REPORT NUMBER: TWG-CAL-19-03

NEW CAR ASSESSMENT PROGRAM (NCAP)
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING

Toyota Motor Manufacturing Canada INC.
2019 Toyota RAV-4

NHTSA NUMBER: M20195103TWG2
CALSPAN TEST NUMBER: CT2019-03

PREPARED BY:
CALSPAN CORPORATION
4455 Genesee St.
BUFFALO, NEW YORK 14225

June 24, 2020

DRAFT REPORT

Alpha Technology Associate, Inc.
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Approved By: Vanessa Hansen, Program Manager

Approval Date: June 24, 2020

FINAL REPORT ACCEPTANCE BY:

Accepted By: _____

Acceptance Date: _____

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15. Supplementary Notes

16. Abstract

This side airbag Out-Of-Position test was performed in conjunction with a New Car Assessment Program (NCAP) on a 2019 Toyota RAV-4. This test was conducted at the Calspan Test Facility in Buffalo, New York, on July 30, 2019.

Injury Summary

HIC15	Peak Tension (CFC1000)	Peak Compression (CFC1000)	NIJ(NTF)	NIJ(NTE)	NIJ(NCF)	NIJ(NCE)
39.96	470.374	-1704.624	0.148	0.255	0.502	0.192

17. Key Words New Car Assessment Program (NCAP) Side Airbag Out-Of-Position	18. Distribution Statement Copies of this report are available from: Alpha Technology Associate, Inc. 2810 Old Lee Hwy, Suite 120 Fairfax, VA 22031 Phone: (703) 876-0010 Fax: (703) 876-0120

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SECTION 1

PURPOSE AND SUMMARY OF TEST:

1.1 PURPOSE

The purpose of this test was to obtain data from a static out-of-position side air bag deployment using a vehicle that had previously undergone a New Car Assessment Program (NCAP) sponsored side moving deformable barrier impact test requested by the National Highway Traffic Safety Administration (NHTSA). This test was performed under NHTSA contract No. DTNH22-13-D-00311L and through Alpha Technology Associate, Inc.

1.2 SUMMARY

The effects of both a seat-mounted side airbag and a curtain airbag deployment in a 2019 Toyota RAV-4 on an out-of-position SID-IIs ATD were evaluated. The test was performed by Calspan on July 30, 2019. Pre-and post-test photographs of the vehicle and ATD can be found in Appendix A.

Three high-speed digital cameras were used to document the side airbag deployment event. Images were recorded at rates of 1000 frames per second. The cameras were placed perpendicular to the right-front passenger seat centerline, Oblique, and through the passenger window to capture the deployment event from various positions.

The SID-IIs anthropomorphic test device (ATD) was placed in the right front (passenger) seat facing toward the center of the vehicle with its arm against the seatback according to the ATD placement instructions specified by Alpha Technology Associate, Inc. who referenced 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). 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.

The SID-IIs ATD was instrumented with head x, y and z accelerometers. In addition, a six axis upper and lower neck load cell sensor was utilized to record the resulting neck forces and moments during the event.

Eighteen channels of data were recorded using an on-board data acquisition system. Appendix A contains photographs. Appendix B contains ATD response data traces. Appendix C contains the Instrumentation Data Channel assignments.

SECTION 2

DATA SHEET NO. 1
TEST SUMMARY

TEST CONFIGURATION INFORMATION:

Seating Position:	P2	Right Front Seating Position
Test:	3.3.5.3	Roof Rail Mounted – Inboard facing SID IIs on Raised Seat
Airbag: 1	Curtain	Roof Rail Mounted – Passenger Side
Airbag: 2	Seat/Torso	Passenger Seat Mounted – Outside Seam
Booster Block:	N/A	N/A
ATD Type/Serial No.:	DG8012	SID IIs

Number of Data Channels:	18	
Number of Cameras:	0	Real Time
	3	High Speed Digital

PRE-TEST VISIBLE DUMMY CONTACT POINTS

Head Contact:	None
Upper Torso Contact:	Passenger Door, Passenger Seat Back
Lower Torso Contact:	Passenger Seat Back
Knee Contact:	None
Foot Contact:	Driver's Seat Pan

POST-TEST VISIBLE DUMMY CONTACT POINTS

Head Contact:	Window, Curtain Airbag
Upper Torso Contact:	Passenger Door, Passenger Seat Back
Lower Torso Contact:	Passenger Seat Back
Knee Contact:	None
Foot Contact:	Driver's Seat Pan

DATA SHEET NO. 2
VEHICLE PARAMETER DATA

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 2019 Toyota RAV-4 SUV

NHTSA No. : M20195103TWG2 ; VIN: 2T3H1RFV3KW005554 Color: Red

Engine Data: I4 cylinders; - CID; 2.5 Liters; - cc

Placement: - Longitudinal or In-Line; X Transverse or Lateral

Transmission Data: 8 speeds; - Manual; X Automatic; X Overdrive

Final Drive: - Rear Wheel Drive; X Front Wheel Drive; - Four Wheel Drive

Safety Belt Features – Driver X Pretensioner (Shoulder); X Load Limiter; X Adj. Anchorage

Safety Belt Features - Passenger X Pretensioner (Shoulder); X Load Limiter; X Adj. Anchorage

Major Options: X A/C; X Pwr. Steering.; X Pwr. Brakes

X Pwr. Windows; X Pwr. Door Locks; X Tilt Wheel

Date Received: 2/1/2019 ; Odometer Reading 174 Km

Selling Dealer: Jerry's Toyota

& Address: 8001 Belair Rd, Baltimore MD 21236

DATA FROM TIRE VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Toyota Motor Manufacturing Canada INC.

Date of Manufacture 01/19

GVWR: 2090 kg; GAWR: 1150 kg FRONT; 1150 kg REAR

DATA FROM TIRE PLACARD:

Recommended Tire Size: 255/65R17

*Recommended Cold Tire Pressure: 240 kPa Front 240 kPa Rear

DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: 255/65R17 ; Manufacturer: Dunlop

Tire Pressure with Maximum Capacity Vehicle Load: Front 350 kPa Rear: 350 kPa

Treadwear: 360 ; Traction: B : Temperature: A

VEHICLE CAPACITY DATA:

Type of Front Seats: - Bench; X Bucket; - Split Bench

Number of Occupants: 2 Front; 3 Rear; 5 Total

Vehicle Capacity Weight (VCW) = 410 Kg

No. of Occupants x 68.04 kg = 340.2 Kg

Rated Cargo/Luggage Weight (RCLW) = 69.3 Kg

*Tire pressure used for test

‡Vehicle had previously undergone a New Car Assessment Program Side MDB NCAP Test.

DATA SHEET NO. 3
SID-IIs Dummy POSITIONING IN VEHICLE

NHTSA No. M20195103TWG2

Measurement	Value
Total Fore/Aft Travel (mm)	240
Test Distance Rearward of Full-Forward (mm)	160
Total Fore/Aft Travel (Detents)	25 (0-24)
Placed in Position #	16

Seat Back Angle (headrest post)	SA (-21.6º)	Value
Airbag Module Width	AMW (mm)	-
Airbag Width	ABW (mm)	-
Airbag Module Length	AML (mm)	-
Airbag Length	ABL (mm)	-
Top of Airbag Module to Head/Neck Junction	AN (mm)	-
Head CG to Door Panel/Side Window	HD (mm)	159
Head to Seat Back Centerline	HSC (mm)	245
Head to B-Pillar (cg)	HB (mm)	125
Head to Roof, Z (top of the head)	HZ (mm)	75
Head to Header	HHD (mm)	345
Chest to Dash	CD (mm)	520
Chest to Seatback	CS (mm)	240
Right Arm to Seat Back Centerline	RACL (mm)	-
Right Arm to Seat Back Centerline	RACL (deg)	-
Left Arm to Door Panel	LA (mm)	70
Knee to Knee	KK (mm)	120
Toe to Toe	TT (mm)	125
Right Knee to Seat Cushion Centerline	KSCR (mm)	-
Left Knee to Seat Cushion Centerline	KSCL (mm)	-
Right Toe to Seat Cushion Centerline	TSCR (mm)	-
Left Toe to Seat Cushion Centerline	TSCL (mm)	-

DATA SHEET 4
SID-IIs Dummy INJURY CRITERIA VALUES

NHTSA No.: M20195103TWG2

Channel	Units	Max	Time (ms)	Min	Time (ms)
V1P2 Head x [CFC_1000]	g's	31.77	8.45	-4.52	77.00
V1P2 Head y [CFC_1000]	g's	14.67	17.00	-9.08	8.60
V1P2 Head z [CFC_1000]	g's	143.77	7.05	-17.90	11.40
V1P2 Headform Resultant [CFC_1000]	g's	143.81	7.05	0.02	-17.15
V1P2 Upper Neck Mocy [CFC_600]	Nm	16.12	64.40	-11.12	35.95
V1P2 Upper Neck Ntf [CFC_600]	-	0.15	47.45	0.00	-50.00
V1P2 Upper Neck Nte [CFC_600]	-	0.26	36.20	0.00	-49.60
V1P2 Upper Neck Ncf [CFC_600]	-	0.50	10.80	0.00	-50.00
V1P2 Upper Neck Nce [CFC_600]	-	0.19	15.25	0.00	-50.00
V1P2 Upper Neck Nij [CFC_600]	-	0.50	10.80	0.00	-37.60
V1P2 Upper Neck Fx [CFC_1000]	N	167.02	9.10	-249.16	37.25
V1P2 Upper neck Fy [CFC_1000]	N	214.19	17.90	-60.12	104.30
V1P2 Upper neck Fz [CFC_1000]	N	470.37	47.45	-1704.62	10.85
V1P2 Neck Force Resultant [CFC_1000]	N	1708.15	10.85	0.25	-34.40
V1P2 Upper Neck Mx [CFC_600]	Nm	19.18	24.45	-4.96	16.10
V1P2 Upper Neck My [CFC_600]	Nm	14.64	64.45	-15.33	35.95
V1P2 Upper Neck Mz [CFC_600]	Nm	7.16	25.75	-6.15	73.55
V1P2 Neck Moment Resultant [CFC_600]	Nm	20.63	24.50	0.00	-31.30
V1P2 Lower Neck Fx F [CFC_1000]	N	327.97	35.80	-256.52	16.90
V1P2 Lower Neck Fy F [CFC_1000]	N	388.68	30.90	-108.95	20.75
V1P2 Lower Neck Fz F [CFC_1000]	N	215.94	25.50	-1762.54	11.35
V1P2 Lower Neck Force Resultant [CFC_1000]	N	1772.52	11.35	0.43	-15.40
V1P2 Lower Neck Mx F [CFC_600]	Nm	45.77	31.00	-14.88	99.00
V1P2 Lower Neck My F [CFC_600]	Nm	78.93	11.40	-6.69	25.20
V1P2 Lower Neck Mz F [CFC_600]	Nm	13.35	31.05	-11.95	78.25
V1P2 Lower Neck Moment Resultant [CFC_600]	Nm	81.33	11.40	0.00	-13.90
Curtain Airbag Volts	V	15.75	0.30	-0.07	25.80
Torso/Pelvis Airbag Volts	V	16.71	0.30	-0.26	4.15
Front Center Airbag Volts	V	-	-	-	-
Curtain Airbag Current	A	8.60	11.00	-0.08	25.80
Torso/Pelvis Airbag Current	A	13.92	4.15	-1.07	11.00
Front Center Airbag Current	A	-	-	-	-

