REPORT NUMBER: TWG-CAL-18-02

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

Toyota Motor Corporation
2018 Toyota Prius C

NHTSA NUMBER: M20185107TWG2
CALSPAN TEST NUMBER: CT2018-02

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

November 14, 2018

DRAFT REPORT

Alpha Technology Associate, Inc.
2810 Old Lee Highway, Suite 120
Fairfax, VA 22031

This Final Test Report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DTNH22-13-D-00311L, Alpha Technology PO 12GC150. This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

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Approved By: Vanessa Hansen, Program Manager

Approval Date: November 14, 2018

FINAL REPORT ACCEPTANCE BY:

Accepted By: _____

Acceptance Date: _____

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. TWG-CAL-18-02	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Final Report 2018 , TWG/Out-of-Position Tests NHTSA No.: M20185107TWG2		5. Report Date November 14, 2018
		6. Performing Organization Code CAL
7. Author(s) Vanessa Hansen, Program Manager Zachary Granby, Test Engineer		8. Performing Organization Report No. CT2018-02
9. Performing Organization Name and Address Calspan Corporation 4455 Genesee St. Buffalo, New York 14225		10. Work Unit No.
		11. Contract or Grant No. DTNH22-13-D-00311L
12. Sponsoring Agency Name and Address Alpha Technology Associate, Inc. 2810 Old Lee Hwy, Suite 120 Fairfax, VA 22031		13. Type of Report and Period Covered Final Report, November 14, 2018
		14. Sponsoring Agency Code NRM-110

15. Supplementary Notes

16. Abstract

This side impact Out-Of-Position test was performed in conjunction with a New Car Assessment Program (NCAP) on a 2018 Toyota Prius with a SID-IIs sitting in the front passenger seat facing the driver seat. This test was conducted at the Calspan Test Facility in Buffalo, New York, on July 19, 2018.

Injury Summary

HIC15	Peak Tension (CFC1000)	Peak Compression (CFC1000)	NIJ(NTF)	NIJ(NTE)	NIJ(NCF)	NIJ(NCE)
20.26	73.376	-2003.130	0.086	0.051	0.571	0.992

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

19. Security Classification of Report UNCLASSIFIED	20. Security Classification of Page UNCLASSIFIED	21. No. of Pages 31	22. Price

TABLE OF CONTENTS

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 impact using a vehicle that had previously undergone a New Car Assessment Program (NCAP) sponsored side MDB 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 2018 Toyota Prius c on an out-of-position SID-IIs ATD were evaluated. The test was performed by Calspan on July 19, 2018. 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 neck load cell sensor was utilized to record the resulting neck forces and moments during the event.

Twelve 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:	12	
Number of Cameras:	0	Real Time
	3	High Speed Digital

PRE-TEST VISIBLE DUMMY CONTACT POINTS

Head Contact:	None
Upper Torso Contact:	Seatback, Passenger Door
Lower Torso Contact:	Seatback
Knee Contact:	Passenger Seatpan
Foot Contact:	Driver Seatpan

POST-TEST VISIBLE DUMMY CONTACT POINTS

Head Contact:	Curtain Air Bag
Upper Torso Contact:	Torso Air Bag, Seatback
Lower Torso Contact:	Torso Air Bag, Seatback
Knee Contact:	Passenger Seatpan
Foot Contact:	Driver Seatpan

DATA SHEET NO. 2
VEHICLE PARAMETER DATA

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 2018 Toyota Prius

NHTSA No. : M20185107TWG2 ; VIN: JTDKDTB30J1600244 Color: Silver

Engine Data: I4 cylinders; - CID; 1.5 Liters; - cc

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

Transmission Data: CVT 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; - Adj. Anchorage

Safety Belt Features - Passenger X Pretensioner (Shoulder); X Load Limiter; - 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: 10/12/2017 ; Odometer Reading 201.2 Km

Selling Dealer: Toyota of Scranton

& Address: 3400 North Main Avenue, Scranton PA 18508

DATA FROM TIRE VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Toyota Motor Corporation

Date of Manufacture 07/17

GVWR: 1580 kg; GAWR: 884 kg FRONT; 835 kg REAR

DATA FROM TIRE PLACARD:

Recommended Tire Size: P175/65R15

*Recommended Cold Tire Pressure: 260 kPa Front 230 kPa Rear

DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: P175/65R15 ; Manufacturer: Bridgestone

Tire Pressure with Maximum Capacity Vehicle Load: Front 300 kPa Rear: 300 kPa

Treadwear: 300 ; Traction: A : 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) = 375 Kg

No. of Occupants x 68.04 kg = 340.2 Kg

Rated Cargo/Luggage Weight (RCLW) = 34.8 Kg

*Tire pressure used for test

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

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

NHTSA No. M20185107TWG2

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

Seat Back Angle (headrest post)	SA (-17.3º)	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)	220
Head CG to Door Panel/Side Window	HD (mm)	184
Head to Seat Back Centerline	HSC (mm)	251
Head to B-Pillar (cg)	HB (mm)	282
Head to Roof, Z (top of the head)	HZ (mm)	30
Head to Header	HHD (mm)	215
Chest to Dash	CD (mm)	425
Chest to Seatback	CS (mm)	261
Right Arm to Seat Back Centerline	RACL (mm)	-
Right Arm to Seat Back Centerline	RACL (deg)	-
Left Arm to Door Panel	LA (mm)	-
Knee to Knee	KK (mm)	282
Toe to Toe	TT (mm)	284
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.: M20185107TWG2

Channel	Units	Max	Time (ms)	Min	Time (ms)
V1P2 Head x [CFC_1000]	g's	26.22	7.50	-3.98	86.45
V1P2 Head y [CFC_1000]	g's	18.39	20.45	-20.79	7.65
V1P2 Head z [CFC_1000]	g's	38.66	7.15	-6.42	12.40
V1P2 Headform Resultant [CFC_1000]	g's	46.49	7.30	0.00	-40.20
V1P2 Upper Neck Mocy [CFC_600]	Nm	16.73	16.15	-35.03	34.25
V1P2 Upper Neck Ntf [CFC_600]	-	0.09	104.10	0.00	-50.00
V1P2 Upper Neck Nte [CFC_600]	-	0.05	186.55	0.00	-50.00
V1P2 Upper Neck Ncf [CFC_600]	-	0.57	15.20	0.00	-50.00
V1P2 Upper Neck Nce [CFC_600]	-	0.99	32.60	0.00	-49.55
V1P2 Upper Neck Nij [CFC_600]	-	0.99	32.60	0.00	-38.70
V1P2 Upper Neck Fx [CFC_1000]	N	131.53	9.90	-414.74	32.40
V1P2 Upper neck Fy [CFC_1000]	N	328.85	45.75	-76.31	125.55
V1P2 Upper neck Fz [CFC_1000]	N	73.38	5.25	-2003.13	23.55
V1P2 Neck Force Resultant [CFC_1000]	N	2031.28	29.60	0.05	-38.70
V1P2 Upper Neck Mx [CFC_600]	Nm	17.15	63.95	-9.52	24.25
V1P2 Upper Neck My [CFC_600]	Nm	18.19	15.95	-42.10	34.00
V1P2 Upper Neck Mz [CFC_600]	Nm	3.27	21.60	-6.95	78.55
V1P2 Neck Moment Resultant [CFC_600]	Nm	42.42	34.10	0.00	-45.20
V1P2 Lower Neck Fx F [CFC_1000]	N	-	-	-	-
V1P2 Lower Neck Fy F [CFC_1000]	N	-	-	-	-
V1P2 Lower Neck Fz F [CFC_1000]	N	-	-	-	-
V1P2 Lower Neck Force Resultant [CFC_1000]	N	-	-	-	-
V1P2 Lower Neck Mx F [CFC_600]	Nm	-	-	-	-
V1P2 Lower Neck My F [CFC_600]	Nm	-	-	-	-
V1P2 Lower Neck Mz F [CFC_600]	Nm	-	-	-	-
V1P2 Lower Neck Moment Resultant [CFC_600]	Nm	-	-	-	-
Curtain Airbag Volts	V	6.61	0.75	-6.85	0.00
Torso/Pelvis Airbag Volts	V	7.01	19.40	-20.14	0.00
Front Center Airbag Volts	V	-	-	-	-
Curtain Airbag Current	A	0.70	0.40	-2.73	0.00
Torso/Pelvis Airbag Current	A	2.47	0.70	-1.02	21.80
Front Center Airbag Current	A	-	-	-	-

DATA SHEET 4

SID-IIs DUMMY INJURY CRITERIA VALUES (CONTINUED)

VEHICLE: 2018 Toyota Prius NHTSA No.: M20185107TWG2

HEAD INJURY CRITERIA (HIC)

	HIC15			
	HIC(15)	t_1 (msec)	t_2 (msec)	Average Acceleration t_1 to t_2
Position P2	20.26	6.90	11.60	28.52

