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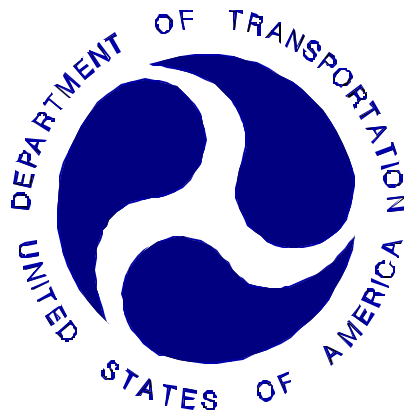
NEW CAR ASSESSMENT PROGRAM (NCAP)
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING

2004 HYUNDAI XG350

NHTSA NUMBER: M40503TWG2

GENERAL DYNAMICS TEST NUMBER: 8642-TWG-06

GENERAL DYNAMICS
ADVANCED INFORMATION ENGINEERING SERVICES
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April 8, 2004

FINAL REPORT

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Rulemaking
Office of Crashworthiness Standards
Mail Code: NVS-111
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Washington, DC 20590

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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 General Dynamics Advanced Information Engineering Services Crash Test Facility in Buffalo, New York, on April 8, 2004.							
Injury Summary							
HIC15	HIC36	Clip (g's)	Chest Displacement (mm)	NIJ NTF	NIJ NTE	NIJ NCF	NIJ NCE
680.5	680.5	56.4	-5.8	0.92	0.36	0.73	0.26
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SECTION 1

PURPOSE AND SUMMARY OF TEST M40503TWG2

1.1 PURPOSE

The purpose of this test was to obtain data in a static out-of-position side impact. These data constitute part of the general consumer information collected by the New Car Assessment Program (NCAP) sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract No. DTNH22-01-D-32005.

1.2 SUMMARY

The effects of a seat mounted side airbag deployment in a 2004 Hyundai XG350 with an out-of-position three-year-old child were evaluated. The test was performed by General Dynamics Advanced Information Engineering Services on April 8, 2004. Pre-and post-test photographs of the vehicle and dummy can be found in Appendix A.

One high-speed digital camera was used to document the side airbag deployment event. The camera was placed in line with the right-front seat centerline as to capture the deployment event. The recorded image rate is 1000 frames per second.

One part 572, Hybrid III three-year-old child anthropomorphic test device (ATD), was placed in the right front seat situated in the forward facing position 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 child dummy was instrumented with head, chest, and pelvic triaxial accelerometers. In addition, chest displacement and upper and lower six axial neck force and moment load cell sensors were utilized.

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

The Hybrid III three-year-old child dummy's visible contact points were as follows: The airbag to the back of the head and back of the right side of the torso of the ATD.

The three-year-old child dummy was placed on a booster block and oriented in the forward facing position on the outboard portion of the seat cushion. The right side window was raised and the seatback was set to the manufacturer's design position for a fiftieth percentile male dummy. The seat was placed in the lowest height position and the seat tracks were set in mid-position because the full rearward position could not be achieved due to the car being previously used in an NCAP 35 mph frontal barrier impact. The dummy's spine was aligned with the leading edge of the seat bolster with the head placed between but not in contact with the seat bolster and the B-Pillar with the neck/torso junction aligned vertically with the top edge of the airbag module. The dummy legs were aligned so that they crossed the heel placement points at a location of 20 to 20 mm from the leading edge of the seat cushion and 75 mm to either side of the seat cushion centerline. The dummy's heels were in line with leading edge of the seat cushion. The dummy's right arm was placed on the arm rest with the forearm and hand aligned along the armrest. The dummy's left arm was in contact with the seatback with the left forearm located such that the fingertips contacted the booster seat. This orientation complies with section 3.3.3.1 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 dated July 2003.

SECTION 2

DATA SHEET NO. 1

TEST SUMMARY

TEST CONFIGURATION INFORMATION:

	TEST DATA	DESCRIPTION
Seating Position:	P2	Right Front Seating Position
Test:	3.3.3.1*	Forward facing Hybrid-III 3-year-old child dummy on booster block
Airbag:	Seatback	Seatback side airbag
Booster Block	300mm x 450 mm x 75 mm	Block consisted of HD36 foam with a density of 44.8 g/L
ATD Type/Serial No.:	P572P/044	Hybrid III three-year-old child dummy

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

<u>Number of Data Channels</u>	23	
<u>Number of Cameras:</u>	0	<u>Real Time</u>
	1	<u>High Speed Digital</u>
	0	<u>High Speed Film</u>

VISIBLE DUMMY CONTACT POINTS

Head Contact:	The back of the head was struck by the airbag during deployment
Upper Torso Contact:	The back of the right side of the torso.
Lower Torso Contact:	The back of the right side of the torso.
Left Knee Contact:	None
Right Knee Contact:	None

DATA SHEET 2

VEHICLE PARAMETER DATA

TEST VEHICLE INFORMATION:

Year/Make/Model/Body Style : 2004 Hyundai XG350 4-Door Sedan

NHTSA No. : M40503 ; VIN: KMHFU45E64A311695‡ ; Color: gold

Engine Data: 6 cylinders; - CID; 3.5 Liters; - cc

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

Transmission Data: 5 Seeds; - 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.Strg.; X Pwr. Brakes

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

Date Received: 12/04/03 ; Odometer Reading 50 km

Selling Dealer: Towne Hyundai

& Address: 3525 Southwestern Blvd., Orchard Park, NY 14127

DATA FROM TIRE VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Hyundai Motor Company

