

REPORT NUMBER: NCAP-MGA-21-033

**NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test**

**HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC
2021 Hyundai Elantra SEL 4-Door Sedan NCAP
NHTSA No.: O20214206**

**MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105**



Test Date: March 30, 2021

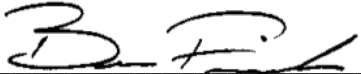
Final Report Date: July 21, 2021

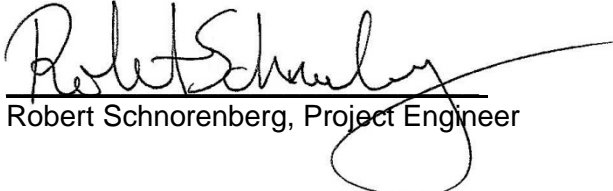
FINAL REPORT

**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**

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof.

If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Prepared by: 
Ben Fischer, Program Manager

Approved by: 
Robert Schnorenberg, Project Engineer

Approval Date: July 21, 2021

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date: _____

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

Date: _____

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NCAP-MGA-21-033	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 Hyundai Elantra SEL 4-Door Sedan NCAP, NHTSA No.: O20214206		5. Report Date July 21, 2021																																																							
		6. Performing Organization Code MGA																																																							
7. Author(s) Ben Fischer, Program Manager		8. Performing Organization Report No. NCAP-MGA-21-033																																																							
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 30, 2021 to July 21, 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 Hyundai Elantra SEL 4-Door Sedan NCAP in accordance with the specifications of the Office of Crashworthiness Standards Laboratory Procedure for NCAP Full Frontal Rigid Barrier Impact Testing. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on March 30, 2021. The impact velocity of the vehicle was 56.25 km/h and the ambient temperature at the barrier face at the time of impact was 21.3°C. The target vehicle post-test maximum crush was 530 mm located to the right of the vehicle centerline. The test vehicle's performance was as follows:																																																									
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th rowspan="2">Units</th> <th colspan="2">Driver ATD</th> <th colspan="2">Passenger ATD</th> </tr> <tr> <th>Threshold</th> <th>Result</th> <th>Threshold</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₁₅)</td> <td></td> <td>700</td> <td>142</td> <td>700</td> <td>314</td> </tr> <tr> <td>Maximum Chest Compression</td> <td>mm</td> <td>63</td> <td>28</td> <td>52</td> <td>14</td> </tr> <tr> <td>Nij</td> <td></td> <td>1</td> <td>0.21</td> <td>1</td> <td>0.42</td> </tr> <tr> <td>Neck Tension</td> <td>N</td> <td>4170</td> <td>1193</td> <td>2620</td> <td>787</td> </tr> <tr> <td>Neck Compression</td> <td>N</td> <td>4000</td> <td>229</td> <td>2520</td> <td>252</td> </tr> <tr> <td>Left Femur Force</td> <td>N</td> <td>10008</td> <td>292</td> <td>6805</td> <td>600</td> </tr> <tr> <td>Right Femur Force</td> <td>N</td> <td>10008</td> <td>212</td> <td>6805</td> <td>270</td> </tr> </tbody> </table>						Measurement Description	Units	Driver ATD		Passenger ATD		Threshold	Result	Threshold	Result	Head Injury Criteria (HIC ₁₅)		700	142	700	314	Maximum Chest Compression	mm	63	28	52	14	Nij		1	0.21	1	0.42	Neck Tension	N	4170	1193	2620	787	Neck Compression	N	4000	229	2520	252	Left Femur Force	N	10008	292	6805	600	Right Femur Force	N	10008	212	6805	270
Measurement Description	Units	Driver ATD		Passenger ATD																																																					
		Threshold	Result	Threshold	Result																																																				
Head Injury Criteria (HIC ₁₅)		700	142	700	314																																																				
Maximum Chest Compression	mm	63	28	52	14																																																				
Nij		1	0.21	1	0.42																																																				
Neck Tension	N	4170	1193	2620	787																																																				
Neck Compression	N	4000	229	2520	252																																																				
Left Femur Force	N	10008	292	6805	600																																																				
Right Femur Force	N	10008	212	6805	270																																																				
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

<u>Section</u>		<u>Page No.</u>
1	Purpose and Summary of Test	1
2	Occupant and Vehicle Information / Data Sheets	3
<u>Data Sheet No.</u>		<u>Page No.</u>
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
<u>Appendix</u>		
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 Hyundai Elantra SEL 4-Door Sedan NCAP at a velocity of 56.25 km/h. The test was performed at MGA Research Corporation on March 30, 2021. Pre-test and post-test photographs of the vehicle and dummies can be found in Appendix A.

Two (2) real-time cameras and sixteen (16) high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in this report.

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

Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometers, upper neck transducers, right/left femur load cells, and lower leg instrumentation. Seat belt load cells were installed on the driver's lap and shoulder belts and passenger's shoulder belt to measure dummy torso and pelvic section loading.

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

The 633 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 530 mm located to the right of the vehicle centerline and both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

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

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

The occupant data is summarized below:

ATD position	HIC₁₅	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (g)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50 th)	142	0.21	1193	229	40.7	28	292	212
Passenger (5 th)	314	0.42	787	252	47.0	14	600	270

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

TEST NOTES

Bottom of Engine X recorded no valid data after 57 ms.

Passenger Lap Belt load cell was not installed.

Barrier C-01 Fx recorded no valid data.

Barrier C-01 Mz recorded questionable data.

Barrier C-02 Fx recorded questionable data.

Barrier C-02 My recorded questionable data.

Barrier F-01 Mz recorded questionable data.

Barrier I-05 My recorded no valid data.

Barrier J-04 My recorded questionable data.

Barrier K-03 Fx recorded questionable data.

Barrier K-15 My recorded no valid data.

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	O20214206	Traction Control System (TCS)	Yes
Model Year	2021	Power Steering	Yes
Make	Hyundai	Power Window Auto-Reverse	Yes
Model	Elantra SEL	Driver Frontal Airbag	Yes
Body Style	4-Door Sedan	Driver Curtain Airbag	Yes
VIN	5NPLS4AG0MH008859	Driver Head/Torso Airbag	No
Body Color	Shimmering Silver Pearl	Driver Torso Airbag	No
Odometer (km/mi)	23 km / 14 mi	Driver Torso/Pelvis Airbag	Yes
Engine Displacement (L)	2.0 L	Driver Pelvis Airbag	No
Type/No. Cylinders	Inline 4	Driver Knee Airbag	No
Engine Placement	Lateral	Front Pass. Frontal Airbag	Yes
Transmission Type	Automatic	Front Pass. Curtain Airbag	Yes
Transmission Speeds	CVT	Front Pass. Head/Torso Airbag	No
Overdrive	Yes	Front Pass. Torso Airbag	No
Final Drive	FWD	Front Pass. Torso/Pelvis Airbag	Yes
Roof Rack	No	Front Pass. Pelvis Airbag	No
Sunroof/T-Top	No	Front Pass. Knee Airbag	No
Running Boards	No	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?	No
--	----

DATA FROM CERTIFICATION LABEL

Manufactured By	HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC	GVWR (kg)	1750
		GAWR Front (kg)	1030
Date of Manufacture	Nov/03/20	GAWR Rear (kg)	950

VEHICLE SEATING AND WEIGHT CAPACITY DATA

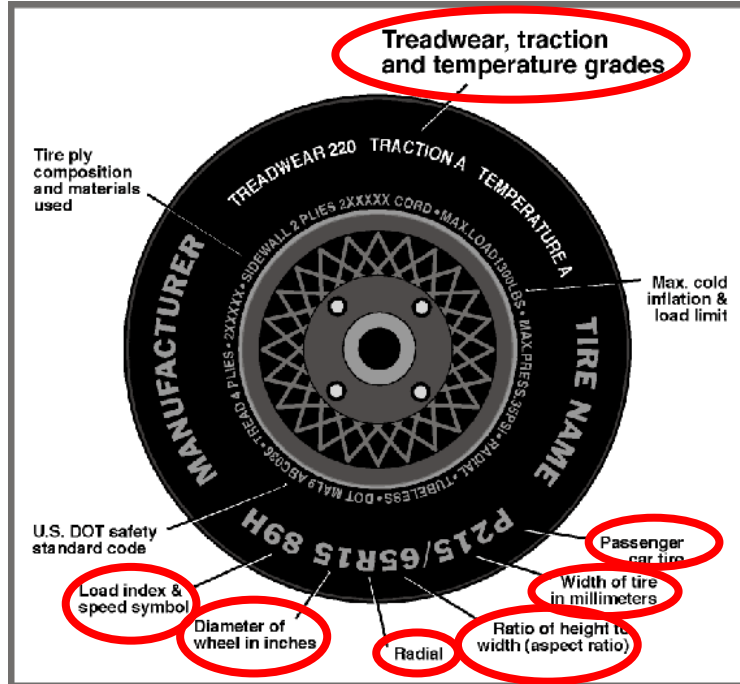
Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Contoured		
Designated Seating Capacity (DSC)	2	3		5
Capacity Weight (VCW) (kg)				385
Cargo Weight (RCLW) (kg)				45

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	235	215
Recommended Tire Size	205/55R16	205/55R16
Tire Size on Vehicle	205/55R16	205/55R16
Tire Manufacturer	Kumho	Kumho
Tire Model	Solus	Solus
Treadwear	500	500
Traction	A	A
Temperature Grade	A	A
Tire Plies Sidewall	1 Polyester	1 Polyester
Tire Plies Body	2 Steel, 1 Polyester, 1 Nylon	2 Steel, 1 Polyester, 1 Nylon
Load Index/Speed Symbol	91H	91H
Tire Material	Rubber	Rubber
DOT Safety Code Left	000 LMYAY1 4320	000 LMYAY1 4320
DOT Safety Code Right	000 LMYAY1 4320	000 LMYAY1 4320

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	400.5	241.5		434.5	308.5	
Right	kg	380.0	250.5		400.5	308.5	
Ratio	%	61.3%	38.7%		57.5%	42.5%	
Totals	kg	780.5	492.0	1272.5	835.0	617.0	1452.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1272.5
Weight of 1 P572E ATD & 1 P572O ATD	kg	141
Rated Cargo/Luggage Weight (RCLW)	kg	45
Calculated Test Vehicle Target Weight (TVTW)	kg	1458.5

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	667	672	676	676	1052
As Tested	mm	657	662	638	650	1156
Post Test	mm	686	724	625	650	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2720
Total Vehicle Length at Left Side	mm	4588
Total Vehicle Length at Centerline	mm	4681
Total Vehicle Length at Right Side	mm	4588
Weight of Ballast in Cargo Area	kg	2
Weight of Vehicle Components Removed	kg	20
Amount of Stoddard Solvent in Fuel Tank	L	43.5

List of components removed to meet test weight: None.

List of components removed for instrumentation, data box, and equipment installation: Cargo area carpet/trim/divider, jack and tools, spare tire, RR taillight.

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

TARGET VEHICLE STRUCTURAL MEASUREMENT

	Elements	Pre-Test (mm)
1	Total Length	4681
2	Total Width	1833
3	Bumper Top Height	510
4	Bumper Bottom Height	400
5	Longitudinal Member Top Height	520
6	Distance between Longitudinal Members	959
7	Longitudinal Member Width	57
8	Engine Top Height	800
9	Engine Bottom Height	180
10	Engine and Gearbox Width	830
11	Front Bumper-Engine Distance	560
12	Front Shock Absorber Fixing Height	845
13	Bonnet Leading Edge Height	713
14	Front Shock Absorber Fixing Width	1170
15	Front Bumper – Front Axle Distance	890
16	Front Axle – A-Pillar Distance	417
17	A-Pillar – B-Pillar Distance	1157
18	B-Pillar – Rear Axle Distance	1145
19	B-Pillar – C-Pillar Distance	727
20	Roof Sill Bottom Height	1240
21	Roof Sill Top Height	1322
22	Floor Sill Bottom Height	180
23	Floor Sill Top Height	350

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

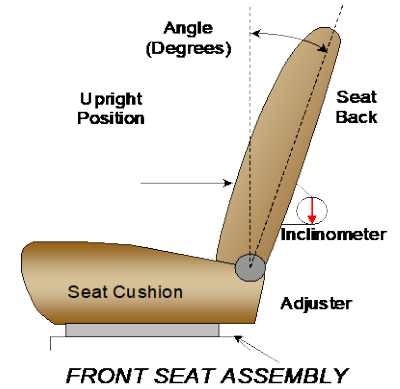
Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

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	0.3° on outboard headrest post
Passenger Seat Back Angle	-1.5° on outboard headrest post



SEAT FORE/AFT POSITIONS

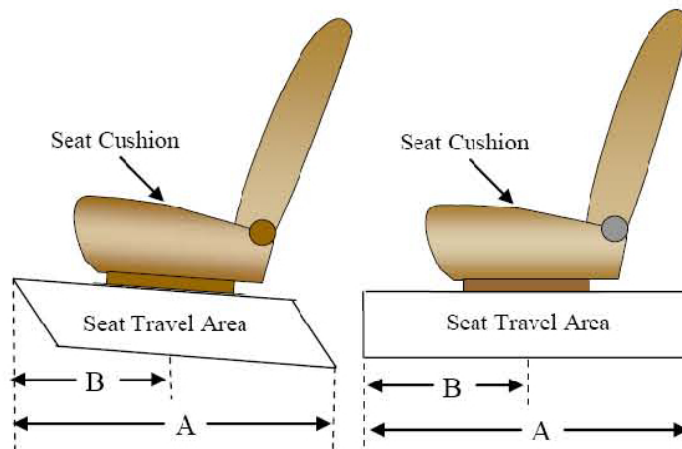
The driver and passenger seat fore/aft positions are adjusted following Appendix F, “Driver & Passenger Dummy Seating & Positioning Procedures” in the NCAP Test Procedure dated May 2018.

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	322 mm / 41 detents (1 st as 1)	161 mm / 15 th detent (1 st as 0)
Passenger Seat	260 mm / 41 detents (1 st as 1)	0 mm / 0 th detent (1 st 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	3 (1 st as 1)	0 (1 st as 0)
Passenger Seat	3 (1 st as 1)	0 (1 st as 0)



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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

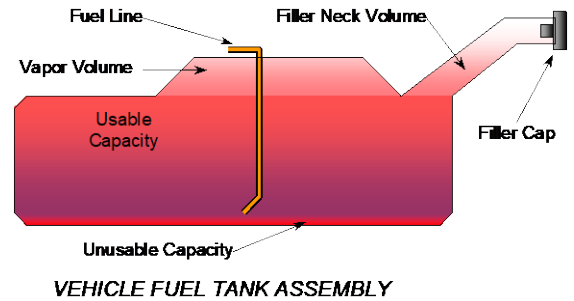
NHTSA No.: O20214206
 Test Date: 3/30/2021

FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	46.9
Usable Capacity of "Optional Tank"	
92-94% of Usable Capacity	43.1 to 44.1
Actual Amount of Solvent used	43.5
1/3 of Usable Capacity	15.6

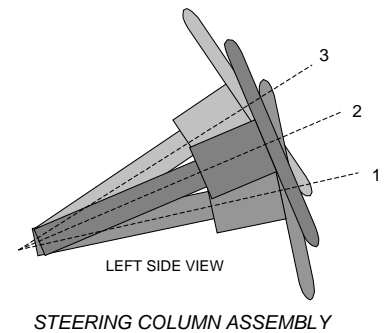
FUEL PUMP

The vehicle is equipped with an electronic fuel pump. The fuel pump will run when the engine is running. The filler neck is located on the driver's side.



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.



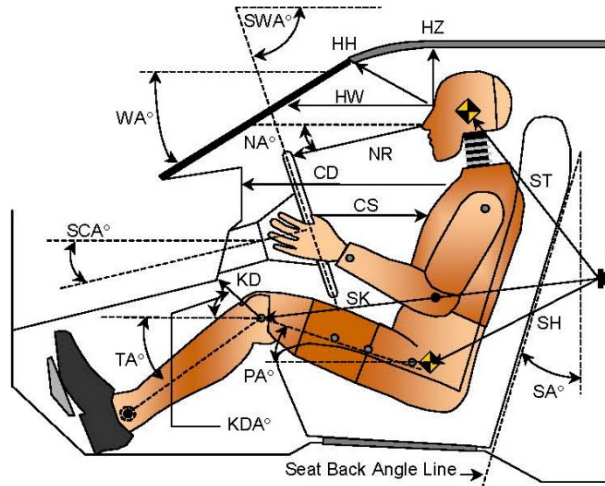
STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost Position 1	70.1	
Geometric Center Position 2	67.5	
Uppermost Position 3	64.8	
Telescoping Steering Wheel Travel		58
Test Position	67.5	29

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
Test Date: 3/30/2021



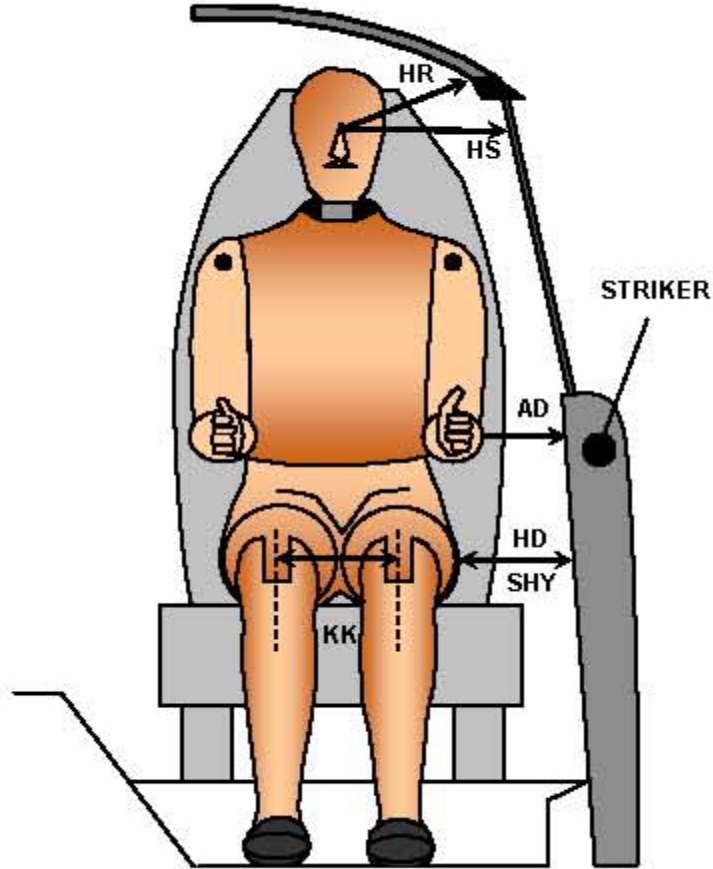
LEFT SIDE VIEW

Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		22.5		
SWA°	Steering Wheel Angle		67.5		
SCA°	Steering Column Angle		22.5		
SA°	Seat Back Angle		0.3		-1.5
HZ	Head to Roof (Z)	151	90	209	90
HH	Head to Header	315	23.3	283	40.2
HW	Head to Windshield	612	0	670	0
NR	Nose to Rim	367	6.6		
CD	Chest to Dash	510		423	
CS	Chest to Steering Hub	291	1.4		
RA	Rim to Abdomen	205	0		
KDL	Left Knee to Dash	196	28.7	135	36.5
KDR	Right Knee to Dash	182	28.2	145	34.4
PA°	Pelvic Angle		24.8		22.0
TA°	Tibia Angle		41.3		38.6
SK	Striker to Knee	605	100.7	675	103.2
ST	Striker to Head	390	11.4	362	34.1
SH	Striker to H-Point	394	137.2	408	122.0

**DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021



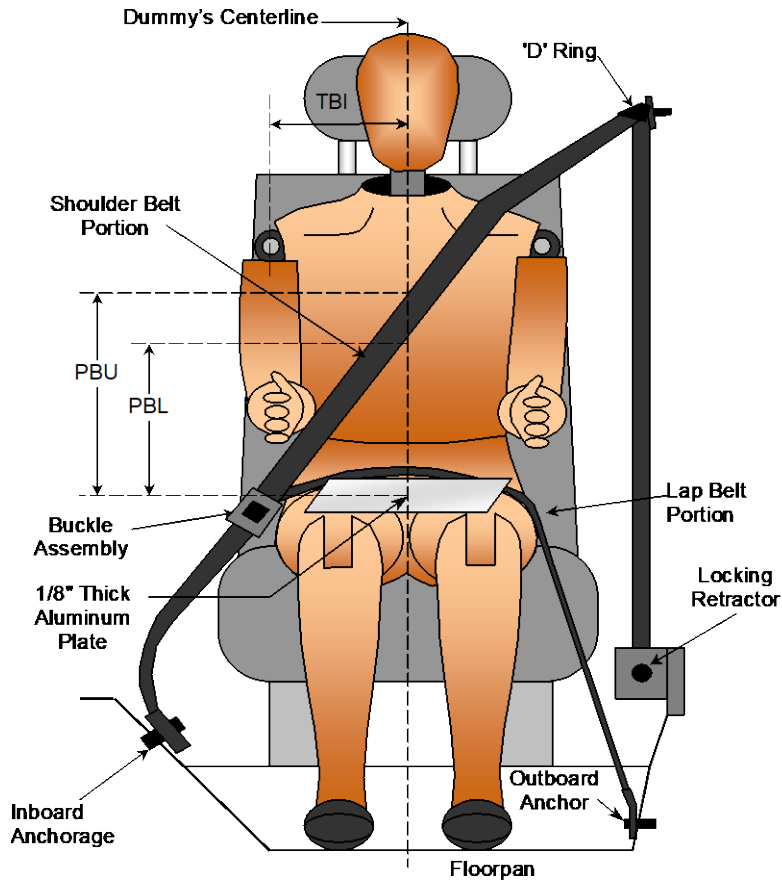
FRONT VIEW OF DUMMY

Code	Measurement Description	Driver	Passenger
		Length (mm)	
AD	Arm to Door	58	91
HD	H-Point to Door	131	174
HR	Head to Side Header	218	263
HS	Head to Side Window	357	385
KK	Knee to Knee	363	227
SHY	Striker to H-Point (Y Direction)	260	325
AA	Ankle to Ankle	360	175

**DATA SHEET NO. 5
SEAT BELT POSITIONING DATA**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	350	315
PBL - Top surface of reference to belt lower edge	mm	280	225

BELT LENGTH DATA

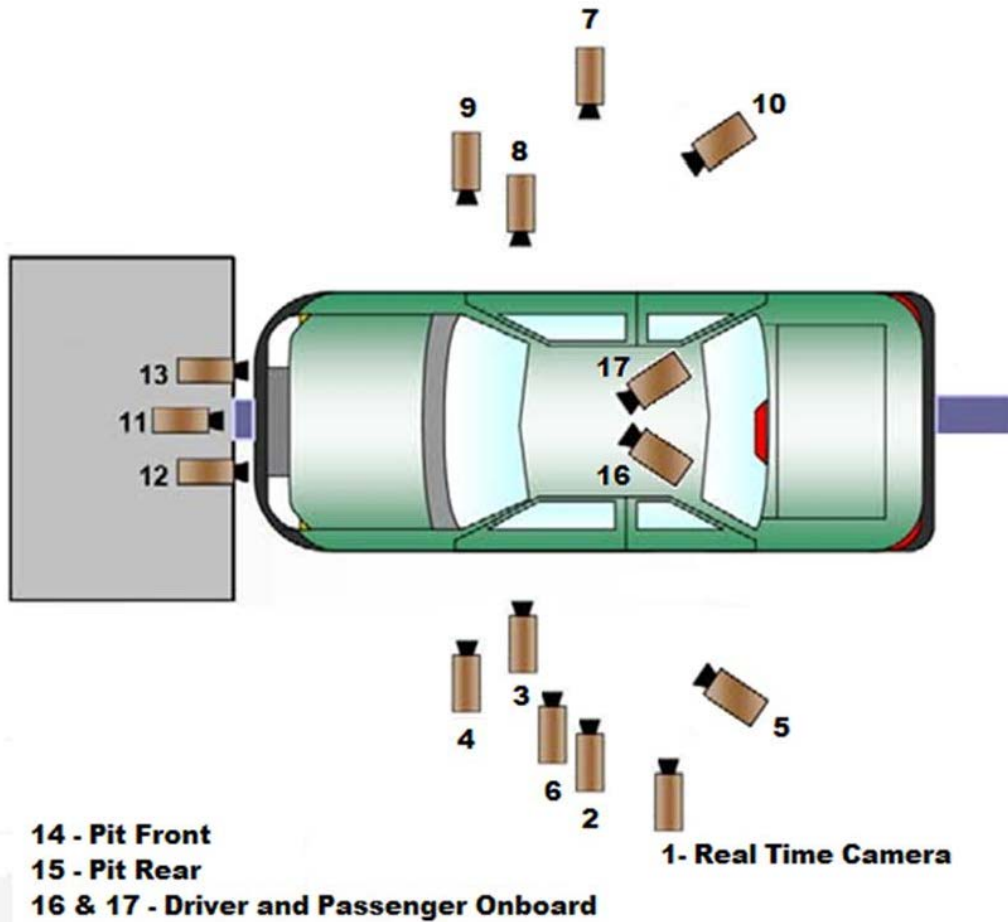
Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	885	920
Lap Belt Length as measured on ATD	mm	765	845
Remainder of belt on reel	mm	1000	885
Total Belt Length for Continuous Webbing Systems	mm	3200	3200

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
Test Date: 3/30/2021

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

CAMERA LOCATIONS

No.	Camera View	Coordinates* (mm)			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Real-Time Left Overall					30
2	Left Overall	-2320	-5800	-1340	12	1000
3	Driver Close-Up	-1530	-6480	-1760	50	1000
4	Left Front Half	-1350	-5260	-1280	24	1000
5	Left Angle	-7400	-5700	-1790	75	1000
6	Steering Column	-1010	-5460	-1250	50	1000
7	Right Overall	-2200	5870	-1300	12	1000
8	Passenger Close-Up	-1610	6530	-1800	50	1000
9	Right Front Half	-1140	5420	-1230	24	1000
10	Right Angle	-7380	5480	-1820	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	-870	0	3340	24	1000
15	Pit Rear	-2890	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

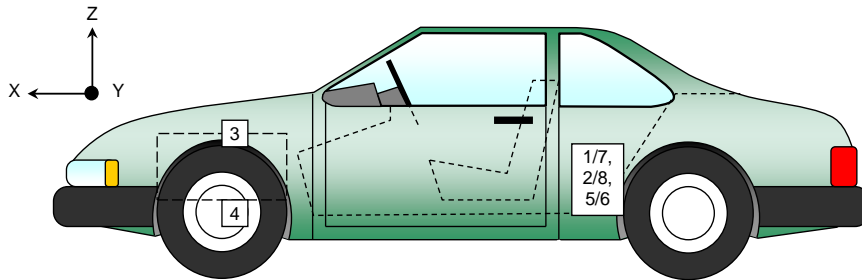
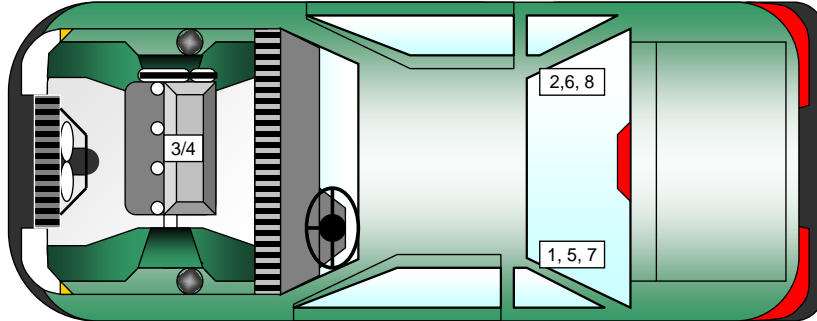
+Y = right of monorail centerline

+Z = below ground level

**DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021



VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Crossmember Accelerometer – X Direction	1887	-380	-230
2	Right Rear Crossmember Accelerometer – X Direction	1892	350	-230
3	Engine Top X	3984	-83	-800
4	Engine Bottom X	4127	50	-226
5	Left Rear Crossmember Accelerometer – Z Direction	1887	-380	-230
6	Right Rear Crossmember Accelerometer – Z Direction	1892	350	-230
7	Left Rear Crossmember Accelerometer Redundant – X Direction	1887	-345	-230
8	Right Rear Crossmember Accelerometer Redundant – X Direction	1892	392	-230

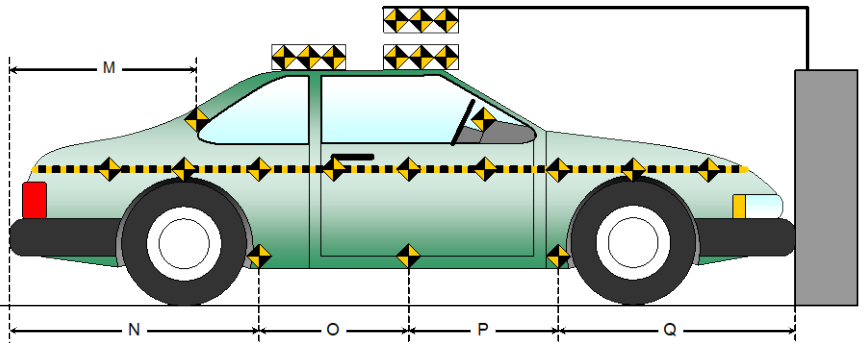
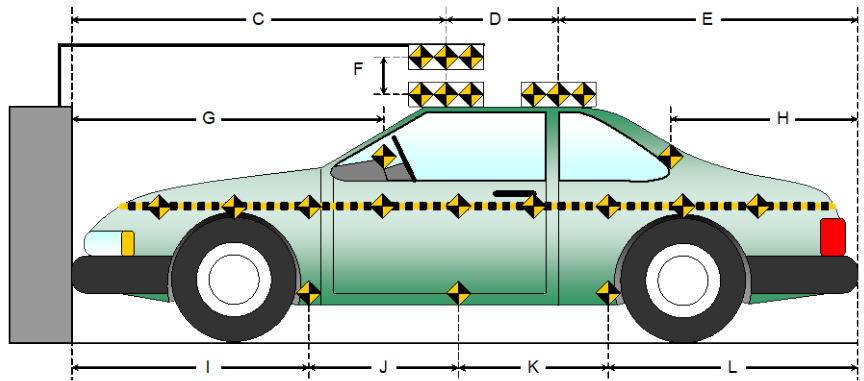
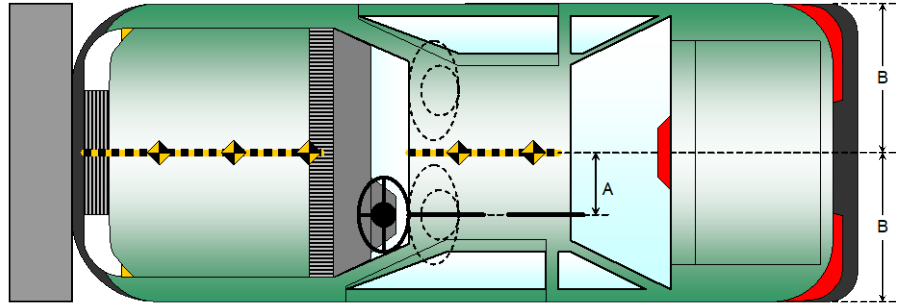
Reference Points: X - Rear Surface of Vehicle (+ forward)
 Y - Vehicle Centerline (+ to right)
 Z - Ground Plane (+ down)

DATA SHEET NO. 8
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

Item	Value (mm)
A	355
B	917
C	2300
D	610
E	1771
F	150
G	
H	1115
I	1315
J	944
K	944
L	1478
M	1115
N	1478
O	944
P	944
Q	1315



**DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

ADVANCED RESEARCH LOAD CELL BARRIER

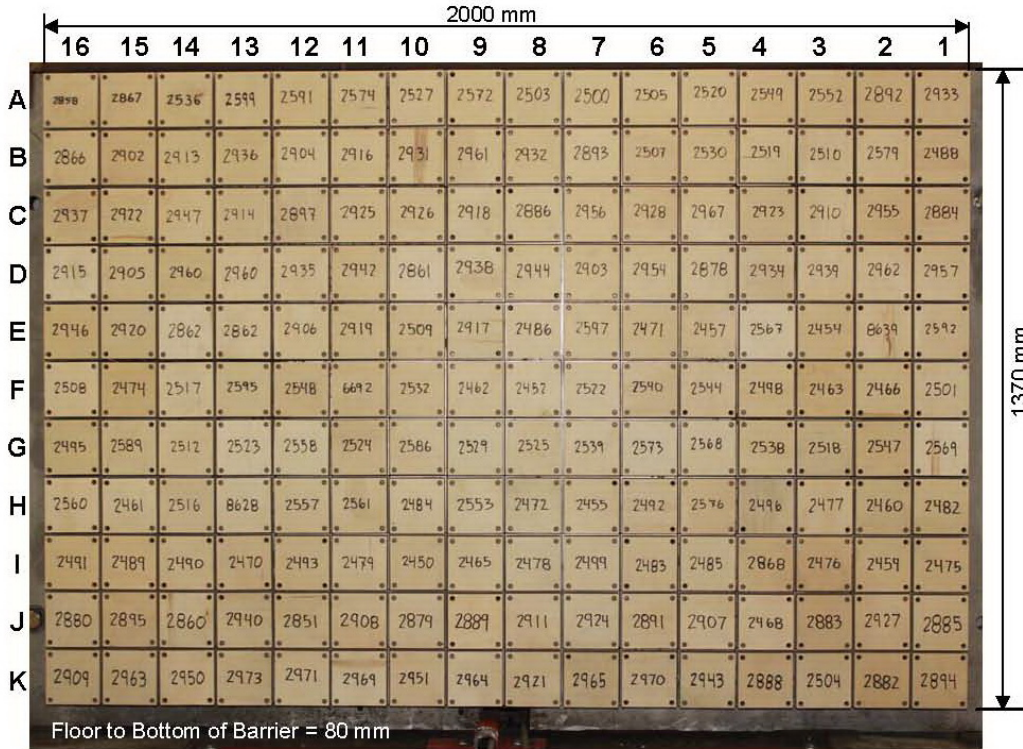


Photo for Reference Only

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

INSTRUMENTATION

Instrumentation	Number of Channels Collected
Driver Dummy Data Channels	49
Passenger Dummy Data Channels	48
Vehicle Structure Accelerometers	8
Barrier Channels	528
Total	633

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

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 Bolster	Glove Box
Right Knee Contact	Knee Bolster	Glove Box

DOOR OPENING, TRUNK OPENING, AND SEAT TRACK INFORMATION

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

VEHICLE REBOUND FROM BARRIER

Measured Parameter	Units	Value
Left Side	mm	3205
Center	mm	3160
Right Side	mm	3135
Average	mm	3167

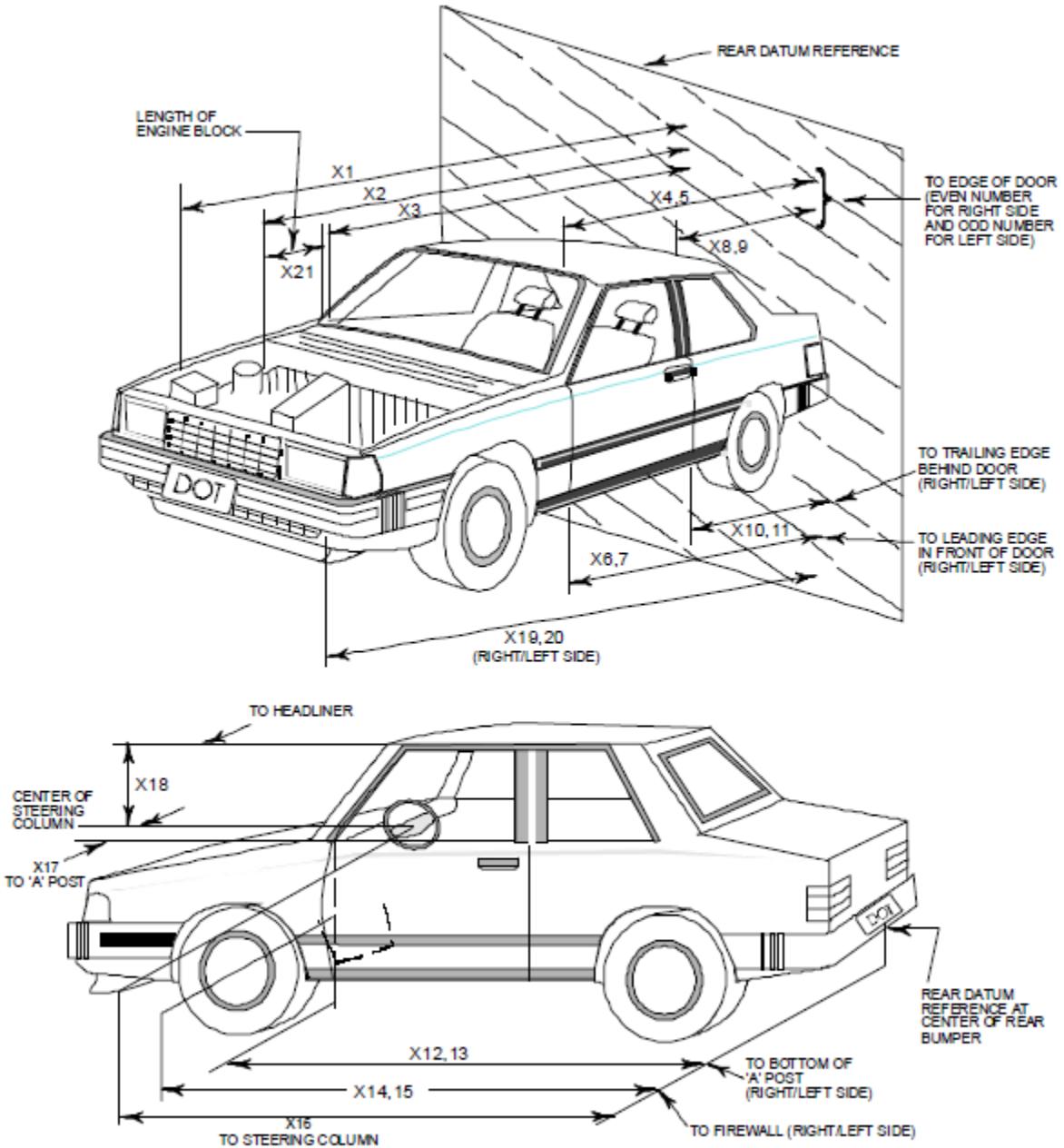
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

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	No		No	
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes		Yes	
Other				

DATA SHEET NO. 12 VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021



**DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
Test Date: 3/30/2021

No.	Measurement Description	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	4681	4182	499
2	RSOV to Front of Engine	4033	3853	180
3	RSOV to Firewall	3682	3641	41
4	RSOV to Upper Leading Edge of Right Door	3259	3264	-5
5	RSOV to Upper Leading Edge of Left Door	3261	3259	2
6	RSOV to Lower Leading Edge of Right Door	3263	3268	-5
7	RSOV to Lower Leading Edge of Left Door	3267	3266	1
8	RSOV to Upper Trailing Edge of Right Door	2158	2152	6
9	RSOV to Upper Trailing Edge of Left Door	2148	2145	3
10	RSOV to Lower Trailing Edge of Right Door	2167	2167	0
11	RSOV to Lower Trailing Edge of Left Door	2194	2168	26
12	RSOV to Bottom of "A" Post of Right Side	3192	3191	1
13	RSOV to Bottom of "A" Post of Left Side	3179	3180	-1
14	RSOV to Firewall, Right Side	3502	3517	-15
15	RSOV to Firewall, Left Side	3525	3505	20
16	RSOV to Steering Column	2764	2879	-115
17	Center of Steering Column to "A" Post	392	399	-7
18	Center of Steering Column to Headliner	418	423	-5
19	RSOV to Right Side of Front Bumper	4588	4143	445
20	RSOV to Left Side of Front Bumper	4588	4176	412
21	Length of Engine Block	479	479	0
RD	RSOV to Right Side of Dash Panel	3203	3215	-12
CD	RSOV to Center of Dash Panel	3153	3203	-50
LD	RSOV to Left Side of Dash Panel	3208	3220	-12

All Dimensions in mm

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
Test Program: NCAP Frontal Barrier Impact Test

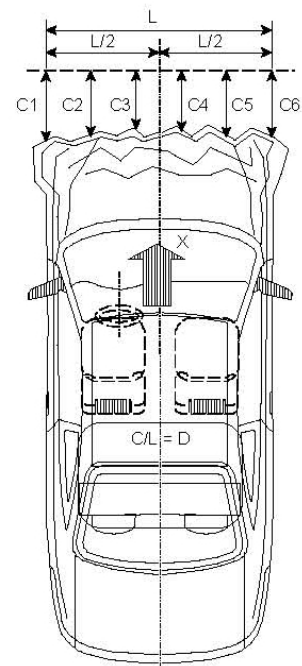
NHTSA No.: O20214206
Test Date: 3/30/2021

VEHICLE INFORMATION

VIN:	<u>5NPLS4AG0MH008859</u>	Wheelbase (mm):	<u>2720</u>
Vehicle Size Category:	<u>Passenger Car</u>	Test Weight (kg):	<u>1452.0</u>

ACCELEROMETER DATA

Accelerometer Locations:	<u>As per Data Sheet No. 7</u>
Cal. Procedure/Interval:	<u>MGA Procedure / 6 month</u>
Integration Algorithm:	<u>Trapezoidal</u>
Linearity:	<u>> 99%</u>
Impact Velocity (km/h):	<u>56.25</u>
Velocity Change (km/h):	<u>64.8</u>
Time of Separation (msec)	<u>93</u>



CRUSH PROFILE

Collision Deformation Classification:	<u>12FDEW3</u>
Midpoint of Damage:	<u>Centerline</u>
Damage Region Length (mm):	<u>1320</u>
Impact Mode:	<u>Frontal</u>

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	4588	4176	412
C2	Crush zone 2 at left side	mm	4667	4179	488
C3	Crush zone 3 at left side	mm	4667	4191	476
C4	Crush zone 4 at right side	mm	4667	4178	489
C5	Crush zone 5 at right side	mm	4667	4137	530
C6	Crush zone 6 at right side	mm	4588	4143	445
L	C1 TO C6	mm	1320	1361	-41

**DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS**

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

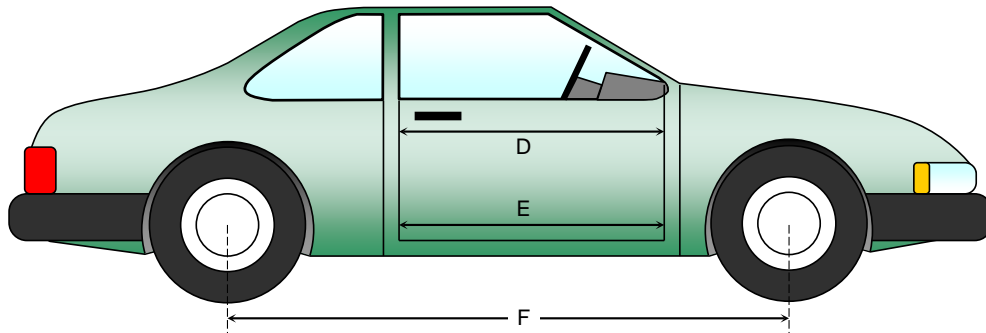
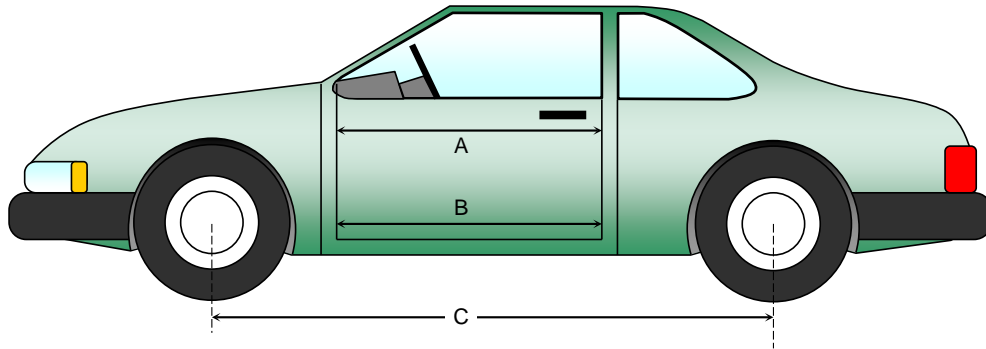
NHTSA No.: O20214206
 Test Date: 3/30/2021

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1034	1034	0
B	Left Side Lower	mm	947	947	0
D	Right Side Upper	mm	1032	1032	0
E	Right Side Lower	mm	942	942	0

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2720	2681	39
F	Right Side Wheelbase	mm	2720	2687	33



**DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS**

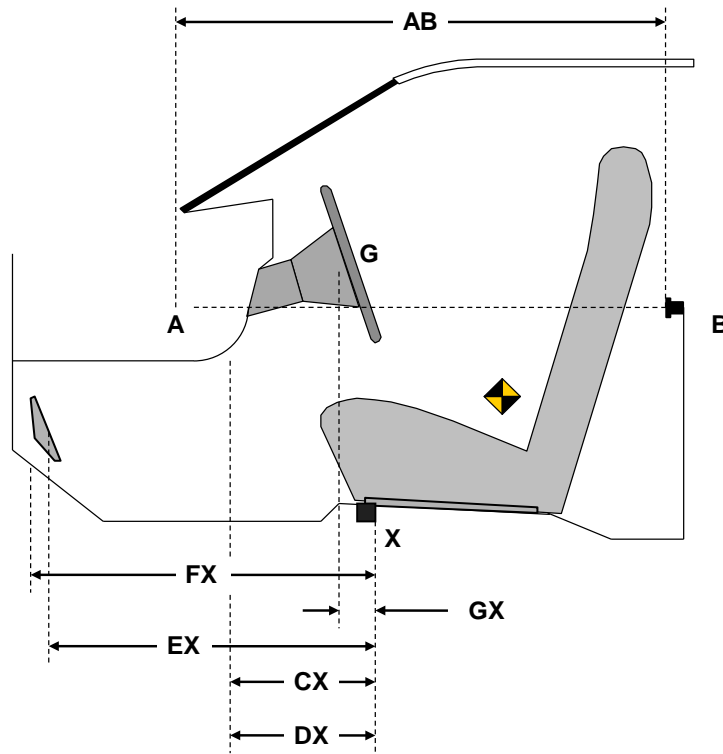
Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	746	746	0
CX	Left Knee Bolster to X	mm	300	304	-4
DX	Right Knee Bolster to X	mm	300	310	-10
EX	Brake Pedal to X	mm	569	494	75
FX	Foot Rest to X	mm	599	582	17
GX	Center of Steering Column Wheel Hub to X	mm	52	115	-63

X = Front of Seat Track (stationary)



DRIVER COMPARTMENT

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

WINDSHIELD MOUNTING DETAILS

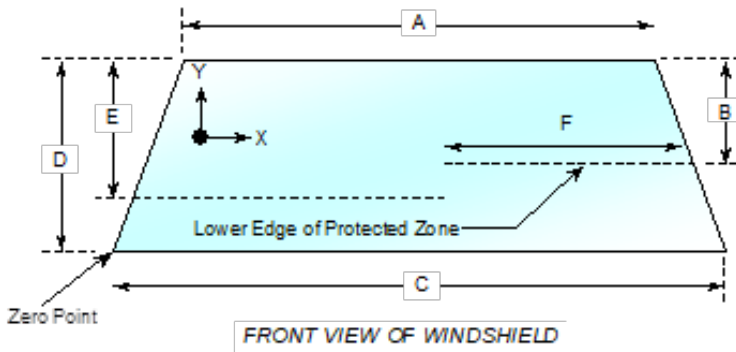
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

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: 21.3°C.

