REPORT NUMBER: NCAP-MGA-2019-045

NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test

NISSAN MOTOR CO., LTD.
2019 Nissan Altima S AWD 4-Door Sedan
NHTSA No.: O20195200

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: May 30, 2019

Final Report Date: September 13, 2019

FINAL REPORT

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crashworthiness Standards
Mail Code: NRM-110
1200 New Jersey Ave, SE
Room W43-410
Washington, DC 20590

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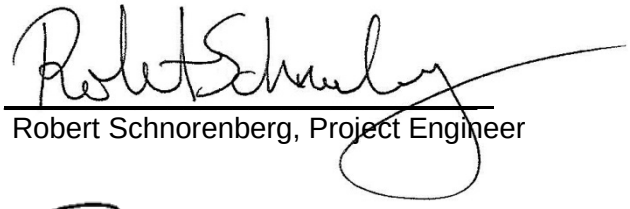
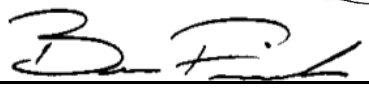
Prepared by: 
Robert Schnorenberg, Project Engineer

Approved by: 
Ben Fischer, Project Engineer

Approval Date: September 13, 2019

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date: _____

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

Date: _____

Technical Report Documentation Page

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15. Supplementary Notes		

16. Abstract

A 56.3 km/h NCAP Frontal Impact Test was conducted on a 2019 Nissan Altima S AWD 4-Door Sedan in accordance with the specifications of the Office of Crashworthiness Standards Frontal NCAP Laboratory Test Procedure. This test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), and 301 performance. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on May 30, 2019.

The impact velocity of the vehicle was 56.62 km/h and the ambient temperature at the barrier face at the time of impact was 21.5°C. The target vehicle post-test maximum crush was 449 mm located to the right of the vehicle centerline. The test vehicle's performance was as follows:

Measurement Description	Units	Driver ATD		Passenger ATD	
		Threshold	Result	Threshold	Result
Head Injury Criteria (HIC_{15})	N/A	700	171	700	239
Maximum Chest	mm	63	24	52	13
Nij	N/A	1	0.30	1	0.54
Neck Tension	N	4170	1525	2620	1245
Neck Compression	N	4000	345	2520	489
Left Femur Force	N	10008	509	6805	1157
Right Femur Force	N	10008	1522	6805	1246

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SECTION 1
PURPOSE AND SUMMARY OF TEST

PURPOSE

This 56.3 km/h frontal barrier impact test is part of the Vehicle Barrier Impact Testing Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-12-D-00258. The purpose of this test was to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

The 56.3 km/h frontal barrier impact was conducted in accordance with the Office of Crashworthiness Standards Frontal NCAP Laboratory Test Procedure.

SUMMARY

A rigid flat barrier was impacted by a 2019 Nissan Altima S AWD 4-Door Sedan at a velocity of 56.62 km/h. The test was performed at MGA Research Corporation on May 30, 2019. Pre-test and post-test photographs of the vehicle and dummies can be found in Appendix A.

Two (2) real-time cameras and fourteen (14) high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in this report.

One Part 572E 50th percentile male anthropomorphic test device (ATD), was placed in the driver seating position and one Part 572O 5th percentile female test device (ATD) was placed in the right-front passenger seating position according to dummy placement instructions specified in the Frontal NCAP Laboratory Test Procedure.

Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometers, upper neck transducers, right/left femur load cells, and lower leg instrumentation.

The driver (position 1) ATD (Serial No. 351) and the right-front passenger (position 2) ATD (Serial No. 1659) were calibrated previous to this test. Certification details, along with instrumentation calibration data, are found in Appendix C of this report.

The 106 channels of data were recorded on a data acquisition system. Appendix B contains the dummy response data traces.

There was 100 percent windshield retention and no intrusion into the protected zone of the windshield during the event. There was no Stoddard Solvent leakage after the event or during any phase of the static rollover.

The maximum static crush of the vehicle was 449 mm located to the right of the vehicle centerline and both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

The driver's visible contact points were as follows: The driver's head contacted the airbag. The driver's head also contacted the headrest. The driver's knees contacted the knee airbag.
The passenger's visible contact points were as follows: The passenger's head contacted the airbag. The passenger's head also contacted the headrest. The passenger's knees contacted the knee airbag.

The occupant data is summarized below:

ATD position	HIC_{15}	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (Gs)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50^{th})	171	0.30	1525	345	40	24	509	1522
Passenger (5^{th})	239	0.54	1245	489	40	13	1157	1246

The test data can be found on the NHTSA website at www.nhtsa.gov

TEST NOTES

Bottom of Engine X recorded no valid data after 85 ms.

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	O20195200	Traction Control System (TCS)	Yes
Model Year	2019	Power Steering	Yes
Make	Nissan	Power Window Auto-Reverse	Yes
Model	Altima S AWD	Driver Frontal Airbag	Yes
Body Style	4-Door Sedan	Driver Curtain Airbag	Yes
VIN	1N4BL4BWXKC161066	Driver Head/Torso Airbag	No
Body Color	Deep Blue Pearl	Driver Torso Airbag	No
Odometer (km/mi)	13km / 8mi	Driver Torso/Pelvis Airbag	Yes
Engine Displacement (L)	2.5 L	Driver Pelvis Airbag	No
Type/No. Cylinders	I4	Driver Knee Airbag	Yes
Engine Placement	Lateral	Front Pass. Frontal Airbag	Yes
Transmission Type	Automatic	Front Pass. Curtain Airbag	Yes
Transmission Speeds	CVT	Front Pass. Head/Torso Airbag	No
Overdrive	Yes	Front Pass. Torso Airbag	No
Final Drive	AWD	Front Pass. Torso/Pelvis Airbag	Yes
Roof Rack	No	Front Pass. Pelvis Airbag	No
Sunroof/T-Top	No	Front Pass. Knee Airbag	Yes
Running Boards	No	Driver Pretensioner	Yes
Tilt Steering Wheel	Yes	Driver Load Limiter	Yes
Power Seats	Yes	Front Pass. Pretensioner	Yes
Anti-Lock Brakes (ABS)	Yes	Front Pass. Load Limiter	Yes
Automatic Door Locks (ADLs)	Yes	Other	N/A

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

DATA FROM CERTIFICATION LABEL

Manufactured By	NISSAN MOTOR CO., LTD.
Date of Manufacture	12/18

GVWR (kg)	2018
GAWR Front (kg)	1097
GAWR Rear (kg)	969

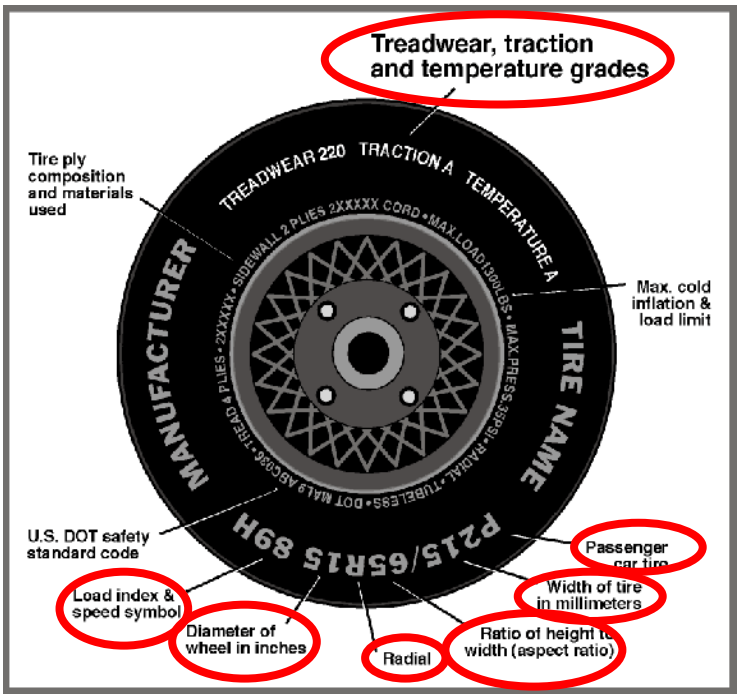
VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Contoured		
Designated Seating Capacity (DSC)	2	3		5
Capacity Weight (VCW) (kg)				408
Cargo Weight (RCLW) (kg)				68

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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	220	220
Recommended Tire Size	215/60R16	215/60R16
Tire Size on Vehicle	215/60R16	215/60R16
Tire Manufacturer	Continental	Continental
Tire Model	ProContact	ProContact
Treadwear	500	500
Traction	A	A
Temperature Grade	A	A
Tire Plies Sidewall	1 Polyester	1 Polyester
Tire Plies Body	1Polyester, 2 Steel, 1 Polyamide	1Polyester, 2 Steel, 1 Polyamide
Load Index/Speed Symbol	95H	95H
Tire Material	Rubber	Rubber
DOT Safety Code Left	A35M WD3T 4418	A35M WD3T 4418
DOT Safety Code Right	A35M WD3T 4418	A35M WD3T 4418

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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	455.0	313.0		486.0	389.5	
Right	kg	448.0	296.5		473.0	365.0	
Ratio	%	59.7%	40.3%		56.0%	44.0%	
Totals	kg	903.0	609.5	1512.5	959.0	754.5	1713.5

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1512.5
Weight of 1 P572E ATD & 1 P572O ATD	kg	141
Rated Cargo/Luggage Weight (RCLW)	kg	68
Calculated Test Vehicle Target Weight (TVTW)	kg	1721.5

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	703	709	727	733	1139
As Tested	mm	696	700	688	695	1244
Post Test	mm	722	728	704	704	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2826
Total Vehicle Length at Left Side	mm	4812
Total Vehicle Length at Centerline	mm	4905
Total Vehicle Length at Right Side	mm	4812
Weight of Ballast in Cargo Area	kg	17
Weight of Vehicle Components Removed	kg	20
Amount of Stoddard Solvent in Fuel Tank	L	56.4

List of components removed to meet test weight: None.

List of components removed for instrumentation, data box, and equipment installation: Cargo area divider, jack and tool kit, spare tire and cover, RR taillight, LF/RF underbody plastic, LF/RF/LR/RR wheel covers.

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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

TARGET VEHICLE STRUCTURAL MEASUREMENT

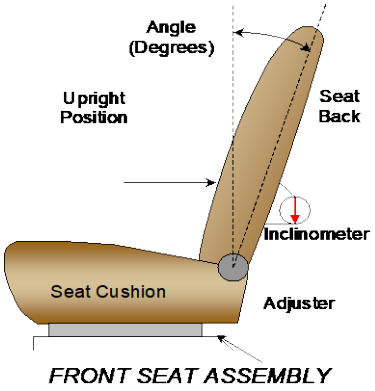
	Elements	Pre-Test (mm)
1	Total Length	4905
2	Total Width	1835
3	Bumper Top Height	554
4	Bumper Bottom Height	434
5	Longitudinal Member Top Height	548
6	Distance between Longitudinal Members	938
7	Longitudinal Member Width	75
8	Engine Top Height	830
9	Engine Bottom Height	150
10	Engine and Gearbox Width	940
11	Front Bumper-Engine Distance	300
12	Front Shock Absorber Fixing Height	872
13	Bonnet Leading Edge Height	770
14	Front Shock Absorber Fixing Width	1188
15	Front Bumper – Front Axle Distance	972
16	Front Axle – A-Pillar Distance	496
17	A-Pillar – B-Pillar Distance	1172
18	B-Pillar – Rear Axle Distance	1156
19	B-Pillar – C-Pillar Distance	724
20	Roof Sill Bottom Height	1306
21	Roof Sill Top Height	1391
22	Floor Sill Bottom Height	190
23	Floor Sill Top Height	380

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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

NOMINAL DESIGN RIDING POSITION

The driver seat back is positioned as close as possible to the manufacturer's design angle. For the passenger seat back, seat back is adjusted following Appendix F, "Driver & Passenger Dummy Seating & Positioning Procedures" in the NCAP Test Procedure dated October 2015.



	Degrees
Driver Seat Back Angle	1.7° on outboard headrest post
Passenger Seat Back Angle	7.0° on outboard headrest post

SEAT FORE/AFT POSITIONS

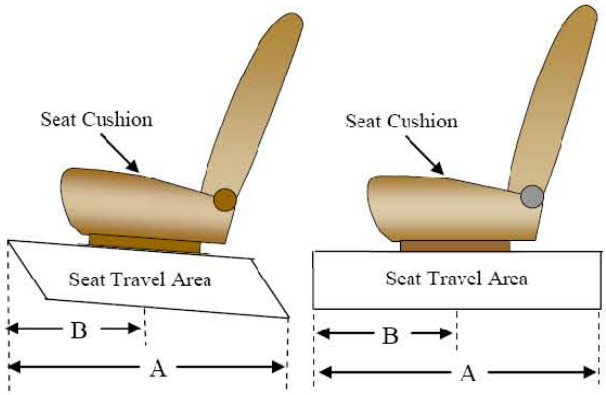
The driver and passenger seat fore/aft positions are adjusted following Appendix F, "Driver & Passenger Dummy Seating & Positioning Procedures" in the NCAP Test Procedure dated October 2015.

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	270 mm	135 mm
Passenger Seat	240 mm / 25 detents (1st as 1)	0 mm / 0th (1st as 0)

SEAT BELT UPPER ANCHORAGES

The seat belt upper anchorages are positioning following the manufacturer's specified position as listed in Form 1.

	Total # of Positions	Placed in Position #
Driver Seat	3 (1st as 1)	0 (1st as 0)
Passenger Seat	3 (1st as 1)	0 (1st as 0)



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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

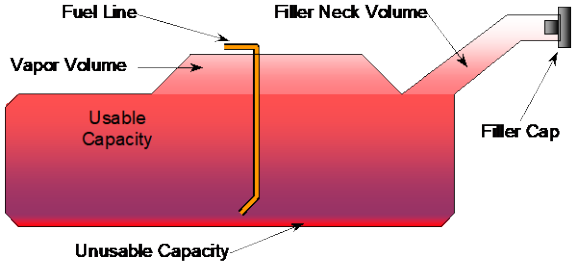
FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	60.6
Usable Capacity of "Optional Tank"	
92-94% of Usable Capacity	55.8 to 57
Actual Amount of Solvent used	56.4
1/3 of Usable Capacity	20.2

FUEL PUMP

Describe the fuel pump type, its behavior, and the location of the fuel filler pipe.

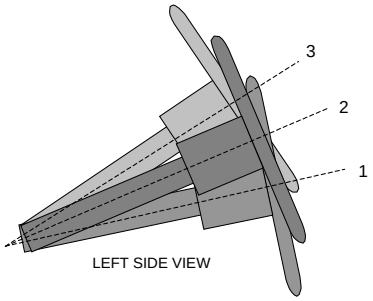
The vehicle is equipped with an electronic fuel pump. The fuel pump is activated approximately 1 second after the ignition is turned on. It remains on while the engine is running. The filler neck is located on the driver's side.



VEHICLE FUEL TANK ASSEMBLY

STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. An aluminum plate is placed across the rim of the steering wheel, an inclinometer is placed on the plate and the angle is measured.



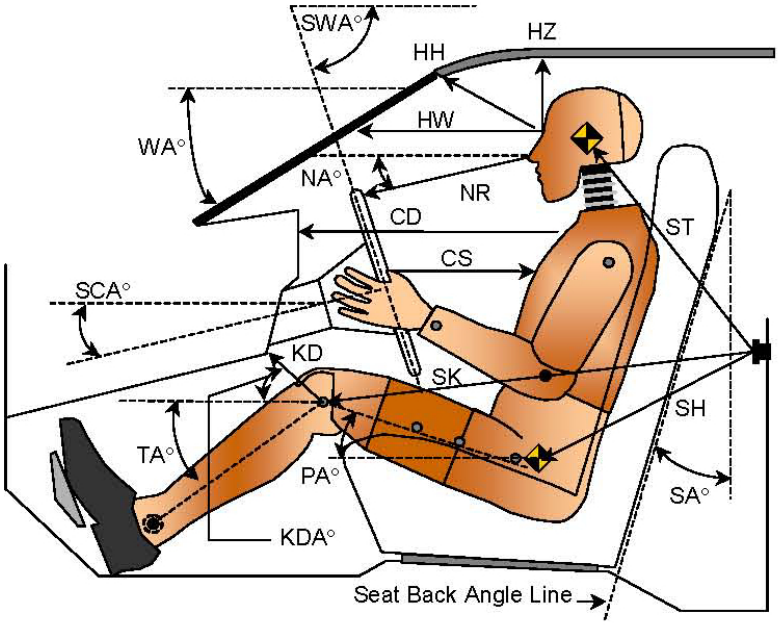
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost Position 1	69.3	210
Geometric Center Position 2	66.6	183
Uppermost Position 3	63.8	156
Telescoping Steering Wheel Travel		54
Test Position	66.6	183

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

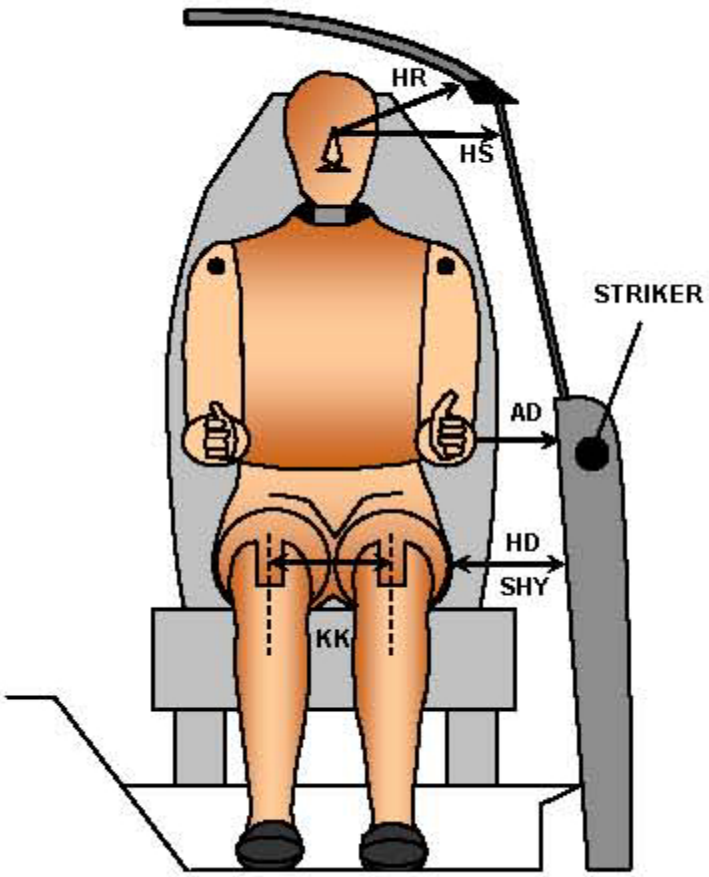


LEFT SIDE VIEW

Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		21.7		
SWA°	Steering Wheel Angle		66.6		
SCA°	Steering Column Angle		23.4		
SA°	Seat Back Angle		1.7		7.0
HZ	Head to Roof (Z)	168	90	205	90
HH	Head to Header	317	23.8	303	46.4
HW	Head to Windshield	621	0	683	0
NR	Nose to Rim	364	3.7		
CD	Chest to Dash	505		404	
CS	Chest to Steering Hub	296	0.8		
RA	Rim to Abdomen	191	0		
KDL	Left Knee to Dash	157	31.5	111	36.1
KDR	Right Knee to Dash	126	27.9	118	34.3
PA°	Pelvic Angle		24.2		20.9
TA°	Tibia Angle		41.3		44.5
SK	Striker to Knee	621	94.1	687	96.3
ST	Striker to Head	498	17.5	462	27.1
SH	Striker to H-Point	295	130.3	379	112.9

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

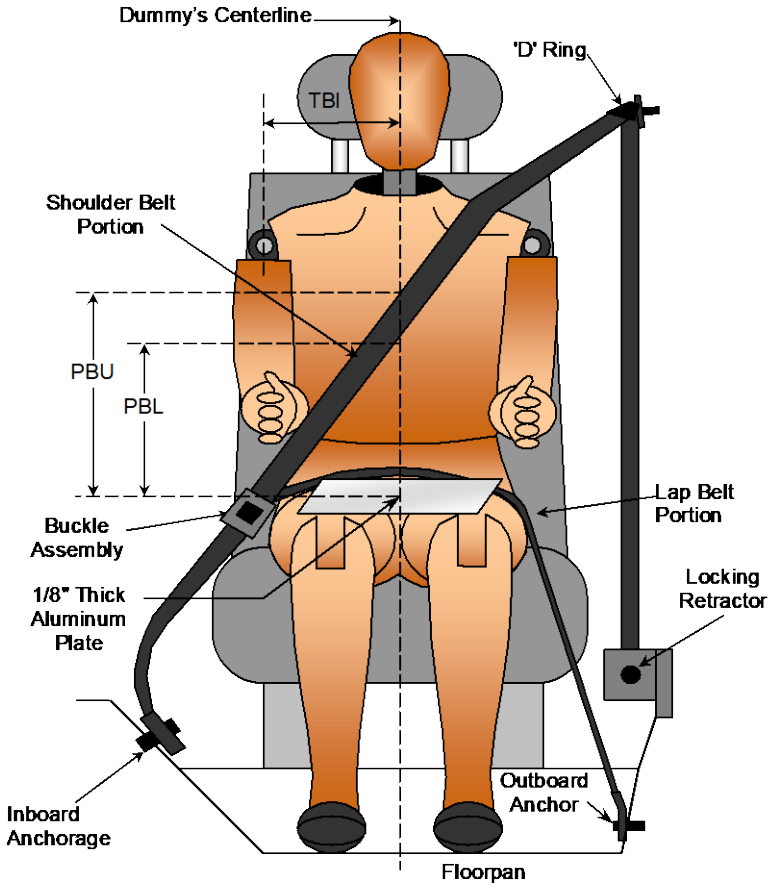


FRONT VIEW OF DUMMY

Code	Measurement Description	Driver	Passenger
		Length (mm)	
AD	Arm to Door	130	81
HD	H-Point to Door	151	170
HR	Head to Side Header	212	255
HS	Head to Side Window	343	358
KK	Knee to Knee	350	231
SHY	Striker to H-Point (Y Direction)	285	329
AA	Ankle to Ankle	356	167

DATA SHEET NO. 5
SEAT BELT POSITIONING DATA

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	370	310
PBL - Top surface of reference to belt lower edge	mm	285	220

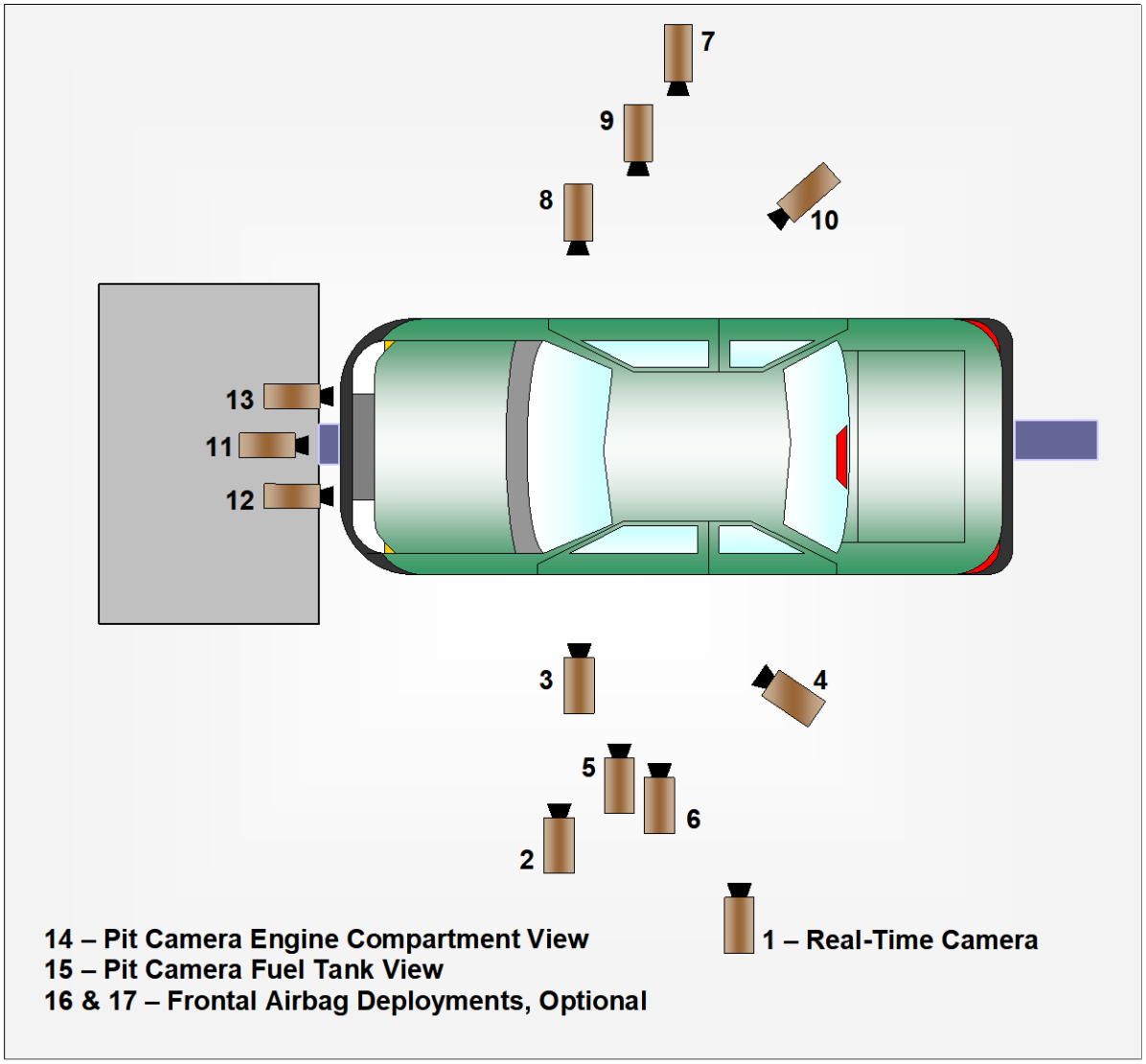
BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	870	885
Lap Belt Length as measured on ATD	mm	750	805
Remainder of belt on reel	mm	580	510
Total Belt Length for Continuous Webbing Systems	mm	2800	2800

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

Test Vehicle:	2019 Nissan Altima S AWD 4-Door Sedan	NHTSA No.:	O20195200
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	5/30/2019

CAMERA POSITIONS FOR FRONTAL IMPACTS



DATA SHEET NO. 6 (CONTINUED)
CAMERA LOCATIONS AND DATA

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

CAMERA LOCATIONS

No.	Camera View	Coordinates (mm)			Lens (mm)	Speed (fps)
		X*	Y*	Z*		
1	Real-Time Left Overall					30
2	Driver Close-Up	2130	-6700	-1990	50	1000
3	Left Front Half	1220	-5880	-1380	24	1000
4	Left Angle	7550	-5780	-2030	75	1000
5	Steering Column - Top					
6	Steering Column - Bottom					
7	Right Overall	2250	5820	-1400	16	1000
8	Passenger Close-Up	1690	6150	-1940	50	1000
9	Right Front Half	1120	5770	-1250	24	1000
10	Right Angle	7740	5410	-2050	75	1000
11	Windshield	-140	0	-2310	11	1000
12	Driver Windshield	-40	-370	-2230	25	1000
13	Passenger Windshield	-40	370	-2230	25	1000
14	Pit Front	1100	0	-3340	24	1000
15	Pit Rear	3550	0	-3340	24	1000
16	Onboard Driver Side				12	1000
17	Onboard Passenger Side				12	1000
18	Real-Time Pan View					30

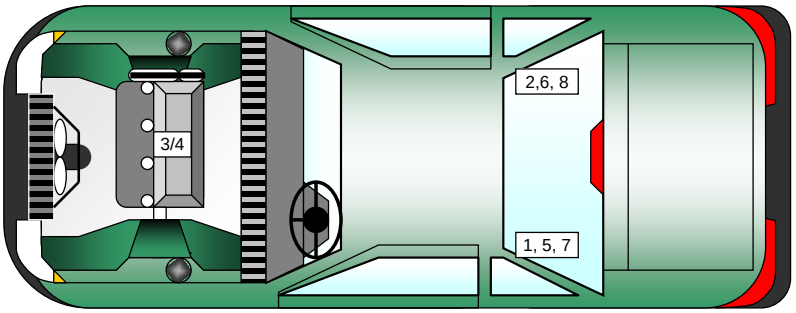
*COORDINATES:

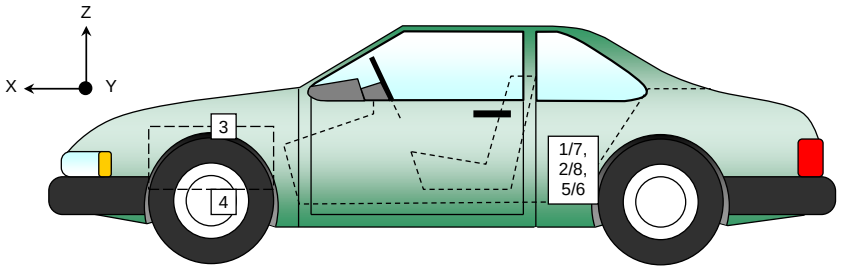
+X = forward of impact plane
+Y = right of monorail centerline
+Z = below ground level

Cameras 5 & 6 were not used for this test.

DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20195200
Test Date: 5/30/2019





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Crossmember Accelerometer – X Direction	1955	-395	-215
2	Right Rear Crossmember Accelerometer – X Direction	1955	400	-215
3	Engine Top X	4128	95	-808
4	Engine Bottom X	4085	225	-150
5	Left Rear Crossmember Accelerometer – Z Direction	1955	-395	-215
6	Right Rear Crossmember Accelerometer – Z Direction	1955	400	-215
7	Left Rear Crossmember Accelerometer Redundant – X Direction	1955	-425	-215
8	Right Rear Crossmember Accelerometer Redundant – X Direction	1955	430	-215

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

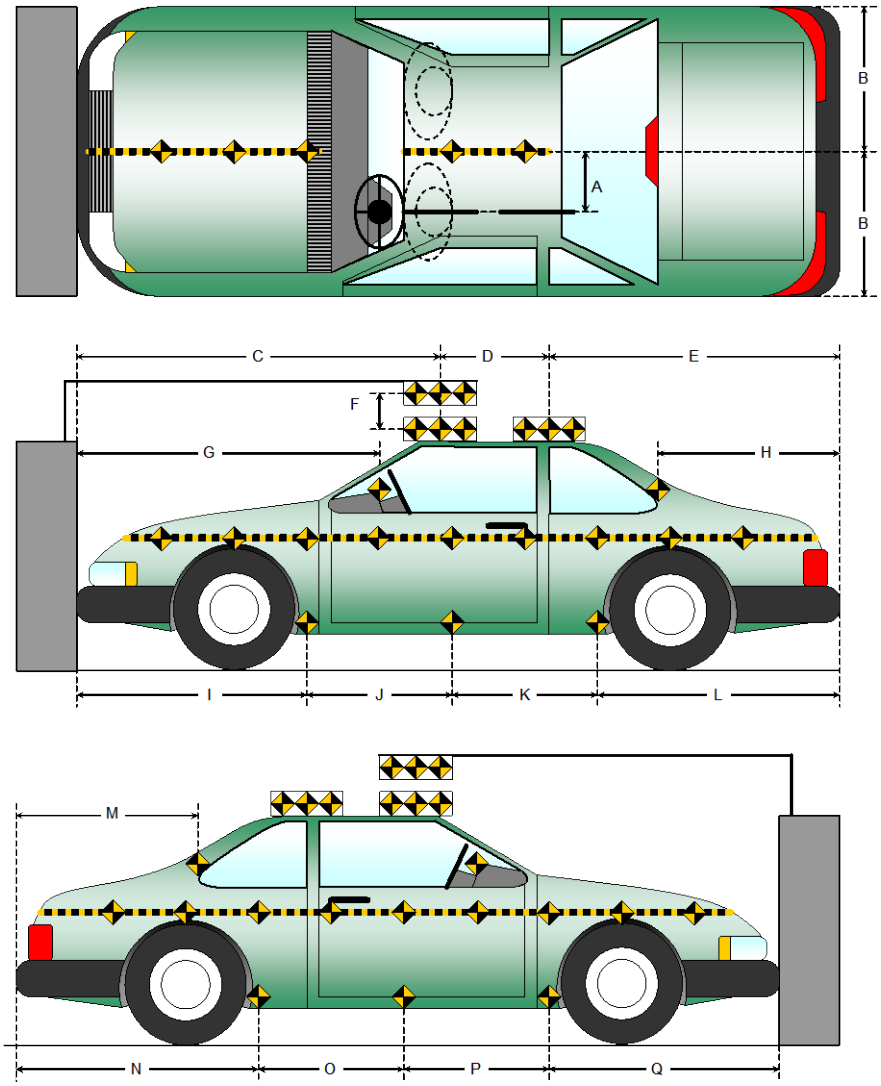
DATA SHEET NO. 8

PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20195200
Test Date: 5/30/2019

Item	Value (mm)
A	367
B	918
C	2370
D	614
E	1921
F	340
G	
H	1092
I	1488
J	945
K	945
L	1527
M	1042
N	1527
O	945
P	945
Q	1488



DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

Advanced Research Load Cell Barrier

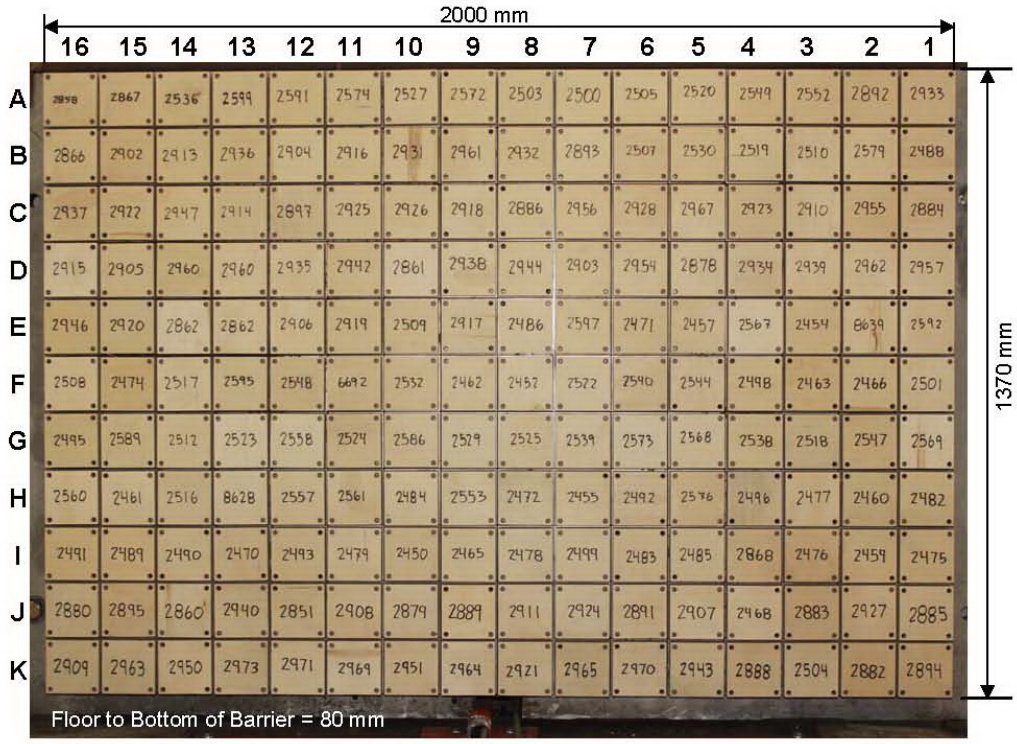


Photo for Reference Only

Centerline

A-16	A-15	A-14	A-13	A-12	A-11	A-10	A-09	A-08	A-07	A-06	A-05	A-04	A-03	A-02	A-01
B-16	B-15	B-14	B-13	B-12	B-11	B-10	B-09	B-08	B-07	B-06	B-05	B-04	B-03	B-02	B-01
C-16	C-15	C-14	C-13	C-12	C-11	C-10	C-09	C-08	C-07	C-06	C-05	C-04	C-03	C-02	C-01
D-16	D-15	D-14	D-13	D-12	D-11	D-10	D-09	D-08	D-07	D-06	D-05	D-04	D-03	D-02	D-01
E-16	E-15	E-14	E-13	E-12	E-11	E-10	E-09	E-08	E-07	E-06	E-05	E-04	E-03	E-02	E-01
F-16	F-15	F-14	F-13	F-12	F-11	F-10	F-09	F-08	F-07	F-06	F-05	F-04	F-03	F-02	F-01
G-16	G-15	G-14	G-13	G-12	G-11	G-10	G-09	G-08	G-07	G-06	G-05	G-04	G-03	G-02	G-01
H-16	H-15	H-14	H-13	H-12	H-11	H-10	H-09	H-08	H-07	H-06	H-05	H-04	H-03	H-02	H-01
I-16	I-15	I-14	I-13	I-12	I-11	I-10	I-09	I-08	I-07	I-06	I-05	I-04	I-03	I-02	I-01
J-16	J-15	J-14	J-13	J-12	J-11	J-10	J-09	J-08	J-07	J-06	J-05	J-04	J-03	J-02	J-01
K-16	K-15	K-14	K-13	K-12	K-11	K-10	K-09	K-08	K-07	K-06	K-05	K-04	K-03	K-02	K-01

Load Cells are 121 mm x 121 mm with a 7 mm gap in between each load cell.

DATA SHEET NO. 10
TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

INSTRUMENTATION

Driver Dummy Data Channels	49
Passenger Dummy Data Channels	49
Vehicle Structure Accelerometers	8
Barrier Channels	0
Total	106

CAMERA COVERAGE

High-Speed Vehicle Onboard	2
High-Speed Offboard	12
Real-Time	2
Total	16

DATA SHEET NO. 11
POST-TEST OBSERVATIONS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Passenger
Dummy Type / Serial No.	HIII 50% / 351	HIII 5% / 1659
Head Contact	Frontal Airbag, Headrest	Frontal Airbag, Headrest
Upper Torso Contact	None	None
Lower Torso Contact	None	None
Left Knee Contact	Knee Airbag	Knee Airbag
Right Knee Contact	Knee Airbag	Knee Airbag

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Locked/Unlocked Doors	Doors were locked	Doors were locked
Front Door Opening	Door remained closed and latched; Door opened without tools	Door remained closed and latched; Door opened without tools
Rear Door Opening	Door remained closed and latched; Door opened without tools	Door remained closed and latched; Door opened without tools
Seat Track Shift (mm)	0	0
Seat Back Failure	None	None

POST TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	Cracked
Window Damage	None
Other Notable Effects	None

VEHICLE REBOUND FROM BARRIER

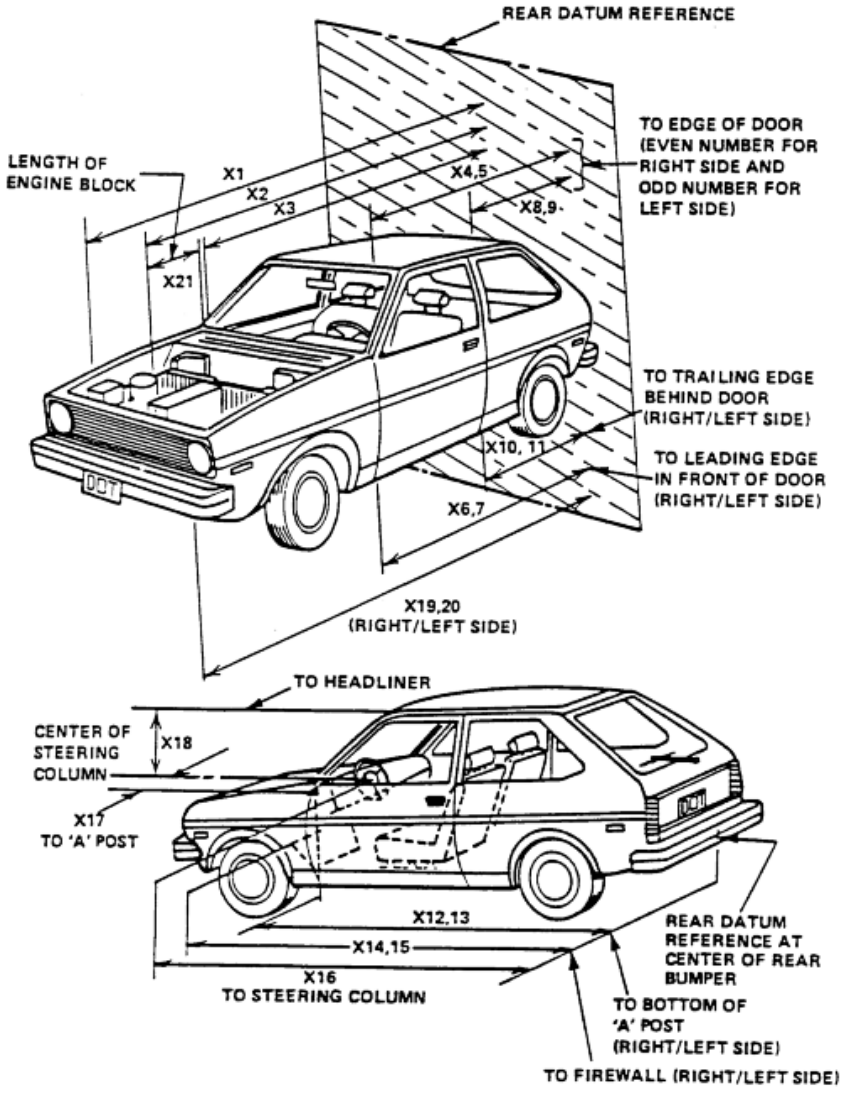
Measured Parameter	Units	Value
Left Side	mm	715
Center	mm	650
Right Side	mm	695
Average	mm	687

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Driver (Occupant 1)		Passenger (Occupant 2)	
	Mounted	Deployed	Mounted	Deployed
Frontal Airbag	Yes	Yes	Yes	Yes
Curtain Side Airbag	Yes	No	Yes	No
Torso/Pelvis Side Airbag	Yes	No	Yes	No
Knee Airbag	Yes	Yes	Yes	Yes
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes		Yes	

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2019 Nissan Altima S AWD 4-Door Sedan	NHTSA No.:	O20195200
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	5/30/2019



DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

RSOV (Rear Surface of Vehicle)

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	mm	4905	4468	437
2	RSOV to Front of Engine	mm	4362	4137	225
3	RSOV to Firewall	mm	3812	3735	77
4	RSOV to Upper Leading Edge of Right Door	mm	3367	3378	-11
5	RSOV to Upper Leading Edge of Left Door	mm	3367	3385	-18
6	RSOV to Lower Leading Edge of Right Door	mm	3370	3346	24
7	RSOV to Lower Leading Edge of Left Door	mm	3370	3352	18
8	RSOV to Upper Trailing Edge of Right Door	mm	2250	2242	8
9	RSOV to Upper Trailing Edge of Left Door	mm	2250	2251	-1
10	RSOV to Lower Trailing Edge of Right Door	mm	2260	2237	23
11	RSOV to Lower Trailing Edge of Left Door	mm	2260	2245	15
12	RSOV to Bottom of “A” Post of Right Side	mm	3375	3372	3
13	RSOV to Bottom of “A” Post of Left Side	mm	3372	3382	-10
14	RSOV to Firewall, Right Side	mm	3792	3685	107
15	RSOV to Firewall, Left Side	mm	3792	3685	107
16	RSOV to Steering Column	mm	2884	2911	-27
17	Center of Steering Column to “A” Post	mm	376	391	-15
18	Center of Steering Column to Headliner	mm	407	442	-35
19	RSOV to Right Side of Front Bumper	mm	4812	4392	420
20	RSOV to Left Side of Front Bumper	mm	4812	4450	362
21	Length of Engine Block	mm	570	570	0
RD	RSOV to Right Side of Dash Panel	mm	3180	3187	-7
CD	RSOV to Center of Dash Panel	mm	3242	3260	-18
LD	RSOV to Left Side of Dash Panel	mm	3183	3180	3

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

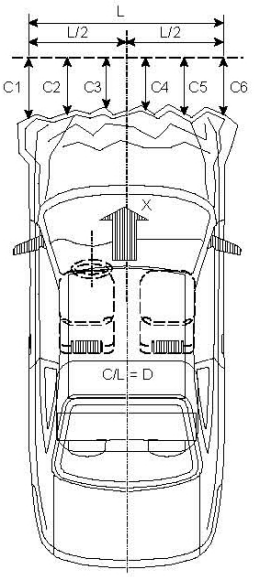
Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

VEHICLE INFORMATION

VIN: 1N4BL4BWXKC161066 Wheelbase (mm): 2826
Vehicle Size Category: Passenger Car Test Weight (kg): 1713.5

ACCELEROMETER DATA

Accelerometer Locations: As per measurements on Page 15
Cal. Procedure/Interval: MGA procedure / 6 month
Integration Algorithm: Trapezoidal
Linearity: > 99%
Impact Velocity (km/h): 56.62
Velocity Change (km/h): 65.4
Time of Separation (msec): 100



CRUSH PROFILE

Collision Deformation Classification: 12FDEW2
Midpoint of Damage: Centerline
Damage Region Length (mm): 1090
Impact Mode: Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	4812	4450	362
C2	Crush zone 2 at left side	mm	4879	4472	407
C3	Crush zone 3 at left side	mm	4882	4480	402
C4	Crush zone 4 at right side	mm	4882	4476	406
C5	Crush zone 5 at right side	mm	4879	4430	449
C6	Crush zone 6 at right side	mm	4812	4392	420
L	C1 TO C6	mm	1090	1097	-7

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

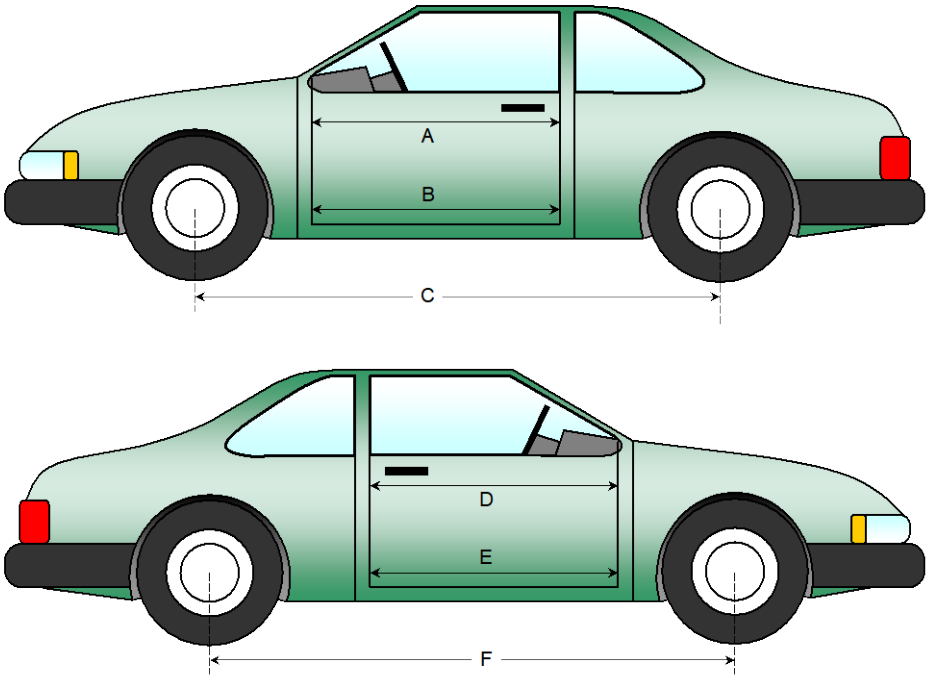
Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20195200
Test Date: 5/30/2019

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1043	1043	0
B	Left Side Lower	mm	950	950	0
D	Right Side Upper	mm	1043	1044	-1
E	Right Side Lower	mm	950	950	0

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2826	2790	36
F	Right Side Wheelbase	mm	2826	2797	29



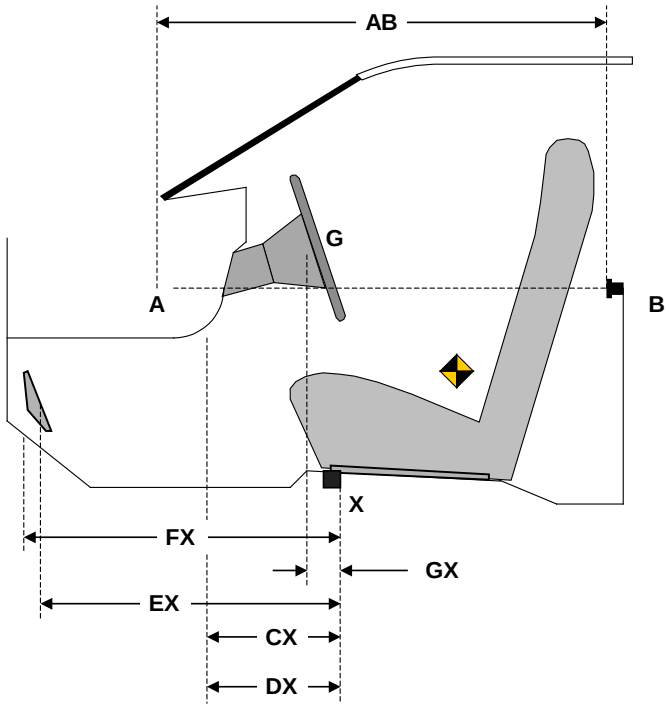
DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	794	794	0
CX	Left Knee Bolster to X	mm	249	259	-10
DX	Right Knee Bolster to X	mm	218	229	-11
EX	Brake Pedal to X	mm	579	587	-8
FX	Foot Rest to X	mm	592	585	7
GX	Center of Steering Column Wheel Hub to X	mm	58	100	-42

X = Front of Seat Track (stationary)



DRIVER COMPARTMENT

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

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019

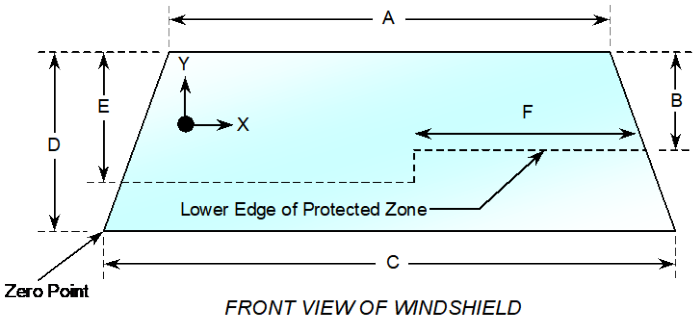
Windshield Mounting Details:
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

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

Temperature of windshield molding during test: 21.5°C.

