REPORT NUMBER: TWG-MGA-20-006

SIDE AIRBAG OUT-OF-POSITION INJURY
TECHNICAL WORKING GROUP

NISSAN MOTOR CO., LTD.
2020 Nissan Maxima S 4-Door Sedan
NHTSA No.: M20205208TWG2

MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105

Test Date: September 8, 2020

Final Report Date: June 30, 2021

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

SIGNATURE APPROVAL PAGE

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Approval Date: June 30, 2021

FINAL REPORT ACCEPTANCE BY:

_____

Date: _____

The results presented in this report relate only to the specified test items.

TECHNICAL REPORT DOCUMENTATION PAGE

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TWG-MGA-20-006		

4. Title and Subtitle	5. Report Date
Final Report of Side Airbag Out-of-Position Injury Technical Working Group evaluation of a 2020 Nissan Maxima S 4-Door Sedan, NHTSA No.: M20205208TWG2	June 30, 2021
	6. Performing Organization Code MGA
7. Author(s) Ben Fischer, Project Manager	**8. Performing Organization Report No.** TWG-MGA-20-006
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105	**10. Work Unit No.**
	11. Contract or Grant No. 693JJ919D000006
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Crashworthiness Standards (NRM-110) 1200 New Jersey Ave, SE, Room W43-410 Washington, D.C. 20590	**13. Type of Report and Period Covered:** Final Test Report September 8, 2020 to June 30, 2021
	14. Sponsoring Agency Code NRM-110

15. Supplementary Notes

16. Abstract

A Side Airbag Out-of-Position Injury evaluation was conducted on the subject 2020 Nissan Maxima S 4-Door Sedan in accordance with the specifications of the Side Airbag Out-of-Position Injury Technical Working Group Laboratory Test Procedure for the generation of consumer information. The test was conducted at MGA Research Corporation in Burlington, Wisconsin on September 8, 2020.

Measurement Description	Units	Driver ATD (SID-IIs)	
		Threshold	Result
Head Injury Criteria (HIC_{15})		779	17
Nij		1	0.63
Neck Tension	N	2070	89
Neck Compression	N	2520	1257
Maximum Chest Displacement	mm		
Maximum Chest Displacement Rate	m/s		

17. Key Words	18. Distribution Statement
Side Airbag Out-of-Position Technical Working Group OOP TWG SID-IIs	Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division 1200 New Jersey Ave, SE Washington, DC 20590

19. Security Classification of Report	20. Security Classification of Page	21. No. of Pages	22. Price
Unclassified	Unclassified	96	

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SECTION 1
TEST PURPOSE AND PROCEDURE

This side airbag out-of-position test is part of the MY2020 New Car Assessment Program (NCAP), sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number 693JJ919D000006. The purpose of this test is to obtain data on the performance of side airbags with out-of-position occupants in a 2020 Nissan Maxima S 4-Door Sedan. The airbag test was conducted in accordance with the Office of Crashworthiness Standard's Side Airbag Out-of-Position Laboratory Test Procedure, dated November 2019.

SECTION 2
SUMMARY OF TEST RESULTS

The effects of both a curtain and torso airbag deployment in a 2020 Nissan Maxima S 4-Door Sedan with an out-of-position SID-IIs Build Level D 5th-percentile female dummy were evaluated. The curtain and seat airbags were fired remotely. The test was performed by MGA Research Corporation on September 8, 2020. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Three high-speed cameras (2,700 fps) were used to document the side airbag deployment event. The following camera locations were used:

- Left Side Through Removed Driver Door
- Left Side Oblique Through Windshield
- Front Through Windshield

One SID-IIs Build Level D 5th-percentile female dummy (Serial Number 304) was placed in the right front passenger seat situated in the inboard-facing position along the outboard edge of the seat per Section 3.3.5.3 according to dummy placement instructions specified in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as prepared by the Side Airbag Out-of-Position Injury Technical Working Group (TWG).

The dummy was instrumented with the following instrumentation:

- Head Accelerometers
- Upper Neck Load Cell
- Lower Neck Load Cell

The 15 channels of data were recorded using an off board data acquisition system. Appendix B contains the dummy data traces.

The SID-IIs Build Level D 5th-percentile female dummy's visible contact points were as follows:

- Side curtain airbag to top and back of head
- Side torso/pelvis airbag to left side of torso and pelvis

The SID-IIs Build Level D 5th-percentile female dummy was placed in the right front passenger seat facing toward the center of the vehicle with its arm against the seatback. The arm was rotated horizontally in the forward direction with respect to the dummy. The seat track was adjusted forward to minimize the vertical distance between the dummy's head and curtain airbag. The dummy's pelvis was slid outboard until the dummy's back contacted the door trim panel or armrest and the CG of the head was centered in the deployment trajectory of the airbag. The vertical plane through the centerline of the dummy's rib-stiffener and shoulder bolt was parallel to the centerline of the vehicle.

The dummy's skullcap seam was covered with 4mm electrical tape to prevent the airbag from getting caught in the seam. The dummy's head skin was cleaned with alcohol and dusted with baby powder to achieve acceptable frictional characteristics.

This orientation complies with Section 3.3.5.3 of the TWG Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags as defined by Lund, et al and the Technical Working Group First Revision dated July 2003.

SECTION 3
OCCUPANT AND VEHICLE INFORMATION

DATA SHEET NO. 1
TEST SUMMARY

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

TEST CONFIGURATION INFORMATION

Seating Position	P2	Right Front Seating Position
Test Section	3.3.5.3*	Inboard Facing SID-IIs on Raised Seat
Curtain Airbag	Roof-Rail Mounted	Side Curtain Airbag
Torso Airbag	Seat Mounted	Side Torso/Pelvis Airbag
ATD Type/Serial No.	SID-IIs Build Level D	S/N: 304
Vehicle	Nissan	Maxima
Previous Crash Test	Side MDB NCAP	December 13, 2019 – M20205208

*Procedure as defined by Lund, et al and the Technical Working Group dated July 2003

EQUIPMENT INFORMATION

Number of Data Channels	15
Number of Airbag Channels	4
Number of High-Speed Video	3

VISIBLE DUMMY CONTACT POINTS

Head	Side curtain airbag to top and back of head
Left Shoulder Contact	None
Left Torso Contact	Side torso/pelvis airbag to torso
Left Pelvis Contact	Side torso/pelvis airbag to pelvis

DATA SHEET NO. 2
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	M20205208	Traction Control System (TCS)	Yes
Model Year	2020	Auto-Leveling System	No
Make	Nissan	Automatic Door Locks (ADL)	Yes
Model	Maxima S	Power Window Auto-Reverse	Yes
Body Style	4-Door Sedan	Other Optional Feature	No
VIN	1N4AA6BV3LC361065	Driver Front Airbag	Yes
Body Color	Gun Metallic	Driver Curtain Airbag	Yes
Odometer Reading (km/mi)	21 km / 13 mi	Driver Head/Torso Airbag	No
Engine Displacement (L)	3.5 L	Driver Torso Airbag	No
Type/No. Cylinders	V6	Driver Torso/Pelvis Airbag	Yes
Engine Placement	Lateral	Driver Pelvis Airbag	No
Transmission Type	Automatic	Driver Knee Airbag	Yes
Transmission Speeds	CVT	Rear Pass. Curtain Airbag	Yes
Overdrive	Yes	Rear Pass. Head/Torso Airbag	No
Final Drive	FWD	Rear Pass. Torso Airbag	No
Roof Rack	No	Rear Pass. Torso/Pelvis Airbag	Yes
Sunroof/T-Top	No	Rear Pass. Pelvis Airbag	No
Running Boards	No	Driver Seat Belt Pretensioner	Yes
Tilt Steering Wheel	Yes	Rear Pass. Seat Belt Pretensioner	Yes
Power Seats	Yes	Driver Load Limiter	Yes
Anti-Lock Brakes (ABS)	Yes	Rear Pass. Load Limiter	Yes
		Other Safety Restraint	N/A

DATA FROM CERTIFICATION LABEL

Manufactured By	NISSAN MOTOR CO., LTD.
Date of Manufacture	08/19
Vehicle Type	Passenger Car

GVWR (kg)	2125
GAWR Front (kg)	1145
GAWR Rear (kg)	1000

VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total	
Designated Seating Capacity (DSC)	2	3		5	
Capacity Weight (VCW) (kg)				408	(A)
DSC x 68.04 kg				340	(B)
Rated Cargo and Luggage Weight (RCLW) (kg)				68	(A-B)

VEHICLE SEAT TYPE

Seating Location	Type of Seat Pan				Type of Seat Back		
	Bucket	Bench	Split Bench	Contoured	Fixed	Adjustable	
						w/ Lever	w/ Knob
Front Seat	X					X	
Rear or Second Row				X	X		
Third Row Seat							

DATA SHEET NO. 3
SEAT ADJUSTMENT DATA

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

VEHICLE SEAT FORE/AFT POSITION

Seat	Total Fore/Aft Travel		Test Position from Forward-Most Position	
	mm	Detents (1st as 1)	mm	Detent (1st as 0)
Right Front Passenger Seat	240		0	
Right Rear Passenger Seat				
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Forward-most and highest adjustment			
	Seat Track Adjustments: Allowed to ensure proper alignment of the ATD head and vertical centerline of the airbag deployment trajectory and maximize head/neck interaction			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

VEHICLE SEAT BACK ANGLE ADJUSTMENT

Seat	Total Seat Back Angle Range		Test Position from Vertical	
	Degrees	Detents (1st as 1)	Degrees	Detent (1st as 0)
Right Front Passenger Seat	57.6		4.0	
Right Rear Passenger Seat				
OEM Back Angle Design Position	7.6° rearward of vertical, measured on outboard headrest post			
Method of Measuring Back Angle Position	Angle measured on outboard headrest post			
Seat Back Position per TWG Guidelines	Initial Position: Manufacturer's design angle			
	Seat Back Adjustments: None			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

VEHICLE SEAT HEIGHT ADJUSTMENT

Seat	Total Seat Height Travel		Test Position from Lowest Position	
	mm	Detents (1st as 1)	mm	Detent (1st as 0)
Right Front Passenger Seat	Fixed		Fixed	
Right Rear Passenger Seat				
Seat Fore/Aft Position per TWG Guidelines	Initial Position: Forward-most and highest adjustment			
	Seat Height Adjustments: None			
Reason for Deviation from TWG Guidelines	No deviation from TWG guidelines			

DATA SHEET NO. 4
DUMMY SETUP AND POSITIONING DATA

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

ATD Type	SID-IIs Build Level D 5th-percentile female dummy
Serial Number	304
Qualification Date	7/30/2020
Qualification Type	Full
Clothing	Cotton shirt and pants, shoes
Other ATD Preparation	Skullcap seam covered with 4mm electrical tape. Head skin cleaned with alcohol and dusted with baby powder.

DATA SHEET NO. 5
DUMMY INJURY CRITERIA VALUES

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

RECORDED DATA – MINIMUMS AND MAXIMUMS

Channel	Unit	CFC	Maximum	Time (ms)	Minimum	Time (ms)
Passenger Head X	g	1000	20.4	24.1	-9.5	74.7
Passenger Head Y			25.3	24.2	-8.0	37.4
Passenger Head Z			24.7	15.3	-8.1	11.9
Passenger Upper Neck Fx	N	1000	165.3	17.1	-290.7	60.8
Passenger Upper Neck Fy			218.0	68.4	-185.3	22.8
Passenger Upper Neck Fz			89.1	237.0	-1257.2	34.3
Passenger Upper Neck Mx	Nm	600	19.8	23.0	-4.6	14.6
Passenger Upper Neck My			15.4	17.2	-27.0	58.0
Passenger Upper Neck Mz			6.2	23.1	-5.6	88.8
Passenger Lower Neck Fx	N	1000	240.1	15.7	-340.9	59.2
Passenger Lower Neck Fy			106.0	13.3	-162.1	23.7
Passenger Lower Neck Fz			89.5	236.4	-1244.5	34.3
Passenger Lower Neck Mx	Nm	600	28.1	70.8	-12.4	131.9
Passenger Lower Neck My			74.9	59.6	-16.3	15.3
Passenger Lower Neck Mz			7.1	14.2	-10.0	94.9

HEAD INJURY SUMMARY

HIC_{15}	T_1 (ms)	T_2 (ms)	HIC_{36}	T_1 (ms)	T_2 (ms)
17	22.4	37.4	24	14.9	49.2

NECK INJURY SUMMARY

Injury Criteria	Unit	Value	Time (ms)
Upper Neck NTF		0.09	122.9
Upper Neck NTE		0.05	225.3
Upper Neck NCF		0.20	18.9
Upper Neck NCE		0.63	33.5
Peak Tension	N	89.1	237.0
Peak Compression	N	1257.2	34.3

DATA SHEET NO. 5 (CONT.)
DUMMY INJURY CRITERIA DATA

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

CHEST INJURY SUMMARY

Injury Criteria	Unit	Value	Time (ms)
Chest Deflection	mm		
Deflection Rate[1]	m/s		

[1]Deflection rate is calculated based on Chest Deflection potentiometer.

RESEARCH VALUE SUMMARY

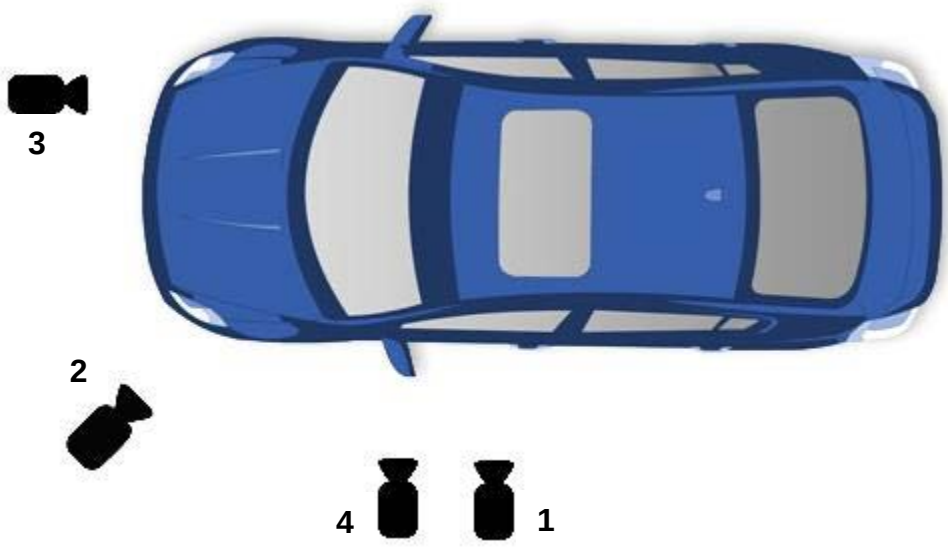
Research Injury Criteria[1]	Unit	Value	Time (ms)
Upper Neck Lateral Moment	Nm	19.8	23.0
Upper Neck Twist Moment	Nm	6.2	23.1
Lower Neck Flexion Moment	Nm	74.9	59.6
Lower Neck Extension Moment	Nm	16.3	15.3
Lower Neck Lateral Moment	Nm	28.1	70.8
Lower Neck Twist Moment	Nm	10.0	94.9
Lower Neck Tension	N	89.5	236.4
Lower Neck Compression	N	1244.5	34.3
Spine Acceleration	g		

[1]These injury criteria are only monitored and not considered pass/fail.

DATA SHEET NO. 6
CAMERA SETUP AND DESCRIPTION

Test Vehicle: 2020 Nissan Maxima S 4-Door Sedan NHTSA No.: M20205208TWG2
Test Program: NCAP Side Airbag Out-of-Position Test Date: 9/8/2020

CAMERA SETUP DIAGRAM FOR OOP TESTS



CAMERA LOCATIONS

No.	Camera View	Location			Lens (mm)	Speed (fps)
		X	Y	Z		
1	Left View	2550	-1405	-1131	24	2700
2	Oblique View	4650	-890	-1809	24	2700
3	Front View	4705	405	-1756	24	2700
4	Real Time (optional)					30

Reference:
+X = Forward of Rear Surface of Vehicle (RSOV)
+Y = Right of Vehicle Centerline
+Z = Down from Ground

APPENDIX A

PHOTOGRAPHS

Photo No. 001 - Right Three-Quarter Front View of Vehicle, As Received

Photo No. 002 - Vehicle Certification Placard

Photo No. 003 - Pre-Test Vehicle Left Side View

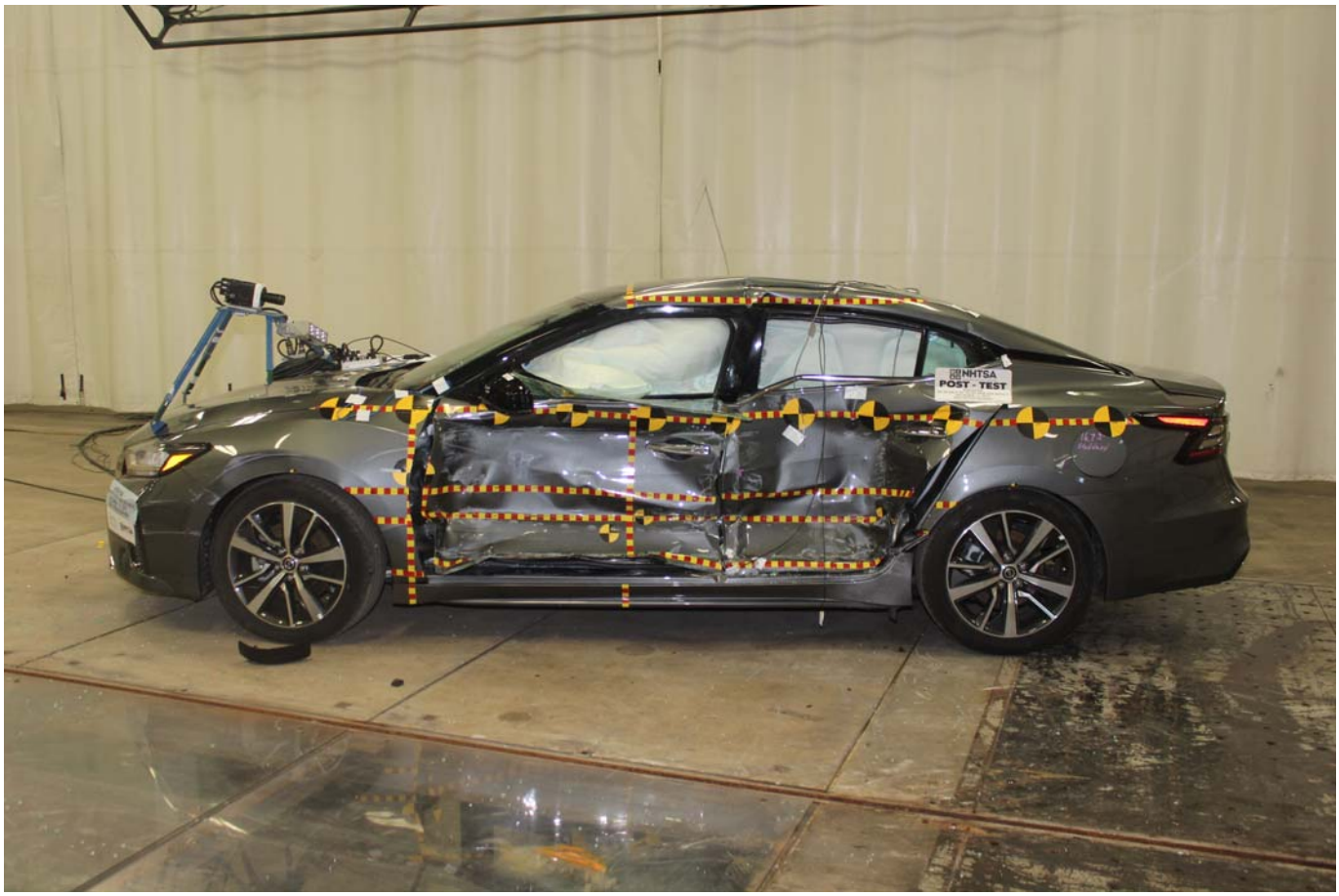


Photo No. 004 - Post-Test Vehicle Left Side View

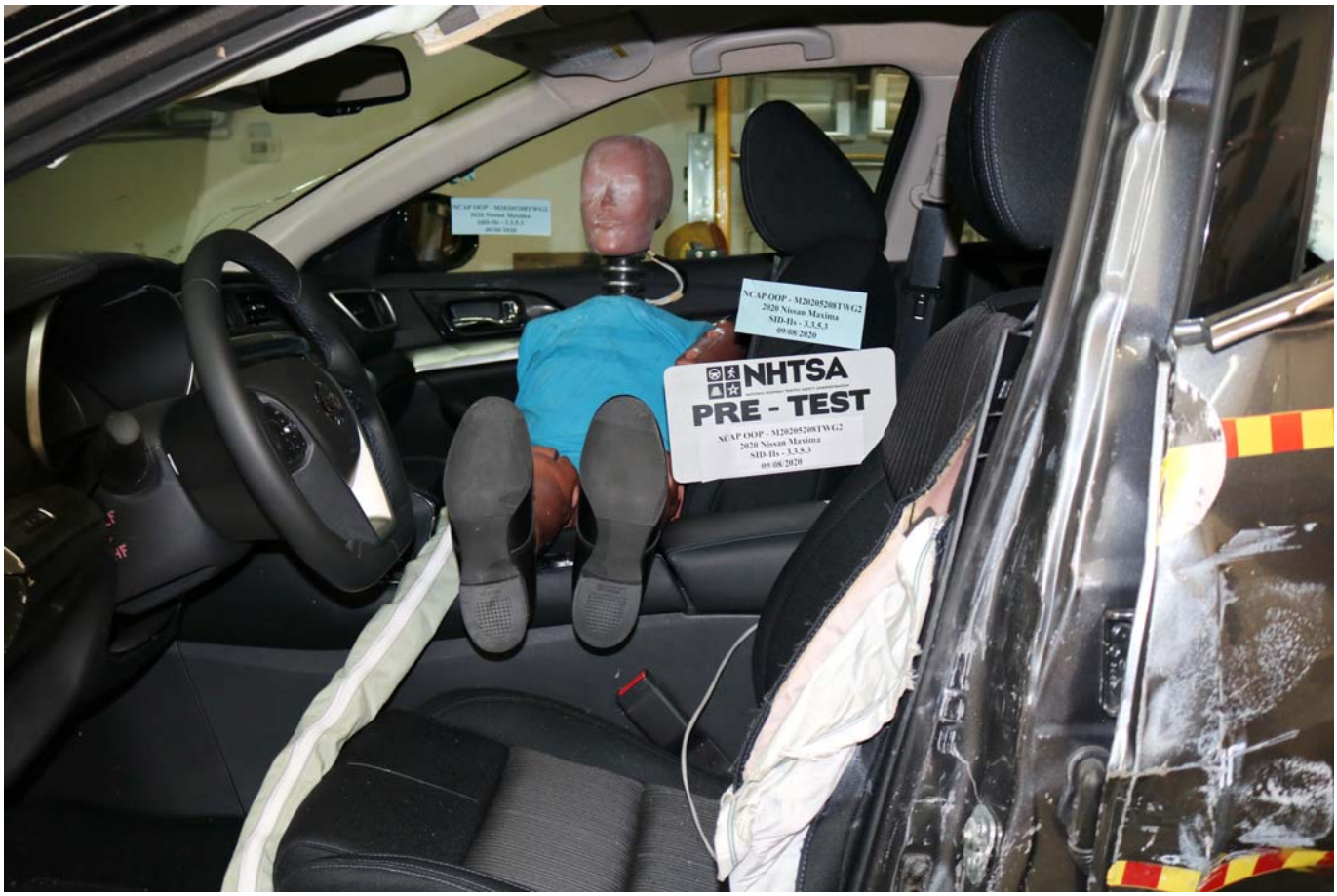


Photo No. 005 - Pre-Test Dummy Left Side View

Photo No. 006 - Post-Test Dummy Left Side View

Photo No. 007 - Pre-Test Dummy Left Side Close-Up View

Photo No. 008 - Post-Test Dummy Left Side Close-Up View

Photo No. 009 - Pre-Test Dummy Left Three-Quarter Front View

Photo No. 010 - Post-Test Dummy Left Three-Quarter Front View

Photo No. 011 - Pre-Test Dummy Left Three-Quarter Front Close-Up View

Photo No. 012 - Post-Test Dummy Left Three-Quarter Front Close-Up View

Photo No. 013 - Pre-Test Dummy Front View

Photo No. 014 - Post-Test Dummy Front View

Photo No. 015 - Pre-Test Dummy Front Close-Up View

Photo No. 016 - Post-Test Dummy Front Close-Up View

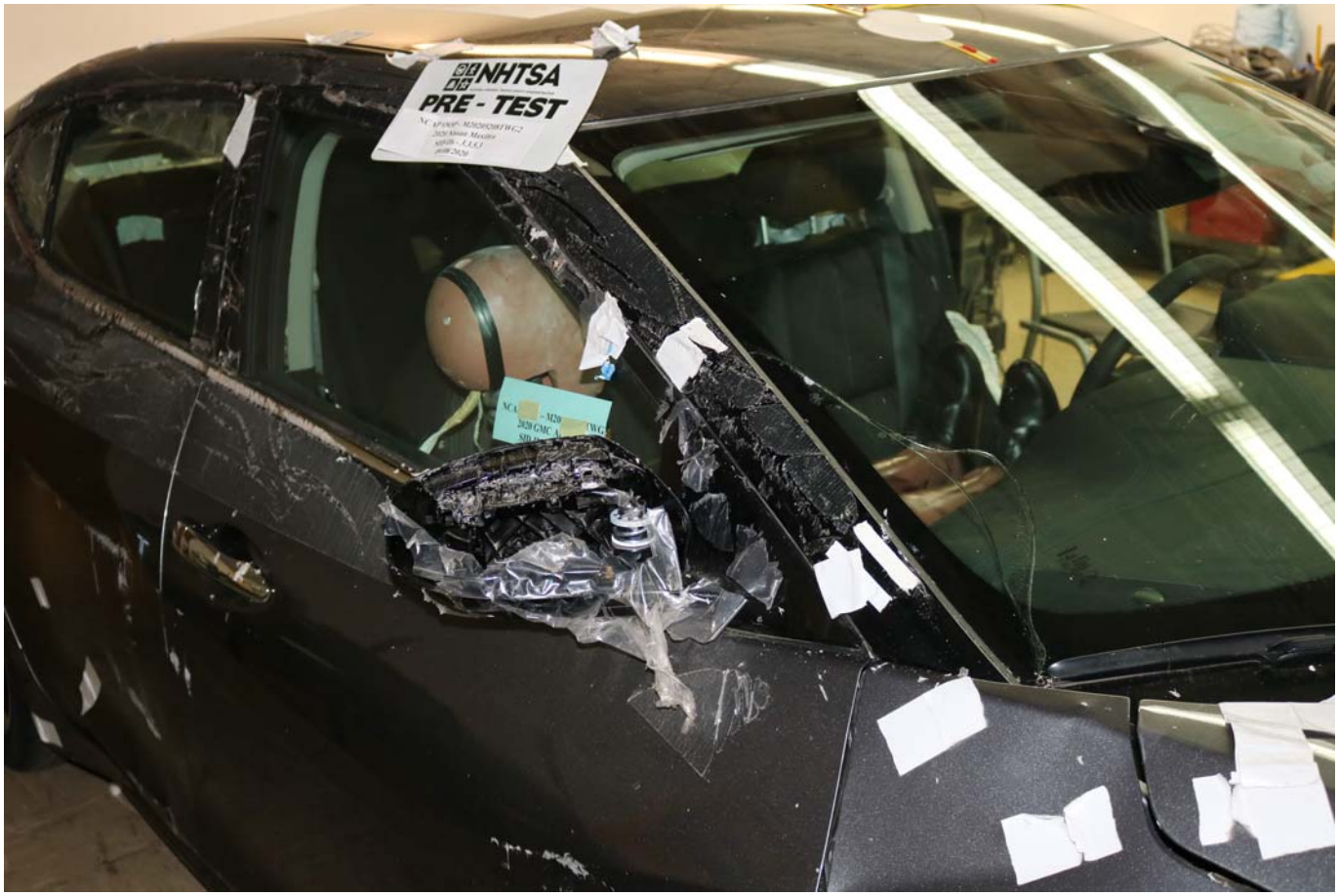


Photo No. 017 - Pre-Test Dummy Right Three-Quarter Front View

Photo No. 018 - Post-Test Dummy Right Three-Quarter Front View

Photo No. 019 - Pre-Test Dummy Right Side View

Photo No. 020 - Post-Test Dummy Right Side View

Photo No. 021 - Post-Test Dummy Right Side View (Door Open)

Photo No. 022 - Post-Test Curtain Airbag Left Side View

Photo No. 023 - Post-Test Curtain Airbag Left Three-Quarter Front View

Photo No. 024 - Post-Test Curtain Airbag Front View

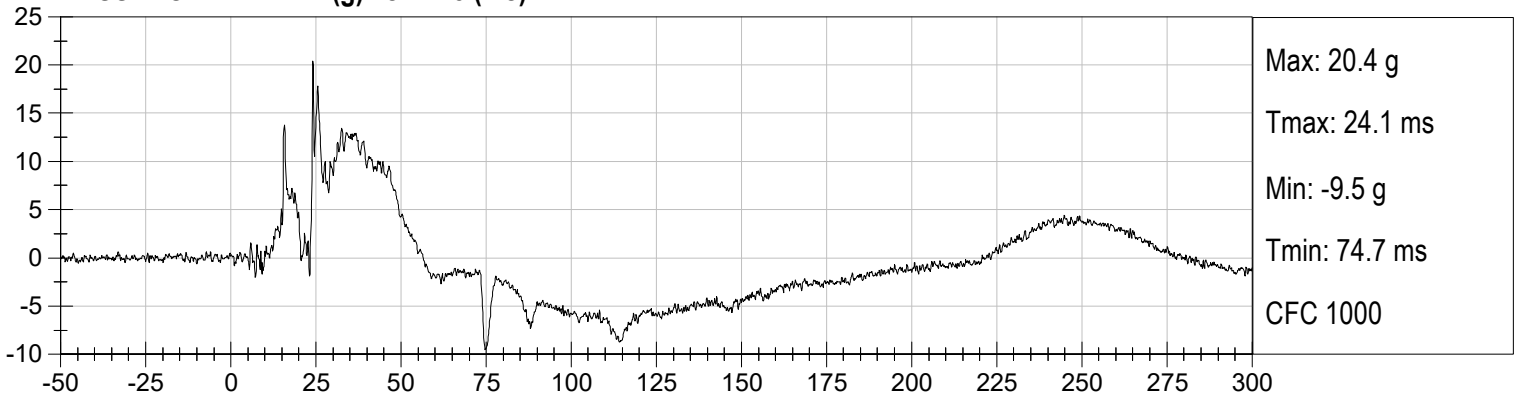
Photo No. 025 - Post-Test Curtain Airbag Right Side View (Door Open)

APPENDIX B

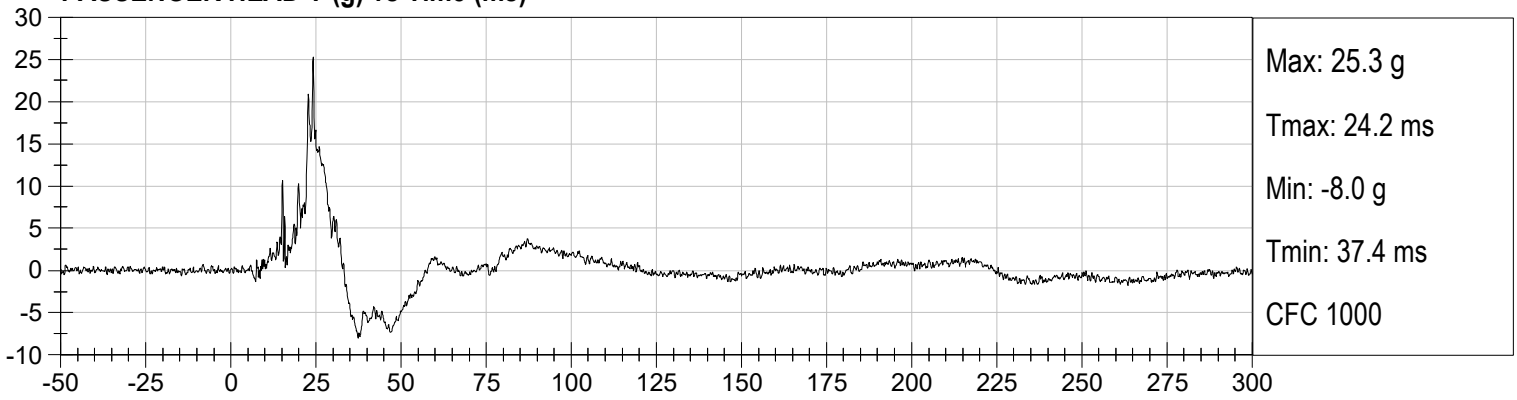
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

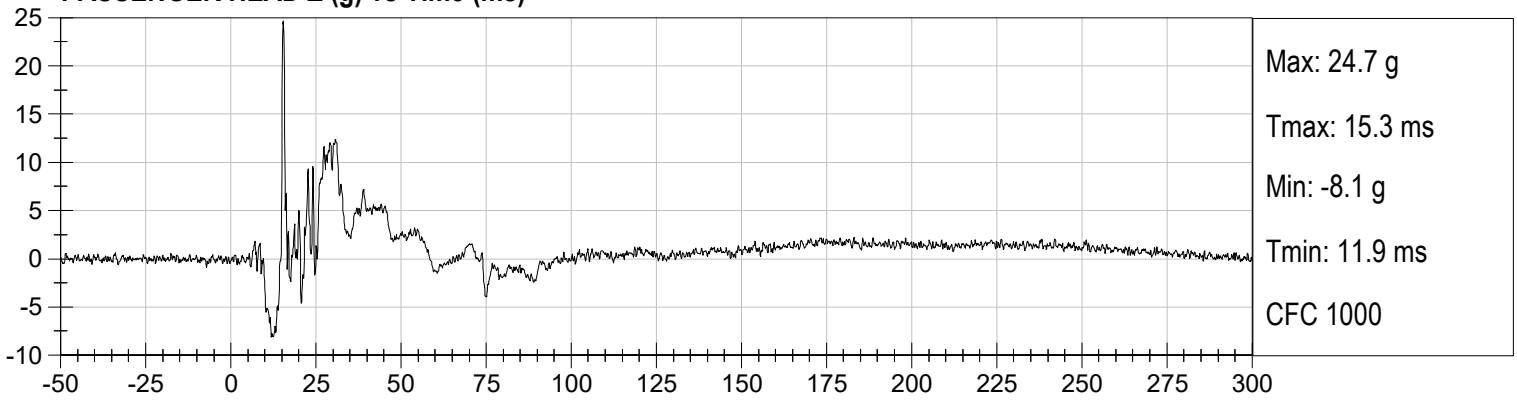
PASSENGER HEAD X (g) vs Time (ms)



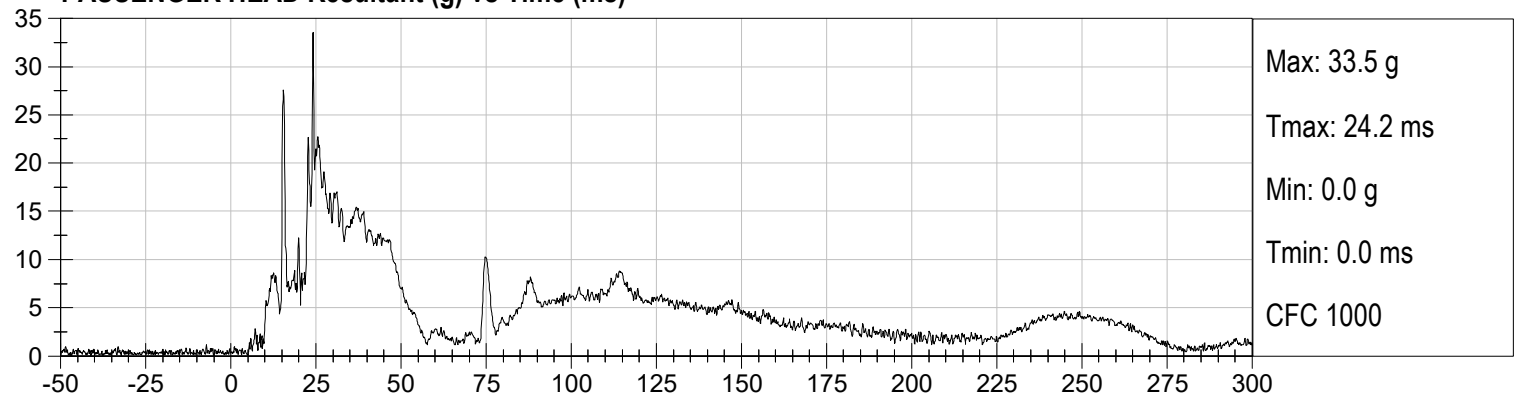
PASSENGER HEAD Y (g) vs Time (ms)



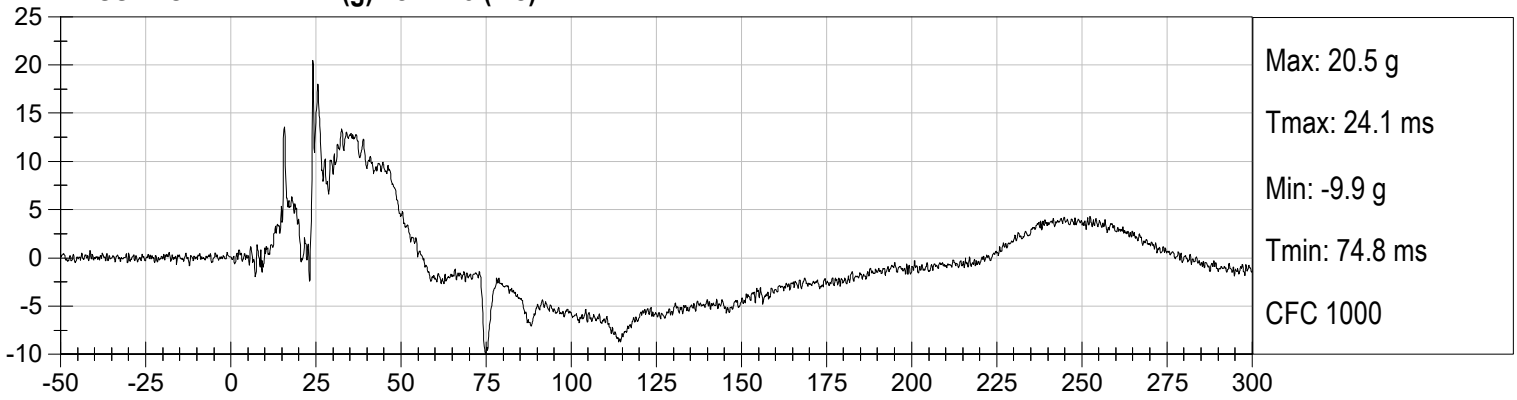
PASSENGER HEAD Z (g) vs Time (ms)



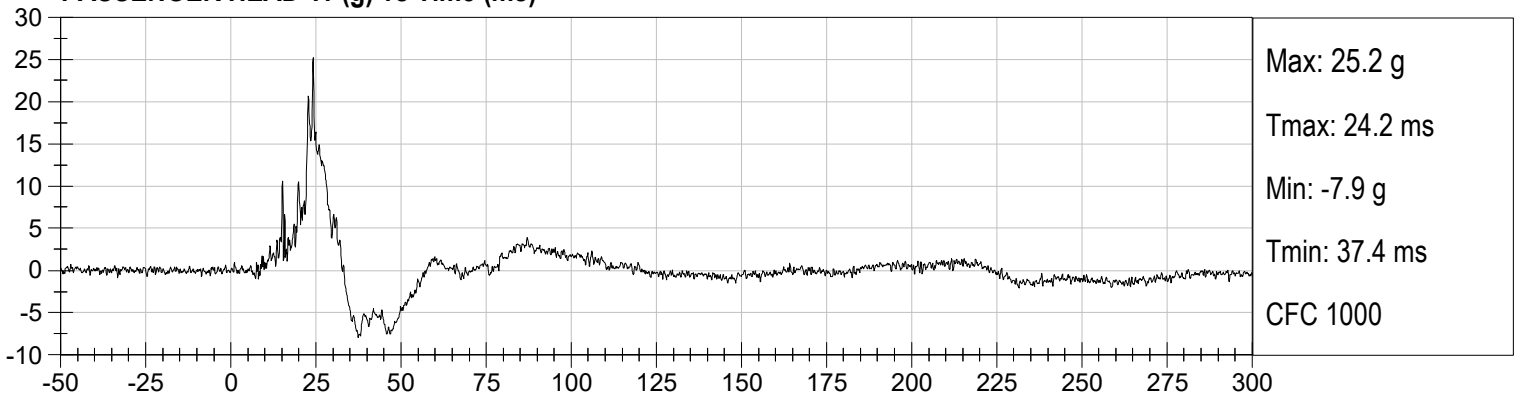
PASSENGER HEAD Resultant (g) vs Time (ms)



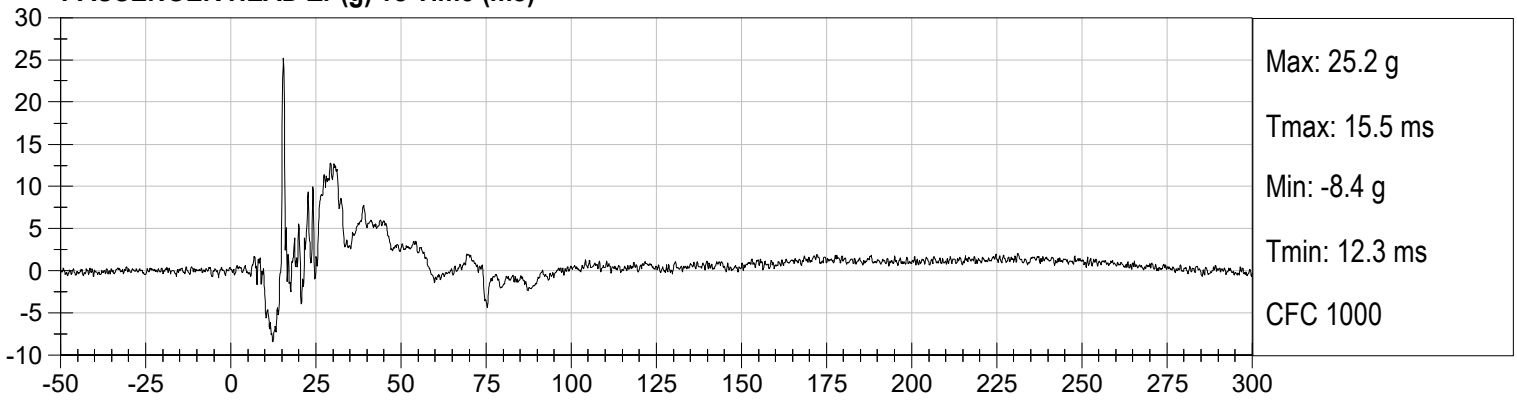
PASSENGER HEAD Xr (g) vs Time (ms)



