REPORT NUMBER: NCAP-MGA-21-024

NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test

TOYOTA MOTOR MANUFACTURING, INDIANA, INC.
2021 Toyota Sienna Hybrid XLE AWD Minivan
NHTSA No.: O20215108

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: March 3, 2021

Final Report Date: June 10, 2021

FINAL REPORT

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

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Approval Date: June 10, 2021

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: _____

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Final Report of New Car Assessment Program Frontal Impact Testing and FMVSS No. 305 Indicant Testing of a 2021 Toyota Sienna Hybrid XLE AWD Minivan, NHTSA No.: O20215108	June 10, 2021
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	11. Contract or Grant No. 693JJ919D000006
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards (NRM-110) 1200 New Jersey Ave, SE, Room W43-410 Washington, D.C. 20590	**13. Type of Report and Period Covered** Final Test Report March 3, 2021 to June 10, 2021
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15. Supplementary Notes

16. Abstract

A 56.3 km/h NCAP Frontal Rigid Barrier Impact Test was conducted on a 2021 Toyota Sienna Hybrid XLE AWD Minivan in accordance with the specifications of the Office of Crashworthiness Standards Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on March 3, 2021.

The impact velocity of the vehicle was 56.29 km/h and the ambient temperature at the barrier face at the time of impact was 21.9°C. The target vehicle post-test maximum crush was 496 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})		700	215	700	175
Maximum Chest Compression	mm	63	27	52	16
Nij		1	0.61	1	0.48
Neck Tension	N	4170	1730	2620	891
Neck Compression	N	4000	587	2520	189
Left Femur Force	N	10008	1438	6805	1994
Right Femur Force	N	10008	1436	6805	977

17. Key Words	18. Distribution Statement
56.3 km/h (35 mph) Full Frontal Rigid Barrier Impact Test New Car Assessment Program (NCAP)	Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division 1200 New Jersey Ave, SE Washington, DC 20590

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Unclassified	Unclassified	209	

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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 693JJ919D000006. 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 Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing.

SUMMARY

A load cell barrier consisting of 176 load cells was impacted by a 2021 Toyota Sienna Hybrid XLE AWD Minivan at a velocity of 56.29 km/h. The test was performed at MGA Research Corporation on March 3, 2021. Pre-test and post-test photographs of the vehicle and dummies can be found in Appendix A.

Two (2) real-time cameras and sixteen (16) 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 Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing.

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. Seat belt load cells were installed on the driver's and passenger's lap and shoulder belts to measure dummy torso and pelvic section loading.

The driver (position 1) ATD (Serial No. 351) and the right-front passenger (position 2) ATD (Serial No. 138) were qualified previous to this test. Certification details, along with instrumentation calibration data, are found in Appendix C of this report.

The 630 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 or battery electrolyte leakage and no loss of high-voltage battery isolation after the event or during any phase of the static rollover.

The maximum static crush of the vehicle was 496 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 restraint and knee bolster.
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 glove box.

The occupant data is summarized below:

ATD position	HIC_{15}	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (g)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50^{th})	215	0.61	1730	587	45.8	27	1438	1436
Passenger (5^{th})	175	0.48	891	189	42.7	16	1994	977

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

TEST NOTES

Driver Shoulder Belt load cell was not installed.
Driver Lap Belt load cell was not installed.
Passenger Shoulder Belt load cell was not installed.
Passenger Lap Belt load cell was not installed.
Barrier C-01 Fx recorded no valid data.
Barrier C-02 Fx recorded no valid data.
Barrier C-02 My recorded no valid data.
Barrier F-01 Mz recorded noise spikes throughout data.
Barrier I-05 My recorded no valid data.
Barrier J-04 My recorded questionable data.
Barrier K-03 Fx recorded questionable data.
Barrier K-15 My recorded no valid data.

Test vehicle placards indicate that the vehicle tested was a 2021 Toyota Sienna, however, the actual test vehicle was a 2021 Toyota Sienna Hybrid.

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	O20215108	Traction Control System (TCS)	Yes
Model Year	2021	Power Steering	Yes
Make	Toyota	Power Window Auto-Reverse	Yes
Model	Sienna Hybrid XLE AWD	Driver Frontal Airbag	Yes
Body Style	Minivan	Driver Curtain Airbag	Yes
VIN	5TDYSKFC1MS002613	Driver Head/Torso Airbag	No
Body Color	Predawn Gray Mica	Driver Torso Airbag	No
Odometer (km/mi)	16 km / 10 mi	Driver Torso/Pelvis Airbag	Yes
Engine Displacement (L)	2.5 L	Driver Pelvis Airbag	No
Type/No. Cylinders	Inline 4	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	Yes	Front Pass. Knee Airbag	No
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	Front Pass. Seat Pan Airbag	Yes

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

DATA FROM CERTIFICATION LABEL

Manufactured By	TOYOTA MOTOR MANUFACTURING, INDIANA, INC.
Date of Manufacture	11/20

GVWR (kg)	2800
GAWR Front (kg)	1590
GAWR Rear (kg)	1590

VEHICLE SEATING AND WEIGHT CAPACITY DATA

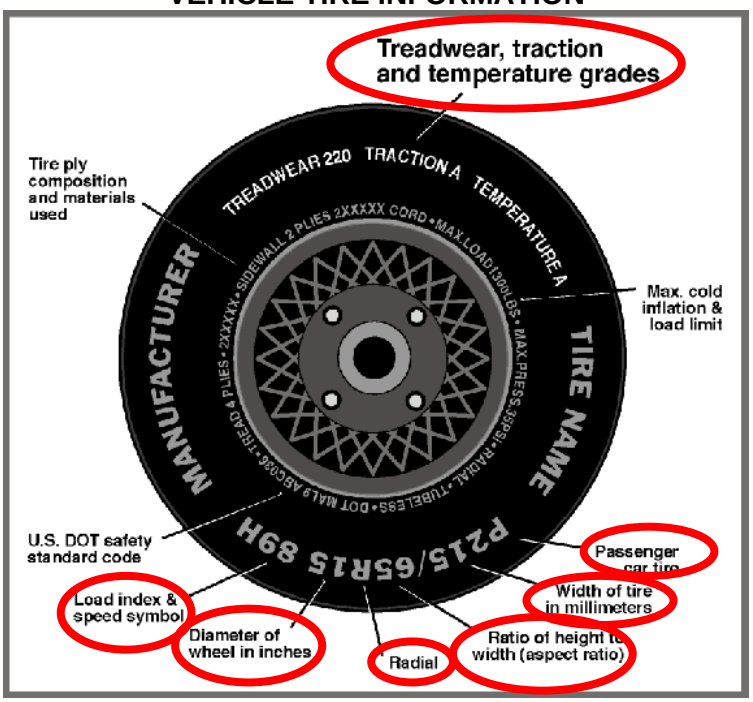
Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bucket	Split Bench	
Designated Seating Capacity (DSC)	2	2	3	7
Capacity Weight (VCW) (kg)				560
Cargo Weight (RCLW) (kg)				78

* Rated Cargo and Luggage Weight (RCLW) reduced by 6 kg to account for Load Carrying Capacity Reduction Label.

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	240	240
Recommended Tire Size	235/65R17	235/65R17
Tire Size on Vehicle	235/65R17	235/65R17
Tire Manufacturer	Falken	Falken
Tire Model	ZIEX ZE001 A/S	ZIEX ZE001 A/S
Treadwear	380	380
Traction	B	B
Temperature Grade	B	B
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	2 Polyester, 2 Steel, 1 Polyamide	2 Polyester, 2 Steel, 1 Polyamide
Load Index/Speed Symbol	103T	103T
Tire Material	Rubber	Rubber
DOT Safety Code Left	1DA38 3M2R 2020	1DA38 3M2R 2020
DOT Safety Code Right	1DA38 3M2R 2020	1DA38 3M2R 2020

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	581.5	496.5		626.5	570.0	
Right	kg	567.0	494.0		592.5	562.5	
Ratio	%	53.7%	46.3%		51.8%	48.2%	
Totals	kg	1148.5	990.5	2139.0	1219.0	1132.5	2351.5

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	2139.0
Weight of 1 P572E ATD & 1 P572O ATD	kg	141
Rated Cargo/Luggage Weight (RCLW)	kg	78
Calculated Test Vehicle Target Weight (TVTW)	kg	2358.0

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	789	791	799	799	1422
As Tested	mm	781	785	776	787	1479
Post Test	mm	811	844	764	795	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	3070
Total Vehicle Length at Left Side	mm	4994
Total Vehicle Length at Centerline	mm	5174
Total Vehicle Length at Right Side	mm	4994
Weight of Ballast in Cargo Area	kg	16
Weight of Vehicle Components Removed	kg	14
Amount of Stoddard Solvent in Fuel Tank	L	62.8

List of components removed to meet test weight: None.

List of components removed for instrumentation, data box, and equipment installation: Cargo area carpet/trim/divider, RR taillight, underbody plastic.

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

TARGET VEHICLE STRUCTURAL MEASUREMENT

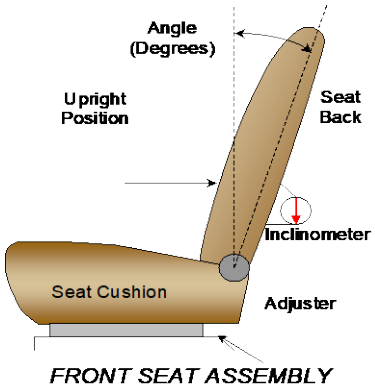
	Elements	Pre-Test (mm)
1	Total Length	5174
2	Total Width	1989
3	Bumper Top Height	598
4	Bumper Bottom Height	439
5	Longitudinal Member Top Height	565
6	Distance between Longitudinal Members	976
7	Longitudinal Member Width	130
8	Engine Top Height	856
9	Engine Bottom Height	195
10	Engine and Gearbox Width	839
11	Front Bumper-Engine Distance	570
12	Front Shock Absorber Fixing Height	920
13	Bonnet Leading Edge Height	911
14	Front Shock Absorber Fixing Width	1394
15	Front Bumper – Front Axle Distance	940
16	Front Axle – A-Pillar Distance	480
17	A-Pillar – B-Pillar Distance	1073
18	B-Pillar – Rear Axle Distance	1513
19	B-Pillar – C-Pillar Distance	967
20	Roof Sill Bottom Height	1520
21	Roof Sill Top Height	1630
22	Floor Sill Bottom Height	214
23	Floor Sill Top Height	433

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

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 May 2018.



	Degrees
Driver Seat Back Angle	1.1° on outboard headrest post
Passenger Seat Back Angle	3.0° on outboard headrest post

SEAT FORE/AFT POSITIONS

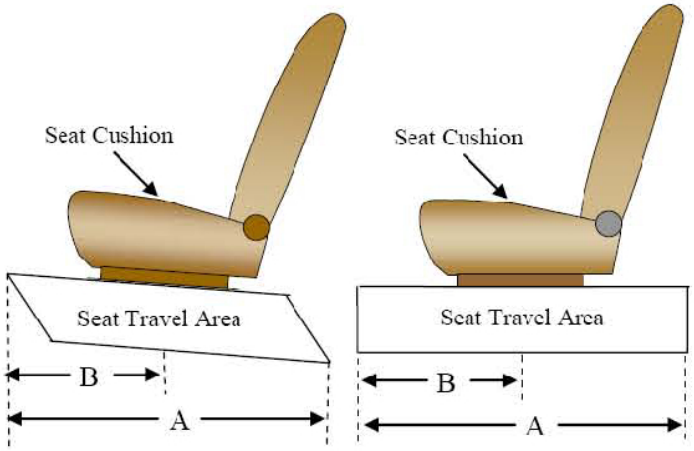
The driver and passenger seat fore/aft positions are adjusted following Appendix F, "Driver & Passenger Dummy Seating & Positioning Procedures" in the NCAP Test Procedure dated May 2018.

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	284 mm	142 mm
Passenger Seat	240 mm	0 mm

SEAT BELT UPPER ANCHORAGES

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

	Total # of Positions	Placed in Position #
Driver Seat	4 (1st as 1)	0 (1st as 0)
Passenger Seat	4 (1st as 1)	0 (1st as 0)



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

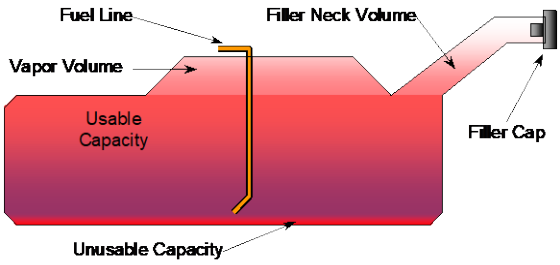
Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	67.4
Usable Capacity of "Optional Tank"	
92-94% of Usable Capacity	62.0 to 63.4
Actual Amount of Solvent used	62.8
1/3 of Usable Capacity	22.5

FUEL PUMP

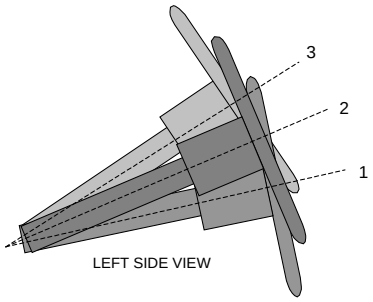
The vehicle is equipped with an electronic fuel pump. The filler neck is located on the driver's side.



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.



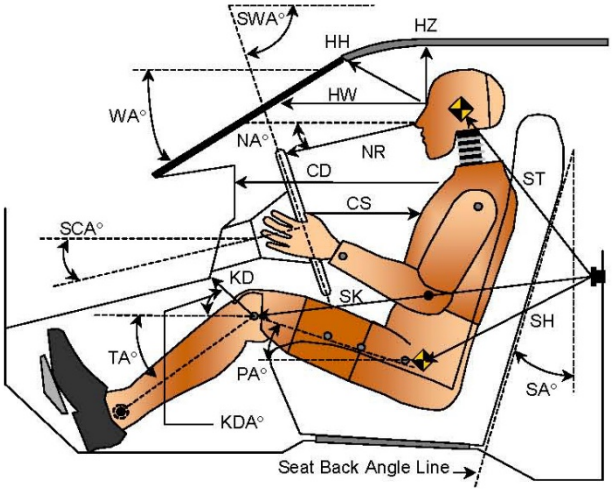
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost Position 1	66.0	
Geometric Center Position 2	63.7	
Uppermost Position 3	61.4	
Telescoping Steering Wheel Travel		50
Test Position	63.7	25

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

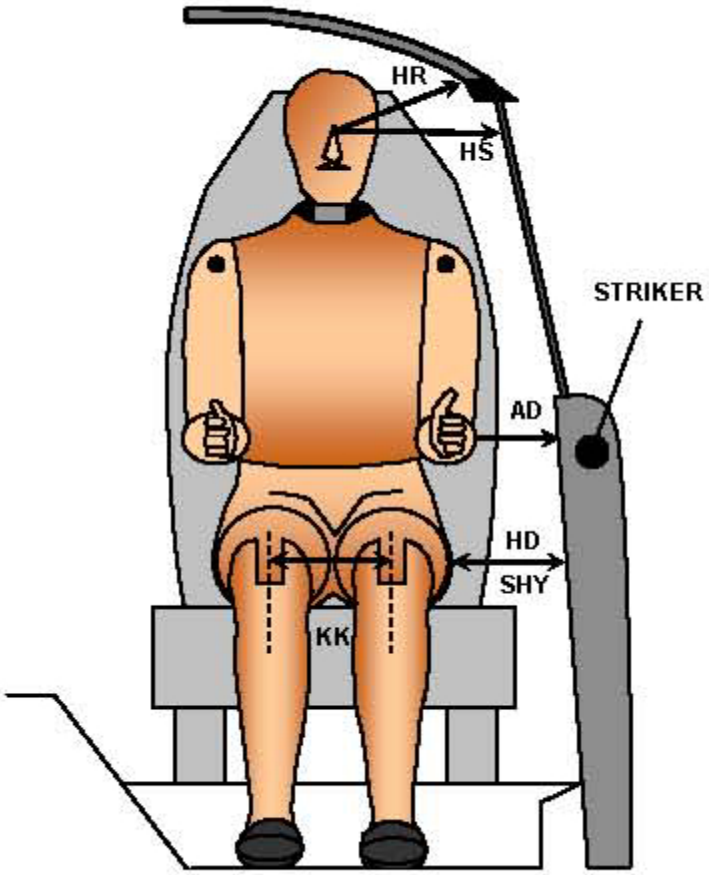


LEFT SIDE VIEW

Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		22.3		
SWA°	Steering Wheel Angle		63.7		
SCA°	Steering Column Angle		26.3		
SA°	Seat Back Angle		1.1		3.0
HZ	Head to Roof (Z)	182	90	247	90
HH	Head to Header	395	25.2	358	42.1
HW	Head to Windshield	718	0	778	0
NR	Nose to Rim	400	5.6		
CD	Chest to Dash	521		454	
CS	Chest to Steering Hub	308	5.8		
RA	Rim to Abdomen	190	0		
KDL	Left Knee to Dash	167	20.9	84	24.6
KDR	Right Knee to Dash	172	46.5	94	25.1
PA°	Pelvic Angle		23.8		21.2
TA°	Tibia Angle		52.7		56.0
SK	Striker to Knee	624	100.1	645	100.4
ST	Striker to Head	480	16.9	424	32.7
SH	Striker to H-Point	282	134.3	387	114.5

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

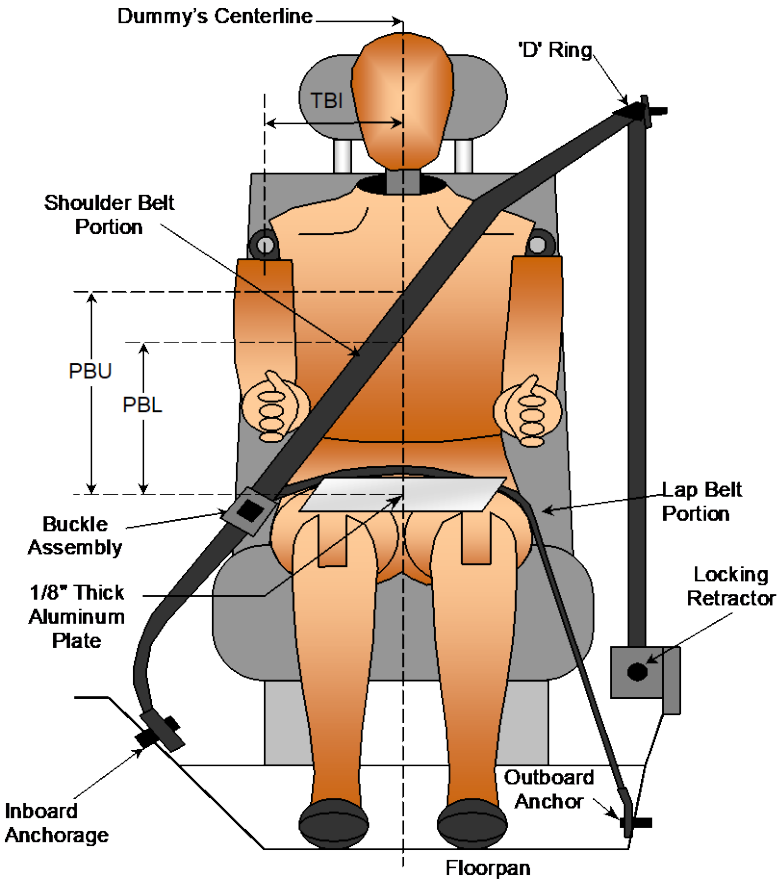


FRONT VIEW OF DUMMY

Code	Measurement Description	Driver	Passenger
		Length (mm)	
AD	Arm to Door	148	104
HD	H-Point to Door	143	180
HR	Head to Side Header	214	263
HS	Head to Side Window	359	375
KK	Knee to Knee	332	228
SHY	Striker to H-Point (Y Direction)	314	339
AA	Ankle to Ankle	306	169

DATA SHEET NO. 5
SEAT BELT POSITIONING DATA

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	365	345
PBL - Top surface of reference to belt lower edge	mm	275	250

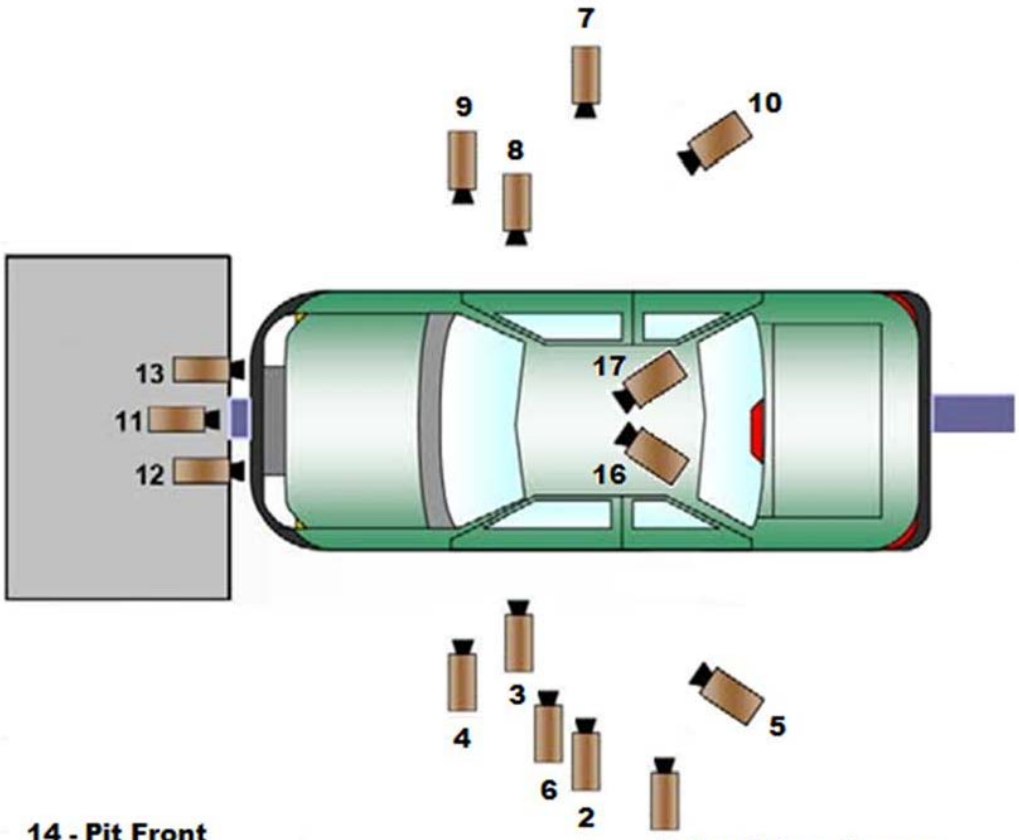
BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	870	880
Lap Belt Length as measured on ATD	mm	750	850
Remainder of belt on reel	mm	680	570
Total Belt Length for Continuous Webbing Systems	mm	3000	3000

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

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021

CAMERA POSITIONS FOR FRONTAL IMPACTS



14 - Pit Front
15 - Pit Rear
16 & 17 - Driver and Passenger Onboard

***Camera locations are approximate and not to scale*

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

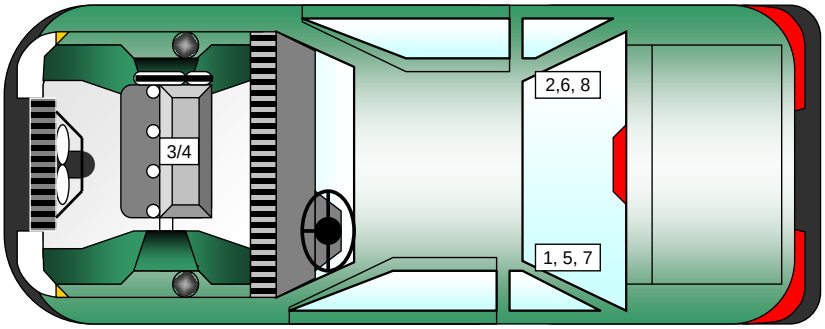
CAMERA LOCATIONS

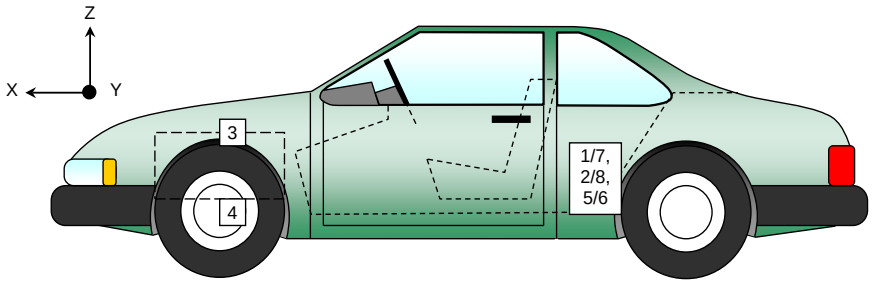
No.	Camera View	Coordinates* (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Overall					30
2	Left Overall	-2410	-6390	-1250	12	1000
3	Driver Close-Up	-1490	-6710	-1770	50	1000
4	Left Front Half	-1220	-7490	-1360	24	1000
5	Left Angle	-7370	-5820	-1840	75	1000
6	Steering Column	-900	-5630	-1260	50	1000
7	Right Overall	-2420	6090	-1310	12	1000
8	Passenger Close-Up	-1570	6860	-1710	50	1000
9	Right Front Half	-990	5820	-1280	24	1000
10	Right Angle	-7490	5510	-1800	75	1000
11	Windshield	130	0	-2310	12	1000
12	Driver Windshield	180	-370	-2230	25	1000
13	Passenger Windshield	180	370	-2230	25	1000
14	Pit Front	-930	0	3340	24	1000
15	Pit Rear	-3090	0	3340	24	1000
16	Driver Onboard				12	1000
17	Passenger Onboard				12	1000
18	Real-Time Pan View					30

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

DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

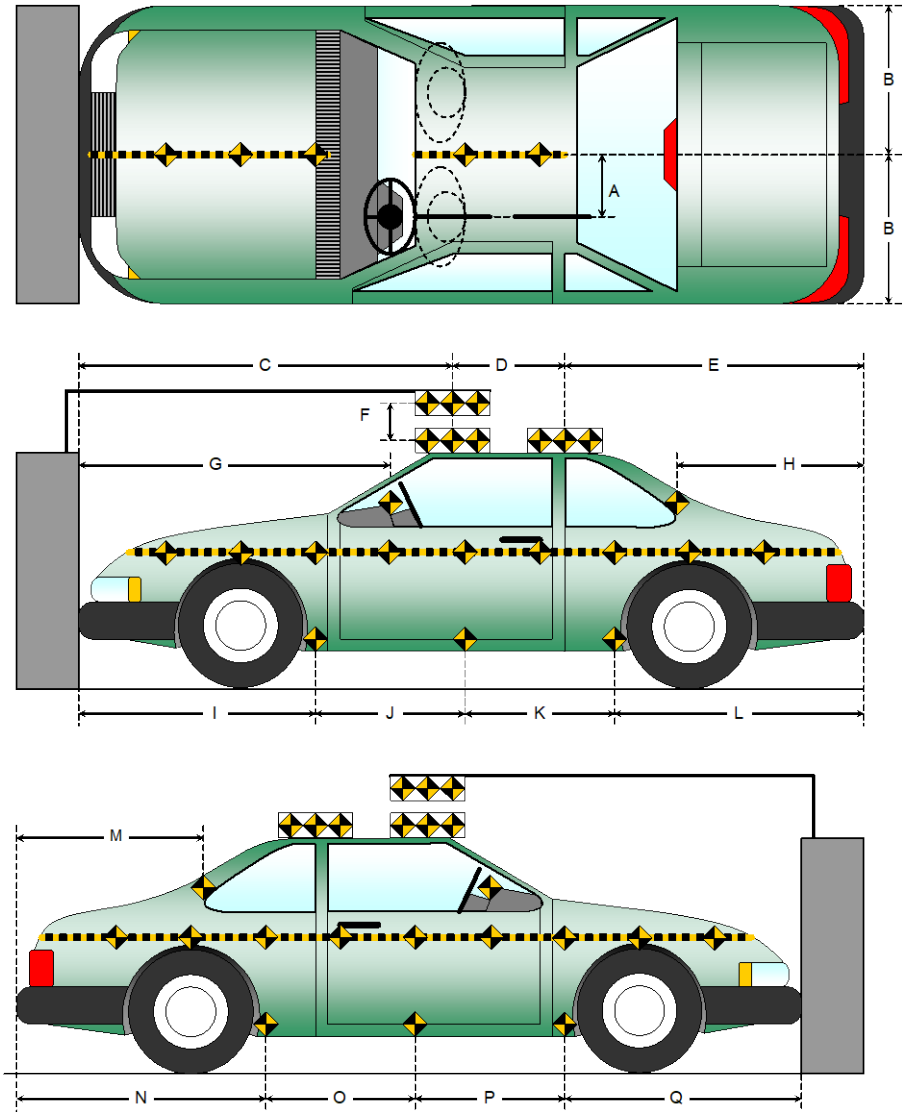
No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Crossmember Accelerometer – X Direction	1922	-405	-443
2	Right Rear Crossmember Accelerometer – X Direction	1922	420	-450
3	Engine Top X	4382	80	-856
4	Engine Bottom X	4505	158	-195
5	Left Rear Crossmember Accelerometer – Z Direction	1922	-405	-443
6	Right Rear Crossmember Accelerometer – Z Direction	1922	420	-450
7	Left Rear Crossmember Accelerometer Redundant – X Direction	1922	-370	-443
8	Right Rear Crossmember Accelerometer Redundant – X Direction	1922	380	-450

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: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

Item	Value (mm)
A	420
B	995
C	2270
D	610
E	2294
F	100
G	
H	1482
I	1428
J	1023
K	1023
L	1700
M	1482
N	1700
O	1023
P	1023
Q	1428



DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

ADVANCED RESEARCH LOAD CELL BARRIER

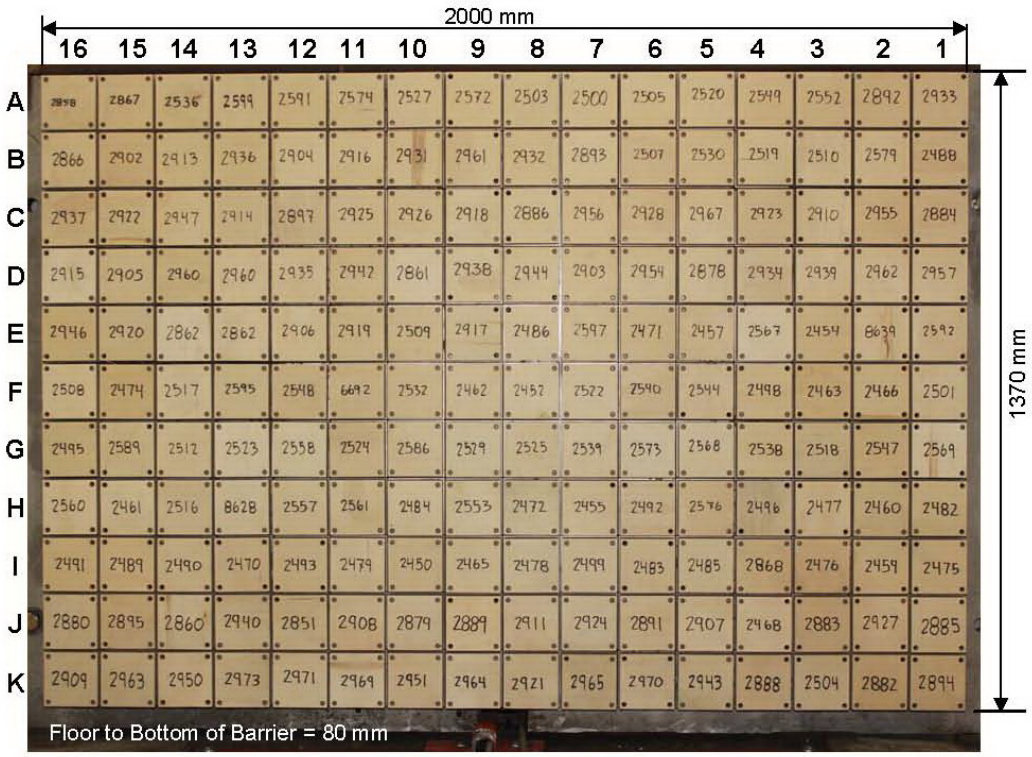


Photo for Reference Only

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: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

INSTRUMENTATION

Instrumentation	Number of Channels Collected
Driver Dummy Data Channels	47
Passenger Dummy Data Channels	47
Vehicle Structure Accelerometers	8
Barrier Channels	528
Total	630

CAMERA COVERAGE

Type of Camera	Number Used in this Test
High-Speed Vehicle Onboard	2
High-Speed Offboard	14
Real-Time	2
Total	18

DATA SHEET NO. 11
POST-TEST OBSERVATIONS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Passenger
Dummy Type / Serial No.	HIII 50% / 351	HIII 5% / 138
Head Contact	Frontal Airbag, Headrest	Frontal Airbag, Headrest
Upper Torso Contact	Frontal Airbag	Frontal Airbag
Lower Torso Contact	None	None
Left Knee Contact	Knee Airbag, Knee Bolster	Glove Box
Right Knee Contact	Knee Bolster	Glove Box

DOOR OPENING, TRUNK OPENING, AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Locked/Unlocked Doors	Doors were unlocked	Doors were unlocked
Front Door Opening	Remained closed and unlocked; opened without tools	Remained closed and unlocked; opened without tools
Rear Door Opening	Remained closed and unlocked; opened without tools	Remained closed and unlocked; opened without tools
Trunk/Hatch/Tailgate Opening	Remained closed; opened without tools	
Seat Track Shift (mm)	0	0
Seat Back Movement	None	None

OTHER VEHICLE POST-TEST OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	Cracked at lower corners
Window Damage	None
Other Notable Effects	Hood unlatched during event.

VEHICLE REBOUND FROM BARRIER

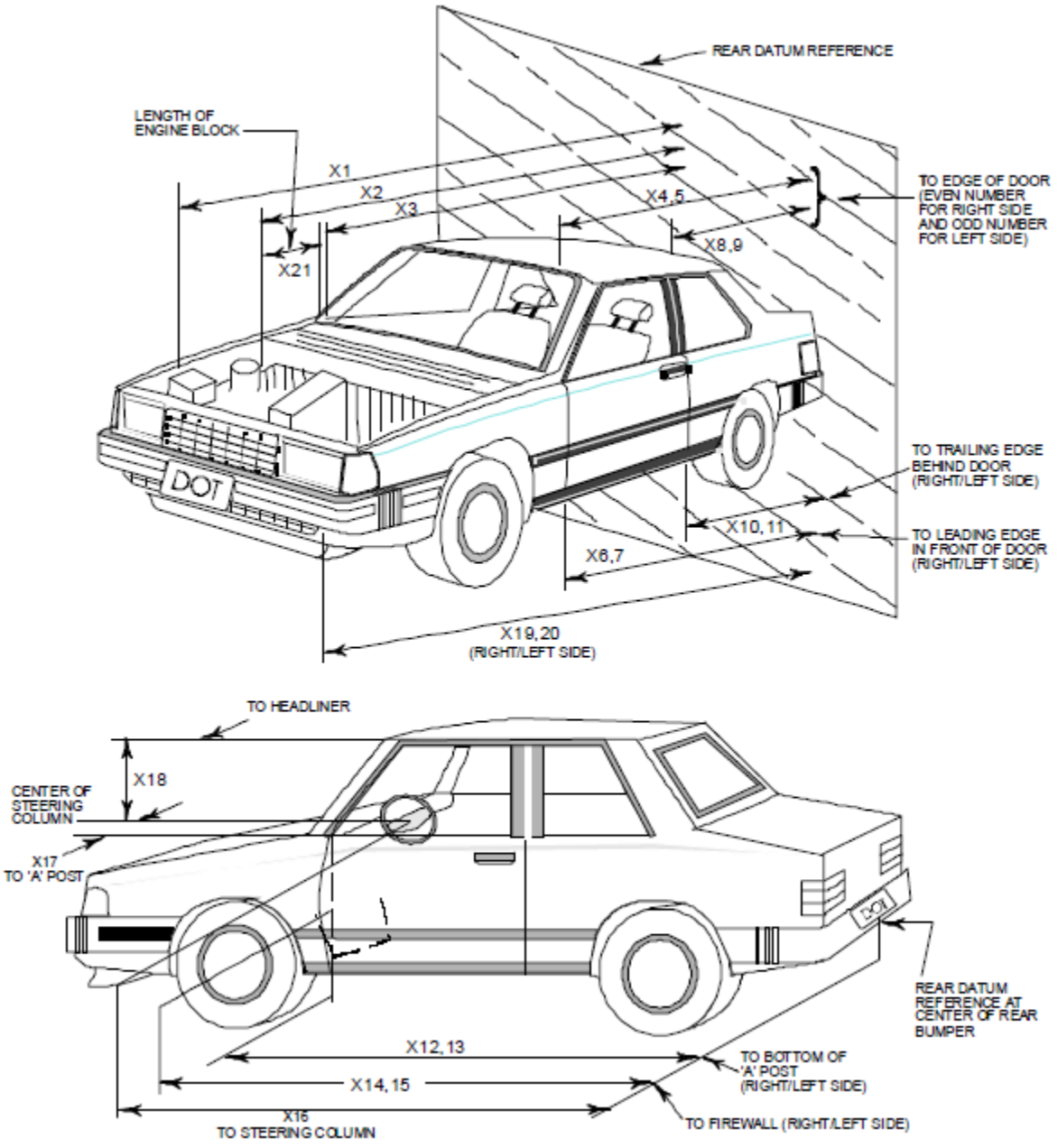
Measured Parameter	Units	Value
Left Side	mm	1620
Center	mm	1635
Right Side	mm	1640
Average	mm	1632

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Driver		Passenger	
	Mounted	Deployed	Mounted	Deployed
Frontal Airbag	Yes	Yes	Yes	Yes
Curtain Side Airbag	Yes	Yes	Yes	Yes
Torso/Pelvis Side Airbag	Yes	No	Yes	No
Knee Airbag	Yes	Yes	No	
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes		Yes	
Seat Pan Airbag	No		Yes	Yes

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021



DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

No.	Measurement Description	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	5174	4683	491
2	RSOV to Front of Engine	4439	4193	246
3	RSOV to Firewall	4243	4247	-4
4	RSOV to Upper Leading Edge of Right Door	3678	3677	1
5	RSOV to Upper Leading Edge of Left Door	3699	3698	1
6	RSOV to Lower Leading Edge of Right Door	3626	3627	-1
7	RSOV to Lower Leading Edge of Left Door	3636	3634	2
8	RSOV to Upper Trailing Edge of Right Door	2639	2640	-1
9	RSOV to Upper Trailing Edge of Left Door	2631	2629	2
10	RSOV to Lower Trailing Edge of Right Door	2665	2665	0
11	RSOV to Lower Trailing Edge of Left Door	2663	2665	-2
12	RSOV to Bottom of “A” Post of Right Side	3582	3579	3
13	RSOV to Bottom of “A” Post of Left Side	3569	3569	0
14	RSOV to Firewall, Right Side	4161	4143	18
15	RSOV to Firewall, Left Side	4182	4132	50
16	RSOV to Steering Column	3210	3328	-118
17	Center of Steering Column to “A” Post	400	367	33
18	Center of Steering Column to Headliner	442	462	-20
19	RSOV to Right Side of Front Bumper	4994	4593	401
20	RSOV to Left Side of Front Bumper	4994	4610	384
21	Length of Engine Block	509	509	0
RD	RSOV to Right Side of Dash Panel	3586	3586	0
CD	RSOV to Center of Dash Panel	3589	3589	0
LD	RSOV to Left Side of Dash Panel	3598	3598	0

All Dimensions in mm

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

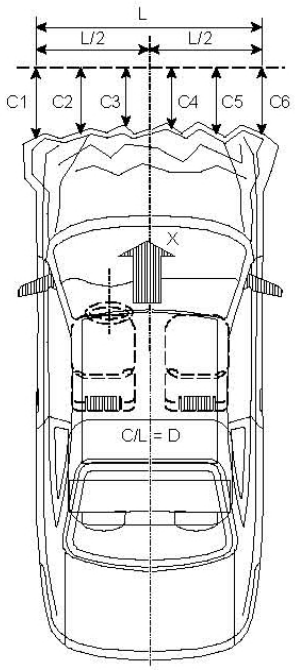
Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

VEHICLE INFORMATION

VIN: 5TDYSKFC1MS002613
Vehicle Size Category: MPV
Wheelbase (mm): 3070
Test Weight (kg): 2351.5

ACCELEROMETER DATA

Accelerometer Locations: As per Data Sheet No. 7
Cal. Procedure/Interval: MGA Procedure / 6 month
Integration Algorithm: Trapezoidal
Linearity: > 99%
Impact Velocity (km/h): 56.29
Velocity Change (km/h): 65.4
Time of Separation (msec) 98



CRUSH PROFILE

Collision Deformation Classification: 12FDEW3
Midpoint of Damage: Centerline
Damage Region Length (mm): 1632
Impact Mode: Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	4994	4610	384
C2	Crush zone 2 at left side	mm	5118	4665	453
C3	Crush zone 3 at left side	mm	5150	4658	492
C4	Crush zone 4 at right side	mm	5150	4654	496
C5	Crush zone 5 at right side	mm	5118	4642	476
C6	Crush zone 6 at right side	mm	4994	4593	401
L	C1 TO C6	mm	1632	1663	-31

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

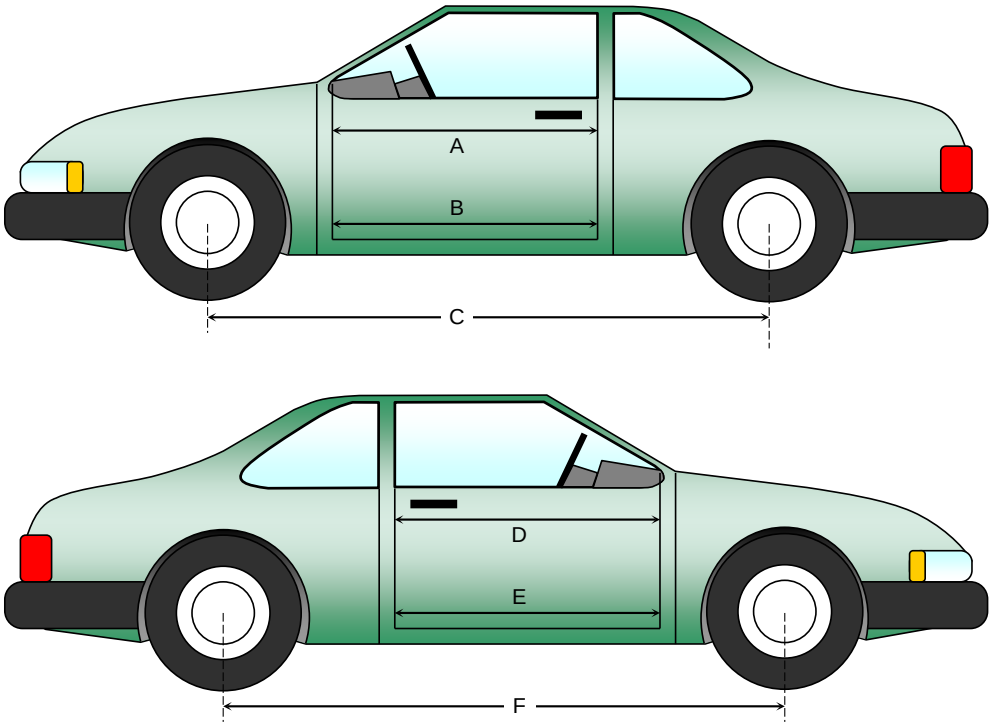
Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	990	990	0
B	Left Side Lower	mm	828	828	0
D	Right Side Upper	mm	990	990	0
E	Right Side Lower	mm	829	829	0

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	3070	2999	71
F	Right Side Wheelbase	mm	3070	3047	23



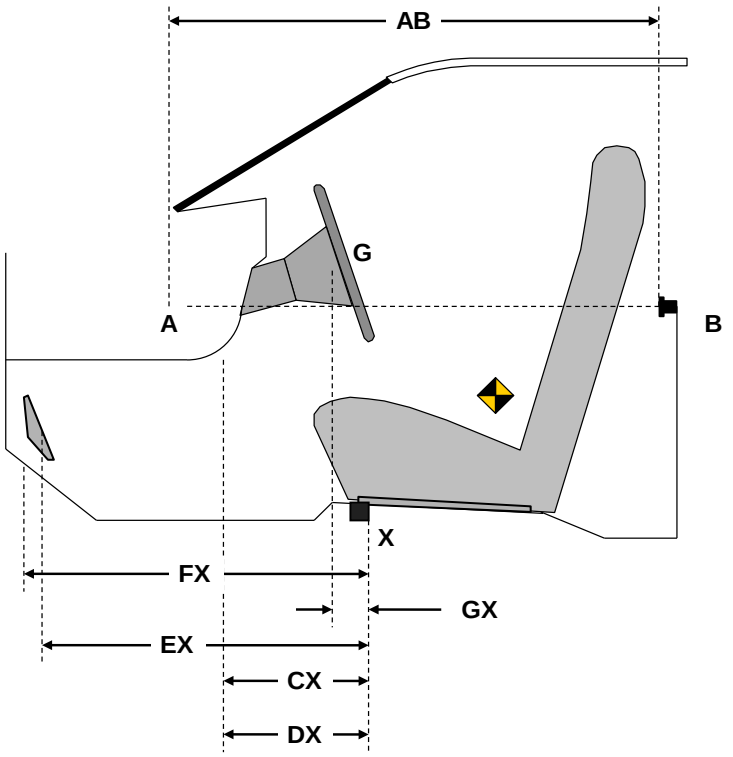
DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
Test Program: NCAP Frontal Barrier Impact Test
NHTSA No.: O20215108
Test Date: 3/3/2021

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	717	717	0
CX	Left Knee Bolster to X	mm	309	308	1
DX	Right Knee Bolster to X	mm	310	305	5
EX	Brake Pedal to X	mm	526	515	11
FX	Foot Rest to X	mm	534	513	21
GX	Center of Steering Column Wheel Hub to X	mm	68	100	-32

X = Front of Seat Track (stationary)



DRIVER COMPARTMENT

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

WINDSHIELD MOUNTING DETAILS

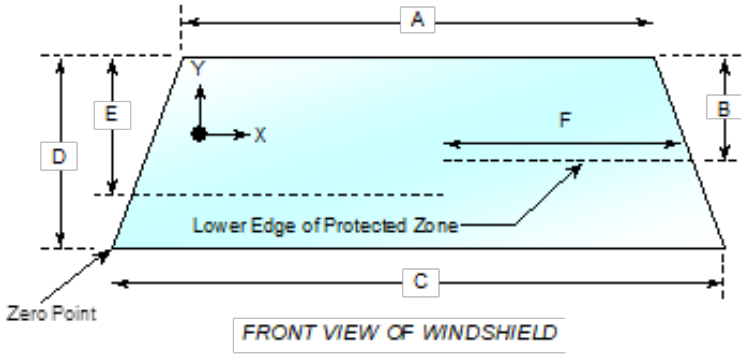
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

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: 21.9°C.

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2413	2413	100
Right Side	2354	2354	100
Total	4767	4767	100



FRONT VIEW OF WINDSHIELD

Item	Units	Value
A	mm	1288
B	mm	536
C	mm	1621
D	mm	927
E	mm	571
F	mm	603

AREA OF PROTECTED ZONE FAILURES

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. 16
FMVSS 301 BARRIER IMPACT AND STATIC ROLLOVER

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Temperature at Time of Impact: 21.9°C Test Time: 11:35 a.m.

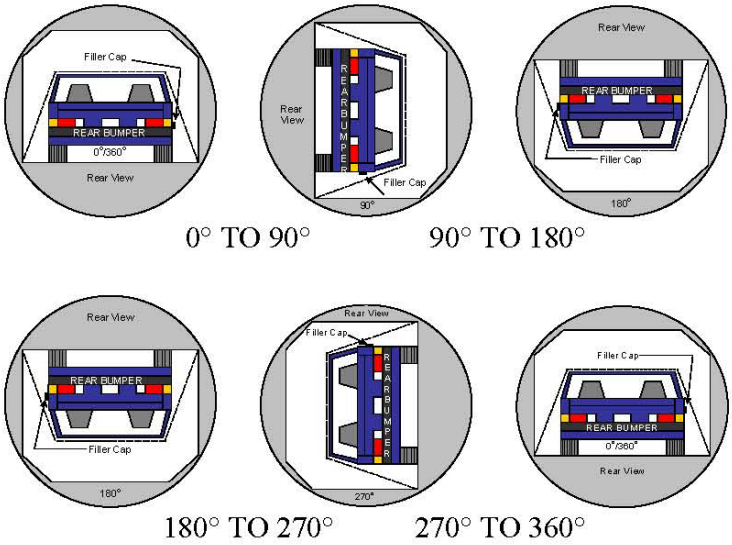
A. From impact until vehicle motion ceases: (Maximum Allowable = 1 ounce) 0.0 oz.

B. For the 5 minute period after motion ceases: (Maximum Allowable = 5 ounces) 0.0 oz.

C. For the following 25 minutes: (Maximum Allowable = 1 ounce / minute) None

D. Spillage Details: None

FMVSS 301 STATIC ROLLOVER RESULTS



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°	111	300	411
90° to 180°	111	300	411
180° to 270°	107	300	407
270° to 360°	111	300	411

DATA SHEET NO. 16 (CONTINUED)
FMVSS 301 BARRIER IMPACT AND STATIC ROLLOVER

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

FMVSS 301 SPILLAGE TABLE (UNITS IN OUNCES)

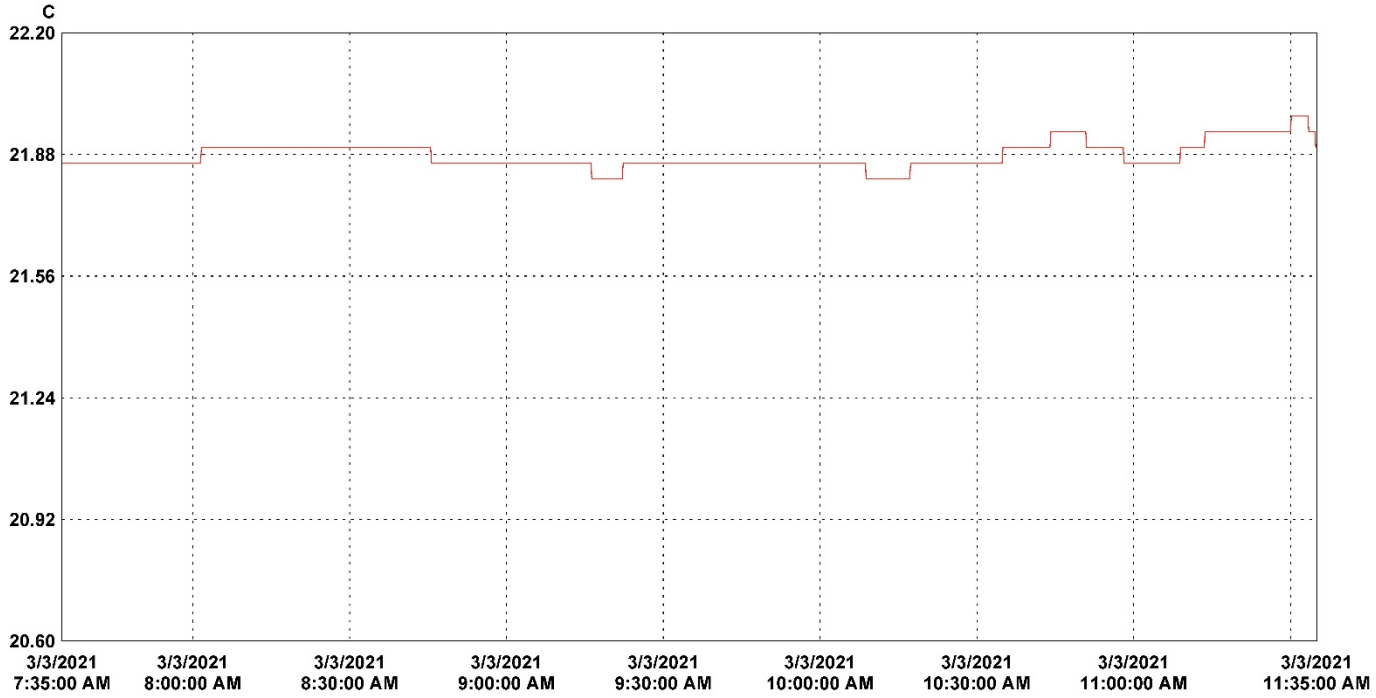
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eight Minute
0° to 90°	0	0	0	
90° to 180°	0	0	0	
180° to 270°	0	0	0	
270° to 360°	0	0	0	

SOLVENT SPILLAGE LOCATION TABLE

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

DATA SHEET NO. 17
DUMMY/VEHICLE TEMPERATURE STABILIZATION DATA

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan
NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test
Test Date: 3/3/2021



LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	18352041	VSC_Prep_Room	1		21.98	21.88	21.82	C	Temperature	18352041_VSC_Prep_Room.spl

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

ELECTRIC VEHICLE PROPULSION SYSTEM

	Units	Observations and Conclusions
Type of Electric Vehicle		Gas-Electric Hybrid
Propulsion Battery Type		Ni-MH
Nominal Voltage	V	288
Physical Location of Automatic Propulsion Battery Disconnect		Physically located within the Hybrid Battery system
Auxiliary Battery Type		Lead-Acid

PROPULSION BATTERY SYSTEM DATA

	Units		Observations and Conclusions
Electrolyte Fluid Type			KOH (Potassium Hydroxide)
Electrolyte Fluid Specific Gravity	g/L		1.3
Electrolyte Fluid Kinematic Viscosity	cSt		2.3
Electrolyte Fluid Color			Clear
Propulsion Battery Coolant Type, Color, Specific Gravity (if applicable)			Air-Cooled
Location of Battery Modules		X	Inside Passenger Compartment
			Outside Passenger Compartment
			The high-voltage battery is located below the driver and front passenger seats.

PROPULSION BATTERY STATE OF CHARGE

For all battery types:	
Voltage range corresponding to **useable energy** of the battery:	
Minimum State of Charge	
Maximum State of Charge	
95% of Maximum State of Charge	
Test Voltage - No less than 95% of maximum State of Charge	
For batteries that are rechargeable ONLY by an energy source on the vehicle:	
Voltage range corresponding to **useable energy** of the battery:	
Minimum State of Charge	240 V
Maximum State of Charge	330 V
Test Voltage – Maximum practicable State of Charge within Normal Operating Range	321.5 V

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

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021

VEHICLE CHASSIS GROUND POINT(S) LOCATION(S)

Details of Vehicle Chassis Ground Point(s) & Location(s)	Chassis grounding bolt near high-voltage battery pack

PROPULSION BATTERY SYSTEM

Details of Electric Energy Storage/Conversion System Test Points	Connected at + and – terminal ends of propulsion system
Additional Comments	None

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

VOLTMETER INFORMATION

	Units	Observations and Conclusions
Make		Fluke
Model		289
Serial Number		32910090
Internal Impedance Value	MΩ	> 10 MΩ < 100 pF
Resolution	V	0.001
Last Calibration Date		11/19/2020

PROPULSION BATTERY VOLTAGE

Measurement shall be made with Energy Storage/Conversion System connected to the vehicle propulsion system, and the vehicle in the "ready-to-drive" (propulsion system energized) position.

NOTE: If voltage measurement is not at the voltage or within the normal operating voltage range specified by the manufacturer, the battery must be charged.

Vb	V	321.5

ELECTRIC ISOLATION MEASUREMENTS
PROPULSION BATTERY TO VEHICLE CHASSIS

Vehicle chassis point(s) determined and supplied to contractor by COTR.

V1	V	151.3
V2	V	159.8

PROPULSION BATTERY TO VEHICLE CHASSIS ACROSS RESISTOR

The known resistance Ro (in ohms) should be approximately 500 times the normal operating voltage of the vehicle (in volts) per SAE J1766.

Ro	Ω	158,200

V1' Pre-Impact	V	27.4
V2' Pre-Impact	V	25.8

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

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021

ELECTRICAL ISOLATION CALCULATIONS

NOTE: If measured voltage is zero and results in a division by zero, record “Zero Volts”.
This “zero voltage” condition is considered as being compliant.

Ri1 = Ro (1 + V2/V1) [(V1-V1’)/V1’]		
Ri1 Pre-Impact	Ω	1,470,917
Ri2 = Ro (1 + V1/V2) [(V2-V2’)/V2’]		
Ri2 Pre-Impact	Ω	1,599,613
Ri = The lesser of Ri1 and Ri2		
Ri Pre-Impact	Ω	1,470,917
Ri / Vb = Electrical Isolation Value / Nominal Battery Voltage		
Ri / Vb Pre-Impact	Ω	4,575

NOTE: The minimum Electrical Isolation Value is 500 Ω/V.

	Yes	No (Fail)
Is the measured Electrical Isolation Value ≥ 500 Ω/V?	X	
Additional Comments	None	

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

VOLTMETER INFORMATION

	Units	Observations and Conclusions
Make		Fluke
Model		289
Serial Number		32910090
Internal Impedance Value	MΩ	> 10 MΩ < 100 pF
Resolution	V	0.001
Last Calibration Date		11/19/2020

ELECTRICAL ISOLATION MEASUREMENTS

Vb Post-Impact	V	0.4

V1 Post-Impact	V	2.4	Impact Time	1	Minutes	10	Seconds
V2 Post-Impact	V	2.8		1	Minutes	14	Seconds
V1' Post-Impact	V	0.2		1	Minutes	21	Seconds
V2' Post-Impact	V	0.2		1	Minutes	17	Seconds

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

Test Vehicle:	2021 Toyota Sienna Hybrid XLE AWD Minivan	NHTSA No.:	O20215108
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/3/2021

ELECTRICAL ISOLATION CALCULATIONS

NOTE: If measured voltage is zero and results in a division by zero, record "Zero Volts". This "zero voltage" condition is considered as being compliant.

Ri1 = Ro (1 + V2/V1) [(V1-V1')/V1']							
Ri1 Post-Impact	Ω	3,770,433	Impact Time	1	Minutes	17	Seconds
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']							
Ri2 Post-Impact	Ω	3,819,400	Impact Time	1	Minutes	21	Seconds
Ri = The lesser of Ri1 and Ri2							
Ri Post-Impact	Ω	3,770,433	Impact Time	1	Minutes	17	Seconds
Ri / Vb = Electrical Isolation Value / Nominal Battery Voltage							
Ri / Vb Post-Impact	Ω	9,426,083	Impact Time	1	Minutes	0	Seconds

NOTE: The minimum Electrical Isolation Value is 500 Ω/V.

	Yes	No (Fail)
Is the measured Electrical Isolation Value ≥ 500 Ω/V?	X	
Additional Comments	None	

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

PROPULSION BATTERY SYSTEM COMPONENTS

Describe any Propulsion Battery Module movement within the passenger compartment [Supply photographs as appropriate]:
Not Applicable

	Yes (Fail)	No
Has the Propulsion Battery Module moved within the passenger compartment?		X

Describe intrusion of an outside Propulsion Battery Component into the passenger compartment [Supply photographs as appropriate]:
No Intrusion

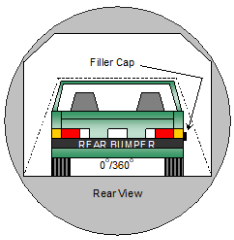
	Yes (Fail)	No
Has an outside Propulsion Battery Component intruded into the passenger compartment?		X

	Yes (Fail)	No
Is the Propulsion Battery Electrolyte Spillage visible in the passenger compartment?		X

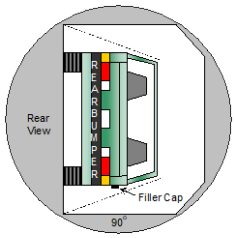
DATA SHEET NO. 305-5
STATIC ROLLOVER TEST DATA
FOR INDICANT FMVSS NO. 305 TESTING

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

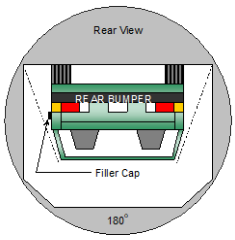
PROPULSION BATTERY SYSTEM COMPONENTS



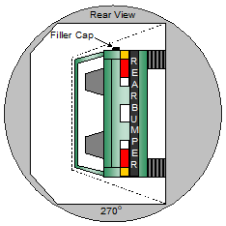
0°/360°



90°



180°



270°

PROPULSION BATTERY ELECTROLYTE COLLECTION TIME PERIOD

Test Phase	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	1	min	51	sec	5	min	6	min	51	sec	7	min
90° - 180°	1	min	51	sec	5	min	6	min	51	sec	7	min
180° - 270°	1	min	47	sec	5	min	6	min	47	sec	7	min
270° - 360°	1	min	51	sec	5	min	6	min	51	sec	7	min

TEST VEHICLE PROPULSION BATTERY ELECTROLYTE SPILLAGE

NOTE: The maximum allowable Propulsion Battery Electrolyte Spillage is 5.0 Liters.

