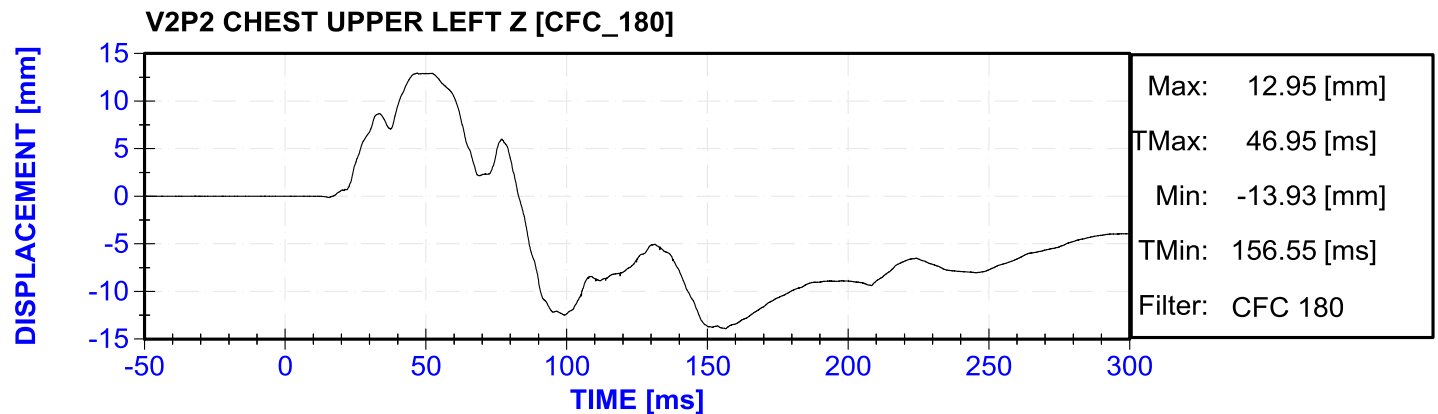
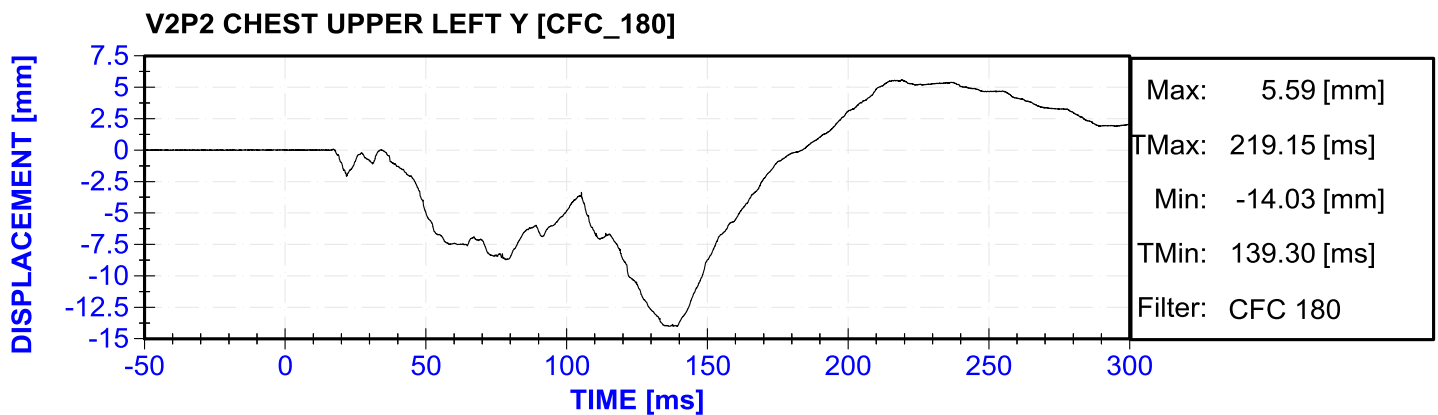
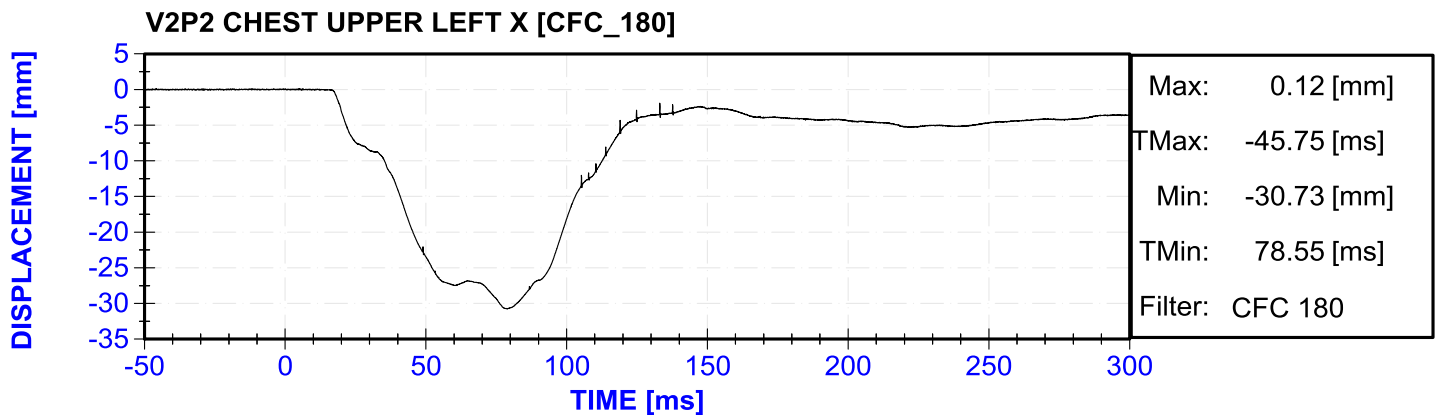
V2P2 NECK UPPER FORCE X [THORTEST]

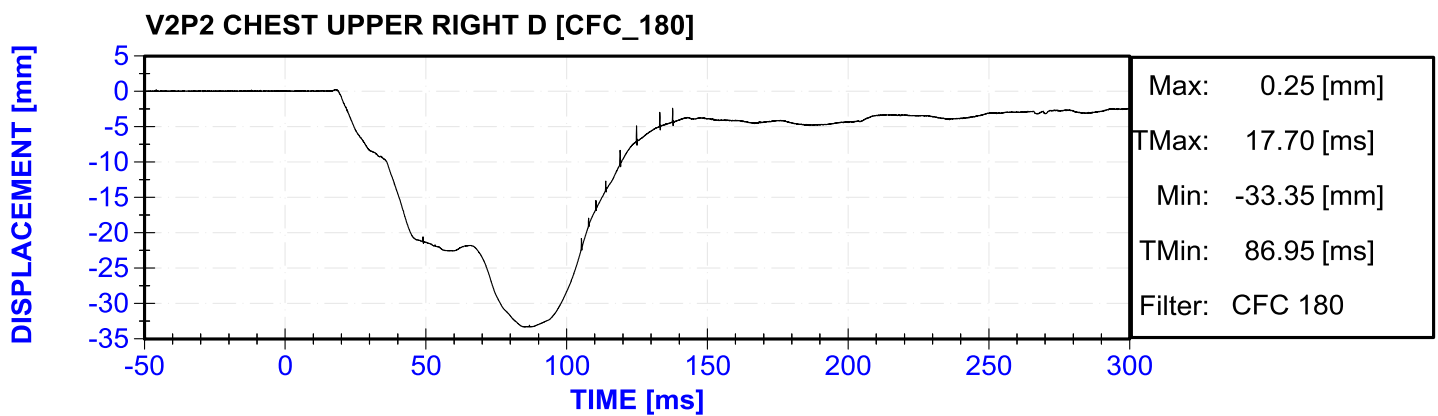
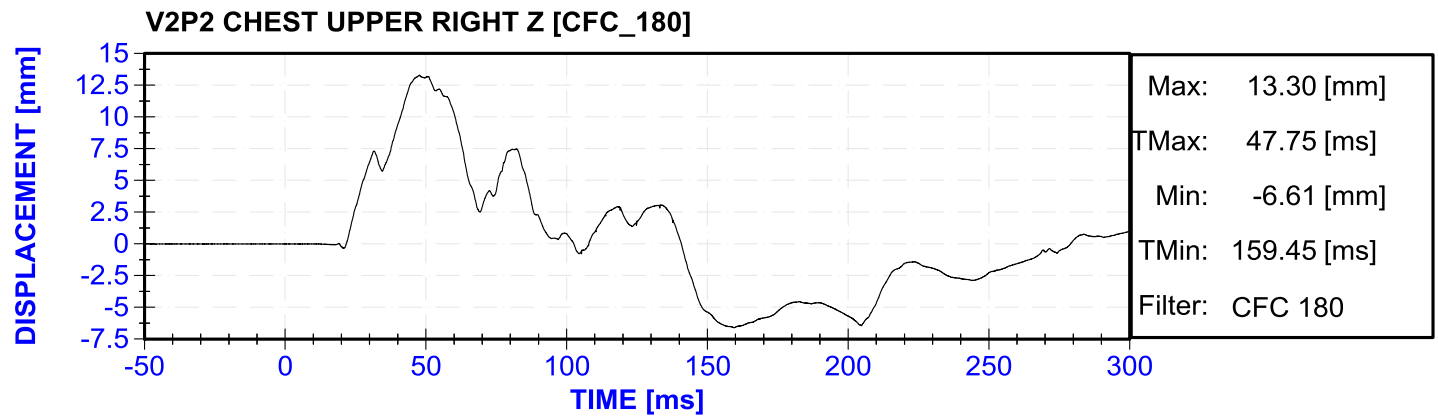
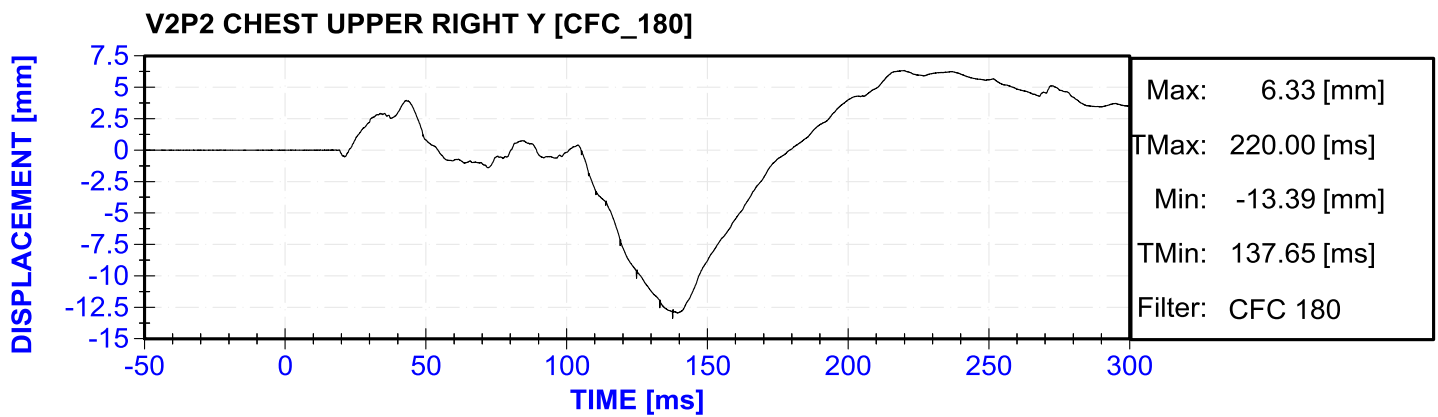
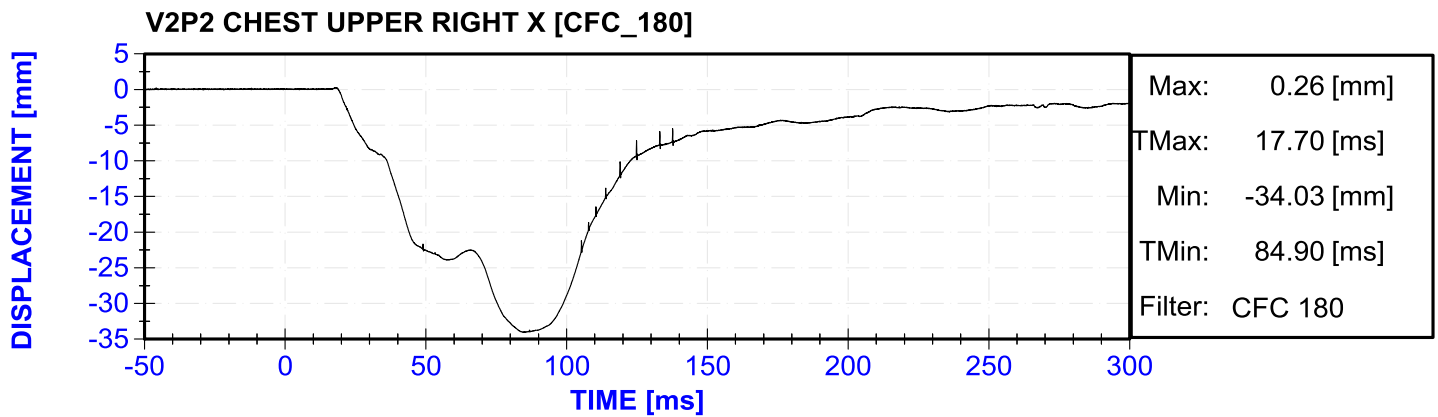


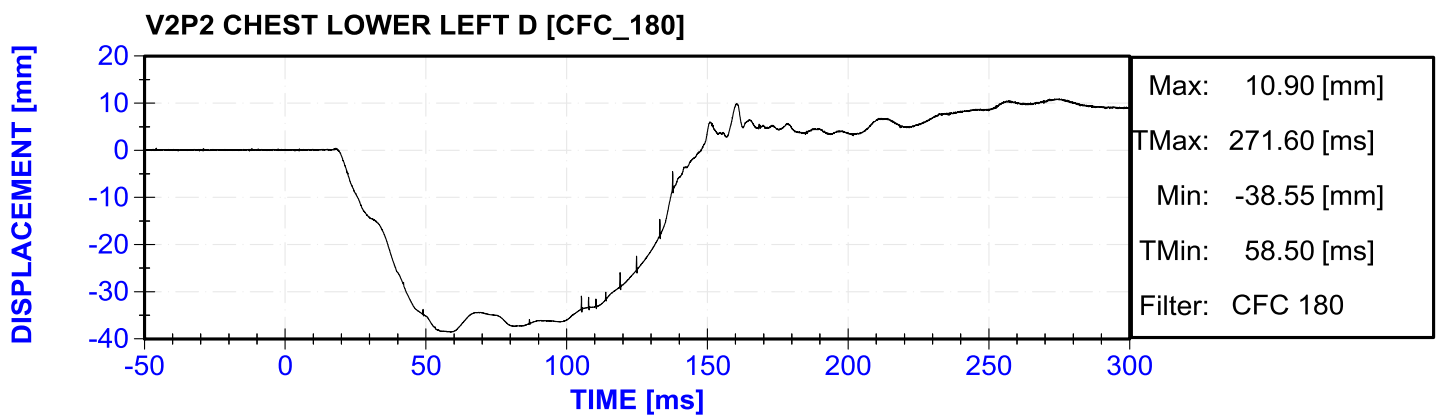
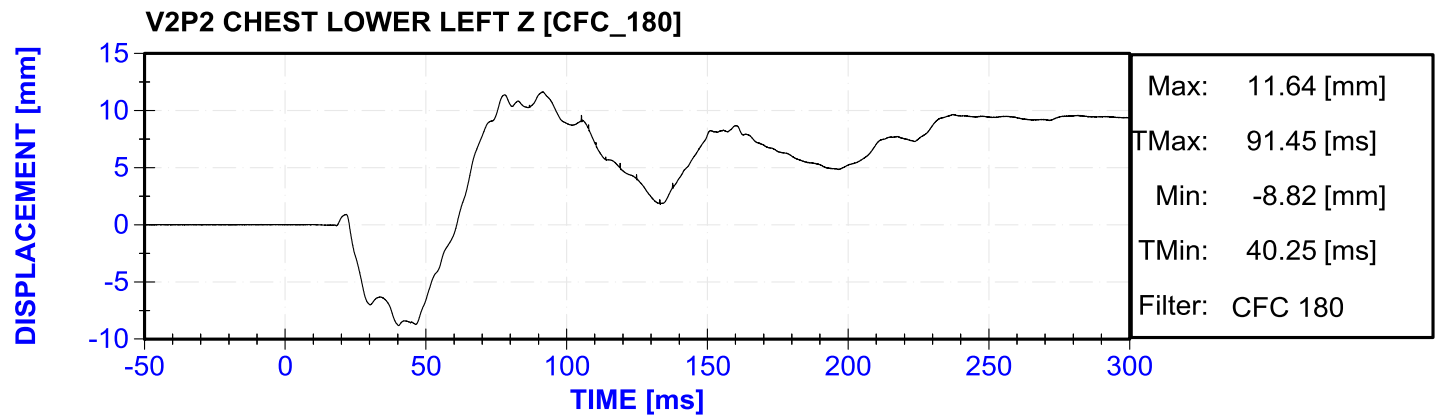
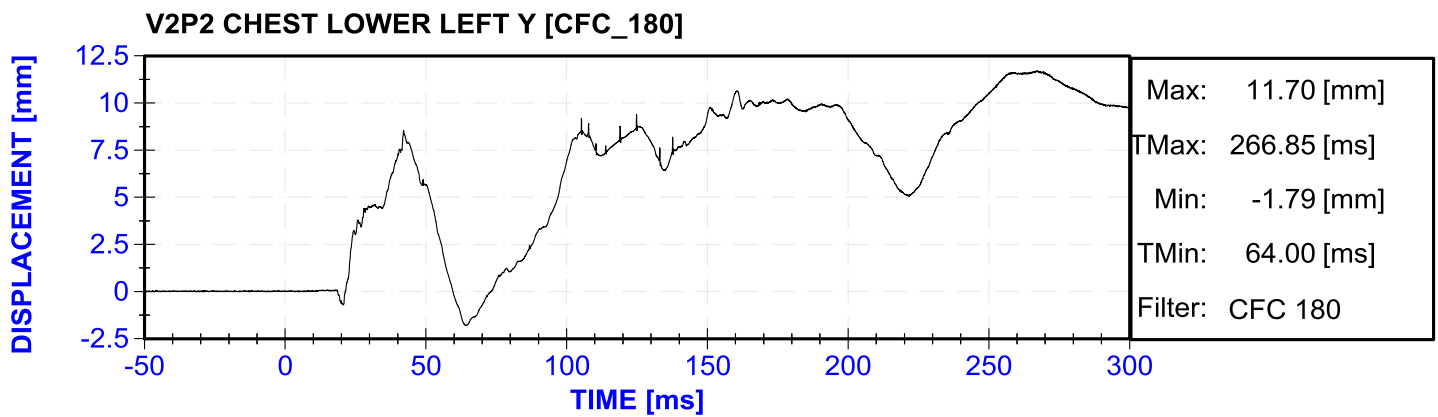
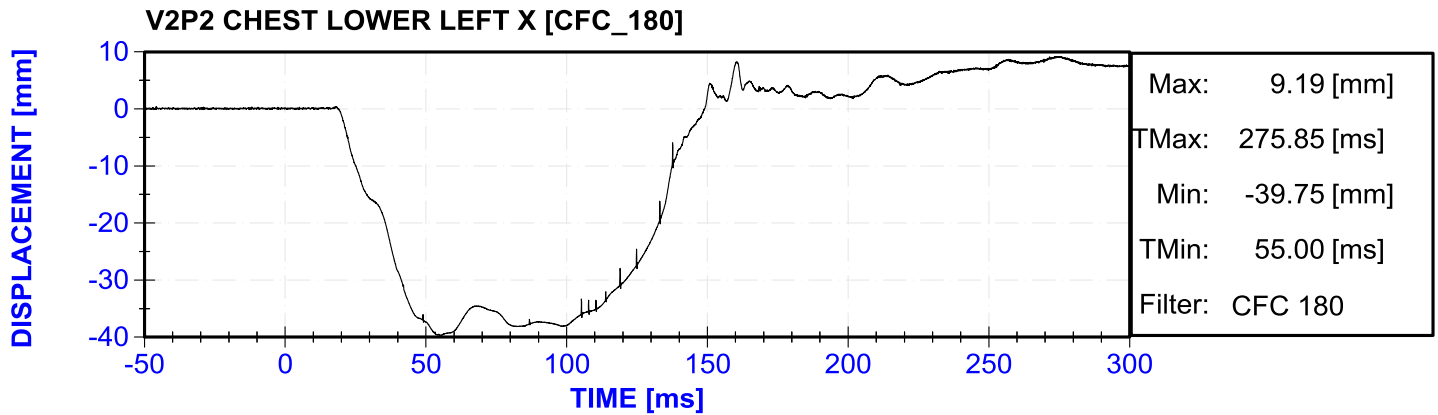
V2P2 NECK UPPER FORCE Y [THORTEST]

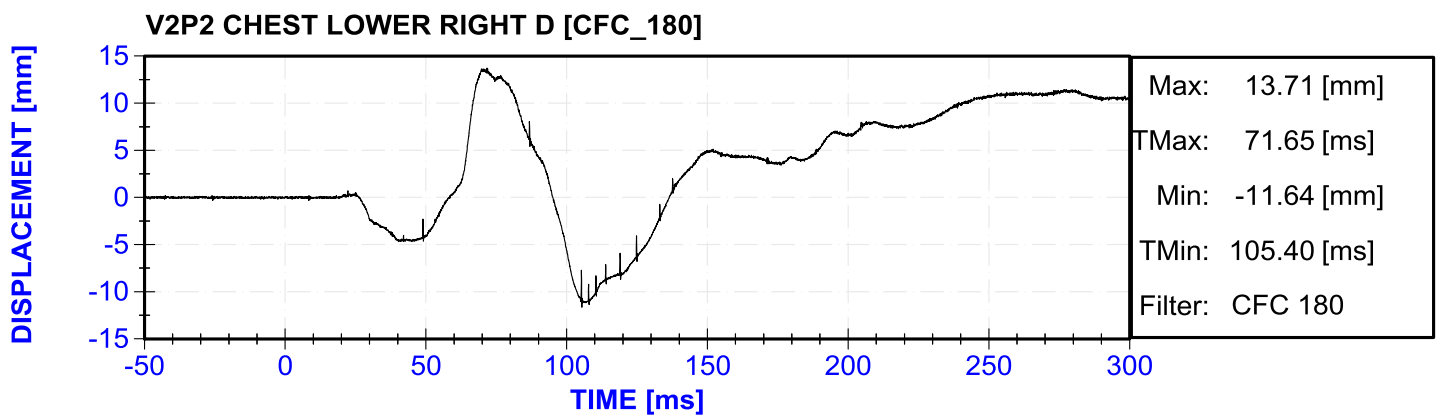
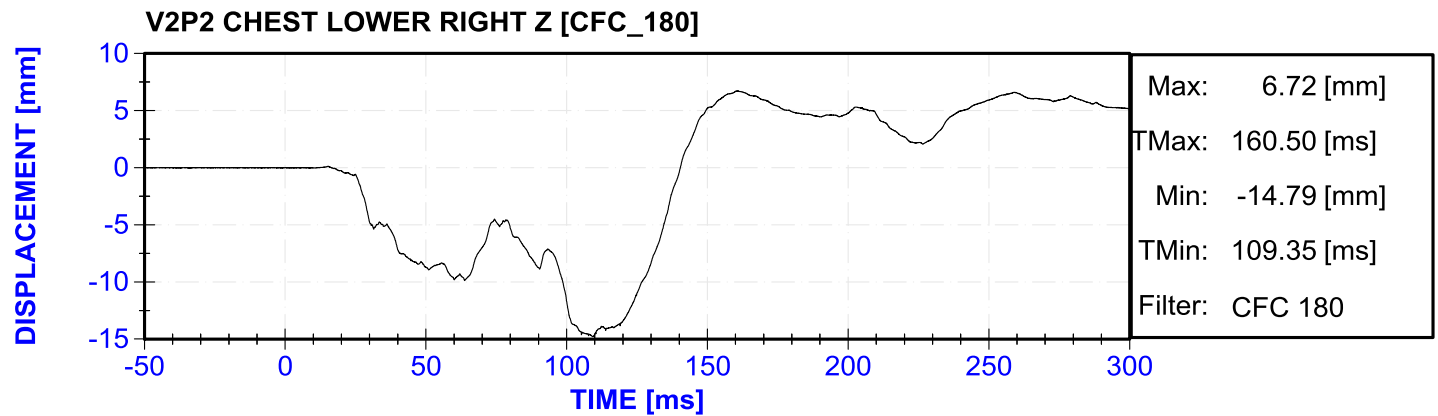
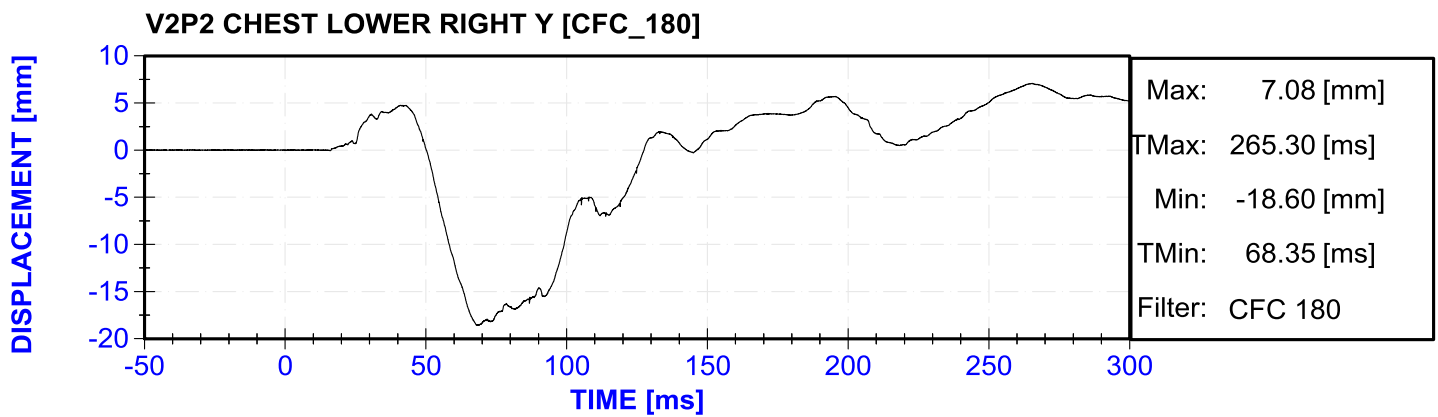
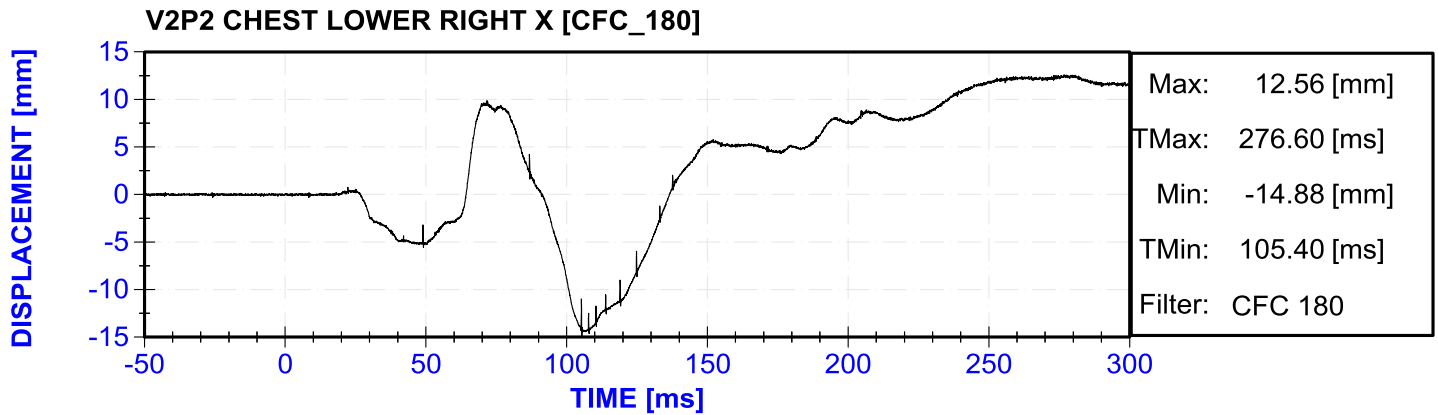


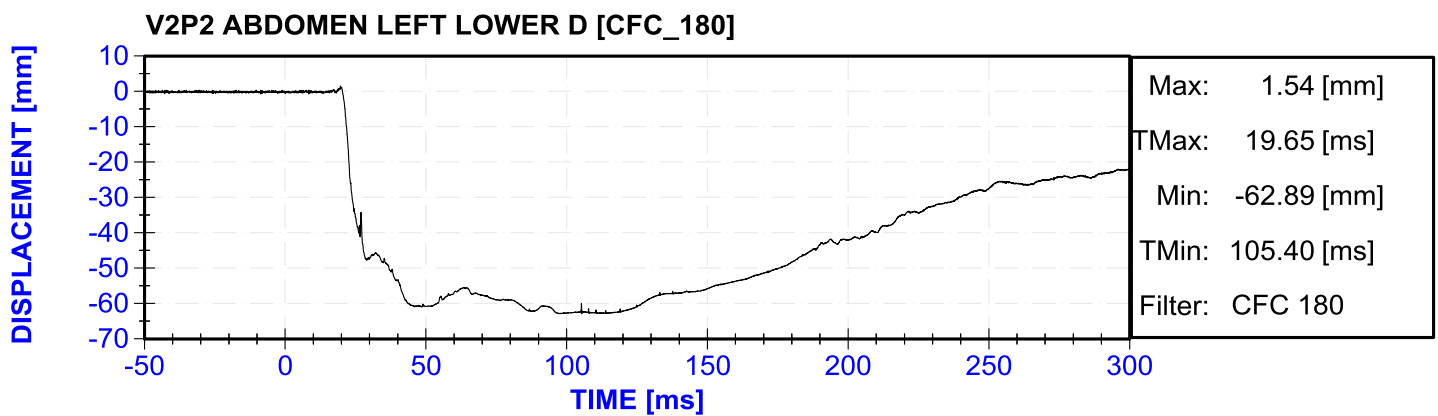
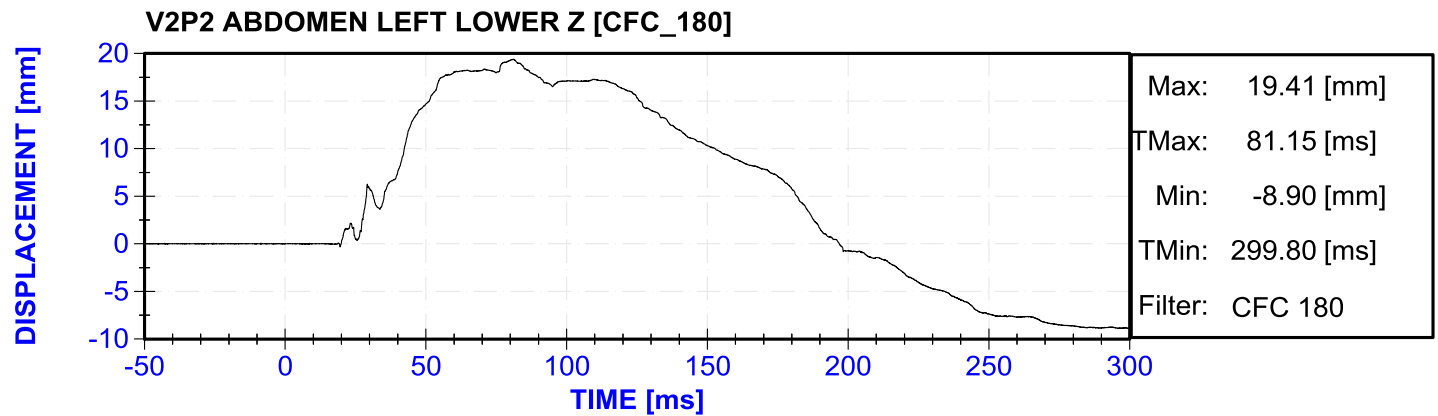
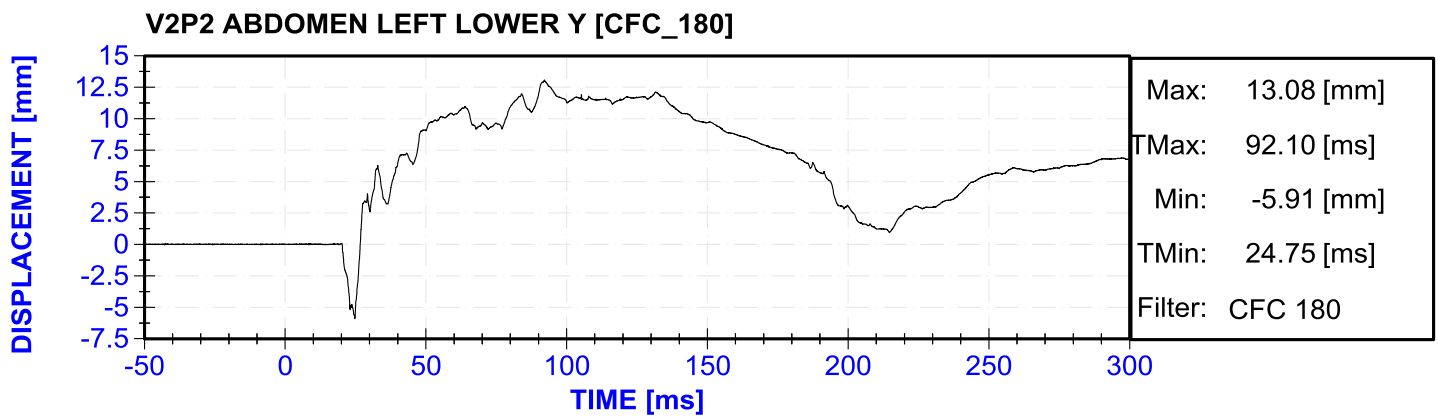
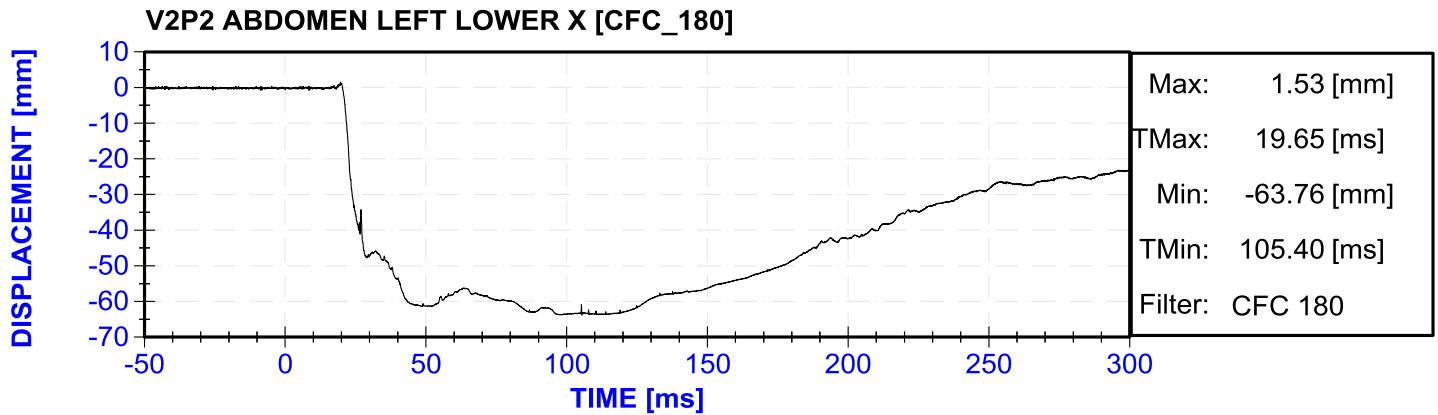


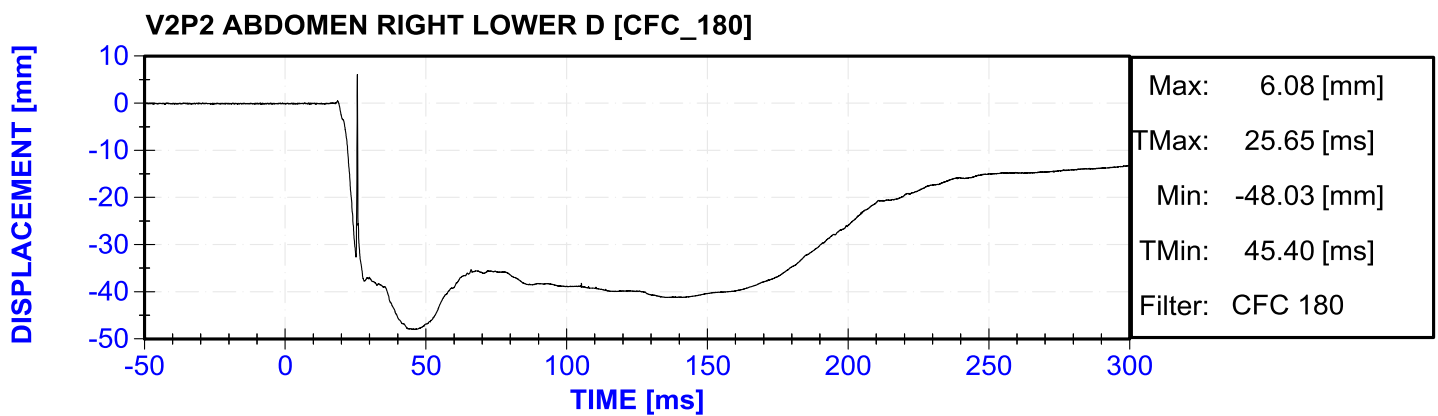
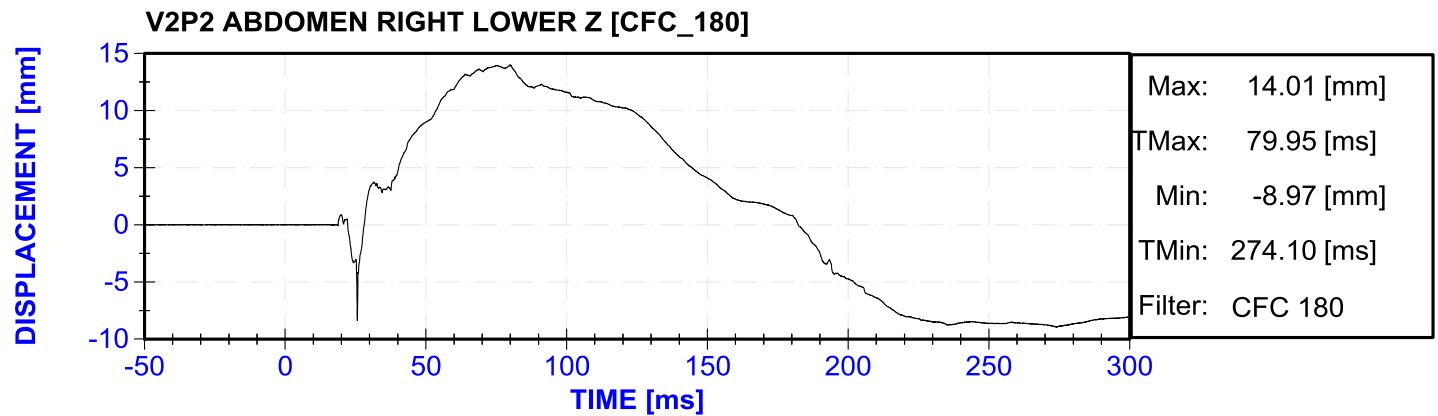
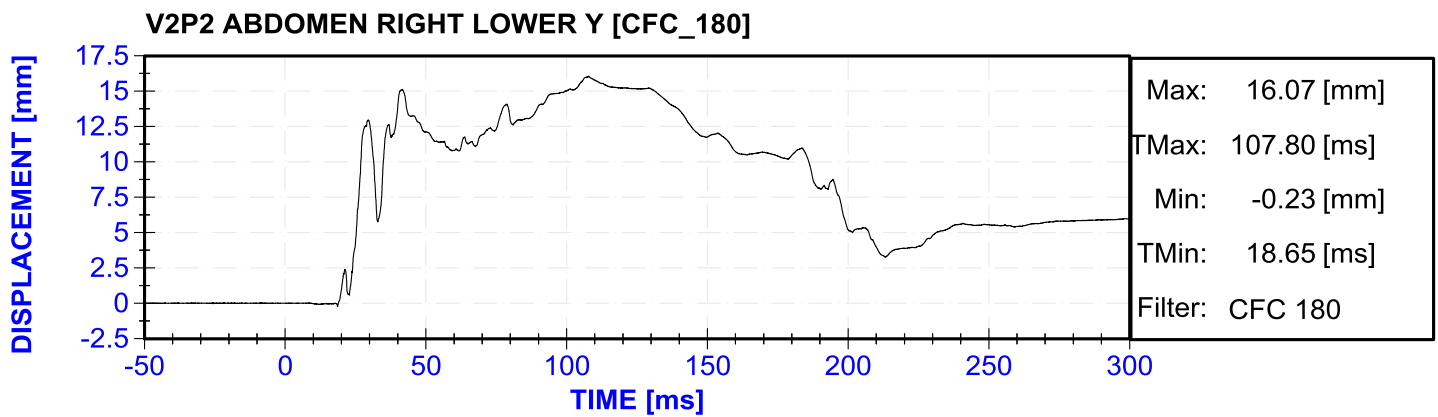
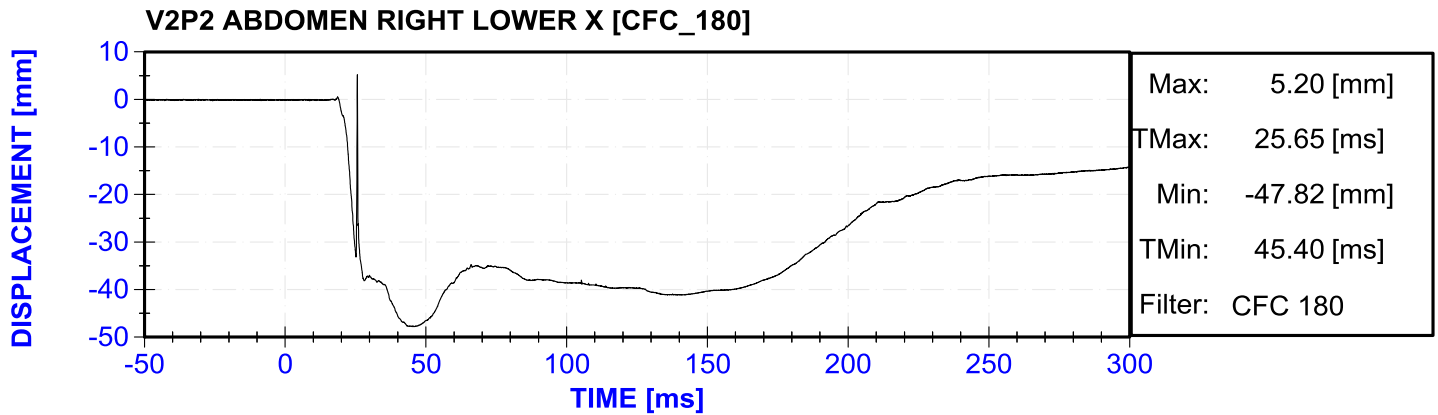












