

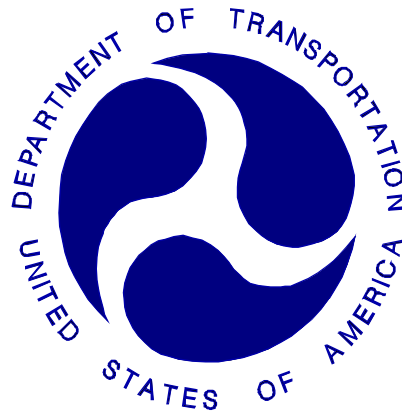
REPORT NUMBER: TWG-CAL-12-02

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

TOYOTA MOTOR MANUFACTURING, INDIANA, INC.
2012 TOYOTA SIENNA
MINIVAN

NHTSA NUMBER: QC5100-TWG2
CALSPAN TEST NUMBER: CT2012-02

CALSPAN
TRANSPORTATION SCIENCES CENTER
P.O. BOX 400
BUFFALO, NEW YORK 14225



March 29, 2012

FINAL 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. DTNH22-08-D-00088, Alpha Technology PO 3GC164. 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.

Prepared By: _____
Edward Dutton, Project Engineer

Approved By: _____
David Travale, Program Manager
Technical Director, Test Operations

Approval Date: _____

FINAL REPORT ACCEPTANCE BY:

Accepted By: _____

Acceptance Date: _____

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. TWG-CAL-12-02	2. Government Accession No.	3. Recipient's Catalog No.				
4. Title and Subtitle Final Report 2012 , TWG/Out-of-Position Tests NHTSA No.: QC5100TWG2		5. Report Date				
		6. Performing Organization Code CAL				
7. Author(s) Edward Dutton, Project Engineer David Travale, Program Manager		8. Performing Organization Report No. CT2012-02				
9. Performing Organization Name and Address Calspan Corporation Transportation Sciences Center P.O. Box 400 Buffalo, New York 14225		10. Work Unit No.				
		11. Contract or Grant No. DTNH22-08-D-00088				
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, March 29, 2012				
		14. Sponsoring Agency Code NVS-111				
15. Supplementary Notes						
16. Abstract This side impact Out-Of-Position test was performed in conjunction with a New Car Assessment Program (NCAP). This test was conducted at the Calspan Test Facility in Buffalo, New York, on February 17, 2012.						
Injury Summary						
HIC15	Maximum Chest Displacement (mm)	Maximum Chest Displacement Rate (m/s)	NIJ(NTF)	NIJ(NTE)	NIJ(NCF)	NIJ(NCE)
4.822	N/A	N/A	0.034	0.042	0.055	0.253
17. Key Words New Car Assessment Program (NCAP) Side Airbag Out-Of-Position			18. Distribution Statement <u>Copies of this report are available from:</u> Alpha Technology Associate, Inc 2810 Old Lee Hwy, Suite 120 Fairfax,VA 22031 Phone: (703) 876-0010 Fax: (703) 876-0120 Attn: Mai Lan Aram			
19. Security Classification of Report UNCLASSIFIED		20. Security Classification of Page UNCLASSIFIED		21. No. of Pages 40		22. Price

TABLE OF CONTENTS

<u>Section</u>		<u>Page No.</u>
1	PURPOSE AND SUMMARY OF TEST	1-1
2	DATA SHEETS	2-1
	Data Sheet 1 – Test Summary	2-1
	Data Sheet 2 – Vehicle Parameter Data	2-2
	Data Sheet 3 – Dummy Positioning in Vehicle	2-3
	Data Sheet 4 – Dummy Injury Criteria Values	2-4
A	PHOTOGRAPHS	A-1
B	DUMMY RESPONSE DATA TRACES	B-1
C	TEST EQUIPMENT LIST AND CALIBRATION INFORMATION	C-1

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 undergone a New Car Assessment Program (NCAP) sponsored test requested by the National Highway Traffic Safety Administration (NHTSA). This test was performed following the technical requirements under NHTSA contract No. DTNH22-08-D-00088 and through Alpha Technology Associate, Inc. PO 2GC154. The test was funded under the optional NCAP requirements by the vehicle manufacturer.

1.2 SUMMARY

The effects of both a seat-mounted side airbag and a curtain airbag deployment in a 2012 Toyota Sienna 4-Door Minivan on an out-of-position SIDII (Hybrid III 5th female anthropomorphic test device (ATD)) were evaluated. The test was performed by Calspan on February 17, 2012. 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. One camera was placed perpendicular to the right-front seat centerline to capture the deployment event from the side. The second camera was placed parallel to the right-front seat centerline to capture the deployment event from the front. The third camera was placed $\frac{3}{4}$ to the front to also capture the deployment event.

The SID-II 5th female anthropomorphic test device (ATD) was placed in the right front (passenger) seat situated parallel to the centerline of the seat, facing forward. This was placed following the ATD 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 specific test was section 3.3.5.2.

The female ATD was instrumented with head x, y and z accelerometers (primary and redundant). In addition, upper six axial neck force, and moment load cell sensors were utilized. Please note that the supplied ATD did not come with a lower six axial neck force and moment load cell sensor nor could one be installed.

Seventeen 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.

The 5th female ATD was placed facing forward with its midsagittal plane parallel to the vehicle centerline but shifted outboard (to the right) until the outer pelvis contacted the right side seat cushion bolster. The upper torso was then tipped outboard to move the head outboard into the expected path of the deploying head curtain air bag. The seat track was then adjusted to locate the head c.g. under the expected deployment location of a head curtain chamber to maximize the airbag to head interaction. The overriding placement decision is to place the ATD in the expected worst case location. The placement decisions were made after consultation with the program monitor. The location was determined by observing test data from a previous left side impact test on the previous model year vehicle. This orientation complies with section 3.3.5.2 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 2

DATA SHEET NO. 1 TEST SUMMARY

TEST CONFIGURATION INFORMATION:

Seating Position:	P2	Right Front Seating Position
Test:	3.3.5.2	Front Facing SID-IIs on Raised Seat (Driver and Passenger Positions with Roof-Rail-Mounted Airbags)
Airbag:	Seat	Seat mounted – outside seam
Airbag:	Side Rail	Side curtain airbag.
Booster Block:	N/A	N/A
ATD Type/Serial No.:	DG 8012	5 th Female SID-IIs

Number of Data Channels:

17

Number of Cameras:

0

Real Time

3

High Speed Digital

0

High Speed Film

VISIBLE DUMMY CONTACT POINTS

Head Contact:	Curtain Airbag
Upper Torso Contact:	Torso Airbag
Lower Torso Contact:	None
Left Knee Contact:	None
Right Knee Contact:	None

DATA SHEET NO. 2
VEHICLE PARAMETER DATA

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style: 2012 Toyota Sienna Four Door Mini Van

NHTSA No. : QC5100TWG2 ; VIN: 5TDJK3DC6CS032568 Color: Light Grey/Silver

Engine Data: V6 cylinders; - CID; 3.5 Liters; - cc

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

Transmission Data: 6 speeds; - Manual; X Automatic; X Overdrive

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

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

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

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

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

Date Received: 12/13/2011 ; Odometer Reading 162.5 Km

Selling Dealer: Lebrun Toyota

& Address: 2435 Route 332 Canandaigua, NY 14424

DATA FROM TIRE VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Toyota Motor Manufacturing, Indiana, Inc.

Date of Manufacture 10/11

GVWR: 2,715 kg; GAWR: 1,405 kg FRONT; 1,405 kg REAR

DATA FROM TIRE PLACARD:

Recommended Tire Size: P235/55R18

*Recommended Cold Tire Pressure: 240 Kpa Front 240 kpa Rear

DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: P235/55R18 ; Manufacturer: Bridgestone

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

Treadwear: 400 ; Traction: B ; Temperature: B

VEHICLE CAPACITY DATA:

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

Number of Occupants: 2 Front; 5 Rear; 7 Total

Vehicle Capacity Weight (VCW) = 620 Kg

No. of Occupants x 68.04 kg = 143.7 Kg

Rated Cargo/Luggage Weight (RCLW) = 136.1 Kg

*Tire pressure used for test

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

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

NHTSA No. QC5100-TWG2

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

Seat Back Angle	SA (°)	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)	176
Head to Seat Back Centerline	HSC (mm)	-
Head to B-Pillar (cg)	HB (mm)	314
Head to Roof, Z (top of the head)	HZ (mm)	143
Head to Header	HHD (mm)	346
Chest to Dash	CD (mm)	362
Chest to Seatback	CS (mm)	-
Right Arm to Seat Back Centerline	RACL (mm)	-
Right Arm to Seat Back Centerline	RACL (°)	-
Left Arm to Seat Back Centerline	LACL (mm)	-
Left Arm to Seat Back Centerline	LACL (°)	-
Right Arm to Door Panel	RA (mm)	N/A
Left Arm to Door Panel	LA (mm)	N/A
Knee to Knee	KK (mm)	142
Toe to Toe	TT (mm)	155
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)	-
Nose to Dash	ND (mm)	-
Nose to Seatback	NS (mm)	-
Nose to Header	NR (mm)	-
Foam Block Depth	(mm)	-
Foam Block Width	(mm)	-
Foam Block Thickness	(mm)	-
HD36 foam density	(g/L)	-

DATA SHEET 4

SID-IIs DUMMY INJURY CRITERIA VALUES

NHTSA No.: QC5100-TWG2

Channel	Max	Time (ms)	Min	Time (ms)
V1P2 Head x [g , CFC_1000]	12.252	13.400	-3.289	44.550
V1P2 Head y [g , CFC_1000]	2.554	32.650	-30.136	13.500
V1P2 Head z [g , CFC_1000]	41.948	13.200	-10.244	14.650
V1P2 Head x Redundant [g , CFC_1000]	11.544	13.000	-3.258	45.000
V1P2 Head y Redundant [g , CFC_1000]	2.448	33.000	-27.882	13.000
V1P2 Head z Redundant [g , CFC_1000]	40.185	13.000	-9.928	15.000
V1P2 Headform Resultant [g, CFC_1000]	43.555	13.200	0	0
V1P2 Upper Neck Mocv [N-m, CFC_600]	5.568	8.700	-8.252	47.950
V1P2 Upper Neck Ntf [N-m, CFC_600]	0.034	9.300	0	0
V1P2 Upper Neck Nte [N-m, CFC_600]	0.025	226.350	0	0
V1P2 Upper Neck Ncf [N-m, CFC_600]	0.055	7.500	0	0
V1P2 Upper Neck Nce [N-m, CFC_600]	0.253	52.300	0	0
V1P2 Upper Neck Nij [Nij, CFC_600]	0.253	52.000	0	0
V1P2 Upper Neck Fx [N , CFC_1000]	85.969	14.900	-42.491	153.950
V1P2 Upper neck Fy [N , CFC_1000]	77.902	178.650	-96.302	111.800
V1P2 Upper neck Fz [N , CFC_1000]	89.249	3.950	-619.916	17.150
Input: V1P2 NEKU Fx F (32), V1P2 NEKU Fy F (33)	620.223	17.000	0	0
V1P2 Upper Neck Mx [N-m , CFC_600]	4.133	172.750	-18.952	76.650
V1P2 Upper Neck My [N-m , CFC_600]	6.925	8.600	-8.435	31.000
V1P2 Upper Neck Mz [N-m , CFC_600]	1.896	174.050	-3.215	88.300
Input: V1P2 NEKU Mx F (35), V1P2 NEKU My F (36)	20.281	76.000	0	0
Curtain Volts	32.031	1.000	0	0
Torso Volts	28.467	3.000	0	0
Curtain Current	3.396	0	-0.004	14.700
Torso Current	3.384	0	-0.002	21.000