Date of Manufacture SEP/16/03

GVWR: 2120 kg; GAWR: 1230 kg FRONT; 1095 kg REAR

DATA FROM TIRE PLACARD:

Recommended Tire Size: P205/60R16

* Recommended Cold Tire Pressure: 230 kPa FRONT; 210 kPa REAR

DATA FROM TIRE SIDEWALL:

Size of Tires on Test Vehicle: P205/60R16 ; Manufacturer: Michelin

Tire Pressure with Maximum Capacity Vehicle Load: Front: 340 kPa; Rear: 340 kPa

Treadwear: 400 ; 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) = 390.1 kg

No. of Occupants x 68.04 kg = 340.2 kg

Rated Cargo/Luggage Weight (RCLW) = 49.9 kg

*Tire pressure used for test

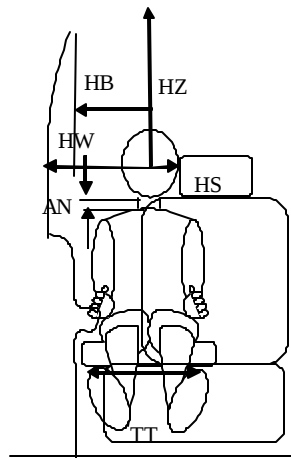
‡ This vehicle had previously been tested in an NCAP 35 mph frontal barrier impact on December 19, 2003.

DATA SHEET NO. 3

CHILD DUMMY POSITIONING IN VEHICLE

NHTSA No. M40503TWG2

Measurements for Seat Mounted Airbags



X-Y View

HZ = Head CG to Roof
 HC = Head CG to C-Pillar
 HB = Head CG to B-Pillar
 HS = Head CG to Seat
 HW = Head CG to Window
 TT = Toe to Toe
 AN = Top of the Airbag Module to the Head/Neck Junction

Measurements for Position #2 (Right Front)	
	Dimension (mm)
HZ	356
HW	126
HC	-
HB	193
HS	113
TT	140
AN	18
Airbag Module Length	200
Airbag Module Width	100
Foam Block Depth ¹	300
Foam Block Width ¹	450
Foam Block Thickness ¹	75

¹ Foam block consisted of HD36 foam material with a density of 44.8 g/L

DATA SHEET 4

CHILD DUMMY INJURY CRITERIA VALUES

NHTSA No. M40503TWG2

DESCRIPTION	Unit	MAXIMUM VALUE			
		Position #2			
		Maximum	Time (ms)	Minimum	Time (ms)
Head X	g	125.0	14.0	-25.3	92.3
Head Y	g	54.8	10.8	-89.5	14.1
Head Z	g	16.6	140.9	-58.1	14.1
Head Resultant	g	162.4	14.1	0.0	-7.8
Head Rear Z	g	68.6	14.6	-141.5	14.0
Upper Neck Fx	N	284.7	17.4	-214.3	175.3
Upper Neck Fy	N	340.8	14.2	-228.4	127.2
Upper Neck Fz	N	1618.3	15.0	-1214.5	130.4
Upper Neck F Resultant	N	1639.0	15.0	0.0	-23.7
Upper Neck Mx	N-m	29.4	138.2	-9.6	101.0
Upper Neck My	N-m	19.3	164.6	-6.4	49.3
Upper Neck Mz	N-m	7.2	141.2	-15.8	39.4
Upper Neck M Resultant	N-m	31.8	139.0	0.0	-6.1
Lower Neck Fx	N	693.0	16.0	-99.6	184.3
Lower Neck Fy	N	137.9	13.0	-224.1	136.8
Lower Neck Fz	N	1689.8	14.8	-1156.2	130.6
Lower Neck F Resultant	N	1799.5	14.8	0.0	-24.9
Lower Neck Mx	N-m	21.4	159.3	-13.9	34.5
Lower Neck My	N-m	30.3	177.2	-26.9	16.2
Lower Neck Mz	N-m	5.8	142.3	-12.6	35.7
Lower Neck M Resultant	N-m	33.2	176.3	0.0	-30.6
Chest X	g	69.7	13.8	-10.9	143.7
Chest Y	g	9.2	9.3	-14.9	19.3
Chest Z	g	16.4	17.3	-9.7	12.0
Chest Resultant	g	69.8	13.8	0.0	-33.8
Chest Displacement	mm	2.1	130.1	-5.8	19.2
Pelvic X	g	10.2	39.5	-5.6	13.2
Pelvic Y	g	2.1	33.1	-4.2	27.2
Pelvic Z	g	15.3	130.3	-27.4	13.5
Pelvic Resultant	g	28.0	13.5	0.0	-25.0

DATA SHEET 4

CHILD DUMMY INJURY CRITERIA VALUES (CONTINUED)

NHTSA No. M40503TWG2

	HEAD INJURY CRITERIA (HIC)							
	HIC15				HIC36			
	HIC	t ₁ (msec)	t ₂ (msec)	Average Acceleration t ₁ to t ₂	HIC	t ₁ (msec)	t ₂ (msec)	Average Acceleration t ₁ to t ₂
Position #2 – Right Front	680.5	9.9	19.9	85.9	680.5	9.9	19.9	85.9

	CLIP SUMMARY*			
	CLIP (g's)	t ₁ (msec)	t ₂ (msec)	CSI
Position #2 – Right Front	56.4	12.4	15.4	211.4

* The maximum chest resultant acceleration is defined as the maximum acceleration which exceeds 0.003 seconds in duration.