DATA SHEET 4

SID-IIs DUMMY INJURY CRITERIA VALUES (CONTINUED)

VEHICLE: 2019 Toyota RAV-4 NHTSA No.: M20195103TWG2

HEAD INJURY CRITERIA (HIC)

	HIC15			
	HIC(15)	t_1 (msec)	t_2 (msec)	Average Acceleration t_1 to t_2
Position P2	39.96	6.90	7.15	129.51

THORAX CRITERIA

	Critical Values	Actual	Time(ms)
Maximum Deflection (mm)	N/A	N/A	N/A
Maximum Deflection Rate (m/s)	N/A	N/A	N/A

Position P2 - Neck Injury Summary (SID-IIs – In Position)

Nij V10	Nij	Time (ms)	Z Force (N)	X Force (N)	Y Moment (N-m)
Ntf	0.148	47.450	470.374	-123.226	5.998
Nte	0.255	36.200	295.566	-240.446	-15.229
Ncf	0.502	10.800	-1700.233	87.865	11.482
Nce	0.192	15.250	-695.866	-54.900	-1.939

Peak Tension (CFC1000) 470.374 **N** **Peak Compression (CFC1000)** -1704.624 **N**

Critical Values

Nij Intercepts				Peak Limits	
Tension (CVt)	3880.00 N	Extension (mCVe)	61.00 N-m	Tension	2070.00 N
Compression (CVc)	3880.00 N	Flexion (mCVf)	155.00 N-m	Compression	2520.00 N

Appendix A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Figure A-1: Right ¾ Front View of Vehicle, As Received