APPENDIX C

PART 572 E/O DUMMY CALIBRATION AND PERFORMANCE VERIFICATION DATA SHEETS

Table C-1: Dummy Information

TYPE	DESCRIPTION	SERIAL NUMBER
THOR TK	50 TH Male	007
THOR TK	50 TH Male	016

Table C-2: Ankle Offset Files

THOR – TK S/N: 007					
LFTX	LFTY	LFTZ	RFTX	RFTY	RFTZ
Left Ankle X Rotation	Left Ankle Y Rotation	Left Ankle Z Rotation	Right Ankle X Rotation	Right Ankle Y Rotation	Right Ankle Z Rotation
-0.83479	-16.049		0.0405	-11.961	
THOR – TK S/N: 016					
LFTX	LFTY	LFTZ	RFTX	RFTY	RFTZ
Left Ankle X Rotation	Left Ankle Y Rotation	Left Ankle Z Rotation	Right Ankle X Rotation	Right Ankle Y Rotation	Right Ankle Z Rotation
-0.9575	-14.97		-6.842	13.223	

Table C- 3: THOR Dummies Initial Set-Up Information

THOR – TK S/N: 0007								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
HEAD CG X	MFG: ENDEVCO S/N: P74967	2000	g	g	-1000	1000	0.0185	0
HEAD CG Y	MFG: ENDEVCO S/N: P71875	2000	g	g	-1000	1000	0.0176	0
HEAD CG Z	MFG: ENDEVCO S/N: P74784	2000	g	g	-1000	1000	0.01999	0
HDCG Wx	MFG: DTS S/N: ARS4643	36000	deg/s	deg/s	-18000	1000	0.0921	0
HDCG Wy	MFG: DTS S/N: ARS4651	36000	deg/s	deg/s	-18000	1000	0.09301	0
HDCG Wz	MFG: DTS S/N: ARS4650	36000	deg/s	deg/s	-18000	1000	0.09444	0
NEKU Fx	MFG: Denton S/N: 94	18000	lbf	N	-9000	1000	-0.00022811	0
NEKU Fy	MFG: Denton S/N: 94	18000	lbf	N	-9000	1000	0.00022894	0
NEKU Fz	MFG: Denton S/N: 94	26000	lbf	N	-13000	1000	-0.00008764	0
NEKU Mx	MFG: Denton S/N: 94	1200	in-lbf	N-m	-600	600	-0.00591849	0
NEKU My	MFG: Denton S/N: 94	1200	in-lbf	N-m	-600	600	0.00598399	0
NEKU Mz	MFG: Denton S/N: 94	1200	in-lbf	N-m	-600	600	0.00965262	0
NEKL Fx	MFG: DENTON S/N: 88	26000	lbf	N	-13000	1000	0.00017038	0
NEKL Fy	MFG: DENTON S/N: 88	26000	lbf	N	-13000	1000	0.0001704	0
NEKL Fz	MFG: DENTON S/N: 88	26000	lbf	N	-13000	1000	-0.00007065	0
NEKL Mx	MFG: DENTON S/N: 88	1200	in-lbf	N-m	-600	600	-0.0040085	0
NEKL My	MFG: DENTON S/N: 88	1200	in-lbf	N-m	-600	600	0.00400231	0
NEKL Mz	MFG: DENTON S/N: 88	1200	in-lbf	N-m	-600	600	0.0067779	0
NKCF Fz	MFG: DENTON S/N: 93	90000	lbf	N	-45000	1000	0.00086877	0

THOR – TK (Continued) S/N: 0007								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
NKCR Fz	MFG: DENTON S/N: 132	90000	lbf	N	-45000	1000	0.00071044	0
HDOT RDy	MFG: Sfernice S/N: 0942	340	deg	deg	-170	180	3.038	0
SPNU Ax	MFG: ENDEVCO S/N: P74970	1000	g	g	-500	180	0.02212	0
SPNU Ay	MFG: ENDEVCO S/N: P74979	1000	g	g	-500	180	0.01907	0
SPNU Az	MFG: ENDEVCO S/N: P75158	1000	g	g	-500	180	0.01723	0
SPNM Ax	MFG: ENDEVCO S/N: P75155	1000	g	g	-500	180	0.01993	0
SPNM Ay	MFG: ENDEVCO S/N: P75150	1000	g	g	-500	180	0.01954	0
SPNM Az	MFG: ENDEVCO S/N: P75153	1000	g	g	-500	180	0.02378	0
CHLU Dx	MFG: FTSS S/N: AC3556	3.3	V	mm	3.3	600	1000	
CHLU Ry	MFG: Sfernice S/N: AC6043	150	deg	deg	-75	180	3.0419	8.364
CHLU Rz	MFG: Sfernice S/N: AC6041	150	deg	deg	-75	180	3.0642	12.383
CHRU Dx	MFG: FTSS S/N: AC2288	3.3	V	mm	3.3	600	1000	
CHRU Ry	MFG: Sfernice S/N: AC6045	150	deg	deg	-75	180	3.0685	4.271
CHRU Rz	MFG: Sfernice S/N: AC6044	150	deg	deg	-75	180	3.0637	-7.104
CHLL Dx	MFG: FTSS S/N: AC3555	3.3	V	mm	3.3	600	1000	
CHLL Ry	MFG: Sfernice S/N: AC6158	150	deg	deg	-75	180	3.0696	-2.058
CHLL Rz	MFG: Sfernice S/N: AC6159	150	deg	deg	-75	180	3.0682	12.064
CHRL Dx	MFG: FTSS S/N: AC2287	3.3	V	mm	3.3	600	1000	
CHRL Ry	MFG: Sfernice S/N: AC6042	150	deg	deg	-75	180	2.6324	4.158
CHRL Rz	MFG: Sfernice S/N: AC6040	150	deg	deg	-75	180	3.0327	-3.550
ABDL Dx	MFG: Denton S/N: 173	3.3	V	mm	3.3	600	12.97679	
ABDL Ry	MFG: Contelec S/N: DS-558	150	deg	deg	-75	180	3.0172	1.067
ABDL Rz	MFG: Contelec S/N: DS-556	150	deg	deg	-75	180	3.0149	4.797
ABDR Dx	MFG: Denton S/N: 172	3.3	V	mm	3.3	600	13.03657	
ABDR Ry	MFG: Contelec S/N: DS-523	150	deg	deg	-75	180	3.0277	16.200
ABDR Rz	MFG: Contelec S/N: DS-557	150	deg	deg	-75	180	3.0114	-4.094
SPNL Fx	MFG: Denton S/N: 122	26000	lbf	N	-13000	1000	-0.0001395	0
SPNL Fy	MFG: Denton S/N: 122	26000	lbf	N	-13000	1000	0.00014053	0
SPNL Fz	MFG: Denton S/N: 122	36000	lbf	N	-18000	1000	-0.0000533	0
SPNL Mx	MFG: Denton S/N: 122	1400	in-lbf	N-m	-700	1000	-0.00209586	0
SPNL My	MFG: Denton S/N: 122	1400	in-lbf	N-m	-700	1000	0.00184981	0
PVCG Ax	MFG: ENDEVCO S/N: P74965	1000	g	g	-500	1000	0.0202	0
PVCG Ay	MFG: ENDEVCO S/N: P74976	1000	g	g	-500	1000	0.01703	0
PVCG Az	MFG: ENDEVCO S/N: P49439	1000	g	g	-500	1000	0.01961	0
PVAL Fx	MFG: DENTON S/N: 75	44000	lbf	N	-22000	600	0.00012174	0
PVAL Fy	MFG: DENTON S/N: 75	27000	lbf	N	-13500	600	-0.00005981	0
PVAL Fz	MFG: DENTON S/N: 75	27000	lbf	N	-13500	600	0.00016528	0
PVAR Fx	MFG: DENTON S/N: 75	44000	lbf	N	-22000	600	0.00012302	0
PVAR Fy	MFG: DENTON S/N: 75	26000	lbf	N	-13000	600	-0.00006078	0
PVAR Fz	MFG: DENTON S/N: 75	26000	lbf	N	-13000	600	-0.0001662	0
PILL Fx	MFG: Denton S/N: 75	26000	lbf	N	-13000	600	-0.00006743	0
PILR Fx	MFG: Denton S/N: 76	26000	lbf	N	-13000	600	-0.00006867	0
FMRL Fx	MFG: Humanetics S/N: DJ1040Fx	30000	N	N	-15000	600	0.0001436	0
FMRL Fy	MFG: Humanetics S/N: DJ1040Fy	30000	N	N	-15000	600	0.0001441	0
FMRL Fz	MFG: Humanetics S/N: DJ1040Fz	40000	N	N	-20000	600	-0.0000728	0
FMRL Mx	MFG: Humanetics S/N: DJ1040Mx	700	N-m	N-m	-350	600	0.0064454	0

THOR – TK (Continued) S/N: 0007								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
FMRL My	MFG: Humanetics S/N: DJ1040My	700	N-m	N-m	-350	600	0.0064621	0
FMRL Mz	MFG: Humanetics S/N: DJ1040Mz	600	N-m	N-m	-300	600	0.009063	0
KNEL Dx	MFG: Space Age Controls S/N: 025670	80	mm	mm	-40	180	23.8618	0
TBLU Fz	MFG: DENTON S/N: 110Fz	50000	N	N	-25000	600	-0.0000908	0
TBLU Mx	MFG: DENTON S/N: 110Mx	800	N-m	N-m	-400	600	0.0072731	0
TBLU My	MFG: DENTON S/N: 110My	800	N-m	N-m	-400	600	0.0072771	0
TBLL Fz	MFG: Denton S/N: 120Fz	50000	N	N	-25000	600	-0.00009686	0
TBLL Mx	MFG: Denton S/N: 120Mx	800	N-m	N-m	-400	600	0.00750986	0
TBLL My	MFG: Denton S/N: 120My	800	N-m	N-m	-400	600	0.0075842	0
ANKL Rx	MFG: Contelec S/N: ANKLX-0371	200	deg	deg	-100	180	2.995	-0.83479
ANKL Ry	MFG: Contelec S/N: ANKLY-0367	200	deg	deg	-100	180	3.014	-16.049
FOTL Az	MFG: ENDEVCO S/N: P51711	3000	g	g	-1500	1000	0.01972	0
FMRR Fx	MFG: Humanetics S/N: DJ1045Fx	30000	N	N	-15000	600	0.0001461	0
FMRR Fy	MFG: Humanetics S/N: DJ1045Fy	30000	N	N	-15000	600	0.0001465	0
FMRR Fz	MFG: Humanetics S/N: DJ1045Fz	40000	N	N	-20000	600	-0.0000756	0
FMRR Mx	MFG: Humanetics S/N: DJ1045Mx	700	N-m	N-m	-350	600	0.0065482	0
FMRR My	MFG: Humanetics S/N: DJ1045My	700	N-m	N-m	-350	600	0.006518	0
FMRR Mz	MFG: Humanetics S/N: DJ1045Mz	600	N-m	N-m	-300	600	0.0097325	0
KNER Dx	MFG: Space Age Controls S/N: 019588	80	mm	mm	-40	180	23.9349	0
TBRU Fz	MFG: DENTON S/N: 107Fz	50000	N	N	-25000	600	-0.0000955	0
TBRU Mx	MFG: DENTON S/N: 107Mx	800	N-m	N-m	-400	600	0.0074272	0
TBRU My	MFG: DENTON S/N: 107My	800	N-m	N-m	-400	600	0.007333	0
TBRL Fz	MFG: Denton S/N: 75Fz	50000	N	N	-25000	600	-0.00009964	0
TBRL Mx	MFG: Denton S/N: 75Mx	800	N-m	N-m	-400	600	0.00736028	0
TBRL My	MFG: Denton S/N: 75My	800	N-m	N-m	-400	600	0.00736294	0
ANKR Rx	MFG: Contelec S/N: ANKRX-0368	200	deg	deg	-100	180	3.017	0.0405
ANKR Ry	MFG: Contelec S/N: ANKRY-0369	200	deg	deg	-100	180	3.009	-11.961
FOTR Az	MFG: ENDEVCO S/N: P64128	3000	g	g	-1500	1000	0.02344	0

THOR – TK S/N: 016								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
HEAD CG X	MFG: First Technology S/N: 294	2000	g	g	-1000	1000	0.0177	0
HEAD CG Y	MFG: First Technology S/N: 156	2000	g	g	-1000	1000	0.02065	0
HEAD CG Z	MFG: ENDEVCO S/N: P49194	2000	g	g	-1000	1000	0.01721	0
HDCG Wx	MFG: ENDEVCO S/N: P52086	36000	deg/s	deg/s	-18000	1000	0.09262	0
HDCG Wy	MFG: ENDEVCO S/N: P52043	36000	deg/s	deg/s	-18000	1000	0.09378	0
HDCG Wz	MFG: DTS S/N: ARS4727	36000	deg/s	deg/s	-18000	1000	0.09563	0
NEKU Fx	MFG: DTS S/N: ARS4712	18000	lbf	N	-9000	1000	0.0002406	0
NEKU Fy	MFG: DTS S/N: ARS4714	18000	lbf	N	-9000	1000	0.00024081	0
NEKU Fz	MFG: DENTON S/N: 77	26000	lbf	N	-13000	1000	-0.00008546	0
NEKU Mx	MFG: DENTON S/N: 77	1200	in-lbf	N-m	-600	600	0.00584857	0
NEKU My	MFG: DENTON S/N: 77	1200	in-lbf	N-m	-600	600	0.00609285	0

THOR – TK (Continued) S/N: 016								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
NEKU Mz	MFG: DENTON S/N: 77	1200	in-lbf	N-m	-600	600	0.00980132	0
NEKL Fx	MFG: DENTON S/N: 80	26000	lbf	N	-13000	1000	-0.00017312	0
NEKL Fy	MFG: DENTON S/N: 80	26000	lbf	N	-13000	1000	0.00017328	0
NEKL Fz	MFG: DENTON S/N: 80	26000	lbf	N	-13000	1000	-0.00006903	0
NEKL Mx	MFG: DENTON S/N: 80	1200	in-lbf	N-m	-600	600	-0.00417667	0
NEKL My	MFG: DENTON S/N: 80	1200	in-lbf	N-m	-600	600	0.00421295	0
NEKL Mz	MFG: DENTON S/N: 80	1200	in-lbf	N-m	-600	600	0.00690093	0
NKCF Fz	MFG: DENTON S/N: 80	90000	lbf	N	-45000	1000	0.00052317	0
NKCR Fz	MFG: DENTON S/N: 75	90000	lbf	N	-45000	1000	0.0004801	0
HDOT RDy	MFG: Sfernice S/N: DI7189	340	deg	deg	-170	180	3.038	0
SPNU Ax	MFG: ENDEVCO S/N: P64099	1000	g	g	-500	180	0.01844	0
SPNU Ay	MFG: ENDEVCO S/N: P58838	1000	g	g	-500	180	0.01739	0
SPNU Az	MFG: ENDEVCO S/N: P58834	1000	g	g	-500	180	0.0188	0
SPNM Ax	MFG: ENDEVCO S/N: P64002	1000	g	g	-500	180	0.01799	0
SPNM Ay	MFG: ENDEVCO S/N: P58735	1000	g	g	-500	180	0.01841	0
SPNM Az	MFG: ENDEVCO S/N: P64111	1000	g	g	-500	180	0.01674	0
CHLU Dx	MFG: FTSS S/N: DI4715	3.3	V	mm	3.3	600	1000	
CHLU Ry	MFG: Denton S/N: DI2382	150	deg	deg	-75	180	3.0087	8.434
CHLU Rz	MFG: Denton S/N: DI2383	150	deg	deg	-75	180	3.0074	11.913
CHRU Dx	MFG: FTSS S/N: DI4716	3.3	V	mm	3.3	600	1000	
CHRU Ry	MFG: Denton S/N: DI2381	150	deg	deg	-75	180	3.0077	7.451
CHRU Rz	MFG: Denton S/N: DI2380	150	deg	deg	-75	180	3.0199	-9.781
CHLL Dx	MFG: FTSS S/N: DI4718	3.3	V	mm	3.3	600	1000	
CHLL Ry	MFG: Denton S/N: DI2386	150	deg	deg	-75	180	3.0211	3.758
CHLL Rz	MFG: Denton S/N: DI6129	150	deg	deg	-75	180	3.01218	7.021
CHRL Dx	MFG: FTSS S/N: DI4717	3.3	V	mm	3.3	600	1000	
CHRL Ry	MFG: Denton S/N: DI2385	150	deg	deg	-75	180	3.016	.5991
CHRL Rz	MFG: Denton S/N: DI2384	150	deg	deg	-75	180	3.0217	-8.613
ABDL Dx	MFG: Denton S/N: 183	3.3	V	mm	3.3	600	1000	
ABDL Ry	MFG: Denton S/N: 219	150	deg	deg	-75	180	3.218	4.171
ABDL Rz	MFG: Denton S/N: 218	150	deg	deg	-75	180	3.165	1.789
ABDR Dx	MFG: Denton S/N: 184	3.3	V	mm	3.3	600	1000	
ABDR Ry	MFG: Denton S/N: 220	150	deg	deg	-75	180	3.182	5.652
ABDR Rz	MFG: Denton S/N: 221	150	deg	deg	-75	180	3.168	-1.162
SPNL Fx	MFG: Denton S/N: 123	26000	lbf	N	-13000	1000	0.00139138	0
SPNL Fy	MFG: Denton S/N: 123	26000	lbf	N	-13000	1000	0.00013943	0
SPNL Fz	MFG: Denton S/N: 123	36000	lbf	N	-18000	1000	-0.00005291	0
SPNL Mx	MFG: Denton S/N: 123	1400	in-lbf	N-m	-700	1000	-0.00209586	0
SPNL My	MFG: Denton S/N: 123	1400	in-lbf	N-m	-700	1000	0.00182945	0
PVCG Ax	MFG: ENDEVCO S/N: P64087	1000	g	g	-500	1000	0.01834	0
PVCG Ay	MFG: ENDEVCO S/N: P50065	1000	g	g	-500	1000	0.01785	0
PVCG Az	MFG: ENDEVCO S/N: P64123	1000	g	g	-500	1000	0.01914	0
PVAL Fx	MFG: DENTON S/N: 77	44000	lbf	N	-22000	600	-0.00011976	0
PVAL Fy	MFG: DENTON S/N: 77	27000	lbf	N	-13500	600	-0.00005959	0
PVAL Fz	MFG: DENTON S/N: 77	27000	lbf	N	-13500	600	-0.00016344	0

THOR – TK (Continued) S/N: 016								
Sensor	Manufacturer/ Serial #	Capacity	Units (E)	Units (M)	Range	CFC	Sensitivity (mv/V/EU)	Initial Offset (EU)
PVAR Fx	MFG: DENTON S/N: 84	44000	lbf	N	-22000	600	0.00012055	0
PVAR Fy	MFG: DENTON S/N: 84	26000	lbf	N	-13000	600	-0.00006006	0
PVAR Fz	MFG: DENTON S/N: 84	26000	lbf	N	-13000	600	0.00016272	0
PILL Fx	MFG: Denton S/N: DI4774	26000	lbf	N	-13000	1000	-0.00012118	0
PILR Fx	MFG: Denton S/N: DI4775	26000	lbf	N	-13000	1000	-0.00012068	0
FMRL Fx	MFG: Denton S/N: DH9717	30000	N	N	-15000	600	0.0001446	0
FMRL Fy	MFG: Denton S/N: DH9717	30000	N	N	-15000	600	0.0001458	0
FMRL Fz	MFG: Denton S/N: DH9717	40000	N	N	-20000	600	-0.0000724	0
FMRL Mx	MFG: Denton S/N: DH9717	700	N-m	N-m	-350	600	0.0065482	0
FMRL My	MFG: Denton S/N: DH9717	700	N-m	N-m	-350	600	0.0065257	0
FMRL Mz	MFG: Denton S/N: DH9717	600	N-m	N-m	-300	600	0.0091723	0
KNEL Dx	MFG: Space Age Controls S/N: D2103665B	80	mm	mm	-40	180	22.147	0
TBLU Fz	MFG: Denton S/N: 89	50000	N	N	-25000	600	-0.0000921	0
TBLU Mx	MFG: Denton S/N: 89	800	N-m	N-m	-400	600	0.0073598	0
TBLU My	MFG: Denton S/N: 89	800	N-m	N-m	-400	600	0.0073288	0
TBLL Fz	MFG: Denton S/N: 142	50000	N	N	-25000	600	-0.0000948	0
TBLL Mx	MFG: Denton S/N: 142	800	N-m	N-m	-400	600	0.0073026	0
TBLL My	MFG: Denton S/N: 142	800	N-m	N-m	-400	600	0.0073735	0
ANKL Rx	MFG: Contelec S/N: LX0019	200	deg	deg	-100	180	3.04982	-0.9575
ANKL Ry	MFG: Contelec S/N: LX0019	200	deg	deg	-100	180	2.96419	-14.97
FOTL Az	MFG: ENDEVCO S/N: P52001	3000	g	g	-1500	1000	0.0191	0
FMRR Fx	MFG: Denton S/N: DH9722	30000	N	N	-15000	600	0.0001474	0
FMRR Fy	MFG: Denton S/N: DH9722	30000	N	N	-15000	600	0.0001474	0
FMRR Fz	MFG: Denton S/N: DH9722	40000	N	N	-20000	600	-0.0000737	0
FMRR Mx	MFG: Denton S/N: DH9722	700	N-m	N-m	-350	600	0.0065614	0
FMRR My	MFG: Denton S/N: DH9722	700	N-m	N-m	-350	600	0.0065759	0
FMRR Mz	MFG: Denton S/N: DH9722	600	N-m	N-m	-300	600	0.0089348	0
KNER Dx	MFG: Space Age Controls S/N: D2103657B	80	mm	mm	-40	180	23.135	0
TBRU Fz	MFG: Denton S/N: 95	50000	N	N	-25000	600	-0.0000918	0
TBRU Mx	MFG: Denton S/N: 95	800	N-m	N-m	-400	600	0.0073681	0
TBRU My	MFG: Denton S/N: 95	800	N-m	N-m	-400	600	0.0072947	0
TBRL Fz	MFG: Denton S/N: 164	50000	N	N	-25000	600	-0.0000956	0
TBRL Mx	MFG: Denton S/N: 164	800	N-m	N-m	-400	600	0.0075105	0
TBRL My	MFG: Denton S/N: 164	800	N-m	N-m	-400	600	0.0073588	0
ANKR Rx	MFG: Contelec S/N: LX0018	200	deg	deg	-100	180	3.13066	-6.842
ANKR Ry	MFG: Contelec S/N: LX0018	200	deg	deg	-100	180	2.95682	13.223
FOTR Az	MFG: ENDEVCO S/N: P64102	3000	g	g	-1500	1000	0.01986	0

Table C-4: THOR Dummy Initial Set-Up Information (IR-TRACC)

THOR – TK S/N: 007			
Sensor	IR-TRACC Exponent	IR-TRACC Slope	IR-TRACC Intercept
CHLU Dx	-0.4675	-34.009493	120.7103
CHRU Dx	-0.4675	-34.871682	125.2528
CHLL Dx	-0.4675	-34.916600	123.9557
CHRL Dx	-0.4675	-34.121632	121.9603
ABDL Dx	-0.43568	31.6159	3.688
ABDR Dx	-0.40940	31.7099	3.774
THOR – TK S/N: 016			
Sensor	IR-TRACC Exponent	IR-TRACC Slope	IR-TRACC Intercept
CHLU Dx	-0.48024	33.0284	3.680
CHRU Dx	-0.4675	-34.919035	121.2325
CHLL Dx	-0.4672	33.6317	3.612
CHRL Dx	-0.48206	32.0908	3.791
ABDL Dx	-0.47743	38.9774	3.894
ABDR Dx	-0.48020	53.1720	2.874

Table 5 - THOR IR-TRACC Polarity

In order to reduce the risk of damage to instrumentation, it is recommended that the 3D IR-TRACC units are not disconnected from the rib cage to conduct the polarity test. An alternate procedure for checking the IR-TRACC polarity is described below.

1. Using the data acquisition system control software, open a live view of each channel. If possible, view the DX, RY, and RZ components of a given quadrant simultaneously.
2. Record the initial reading of each channel
3. Perform the following motions on each of the four rib attachment locations and two abdomen attachment locations (specified by the hexagonal bolt attaching the blue ribs).
 - a. DX: Push inward (front-to-back). The IR-TRACC tube voltage should increase.
 - b. RY: Push downward (head-to-pelvis). The Y-axis potentiometer reading should decrease.
 - c. RZ: Push rightward (left-to-right). The Z-axis potentiometer should increase.
4. Record the final reading of each channel
5. If the “Measured” value (increase or decrease) does not match the “Expected” value, the polarity of the channel must be inverted.

THOR 007

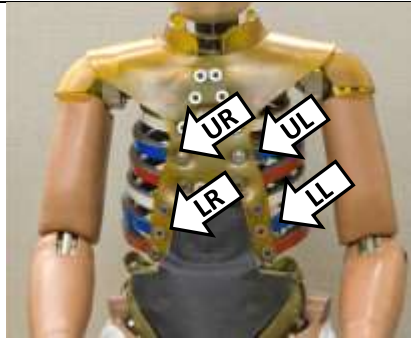
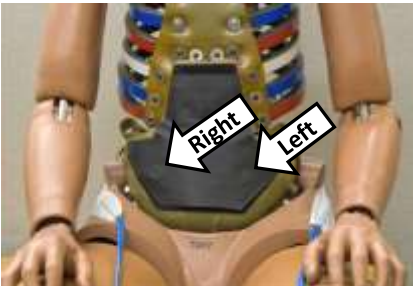


Figure 1. Manipulation to determine thoracic IR-TRACC polarity.

UR				UL			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.1501	.1760	Increase	DX (V)	.1759	.2025	Increase
			Increase				Increase
RY (Deg)	4.271	-.331	Increase	RY (Deg)	8.364	5.141	Decrease
			Decrease				Decrease
RZ (Deg)	-7.104	-5.851	Decrease	RZ (Deg)	12.383	13.858	Decrease
			Increase				Increase
LR				LL			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.0781	.1042	Increase	DX (V)	.0921	.1323	Increase
			Increase				Increase
RY (Deg)	4.158	.9250	Increase	RY (Deg)	-2.058	-4.612	Decrease
			Decrease				Decrease
RZ (Deg)	-3.550	-1.357	Decrease	RZ (Deg)	12.064	17.925	Increase
			Increase				Increase
							
Abdomen Left				Abdomen Right			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.0431	.1373	Increase	DX (V)	.0329	.9302	Increase
			Increase				Increase
RY (Deg)	1.067	-3.028	Decrease	RY (Deg)	16.200	8.392	Increase
			Decrease				Decrease
RZ (Deg)	4.797	10.073	Increase	RZ (Deg)	-4.094	.4204	Decrease
			Increase				Increase

THOR 0016

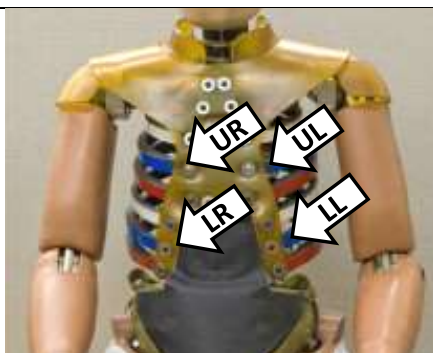
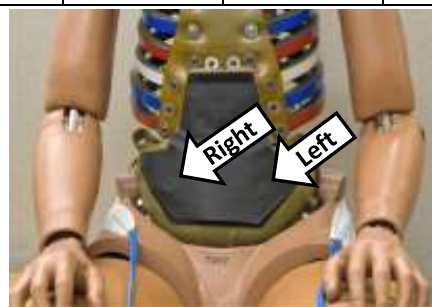


Figure 2. Manipulation to determine thoracic IR-TRACC polarity.

UR				UL			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.1312	.2071	Increase	DX (V)	.1357	.2316	Increase
			Increase				Increase
RY (Deg)	7.451	2.791	Increase	RY (Deg)	8.434	1.591	Decrease
			Decrease				Decrease
RZ (Deg)	-9.781	-6.440	Decrease	RZ (Deg)	11.913	16.909	Decrease
			Increase				Increase
LR				LL			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.0856	.1421	Increase	DX (V)	.0753	.1350	Increase
			Increase				Increase
RY (Deg)	.5991	-3.319	Increase	RY (Deg)	3.758	-1.598	Decrease
			Decrease				Decrease
RZ (Deg)	-8.613	-1.556	Decrease	RZ (Deg)	7.021	15.472	Increase
			Increase				Increase
							
Abdomen Left				Abdomen Right			
Channel	Initial	Final	Measured	Channel	Initial	Final	Measured
			Expected				Expected
DX (V)	.0512	.1152	Increase	DX (V)	.1361	.2685	Increase
			Increase				Increase
RY (Deg)	4.171	-2.343	Decrease	RY (Deg)	5.652	-.500	Increase
			Decrease				Decrease
RZ (Deg)	1.789	10.213	Increase	RZ (Deg)	-1.162	2.668	Decrease
			Increase				Increase

THOR Inspection Checklist

Date: 12/8/2012							
NHTSA Representative: James Saunders							
Witness(es):							
Inspection type (check one):	☒ PRE ☐ POST						
Dummy S/N: 007							
Dummy Description: Thor NT 50th Male							
Date of last Certification or Inspection: 12/6/2012							
<u>Tests conducted since last full certification or inspection:</u> <u>Since last inspection:</u> RD5226 Left side Versa <u>Since last certification:</u> RD5227 Right side Versa RC5142 Right side Camry RD5226 Left side Versa							
<u>Known errors in data channels (no data, clipping, unexpected drops):</u> <table> <tr> <td>V2P1 NKCF FZ</td> <td>Spikes on Data – consistent with previous data</td> </tr> <tr> <td>V2P1 PILL FX</td> <td>Questionable Data – data spikes around 270ms, 170 ms – checked ok</td> </tr> <tr> <td>V2P1 FOTL AZ</td> <td>Questionable Data Spikes – 106g magnitude is possible – sensor appears fine</td> </tr> </table>		V2P1 NKCF FZ	Spikes on Data – consistent with previous data	V2P1 PILL FX	Questionable Data – data spikes around 270ms, 170 ms – checked ok	V2P1 FOTL AZ	Questionable Data Spikes – 106g magnitude is possible – sensor appears fine
V2P1 NKCF FZ	Spikes on Data – consistent with previous data						
V2P1 PILL FX	Questionable Data – data spikes around 270ms, 170 ms – checked ok						
V2P1 FOTL AZ	Questionable Data Spikes – 106g magnitude is possible – sensor appears fine						
<u>Physical evidence of damage:</u>							
<u>Anecdotal evidence of damage:</u>							
<u>Equipment delivered to Borrower:</u>							

HEAD	
Y / N	Rear head cap mounts securely to head
Y / N	Head skin fits securely over skull -slightly small, does not fit 100% in rear
Y / N	Head skin shows no sign of tears or damage -nicks/cuts 
Y / N	Interior components of skull cavity (ballast, accelerometer mount, accelerometers) securely attached
Y / N	Head securely mounted to OC joint
OTHER	

NECK	
Y / N	Neck cables slide freely through holes in neck plates
Y / N	Neck cables show no sign of fraying, broken strands, or kinking
Y / N	No evidence of debonding between neck pucks and plates If N – indicate which interface (where plate/puck 1 attach to upper neck load cell): -debonding above pucks 4, 5 
Y / N	No evidence of debonding or permanent compression in neck soft stop assemblies
Y / N	Neck securely attached to upper neck load cell
Y / N	Neck securely attached to lower neck load cell
Y / N	Neck pitch change joint mechanism mating teeth are engaged
OTHER	

SPINE	
Y / N	No evidence of debonding between thoracic spine flex joint and metal plates -tears in left/right sides? 
Y / N	No evidence of debonding between lumbar spine flex joint and metal plates
Y / N	Lumbar spine pitch change joint mechanism mating teeth are engaged
OTHER	

SHOULDER	
Y / N	Urethane shoulder pads show no evidence of contact
Y / N	Clavicles securely attached to sternum and shoulder
Y / N	No evidence of debonding, tearing, or permanent compression of posterior soft stops -left stop slightly debonded 
OTHER	

THORAX	
Y / N	No evidence of contact at top, bottom, or interior faces of rib damping material -top interior left ribs 2, 5 -top interior right rib 4
Y / N	No evidence of debonding between rib damping material and ribs
Y / N	CRUX anterior arms securely attached to anterior ribs
Y / N	CRUX posterior arms securely attached to double gimbals, spine
Y / N	Urethane bib is securely attached to ribs with no sign of tearing or washer penetration
Y / N	Ribs securely attached to posterior spine
Y / N	Rib stiffeners show no evidence of bending (no gaps between ribs and stiffeners)

OTHER	
ABDOMEN	
Y / N	No evidence of tearing, cuts, or broken stitches in upper abdomen bag and zipper -holes in left, right sides near zipper 
Y / N	Upper abdomen insert securely attached to spine
Y / N	Upper abdomen insert shows no evidence of permanent set
Y / N	No evidence of tearing, cuts, or broken stitches in lower abdomen bag and zipper
Y / N	Lower abdomen insert securely attached to spine
Y / N	Lower abdomen insert shows no evidence of permanent set
OTHER	
PELVIS	
Y / N	Pelvis flesh fits securely over pelvis bones
Y / N	H-point tool fits securely into hole on both sides of pelvis
OTHER	-holes in pelvis flesh near ASIS anterior surfaces 

FEMUR	
Y / N	Acetabular load cells firmly attached
Y / N	Femur load cells firmly attached
Y / N	No evidence of deformation of knee slider bump stop
Y / N	No cuts, tears, or scuffing of knee flesh -cuts/tears/hole in both knee flesh covers 
OTHER	

LOWER EXTREMITY (LX)	
Y / N	Rotational potentiometers in ankle securely attached
Y / N	Achilles tendon provides resistance to dorsiflexion
Y / N	No evidence of debonding, tearing, or permanent compression of ankle soft stops
OTHER	-Both feet starting to tear at rear 

JACKET	
Y / N	Rib stiffeners show no sign of permanent deformation
Y / N	No evidence of tears or holes in jacket fabric, Velcro, or zippers
OTHER	

THOR Inspection Checklist

Date: 12/10/2012
NHTSA Representative: James Saunders
Witness(es):
Inspection type (check one): ☐ PRE ☒ POST
Dummy S/N: 007
Dummy Description: Thor NT 50th Male
Date of last Certification or Inspection: 12/8/2012
<u>Tests conducted since last full certification or inspection:</u> <u>Since last inspection:</u> RD4200 Left side Elantra <u>Since last certification:</u> RD5227 Right side Versa RC5142 Right side Camry RD5226 Left side Versa RD4200 Left side Elantra
<u>Known errors in data channels (no data, clipping, unexpected drops):</u> V2P1 ANKL RY Questionable Min at 56ms Let me know if this is ok for the ankles – that they flatten out – This is okay. There is a physical stop causing the data to be flat once the ankle hits the stop. V2P1 SPNM AX -Found questionable data during ringout. Found poor connection on GFE side of Amp connector. We repaired it. Based on the last test's good data, it was likely caused during ATD transport.
<u>Physical evidence of damage:</u>
<u>Anecdotal evidence of damage:</u>
<u>Equipment delivered to Borrower:</u>

HEAD	
Y / N	Rear head cap mounts securely to head
Y / N	Head skin fits securely over skull -slightly small, does not fit 100% in rear
Y / N	Head skin shows no sign of tears or damage -nicks/cuts 
Y / N	Interior components of skull cavity (ballast, accelerometer mount, accelerometers) securely attached
Y / N	Head securely mounted to OC joint
OTHER	

NECK	
Y / N	Neck cables slide freely through holes in neck plates
Y / N	Neck cables show no sign of fraying, broken strands, or kinking
Y / N	No evidence of debonding between neck pucks and plates If N – indicate which interface (where plate/puck 1 attach to upper neck load cell): -debonding above pucks 4, 5 
Y / N	No evidence of debonding or permanent compression in neck soft stop assemblies
Y / N	Neck securely attached to upper neck load cell
Y / N	Neck securely attached to lower neck load cell
Y / N	Neck pitch change joint mechanism mating teeth are engaged
OTHER	

SPINE	
Y / N	No evidence of debonding between thoracic spine flex joint and metal plates -tears in left/right sides? 
Y / N	No evidence of debonding between lumbar spine flex joint and metal plates
Y / N	Lumbar spine pitch change joint mechanism mating teeth are engaged
OTHER	
SHOULDER	
Y / N	Urethane shoulder pads show no evidence of contact
Y / N	Clavicles securely attached to sternum and shoulder
Y / N	No evidence of debonding, tearing, or permanent compression of posterior soft stops -left stop slightly debonded 
OTHER	
THORAX	
Y / N	No evidence of contact at top, bottom, or interior faces of rib damping material -top interior left ribs 2, 5 -top interior right rib 4
Y / N	No evidence of debonding between rib damping material and ribs
Y / N	CRUX anterior arms securely attached to anterior ribs
Y / N	CRUX posterior arms securely attached to double gimbals, spine
Y / N	Urethane bib is securely attached to ribs with no sign of tearing or washer penetration
Y / N	Ribs securely attached to posterior spine
Y / N	Rib stiffeners show no evidence of bending (no gaps between ribs and stiffeners)
OTHER	

ABDOMEN	
Y / N	No evidence of tearing, cuts, or broken stitches in upper abdomen bag and zipper -holes in left, right sides near zipper 
Y / N	Upper abdomen insert securely attached to spine
Y / N	Upper abdomen insert shows no evidence of permanent set
Y / N	No evidence of tearing, cuts, or broken stitches in lower abdomen bag and zipper
Y / N	Lower abdomen insert securely attached to spine
Y / N	Lower abdomen insert shows no evidence of permanent set
OTHER	
PELVIS	
Y / N	Pelvis flesh fits securely over pelvis bones
Y / N	H-point tool fits securely into hole on both sides of pelvis
OTHER	-holes in pelvis flesh near ASIS anterior surfaces 

FEMUR	
Y / N	Acetabular load cells firmly attached
Y / N	Femur load cells firmly attached
Y / N	No evidence of deformation of knee slider bump stop
Y / N	No cuts, tears, or scuffing of knee flesh -cuts/tears/hole in both knee flesh covers 
OTHER	

LOWER EXTREMITY (LX)	
Y / N	Rotational potentiometers in ankle securely attached
Y / N	Achilles tendon provides resistance to dorsiflexion
Y / N	No evidence of debonding, tearing, or permanent compression of ankle soft stops
OTHER	-Both feet starting to tear at rear 

JACKET	
Y / N	Rib stiffeners show no sign of permanent deformation
Y / N	No evidence of tears or holes in jacket fabric, Velcro, or zippers
OTHER	

THOR Inspection Checklist

Date: 12/8/2012	
NHTSA Representative: James Saunders	
Witness(es):	
Inspection type (check one):	☒ PRE ☐ POST
Dummy S/N: 0016	
Dummy Description: Thor NT 50th Male	
Date of last Certification or Inspection: 12/6/2012	
<u>Tests conducted since last full certification or inspection:</u> <u>Since last inspection:</u> RD5226 Left side Versa <u>Since last certification:</u> RD5227 Right side Versa RC5142 Right side Camry RD5226 Left side Versa	
<u>Known errors in data channels (no data, clipping, unexpected drops):</u> V2P2 NKCR FZ - Questionable Data Spikes – some noise around 73 ms, but looks okay during ringout V2P2 FOTL AZ - Questionable Data Spikes – Known dead channel V2P2 ANKR RX - Questionable Max & Min – hitting physical stops – this is okay V2P2 FOTR AZ - Questionable Data Spikes – noise at 53 ms – appears fine for ringout	
<u>Physical evidence of damage:</u> 	
<u>Anecdotal evidence of damage:</u> 	
<u>Equipment delivered to Borrower:</u> Thor 16 ATD	

HEAD	
Y / N	Rear head cap mounts securely to head
Y / N	Head skin fits securely over skull
Y / N	Head skin shows no sign of tears or damage
Y / N	Interior components of skull cavity (ballast, accelerometer mount, accelerometers) securely attached
Y / N	Head securely mounted to OC joint
OTHER	

NECK	
Y / N	Neck cables slide freely through holes in neck plates
Y / N	Neck cables show no sign of fraying, broken strands, or kinking
Y / N	No evidence of debonding between neck pucks and plates If N – indicate which interface (where plate/puck 1 attach to upper neck load cell): -cracks in neck rubber, 2-3, 3-4 
Y / N	No evidence of debonding or permanent compression in neck soft stop assemblies
Y / N	Neck securely attached to upper neck load cell
Y / N	Neck securely attached to lower neck load cell
Y / N	Neck pitch change joint mechanism mating teeth are engaged
OTHER	

SPINE	
Y / N	No evidence of debonding between thoracic spine flex joint and metal plates
Y / N	No evidence of debonding between lumbar spine flex joint and metal plates
Y / N	Lumbar spine pitch change joint mechanism mating teeth are engaged
OTHER	
SHOULDER	
Y / N	Urethane shoulder pads show no evidence of contact -small white mark on left shoulder 
Y / N	Clavicles securely attached to sternum and shoulder
Y / N	No evidence of debonding, tearing, or permanent compression of posterior soft stops
OTHER	
THORAX	
Y / N	No evidence of contact at top, bottom, or interior faces of rib damping material -slight contact top right of rib #2 under arm 
Y / N	No evidence of debonding between rib damping material and ribs -right front of rib #5 
Y / N	CRUX anterior arms securely attached to anterior ribs
Y / N	CRUX posterior arms securely attached to double gimbals, spine
Y / N	Urethane bib is securely attached to ribs with no sign of tearing or washer penetration
Y / N	Ribs securely attached to posterior spine

Y / N	Rib stiffeners show no evidence of bending (no gaps between ribs and stiffeners)
OTHER	- Left lower IR-Tracc sticks during compression
ABDOMEN	
Y / N	No evidence of tearing, cuts, or broken stitches in upper abdomen bag and zipper
Y / N	Upper abdomen insert securely attached to spine
Y / N	Upper abdomen insert shows no evidence of permanent set
Y / N	No evidence of tearing, cuts, or broken stitches in lower abdomen bag and zipper -torn stitches on left/right side at leg zipper 
Y / N	Lower abdomen insert securely attached to spine
Y / N	Lower abdomen insert shows no evidence of permanent set
OTHER	

PELVIS	
Y / N	Pelvis flesh fits securely over pelvis bones
Y / N	H-point tool fits securely into hole on both sides of pelvis
OTHER	

FEMUR	
Y / N	Acetabular load cells firmly attached
Y / N	Femur load cells firmly attached
Y / N	No evidence of deformation of knee slider bump stop
Y / N	No cuts, tears, or scuffing of knee flesh
OTHER	
LOWER EXTREMITY (LX)	
Y / N	Rotational potentiometers in ankle securely attached
Y / N	Achilles tendon provides resistance to dorsiflexion
Y / N	No evidence of debonding, tearing, or permanent compression of ankle soft stops -ankle roll stops cracked 
OTHER	-Right leg skin is tearing 

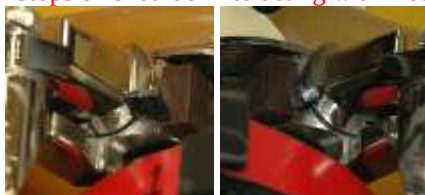
JACKET	
Y / N	Rib stiffeners show no sign of permanent deformation
Y / N	No evidence of tears or holes in jacket fabric, Velcro, or zippers
OTHER	