Position 2 Neck Injury Summary (HIII 3 year old – Out of Position)

Nij V10	Nij	Time (ms)	Z Force (N)	X Force (N)	Y Moment (N-m)
Ntf	0.92	15.0	1606.7	244.5	11.0
Nte	0.36	49.5	259.1	-103.4	-6.4
Ncf	0.73	130.7	-1212.7	276.8	10.8
Nce	0.26	119.9	-541.4	107.8	0.0

Peak Tension (CFC1000) 1618.3 N

Peak Compression (CFC1000) -1214.3 N

Critical Values

Nij Intercepts				Peak Limits	
Tension (CVt)	2120 N	Extension (mCVe)	27 N-m	Tension	1430 N
Compression (CVc)	2120 N	Flexion (mCVf)	68 N-m	Compression	-1380 N

Condyle Offset 0.0

APPENDIX A

PHOTOGRAPHS

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Figure A-1: Pre-Test Vehicle Left Side View



Figure A-2: Post-Test Vehicle Left Side View



Figure A-3: Vehicle Certification Placard



Figure A-4: Vehicle Tire Placard



Figure A-5: Pre-Test Frontal View of Dummy



Figure A-6: Post-Test Frontal View of Dummy



Figure A-7: Pre-Test Left Side View of Dummy



Figure A-8: Post-Test Left Side View of Dummy



Figure A-9: Pre-Test Right Side View of Dummy



Figure A-9: Post-Test Right Side View of Dummy

APPENDIX B

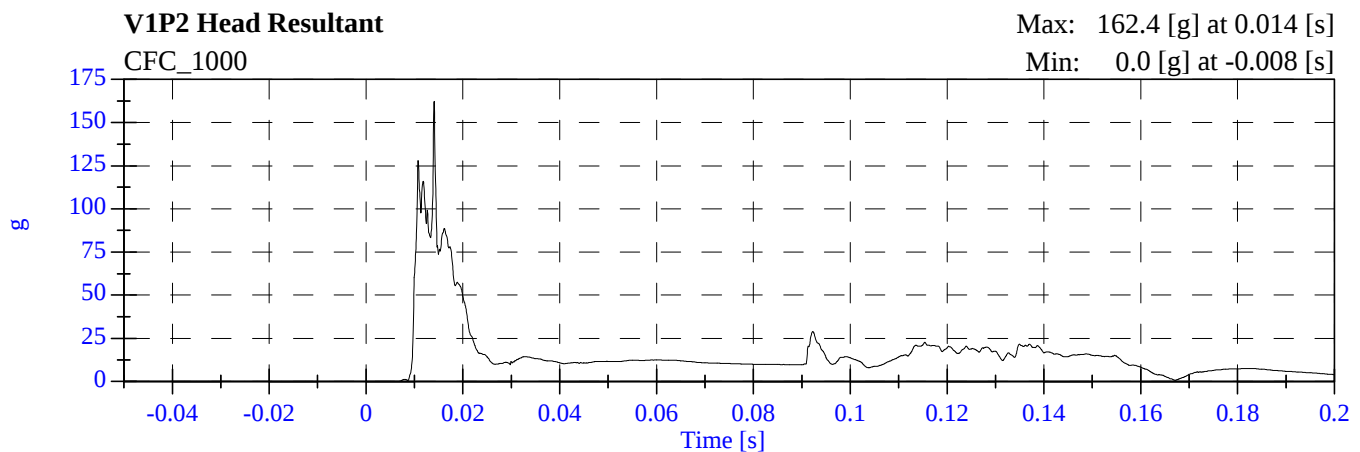
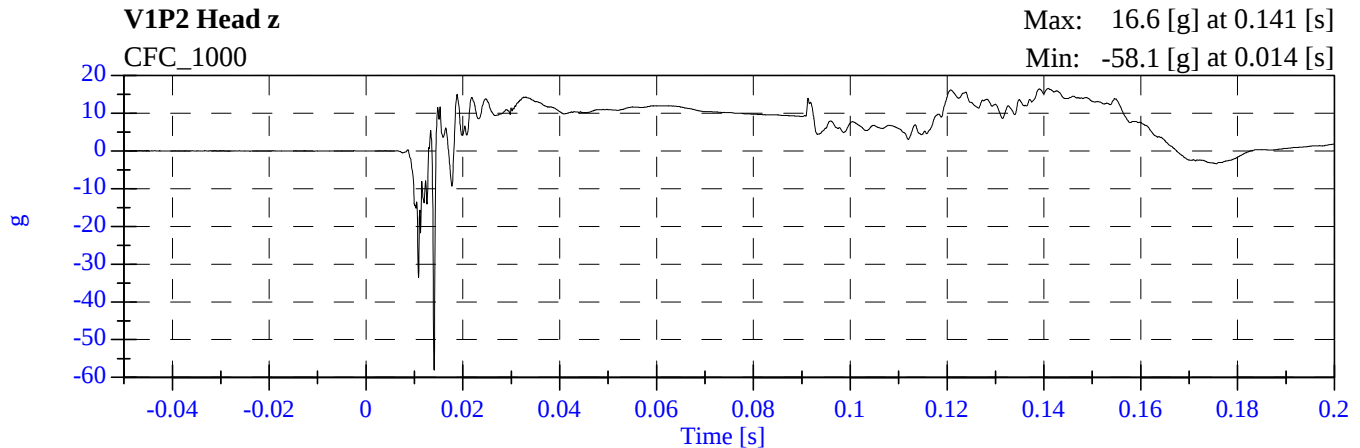
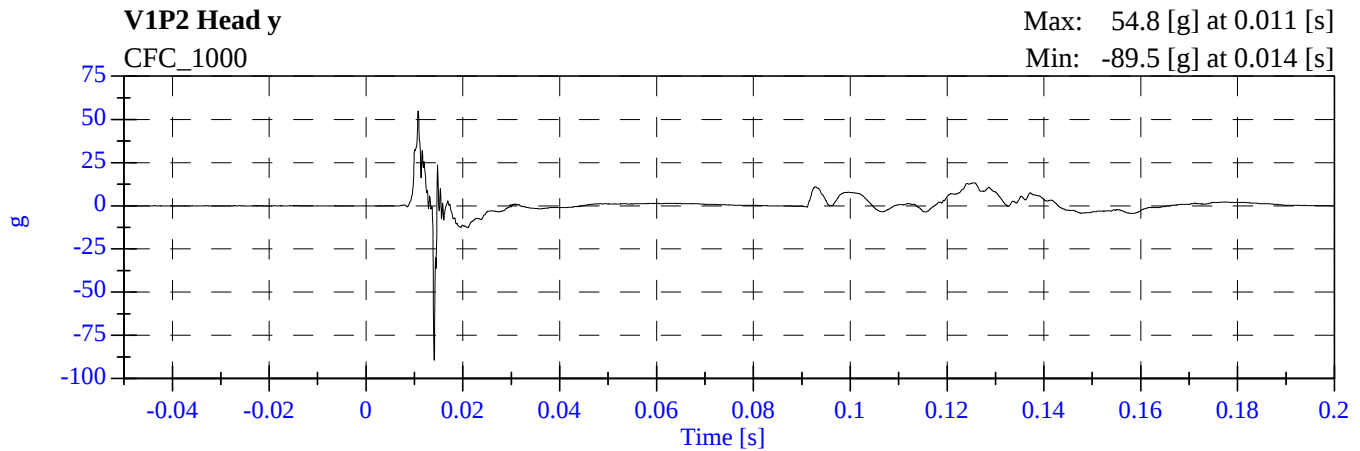
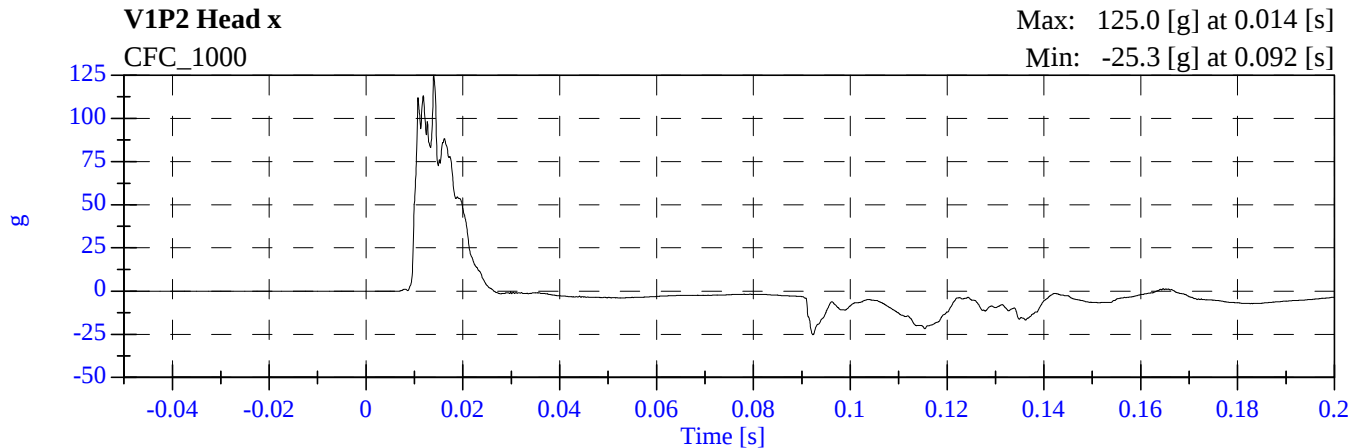
CHILD DUMMY RESPONSE DATA TRACES

