REPORT NUMBER: NCAP-MGA-21-027

NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test

FORD MOTOR CO.
2021 Ford F-150 4x4 SuperCrew
NHTSA No.: M20210207

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: March 10, 2021

Final Report Date: September 27, 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: September 27, 2021

FINAL REPORT ACCEPTANCE BY OCWS:

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NHTSA, Office of Crashworthiness Standards

Date: _____

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

Date: _____

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NCAP-MGA-21-027	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Final Report of New Car Assessment Program Frontal Impact Testing of a 2021 Ford F-150 4x4 SuperCrew, NHTSA No.: M20210207		**5. Report Date** September 27, 2021 **6. Performing Organization Code** MGA
7. Author(s) Ben Fischer, Program Manager		**8. Performing Organization Report No.** NCAP-MGA-21-027
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		**10. Work Unit No.** **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 10, 2021 to September 27, 2021 **14. Sponsoring Agency Code** NRM-110
15. Supplementary Notes		

16. Abstract

A 56.3 km/h NCAP Frontal Rigid Barrier Impact Test was conducted on a 2021 Ford F-150 4x4 SuperCrew in accordance with the specifications of the Office of Crashworthiness Standards Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing. This test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), and 301 performance. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on March 10, 2021.

The impact velocity of the vehicle was 56.99 km/h and the ambient temperature at the barrier face at the time of impact was 21.0°C. The target vehicle post-test maximum crush was 598 mm located at 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	275	700	421
Maximum Chest Compression	mm	63	21	52	8
Nij		1	0.28	1	0.26
Neck Tension	N	4170	1058	2620	740
Neck Compression	N	4000	70	2520	345
Left Femur Force	N	10008	872	6805	1326
Right Femur Force	N	10008	1063	6805	225

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

19. Security Classification of Report Unclassified	**20. Security Classification of Page** Unclassified	**21. No. of Pages** 178	**22. Price**

TABLE OF CONTENTS

Section		Page No.
1	Purpose and Summary of Test	1
2	Occupant and Vehicle Information / Data Sheets	3

Data Sheet No.		Page No.
1	General Test and Vehicle Parameter Data	4
2	Seat Adjustment, Fuel System, and Steering Wheel Data	8
3	Dummy Longitudinal Clearance Dimensions	10
4	Dummy Lateral Clearance Dimensions	11
5	Seat Belt Positioning Data	12
6	High-Speed Camera Locations and Data	13
7	Vehicle Accelerometer Locations	15
8	Photographic Reference Target Locations	16
9	Load Cell Locations on Fixed Barrier	17
10	Test Vehicle Summary of Results	18
11	Post-Test Observations	19
12	Vehicle Profile Measurements	20
13	Accident Investigation Division Data	22
14	Vehicle Intrusion Measurements	23
15	Summary of Indicant FMVSS No. 212 and FMVSS No. 219 (Partial) Data	25
16	FMVSS No. 301 Barrier Impact and Static Rollover Results	26
17	Dummy/Vehicle Temperature Stabilization Data	28

Appendix		
A	Photographs	A
B	Dummy Response Data Traces	B
C	Dummy Qualification and Performance Verification Data	C
D	Test Equipment and Instrumentation Qualification Data	D

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 Ford F-150 4x4 SuperCrew at a velocity of 56.99 km/h. The test was performed at MGA Research Corporation on March 10, 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.

The driver (position 1) ATD (Serial No. 351) and the right-front passenger (position 2) ATD (Serial No. DH1659) were qualified previous to this test. Certification details, along with instrumentation calibration data, are found in Appendix C of this report.

The 102 channels of data were recorded on a data acquisition system. Appendix B contains the dummy response data traces.

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

The maximum static crush of the vehicle was 598 mm located at the vehicle centerline and both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

The driver's visible contact points were as follows: The driver's head contacted the airbag. The driver's head also contacted the headrest. The driver's knees contacted the knee airbag.
The passenger's visible contact points were as follows: The passenger's head contacted the airbag. The passenger's head also contacted the headrest. The passenger's knees contacted the 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 (50th)	275	0.28	1058	70	36.4	21	872	1063
Passenger (5th)	421	0.26	740	345	46.9	8	1326	225

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.

Low-level cyclical noise observed throughout many of the data channels.

Load cell barrier was not used in this test due to vehicle size.

MGA does not endorse or certify products. The manufacturer's name appears solely for identification purposes.

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20210207	Traction Control System (TCS)	Yes
Model Year	2021	Power Steering	Yes
Make	Ford	Power Window Auto-Reverse	Yes
Model	F-150 4x4 SuperCrew	Driver Frontal Airbag	Yes
Body Style	4-Door Pickup Truck	Driver Curtain Airbag	Yes
VIN	1FTFW1E88MKD13191	Driver Head/Torso Airbag	No
Body Color	Race Red	Driver Torso Airbag	No
Odometer (km/mi)	82 mi	Driver Torso/Pelvis Airbag	Yes
Engine Displacement (L)	3.5 L	Driver Pelvis Airbag	No
Type/No. Cylinders	V6	Driver Knee Airbag	Yes
Engine Placement	Longitudinal	Front Pass. Frontal Airbag	Yes
Transmission Type	Automatic	Front Pass. Curtain Airbag	Yes
Transmission Speeds	10	Front Pass. Head/Torso Airbag	No
Overdrive	Yes	Front Pass. Torso Airbag	No
Final Drive	AWD	Front Pass. Torso/Pelvis Airbag	Yes
Roof Rack	No	Front Pass. Pelvis Airbag	No
Sunroof/T-Top	No	Front Pass. Knee Airbag	Yes
Running Boards	Yes	Driver Pretensioner	Yes
Tilt Steering Wheel	Yes	Driver Load Limiter	Yes
Power Seats	No	Front Pass. Pretensioner	Yes
Anti-Lock Brakes (ABS)	Yes	Front Pass. Load Limiter	Yes
Automatic Door Locks (ADLs)	Yes	Other	N/A

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

DATA FROM CERTIFICATION LABEL

Manufactured By	FORD MOTOR CO.
Date of Manufacture	12/20

GVWR (kg)	3243
GAWR Front (kg)	1599
GAWR Rear (kg)	1724

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Split Bench		
Designated Seating Capacity (DSC)	2	3		5
Capacity Weight (VCW) (kg)				911
Cargo Weight (RCLW) (kg)				136

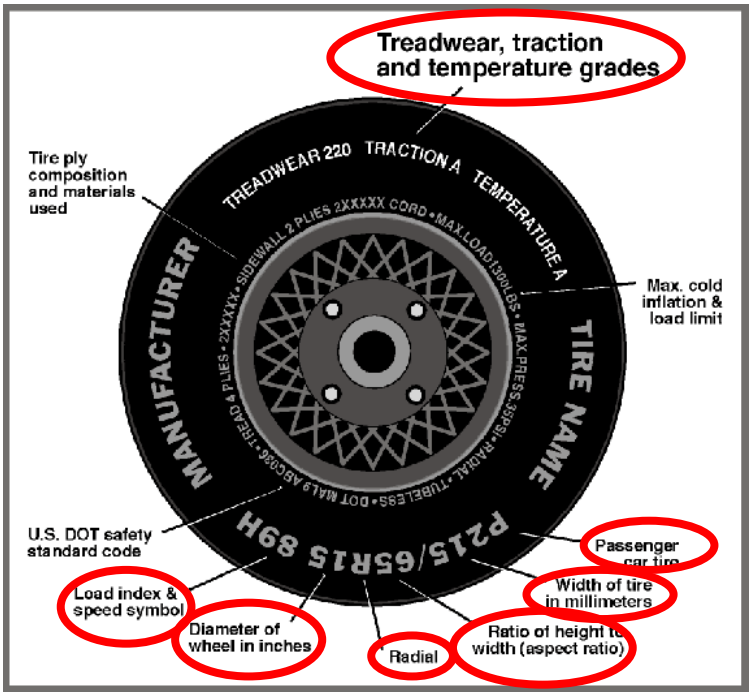
* Rated Cargo and Luggage Weight (RCLW) limited to maximum of 300 lbs (136 kg).

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	240	240
Recommended Tire Size	275/60R20	275/60R20
Tire Size on Vehicle	275/60R20	275/60R20
Tire Manufacturer	Hankook	Hankook
Tire Model	Dynapro AT2	Dynapro AT2
Treadwear	440	440
Traction	A	A
Temperature Grade	A	A
Tire Plies Sidewall	2 Polyester	2 Polyester
Tire Plies Body	2 Steel, 2 Polyester, 2 Nylon	2 Steel, 2 Polyester, 2 Nylon
Load Index/Speed Symbol	115T	115T
Tire Material	Rubber	Rubber
DOT Safety Code Left	15MDL RN H0	15MDL RN H0
DOT Safety Code Right	15MDL RN H0	15MDL RN H0

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	706.0	462.5		741.5	559.5	
Right	kg	701.5	460.5		741.0	558.0	
Ratio	%	60.4%	39.6%		57.0%	43.0%	
Totals	kg	1407.5	923.0	2330.5	1482.5	1117.5	2600.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	2330.5
Weight of 1 P572E ATD & 1 P572O ATD	kg	141
Rated Cargo/Luggage Weight (RCLW)	kg	136
Calculated Test Vehicle Target Weight (TVTW)	kg	2607.5

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	971	966	1052	1053	1591
As Tested	mm	945	942	1023	1025	1727
Post Test	mm	908	890	1029	1023	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	4017
Total Vehicle Length at Left Side	mm	5672
Total Vehicle Length at Centerline	mm	6180
Total Vehicle Length at Right Side	mm	5672
Weight of Ballast in Cargo Area	kg	74
Weight of Vehicle Components Removed	kg	2
Amount of Stoddard Solvent in Fuel Tank	L	95.0

List of components removed to meet test weight: None.

List of components removed for instrumentation, data box, and equipment installation: Underbody plastic.

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

TARGET VEHICLE STRUCTURAL MEASUREMENT

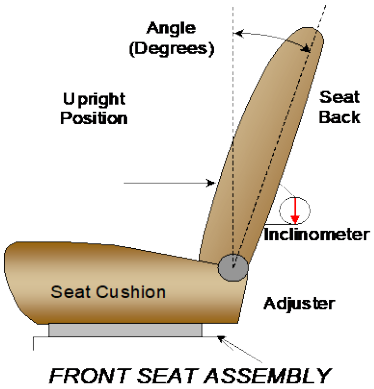
	Elements	Pre-Test (mm)
1	Total Length	6180
2	Total Width	2072
3	Bumper Top Height	660
4	Bumper Bottom Height	430
5	Longitudinal Member Top Height	619
6	Distance between Longitudinal Members	762
7	Longitudinal Member Width	90
8	Engine Top Height	1113
9	Engine Bottom Height	381
10	Engine and Gearbox Width	1011
11	Front Bumper-Engine Distance	740
12	Front Shock Absorber Fixing Height	875
13	Bonnet Leading Edge Height	1143
14	Front Shock Absorber Fixing Width	996
15	Front Bumper – Front Axle Distance	941
16	Front Axle – A-Pillar Distance	542
17	A-Pillar – B-Pillar Distance	1333
18	B-Pillar – Rear Axle Distance	2140
19	B-Pillar – C-Pillar Distance	1009
20	Roof Sill Bottom Height	1760
21	Roof Sill Top Height	1870
22	Floor Sill Bottom Height	418
23	Floor Sill Top Height	612

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

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021

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	3.5° on outboard headrest post
Passenger Seat Back Angle	1.7° on outboard headrest post

SEAT FORE/AFT POSITIONS

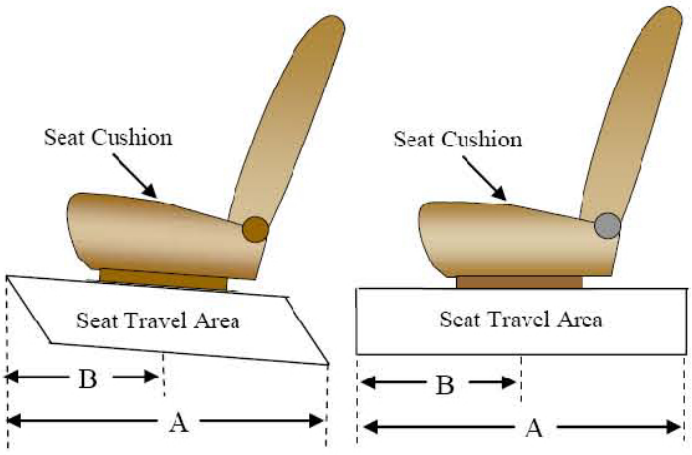
The driver and passenger seat fore/aft positions are adjusted following Appendix F, "Driver & Passenger Dummy Seating & Positioning Procedures" in the NCAP Test Procedure dated May 2018.

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	255 mm / 38 detents (1st as 1)	131 mm / 19th detent (1st as 0)
Passenger Seat	241 mm / 36 detents (1st as 1)	0 mm / 0th detent (1st as 0)

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)	1 (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 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

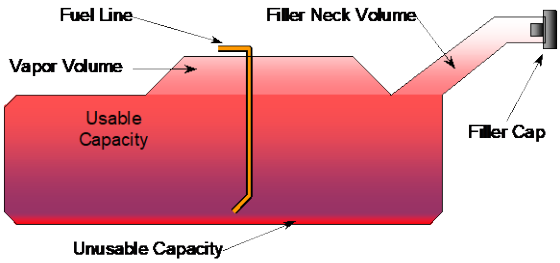
NHTSA No.: M20210207
Test Date: 3/10/2021

FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	102.2
Usable Capacity of "Optional Tank"	
92-94% of Usable Capacity	94.0 to 96.1
Actual Amount of Solvent used	95.0
1/3 of Usable Capacity	34.1

FUEL PUMP

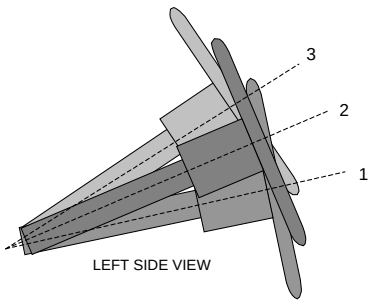
The vehicle is equipped with an electronic fuel pump. The electric fuel pump operates for 3 seconds to pressurize the fuel system following the actuation of the ignition. If no attempt has been made to start the engine within 3 seconds following ignition actuation the fuel pump will shut off. The fuel pump operates continuously while the engine is running. If the engine stalls the fuel pump is deactivated. Also, the fuel pump is shut off by the restraint control module to stop fuel flow to the engine if the vehicle sustains an impact above a certain magnitude. The filler neck is located on the driver's side.



VEHICLE FUEL TANK ASSEMBLY

STEERING COLUMN ADJUSTMENT

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



STEERING COLUMN ASSEMBLY

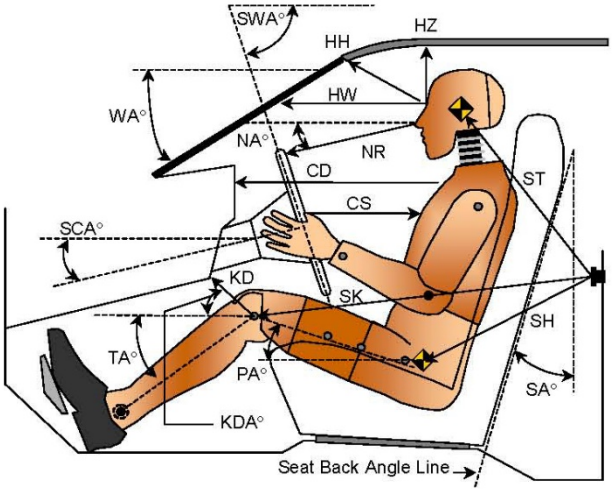
STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost Position 1	69.5	
Geometric Center Position 2	66.8	
Uppermost Position 3	64.0	
Telescoping Steering Wheel Travel		53
Test Position	66.8	27

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021



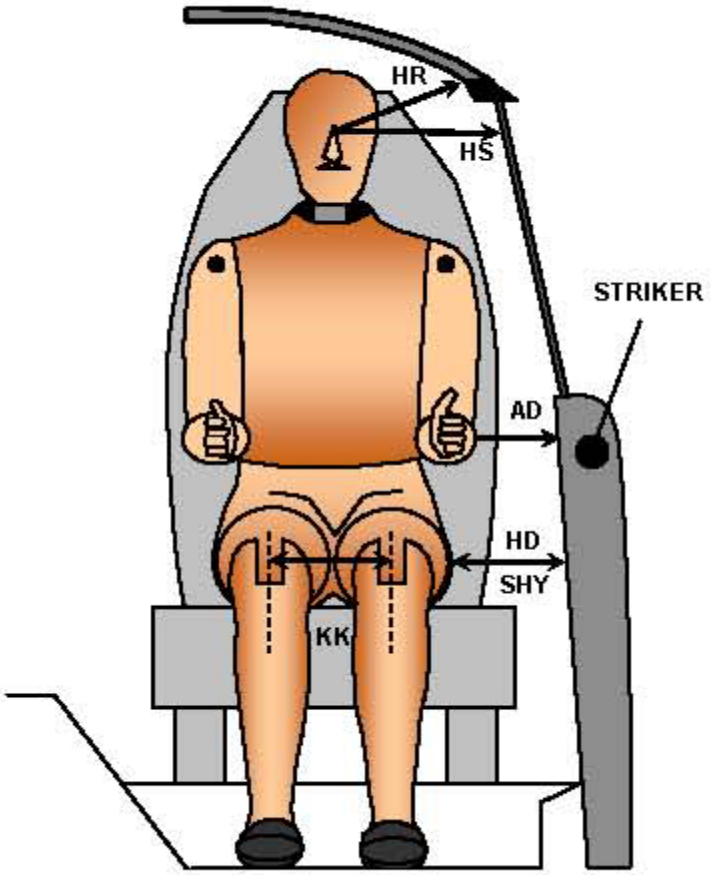
LEFT SIDE VIEW

Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		31.6		
SWA°	Steering Wheel Angle		66.8		
SCA°	Steering Column Angle		23.2		
SA°	Seat Back Angle		3.5		1.7
HZ	Head to Roof (Z)	227	90	281	90
HH	Head to Header	462	22.0	424	35.1
HW	Head to Windshield	716	0	746	0
NR	Nose to Rim	408	10.7		
CD	Chest to Dash	586		453	
CS	Chest to Steering Hub	341	3.0		
RA	Rim to Abdomen	218	0		
KDL	Left Knee to Dash	226	28.6	132	35.0
KDR	Right Knee to Dash	223	38.0	127	35.4
PA°	Pelvic Angle		22.7		21.5
TA°	Tibia Angle		58.1		68.2
SK	Striker to Knee	677	85.6	775	89.0
ST	Striker to Head	636	19.6	603	33.7
SH	Striker to H-Point	302	102.1	479	96.5

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

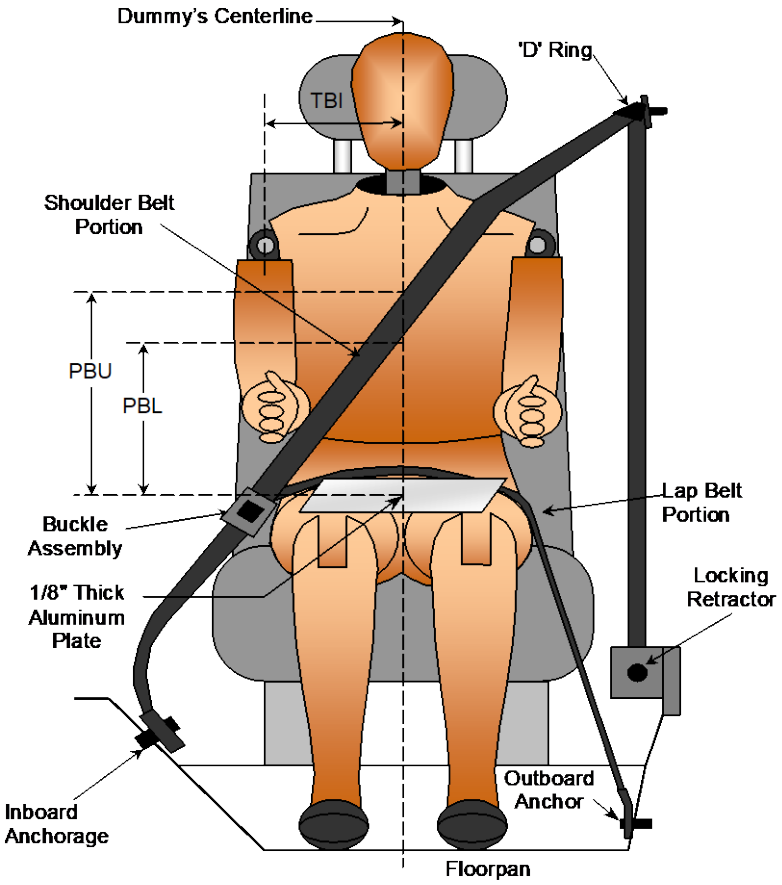


FRONT VIEW OF DUMMY

Code	Measurement Description	Driver	Passenger
		Length (mm)	
AD	Arm to Door	140	88
HD	H-Point to Door	151	186
HR	Head to Side Header	208	283
HS	Head to Side Window	349	377
KK	Knee to Knee	348	228
SHY	Striker to H-Point (Y Direction)	285	306
AA	Ankle to Ankle	337	158

DATA SHEET NO. 5
SEAT BELT POSITIONING DATA

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	360	315
PBL - Top surface of reference to belt lower edge	mm	275	225

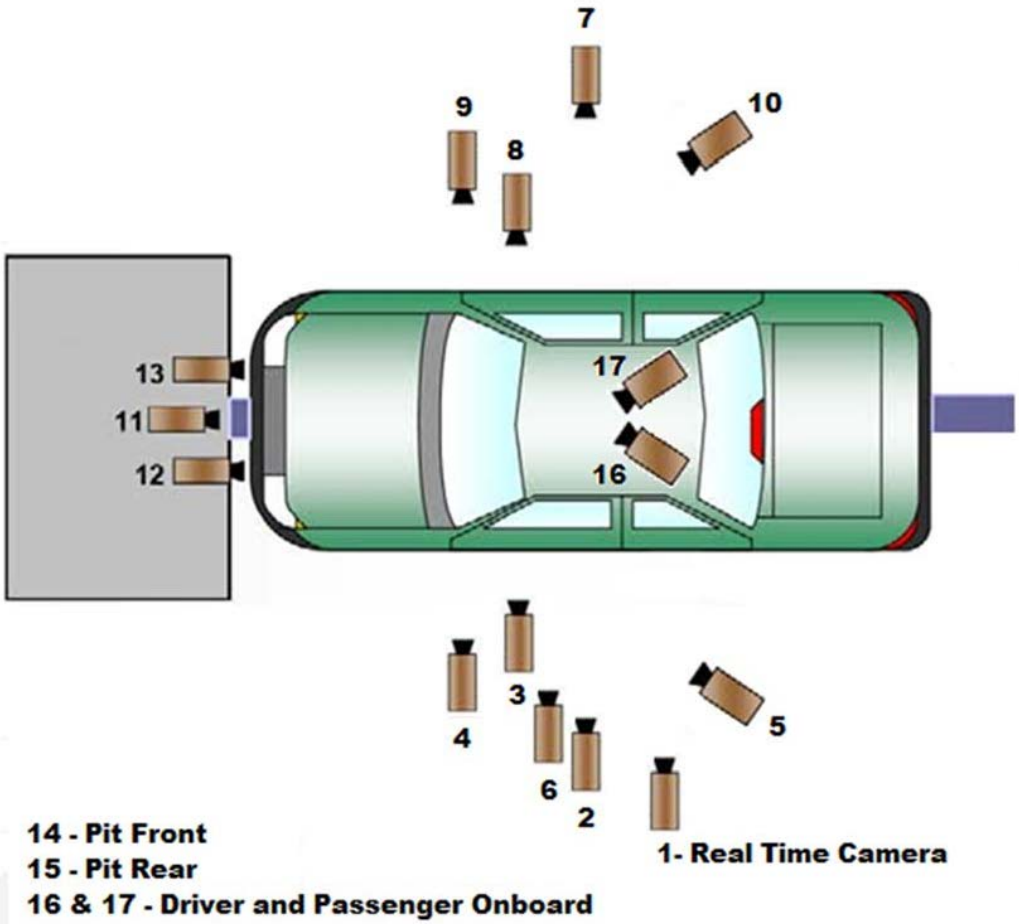
BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	900	925
Lap Belt Length as measured on ATD	mm	705	720
Remainder of belt on reel	mm	915	875
Total Belt Length for Continuous Webbing Systems	mm	3070	3070

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

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021

CAMERA POSITIONS FOR FRONTAL IMPACTS



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

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

CAMERA LOCATIONS

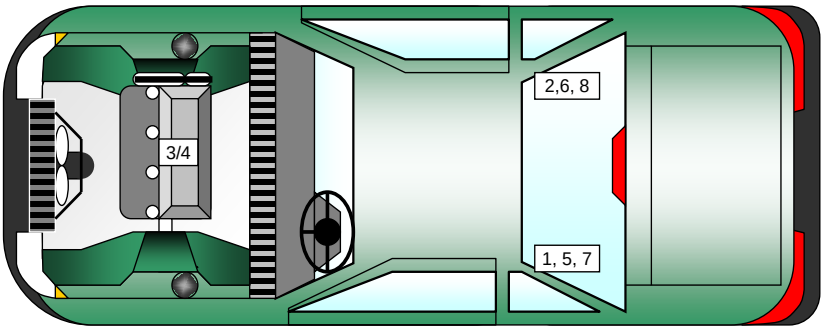
No.	Camera View	Coordinates* (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Overall					30
2	Left Overall	-3080	-6150	-1350	12	1000
3	Driver Close-Up	-2000	-6700	-1770	50	1000
4	Left Front Half	-1350	-5970	-1290	24	1000
5	Left Angle	-7500	-5970	-1820	75	1000
6	Steering Column	-1040	-5850	-1250	50	1000
7	Right Overall	-1300	6150	-1310	12	1000
8	Passenger Close-Up	-1670	6990	-1840	50	1000
9	Right Front Half	-2820	6200	-1260	24	1000
10	Right Angle	-7710	5530	-1800	75	1000
11	Windshield	80	0	-2310	12	1000
12	Driver Windshield	60	-370	-2230	25	1000
13	Passenger Windshield	60	370	-2230	25	1000
14	Pit Front	-970	0	3340	24	1000
15	Pit Rear	-3000	0	3340	24	1000
16	Driver Onboard				12	1000
17	Passenger Onboard				12	1000
18	Real-Time Pan View					30

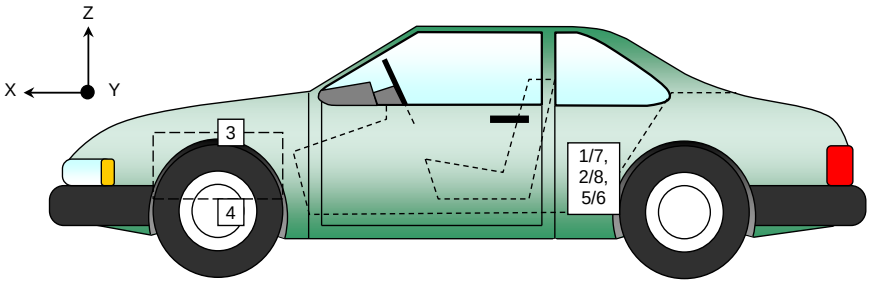
*COORDINATES:
+X = forward of impact plane
+Y = right of monorail centerline
+Z = below ground level

DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Crossmember Accelerometer – X Direction	2710	-450	-667
2	Right Rear Crossmember Accelerometer – X Direction	2710	453	-670
3	Engine Top X	5277	28	-1113
4	Engine Bottom X	5080	21	-381
5	Left Rear Crossmember Accelerometer – Z Direction	2710	-450	-667
6	Right Rear Crossmember Accelerometer – Z Direction	2710	453	-670
7	Left Rear Crossmember Accelerometer Redundant – X Direction	2754	-450	-667
8	Right Rear Crossmember Accelerometer Redundant – X Direction	2754	453	-670

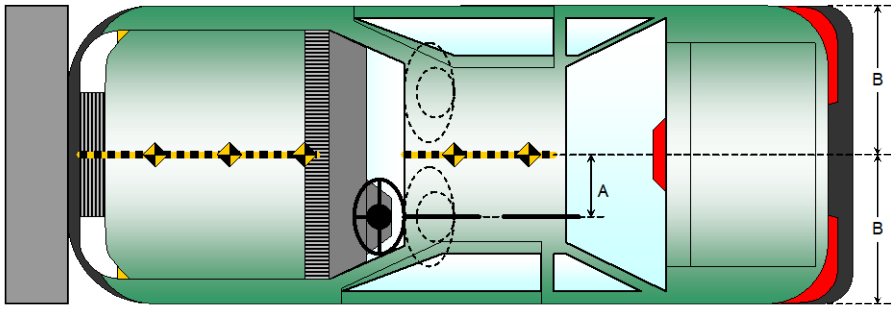
Reference Points: X - Rear Surface of Vehicle (+ forward)
Y - Vehicle Centerline (+ to right)
Z - Ground Plane (+ down)

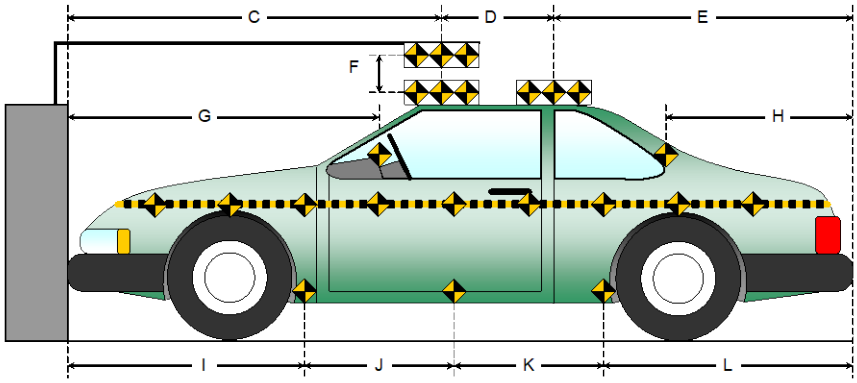
DATA SHEET NO. 8
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

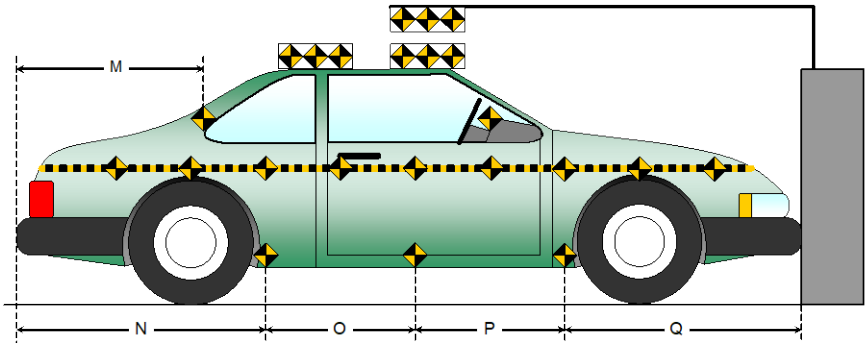
Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

Item	Value (mm)
A	470
B	1036
C	2550
D	610
E	3020
F	30
G	
H	2414
I	1488
J	1172
K	1172
L	2348
M	2414
N	2348
O	1172
P	1172
Q	1488







DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021

ADVANCED RESEARCH LOAD CELL BARRIER

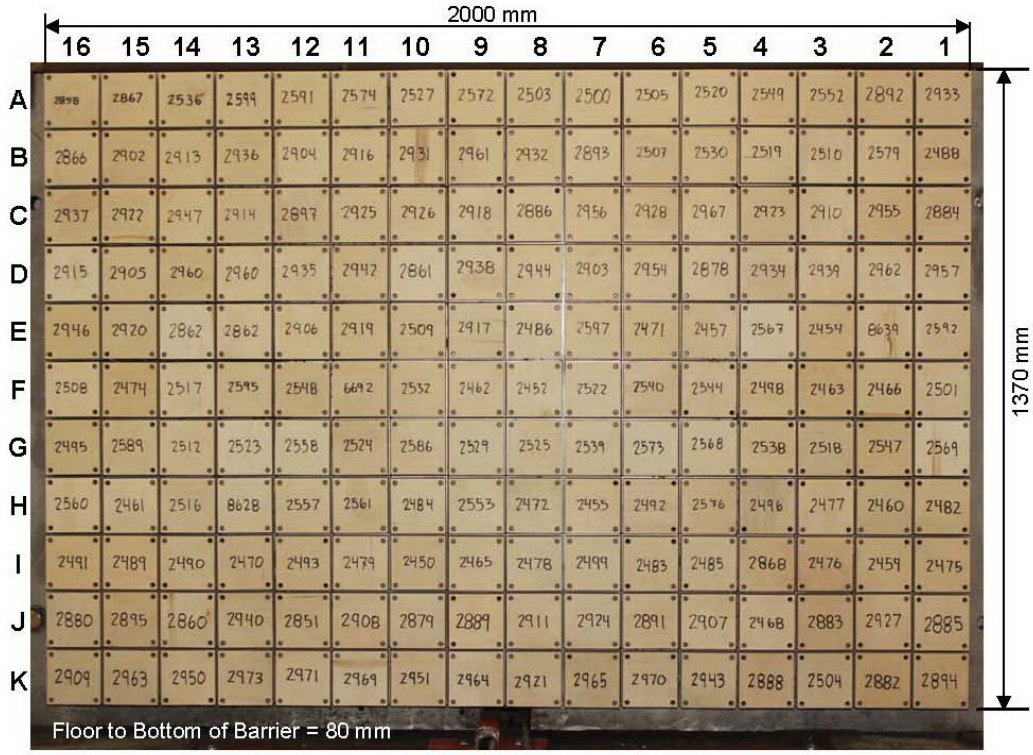


Photo for Reference Only

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 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

INSTRUMENTATION

Instrumentation	Number of Channels Collected
Driver Dummy Data Channels	47
Passenger Dummy Data Channels	47
Vehicle Structure Accelerometers	8
Barrier Channels	0
Total	102

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 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

Description	Driver	Passenger
Dummy Type / Serial No.	HIII 50% / 351	HIII 5% / DH1659
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	Glove Box
Right Knee Contact	Knee Airbag	Glove Box

DOOR OPENING, TRUNK OPENING, AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Locked/Unlocked Doors	Doors were locked	Doors were locked
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	None
Window Damage	None
Other Notable Effects	None

VEHICLE REBOUND FROM BARRIER

Measured Parameter	Units	Value
Left Side	mm	435
Center	mm	445
Right Side	mm	440
Average	mm	440

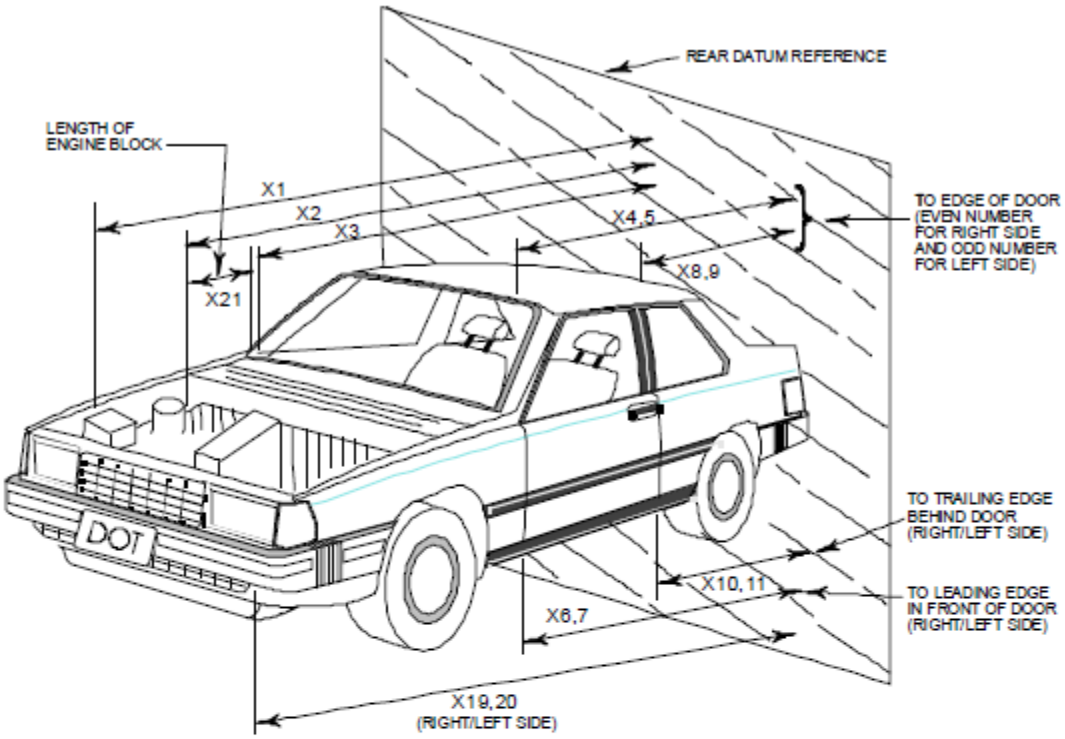
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

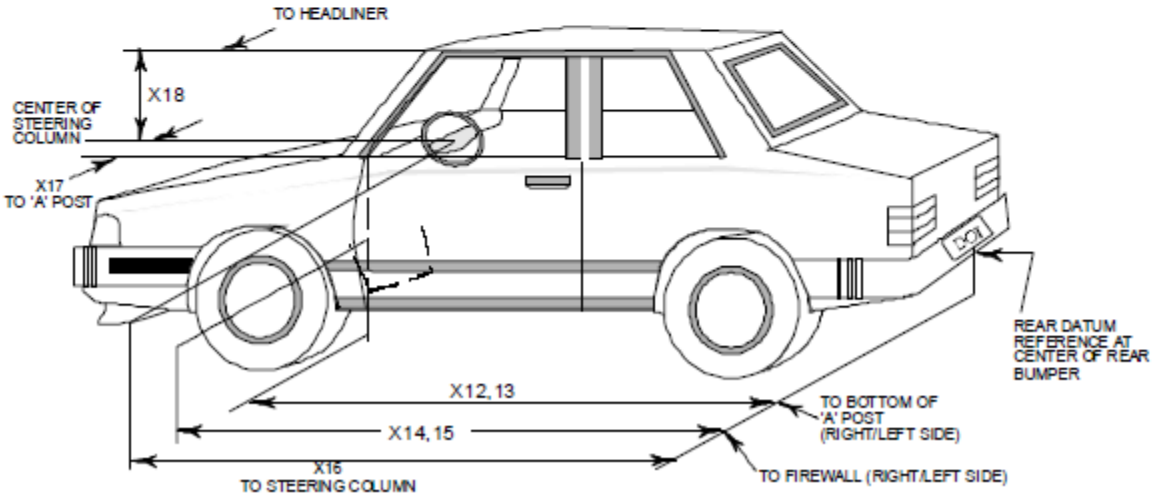
Restraint Type	Driver		Passenger	
	Mounted	Deployed	Mounted	Deployed
Frontal Airbag	Yes	Yes	Yes	Yes
Curtain Side Airbag	Yes	No	Yes	No
Torso/Pelvis Side Airbag	Yes	No	Yes	No
Knee Airbag	Yes	Yes	Yes	No*
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes		Yes	
Other				

*Passenger Knee Airbag not designed to deploy in full frontal impact w/belted 5th percentile occupant.

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2021 Ford F-150 4x4 SuperCrew	NHTSA No.:	M20210207
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	3/10/2021





DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

No.	Measurement Description	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	6180	5582	598
2	RSOV to Front of Engine	5323	5206	117
3	RSOV to Firewall	5013	5034	-21
4	RSOV to Upper Leading Edge of Right Door	4612	4605	7
5	RSOV to Upper Leading Edge of Left Door	4612	4603	9
6	RSOV to Lower Leading Edge of Right Door	4560	4553	7
7	RSOV to Lower Leading Edge of Left Door	4560	4551	9
8	RSOV to Upper Trailing Edge of Right Door	3368	3360	8
9	RSOV to Upper Trailing Edge of Left Door	3368	3353	15
10	RSOV to Lower Trailing Edge of Right Door	3362	3354	8
11	RSOV to Lower Trailing Edge of Left Door	3362	3348	14
12	RSOV to Bottom of “A” Post of Right Side	4551	4520	31
13	RSOV to Bottom of “A” Post of Left Side	4551	4523	28
14	RSOV to Firewall, Right Side	5032	5031	1
15	RSOV to Firewall, Left Side	5034	5027	7
16	RSOV to Steering Column	4076	4157	-81
17	Center of Steering Column to “A” Post	383	392	-9
18	Center of Steering Column to Headliner	452	475	-23
19	RSOV to Right Side of Front Bumper	5672	5347	325
20	RSOV to Left Side of Front Bumper	5672	5334	338
21	Length of Engine Block	404	404	0
RD	RSOV to Right Side of Dash Panel	4386	4370	16
CD	RSOV to Center of Dash Panel	4367	4346	21
LD	RSOV to Left Side of Dash Panel	4389	4377	12

All Dimensions in mm

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

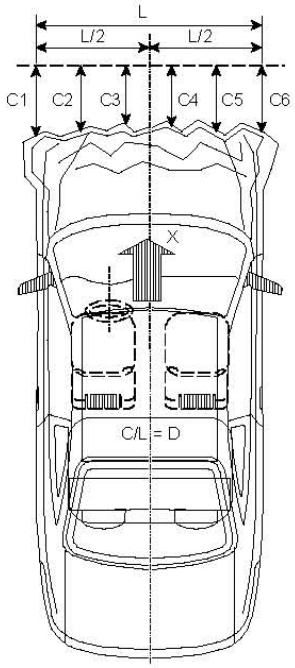
VEHICLE INFORMATION

VIN: 1FTFW1E88MKD13191
Vehicle Size Category: Truck

Wheelbase (mm): 4017
Test Weight (kg): 2600.0

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): 56.99
Velocity Change (km/h): 66.3
Time of Separation (msec) 126



CRUSH PROFILE

Collision Deformation Classification: 12FDEW3
Midpoint of Damage: Centerline
Damage Region Length (mm): 2373
Impact Mode: Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	5672	5334	338
C2	Crush zone 2 at left side	mm	6036	5573	463
C3	Crush zone 3 at left side	mm	6171	5587	584
C4	Crush zone 4 at right side	mm	6171	5585	586
C5	Crush zone 5 at right side	mm	6036	5576	460
C6	Crush zone 6 at right side	mm	5672	5347	325
L	C1 TO C6	mm	2416	2373	43

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

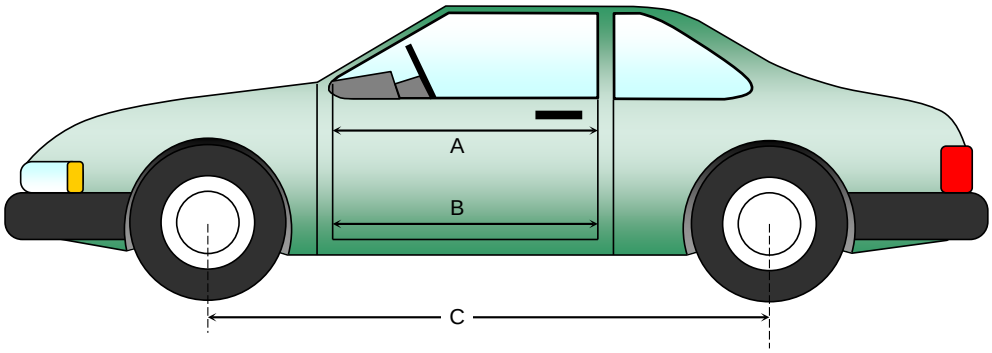
NHTSA No.: M20210207
Test Date: 3/10/2021

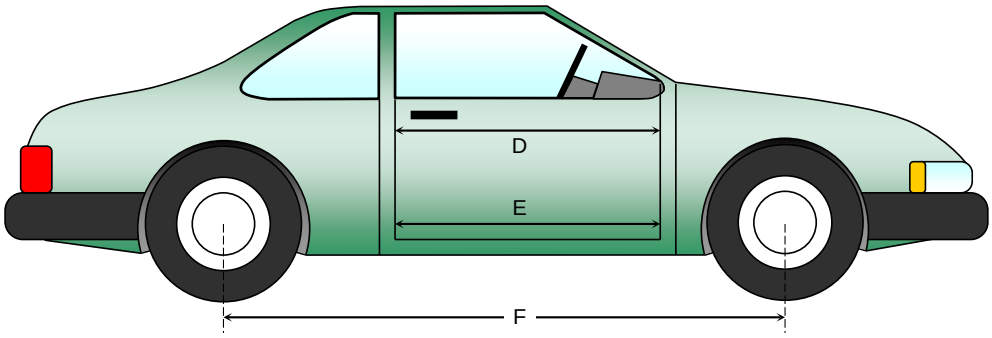
DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1100	1100	0
B	Left Side Lower	mm	1076	1076	0
D	Right Side Upper	mm	1100	1100	0
E	Right Side Lower	mm	1076	1076	0

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	4017	3867	150
F	Right Side Wheelbase	mm	4017	3864	153





DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

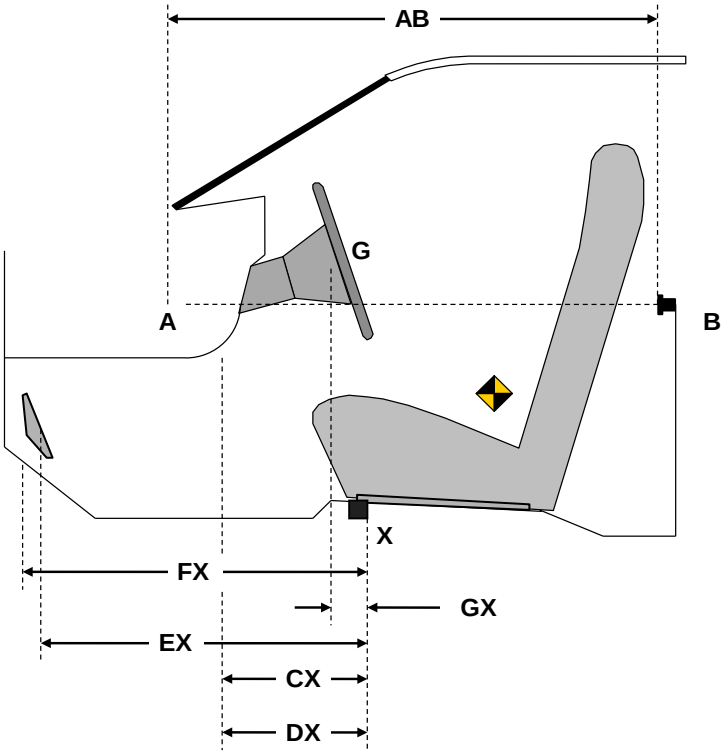
Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	856	856	0
CX	Left Knee Bolster to X	mm	360	370	-10
DX	Right Knee Bolster to X	mm	363	368	-5
EX	Brake Pedal to X	mm	534	527	7
FX	Foot Rest to X	mm	560	558	2
GX	Center of Steering Column Wheel Hub to X	mm	78	163	-85

X = Front of Seat Track (stationary)



DRIVER COMPARTMENT

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

WINDSHIELD MOUNTING DETAILS

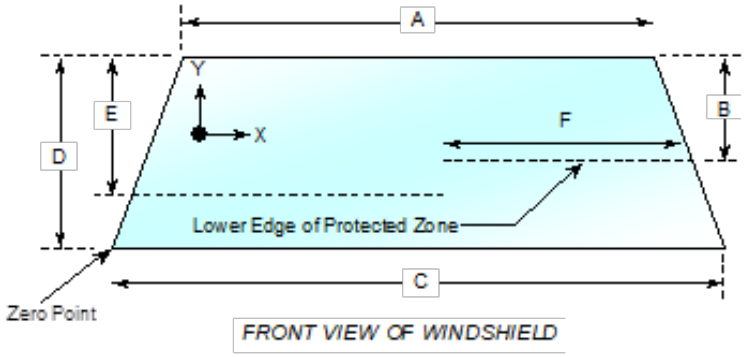
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

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: 21.0°C.

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2384	2384	100
Right Side	2384	2384	100
Total	4768	4768	100



Item	Units	Value
A	mm	1466
B	mm	484
C	mm	1790
D	mm	756
E	mm	494
F	mm	500

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 Ford F-150 4x4 SuperCrew NHTSA No.: M20210207
Test Program: NCAP Frontal Barrier Impact Test Test Date: 3/10/2021

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Temperature at Time of Impact: 21.0°C Test Time: 11:50 a.m.

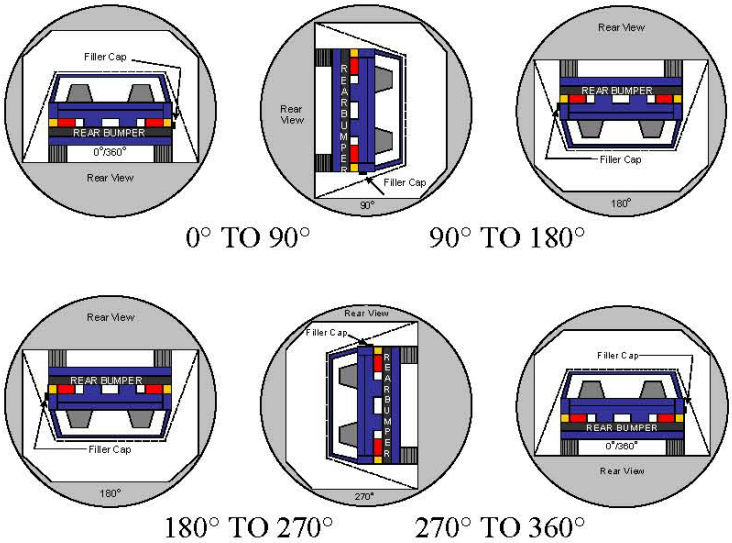
A. From impact until vehicle motion ceases: (Maximum Allowable = 1 ounce) 0.0 oz.