Test Phase	Propulsion Battery Electrolyte Spillage (L)	Spillage Location
0° to 90°	0	Not Applicable
90° to 180°	0	Not Applicable
180° to 270°	0	Not Applicable
270° to 360°	0	Not Applicable
Total Spillage	0	

	Yes (Fail)	No
Is the total Propulsion Battery Electrolyte Spillage greater than 5.0 Liters?		X
Is the Propulsion Battery Electrolyte Spillage visible in the passenger compartment?		X

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

VOLTMETER INFORMATION

	Units	Observations and Conclusions
Make		Fluke
Model		289
Serial Number		32910090
Internal Impedance Value	MΩ	> 10 MΩ < 100 pF
Resolution	V	0.001
Last Calibration Date		11/19/2020

ELECTRICAL ISOLATION MEASUREMENTS

Vb Post-Impact	V	0.4

Record V1, V2, V1', V2' voltage measurements at the start of each successive increment of 90°, 180°, 270°, and 360° of the static rollover test.

	Voltage	Units	Test Phase	Time			
V1	0.0	V	0°		min		sec
	0.0		90°	2		23	
	0.0		180°	2		18	
	0.0		270°	2		12	
	0.0		360°	2		9	
V2	0.0	V	0°		min		sec
	0.0		90°	2		26	
	0.0		180°	2		21	
	0.0		270°	2		15	
	0.0		360°	2		13	
V1'	0.0	V	0°		min		sec
	0.0		90°	2		32	
	0.0		180°	2		29	
	0.0		270°	2		22	
	0.0		360°	2		19	
V2'	0.0	V	0°		min		sec
	0.0		90°	2		28	
	0.0		180°	2		25	
	0.0		270°	2		18	
	0.0		360°	2		16	

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

Test Vehicle: 2021 Toyota Sienna Hybrid XLE AWD Minivan NHTSA No.: O20215108
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/3/2021

ELECTRICAL ISOLATION CALCULATIONS

NOTE: If measured voltage is zero and results in a division by zero, record "Zero Volts". This "zero voltage" condition is considered as being compliant.

	Voltage	Units	Test Phase	Time			
Ri1 = Ro (1 + V2/V1) [(V1-V1')/V1']							
Ri1	Zero Volts	Ω	0°		min		sec
	Zero Volts		90°	2		26	
	Zero Volts		180°	2		21	
	Zero Volts		270°	2		15	
	Zero Volts		360°	2		13	
Ri2 = Ro (1 + V1/V2) [(V2-V2')/V2']							
Ri2	Zero Volts	Ω	0°		min		sec
	Zero Volts		90°	2		23	
	Zero Volts		180°	2		18	
	Zero Volts		270°	2		12	
	Zero Volts		360°	2		9	
Ri = The lesser of Ri1 and Ri2							
Ri	Zero Volts	Ω	0°		min		sec
	Zero Volts		90°	2		32	
	Zero Volts		180°	2		29	
	Zero Volts		270°	2		22	
	Zero Volts		360°	2		19	
Ri / Vb = Electrical Isolation Value / Nominal Battery Voltage							
Ri / Vb	Zero Volts	Ω/V	0°		min		sec
	Zero Volts		90°	2		32	
	Zero Volts		180°	2		29	
	Zero Volts		270°	2		22	
	Zero Volts		360°	2		19	

NOTE: The minimum Electrical Isolation Value is 500 Ω/V.

	Yes	No (Fail)
Is the measured Electrical Isolation Value ≥ 500 Ω/V?	X	
Additional Comments	None	

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

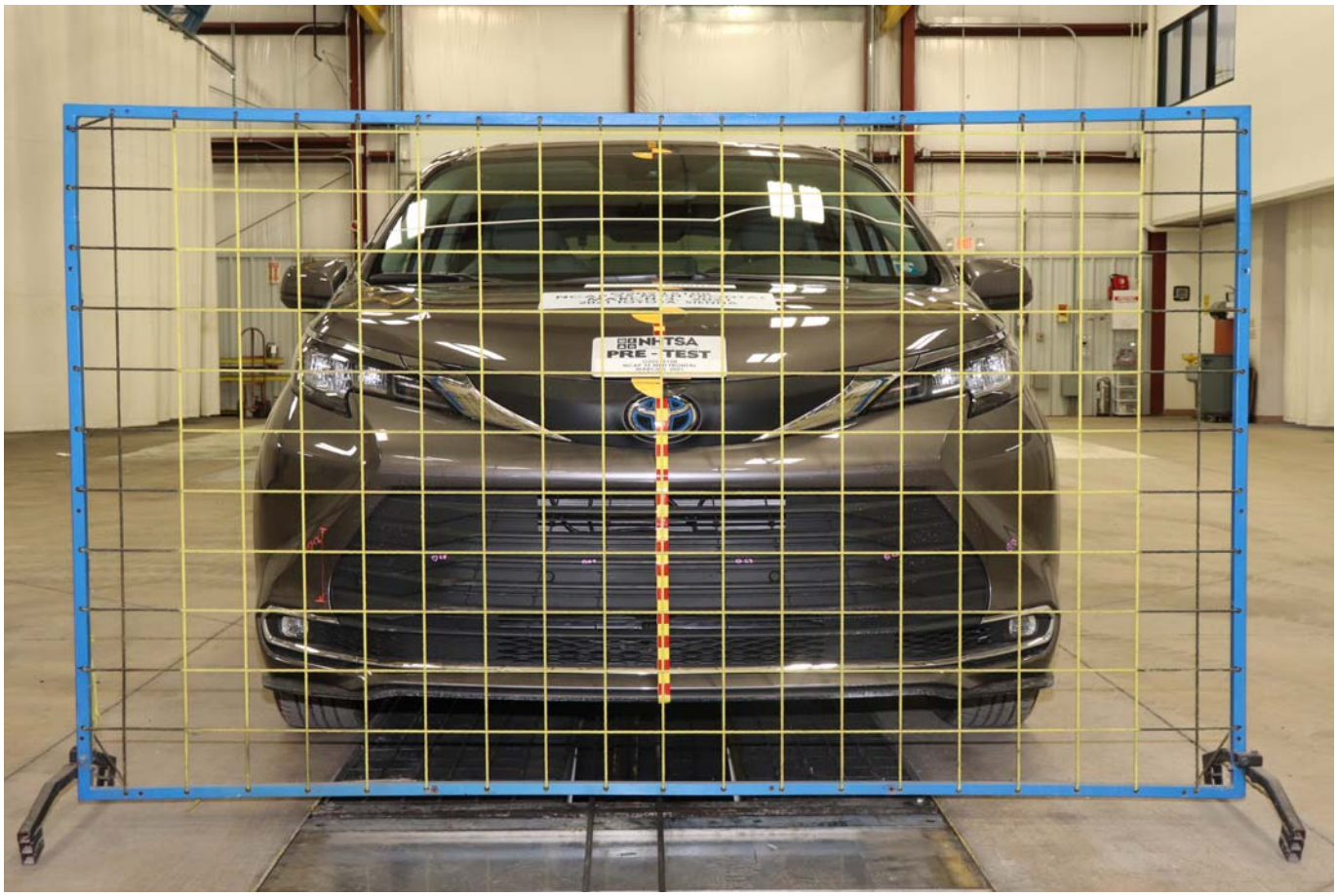


Photo No. 001 - Load Cell Location

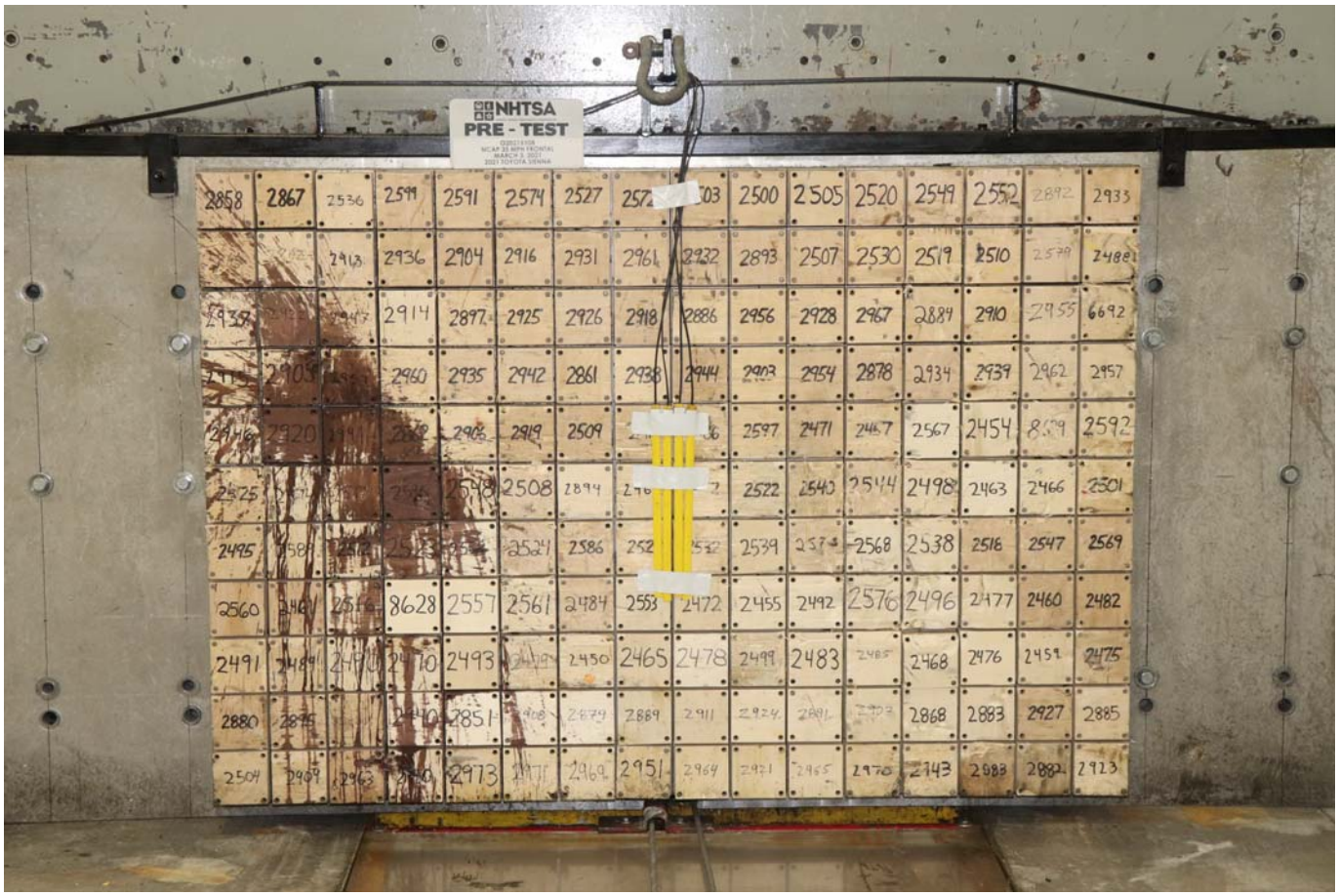


Photo No. 002 - Pre-Test Load Cell Wall

Photo No. 003 - Post-Test Load Cell Wall

Photo No. 004 - Manufacturer Label

Photo No. 005 - Tire Placard

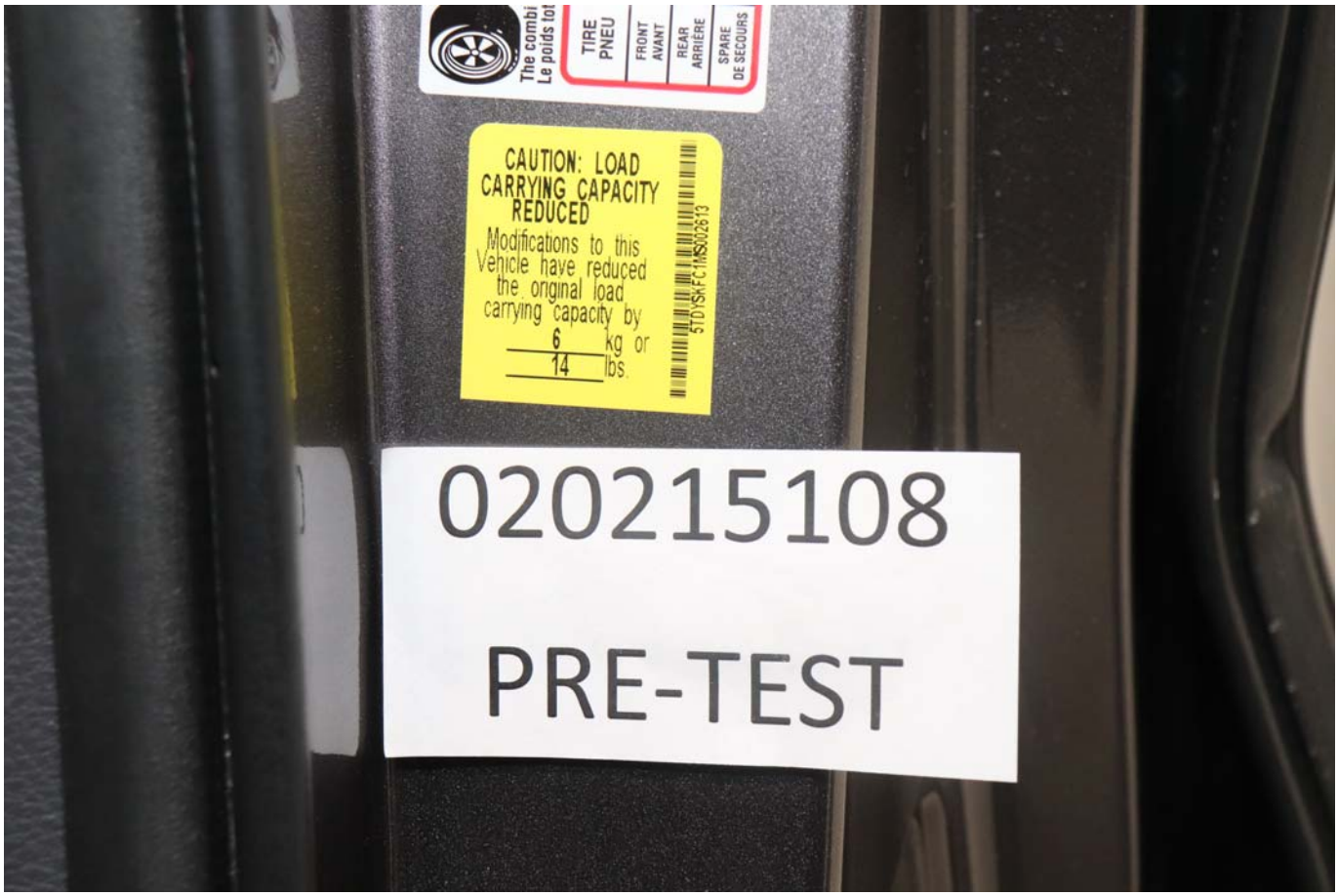


Photo No. 005a - Vehicle Load Carrying Capacity Reduction Label

Photo No. 006 - 2021 Toyota Sienna Hybrid XLE AWD Minivan Frontal As Delivered

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

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

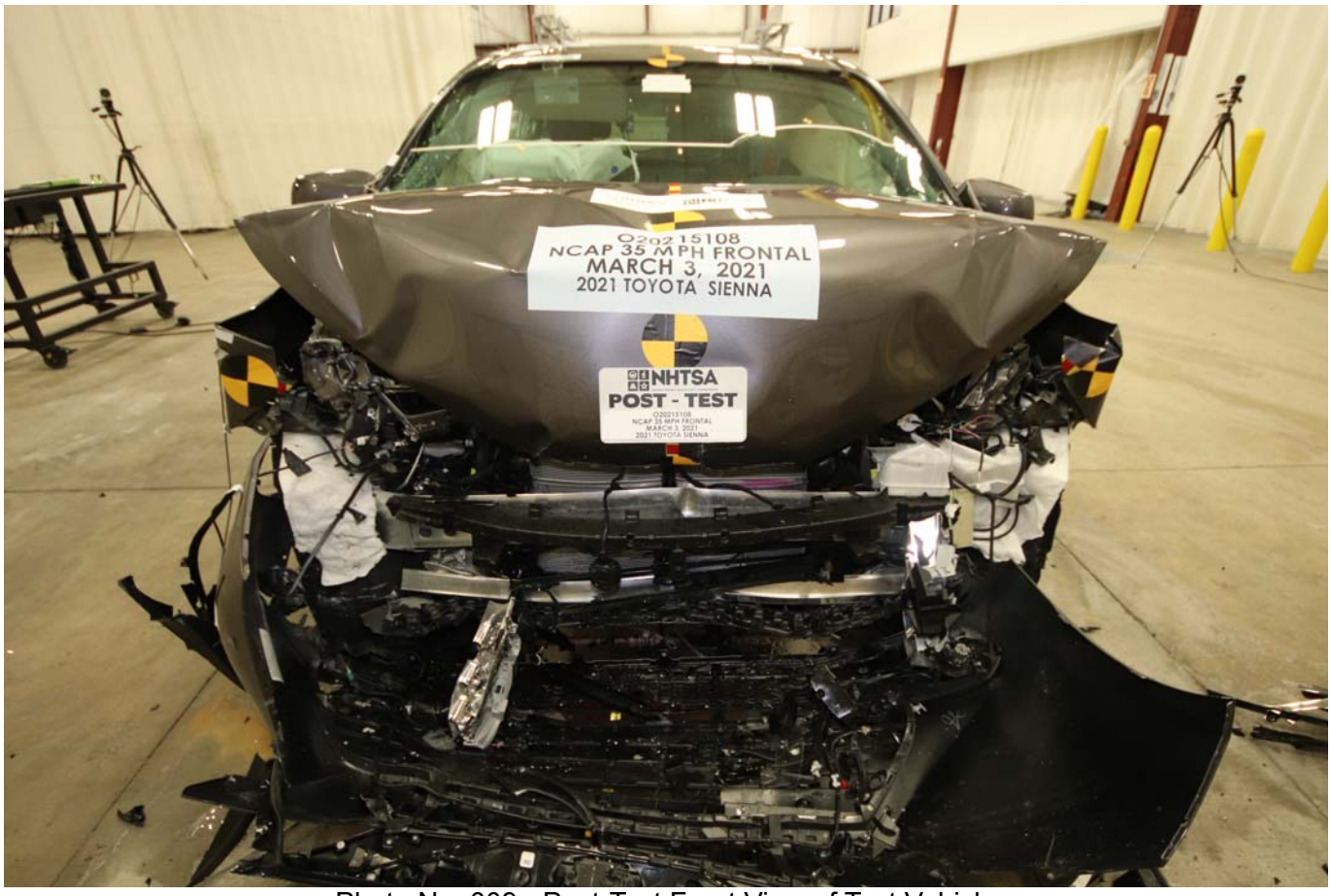


Photo No. 009 - Post-Test Front View of Test Vehicle

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

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

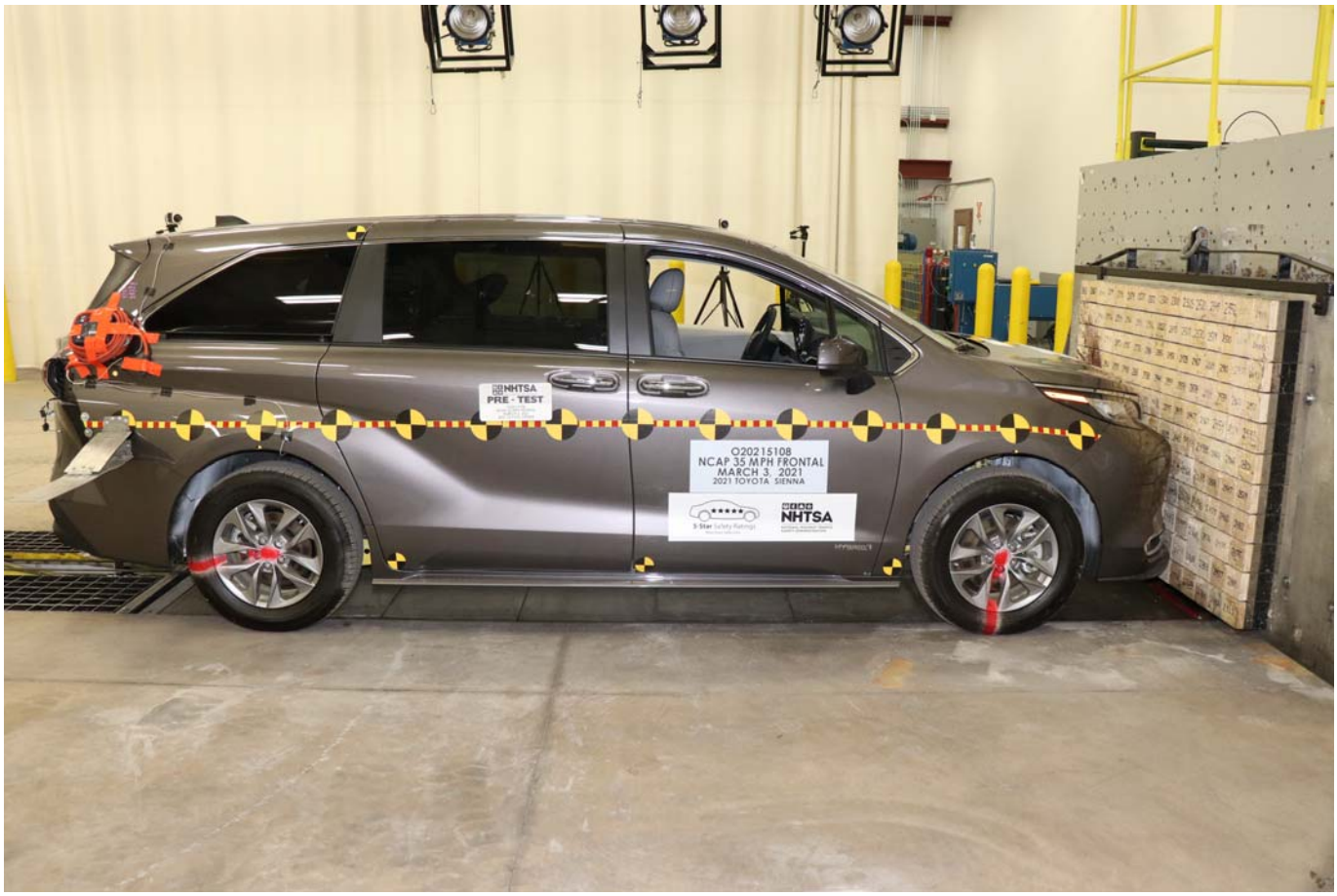


Photo No. 012 - Pre-Test Right View of Test Vehicle

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

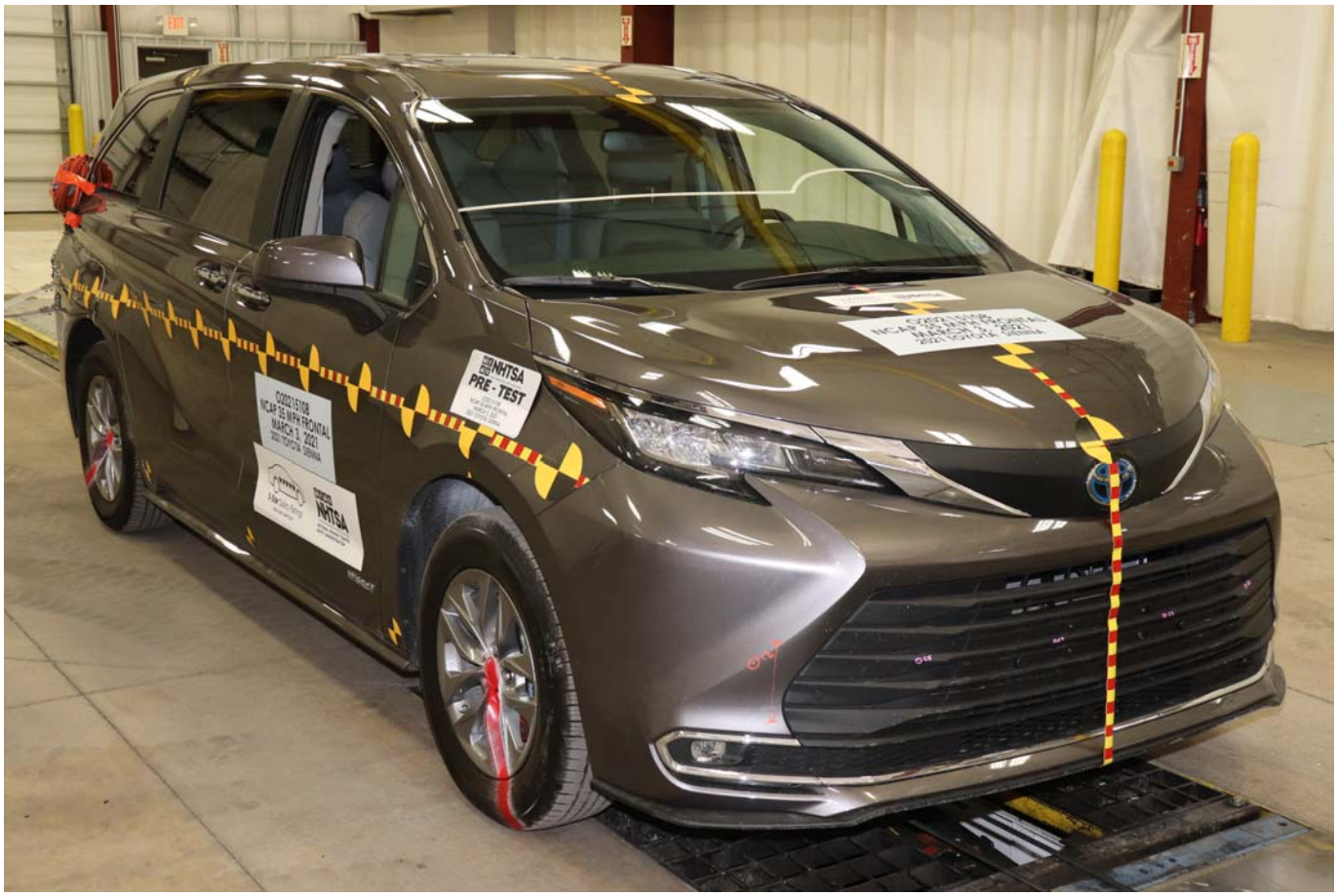


Photo No. 014 - Pre-Test Right Front 3-4 View

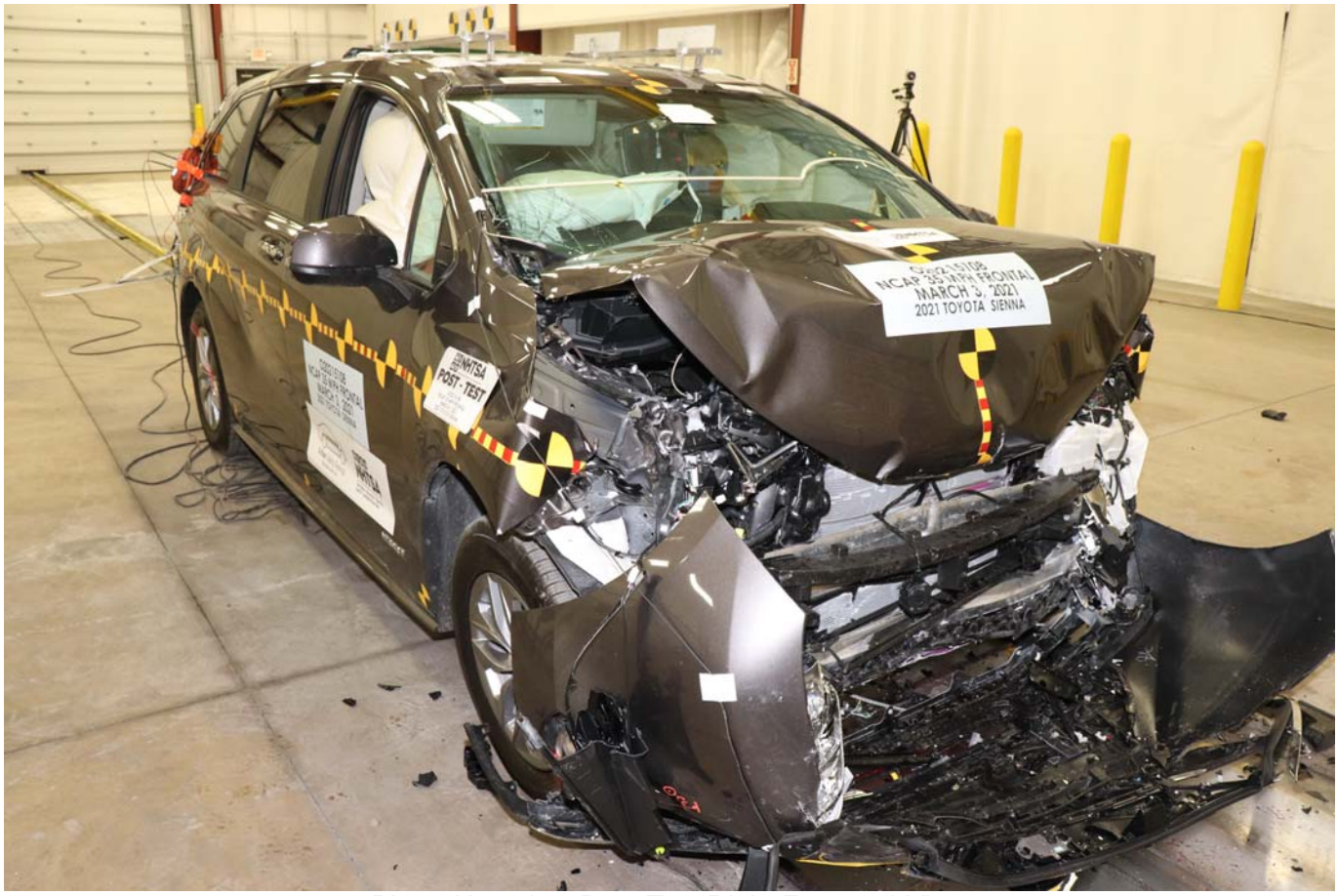


Photo No. 015 - Post-Test Right Front 3-4 View

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

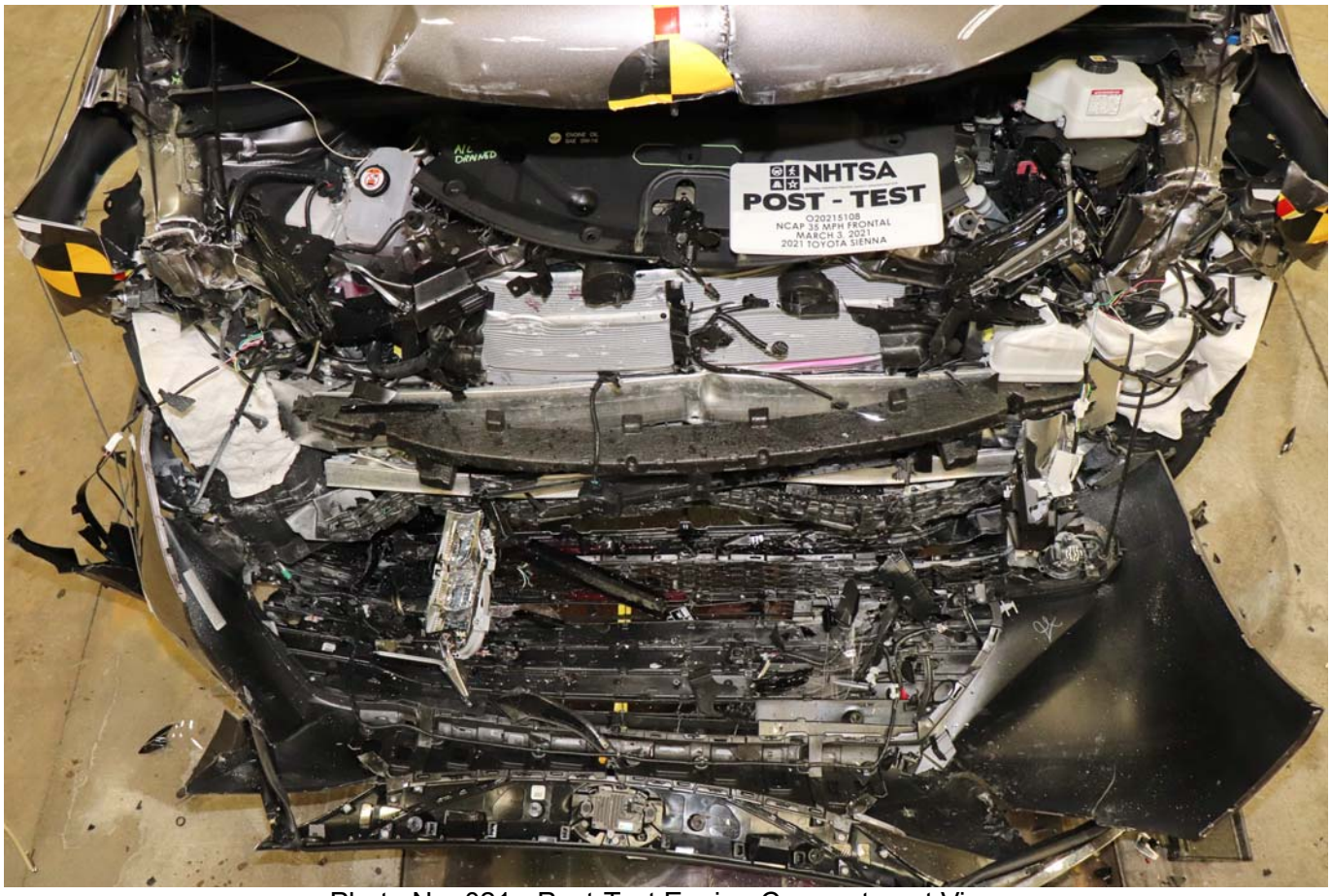


Photo No. 021 - Post-Test Engine Compartment View

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

PHOTOGRAPH NOT AVAILABLE

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

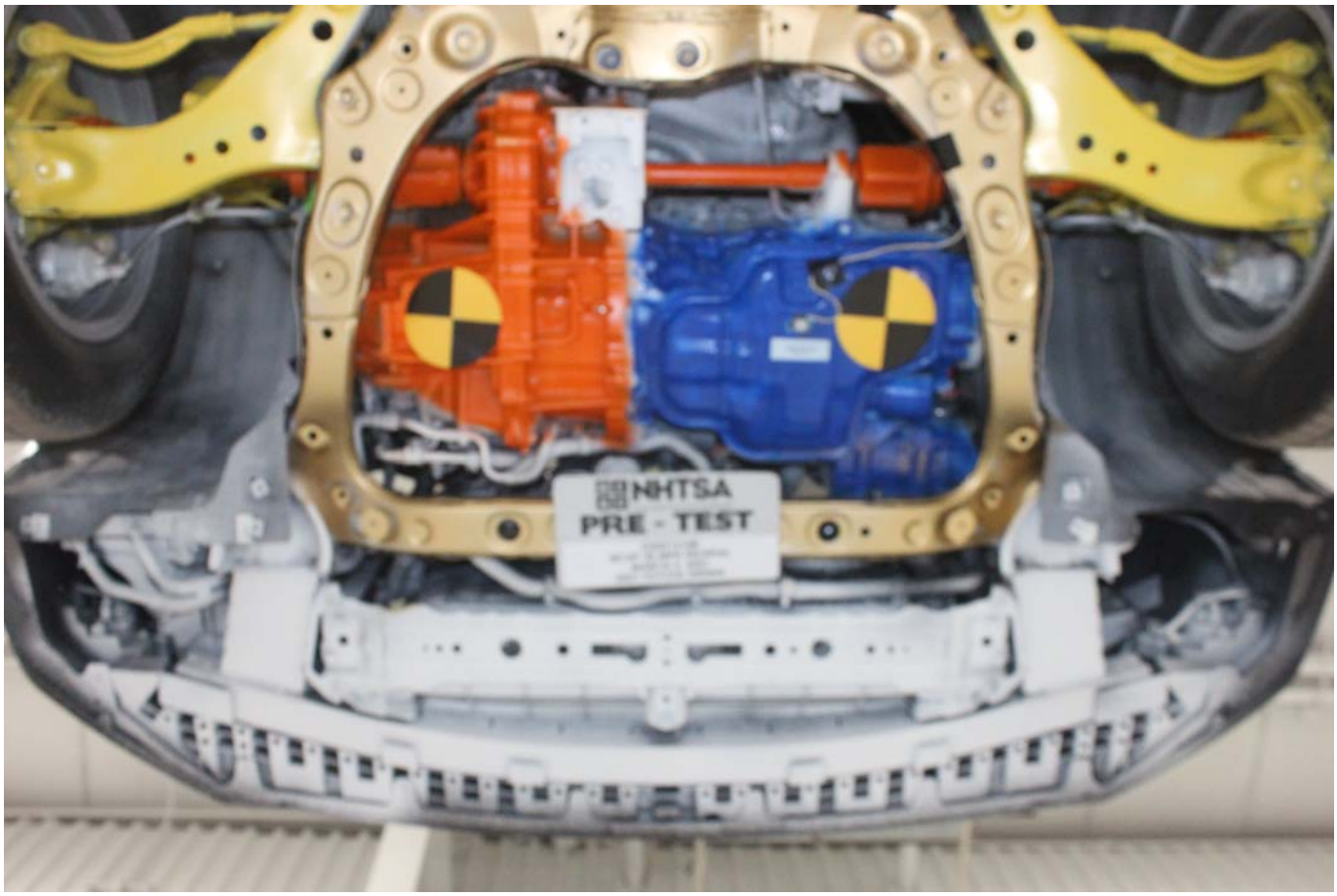


Photo No. 024 - Pre-Test Front Underbody View

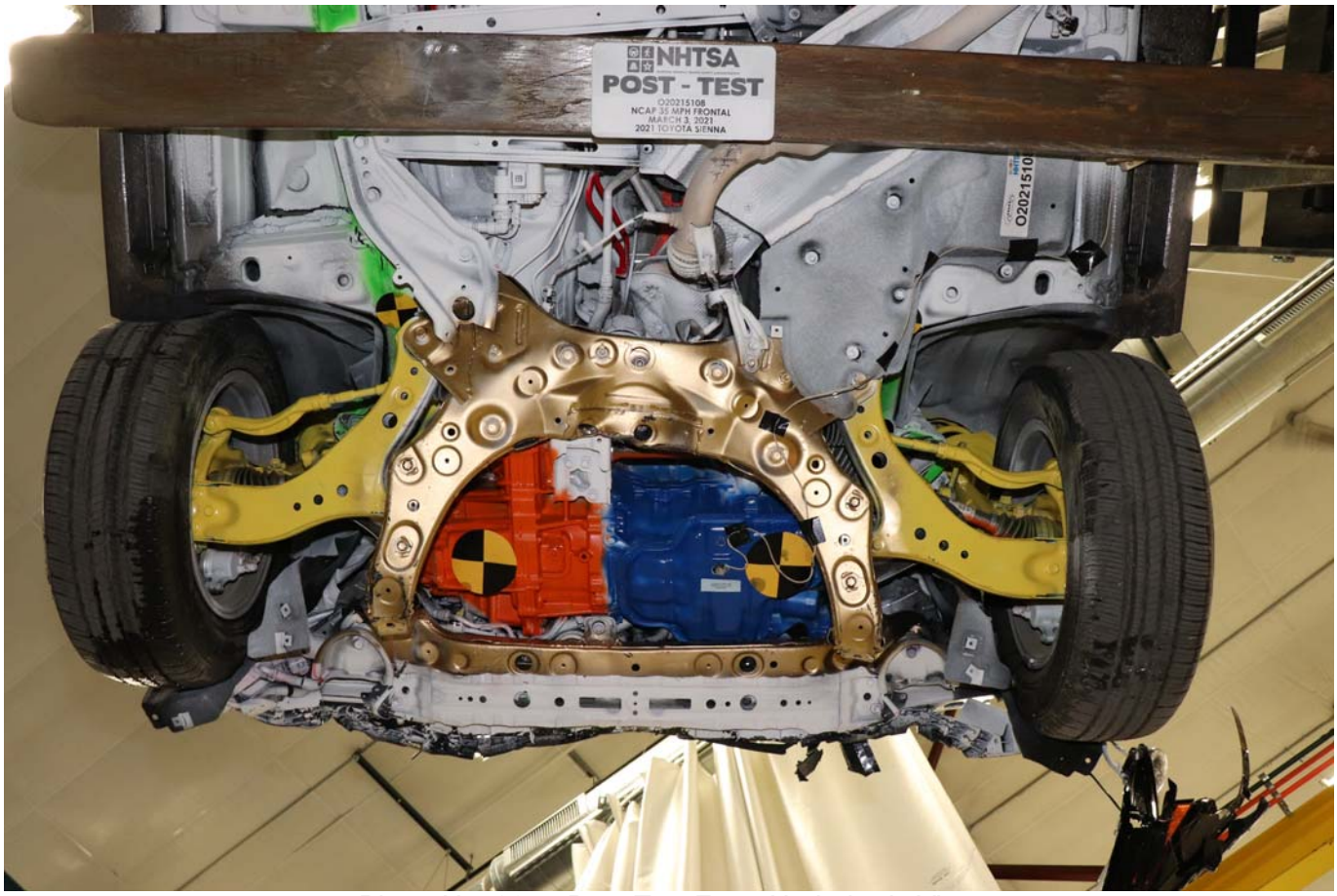


Photo No. 025 - Post-Test Front Underbody View

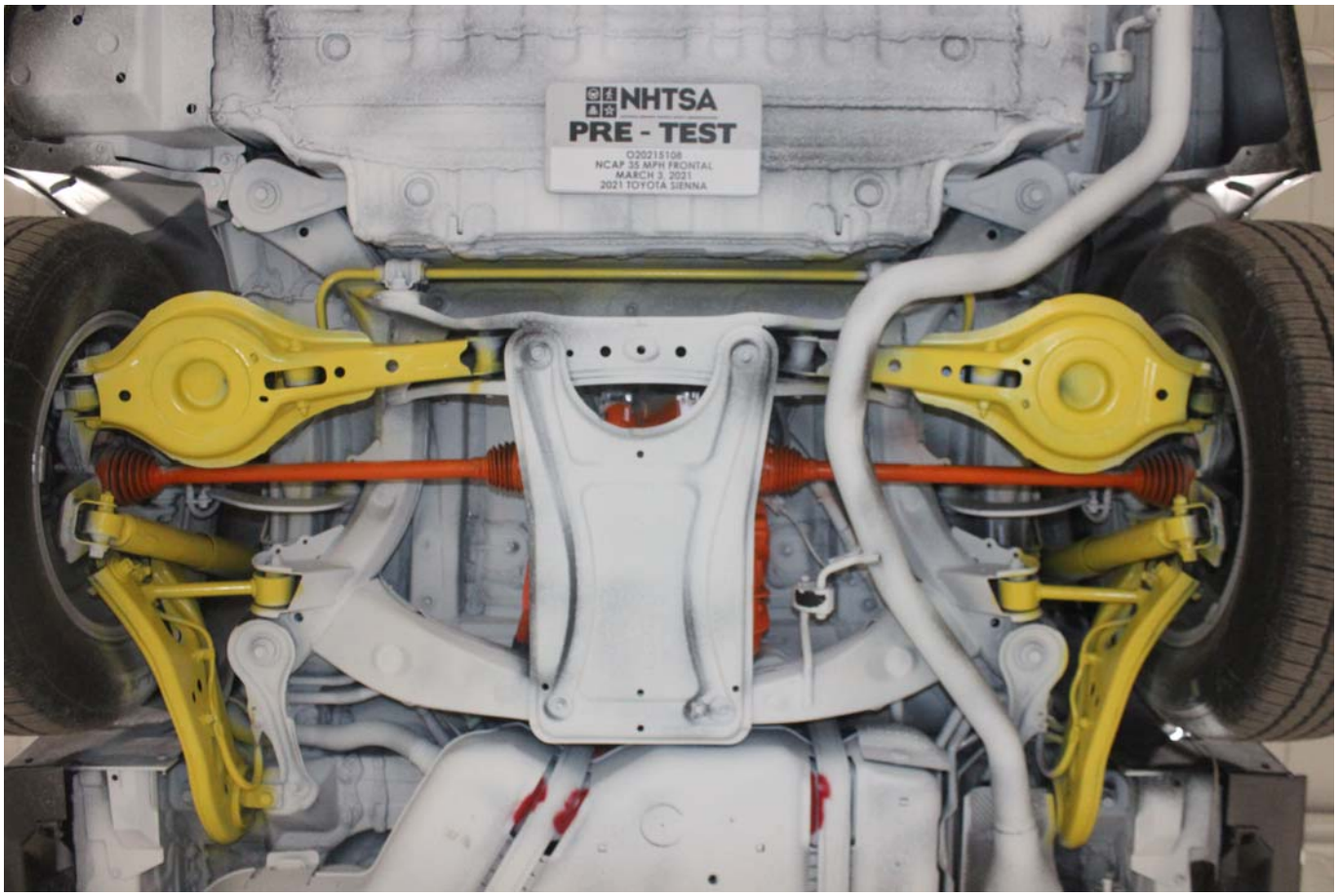


Photo No. 026 - Pre-Test Rear Underbody View

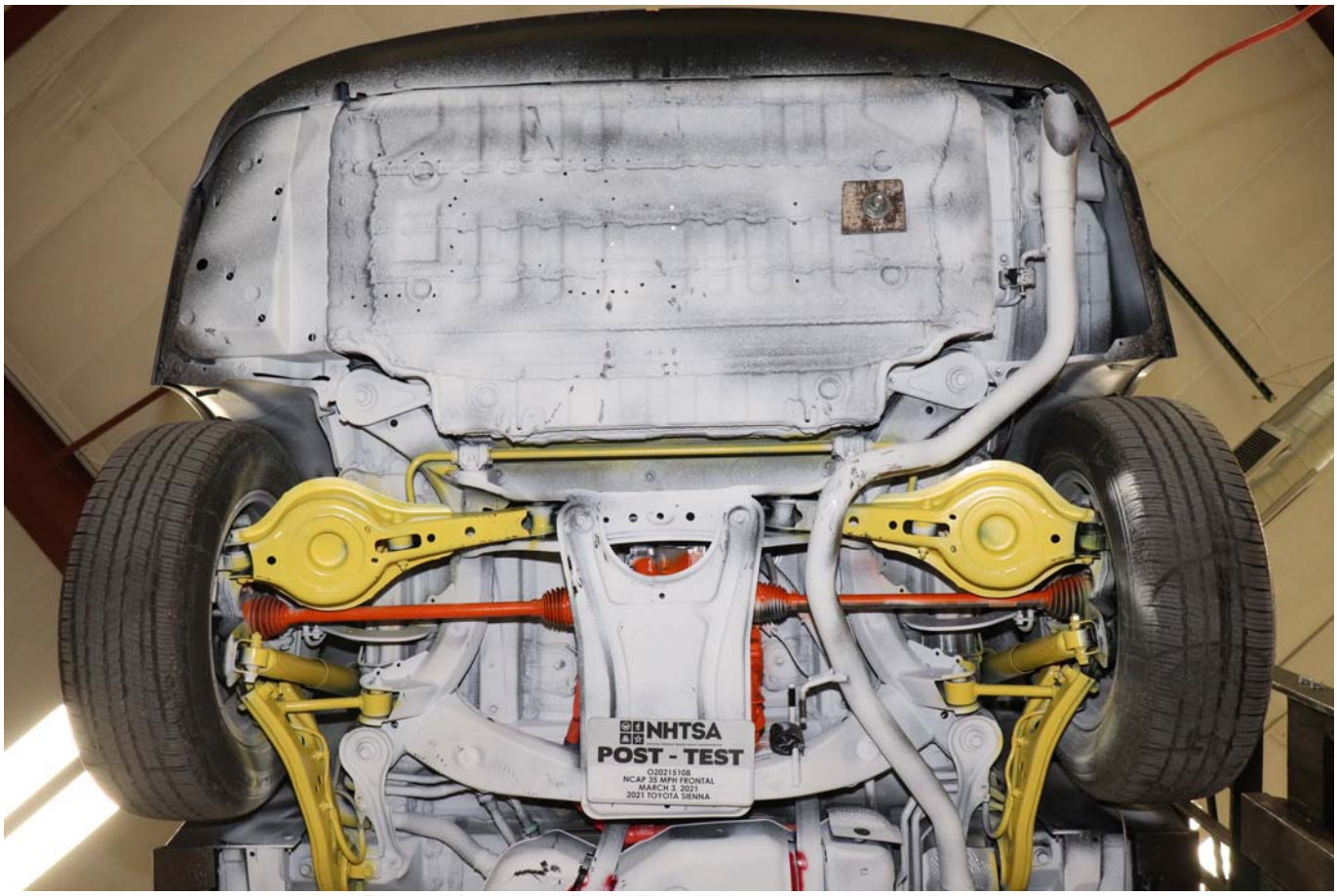


Photo No. 027 - Post-Test Rear Underbody View

Photo No. 028 - Pre-Test Dummy Cable Routing

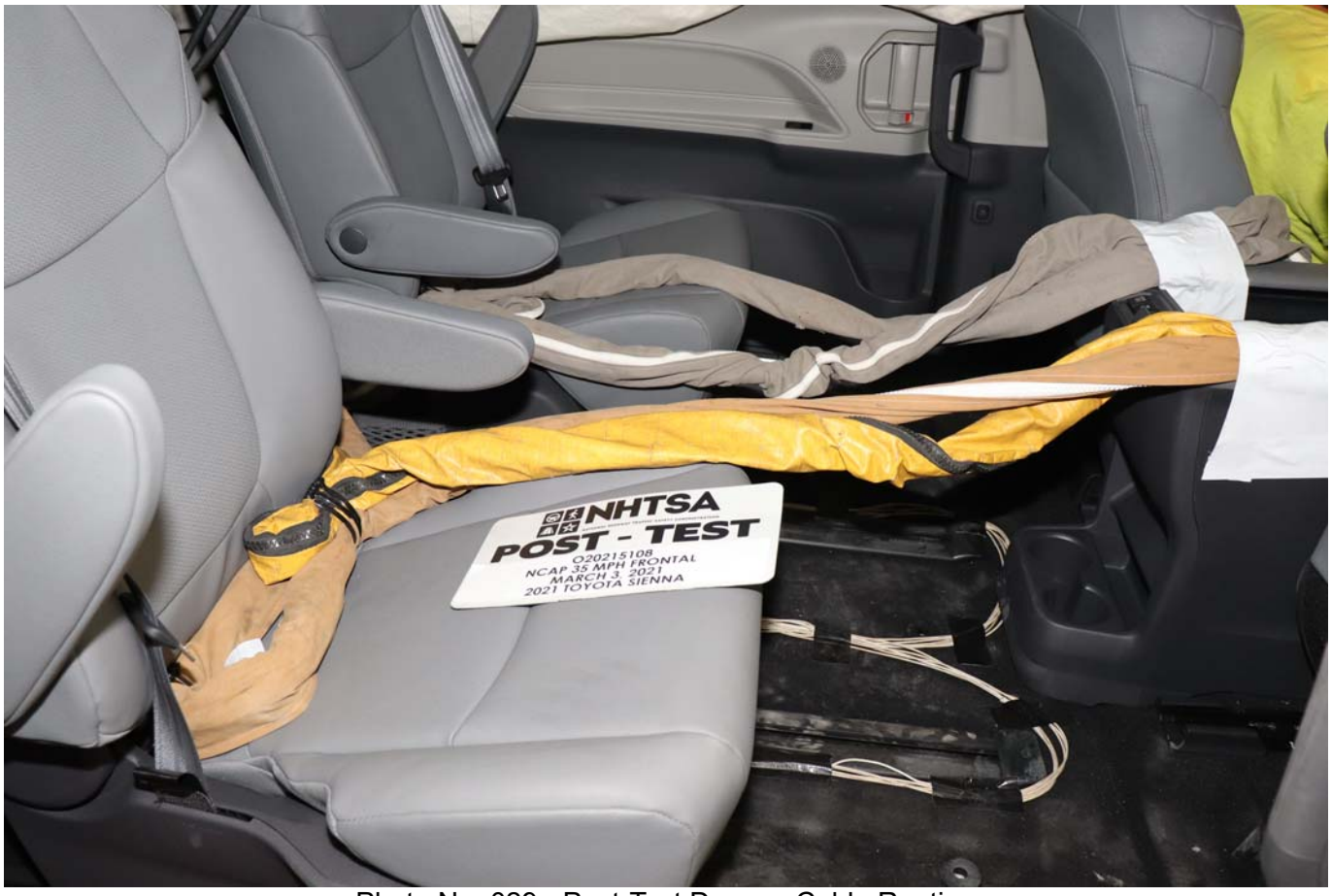


Photo No. 029 - Post-Test Dummy Cable Routing

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Photo No. 074 - Ballast Installed in Vehicle

PHOTOGRAPH NOT APPLICABLE

Photo No. 075 - Post-Test Stoddard Solvent Spillage Location View

Photo No. 076 - Post-Test Speed Trap Read-Out

Photo No. 077 - Vehicle at 0 Degrees on Static Rollover Device

Photo No. 078 - Vehicle at 90 Degrees on Static Rollover Device

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Photo No. 080 - Vehicle at 270 Degrees on Static Rollover Device

Photo No. 081 - Vehicle at 360 Degrees on Static Rollover Device

Photo No. 082 - 2021 Toyota Sienna Hybrid XLE AWD Minivan Frontal Impact Event

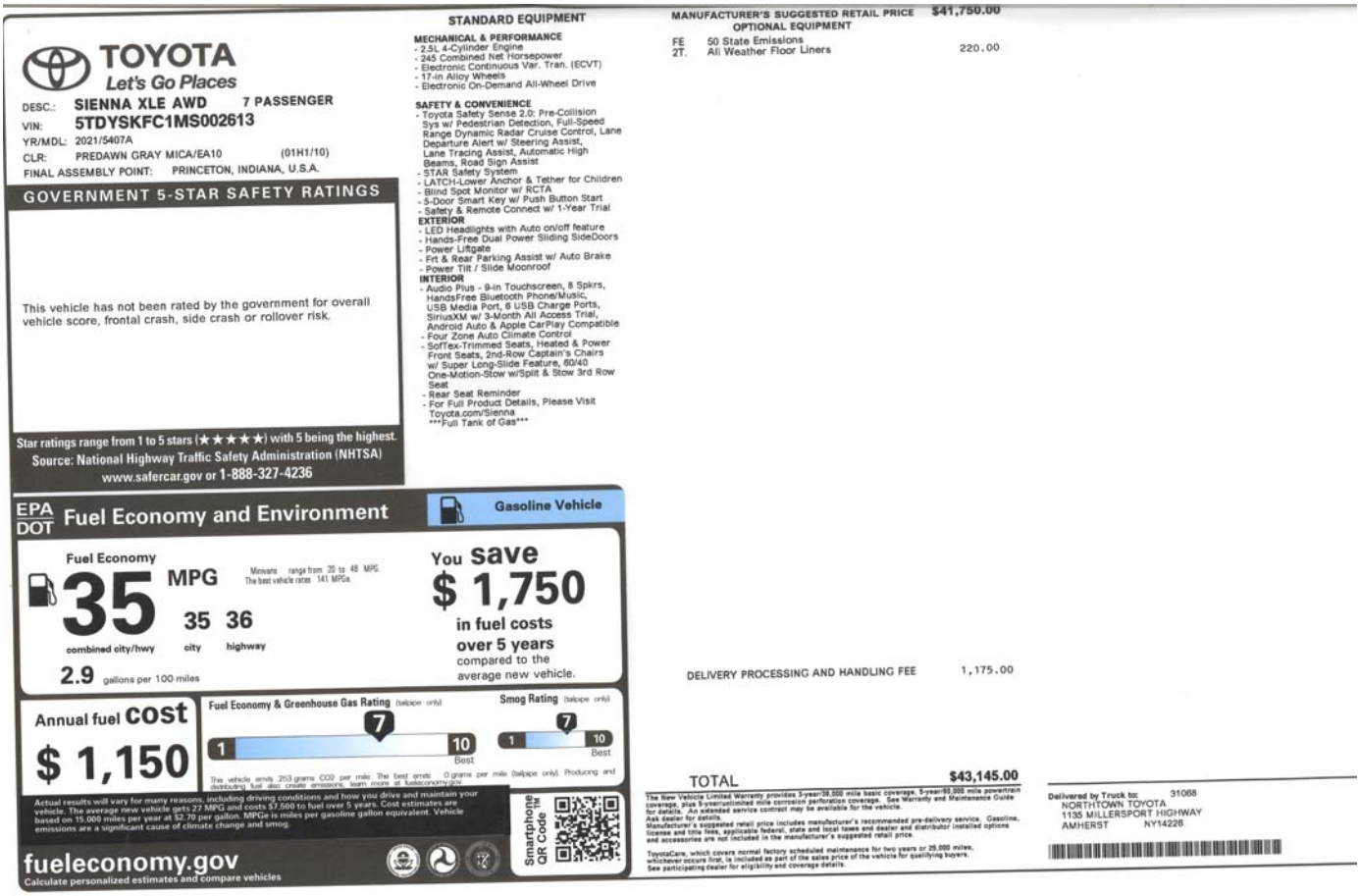

Photo No. 083 - Monroney Label Photograph

Photo No. 305-01 - Auxiliary Power Module Warning Label

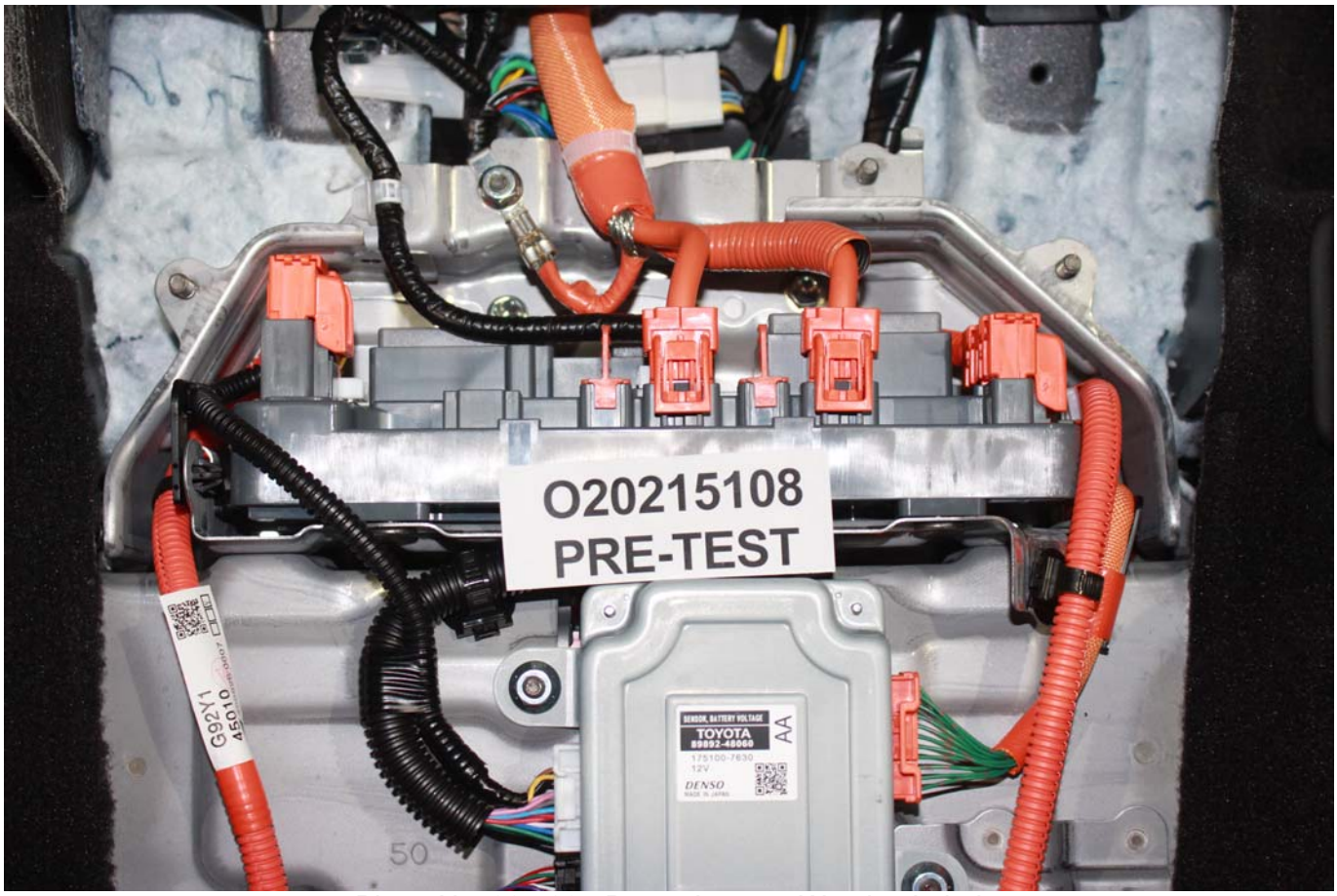

Photo No. 305-02 - Power Inverter Warning Label

Photo No. 305-03 - First Responder Warning Label

Photo No. 305-04 - First Responder Warning Location

Photo No. 305-05 - Other Vehicle Label(s) Related to Electrical Propulsion System