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	0.086	104.100	46.896	-97.480	9.793
Nte	0.051	186.550	71.066	-14.533	-2.267
Ncf	0.571	15.200	-1807.421	91.533	17.998
Nce	0.992	32.600	-1714.635	-409.214	-40.814

Peak Tension (CFC1000) 73.376 **N** **Peak Compression (CFC1000)** -2003.130 **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

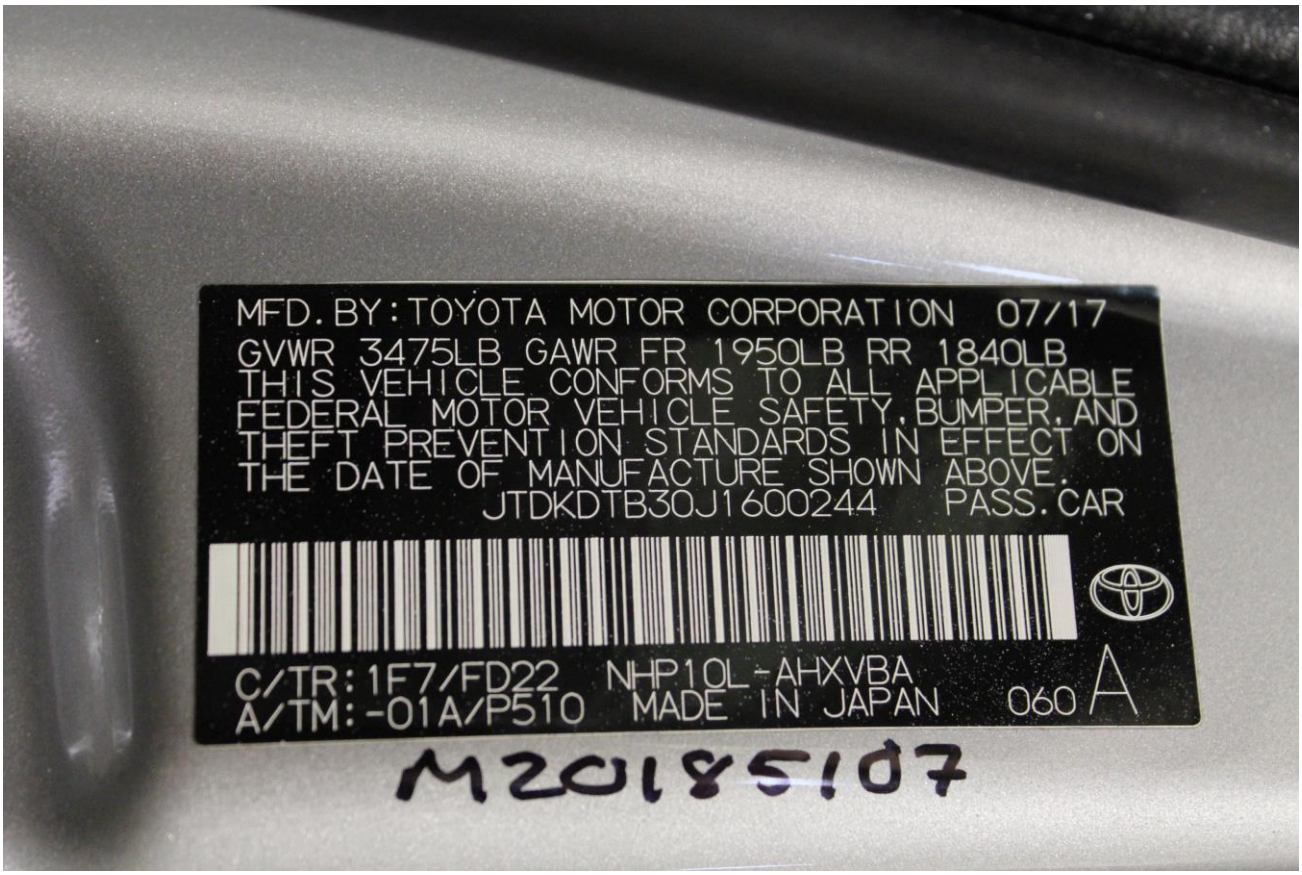


Figure A-2: Vehicle Certification Placard

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

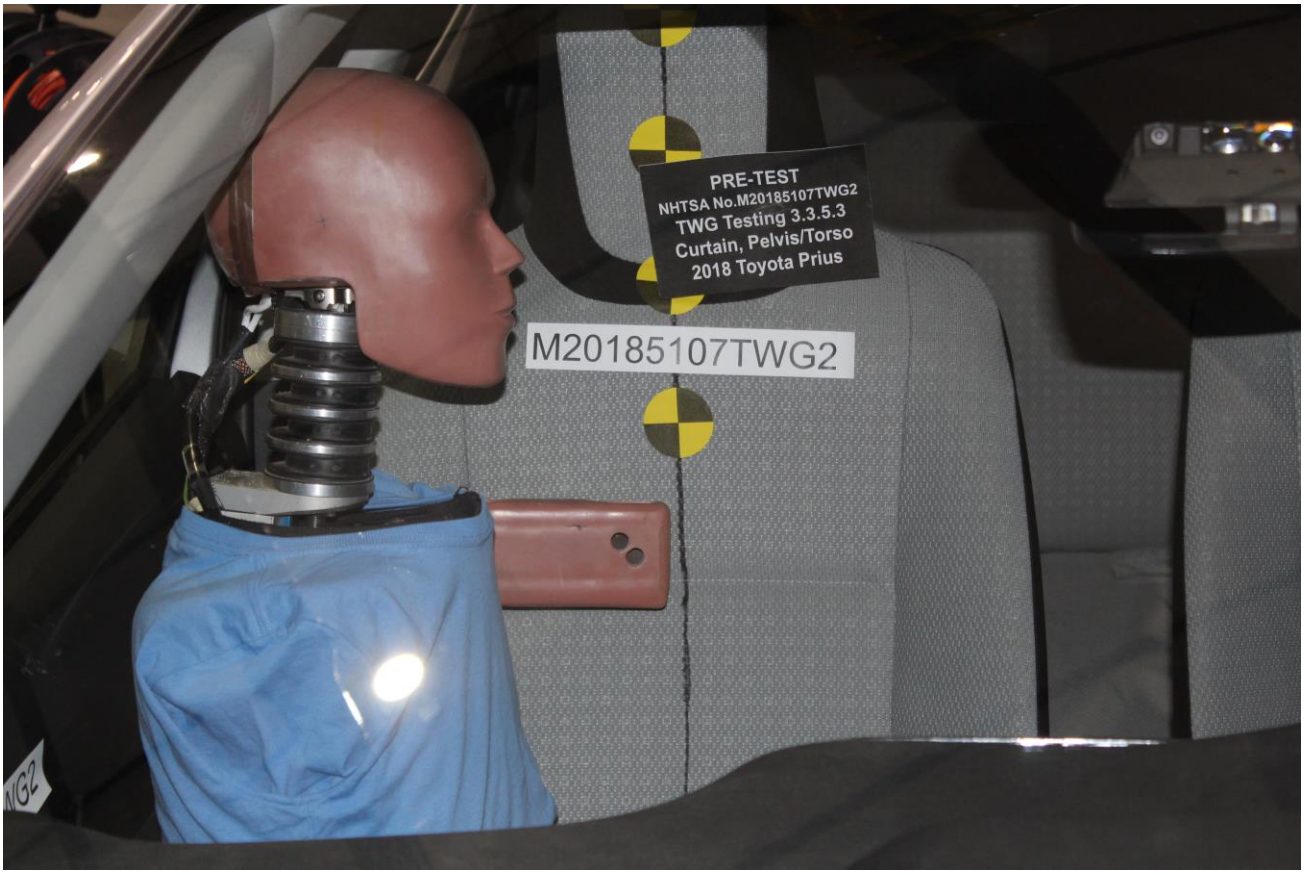


Figure A-7: Pre-Test SID-IIs Front View

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

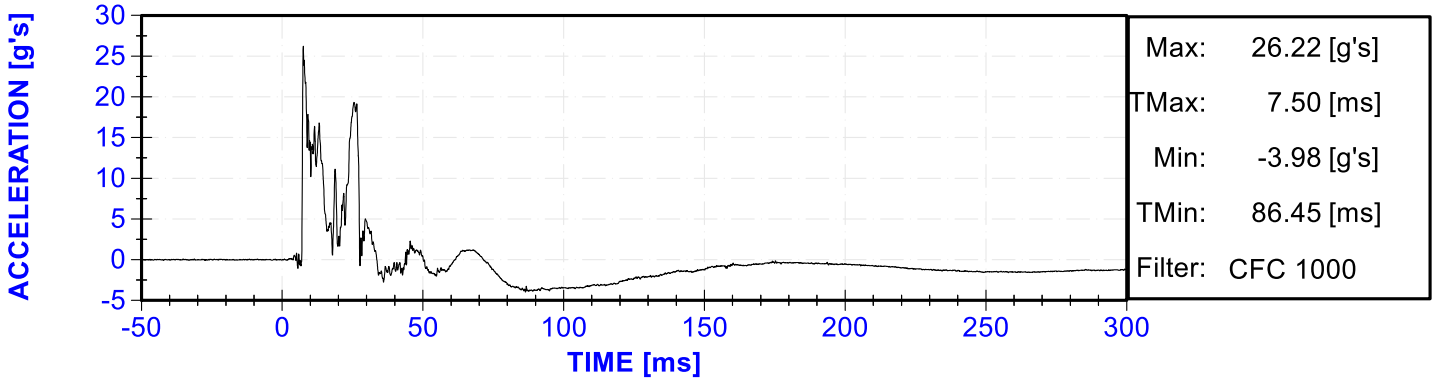
Figure A-14: Post-Test Seat Airbag View

Figure A-15: Impact Event

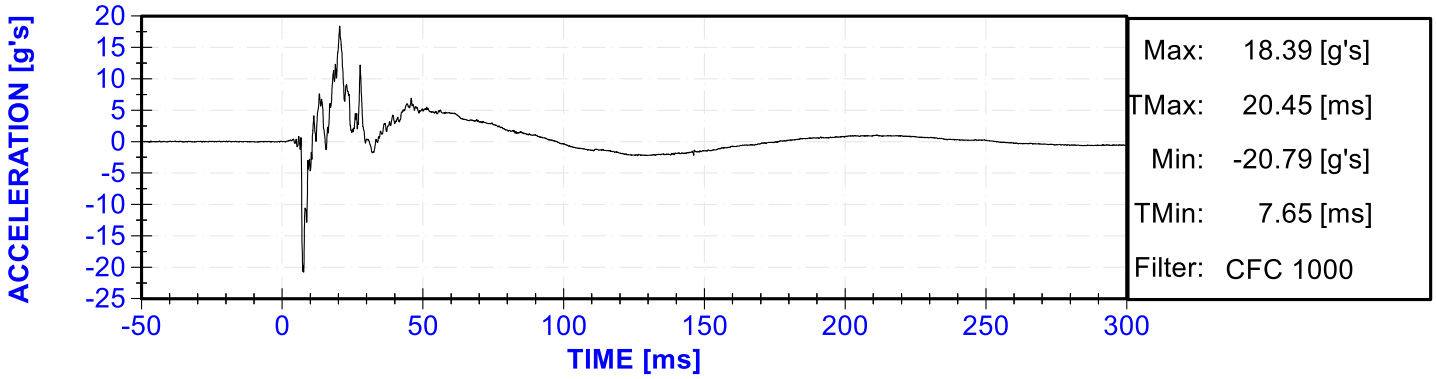
APPENDIX B
VEHICLE & DUMMY RESPONSE DATA TRACES

