REPORT NUMBER: NCAP-MGA-2019-018

NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test

TOYOTA MOTOR CORPORATION
2019 Toyota Corolla Hatchback SE 5-Door Hatchback
NHTSA No.: O20195100

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: January 11, 2019

Final Report Date: April 12, 2019

FINAL REPORT

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

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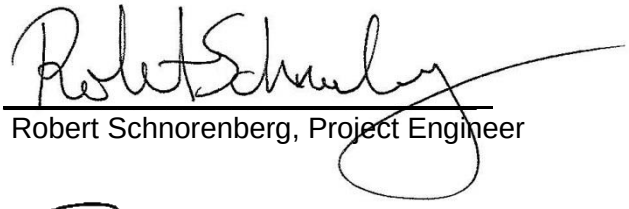
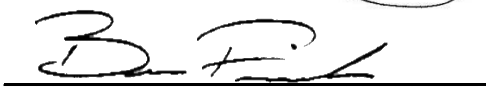
Prepared by: 
Robert Schnorenberg, Project Engineer

Approved by: 
Ben Fischer, Project Engineer

Approval Date: April 12, 2019

FINAL REPORT ACCEPTANCE BY OCWS:

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

Date: _____

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

Date: _____

Technical Report Documentation Page

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9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-12-D-00258
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15. Supplementary Notes		

16. Abstract

A 56.3 km/h NCAP Frontal Impact Test was conducted on a 2019 Toyota Corolla Hatchback SE 5-Door Hatchback in accordance with the specifications of the Office of Crashworthiness Standards Frontal NCAP Laboratory Test Procedure. This test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), and 301 performance. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on January 11, 2019.

The impact velocity of the vehicle was 56.41 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 506 mm located at the vehicle centerline. The test vehicle's performance was as follows:

Measurement Description	Units	Driver ATD		Passenger ATD	
		Threshold	Result	Threshold	Result
Head Injury Criteria (HIC_{15})	N/A	700	187	700	356
Maximum Chest	mm	63	24	52	14
Nij	N/A	1	0.27	1	0.27
Neck Tension	N	4170	1081	2620	734
Neck Compression	N	4000	221	2520	382
Left Femur Force	N	10008	1468	6805	1337
Right Femur Force	N	10008	1381	6805	694

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SECTION 1
PURPOSE AND SUMMARY OF TEST

PURPOSE

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

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

SUMMARY

A load cell barrier consisting of 176 load cells was impacted by a 2019 Toyota Corolla Hatchback SE 5-Door Hatchback at a velocity of 56.41 km/h. The test was performed at MGA Research Corporation on January 11, 2019. Pre-test and post-test photographs of the vehicle and dummies can be found in Appendix A.

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

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

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

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

The 634 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 506 mm located at the vehicle centerline and both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

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

The occupant data is summarized below:

ATD position	HIC_{15}	Nij	Neck Tension (N)	Neck Comp. (N)	3ms Chest Clip (Gs)	Chest Disp. (mm)	Left Femur (N)	Right Femur (N)
Driver (50^{th})	187	0.27	1081	221	45	24	1468	1381
Passenger (5^{th})	356	0.27	734	382	49	14	1337	694

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

TEST NOTES

Driver Right Ankle Z recorded no valid data after 54ms.
Bottom of Engine X recorded no valid data after 34ms.
Barrier C-01 Fx recorded no valid data.
Barrier C-01 Mz recorded no valid data.
Barrier I-05 My recorded no valid data.
Barrier K-15 My recorded no valid data.

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	O20195100	Traction Control System (TCS)	Yes
Model Year	2019	Power Steering	Yes
Make	Toyota	Power Window Auto-Reverse	Yes
Model	Corolla Hatchback SE	Driver Frontal Airbag	Yes
Body Style	5-Door Hatchback	Driver Curtain Airbag	Yes
VIN	JTNK4RBEXK3019307	Driver Head/Torso Airbag	No
Body Color	Blue Flame	Driver Torso Airbag	No
Odometer (km/mi)	156 km / 97 mi	Driver Torso/Pelvis Airbag	Yes
Engine Displacement (L)	2.0 L	Driver Pelvis Airbag	No
Type/No. Cylinders	I4	Driver Knee Airbag	Yes
Engine Placement	Lateral	Front Pass. Frontal Airbag	Yes
Transmission Type	Automatic	Front Pass. Curtain Airbag	Yes
Transmission Speeds	CVT	Front Pass. Head/Torso Airbag	No
Overdrive	Yes	Front Pass. Torso Airbag	No
Final Drive	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)	No	Front Pass. Seat Pan Airbag	Yes

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

DATA FROM CERTIFICATION LABEL

Manufactured By	TOYOTA MOTOR CORPORATION
Date of Manufacture	09/18

GVWR (kg)	2210
GAWR Front (kg)	1050
GAWR Rear (kg)	971

VEHICLE SEATING AND WEIGHT CAPACITY DATA

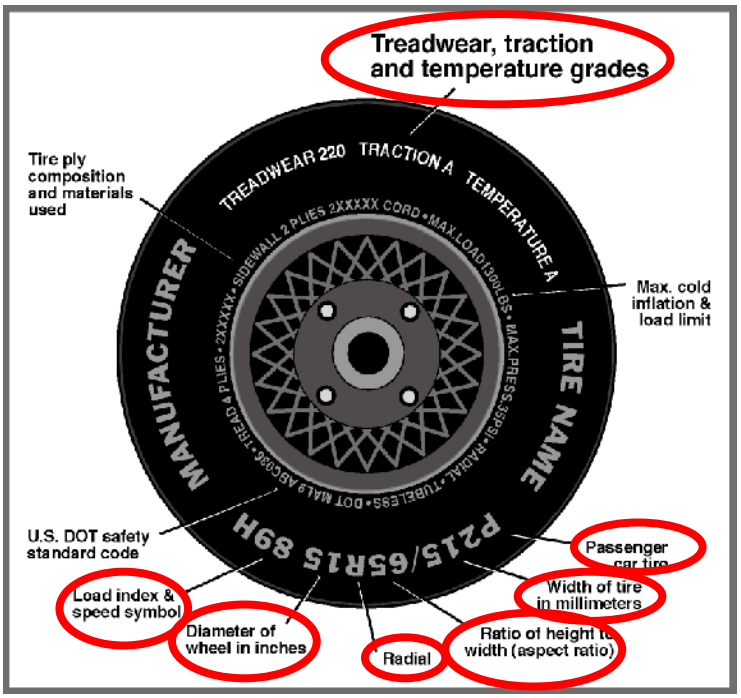
Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Designated Seating Capacity (DSC)	2	3		5
Capacity Weight (VCW) (kg)				384*
Cargo Weight (RCLW) (kg)				44

*Vehicle Capacity Weight (VCW) reduced by 6 kg to account for Load Carrying Capacity Reduction label.

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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	350	350
Cold Pressure (kPa)	240	230
Recommended Tire Size	205/55R16	205/55R16
Tire Size on Vehicle	205/55R16	205/55R16
Tire Manufacturer	Dunlop	Dunlop
Tire Model	Enasave	Enasave
Treadwear	340	340
Traction	B	B
Temperature Grade	A	A
Tire Plies Sidewall	1 Polyester	1 Polyester
Tire Plies Body	1 Polyester, 2 Steel, 1 Polyamide	1 Polyester, 2 Steel, 1 Polyamide
Load Index/Speed Symbol	91H	91H
Tire Material	Rubber	Rubber
DOT Safety Code Left	EV8K 3MMR 3518	EV8K 3MMR 3518
DOT Safety Code Right	EV8K 3MMR 3518	EV8K 3MMR 3518

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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	422.5	273.5		460.5	331.0	
Right	kg	421.5	254.5		451.0	307.5	
Ratio	%	61.5%	38.5%		58.8%	41.2%	
Totals	kg	844.0	528.0	1372.0	911.5	638.5	1550.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1372.0
Weight of 1 P572E ATD & 1 P572O ATD	kg	141
Rated Cargo/Luggage Weight (RCLW)	kg	44
Calculated Test Vehicle Target Weight (TVTW)	kg	1557.0

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	675	674	687	697	1016
As Tested	mm	667	666	663	668	1088
Post Test	mm	688	702	658	666	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2640
Total Vehicle Length at Left Side	mm	4172
Total Vehicle Length at Centerline	mm	4376
Total Vehicle Length at Right Side	mm	4172
Weight of Ballast in Cargo Area	kg	3
Weight of Vehicle Components Removed	kg	29
Amount of Stoddard Solvent in Fuel Tank	L	46.6

List of components removed to meet test weight: None.

List of components removed for instrumentation, data box, and equipment installation: Cargo area cover, divider, side trim, floor mat and carpet, jack/tool kit, spare tire and tire cover, LR and RR floor mats, rear sill trim, RR taillight.

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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

TARGET VEHICLE STRUCTURAL MEASUREMENT

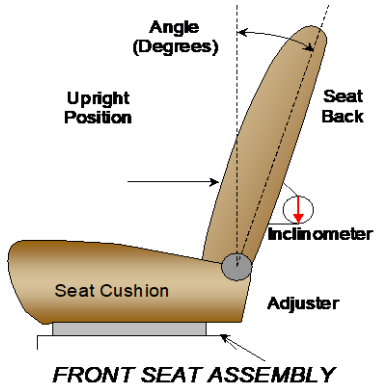
	Elements	Pre-Test (mm)
1	Total Length	4376
2	Total Width	1770
3	Bumper Top Height	508
4	Bumper Bottom Height	392
5	Longitudinal Member Top Height	512
6	Distance between Longitudinal Members	920
7	Longitudinal Member Width	60
8	Engine Top Height	821
9	Engine Bottom Height	191
10	Engine and Gearbox Width	842
11	Front Bumper-Engine Distance	274
12	Front Shock Absorber Fixing Height	835
13	Bonnet Leading Edge Height	729
14	Front Shock Absorber Fixing Width	1176
15	Front Bumper – Front Axle Distance	951
16	Front Axle – A-Pillar Distance	417
17	A-Pillar – B-Pillar Distance	1152
18	B-Pillar – Rear Axle Distance	1071
19	B-Pillar – C-Pillar Distance	659
20	Roof Sill Bottom Height	1250
21	Roof Sill Top Height	1365
22	Floor Sill Bottom Height	178
23	Floor Sill Top Height	360

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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

NOMINAL DESIGN RIDING POSITION

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



	Degrees
Driver Seat Back Angle	5.0° on outboard headrest post
Passenger Seat Back Angle	4.5° on outboard headrest post

SEAT FORE/AFT POSITIONS

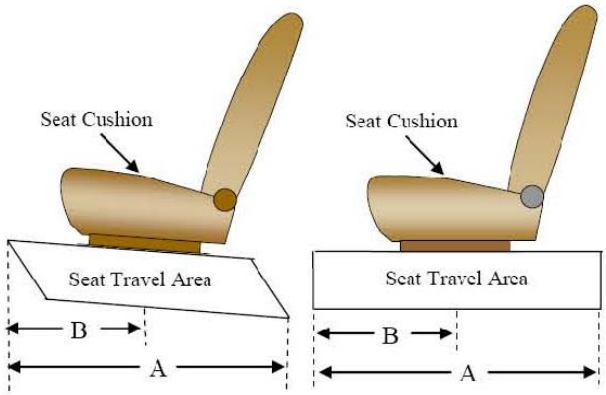
The driver and passenger seat fore/aft positions are adjusted following Appendix F, "Driver & Passenger Dummy Seating & Positioning Procedures" in the NCAP Test Procedure dated October 2015.

	Total Fore/Aft Travel	Placed in Position #
Driver Seat	298 mm / 27 detents (1st as 1)	149 mm / 11th detent (1st as 0)
Passenger Seat	260 mm / 27 detents (1st as 1)	0 mm / 0th detent (1st as 0)

SEAT BELT UPPER ANCHORAGES

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

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



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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

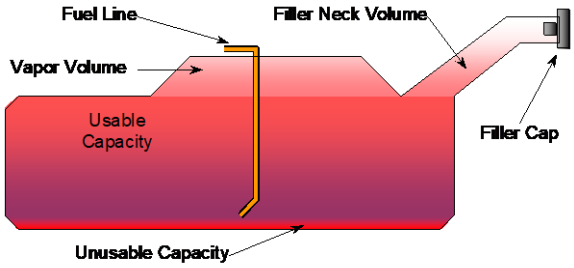
FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	50
Usable Capacity of "Optional Tank"	
92-94% of Usable Capacity	46 to 47
Actual Amount of Solvent used	46.6
1/3 of Usable Capacity	16.7

FUEL PUMP

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

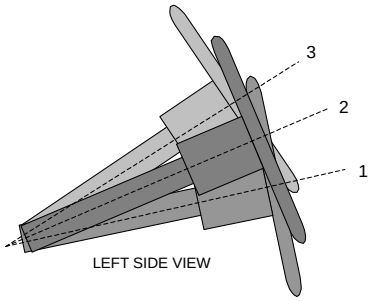
The vehicle is equipped with an electronic fuel pump. The fuel pump is activated when the ignition is turned on. The filler neck is located on the driver's side.



VEHICLE FUEL TANK ASSEMBLY

STEERING COLUMN ADJUSTMENT

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



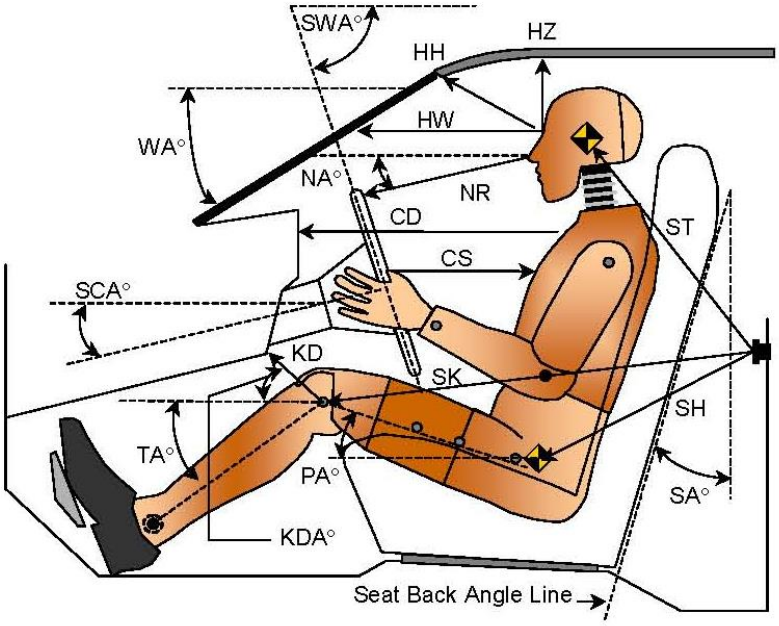
STEERING COLUMN ASSEMBLY

STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost Position 1	70.8	268
Geometric Center Position 2	68.9	244
Uppermost Position 3	66.9	222
Telescoping Steering Wheel Travel		40
Test Position	68.9	244

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

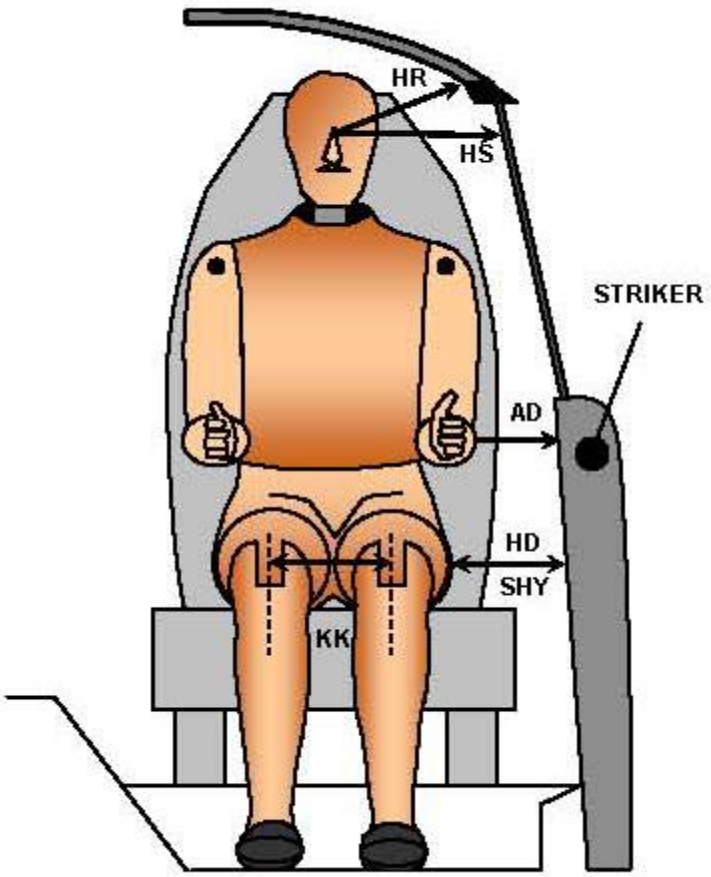


LEFT SIDE VIEW

Code	Measurement Description	Driver		Passenger	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA°	Windshield Angle		21.9		
SWA°	Steering Wheel Angle		68.9		
SCA°	Steering Column Angle		21.1		
SA°	Seat Back Angle		5.0		4.5
HZ	Head to Roof (Z)	180	90	220	90
HH	Head to Header	379	22.4	314	36.6
HW	Head to Windshield	741	0	739	0
NR	Nose to Rim	406	9.0		
CD	Chest to Dash	532		320	
CS	Chest to Steering Hub	328	0.6		
RA	Rim to Abdomen	210	0		
KDL	Left Knee to Dash	167	29.4	109	45.2
KDR	Right Knee to Dash	155	45.2	110	44.9
PA°	Pelvic Angle		24.2		21.1
TA°	Tibia Angle		45.4		46.8
SK	Striker to Knee	572	95.8	684	95.8
ST	Striker to Head	431	7.7	427	31.2
SH	Striker to H-Point	301	140.3	401	119.4

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

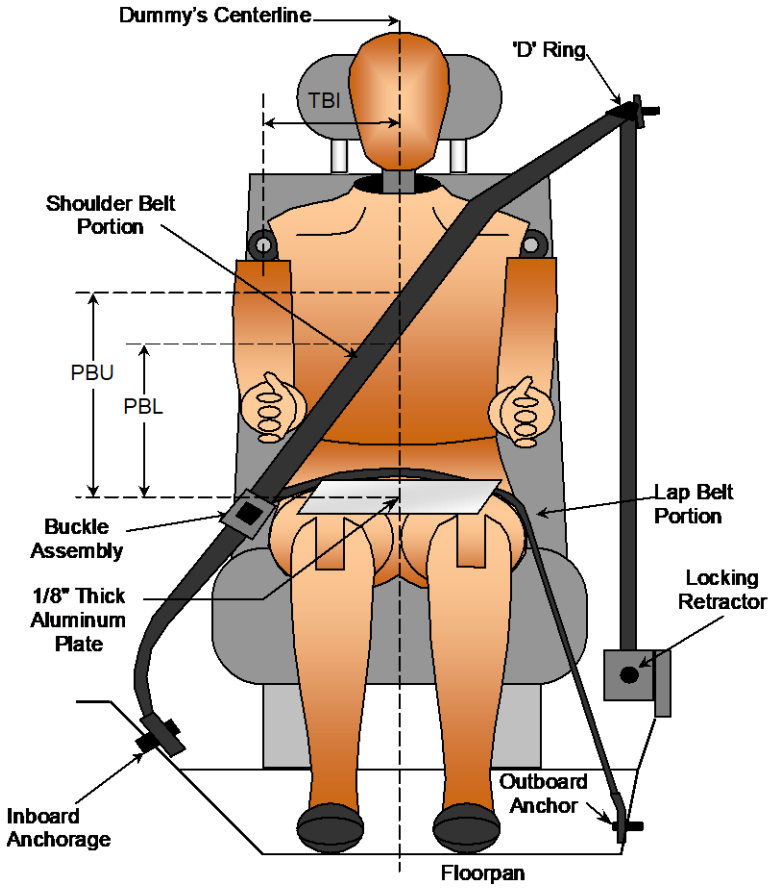


FRONT VIEW OF DUMMY

Code	Measurement Description	Driver	Passenger
		Length (mm)	
AD	Arm to Door	152	80
HD	H-Point to Door	148	184
HR	Head to Side Header	190	244
HS	Head to Side Window	297	375
KK	Knee to Knee	347	225
SHY	Striker to H-Point (Y Direction)	282	313
AA	Ankle to Ankle	335	189

DATA SHEET NO. 5
SEAT BELT POSITIONING DATA

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	360	300
PBL - Top surface of reference to belt lower edge	mm	270	210

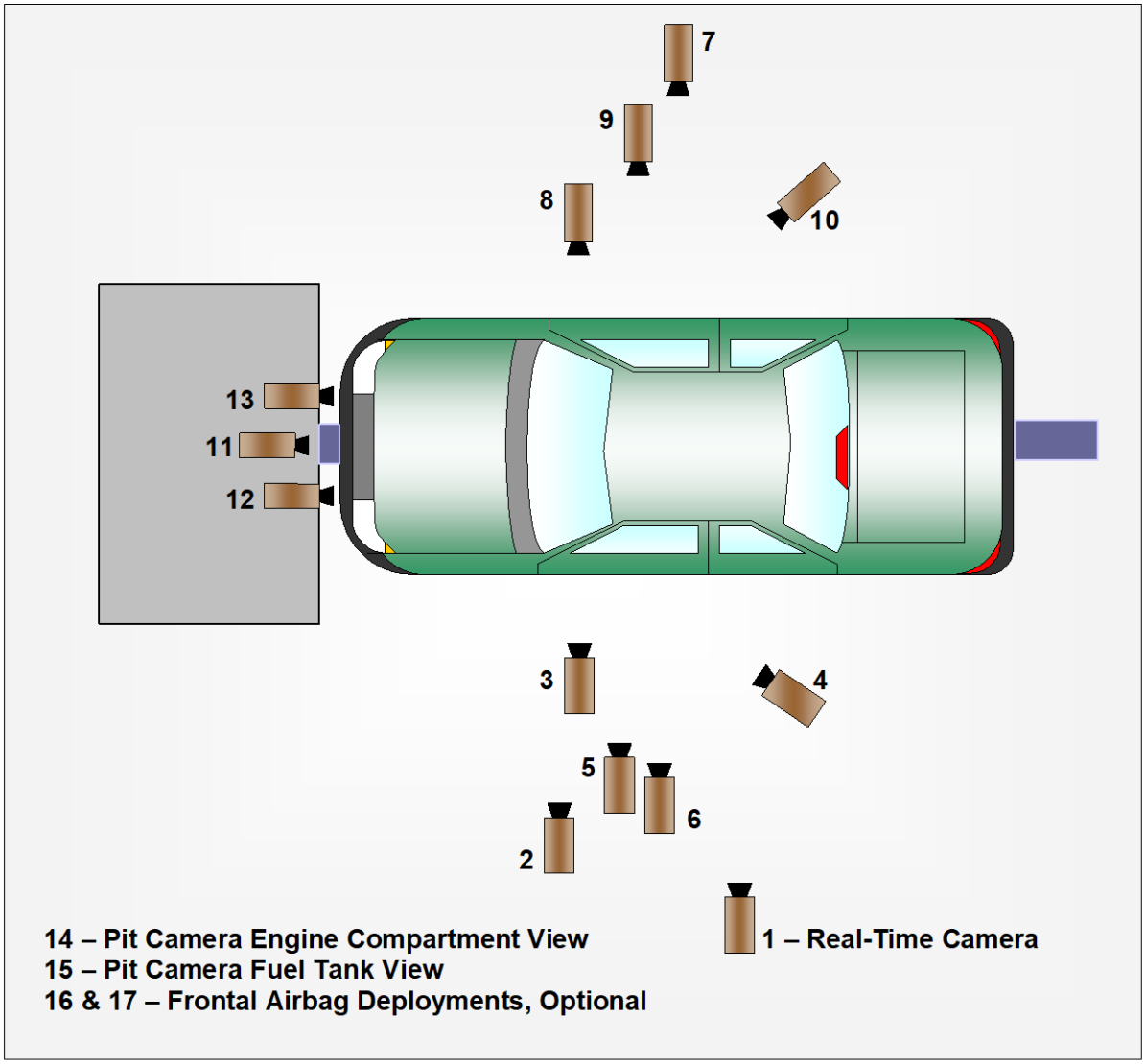
BELT LENGTH DATA

Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	810	910
Lap Belt Length as measured on ATD	mm	730	840
Remainder of belt on reel	mm	1090	880
Total Belt Length for Continuous Webbing Systems	mm	3200	3200

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

Test Vehicle:	2019 Toyota Corolla Hatchback SE 5-Dr Hatchback	NHTSA No.:	O20195100
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	01/11/2019

CAMERA POSITIONS FOR FRONTAL IMPACTS



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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

CAMERA LOCATIONS

No.	Camera View	Coordinates (mm)			Lens (mm)	Speed (fps)
		X*	Y*	Z*		
1	Real-Time Left Overall					30
2	Driver Close-Up	-1740	-6180	-1920	50	1000
3	Left Front Half	-1120	-5350	-1390	24	1000
4	Left Angle	-7070	-5850	-2090	75	1000
5	Steering Column - Top					
6	Steering Column - Bottom					
7	Right Overall	-1800	11600	-1500	14	1000
8	Passenger Close-Up	-1610	12910	-1960	50	1000
9	Right Front Half	-1310	9980	-1410	24	1000
10	Right Angle	-6880	5600	-2060	75	1000
11	Windshield	100	0	-2310	16	1000
12	Driver Windshield	180	-370	-2230	25	1000
13	Passenger Windshield	180	370	-2230	25	1000
14	Pit Front	-910	0	3340	24	1000
15	Pit Rear	-3200	0	3340	24	1000
16	Onboard Driver Side				12	1000
17	Onboard Passenger Side				12	1000
18	Real-Time Pan View					30

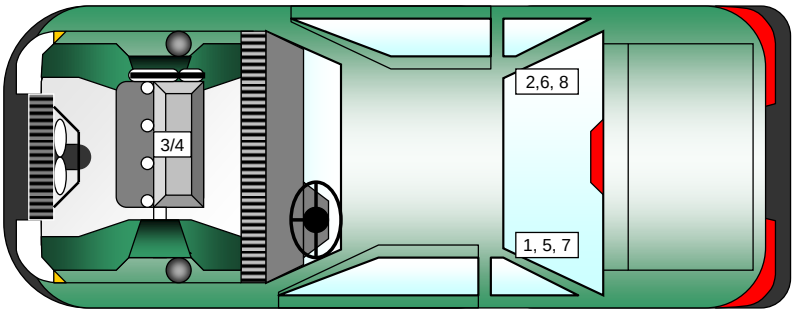
*COORDINATES:

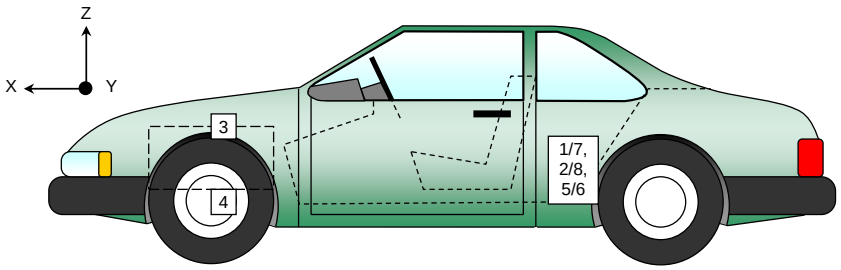
+X = forward of impact plane
+Y = right of monorail centerline
+Z = below ground level

Cameras 5 & 6 were not used for this test.

DATA SHEET NO. 7
VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019





VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear Crossmember Accelerometer – X Direction	1666	-374	-210
2	Right Rear Crossmember Accelerometer – X Direction	1666	374	-225
3	Engine Top X	3596	0	-805
4	Engine Bottom X	3608	0	-201
5	Left Rear Crossmember Accelerometer – Z Direction	1666	-374	-210
6	Right Rear Crossmember Accelerometer – Z Direction	1666	374	-225
7	Left Rear Crossmember Accelerometer Redundant – X Direction	1690	-374	-212
8	Right Rear Crossmember Accelerometer Redundant – X Direction	1690	374	-227

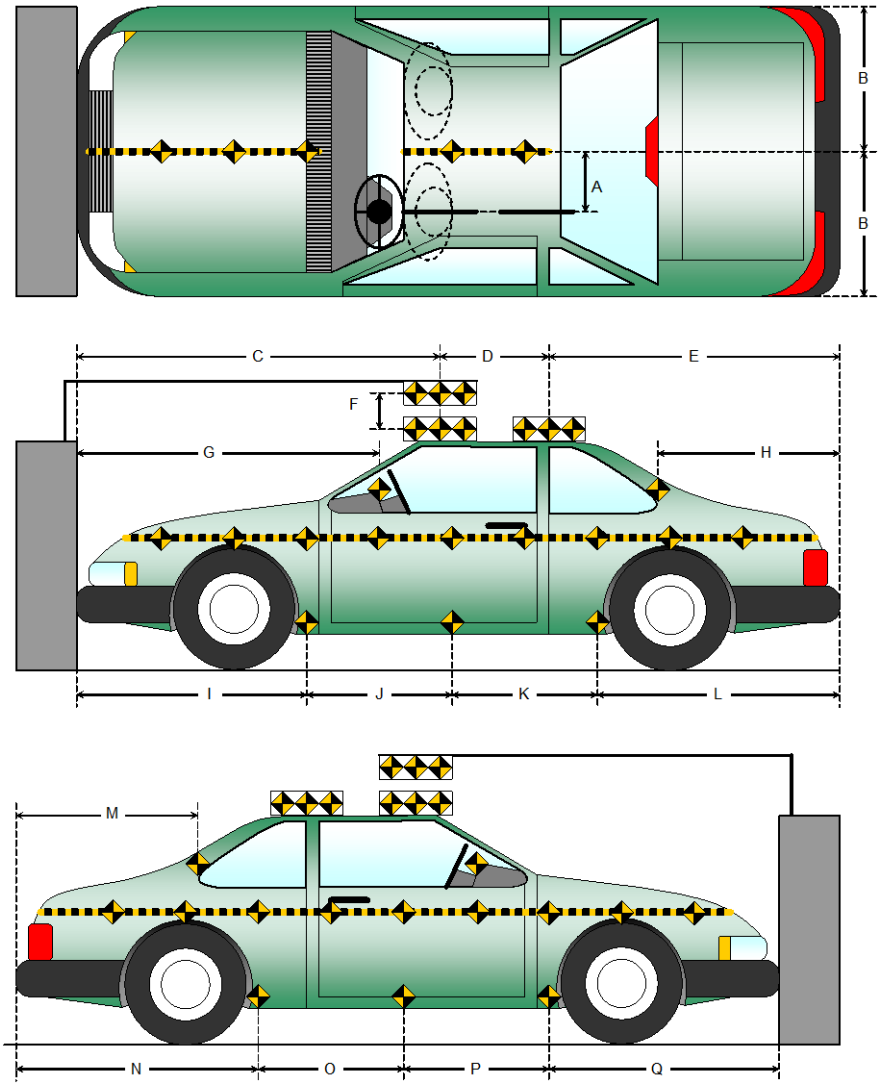
Reference Points: X - Rear Surface of Vehicle (+ forward)
Y - Vehicle Centerline (+ to right)
Z - Ground Plane (+ down)

DATA SHEET NO. 8

PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

Item	Value (mm)
A	362
B	885
C	2312
D	514
E	1550
F	100
G	
H	883
I	1352
J	907
K	907
L	1210
M	883
N	1210
O	907
P	907
Q	1352



DATA SHEET NO. 9
LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

Advanced Research Load Cell Barrier

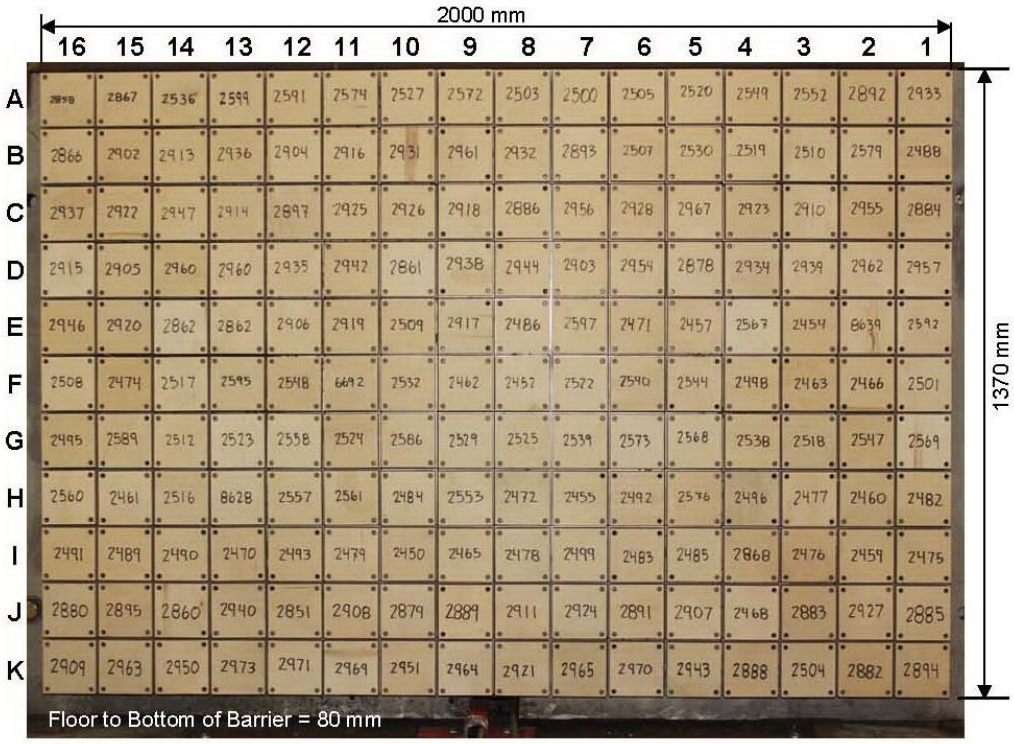


Photo for Reference Only

Centerline

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

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

DATA SHEET NO. 10
TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

INSTRUMENTATION

Driver Dummy Data Channels	49
Passenger Dummy Data Channels	49
Vehicle Structure Accelerometers	8
Barrier Channels	528
Total	634

CAMERA COVERAGE

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

DATA SHEET NO. 11
POST-TEST OBSERVATIONS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

TEST DUMMY INFORMATION AND CONTACT LOCATIONS

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

DOOR OPENING AND SEAT TRACK INFORMATION

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

POST TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	Lower left windshield cracked by hood corner
Window Damage	None
Other Notable Effects	None

VEHICLE REBOUND FROM BARRIER

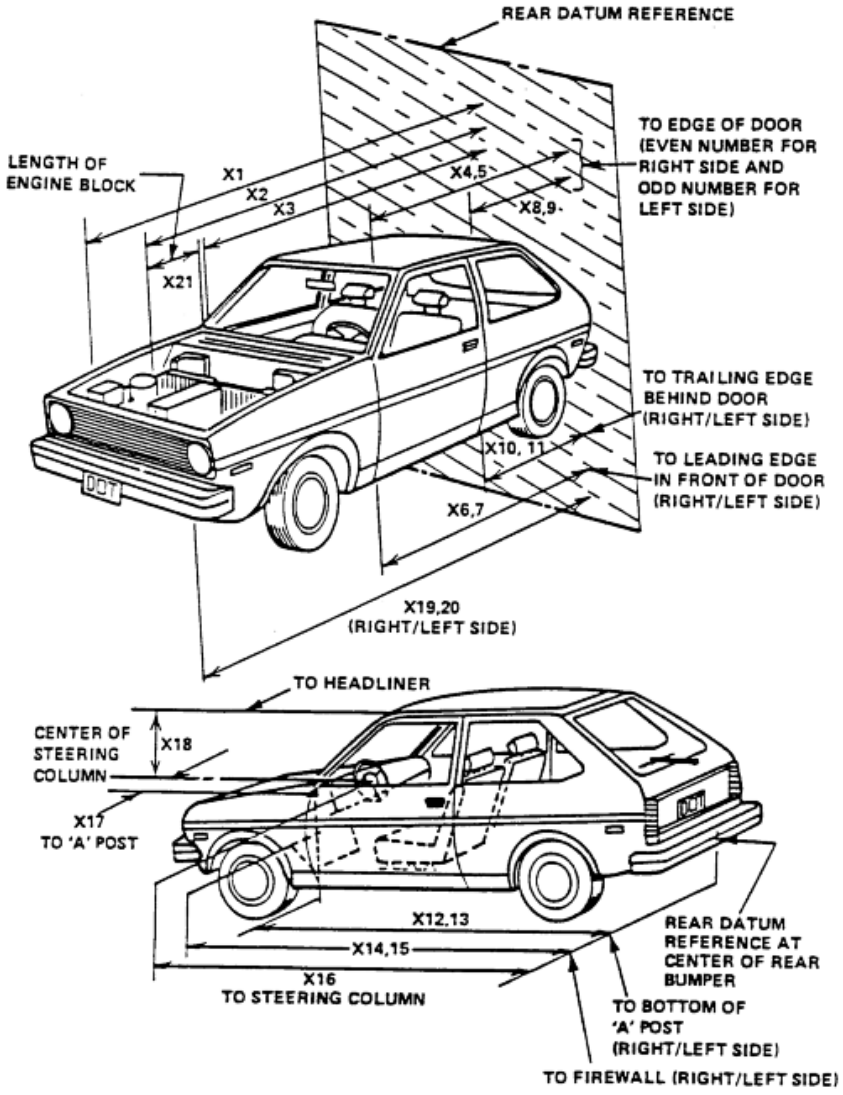
Measured Parameter	Units	Value
Left Side	mm	3380
Center	mm	3320
Right Side	mm	3205
Average	mm	3302

SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

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

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle:	2019 Toyota Corolla Hatchback SE 5-Dr Hatchback	NHTSA No.:	O20195100
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	01/11/2019



DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

RSOV (Rear Surface of Vehicle)

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	mm	4376	3870	506
2	RSOV to Front of Engine	mm	3789	3605	184
3	RSOV to Firewall	mm	3416	3402	14
4	RSOV to Upper Leading Edge of Right Door	mm	2924	2924	0
5	RSOV to Upper Leading Edge of Left Door	mm	2924	2922	2
6	RSOV to Lower Leading Edge of Right Door	mm	2895	2886	9
7	RSOV to Lower Leading Edge of Left Door	mm	2895	2888	7
8	RSOV to Upper Trailing Edge of Right Door	mm	1841	1839	2
9	RSOV to Upper Trailing Edge of Left Door	mm	1841	1837	4
10	RSOV to Lower Trailing Edge of Right Door	mm	1856	1846	10
11	RSOV to Lower Trailing Edge of Left Door	mm	1856	1847	9
12	RSOV to Bottom of “A” Post of Right Side	mm	2911	2907	4
13	RSOV to Bottom of “A” Post of Left Side	mm	2906	2901	5
14	RSOV to Firewall, Right Side	mm	3393	3385	8
15	RSOV to Firewall, Left Side	mm	3395	3383	12
16	RSOV to Steering Column	mm	2434	2504	-70
17	Center of Steering Column to “A” Post	mm	389	369	20
18	Center of Steering Column to Headliner	mm	415	432	-17
19	RSOV to Right Side of Front Bumper	mm	4172	3910	262
20	RSOV to Left Side of Front Bumper	mm	4172	3855	317
21	Length of Engine Block	mm	465	465	0
RD	RSOV to Right Side of Dash Panel	mm	2711	2716	-5
CD	RSOV to Center of Dash Panel	mm	2755	2720	35
LD	RSOV to Left Side of Dash Panel	mm	2714	2738	-24

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

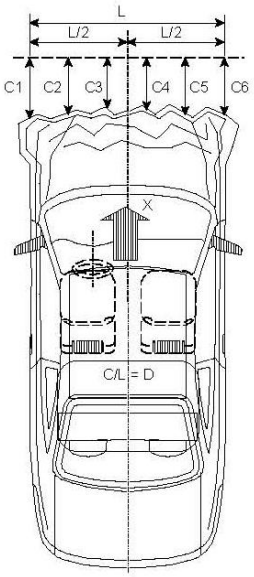
Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

VEHICLE INFORMATION

VIN: JTNK4RBEXK3019307 Wheelbase (mm): 2640
Vehicle Size Category: Passenger Car Test Weight (kg): 1550.0

ACCELEROMETER DATA

Accelerometer Locations: As per measurements on Page 15
Cal. Procedure/Interval: MGA procedure / 6 month
Integration Algorithm: Trapezoidal
Linearity: > 99%
Impact Velocity (km/h): 56.41
Velocity Change (km/h): 65.0
Time of Separation (msec): 80



CRUSH PROFILE

Collision Deformation Classification: 12FDEW2
Midpoint of Damage: Centerline
Damage Region Length (mm): 1400
Impact Mode: Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	4172	3855	317
C2	Crush zone 2 at left side	mm	4294	3865	429
C3	Crush zone 3 at left side	mm	4350	3879	471
C4	Crush zone 4 at right side	mm	4350	3882	468
C5	Crush zone 5 at right side	mm	4294	3898	396
C6	Crush zone 6 at right side	mm	4172	3910	262
L	C1 TO C6	mm	1400	1372	28

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

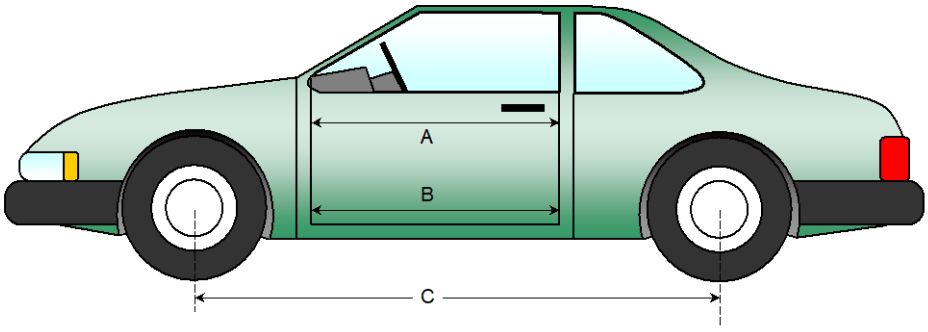
Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

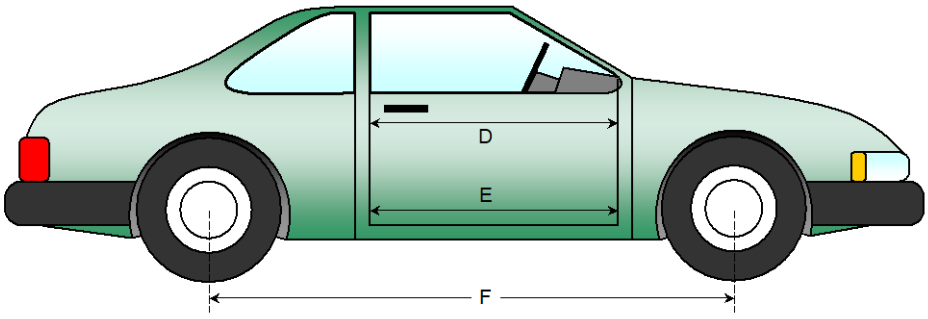
DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1002	1002	0
B	Left Side Lower	mm	914	914	0
D	Right Side Upper	mm	1002	1002	0
E	Right Side Lower	mm	914	914	0

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2640	2563	77
F	Right Side Wheelbase	mm	2640	2560	80





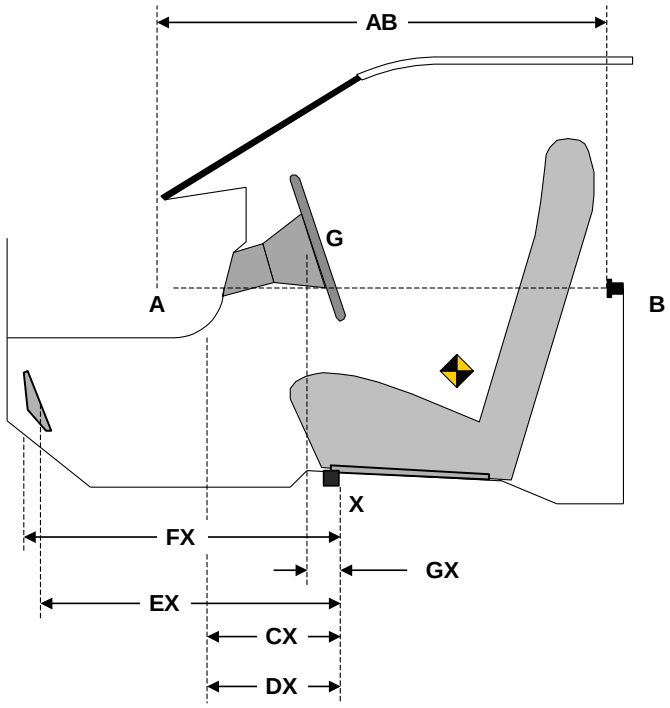
DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside Window Jam)	mm	804	804	0
CX	Left Knee Bolster to X	mm	247	244	3
DX	Right Knee Bolster to X	mm	238	249	-11
EX	Brake Pedal to X	mm	553	538	15
FX	Foot Rest to X	mm	538	523	15
GX	Center of Steering Column Wheel Hub to X	mm	41	102	-61

X = Front of Seat Track (stationary)



DRIVER COMPARTMENT

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

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

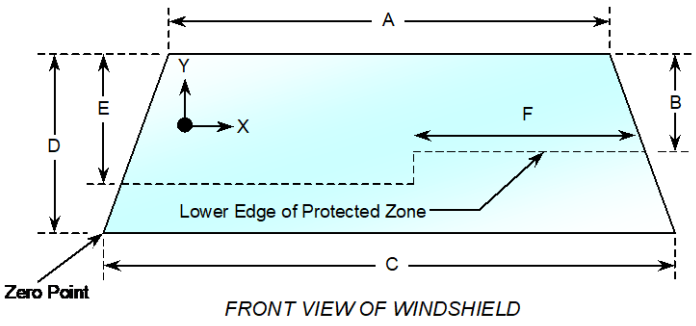
Windshield Mounting Details:
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

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

Temperature of windshield molding during test: 21.3° C.

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2165	2165	100.0
Right Side	2157	2157	100.0
Total	4322	4322	100.0



FRONT VIEW OF WINDSHIELD

Item	Units	Value
A	mm	1090
B	mm	548
C	mm	1436
D	mm	898
E	mm	508
F	mm	518

AREA OF PROTECTED ZONE FAILURES - NONE

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

X	Y

B. Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component. **None**

X	Y

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

Test Vehicle:	2019 Toyota Corolla Hatchback SE 5-Dr Hatchback	NHTSA No.:	O20195100
Test Program:	NCAP Frontal Barrier Impact Test	Test Date:	01/11/2019

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

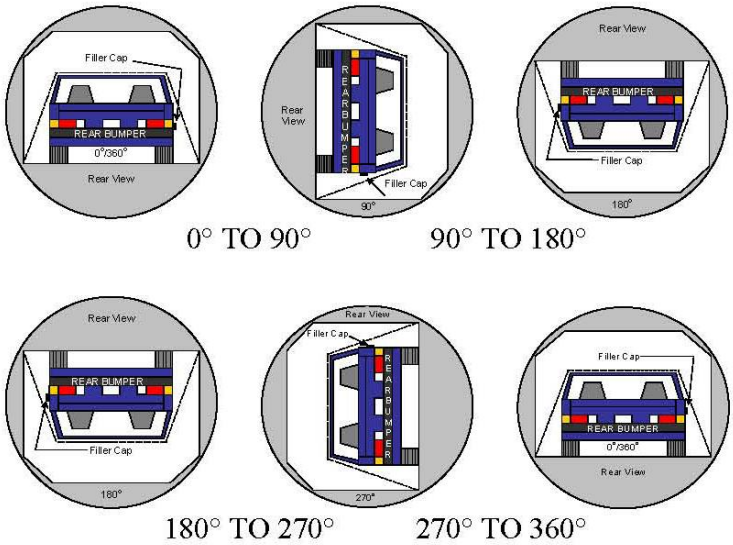
Temperature at Time of Impact: 21.3°C Test Time: 12:45 p.m.