Figure A-2: Vehicle Certification Placard

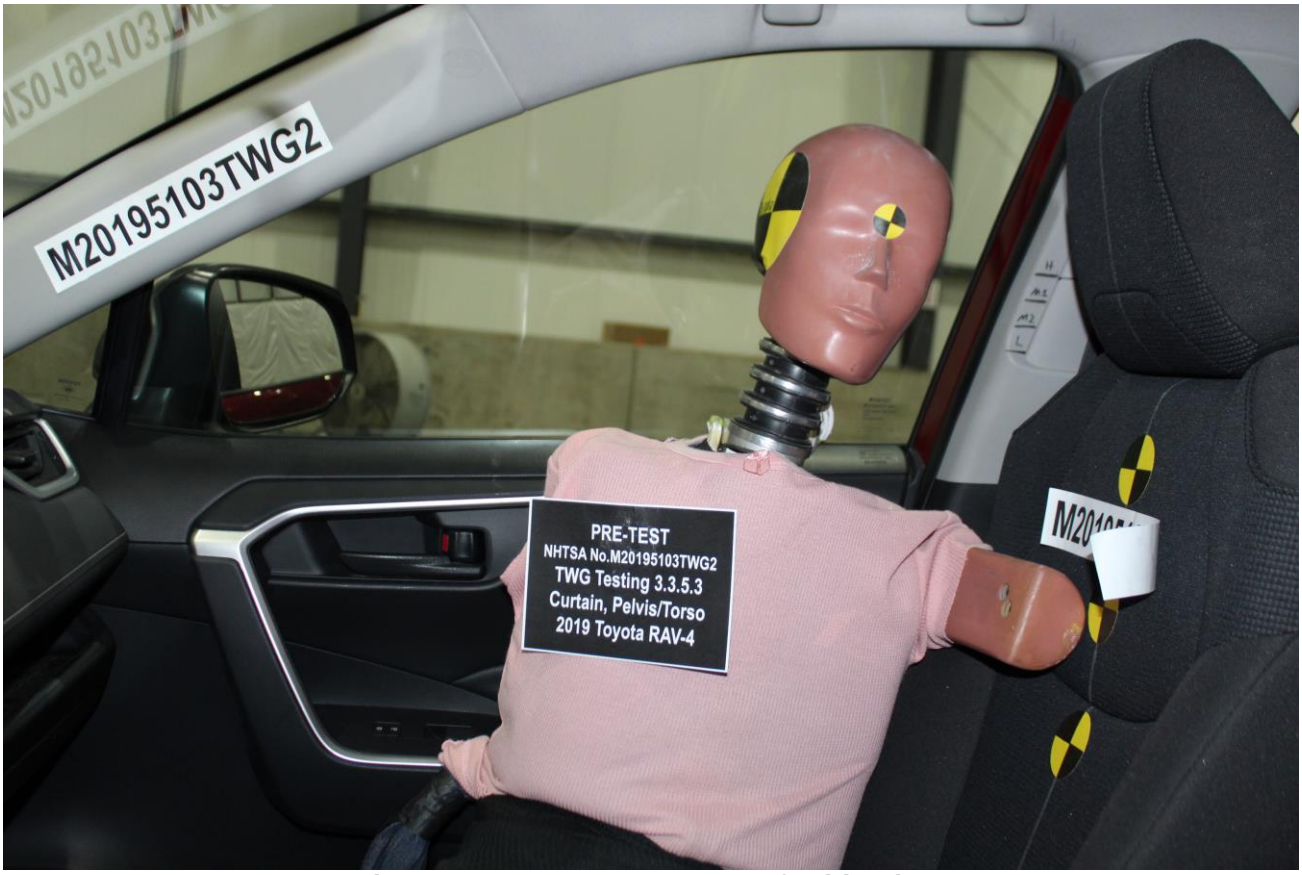


Figure A-3: Pre-Test SID-IIs Left Side View

Figure A-4: Post-Test SID-IIs Left Side View

Figure A-5: Pre-Test SID-IIs Left Side Close-up View

Figure A-6: Post-Test SID-IIs Left Side Close-up View

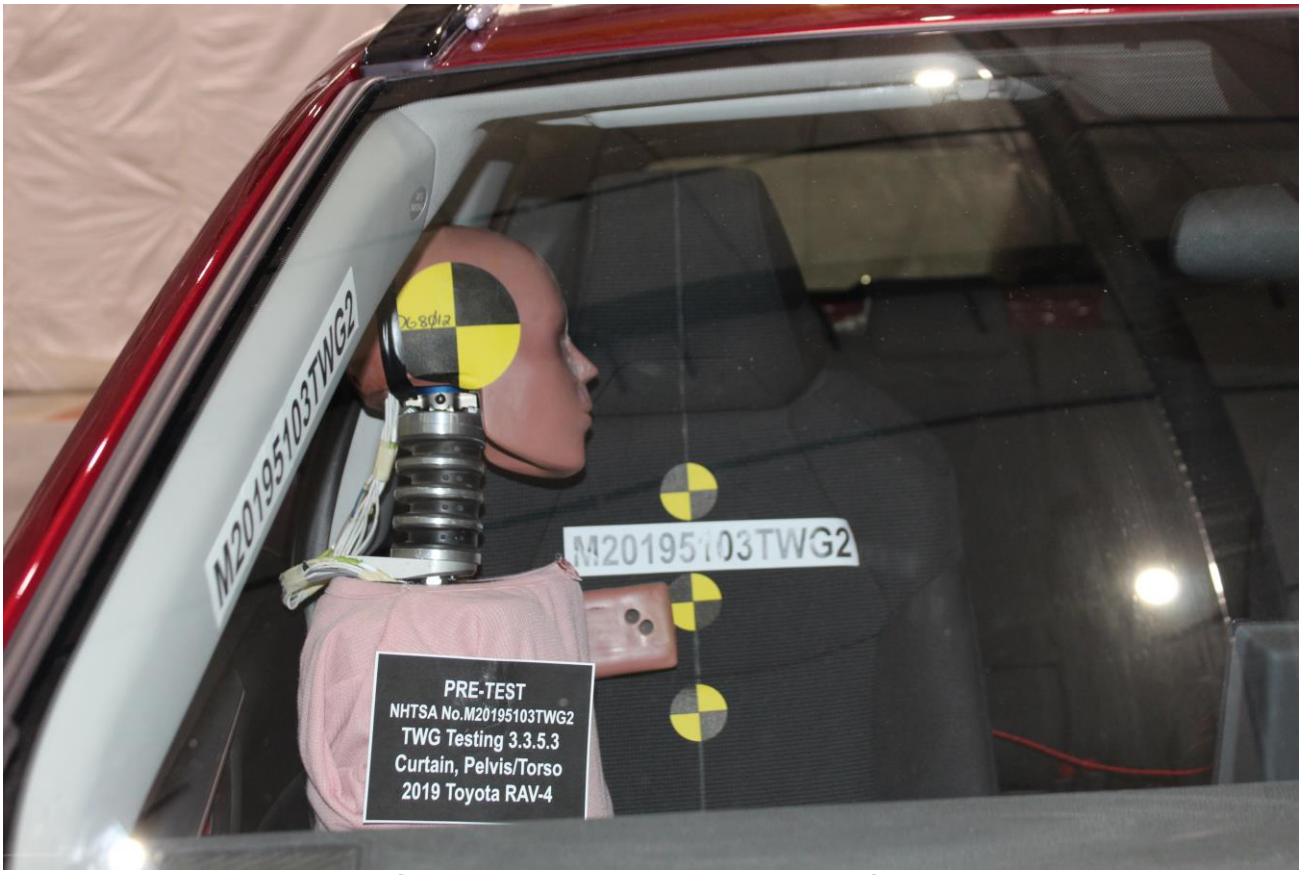


Figure A-7: Pre-Test SID-IIs Front View

Figure A-8: Post-Test SID-IIs Front View

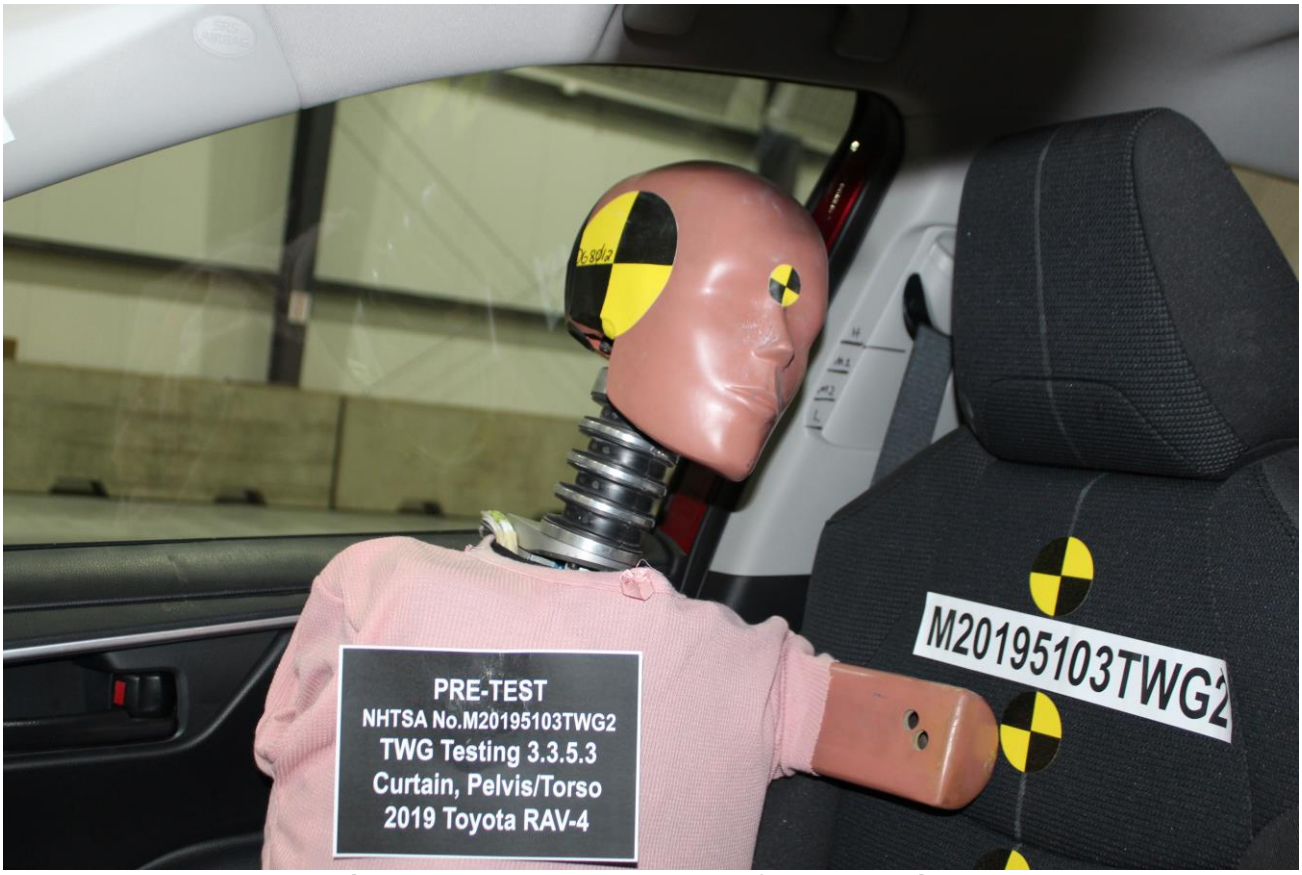


Figure A-9: Pre-Test SID-IIs Left ¾ Front View

Figure A-10: Post-Test SID-IIs Left ¾ Front View

Figure A-11: Pre-Test SID-IIs Right Side View

Figure A-12: Post-Test SID-IIs Right Side View