THOR Inspection Checklist

Date: 12/10/2012											
NHTSA Representative: James Saunders											
Witness(es):											
Inspection type (check one):	☐ PRE ☒ POST										
Dummy S/N: 0016											
Dummy Description: Thor NT 50th Male											
Date of last Certification or Inspection: 12/8/2012											
<u>Tests conducted since last full certification or inspection:</u> <u>Since last inspection:</u> RD4200 Left side Elantra <u>Since last certification:</u> RD5227 Right side Versa RC5142 Right side Camry RD5226 Left side Versa RD4200 Left side Elantra											
<u>Known errors in data channels (no data, clipping, unexpected drops):</u> <table> <tr> <td>V2P2 FMRL FX</td> <td>Noise spikes throughout data – Seems to be happening every test but the ringout produces no questionable data</td> </tr> <tr> <td>V2P2 FMRL FY</td> <td>Noise spikes throughout data – Same as channel above.</td> </tr> <tr> <td>V2P2 ANKL RX</td> <td>Questionable Min at 53ms Let me know if this is ok for the ankles – that they flatten out – This is okay. Same reasoning as P1 noted above.</td> </tr> <tr> <td>V2P2 FOTL AZ</td> <td>Questionable Data (failed?) – known dead channel</td> </tr> <tr> <td>V2P2 TBRL MY</td> <td>Noise spikes at 225 & 247ms – Everything seems fine during ringout.</td> </tr> </table>		V2P2 FMRL FX	Noise spikes throughout data – Seems to be happening every test but the ringout produces no questionable data	V2P2 FMRL FY	Noise spikes throughout data – Same as channel above.	V2P2 ANKL RX	Questionable Min at 53ms Let me know if this is ok for the ankles – that they flatten out – This is okay. Same reasoning as P1 noted above.	V2P2 FOTL AZ	Questionable Data (failed?) – known dead channel	V2P2 TBRL MY	Noise spikes at 225 & 247ms – Everything seems fine during ringout.
V2P2 FMRL FX	Noise spikes throughout data – Seems to be happening every test but the ringout produces no questionable data										
V2P2 FMRL FY	Noise spikes throughout data – Same as channel above.										
V2P2 ANKL RX	Questionable Min at 53ms Let me know if this is ok for the ankles – that they flatten out – This is okay. Same reasoning as P1 noted above.										
V2P2 FOTL AZ	Questionable Data (failed?) – known dead channel										
V2P2 TBRL MY	Noise spikes at 225 & 247ms – Everything seems fine during ringout.										
<u>Physical evidence of damage:</u>											
<u>Anecdotal evidence of damage:</u>											
<u>Equipment delivered to Borrower:</u> Thor 16 ATD											

HEAD	
Y / N	Rear head cap mounts securely to head
Y / N	Head skin fits securely over skull
Y / N	Head skin shows no sign of tears or damage
Y / N	Interior components of skull cavity (ballast, accelerometer mount, accelerometers) securely attached
Y / N	Head securely mounted to OC joint
OTHER	

NECK	
Y / N	Neck cables slide freely through holes in neck plates
Y / N	Neck cables show no sign of fraying, broken strands, or kinking
Y / N	No evidence of debonding between neck pucks and plates If N – indicate which interface (where plate/puck 1 attach to upper neck load cell): -cracks in neck rubber, 2-3, 3-4 
Y / N	No evidence of debonding or permanent compression in neck soft stop assemblies
Y / N	Neck securely attached to upper neck load cell
Y / N	Neck securely attached to lower neck load cell
Y / N	Neck pitch change joint mechanism mating teeth are engaged
OTHER	

SPINE	
Y / N	No evidence of debonding between thoracic spine flex joint and metal plates
Y / N	No evidence of debonding between lumbar spine flex joint and metal plates
Y / N	Lumbar spine pitch change joint mechanism mating teeth are engaged
OTHER	
SHOULDER	
Y / N	Urethane shoulder pads show no evidence of contact -small white mark on left shoulder 
Y / N	Clavicles securely attached to sternum and shoulder
Y / N	No evidence of debonding, tearing, or permanent compression of posterior soft stops
OTHER	-Stops on shoulder interacting with mechanism that rotates on the y-axis are breaking. 
THORAX	
Y / N	No evidence of contact at top, bottom, or interior faces of rib damping material -slight contact top right of rib #2 under arm 
Y / N	No evidence of debonding between rib damping material and ribs -right front of rib #5 
Y / N	CRUX anterior arms securely attached to anterior ribs
Y / N	CRUX posterior arms securely attached to double gimbals, spine

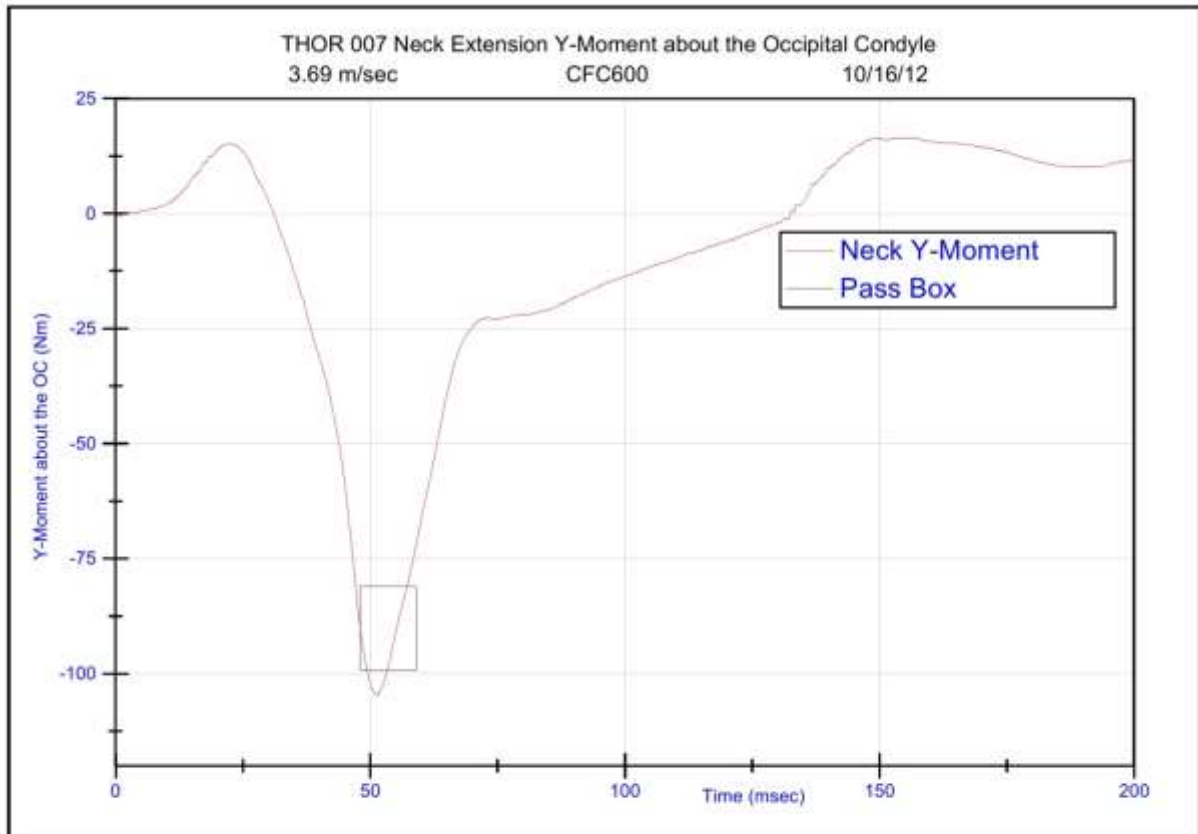
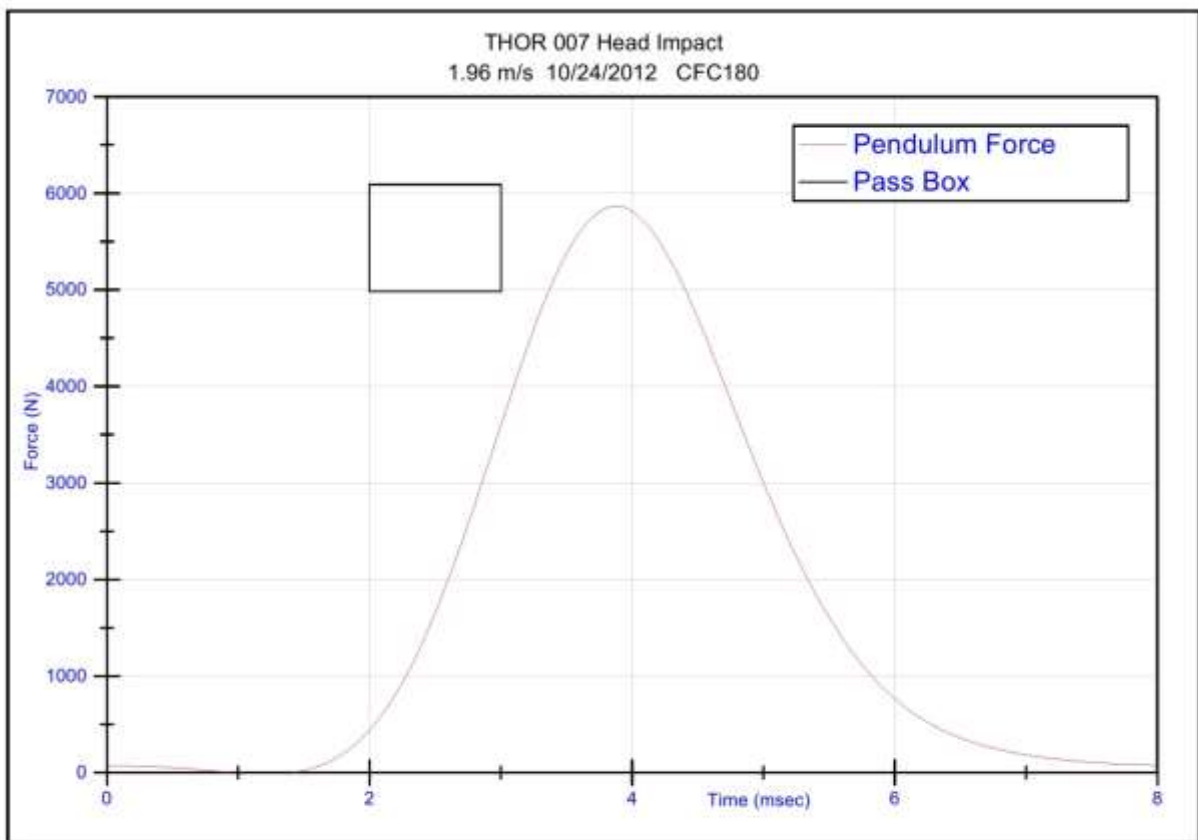
Y / N	Urethane bib is securely attached to ribs with no sign of tearing or washer penetration
Y / N	Ribs securely attached to posterior spine
Y / N	Rib stiffeners show no evidence of bending (no gaps between ribs and stiffeners)
OTHER	- Left lower IR-Tracc sticks during compression
ABDOMEN	
Y / N	No evidence of tearing, cuts, or broken stitches in upper abdomen bag and zipper
Y / N	Upper abdomen insert securely attached to spine
Y / N	Upper abdomen insert shows no evidence of permanent set
Y / N	No evidence of tearing, cuts, or broken stitches in lower abdomen bag and zipper -torn stitches on left/right side at leg zipper
	
Y / N	Lower abdomen insert securely attached to spine
Y / N	Lower abdomen insert shows no evidence of permanent set
OTHER	
PELVIS	
Y / N	Pelvis flesh fits securely over pelvis bones
Y / N	H-point tool fits securely into hole on both sides of pelvis
OTHER	

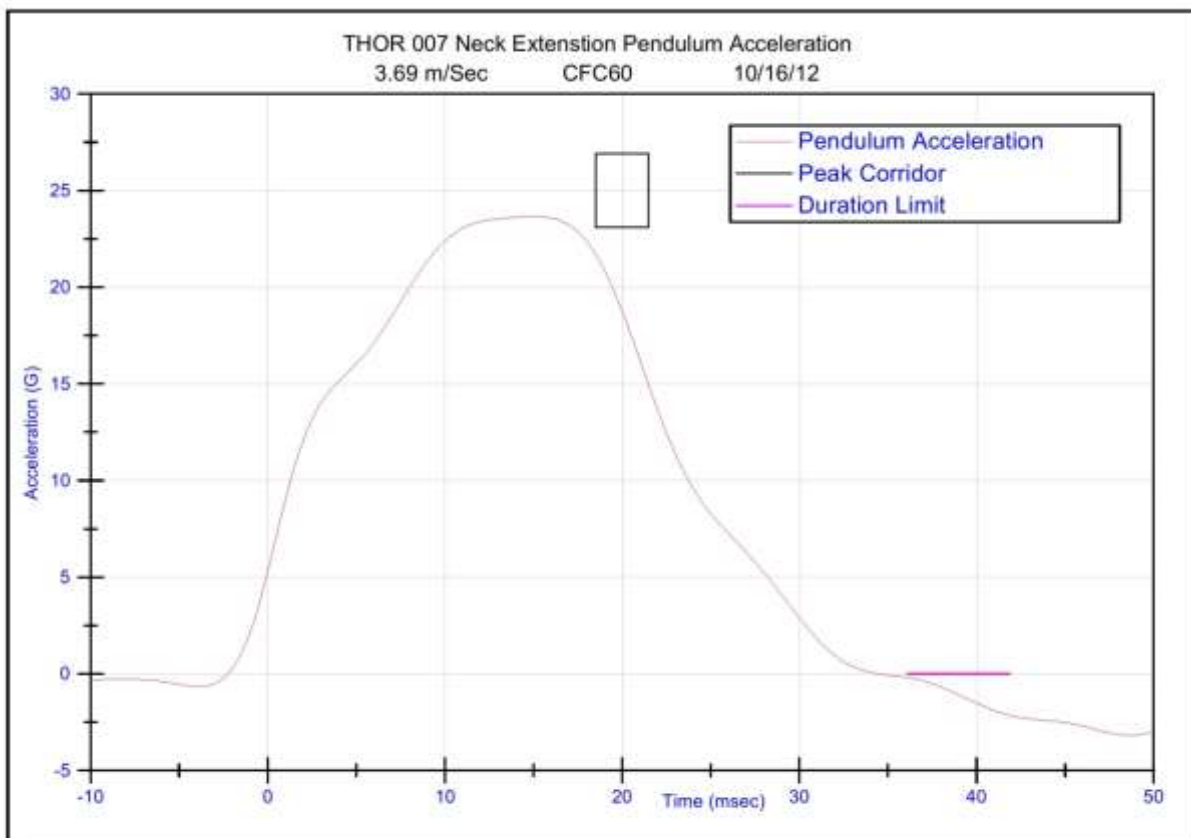
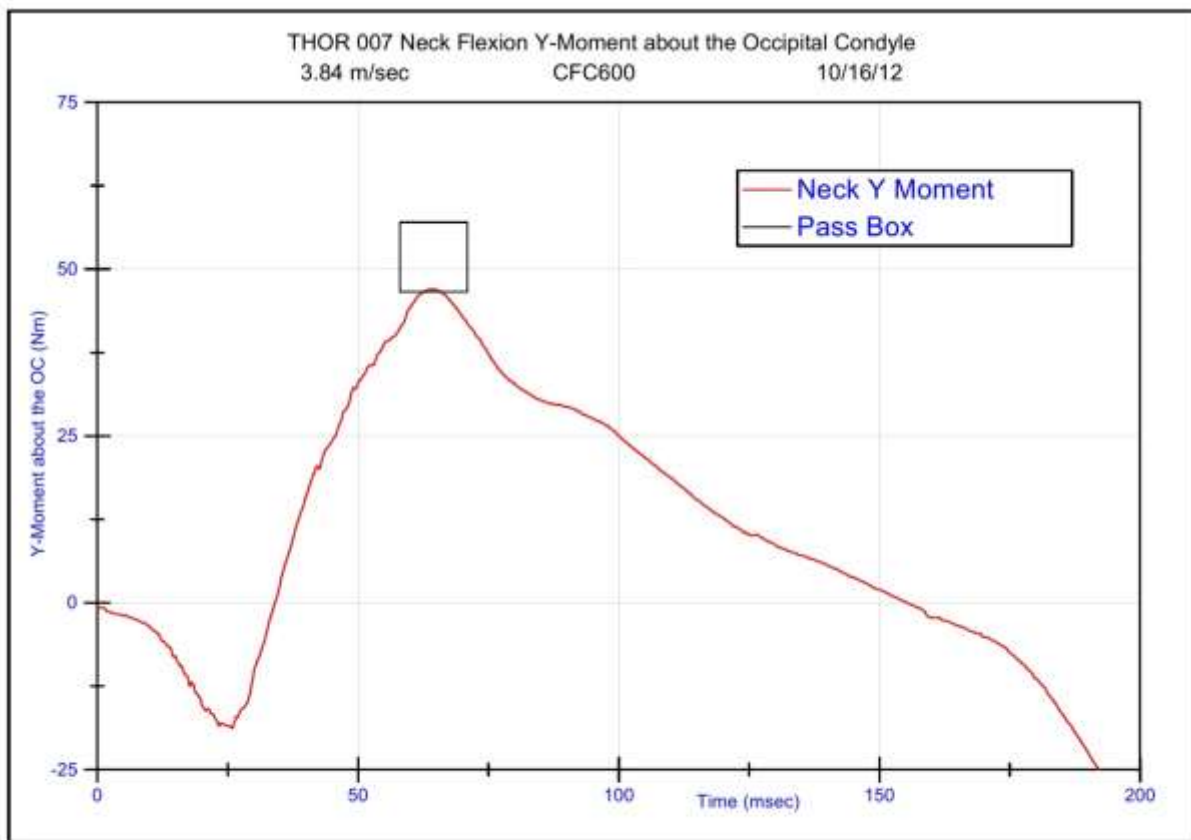
FEMUR	
Y / N	Acetabular load cells firmly attached
Y / N	Femur load cells firmly attached
Y / N	No evidence of deformation of knee slider bump stop
Y / N	No cuts, tears, or scuffing of knee flesh
OTHER	
LOWER EXTREMITY (LX)	
Y / N	Rotational potentiometers in ankle securely attached
Y / N	Achilles tendon provides resistance to dorsiflexion
Y / N	No evidence of debonding, tearing, or permanent compression of ankle soft stops -ankle roll stops cracked 
OTHER	-Right leg skin is tearing 
JACKET	
Y / N	Rib stiffeners show no sign of permanent deformation
Y / N	No evidence of tears or holes in jacket fabric, Velcro, or zippers
OTHER	

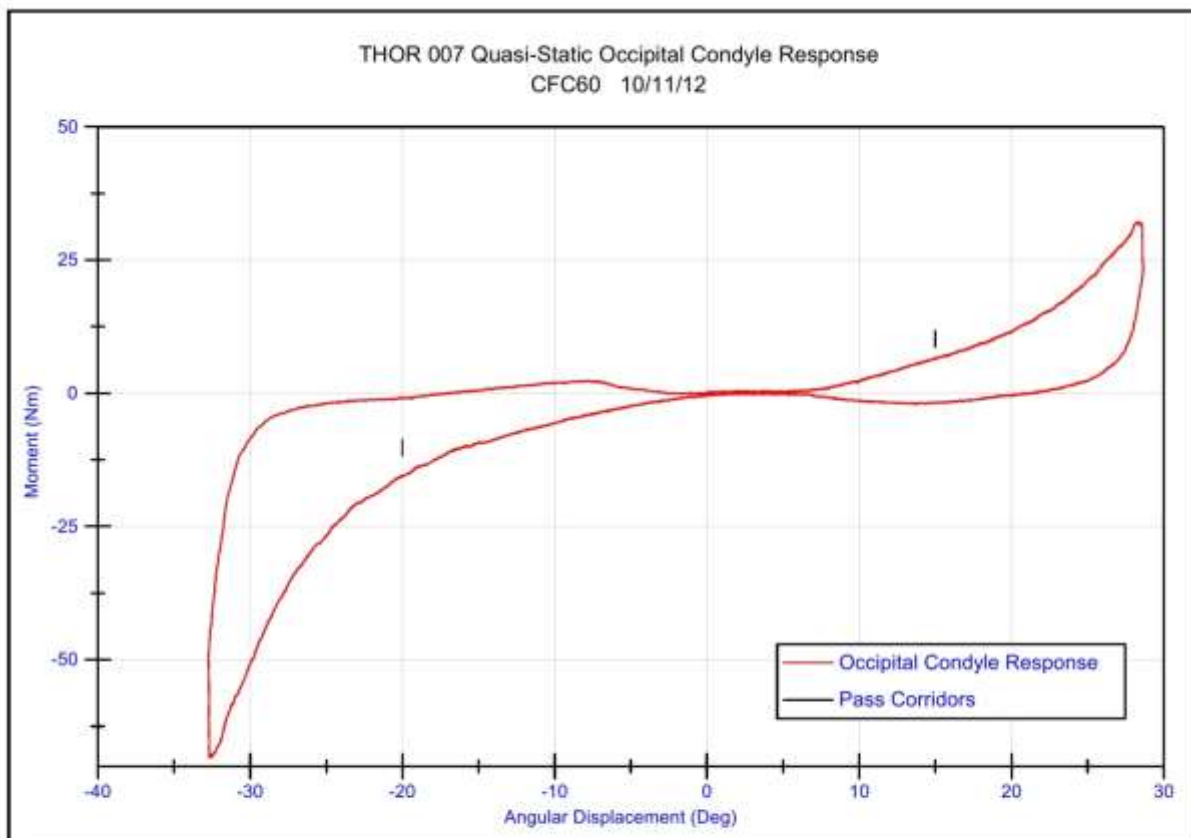
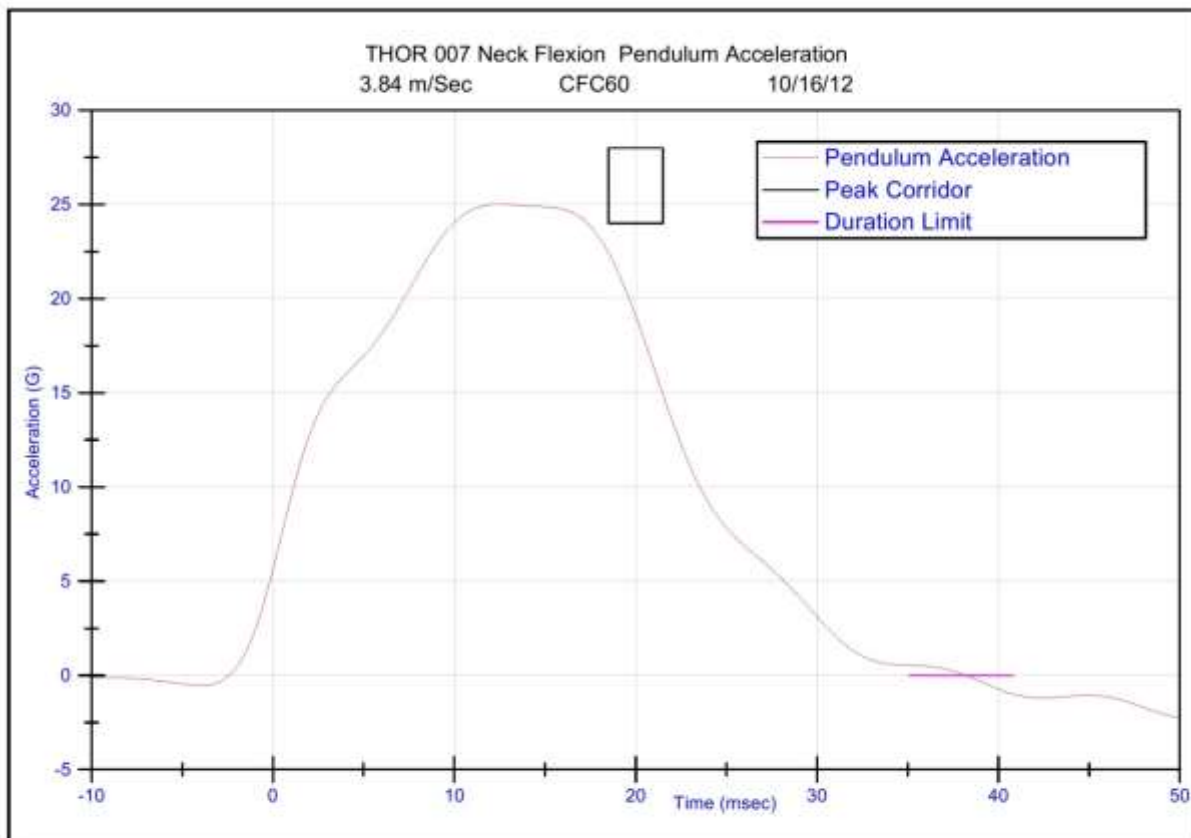
Test Data/Sensor Repair Notes

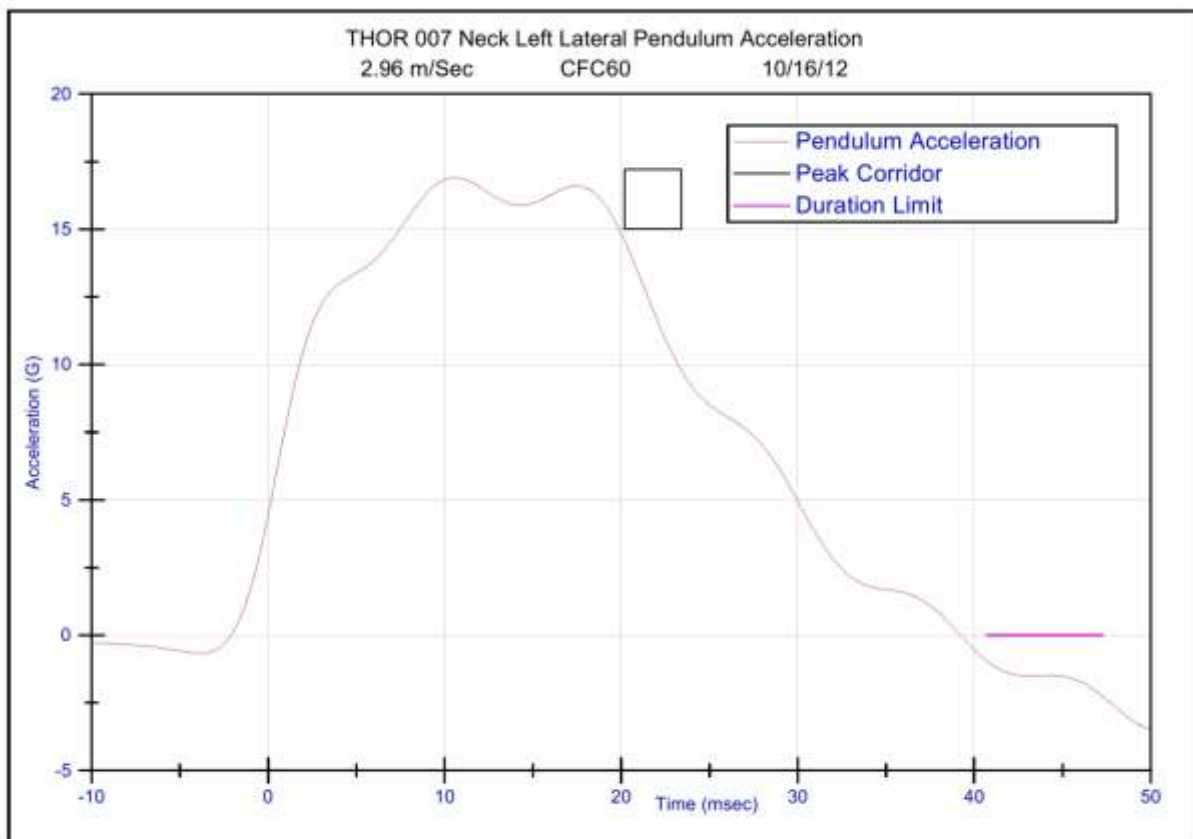
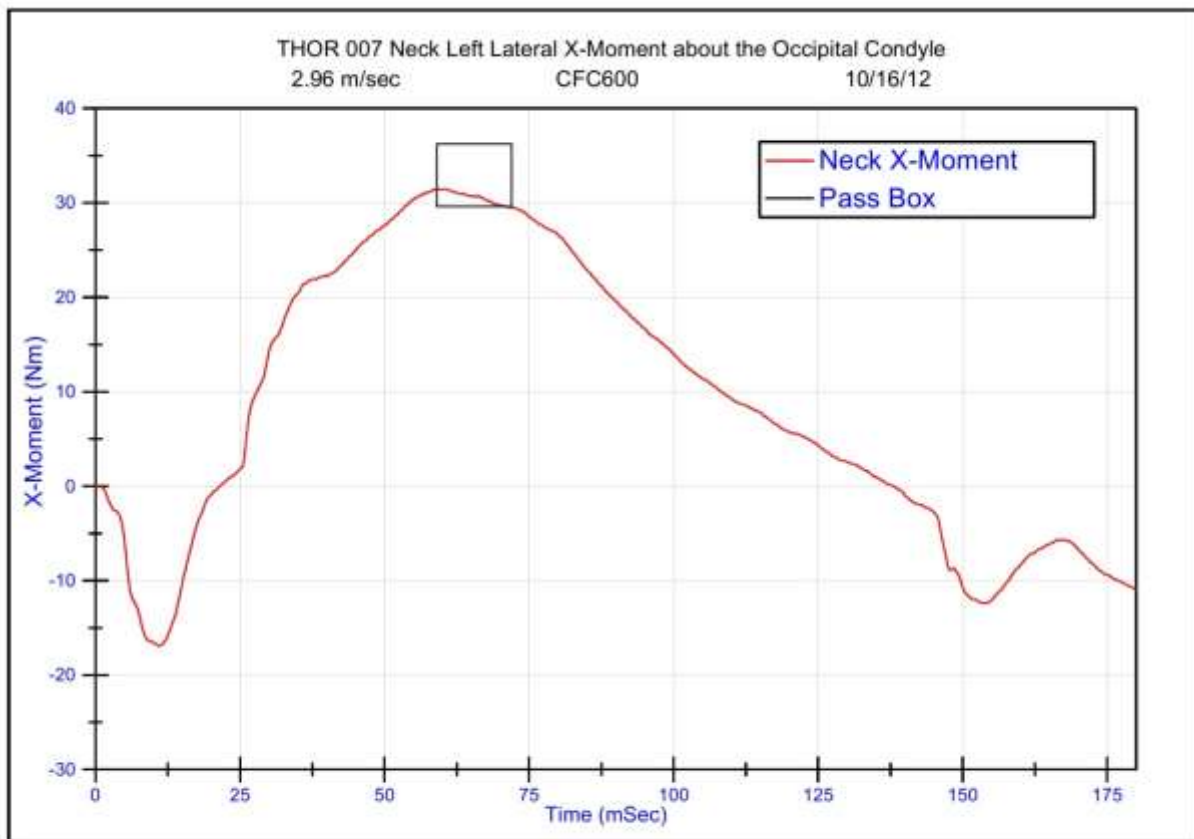
DUMMY CALIBRATIONS

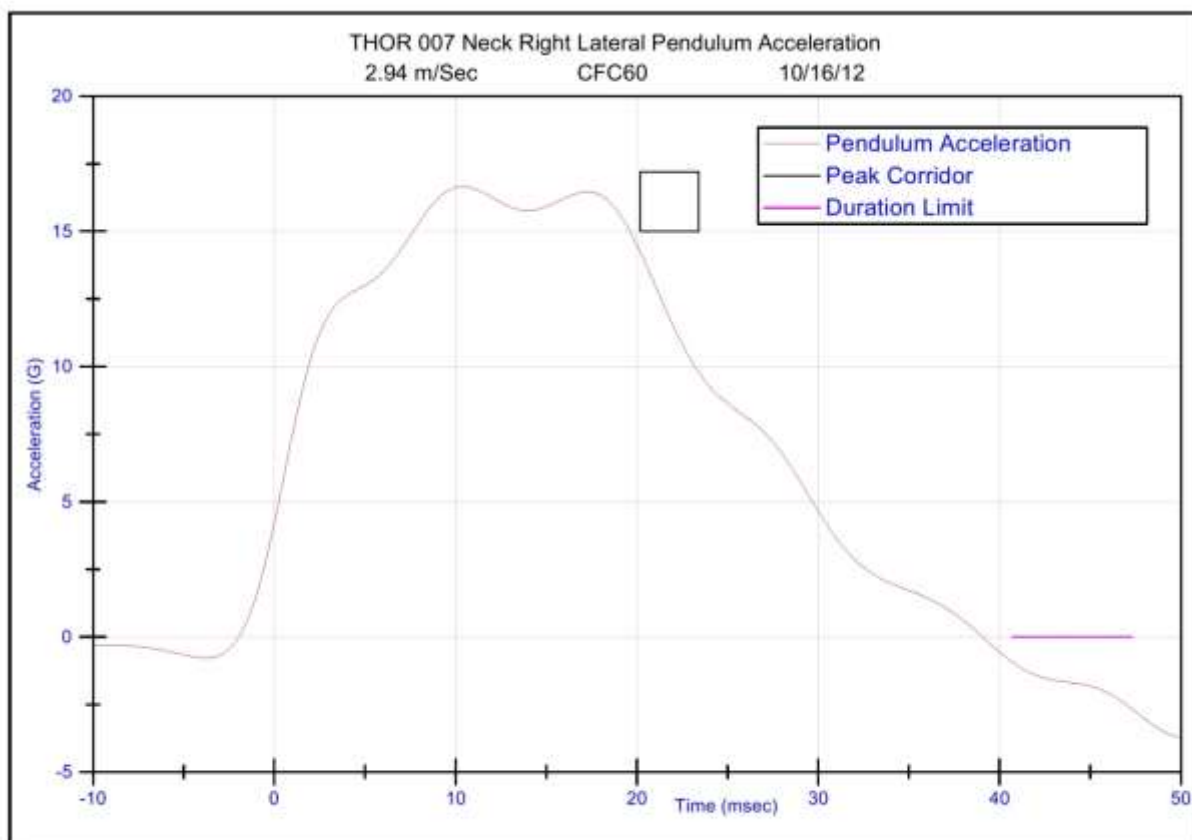
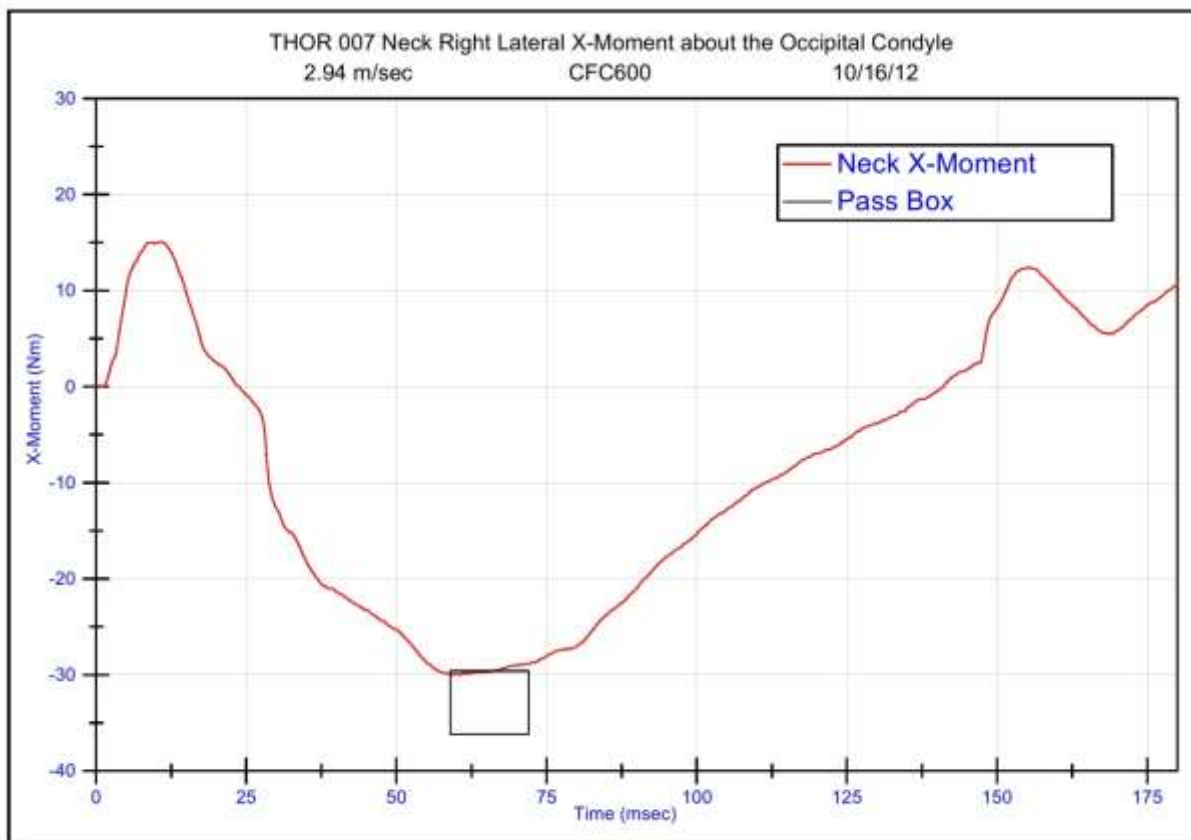
50% ADULT MALE THOR007 DUMMY CALIBRATIONS

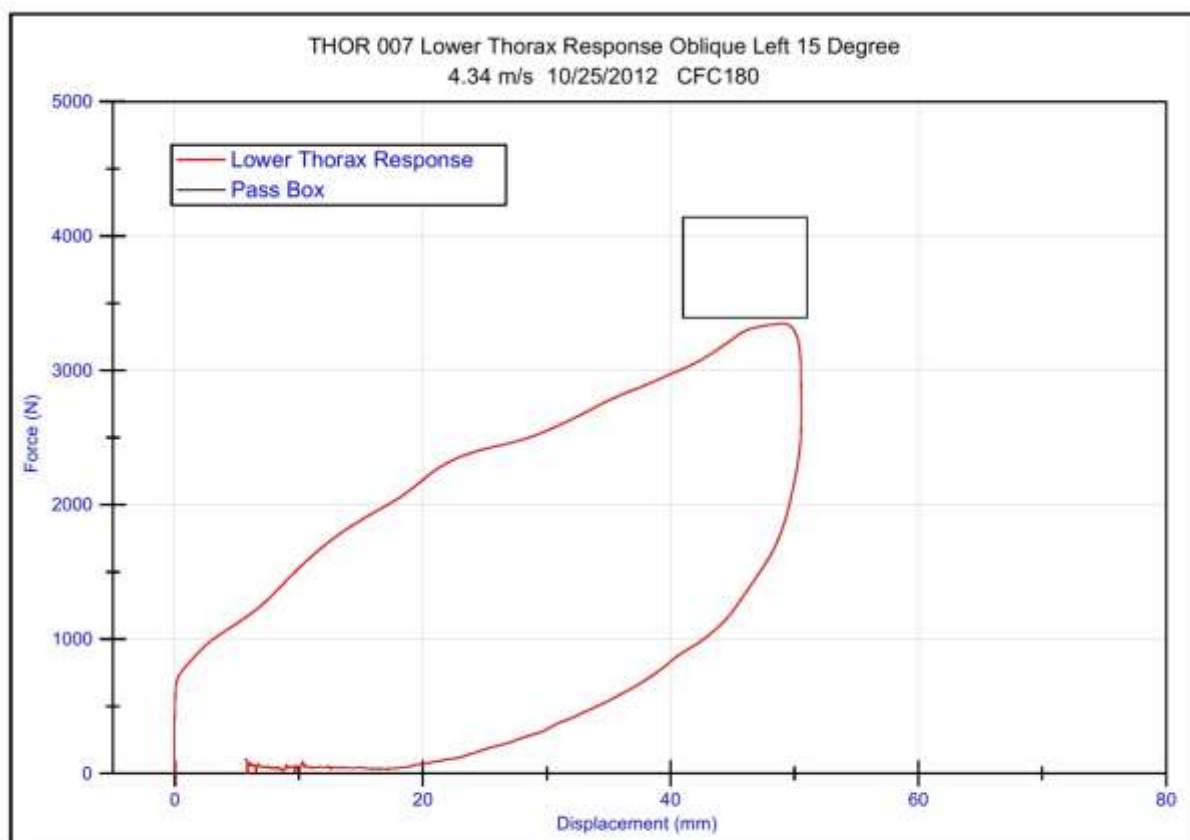
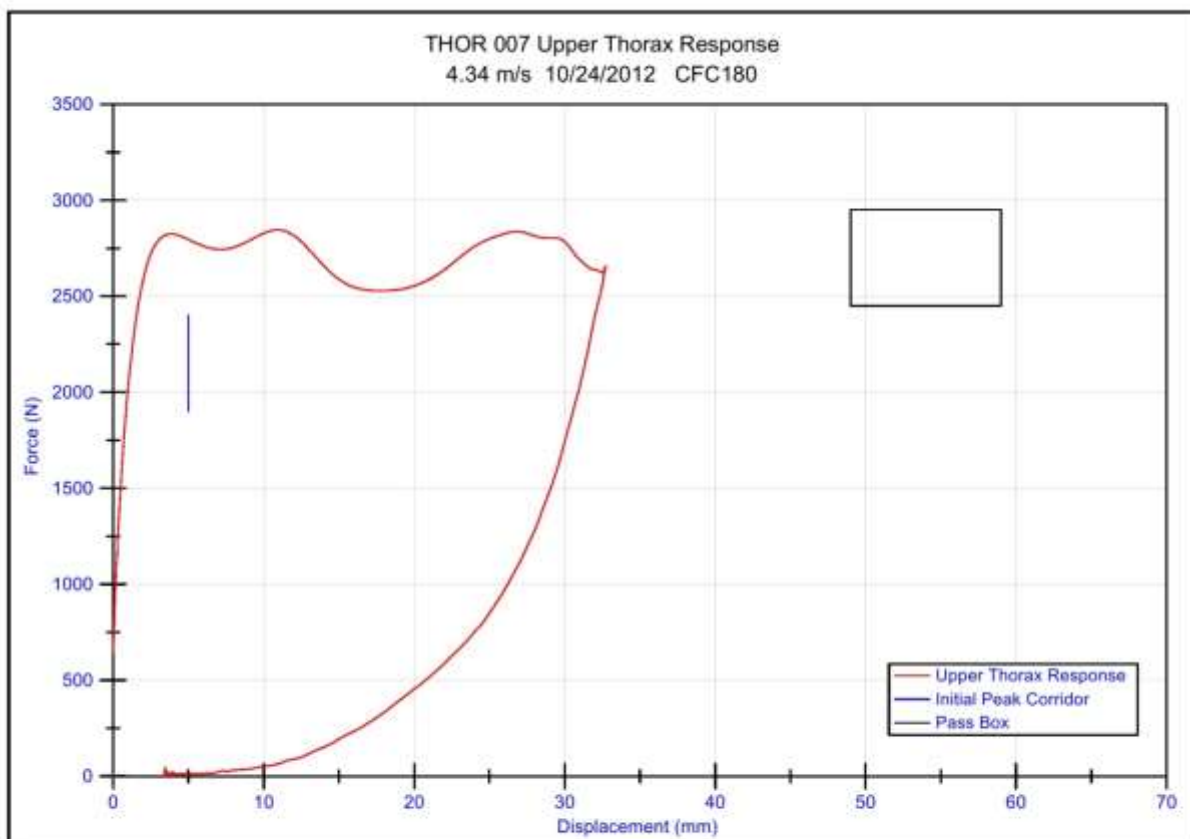