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2203	2203	100
Right Side	2203	2203	100
Total	4406	4406	100



FRONT VIEW OF WINDSHIELD

Item	Units	Value
A	mm	1228
B	mm	430
C	mm	1425
D	mm	877
E	mm	495
F	mm	532

AREA OF PROTECTED ZONE FAILURES - NONE

A. Provide coordinates of the area that the protected zone was penetrated more than 0.25 inches by a vehicle component other than one that is normally in contact with the windshield. **None**

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. **None**

X	Y

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

Test Vehicle:	2019 Nissan Altima S AWD 4-Door Sedan	NHTSA No.:	O20195200
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	5/30/2019

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

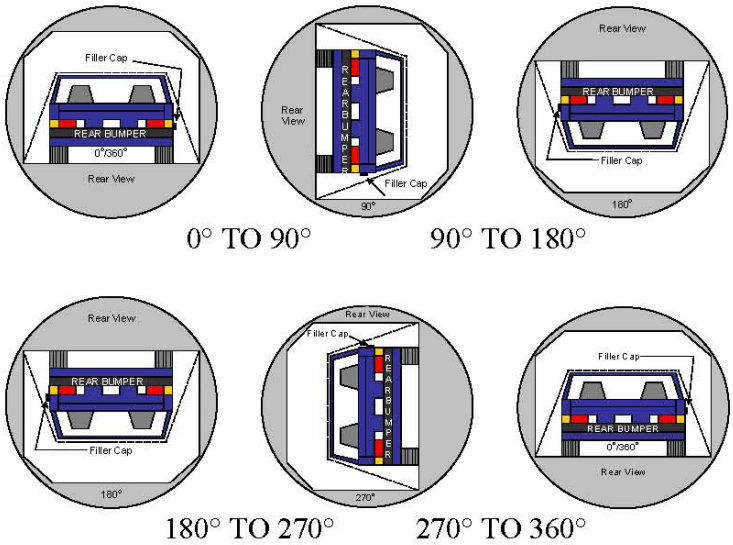
Temperature at Time of Impact: 21.5°C Test Time: 10:11 a.m.

A. From impact until vehicle motion ceases: 0 oz.
(Maximum allowable = 1 oz.)
B. For the 5 minute period after motion ceases: 0 oz.
(Maximum allowable = 5 oz.)
C. For the following 25 minutes: 0 oz.
(Maximum allowable = 1 oz./minute)
D. Spillage: None

DATA SHEET NO. 16
FMVSS 301 STATIC ROLLOVER RESULTS

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20195200
Test Date: 5/30/2019

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°	113	300	413
90° to 180°	112	300	412
180° to 270°	107	300	407
270° to 360°	111	300	411

FMVSS 301 SPILLAGE TABLE (units in ounces)

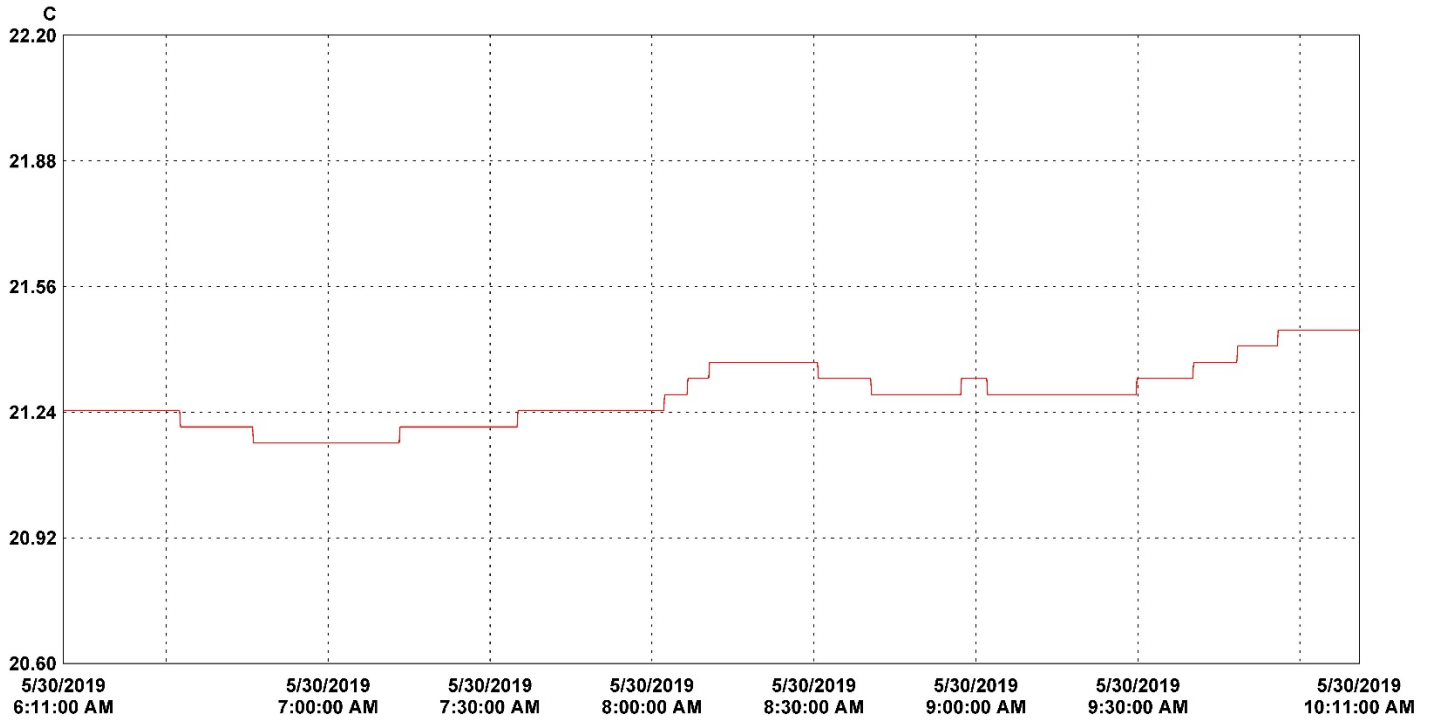
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eight Minute
0° to 90°	0	0	0	0
90° to 180°	0	0	0	0
180° to 270°	0	0	0	0
270° to 360°	0	0	0	0

SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° to 90°	
90° to 180°	
180° to 270°	
270° to 360°	

DATA SHEET NO. 17
DUMMY/VEHICLE TEMPERATURE STABILIZATION DATA

Test Vehicle: 2019 Nissan Altima S AWD 4-Door Sedan NHTSA No.: O20195200
Test Program: NCAP Frontal Barrier Impact Test Test Date: 5/30/2019



30 minutes/div 4 hours (M/d/yyyy h:mm:ss tt) Central Time Graph file (truncated): O20195200 2019 Nissan Altima S AWD 4-Door Sedan NCAP.spg

LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	18352047	VSC_Prep_Room	1		21.45	21.28	21.16	C	Temperature	18352047_VSC_Prep_Room.spl

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

PHOTOGRAPH NOT APPLICABLE

Photo No. 001 - Load Cell Location

Photo No. 002 - Pre-Test Load Cell Wall

Photo No. 003 - Post-Test Load Cell Wall

Photo No. 004 - Manufacturer Label

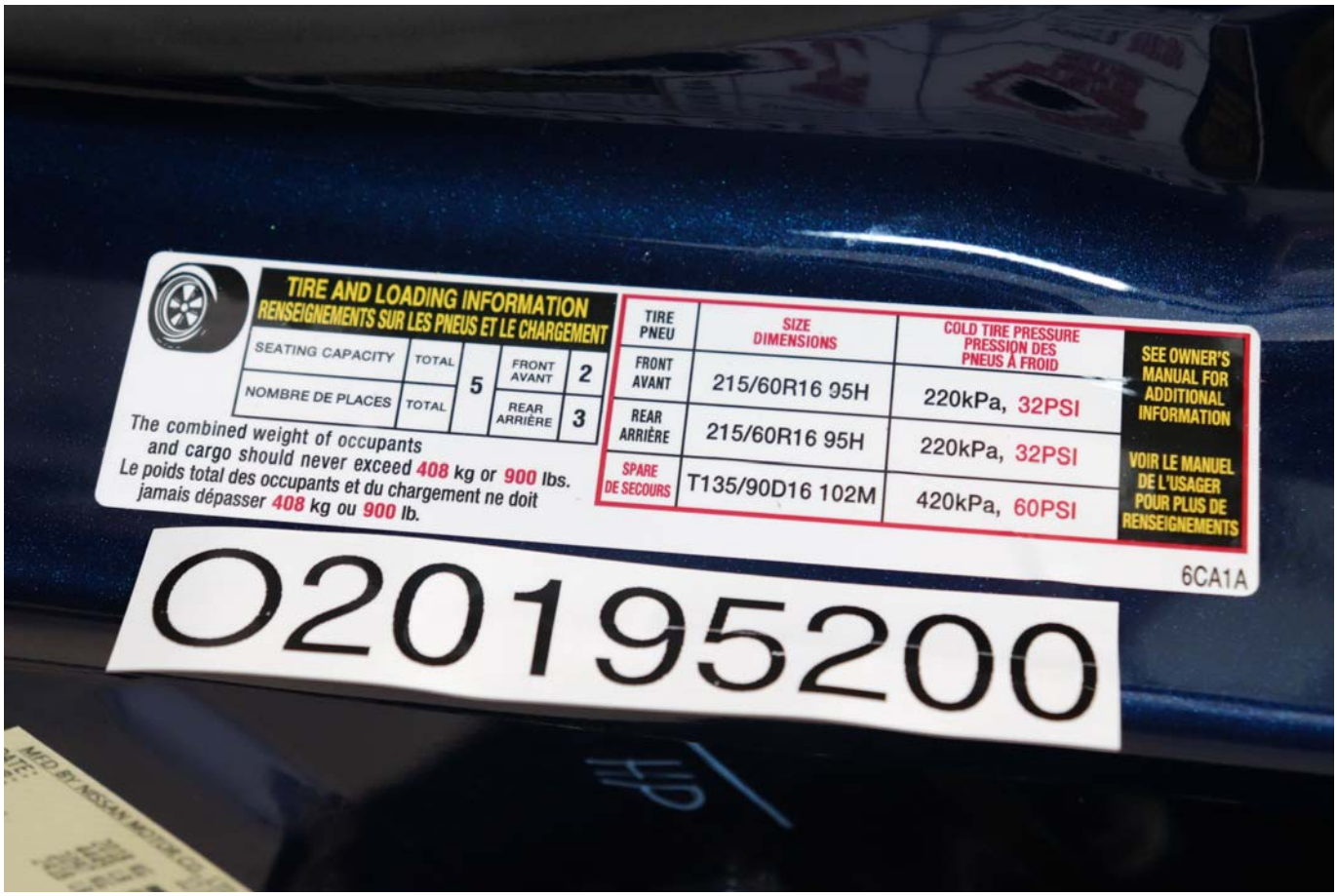


Photo No. 005 - Tire Placard

Photo No. 006 - 2019 Nissan Altima S AWD 4-Door Sedan Frontal As Delivered

Photo No. 007 - Left Rear 3-4 View, As Received

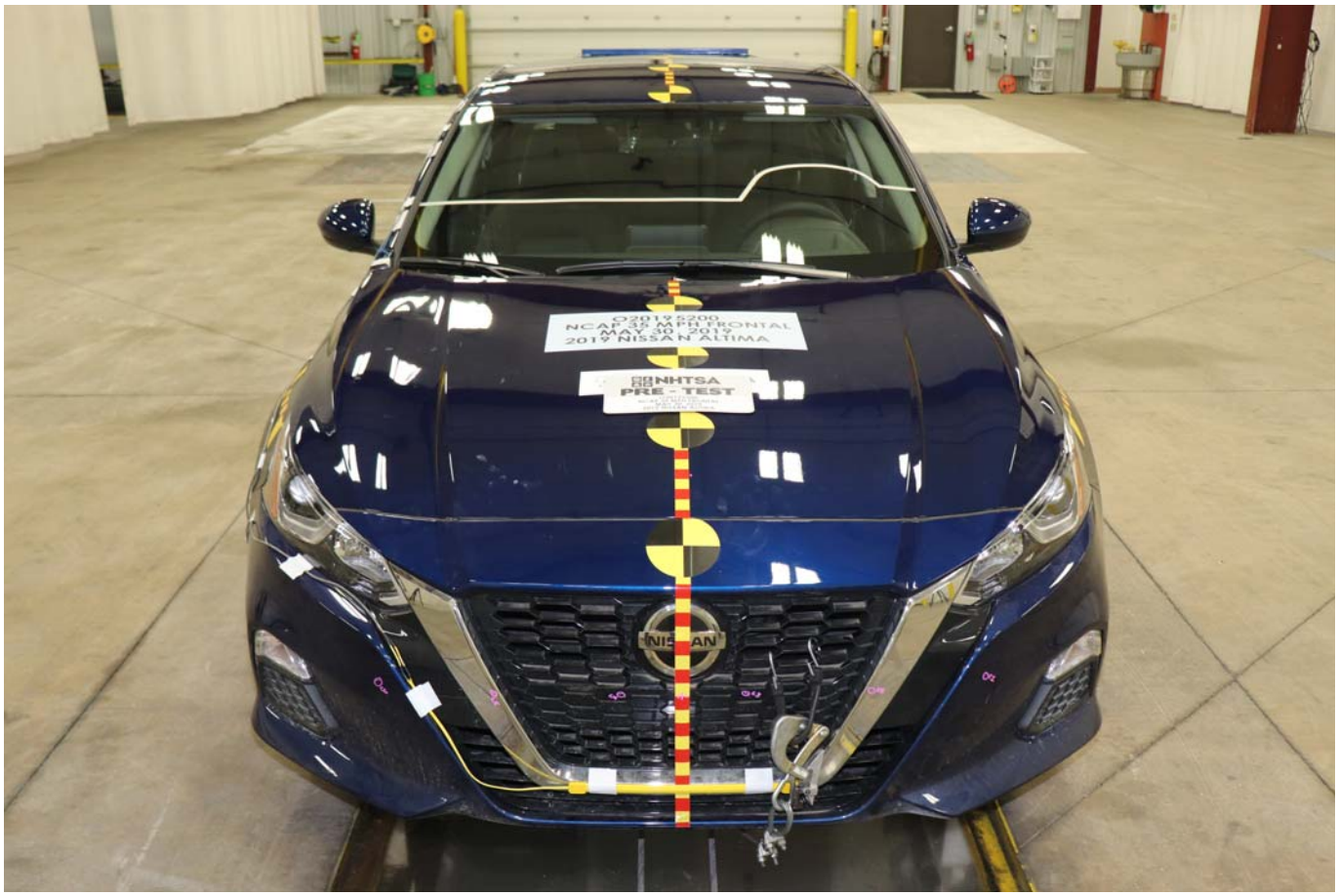


Photo No. 008 - Pre-Test Front View of Test Vehicle

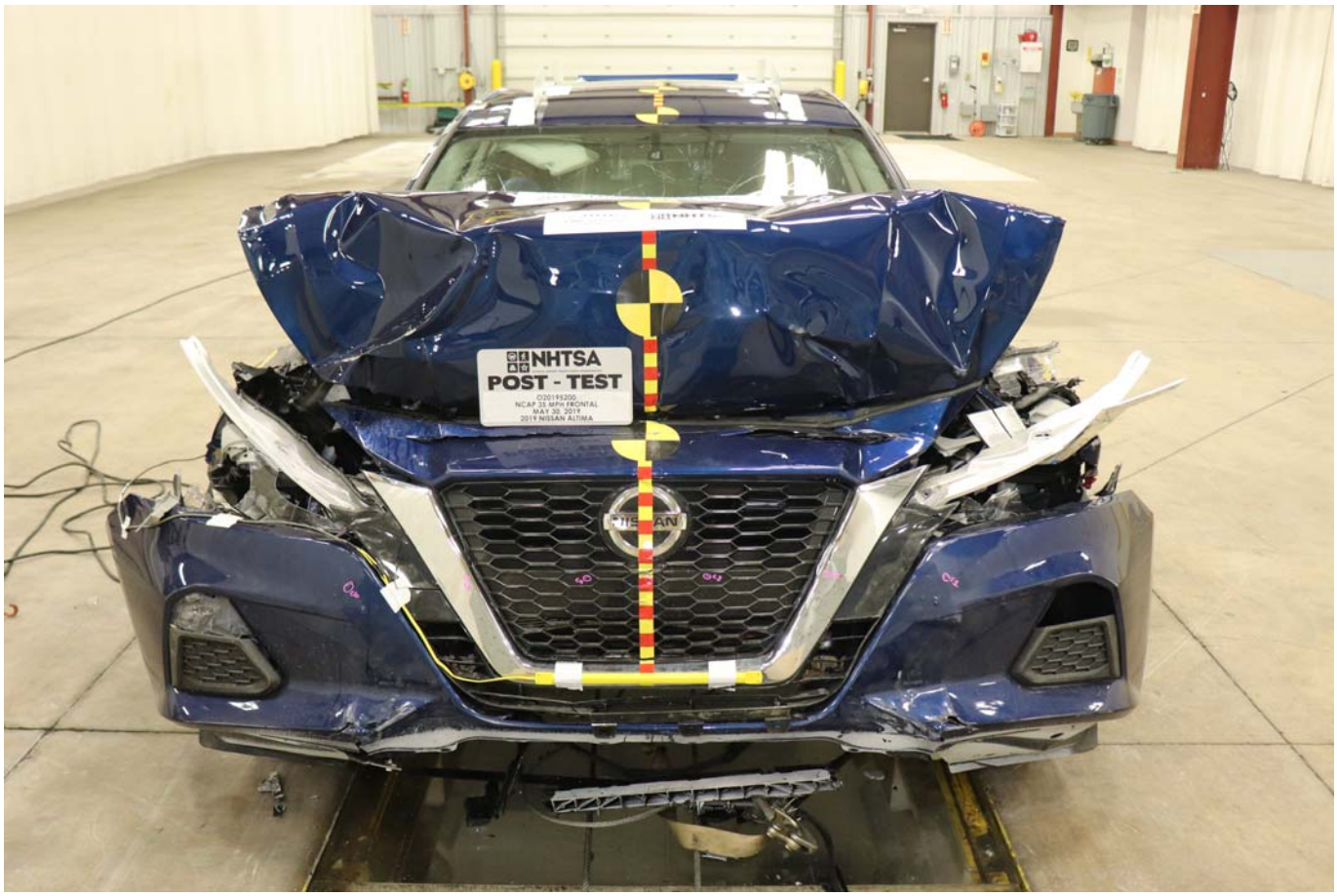


Photo No. 009 - Post-Test Front View of Test Vehicle

Photo No. 010 - Pre-Test Left View of Test Vehicle

Photo No. 011 - Post-Test Left View of Test Vehicle

Photo No. 012 - Pre-Test Right View of Test Vehicle

Photo No. 013 - Post-Test Right View of Test Vehicle

Photo No. 014 - Pre-Test Right Front 3-4 View

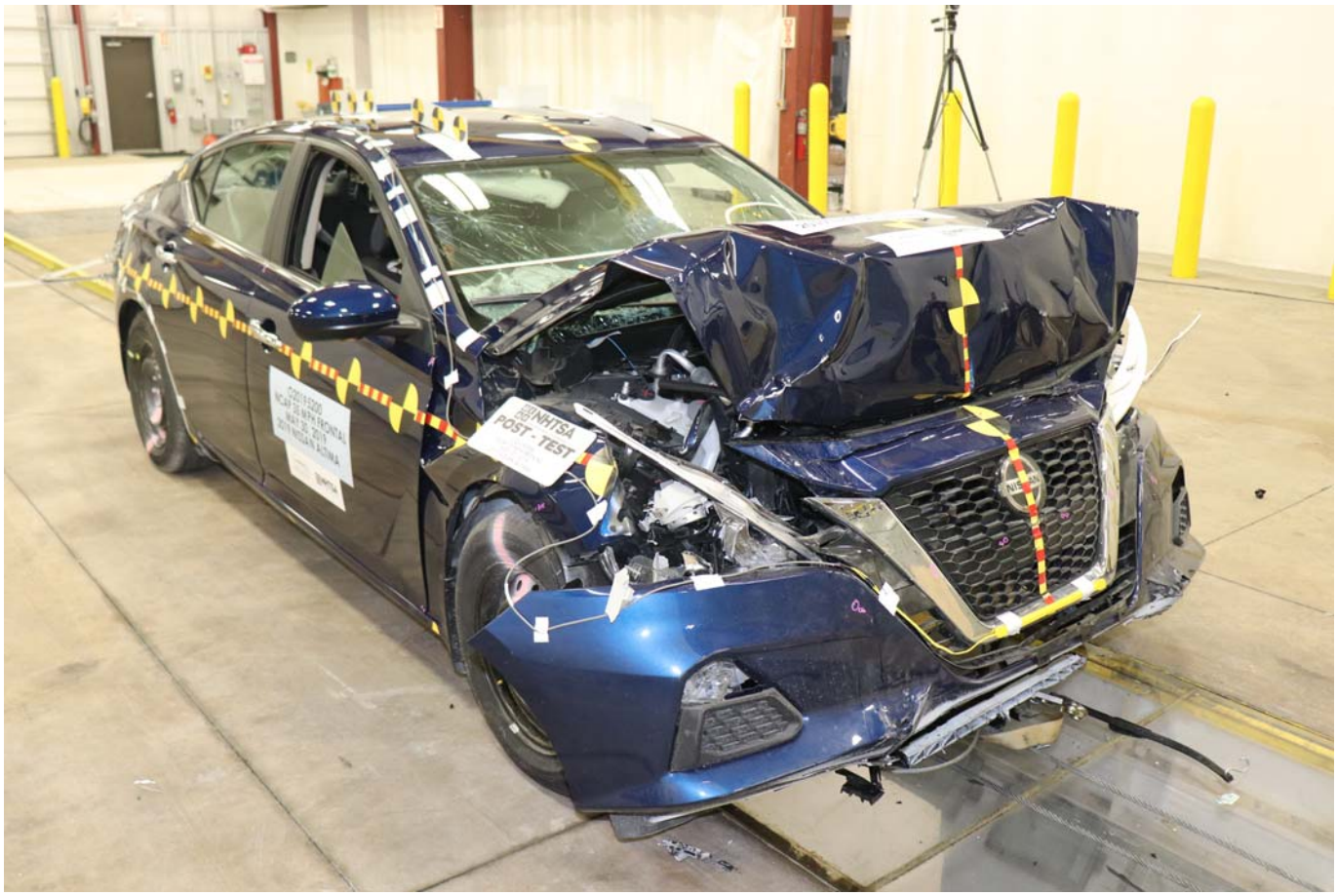


Photo No. 015 - Post-Test Right Front 3-4 View

Photo No. 016 - Pre-Test Left Rear 3-4 View

Photo No. 017 - Post-Test Left Rear 3-4 View

Photo No. 018 - Pre-Test Windshield View

Photo No. 019 - Post-Test Windshield View

Photo No. 020 - Pre-Test Engine Compartment View

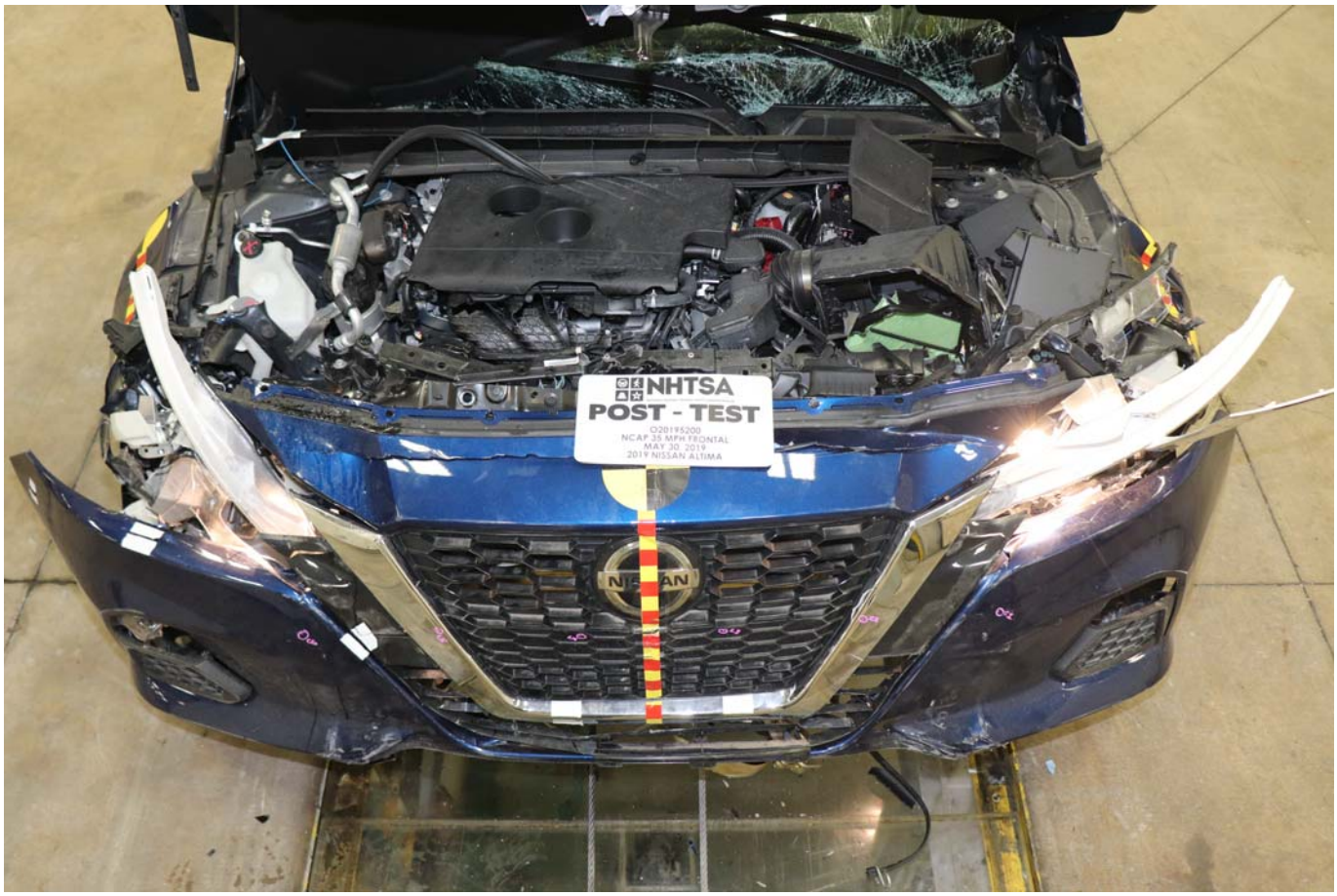


Photo No. 021 - Post-Test Engine Compartment View

Photo No. 022 - Pre-Test Fuel Filler Cap View

Photo No. 023 - Post-Test Fuel Filler Cap View

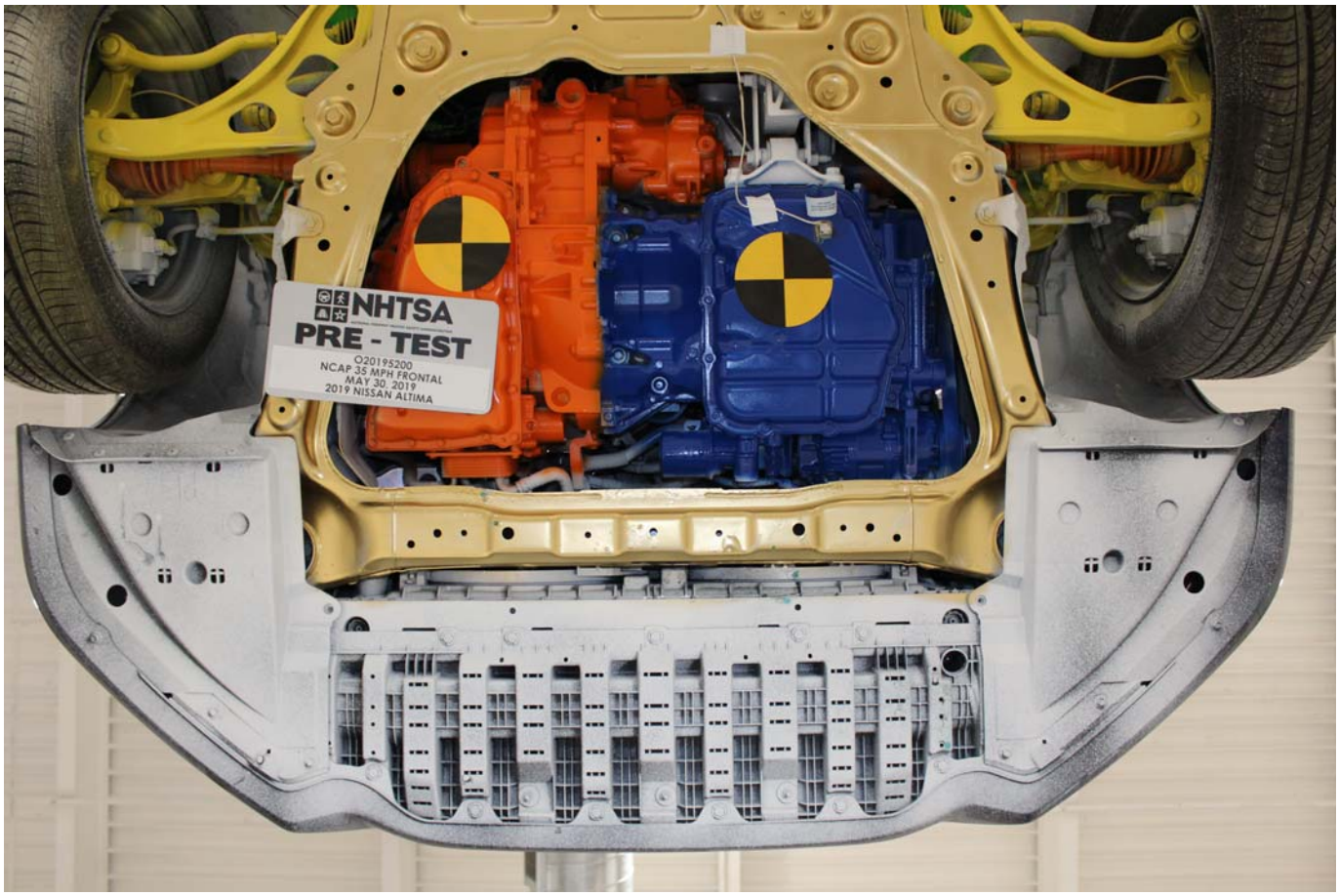


Photo No. 024 - Pre-Test Front Underbody View

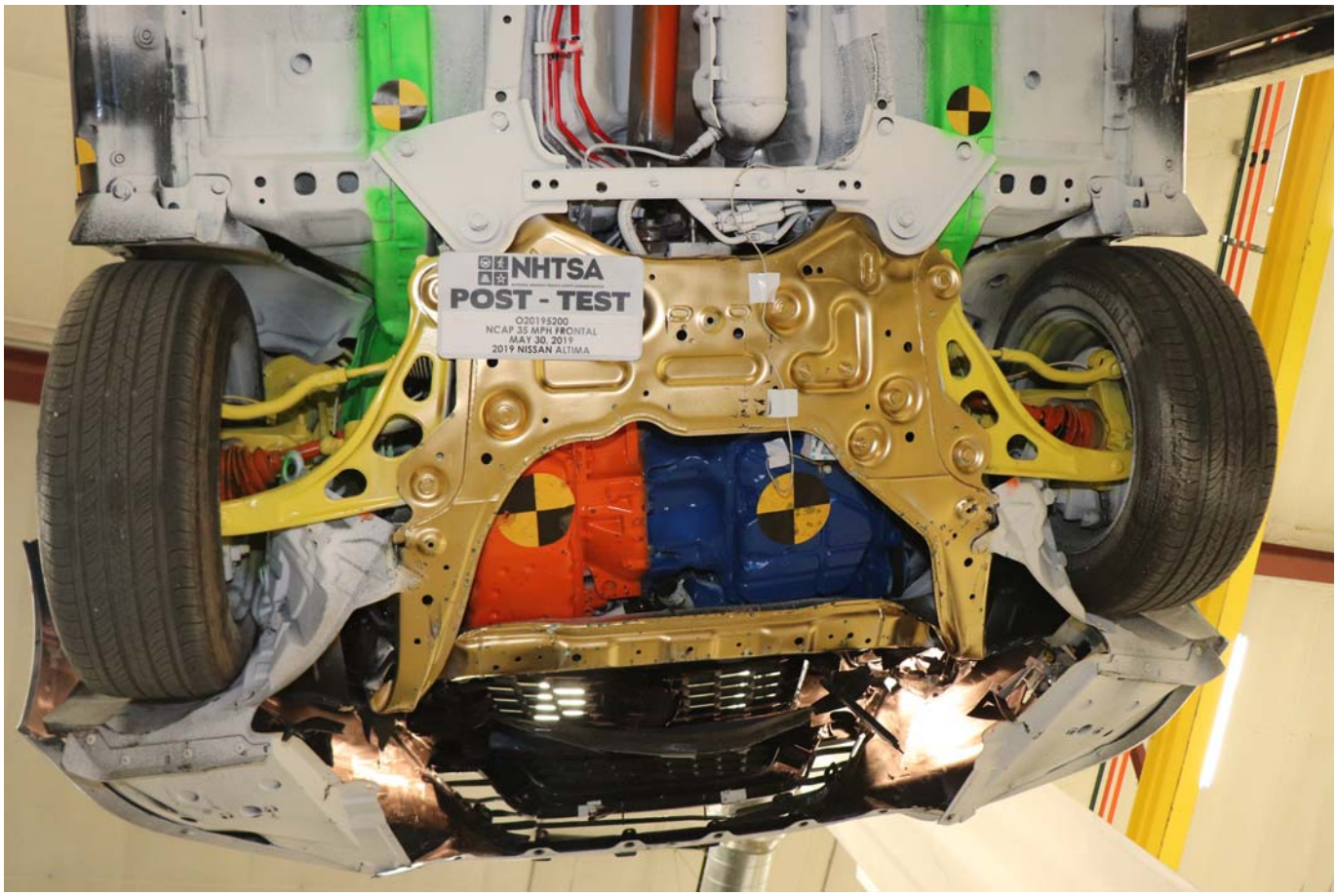


Photo No. 025 - Post-Test Front Underbody View

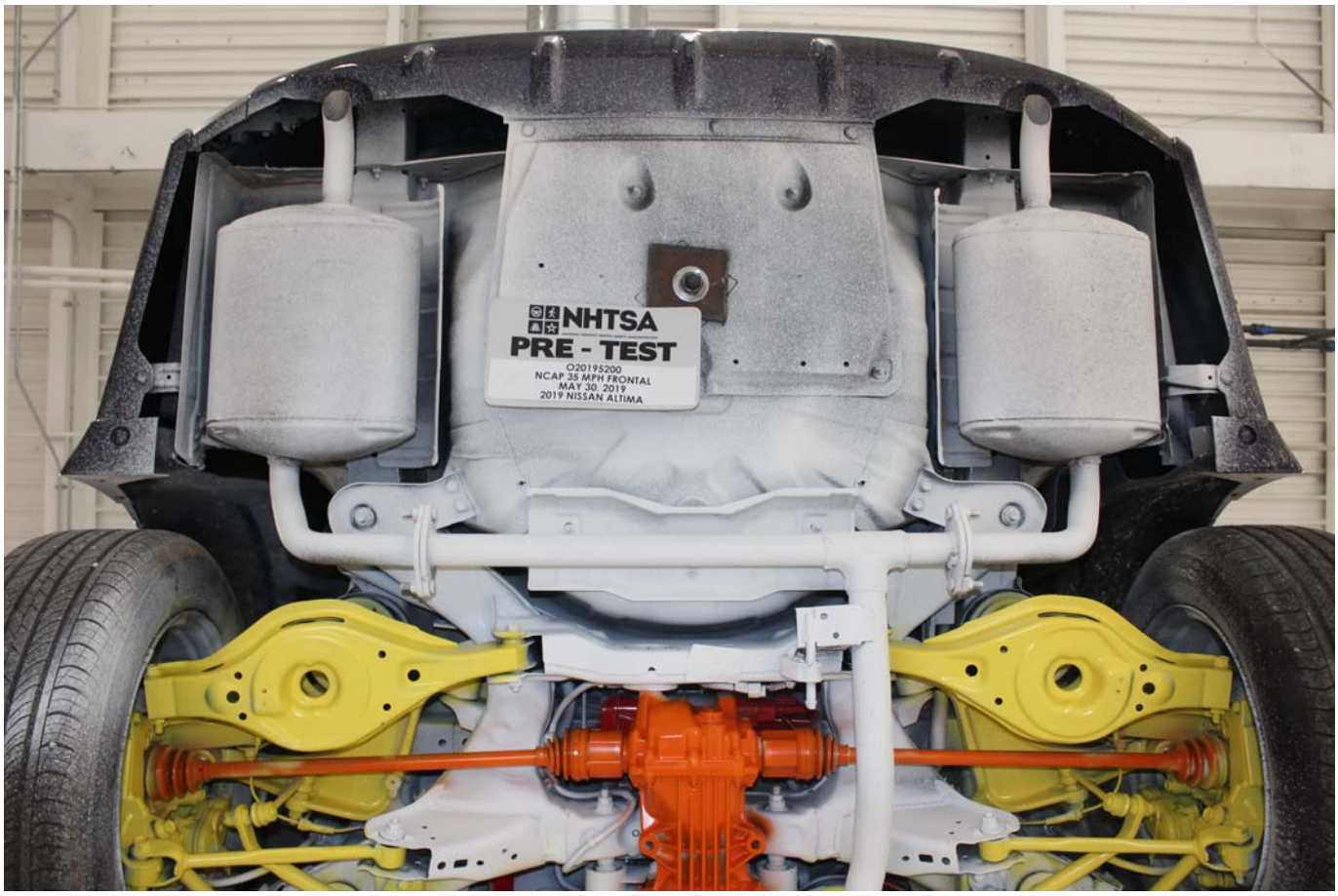


Photo No. 026 - Pre-Test Rear Underbody View

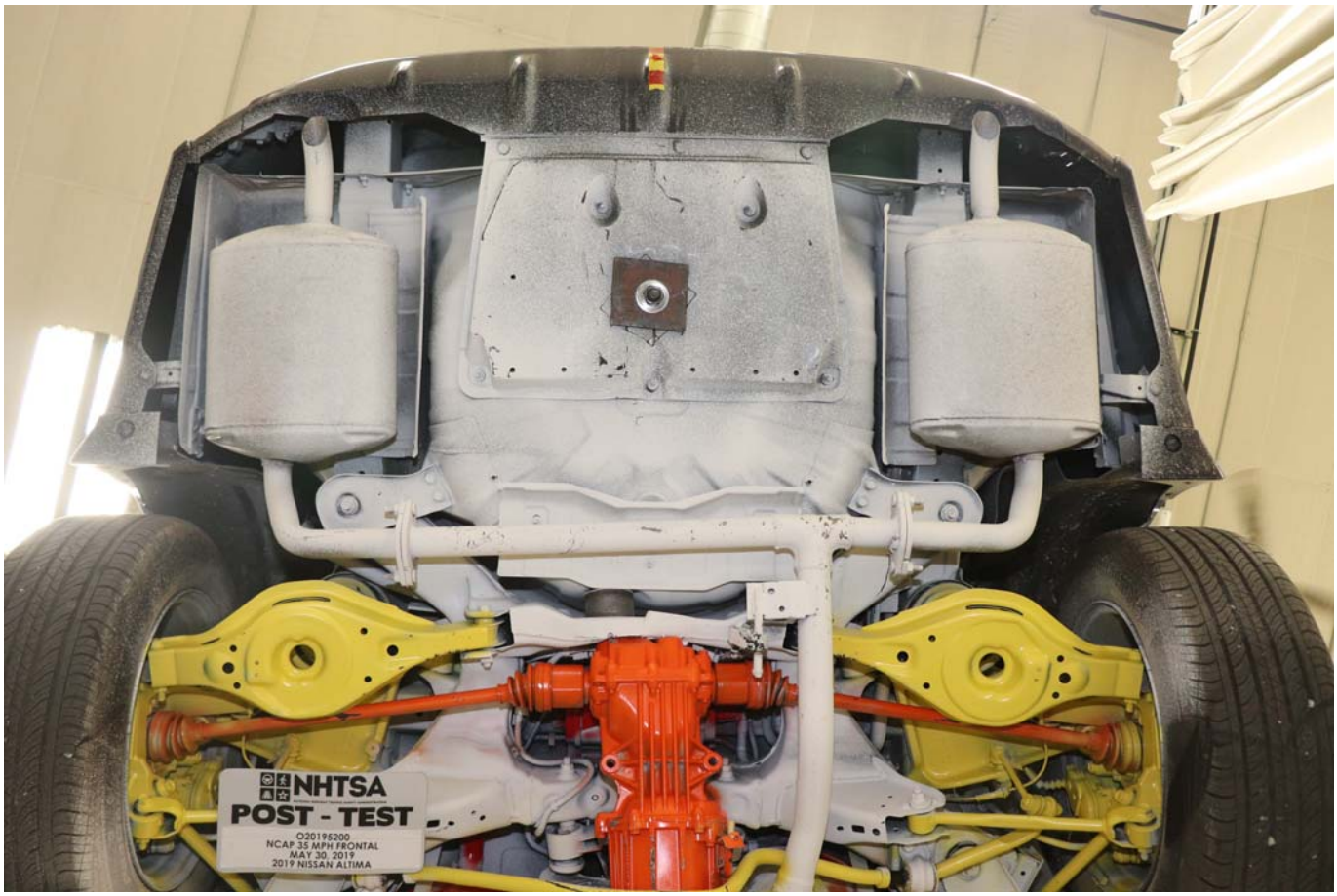


Photo No. 027 - Post-Test Rear Underbody View

Photo No. 028 - Pre-Test Dummy Cable Routing

Photo No. 029 - Post-Test Dummy Cable Routing

Photo No. 030 - Pre-Test Driver Dummy Front View

Photo No. 031 - Post-Test Driver Dummy Front View

Photo No. 032 - Pre-Test Driver Dummy Window View

Photo No. 033 - Post-Test Driver Dummy Window View

Photo No. 034 - Pre-Test Driver Dummy and Vehicle Interior

Photo No. 035 - Post-Test Driver Dummy and Vehicle Interior

Photo No. 036 - Pre-Test Driver Seat Fore-Aft Markings

Photo No. 037 - Post-Test Driver Seat Fore-Aft Markings

Photo No. 038 - Pre-Test View of Belt Anchorage for Driver Dummy

Photo No. 039 - Post-Test View of Belt Anchorage for Driver Dummy

Photo No. 040 - Pre-Test Driver Dummy Feet

Photo No. 041 - Post-Test Driver Dummy Feet

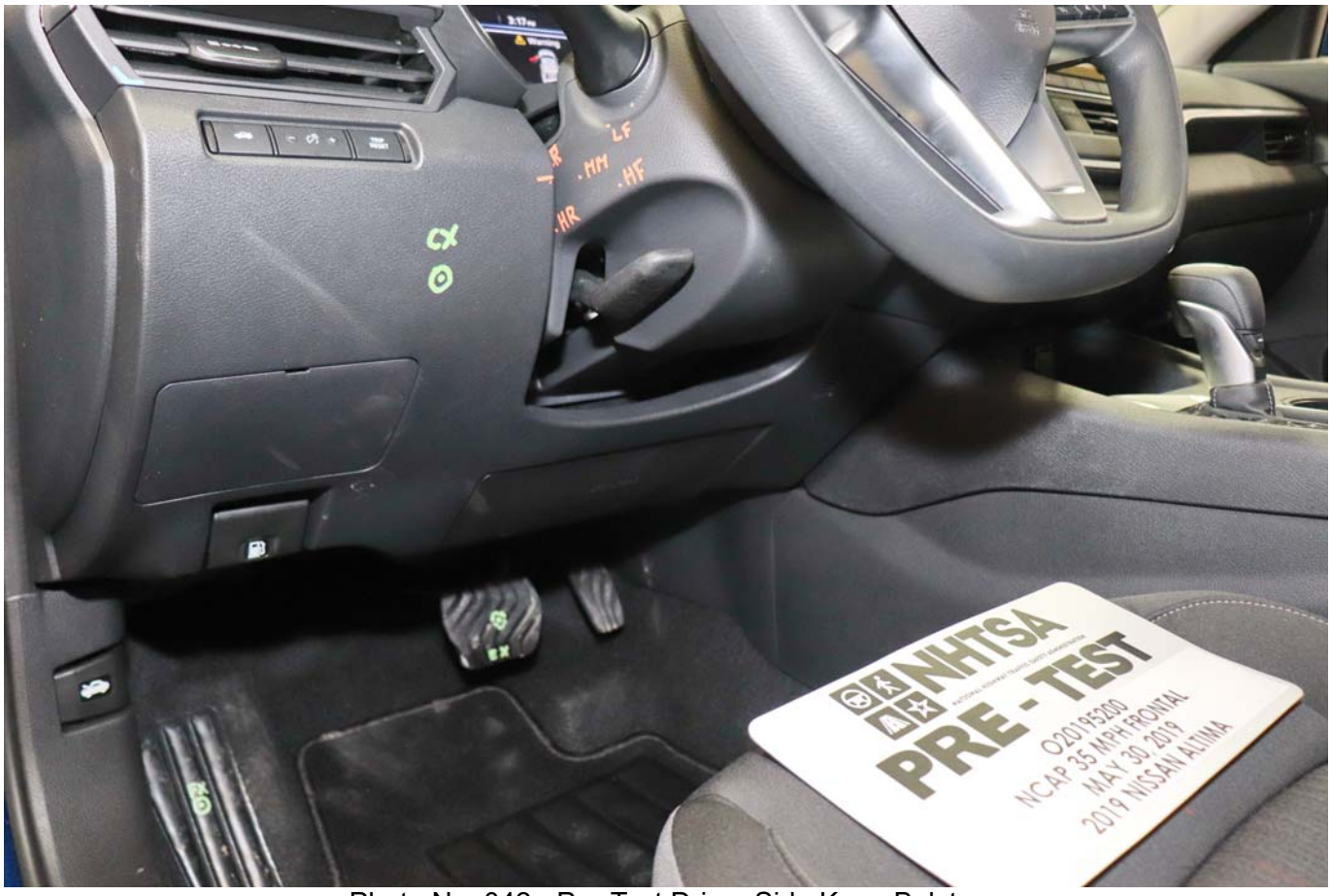


Photo No. 042 - Pre-Test Driver Side Knee Bolster

Photo No. 043 - Post-Test Driver Side Knee Bolster

Photo No. 044 - Pre-Test Driver Side Floorpan

Photo No. 045 - Post-Test Driver Side Floorpan

Photo No. 046 - Post-Test Driver Dummy Face

Photo No. 047 - Post-Test Driver Dummy Contact with Airbag

Photo No. 048 - Post-Test Driver Dummy Contact with Headrest

Photo No. 049 - Pre-Test View of the Steering Wheel

Photo No. 050 - Post-Test View of the Steering Wheel

Photo No. 051 - Pre-Test Passenger Dummy Front View

Photo No. 052 - Post-Test Passenger Dummy Front View

Photo No. 053 - Pre-Test Passenger Dummy Window View

Photo No. 054 - Post-Test Passenger Dummy Window View

Photo No. 055 - Pre-Test Passenger Dummy and Vehicle Interior

Photo No. 056 - Post-Test Passenger Dummy and Vehicle Interior

Photo No. 057 - Pre-Test Passenger Seat Fore-Aft Markings

Photo No. 058 - Post-Test Passenger Seat Fore-Aft Markings

Photo No. 059 - Pre-Test View of Belt Anchorage for Passenger Dummy

Photo No. 060 - Post-Test View of Belt Anchorage for Passenger Dummy

Photo No. 061 - Pre-Test Passenger Dummy Feet

Photo No. 062 - Post-Test Passenger Dummy Feet

Photo No. 063 - Pre-Test Passenger Side Knee Bolster

Photo No. 064 - Post-Test Passenger Side Knee Bolster

Photo No. 065 - Pre-Test Passenger Side Floorpan

Photo No. 066 - Post-Test Passenger Side Floorpan

Photo No. 067 - Post-Test Passenger Dummy Face

Photo No. 068 - Post-Test Passenger Dummy Contact with Airbag

Photo No. 069 - Post-Test Passenger Dummy Contact with Headrest

Photo No. 070 - Ballast Installed in Vehicle

PHOTOGRAPH NOT APPLICABLE

Photo No. 071 - Post-Test Stoddard Solvent Spillage Location View

Photo No. 072 - Post-Test Speed Trap Read-Out

Photo No. 073 - Vehicle at 0 Degree on Static Rollover Device

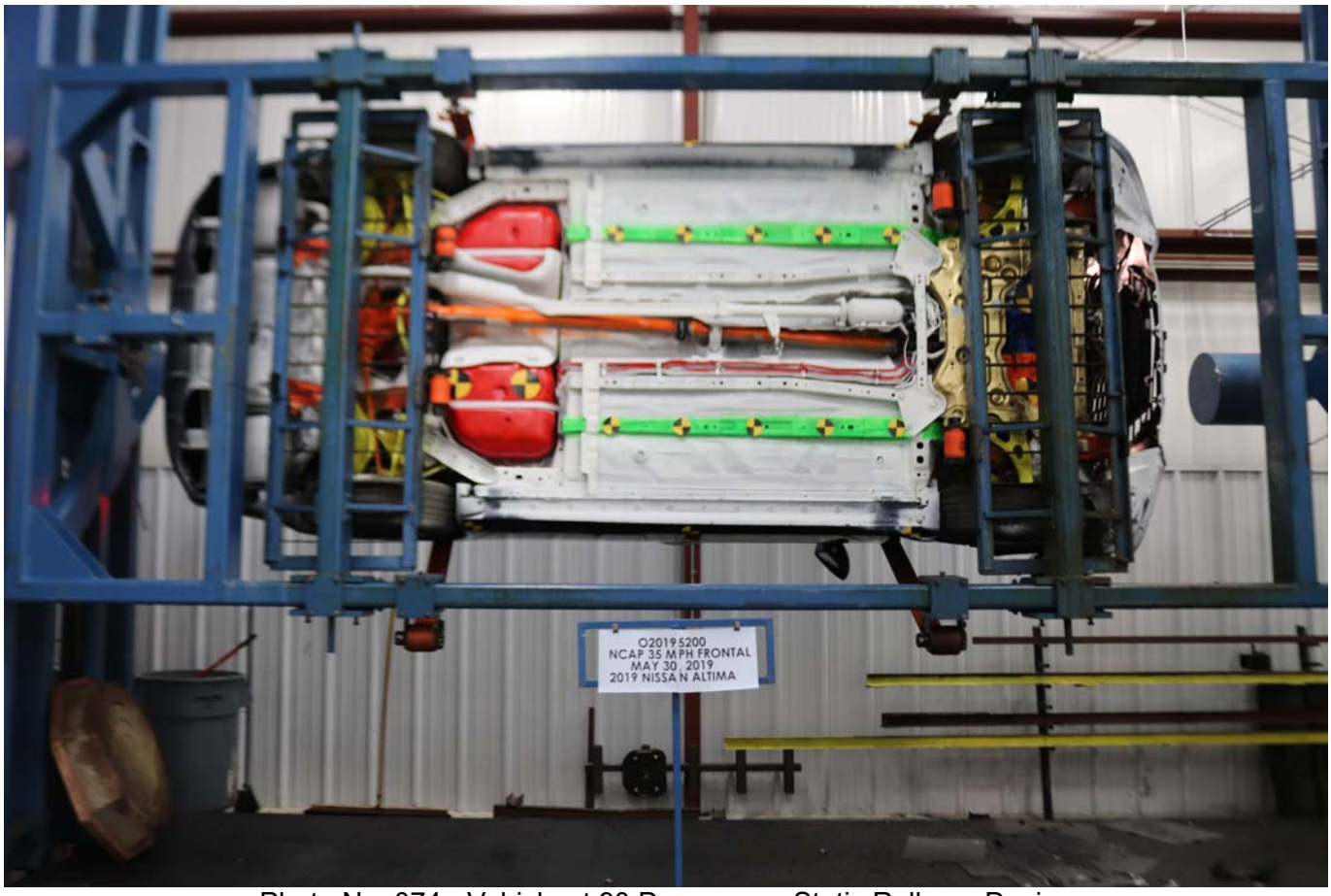


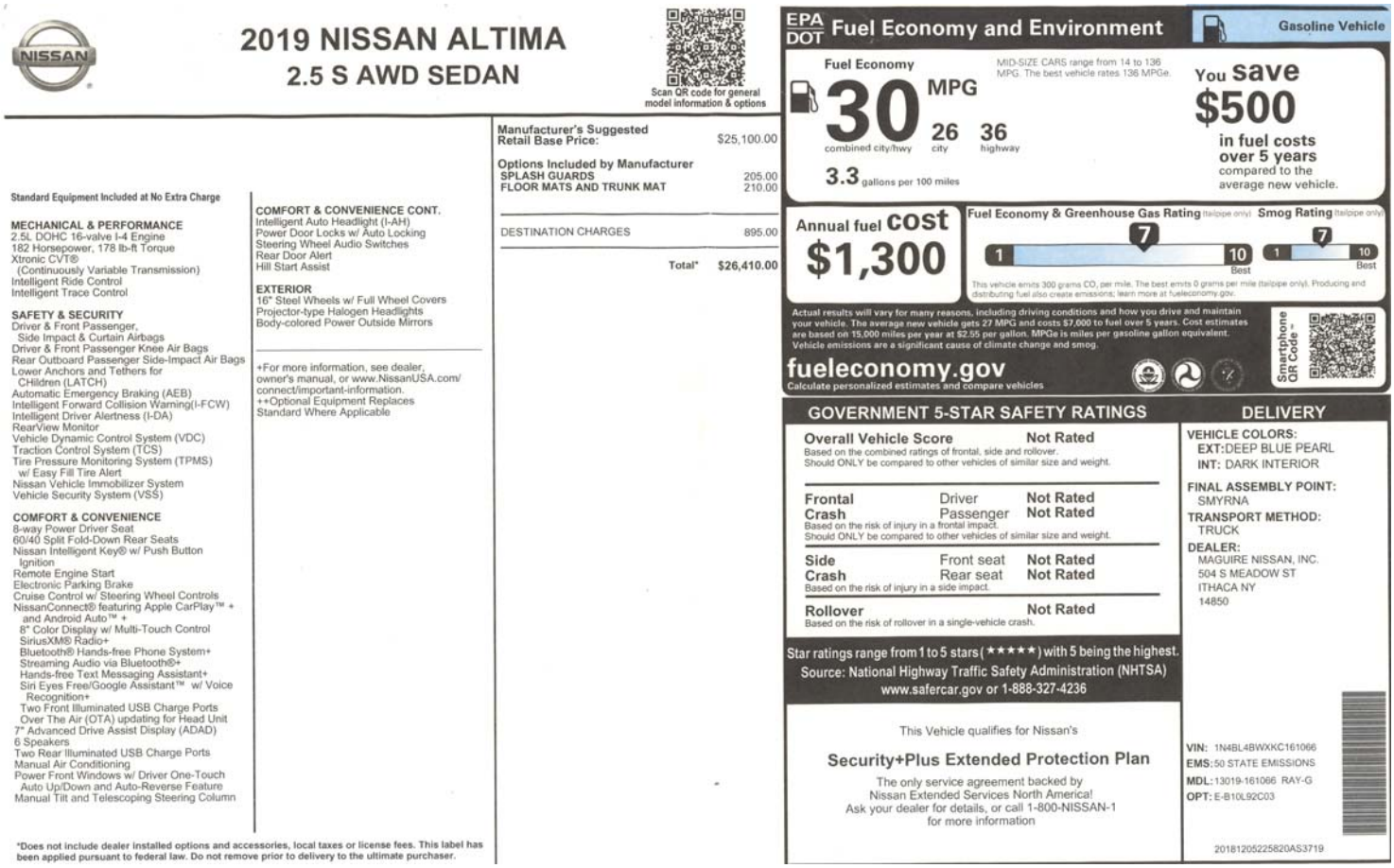
Photo No. 074 - Vehicle at 90 Degrees on Static Rollover Device

Photo No. 075 - Vehicle at 180 Degrees on Static Rollover Device

Photo No. 076 - Vehicle at 270 Degrees on Static Rollover Device

Photo No. 077 - Vehicle at 360 Degrees on Static Rollover Device

Photo No. 078 - 2019 Nissan Altima S AWD 4-Door Sedan Frontal Impact Event



2019 NISSAN ALTIMA
2.5 S AWD SEDAN

Scan QR code for general model information & options

Standard Equipment Included at No Extra Charge

MECHANICAL & PERFORMANCE
2.5L DOHC 16-valve I-4 Engine
182 Horsepower, 178 lb-ft Torque
Xtronic CVT®
(Continuously Variable Transmission)
Intelligent Ride Control
Intelligent Trace Control

SAFETY & SECURITY
Driver & Front Passenger, Side Impact & Curtain Airbags
Driver & Front Passenger Knee Air Bags
Rear Outboard Passenger Side-Impact Air Bags
Lower Anchors and Tethers for Children (LATCH)
Automatic Emergency Braking (AEB)
Intelligent Forward Collision Warning(I-FCW)
Intelligent Driver Alertness (I-DA)
RearView Monitor
Vehicle Dynamic Control System (VDC)
Traction Control System (TCS)
Tire Pressure Monitoring System (TPMS) w/ Easy Fill Tire Alert
Nissan Vehicle Immobilizer System
Vehicle Security System (VSS)

COMFORT & CONVENIENCE
8-way Power Driver Seat
60/40 Split Fold-Down Rear Seats
Nissan Intelligent Key® w/ Push Button Ignition
Remote Engine Start
Electronic Parking Brake
Cruise Control w/ Steering Wheel Controls
NissanConnect® featuring Apple CarPlay™ + and Android Auto™ +
8" Color Display w/ Multi-Touch Control
SiriusXM® Radio+
Bluetooth® Hands-free Phone System+
Streaming Audio via Bluetooth®+
Hands-free Text Messaging Assistant+
Siri Eyes Free/Google Assistant™ w/ Voice Recognition+
Two Front Illuminated USB Charge Ports
Over The Air (OTA) updating for Head Unit
7" Advanced Drive Assist Display (ADAD)
6 Speakers
Two Rear Illuminated USB Charge Ports
Manual Air Conditioning
Power Front Windows w/ Driver One-Touch Auto Up/Down and Auto-Reverse Feature
Manual Tilt and Telescoping Steering Column

COMFORT & CONVENIENCE CONT.
Intelligent Auto Headlight (I-AH)
Power Door Locks w/ Auto Locking
Steering Wheel Audio Switches
Rear Door Alert
Hill Start Assist

EXTERIOR
16" Steel Wheels w/ Full Wheel Covers
Projector-type Halogen Headlights
Body-colored Power Outside Mirrors

+For more information, see dealer, owner's manual, or www.NissanUSA.com/connect/important-information.
++Optional Equipment Replaces Standard Where Applicable

Manufacturer's Suggested Retail Base Price: $25,100.00

Options Included by Manufacturer
SPLASH GUARDS 205.00
FLOOR MATS AND TRUNK MAT 210.00

DESTINATION CHARGES 895.00

Total* **$26,410.00**

*Does not include dealer installed options and accessories, local taxes or license fees. This label has been applied pursuant to federal law. Do not remove prior to delivery to the ultimate purchaser.