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

DATA SHEET NO. 16
FMVSS 301 STATIC ROLLOVER RESULTS

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019

1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).
3. Details of Stoddard Solvent spillage: **None**



SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	112	300	412
90° to 180°	111	300	411
180° to 270°	108	300	408
270° to 360°	110	300	410

FMVSS 301 SPILLAGE TABLE (units in ounces)

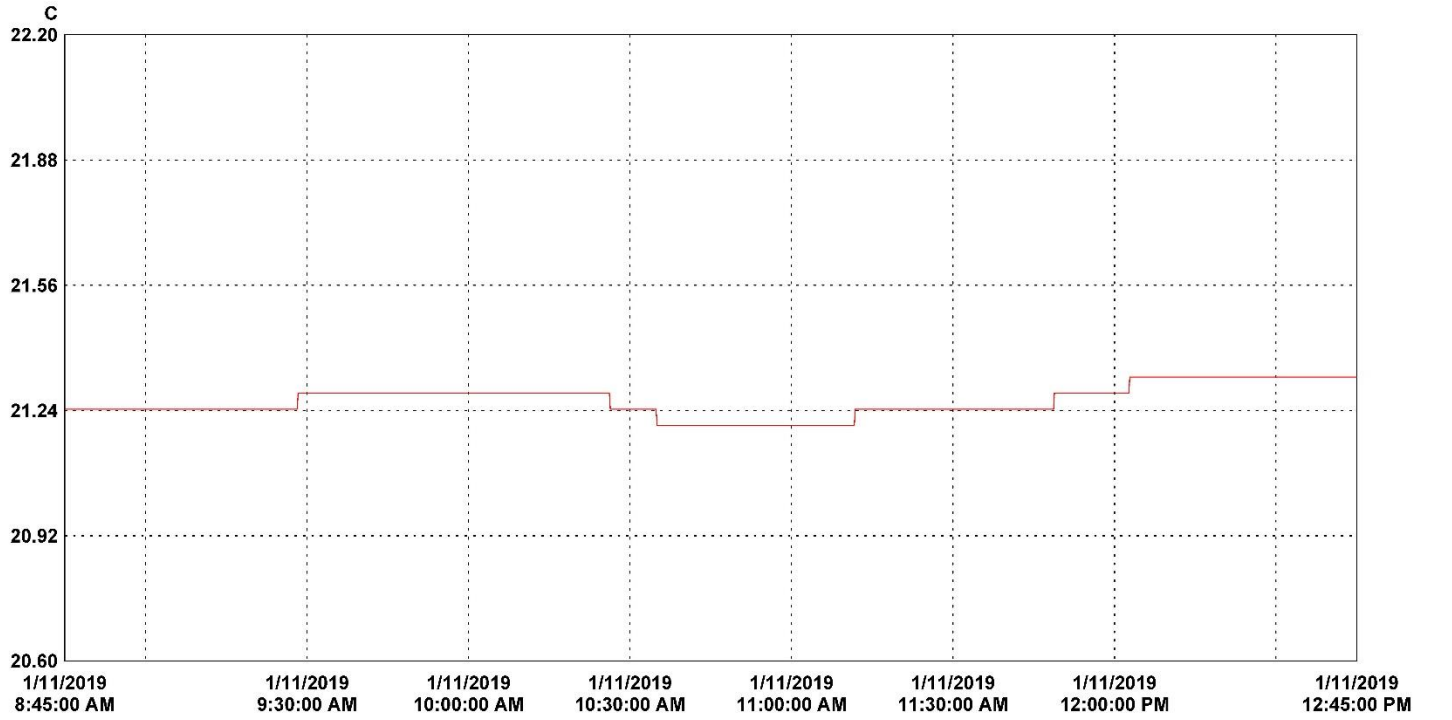
Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eight Minute
0° to 90°	0	0	0	0
90° to 180°	0	0	0	0
180° to 270°	0	0	0	0
270° to 360°	0	0	0	0

SOLVENT SPILLAGE LOCATION TABLE

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

DATA SHEET NO. 17
DUMMY/VEHICLE TEMPERATURE STABILIZATION DATA

Test Vehicle: 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NHTSA No.: O20195100
Test Program: NCAP Frontal Barrier Impact Test Test Date: 01/11/2019



30 minutes/div 4 hours (M/d/yyyy h:mm:ss tt) Central Time Graph file (truncated): O20195100 2019 Toyota Corolla Hatchback SE 5-Dr Hatchback NCAP

LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	12032257	VSC_Prep_Room	1		21.33	21.26	21.20	C	Temperature	12032257_VSC_Prep_Room.spl

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

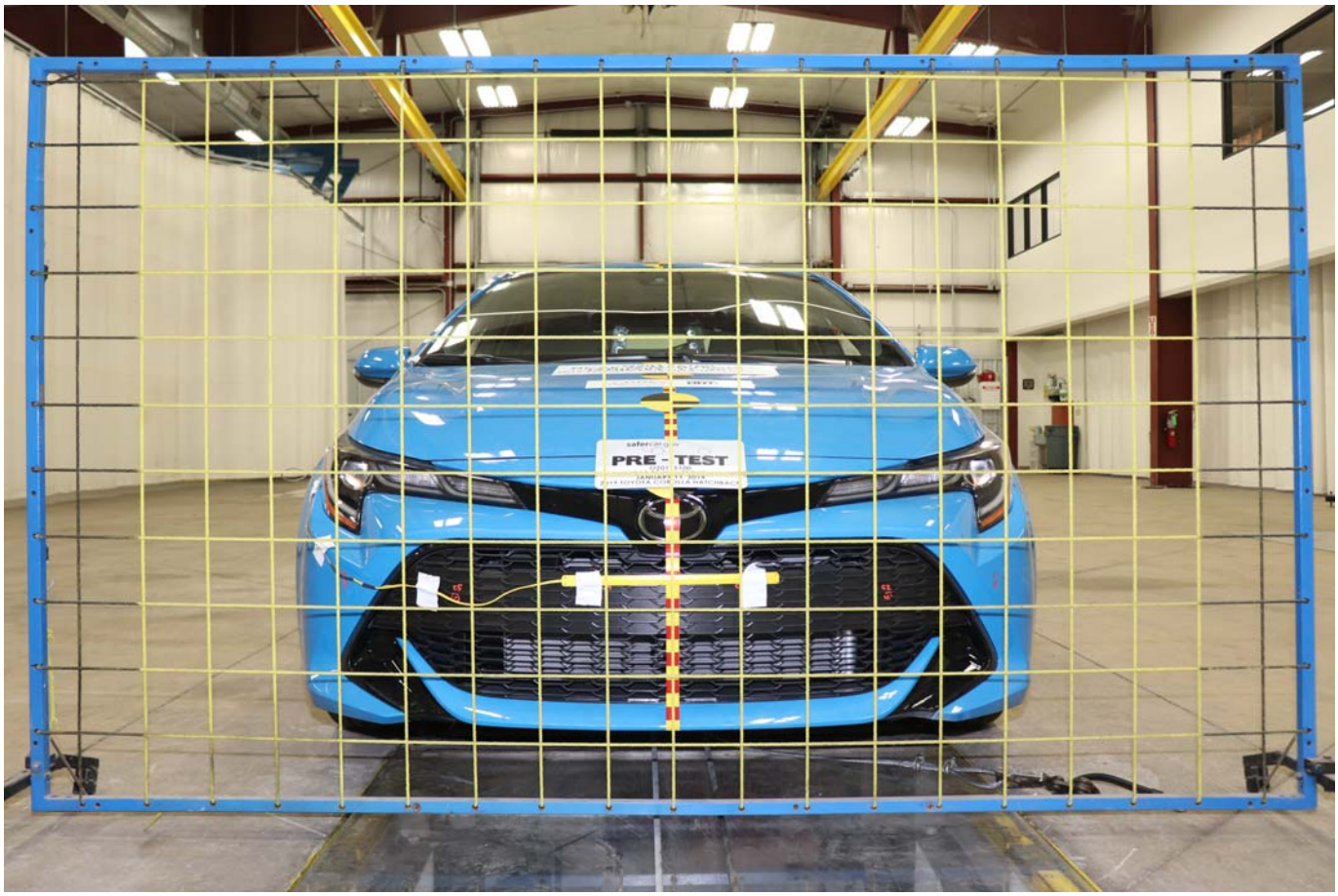


Photo No. 001 - Load Cell Location

Photo No. 002 - Pre-Test Load Cell Wall

Photo No. 003 - Post-Test Load Cell Wall

Photo No. 004 - Manufacturer Label

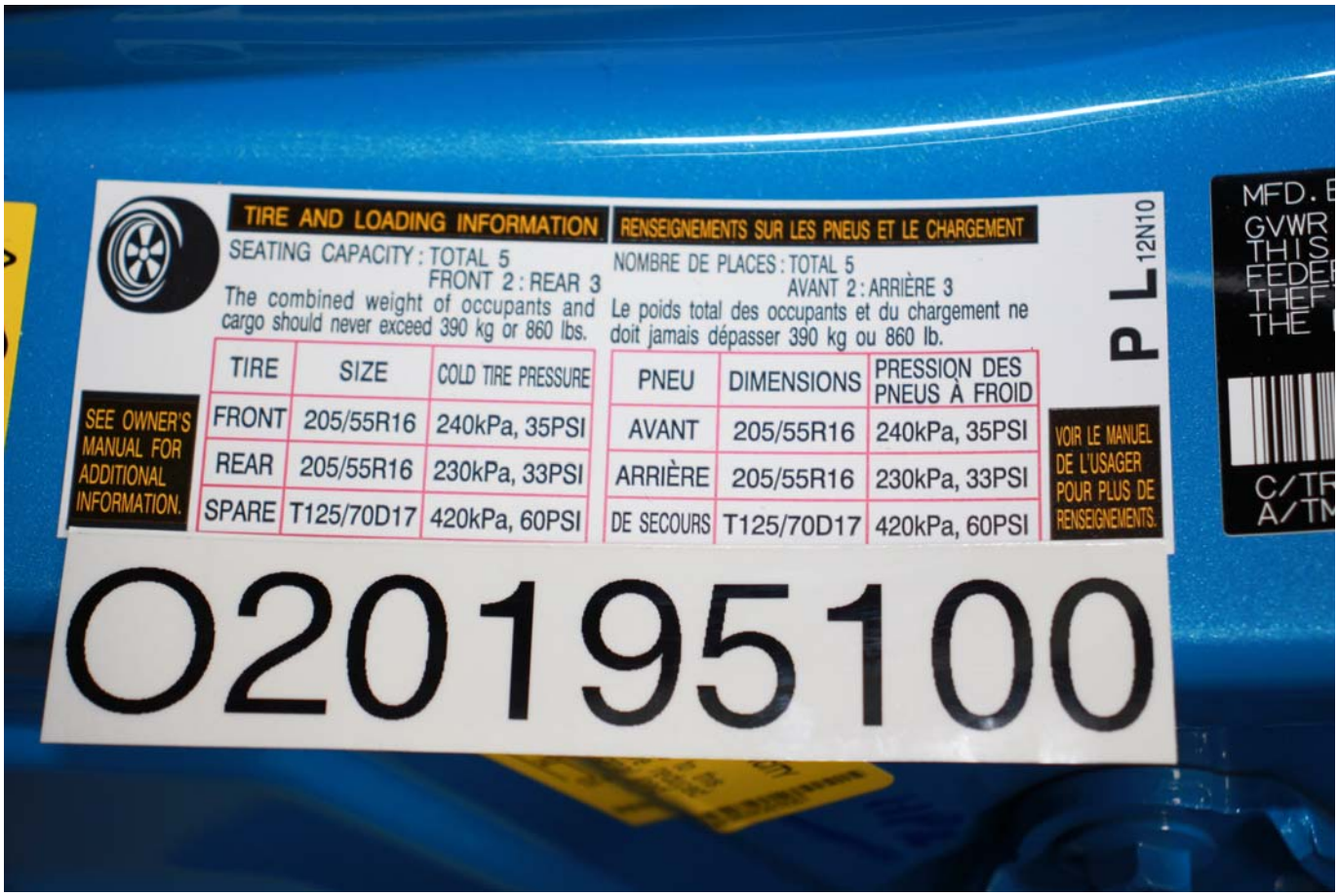


Photo No. 005 - Tire Placard

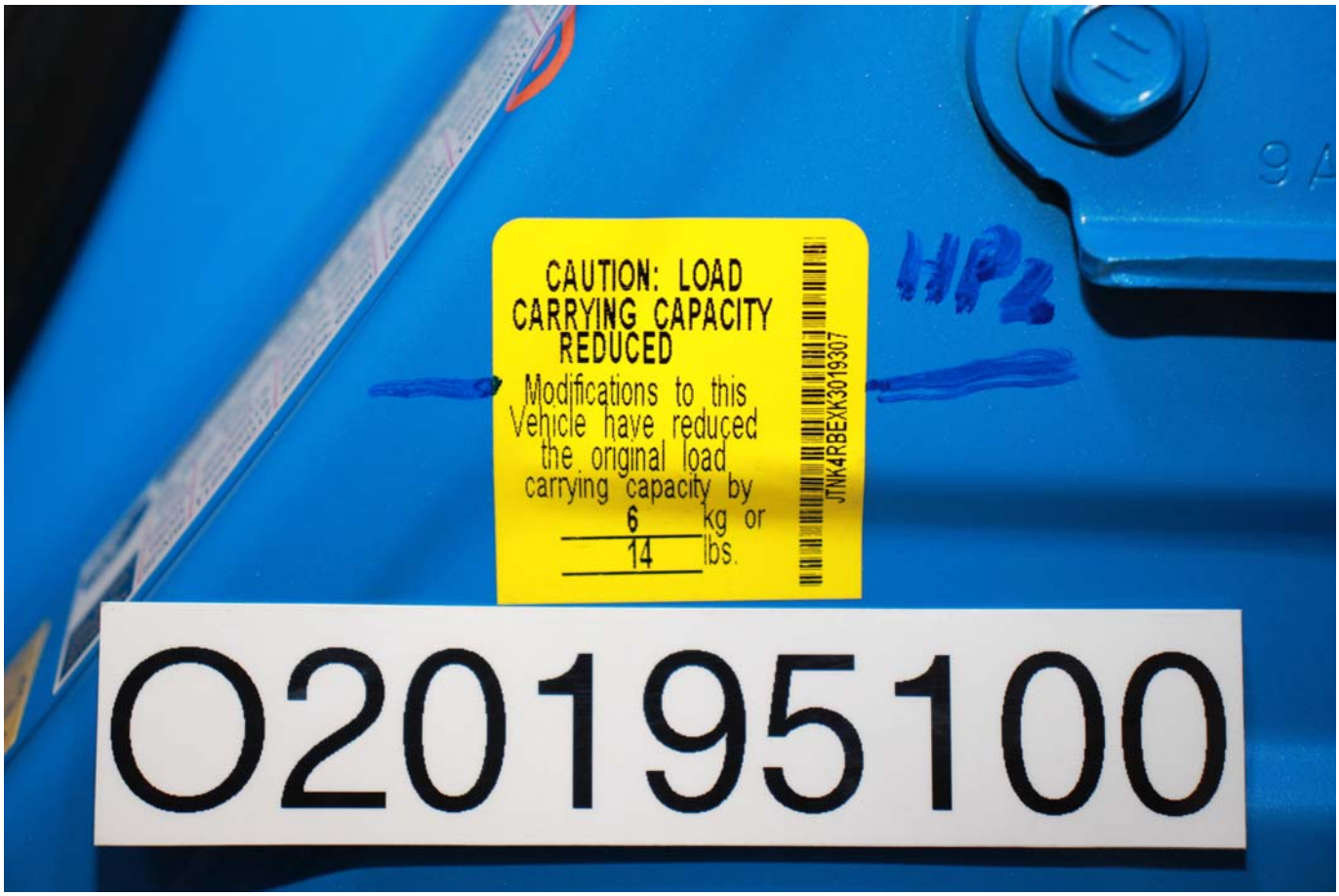


Photo No. 005a - Vehicle Load Carrying Capacity Reduction Label

Photo No. 006 - 2019 Toyota Corolla Hatchback SE 5-Door Hatchback Frontal As Delivered