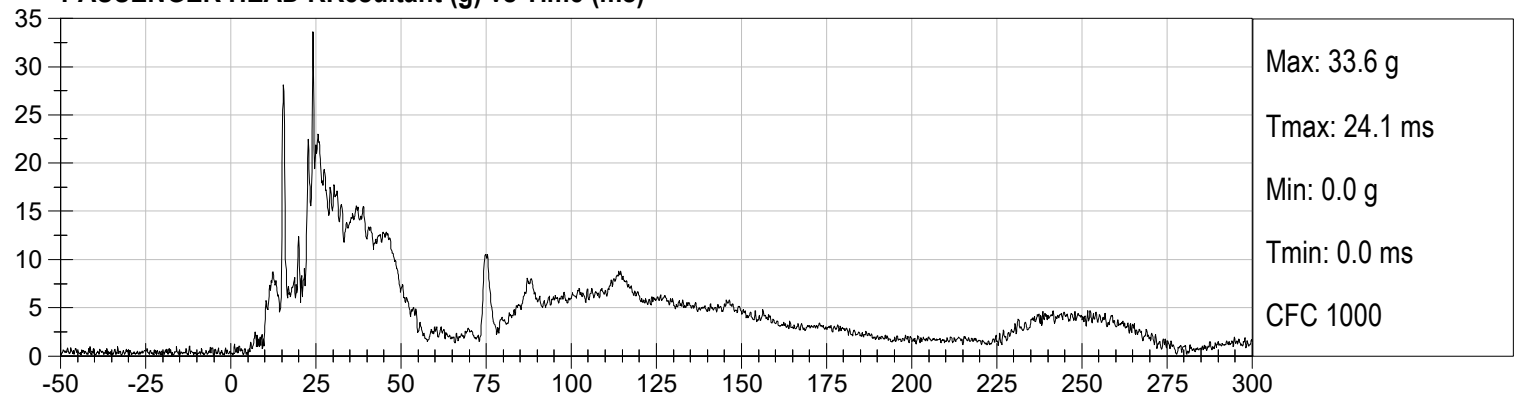
PASSENGER HEAD Yr (g) vs Time (ms)



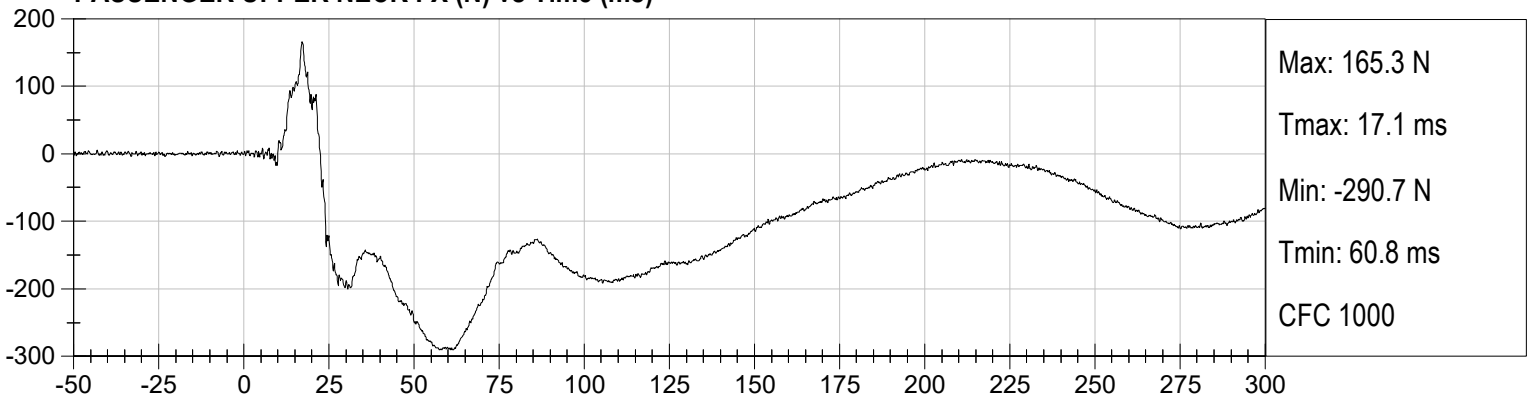
PASSENGER HEAD Zr (g) vs Time (ms)



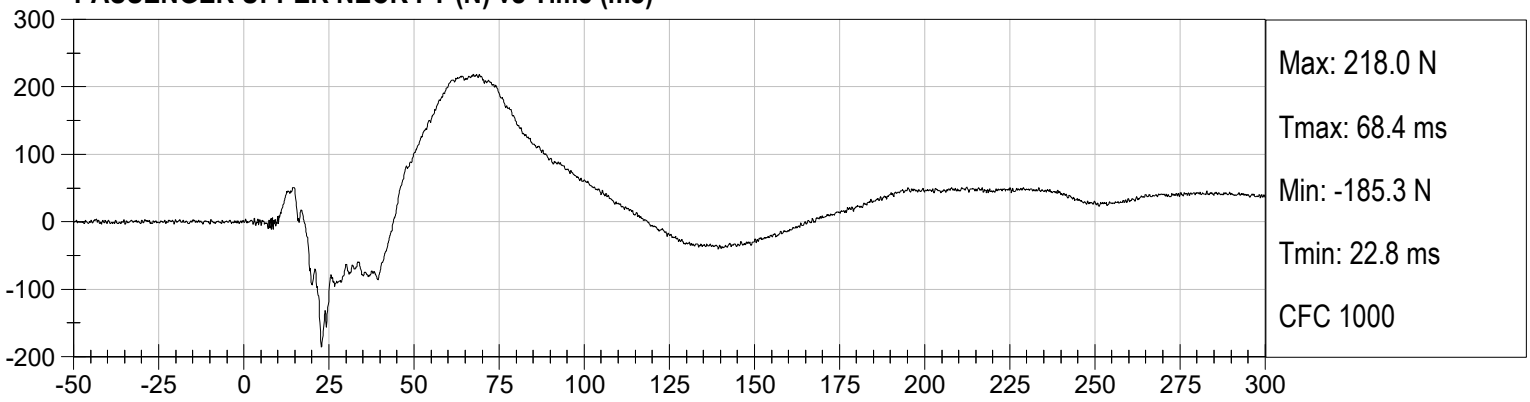
PASSENGER HEAD RResultant (g) vs Time (ms)



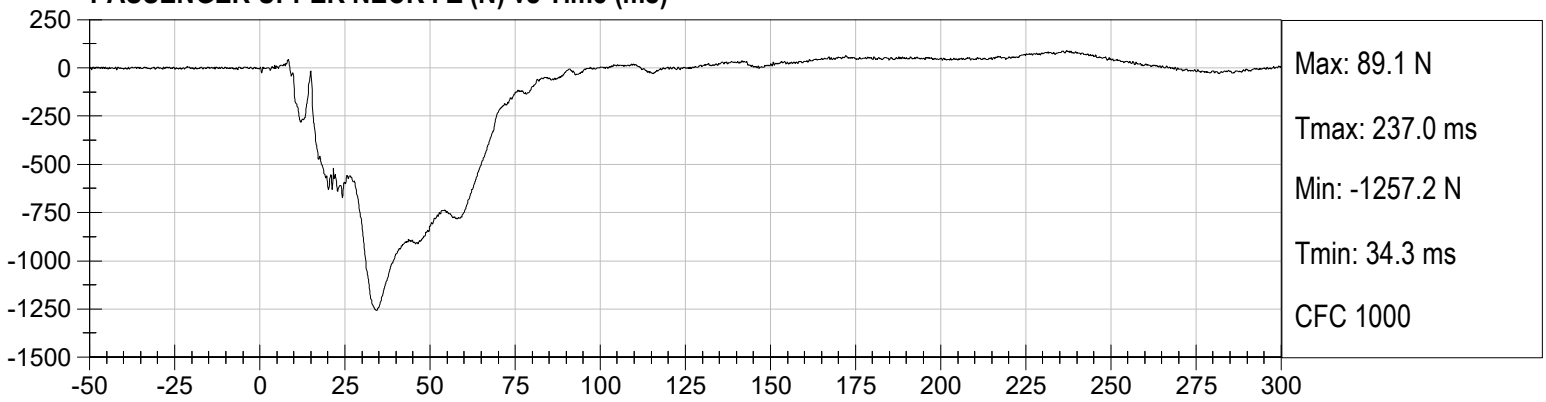
PASSENGER UPPER NECK FX (N) vs Time (ms)



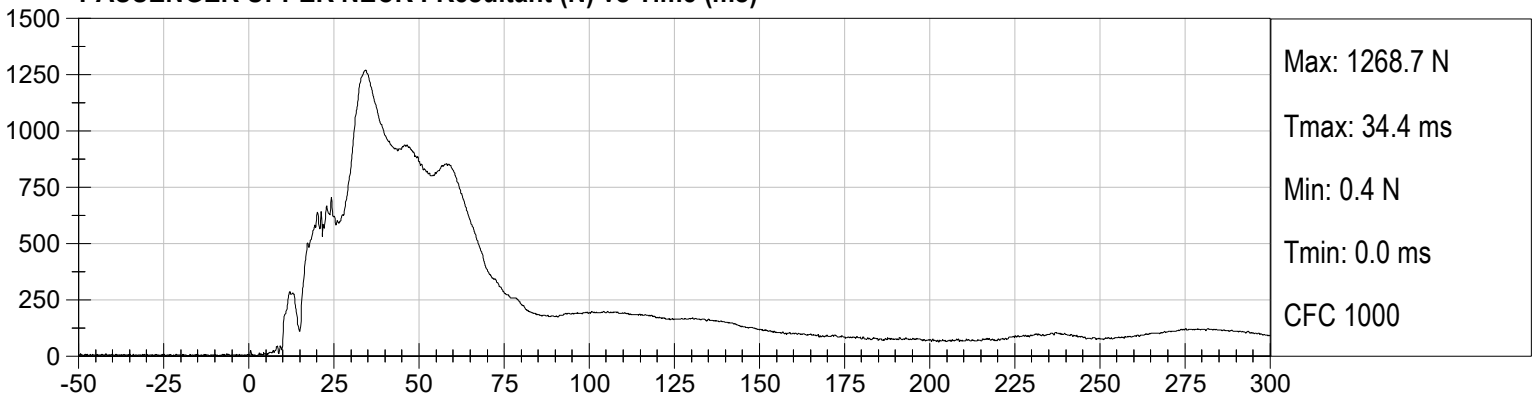
PASSENGER UPPER NECK FY (N) vs Time (ms)



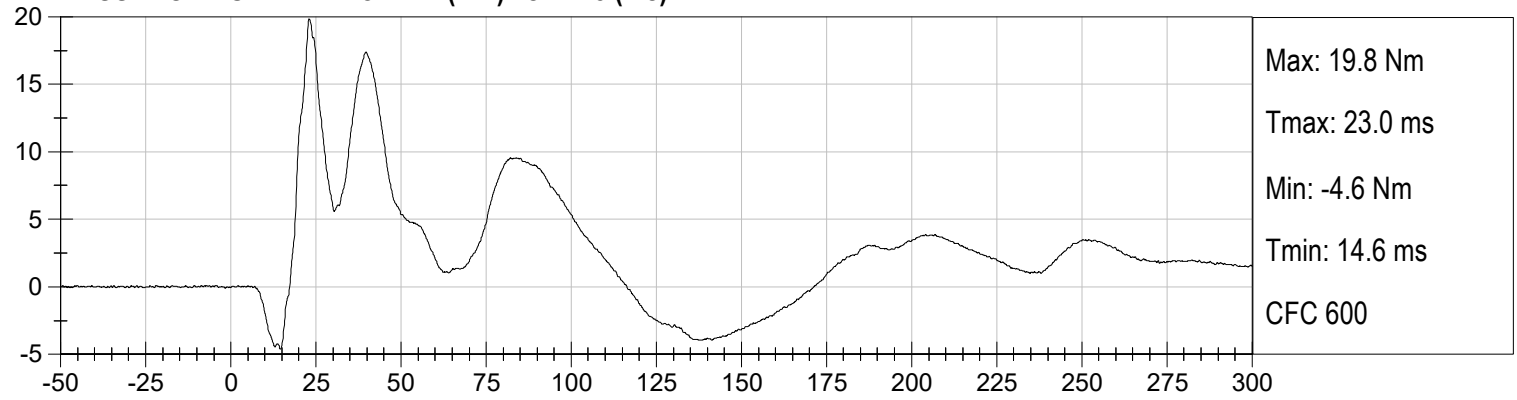
PASSENGER UPPER NECK FZ (N) vs Time (ms)



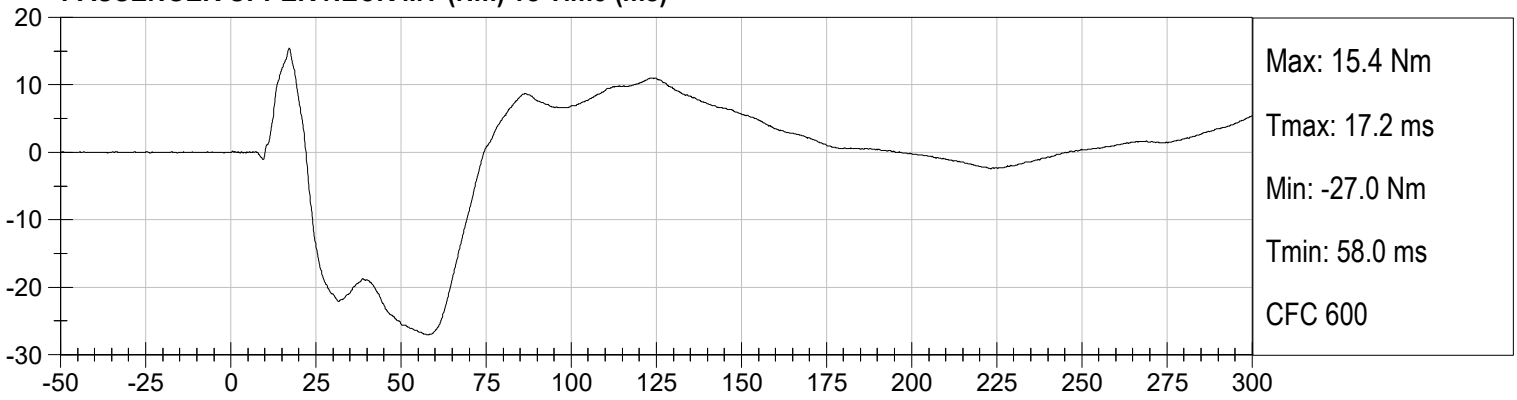
PASSENGER UPPER NECK FResultant (N) vs Time (ms)



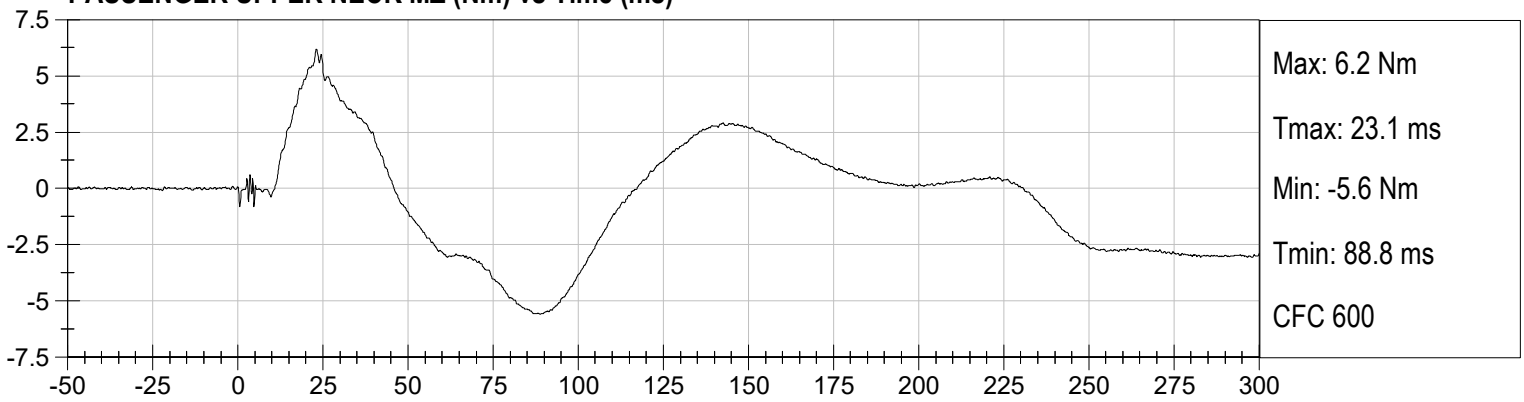
PASSENGER UPPER NECK MX (Nm) vs Time (ms)



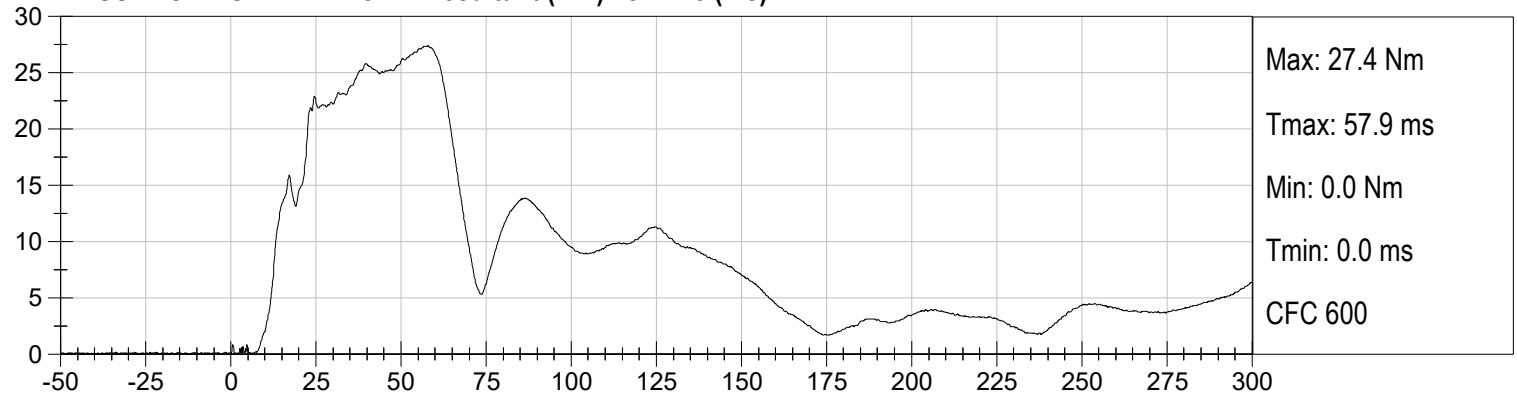
PASSENGER UPPER NECK MY (Nm) vs Time (ms)



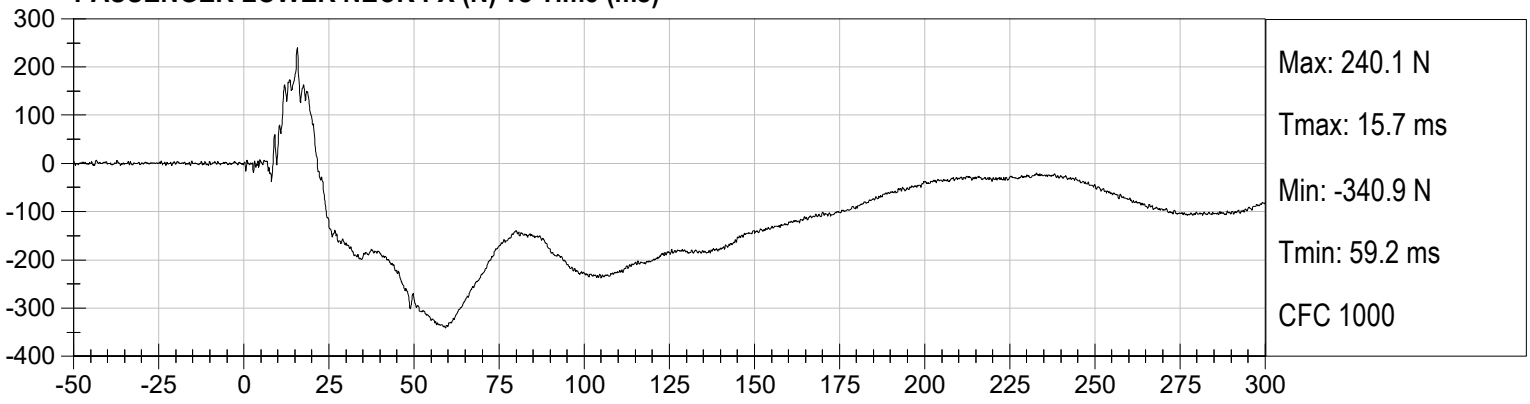
PASSENGER UPPER NECK MZ (Nm) vs Time (ms)



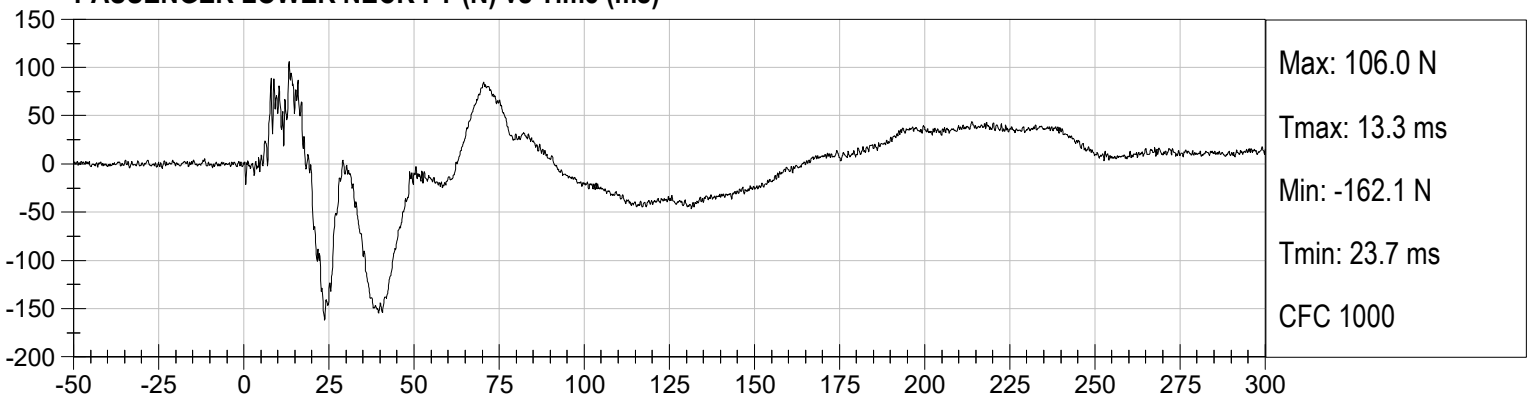
PASSENGER UPPER NECK MResultant (Nm) vs Time (ms)



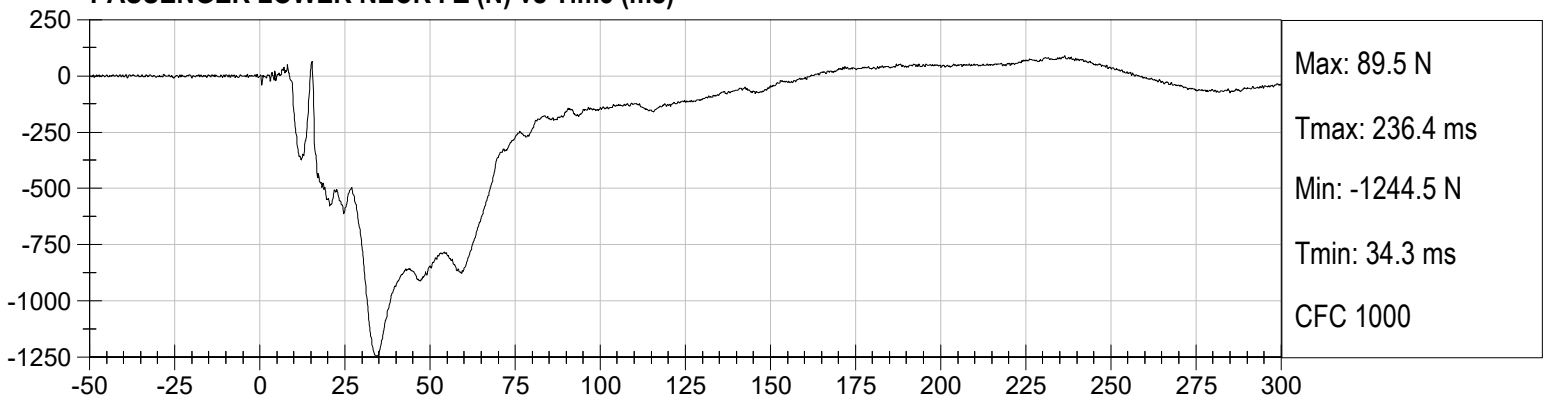
PASSENGER LOWER NECK FX (N) vs Time (ms)



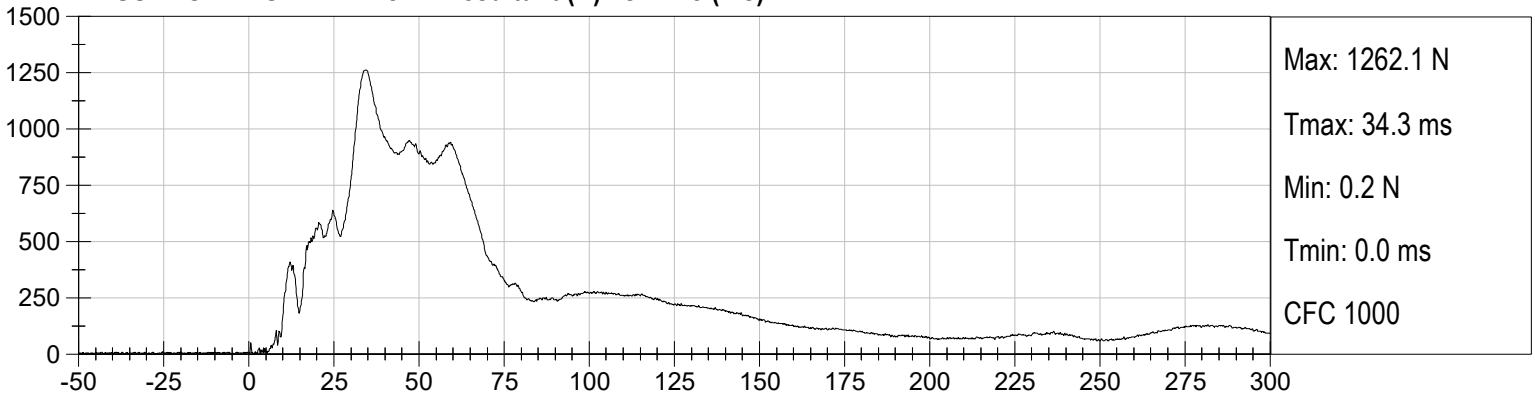
PASSENGER LOWER NECK FY (N) vs Time (ms)



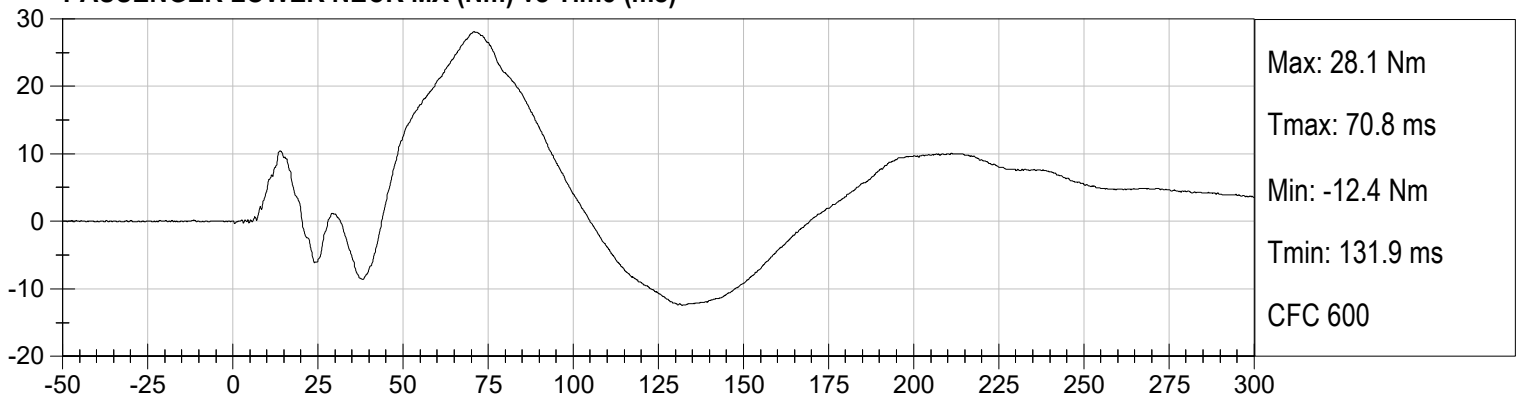
PASSENGER LOWER NECK FZ (N) vs Time (ms)



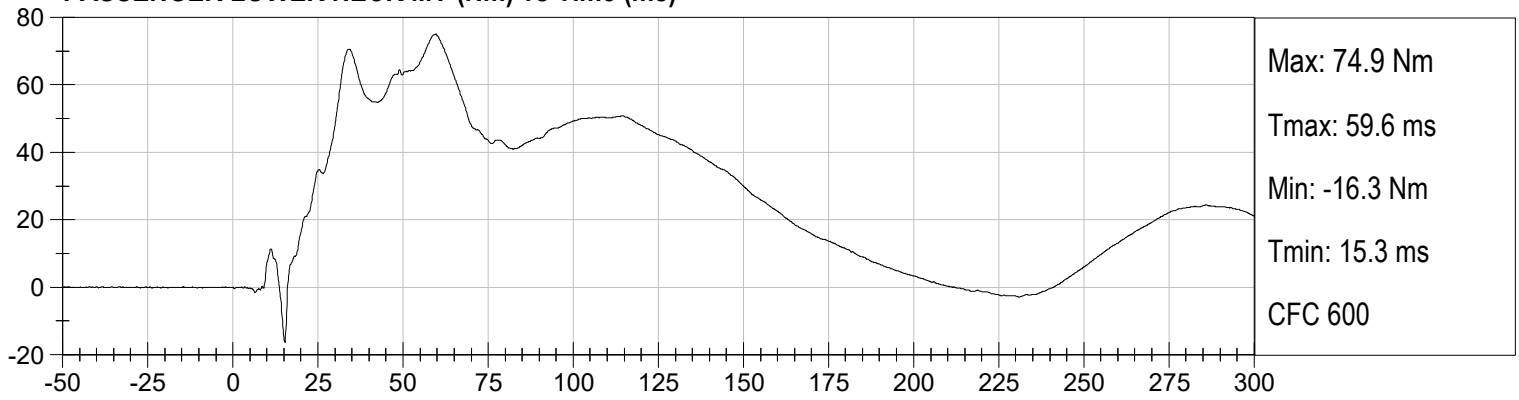
PASSENGER LOWER NECK FResultant (N) vs Time (ms)



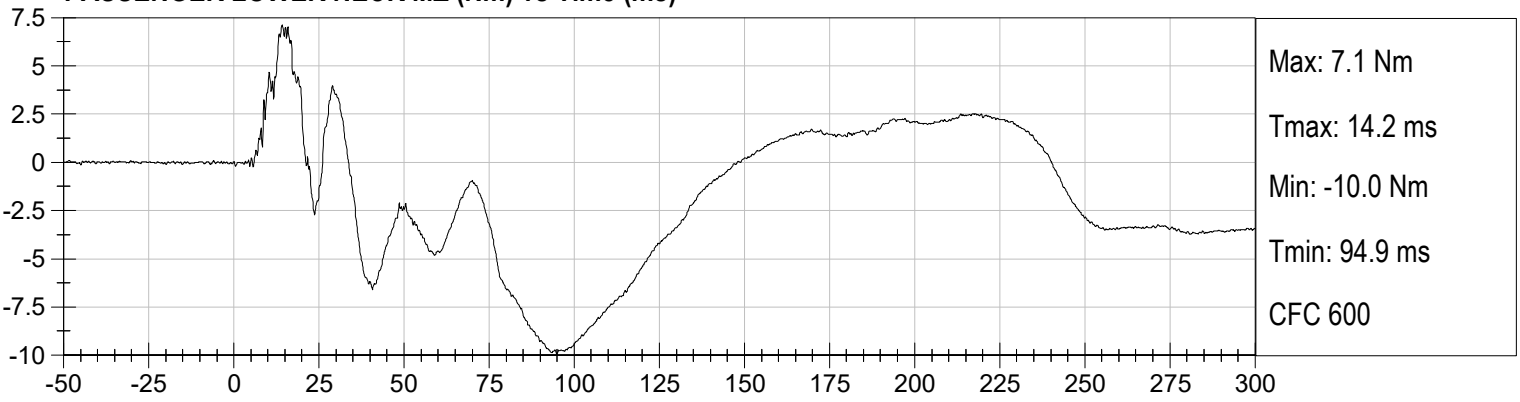
PASSENGER LOWER NECK MX (Nm) vs Time (ms)



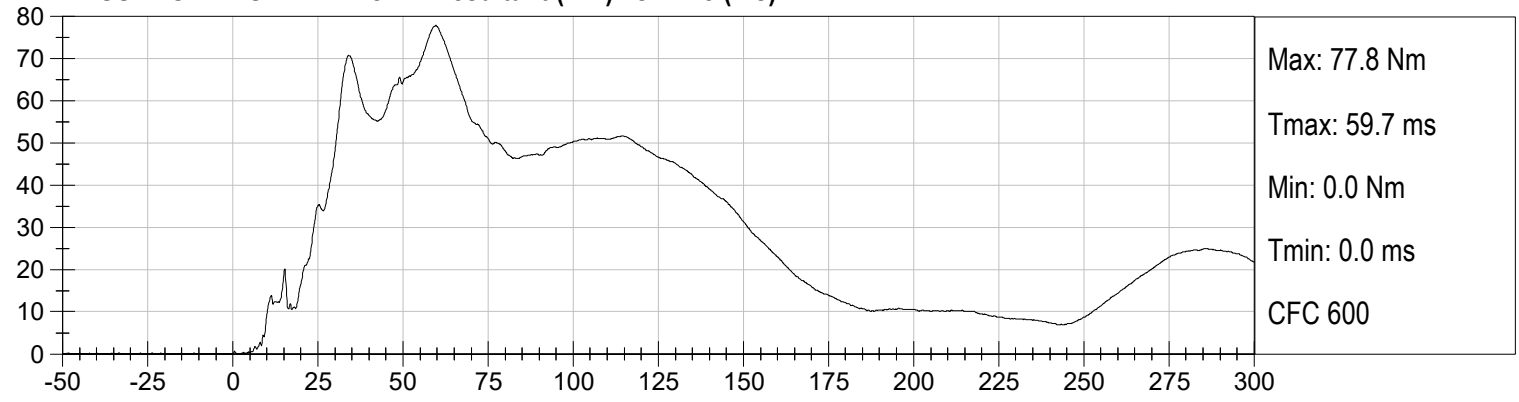
PASSENGER LOWER NECK MY (Nm) vs Time (ms)



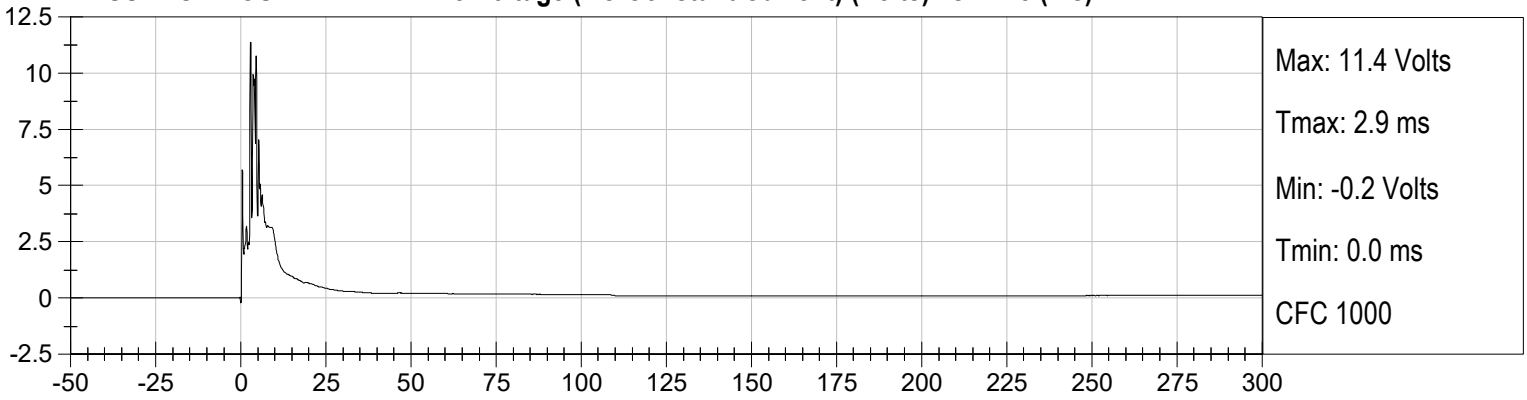
PASSENGER LOWER NECK MZ (Nm) vs Time (ms)



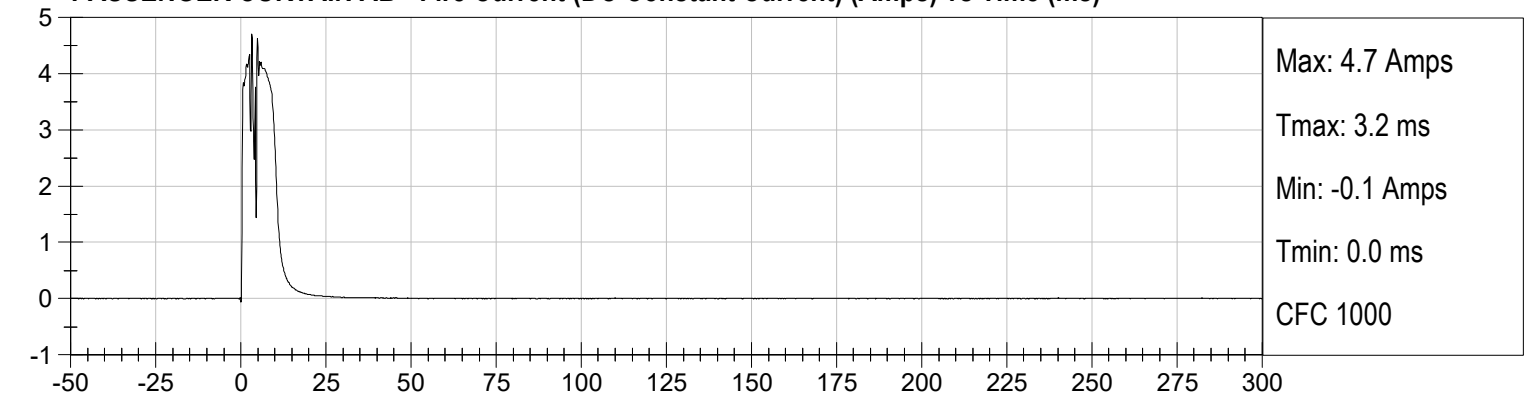
PASSENGER LOWER NECK MResultant (Nm) vs Time (ms)



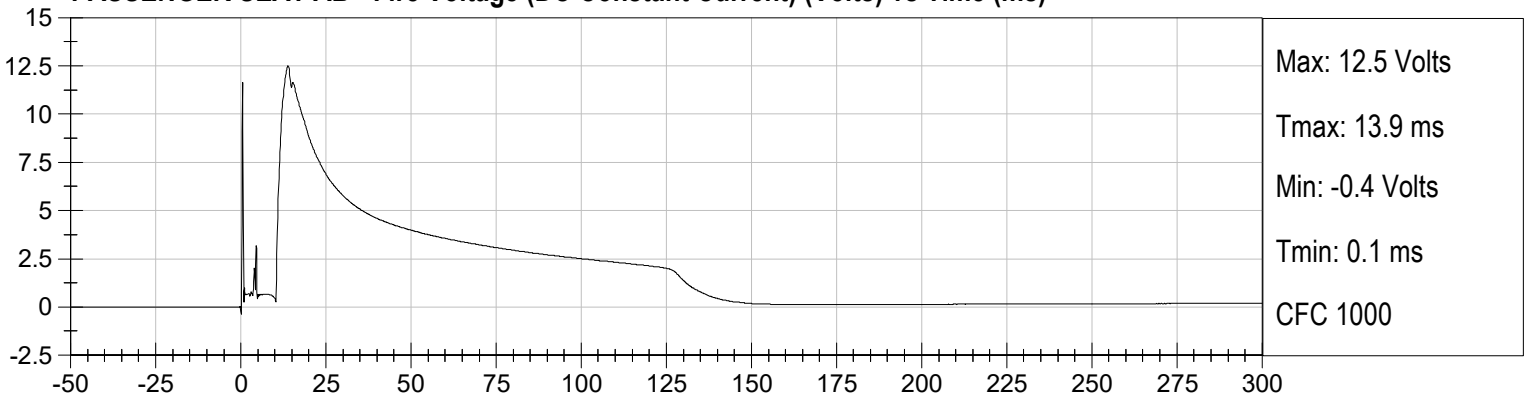
PASSENGER CURTAIN AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)