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°	92	300	392
90° to 180°	90	300	390
180° to 270°	85	300	385
270° to 360°	86	300	386

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

Test Vehicle: 2021 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021

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	

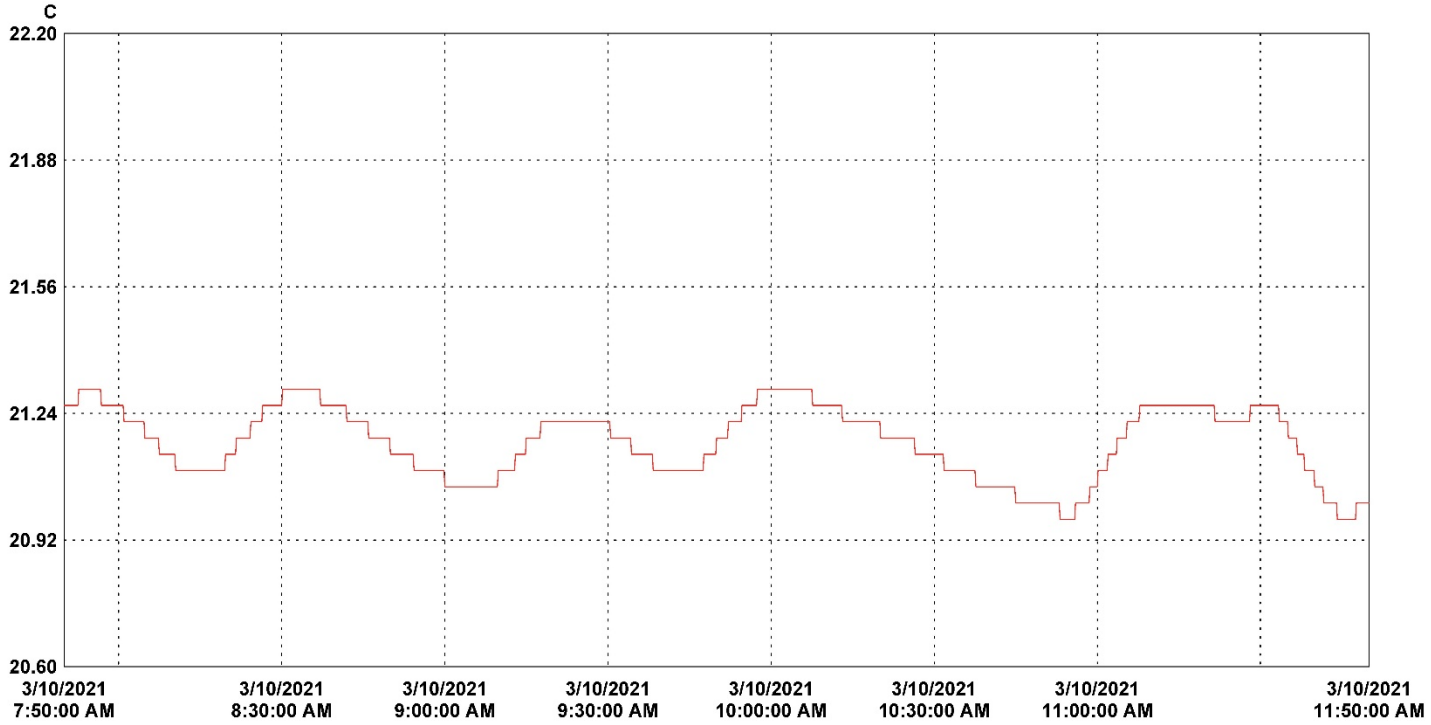
SOLVENT SPILLAGE LOCATION TABLE

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 Ford F-150 4x4 SuperCrew
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: M20210207
Test Date: 3/10/2021



30 minutes/div 4 hours (M/d/yyyy h:mm:ss tt) Central Time Graph file (truncated): M20210207 2021 Ford F-150 4x4 SuperCrew NCAP.spg

LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	18352041	VSC_Prep_Room	1		21.30	21.17	20.97	C	Temperature	18352041_VSC_Prep_Room.spl

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

		Page No.
Photo No. 001	Load Cell Location	A-1
Photo No. 002	Pre-Test Load Cell Wall	A-1
Photo No. 003	Post-Test Load Cell Wall	A-2
Photo No. 004	Manufacturer's Label	A-2
Photo No. 005	Tire Placard	A-3
Photo No. 006	2021 Ford F-150 4x4 SuperCrew Frontal As Delivered	A-3
Photo No. 007	Left Rear 3-4 View, As Received	A-4
Photo No. 008	Pre-Test Front View of Test Vehicle	A-4
Photo No. 009	Post-Test Front View of Test Vehicle	A-5
Photo No. 010	Pre-Test Left View of Test Vehicle	A-5
Photo No. 011	Post-Test Left View of Test Vehicle	A-6
Photo No. 012	Pre-Test Right View of Test Vehicle	A-6
Photo No. 013	Post-Test Right View of Test Vehicle	A-7
Photo No. 014	Pre-Test Right Front 3-4 View	A-7
Photo No. 015	Post-Test Right Front 3-4 View	A-8
Photo No. 016	Pre-Test Left Rear 3-4 View	A-8
Photo No. 017	Post-Test Left Rear 3-4 View	A-9
Photo No. 018	Pre-Test Windshield View	A-9
Photo No. 019	Post-Test Windshield View	A-10
Photo No. 020	Pre-Test Engine Compartment View	A-10
Photo No. 021	Post-Test Engine Compartment View	A-11
Photo No. 022	Pre-Test Fuel Filler Cap View	A-11
Photo No. 023	Post-Test Fuel Filler Cap View	A-12
Photo No. 024	Pre-Test Front Underbody View	A-12
Photo No. 025	Post-Test Front Underbody View	A-13
Photo No. 026	Pre-Test Rear Underbody View	A-13
Photo No. 027	Post-Test Rear Underbody View	A-14
Photo No. 028	Pre-Test Dummy Cable Routing	A-14
Photo No. 029	Post-Test Dummy Cable Routing	A-15
Photo No. 030	Pre-Test Driver Dummy Front View	A-15

		Page No.
Photo No. 031	Post-Test Driver Dummy Front View	A-16
Photo No. 032	Pre-Test Driver Dummy Window View	A-16
Photo No. 033	Post-Test Driver Dummy Window View	A-17
Photo No. 034	Pre-Test Driver Dummy and Vehicle Interior View	A-17
Photo No. 035	Post-Test Driver Dummy and Vehicle Interior View	A-18
Photo No. 036	Pre-Test Driver's Seat Fore-Aft Markings	A-18
Photo No. 037	Post-Test Driver's Seat Fore-Aft Markings	A-19
Photo No. 038	Pre-Test View of Belt Anchorage for Driver Dummy	A-19
Photo No. 039	Post-Test View of Belt Anchorage for Driver Dummy	A-20
Photo No. 040	Pre-Test View of Belt Buckle and Latch Plate for Driver Dummy	A-20
Photo No. 041	Post-Test View of Belt Buckle and Latch Plate for Driver Dummy	A-21
Photo No. 042	Pre-Test Driver Dummy Feet	A-21
Photo No. 043	Post-Test Driver Dummy Feet	A-22
Photo No. 044	Pre-Test Driver's Side Knee Bolster	A-22
Photo No. 045	Post-Test Driver's Side Knee Bolster	A-23
Photo No. 046	Pre-Test Driver's Side Floorpan	A-23
Photo No. 047	Post-Test Driver's Side Floorpan	A-24
Photo No. 048	Post-Test Driver Dummy Face	A-24
Photo No. 049	Post-Test Driver Dummy Contact with Airbag	A-25
Photo No. 050	Post-Test Driver Dummy Contact with Headrest	A-25
Photo No. 051	Pre-Test View of the Steering Wheel	A-26
Photo No. 052	Post-Test View of the Steering Wheel	A-26
Photo No. 053	Pre-Test Passenger Dummy Front View	A-27
Photo No. 054	Post-Test Passenger Dummy Front View	A-27
Photo No. 055	Pre-Test Passenger Dummy Window View	A-28
Photo No. 056	Post-Test Passenger Dummy Window View	A-28
Photo No. 057	Pre-Test Passenger Dummy and Vehicle Interior	A-29
Photo No. 058	Post-Test Passenger Dummy and Vehicle Interior	A-29
Photo No. 059	Pre-Test Passenger's Seat Fore-Aft Markings	A-30
Photo No. 060	Post-Test Passenger's Seat Fore-Aft Markings	A-30

		Page No.
Photo No. 061	Pre-Test View of Belt Anchorage for Passenger Dummy	A-31
Photo No. 062	Post-Test View of Belt Anchorage for Passenger Dummy	A-31
Photo No. 063	Pre-Test View of Belt Buckle and Latch Plate for Passenger Dummy	A-32
Photo No. 064	Post-Test View of Belt Buckle and Latch Plate for Passenger Dummy	A-32
Photo No. 065	Pre-Test Passenger Dummy Feet	A-33
Photo No. 066	Post-Test Passenger Dummy Feet	A-33
Photo No. 067	Pre-Test Passenger's Side Knee Bolster	A-34
Photo No. 068	Post-Test Passenger's Side Knee Bolster	A-34
Photo No. 069	Pre-Test Passenger's Side Floorpan	A-35
Photo No. 070	Post-Test Passenger's Side Floorpan	A-35
Photo No. 071	Post-Test Passenger Dummy Face	A-36
Photo No. 072	Post-Test Passenger Dummy Contact with Airbag	A-36
Photo No. 073	Post-Test Passenger Dummy Contact with Headrest	A-37
Photo No. 074	Ballast Installed in Vehicle	A-37
Photo No. 075	Post-Test Stoddard Solvent Spillage Location View	A-38
Photo No. 076	Post-Test Speed Trap Read-Out	A-38
Photo No. 077	Vehicle at 0 Degree on Static Rollover Device	A-39
Photo No. 078	Vehicle at 90 Degrees on Static Rollover Device	A-39
Photo No. 079	Vehicle at 180 Degrees on Static Rollover Device	A-40
Photo No. 080	Vehicle at 270 Degrees on Static Rollover Device	A-40
Photo No. 081	Vehicle at 360 Degrees on Static Rollover Device	A-41
Photo No. 082	2021 Ford F-150 4x4 SuperCrew Sedan Frontal Impact Event	A-41
Photo No. 083	Monroney Label Photograph	A-42

PHOTOGRAPH NOT APPLICABLE

Photo No. 001 - Load Cell Location

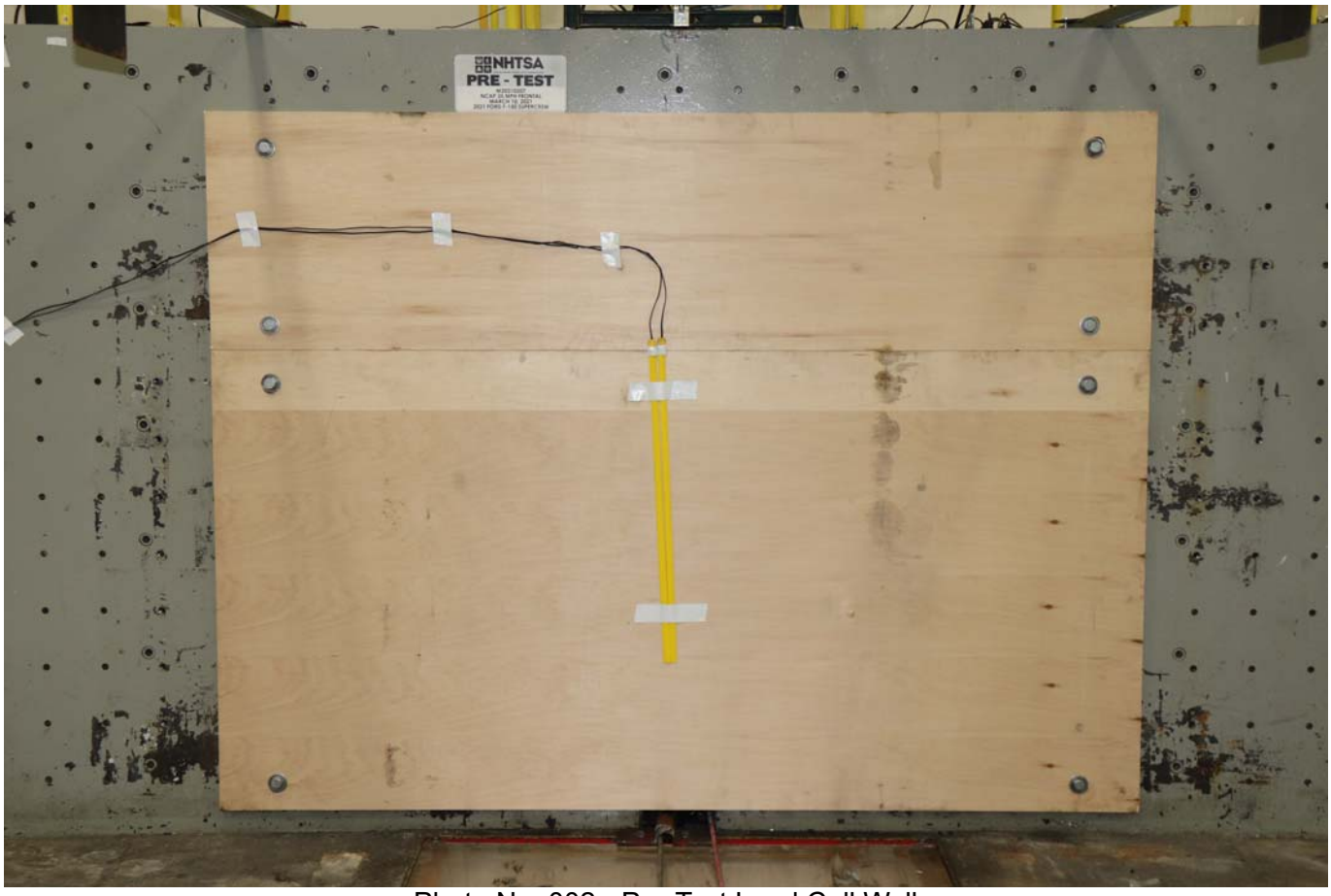


Photo No. 002 - Pre-Test Load Cell Wall

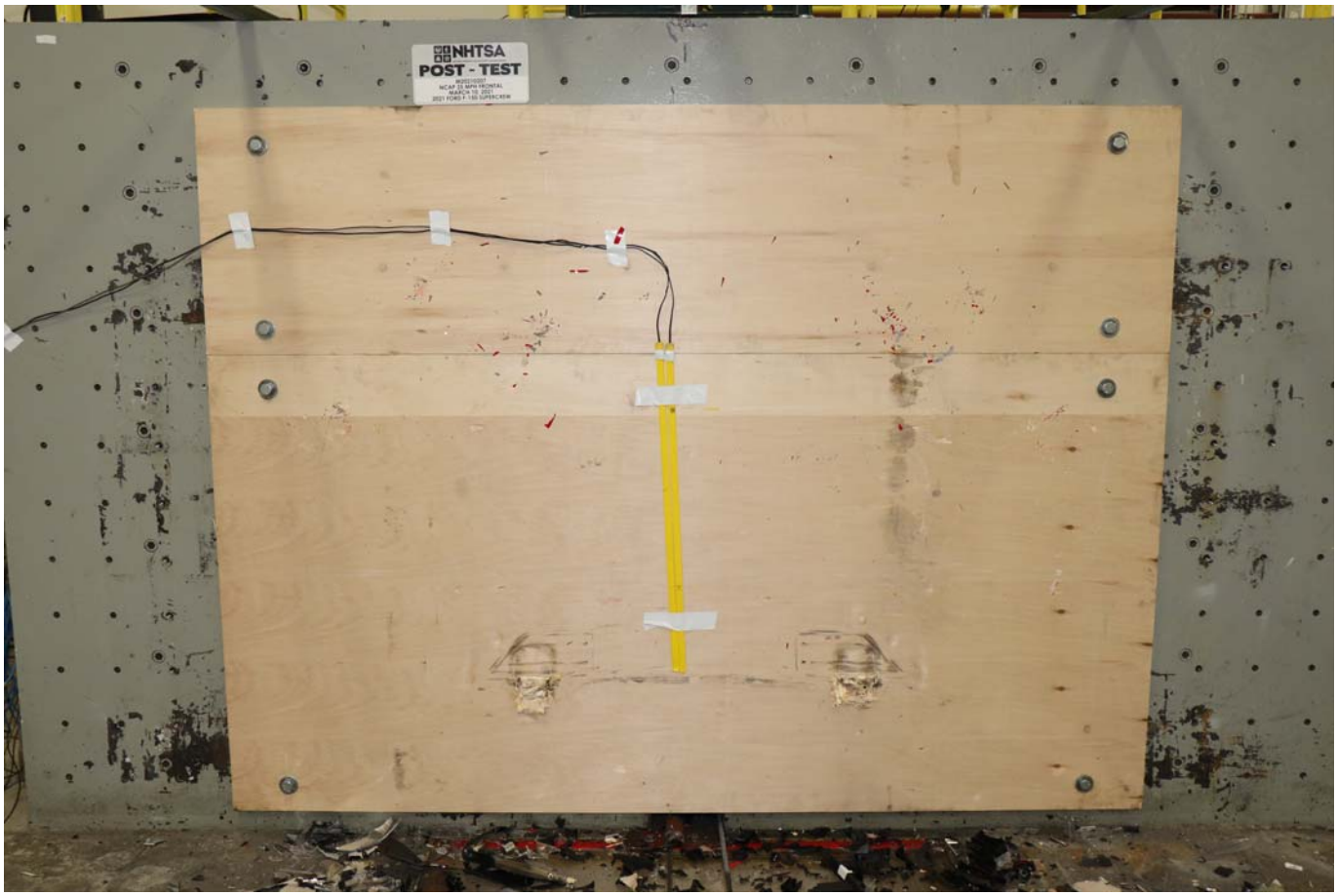


Photo No. 003 - Post-Test Load Cell Wall

Photo No. 004 - Manufacturer Label

Photo No. 005 - Tire Placard

Photo No. 006 - 2021 Ford F-150 4x4 SuperCrew 4-Door Pickup Truck Frontal As Delivered

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

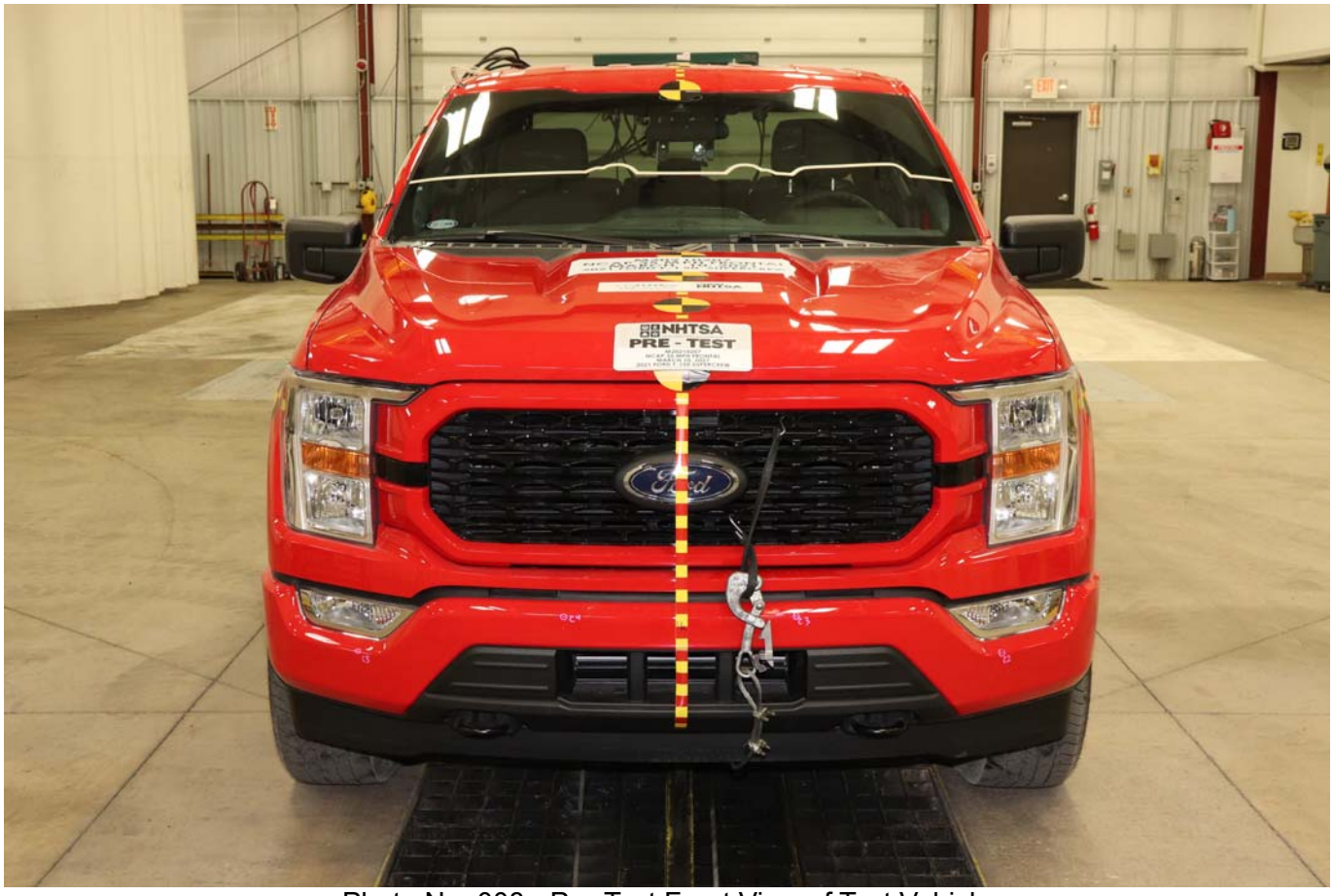


Photo No. 008 - Pre-Test Front View of Test Vehicle

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

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

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

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

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

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

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

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

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

Photo No. 018 - Pre-Test Windshield View

Photo No. 019 - Post-Test Windshield View

Photo No. 020 - Pre-Test Engine Compartment View

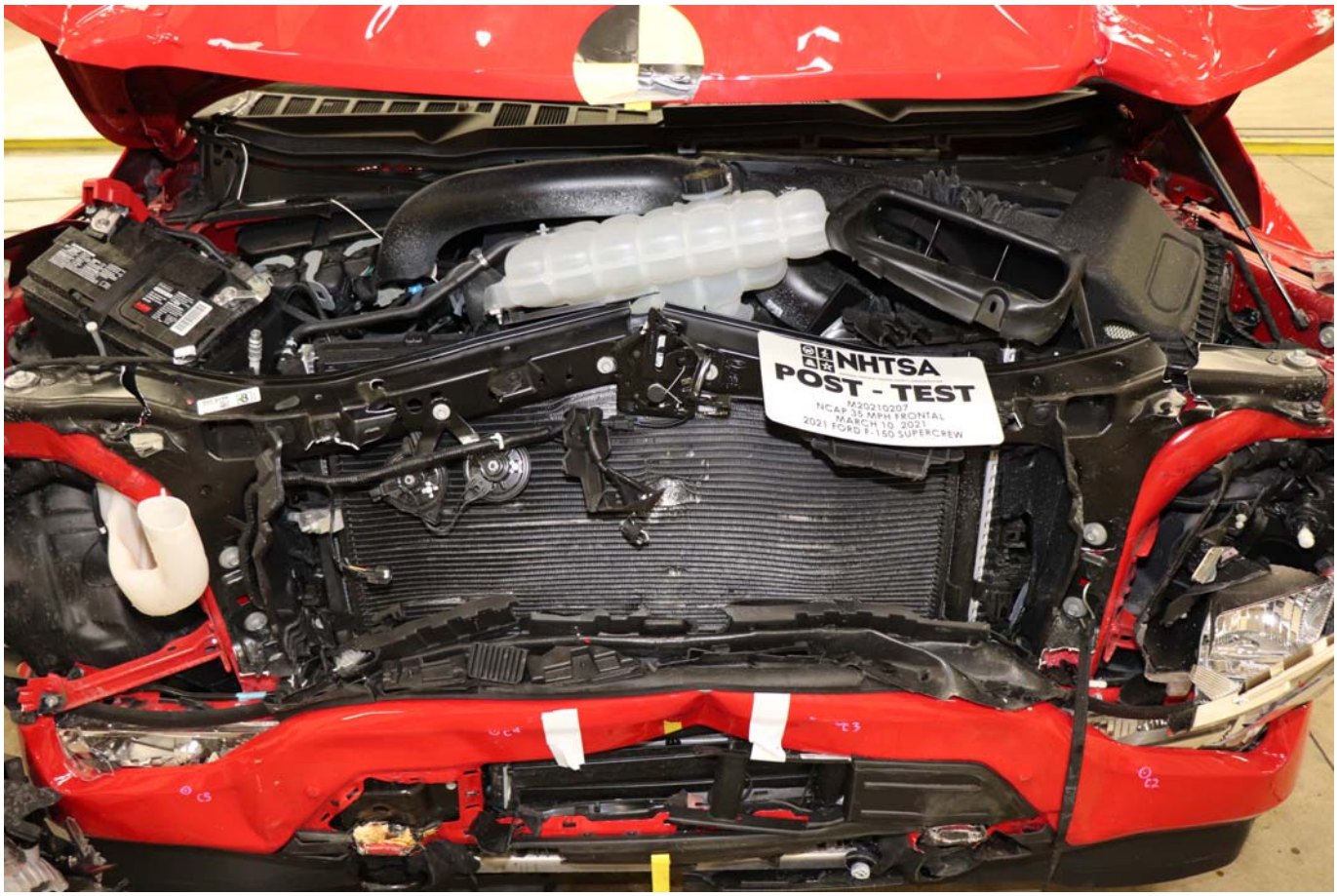


Photo No. 021 - Post-Test Engine Compartment View

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

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

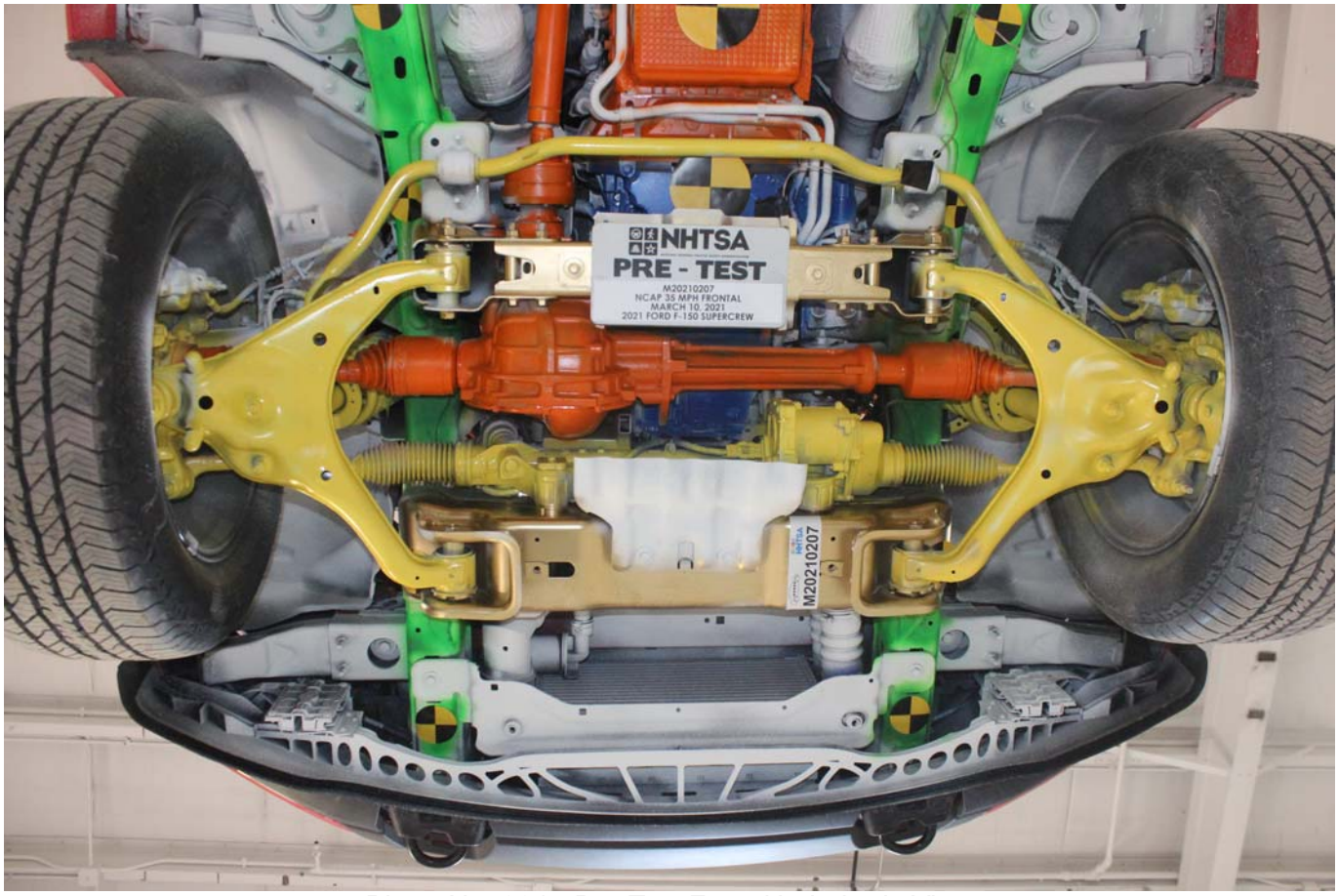


Photo No. 024 - Pre-Test Front Underbody View

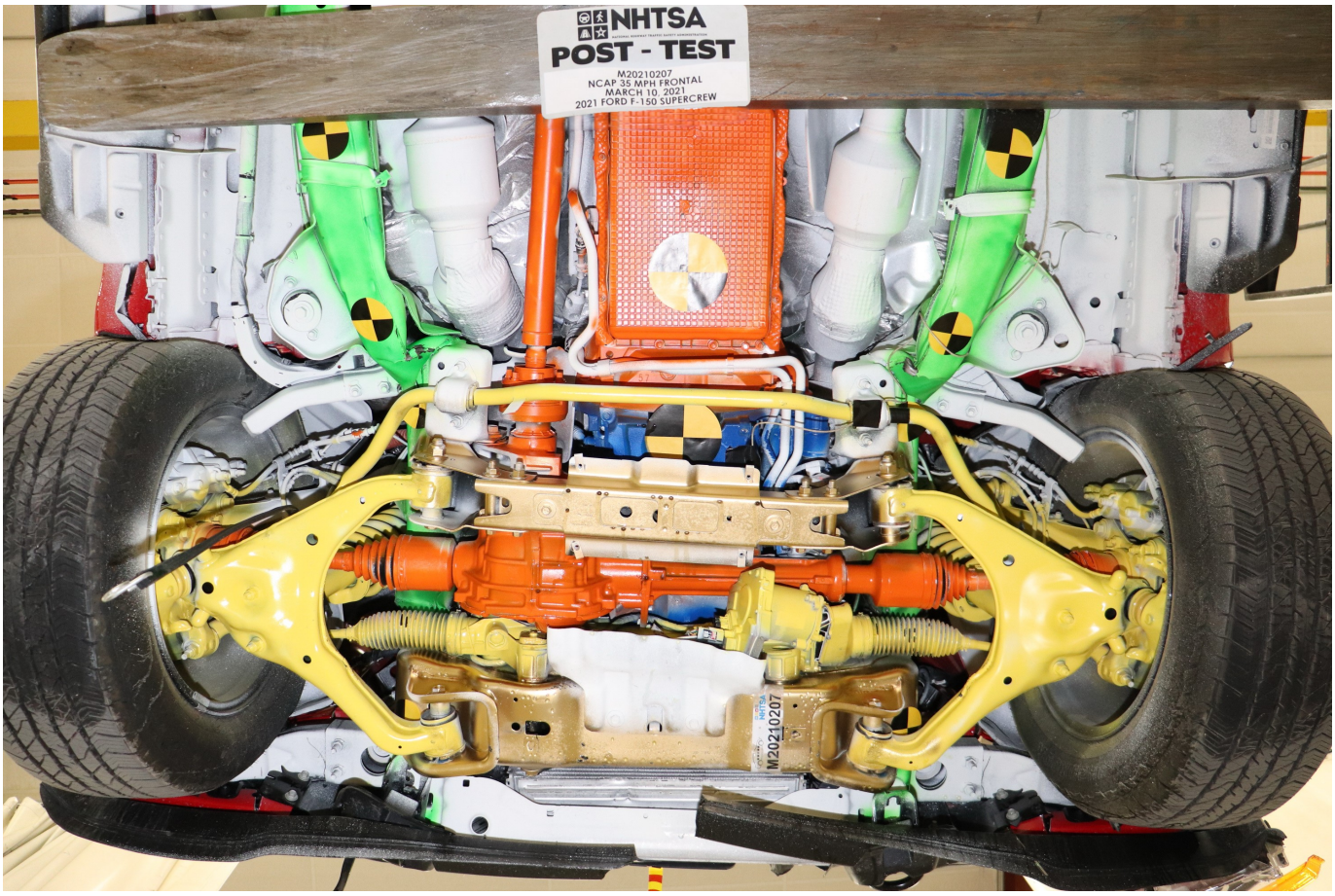


Photo No. 025 - Post-Test Front Underbody View

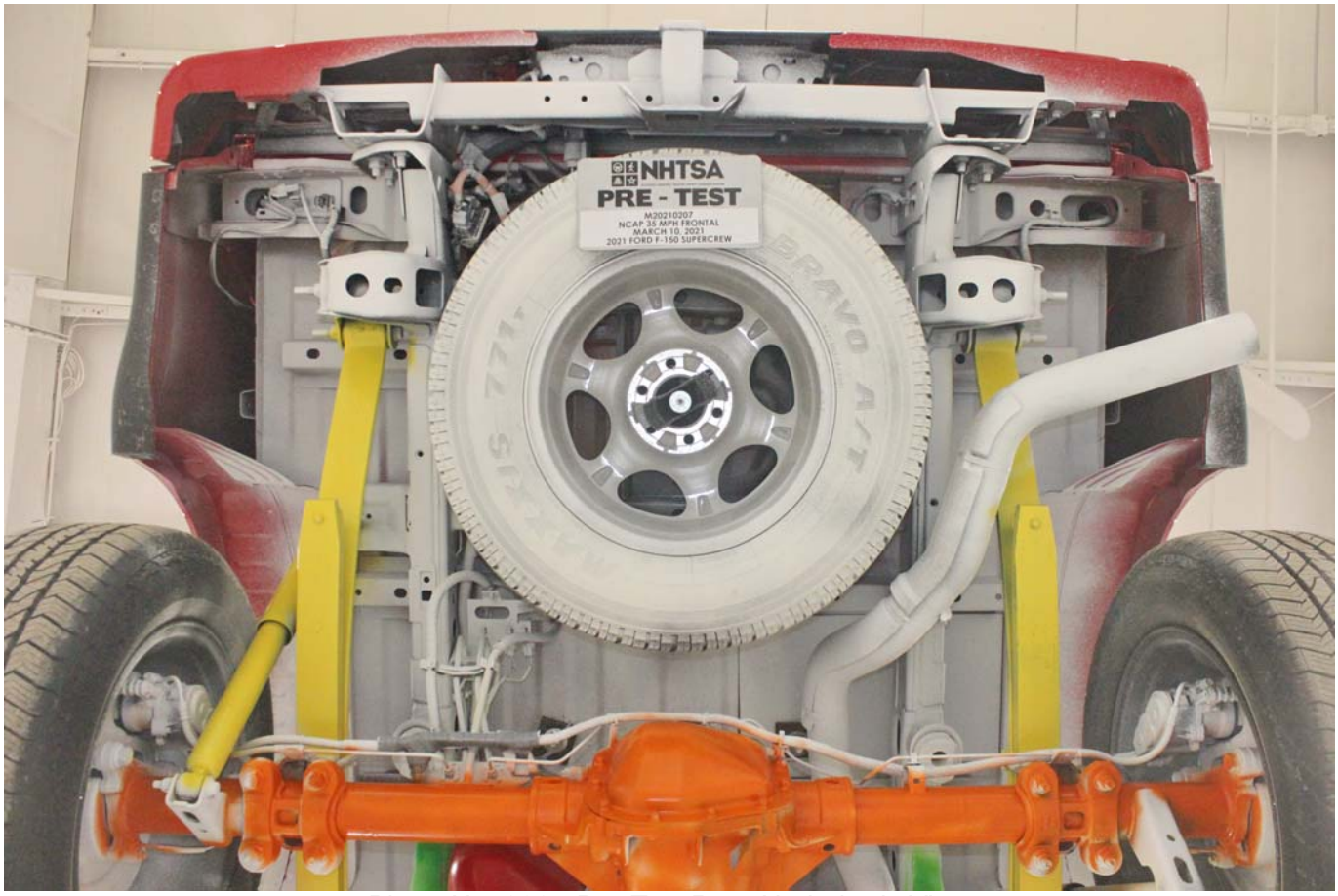


Photo No. 026 - Pre-Test Rear Underbody View

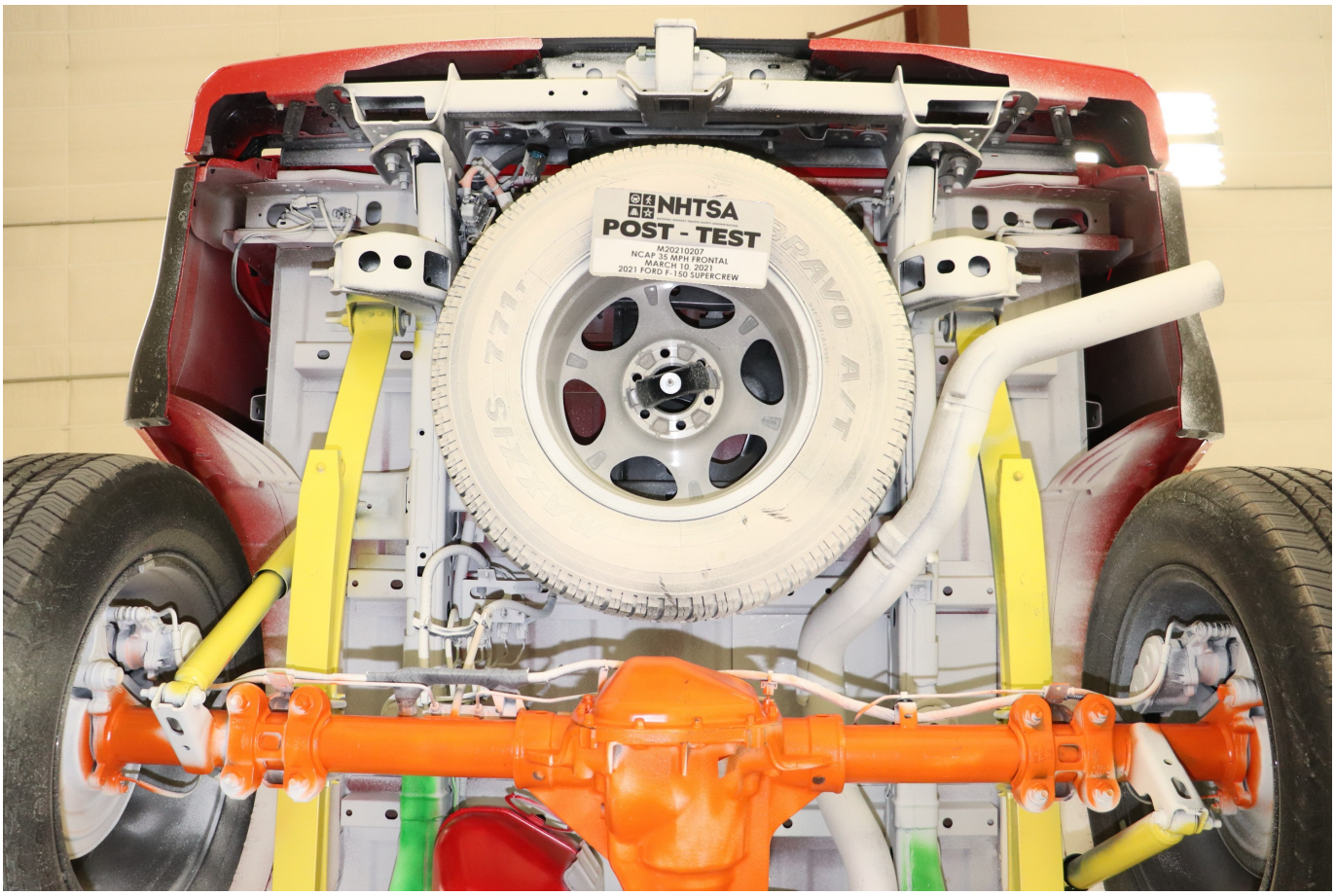


Photo No. 027 - Post-Test Rear Underbody View

Photo No. 028 - Pre-Test Dummy Cable Routing

Photo No. 029 - Post-Test Dummy Cable Routing

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

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

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

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

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

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

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

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

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

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

Photo No. 040 - Pre-Test View of Belt Buckle and Latch Plate for Driver Dummy

Photo No. 041 - Post-Test View of Belt Buckle and Latch Plate for Driver Dummy

Photo No. 042 - Pre-Test Driver Dummy Feet

Photo No. 043 - Post-Test Driver Dummy Feet

Photo No. 044 - Pre-Test Driver Side Knee Bolster

Photo No. 045 - Post-Test Driver Side Knee Bolster

Photo No. 046 - Pre-Test Driver Side Floorpan

Photo No. 047 - Post-Test Driver Side Floorpan

Photo No. 048 - Post-Test Driver Dummy Face

Photo No. 049 - Post-Test Driver Dummy Contact with Airbag

Photo No. 050 - Post-Test Driver Dummy Contact with Headrest

Photo No. 051 - Pre-Test View of the Steering Wheel

Photo No. 052 - Post-Test View of the Steering Wheel

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

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

Photo No. 055 - Pre-Test Passenger Dummy Window View

Photo No. 056 - Post-Test Passenger Dummy Window View

Photo No. 057 - Pre-Test Passenger Dummy and Vehicle Interior

Photo No. 058 - Post-Test Passenger Dummy and Vehicle Interior

Photo No. 059 - Pre-Test Passenger Seat Fore-Aft Markings

Photo No. 060 - Post-Test Passenger Seat Fore-Aft Markings

Photo No. 061 - Pre-Test View of Belt Anchorage for Passenger Dummy

Photo No. 062 - Post-Test View of Belt Anchorage for Passenger Dummy

Photo No. 063 - Pre-Test View of Belt Buckle and Latch Plate for Passenger Dummy

Photo No. 064 - Post-Test View of Belt Buckle and Latch Plate for Passenger Dummy

Photo No. 065 - Pre-Test Passenger Dummy Feet

Photo No. 066 - Post-Test Passenger Dummy Feet

Photo No. 067 - Pre-Test Passenger Side Knee Bolster

Photo No. 068 - Post-Test Passenger Side Knee Bolster

Photo No. 069 - Pre-Test Passenger Side Floorpan

Photo No. 070 - Post-Test Passenger Side Floorpan

Photo No. 071 - Post-Test Passenger Dummy Face

Photo No. 072 - Post-Test Passenger Dummy Contact with Airbag

Photo No. 073 - Post-Test Passenger Dummy Contact with Headrest

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

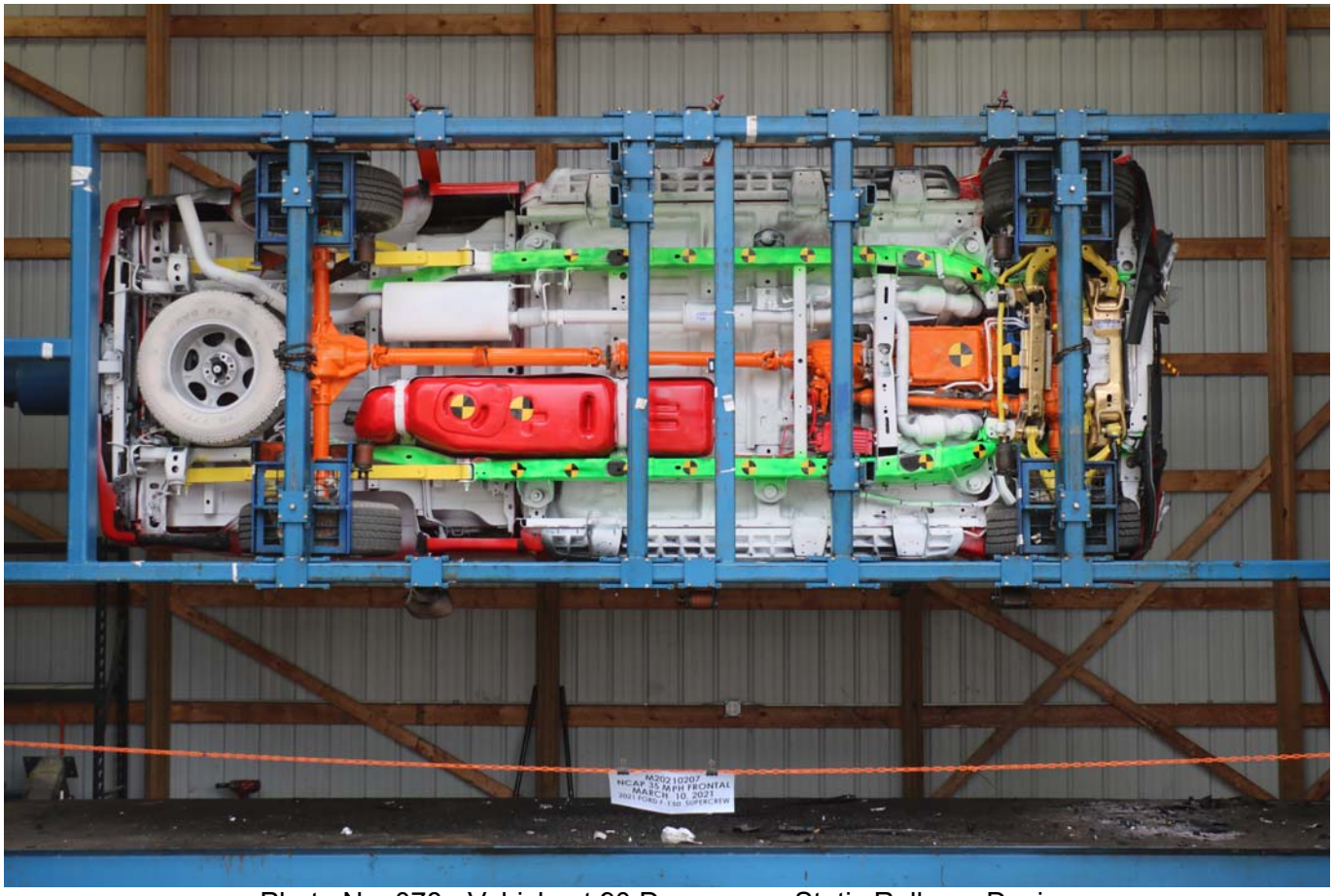


Photo No. 078 - Vehicle at 90 Degrees on Static Rollover Device

Photo No. 079 - Vehicle at 180 Degrees on Static Rollover Device

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 Ford F-150 4x4 SuperCrew 4-Door Pickup Truck Frontal Impact Event

Ford
Go Further
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VEHICLE DESCRIPTION
F-150

2021 F-150 4X4 SUPERCREW
157" WHEELBASE
3.5L V6 ECOBOOST
ELEC TEN-SPEED AUTO W/TOW M

EXTERIOR
RACE RED
INTERIOR
BLACK SPORT CLOTH40/CON/40

MK D13191

STANDARD EQUIPMENT INCLUDED AT NO EXTRA CHARGE

EXTERIOR
- DAYTIME RUNNING LAMPS
- EASY FUEL® CAPLESS FILLER
- FULLY BOXED STEEL FRAME
- HALOGEN HEADLAMPS
- HEADLAMPS - AUTO HIGH BEAM
- HEADLAMPS - AUTOLAMP (ON/OFF)
- LOCKING REMOVABLE TAILGATE
- PICKUP BOX TIE DOWN HOOKS
- TRAILER SWAY CONTROL
- WIPERS- INTERMITTENT

INTERIOR
- 4" PRODUCTIVITY SCREEN
- 60/40 FOLD-UP REAR BENCH SEAT
- DUAL SUNVISORS
- MESSAGE CTR: OUTSIDE TEMP, COMPASS, TRIP COMPUTER
- POWERPOINTS - 12V
- TILT/TELESCOPE STR COLUMN

FUNCTIONAL
- AUTO HOLD
- AUTO START STOP TECH
- CURVE CONTROL
- DYNAMIC HITCH ASSIST
- ELECT 4X4 SHIFT-ON-FLY
- FAIL-SAFE COOLING SYSTEM
- FORDPASS CONNECT™ 4G HOTSPOT TELEMATICS MODEM
- GAS-CHARGED SHOCKS
- OUTBOARD MNTD REAR SHOCKS
- PRE-COLLISION ASSIST W/AEB
- PWR RACK AND PINION STEER
- REAR VIEW CAMERA
- SELECTSHIFT®

SAFETY/SECURITY
- ADVANCETRAC® WITH RSC®
- AIRBAGS - FRONT SEAT MOUNTED SIDE IMPACT
- AIRBAGS - SAFETY CANOPY®
- CTR HIGH MOUNT STOP LAMP
- SECURILOCK® ANTI-THEFT SYS
- SOS POST-CRASH ALERT SYS™
- TIRE PRESSURE MONIT SYS

WARRANTY
- 3YR/36,000 BUMPER / BUMPER
- 5YR/100,000 DIESEL ENGINE
- 5YR/60,000 POWERTRAIN
- 5YR/60,000 ROADSIDE ASSIST
- 8YR/100,000 HYBRID BATTERY

INCLUDED ON THIS VEHICLE	(MSRP)
EQUIPMENT GROUP 101A	920.00
•XL SERIES	
•XL POWER EQUIPMENT GROUP	
•CRUISE CONTROL	
•REVERSE SENSING SYSTEM	
OPTIONAL EQUIPMENT/OTHER	
3.5L V6 ECOBOOST	600.00
275/60R20 BSW ALL-TERRAIN	NO CHARGE
3.55 ELECTRONIC LOCK RR AXLE	470.00
7150# GVWR PACKAGE	
FRONT LICENSE PLATE BRACKET	NO CHARGE
BLACK PLATFORM RUNNING BOARDS	250.00
ENGINE BLOCK HEATER	90.00
50 STATE EMISSIONS	NO CHARGE
ONBOARD 400W OUTLET	340.00
TRAILER TOW PACKAGE	1,090.00
.INTEGRATED TRAILER BRAKE CONT	
STX APPEARANCE PACKAGE	1,780.00
.REAR-WINDOW DEFROSTER	
.FOG LAMPS	
.PRIVACY GLASS	
20" 6-SPOKE MAGNETIC PKT WHLS	1,000.00
EXTENDED RANGE 36GAL FUEL TANK	445.00
STX SPORT CLOTH 40/CON/40	295.00

PRICE INFORMATION	(MSRP)
BASE PRICE	$42,635.00
TOTAL OPTIONS/OTHER	7,280.00
TOTAL VEHICLE & OPTIONS/OTHER	49,915.00
DESTINATION & DELIVERY	1,695.00
TOTAL BEFORE DISCOUNTS	**51,610.00**
XL HIGH DISCOUNT	**- 750.00**
STX APPEARANCE DISCT	**- 750.00**
XL HIGH STX WHEEL	**- 595.00**
TOTAL SAVINGS	**- 2,095.00**

SOLD TO 41A 585
Gordie Boucher Ford of West Be
3021 West Washington Avenue
West Bend WI 53095

SHIP TO (IF OTHER THAN SOLD TO):

SHIP THROUGH

RAMP ONE: CW79
RAMP TWO:

FINAL ASSEMBLY PLANT: KANSAS CITY
METHOD OF TRANSP.: CONVOY
ITEM #: 41-D122 O/T 2

This label is affixed pursuant to the Federal Automobile Information Disclosure Act. Gasoline, License, and Title Fees, State and Local taxes are not included. Dealer installed options or accessories are not included unless listed above.