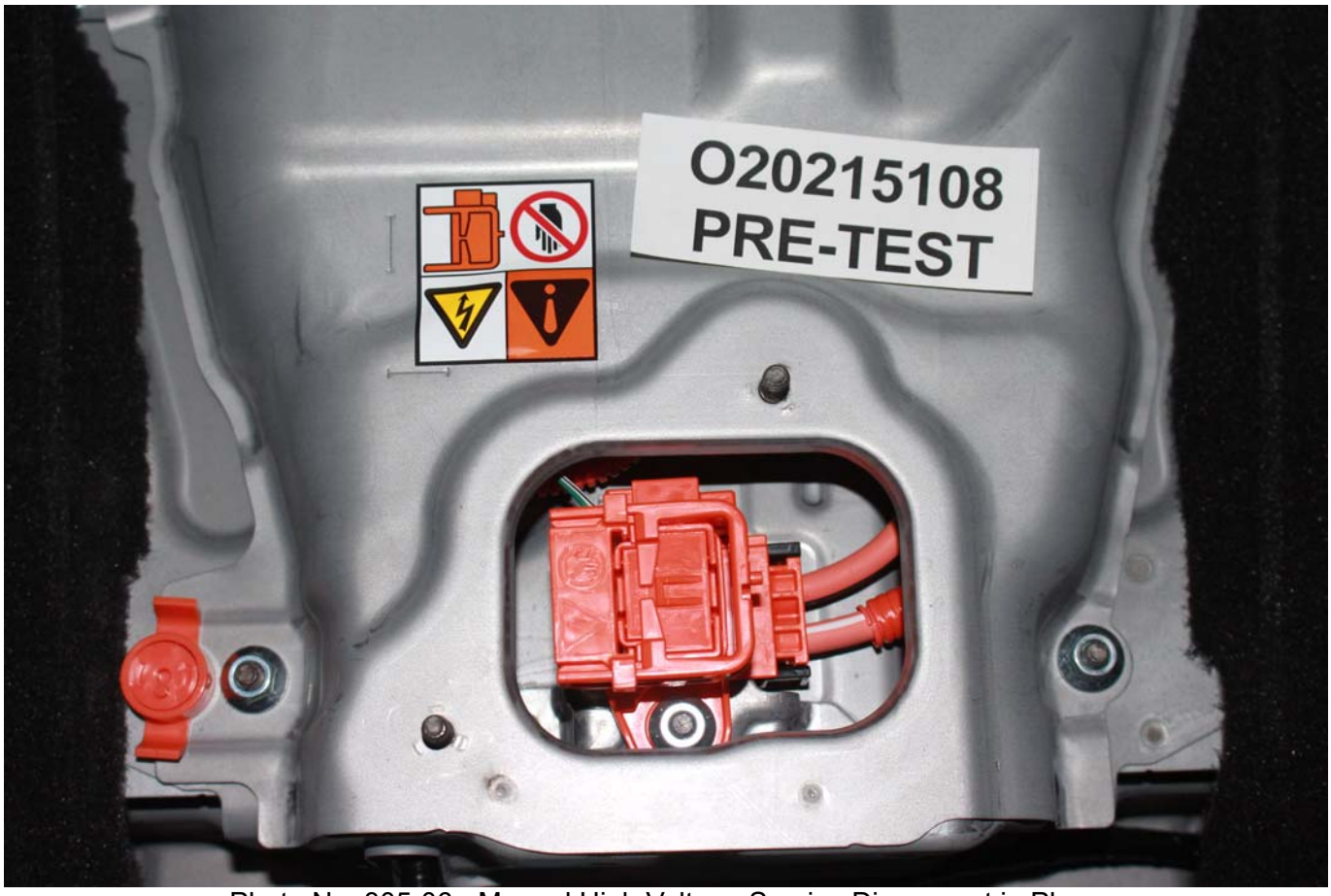

Photo No. 305-06 - Manual High Voltage Service Disconnect in Place

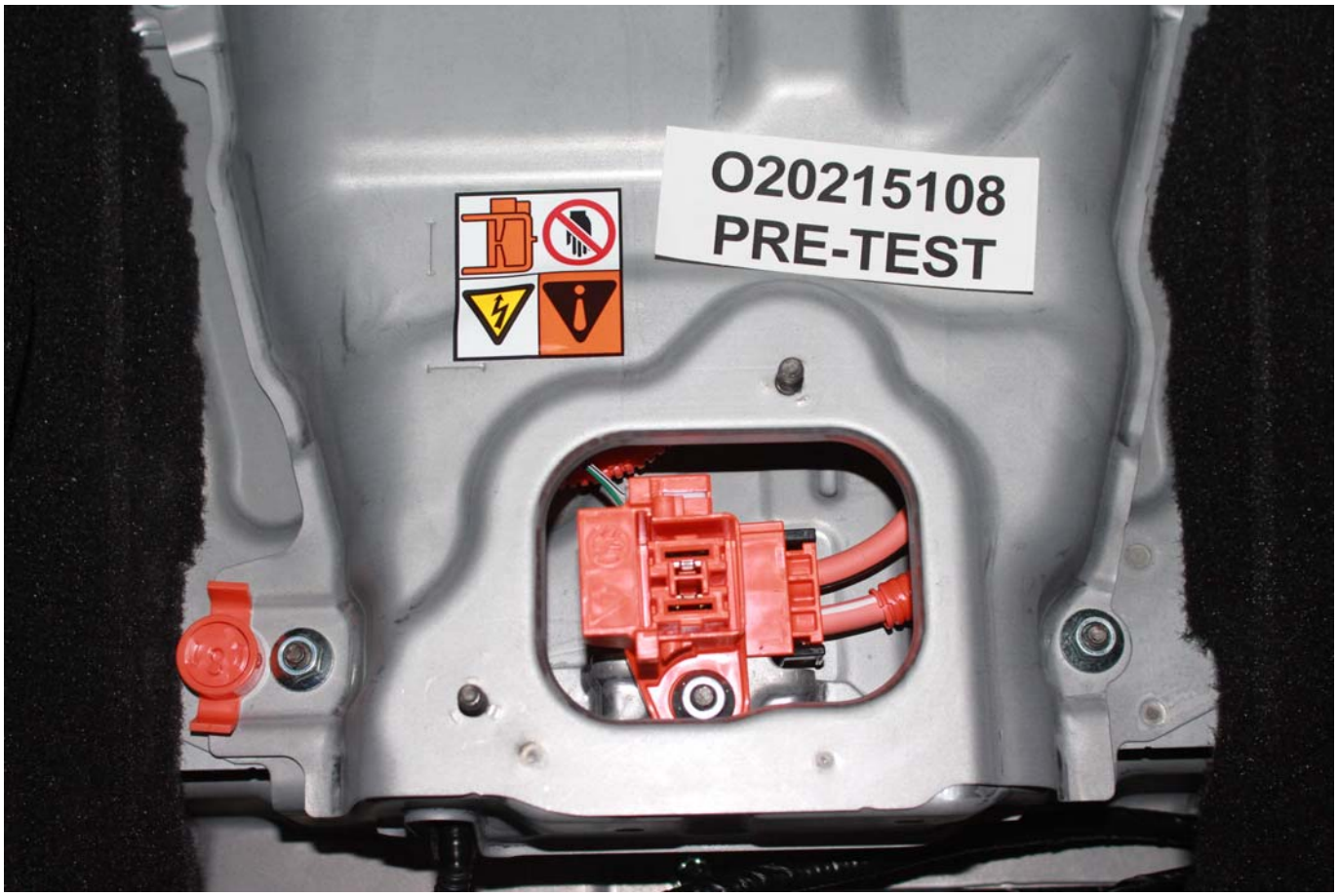

Photo No. 305-07 - Manual High Voltage Service Disconnect Removed

Photo No. 305-08 - Manual High Voltage Service Disconnect Removed

Photo No. 305-09 - Pre-Impact View of Propulsion Battery

PHOTOGRAPH NOT AVAILABLE

Photo No. 305-10 - Post-Impact Front View of Propulsion Battery

Photo No. 305-11 - Post-Impact Rear View of Propulsion Battery

PHOTOGRAPH NOT APPLICABLE

Photo No. 305-12 - Pre-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

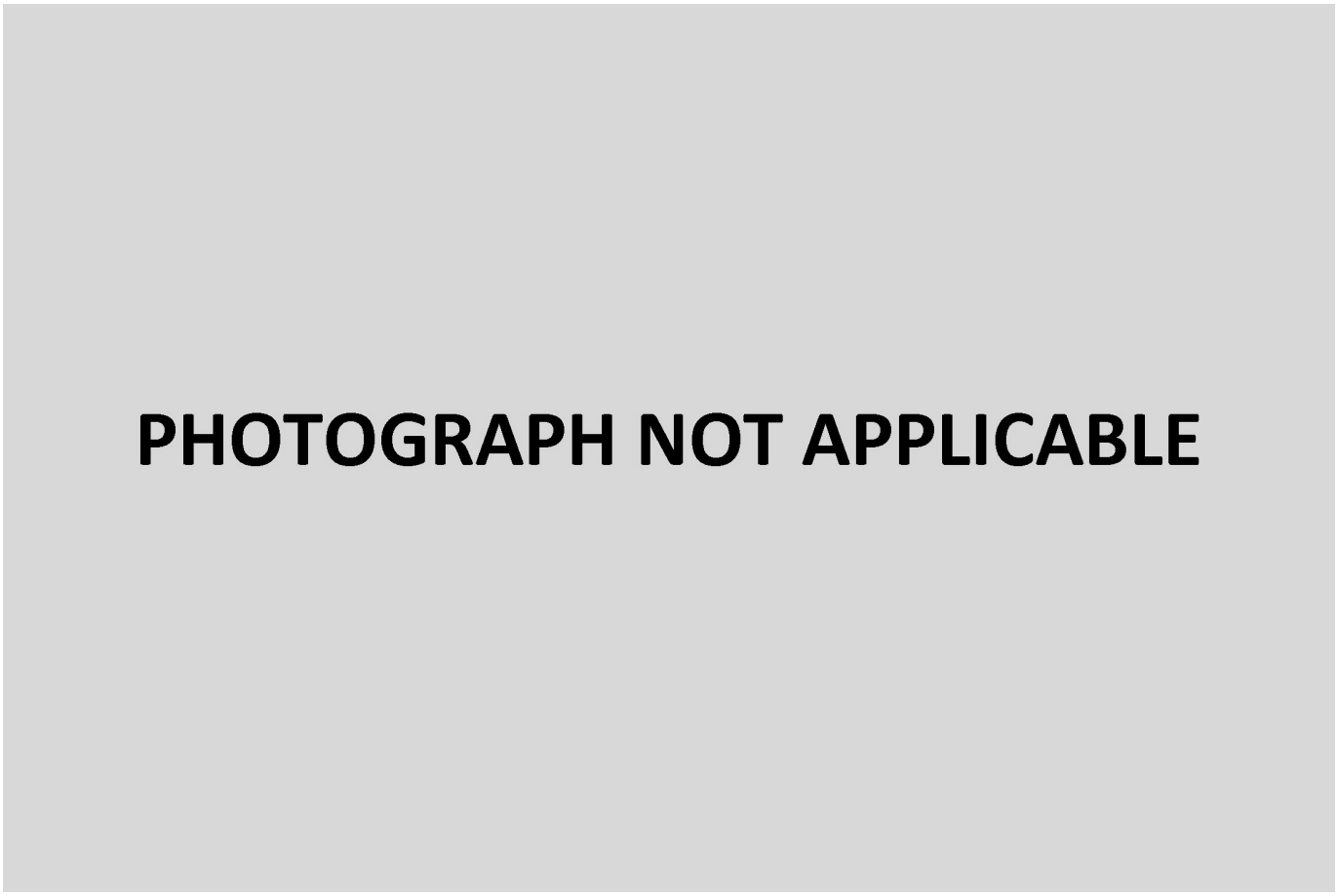

Photo No. 305-13 - Post-Impact View of Battery Box(s) or Container(s) Which Holds Individual Battery Modules

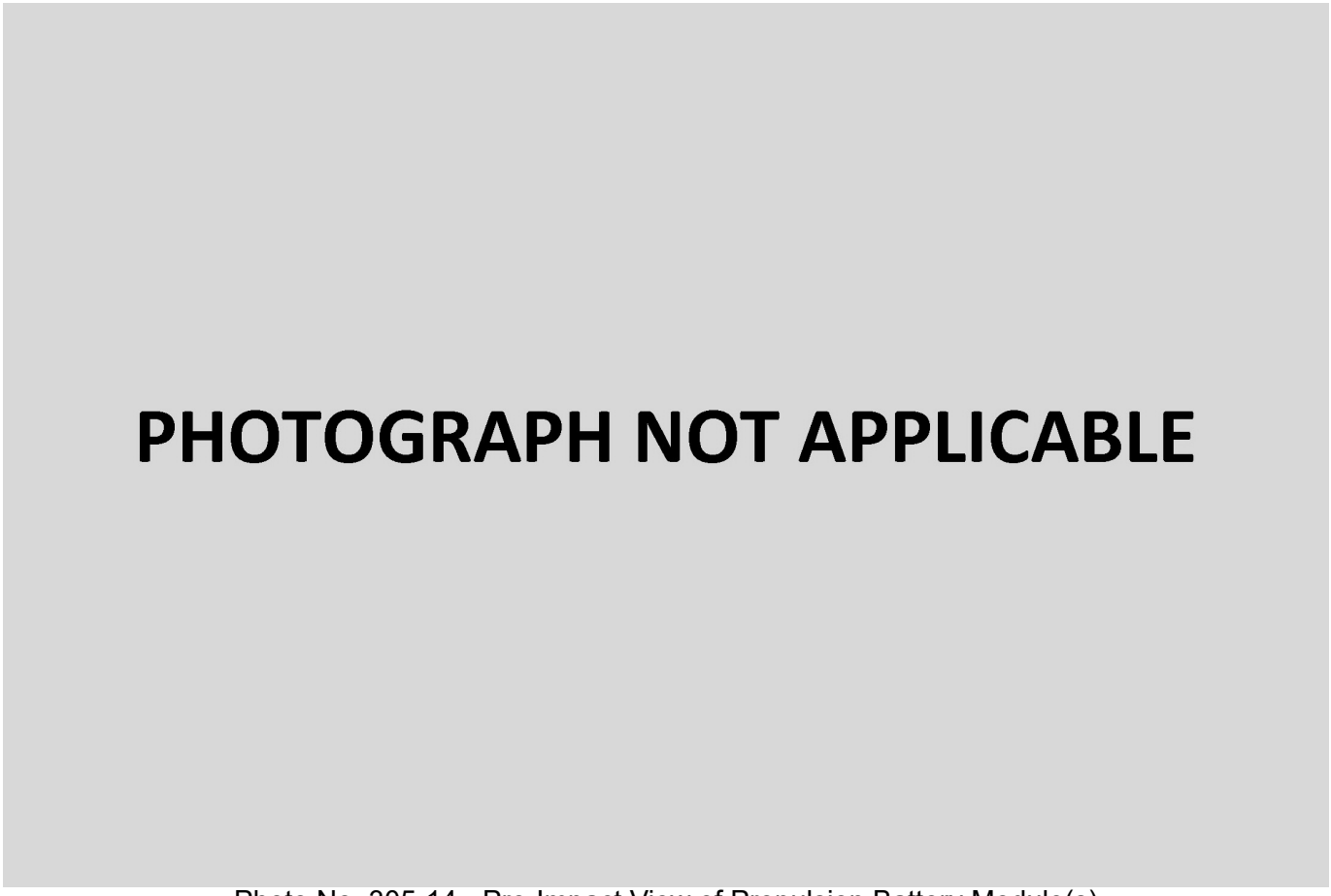

Photo No. 305-14 - Pre-Impact View of Propulsion Battery Module(s)

PHOTOGRAPH NOT APPLICABLE

Photo No. 305-15 - Post-Impact View of Propulsion Battery Module(s)

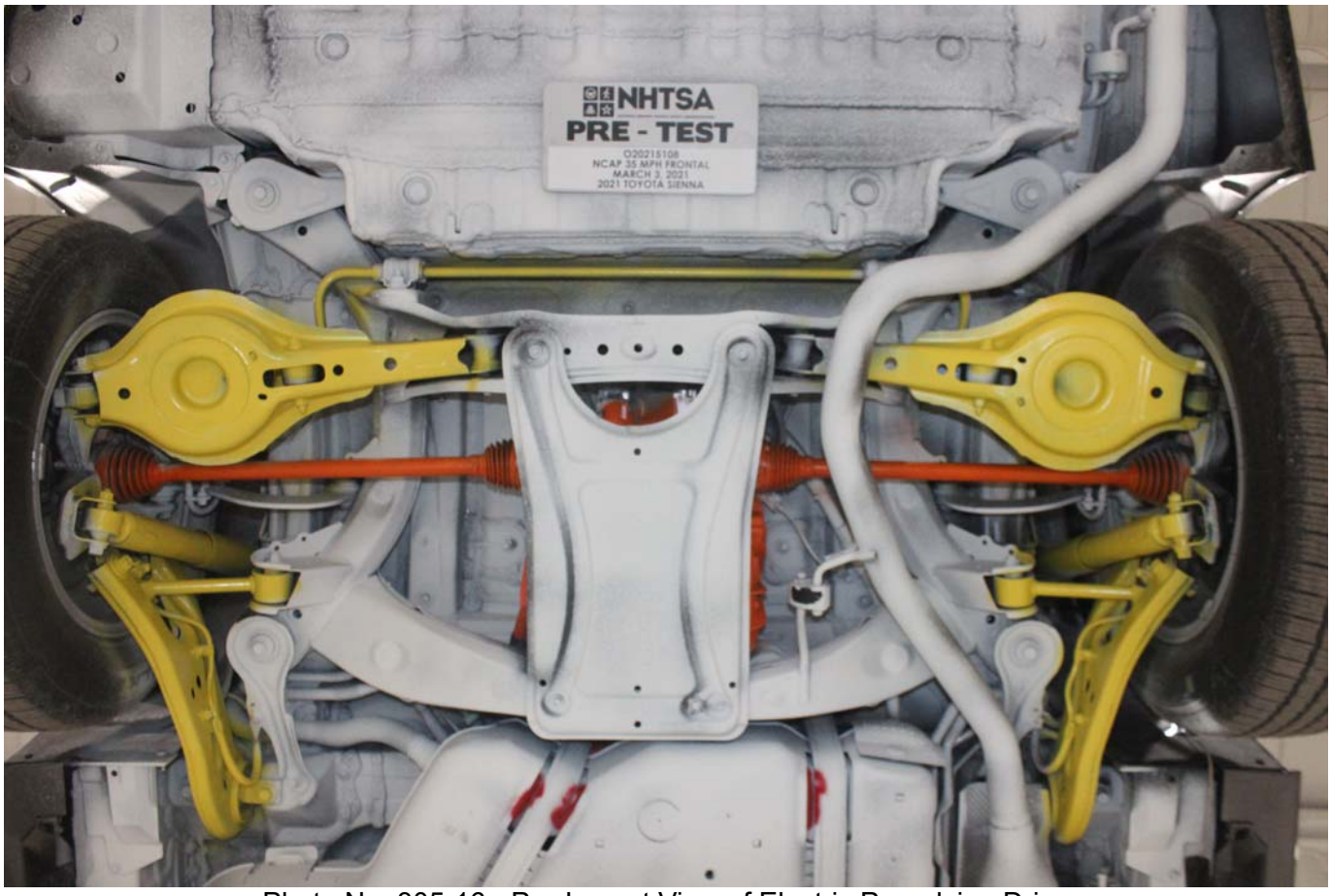

Photo No. 305-16 - Pre-Impact View of Electric Propulsion Drive

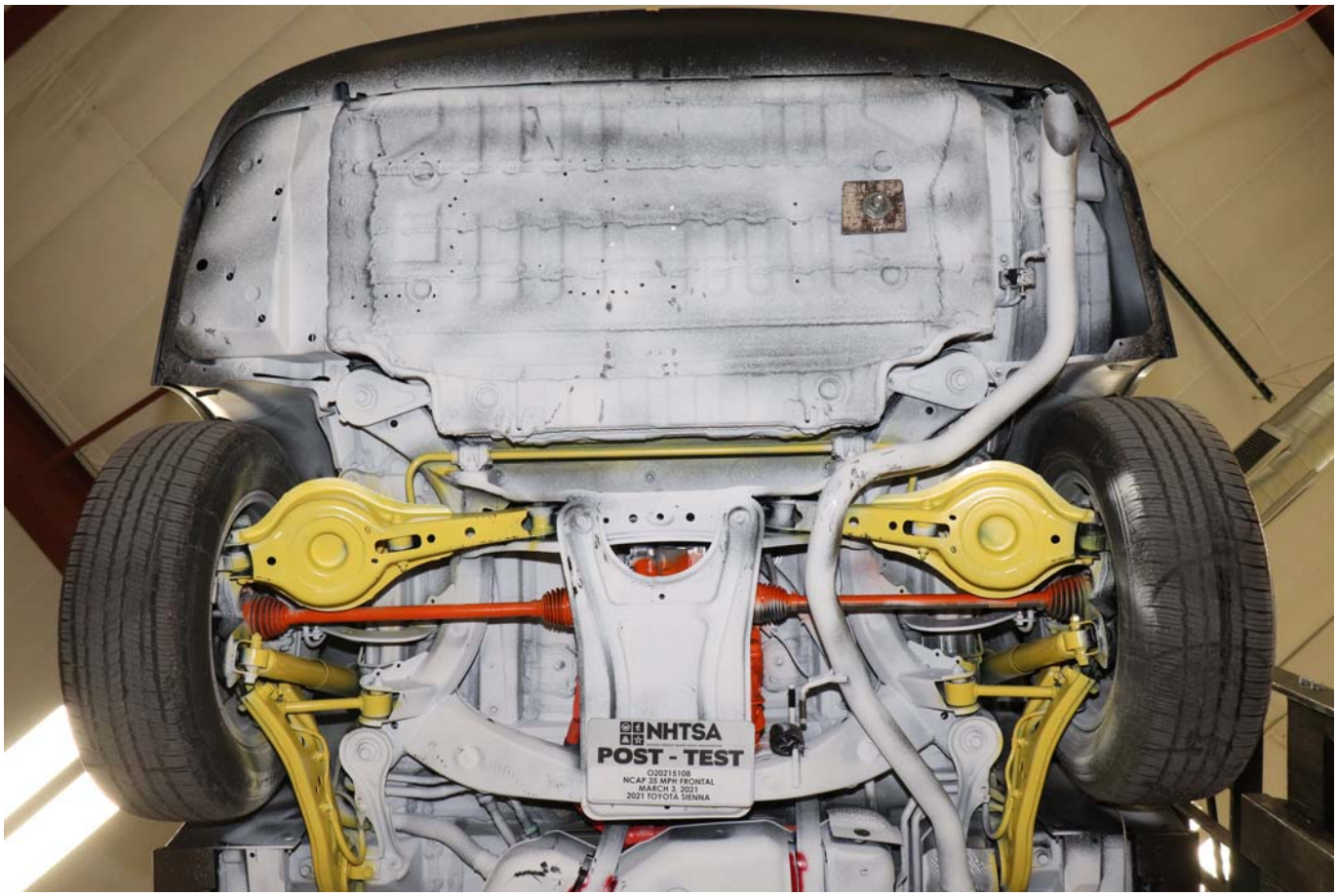

Photo No. 305-17 - Post-Impact View of Electric Propulsion Drive

Photo No. 305-18 - Pre-Impact View of High Voltage Interconnect(s)

PHOTOGRAPH NOT APPLICABLE

Photo No. 305-19 - Pre-Impact View Propulsion Battery Venting System(s)

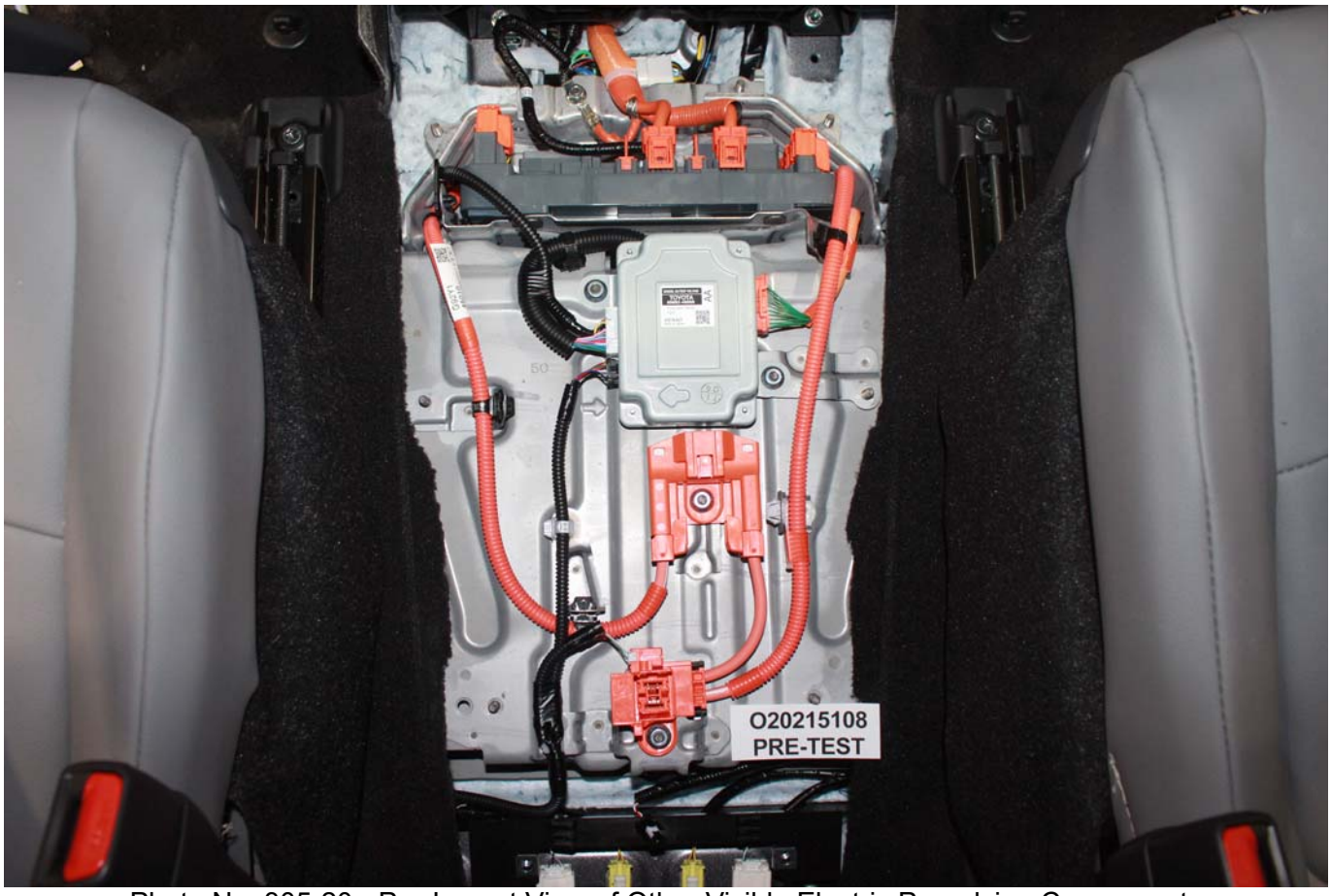

Photo No. 305-20 - Pre-Impact View of Other Visible Electric Propulsion Components

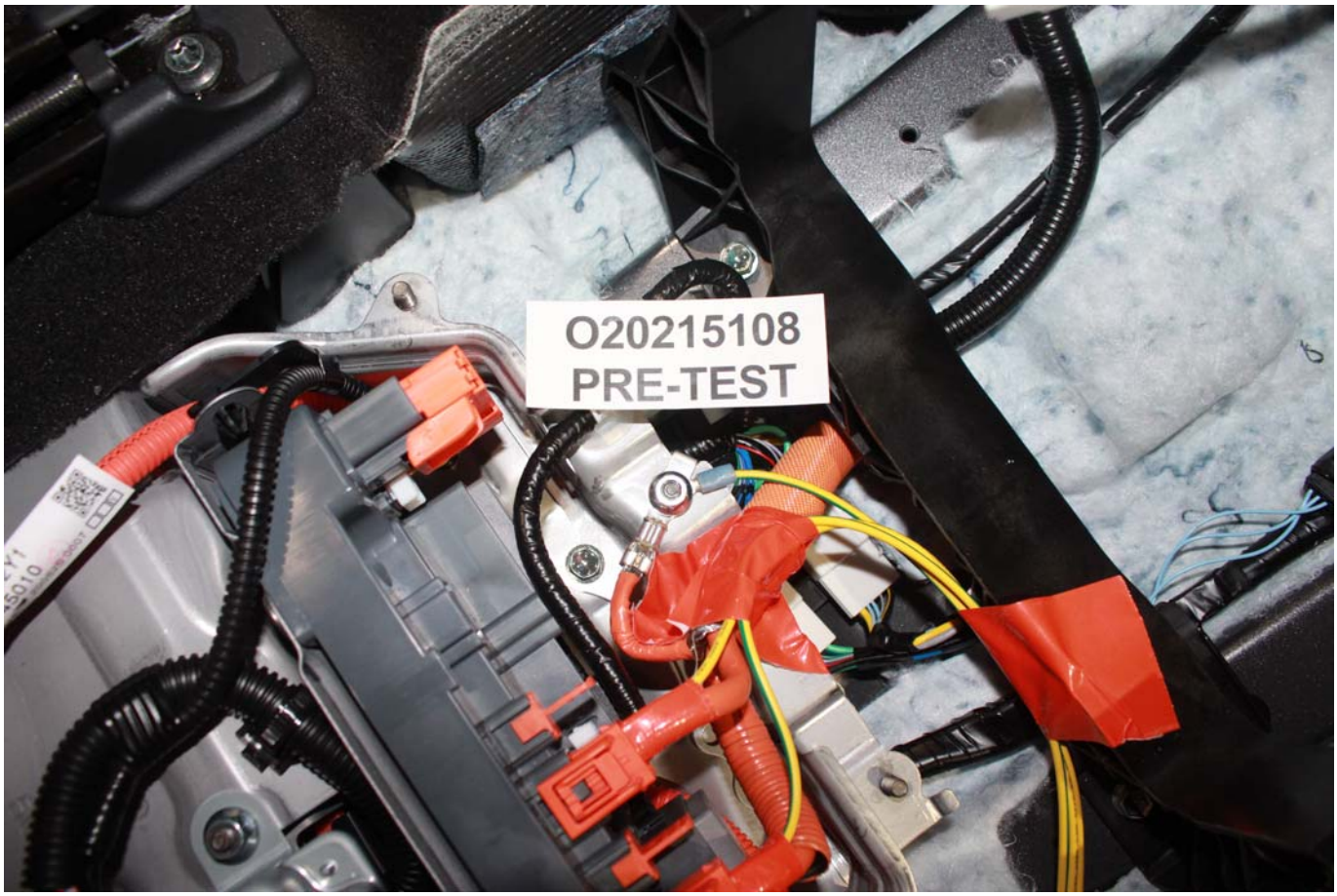

Photo No. 305-21 - Pre-Impact View of Ground Lead Attached

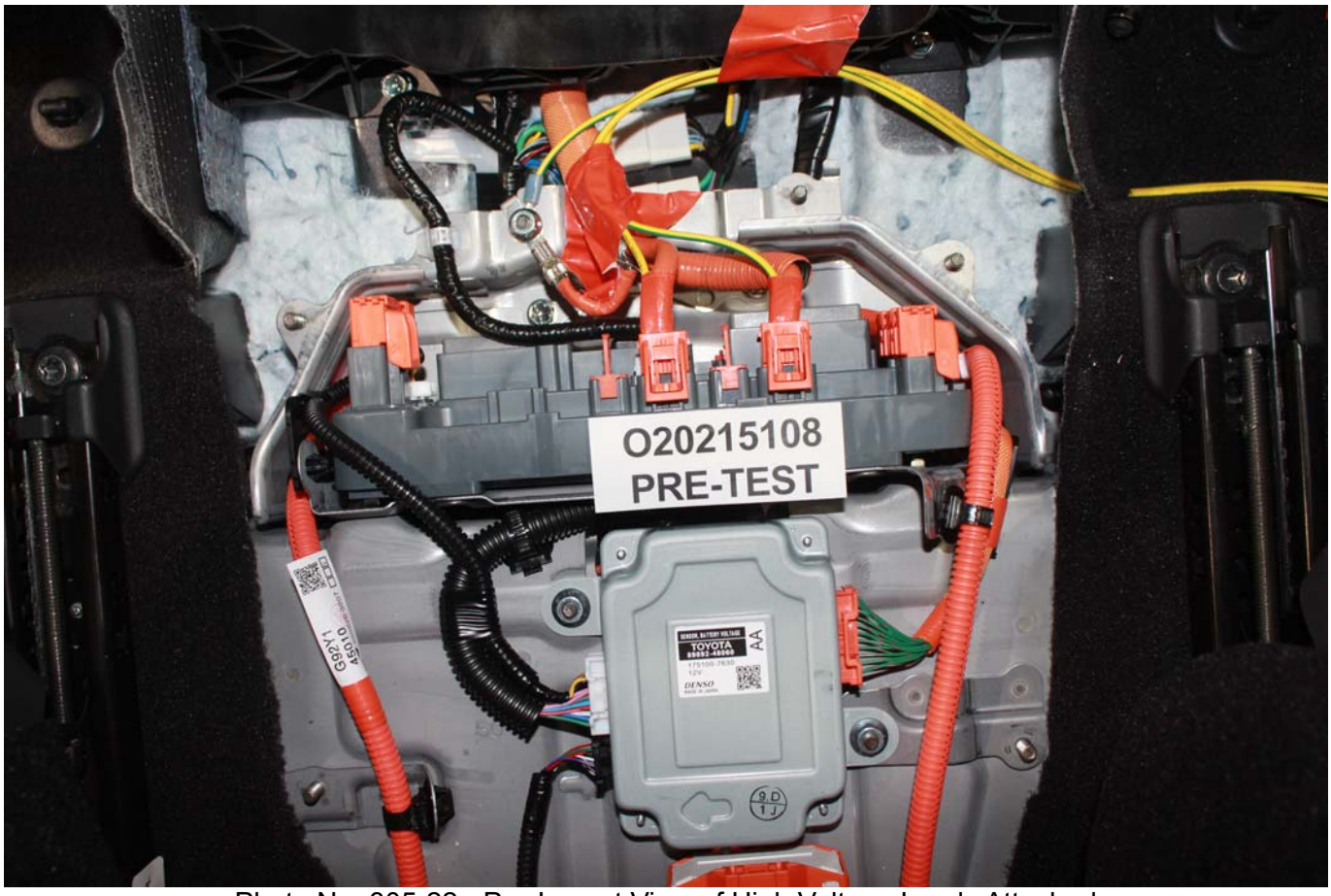

Photo No. 305-22 - Pre-Impact View of High Voltage Leads Attached

Photo No. 305-23 - Pre-Impact Close-Up View of High Voltage Leads Attached

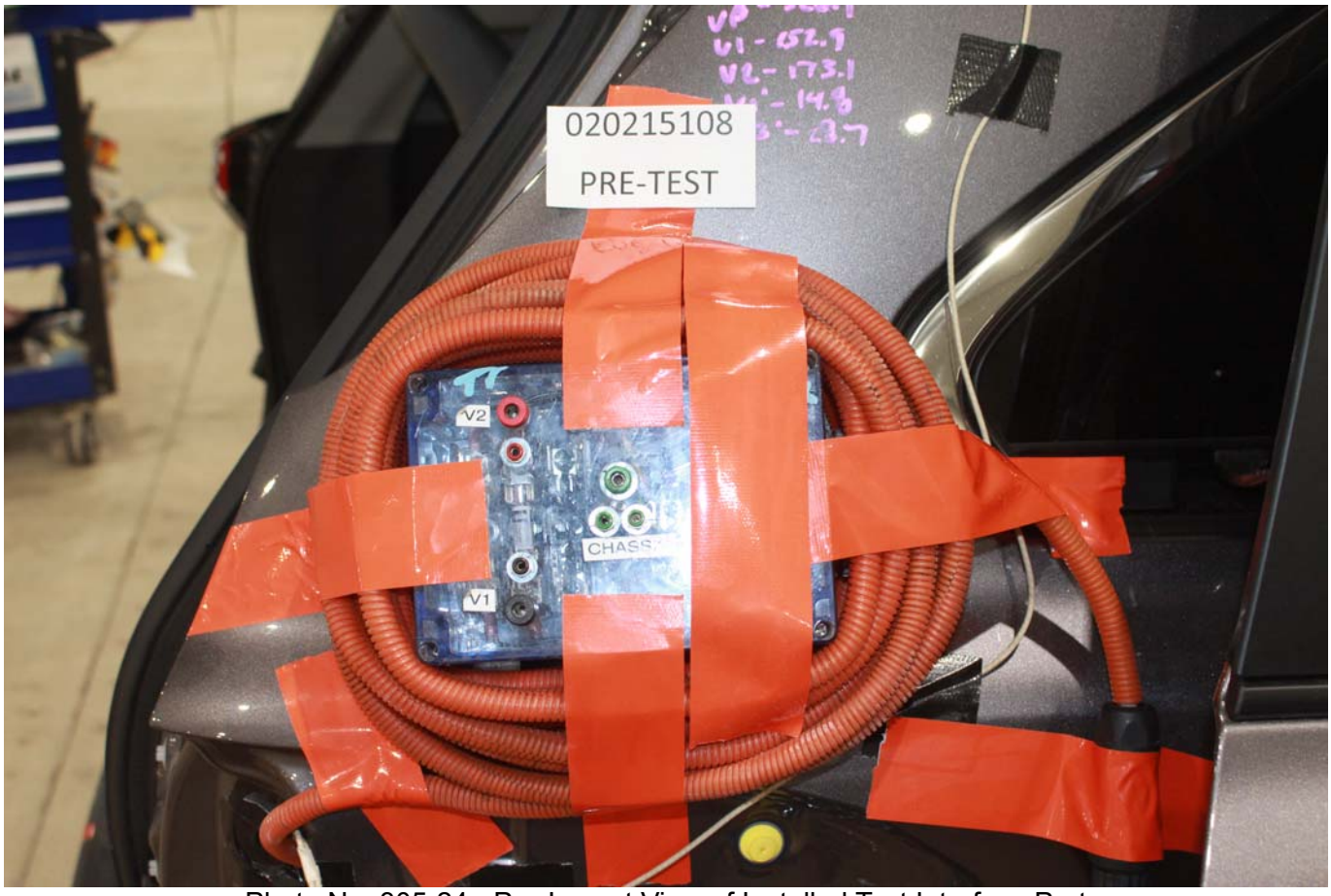

Photo No. 305-24 - Pre-Impact View of Installed Test Interface Port

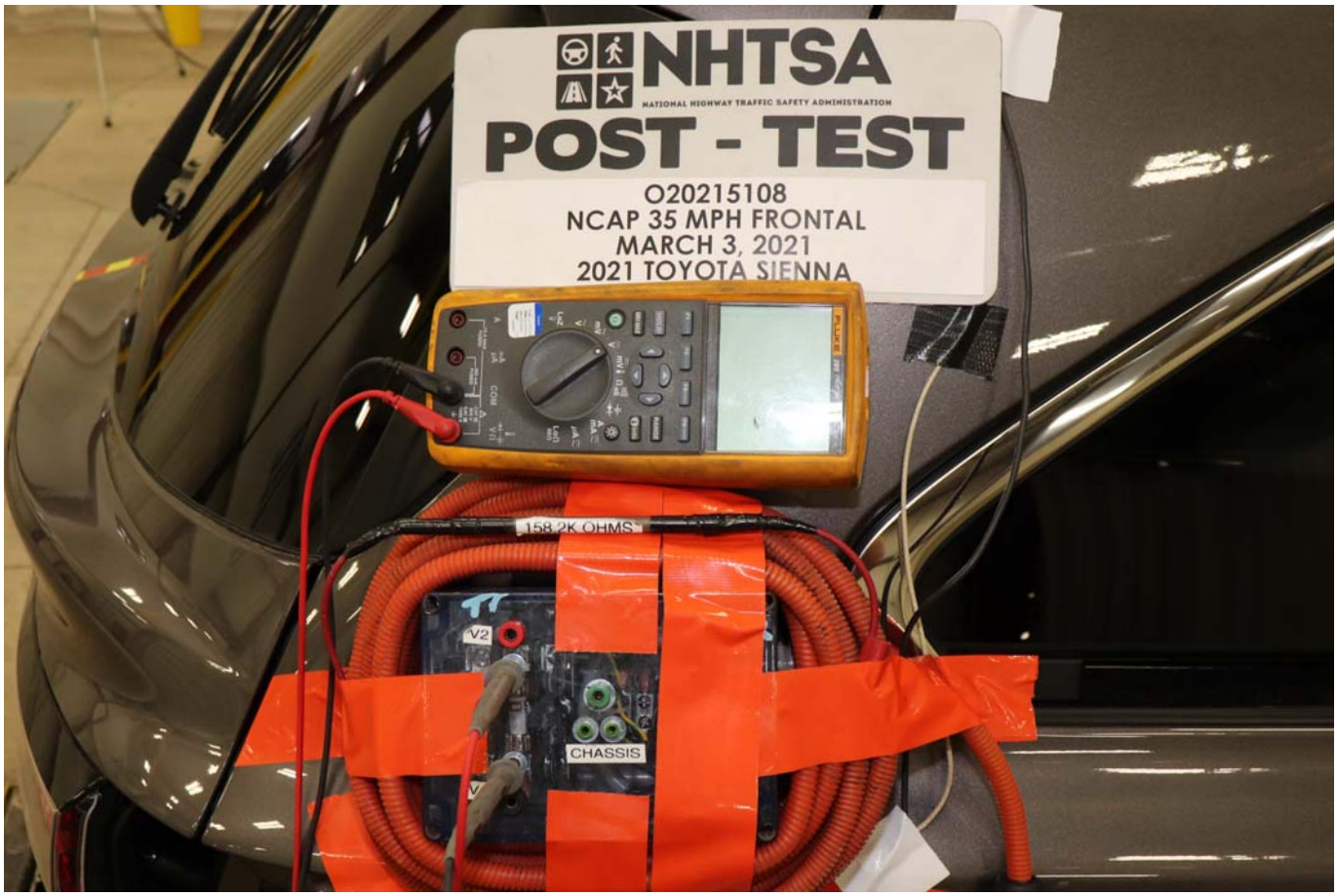

Photo No. 305-25 - Post-Impact View of Installed Test Interface Port

Photo No. 305-26 - Pre-Impact View of Other Test Devices

Photo No. 305-27 - Post-Impact View of Other Test Devices

Photo No. 305-28 - FMVSS No. 305 Static Rollover at 90 Degrees

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Photo No. 305-31 - FMVSS No. 305 Static Rollover at 360 Degrees

Photo No. 305-32 - Pre-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery

Photo No. 305-33 - Post-Impact View of the Vehicle Passenger Compartment Adjacent to Propulsion Battery

PHOTOGRAPH NOT APPLICABLE

Photo No. 305-34 - Post-Impact Propulsion Battery System Mounting and-or Intrusion Failure(s)

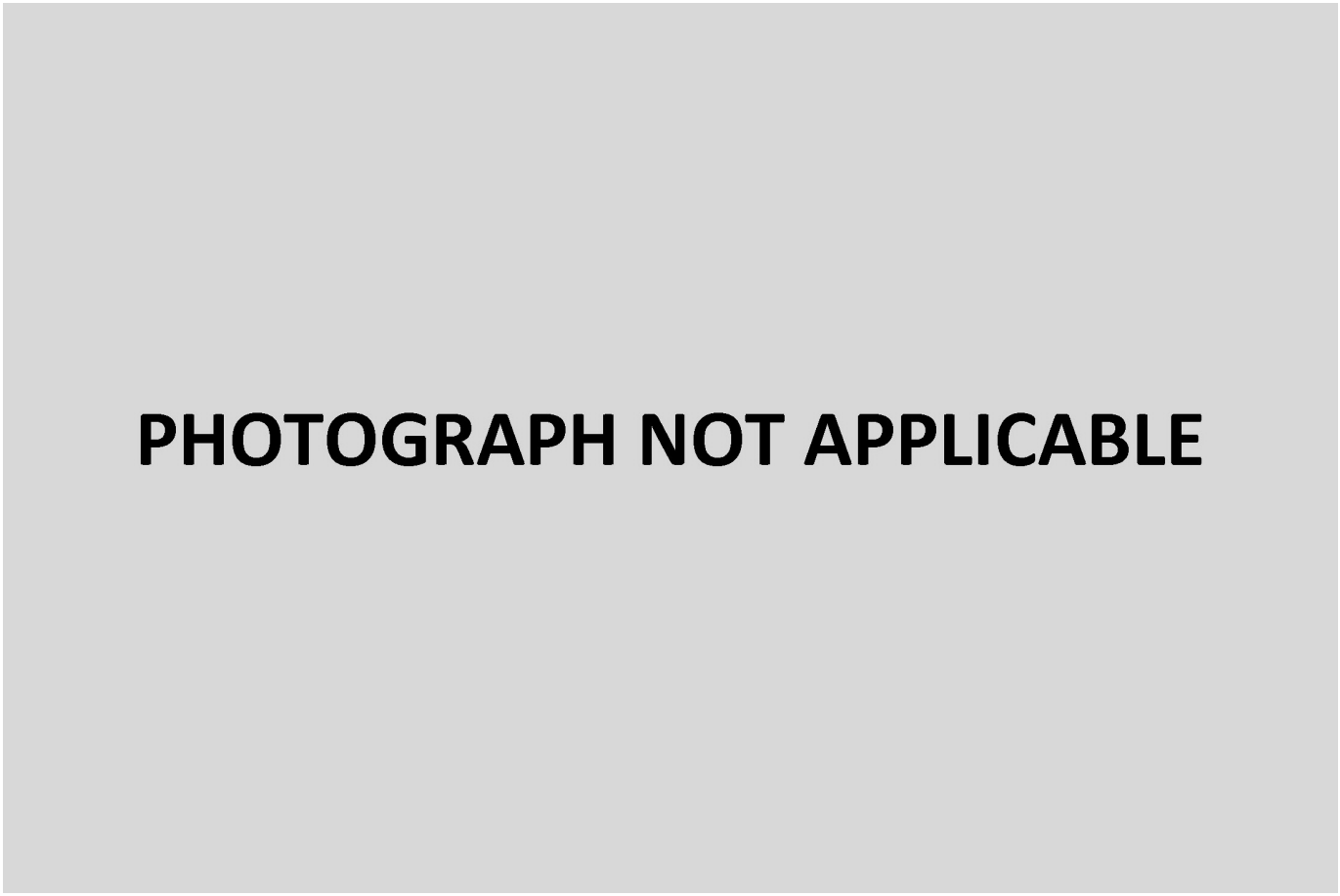


Photo No. 305-35 - Post-Impact View of Battery Component Intrusion

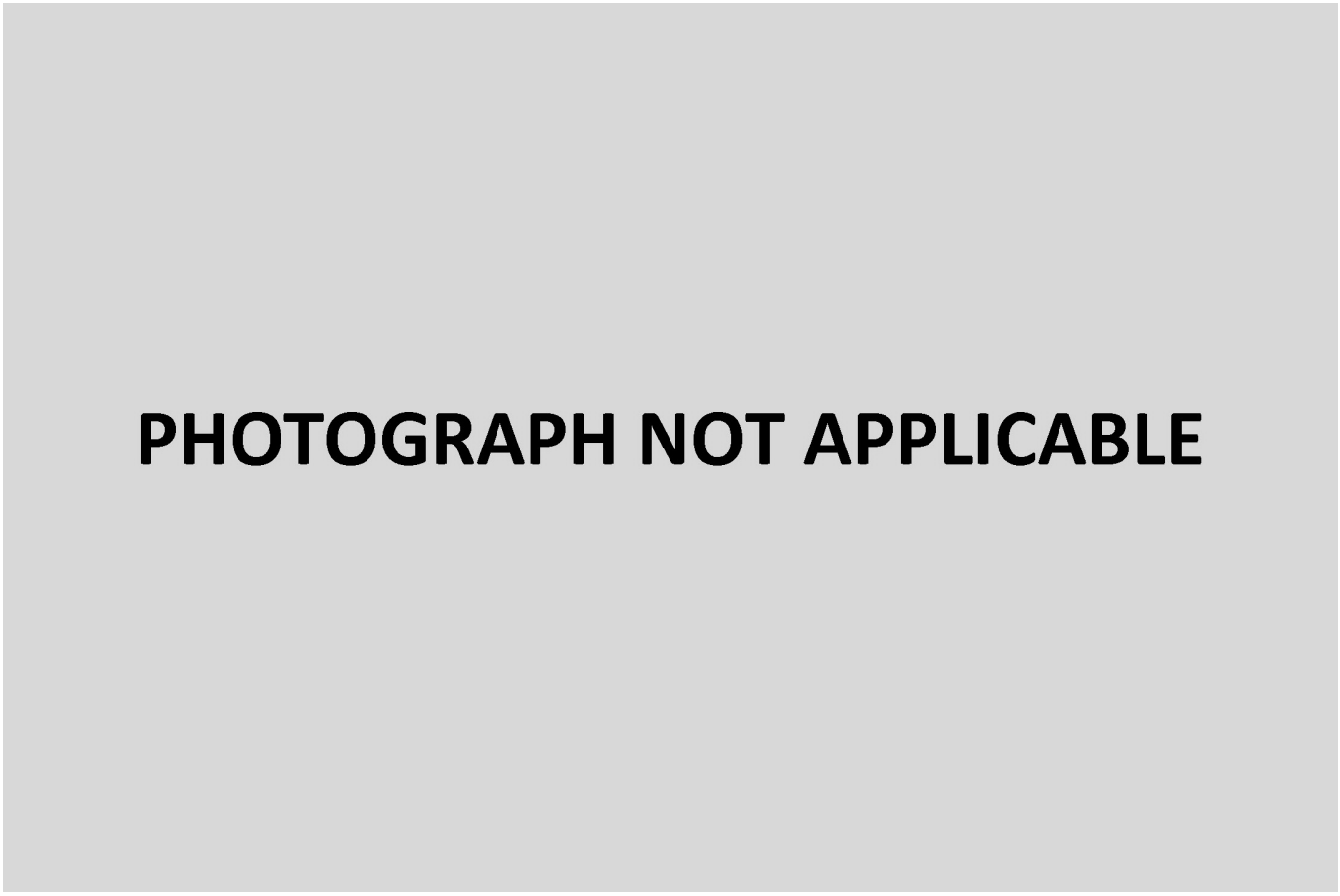


Photo No. 305-36 - Post-Impact View of Battery Module Movement or Retention Loss

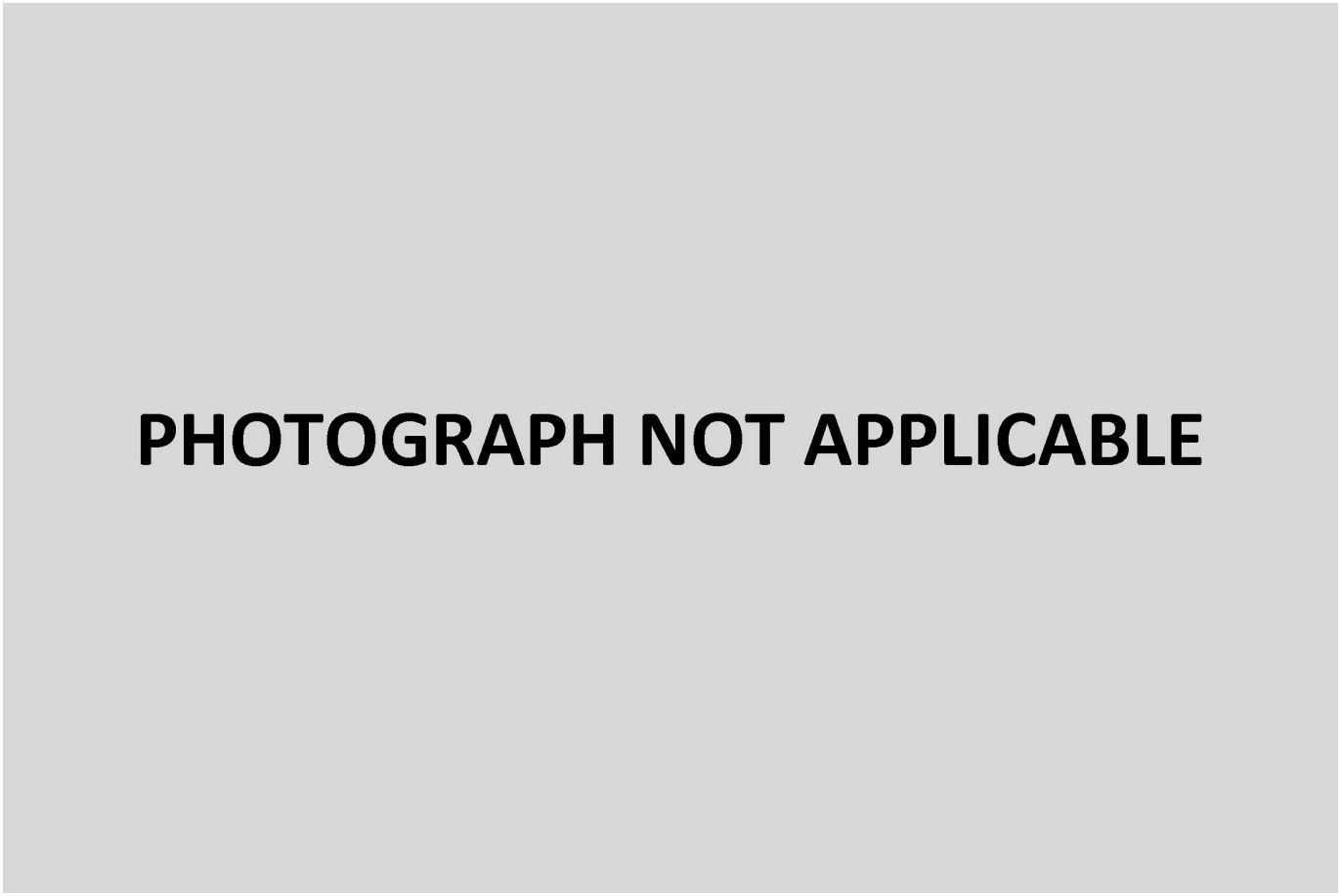


Photo No. 305-37 - Post-Impact View of Propulsion Battery Electrolyte Spillage Location

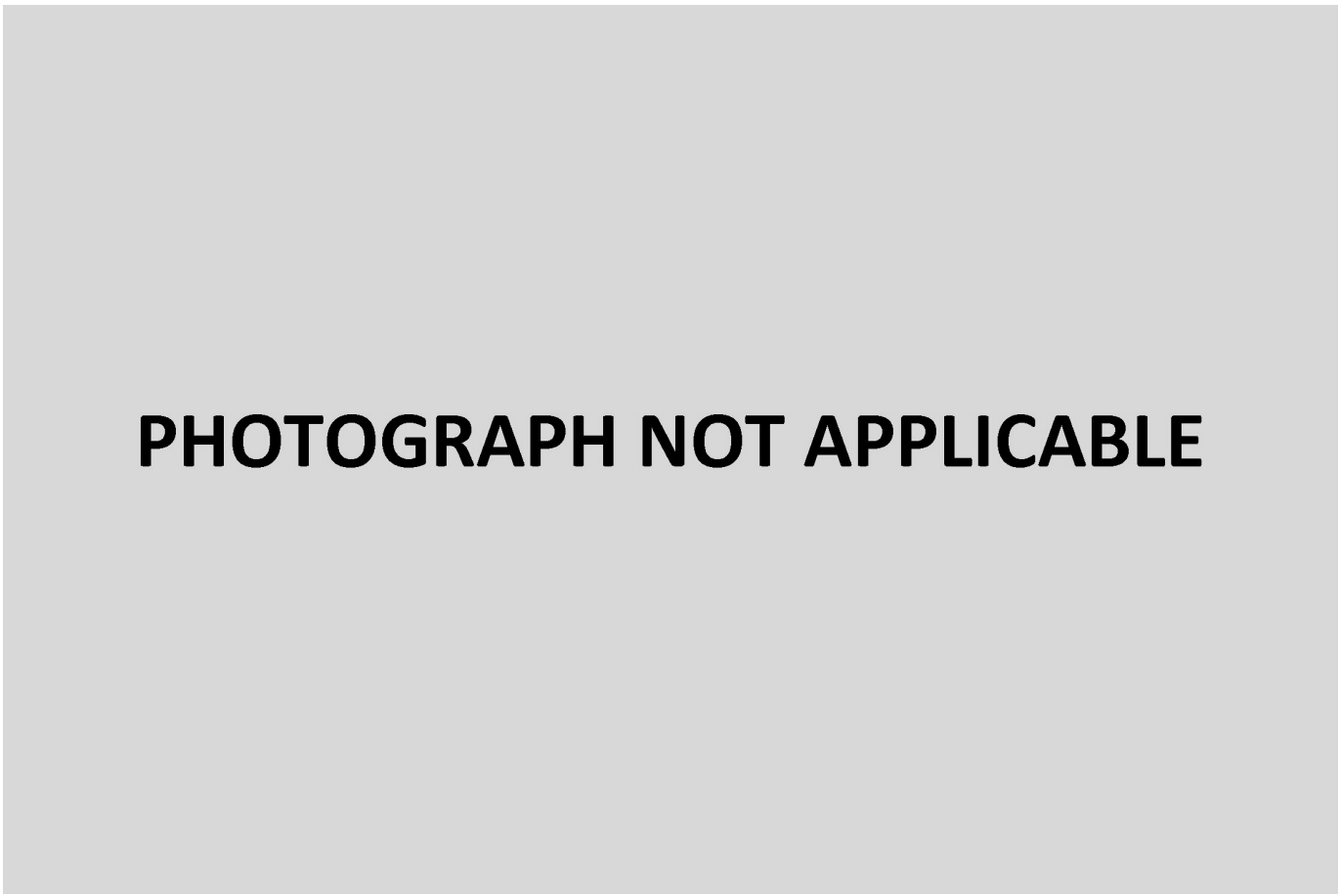


Photo No. 305-38 - Post-Test View of Propulsion Battery Electrolyte Spillage Location