Table of Data Plots

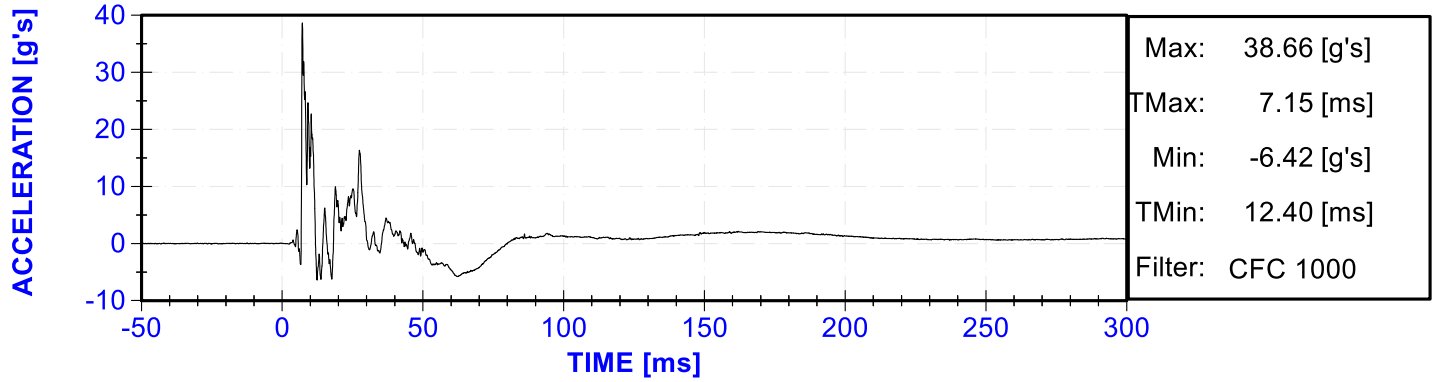
Head CG X Acceleration



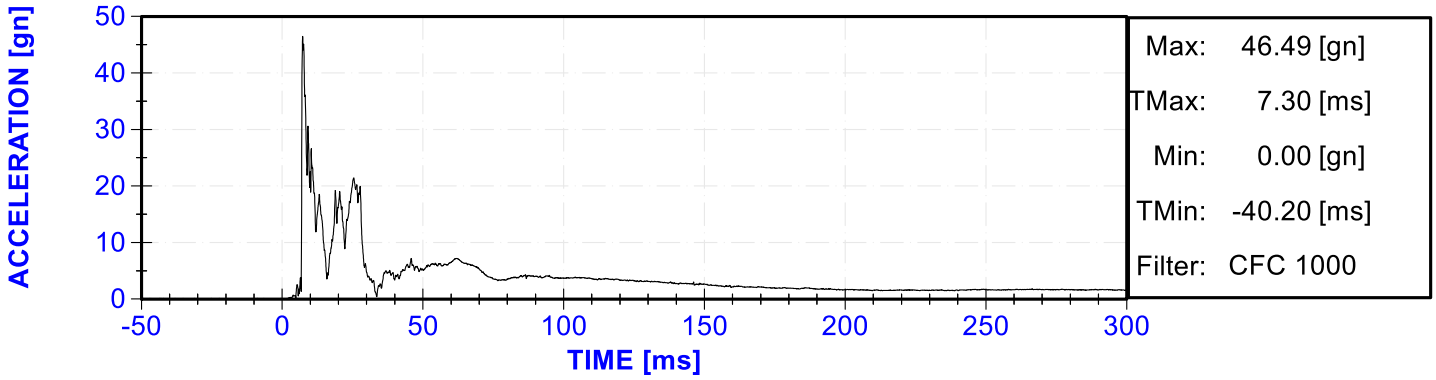
Head CG Y Acceleration

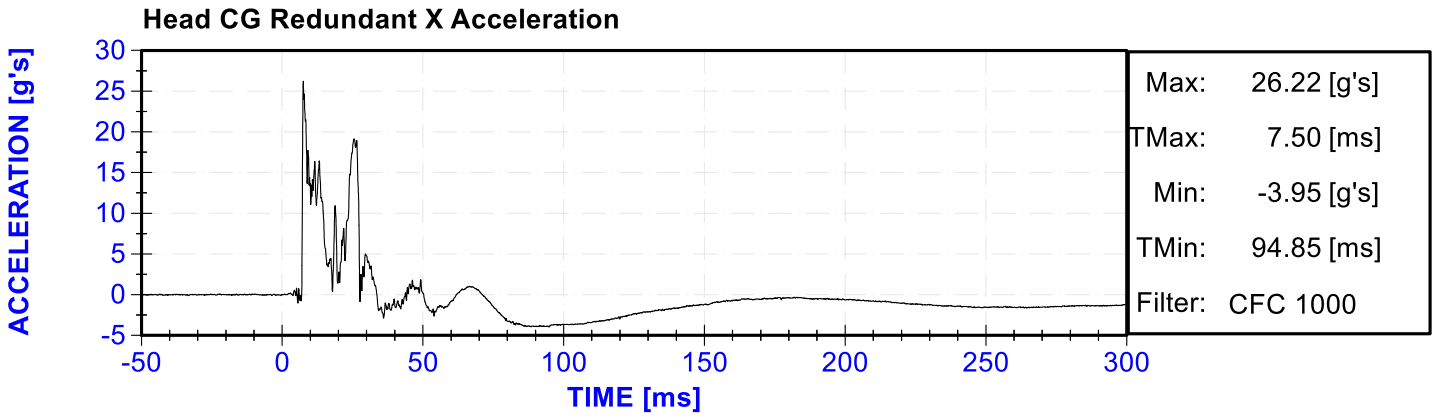


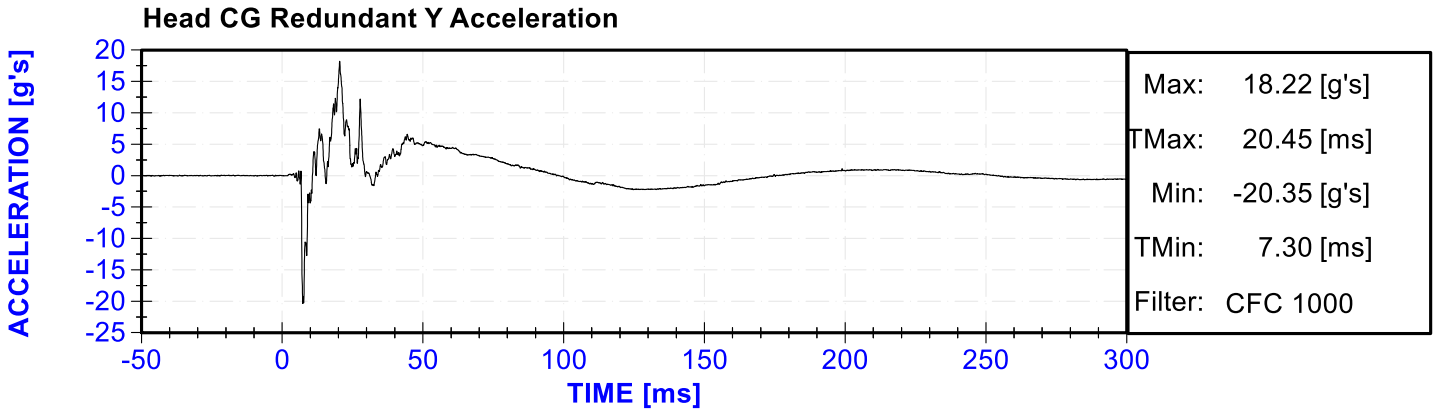
Head CG Z Acceleration



Head CG Acceleration Resultant




Head CG Redundant X Acceleration
ACCELERATION [g's]
TIME [ms]
Max: 26.22 [g's]
TMax: 7.50 [ms]
Min: -3.95 [g's]