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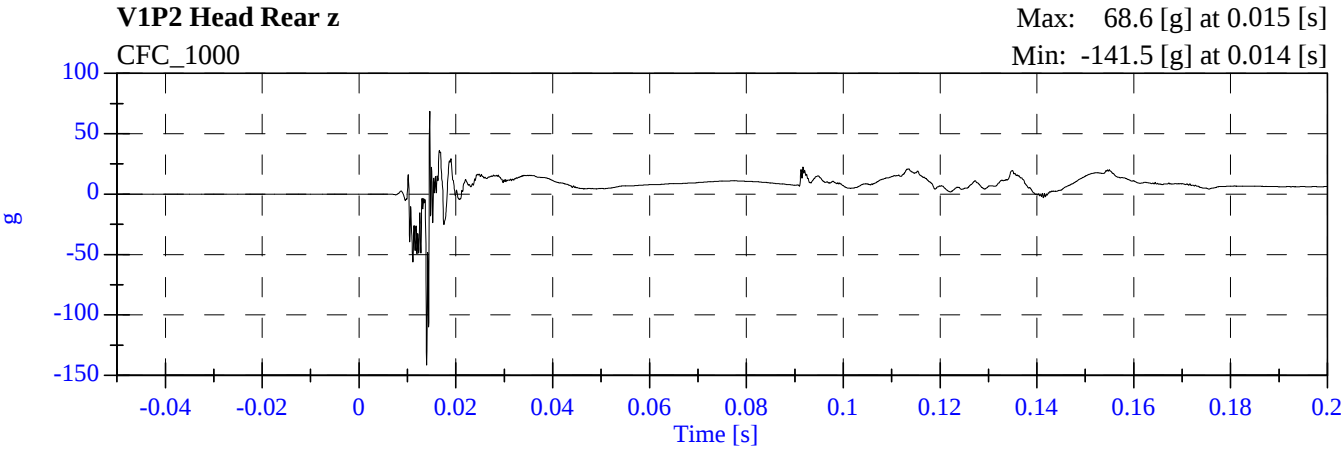
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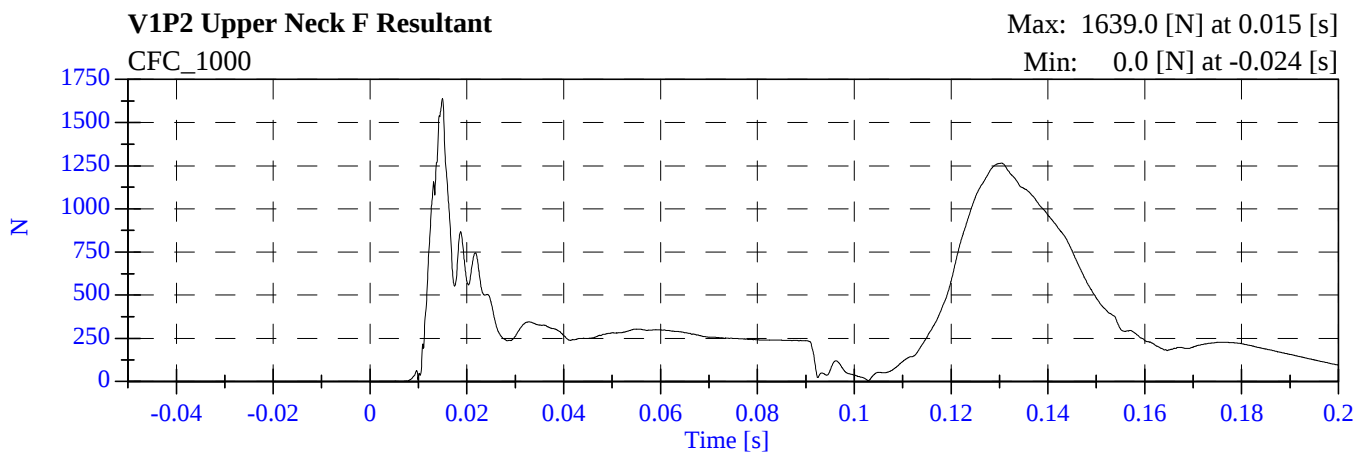