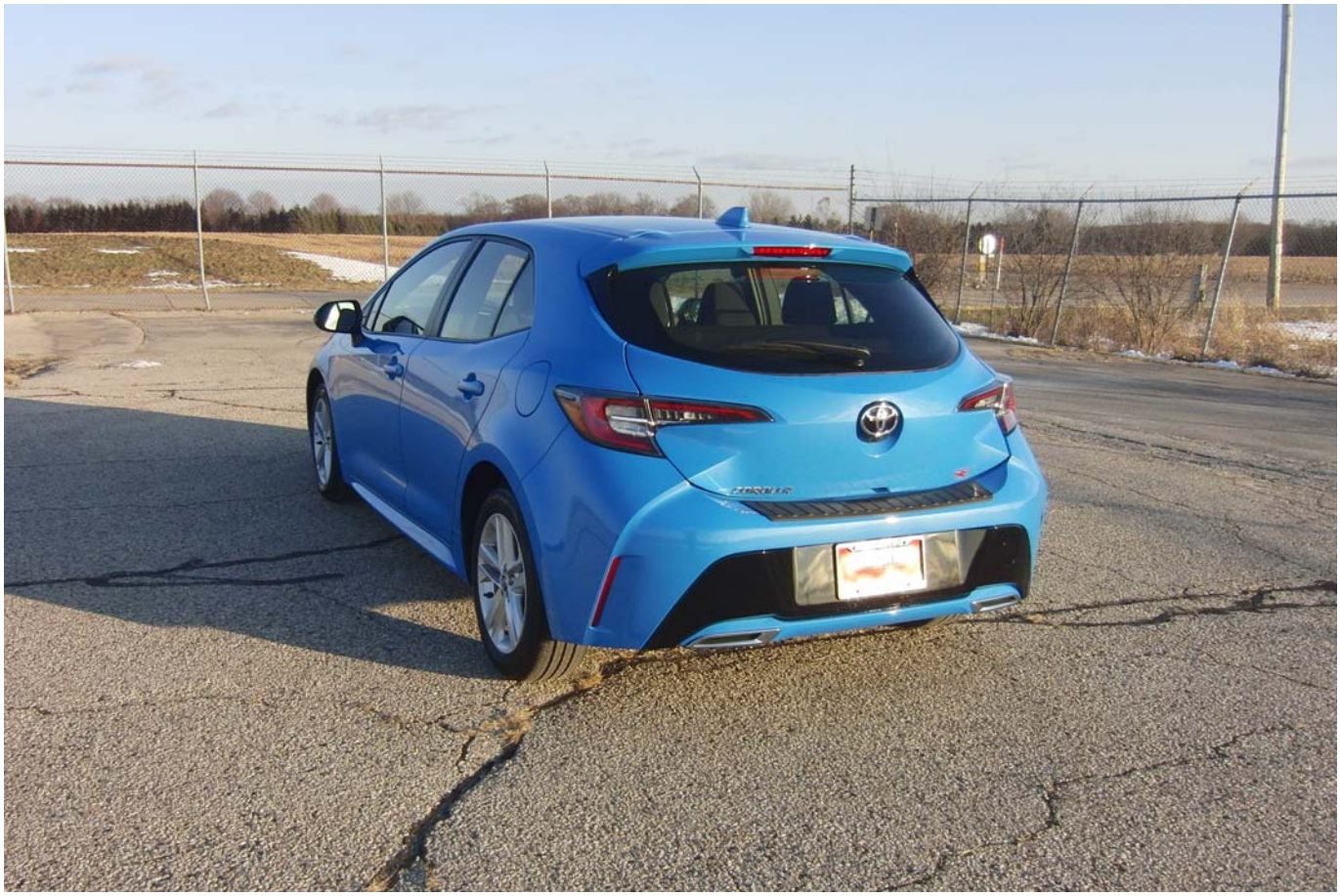


Photo No. 007 - Left Rear 3-4 View, As Received

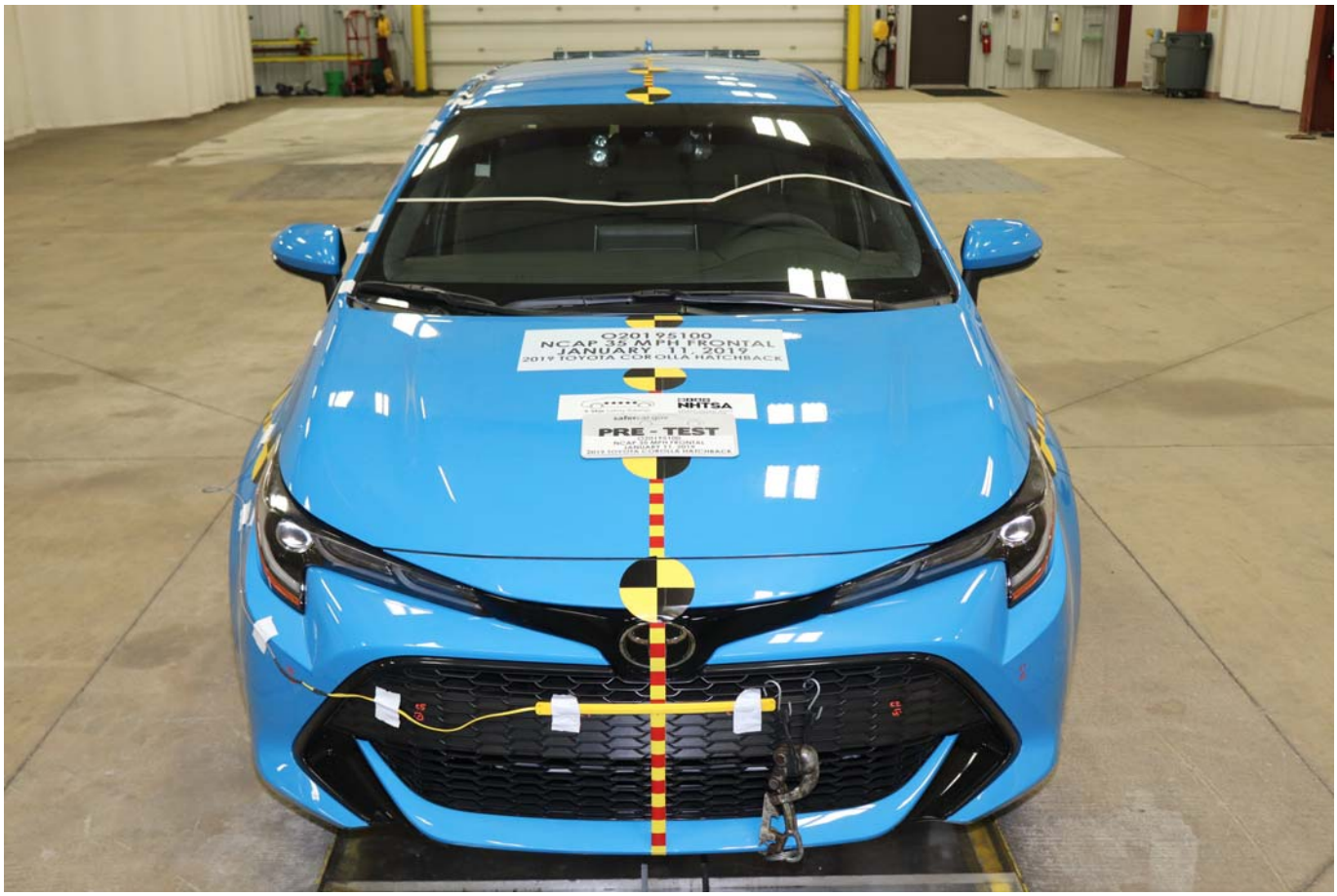


Photo No. 008 - Pre-Test Front View of Test Vehicle

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

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

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

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

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

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

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

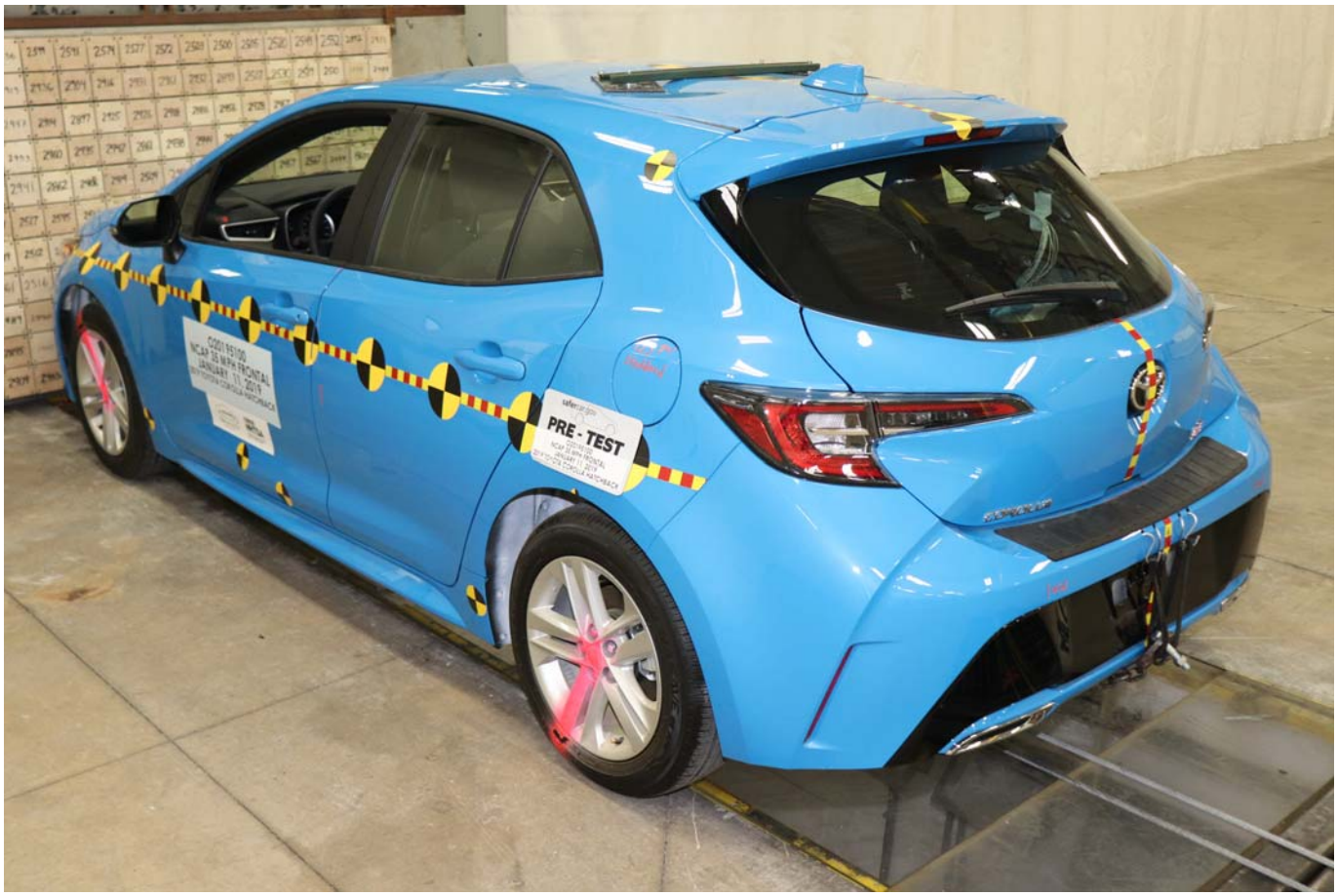


Photo No. 016 - Pre-Test Left Rear 3-4 View

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

Photo No. 018 - Pre-Test Windshield View

Photo No. 019 - Post-Test Windshield View

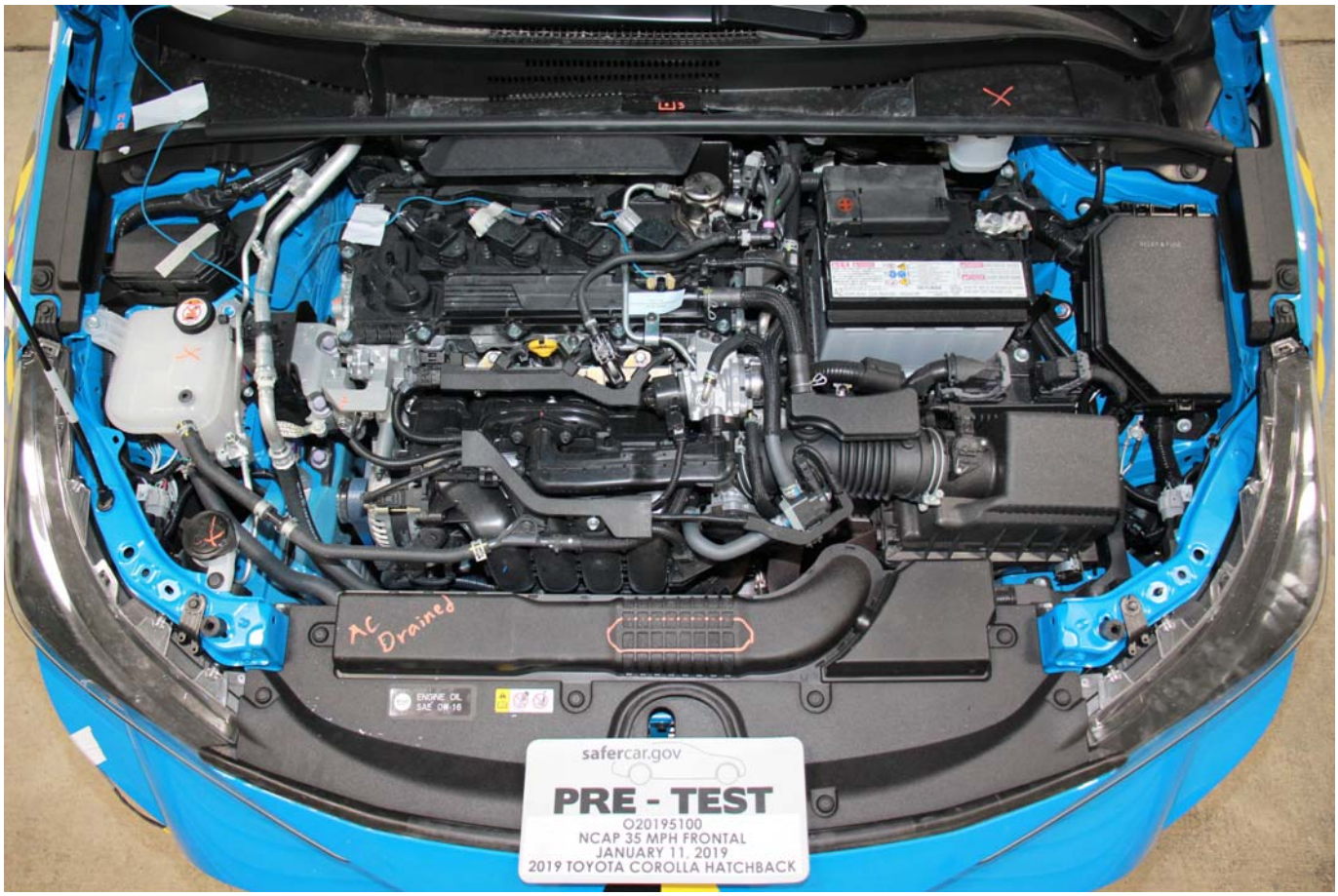


Photo No. 020 - Pre-Test Engine Compartment View

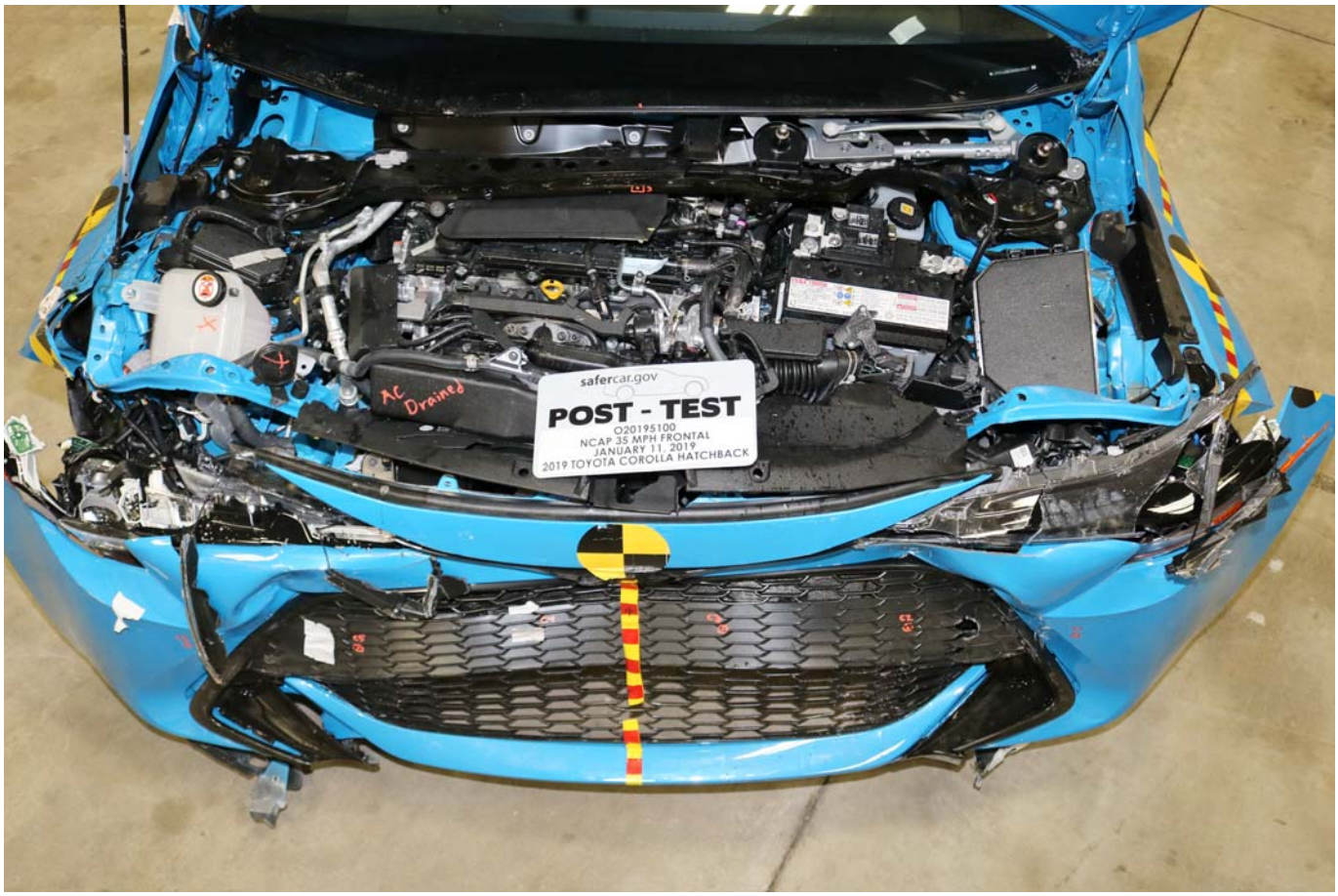


Photo No. 021 - Post-Test Engine Compartment View

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

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

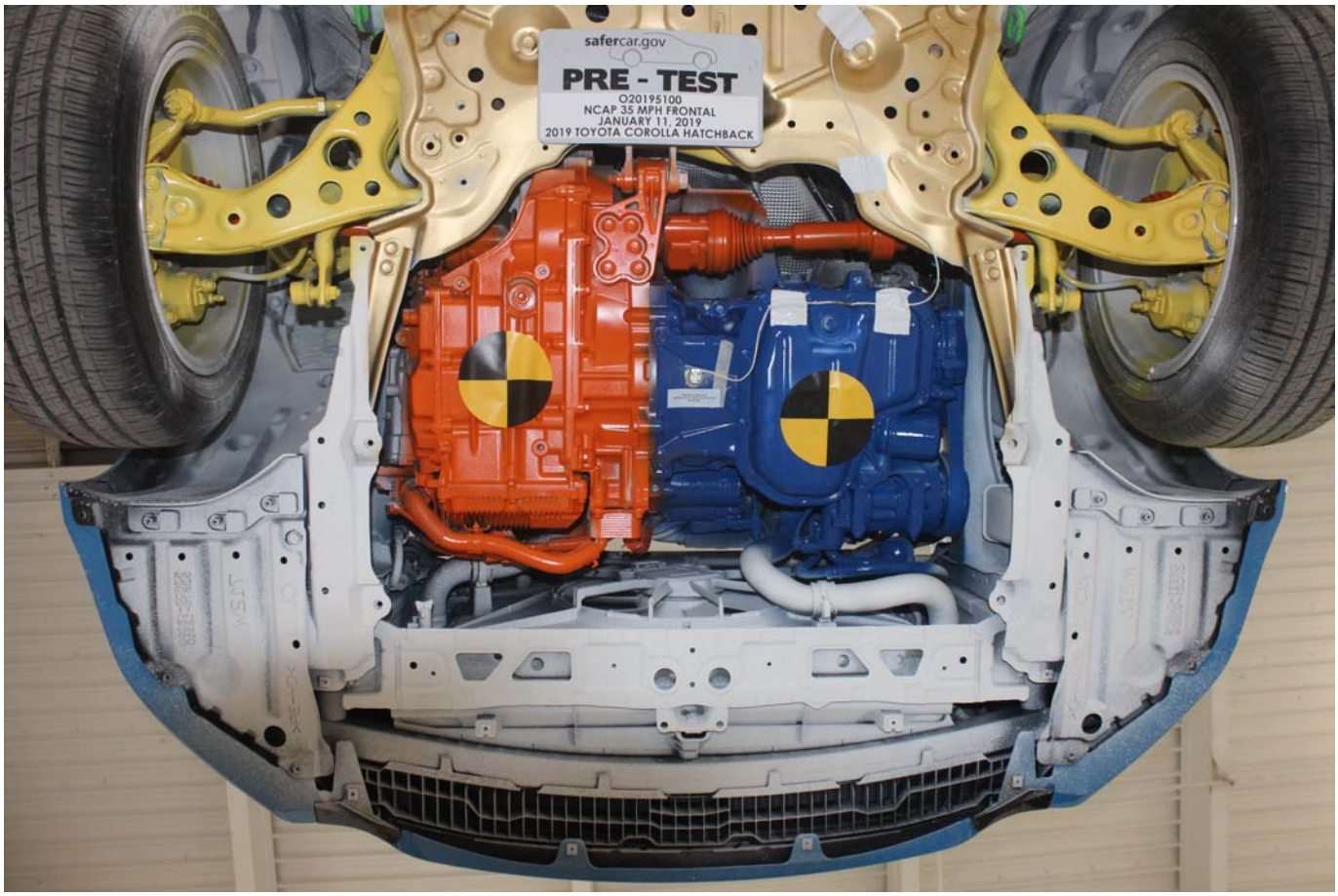


Photo No. 024 - Pre-Test Front Underbody View

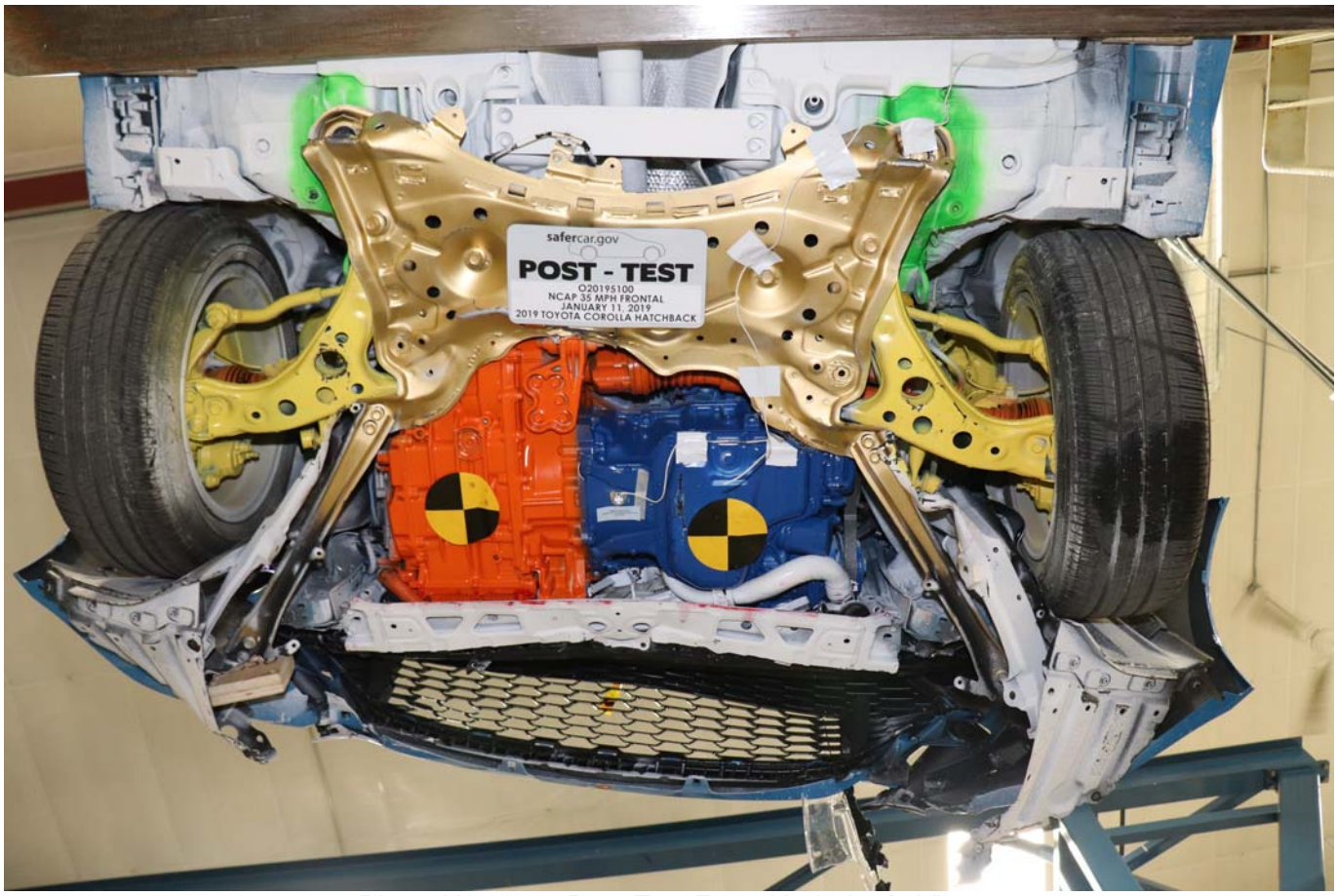


Photo No. 025 - Post-Test Front Underbody View

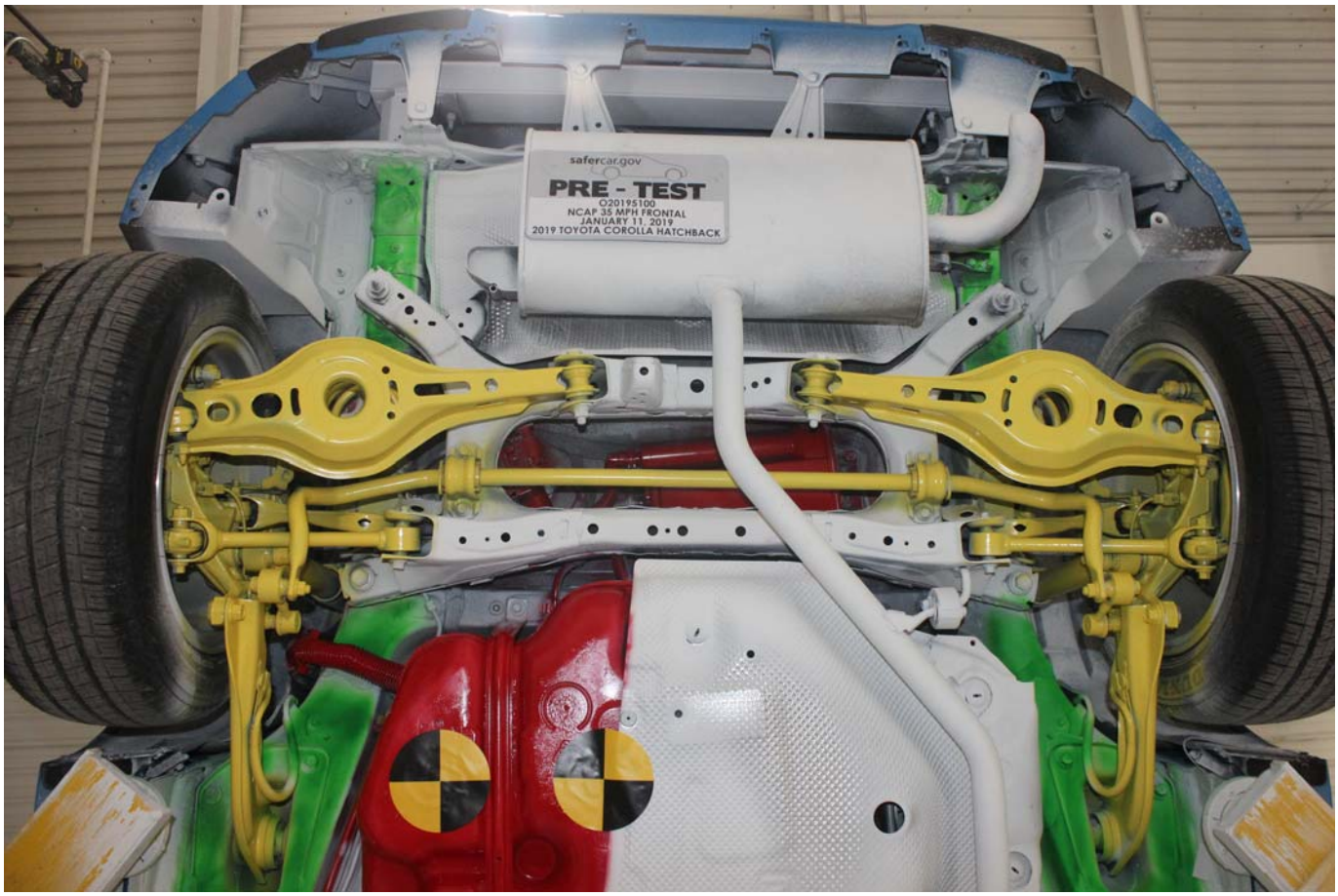


Photo No. 026 - Pre-Test Rear Underbody View

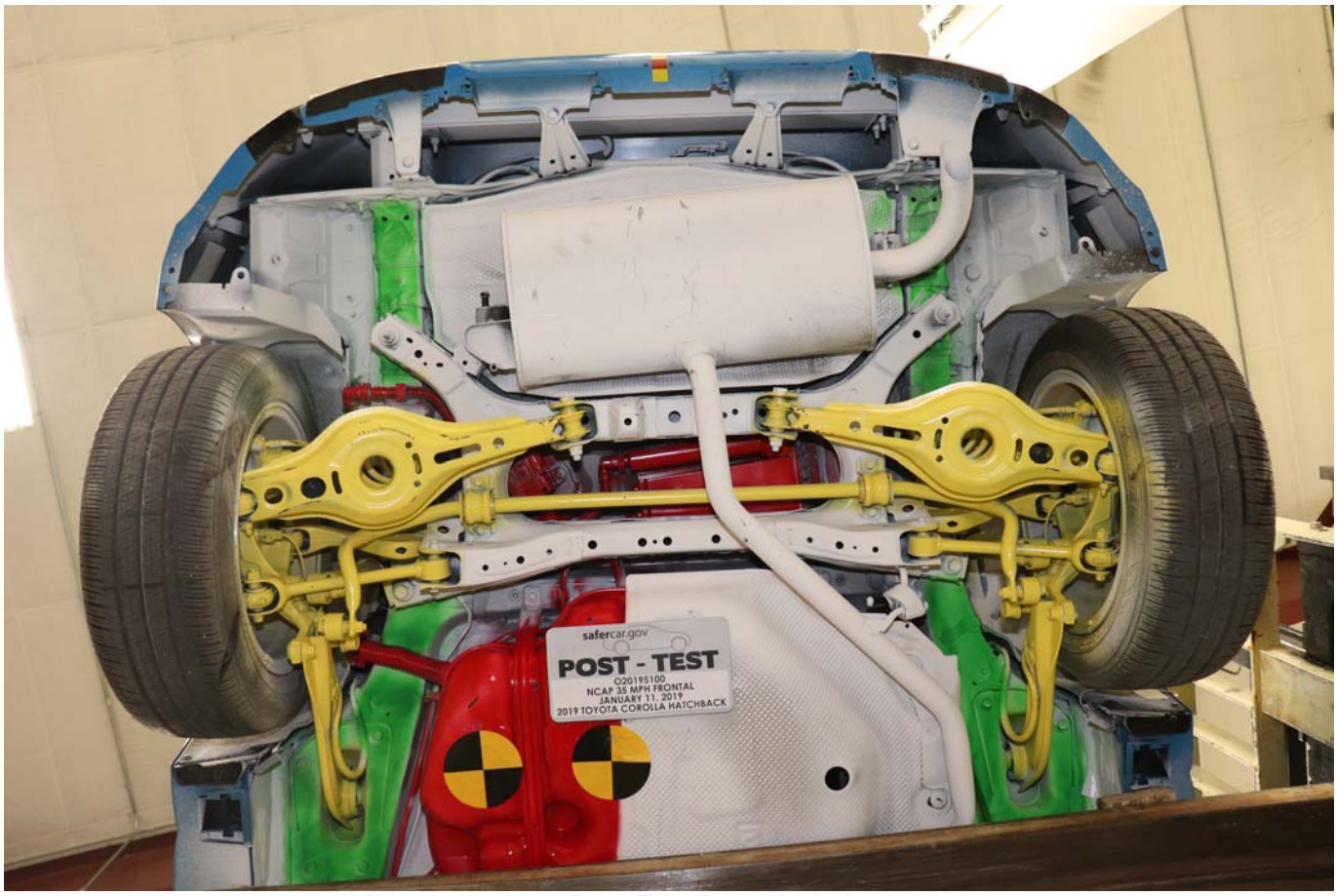


Photo No. 027 - Post-Test Rear Underbody View

Photo No. 028 - Pre-Test Dummy Cable Routing

Photo No. 029 - Post-Test Dummy Cable Routing

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

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

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

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

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

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

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

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

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

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

Photo No. 040 - Pre-Test Driver Dummy Feet

Photo No. 041 - Post-Test Driver Dummy Feet

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

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

Photo No. 044 - Pre-Test Driver Side Floorpan

Photo No. 045 - Post-Test Driver Side Floorpan

Photo No. 046 - Post-Test Driver Dummy Face

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

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

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

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

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

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

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

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

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

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

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

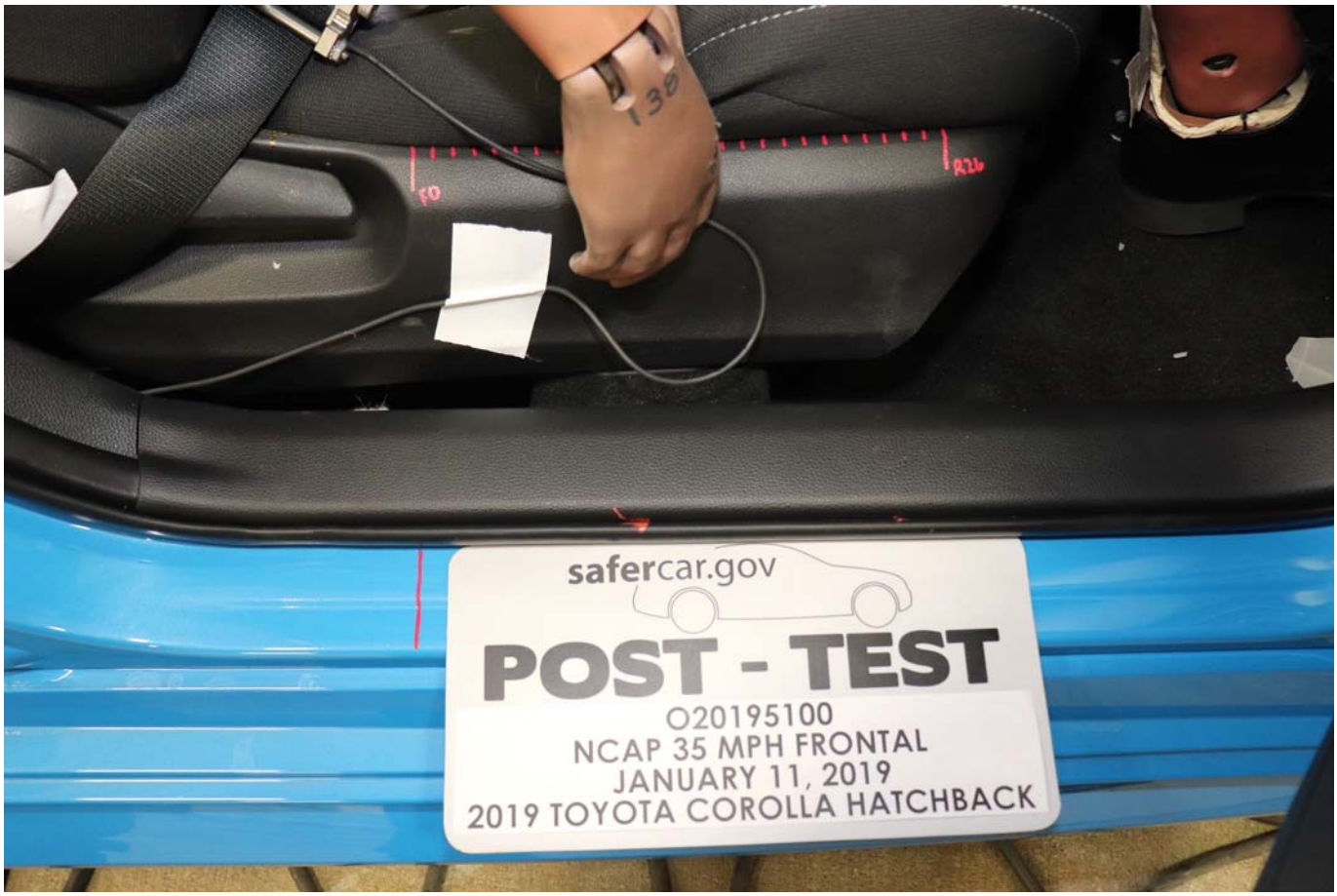


Photo No. 058 - Post-Test Passenger Seat Fore-Aft Markings

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

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

Photo No. 061 - Pre-Test Passenger Dummy Feet

Photo No. 062 - Post-Test Passenger Dummy Feet

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

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

Photo No. 065 - Pre-Test Passenger Side Floorpan

Photo No. 066 - Post-Test Passenger Side Floorpan

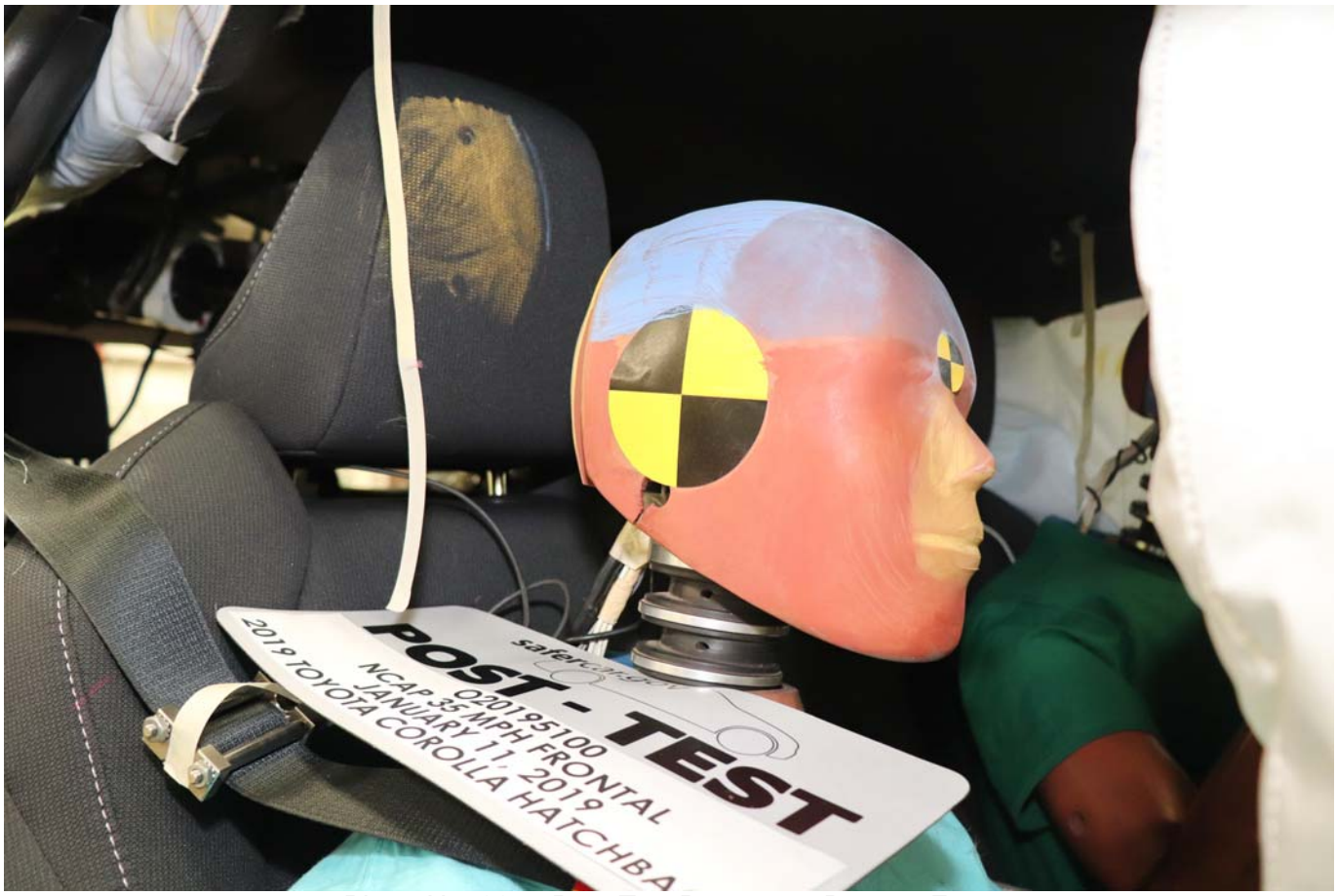


Photo No. 067 - Post-Test Passenger Dummy Face

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

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

Photo No. 070 - Ballast Installed in Vehicle

PHOTOGRAPH NOT APPLICABLE

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

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

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

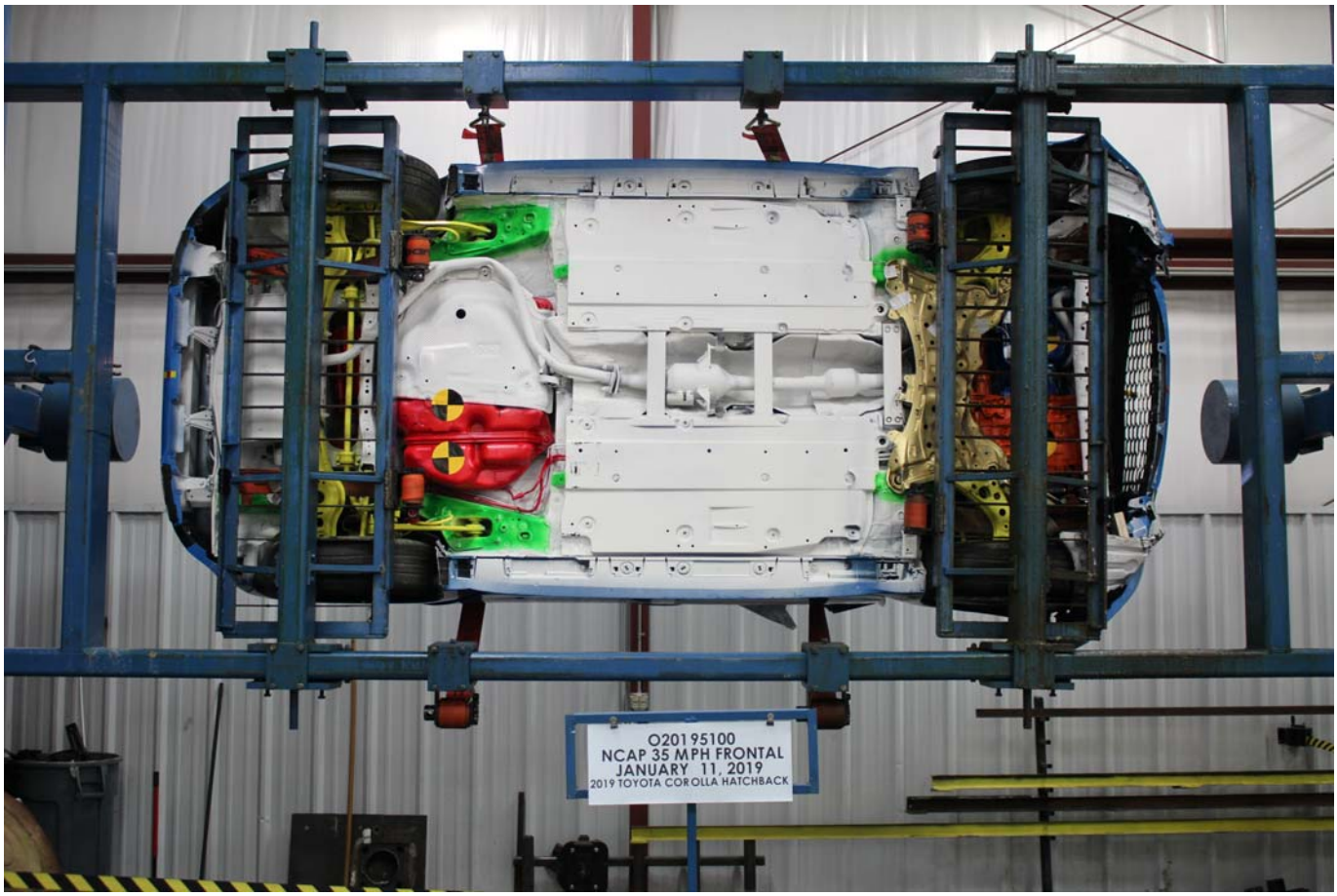


Photo No. 074 - Vehicle at 90 Degrees on Static Rollover Device

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

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

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

Photo No. 078 - 2019 Toyota Corolla Hatchback SE 5-Door Hatchback Frontal Impact Event

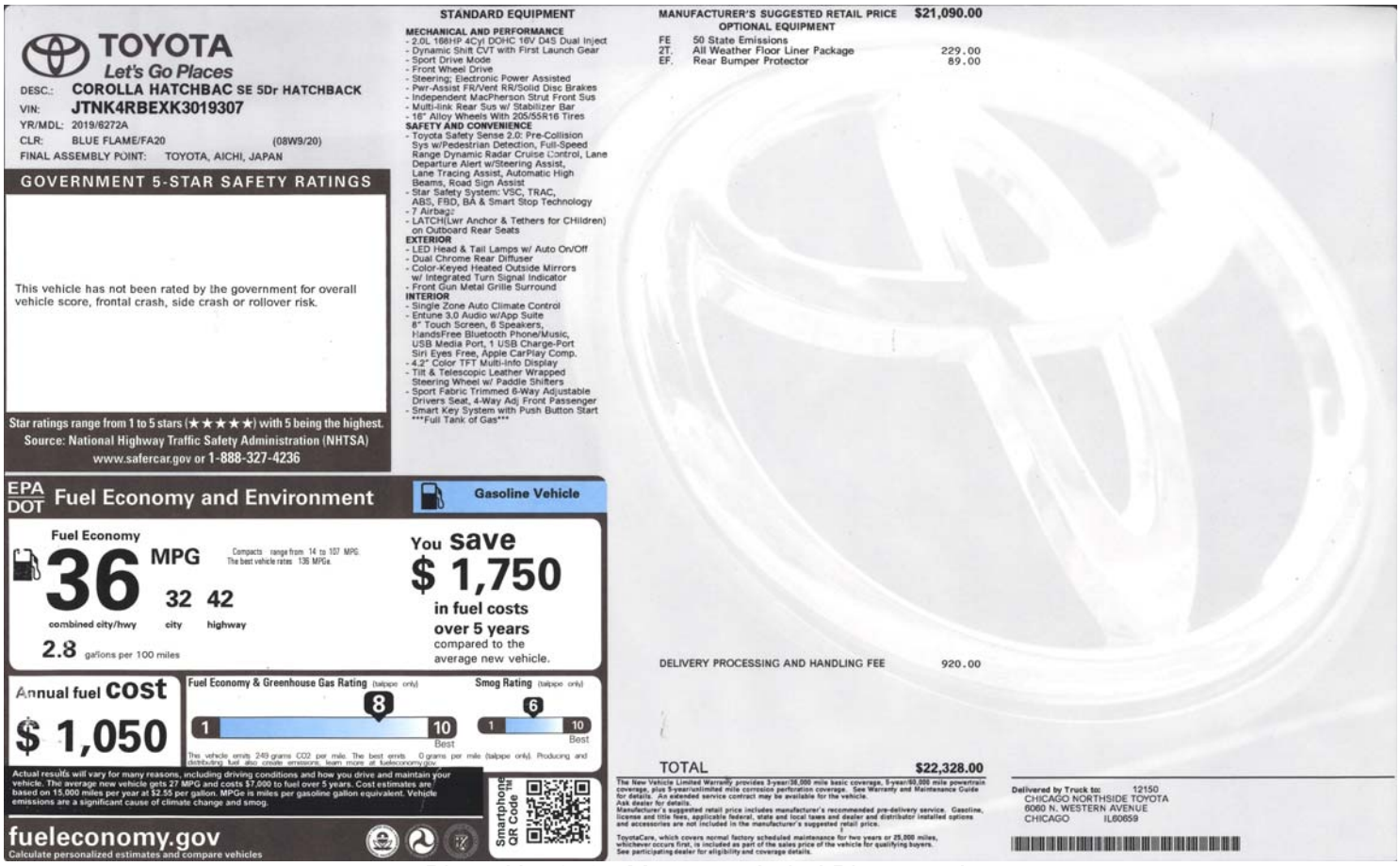


Photo No. 079 - Monroney Label Photograph

APPENDIX B
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

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

Driver Head X Redundant

Driver Head Y Redundant

Driver Head Z Redundant

Driver Head Angular Velocity X

Driver Head Angular Velocity Y

Driver Head Angular Velocity Z

Driver Upper Neck Force Y

Driver Upper Neck Moment X

Driver Upper Neck Moment Z

Driver Chest X Redundant

Driver Chest Y Redundant

Driver Chest Z Redundant

Driver Pelvis X

Driver Pelvis Y

Driver Pelvis Z

Driver Left Femur Redundant

Driver Right Femur Redundant

Driver Left Upper Tibia Moment X

Driver Left Upper Tibia Moment Y

Driver Left Upper Tibia Force Z

Driver Left Lower Tibia Moment X

Driver Left Lower Tibia Moment Y

Driver Left Lower Tibia Force Z

Driver Right Upper Tibia Moment X

Driver Right Upper Tibia Moment Y

Driver Right Upper Tibia Force Z

Driver Right Lower Tibia Moment X

Driver Right Lower Tibia Moment Y

Driver Right Lower Tibia Force Z

Driver Left Foot Fore Z

Driver Left Foot Aft X

Driver Left Foot Aft Z

Driver Right Foot Fore Z

Driver Right Foot Aft X

Driver Right Foot Aft Z

Driver Lap Belt Force

Driver Shoulder Belt Force

Passenger Head X Redundant

Passenger Head Y Redundant

Passenger Head Z Redundant

Passenger Head Angular Velocity X

Passenger Head Angular Velocity Y

Passenger Head Angular Velocity Z

Passenger Upper Neck Force Y

Passenger Upper Neck Moment X

Passenger Upper Neck Moment Z

Passenger Chest X Redundant

Passenger Chest Y Redundant

Passenger Chest Z Redundant

Passenger Pelvis X

Passenger Pelvis Y

Passenger Pelvis Z

Passenger Left Femur Redundant

Passenger Right Femur Redundant

Passenger Left Upper Tibia Moment X

Passenger Left Upper Tibia Moment Y

Passenger Left Upper Tibia Force Z

Passenger Left Lower Tibia Moment X

Passenger Left Lower Tibia Moment Y

Passenger Left Lower Tibia Force Z

Passenger Right Upper Tibia Moment X

Passenger Right Upper Tibia Moment Y

Passenger Right Upper Tibia Force Z

Passenger Right Lower Tibia Moment X

Passenger Right Lower Tibia Moment Y

Passenger Right Lower Tibia Force Z

Passenger Left Foot Fore Z

Passenger Left Foot Aft X

Passenger Left Foot Aft Z

Passenger Right Foot Fore Z

Passenger Right Foot Aft X

Passenger Right Foot Aft Z

Passenger Lap Belt Force

Passenger Shoulder Belt Force

Left Rear Seat Crossmember X

Right Rear Seat Crossmember X

Vehicle Engine Top X

Vehicle Engine Bottom X

Left Rear Seat Crossmember Z

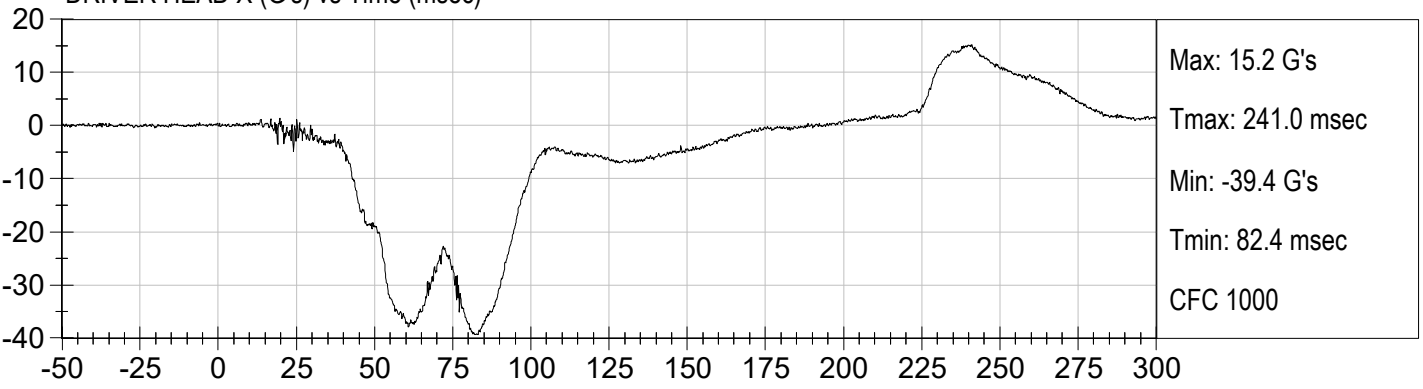
Right Rear Seat Crossmember Z

Left Rear Seat Crossmember Xr

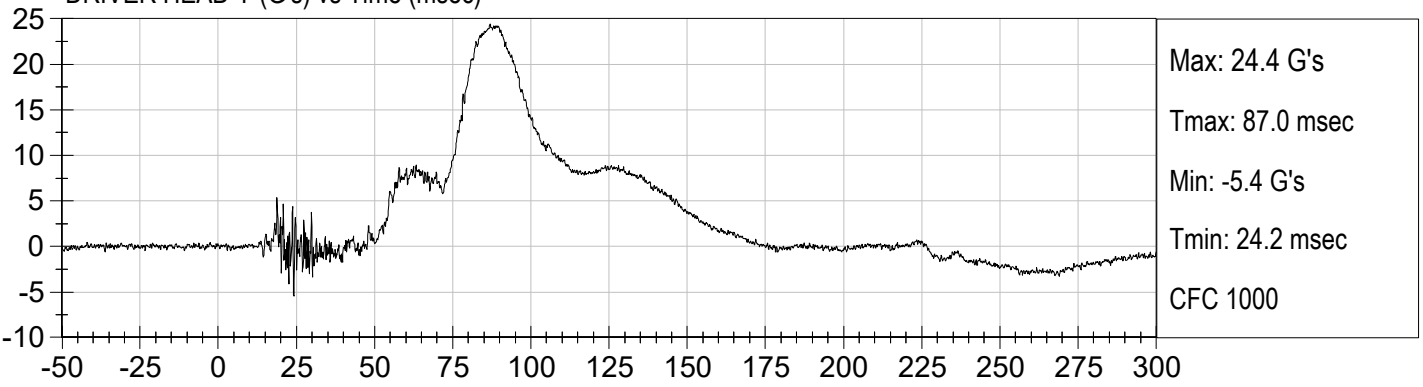
Right Rear Seat Crossmember Xr

Advanced Research Load Cell Barrier – 528 channels

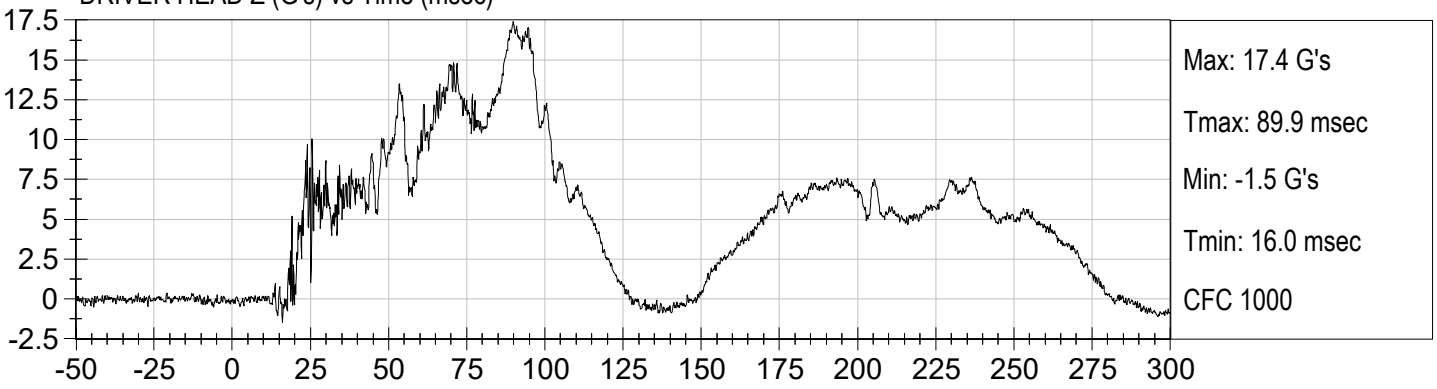
DRIVER HEAD X (G's) vs Time (msec)



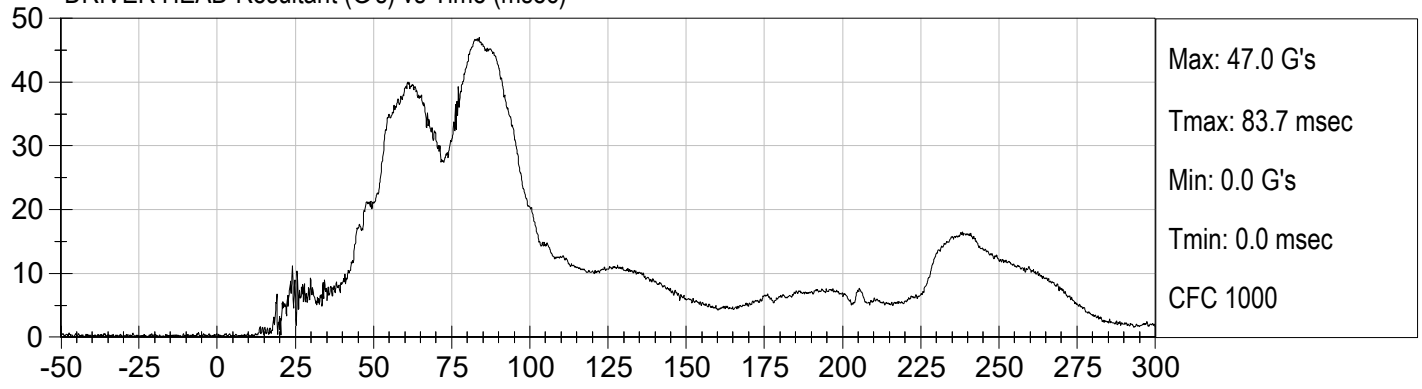
DRIVER HEAD Y (G's) vs Time (msec)

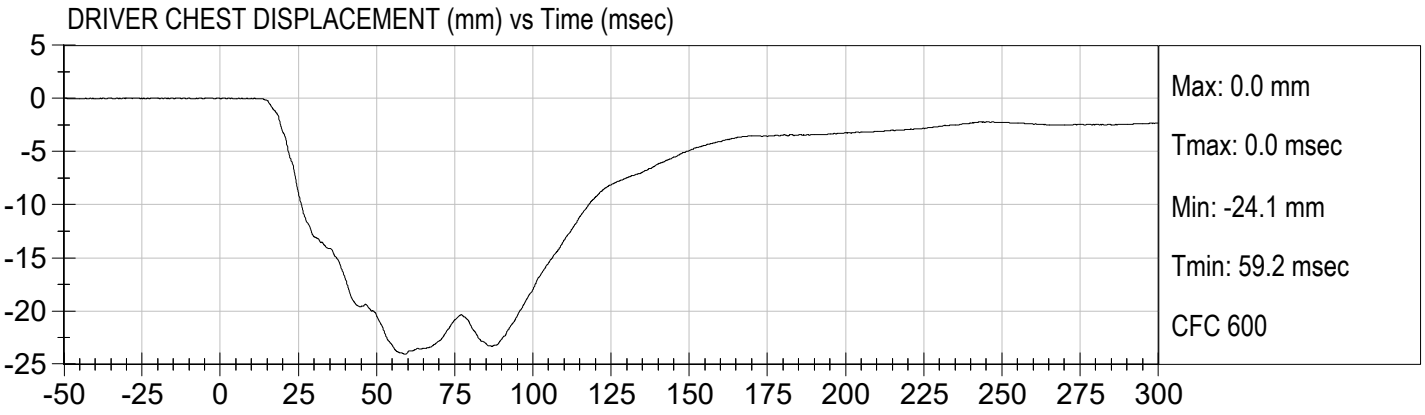


DRIVER HEAD Z (G's) vs Time (msec)

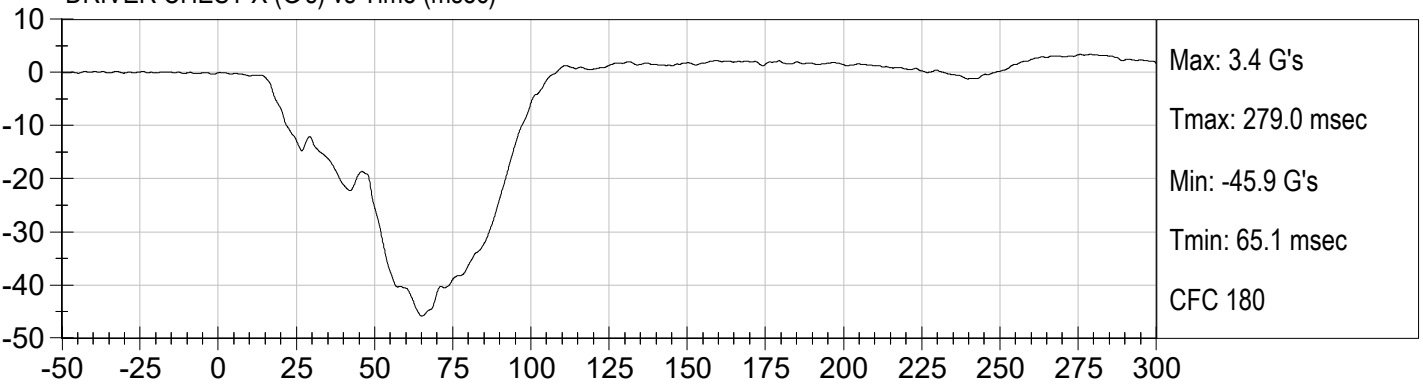


DRIVER HEAD Resultant (G's) vs Time (msec)

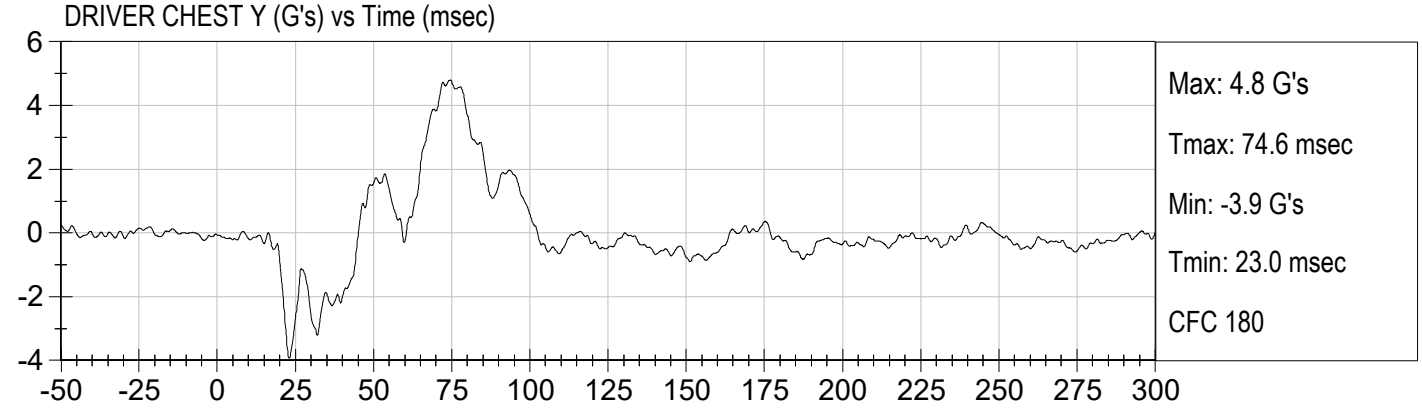



DRIVER CHEST DISPLACEMENT (mm) vs Time (msec)
5
0
-5
-10
-15
-20
-25
-50
-25
0
25
50
75
100
125
150
175
200
225
250
275
300
Max: 0.0 mm
Tmax: 0.0 msec
Min: -24.1 mm
Tmin: 59.2 msec
CFC 600

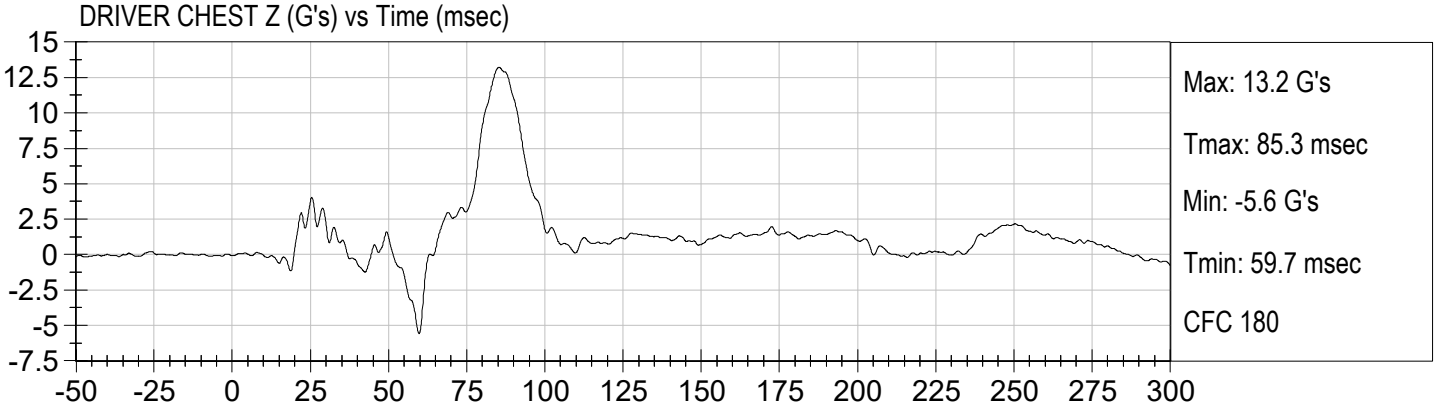
DRIVER CHEST X (G's) vs Time (msec)



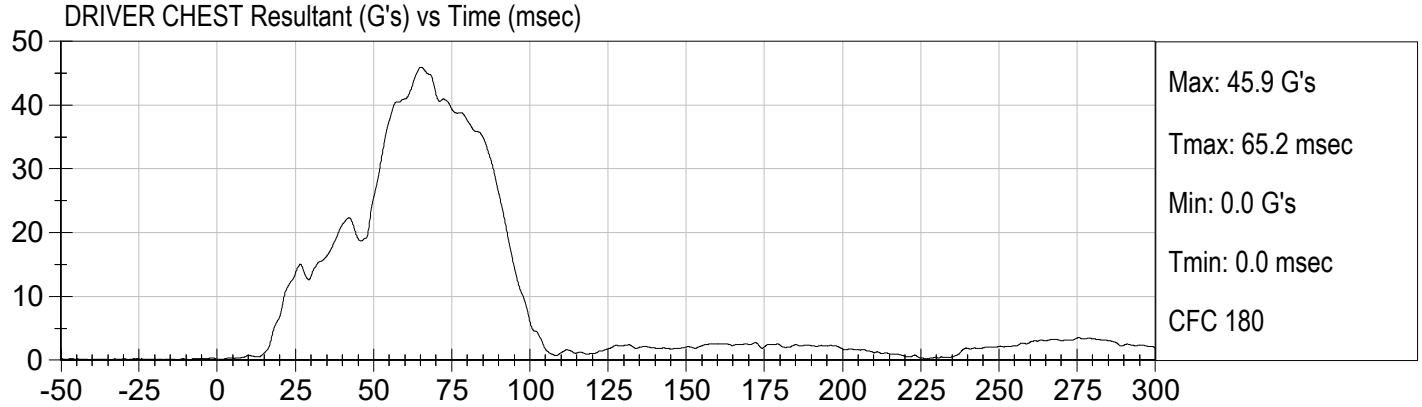
DRIVER CHEST Y (G's) vs Time (msec)



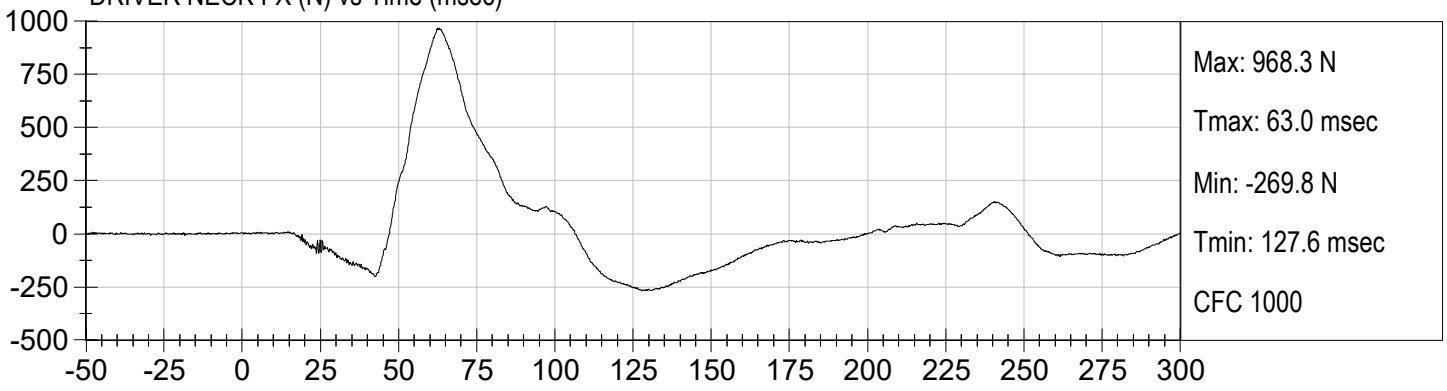
DRIVER CHEST Z (G's) vs Time (msec)



DRIVER CHEST Resultant (G's) vs Time (msec)

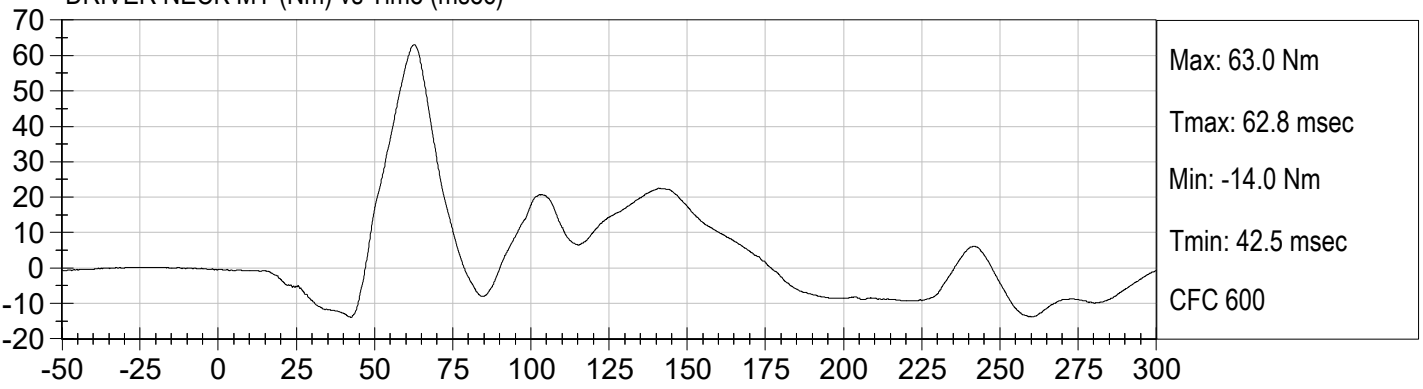


DRIVER NECK FX (N) vs Time (msec)

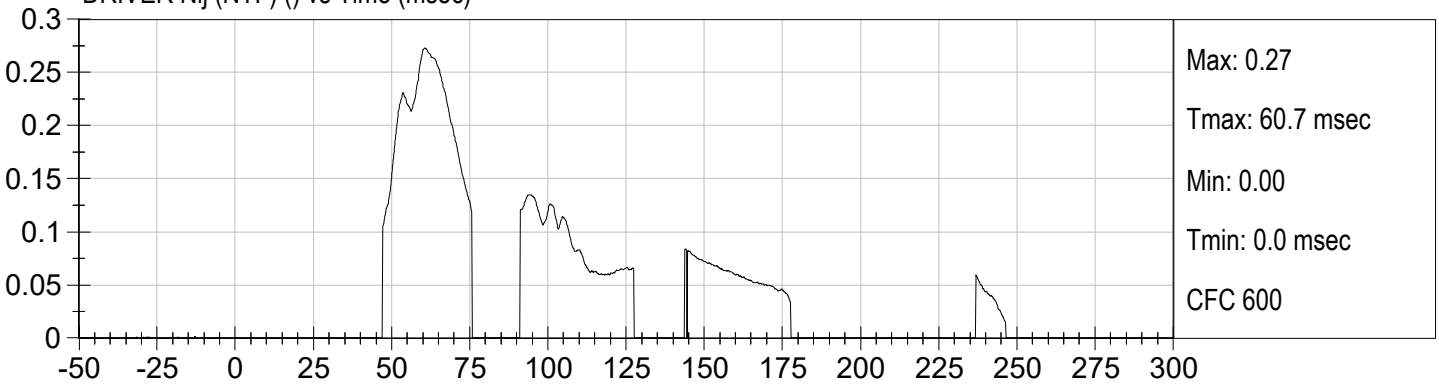


DRIVER NECK FZ (N) vs Time (msec)

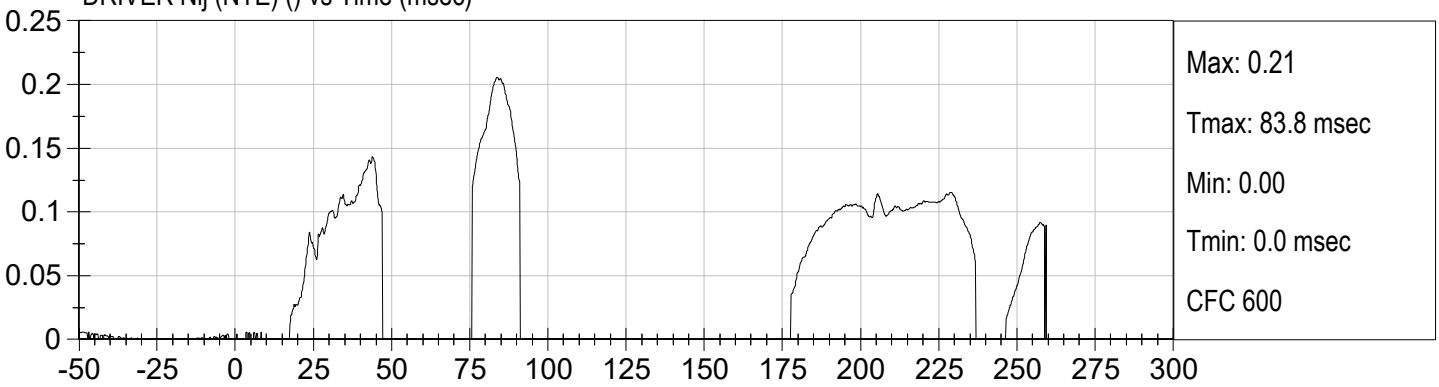
DRIVER NECK MY (Nm) vs Time (msec)



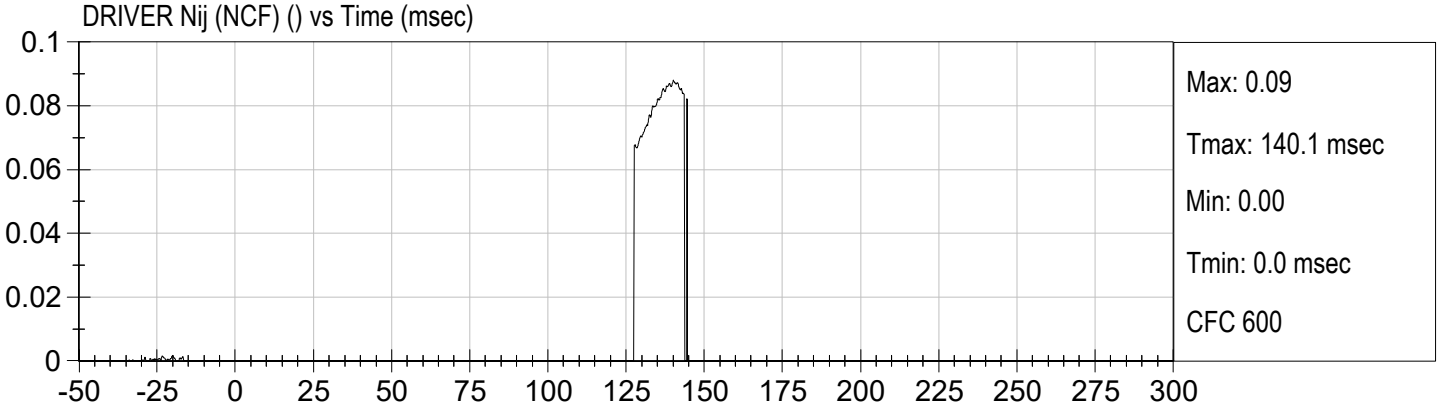
DRIVER Nij (NTF) () vs Time (msec)



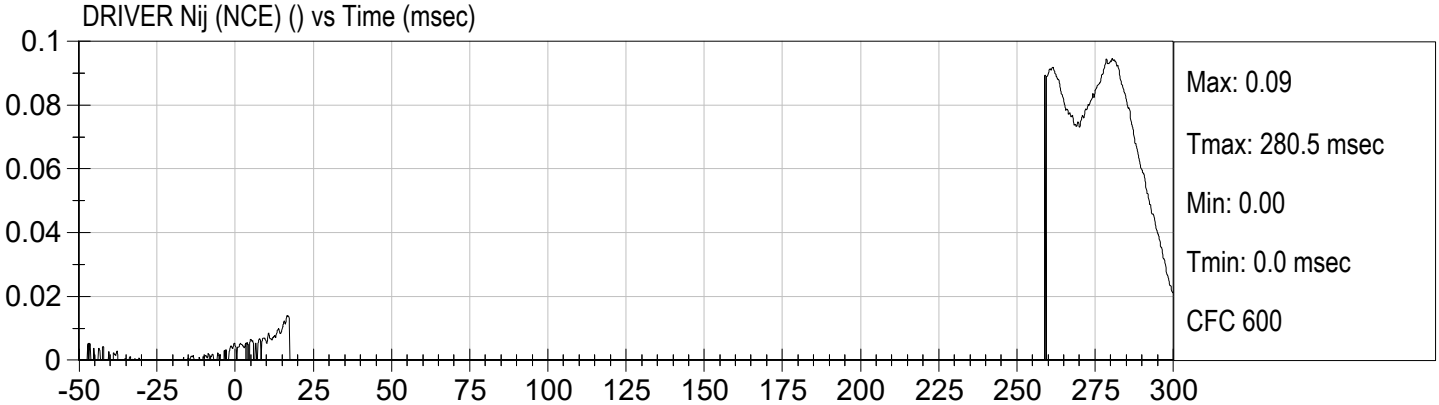
DRIVER Nij (NTE) () vs Time (msec)



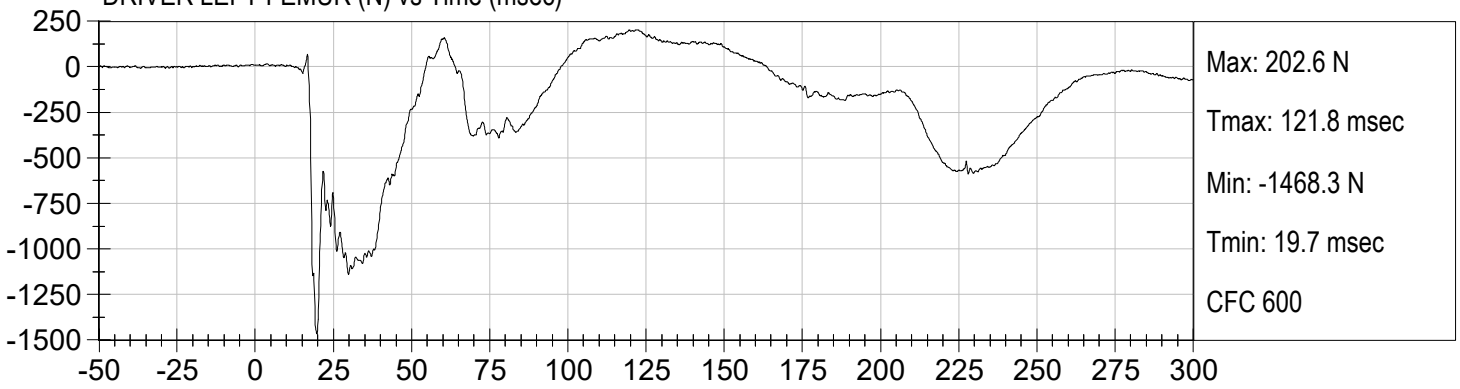
DRIVER Nij (NCF) () vs Time (msec)



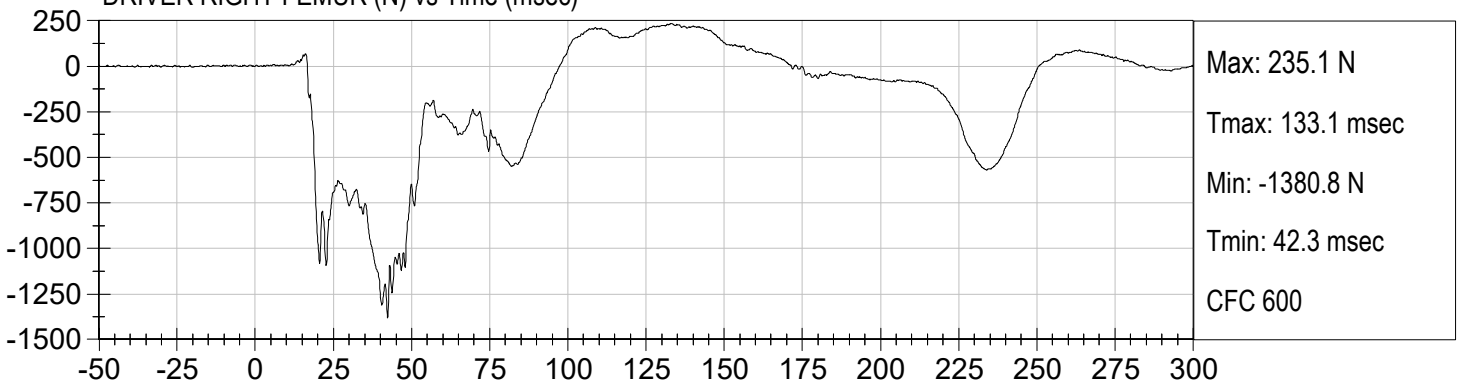
DRIVER Nij (NCE) () vs Time (msec)



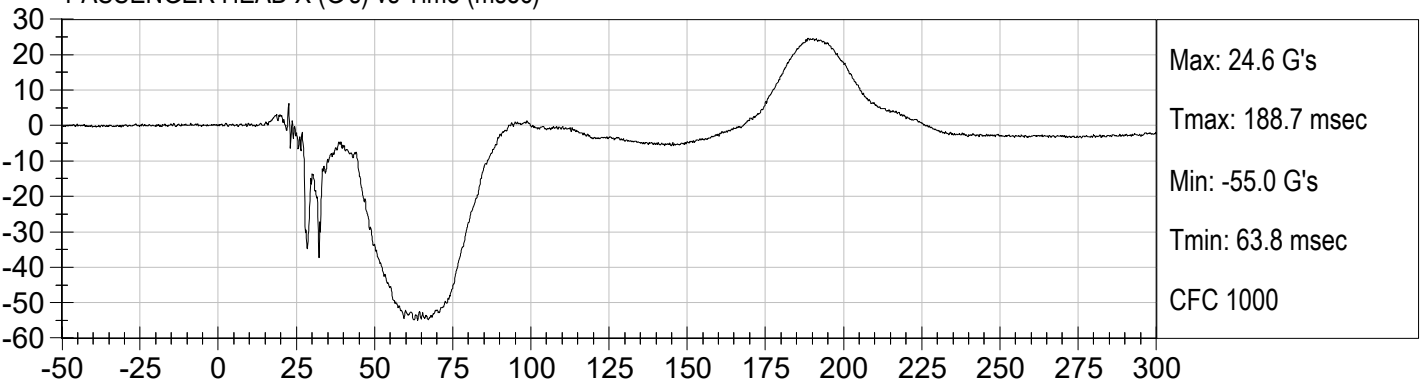
DRIVER LEFT FEMUR (N) vs Time (msec)