TMin: 94.85 [ms]
Filter: CFC 1000


Head CG Redundant Y Acceleration
ACCELERATION [g's]
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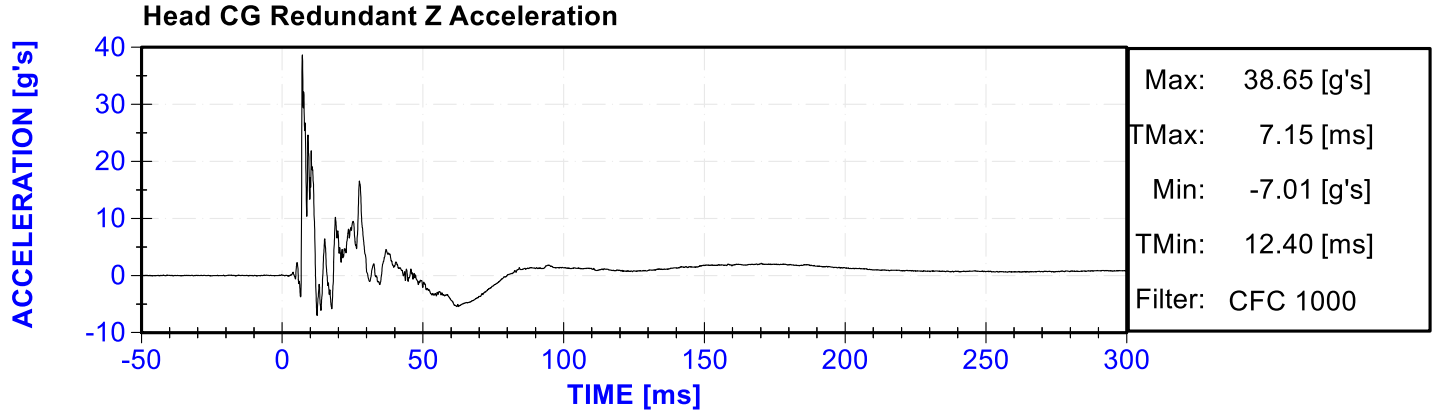
Min: -20.35 [g's]
TMin: 7.30 [ms]
Filter: CFC 1000


Head CG Redundant Z Acceleration
ACCELERATION [g's]
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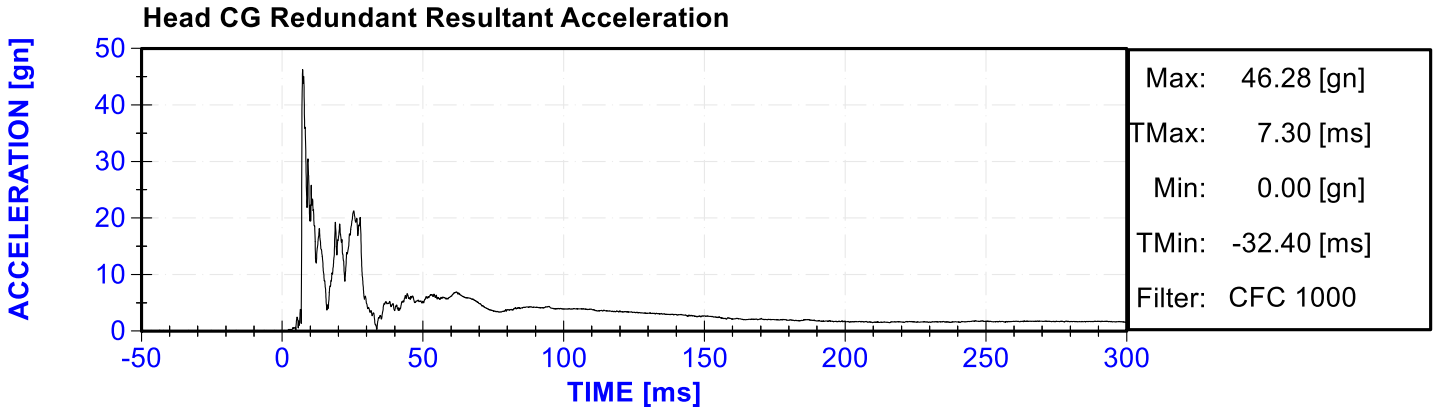
TMin: 12.40 [ms]
Filter: CFC 1000