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

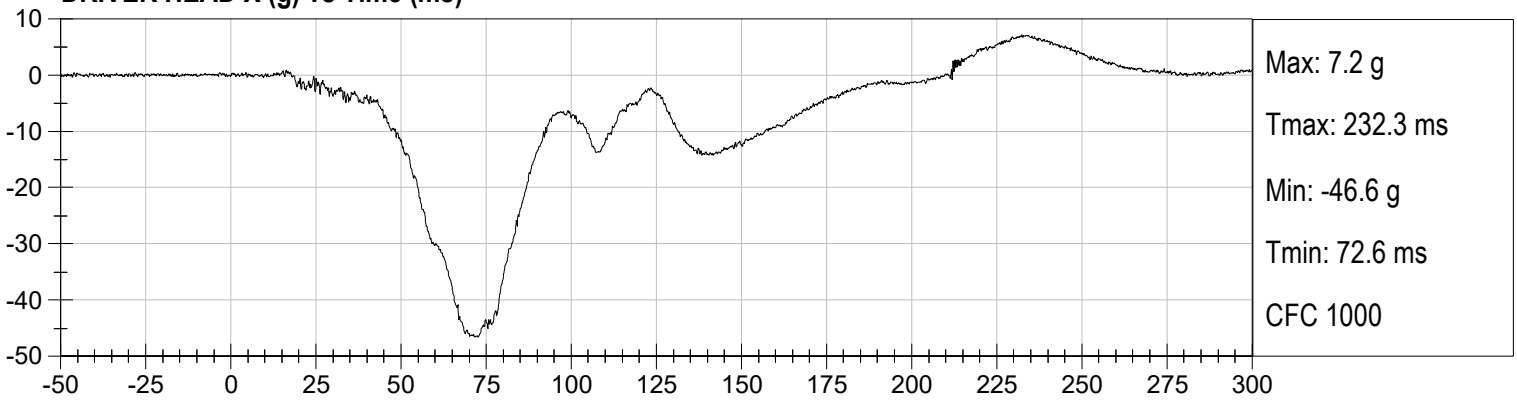
Right Rear Seat Crossmember Z

Left Rear Seat Crossmember Xr

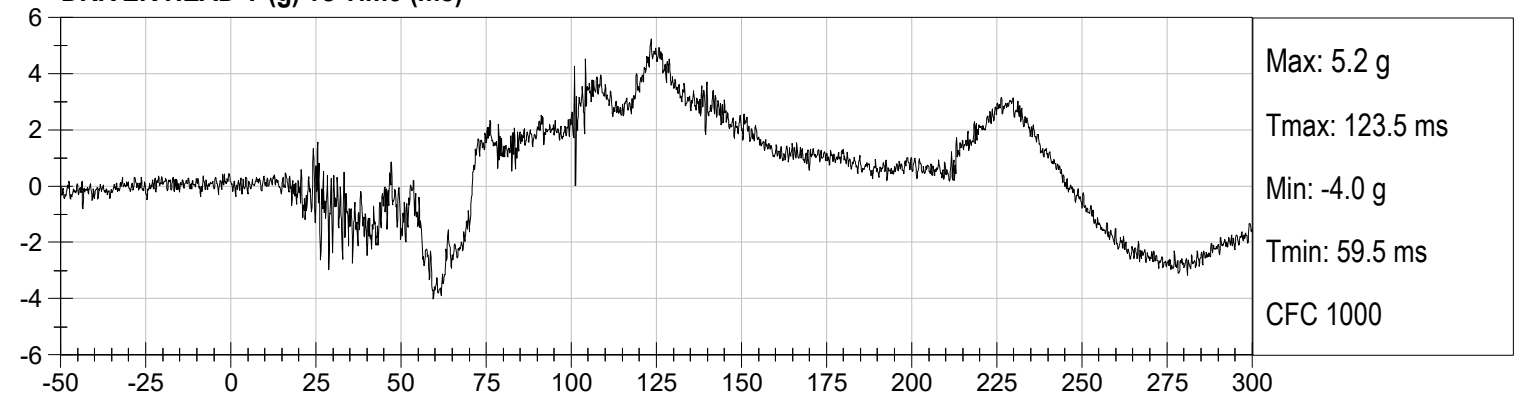
Right Rear Seat Crossmember Xr

Advanced Research Load Cell Barrier – 528 channels

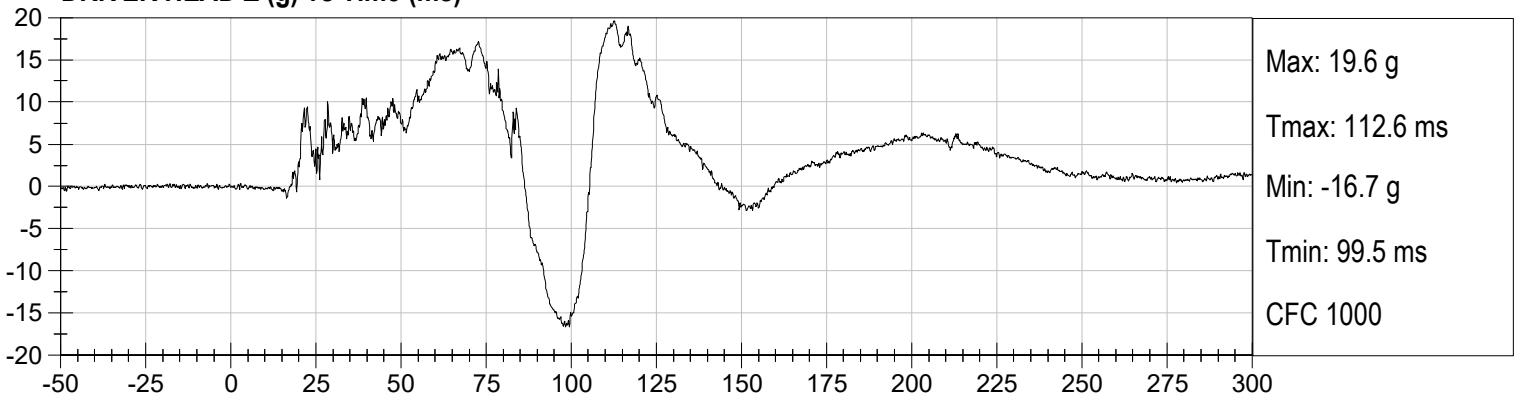
DRIVER HEAD X (g) vs Time (ms)



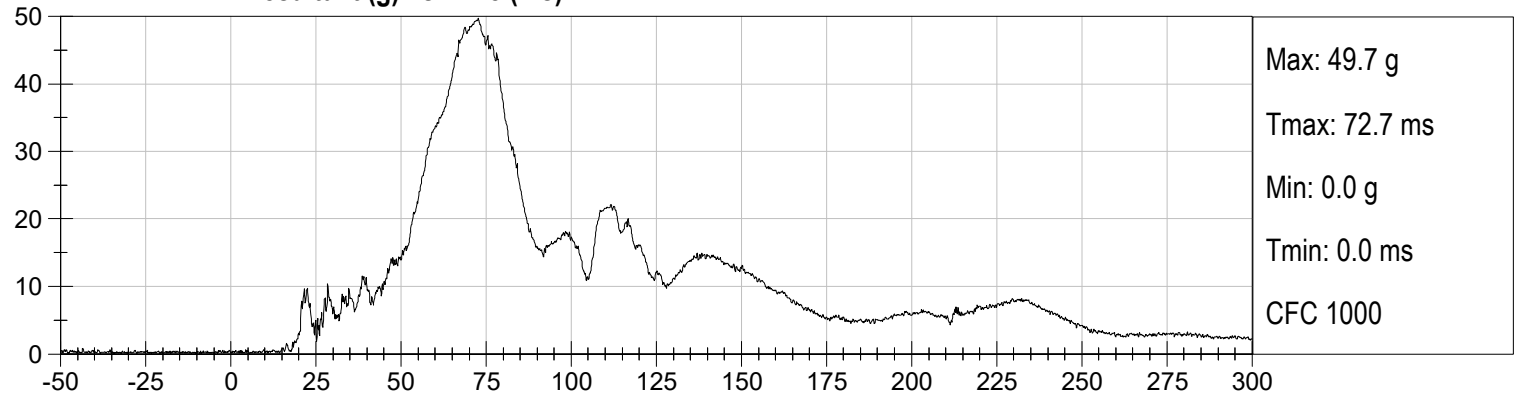
DRIVER HEAD Y (g) vs Time (ms)



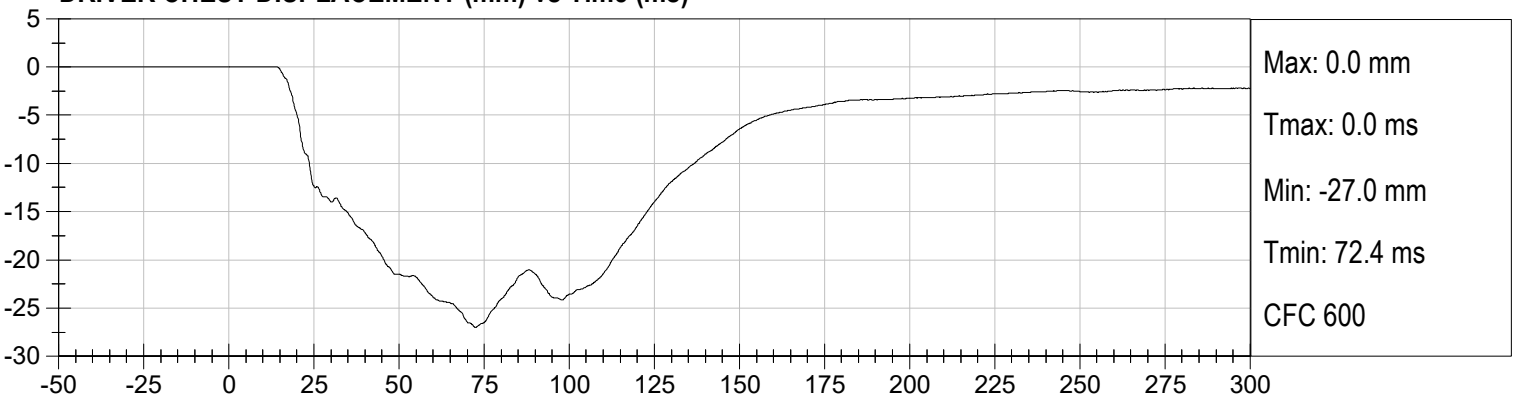
DRIVER HEAD Z (g) vs Time (ms)



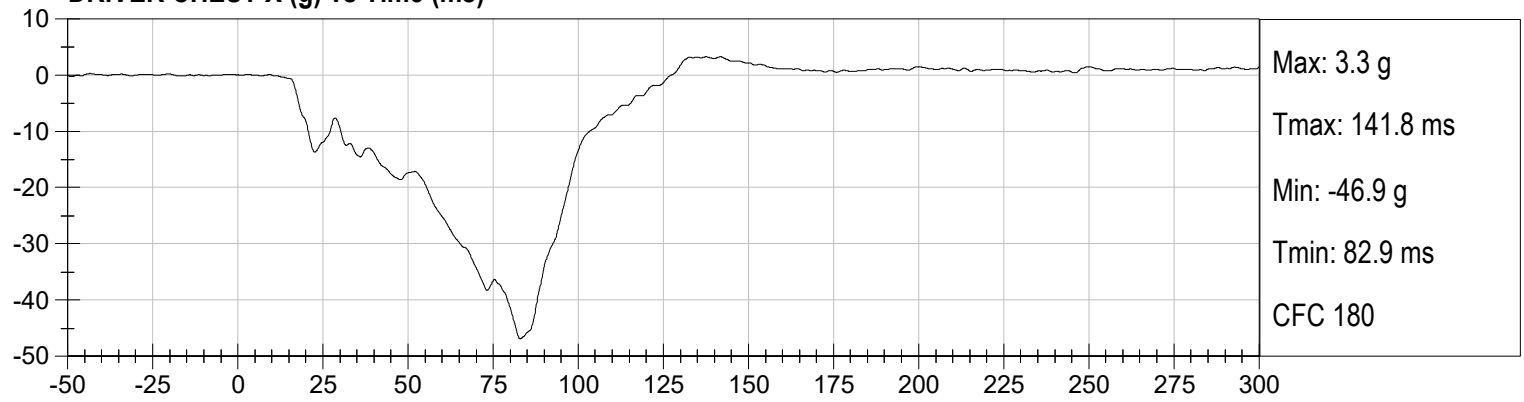
DRIVER HEAD Resultant (g) vs Time (ms)



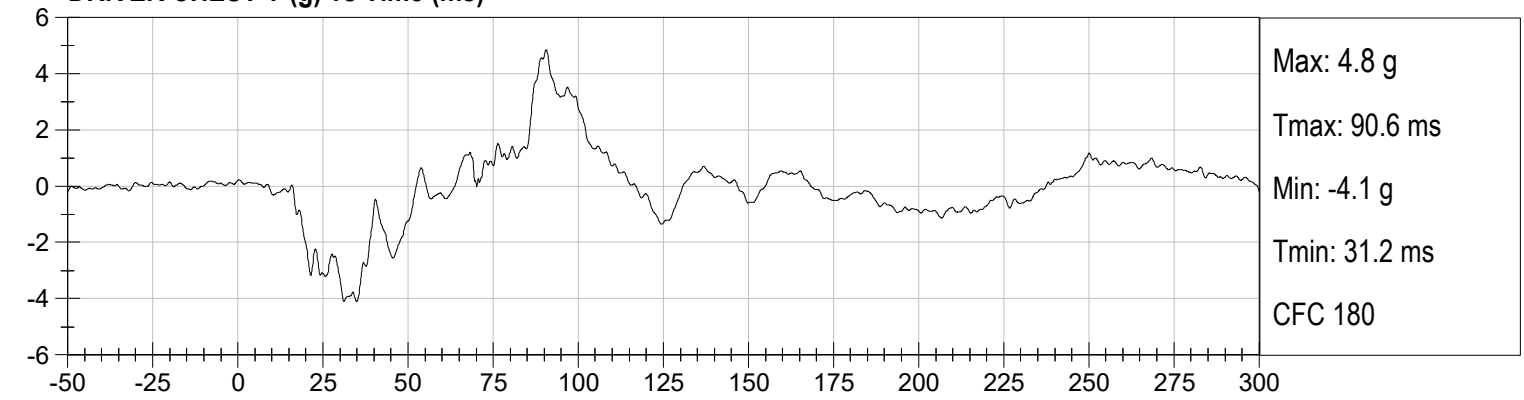
DRIVER CHEST DISPLACEMENT (mm) vs Time (ms)



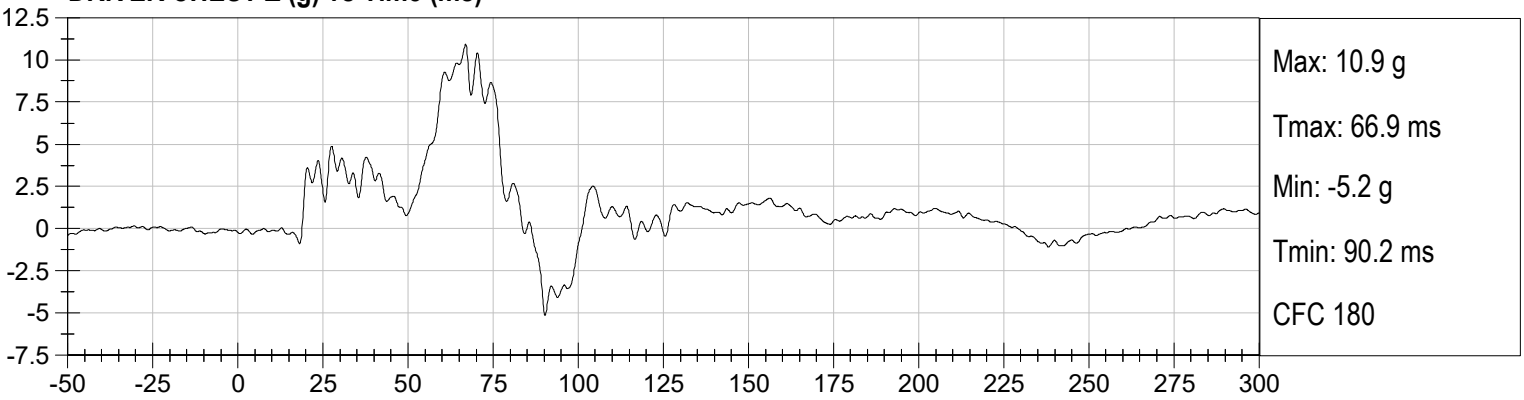
DRIVER CHEST X (g) vs Time (ms)



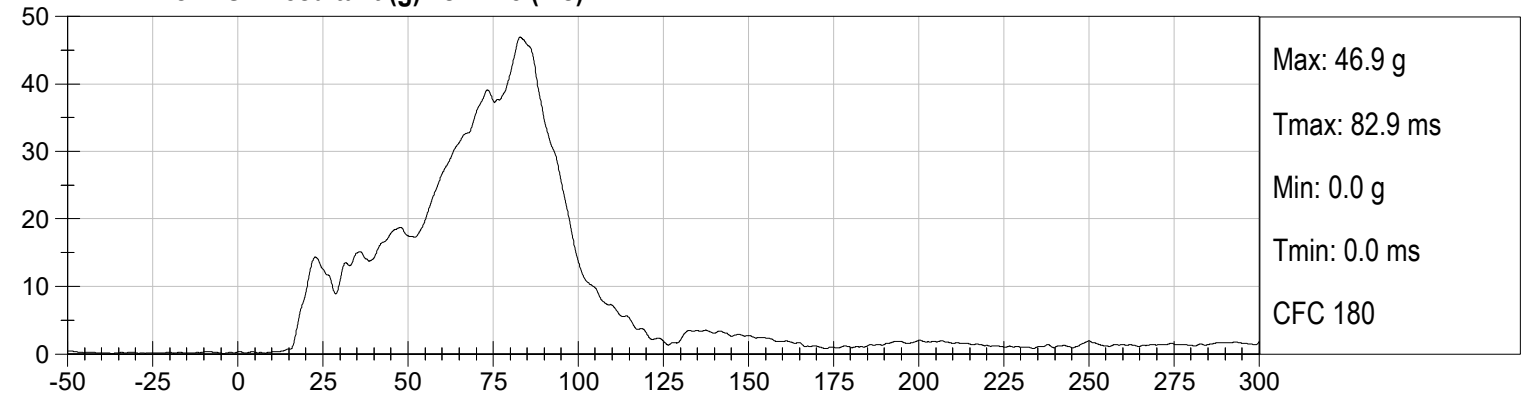
DRIVER CHEST Y (g) vs Time (ms)



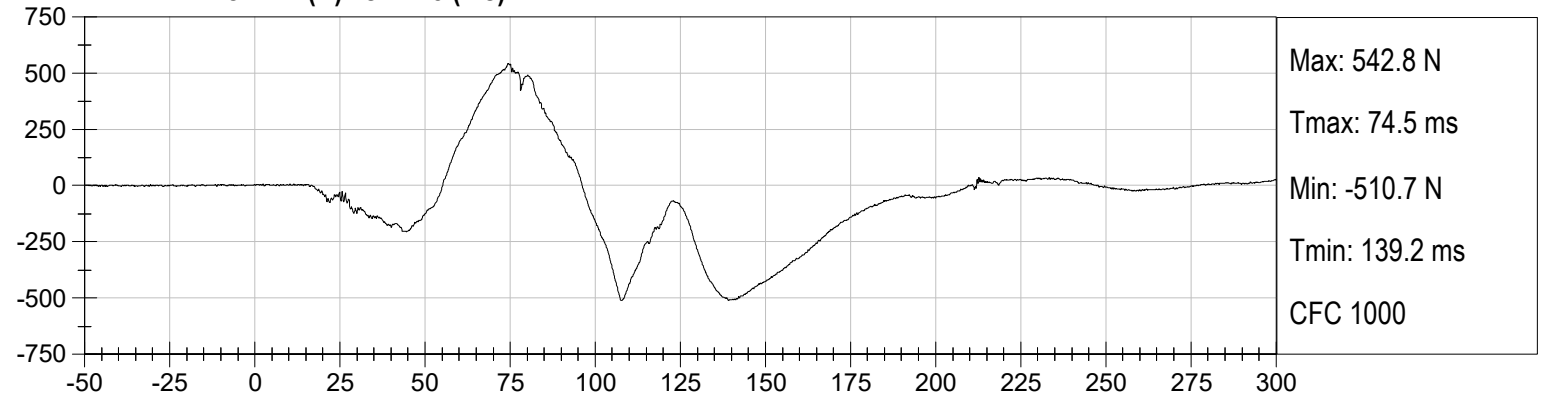
DRIVER CHEST Z (g) vs Time (ms)



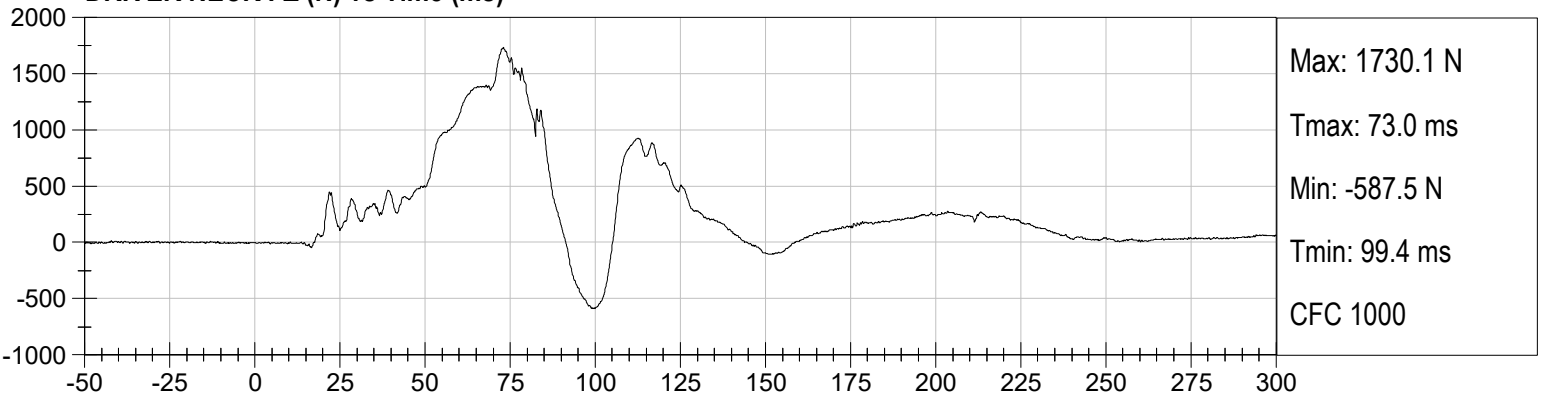
DRIVER CHEST Resultant (g) vs Time (ms)



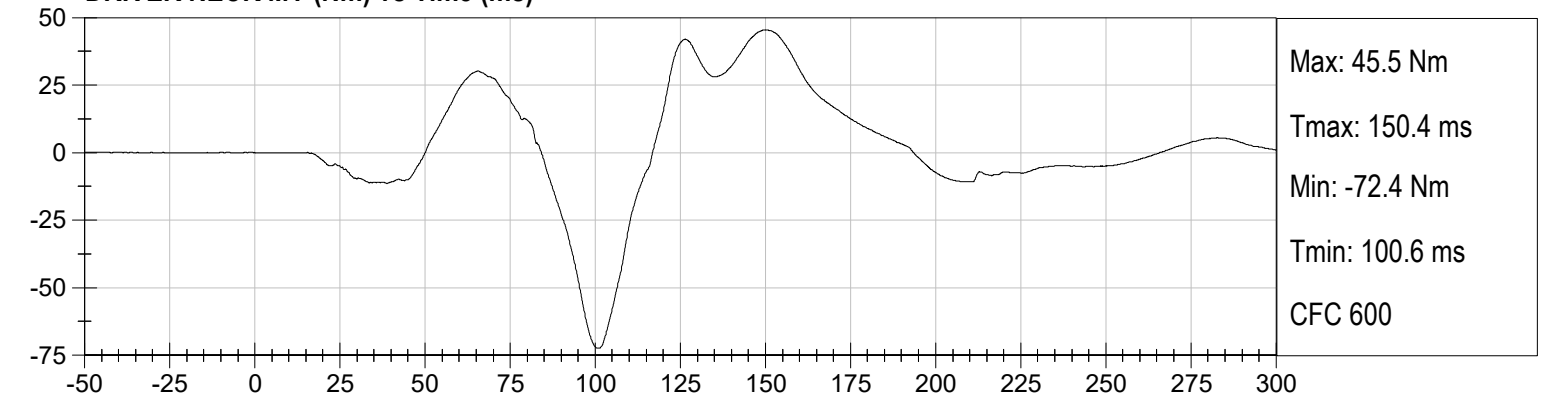
DRIVER NECK FX (N) vs Time (ms)



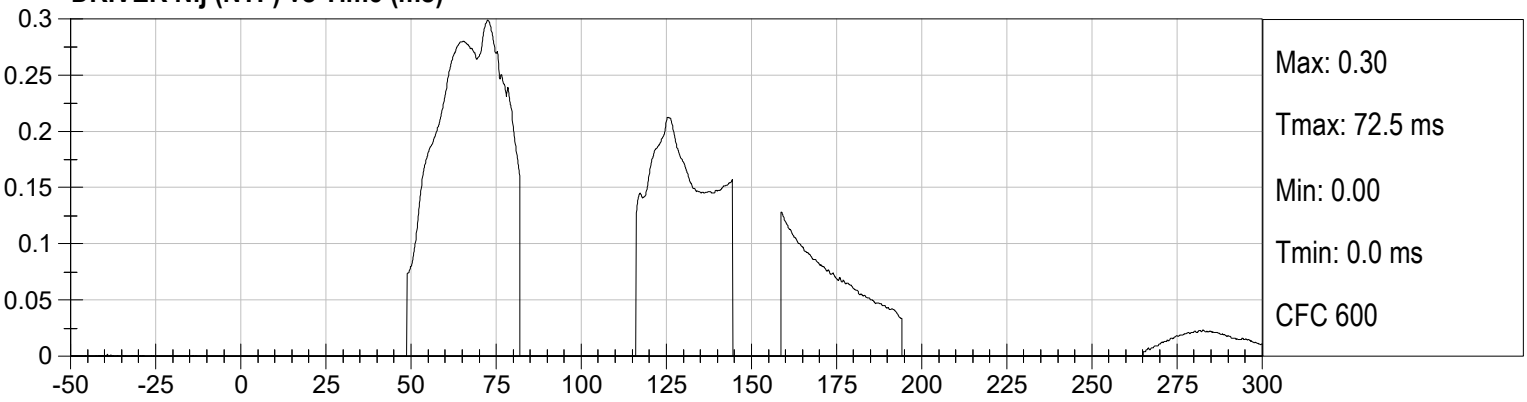
DRIVER NECK FZ (N) vs Time (ms)



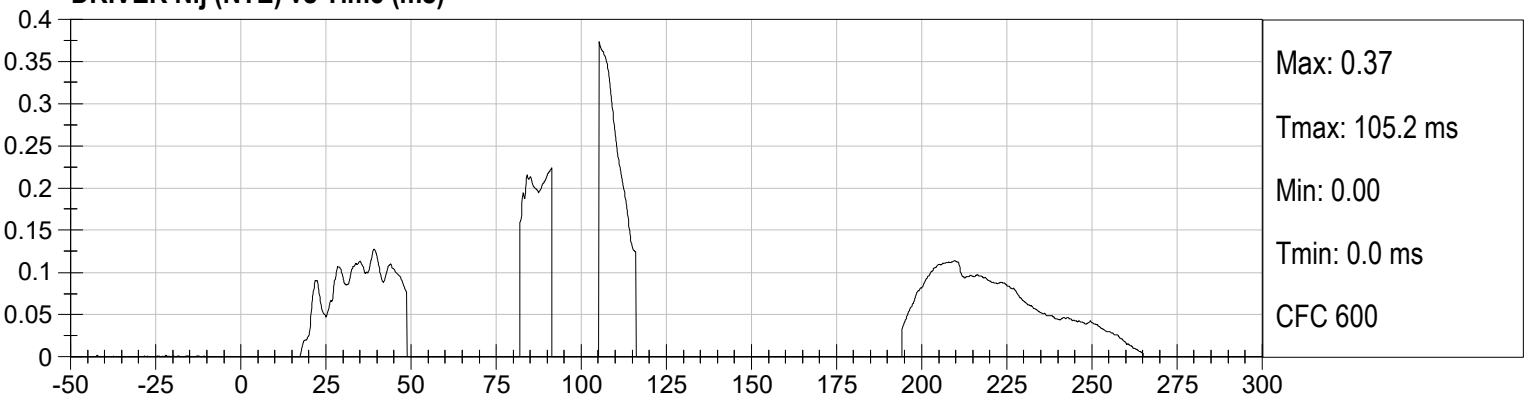
DRIVER NECK MY (Nm) vs Time (ms)



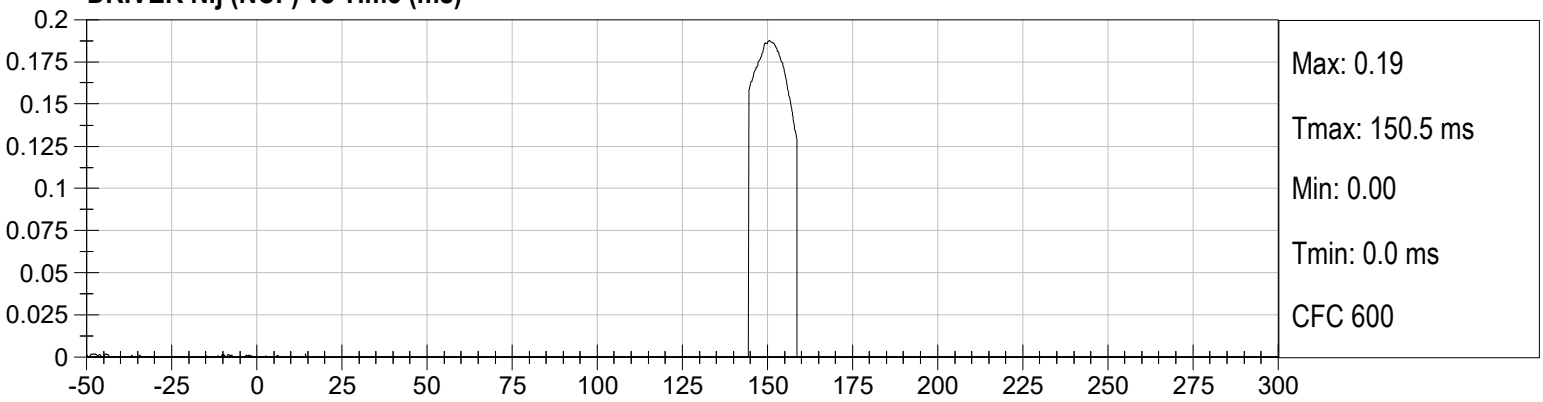
DRIVER Nij (NTF) vs Time (ms)



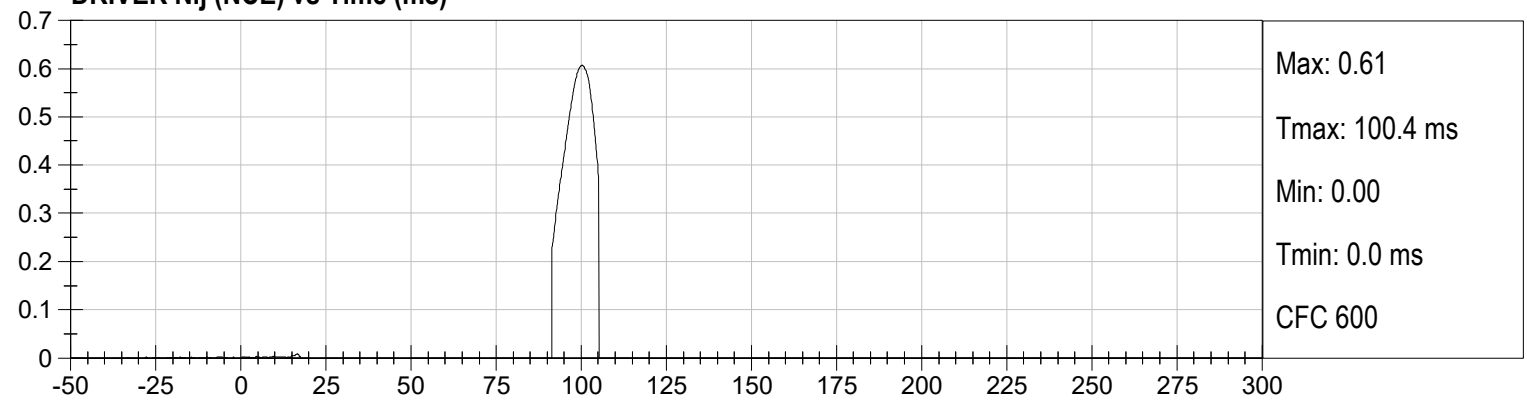
DRIVER Nij (NTE) vs Time (ms)



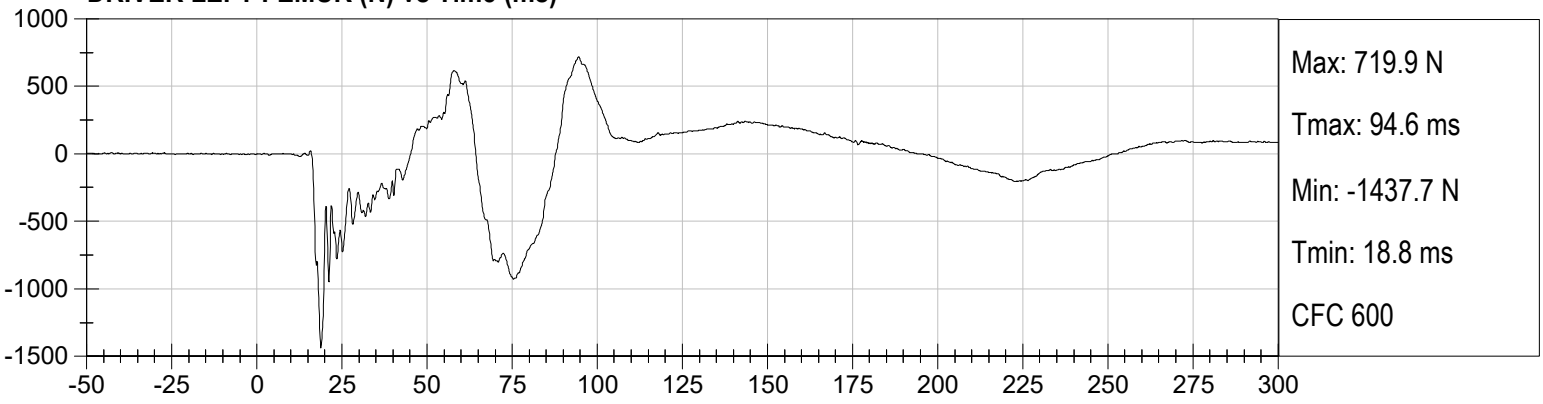
DRIVER Nij (NCF) vs Time (ms)



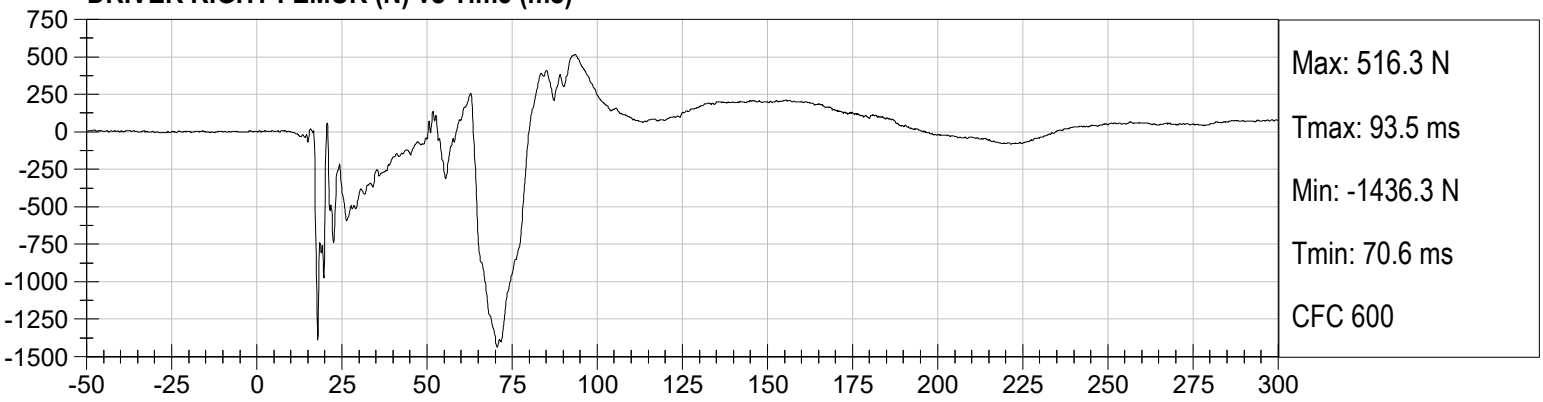
DRIVER Nij (NCE) vs Time (ms)



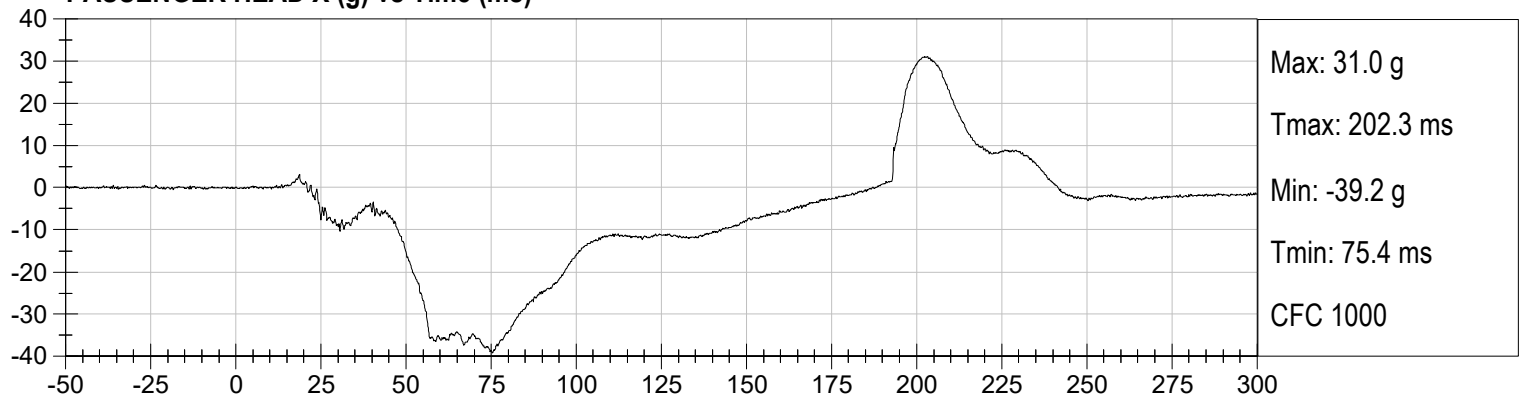
DRIVER LEFT FEMUR (N) vs Time (ms)



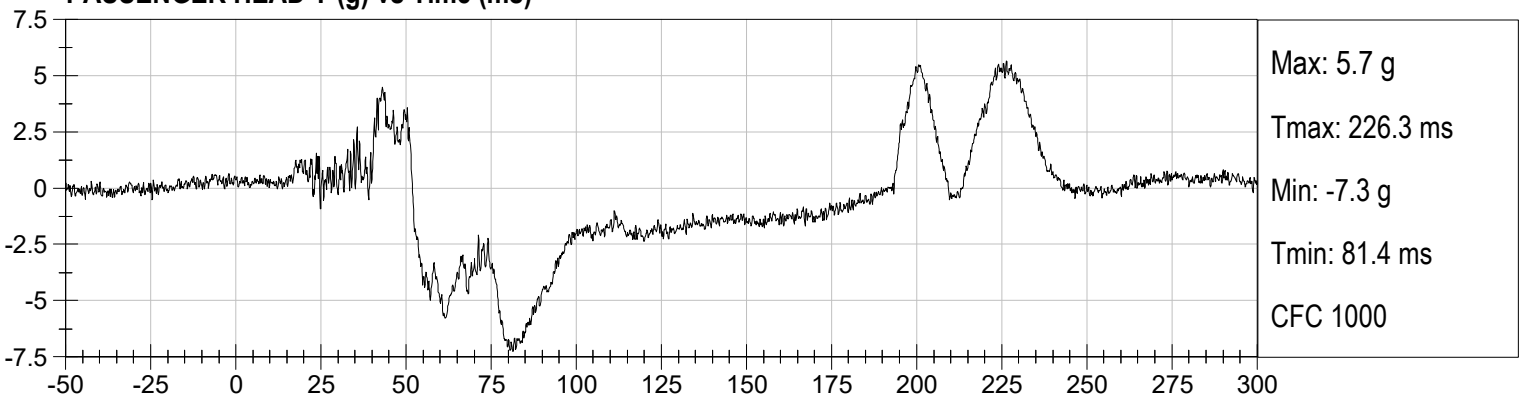
DRIVER RIGHT FEMUR (N) vs Time (ms)



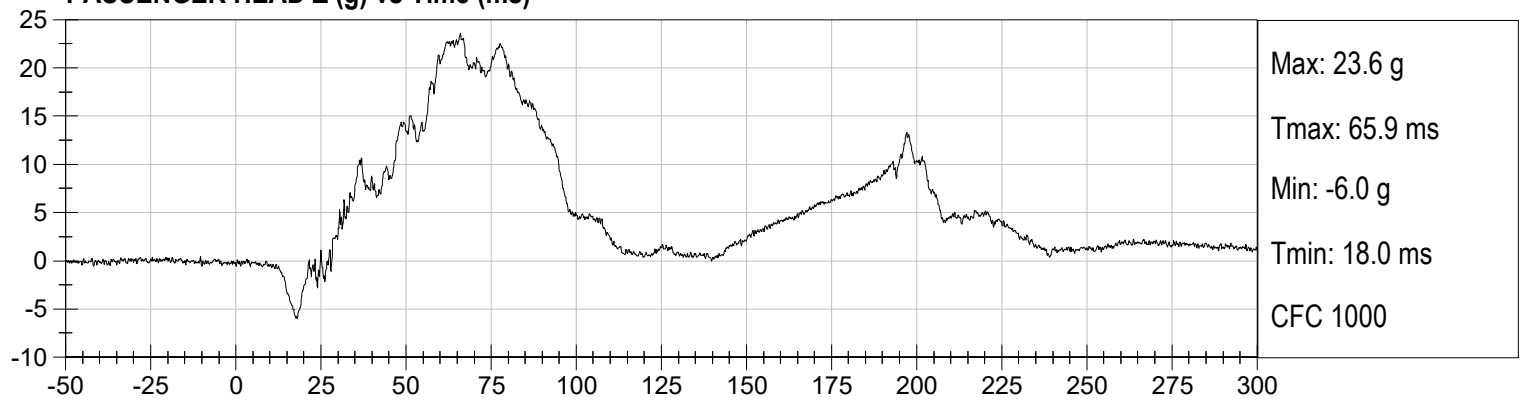
PASSENGER HEAD X (g) vs Time (ms)



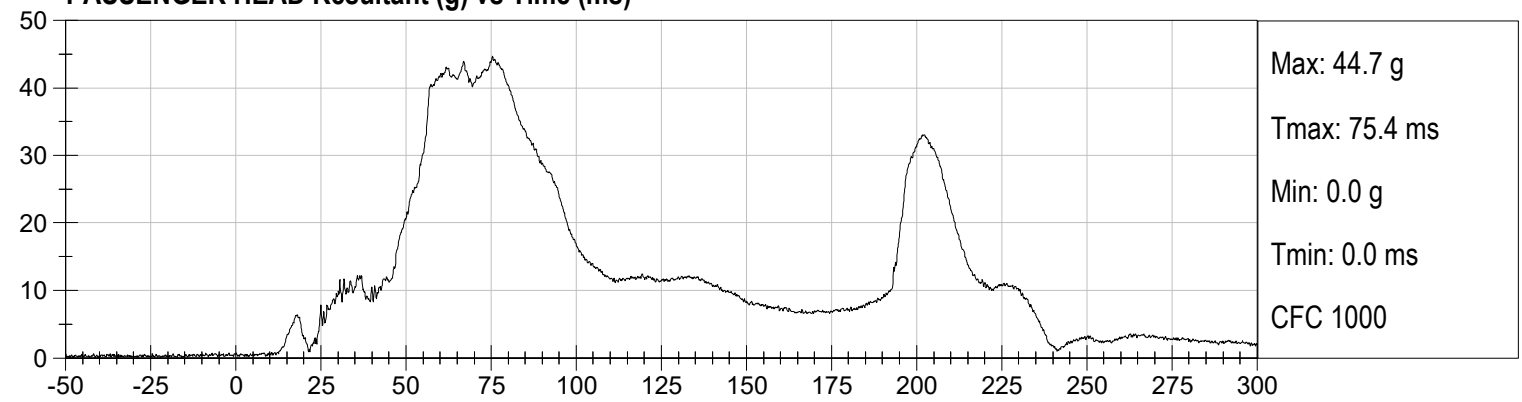
PASSENGER HEAD Y (g) vs Time (ms)



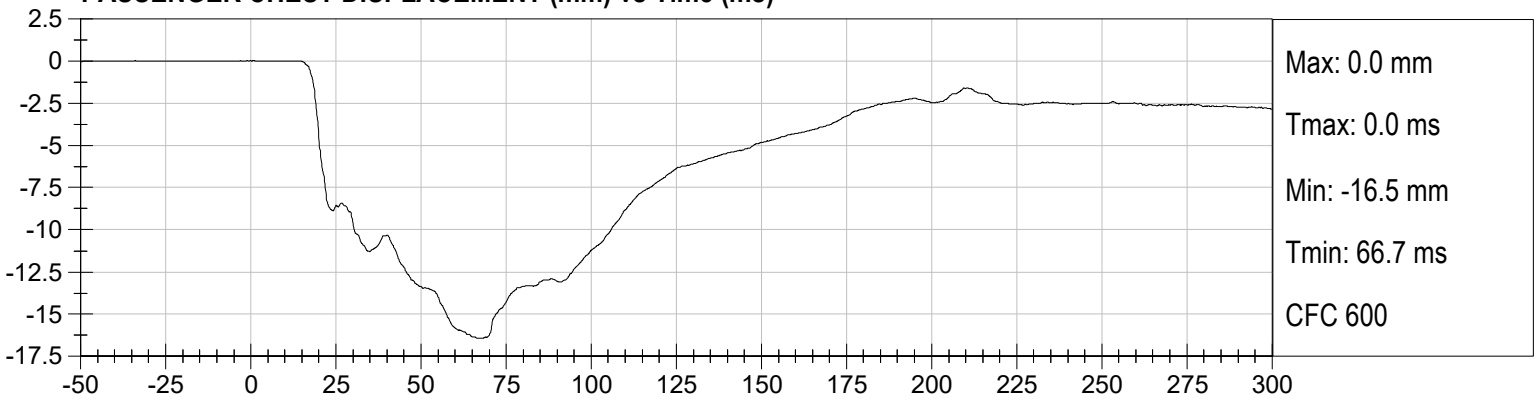
PASSENGER HEAD Z (g) vs Time (ms)



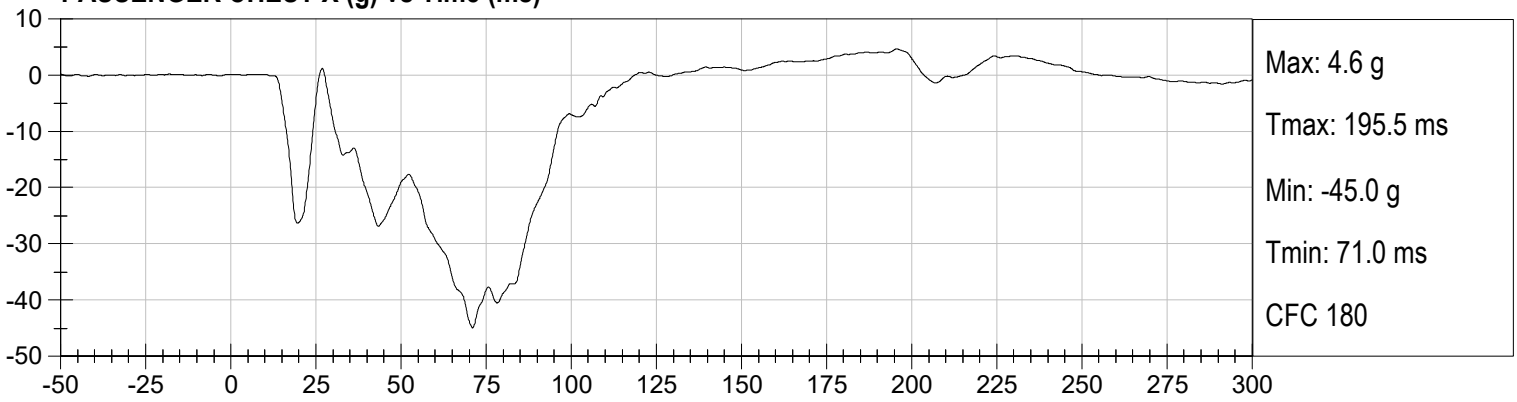
PASSENGER HEAD Resultant (g) vs Time (ms)



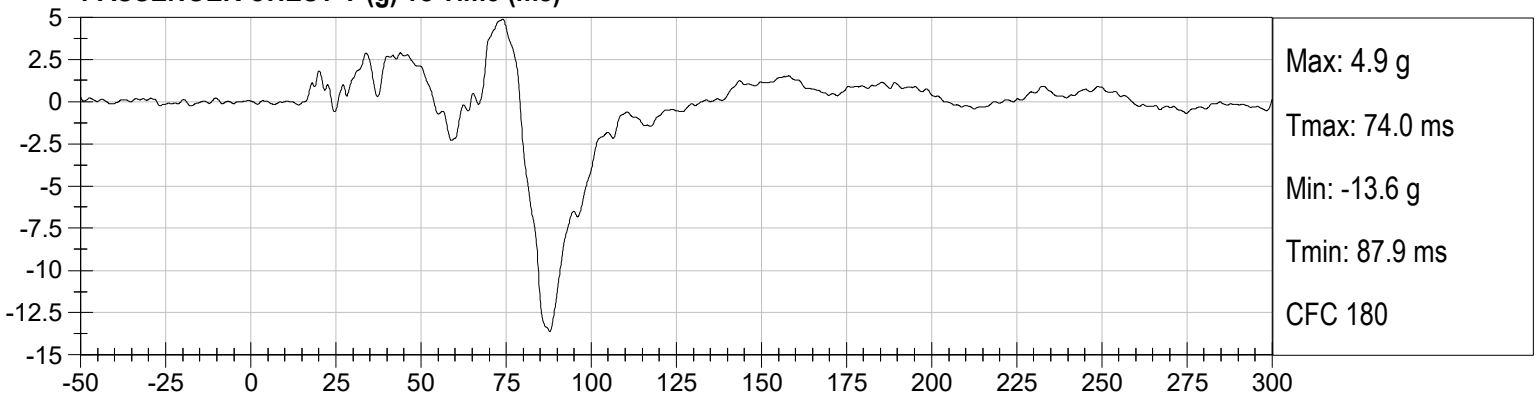
PASSENGER CHEST DISPLACEMENT (mm) vs Time (ms)



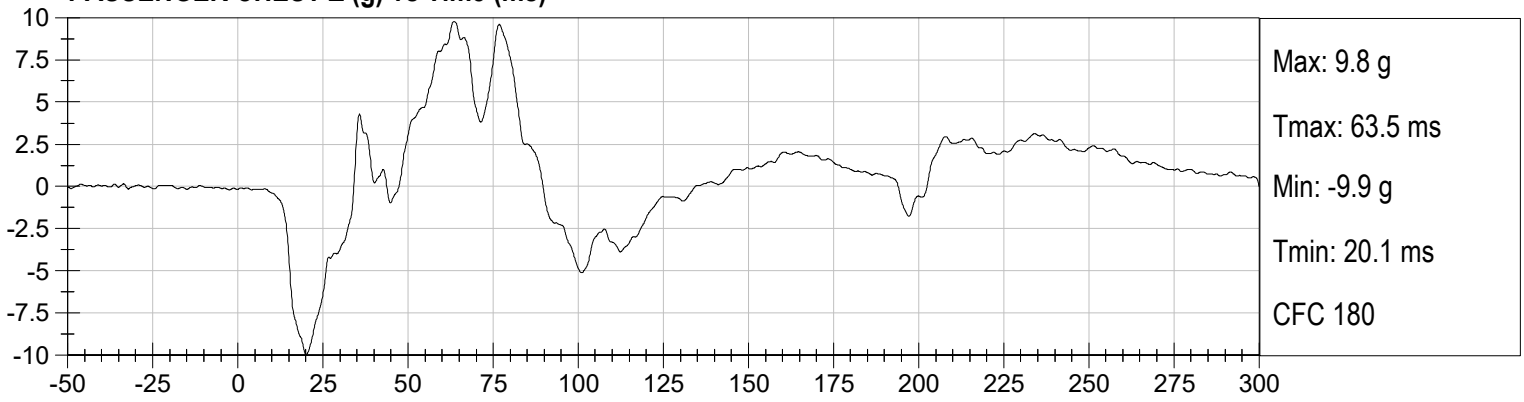
PASSENGER CHEST X (g) vs Time (ms)



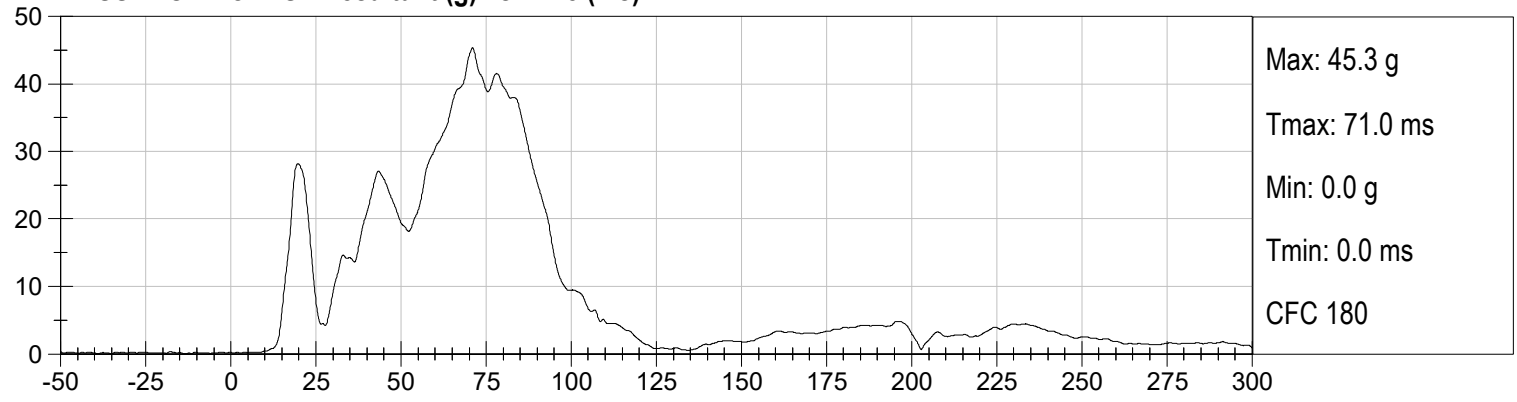
PASSENGER CHEST Y (g) vs Time (ms)



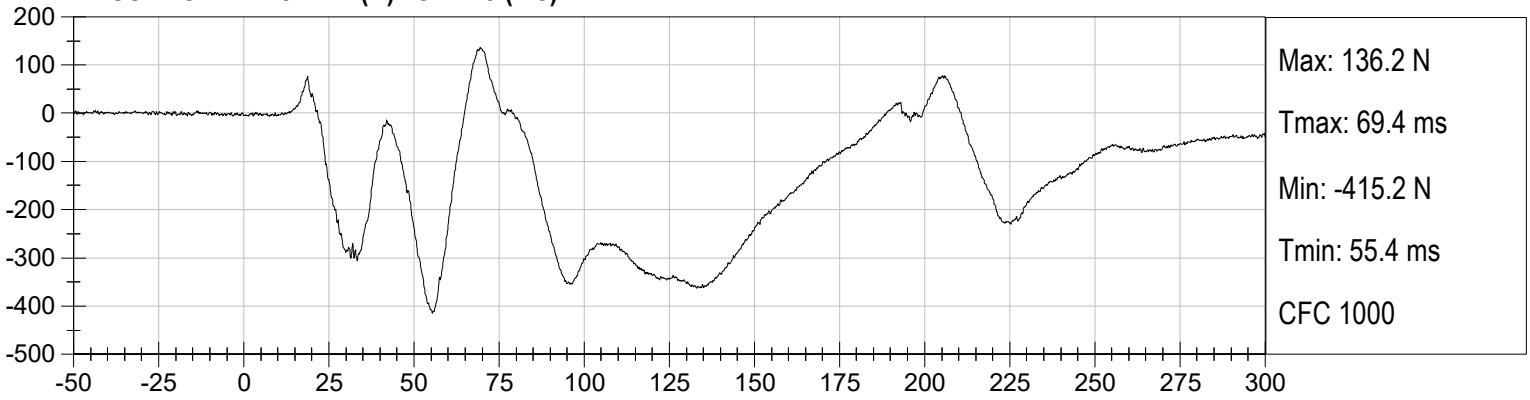
PASSENGER CHEST Z (g) vs Time (ms)



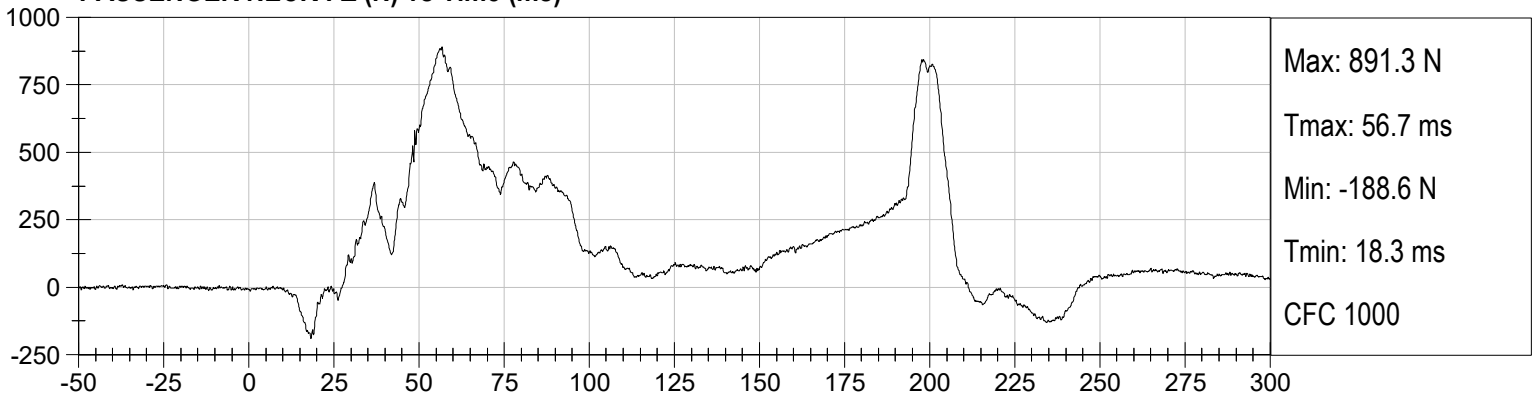
PASSENGER CHEST Resultant (g) vs Time (ms)



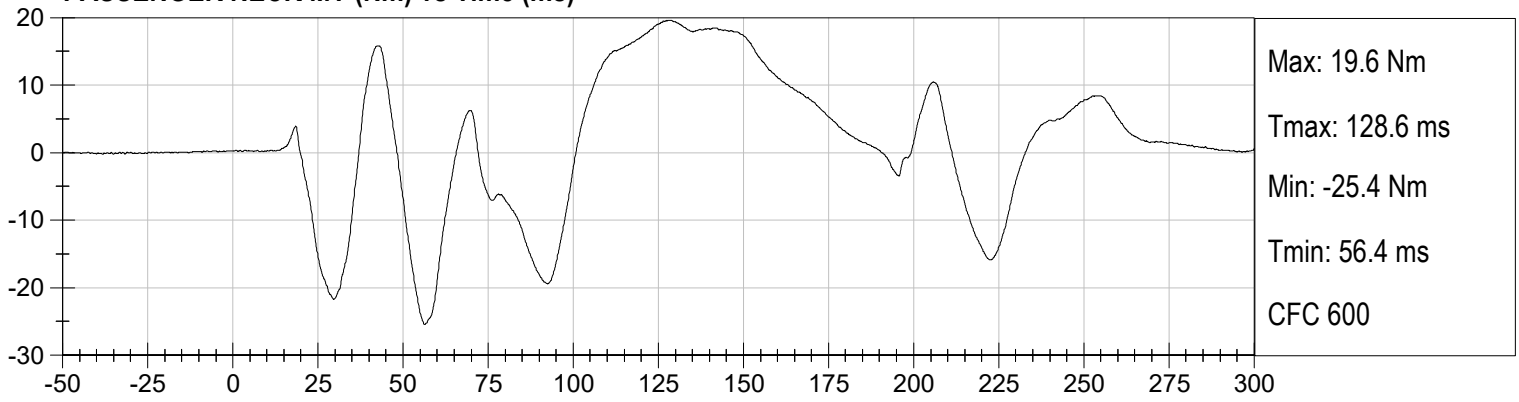
PASSENGER NECK FX (N) vs Time (ms)