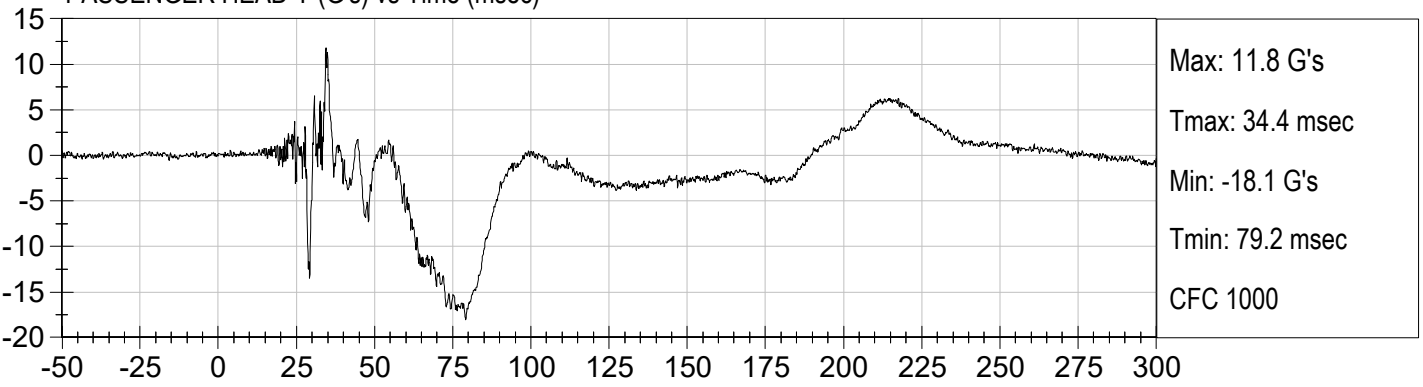
DRIVER RIGHT FEMUR (N) vs Time (msec)



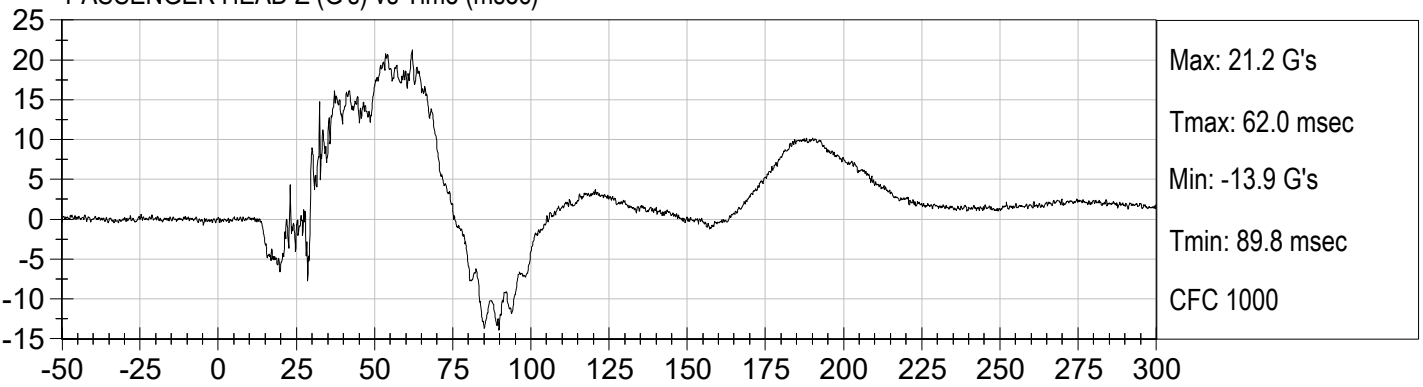
PASSENGER HEAD X (G's) vs Time (msec)



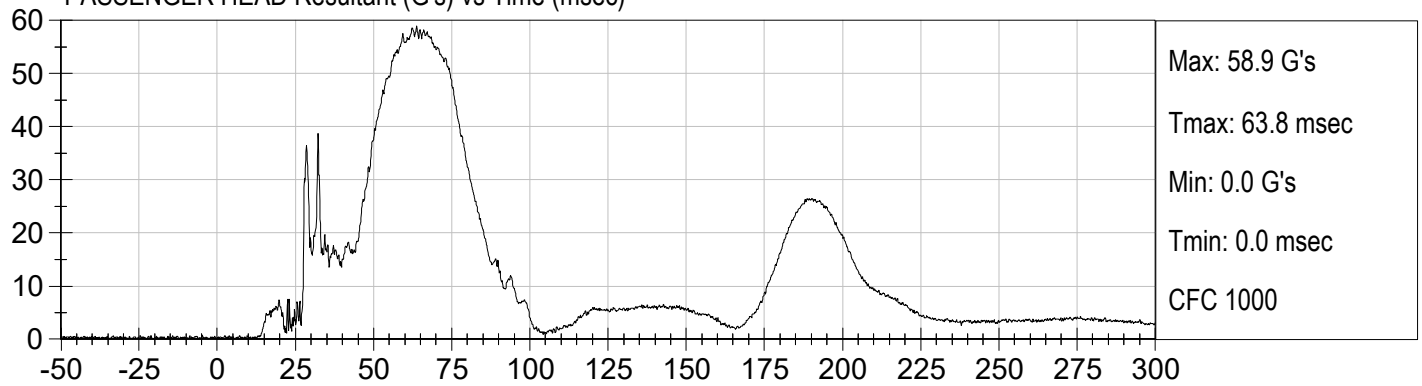
PASSENGER HEAD Y (G's) vs Time (msec)



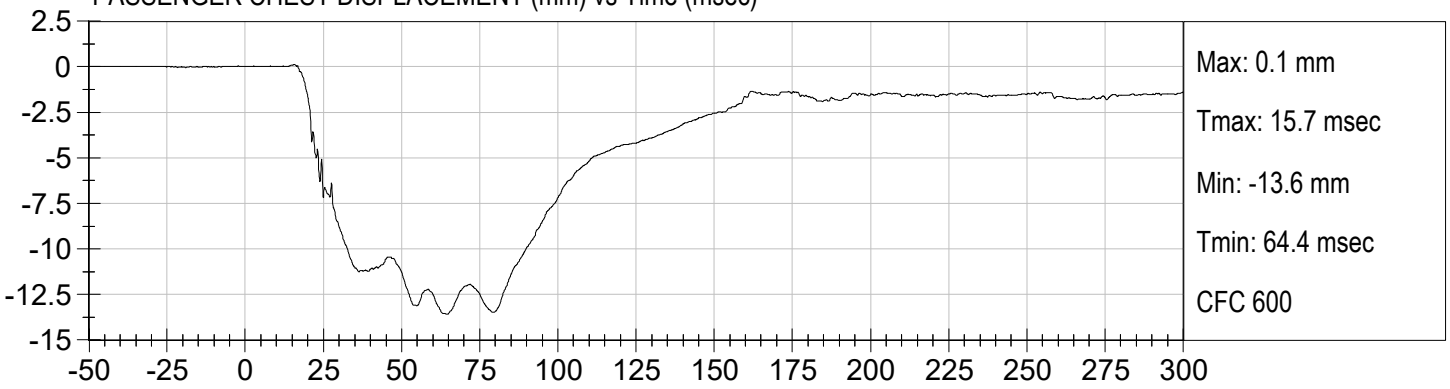
PASSENGER HEAD Z (G's) vs Time (msec)



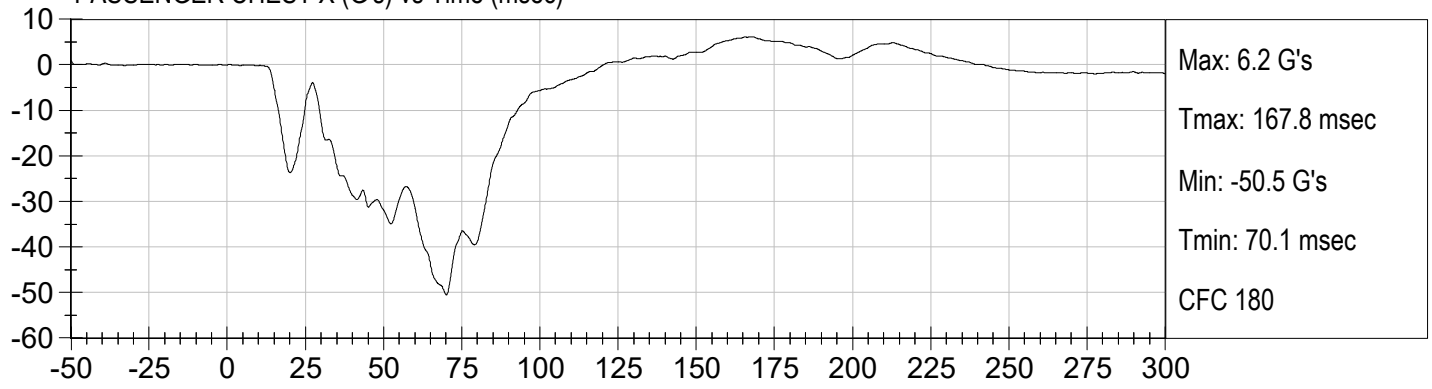
PASSENGER HEAD Resultant (G's) vs Time (msec)



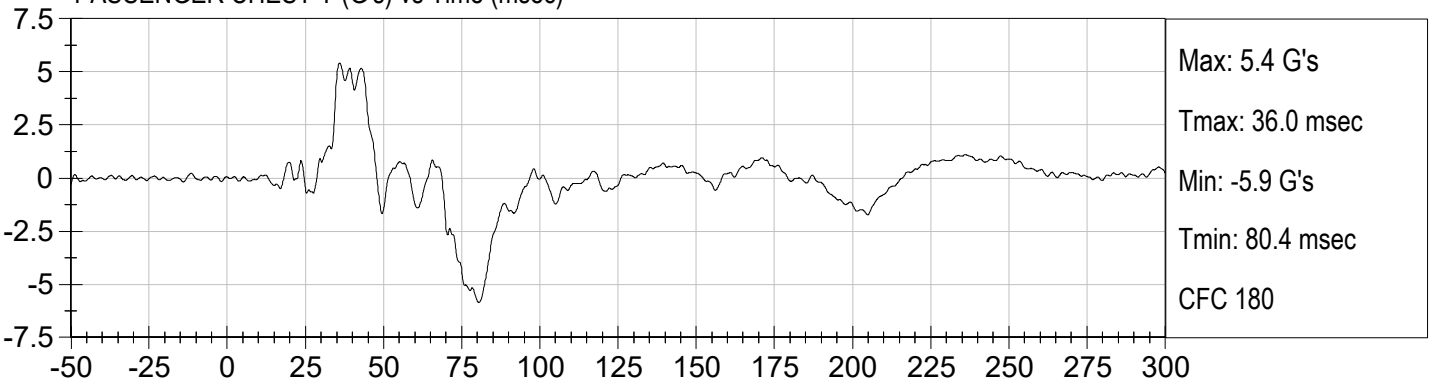
PASSENGER CHEST DISPLACEMENT (mm) vs Time (msec)



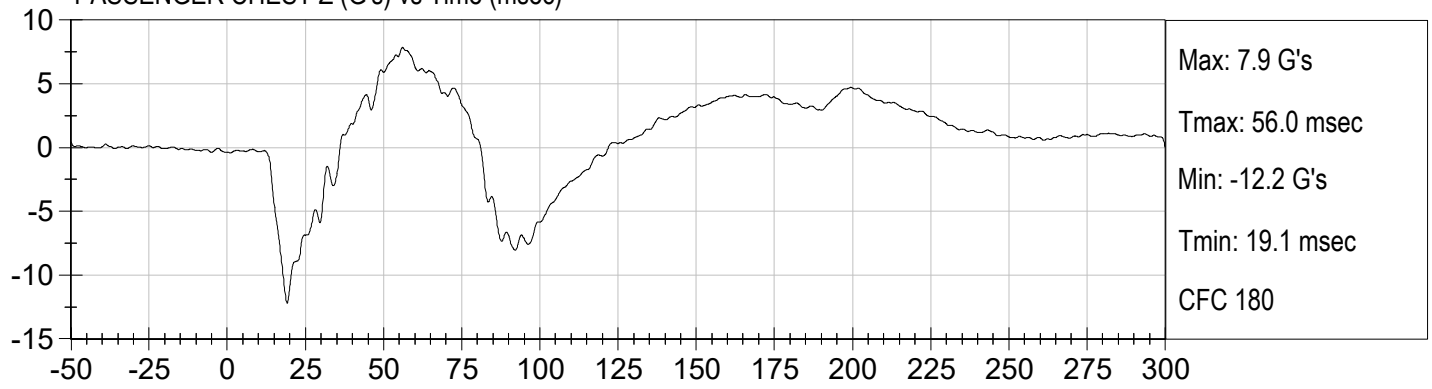
PASSENGER CHEST X (G's) vs Time (msec)



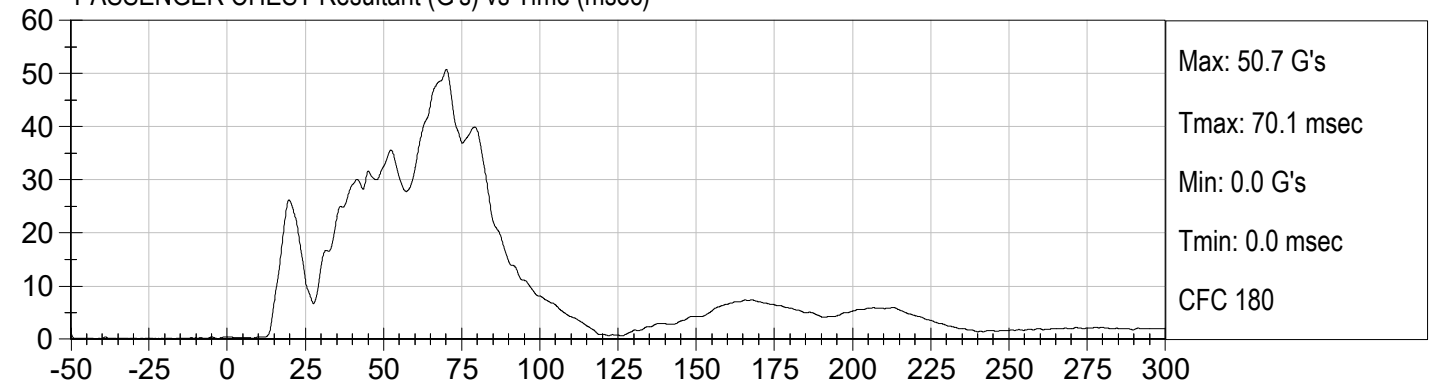
PASSENGER CHEST Y (G's) vs Time (msec)

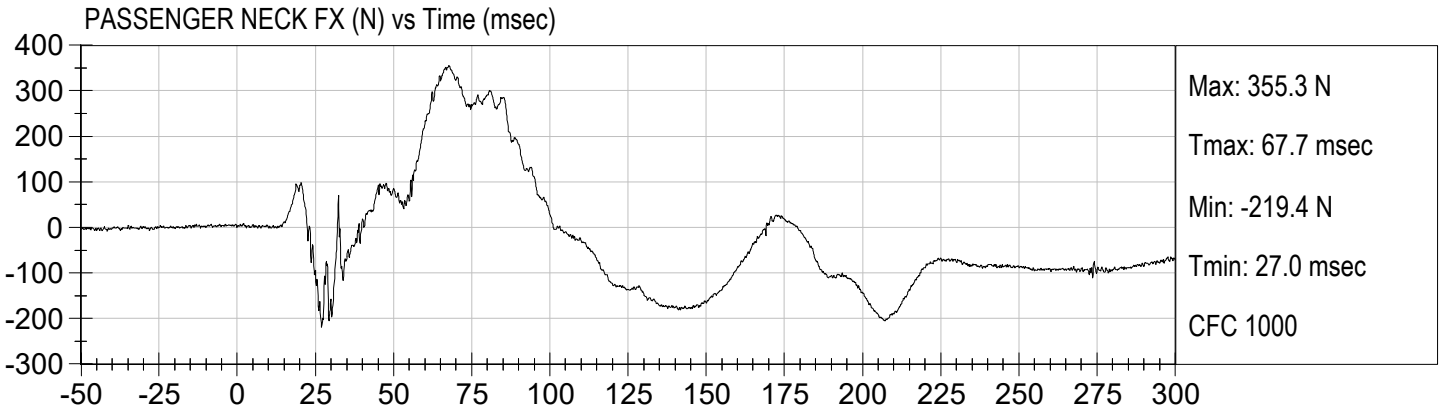


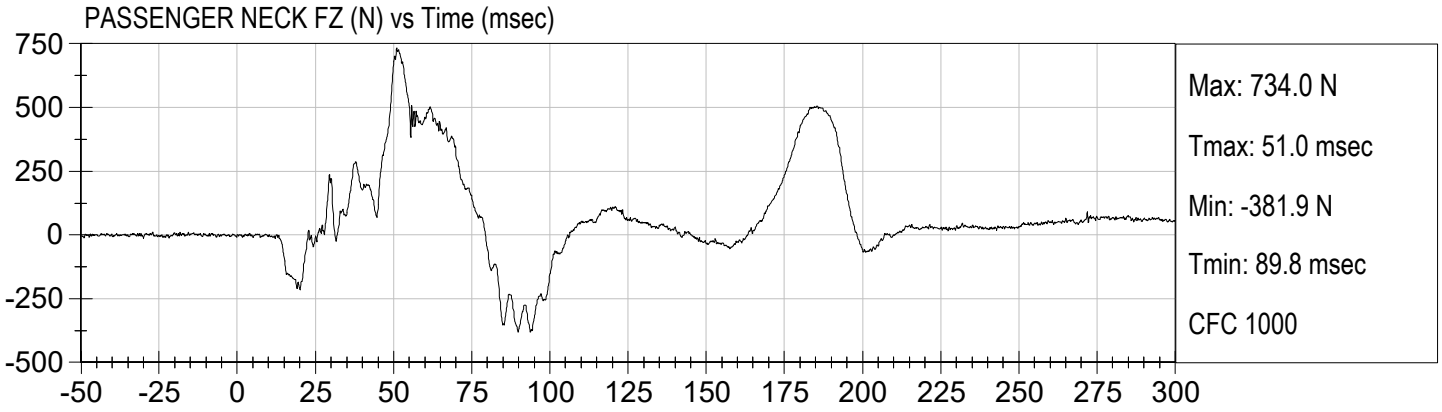
PASSENGER CHEST Z (G's) vs Time (msec)

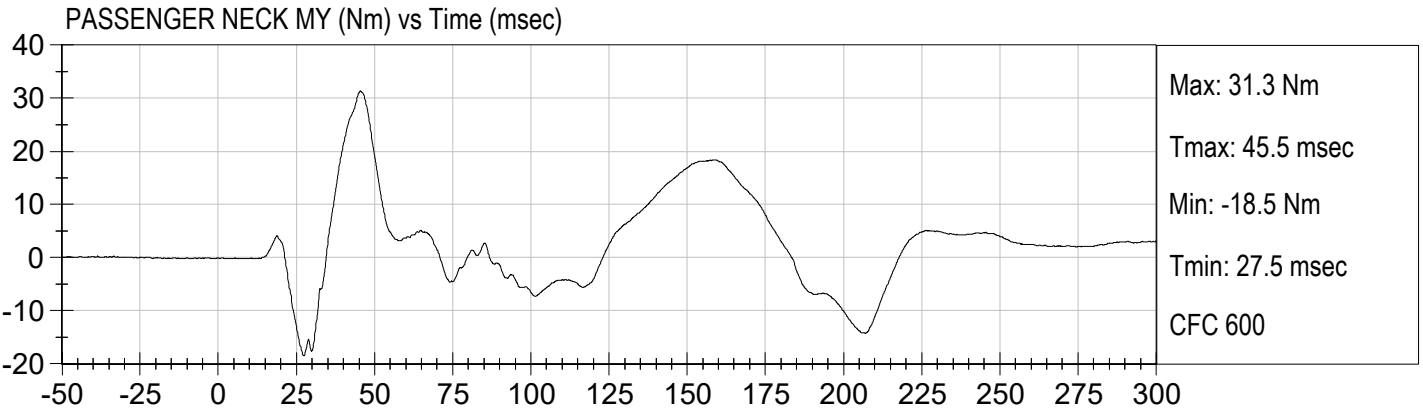


PASSENGER CHEST Resultant (G's) vs Time (msec)

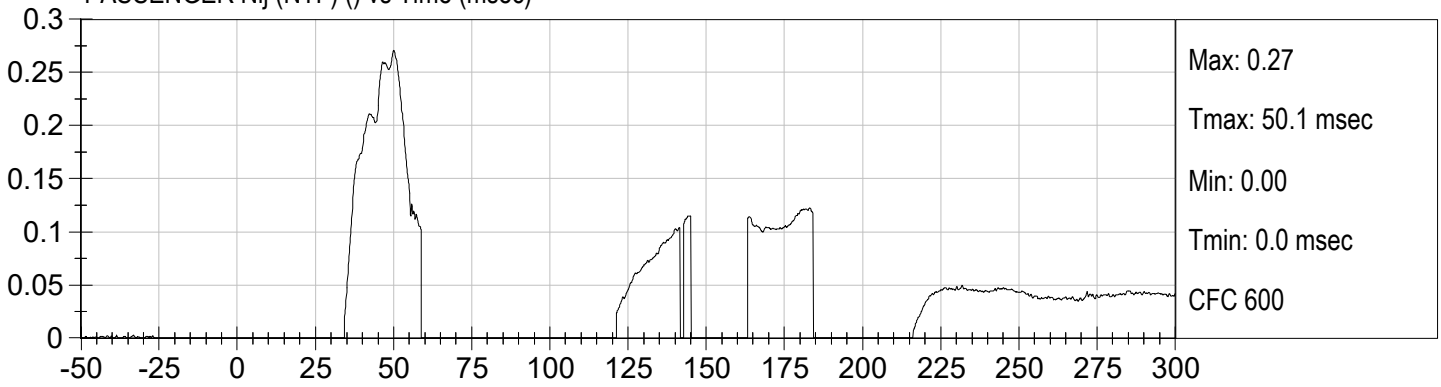



PASSENGER NECK FX (N) vs Time (msec)
400
300
200
100
0
-100
-200
-300
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Max: 355.3 N
Tmax: 67.7 msec
Min: -219.4 N
Tmin: 27.0 msec
CFC 1000

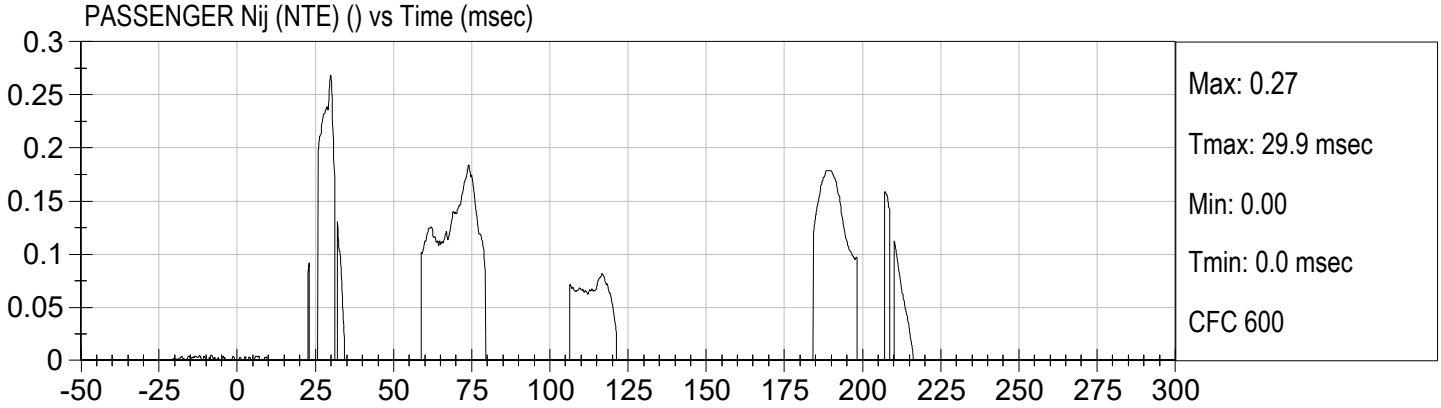

PASSENGER NECK FZ (N) vs Time (msec)
750
500
250
0
-250
-500
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Max: 734.0 N
Tmax: 51.0 msec
Min: -381.9 N
Tmin: 89.8 msec
CFC 1000


PASSENGER NECK MY (Nm) vs Time (msec)
40
30
20
10
0
-10
-20
-50 -25 0 25 50 75 100 125 150 175 200 225 250 275 300
Max: 31.3 Nm
Tmax: 45.5 msec
Min: -18.5 Nm
Tmin: 27.5 msec
CFC 600

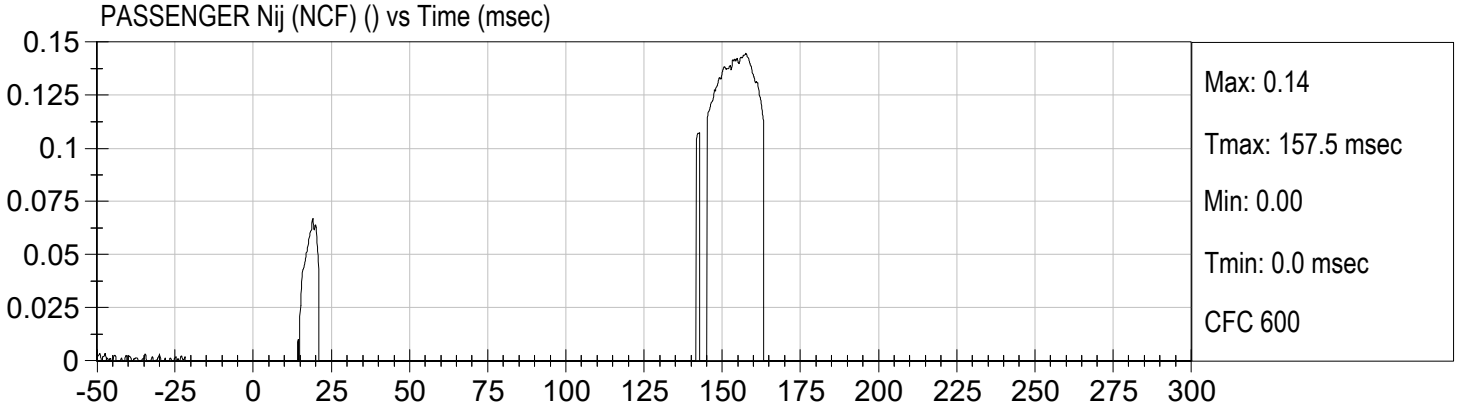
PASSENGER Nij (NTF) () vs Time (msec)



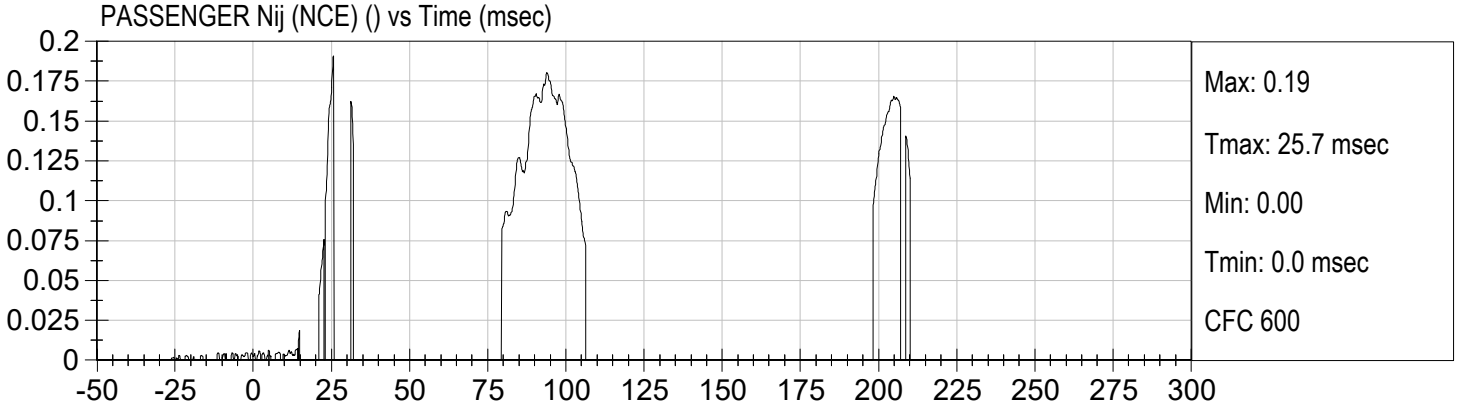
PASSENGER Nij (NTE) () vs Time (msec)



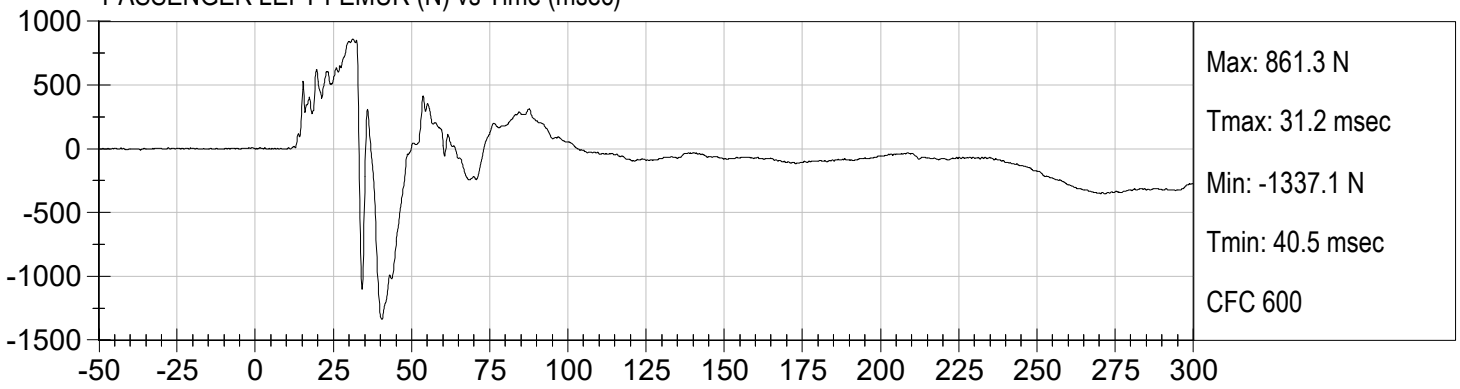
PASSENGER Nij (NCF) () vs Time (msec)



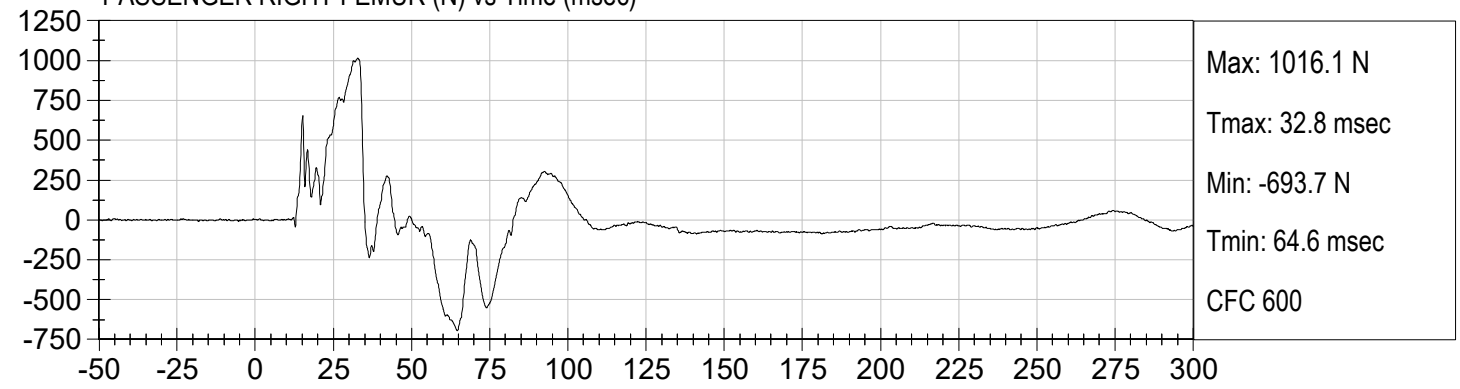
PASSENGER Nij (NCE) () vs Time (msec)



PASSENGER LEFT FEMUR (N) vs Time (msec)



PASSENGER RIGHT FEMUR (N) vs Time (msec)



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:** D190051

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	21.7	Pass
Peak Resultant Acceleration	G's	225 to 275	246	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-2.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

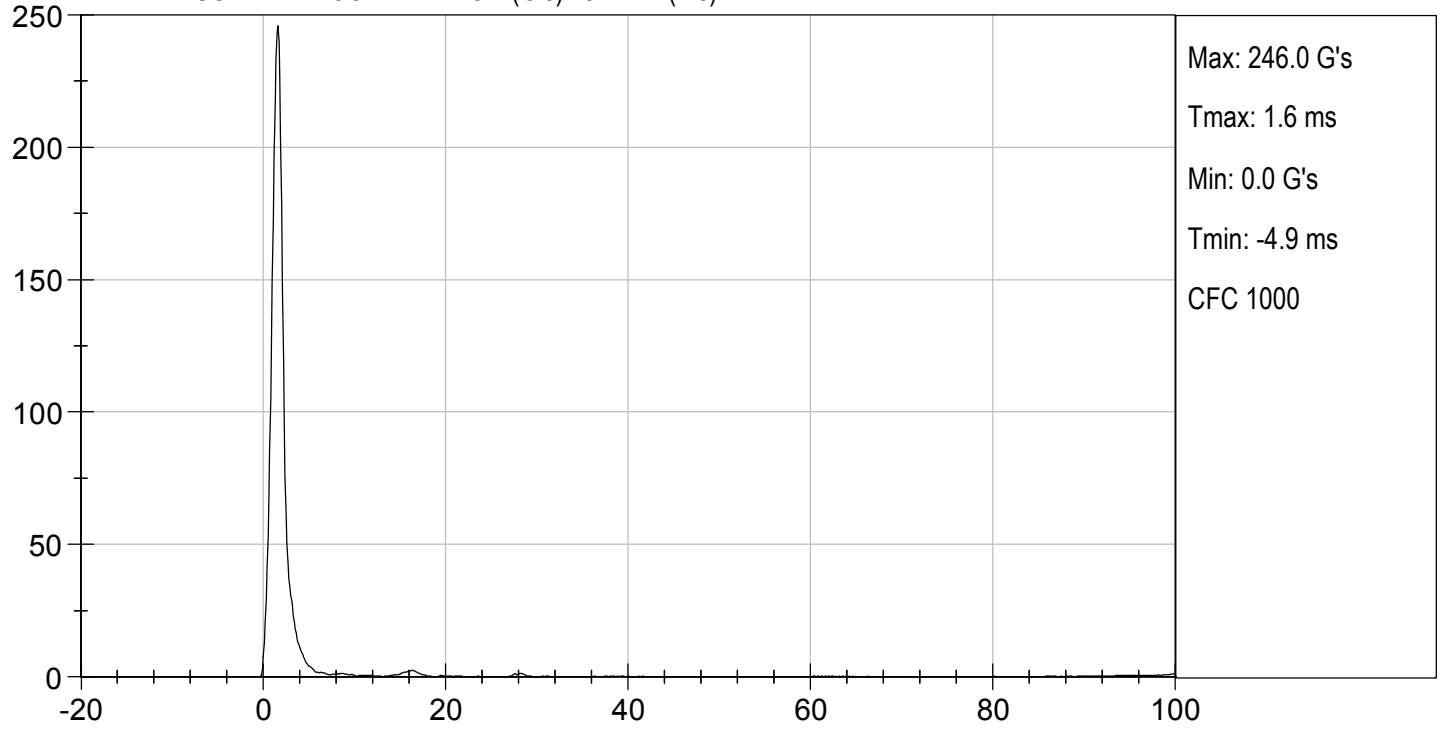
01/03/2019
Test Date

Robert Schmalz
Approved By

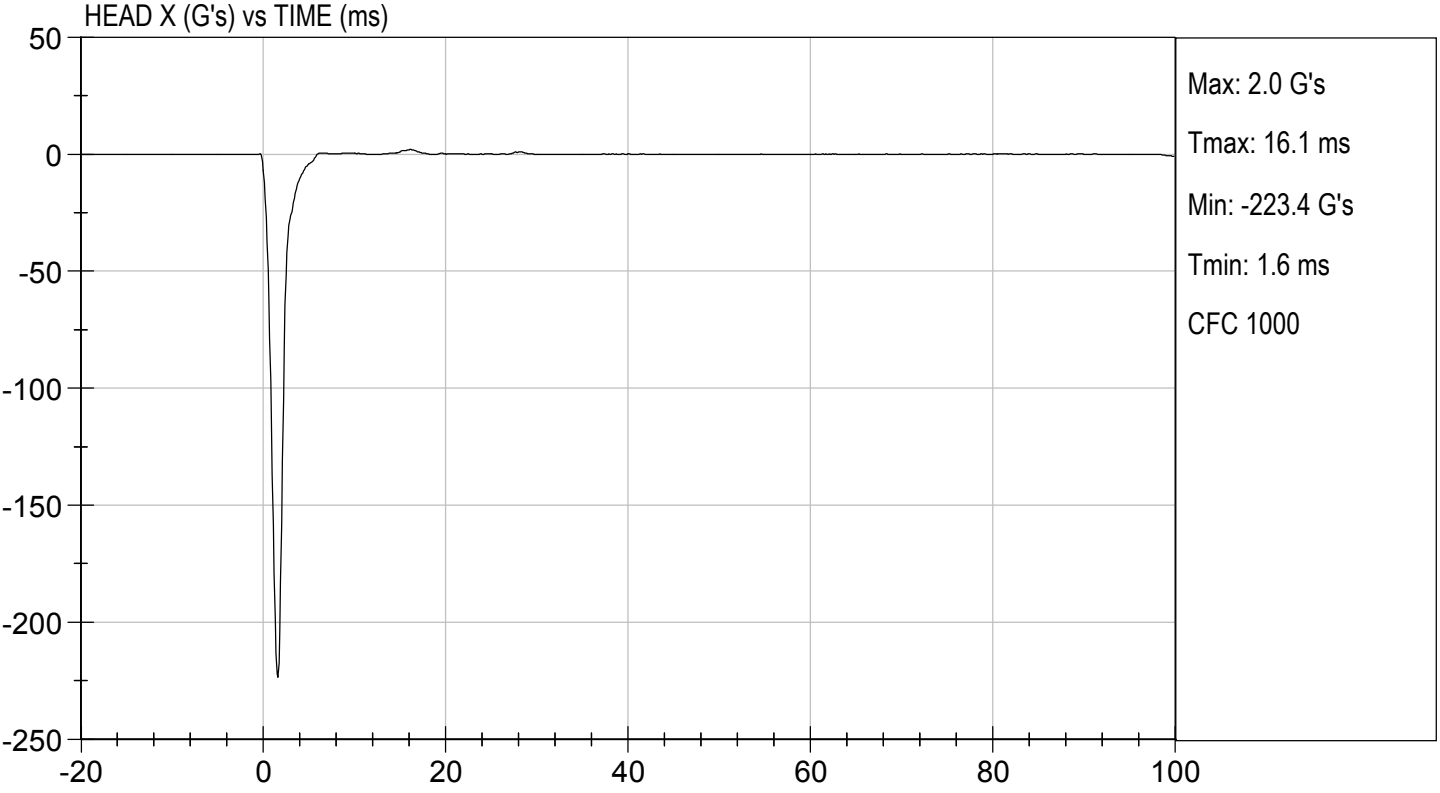
TEST DESC: HEAD DROP

TEST DATE: 01/03/2019
TEST #: D190051

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

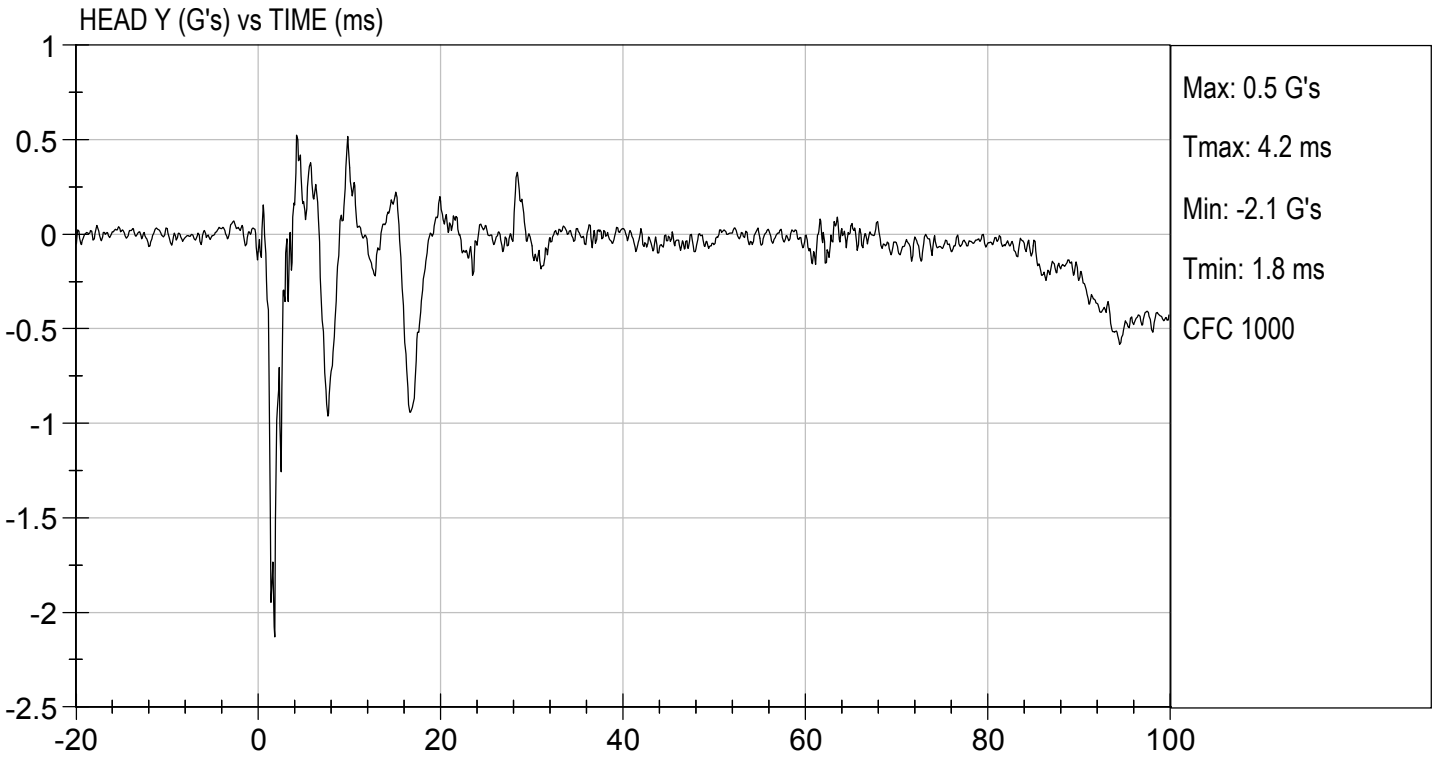


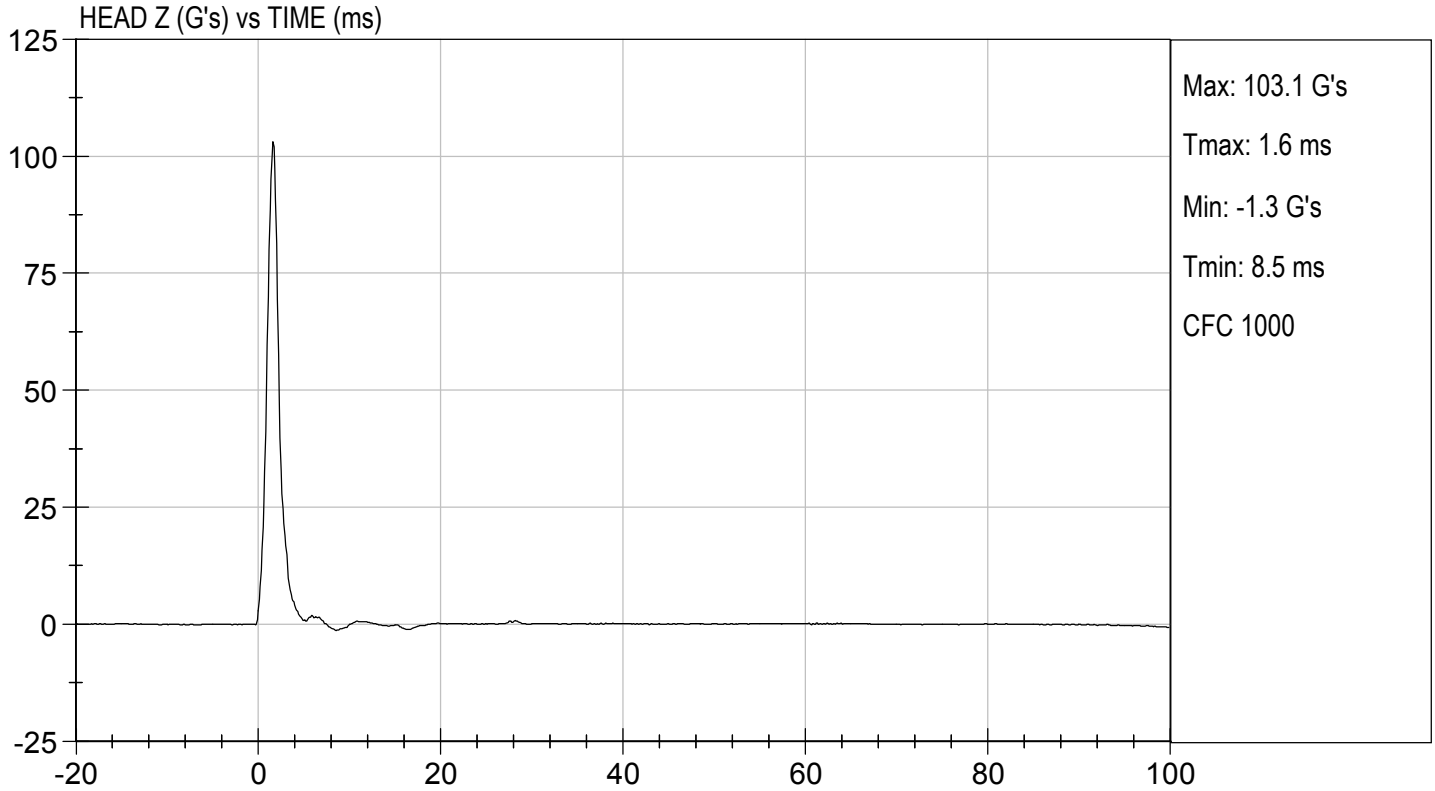
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 01/03/2019
TEST #: D190051





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190052

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	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	24.41	Pass
	20 ms	G's	17.60 to 22.60	20.21	Pass
	30 ms	G's	12.50 to 18.50	14.76	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	36.7	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	75.7	Pass
	Time	ms	57.0 to 64.0	62.7	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	122.1	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	89.9	Pass
	Time	ms	47.0 to 58.0	50.8	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	100.1	Pass
			Overall Test Results		Pass