Figure A-13: Post-Test Curtain Airbag View

Figure A-14: Post-Test Seat Airbag View

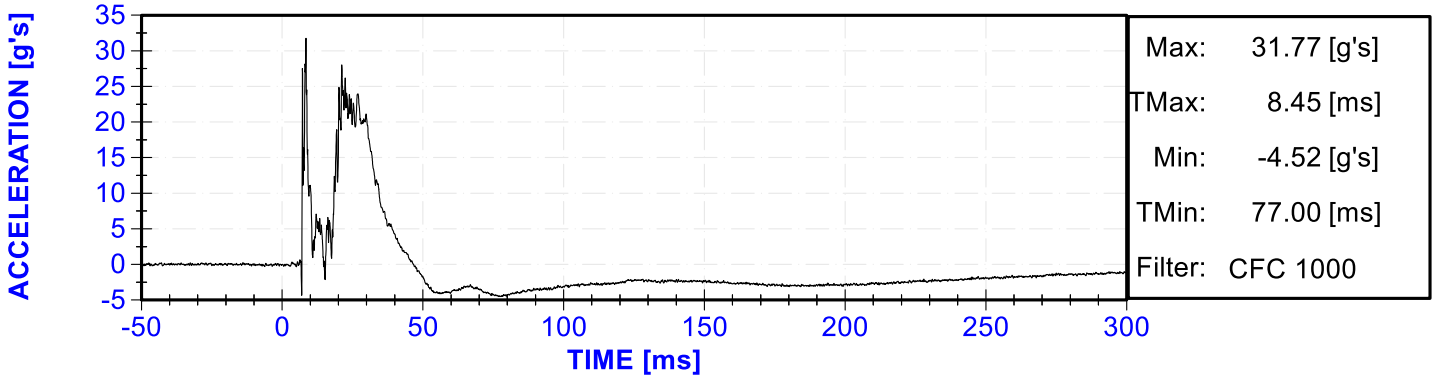
Figure A-15: Impact Event

APPENDIX B

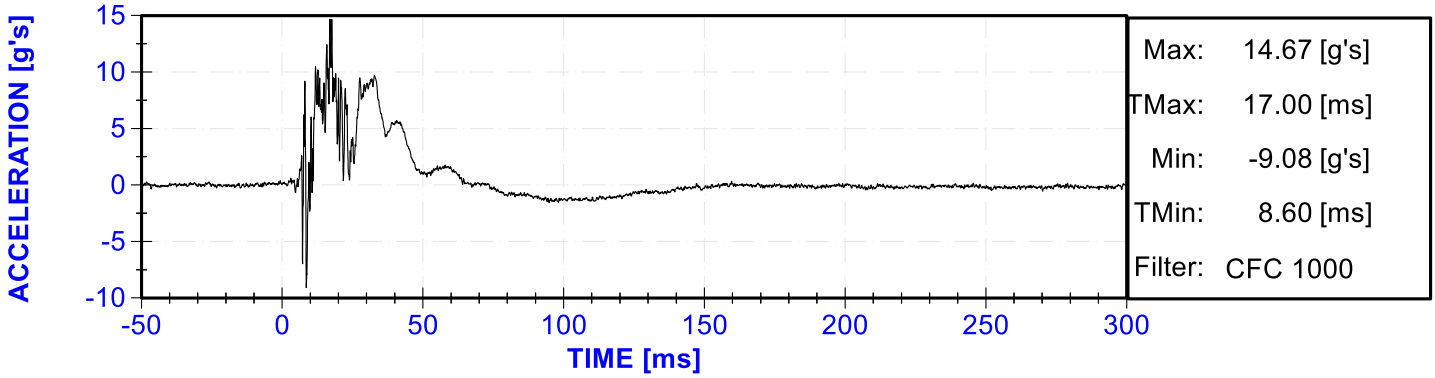
VEHICLE & DUMMY RESPONSE DATA TRACES

Table of Data Plots

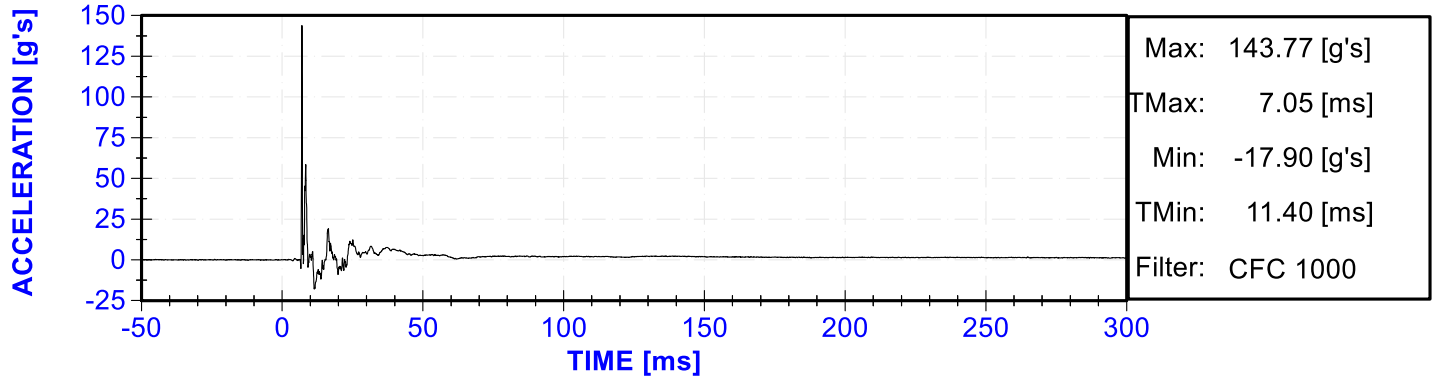
Head CG X Acceleration



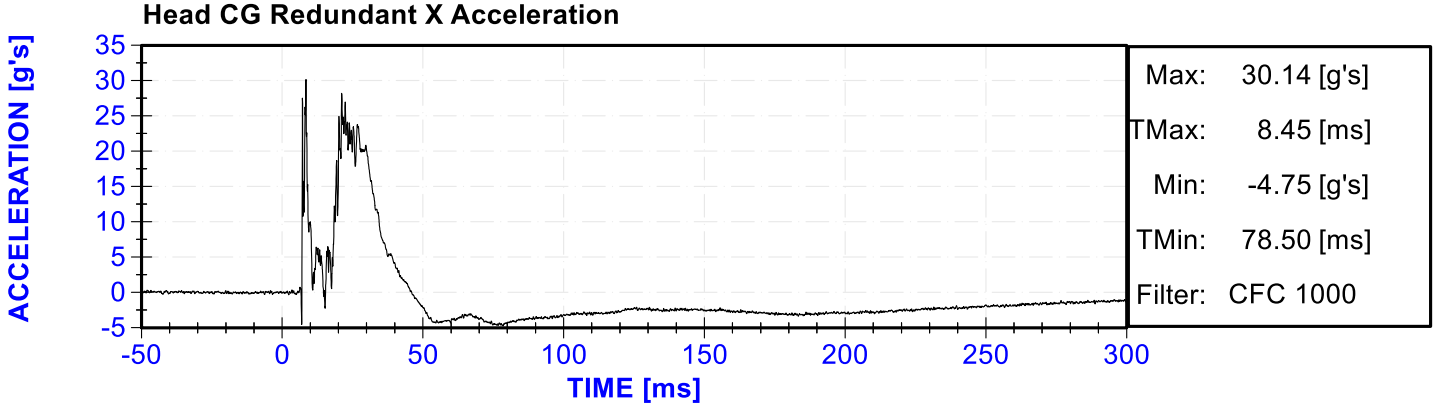
Head CG Y Acceleration

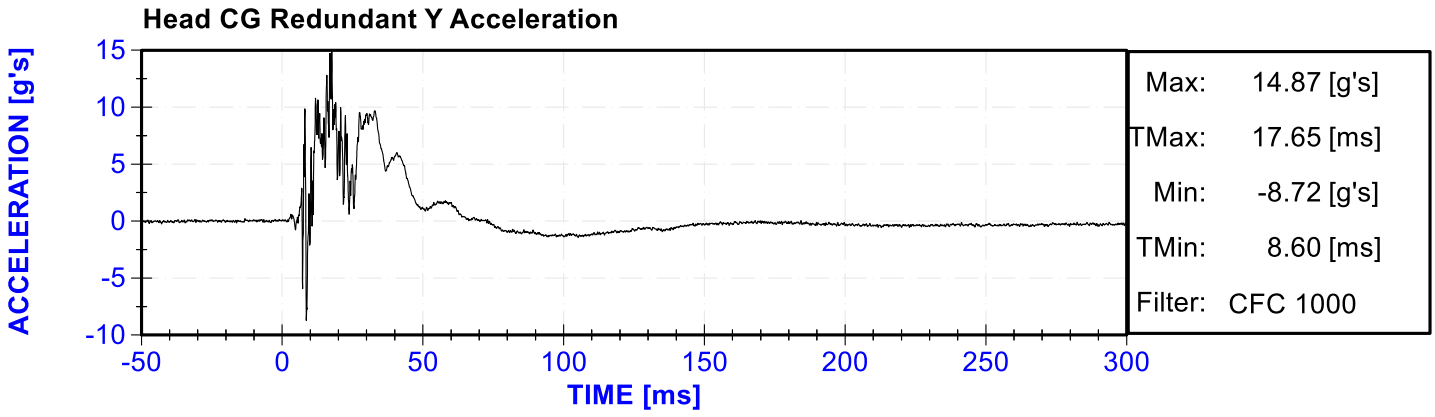


Head CG Z Acceleration



Head CG Redundant X Acceleration




Head CG Redundant Y Acceleration
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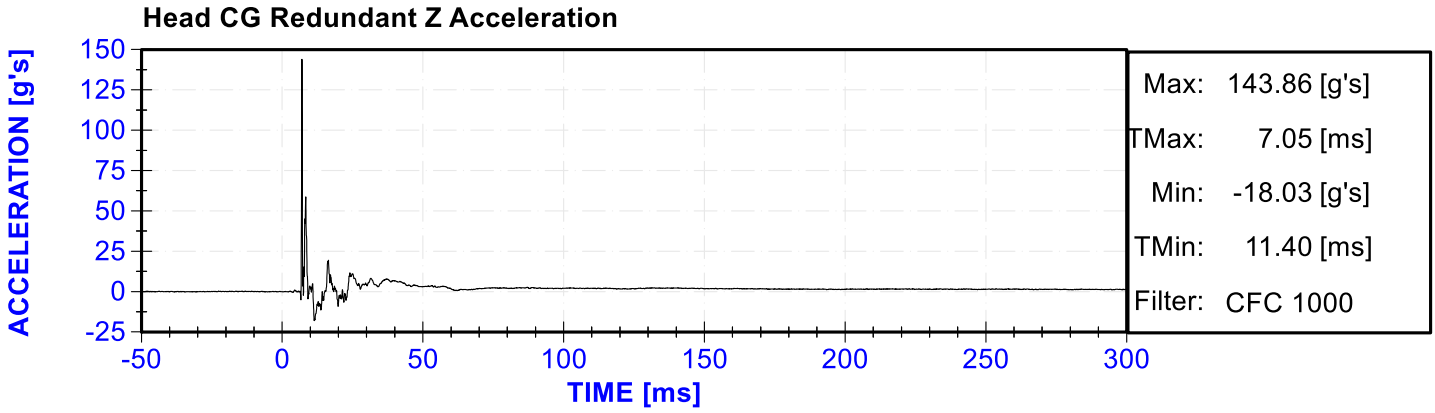
Min: -8.72 [g's]
TMin: 8.60 [ms]