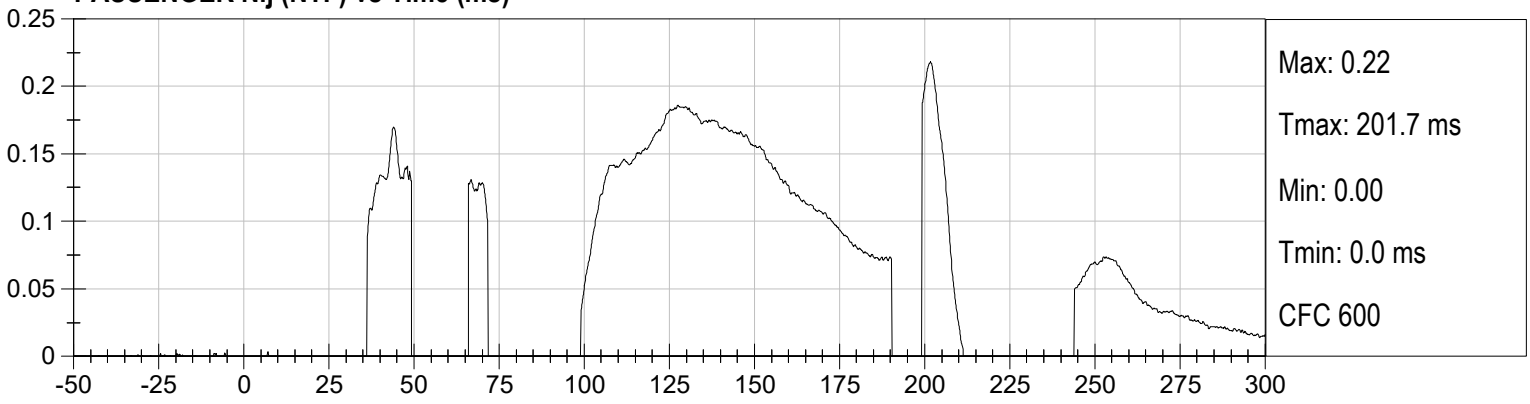
PASSENGER NECK FZ (N) vs Time (ms)



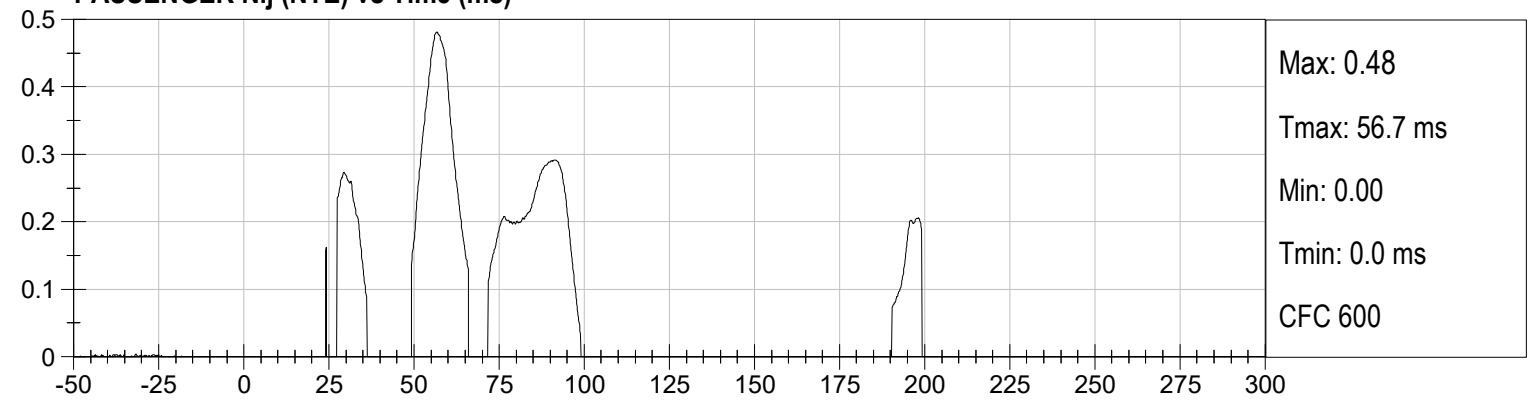
PASSENGER NECK MY (Nm) vs Time (ms)



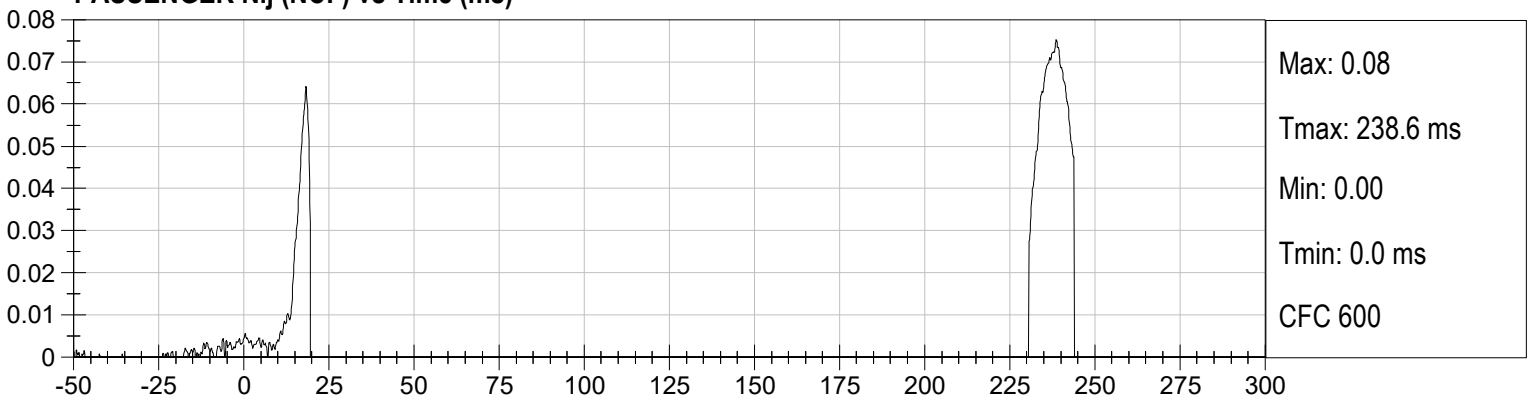
PASSENGER Nij (NTF) vs Time (ms)



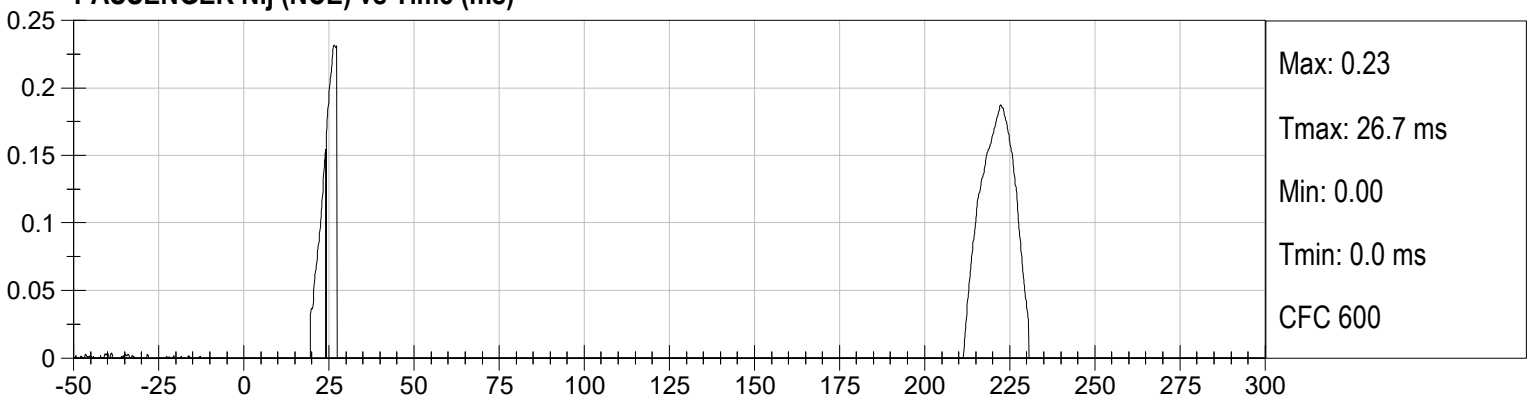
PASSENGER Nij (NTE) vs Time (ms)



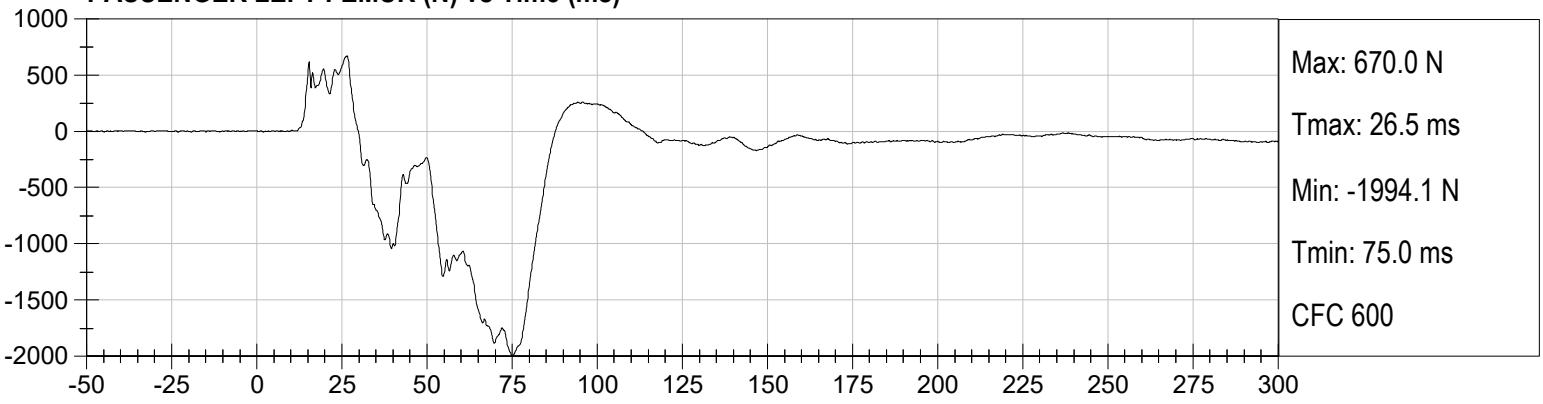
PASSENGER Nij (NCF) vs Time (ms)



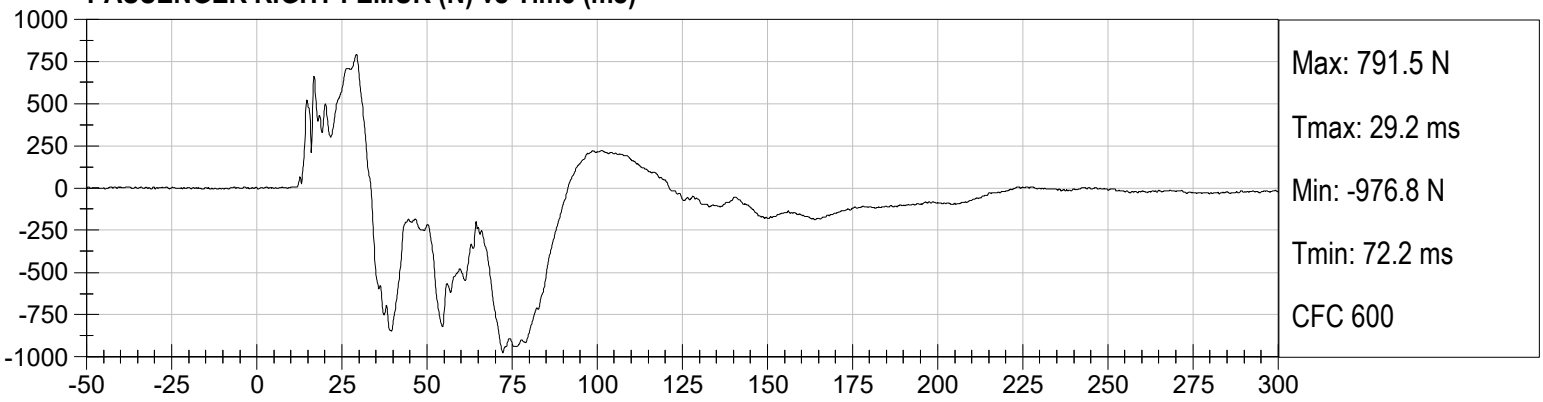
PASSENGER Nij (NCE) vs Time (ms)



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:** D210571

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	23	Pass
Peak Resultant Acceleration	G's	225 to 275	249	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-5.2	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Laboratory Technician

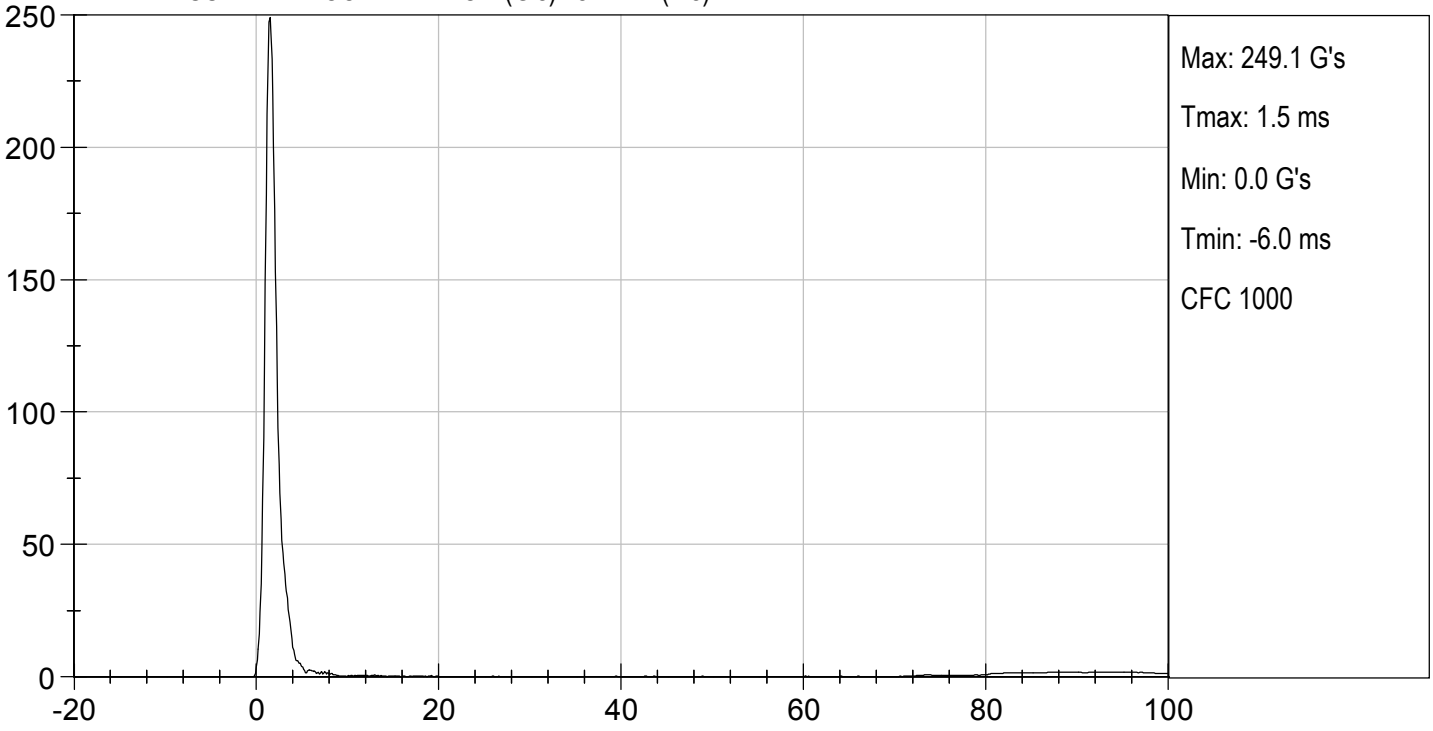
02/25/2021
Test Date

Approved By

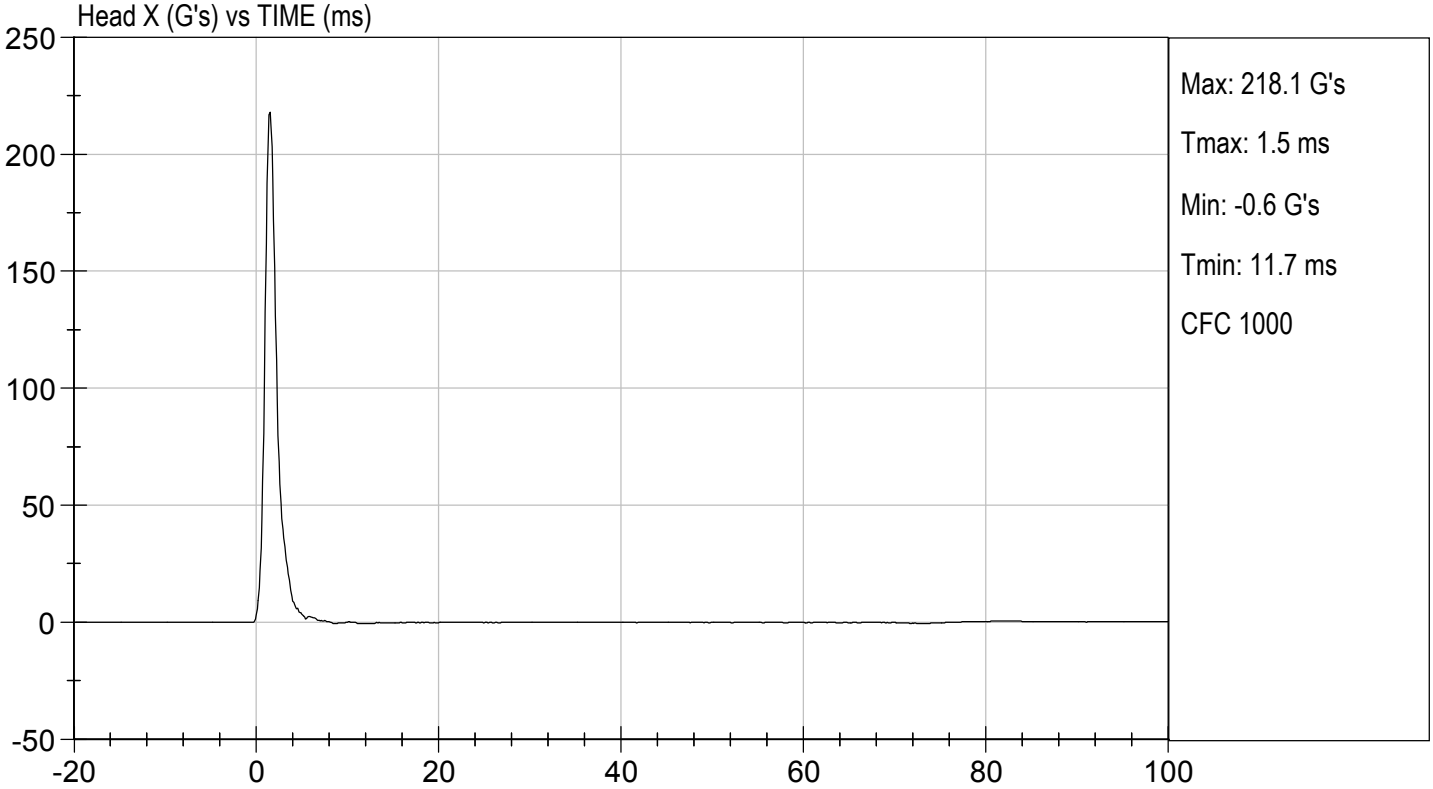
TEST DESC: HEAD DROP

TEST DATE: 02/25/2021
TEST #: D210571

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

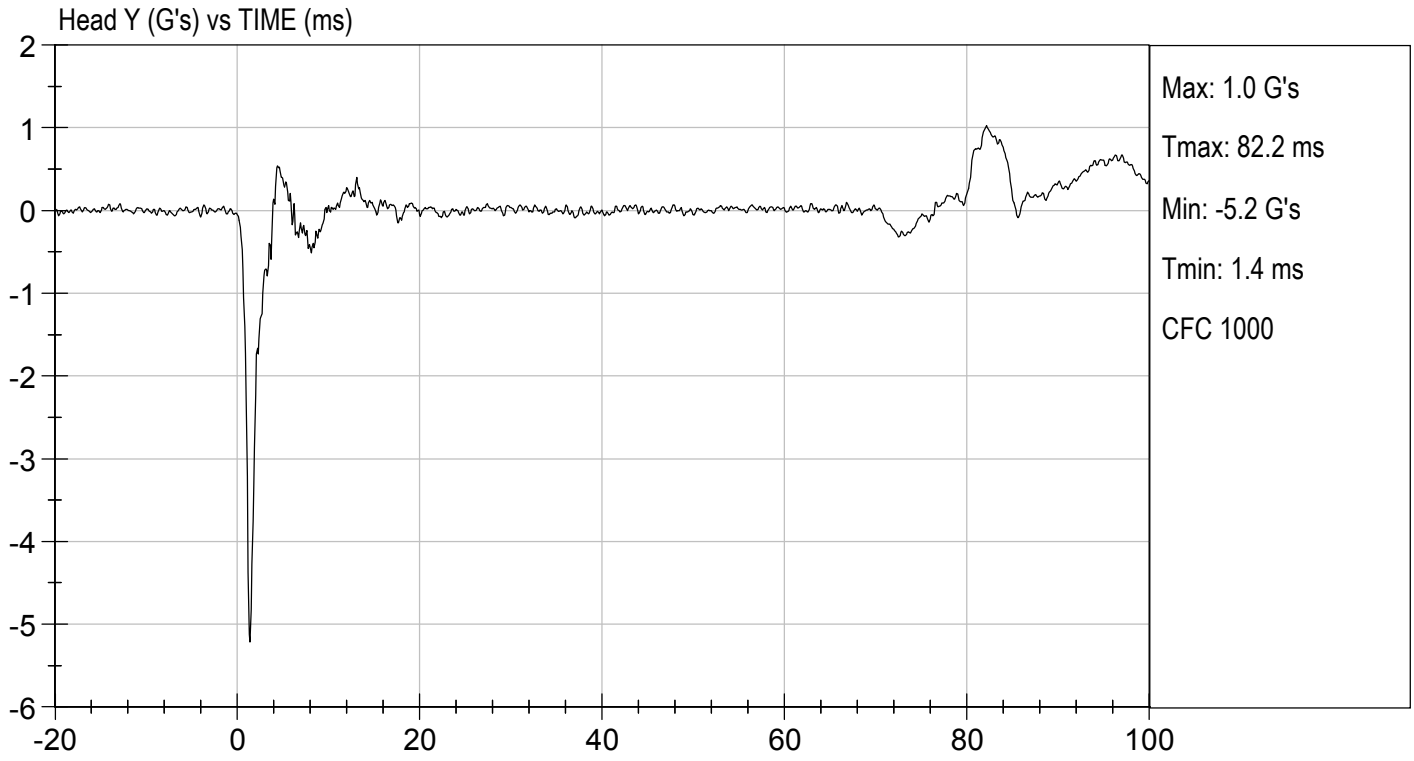


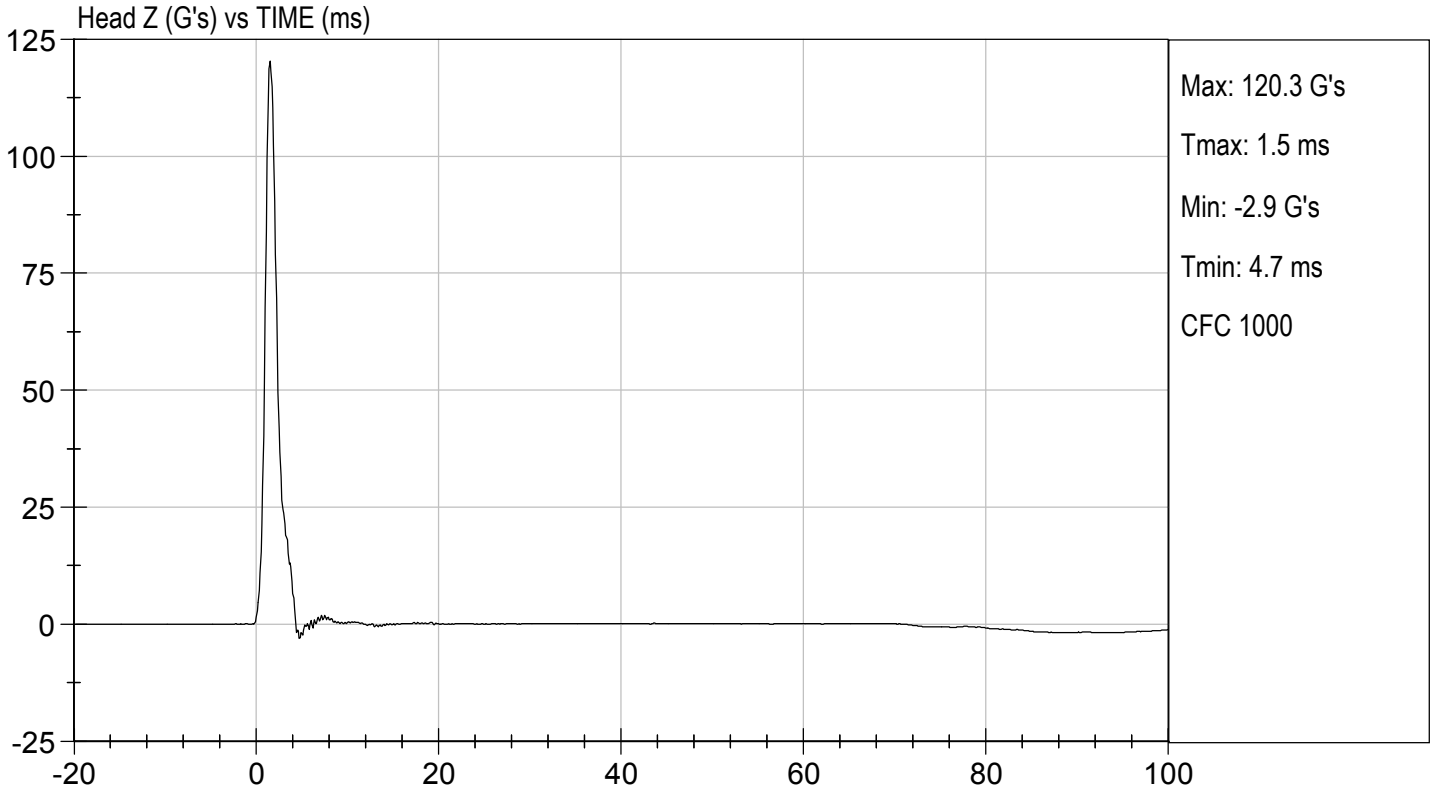
Head X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 02/25/2021
TEST #: D210571





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210572

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity		%	10 to 70	21	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.40	Pass
	20 ms	G's	17.60 to 22.60	20.45	Pass
	30 ms	G's	12.50 to 18.50	14.87	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	15.1	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	36.9	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	68.9	Pass
	Time	ms	57.0 to 64.0	58.8	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	116.3	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	91.5	Pass
	Time	ms	47.0 to 58.0	48.8	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	99.1	Pass
			Overall Test Results		Pass

Laboratory Technician

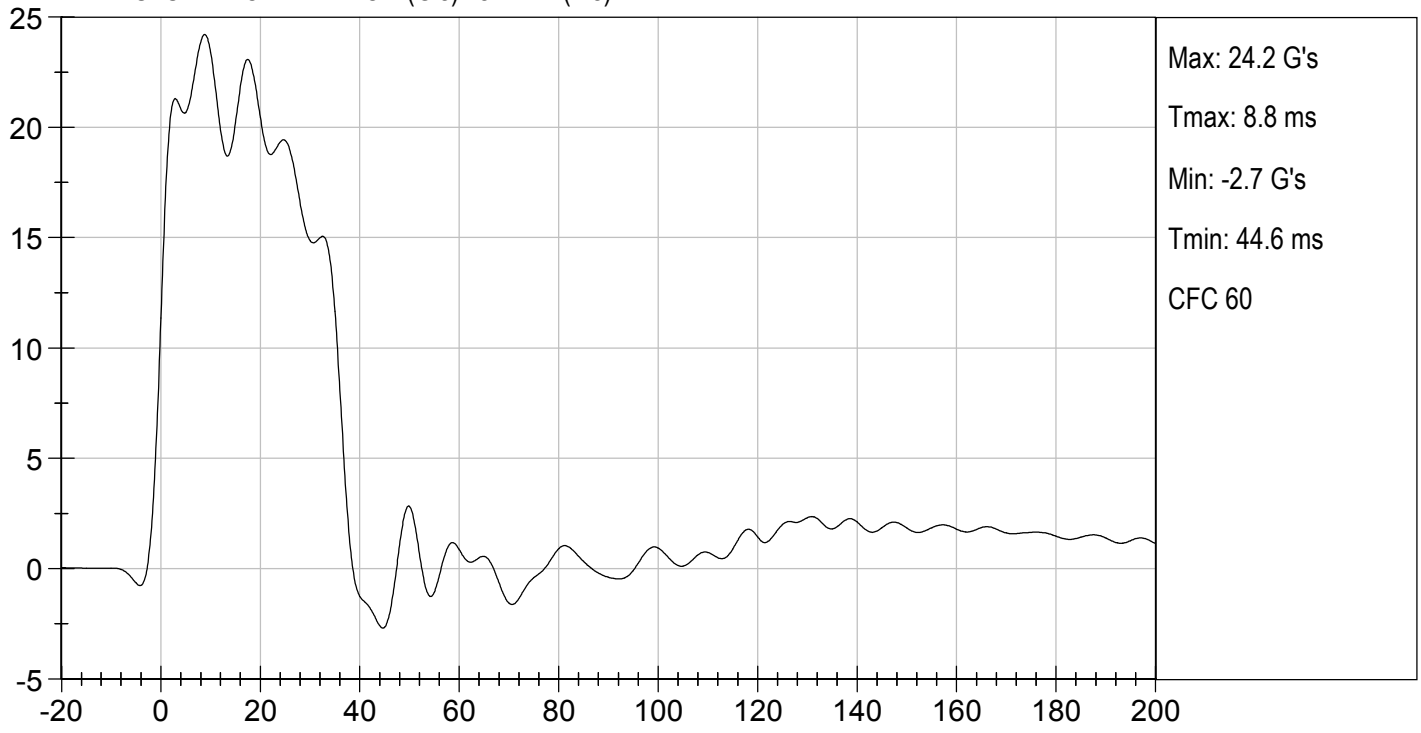
02/25/2021
Test Date

Approved By

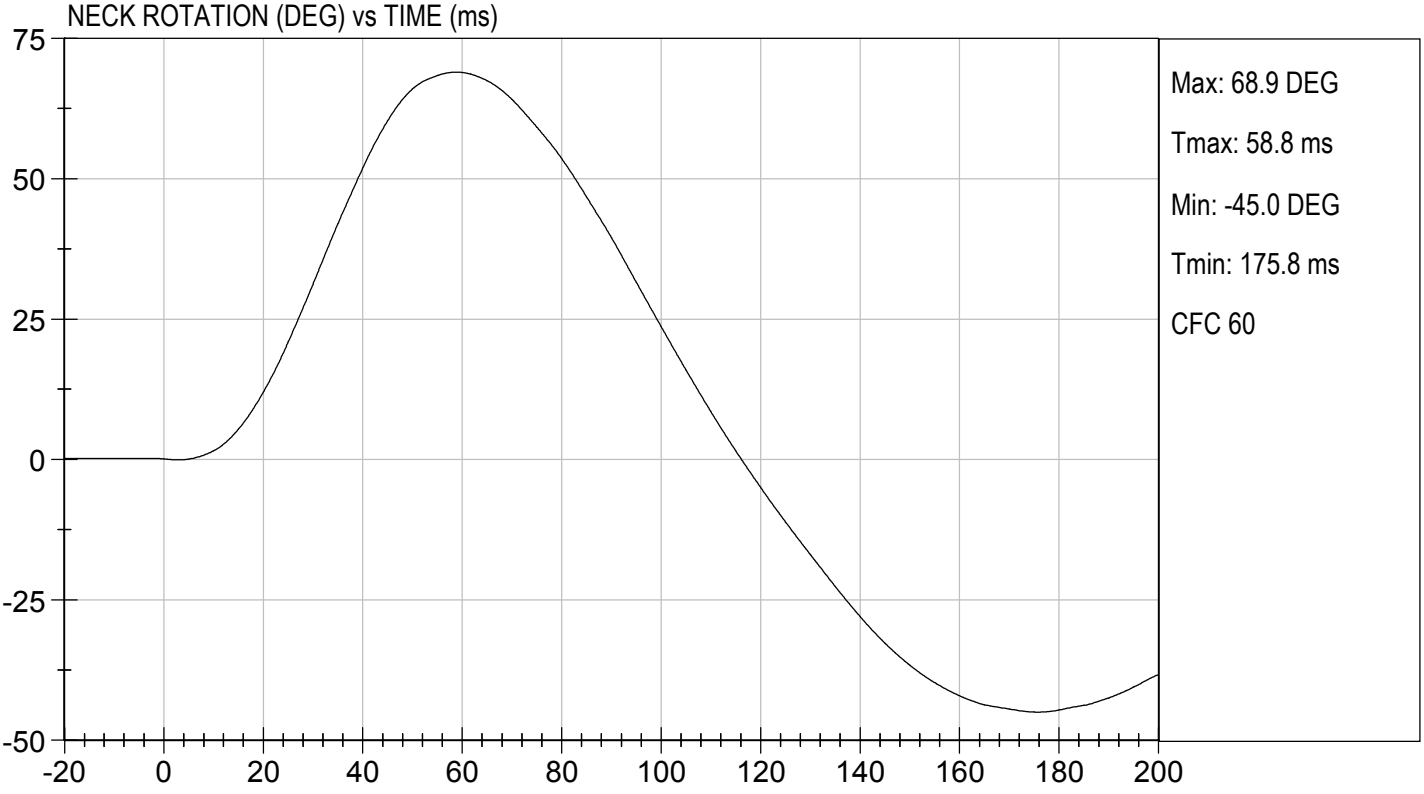
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 02/25/2021
TEST #: D210572

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

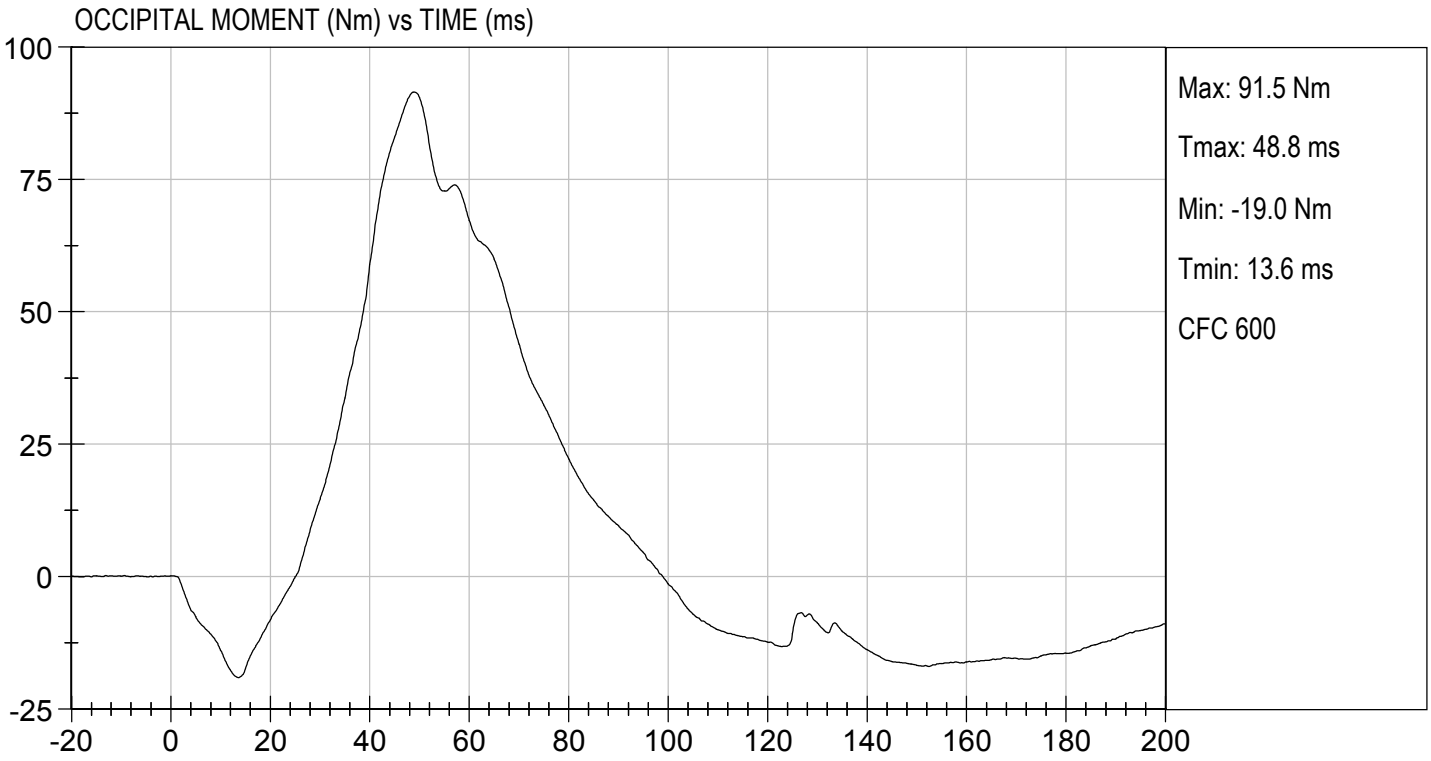


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 02/25/2021
TEST #: D210572



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210573

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity		%	10 to 70	21	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.18	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	17.59	Pass
	20 ms	G's	14.00 to 19.00	16.70	Pass
	30 ms	G's	11.00 to 16.00	14.00	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.1	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	40.2	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	97.4	Pass
	Time	ms	72.0 to 82.0	76.4	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	160.1	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	143.1	Pass
			Overall Test Results		Pass

Laboratory Technician

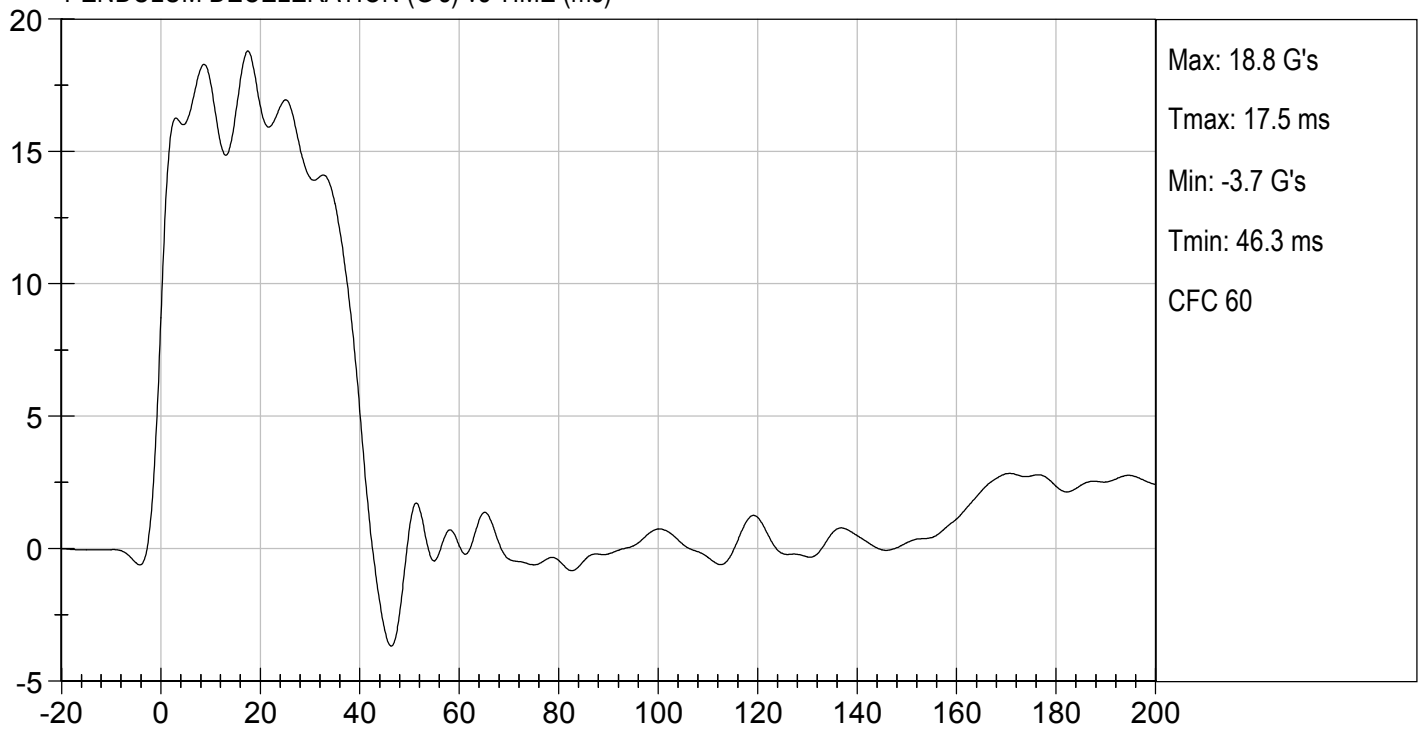
02/25/2021
Test Date

Approved By

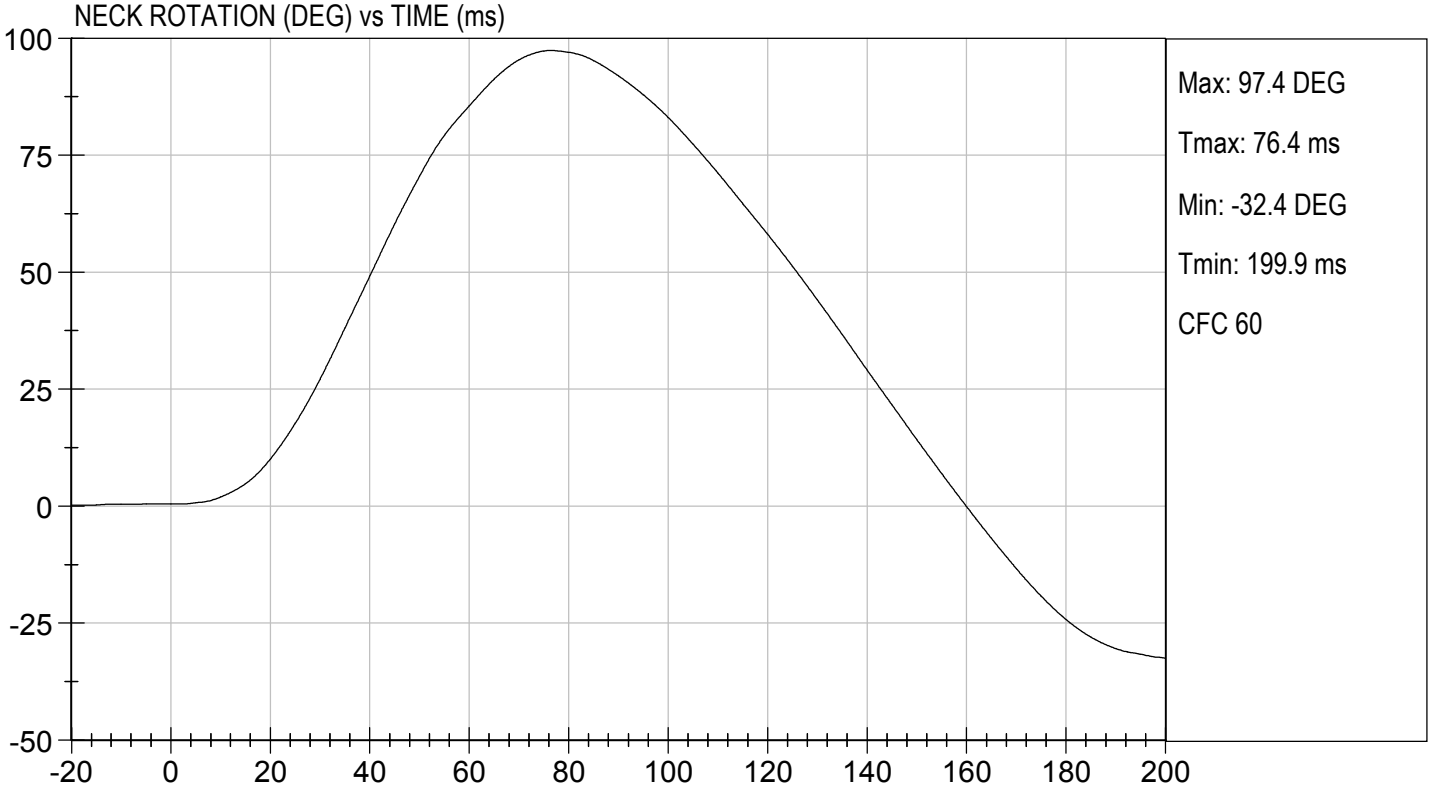
TEST DESC: NECK EXTENSION
VELOCITY: 20.28 ft/s, 6.18 m/s

TEST DATE: 02/25/2021
TEST #: D210573

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

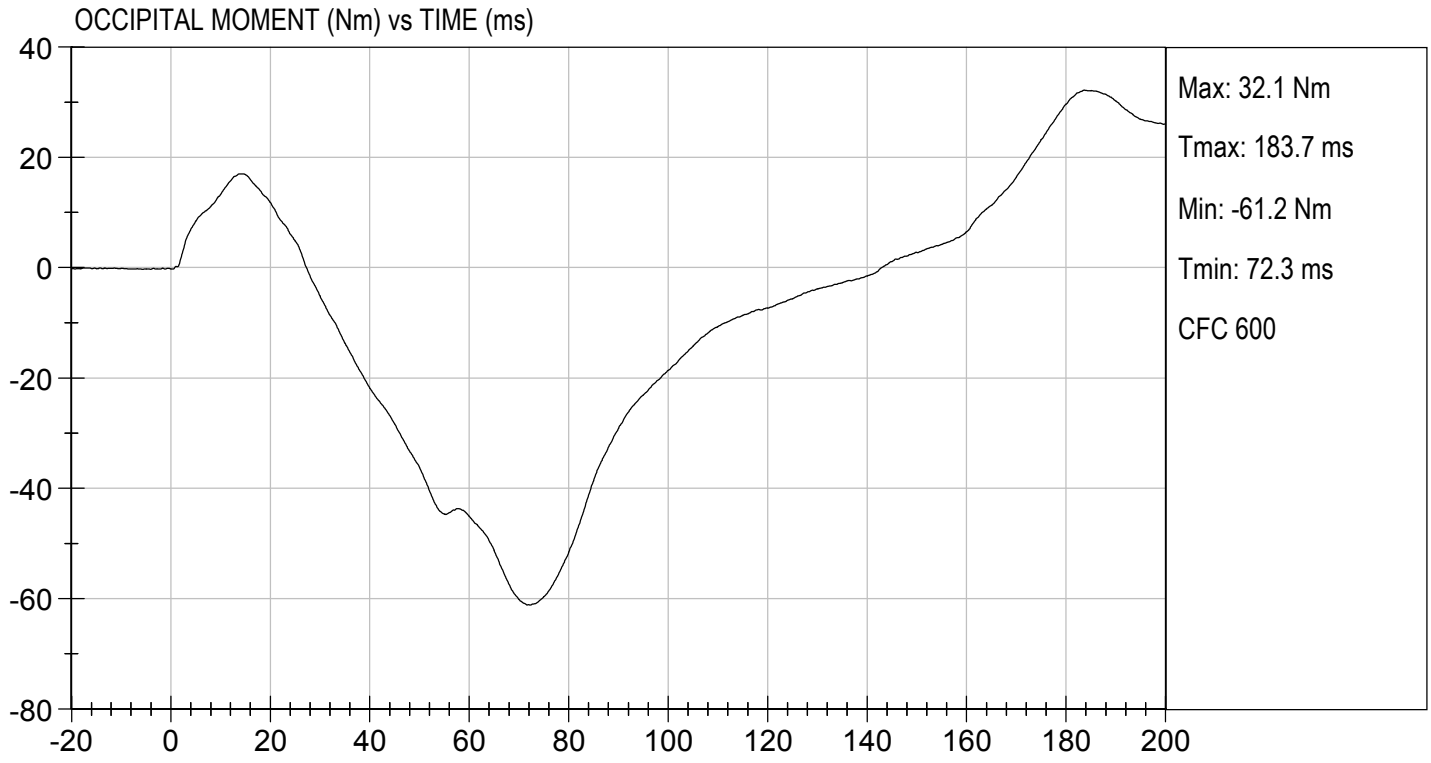


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK EXTENSION
VELOCITY: 20.28 ft/s, 6.18 m/s

TEST DATE: 02/25/2021
TEST #: D210573



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

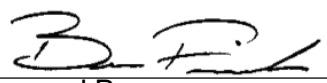
ATD Serial No: 351 **Test I.D:** D210574

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	28	Pass
Probe Velocity	m/s	6.58 to 6.82	6.68	Pass
Peak Probe Force	N	5159 to 5893	5,388	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	7.22	Pass
Internal Hysteresis	%	69 to 85	69	Pass
		Overall Test Results		Pass

Laboratory Technician

02/24/2021

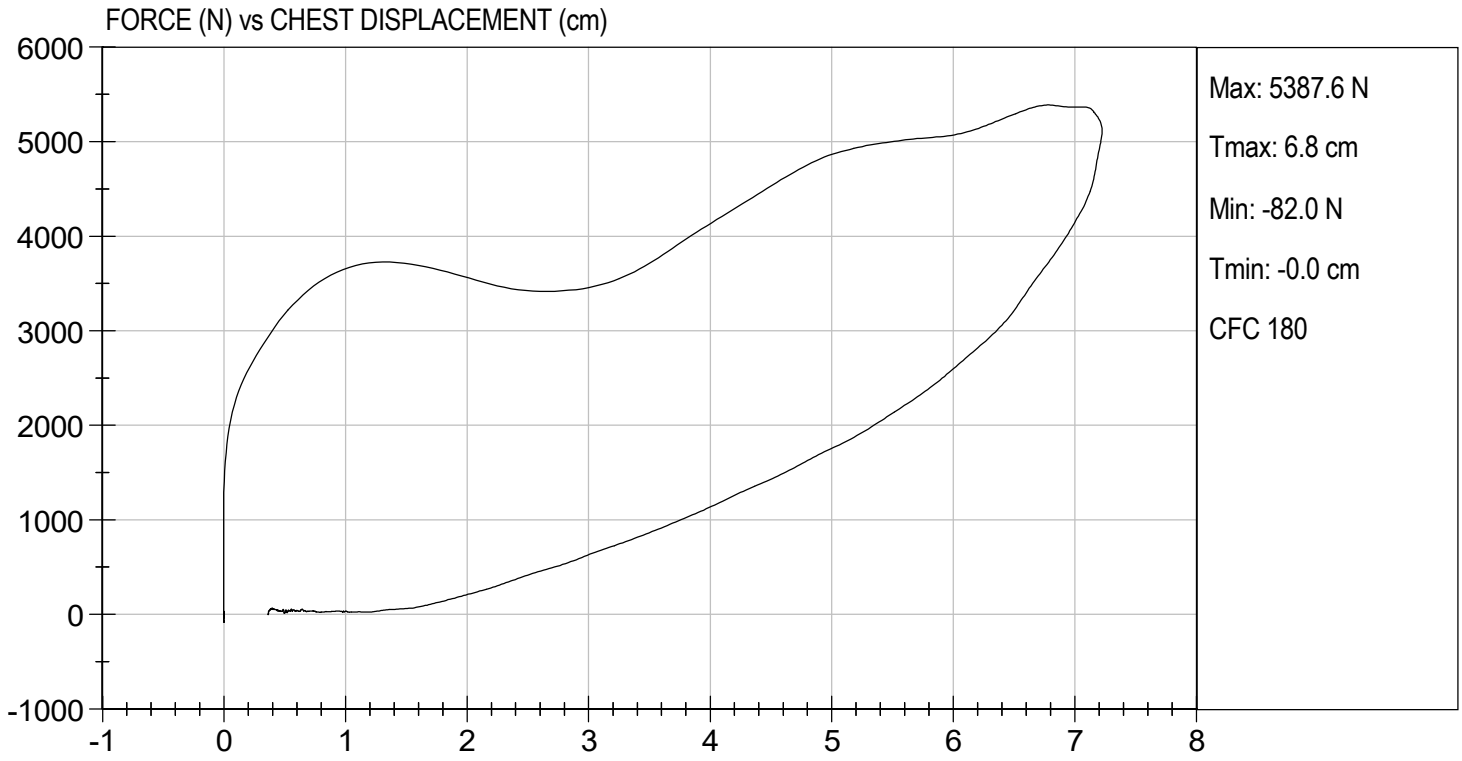
Test Date



Approved By

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

TEST DATE: 02/24/2021
TEST #: D210574



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210575

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	20	Pass
Probe Velocity	m/s	2.07 to 2.13	2.07	Pass
Peak Probe Force	N	4715 to 5782	4,914	Pass
		Overall Test Results		Pass

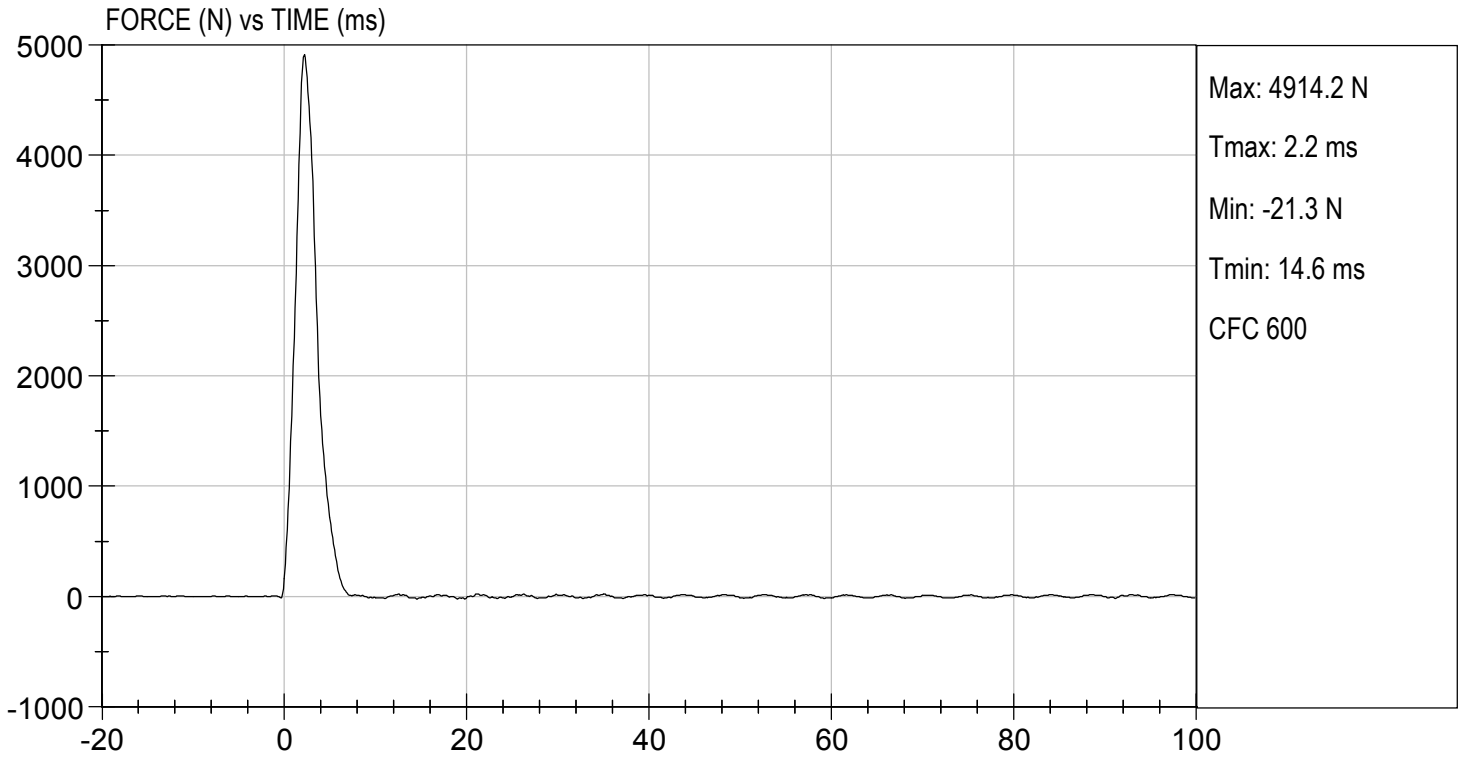
Laboratory Technician

02/26/2021
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.79 ft/s, 2.07 m/s

TEST DATE: 02/26/2021
TEST #: D210575



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210576

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	20	Pass
Probe Velocity	m/s	2.07 to 2.13	2.09	Pass
Peak Probe Force	N	4715 to 5782	4,872	Pass
		Overall Test Results		Pass

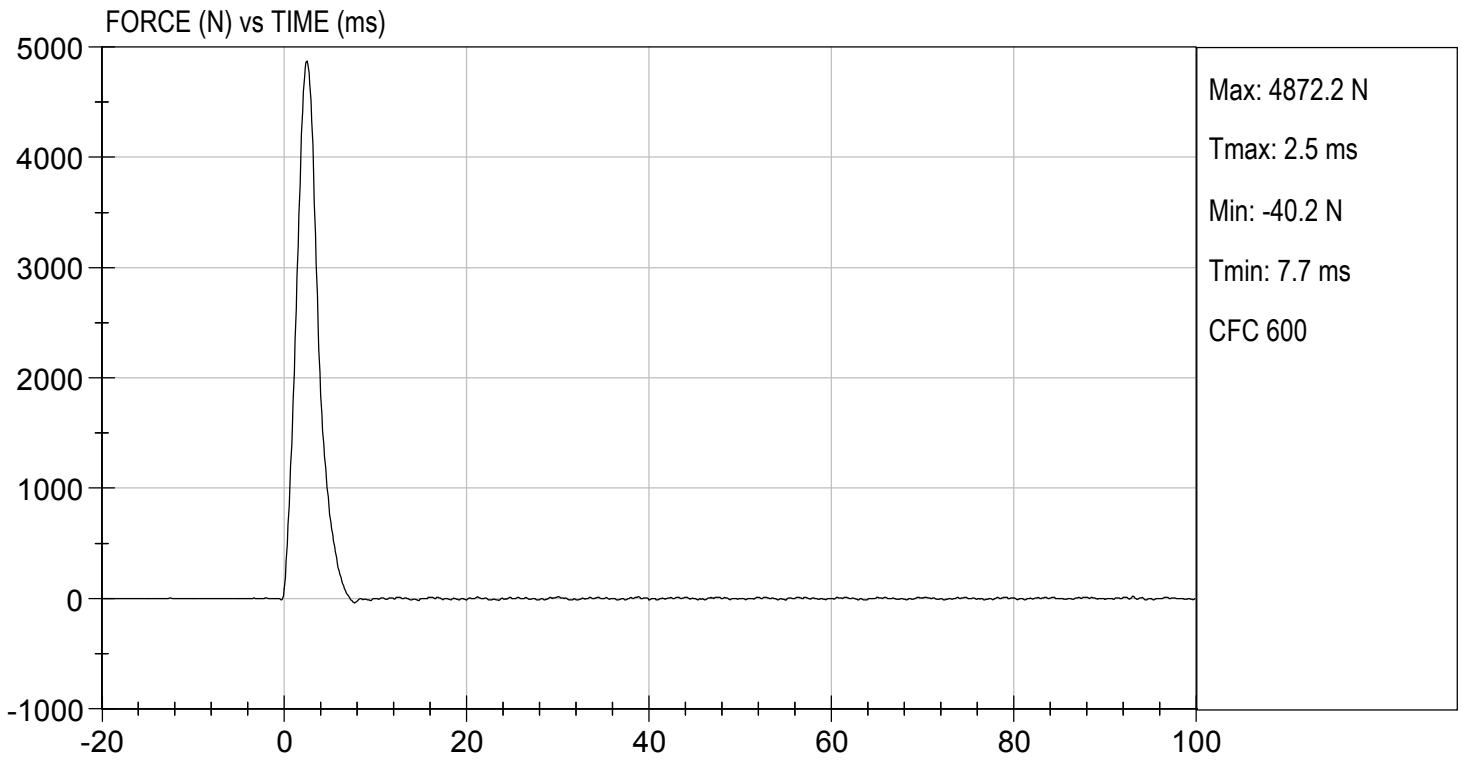
Laboratory Technician

02/26/2021
Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.86 ft/s, 2.09 m/s