Laboratory Technician

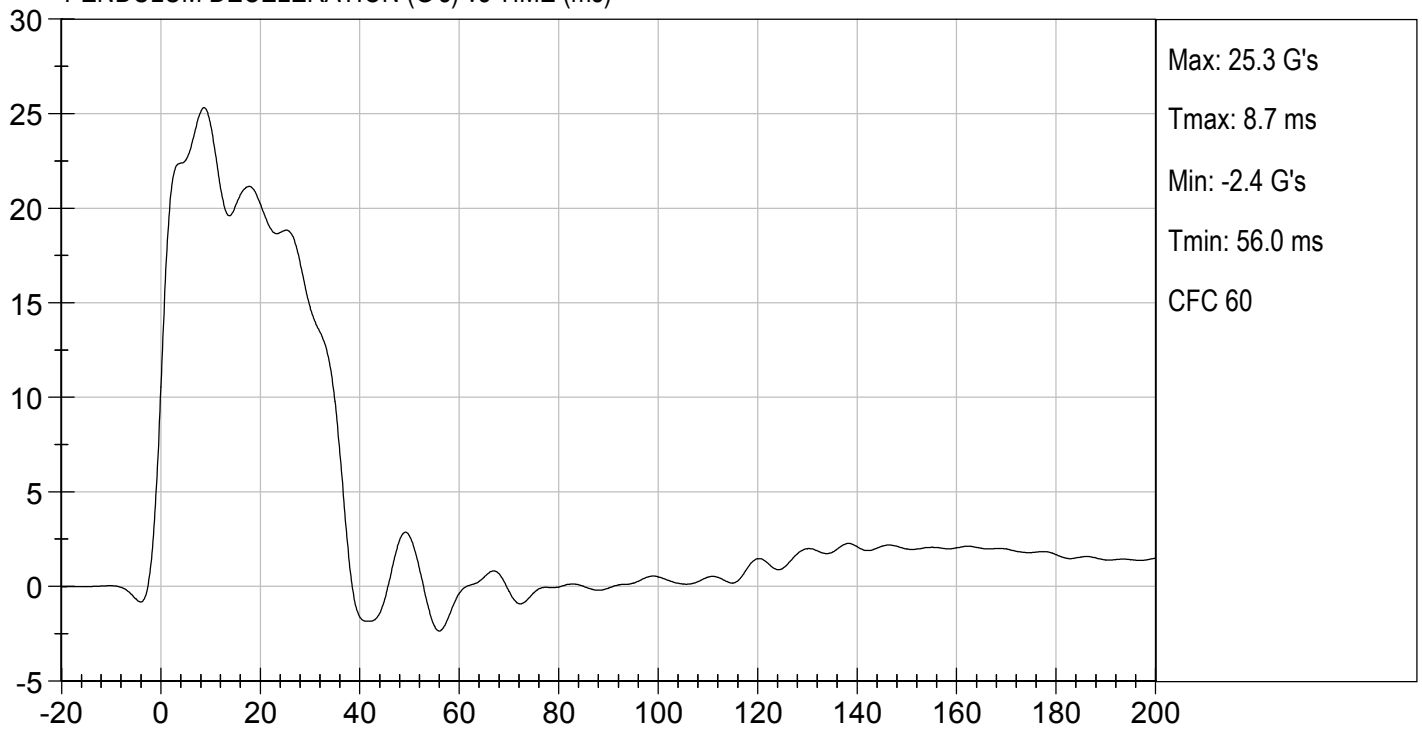
01/03/2019
Test Date

Approved By

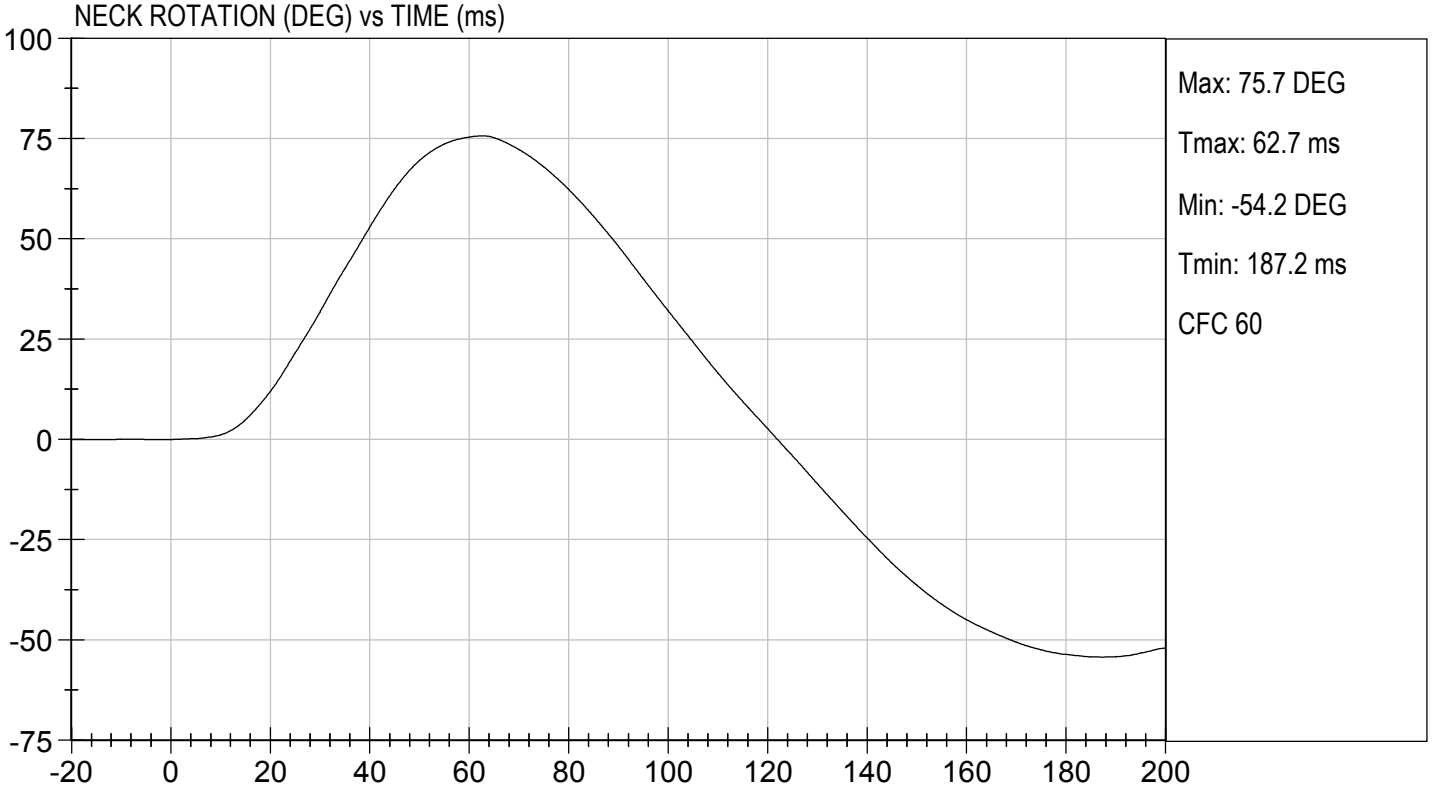
TEST DESC: NECK FLEXION
VELOCITY: 22.83 ft/s, 6.96 m/s

TEST DATE: 01/03/2019
TEST #: D190052

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

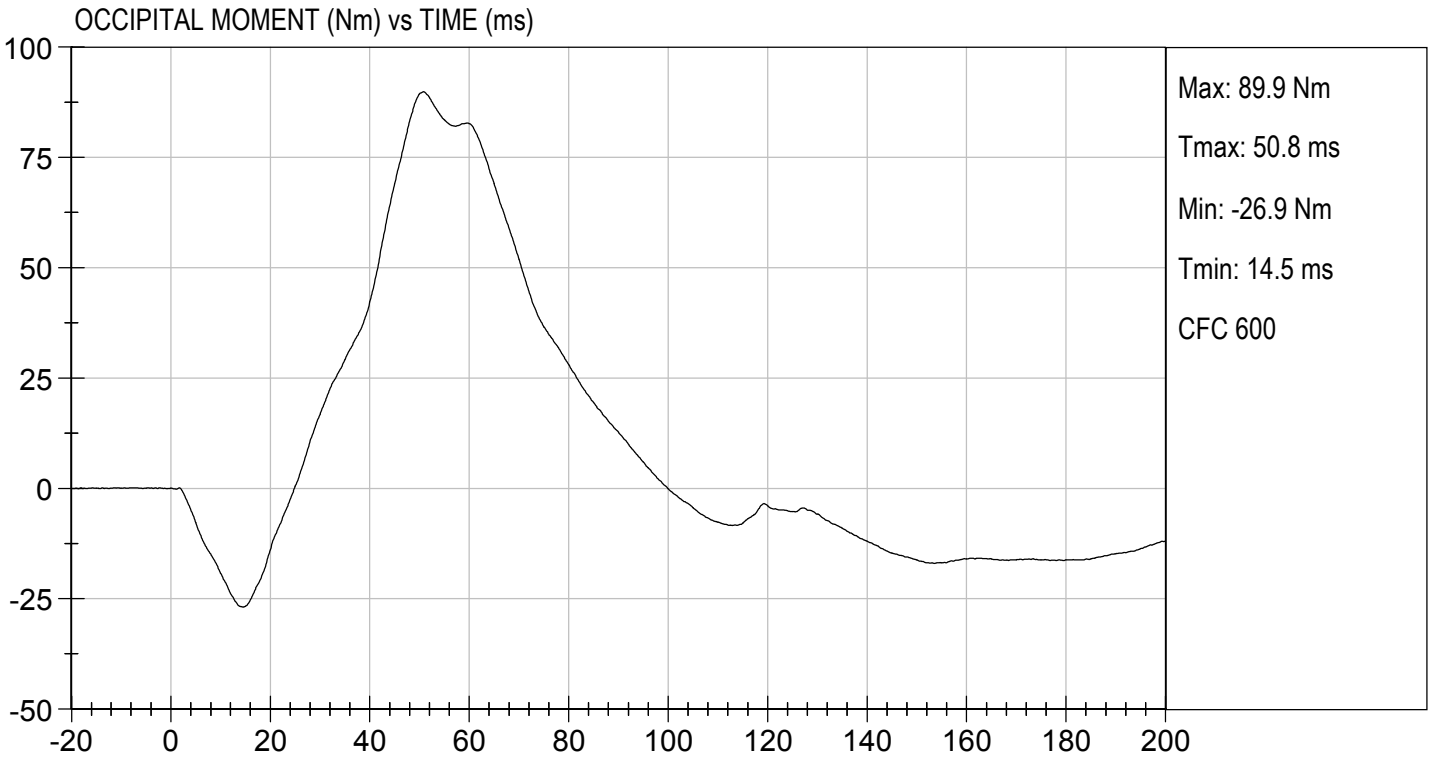


NECK ROTATION (DEG) vs TIME (ms)



TEST DESC: NECK FLEXION
VELOCITY: 22.83 ft/s, 6.96 m/s

TEST DATE: 01/03/2019
TEST #: D190052



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190053

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	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	18.89	Pass
	20 ms	G's	14.00 to 19.00	16.05	Pass
	30 ms	G's	11.00 to 16.00	13.08	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	14.8	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	39.7	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	104.2	Pass
	Time	ms	72.0 to 82.0	78.8	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	167.0	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-65.2	Pass
	Time	ms	65.0 to 79.0	73.8	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	147.2	Pass
			Overall Test Results		Pass

Laboratory Technician

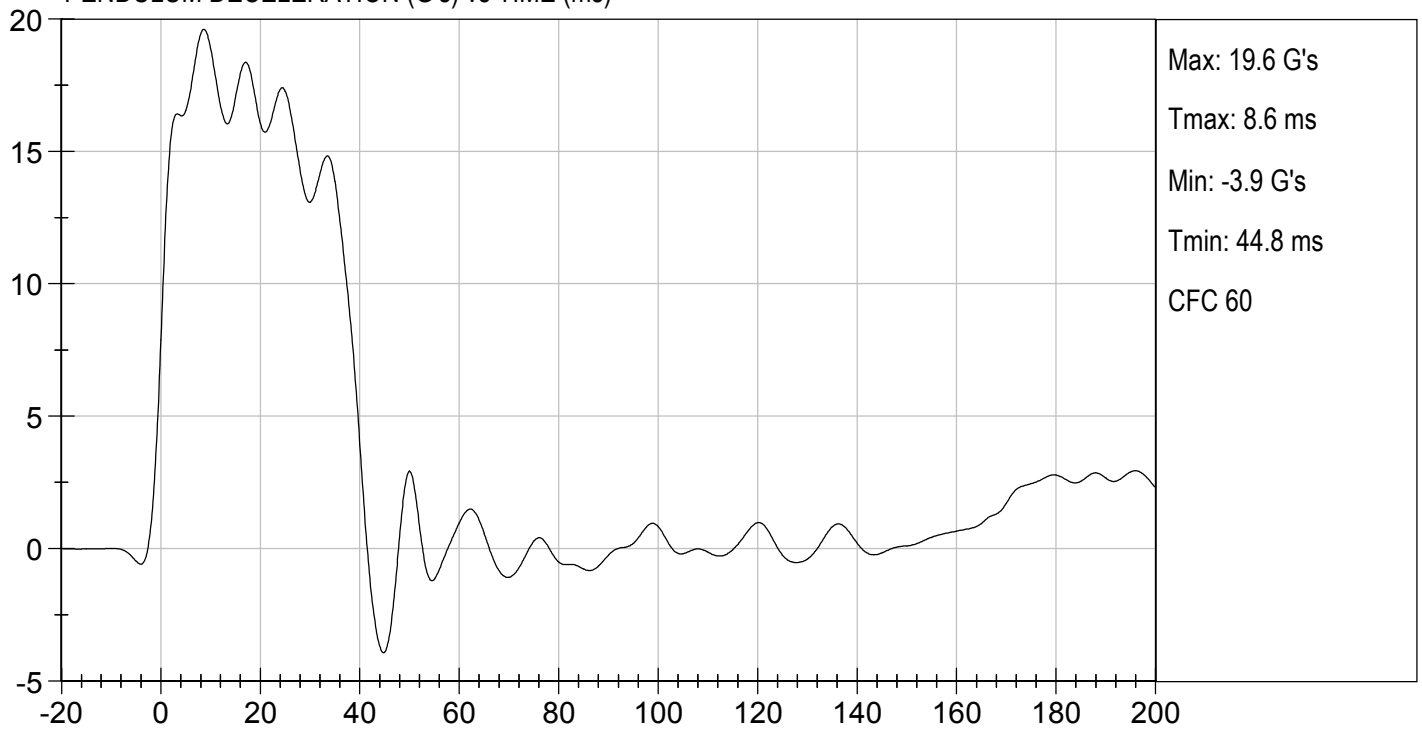
01/03/2019
Test Date

Approved By

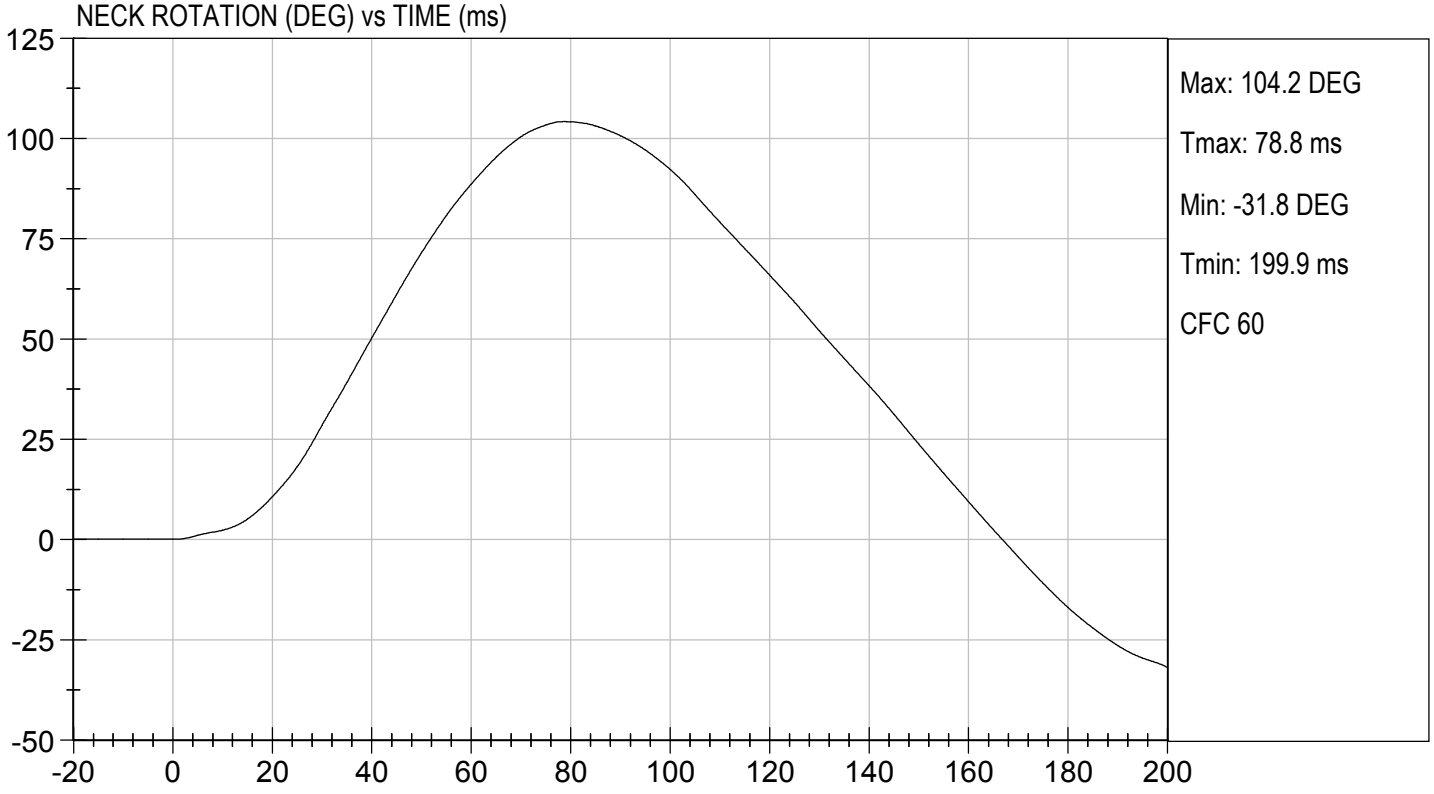
TEST DESC: NECK EXTENSION
VELOCITY: 20.08 ft/s, 6.12 m/s

TEST DATE: 01/03/2019
TEST #: D190053

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



NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 01/03/2019
TEST #: D190053

MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190054

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	21.7	Pass
Probe Velocity	m/s	6.58 to 6.82	6.77	Pass
Peak Probe Force	N	5159 to 5893	5,550	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.84	Pass
Internal Hysteresis	%	69 to 85	72	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

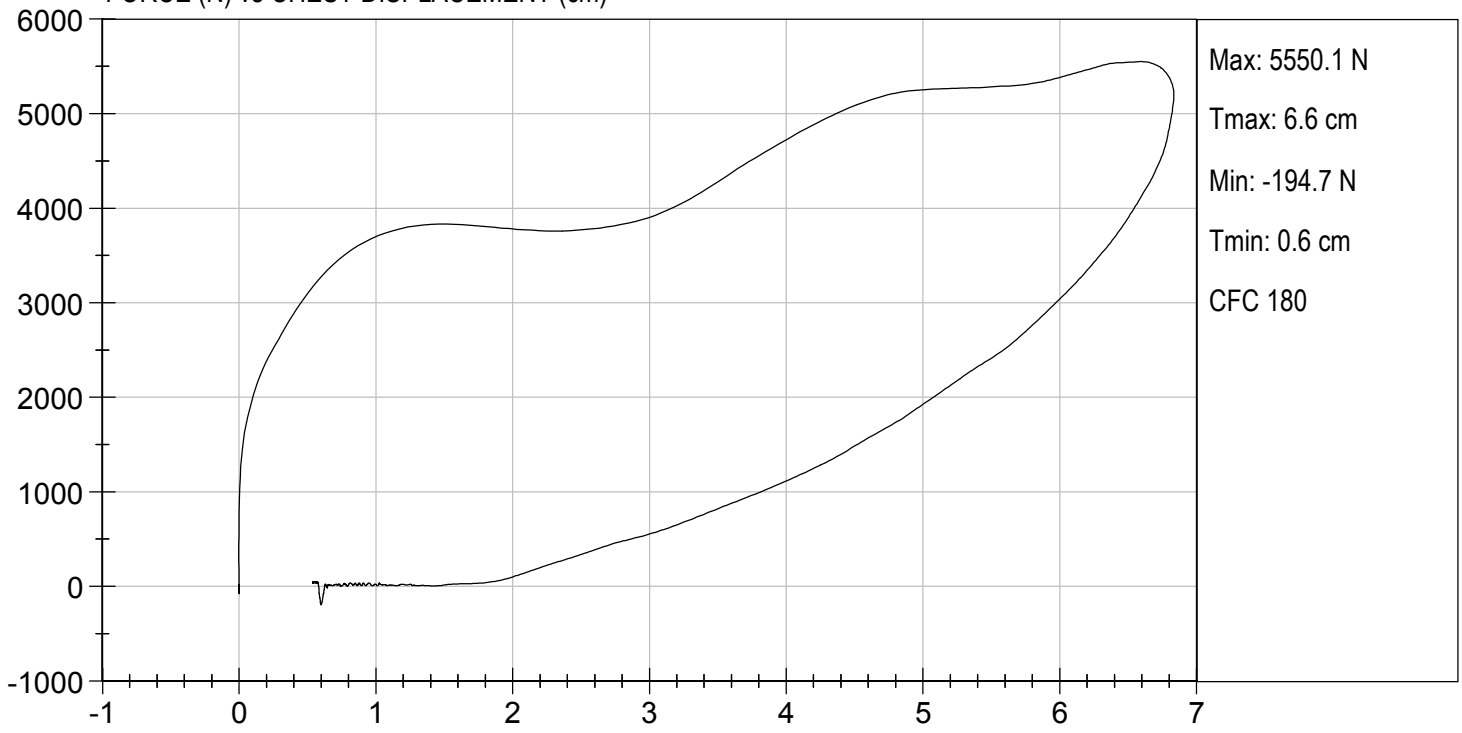
01/03/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/03/2019
TEST #: D190054

FORCE (N) vs CHEST DISPLACEMENT (cm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190055

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	21.7	Pass
Probe Velocity	m/s	2.07 to 2.13	2.09	Pass
Peak Probe Force	N	4715 to 5782	4,893	Pass
		Overall Test Results		Pass

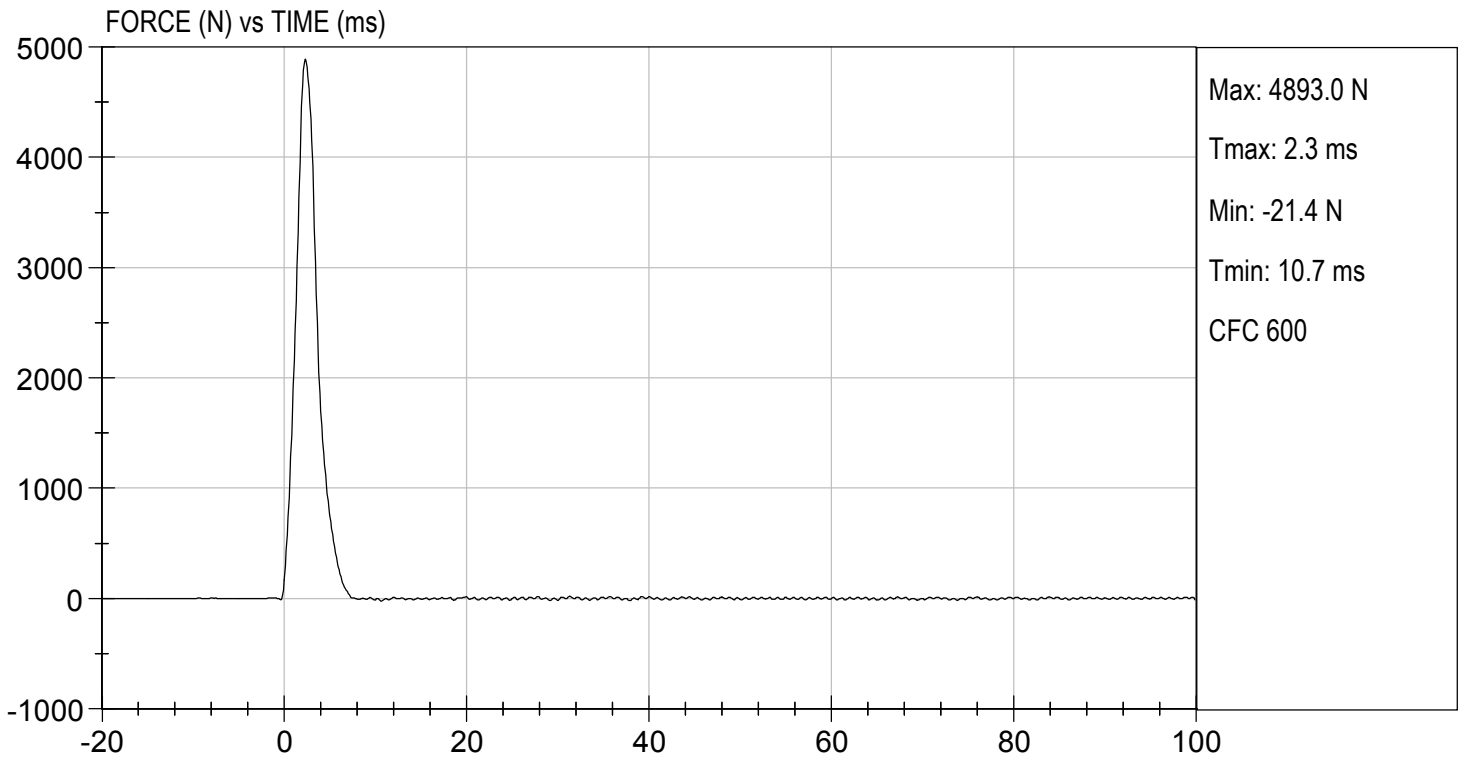
Danielle Redenbaugh
Laboratory Technician

01/03/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/03/2019
TEST #: D190055



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190056

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	21.7	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	N	4715 to 5782	5,181	Pass
		Overall Test Results		Pass

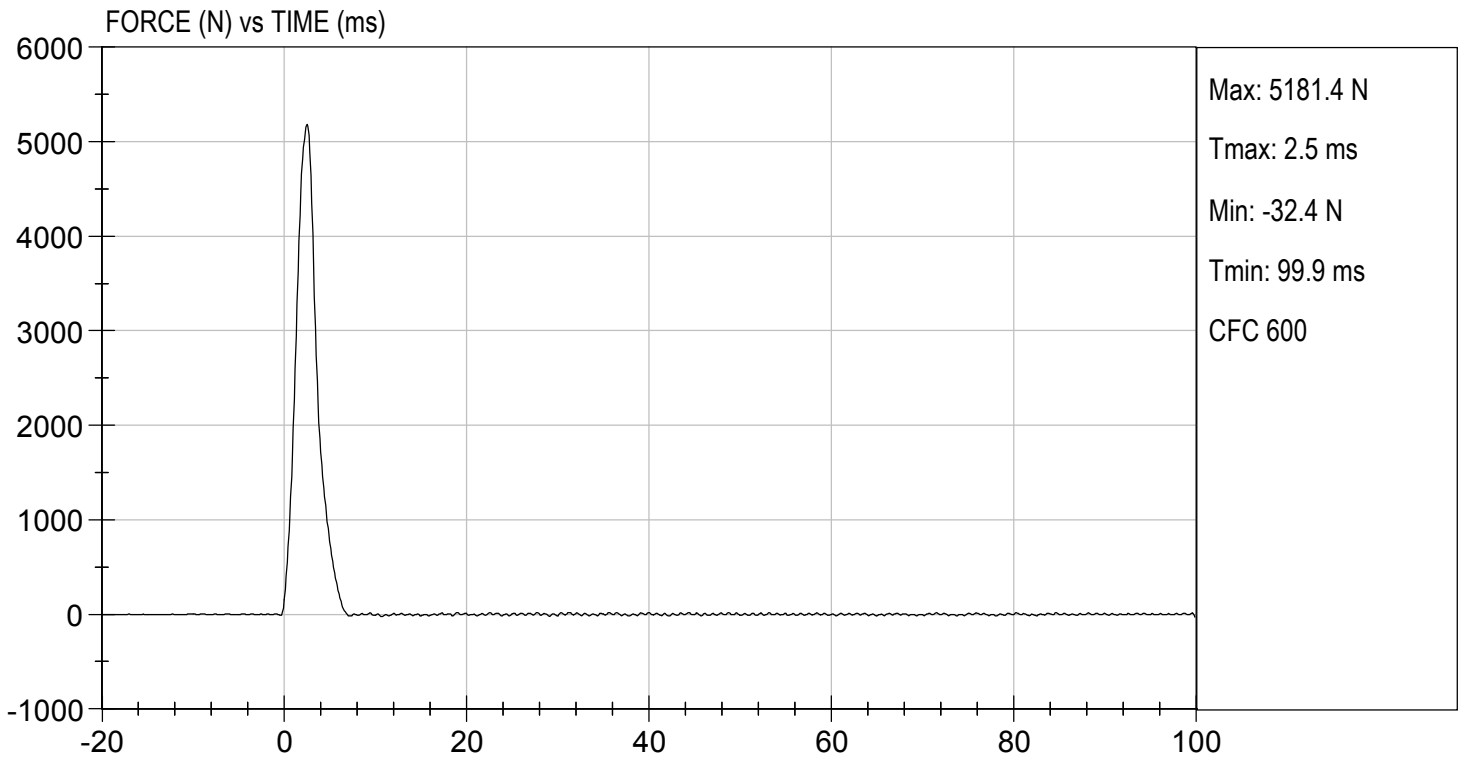
Danielle Redinbaugh
Laboratory Technician

01/03/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/03/2019
TEST #: D190056



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190050

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.6	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	22	22	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.4	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	91.8	88.2	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	46.1	44.3	Pass
		Overall Test Results			Pass

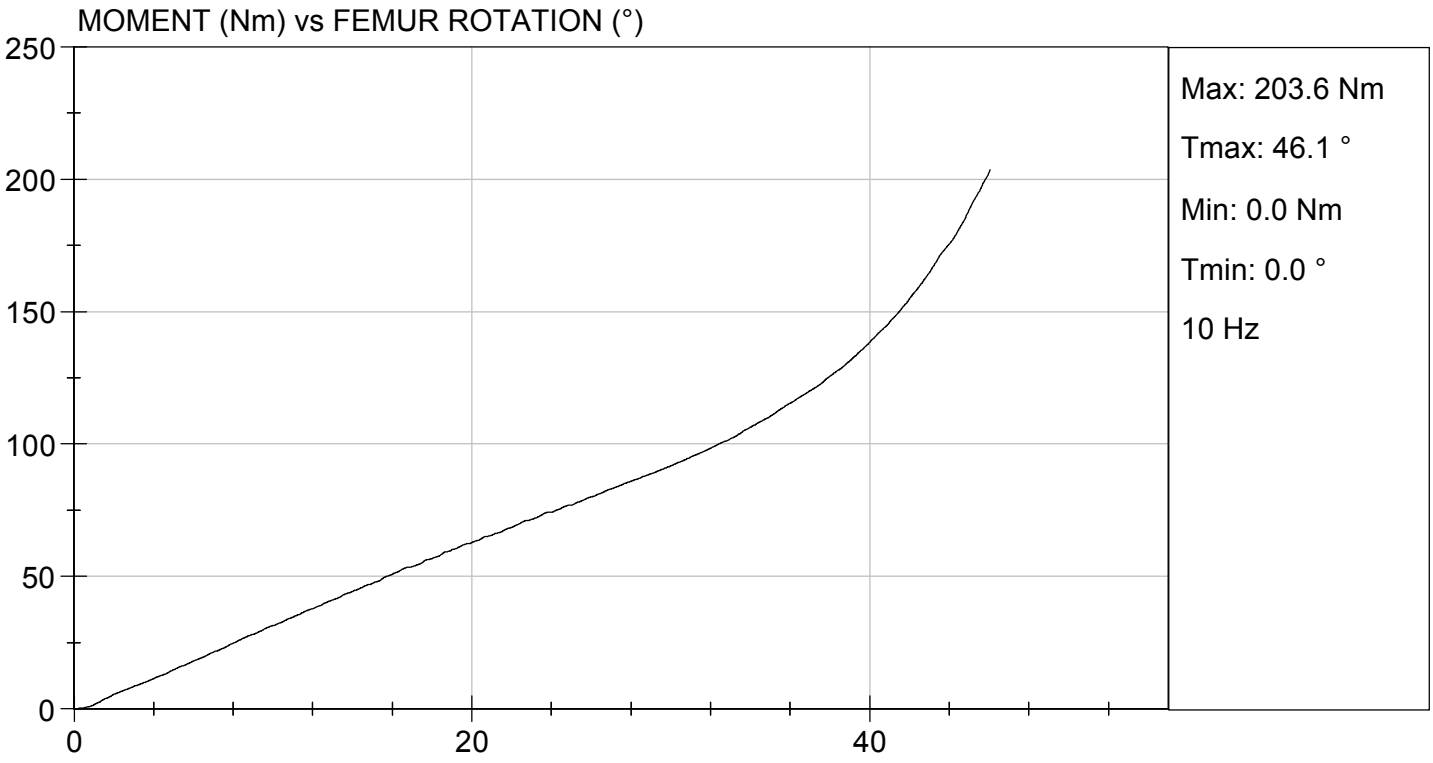
Laboratory Technician

01/03/2019
Test Date

Approved By

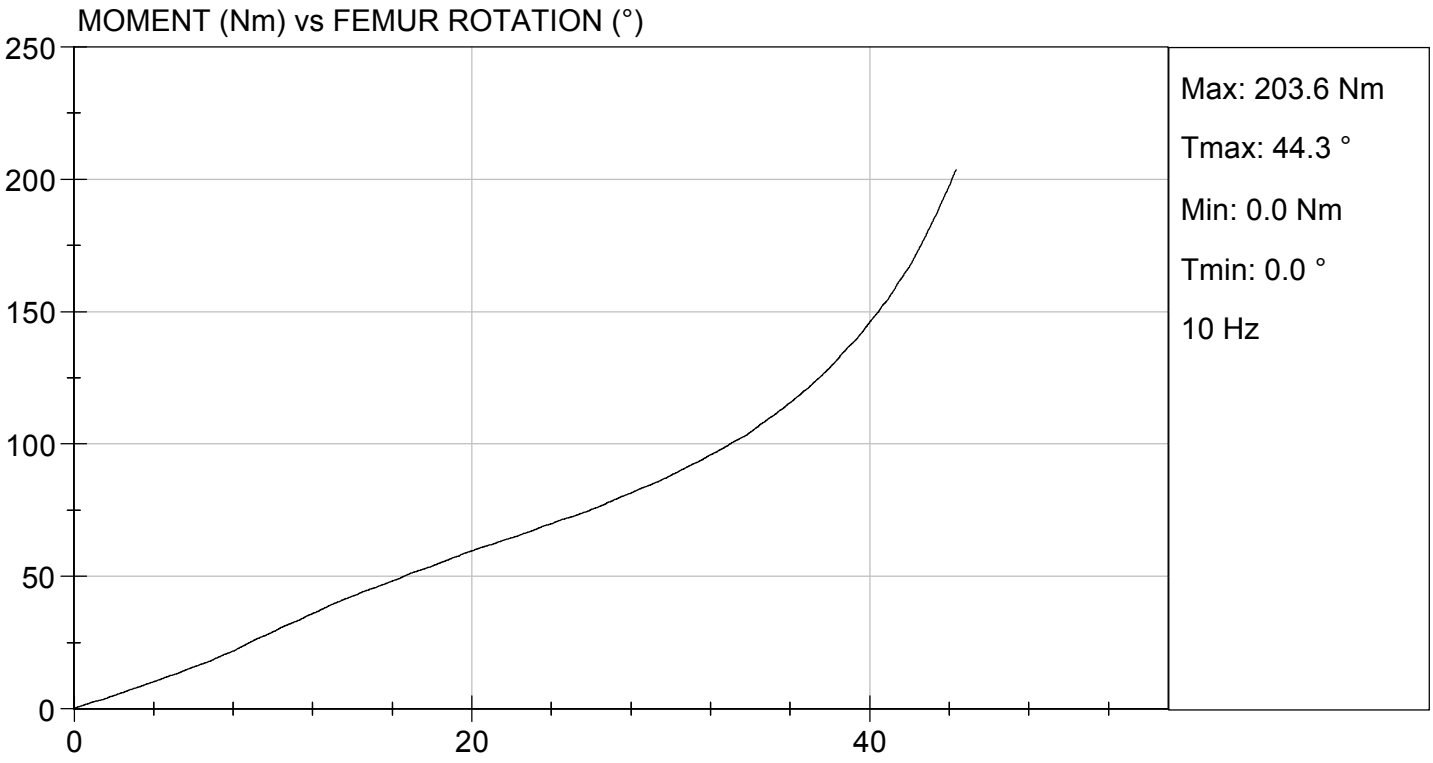
TEST DESC: RIGHT HIP FEMUR FLEXION

TEST DATE: 01/03/2019
TEST #: D190059



TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 01/03/2019
TEST #: D190050



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:** D190191

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	19	Pass
Peak Resultant Acceleration	G's	225 to 275	254	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-14.0	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

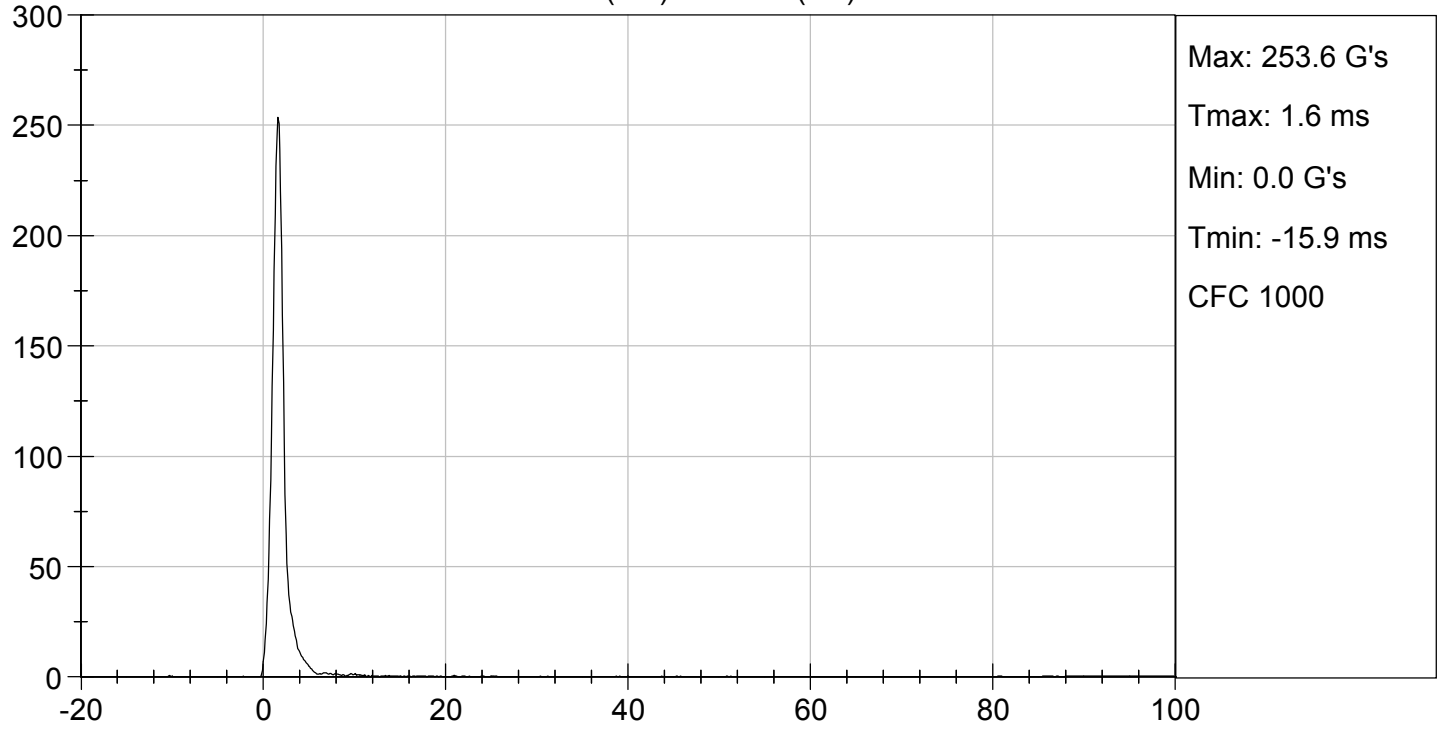
01/14/2019
Test Date

Robert Schmalz
Approved By

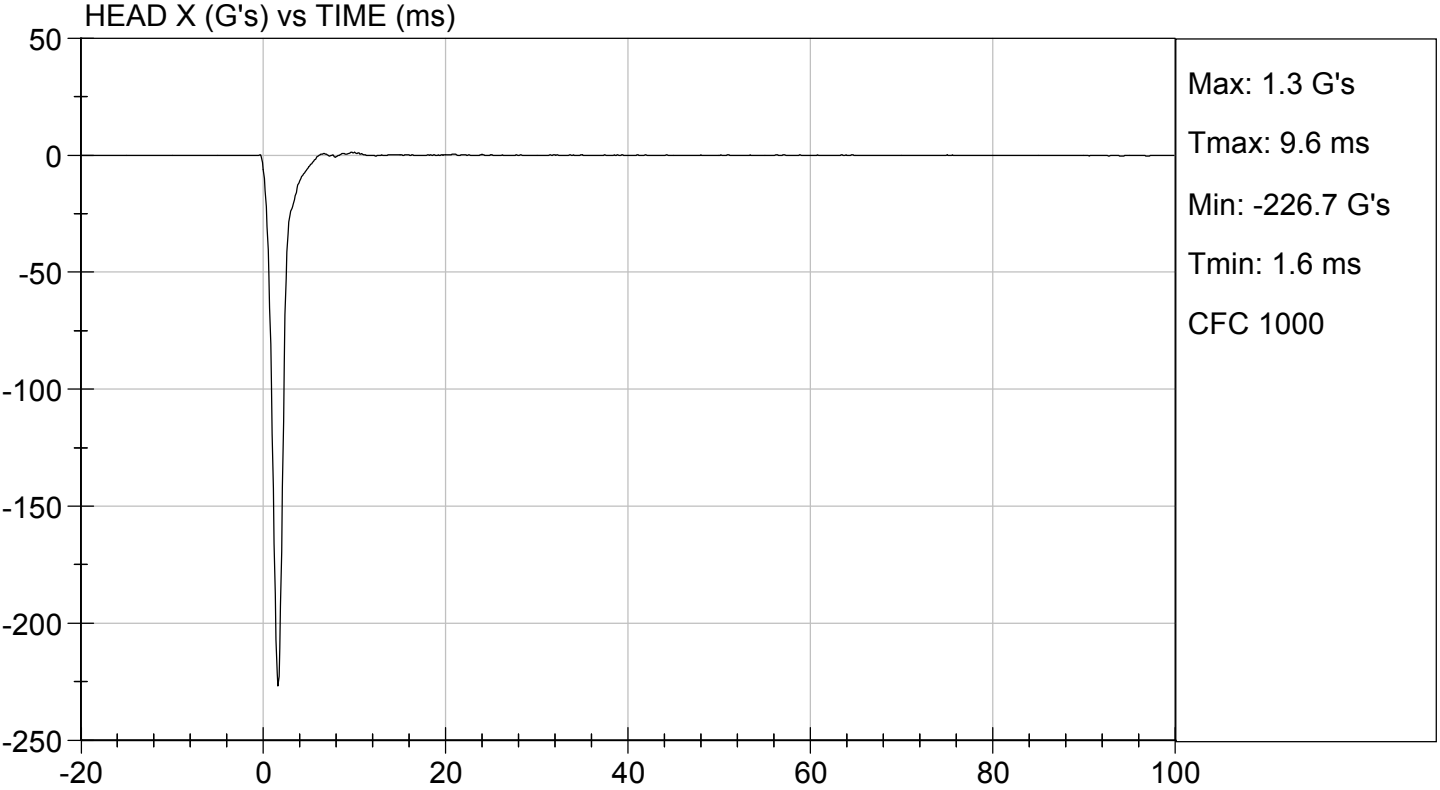
TEST DESC: HEAD DROP

TEST DATE: 01/14/2019
TEST #: D190191

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

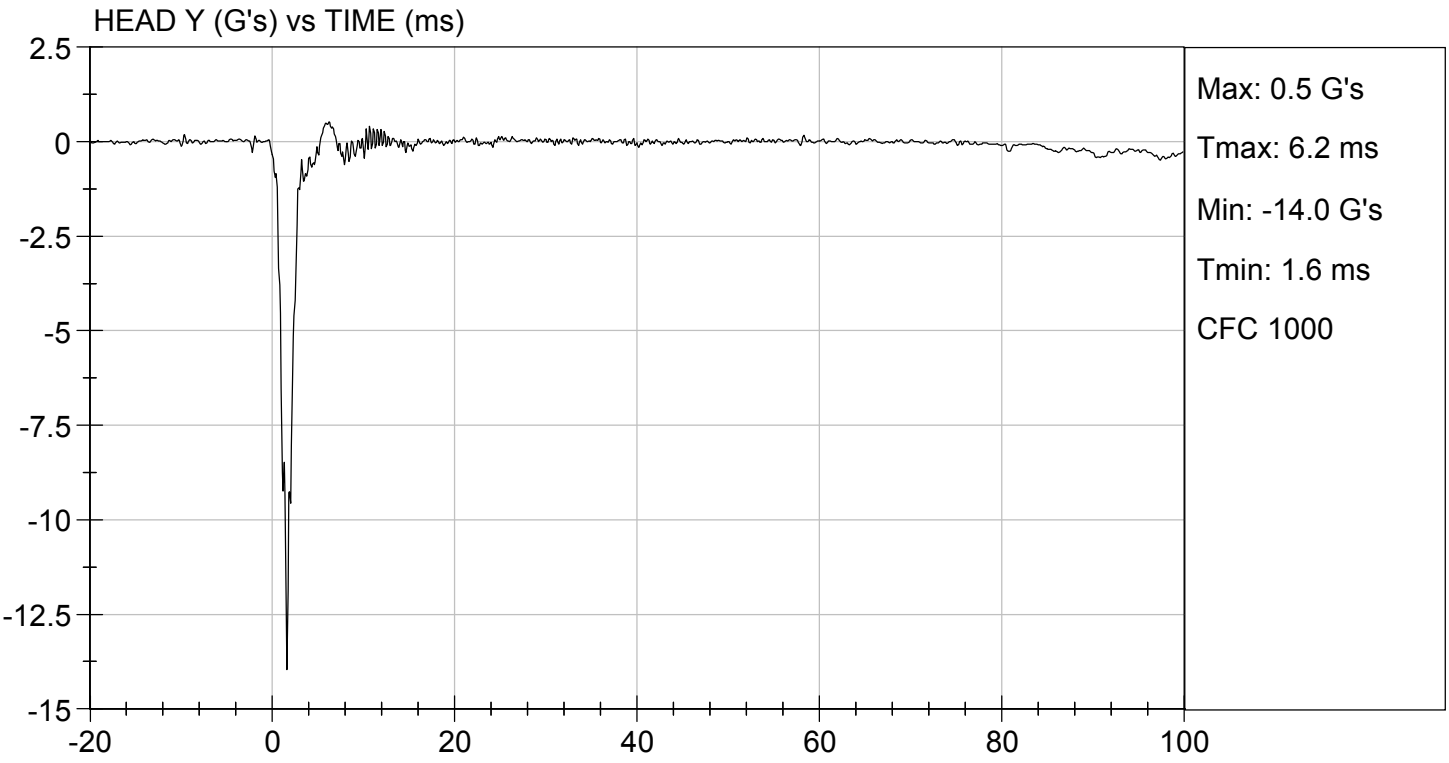


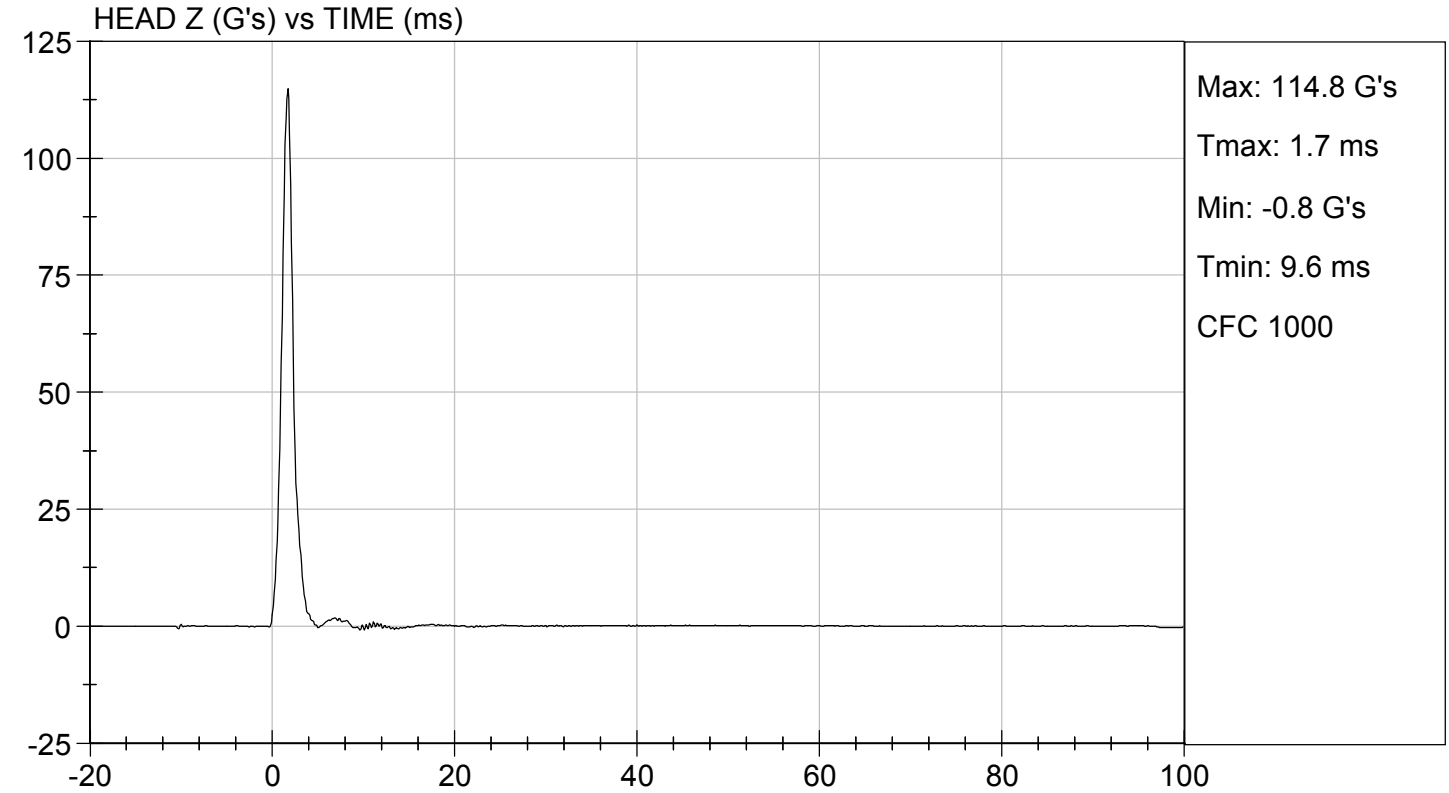
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 01/14/2019
TEST #: D190191





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190192

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	21.4	Pass
Pendulum Velocity		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.37	Pass
	20 ms	G's	17.60 to 22.60	20.57	Pass
	30 ms	G's	12.50 to 18.50	16.42	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	16.4	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	35.5	Pass
Maximum "D" Plane Rotation	Maximum	Deg	64.0 to 78.0	75.1	Pass
	Time	ms	57.0 to 64.0	60.4	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	120.1	Pass
Moment About Occipital Condyle	Maximum	Nm	88.1 to 108.5	91.3	Pass
	Time	ms	47.0 to 58.0	48.8	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	99.2	Pass
			Overall Test Results		Pass