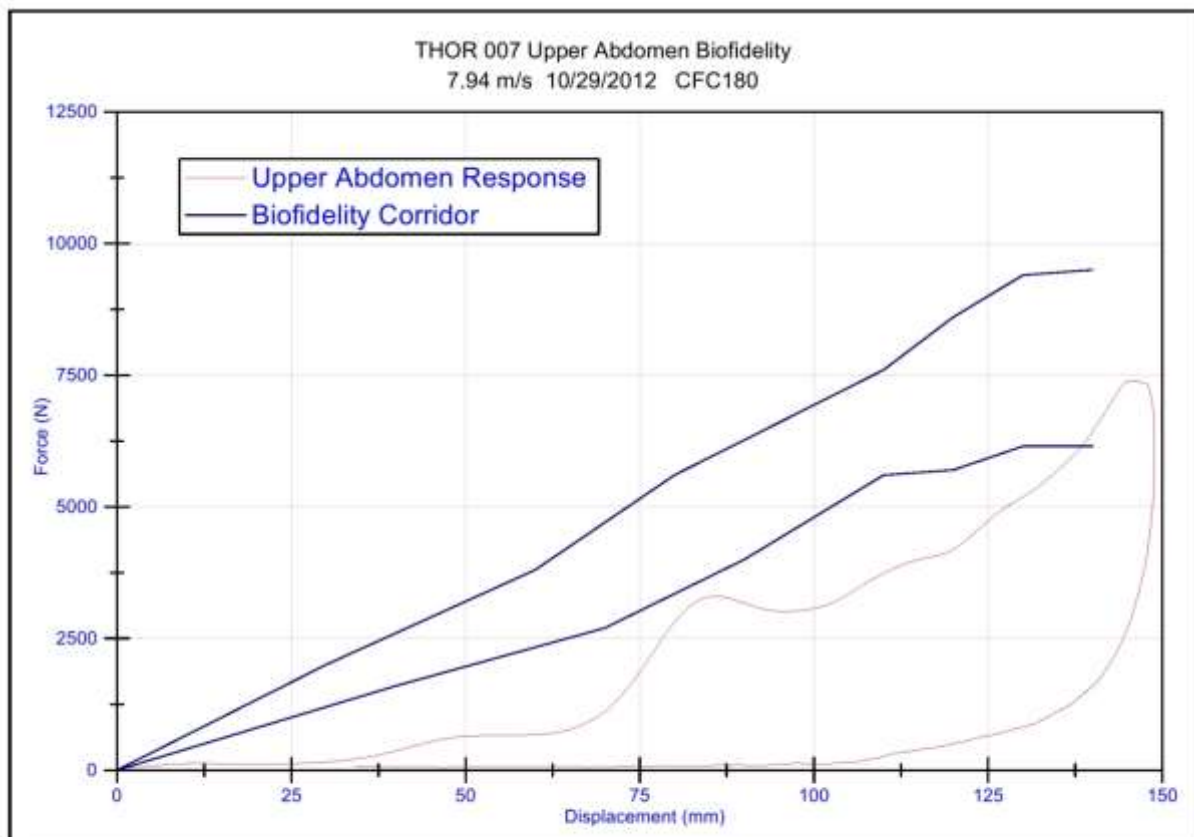
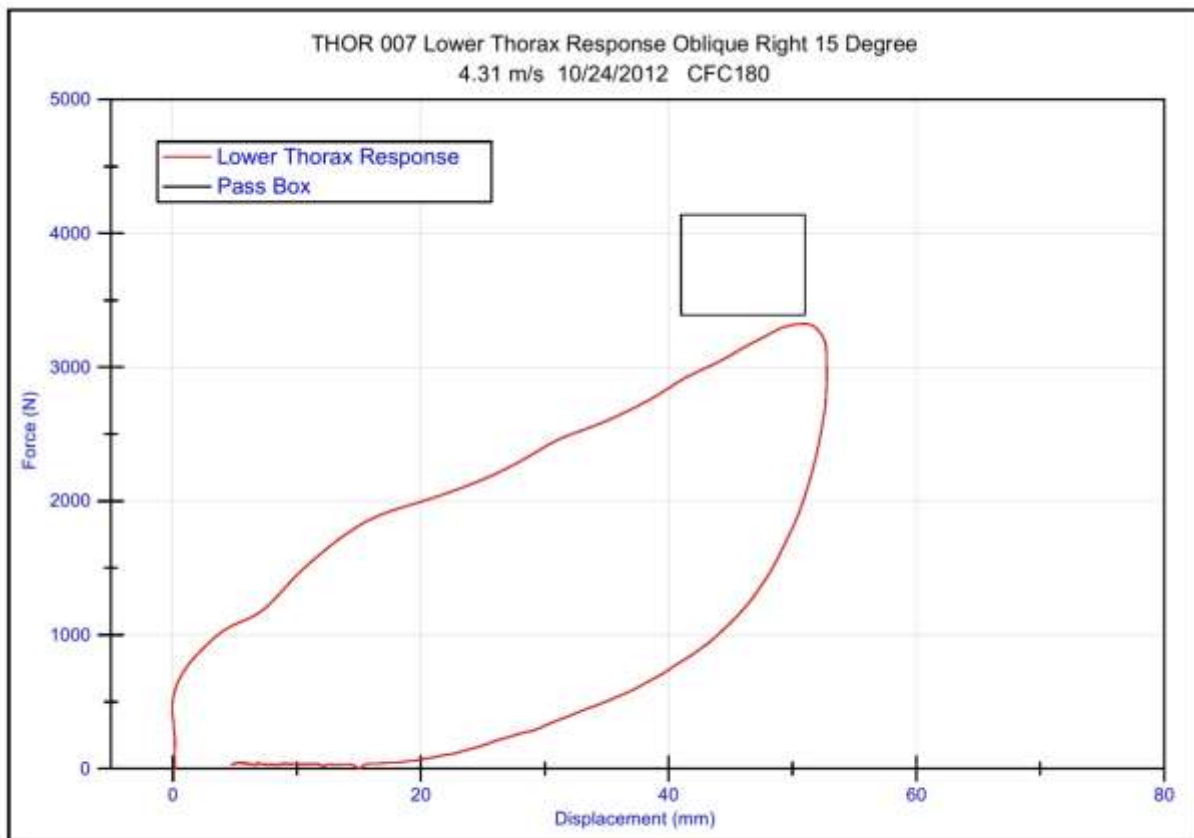


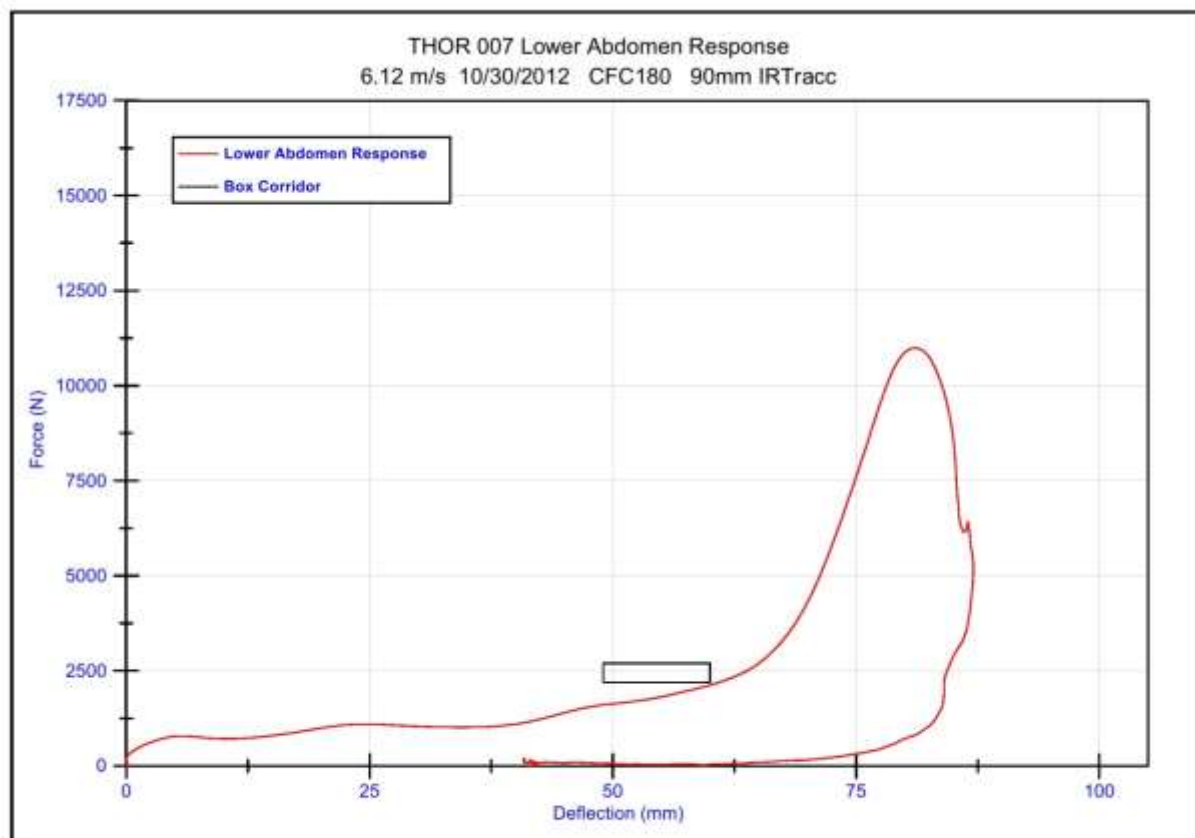






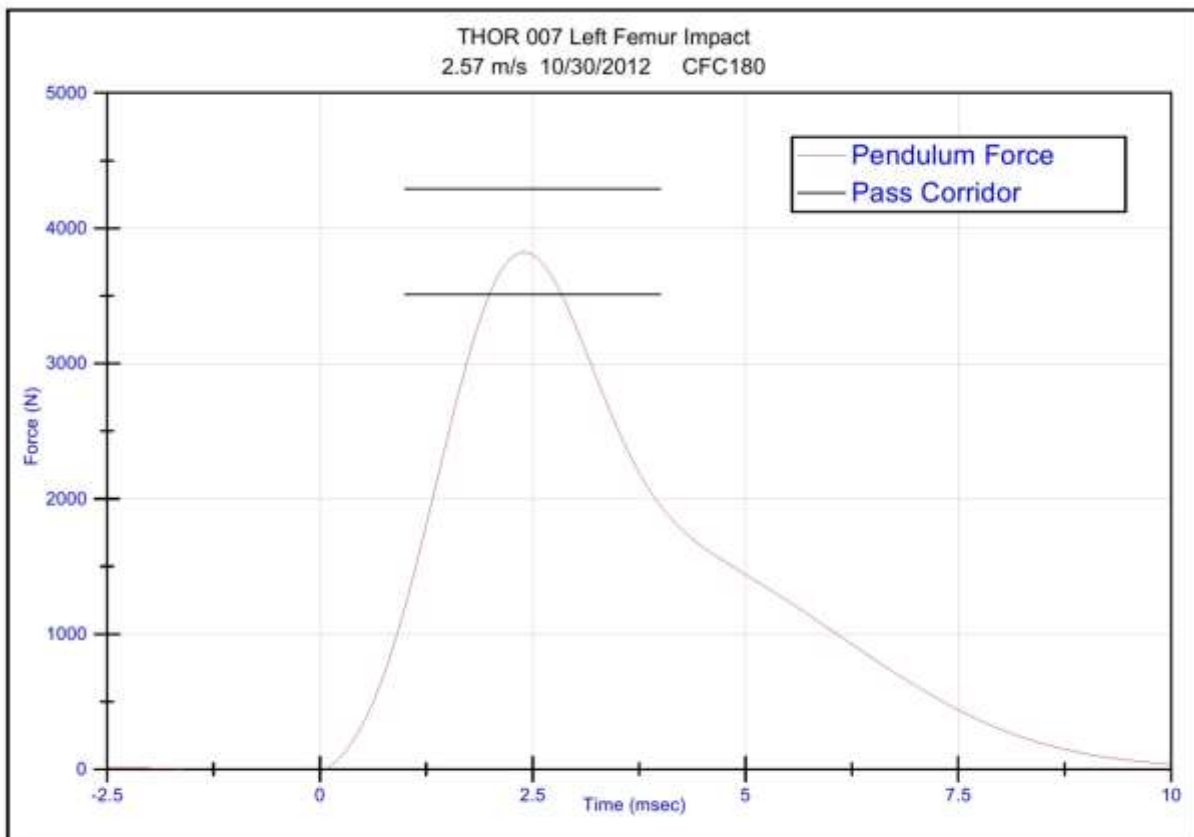
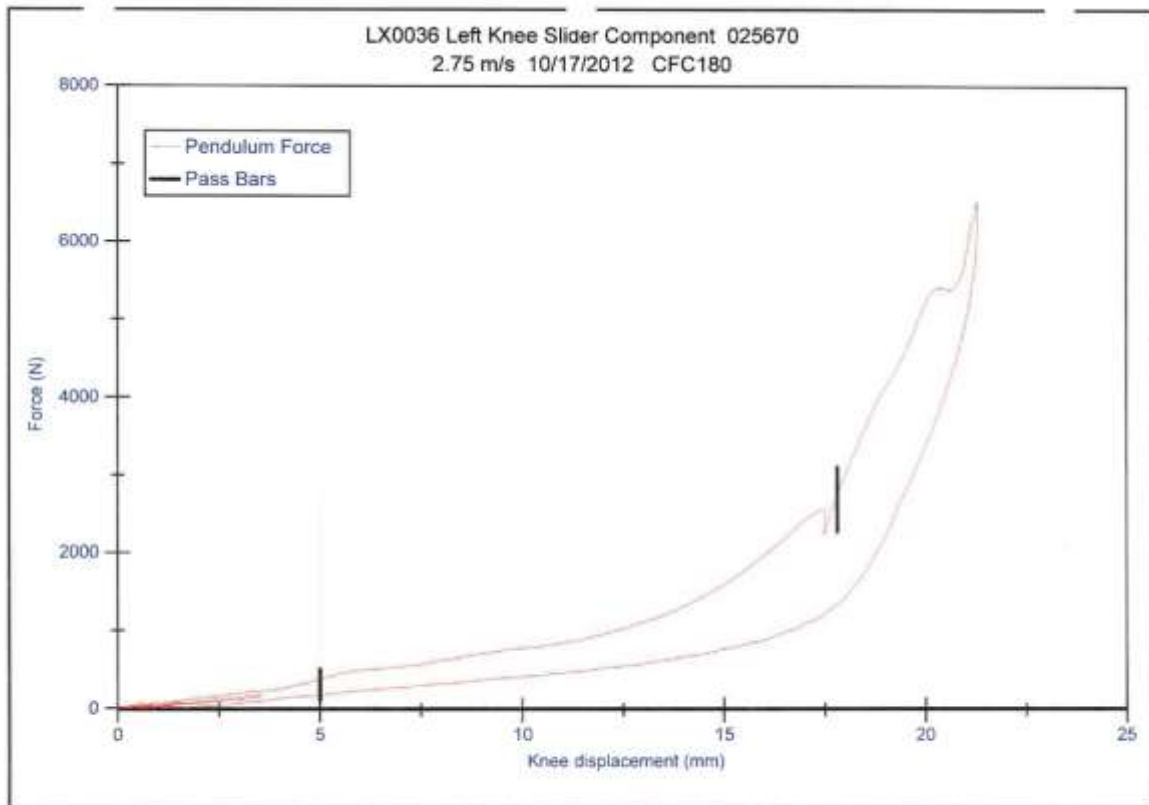


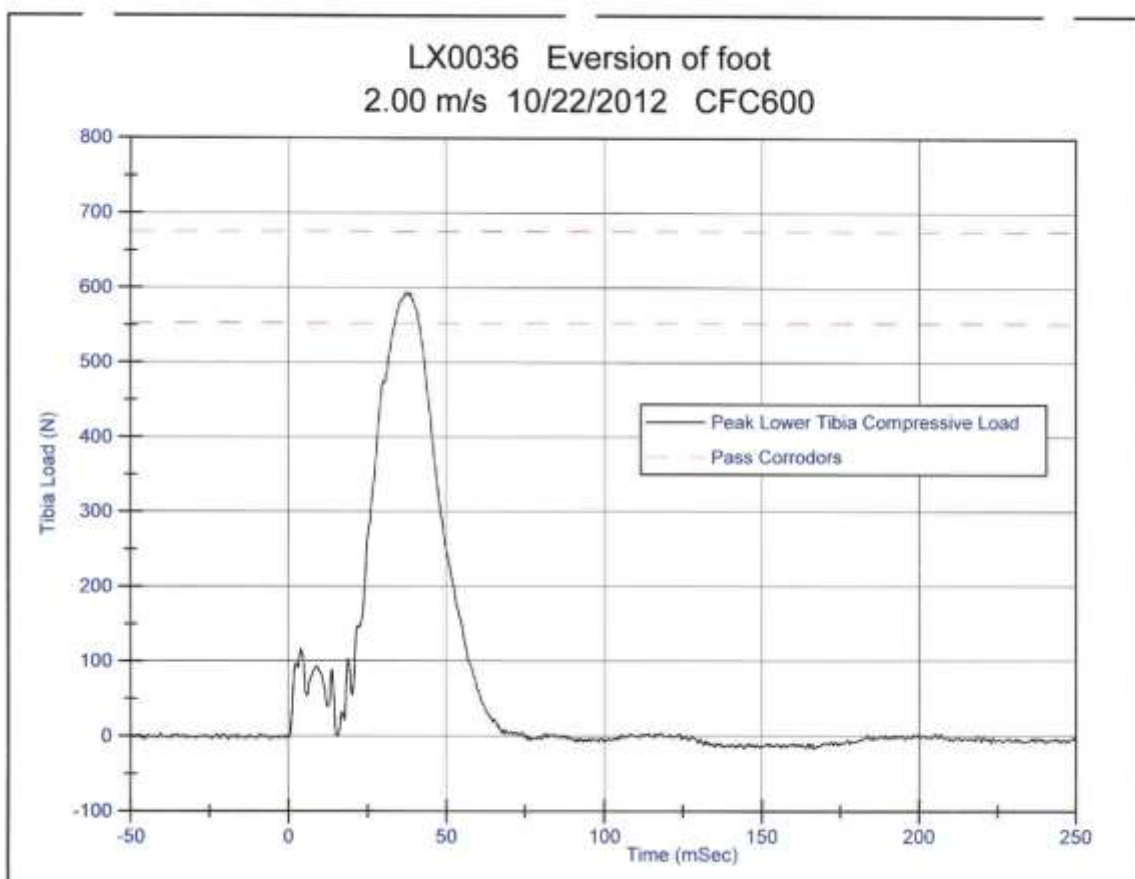
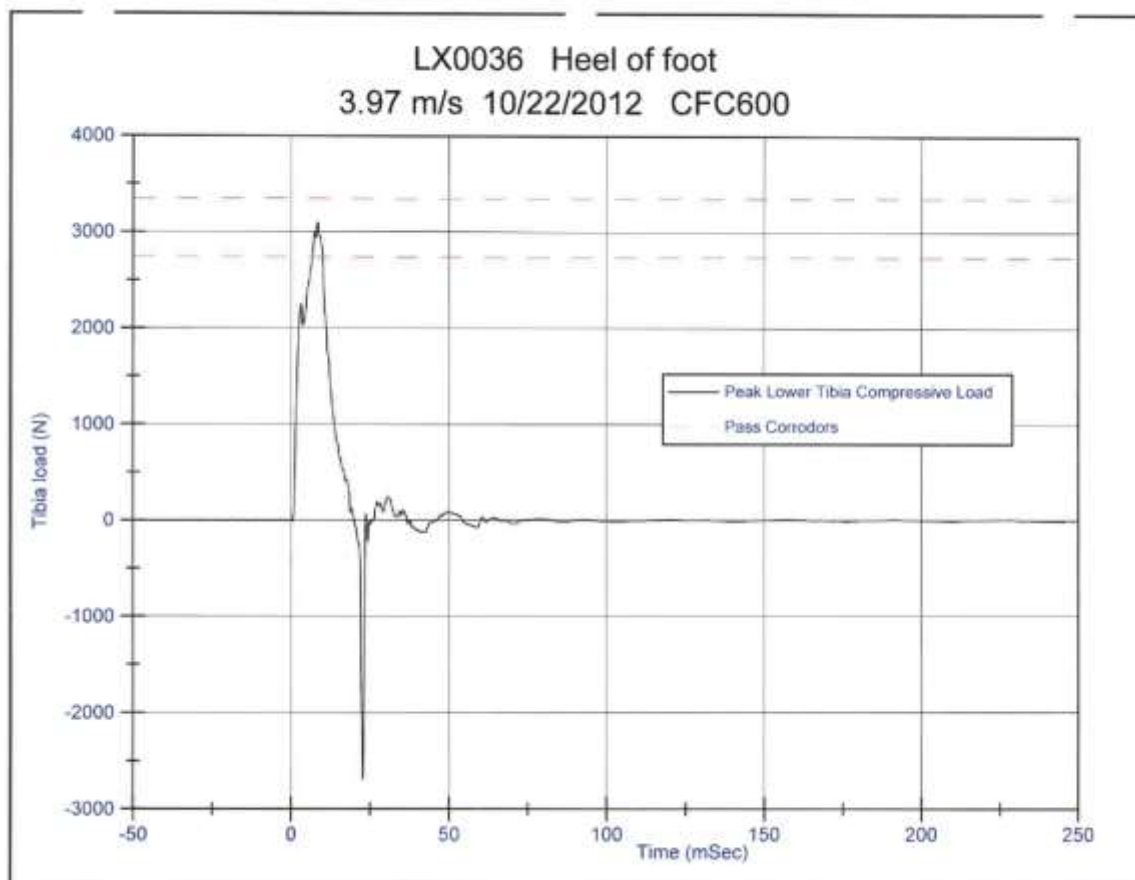


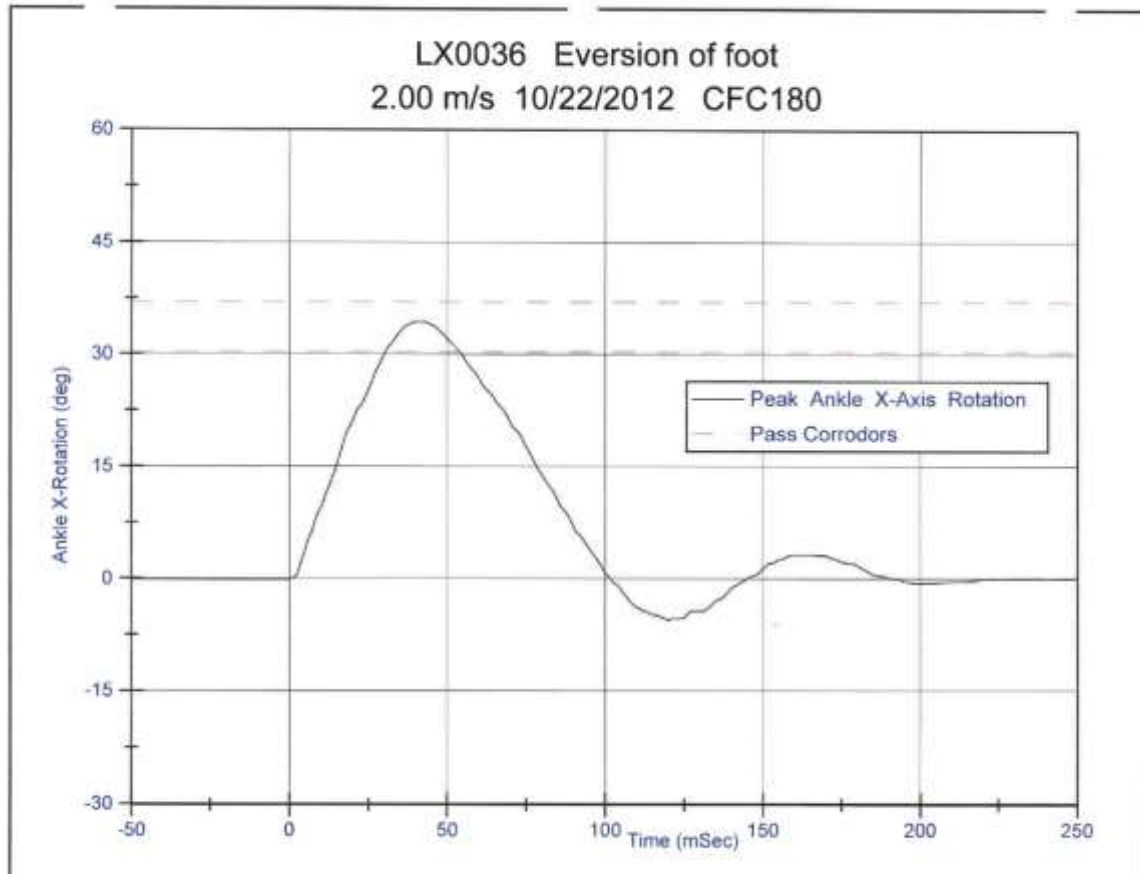
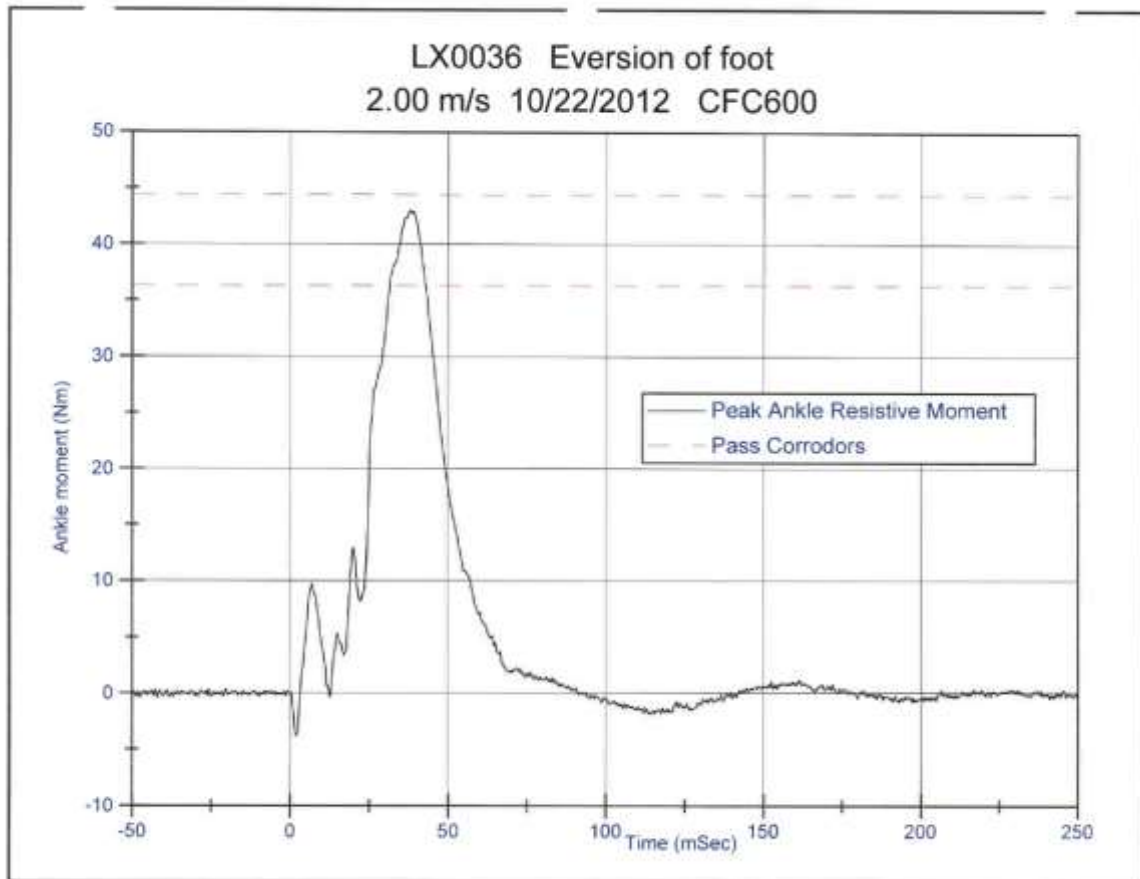


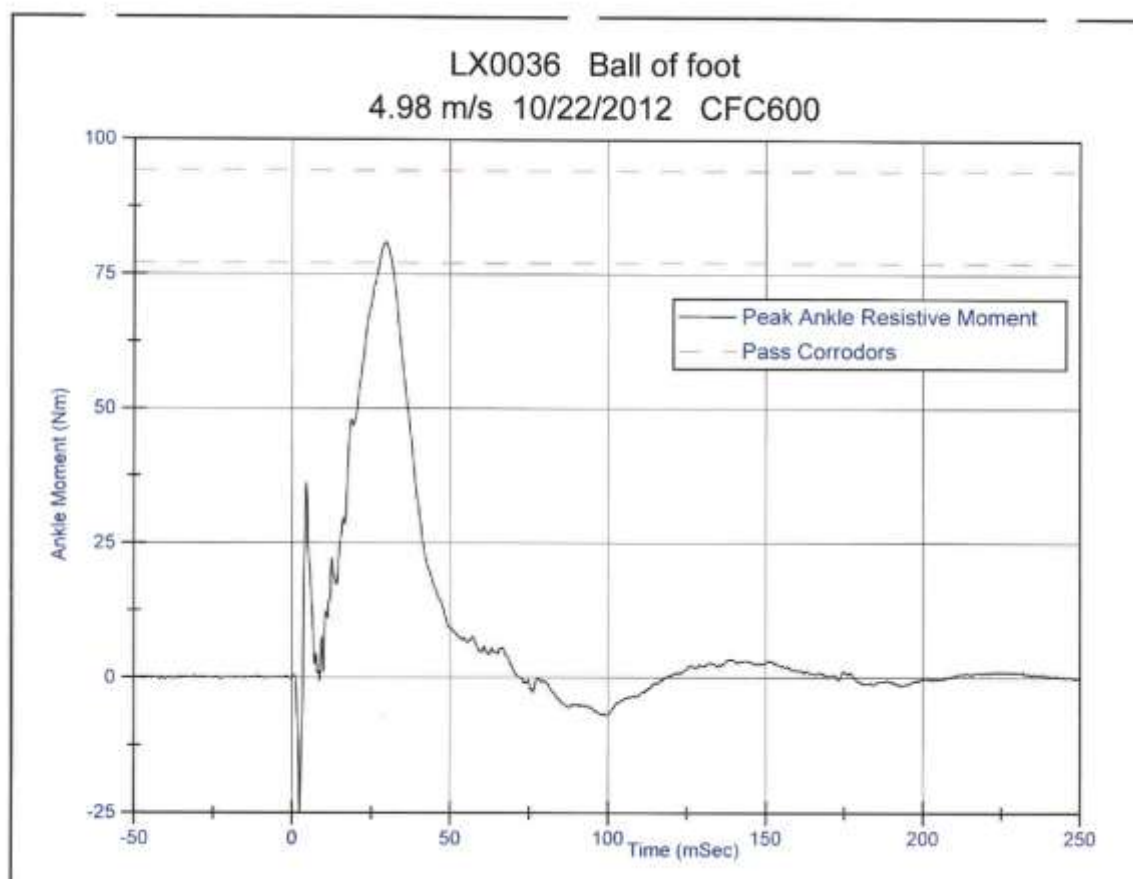
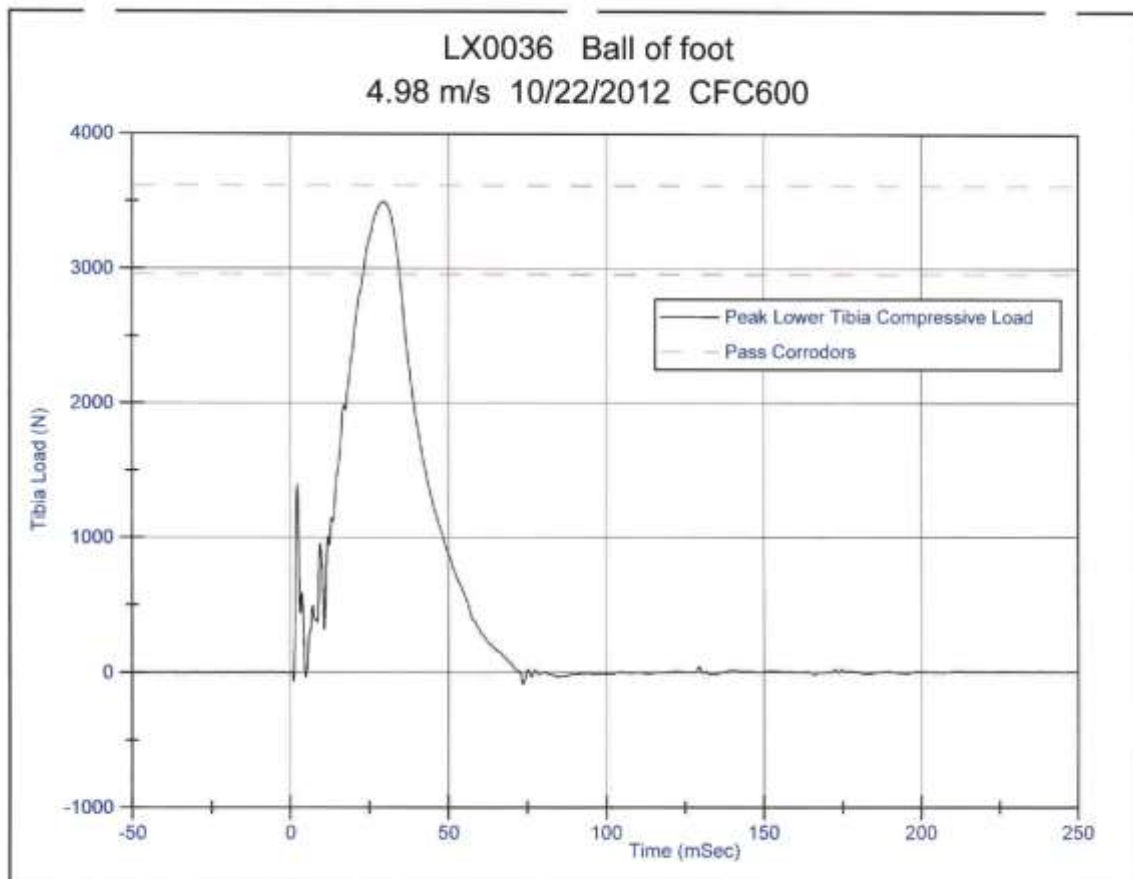
THOR 007 LEG CALIBRATIONS
LX0036 / LX0037

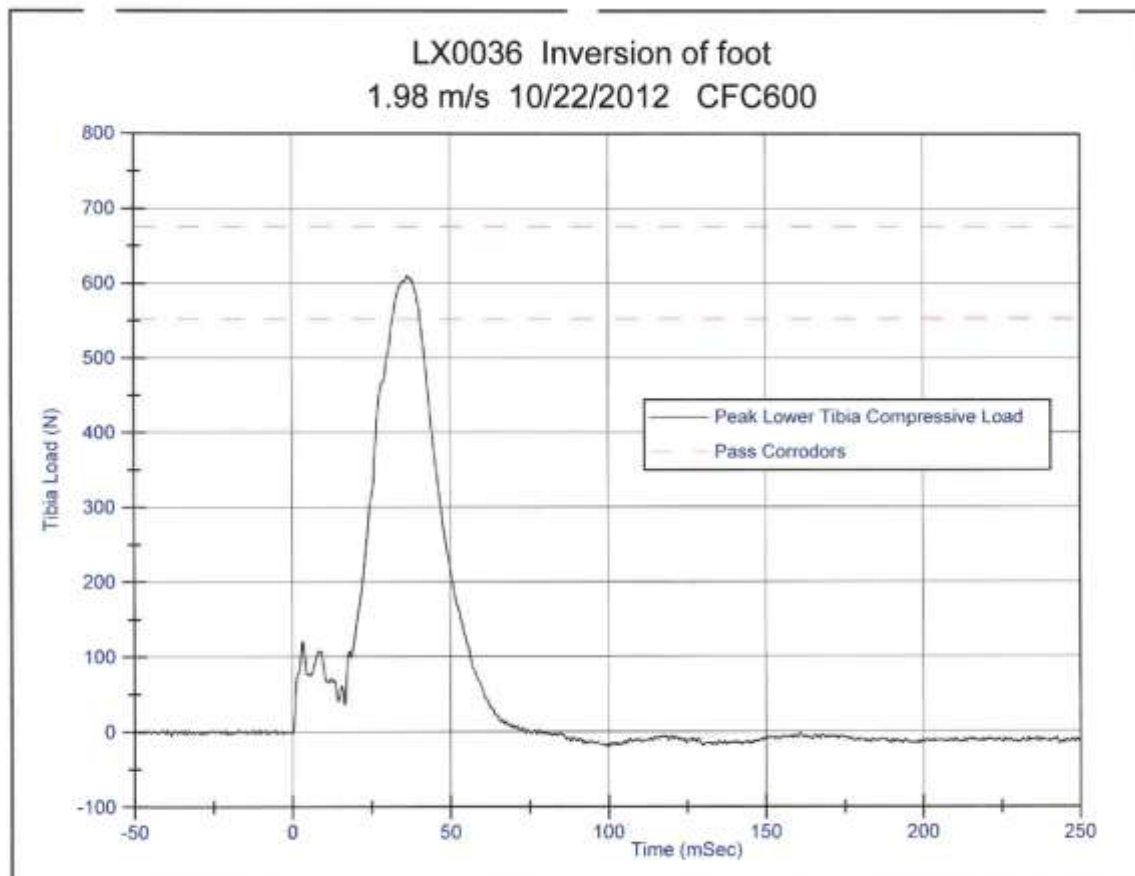
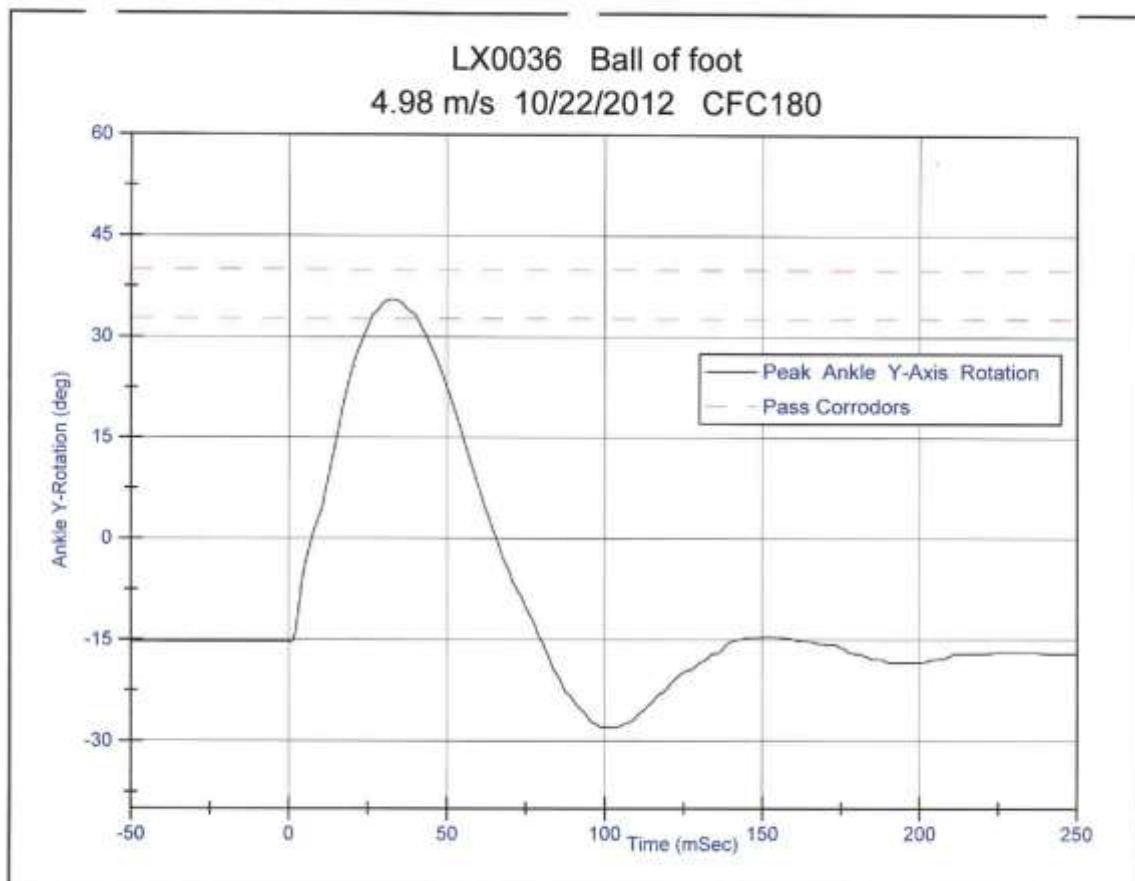
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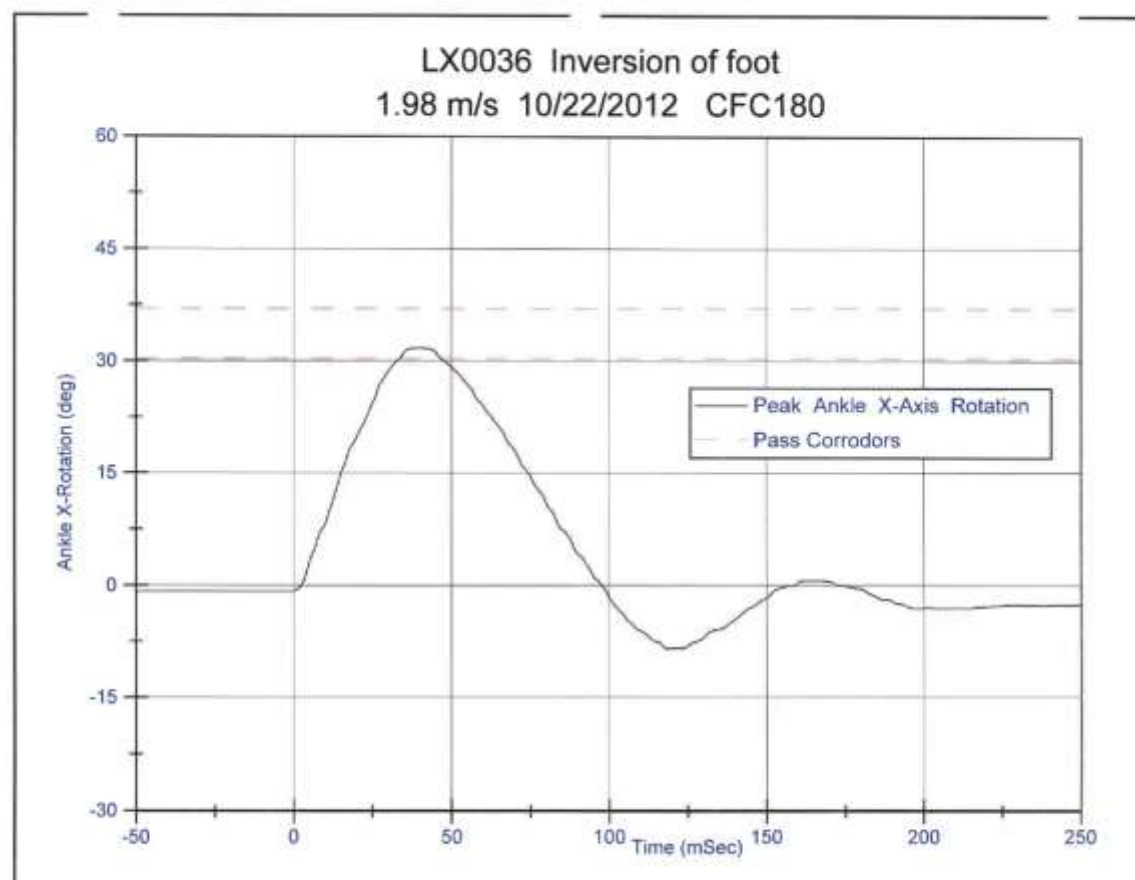
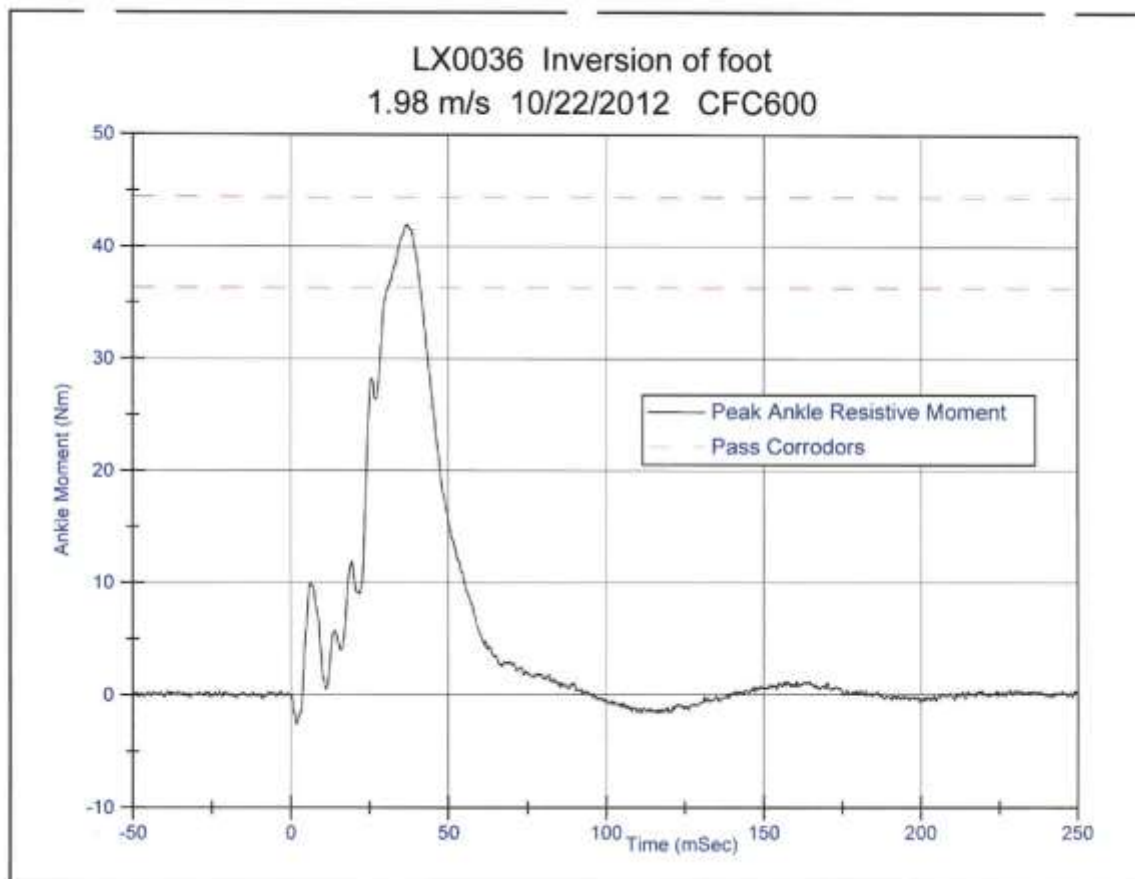