TEST DATE: 02/26/2021
TEST #: D210576



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210570

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.7	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	23	23	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	85.5	89.5	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	44.5	44.4	Pass
		Overall Test Results			Pass

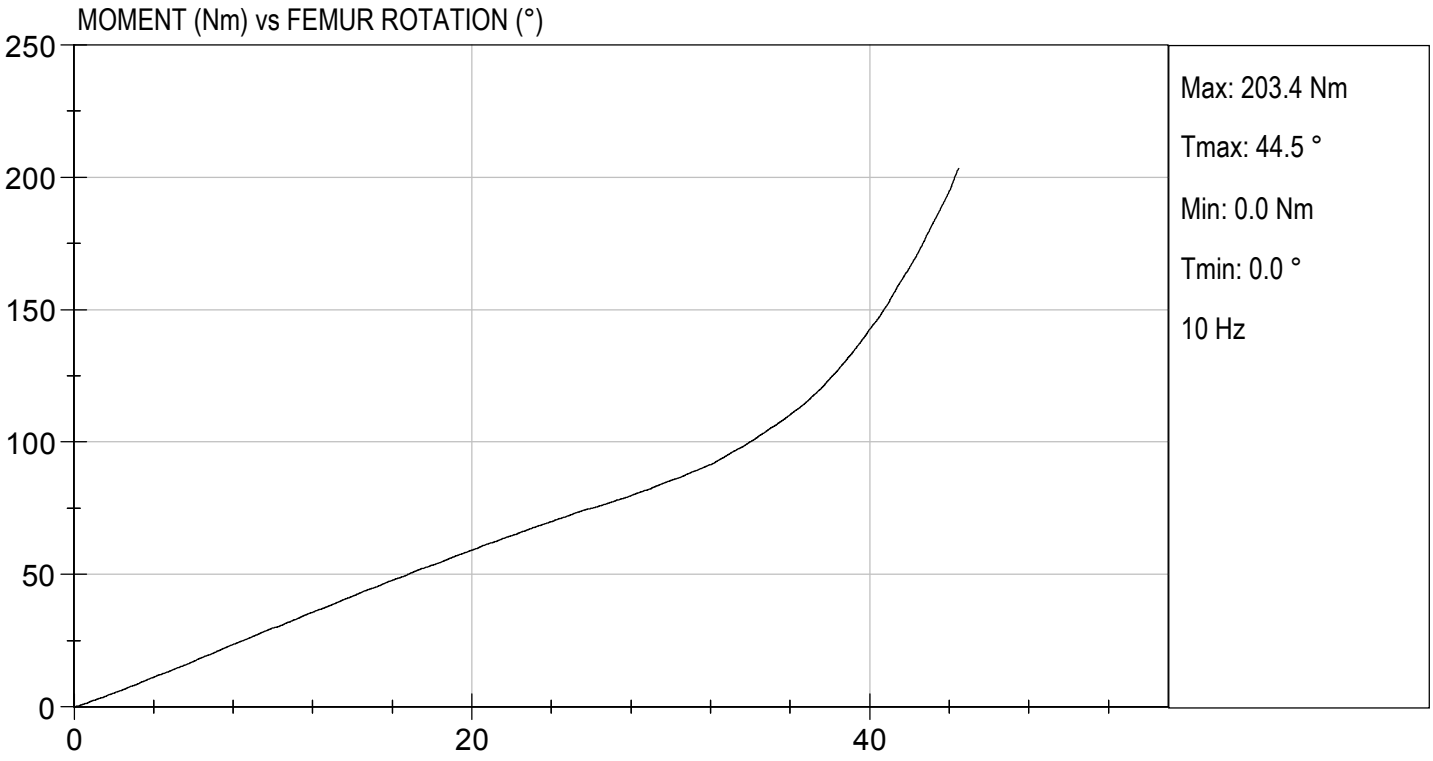
Laboratory Technician

02/25/2021
Test Date

Approved By

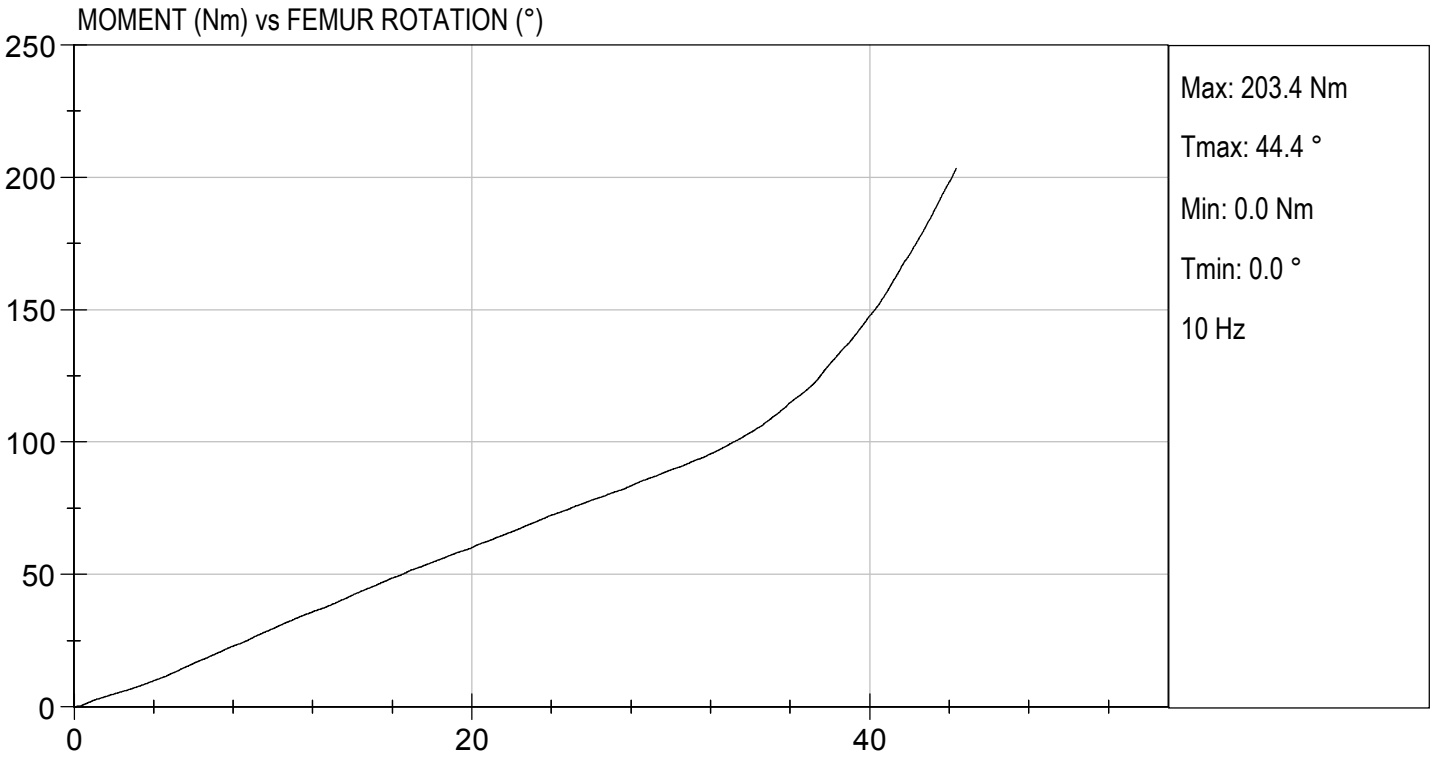
TEST DESC: RIGHT HIP FEMUR FLEXION

TEST DATE: 02/25/2021
TEST #: D210579



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 02/25/2021
TEST #: D210570



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:** D210661

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	25	Pass
Peak Resultant Acceleration	G's	225 to 275	256	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-11.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Laboratory Technician

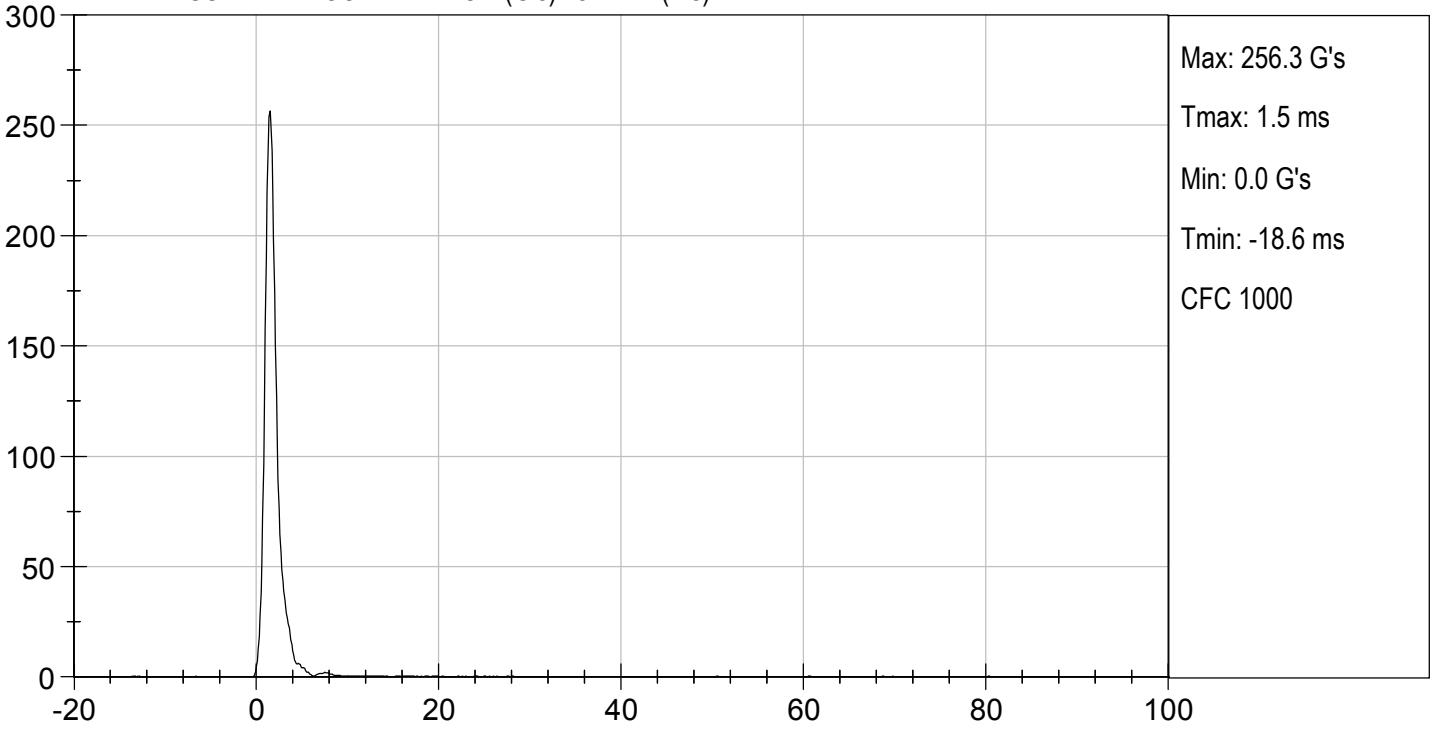
03/04/2021
Test Date

Approved By

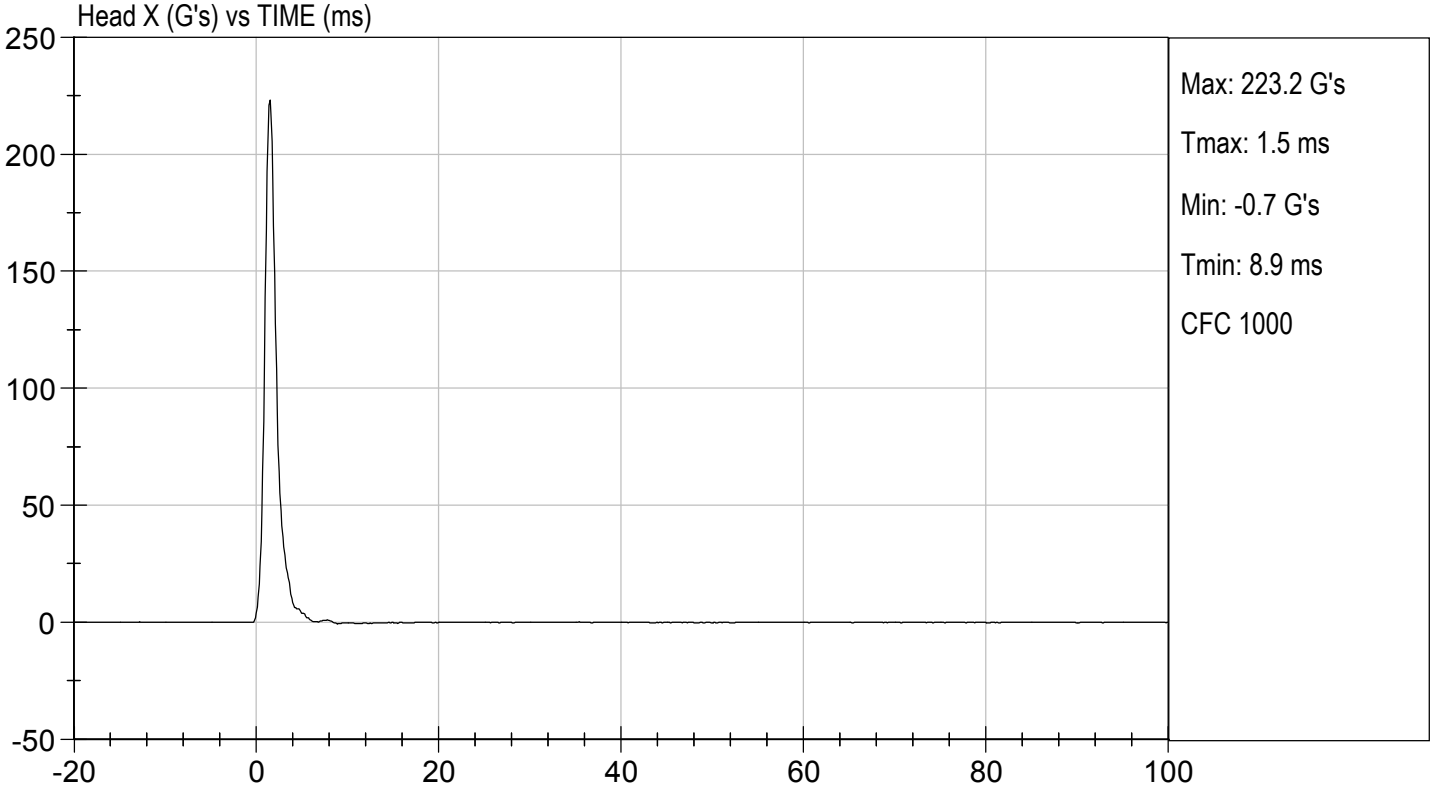
TEST DESC: HEAD DROP

TEST DATE: 03/04/2021
TEST #: D210661

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

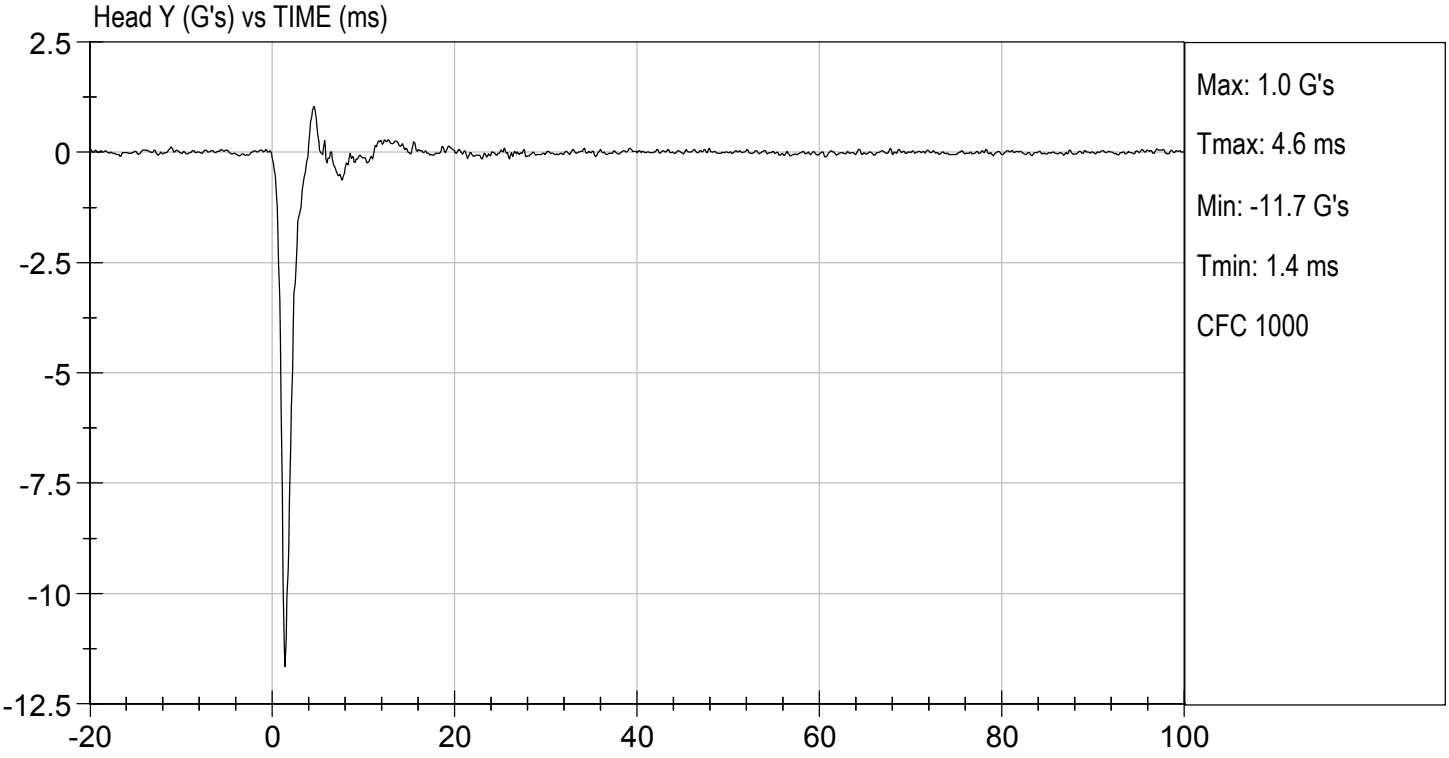


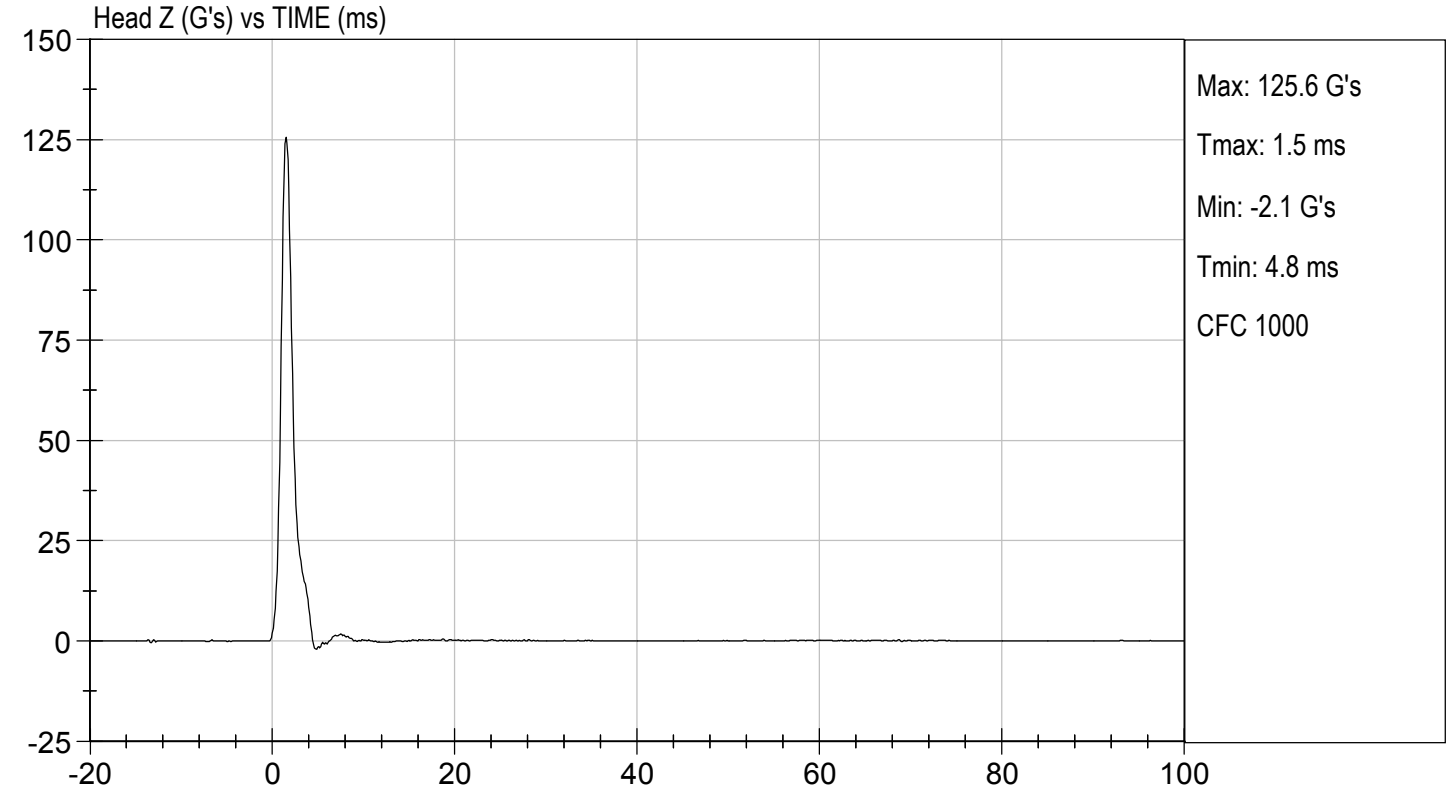
Head X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 03/04/2021
TEST #: D210661





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210662

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	25	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	22.85	Pass
	20 ms	G's	17.60 to 22.60	22.53	Pass
	30 ms	G's	12.50 to 18.50	17.17	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	17.1	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	35.3	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	70.0	Pass
	Time	ms	57.0 to 64.0	61.1	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	118.8	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	94.5	Pass
	Time	ms	47.0 to 58.0	47.0	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	101.5	Pass
			Overall Test Results		Pass

Alex Thomas

Laboratory Technician

03/04/2021

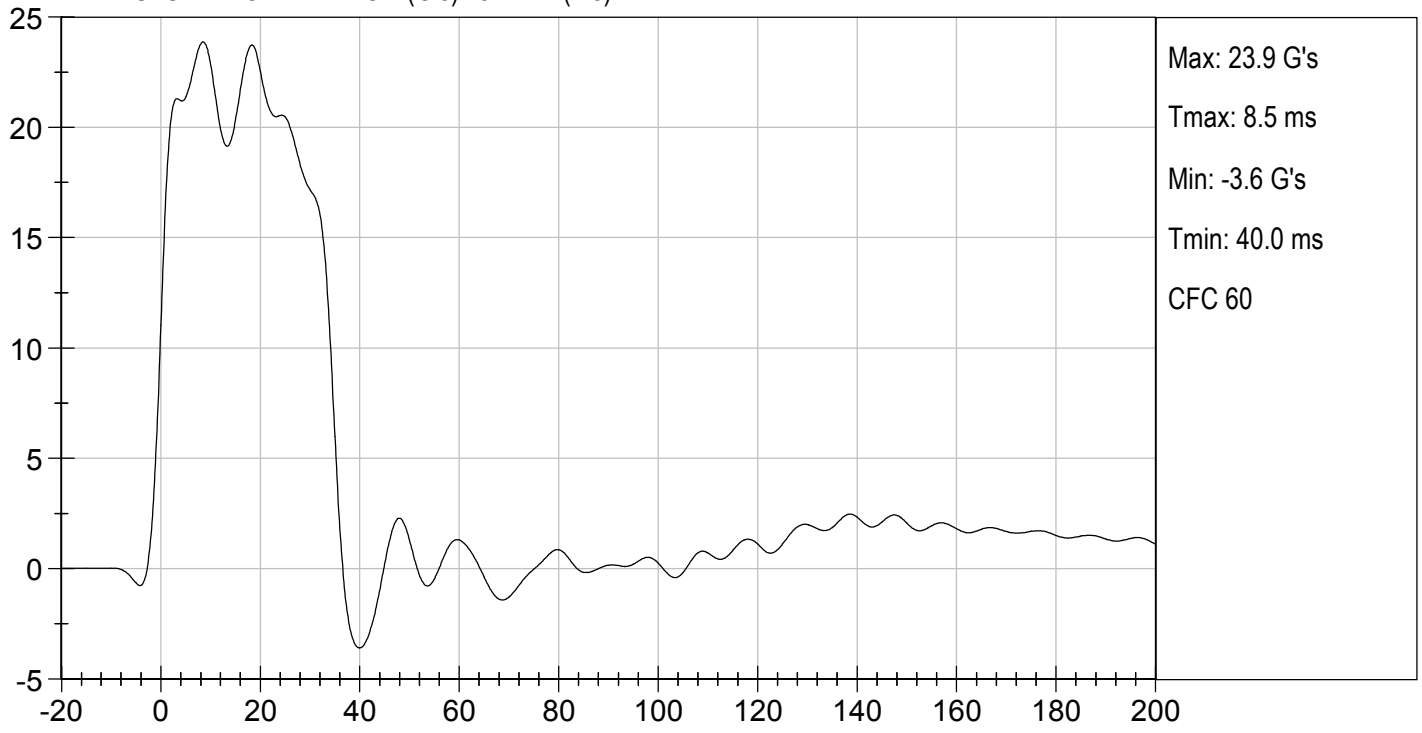
Test Date

Approved By

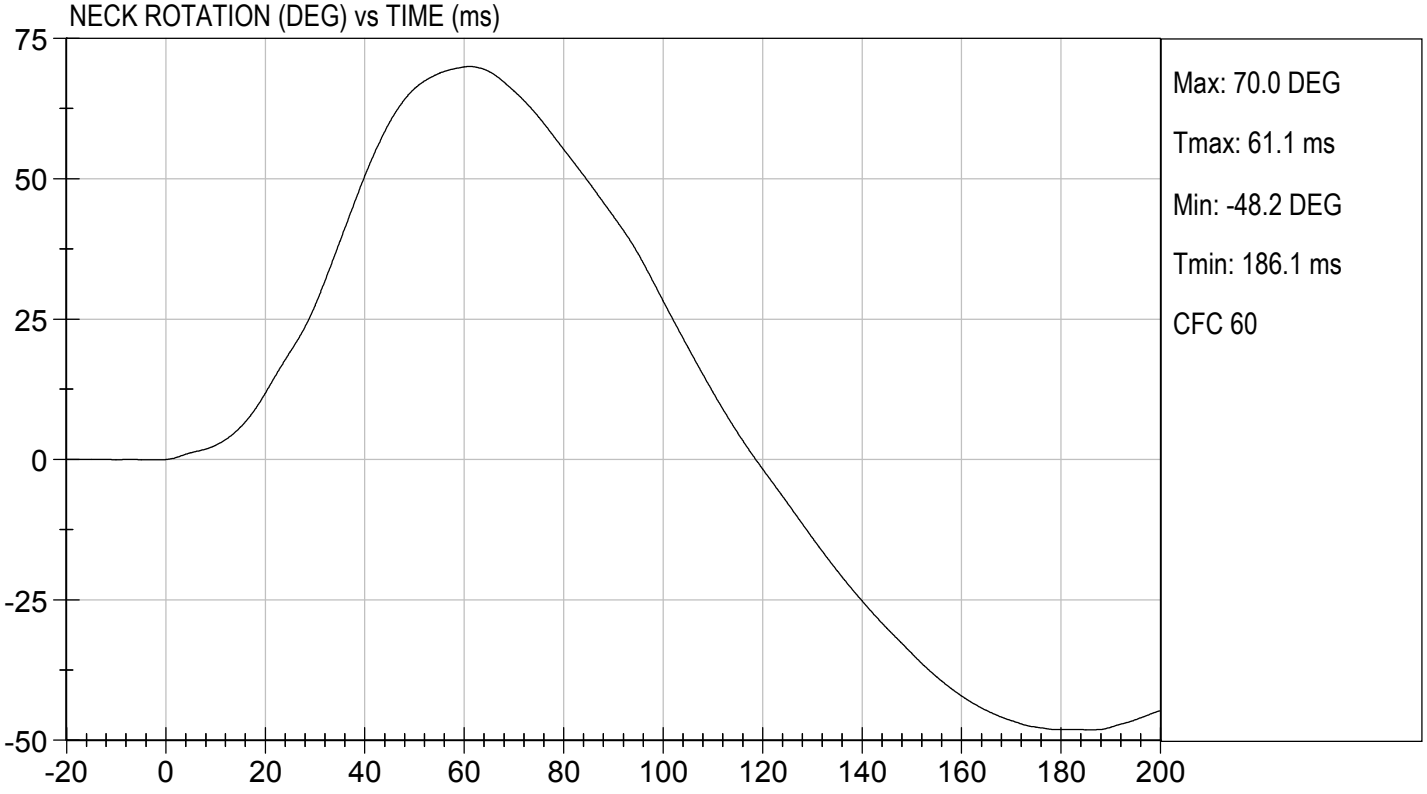
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 03/04/2021
TEST #: D210662

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



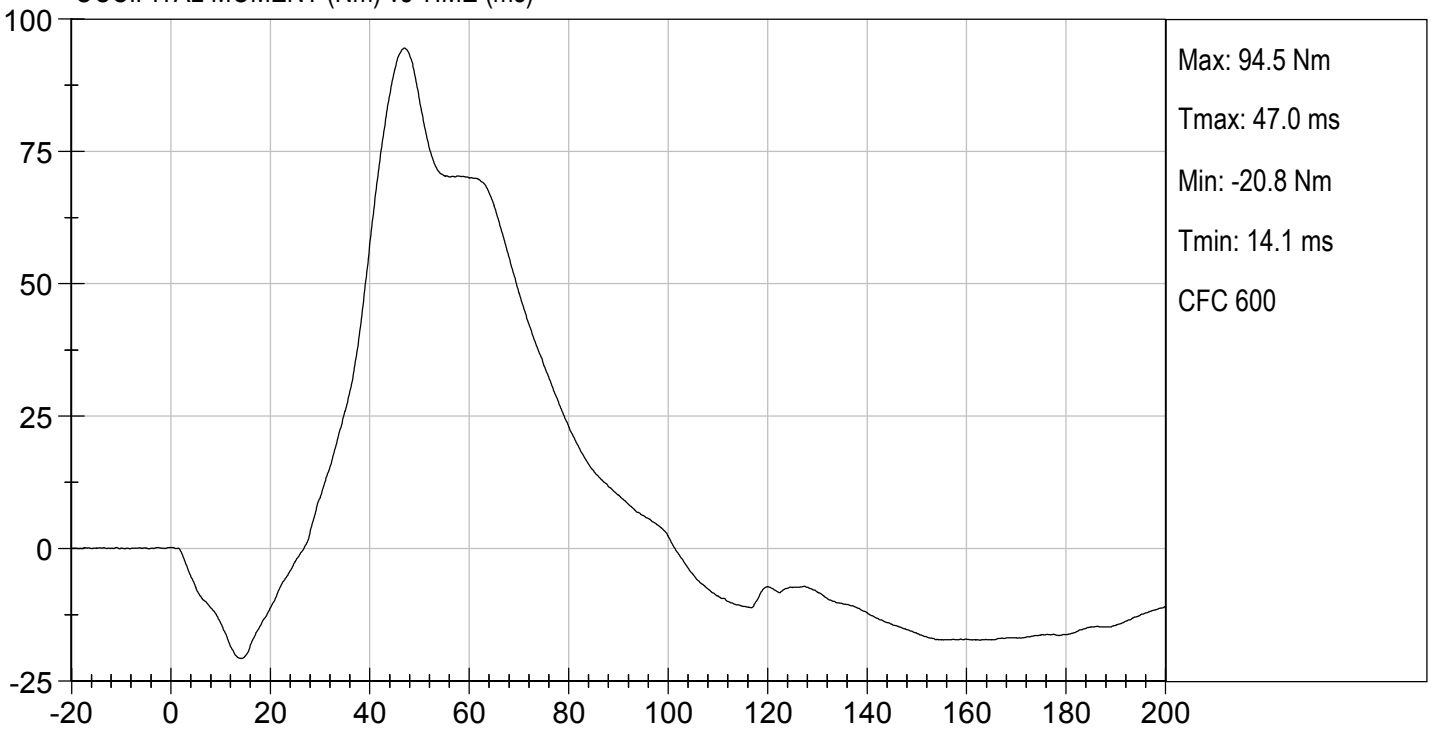
NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 03/04/2021
TEST #: D210662

OCCIPITAL MOMENT (Nm) vs TIME (ms)



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210663

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	25	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	17.42	Pass
	20 ms	G's	14.00 to 19.00	17.09	Pass
	30 ms	G's	11.00 to 16.00	12.96	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.1	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	40.4	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	94.7	Pass
	Time	ms	72.0 to 82.0	80.3	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	161.3	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-58.5	Pass
	Time	ms	65.0 to 79.0	74.1	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	146.7	Pass
			Overall Test Results		Pass

Alex Thomas

Laboratory Technician

03/04/2021

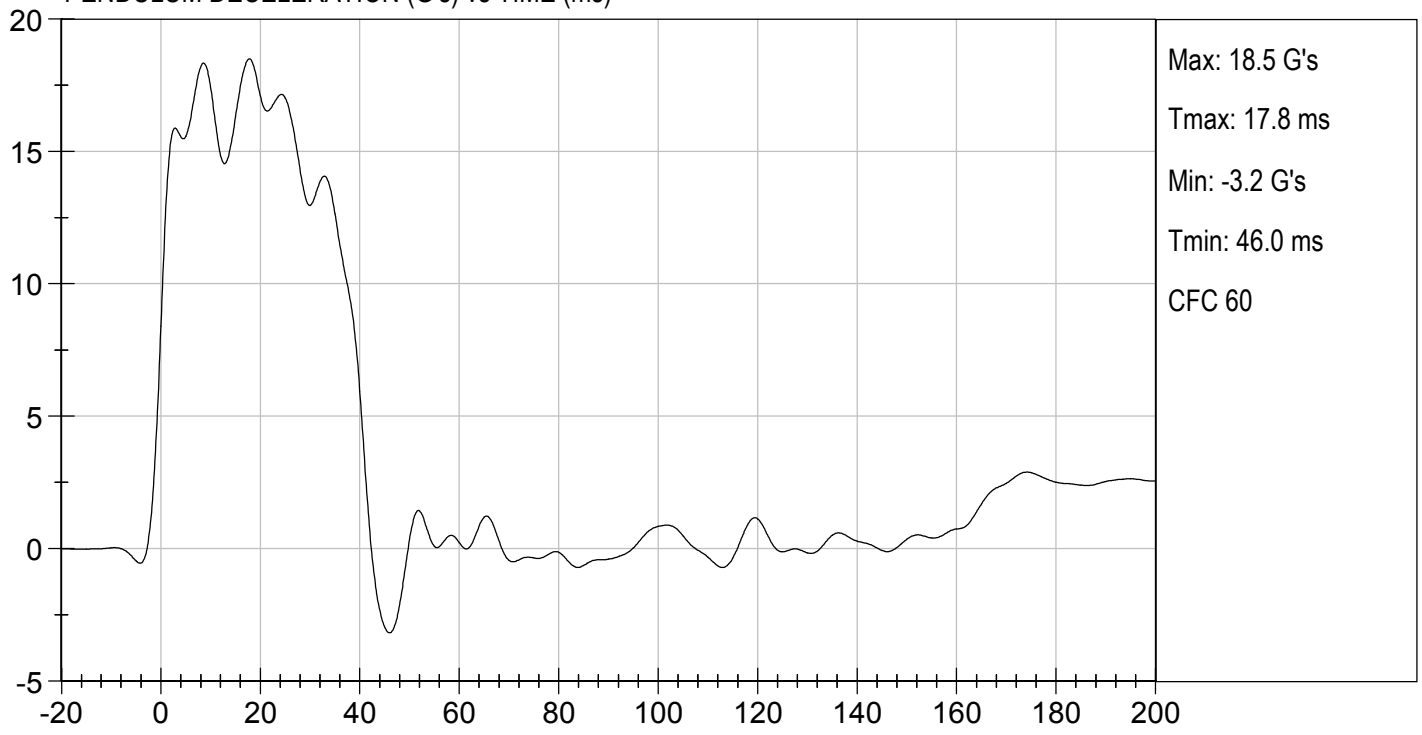
Test Date

Approved By

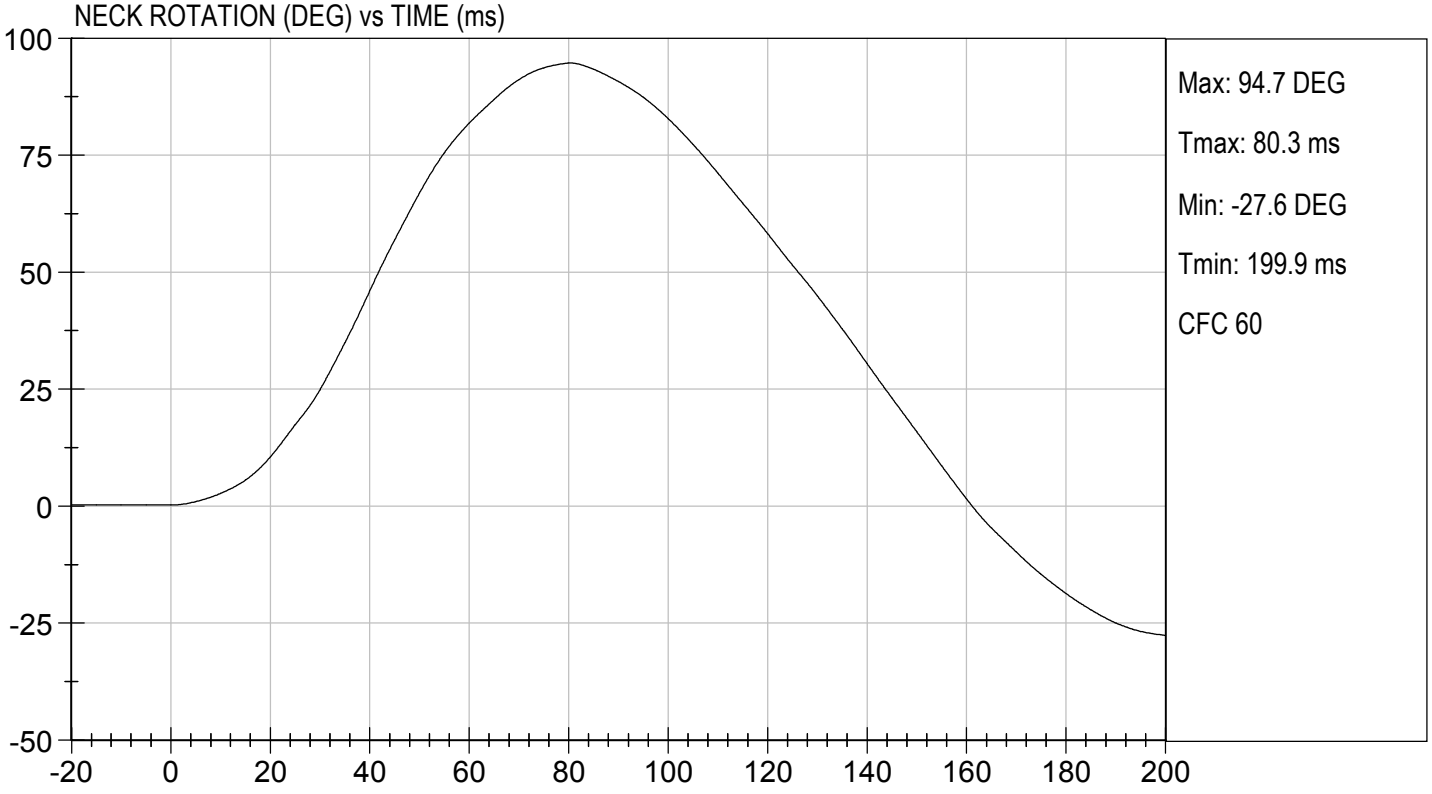
TEST DESC: NECK EXTENSION
VELOCITY: 20.08 ft/s, 6.12 m/s

TEST DATE: 03/04/2021
TEST #: D210663

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

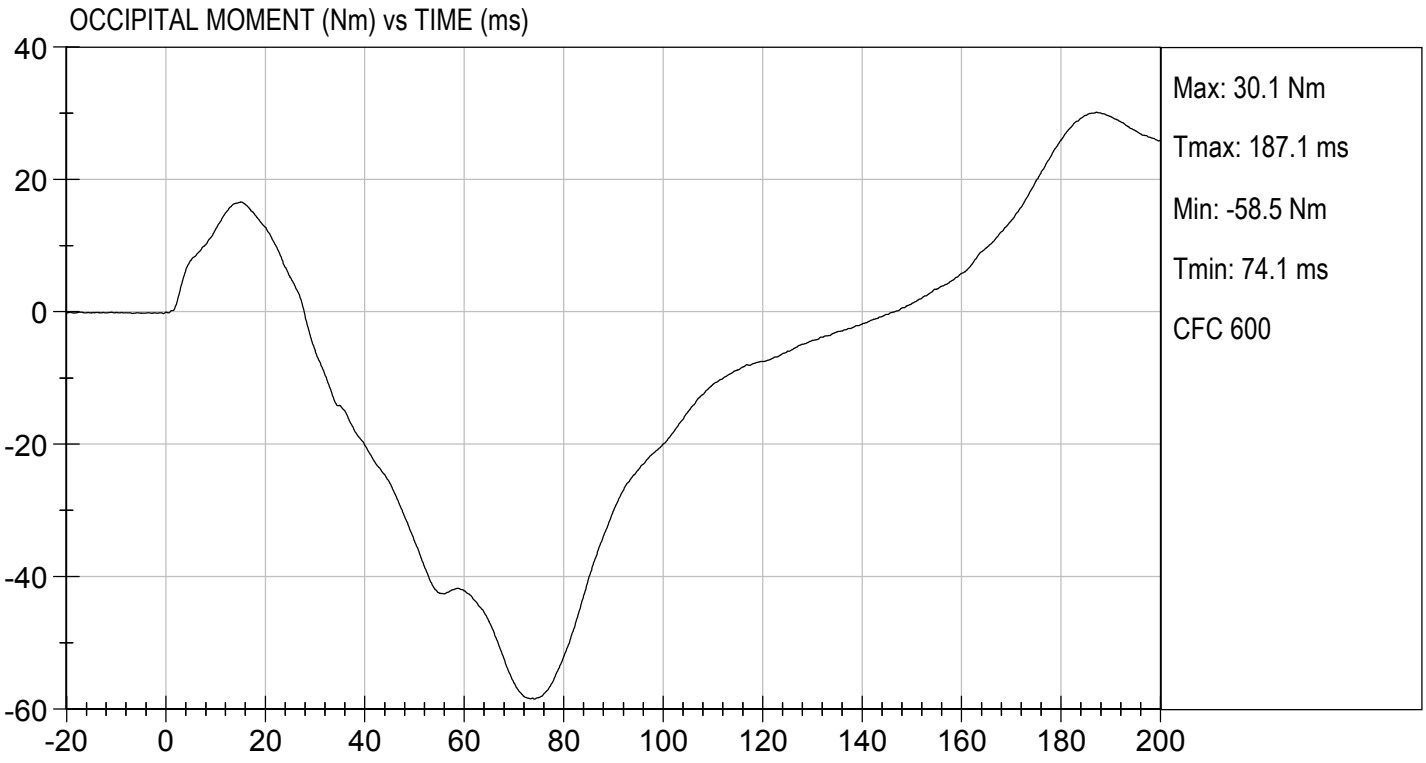


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 03/04/2021
TEST #: D210663



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210664

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Probe Velocity	m/s	6.58 to 6.82	6.60	Pass
Peak Probe Force	N	5159 to 5893	5,474	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	7.11	Pass
Internal Hysteresis	%	69 to 85	70	Pass
		Overall Test Results		Pass

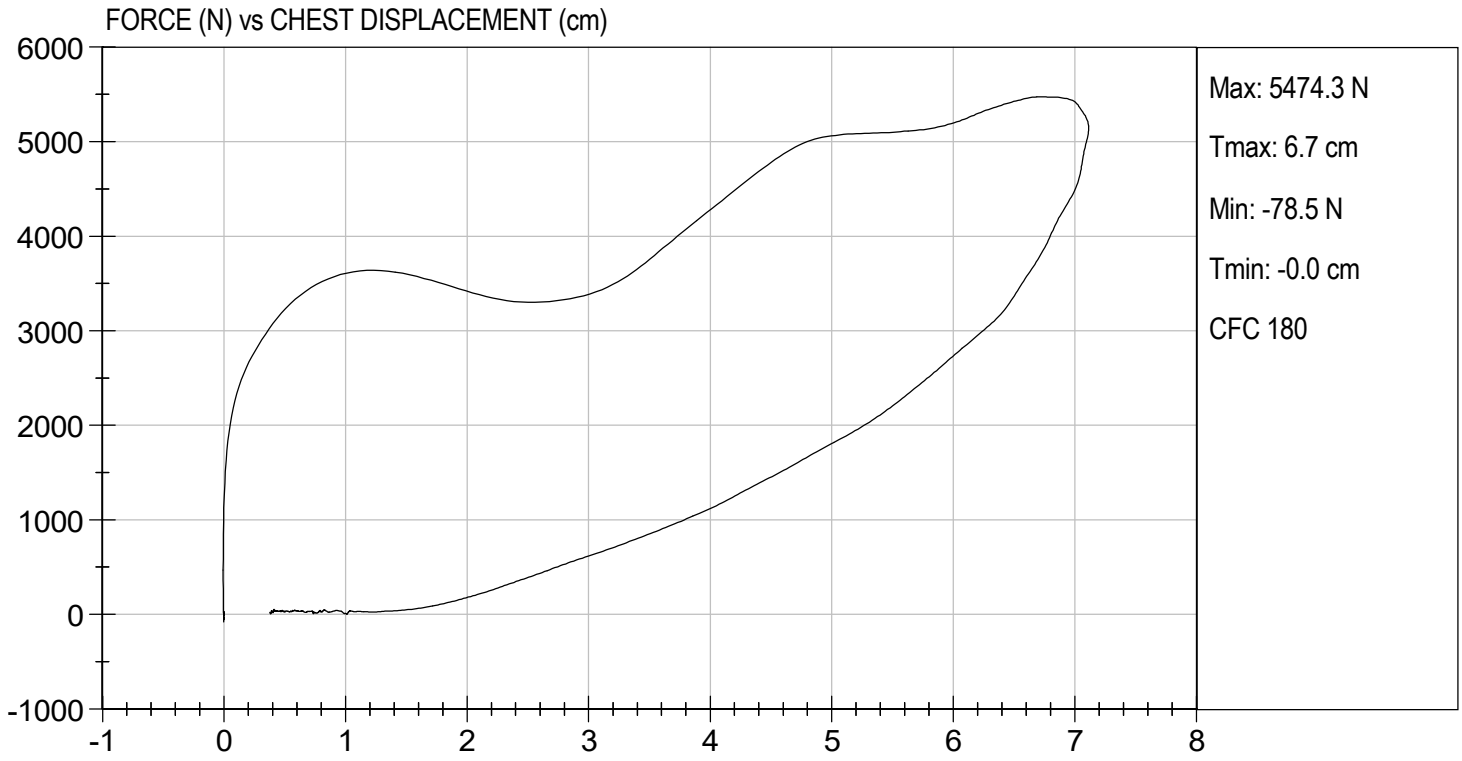
Laboratory Technician

03/08/2021
Test Date

Approved By

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

TEST DATE: 03/08/2021
TEST #: D210664



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210665

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Velocity	m/s	2.07 to 2.13	2.07	Pass
Peak Probe Force	N	4715 to 5782	4,767	Pass
		Overall Test Results		Pass

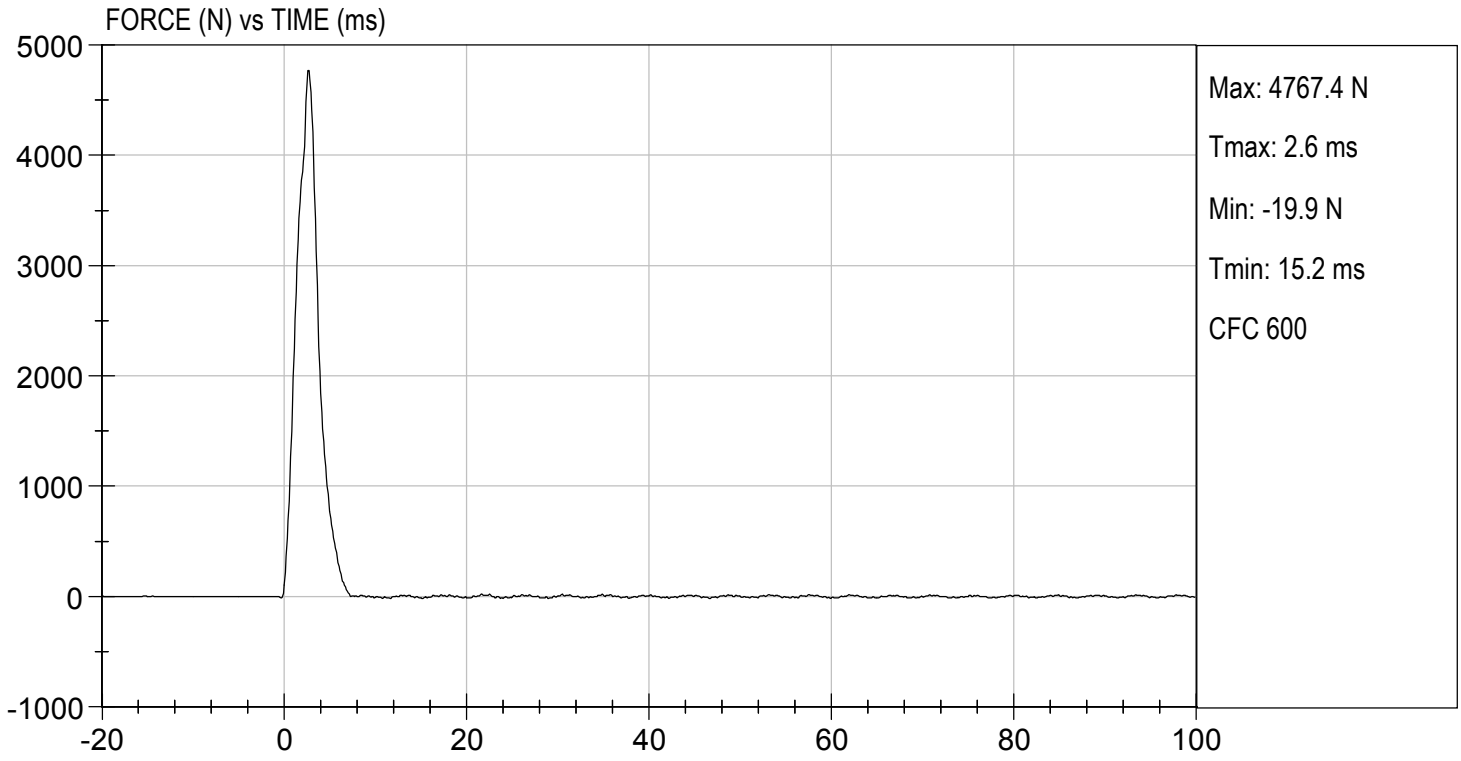
Laboratory Technician

03/04/2021
Test Date

Approved By

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

TEST DATE: 03/04/2021
TEST #: D210665



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210666

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	5,131	Pass
		Overall Test Results		Pass

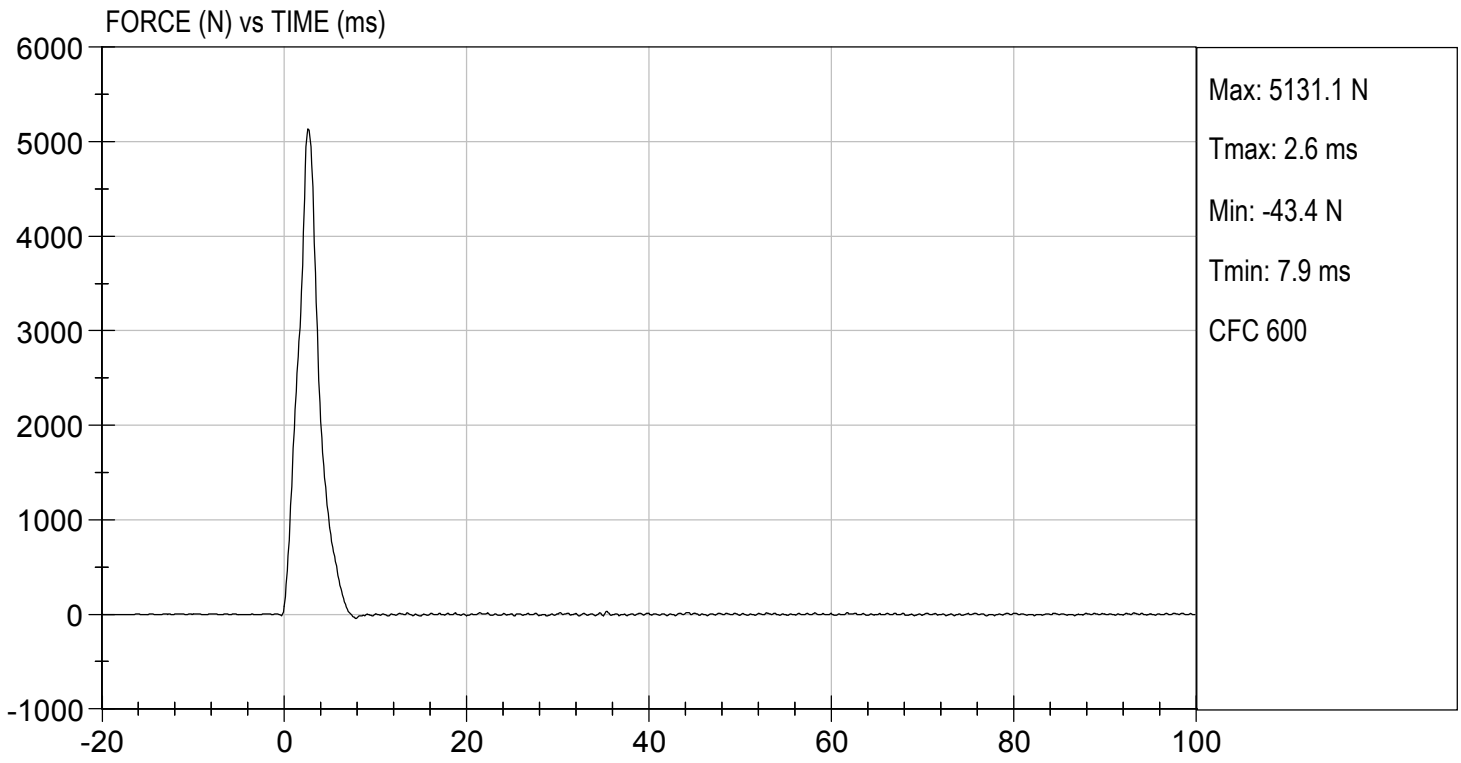
Alex Thomas
Laboratory Technician

03/04/2021
Test Date

Approved By

TEST DESC: LEFT KNEE
VELOCITY: 6.94 ft/s, 2.12 m/s

TEST DATE: 03/04/2021
TEST #: D210666



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210660

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	25	25	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	86.0	86.8	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	44.5	44.3	Pass
		Overall Test Results			Pass

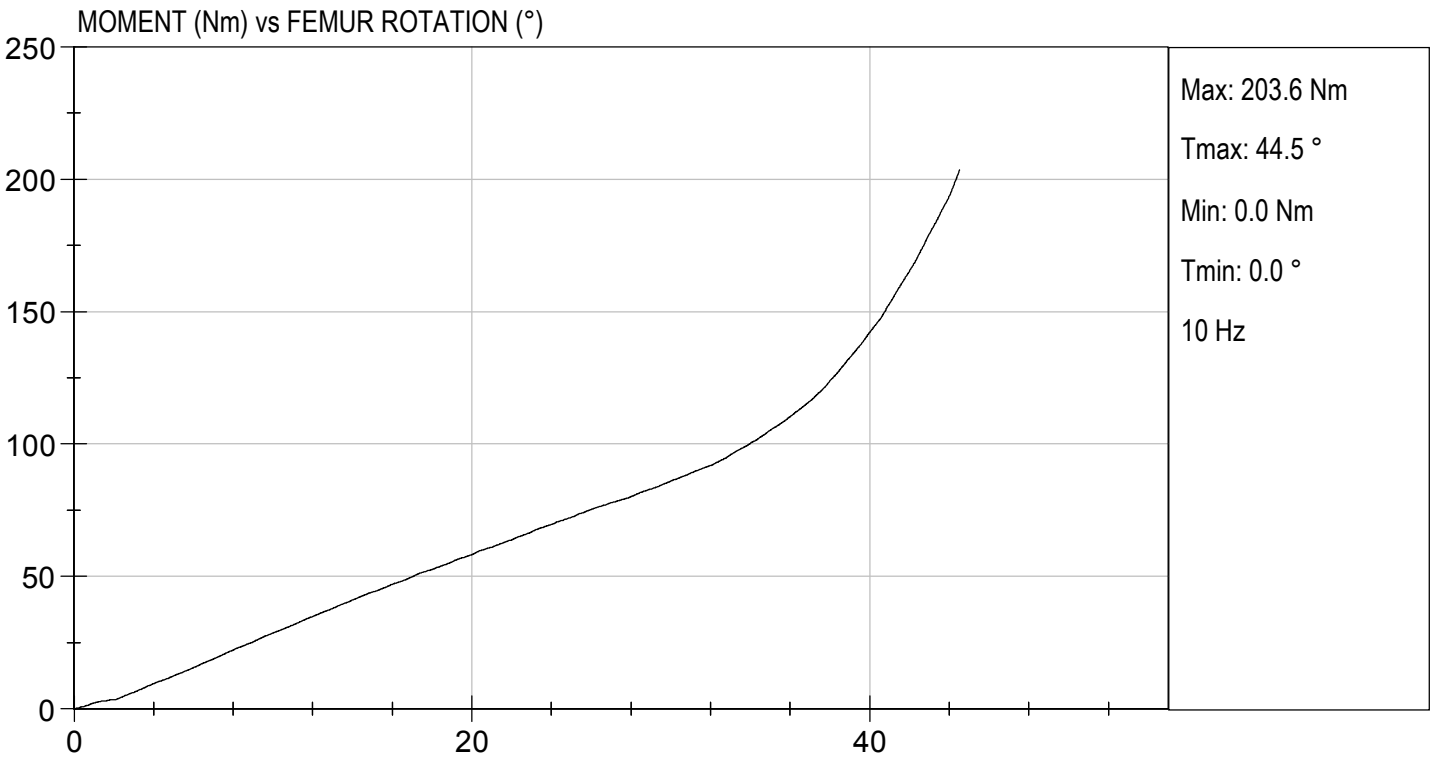
Laboratory Technician

03/04/2021
Test Date

Approved By

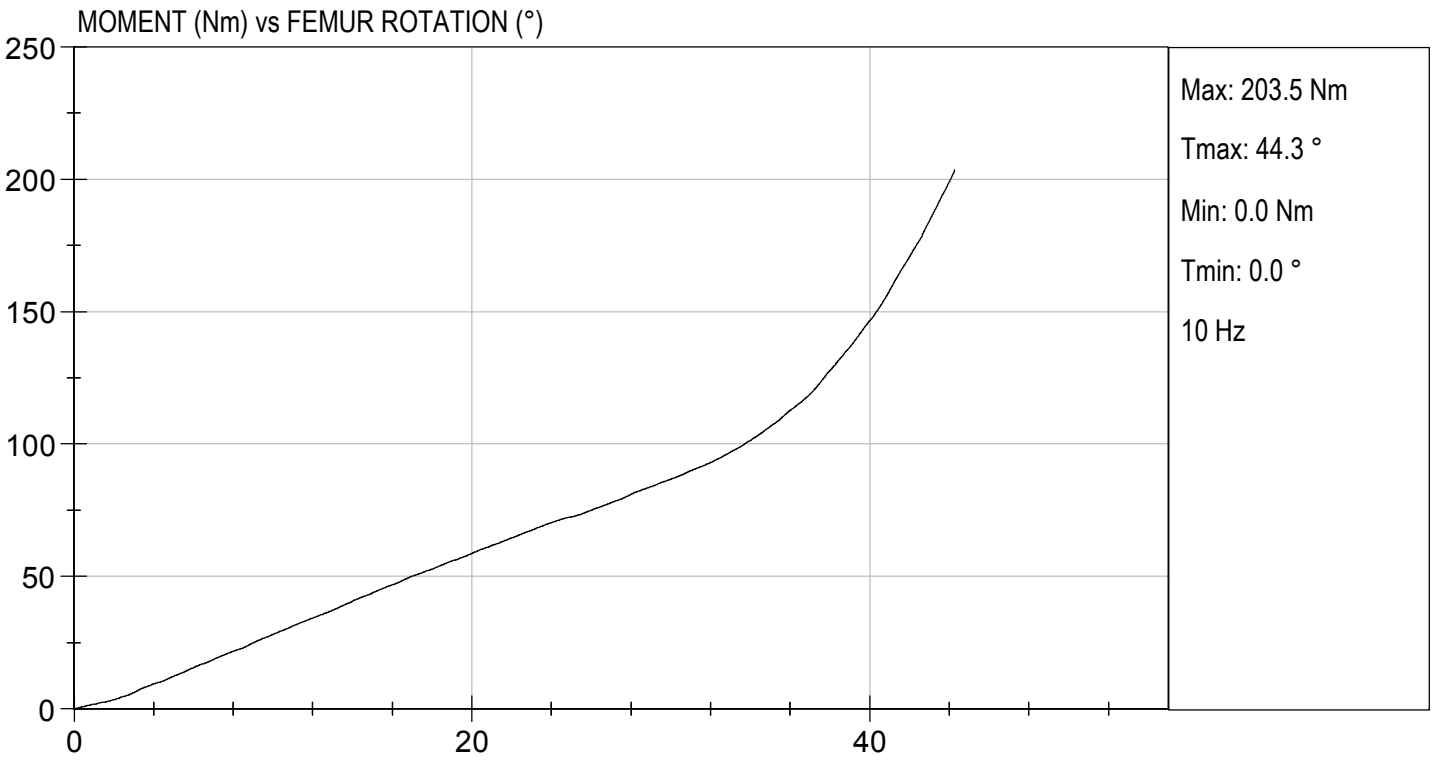
TEST DESC: RIGHT HIP FEMUR FLEXION

TEST DATE: 03/04/2021
TEST #: D210669



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 03/04/2021
TEST #: D210660



CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

Hybrid III, 5th External Measurements
SN: 138

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	785.1
B	SHOULDER PIVOT HEIGHT	Centerline of shoulder pivot bolt to the seat surface.	431.8-457.2	456.8
C	H-POINT HEIGHT	Reference	81.3-86.3	84.0
D	H-POINT LOCATION FROM BACKLINE	Reference	144.8-149.8	146.2
E	SHOULDER PIVOT FROM BACKLINE	Center of the shoulder clevis to the rear vertical surface of the fixture.	68.6-83.8	78.0
F	THIGH CLEARANCE	Measured at the highest point on the upper femur segment.	119.4-134.6	127.5
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	249.6
H	HEAD BACK TO BACKLINE	Back of Skull cap skin to seat rear vertical surface (Reference)	43.2-48.2	45.0
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	280.2
J	ELBOW REST HEIGHT	Measure from the flesh below the elbow pivot bolt to the seat surface.	182.8-203.2	201.9
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	526.7
L	POPLITEAL HEIGHT	Seat surface to the plane of the horizontal plane of the bottom of the feet.	355.6-376.0	362.3
M	KNEE PIVOT HEIGHT	Centerline of knee pivot bolt to the horizontal plane of the bottom of the feet.	393.7-419.1	398.0
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	430.5