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2221	2221	100
Right Side	2221	2221	100
Total	4442	4442	100



Item	Units	Value
A	mm	1262
B	mm	436
C	mm	1568
D	mm	806
E	mm	552
F	mm	631

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

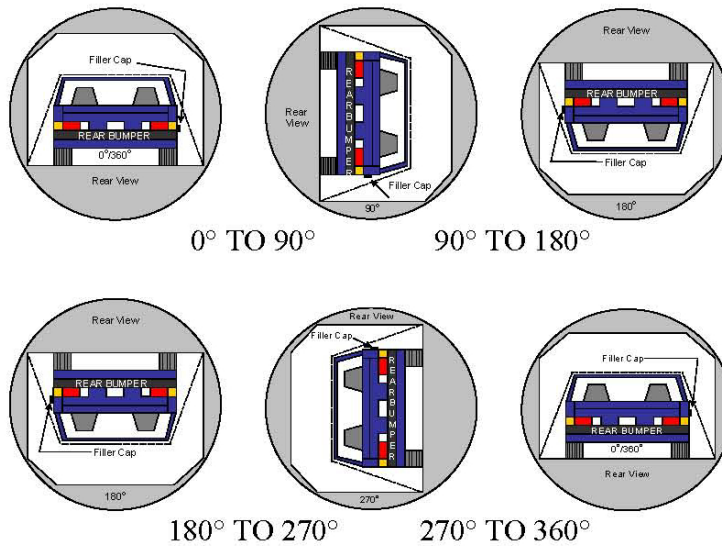
FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Temperature at Time of Impact: 21.3°C

Test Time: 11:55 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°	112	300	412
90° to 180°	111	300	411
180° to 270°	107	300	407
270° to 360°	112	300	412

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

Test Vehicle: 2021 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021

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	

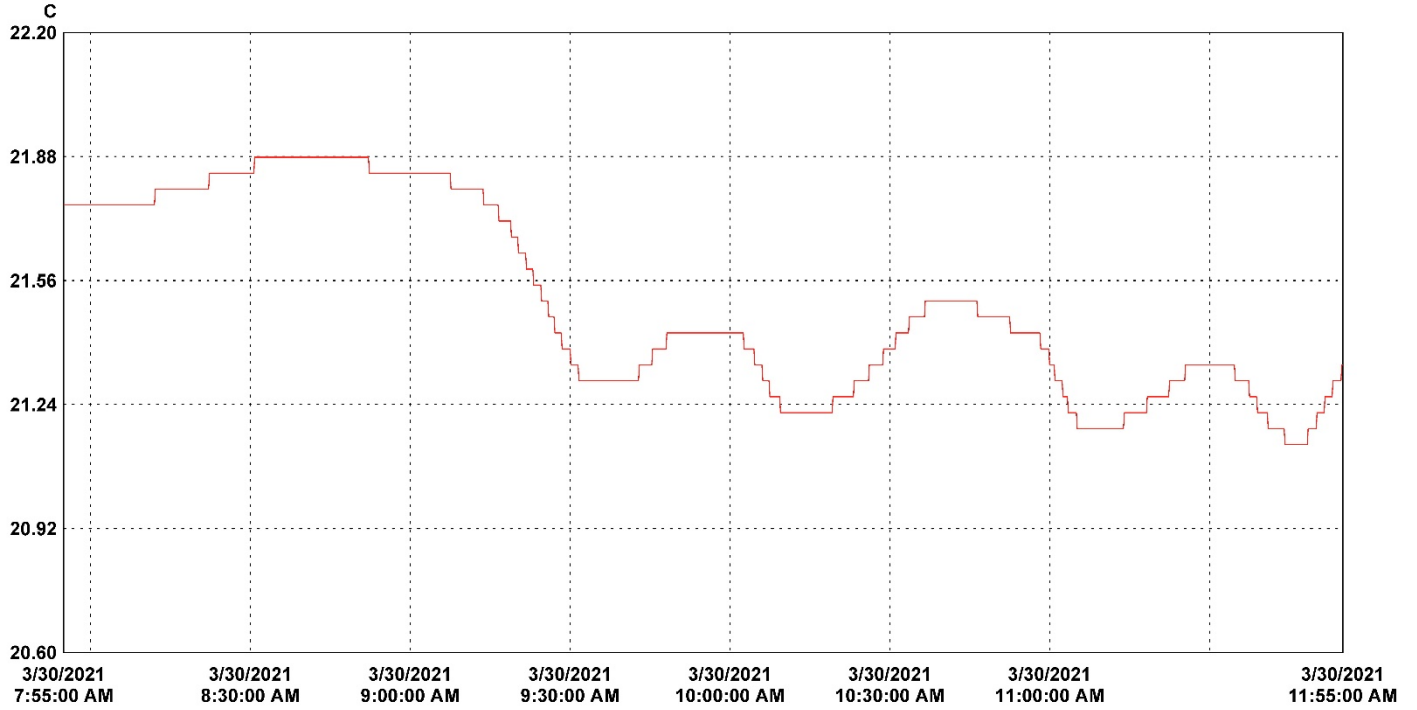
SOLVENT SPILLAGE LOCATION TABLE

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 Hyundai Elantra SEL 4-Door Sedan NCAP
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: O20214206
 Test Date: 3/30/2021



30 minutes/div 4 hours (M/d/yyyy h:mm:ss tt) Central Time Graph file (truncated): O20214206 2021 Hyundai Elantra SEL 4-Door Sedan NCAP.spg

LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	18352041	VSC_Prep_Room	1		21.88	21.51	21.14	C	Temperature	18352041_VSC_Prep_Room.spl

**APPENDIX A
PHOTOGRAPHS**

TABLE OF PHOTOGRAPHS

		<u>Page No.</u>
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. 005a	Vehicle Load Carrying Capacity Reduction Label	A-3
Photo No. 006	2021 Hyundai Elantra SEL 4-Door Sedan Frontal As Delivered	A-4
Photo No. 007	Left Rear 3-4 View, As Received	A-4
Photo No. 008	Pre-Test Front View of Test Vehicle	A-5
Photo No. 009	Post-Test Front View of Test Vehicle	A-5
Photo No. 010	Pre-Test Left View of Test Vehicle	A-6
Photo No. 011	Post-Test Left View of Test Vehicle	A-6
Photo No. 012	Pre-Test Right View of Test Vehicle	A-7
Photo No. 013	Post-Test Right View of Test Vehicle	A-7
Photo No. 014	Pre-Test Right Front 3-4 View	A-8
Photo No. 015	Post-Test Right Front 3-4 View	A-8
Photo No. 016	Pre-Test Left Rear 3-4 View	A-9
Photo No. 017	Post-Test Left Rear 3-4 View	A-9
Photo No. 018	Pre-Test Windshield View	A-10
Photo No. 019	Post-Test Windshield View	A-10
Photo No. 020	Pre-Test Engine Compartment View	A-11
Photo No. 021	Post-Test Engine Compartment View	A-11
Photo No. 022	Pre-Test Fuel Filler Cap View	A-12
Photo No. 023	Post-Test Fuel Filler Cap View	A-12
Photo No. 024	Pre-Test Front Underbody View	A-13
Photo No. 025	Post-Test Front Underbody View	A-13
Photo No. 026	Pre-Test Rear Underbody View	A-14
Photo No. 027	Post-Test Rear Underbody View	A-14
Photo No. 028	Pre-Test Dummy Cable Routing	A-15
Photo No. 029	Post-Test Dummy Cable Routing	A-15

		<u>Page No.</u>
Photo No. 030	Pre-Test Driver Dummy Front View	A-16
Photo No. 031	Post-Test Driver Dummy Front View	A-16
Photo No. 032	Pre-Test Driver Dummy Window View	A-17
Photo No. 033	Post-Test Driver Dummy Window View	A-17
Photo No. 034	Pre-Test Driver Dummy and Vehicle Interior View	A-18
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-19
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-20
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-21
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-22
Photo No. 043	Post-Test Driver Dummy Feet	A-22
Photo No. 044	Pre-Test Driver's Side Knee Bolster	A-23
Photo No. 045	Post-Test Driver's Side Knee Bolster	A-23
Photo No. 046	Pre-Test Driver's Side Floorpan	A-24
Photo No. 047	Post-Test Driver's Side Floorpan	A-24
Photo No. 048	Post-Test Driver Dummy Face	A-25
Photo No. 049	Post-Test Driver Dummy Contact with Airbag	A-25
Photo No. 050	Post-Test Driver Dummy Contact with Headrest	A-26
Photo No. 051	Pre-Test View of the Steering Wheel	A-26
Photo No. 052	Post-Test View of the Steering Wheel	A-27
Photo No. 053	Pre-Test Passenger Dummy Front View	A-27
Photo No. 054	Post-Test Passenger Dummy Front View	A-28
Photo No. 055	Pre-Test Passenger Dummy Window View	A-28
Photo No. 056	Post-Test Passenger Dummy Window View	A-29
Photo No. 057	Pre-Test Passenger Dummy and Vehicle Interior	A-29
Photo No. 058	Post-Test Passenger Dummy and Vehicle Interior	A-30
Photo No. 059	Pre-Test Passenger's Seat Fore-Aft Markings	A-30

		<u>Page No.</u>
Photo No. 060	Post-Test Passenger's Seat Fore-Aft Markings	A-31
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-32
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-33
Photo No. 065	Pre-Test Passenger Dummy Feet	A-33
Photo No. 066	Post-Test Passenger Dummy Feet	A-34
Photo No. 067	Pre-Test Passenger's Side Knee Bolster	A-34
Photo No. 068	Post-Test Passenger's Side Knee Bolster	A-35
Photo No. 069	Pre-Test Passenger's Side Floorpan	A-35
Photo No. 070	Post-Test Passenger's Side Floorpan	A-36
Photo No. 071	Post-Test Passenger Dummy Face	A-36
Photo No. 072	Post-Test Passenger Dummy Contact with Airbag	A-37
Photo No. 073	Post-Test Passenger Dummy Contact with Headrest	A-37
Photo No. 074	Ballast Installed in Vehicle	A-38
Photo No. 075	Post-Test Stoddard Solvent Spillage Location View	A-38
Photo No. 076	Post-Test Speed Trap Read-Out	A-39
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-40
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-41
Photo No. 081	Vehicle at 360 Degrees on Static Rollover Device	A-41
Photo No. 082	2021 Hyundai Elantra SEL 4-Door Sedan Frontal Impact Event	A-42
Photo No. 083	Monroney Label Photograph	A-42

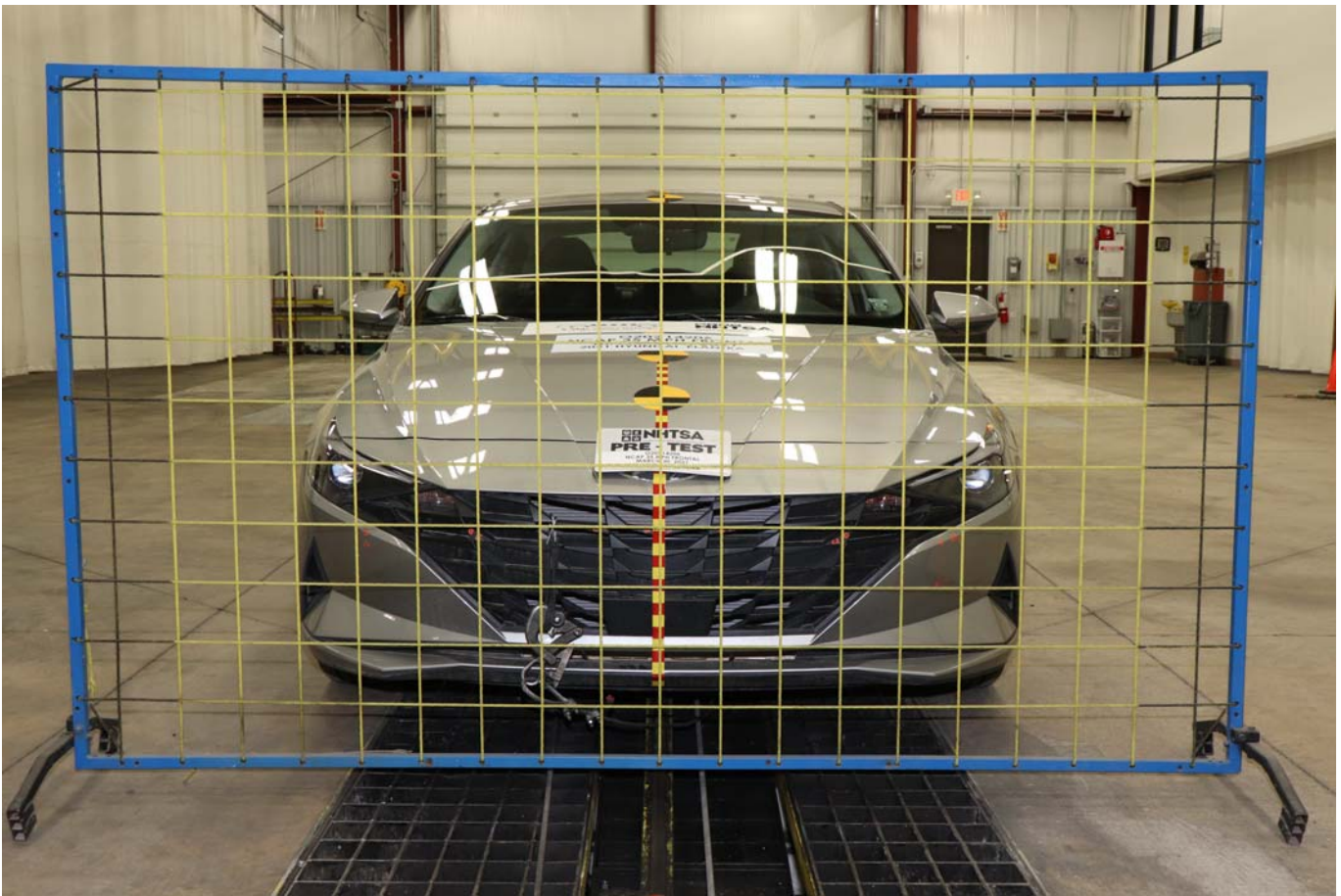


Photo No. 001 - Load Cell Location



Photo No. 002 - Pre-Test Load Cell Wall



Photo No. 003 - Post-Test Load Cell Wall



Photo No. 004 - Manufacturer Label



Photo No. 005 - Tire Placard



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



Photo No. 006 - 2021 Hyundai Elantra SEL 4-Door Sedan Frontal As Delivered



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

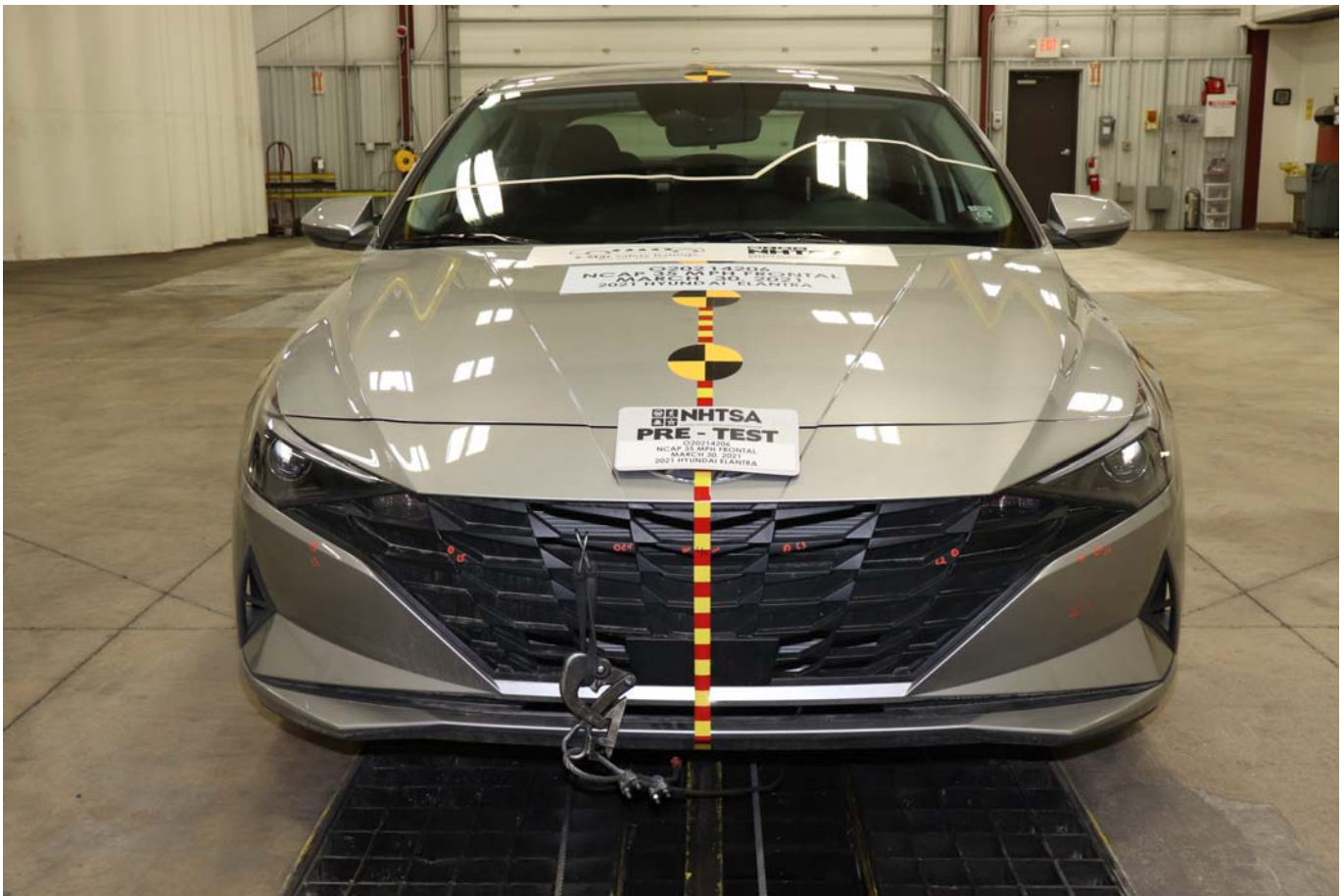


Photo No. 008 - Pre-Test Front View of Test Vehicle

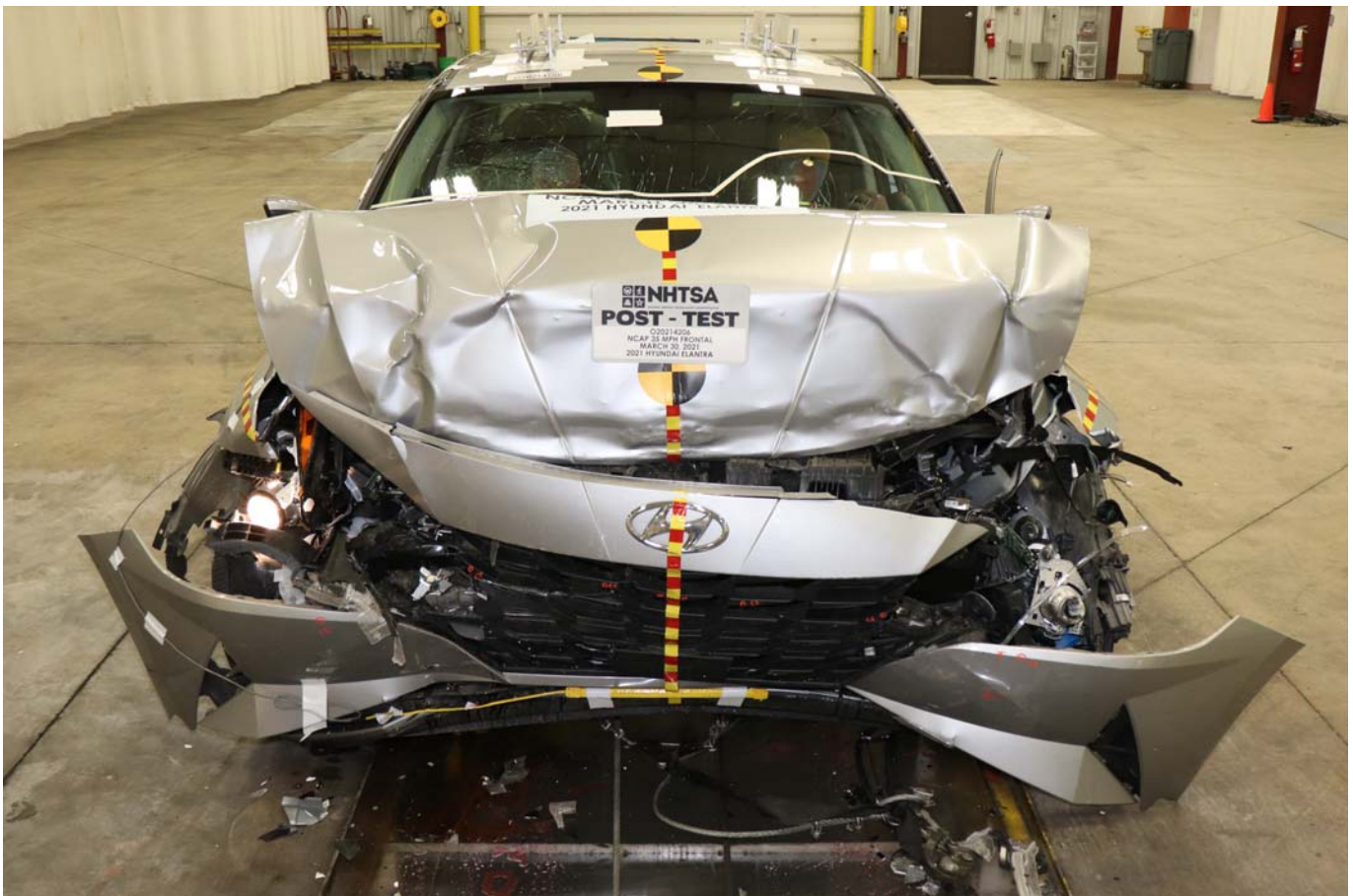


Photo No. 009 - Post-Test Front View of Test Vehicle



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

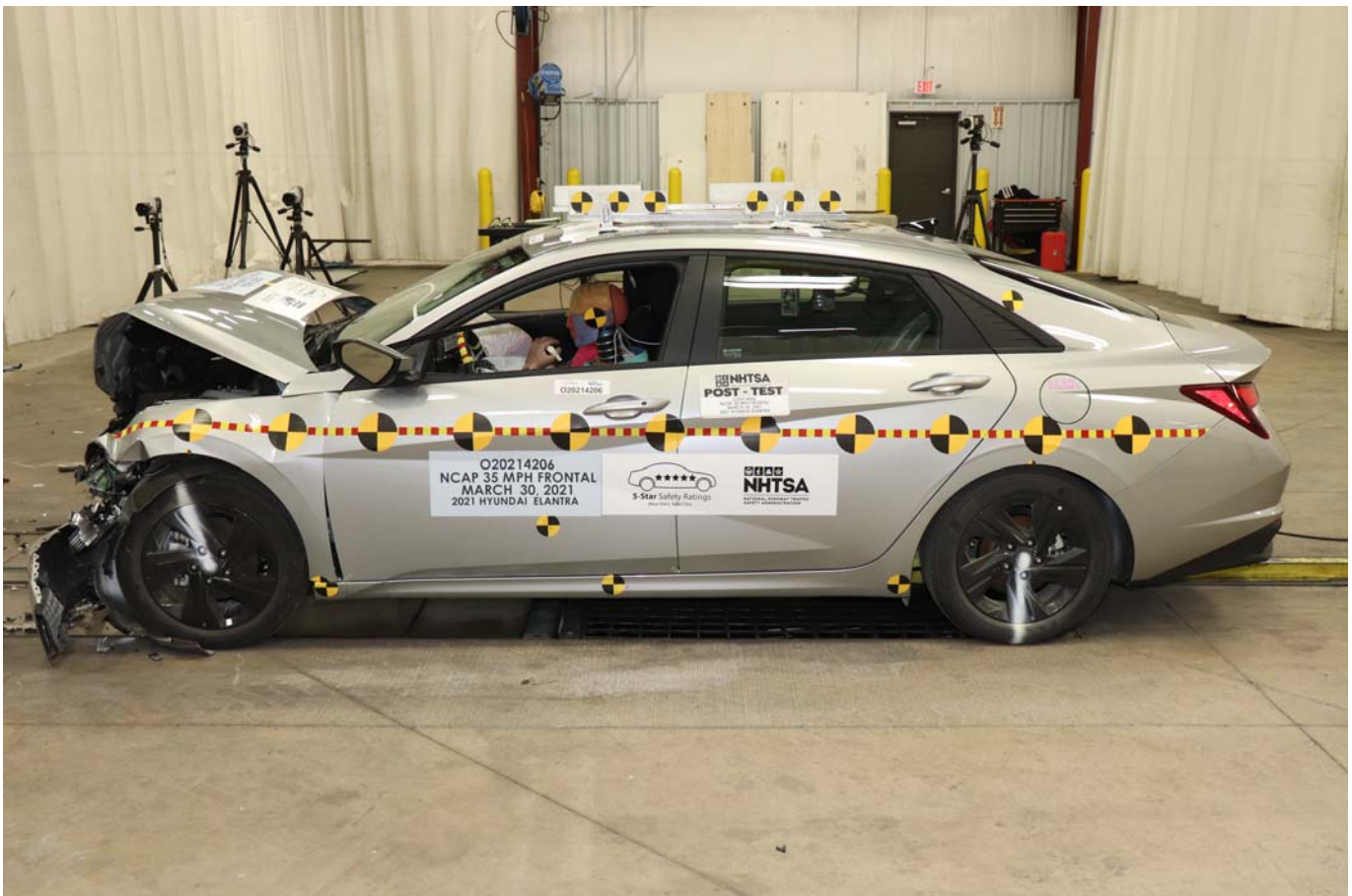


Photo No. 011 - Post-Test Left View of Test Vehicle



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



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

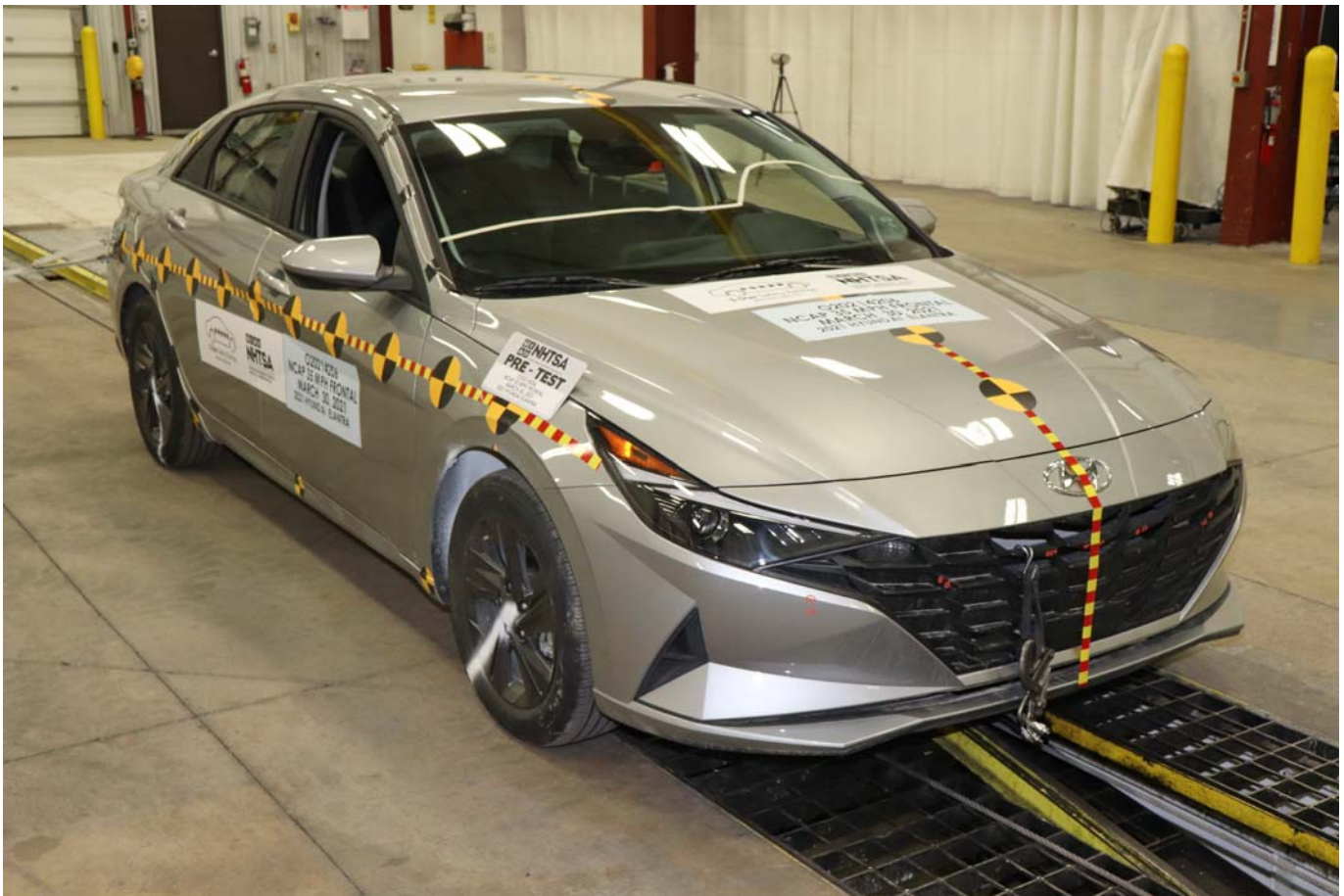


Photo No. 014 - Pre-Test Right Front 3-4 View

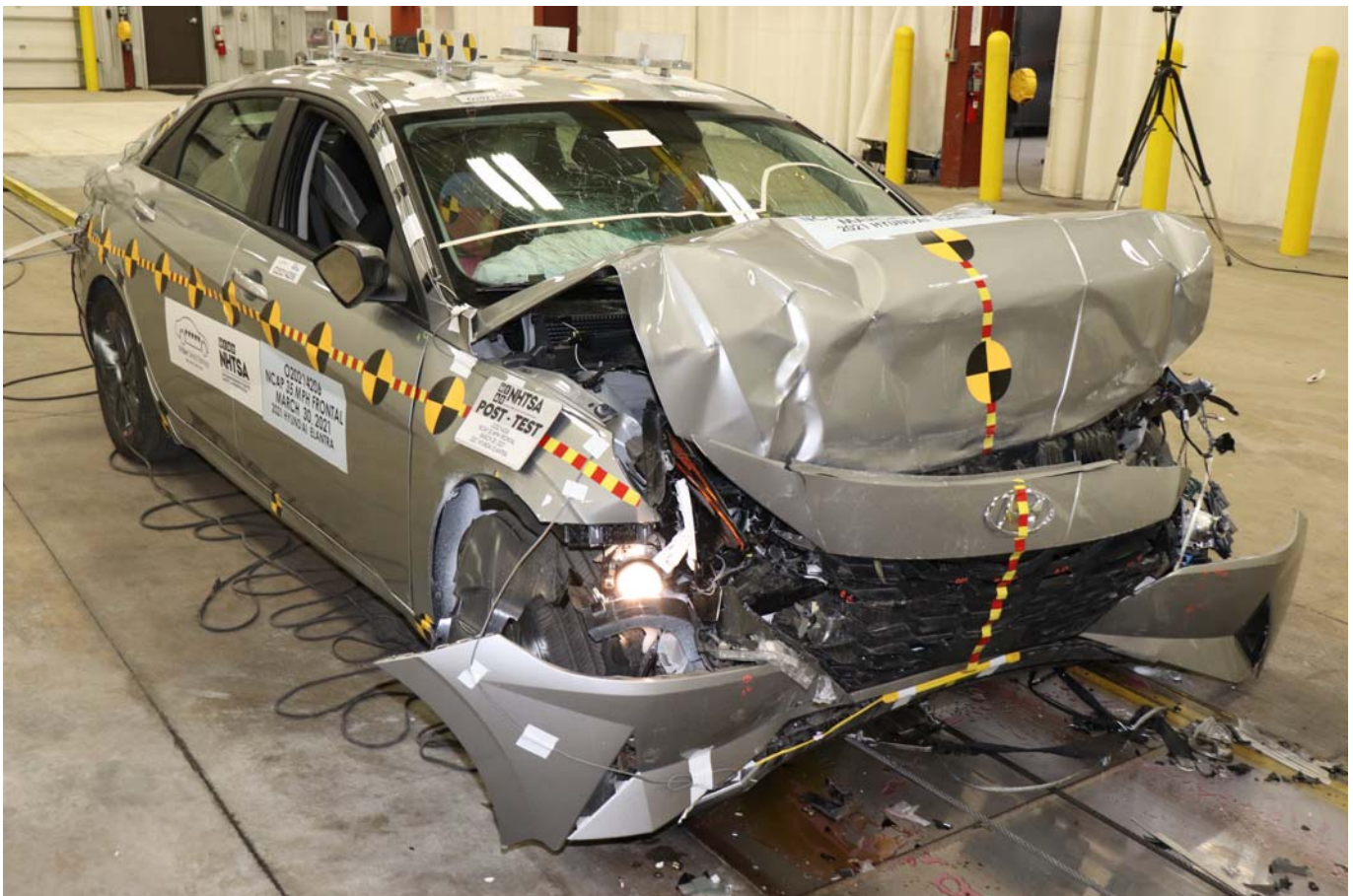


Photo No. 015 - Post-Test Right Front 3-4 View



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

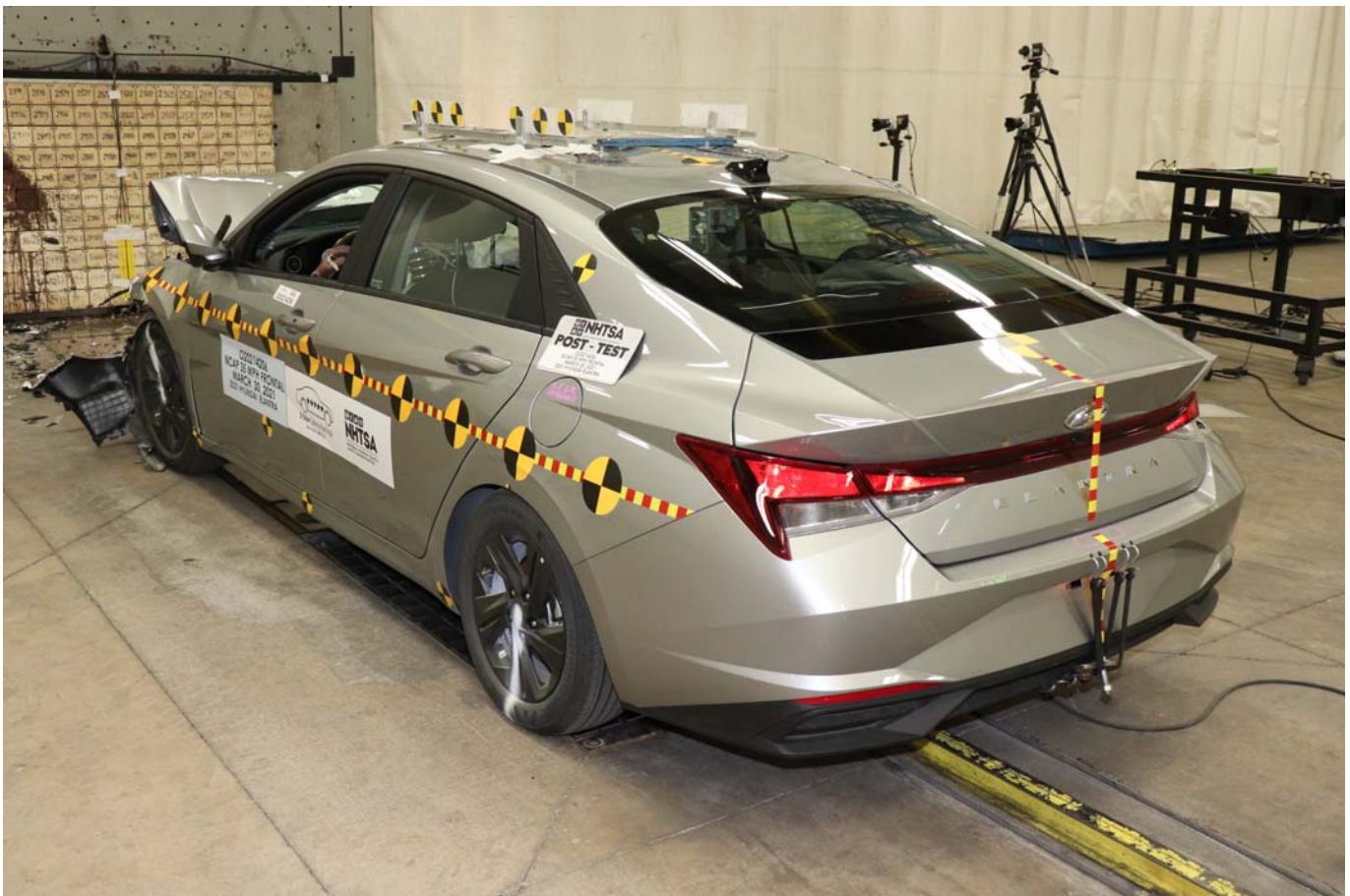


Photo No. 017 - Post-Test Left Rear 3-4 View



Photo No. 018 - Pre-Test Windshield View



Photo No. 019 - Post-Test Windshield View



Photo No. 020 - Pre-Test Engine Compartment View

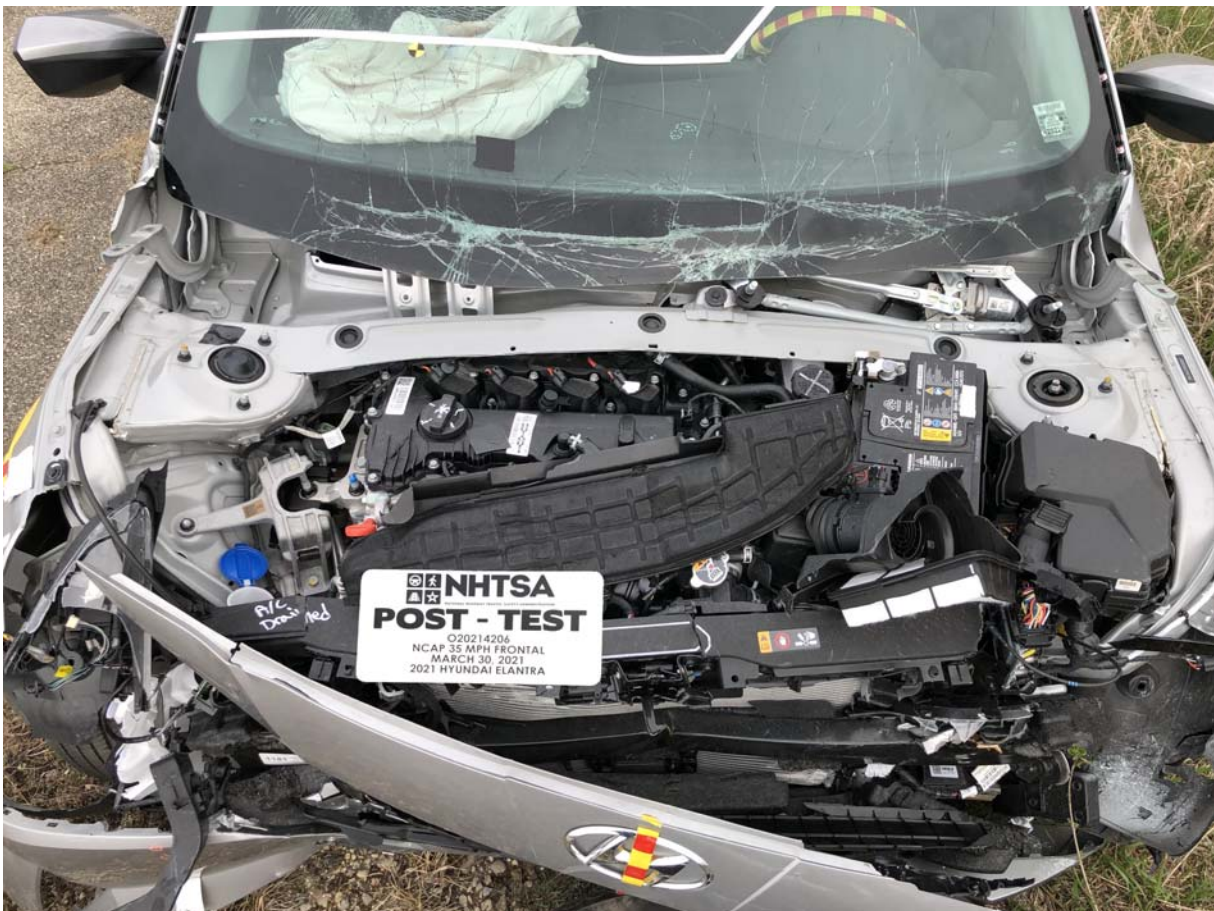


Photo No. 021 - Post-Test Engine Compartment View



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



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

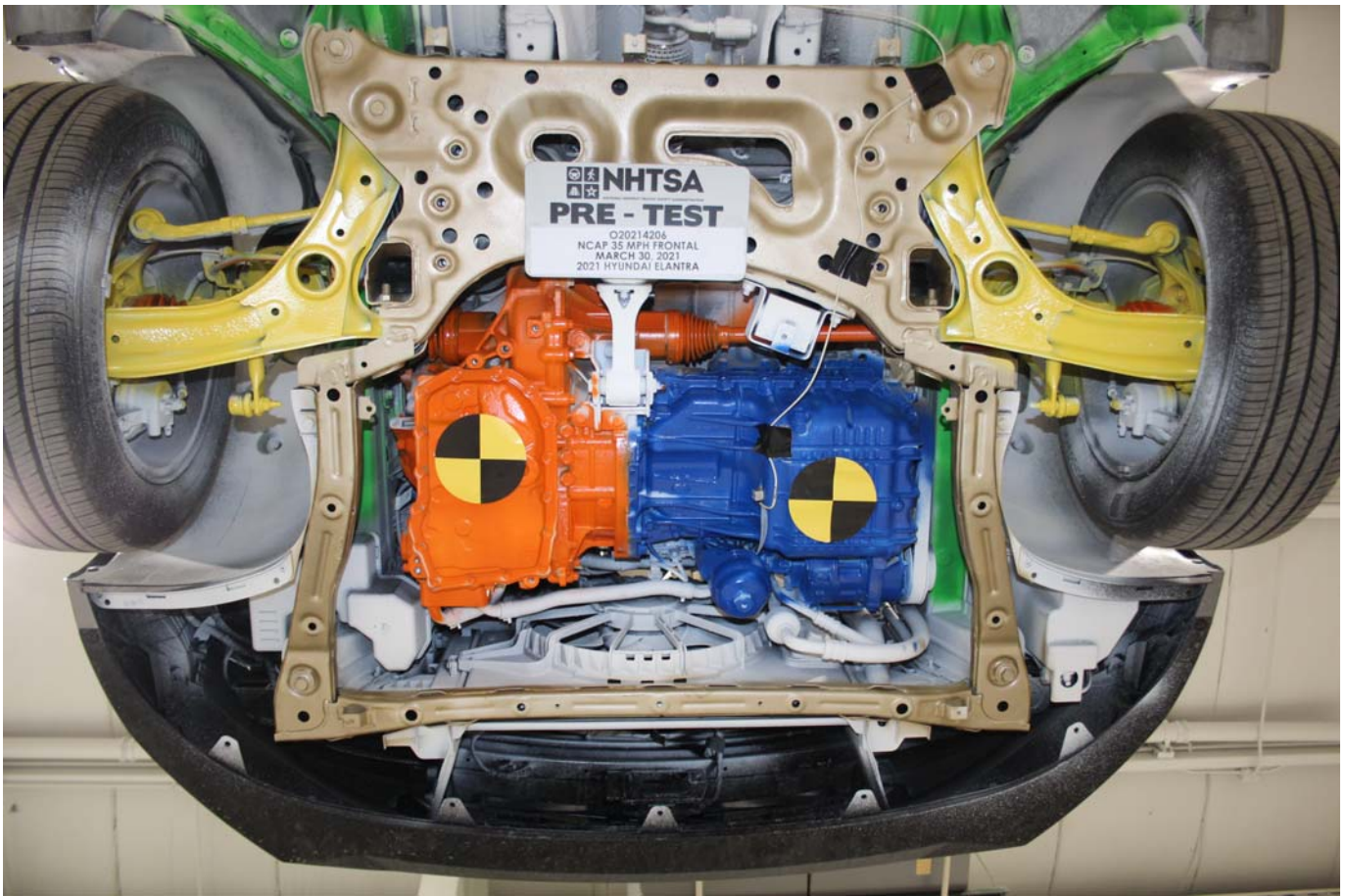


Photo No. 024 - Pre-Test Front Underbody View

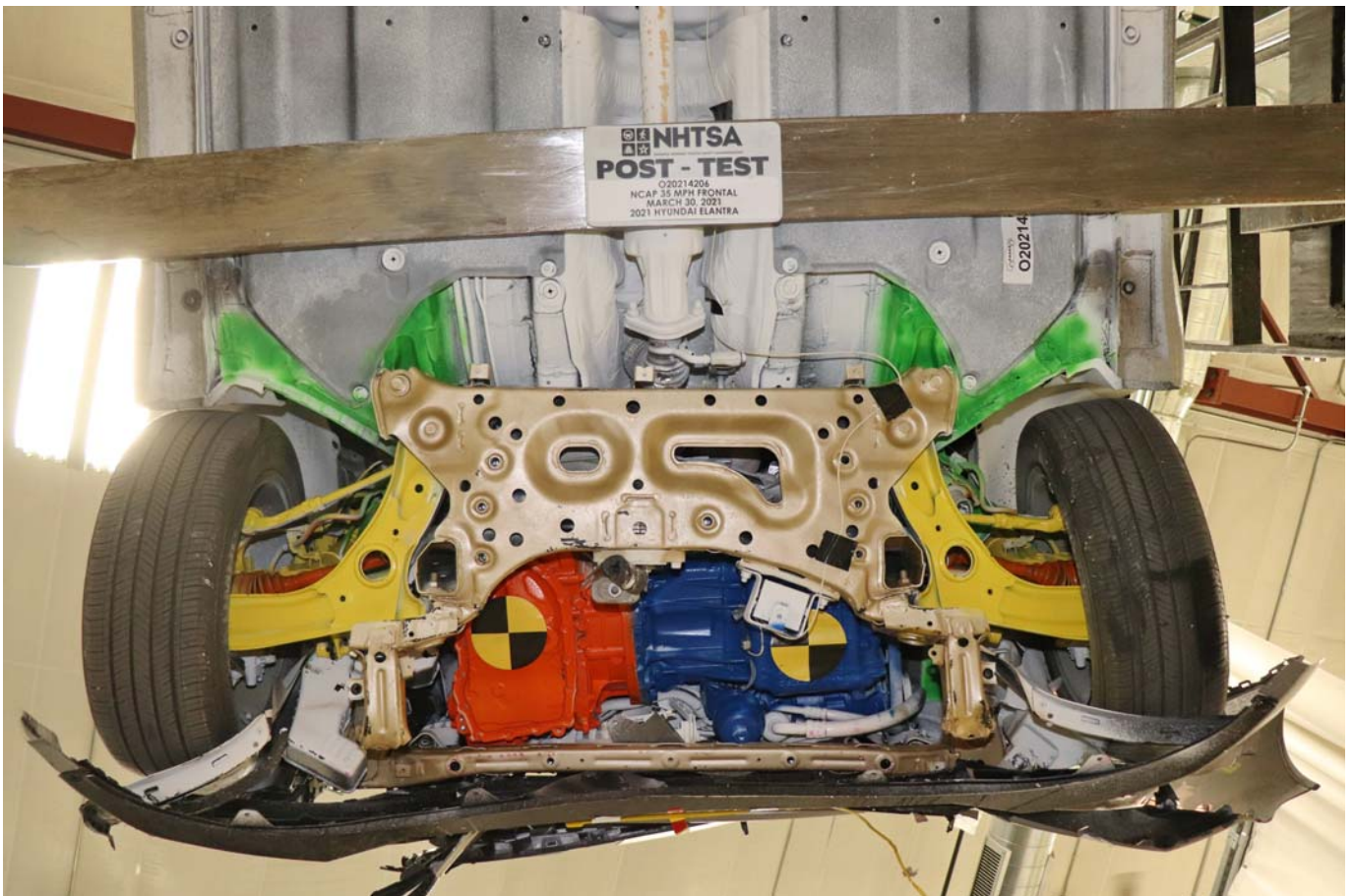


Photo No. 025 - Post-Test Front Underbody View



Photo No. 026 - Pre-Test Rear Underbody View

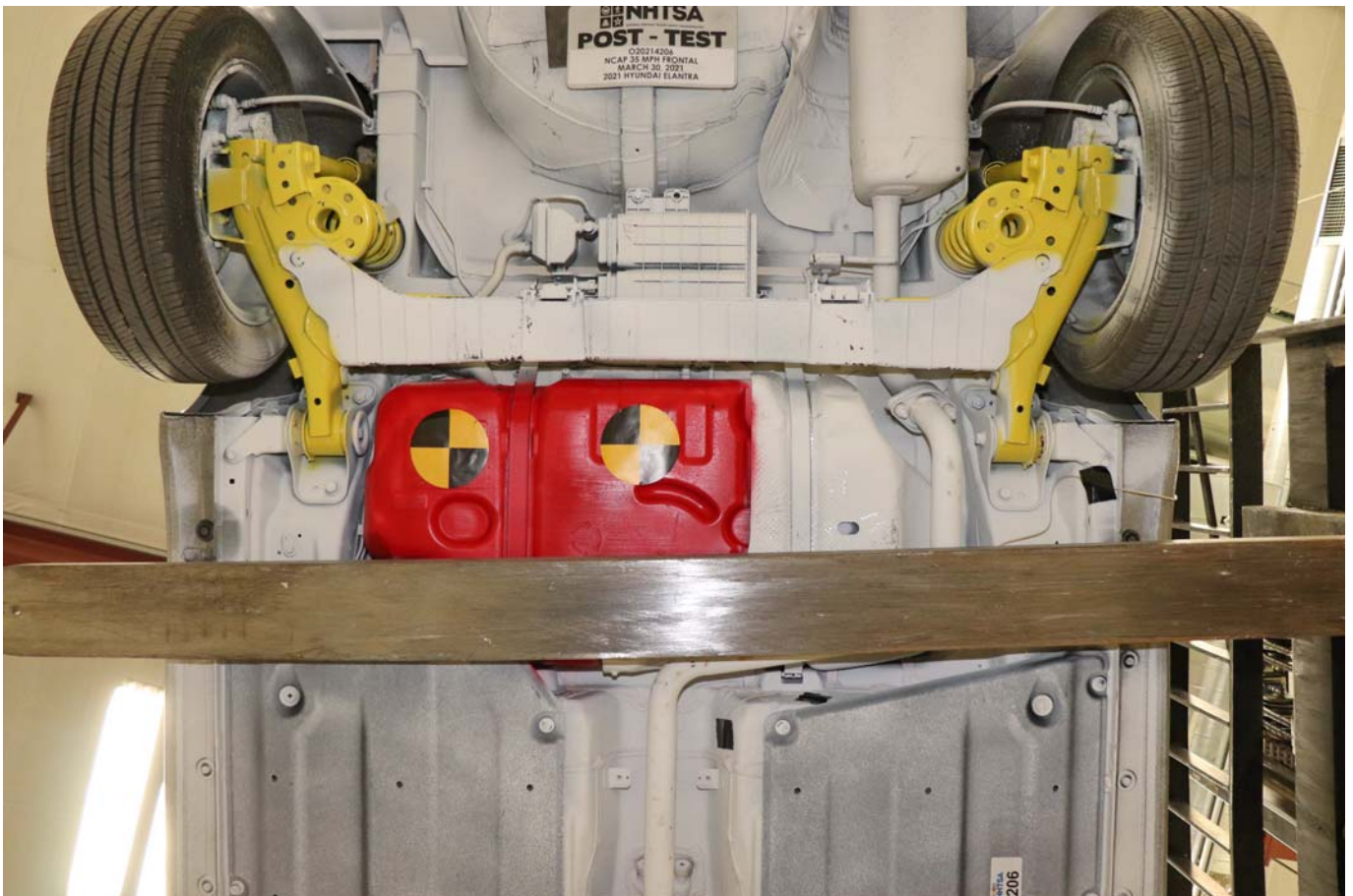


Photo No. 027 - Post-Test Rear Underbody View



Photo No. 028 - Pre-Test Dummy Cable Routing



Photo No. 029 - Post-Test Dummy Cable Routing



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



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



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



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



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



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



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



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



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



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



Photo No. 040 - Pre-Test 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

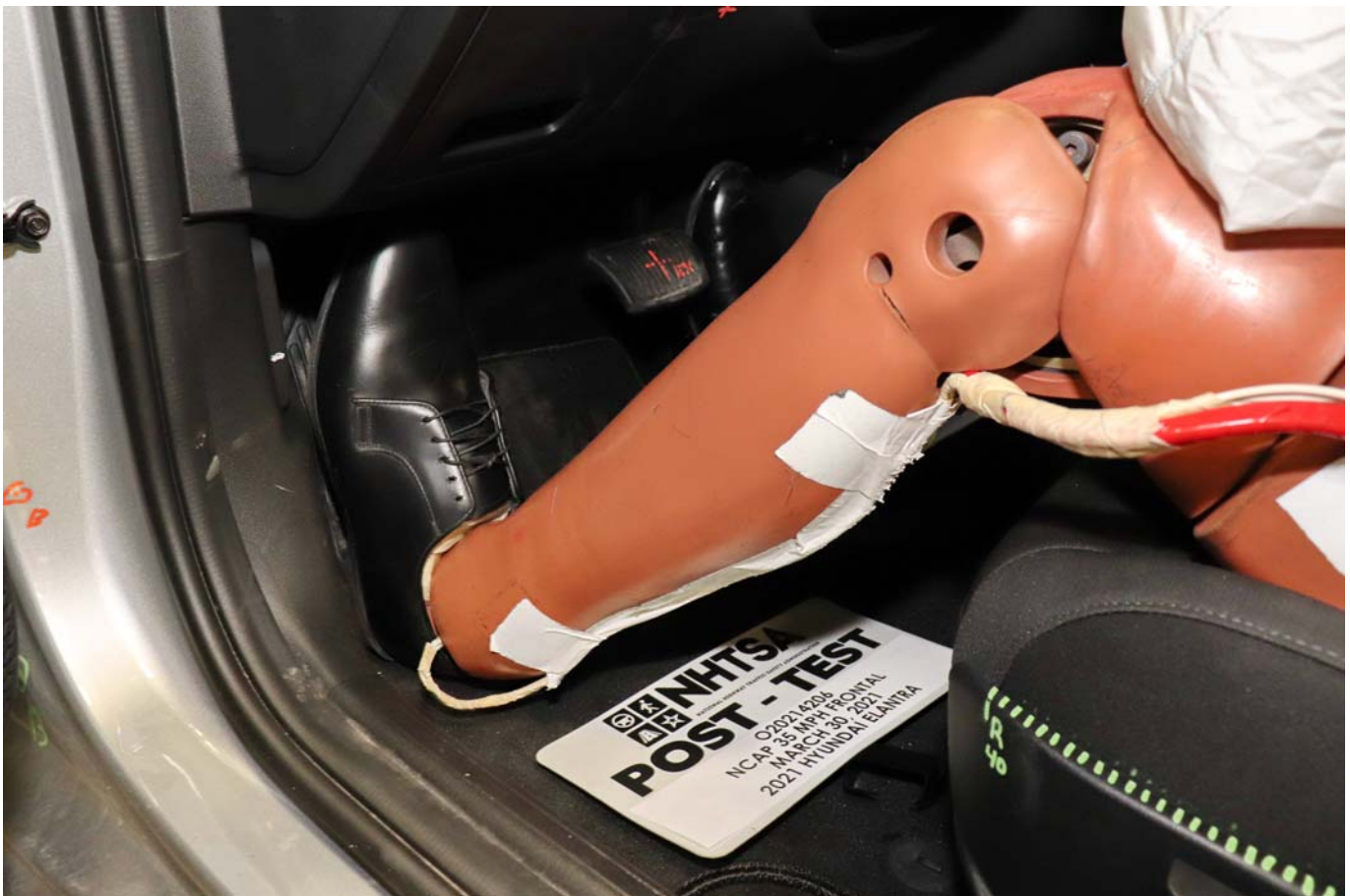


Photo No. 043 - Post-Test Driver Dummy Feet



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

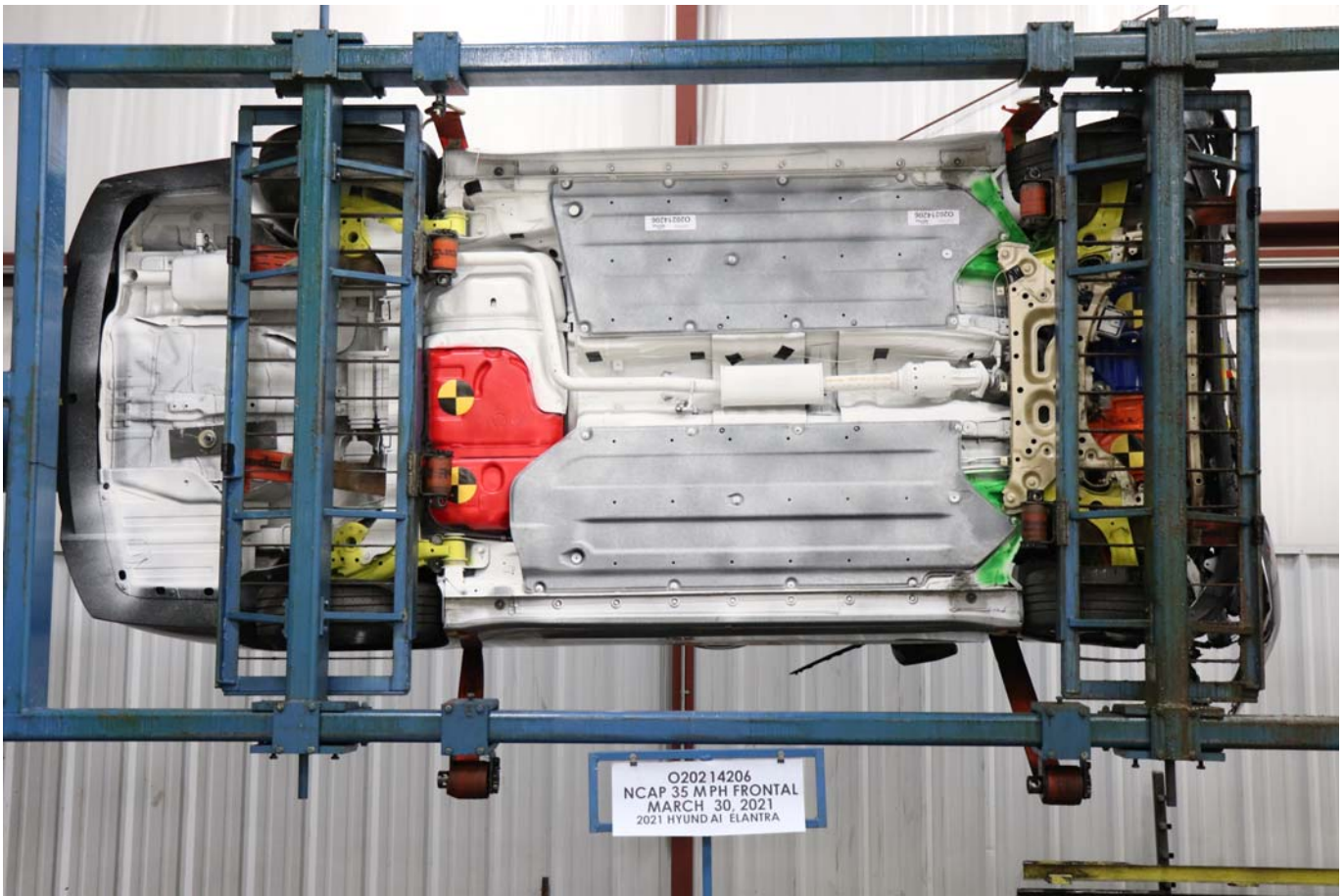


Photo No. 078 - Vehicle at 90 Degrees on Static Rollover Device



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 Hyundai Elantra SEL 4-Door Sedan Frontal Impact Event