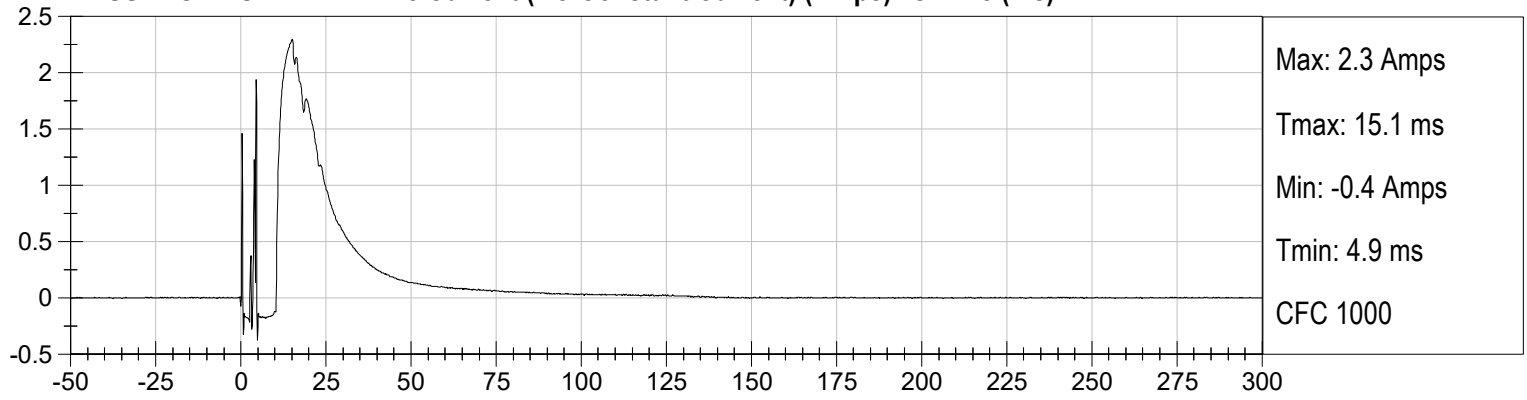
PASSENGER CURTAIN AB - Fire Current (DC Constant Current) (Amps) vs Time (ms)



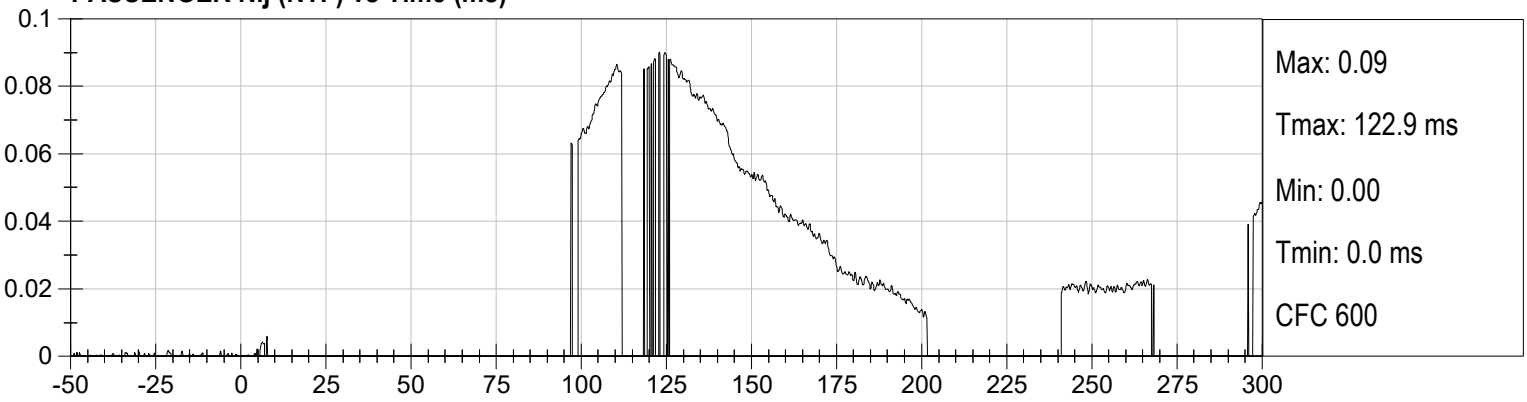
PASSENGER SEAT AB - Fire Voltage (DC Constant Current) (Volts) vs Time (ms)



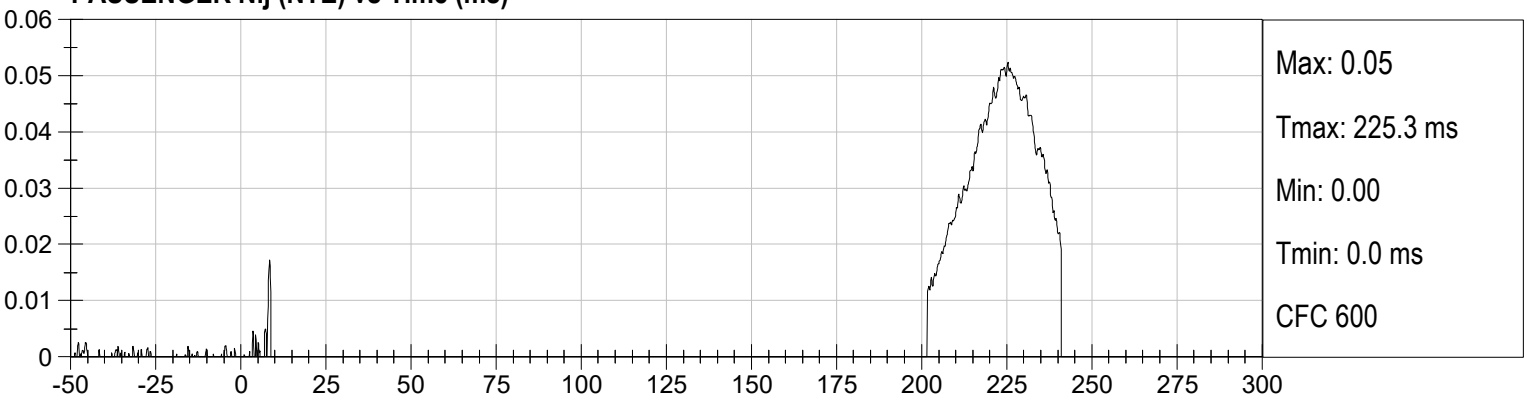
PASSENGER SEAT AB - Fire Current (DC Constant Current) (Amps) vs Time (ms)



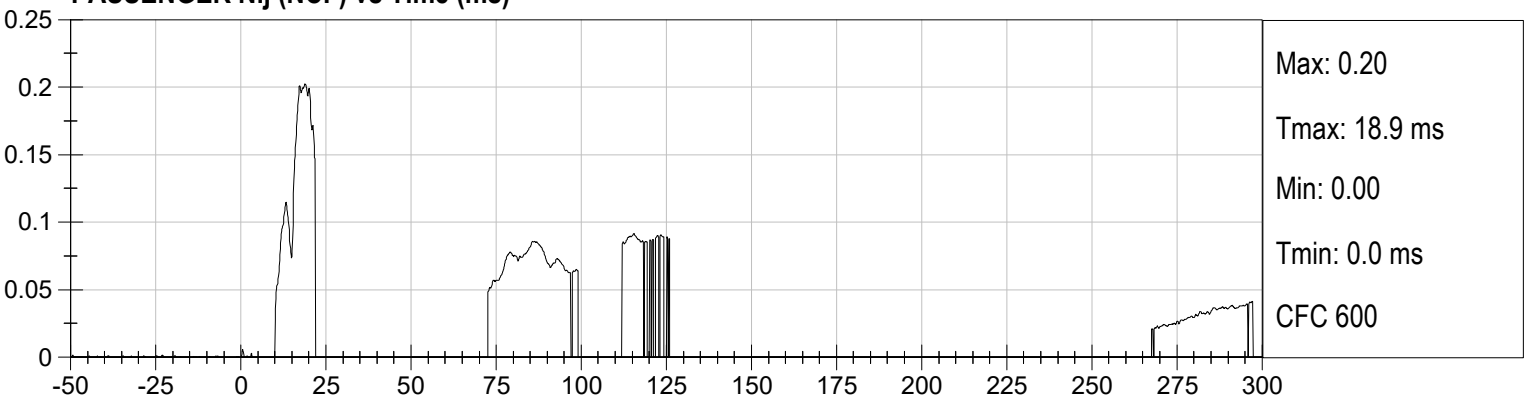
PASSENGER Nij (NTF) vs Time (ms)



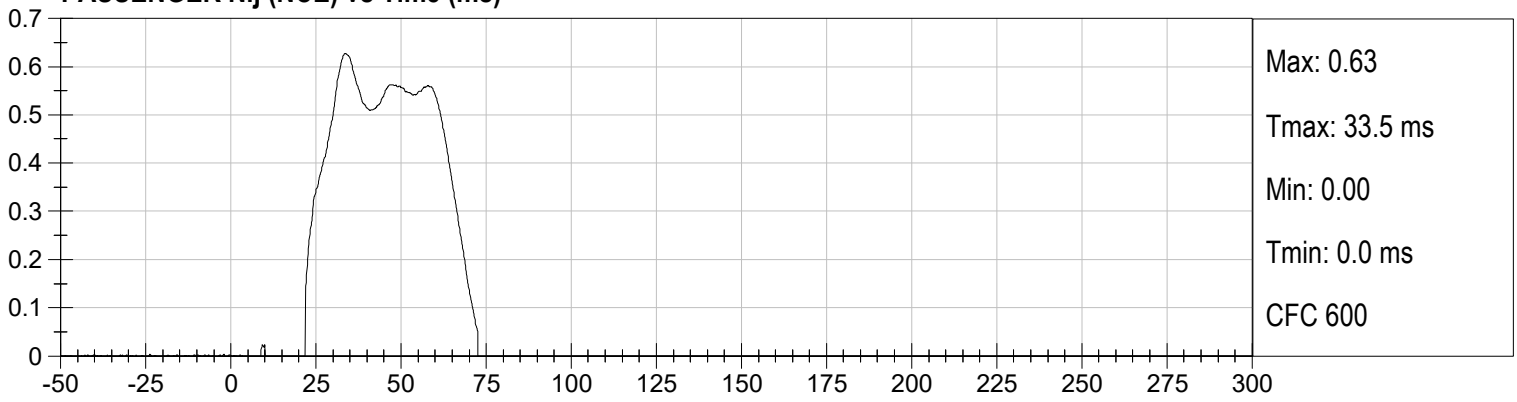
PASSENGER Nij (NTE) vs Time (ms)



PASSENGER Nij (NCF) vs Time (ms)



PASSENGER Nij (NCE) vs Time (ms)



APPENDIX C
DUMMY CONFIGURATION AND PERFORMANCE VERIFICATION DATA

CALIBRATION TEST RESULTS

PRE-TEST

SID-IIs 5TH PERCENTILE FEMALE ATD

MGA RESEARCH CORPORATION

HEAD DROP TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test ID:** D201861

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	43	Pass
Peak Resultant Acceleration	G's	115 to 137	123	Pass
Peak Longitudinal Acceleration	G's	+/- 15	-2.3	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	<15%	Yes	Pass
		Overall Test Results		Pass

Laboratory Technician

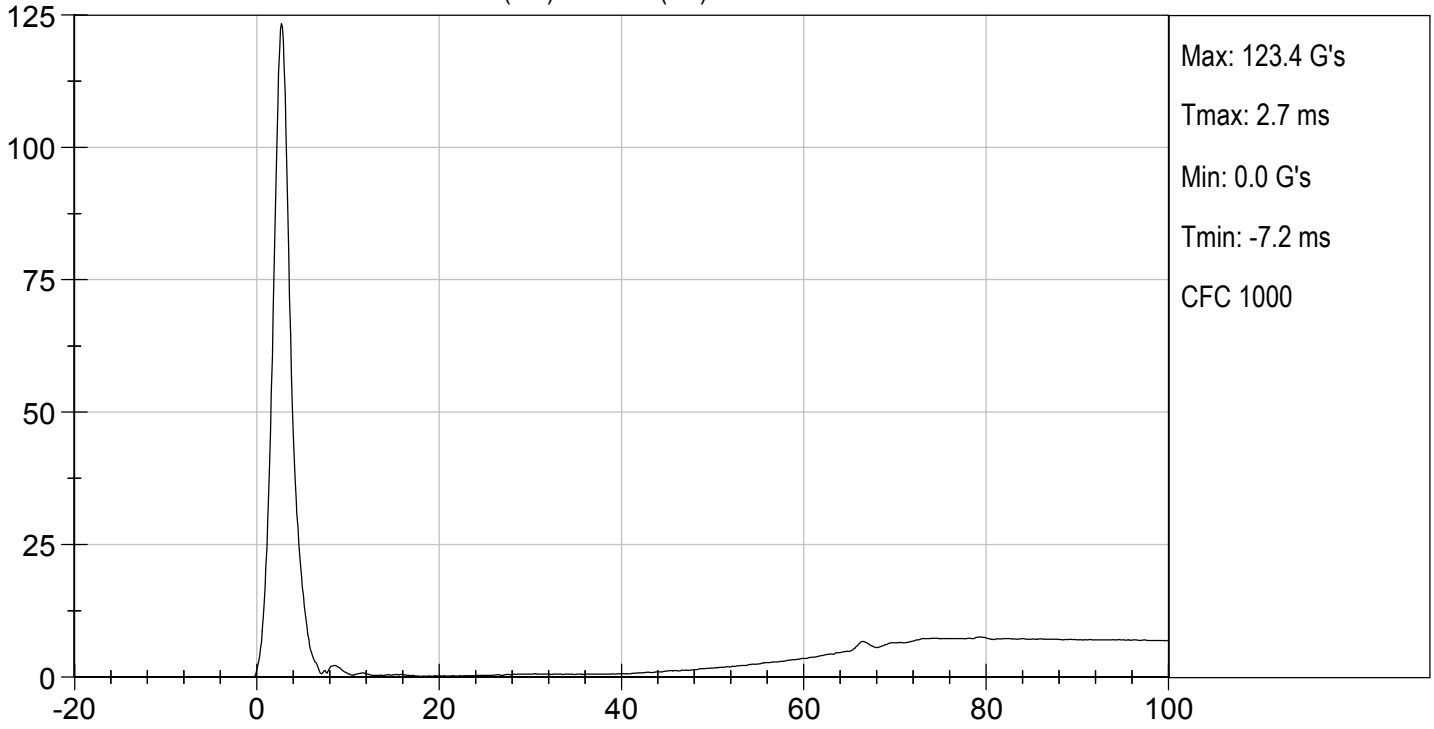
07/30/2020
Test Date

Approved By

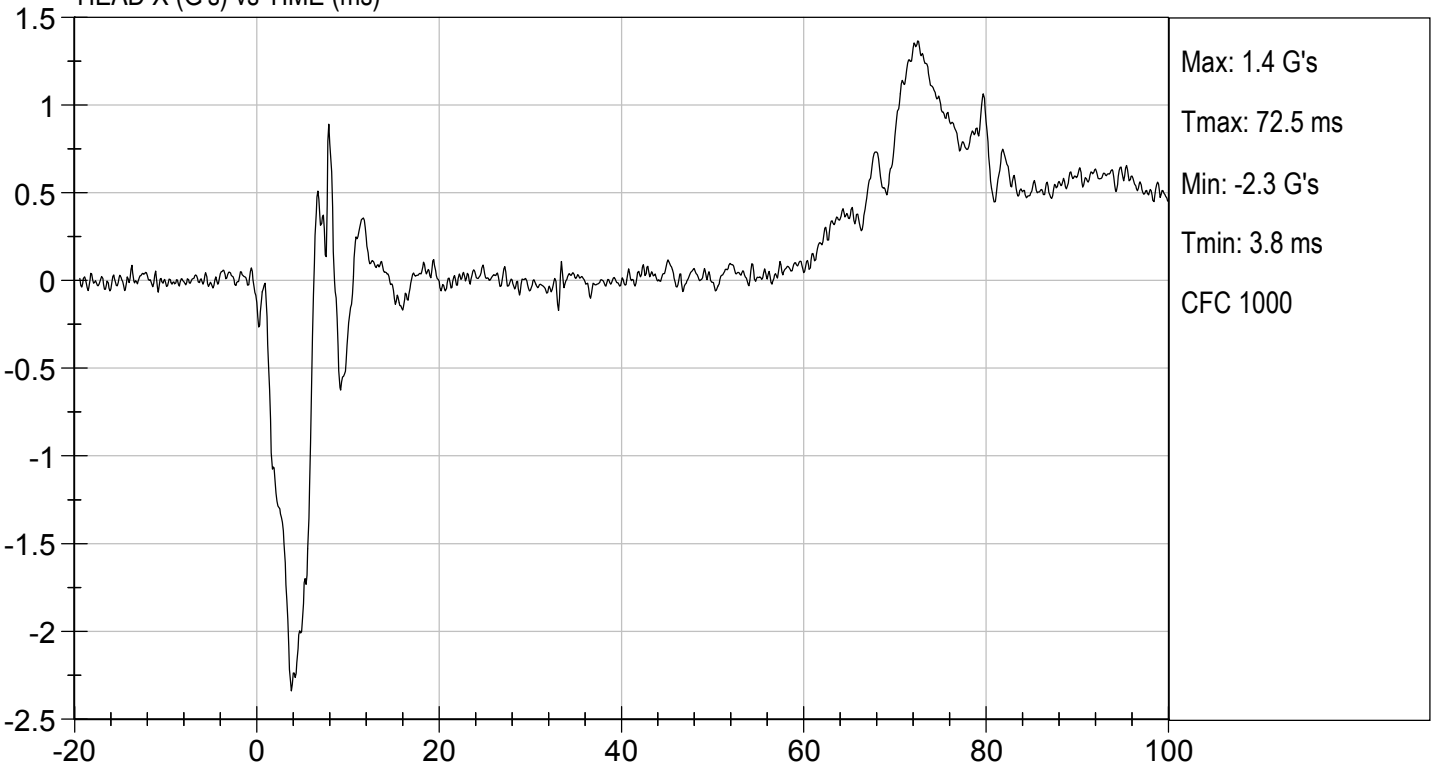
TEST DESC: HEAD DROP

TEST DATE: 07/30/2020
TEST #: D201861

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

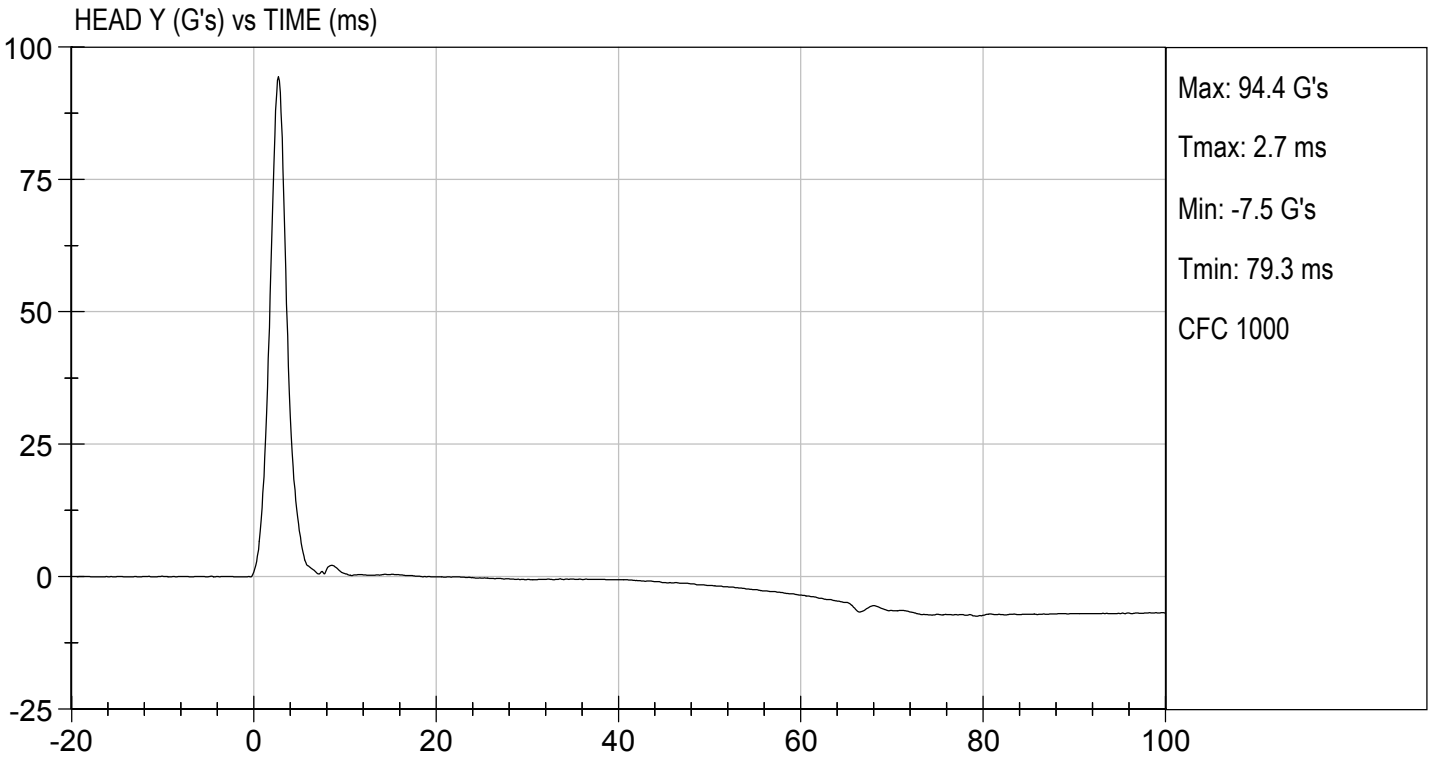


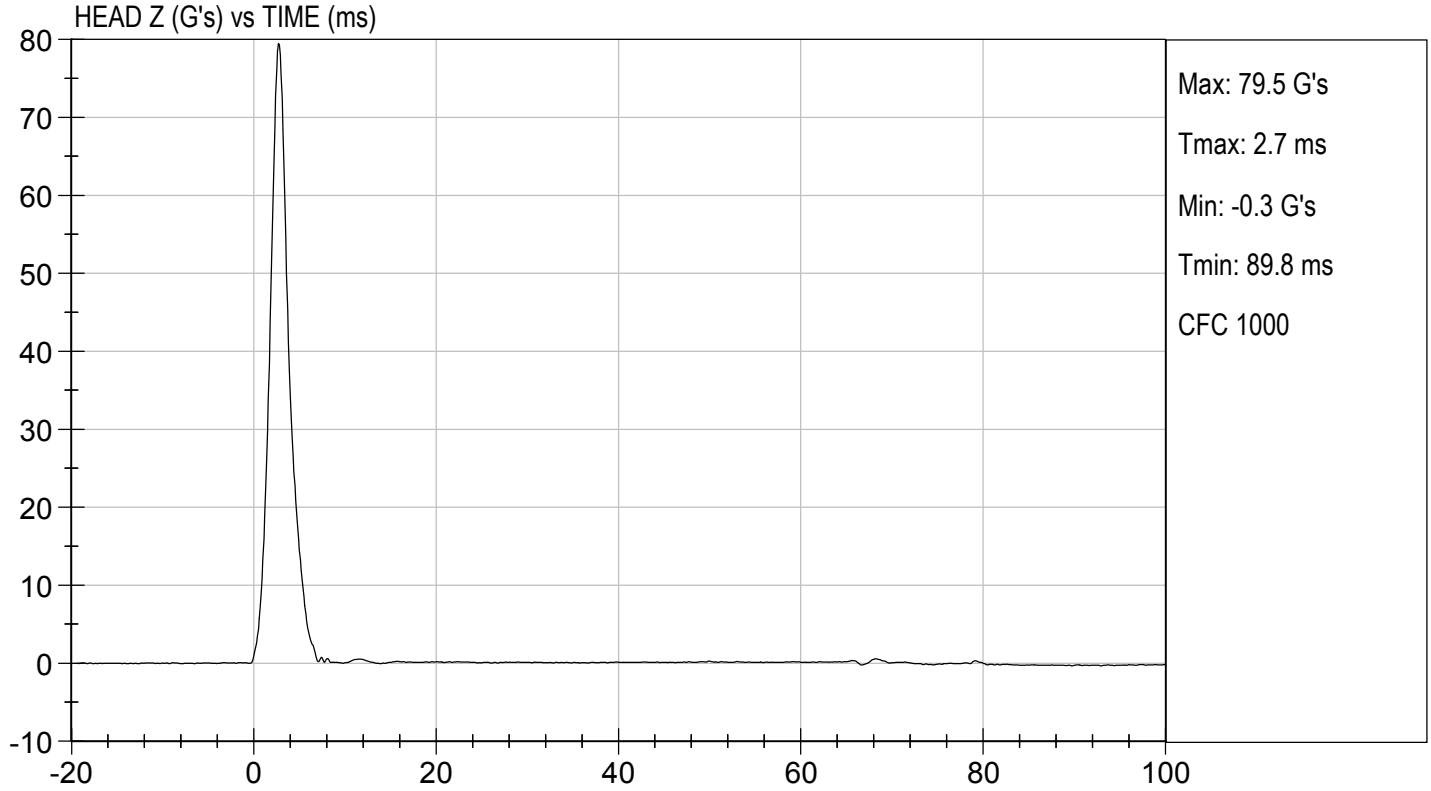
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 07/30/2020
TEST #: D201861





MGA RESEARCH CORPORATION

LATERAL NECK PENDULUM TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201862

Tested Parameter		Units	Specification	Result	Pass/Fail
Temperature		deg C	20.6 to 22.2	21.2	Pass
Humidity		%	10 to 70	43	Pass
Impact Velocity		m/s	5.51 to 5.63	5.58	Pass
Pendulum Velocity	10 ms	m/s	2.20 to 2.80	2.57	Pass
	15 ms	m/s	3.30 to 4.10	3.71	Pass
	20 ms	m/s	4.40 to 5.40	5.25	Pass
	25 ms	m/s	5.40 to 6.10	5.63	Pass
	25-100 ms	m/s	5.50 to 6.20	5.65	Pass
Maximum D-Plane Rotation		deg	71 to 81	76	Pass
Time of Maximum D-Plane Rotation		ms	50 to 70	62	Pass
Maximum Occipital Condyle Moment		Nm	-44 to -36	-39	Pass
Time of Moment Decay to 0 Nm		ms	102 to 126	119	Pass
			Overall Test Results		Pass

Laboratory Technician

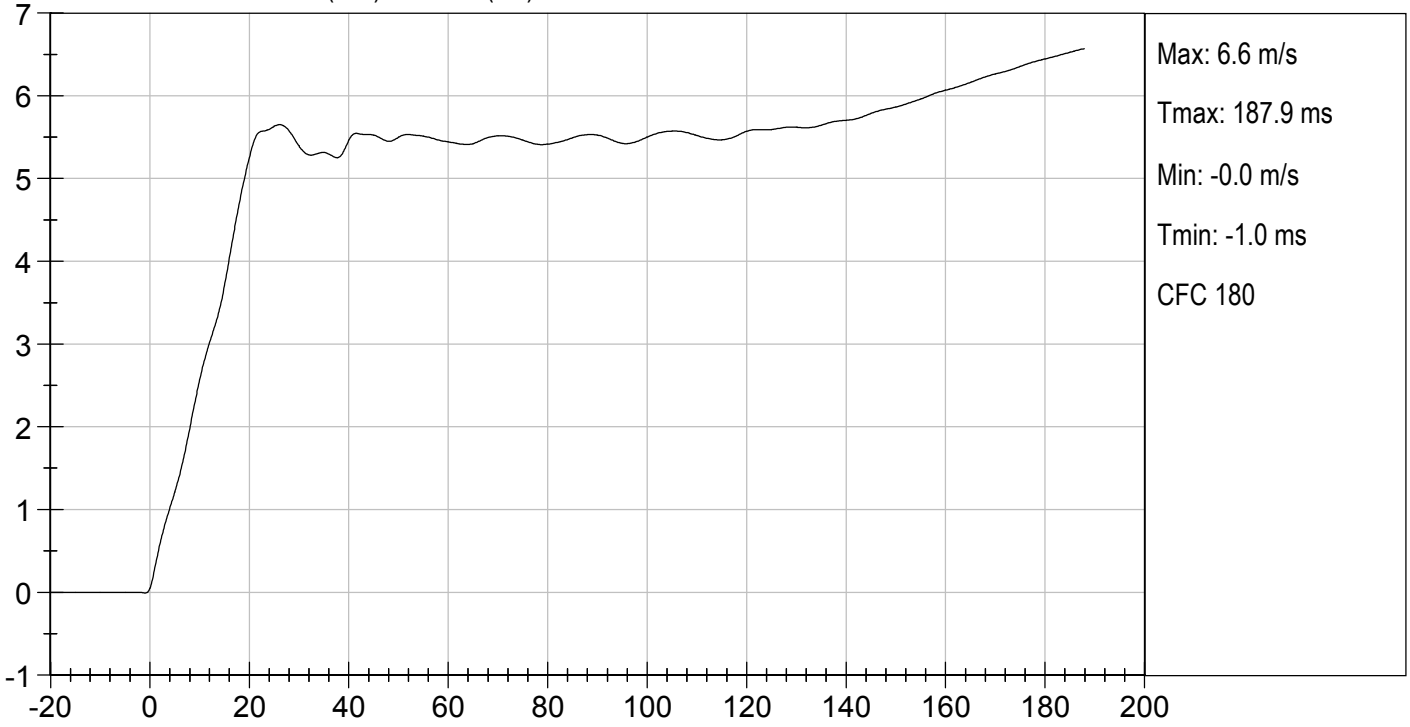
07/30/2020
Test Date

Approved By

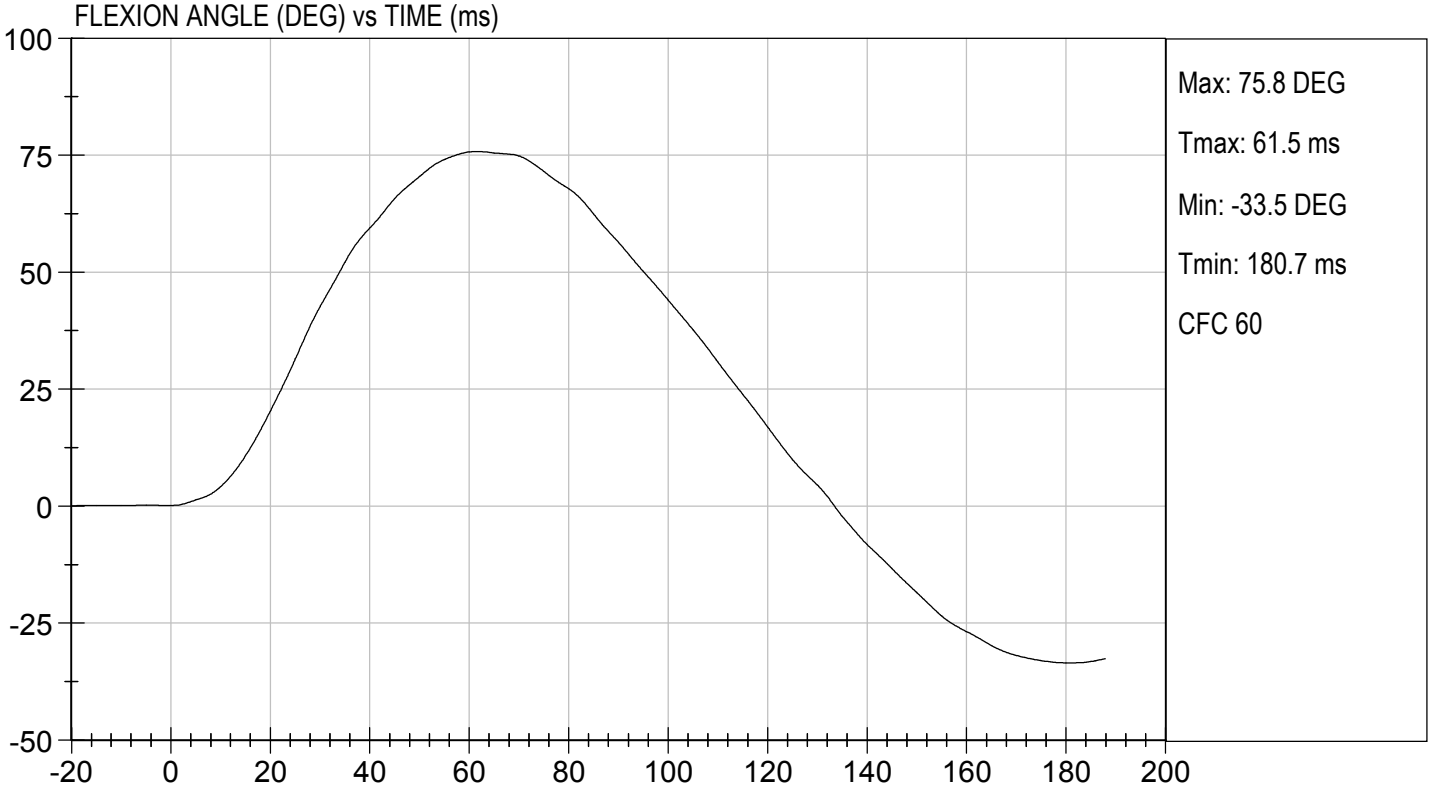
TEST DESC: NECK BENDING
VELOCITY: 18.32 ft/s, 5.58 m/s

TEST DATE: 07/30/2020
TEST #: D201862

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

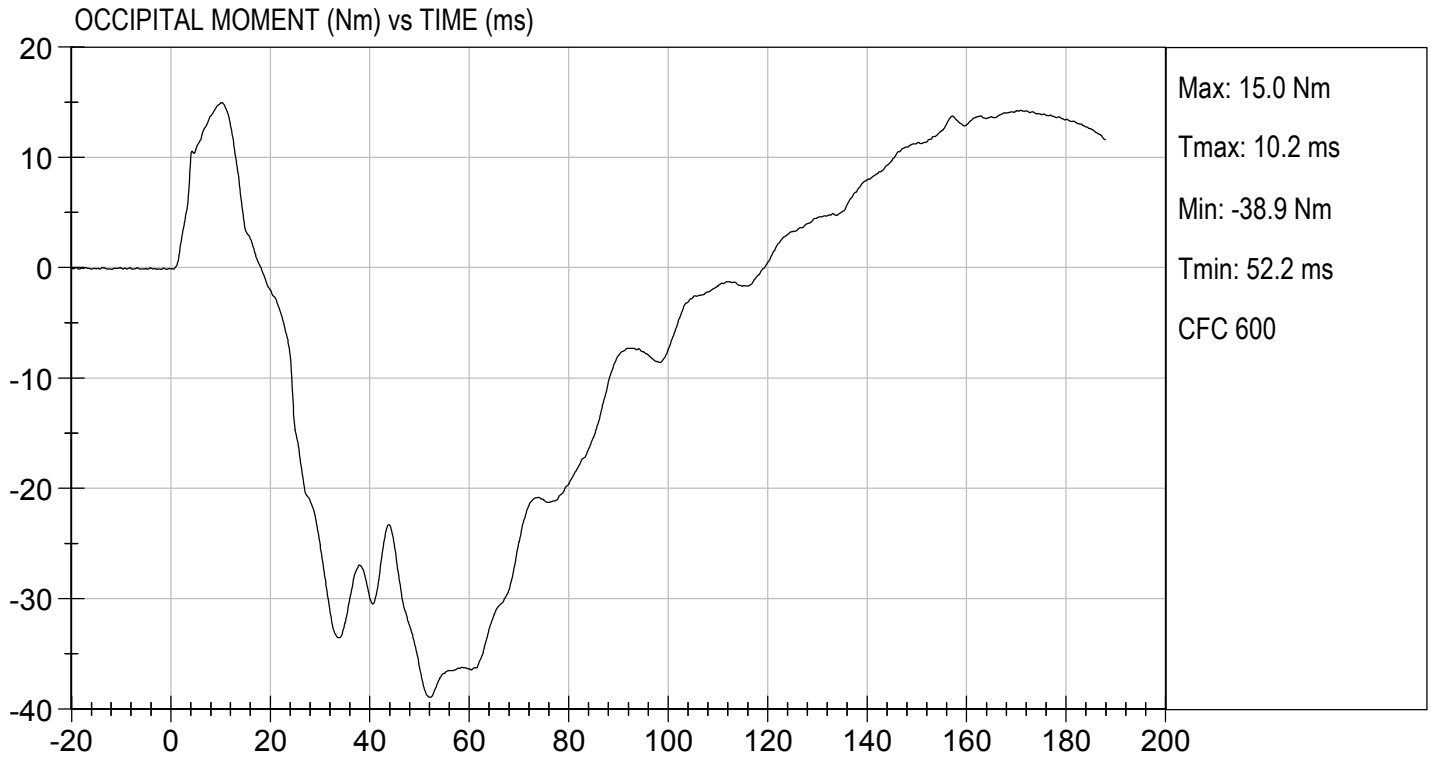


FLEXION ANGLE (DEG) vs TIME (ms)



TEST DESC: NECK BENDING
VELOCITY: 18.32 ft/s, 5.58 m/s

TEST DATE: 07/30/2020
TEST #: D201862



MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test ID:** D201863

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	42	Pass
Impact Velocity	m/s	4.20 to 4.40	4.34	Pass
Maximum Probe Acceleration	G's	13 to 18	16	Pass
Shoulder Displacement	mm	28 to 37	32	Pass
Upper Spine (T1) Y Acceleration	G's	17 to 22	20	Pass
		Overall Test Results		Pass

Laboratory Technician

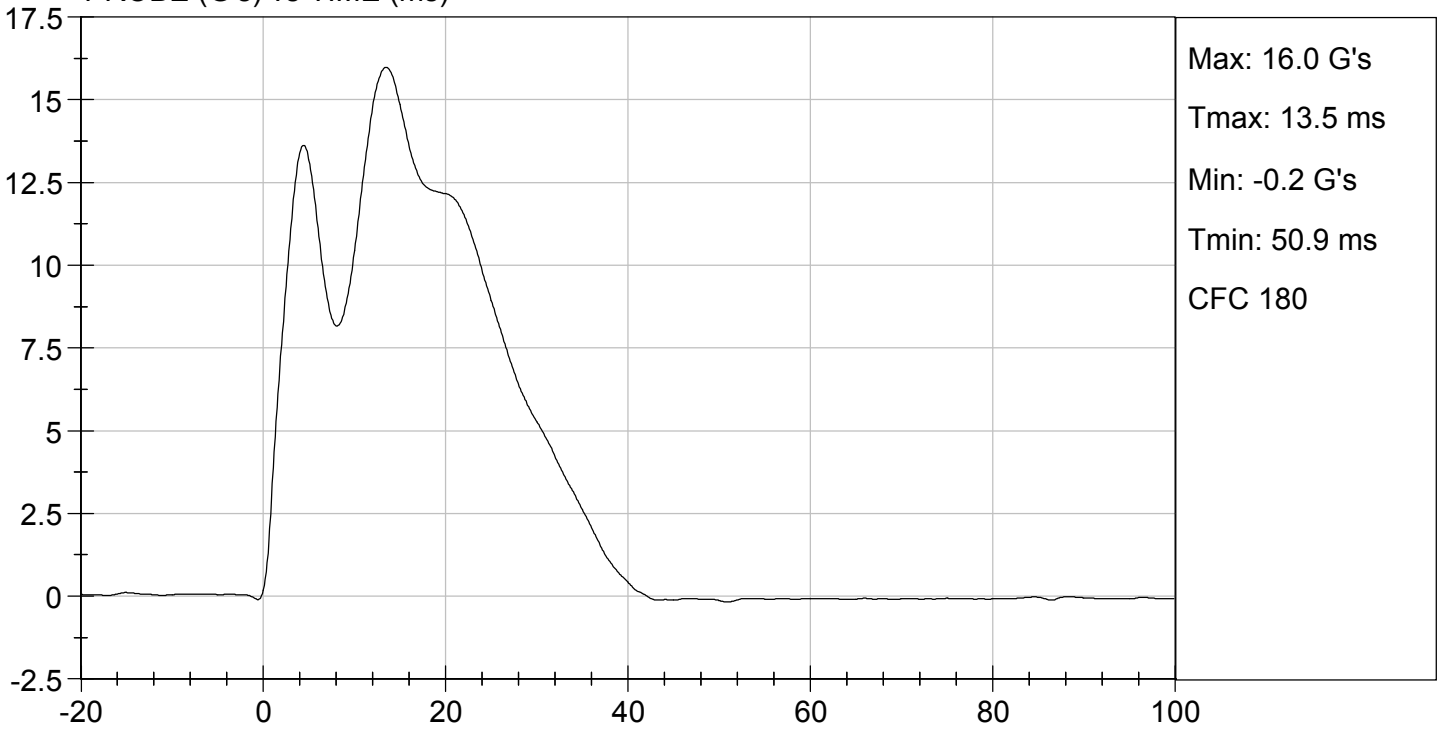
07/30/2020
Test Date

Approved By

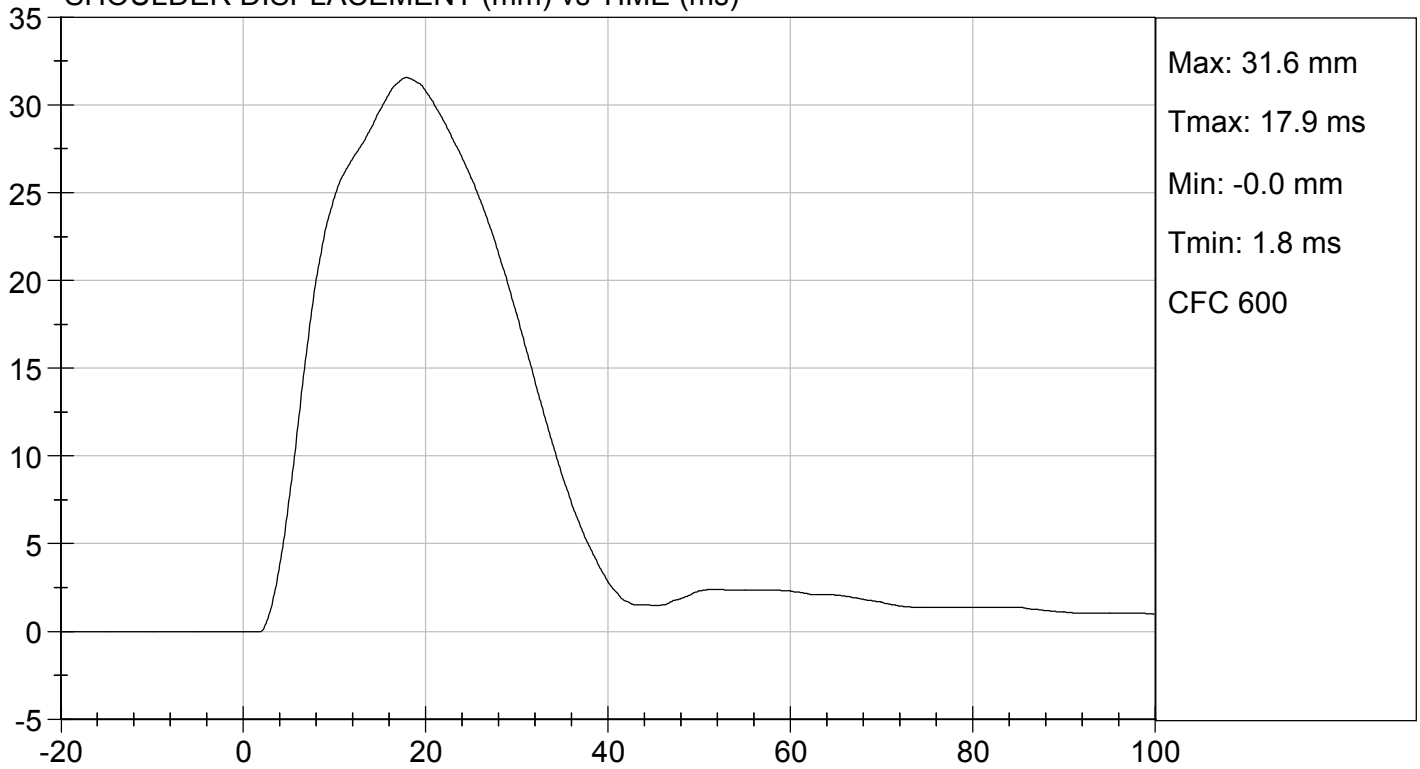
TEST DESC: SHOULDER IMPACT
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 07/30/2020
TEST #: D201863