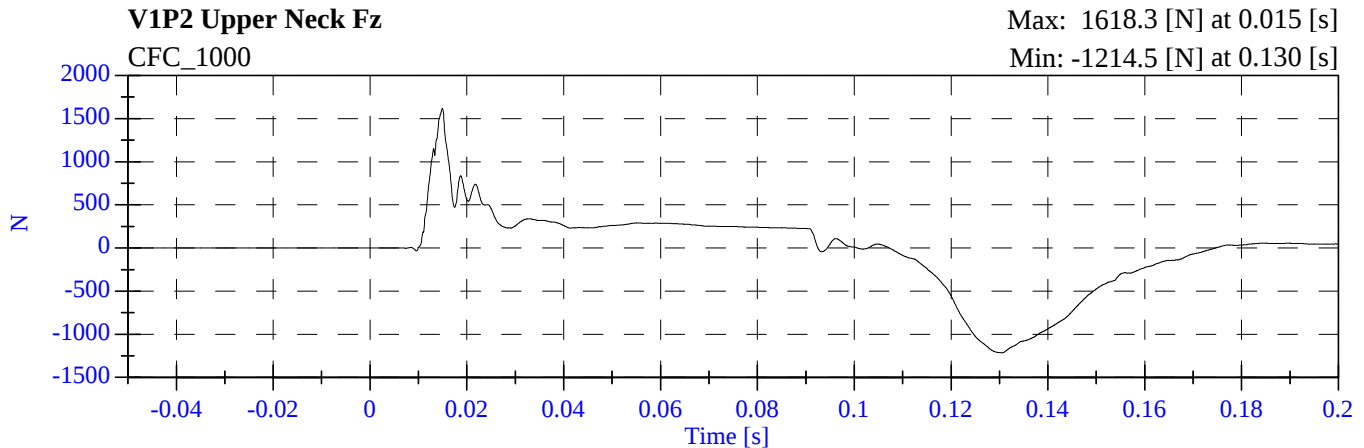
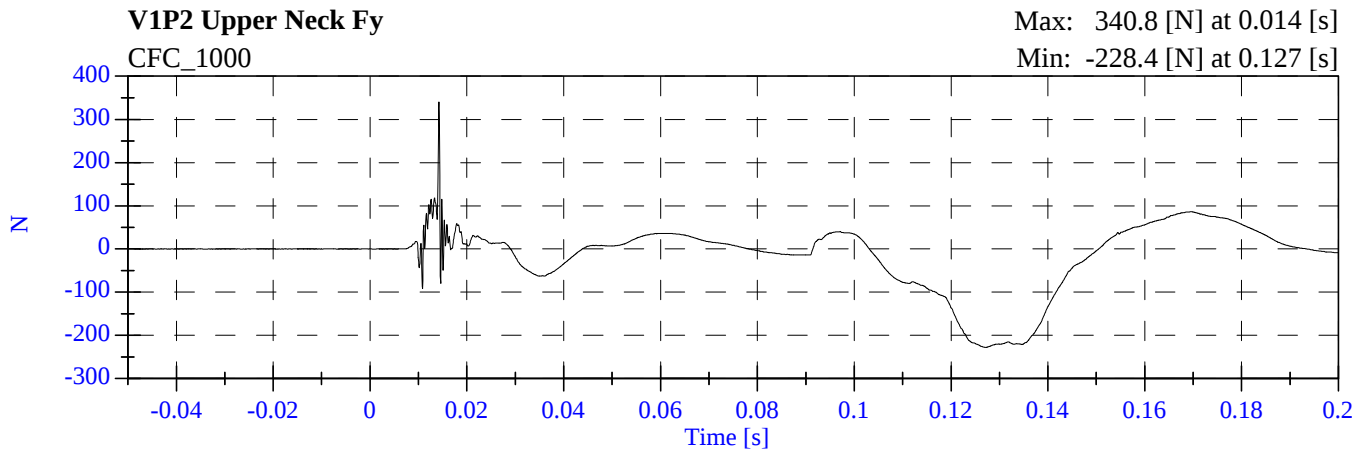
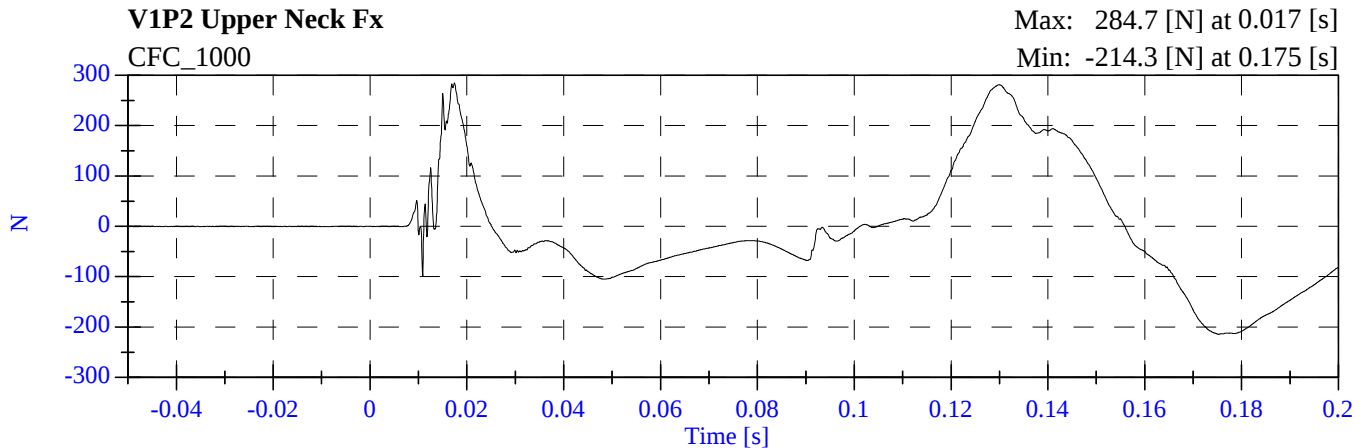
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