Head CG Redundant Resultant Acceleration
ACCELERATION [gn]
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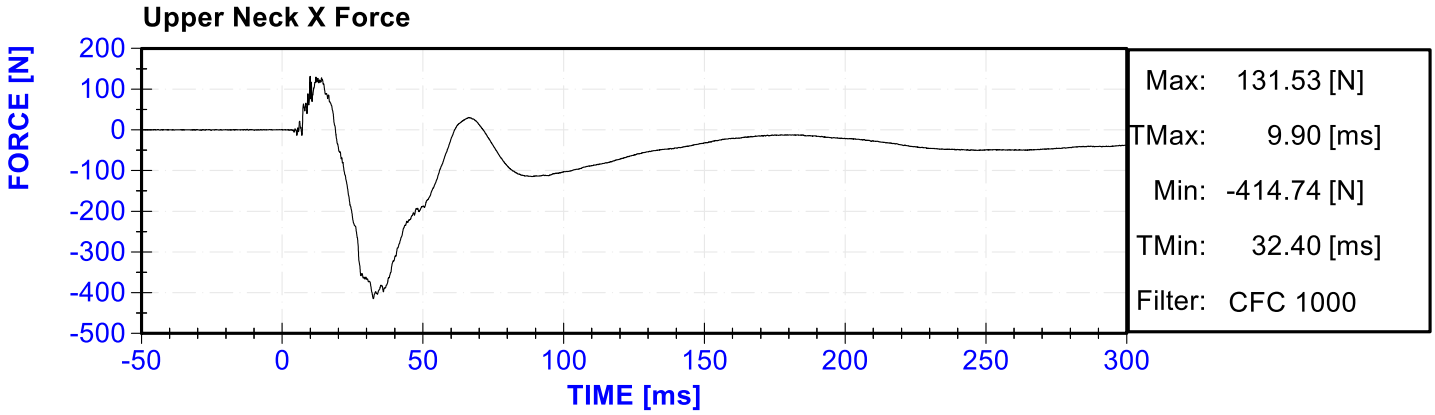
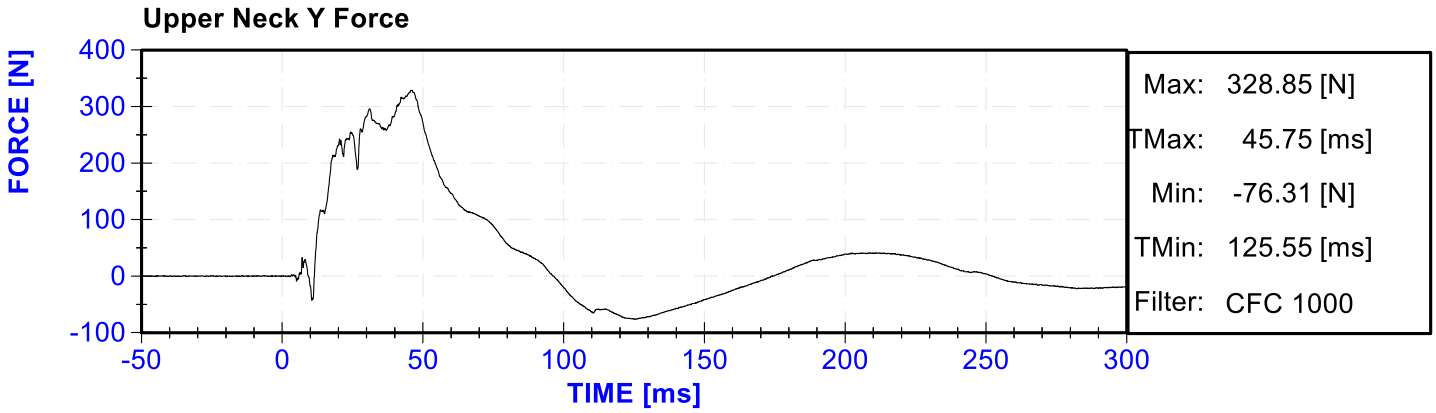
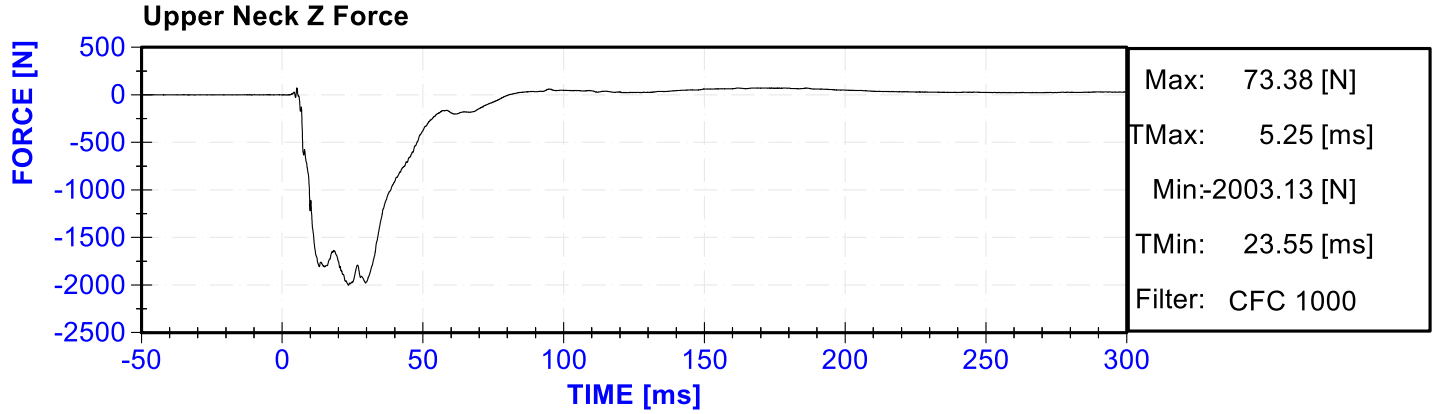
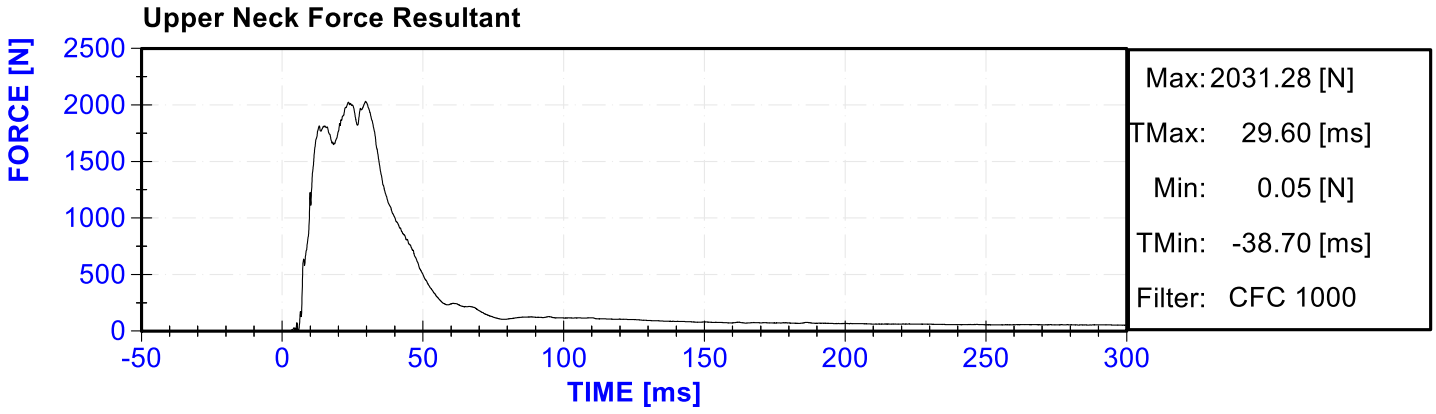
Min: 0.00 [gn]
TMin: -32.40 [ms]
Filter: CFC 1000


Upper Neck X Force
FORCE [N]
200
100
0
-100
-200
-300
-400
-500
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 131.53 [N]
TMax: 9.90 [ms]
Min: -414.74 [N]
TMin: 32.40 [ms]
Filter: CFC 1000


Upper Neck Y Force
FORCE [N]
400
300
200
100
0
-100
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 328.85 [N]
TMax: 45.75 [ms]
Min: -76.31 [N]
TMin: 125.55 [ms]
Filter: CFC 1000


Upper Neck Z Force
FORCE [N]
500
0
-500
-1000
-1500
-2000
-2500
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 73.38 [N]
TMax: 5.25 [ms]
Min:-2003.13 [N]
TMin: 23.55 [ms]
Filter: CFC 1000


Upper Neck Force Resultant
FORCE [N]
2500
2000
1500
1000
500
0
-50
0
50
100
150
200
250
300
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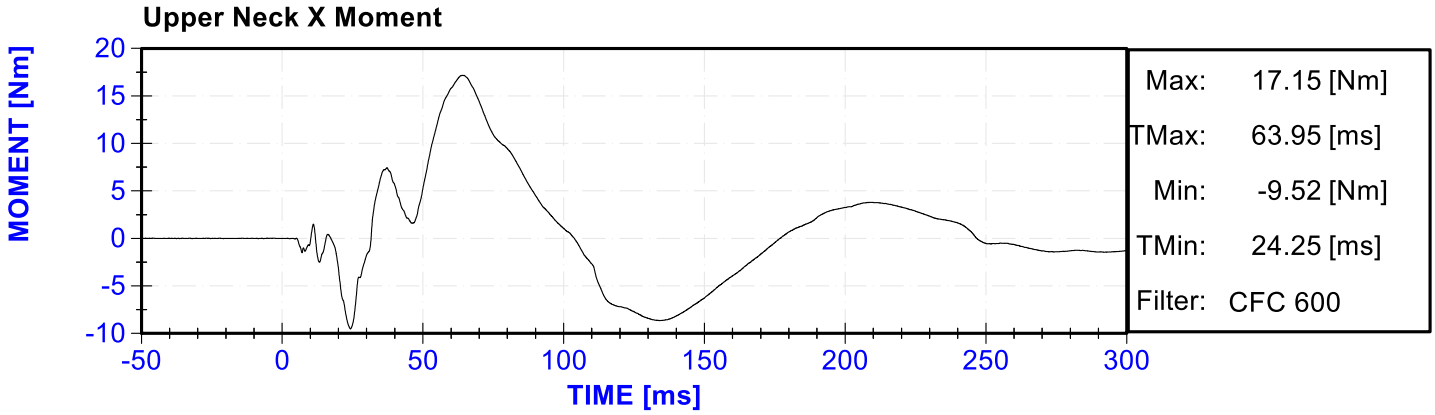
Min: 0.05 [N]
TMin: -38.70 [ms]
Filter: CFC 1000