TOTAL MSRP $49,515.00

FORD CREDIT
Whether you decide to lease or finance your vehicle, you'll find the choices that are right for you. See your dealer for details or visit www.ford.com/finance.

LM102 N RB 2X 125 001554 12 10 20

EPA DOT Fuel Economy and Environment — Gasoline Vehicle

Fuel Economy
20 MPG combined city/hwy
18 city
23 highway
5.0 gallons per 100 miles

Standard Pickup Trucks range from 14 to 27 MPG. The best vehicle rates 141 MPGe.

Miles 80.1

You **spend $2,500** more in fuel costs over 5 years compared to the average new vehicle.

Annual fuel cost **$2,000**

Fuel Economy & Greenhouse Gas Rating (tailpipe only): 4 (1 – 10 Best)
Smog Rating (tailpipe only): 6 (1 – 10 Best)

This vehicle emits 445 grams CO_2 per mile. The best emits 0 grams per mile (tailpipe only). Producing and distributing fuel also create emissions; learn more at fueleconomy.gov.

Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle. The average new vehicle gets 27 MPG and costs $7,500 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $2.70 per gallon. MPGe is miles per gasoline gallon equivalent. Vehicle emissions are a significant cause of climate change and smog.

fueleconomy.gov
Calculate personalized estimates and compare vehicles

Smartphone QR Code™

GOVERNMENT 5-STAR SAFETY RATINGS

Overall Vehicle Score		**Not Rated**
Based on the combined ratings of frontal, side and rollover. Should ONLY be compared to other vehicles of similar size and weight.		
Frontal Crash	Driver	**Not Rated**
	Passenger	**Not Rated**
Based on the risk of injury in a frontal impact. Should ONLY be compared to other vehicles of similar size and weight.		
Side Crash	Front seat	**Not Rated**
	Rear seat	**Not Rated**
Based on the risk of injury in a side impact.		
Rollover		**Not Rated**
Based on the risk of rollover in a single-vehicle crash.		

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

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43 YEARS FORD F-SERIES
AMERICA'S BEST SELLING TRUCKS
BUILT FORD TOUGH

For equipped vehicles, The FordPass Connect™ modem is active and sending vehicle data (e.g., diagnostics) to Ford. See in-vehicle Settings for connectivity options.

FordPass Connect service™ and FordPass App™ required for certain remote features (see App Terms for more information). Connected service and related feature functionality is subject to compatible AT&T network availability. Evolving technology / cellular networks may affect functionality and availability, or continued provision of some features, prohibiting them from functioning. Message and data rates may apply. See your local Ford website for our privacy policy.

Ford | FORD PROTECT™
Insist on Ford Protect! The only extended service plan fully backed by Ford and honored at every Ford dealership in the U.S., Canada and Mexico. See your Ford dealer or visit www.FordOwner.com.

⚠ **WARNING:** Operating, servicing and maintaining a passenger vehicle, pickup truck, van, or off-road vehicle can expose you to chemicals including engine exhaust, carbon monoxide, phthalates, and lead, which are known to the State of California to cause cancer and birth defects or other reproductive harm. To minimize exposure, avoid breathing exhaust, do not idle the engine except as necessary, service your vehicle in a well-ventilated area and wear gloves or wash your hands frequently when servicing your vehicle. For more information go to www.P65Warnings.ca.gov/passenger-vehicle.

SCAN OR TEXT 1FMKD13191 TO 48028
Msg & Data rates may apply. Text HELP for help
www.ford.com/help/privacy

Photo No. 083 - Monroney Label Photograph

APPENDIX B
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

		Page No.
	List of Data Plots Provided in the Test Report	
Figure No. 1.	Driver Head X Acceleration vs. Time	B-1
Figure No. 2.	Driver Head Y Acceleration vs. Time	B-1
Figure No. 3.	Driver Head Z Acceleration vs. Time	B-1
Figure No. 4.	Driver Head Resultant Acceleration vs. Time	B-1
Figure No. 5.	Driver Chest Displacement vs. Time	B-2
Figure No. 6.	Driver Chest X Acceleration vs. Time	B-3
Figure No. 7.	Driver Chest Y Acceleration vs. Time	B-3
Figure No. 8.	Driver Chest Z Acceleration vs. Time	B-3
Figure No. 9.	Driver Chest Resultant Acceleration vs. Time	B-3
Figure No. 10.	Driver Neck Force X vs. Time	B-4
Figure No. 11.	Driver Neck Force Z vs. Time	B-4
Figure No. 12.	Driver Neck Moment Y vs. Time	B-4
Figure No. 13.	Driver Nij (NTF) vs. Time	B-5
Figure No. 14.	Driver Nij (NTE) vs. Time	B-5
Figure No. 15.	Driver Nij (NCF) vs. Time	B-5
Figure No. 16.	Driver Nij (NCE) vs. Time	B-5
Figure No. 17.	Driver Left Femur Force vs. Time	B-6
Figure No. 18.	Driver Right Femur Force vs. Time	B-6
Figure No. 19.	Passenger Head X Acceleration vs. Time	B-7
Figure No. 20.	Passenger Head Y Acceleration vs. Time	B-7
Figure No. 21.	Passenger Head Z Acceleration vs. Time	B-7
Figure No. 22.	Passenger Head Resultant Acceleration vs. Time	B-7
Figure No. 23.	Passenger Chest Displacement vs. Time	B-8
Figure No. 24.	Passenger Chest X Acceleration vs. Time	B-9
Figure No. 25.	Passenger Chest Y Acceleration vs. Time	B-9
Figure No. 26.	Passenger Chest Z Acceleration vs. Time	B-9
Figure No. 27.	Passenger Chest Resultant Z Acceleration vs. Time	B-9

		Page No.
Figure No. 28.	Passenger Neck Force X vs. Time	B-10
Figure No. 29.	Passenger Neck Force Z vs. Time	B-10
Figure No. 30.	Passenger Neck Moment Y vs. Time	B-10
Figure No. 31.	Passenger Nij (NTF) vs. Time	B-11
Figure No. 32.	Passenger Nij (NTE) vs. Time	B-11
Figure No. 33.	Passenger Nij (NCF) vs. Time	B-11
Figure No. 34.	Passenger Nij (NCE) vs. Time	B-11
Figure No. 35.	Passenger Left Femur Force vs. Time	B-12
Figure No. 36.	Passenger Right Femur Force vs. Time	B-12

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

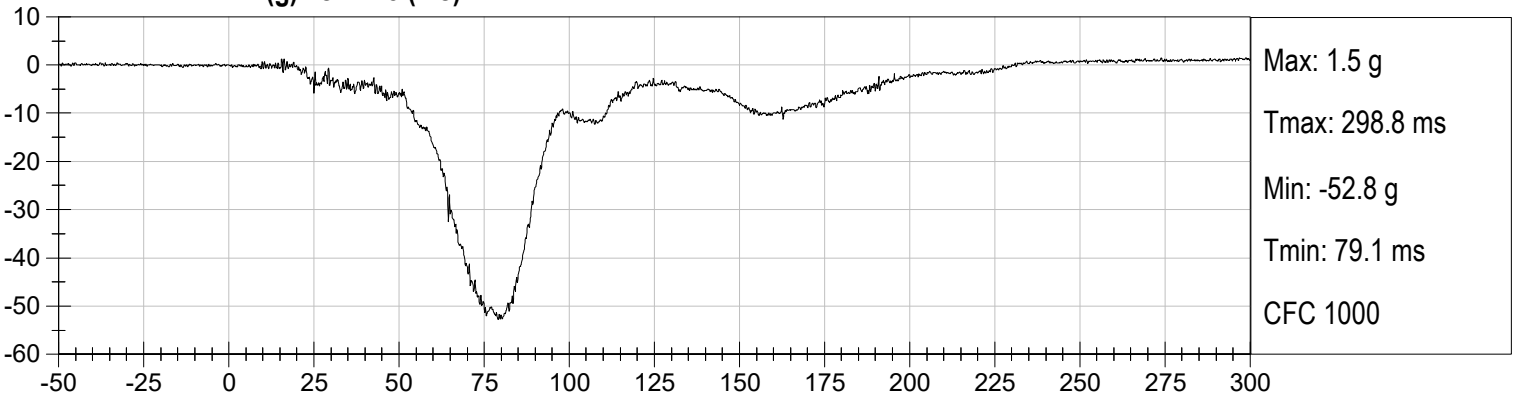
Left Rear Seat Crossmember Z

Right Rear Seat Crossmember Z

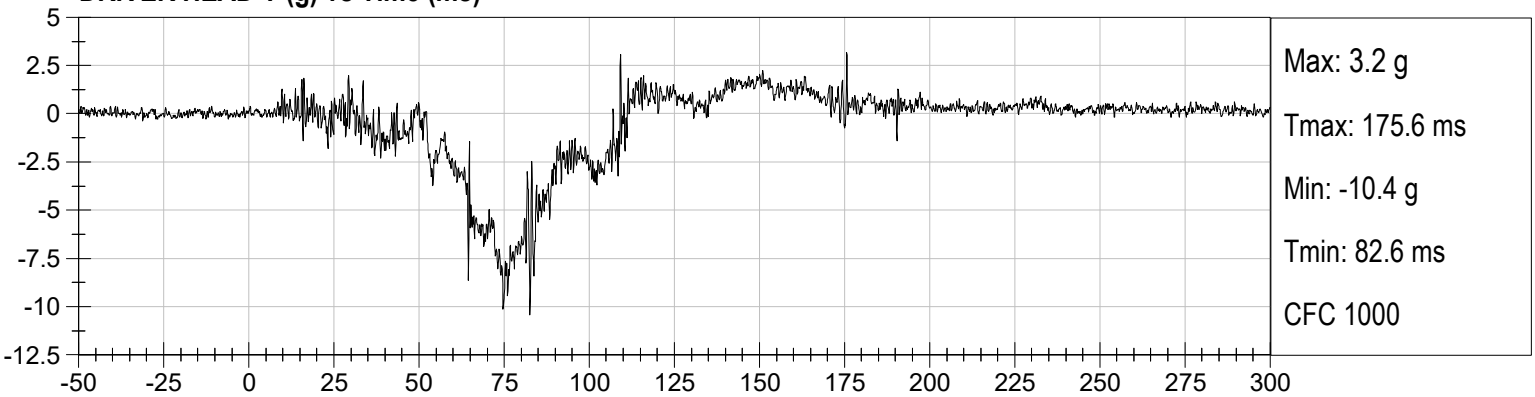
Left Rear Seat Crossmember Xr

Right Rear Seat Crossmember Xr

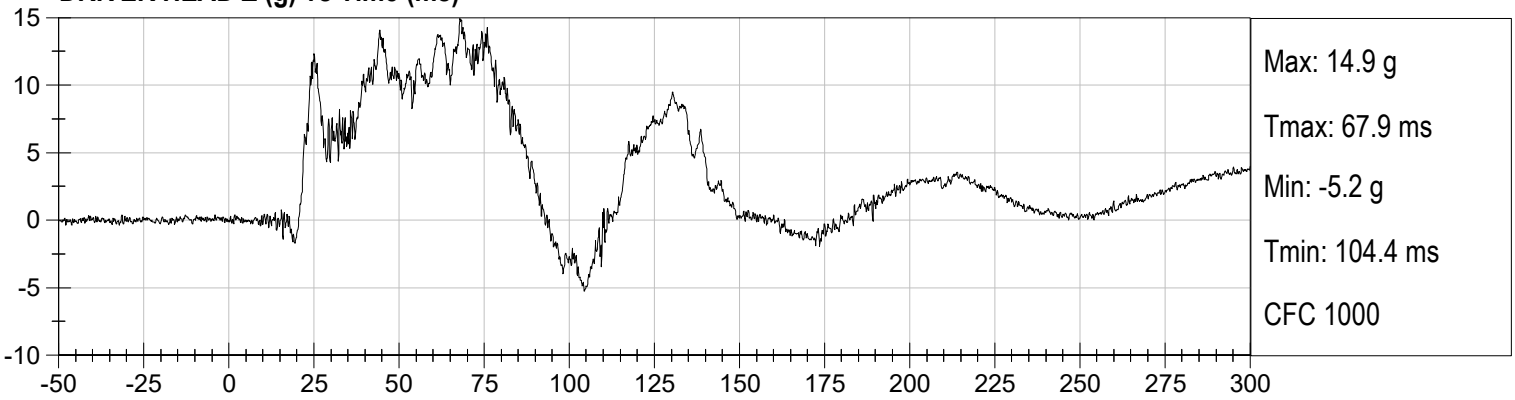
DRIVER HEAD X (g) vs Time (ms)



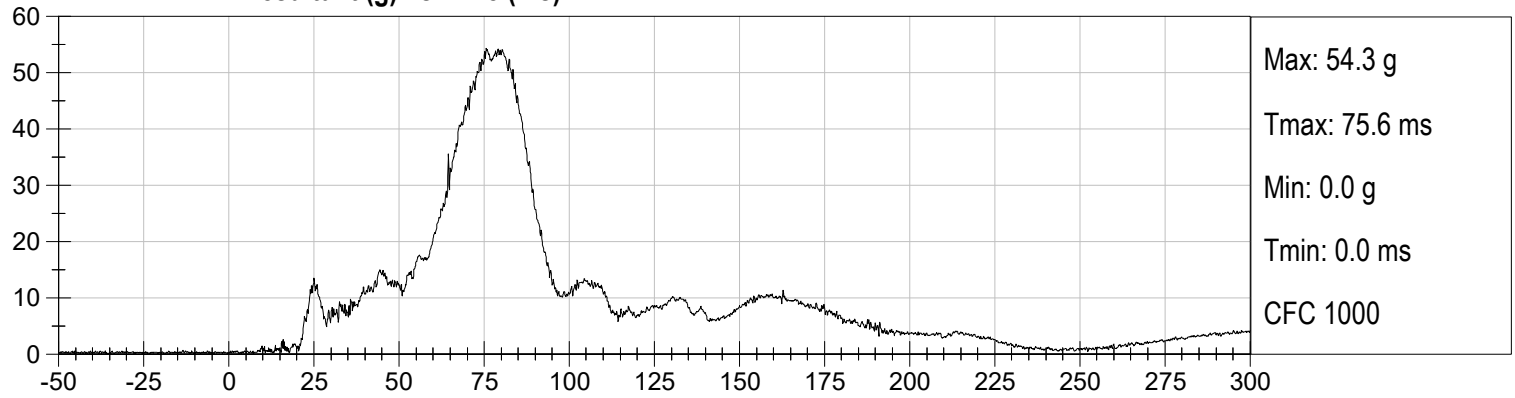
DRIVER HEAD Y (g) vs Time (ms)

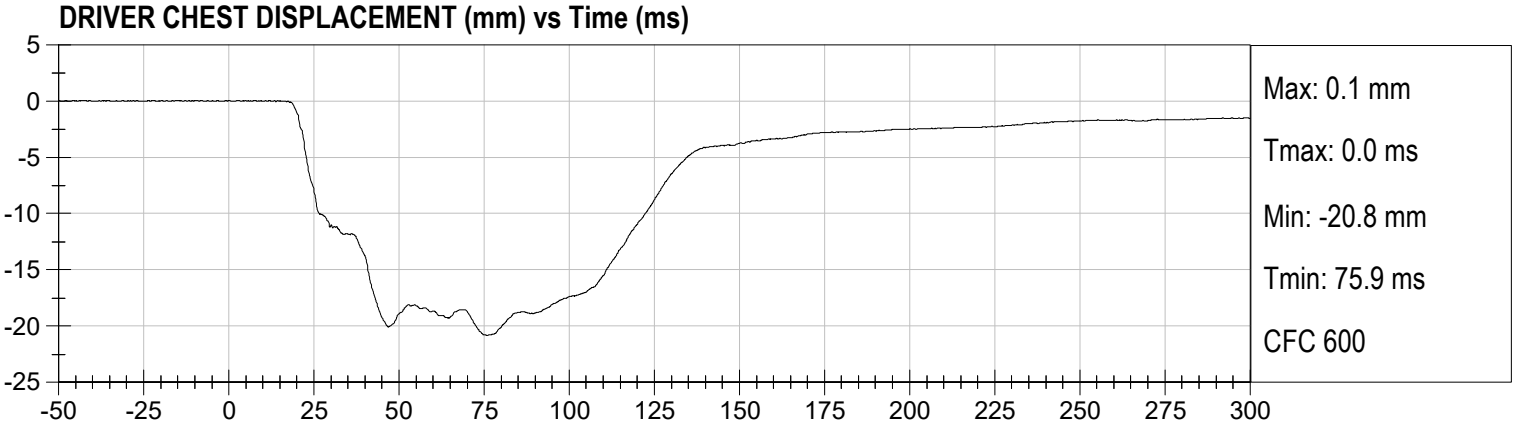


DRIVER HEAD Z (g) vs Time (ms)

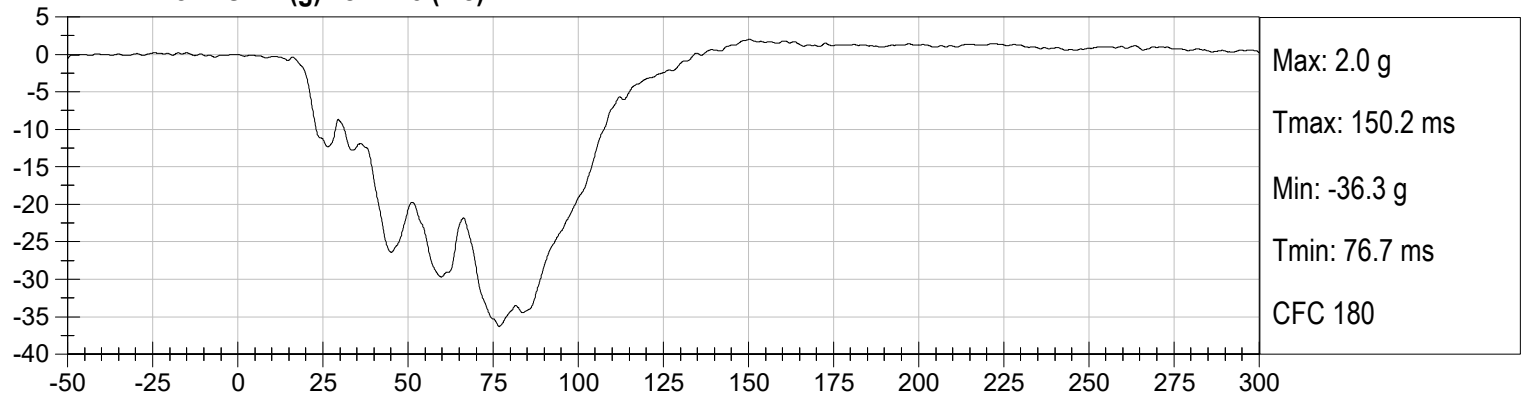


DRIVER HEAD Resultant (g) vs Time (ms)

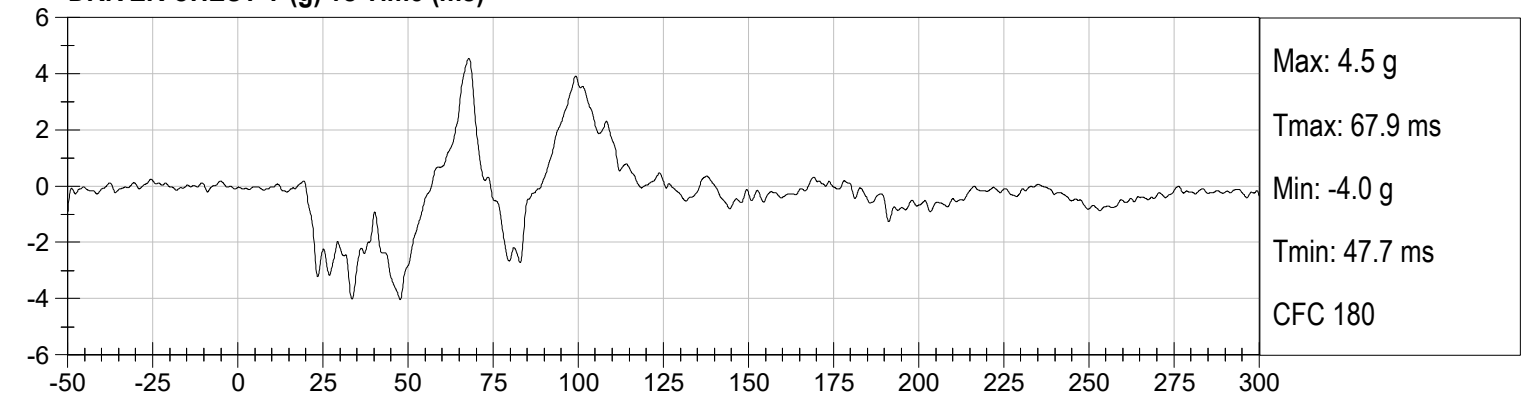



DRIVER CHEST DISPLACEMENT (mm) vs Time (ms)
5
0
-5
-10
-15
-20
-25
-50
-25
0
25
50
75
100
125
150
175
200
225
250
275
300
Max: 0.1 mm
Tmax: 0.0 ms
Min: -20.8 mm
Tmin: 75.9 ms
CFC 600

DRIVER CHEST X (g) vs Time (ms)

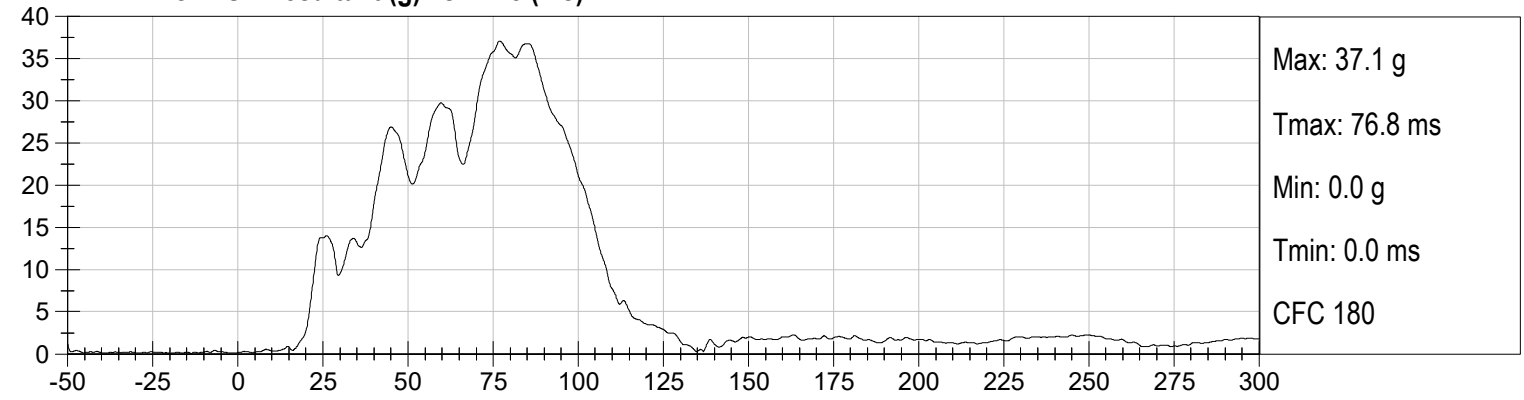


DRIVER CHEST Y (g) vs Time (ms)

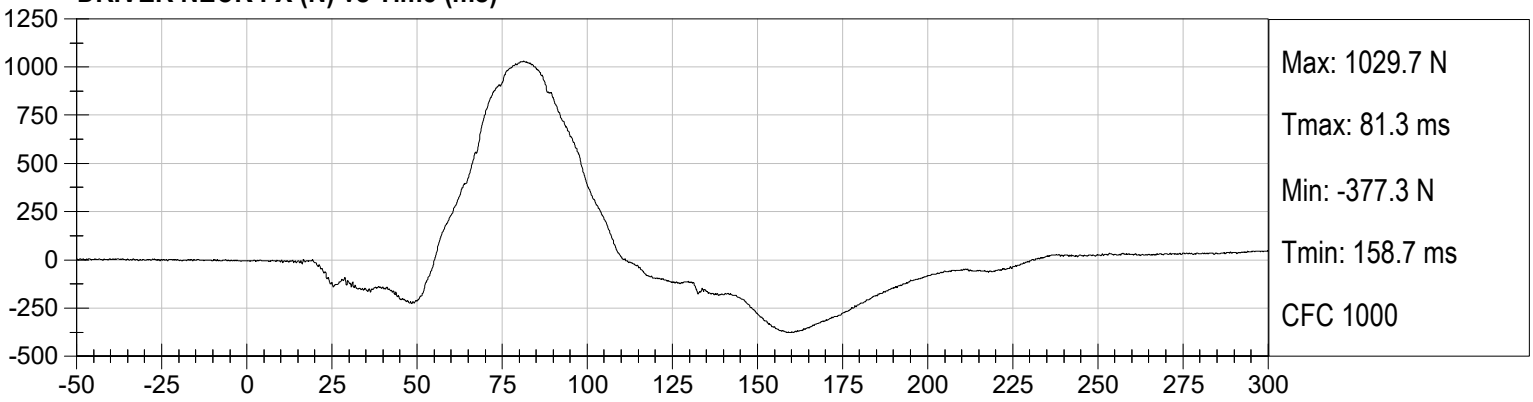


DRIVER CHEST Z (g) vs Time (ms)

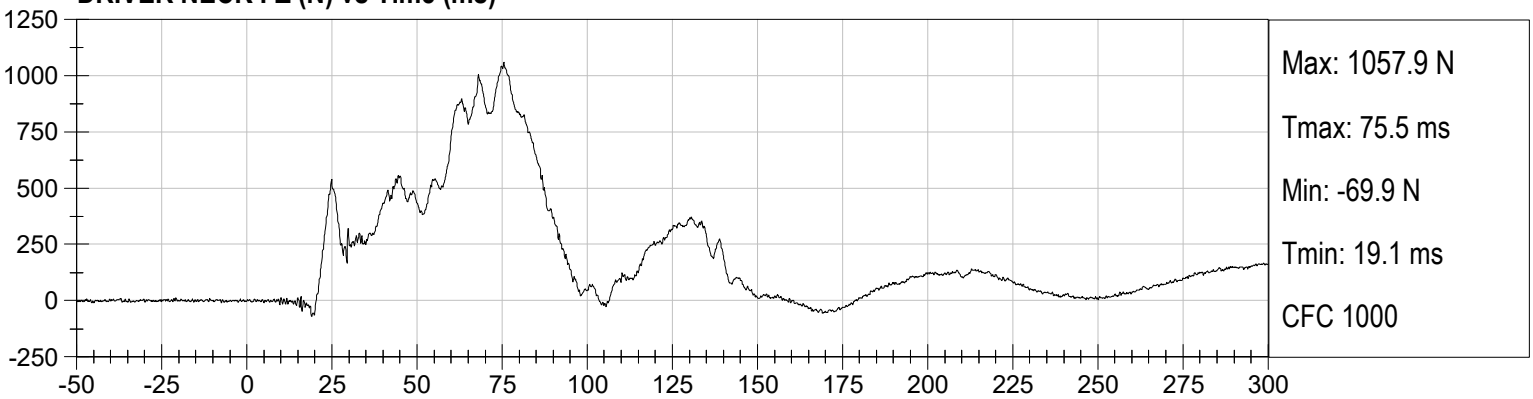
DRIVER CHEST Resultant (g) vs Time (ms)



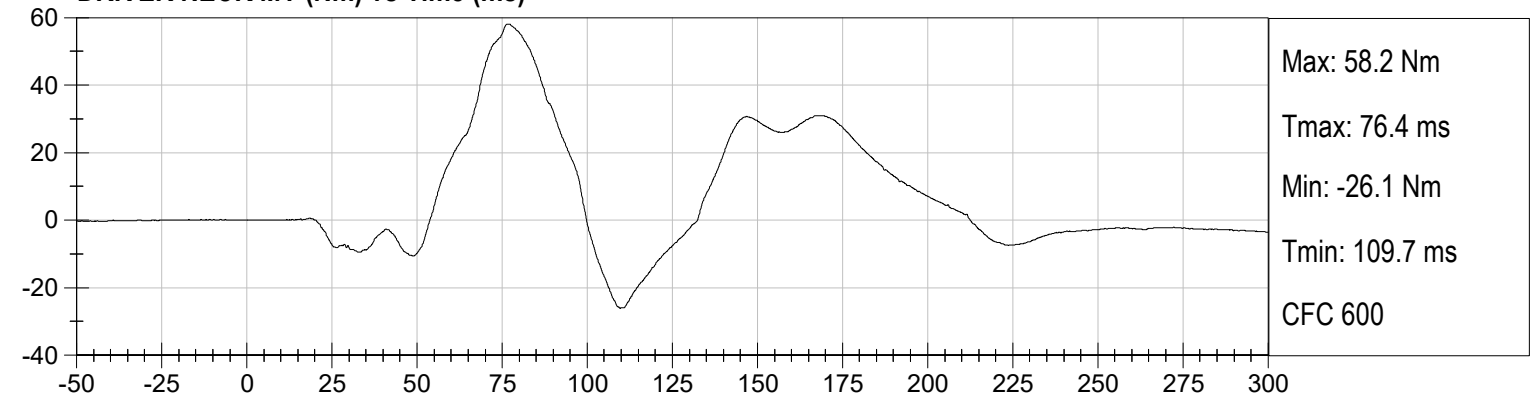
DRIVER NECK FX (N) vs Time (ms)



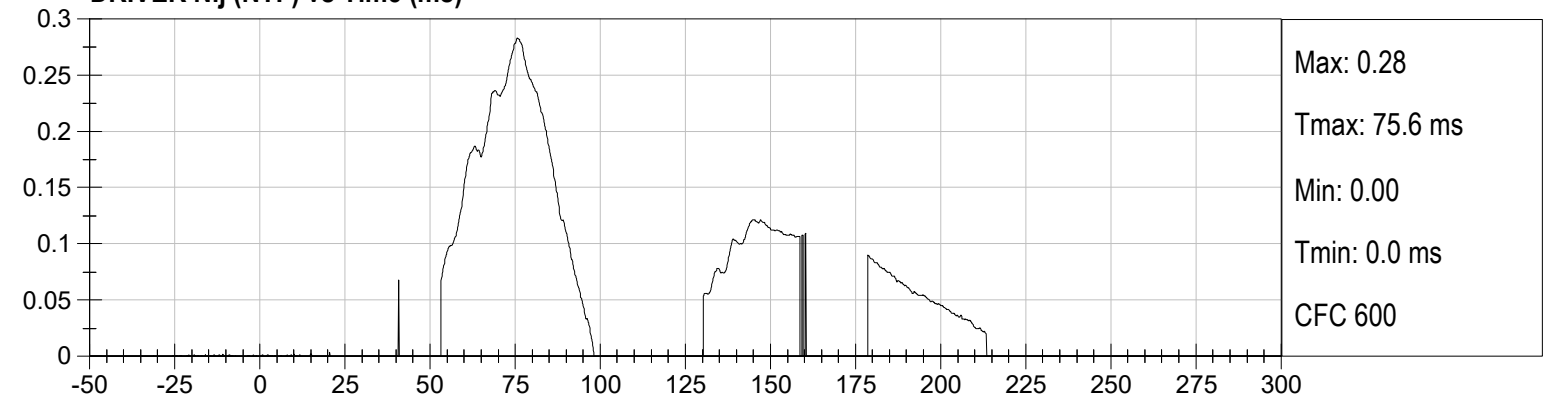
DRIVER NECK FZ (N) vs Time (ms)



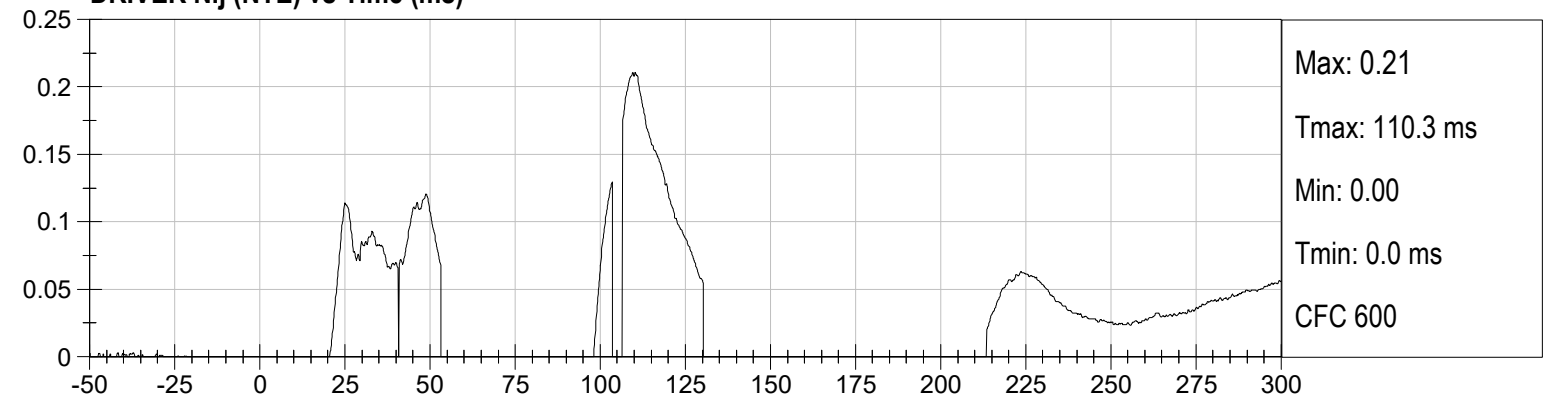
DRIVER NECK MY (Nm) vs Time (ms)



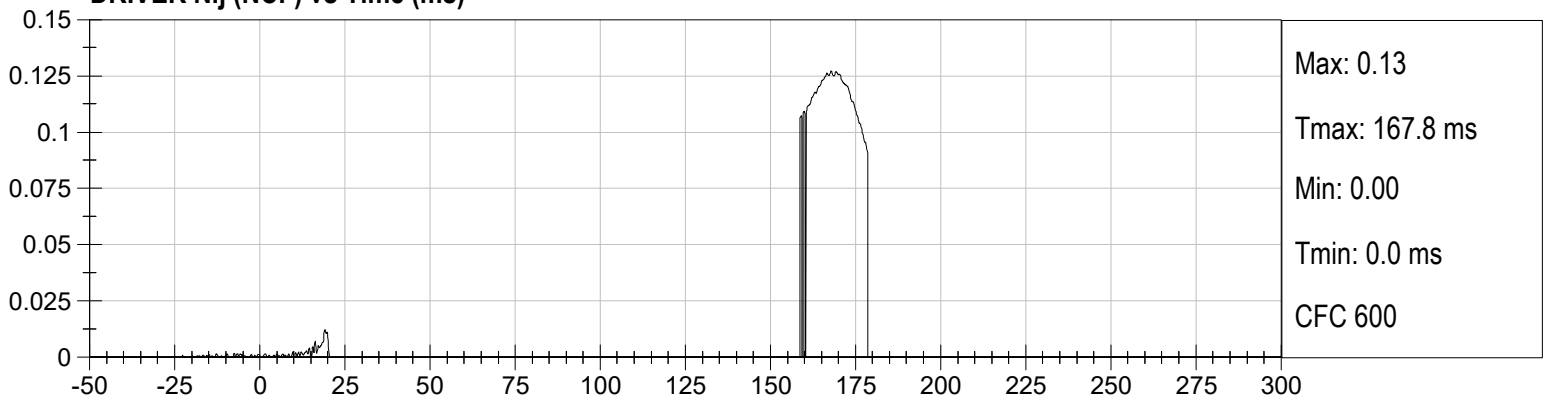
DRIVER Nij (NTF) vs Time (ms)



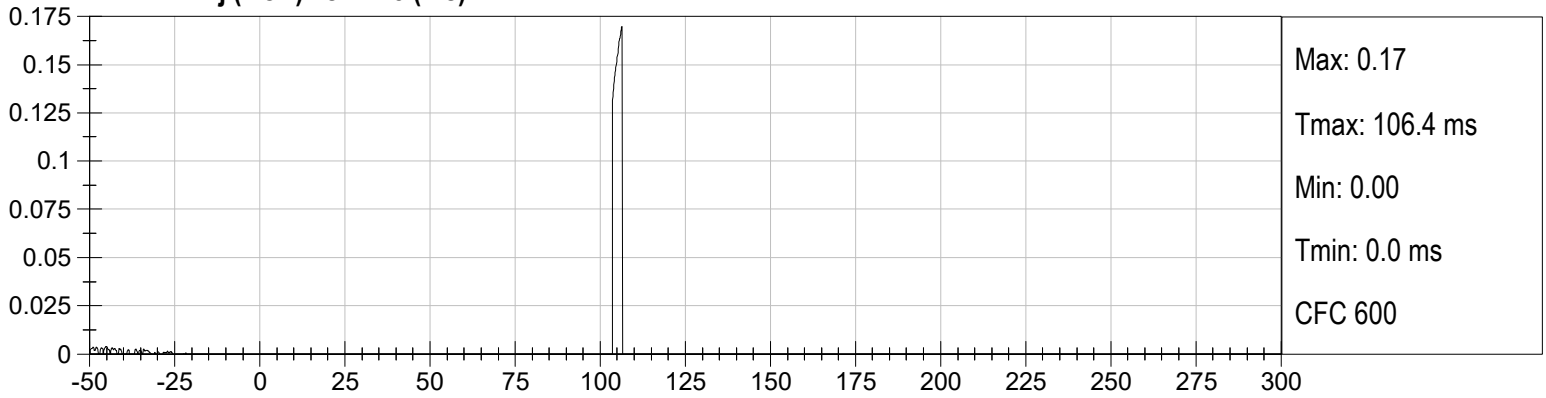
DRIVER Nij (NTE) vs Time (ms)



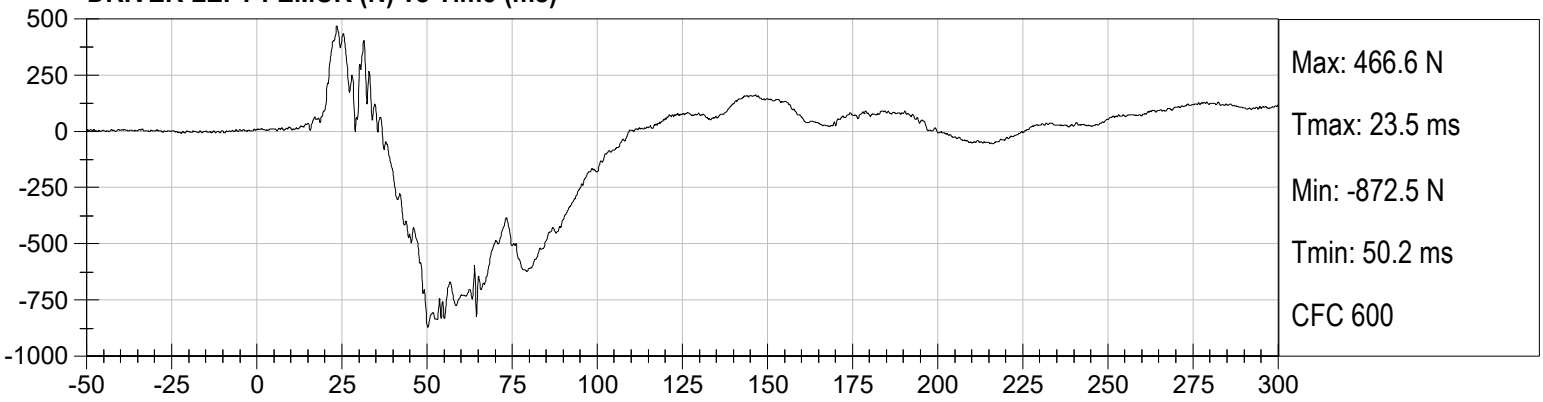
DRIVER Nij (NCF) vs Time (ms)



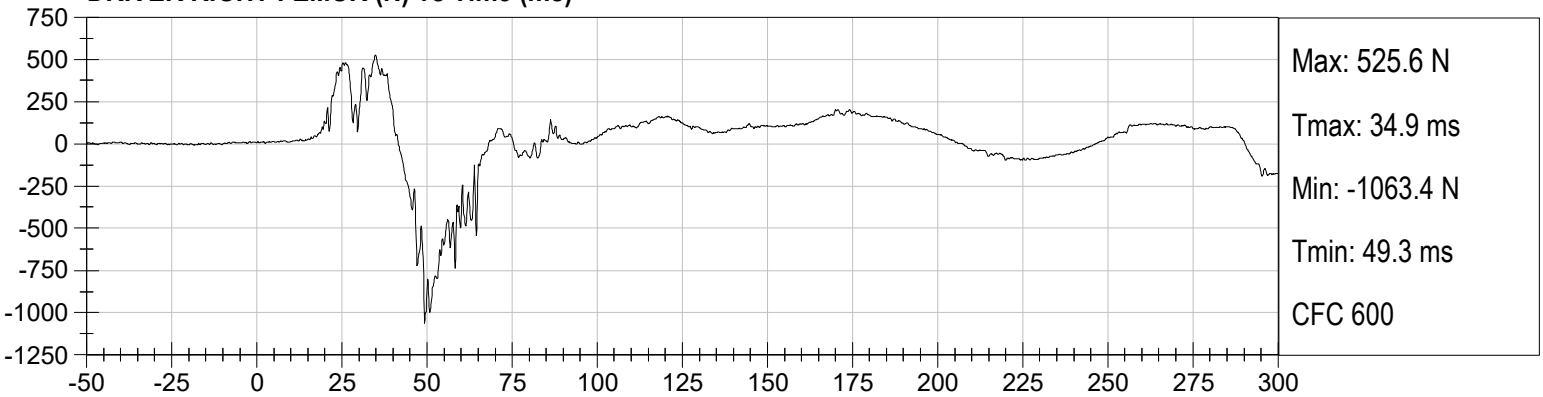
DRIVER Nij (NCE) vs Time (ms)



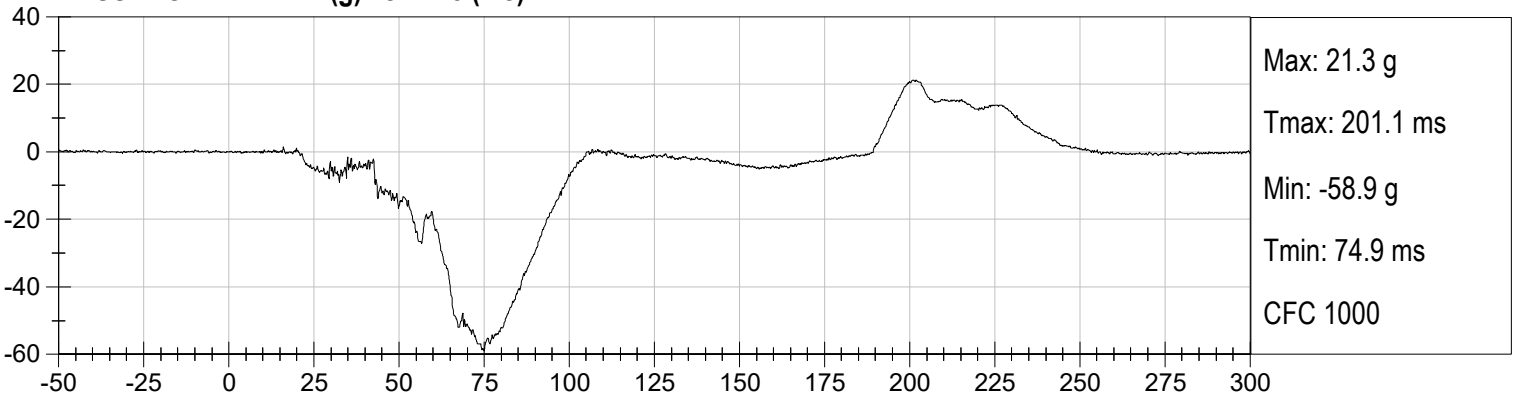
DRIVER LEFT FEMUR (N) vs Time (ms)



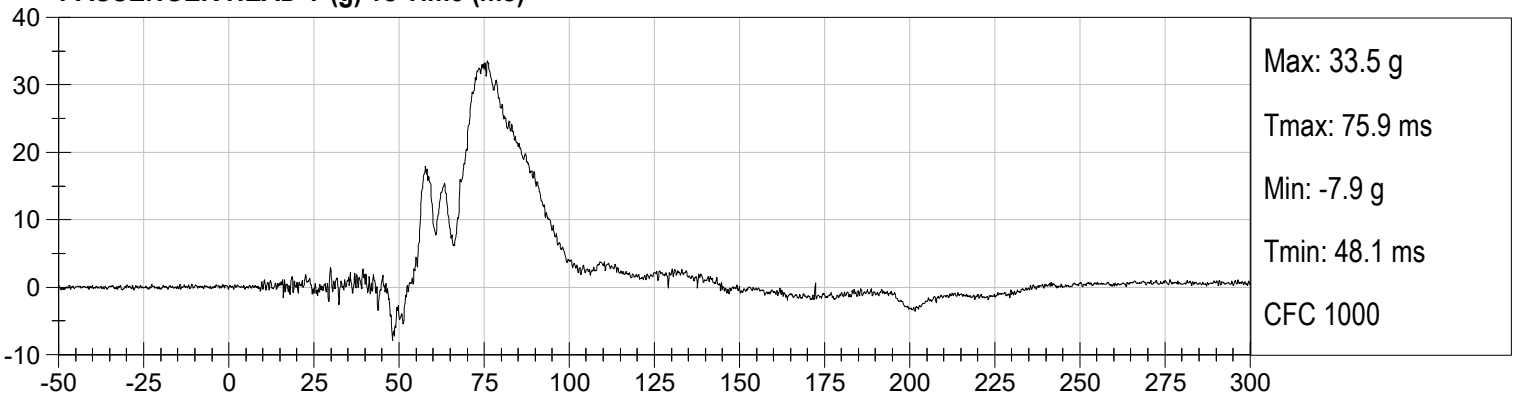
DRIVER RIGHT FEMUR (N) vs Time (ms)



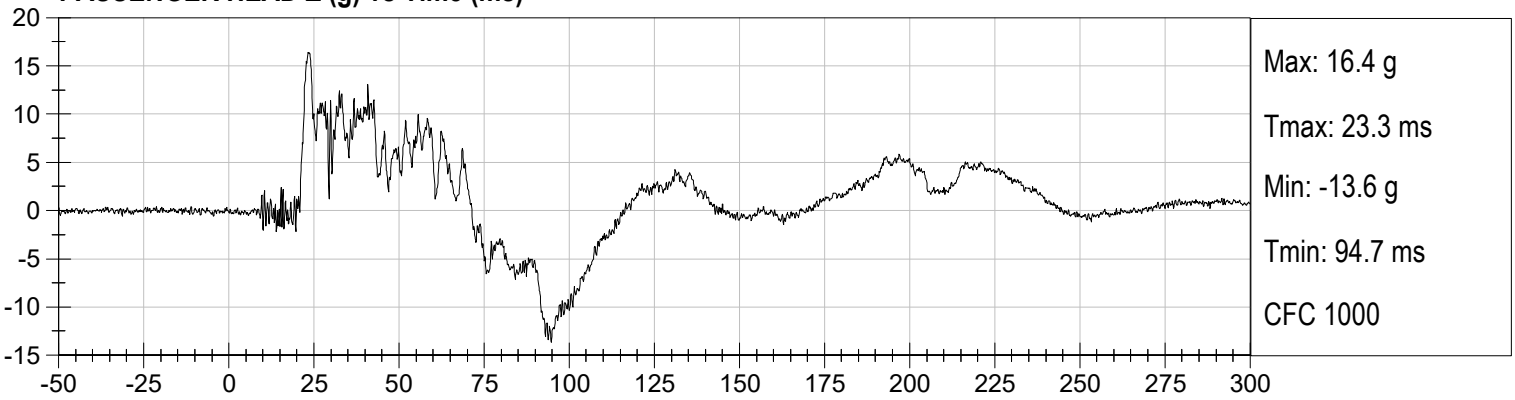
PASSENGER HEAD X (g) vs Time (ms)