DATA SHEET 4

CHILD DUMMY INJURY CRITERIA VALUES (CONTINUED)

VEHICLE: 2012 Toyota Sienna MiniVan

NHTSA No.: QC5100-TWG2

HEAD INJURY CRITERIA (HIC)

	HIC15			
	HIC(15)	t ₁ (msec)	t ₂ (msec)	Average Acceleration t ₁ to t ₂
Position #2 - Right	4.822	13.05	13.65	35.284

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

Nij V10	Nij	Time (ms)	Z Force (N)	X Force (N)	Y Moment (N-m)
Ntf	0.034	9.30	12.46	70.22	4.84
Nte	0.042	226.35	34.77	7.82	-2.3
Ncf	0.055	7.50	-90.16	79.25	4.87
Nce	0.253	52.30	-562.19	9.72	-7.24

Peak Tension (CFC1000) 89.249 N

Peak Compression (CFC1000) 619.916 N

Critical Values

Nij Intercepts				Peak Limits	
Tension (CVt)	3880 N	Extension (mCVe)	61 N-m	Tension	2070 N
Compression (CVc)	3880 N	Flexion (mCVf)	155 N-m	Compression	2520 N

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

<u>Figure</u>	<u>Photograph Title</u>	<u>Page</u>
Figure A- 1	Right ¾ Front View of Vehicle, As Received	A- 3
Figure A- 2	Vehicle Certification Placard	A- 3
Figure A- 3	Pre-Test Vehicle Left Side View	A- 4
Figure A- 4	Post-Test Vehicle Left Side View	A- 4
Figure A- 5	Pre-Test 5th female SID-IIs Dummy Left Side View	A- 5
Figure A- 6	Post-Test 5th female SID-IIs Dummy Left Side View	A- 5
Figure A- 7	Pre-Test 5th female SID-IIs Dummy Left Side Closeup View	A- 6
Figure A- 8	Post-Test 5th female SID-IIs Dummy Left Side Closeup View	A- 6
Figure A- 9	Pre-Test 5th female SID-IIs Dummy Left ¾ Front View	A- 7
Figure A- 10	Post-Test 5th female SID-IIs Dummy Left ¾ Front View	A- 7
Figure A- 11	Pre-Test 5th female SID-IIs Dummy Left ¾ Front Closeup View	A- 8
Figure A- 12	Post-Test 5th female SID-IIs Dummy Left ¾ Front Closeup View	A- 8
Figure A- 13	Pre-Test 5th female SID-IIs Dummy Front View	A- 9
Figure A- 14	Post-Test 5th female SID-IIs Dummy Front View	A- 9
Figure A- 15	Pre-Test 5th female SID-IIs Dummy Front Closeup View	A- 10
Figure A- 16	Pre-Test 5th female SID-IIs Dummy Right Side View	A- 10
Figure A- 17	Post-Test Curtain Airbag Left Side View	A- 11
Figure A- 18	Post-Test Curtain Airbag Left ¾ Front View	A- 11
Figure A- 19	Post-Test Curtain Airbag Front View	A- 12
Figure A- 20	Post-Test Curtain Airbag Right Side View	A- 12



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

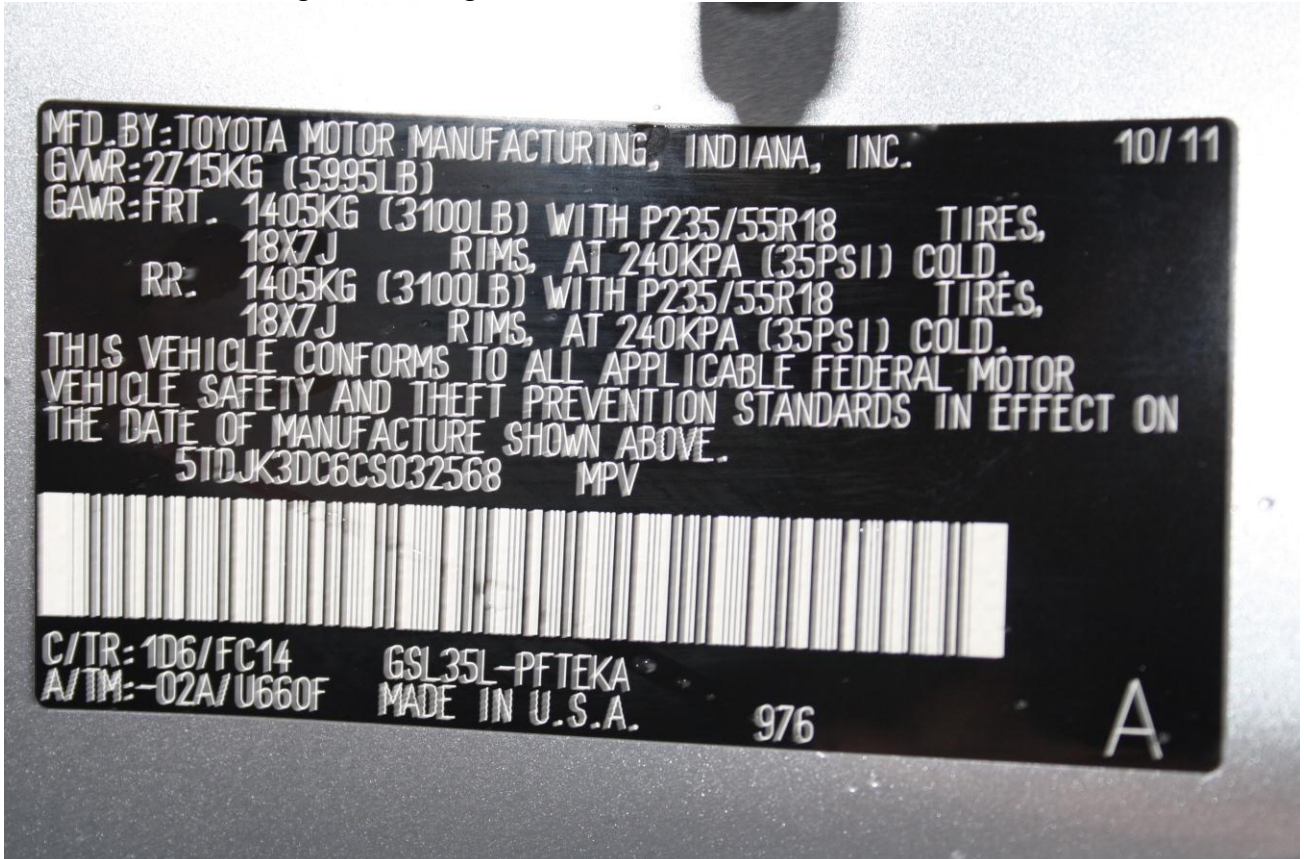


Figure A-2: Vehicle Certification Placard



Figure A-3: Pre-Test Vehicle Left Side View



Figure A-4: Post-Test Vehicle Left Side View



Figure A-5: Pre-Test 5th female SID-IIs Dummy Left Side View



Figure A-6: Post-Test 5th female SID-IIs Dummy Left Side View



Figure A-7: Pre-Test 5th female SID-II's Dummy Left Side Close-up View



Figure A-8: Post-Test 5th female SID-II's Dummy Left Side Close-up View



Figure A-9: Pre-Test 5th female SID-IIIs Dummy Left $\frac{3}{4}$ Front View



Figure A-10: Post-Test 5th female SID-IIIs Dummy Left $\frac{3}{4}$ Front View



Figure A-11: Pre-Test 5th female SID-III Dummy Left $\frac{3}{4}$ Front Close-up View



Figure A-12: Post-Test 5th female SID-III Dummy Left $\frac{3}{4}$ Front Close-up View