PROBE (G's) vs TIME (ms)

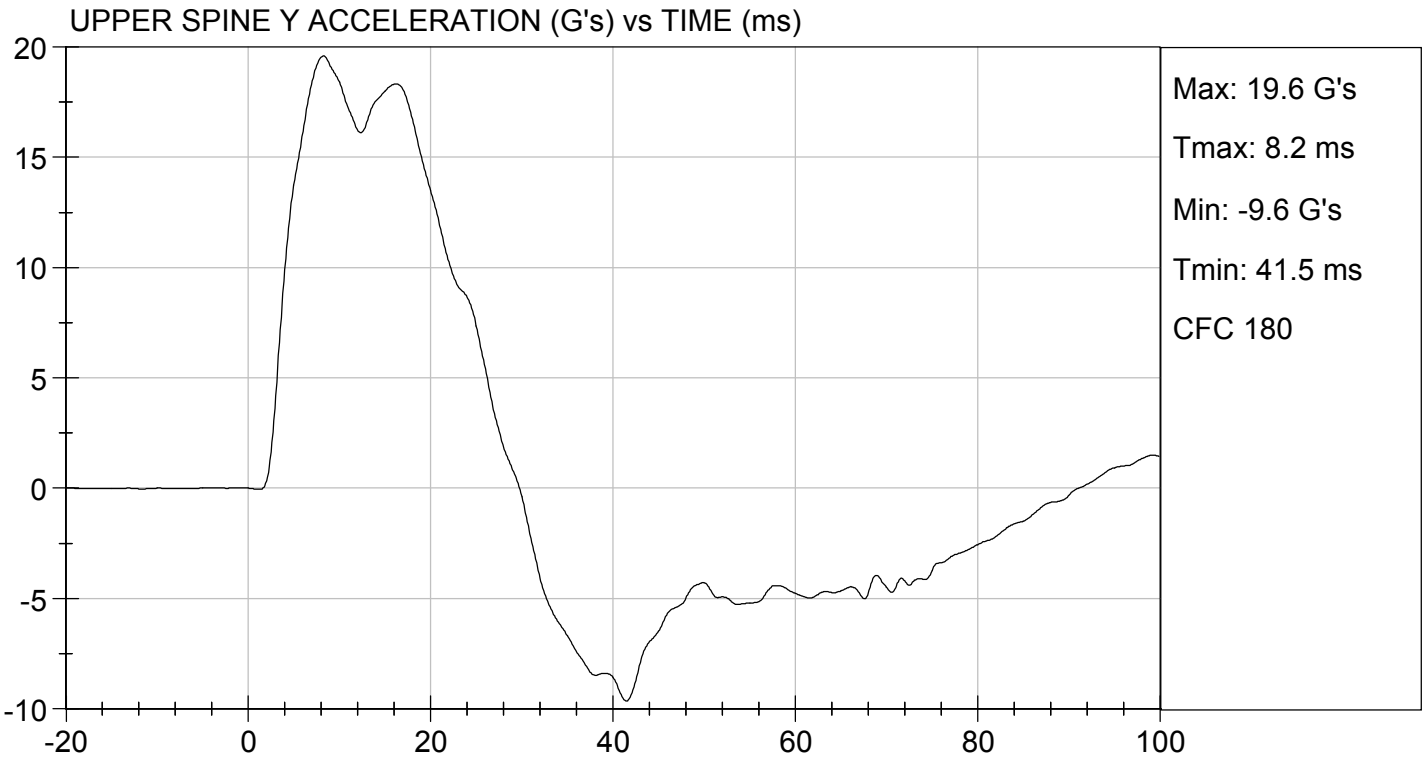


SHOULDER DISPLACEMENT (mm) vs TIME (ms)



TEST DESC: SHOULDER IMPACT
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 07/30/2020
TEST #: D201863



MGA RESEARCH CORPORATION

THORAX (WITH ARM) IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201864

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.1	Pass
Humidity	%	10 to 70	42	Pass
Impact Velocity	m/s	6.60 to 6.80	6.68	Pass
Maximum Probe Acceleration	G's	30 to 36	36	Pass
Shoulder Displacement	mm	31 to 40	34	Pass
Upper Rib Displacement	mm	25 to 32	27	Pass
Middle Rib Displacement	mm	30 to 36	31	Pass
Lower Rib Displacement	mm	32 to 38	34	Pass
Upper Spine (T1) Y Acceleration	G's	34 to 43	42	Pass
Lower Spine (T12) Y Acceleration	G's	29 to 37	33	Pass
		Overall Test Results		Pass

Laboratory Technician

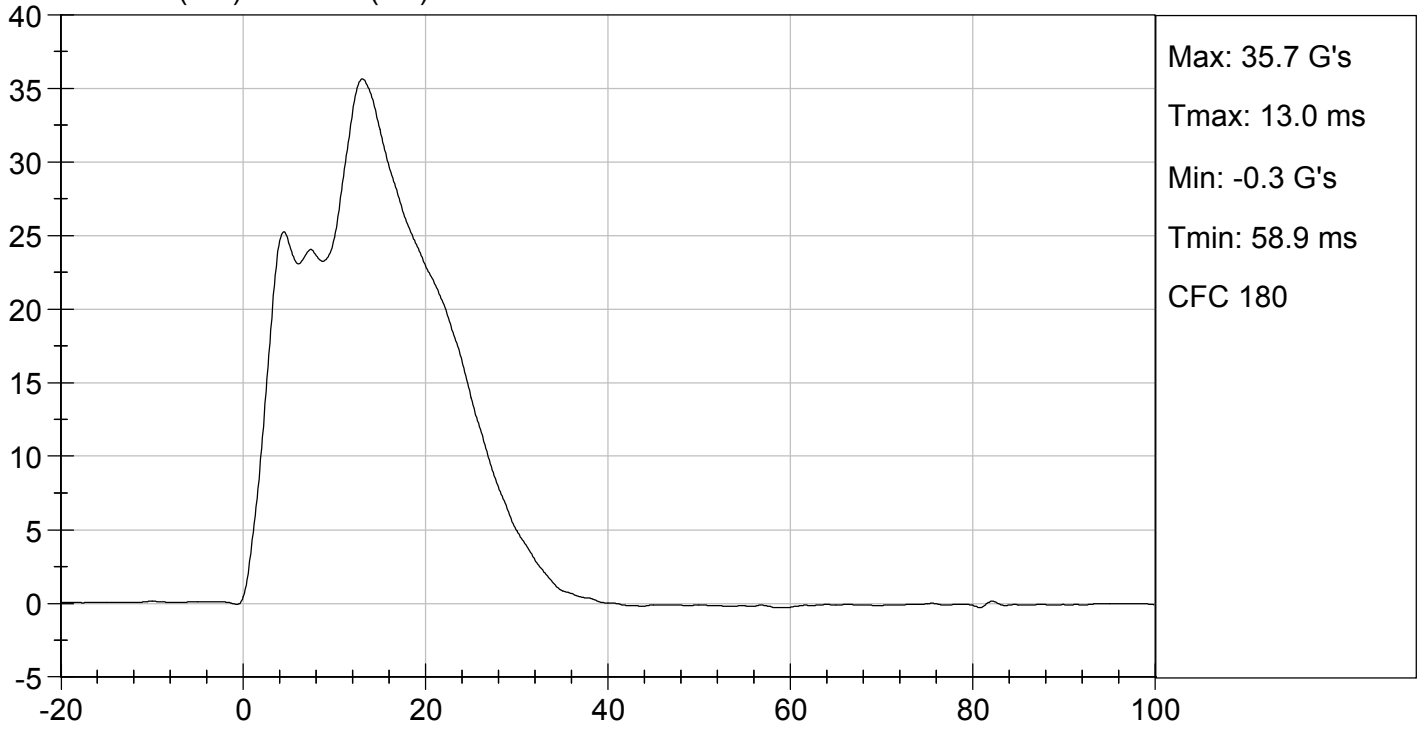
07/30/2020
Test Date

Approved By

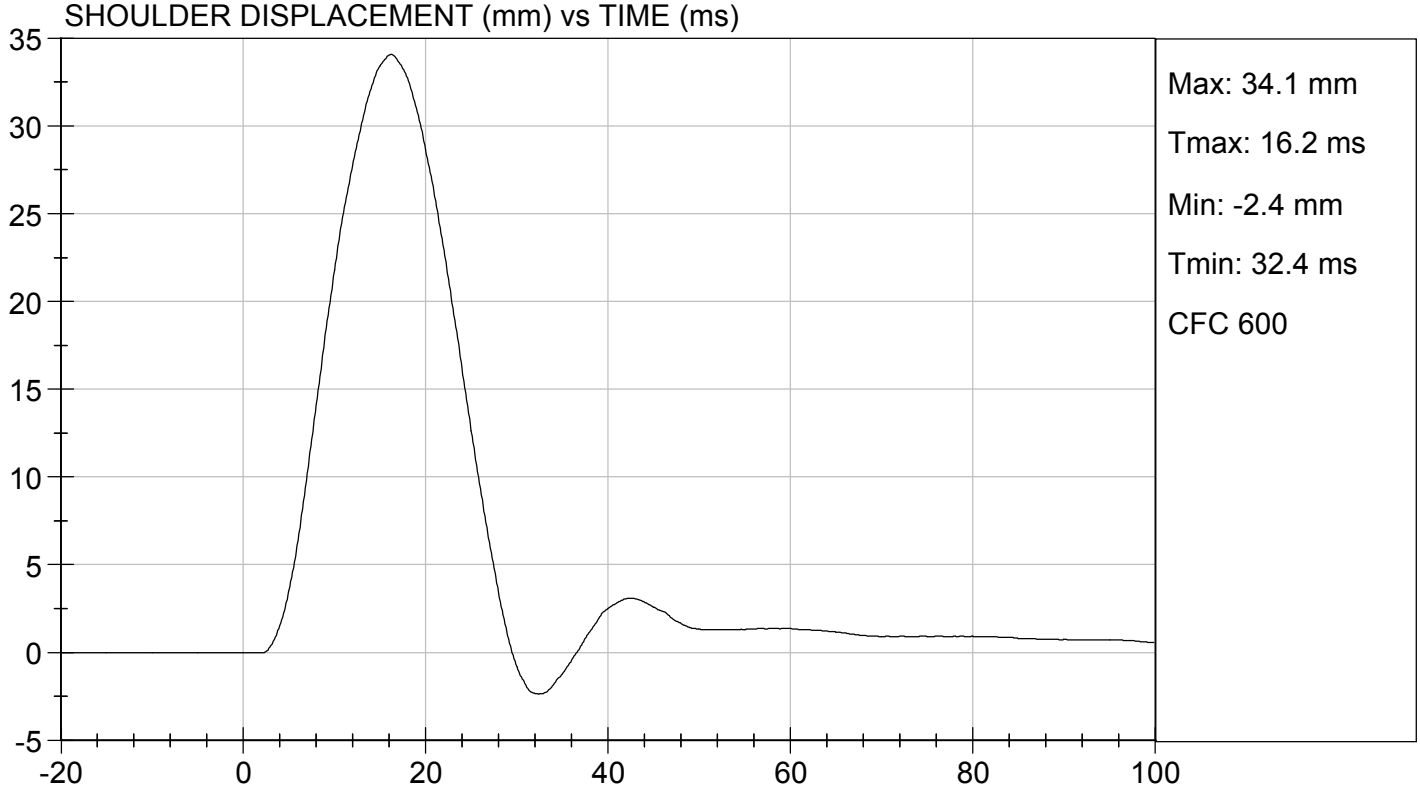
TEST DESC: THORAX IMPACT WITH ARM
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 07/30/2020
TEST #: D201864

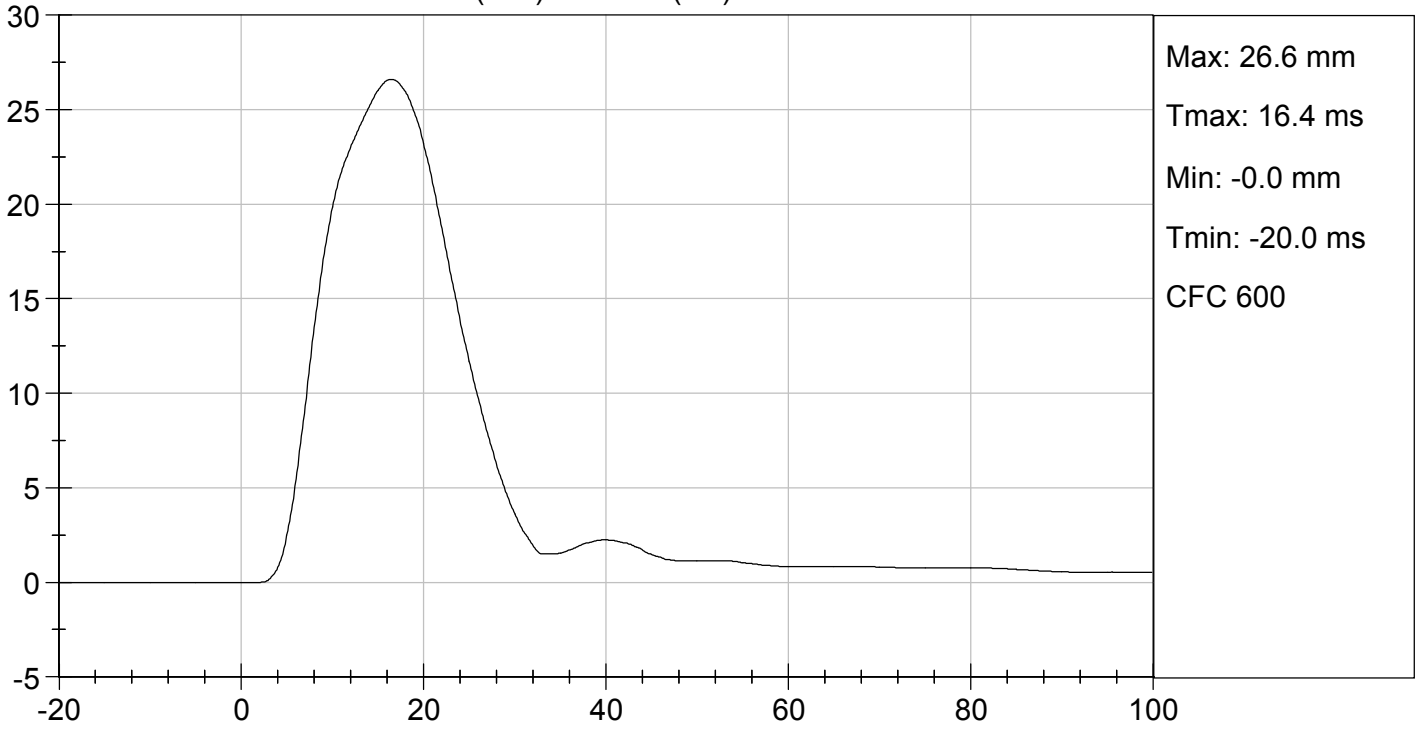
PROBE (G's) vs TIME (ms)



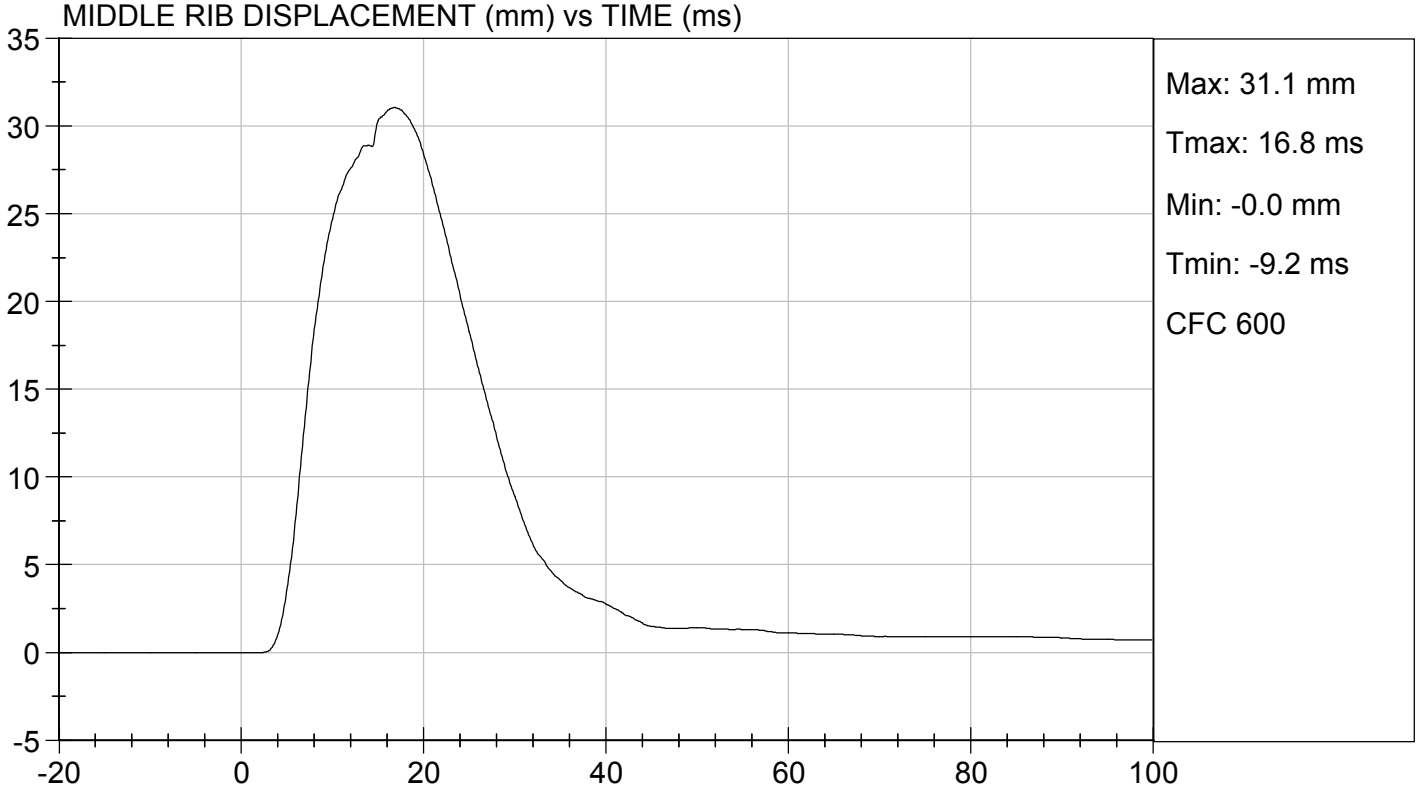
SHOULDER DISPLACEMENT (mm) vs TIME (ms)



UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



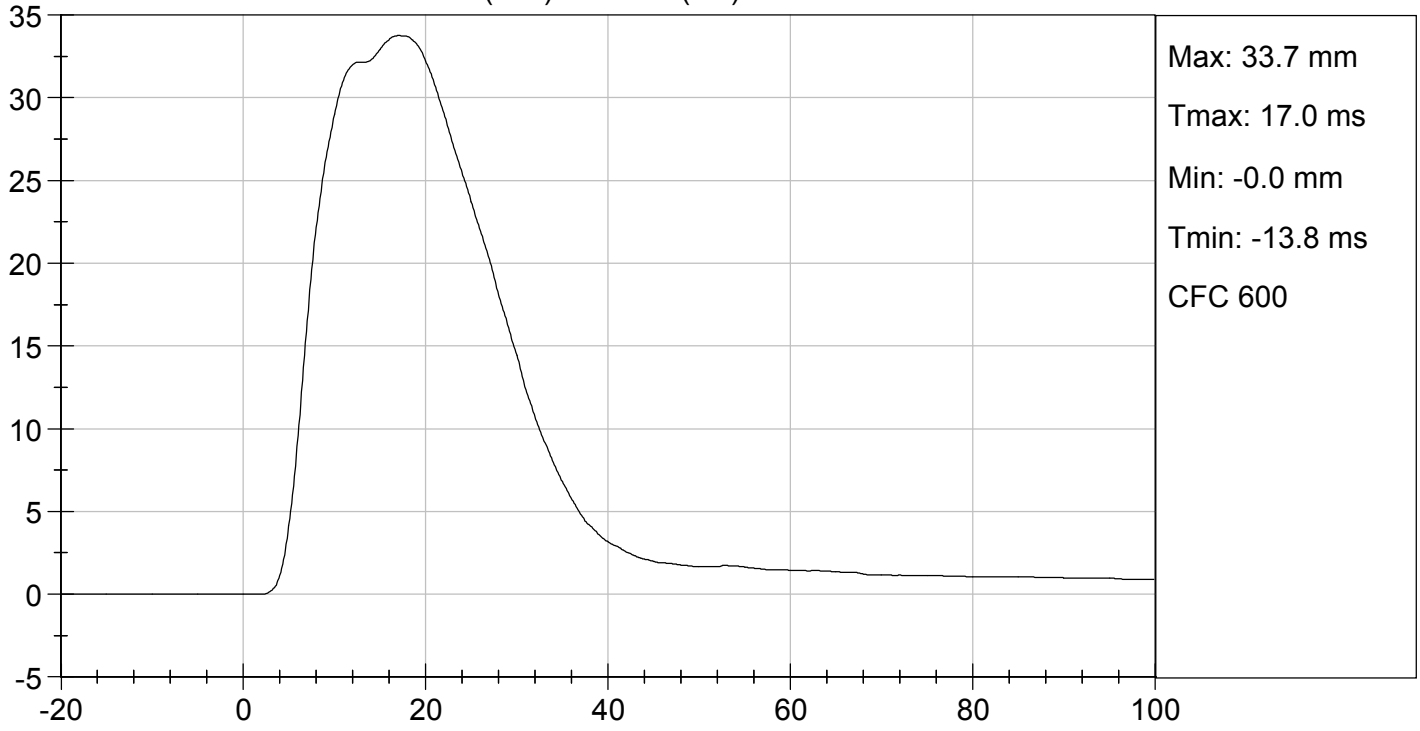
MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



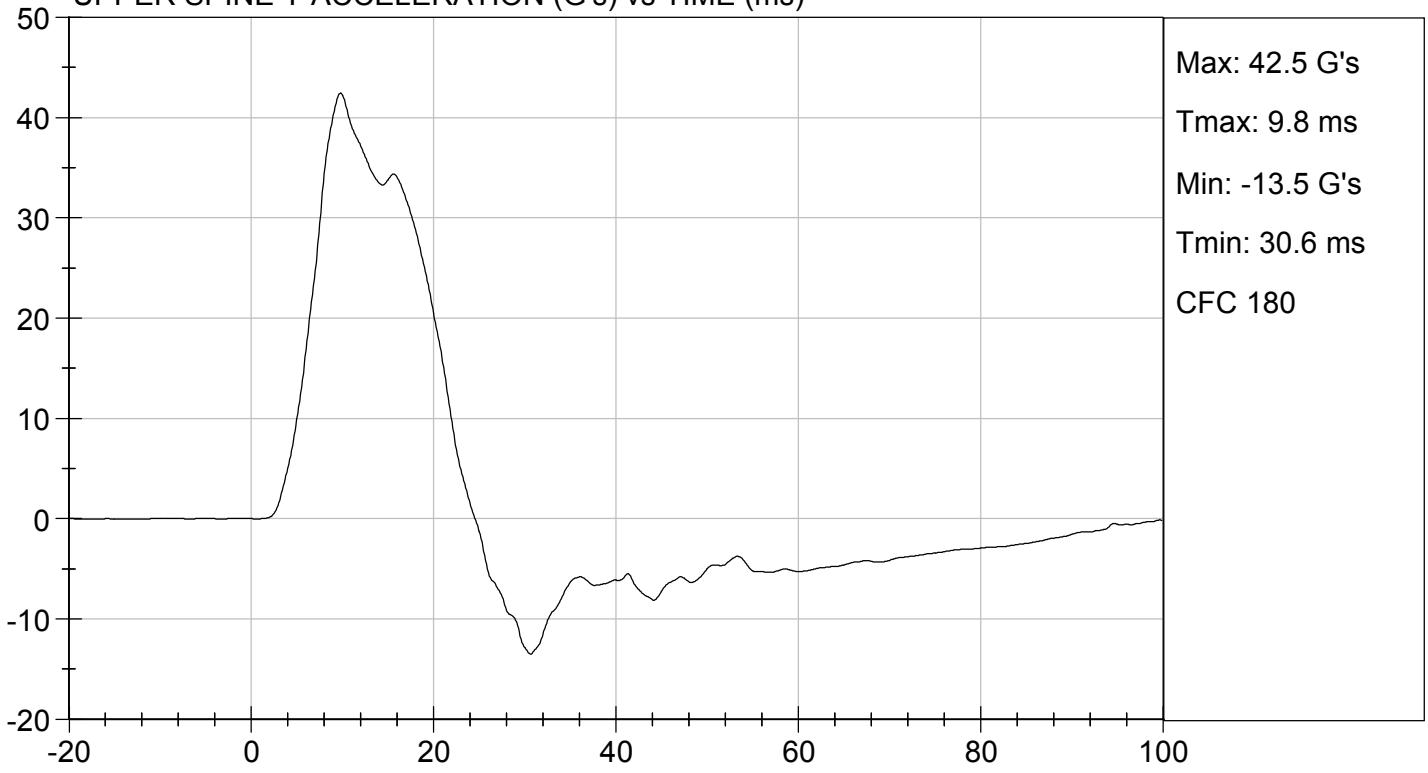
TEST DESC: THORAX IMPACT WITH ARM
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 07/30/2020
TEST #: D201864

LOWER RIB DISPLACEMENT (mm) vs TIME (ms)

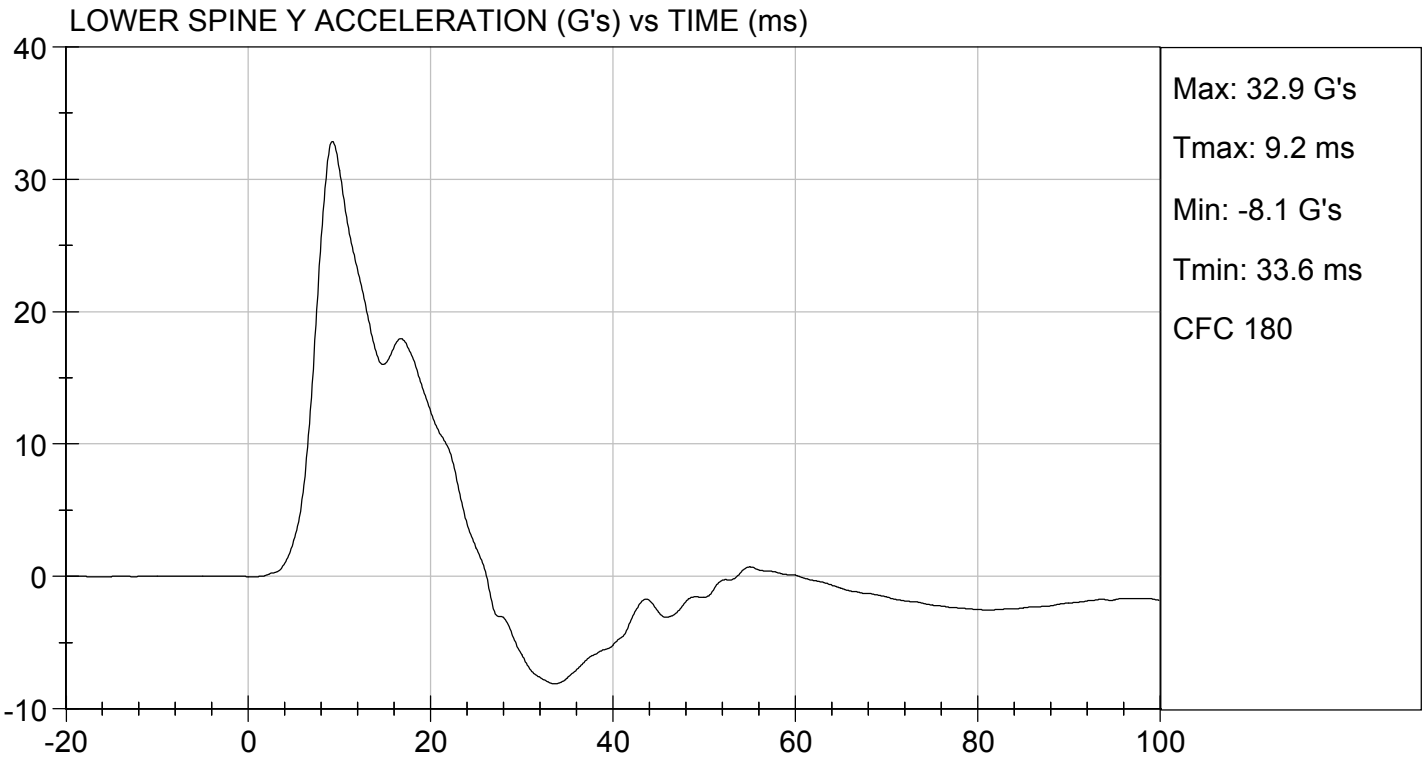


UPPER SPINE Y ACCELERATION (G's) vs TIME (ms)



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

TEST DATE: 07/30/2020
TEST #: D201864



MGA RESEARCH CORPORATION

ABDOMINAL IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201866

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.1	Pass
Humidity	%	10 to 70	42	Pass
Impact Velocity	m/s	4.20 to 4.40	4.38	Pass
Maximum Probe Acceleration	G's	12 to 16	15	Pass
Upper Abdomen Rib Displacement	mm	36 to 47	40	Pass
Lower Abdomen Rib Displacement	mm	33 to 44	39	Pass
Lower Spine (T12) Y Acceleration	G's	9 to 14	11	Pass
		Overall Test Results		Pass

Laboratory Technician

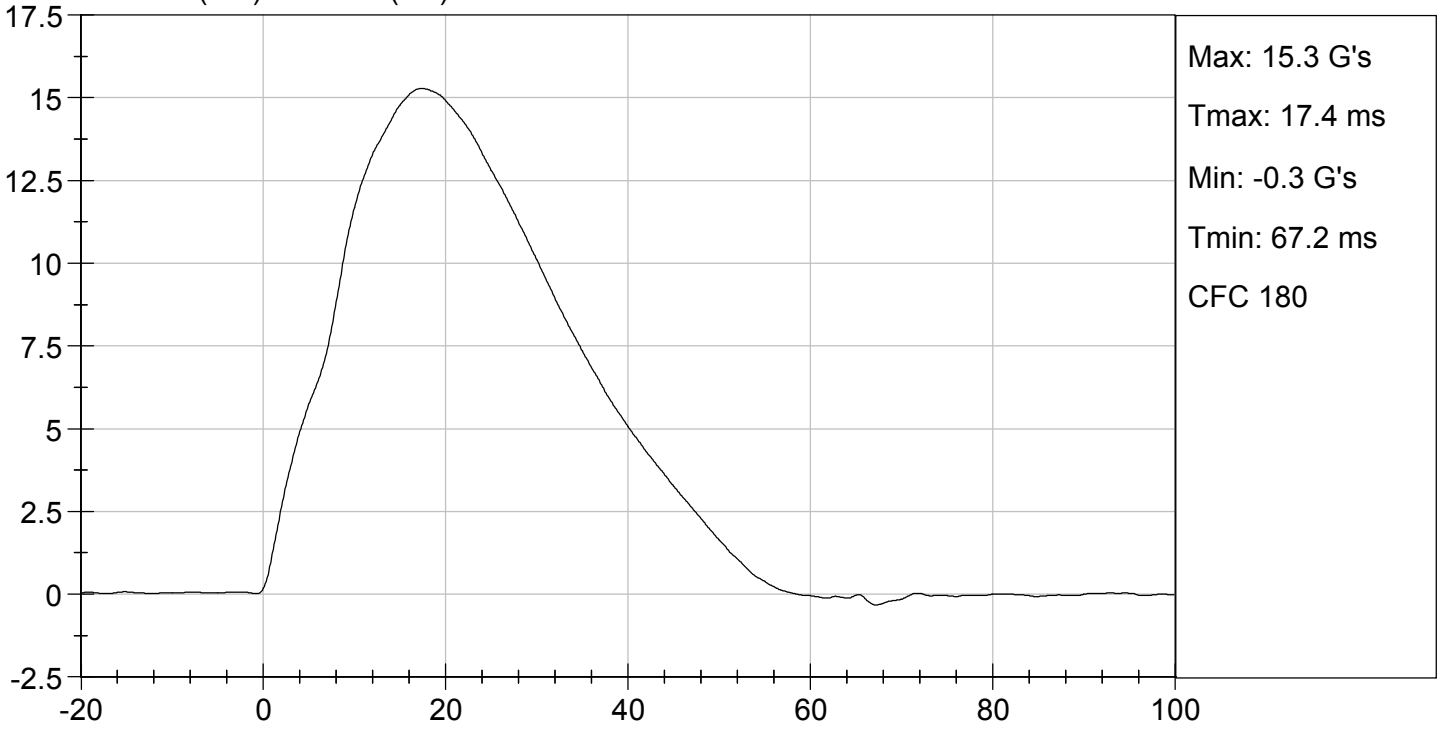
07/30/2020
Test Date

Approved By

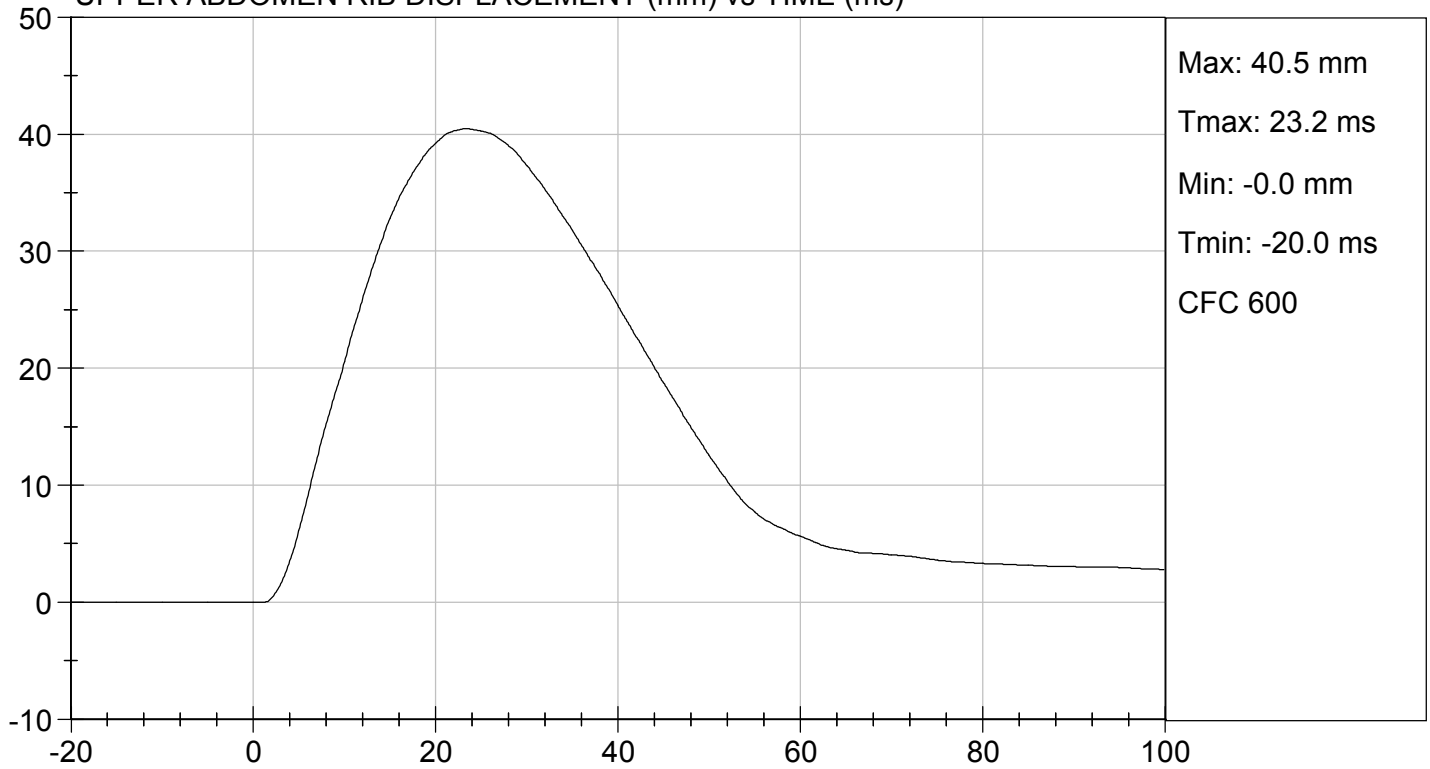
TEST DESC: ABDOMEN IMPACT
VELOCITY: 14.37 ft/s, 4.38 m/s

TEST DATE: 07/30/2020
TEST #: D201866

PROBE (G's) vs TIME (ms)



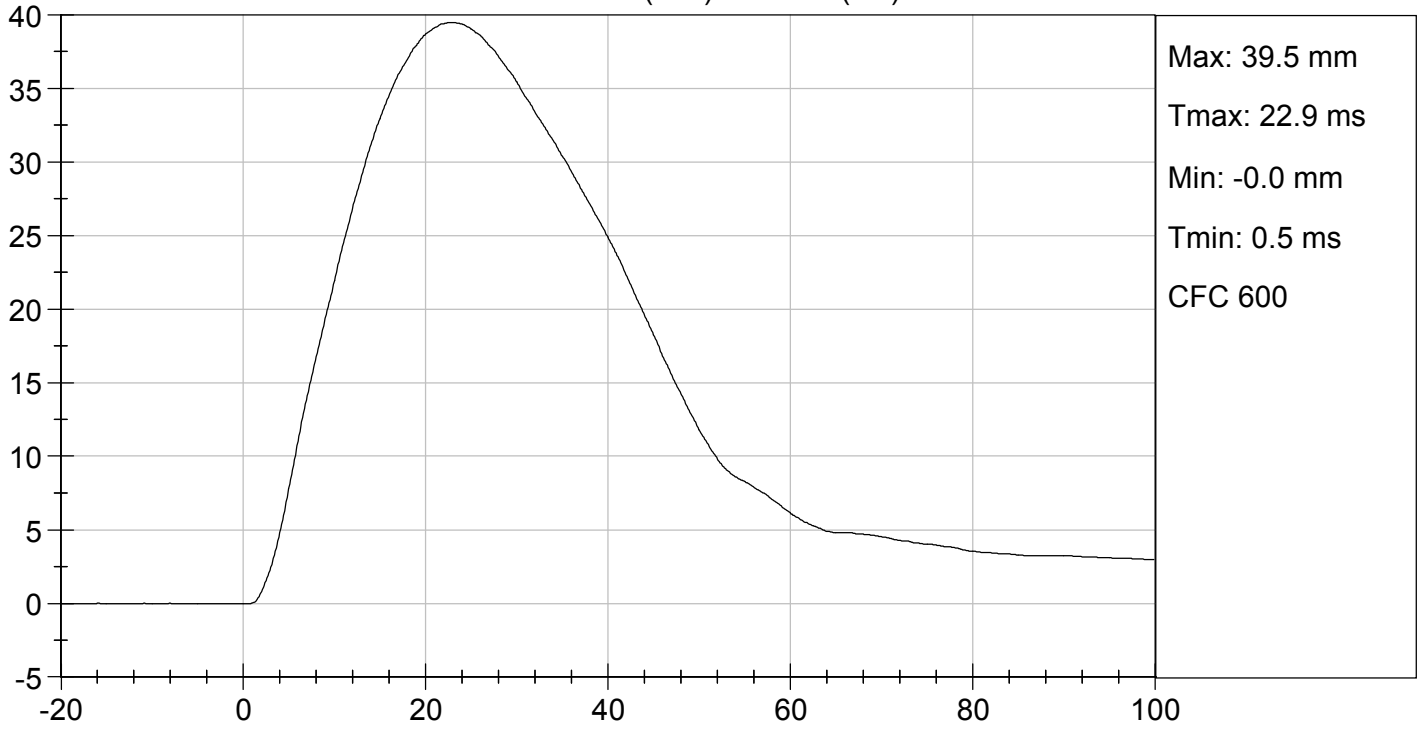
UPPER ABDOMEN RIB DISPLACEMENT (mm) vs TIME (ms)