EPA DOT Fuel Economy and Environment — Gasoline Vehicle

Fuel Economy: **30** MPG combined city/hwy — 26 city, 36 highway
3.3 gallons per 100 miles

MID-SIZE CARS range from 14 to 136 MPG. The best vehicle rates 136 MPGe.

You save **$500** in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost **$1,300**

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 7 (1–10, Best)
Smog Rating (tailpipe only): 7 (1–10, Best)
This vehicle emits 300 grams CO2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs $7,000 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $2.55 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

Smartphone QR Code

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score Not Rated
Based on the combined ratings of frontal, side and rollover.
Should ONLY be compared to other vehicles of similar size and weight.

Frontal Crash — Driver: Not Rated; Passenger: Not Rated
Based on the risk of injury in a frontal impact.
Should ONLY be compared to other vehicles of similar size and weight.

Side Crash — Front seat: Not Rated; Rear seat: Not Rated
Based on the risk of injury in a side impact.

Rollover Not Rated
Based on the risk of rollover in a single-vehicle crash.

Star ratings range from 1 to 5 stars (★★★★★) with 5 being the highest.
Source: National Highway Traffic Safety Administration (NHTSA)
www.safercar.gov or 1-888-327-4236

This Vehicle qualifies for Nissan's
Security+Plus Extended Protection Plan
The only service agreement backed by Nissan Extended Services North America!
Ask your dealer for details, or call 1-800-NISSAN-1 for more information

DELIVERY

VEHICLE COLORS:
EXT: DEEP BLUE PEARL
INT: DARK INTERIOR

FINAL ASSEMBLY POINT:
SMYRNA

TRANSPORT METHOD:
TRUCK

DEALER:
MAGUIRE NISSAN, INC.
504 S MEADOW ST
ITHACA NY
14850

VIN: 1N4BL4BWXKC161066
EMS: 50 STATE EMISSIONS
MDL: 13019-161066 RAY-G
OPT: E-B10L92C03

20181205225820AS3719

Photo No. 079 - Monroney Label Photograph

APPENDIX B
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

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

Driver Head X Redundant

Driver Head Y Redundant

Driver Head Z Redundant

Driver Head Angular Velocity X

Driver Head Angular Velocity Y

Driver Head Angular Velocity Z

Driver Upper Neck Force Y

Driver Upper Neck Moment X

Driver Upper Neck Moment Z

Driver Chest X Redundant

Driver Chest Y Redundant

Driver Chest Z Redundant

Driver Pelvis X

Driver Pelvis Y

Driver Pelvis Z

Driver Left Femur Redundant

Driver Right Femur Redundant

Driver Left Upper Tibia Moment X

Driver Left Upper Tibia Moment Y

Driver Left Upper Tibia Force Z

Driver Left Lower Tibia Moment X

Driver Left Lower Tibia Moment Y

Driver Left Lower Tibia Force Z

Driver Right Upper Tibia Moment X

Driver Right Upper Tibia Moment Y

Driver Right Upper Tibia Force Z

Driver Right Lower Tibia Moment X

Driver Right Lower Tibia Moment Y

Driver Right Lower Tibia Force Z

Driver Left Foot Fore Z

Driver Left Foot Aft X

Driver Left Foot Aft Z

Driver Right Foot Fore Z

Driver Right Foot Aft X

Driver Right Foot Aft Z

Driver Lap Belt Force

Driver Shoulder Belt Force

Passenger Head X Redundant

Passenger Head Y Redundant

Passenger Head Z Redundant

Passenger Head Angular Velocity X

Passenger Head Angular Velocity Y

Passenger Head Angular Velocity Z

Passenger Upper Neck Force Y

Passenger Upper Neck Moment X

Passenger Upper Neck Moment Z

Passenger Chest X Redundant

Passenger Chest Y Redundant

Passenger Chest Z Redundant

Passenger Pelvis X

Passenger Pelvis Y

Passenger Pelvis Z

Passenger Left Femur Redundant

Passenger Right Femur Redundant

Passenger Left Upper Tibia Moment X

Passenger Left Upper Tibia Moment Y

Passenger Left Upper Tibia Force Z

Passenger Left Lower Tibia Moment X

Passenger Left Lower Tibia Moment Y

Passenger Left Lower Tibia Force Z

Passenger Right Upper Tibia Moment X

Passenger Right Upper Tibia Moment Y

Passenger Right Upper Tibia Force Z

Passenger Right Lower Tibia Moment X

Passenger Right Lower Tibia Moment Y

Passenger Right Lower Tibia Force Z

Passenger Left Foot Fore Z

Passenger Left Foot Aft X

Passenger Left Foot Aft Z

Passenger Right Foot Fore Z

Passenger Right Foot Aft X

Passenger Right Foot Aft Z

Passenger Lap Belt Force

Passenger Shoulder Belt Force

Left Rear Seat Crossmember X

Right Rear Seat Crossmember X

Vehicle Engine Top X

Vehicle Engine Bottom X

Left Rear Seat Crossmember Z

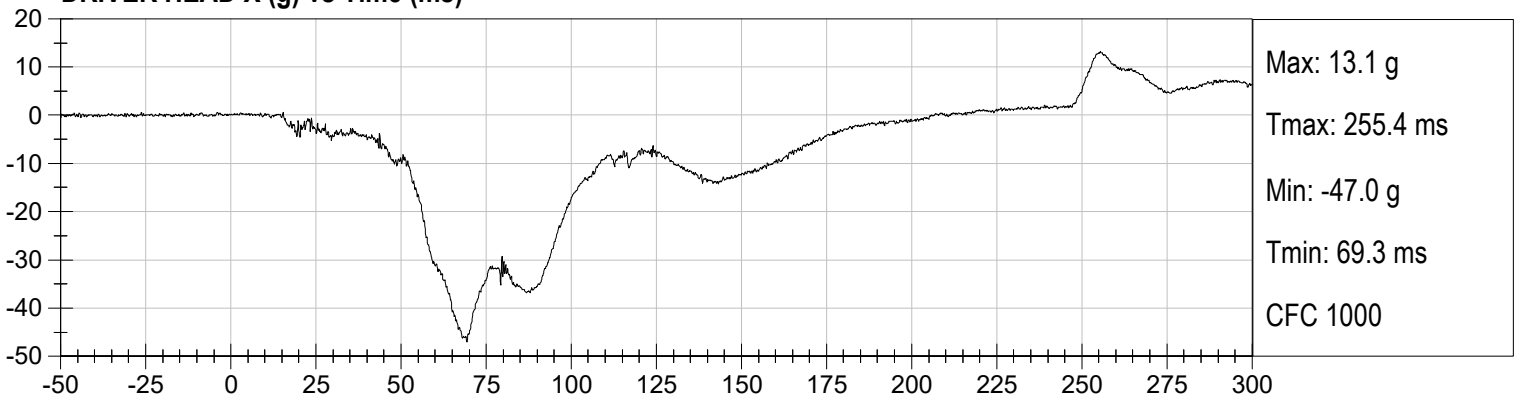
Right Rear Seat Crossmember Z

Left Rear Seat Crossmember Xr

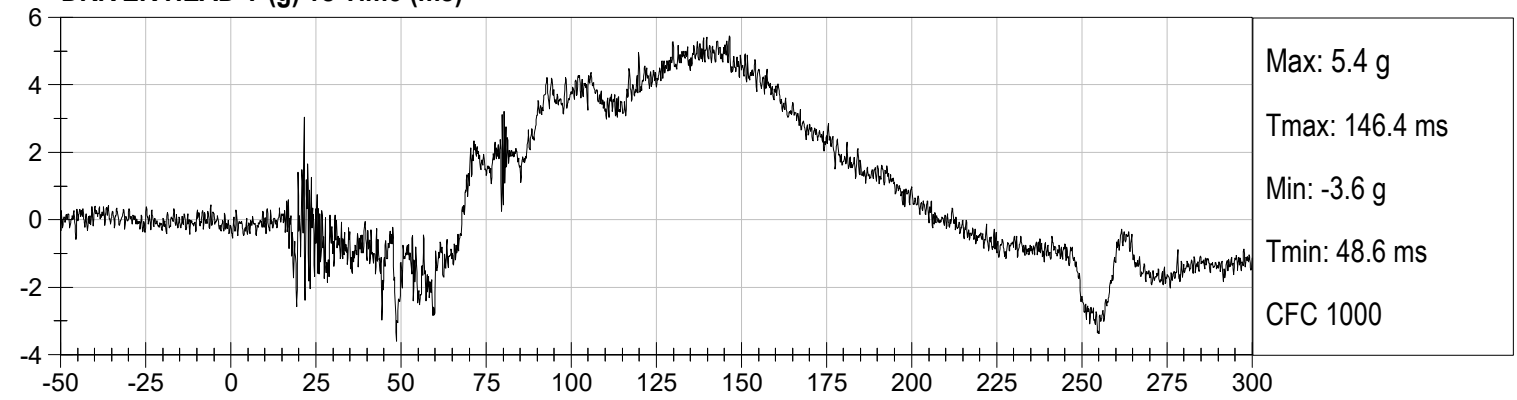
Right Rear Seat Crossmember Xr

Advanced Research Load Cell Barrier – 528 channels

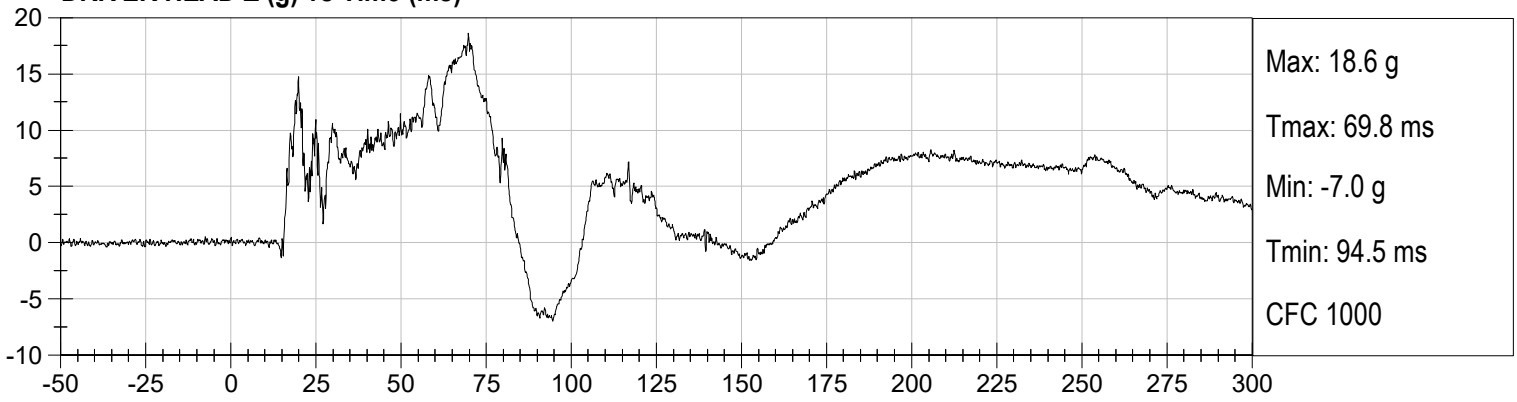
DRIVER HEAD X (g) vs Time (ms)



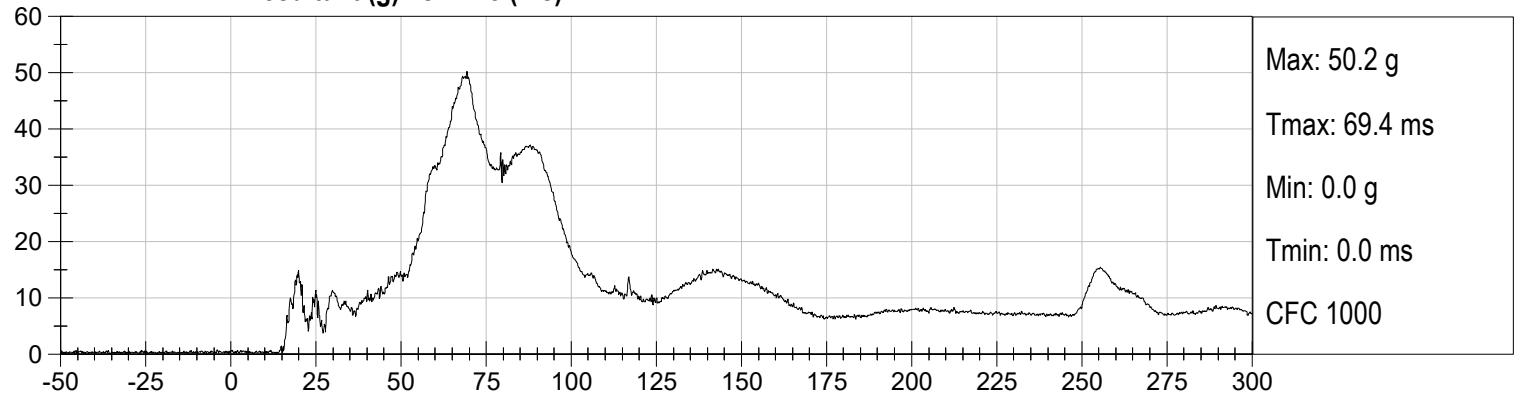
DRIVER HEAD Y (g) vs Time (ms)



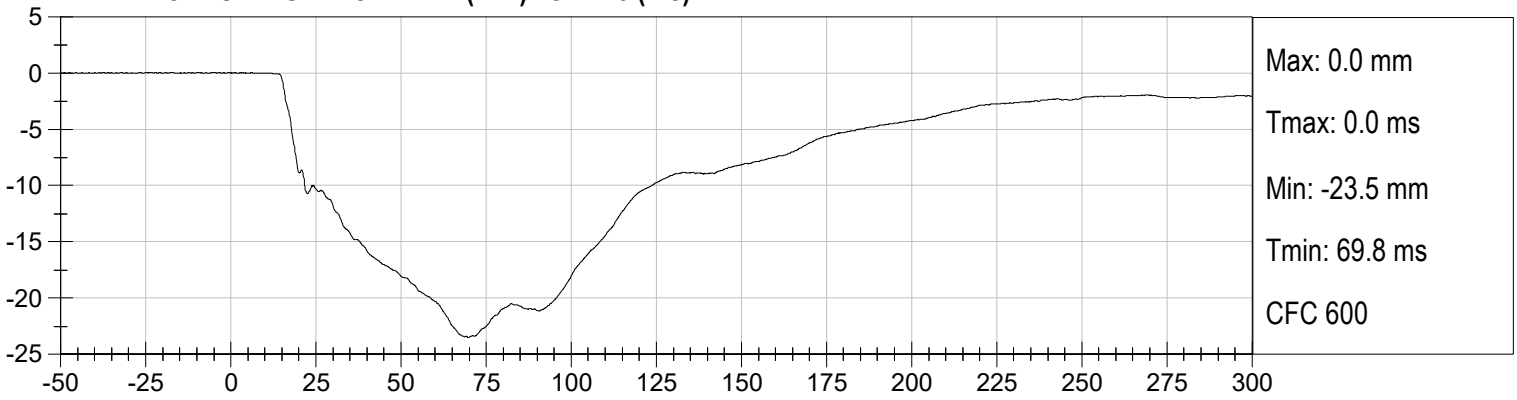
DRIVER HEAD Z (g) vs Time (ms)



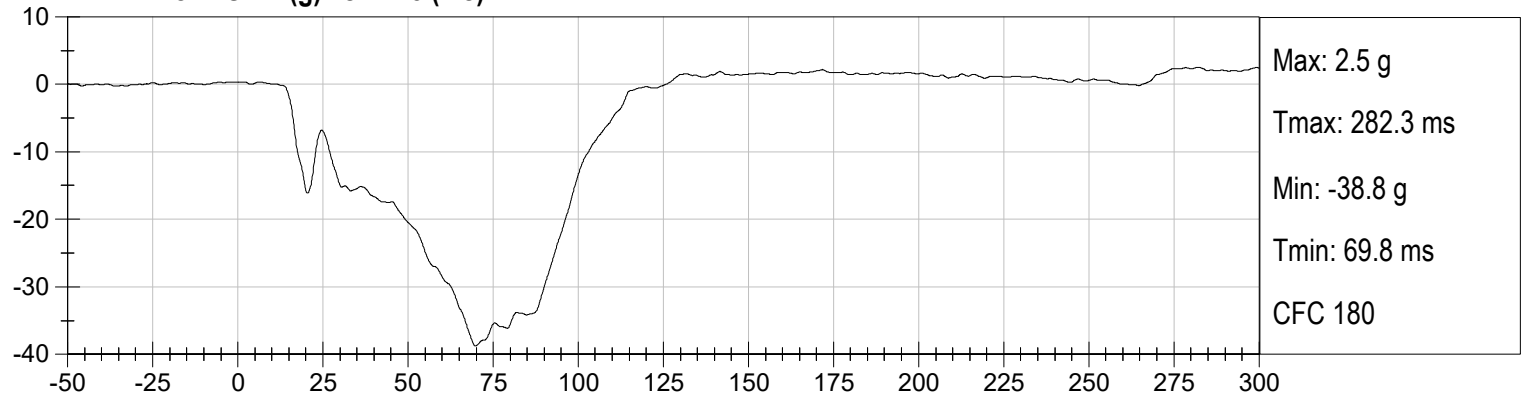
DRIVER HEAD Resultant (g) vs Time (ms)



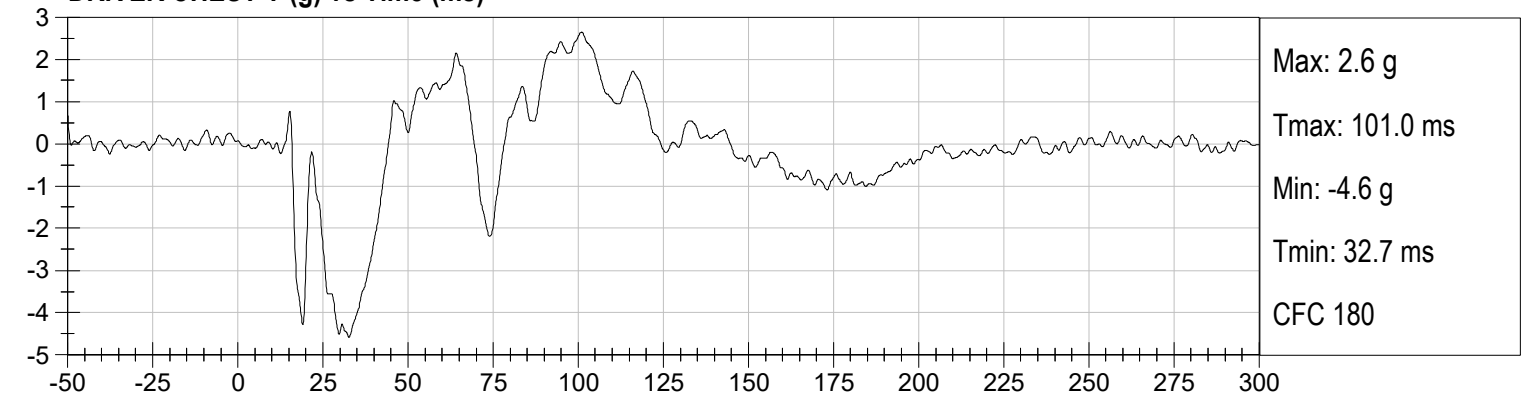
DRIVER CHEST DISPLACEMENT (mm) vs Time (ms)



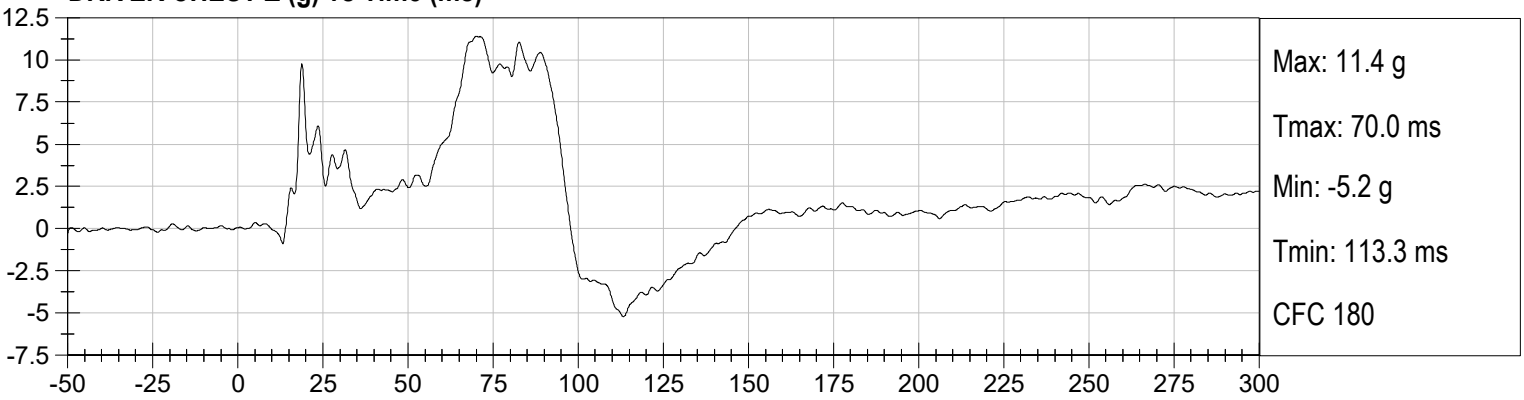
DRIVER CHEST X (g) vs Time (ms)



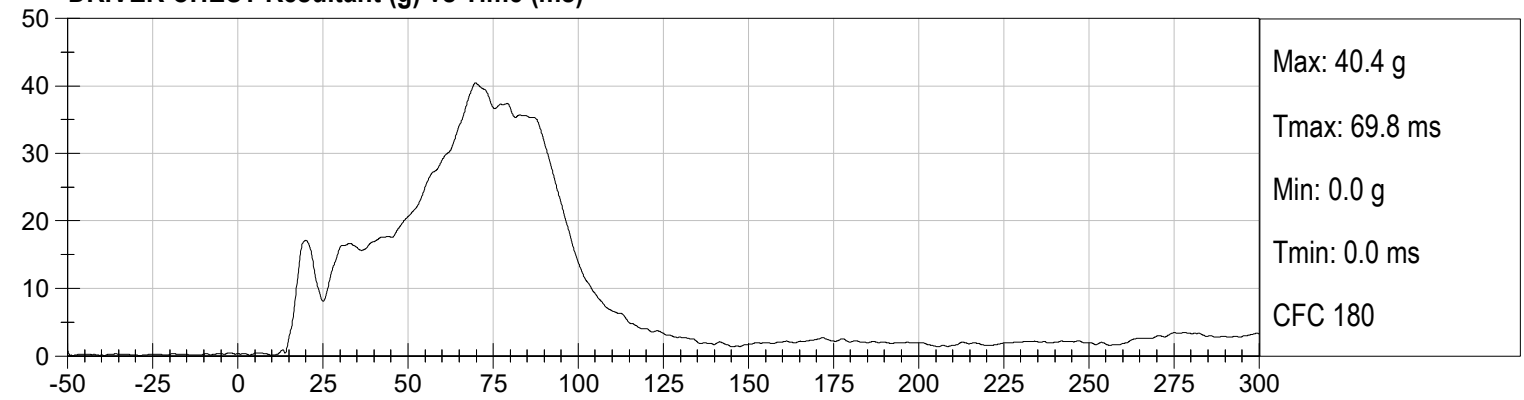
DRIVER CHEST Y (g) vs Time (ms)



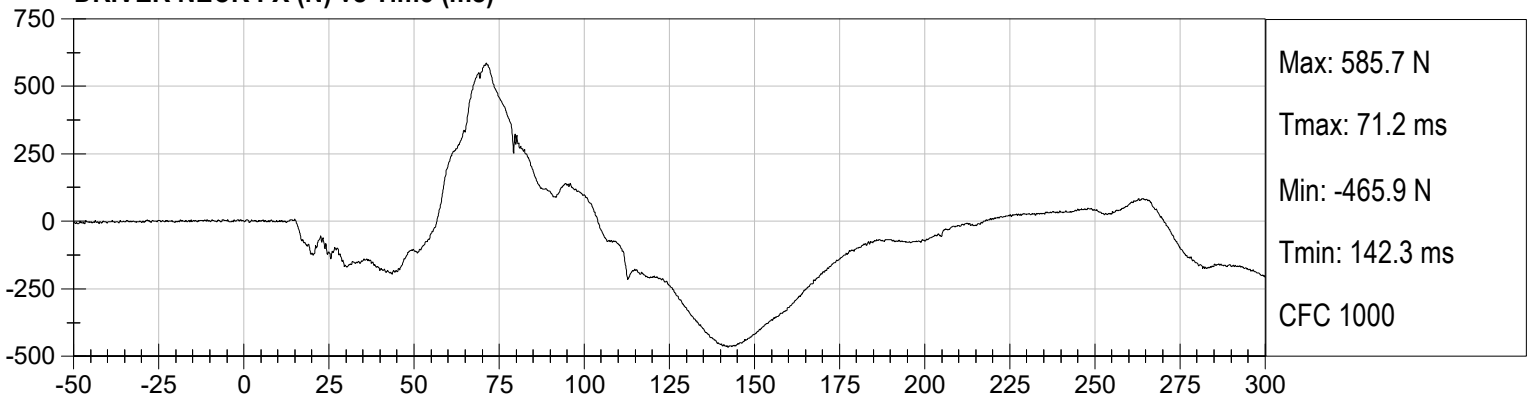
DRIVER CHEST Z (g) vs Time (ms)



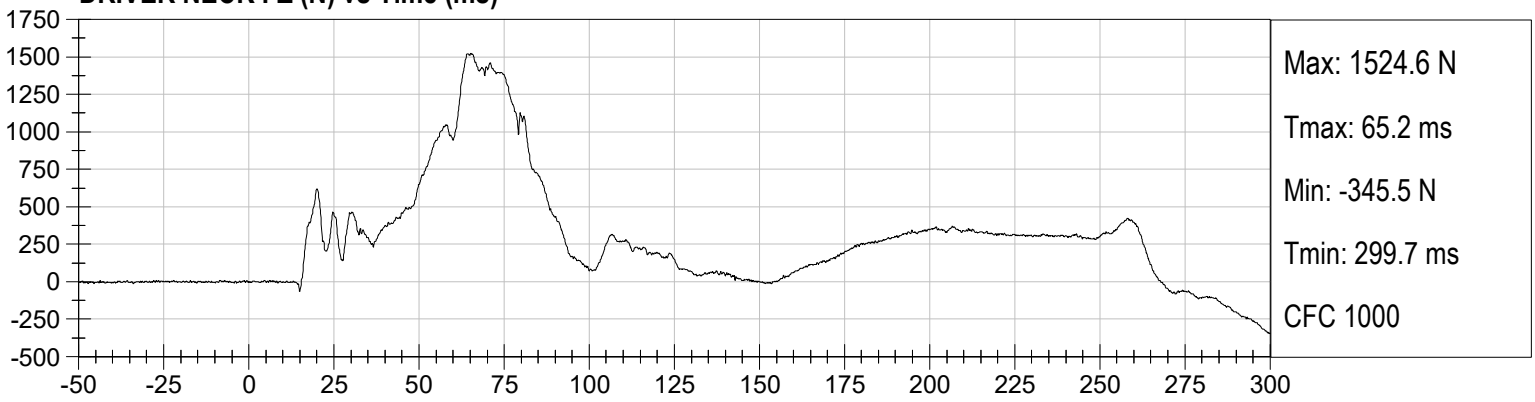
DRIVER CHEST Resultant (g) vs Time (ms)



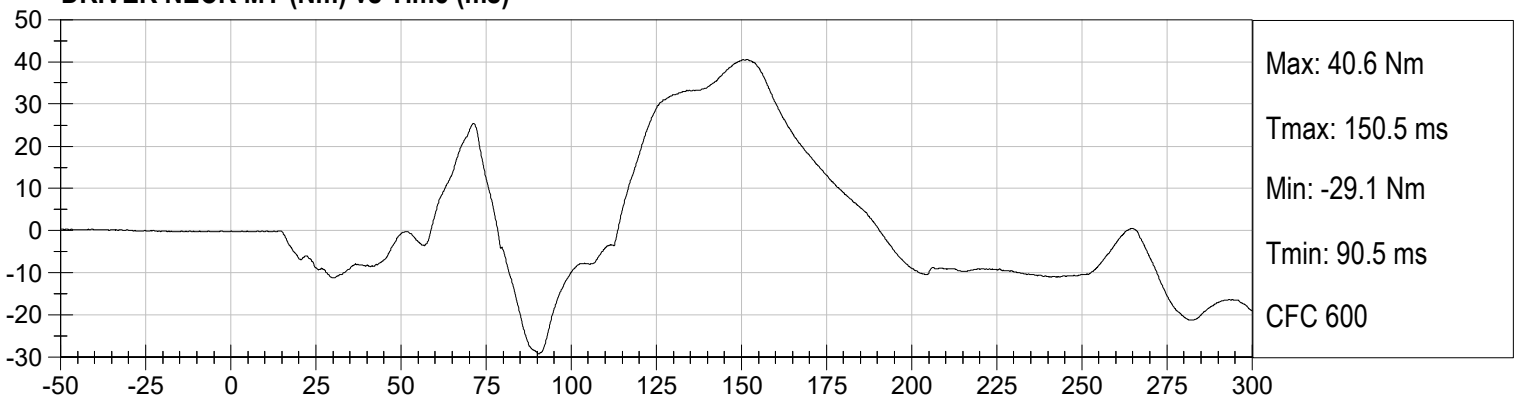
DRIVER NECK FX (N) vs Time (ms)



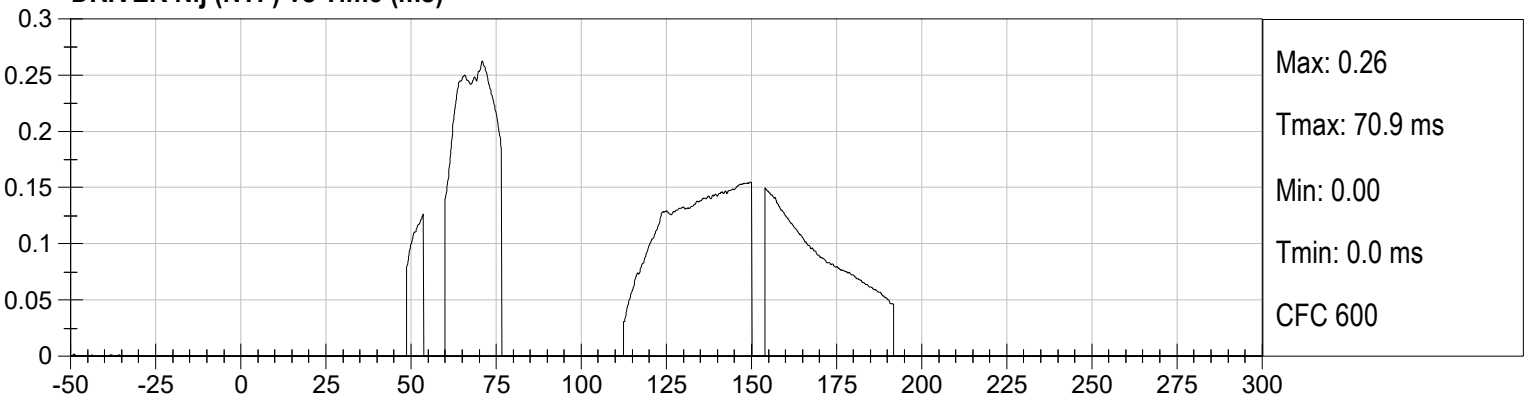
DRIVER NECK FZ (N) vs Time (ms)



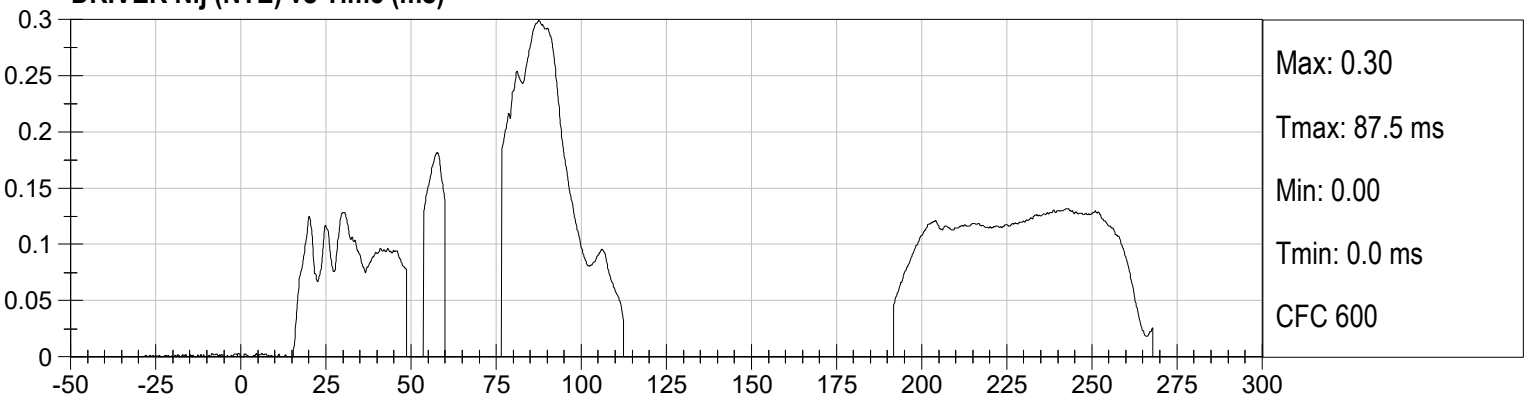
DRIVER NECK MY (Nm) vs Time (ms)



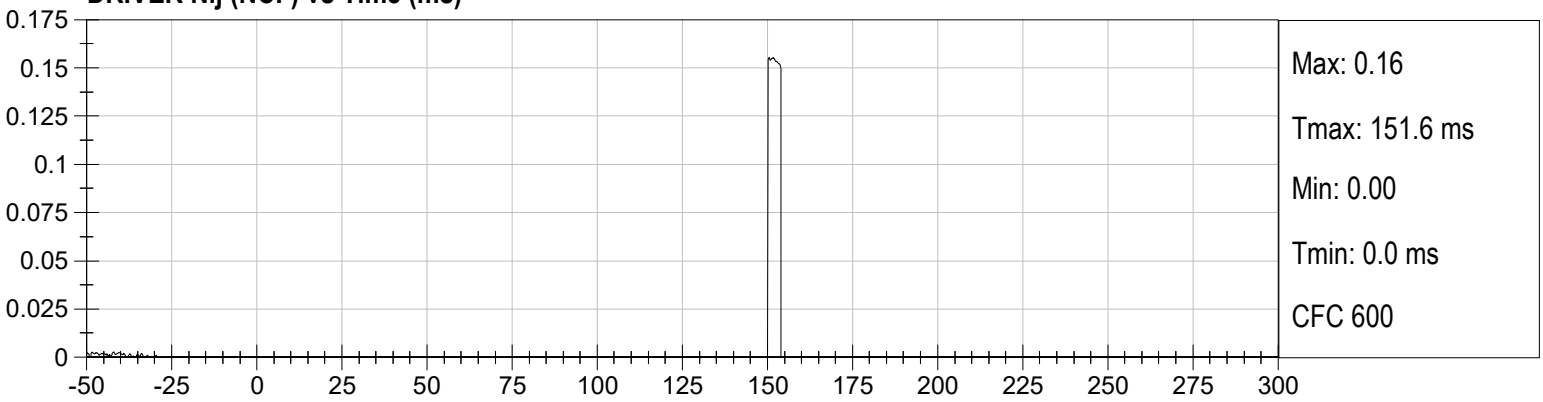
DRIVER Nij (NTF) vs Time (ms)



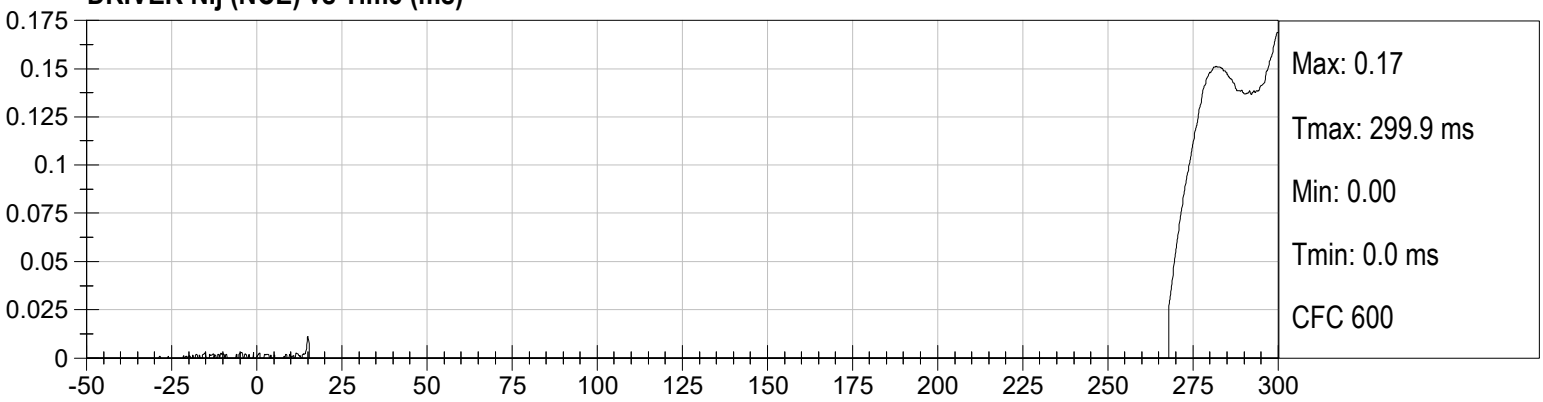
DRIVER Nij (NTE) vs Time (ms)



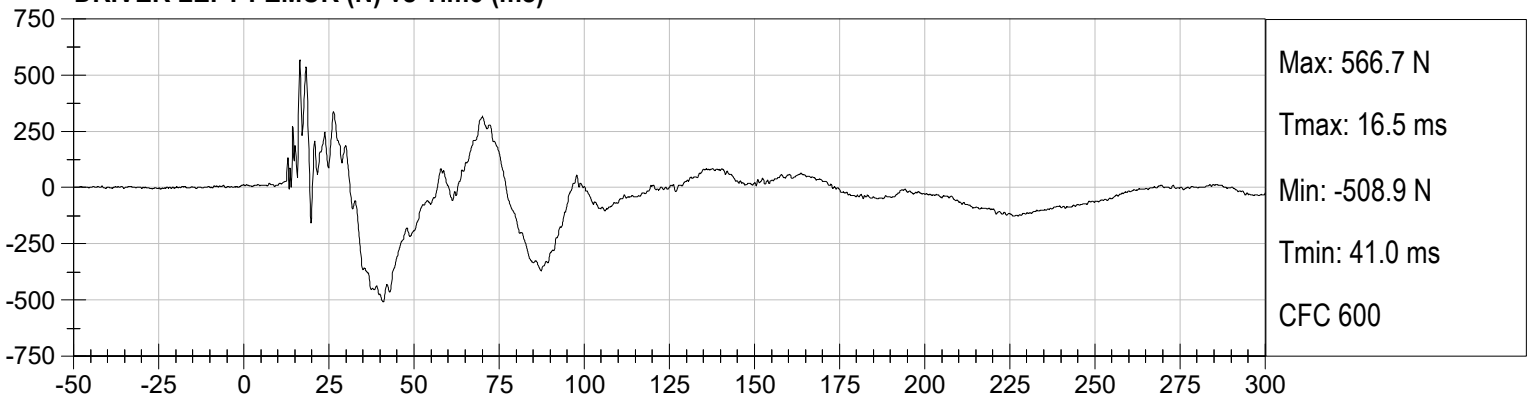
DRIVER Nij (NCF) vs Time (ms)



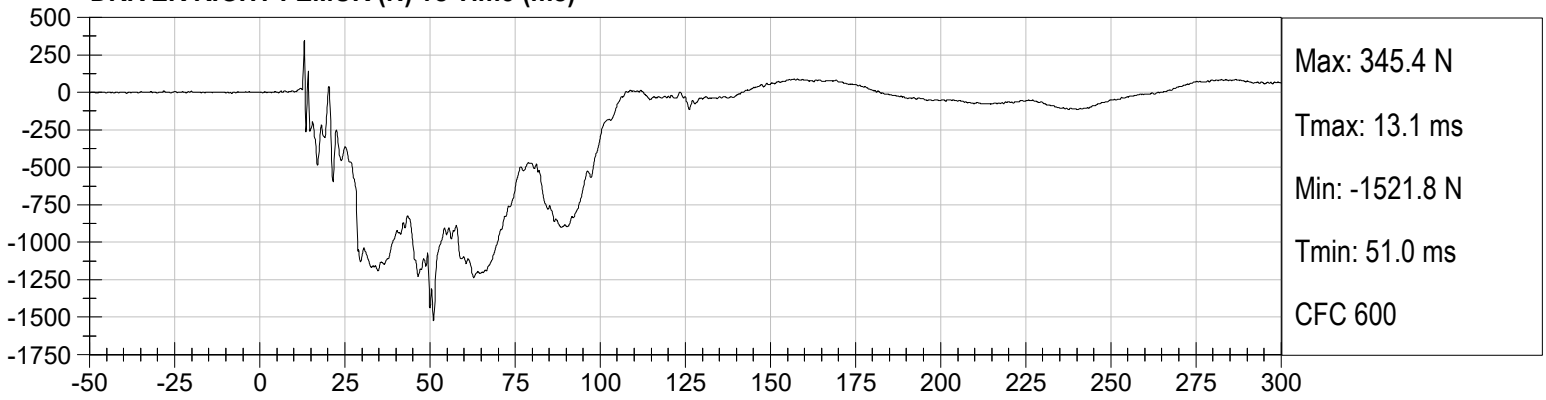
DRIVER Nij (NCE) vs Time (ms)



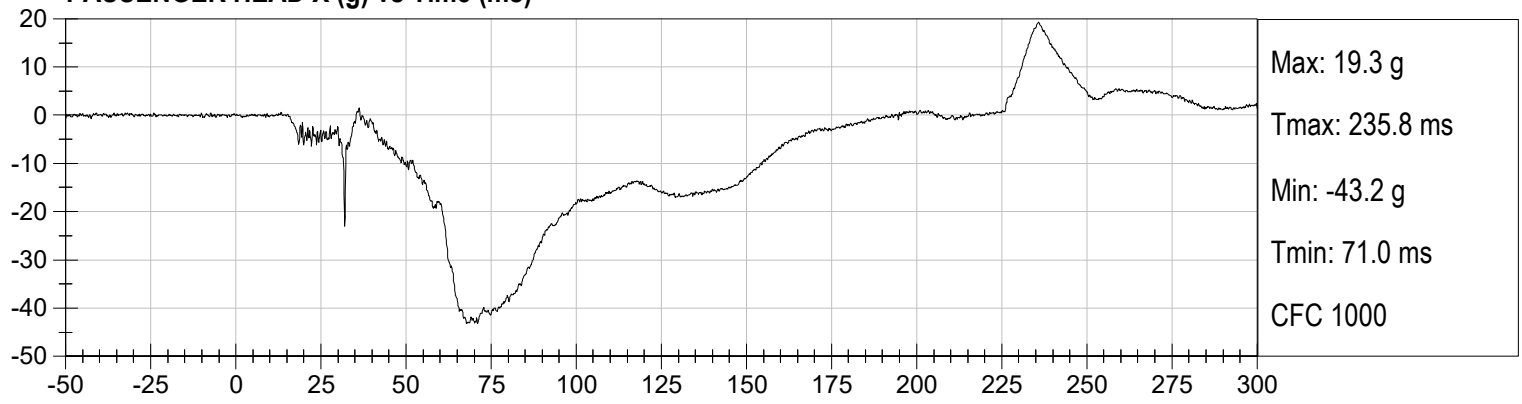
DRIVER LEFT FEMUR (N) vs Time (ms)