Danielle Redinbaugh

Laboratory Technician

01/14/2019

Test Date

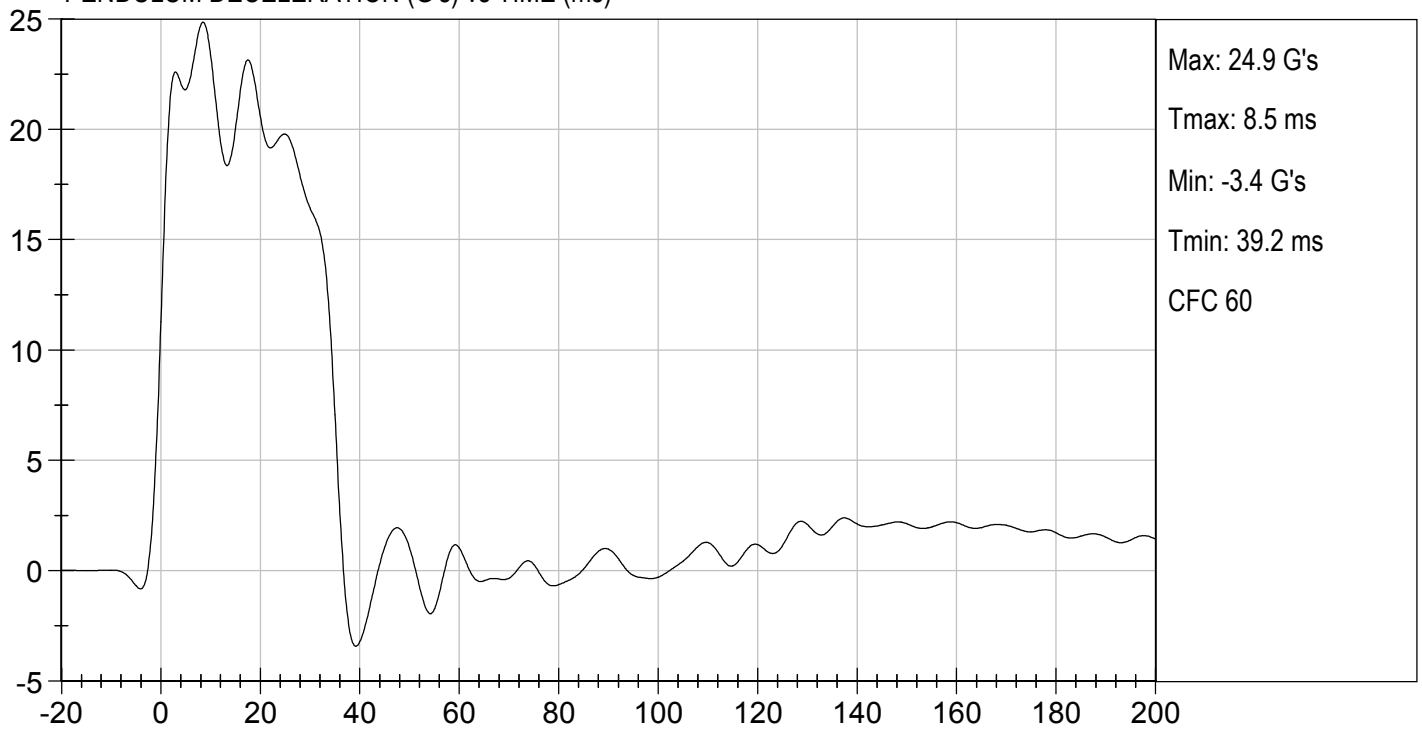
Robert Schmidt

Approved By

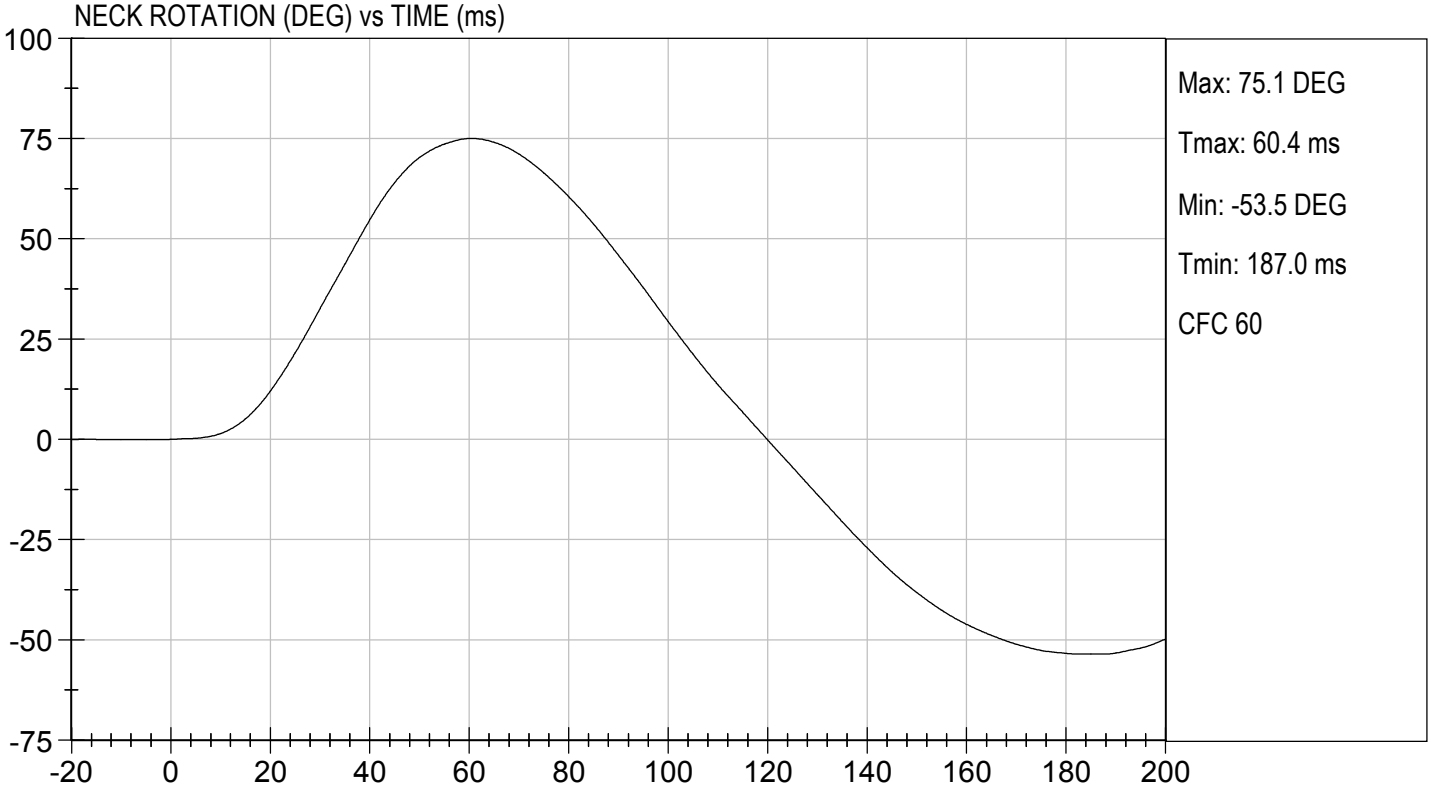
TEST DESC: NECK FLEXION
VELOCITY: 23.15 ft/s, 7.06 m/s

TEST DATE: 01/14/2019
TEST #: D190192

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

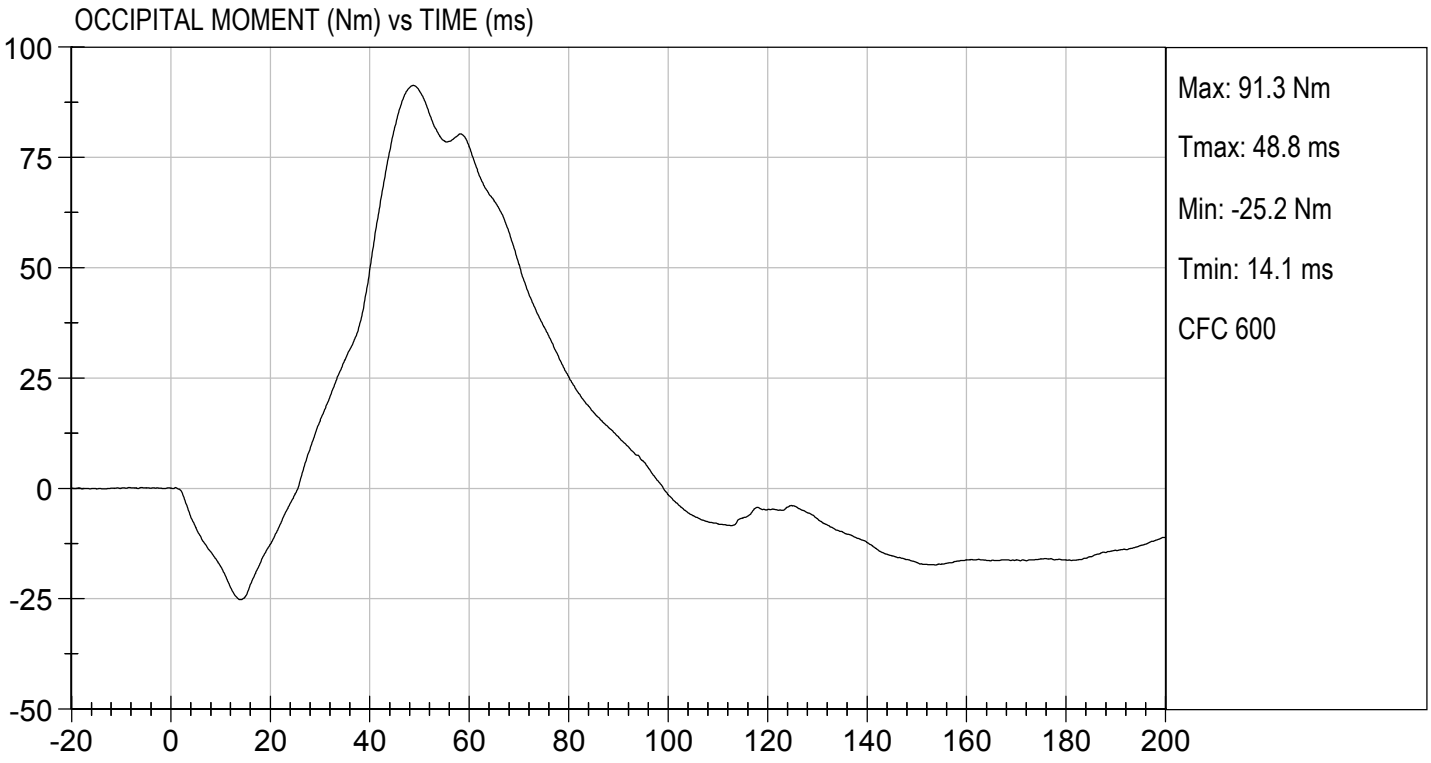


NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 01/14/2019
TEST #: D190192



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190193

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	21.4	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.19	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	18.55	Pass
	20 ms	G's	14.00 to 19.00	16.64	Pass
	30 ms	G's	11.00 to 16.00	13.03	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	13.0	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	40.8	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	104.7	Pass
	Time	ms	72.0 to 82.0	80.6	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	165.5	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-64.5	Pass
	Time	ms	65.0 to 79.0	72.3	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	146.6	Pass
			Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

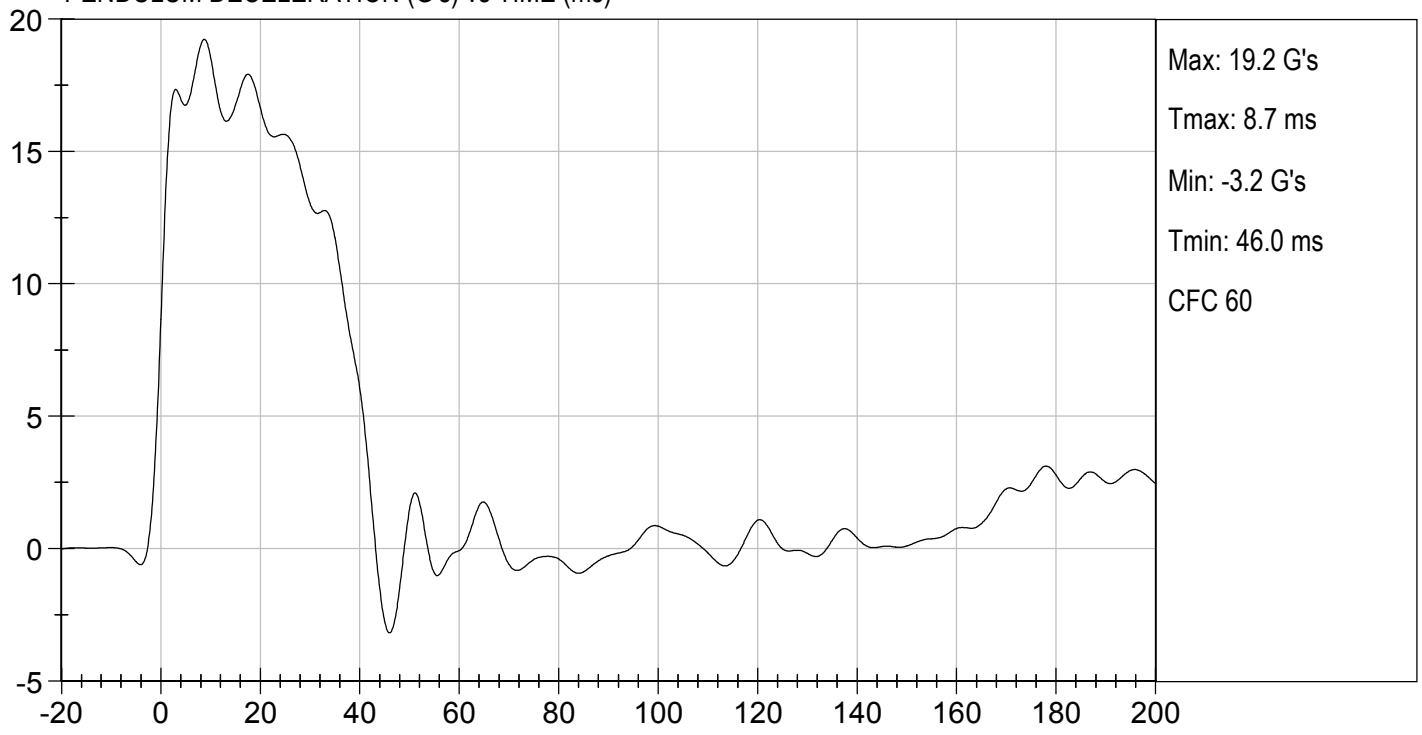
01/14/2019
Test Date

Robert Schmidt
Approved By

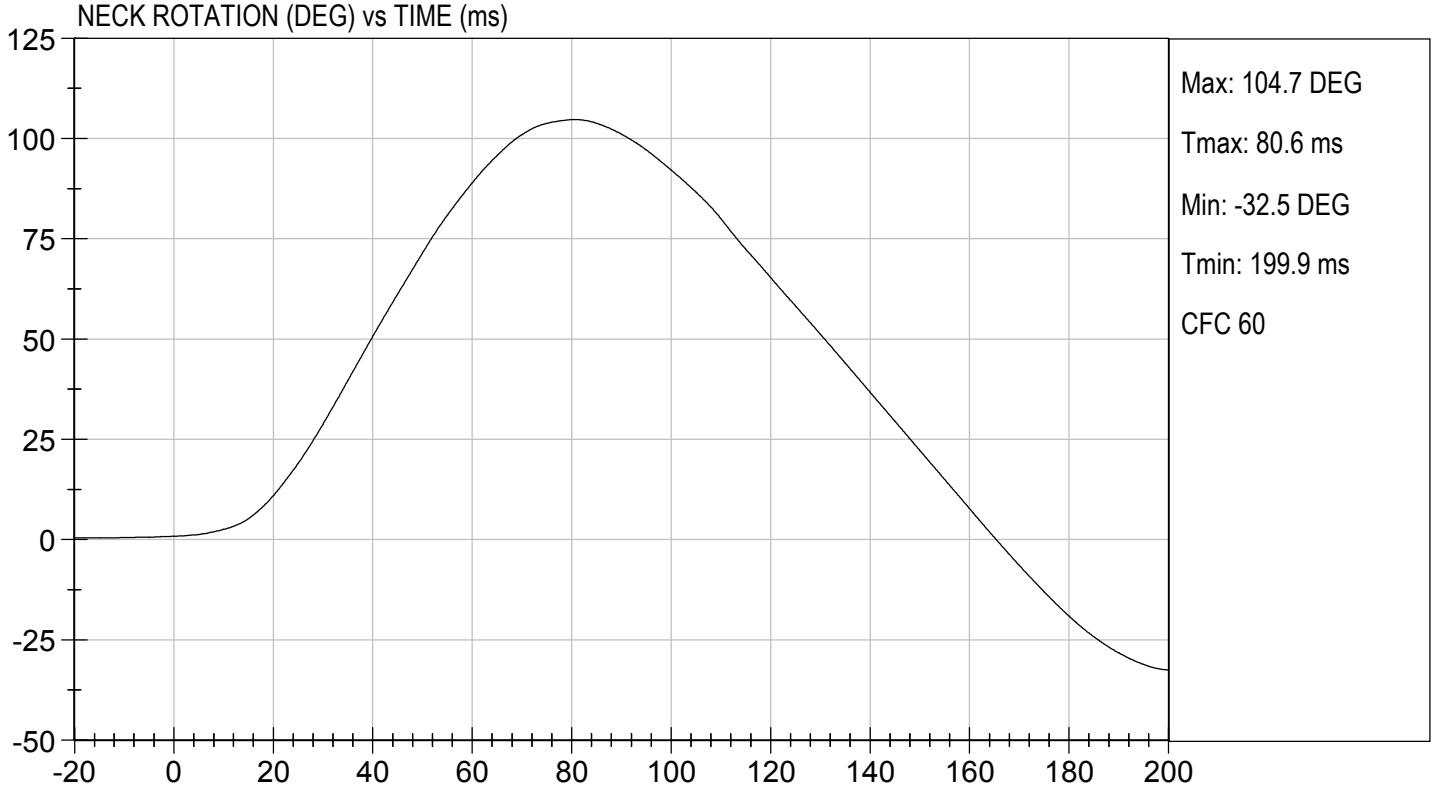
TEST DESC: NECK EXTENSION
VELOCITY: 20.30 ft/s, 6.19 m/s

TEST DATE: 01/14/2019
TEST #: D190193

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



NECK ROTATION (DEG) vs TIME (ms)



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

TEST DATE: 01/14/2019
TEST #: D190193

MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190194

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	22	Pass
Probe Velocity	m/s	6.58 to 6.82	6.60	Pass
Peak Probe Force	N	5159 to 5893	5,505	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.73	Pass
Internal Hysteresis	%	69 to 85	73	Pass
		Overall Test Results		Pass

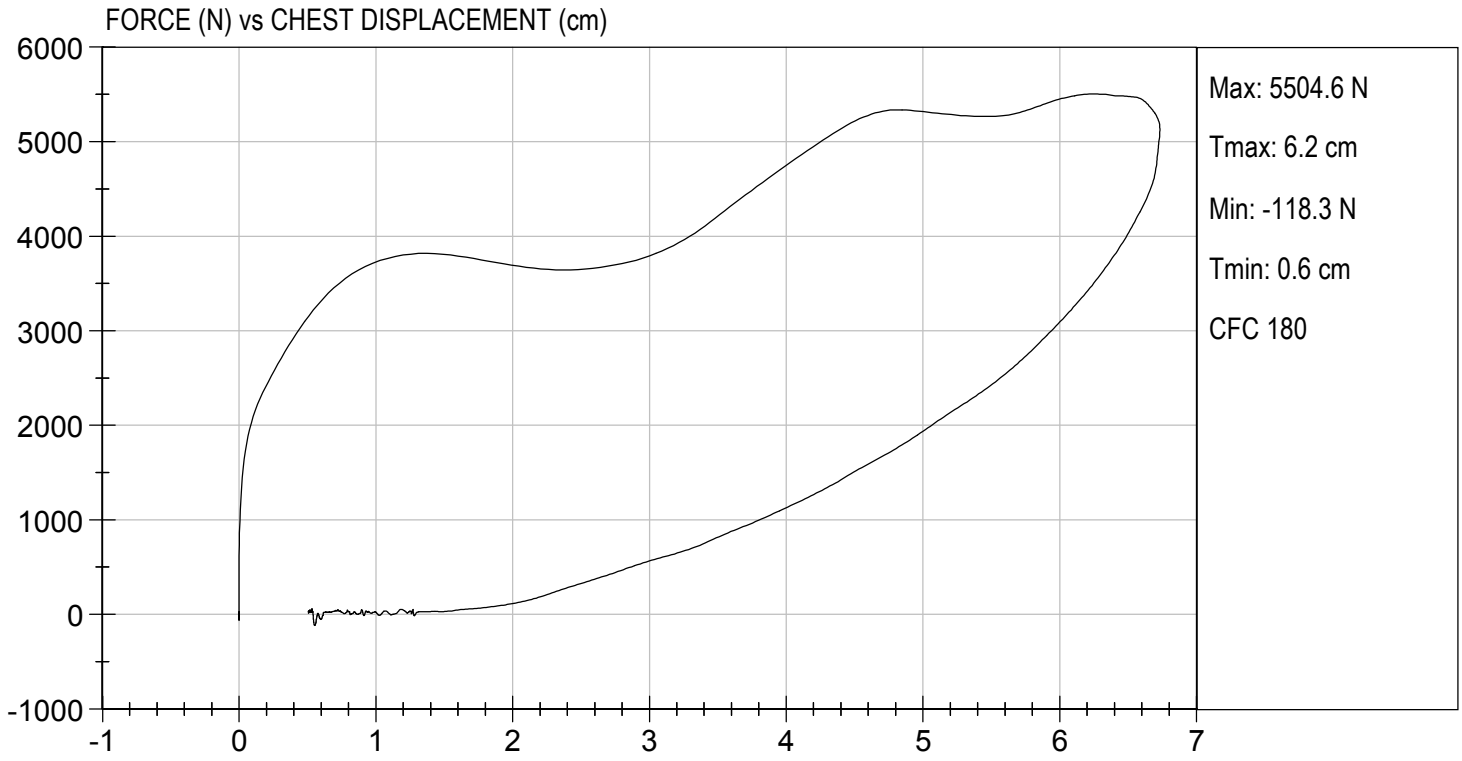
Jacob D Taylor
Laboratory Technician

01/15/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/15/2019
TEST #: D190194



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190195

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	20.3	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	4,728	Pass
		Overall Test Results		Pass

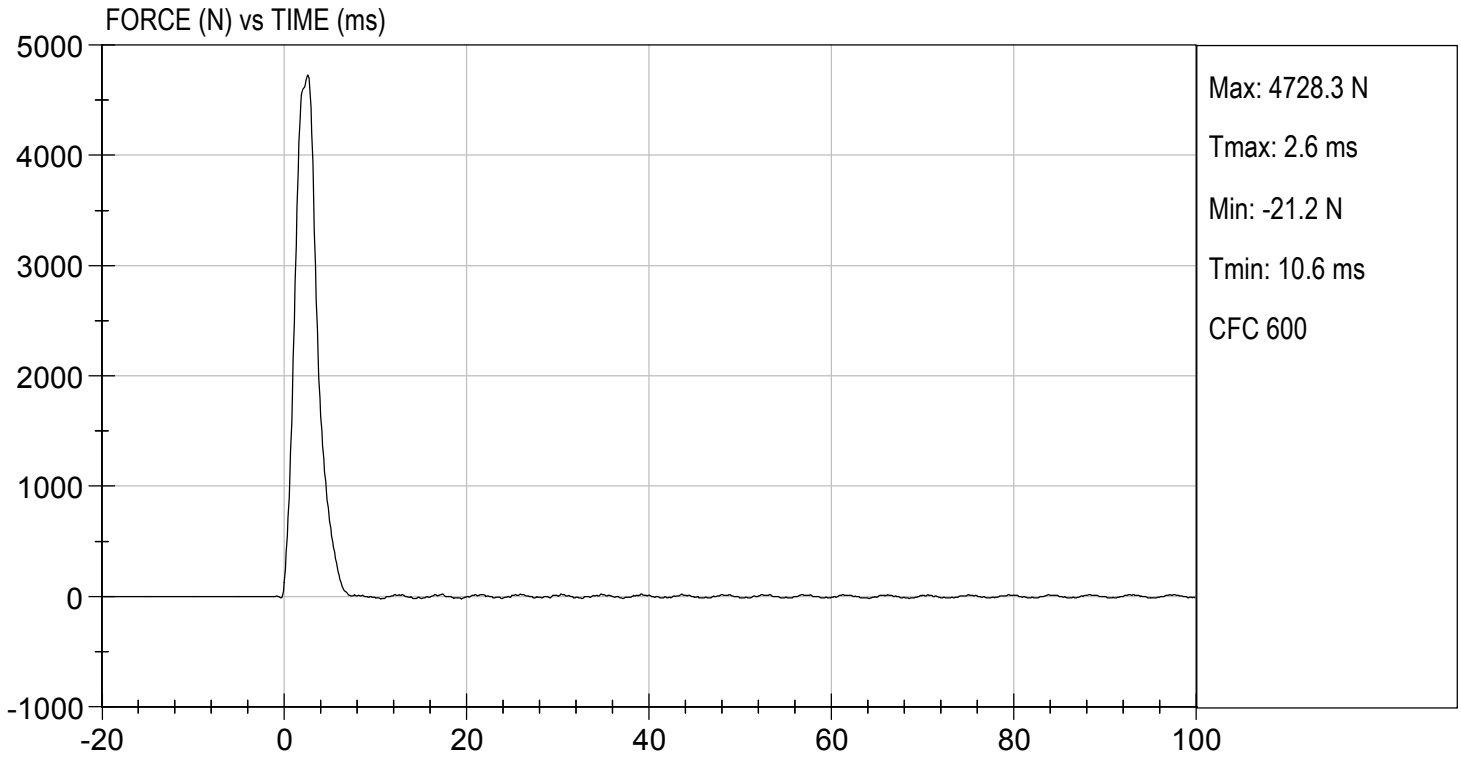
Danielle Redinbaugh
Laboratory Technician

01/14/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/14/2019
TEST #: D190195



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351 **Test I.D:** D190196

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	20.3	Pass
Probe Velocity	m/s	2.07 to 2.13	2.12	Pass
Peak Probe Force	N	4715 to 5782	5,162	Pass
		Overall Test Results		Pass

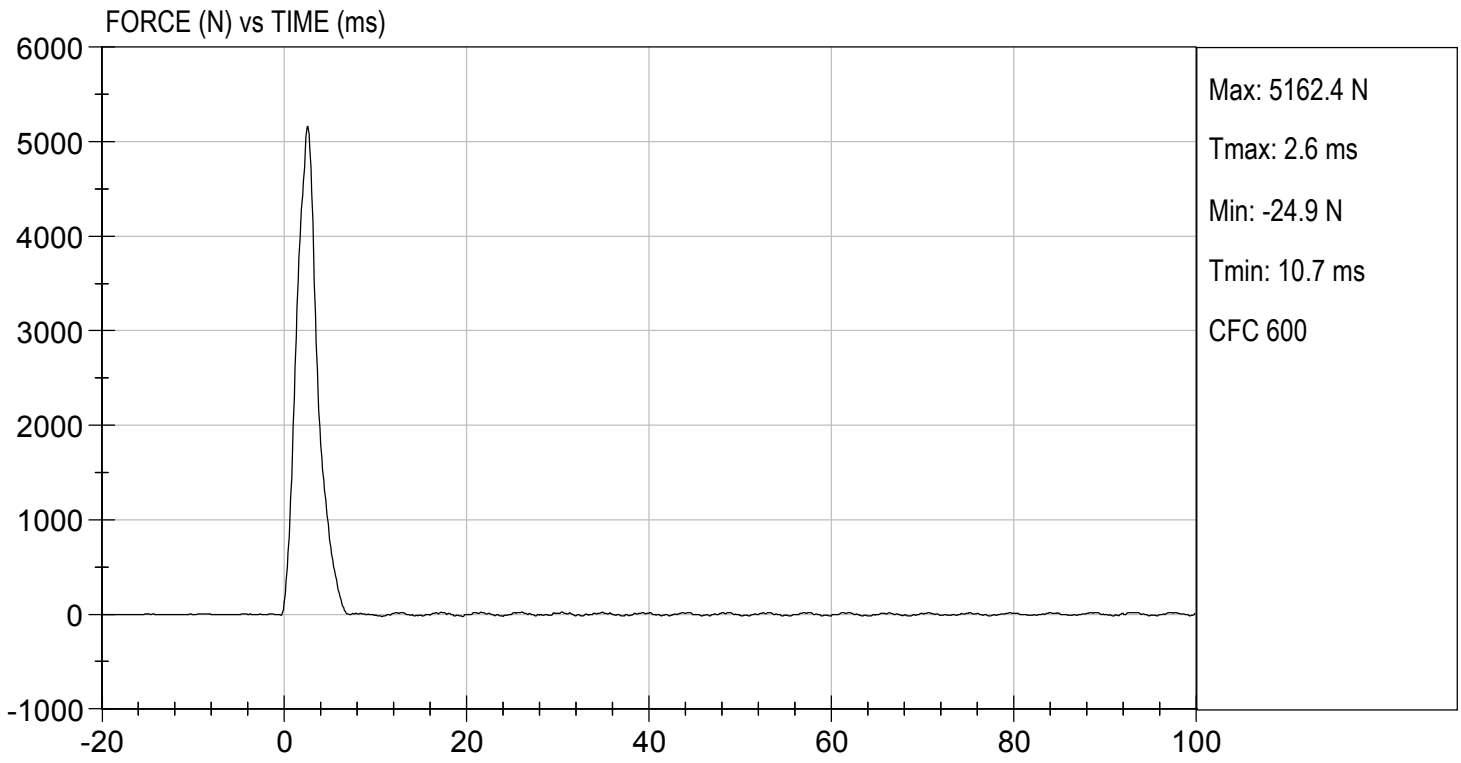
Danielle Redenbaugh
Laboratory Technician

01/14/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/14/2019
TEST #: D190196



MGA RESEARCH CORPORATION

HIP-FEMUR FLEXION TEST

HYBRID III 50TH PERCENTILE MALE

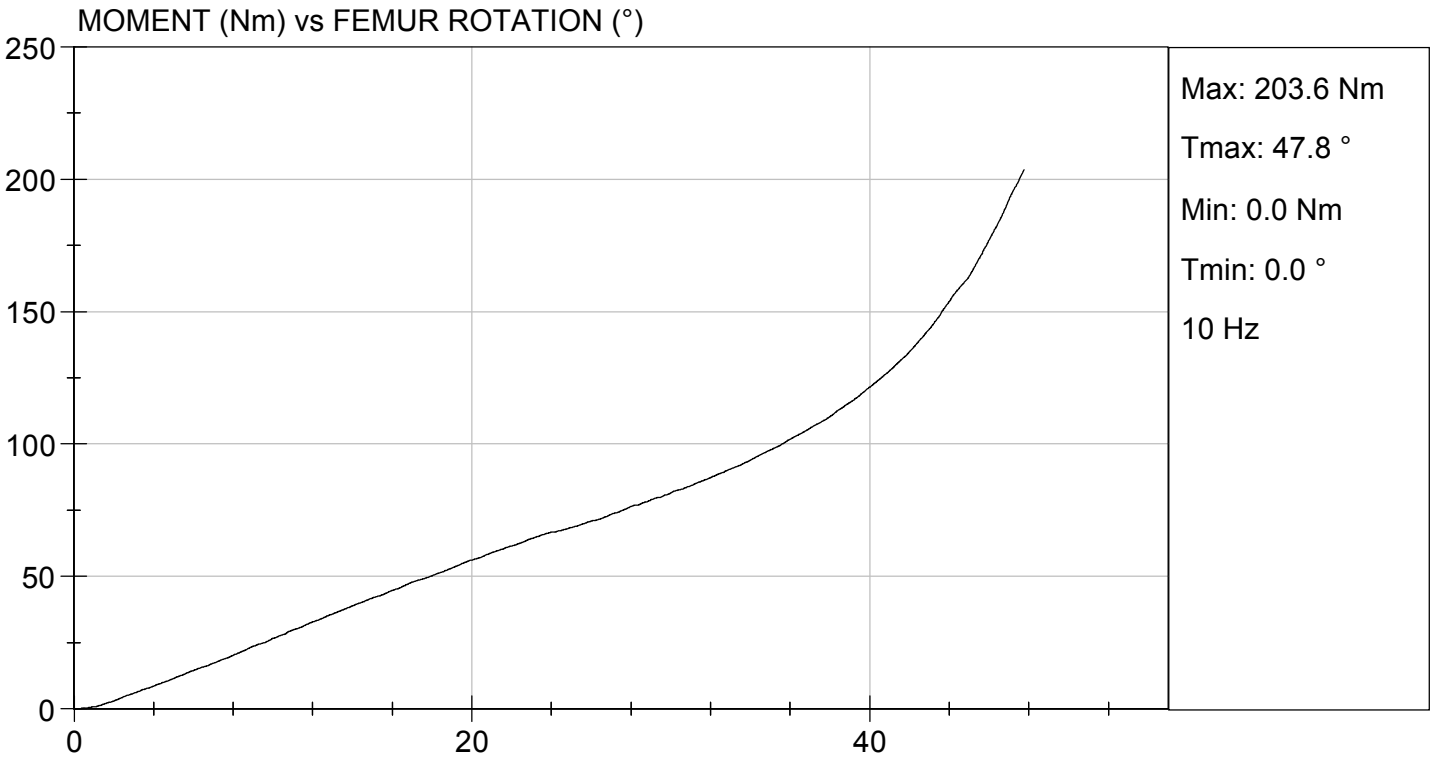
ATD Serial No: 351 **Test I.D:** D190190

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.5	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	22	22	Pass
Rotation Rate	deg/s	5.0 to 10.0	6.5	6.4	Pass
30 Degrees	Nm	94.9 Nm Max	81.6	87.7	Pass
150 ft-lbf / 203.4 Nm	Deg	40.0 to 50.0 Degree Max Rotation	47.8	44.4	Pass
		Overall Test Results			Pass

Danielle Redinbaugh
Laboratory Technician

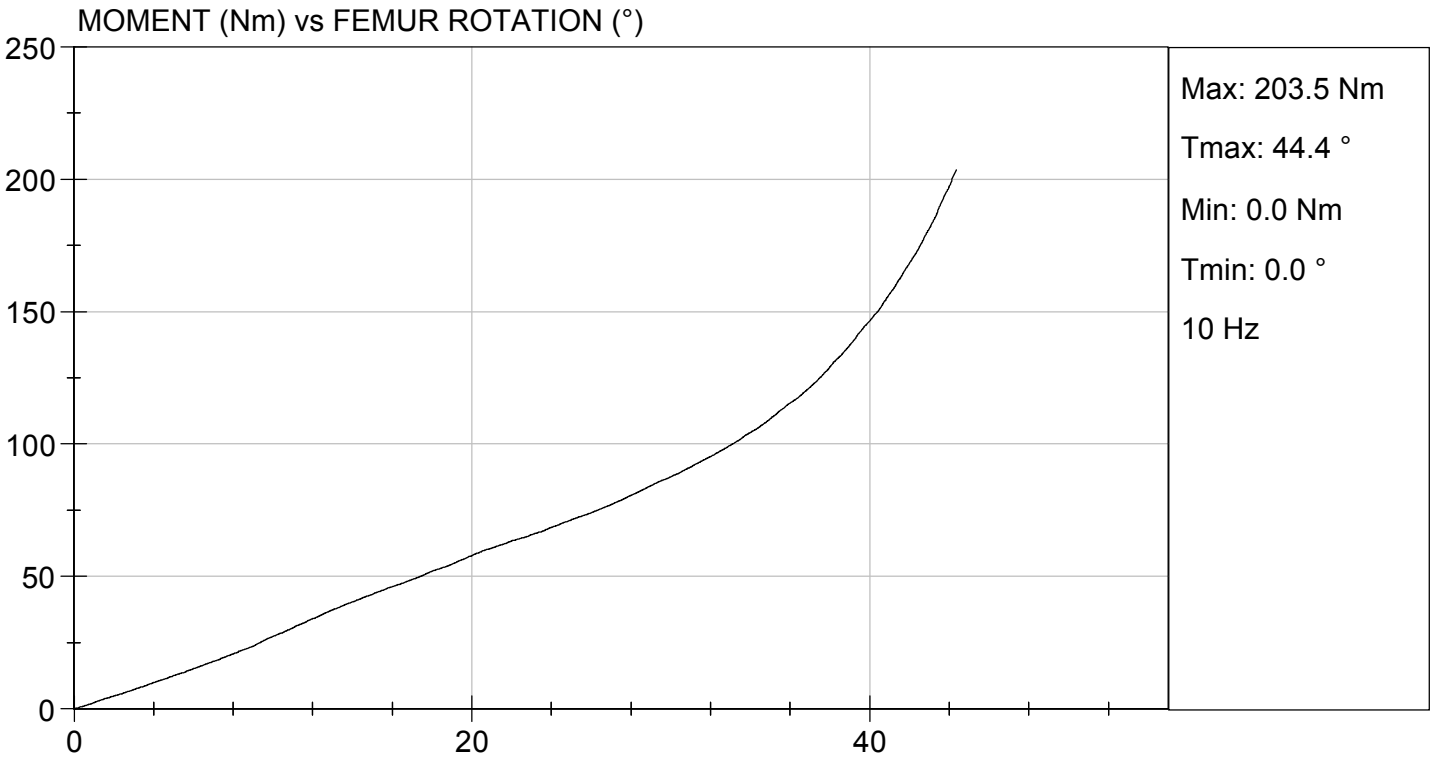
01/14/2019
Test Date

Robert Schmidt
Approved By


MOMENT (Nm) vs FEMUR ROTATION (°)
250
200
150
100
50
0
0
20
40
Max: 203.6 Nm
Tmax: 47.8 °
Min: 0.0 Nm
Tmin: 0.0 °
10 Hz

TEST DESC: LEFT HIP FEMUR FLEXION

TEST DATE: 01/14/2019
TEST #: D190190



CALIBRATION TEST RESULTS

PRE-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

Hybrid III, 5th External Measurements
SN: 138

HYBRID III, PART 572, SUBPART O EXTERNAL DIMENSIONS				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (mm)	ACTUAL MEASUREMENT
A	TOTAL SITTING HEIGHT	Seat surface to highest point on top of the head.	774.7-800.1	785.1
B	SHOULDER PIVOT HEIGHT	Centerline of shoulder pivot bolt to the seat surface.	431.8-457.2	456.8
C	H-POINT HEIGHT	Reference	81.3-86.3	84.0
D	H-POINT LOCATION FROM BACKLINE	Reference	144.8-149.8	146.2
E	SHOULDER PIVOT FROM BACKLINE	Center of the shoulder clevis to the rear vertical surface of the fixture.	68.6-83.8	78.0
F	THIGH CLEARANCE	Measured at the highest point on the upper femur segment.	119.4-134.6	127.5
G	BACK OF ELBOW TO WRIST PIVOT	back of the elbow flesh to the wrist pivot in line with the elbow and wrist pivots	243.9-259.1	249.6
H	HEAD BACK TO BACKLINE	Back of Skull cap skin to seat rear vertical surface (Reference)	43.2-48.2	45.0
I	SHOULDER TO- ELBOW LENGTH	Measure from the highest point on top of the shoulder clevis to the lowest part of the flesh on the elbow in line with the elbow pivot bolt.	276.8-297.2	280.2
J	ELBOW REST HEIGHT	Measure from the flesh below the elbow pivot bolt to the seat surface.	182.8-203.2	201.9
K	BUTTOCK TO KNEE LENGTH	The forward most part of the knee flesh to the rear vertical surface of the fixture.	520.7-546.1	526.7
L	POPLITEAL HEIGHT	Seat surface to the plane of the horizontal plane of the bottom of the feet.	355.6-376.0	362.3
M	KNEE PIVOT HEIGHT	Centerline of knee pivot bolt to the horizontal plane of the bottom of the feet.	393.7-419.1	398.0

N	BUTTOCK POPLITEAL LENGTH	The rearmost surface of the lower leg to the same point on the rear surface of the buttocks used for dim. “K”.	414-439.4	430.5
HYBRID III, SUBPART O EXTERNAL DIMENSIONS, continued				
DIMENSION	DESCRIPTION	DETAILS	ASSEMBLY DIMENSION (mm)	ACTUAL MEASUREMENT
O	CHEST DEPTH WITHOUT JACKET	Measured 304.8 ± 5.1 mm above seat surface	175.3-190.5	184.6
P	FOOT LENGTH	Tip of toe to rear of heal	218.5-233.7	221.0
Q	STANDING HEIGHT	(THEORETICAL)	1501.1	N/A
R	BUTTOCK TO KNEE PIVOT LENGTH	The rear surface of the buttocks to the knee pivot bolt	457.2-482.6	472.6
S	HEAD BREADTH	The widest part of the head	137.1-147.3	141.9
T	HEAD DEPTH	Back of the head to the forehead	177.8-188.0	184.2
U	HIP BREADTH	The widest part of the hip	299.7-314.9	307.4
V	SHOULDER BREADTH	Outside edges of right and left shoulder clevises	350.5-365.7	360.5
W	FOOT BREADTH	The widest part of the foot	78.8-94.0	85.0
X	HEAD CIRCUMFERENCE	Measured at the point as in dim. “T”	528.3-548.7	546.2
Y	CHEST CIRCUMFERENCE (WITH CHEST JACKET)	Measured 345.4 ± 12.7 mm above seat surface	850.9-881.3	875.1
Z	WAIST CIRCUMFERENCE	Measured 165.1 ± 5.1 mm above seat surface	759.5-789.9	785.4
AA	REFERENCE LOCATION FOR MEASUREMENT OF CHEST CIRCUMFERENCE	Reference	332.7-358.1	345.4
BB	REFERENCE LOCATION FOR MEASUREMENT OF WAIST CIRCUMFERENCE	Reference	160.1-170.2	165.1

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test ID:** D190061

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	21.7	Pass
Peak Resultant Acceleration	G's	250 to 300	281	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-3.0	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

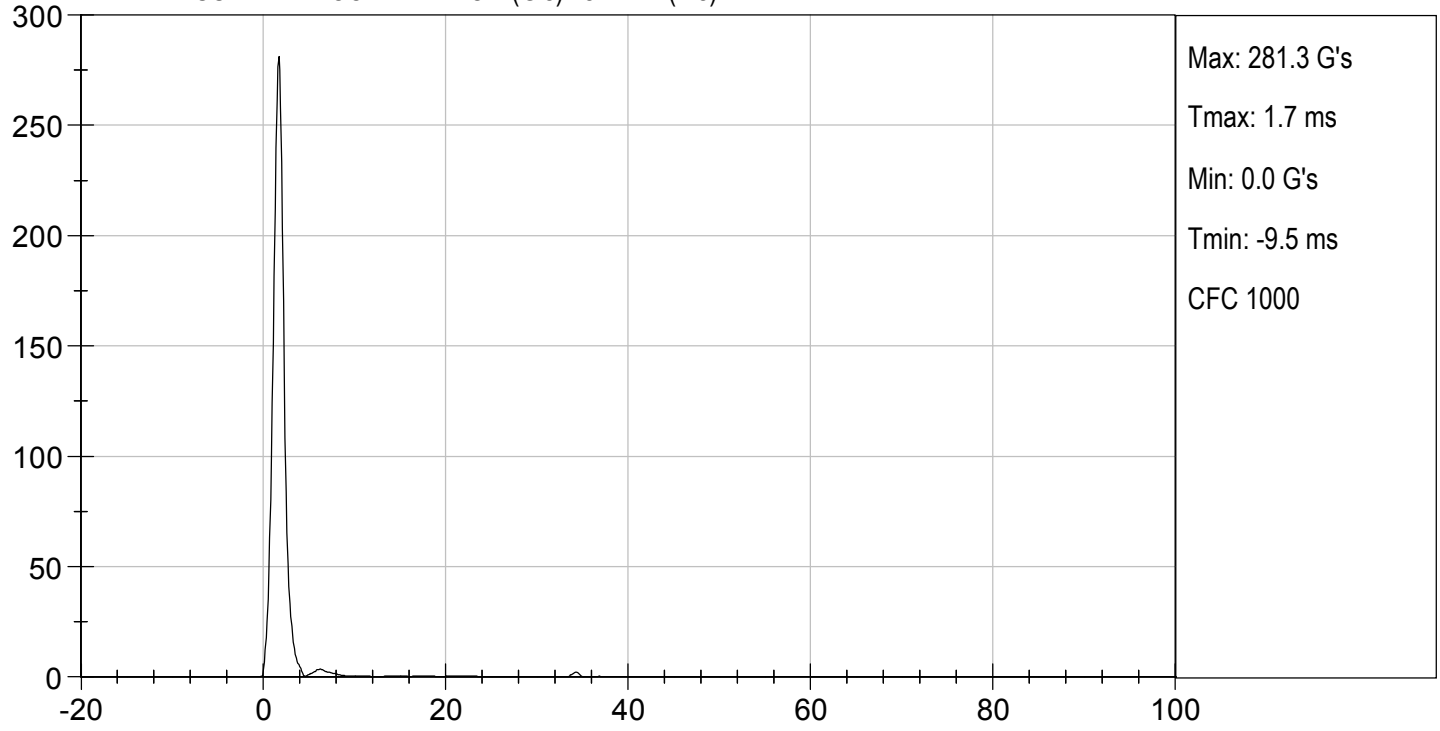
01/03/2019
Test Date

Robert Schmidt
Approved By

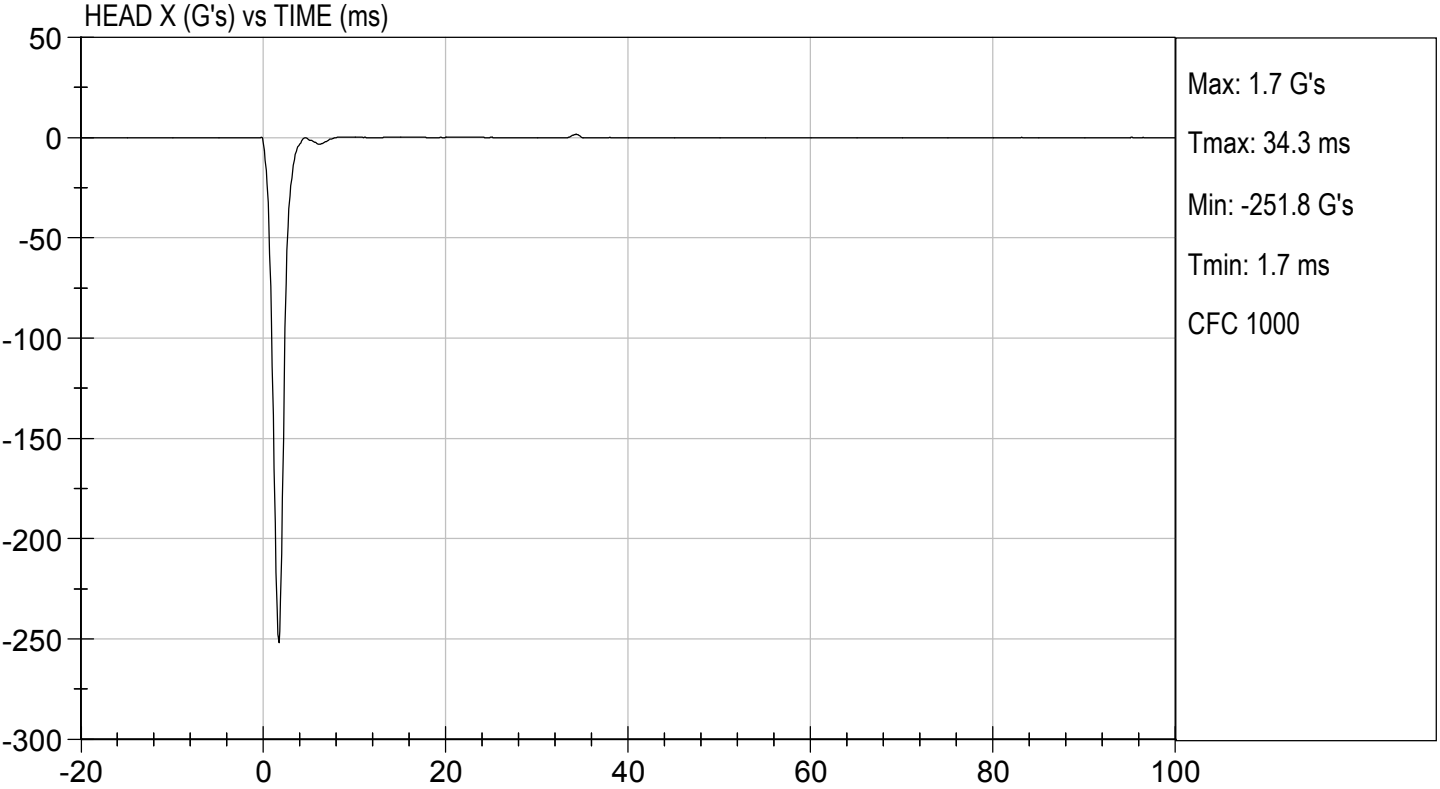
TEST DESC: HEAD DROP

TEST DATE: 01/03/2019
TEST #: D190061

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

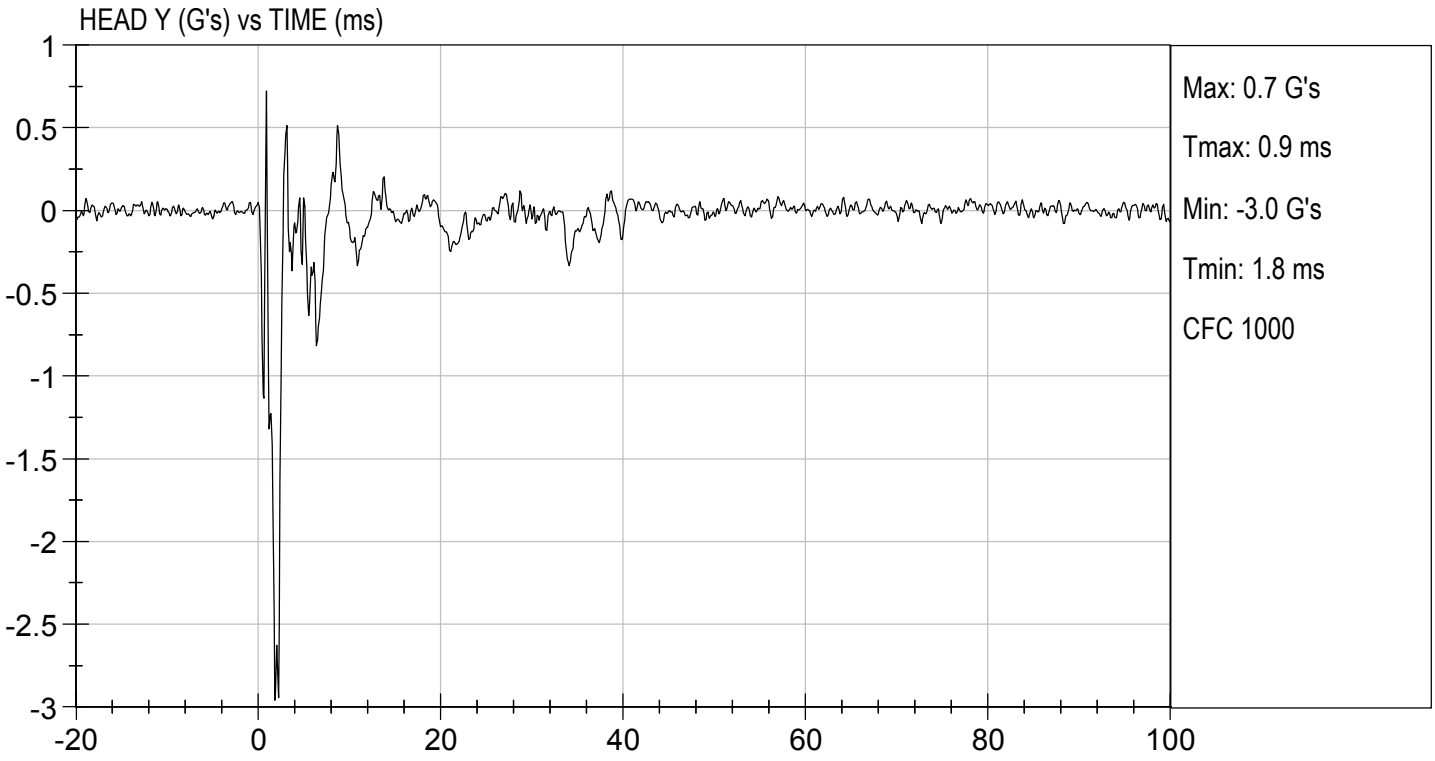


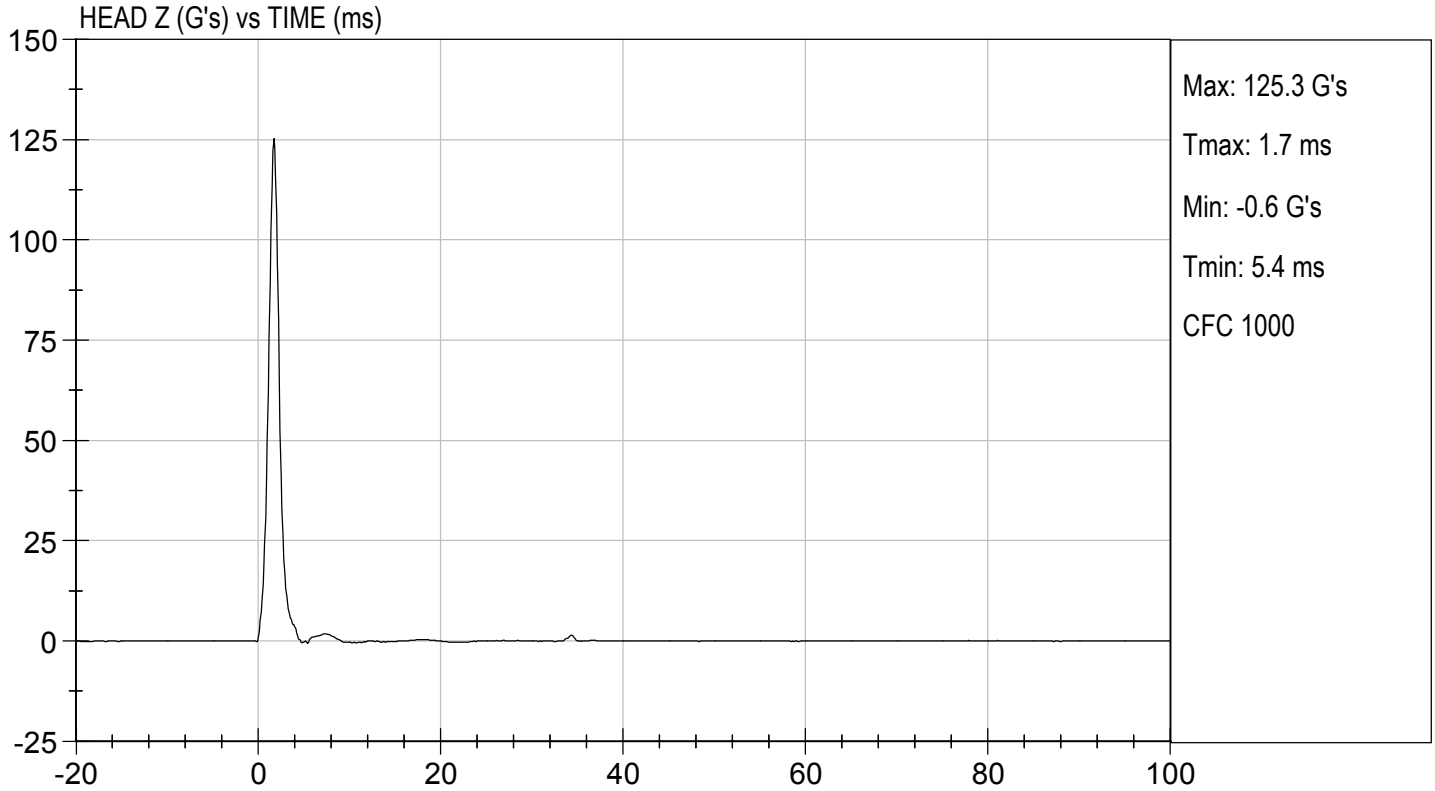
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 01/03/2019
TEST #: D190061