Upper Neck X Moment
MOMENT [Nm]
TIME [ms]
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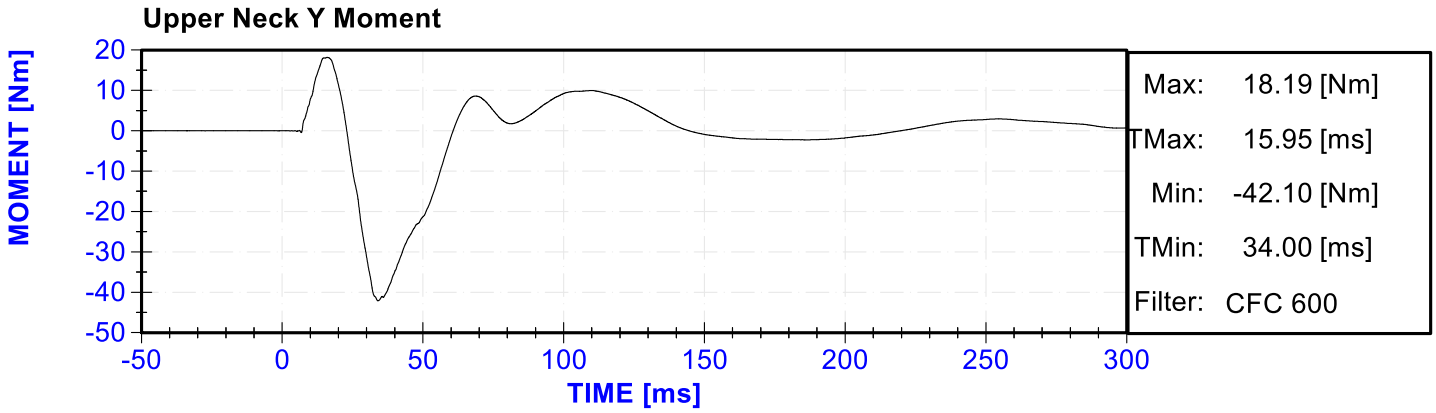
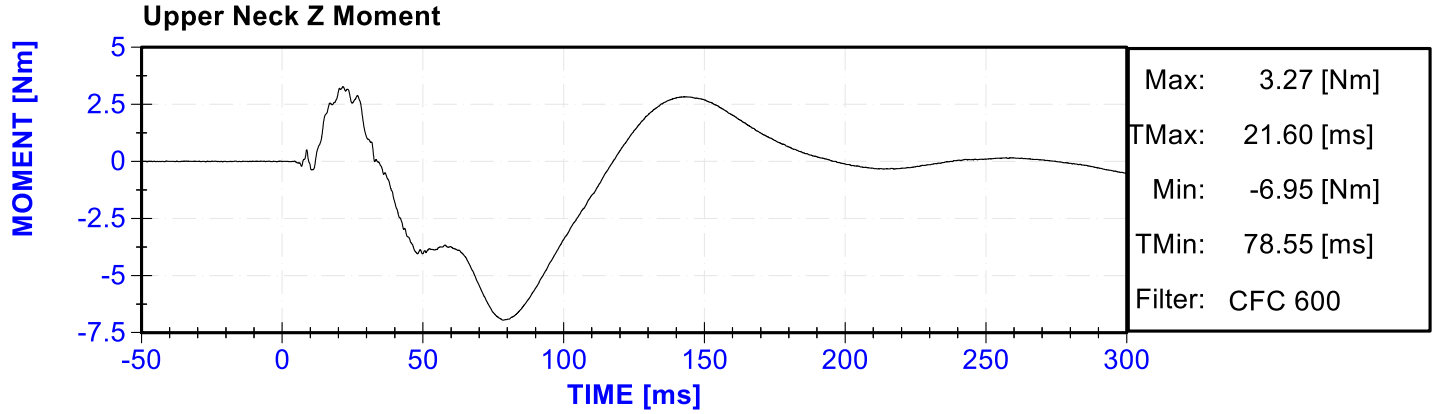
Min: -9.52 [Nm]
TMin: 24.25 [ms]
Filter: CFC 600


Upper Neck Y Moment
MOMENT [Nm]
TIME [ms]
Max: 18.19 [Nm]
TMax: 15.95 [ms]
Min: -42.10 [Nm]
TMin: 34.00 [ms]
Filter: CFC 600


Upper Neck Z Moment
MOMENT [Nm]
TIME [ms]
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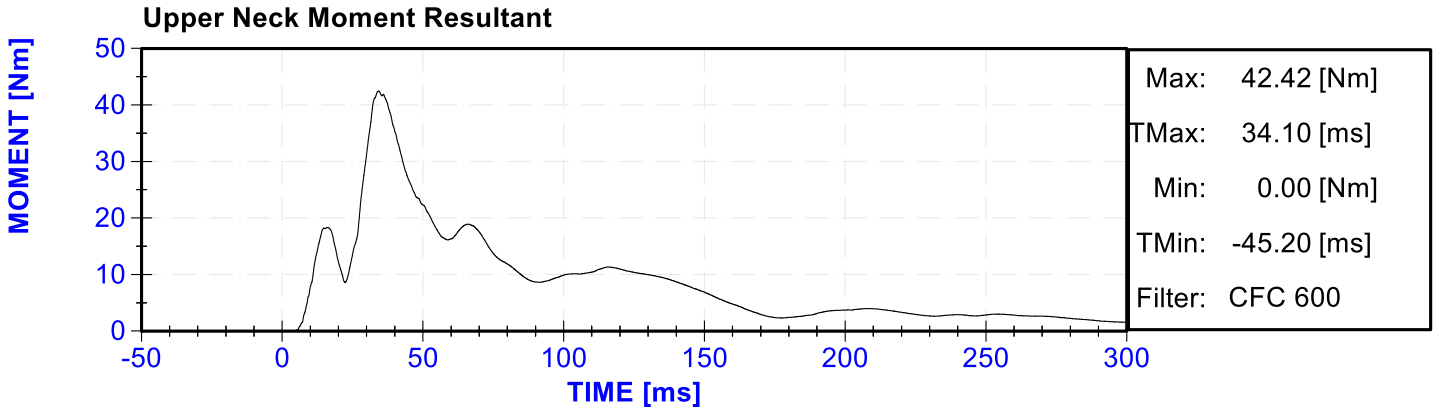
TMax: 21.60 [ms]
Min: -6.95 [Nm]
TMin: 78.55 [ms]
Filter: CFC 600


Upper Neck Moment Resultant
MOMENT [Nm]
TIME [ms]
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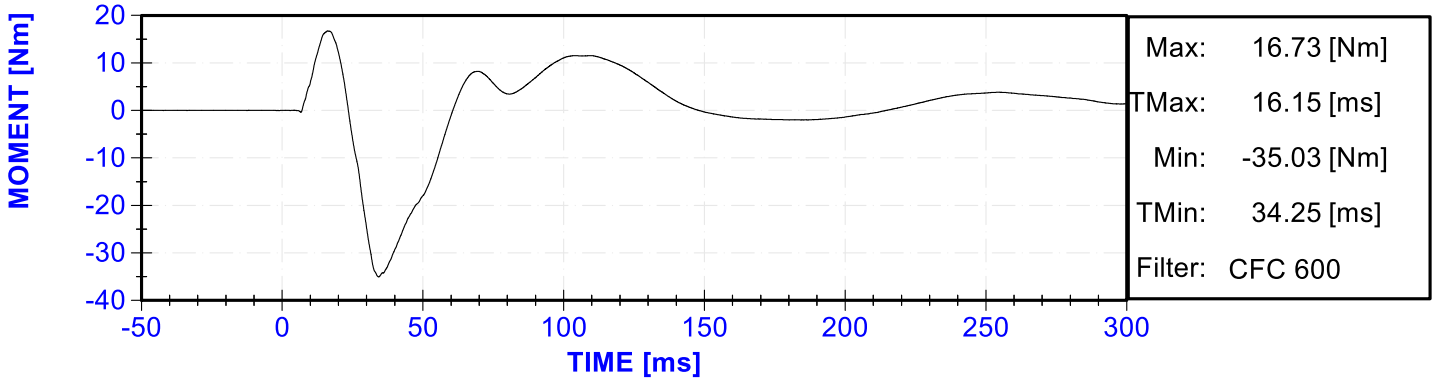
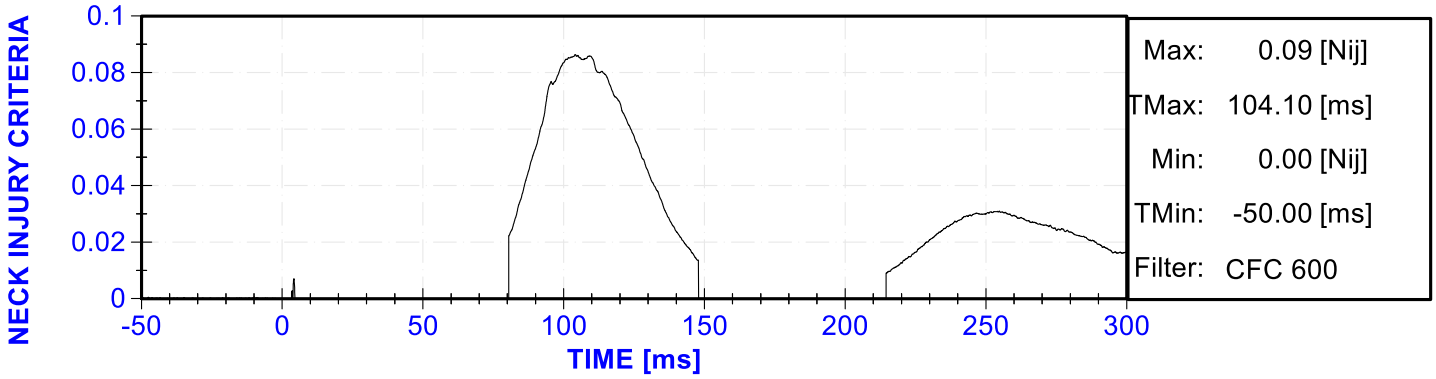
TMax: 34.10 [ms]
Min: 0.00 [Nm]
TMin: -45.20 [ms]
Filter: CFC 600