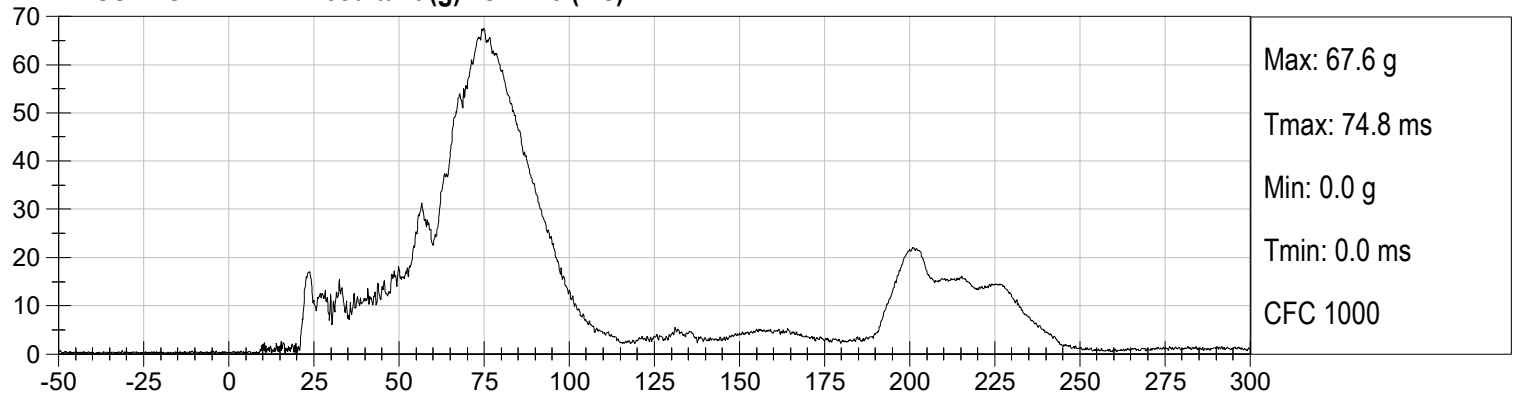
PASSENGER HEAD Y (g) vs Time (ms)



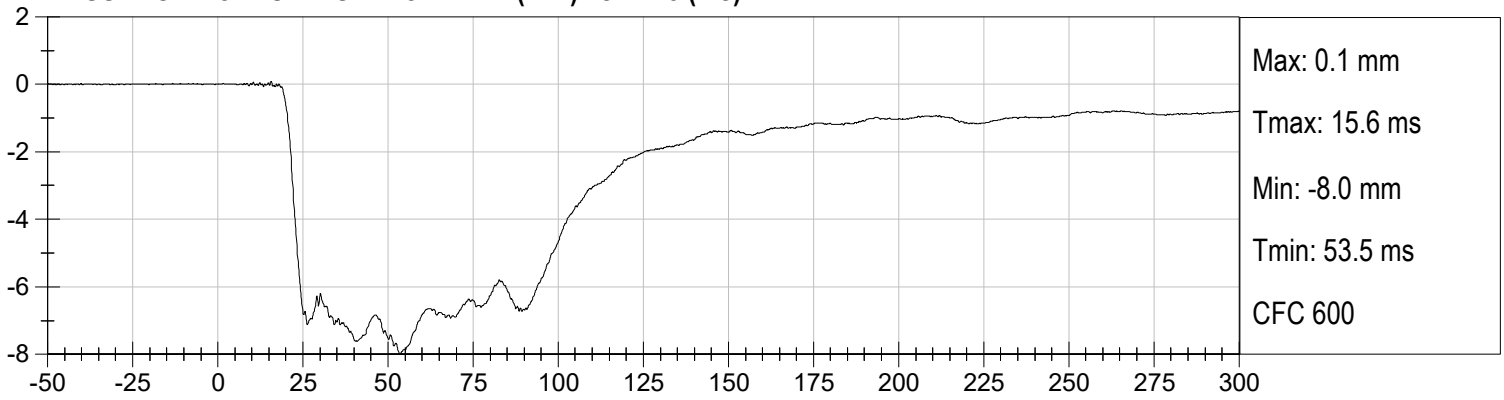
PASSENGER HEAD Z (g) vs Time (ms)



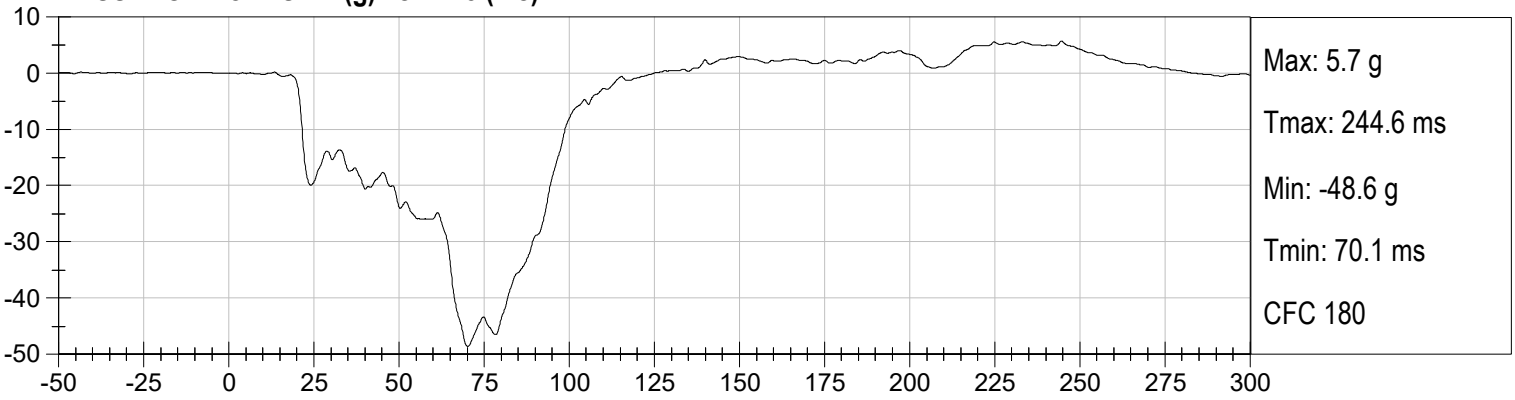
PASSENGER HEAD Resultant (g) vs Time (ms)



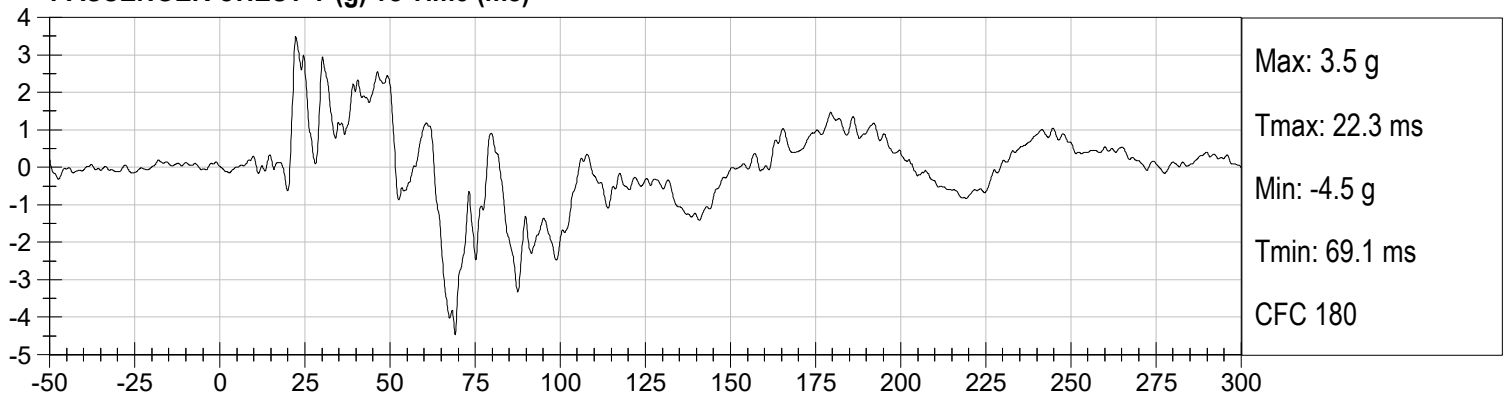
PASSENGER CHEST DISPLACEMENT (mm) vs Time (ms)



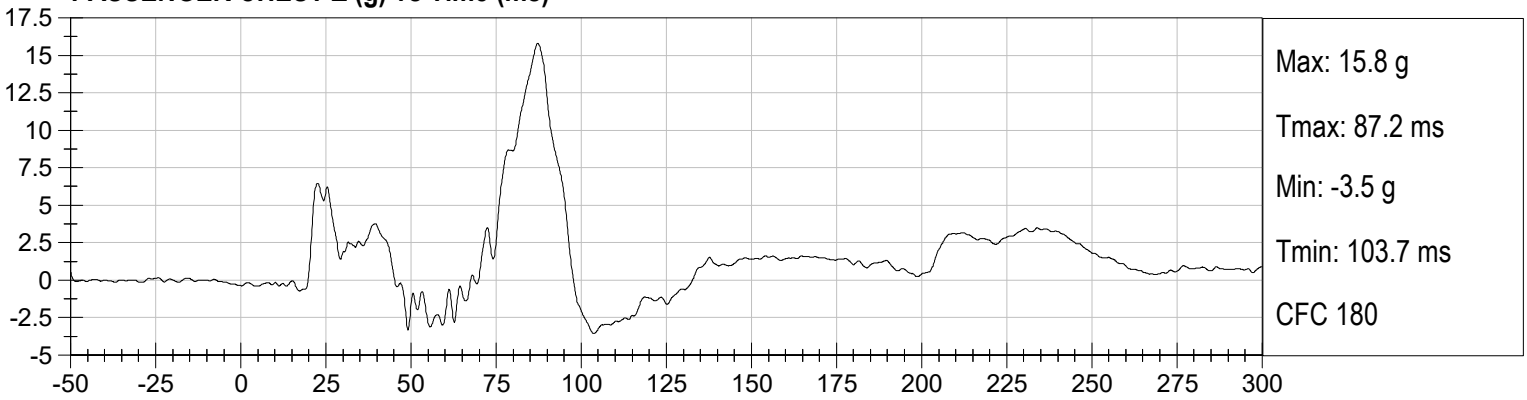
PASSENGER CHEST X (g) vs Time (ms)



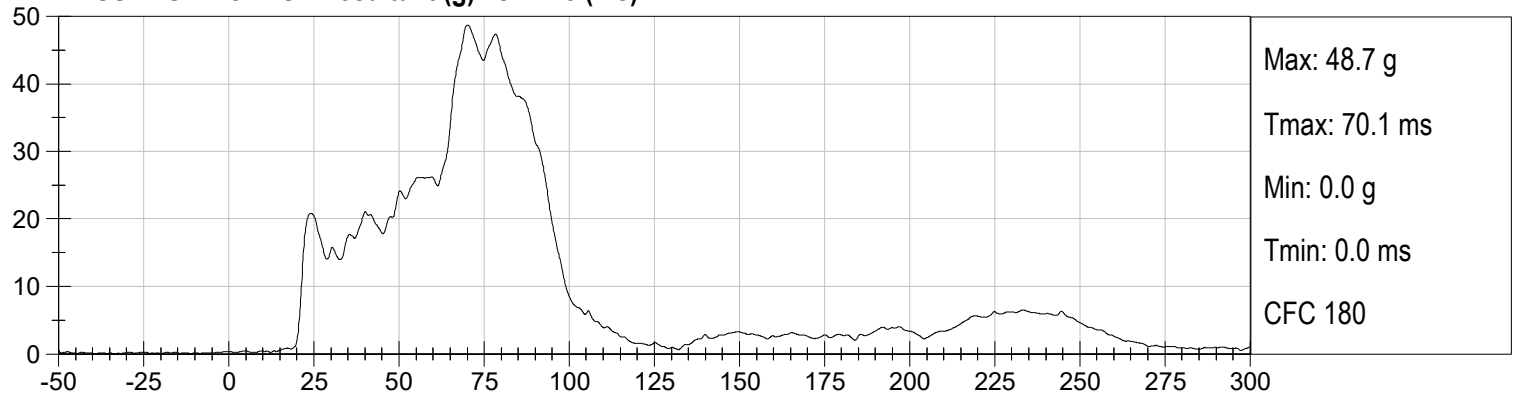
PASSENGER CHEST Y (g) vs Time (ms)



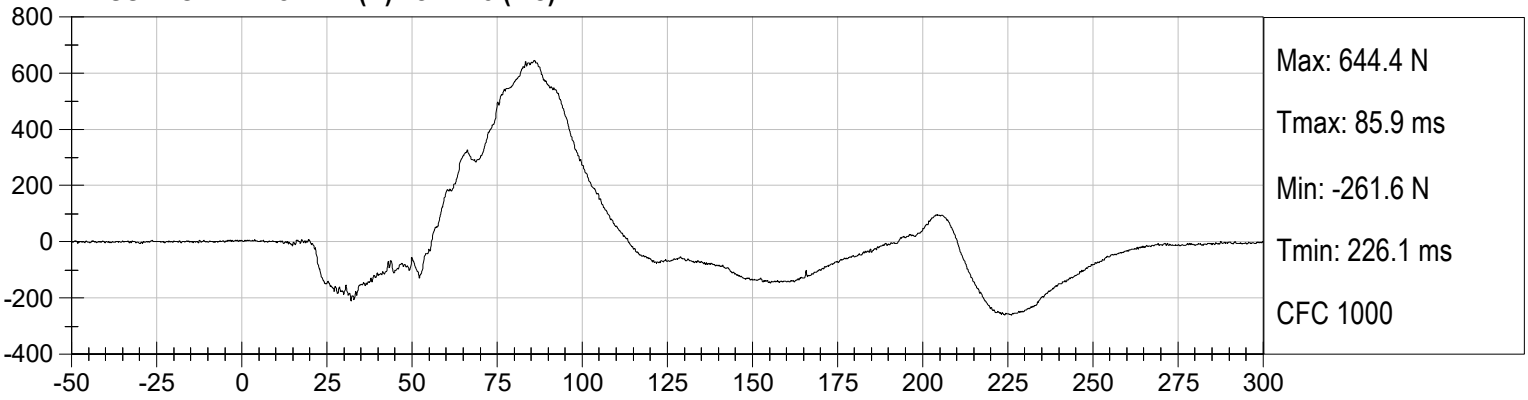
PASSENGER CHEST Z (g) vs Time (ms)



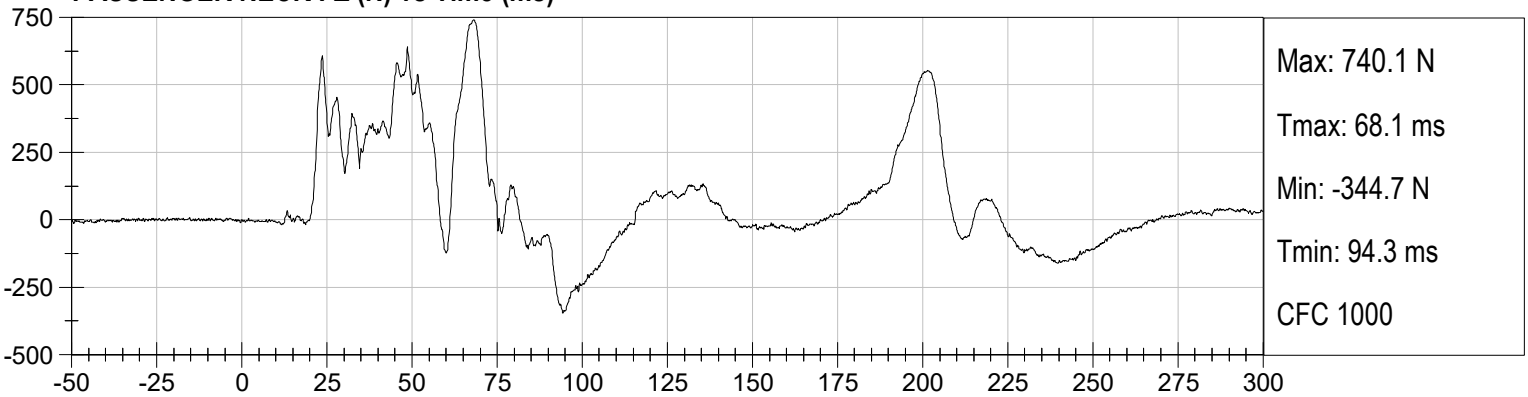
PASSENGER CHEST Resultant (g) vs Time (ms)



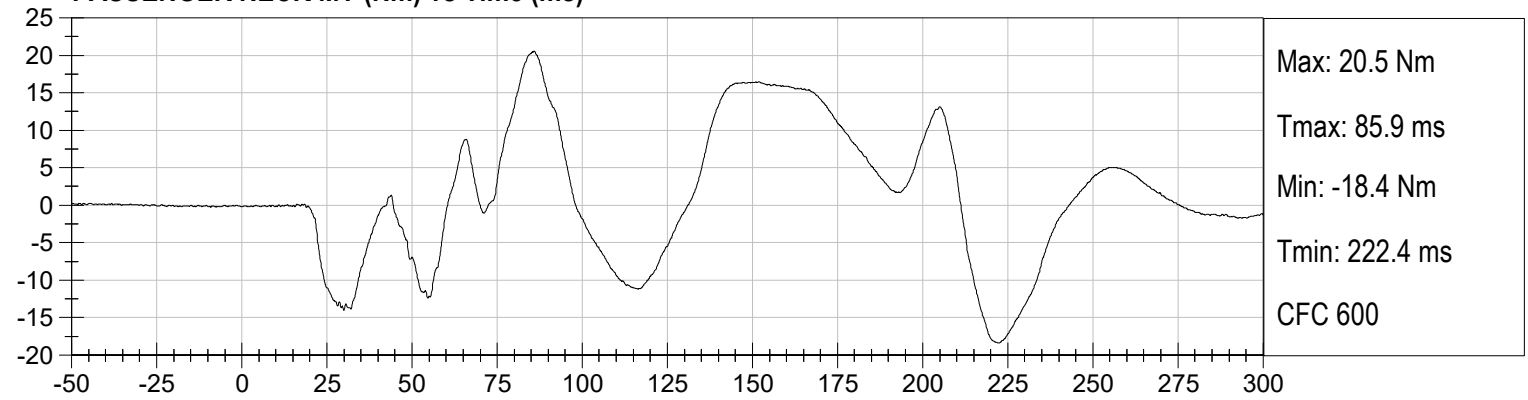
PASSENGER NECK FX (N) vs Time (ms)



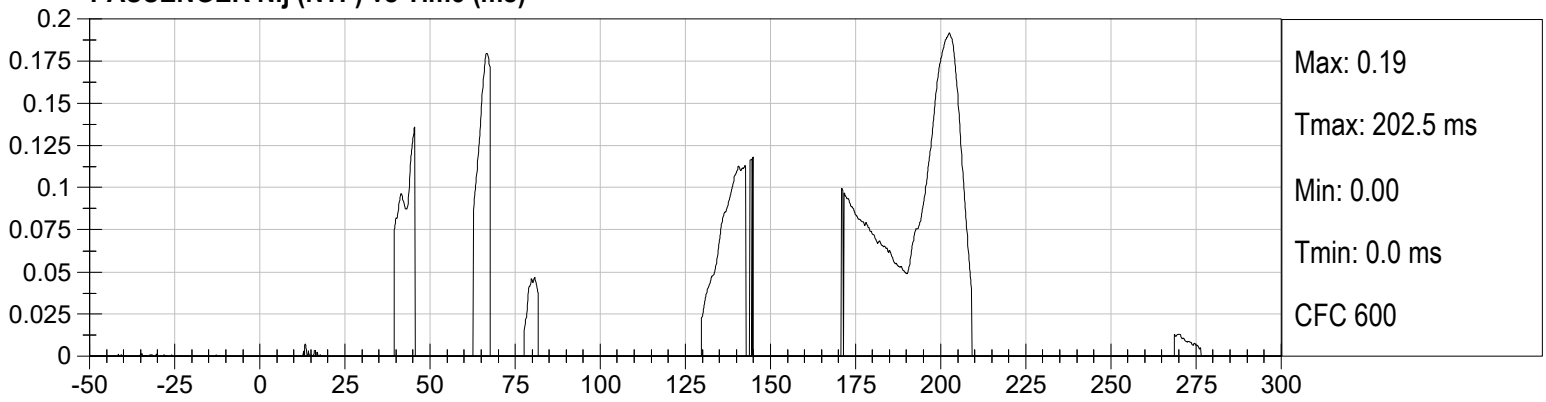
PASSENGER NECK FZ (N) vs Time (ms)



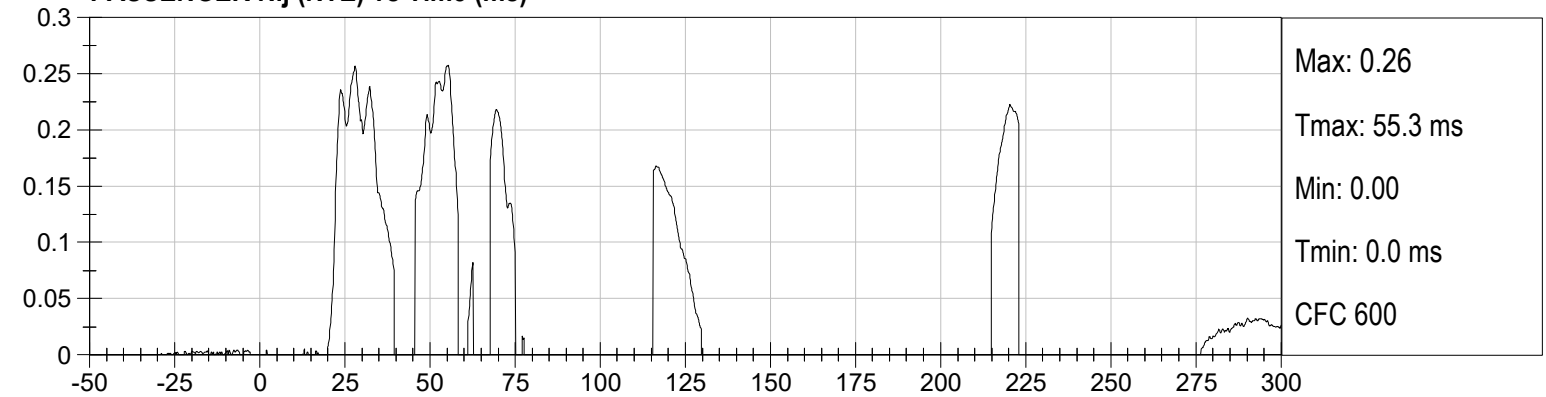
PASSENGER NECK MY (Nm) vs Time (ms)



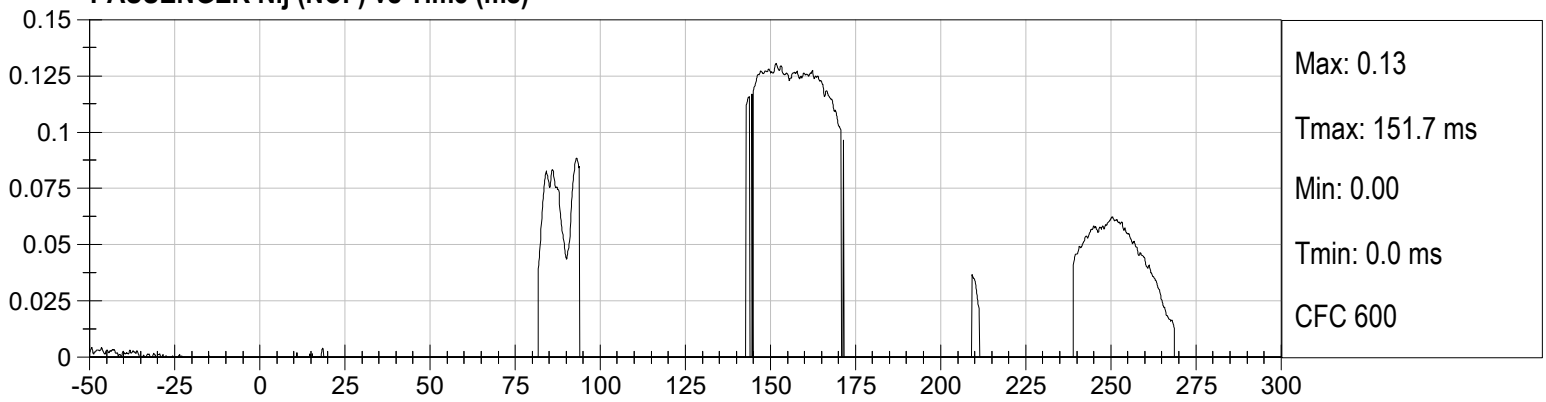
PASSENGER Nij (NTF) vs Time (ms)



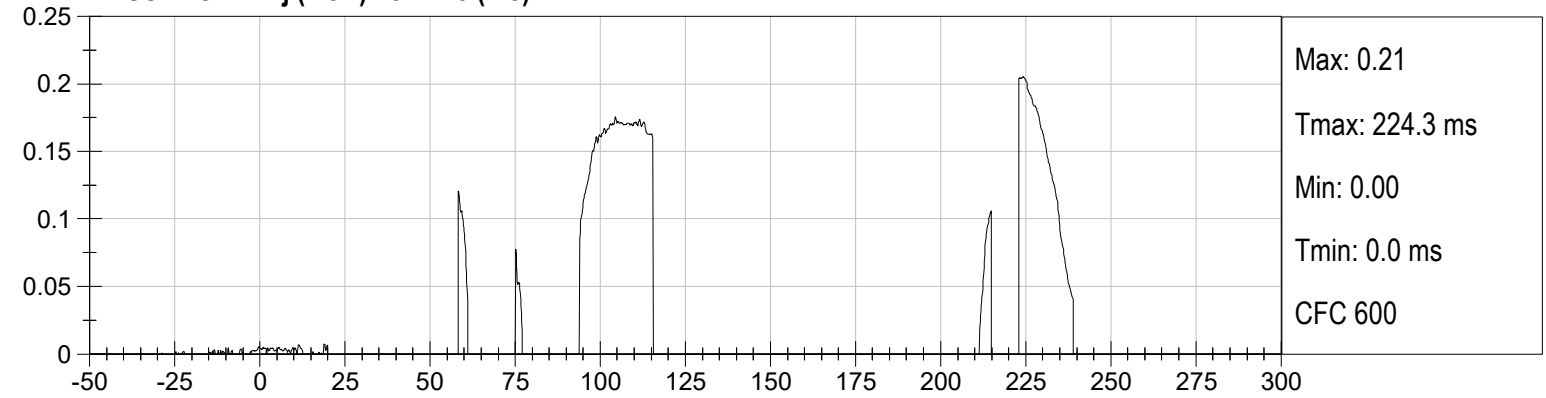
PASSENGER Nij (NTE) vs Time (ms)



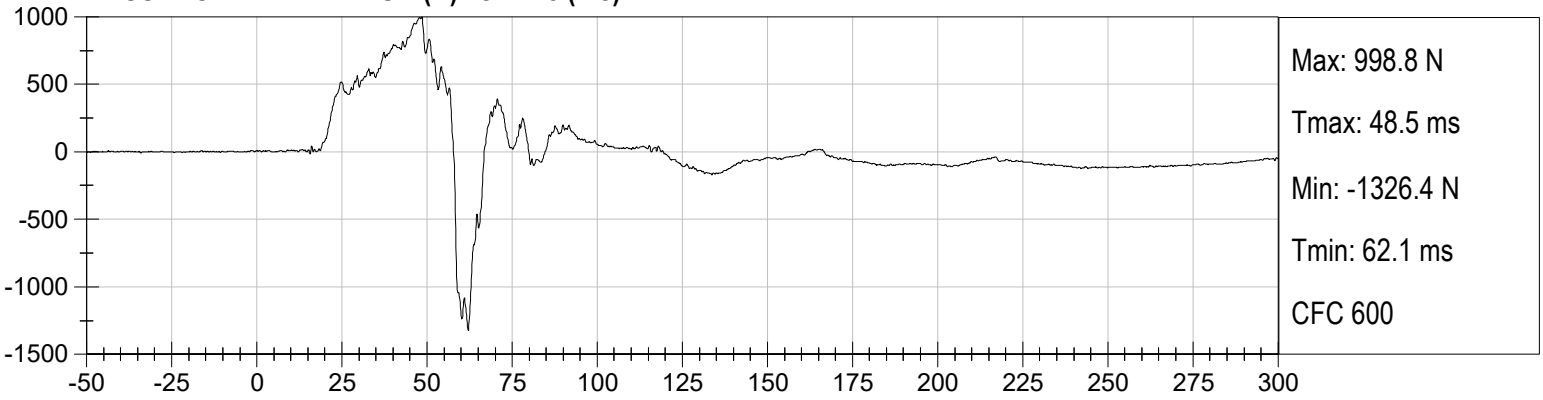
PASSENGER Nij (NCF) vs Time (ms)



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:** 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