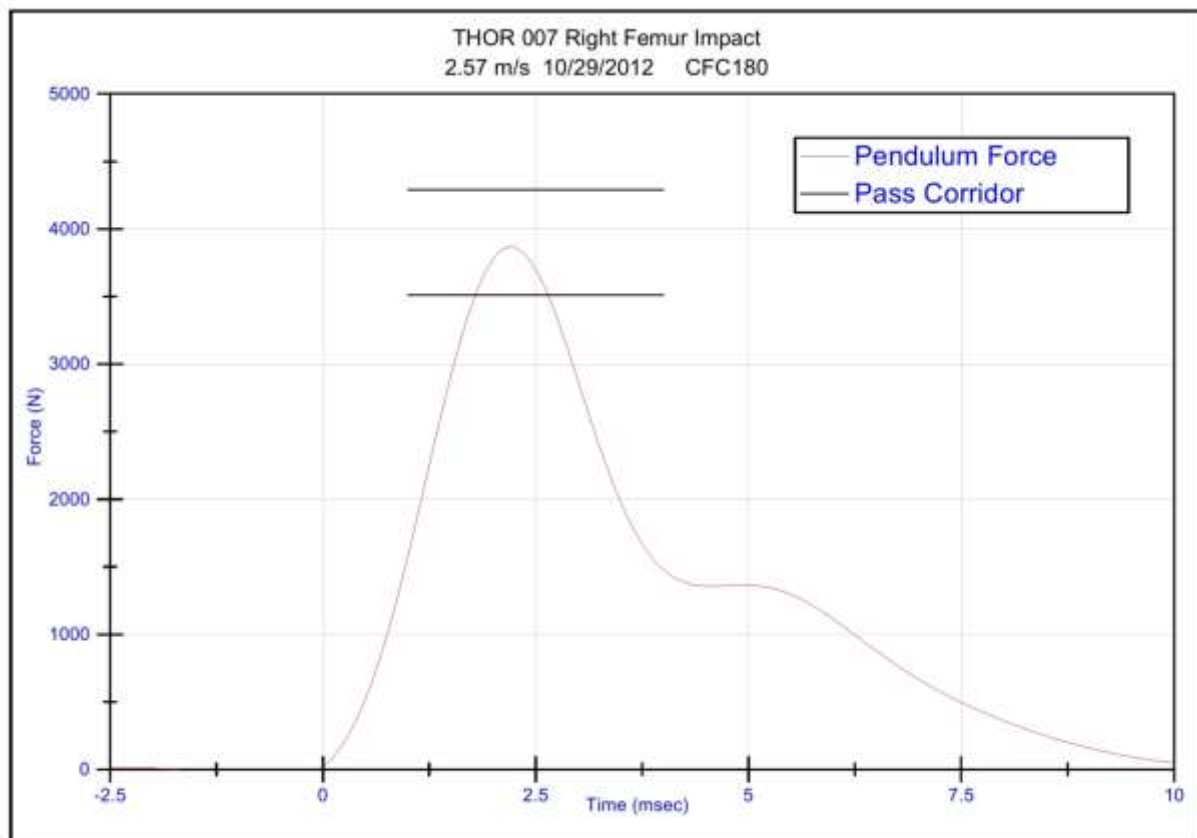
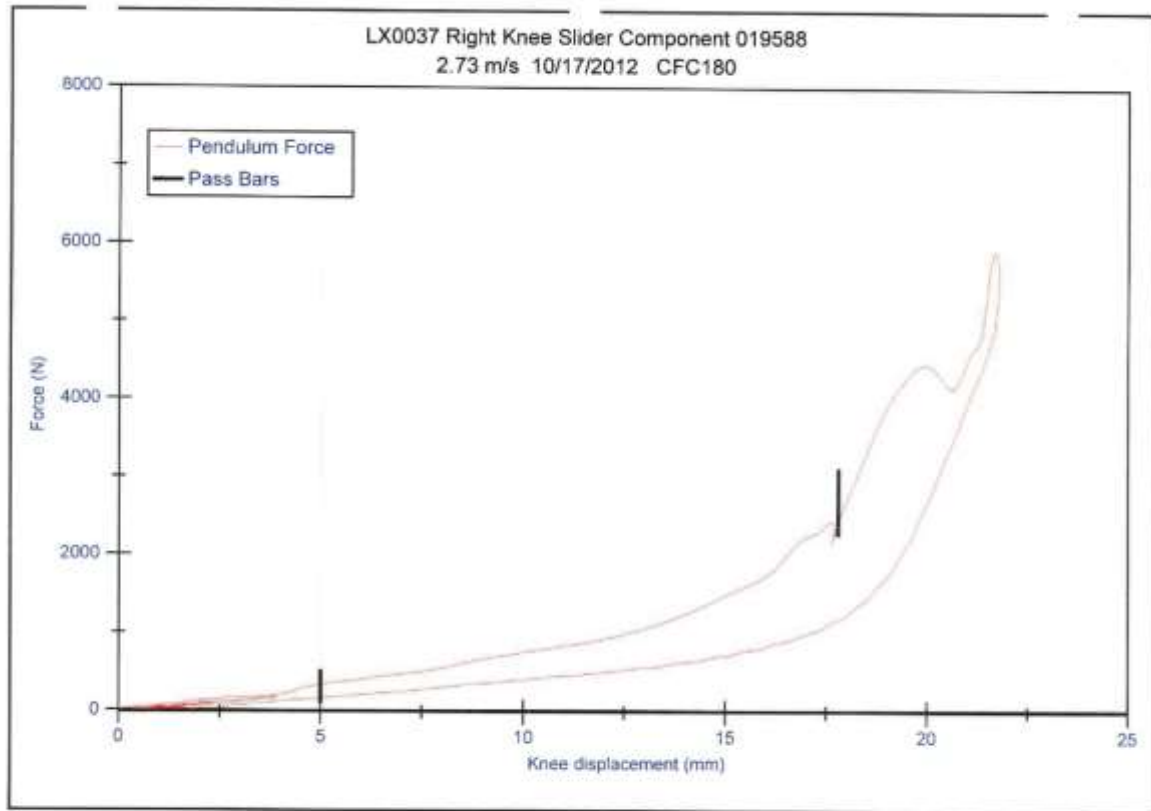


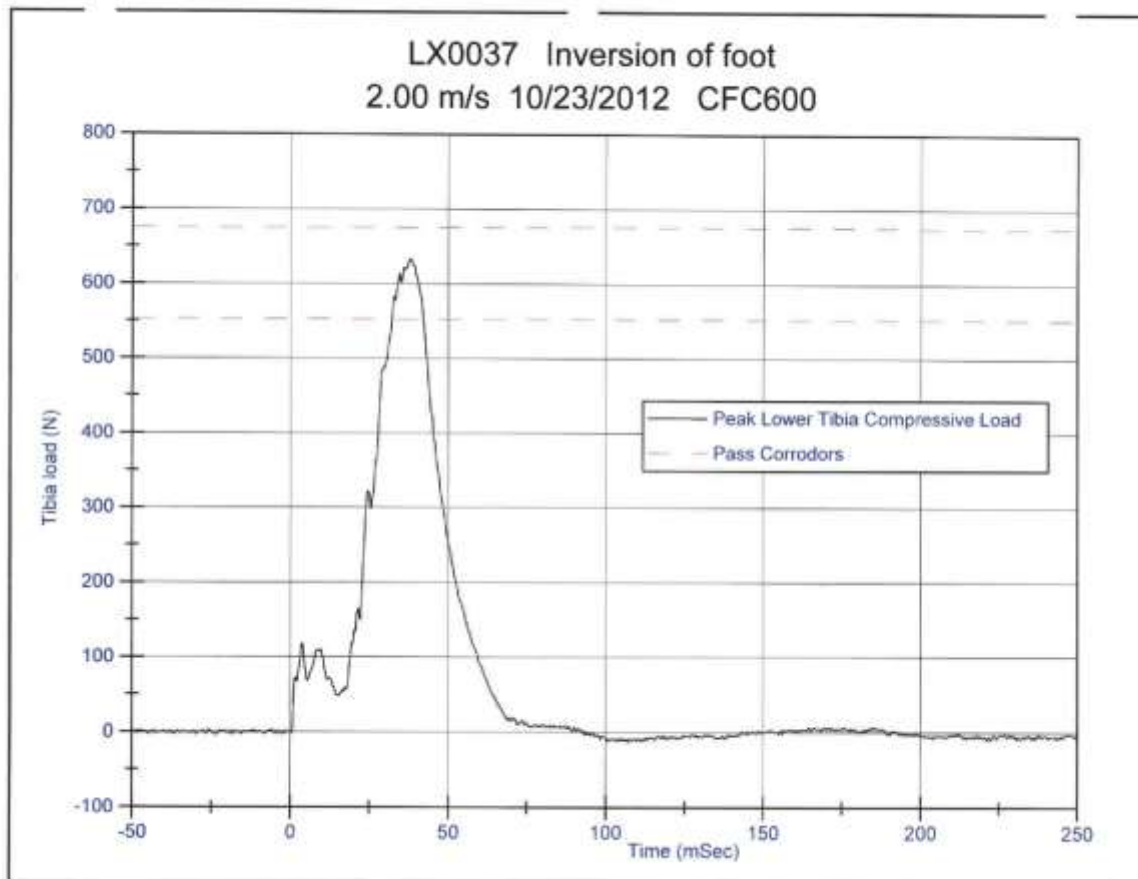
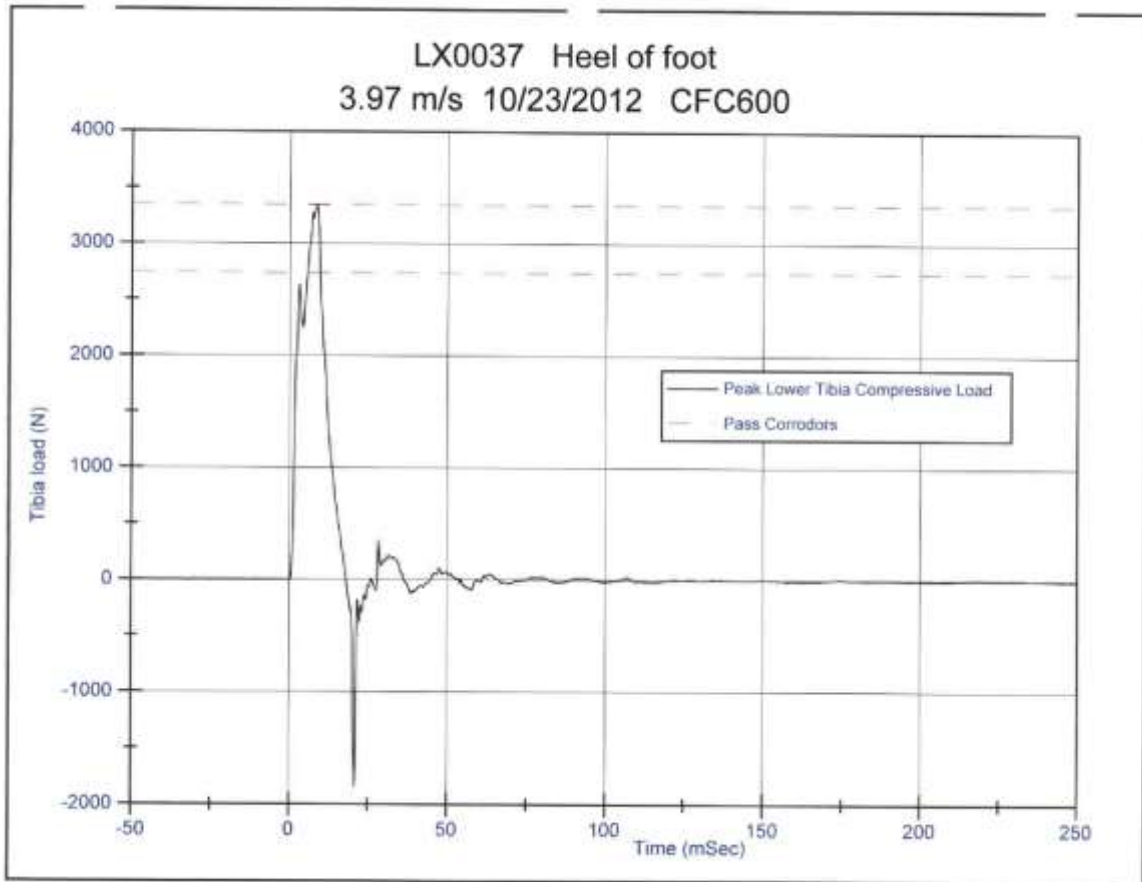


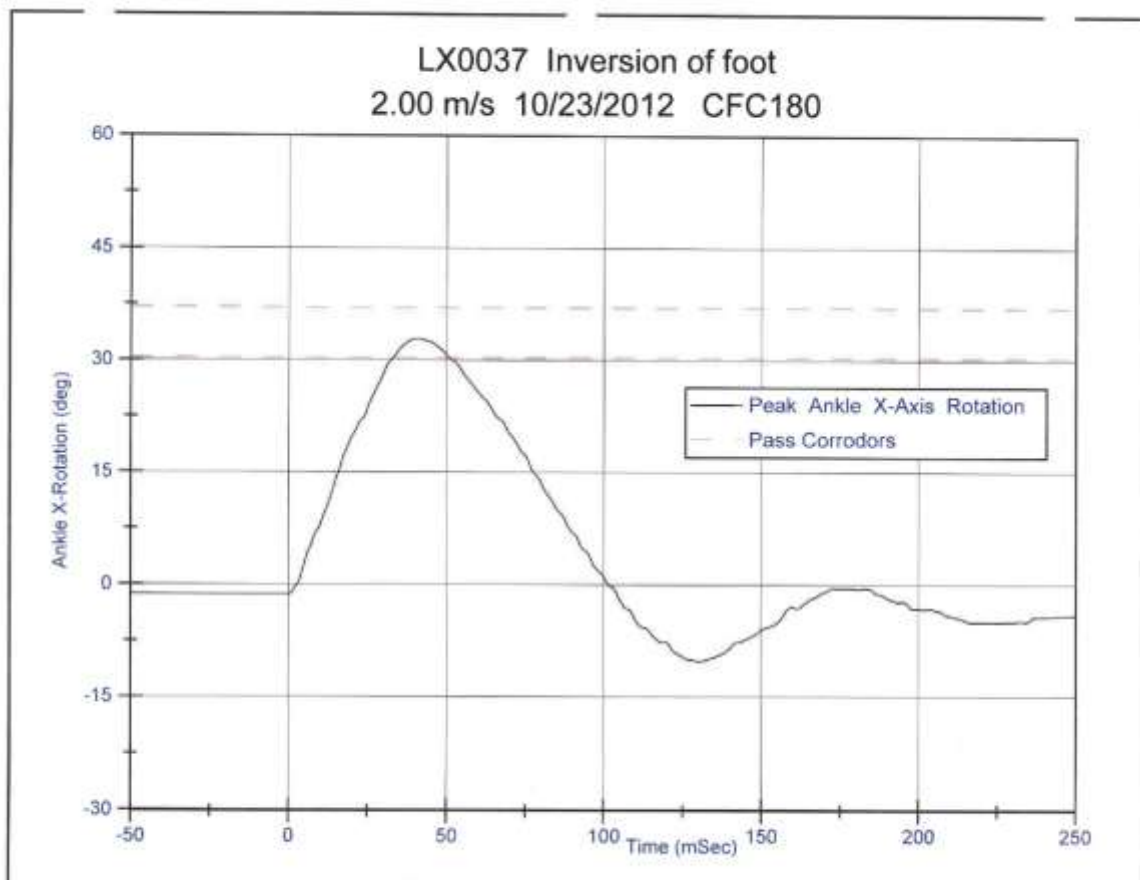
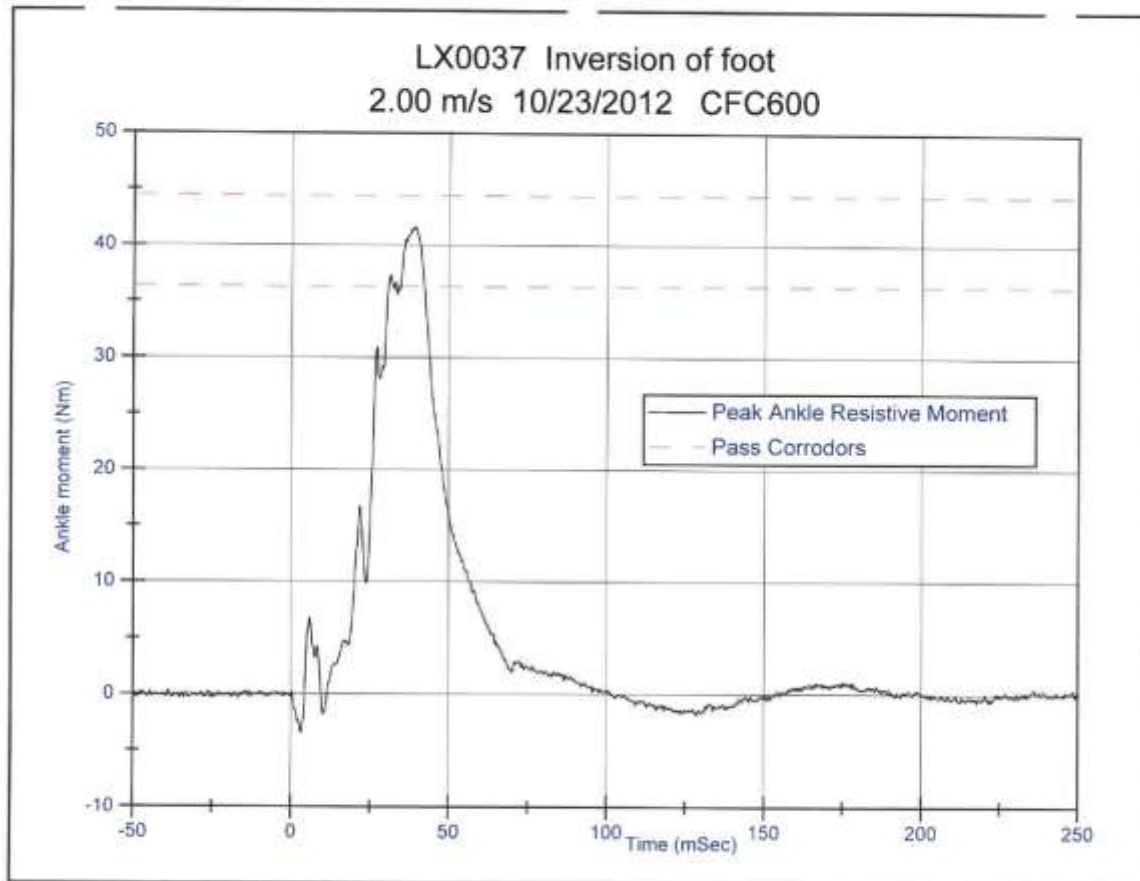


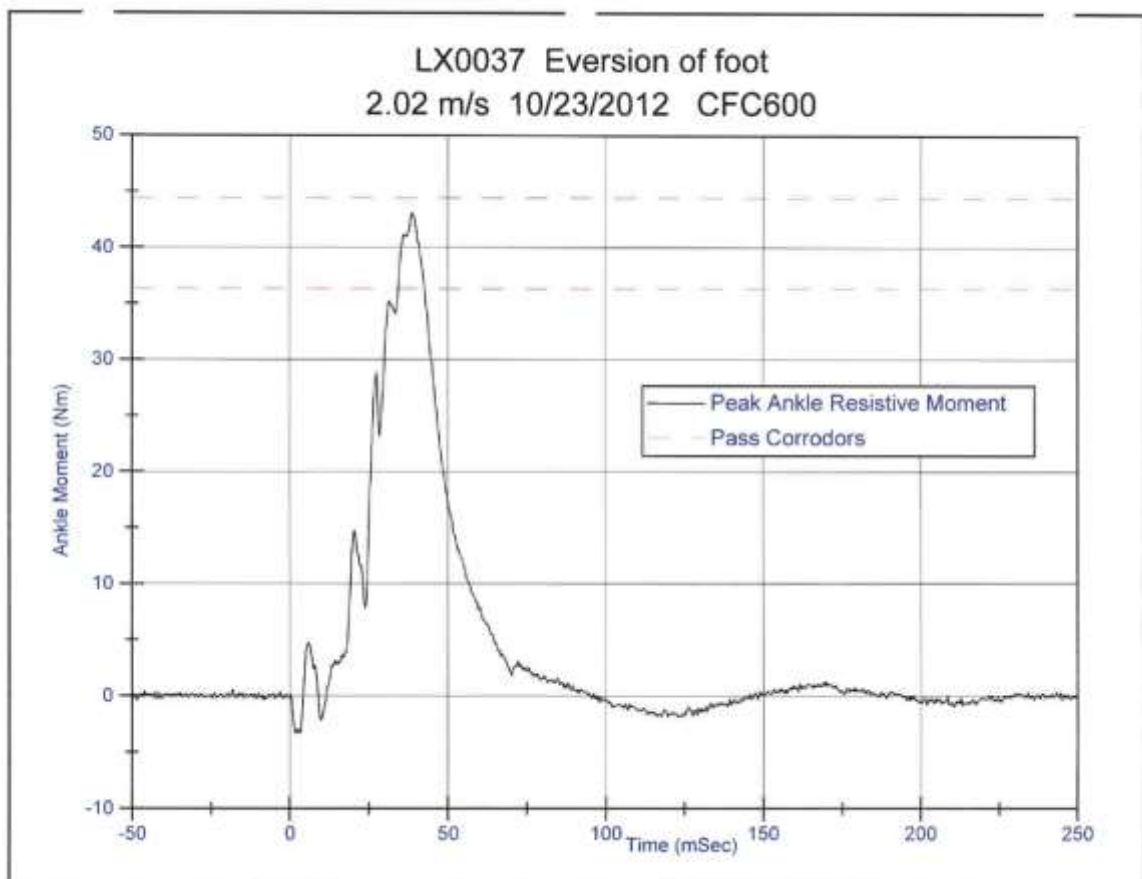
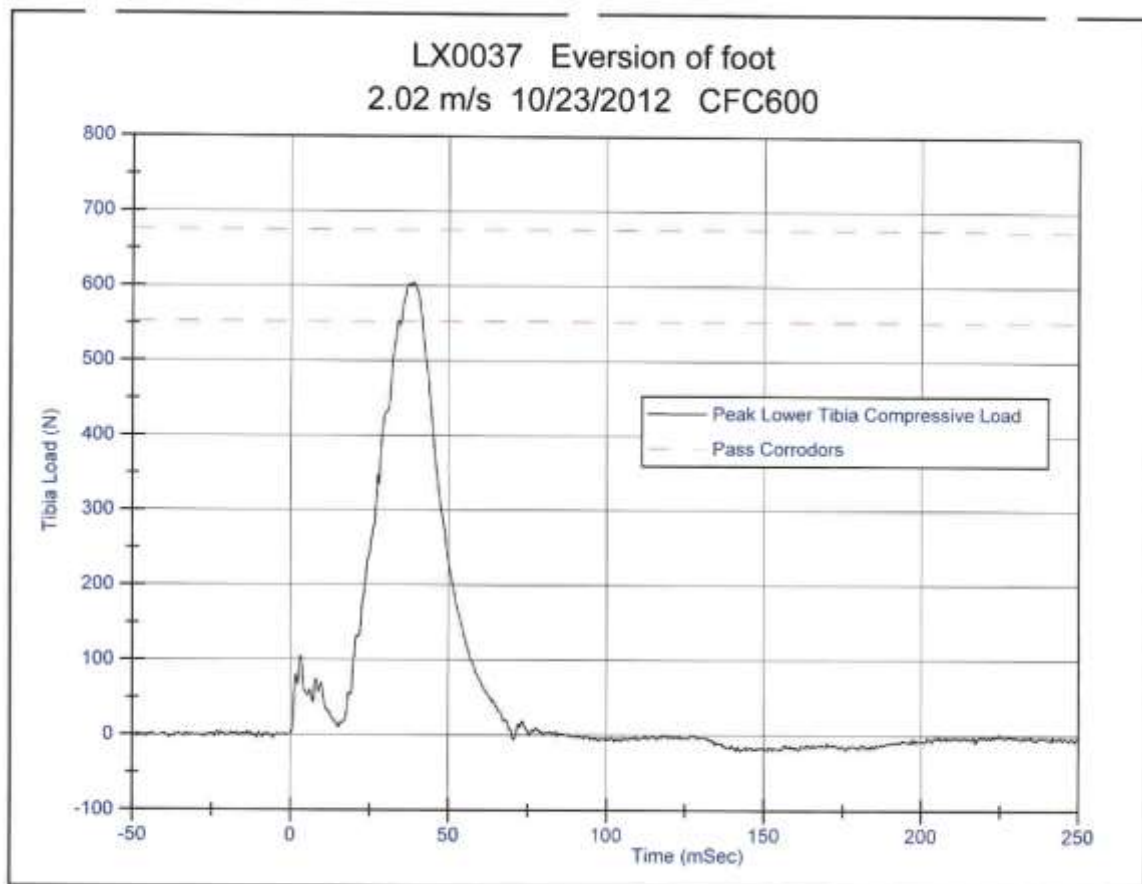


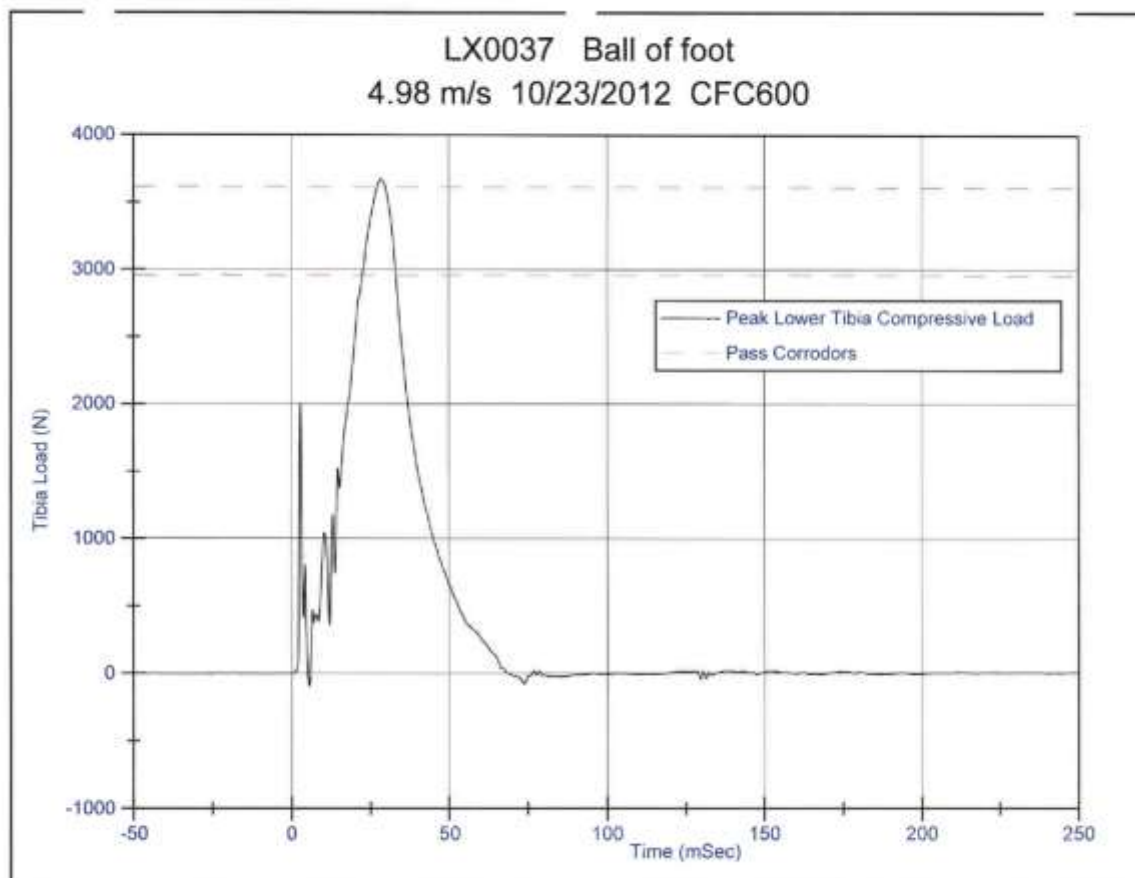
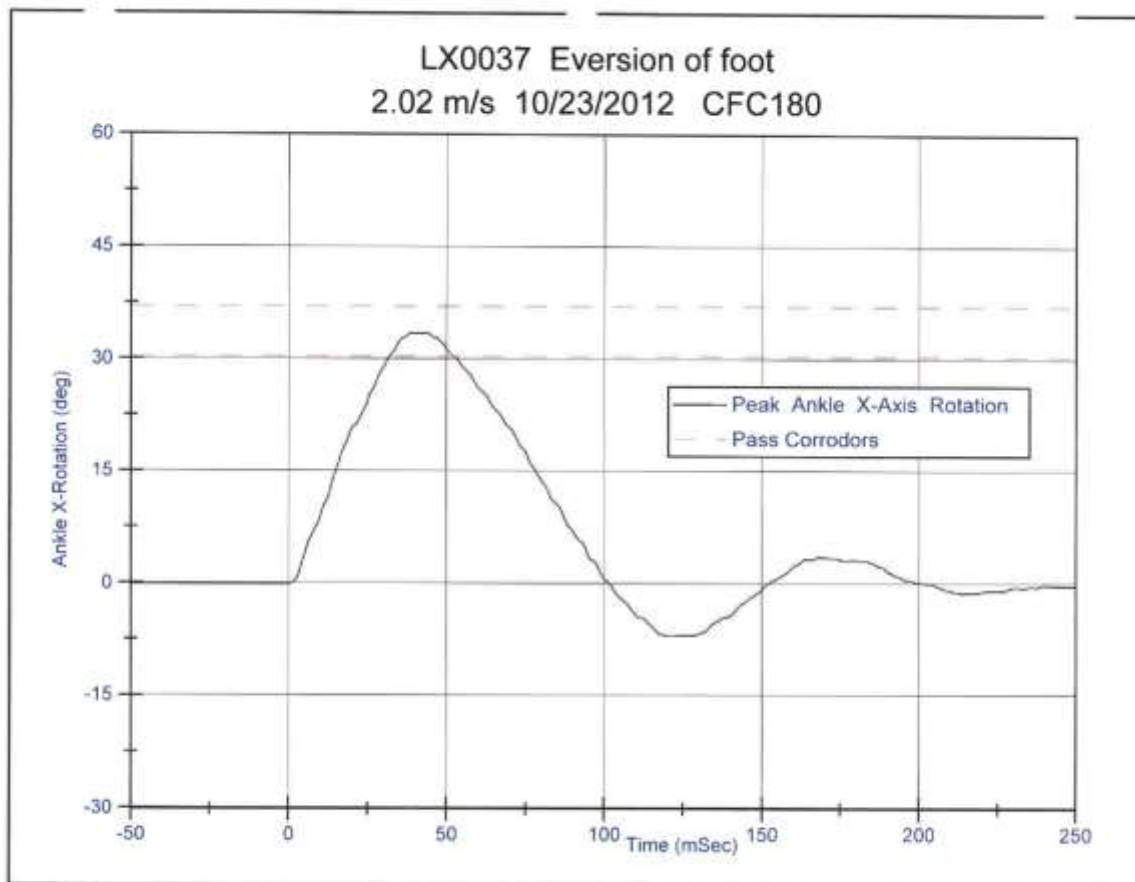
LX0037

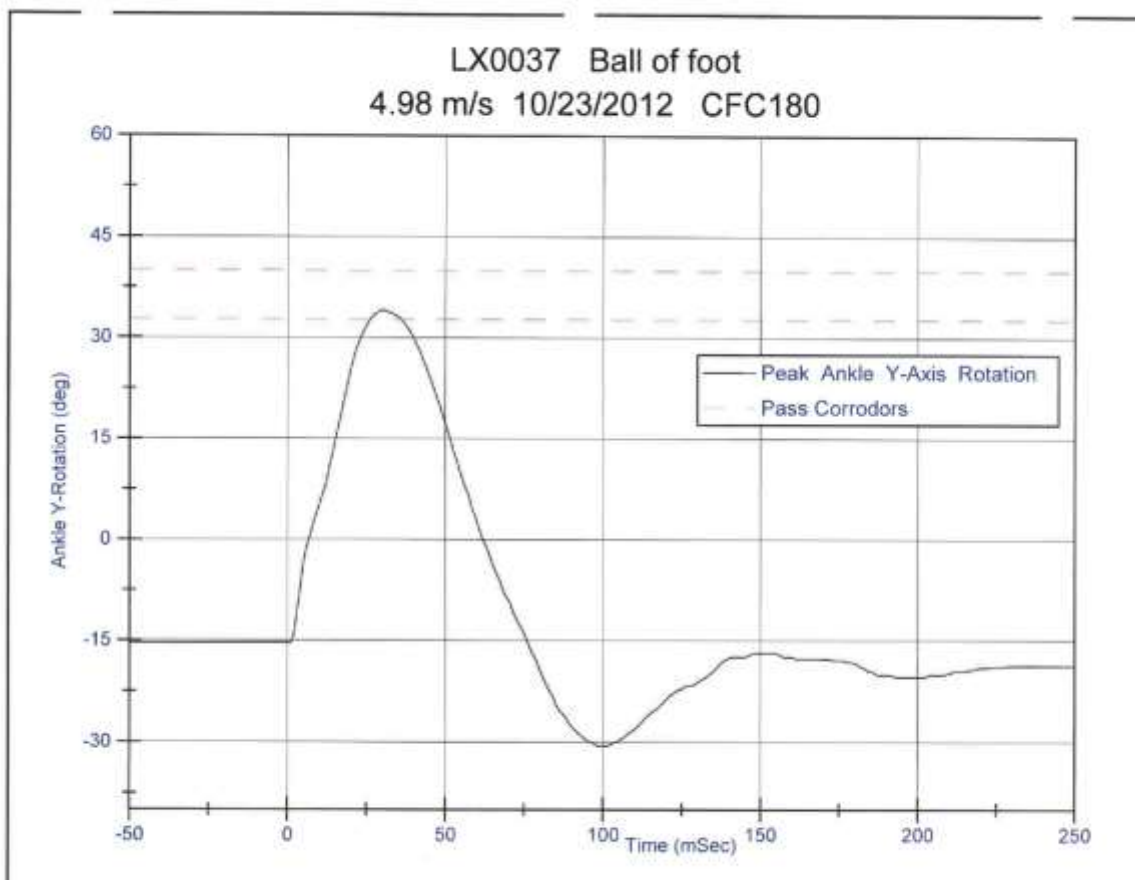
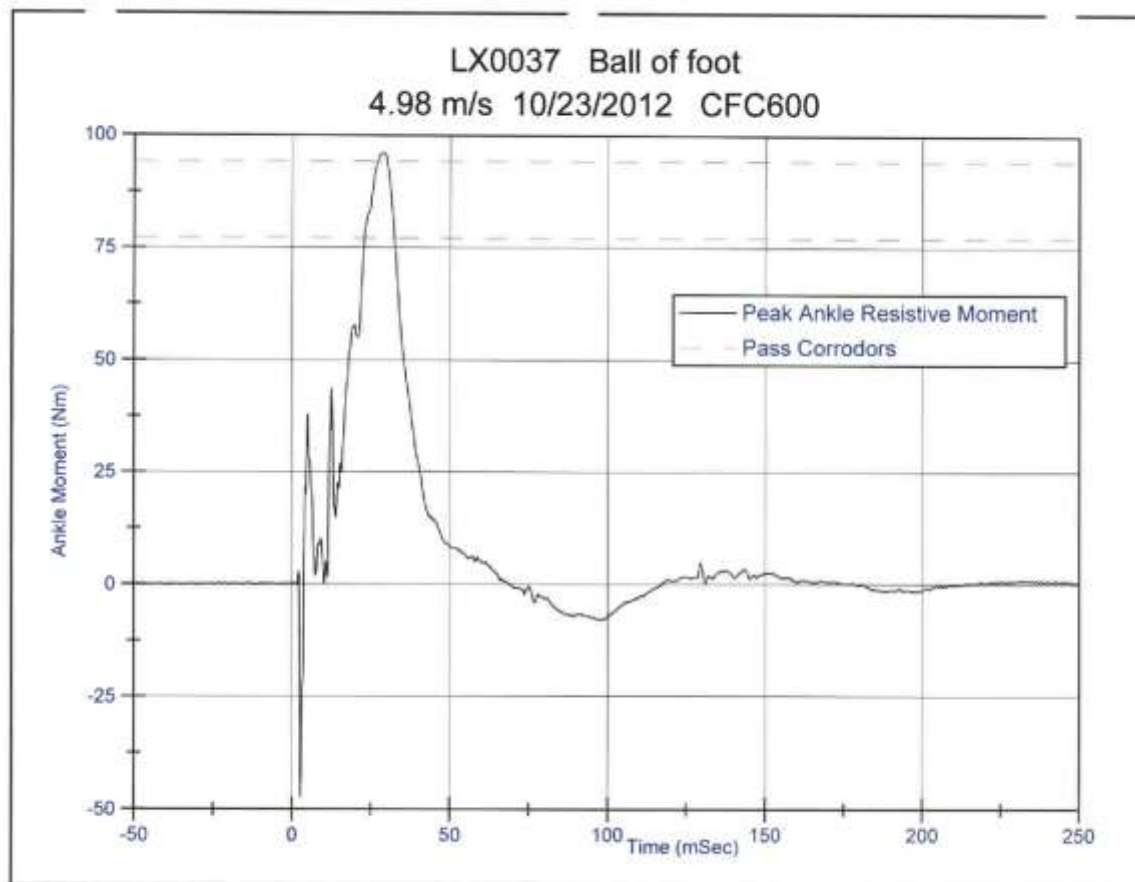