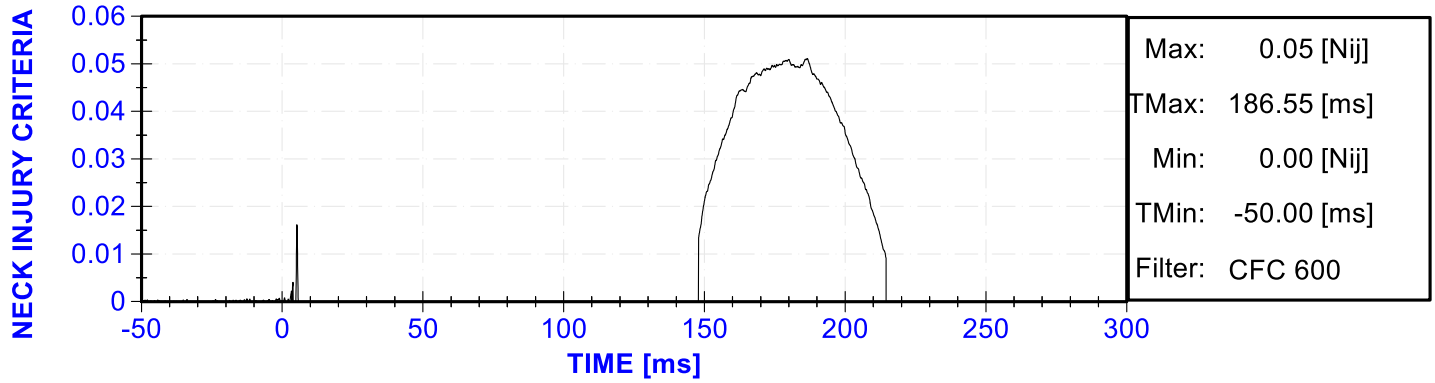
Total Moment about the OC



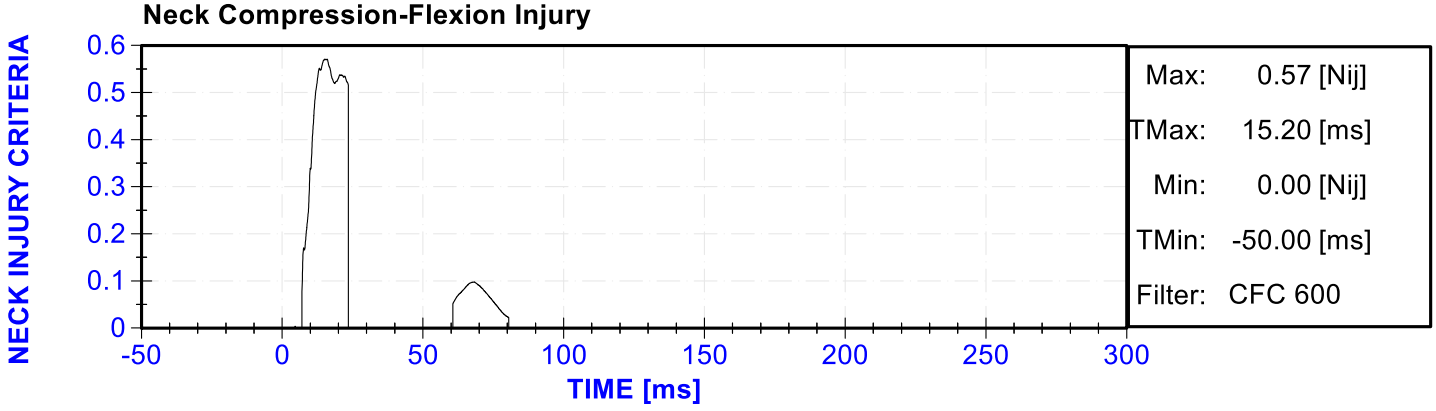
Neck Tension-Flexion Injury



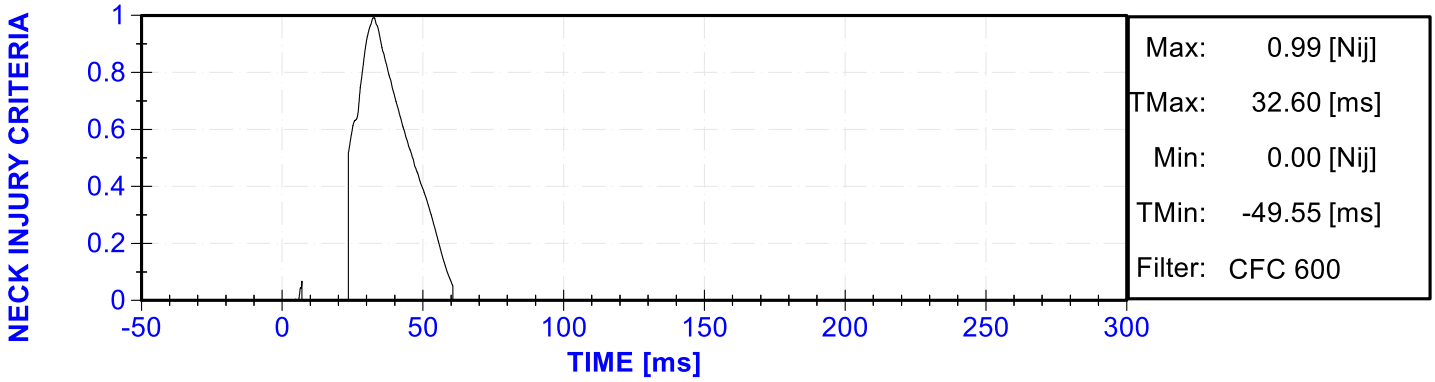
Neck Tension-Extension Injury



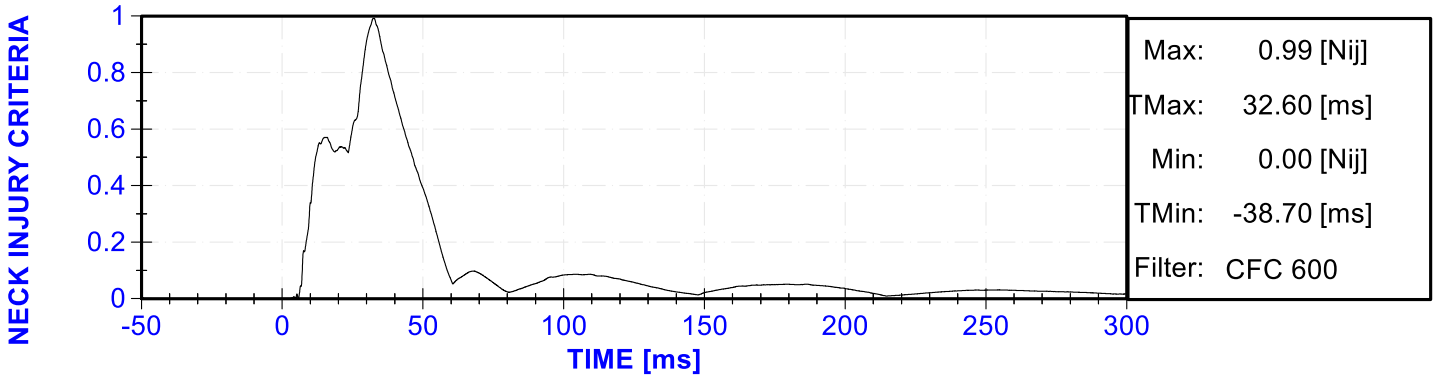
Neck Compression-Flexion Injury



Neck Compression-Extension Injury

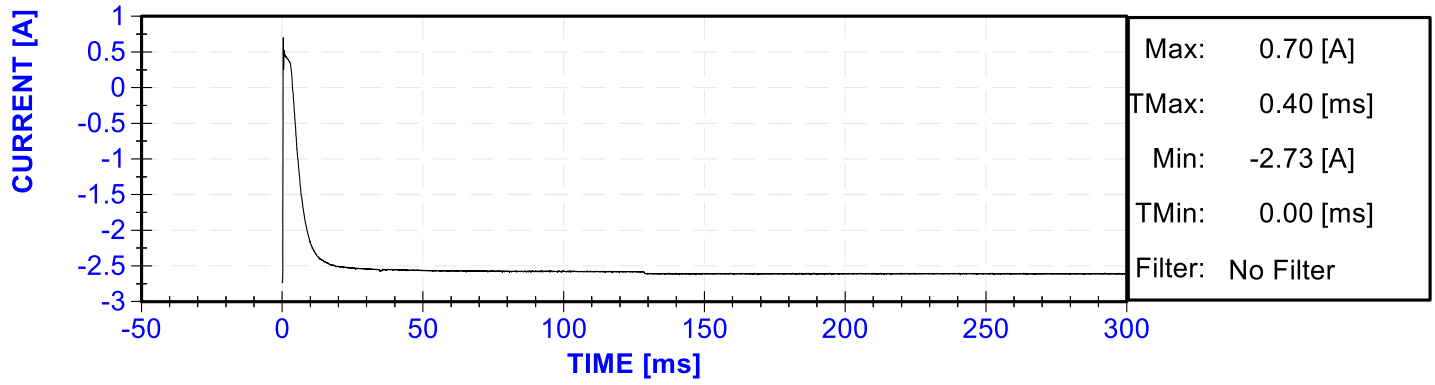


Total Neck Injury



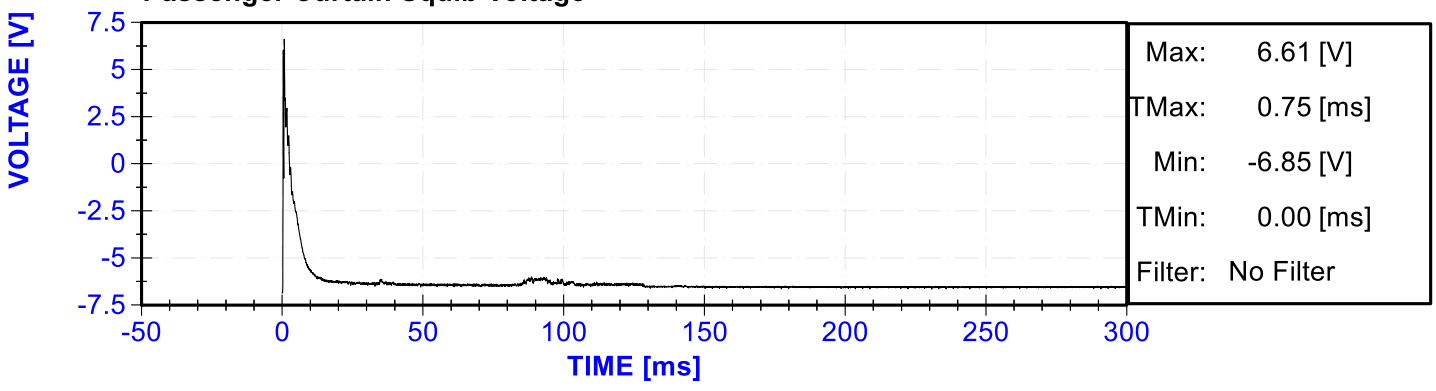
Passenger Curtain Squib Current

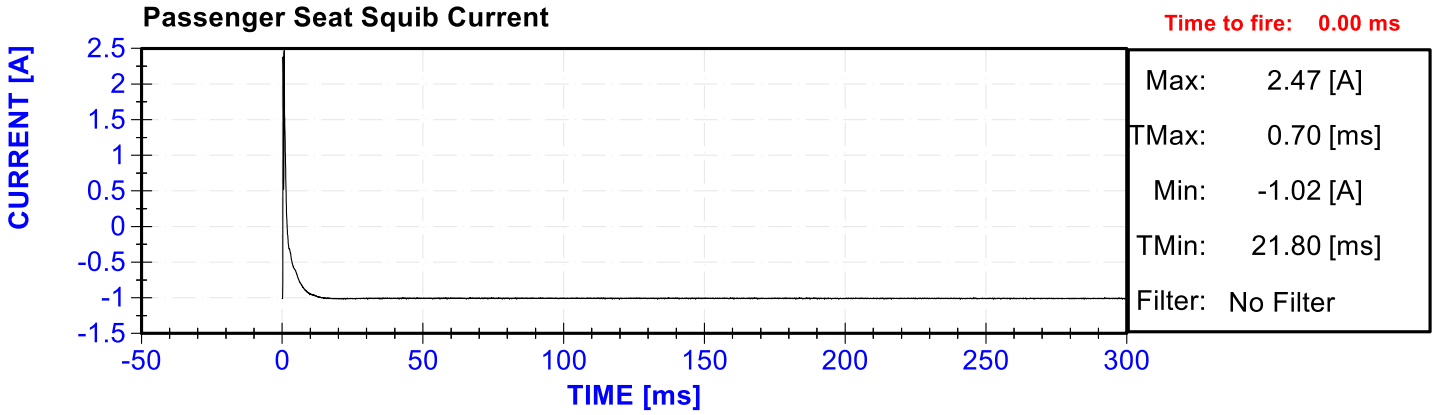
Time to fire: 0.00 ms

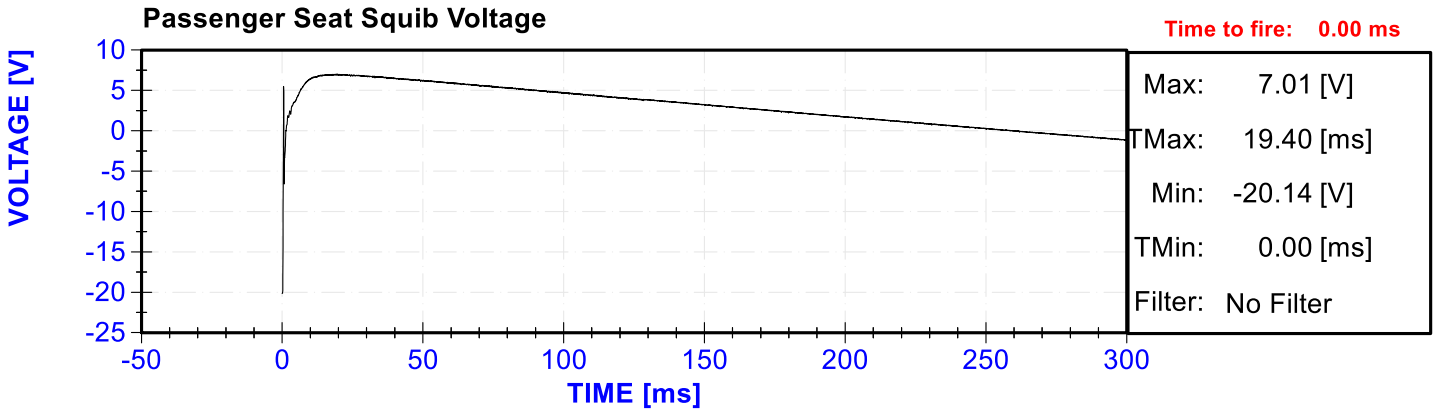


Passenger Curtain Squib Voltage

Time to fire: 0.00 ms




Passenger Seat Squib Current
Time to fire: 0.00 ms
CURRENT [A]
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 2.47 [A]
TMax: 0.70 [ms]
Min: -1.02 [A]
TMin: 21.80 [ms]
Filter: No Filter


Passenger Seat Squib Voltage
Time to fire: 0.00 ms
VOLTAGE [V]
10
5
0
-5
-10
-15
-20
-25
-50
0
50
100
150
200
250
300
TIME [ms]
Max: 7.01 [V]
TMax: 19.40 [ms]
Min: -20.14 [V]