HYUNDAI 2021 ELANTRA SEL

<p>SOLD TO: NY123 MAGUIRE HYUNDAI 320 ELMIRA ROAD ITHACA NY 14850</p> <p>VIN: SNPLS4AG0MH008859 MODEL: 49422F4S ENGINE: G4NSLK009507 PORT OF ENTRY: MA EXTERIOR COLOR: SHIMMERING SILVER PEARL INTERIOR/SEAT COLOR: BLACK/BLACK TRANSPORT: TRUCK ACCESSORY WEIGHT: 14 lbs./7 kgs. EMISSIONS: This vehicle meets California Emissions regulations and is Certified as a Super Ultra Low Emission Vehicle (SULEV)</p>	<p>SHIPPED TO: NY123</p>	<p>GOVERNMENT 5-STAR SAFETY RATINGS</p> <p>This vehicle has not been rated by the government for overall vehicle score, frontal crash, side crash or rollover risk.</p> <p>Source: National Highway Traffic Safety Administration (NHTSA). www.safercar.gov or 1-888-327-4236</p>
---	---------------------------------	--

<p>STANDARD FEATURES: AMERICA'S BEST WARRANTY: 5-year/100,000-mile New Vehicle Warranty* 10-year/100,000-mile Powertrain Warranty* 7-year/Unlimited-mile Anti-perforation Warranty* 5-year/36,000-mile Complimentary Maintenance* 5-year/Unlimited-mile Roadside Assistance *Limited warranties, see dealer for details.</p> <p>ADVANCED SAFETY TECHNOLOGY Forward Collision-Avoidance Assist w/ Pedestrian Detection Blind-Spot Collision-Avoidance Assist Rear Cross-Traffic Collision-Avoidance Assist Lane Keeping Assist & Lane Following Assist Safe Exit Warning & Driver Attention Warning High Beam Assist</p> <p>POWERTRAIN TECHNOLOGY Smartstream 2.0L, 147 HP, 132 lbs-ft Torque, DOHC 4-Cylinder Dual Continuous Variable Valve Timing Smartstream Intelligent Variable Transmission 4-wheel Disc Brakes</p> <p>EXTERIOR 16-inch Alloy Wheels with 205/55 R16 Tires Projector Headlights w/ LED Daytime Running Lights Body-color Door Handles & Power Side Mirrors</p> <p>COMFORT & CONVENIENCE Wireless Apple CarPlay (TM) & Android Auto (TM) Integration 8-inch High Resolution Touchscreen Proximity Key w/ Push Button Start Hands-Free Smart Trunk Release Dual Automatic Temperature Control Driver's Auto-up Window Illuminated Vanity Mirrors and Sliding Sun Violes Rearview Camera w/ Dynamic Guidelines Single 12V Outlet & Dual USB Ports Map Lights w/ Dome Lamp & Trunk Lamp Bluetooth Hands-free Phone System Steering Wheel Mounted Audio & Cruise Controls Automatic Headlamp Control Driver Seat Height Adjustment Bench Folding Rear Seatback Center Armrest w/ Flip-up Storage Compartment 4.5-inch Color TFT Cluster Display AM/FM/HDR Radio w/ 6 Speakers SiriusXM® Radio w/ 90-Day Trial. Not Available in AK & HI Hyundai Blue Link® Connected Car System</p>	<p>COMFORT & CONVENIENCE(cont.) Hyundai Blue Link® Connected Care & Remote Package Complimentary 3-Year Trial (enrollment required) Temporary Compact Spare Tire Full Tank of Gas</p> <p>ADDED FEATURES: Convenience Package: \$950.00 Forward Collision-Avoidance Assist w/ Pedestrian, Cyclist and Junction-Turning Detection Full 10.25-inch LCD TFT cluster Smart Cruise Control w/ Stop & Go Electronic Parking Brake w/ Automatic Vehicle Hold Leather-Wrapped Steering Wheel & Shifter Wireless Charging Pad (Qi format) Heated Front Seats Heated Outside Mirror *Carpeted Floor Mats *Cargo Net *Rear Bumper Applique</p> <p>\$155.00 \$50.00 \$115.00 \$70.00</p>	<p>Manufacturer's Suggested Retail Price: \$20,900.00</p> <p>Total Price: \$23,235.00</p>
--	---	--

All-new 2021 Elantra with Best-in-Class Interior Volume
Class-leading Safety, Tech & Connectivity

Fuel Economy and Environment

35 MPG combined city/hwy
2.9 gallons per 100 miles

Midsize Cars range from 14 to 113 MPG. The best vehicle rates 141 MPG.

You Save \$1,750 in fuel costs over 5 years compared to the average new vehicle.

Annual fuel COST \$1,150

Fuel Economy & Greenhouse Gas Rating (tailpipe only) **7** Best

Smog Rating (tailpipe only) **7** Best

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

fuelconomy.gov
Calculate personalized estimates and compare vehicles.

PARTS CONTENT INFORMATION FOR VEHICLE IN THIS CARLINE:
U.S./CANADIAN PARTS CONTENT: 54 %
MAJOR SOURCES OF FOREIGN PARTS CONTENT: KOREA: 27 % MEXICO: 15 %

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

FOR THIS VEHICLE:
FINAL ASSEMBLY POINT: MONTGOMERY, ALABAMA U.S.A.
COUNTRY OF ORIGIN:
ENGINE: U.S.A.
TRANSMISSION: MEXICO

309 A 1

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

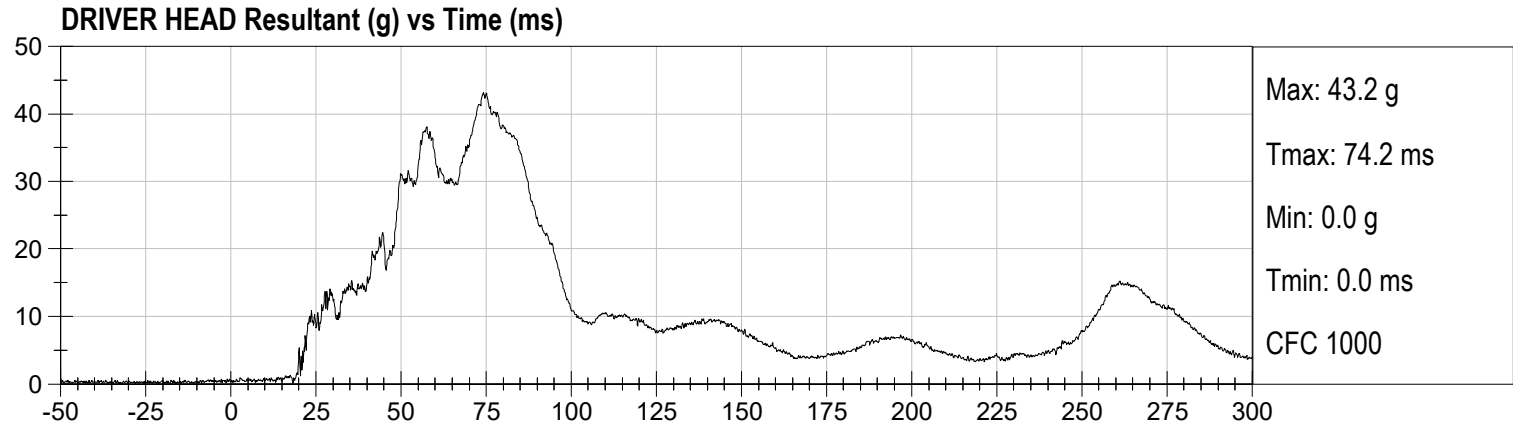
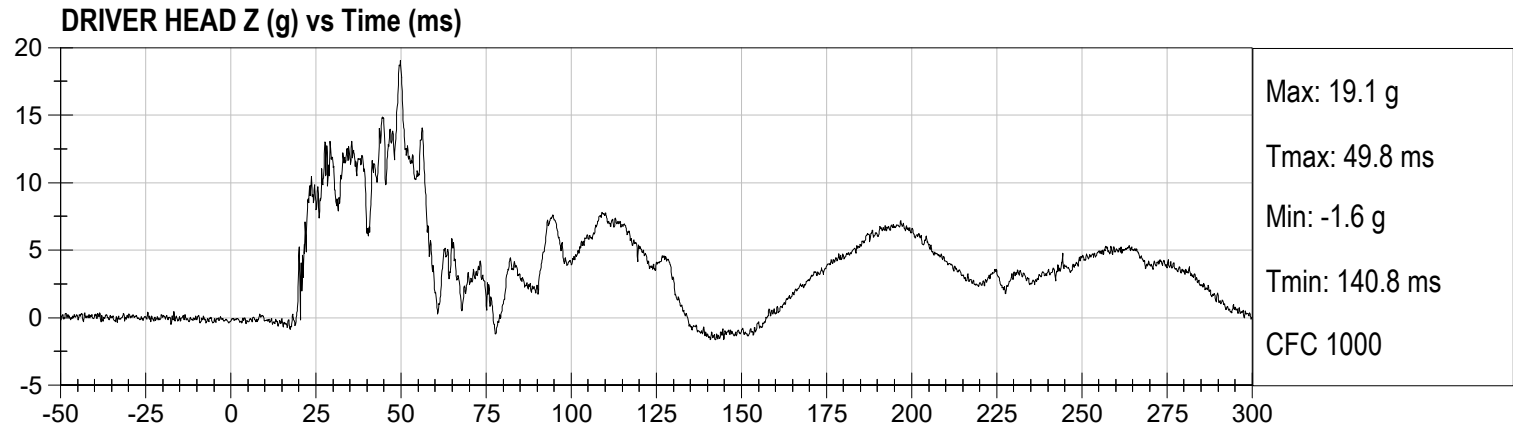
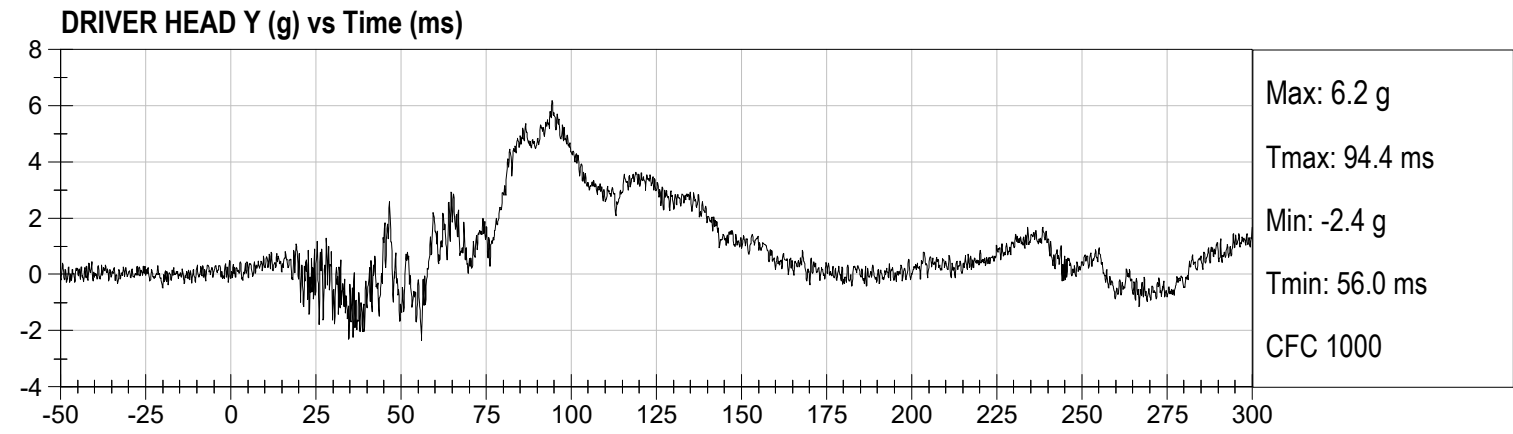
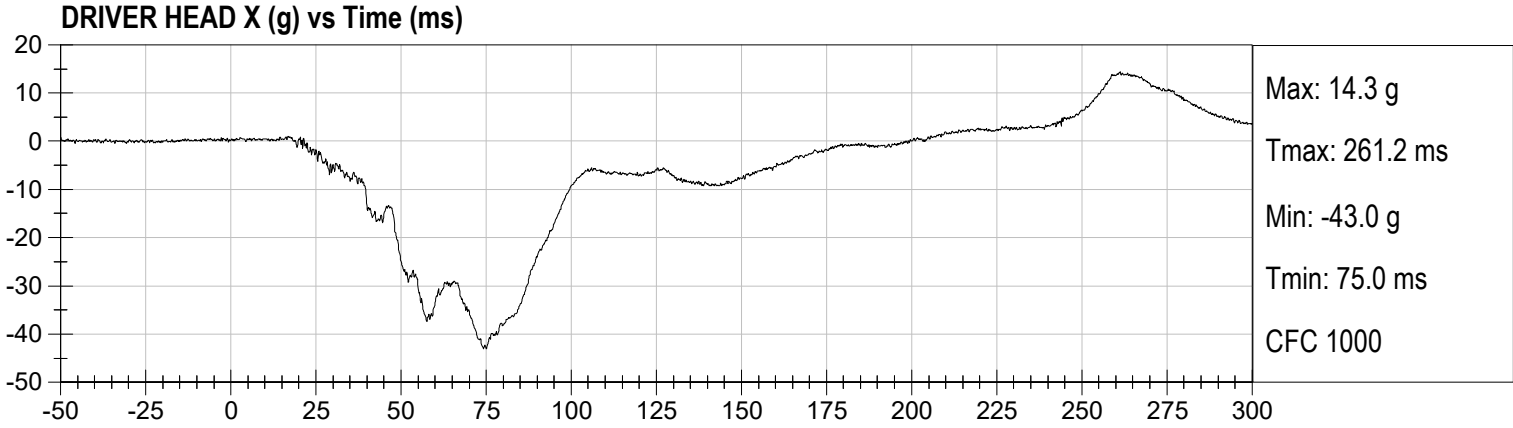
	<u>Page No.</u>
Figure No. 28. Passenger Neck Force X vs. Time	B-10
Figure No. 29. Passenger Neck Force Z vs. Time	B-10
Figure No. 30. Passenger Neck Moment Y vs. Time	B-10
Figure No. 31. Passenger Nij (NTF) vs. Time	B-11
Figure No. 32. Passenger Nij (NTE) vs. Time	B-11
Figure No. 33. Passenger Nij (NCF) 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

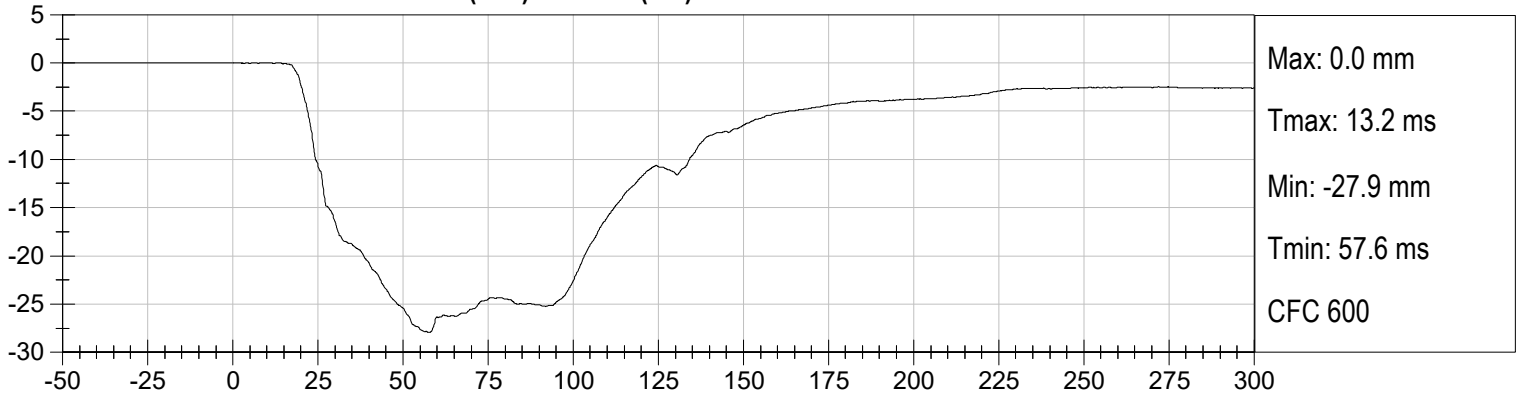
Driver Head X Redundant
 Driver Head Y Redundant
 Driver Head Z Redundant
 Driver Head Angular Velocity X
 Driver Head Angular Velocity Y
 Driver Head Angular Velocity Z
 Driver Upper Neck Force Y
 Driver Upper Neck Moment X
 Driver Upper Neck Moment Z
 Driver Chest X Redundant
 Driver Chest Y Redundant
 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

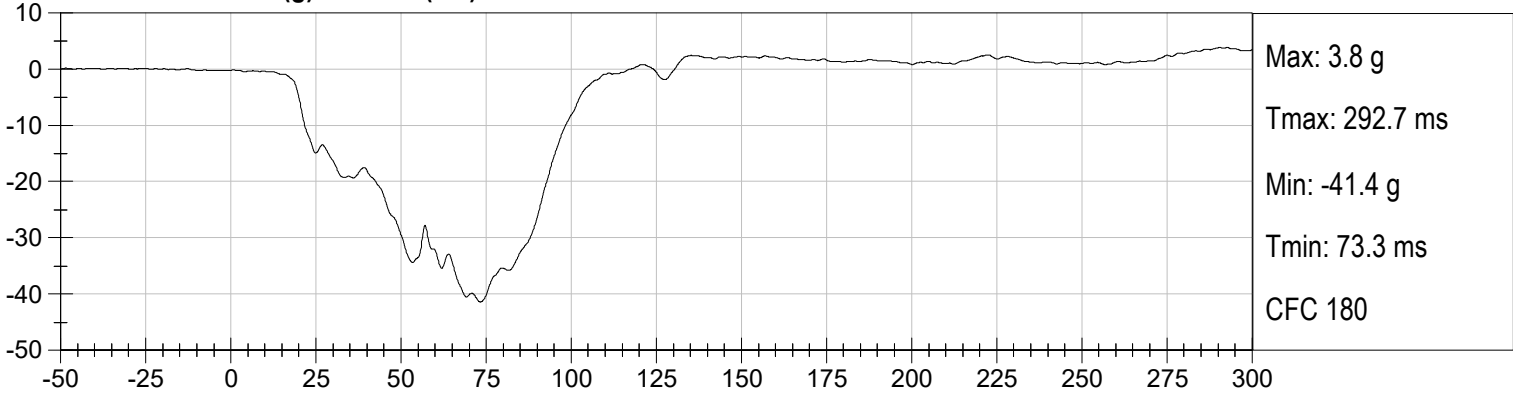
Passenger Pelvis Z
Passenger Left Femur Redundant
Passenger Right Femur Redundant
Passenger Left Upper Tibia Moment X
Passenger Left Upper Tibia Moment Y
Passenger Left Upper Tibia Force Z
Passenger Left Lower Tibia Moment X
Passenger Left Lower Tibia Moment Y
Passenger Left Lower Tibia Force Z
Passenger 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
Advanced Research Load Cell Barrier – 528 channels



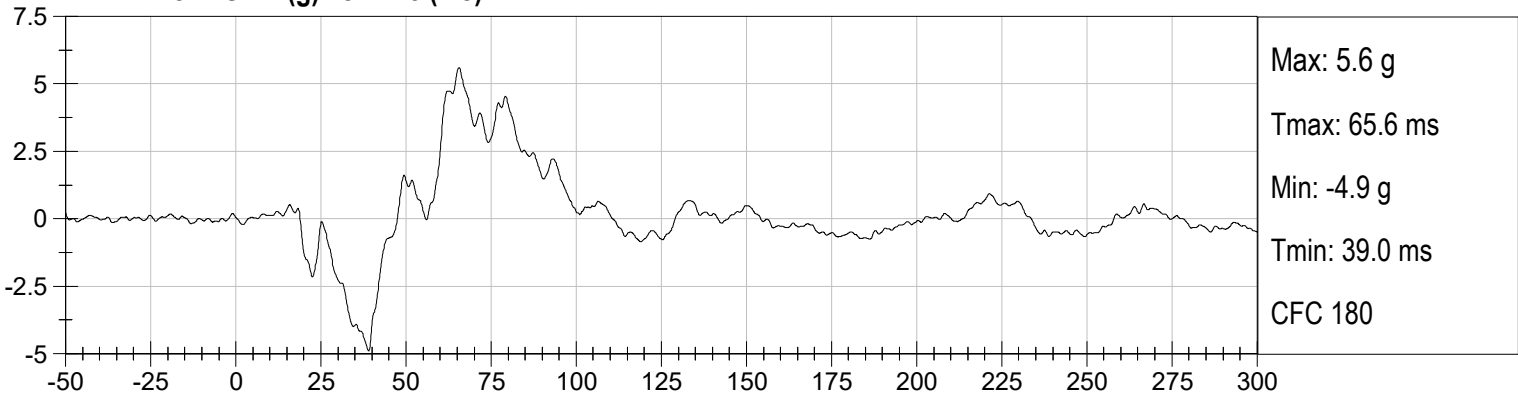
DRIVER CHEST DISPLACEMENT (mm) vs Time (ms)



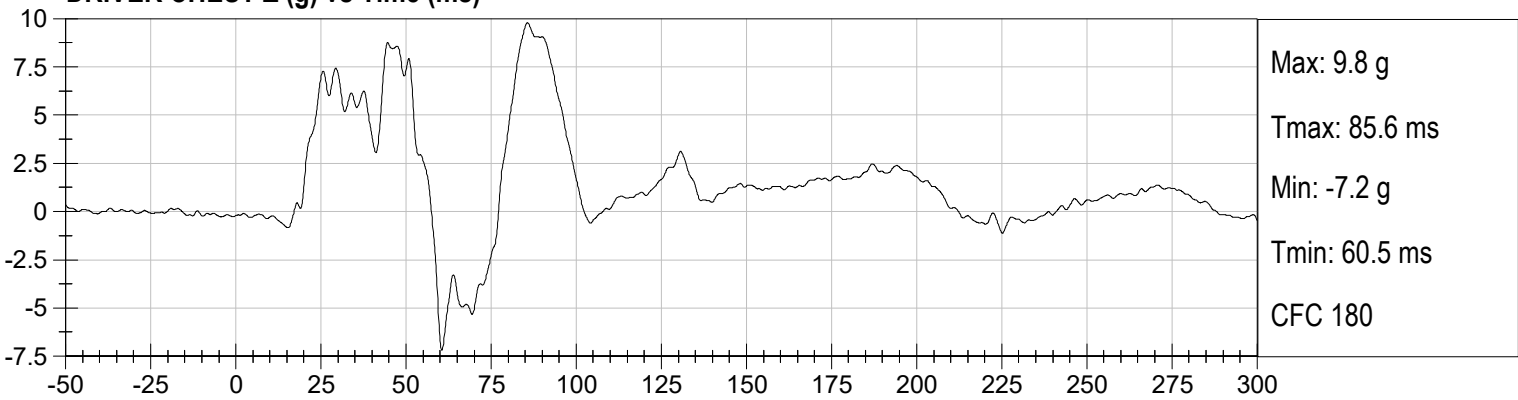
DRIVER CHEST X (g) vs Time (ms)



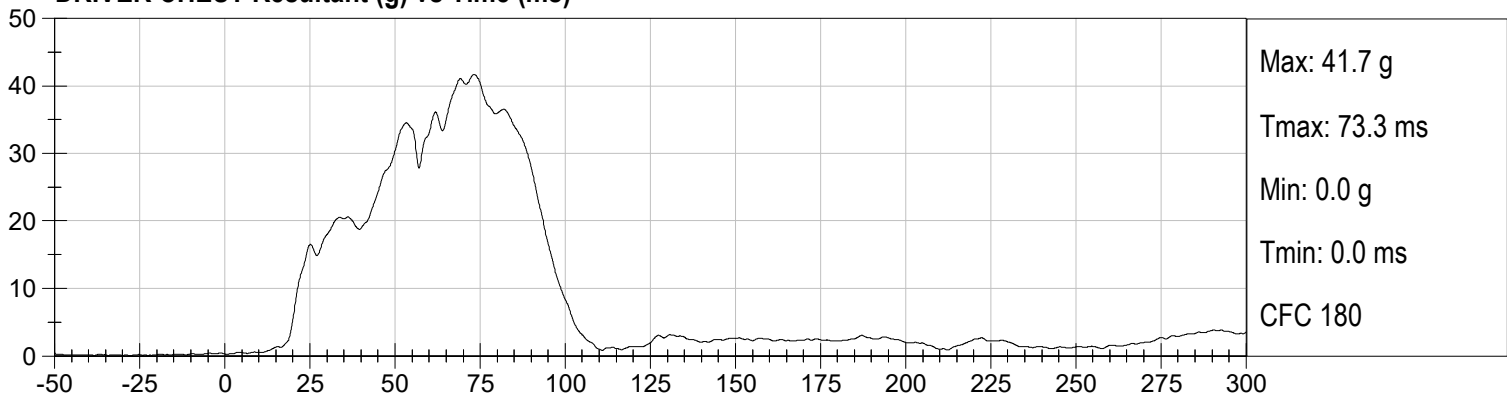
DRIVER CHEST Y (g) vs Time (ms)



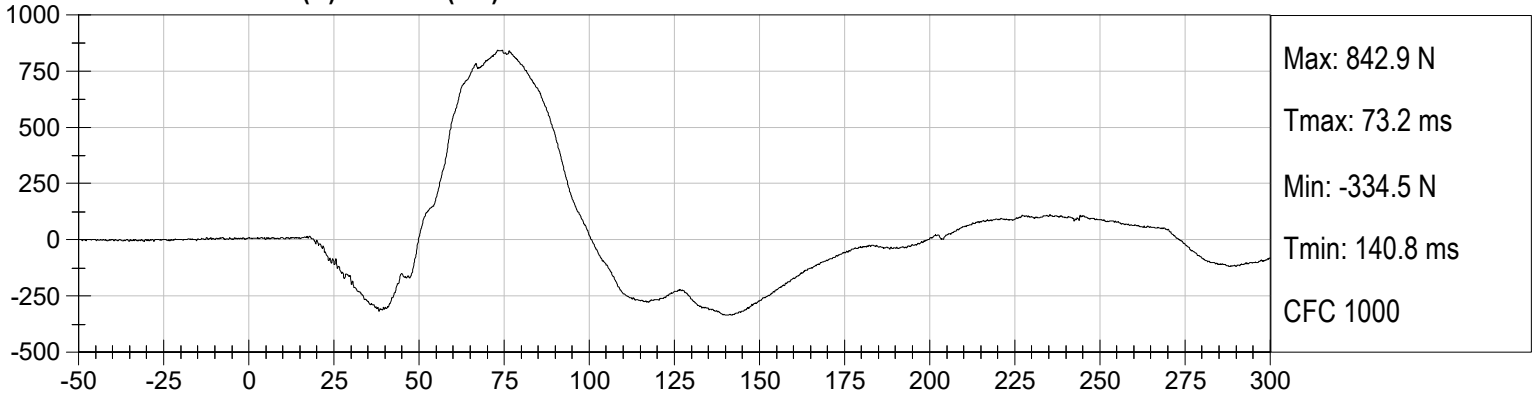
DRIVER CHEST Z (g) vs Time (ms)



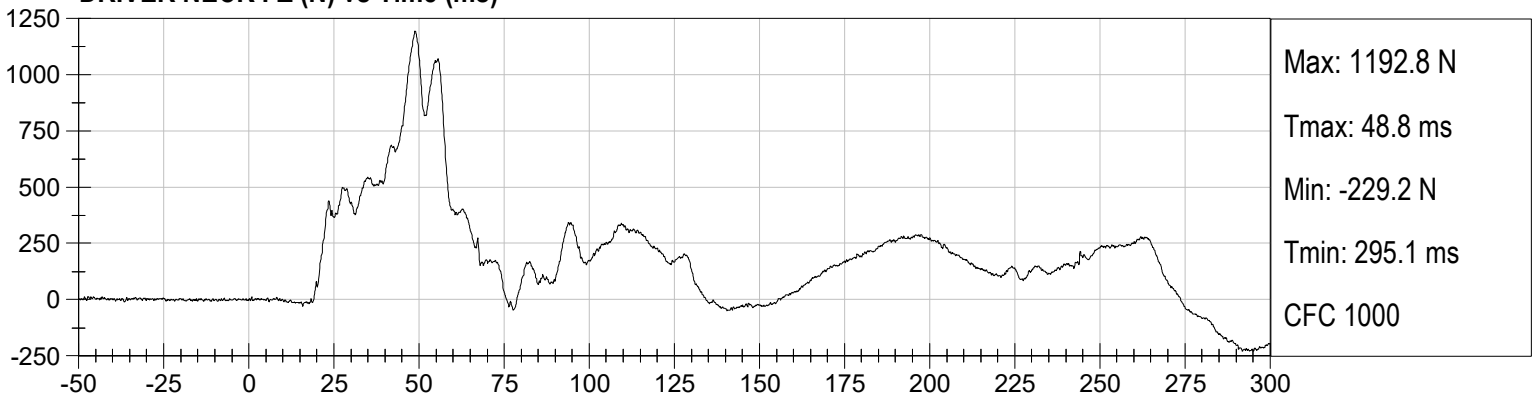
DRIVER CHEST Resultant (g) vs Time (ms)



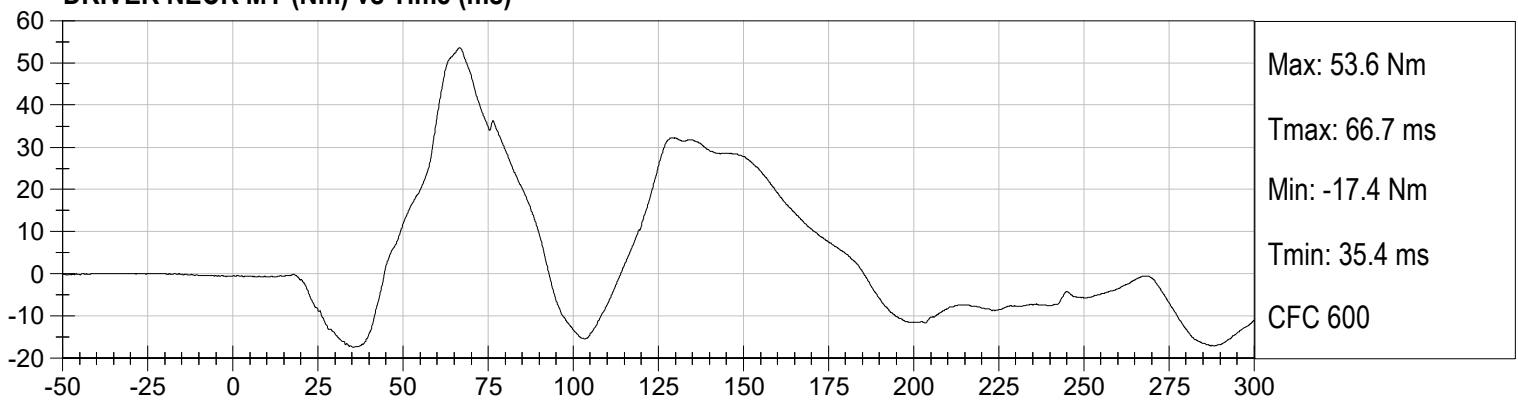
DRIVER NECK FX (N) vs Time (ms)



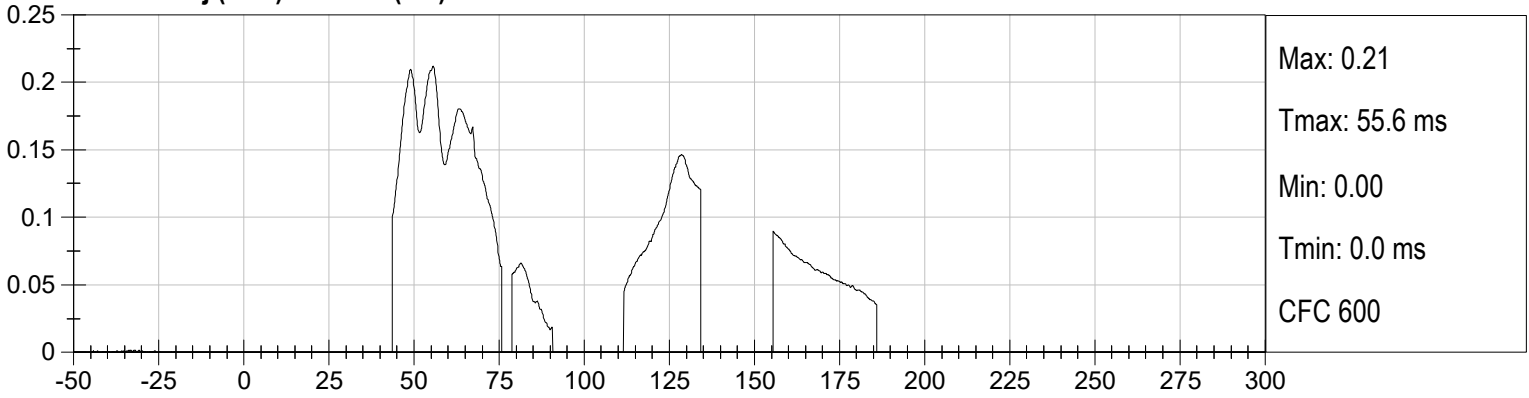
DRIVER NECK FZ (N) vs Time (ms)



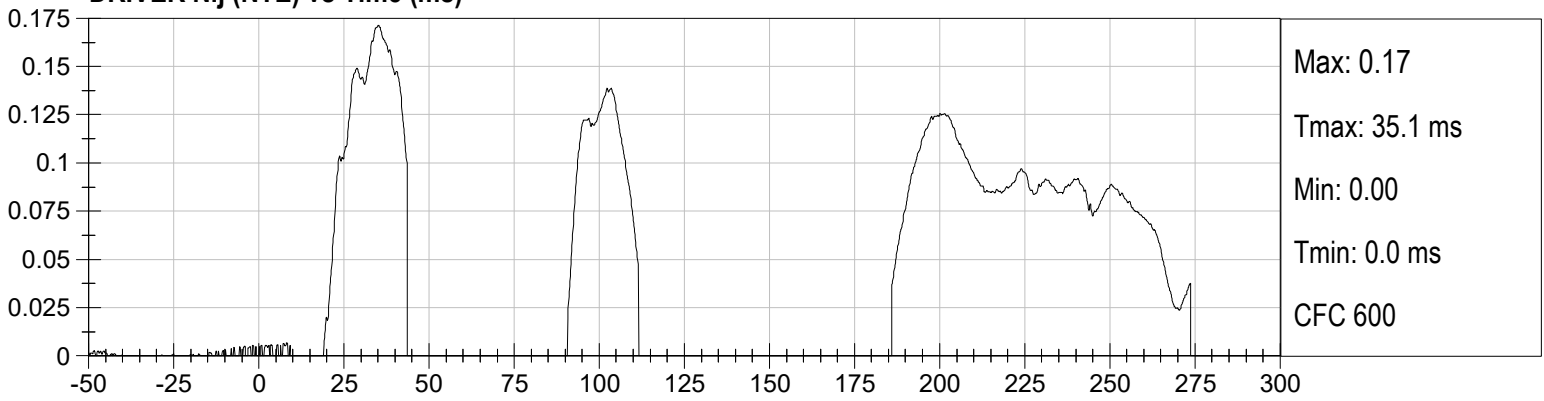
DRIVER NECK MY (Nm) vs Time (ms)



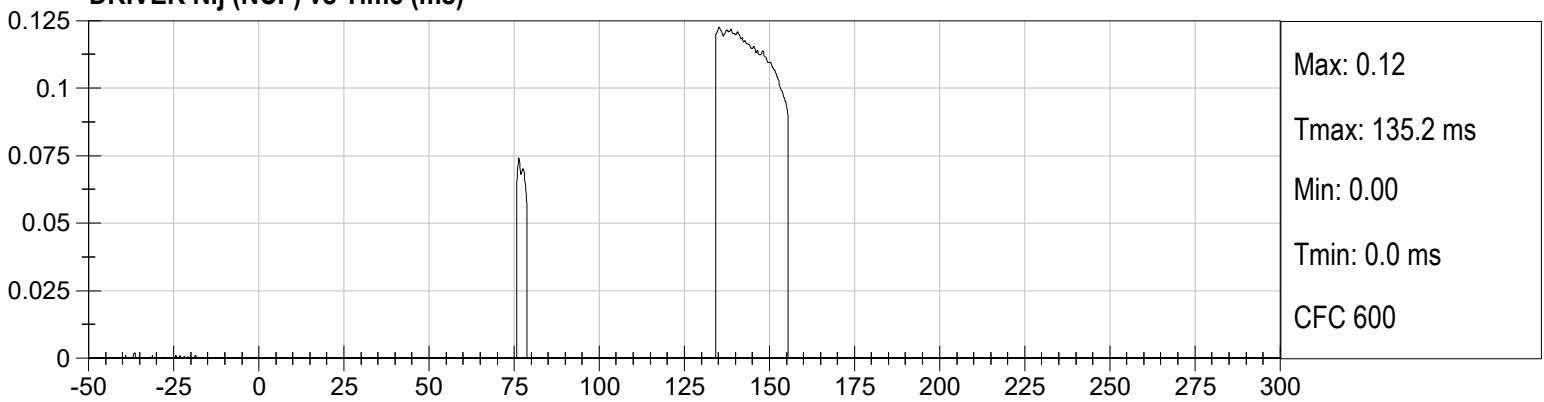
DRIVER Nij (NTF) vs Time (ms)



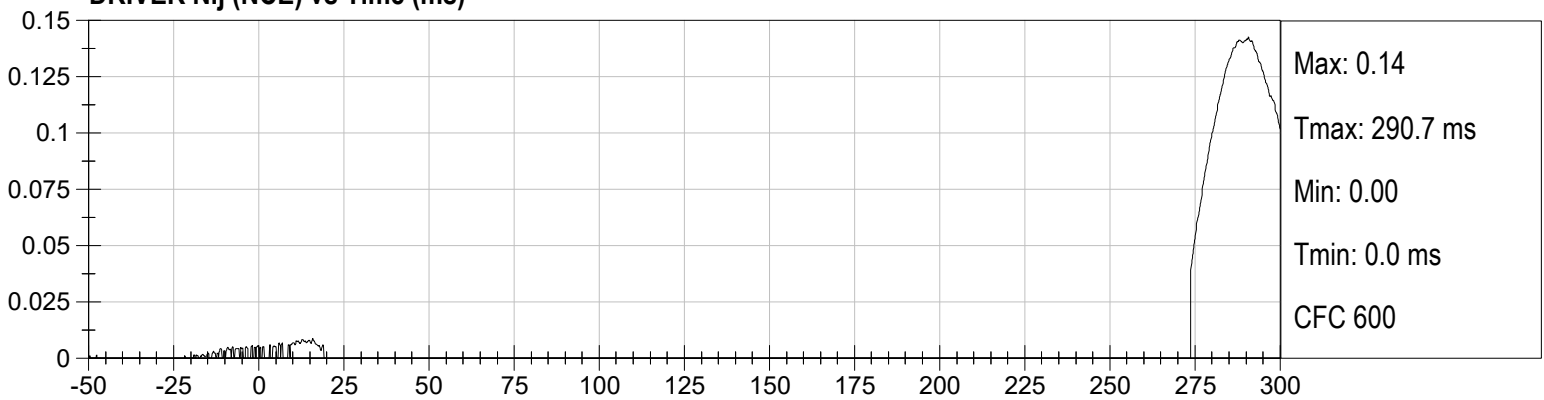
DRIVER Nij (NTE) vs Time (ms)



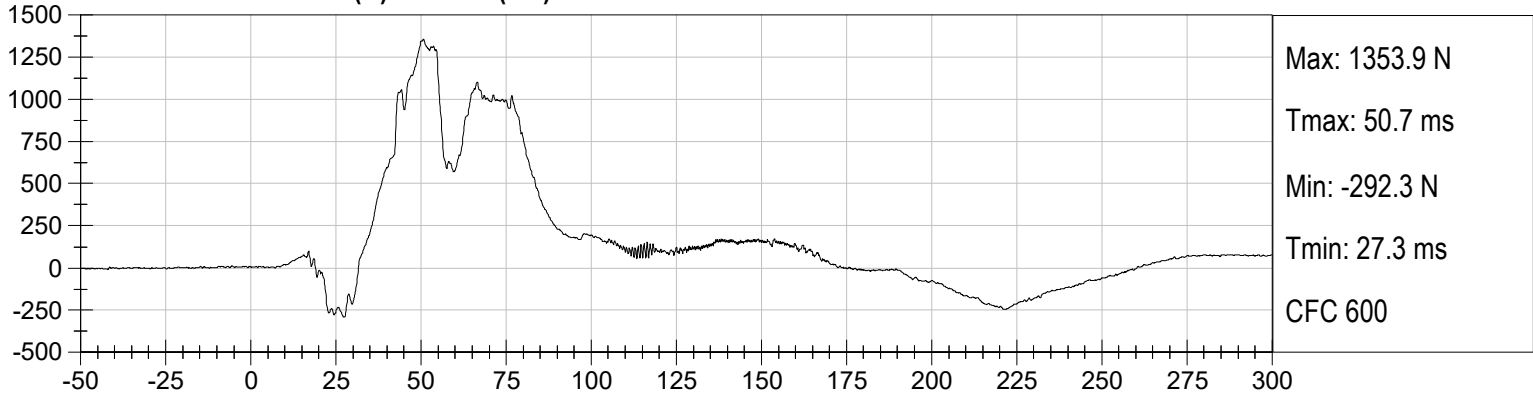
DRIVER Nij (NCF) vs Time (ms)



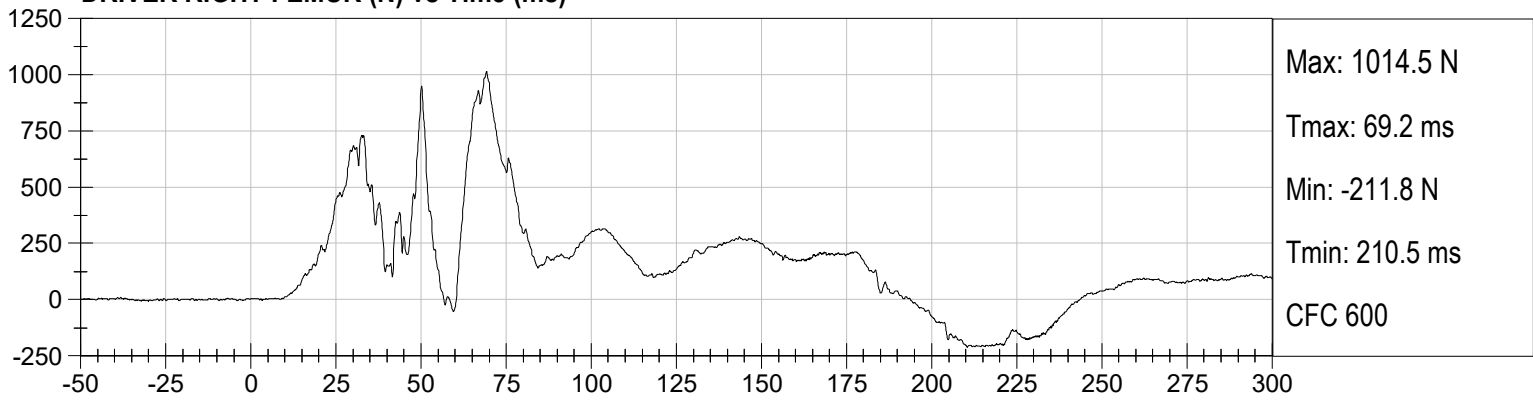
DRIVER Nij (NCE) vs Time (ms)



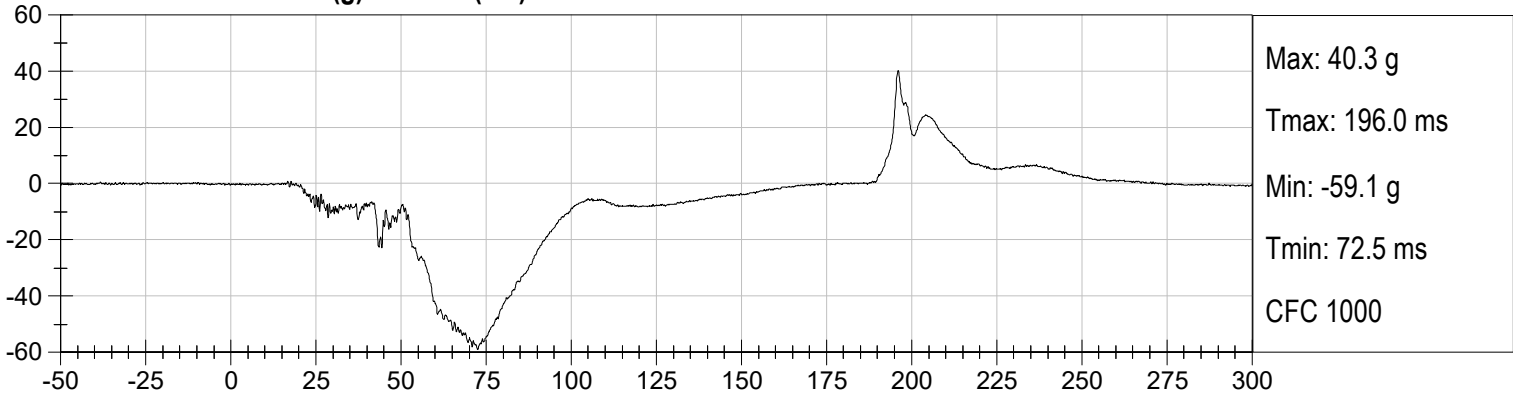
DRIVER LEFT FEMUR (N) vs Time (ms)