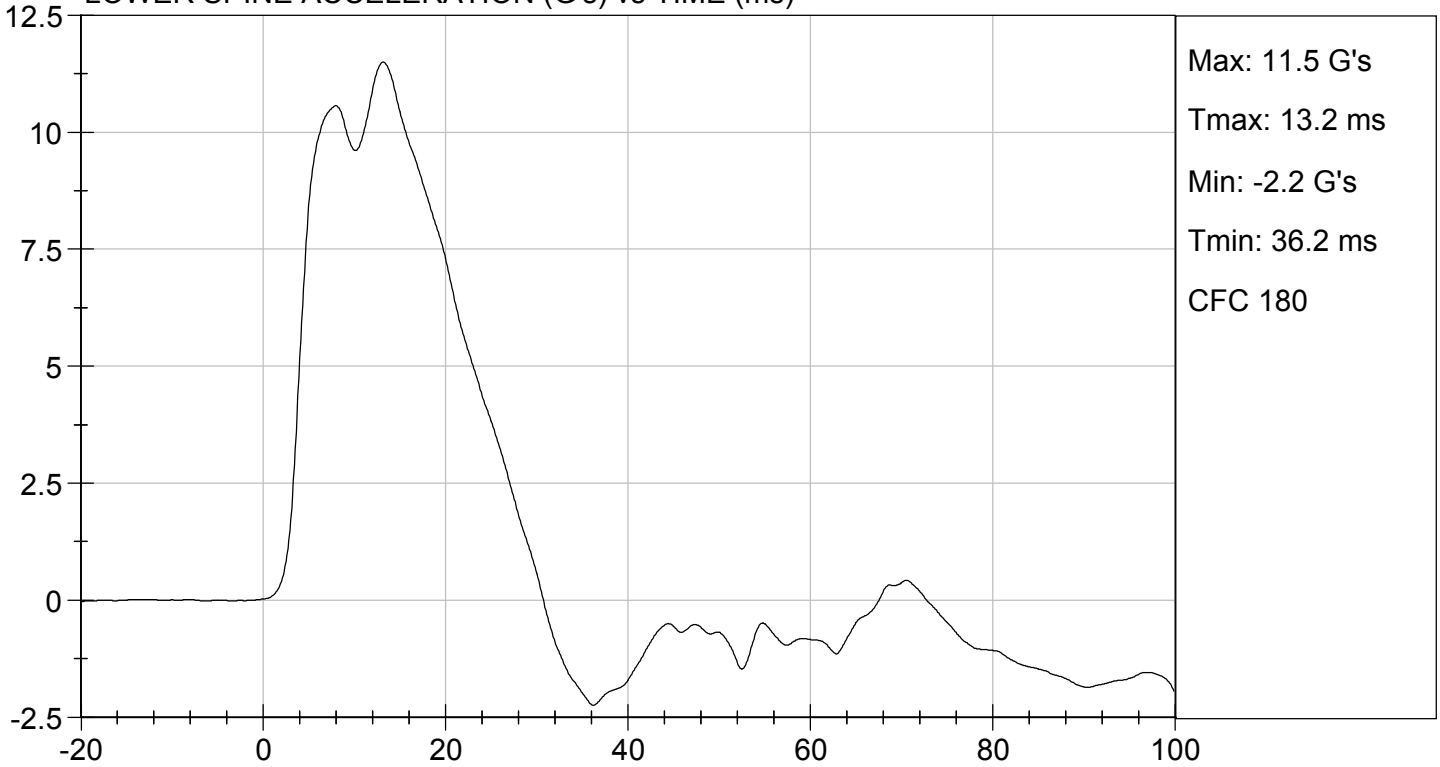
TEST DESC: ABDOMEN IMPACT
VELOCITY: 14.37 ft/s, 4.38 m/s

TEST DATE: 07/30/2020
TEST #: D201866

LOWER ABDOMEN RIB DISPLACEMENT (mm) vs TIME (ms)



LOWER SPINE ACCELERATION (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

PELVIS IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201867

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.2	Pass
Humidity	%	10 to 70	43	Pass
Impact Velocity	m/s	6.60 to 6.80	6.68	Pass
Maximum Probe Acceleration	G's	38 to 47	43	Pass
Pelvis Y Acceleration After 6 ms	G's	34 to 42	40	Pass
Peak Acetabulum Force	N	3600 to 4300	3,896	Pass
		Overall Test Results		Pass

Laboratory Technician

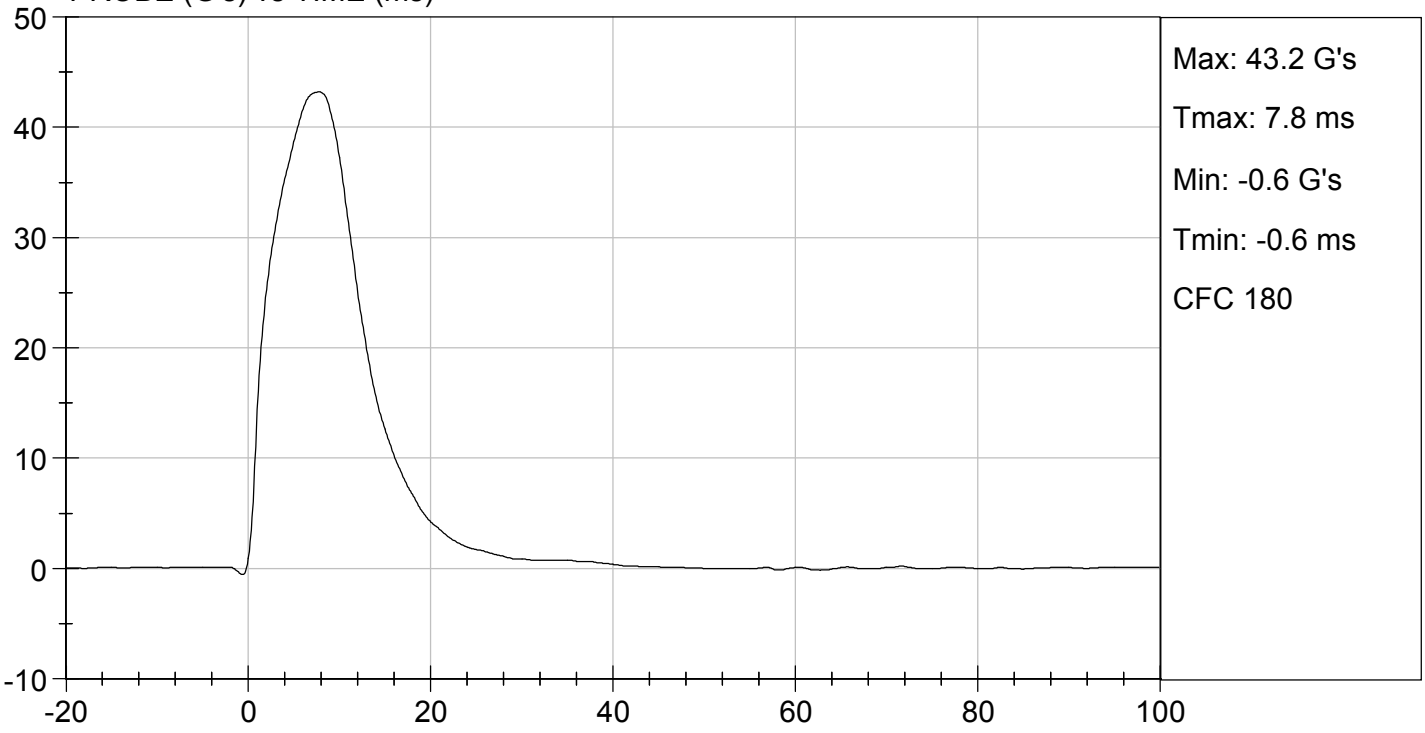
08/06/2020
Test Date

Approved By

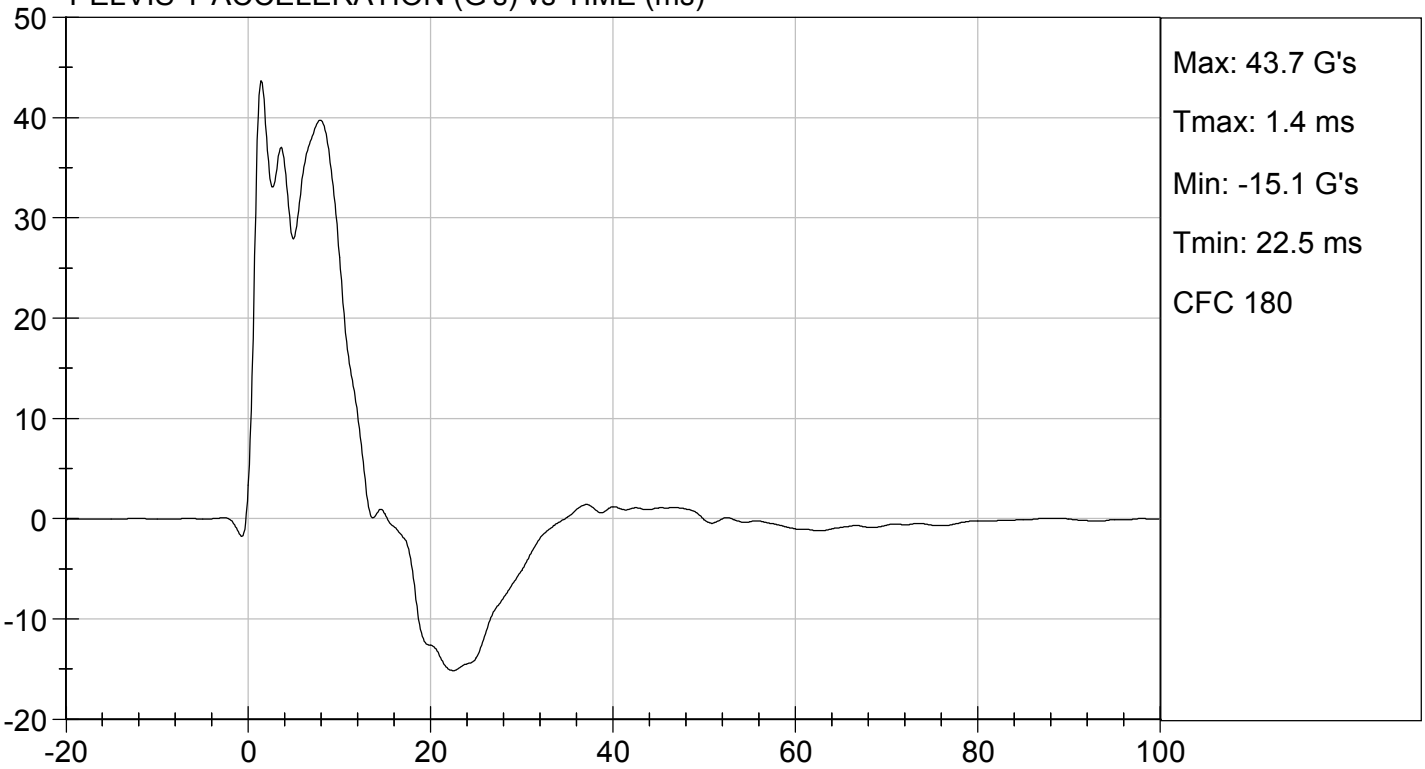
TEST DESC: PELVIS IMPACT
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 08/06/2020
TEST #: D201867

PROBE (G's) vs TIME (ms)

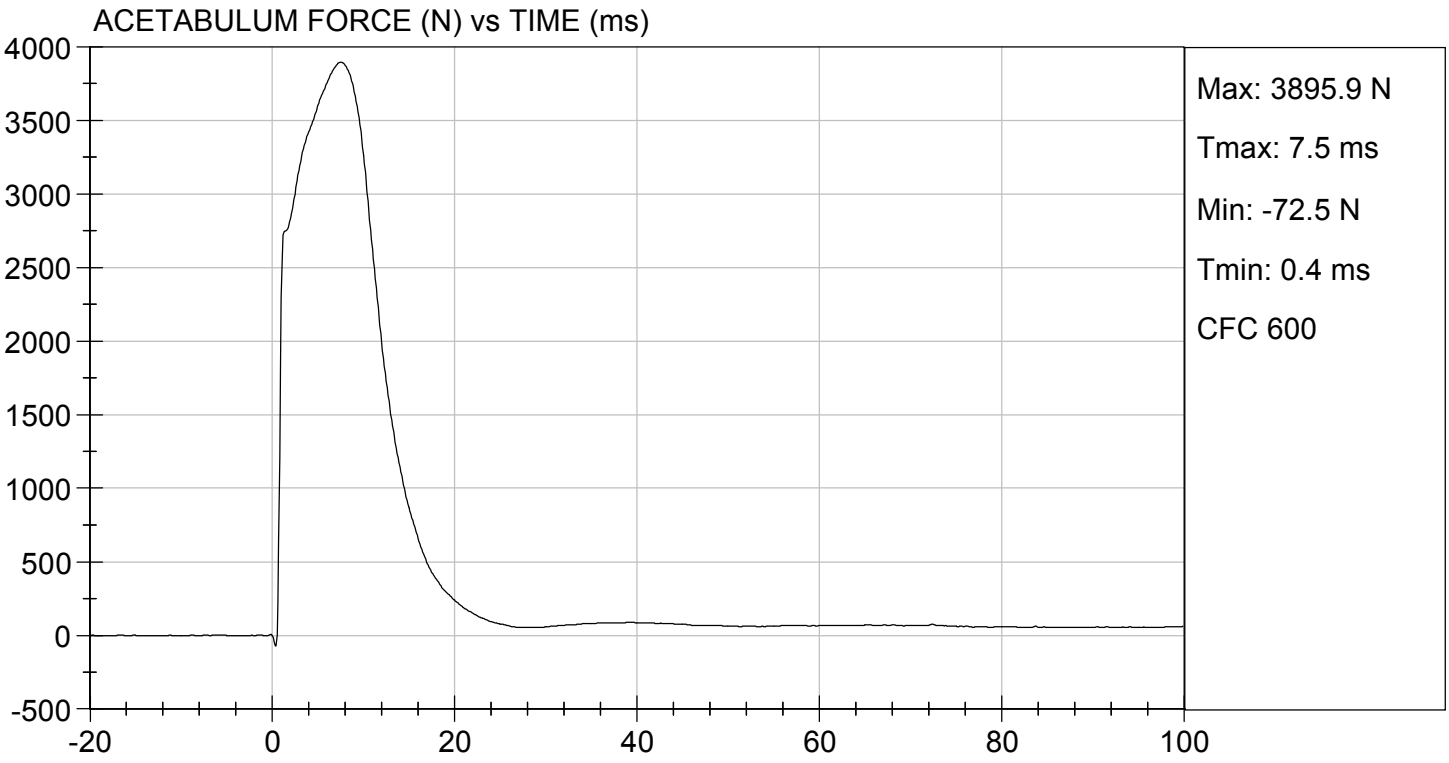


PELVIS Y ACCELERATION (G's) vs TIME (ms)



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

TEST DATE: 08/06/2020
TEST #: D201867



MGA RESEARCH CORPORATION

ILIAC IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201868

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.2	Pass
Humidity	%	10 to 70	43	Pass
Impact Velocity	m/s	4.20 to 4.40	4.34	Pass
Maximum Probe Acceleration	G's	36 to 45	42	Pass
Pelvis Y Acceleration	G's	28 to 39	30	Pass
Peak Pelvis Iliac Force	N	4100 to 5100	4,763	Pass
		Overall Test Results		Pass

Laboratory Technician

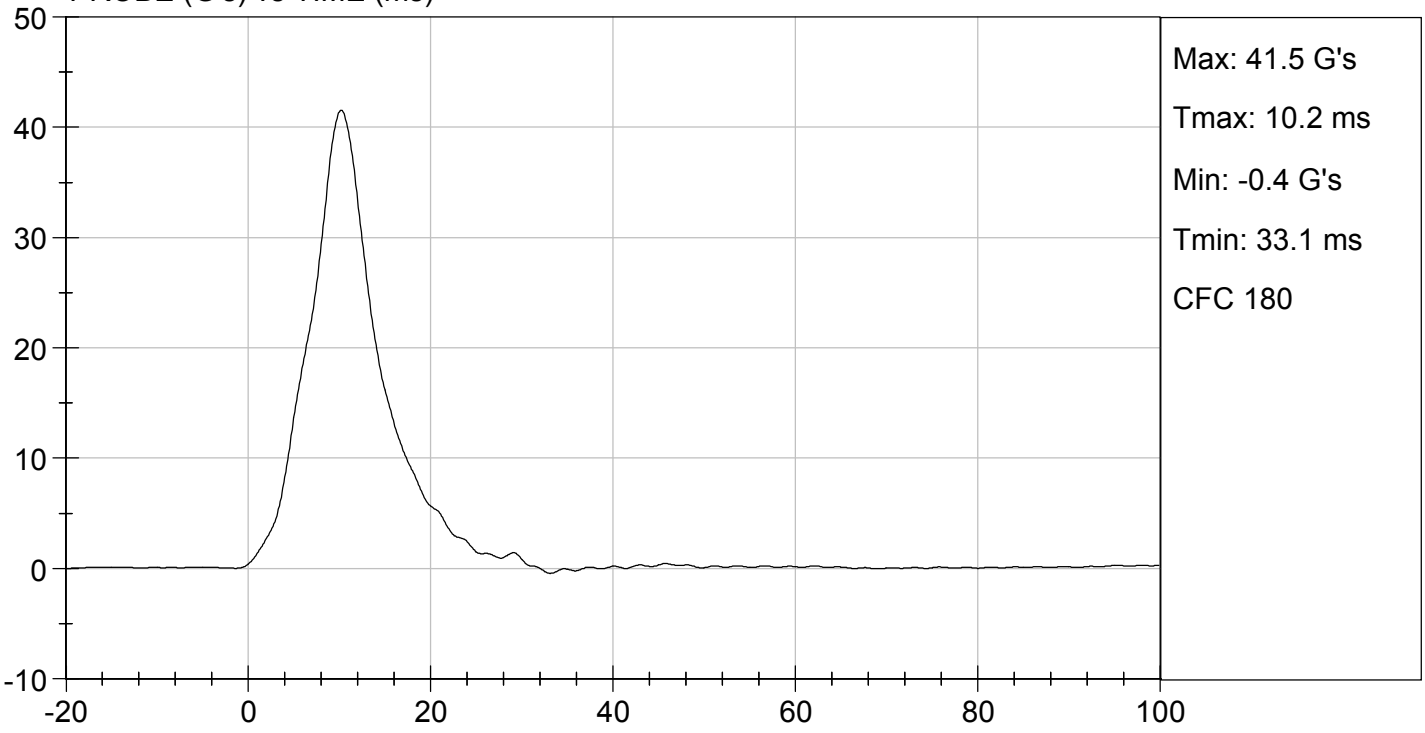
08/06/2020
Test Date

Approved By

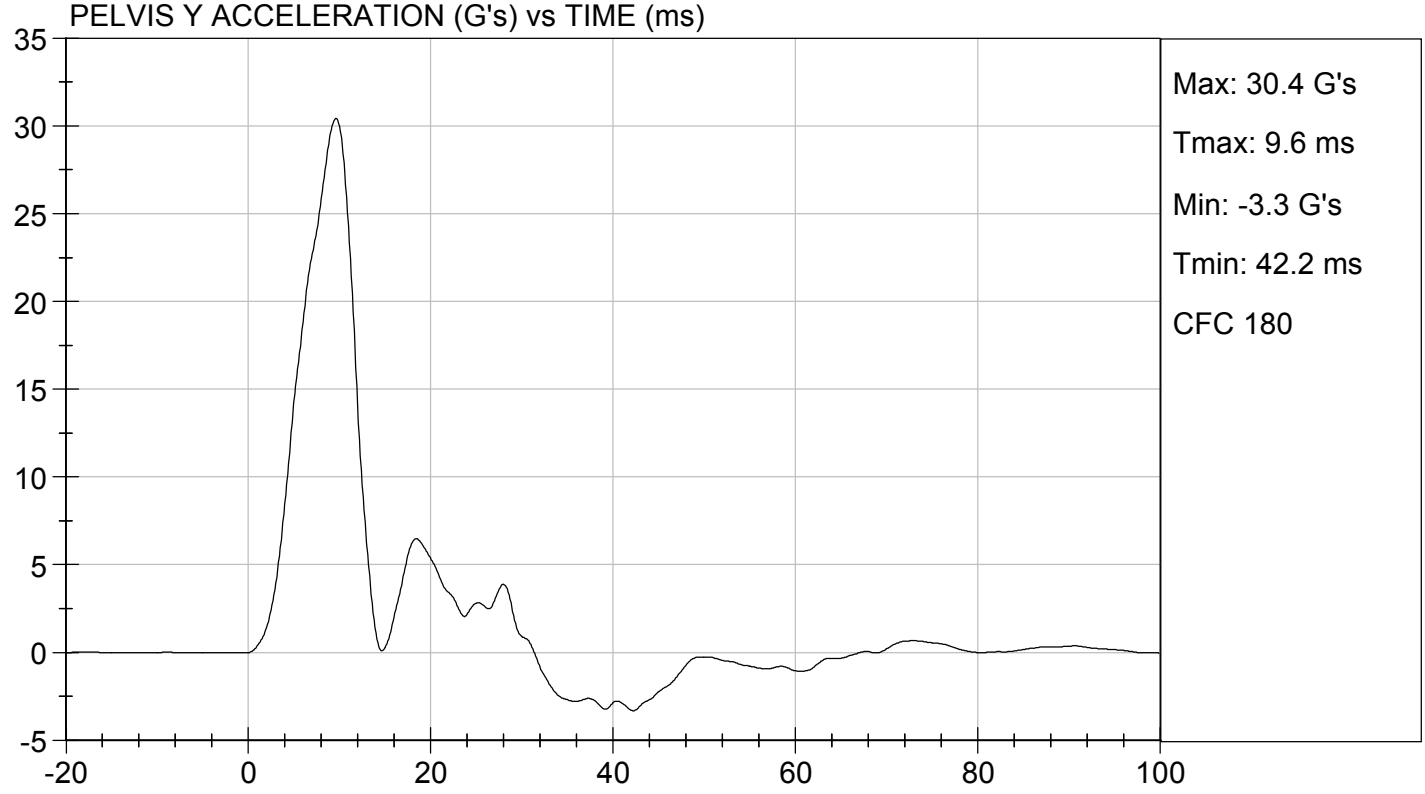
TEST DESC: ILLIAC
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 08/06/2020
TEST #: D201868

PROBE (G's) vs TIME (ms)

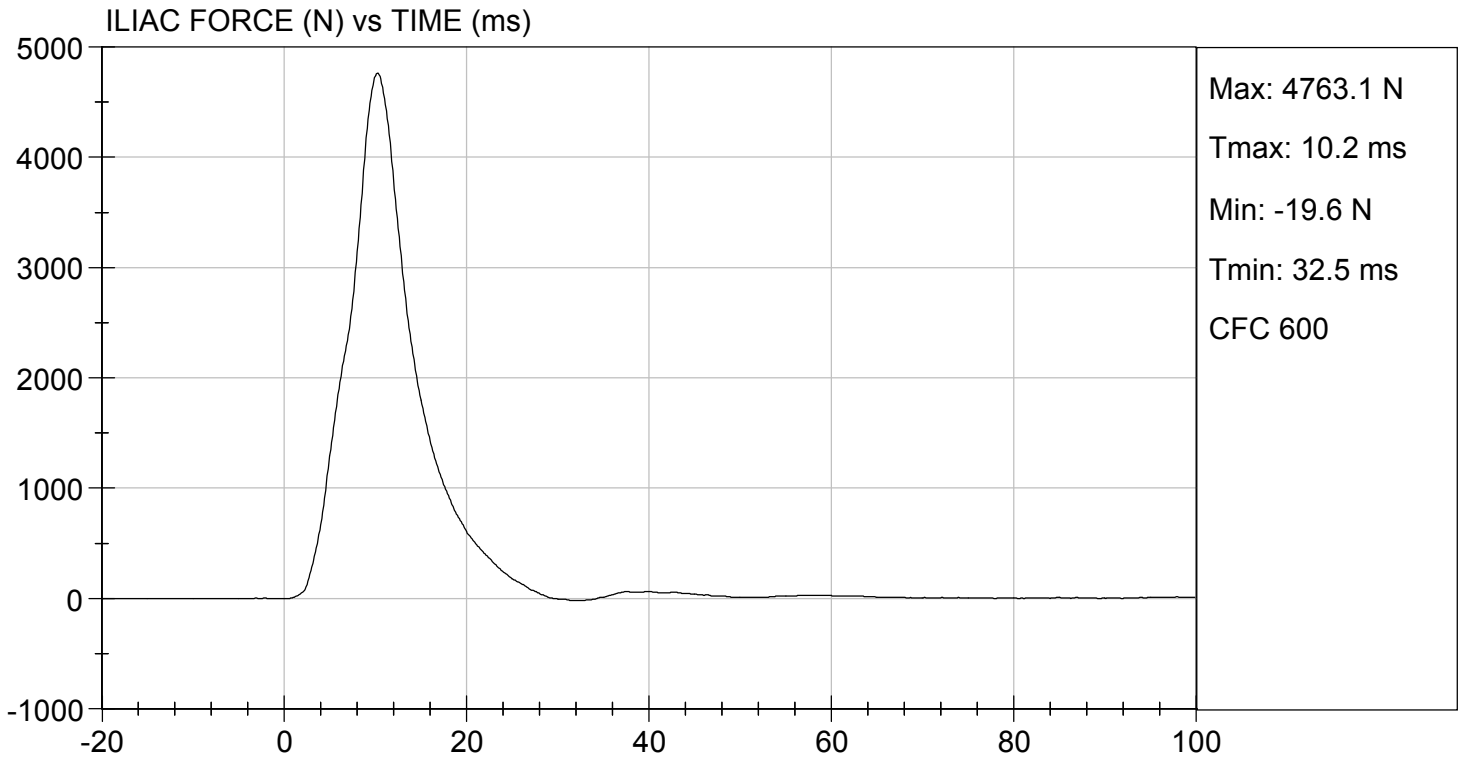


PELVIS Y ACCELERATION (G's) vs TIME (ms)



TEST DESC: ILLIAC
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 08/06/2020
TEST #: D201868



MGA RESEARCH CORPORATION

THORAX (WITHOUT ARM) IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D201965

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.1	Pass
Humidity	%	10 to 70	42	Pass
Impact Velocity	m/s	4.20 to 4.40	4.34	Pass
Maximum Probe Acceleration	G's	14 to 18	17	Pass
Upper Rib Displacement	mm	32 to 40	34	Pass
Middle Rib Displacement	mm	39 to 45	41	Pass
Lower Rib Displacement	mm	35 to 43	39	Pass
Upper Spine (T1) Y Acceleration	G's	13 to 17	16	Pass
Lower Spine (T12) Y Acceleration	G's	7 to 11	10	Pass
		Overall Test Results		Pass

Laboratory Technician

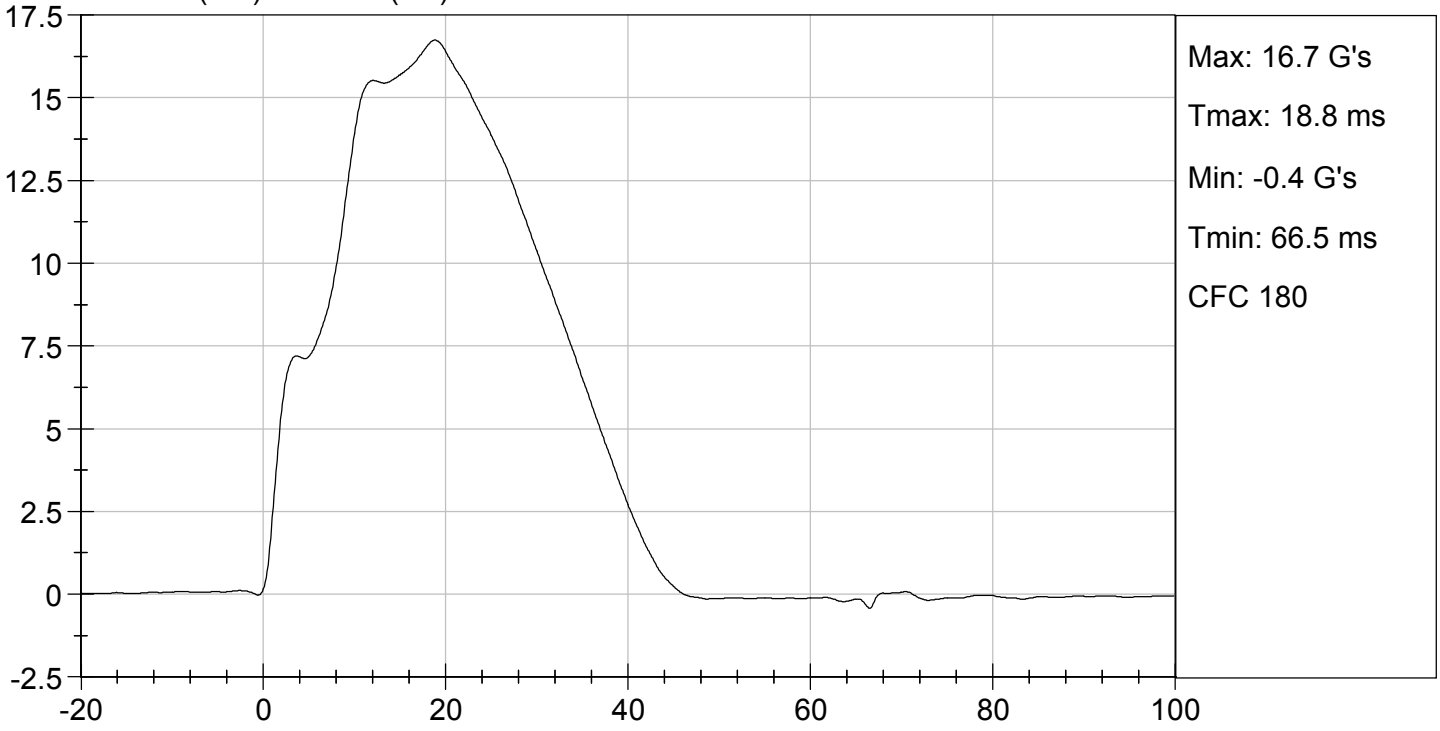
07/30/2020
Test Date

Approved By

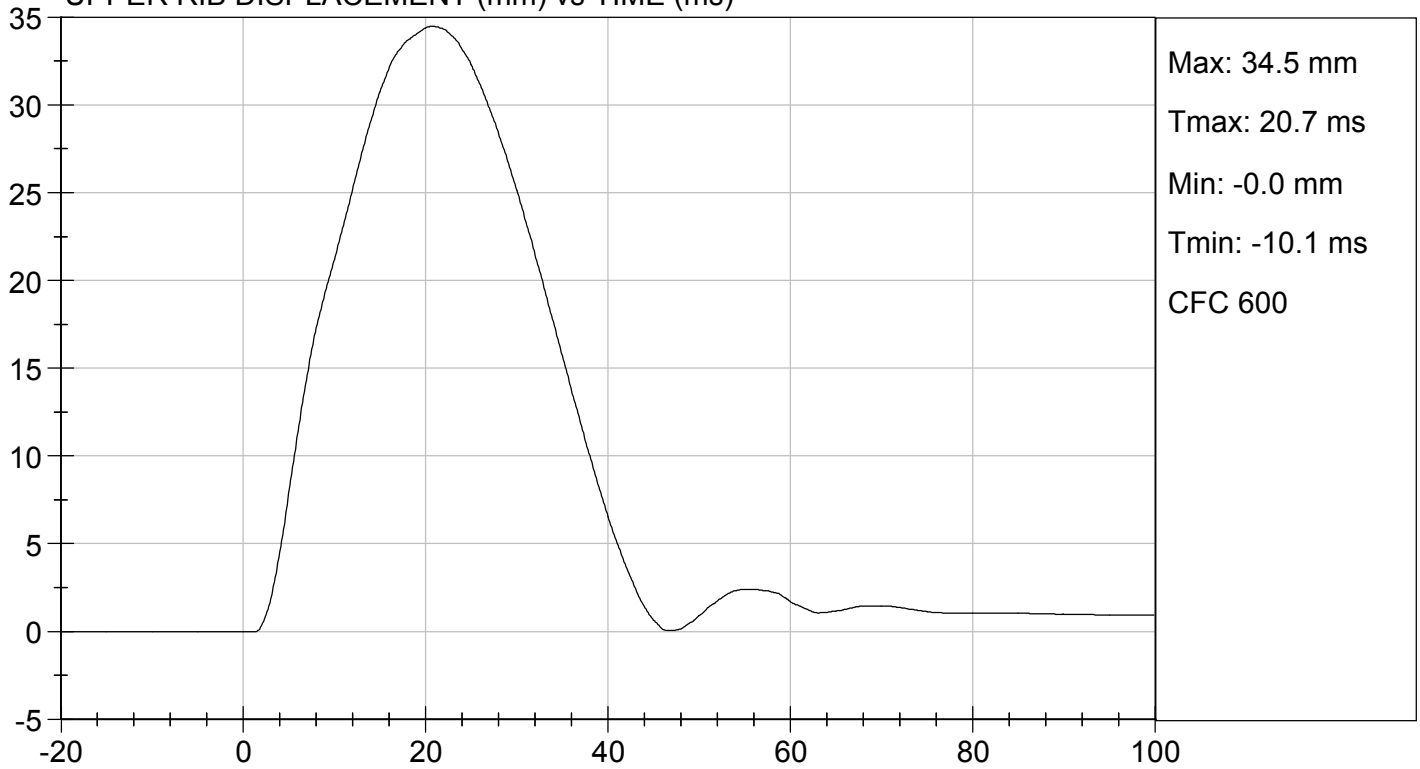
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 07/30/2020
TEST #: D201965

PROBE (G's) vs TIME (ms)



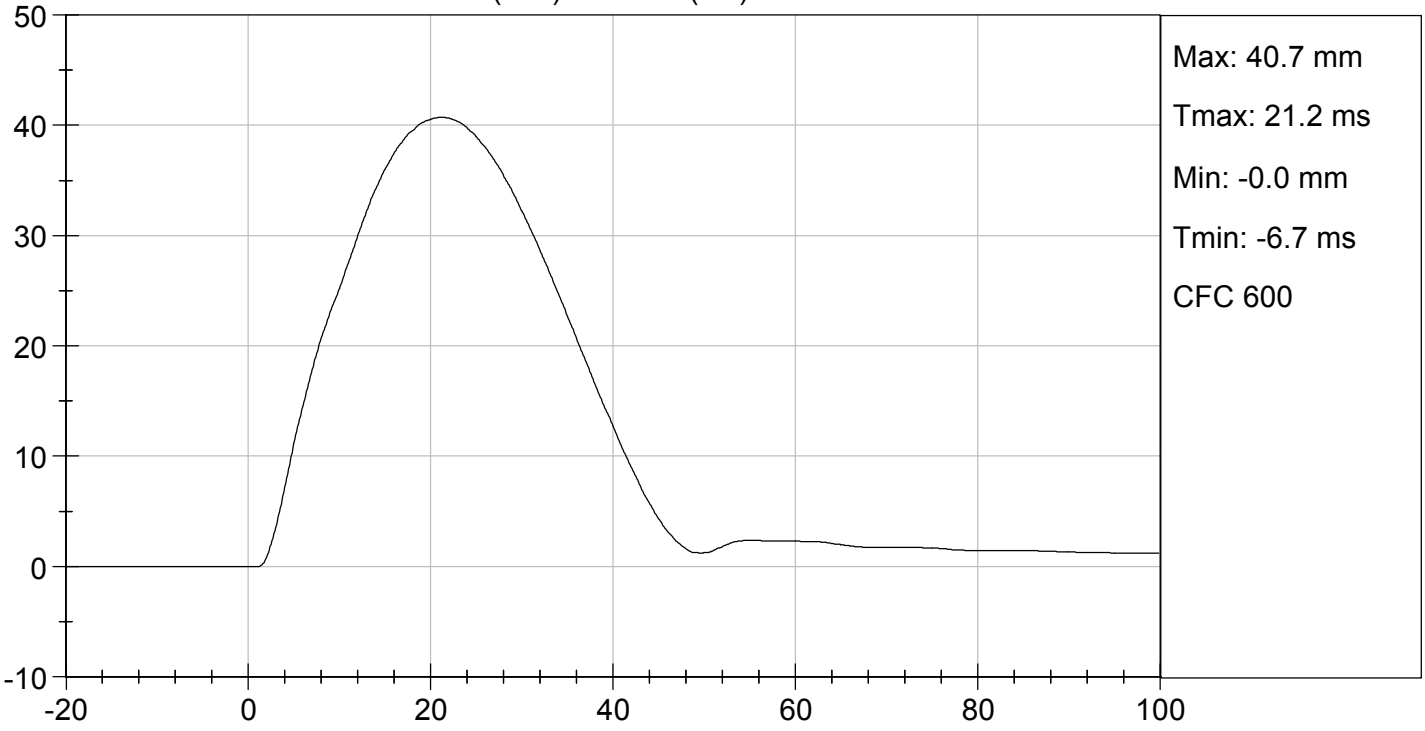
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



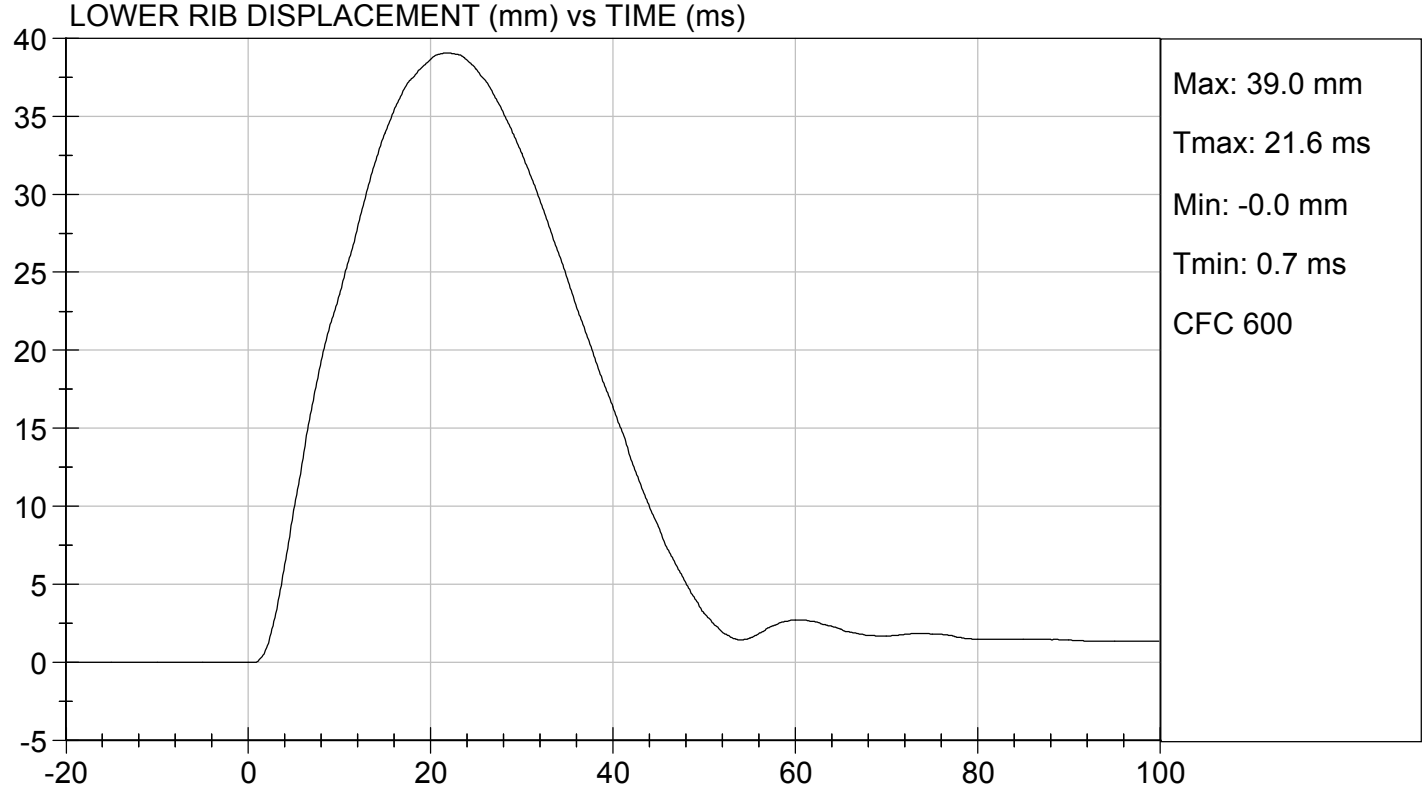
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 07/30/2020
TEST #: D201965

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



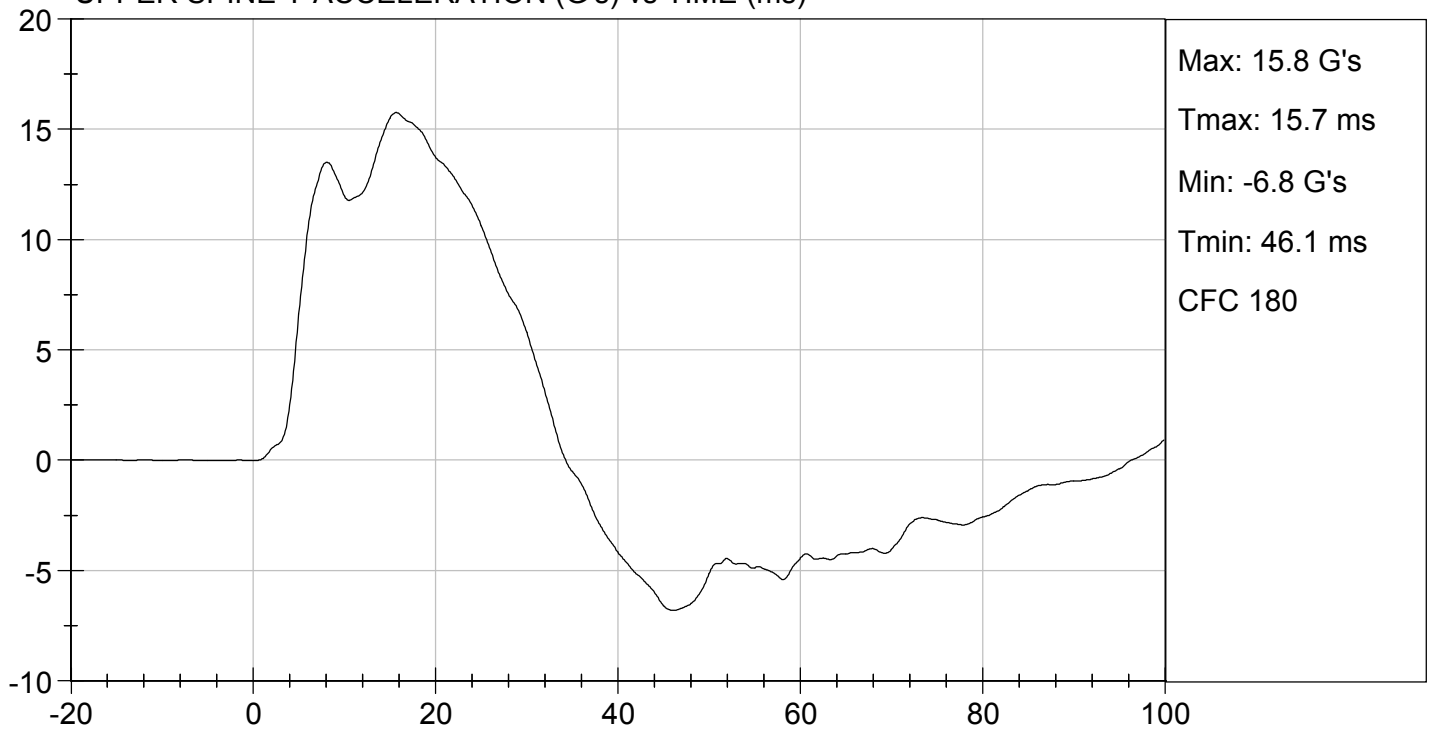
LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