Filter: CFC 1000


Head CG Redundant Z Acceleration
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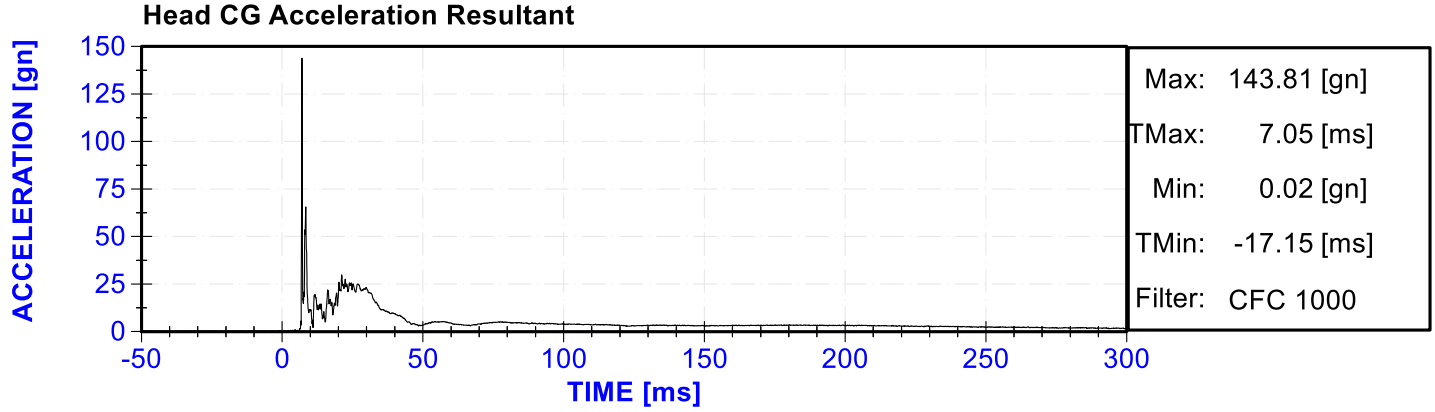
Filter: CFC 1000


Head CG Acceleration Resultant
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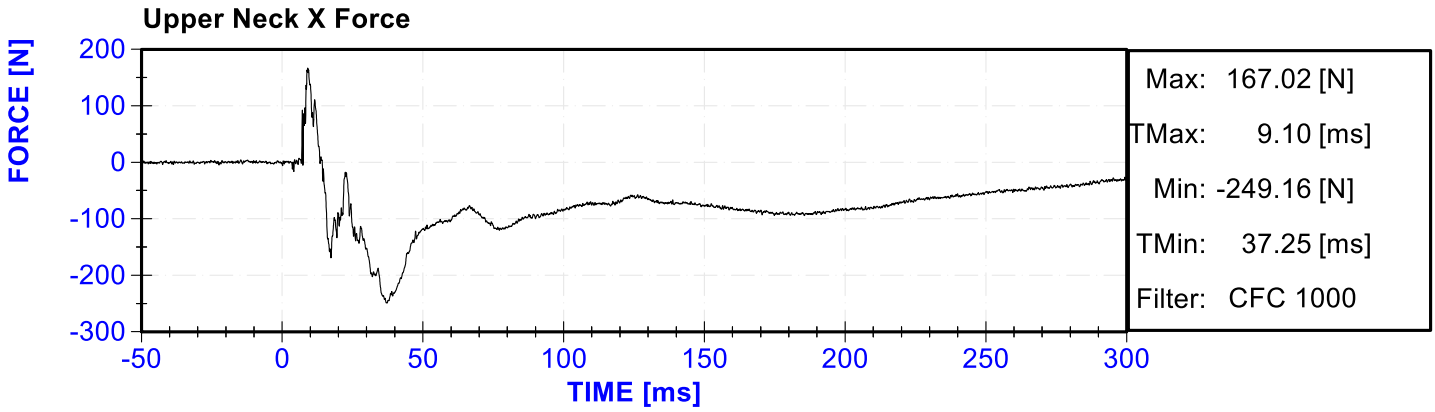
Upper Neck X Force
FORCE [N]
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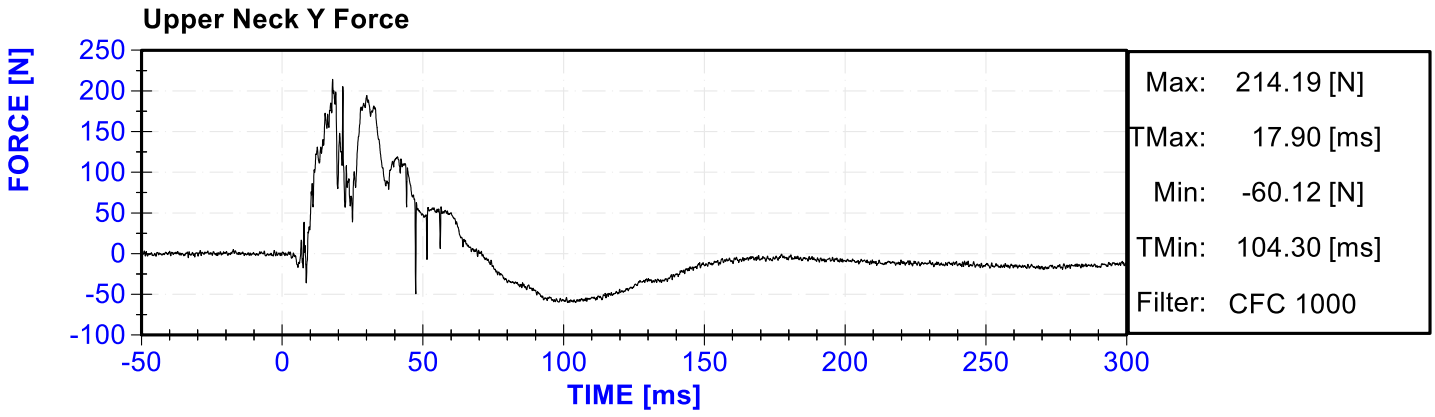
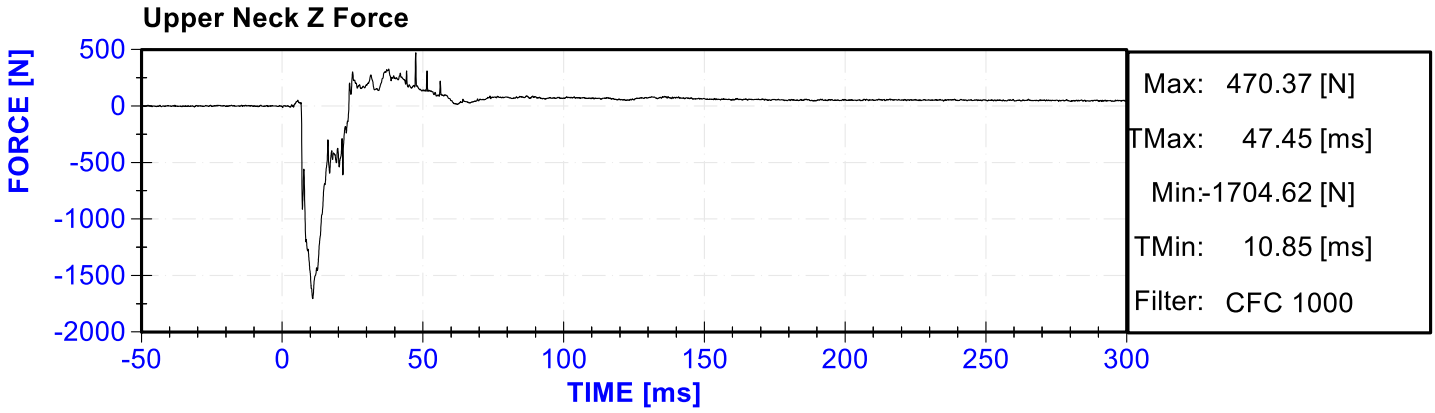

Upper Neck Y Force
FORCE [N]
250
200
150
100
50
0
-50
-100
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 214.19 [N]
TMax: 17.90 [ms]
Min: -60.12 [N]
TMin: 104.30 [ms]
Filter: CFC 1000