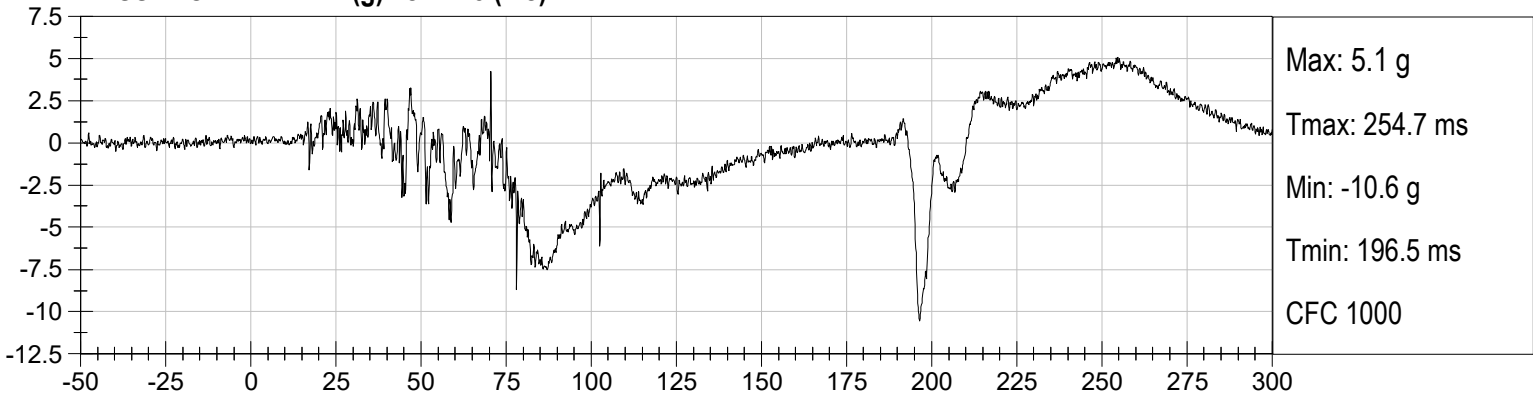
DRIVER RIGHT FEMUR (N) vs Time (ms)



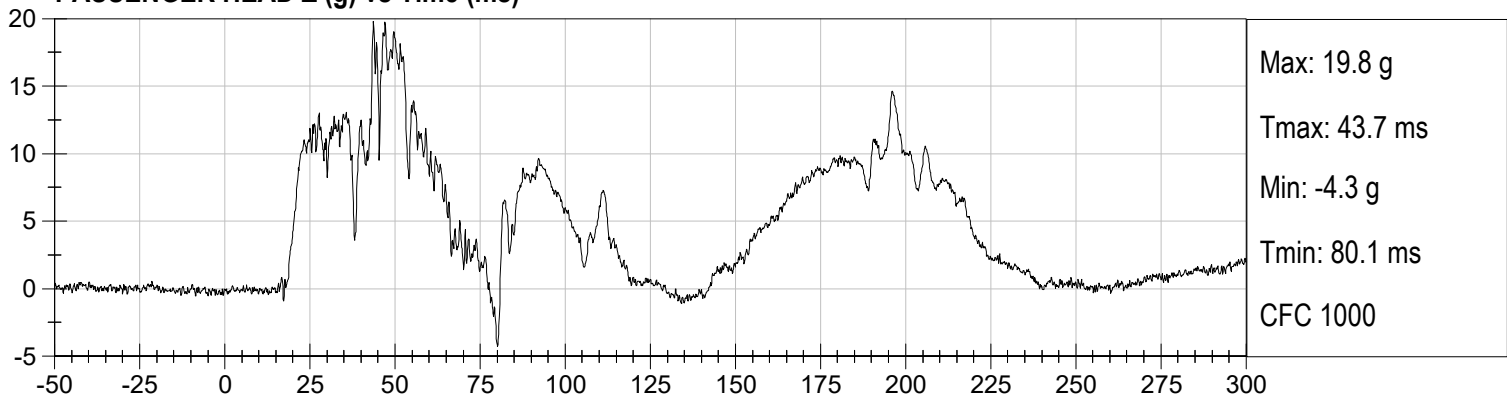
PASSENGER HEAD X (g) vs Time (ms)



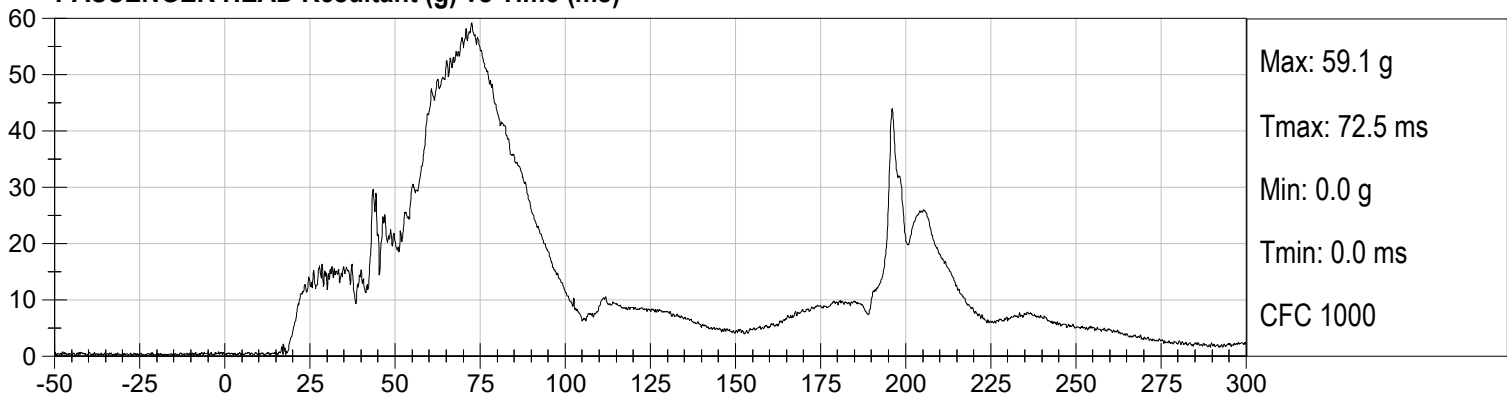
PASSENGER HEAD Y (g) vs Time (ms)



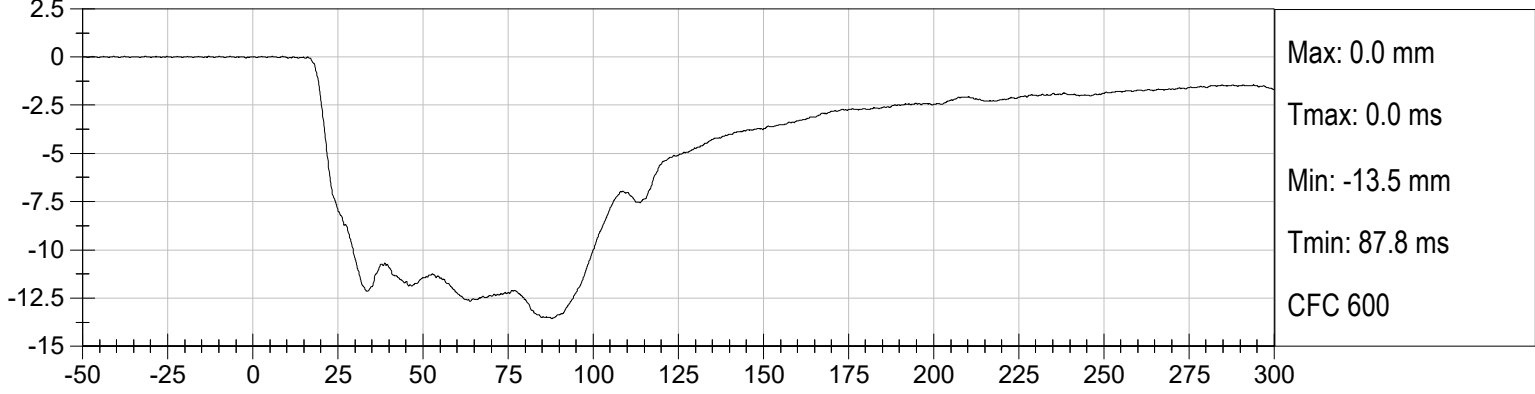
PASSENGER HEAD Z (g) vs Time (ms)



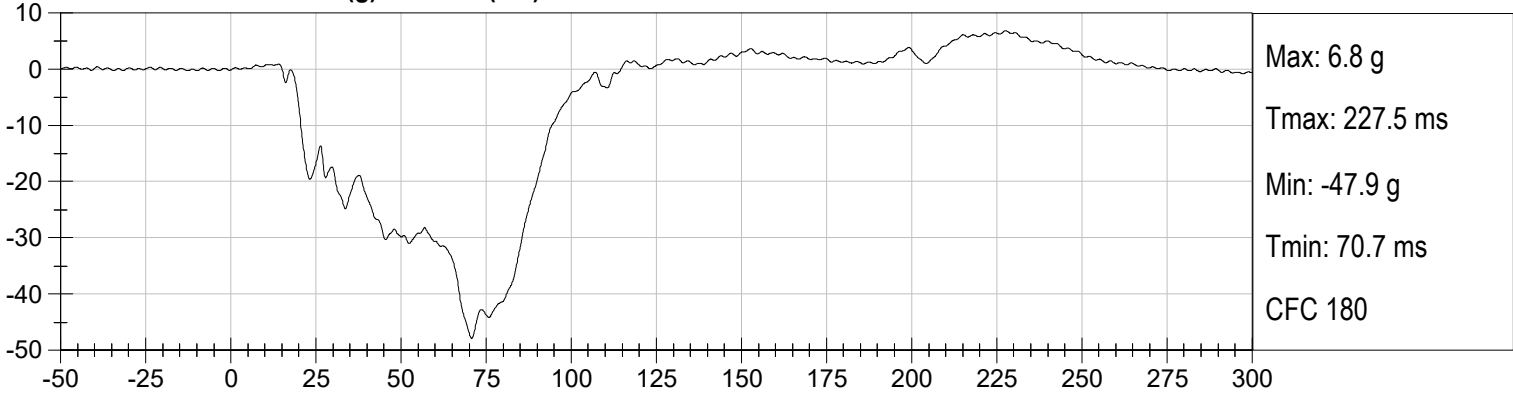
PASSENGER HEAD Resultant (g) vs Time (ms)



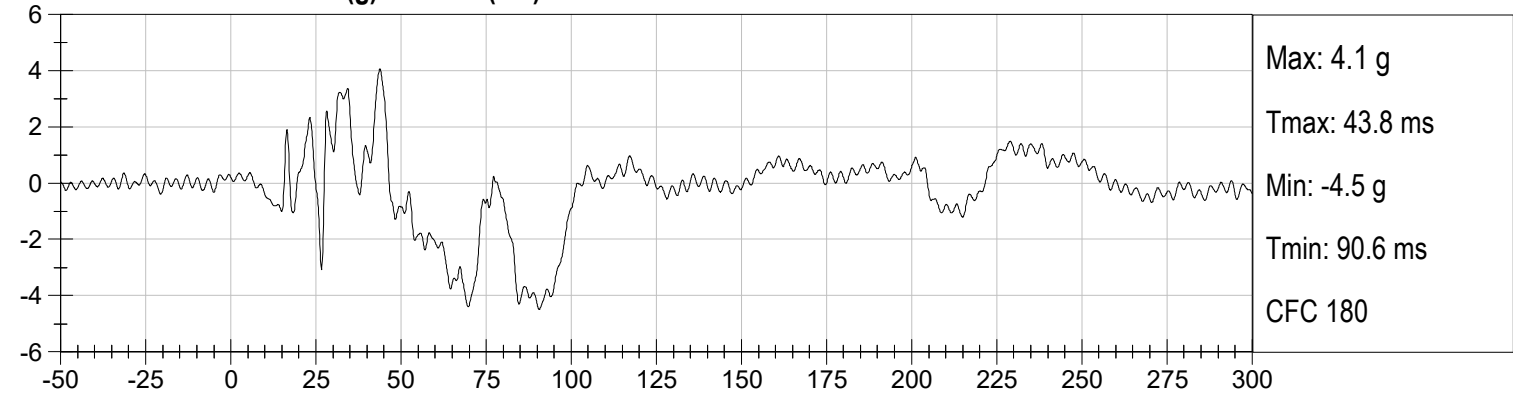
PASSENGER CHEST DISPLACEMENT (mm) vs Time (ms)



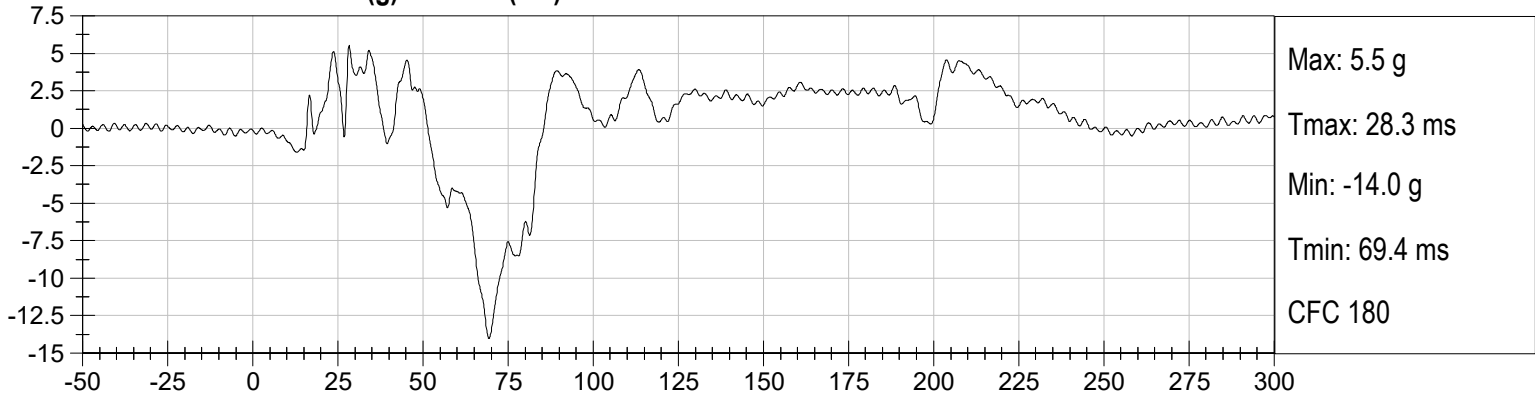
PASSENGER CHEST X (g) vs Time (ms)



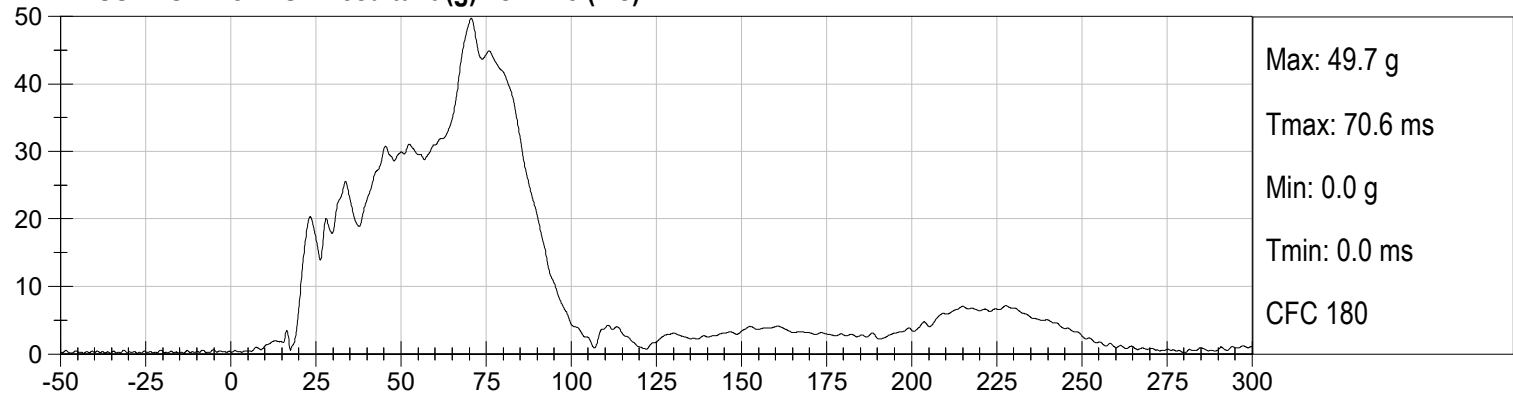
PASSENGER CHEST Y (g) vs Time (ms)



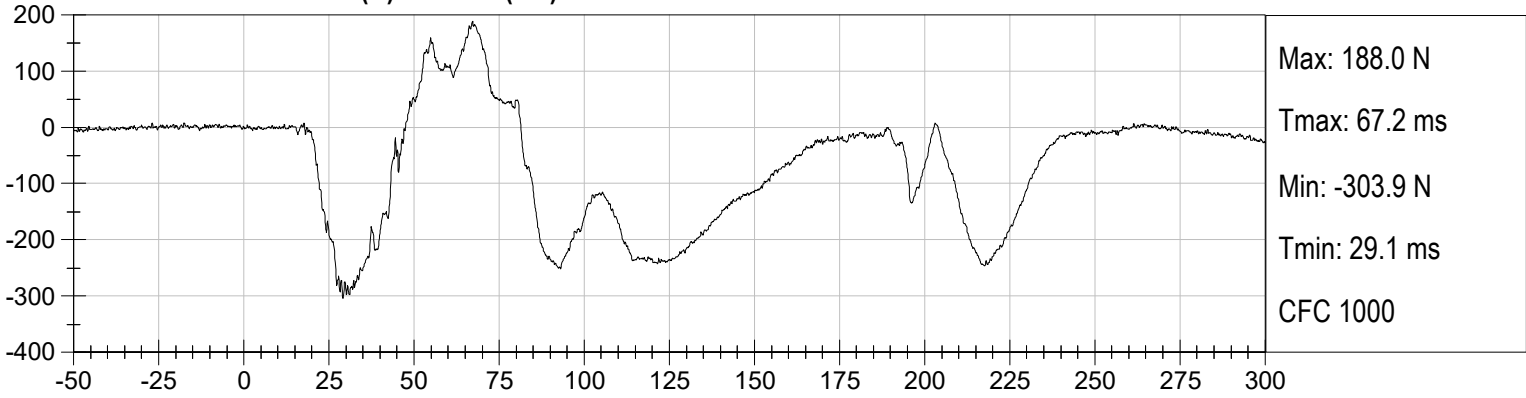
PASSENGER CHEST Z (g) vs Time (ms)



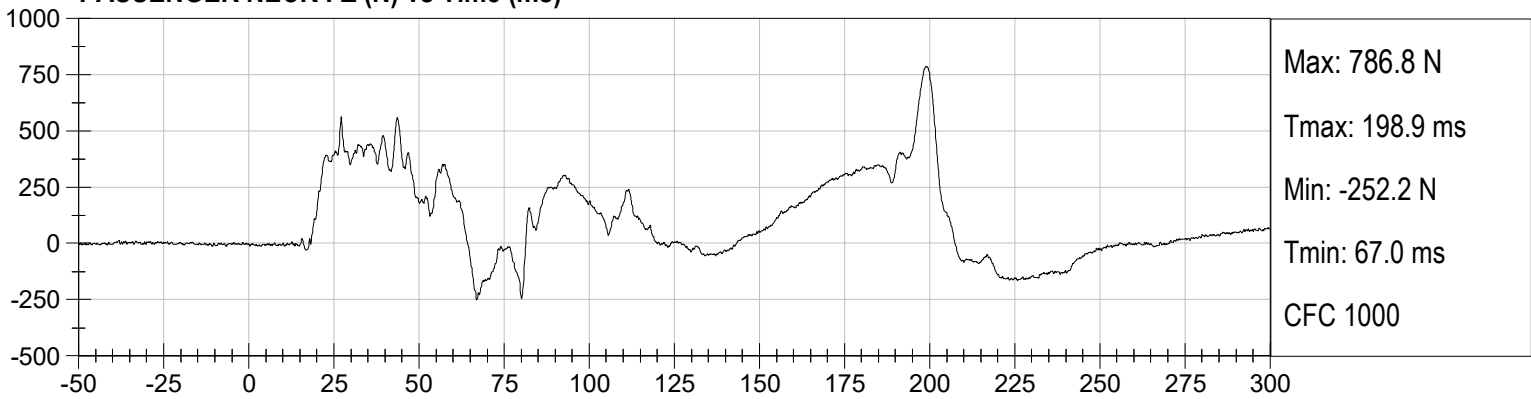
PASSENGER CHEST Resultant (g) vs Time (ms)



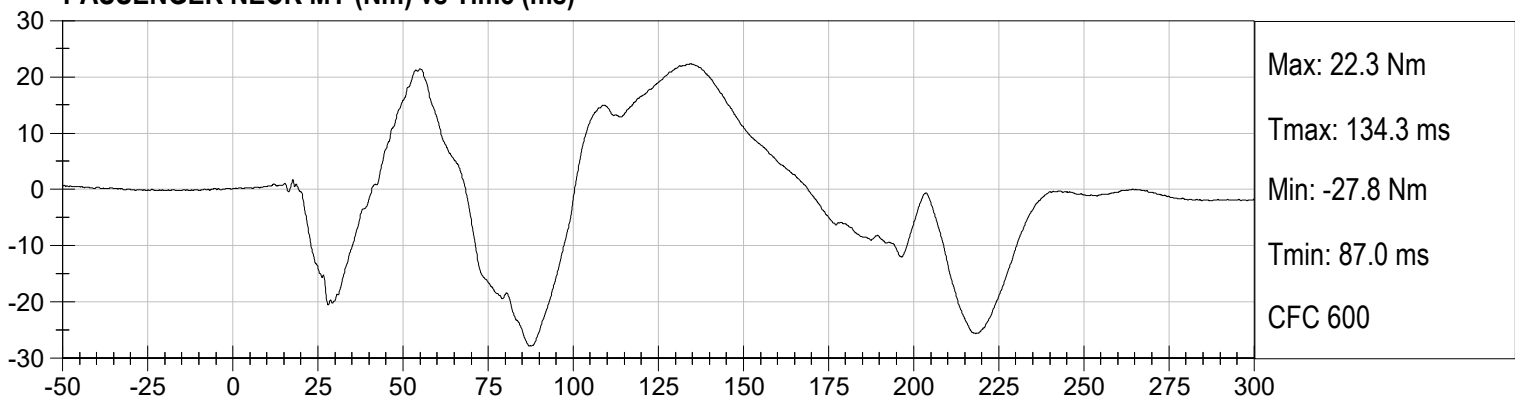
PASSENGER NECK FX (N) vs Time (ms)



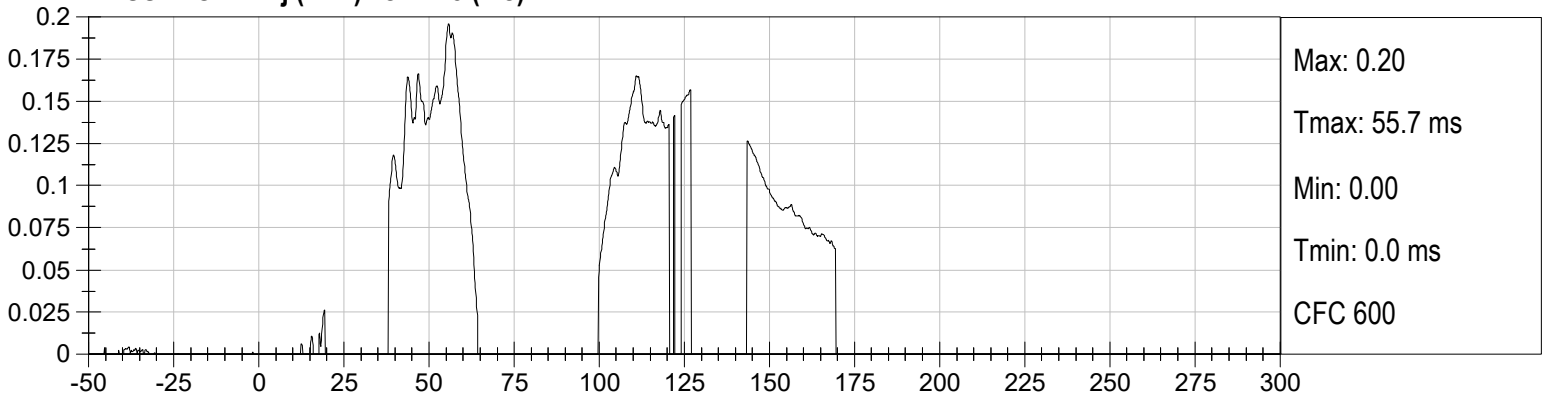
PASSENGER NECK FZ (N) vs Time (ms)



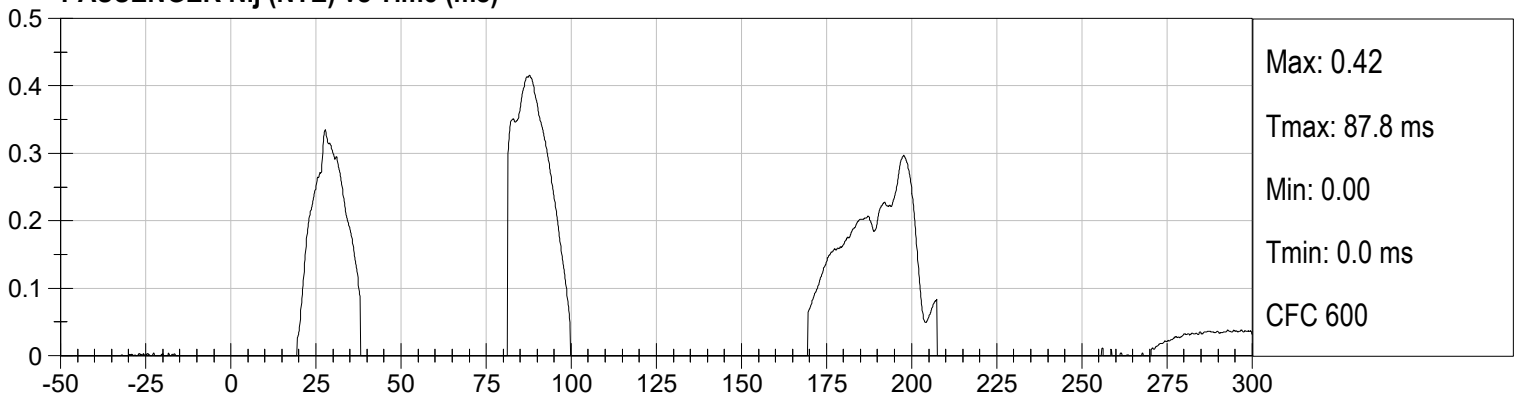
PASSENGER NECK MY (Nm) vs Time (ms)



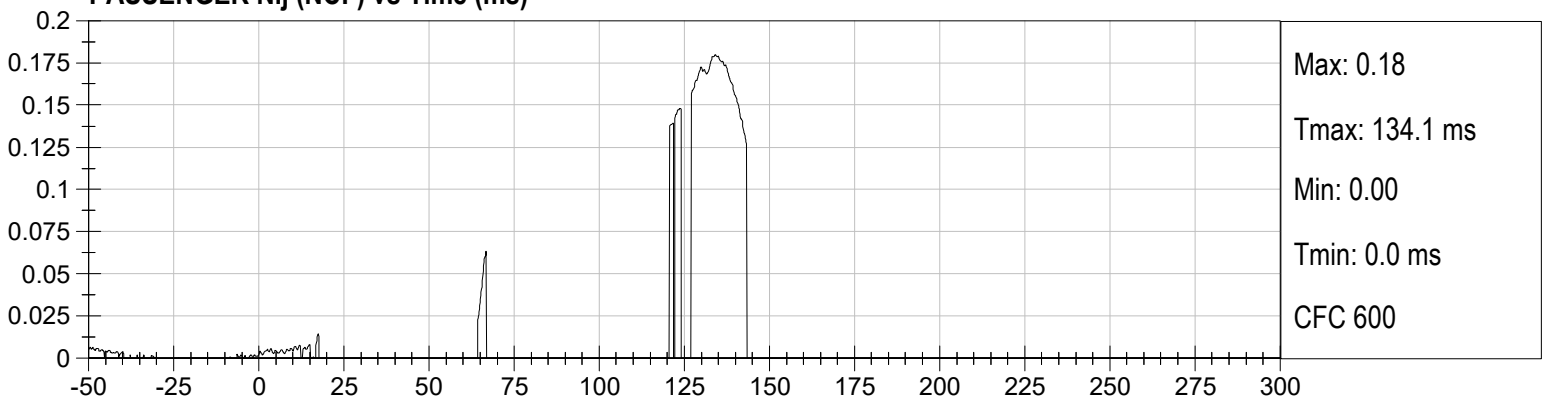
PASSENGER Nij (NTF) vs Time (ms)



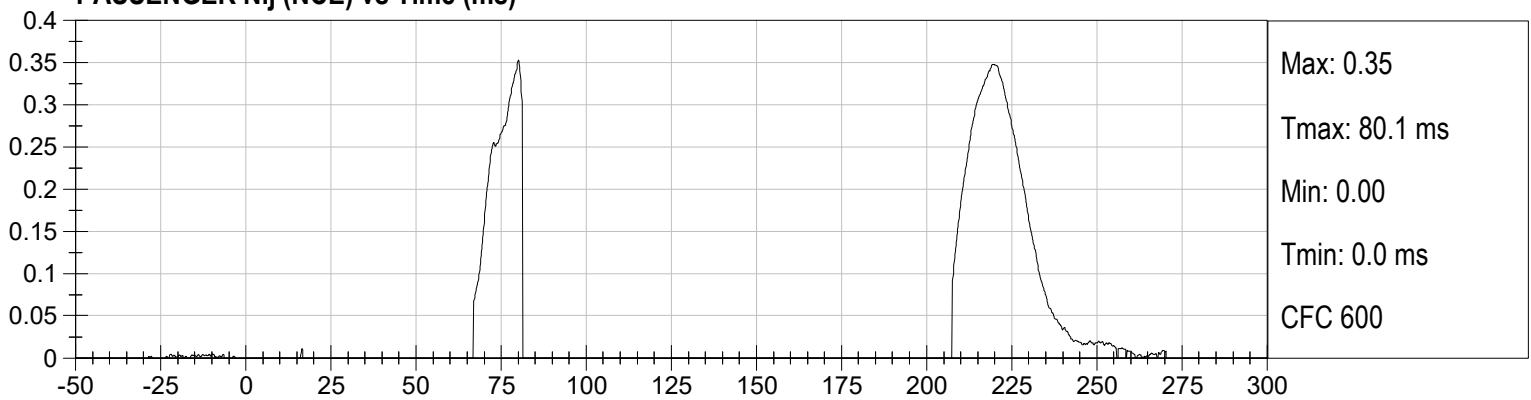
PASSENGER Nij (NTE) vs Time (ms)



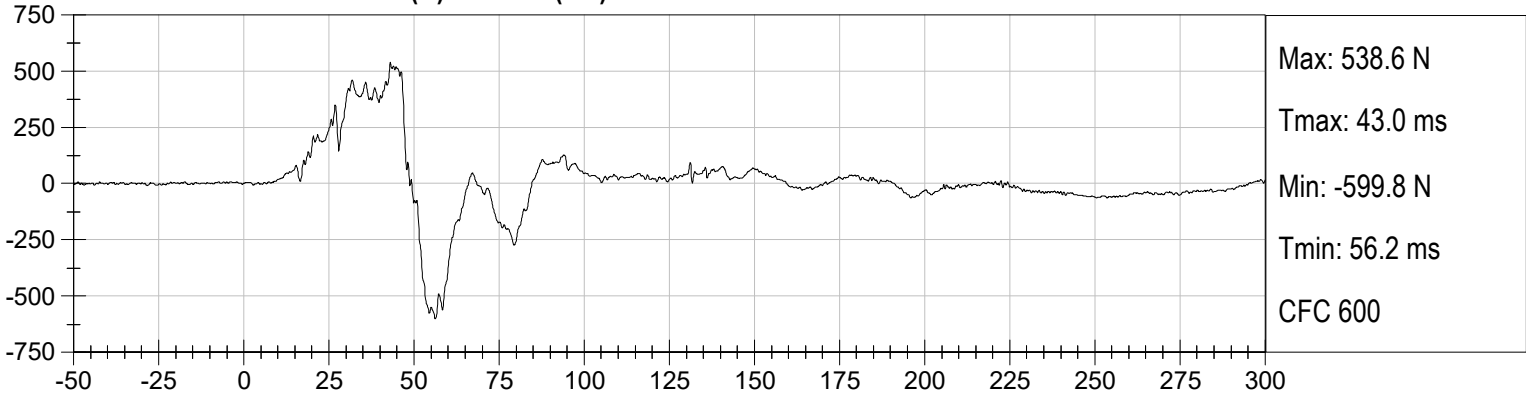
PASSENGER Nij (NCF) vs Time (ms)



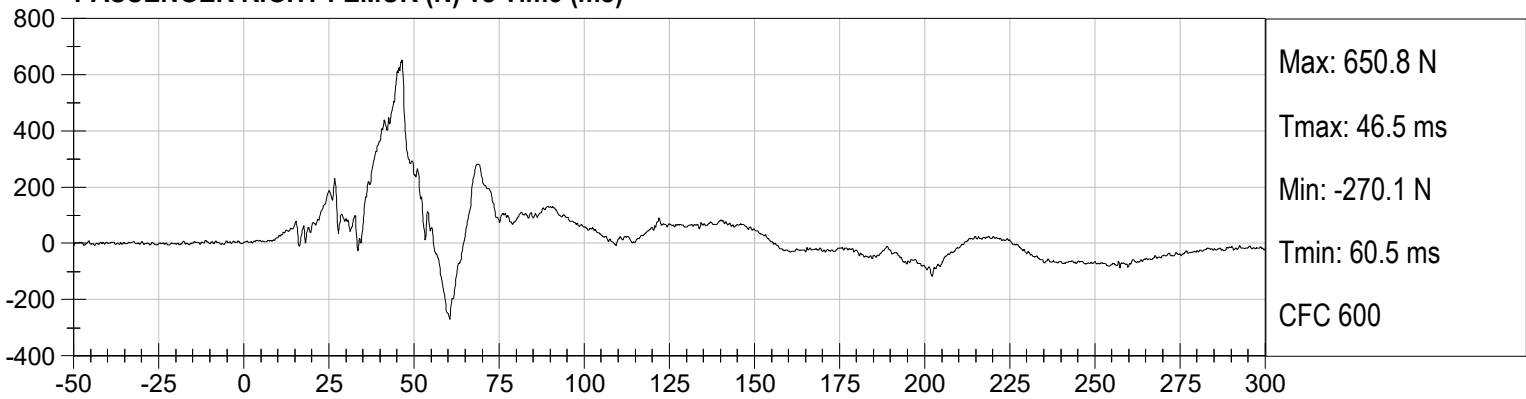
PASSENGER Nij (NCE) vs Time (ms)



PASSENGER LEFT FEMUR (N) vs Time (ms)



PASSENGER RIGHT FEMUR (N) vs Time (ms)



APPENDIX C
DUMMY CALIBRATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

**Hybrid III, 50th External Measurements
SN: 351**

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

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

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

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 50TH PERCENTILE MALE

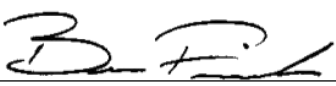
ATD Serial No: 351

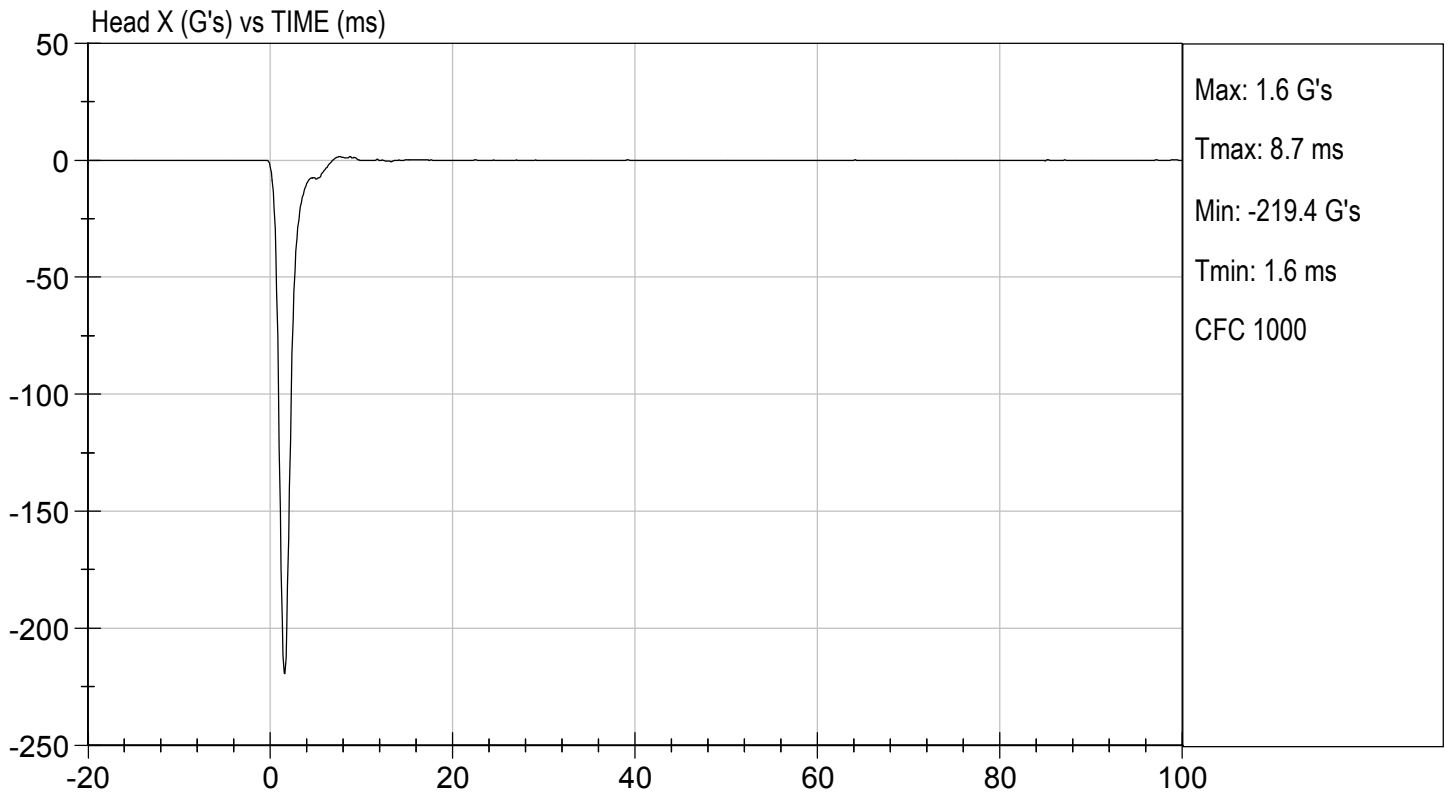
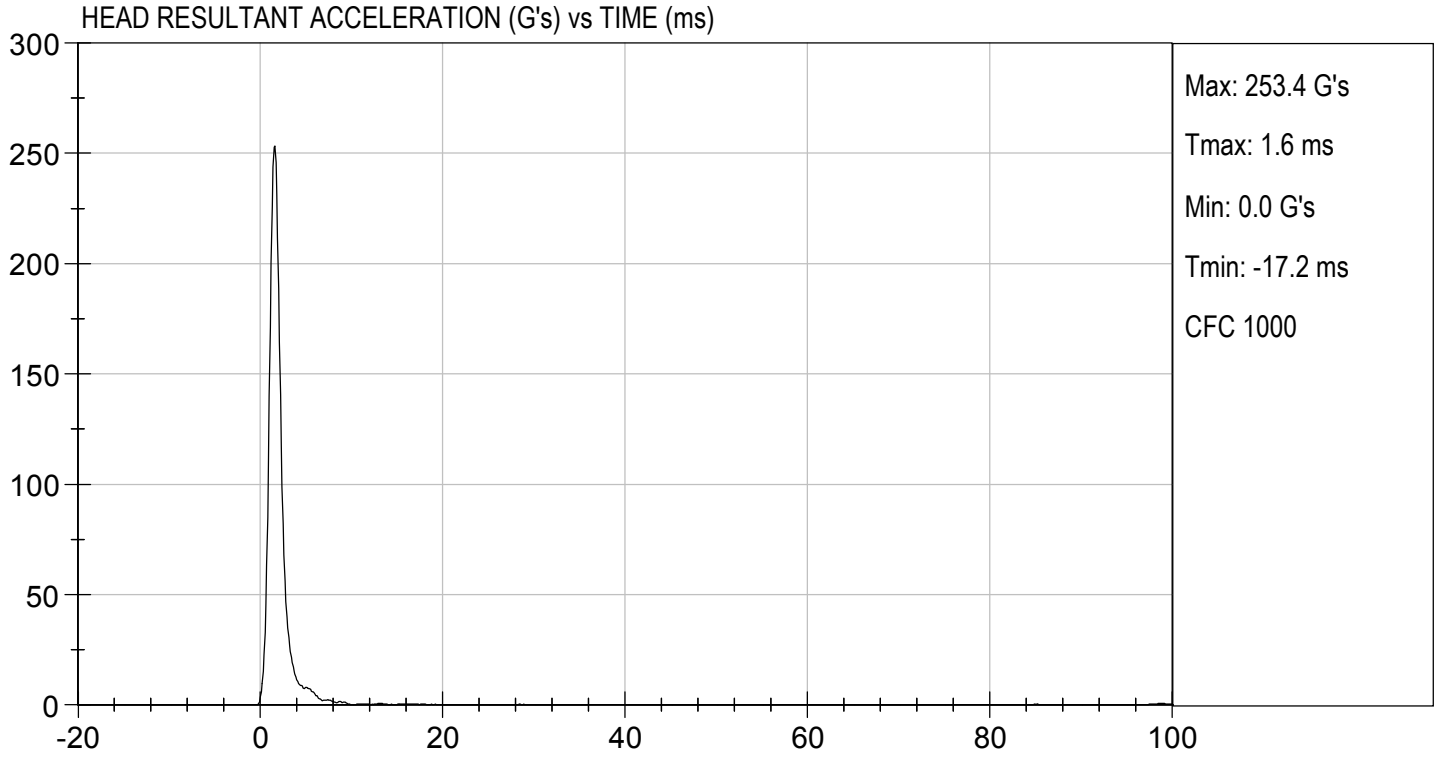
Test ID: D211051

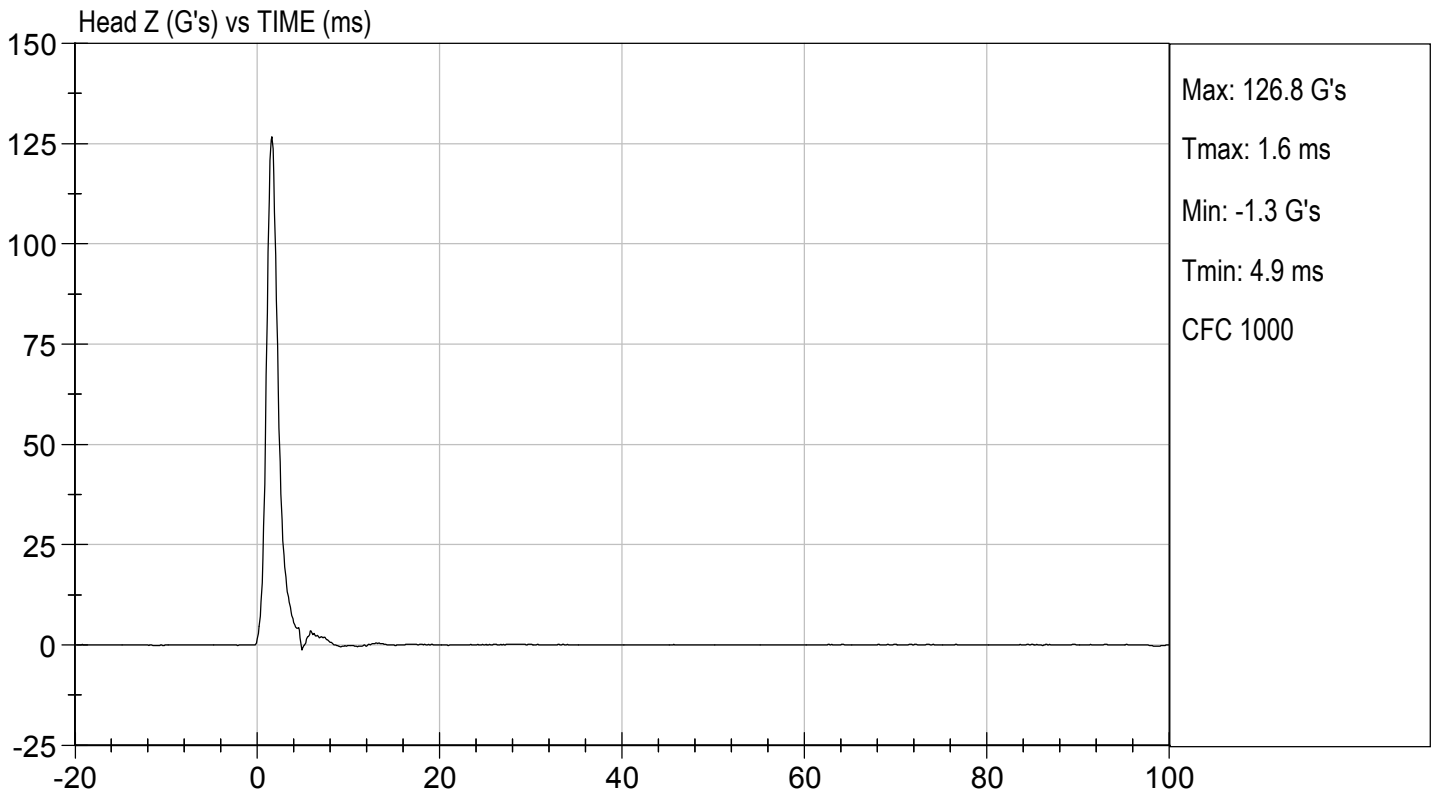
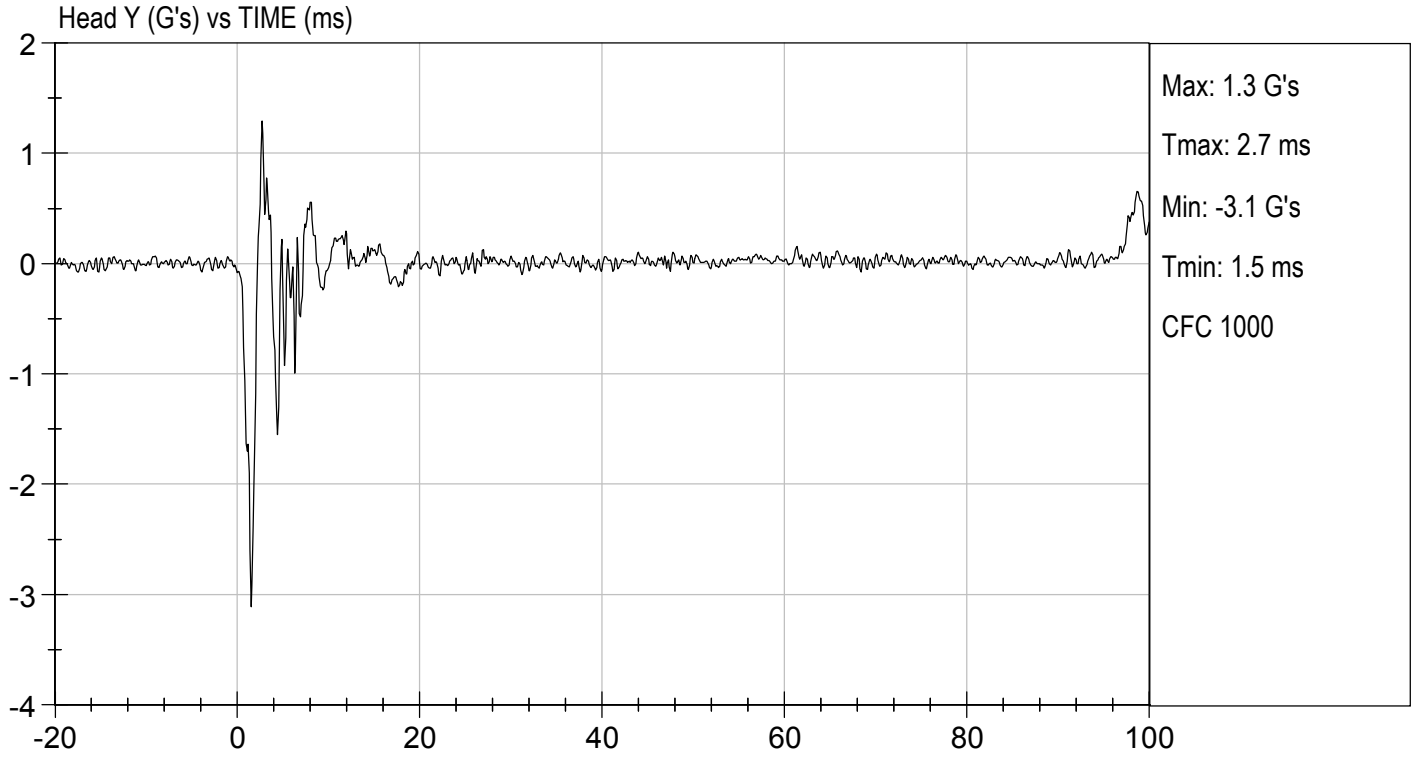
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	36	Pass
Peak Resultant Acceleration	G's	225 to 275	253	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-3.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass


 Laboratory Technician

03/25/2021
 Test Date


 Approved By






MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

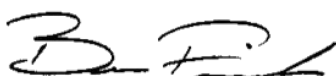
ATD Serial No: 351

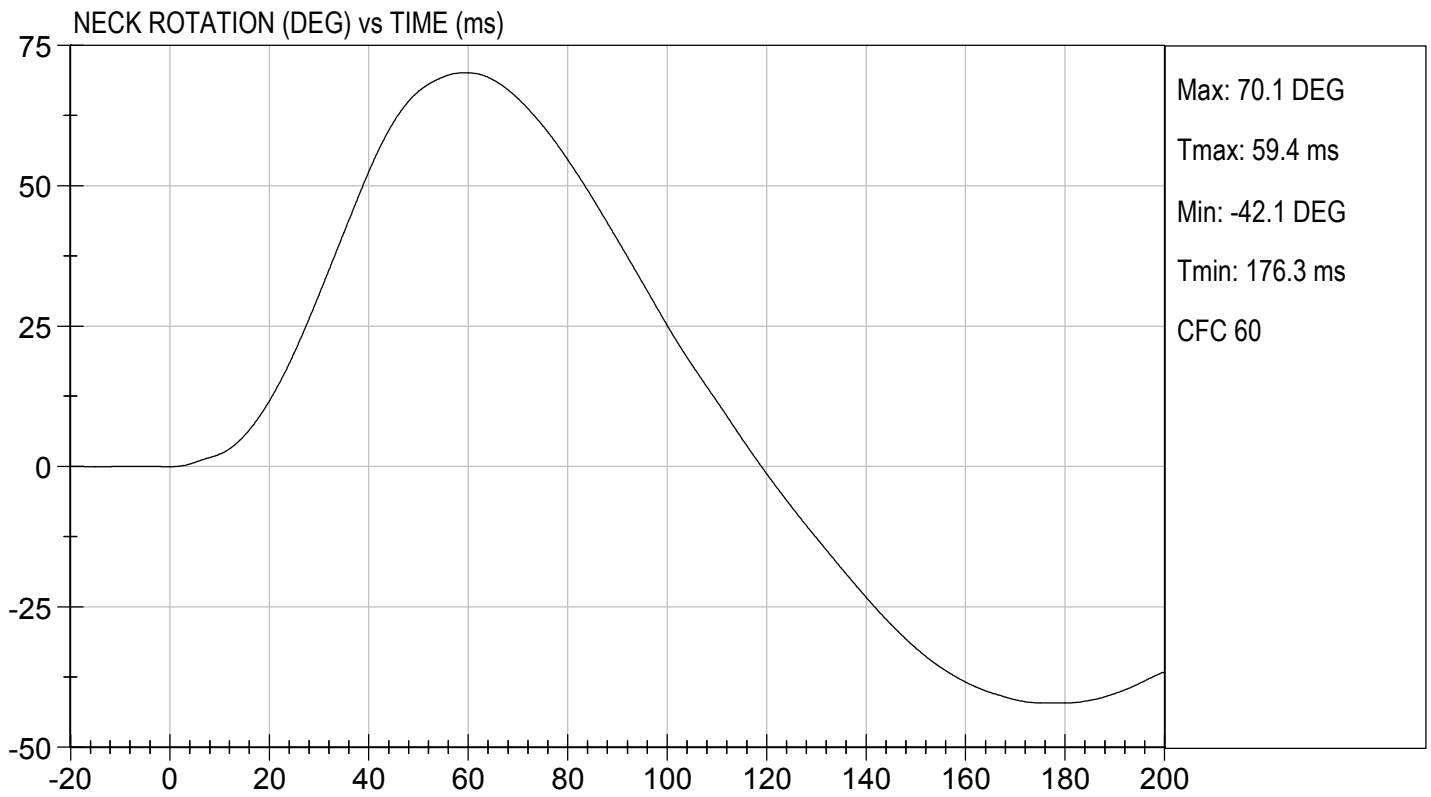
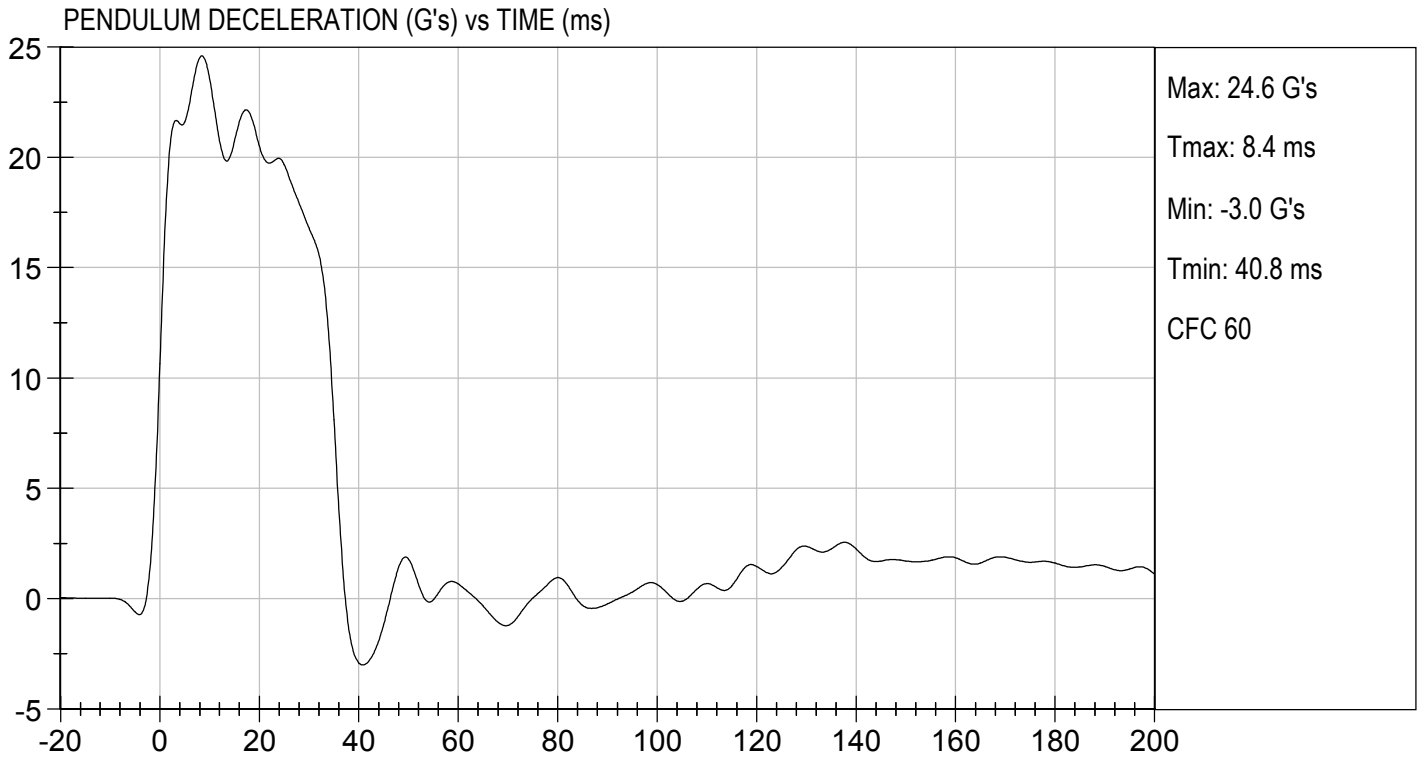
Test I.D.: D211052

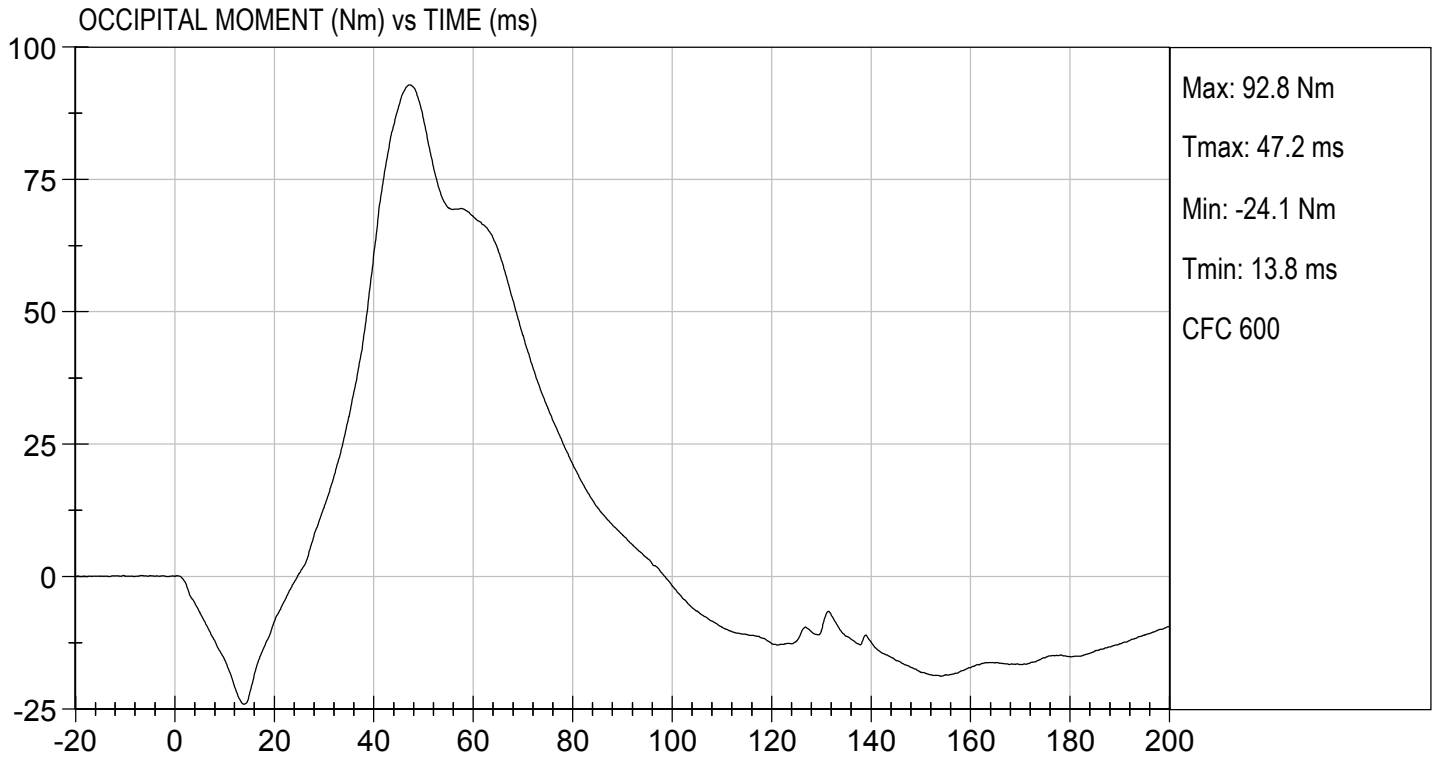
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	36	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.56	Pass
	20 ms	G's	17.60 to 22.60	20.51	Pass
	30 ms	G's	12.50 to 18.50	16.78	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	16.7	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	35.8	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	70.1	Pass
	Time	ms	57.0 to 64.0	59.4	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	119.1	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	92.8	Pass
	Time	ms	47.0 to 58.0	47.2	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	98.7	Pass
Overall Test Results					Pass


 Laboratory Technician

03/25/2021
 Test Date


 Approved By





MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 50TH PERCENTILE MALE

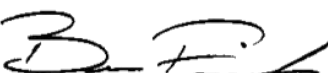
ATD Serial No: 351

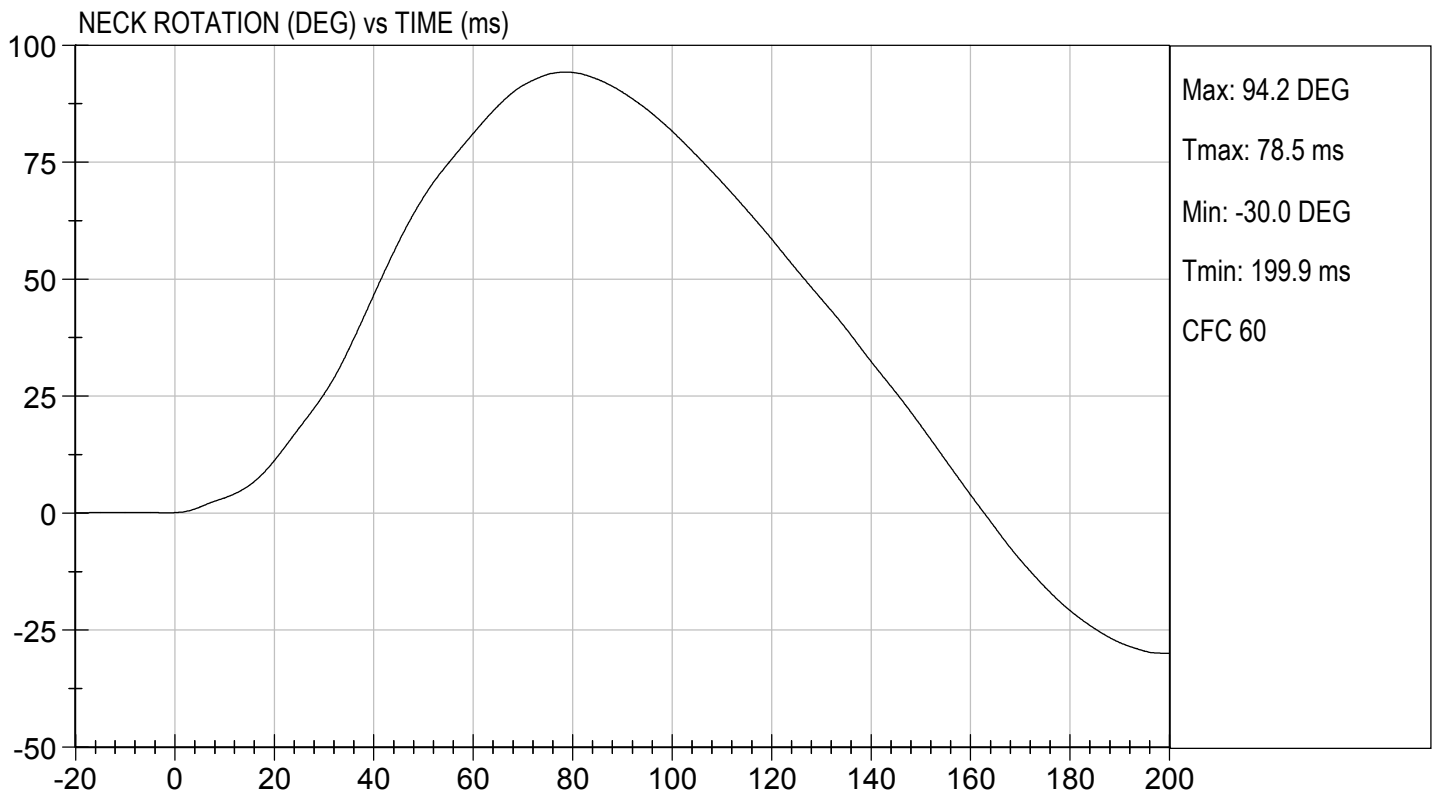
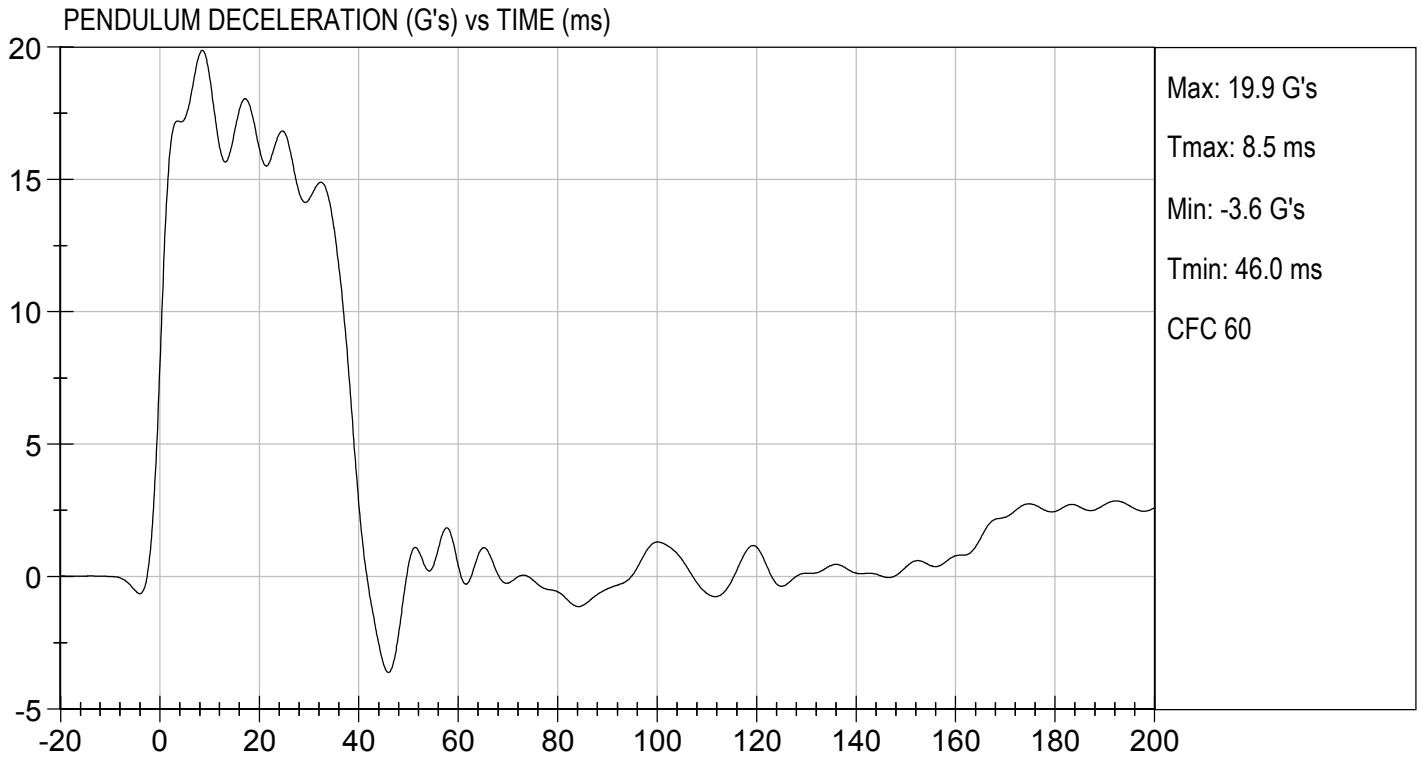
Test I.D.: D211053

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	36	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	18.87	Pass
	20 ms	G's	14.00 to 19.00	16.16	Pass
	30 ms	G's	11.00 to 16.00	14.25	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.9	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	39.1	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	94.2	Pass
	Time	ms	72.0 to 82.0	78.5	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	162.9	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-65.5	Pass
	Time	ms	65.0 to 79.0	72.7	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	147.4	Pass
Overall Test Results					Pass


 Laboratory Technician

03/25/2021
 Test Date


 Approved By





MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 50TH PERCENTILE MALE

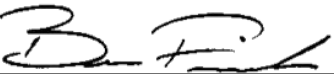
ATD Serial No: 351

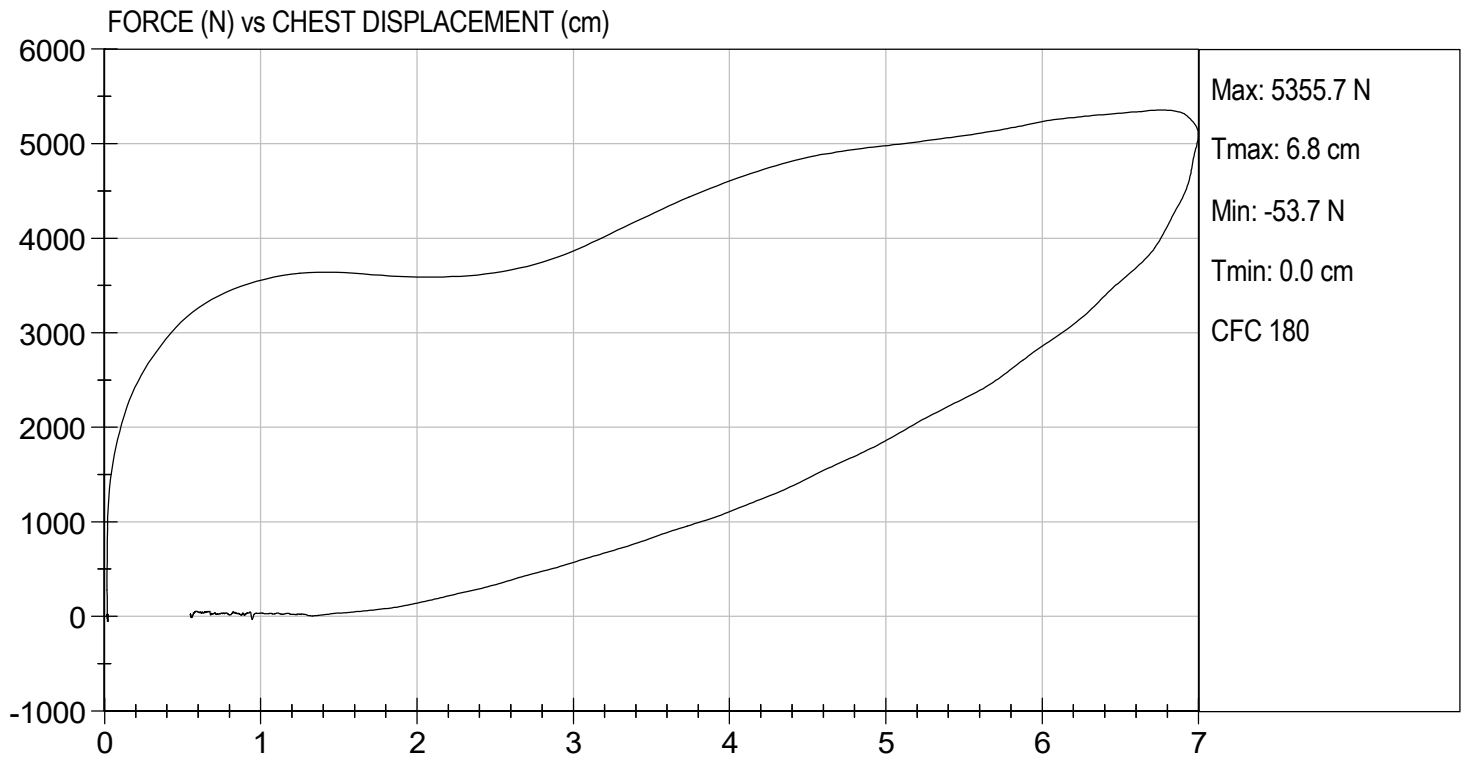
Test I.D: D211054

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	30	Pass
Probe Velocity	m/s	6.58 to 6.82	6.60	Pass
Peak Probe Force	N	5159 to 5893	5,356	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	7.00	Pass
Internal Hysteresis	%	69 to 85	71	Pass
Overall Test Results				Pass


 Laboratory Technician

03/26/2021
 Test Date


 Approved By



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE


ATD Serial No: 351

Test I.D: D211055

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21	Pass
Laboratory Relative Humidity	%	10 to 70	30	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	4,851	Pass
Overall Test Results				Pass


 Laboratory Technician

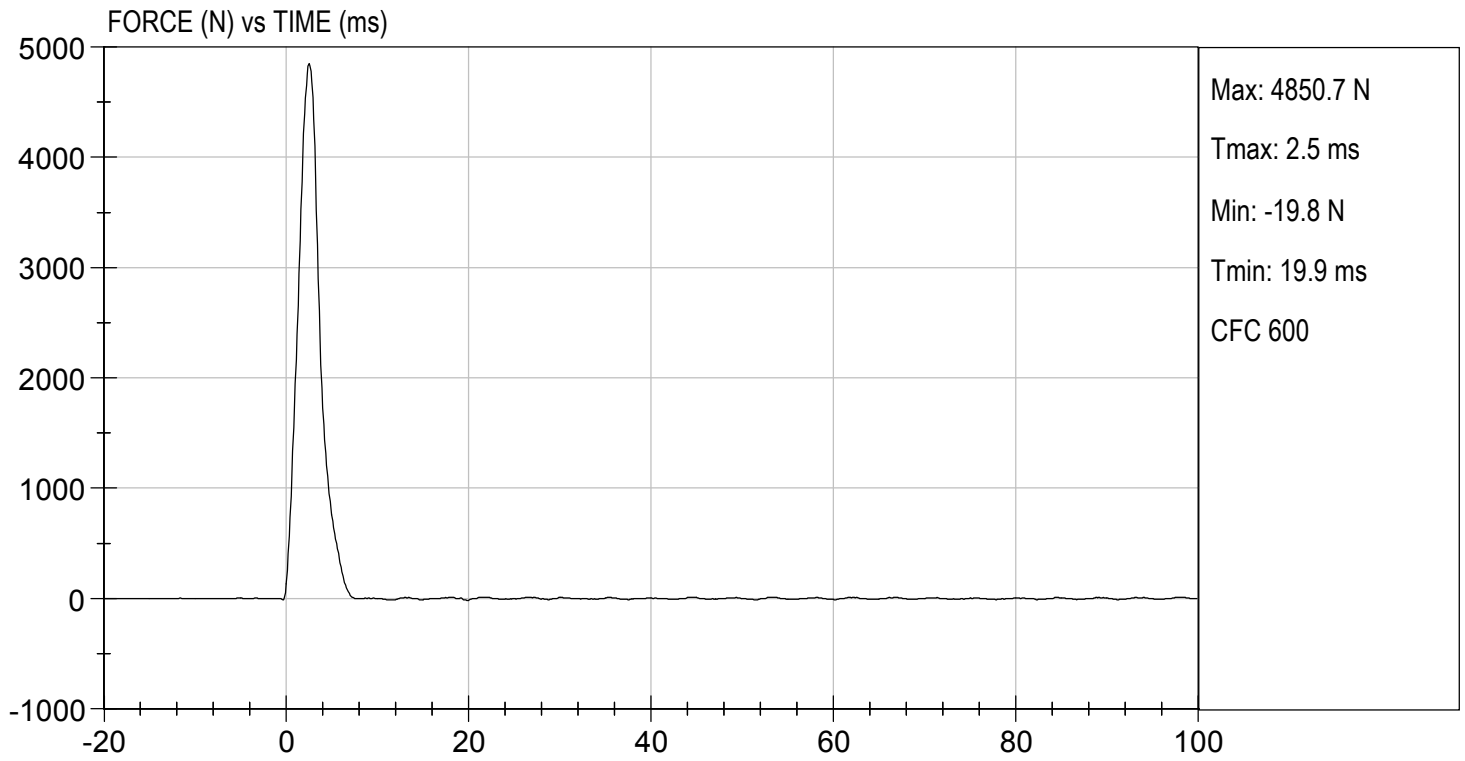
3/26/2021
 Test Date


 Approved By



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

TEST DATE: 3/26/2021
TEST #: D211055



MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D211056

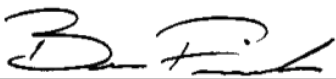
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21	Pass
Laboratory Relative Humidity	%	10 to 70	29.8	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	4,987	Pass
Overall Test Results				Pass



 Laboratory Technician

03/26/2021

 Test Date

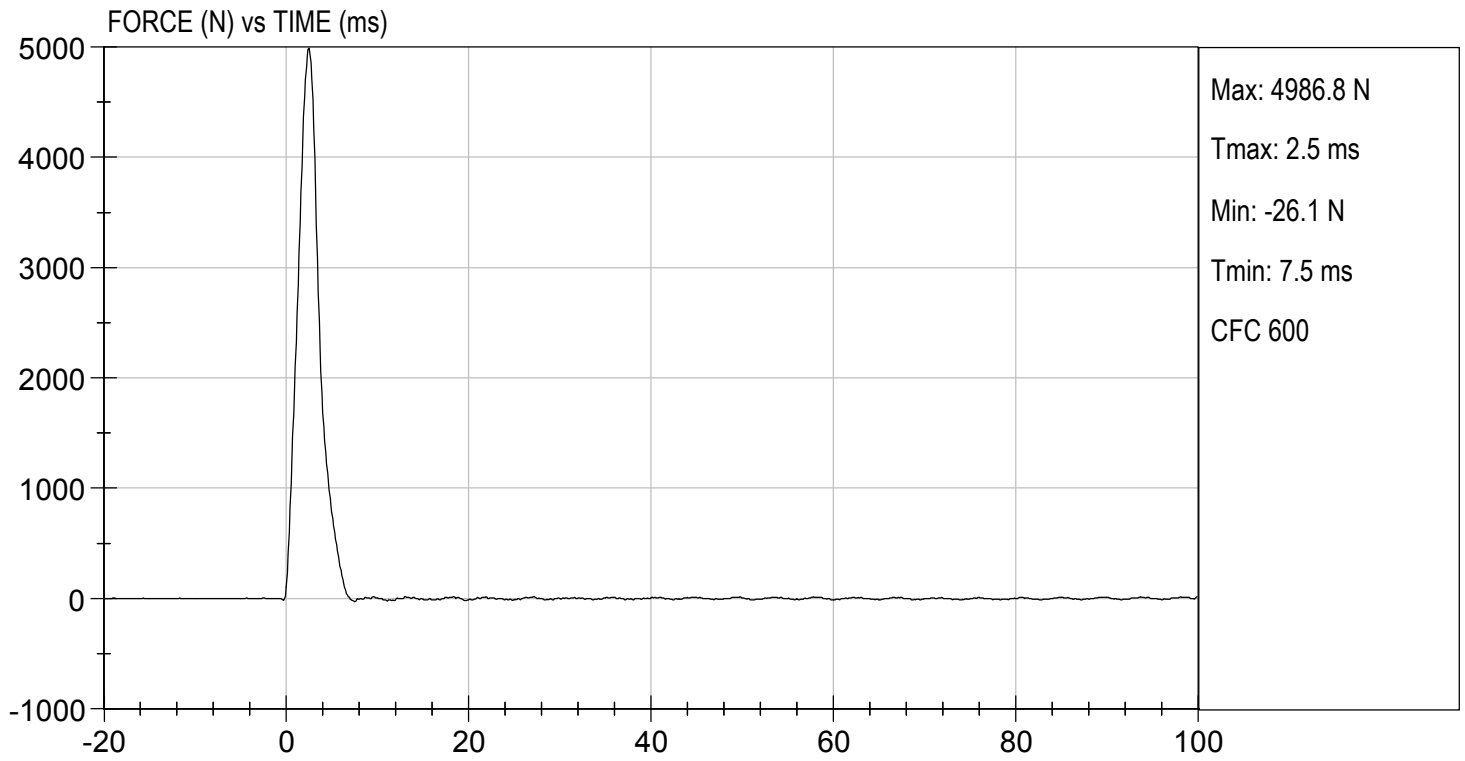


 Approved By



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

TEST DATE: 03/26/2021
TEST #: D211056



MGA RESEARCH CORPORATION
HIP-FEMUR FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

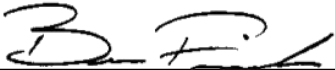
ATD Serial No: 351

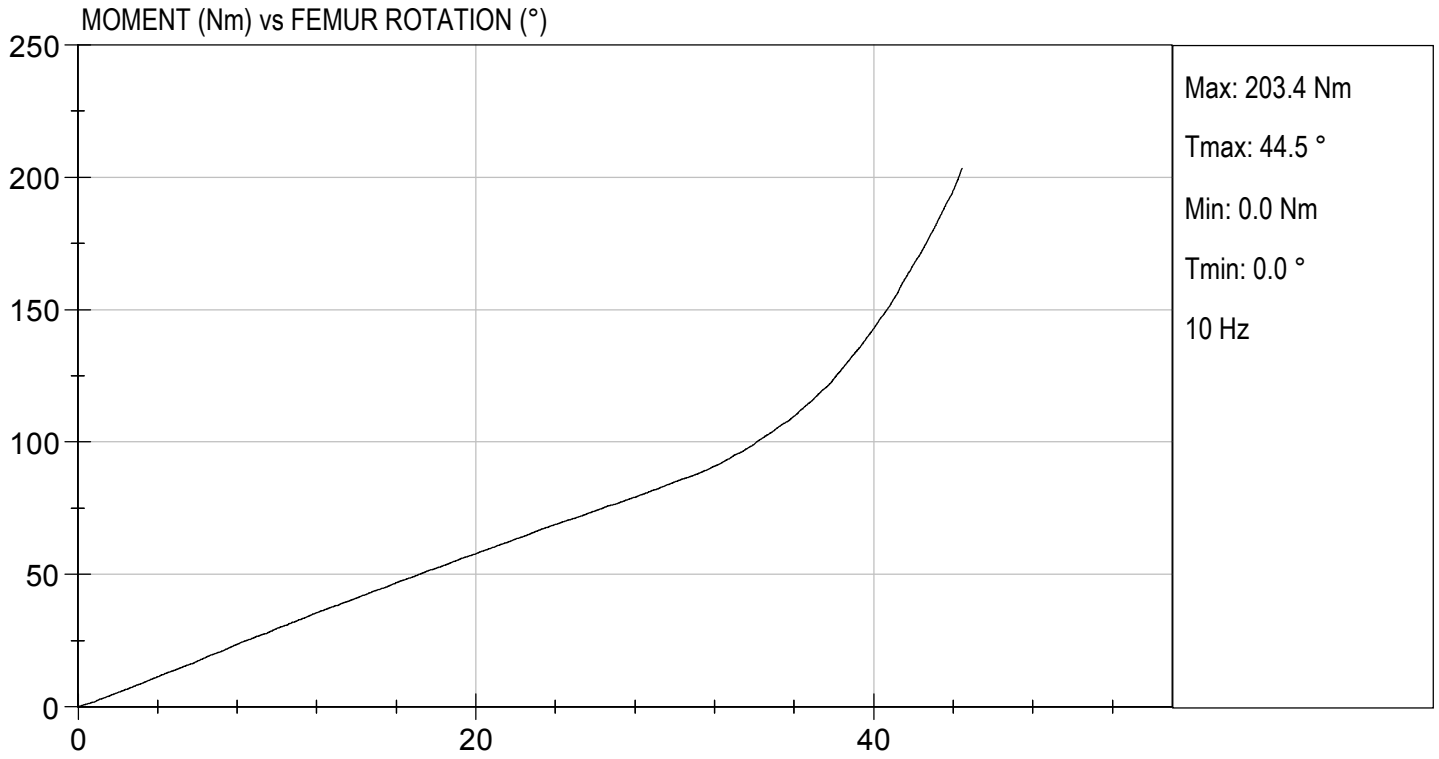
Test I.D: D211050

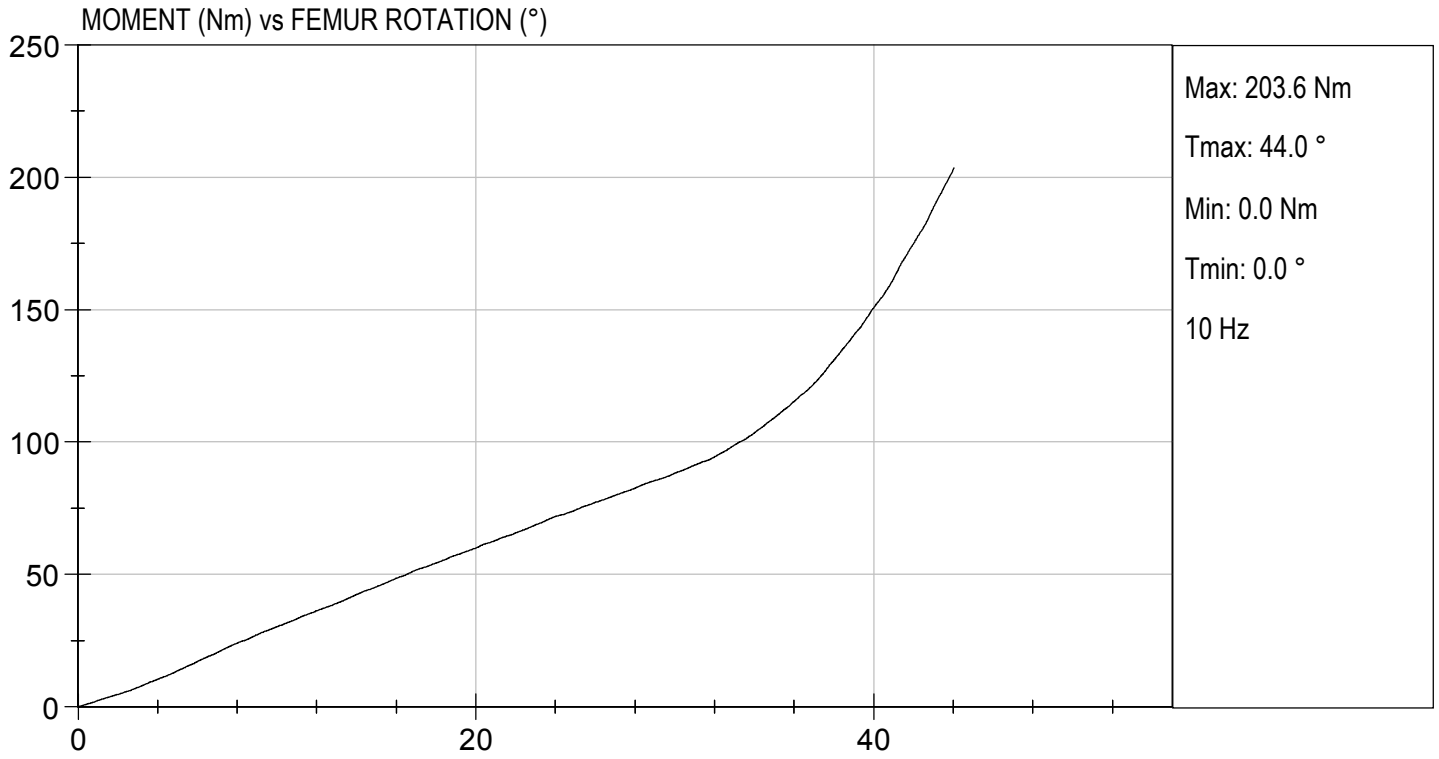
Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.7	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	36.5	36.5	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	85.0	88.2	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	44.5	44.0	Pass
Overall Test Results					Pass


 Laboratory Technician

03/25/2021
 Test Date


 Approved By





CALIBRATION TEST RESULTS

POST-TEST


HYBRID III 50TH PERCENTILE MALE - DRIVER ATD

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 50TH PERCENTILE MALE

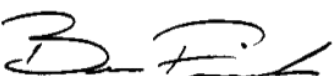
ATD Serial No: 351

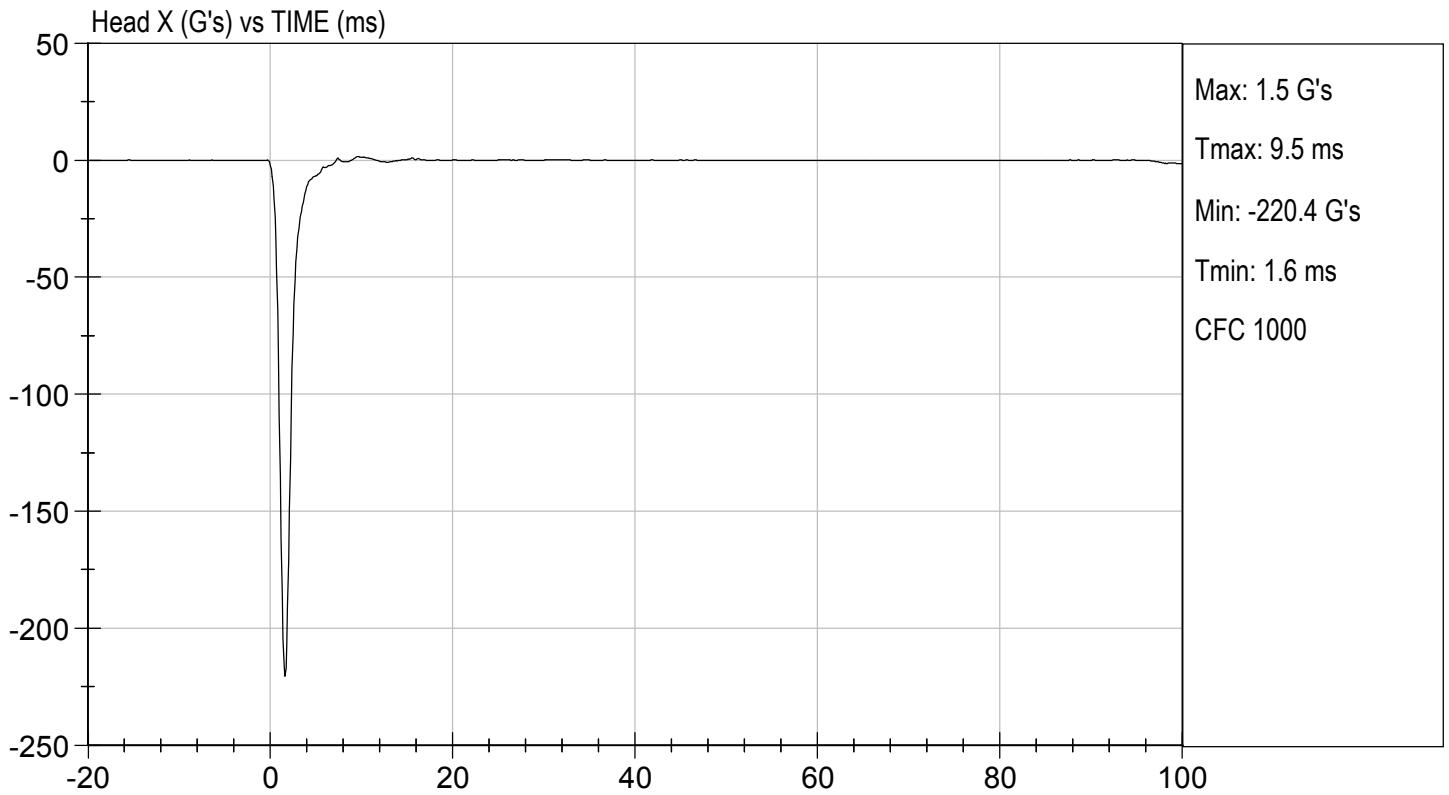
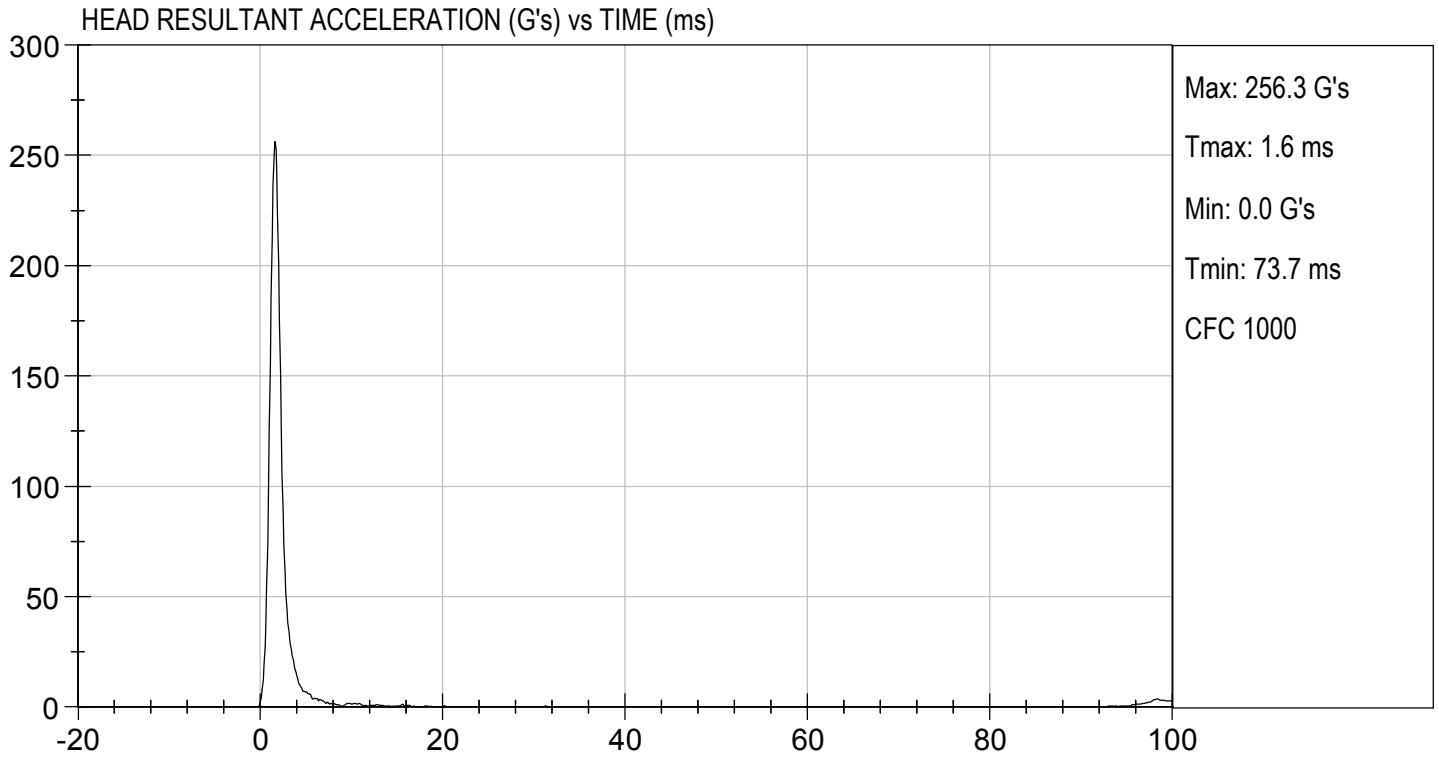
Test ID: D211091

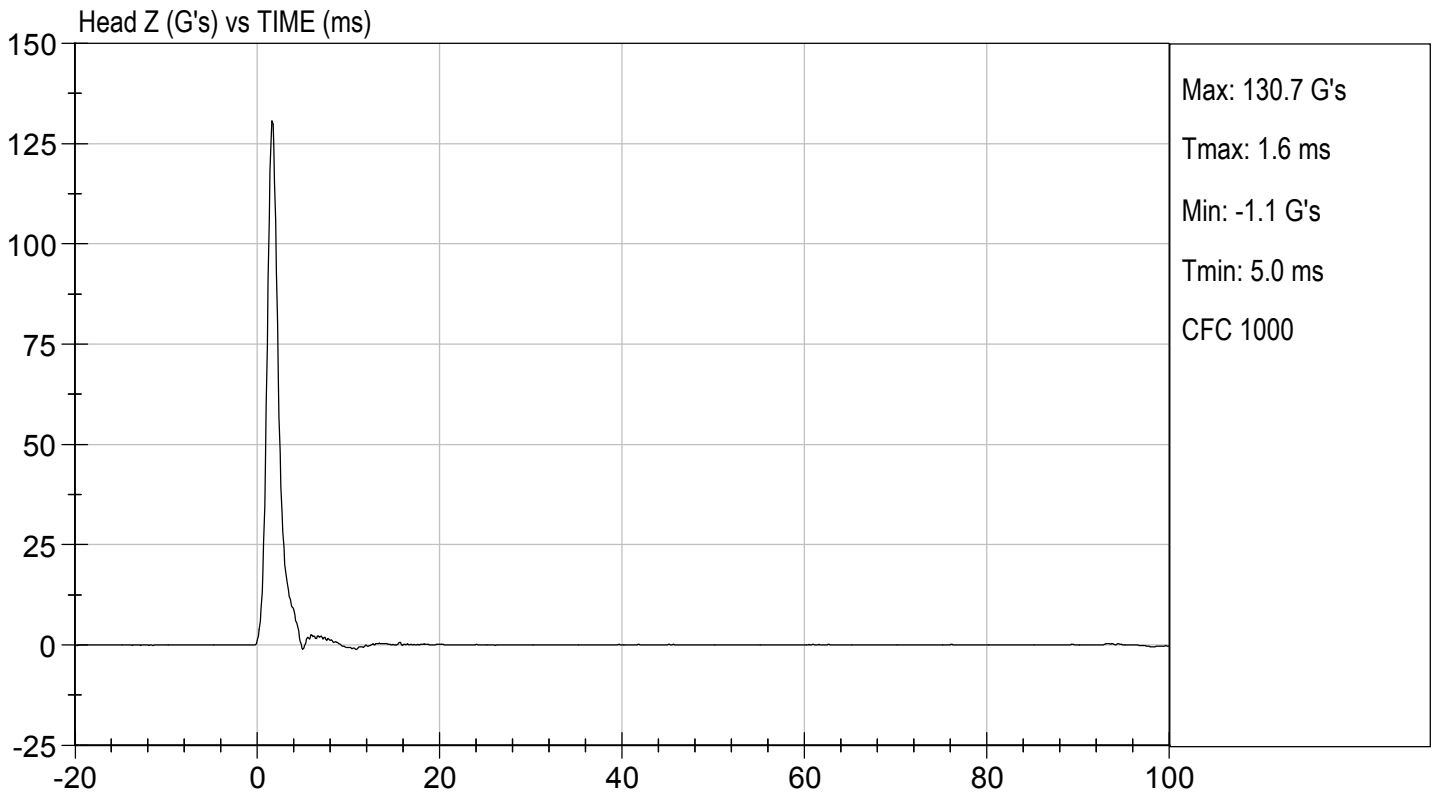
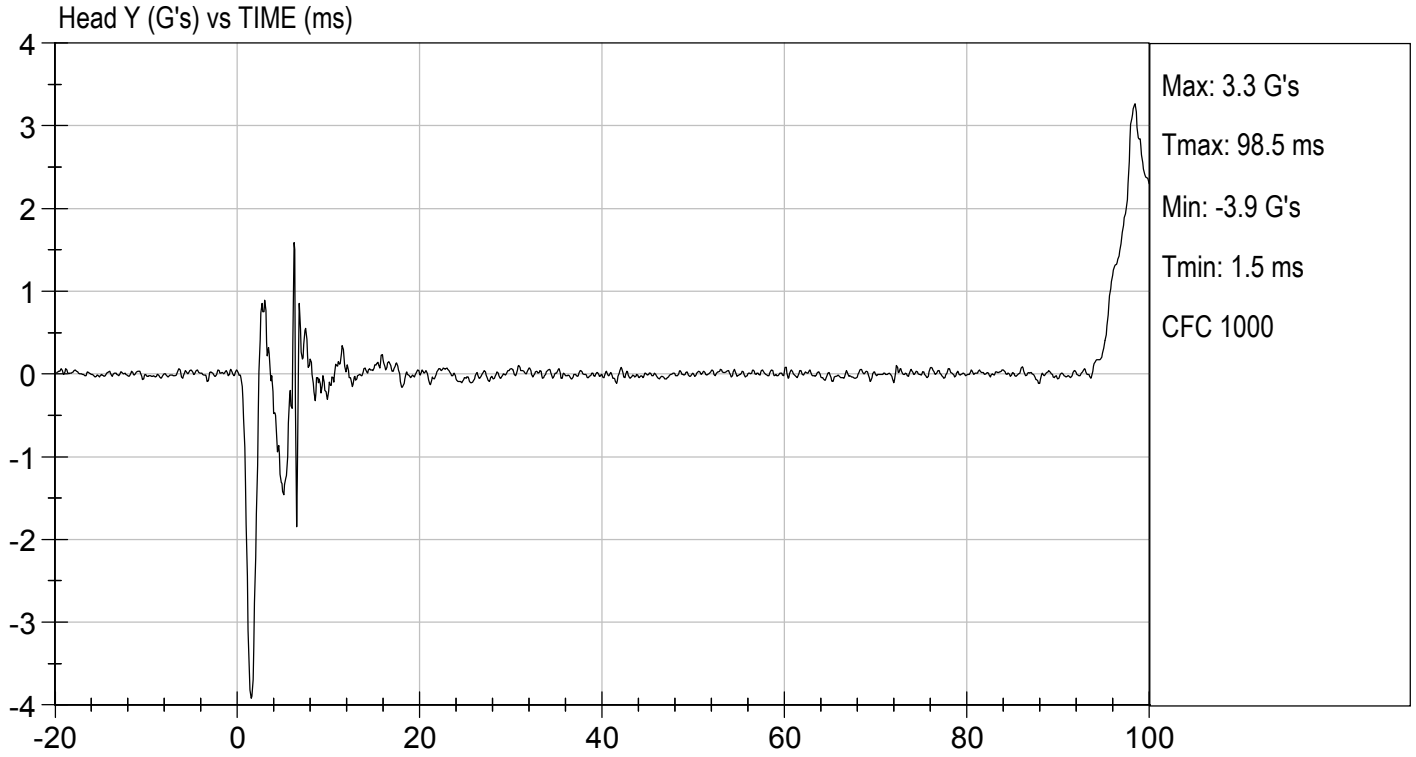
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Peak Resultant Acceleration	G's	225 to 275	256	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-3.9	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass


 Laboratory Technician

03/31/2021
 Test Date


 Approved By





MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D.: D211092

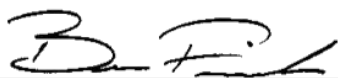
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity		%	10 to 70	22	Pass
Pendulum Velocity		m/s	6.89 to 7.13	6.96	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.62	Pass
	20 ms	G's	17.60 to 22.60	20.38	Pass
	30 ms	G's	12.50 to 18.50	14.73	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	14.7	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	36.4	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	73.2	Pass
	Time	ms	57.0 to 64.0	60.2	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	118.6	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	90.1	Pass
	Time	ms	47.0 to 58.0	48.6	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	101.1	Pass
Overall Test Results					Pass