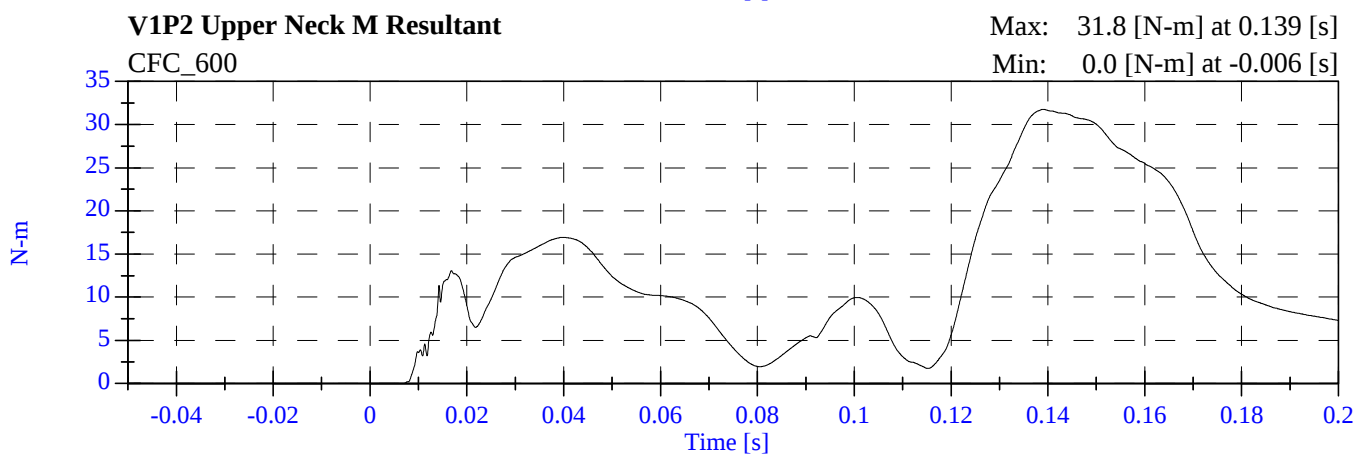
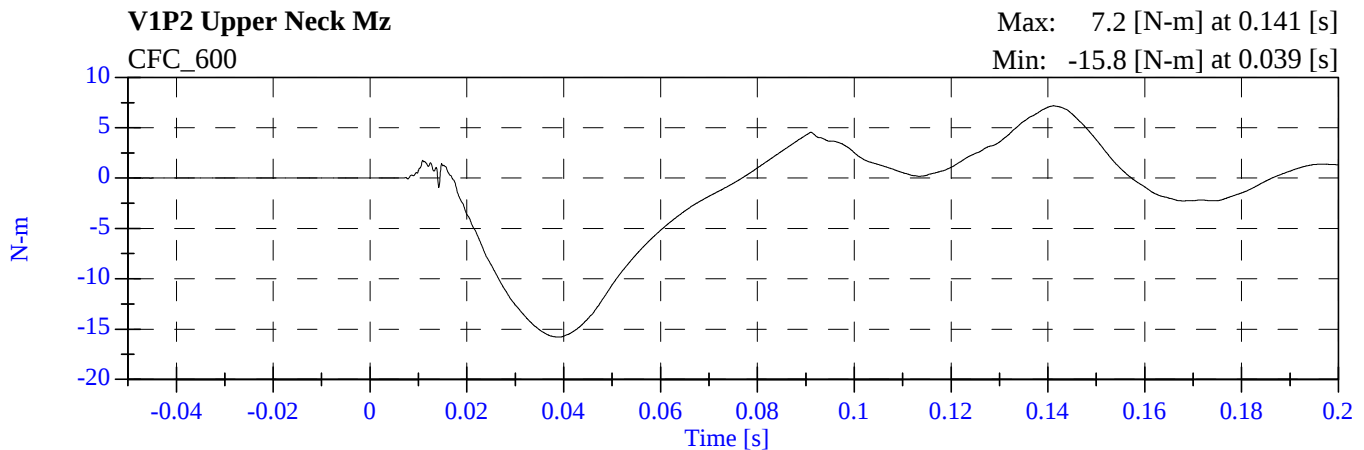
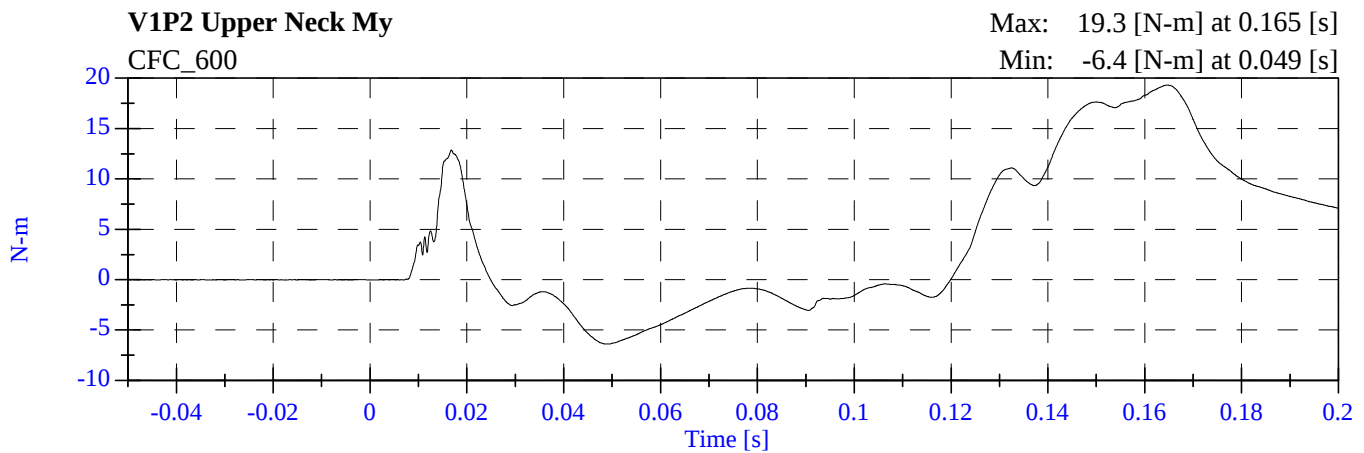
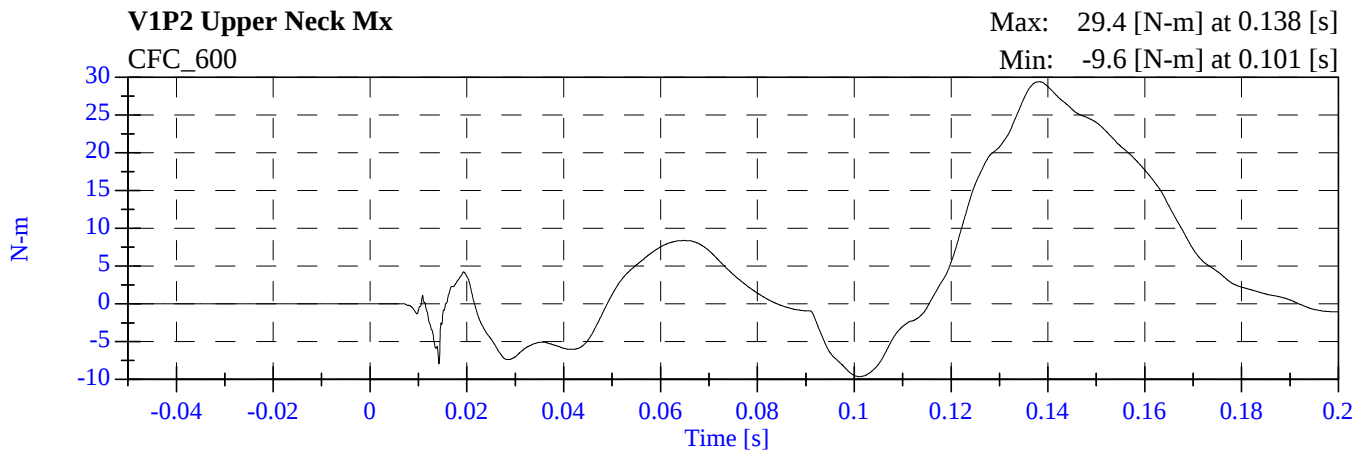