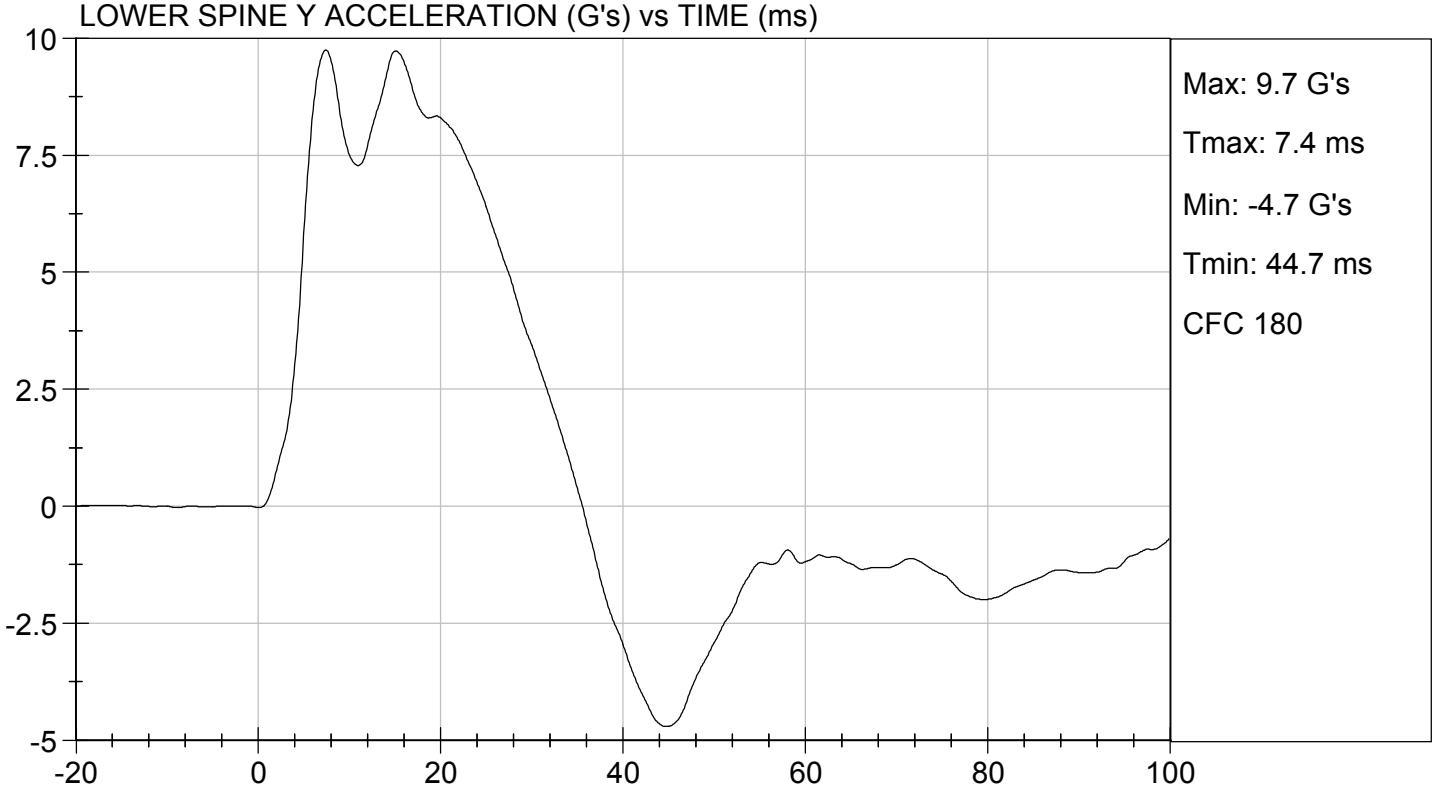
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.25 ft/s, 4.34 m/s

TEST DATE: 07/30/2020
TEST #: D201965

UPPER SPINE Y ACCELERATION (G's) vs TIME (ms)



LOWER SPINE Y ACCELERATION (G's) vs TIME (ms)



CALIBRATION TEST RESULTS

POST-TEST

SID-IIs 5TH PERCENTILE FEMALE ATD

MGA RESEARCH CORPORATION

HEAD DROP TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test ID:** D202401

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	38	Pass
Peak Resultant Acceleration	G's	115 to 137	116	Pass
Peak Longitudinal Acceleration	G's	+/- 15	4.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	<15%	Yes	Pass
		Overall Test Results		Pass

Laboratory Technician

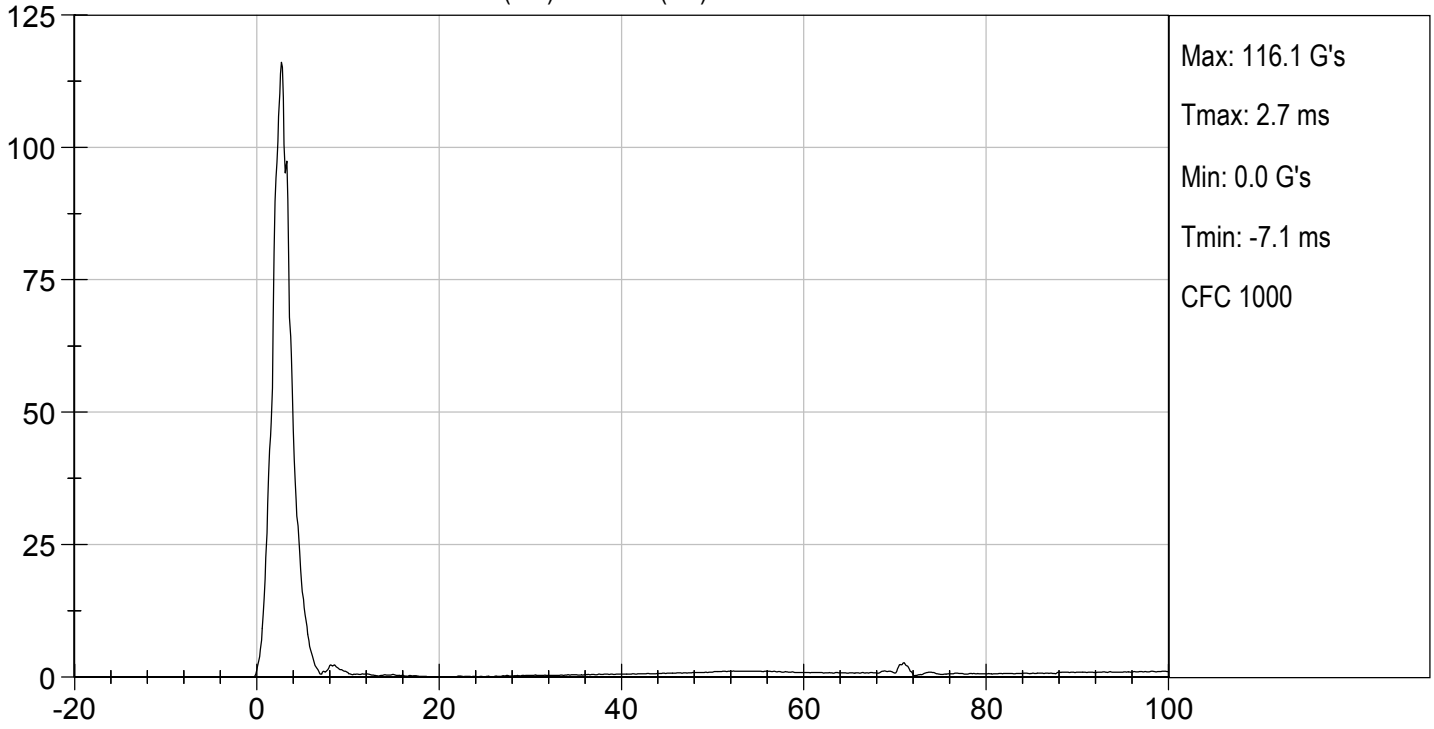
09/23/2020
Test Date

Approved By

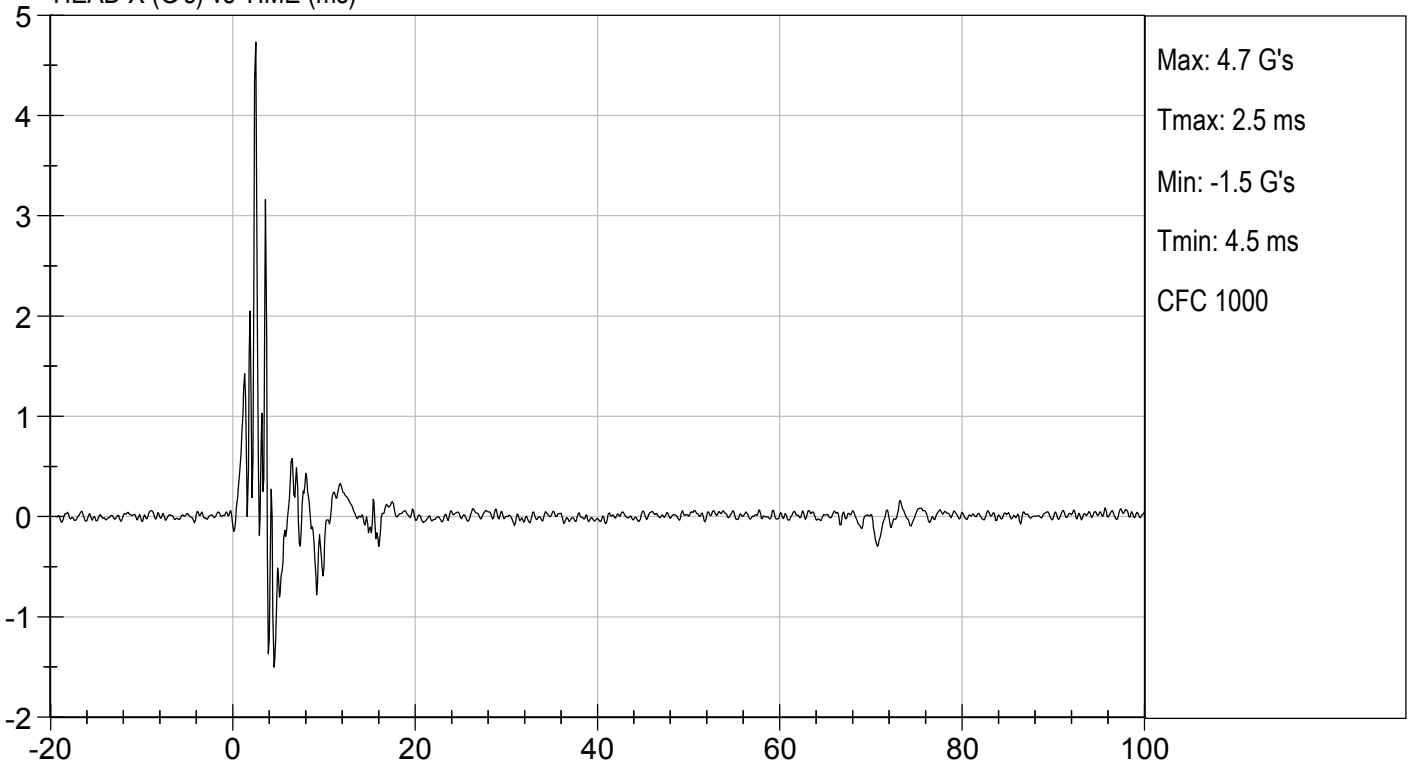
TEST DESC: HEAD DROP

TEST DATE: 09/23/2020
TEST #: D202401

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

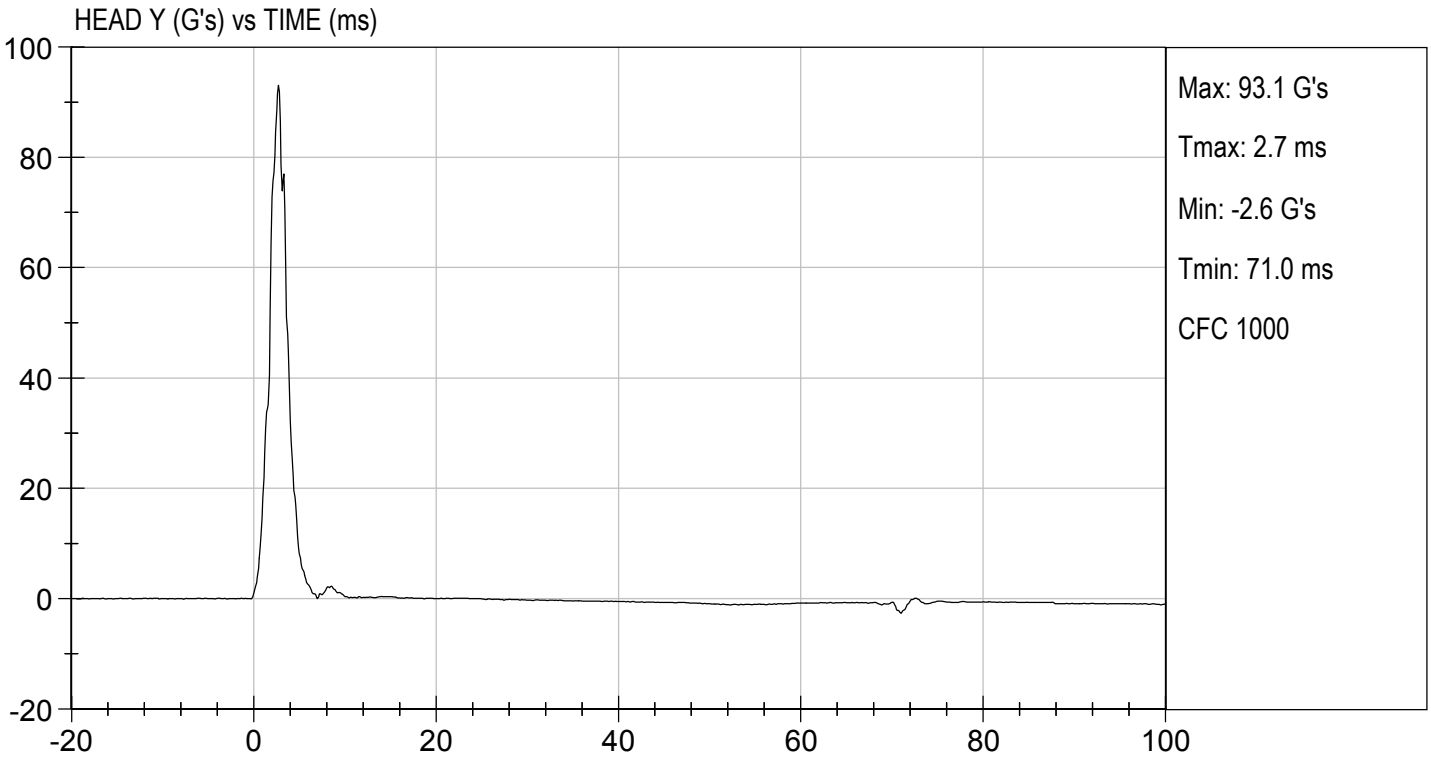


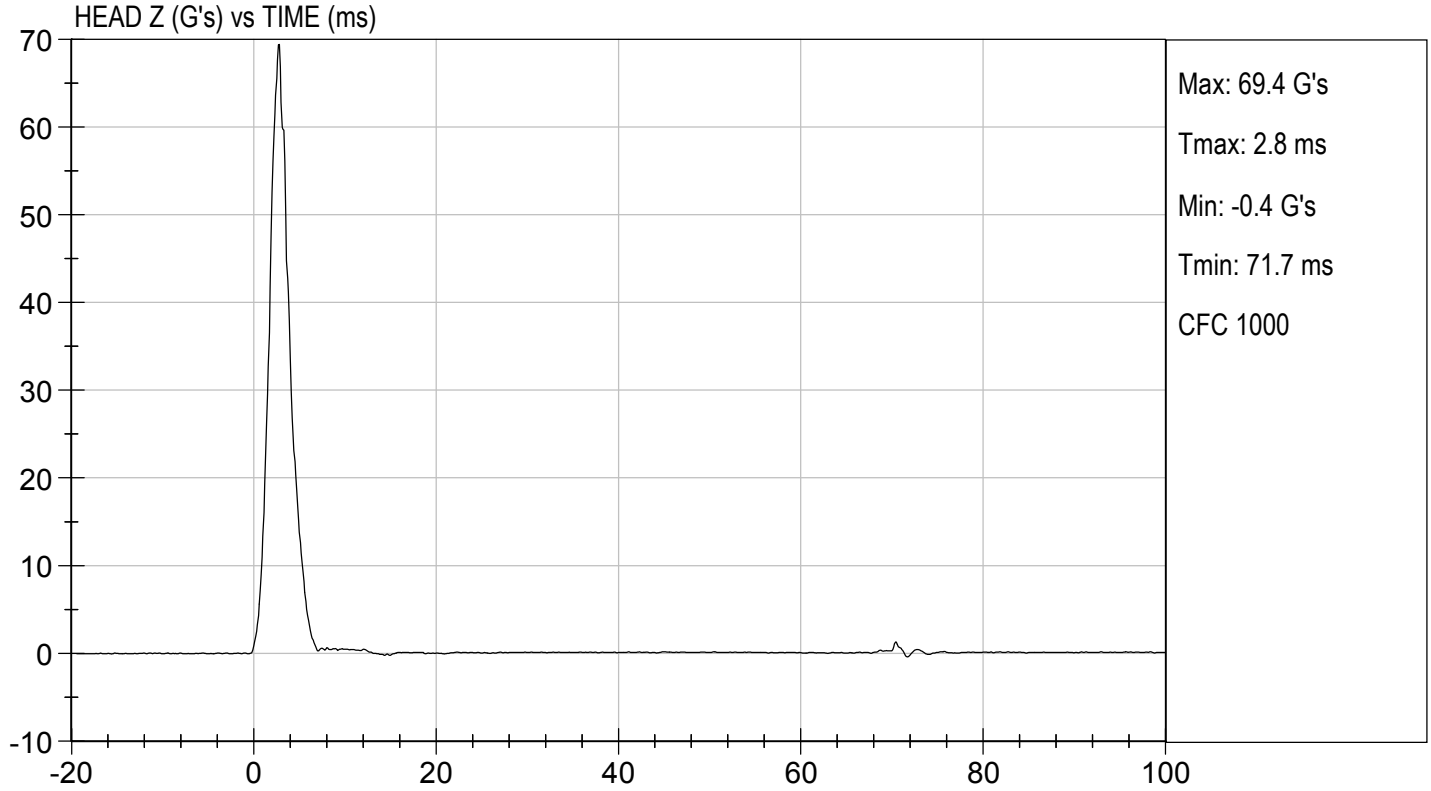
HEAD X (G's) vs TIME (ms)



TEST DESC: HEAD DROP

TEST DATE: 09/23/2020
TEST #: D202401





MGA RESEARCH CORPORATION

LATERAL NECK PENDULUM TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 278 **Test I.D:** D202402

Tested Parameter		Units	Specification	Result	Pass/Fail
Temperature		deg C	20.6 to 22.2	21.8	Pass
Humidity		%	10 to 70	38	Pass
Impact Velocity		m/s	5.51 to 5.63	5.58	Pass
Pendulum Velocity	10 ms	m/s	2.20 to 2.80	2.34	Pass
	15 ms	m/s	3.30 to 4.10	3.44	Pass
	20 ms	m/s	4.40 to 5.40	4.80	Pass
	25 ms	m/s	5.40 to 6.10	5.64	Pass
	25-100 ms	m/s	5.50 to 6.20	5.64	Pass
Maximum D-Plane Rotation		deg	71 to 81	75	Pass
Time of Maximum D-Plane Rotation		ms	50 to 70	64	Pass
Maximum Occipital Condyle Moment		Nm	-44 to -36	-39	Pass
Time of Moment Decay to 0 Nm		ms	102 to 126	120	Pass
			Overall Test Results		Pass

Laboratory Technician

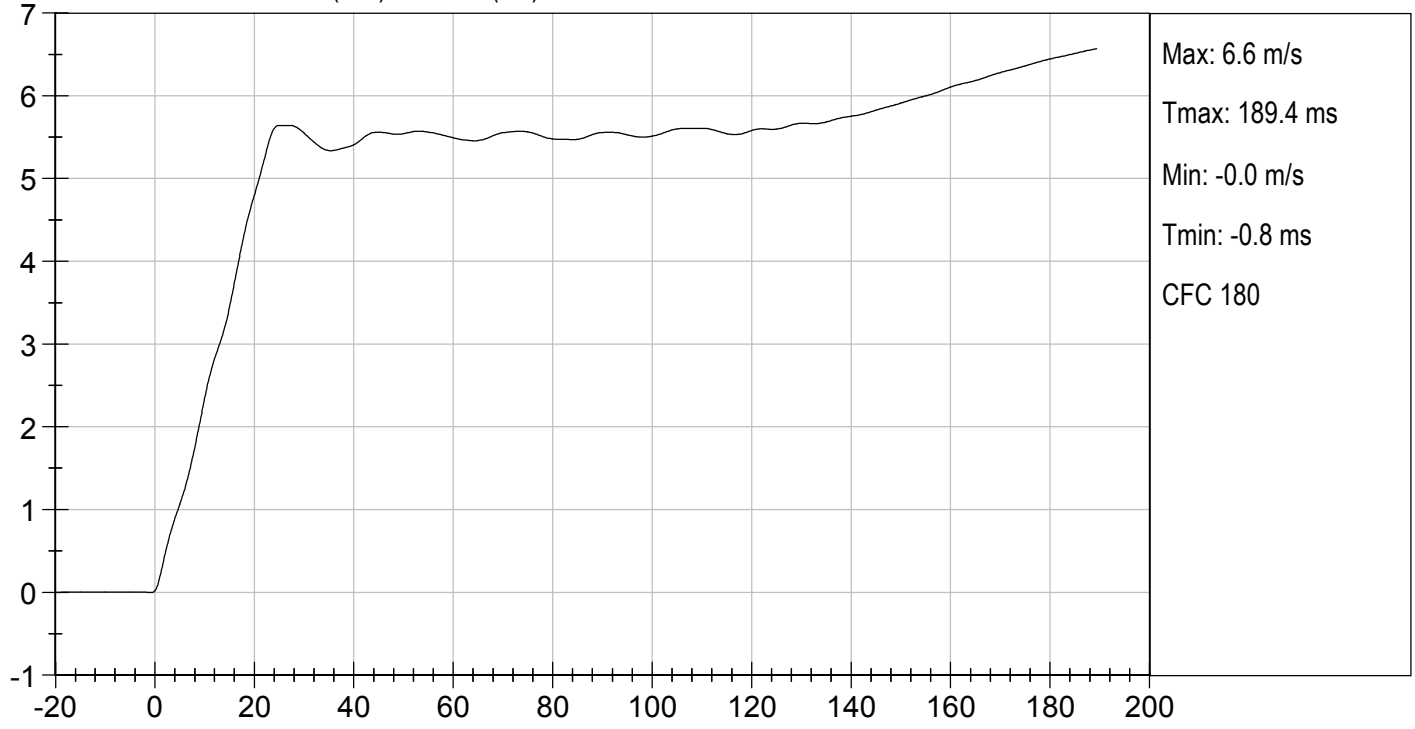
09/23/2020
Test Date

Approved By

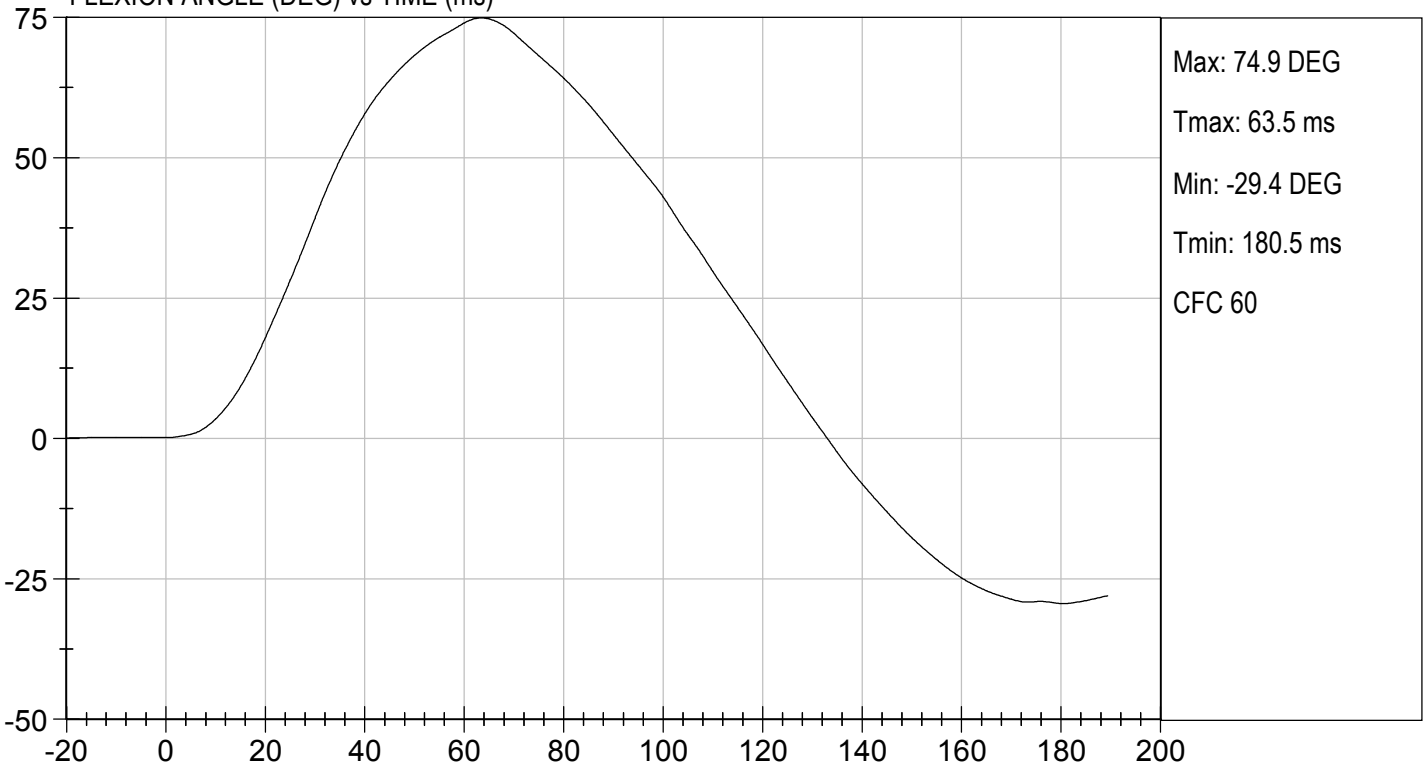
TEST DESC: NECK BENDING
VELOCITY: 18.31 ft/s, 5.58 m/s

TEST DATE: 09/23/2020
TEST #: D202402

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

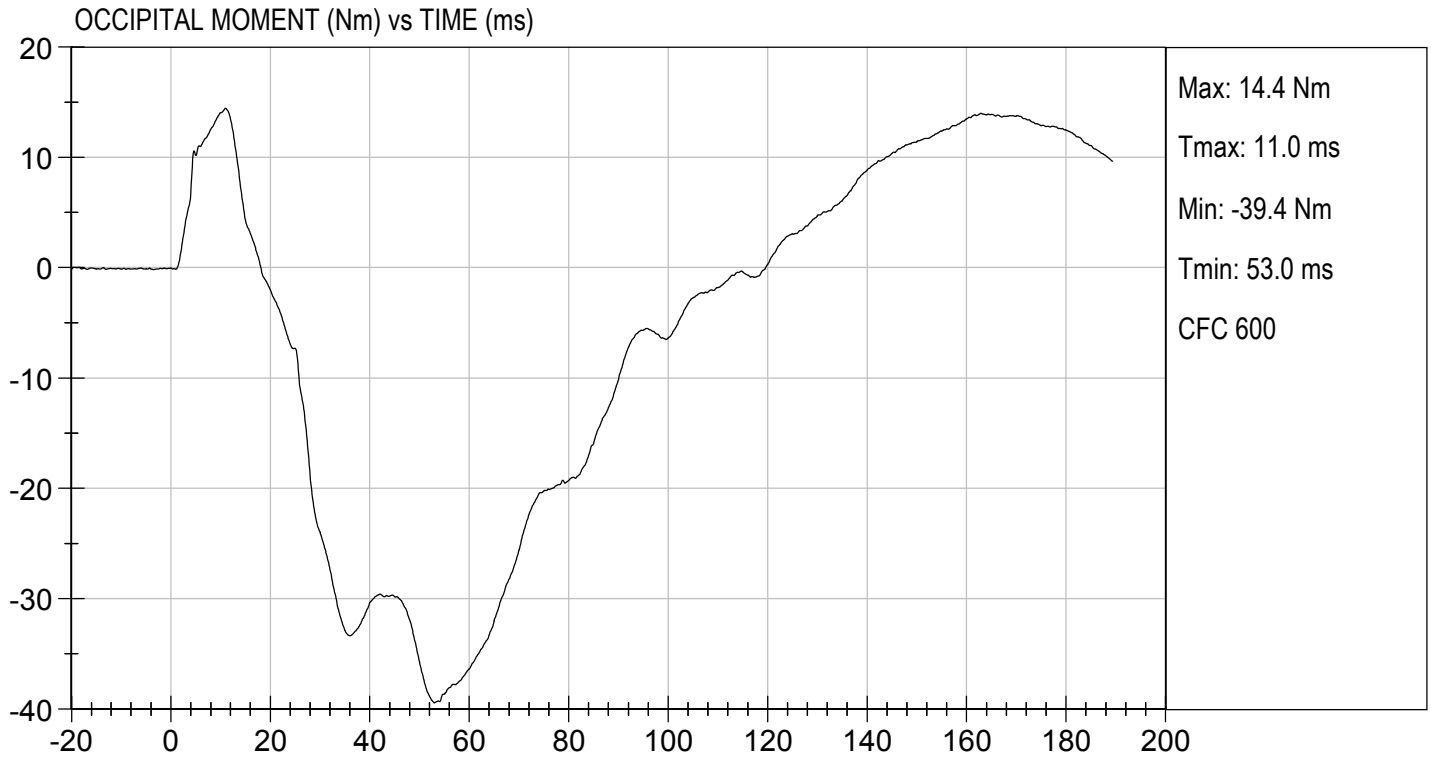


FLEXION ANGLE (DEG) vs TIME (ms)



TEST DESC: NECK BENDING
VELOCITY: 18.31 ft/s, 5.58 m/s

TEST DATE: 09/23/2020
TEST #: D202402



MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test ID:** D202403

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	38	Pass
Impact Velocity	m/s	4.20 to 4.40	4.27	Pass
Maximum Probe Acceleration	G's	13 to 18	16	Pass
Shoulder Displacement	mm	28 to 37	31	Pass
Upper Spine (T1) Y Acceleration	G's	17 to 22	19	Pass
		Overall Test Results		Pass

Laboratory Technician

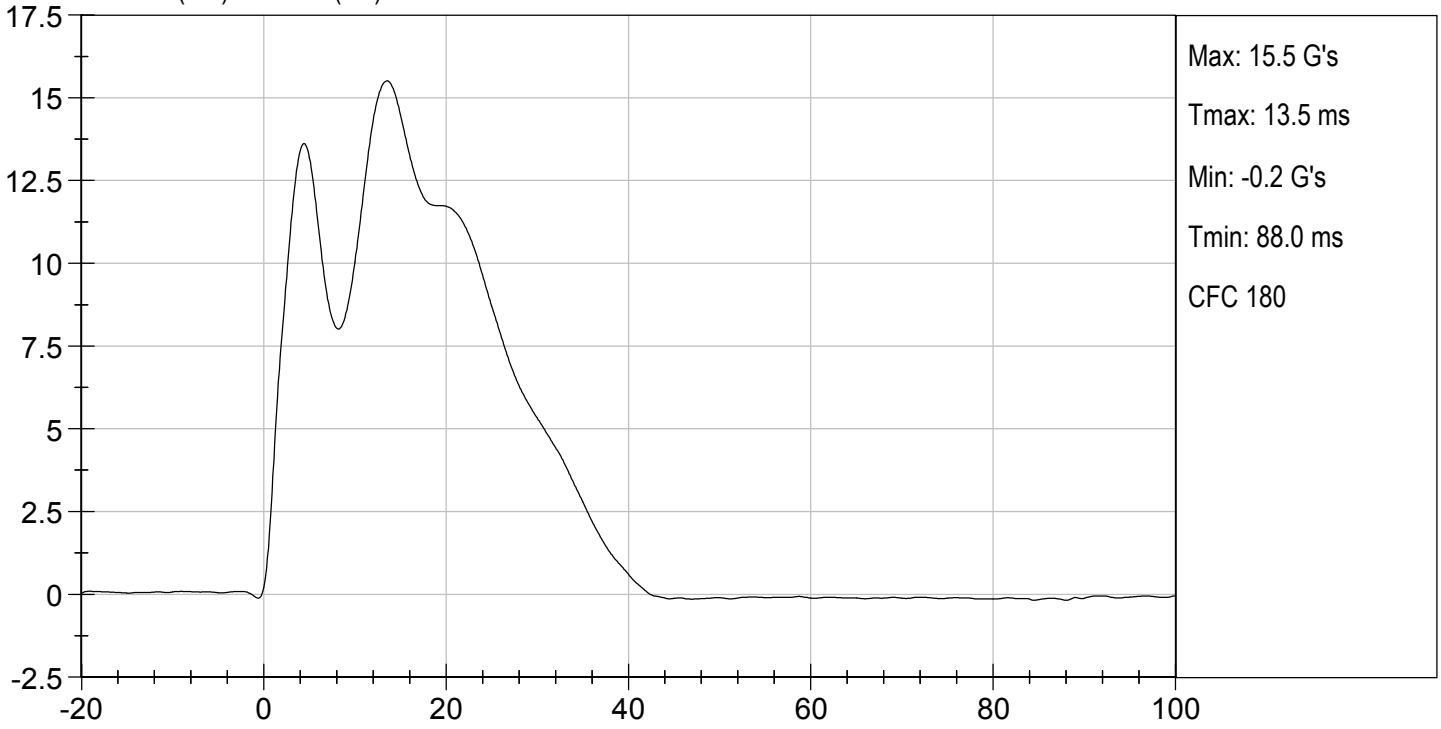
09/23/2020
Test Date

Approved By

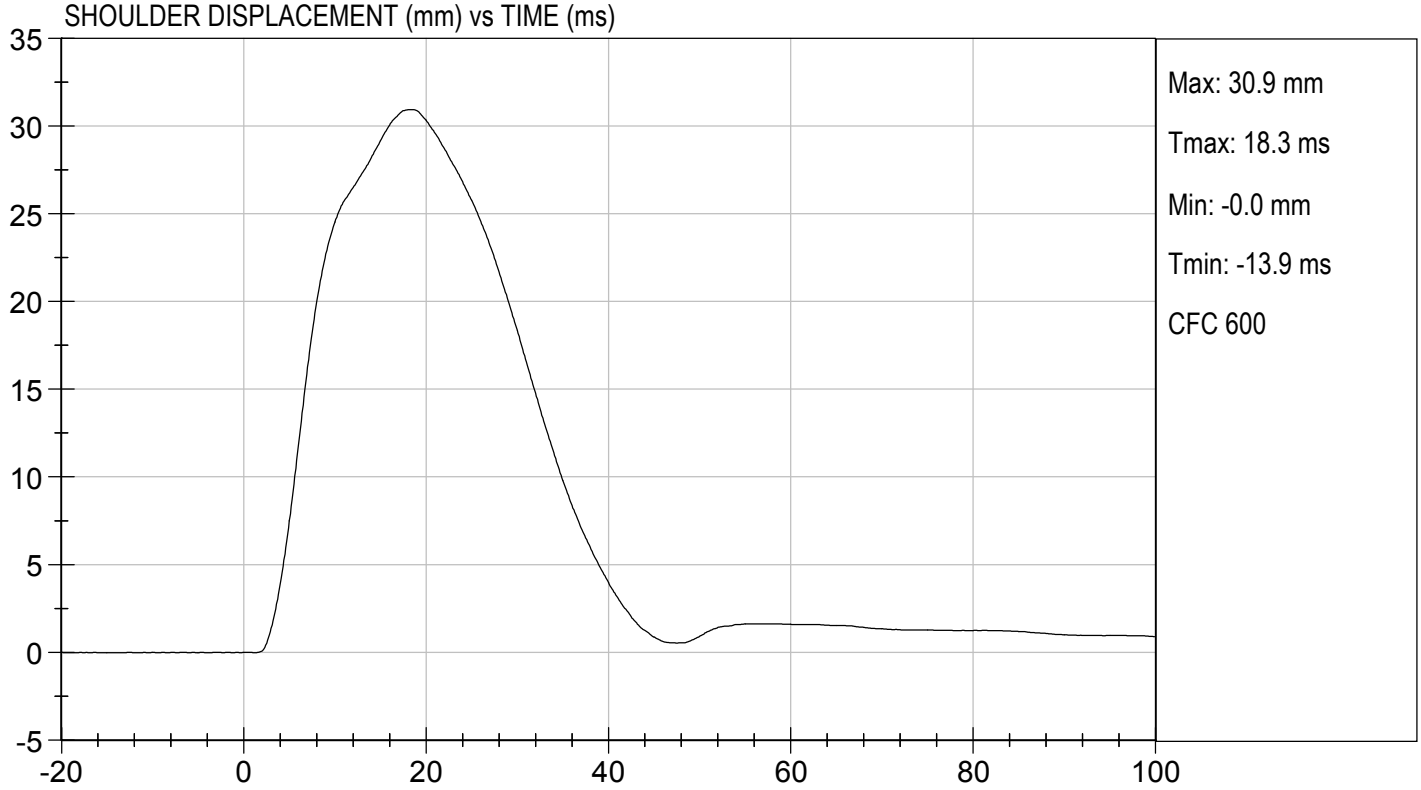
TEST DESC: SHOULDER IMPACT
VELOCITY: 14.01 ft/s, 4.27 m/s

TEST DATE: 09/23/2020
TEST #: D202403

PROBE (G's) vs TIME (ms)



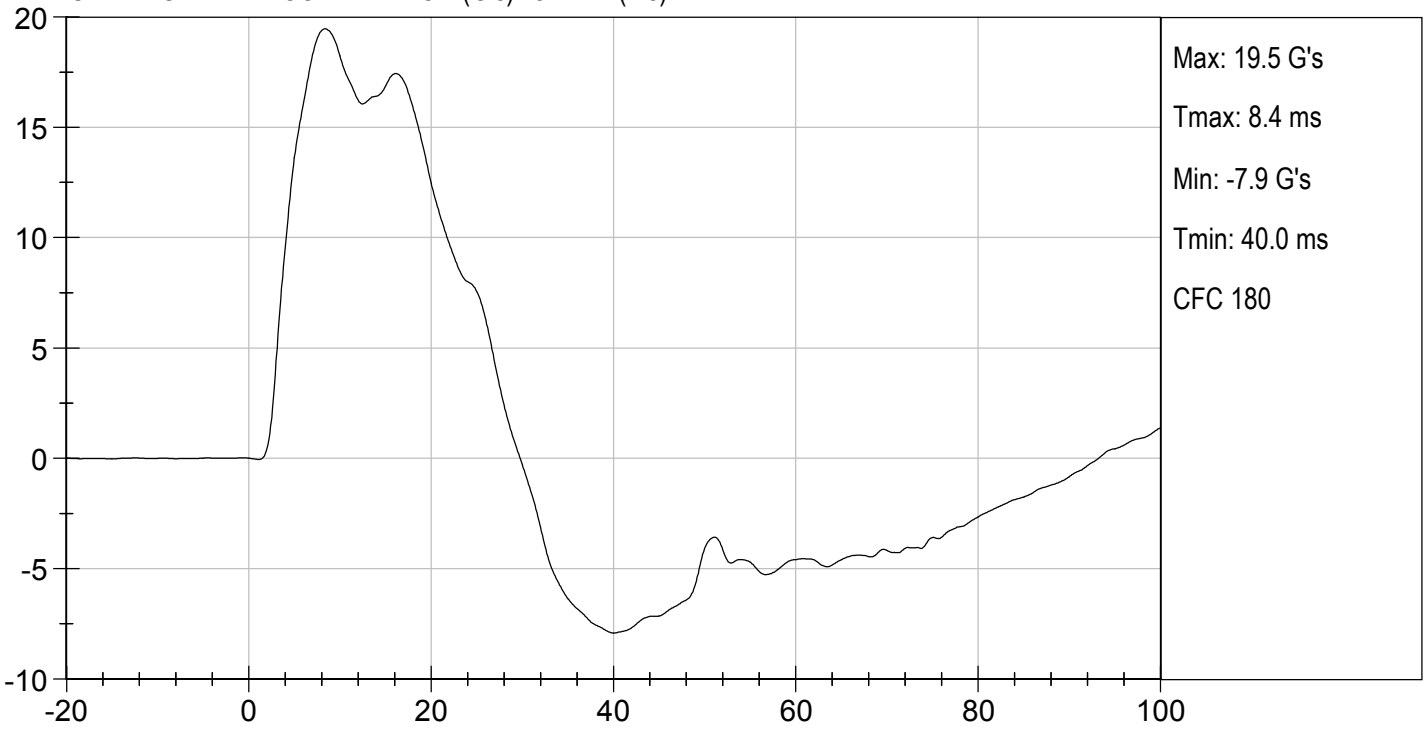
SHOULDER DISPLACEMENT (mm) vs TIME (ms)



TEST DESC: SHOULDER IMPACT
VELOCITY: 14.01 ft/s, 4.27 m/s

TEST DATE: 09/23/2020
TEST #: D202403

UPPER SPINE Y ACCELERATION (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