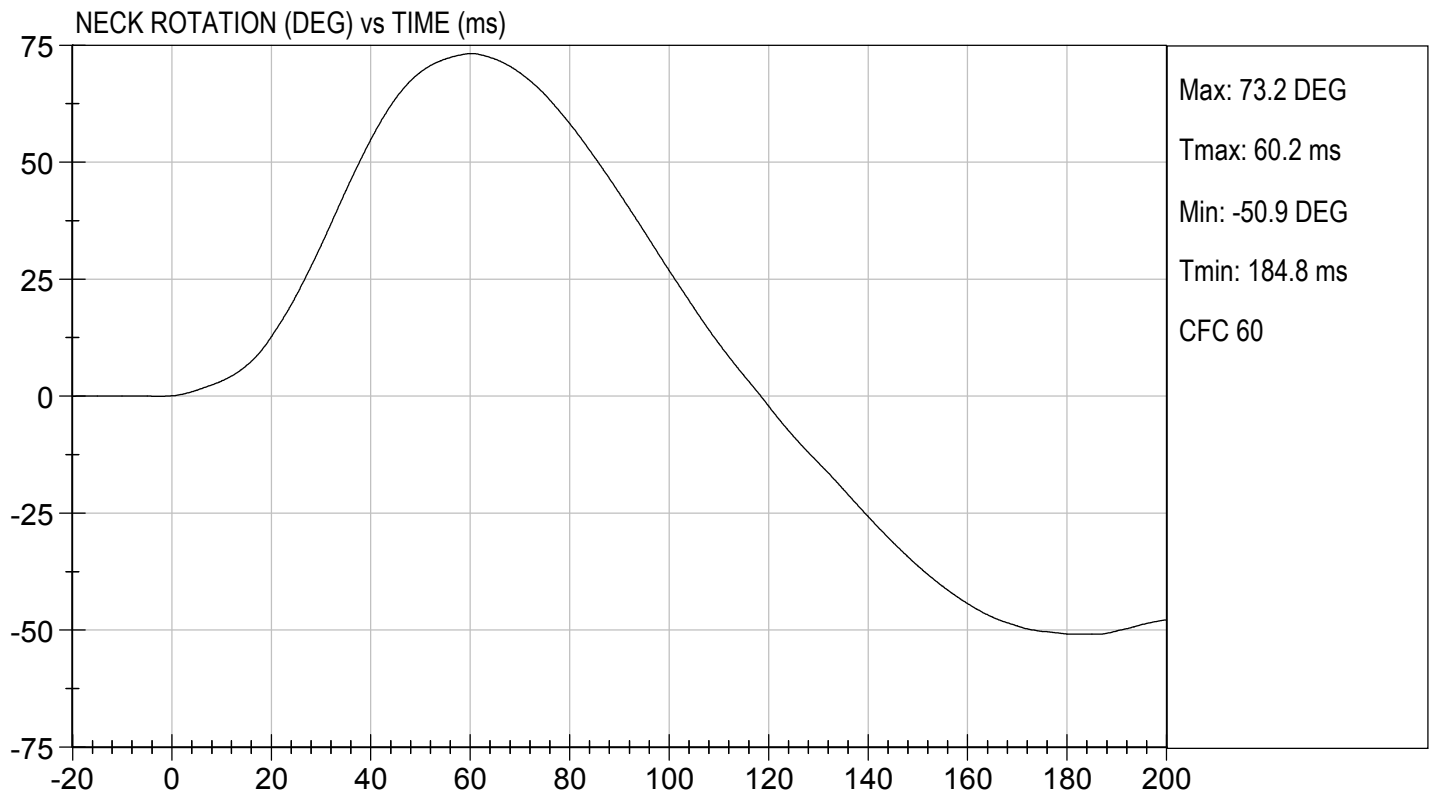
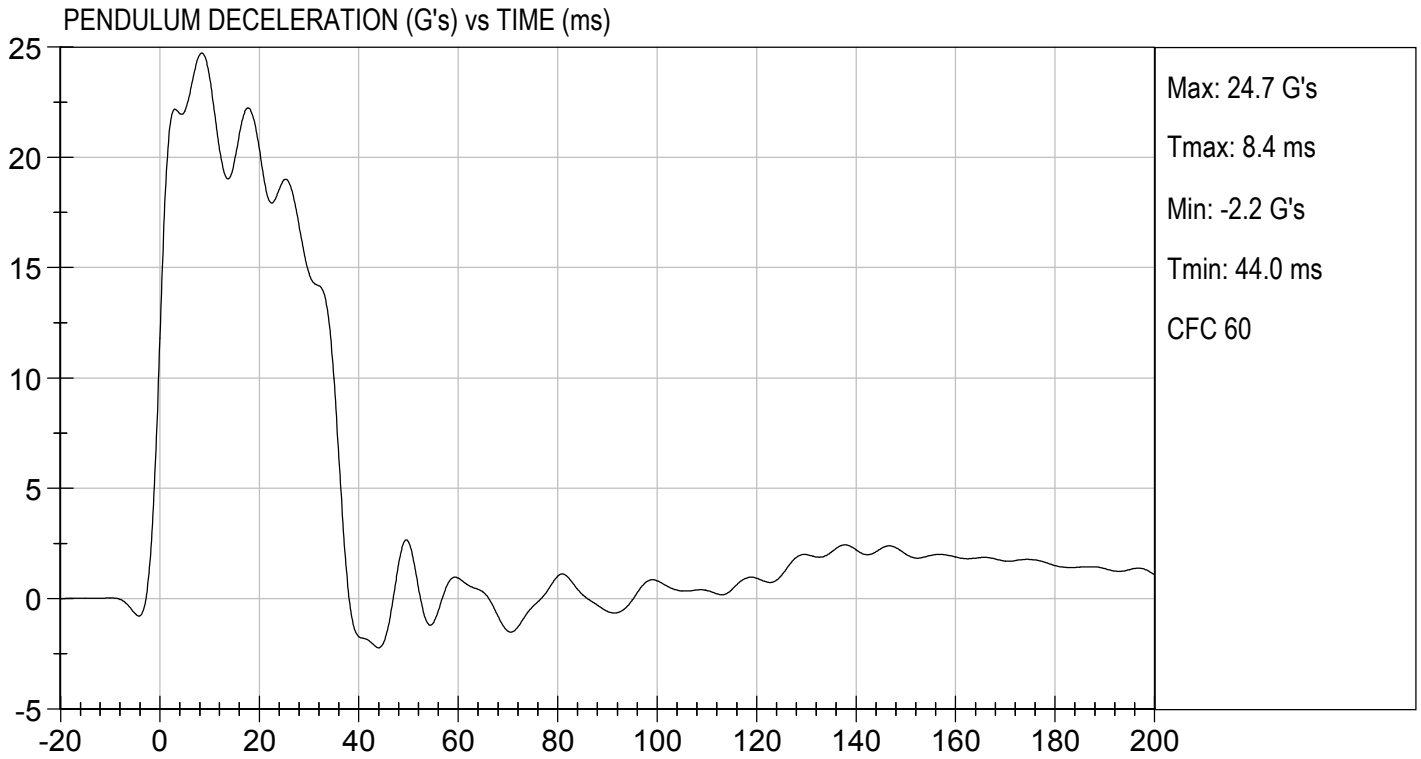
Laboratory Technician

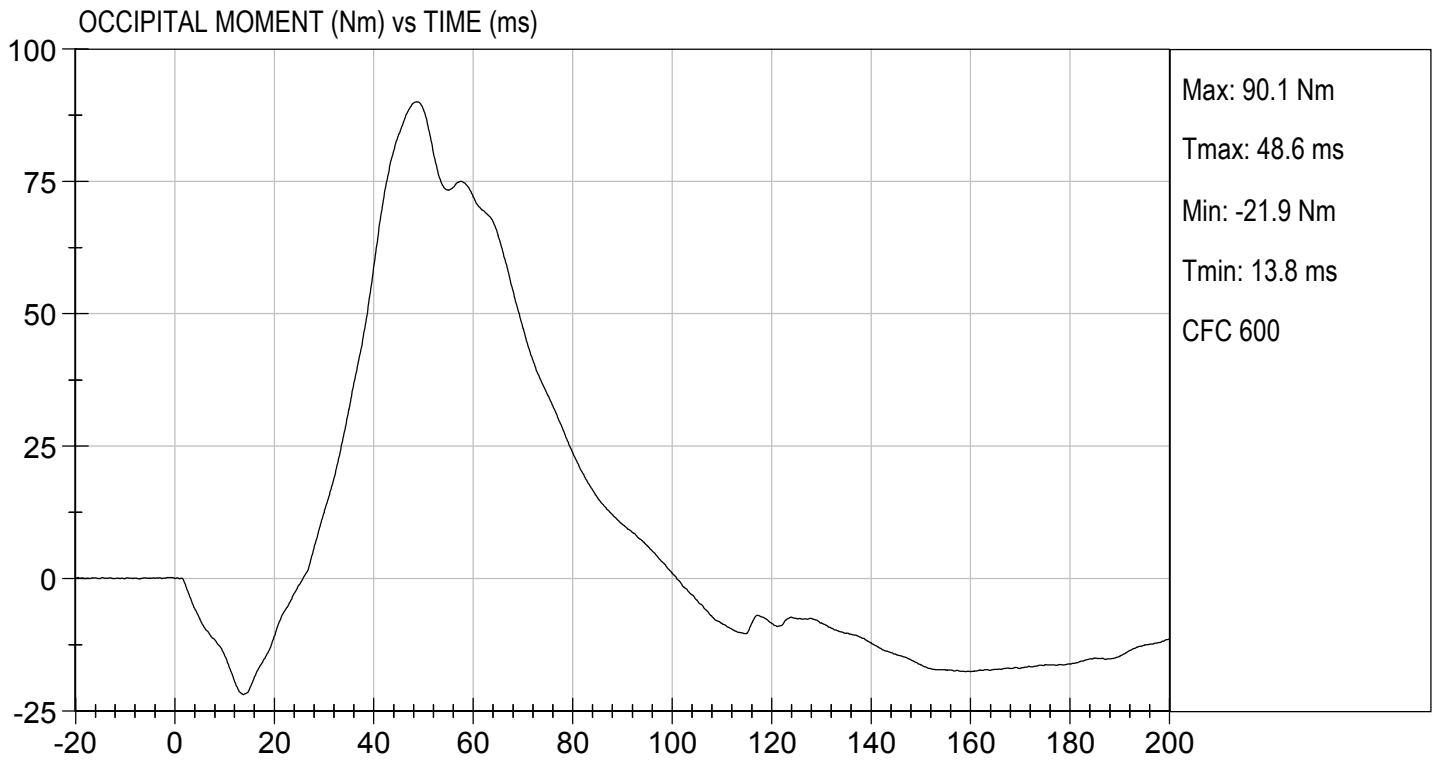
03/31/2021

Test Date



Approved By






MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 50TH PERCENTILE MALE

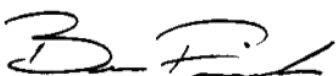
ATD Serial No: 351

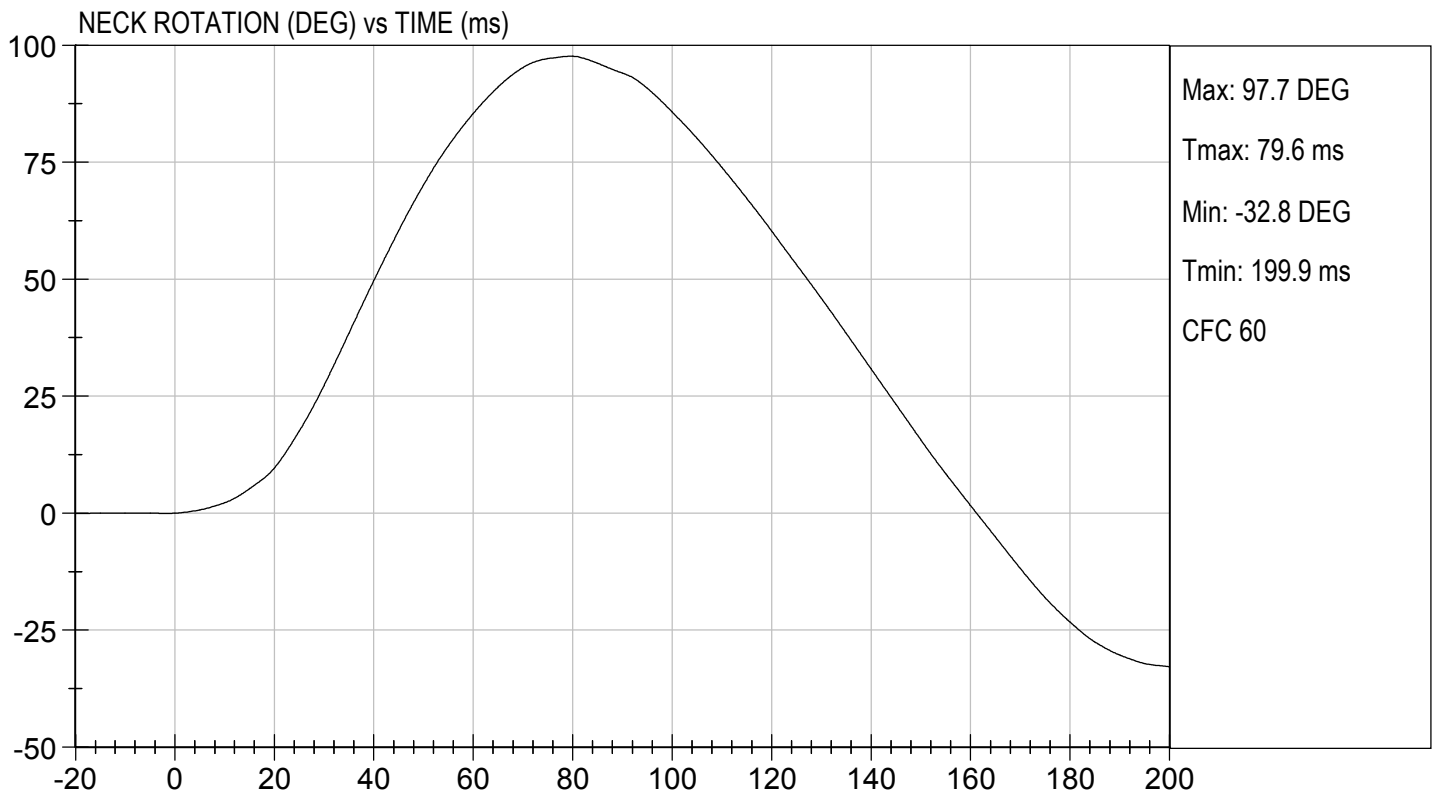
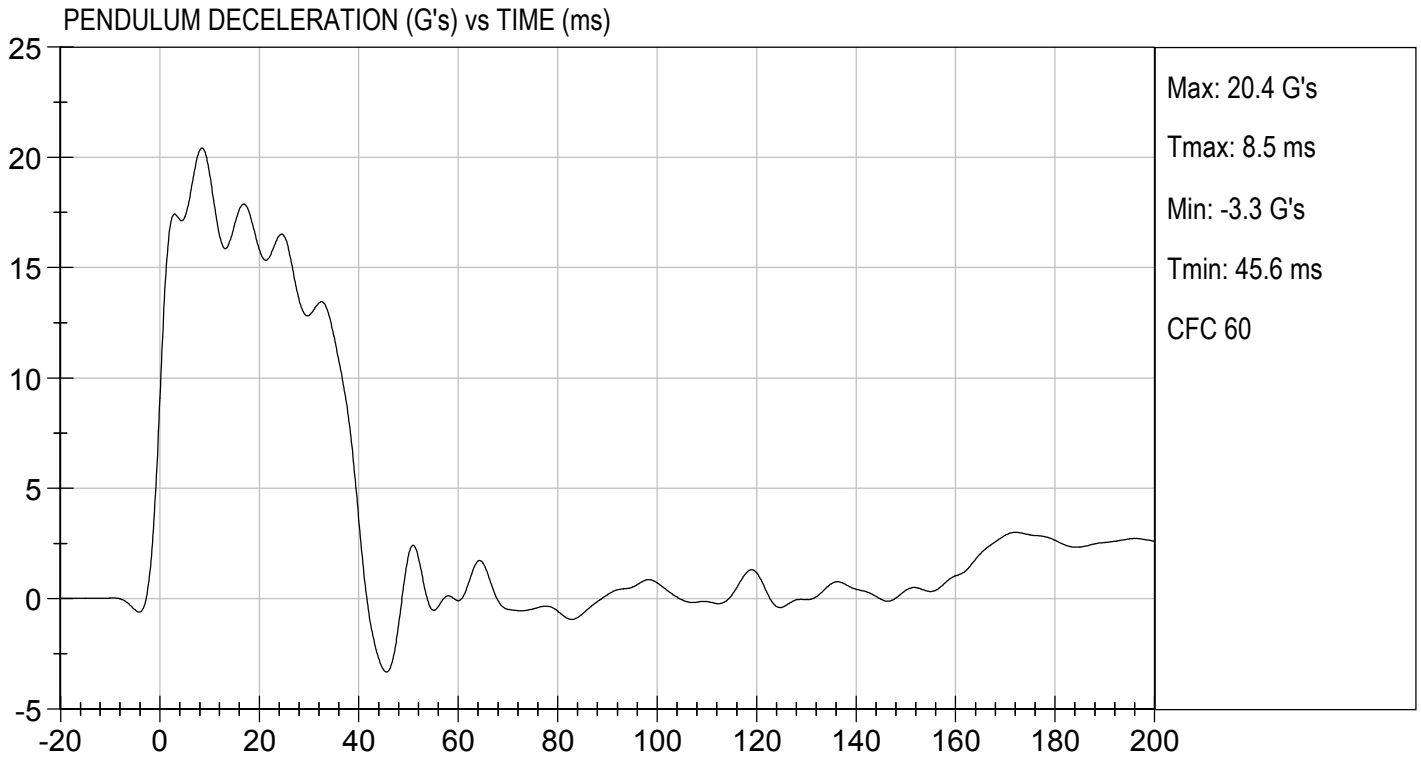
Test I.D.: D211093

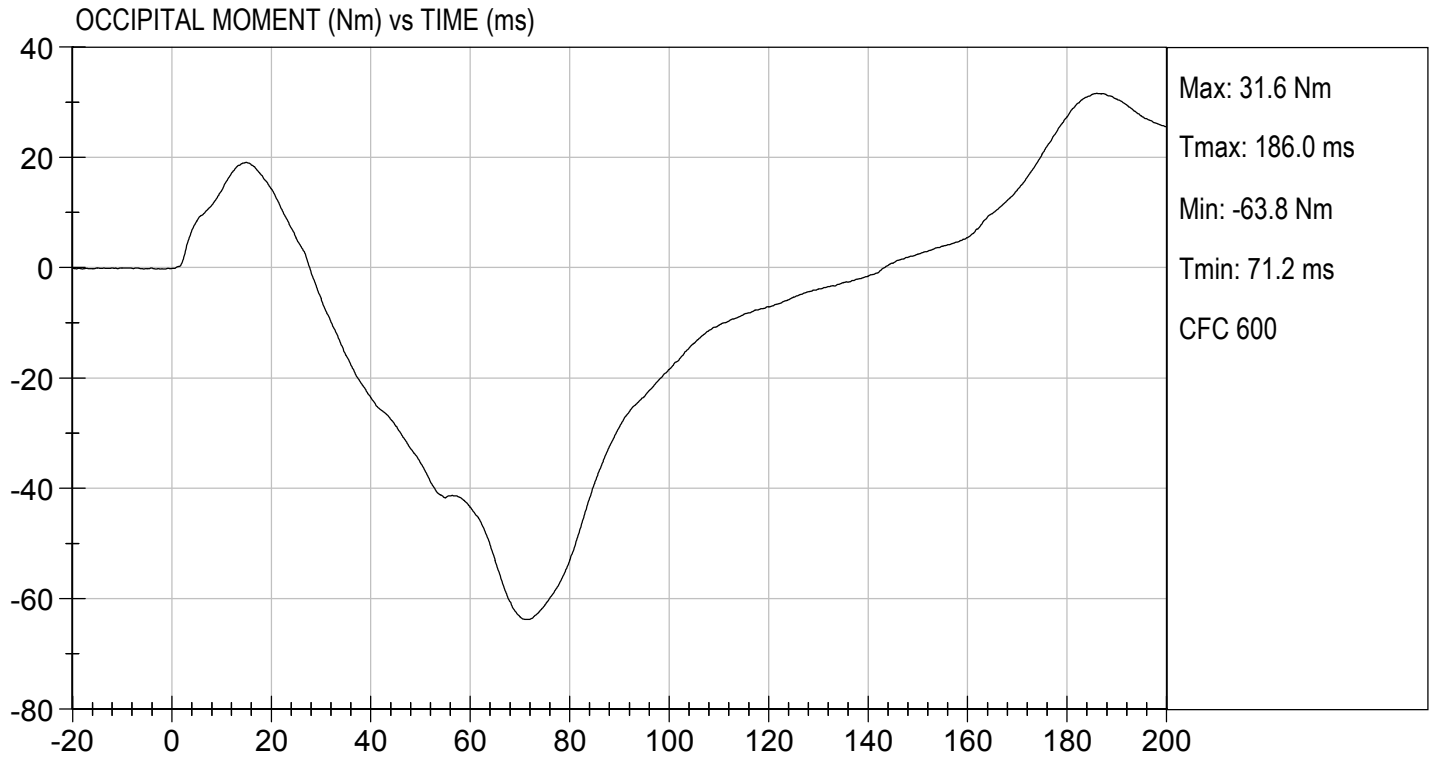
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity		%	10 to 70	22	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	19.25	Pass
	20 ms	G's	14.00 to 19.00	15.82	Pass
	30 ms	G's	11.00 to 16.00	12.84	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	13.5	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	39.5	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	97.7	Pass
	Time	ms	72.0 to 82.0	79.6	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	161.4	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-63.8	Pass
	Time	ms	65.0 to 79.0	71.2	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	143.5	Pass
Overall Test Results					Pass


 Laboratory Technician

03/31/2021
 Test Date


 Approved By






MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 50TH PERCENTILE MALE

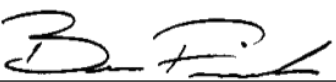
ATD Serial No: 351

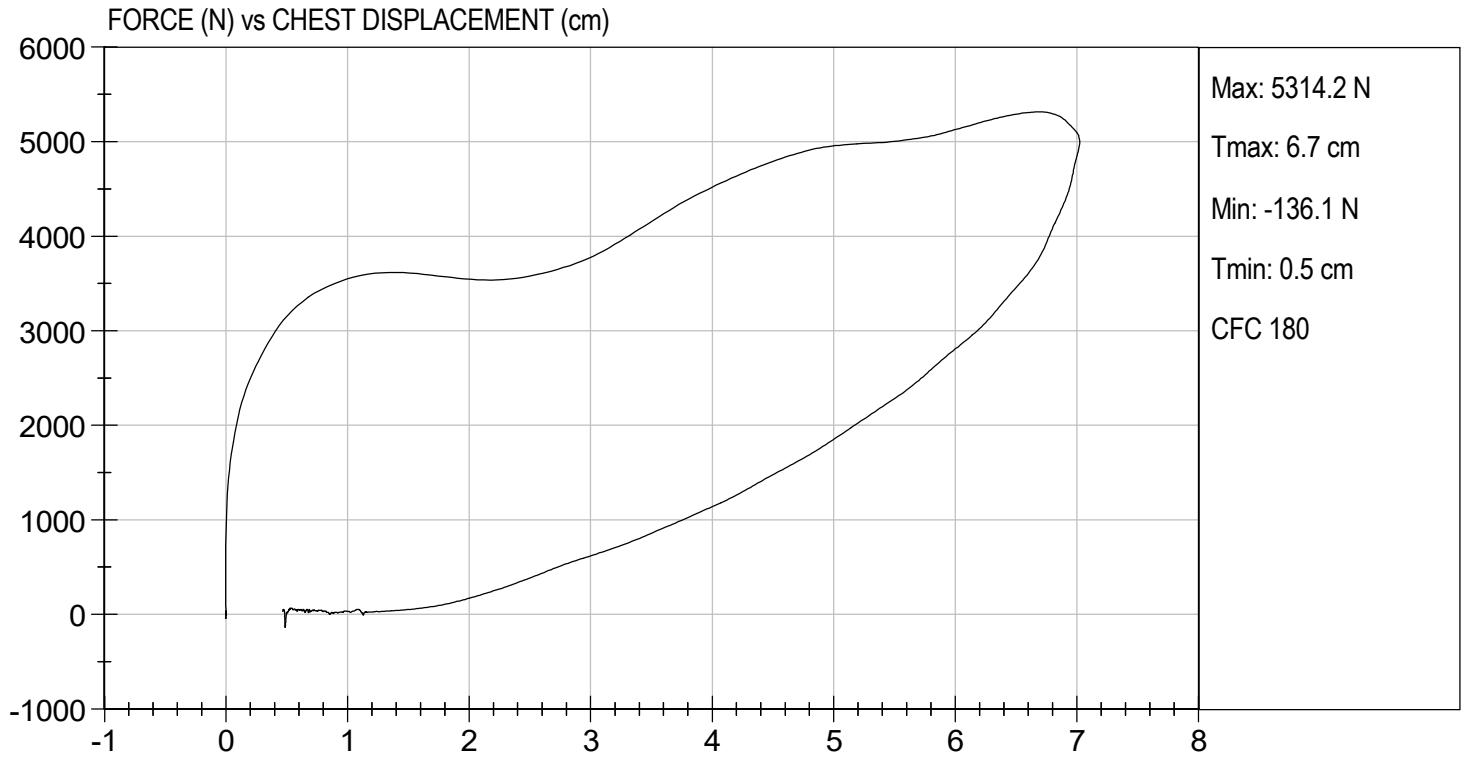
Test I.D: D211094

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	33	Pass
Probe Velocity	m/s	6.58 to 6.82	6.60	Pass
Peak Probe Force	N	5159 to 5893	5,314	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	7.02	Pass
Internal Hysteresis	%	69 to 85	70	Pass
Overall Test Results				Pass


 Laboratory Technician

03/30/2021
 Test Date


 Approved By



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

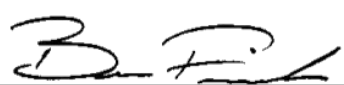
ATD Serial No: 351

Test I.D: D211095

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	33	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	5,240	Pass
Overall Test Results				Pass


 Laboratory Technician

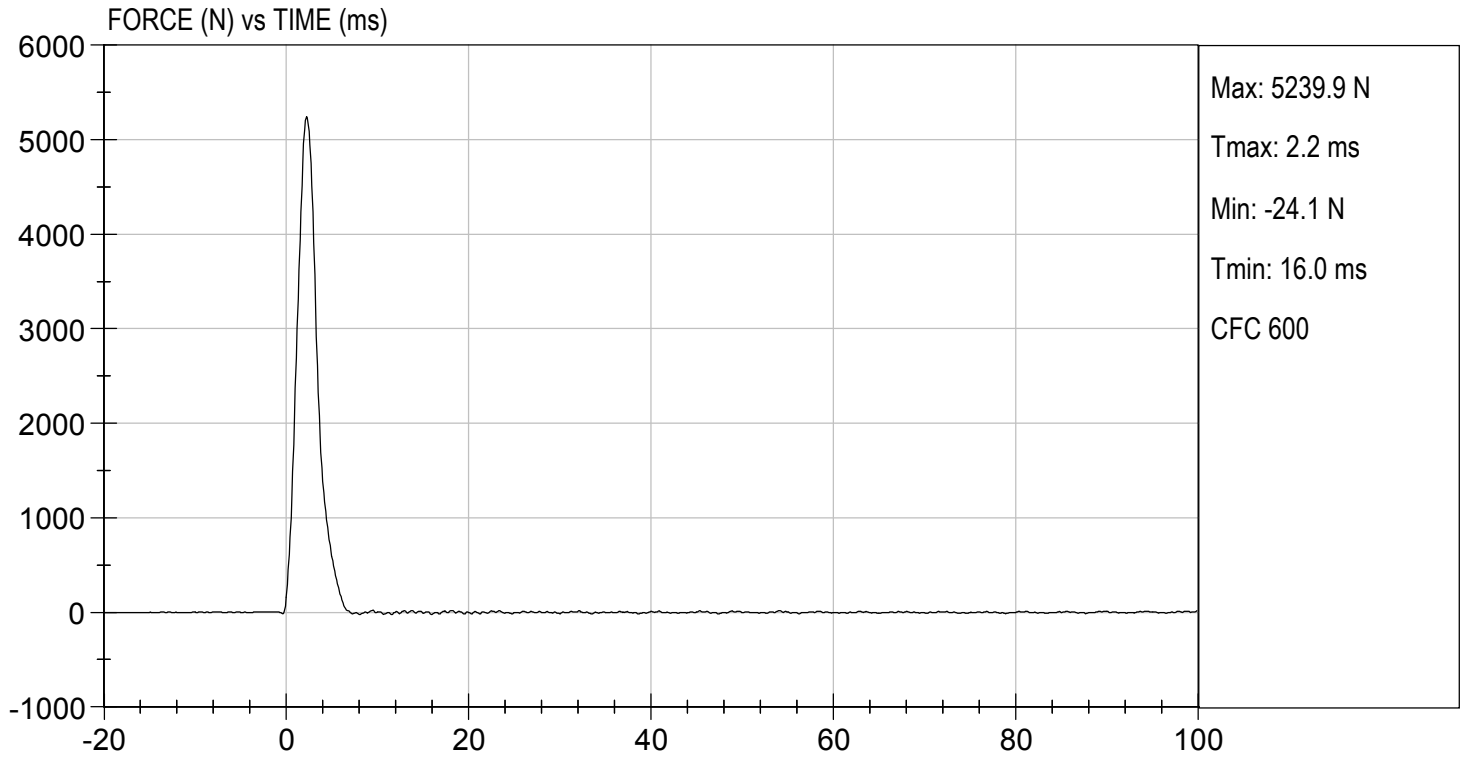
03/30/2021
 Test Date


 Approved By



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

TEST DATE: 03/30/2021
TEST #: D211095



MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

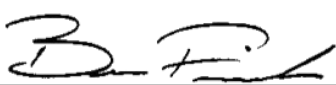
ATD Serial No: 351

Test I.D: D211096

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	33	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	N	4715 to 5782	5,185	Pass
Overall Test Results				Pass


 Laboratory Technician

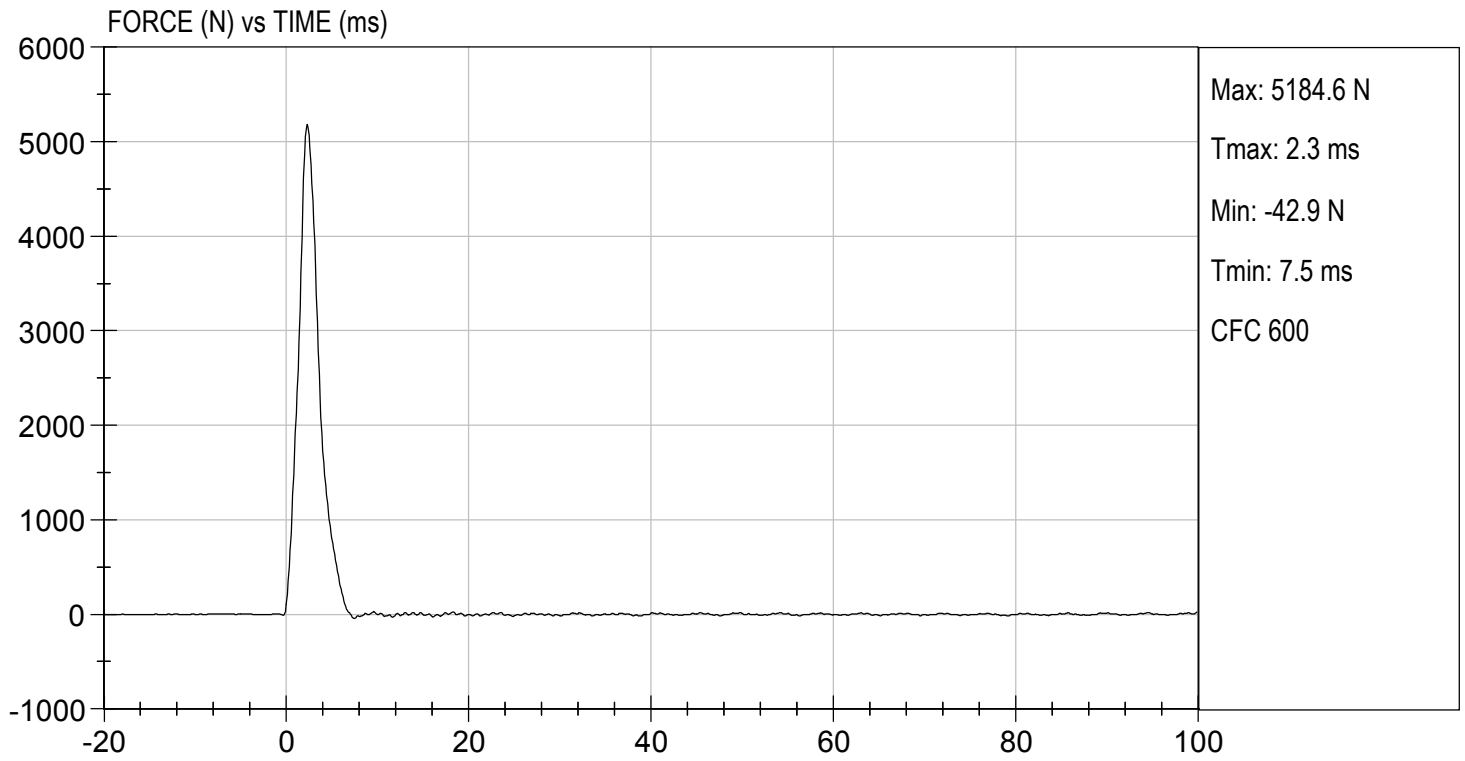
03/30/2021
 Test Date


 Approved By



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

TEST DATE: 03/30/2021
TEST #: D211096




MGA RESEARCH CORPORATION
HIP-FEMUR FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

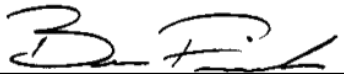
ATD Serial No: 351

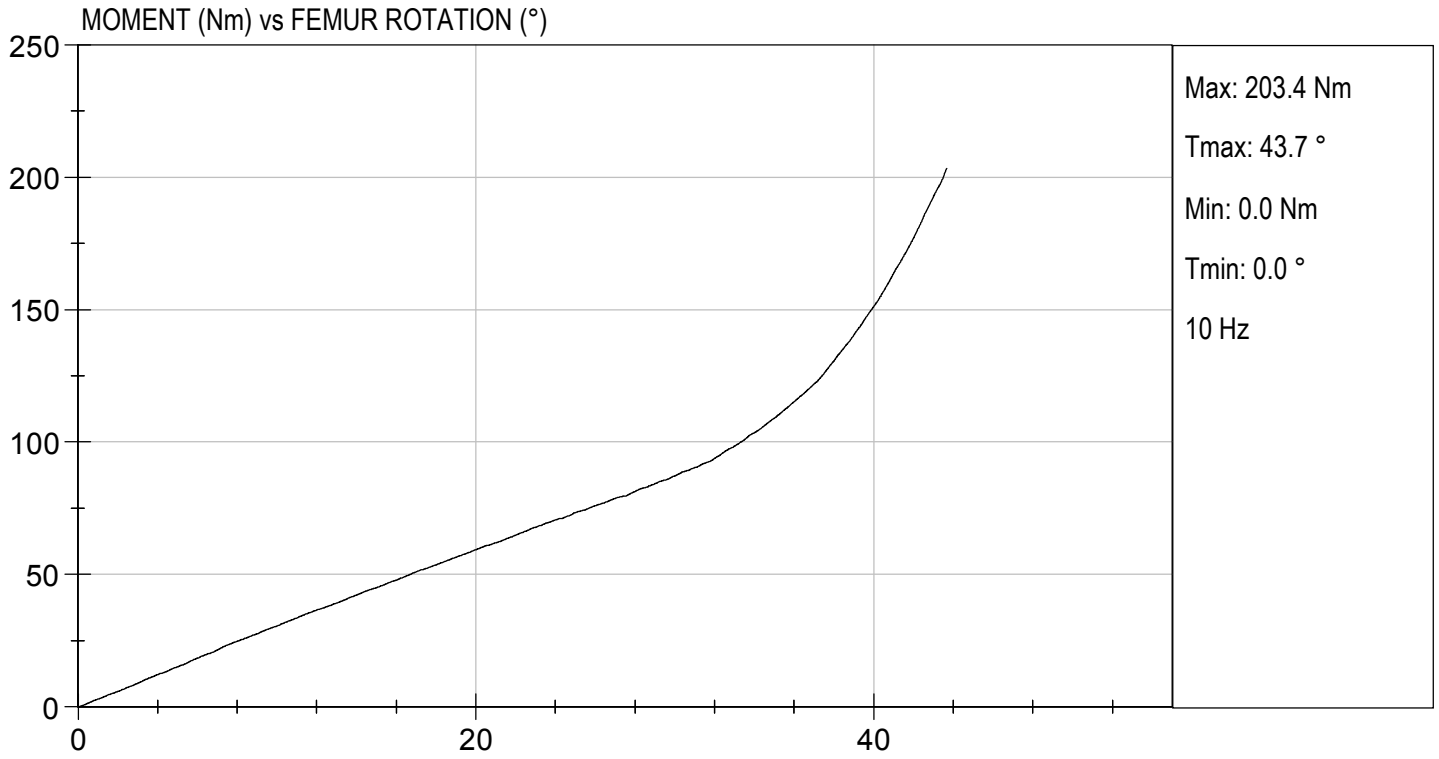
Test I.D: D211090

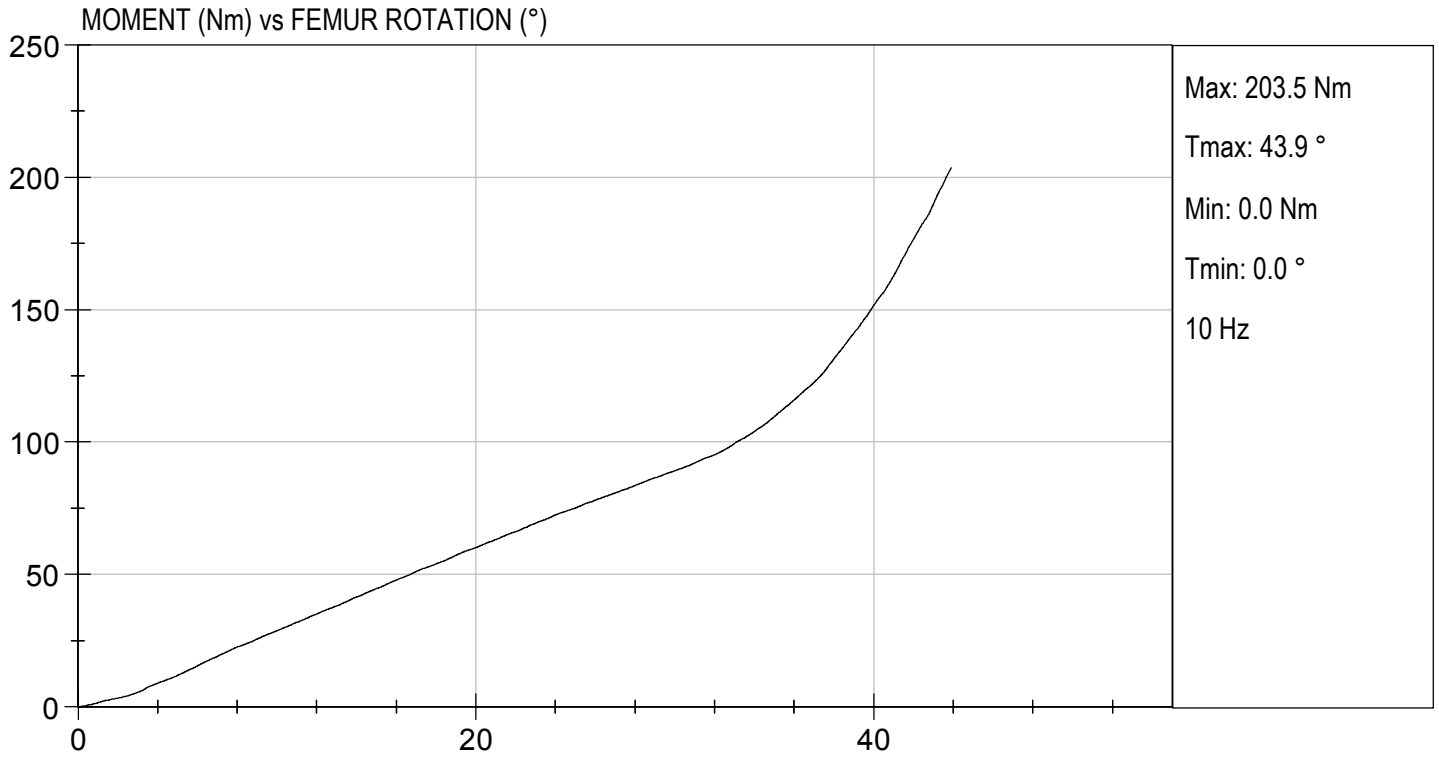
Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.3	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	22	22	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	87.3	89.2	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	43.7	43.9	Pass
Overall Test Results					Pass


 Laboratory Technician

03/31/2021
 Test Date


 Approved By





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 heel	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: D211031

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	36	Pass
Peak Resultant Acceleration	G's	250 to 300	289	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-4.3	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

Gerald Cherrero

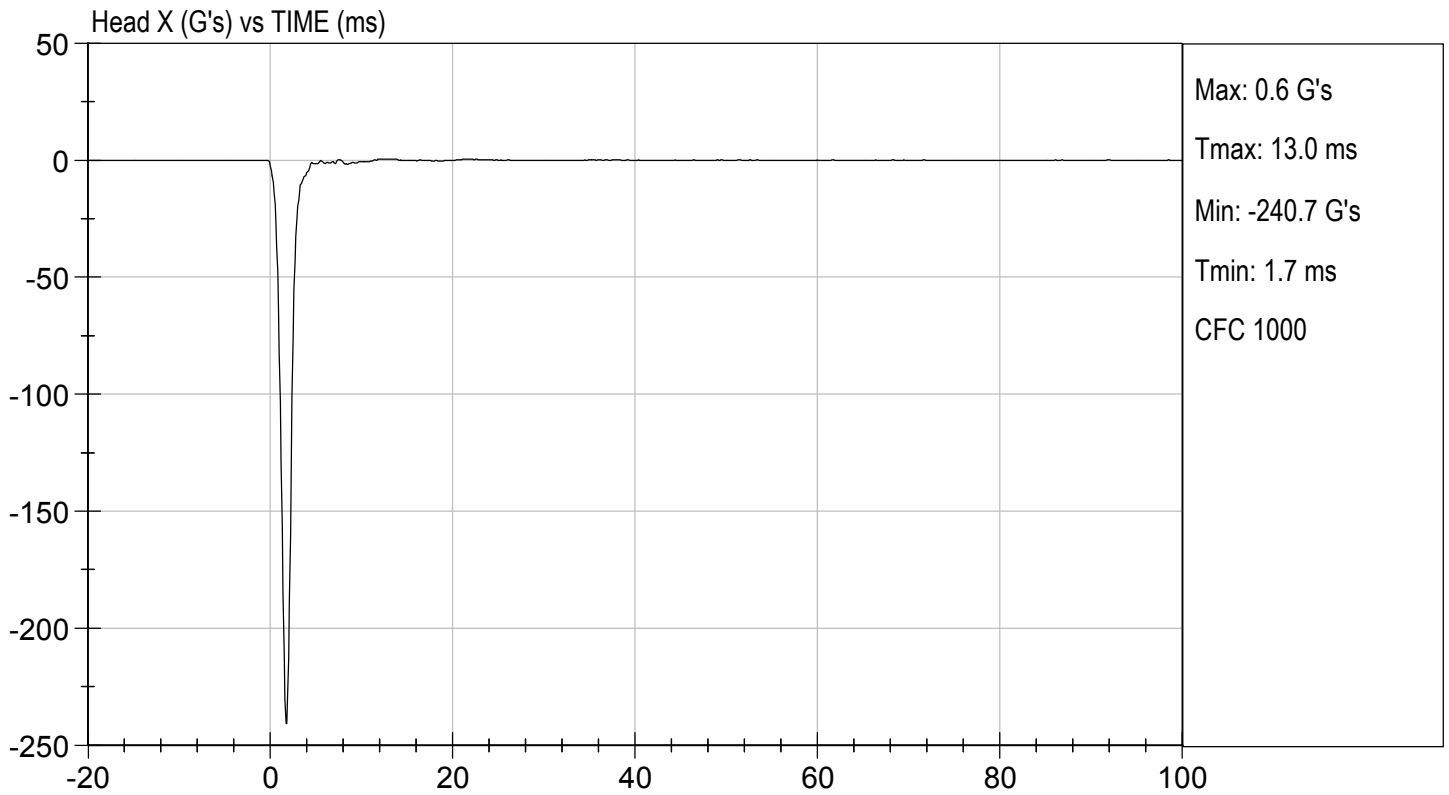
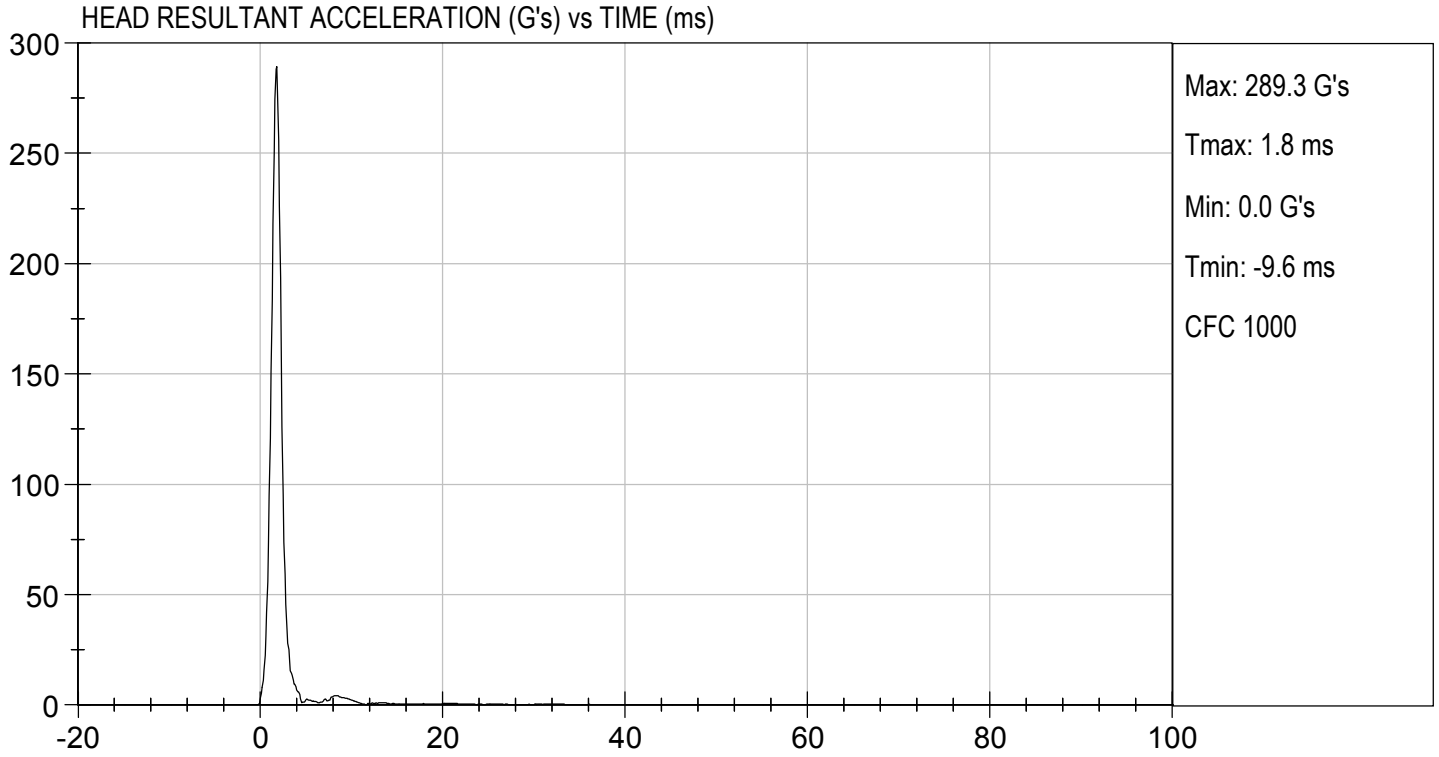
Laboratory Technician