Alex Thomas

Laboratory Technician

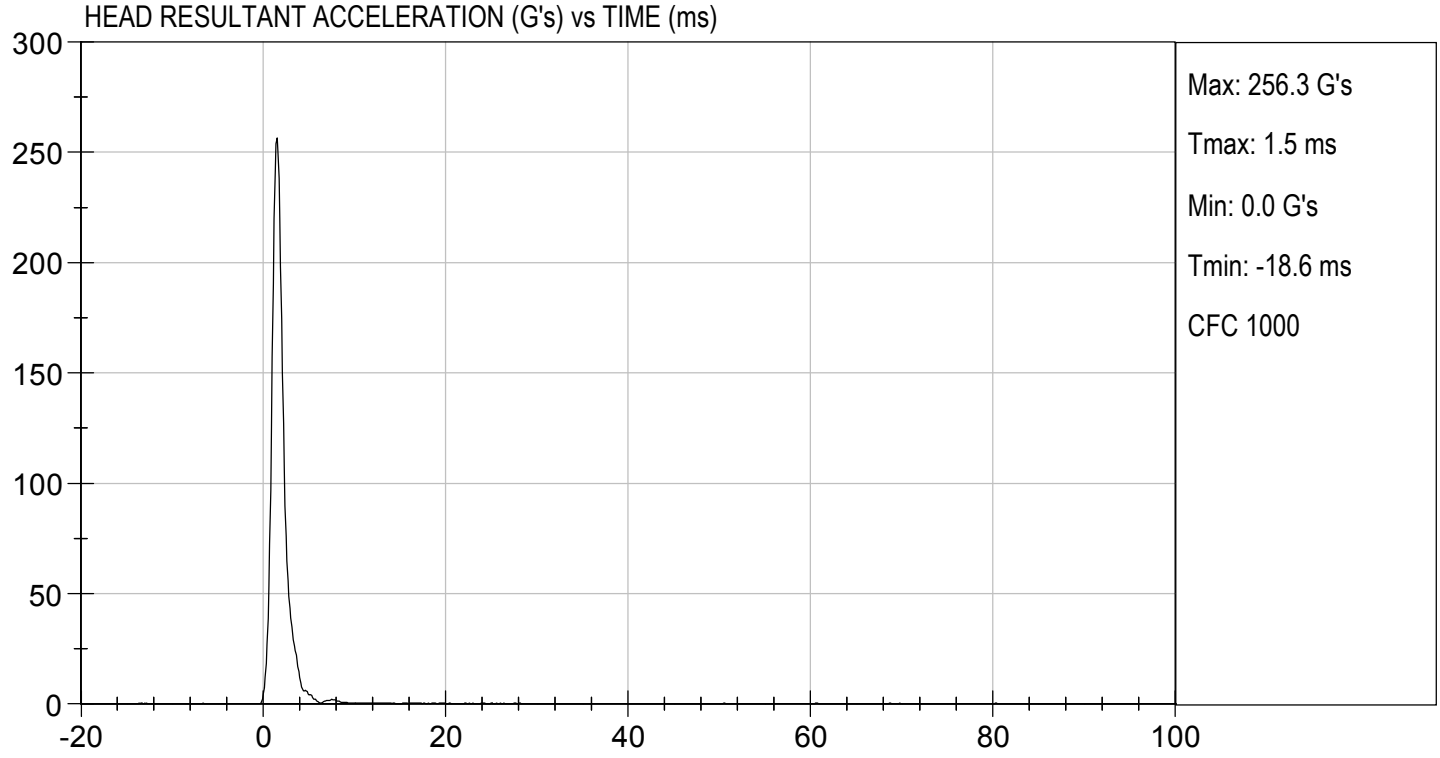
03/04/2021

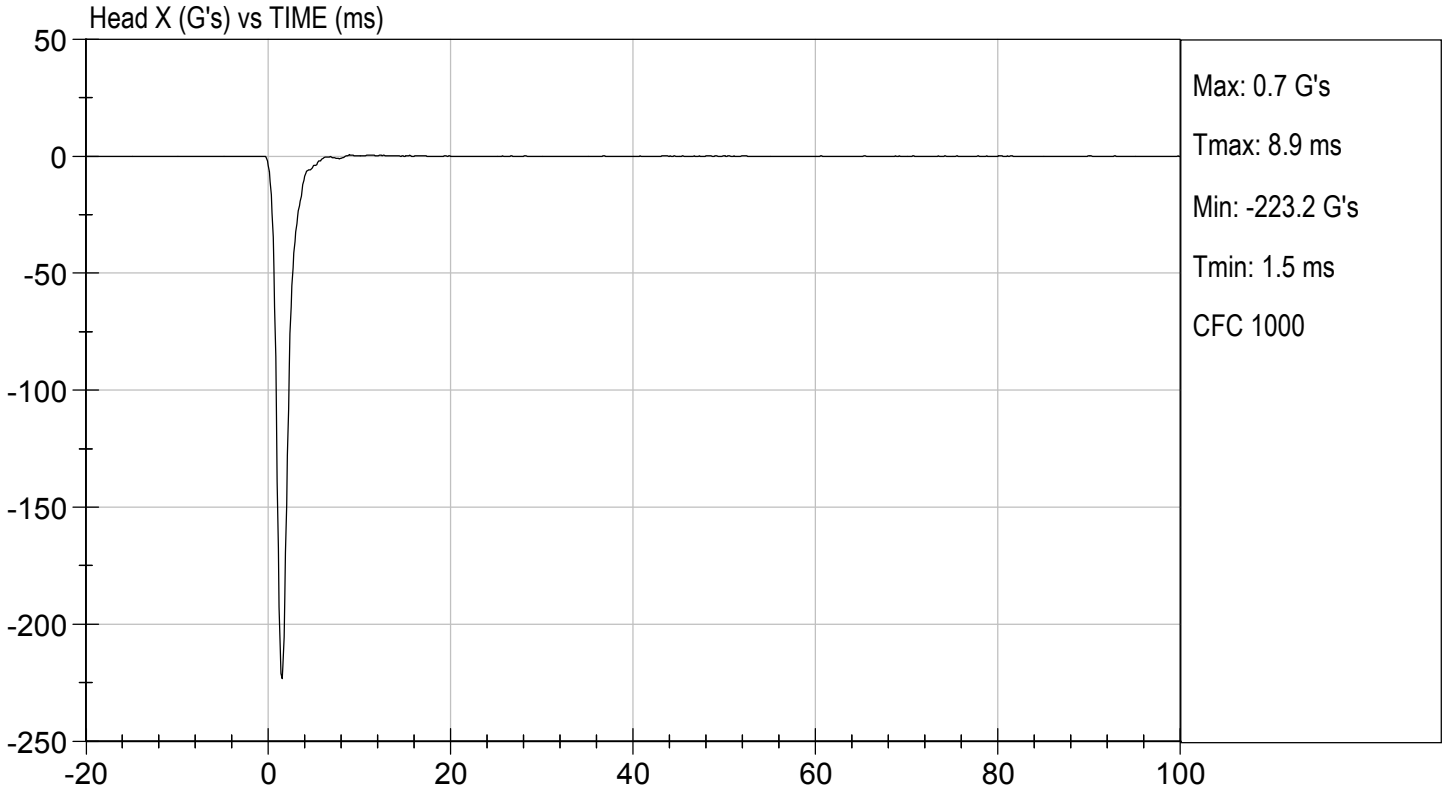
Test Date

Approved By

TEST DESC: HEAD DROP

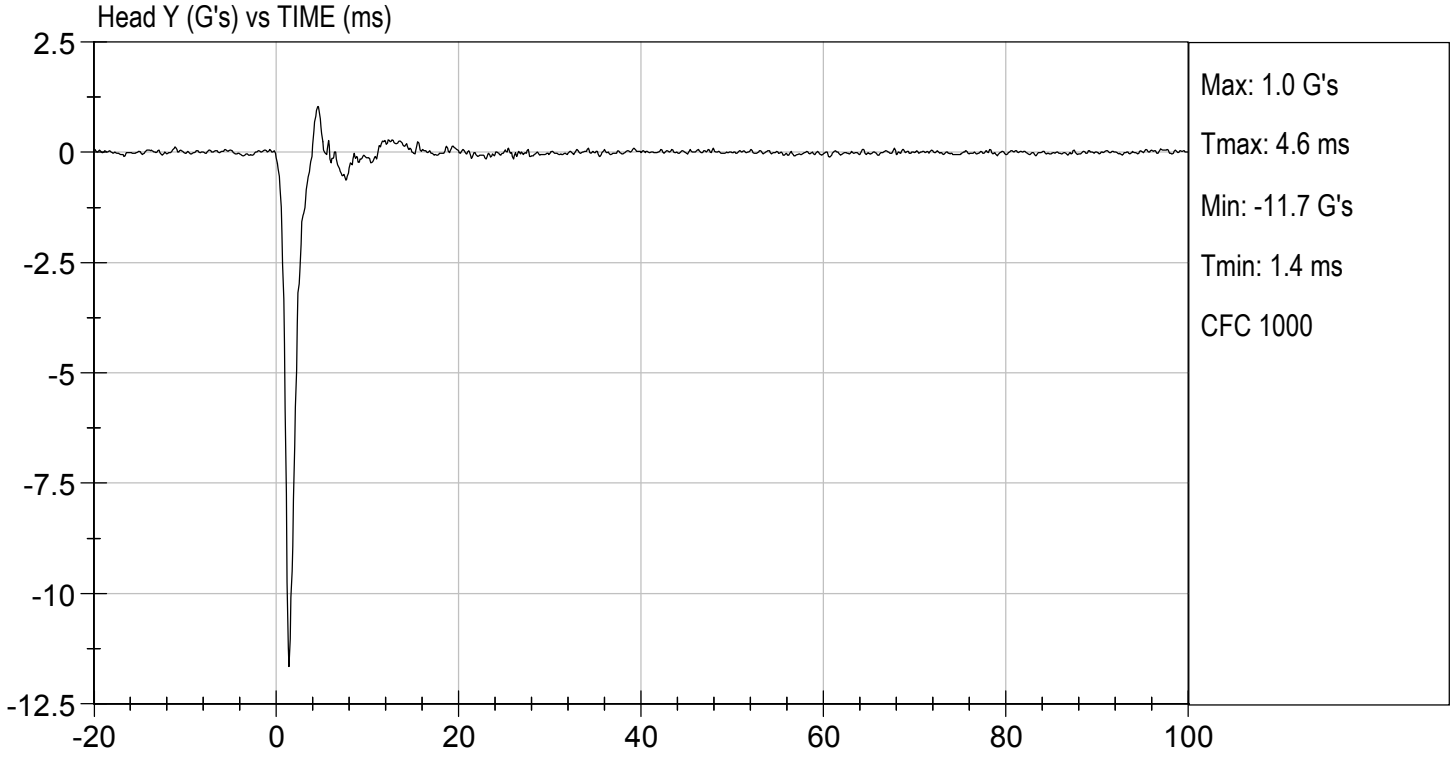
TEST DATE: 03/04/2021
TEST #: D210661

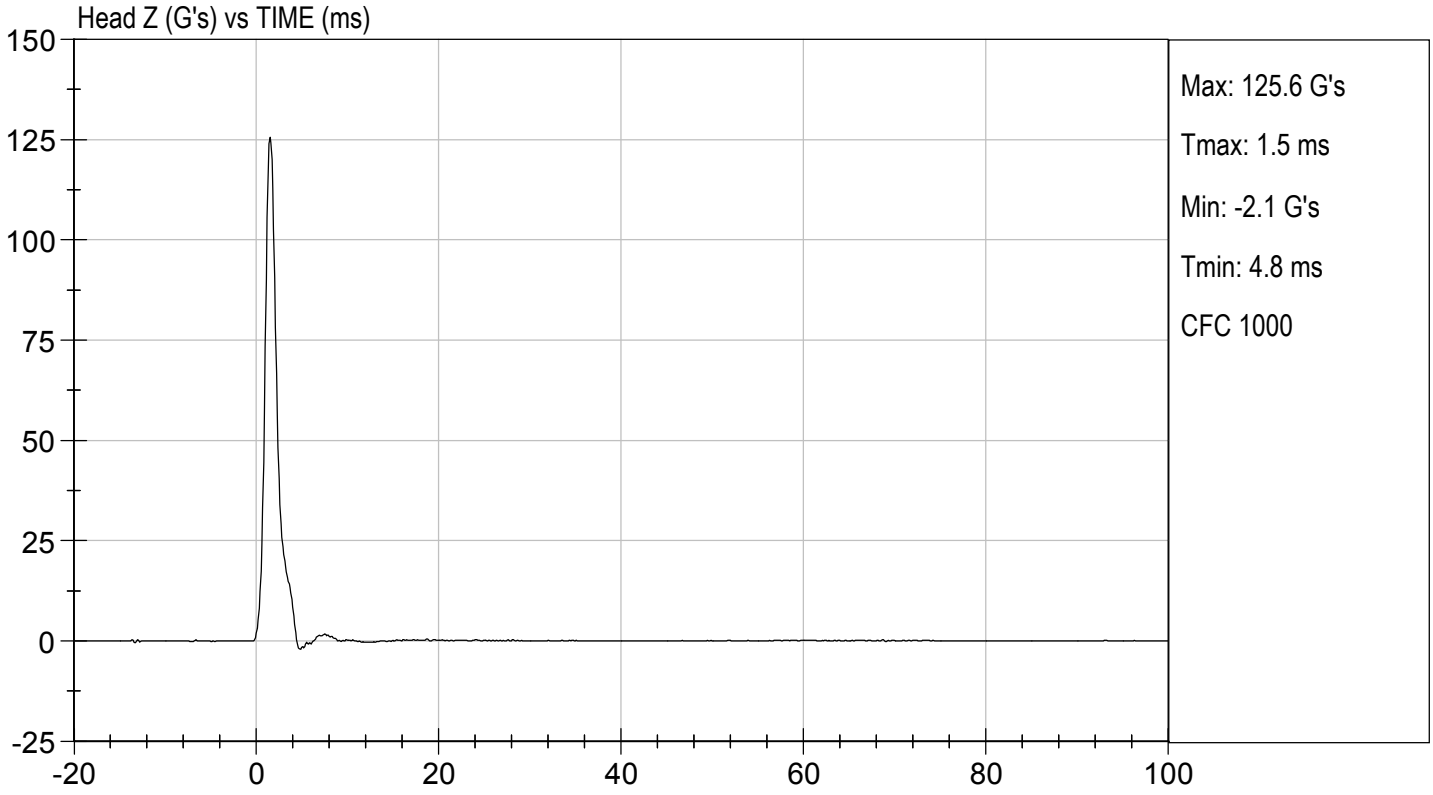




TEST DESC: HEAD DROP

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

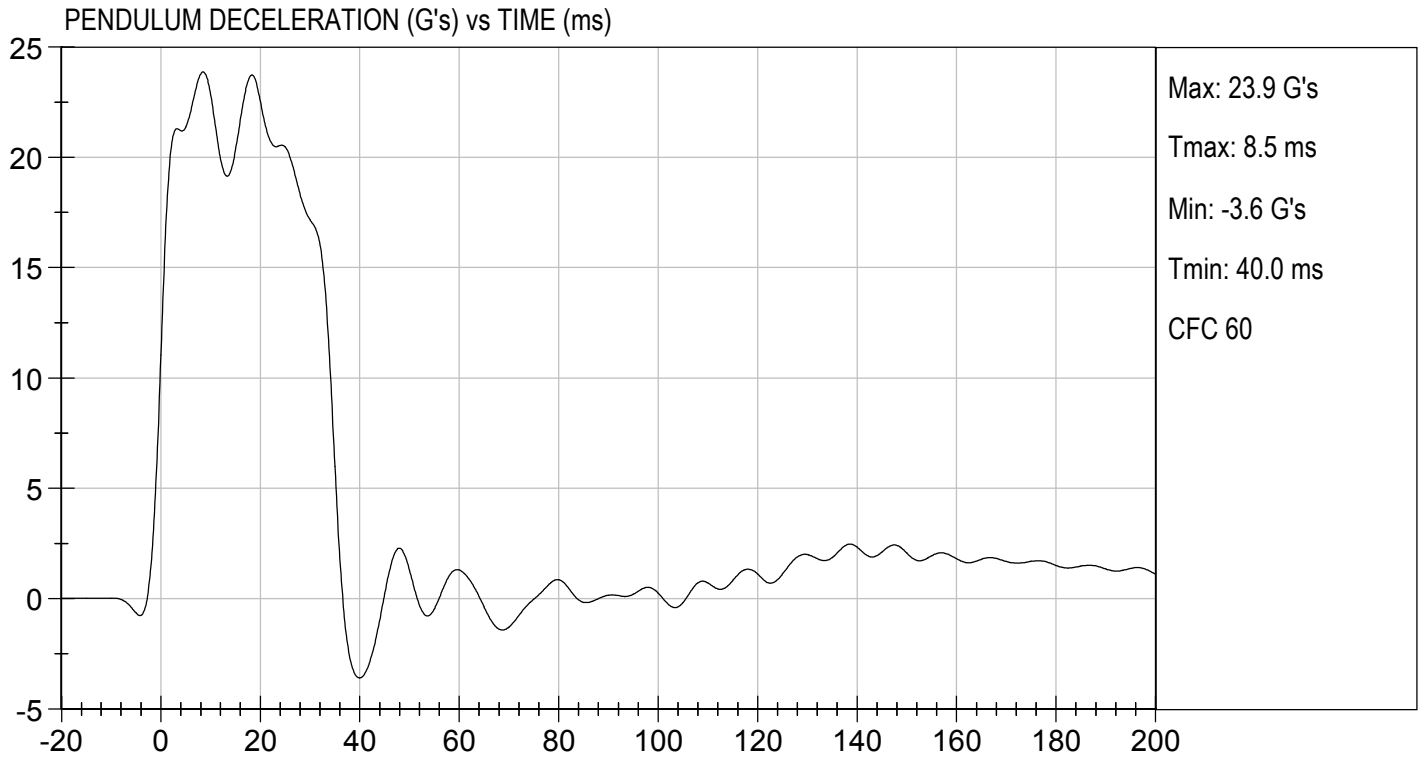
03/04/2021

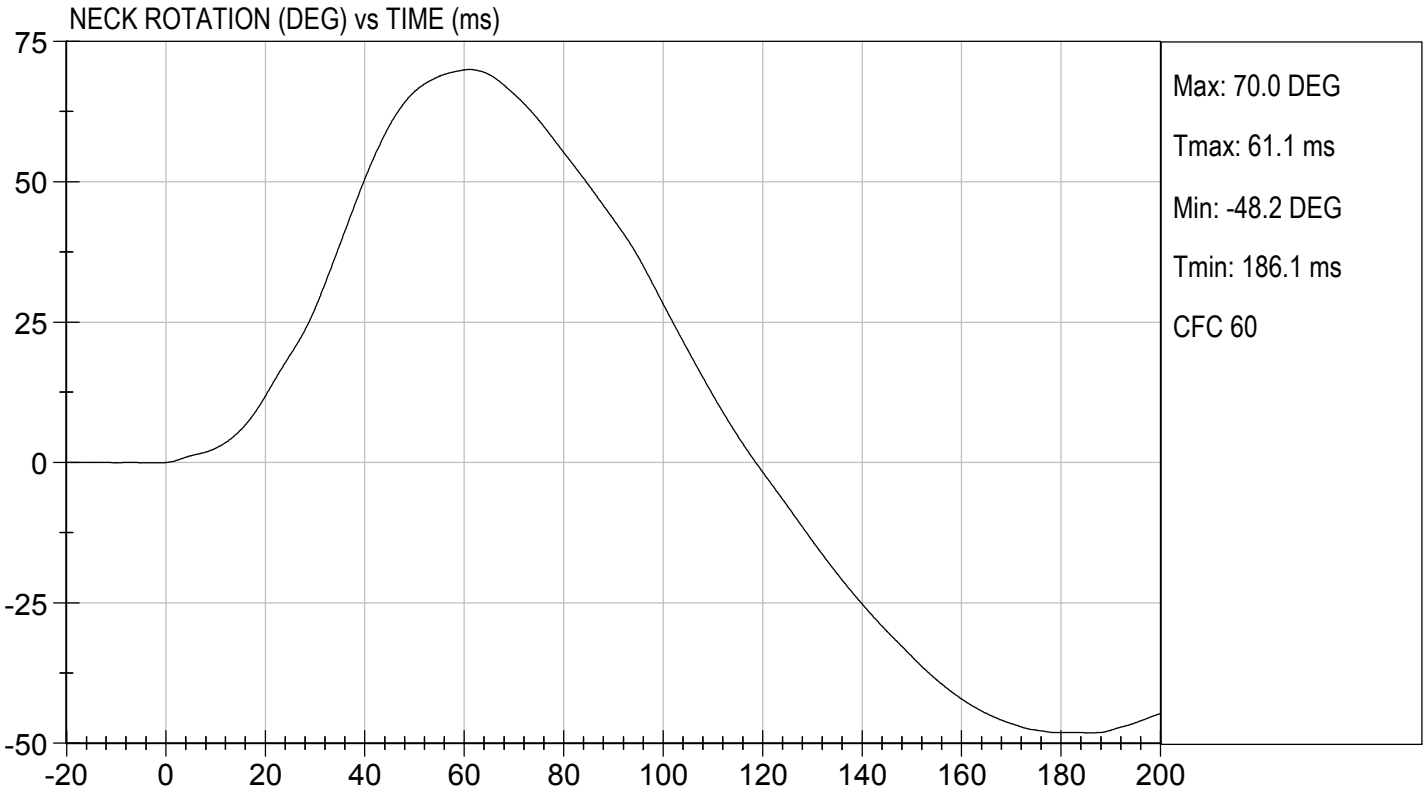
Test Date

Approved By

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

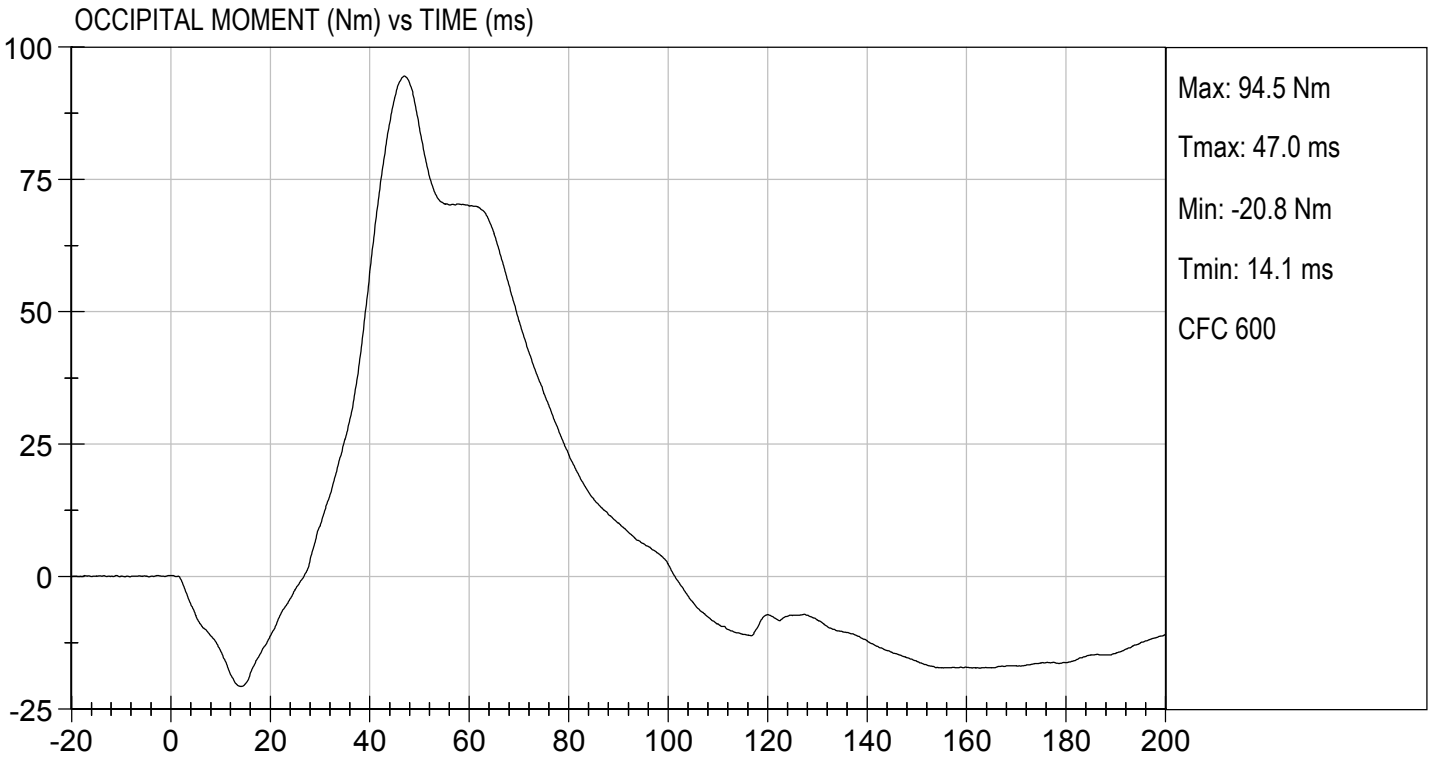
TEST DATE: 03/04/2021
TEST #: D210662





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

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



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

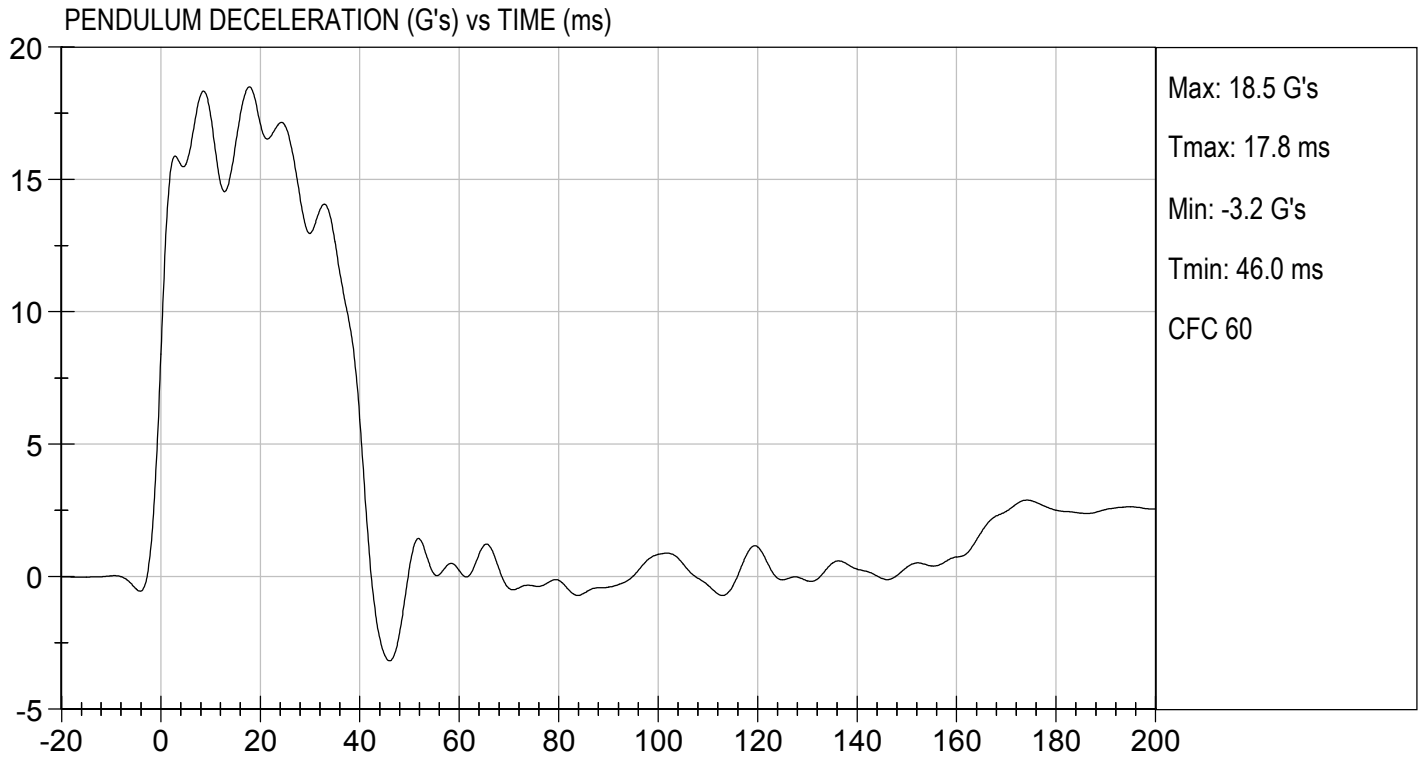
03/04/2021

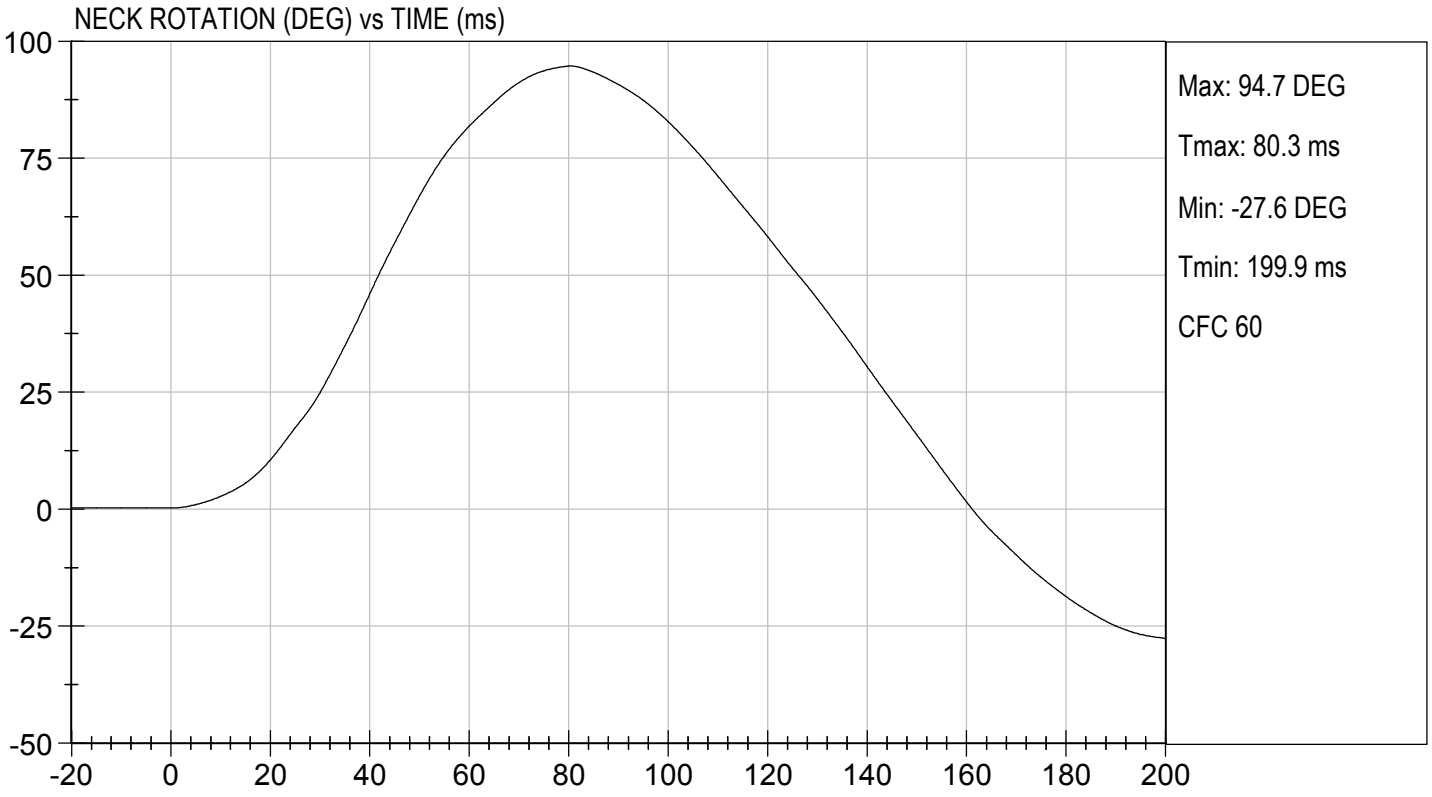
Test Date

Approved By

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

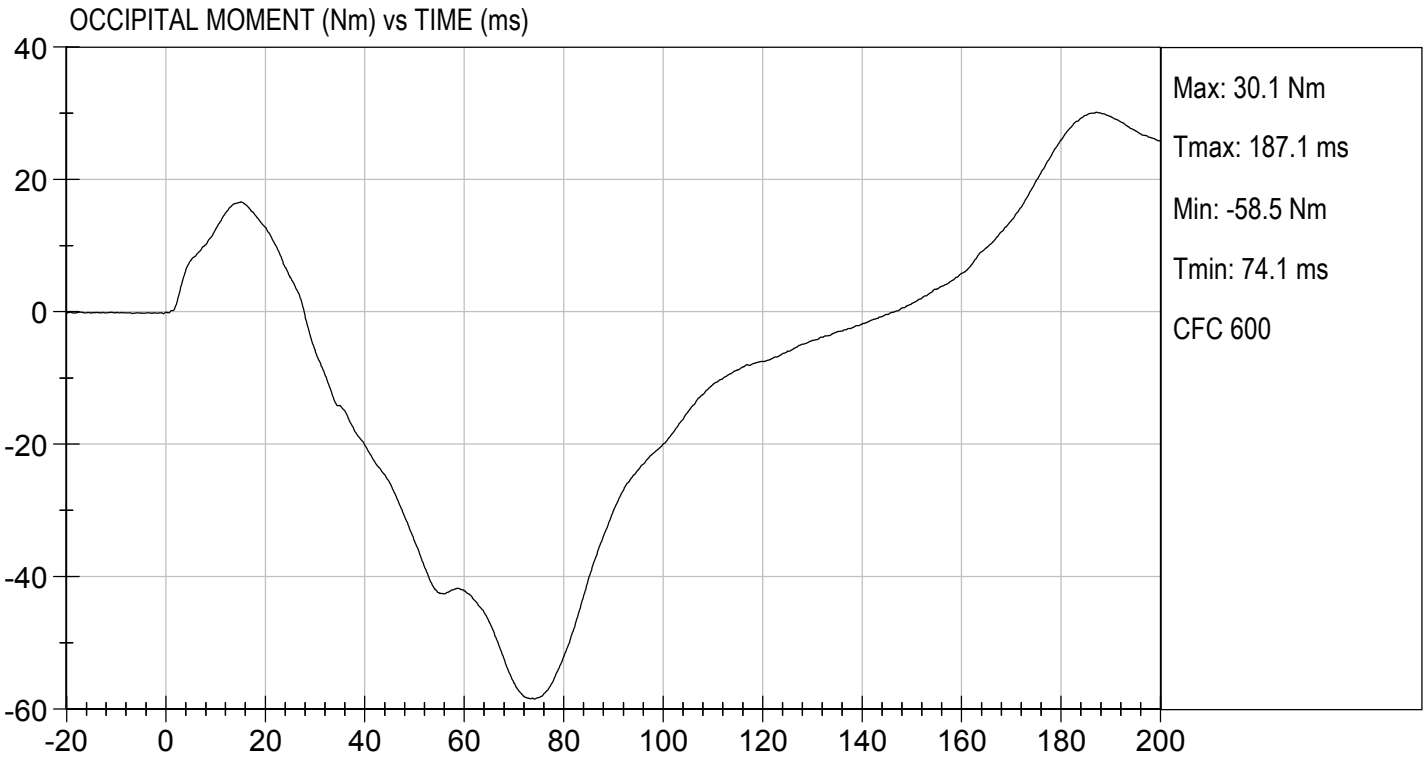
TEST DATE: 03/04/2021
TEST #: D210663





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

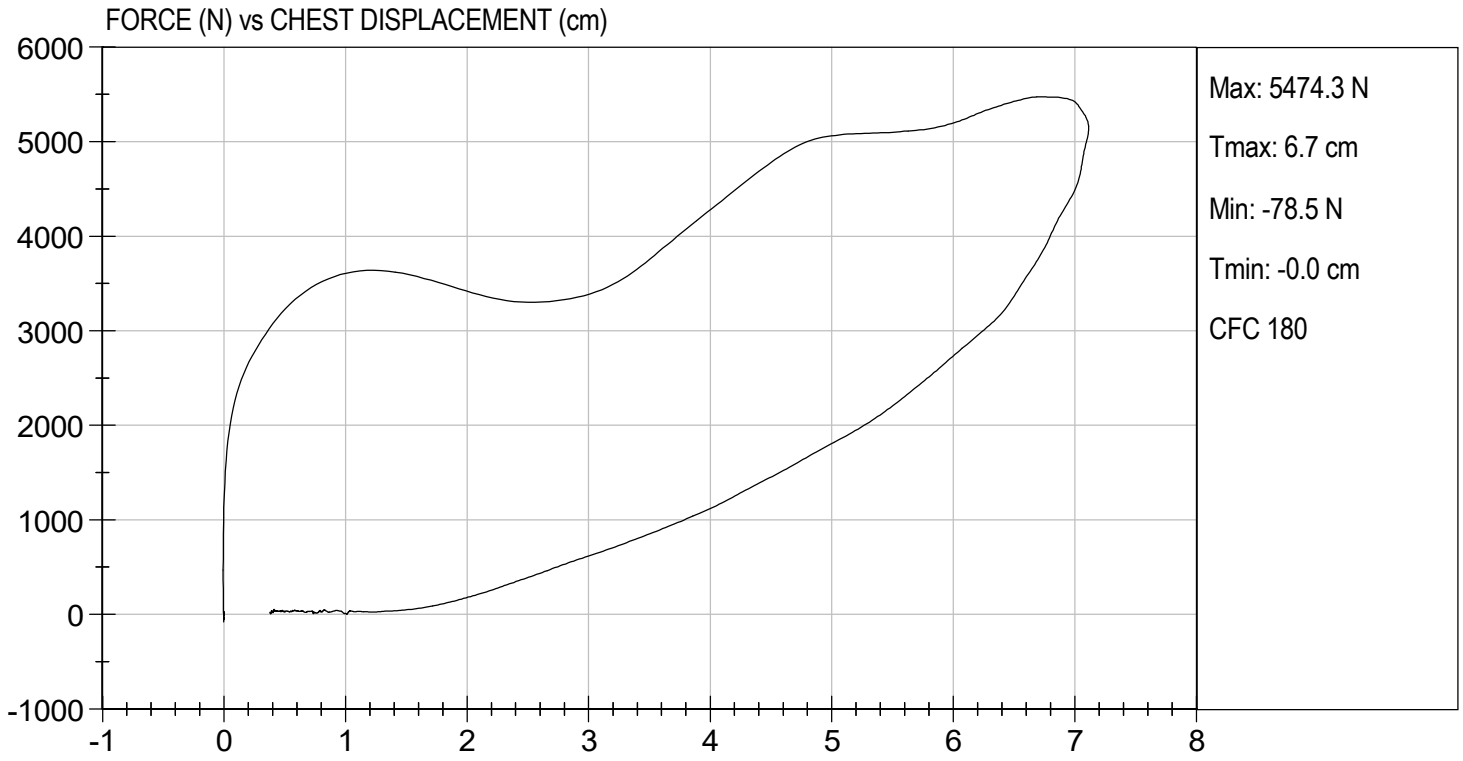
Alex Thomas
Laboratory Technician

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

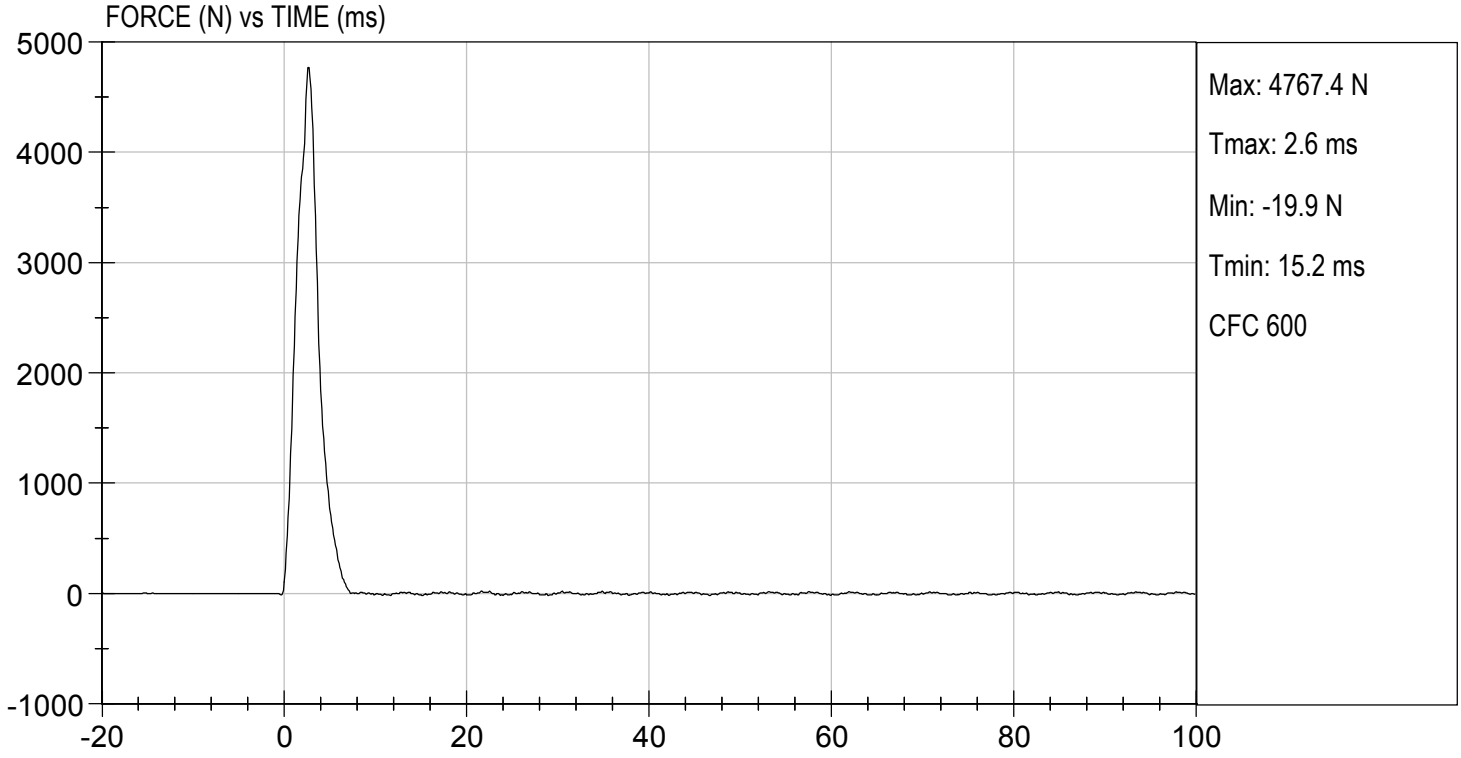
Laboratory Technician

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

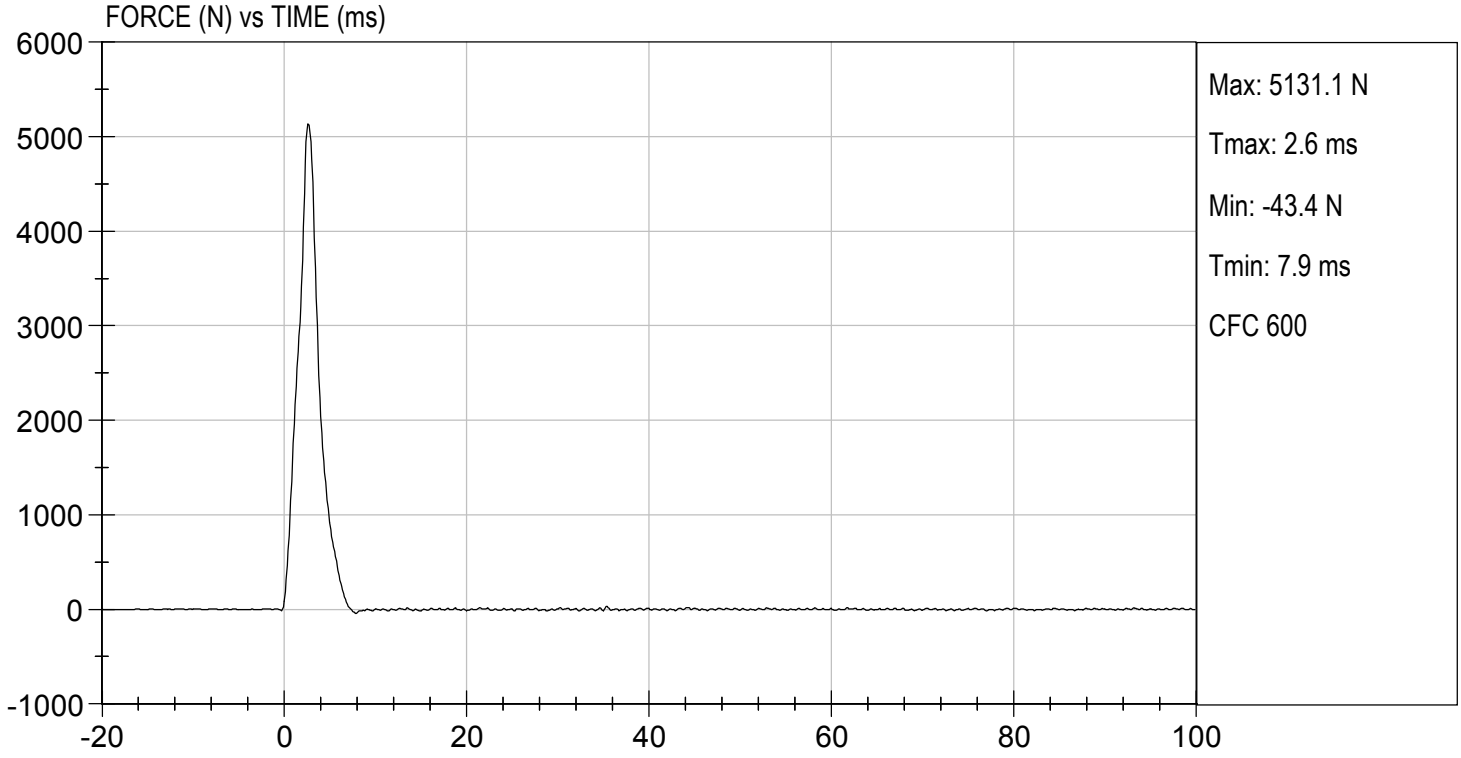
Laboratory Technician

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

Alex Thomas

Laboratory Technician

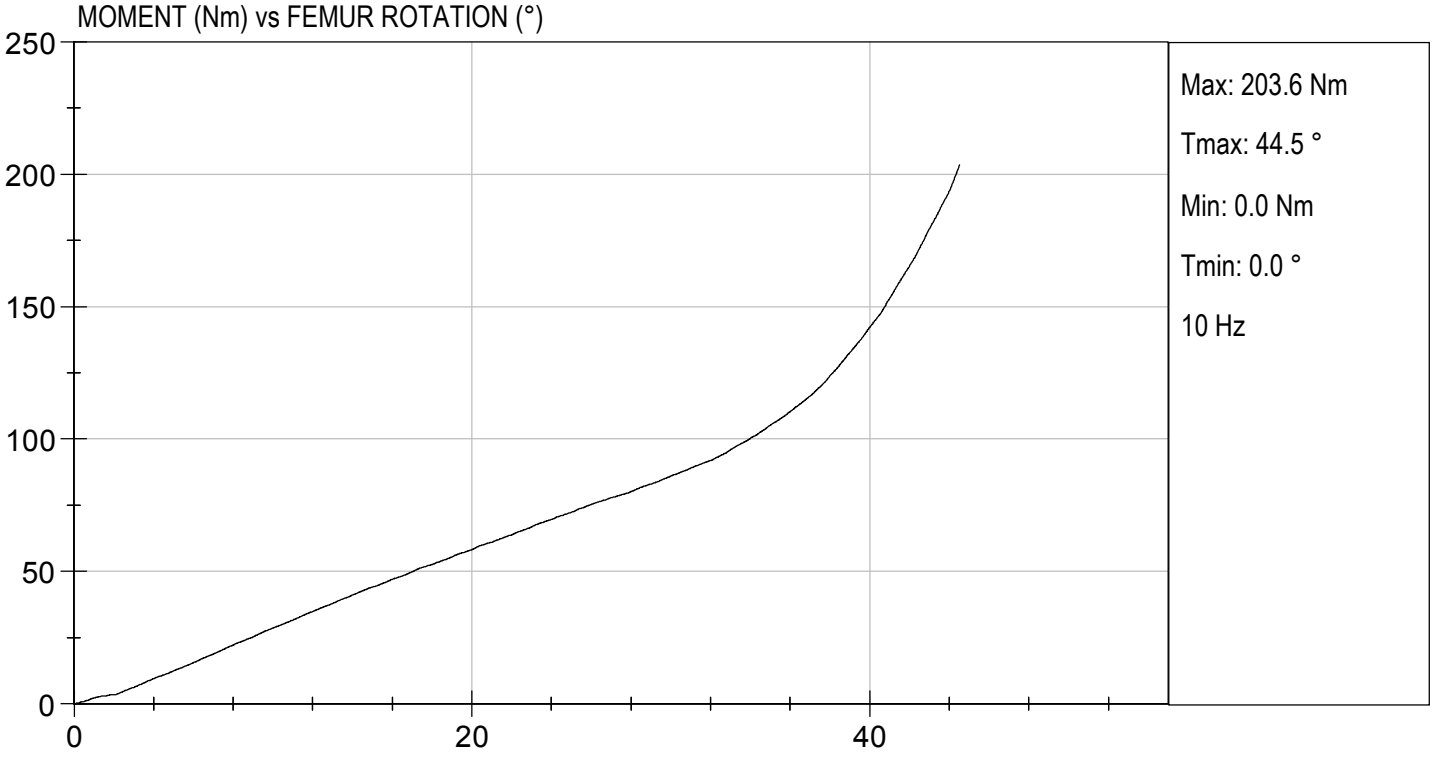
03/04/2021

Test Date

Approved By

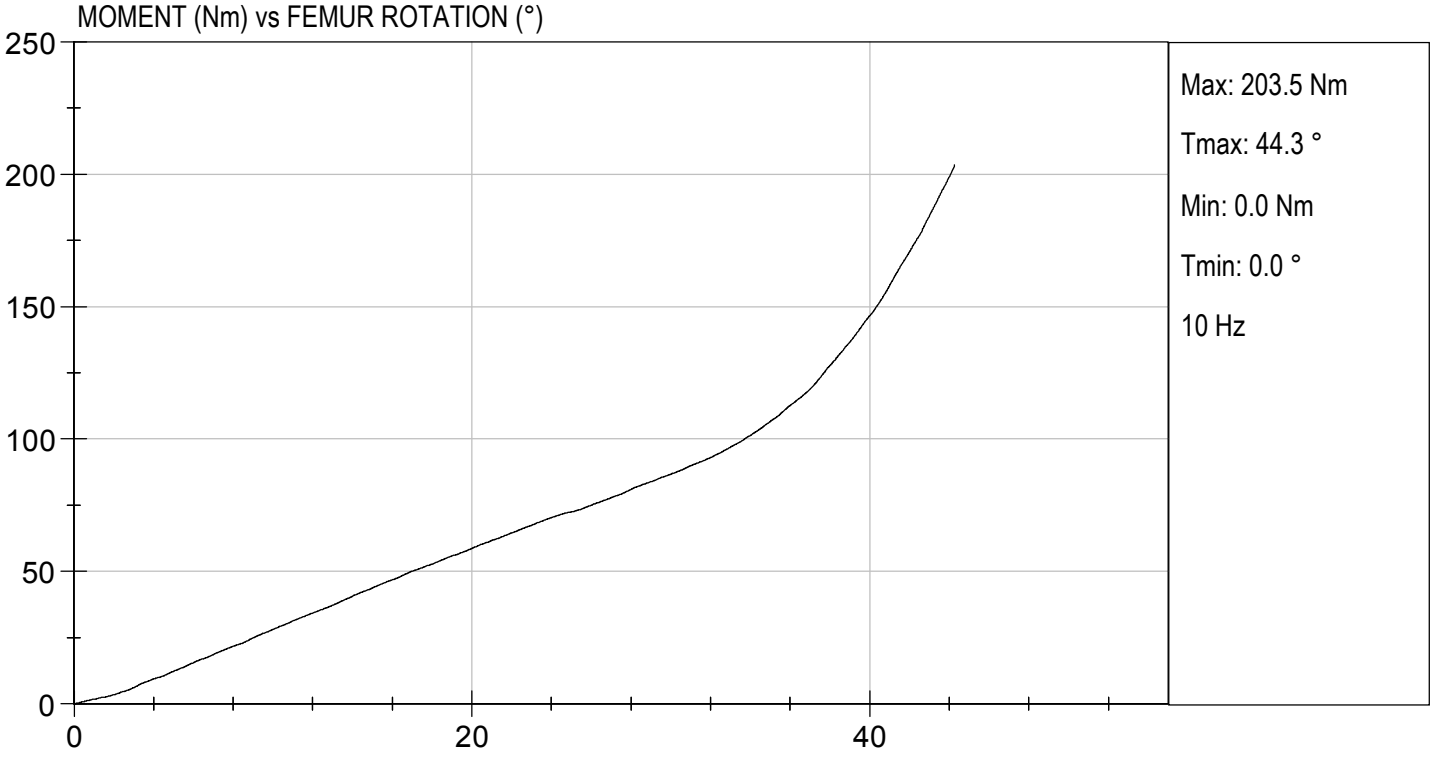
TEST DESC: RIGHT HIP FEMUR FLEXION

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



TEST DESC: LEFT HIP FEMUR FLEXION

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



CALIBRATION TEST RESULTS

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:** D210801

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	39	Pass
Peak Resultant Acceleration	G's	225 to 275	266	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-13.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

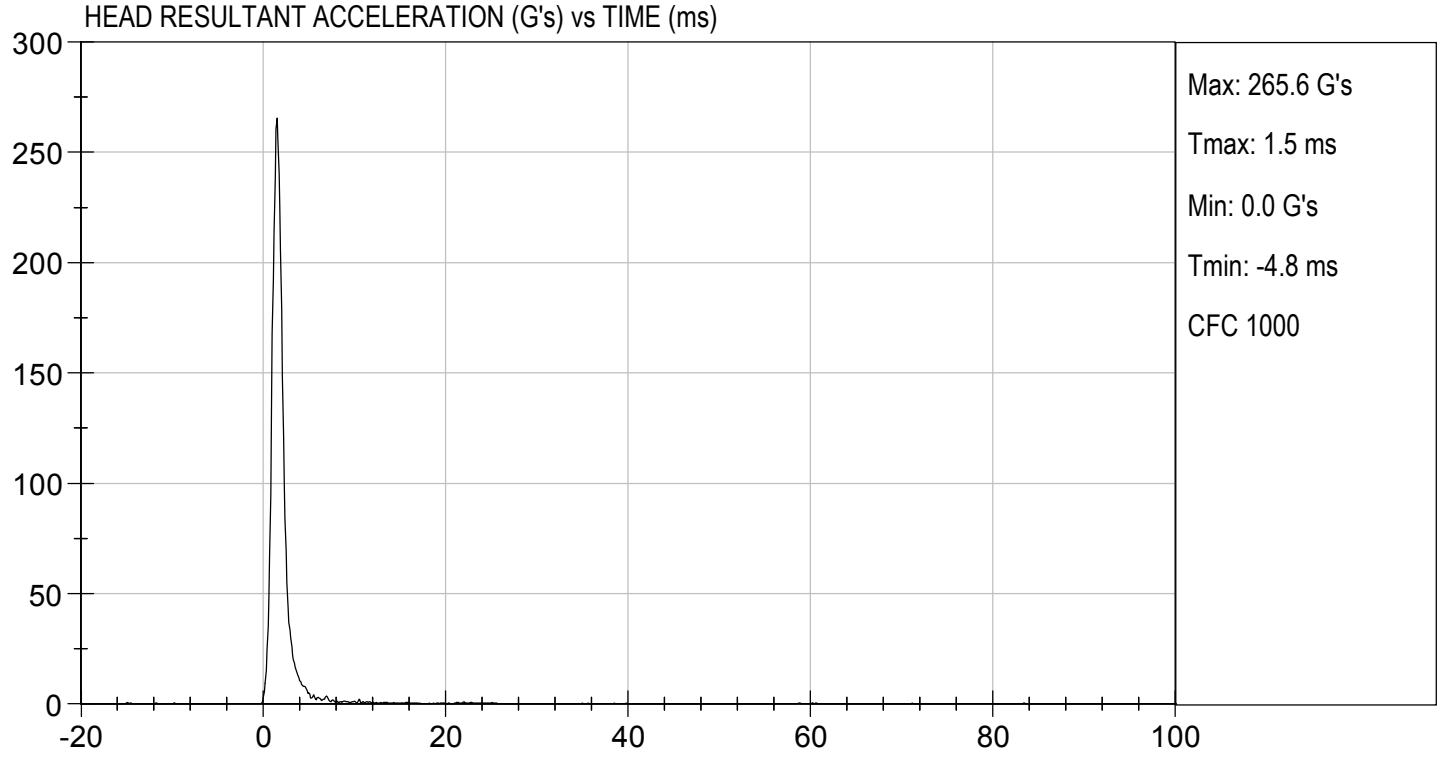
Laboratory Technician

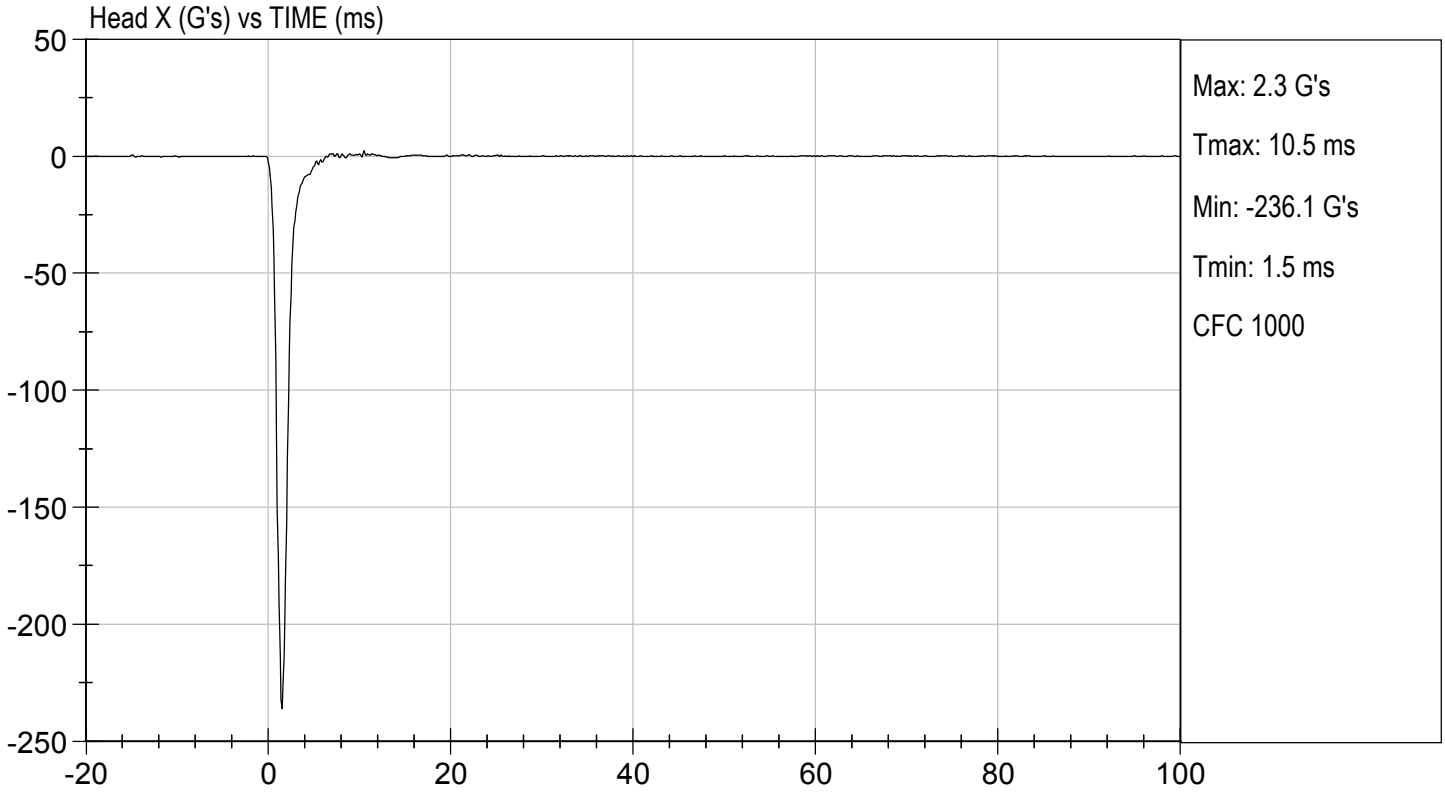
03/11/2021
Test Date

Approved By

TEST DESC: HEAD DROP

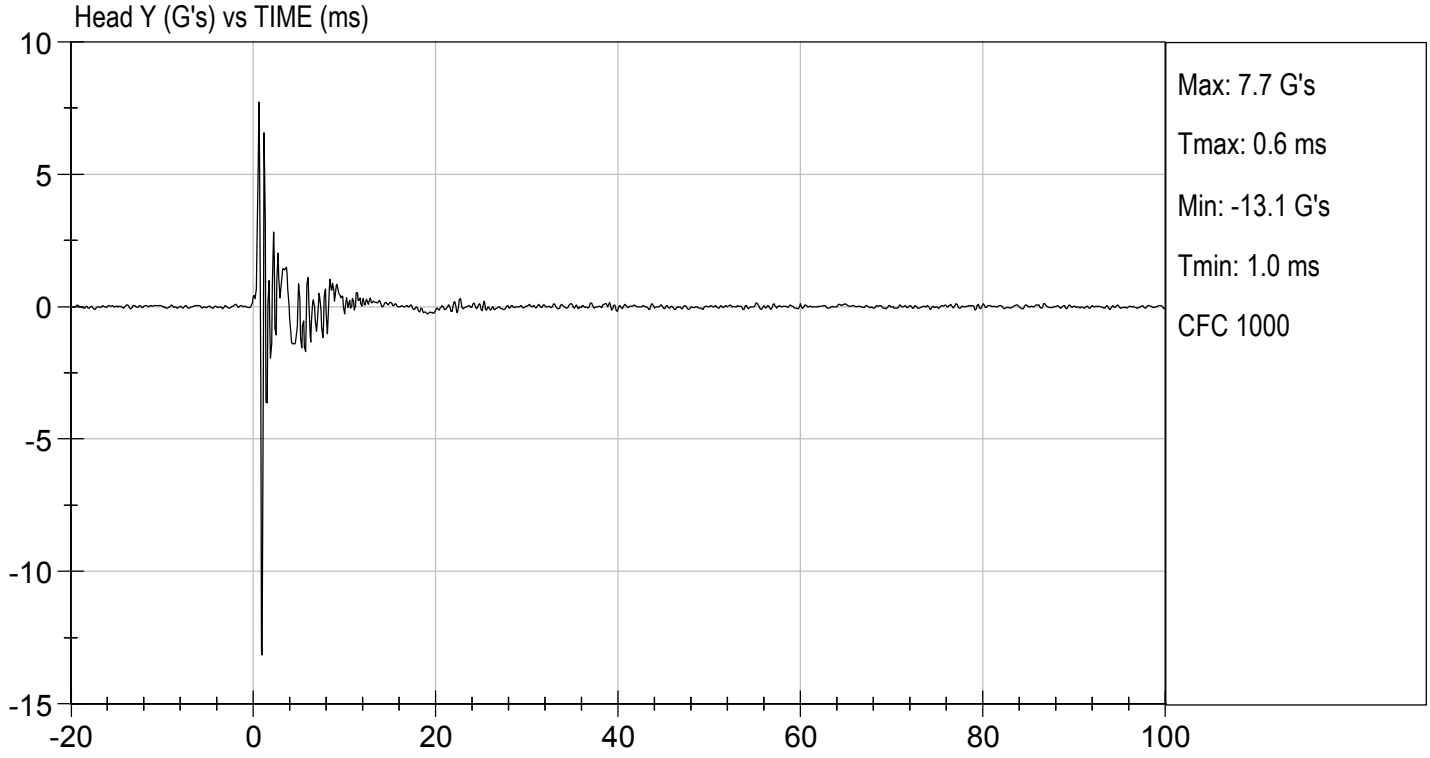
TEST DATE: 03/11/2021
TEST #: D210801

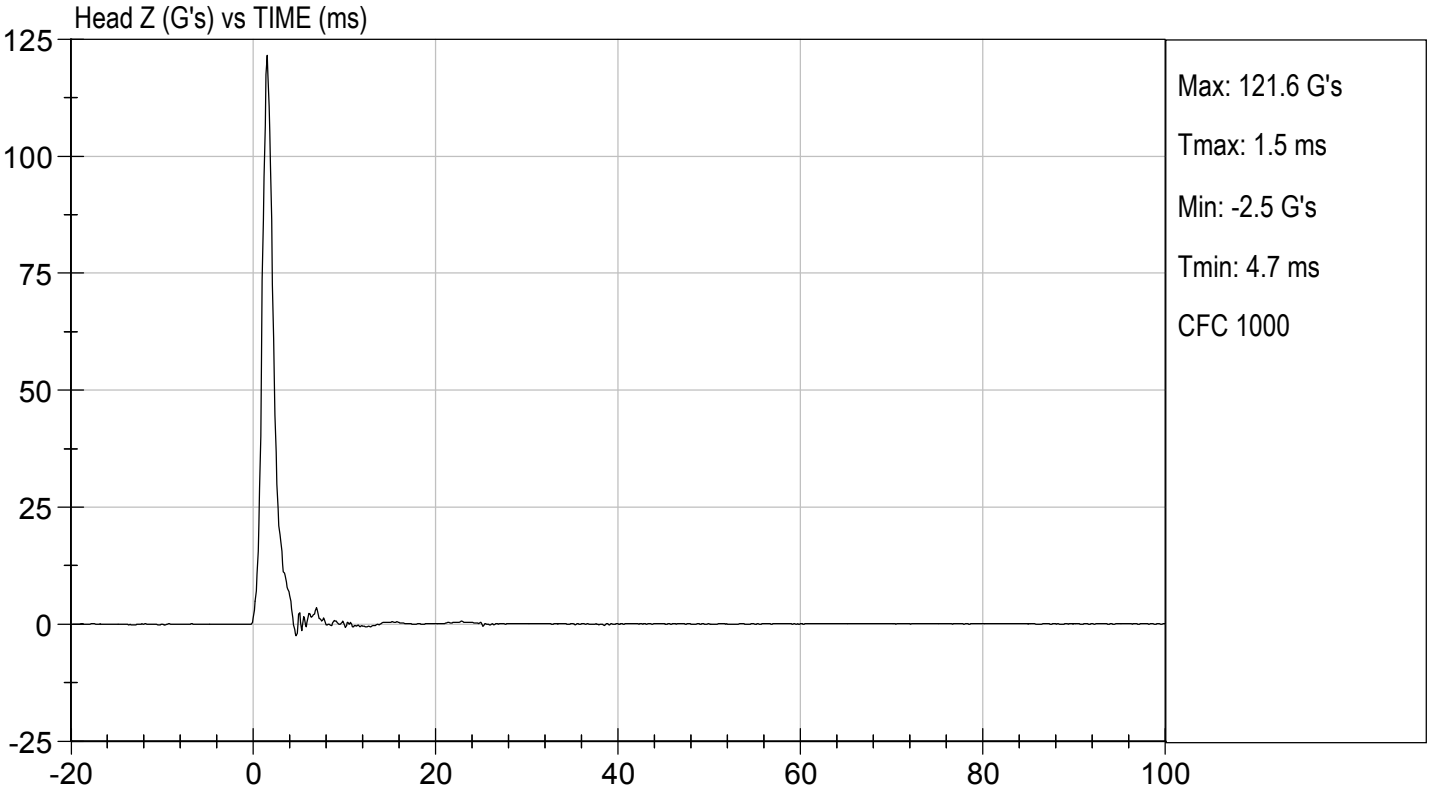




TEST DESC: HEAD DROP

TEST DATE: 03/11/2021
TEST #: D210801





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210802

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	27	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.05	Pass
	20 ms	G's	17.60 to 22.60	20.81	Pass
	30 ms	G's	12.50 to 18.50	15.55	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	15.5	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	37.3	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	72.0	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	119.2	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	89.1	Pass
	Time	ms	47.0 to 58.0	47.8	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	102.1	Pass
			Overall Test Results		Pass