Upper Neck Z Force
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500
0
-500
-1000
-1500
-2000
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 470.37 [N]
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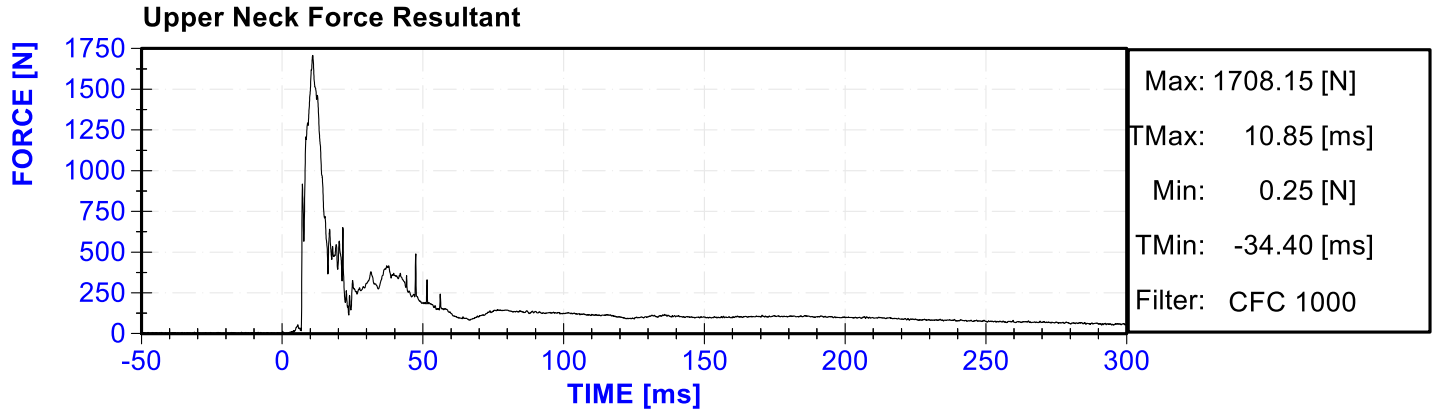
TMin: 10.85 [ms]
Filter: CFC 1000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1500
1250
1000
750
500
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0
-50
0
50
100
150
200
250
300
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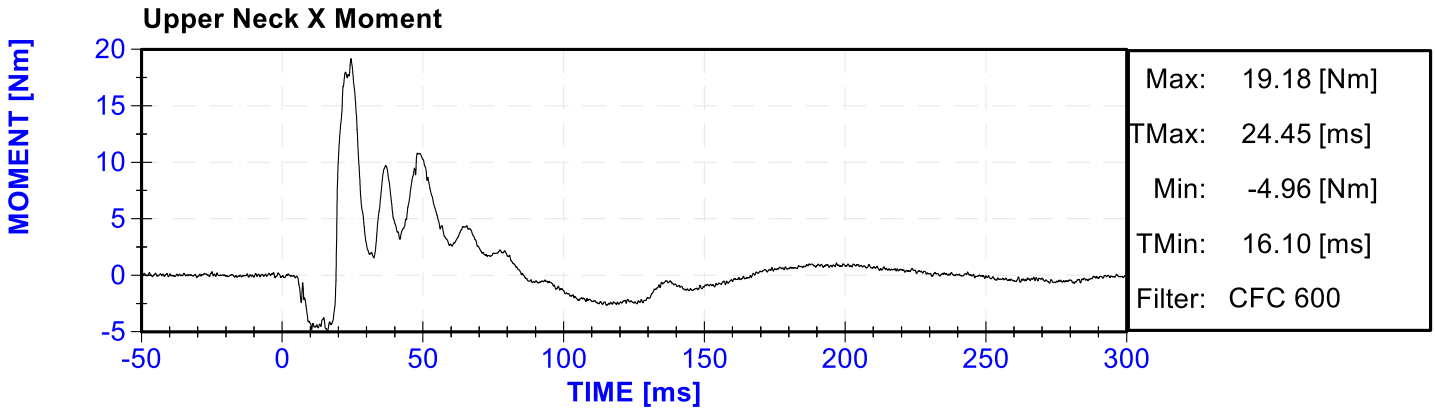
Filter: CFC 1000


Upper Neck X Moment
MOMENT [Nm]
20
15
10
5
0
-5
-50
0
50
100
150
200
250
300
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TMin: 16.10 [ms]
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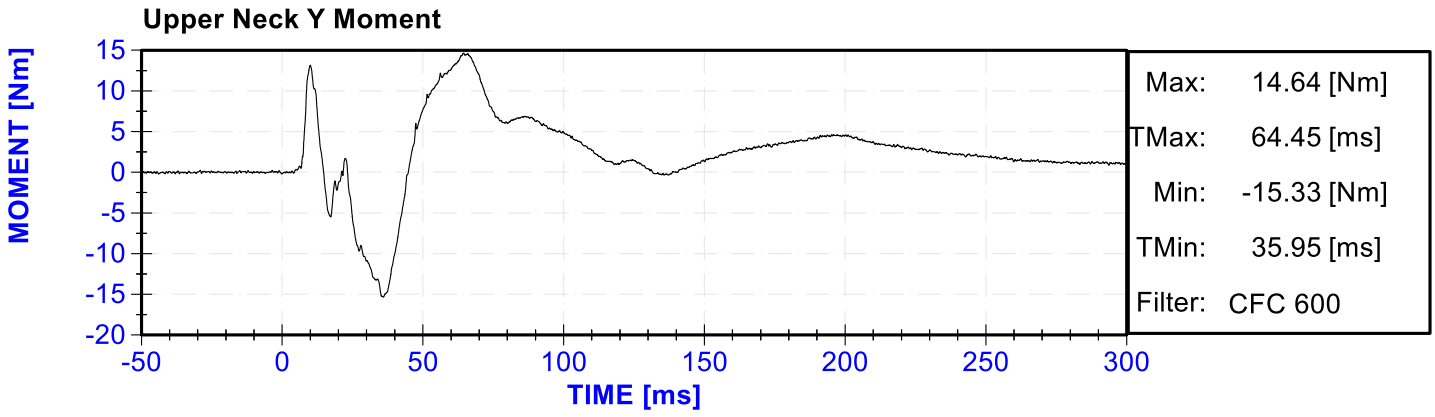
Upper Neck Y Moment
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5
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-5
-10
-15
-20
-50
0
50
100
150
200
250
300
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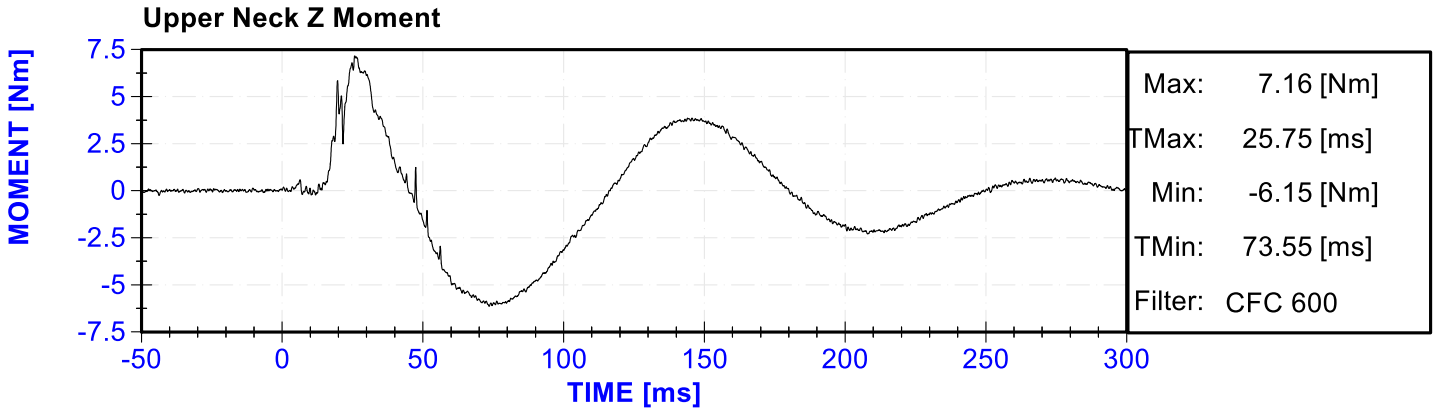
Min: -15.33 [Nm]
TMin: 35.95 [ms]
Filter: CFC 600


Upper Neck Z Moment
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5
2.5
0
-2.5
-5
-7.5
-50
0
50
100
150
200
250
300
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Min: -6.15 [Nm]
TMin: 73.55 [ms]
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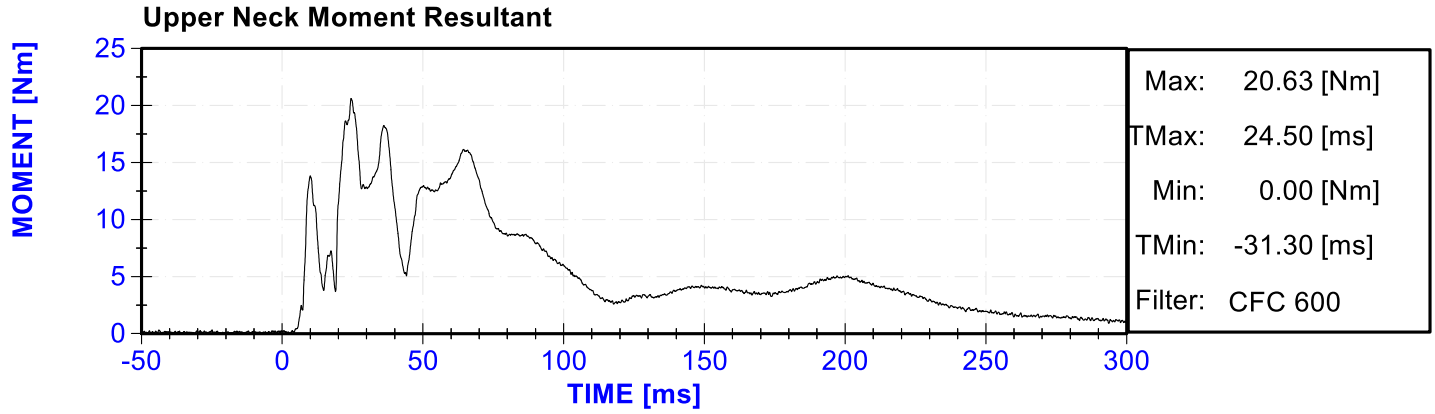
Upper Neck Moment Resultant
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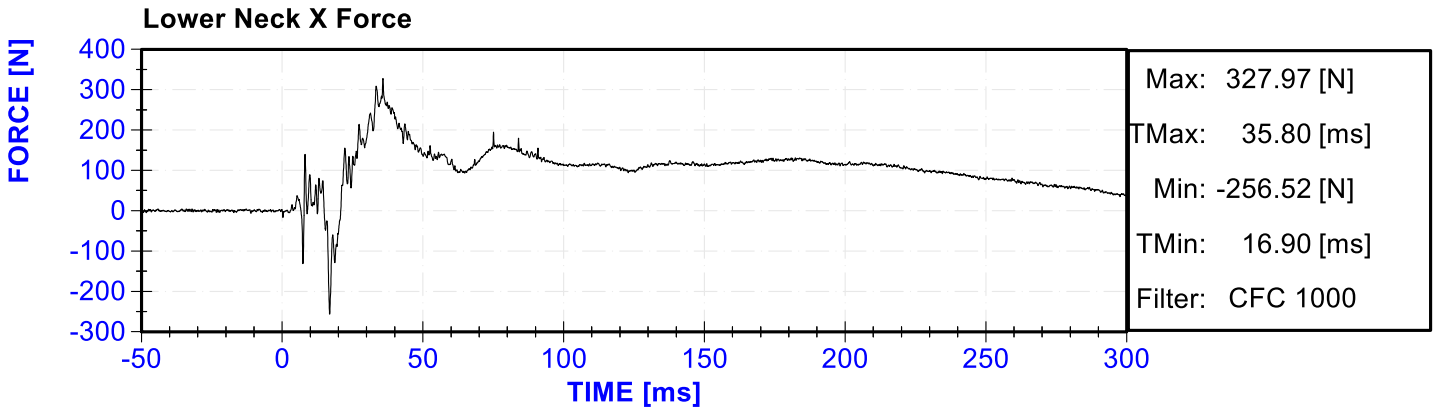
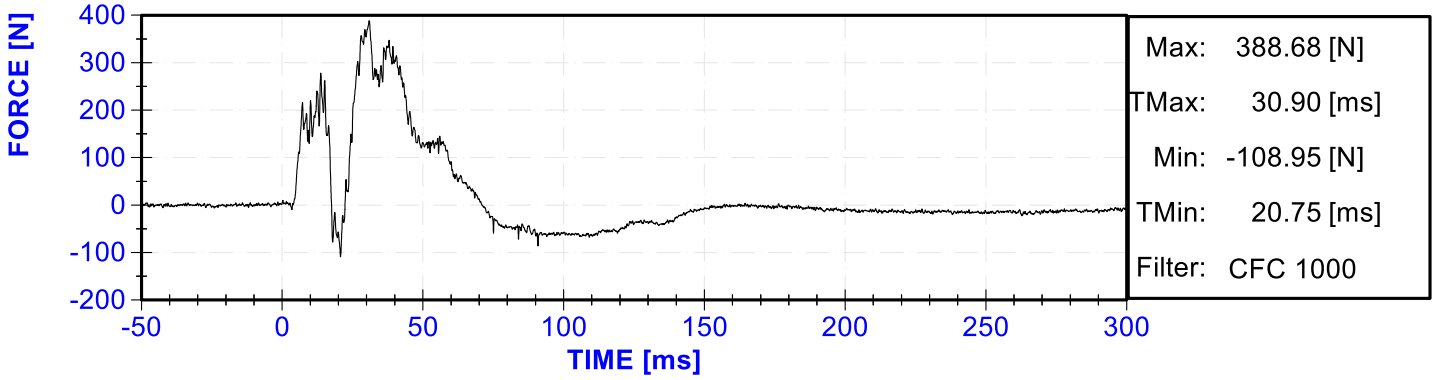
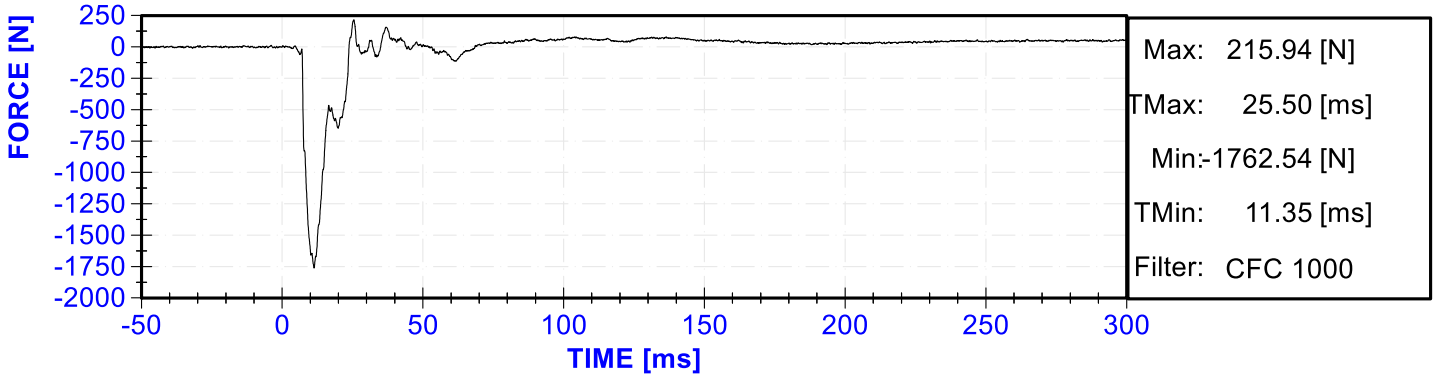
20
15
10
5
0
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 20.63 [Nm]
TMax: 24.50 [ms]
Min: 0.00 [Nm]
TMin: -31.30 [ms]
Filter: CFC 600