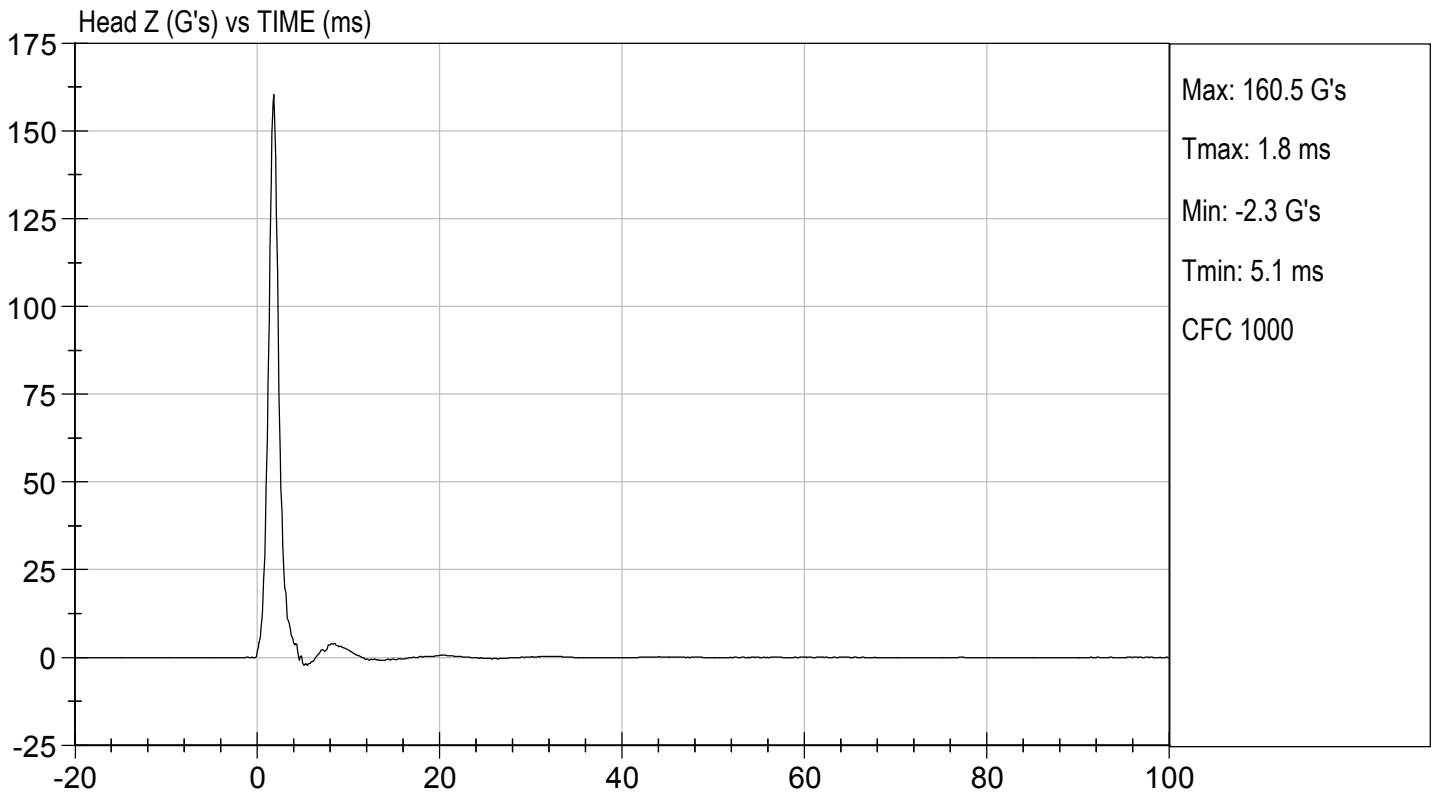
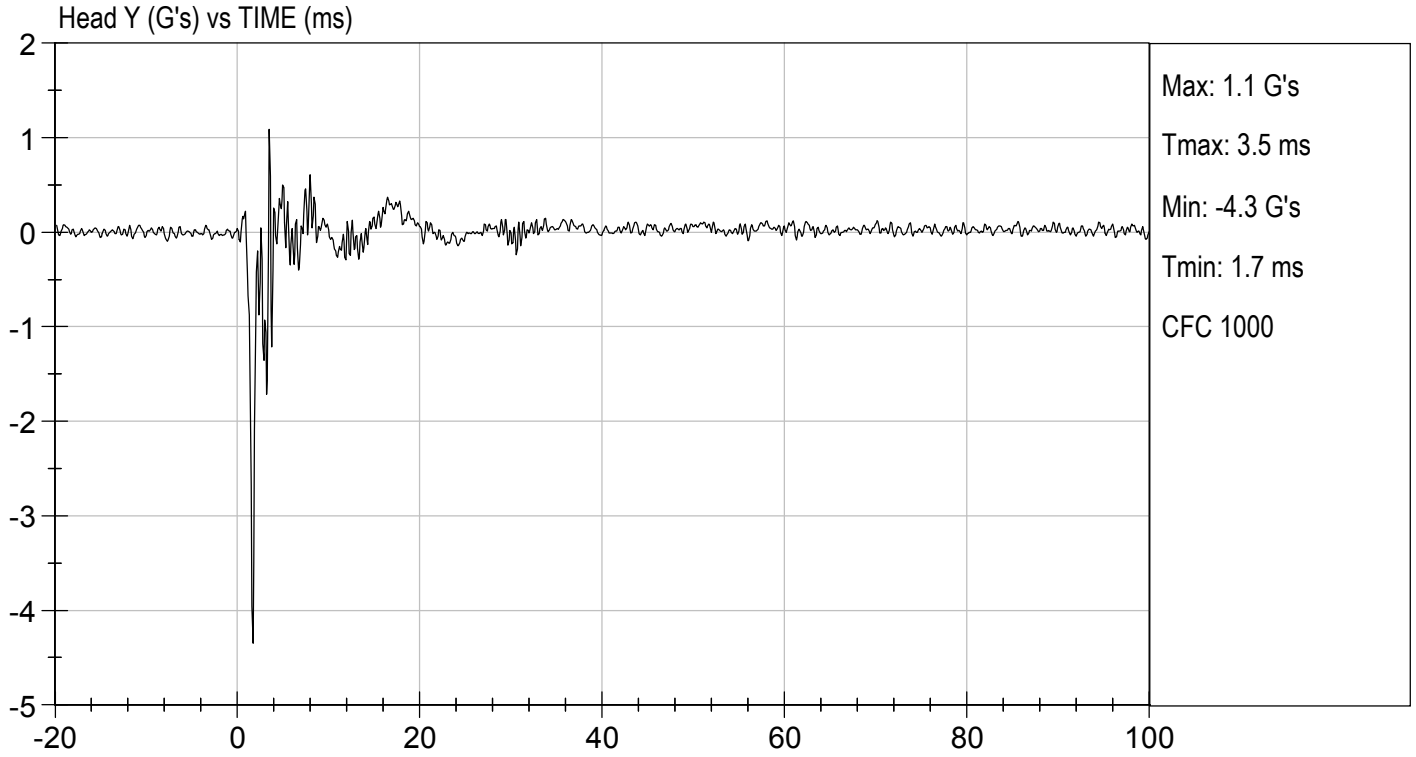
03/25/2021

Test Date

B. F. H.

Approved By





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

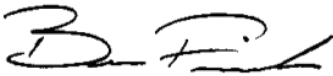
ATD Serial No: DH1659

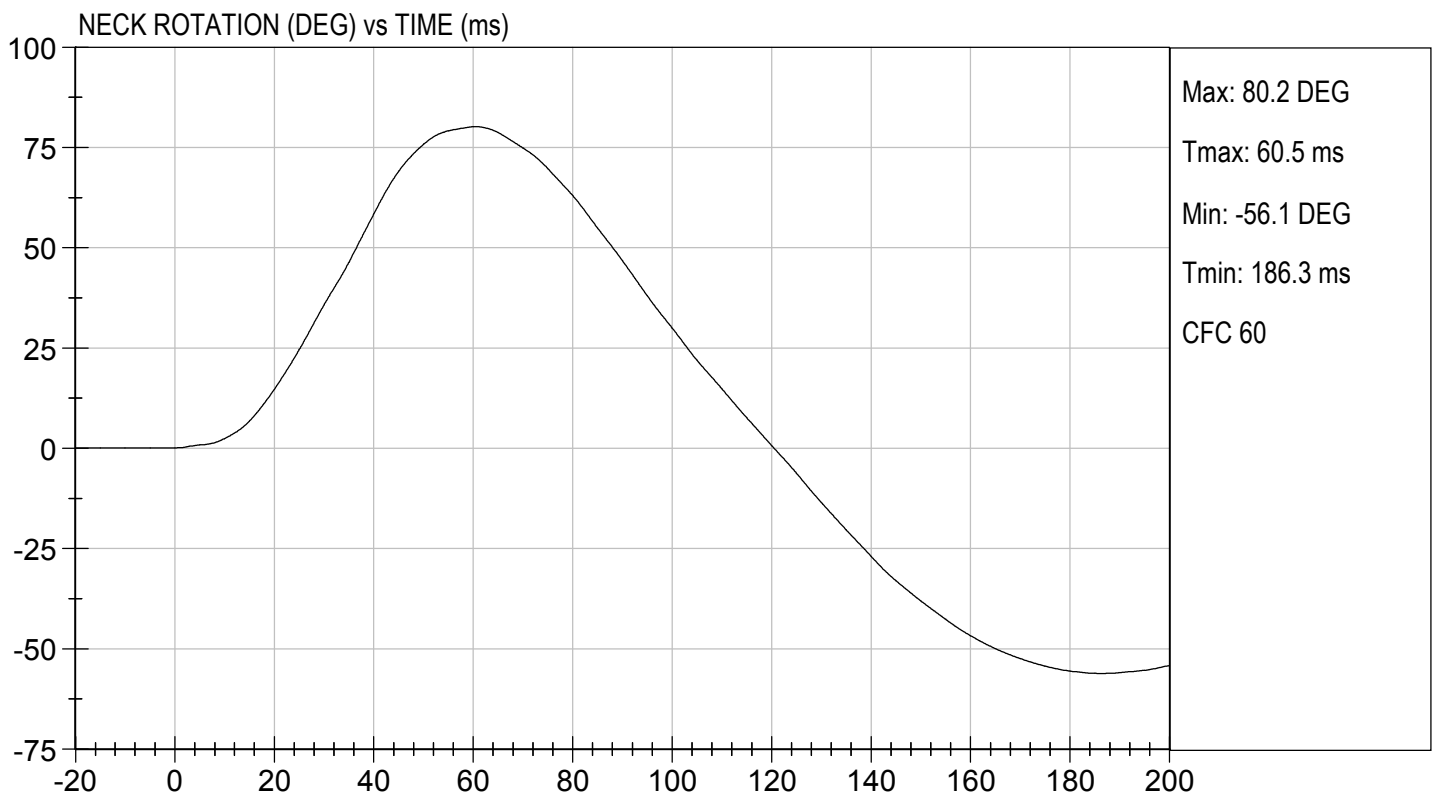
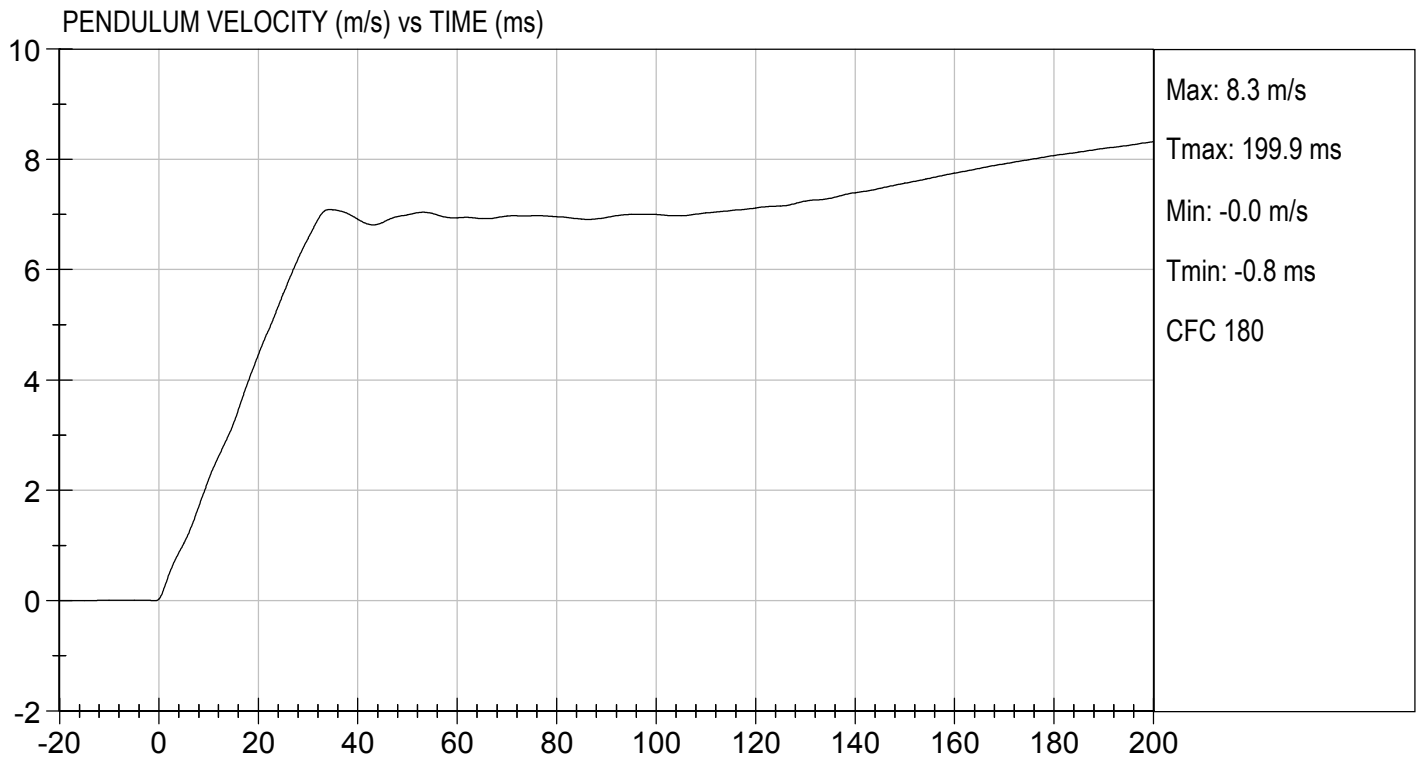
Test I.D.: D211032

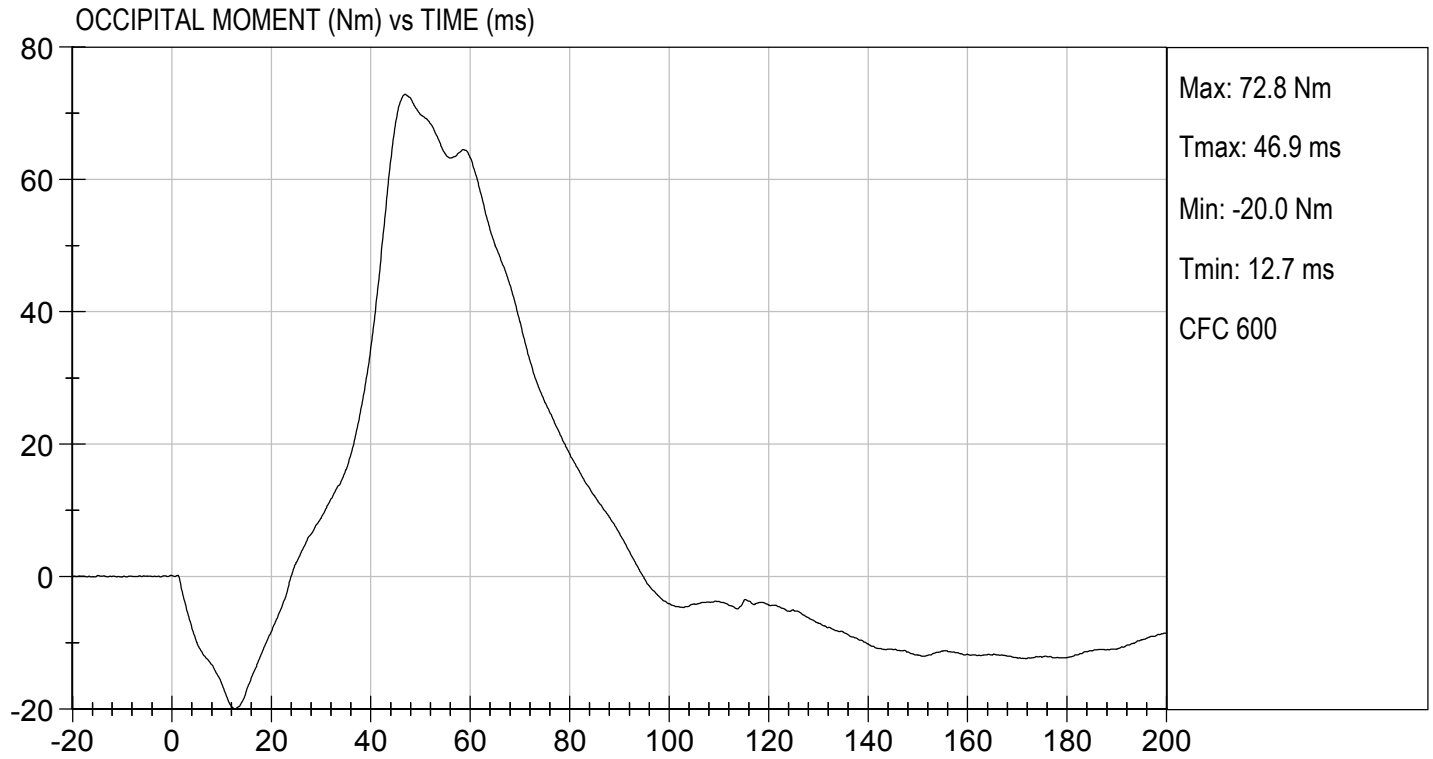
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	36	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.05	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.2	Pass
	20 ms	m/s	4.0 to 5.0	4.5	Pass
	30 ms	m/s	5.8 to 7.0	6.6	Pass
D Plane Rotation	Max	deg	77 to 91	80	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	69	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	85	Pass
Overall Results					Pass


Laboratory Technician

 03/25/2021
Test Date


Approved By





MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211033

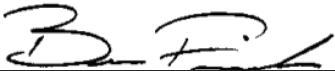
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	36	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.19	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.8	Pass
	20 ms	m/s	3.1 to 3.9	3.7	Pass
	30 ms	m/s	4.6 to 5.6	5.4	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



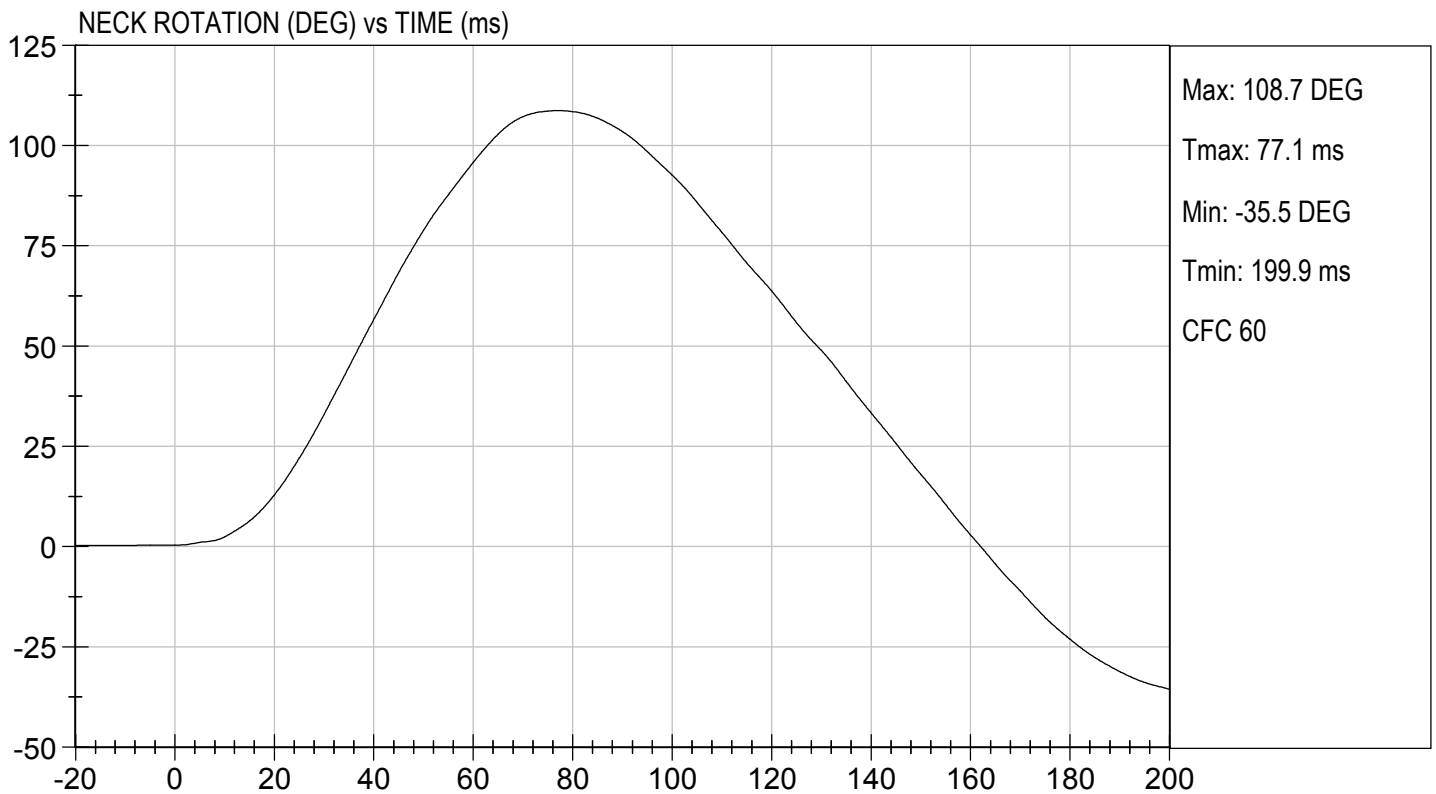
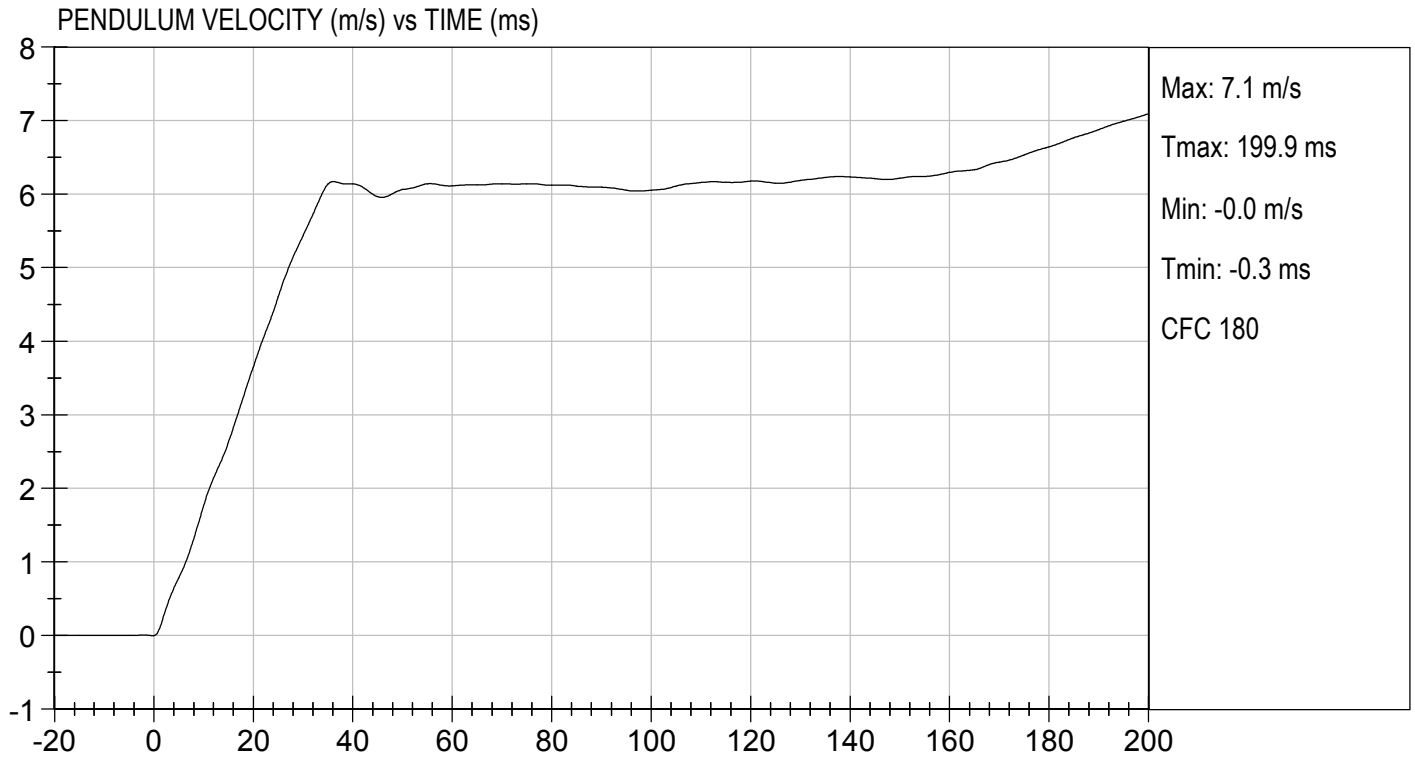
 Laboratory Technician

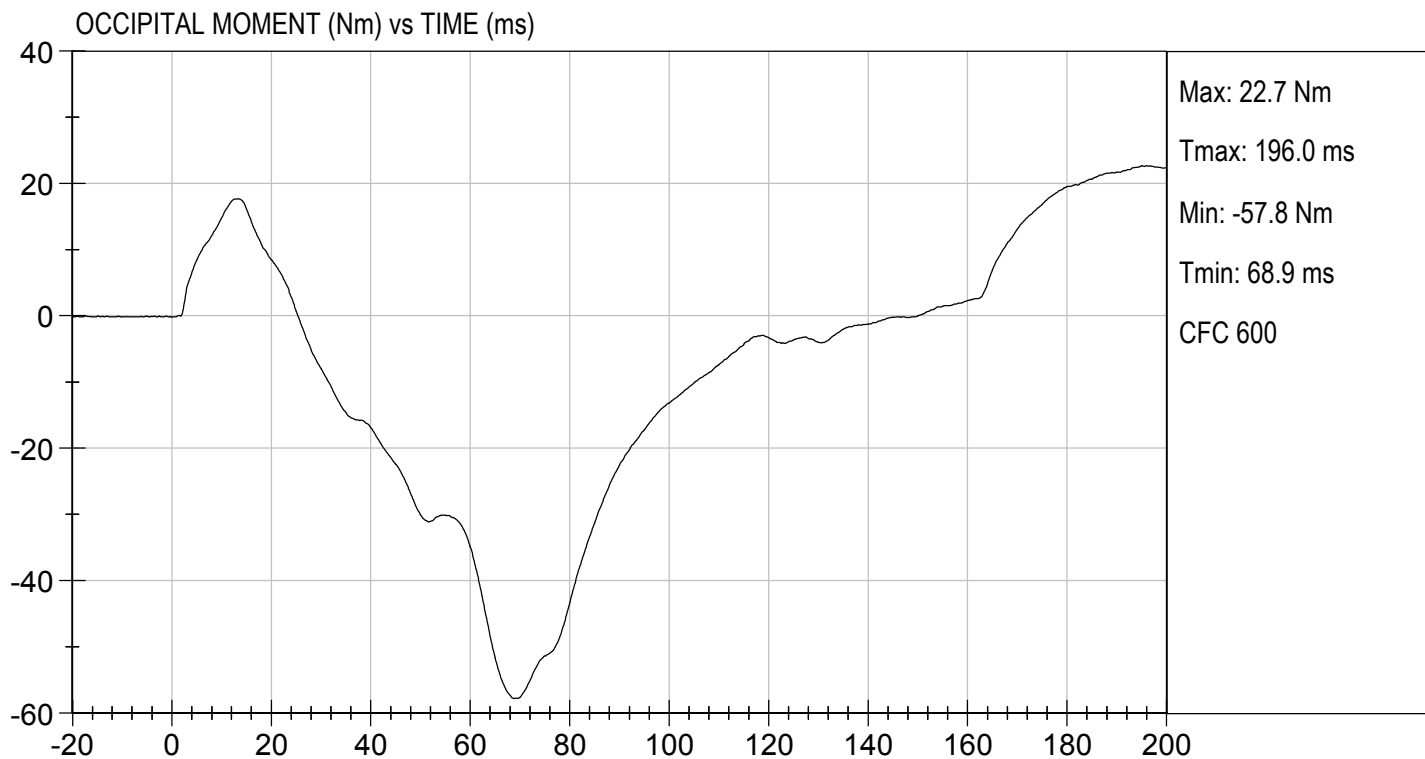
03/25/2021

 Test Date



 Approved By





MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211034

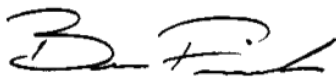
Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.6	Pass
Relative Humidity	%	10 to 70	30	Pass
Probe Speed	m/s	6.59 to 6.83	6.68	Pass
Peak Deflection	mm	50 to 58	52	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4356	Pass
Internal Hysteresis	%	69 to 85	73	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4385	Pass
Overall Test Results				Pass



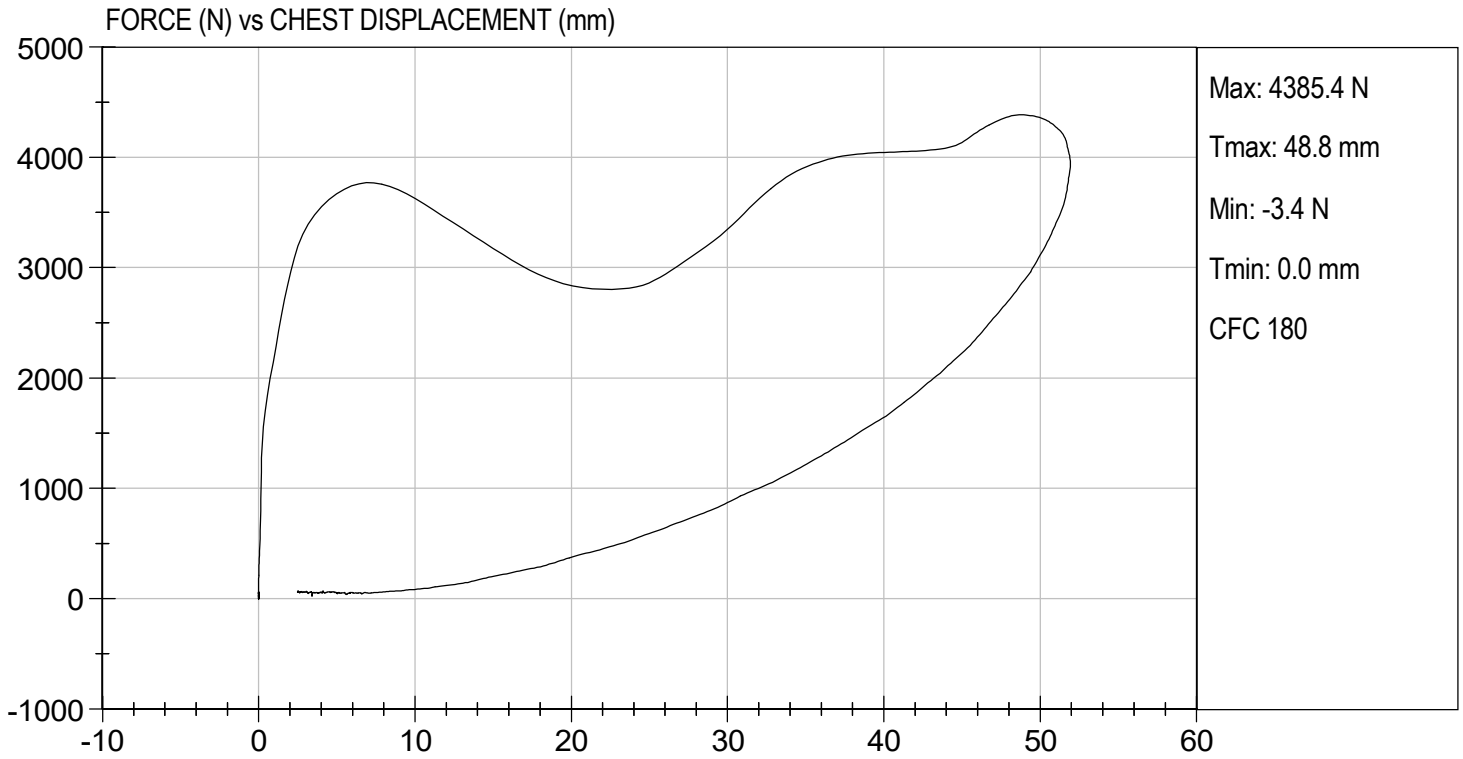
 Laboratory Technician

03/26/2021

 Test Date



 Approved By



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211035

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	42	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3809	Pass
Overall Test Results				Pass

Gerald Guerrero

 Laboratory Technician

03/24/2021

 Test Date

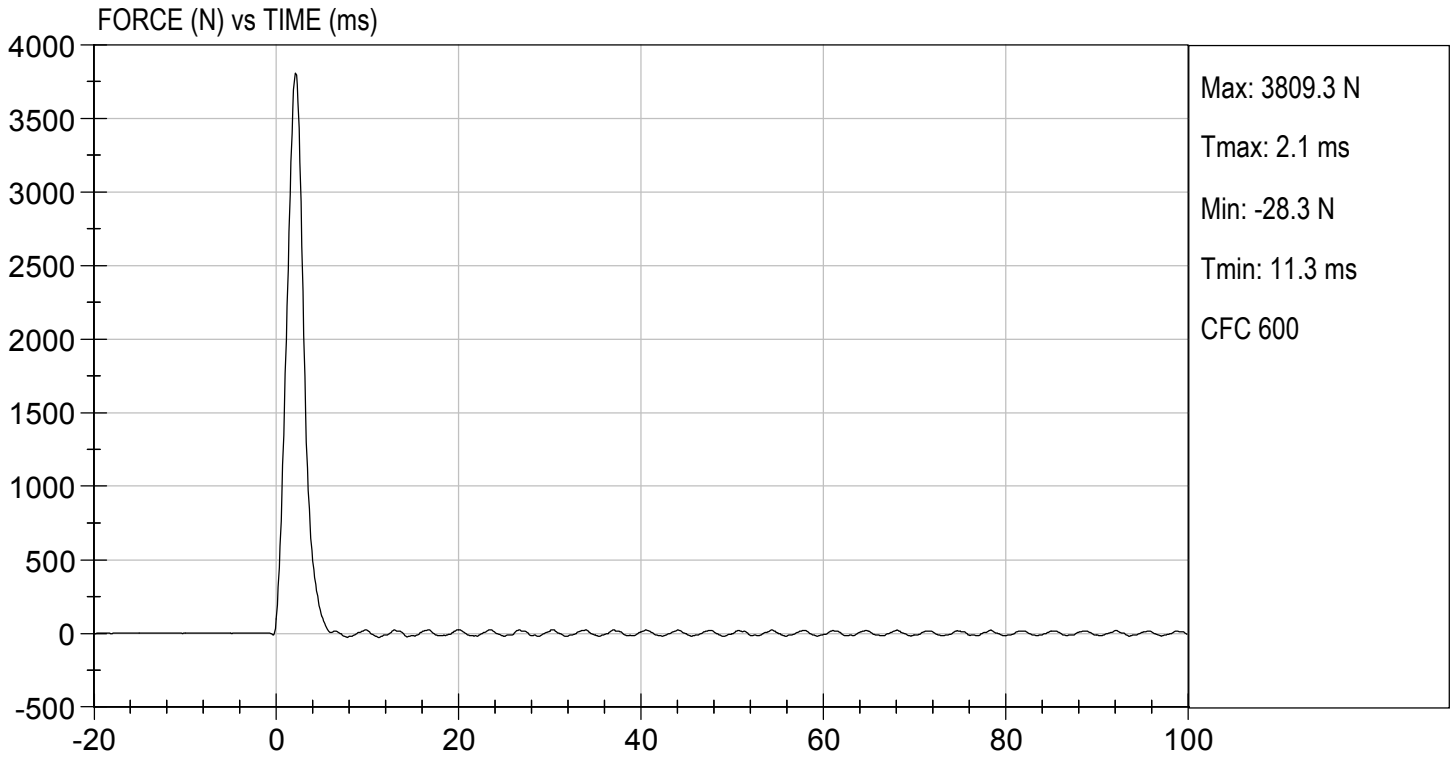
B. F. H.

 Approved By



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

TEST DATE: 03/24/2021
TEST #: D211035



**MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE**

ATD Serial No: DH1659

Test I.D: D211036

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	42	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3584	Pass
Overall Test Results				Pass

Gerald Cervero

Laboratory Technician

03/24/2021

Test Date

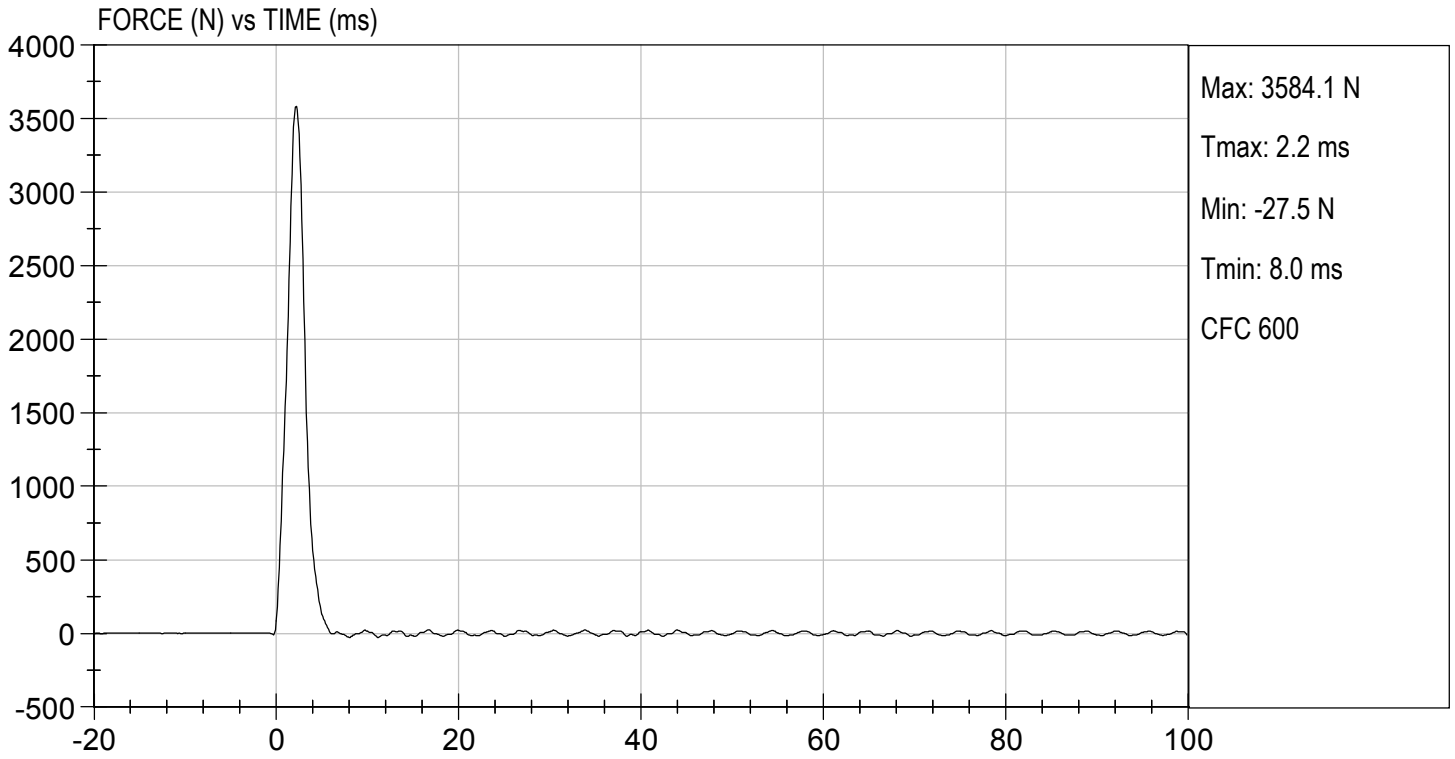
B. F. K.

Approved By



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

TEST DATE: 03/24/2021
TEST #: D211036



MGA RESEARCH CORPORATION
TORSO FLEXION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211037

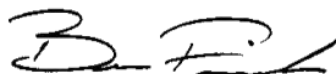
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	36	Pass
Initial Angle	deg	0 to 20	18	Pass
Return Angle	deg	+/- 8	3	Pass
Force at 45 deg	N	320 to 390	349	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
Overall Result				Pass



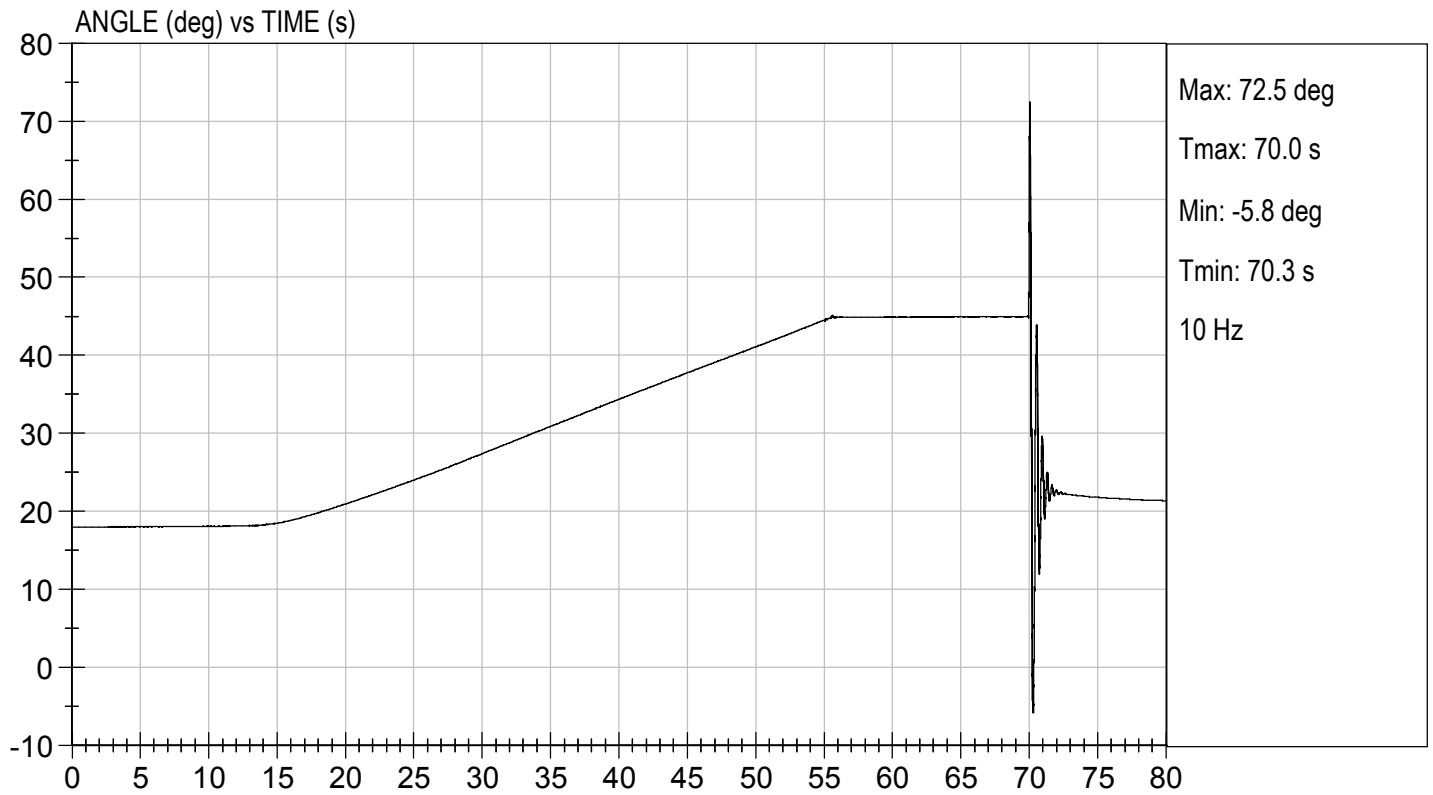
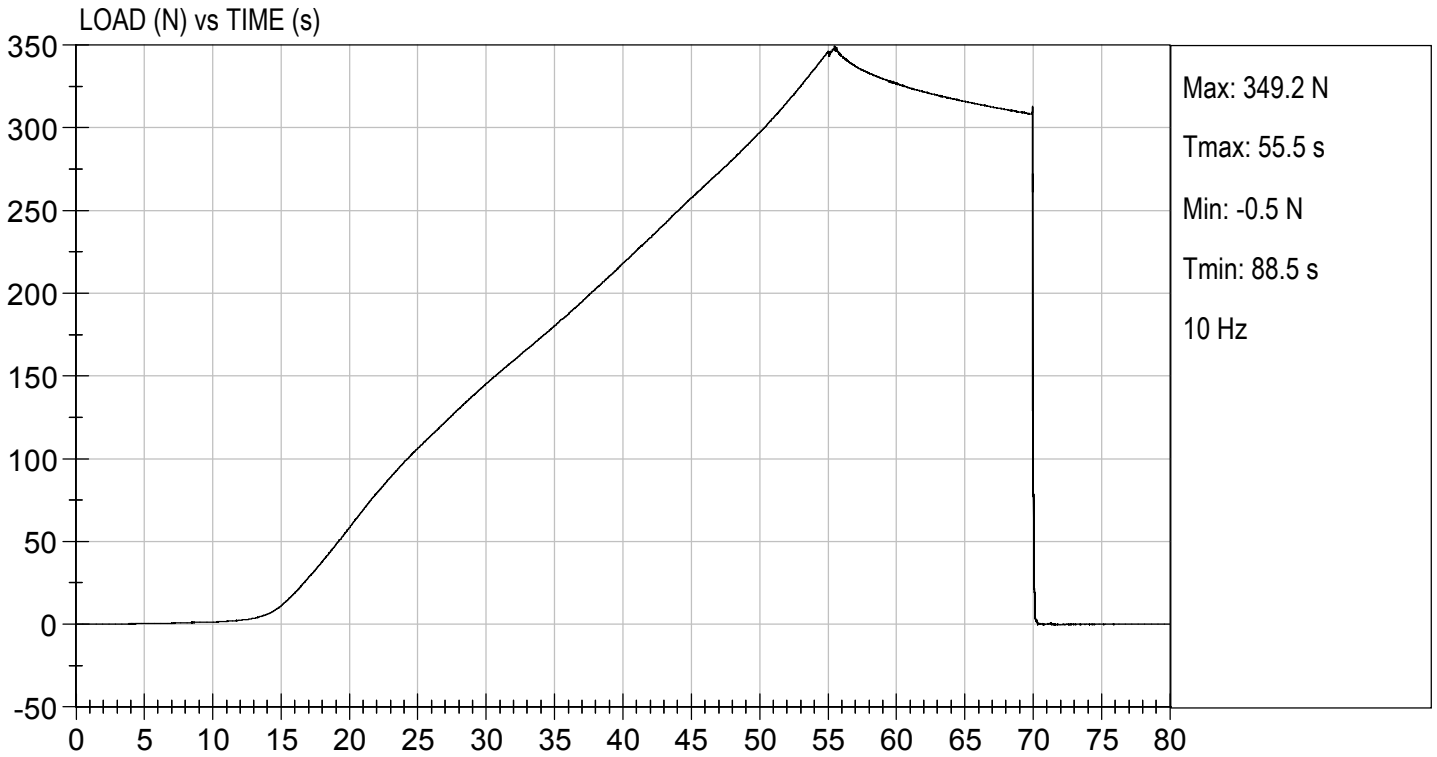
 Laboratory Technician

03/25/2021

 Test Date



 Approved By



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: D211101

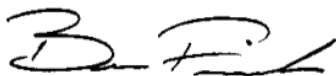
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	15	Pass
Peak Resultant Acceleration	G's	250 to 300	291	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-14.6	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass



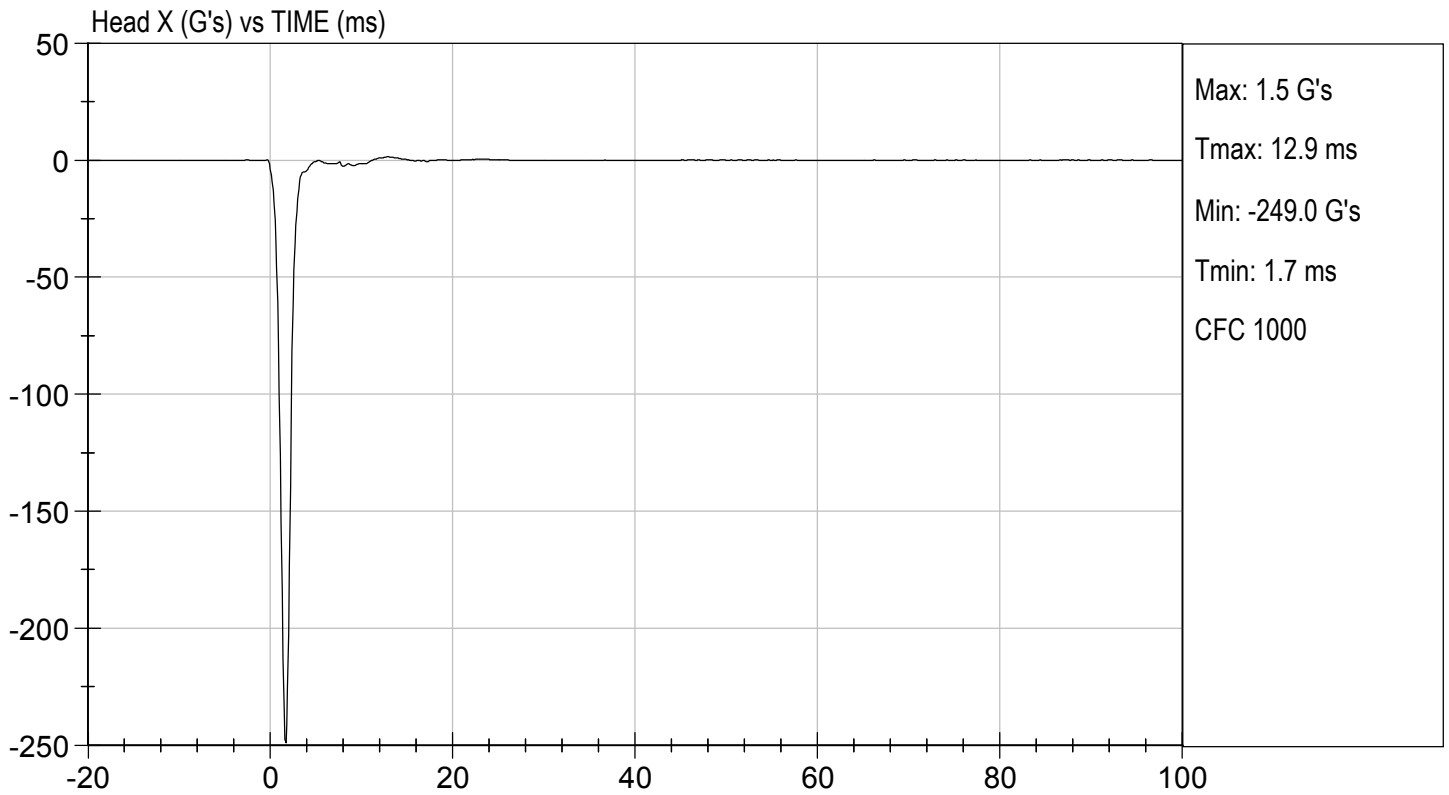
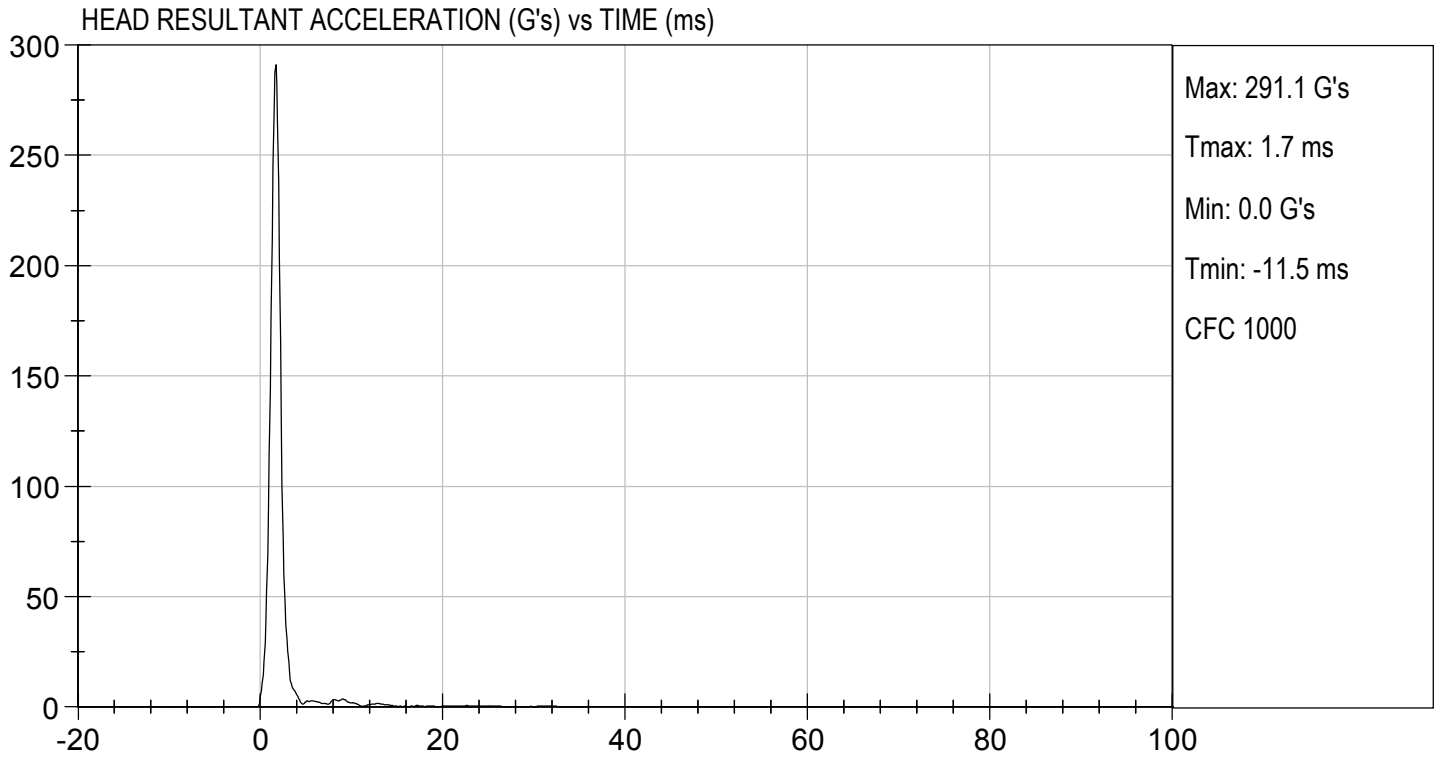
Laboratory Technician