THORAX (WITH ARM) IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D202404

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	38	Pass
Impact Velocity	m/s	6.60 to 6.80	6.68	Pass
Maximum Probe Acceleration	G's	30 to 36	35	Pass
Shoulder Displacement	mm	31 to 40	35	Pass
Upper Rib Displacement	mm	25 to 32	27	Pass
Middle Rib Displacement	mm	30 to 36	31	Pass
Lower Rib Displacement	mm	32 to 38	33	Pass
Upper Spine (T1) Y Acceleration	G's	34 to 43	42	Pass
Lower Spine (T12) Y Acceleration	G's	29 to 37	33	Pass
		Overall Test Results		Pass

Laboratory Technician

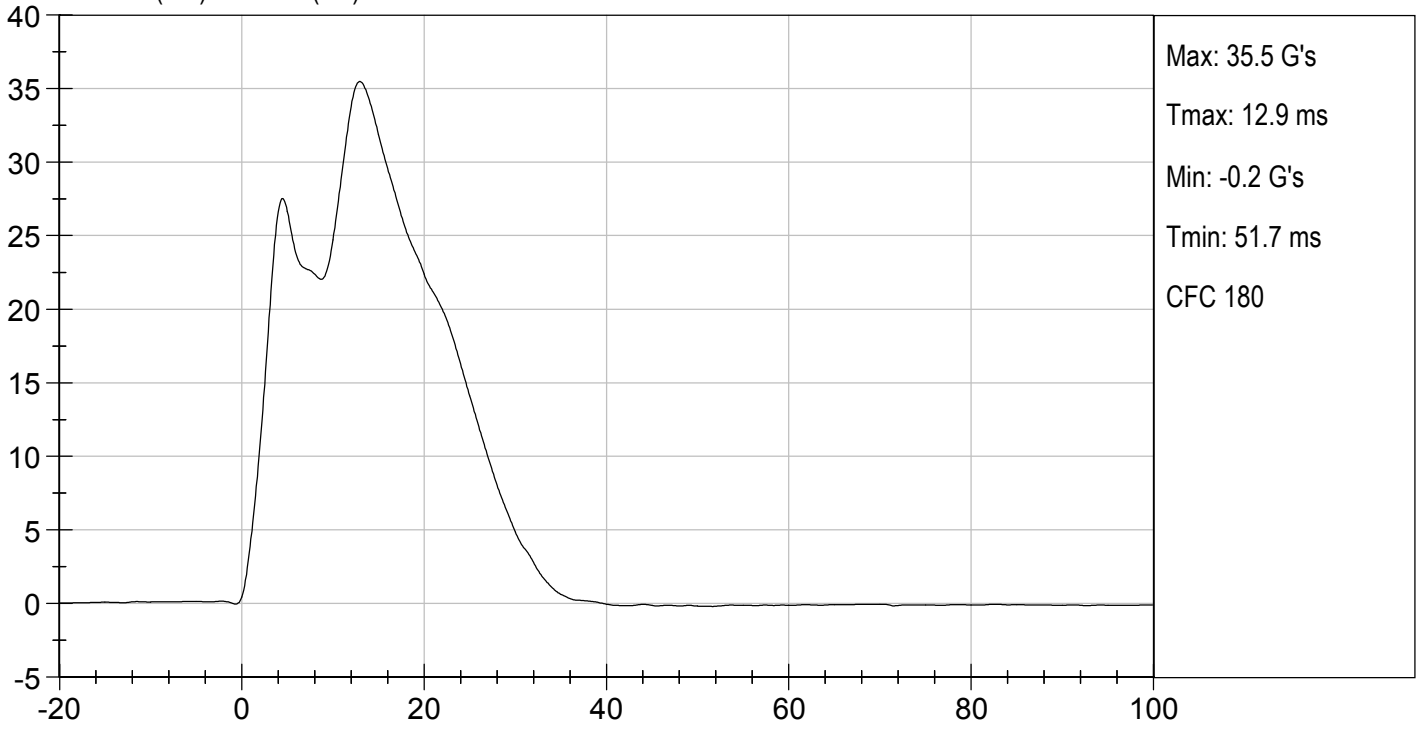
09/23/2020
Test Date

Approved By

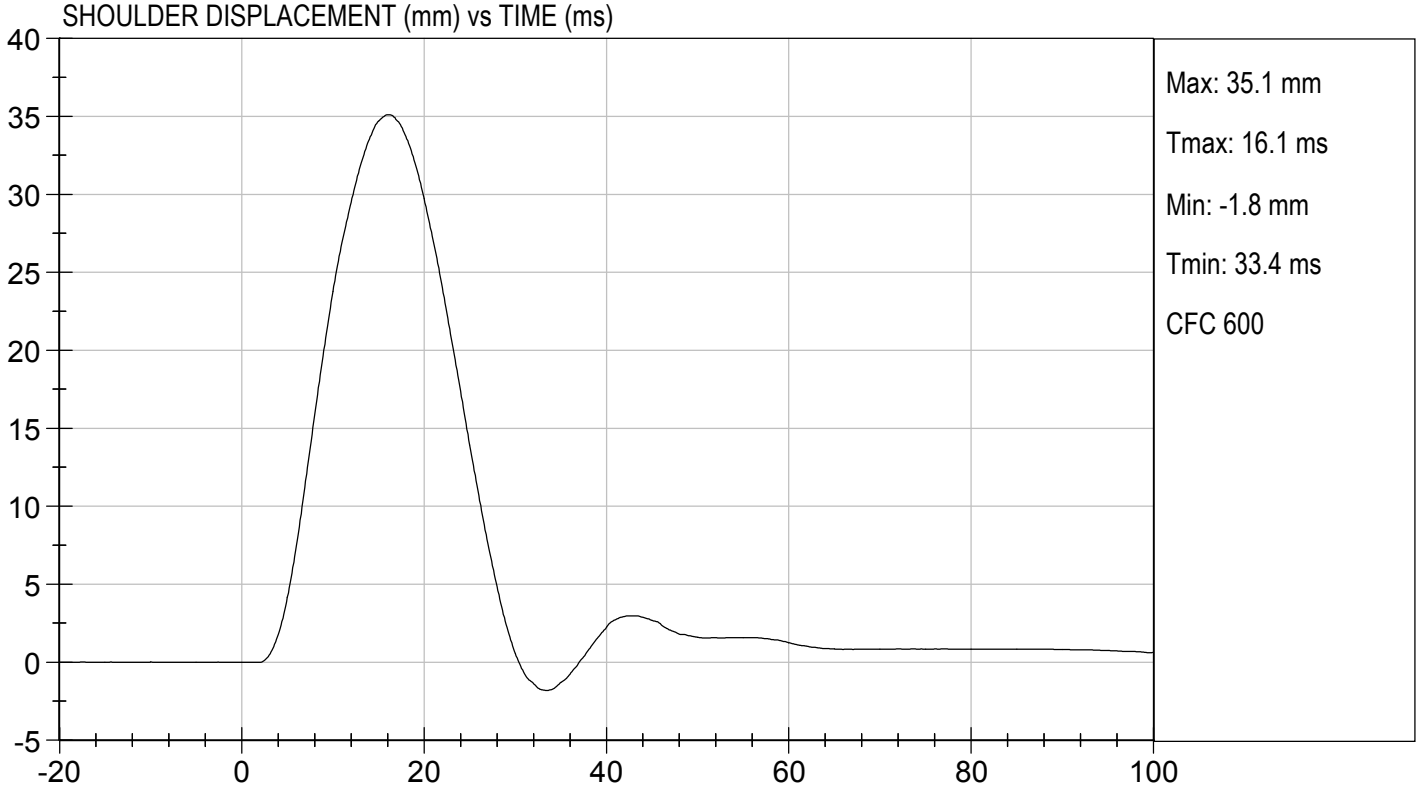
TEST DESC: THORAX IMPACT WITH ARM
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 09/23/2020
TEST #: D202404

PROBE (G's) vs TIME (ms)



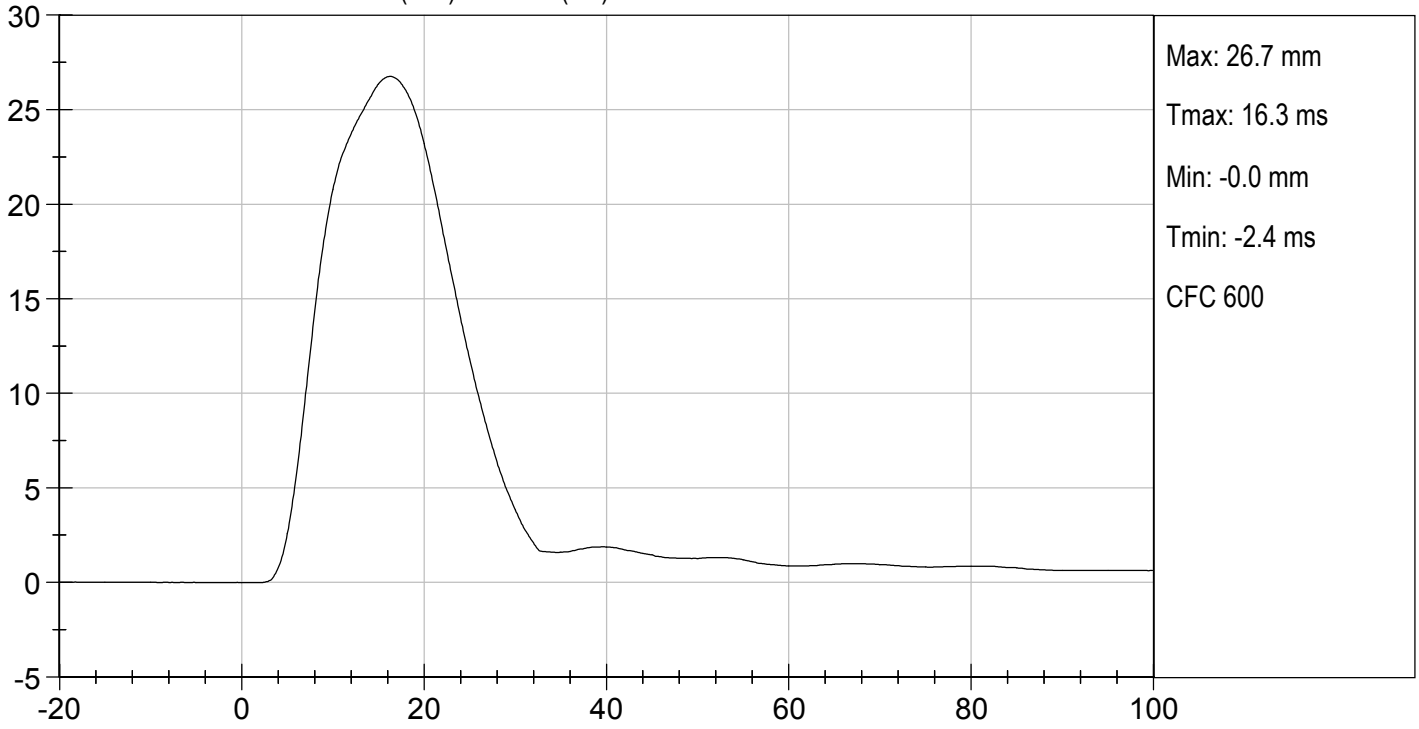
SHOULDER DISPLACEMENT (mm) vs TIME (ms)



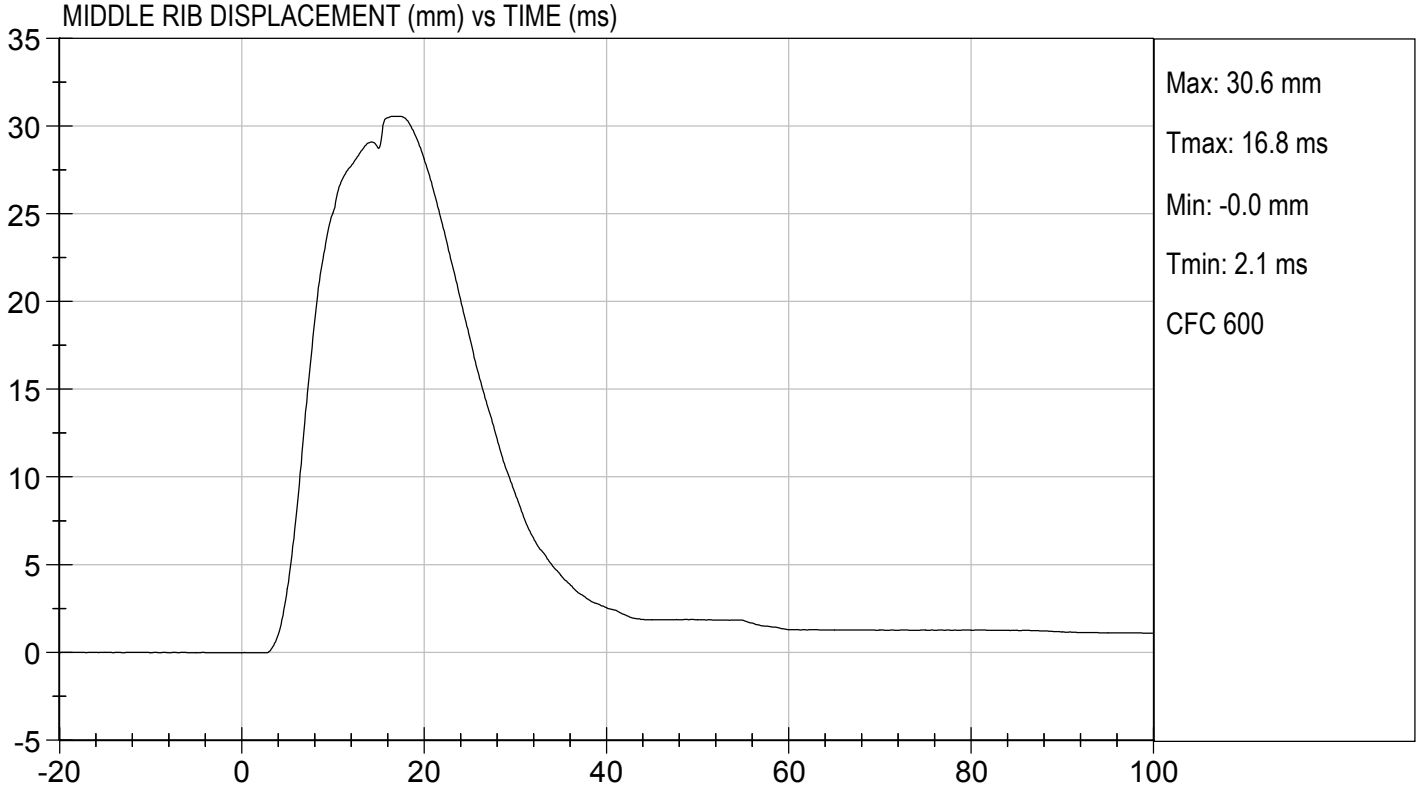
TEST DESC: THORAX IMPACT WITH ARM
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 09/23/2020
TEST #: D202404

UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



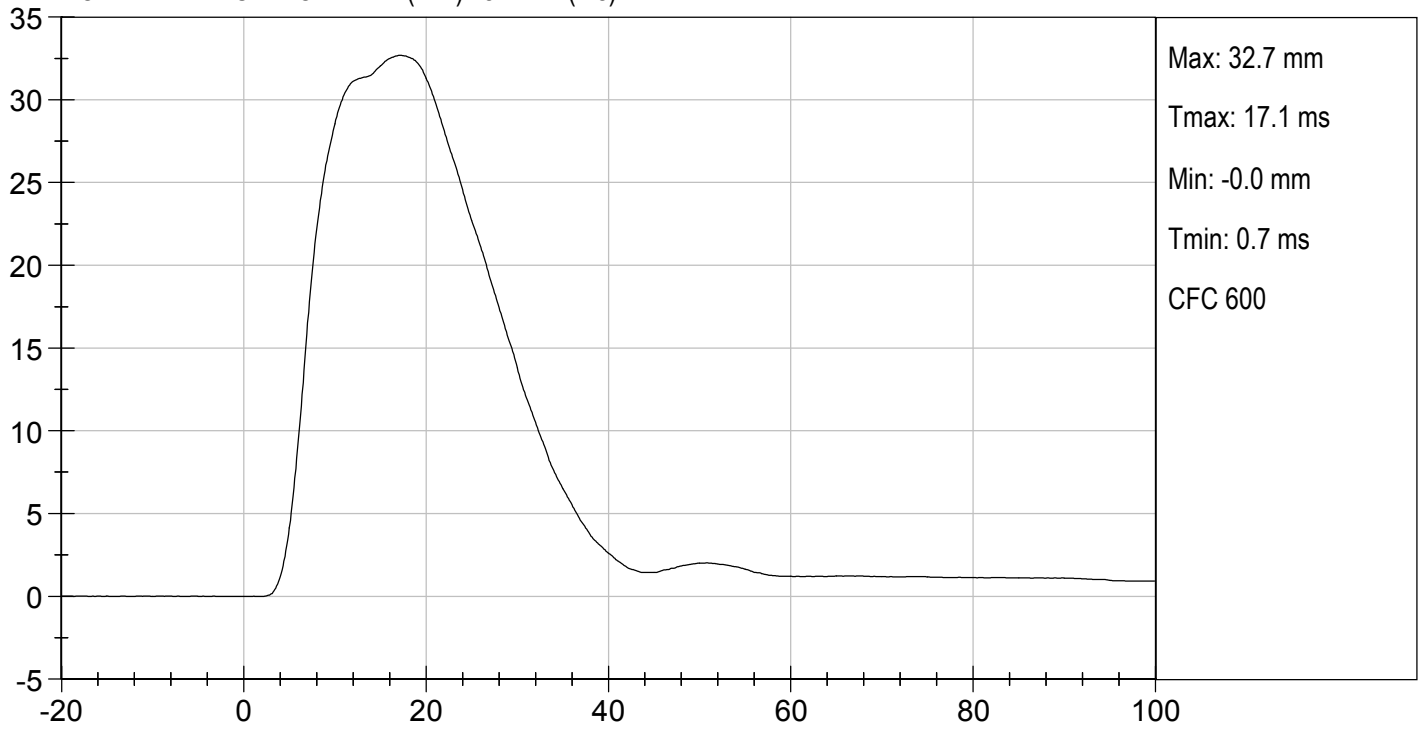
MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



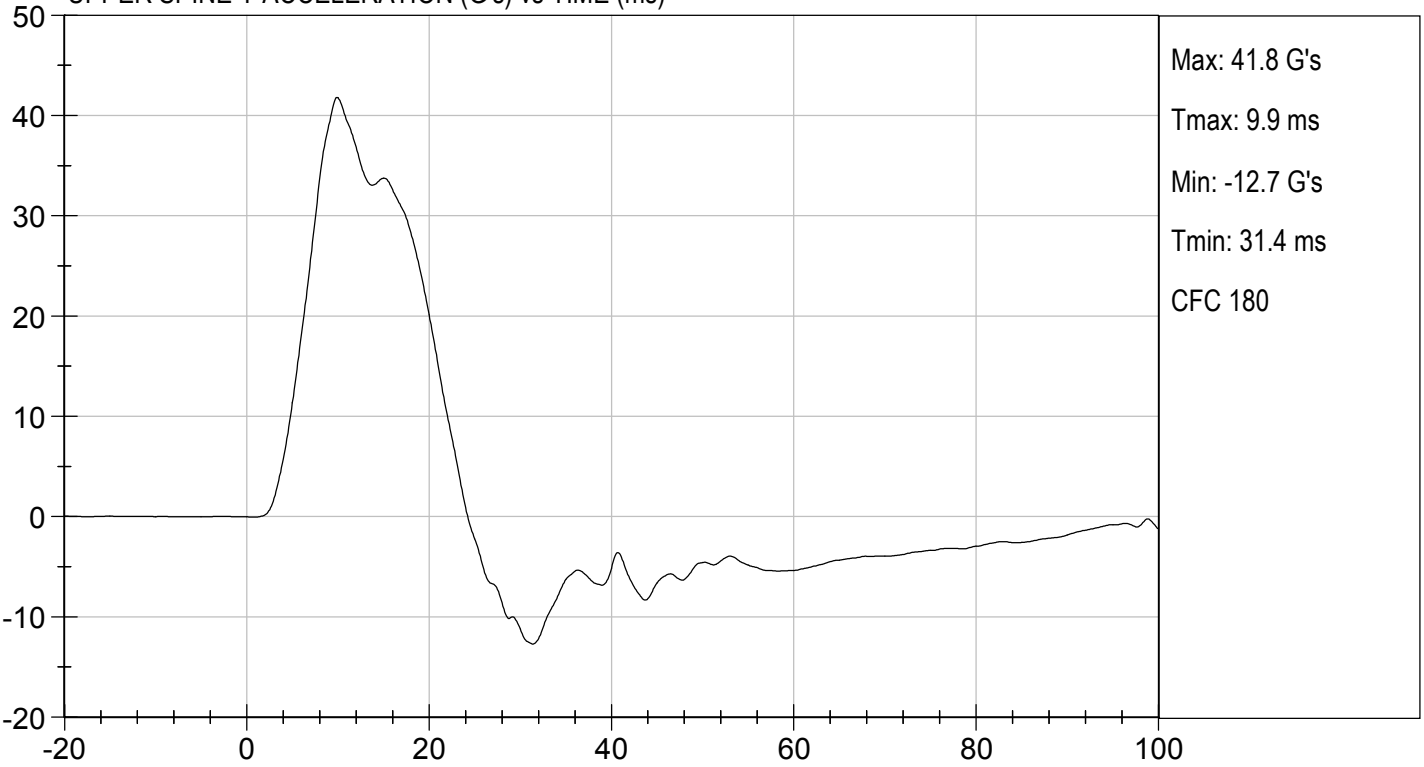
TEST DESC: THORAX IMPACT WITH ARM
VELOCITY: 21.93 ft/s, 6.68 m/s

TEST DATE: 09/23/2020
TEST #: D202404

LOWER RIB DISPLACEMENT (mm) vs TIME (ms)

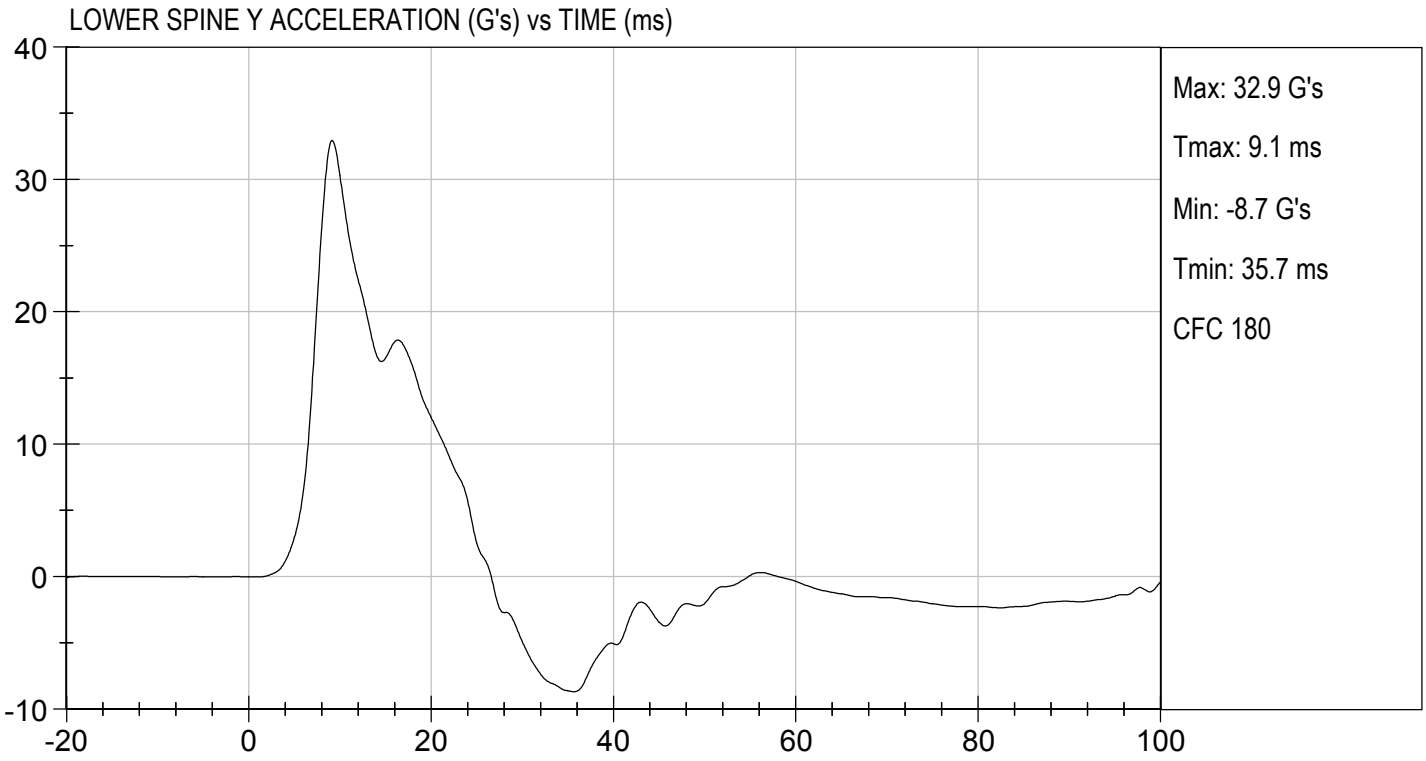


UPPER SPINE Y ACCELERATION (G's) vs TIME (ms)



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

TEST DATE: 09/23/2020
TEST #: D202404



MGA RESEARCH CORPORATION

THORAX (WITHOUT ARM) IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D202405

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	38	Pass
Impact Velocity	m/s	4.20 to 4.40	4.30	Pass
Maximum Probe Acceleration	G's	14 to 18	16	Pass
Upper Rib Displacement	mm	32 to 40	34	Pass
Middle Rib Displacement	mm	39 to 45	39	Pass
Lower Rib Displacement	mm	35 to 43	37	Pass
Upper Spine (T1) Y Acceleration	G's	13 to 17	15	Pass
Lower Spine (T12) Y Acceleration	G's	7 to 11	10	Pass
		Overall Test Results		Pass

Laboratory Technician

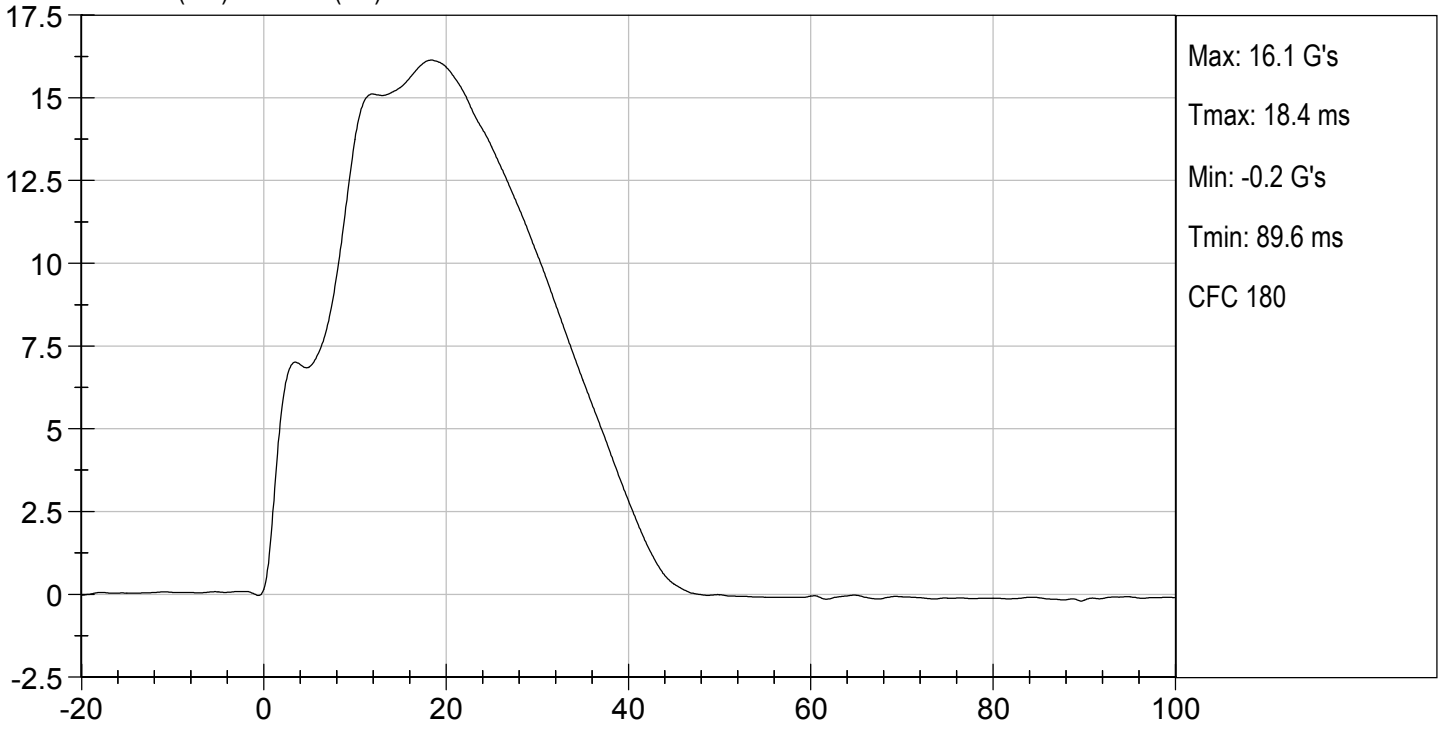
09/24/2020
Test Date

Approved By

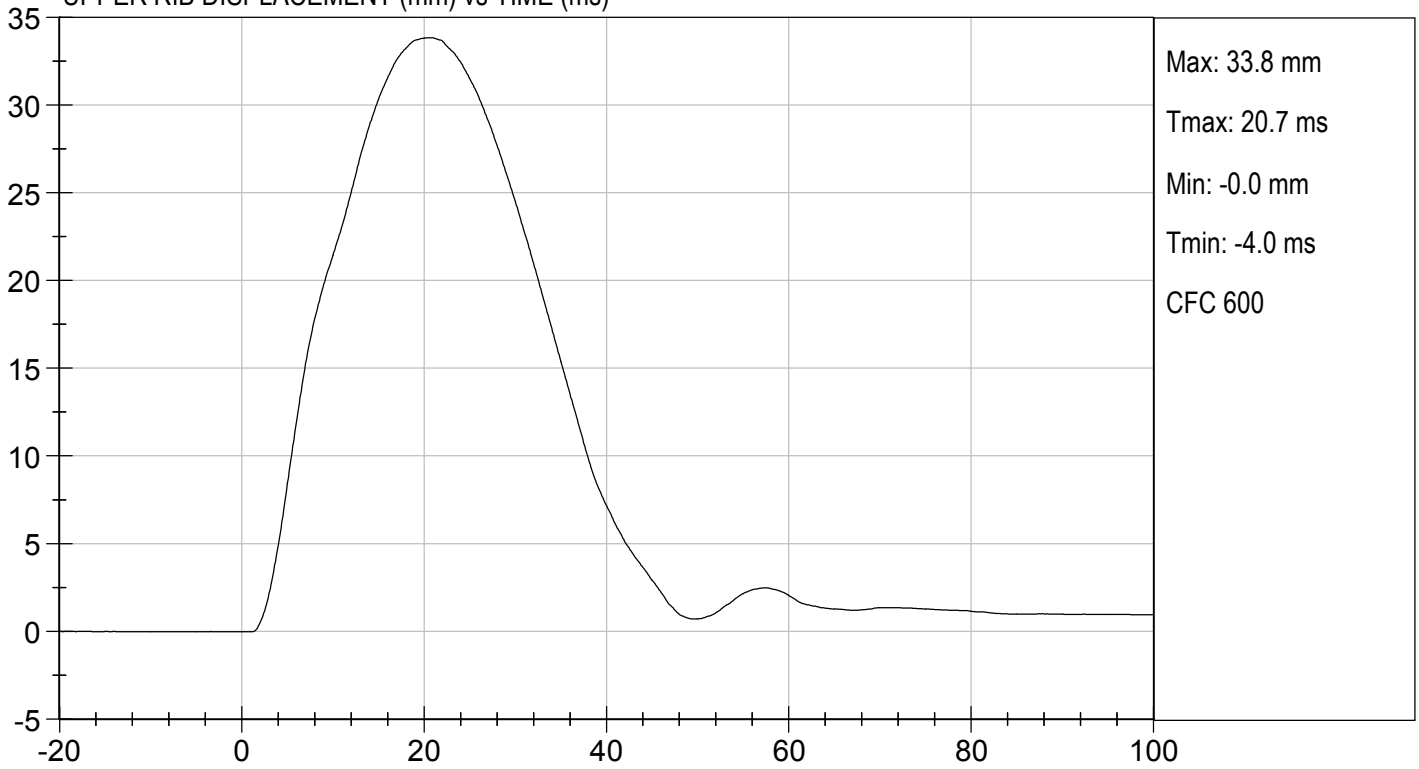
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.12 ft/s, 4.30 m/s

TEST DATE: 09/24/2020
TEST #: D202405

PROBE (G's) vs TIME (ms)



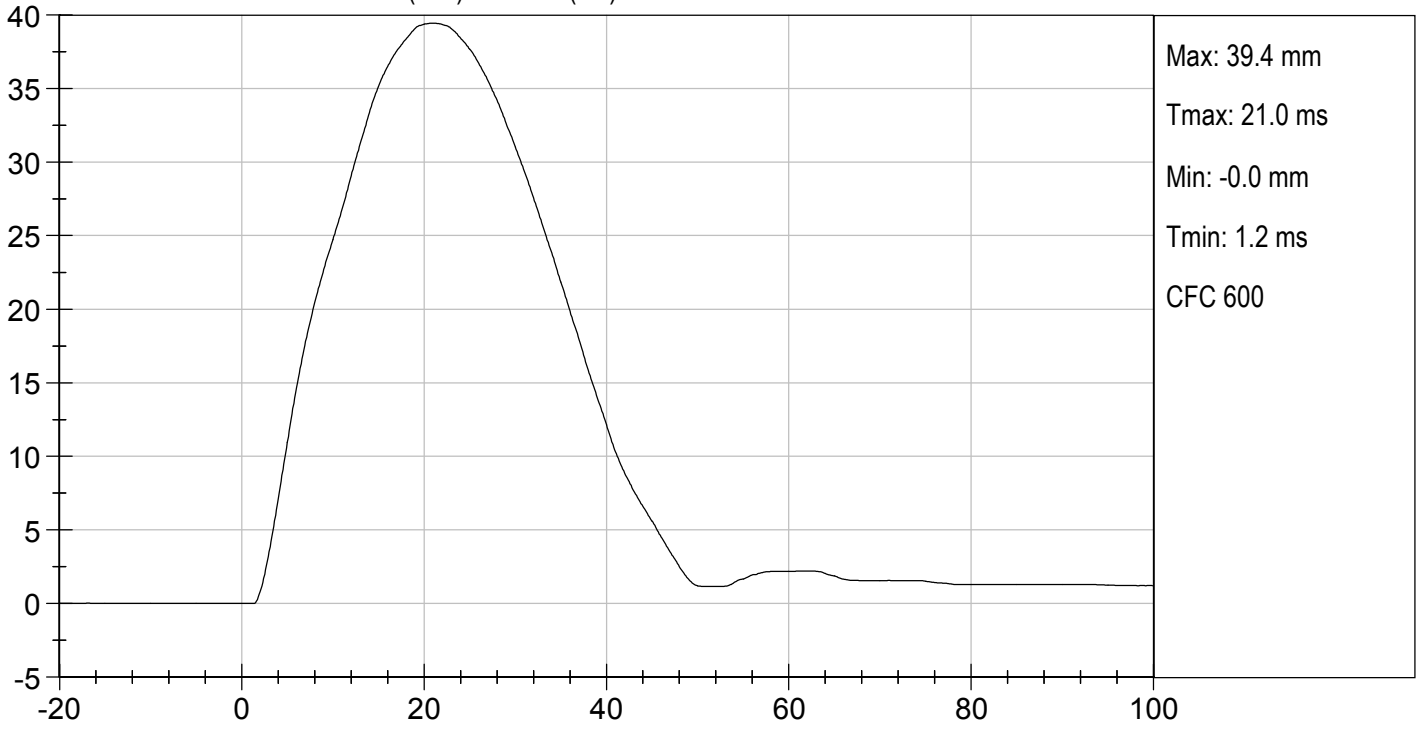
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



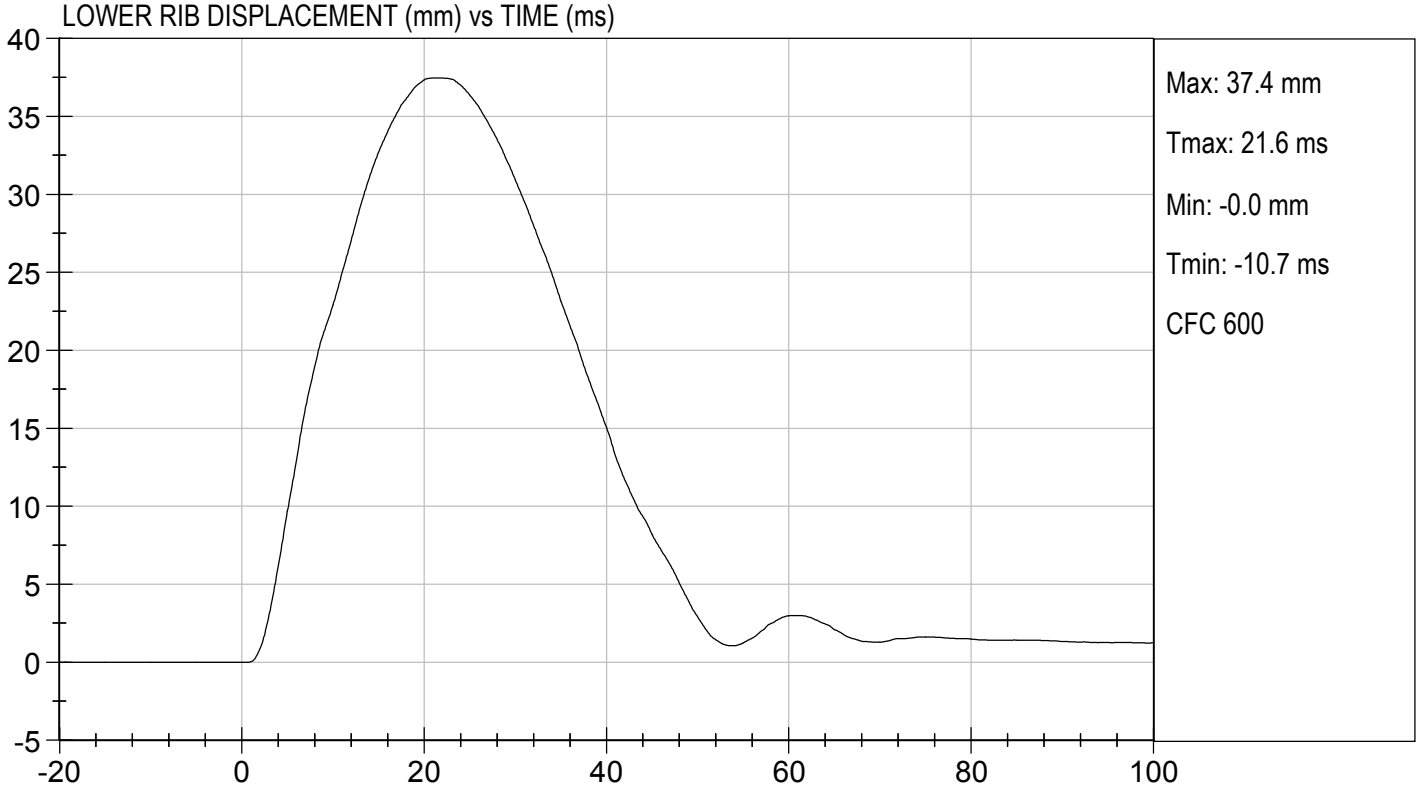
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.12 ft/s, 4.30 m/s

TEST DATE: 09/24/2020
TEST #: D202405

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



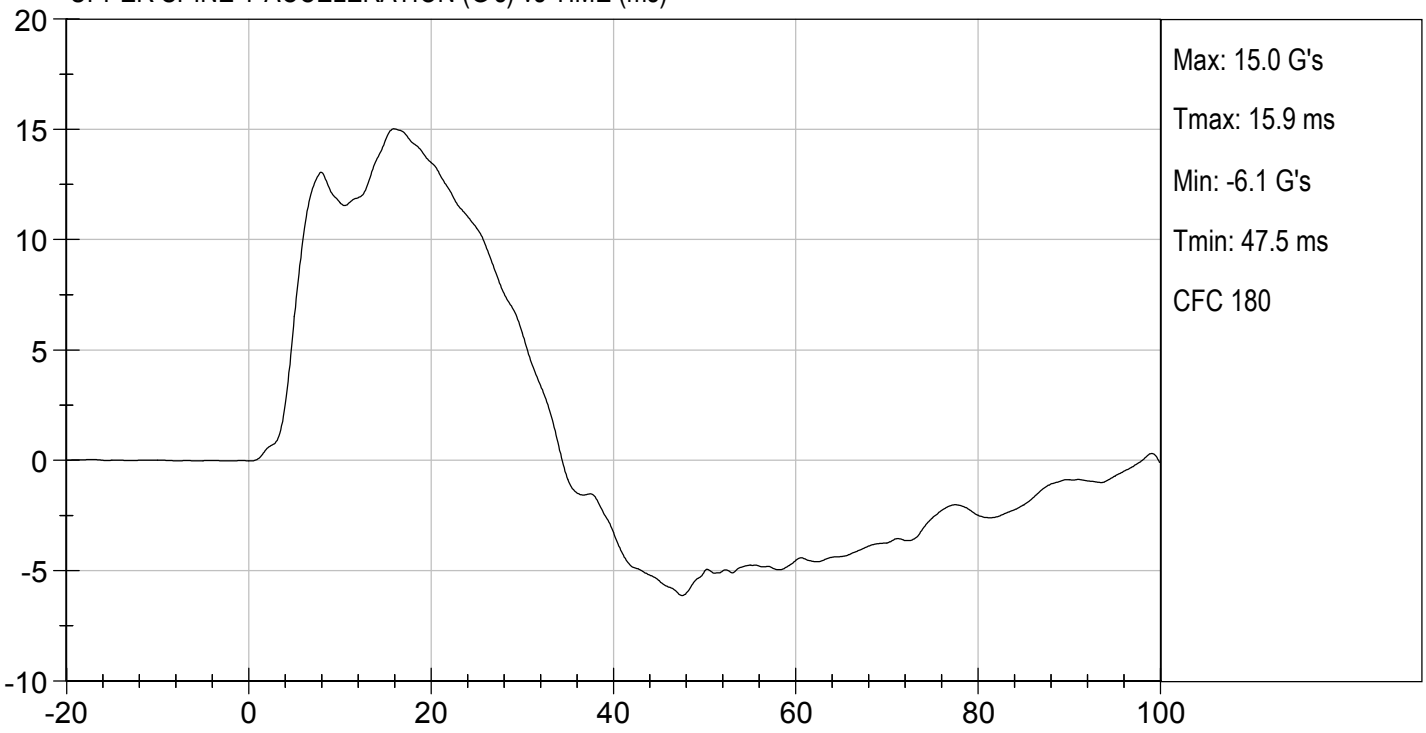
LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