Figure A-13: Pre-Test 5th female SID-II's Dummy Front View



Figure A-14: Post-Test 5th female SID-II's Dummy Front View



Figure A-15: Pre-Test 5th female SID-IIs Dummy Front Close-up View



Figure A-16: Pre-Test 5th female SID-IIs Dummy Right Side View



Figure A-17: Post-Test Curtain Airbag Left Side View



Figure A-18: Post-Test Curtain Airbag Left $\frac{3}{4}$ Front View



Figure A-19: Post-Test Curtain Airbag Front View



Figure A-20: Post-Test Curtain Airbag Right Side View

Photo Not Available

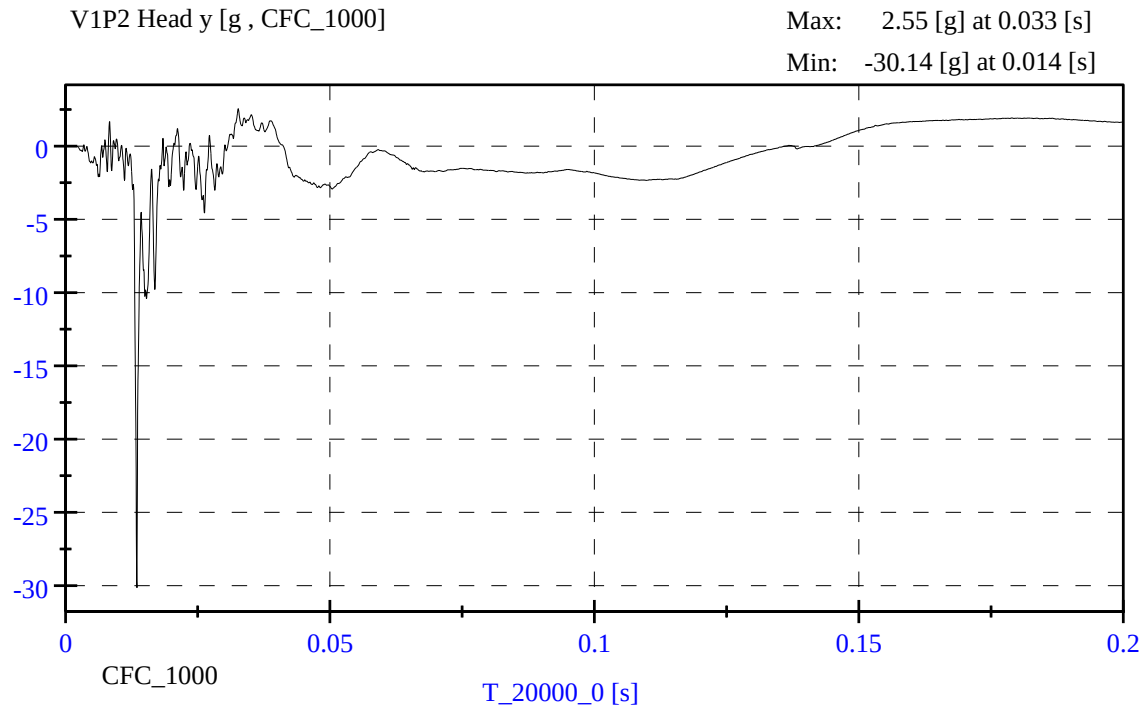
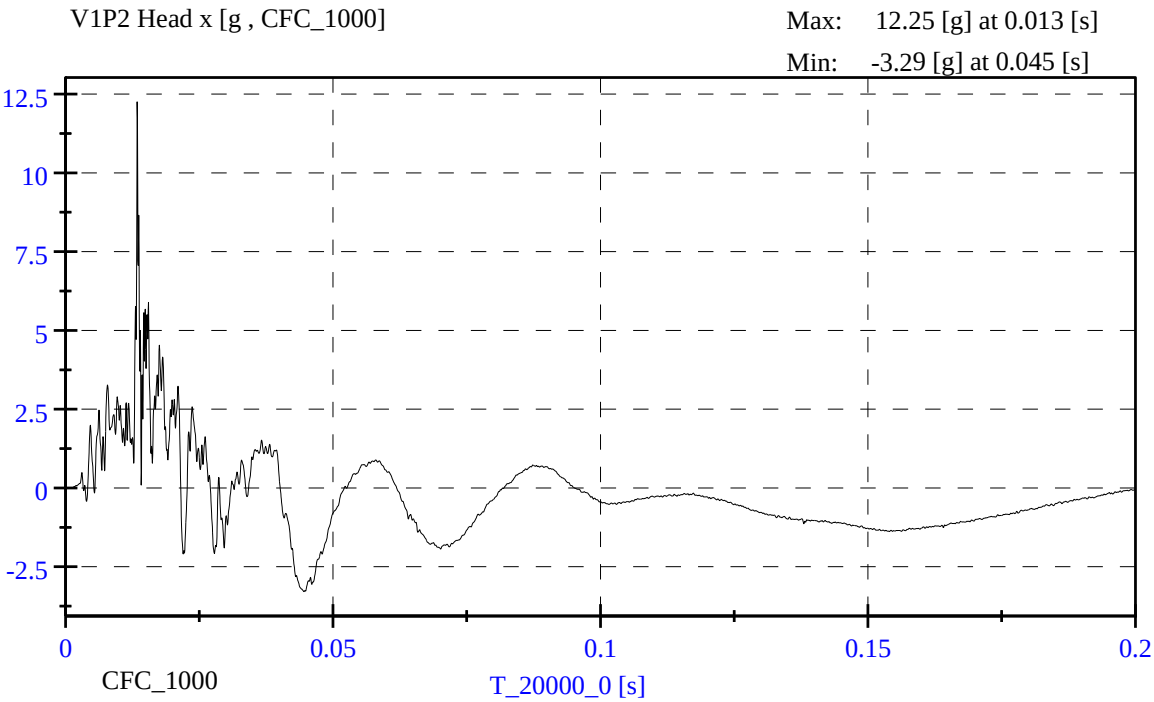
Figure A-21: Side Airbag View

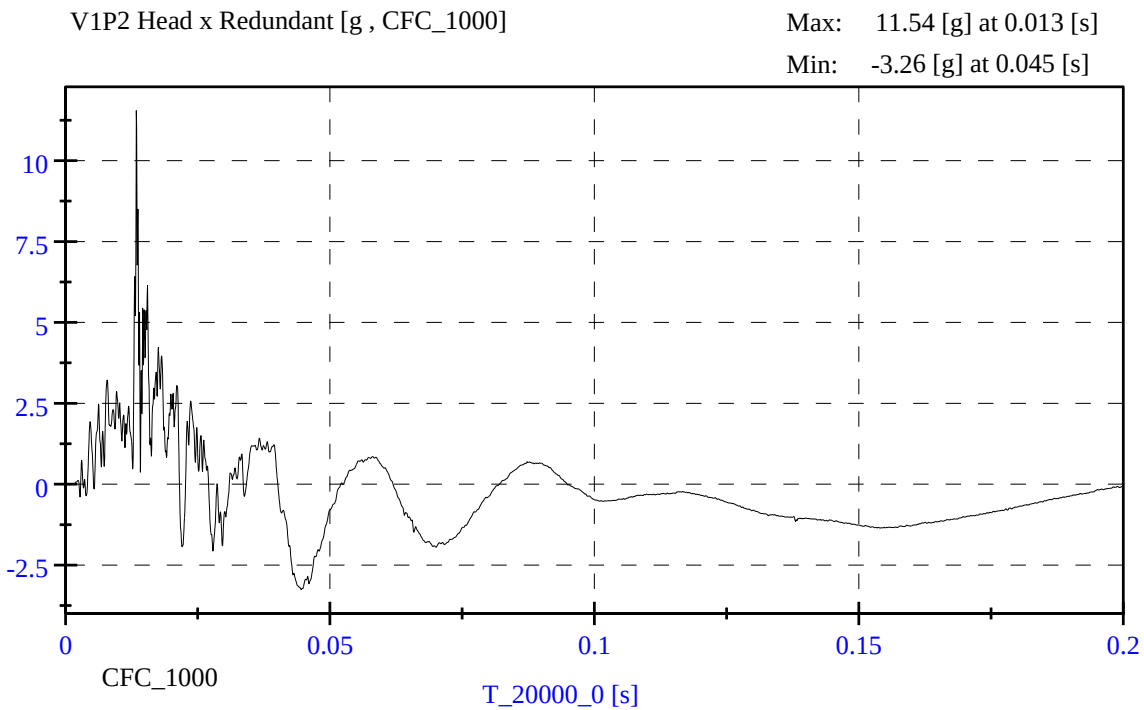
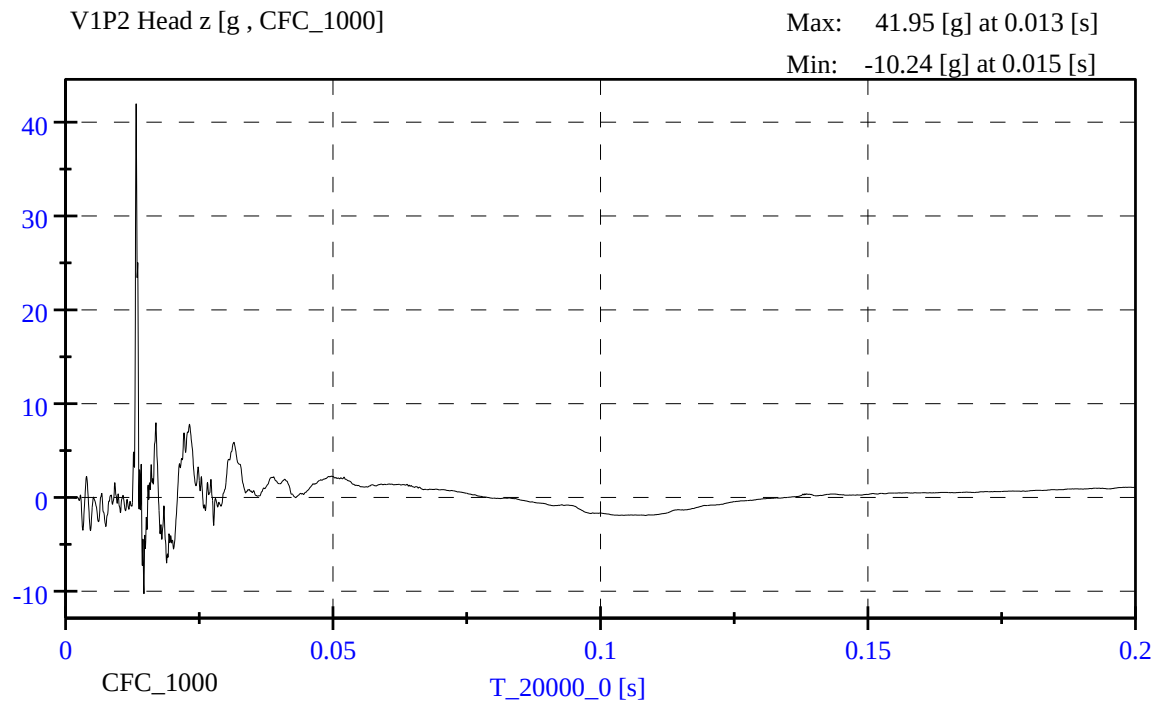
APPENDIX B

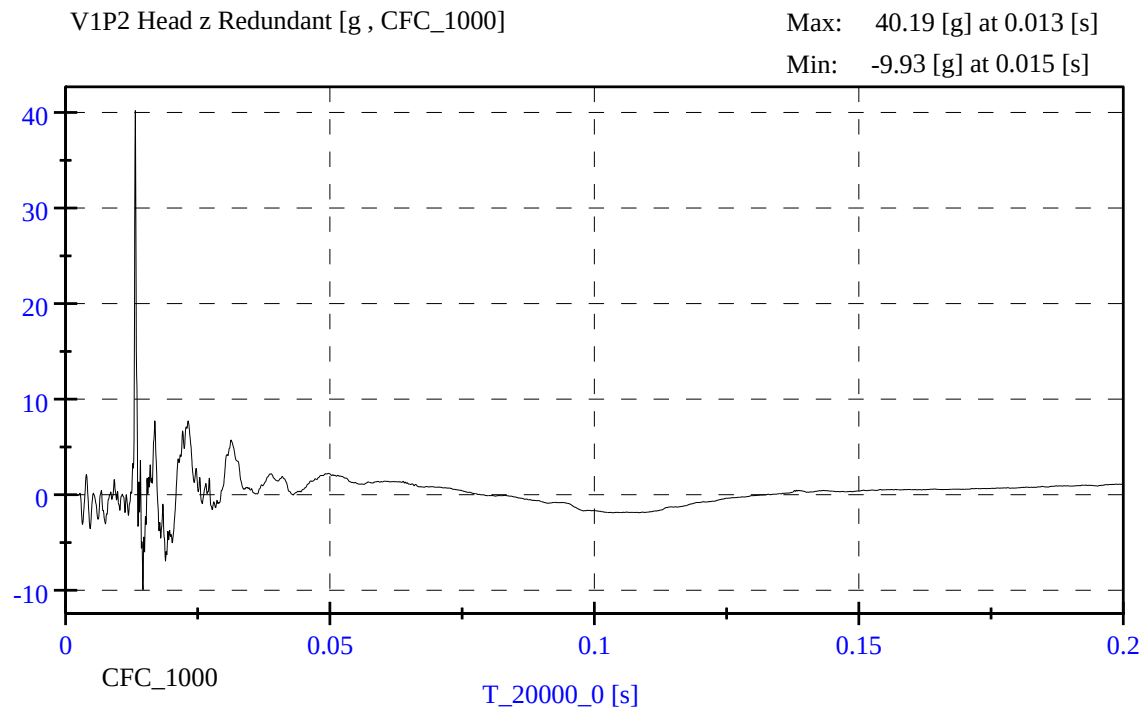
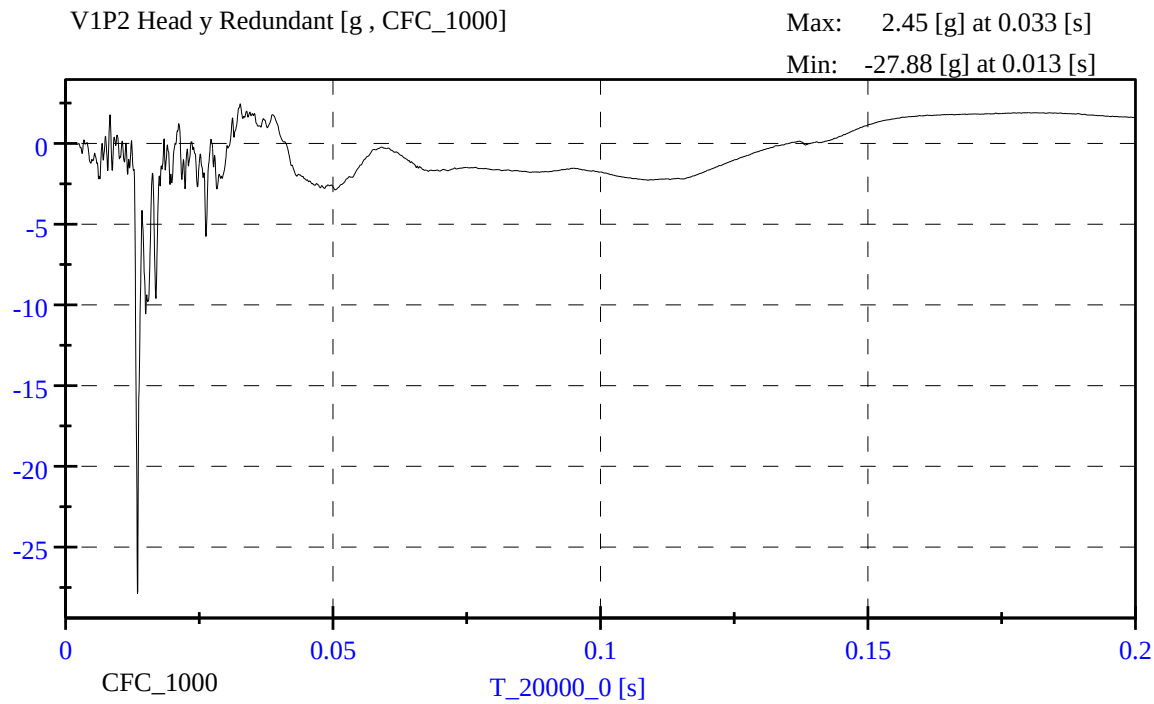
SID-IIs RESPONSE DATA TRACES