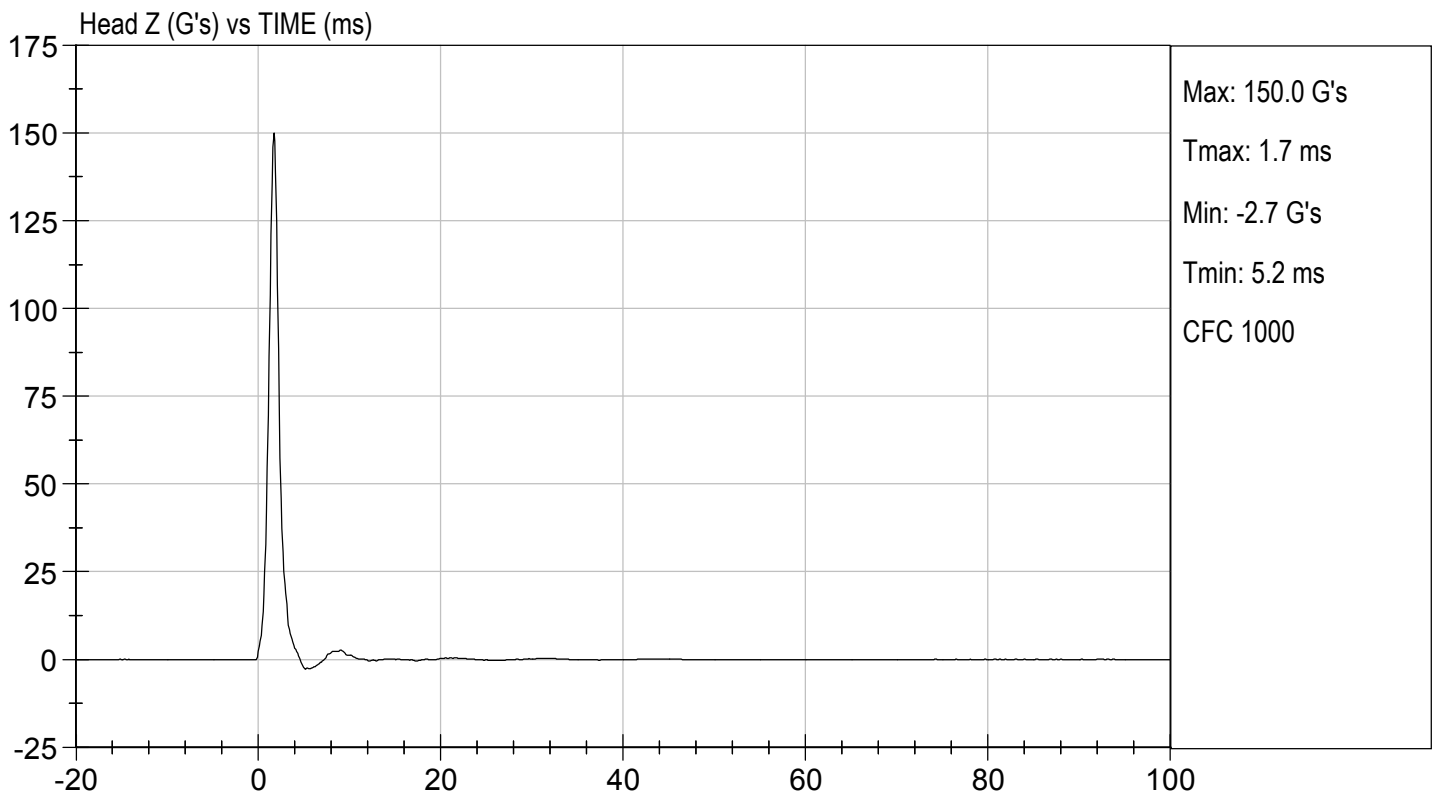
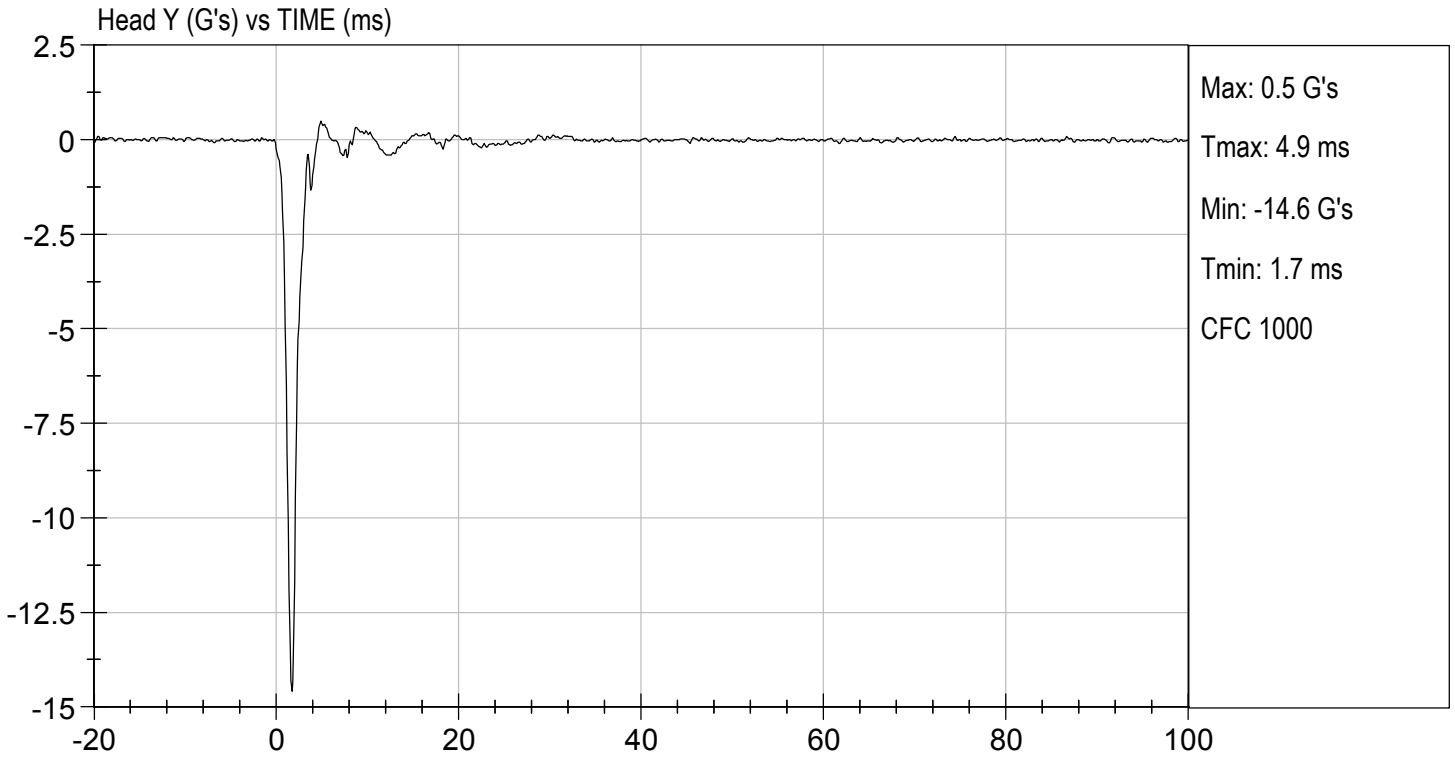
04/01/2021

Test Date



Approved By





MGA RESEARCH CORPORATION


NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

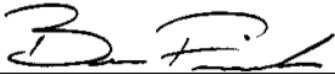
ATD Serial No: DH1659

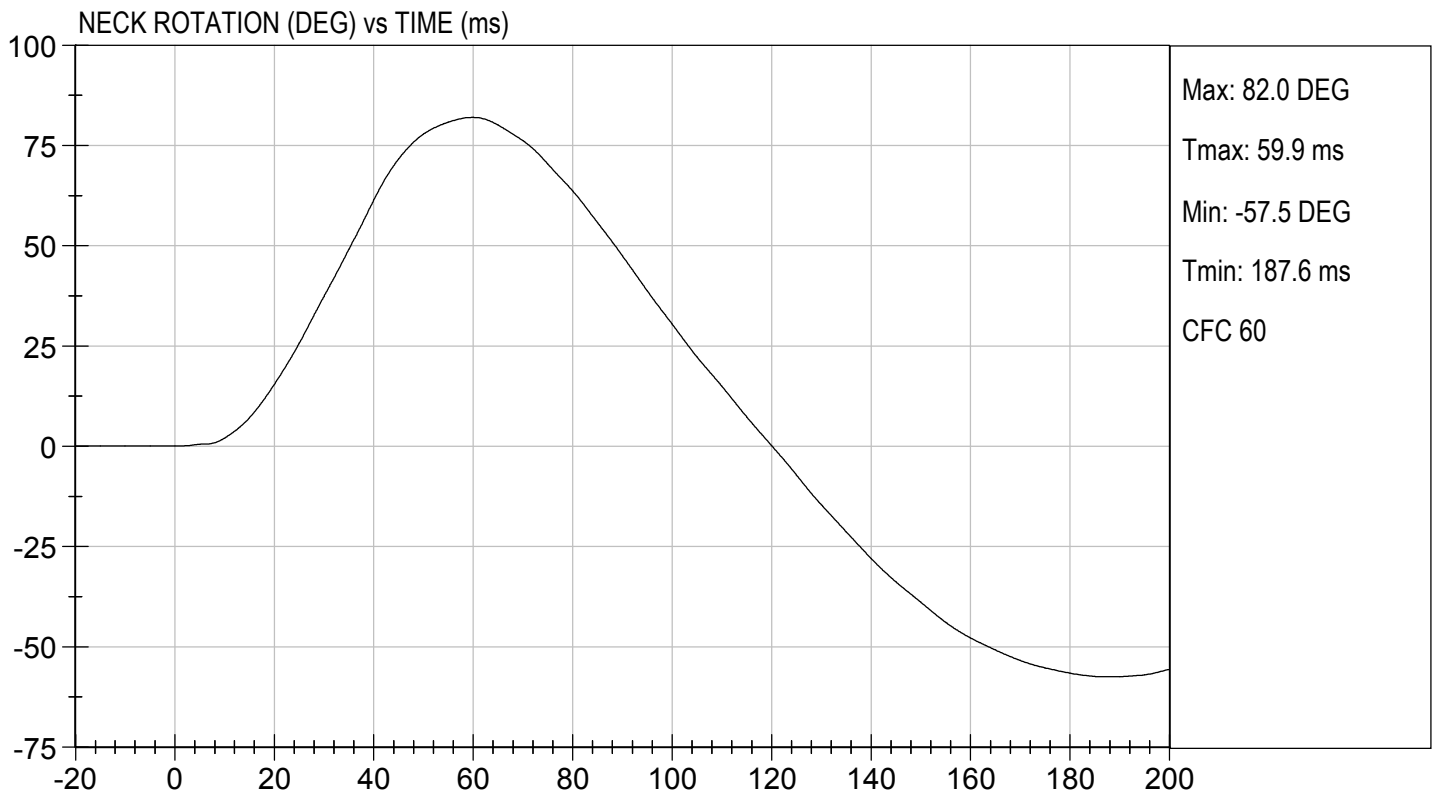
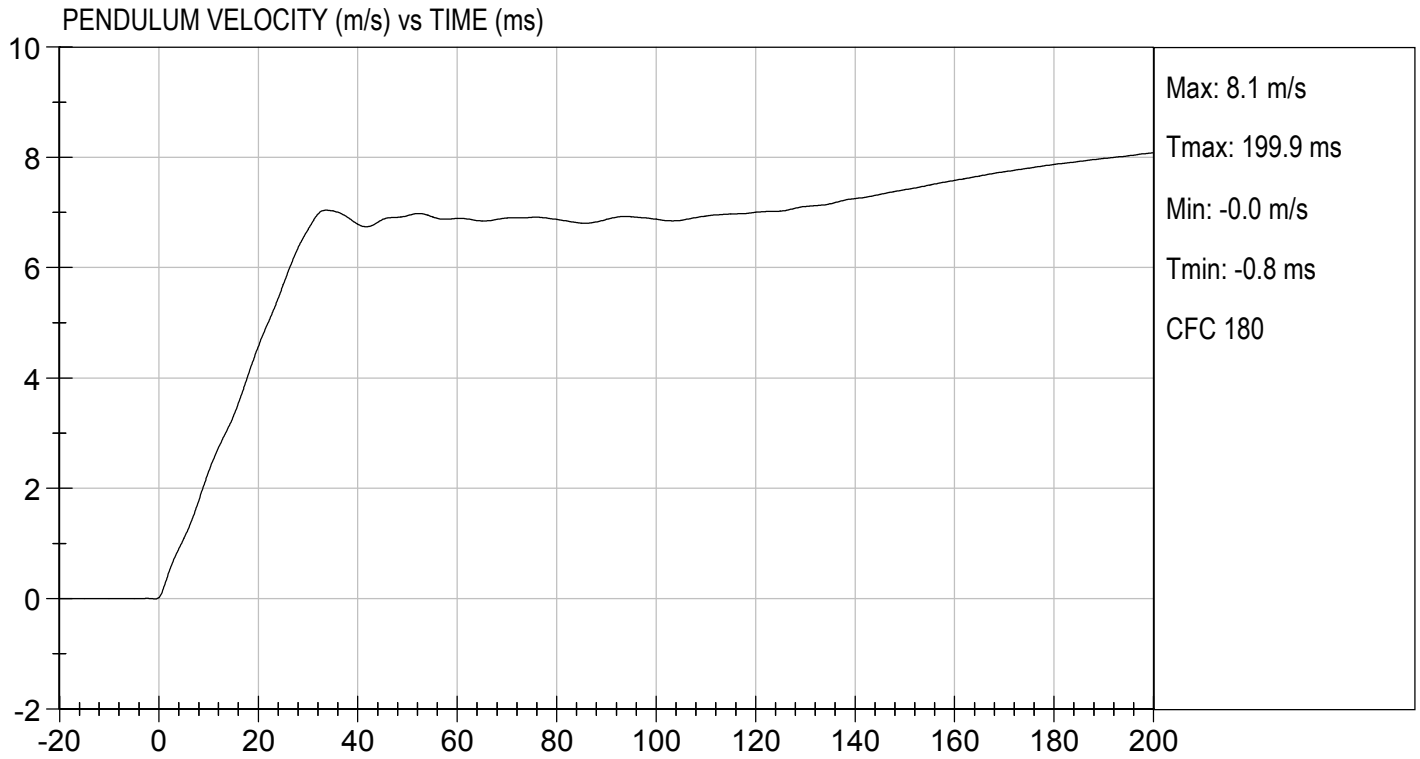
Test I.D.: D211102

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	17	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.06	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.3	Pass
	20 ms	m/s	4.0 to 5.0	4.6	Pass
	30 ms	m/s	5.8 to 7.0	6.7	Pass
D Plane Rotation	Max	deg	77 to 91	82	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	72	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	85	Pass
Overall Results					Pass


Laboratory Technician

 04/01/2021
Test Date

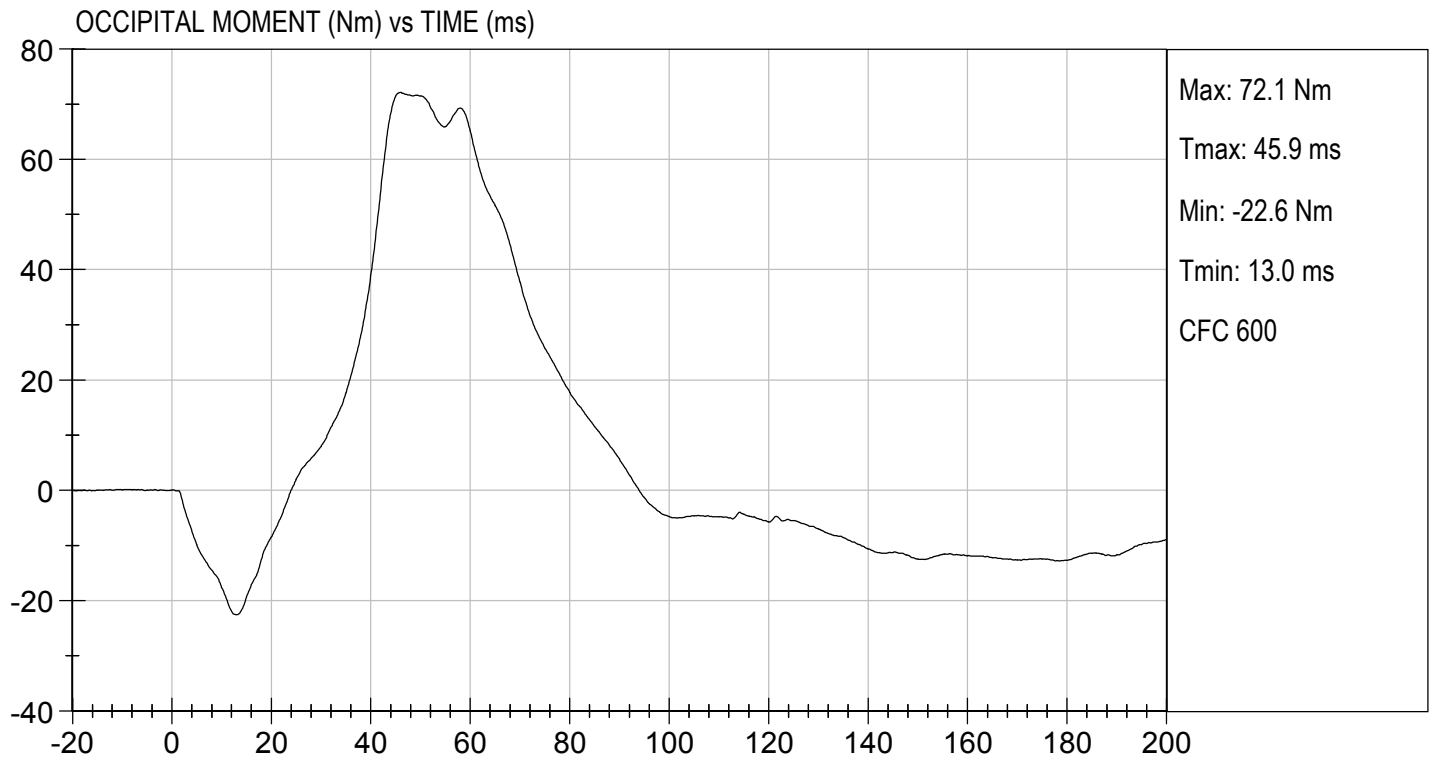

Approved By





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

TEST DATE: 04/01/2021
TEST #: D211102




MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 5TH PERCENTILE

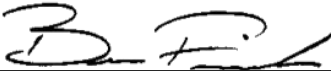
ATD Serial No: DH1659

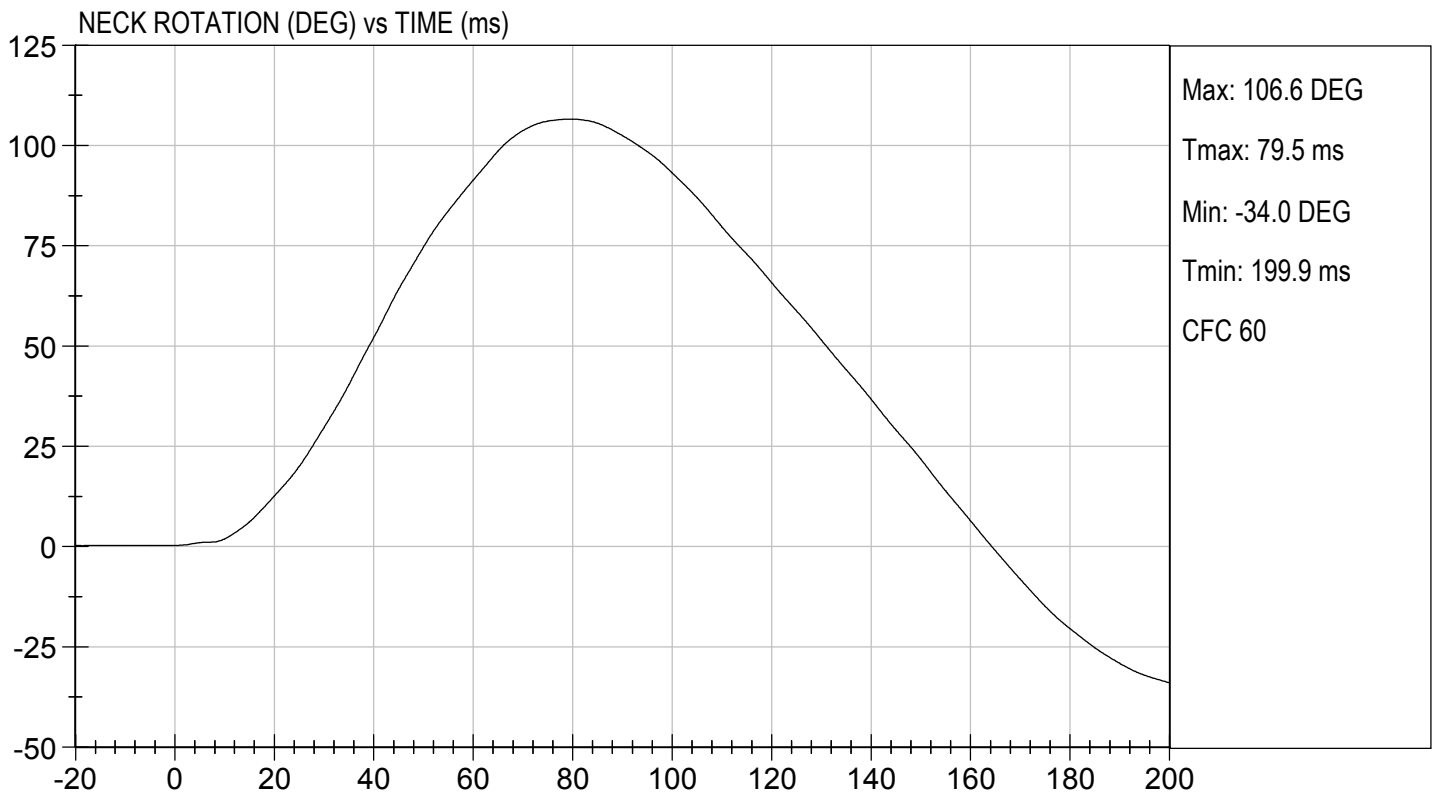
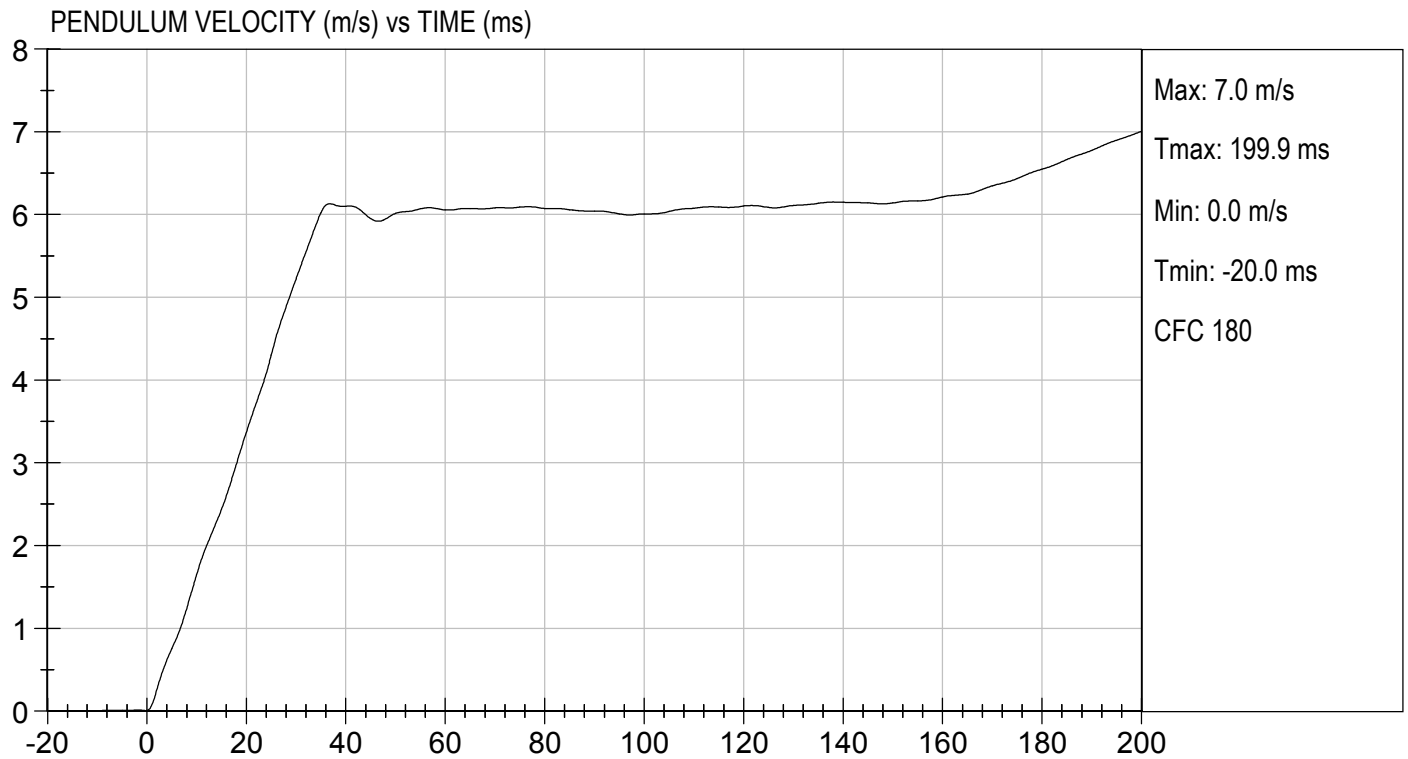
Test I.D: D211103

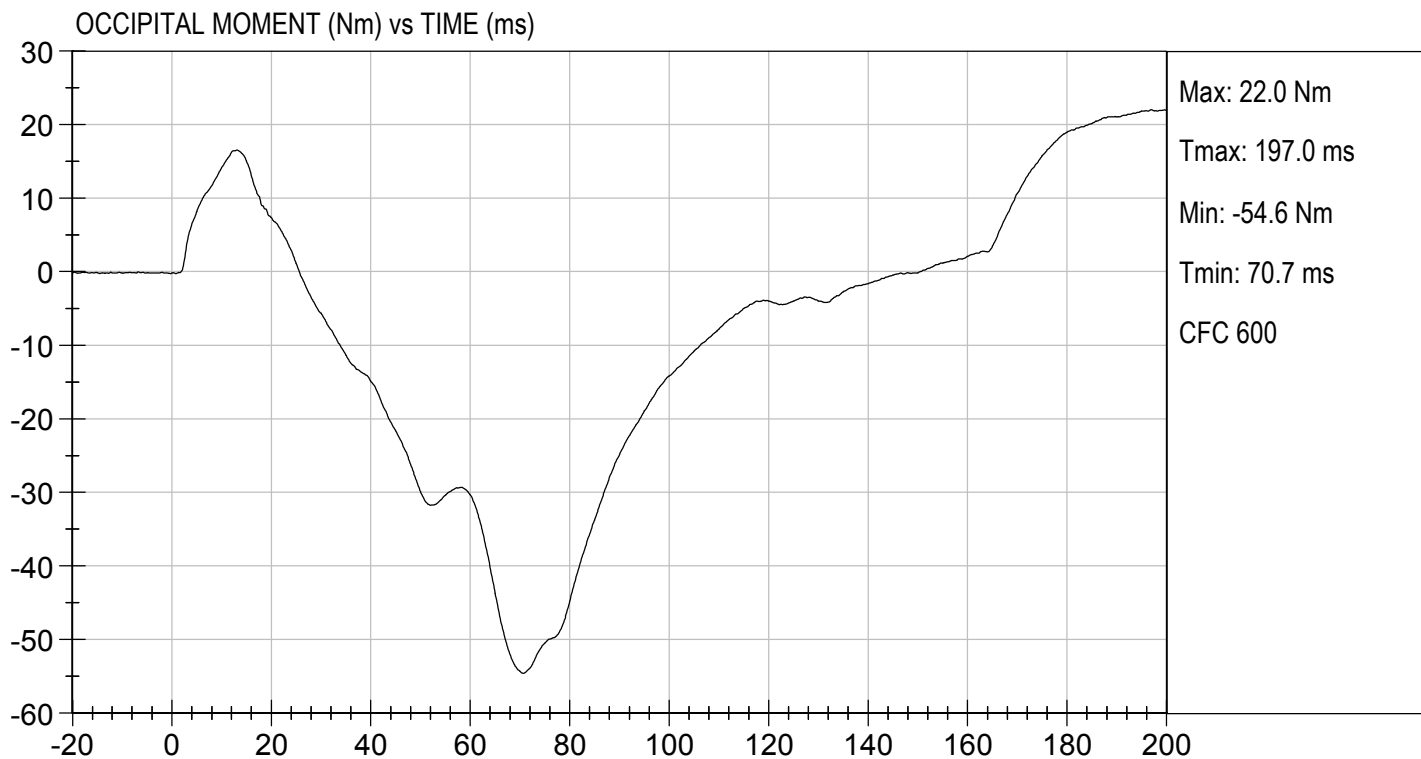
Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.5	Pass
Laboratory Relative Humidity		%	10 to 70	15	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.17	Pass
Pendulum Velocity	10 ms	m/s	1.5 to 1.9	1.6	Pass
	20 ms	m/s	3.1 to 3.9	3.4	Pass
	30 ms	m/s	4.6 to 5.6	5.2	Pass
D Plane Rotation	Max	deg	99 to 114	107	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-55	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	106	Pass
Overall Results					Pass


 Laboratory Technician

 04/01/2021
 Test Date


 Approved By





MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D.: D211104

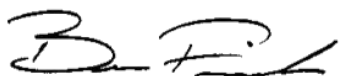
Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	22	Pass
Relative Humidity	%	10 to 70	23	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	51	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4260	Pass
Internal Hysteresis	%	69 to 85	74	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4475	Pass
Overall Test Results				Pass



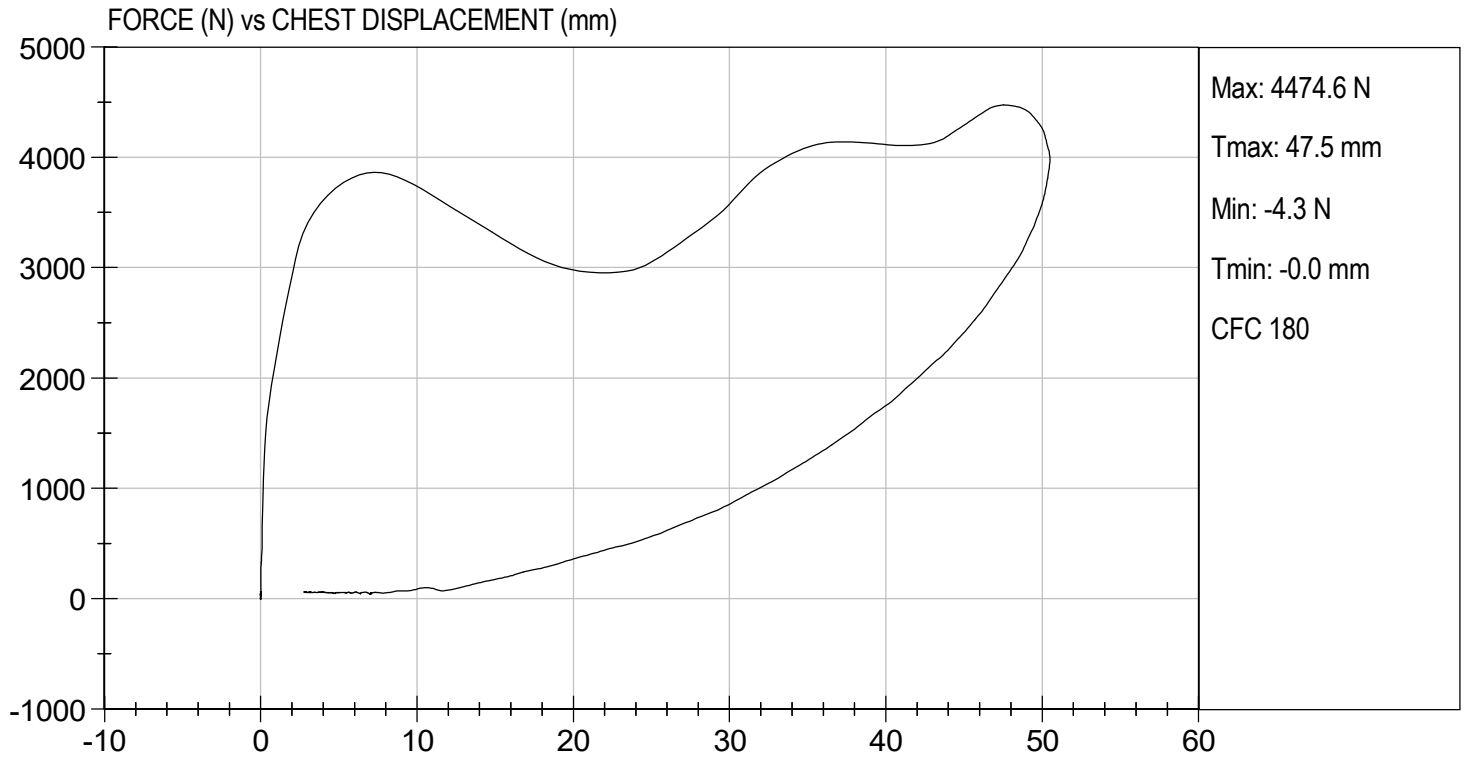
 Laboratory Technician

03/31/2021

 Test Date



 Approved By



MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211105

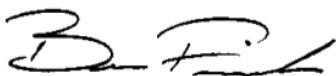
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	17	Pass
Probe Speed	m/s	2.07 to 2.13	2.08	Pass
Maximum Force	N	3450 to 4060	3732	Pass
Overall Test Results				Pass



 Laboratory Technician

04/01/2021

 Test Date

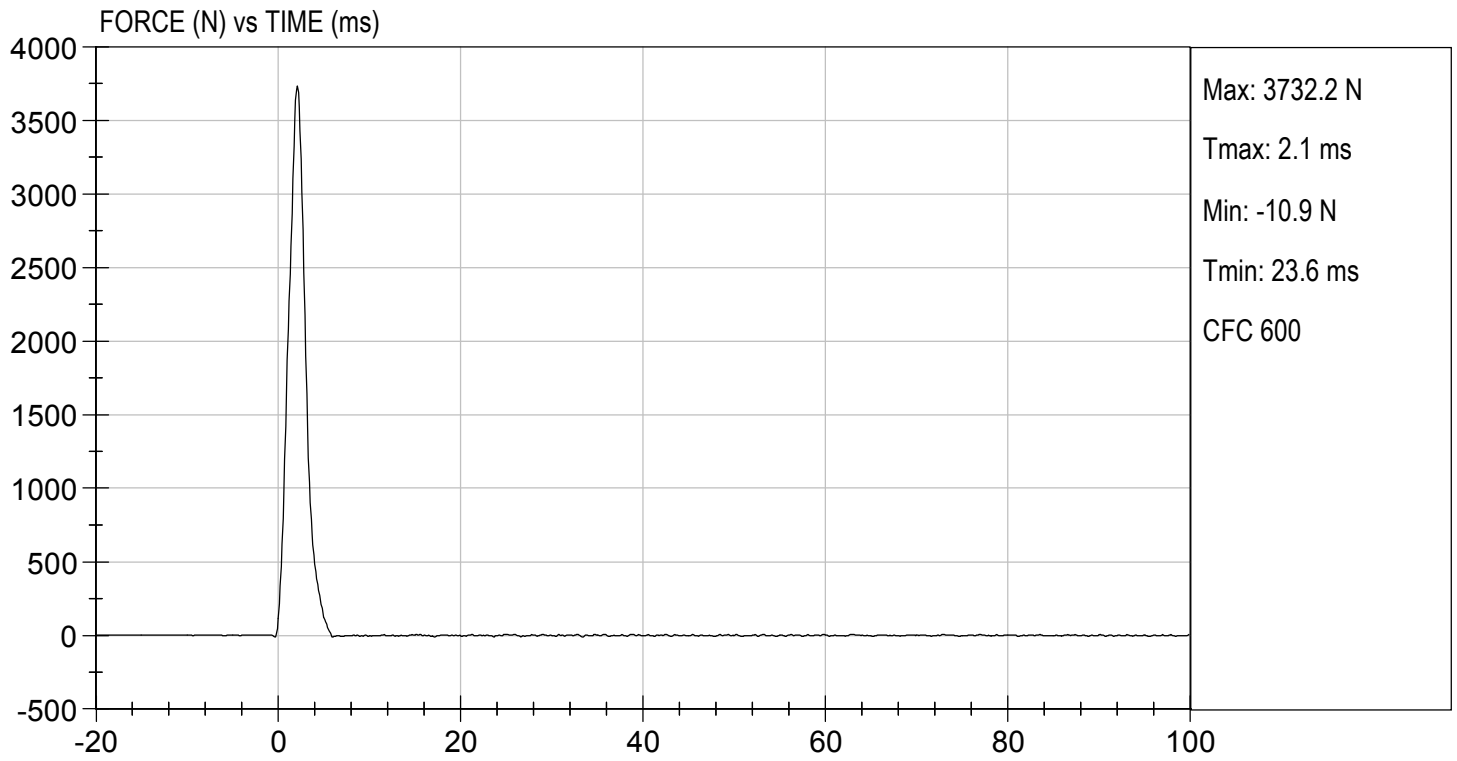


 Approved By



TEST DESC: LEFT KNEE
VELOCITY: 6.83 ft/s, 2.08 m/s

TEST DATE: 04/01/2021
TEST #: D211105



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211106

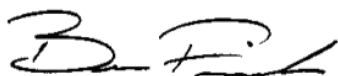
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	17	Pass
Probe Speed	m/s	2.07 to 2.13	2.08	Pass
Maximum Force	N	3450 to 4060	3630	Pass
Overall Test Results				Pass



 Laboratory Technician

04/01/2021

 Test Date

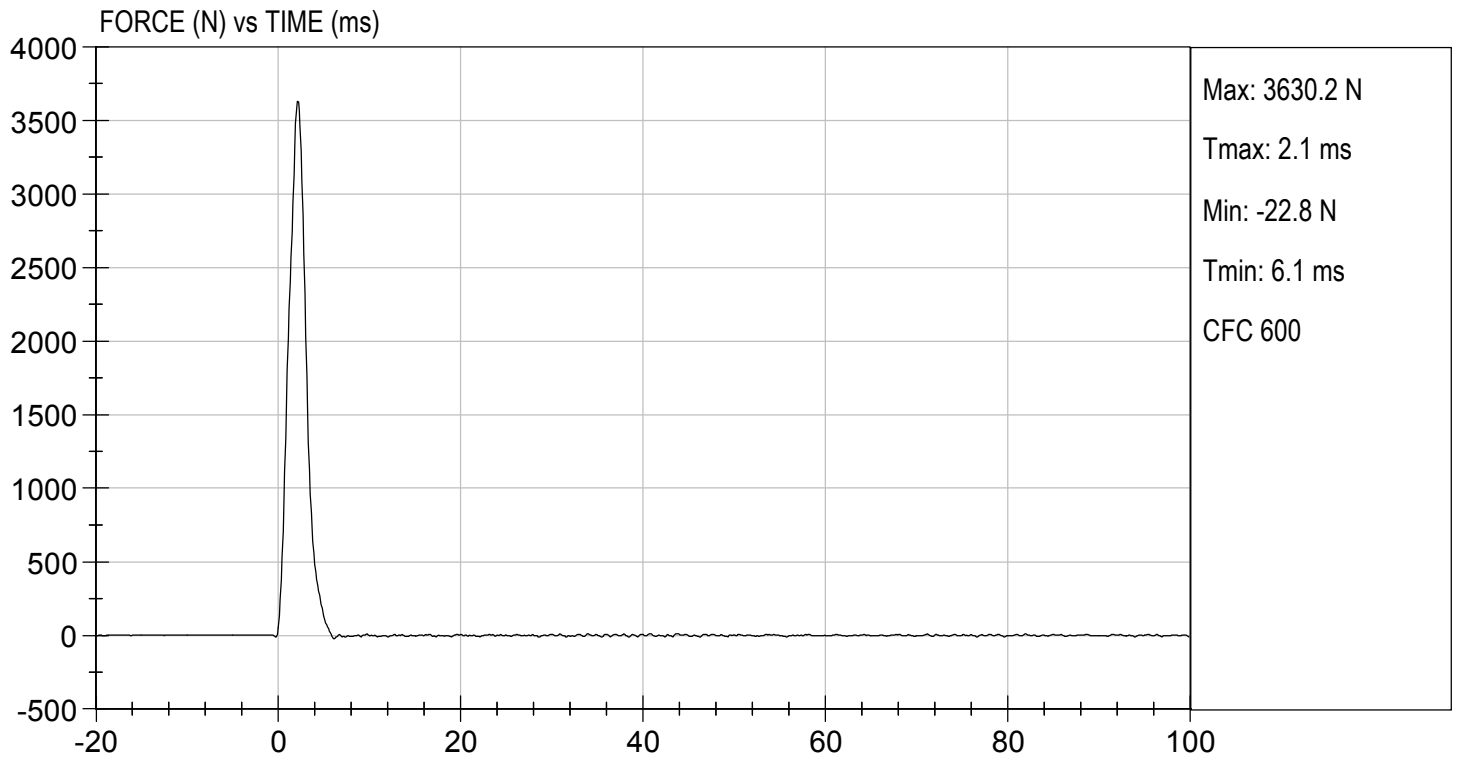


 Approved By



TEST DESC: RIGHT KNEE
VELOCITY: 6.83 ft/s, 2.08 m/s

TEST DATE: 04/01/2021
TEST #: D211106



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: DH1659

Test I.D: D211107

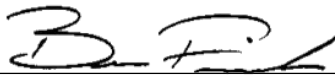
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	15	Pass
Initial Angle	deg	0 to 20	20	Pass
Return Angle	deg	+/- 8	4	Pass
Force at 45 deg	N	320 to 390	328	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.9	Pass
Overall Result				Pass



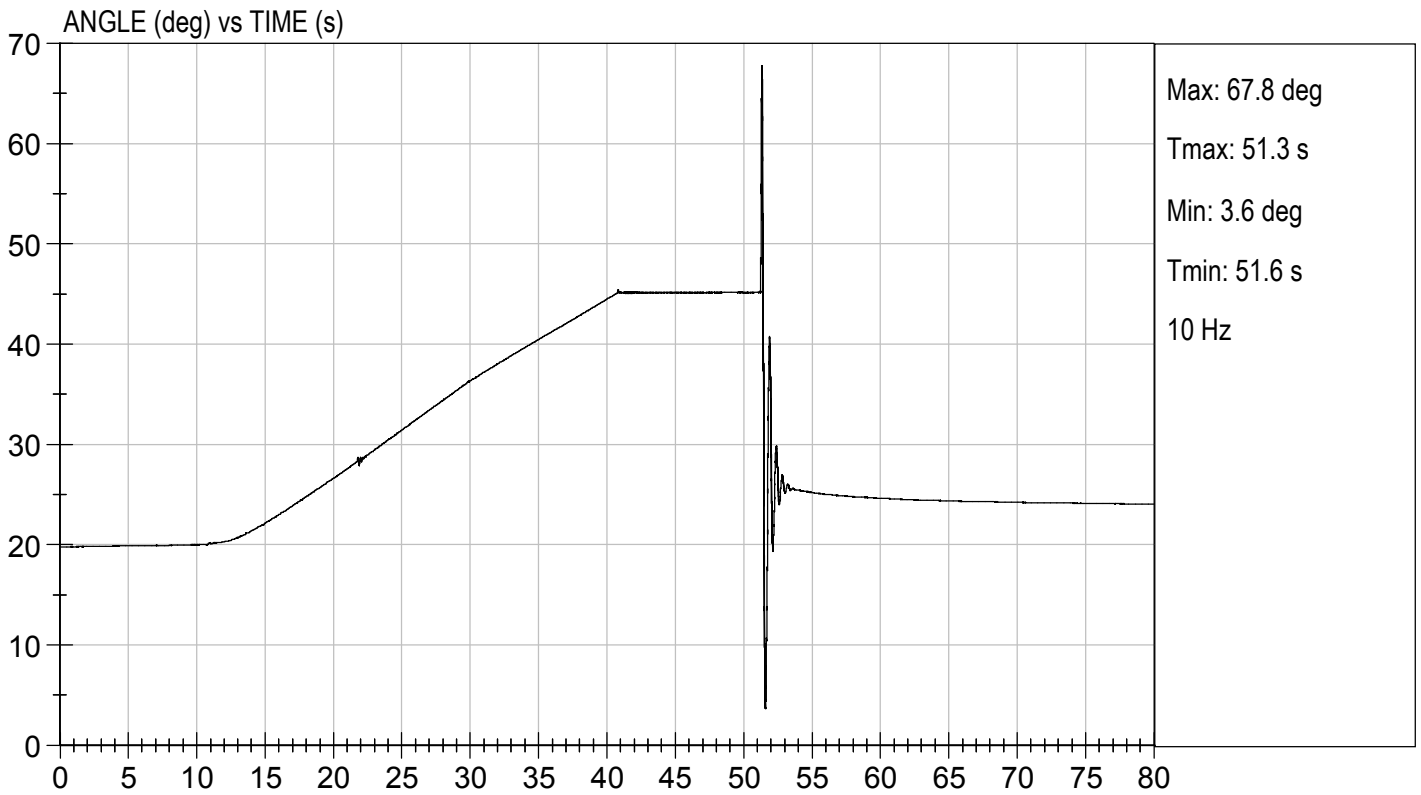
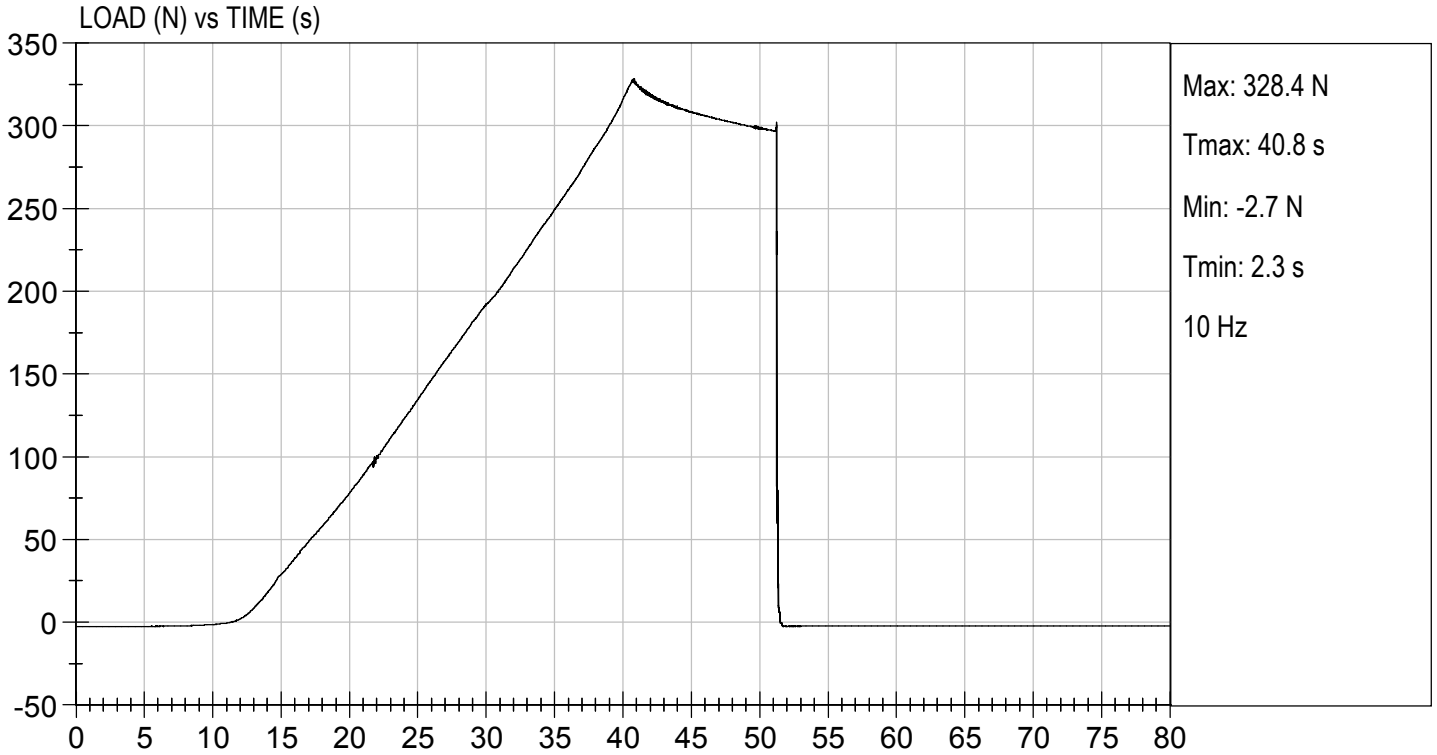
Laboratory Technician

04/01/2021

Test Date



Approved By



APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

TABLE 1 – DRIVER DUMMY INSTRUMENTATION

Instrument Location			Axis	Hybrid III 50 th 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	SBG161	FTSS	11/13/2019
			Shoulder	SBG157	FTSS	11/13/2019

TABLE 2 – FRONT PASSENGER DUMMY INSTRUMENTATION

Instrument Location			Axis	Hybrid III 5 th 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		SBG272	FTSS

TABLE 3 – VEHICLE INSTRUMENTATION

Instrument Location			Axis	Serial Number	Manufacturer	Calibration Date
Crossmember / Rear Seat Accelerometers	Left	Primary	X	A377314	MSI	03/11/2021
			Z	T22711	Endevco	11/02/2020
		Redundant	X	A340713	MSI	10/07/2020
	Right	Primary	X	T20772	Endevco	02/12/2021
			Z	PCB1263	PCB	12/31/2020
		Redundant	X	A340789	MSI	12/05/2020
Engine Accelerometers		Top	X	A361012	MSI	12/12/2020
		Bottom	X	A377286	MSI	03/10/2021