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	184.6
P	FOOT LENGTH	Tip of toe to rear of heal	218.5-233.7	221.0
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	472.6
S	HEAD BREADTH	The widest part of the head	137.1-147.3	141.9
T	HEAD DEPTH	Back of the head to the forehead	177.8-188.0	184.2
U	HIP BREADTH	The widest part of the hip	299.7-314.9	307.4
V	SHOULDER BREADTH	Outside edges of right and left shoulder clevises	350.5-365.7	360.5
W	FOOT BREADTH	The widest part of the foot	78.8-94.0	85.0
X	HEAD CIRCUMFERENCE	Measured at the point as in dim. “T”	528.3-548.7	546.2
Y	CHEST CIRCUMFERENCE (WITH CHEST JACKET)	Measured 345.4 ± 12.7 mm above seat surface	850.9-881.3	875.1
Z	WAIST CIRCUMFERENCE	Measured 165.1 ± 5.1 mm above seat surface	759.5-789.9	785.4
AA	REFERENCE LOCATION FOR MEASUREMENT OF CHEST CIRCUMFERENCE	Reference	332.7-358.1	345.4
BB	REFERENCE LOCATION FOR MEASUREMENT OF WAIST CIRCUMFERENCE	Reference	160.1-170.2	165.1

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test ID:** D210431

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	24	Pass
Peak Resultant Acceleration	G's	250 to 300	256	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	2.3	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Gerald Guerrero
Laboratory Technician

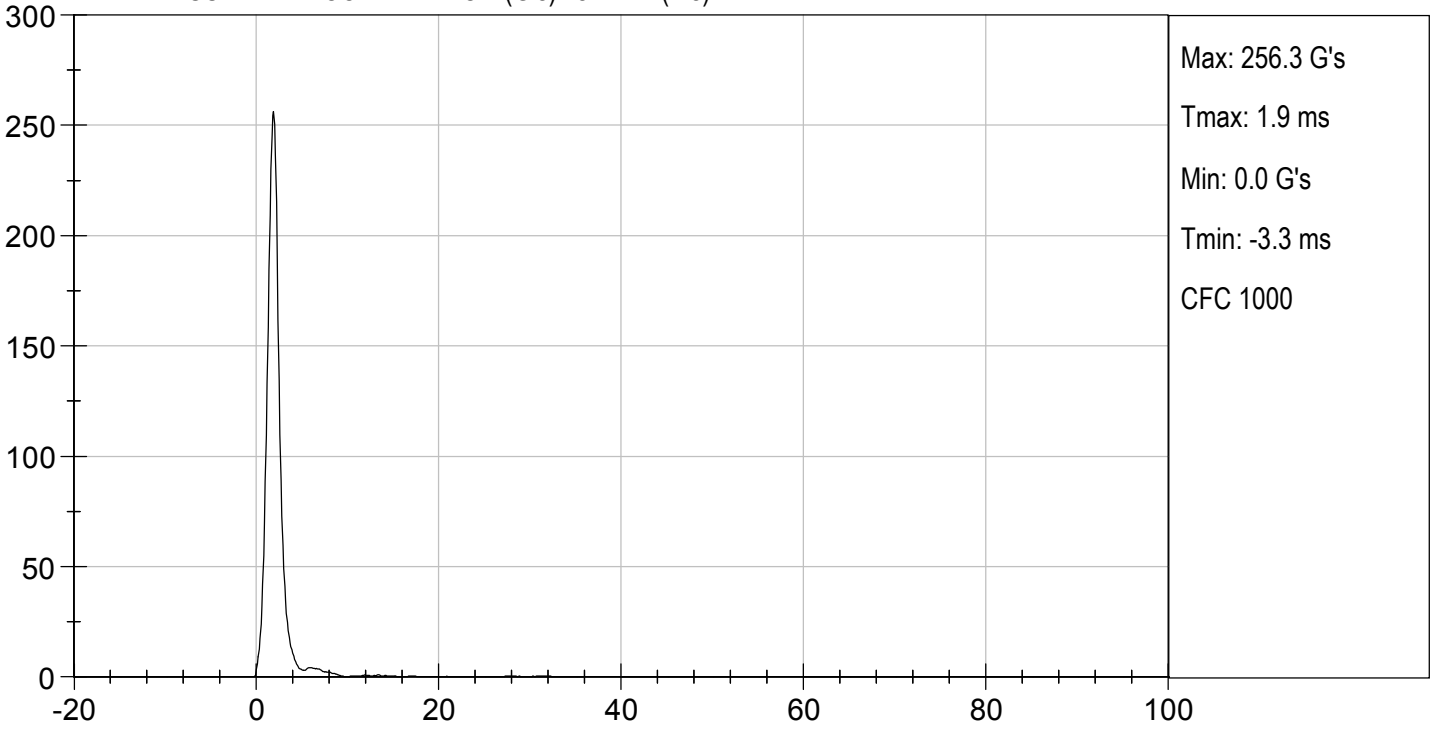
02/18/2021
Test Date

Approved By

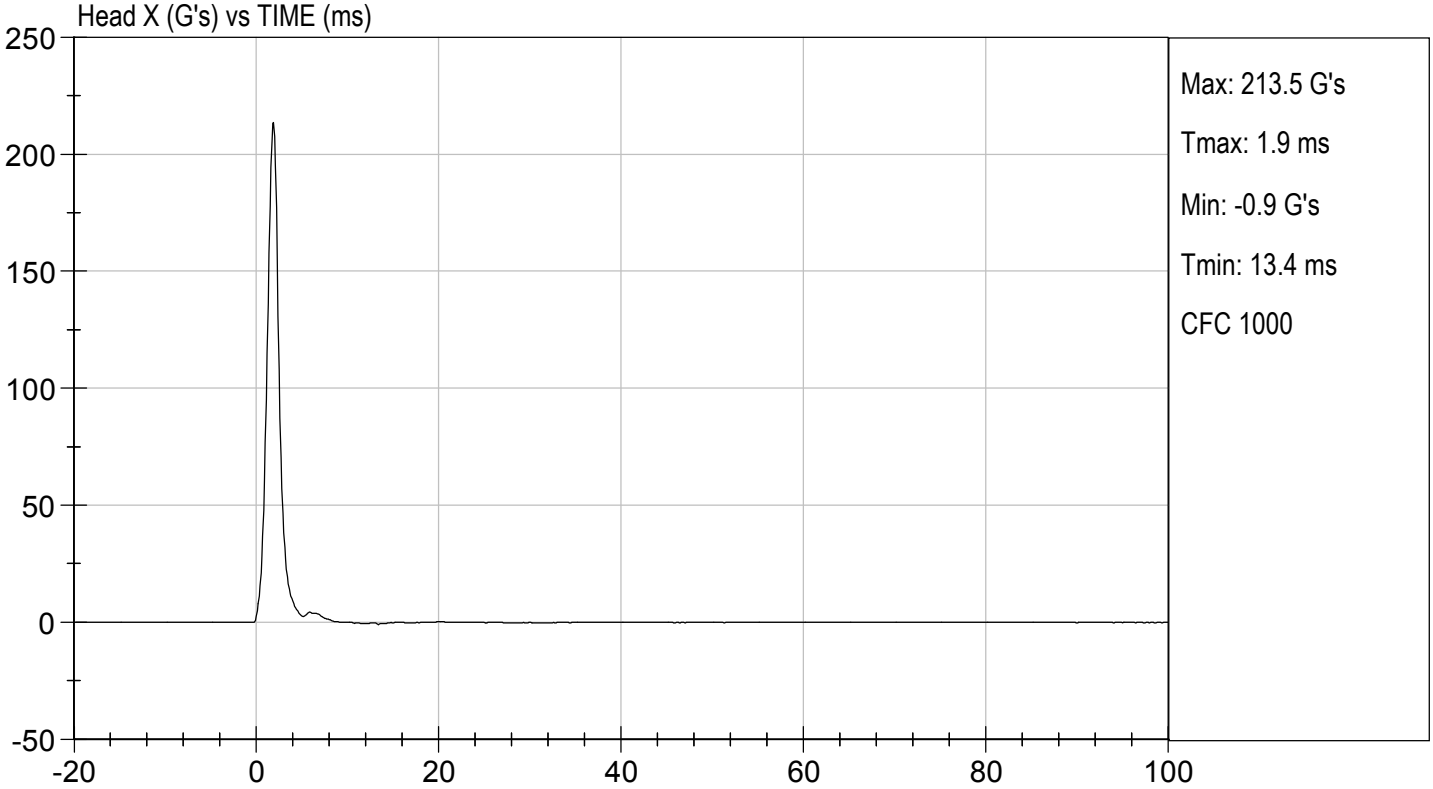
TEST DESC: HEAD DROP

TEST DATE: 02/18/2021
TEST #: D210431

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

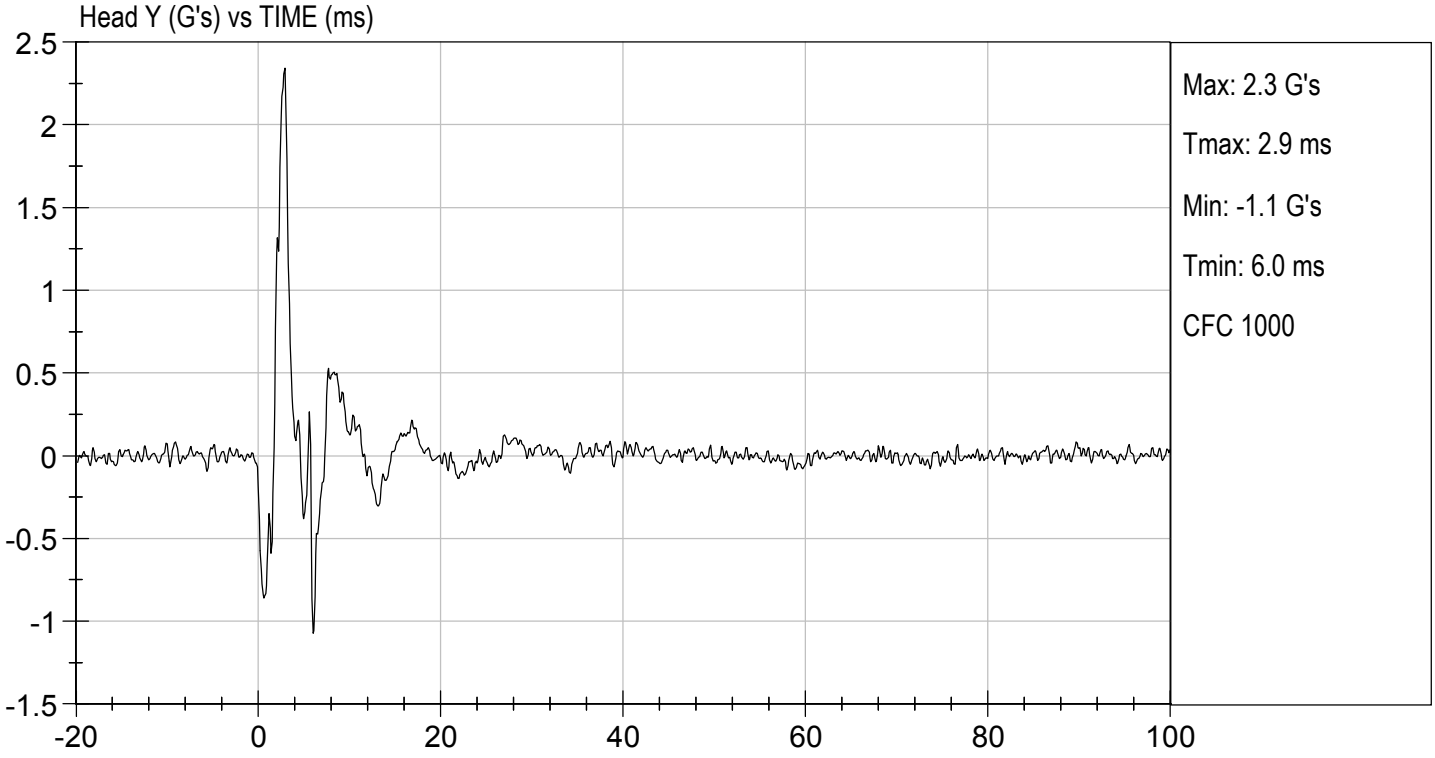


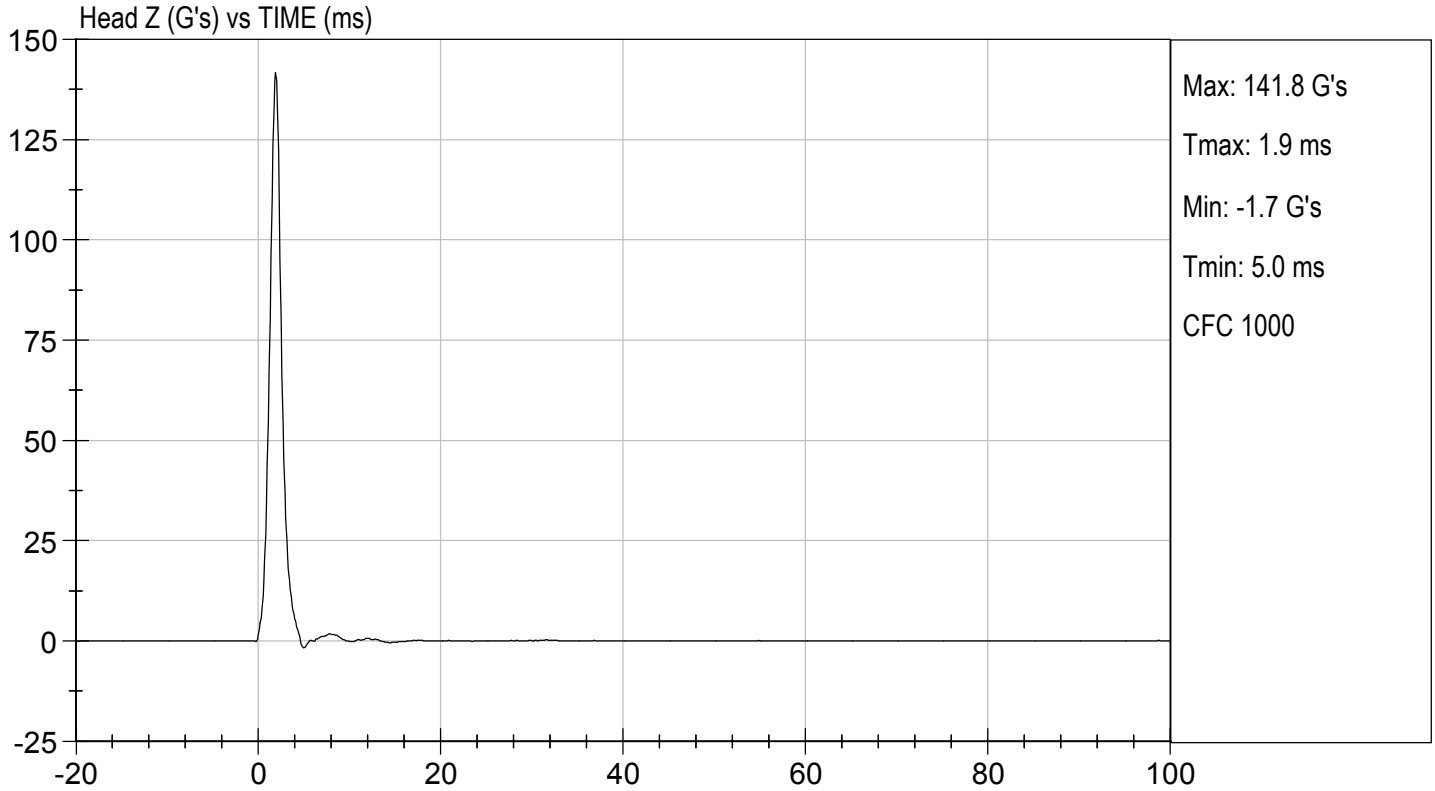
Head X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 02/18/2021
TEST #: D210431





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210432

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	20.9	Pass
Laboratory Relative Humidity		%	10 to 70	19	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	4.6	Pass
	30 ms	m/s	5.8 to 7.0	6.6	Pass
D Plane Rotation	Max	deg	77 to 91	81	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	72	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	85	Pass
			Overall Results		Pass

Gerald Guerrero
Laboratory Technician

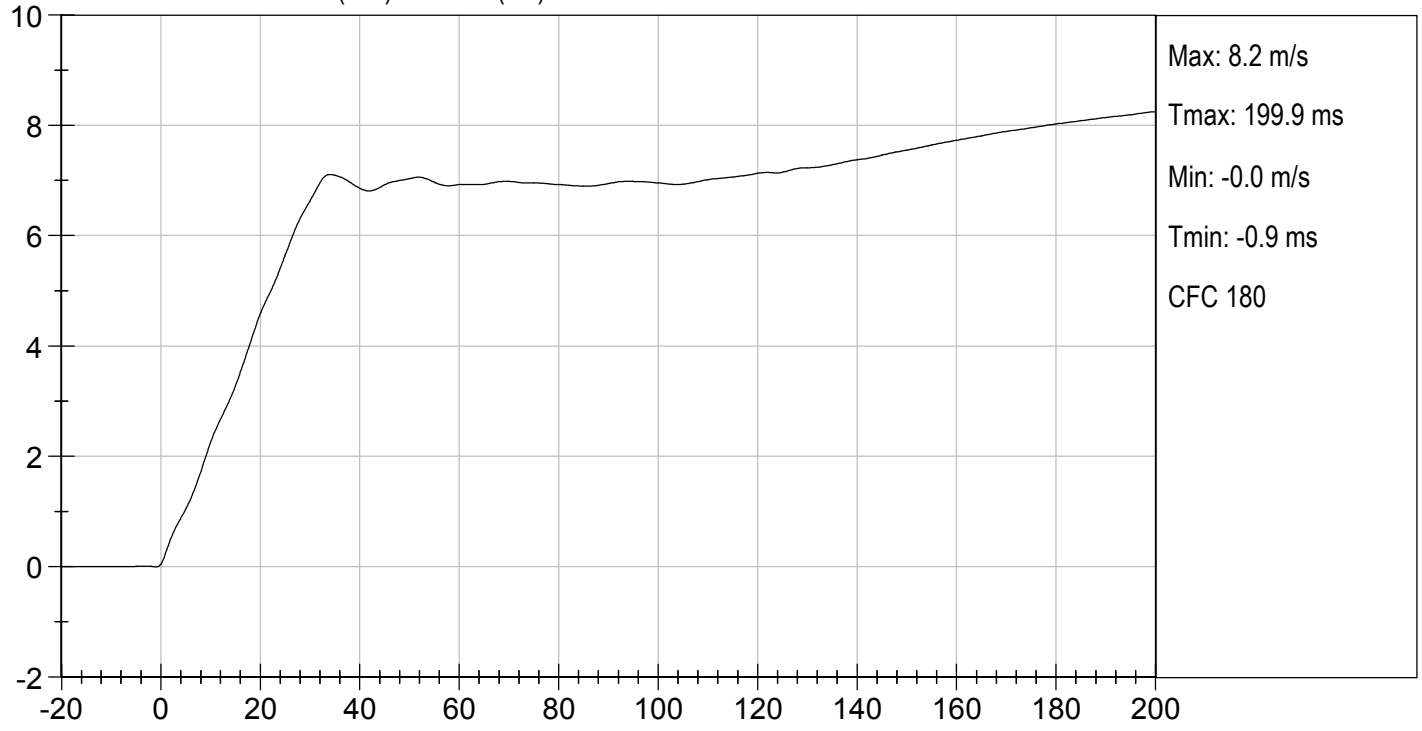
02/18/2021
Test Date

Approved By

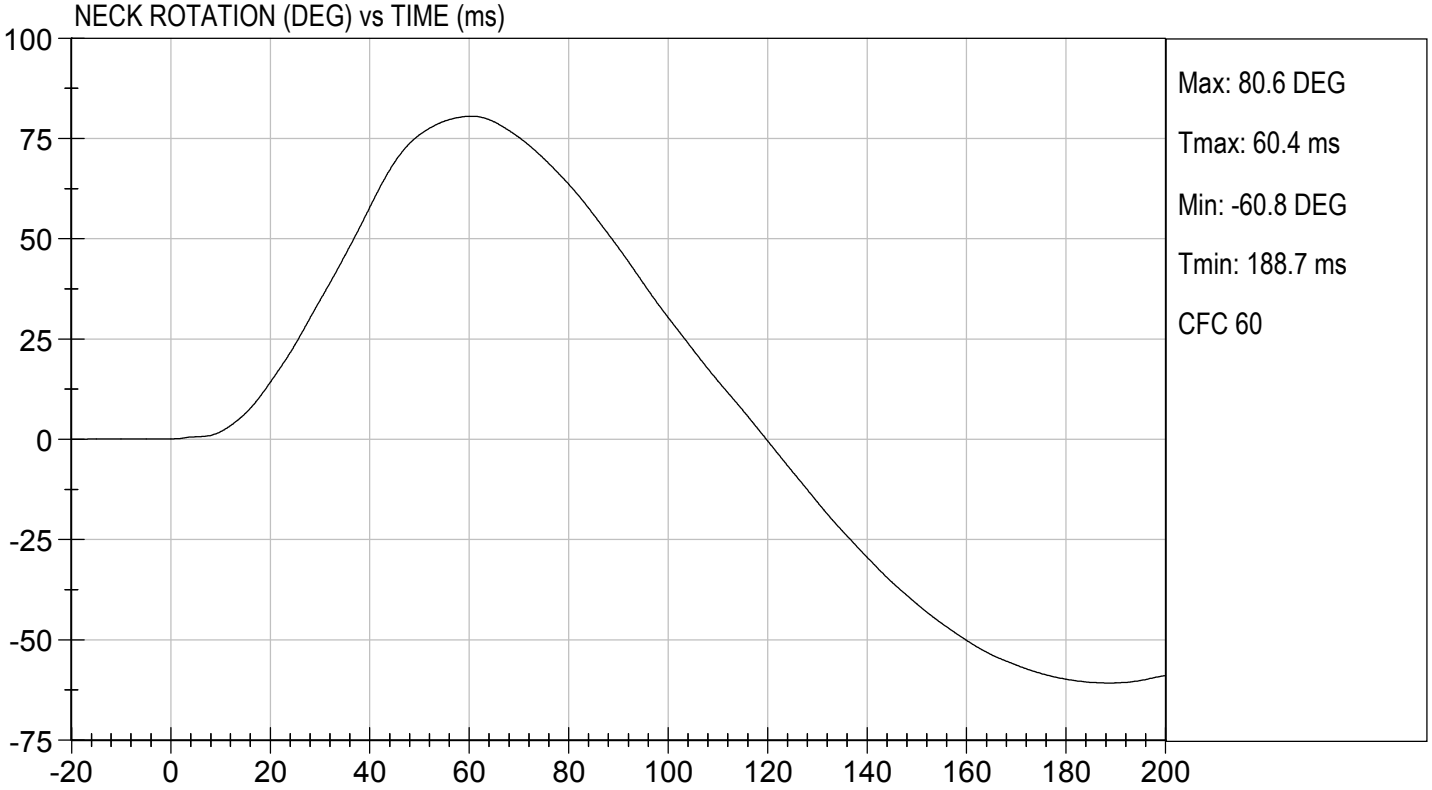
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 02/18/2021
TEST #: D210432

PENDULUM VELOCITY (m/s) vs TIME (ms)

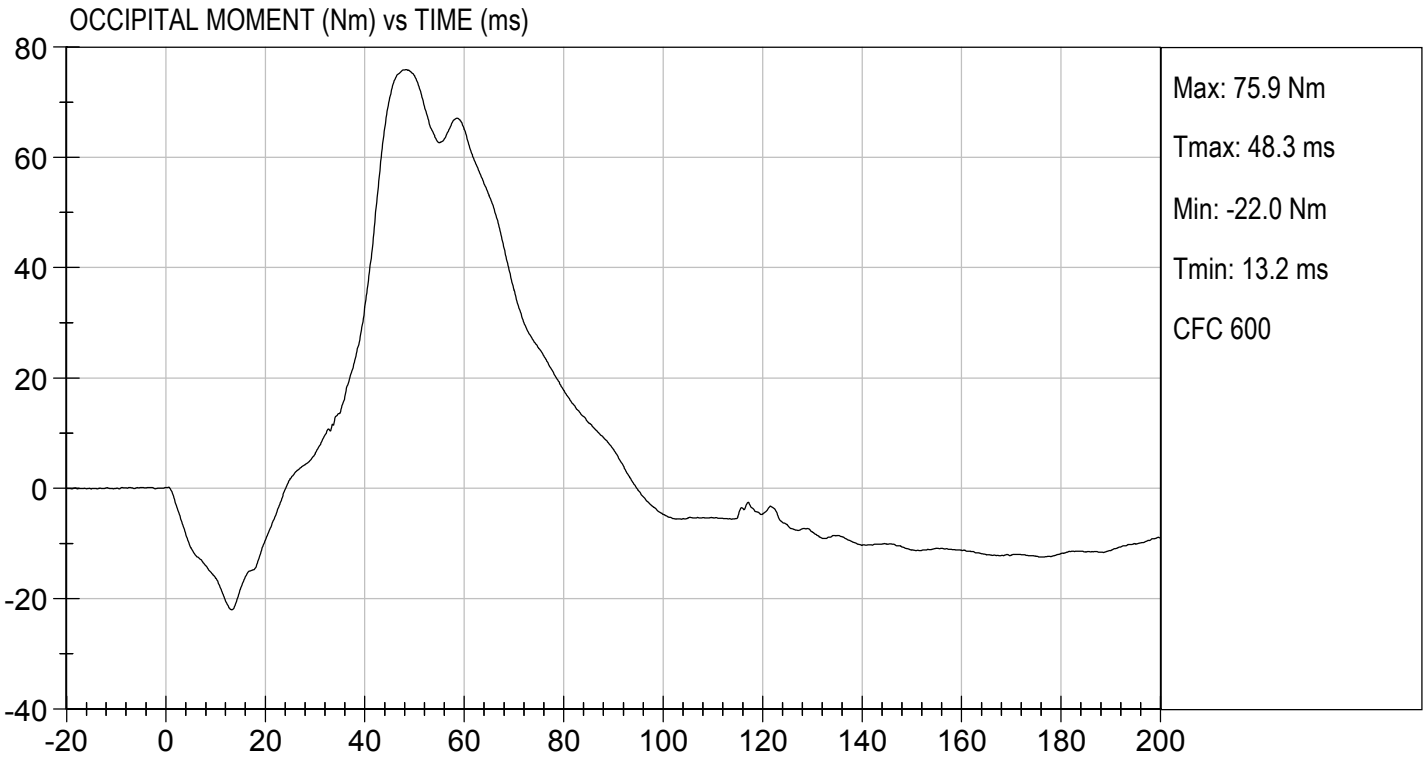


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 02/18/2021
TEST #: D210432



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210433

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	20.9	Pass
Laboratory Relative Humidity		%	10 to 70	19	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.12	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.8	Pass
	20 ms	m/s	3.1 to 3.9	3.8	Pass
	30 ms	m/s	4.6 to 5.6	5.6	Pass
D Plane Rotation	Max	deg	99 to 114	112	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-58	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	106	Pass
			Overall Results		Pass

Gerald Guerrero
Laboratory Technician

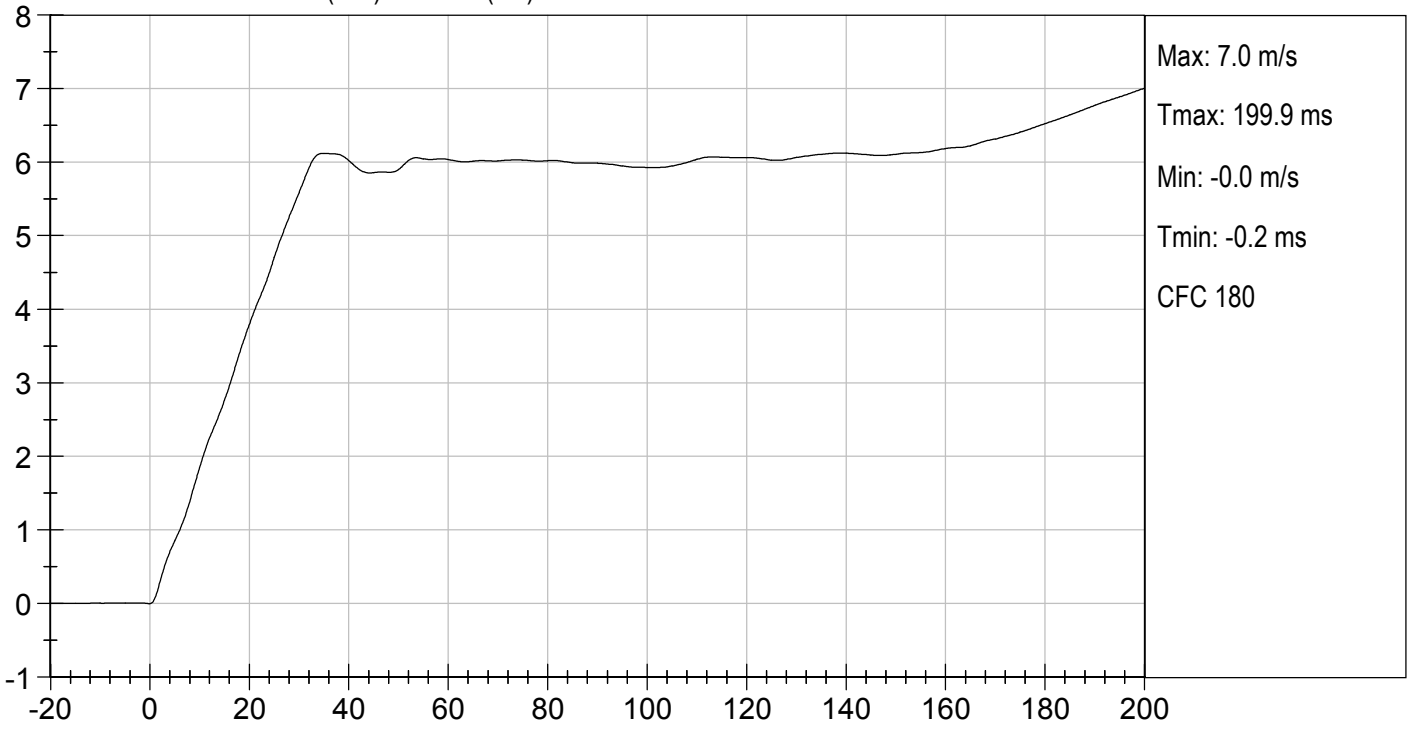
02/18/2021
Test Date

Approved By

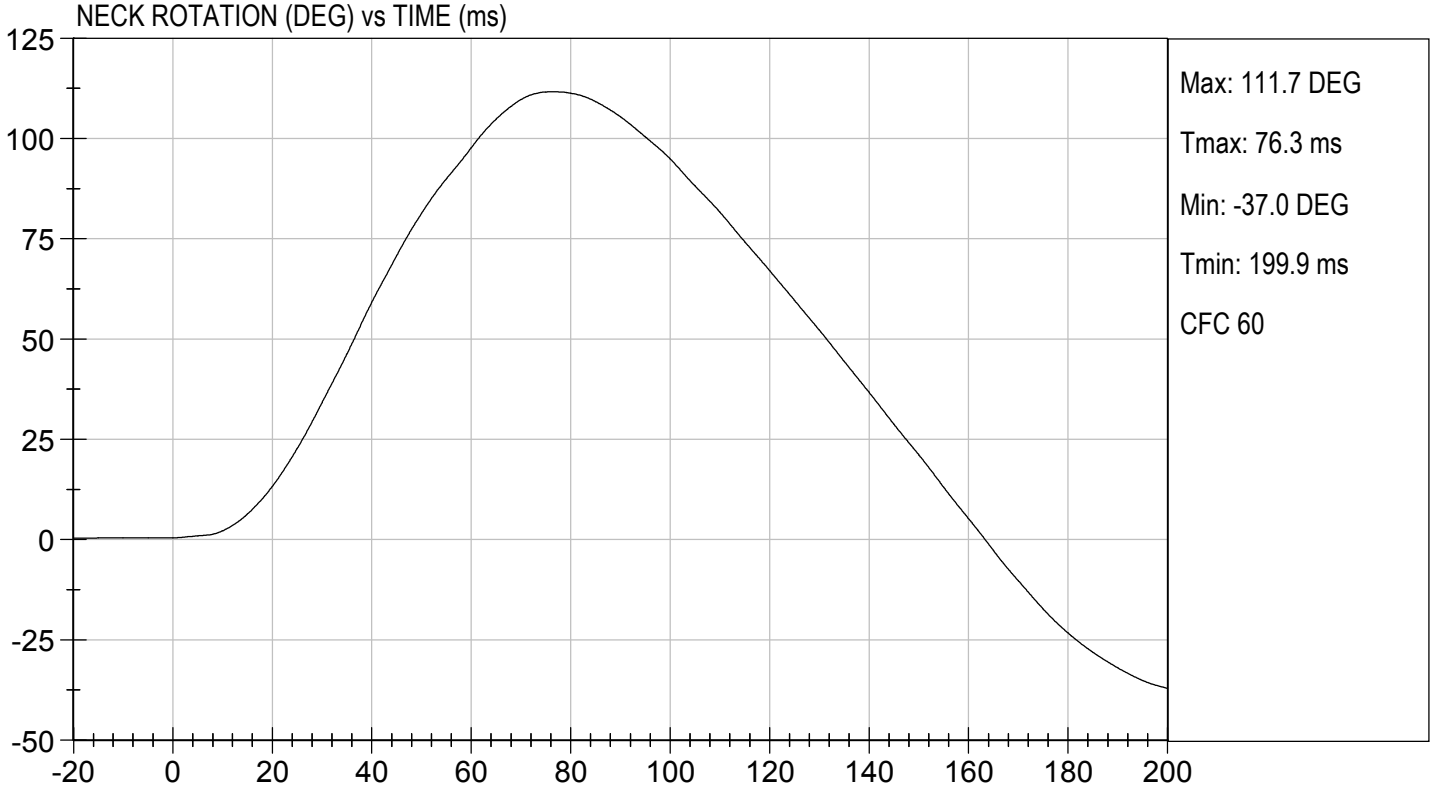
TEST DESC: NECK EXTENSION
VELOCITY: 20.08 ft/s, 6.12 m/s

TEST DATE: 02/18/2021
TEST #: D210433

PENDULUM VELOCITY (m/s) vs TIME (ms)

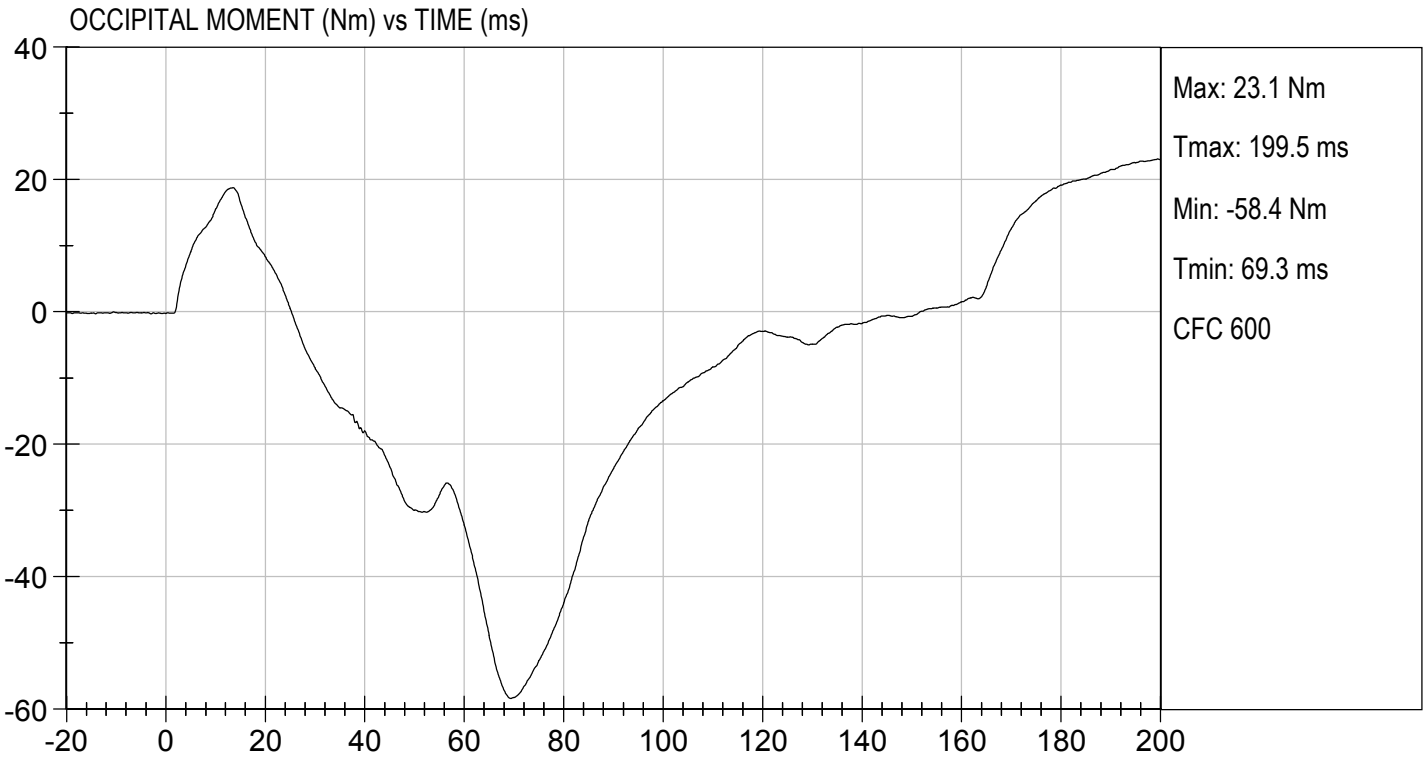


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 02/18/2021
TEST #: D210433



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210434

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.6	Pass
Relative Humidity	%	10 to 70	24	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	55	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4299	Pass
Internal Hysteresis	%	69 to 85	70	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4238	Pass
		Overall Test Results		Pass

Gerald Guerrero
Laboratory Technician

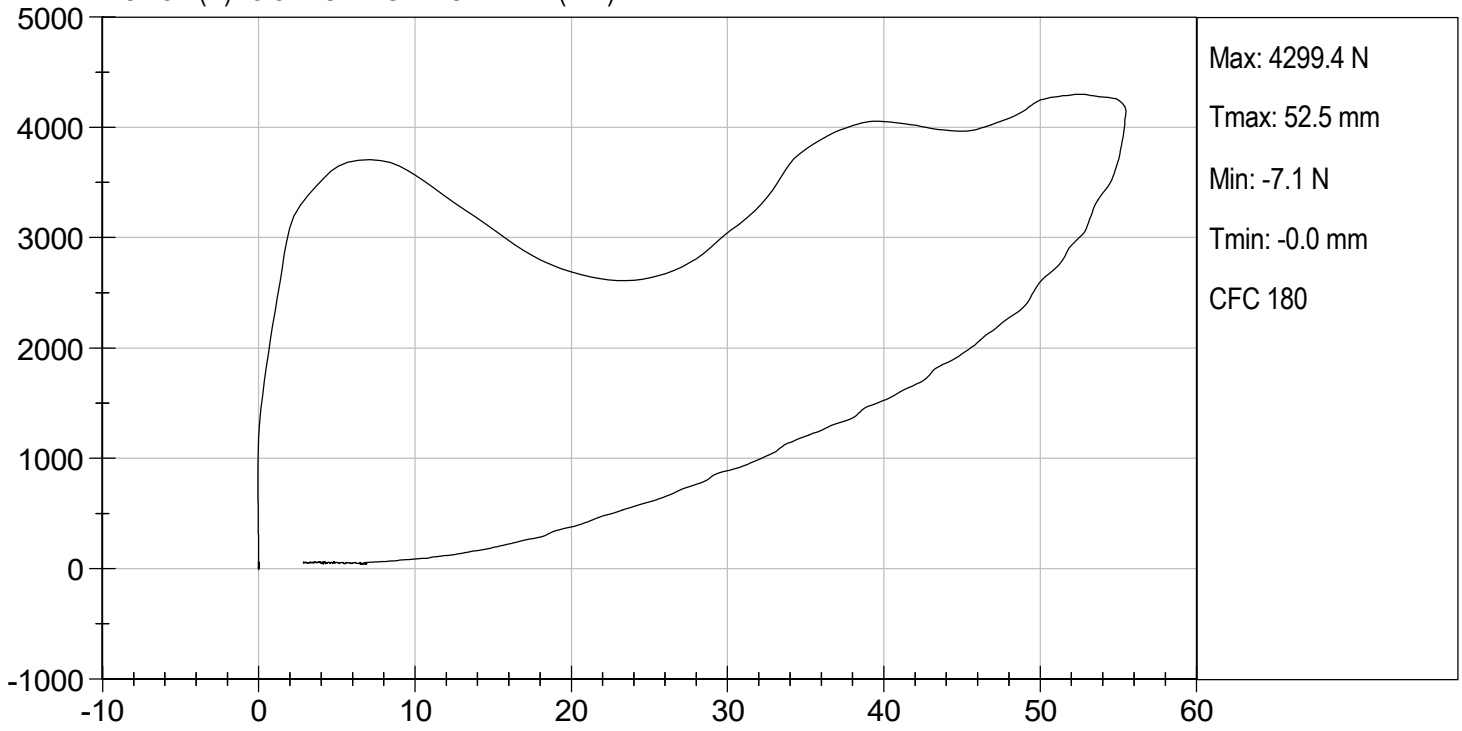
02/18/2021
Test Date

Approved By

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

TEST DATE: 02/18/2021
TEST #: D210434

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210435

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	20	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3638	Pass
		Overall Test Results		Pass

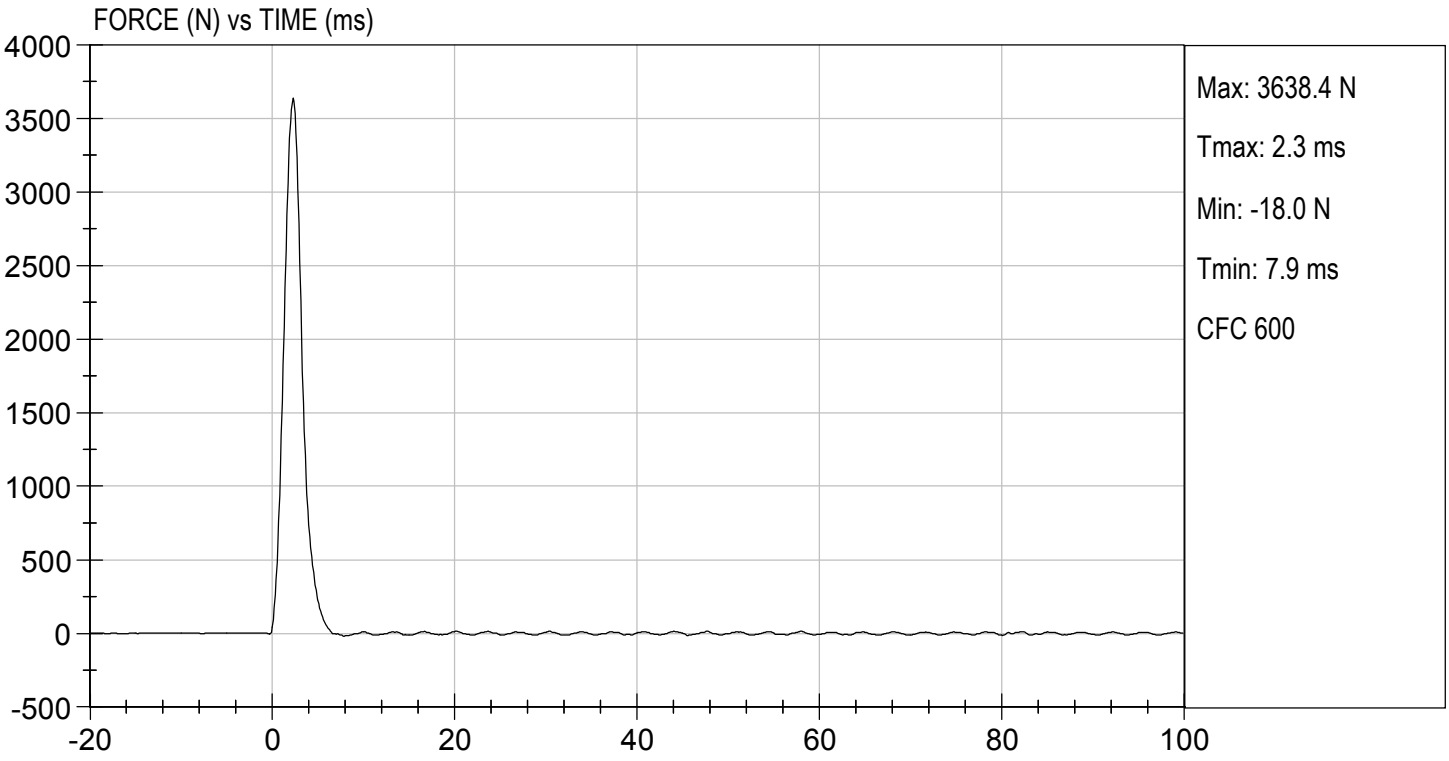
Gerald Guerrero
Laboratory Technician

02/18/2021
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.97 ft/s, 2.12 m/s

TEST DATE: 02/18/2021
TEST #: D210435



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210436

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	20	Pass
Probe Speed	m/s	2.07 to 2.13	2.13	Pass
Maximum Force	N	3450 to 4060	4023	Pass
		Overall Test Results		Pass

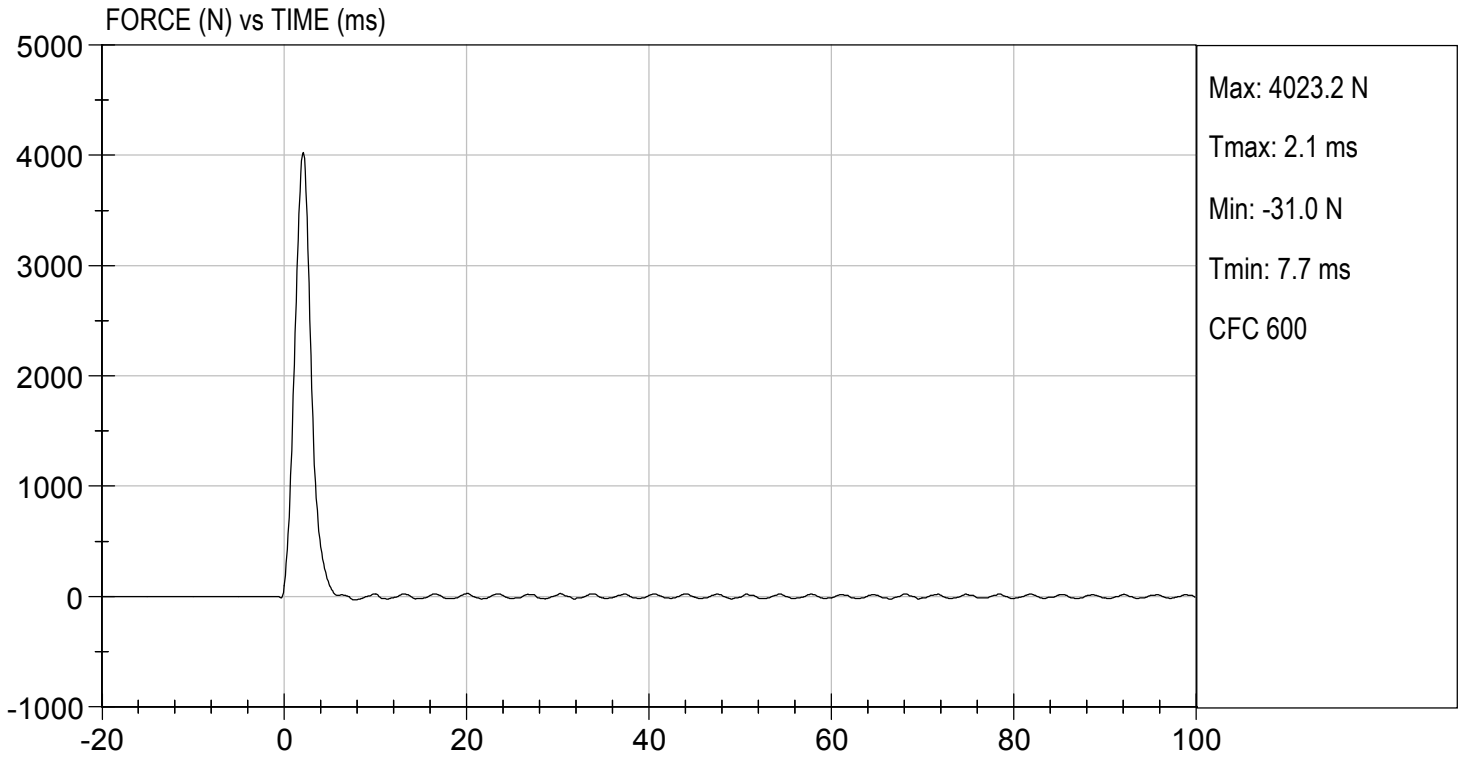
Gerald Guerrero
Laboratory Technician

02/18/2021
Test Date

Approved By

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

TEST DATE: 02/18/2021
TEST #: D210436



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210437

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	24	Pass
Initial Angle	deg	0 to 20	20	Pass
Return Angle	deg	+/- 8	3	Pass
Force at 45 deg	N	320 to 390	355	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.5	Pass
		Overall Result		Pass

Laboratory Technician

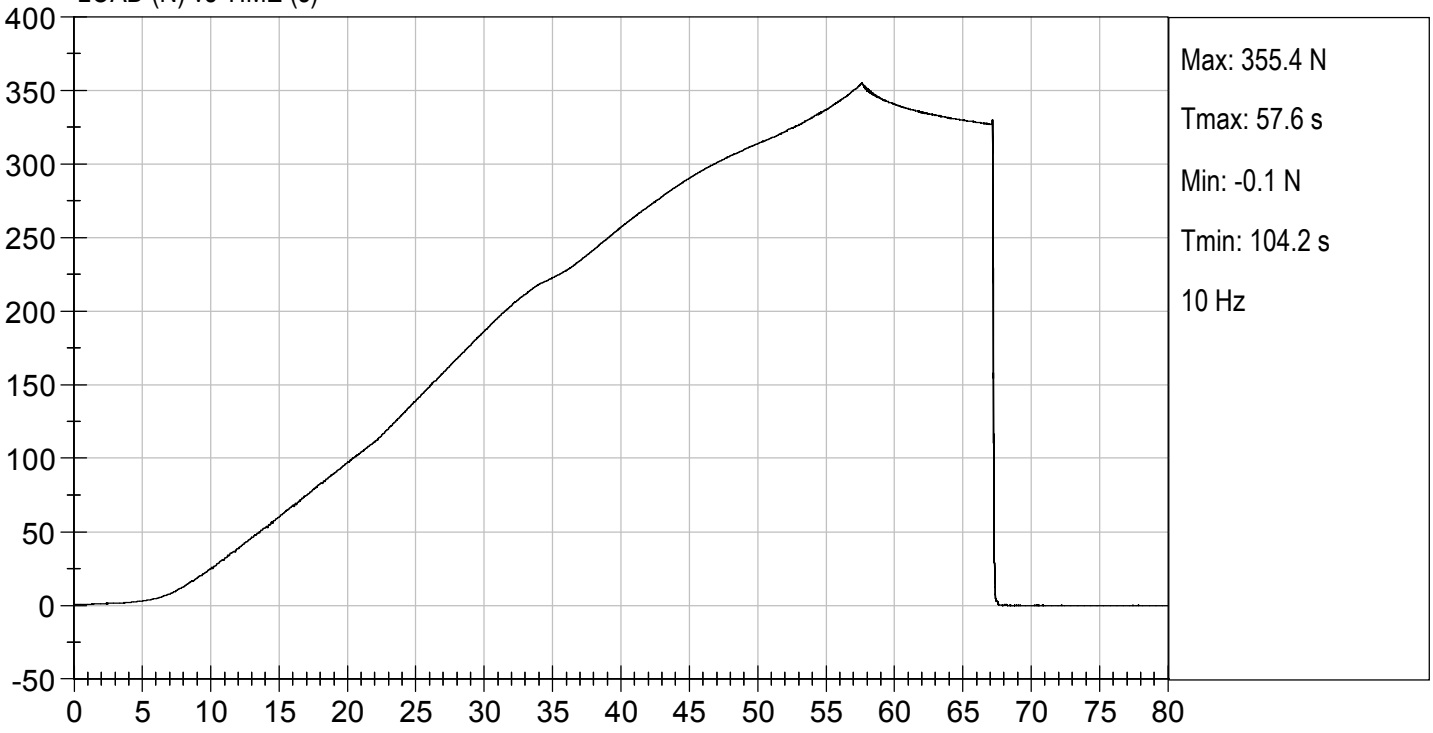
02/18/2021
Test Date

Approved By

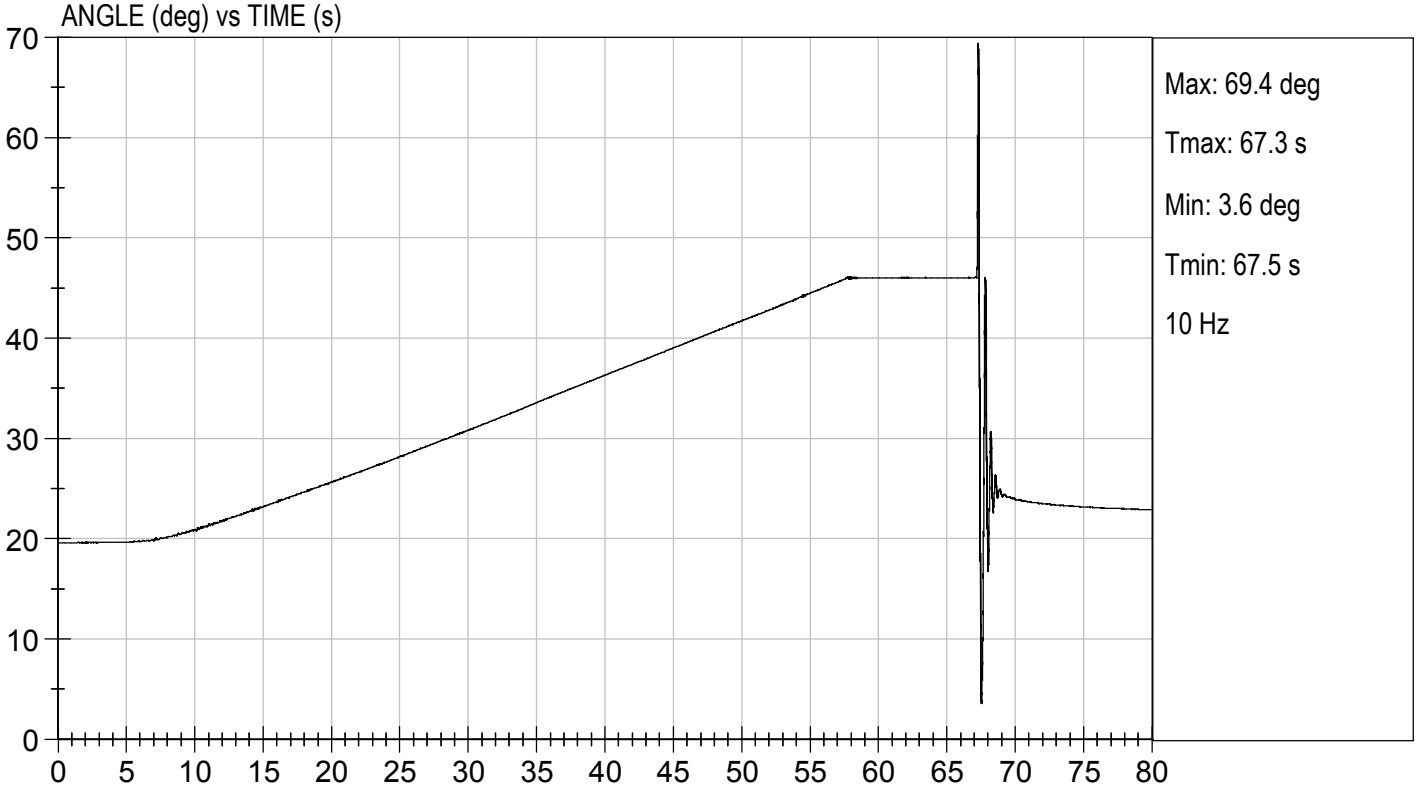
TEST DESC: LUMBAR FLEXION

TEST DATE: 02/18/2021
TEST #: D210437

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: 138 **Test ID:** D210651

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	25	Pass
Peak Resultant Acceleration	G's	250 to 300	257	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-2.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Gerald Guerrero
Laboratory Technician