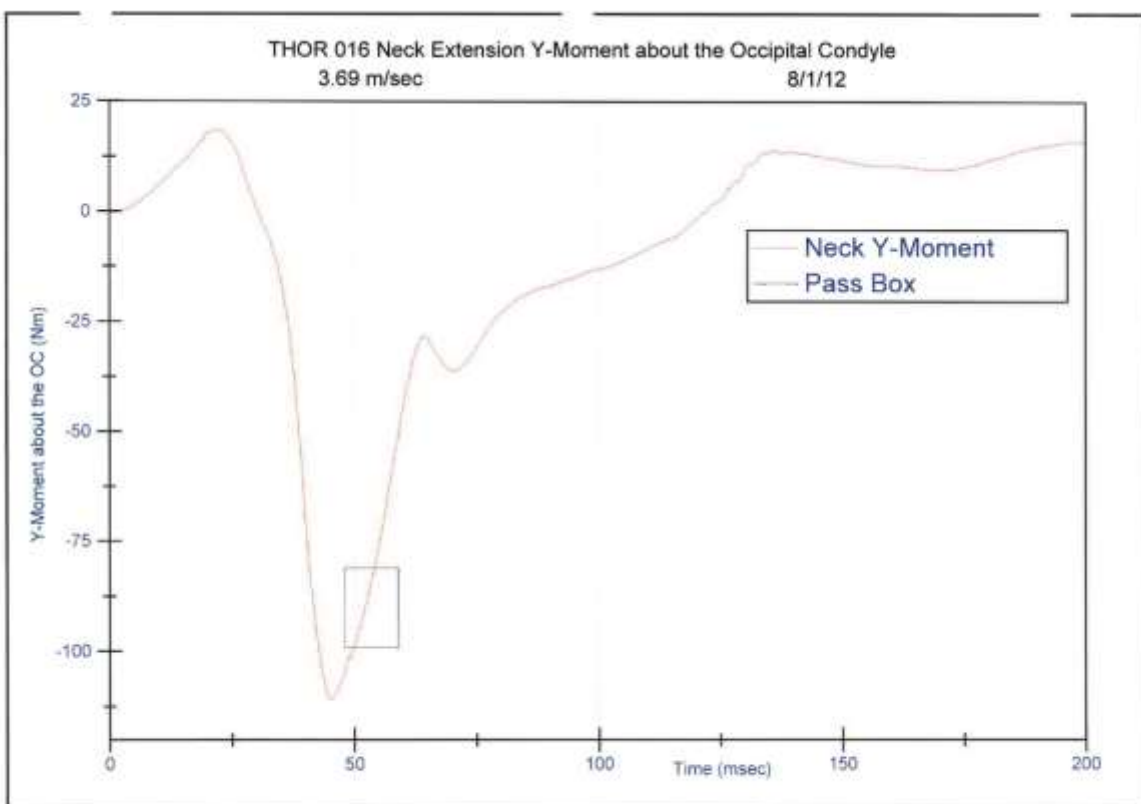
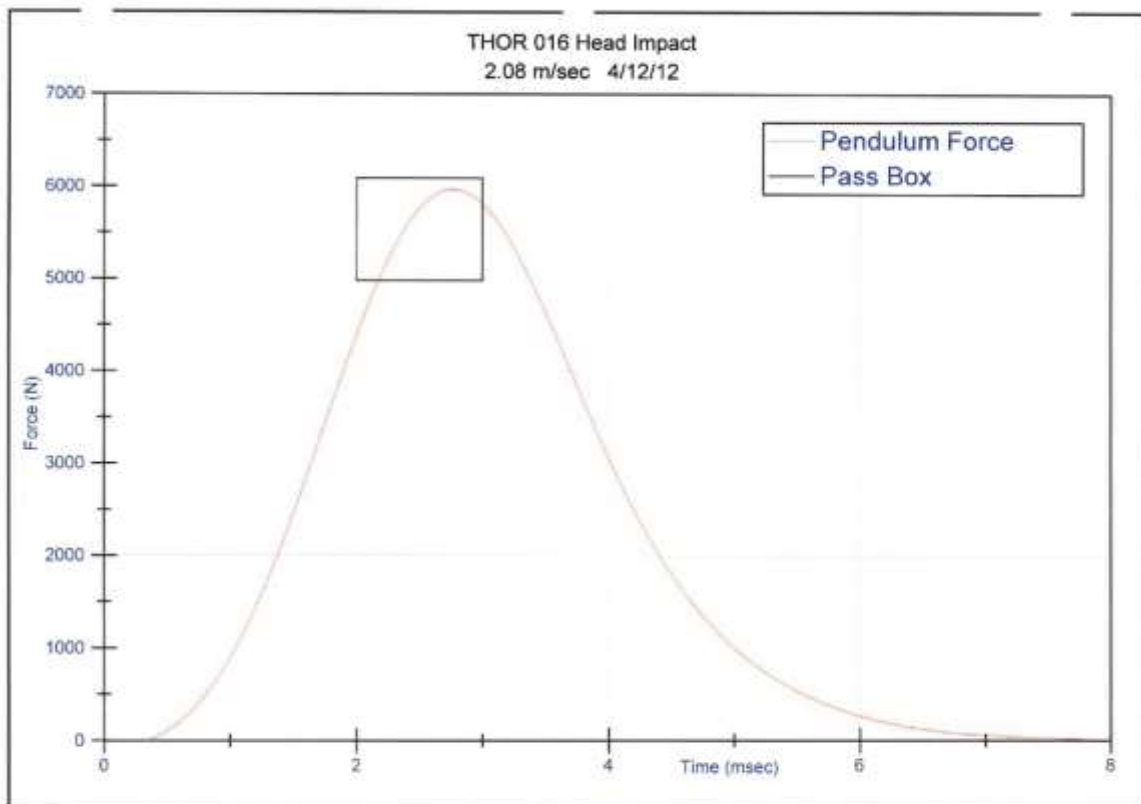


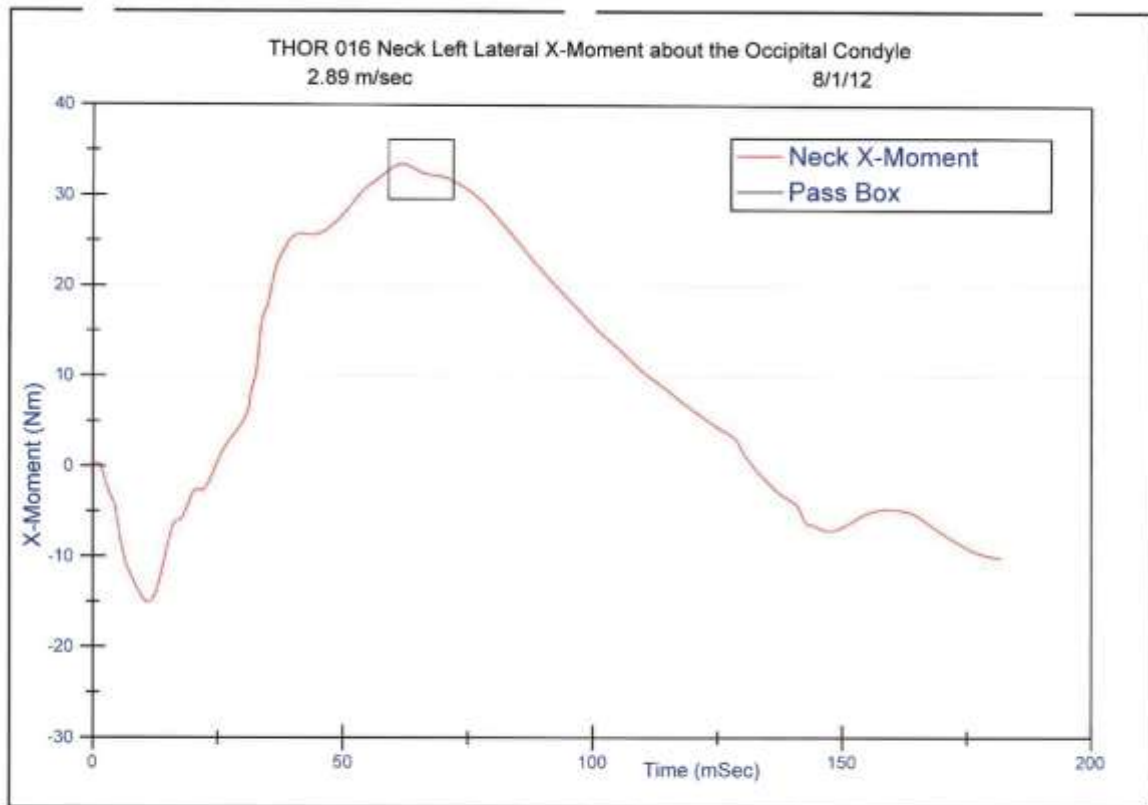
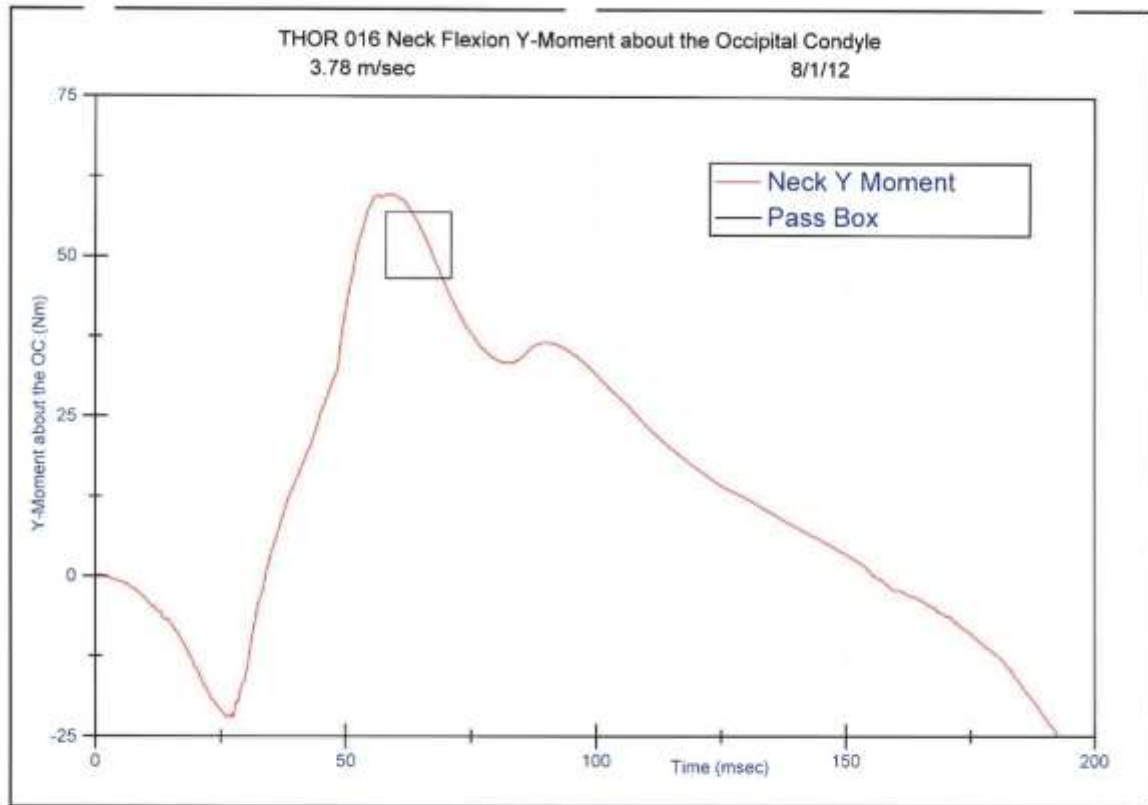


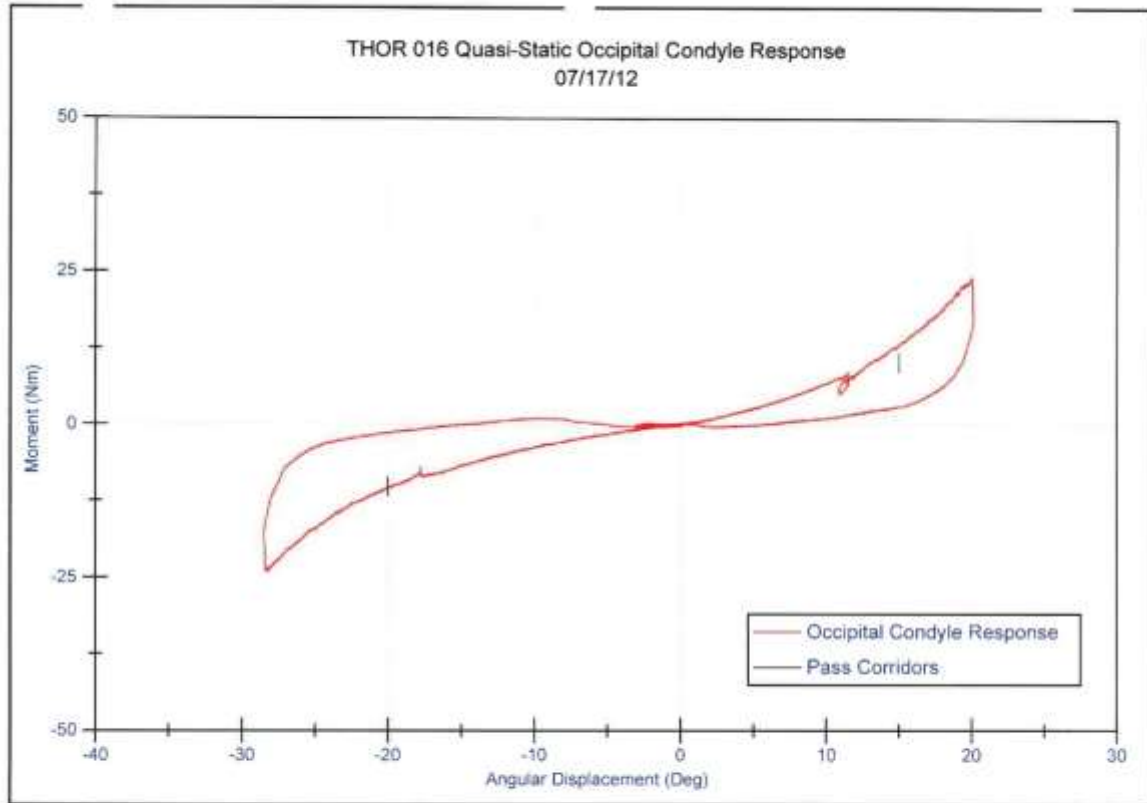
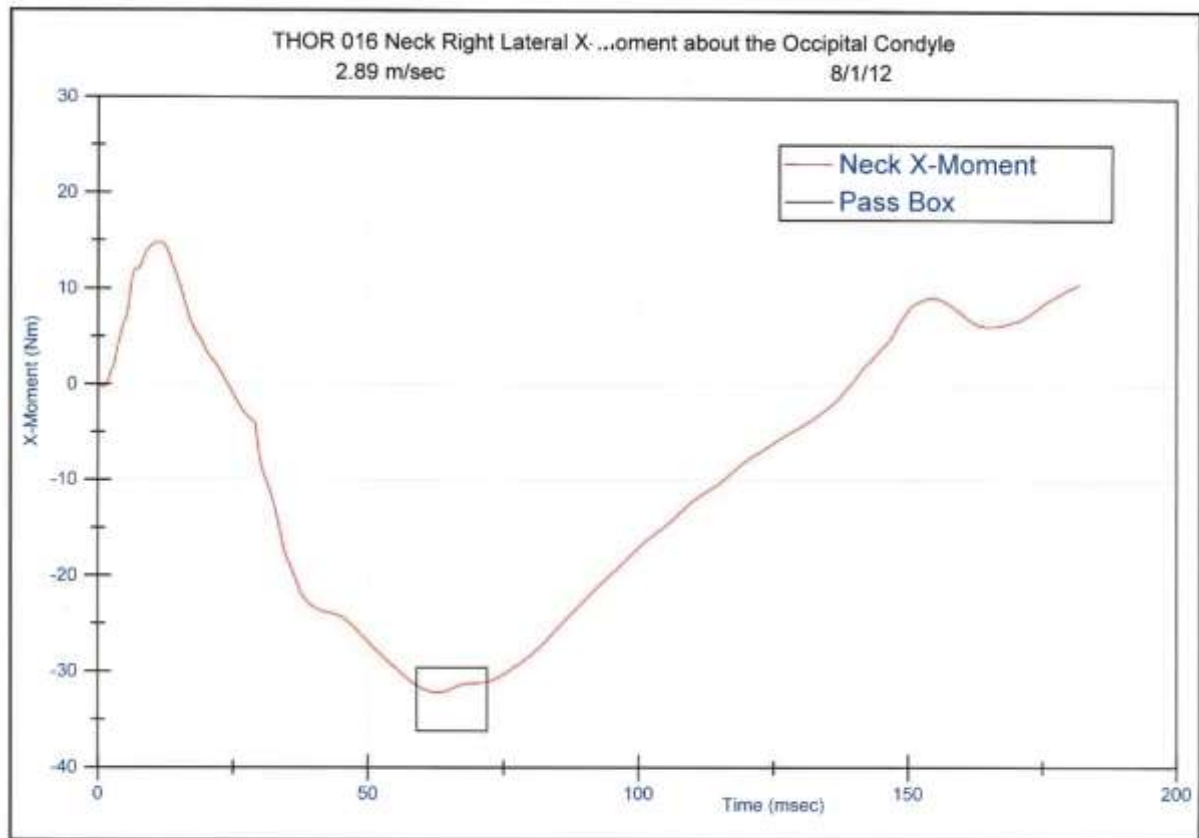


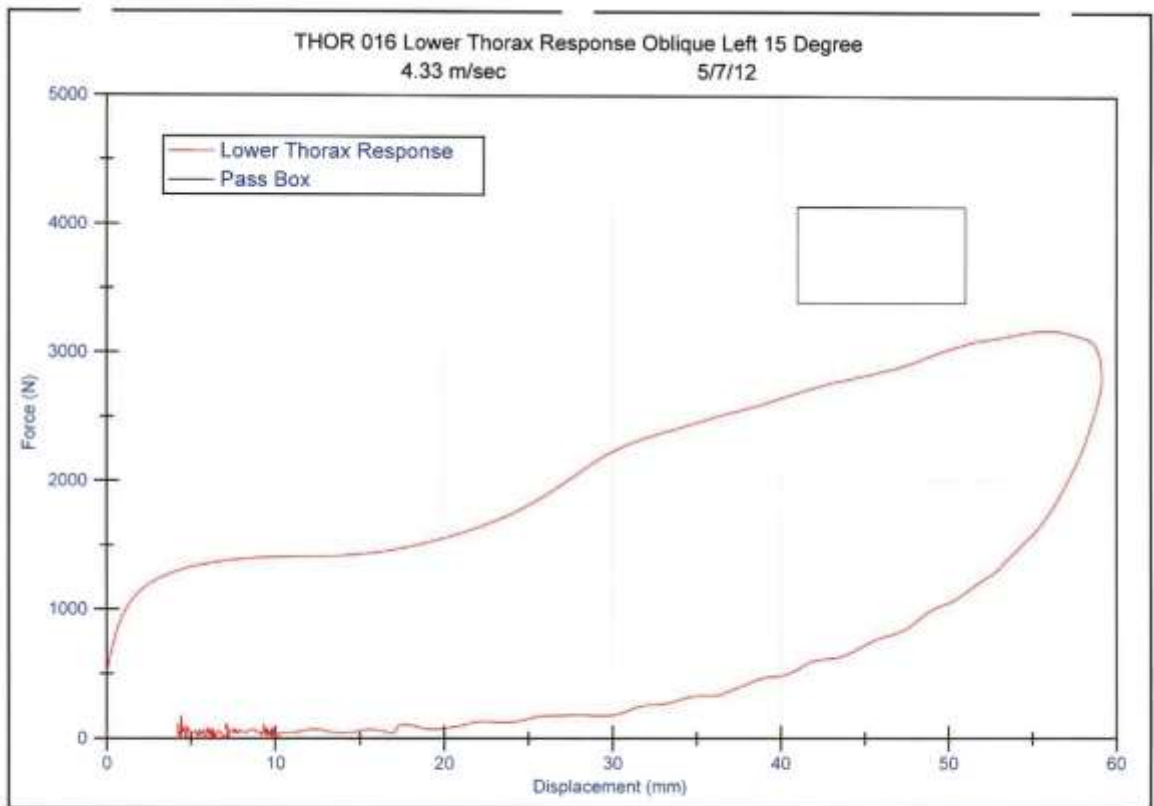
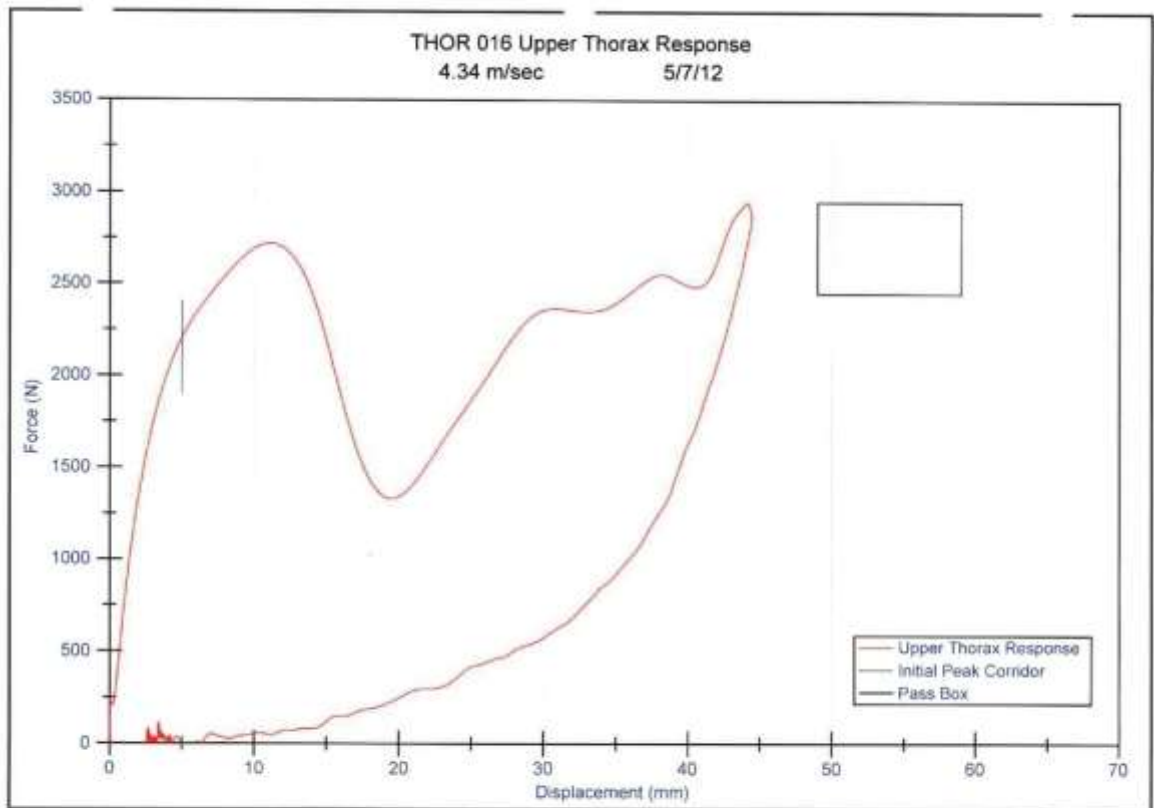


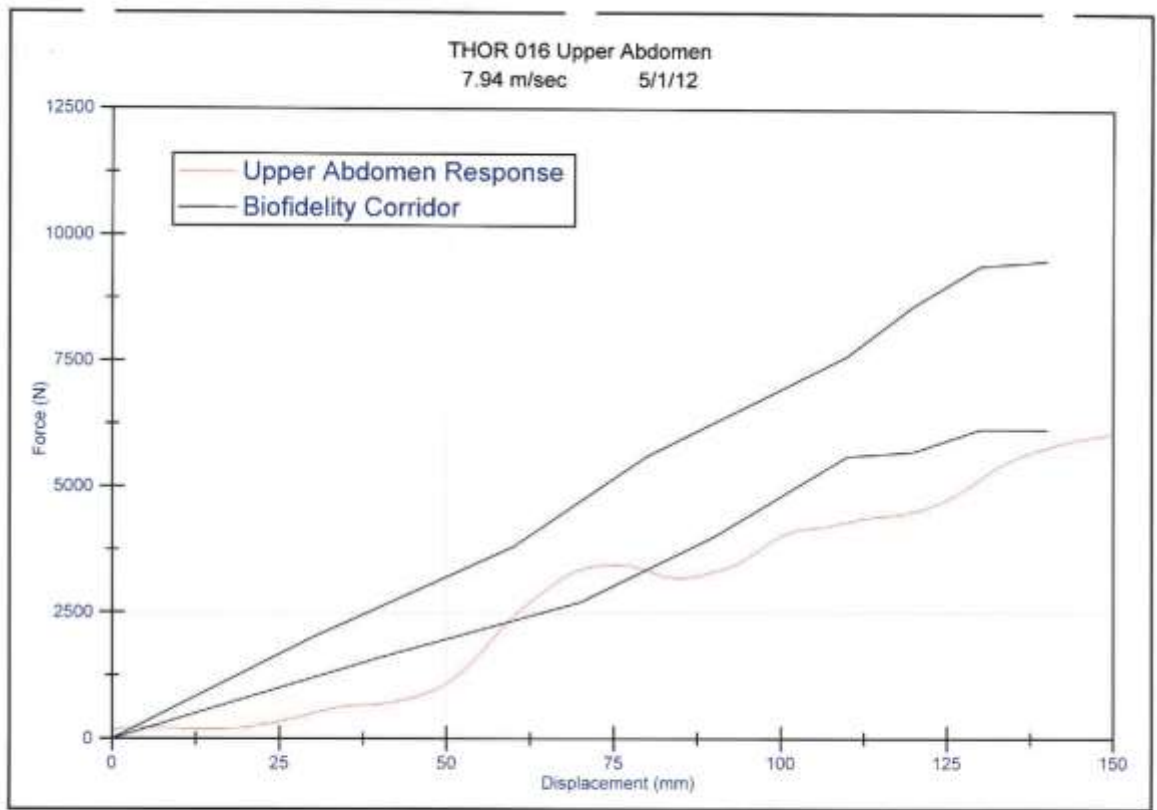
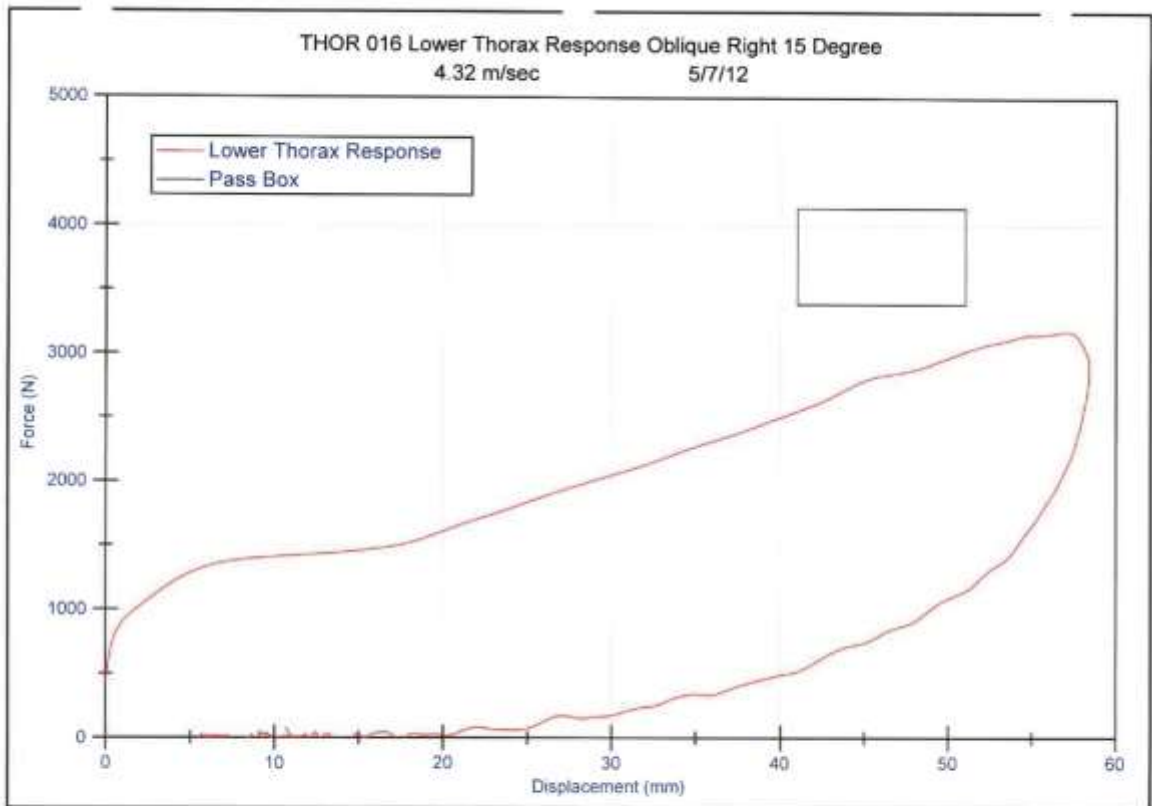
50% ADULT MALE THOR016 DUMMY CALIBRATIONS

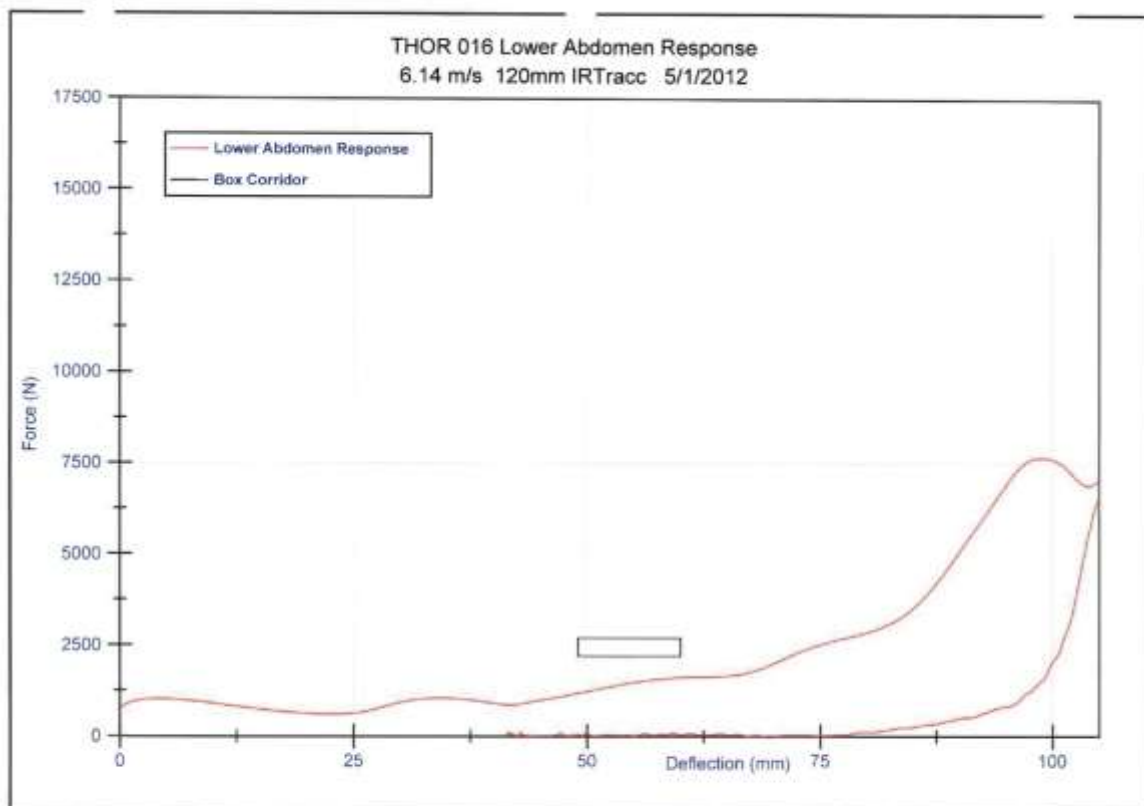




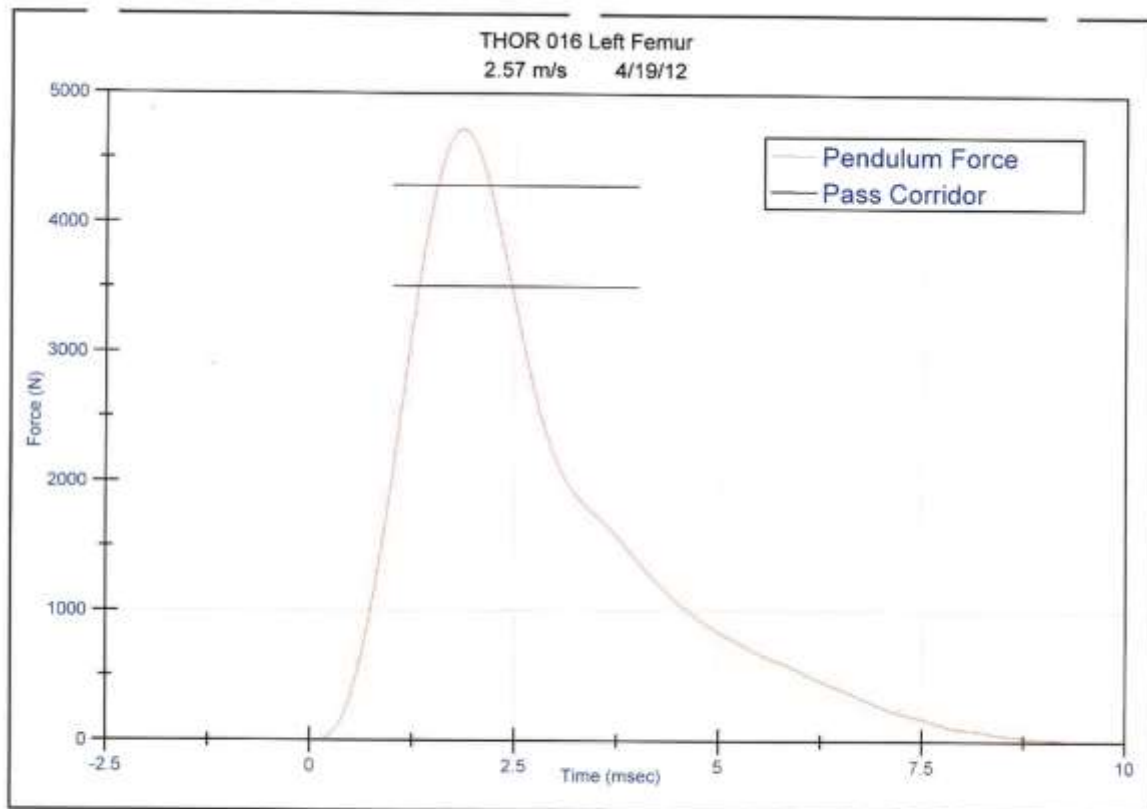
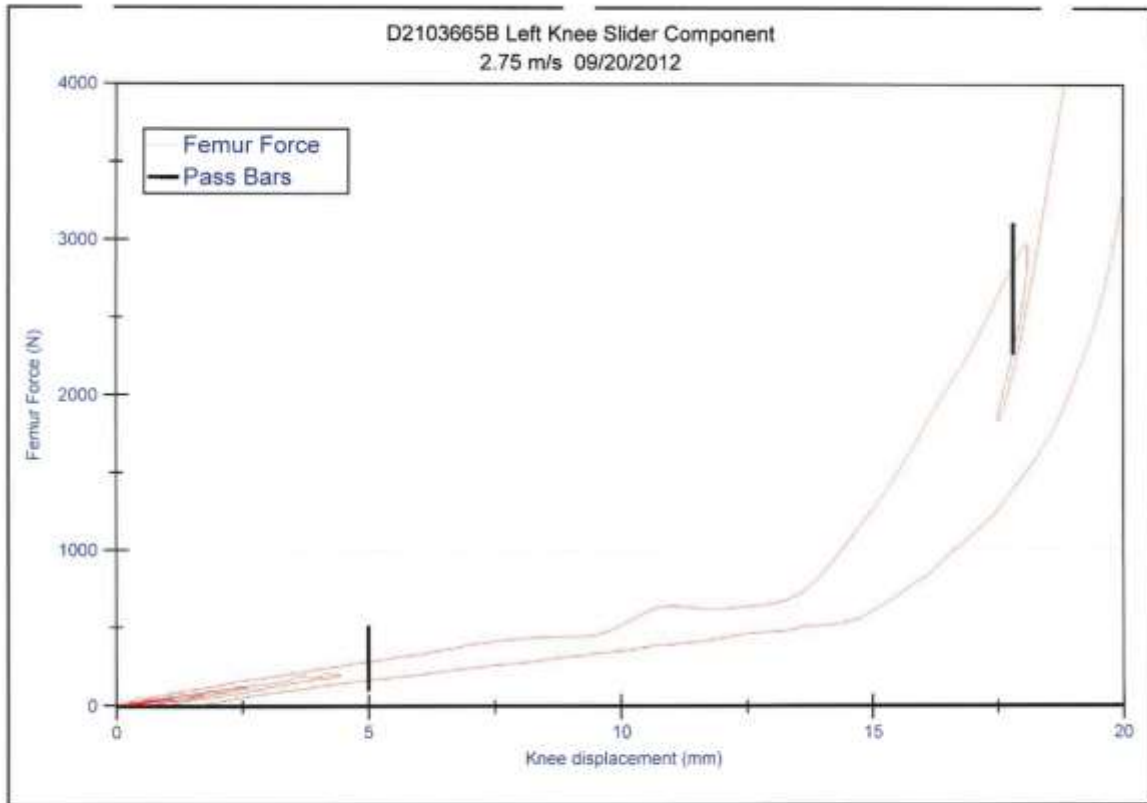


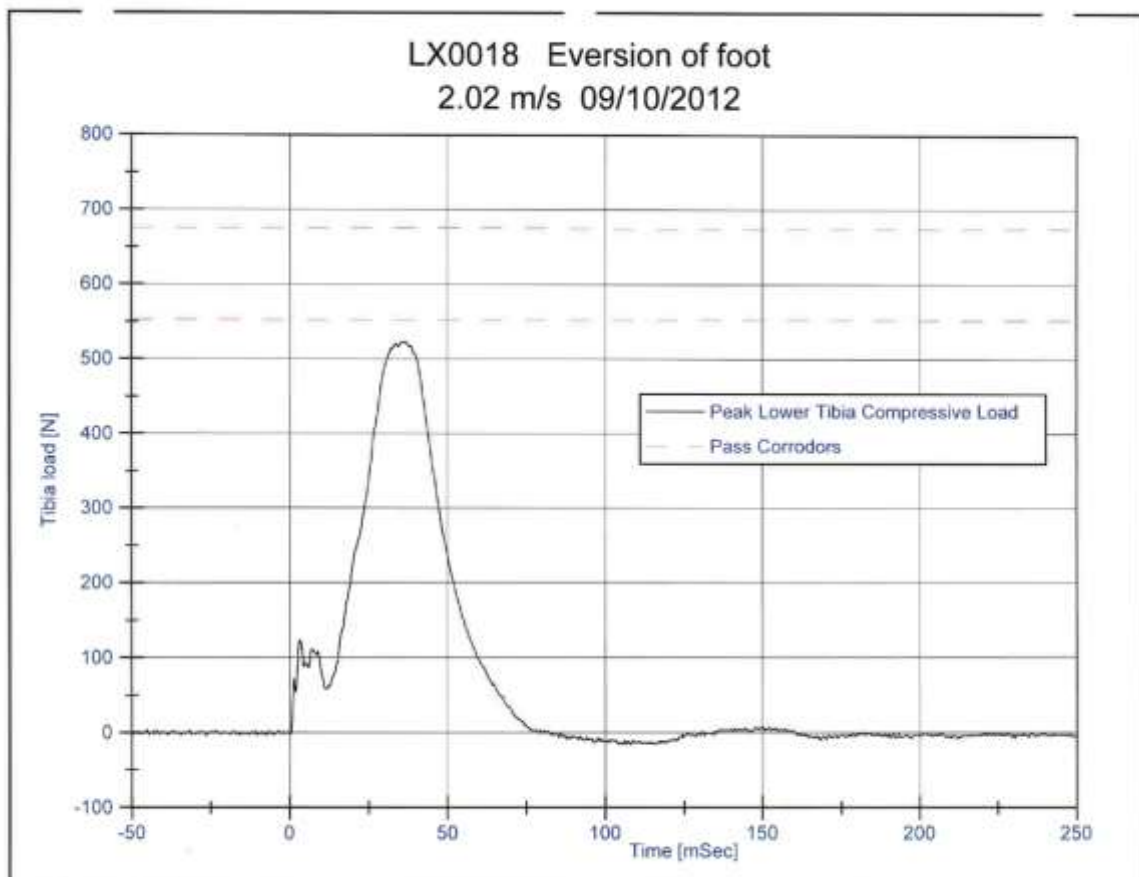
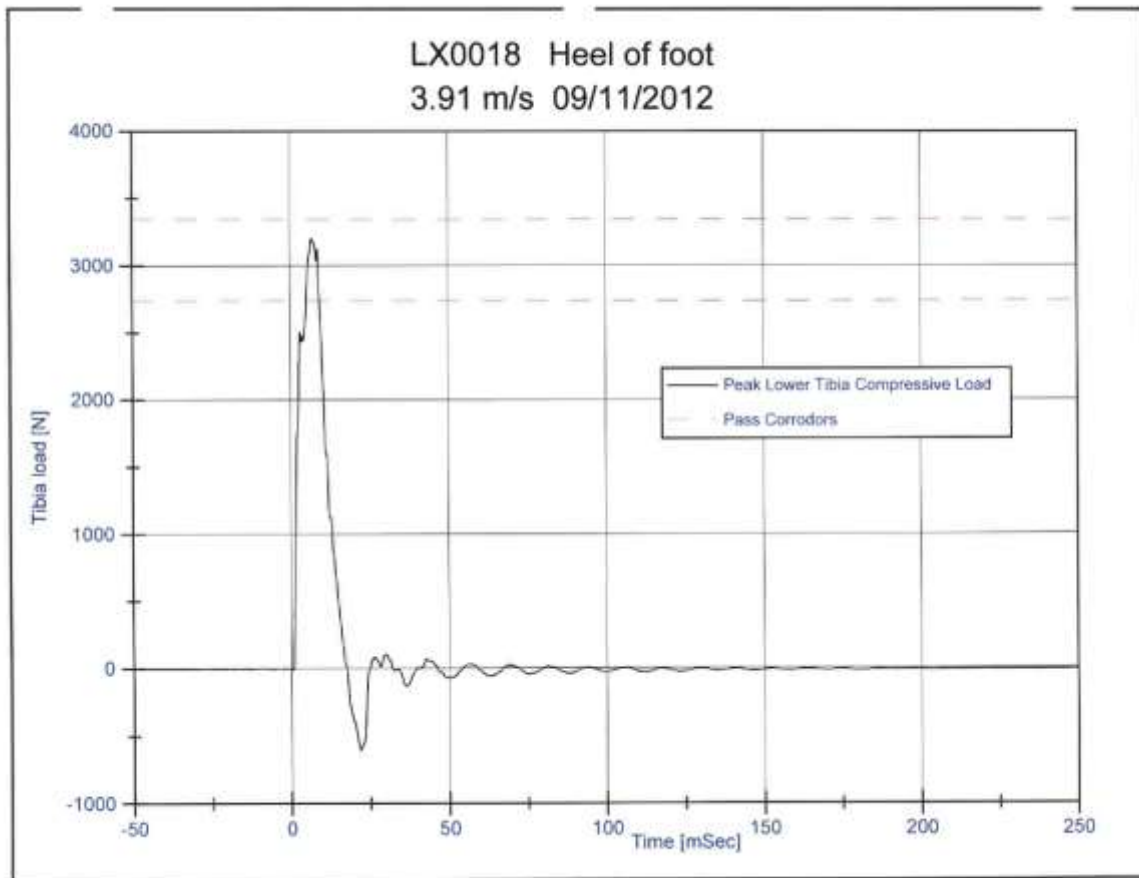