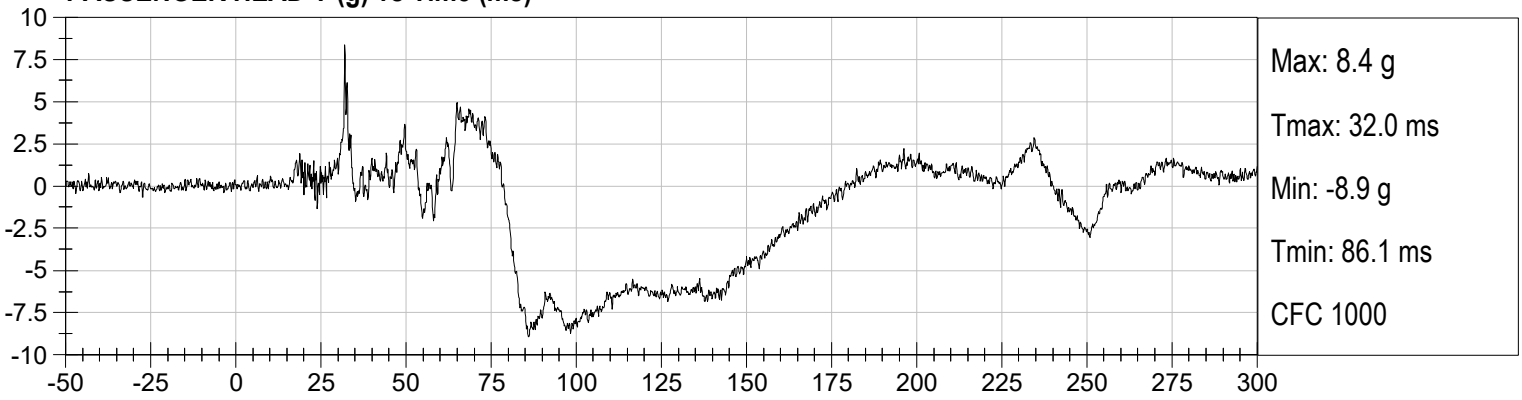
DRIVER RIGHT FEMUR (N) vs Time (ms)



PASSENGER HEAD X (g) vs Time (ms)

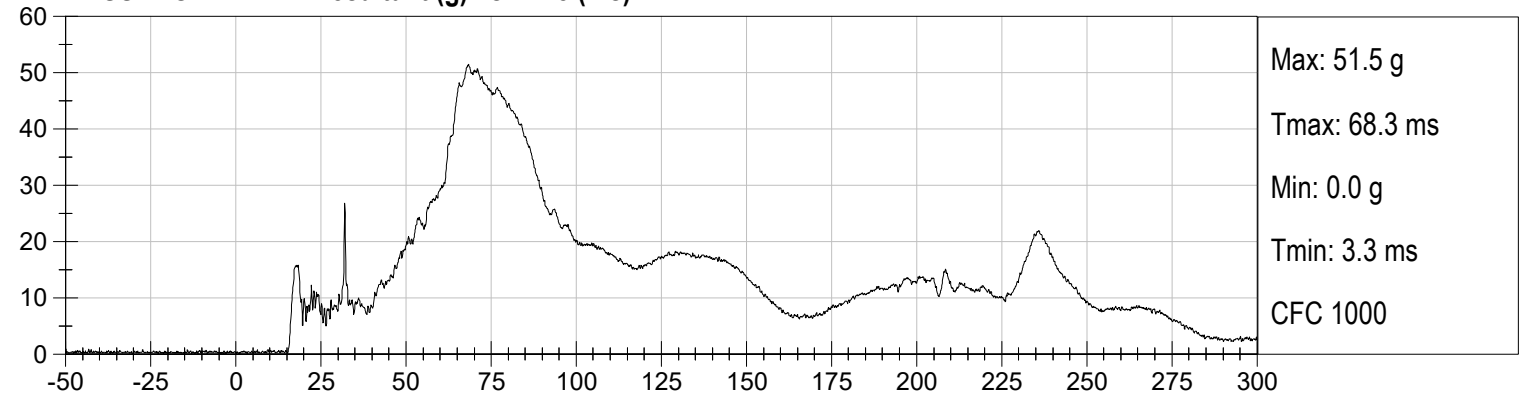


PASSENGER HEAD Y (g) vs Time (ms)

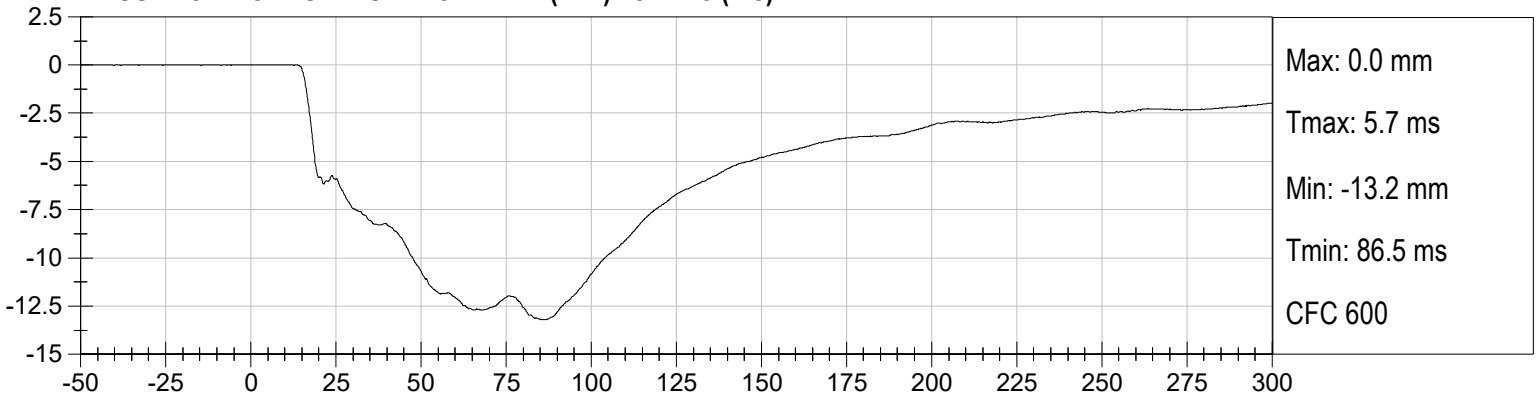


PASSENGER HEAD Z (g) vs Time (ms)

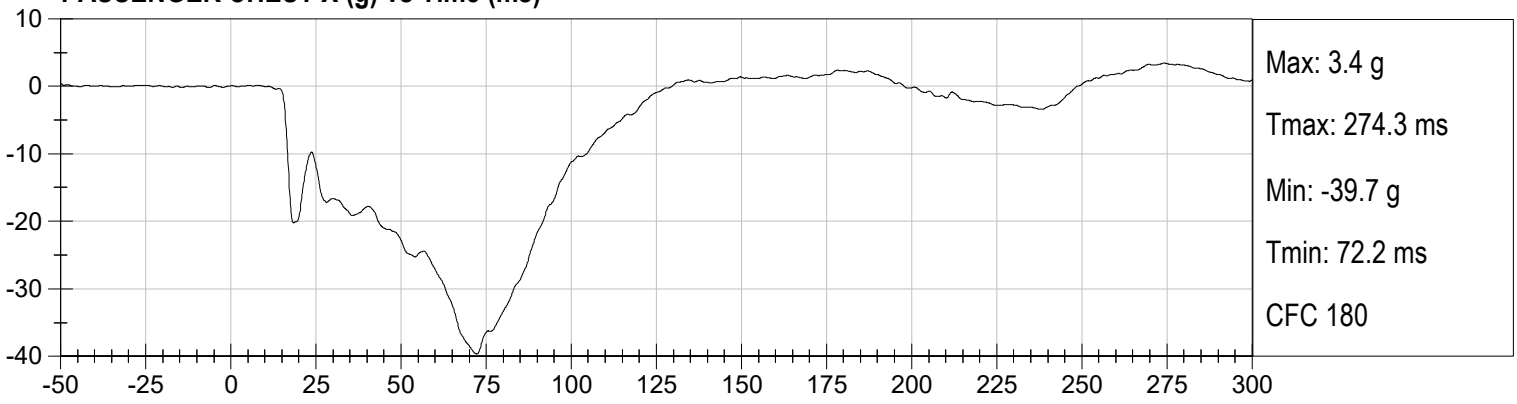
PASSENGER HEAD Resultant (g) vs Time (ms)



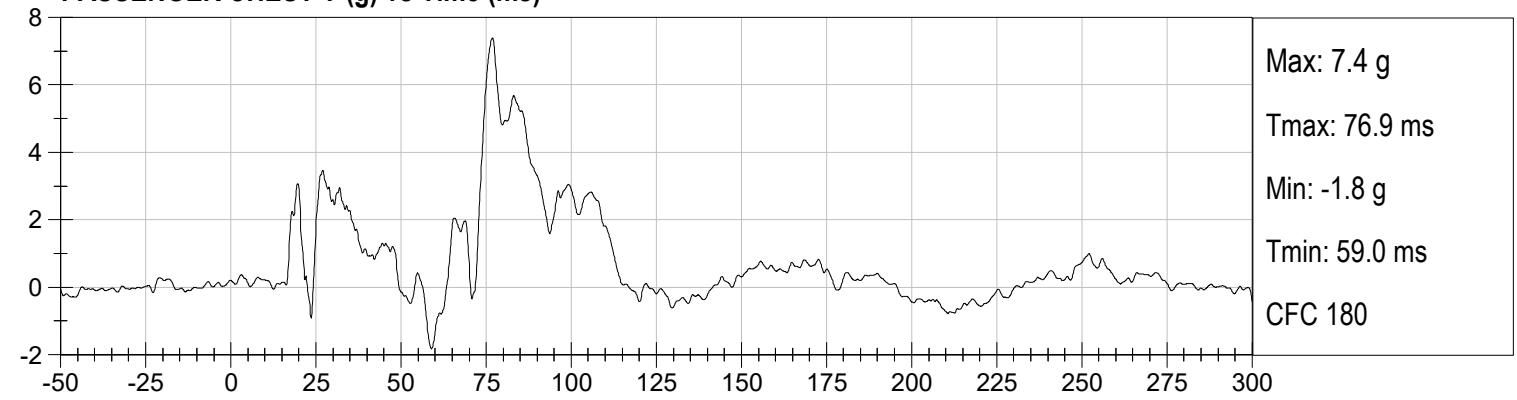
PASSENGER CHEST DISPLACEMENT (mm) vs Time (ms)



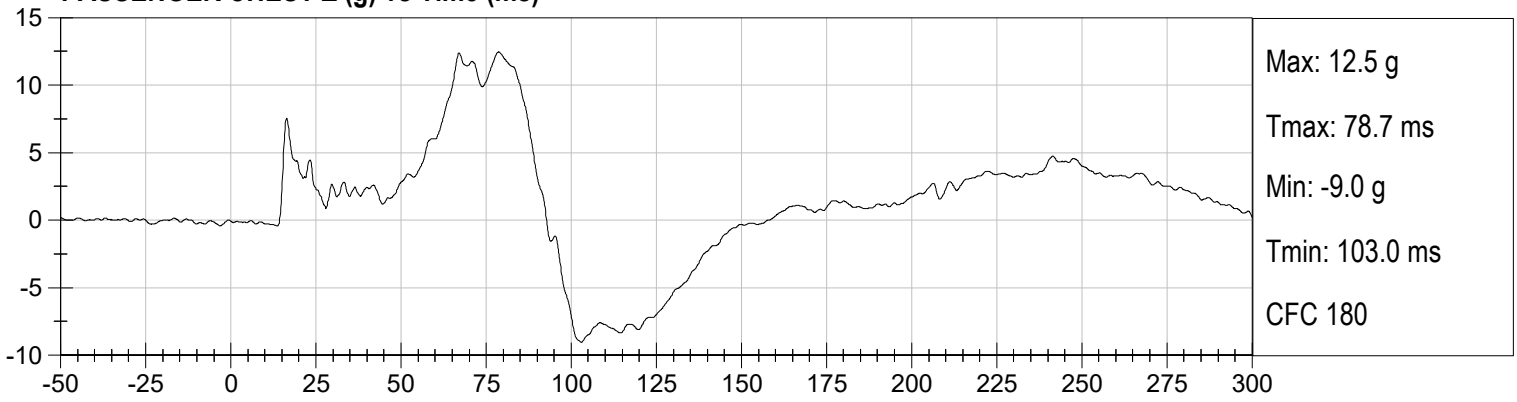
PASSENGER CHEST X (g) vs Time (ms)



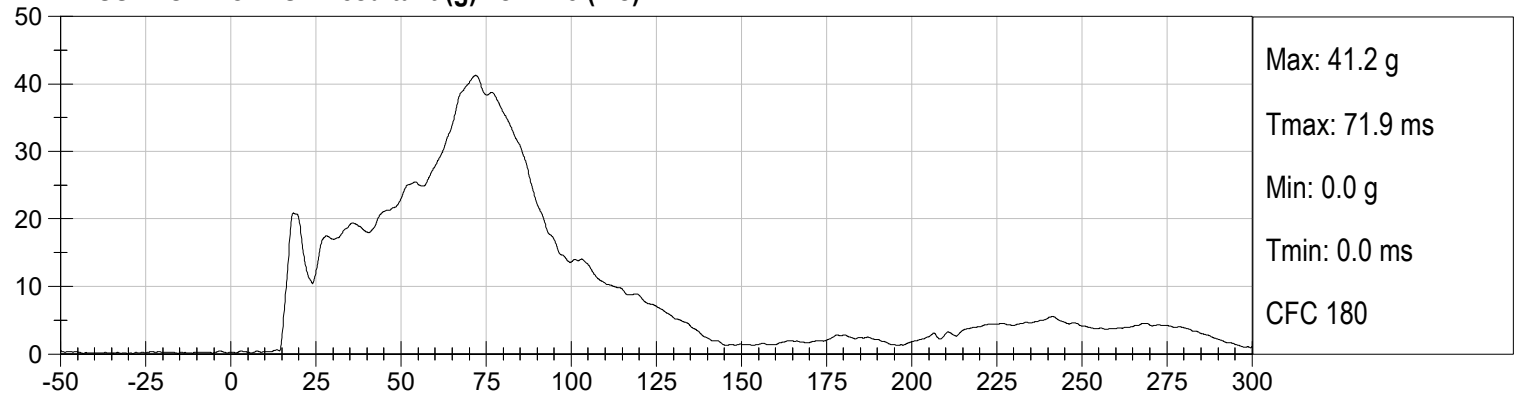
PASSENGER CHEST Y (g) vs Time (ms)



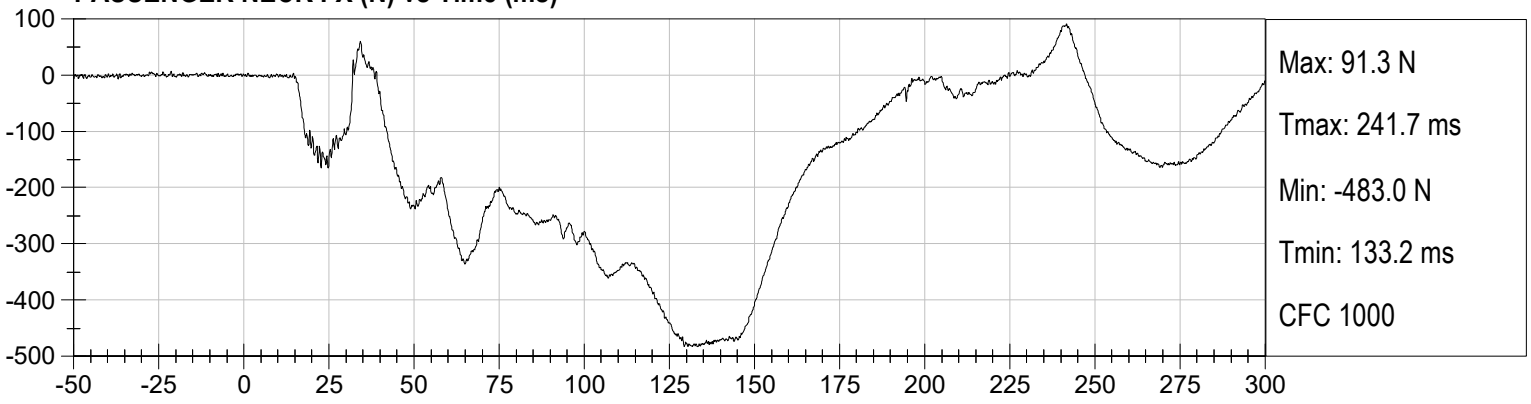
PASSENGER CHEST Z (g) vs Time (ms)



PASSENGER CHEST Resultant (g) vs Time (ms)

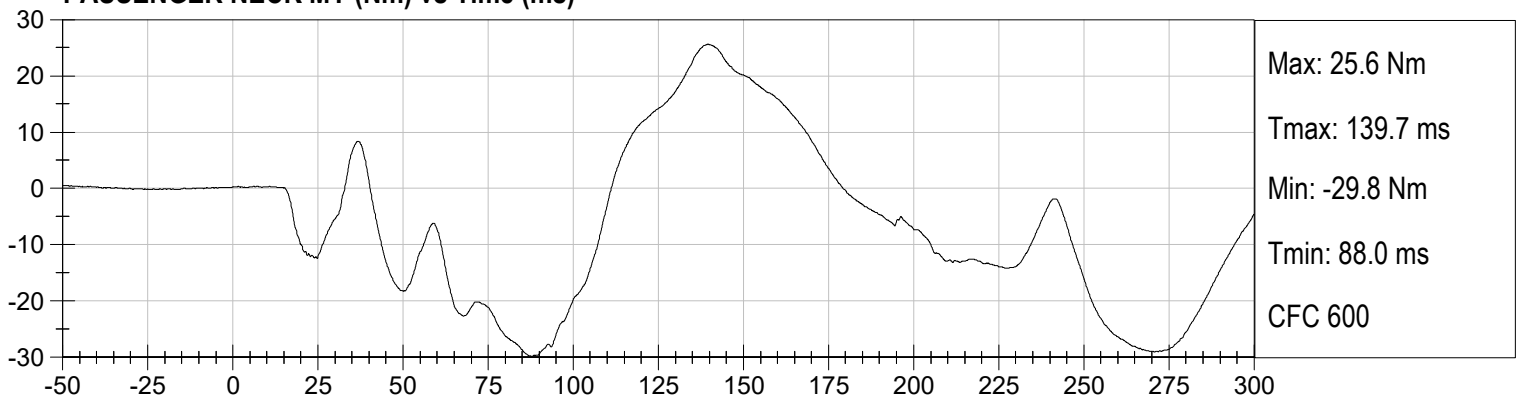


PASSENGER NECK FX (N) vs Time (ms)

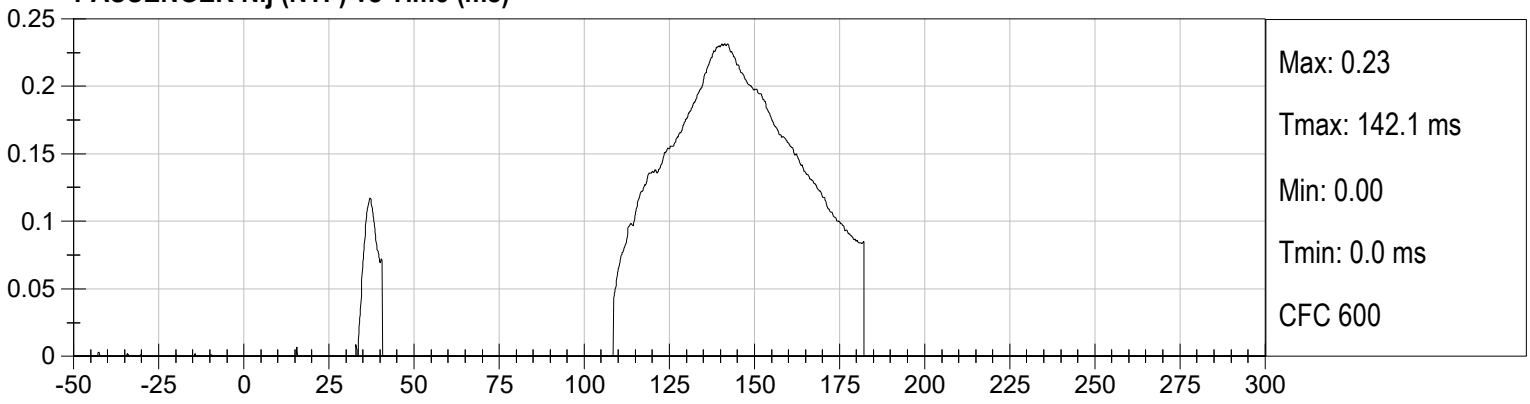


PASSENGER NECK FZ (N) vs Time (ms)

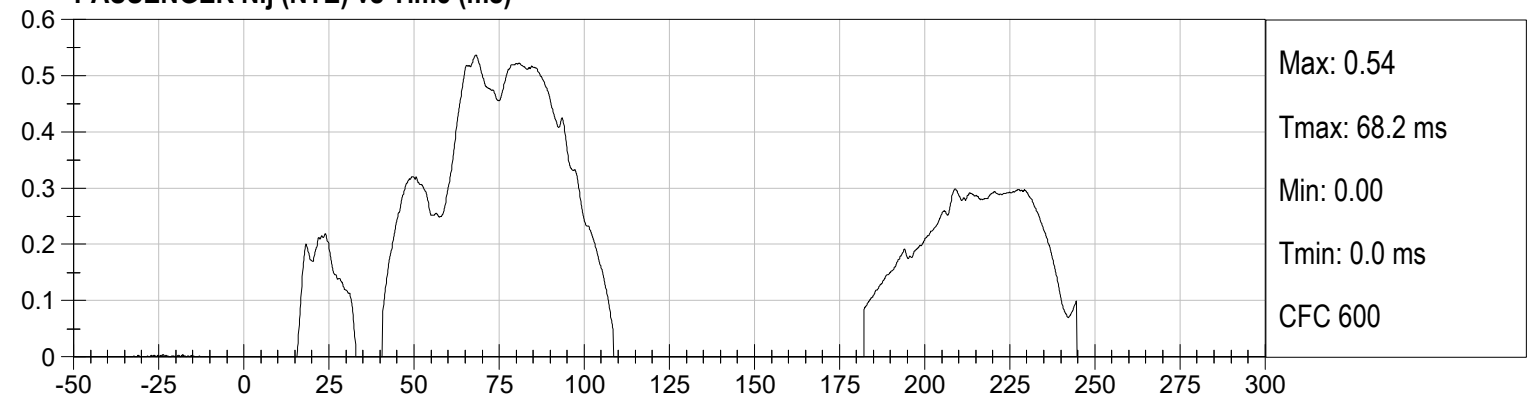
PASSENGER NECK MY (Nm) vs Time (ms)



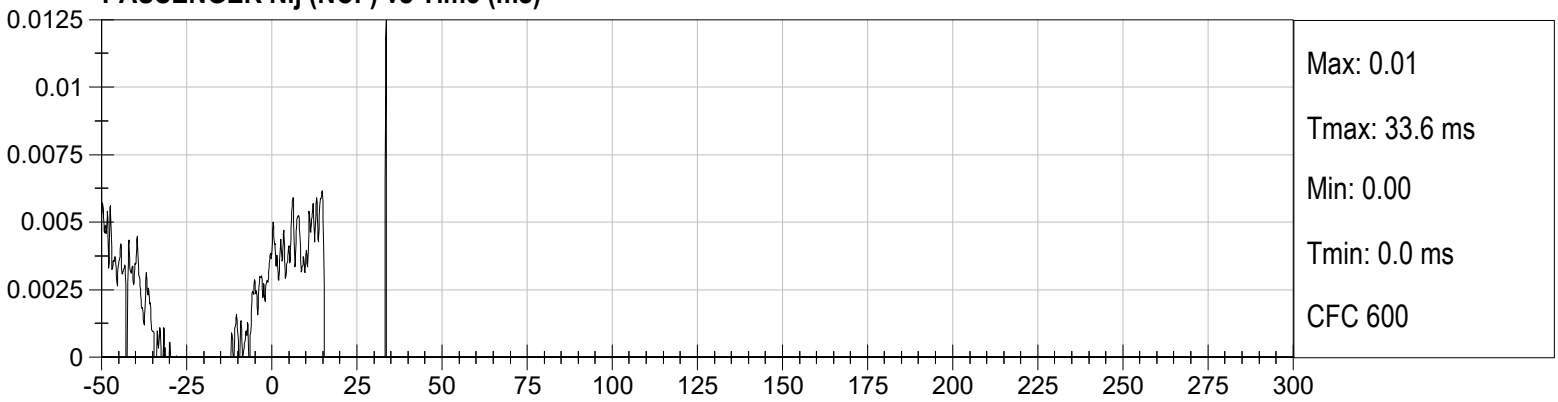
PASSENGER Nij (NTF) vs Time (ms)



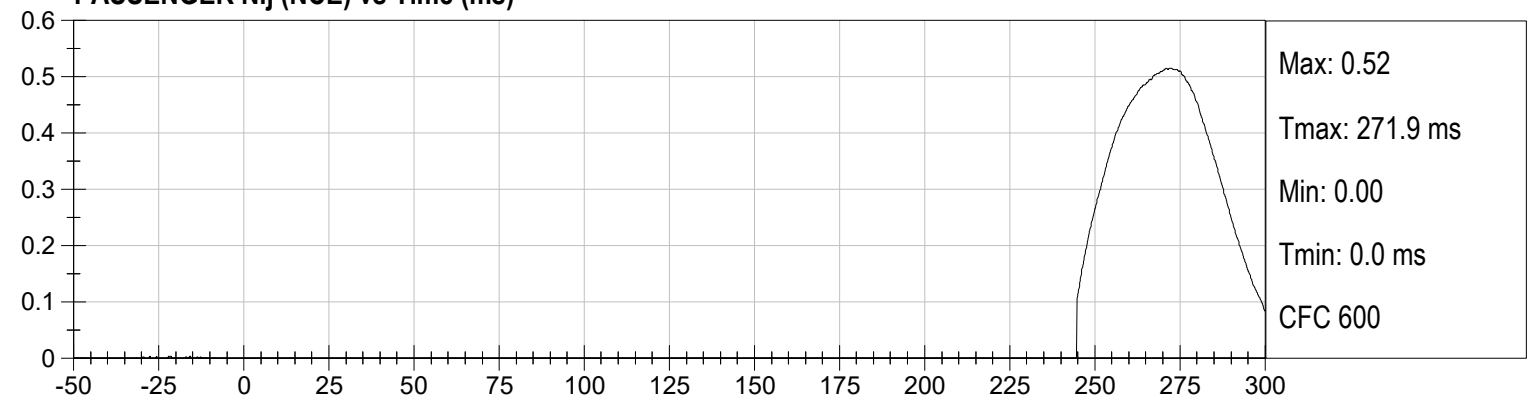
PASSENGER Nij (NTE) vs Time (ms)



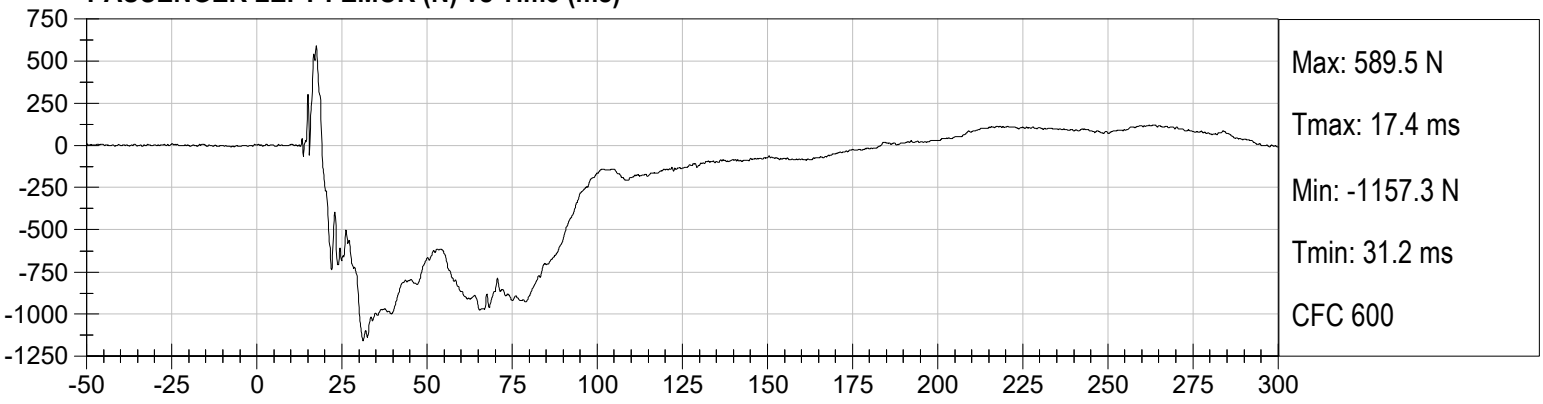
PASSENGER Nij (NCF) vs Time (ms)



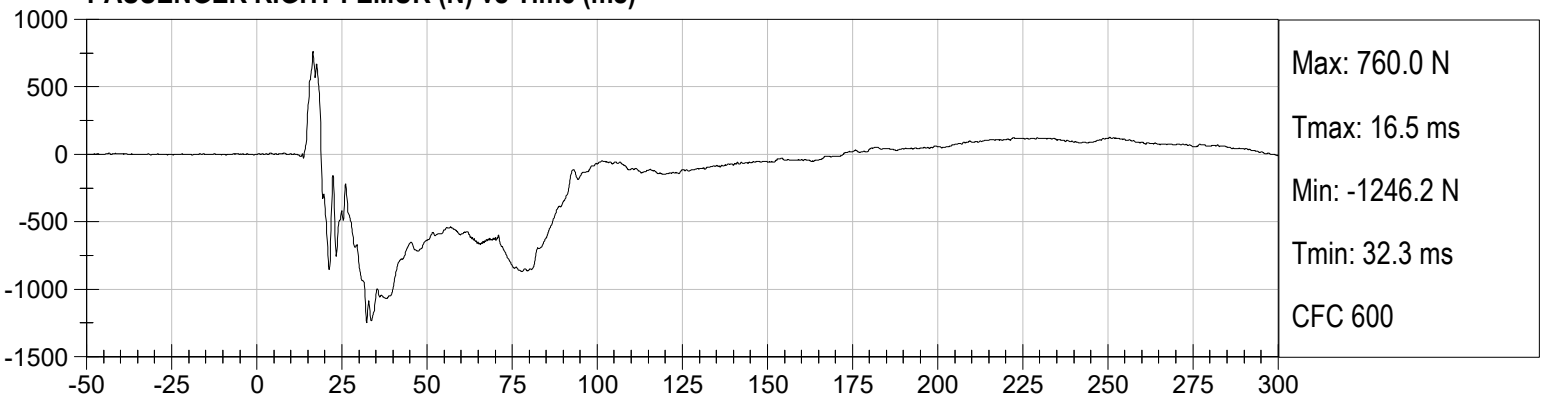
PASSENGER Nij (NCE) vs Time (ms)



PASSENGER LEFT FEMUR (N) vs Time (ms)



PASSENGER RIGHT FEMUR (N) vs Time (ms)



APPENDIX C
DUMMY CALIBRATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

Hybrid III, 50th External Measurements
SN: 351

HYBRID III, PART 572, SUBPART E EXTERNAL DIMENSIONS				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (inches)	ACTUAL MEASUREMENT
A	TOTAL SITTING HEIGHT	Seat surface to highest point on top of the head.	34.6–35.0	34.8
B	SHOULDER PIVOT HEIGHT	Centerline of shoulder pivot bolt to the seat surface.	19.9-20.5	20.0
C	H-POINT HEIGHT	Reference	3.3-3.5	3.4
D	H-POINT LOCATION FROM BACKLINE	Reference	5.3-5.5	5.5
E	SHOULDER PIVOT FROM BACKLINE	Center of the shoulder clevis to the rear vertical surface of the fixture.	3.3-3.7	3.5
F	THIGH CLEARANCE	Measured at the highest point on the upper femur segment.	5.5-6.1	6.0
G	BACK OF ELBOW TO WRIST PIVOT	back of the elbow flesh to the wrist pivot in line with the elbow and wrist pivots	11.4-12.0	11.8
H	HEAD BACK TO BACKLINE	Back of Skull cap skin to seat rear vertical surface (Reference)	1.6-1.8	1.7
I	SHOULDER TO- ELBOW LENGTH	Measure from the highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow in line with the elbow pivot bolt.	13.0-13.6	13.3
J	ELBOW REST HEIGHT	Measure from the flesh below the elbow pivot bolt to the seat surface.	7.5-8.3	7.8
K	BUTTOCK TO KNEE LENGTH	The forward most part of the knee flesh to the rear vertical surface of the fixture.	22.8-23.8	23.8
L	POPLITEAL HEIGHT	Seat surface to the plane of the horizontal plane of the bottom of the feet.	16.9-17.9	17.0
M	KNEE PIVOT HEIGHT	Centerline of knee pivot bolt to the horizontal plane of the bottom of the feet.	19.1-19.7	19.5
N	BUTTOCK POPLITEAL LENGTH	The rearmost surface of the lower leg to the same point on the rear surface of the buttocks used for dim. “K”.	17.8-18.8	18.8

HYBRID III, SUBPART E EXTERIOR DIMENSIONS, continued				
DIMENSION	DESCRIPTION	DETAILS		ACTUAL MEASUREMENT
O	CHEST DEPTH WITHOUT JACKET	Measured 16.9-17.1 in. above seat surface	8.4-9.0	8.5
P	FOOT LENGTH	Tip of toe to rear of heel	9.9-10.5	10.3
V	SHOULDER BREADTH	Outside edges of right and left shoulder clevises	16.3-17.2	16.5
W	FOOT BREADTH	The widest part of the foot	3.6-4.2	4.0
Y	CHEST CIRCUMFERENCE (WITH CHEST JACKET)	Measured 16.9-17.1 in. above seat surface	38.2-39.4	39.2
Z	WAIST CIRCUMFERENCE	Measured 8.9-9.1 in. above seat surface	32.9-34.1	33.7
AA	REFERENCE LOCATION FOR MEASUREMENT OF CHEST CIRCUMFERENCE	Reference	16.9-17.1	17.0
BB	REFERENCE LOCATION FOR MEASUREMENT OF WAIST CIRCUMFERENCE	Reference	8.9-9.1	9.0

NOTE: THE H-POINT IS LOCATED 1.83 INCHES FORWARD AND 2.57 INCHES DOWN FROM THE CENTER OF THE PELVIS ANGLE REFERENCE HOLE.

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test ID:** D19AS1

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Peak Resultant Acceleration	G's	225 to 275	252	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-9.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

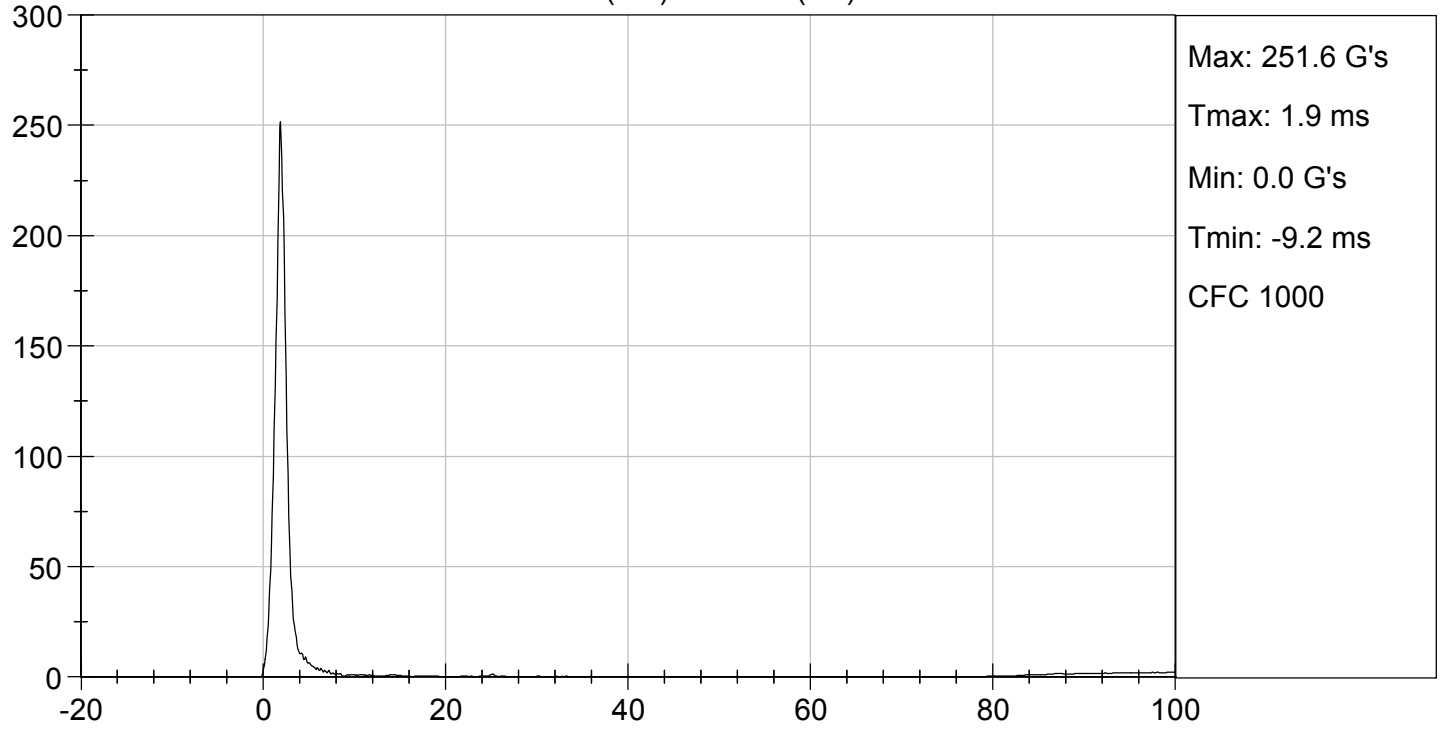
05/20/2019
Test Date

Approved By

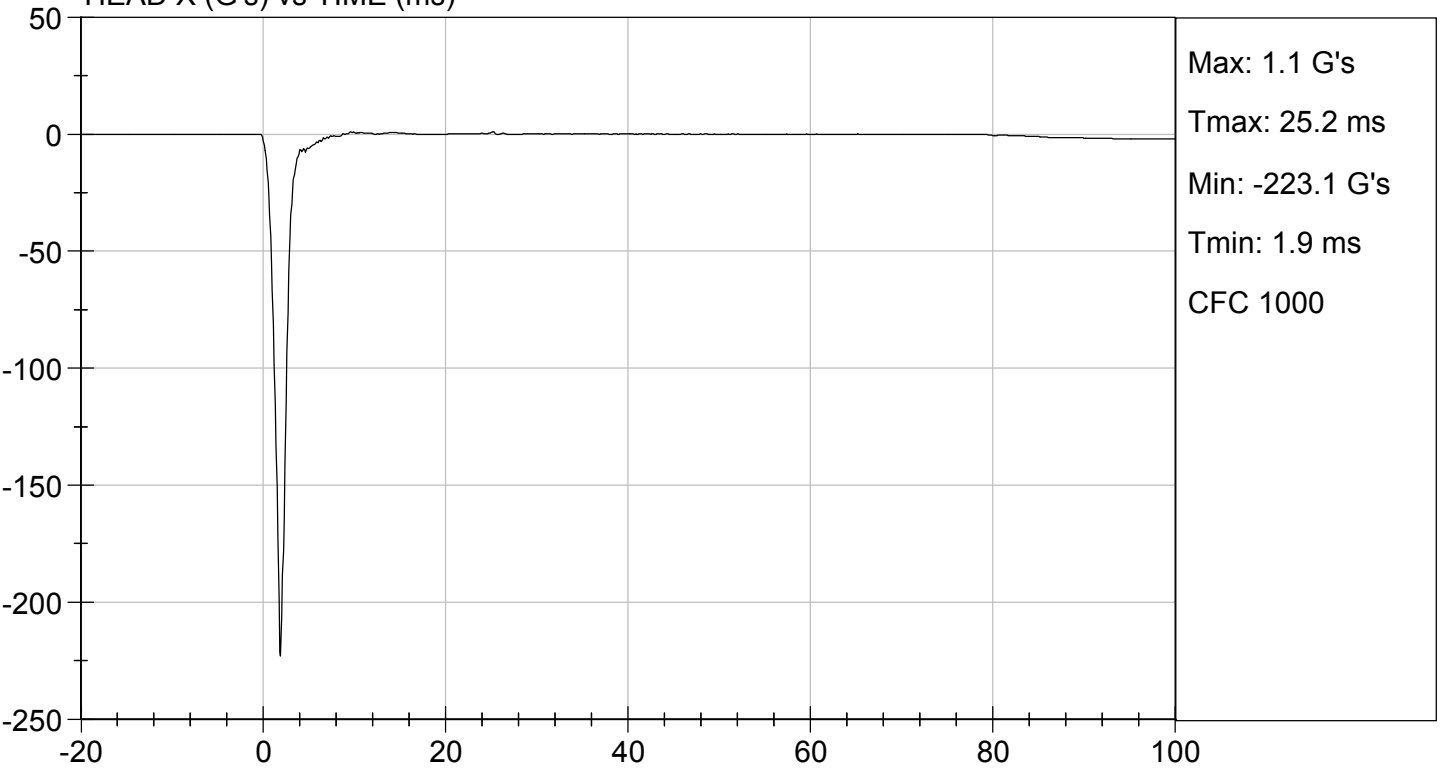
TEST DESC: HEAD DROP

TEST DATE: 05/20/2019
TEST #: D19AS1

HEAD RESULTANT ACCELERATION (G's) vs TIME (ms)

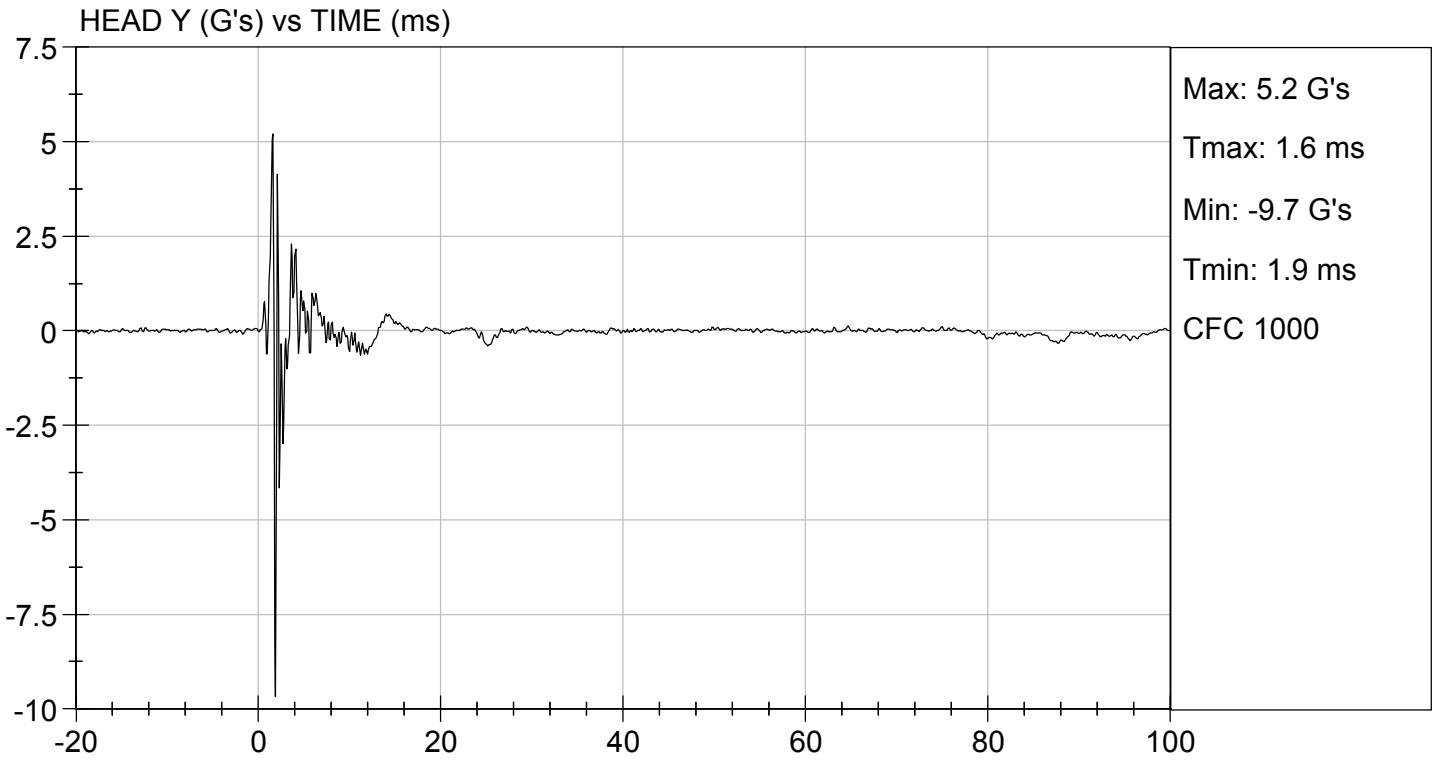


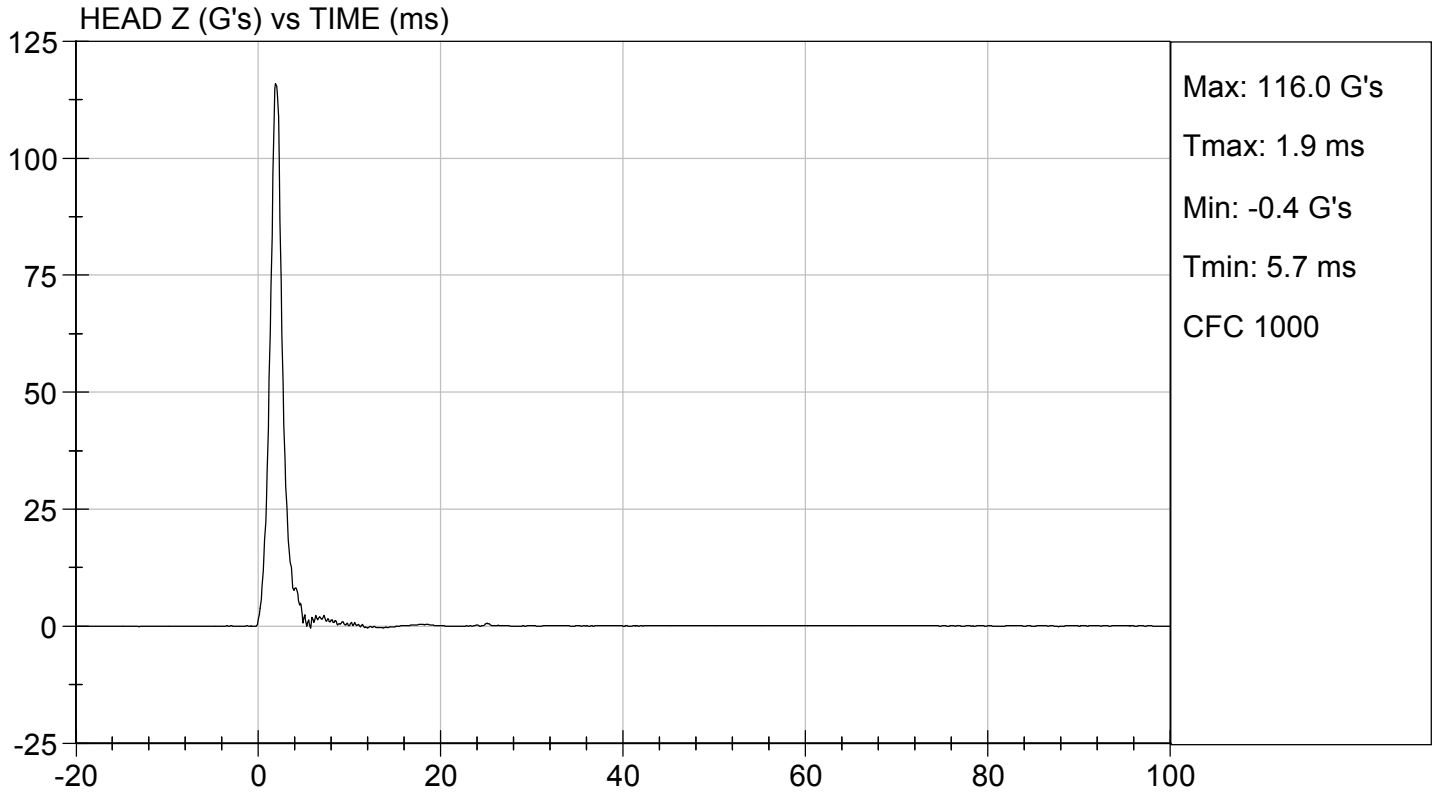
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 05/20/2019
TEST #: D19AS1





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191512

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	46	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	22.77	Pass
	20 ms	G's	17.60 to 22.60	22.52	Pass
	30 ms	G's	12.50 to 18.50	14.14	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	14.1	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	37.2	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	69.4	Pass
	Time	ms	57.0 to 64.0	58.6	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	115.6	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	93.7	Pass
	Time	ms	47.0 to 58.0	49.3	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	98.9	Pass
			Overall Test Results		Pass