Alex Thomas

Laboratory Technician

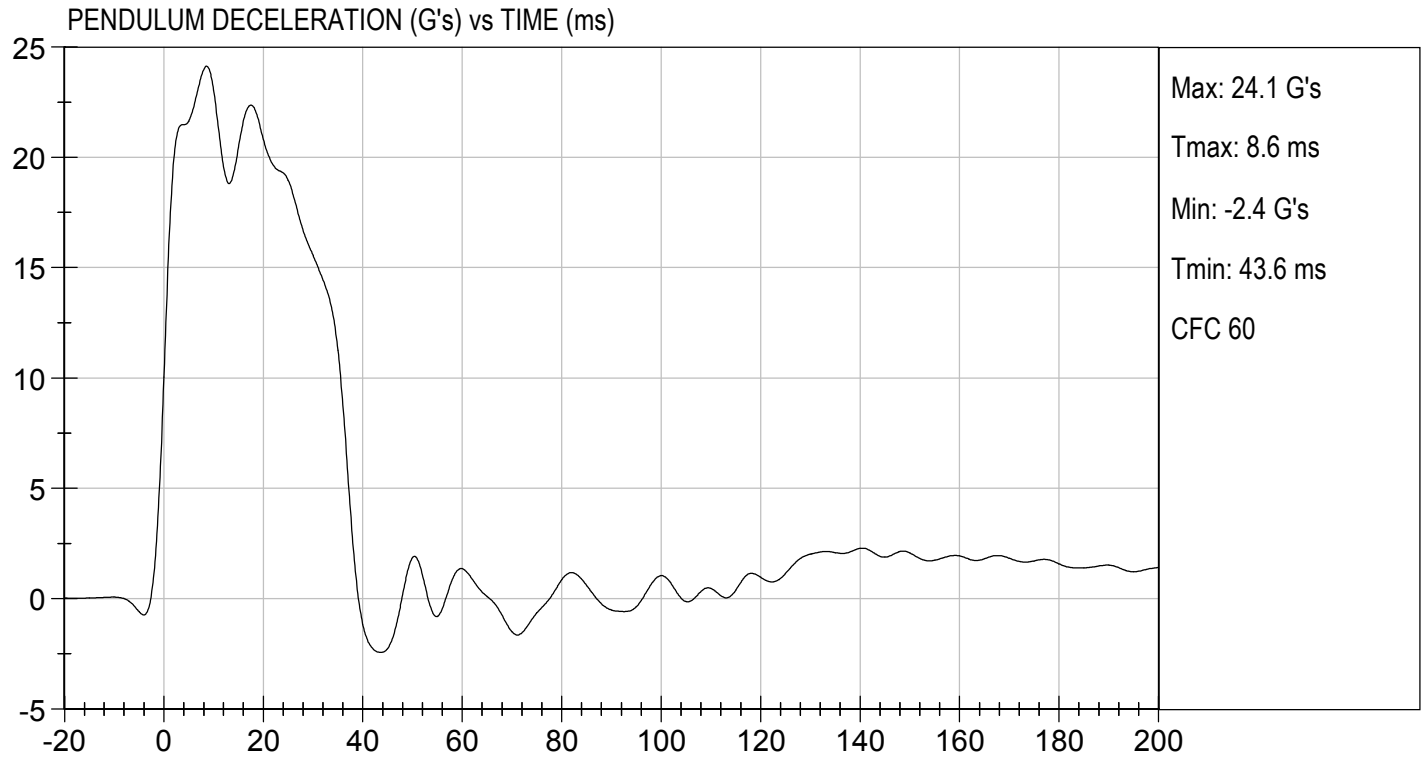
03/12/2021

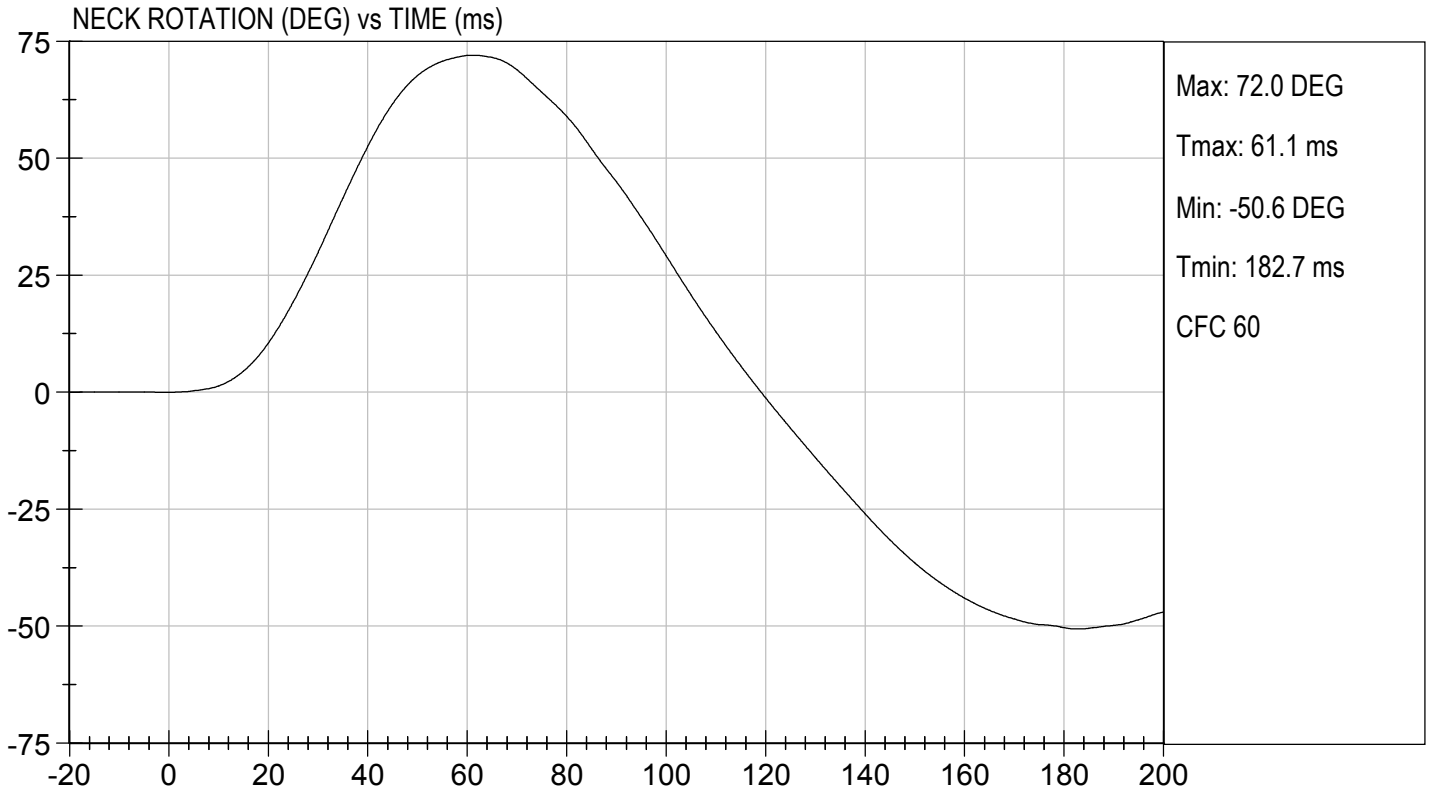
Test Date

Approved By

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

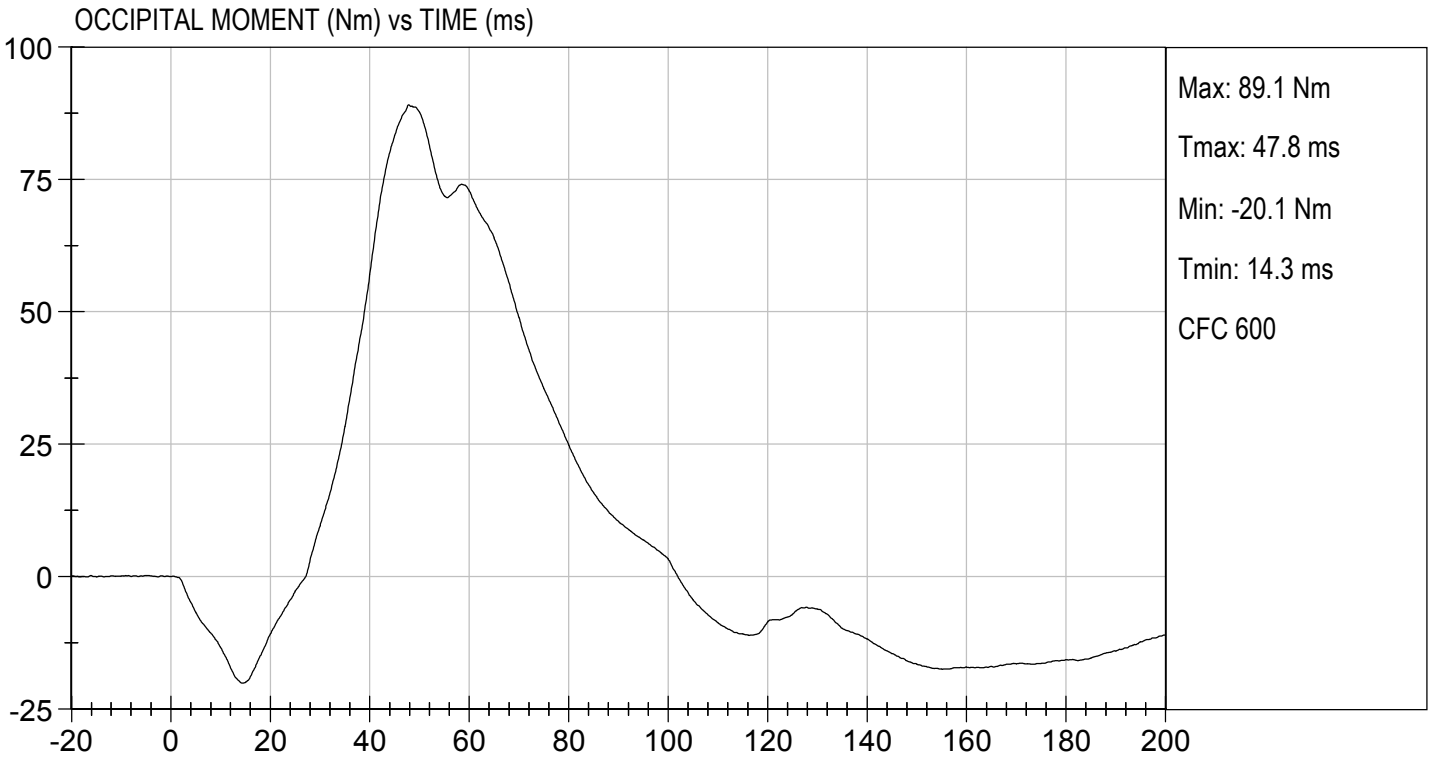
TEST DATE: 03/12/2021
TEST #: D210802





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

TEST DATE: 03/12/2021
TEST #: D210802



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210803

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	27	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	17.72	Pass
	20 ms	G's	14.00 to 19.00	15.06	Pass
	30 ms	G's	11.00 to 16.00	12.98	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	13.4	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	41.6	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	94.1	Pass
	Time	ms	72.0 to 82.0	80.8	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	159.7	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-63.8	Pass
	Time	ms	65.0 to 79.0	72.6	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	143.8	Pass
			Overall Test Results		Pass

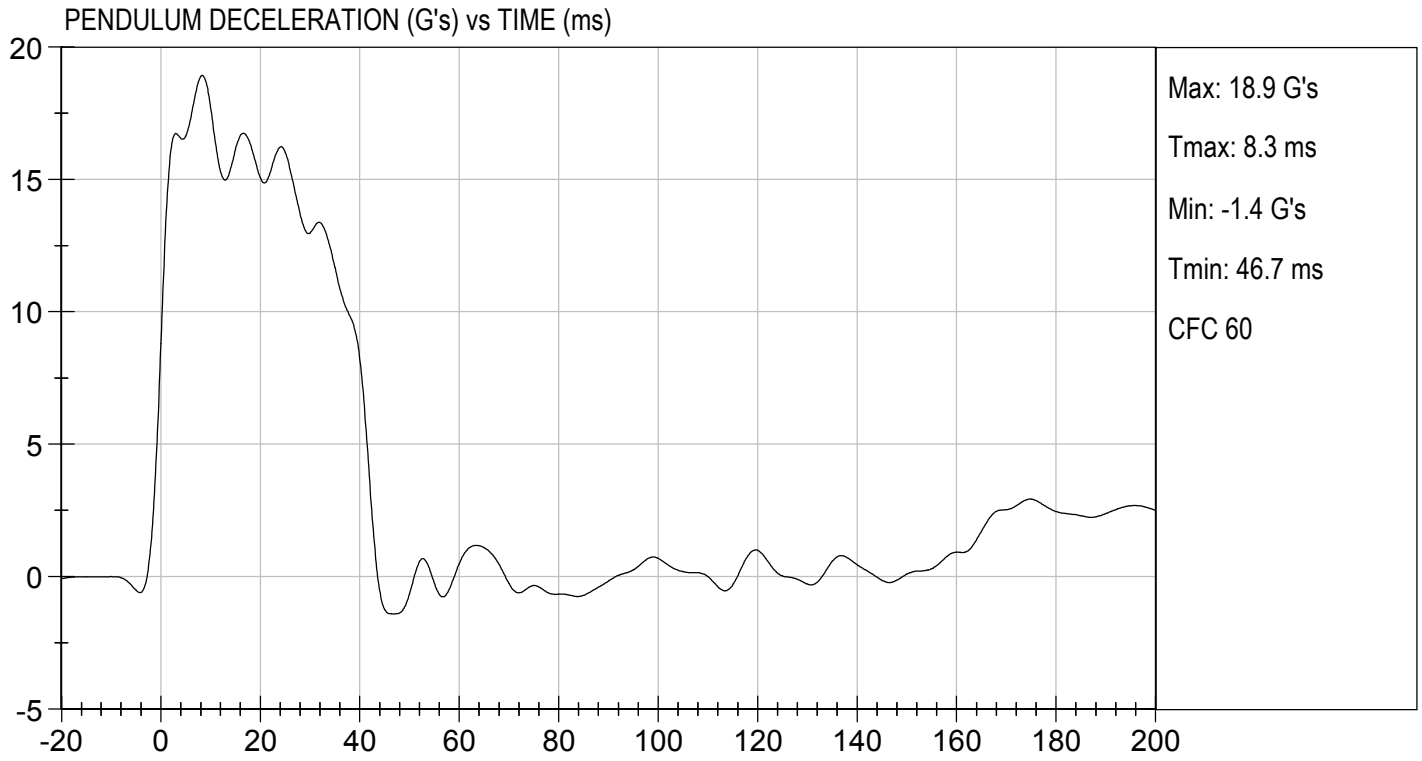
Laboratory Technician

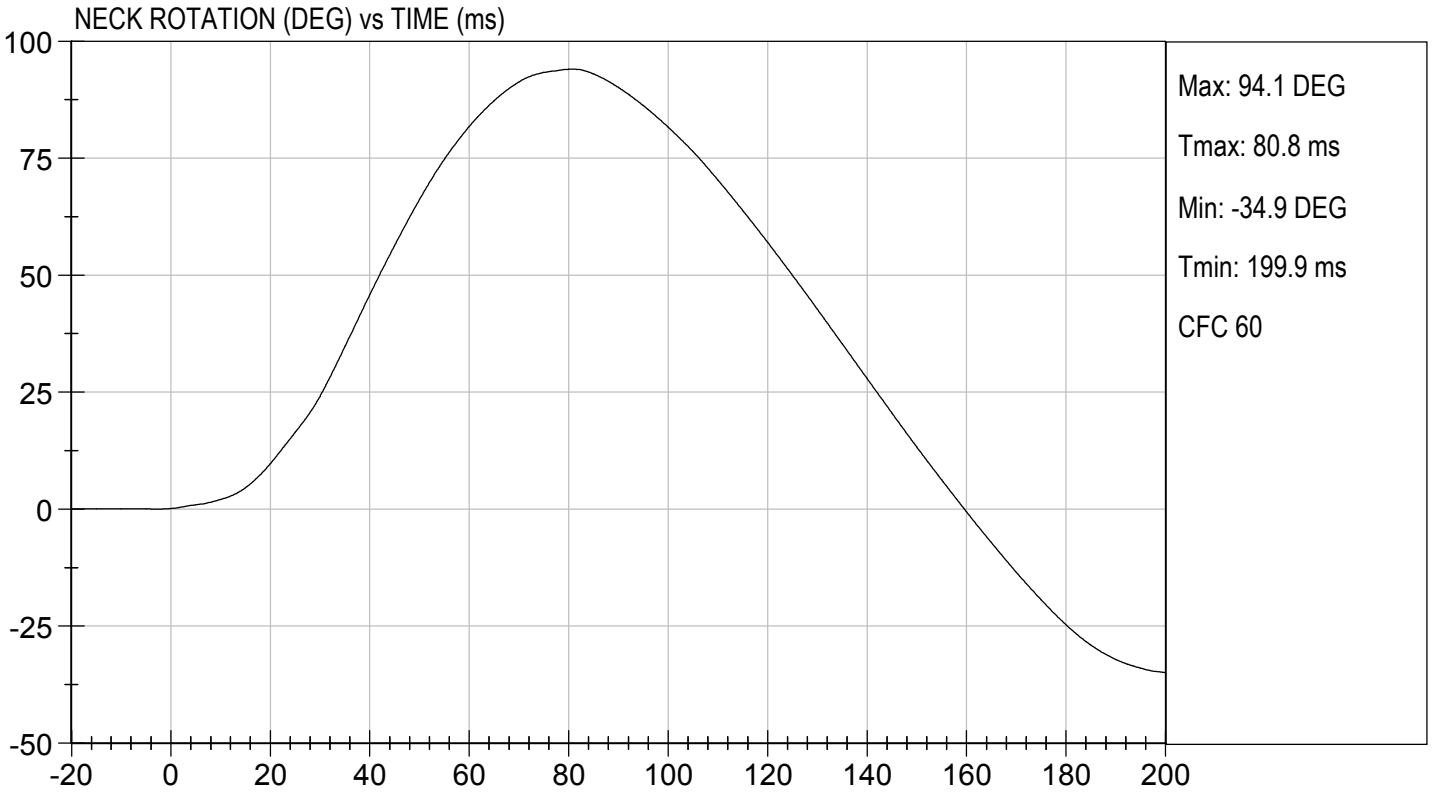
03/12/2021
Test Date

Approved By

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

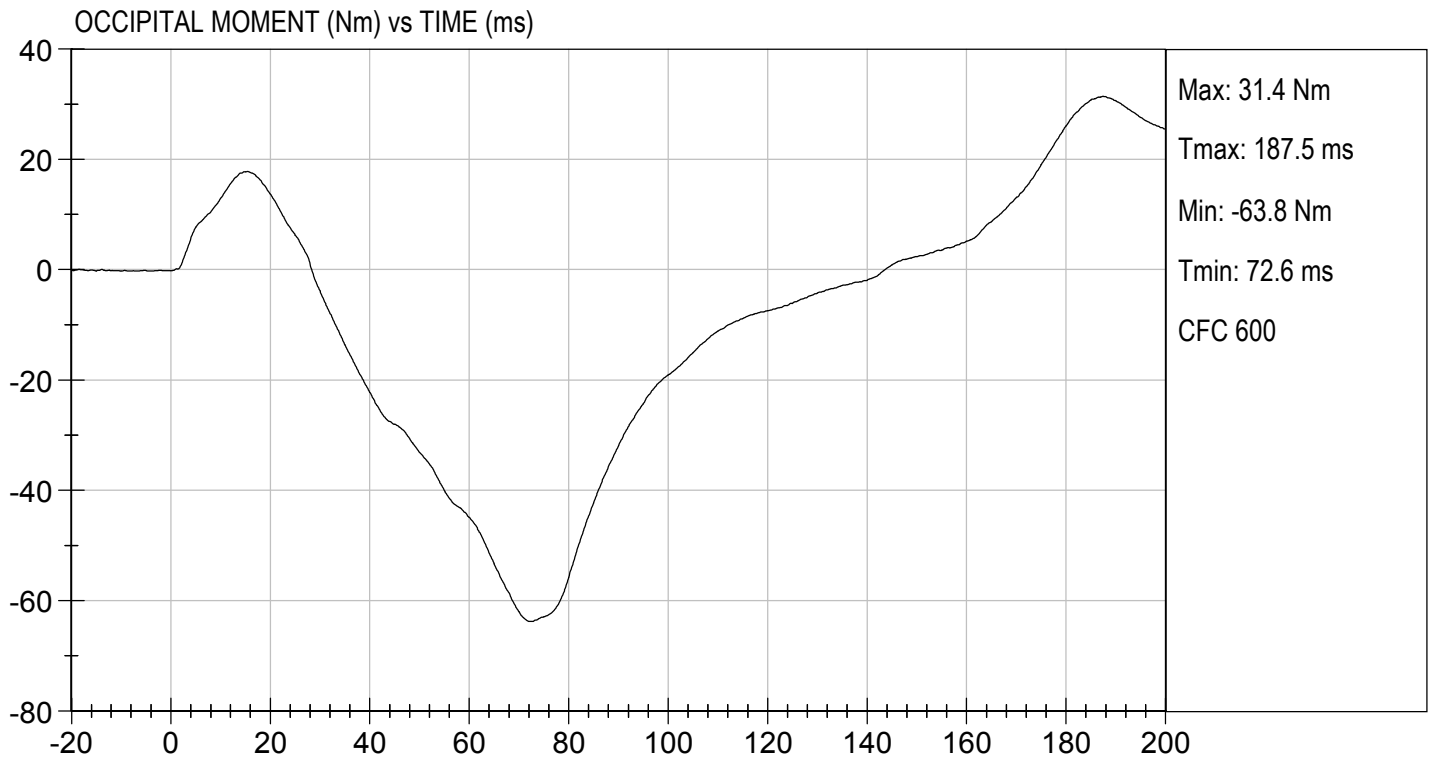
TEST DATE: 03/12/2021
TEST #: D210803





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

TEST DATE: 03/12/2021
TEST #: D210803



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210804A

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	20	Pass
Probe Velocity	m/s	6.58 to 6.82	6.68	Pass
Peak Probe Force	N	5159 to 5893	5,428	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.94	Pass
Internal Hysteresis	%	69 to 85	70	Pass
		Overall Test Results		Pass

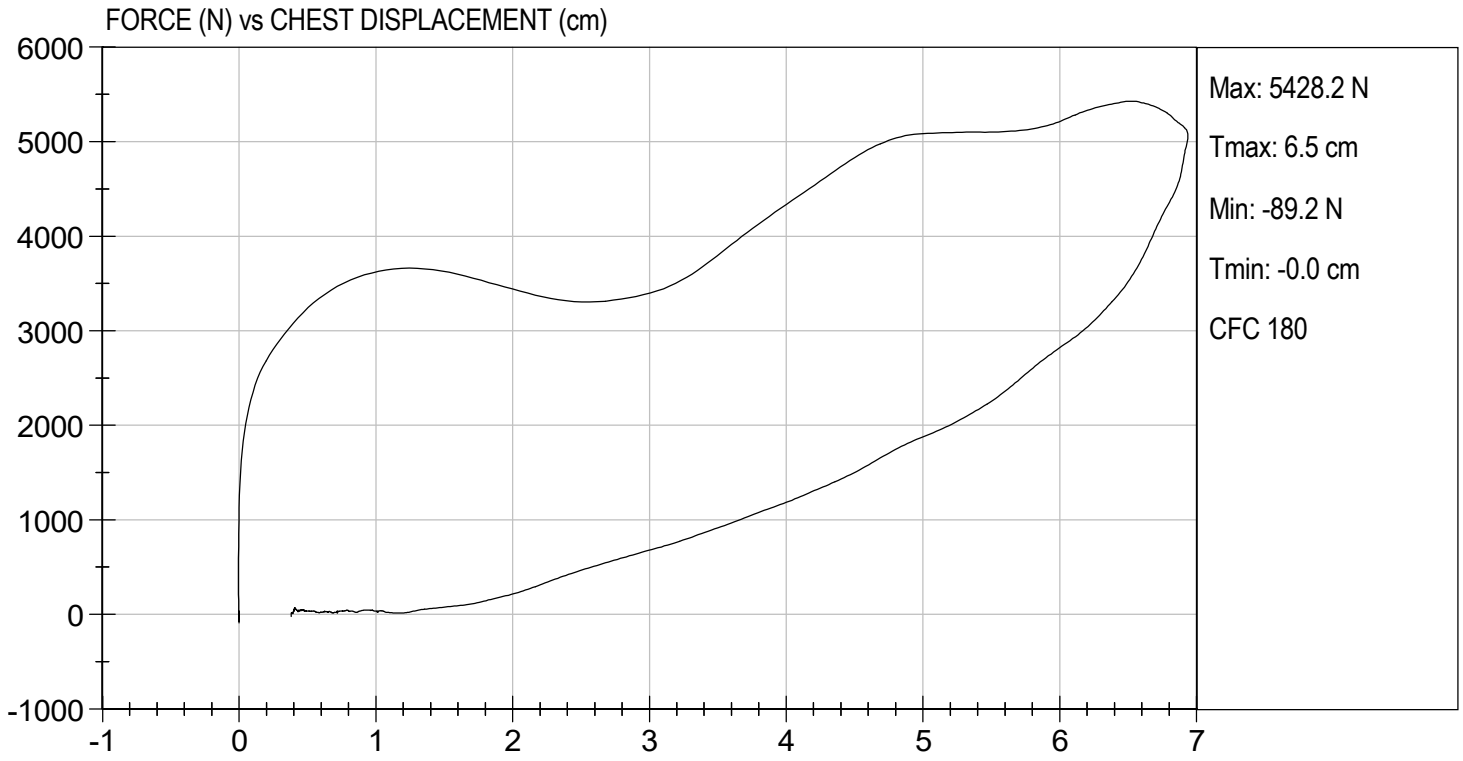
Laboratory Technician

03/15/2021
Test Date

Approved By

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

TEST DATE: 03/15/2021
TEST #: D210804A



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210805

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	38	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	N	4715 to 5782	5,470	Pass
		Overall Test Results		Pass

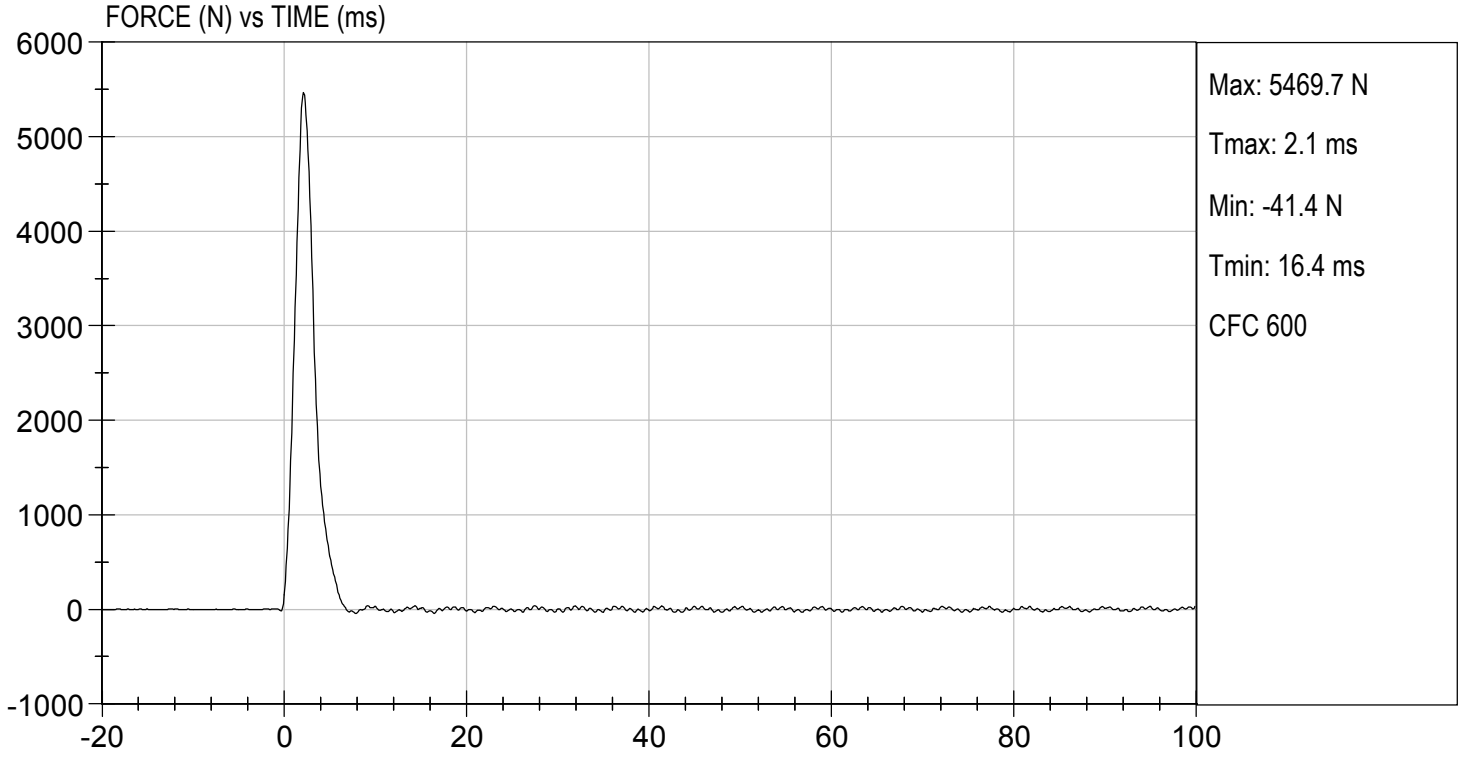
Laboratory Technician

03/11/2021
Test Date

Approved By

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

TEST DATE: 03/11/2021
TEST #: D210805



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210806

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	38	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	5,662	Pass
		Overall Test Results		Pass

Alex Thomas

Laboratory Technician

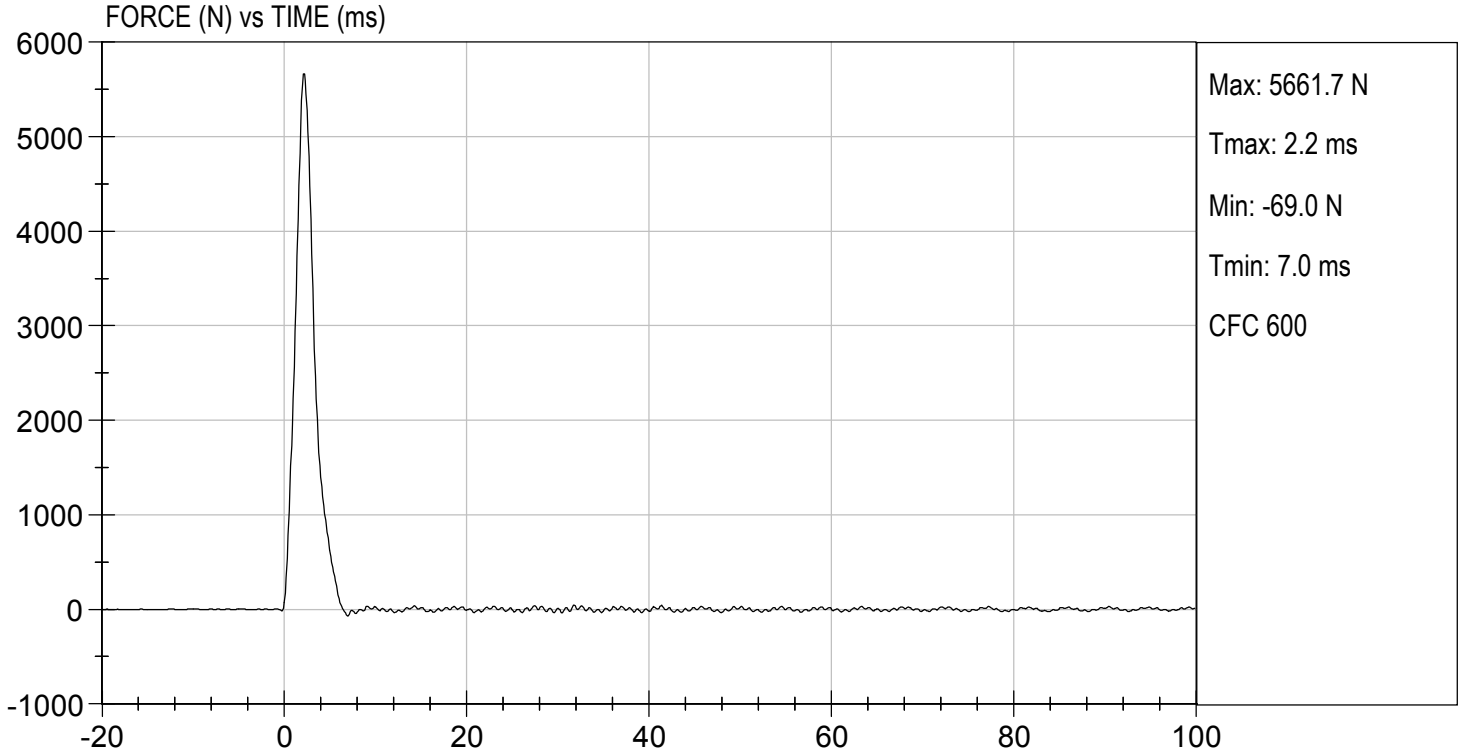
03/11/2021

Test Date

Approved By

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

TEST DATE: 03/11/2021
TEST #: D210806



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D210800

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	39	39	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	88.7	85.2	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	44.6	45.4	Pass
		Overall Test Results			Pass

Alex Thomas

Laboratory Technician

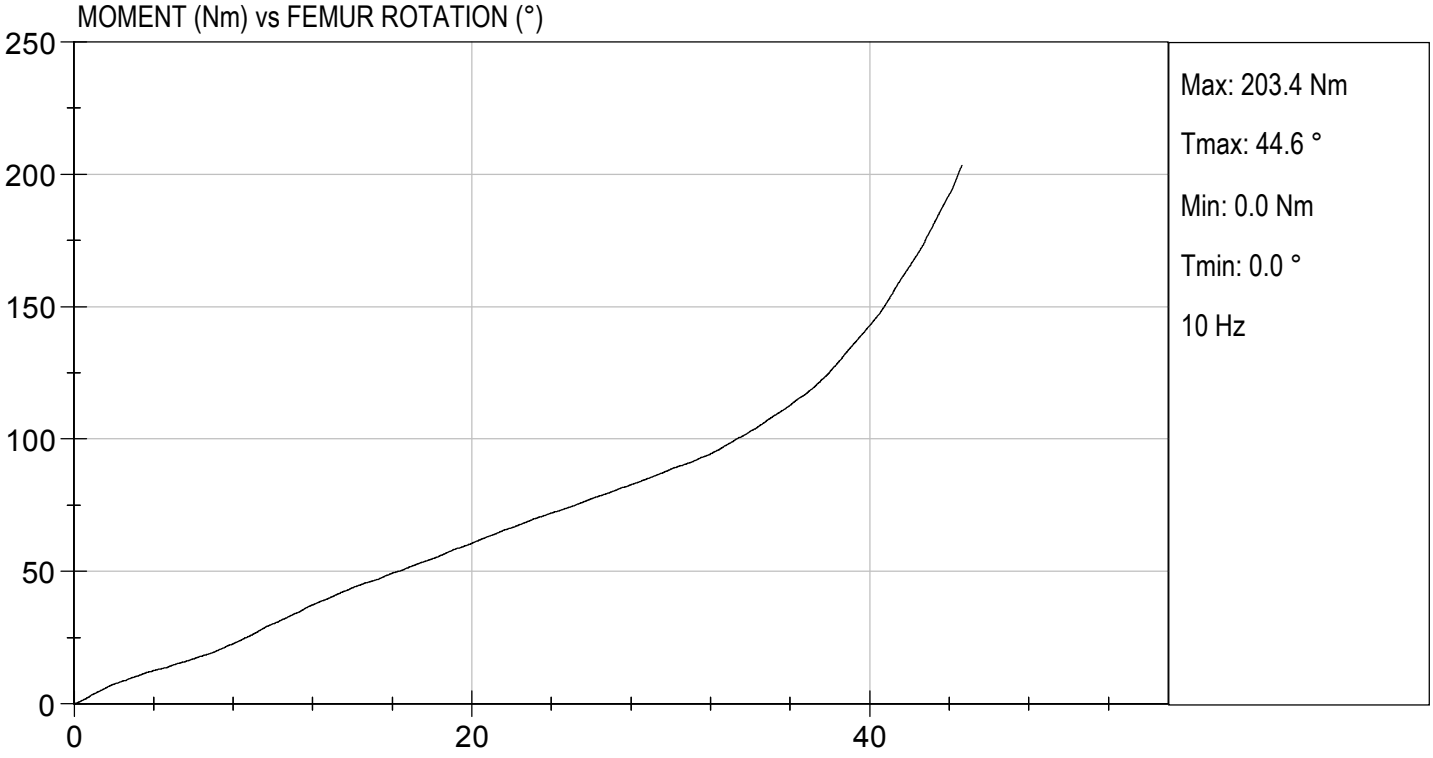
03/11/2021

Test Date

Approved By

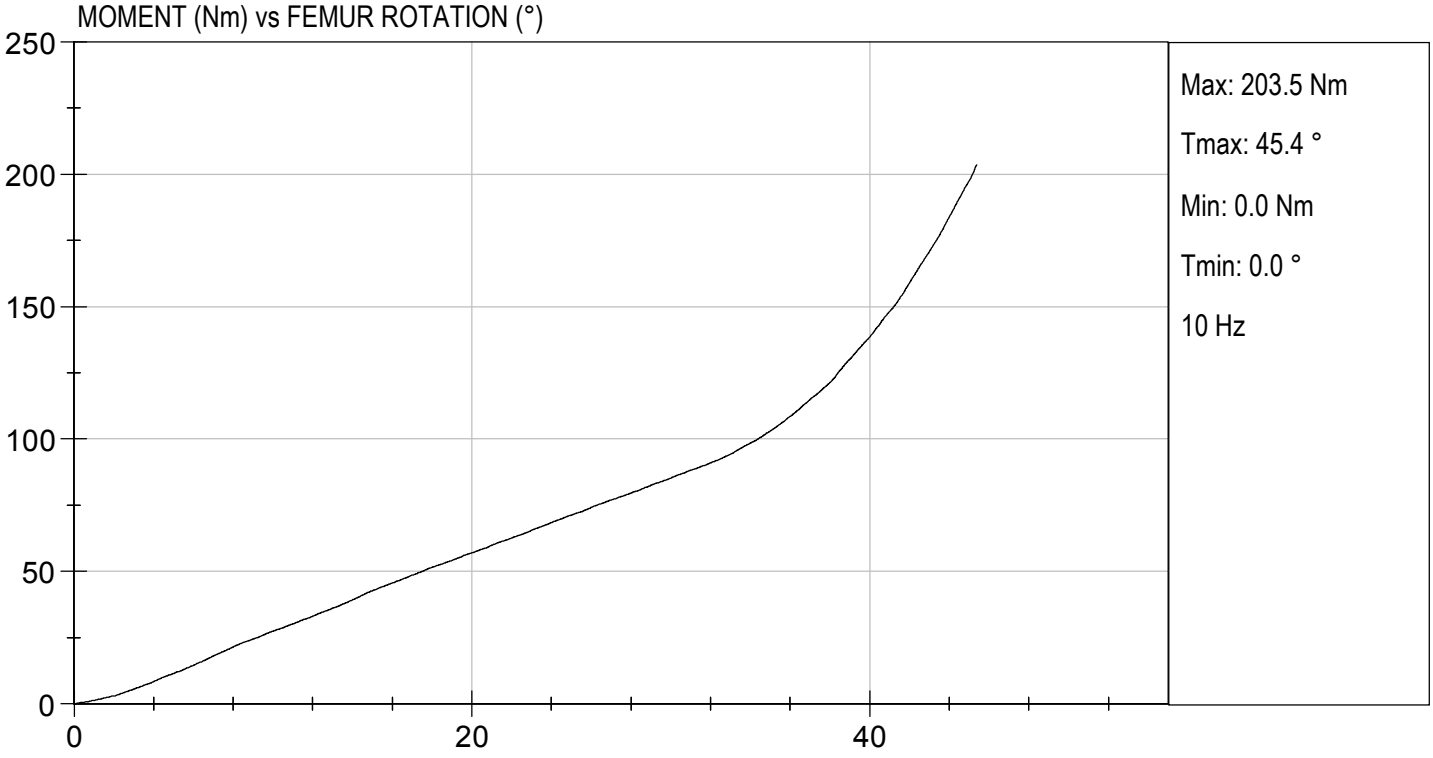
TEST DESC: RIGHT HIP FEMUR FLEXION

TEST DATE: 03/11/2021
TEST #: D210809



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 03/11/2021
TEST #: D210800



CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

Hybrid III, 5th External Measurements
SN: DH1659

HYBRID III, PART 572, SUBPART O EXTERNAL DIMENSIONS				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (mm)	ACTUAL MEASUREMENT
A	TOTAL SITTING HEIGHT	Seat surface to highest point on top of the head.	774.7-800.1	778
B	SHOULDER PIVOT HEIGHT	Centerline of shoulder pivot bolt to the seat surface.	431.8-457.2	440
C	H-POINT HEIGHT	Reference	81.3-86.3	85
D	H-POINT LOCATION FROM BACKLINE	Reference	144.8-149.8	147
E	SHOULDER PIVOT FROM BACKLINE	Center of the shoulder clevis to the rear vertical surface of the fixture.	68.6-83.8	82
F	THIGH CLEARANCE	Measured at the highest point on the upper femur segment.	119.4-134.6	130
G	BACK OF ELBOW TO WRIST PIVOT	back of the elbow flesh to the wrist pivot in line with the elbow and wrist pivots	243.9-259.1	251
H	HEAD BACK TO BACKLINE	Back of Skull cap skin to seat rear vertical surface (Reference)	43.2-48.2	45
I	SHOULDER TO- ELBOW LENGTH	Measure from the highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow in line with the elbow pivot bolt.	276.8-297.2	285
J	ELBOW REST HEIGHT	Measure from the flesh below the elbow pivot bolt to the seat surface.	182.8-203.2	189
K	BUTTOCK TO KNEE LENGTH	The forward most part of the knee flesh to the rear vertical surface of the fixture.	520.7-546.1	543
L	POPLITEAL HEIGHT	Seat surface to the plane of the horizontal plane of the bottom of the feet.	355.6-376	357
M	KNEE PIVOT HEIGHT	Centerline of knee pivot bolt to the horizontal plane of the bottom of the feet.	393.7-419.1	398
N	BUTTOCK POPLITEAL LENGTH	The rearmost surface of the lower leg to the same point on the rear surface of the buttocks used for dim. “K”.	414-439.4	435

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

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test ID:** D210581

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	250 to 300	282	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

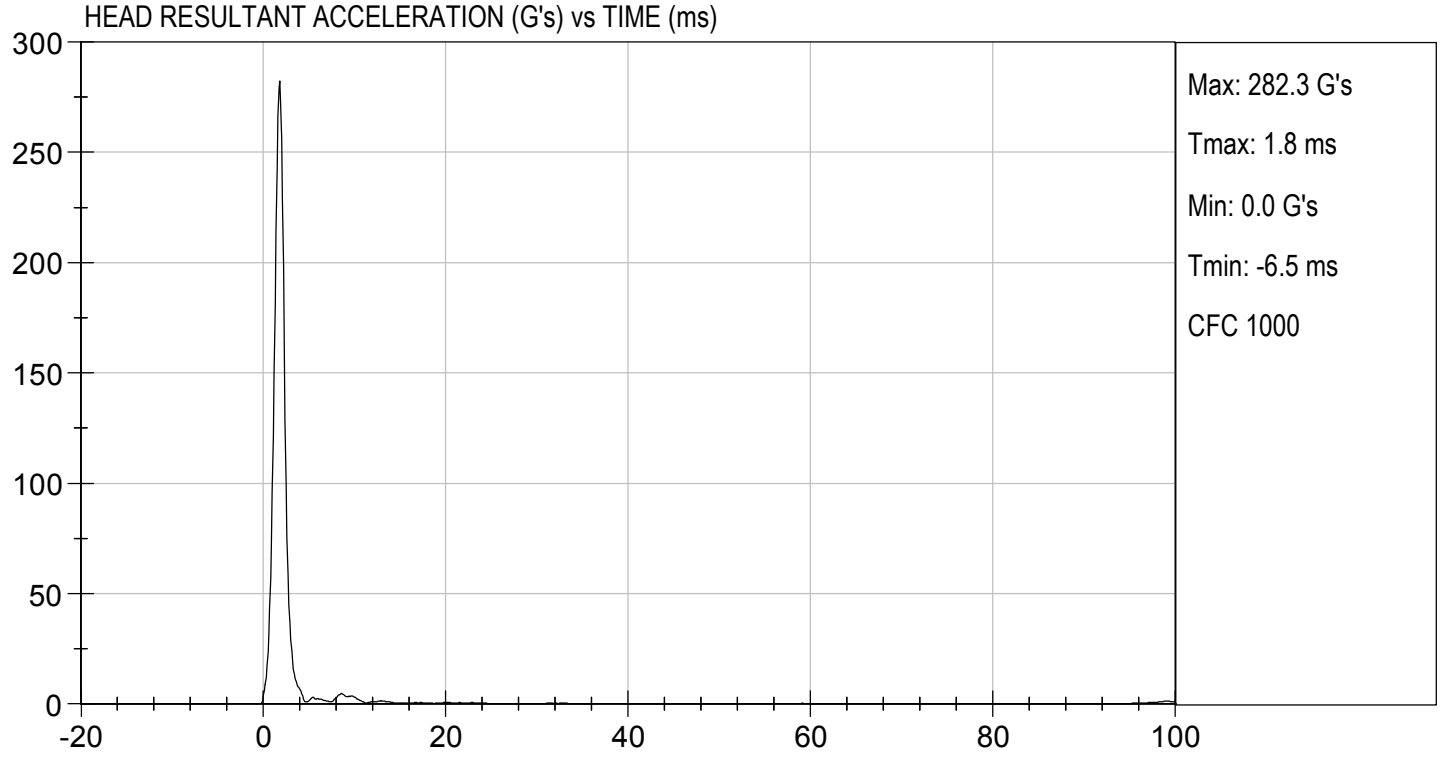
02/25/2021

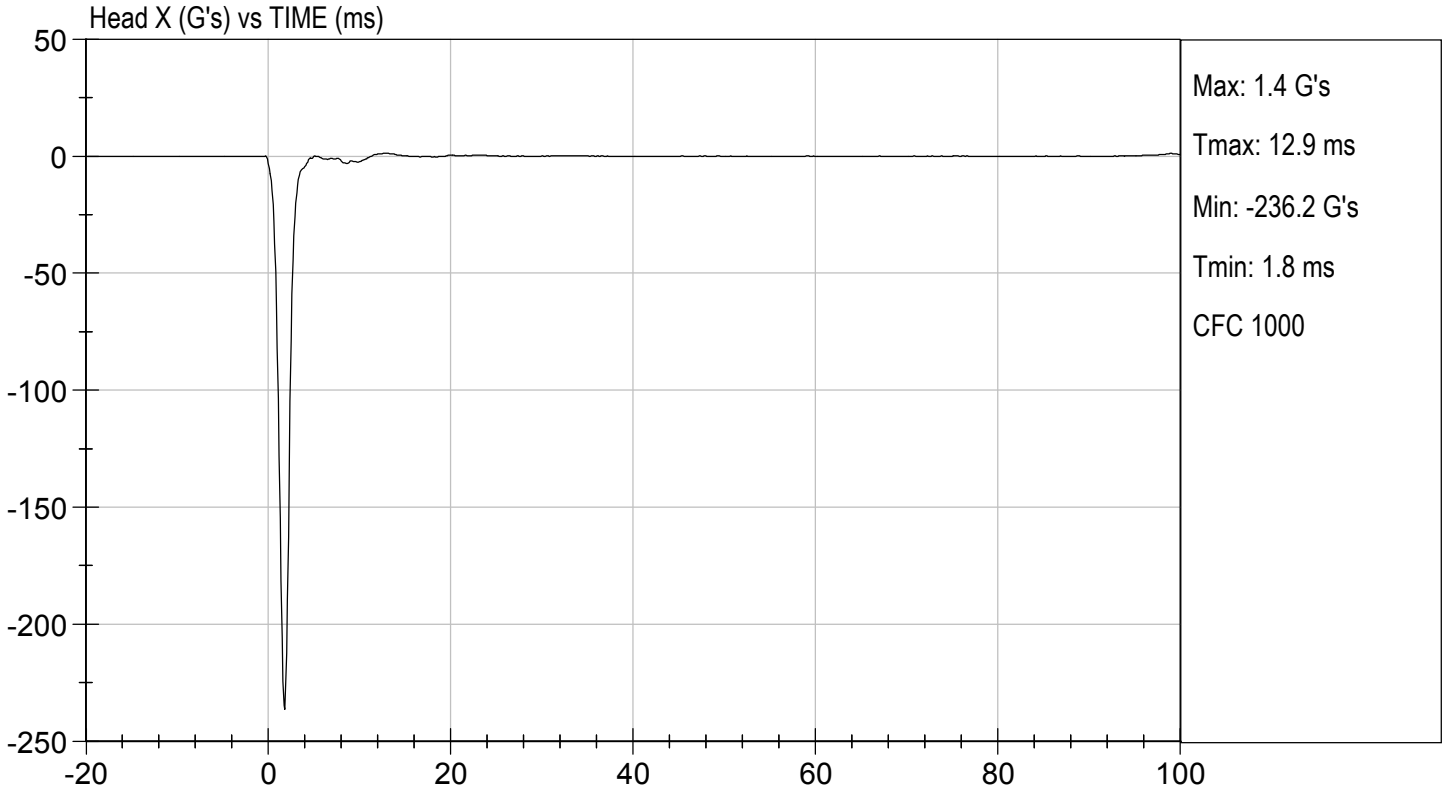
Test Date

Approved By

TEST DESC: HEAD DROP

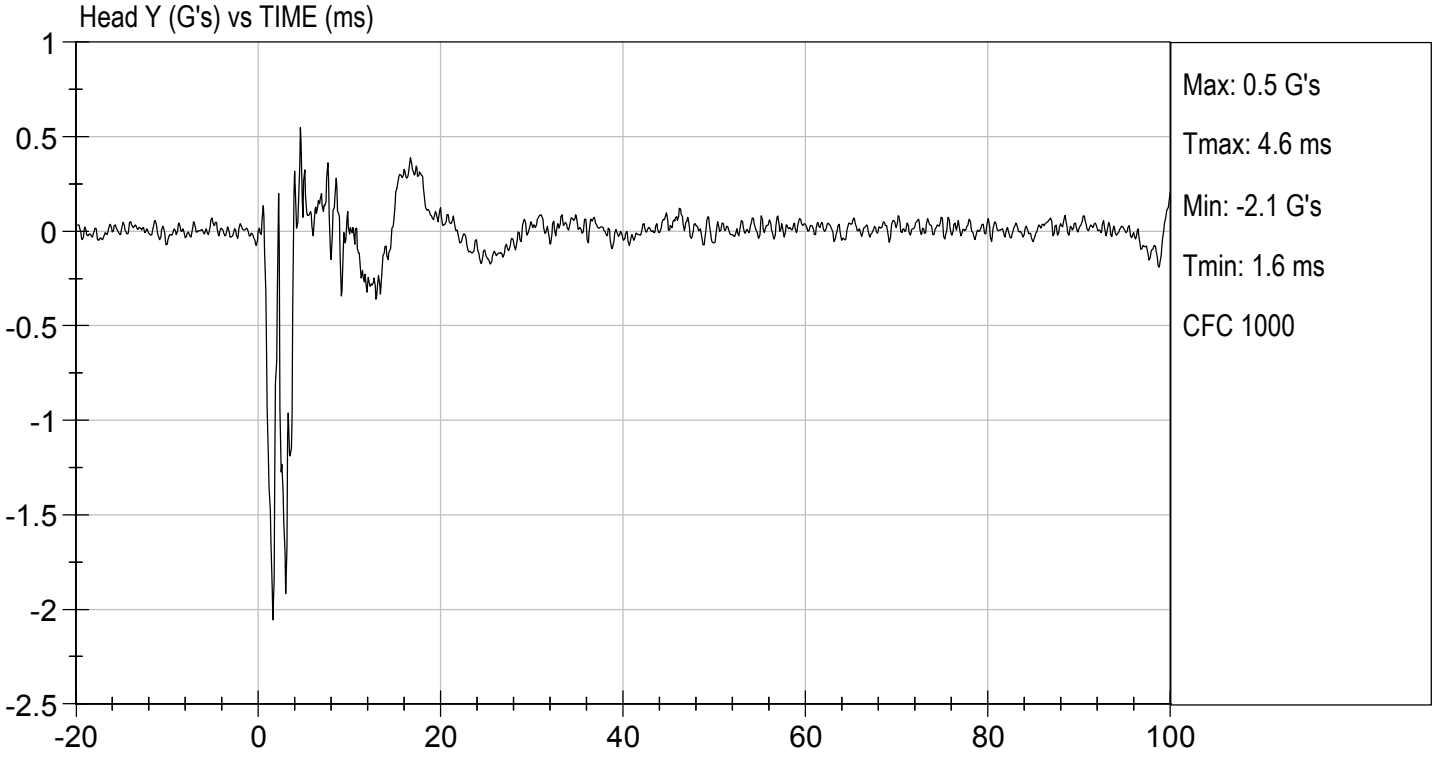
TEST DATE: 02/25/2021
TEST #: D210581

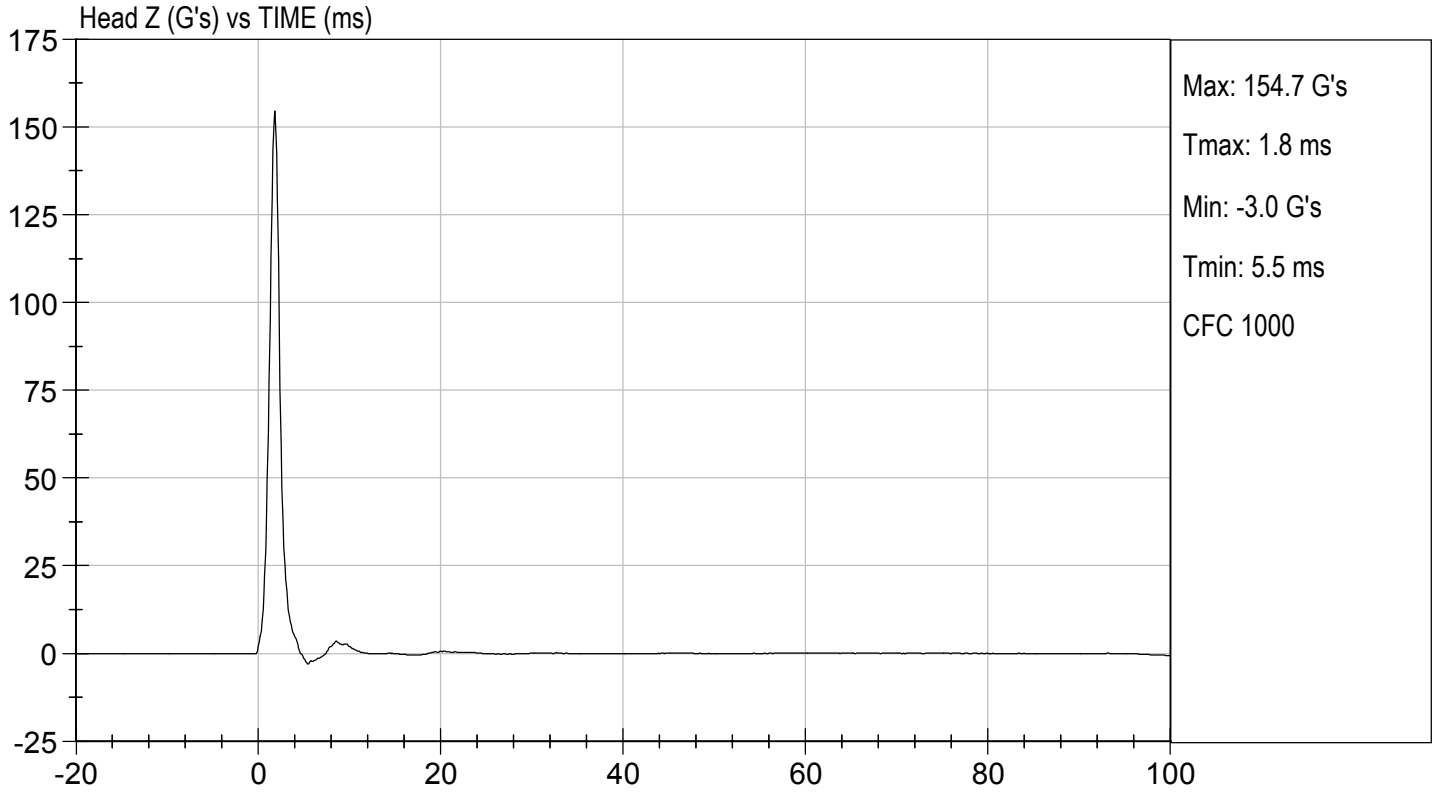




TEST DESC: HEAD DROP

TEST DATE: 02/25/2021
TEST #: D210581





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210582

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 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	4.9	Pass
	30 ms	m/s	5.8 to 7.0	7.0	Pass
D Plane Rotation	Max	deg	77 to 91	82	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	73	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	82	Pass
			Overall Results		Pass