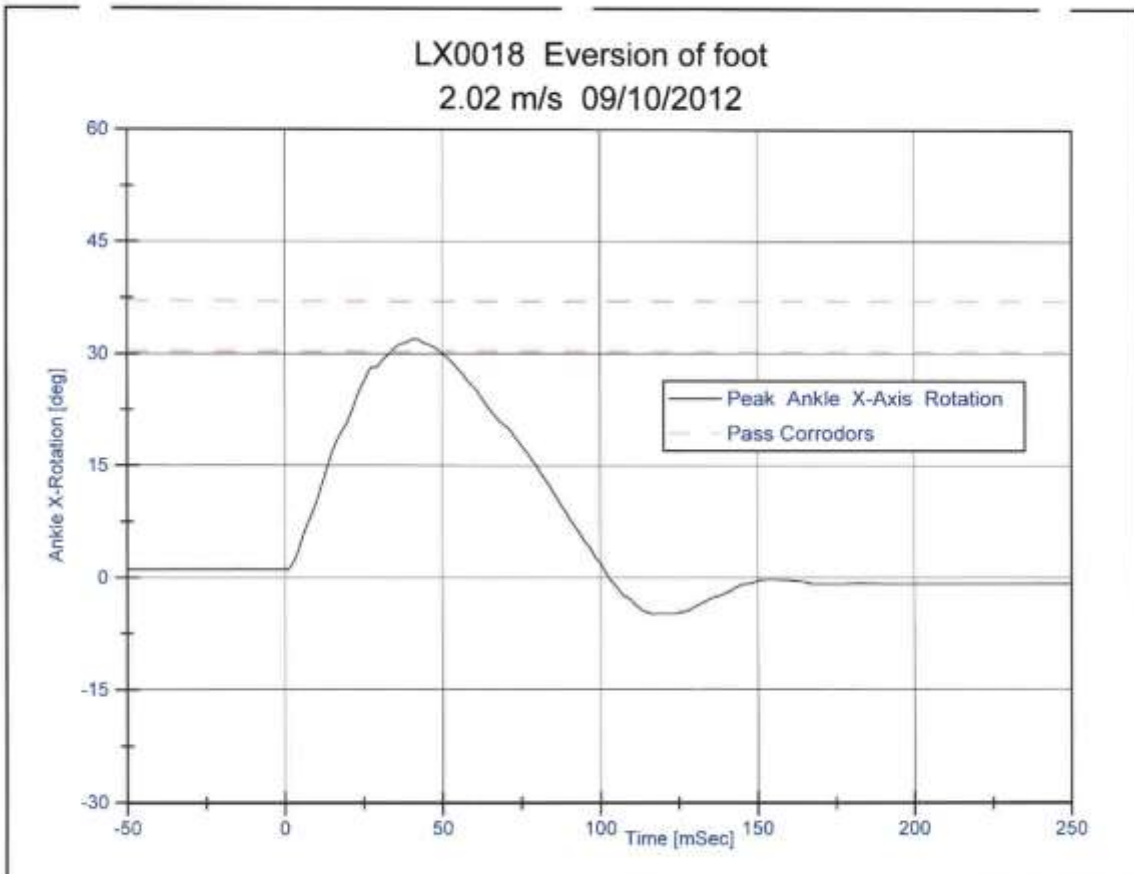
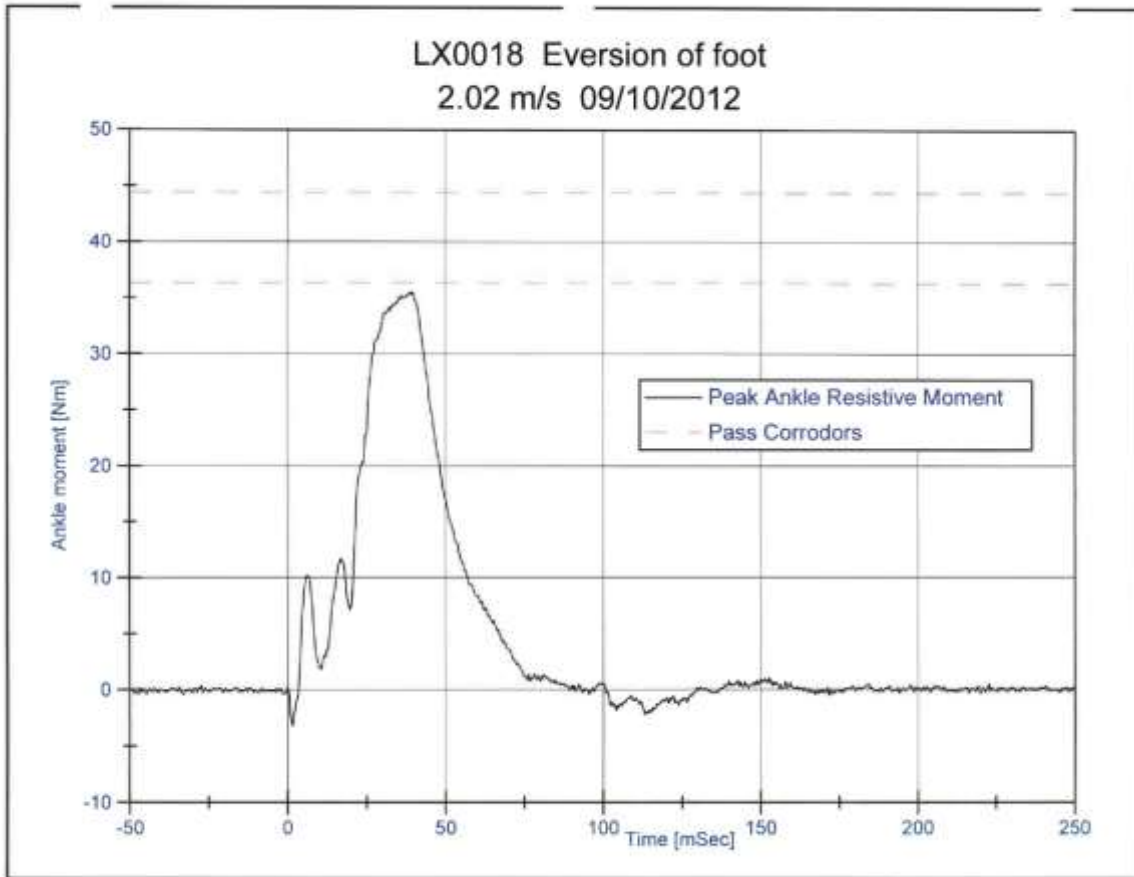


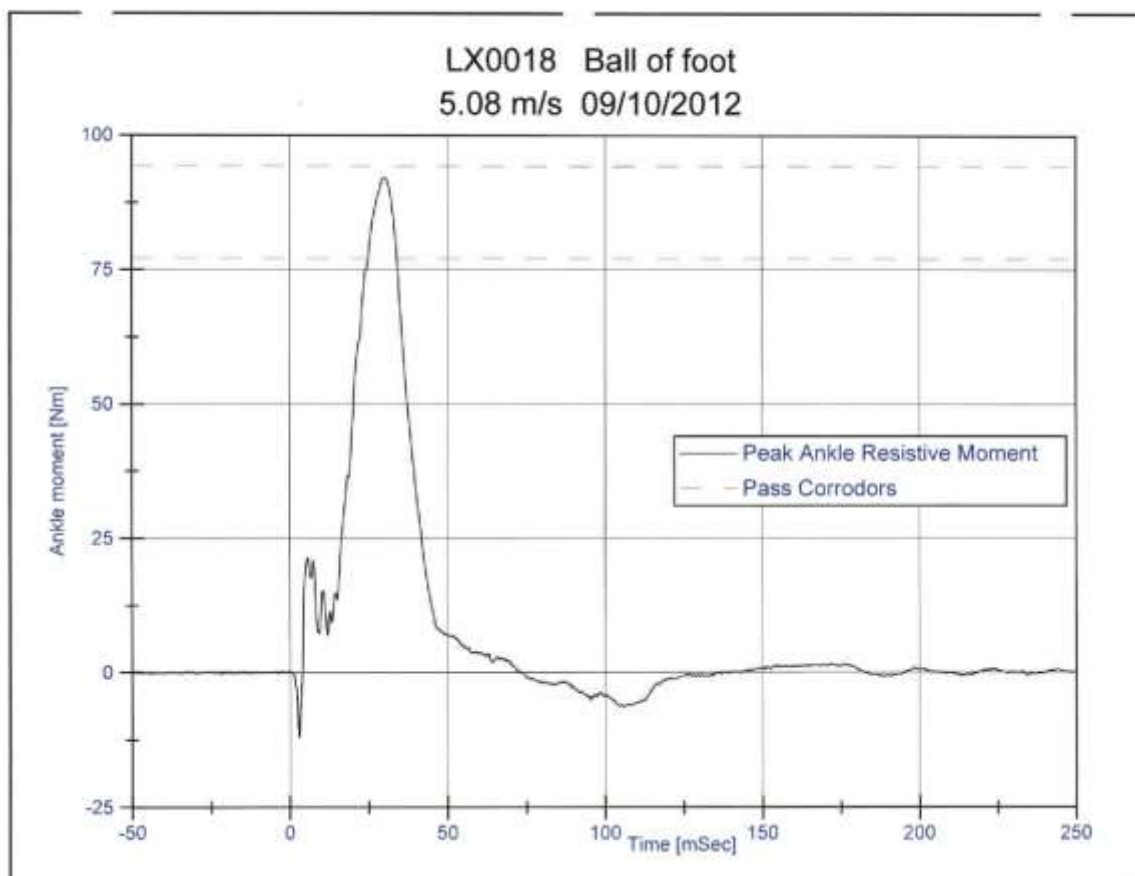
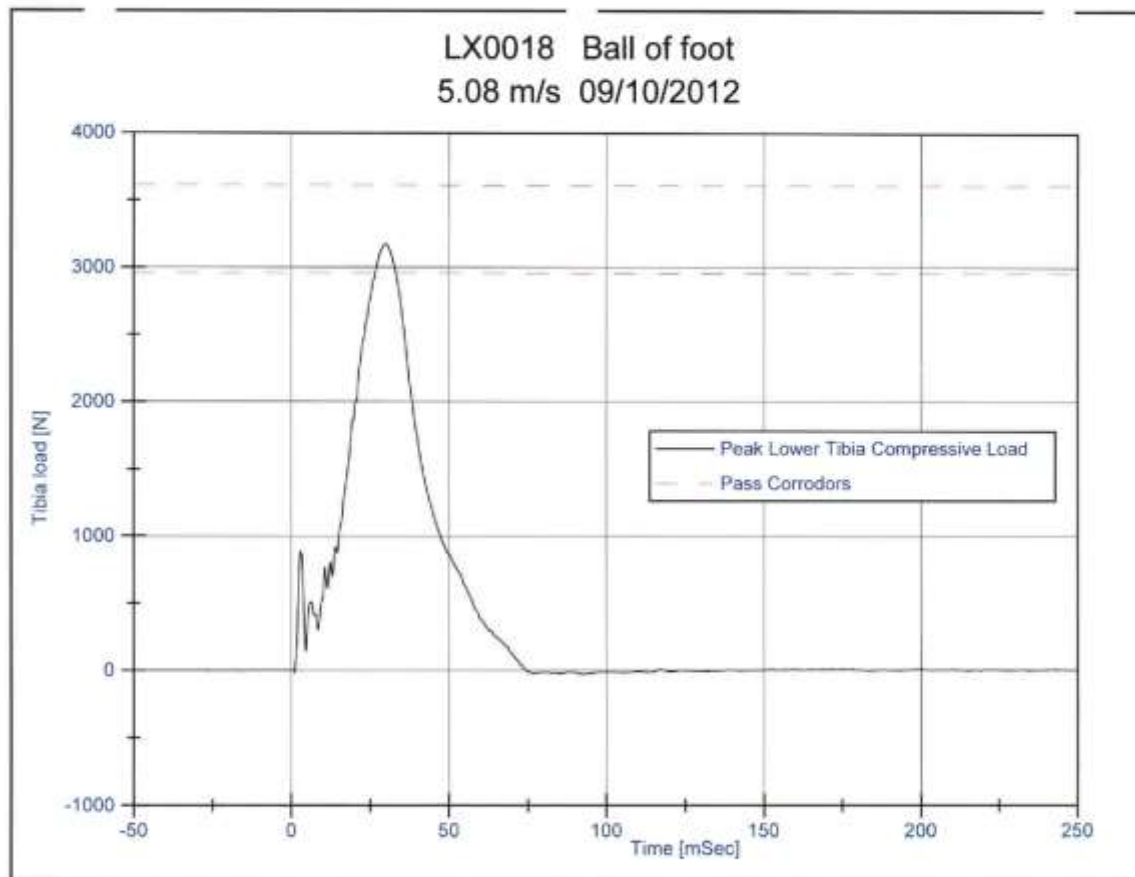


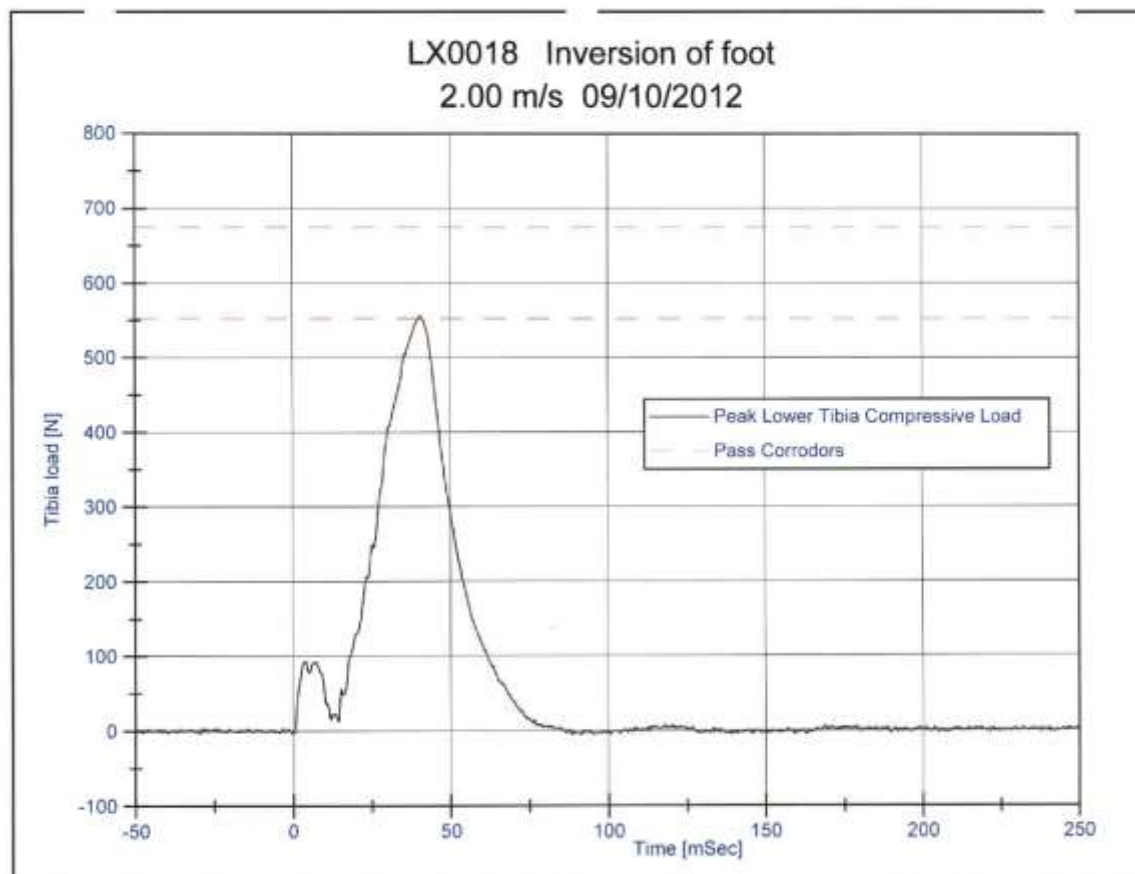
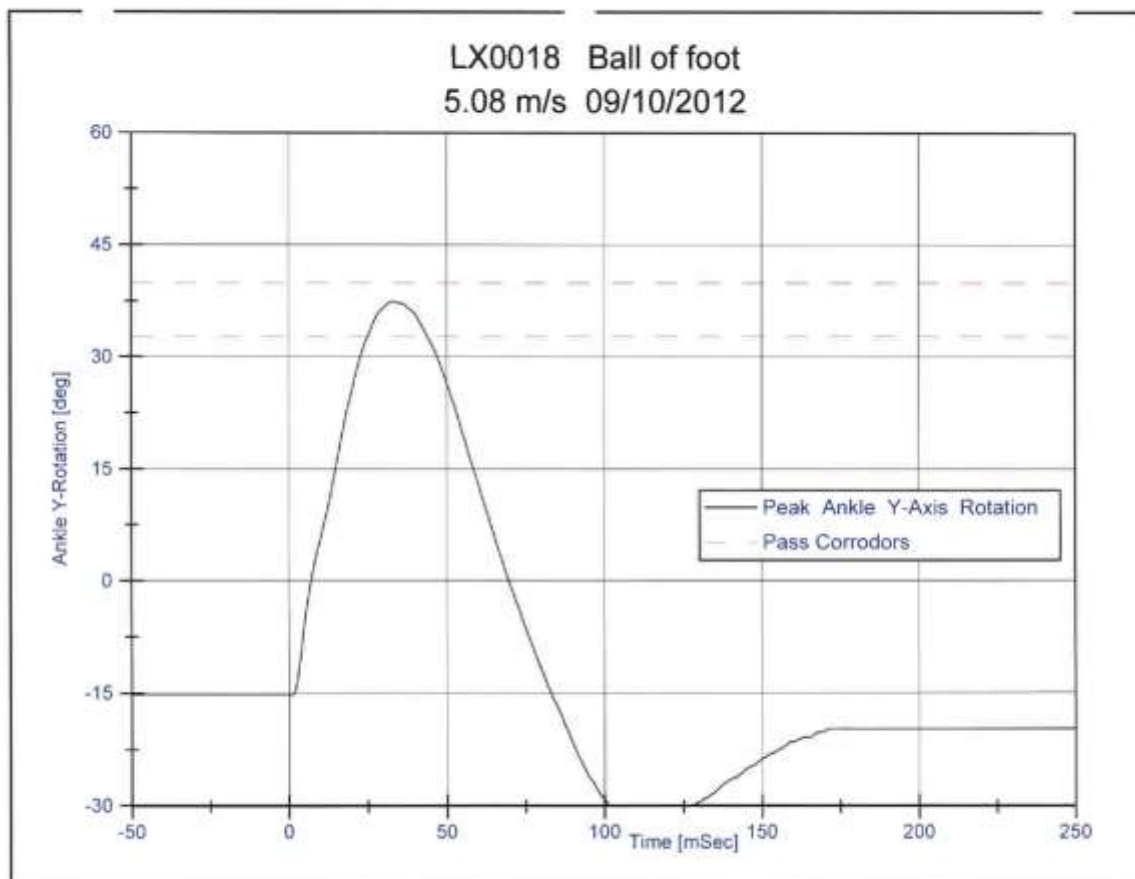
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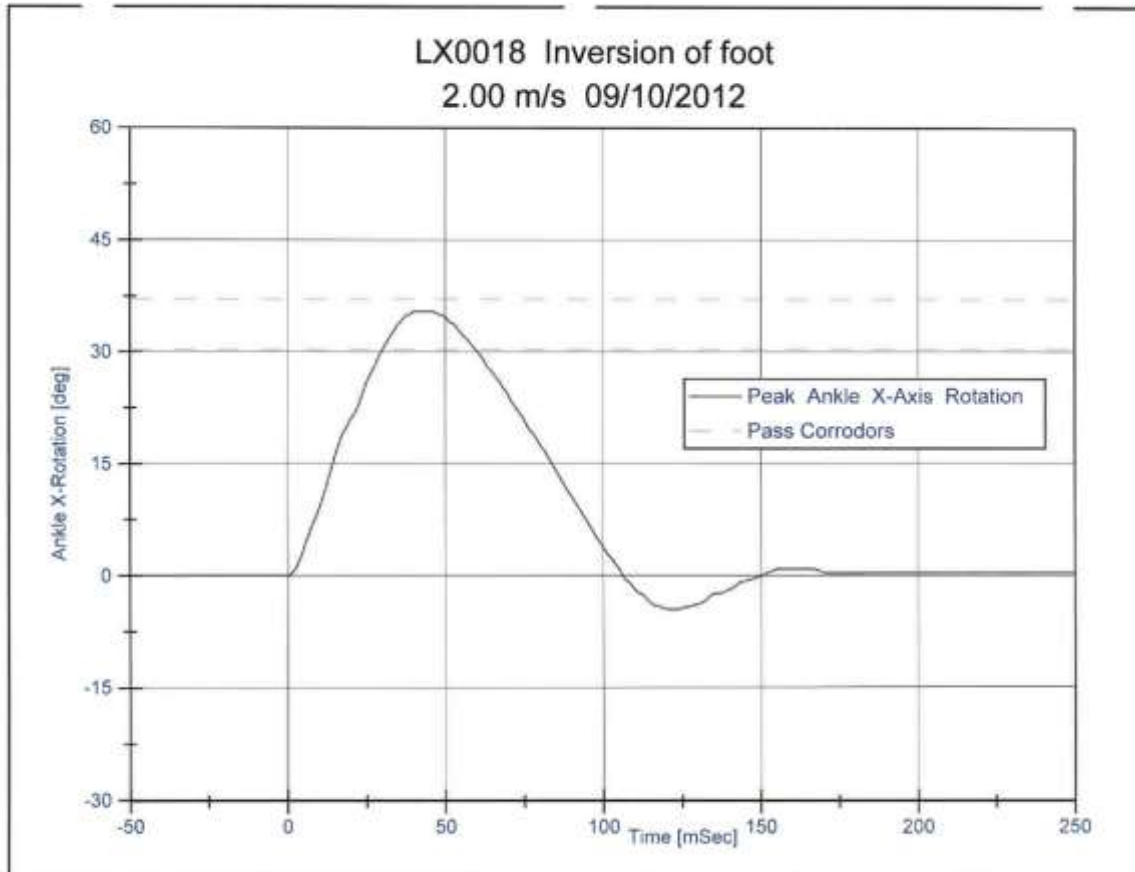
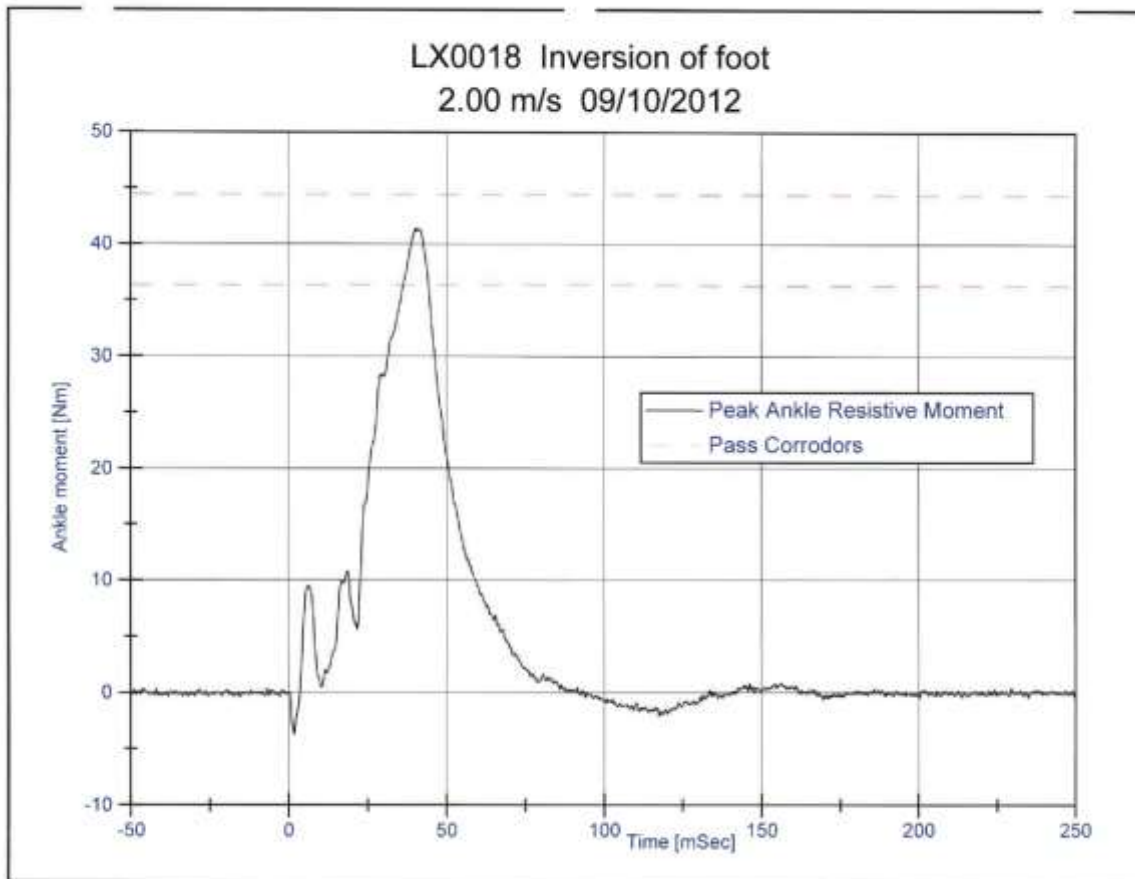




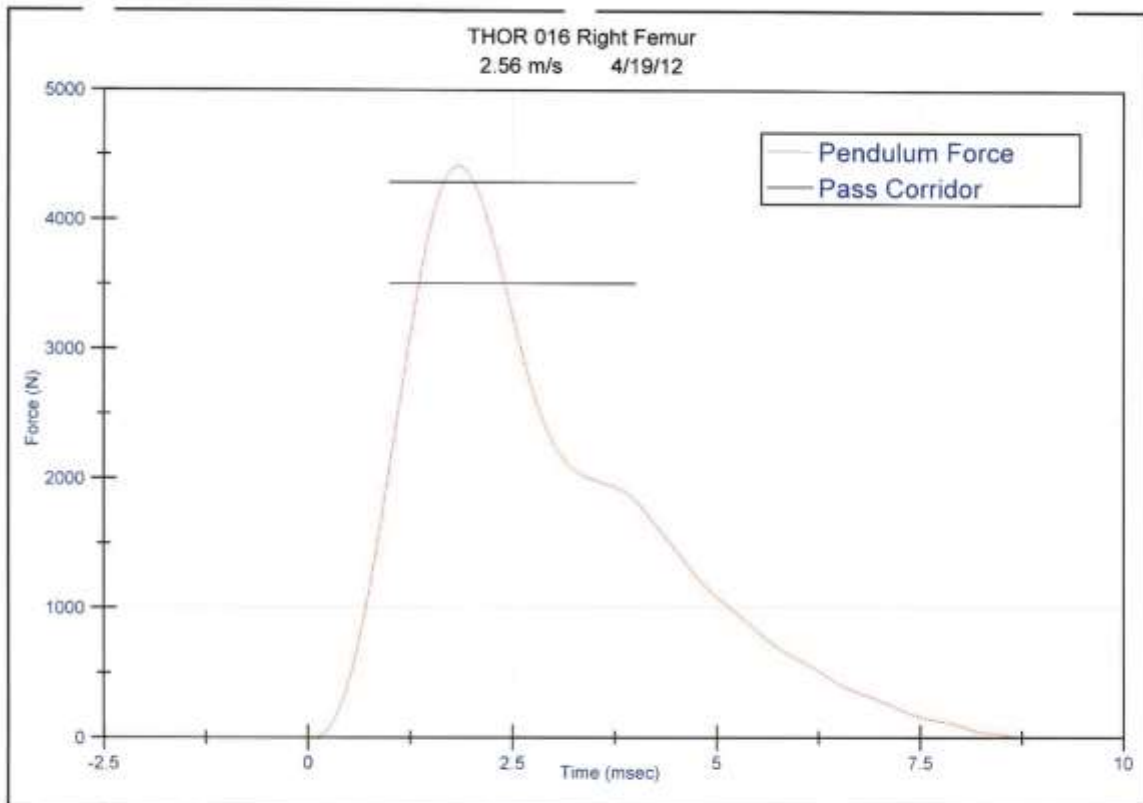
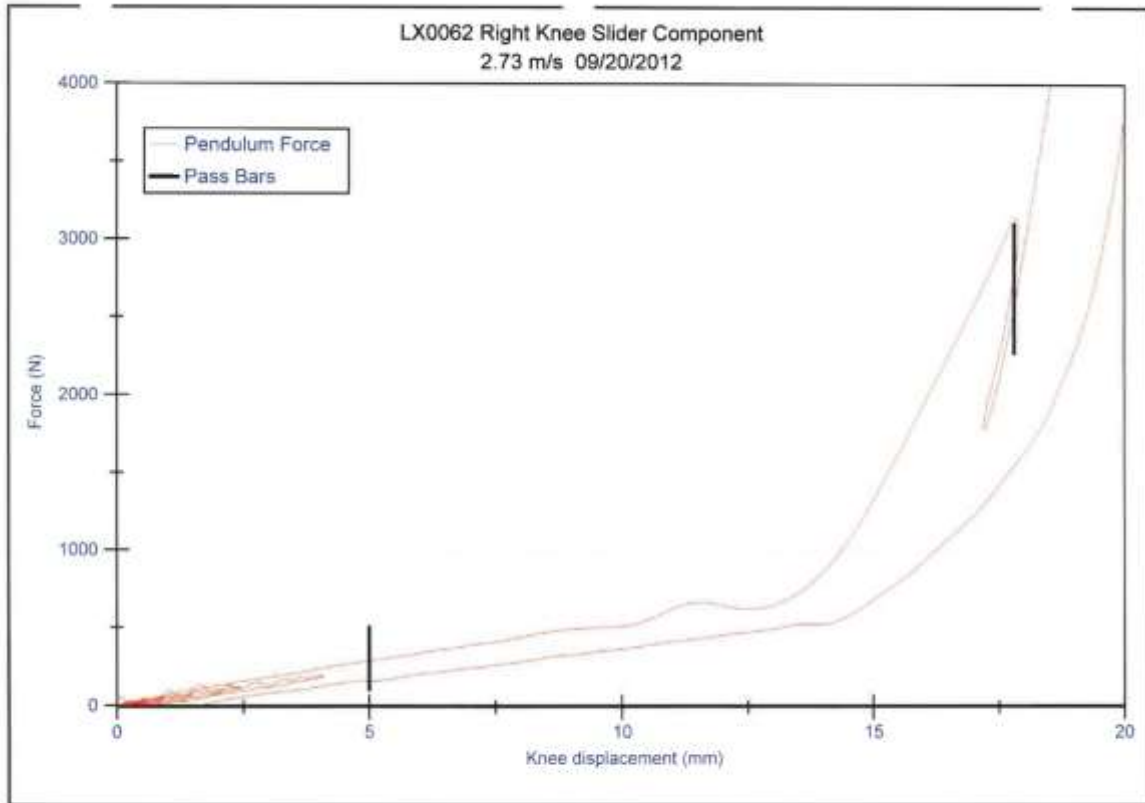


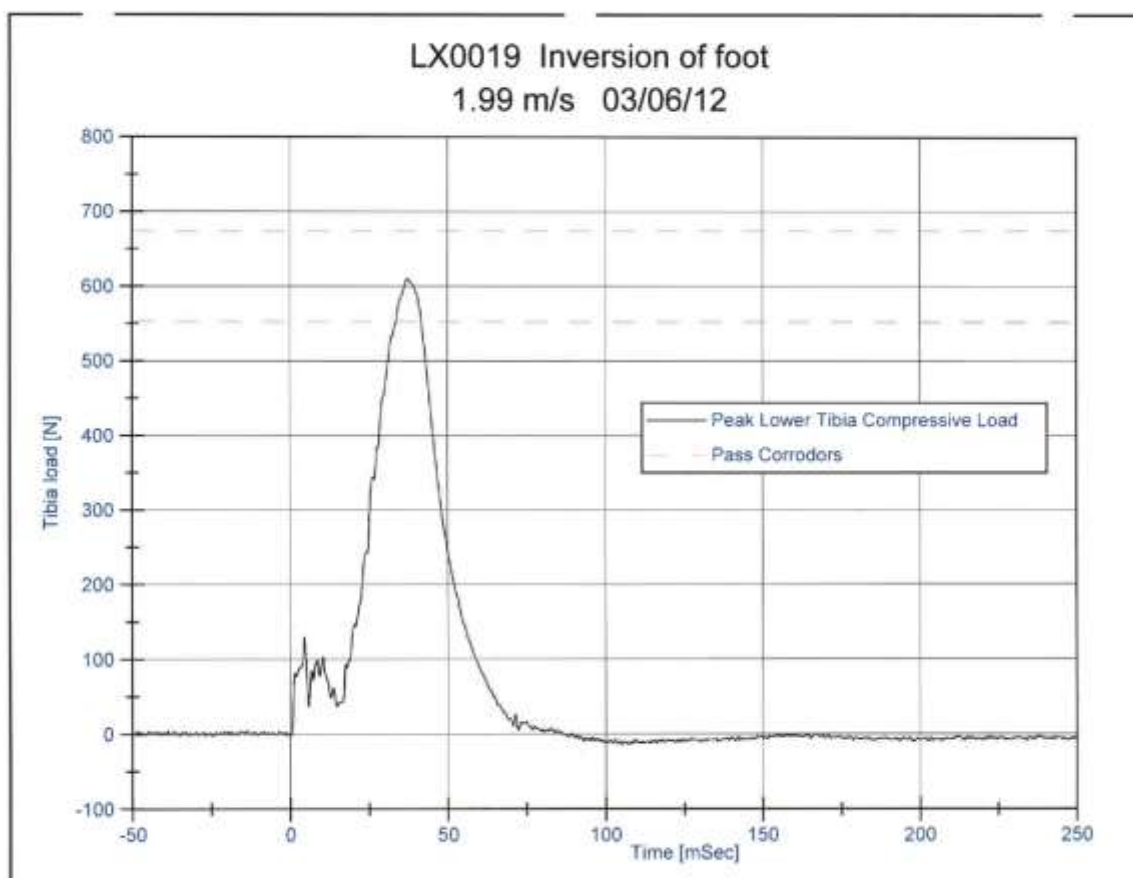
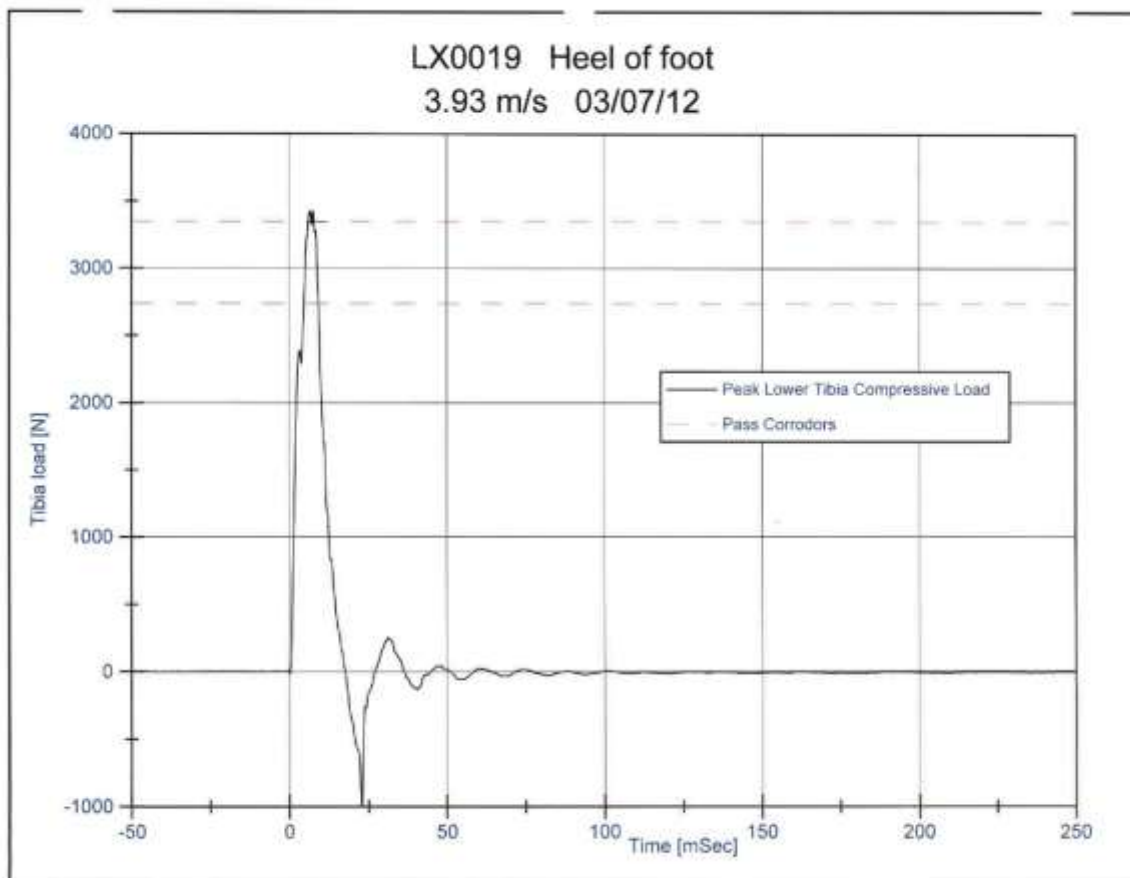


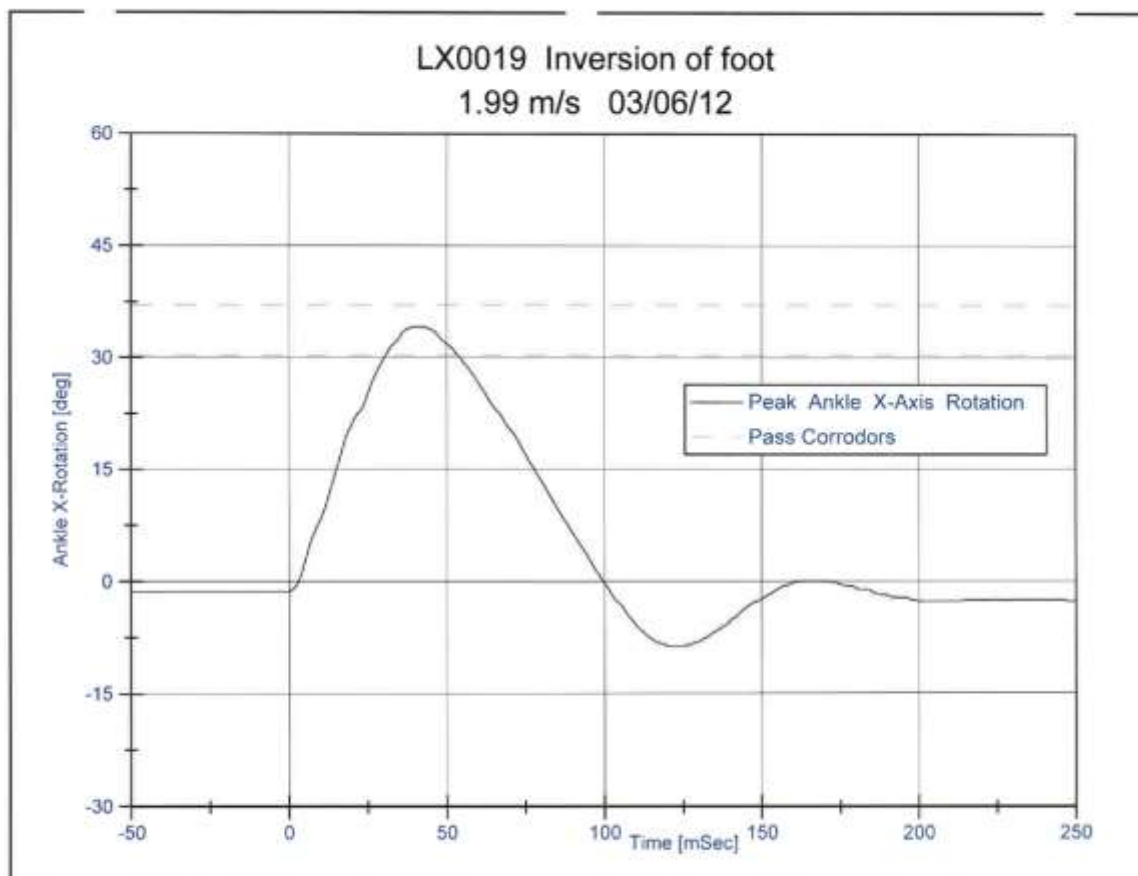
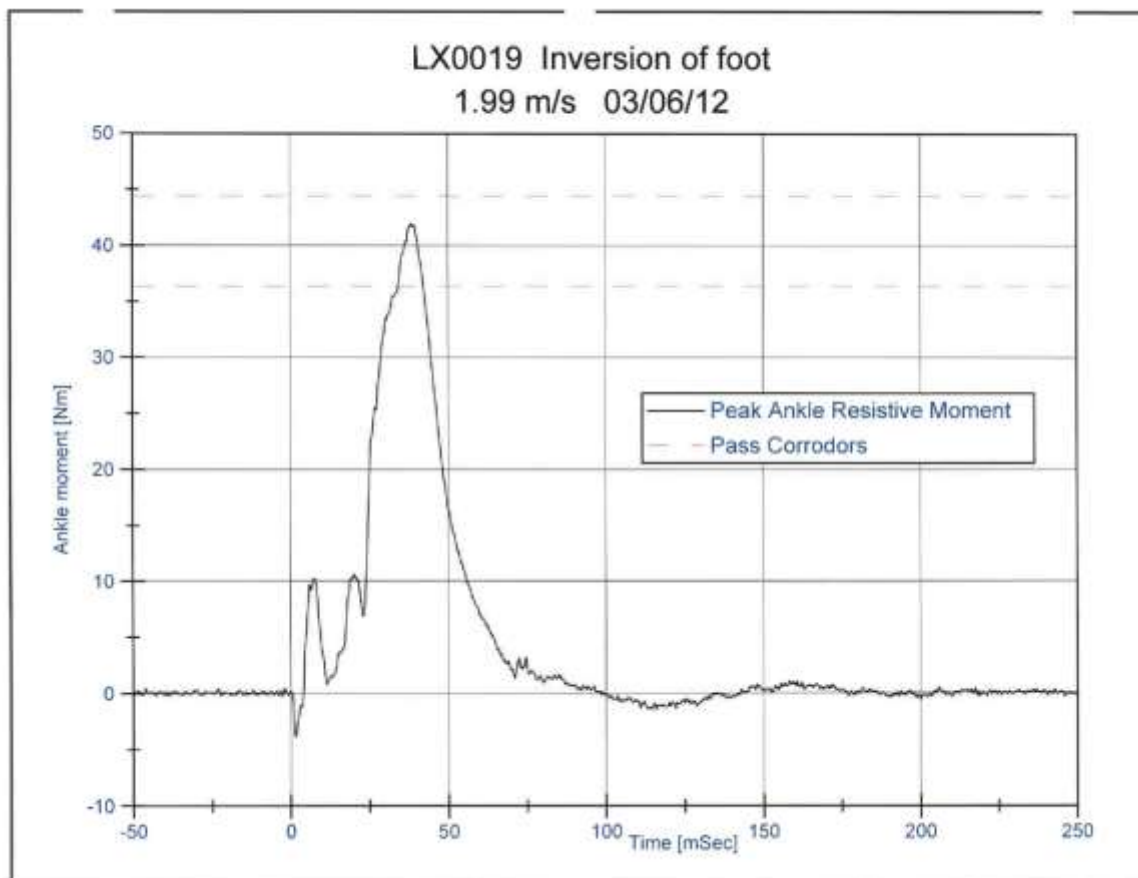