Danielle Redenbaugh

Laboratory Technician

05/09/2019

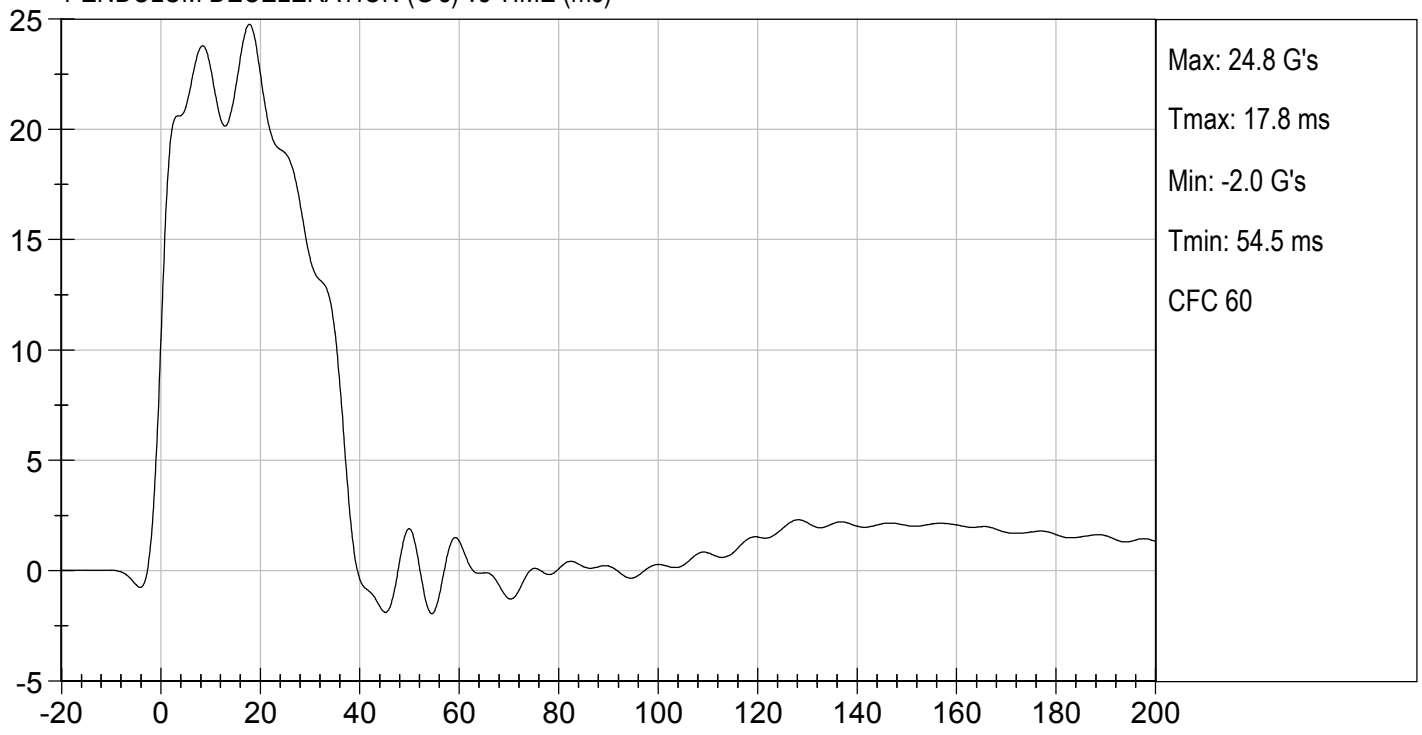
Test Date

Approved By

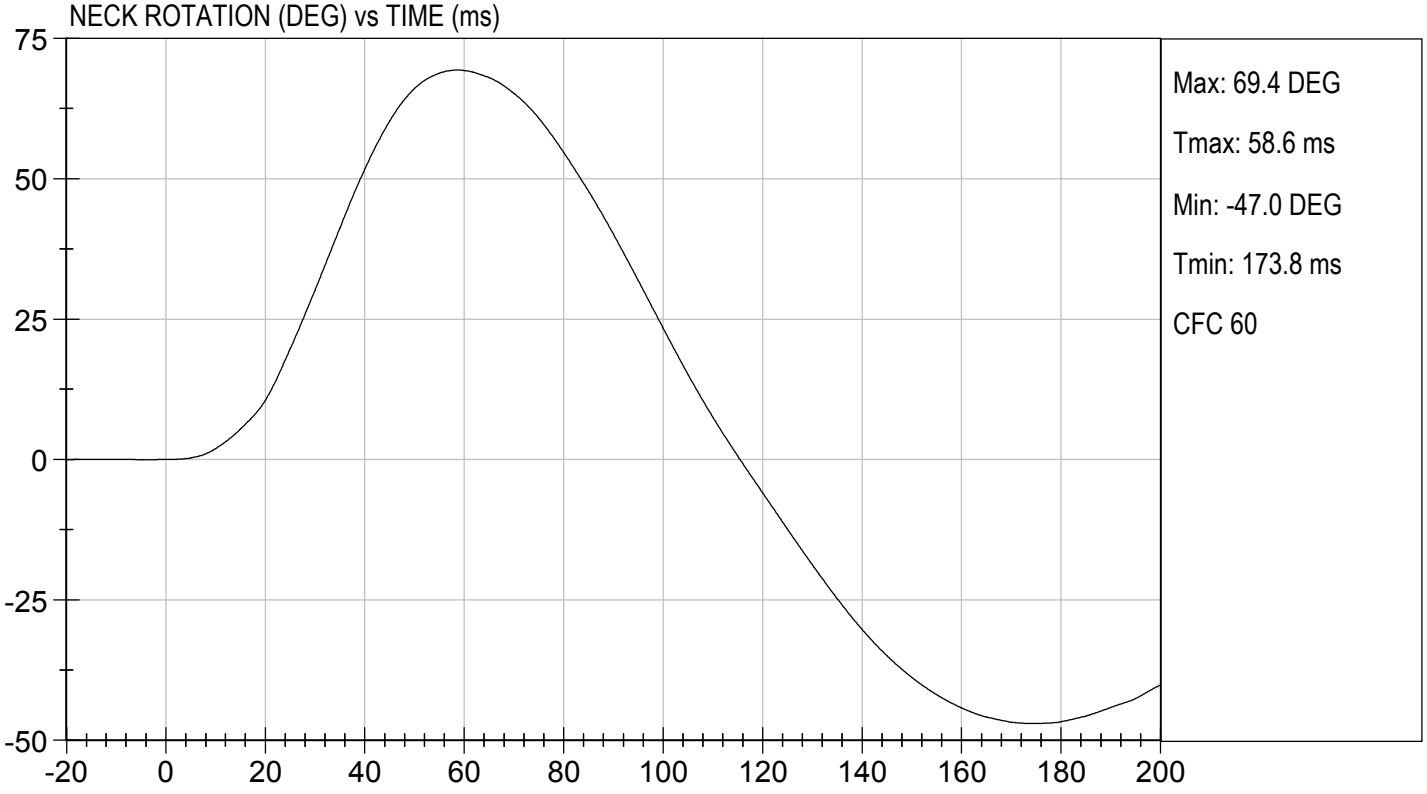
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 05/09/2019
TEST #: D191512

PENDULUM DECELERATION (G's) vs TIME (ms)

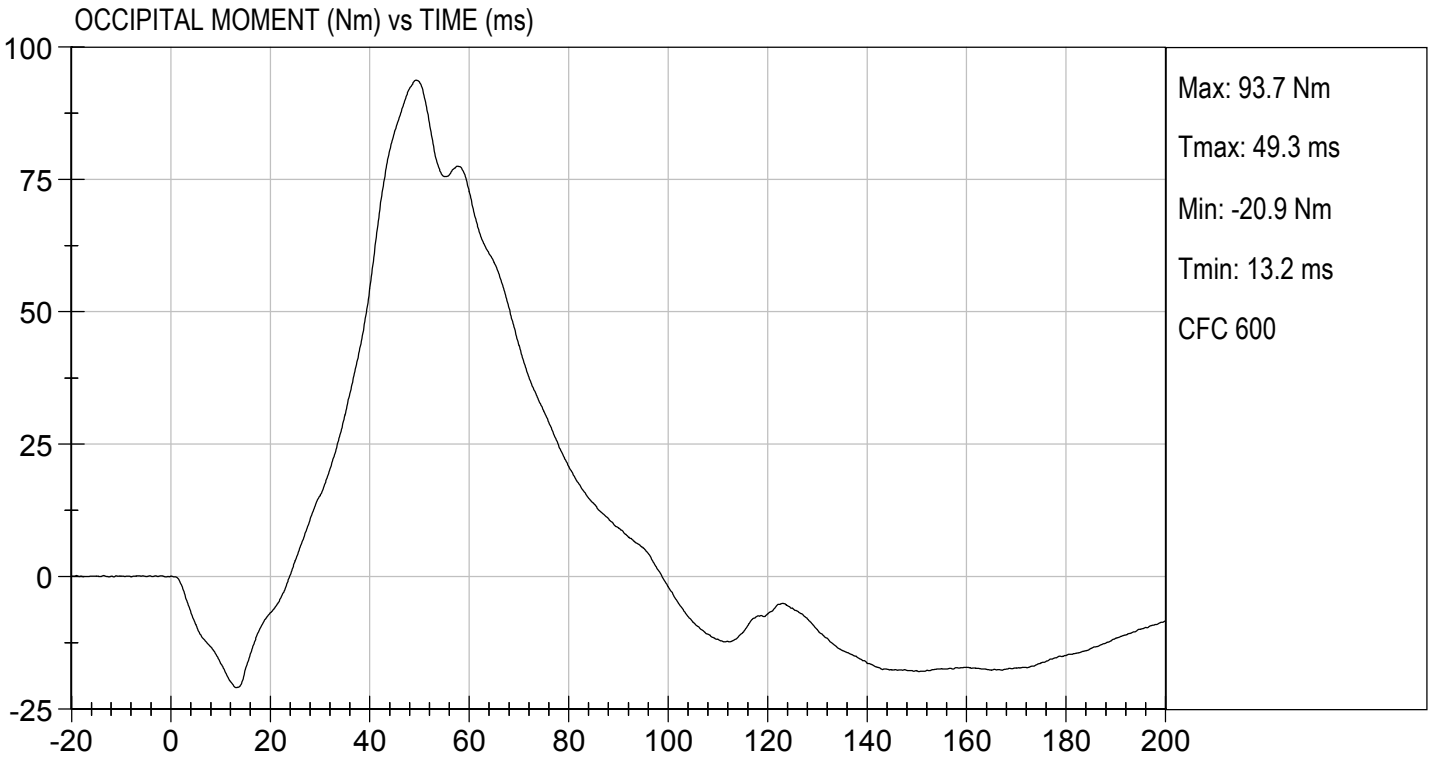


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 05/09/2019
TEST #: D191512



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191513

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	46	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.19	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	19.06	Pass
	20 ms	G's	14.00 to 19.00	17.69	Pass
	30 ms	G's	11.00 to 16.00	13.42	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.4	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	38.4	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	93.8	Pass
	Time	ms	72.0 to 82.0	76.5	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	160.2	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-61.2	Pass
	Time	ms	65.0 to 79.0	72.3	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	141.5	Pass
			Overall Test Results		Pass

Danielle Redinbaugh

Laboratory Technician

05/09/2019

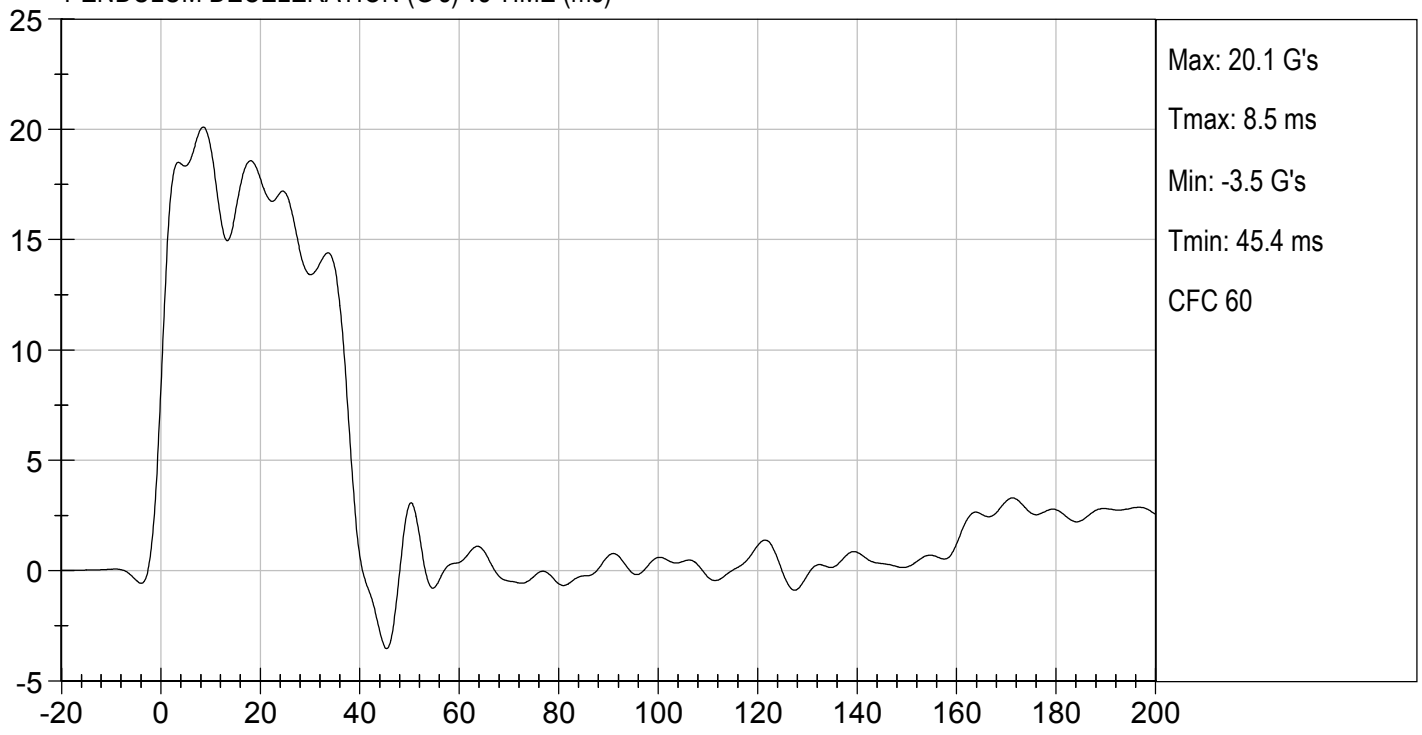
Test Date

Approved By

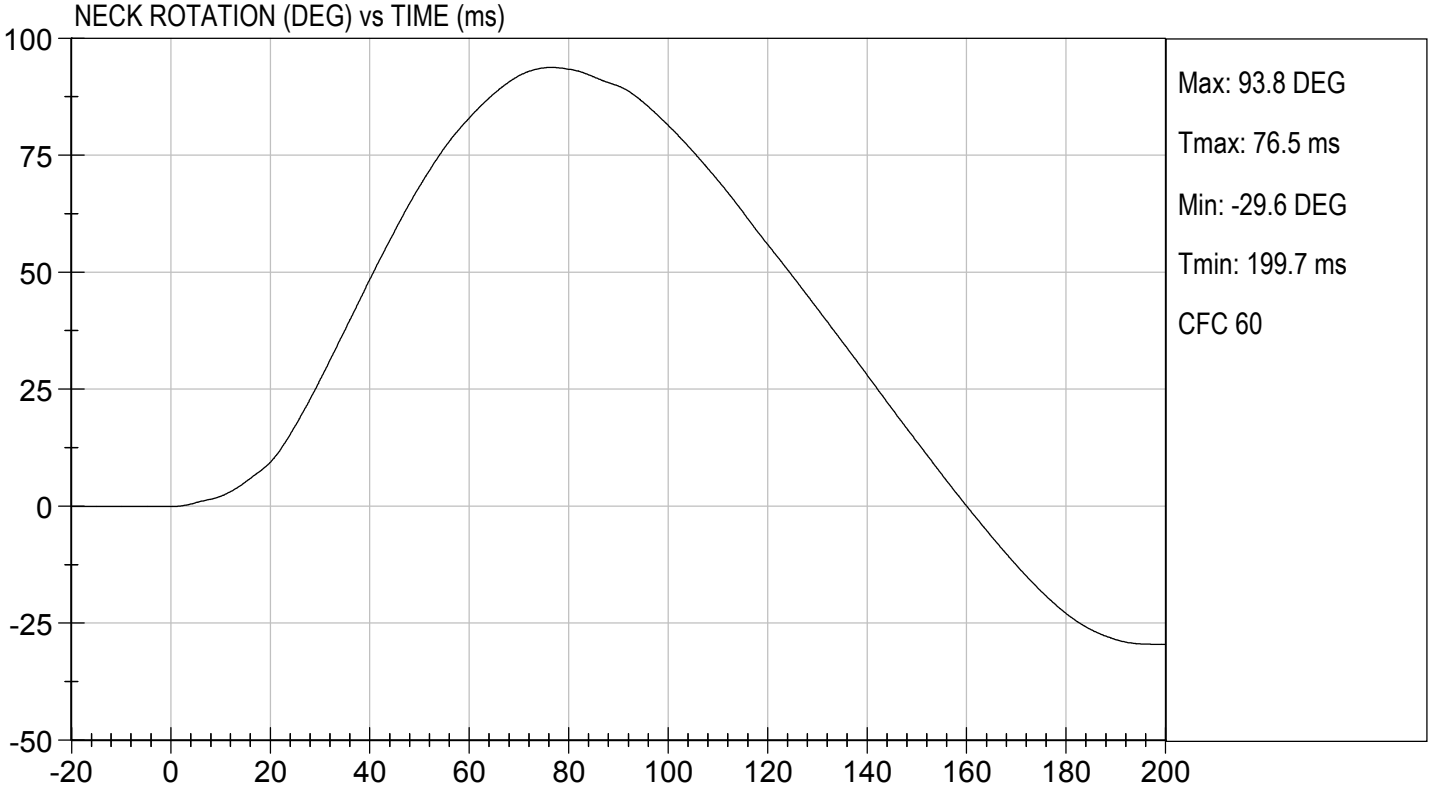
TEST DESC: NECK EXTENSION
VELOCITY: 20.30 ft/s, 6.19 m/s

TEST DATE: 05/09/2019
TEST #: D191513

PENDULUM DECELERATION (G's) vs TIME (ms)

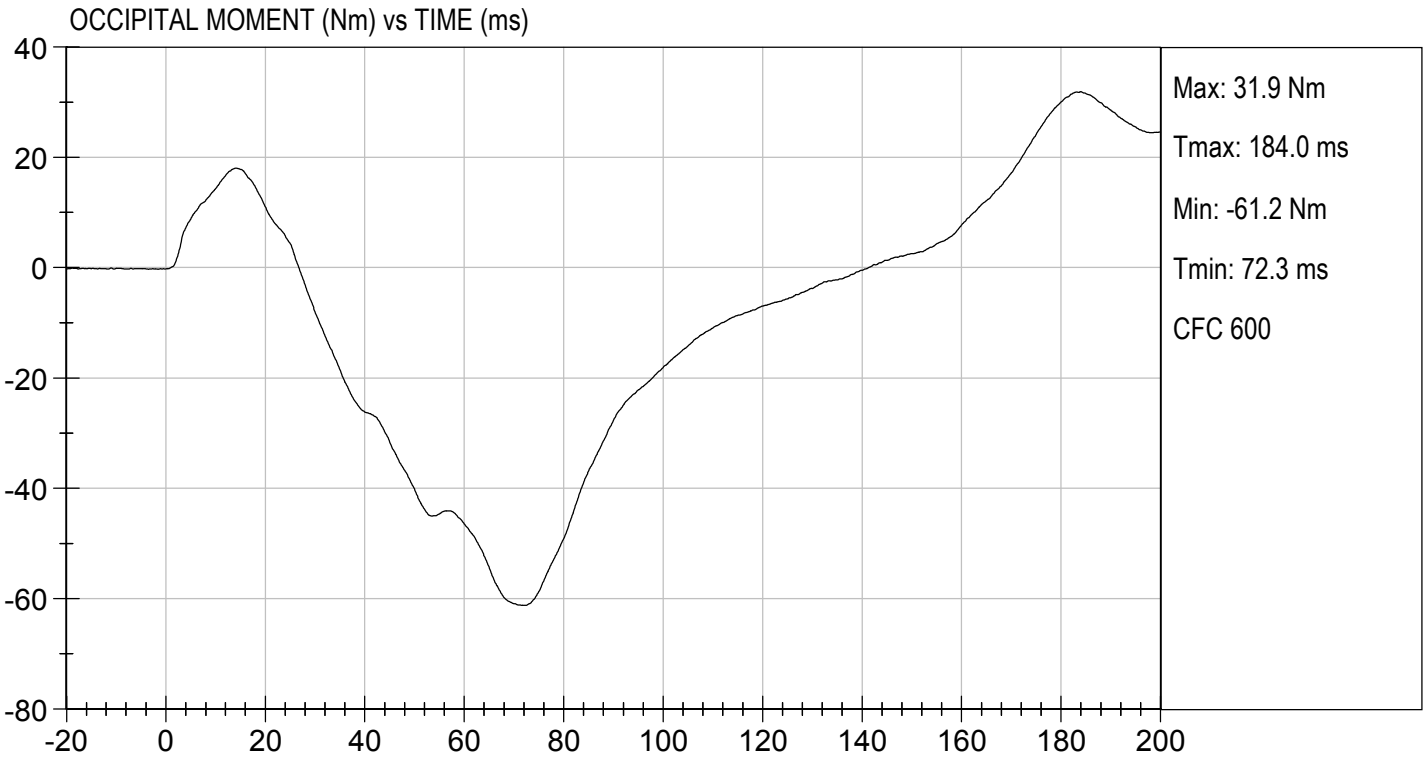


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK EXTENSION
VELOCITY: 20.30 ft/s, 6.19 m/s

TEST DATE: 05/09/2019
TEST #: D191513



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191514

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	34	Pass
Probe Velocity	m/s	6.58 to 6.82	6.68	Pass
Peak Probe Force	N	5159 to 5893	5,608	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.65	Pass
Internal Hysteresis	%	69 to 85	71	Pass
		Overall Test Results		Pass

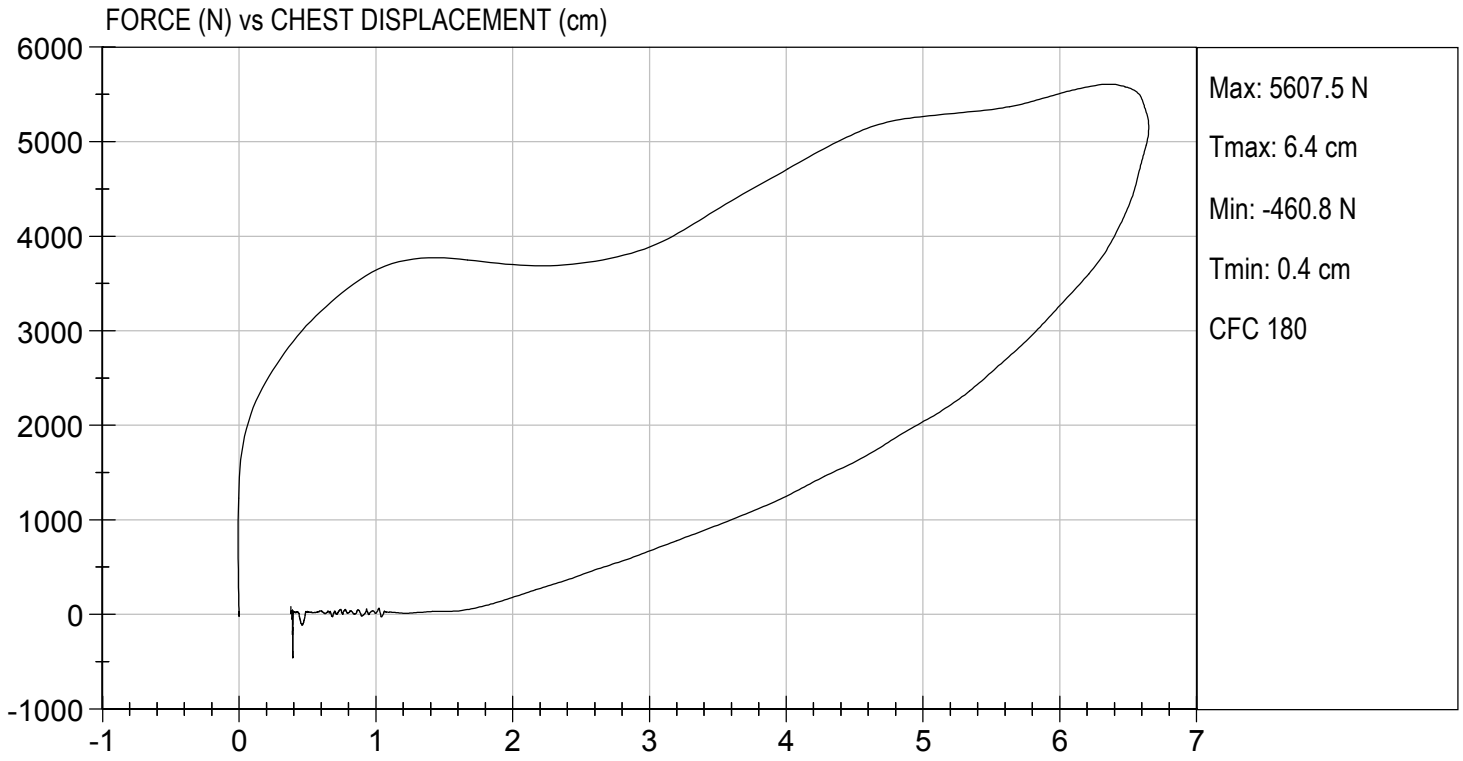
Danielle Redenbaugh
Laboratory Technician

05/08/2019
Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 05/08/2019
TEST #: D191514



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191515

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	30	Pass
Probe Velocity	m/s	2.07 to 2.13	2.13	Pass
Peak Probe Force	N	4715 to 5782	5,576	Pass
		Overall Test Results		Pass

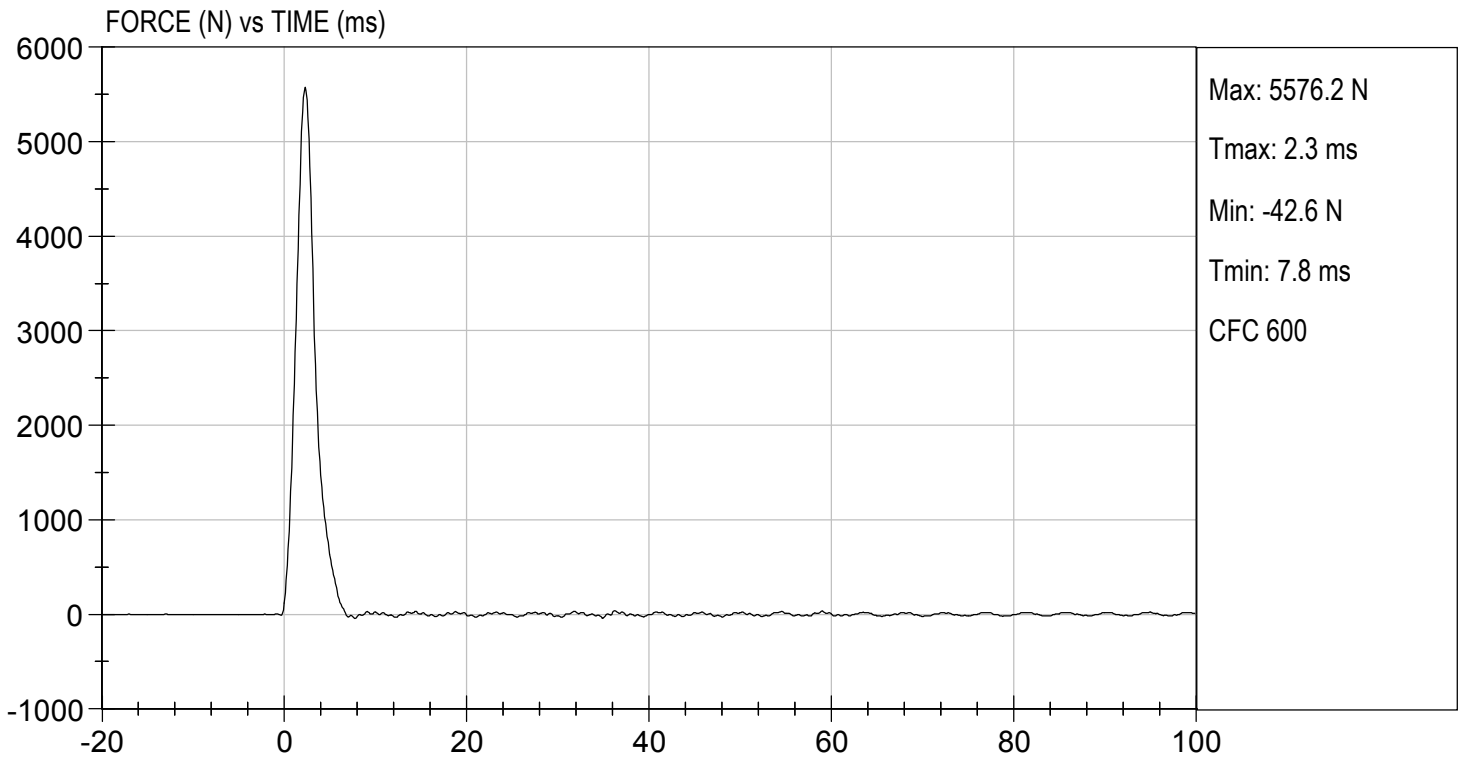
Danielle Redinbaugh
Laboratory Technician

05/08/2019
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 7.00 ft/s, 2.13 m/s

TEST DATE: 05/08/2019
TEST #: D191515



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191516

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	30	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	N	4715 to 5782	5,581	Pass
		Overall Test Results		Pass

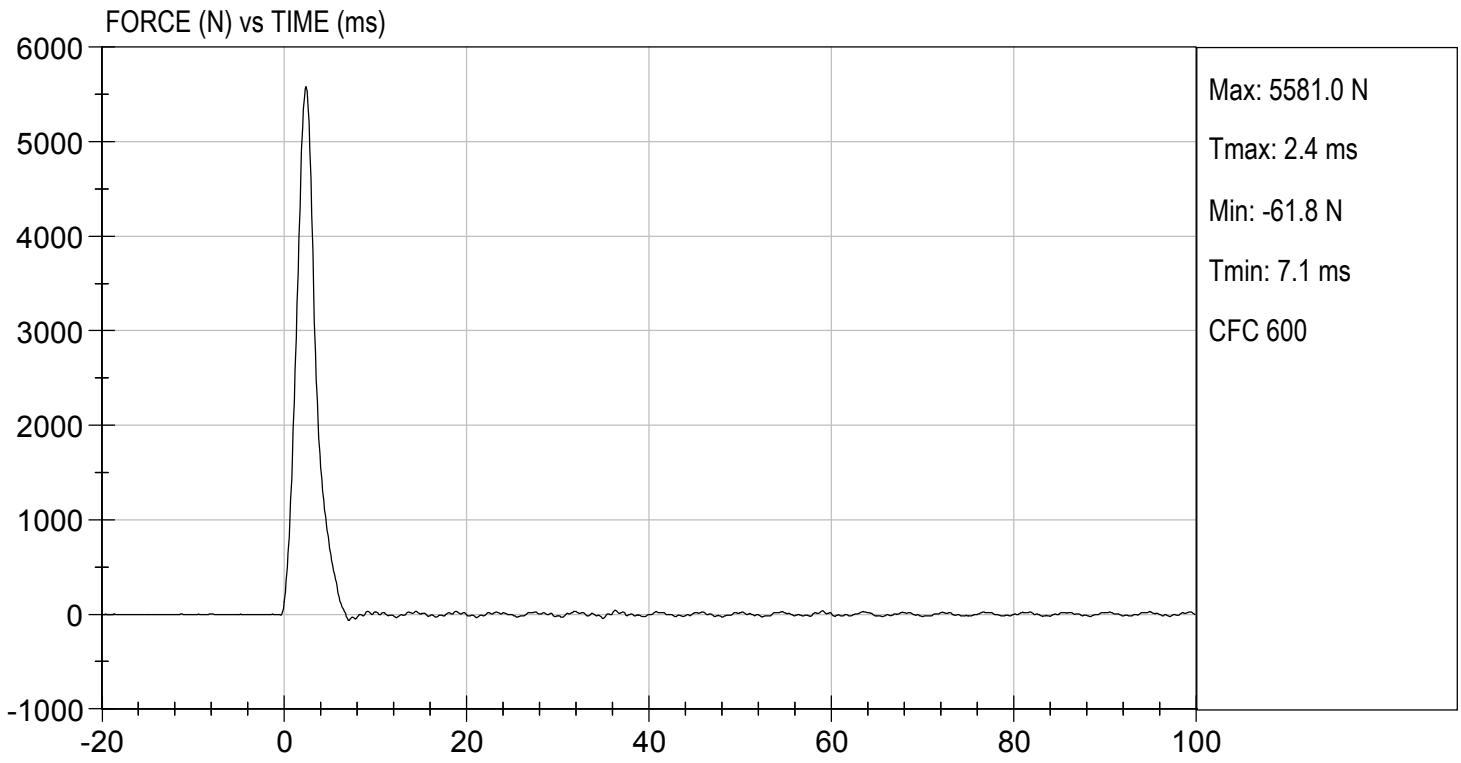
Danielle Redinbaugh
Laboratory Technician

05/08/2019
Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.92 ft/s, 2.11 m/s

TEST DATE: 05/08/2019
TEST #: D191516



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191510

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.3	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	30	30	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.5	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	90.6	86.1	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	46.7	44.6	Pass
		Overall Test Results			Pass

Danielle Redinbaugh
Laboratory Technician

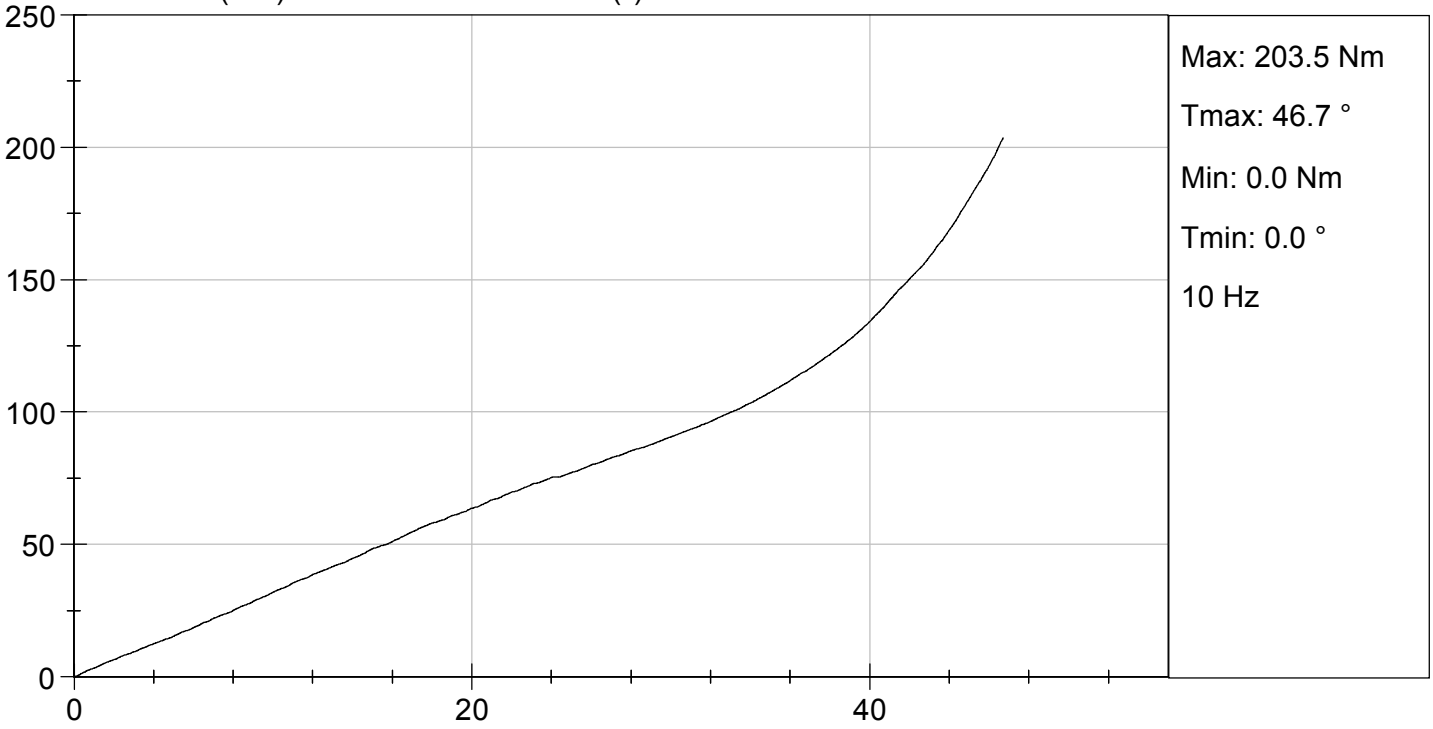
05/08/2019
Test Date

Approved By

TEST DESC: RIGHT HIP FEMUR FLEXION

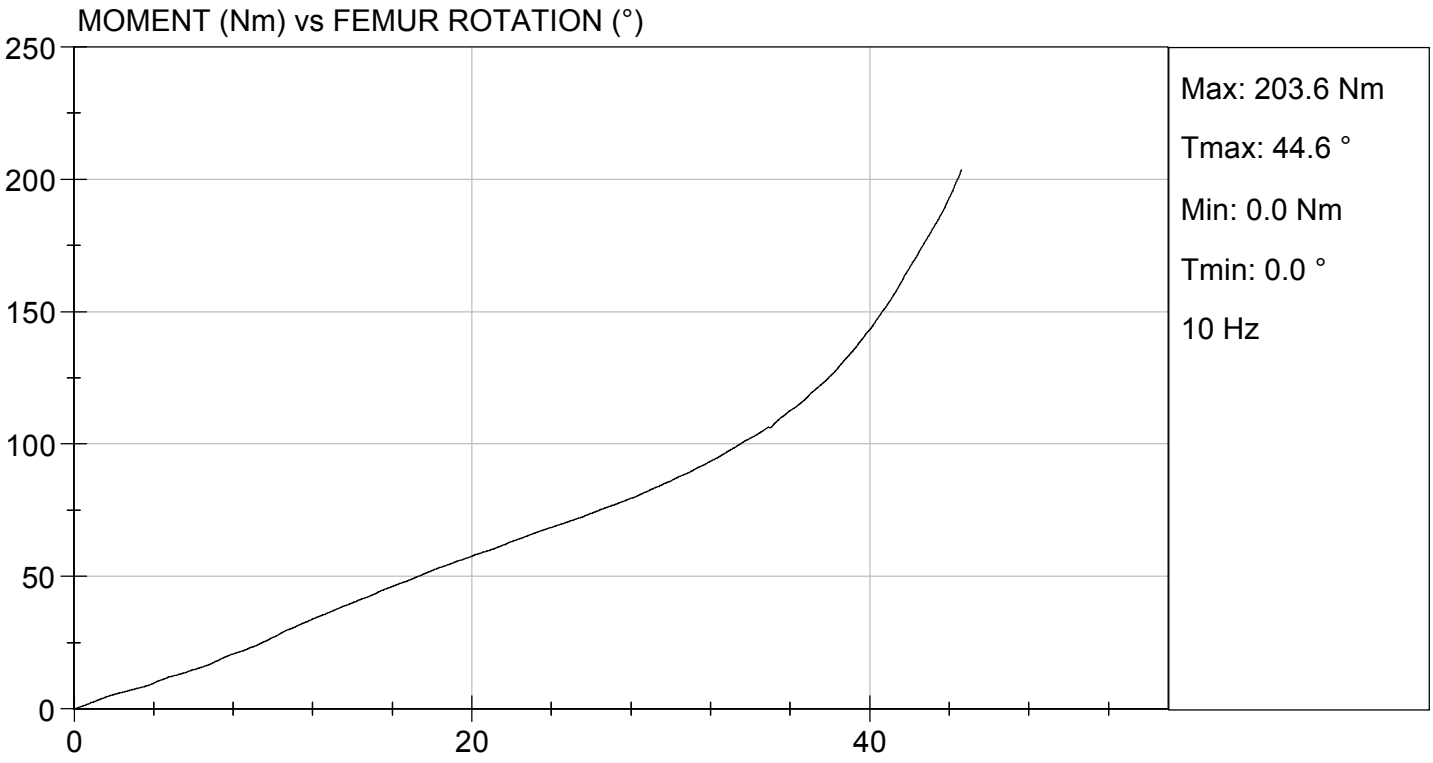
TEST DATE: 05/08/2019
TEST #: D191519

MOMENT (Nm) vs FEMUR ROTATION (°)



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 05/08/2019
TEST #: D191510



CALIBRATION TEST RESULTS

POST-TEST

HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test ID:** D191711

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Peak Resultant Acceleration	G's	225 to 275	232	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-6.8	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Laboratory Technician

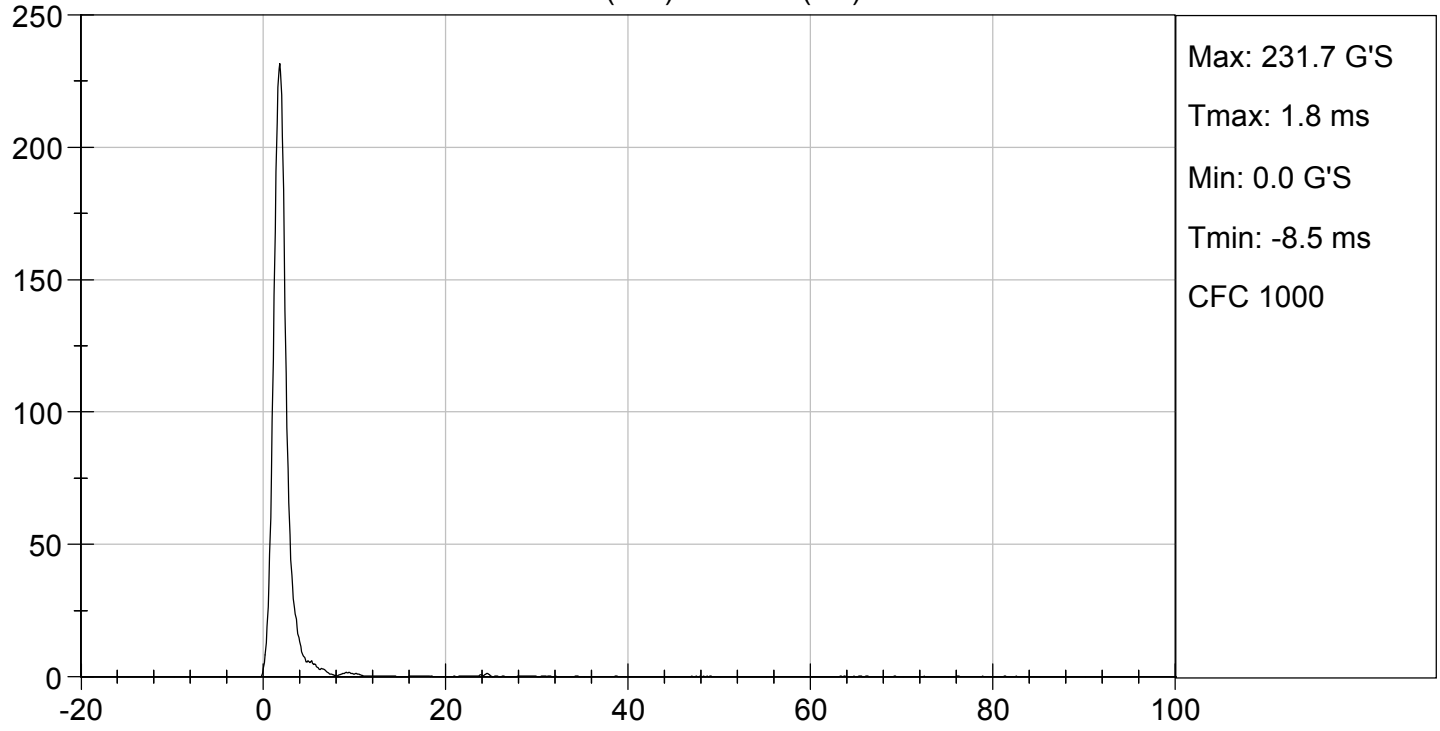
05/31/2019
Test Date

Approved By

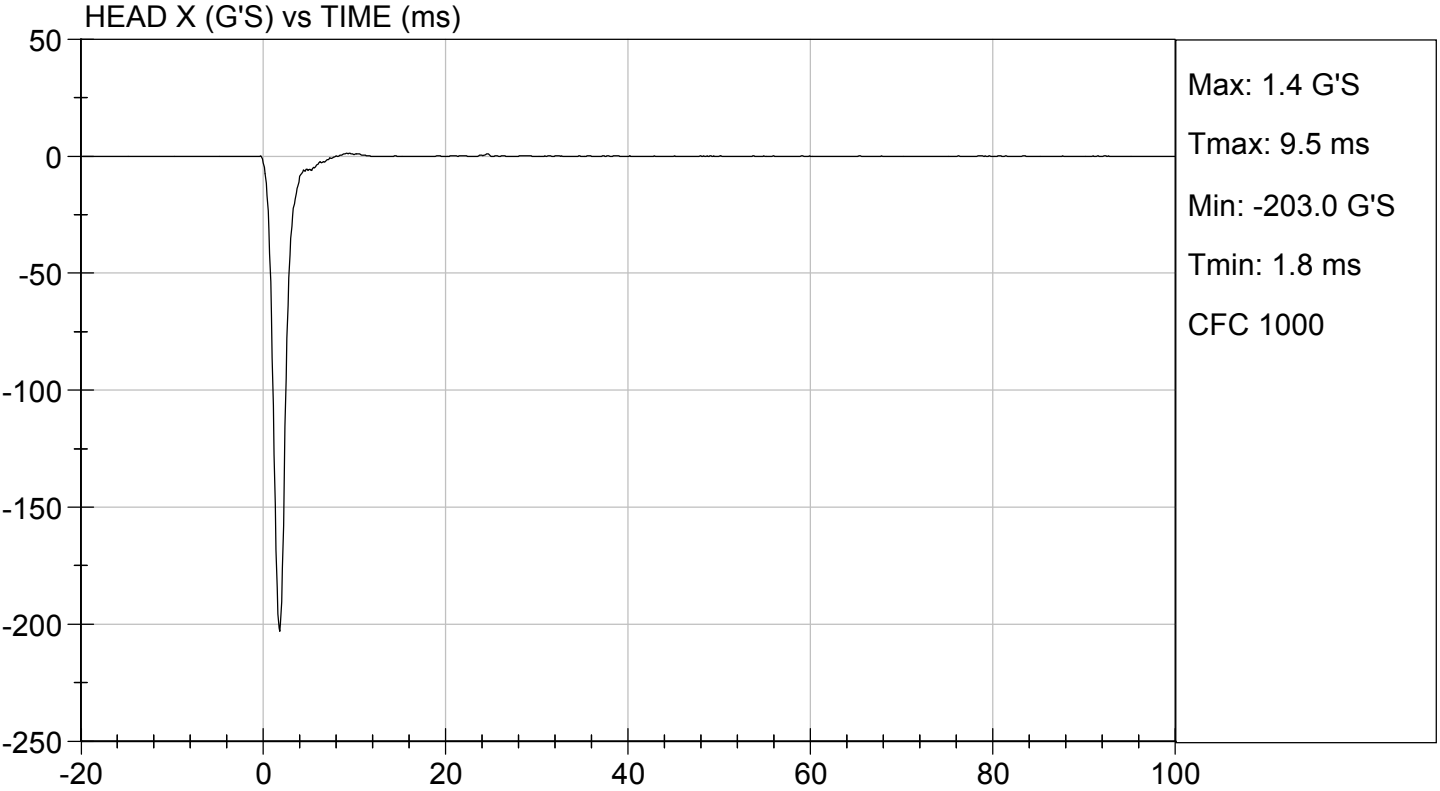
TEST DESC: HEAD DROP

TEST DATE: 05/31/2019
TEST #: D191711

HEAD RESULTANT ACCELERATION (G'S) vs TIME (ms)

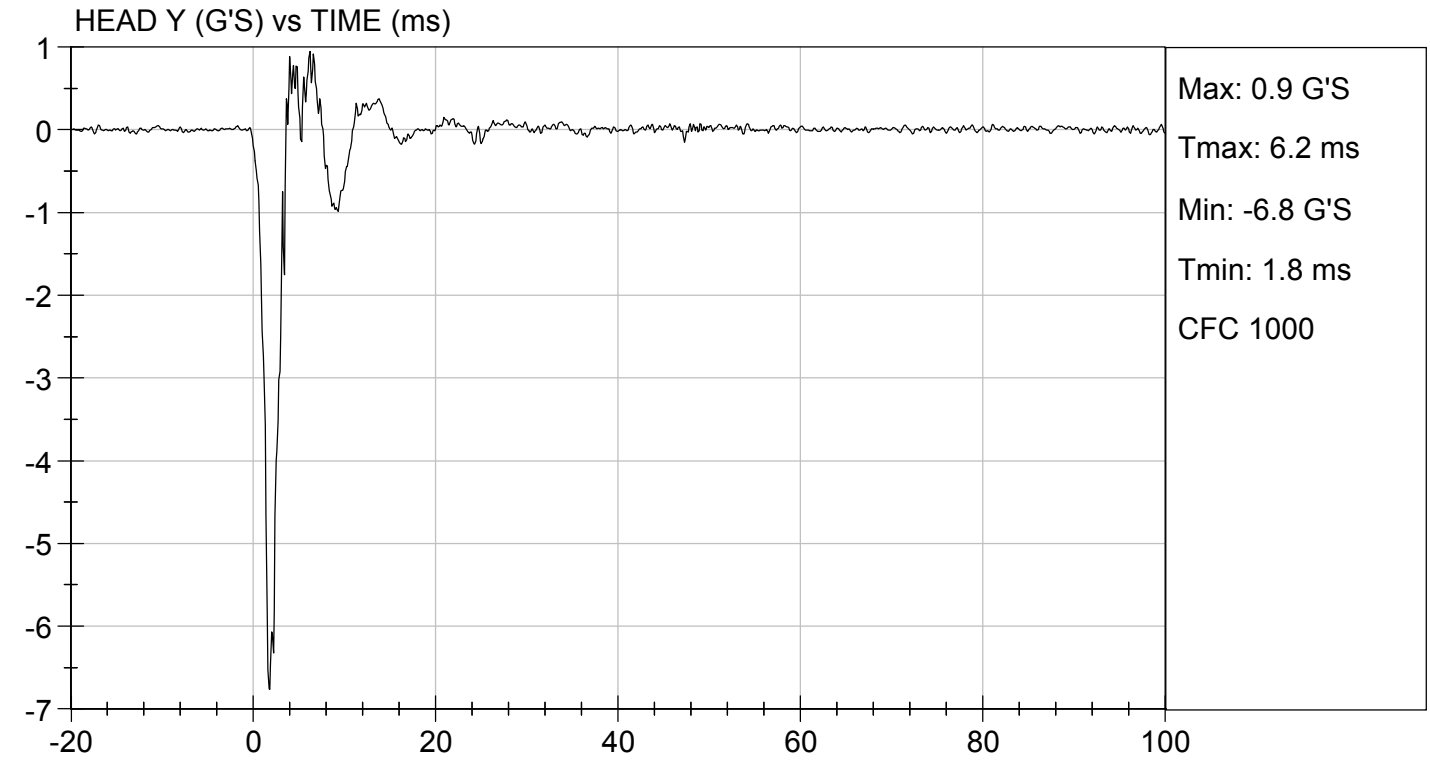


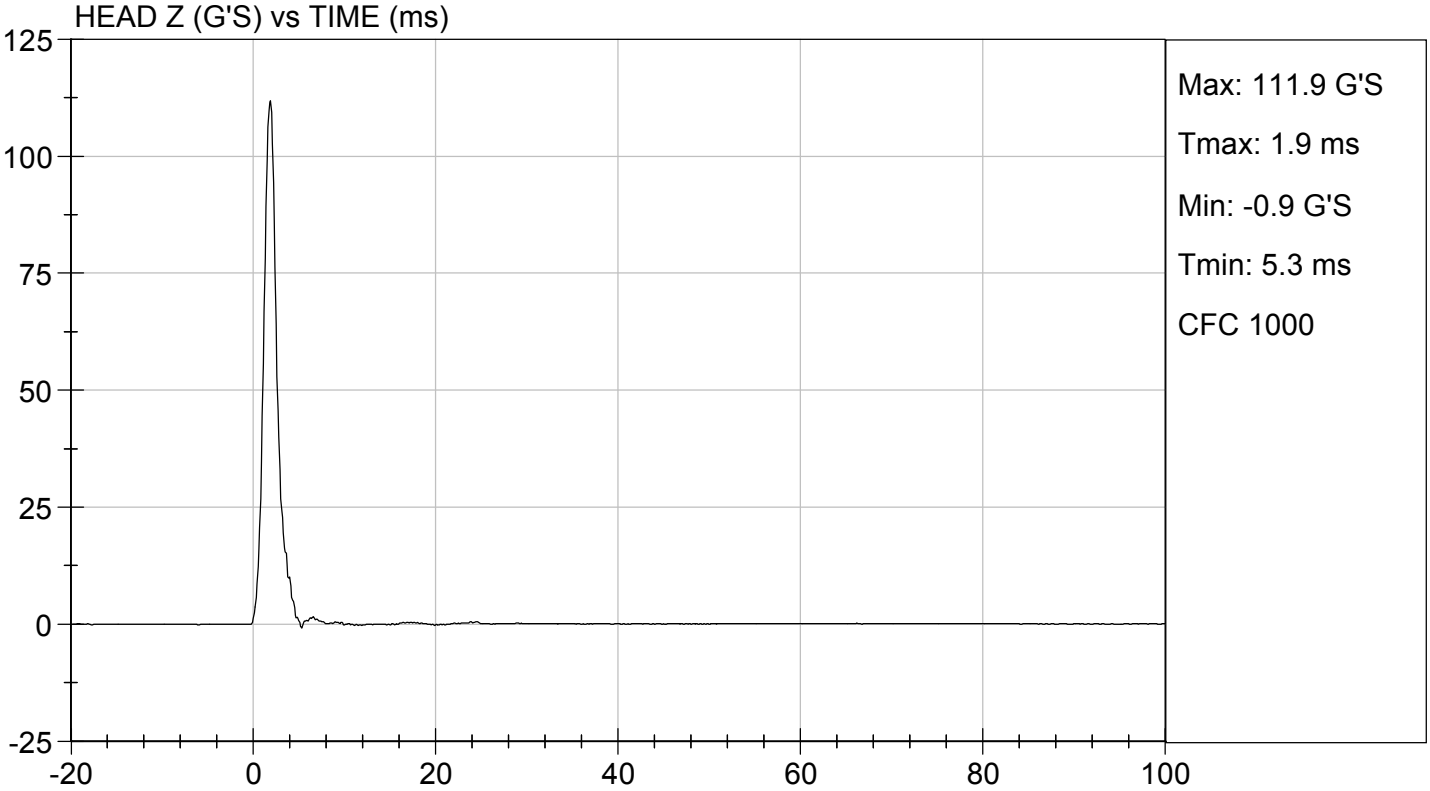
HEAD X (G'S) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 05/31/2019
TEST #: D191711