Lower Neck X Force
FORCE [N]
400
300
200
100
0
-100
-200
-300
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 327.97 [N]
TMax: 35.80 [ms]
Min: -256.52 [N]
TMin: 16.90 [ms]
Filter: CFC 1000

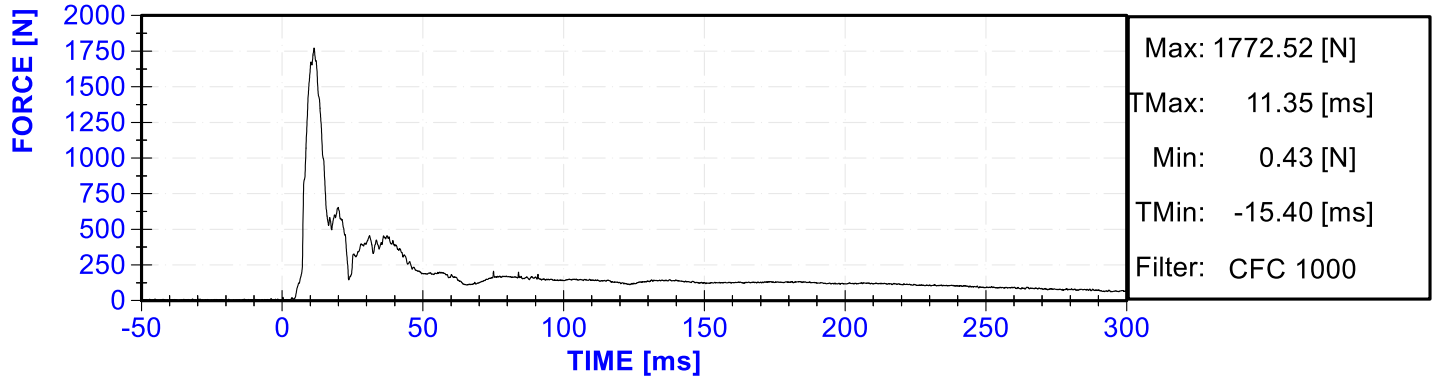
Lower Neck Y Force



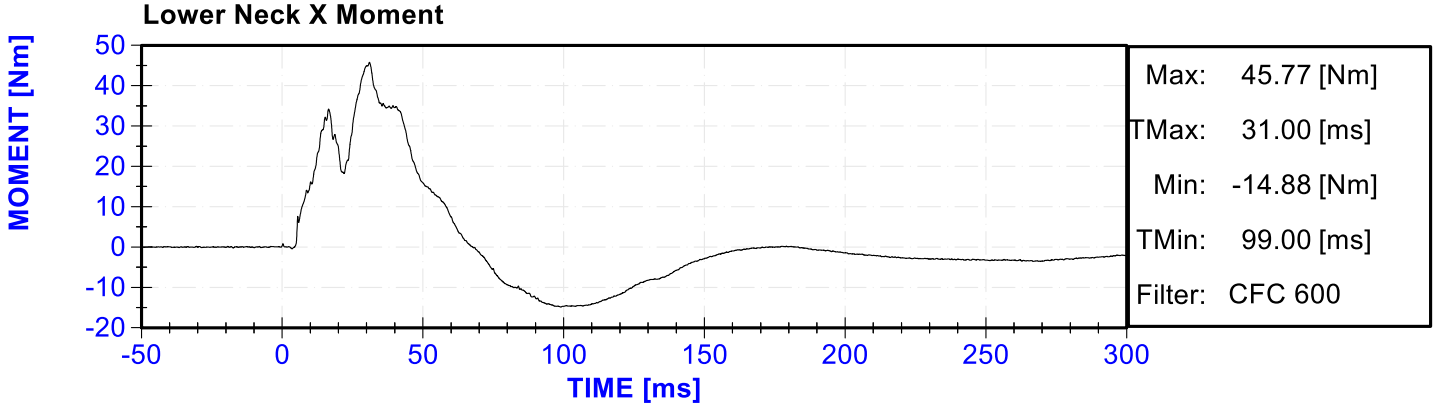
Lower Neck Z Force



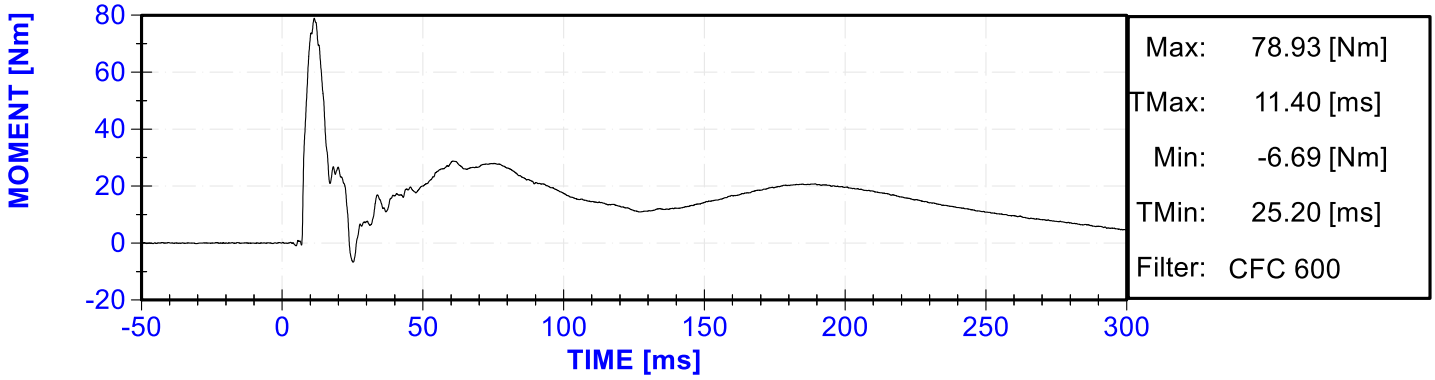
Lower Neck Force Resultant



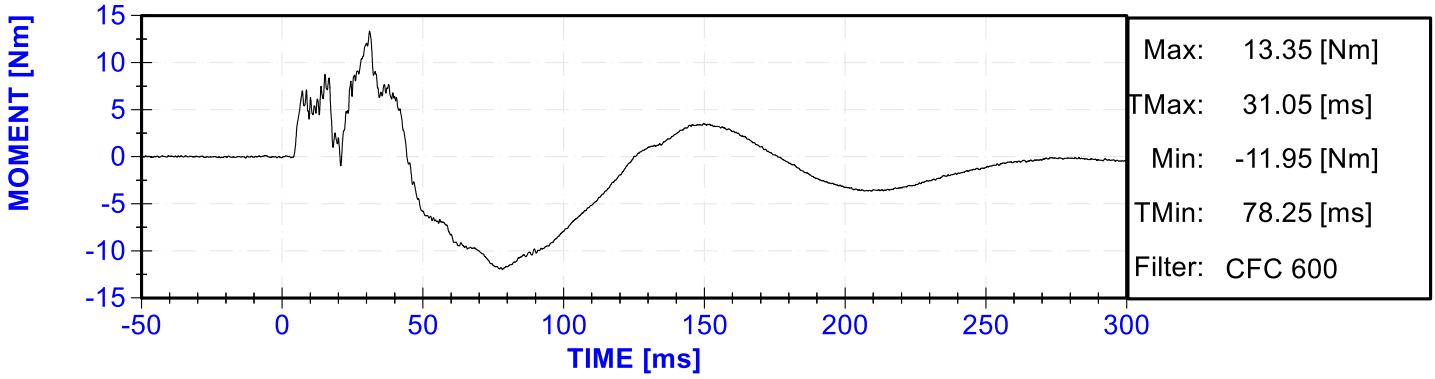
Lower Neck X Moment



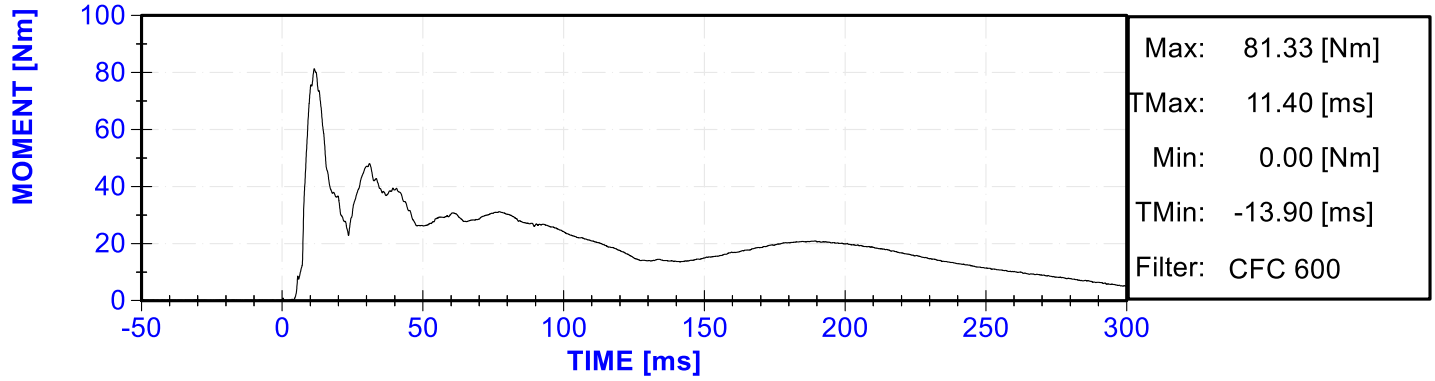
Lower Neck Y Moment



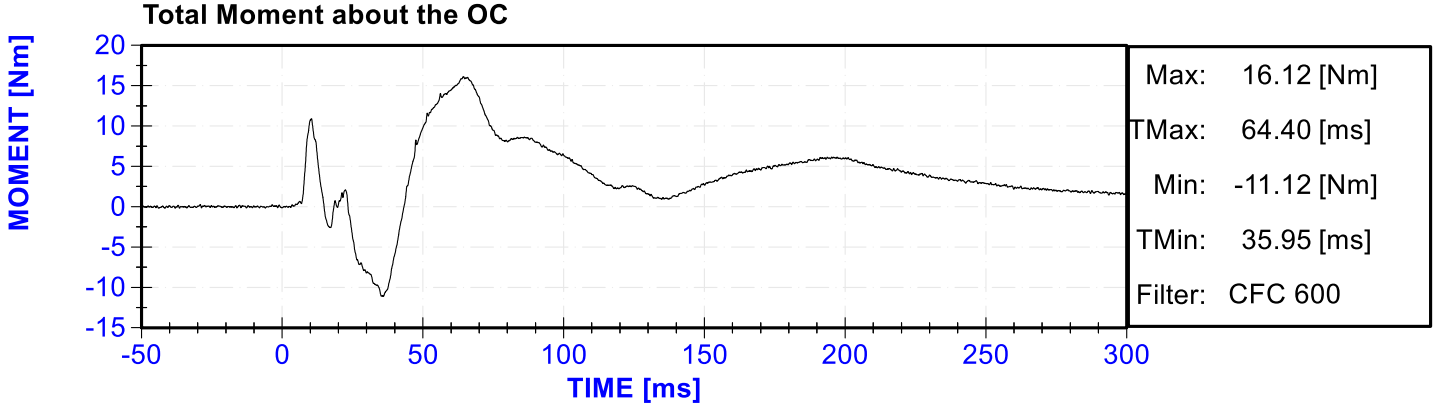
Lower Neck Z Moment



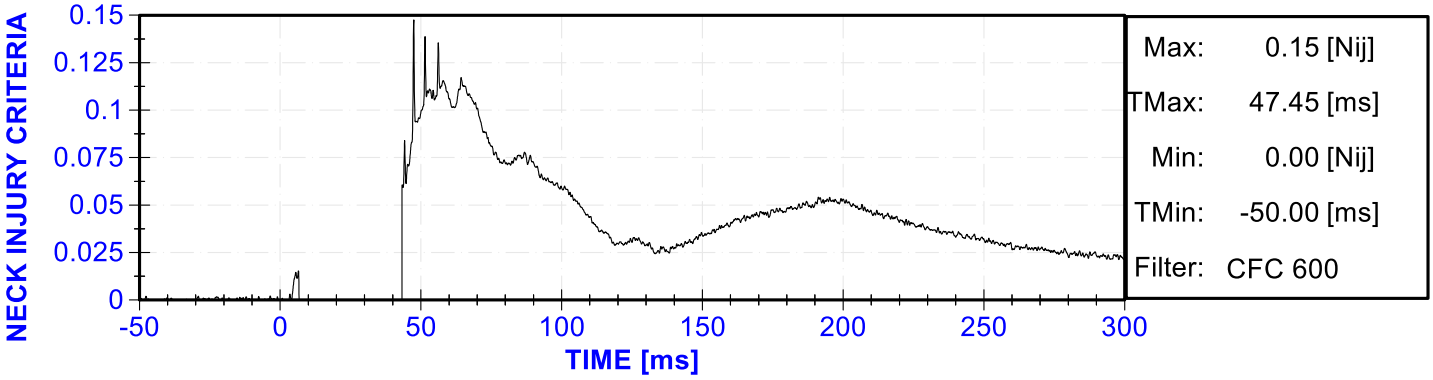
Lower Neck Moment Resultant



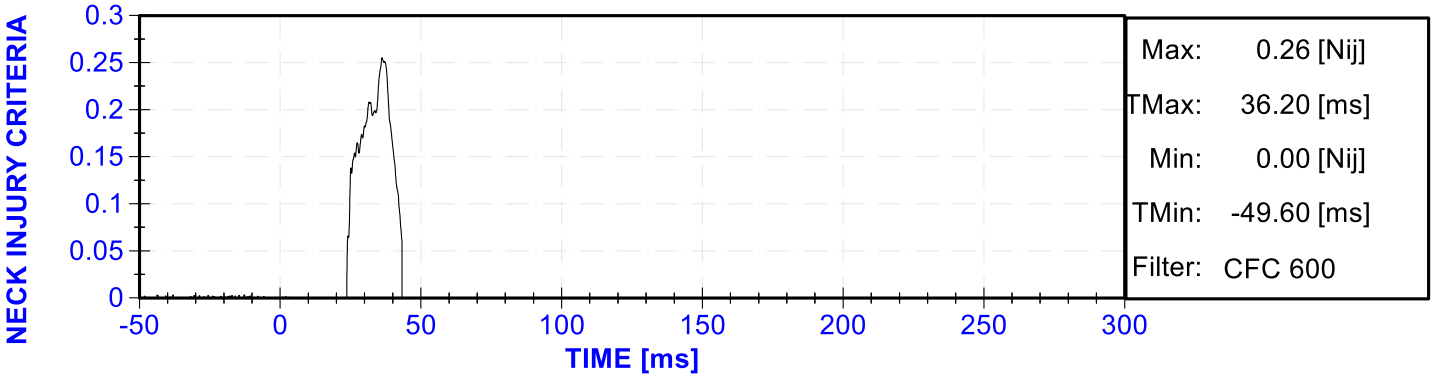
Total Moment about the OC



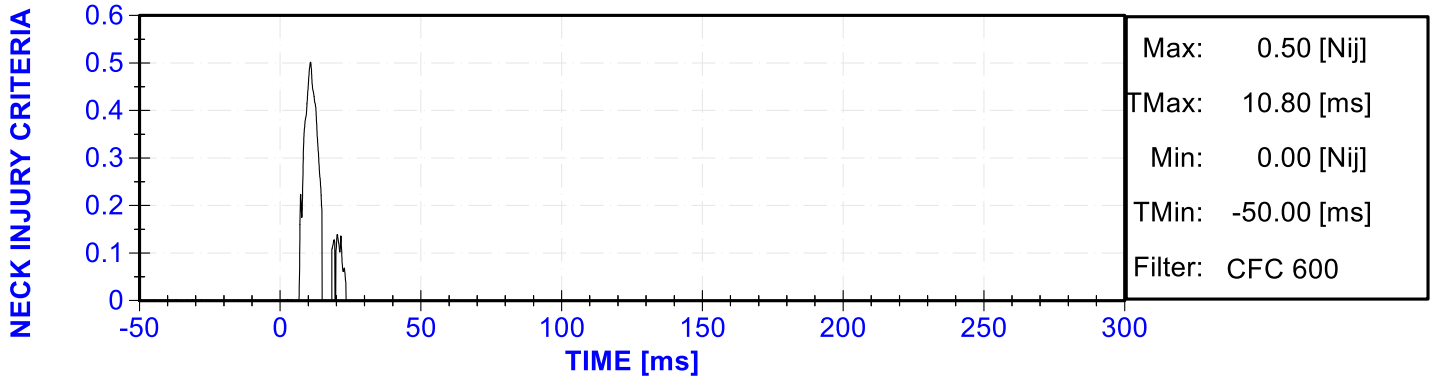
Neck Tension-Flexion Injury



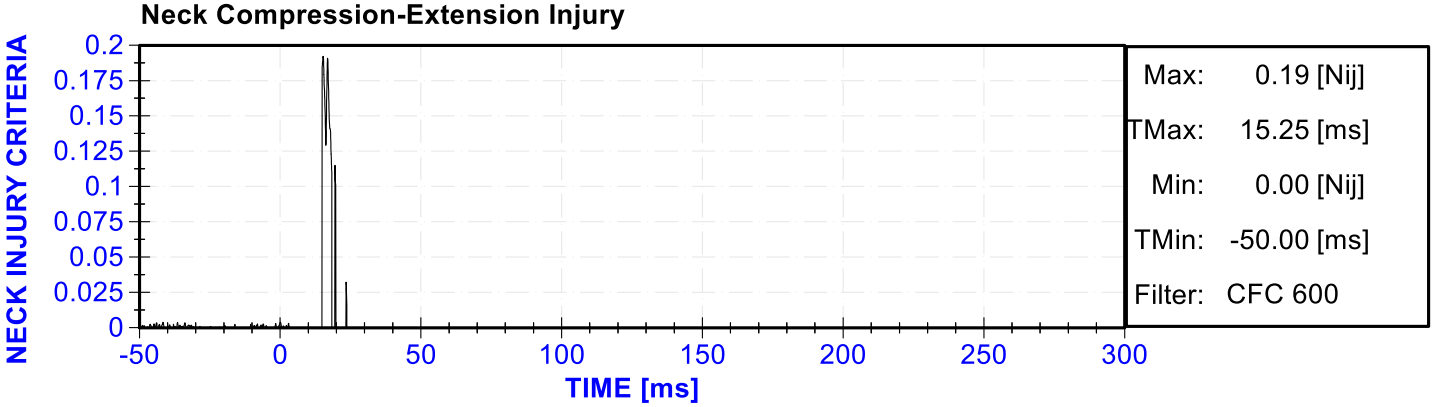
Neck Tension-Extension Injury



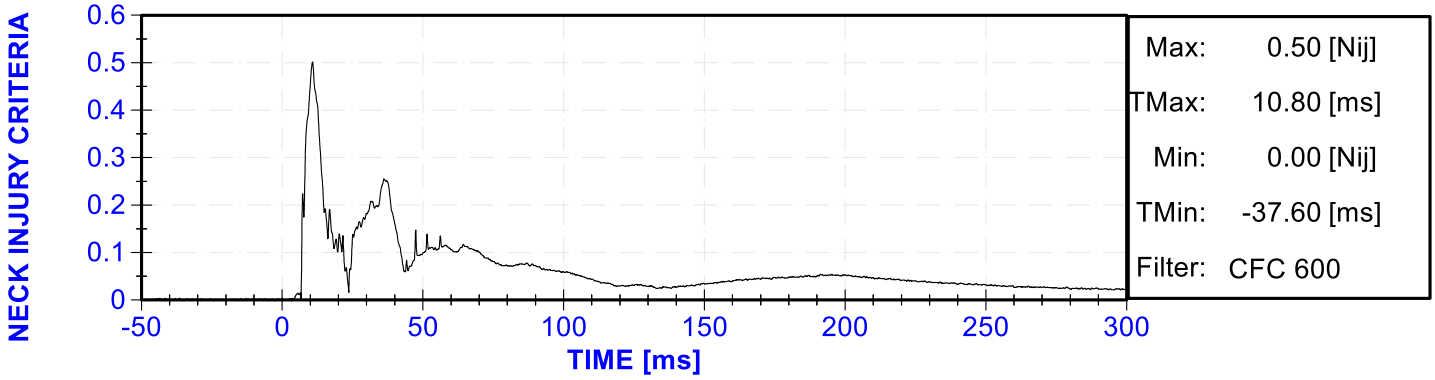
Neck Compression-Flexion Injury



Neck Compression-Extension Injury

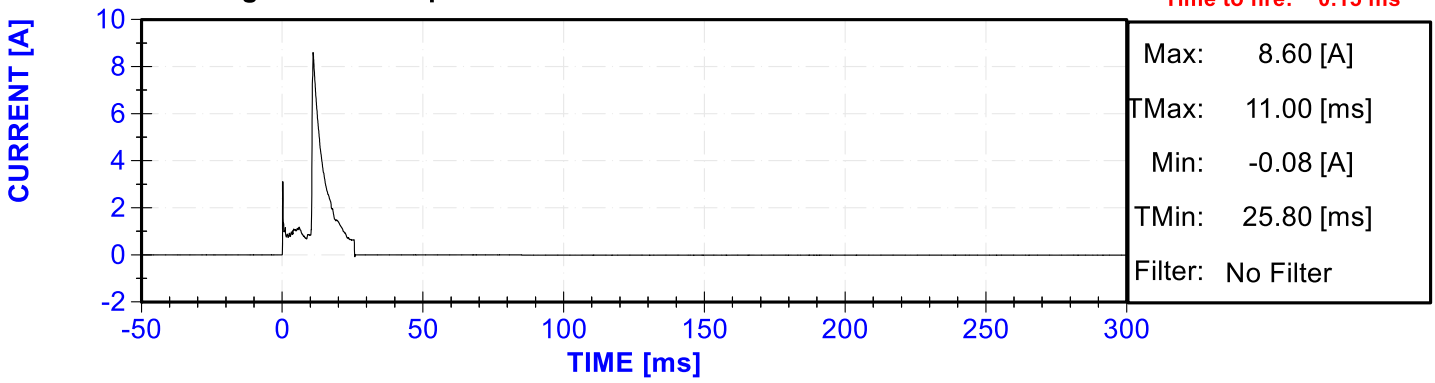


Total Neck Injury



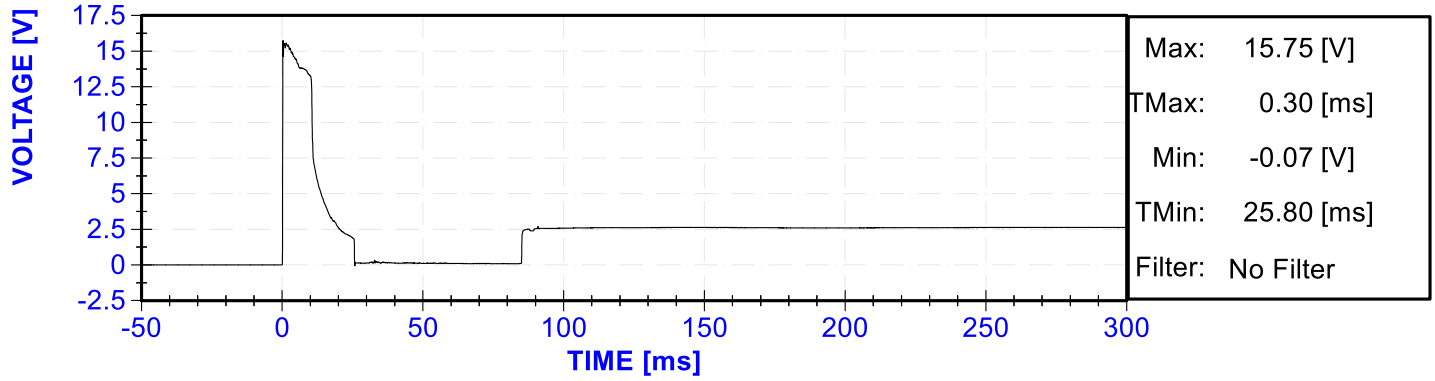
Passenger Curtain Squib Current

Time to fire: 0.15 ms



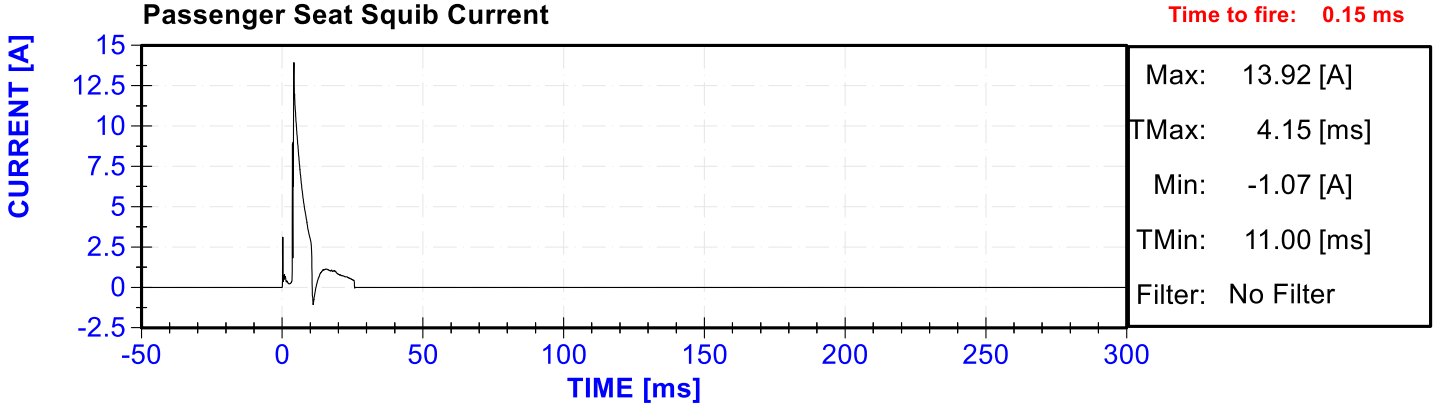
Passenger Curtain Squib Voltage

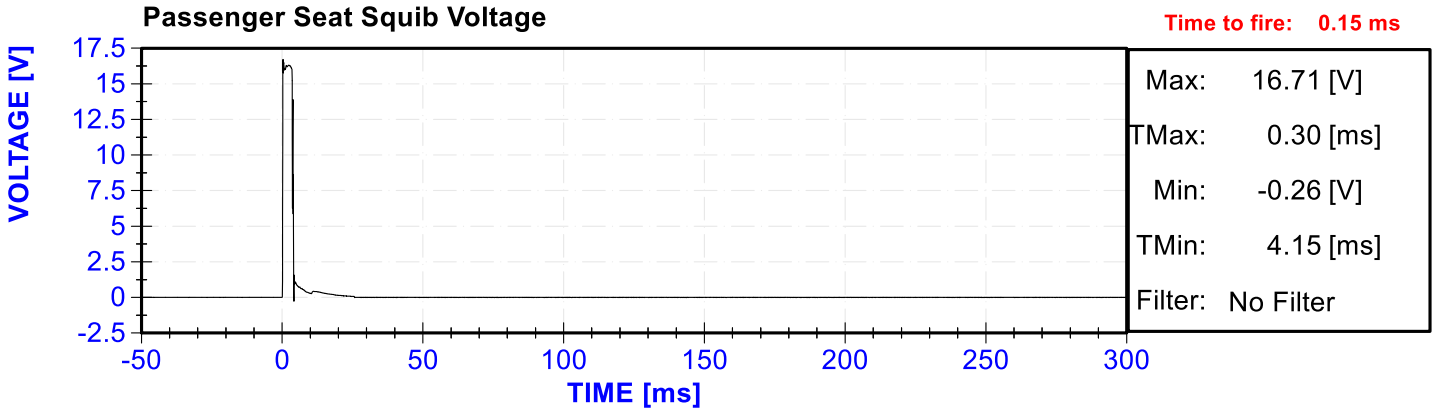
Time to fire: 0.15 ms



Passenger Seat Squib Current

Time to fire: 0.15 ms




Passenger Seat Squib Voltage
Time to fire: 0.15 ms
VOLTAGE [V]
17.5
15
12.5
10
7.5
5
2.5
0
-2.5