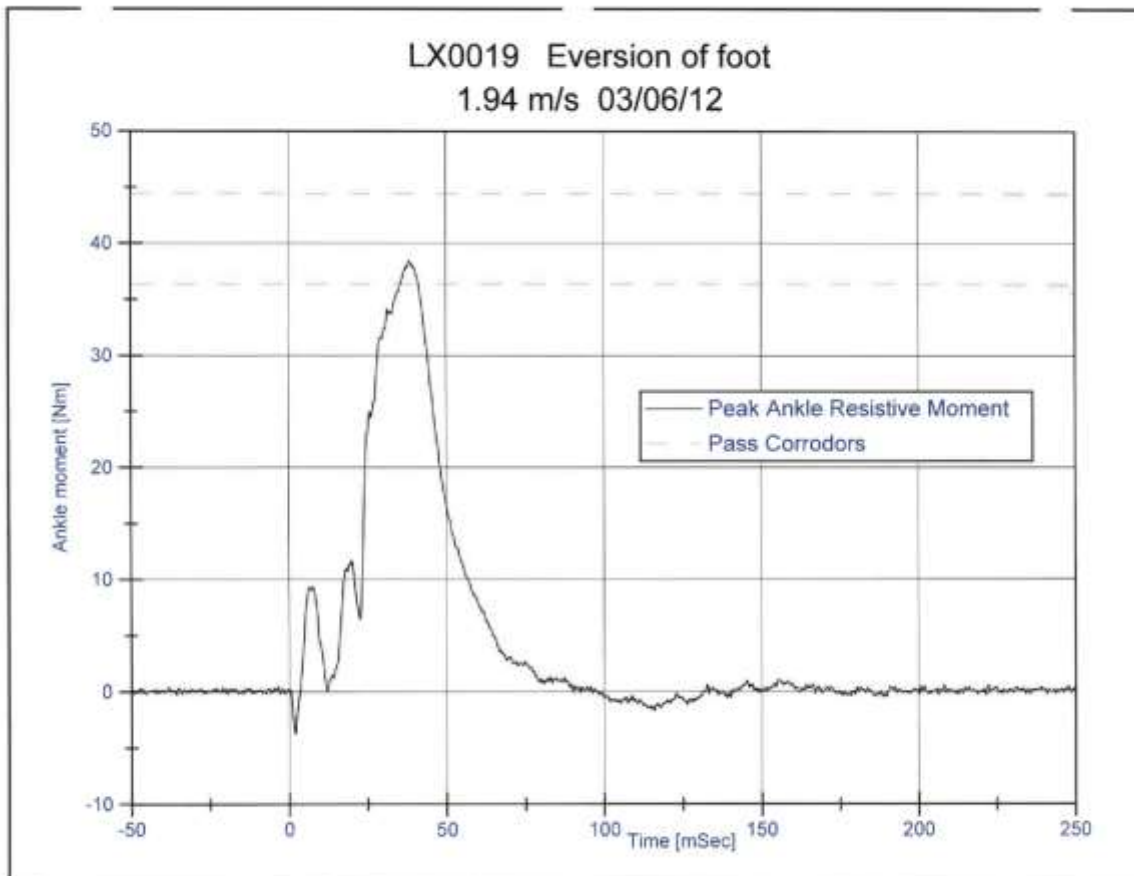
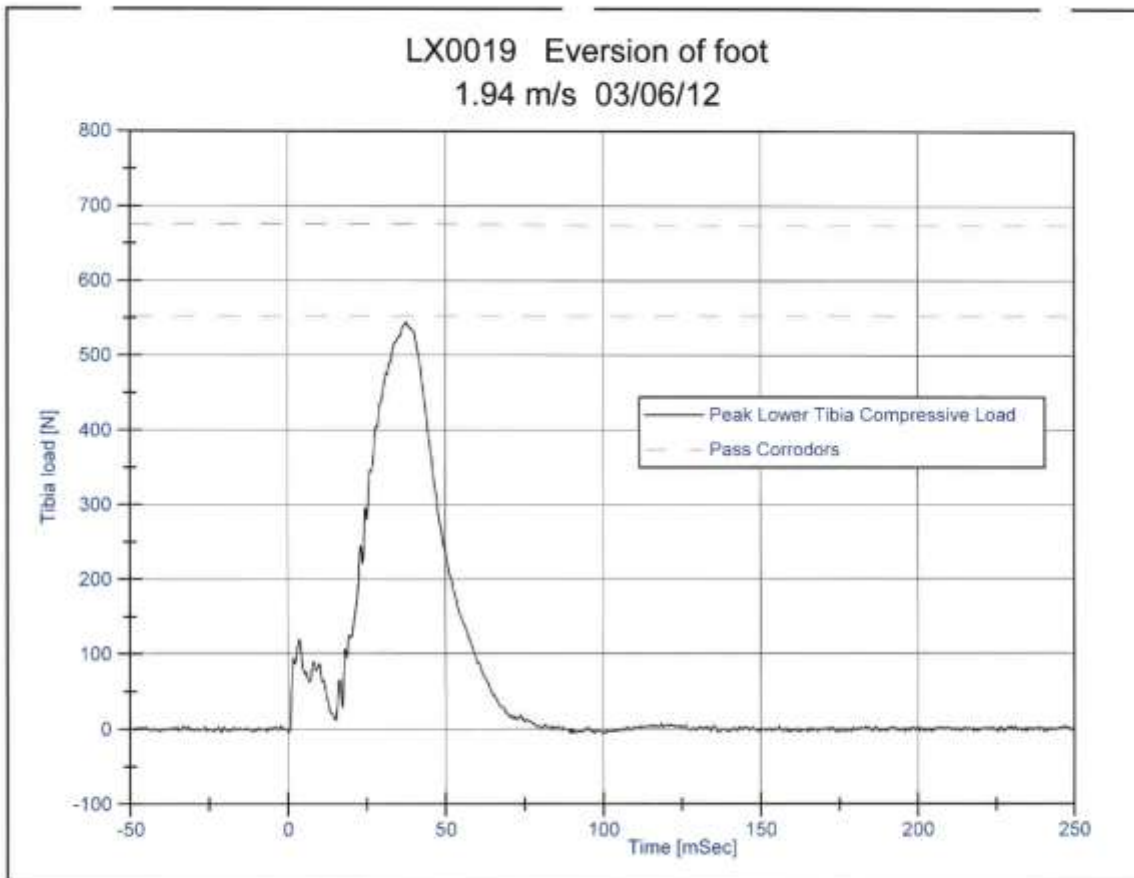


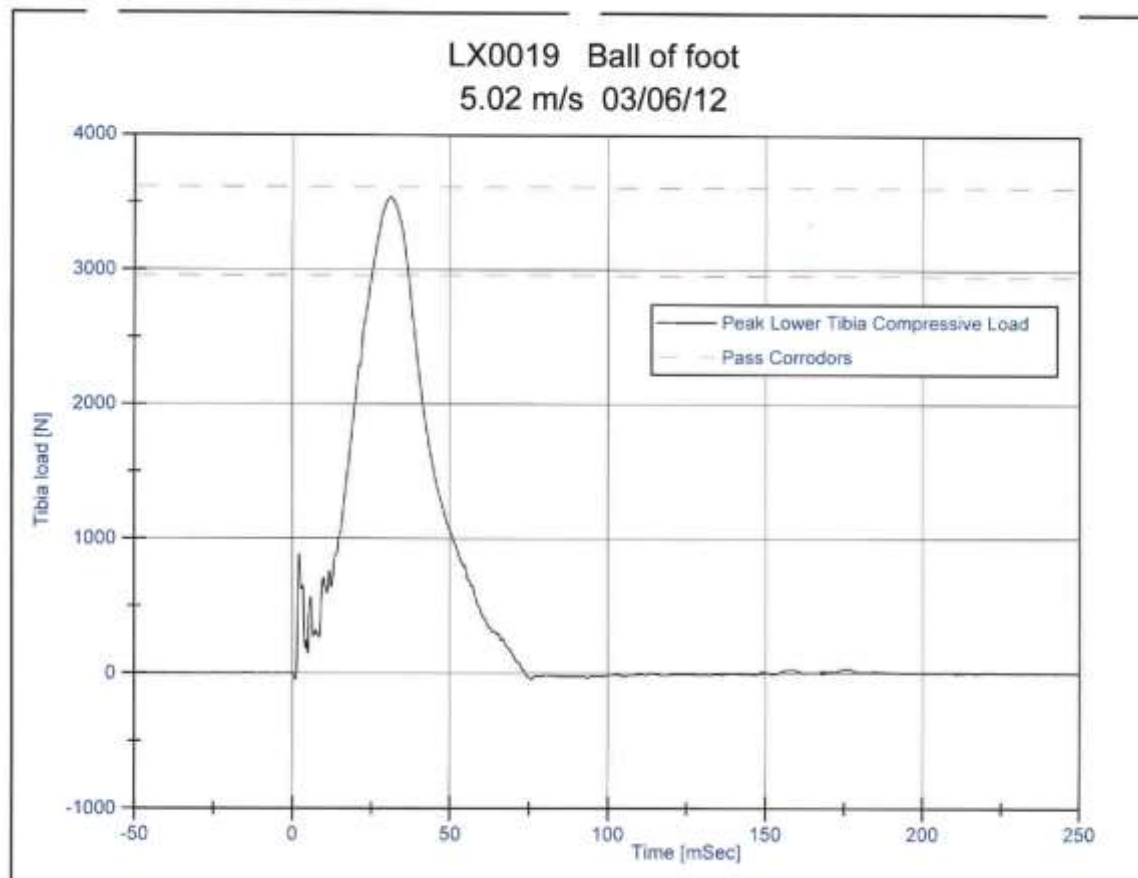
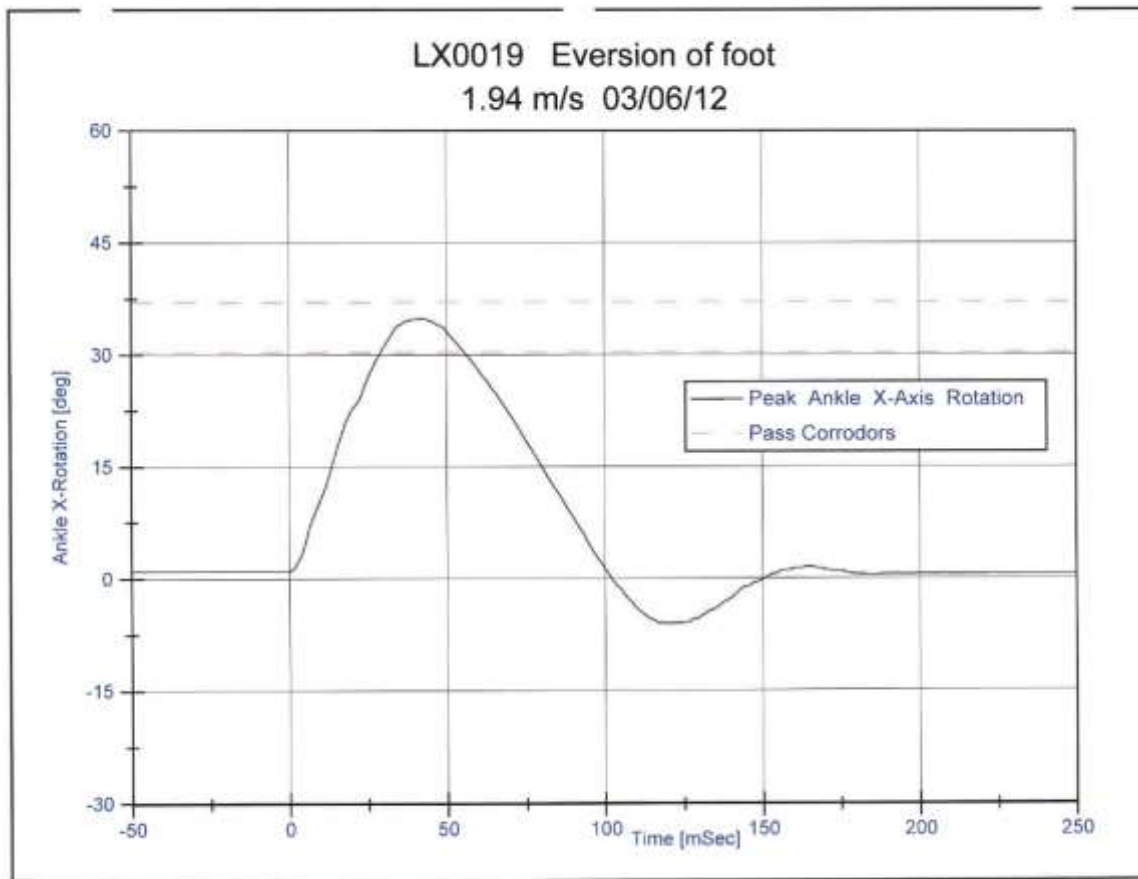
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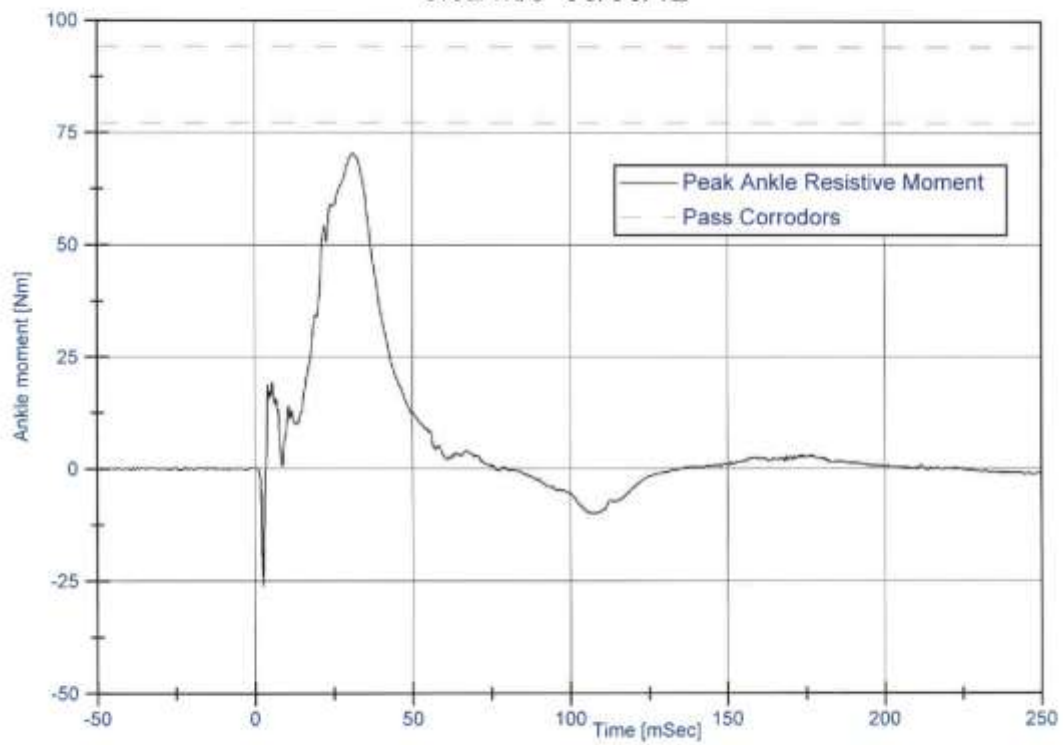




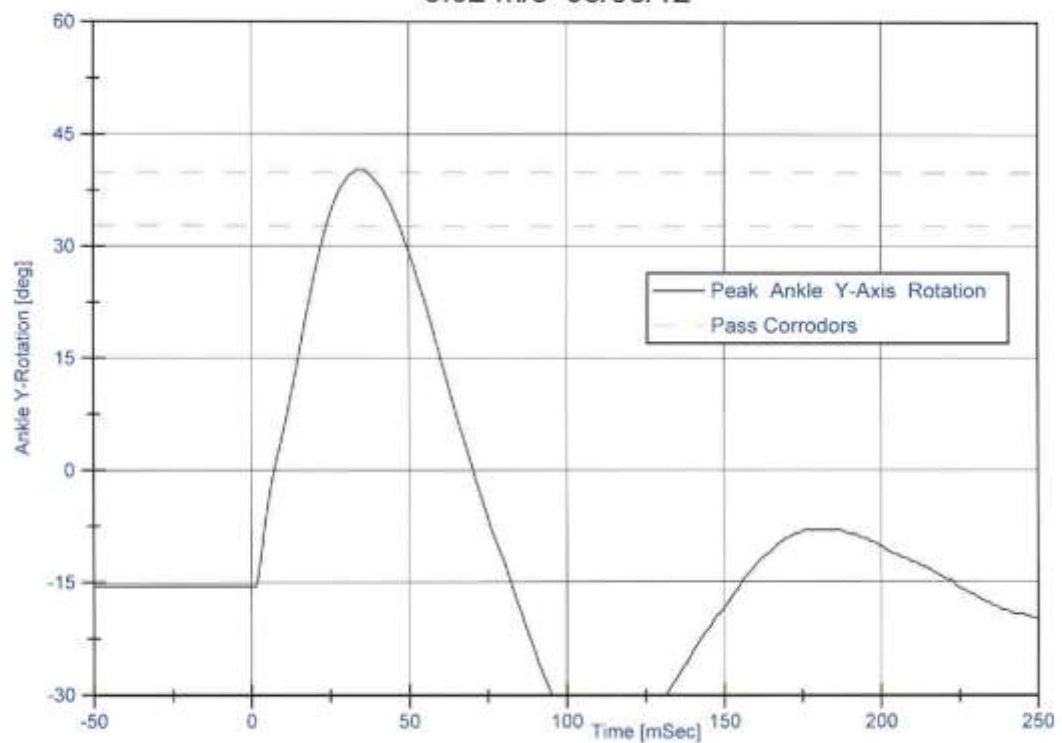




LX0019 Ball of foot
5.02 m/s 03/06/12



LX0019 Ball of foot
5.02 m/s 03/06/12



APPENDIX D:
CMM MEASUREMENT PROCEDURES

Vehicle Coordinate System

The origin point of the VCS is a point 50 mm forward of the rear window glass or hatchback door onto the roof of the vehicle along the vehicle's lateral centerline. The ground is not used as a reference.

The following procedure was used to create the Vehicle Coordinate System (VCS):

- 1) Place the As Delivered vehicle on a flat surface.
- 2) Measure the width of the vehicle at the rear of the vehicle to establish a first center point.
- 3) Measure the width of the vehicle at the front of the vehicle to establish a second center point.
- 4) Using a vertical laser beam, connect the two points to establish the lateral centerline of the vehicle.
- 5) Establish a point 50 mm from the edge of the rear window glass or rear hatchback door frame at the intersection of the roof onto the roof to establish the VCS origin point.
- 6) Construct a line perpendicular to the lateral centerline of the vehicle from VCS origin point towards the C-pillar. Mark a point along this line that is on the C-pillar at the body crease line between the roof and pillar geometry. This will be reference point #2.
- 7) Construct another perpendicular line in the opposite direction from the lateral centerline of the vehicle that is the same distance from the centerline as reference point #2. This will be reference point #3.
- 8) The VCS origin point is defined as the following:
 - Positive X is from the VCS origin point to the front of the vehicle
 - Positive Y is from the driver side of the vehicle to the passenger side of the vehicle
 - Positive Z is from the VCS origin point of the vehicle to the bottom of the vehicle

Steering Column Reference Point

The Steering Column Reference point is the x, y, and z location of the geometric center of the steering wheel in the VCS.

Brake Pedal Reference Point

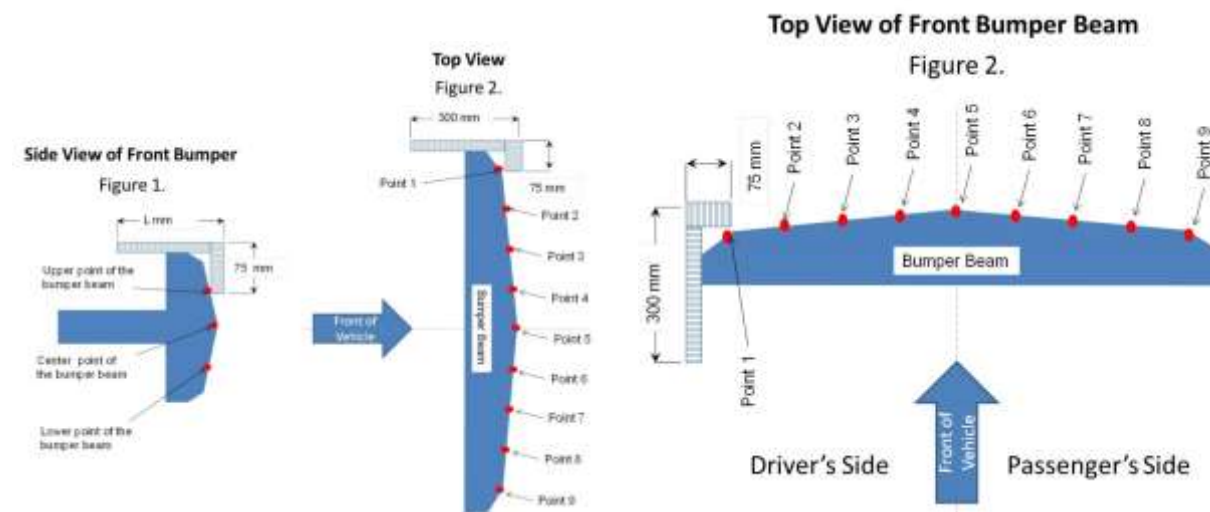
The Brake Pedal Reference Point is the x, y, and z location of the geometric center of the brake pedal pad (top surface) in the VCS.

Floor Reference Point

The Floor Reference Point is the x, y, and z location of the floor in the VCS. Use the following procedure to determine the Floor Reference Point:

1. If the vehicle has an accelerator pedal with fore-aft adjustment, adjust the pedal to its forward most position
2. Locate the centerline of the top surface of the bottom of the accelerator pedal (CLAP)
3. Remove floor mats
4. Project a vertical line down from the CLAP point until contact is made to the floor. This point is the Floor Reference Point

Pre and Post Bumper Beam and Radiator Support Measurement



Find the vertical center of the bumper beam using the following procedure (Reference Figure 1).

- 1) Position a square above the bumper beam at the centerline of the vehicle such that the plan of the square is aligned with the longitudinal axis of the vehicle and the "L mm" part of the square is parallel to the ground.
- 2) Move the square toward the ground until it contacts the bumper beam.
- 3) Move the square toward the rear of the vehicle until it contacts the bumper beam. The point where the 75 mm part of the square contacts the bumper beam is the Upper point of the bumper beam.
- 4) Perform the same procedure for the lower part of the bumper beam. The point where the 75 mm part of the square contacts the bumper beam is the Lower point of the bumper beam.
- 5) The center point of the bumper beam is half the distance between the Upper and Lower points of the bumper beam.
- 6) Transpose the lateral center of the bumper beam up onto the top of the upper radiator support.
- 7) Mark the center of the upper radiator support along its forward leading edge. If the radiator support is not flat this mark is made along the top edge.
- 8) Mark enough points along this edge to define its profile.

Pre and Post Driver Left Lower Instrument Panel

The left lower instrument panel (knee bolster) lateral coordinates are defined by adding 15 cm from the steering column reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor reference point. If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

Create a floor vehicle coordinate system on the floor at the location of this measurement.

Pre and Post Driver Right Lower Instrument Panel

The left lower instrument panel (knee bolster) lateral coordinates are defined by subtracting 15 cm from the steering column reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor reference point. If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

Pre and Post Brake Pedal (Figure 22)

If the brake pedal is constructed so that it dangles loosely after the crash, the brake pedal is pushed straight forward against the toepan/floor pan and held there to take the post-crash measurement. If the pedal drops away entirely, no post-crash measurement is taken.

Pre and Post Driver Toe pan and Floor Board (Figure 22)

DRIVER POINT A1

The vertical coordinate for the A1 measurement location is the vertical of the brake pedal reference. The lateral coordinate of the A1 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

DRIVER POINT B1

The vertical coordinate for the B1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the B1 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT C1

The vertical coordinate for the C1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the C1 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

DRIVER POINT D1

The vertical coordinate for the D1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the D1 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT A2

The vertical coordinate of the A2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the A2 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

DRIVER POINT B2

The vertical coordinate of the B2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference the vertical coordinate of the floor reference. The lateral coordinate of the B2 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT C2

The vertical coordinate of the C2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the C2 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

DRIVER POINT D2

The vertical coordinate of the D2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the 22 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT A3

The vertical coordinate of the A3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the A3 is obtained by subtracting 25 cm

from the brake pedal reference lateral coordinate.

DRIVER POINT B3

The vertical coordinate of the B3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the B3 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT C3

The vertical coordinate of the C3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the C3 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

DRIVER POINT D3

The vertical coordinate of the D3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the D3 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT A4

The longitudinal coordinate of the A4 measurement location is obtained by subtracting 5 cm from the A3 reference. The lateral coordinate of the A4 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

DRIVER POINT B4

The longitudinal coordinate of the B4 measurement location is obtained by subtracting 5 cm from the B3 reference. The lateral coordinate of the B4 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT C4

The longitudinal coordinate of the C4 measurement location is obtained by subtracting 5 cm from the C3 reference. The lateral coordinate of the C4 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

DRIVER POINT D4

The longitudinal coordinate of the D4 measurement location is obtained by subtracting 5 cm from the D3 reference. The lateral coordinate of the D4 is obtained by adding 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT A5

The longitudinal coordinate of the A5 measurement location is obtained by subtracting 5 cm from the A4 reference. The lateral coordinate of the A5 is obtained by subtracting 25 cm from the brake pedal reference lateral coordinate.

DRIVER POINT B5

The longitudinal coordinate of the B5 measurement location is obtained by subtracting 5 cm from the B4 reference. The lateral coordinate of the B5 is obtained by subtracting 15 cm from the brake pedal reference lateral coordinate.

DRIVER POINT C5

The longitudinal coordinate of the C5 measurement location is obtained by subtracting 5 cm from the C4 reference. The lateral coordinate of the C5 is obtained by subtracting 0 cm from the brake pedal reference lateral coordinate.

DRIVER POINT D5

The longitudinal coordinate of the D5 measurement location is obtained by subtracting 5 cm

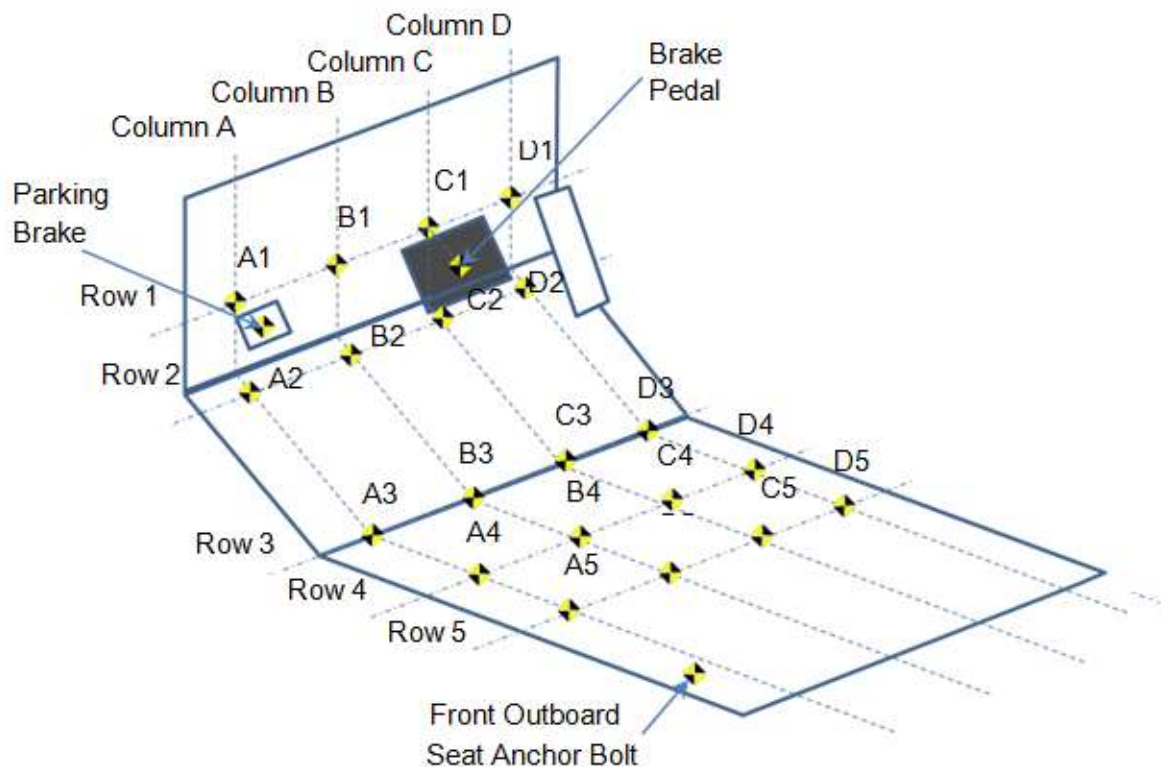
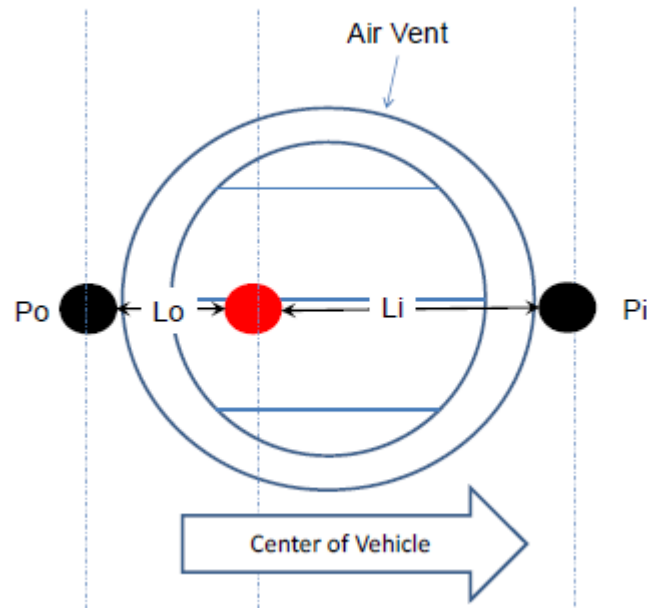


Figure 22: Lower interior intrusion measurements

Driver Upper Dash

The upper dash point is obtained by subtracting 25 cm from the lateral coordinate of the steering column reference lateral coordinate. This defines a line of points on the edge of the upper dash. The upper dash point is located on the rearward most (toward the rear of the vehicle) point on this line. This point must be located at least 30 cm above the brake pedal reference point to ensure a vertical location high enough to represent a location that could be contacted by the driver's upper body or head. If the rearward most point is less than 30 cm above the brake pedal reference point, the upper dash point is located at this 30 cm reference location.

There may be instances when the upper dash point is located on a "soft component" such as an air vent or control knob (Figure 23). To measure a more robust structure, the upper dash point is replaced with two additional points, and the weighted average of their coordinates is used to represent the deformation of a point at the original location (Equation 1). Each new point is determined by moving inboard/outboard to a location that is just off of the soft component.



$$dp = \frac{Li}{Lo + Li} [X_o, Y_o, Z_o] + \frac{Lo}{Lo + Li} [X_i, Y_i, Z_i]$$

Figure 23: Equation for Measuring Soft Component Driver Upper Dash Point

Passenger Left Lower Instrument Panel

The left lower instrument panel (knee bolster) lateral coordinates are defined by adding 15 cm from the center passenger seat reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor (without floor mats). If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

Create a floor vehicle coordinate system on the floor at the location of this measurement.

Passenger Right Lower Instrument Panel

The right lower instrument panel (knee bolster) lateral coordinates are defined by subtracting 15 cm from the center passenger seat reference lateral coordinate, respectively. The vertical coordinate is defined as 45 cm above the height of the floor (without floor mats). If the panel or knee bolster loosens or breaks away in the crash, the post-crash measurements are taken by pressing and holding the panel against the underlying structure.

Passenger Toe pan and Floor Board (Figure 24)

PASSENGER POINT A1

The vertical coordinate for the A1 measurement location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the A1 is obtained by subtracting 25 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT B1

The vertical coordinate for the B1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the B1 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT C1

The vertical coordinate for the C1 location is the vertical coordinate of the brake pedal reference. The lateral coordinate of the C1 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate..

PASSENGER POINT A2

The vertical coordinate of the A2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the A2 is obtained by subtracting 25 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT B2

The vertical coordinate of the B2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference the vertical coordinate of the floor reference. The lateral coordinate of the B2 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT C2

The vertical coordinate of the C2 measurement location is obtained by adding half the distance between the vertical coordinate of the brake pedal reference and the vertical coordinate of the floor reference. The lateral coordinate of the C2 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT A3

The vertical coordinate of the A3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the A3 is obtained by subtracting 25 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT B3

The vertical coordinate of the B3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the B3 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT C3

The vertical coordinate of the C3 measurement location is obtained by subtracting 1 cm from the floor reference. The lateral coordinate of the C3 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT A4

The longitudinal coordinate of the A4 measurement location is obtained by subtracting 5 cm from the A3 reference. The lateral coordinate of the A4 is obtained by subtracting 25 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT B4

The longitudinal coordinate of the B4 measurement location is obtained by subtracting 5 cm from the B3 reference. The lateral coordinate of the B4 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT C4

The longitudinal coordinate of the C4 measurement location is obtained by subtracting 5 cm from the C3 reference. The lateral coordinate of the C4 is obtained by subtracting 0 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT A5

The longitudinal coordinate of the A5 measurement location is obtained by subtracting 5 cm from the A4 reference. The lateral coordinate of the A5 is obtained by subtracting 25 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT B5

The longitudinal coordinate of the B5 measurement location is obtained by subtracting 5 cm from the B4 reference. The lateral coordinate of the B5 is obtained by subtracting 15 cm from the center passenger seat reference lateral coordinate.

PASSENGER POINT C5

The longitudinal coordinate of the C5 measurement location is obtained by subtracting 5 cm from the C4 reference. The lateral coordinate of the C5 is obtained by adding 15 cm from the center passenger seat reference lateral coordinate.

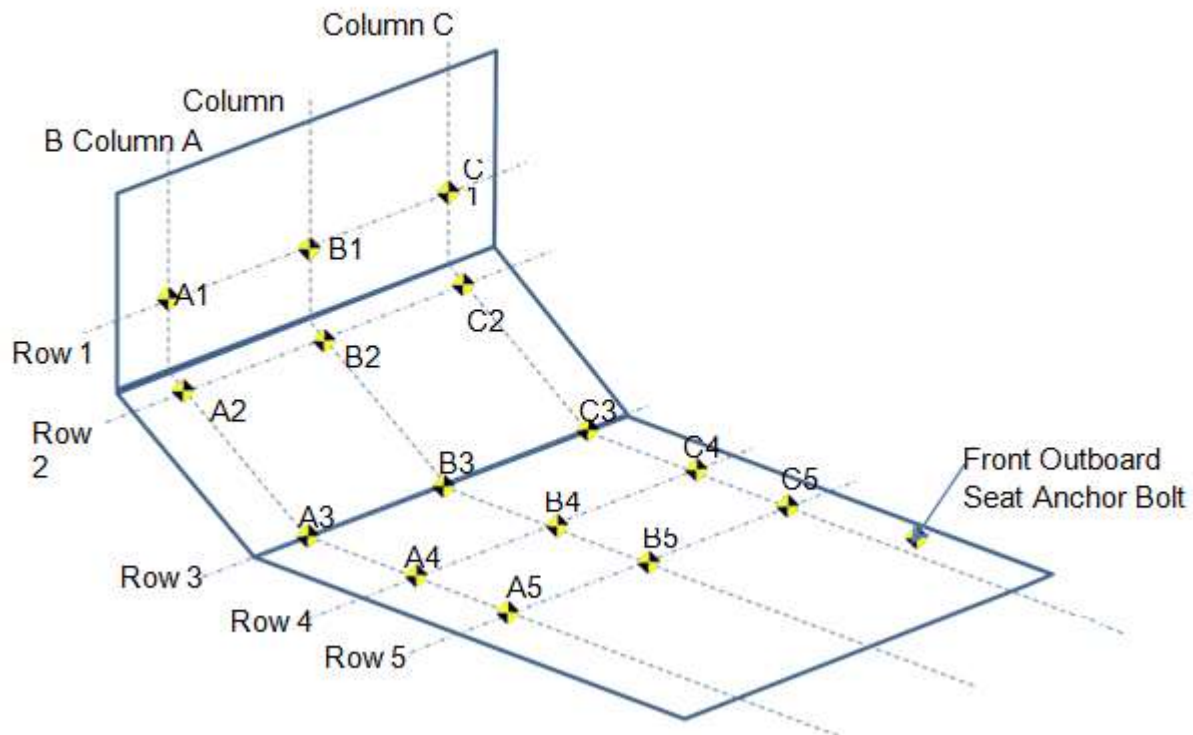


Figure 24: Passenger side lower interior measurements

Passenger Upper Dash

The upper dash point is obtained by adding 25 cm from the lateral coordinate of the center passenger seat reference lateral coordinate. This defines a line of points on the edge of the upper dash. The upper dash point is located on the rearward most (toward the rear of the vehicle) point on this line. This point must be located at least 30 cm above the brake pedal reference point to ensure a vertical location high enough to represent a location that could be contacted by the driver's upper body or head. If the rearward most point is less than 30 cm above the brake pedal reference point, the upper dash point is located at this 30 cm reference location.

There may be instances when the upper dash point is located on a "soft component" such as an air vent or control knob (Figure 23). To measure a more robust structure, the upper dash point is replaced with two additional points, and the weighted average of their coordinates is used to represent the deformation of a point at the original location (Equation 1). Each new point is determined by moving inboard/outboard to a location that is just off of the soft component.

Driver Door Measurements (Figure 25)

Mark the following points on the inner most surface of the door opening, typically on the pinch weld.

- 1) **Point 1:** The vertical coordinates of this point is obtained by subtracting 0 cm from the brake pedal reference point.
- 2) **Point 2:** The vertical coordinates of this point is obtained by subtracting 7.5 cm from the brake pedal reference point.
- 3) **Point 3:** The vertical coordinates of this point is obtained by subtracting 15 cm from the brake pedal reference point
- 4) **Point 4:** The vertical coordinates of this point is obtained by subtracting 45 cm from the brake pedal reference point.
- 5) **Point 5:** The vertical coordinates of this point is obtained by subtracting 52.5 cm from the brake pedal reference point).
- 6) **Point 6:** The vertical coordinates of this point is obtained by subtracting 60 cm from the brake pedal reference point
- 7) **Point 7:** The longitudinal coordinates of this point is obtained by subtracting 20 cm from the brake pedal reference point. If the 20 cm point is forward of the actual door frame, this point is located 5 cm rearward of lower hinge pillar point.
- 8) **Point 8:** The longitudinal coordinates of this point is obtained by subtracting 35 cm from the brake pedal reference point.
- 9) **Point 9:** The longitudinal coordinates of this point is obtained by subtracting 50 cm from the brake pedal reference point.
- 10) **Point 10 and 11:** Mark 2 evenly spaced points between points 1 and 7
- 11) **Point 12 and 13:** Mark 2 evenly spaced points between points 3 and 4
- 12) **Point 26:** Mark a point at the intersection of the roof rail and the start of the B-pillar
- 13) **Points 14-25:** Mark 12 evenly spaced points between points 6 and 26
- 14) **Point 32:** Mark a point at the intersection of the lower sill and the start of the B-pillar
- 15) **Points 27-31:** Mark 5 evenly spaced points between points 9 and 32



Figure 25: Driver Door Measurements

Passenger Door Measurements

Perform the same procedure as the driver door on the passenger side.

Pre-Test Exterior Profile

- 1) Expose the front bumper beam.
- 2) At the lateral center of the bumper beam, measure and mark the center of the front bumper beam (along front face of beam).
- 3) Using this Z coordinate, mark and measure enough points around the complete circumference of the vehicle to establish cross section A-A.
- 4) Transpose the lateral center of the bumper beam up onto the top of the upper radiator support.
- 5) Mark the center of the upper radiator support along its forward leading edge.
- 6) Using this Z coordinate, mark and measure enough points around the complete circumference of the vehicle to establish cross section B-B.

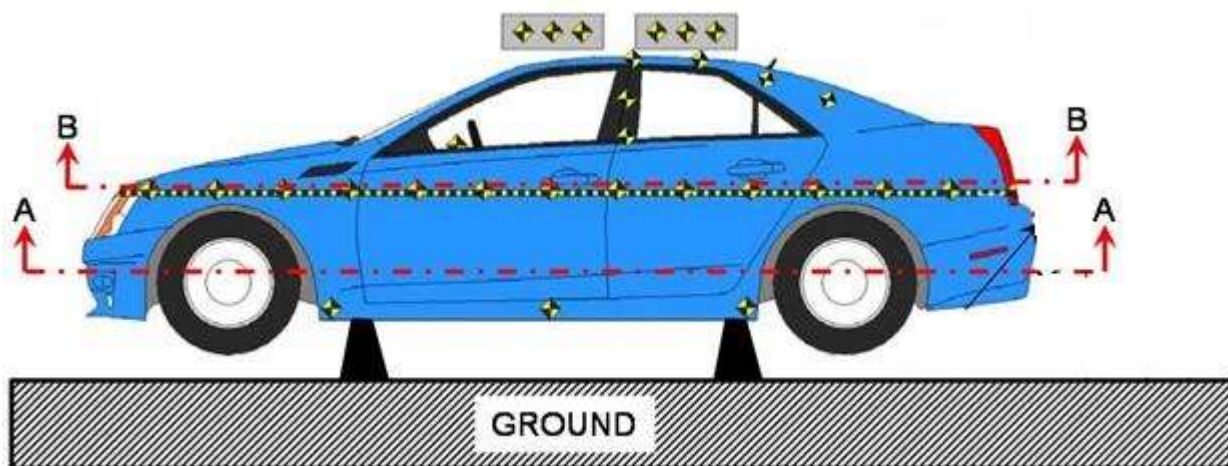


Figure 26: Pre-Test Vehicle Profile

Post-Test Exterior Profile

- 1) Remove bumper cover
- 2) Using the vehicle's origin reference point leap into vehicle's coordinate system.
- 3) Using the pre-test z-value at section A-A which was recorded from VCS origin, take measurements at this z-distance around the circumference of the vehicle.
- 4) Using the pre-test z-value at section B-B that was recorded from VCS origin, take measurements at this z-distance around the circumference of the vehicle.

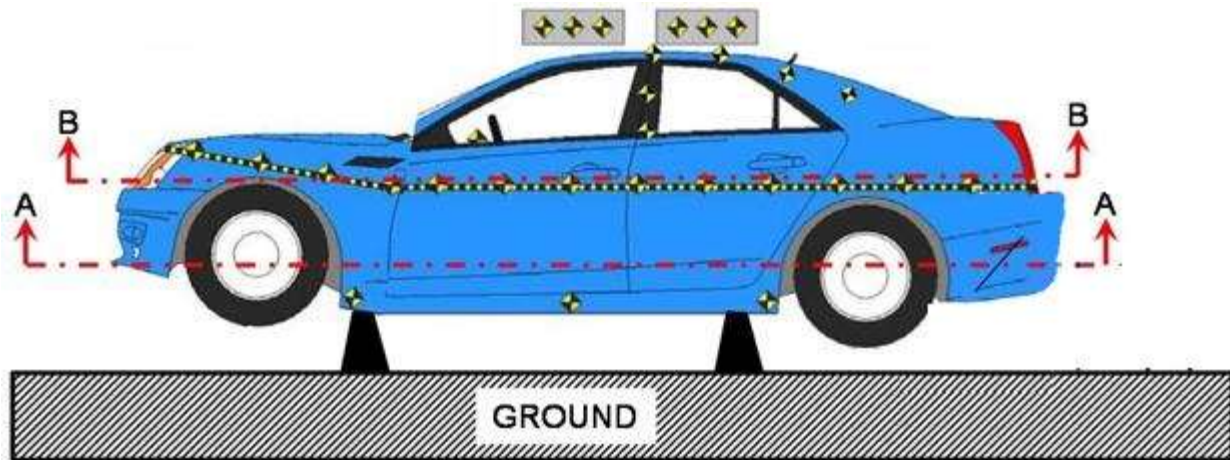


Figure 27: Post-Test Vehicle Profile

Pre and Post Honeycomb Requirements

The contractor shall take pre-and post-crush measurements of the honeycomb while attached to the barrier. These measurements shall be documented in the appropriate datasheet. Also, the contractor shall take pre-and post-test pictures of the left and right side, top, and front view of the honeycomb while attached to the barrier.