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191712

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	22.88	Pass
	20 ms	G's	17.60 to 22.60	20.53	Pass
	30 ms	G's	12.50 to 18.50	16.60	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	16.5	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	35.4	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	71.9	Pass
	Time	ms	57.0 to 64.0	58.6	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	116.6	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	96.0	Pass
	Time	ms	47.0 to 58.0	47.2	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	99.7	Pass
			Overall Test Results		Pass

Laboratory Technician

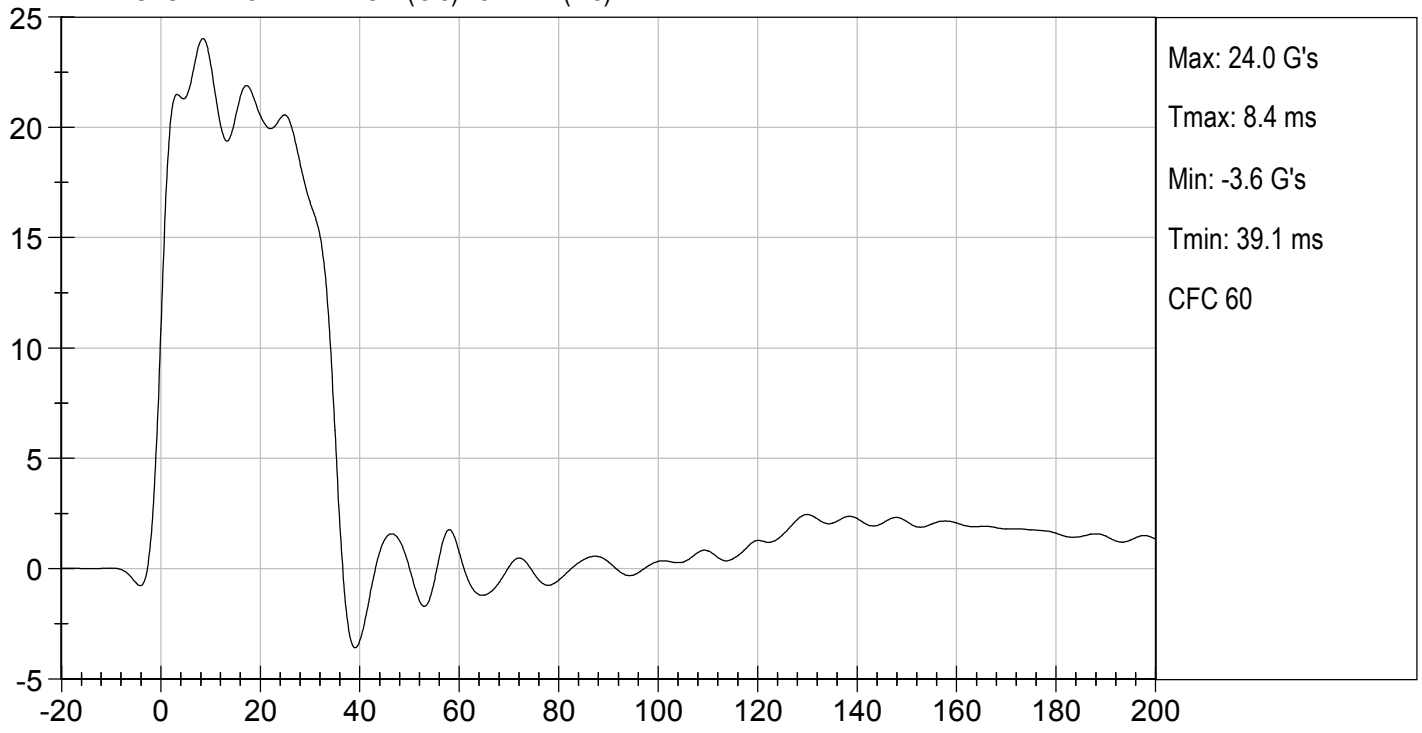
05/31/2019
Test Date

Approved By

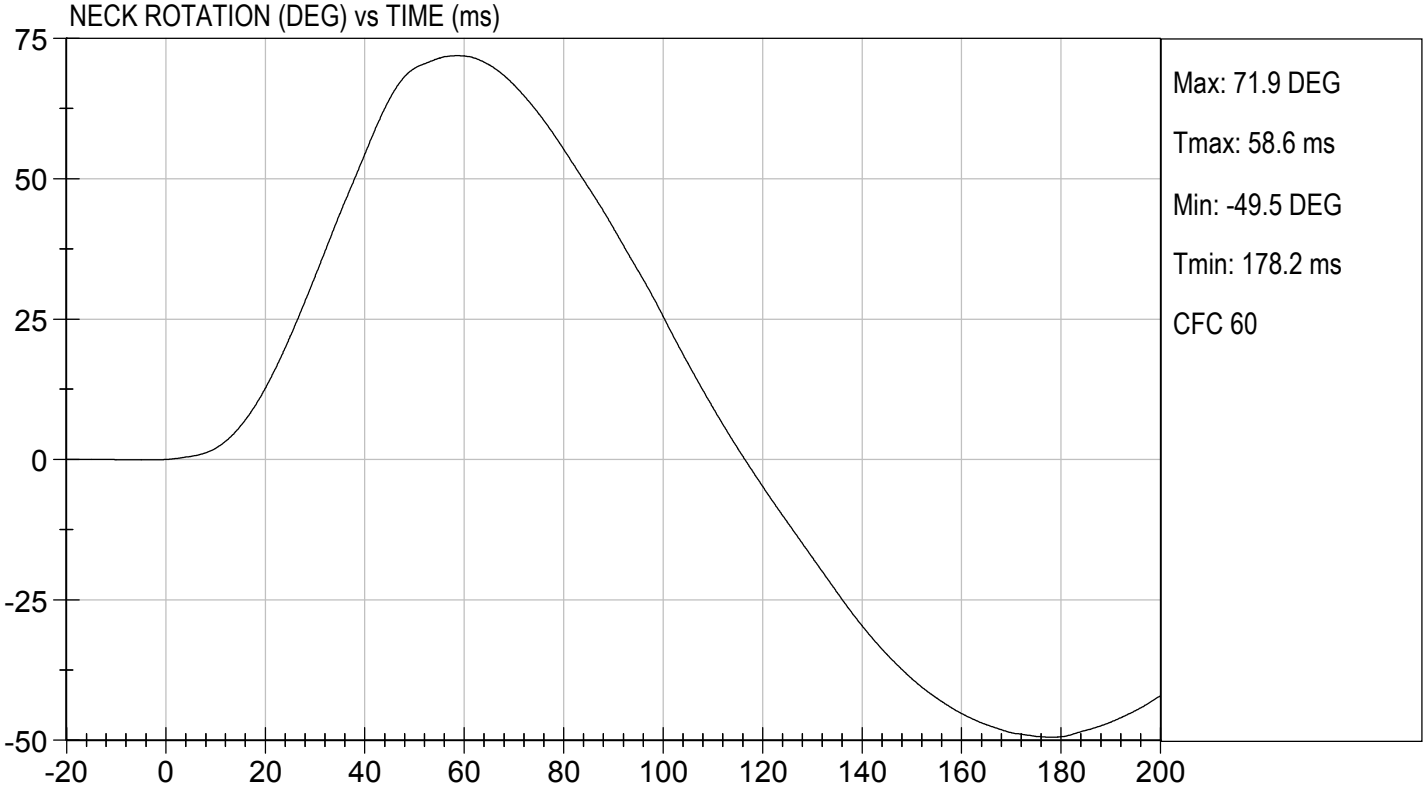
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 05/31/2019
TEST #: D191712

PENDULUM DECELERATION (G's) vs TIME (ms)

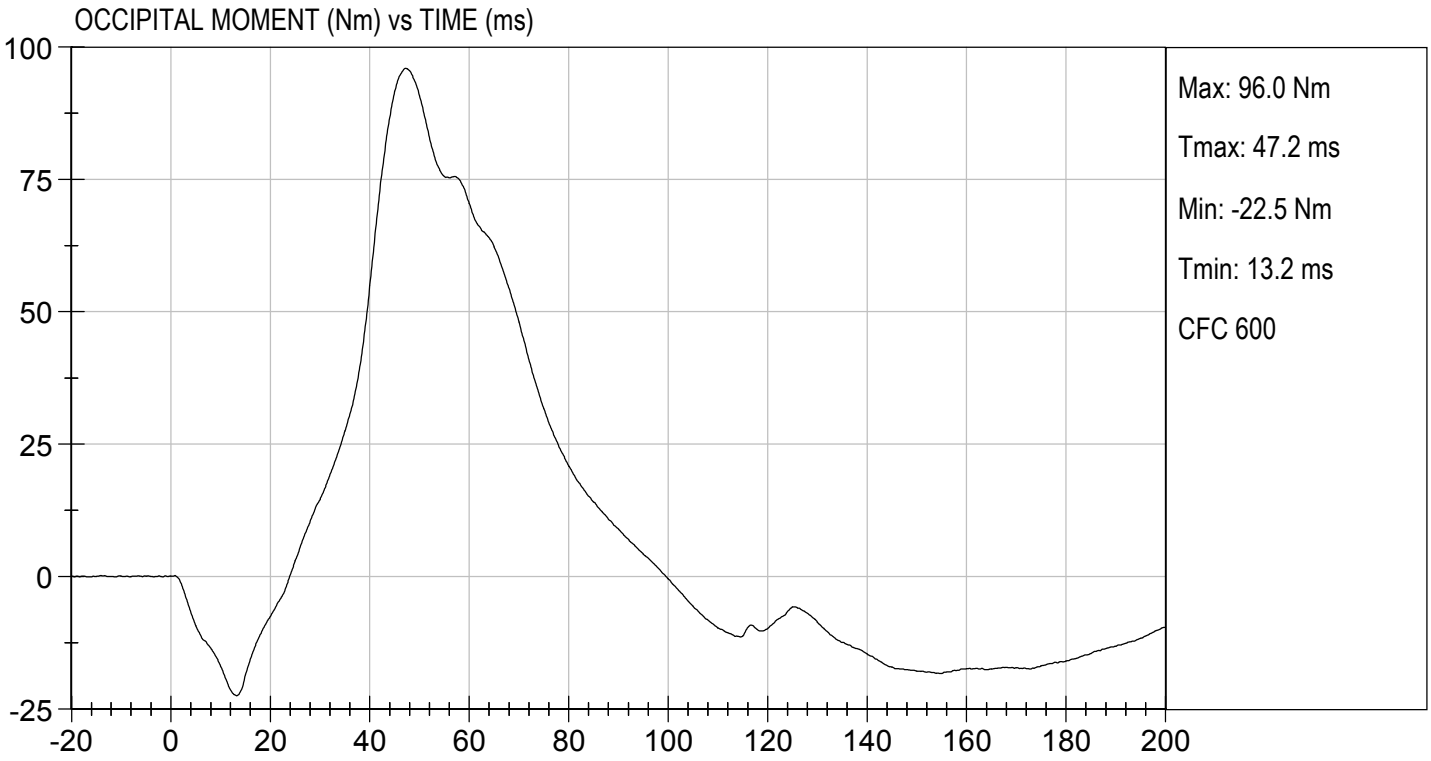


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 05/31/2019
TEST #: D191712



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191713

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.05	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	18.56	Pass
	20 ms	G's	14.00 to 19.00	15.15	Pass
	30 ms	G's	11.00 to 16.00	12.56	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.4	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	39.8	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	94.9	Pass
	Time	ms	72.0 to 82.0	77.7	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	159.1	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-59.7	Pass
	Time	ms	65.0 to 79.0	70.6	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	140.1	Pass
			Overall Test Results		Pass

Laboratory Technician

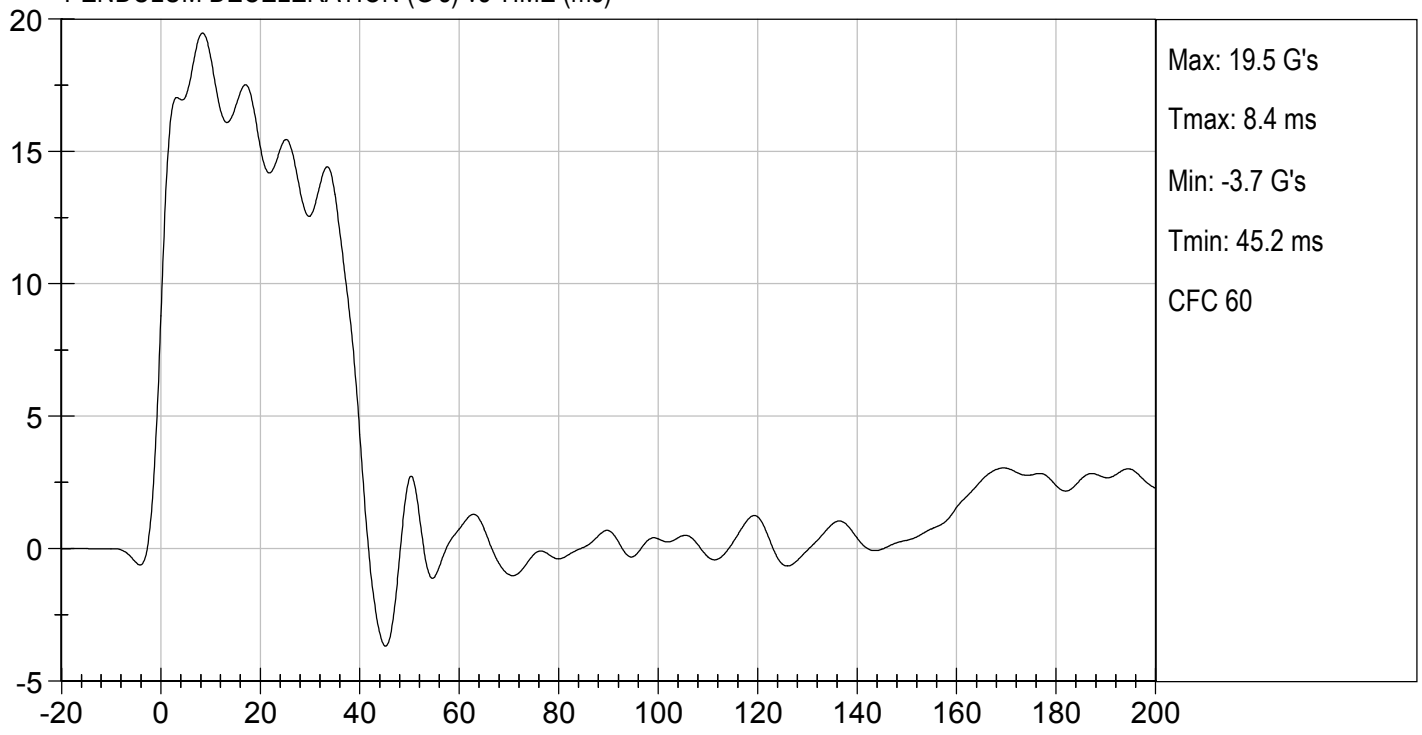
05/31/2019
Test Date

Approved By

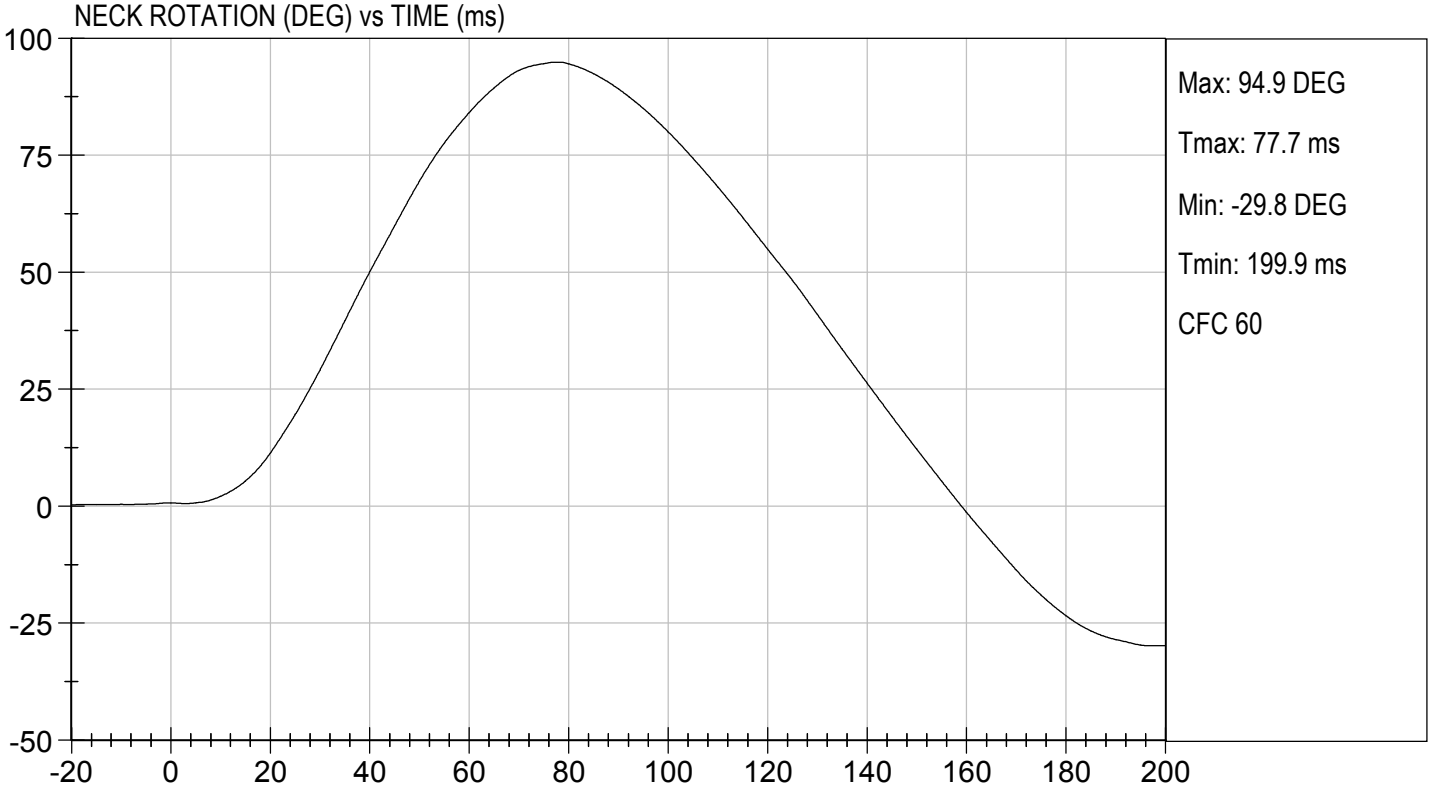
TEST DESC: NECK EXTENSION
VELOCITY: 19.84 ft/s, 6.05 m/s

TEST DATE: 05/31/2019
TEST #: D191713

PENDULUM DECELERATION (G's) vs TIME (ms)

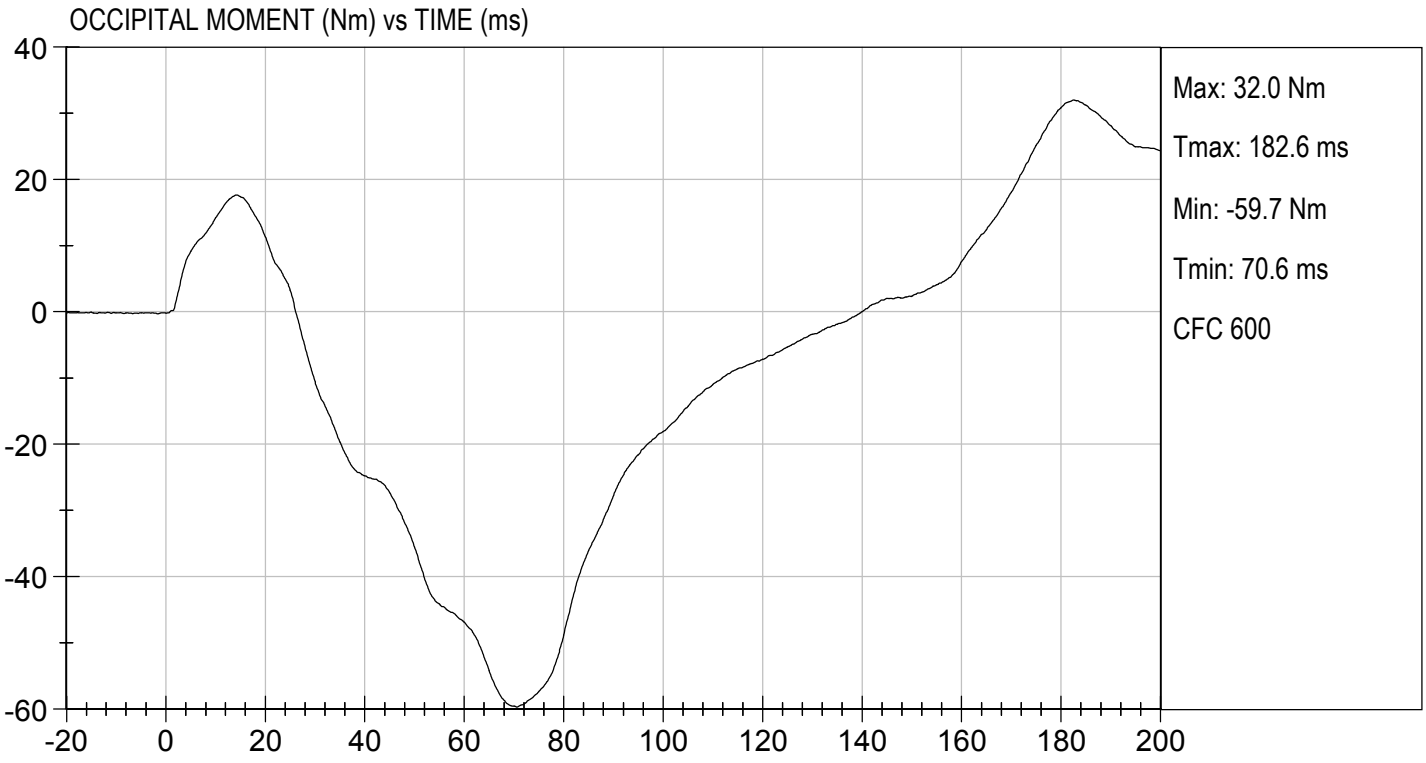


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK EXTENSION
VELOCITY: 19.84 ft/s, 6.05 m/s

TEST DATE: 05/31/2019
TEST #: D191713



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** 191714

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	51	Pass
Probe Velocity	m/s	6.58 to 6.82	6.60	Pass
Peak Probe Force	N	5159 to 5893	5,568	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.77	Pass
Internal Hysteresis	%	69 to 85	71	Pass
		Overall Test Results		Pass

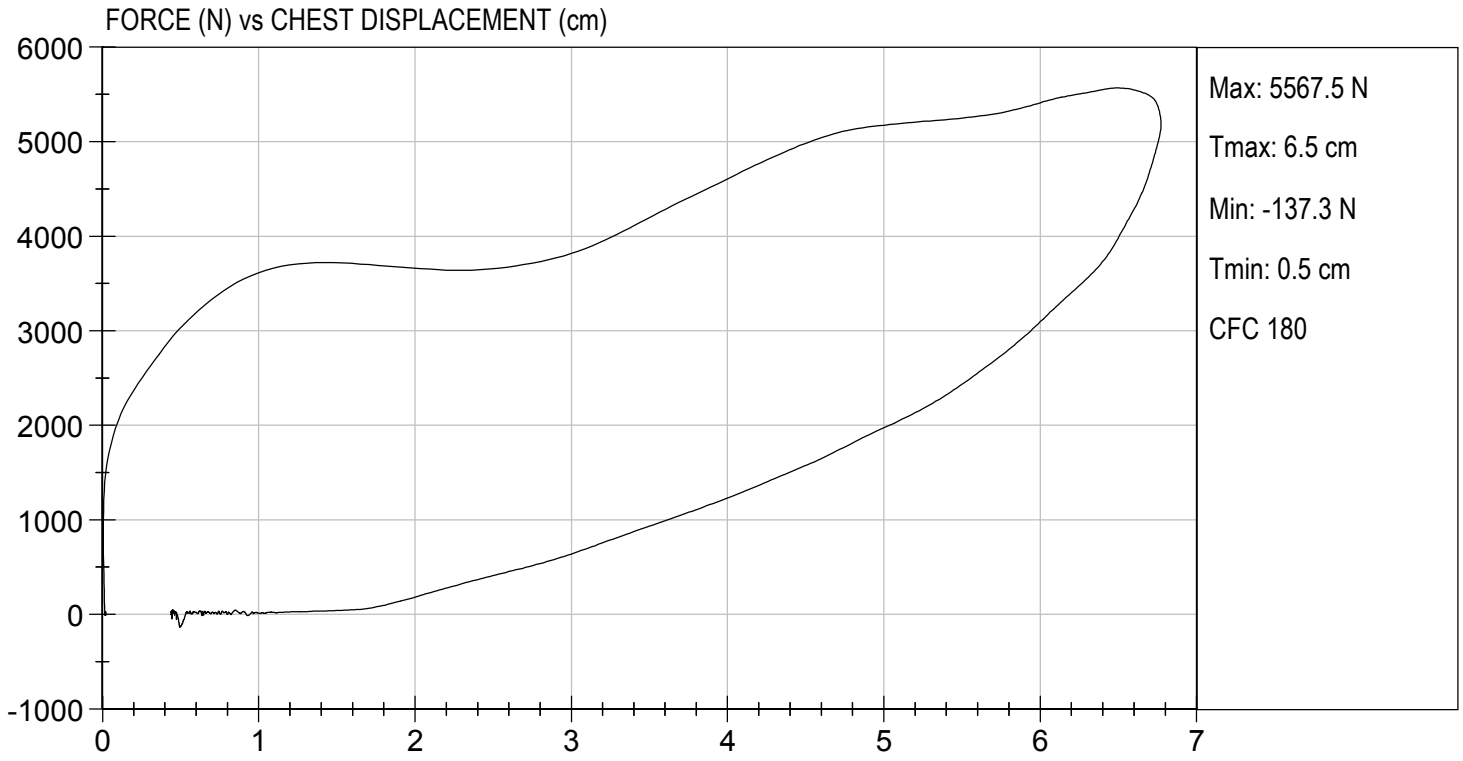
Jacob D Taylor
Laboratory Technician

06/03/2019
Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 21.65 ft/s, 6.60 m/s

TEST DATE: 06/03/2019
TEST #: 191714



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191715

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Velocity	m/s	2.07 to 2.13	2.10	Pass
Peak Probe Force	N	4715 to 5782	4,726	Pass
		Overall Test Results		Pass

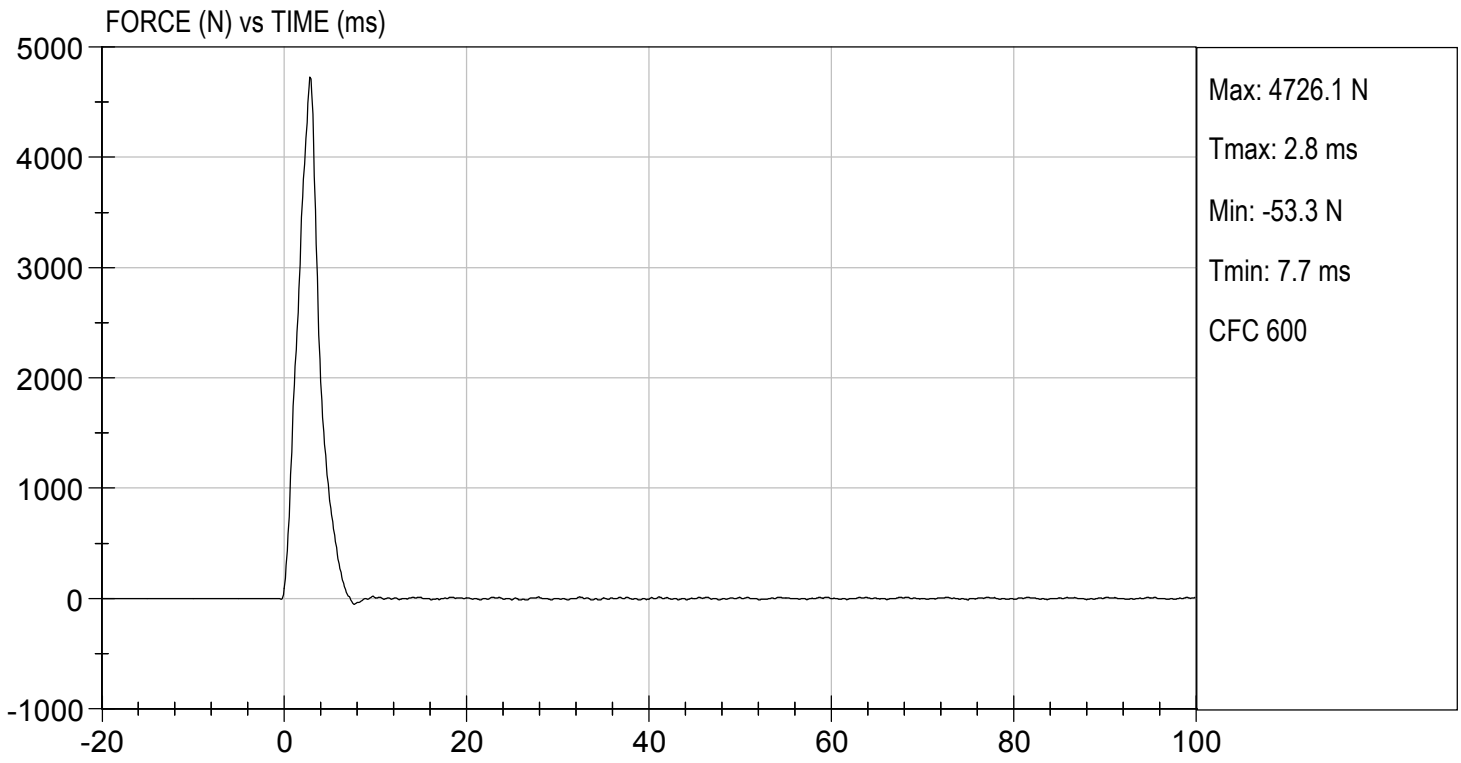
Danielle Redinbaugh
Laboratory Technician

05/31/2019
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.89 ft/s, 2.10 m/s

TEST DATE: 05/31/2019
TEST #: D191715



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191716

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	N	4715 to 5782	5,259	Pass
		Overall Test Results		Pass

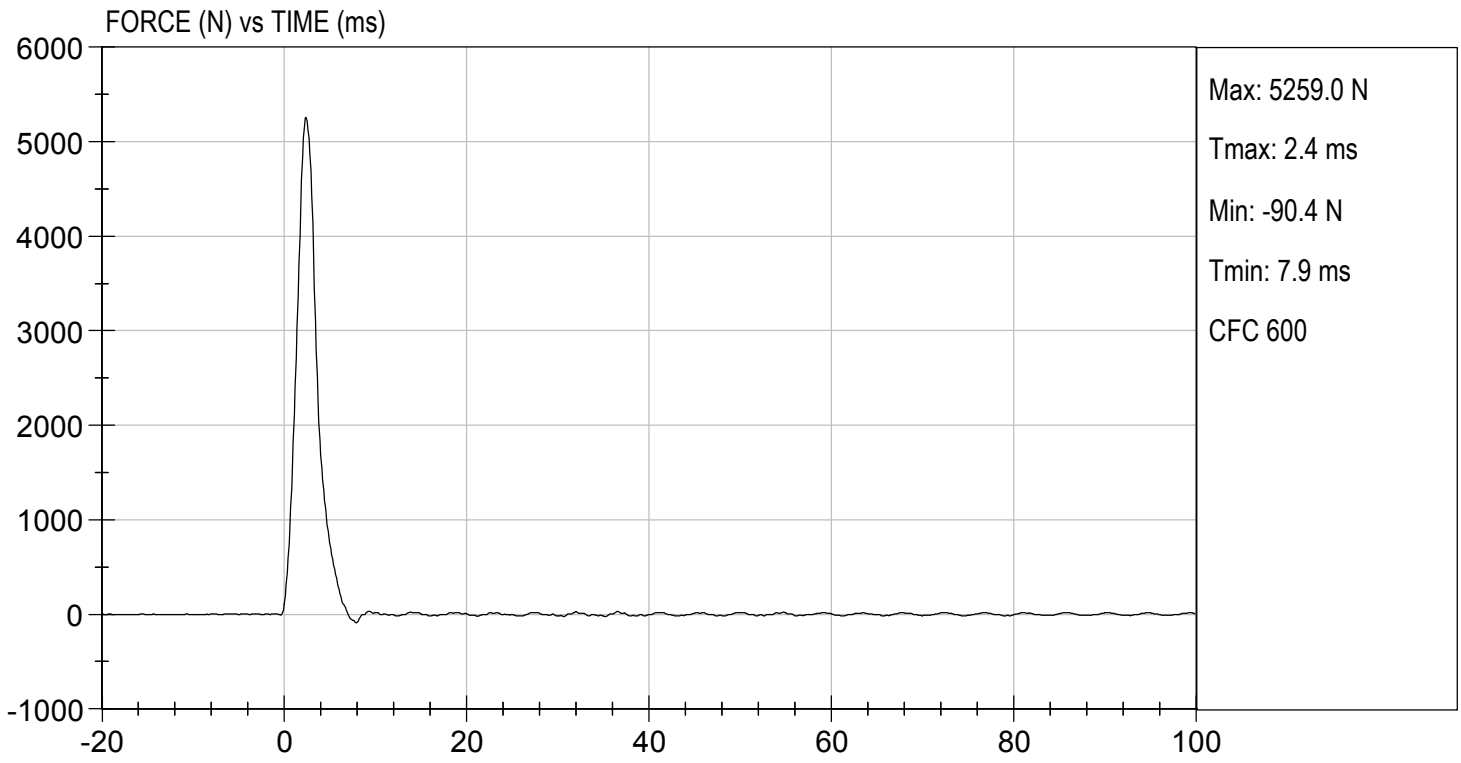
Danielle Redinbaugh
Laboratory Technician

05/31/2019
Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.92 ft/s, 2.11 m/s

TEST DATE: 05/31/2019
TEST #: D191716



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D191710

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.6	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	52	52	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.5	6.5	Pass
30 Degrees	Nm	94.9 Nm Max	79.2	85.7	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	47.5	44.2	Pass
		Overall Test Results			Pass

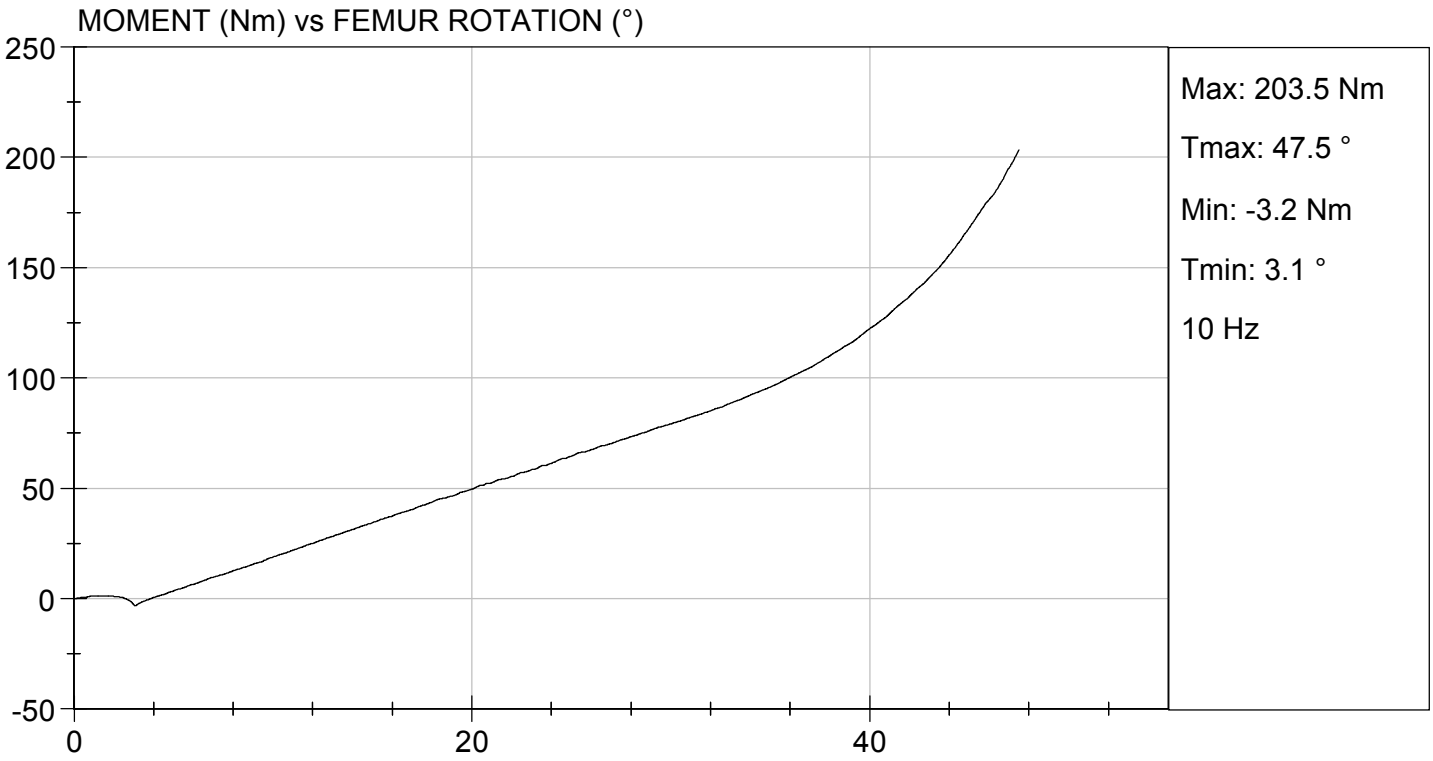
Laboratory Technician

05/31/2019
Test Date

Approved By

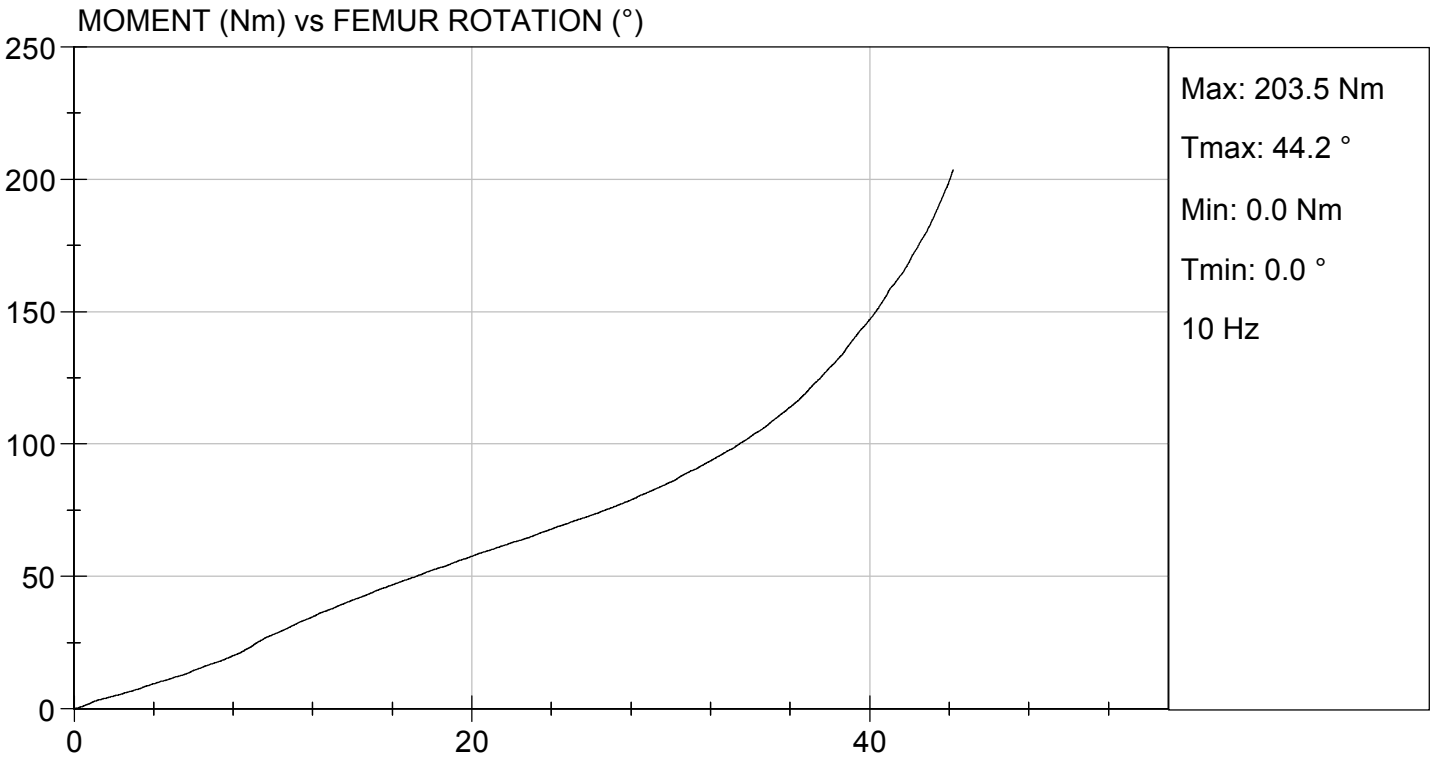
TEST DESC: RIGHT HIP FEMUR FLEXION

TEST DATE: 05/31/2019
TEST #: D191719



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 05/31/2019
TEST #: D191710



CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

Hybrid III, 5th External Measurements
SN: DH1659

HYBRID III, PART 572, SUBPART O EXTERNAL DIMENSIONS				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (mm)	ACTUAL MEASUREMENT
A	TOTAL SITTING HEIGHT	Seat surface to highest point on top of the head.	774.7-800.1	778
B	SHOULDER PIVOT HEIGHT	Centerline of shoulder pivot bolt to the seat surface.	431.8-457.2	440
C	H-POINT HEIGHT	Reference	81.3-86.3	85
D	H-POINT LOCATION FROM BACKLINE	Reference	144.8-149.8	147
E	SHOULDER PIVOT FROM BACKLINE	Center of the shoulder clevis to the rear vertical surface of the fixture.	68.6-83.8	82
F	THIGH CLEARANCE	Measured at the highest point on the upper femur segment.	119.4-134.6	130
G	BACK OF ELBOW TO WRIST PIVOT	back of the elbow flesh to the wrist pivot in line with the elbow and wrist pivots	243.9-259.1	251
H	HEAD BACK TO BACKLINE	Back of Skull cap skin to seat rear vertical surface (Reference)	43.2-48.2	45
I	SHOULDER TO- ELBOW LENGTH	Measure from the highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow in line with the elbow pivot bolt.	276.8-297.2	285
J	ELBOW REST HEIGHT	Measure from the flesh below the elbow pivot bolt to the seat surface.	182.8-203.2	189
K	BUTTOCK TO KNEE LENGTH	The forward most part of the knee flesh to the rear vertical surface of the fixture.	520.7-546.1	543
L	POPLITEAL HEIGHT	Seat surface to the plane of the horizontal plane of the bottom of the feet.	355.6-376	357
M	KNEE PIVOT HEIGHT	Centerline of knee pivot bolt to the horizontal plane of the bottom of the feet.	393.7-419.1	398

N	BUTTOCK POPLITEAL LENGTH	The rearmost surface of the lower leg to the same point on the rear surface of the buttocks used for dim. “K”.	414-439.4	435
HYBRID III, SUBPART O EXTERNAL DIMENSIONS, continued				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (mm)	ACTUAL MEASUREMENT
O	CHEST DEPTH WITHOUT JACKET	Measured 304.8 ± 5.1 mm above seat surface	175.3-190.5	182
P	FOOT LENGTH	Tip of toe to rear of heal	218.5-233.7	221
Q	STANDING HEIGHT	(THEORETICAL)	1501.1	N/A
R	BUTTOCK TO KNEE PIVOT LENGTH	The rear surface of the buttocks to the knee pivot bolt	457.2-482.6	469
S	HEAD BREADTH	The widest part of the head	137.1-147.3	141
T	HEAD DEPTH	Back of the head to the forehead	177.8-188	182
U	HIP BREADTH	The widest part of the hip	299.7-314.9	306
V	SHOULDER BREADTH	Outside edges of right and left shoulder clevises	350.5-365.7	357
W	FOOT BREADTH	The widest part of the foot	78.8-94	83
X	HEAD CIRCUMFERENCE	Measured at the point as in dim. “T”	528.3-548.7	542
Y	CHEST CIRCUMFERENCE (WITH CHEST JACKET)	Measured 345.4 ± 12.7 mm above seat surface	850.9-881.3	865
Z	WAIST CIRCUMFERENCE	Measured 165.1 ± 5.1 mm above seat surface	759.5-789.9	785
AA	REFERENCE LOCATION FOR MEASUREMENT OF CHEST CIRCUMFERENCE	Reference	332.7-358.1	345
BB	REFERENCE LOCATION FOR MEASUREMENT OF WAIST CIRCUMFERENCE	Reference	160.1-170.2	165

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test ID:** D191631

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	41	Pass
Peak Resultant Acceleration	G's	250 to 300	289	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-7.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Jacob D Taylor

Laboratory Technician

05/20/2019

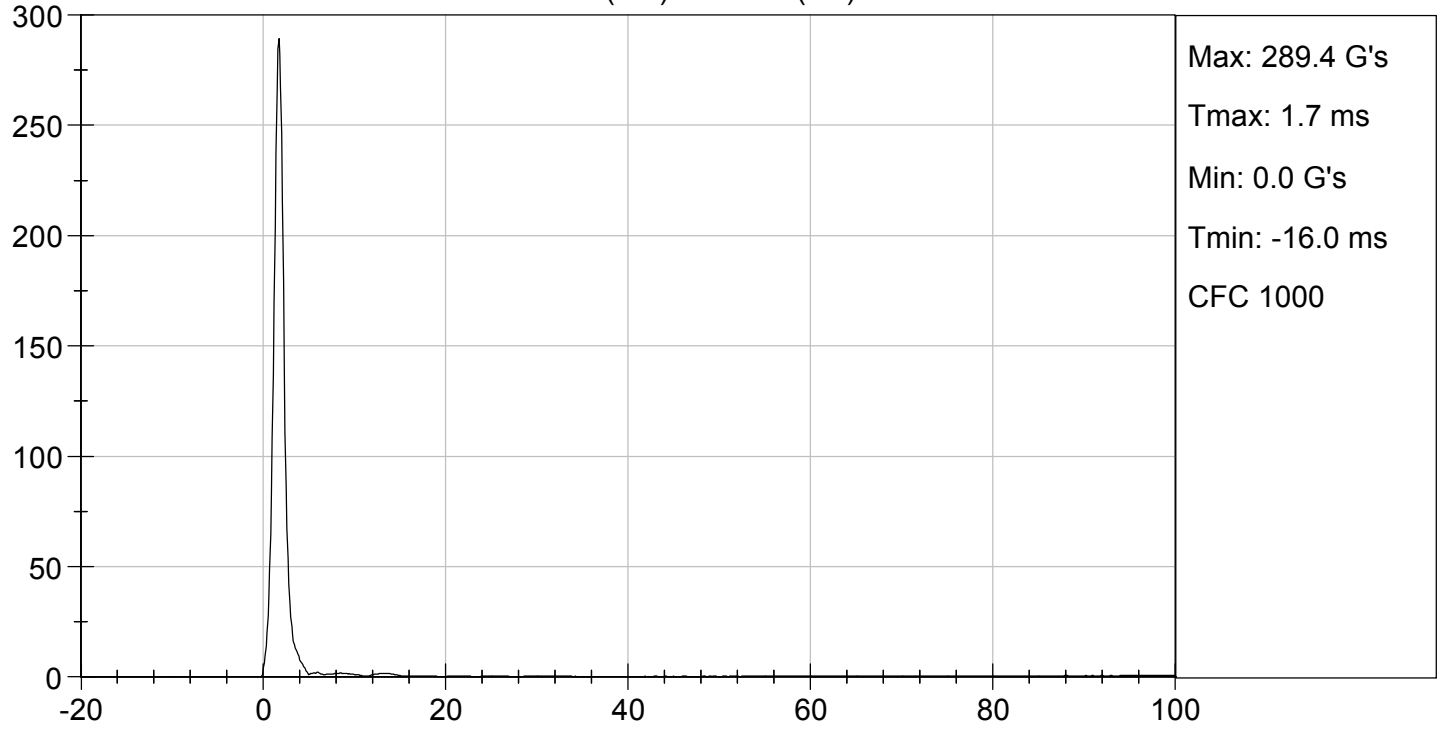
Test Date

Approved By

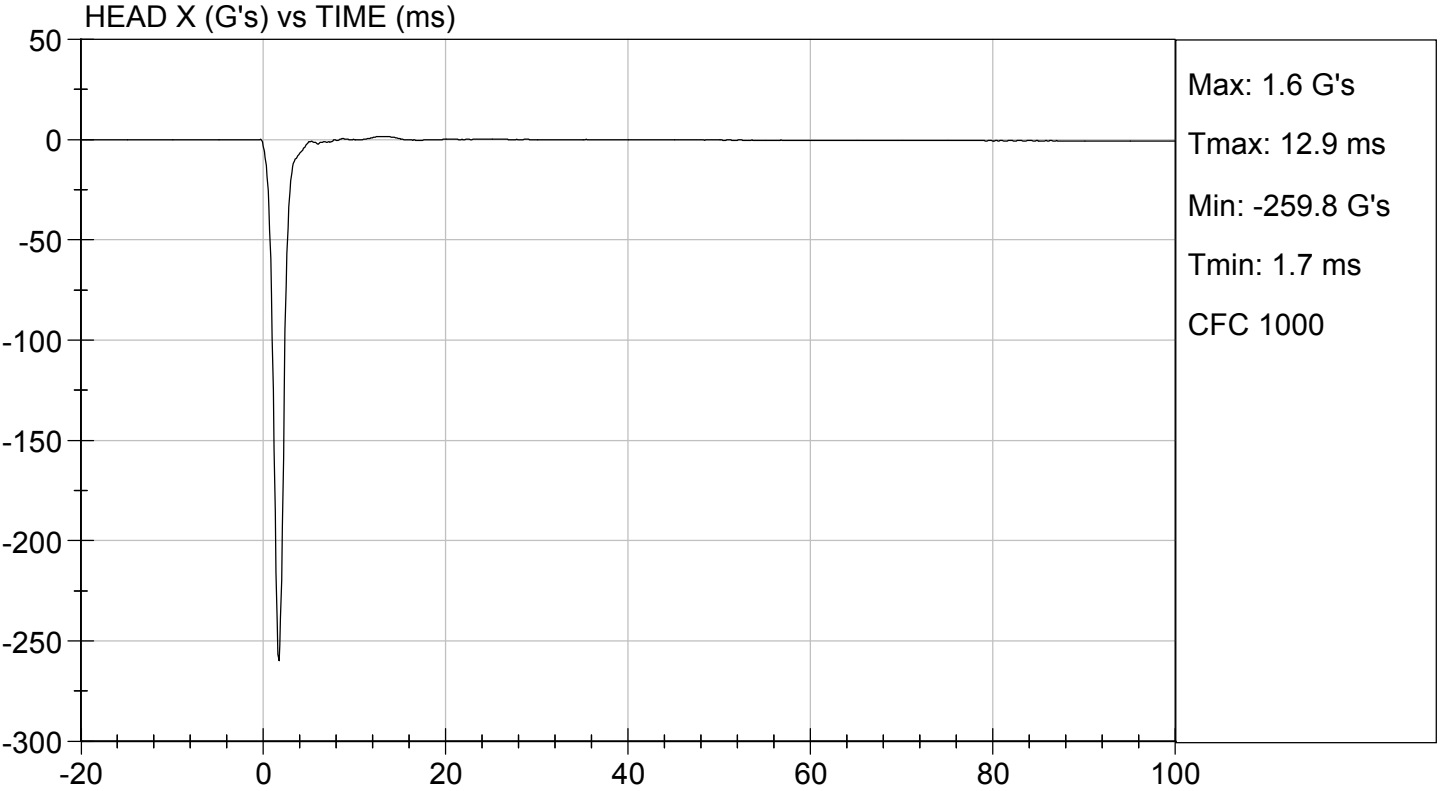
TEST DESC: HEAD DROP

TEST DATE: 05/20/2019
TEST #: D191631

HEAD RESULTANT ACCELERATION (G's) vs TIME (ms)