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 16.71 [V]
TMax: 0.30 [ms]
Min: -0.26 [V]
TMin: 4.15 [ms]
Filter: No Filter

APPENDIX C

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

	POSITION 2 (Front Right Passenger) SERIAL NO.: DG8012 M20195103TWG2		
	SERIAL NUMBER	**MANUFACTURER**	**CALIBRATION DATE**
Head X Acceleration	P74788	Endevco	4/11/2019
Head Y Acceleration	P83432	Endevco	4/11/2019
Head Z Acceleration	P83319	Endevco	4/11/2019
Head Redundant X Acceleration	P80334	Endevco	4/11/2019
Head Redundant Y Acceleration	P63841	Endevco	4/11/2019
Head Redundant Z Acceleration	P83322	Endevco	4/11/2019
Upper Neck X Force	2019-1716A-Fx	Denton	2/18/2019
Upper Neck Y Force	2019-1716A-Fy	Denton	2/18/2019
Upper Neck Z Force	2019-1716A-Fz	Denton	2/18/2019
Upper Neck X Moment	2019-1716A-Mx	Denton	2/18/2019
Upper Neck Y Moment	2019-1716A-My	Denton	2/18/2019
Upper Neck Z Moment	2019-1716A-Mz	Denton	2/18/2019
Lower Neck X Force	153-3166JTF-Fx	Humanetics	8/22/2018
Lower Neck Y Force	153-3166JTF-Fy	Humanetics	8/22/2018
Lower Neck Z Force	153-3166JTF-Fz	Humanetics	8/22/2018
Lower Neck X Moment	153-3166JTF-Mx	Humanetics	8/22/2018
Lower Neck Y Moment	153-3166JTF-My	Humanetics	8/22/2018
Lower Neck Z Moment	153-3166JTF-Mz	Humanetics	8/22/2018
Curtain Bag Voltage	ABT squib volts	AutoLab System	-
Curtain Bag Current	ABT squib amps	AutoLab System	-
Seat/Torso Bag Voltage	ABT squib volts	AutoLab System	-
Seat/Torso Bag Current	ABT squib amps	AutoLab System	-