Gerald Guerrero

Laboratory Technician

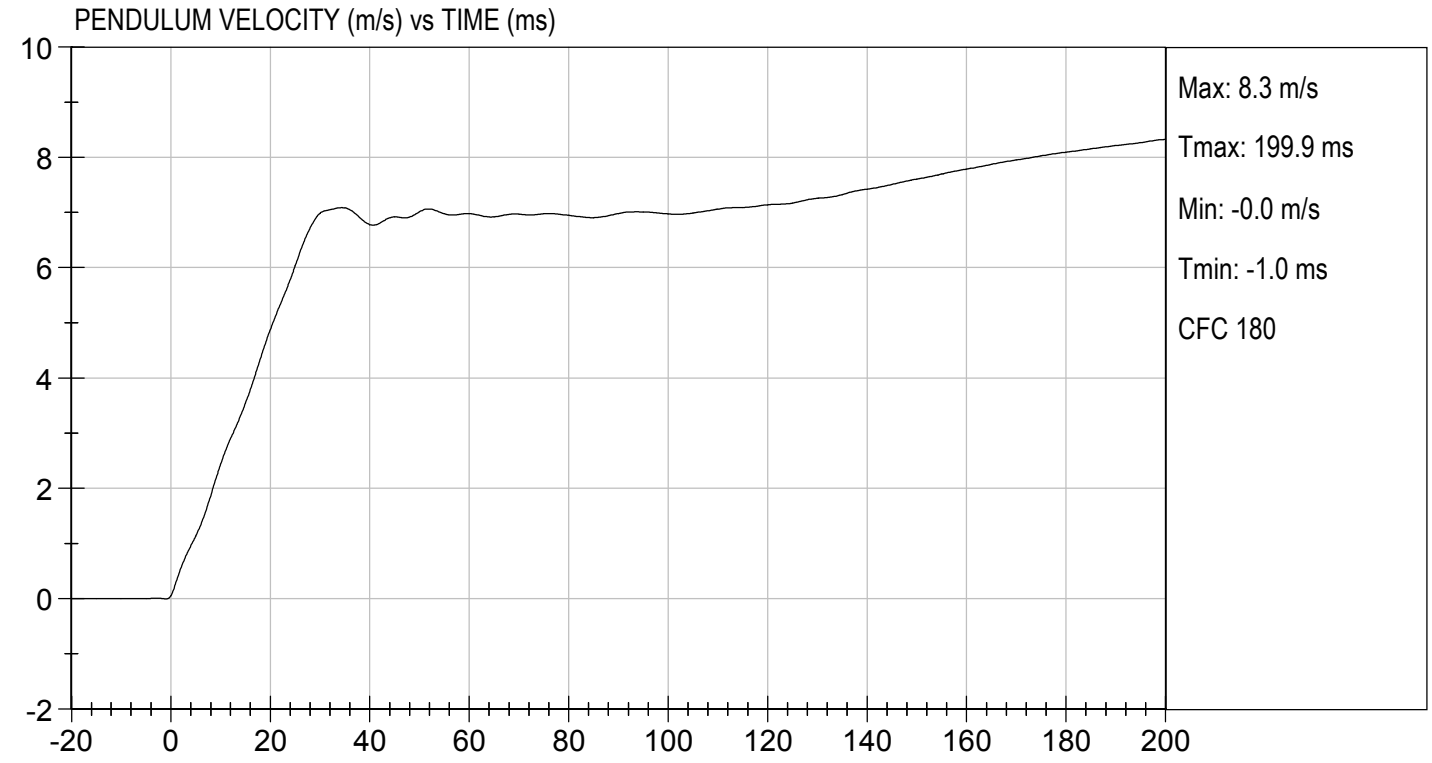
02/25/2021

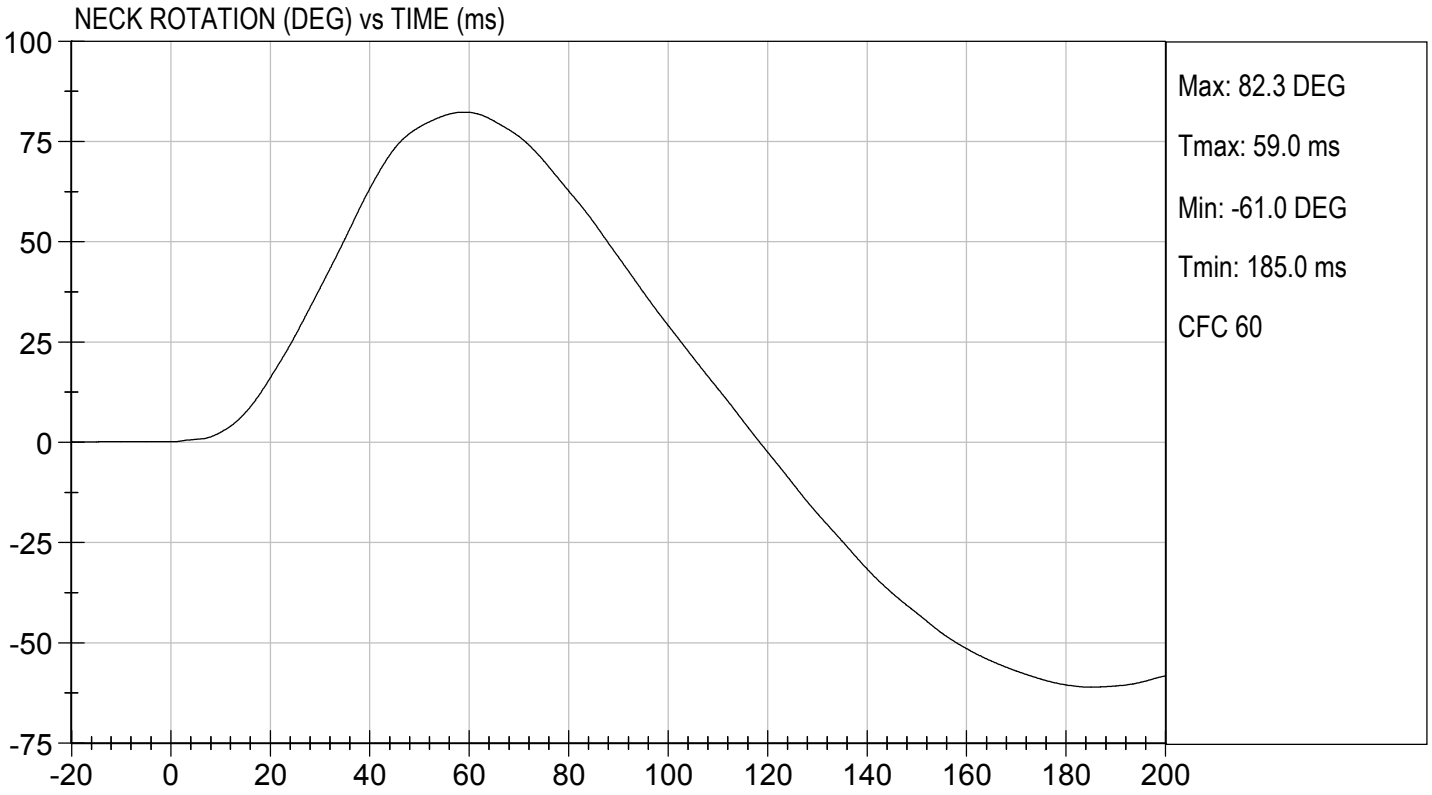
Test Date

Approved By

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

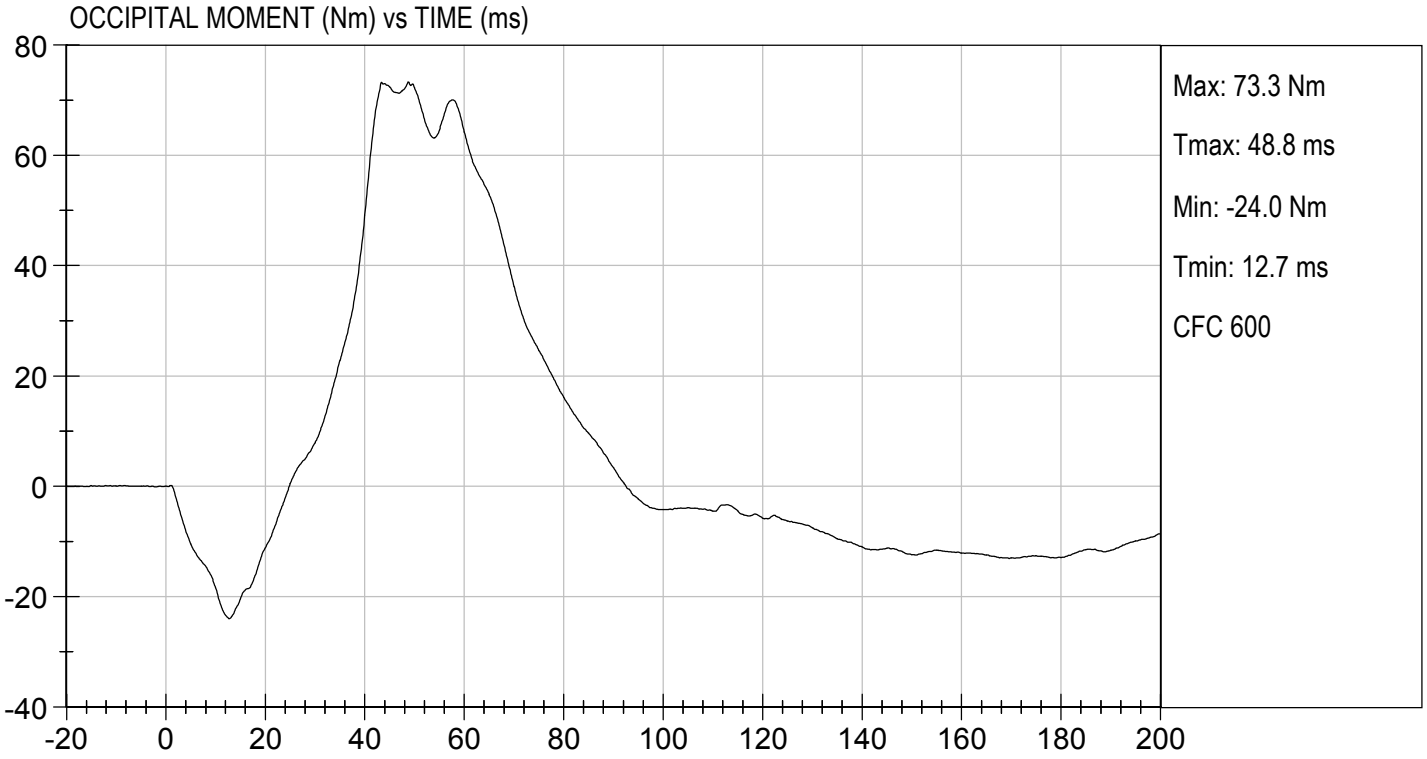
TEST DATE: 02/25/2021
TEST #: D210582





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

TEST DATE: 02/25/2021
TEST #: D210582



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210583

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 Speed		m/s	5.95 to 6.19	6.12	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.9	Pass
	20 ms	m/s	3.1 to 3.9	3.8	Pass
	30 ms	m/s	4.6 to 5.6	5.5	Pass
D Plane Rotation	Max	deg	99 to 114	109	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	105	Pass
			Overall Results		Pass

Gerald Guerrero

Laboratory Technician

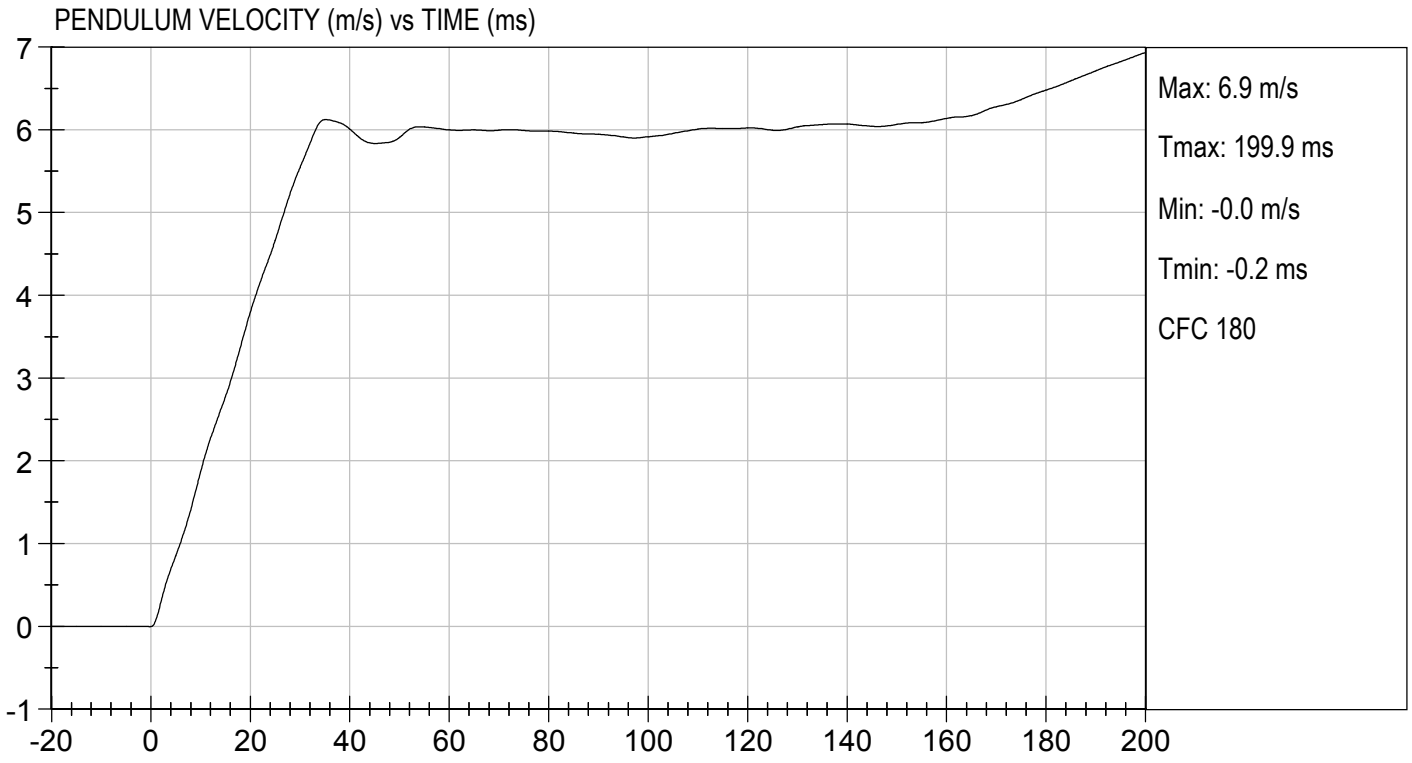
02/25/2021

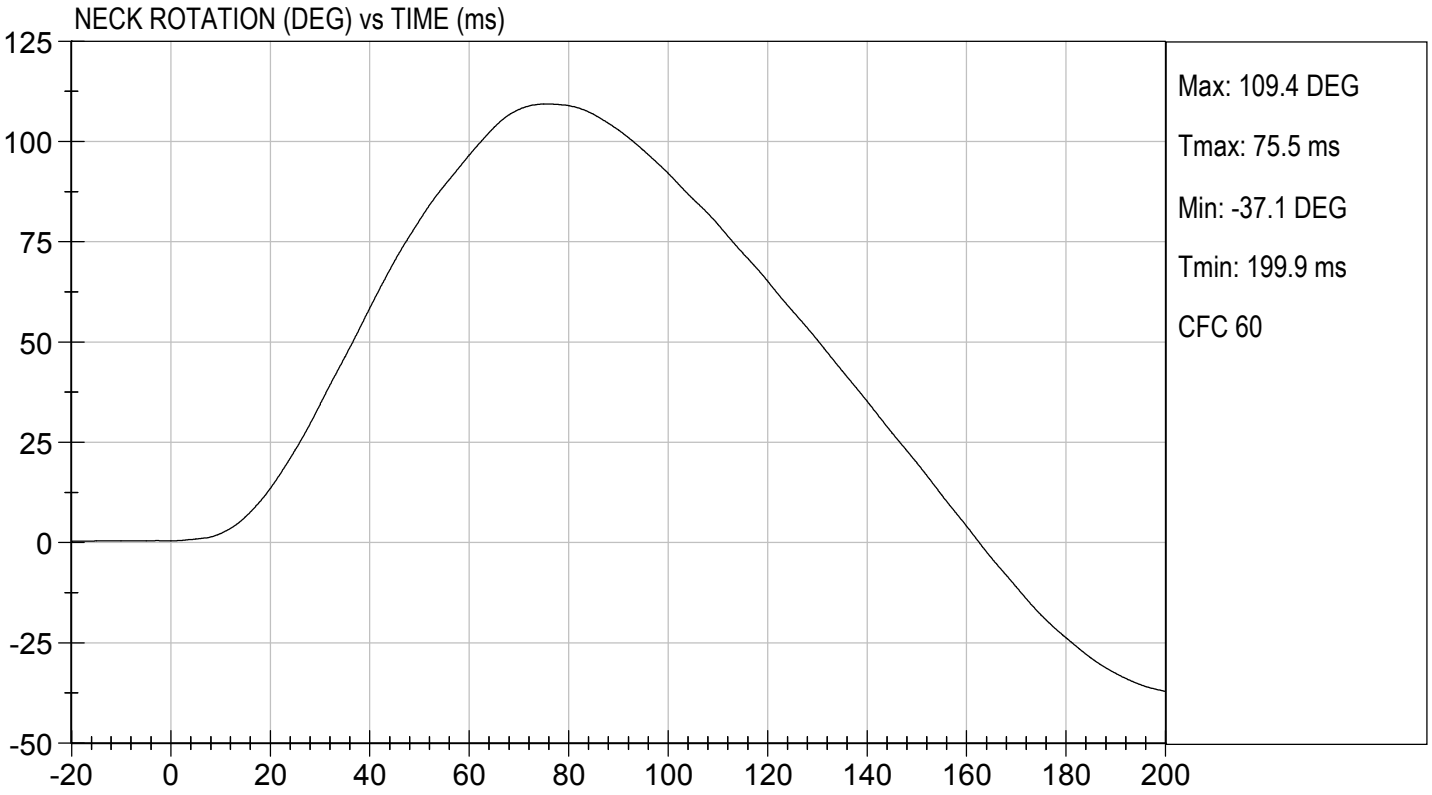
Test Date

Approved By

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

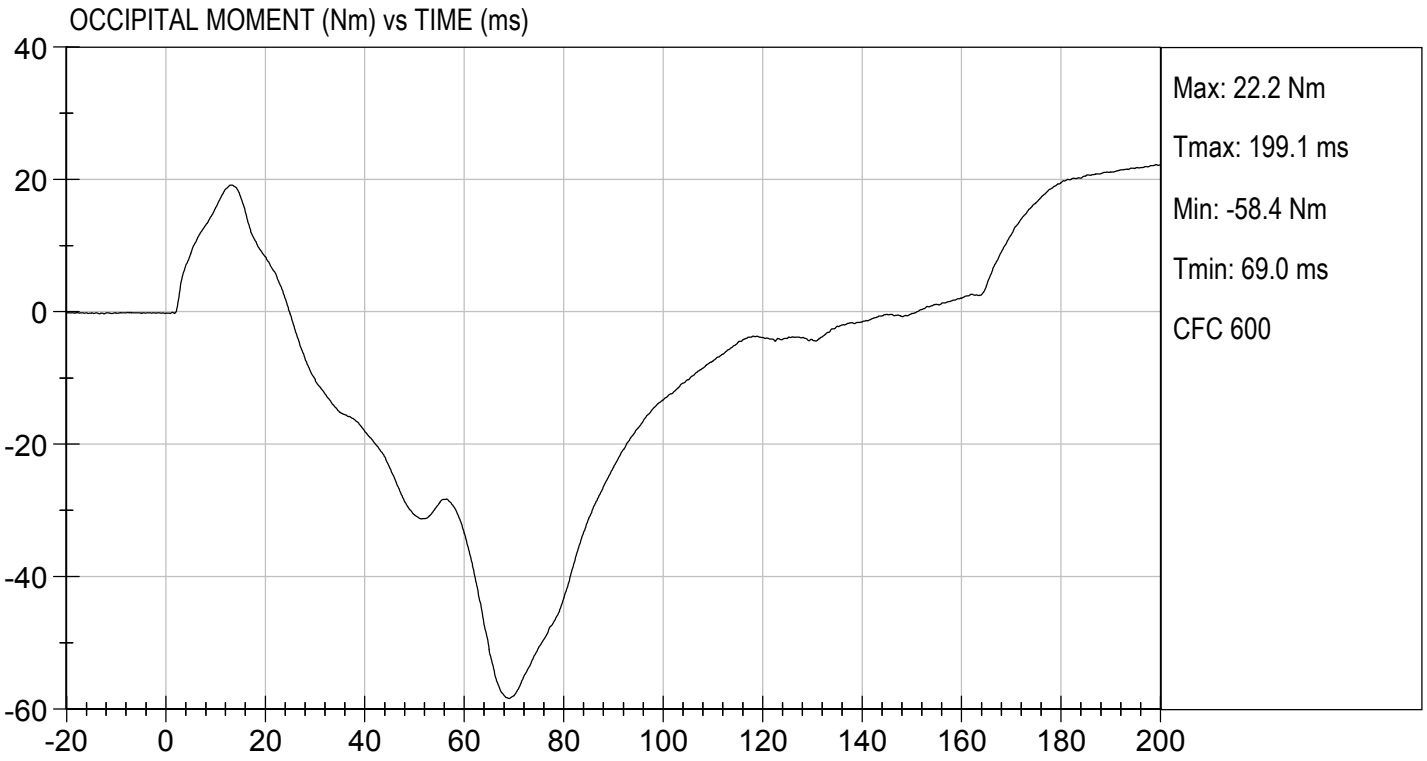
TEST DATE: 02/25/2021
TEST #: D210583





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

TEST DATE: 02/25/2021
TEST #: D210583



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210584

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Relative Humidity	%	10 to 70	28	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	52	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4385	Pass
Internal Hysteresis	%	69 to 85	74	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4405	Pass
		Overall Test Results		Pass

Gerald Guerrero

Laboratory Technician

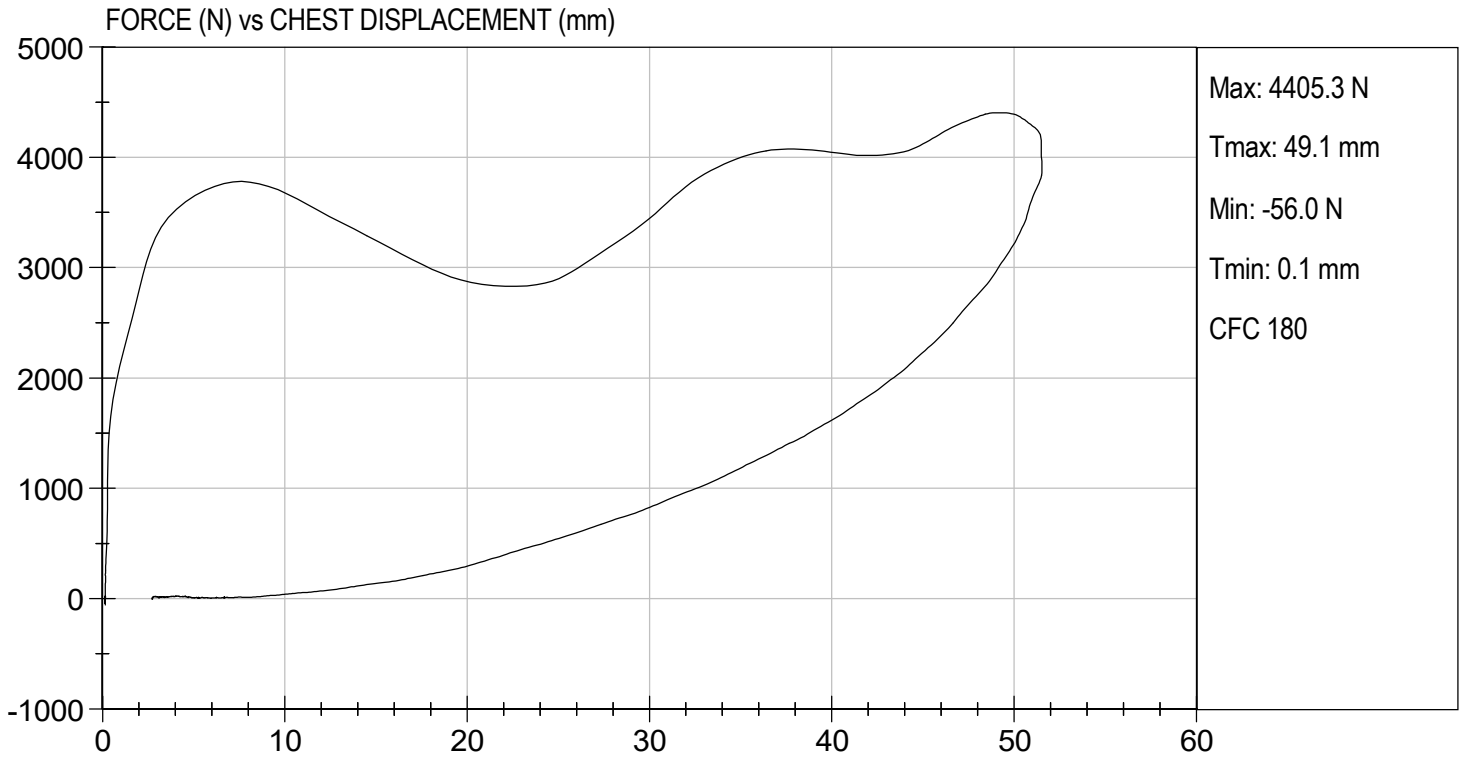
02/24/2021

Test Date

Approved By

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

TEST DATE: 02/24/2021
TEST #: D210584



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210585

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 Speed	m/s	2.07 to 2.13	2.11	Pass
Maximum Force	N	3450 to 4060	3853	Pass
		Overall Test Results		Pass

Gerald Guerrero

Laboratory Technician

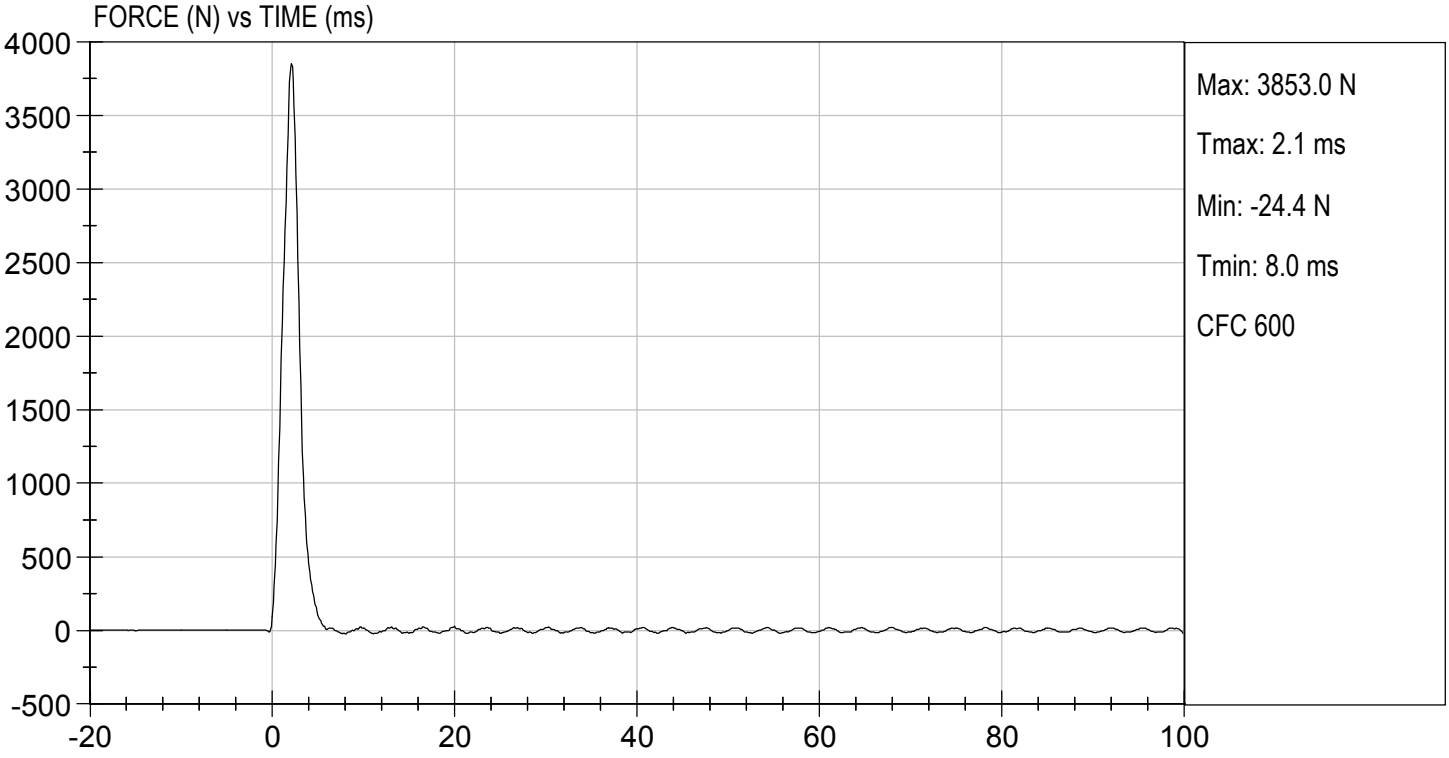
02/26/2021

Test Date

Approved By

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

TEST DATE: 02/26/2021
TEST #: D210585



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210586

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 Speed	m/s	2.07 to 2.13	2.11	Pass
Maximum Force	N	3450 to 4060	3716	Pass
		Overall Test Results		Pass

Gerald Guerrero

Laboratory Technician

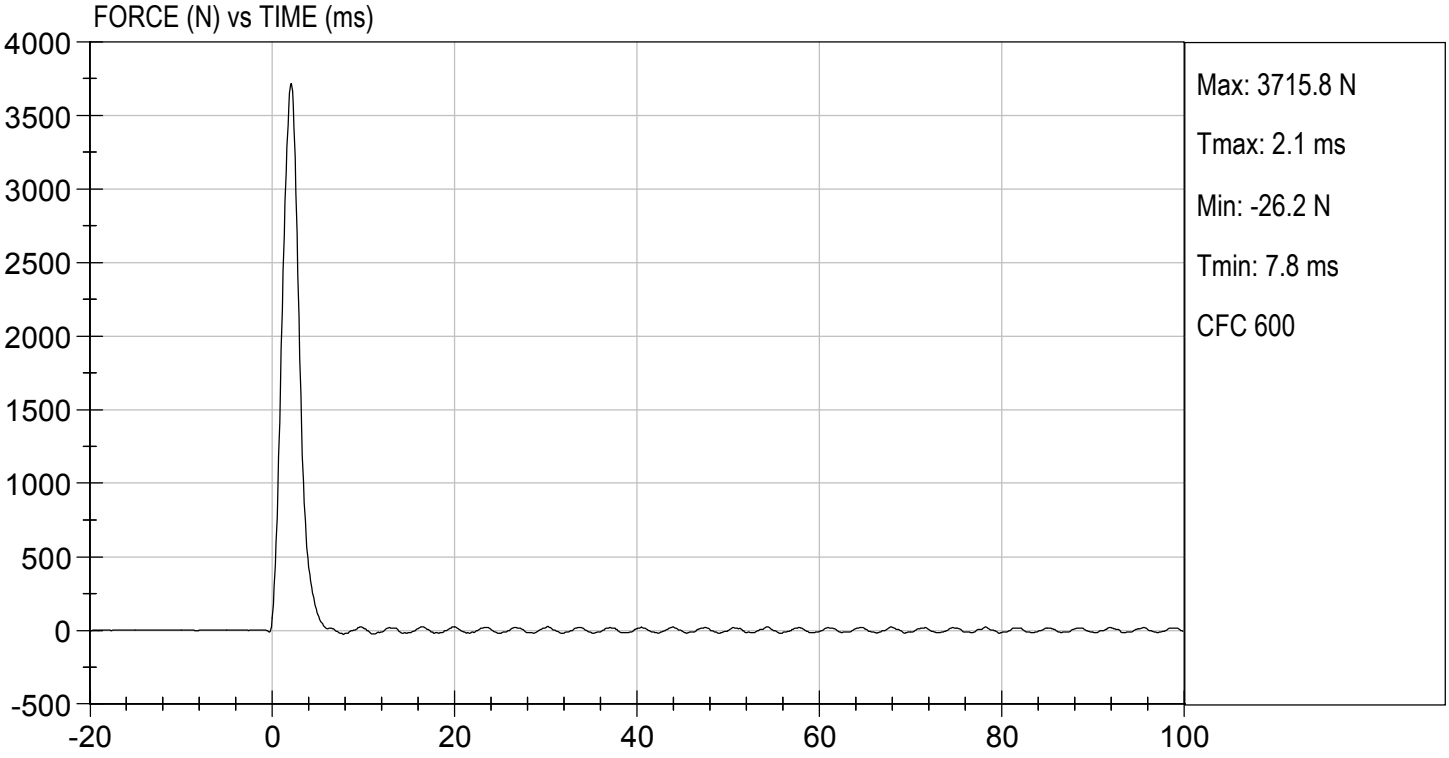
02/26/2021

Test Date

Approved By

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

TEST DATE: 02/26/2021
TEST #: D210586



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210587

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
Initial Angle	deg	0 to 20	19	Pass
Return Angle	deg	+/- 8	2	Pass
Force at 45 deg	N	320 to 390	362	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
		Overall Result		Pass

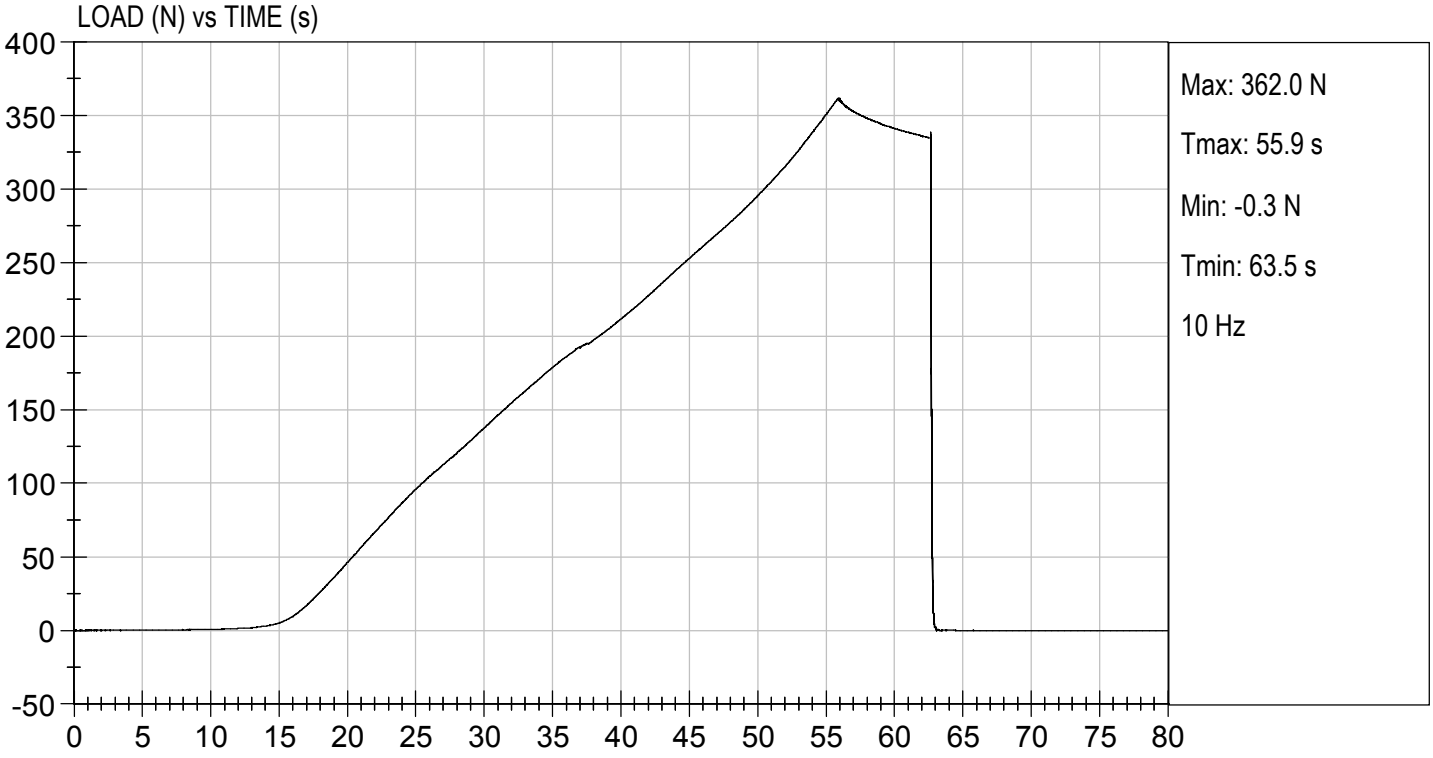
Gerald Guerrero
Laboratory Technician

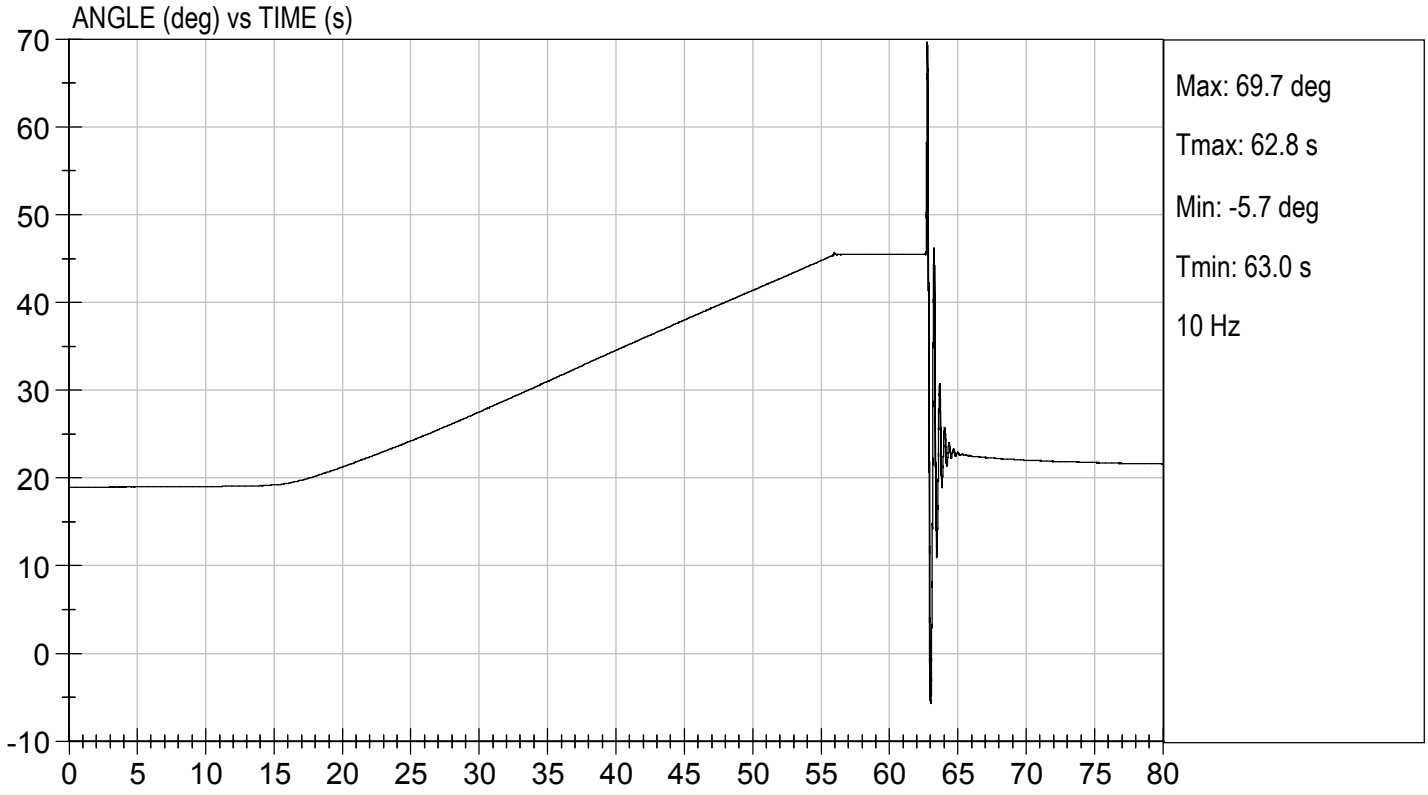
02/26/2021
Test Date

Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 02/26/2021
TEST #: D210587





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: DH1659 **Test ID:** D210811

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	39	Pass
Peak Resultant Acceleration	G's	250 to 300	256	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-11.4	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