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190062

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	23	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.04	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.4	Pass
	20 ms	m/s	4.0 to 5.0	4.8	Pass
	30 ms	m/s	5.8 to 7.0	7.0	Pass
D Plane Rotation	Max	deg	77 to 91	83	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

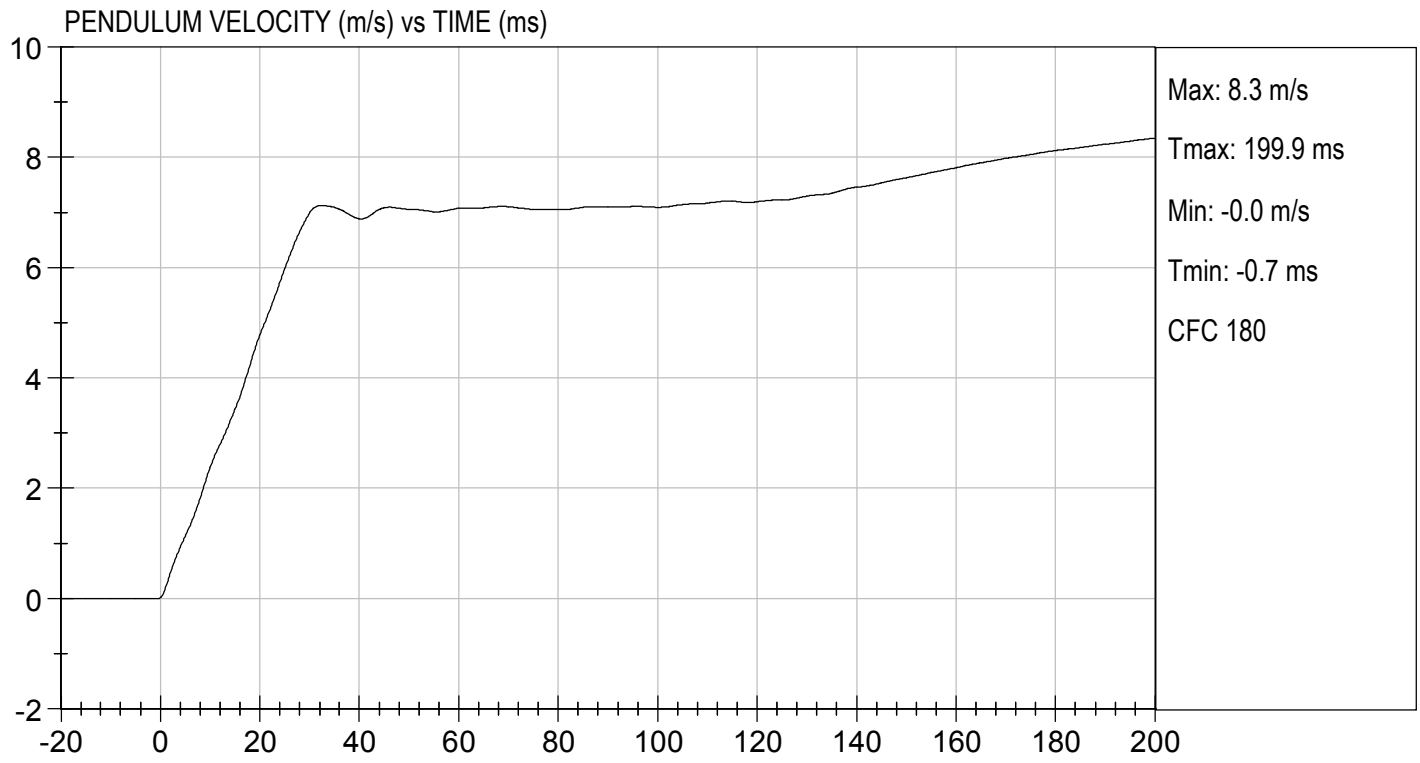
Danielle Redinbaugh
Laboratory Technician

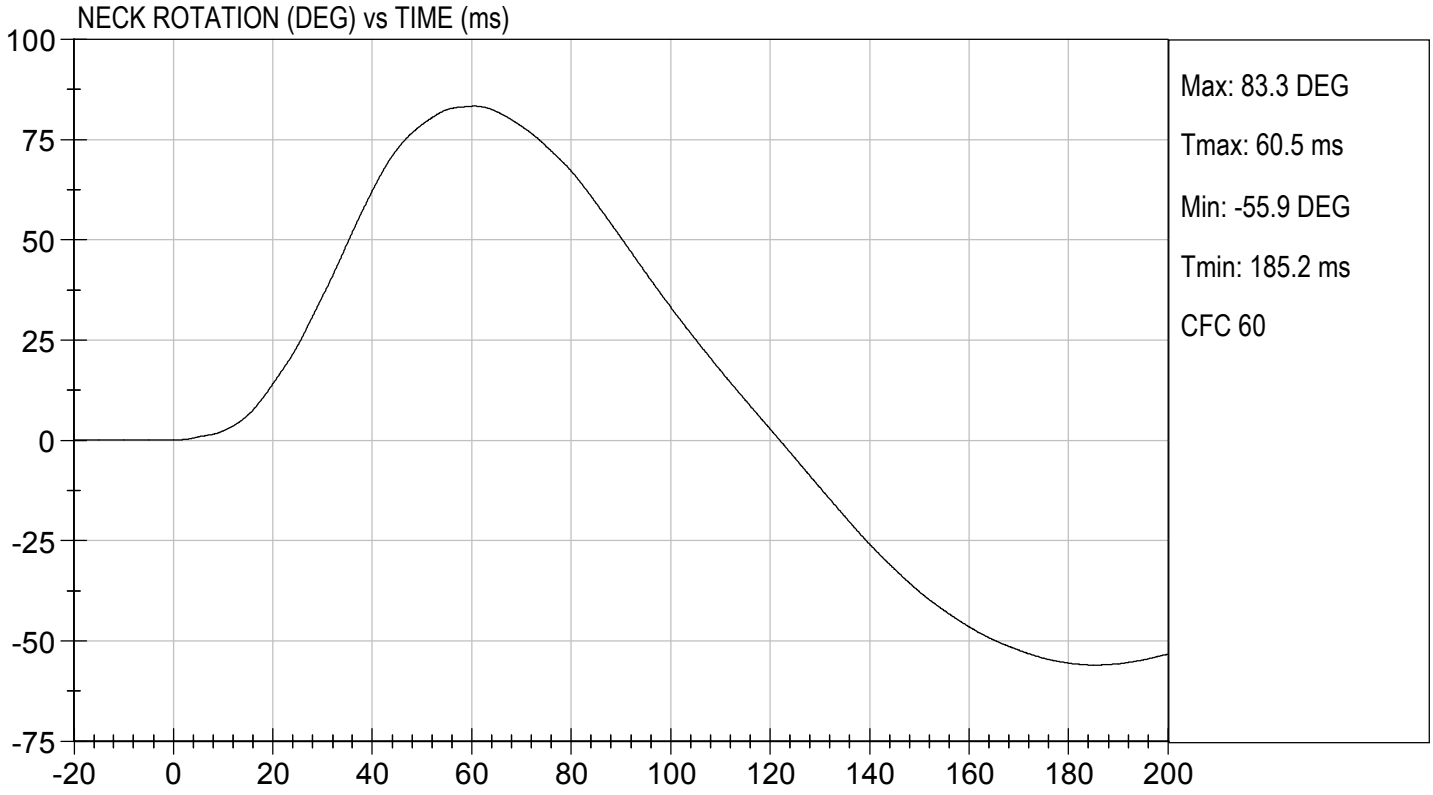
01/04/2019
Test Date

Robert Schmidt
Approved By

TEST DESC: NECK FLEXION
VELOCITY: 23.10 ft/s, 7.04 m/s

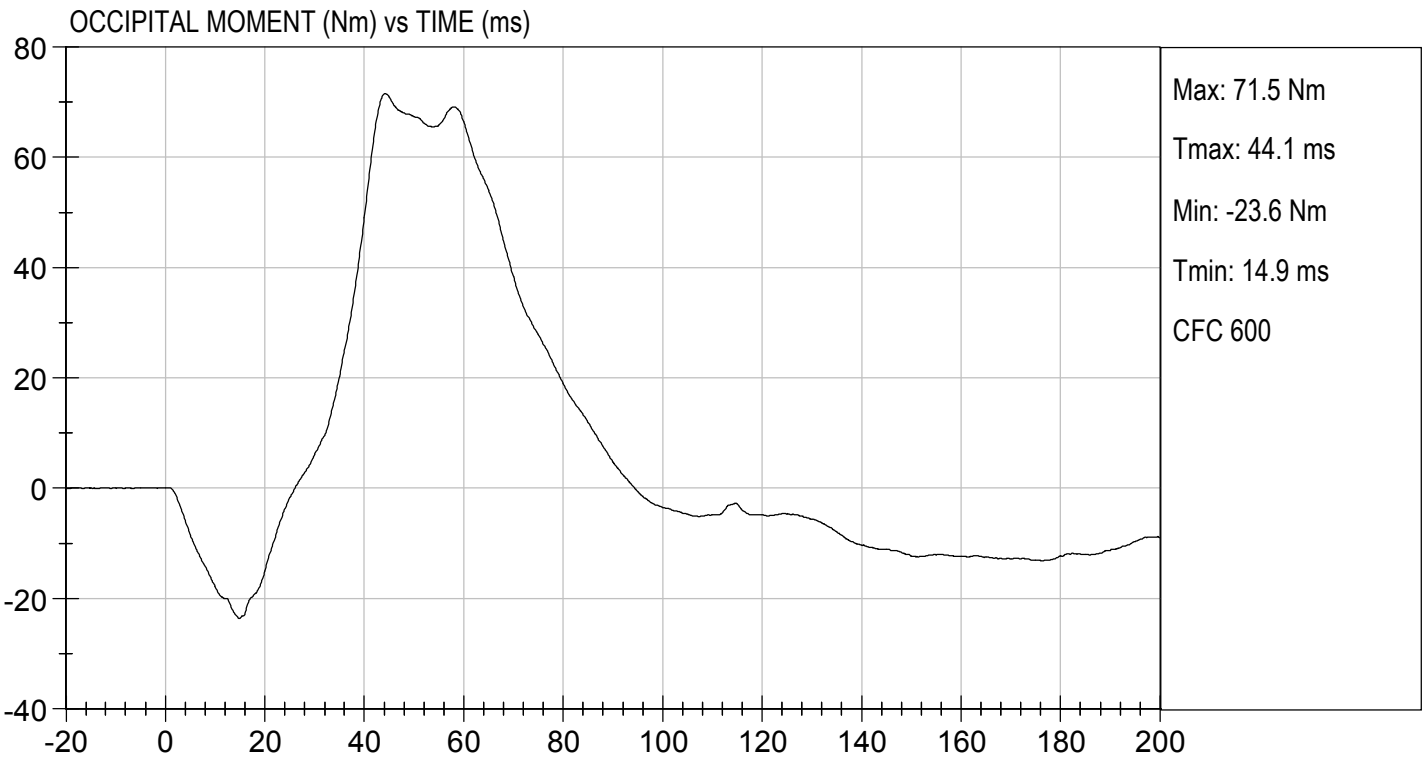
TEST DATE: 01/04/2019
TEST #: D190062





TEST DESC: NECK FLEXION
VELOCITY: 23.10 ft/s, 7.04 m/s

TEST DATE: 01/04/2019
TEST #: D190062



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190063

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	23	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	5.3	Pass
D Plane Rotation	Max	deg	99 to 114	107	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-57	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	103	Pass
			Overall Results		Pass

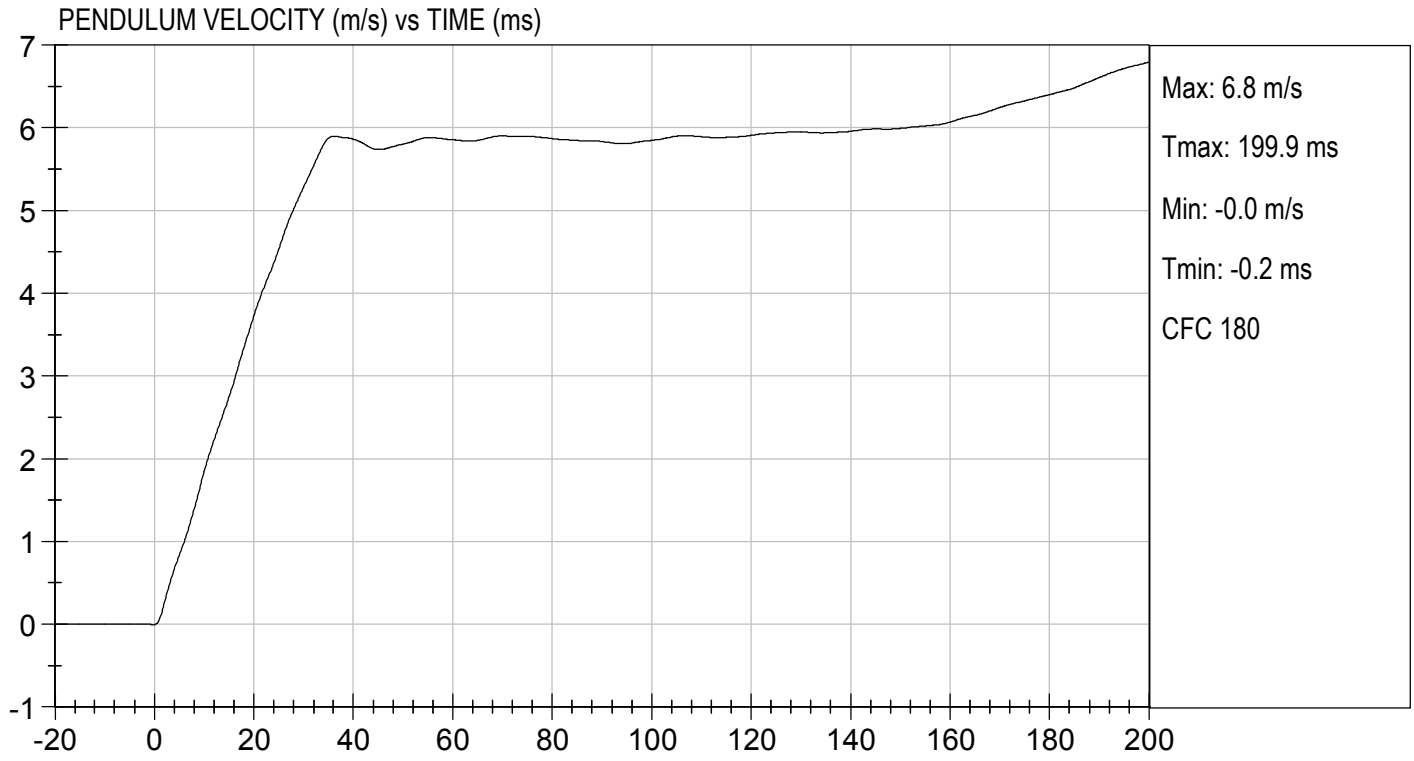
Danielle Redinbaugh
Laboratory Technician

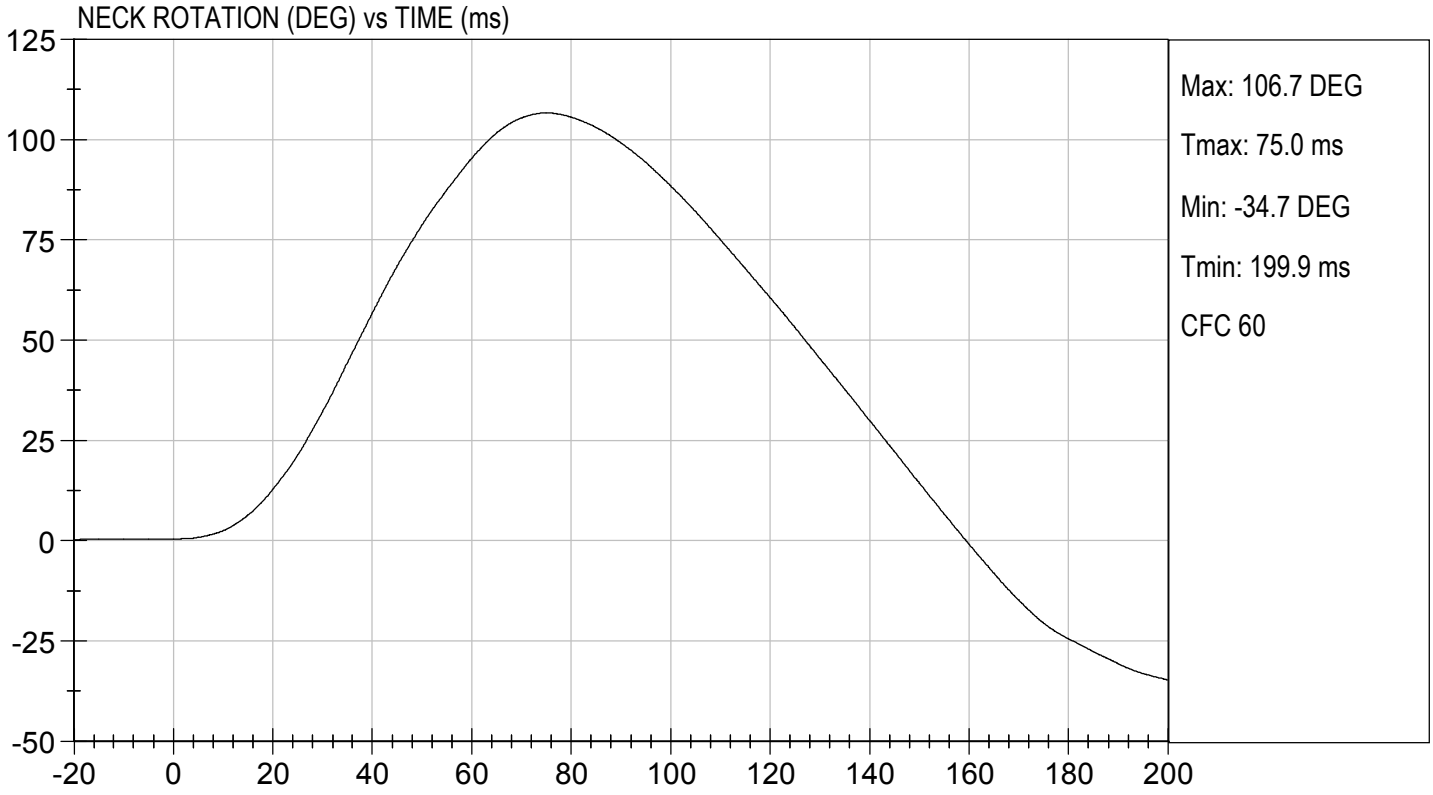
01/04/2019
Test Date

Robert Schmidt
Approved By

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

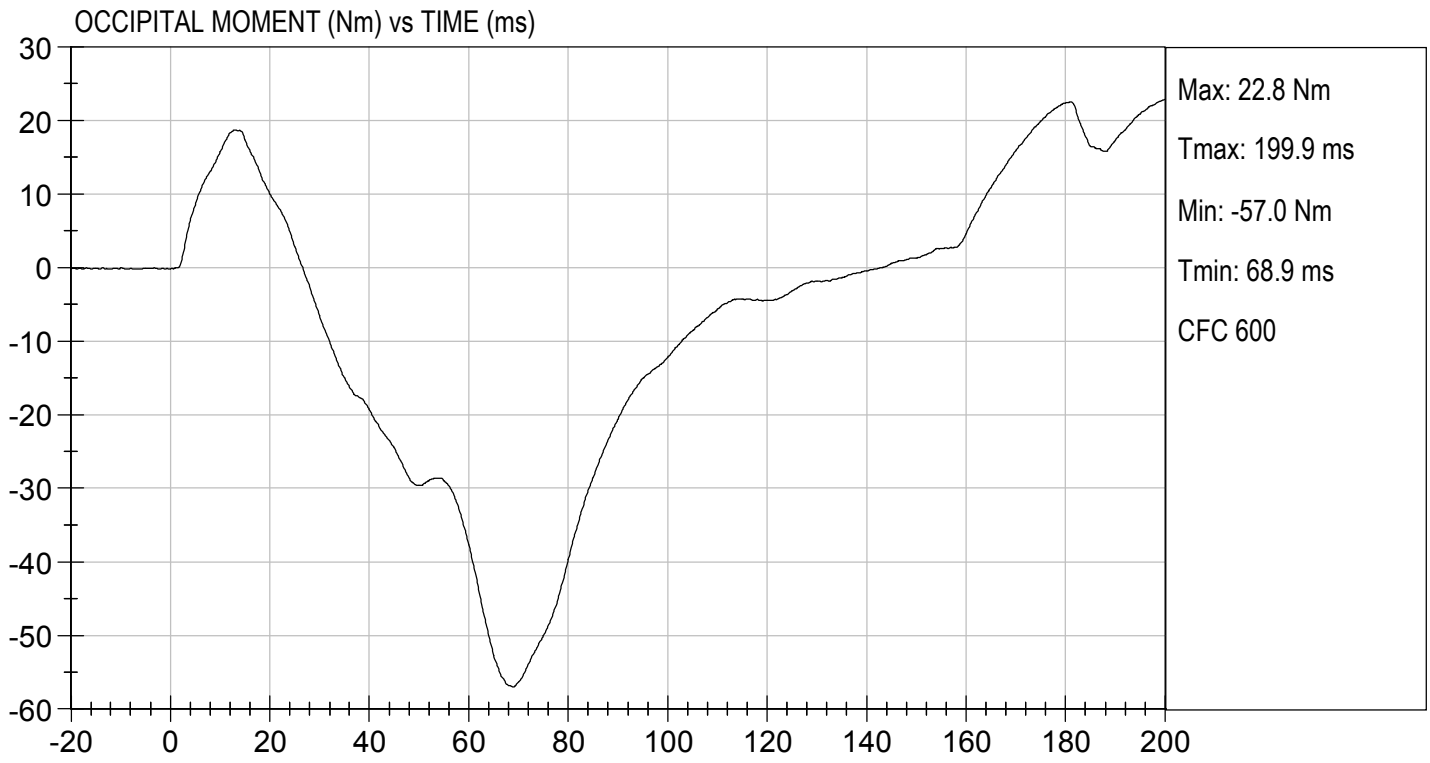
TEST DATE: 01/04/2019
TEST #: D190063





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

TEST DATE: 01/04/2019
TEST #: D190063



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190064

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.9	Pass
Relative Humidity	%	10 to 70	28	Pass
Probe Speed	m/s	6.59 to 6.83	6.71	Pass
Peak Deflection	mm	50 to 58	53	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4388	Pass
Internal Hysteresis	%	69 to 85	71	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4392	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

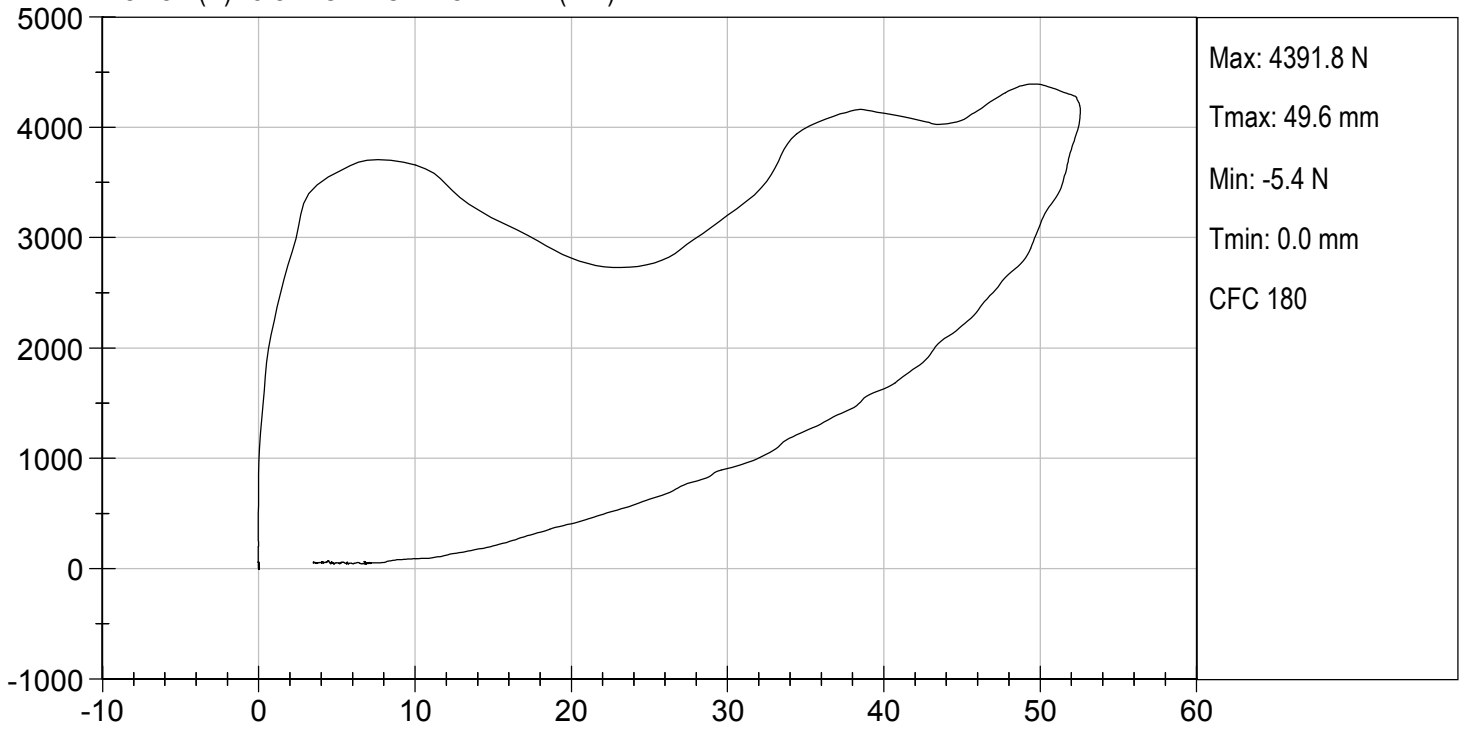
01/07/2019
Test Date

Robert Schmidt
Approved By

TEST DESC: THORAX IMPACT
VELOCITY: 22 ft/s, 6.71 m/s

TEST DATE: 01/07/2019
TEST #: D190064

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190065

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Probe Speed	m/s	2.07 to 2.13	2.07	Pass
Maximum Force	N	3450 to 4060	3619	Pass
		Overall Test Results		Pass

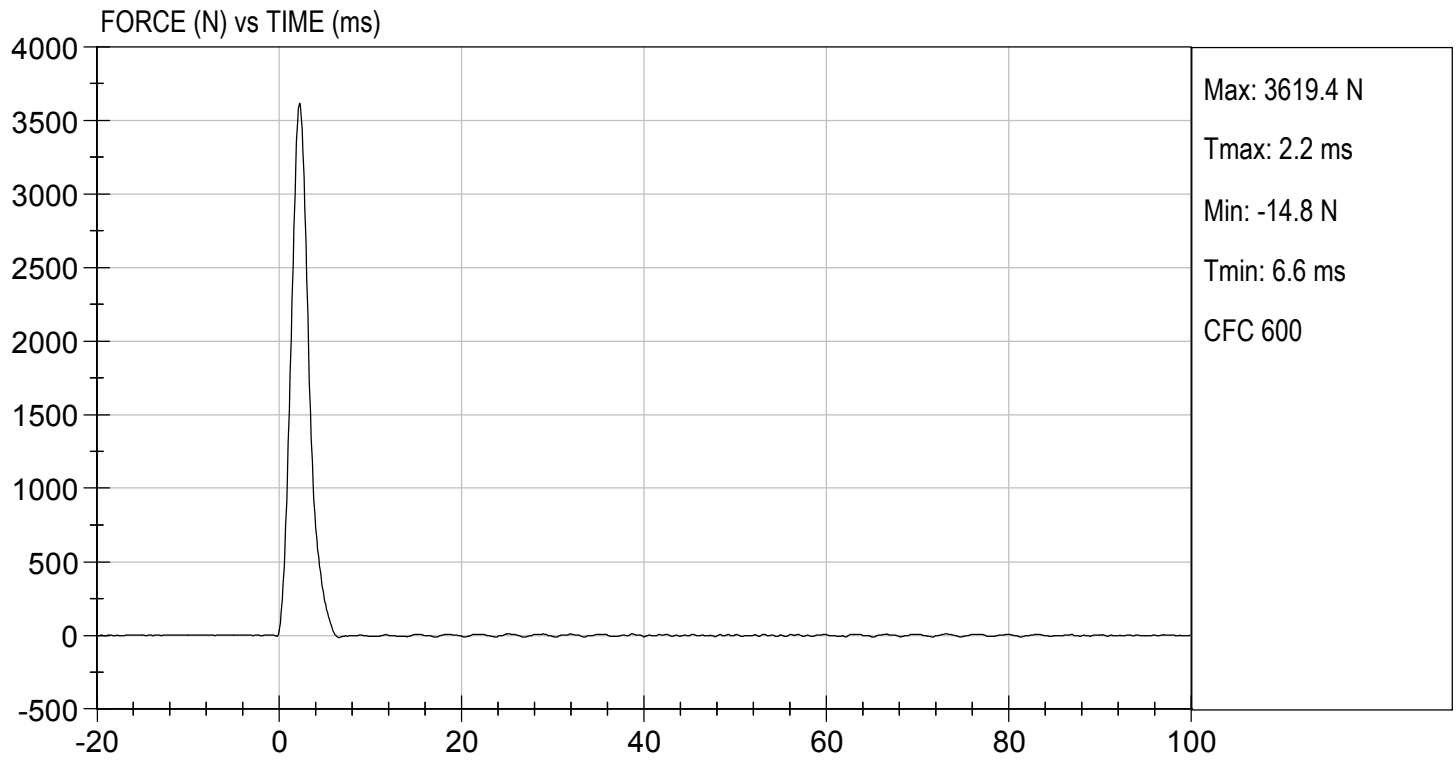
Laboratory Technician

01/04/2019
Test Date

Approved By

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

TEST DATE: 01/04/2019
TEST #: D190065



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190066

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Probe Speed	m/s	2.07 to 2.13	2.09	Pass
Maximum Force	N	3450 to 4060	3586	Pass
		Overall Test Results		Pass

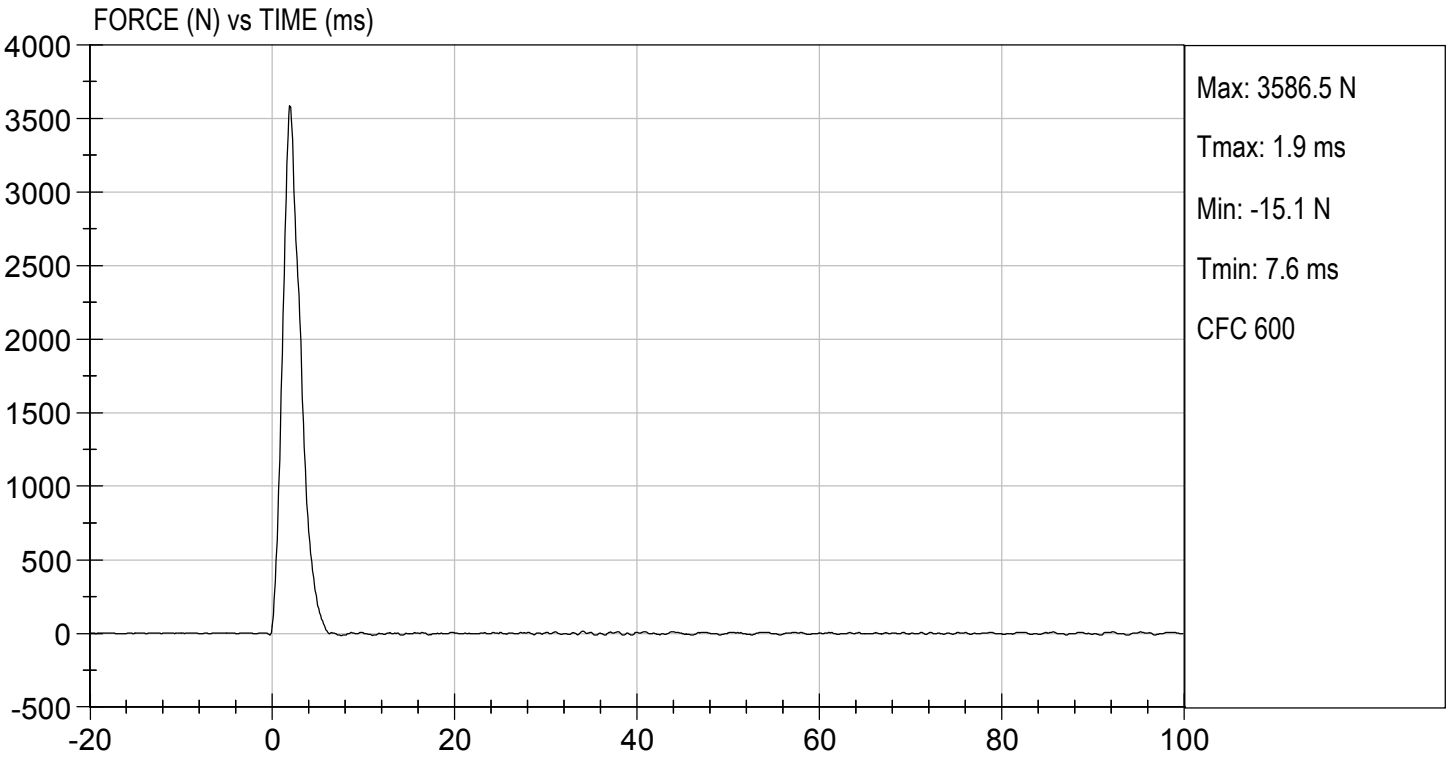
Laboratory Technician

01/04/2019
Test Date

Approved By

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

TEST DATE: 01/04/2019
TEST #: D190066



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190067

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Initial Angle	deg	0 to 20	19	Pass
Return Angle	deg	+/- 8	2	Pass
Force at 45 deg	N	320 to 390	383	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.6	Pass
		Overall Result		Pass

Danielle Redinbaugh
Laboratory Technician

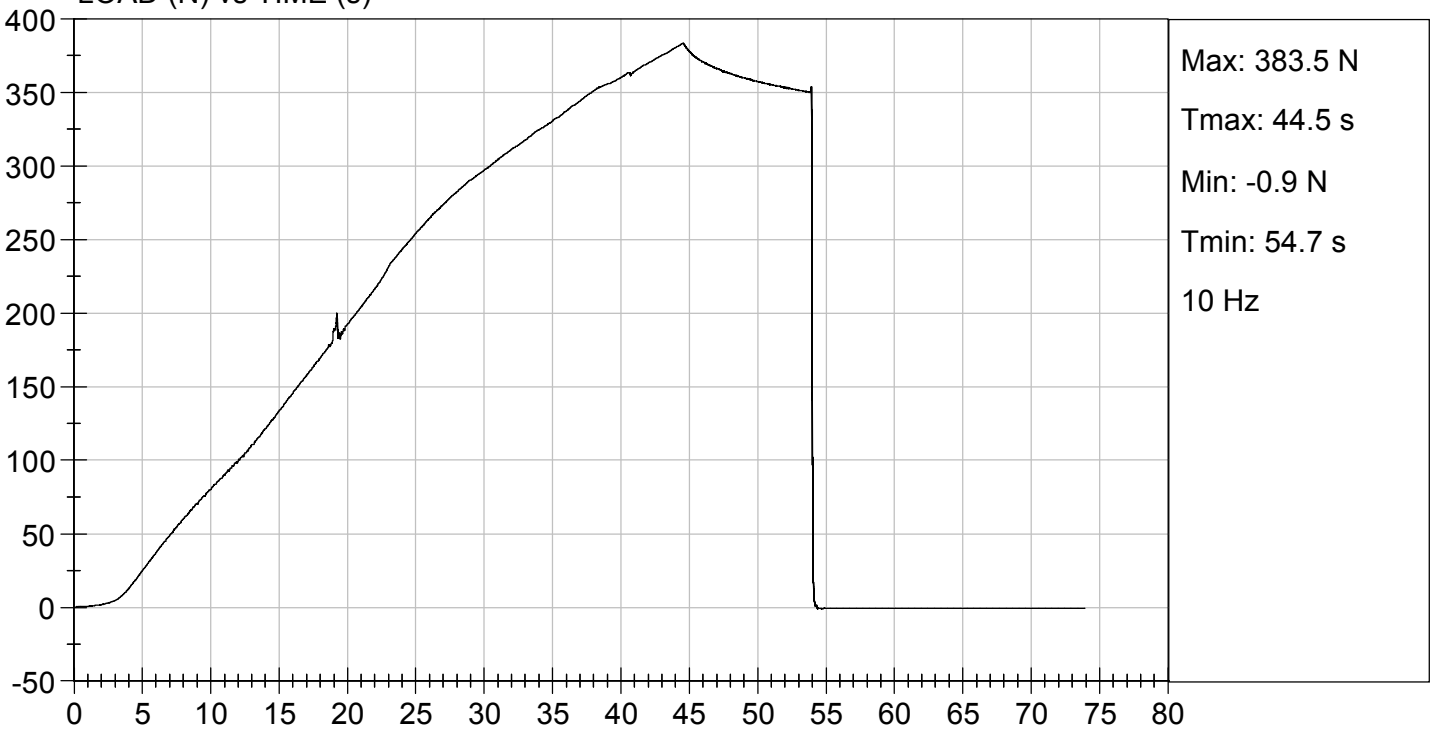
01/04/2019
Test Date

Robert Schneider
Approved By

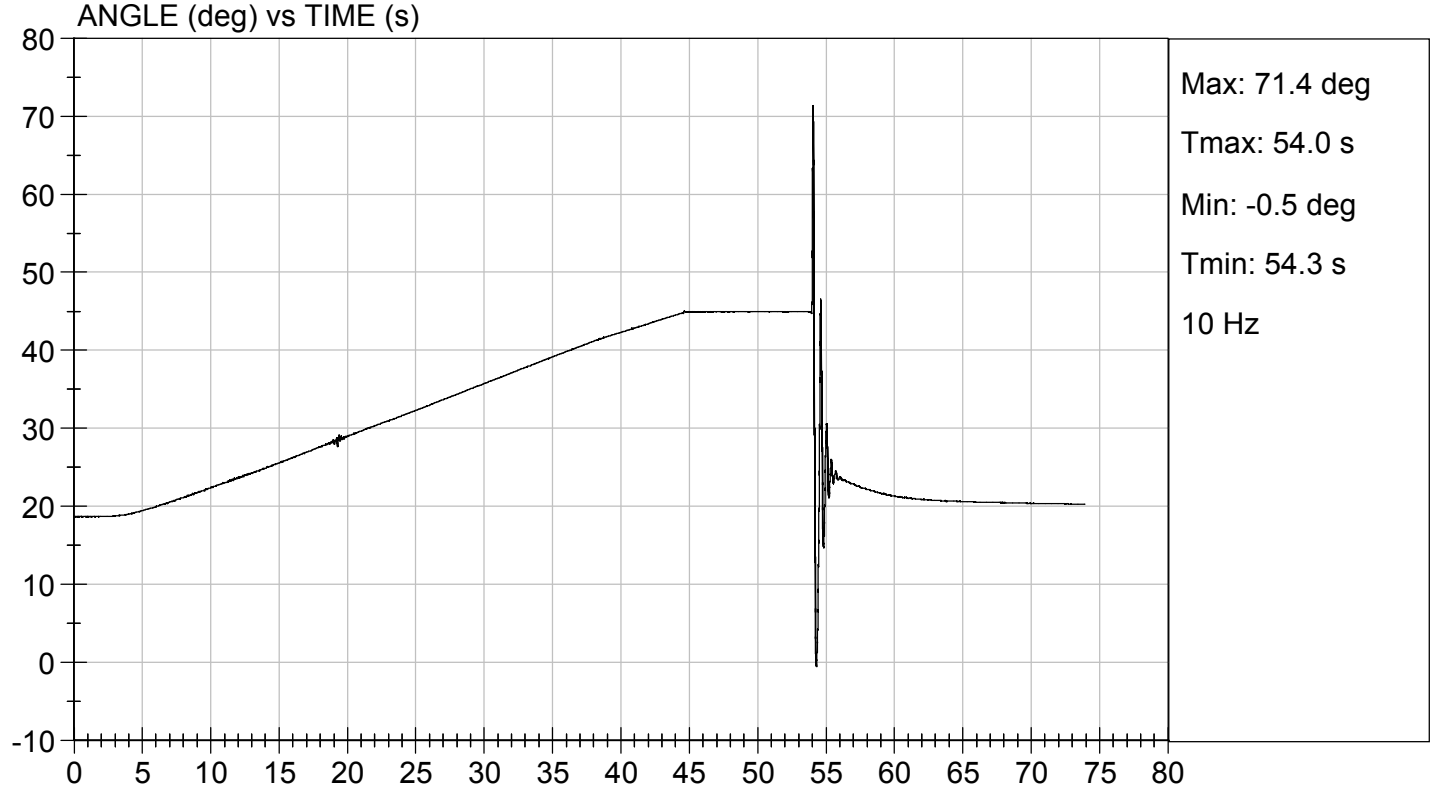
TEST DESC: LUMBAR FLEXION

TEST DATE: 01/04/2019
TEST #: D190067

LOAD (N) vs TIME (s)



ANGLE (deg) vs TIME (s)



CALIBRATION TEST RESULTS

POST-TEST

HYBRID III 5TH PERCENTILE FEMALE - PASSENGER ATD

MGA RESEARCH CORPORATION

HEAD DROP TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test ID:** D190181

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	19	Pass
Peak Resultant Acceleration	G's	250 to 300	265	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-1.5	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