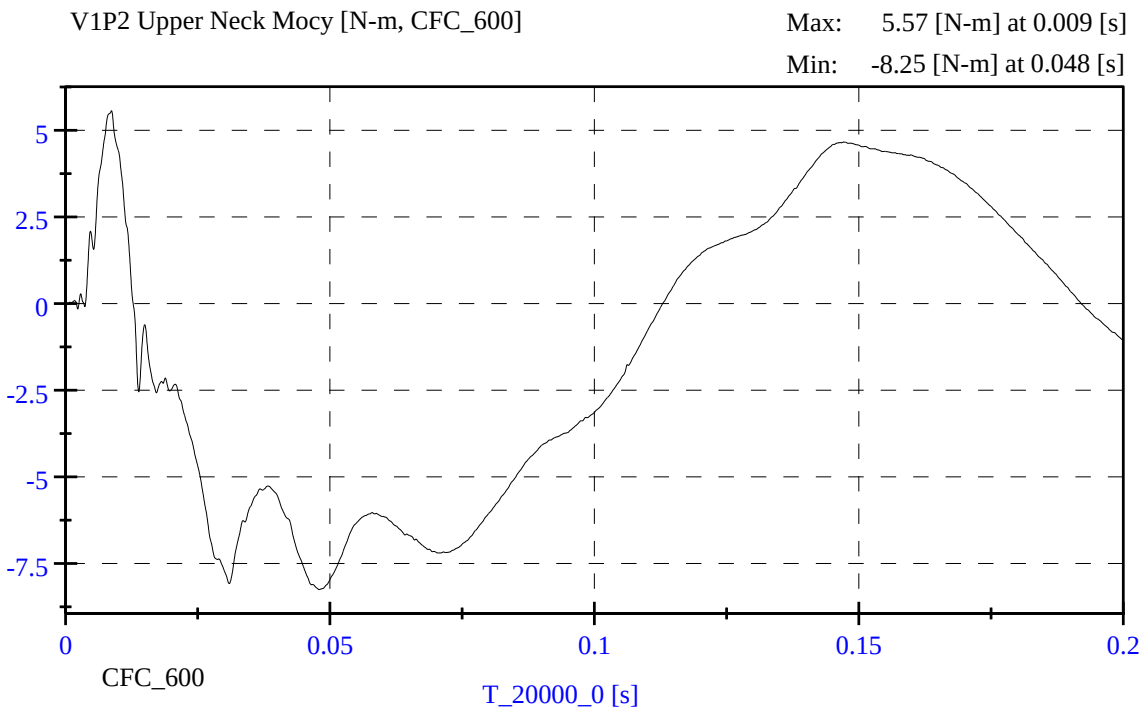
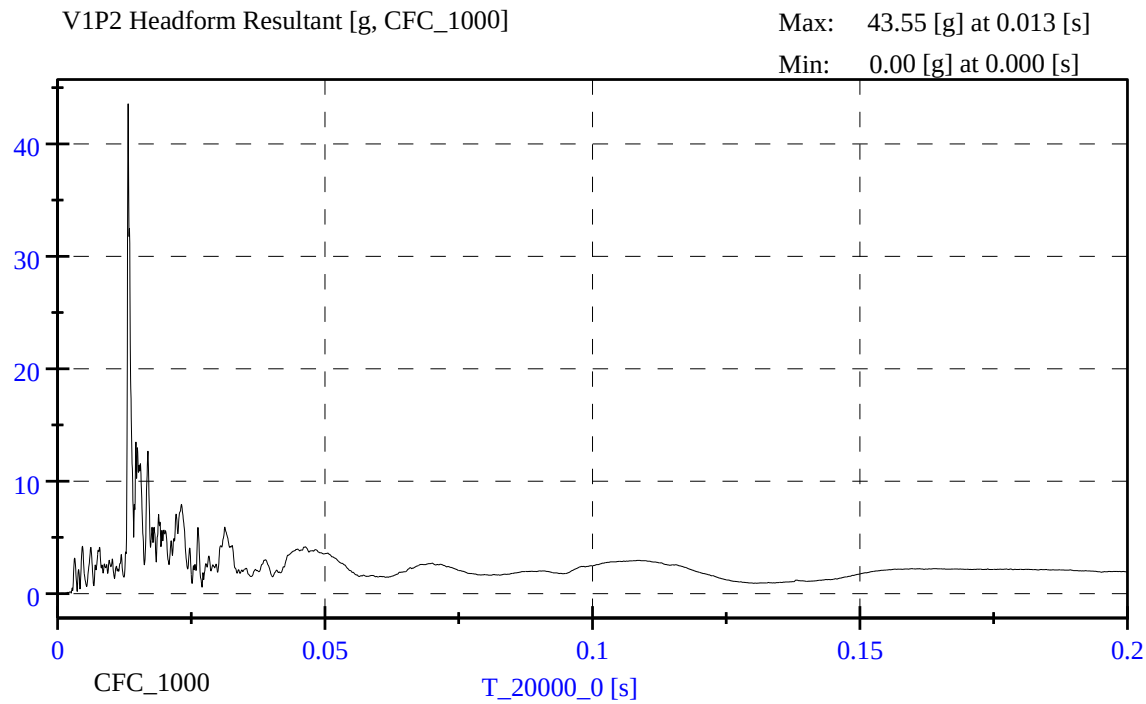
Table of Data Plots