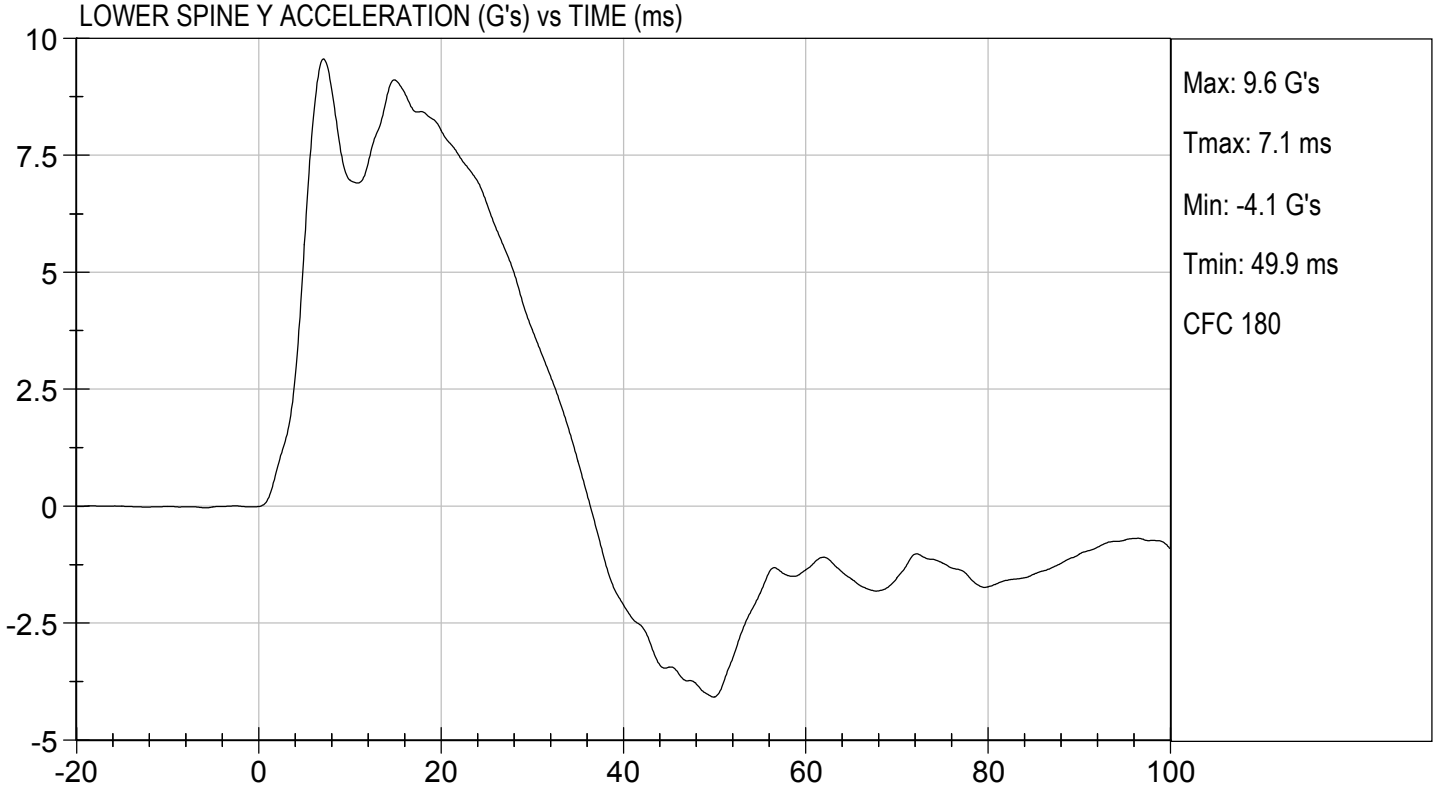
TEST DESC: THORAX IMPACT WITHOUT ARM
VELOCITY: 14.12 ft/s, 4.30 m/s

TEST DATE: 09/24/2020
TEST #: D202405

UPPER SPINE Y ACCELERATION (G's) vs TIME (ms)



LOWER SPINE Y ACCELERATION (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

ABDOMINAL IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D202406

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	38	Pass
Impact Velocity	m/s	4.20 to 4.40	4.38	Pass
Maximum Probe Acceleration	G's	12 to 16	14	Pass
Upper Abdomen Rib Displacement	mm	36 to 47	39	Pass
Lower Abdomen Rib Displacement	mm	33 to 44	40	Pass
Lower Spine (T12) Y Acceleration	G's	9 to 14	11	Pass
		Overall Test Results		Pass

Laboratory Technician

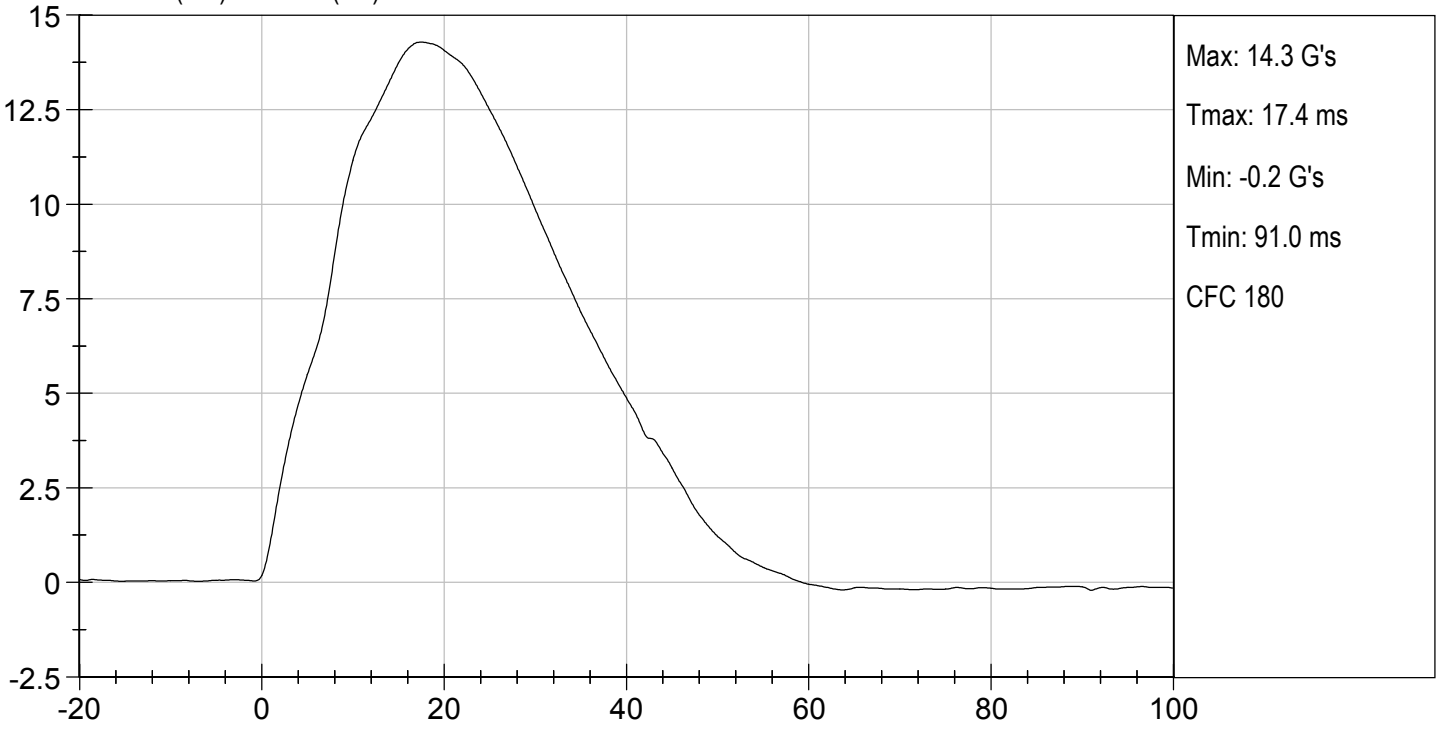
09/23/2020
Test Date

Approved By

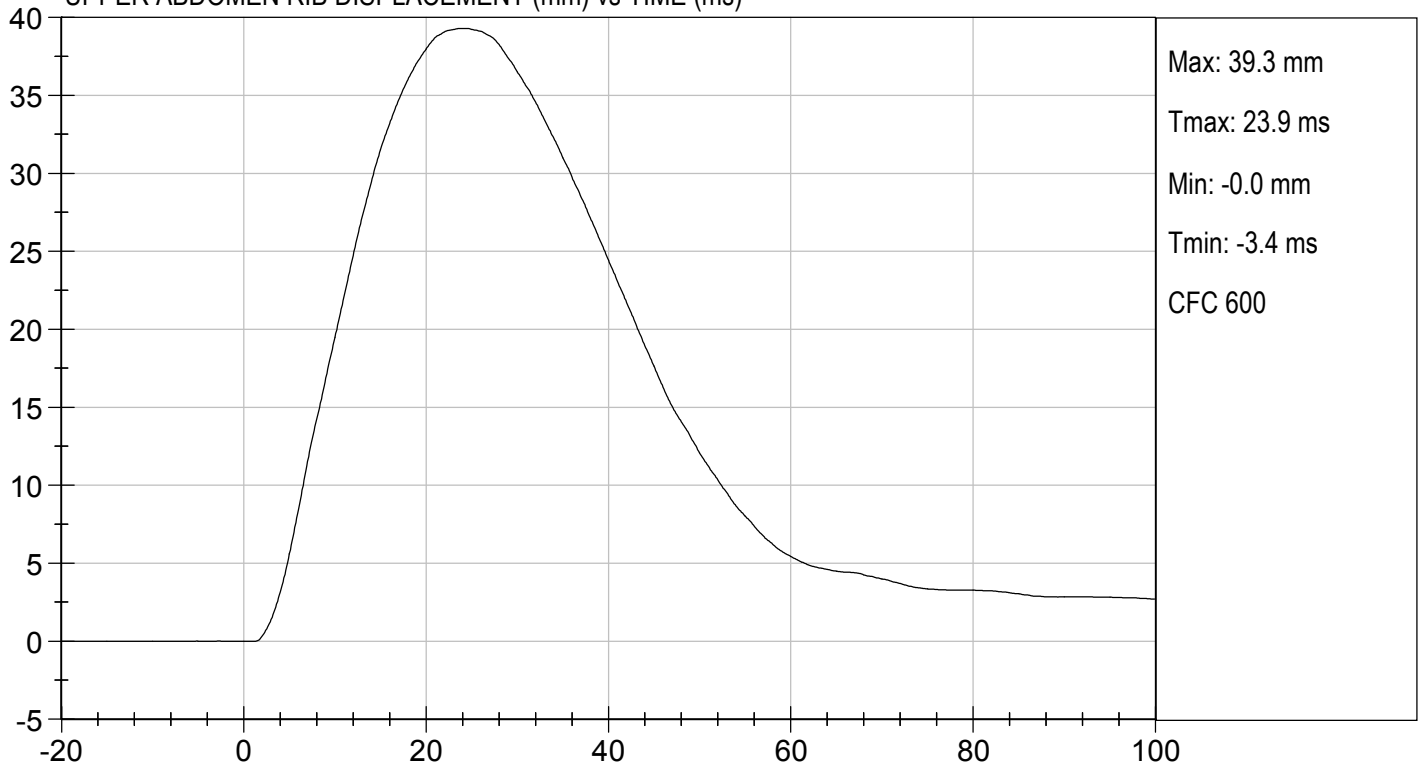
TEST DESC: ABDOMEN IMPACT
VELOCITY: 14.37 ft/s, 4.38 m/s

TEST DATE: 09/23/2020
TEST #: D202406

PROBE (G's) vs TIME (ms)



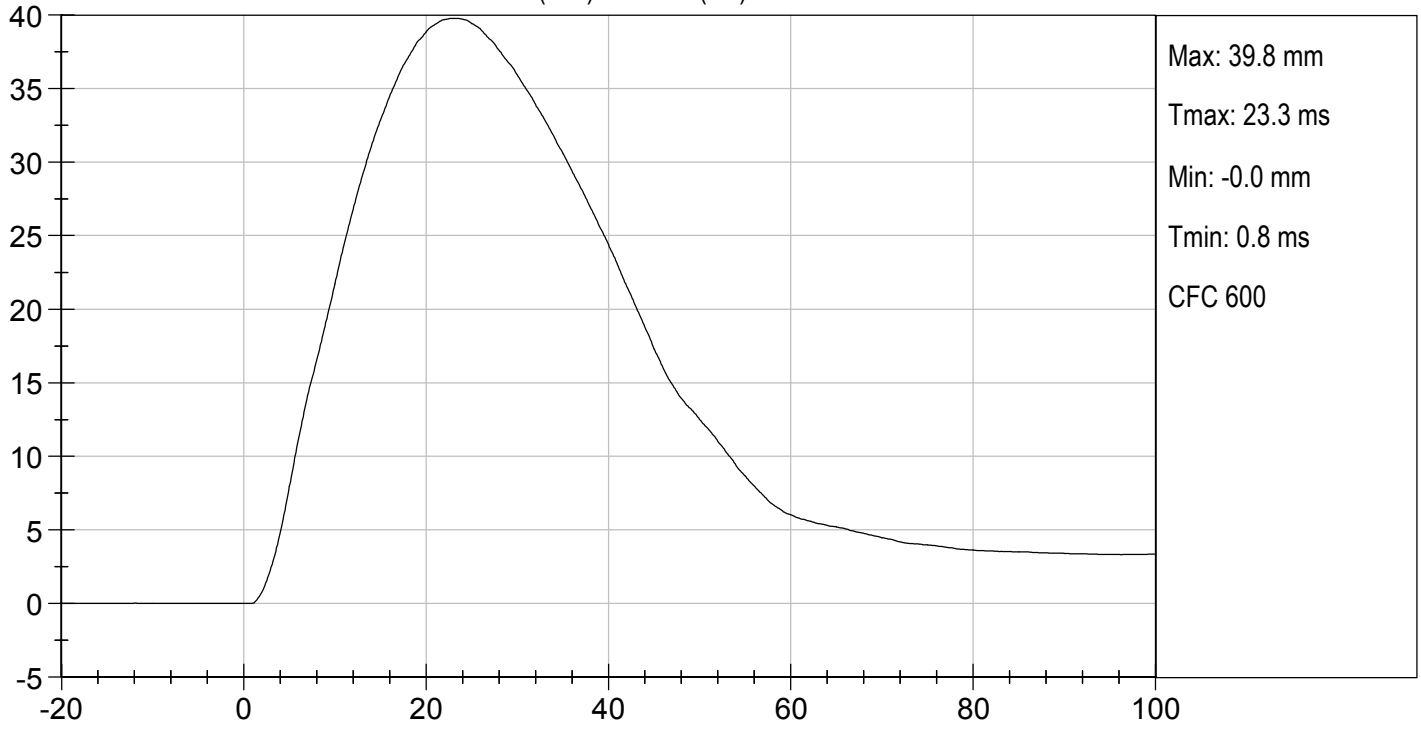
UPPER ABDOMEN RIB DISPLACEMENT (mm) vs TIME (ms)



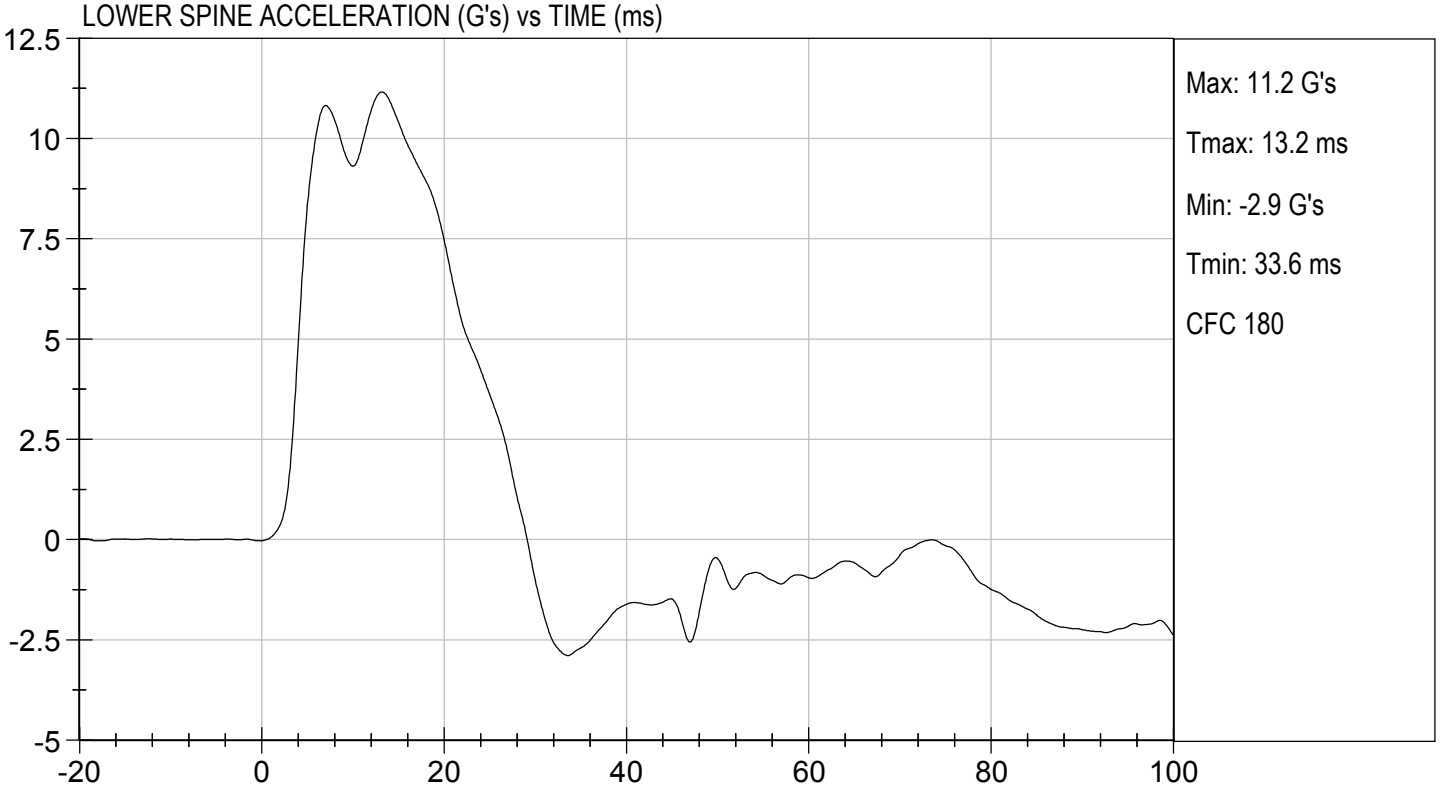
TEST DESC: ABDOMEN IMPACT
VELOCITY: 14.37 ft/s, 4.38 m/s

TEST DATE: 09/23/2020
TEST #: D202406

LOWER ABDOMEN RIB DISPLACEMENT (mm) vs TIME (ms)



LOWER SPINE ACCELERATION (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

PELVIS IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D202407

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	38	Pass
Impact Velocity	m/s	6.60 to 6.80	6.60	Pass
Maximum Probe Acceleration	G's	38 to 47	43	Pass
Pelvis Y Acceleration After 6 ms	G's	34 to 42	39	Pass
Peak Acetabulum Force	N	3600 to 4300	3,760	Pass
		Overall Test Results		Pass

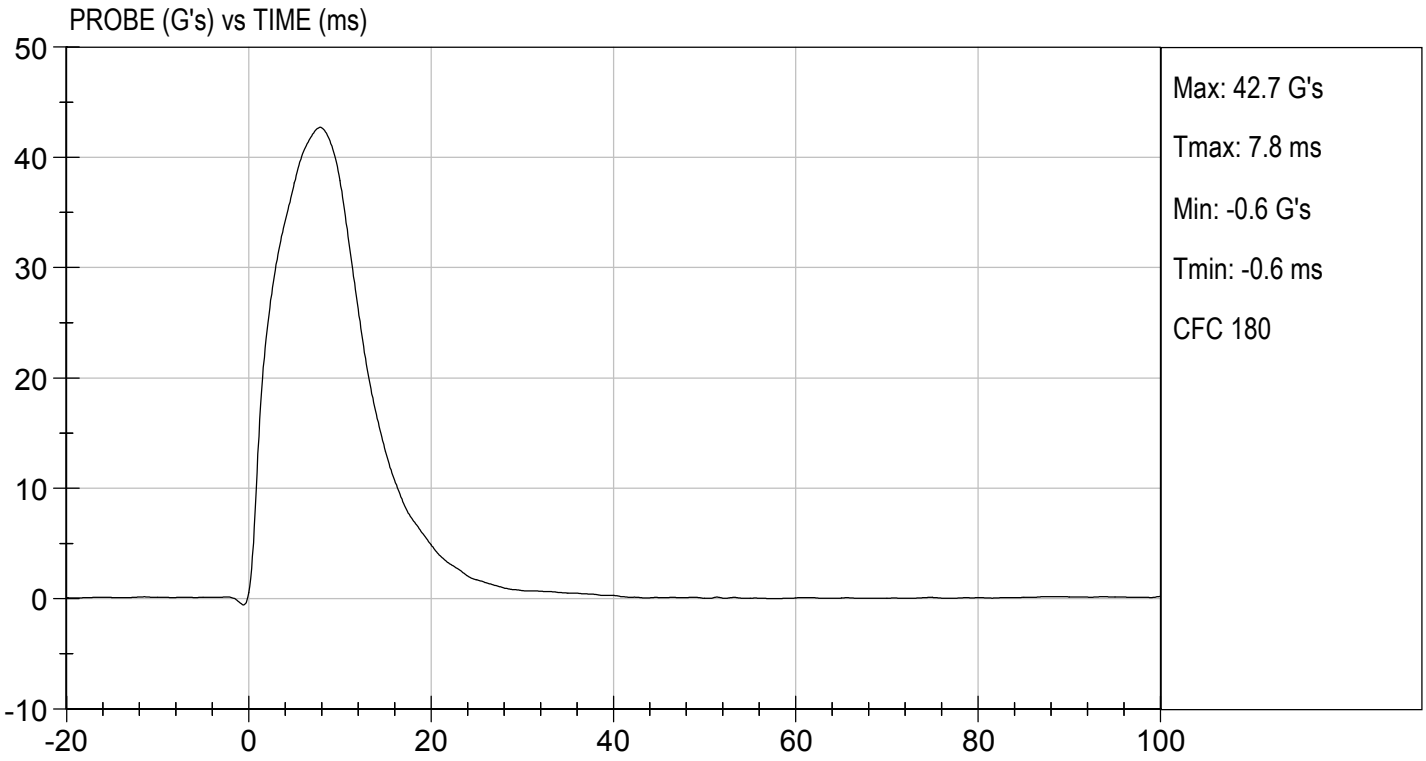
Alex Thomas
Laboratory Technician

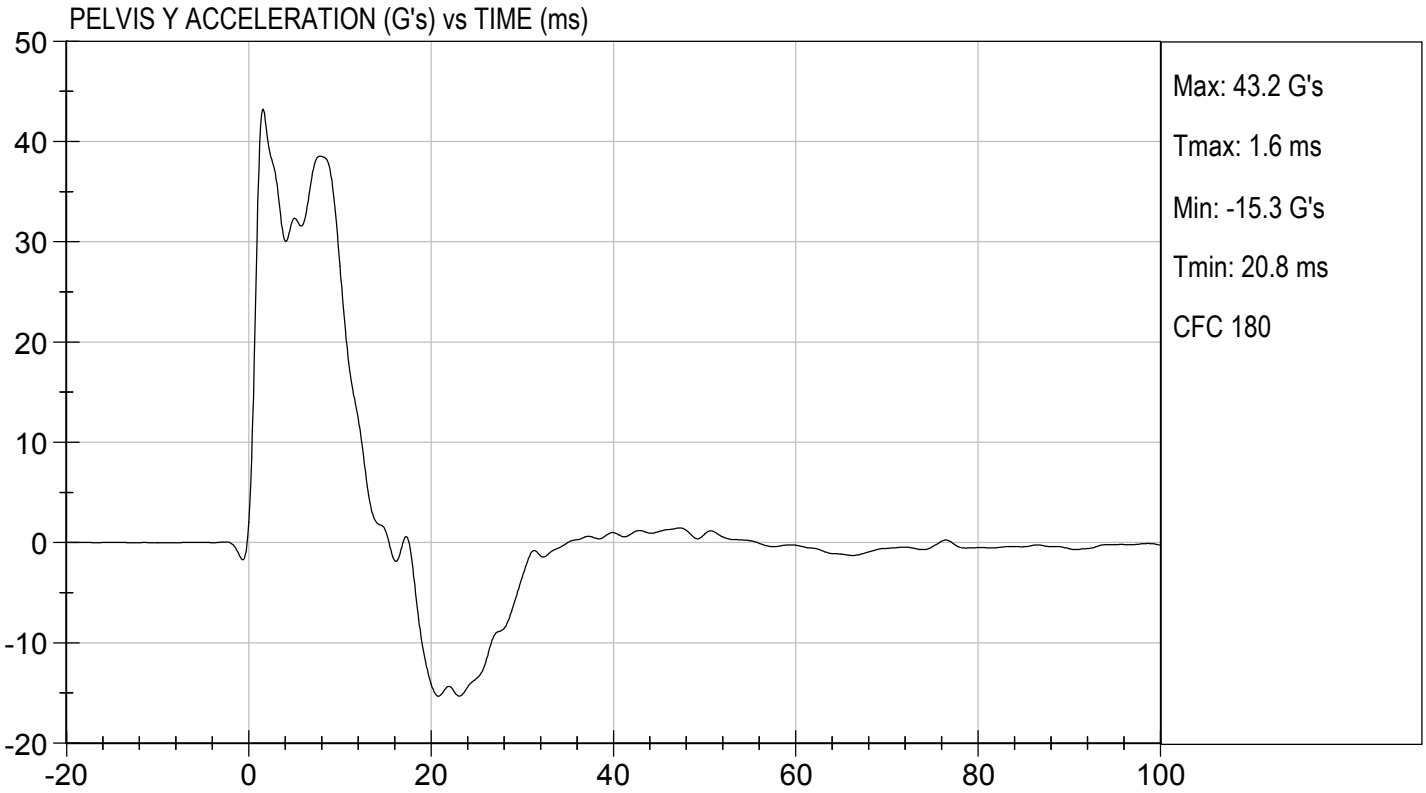
09/23/2020
Test Date

Approved By

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

TEST DATE: 09/23/2020
TEST #: D202407

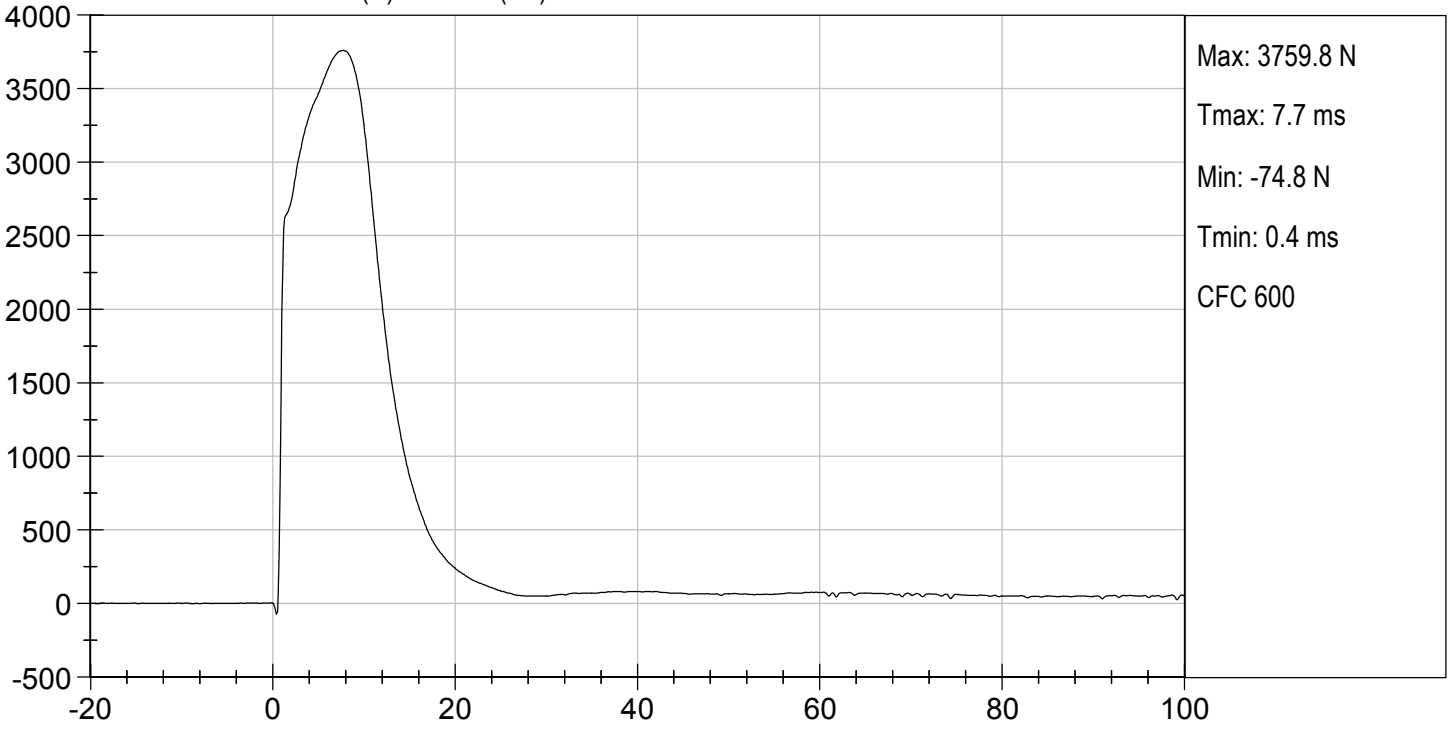




TEST DESC: PELVIS IMPACT
VELOCITY: 21.65 ft/s, 6.60 m/s

TEST DATE: 09/23/2020
TEST #: D202407

ACETABULUM FORCE (N) vs TIME (ms)



MGA RESEARCH CORPORATION

ILIAC IMPACT TEST

SID-IIs BUILD LEVEL D DUMMY

ATD Serial No: 304 **Test I.D:** D202408

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	38	Pass
Impact Velocity	m/s	4.20 to 4.40	4.20	Pass
Maximum Probe Acceleration	G's	36 to 45	40	Pass
Pelvis Y Acceleration	G's	28 to 39	31	Pass
Peak Pelvis Iliac Force	N	4100 to 5100	4,653	Pass
		Overall Test Results		Pass

Laboratory Technician

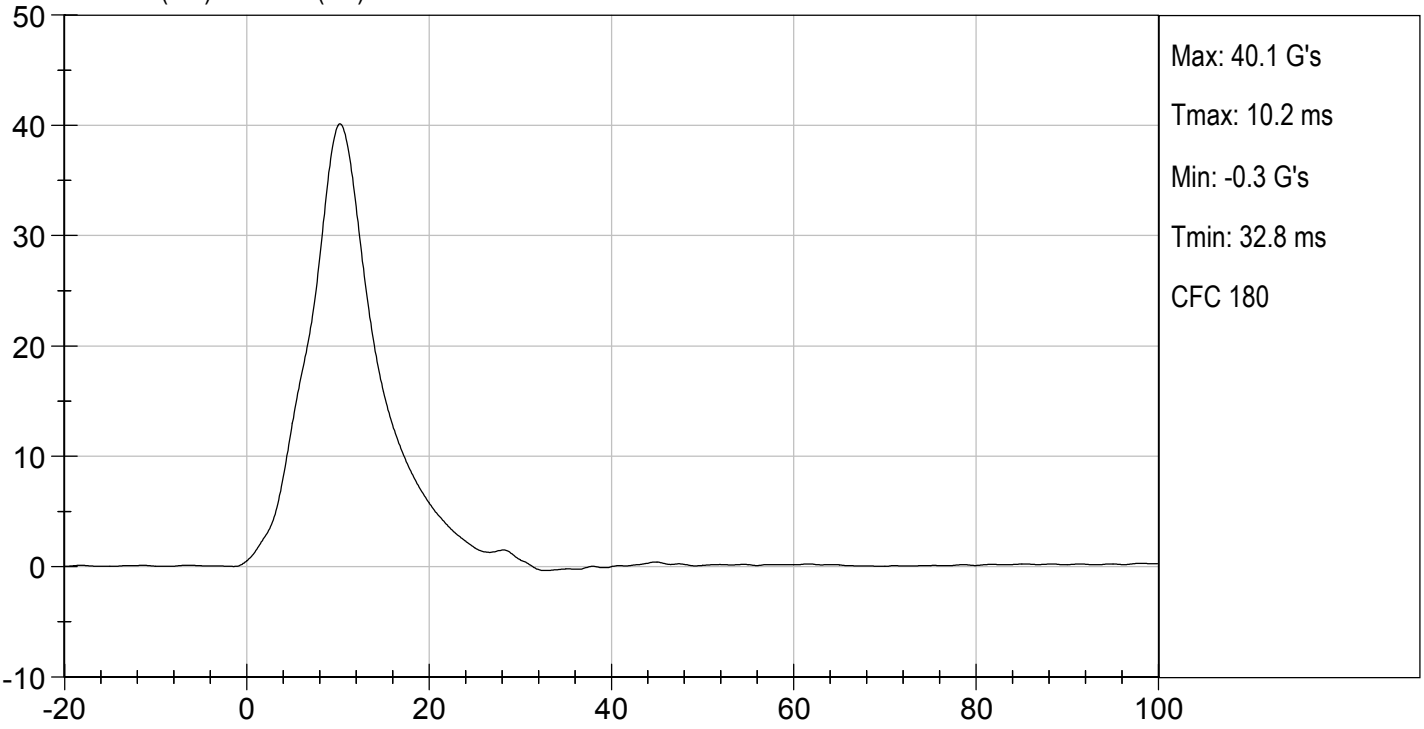
09/23/2020
Test Date

Approved By

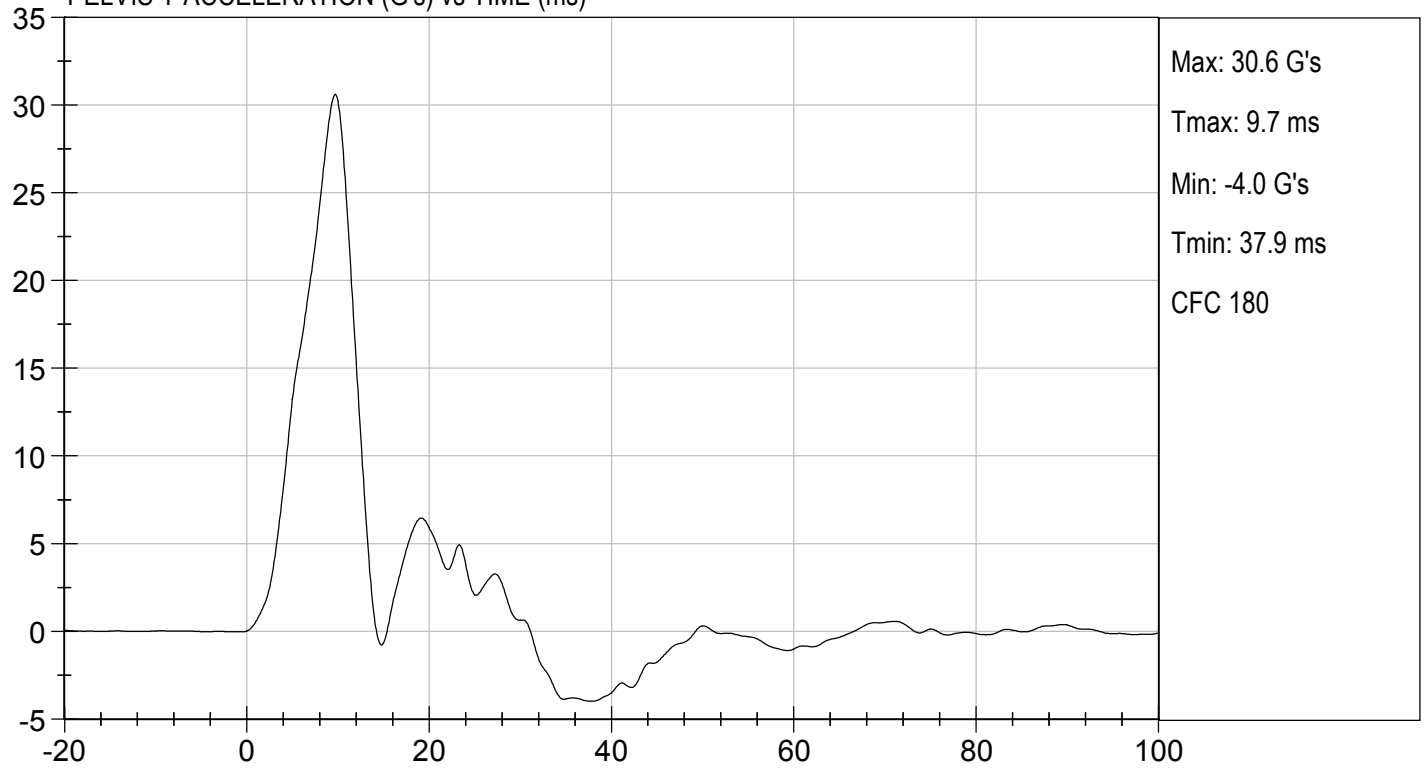
TEST DESC: ILLIAC
VELOCITY: 13.77 ft/s, 4.20 m/s

TEST DATE: 09/23/2020
TEST #: D202408

PROBE (G's) vs TIME (ms)

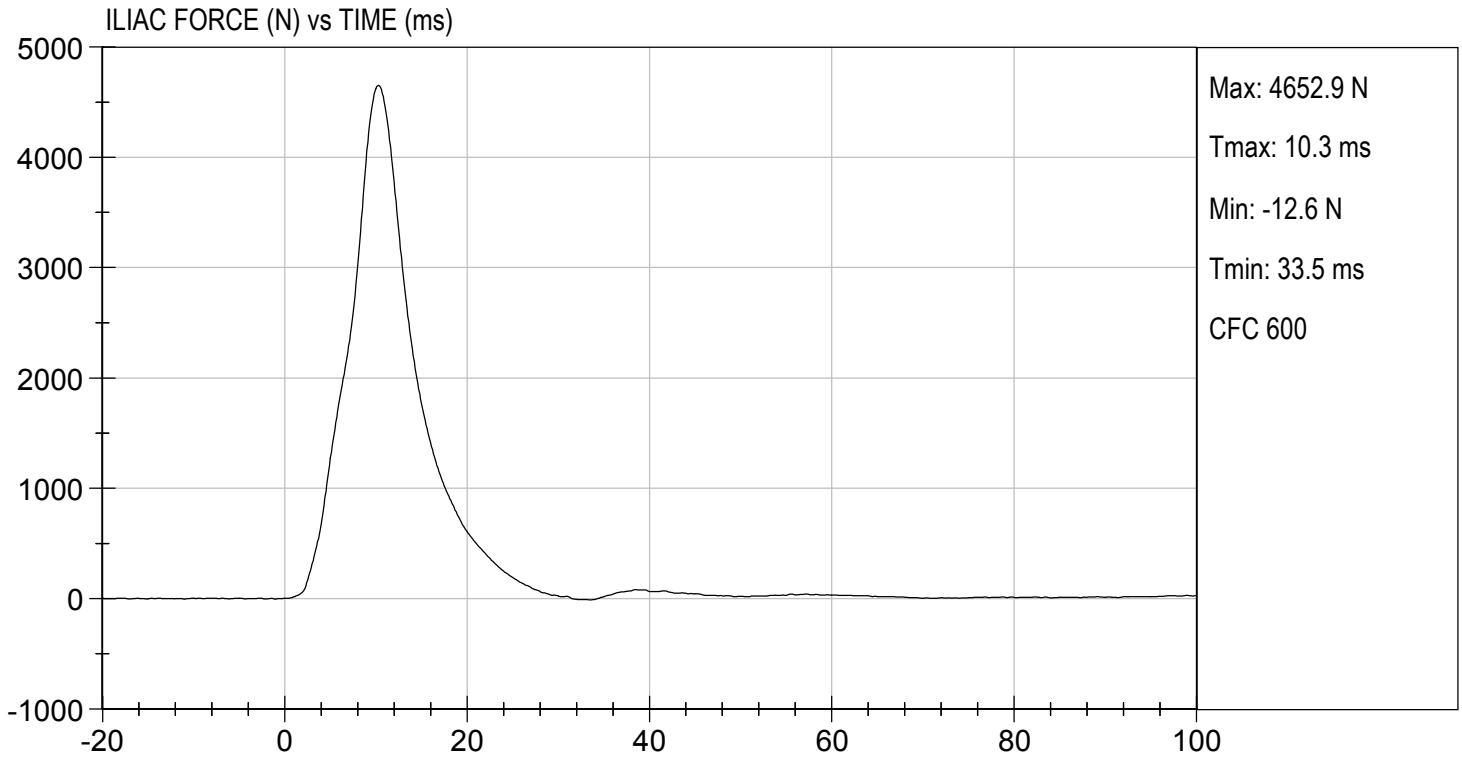


PELVIS Y ACCELERATION (G's) vs TIME (ms)



TEST DESC: ILLIAC
VELOCITY: 13.77 ft/s, 4.20 m/s

TEST DATE: 09/23/2020
TEST #: D202408



APPENDIX D
TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION DATA

Table 1 – Dummy Instrumentation

		SID-IIs S/N 304		
		Serial Number	Manufacturer	Calibration Date
Head CG Accelerometers	X	P83047	Endevco	07/27/2020
	Y	P83048	Endevco	07/27/2020
	Z	P83049	Endevco	07/27/2020
Upper Neck Load Cell		NG1911	Denton	07/20/2020
Lower Neck Load Cell		LNGDJ2031	Denton	02/19/2020