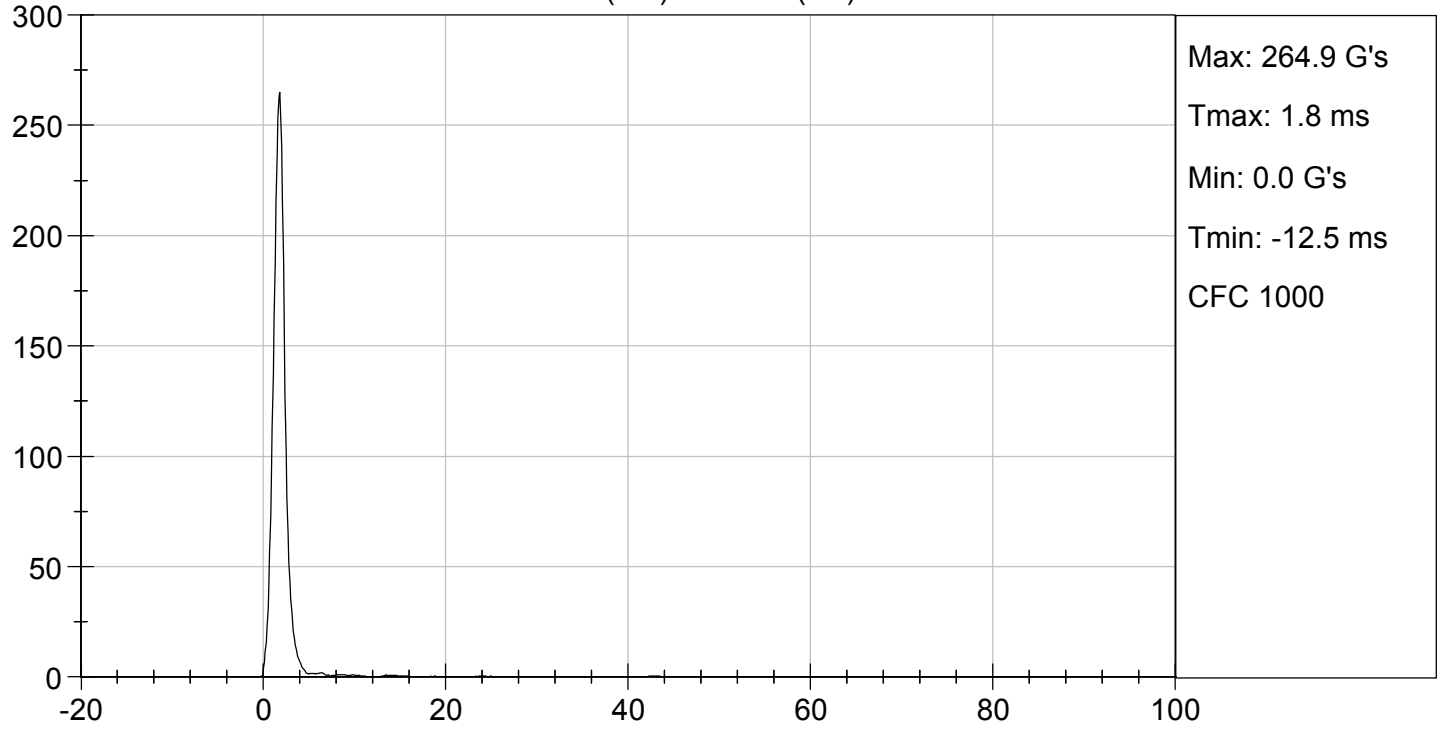
01/14/2019
Test Date

Robert Schmidt
Approved By

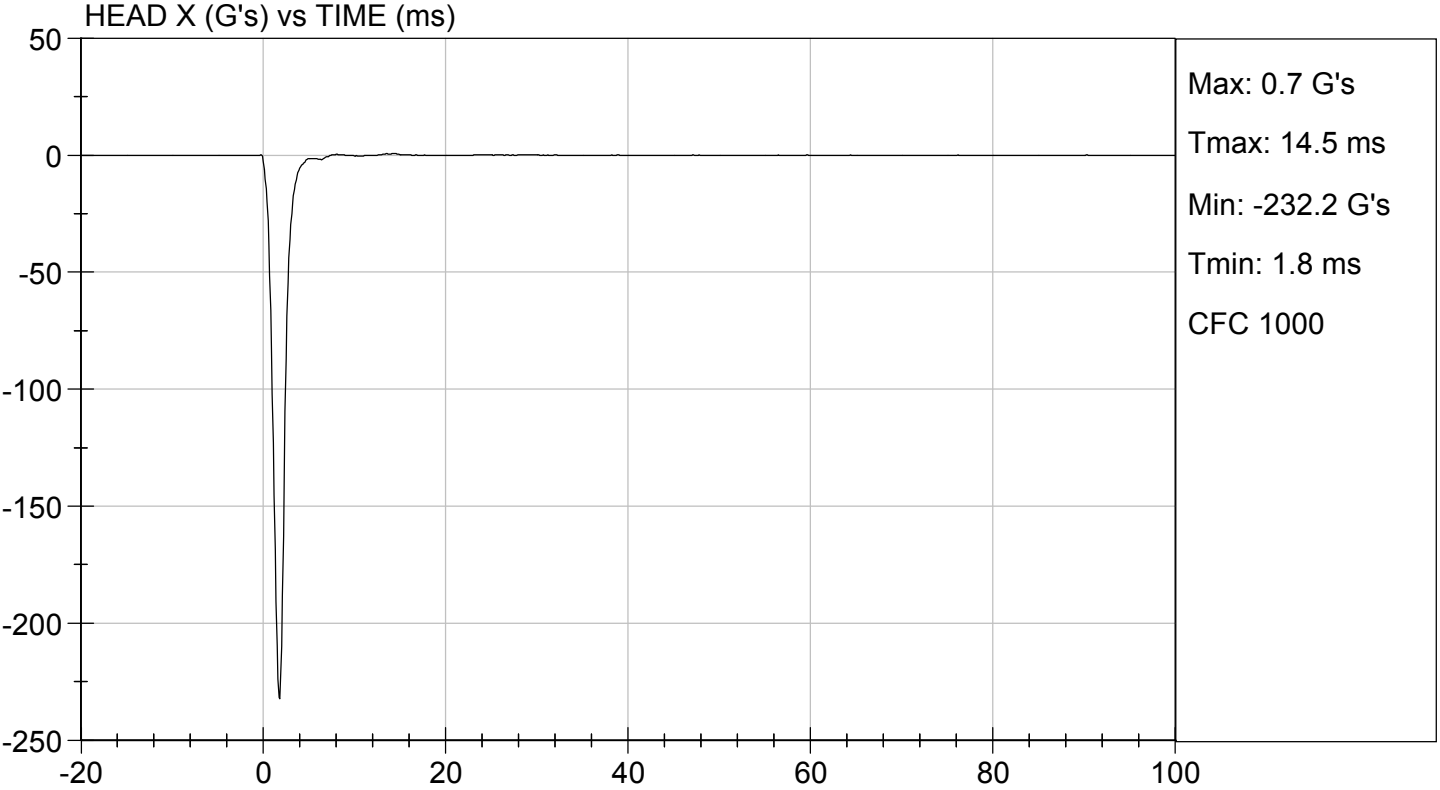
TEST DESC: HEAD DROP

TEST DATE: 01/14/2019
TEST #: D190181

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

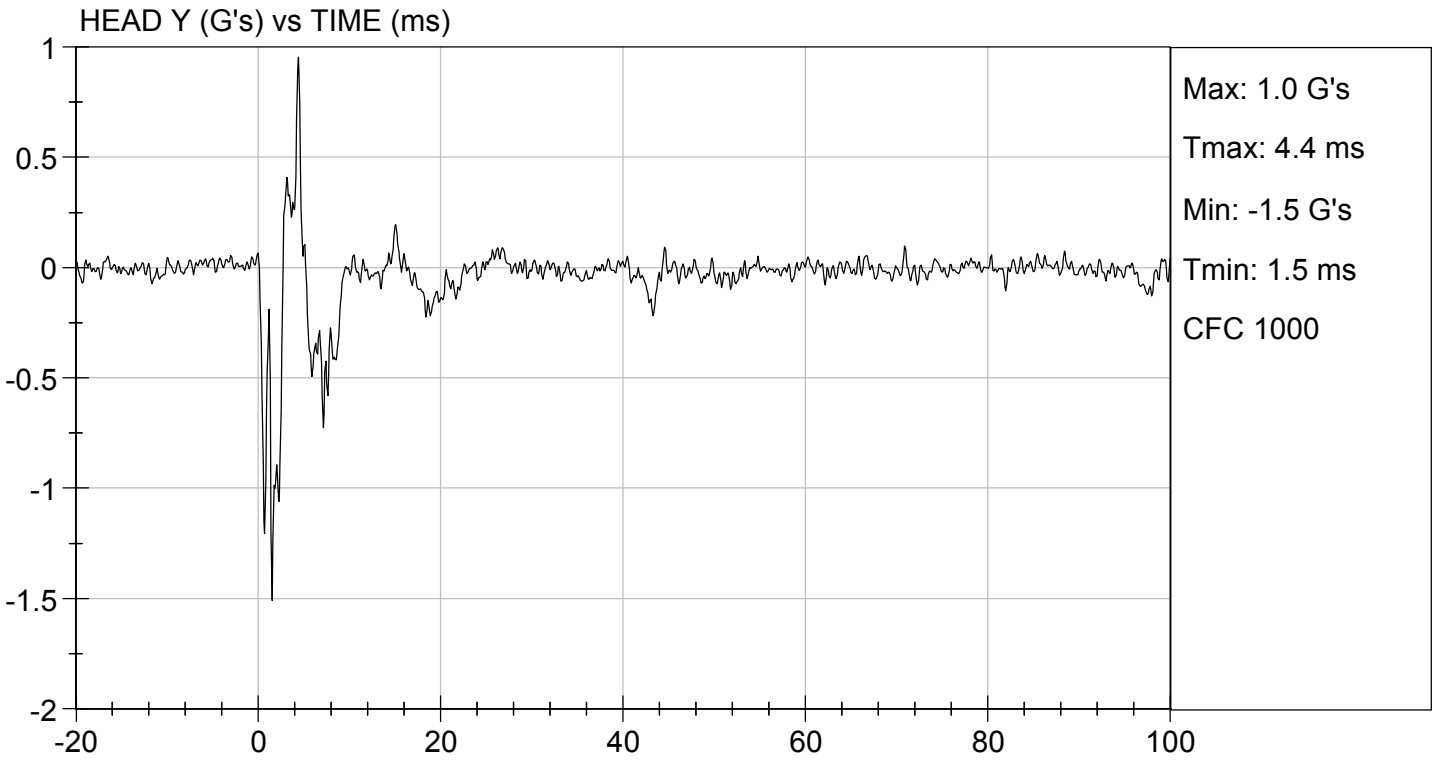


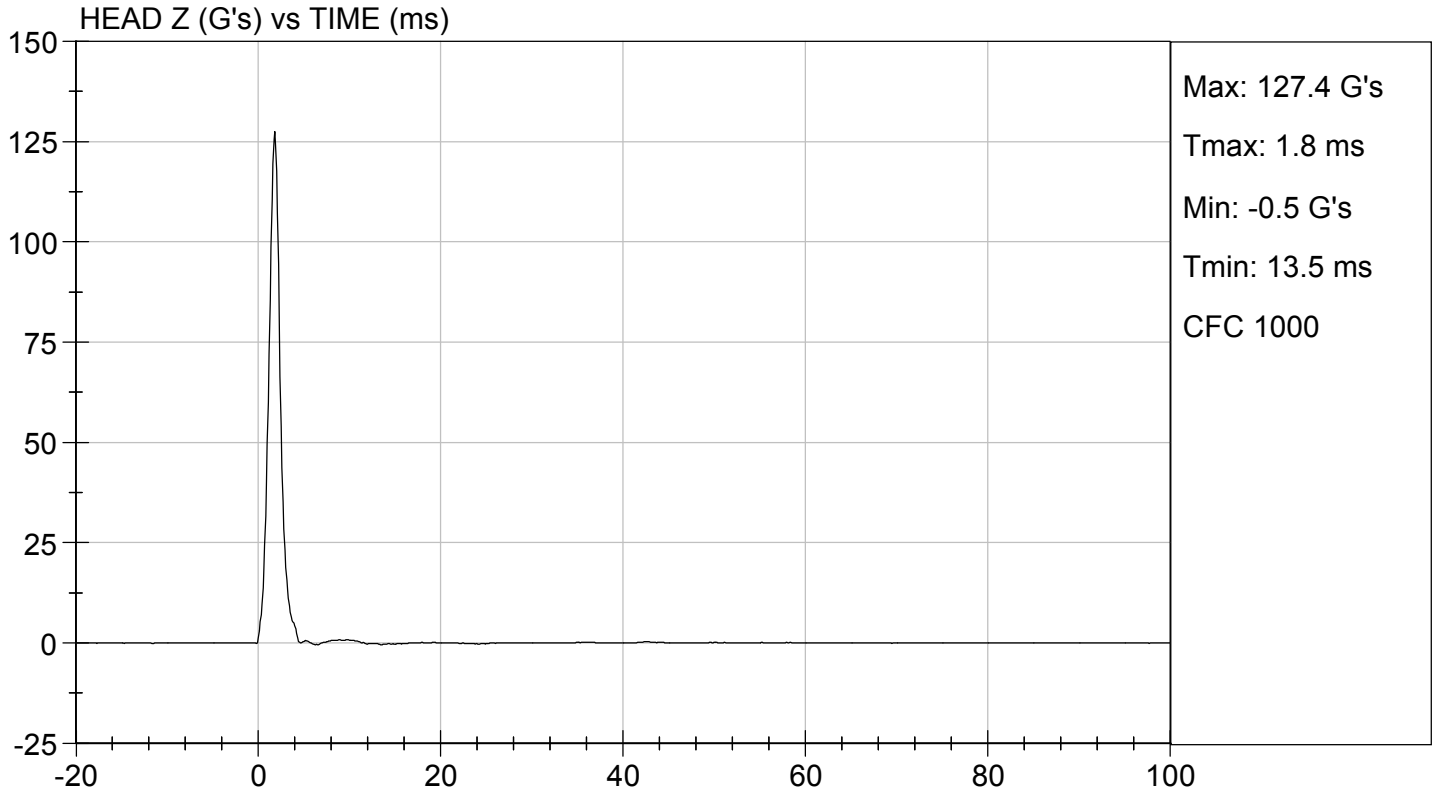
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 01/14/2019
TEST #: D190181





MGA RESEARCH CORPORATION

NECK FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190182

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	21.4	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.13	Pass
Pendulum Velocity	10 ms	m/s	2.1 to 2.5	2.3	Pass
	20 ms	m/s	4.0 to 5.0	4.8	Pass
	30 ms	m/s	5.8 to 7.0	6.8	Pass
D Plane Rotation	Max	deg	77 to 91	80	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	69 to 83	70	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	83	Pass
			Overall Results		Pass

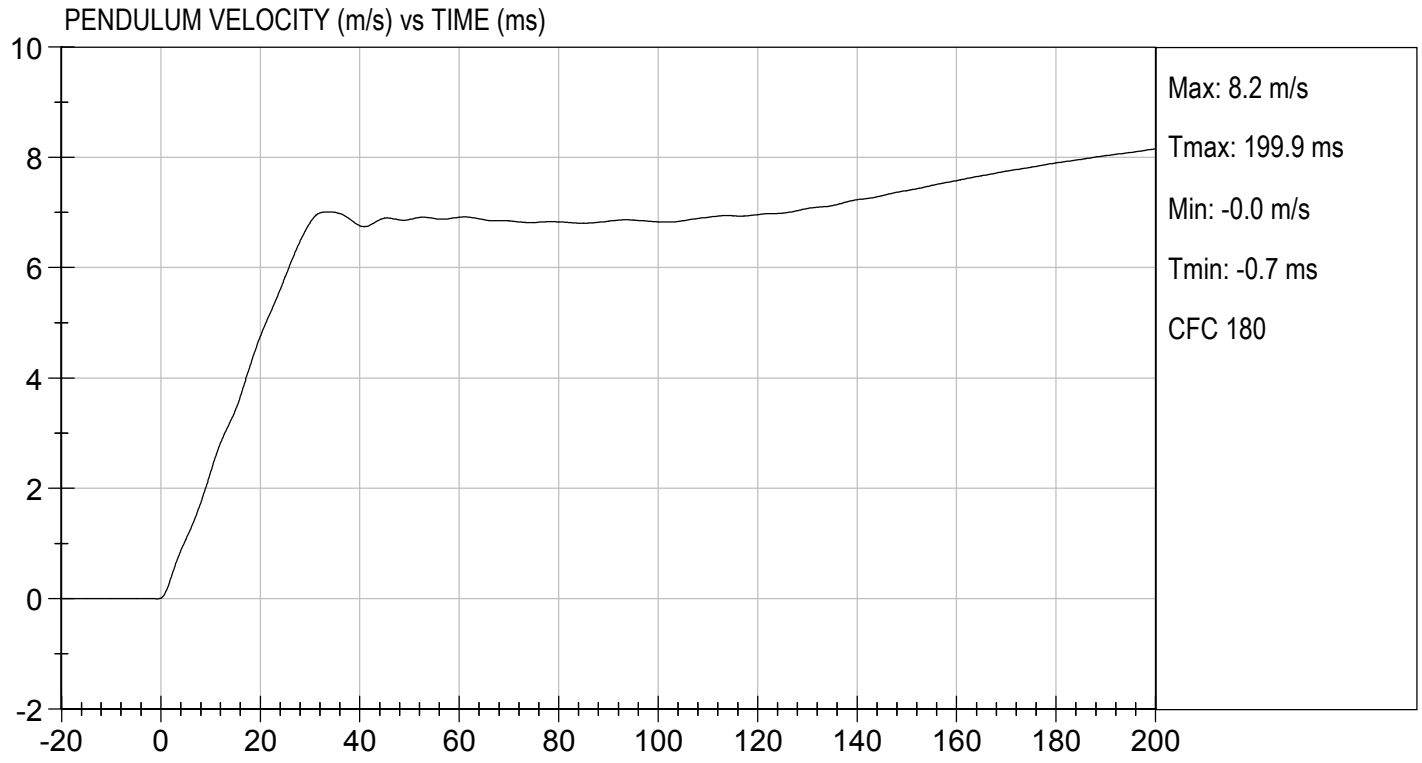
Danielle Redenbaugh
Laboratory Technician

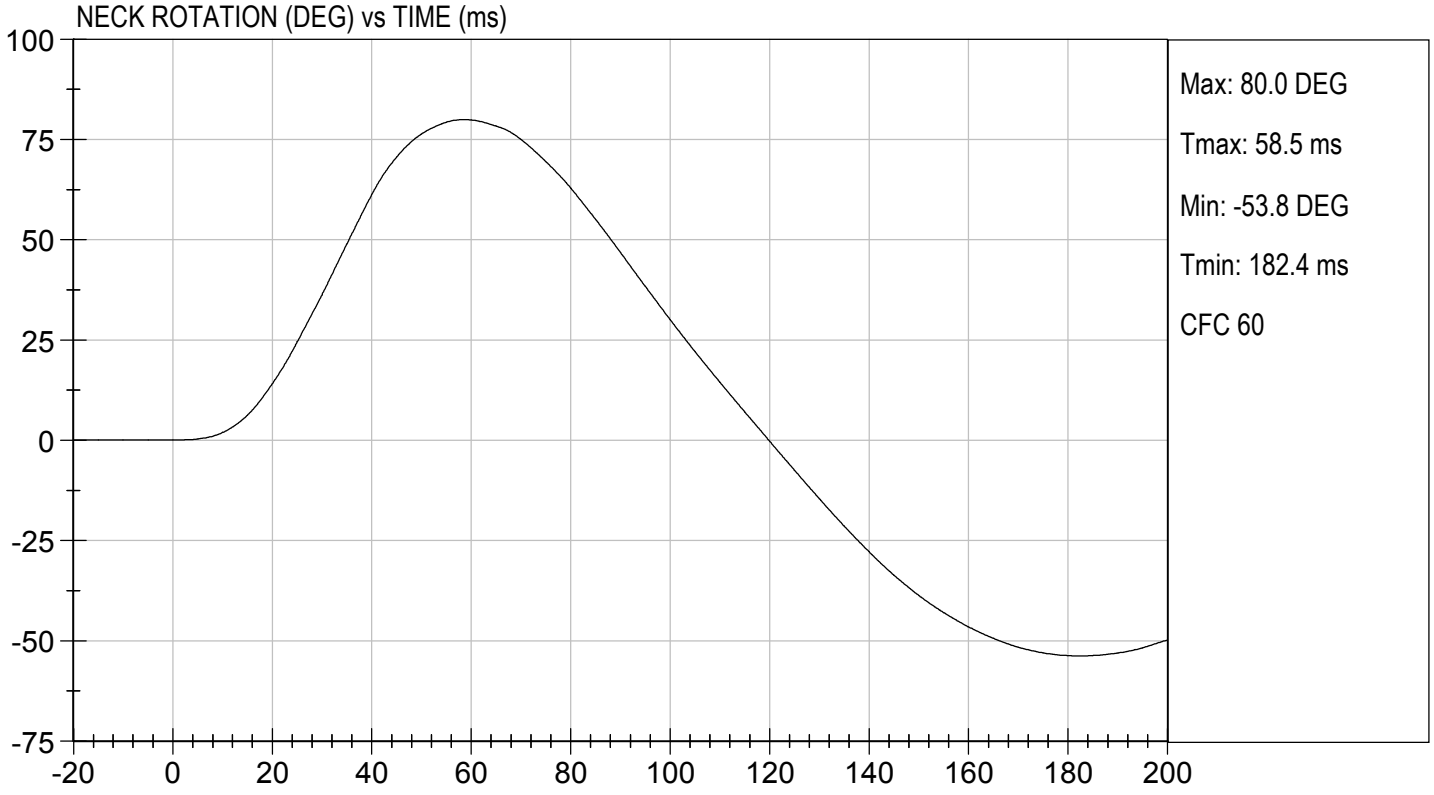
01/14/2019
Test Date

Robert Schmidt
Approved By

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

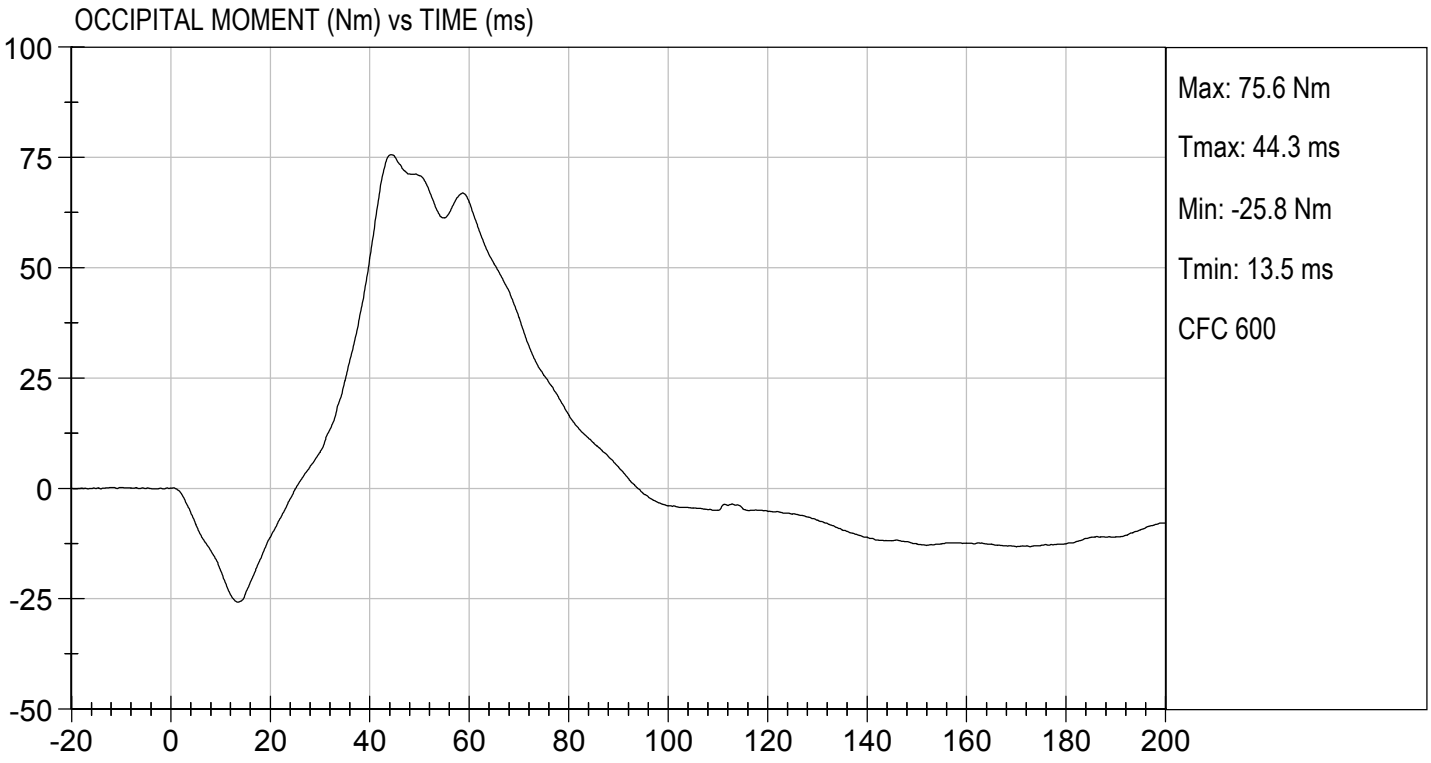
TEST DATE: 01/14/2019
TEST #: D190182





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

TEST DATE: 01/14/2019
TEST #: D190182



MGA RESEARCH CORPORATION

NECK EXTENSION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190183

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity		%	10 to 70	21.4	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	5.3	Pass
D Plane Rotation	Max	deg	99 to 114	109	Pass
Occipital Condyle Moment within Rotation Corridor		Nm	-65 to -53	-57	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	102	Pass
			Overall Results		Pass

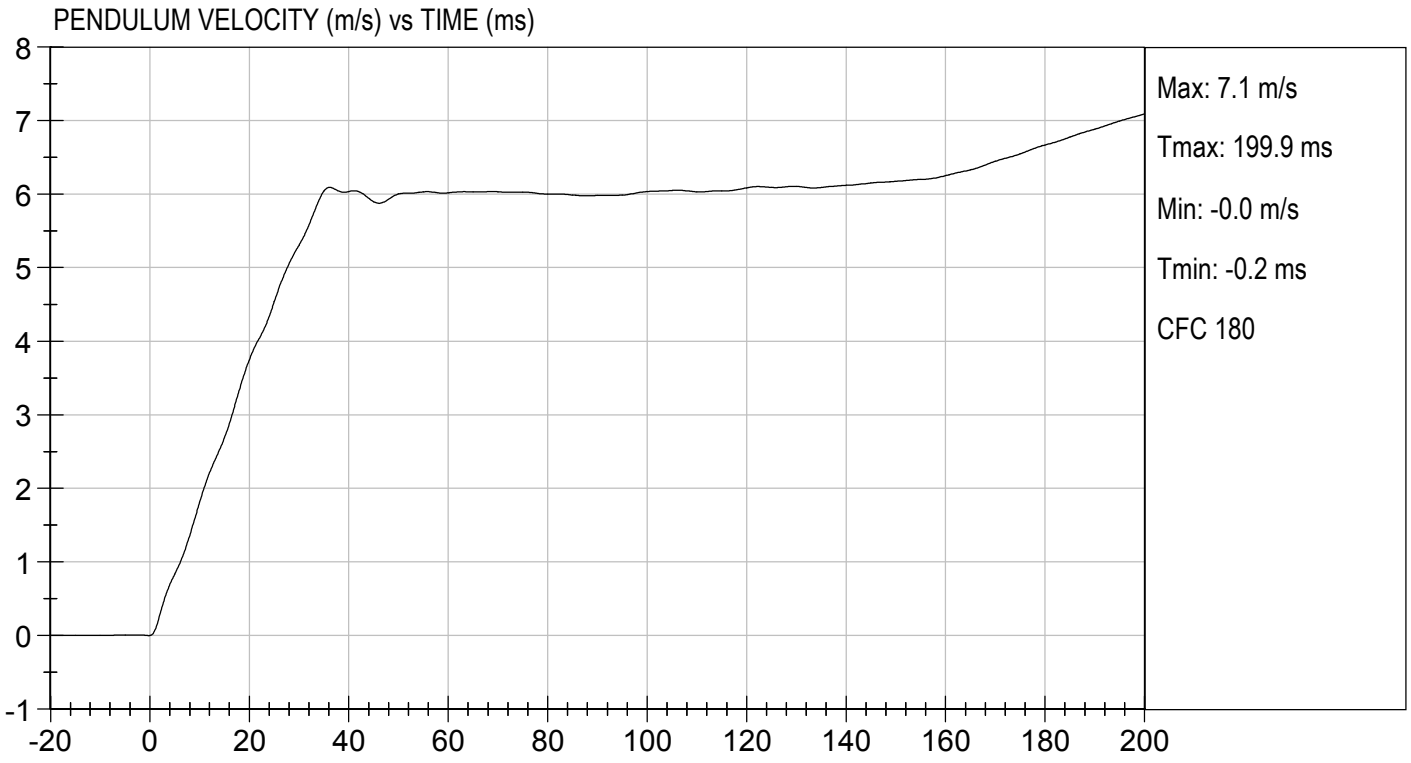
Danielle Redenbaugh
Laboratory Technician

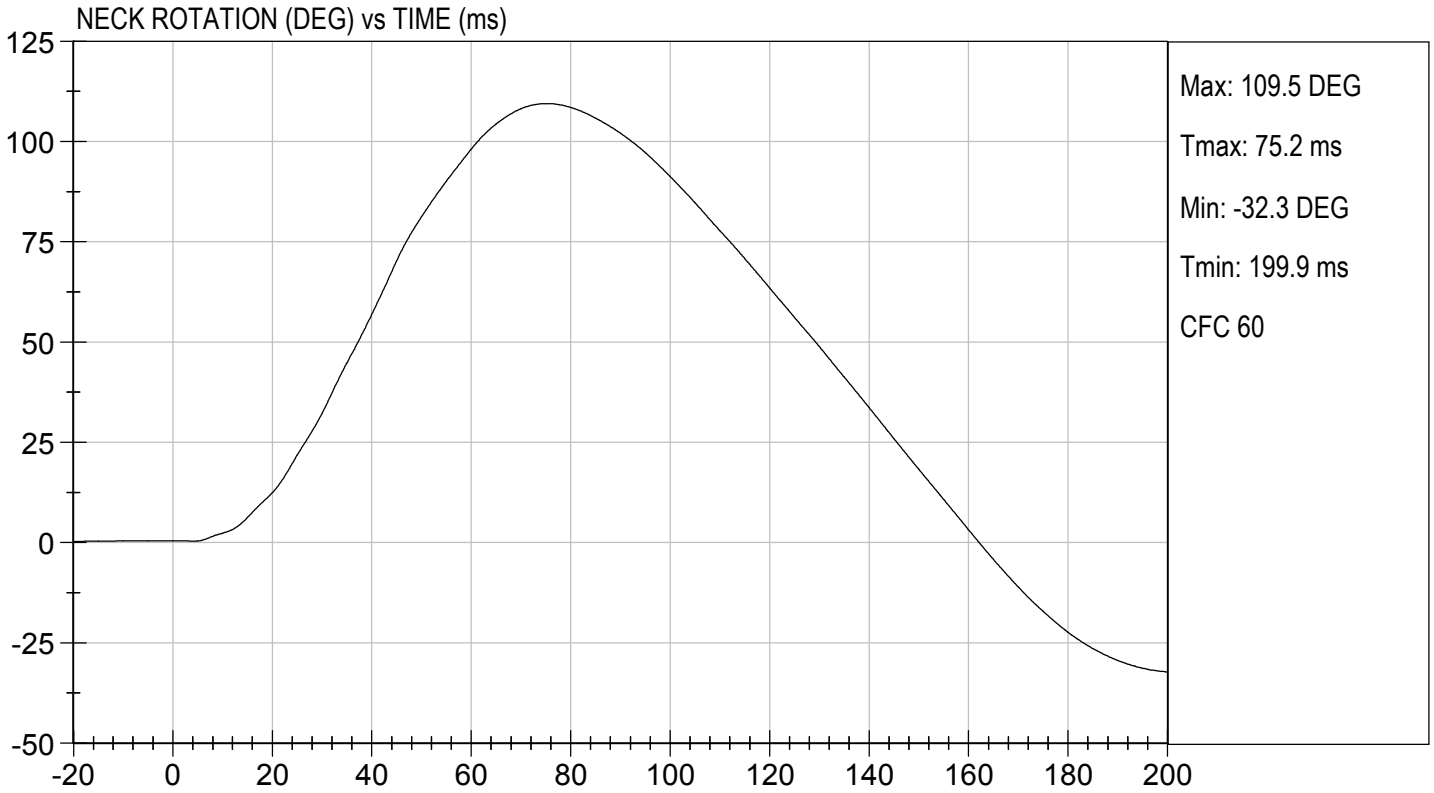
01/14/2019
Test Date

Robert Schmidt
Approved By

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

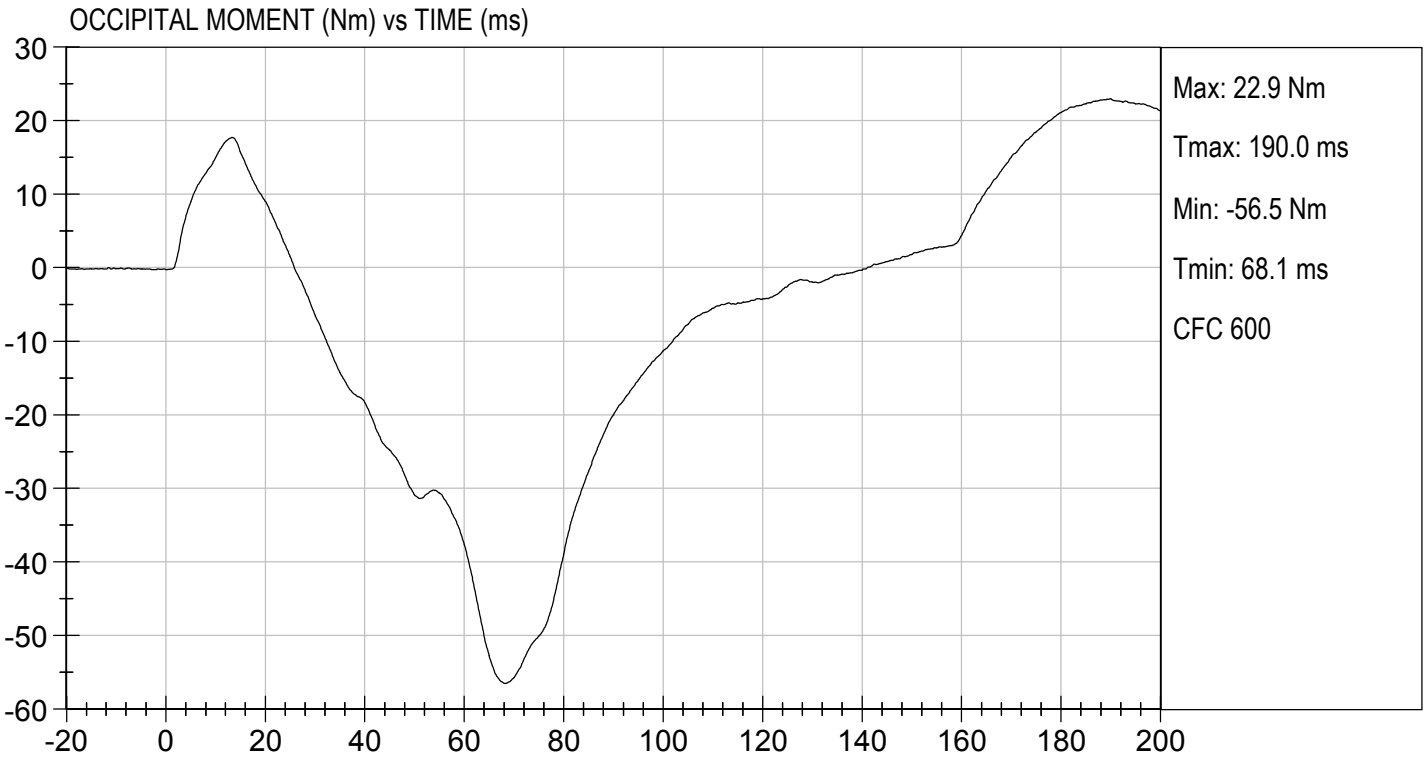
TEST DATE: 01/14/2019
TEST #: D190183





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

TEST DATE: 01/14/2019
TEST #: D190183



MGA RESEARCH CORPORATION

THORAX IMPACT

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190184

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.6	Pass
Relative Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	6.59 to 6.83	6.68	Pass
Peak Deflection	mm	50 to 58	53	Pass
Peak Resistive Force w/in Deflection Corridor	N	3900 to 4400	4292	Pass
Internal Hysteresis	%	69 to 85	71	Pass
Peak Force 18 mm - 50 mm	N	<= 4600	4293	Pass
		Overall Test Results		Pass

Danielle Redinbaugh
Laboratory Technician

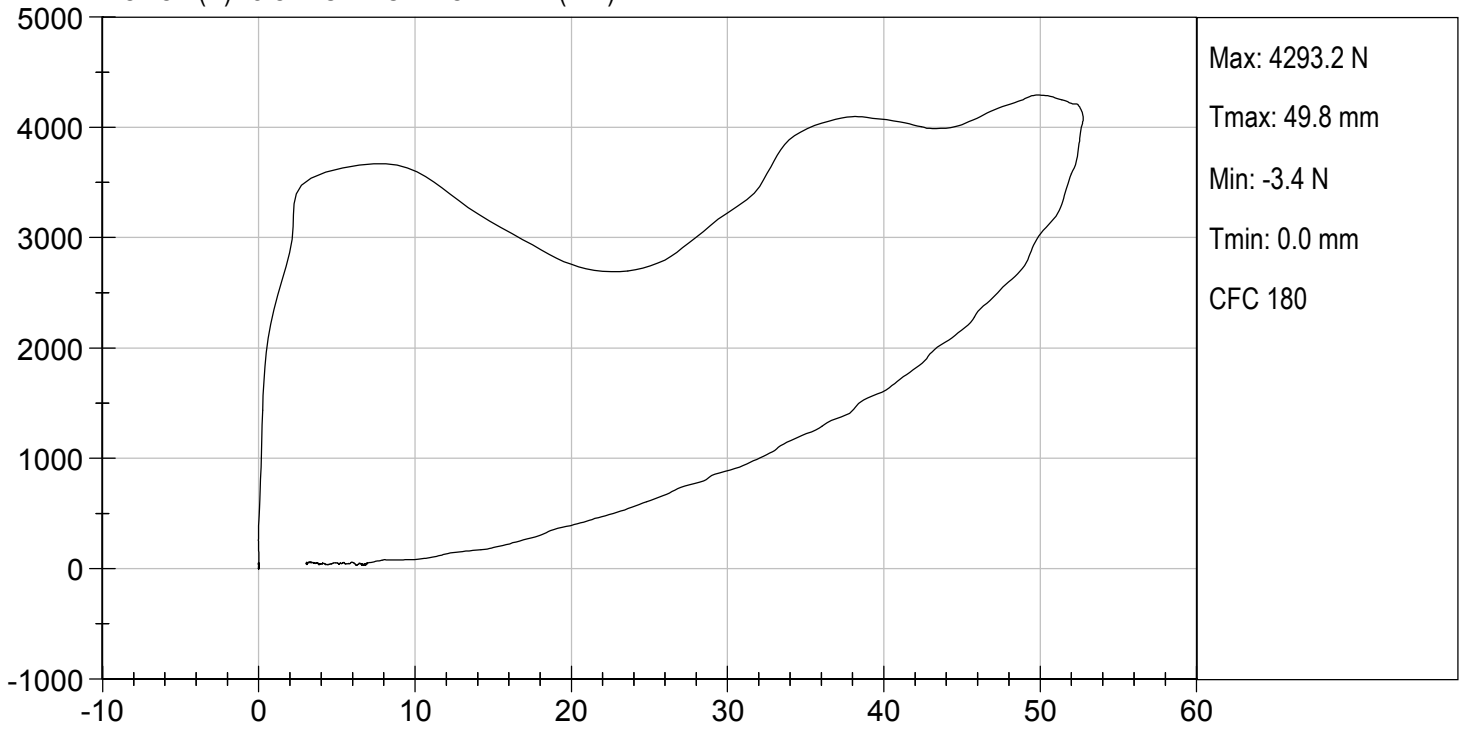
01/15/2019
Test Date

Robert Schmuly
Approved By

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

TEST DATE: 01/15/2019
TEST #: D190184

FORCE (N) vs CHEST DISPLACEMENT (mm)



MGA RESEARCH CORPORATION

RIGHT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190185

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	20.3	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3497	Pass
		Overall Test Results		Pass

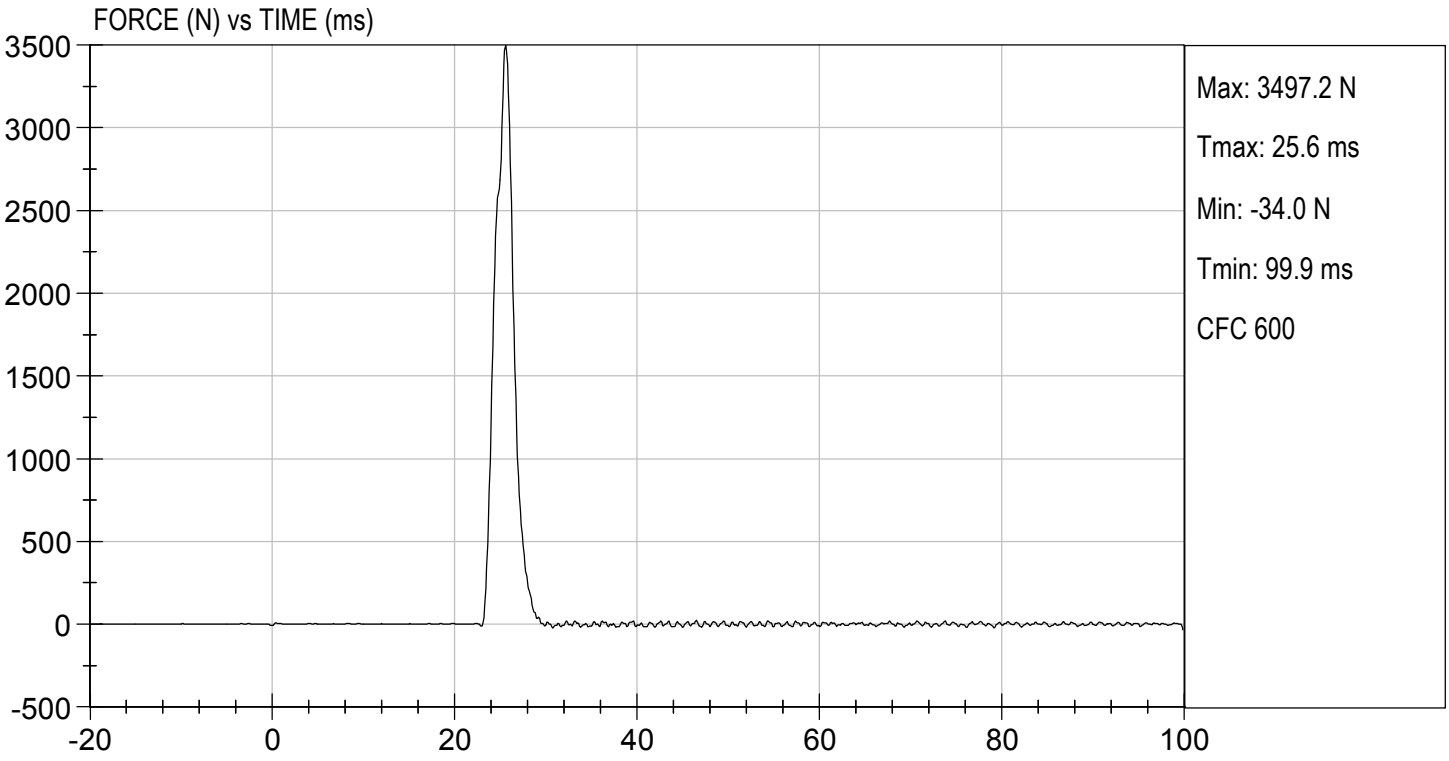
Danielle Redinbaugh
Laboratory Technician

01/14/2019
Test Date

Robert Schmidt
Approved By

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

TEST DATE: 01/14/2019
TEST #: D190185



MGA RESEARCH CORPORATION

LEFT KNEE IMPACT TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190186

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22	Pass
Laboratory Relative Humidity	%	10 to 70	20.3	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	N	3450 to 4060	3532	Pass
		Overall Test Results		Pass

Danielle Redenbaugh

Laboratory Technician

01/14/2019

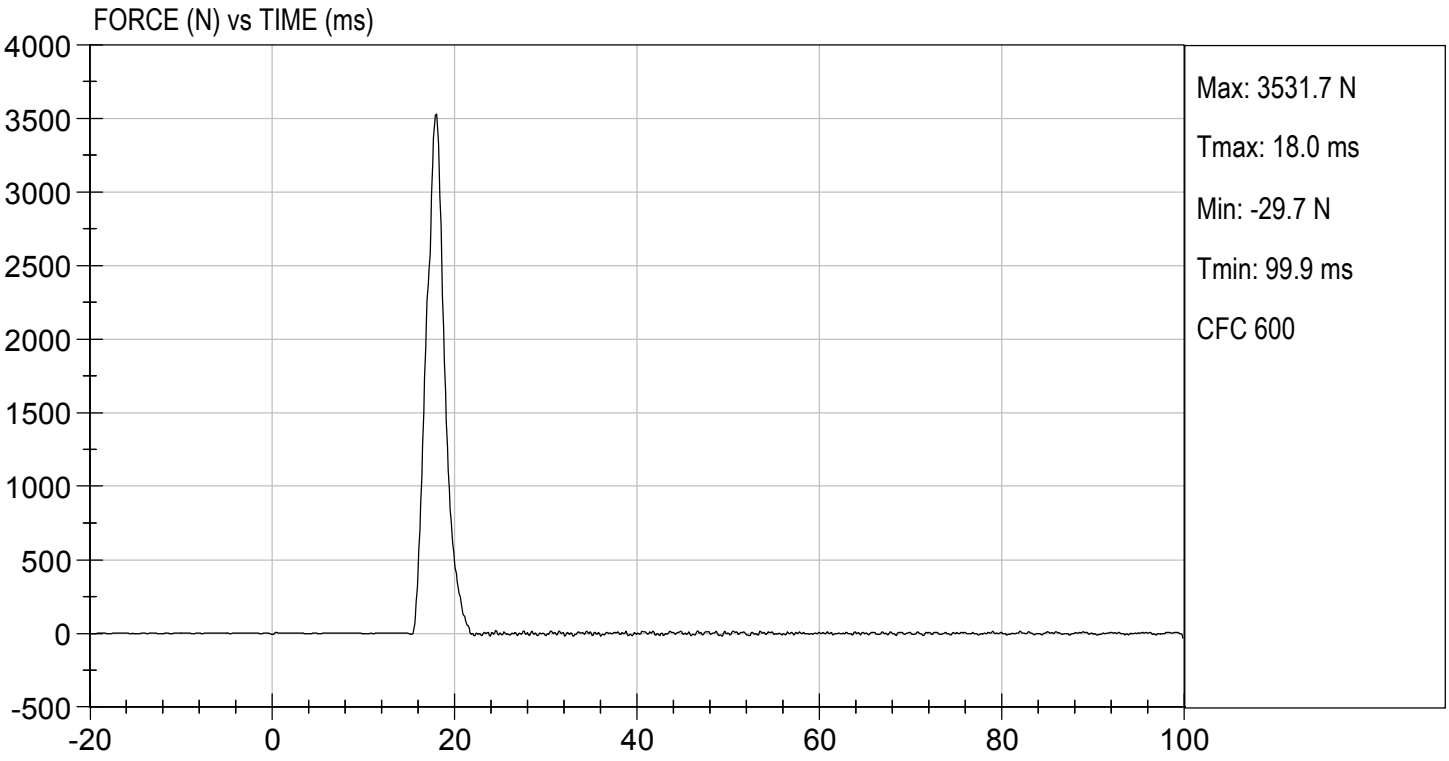
Test Date

Robert Schmidt

Approved By

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

TEST DATE: 01/14/2019
TEST #: D190186



MGA RESEARCH CORPORATION

TORSO FLEXION TEST

HYBRID III 5TH PERCENTILE

ATD Serial No: 138 **Test I.D:** D190187

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.5	Pass
Laboratory Relative Humidity	%	10 to 70	19	Pass
Initial Angle	deg	0 to 20	19	Pass
Return Angle	deg	+/- 8	3	Pass
Force at 45 deg	N	320 to 390	367	Pass
Upper Torso Deflection Rate	deg/s	0.5 to 1.5	0.7	Pass
		Overall Result		Pass

Danielle Redenbaugh
Laboratory Technician

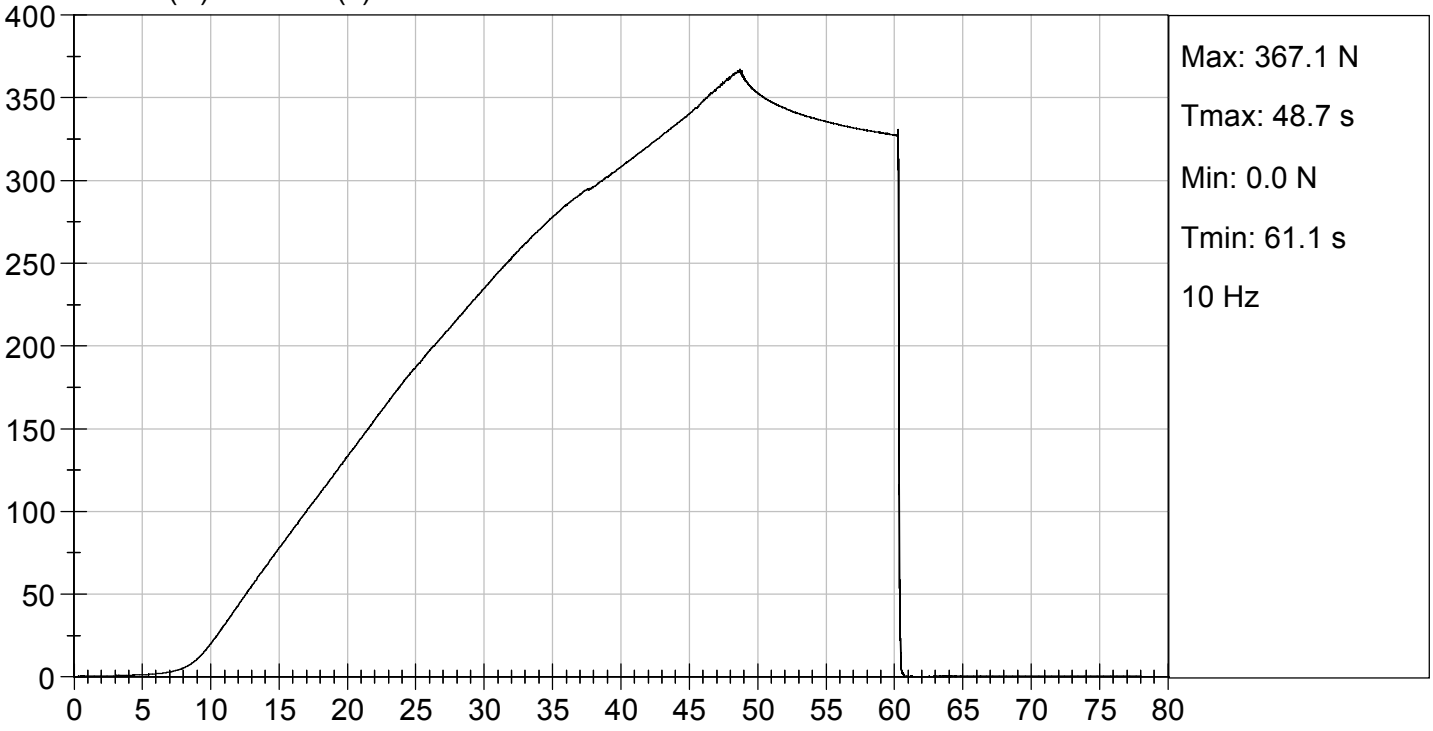
01/14/2019
Test Date

Robert Schmidt
Approved By

TEST DESC: LUMBAR FLEXION

TEST DATE: 01/14/2019
TEST #: D190187

LOAD (N) vs TIME (s)



ANGLE (deg) vs TIME (s)