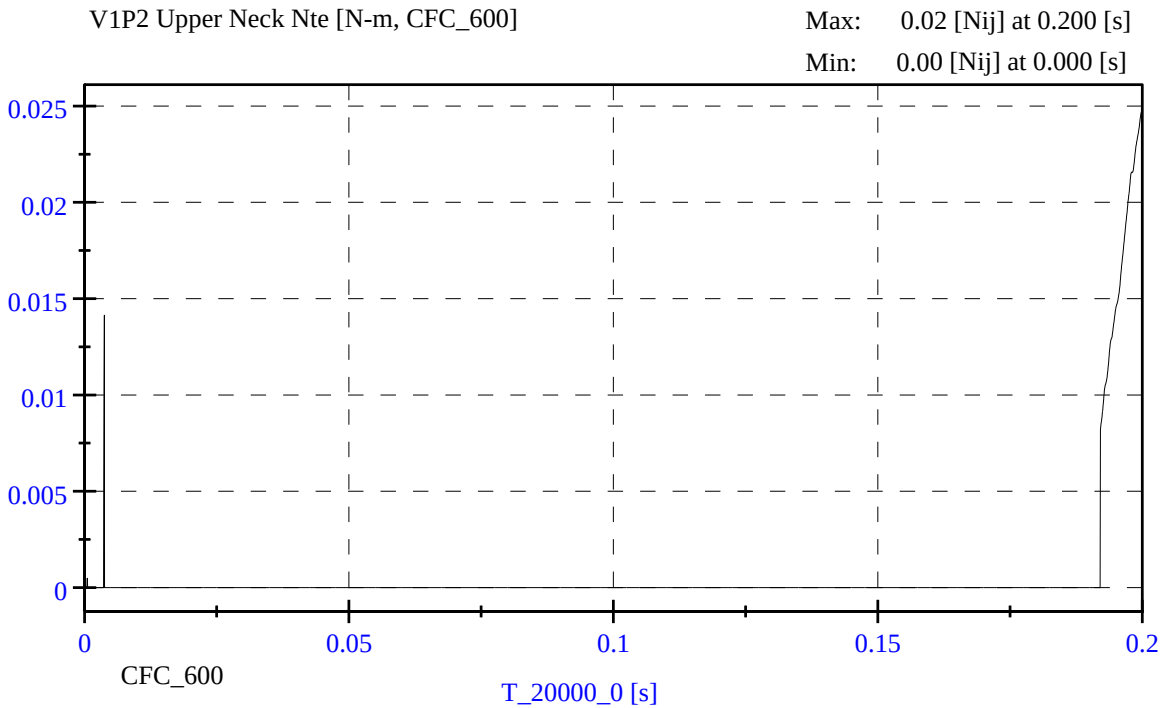
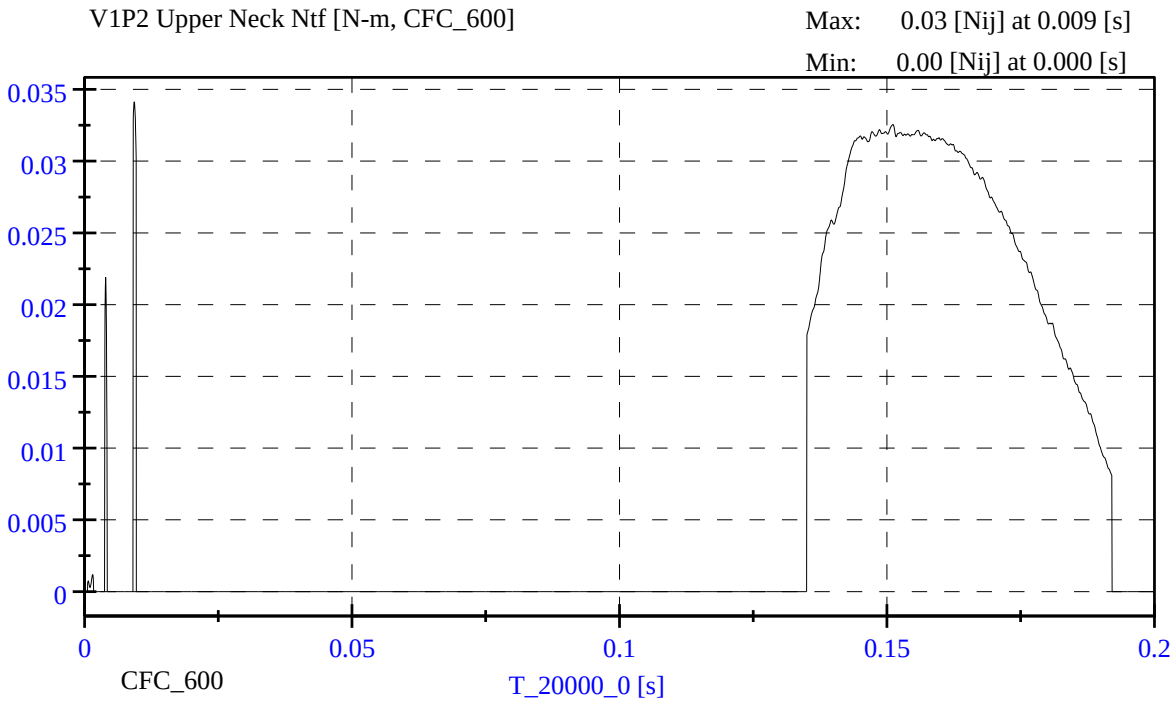
No.	Description	Page
1	V1P2 Head x [g , CFC_1000]	B-3
2	V1P2 Head y [g , CFC_1000]	B-3
3	V1P2 Head z [g , CFC_1000]	B-4
4	V1P2 Head x Redundant [g , CFC_1000]	B-4
5	V1P2 Head y Redundant [g , CFC_1000]	B-5
6	V1P2 Head z Redundant [g , CFC_1000]	B-5
7	V1P2 Headform Resultant [g , CFC_1000]	B-6
8	V1P2 Upper Neck Mocy [N-m, CFC_600]	B-6
9	V1P2 Upper Neck Ntf [N-m, CFC_600]	B-7
10	V1P2 Upper Neck Nte [N-m, CFC_600]	B-7
11	V1P2 Upper Neck Ncf [N-m, CFC_600]	B-8
12	V1P2 Upper Neck Nce [N-m, CFC_600]	B-8
13	V1P2 Upper Neck Nij [Nij, CFC_600]	B-9
14	V1P2 Upper Neck Fx [N , CFC_1000]	B-9
15	V1P2 Upper neck Fy [N , CFC_1000]	B-10
16	V1P2 Upper neck Fz [N , CFC_1000]	B-10
17	Input: V1P2 NEKU Fx F (32), V1P2 NEKU Fy F (33)...	B-11
18	V1P2 Upper Neck Mx [N-m , CFC_600]	B-11
19	V1P2 Upper Neck My [N-m , CFC_600]	B-12
20	V1P2 Upper Neck Mz [N-m , CFC_600]	B-12
21	Input: V1P2 NEKU Mx F (35), V1P2 NEKU My F (36)...	B-13
22	Curtain Volts	B-13
23	Torso Volts	B-14
24	Curtain Current	B-14
25	Torso Current	B-15

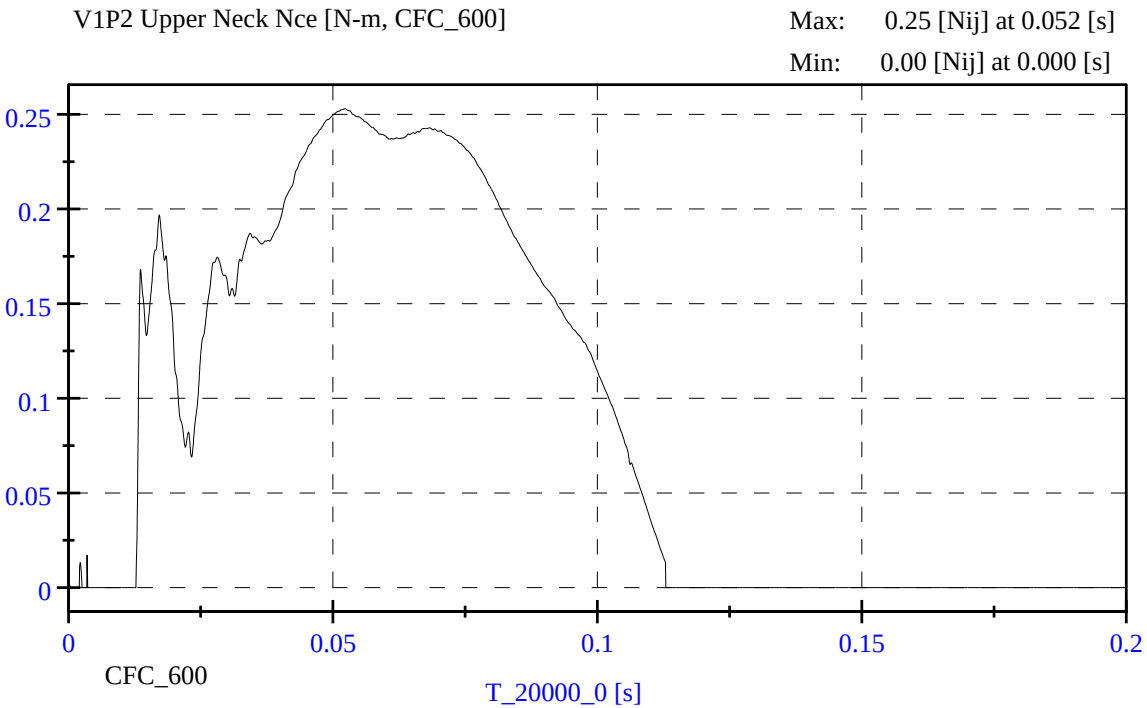
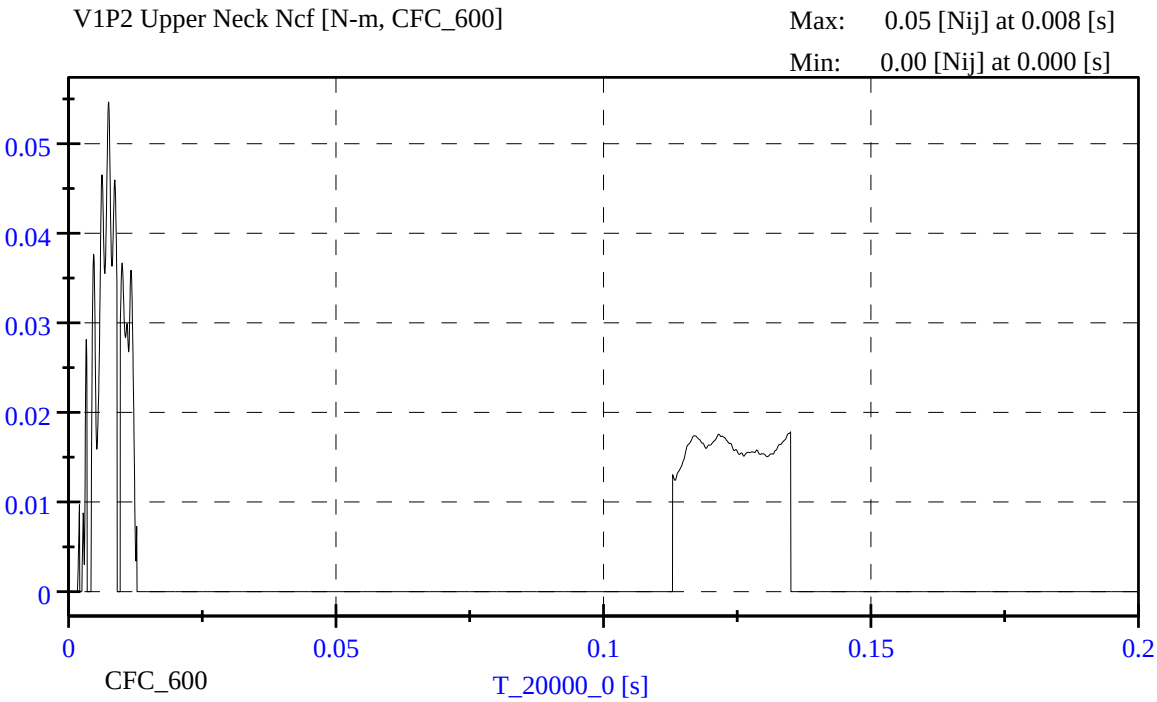