TMin: 0.00 [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 M20185107TWG2		
	SERIAL NUMBER	**MANUFACTURER**	**CALIBRATION DATE**
Head X Acceleration	AC-P51685	ENDEVCO 7264CT	5/4/2018
Head Y Acceleration	AC-P51682	ENDEVCO 7264CT	5/4/2018
Head Z Acceleration	AC-P51699	ENDEVCO 7264CT	5/4/2018
Head Redundant X Acceleration	AC-P51701	ENDEVCO 7264CT	5/4/2018
Head Redundant Y Acceleration	AC-P45019	ENDEVCO 7264CT	5/4/2018
Head Redundant Z Acceleration	AC-P51690	ENDEVCO 7264CT	5/4/2018
Upper Neck X Force	LC-280FxGFE	Denton IF-205	11/7/2017
Upper Neck Y Force	LC-280FyGFE	Denton IF-205	11/7/2017
Upper Neck Z Force	LC-280FzGFE	Denton IF-205	11/7/2017
Upper Neck X Moment	LC-280MxGFE	Denton IF-205	11/7/2017
Upper Neck Y Moment	LC-280MyGFE	Denton IF-205	11/7/2017
Upper Neck Z Moment	LC-280MzGFE	Denton IF-205	11/7/2017
Lower Neck X Force	N/A	N/A	N/A
Lower Neck Y Force	N/A	N/A	N/A
Lower Neck Z Force	N/A	N/A	N/A
Lower Neck X Moment	N/A	N/A	N/A
Lower Neck Y Moment	N/A	N/A	N/A
Lower Neck Z Moment	N/A	N/A	N/A
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	-