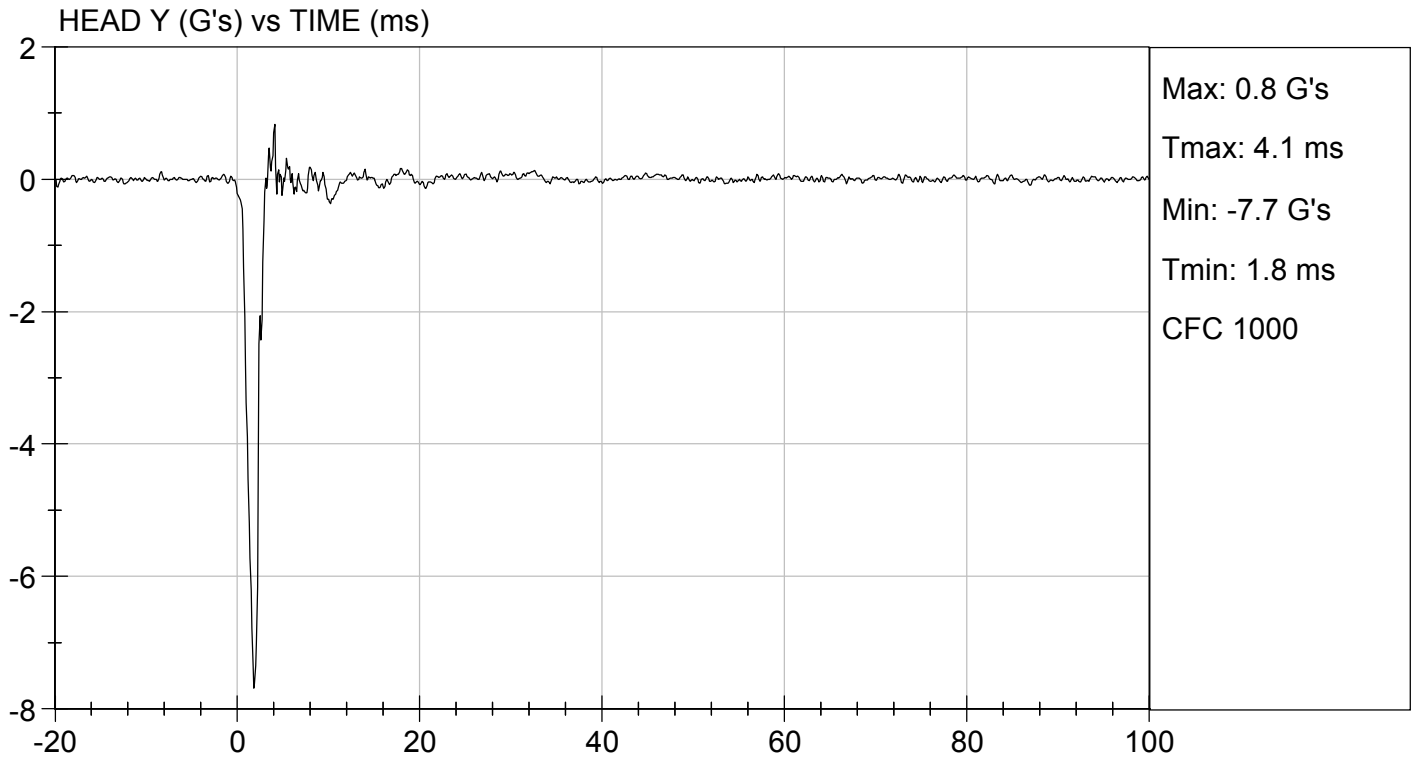


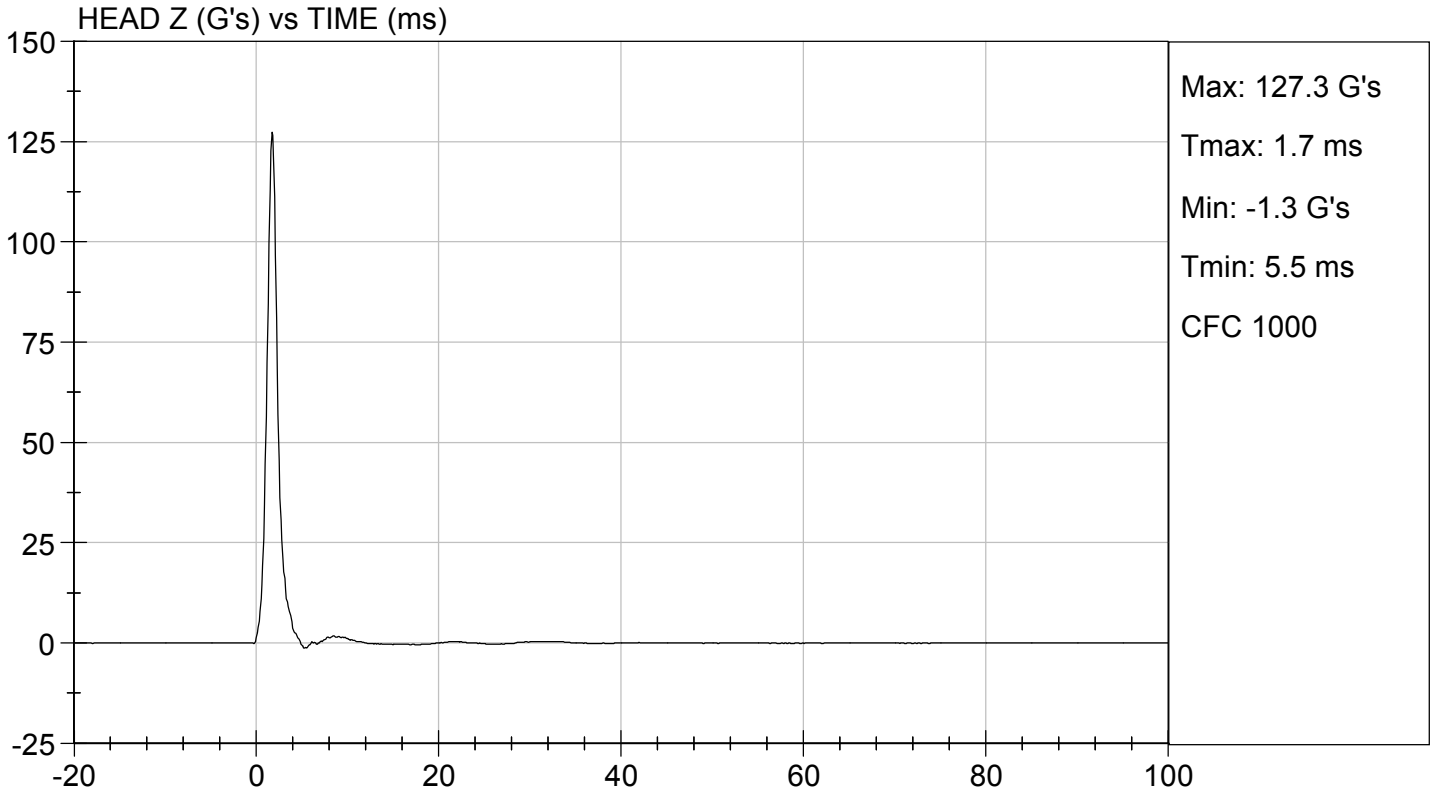
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 05/20/2019
TEST #: D191631





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191632

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	35	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.13	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.4	Pass
	20 ms	m/s	4.0 to 5.0	4.9	Pass
	30 ms	m/s	5.8 to 7.0	7.0	Pass
D Plane Rotation	Max	deg	77 to 91	80	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	69	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	82	Pass
			Overall Results		Pass

Jacob D Taylor

Laboratory Technician

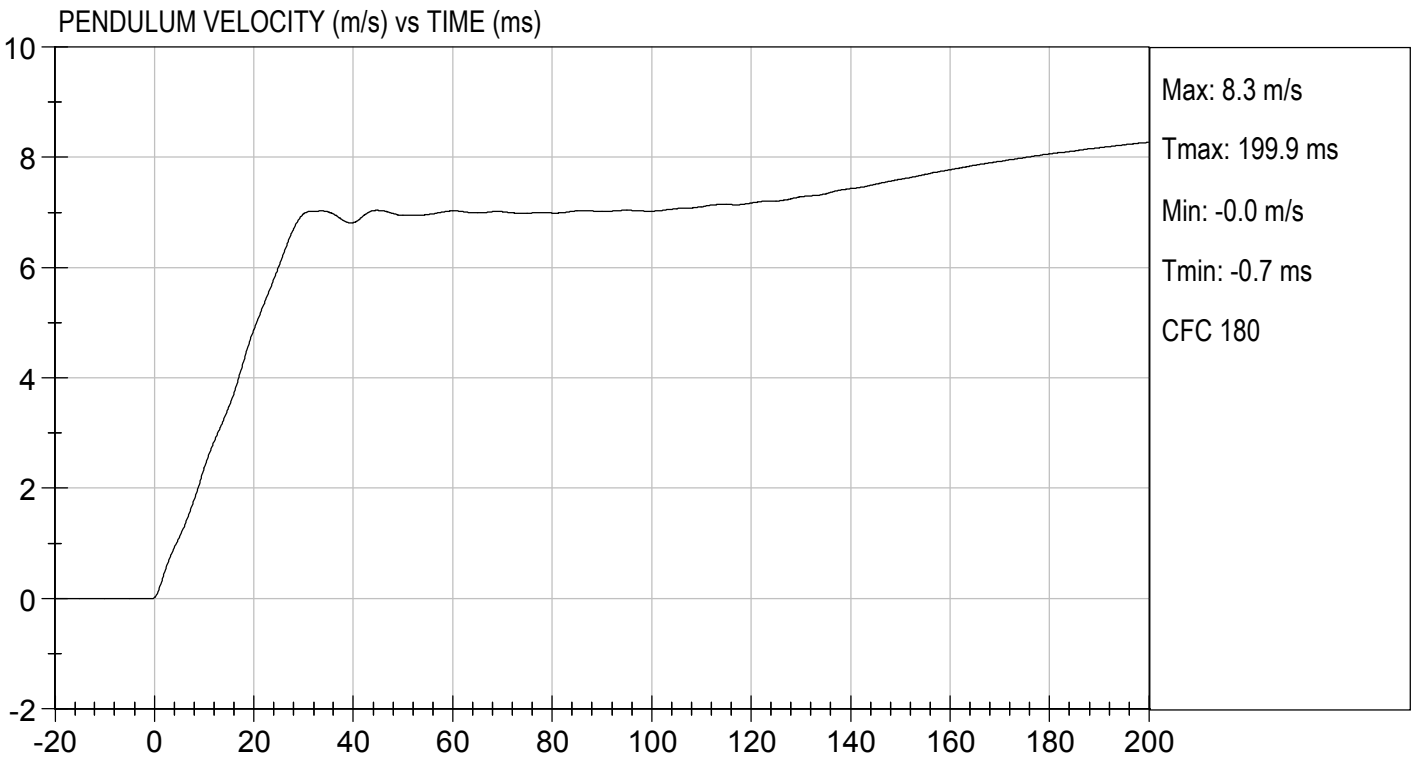
05/20/2019

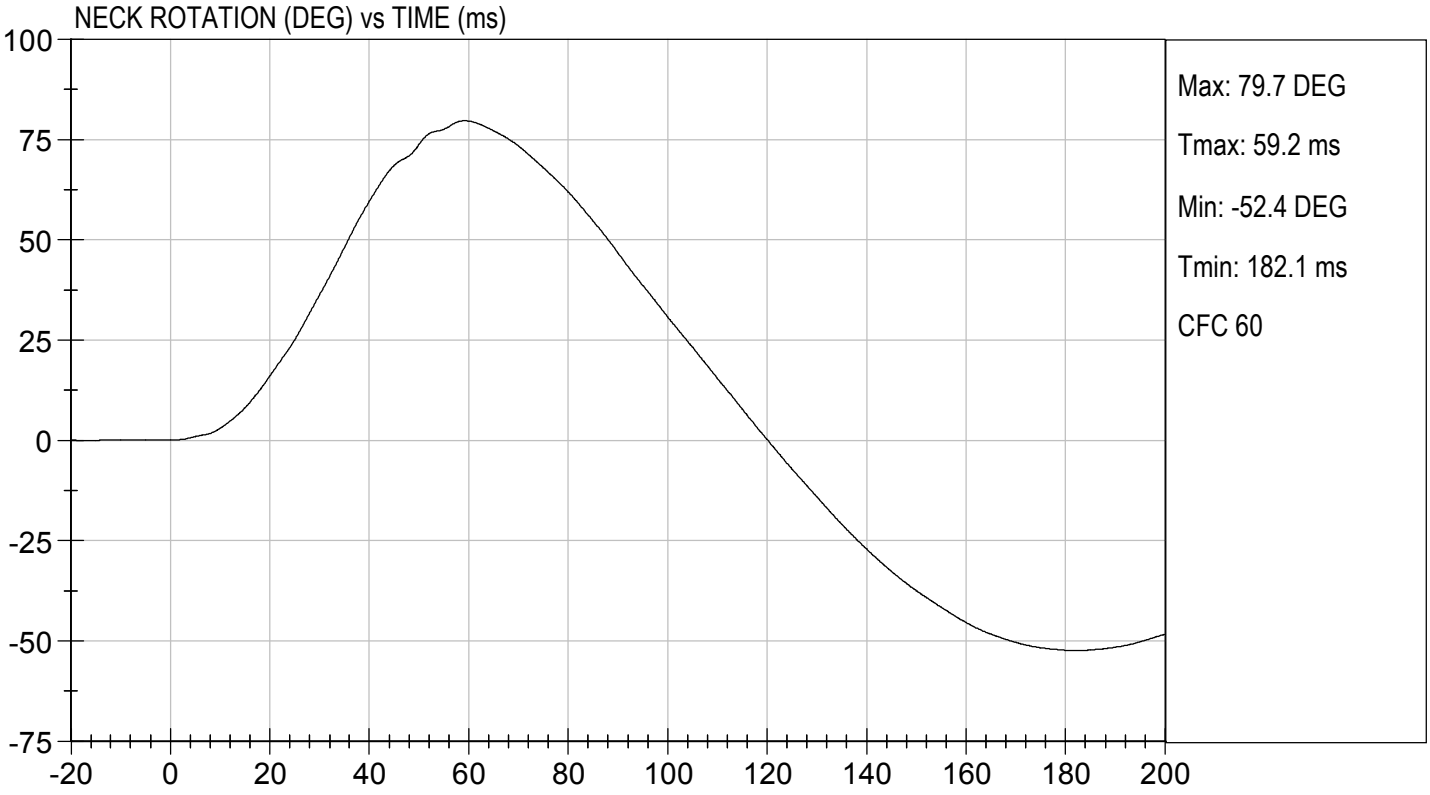
Test Date

Approved By

TEST DESC: NECK FLEXION
VELOCITY: 23.40 ft/s, 7.13 m/s

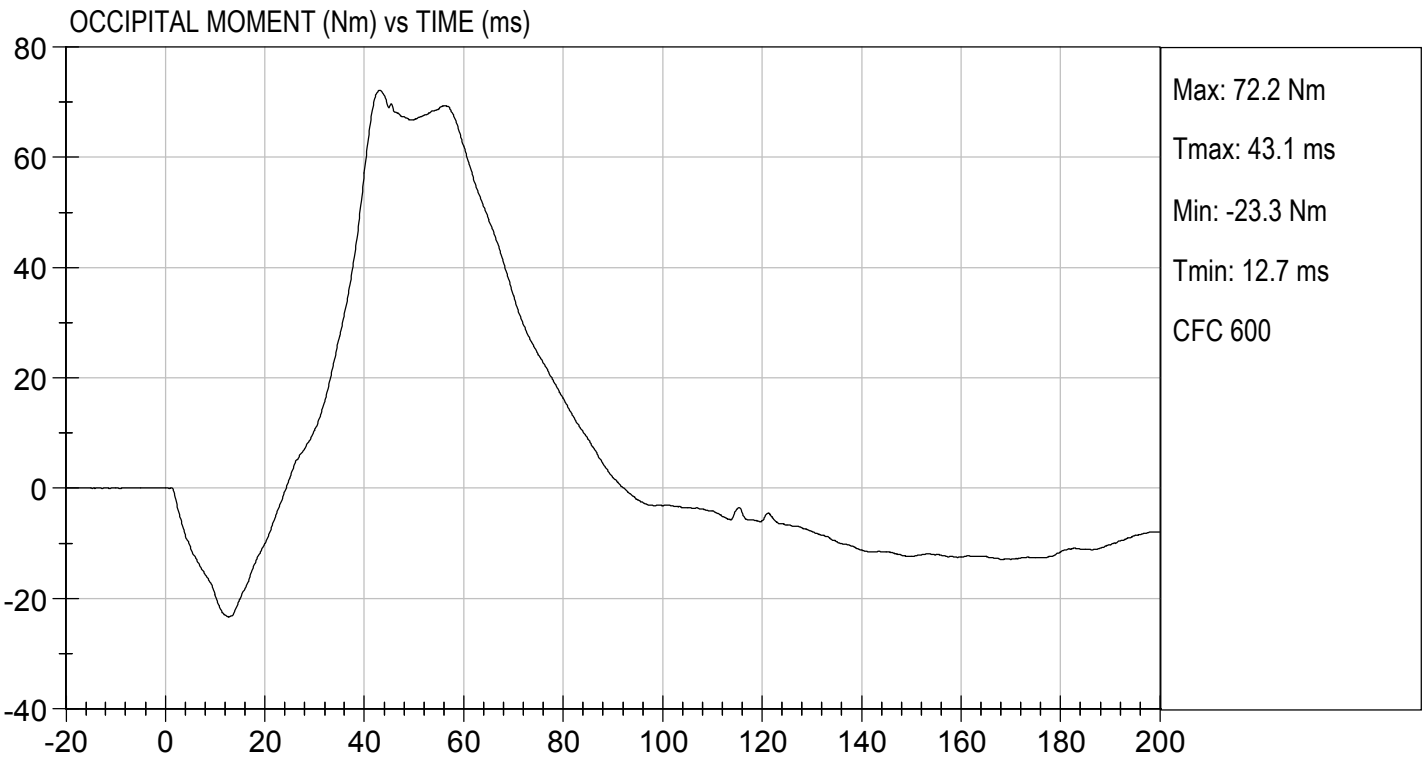
TEST DATE: 05/20/2019
TEST #: D191632





TEST DESC: NECK FLEXION
VELOCITY: 23.40 ft/s, 7.13 m/s

TEST DATE: 05/20/2019
TEST #: D191632



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191633

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	35	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.12	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.7	Pass
	20 ms	m/s	3.1 to 3.9	3.8	Pass
	30 ms	m/s	4.6 to 5.6	5.5	Pass
D Plane Rotation	Max	deg	99 to 114	108	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-55	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	103	Pass
			Overall Results		Pass

Jacob D Taylor

Laboratory Technician

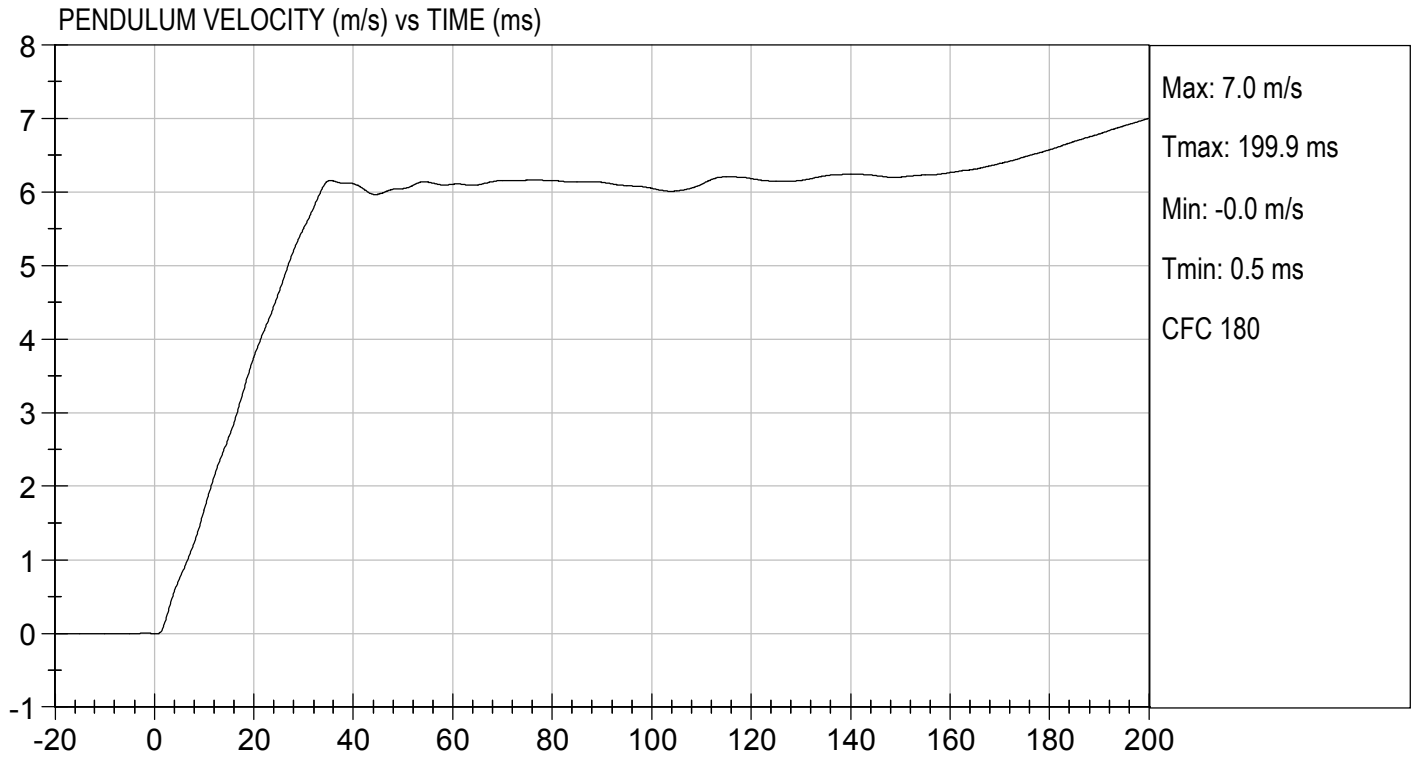
05/20/2019

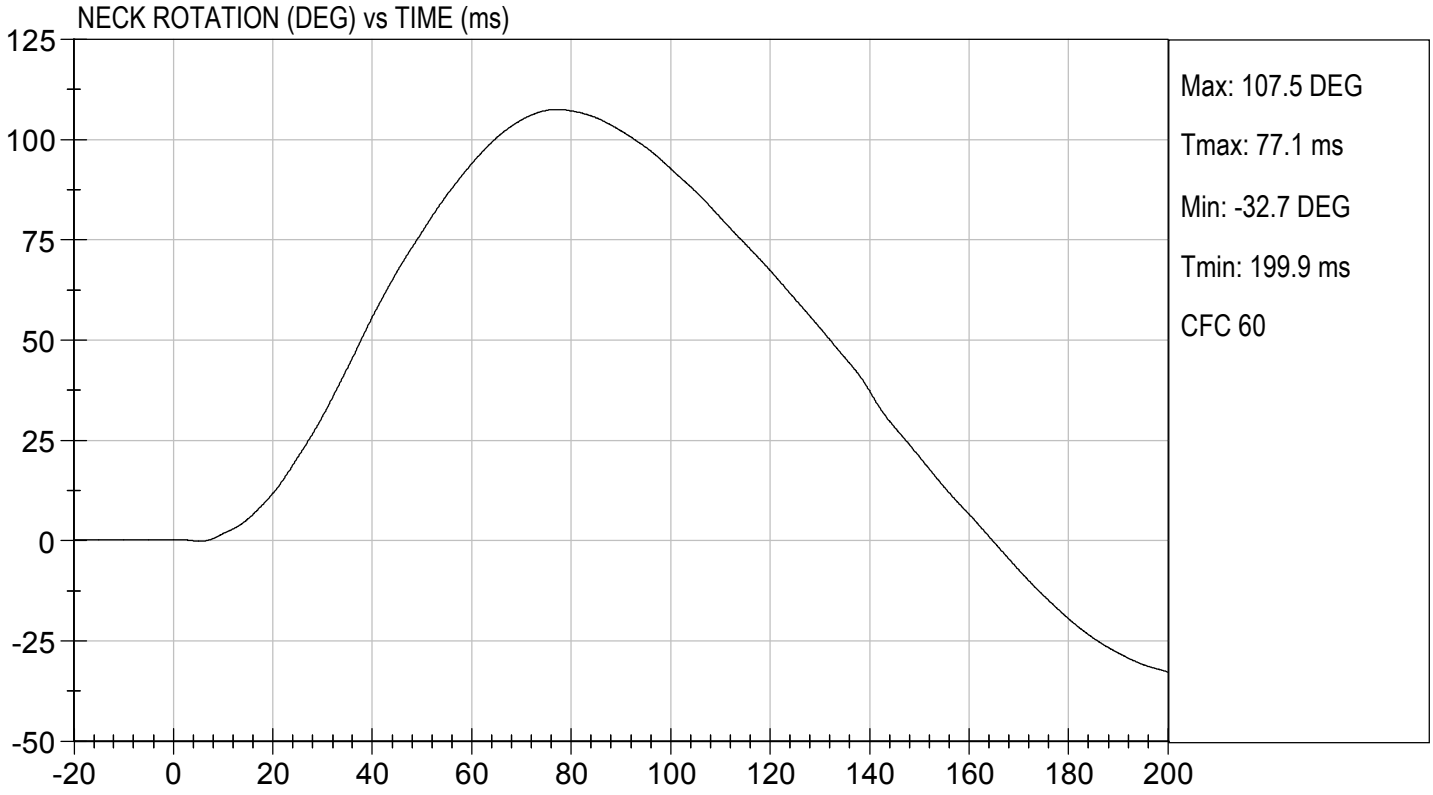
Test Date

Approved By

TEST DESC: NECK EXTENSION
VELOCITY: 20.08 ft/s, 6.12 m/s

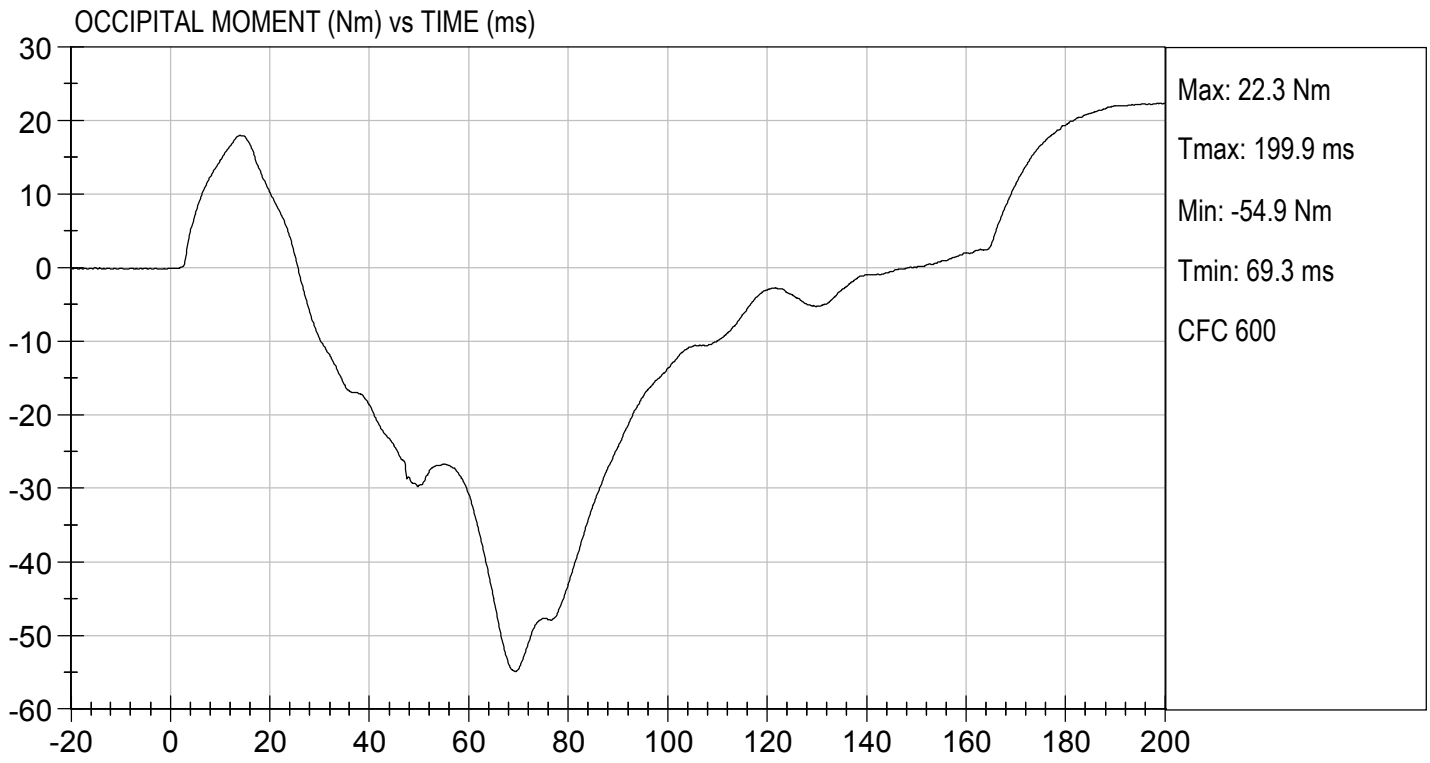
TEST DATE: 05/20/2019
TEST #: D191633





TEST DESC: NECK EXTENSION
VELOCITY: 20.08 ft/s, 6.12 m/s

TEST DATE: 05/20/2019
TEST #: D191633



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191634

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.7	Pass
Relative Humidity	%	10 to 70	33	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	50	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4187	Pass
Internal Hysteresis	%	69 to 85	76	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4572	Pass
		Overall Test Results		Pass

Jacob D Taylor

Laboratory Technician

05/21/2019

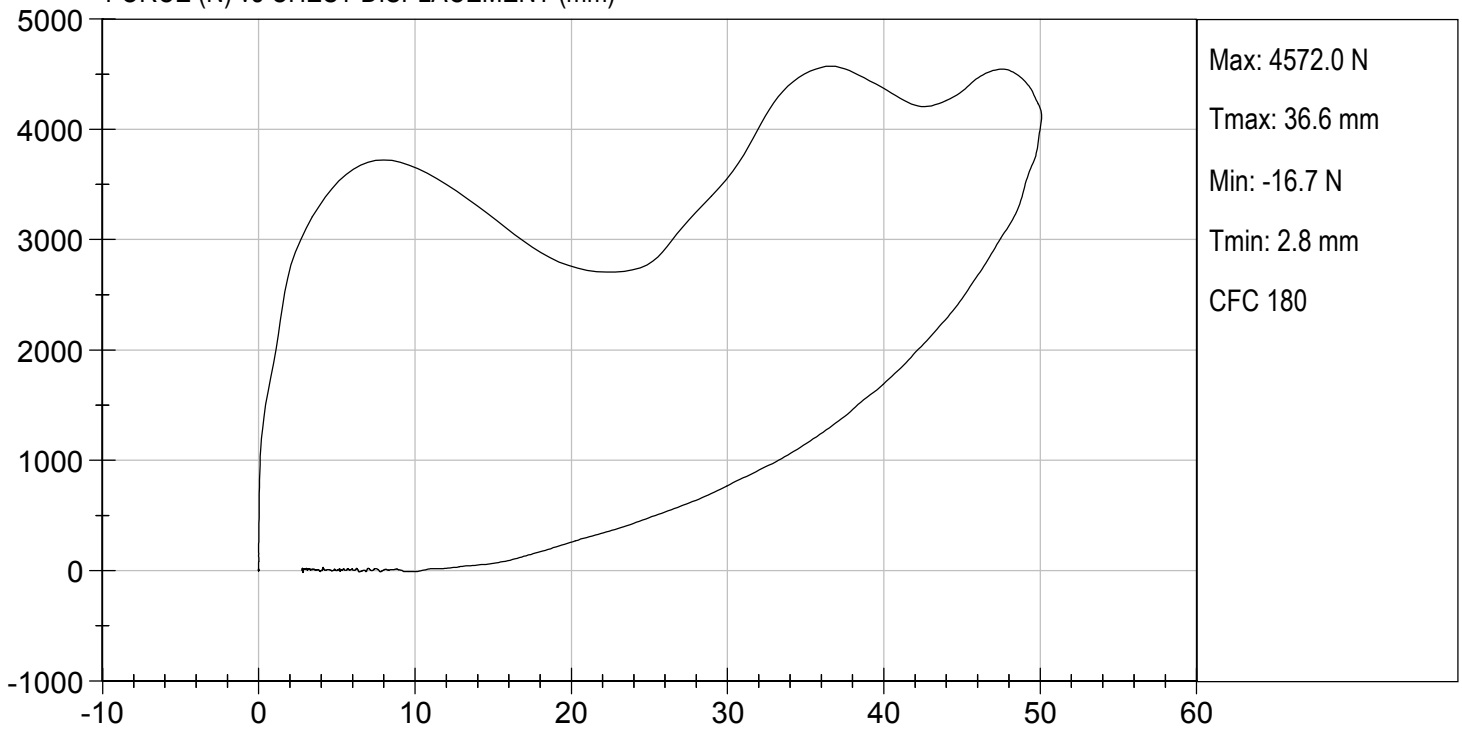
Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 22.22 ft/s, 6.77 m/s

TEST DATE: 05/21/2019
TEST #: D191634

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191635

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Probe Speed	m/s	2.07 to 2.13	2.07	Pass
Maximum Force	N	3450 to 4060	3636	Pass
		Overall Test Results		Pass

Jacob D Taylor

Laboratory Technician

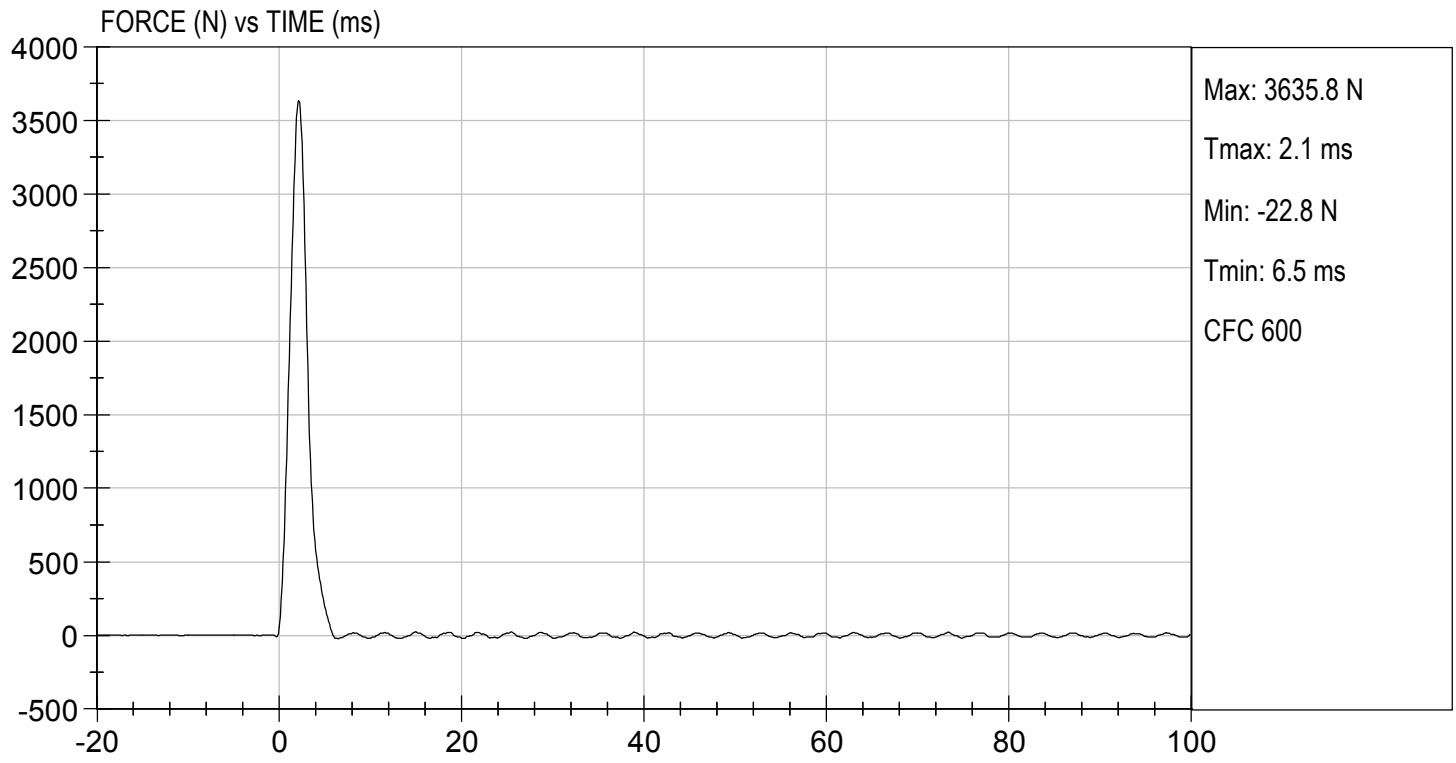
05/20/2019

Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.80 ft/s, 2.07 m/s

TEST DATE: 05/20/2019
TEST #: D191635



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191636

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Probe Speed	m/s	2.07 to 2.13	2.11	Pass
Maximum Force	N	3450 to 4060	3718	Pass
		Overall Test Results		Pass

Jacob D Taylor

Laboratory Technician

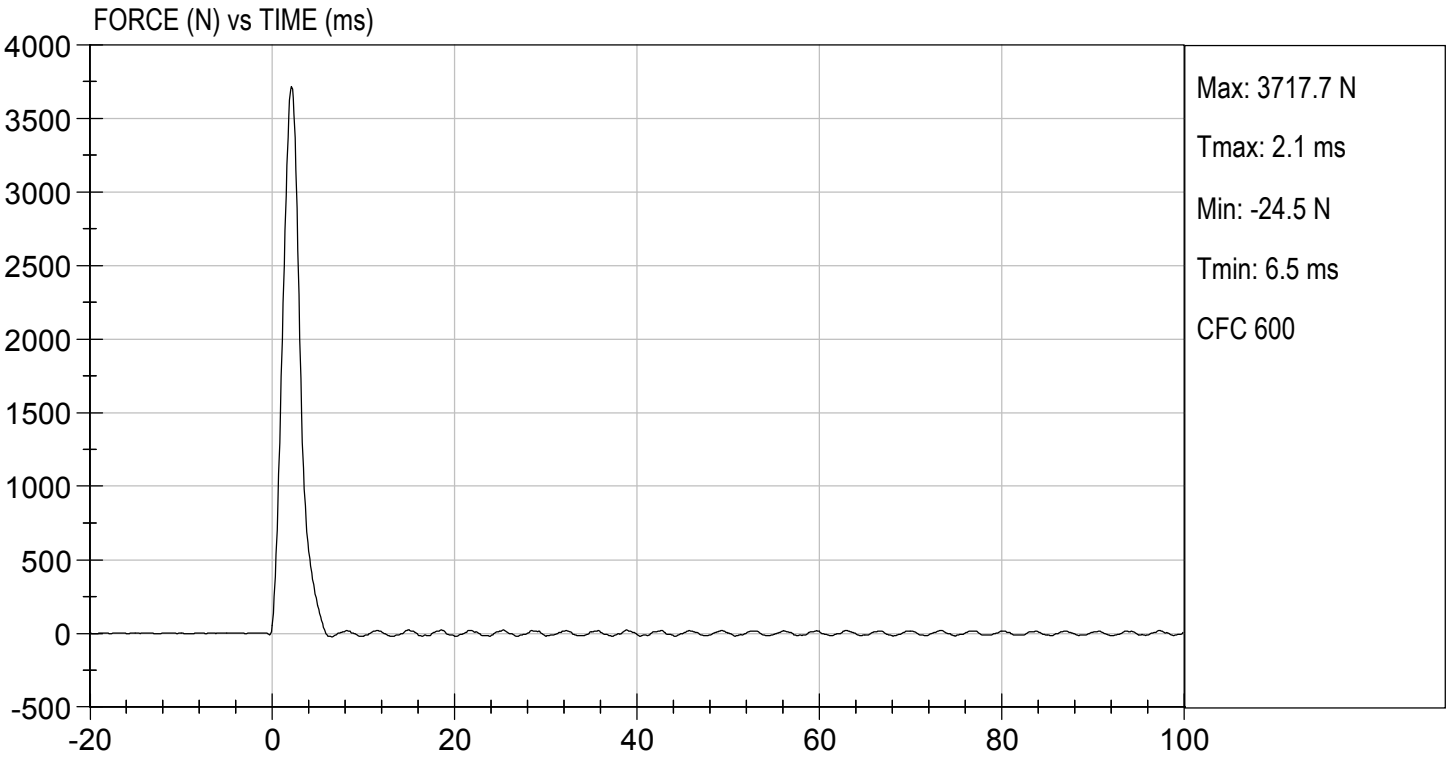
05/20/2019

Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.92 ft/s, 2.11 m/s

TEST DATE: 05/20/2019
TEST #: D191636



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191637

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	37	Pass
Initial Angle	deg	0 to 20	17	Pass
Return Angle	deg	+/- 8	5	Pass
Force at 45 deg	N	320 to 390	367	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.6	Pass
		Overall Result		Pass

Jacob D Taylor

Laboratory Technician

05/21/2019

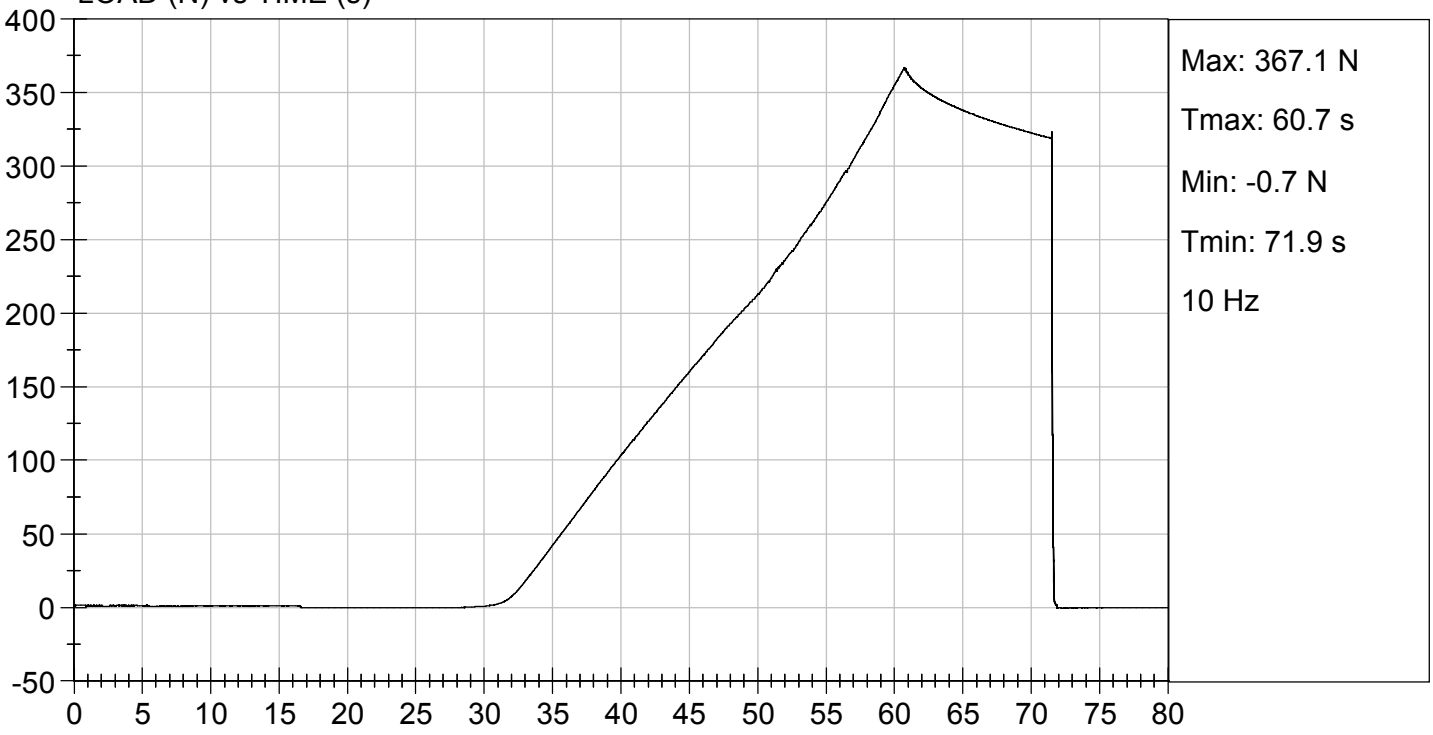
Test Date

Approved By

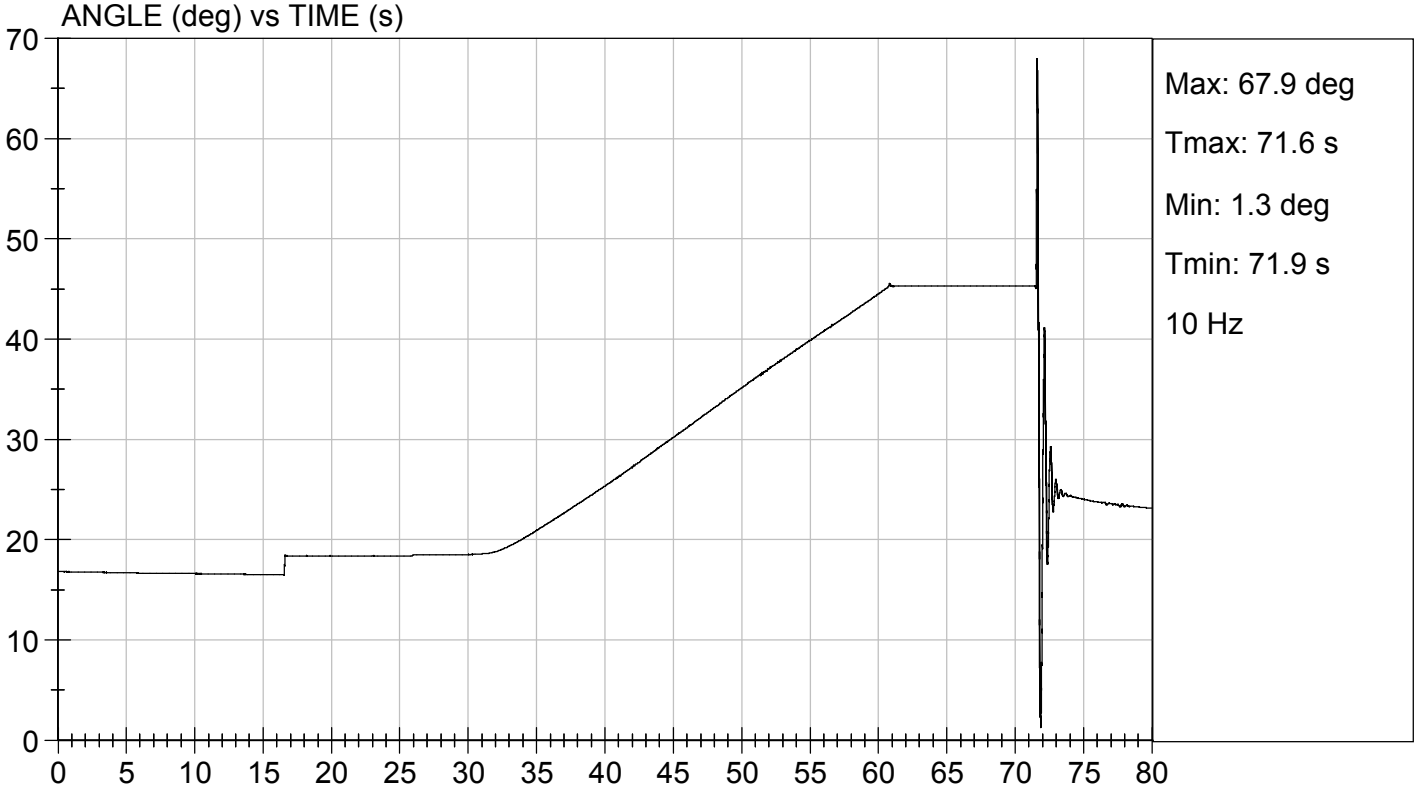
TEST DESC: LUMBAR FLEXION

TEST DATE: 05/21/2019
TEST #: D191637

LOAD (N) vs TIME (s)



ANGLE (deg) vs TIME (s)



CALIBRATION TEST RESULTS

POST-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test ID:** D191721

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Peak Resultant Acceleration	G's	250 to 300	296	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	1.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