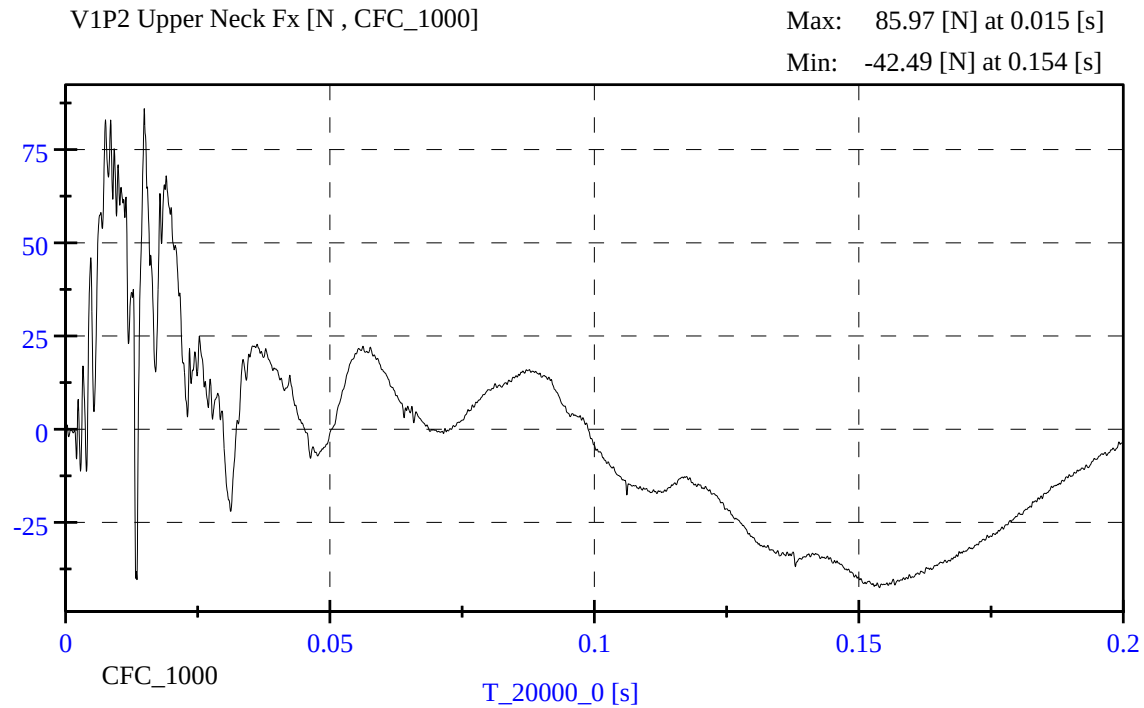
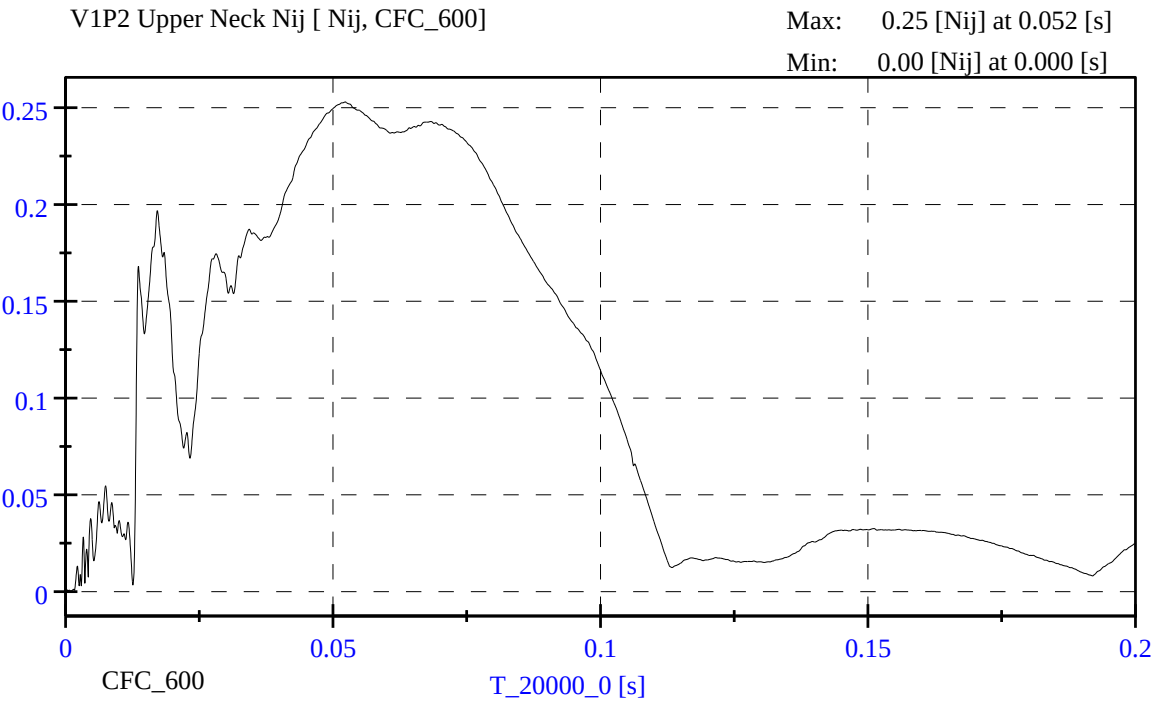


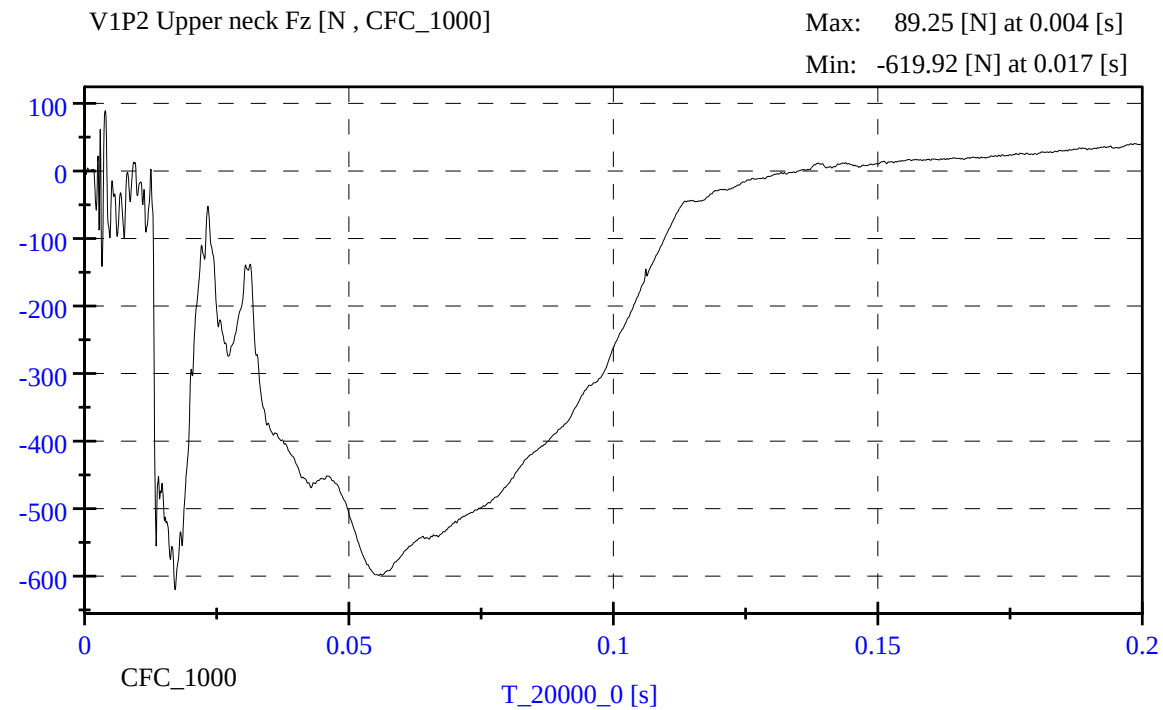
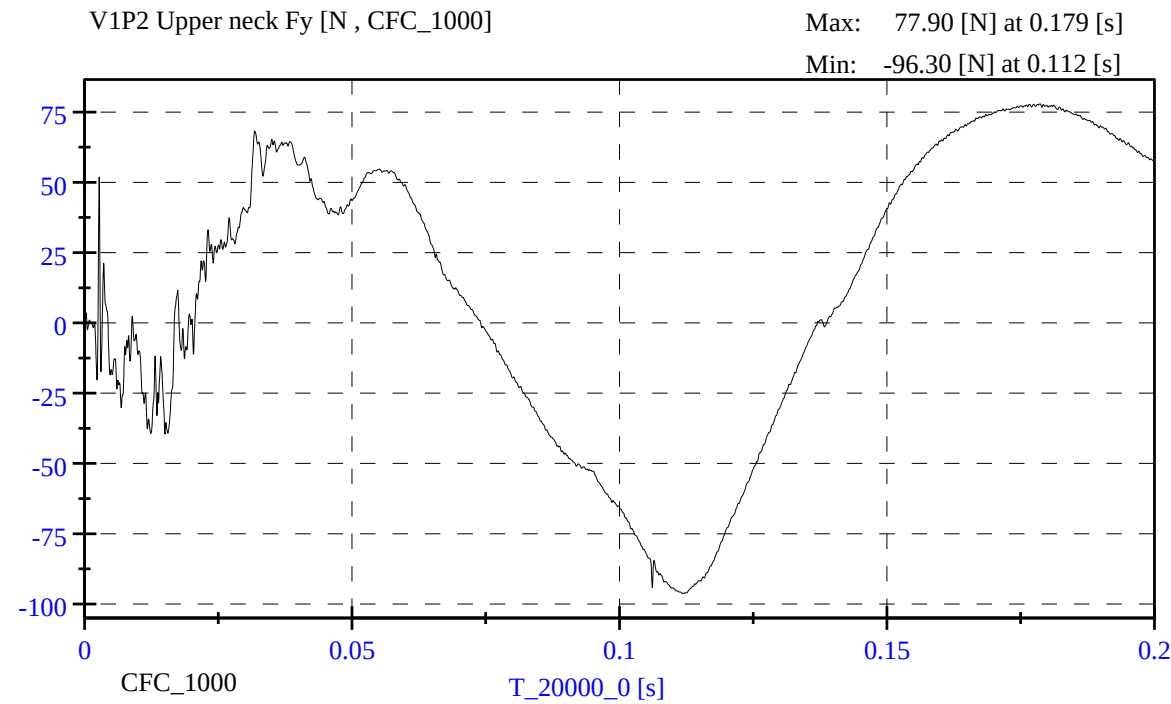