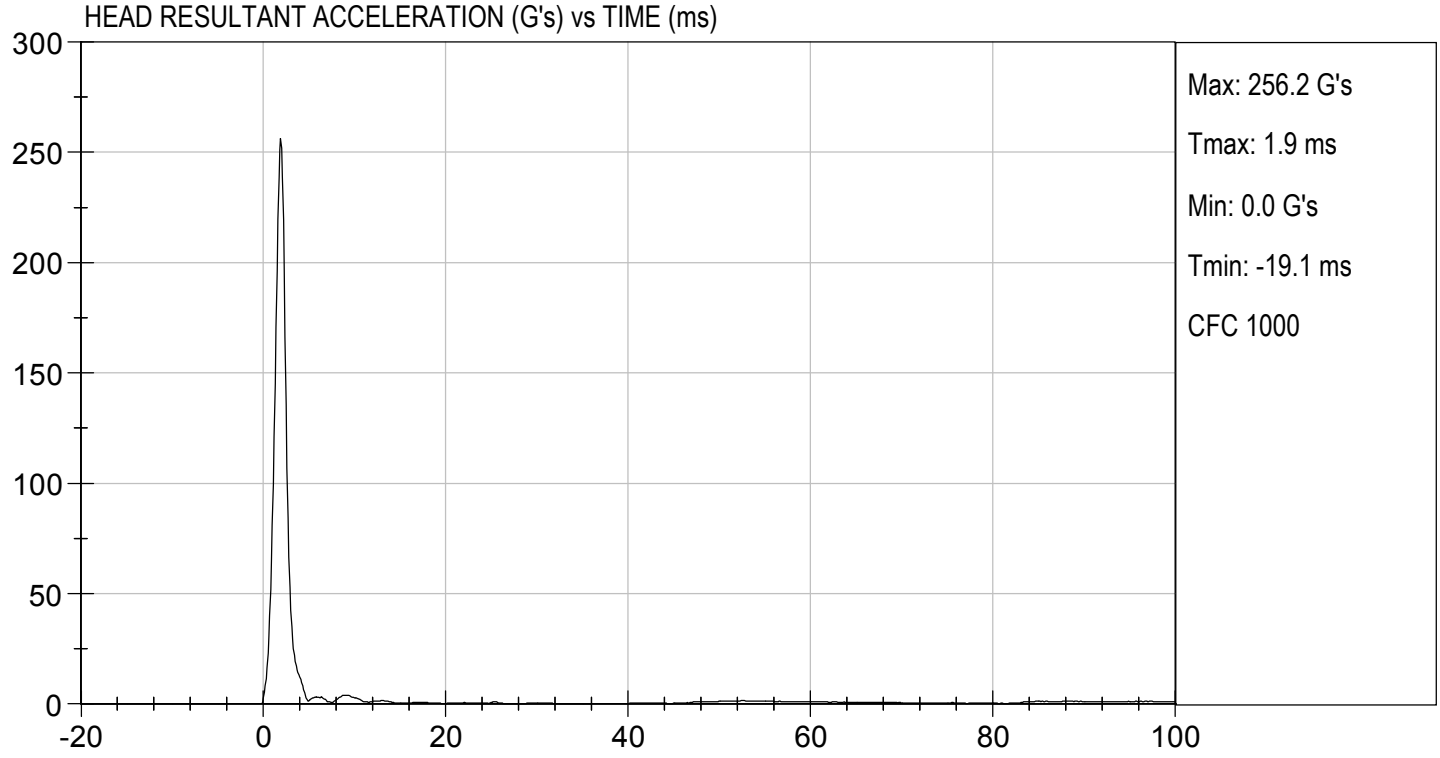
Laboratory Technician

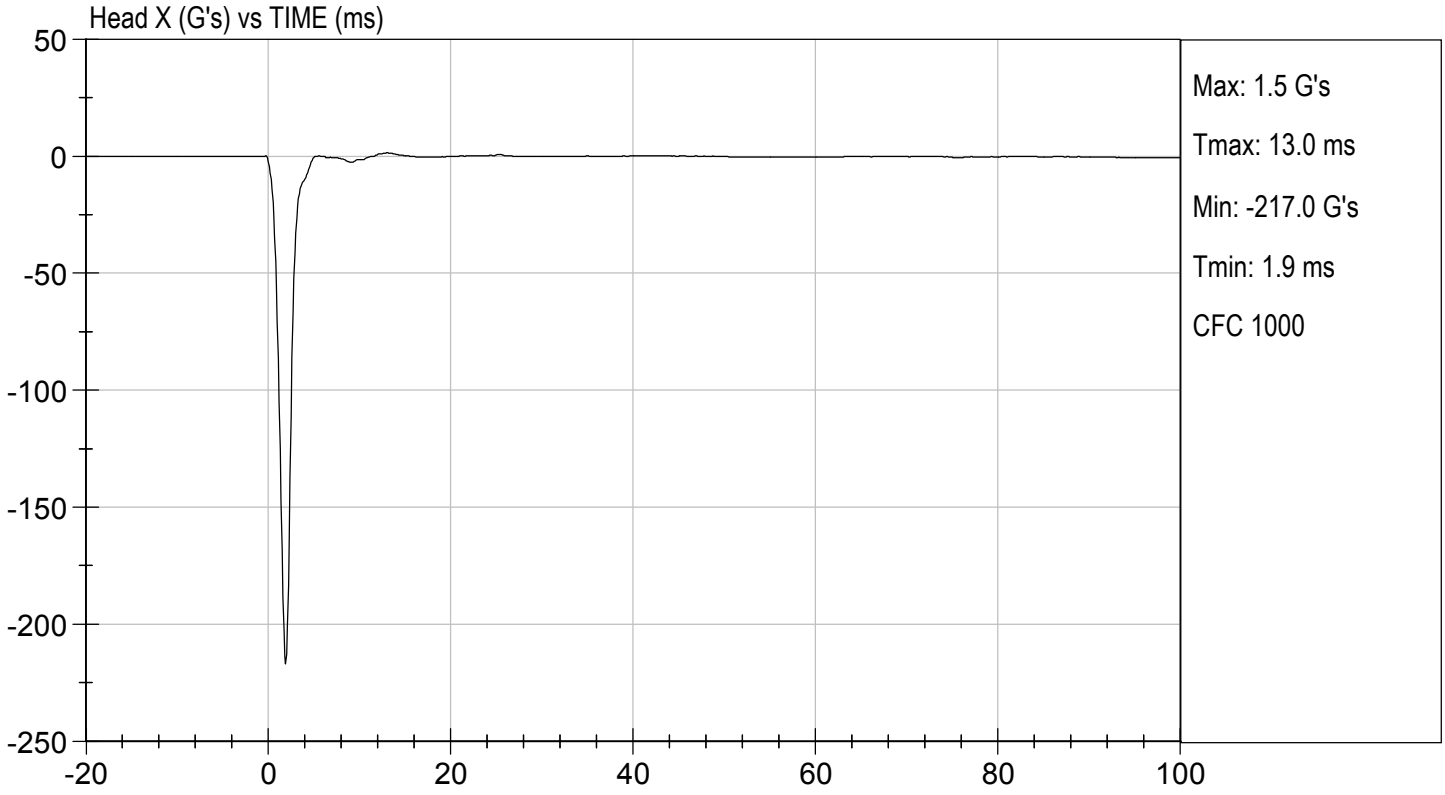
03/11/2021
Test Date

Approved By

TEST DESC: HEAD DROP

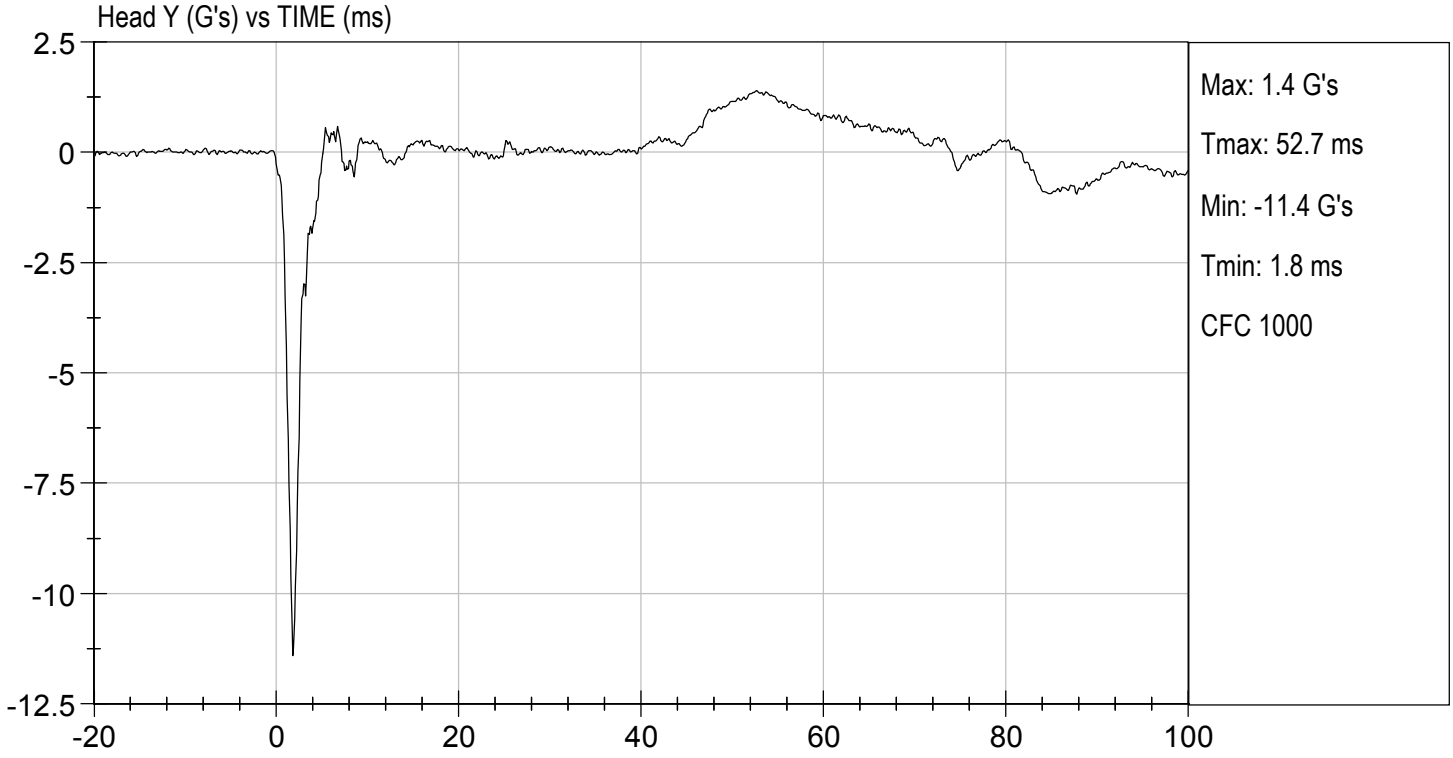
TEST DATE: 03/11/2021
TEST #: D210811

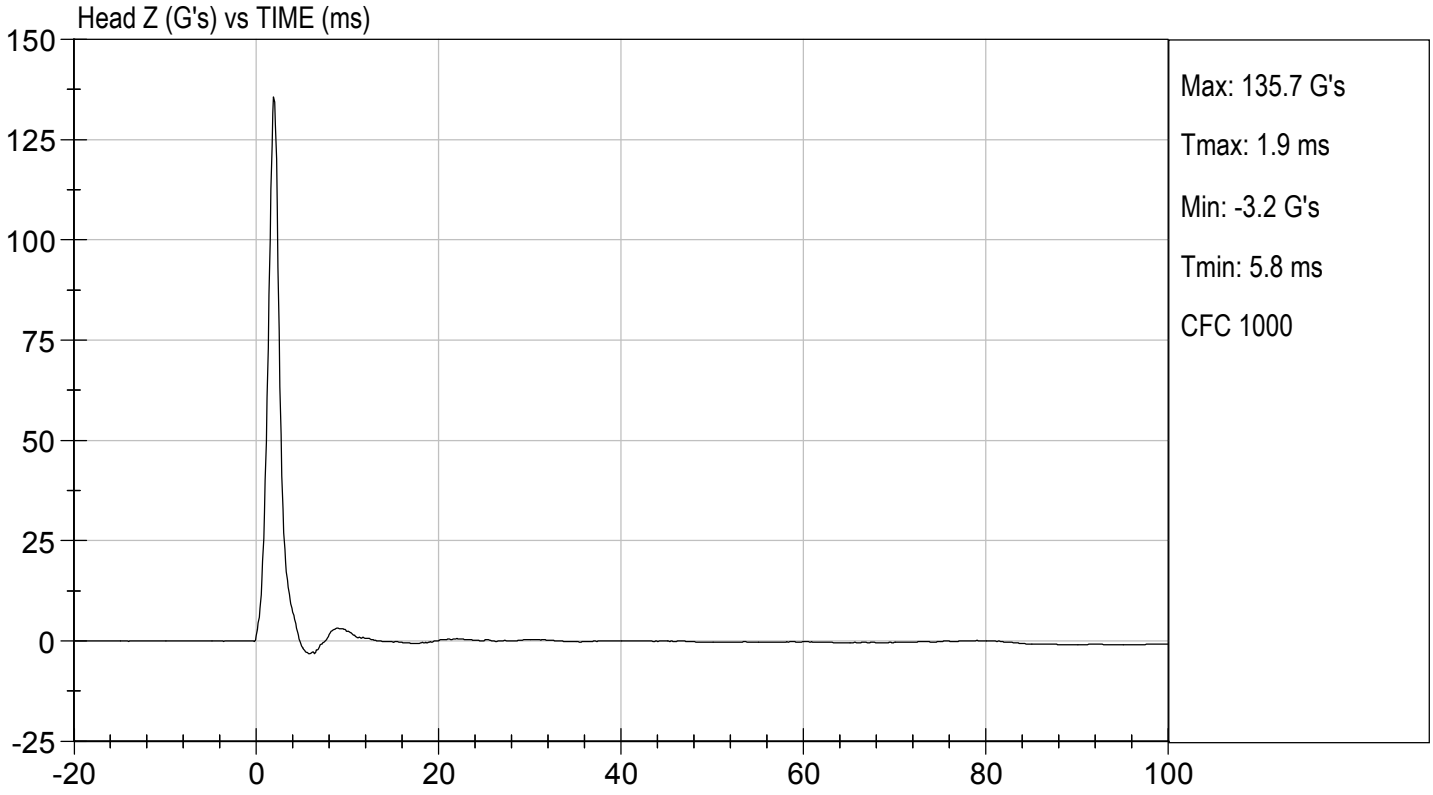




TEST DESC: HEAD DROP

TEST DATE: 03/11/2021
TEST #: D210811





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210812

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	39	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.13	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.4	Pass
	20 ms	m/s	4.0 to 5.0	4.7	Pass
	30 ms	m/s	5.8 to 7.0	7.0	Pass
D Plane Rotation	Max	deg	77 to 91	81	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	71	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	85	Pass
			Overall Results		Pass

Laboratory Technician

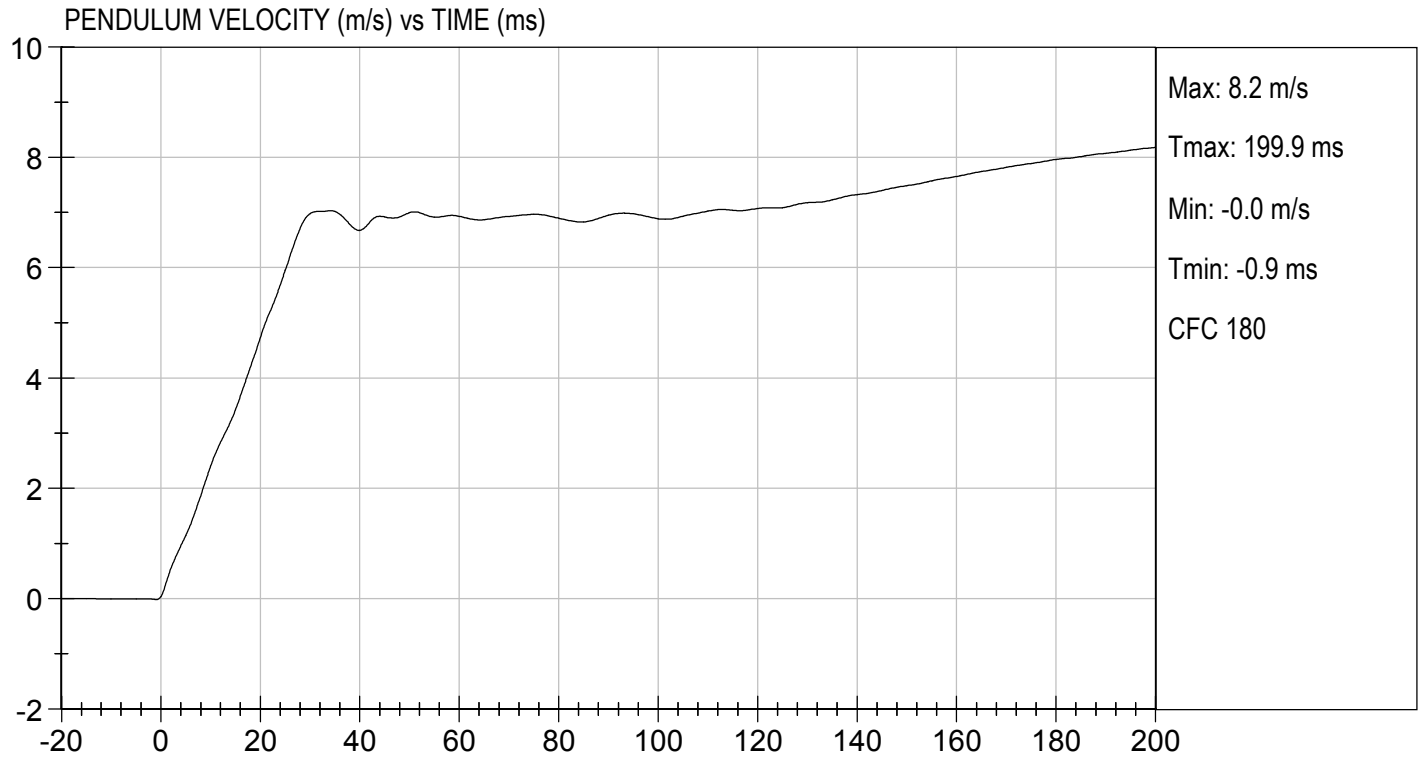
03/11/2021

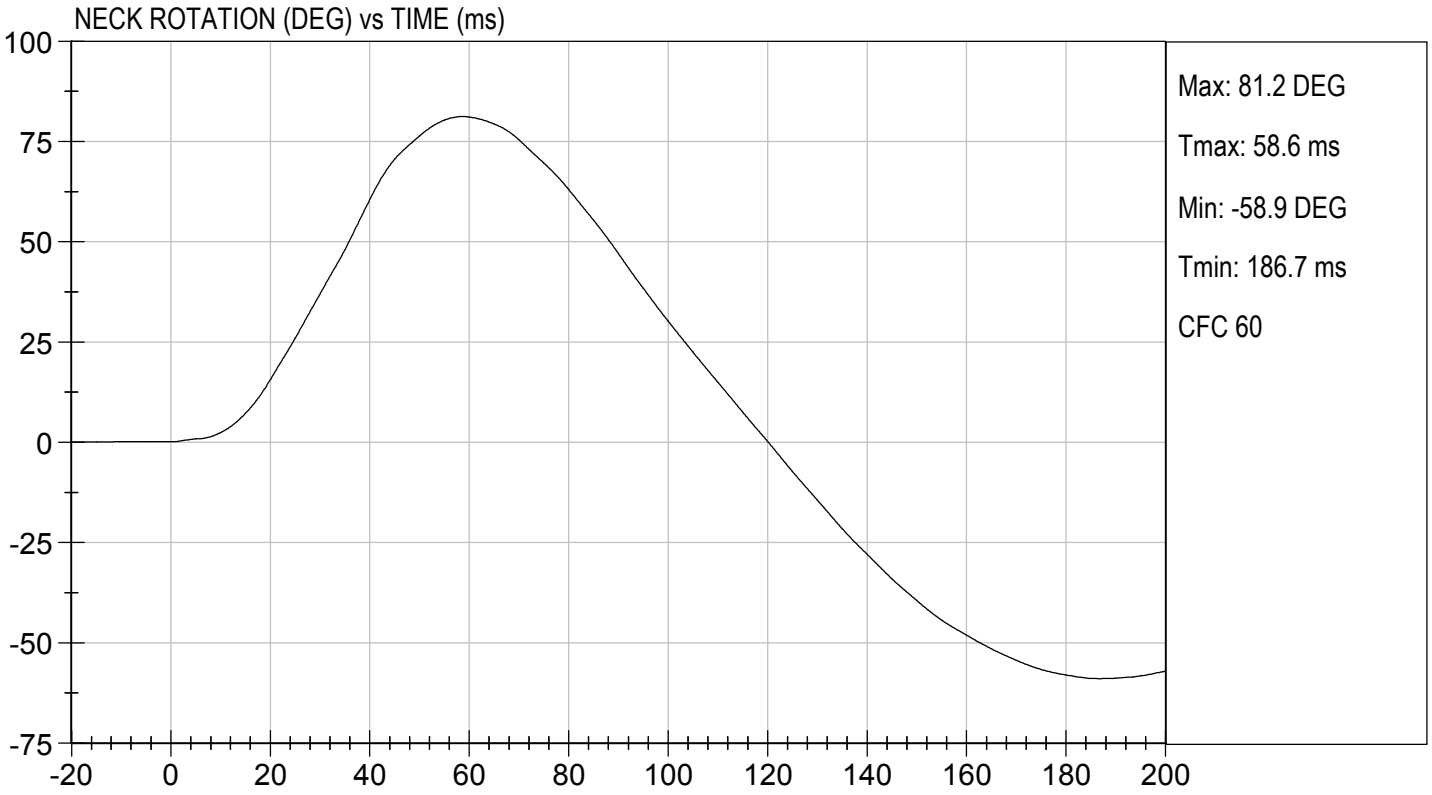
Test Date

Approved By

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

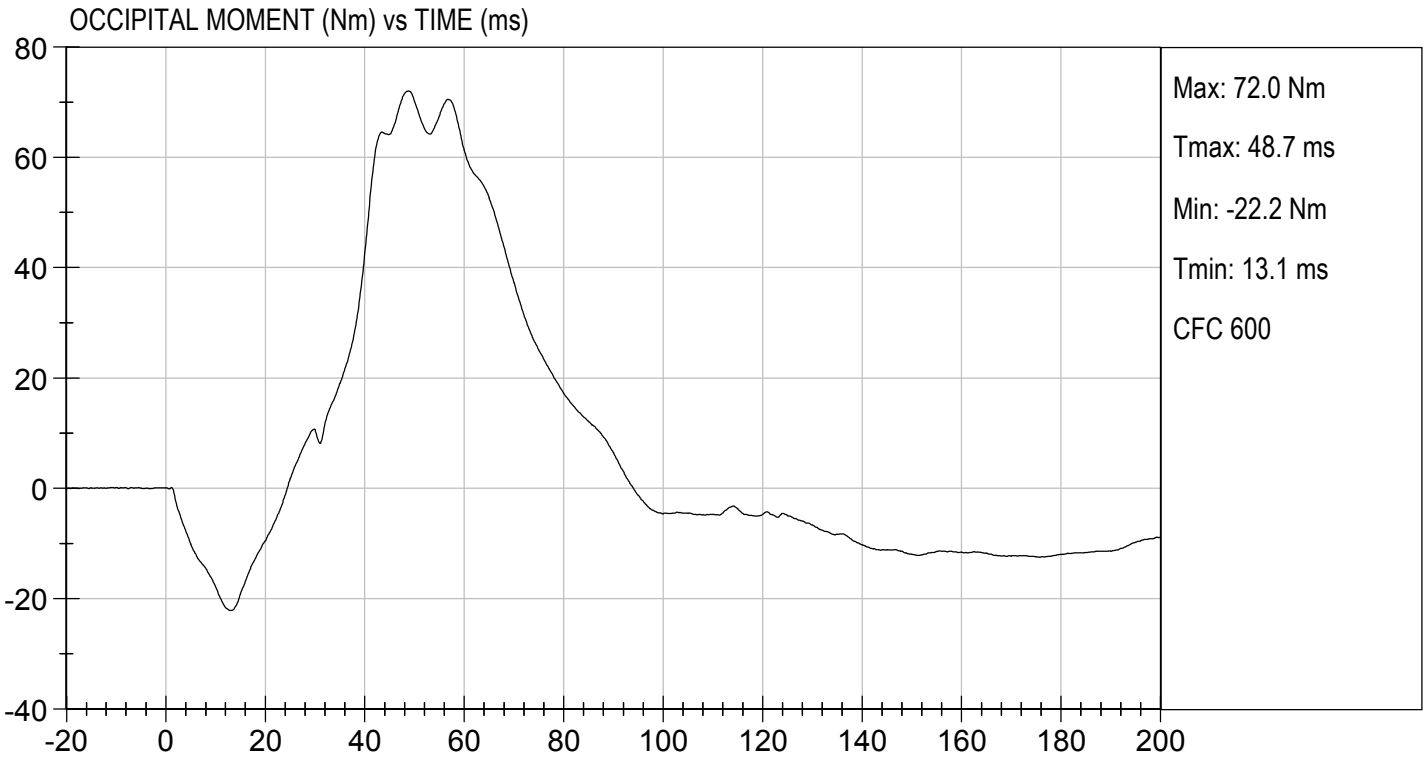
TEST DATE: 03/11/2021
TEST #: D210812





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

TEST DATE: 03/11/2021
TEST #: D210812



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210813

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	39	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.19	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.8	Pass
	20 ms	m/s	3.1 to 3.9	3.6	Pass
	30 ms	m/s	4.6 to 5.6	5.2	Pass
D Plane Rotation	Max	deg	99 to 114	111	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-53	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	107	Pass
			Overall Results		Pass

Laboratory Technician

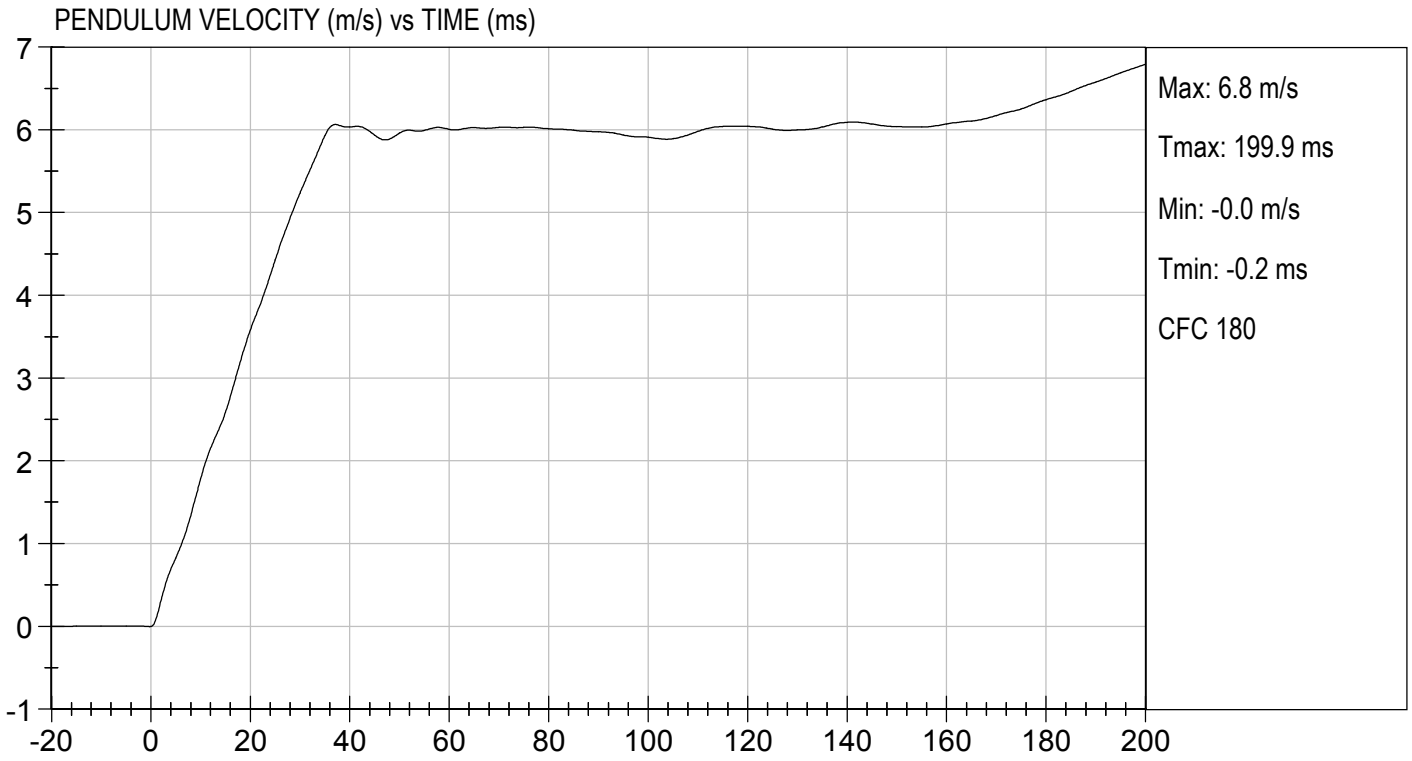
03/11/2021

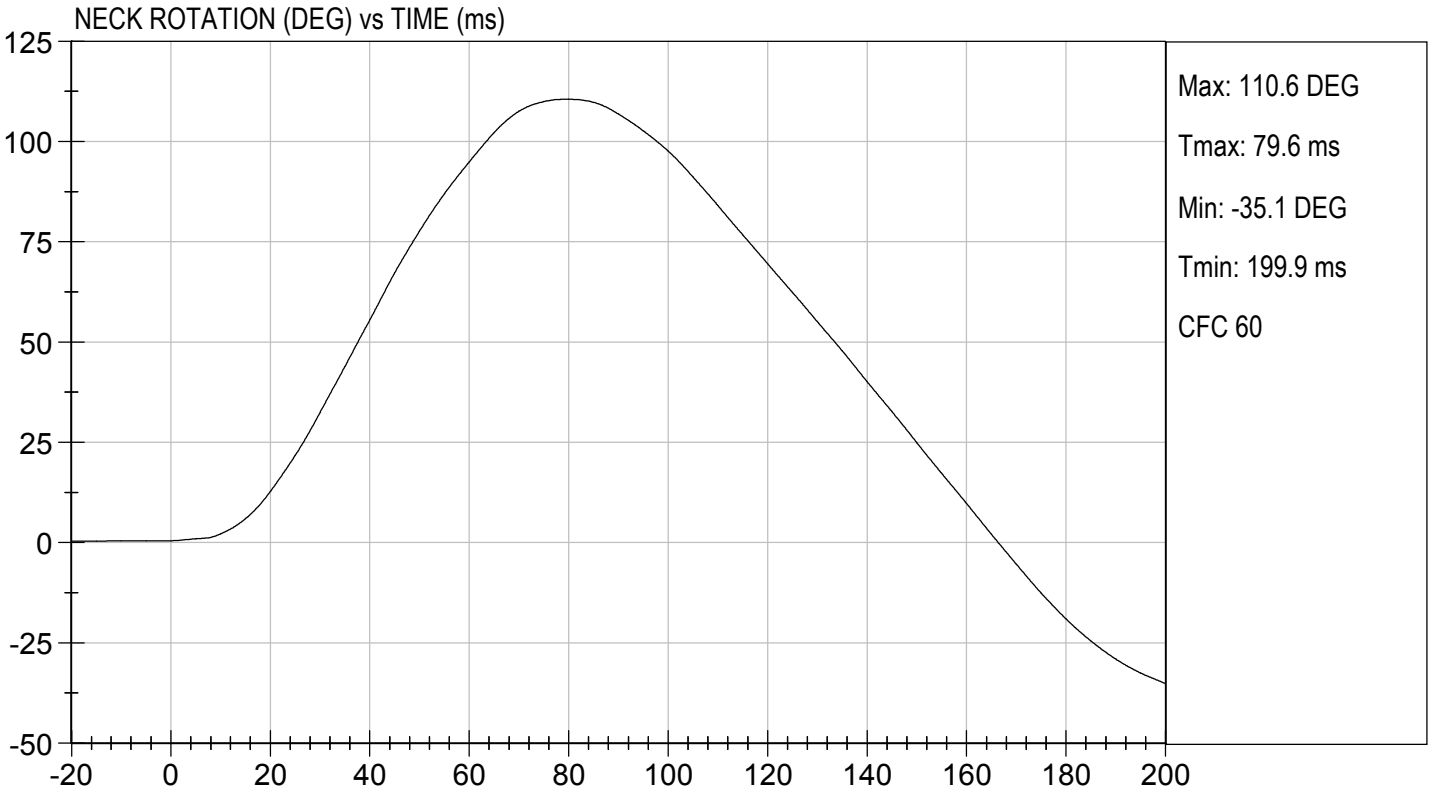
Test Date

Approved By

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

TEST DATE: 03/11/2021
TEST #: D210813





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

TEST DATE: 03/11/2021
TEST #: D210813

MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210814

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.6	Pass
Relative Humidity	%	10 to 70	27	Pass
Probe Speed	m/s	6.59 to 6.83	6.68	Pass
Peak Deflection	mm	50 to 58	50	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4179	Pass
Internal Hysteresis	%	69 to 85	75	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4518	Pass
		Overall Test Results		Pass

Alex Thomas

Laboratory Technician

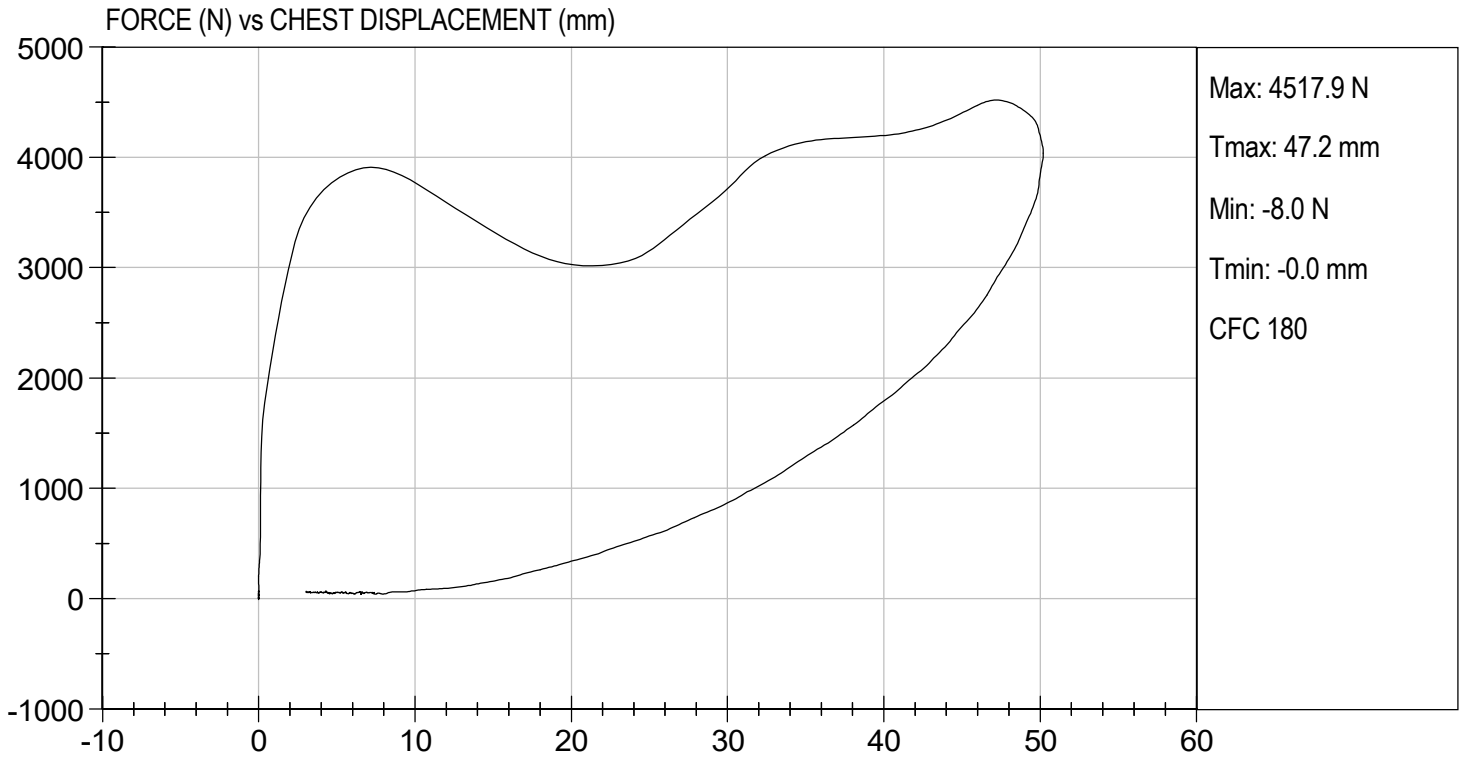
03/12/2021

Test Date

Approved By

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

TEST DATE: 03/12/2021
TEST #: D210814



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210815

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	38	Pass
Probe Speed	m/s	2.07 to 2.13	2.10	Pass
Maximum Force	N	3450 to 4060	3836	Pass
		Overall Test Results		Pass

Alex Thomas

Laboratory Technician

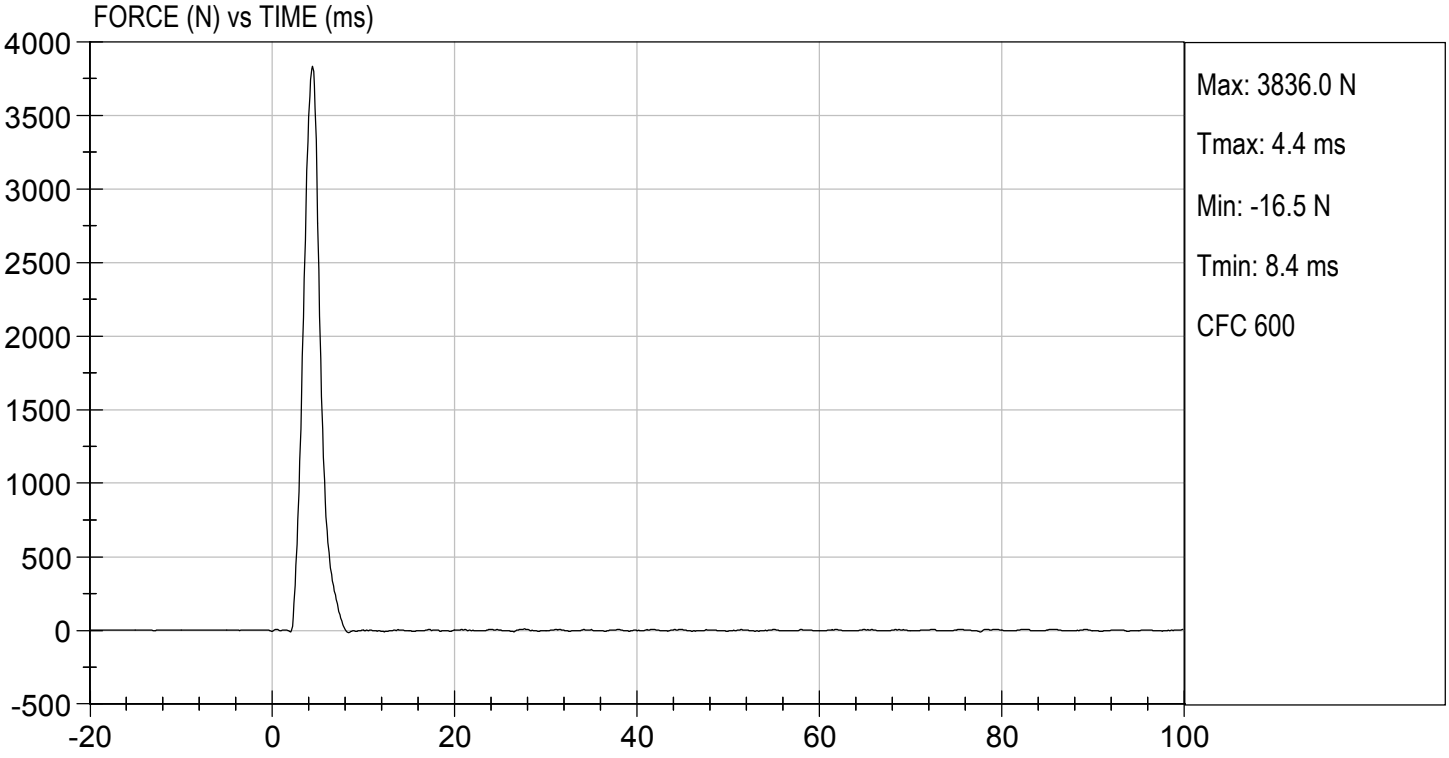
03/11/2021

Test Date

Approved By

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

TEST DATE: 03/11/2021
TEST #: D210815



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210816

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	38	Pass
Probe Speed	m/s	2.07 to 2.13	2.11	Pass
Maximum Force	N	3450 to 4060	3719	Pass
		Overall Test Results		Pass

Alex Thomas

Laboratory Technician

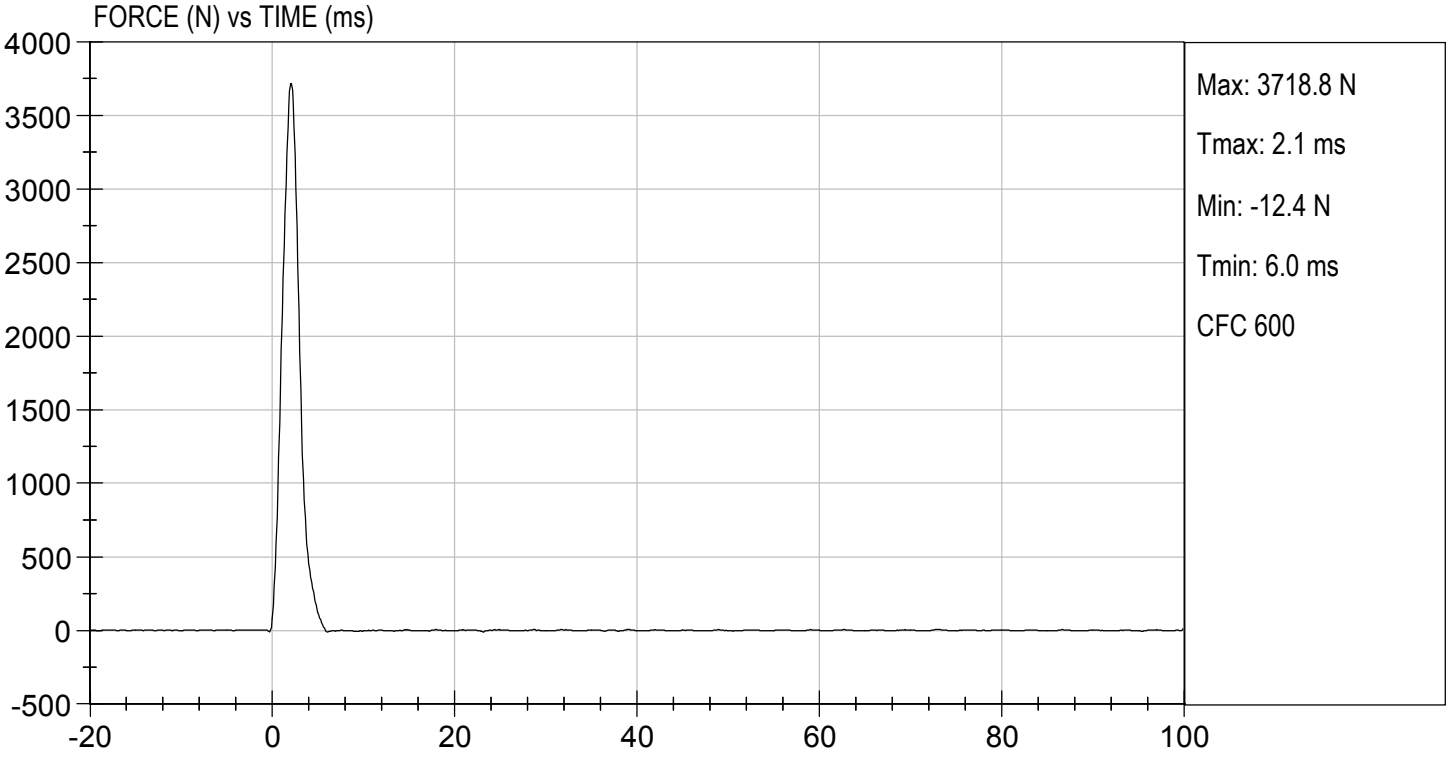
03/11/2021

Test Date

Approved By

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

TEST DATE: 03/11/2021
TEST #: D210816



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659 **Test I.D:** D210817

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	39	Pass
Initial Angle	deg	0 to 20	19	Pass
Return Angle	deg	+/- 8	2	Pass
Force at 45 deg	N	320 to 390	378	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.8	Pass
		Overall Result		Pass

Alex Thomas

Laboratory Technician

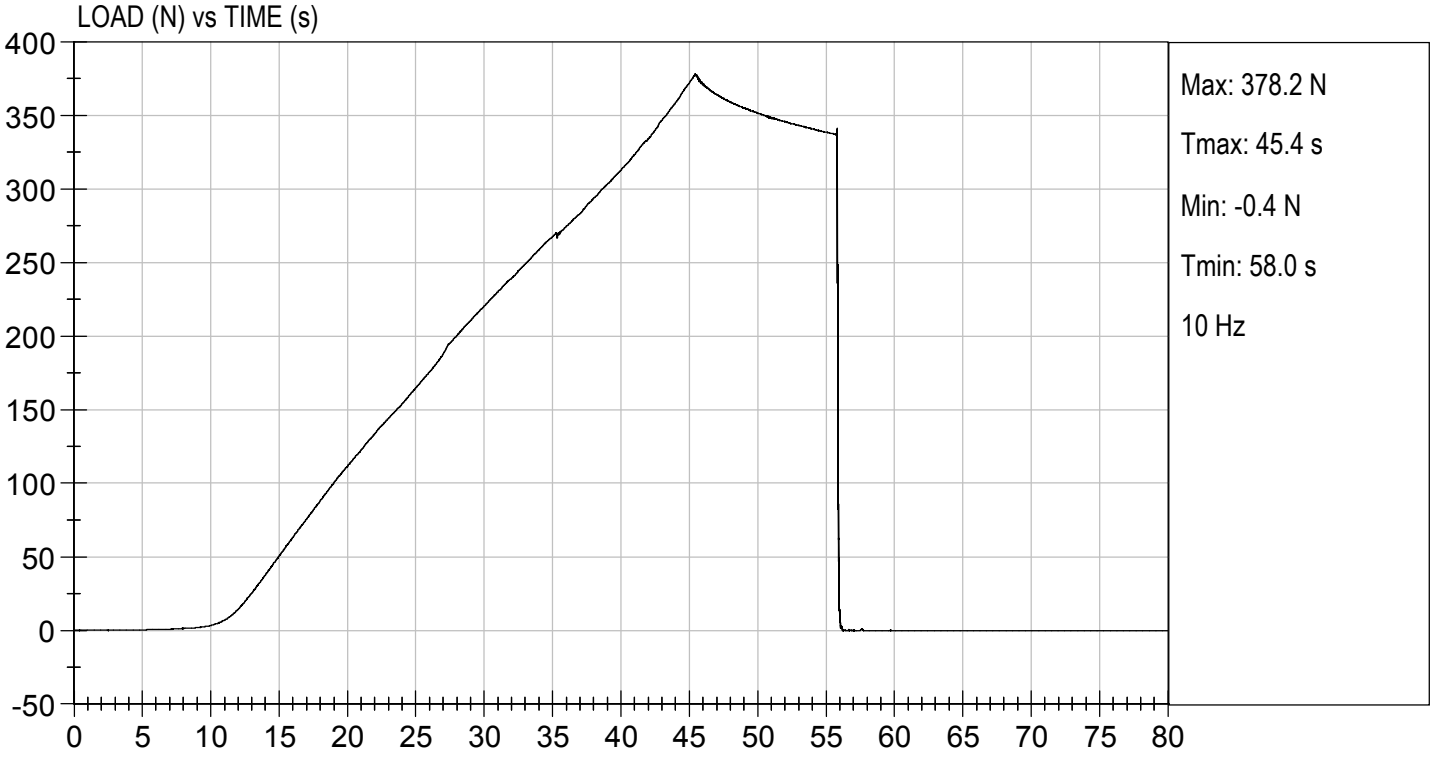
03/11/2021

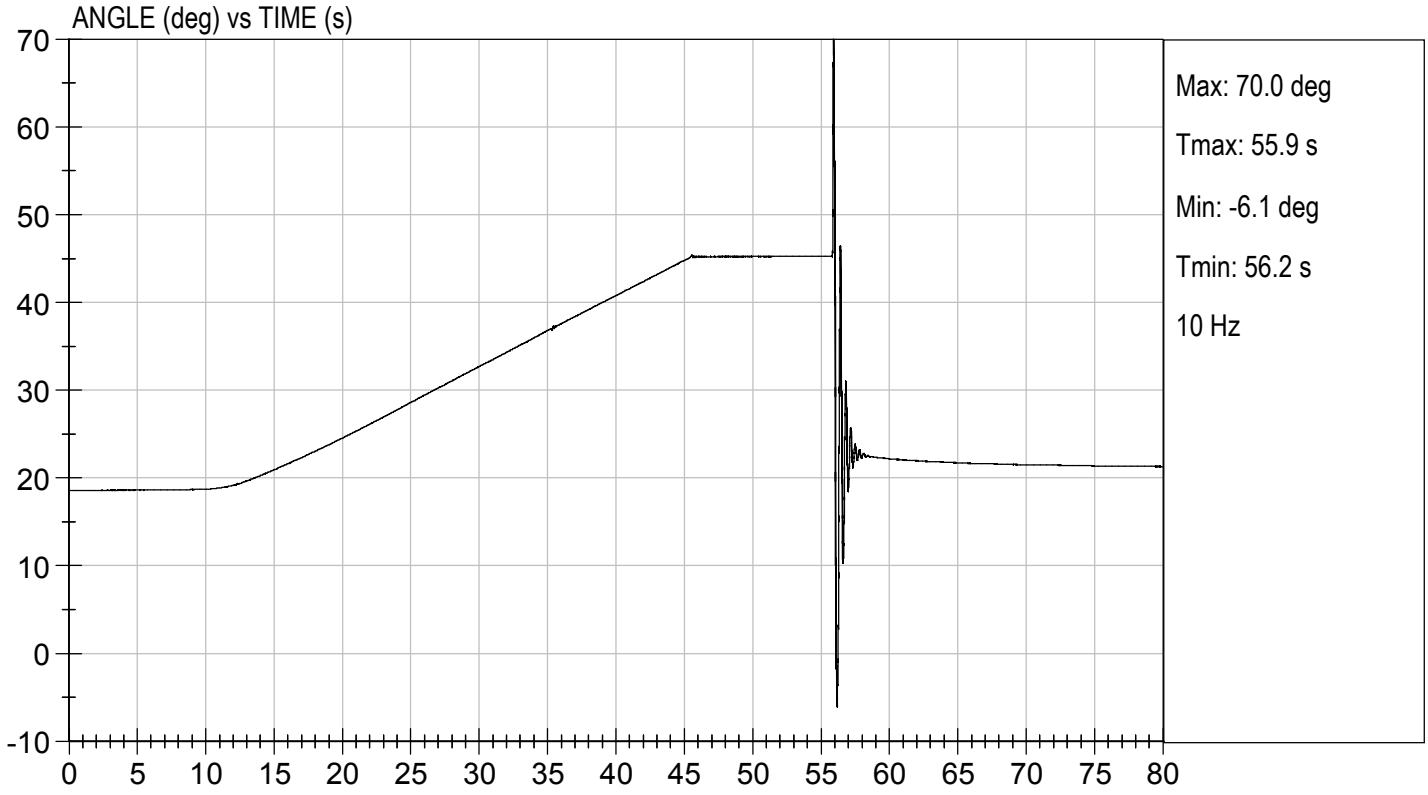
Test Date

Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 03/11/2021
TEST #: D210817





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	NG2203	Denton	02/10/2021
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	FG121	Denton	03/02/2021
		Redundant	Z	FG121	Denton	03/02/2021
	Left	Primary	Z	FG122	Denton	03/02/2021
		Redundant	Z	FG122	Denton	03/02/2021
Tibia Load Cells	Right	Upper	Mx, My, Fz	TG408	Denton	02/09/2021
		Lower	Mx, My, Fz	AG116	Denton	02/09/2021
	Left	Upper	Mx, My, Fz	TG480	Denton	02/09/2021
		Lower	Mx, My, Fz	AG502	Denton	02/09/2021
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 DH1659		
				Serial Number	Manufacturer	Calibration Date
Head Accelerometers		Primary	X	P97377	Endevco	02/10/2021
			Y	P94800	Endevco	02/10/2021
			Z	P94802	Endevco	02/10/2021
		Redundant	X	P94799	Endevco	02/10/2021
			Y	P94801	Endevco	02/10/2021
			Z	P94803	Endevco	02/10/2021
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	NG2256	Denton	05/04/2020
Chest Accelerometers		Primary	X	P94793	Endevco	02/10/2021
			Y	P95322	Endevco	02/10/2021
			Z	P88719	Endevco	02/10/2021
		Redundant	X	P94794	Endevco	02/10/2021
			Y	P95370	Endevco	02/10/2021
			Z	P94785	Endevco	02/10/2021
Chest Potentiometer			X	DH1659	Servo	02/10/2021
Pelvis Accelerometers			X	P94798	Endevco	02/10/2021
			Y	P97705	Endevco	02/10/2021
			Z	P82646	Endevco	02/10/2021
Femur Load Cells	Right	Primary	Z	FG126	Denton	02/10/2021
		Redundant	Z	FG126	Denton	02/10/2021
	Left	Primary	Z	FG127	Denton	02/10/2021
		Redundant	Z	FG127	Denton	02/10/2021
Tibia Load Cells	Right	Upper	Mx, My, Fz	TG467	Denton	05/04/2020
		Lower	Mx, My, Fz	AG491	Denton	05/04/2020
	Left	Upper	Mx, My, Fz	TG478	Denton	05/04/2020
		Lower	Mx, My, Fz	AG500	Denton	05/04/2020
Foot Accelerometers	Right	Rear	X	P94795	Endevco	02/10/2021
			Z	P94796	Endevco	02/10/2021
		Front	Z	P94797	Endevco	02/10/2021
	Left	Rear	X	P83167	Endevco	02/10/2021
			Z	P83168	Endevco	02/10/2021
		Front	Z	P83169	Endevco	02/10/2021
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	A370270	MSI	03/05/2021
			Z	A370260	MSI	03/05/2021
		Redundant	X	A370258	MSI	03/05/2021
	Right	Primary	X	A370271	MSI	03/05/2021
			Z	A377277	MSI	03/05/2021
		Redundant	X	A370274	MSI	03/05/2021
Engine Accelerometers		Top	X	A370389	MSI	03/05/2021
		Bottom	X	A305729	MSI	12/30/2020