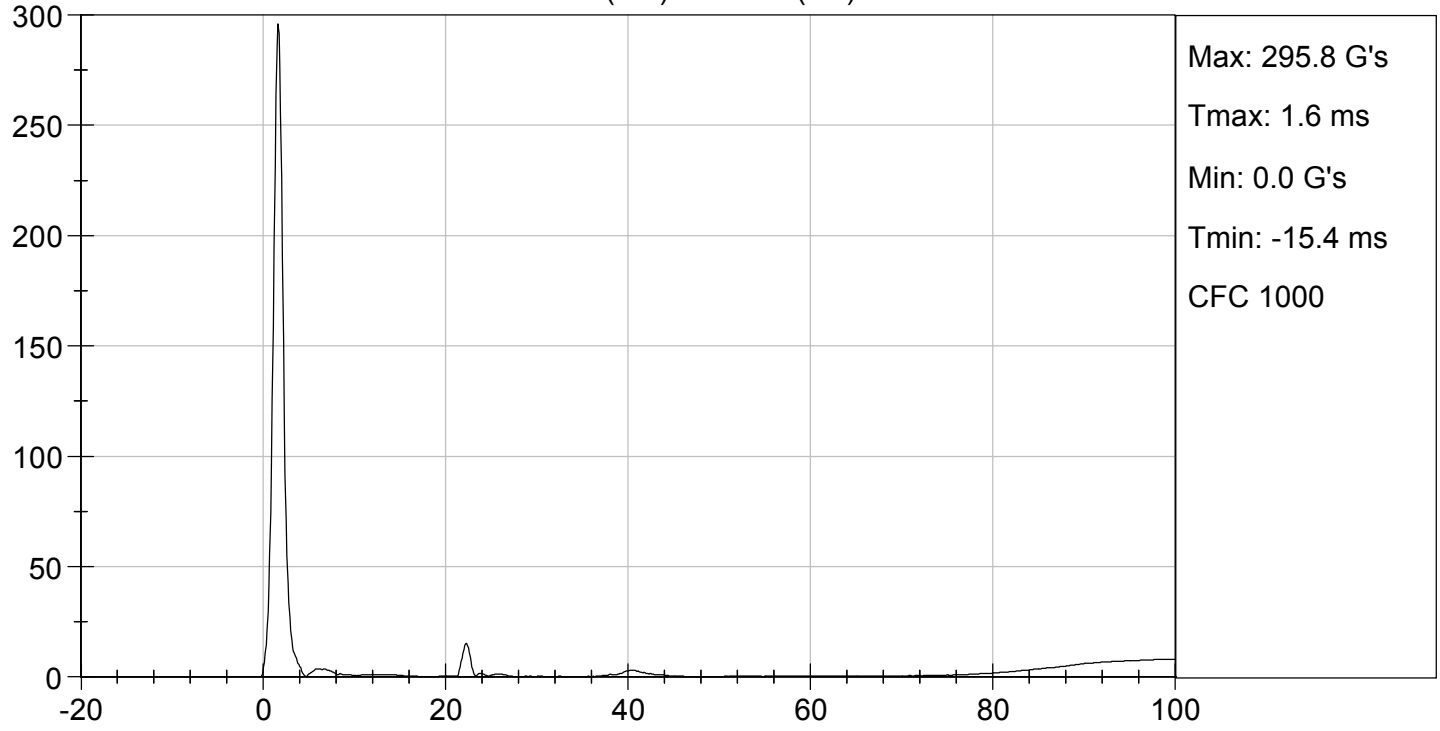
06/03/2019
Test Date

Approved By

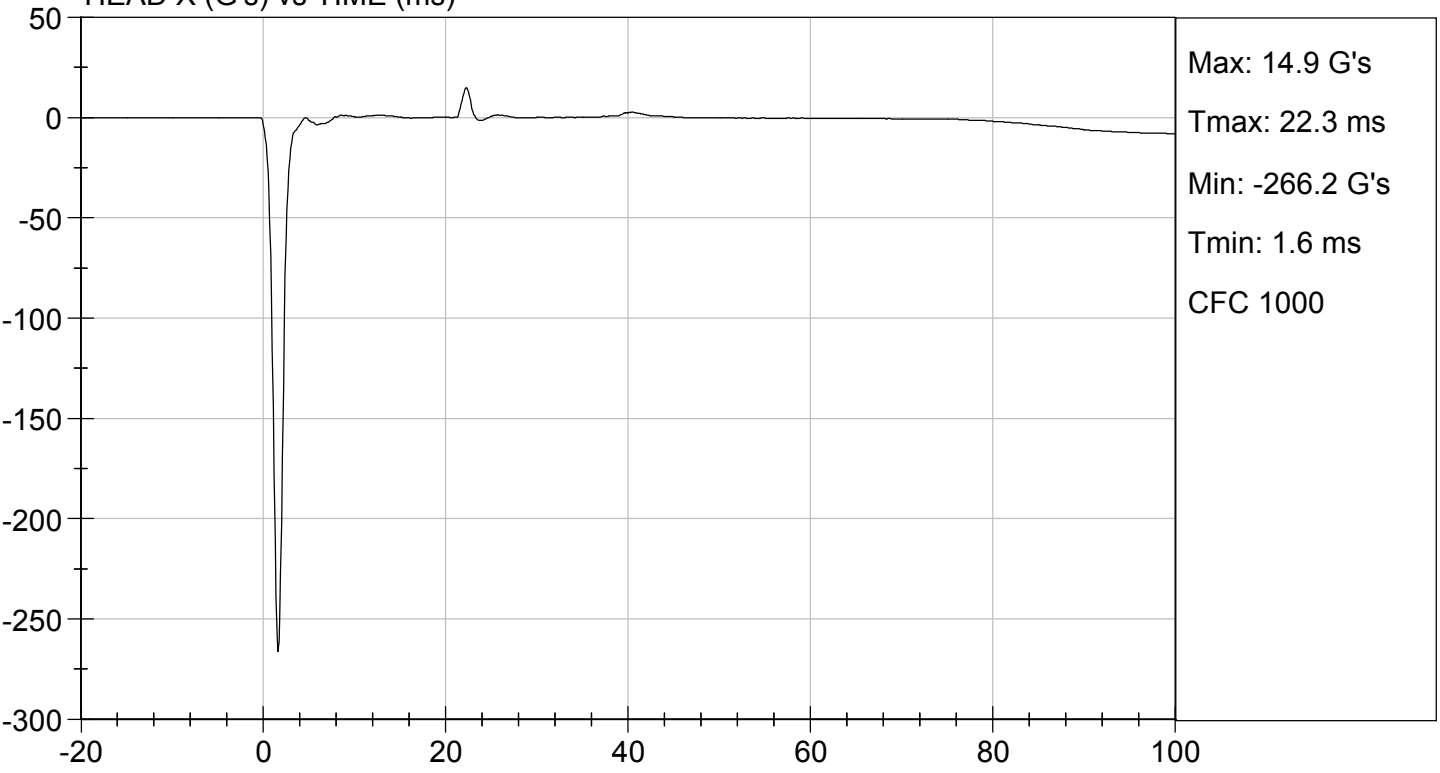
TEST DESC: HEAD DROP

TEST DATE: 06/03/2019
TEST #: D191721

HEAD RESULTANT ACCELERATION (G's) vs TIME (ms)

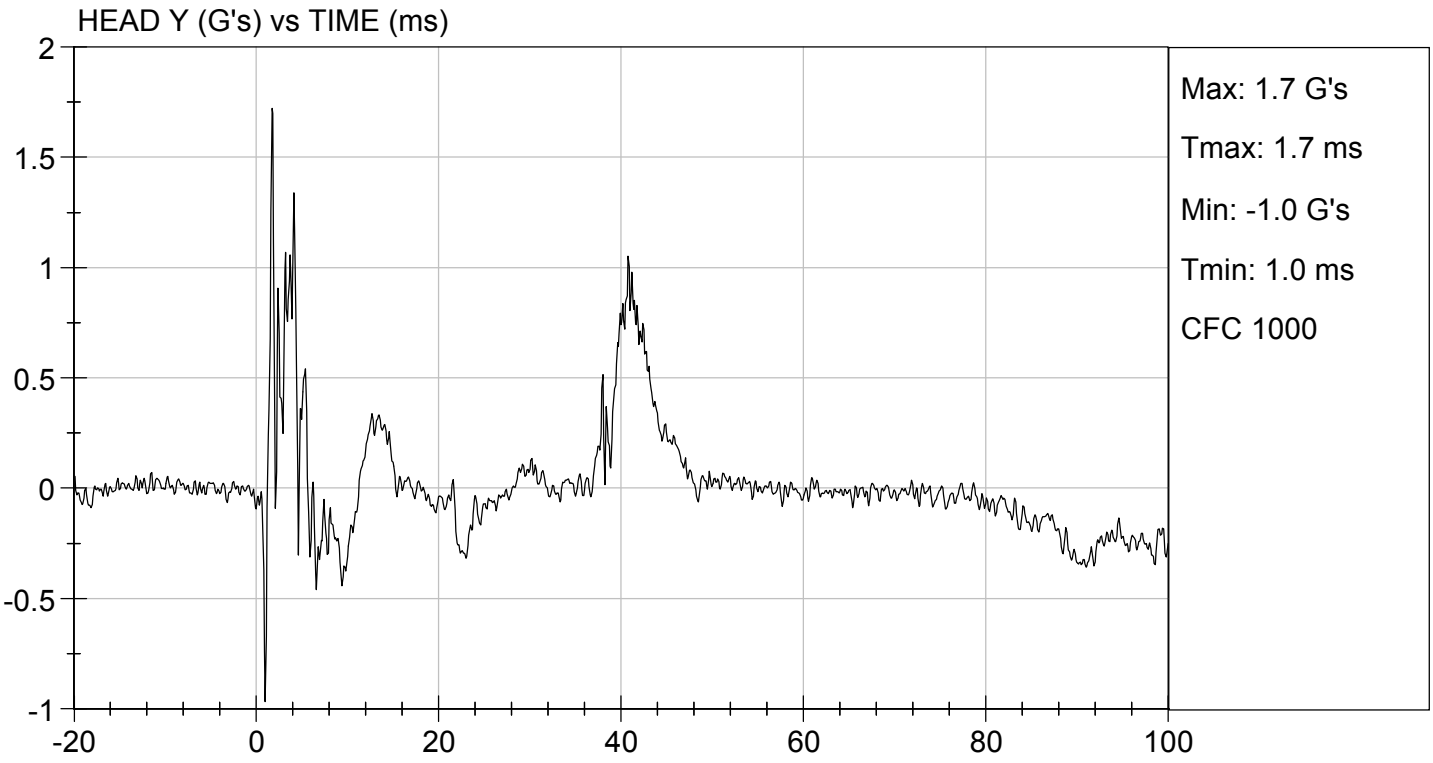


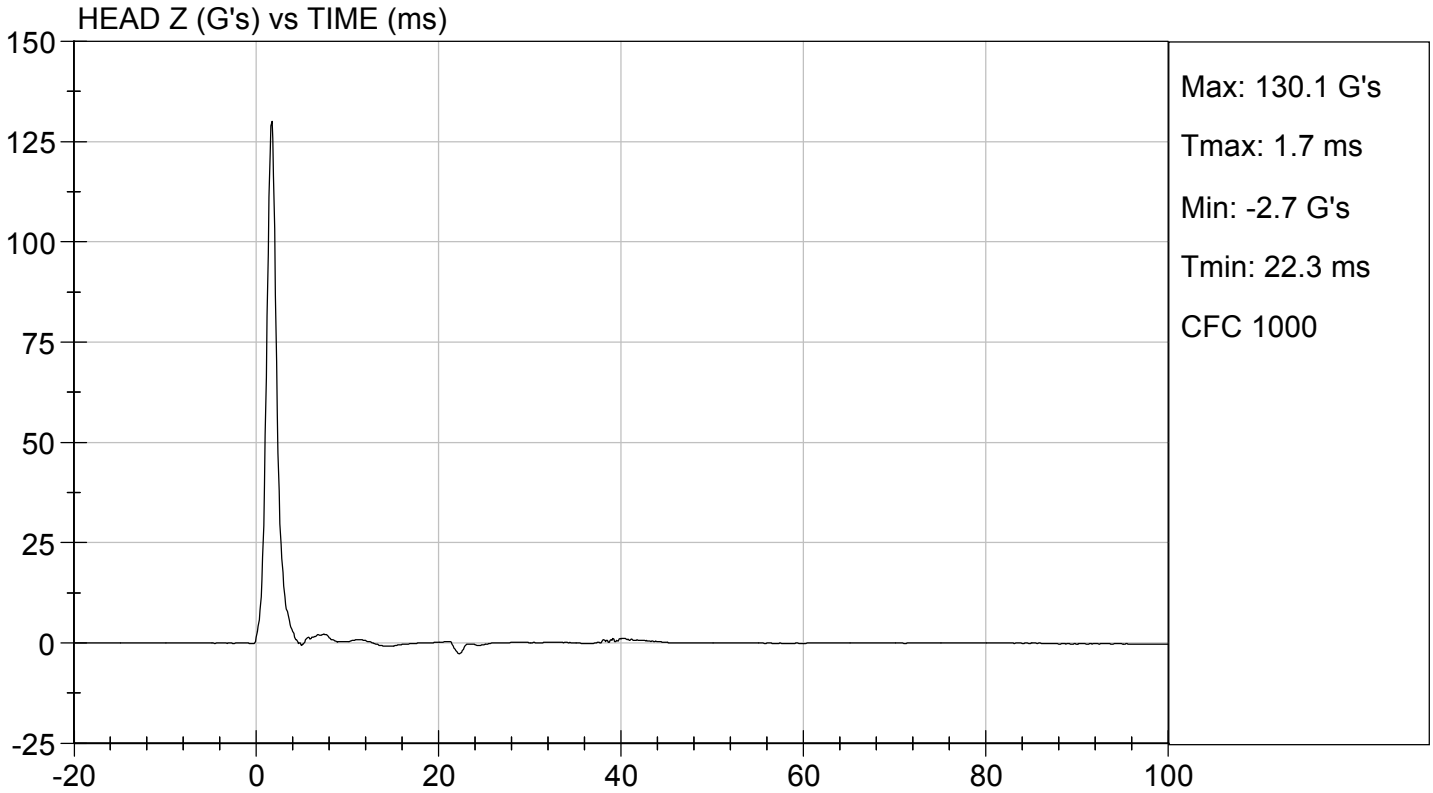
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 06/03/2019
TEST #: D191721





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191722

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	35	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.06	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.3	Pass
	20 ms	m/s	4.0 to 5.0	4.9	Pass
	30 ms	m/s	5.8 to 7.0	6.9	Pass
D Plane Rotation	Max	deg	77 to 91	82	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	76	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	84	Pass
			Overall Results		Pass

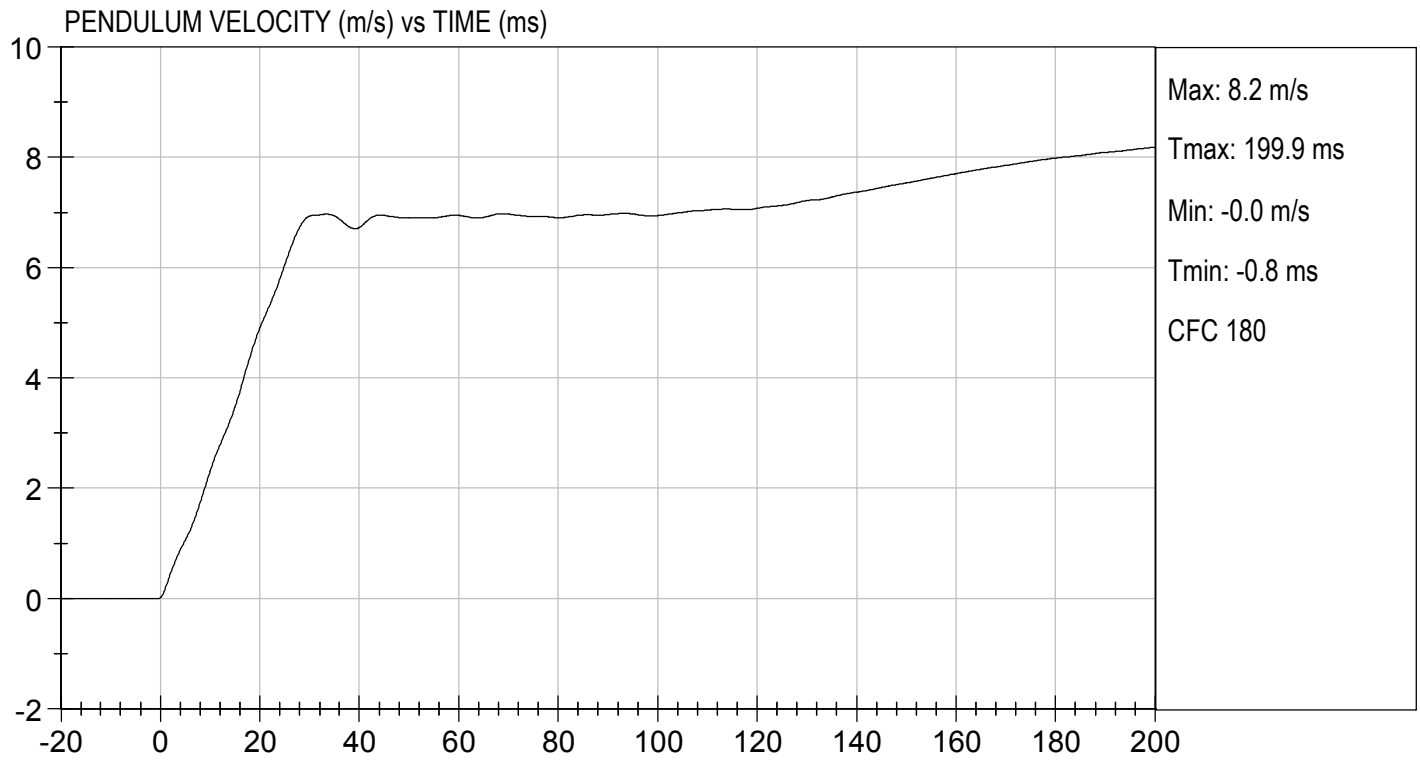
Danielle Redinbaugh
Laboratory Technician

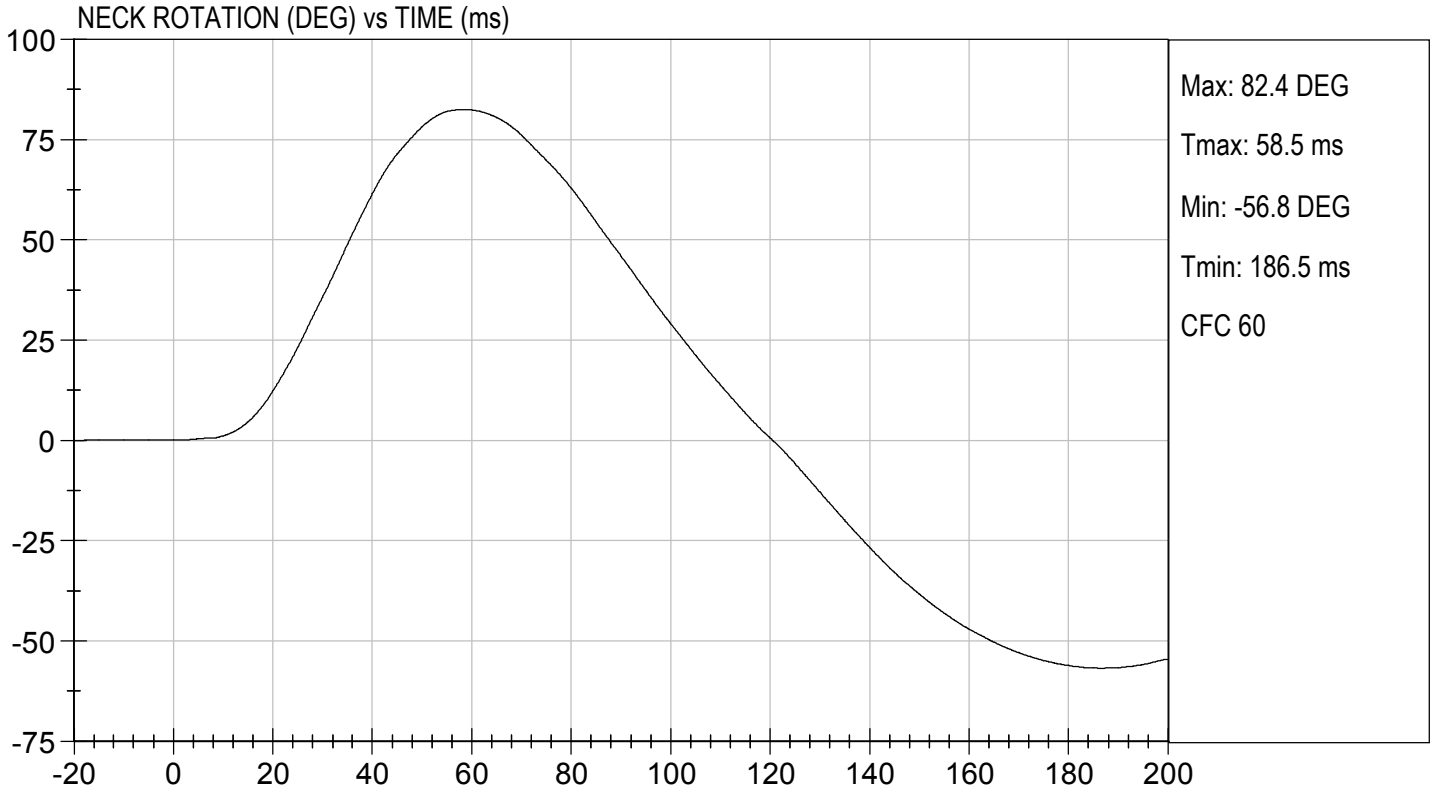
06/03/2019
Test Date

Approved By

TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

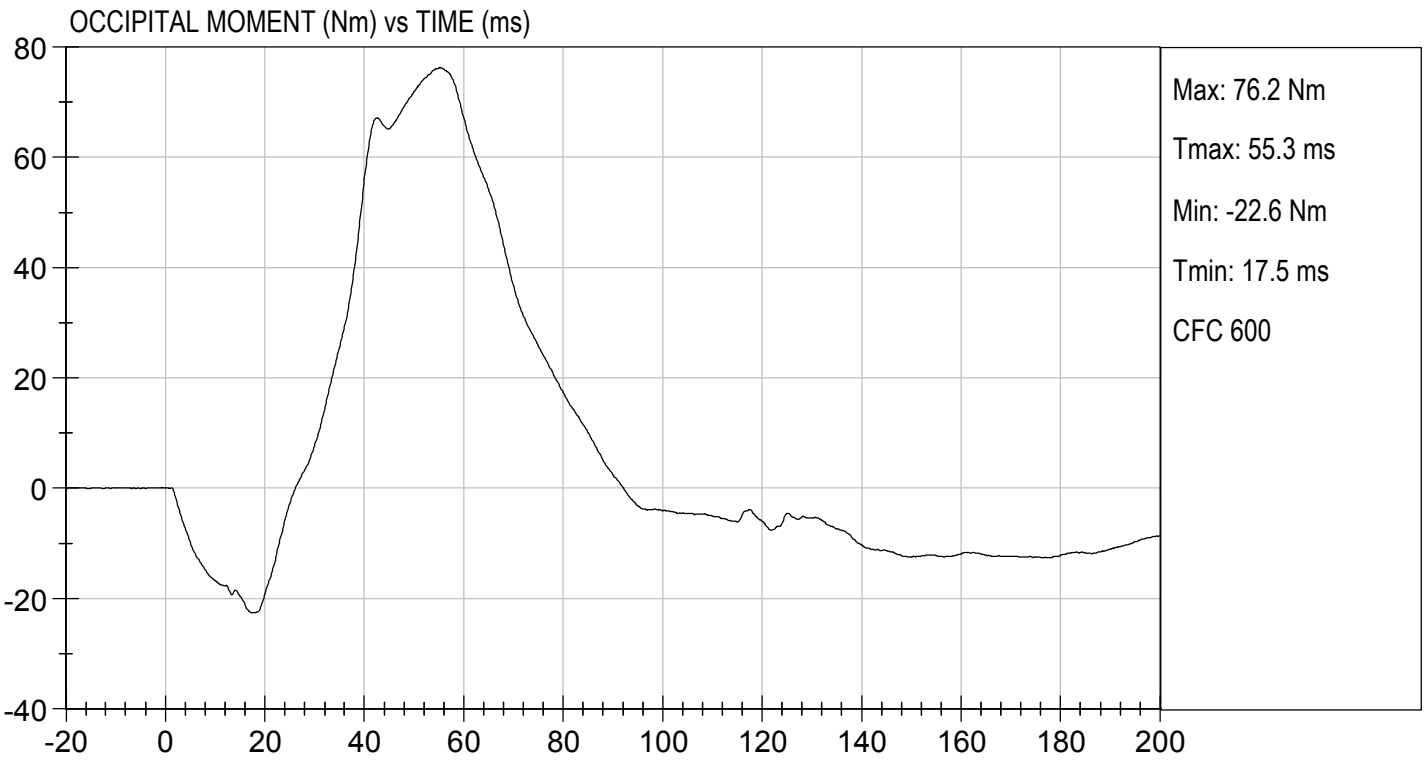
TEST DATE: 06/03/2019
TEST #: D191722





TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 06/03/2019
TEST #: D191722



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191723

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	35	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.19	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.7	Pass
	20 ms	m/s	3.1 to 3.9	3.7	Pass
	30 ms	m/s	4.6 to 5.6	5.2	Pass
D Plane Rotation	Max	deg	99 to 114	109	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-54	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	104	Pass
			Overall Results		Pass

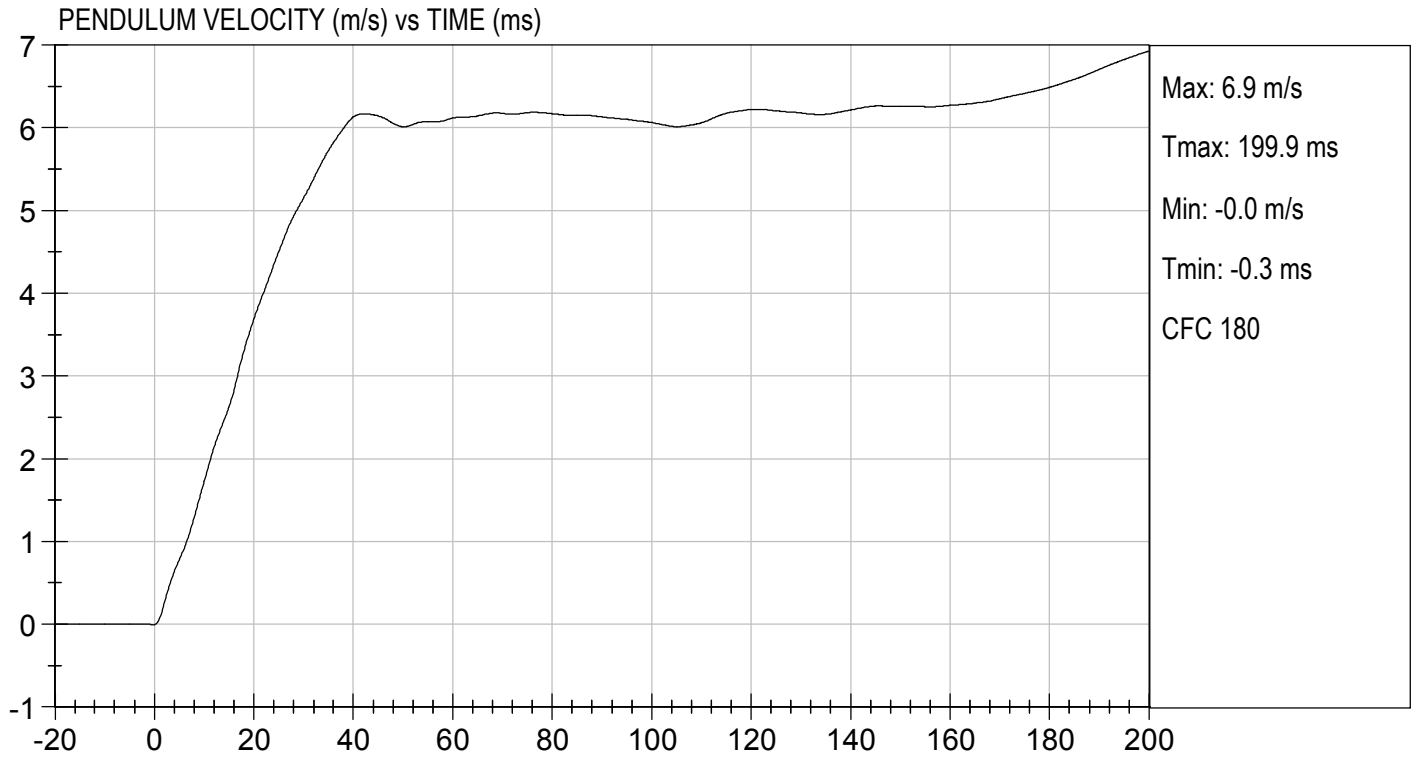
Danielle Redinbaugh
Laboratory Technician

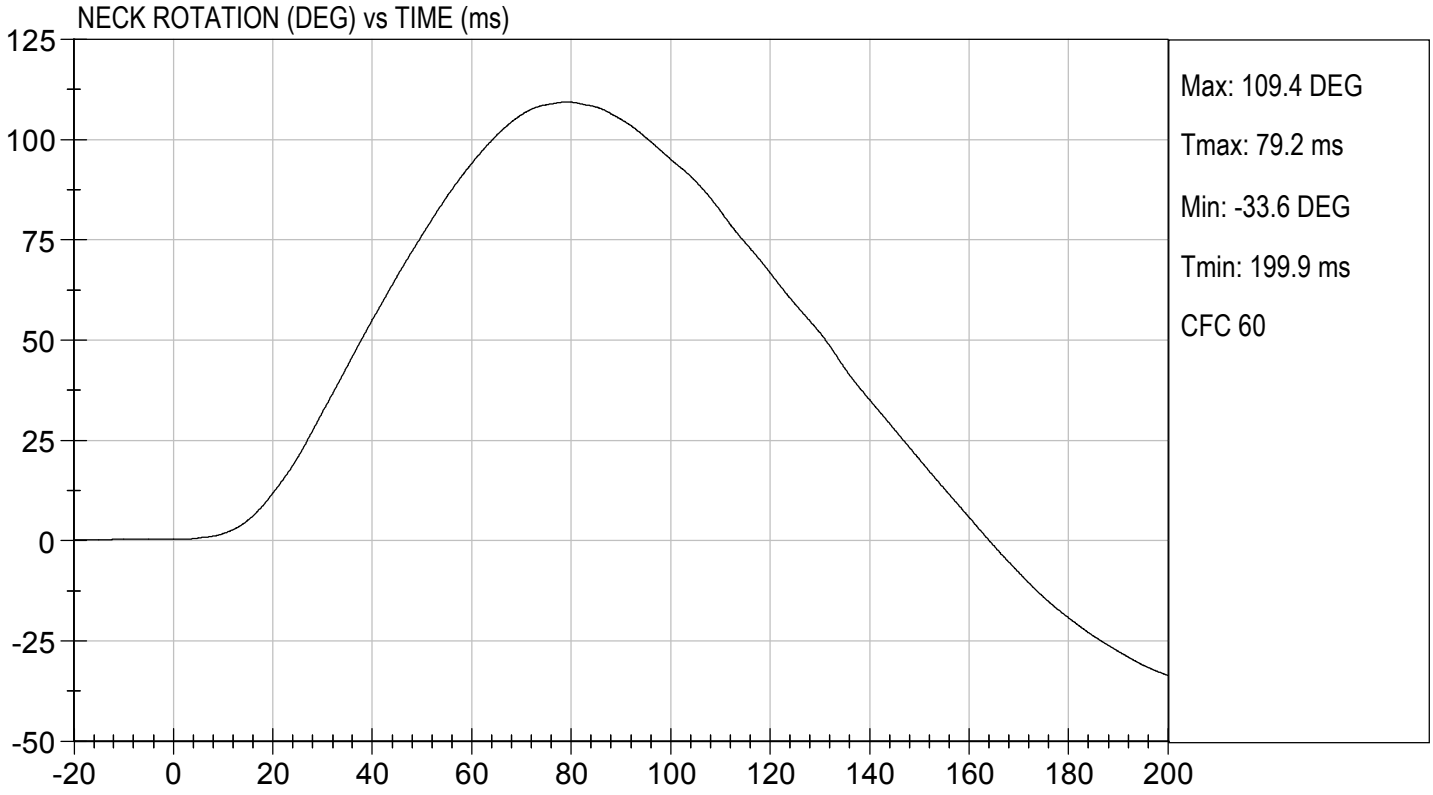
06/03/2019
Test Date

Approved By

TEST DESC: NECK EXTENSION
VELOCITY: 20.30 ft/s, 6.19 m/s

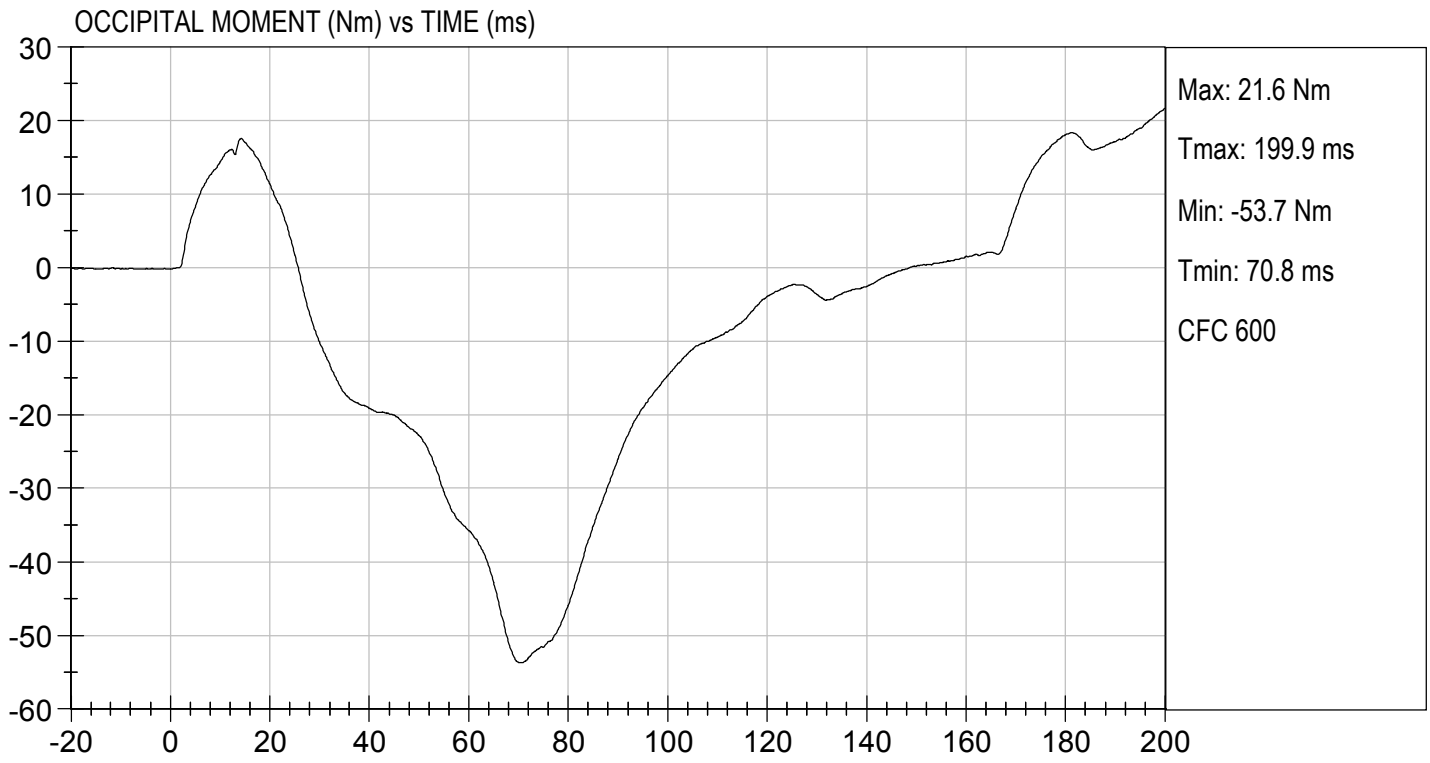
TEST DATE: 06/03/2019
TEST #: D191723





TEST DESC: NECK EXTENSION
VELOCITY: 20.30 ft/s, 6.19 m/s

TEST DATE: 06/03/2019
TEST #: D191723



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191724

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.9	Pass
Relative Humidity	%	10 to 70	40	Pass
Probe Speed	m/s	6.59 to 6.83	6.80	Pass
Peak Deflection	mm	50 to 58	50	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4306	Pass
Internal Hysteresis	%	69 to 85	76	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4489	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

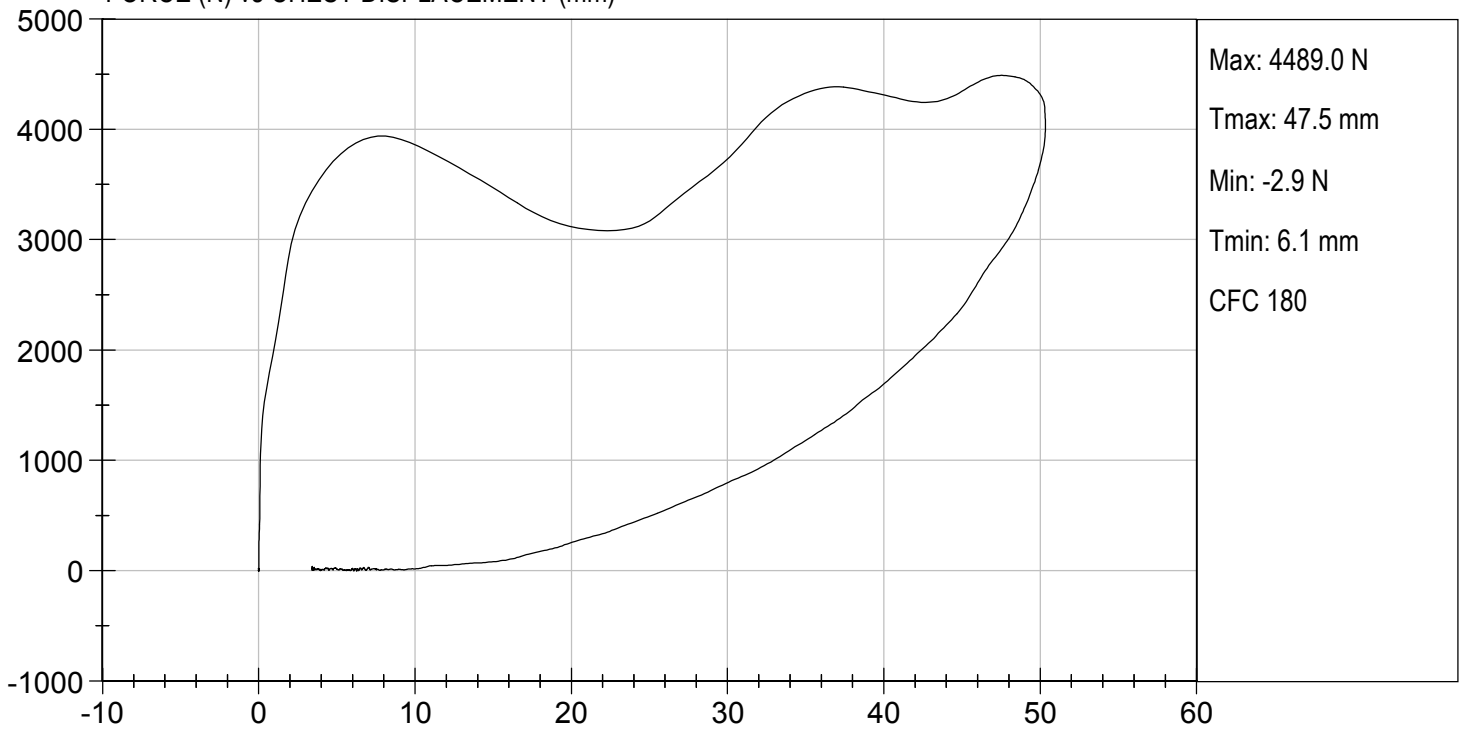
06/03/2019
Test Date

Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 22.30 ft/s, 6.80 m/s

TEST DATE: 06/03/2019
TEST #: D191724

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191725

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Probe Speed	m/s	2.07 to 2.13	2.10	Pass
Maximum Force	N	3450 to 4060	3835	Pass
		Overall Test Results		Pass

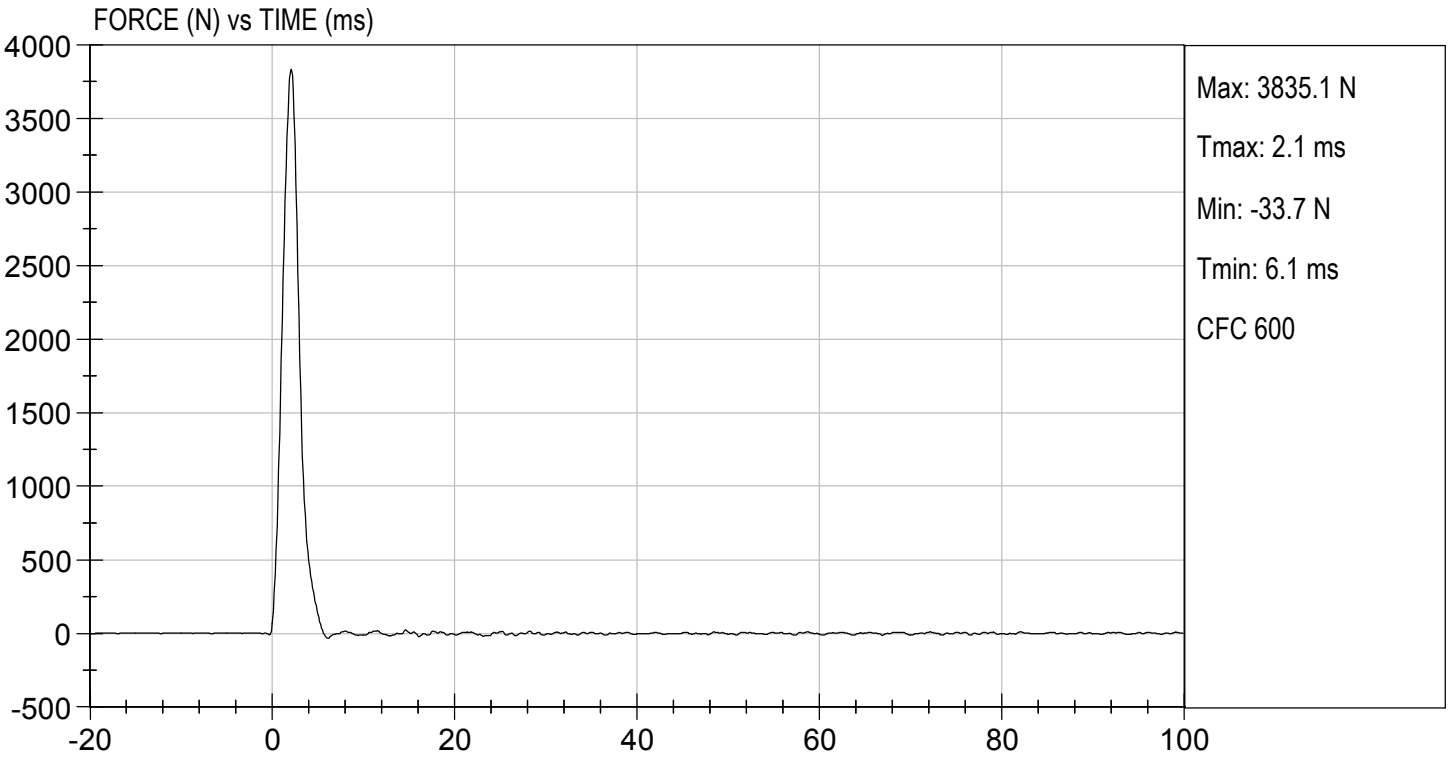
Danielle Redinbaugh
Laboratory Technician

06/03/2019
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.89 ft/s, 2.10 m/s

TEST DATE: 06/03/2019
TEST #: D191725



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191726

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Probe Speed	m/s	2.07 to 2.13	2.11	Pass
Maximum Force	N	3450 to 4060	3767	Pass
		Overall Test Results		Pass

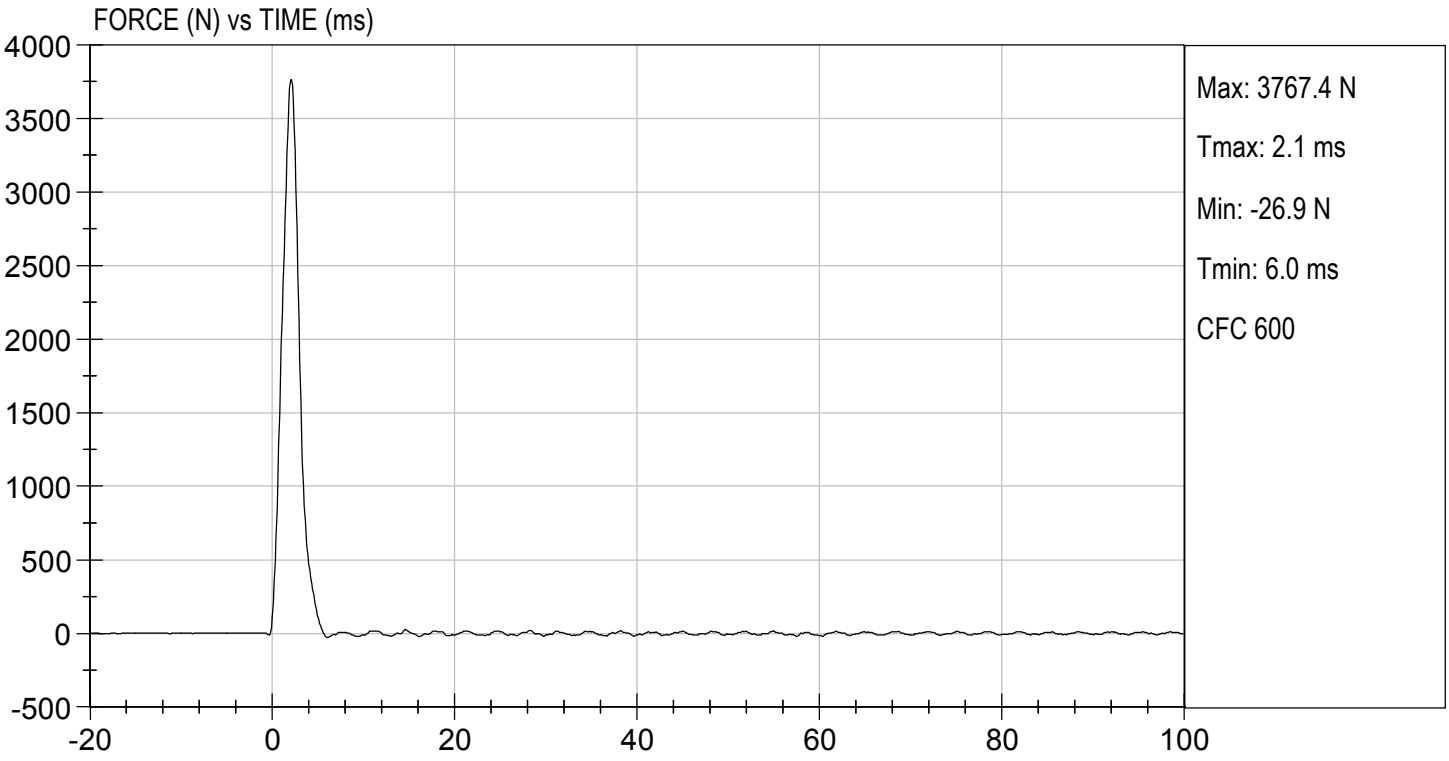
Danielle Redinbaugh
Laboratory Technician

06/03/2019
Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.92 ft/s, 2.11 m/s

TEST DATE: 06/03/2019
TEST #: D191726



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 1659 **Test I.D:** D191727

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	35	Pass
Initial Angle	deg	0 to 20	18	Pass
Return Angle	deg	+/- 8	5	Pass
Force at 45 deg	N	320 to 390	363	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.6	Pass
		Overall Result		Pass

Danielle Redinbaugh
Laboratory Technician

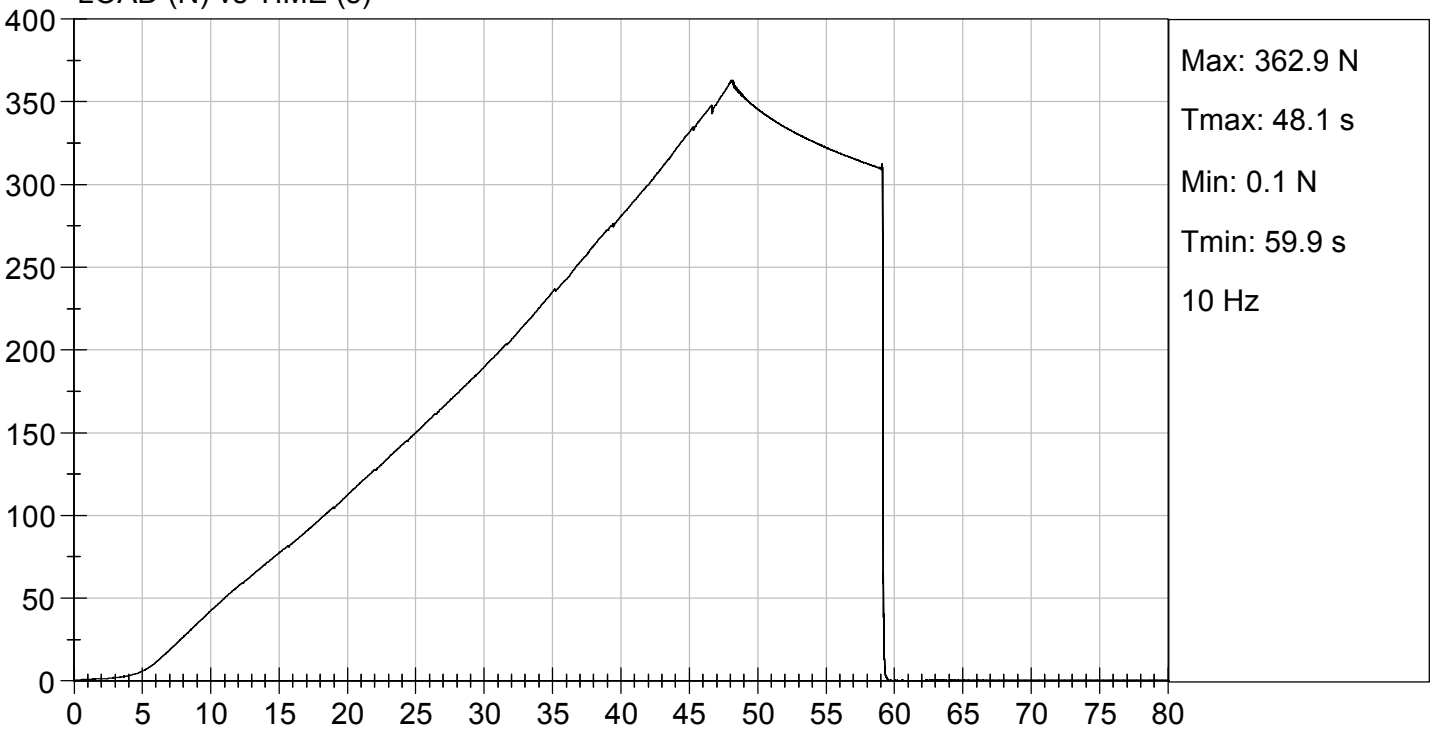
06/03/2019
Test Date

Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 06/03/2019
TEST #: D191727

LOAD (N) vs TIME (s)



ANGLE (deg) vs TIME (s)