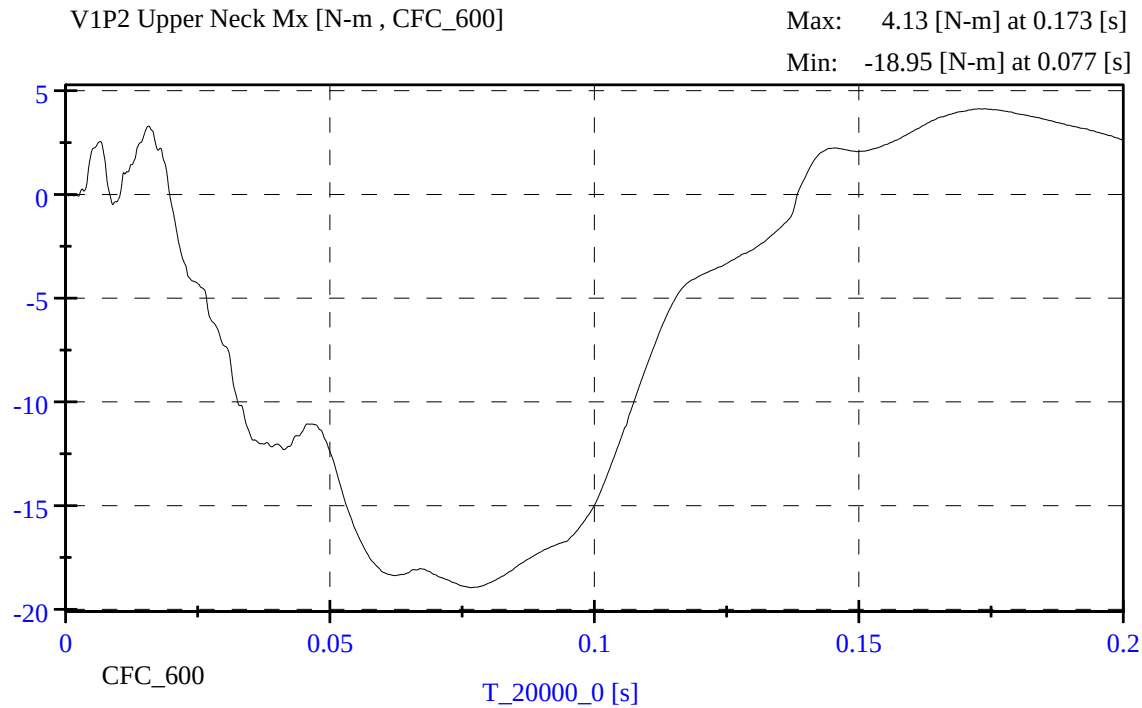
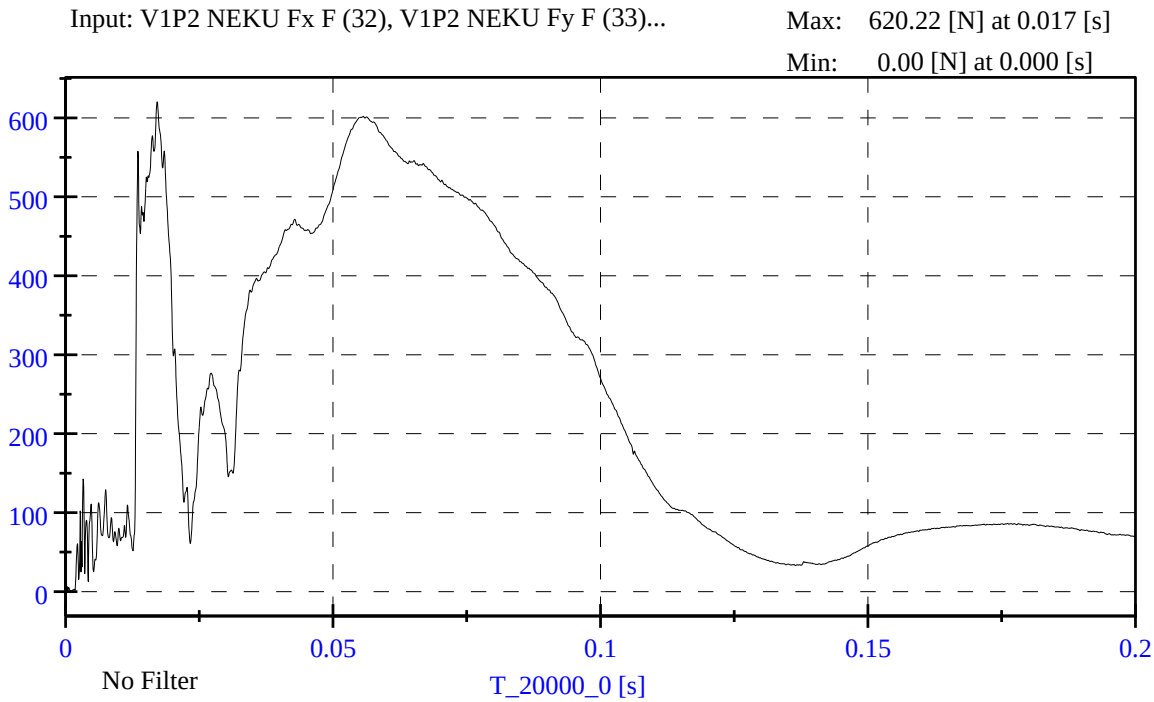


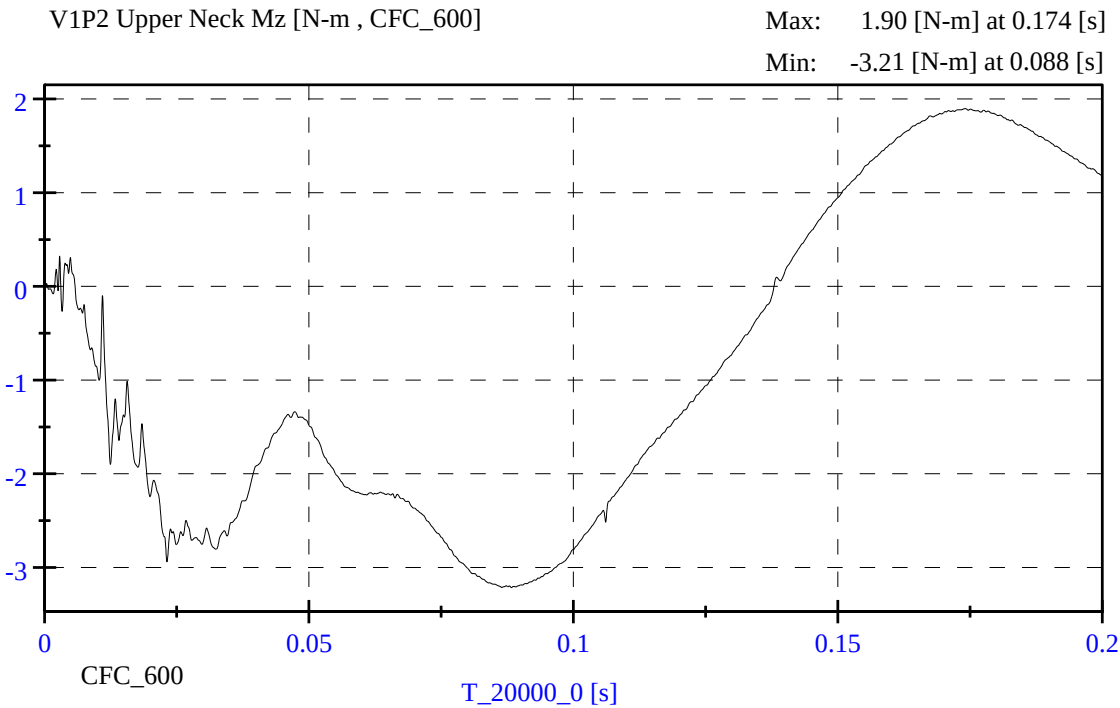
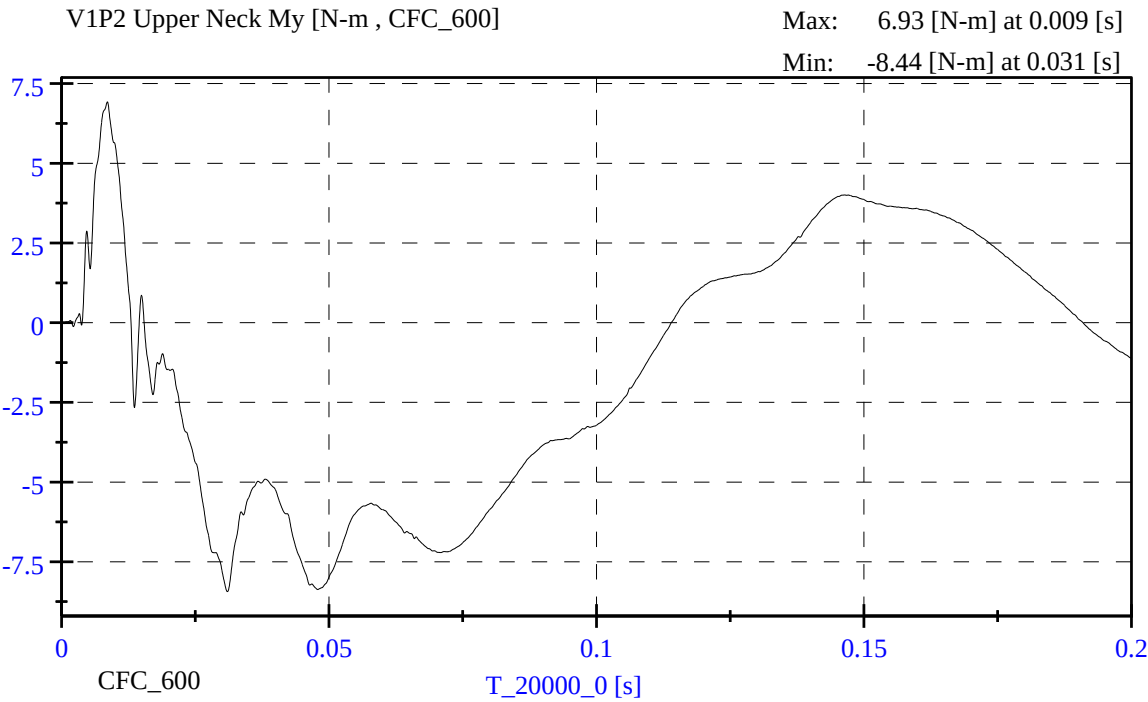


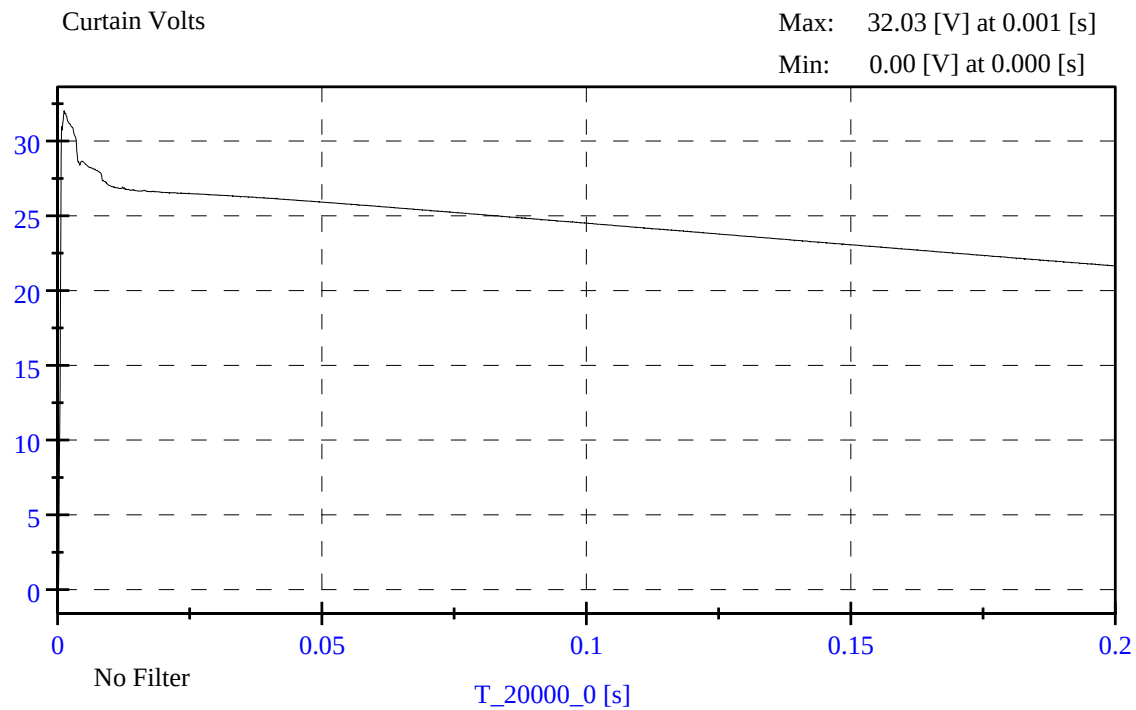
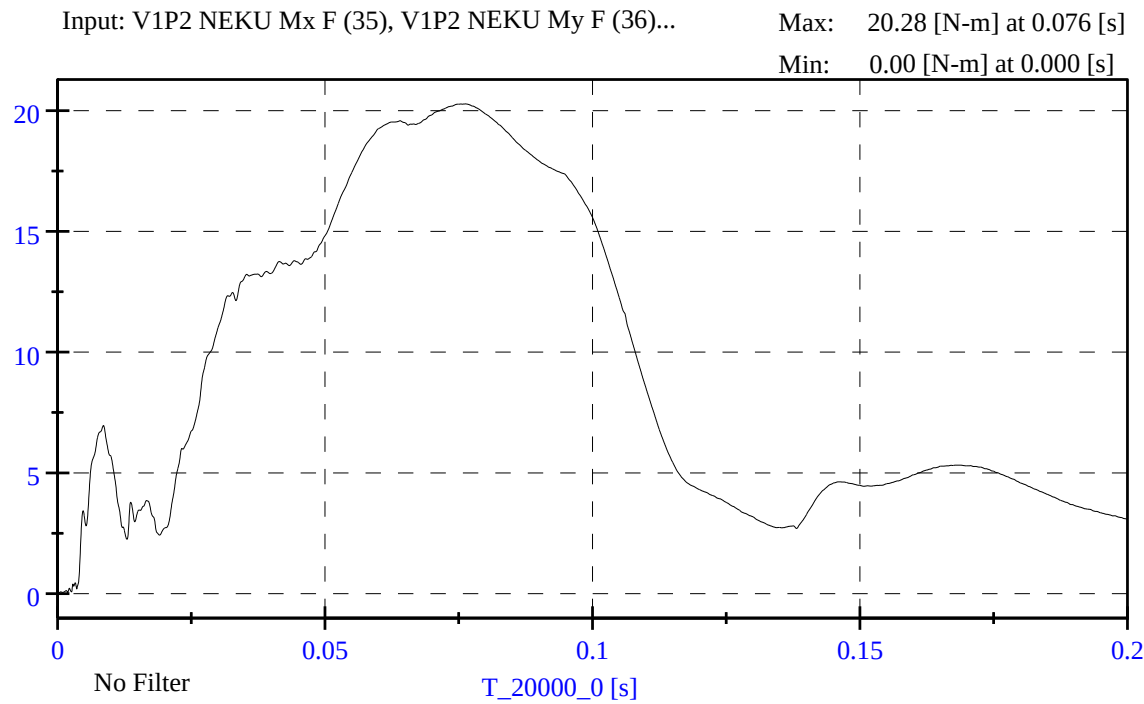