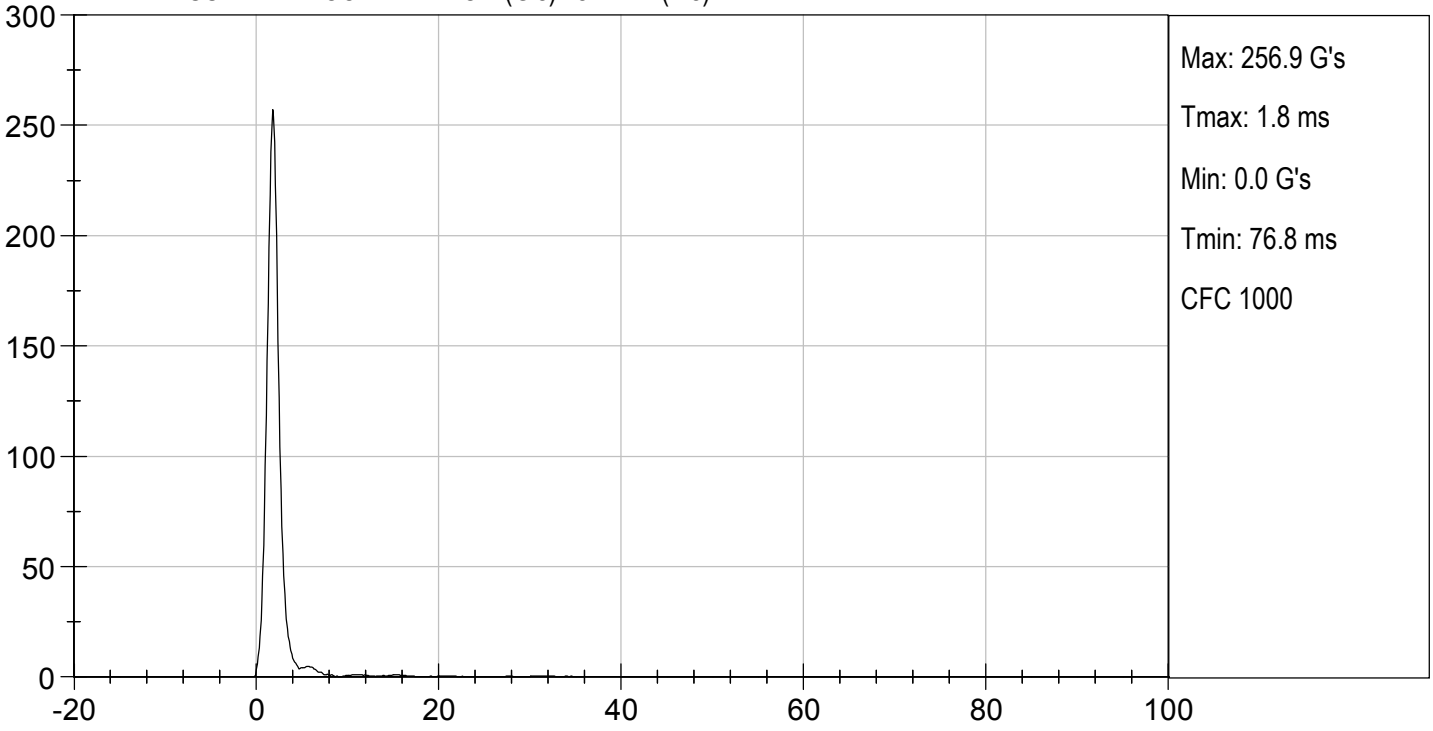
03/04/2021
Test Date

Approved By

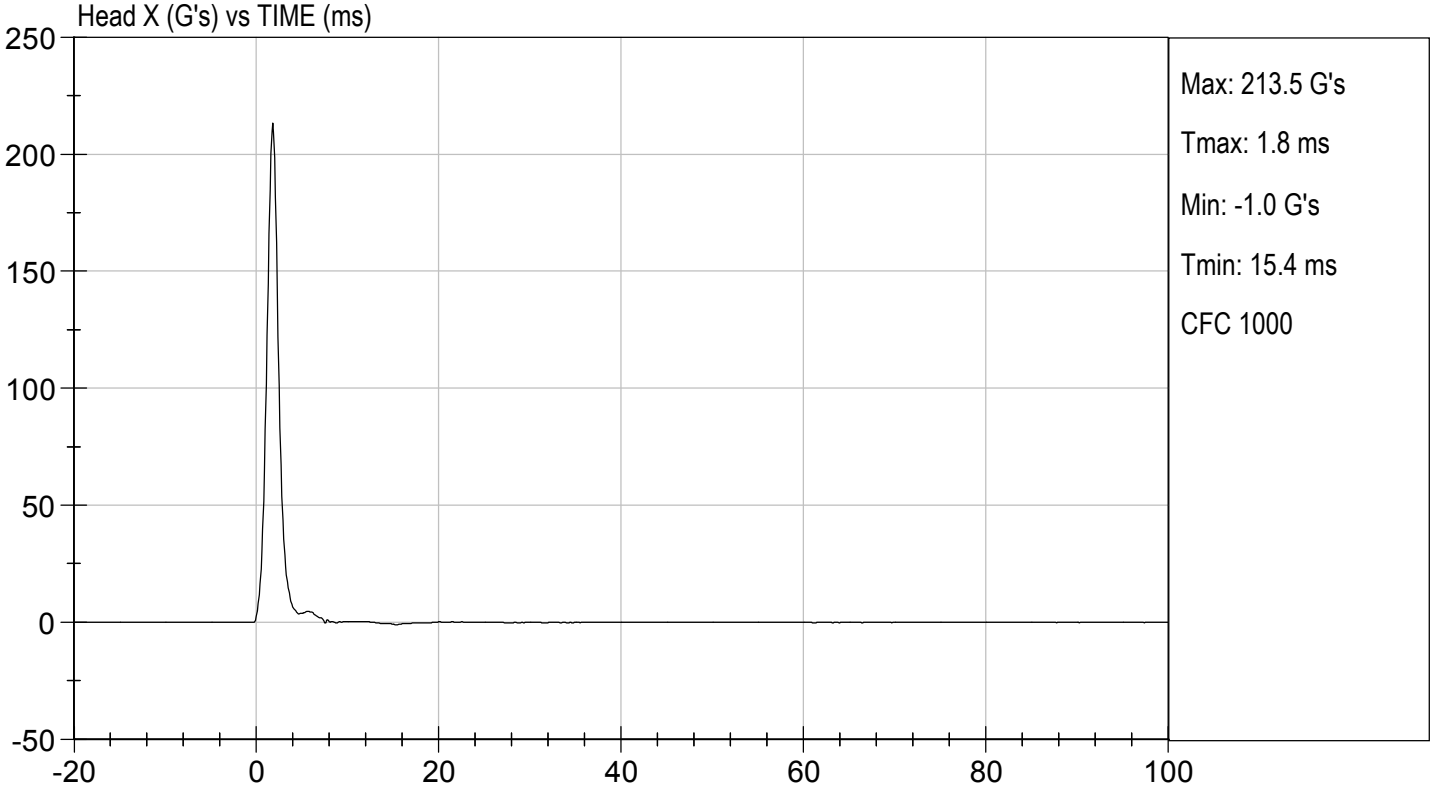
TEST DESC: HEAD DROP

TEST DATE: 03/04/2021
TEST #: D210651

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

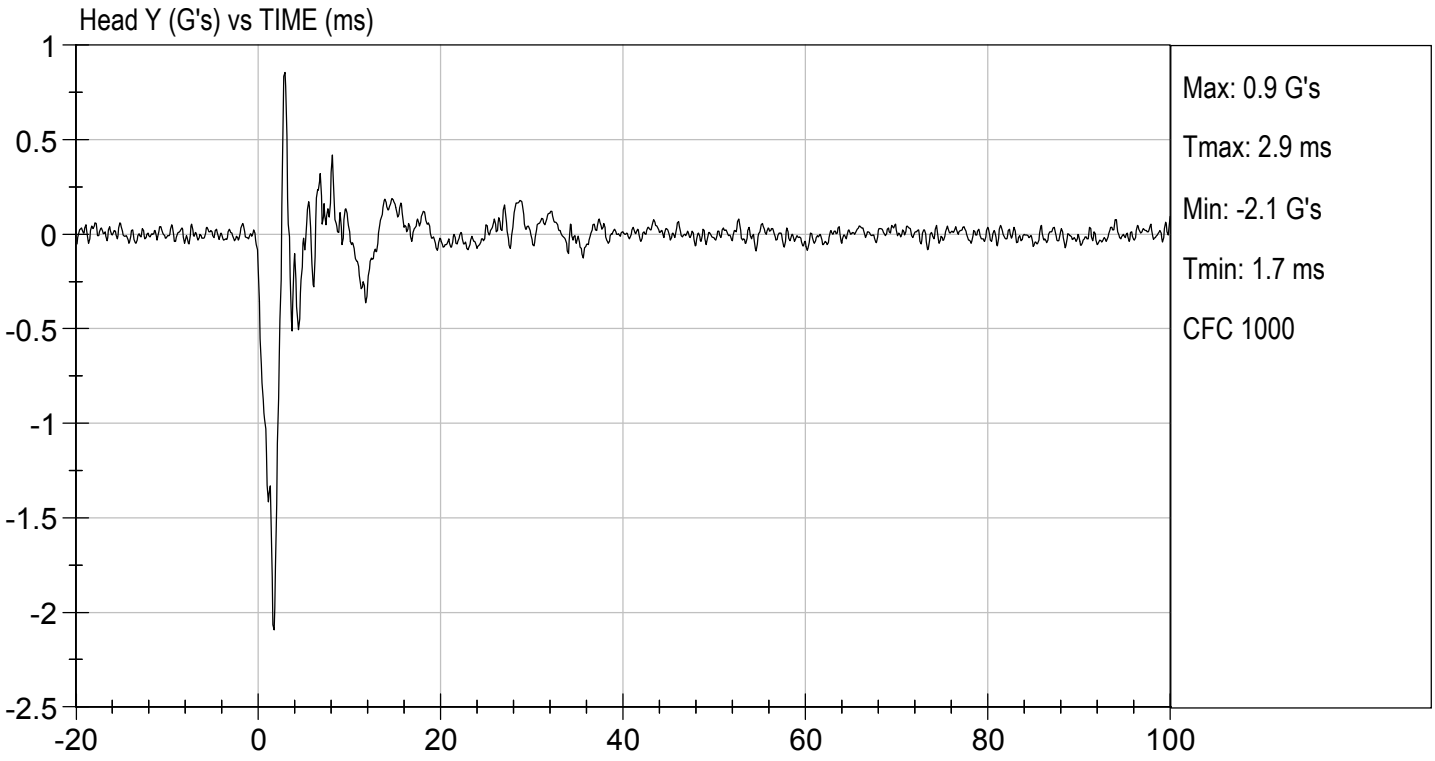


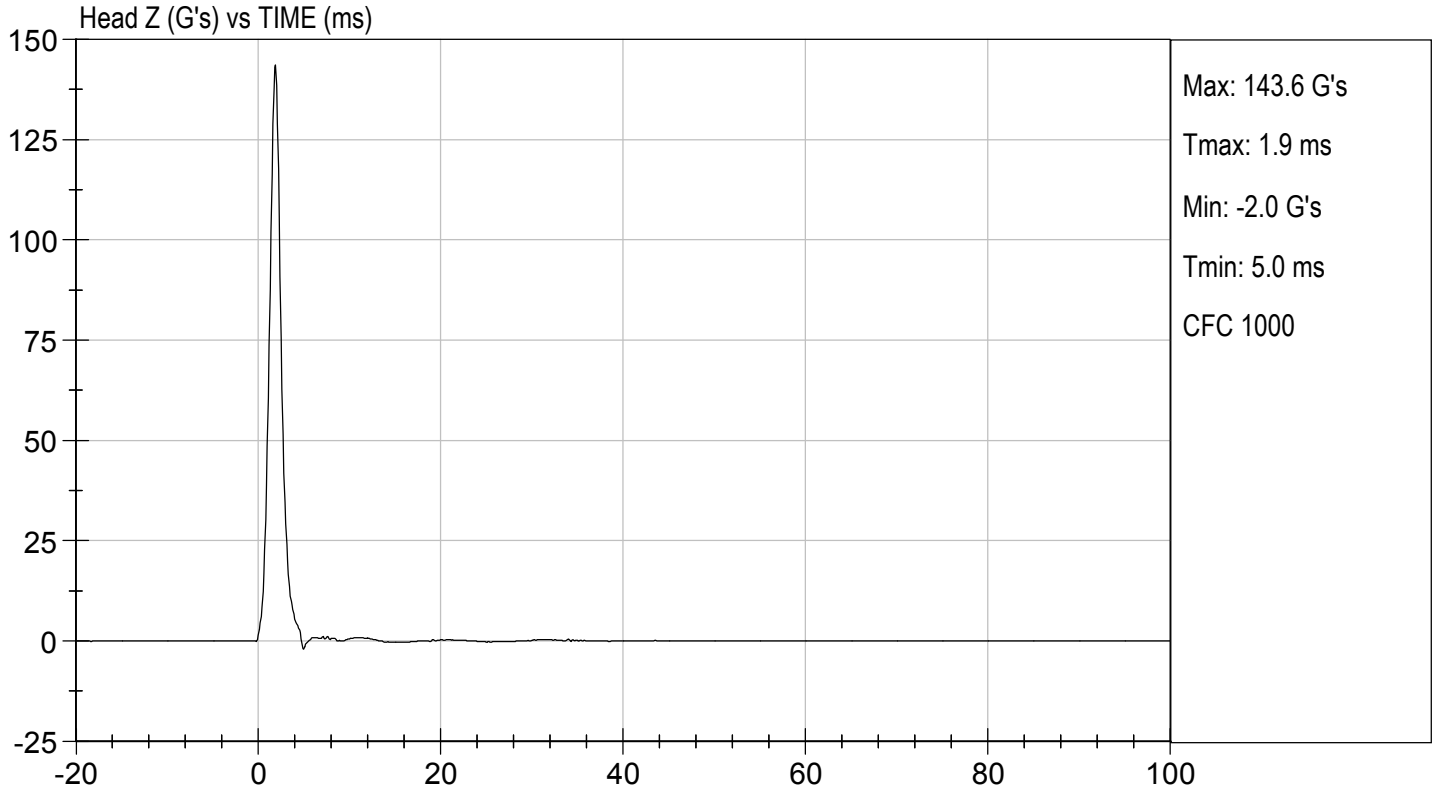
Head X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 03/04/2021
TEST #: D210651





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210652

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	25	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.06	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.4	Pass
	20 ms	m/s	4.0 to 5.0	4.7	Pass
	30 ms	m/s	5.8 to 7.0	6.9	Pass
D Plane Rotation	Max	deg	77 to 91	81	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	70	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	81	Pass
			Overall Results		Pass

Gerald Guerrero
Laboratory Technician

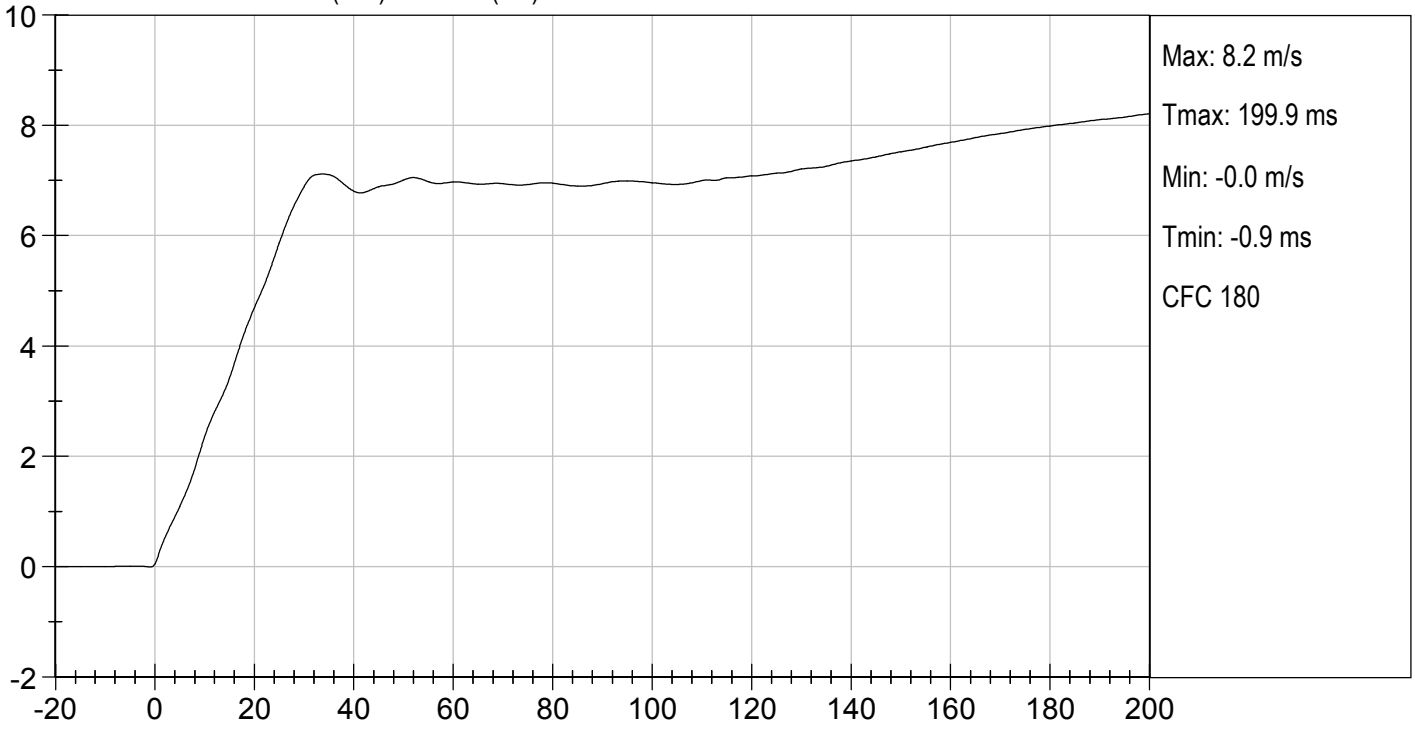
03/04/2021
Test Date

Approved By

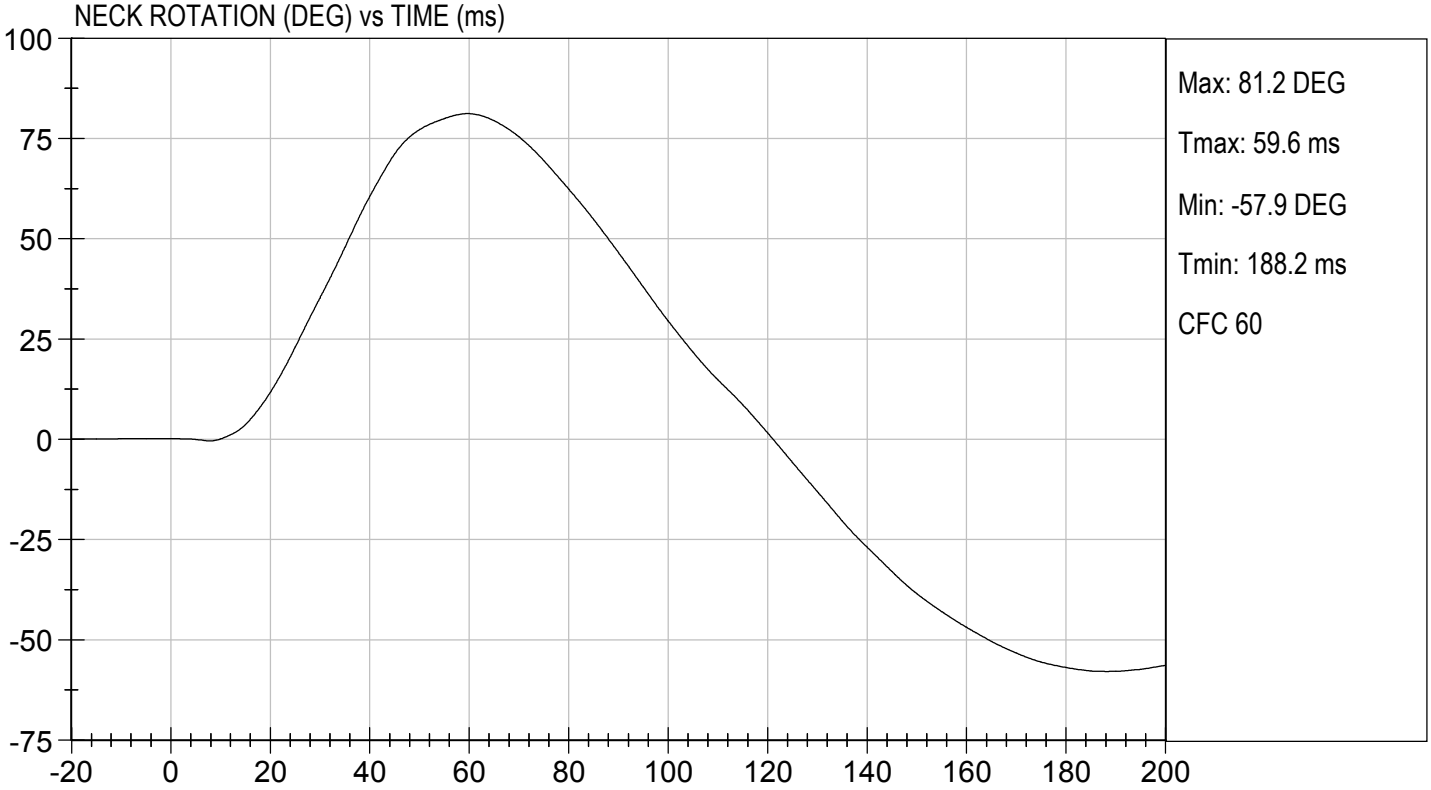
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 03/04/2021
TEST #: D210652

PENDULUM VELOCITY (m/s) vs TIME (ms)

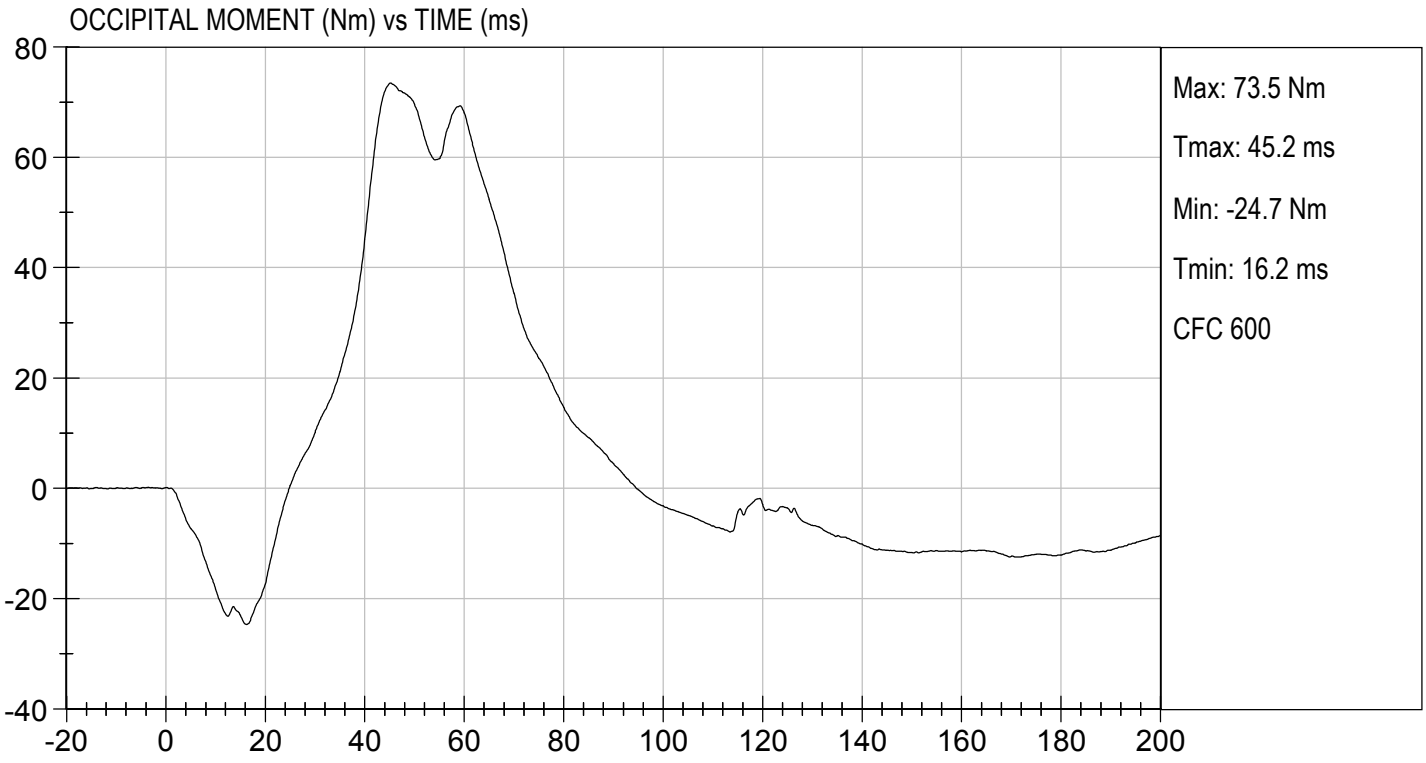


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 03/04/2021
TEST #: D210652



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210653

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	25	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	3.5	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	106	Pass
			Overall Results		Pass

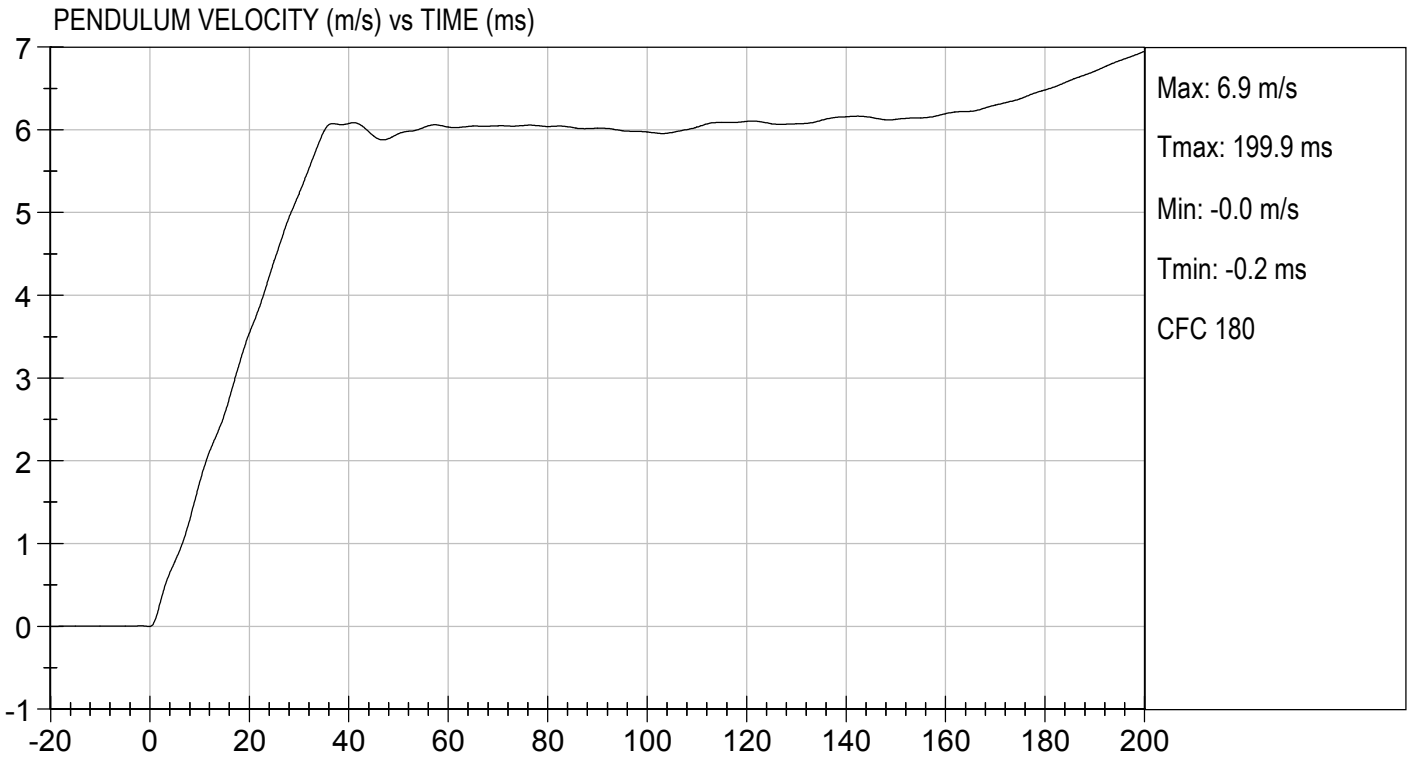
Gerald Guerrero
Laboratory Technician

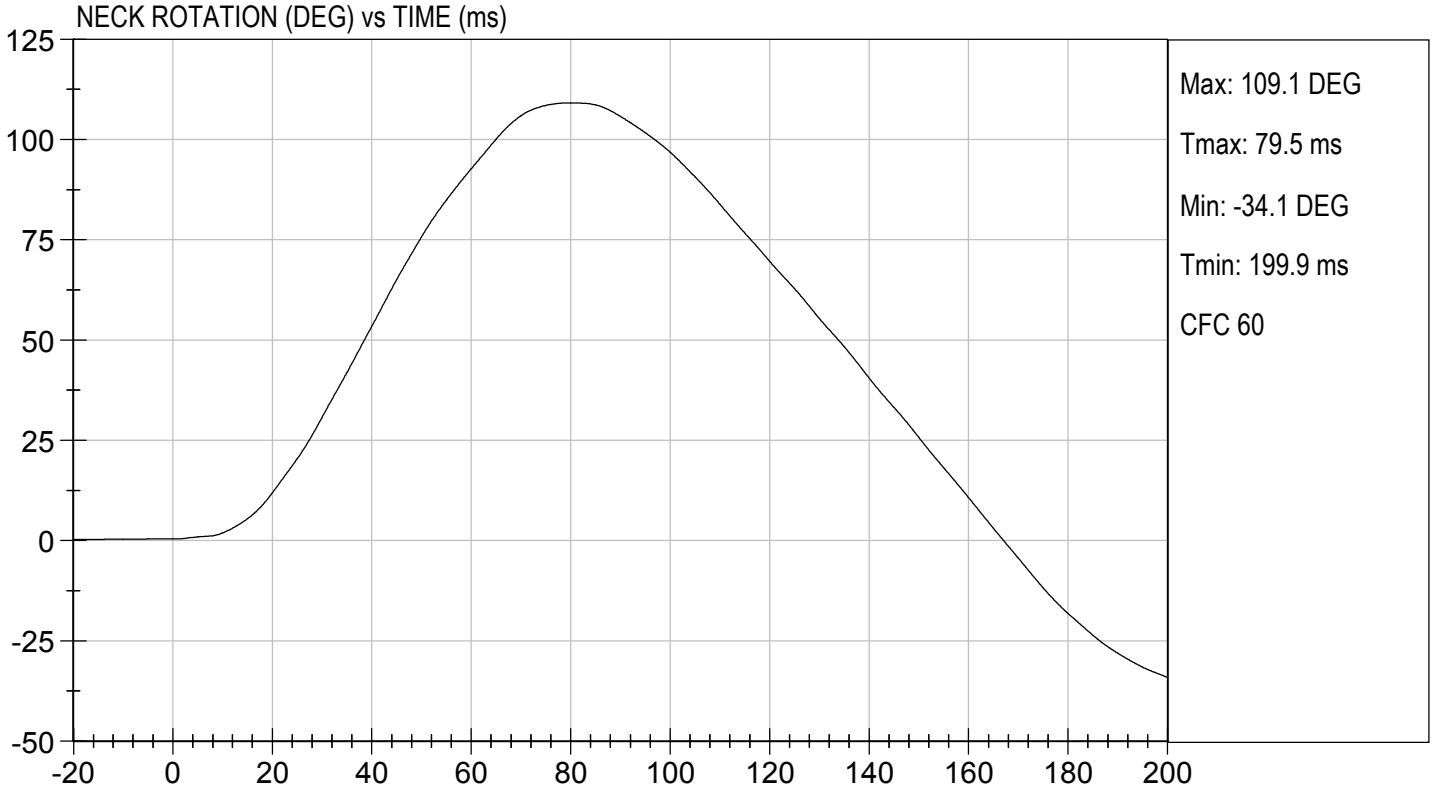
03/04/2021
Test Date

Approved By

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

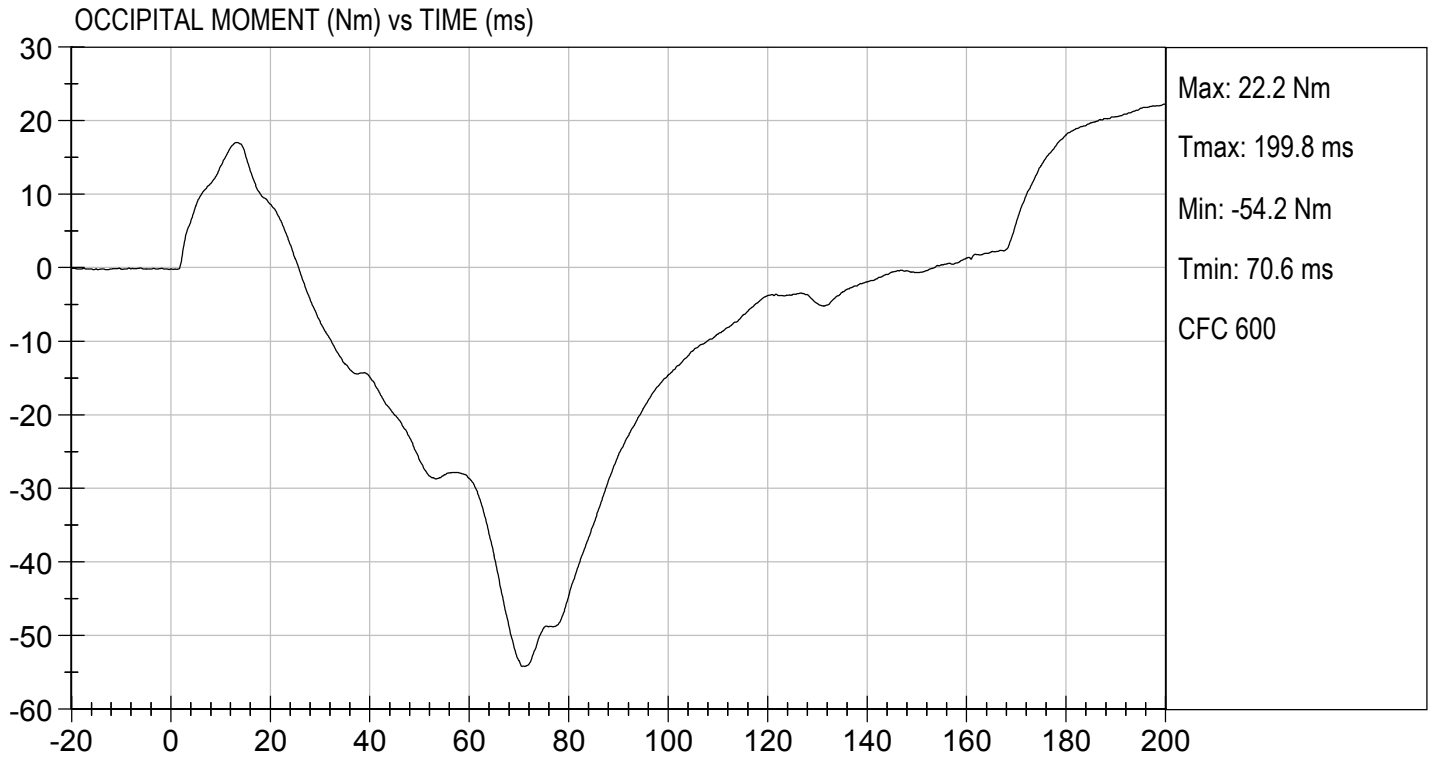
TEST DATE: 03/04/2021
TEST #: D210653





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

TEST DATE: 03/04/2021
TEST #: D210653



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210654

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.3	Pass
Relative Humidity	%	10 to 70	25	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	55	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4301	Pass
Internal Hysteresis	%	69 to 85	70	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4247	Pass
		Overall Test Results		Pass

Gerald Guerrero
Laboratory Technician

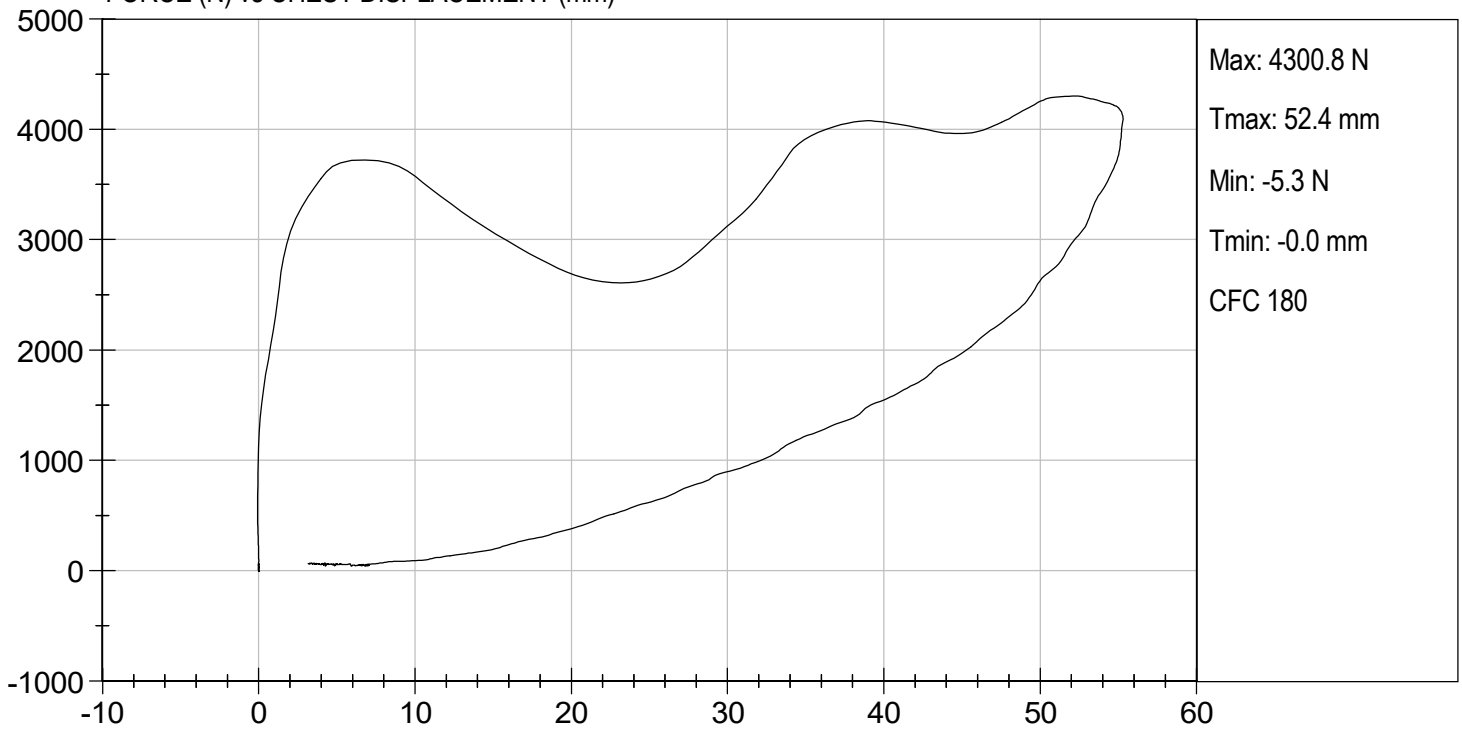
03/04/2021
Test Date

Approved By

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

TEST DATE: 03/04/2021
TEST #: D210654

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210655

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3534	Pass
		Overall Test Results		Pass

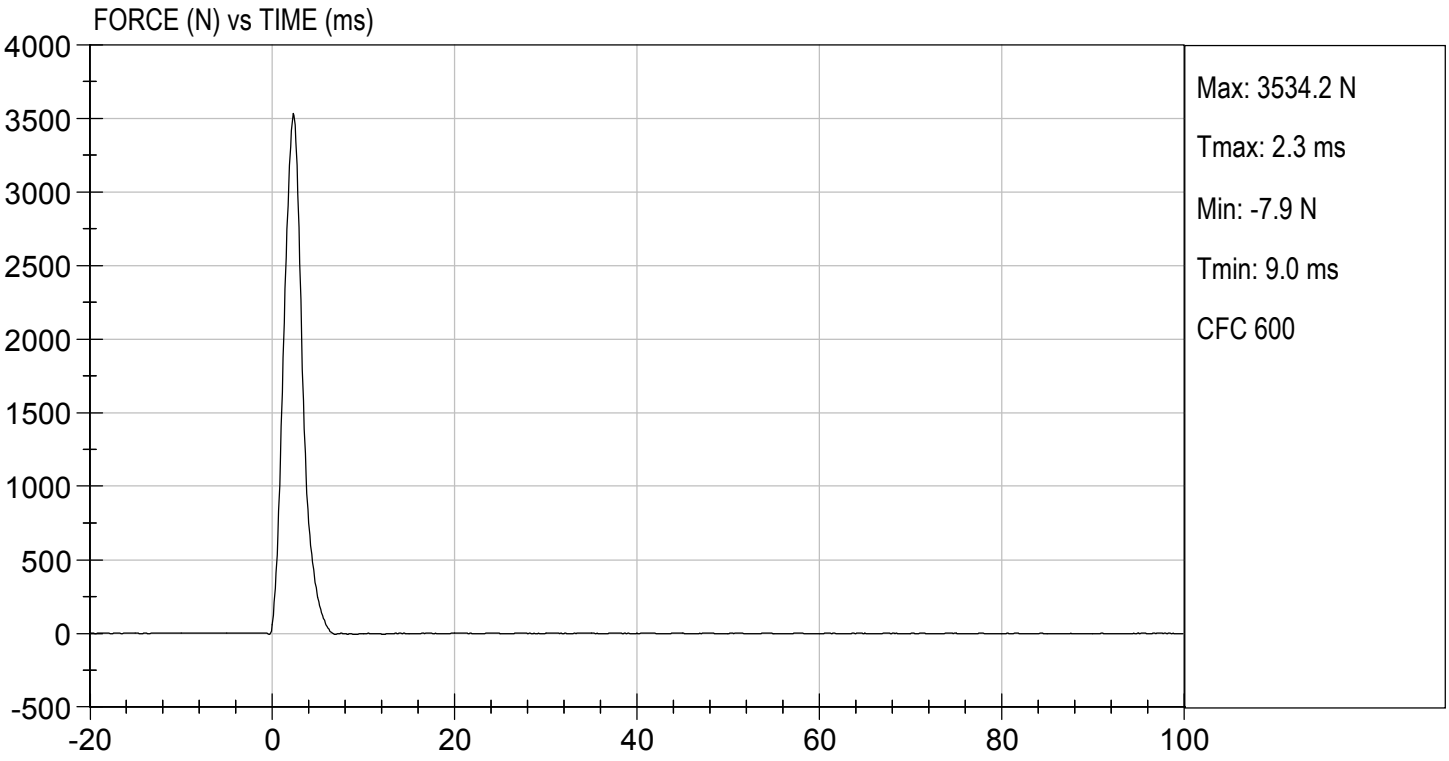
Gerald Guerrero
Laboratory Technician

03/04/2021
Test Date

Approved By

TEST DESC: RIGHT KNEE
VELOCITY: 6.97 ft/s, 2.12 m/s

TEST DATE: 03/04/2021
TEST #: D210655



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210656

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Speed	m/s	2.07 to 2.13	2.13	Pass
Maximum Force	N	3450 to 4060	3896	Pass
		Overall Test Results		Pass

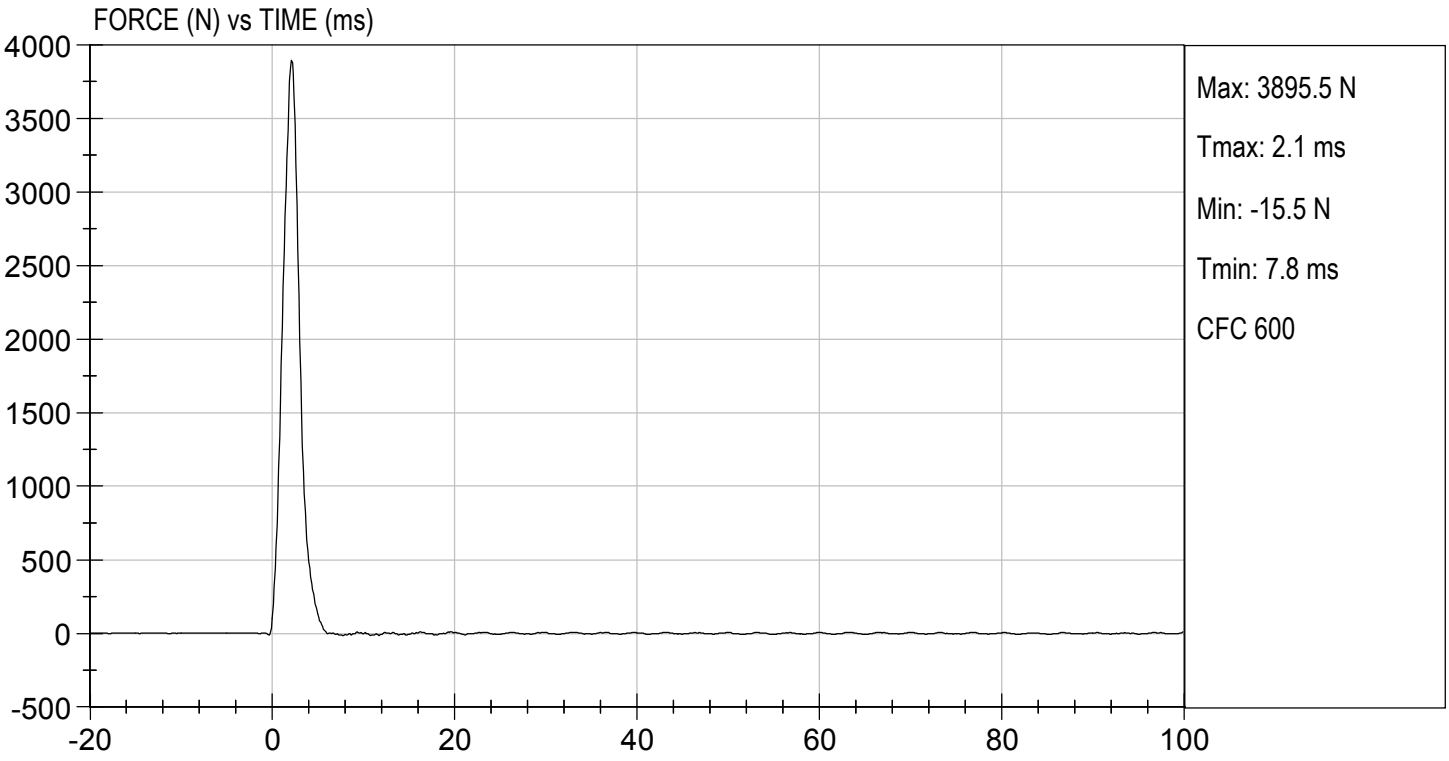
Gerald Guerrero
Laboratory Technician

03/04/2021
Test Date

Approved By

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

TEST DATE: 03/04/2021
TEST #: D210656



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D210657

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	25	Pass
Initial Angle	deg	0 to 20	17	Pass
Return Angle	deg	+/- 8	4	Pass
Force at 45 deg	N	320 to 390	389	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.5	Pass
		Overall Result		Pass

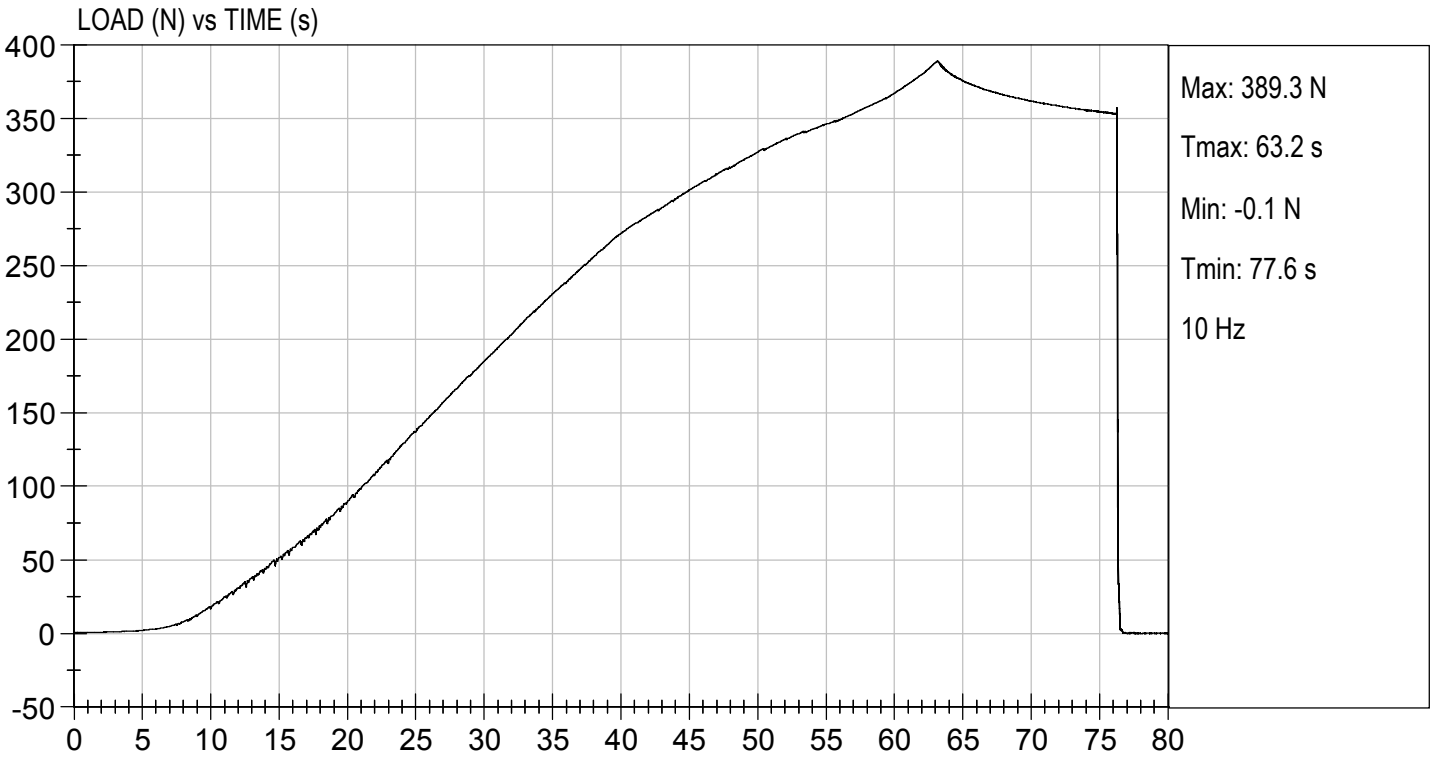
Gerald Guerrero
Laboratory Technician

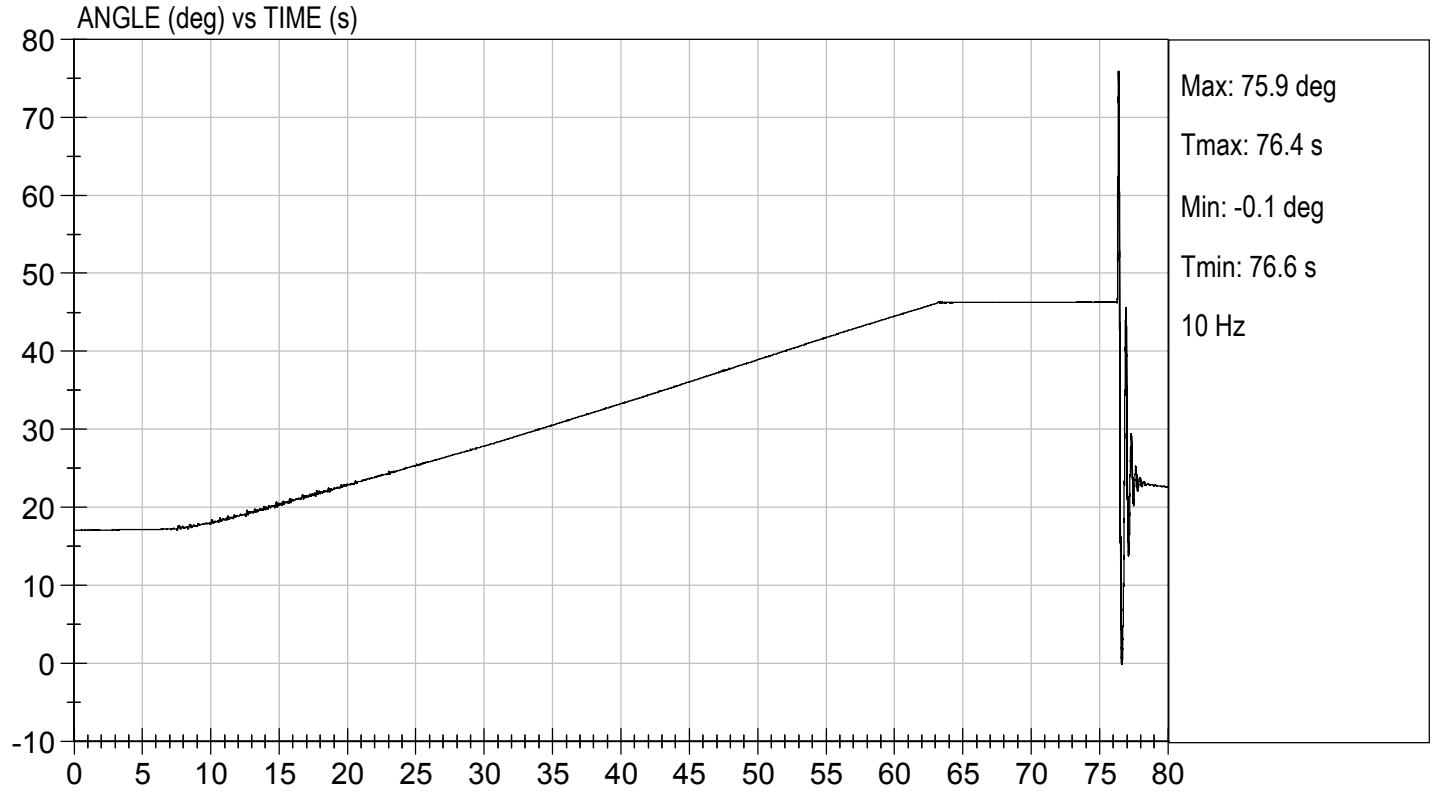
03/04/2021
Test Date

Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 03/04/2021
TEST #: D210657





APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

TABLE 1 – DRIVER DUMMY INSTRUMENTATION

Instrument Location			Axis	Hybrid III 50th S/N 351		
				Serial Number	Manufacturer	Calibration Date
Head Accelerometers		Primary	X	P79741	Endevco	03/01/2021
			Y	P79743	Endevco	03/01/2021
			Z	P79744	Endevco	03/01/2021
		Redundant	X	P94834	Endevco	03/01/2021
			Y	P94856	Endevco	03/01/2021
			Z	P97412	Endevco	03/01/2021
Head Angular Rate Sensors			X	ARS7402	DTS	08/04/2020
			Y	ARS7416	DTS	08/04/2020
			Z	ARS7366	DTS	08/04/2020
Upper Neck Load Cell			Fx, Fy, Fz Mx, My, Mz	NG1915	Denton	03/05/2020
Chest Accelerometers		Primary	X	P86792	Endevco	03/01/2021
			Y	P86793	Endevco	03/01/2021
			Z	P88348	Endevco	03/01/2021
		Redundant	X	P88666	Endevco	03/01/2021
			Y	P88667	Endevco	03/01/2021
			Z	P94109	Endevco	03/01/2021
Chest Potentiometer			X	351	Servo	03/02/2021
Pelvis Accelerometers			X	P95526	Endevco	03/01/2021
			Y	P96038	Endevco	03/01/2021
			Z	P97742	Endevco	03/01/2021
Femur Load Cells	Right	Primary	Z	FG121P	Denton	09/02/2020
		Redundant	Z	FG121R	Denton	09/02/2020
	Left	Primary	Z	FG122P	Denton	09/02/2020
		Redundant	Z	FG122R	Denton	09/02/2020
Tibia Load Cells	Right	Upper	Mx, My, Fz	TGDH3308	FTSS	03/05/2020
		Lower	Mx, My, Fz	AGDI4208	FTSS	03/05/2020
	Left	Upper	Mx, My, Fz	TGDG6744	FTSS	03/05/2020
		Lower	Mx, My, Fz	AGDI4273	FTSS	03/05/2020
Foot Accelerometers	Right	Rear	X	T22486	Endevco	03/01/2021
			Z	P97382	Endevco	03/01/2021
		Front	Z	P82120	Endevco	03/01/2021
	Left	Rear	X	T16468	Endevco	03/01/2021
			Z	T16496	Endevco	03/01/2021
		Front	Z	T16501	Endevco	03/01/2021
Seat Belt Load Cells		Lap				
		Shoulder				

TABLE 2 – FRONT PASSENGER DUMMY INSTRUMENTATION

Instrument Location			Axis	Hybrid III 5th S/N 138		
				Serial Number	Manufacturer	Calibration Date
Head Accelerometers		Primary	X	P79568	Endevco	01/21/2021
			Y	P79569	Endevco	01/21/2021
			Z	P79570	Endevco	01/21/2021
		Redundant	X	P86797	Endevco	01/21/2021
			Y	P94957	Endevco	01/21/2021
			Z	P97381	Endevco	01/21/2021
Head Angular Rate Sensors			X	ARS7340	DTS	08/04/2020
			Y	ARS7357	DTS	08/04/2020
			Z	ARS7442	DTS	08/04/2020
Upper Neck Load Cell			Fx, Fy, Fz Mx, My, Mz	NG174	FTSS	05/04/2020
Chest Accelerometers		Primary	X	P79680	Endevco	01/21/2021
			Y	P82118	Endevco	01/21/2021
			Z	P84452	Endevco	01/21/2021
		Redundant	X	P94811	Endevco	01/21/2021
			Y	P94835	Endevco	01/21/2021
			Z	P95516	Endevco	01/21/2021
Chest Potentiometer			X	138	Servo	02/10/2021
Pelvis Accelerometers			X	P97375	Endevco	01/21/2021
			Y	P97376	Endevco	01/21/2021
			Z	P97379	Endevco	01/21/2021
Femur Load Cells	Right	Primary	Z	FG123P	Denton	02/10/2021
		Redundant	Z	FG123R	Denton	02/10/2021
	Left	Primary	Z	FGDS9754P	Humanetics	02/10/2021
		Redundant	Z	FGDS9754R	Humanetics	02/10/2021
Tibia Load Cells	Right	Upper	Mx, My, Fz	TG475	Denton	05/05/2020
		Lower	Mx, My, Fz	AG504	Denton	05/04/2020
	Left	Upper	Mx, My, Fz	TG405	Denton	05/05/2020
		Lower	Mx, My, Fz	AG368	Denton	05/04/2020
Foot Accelerometers	Right	Rear	X	P85005	Endevco	01/21/2021
			Z	P85006	Endevco	01/21/2021
		Front	Z	P97372	Endevco	01/21/2021
	Left	Rear	X	P79441	Endevco	01/21/2021
			Z	P79763	Endevco	01/21/2021
		Front	Z	P79766	Endevco	01/21/2021
Seat Belt Load Cells		Lap				
		Shoulder				

TABLE 3 – VEHICLE INSTRUMENTATION

Instrument Location			Axis	Serial Number	Manufacturer	Calibration Date
Crossmember / Rear Seat Accelerometers	Left	Primary	X	A360981	MSI	12/14/2020
			Z	A360968	MSI	12/14/2020
		Redundant	X	A360980	MSI	12/14/2020
	Right	Primary	X	A340790	MSI	10/09/2020
			Z	A340758	MSI	10/09/2020
		Redundant	X	A340756	MSI	10/09/2020
Engine Accelerometers		Top	X	A356224	MSI	12/09/2020
		Bottom	X	A337182	MSI	11/03/2020