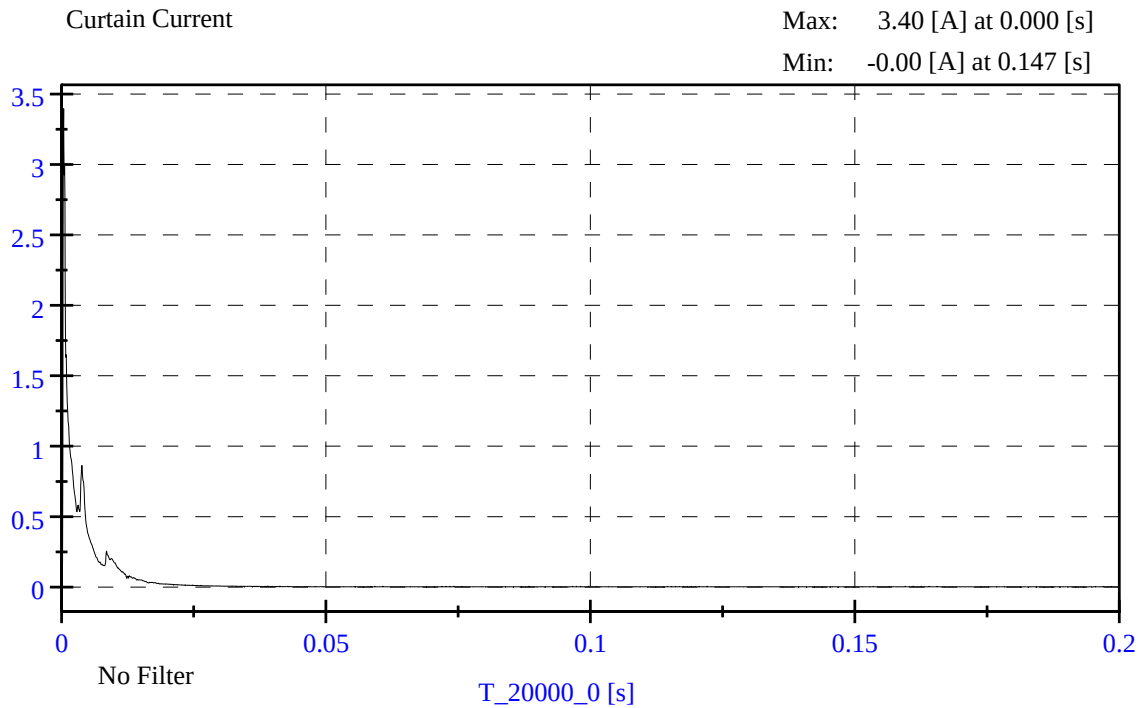
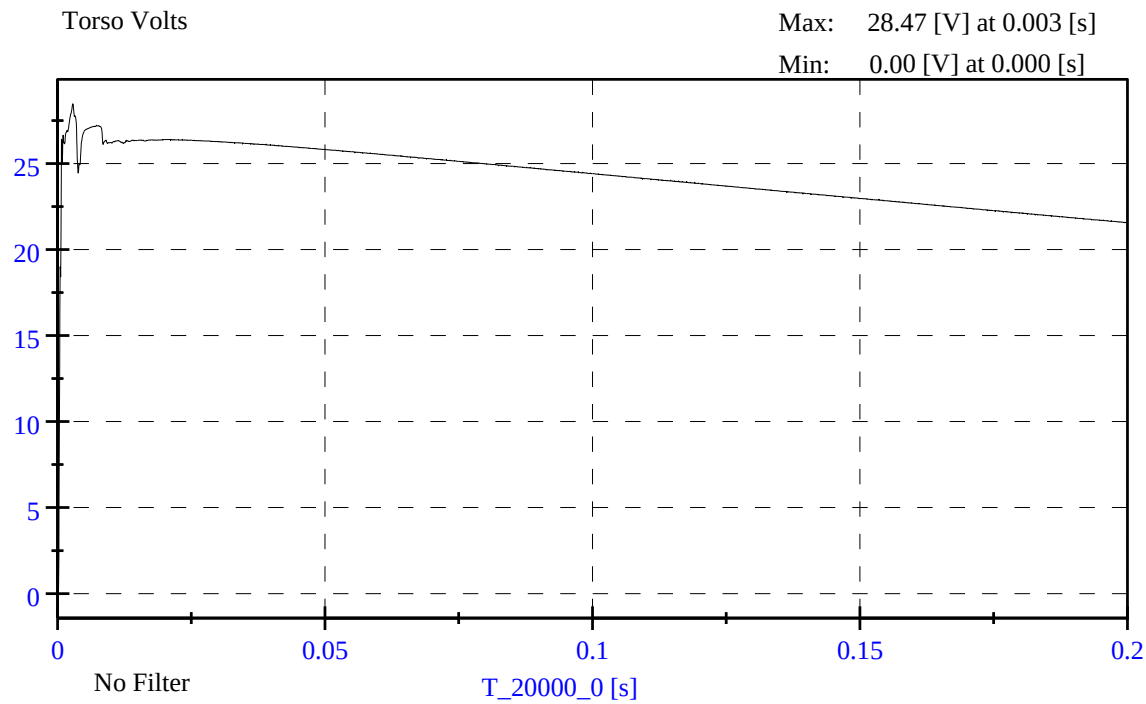


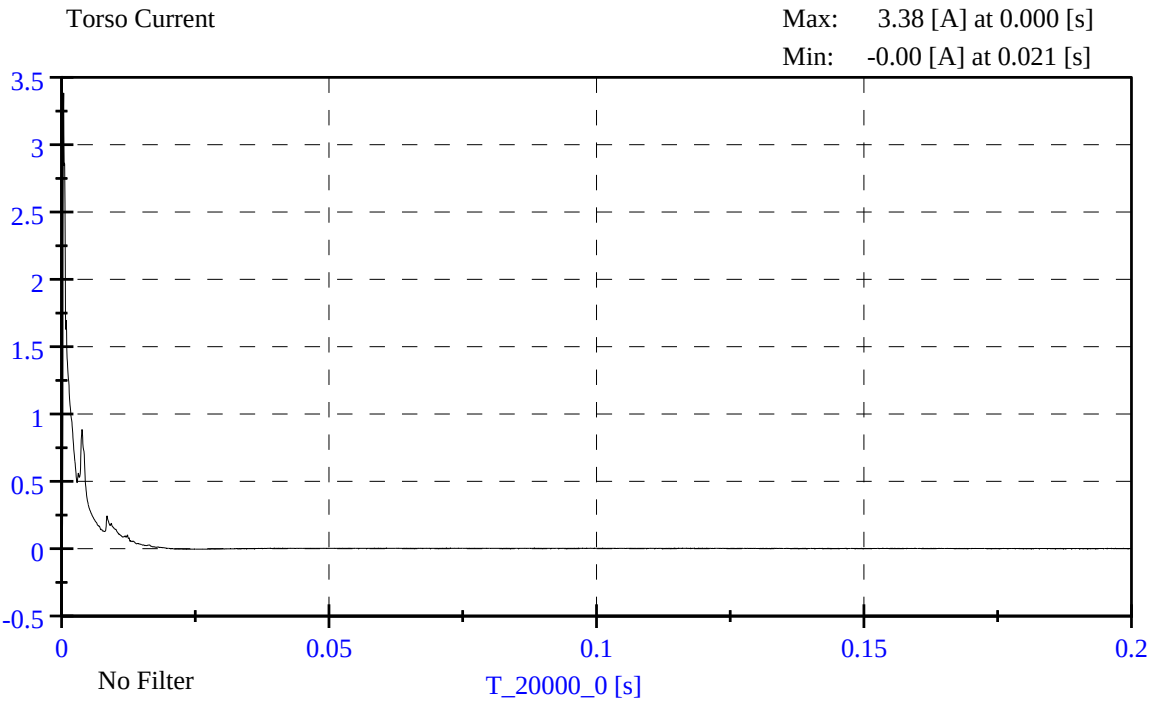












APPENDIX C

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

P572C INSTRUMENTATION

	POSITION #2 (RIGHT) SERIAL NO.: MC5401TWG2		
	SERIAL NUMBER	MANUFACTURER	CALIBRATION DATE
HEAD AX	P49185	ENDEVCO	11/3/2011
HEAD AY	AC-P51949	ENDEVCO	2/13/2012
HEAD AZ	P51991	ENDEVCO	10/17/2011
HEAD RedAX	P68058	ENDEVCO	10/17/2011
HEAD RedAY	AC-P51994	ENDEVCO	10/17/2011
HEAD RedAZ	P68059	ENDEVCO	10/17/2011
UPPER NECK FX	2192Fx	DENTON	8/31/2011
UPPER NECK FY	2192Fy	DENTON	8/31/2011
UPPER NECK FZ	2192Fz	DENTON	8/31/2011
UPPER NECK MX	2192Mx	DENTON	8/31/2011
UPPER NECK MY	2192My	DENTON	8/31/2011
UPPER NECK MZ	2192Mz	DENTON	8/31/2011
Torso Bag Voltage	N/A	N/A	6/21/2011
Curtain Bag Voltage	N/A	N/A	6/21/2011
Torso Bag Curent	N/A	N/A	6/21/2011
Curtain Bag Current	N/A	N/A	6/21/2011