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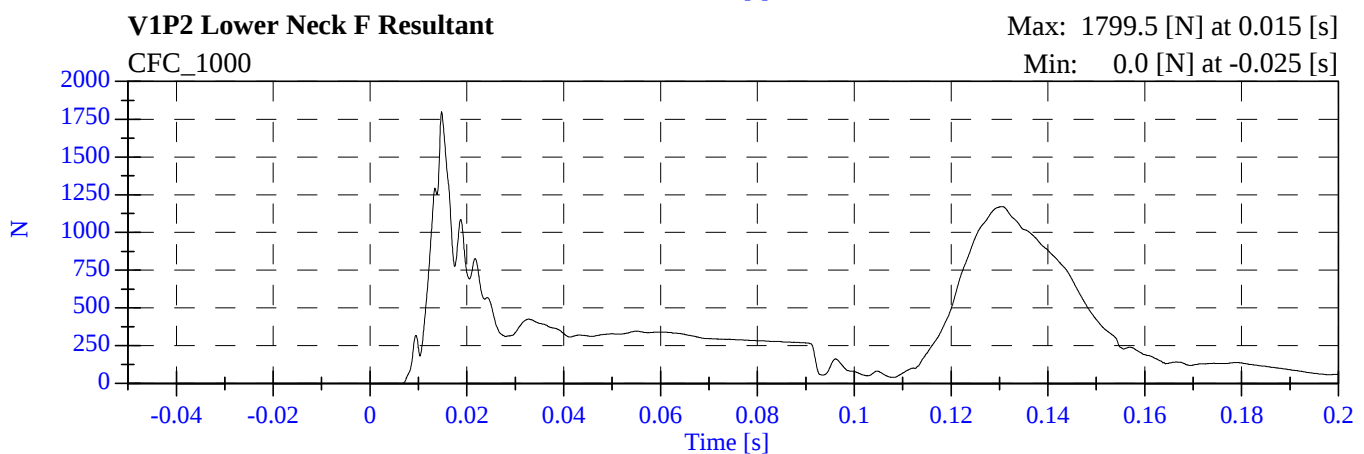
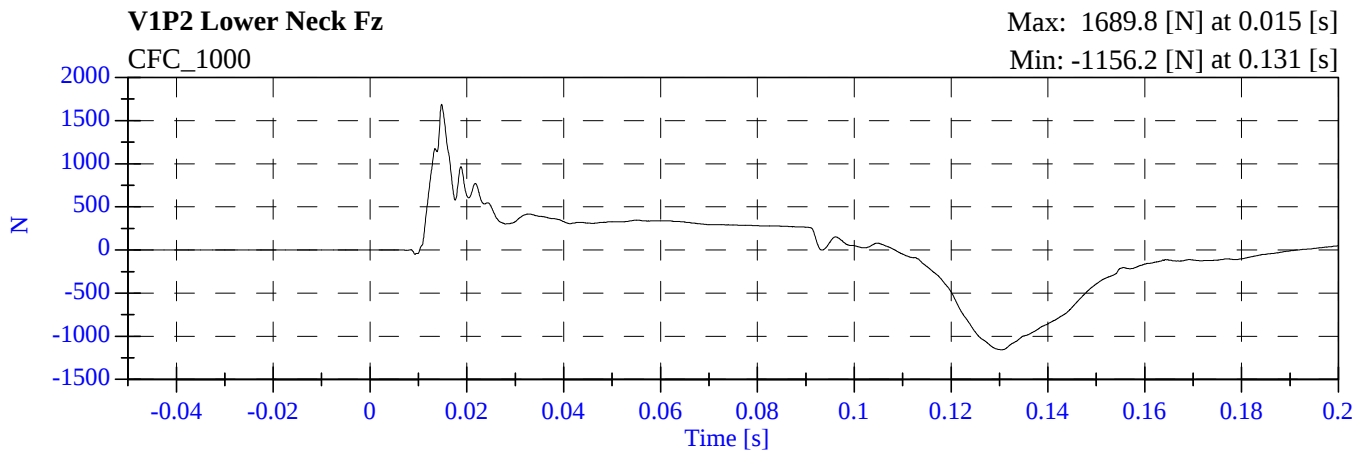
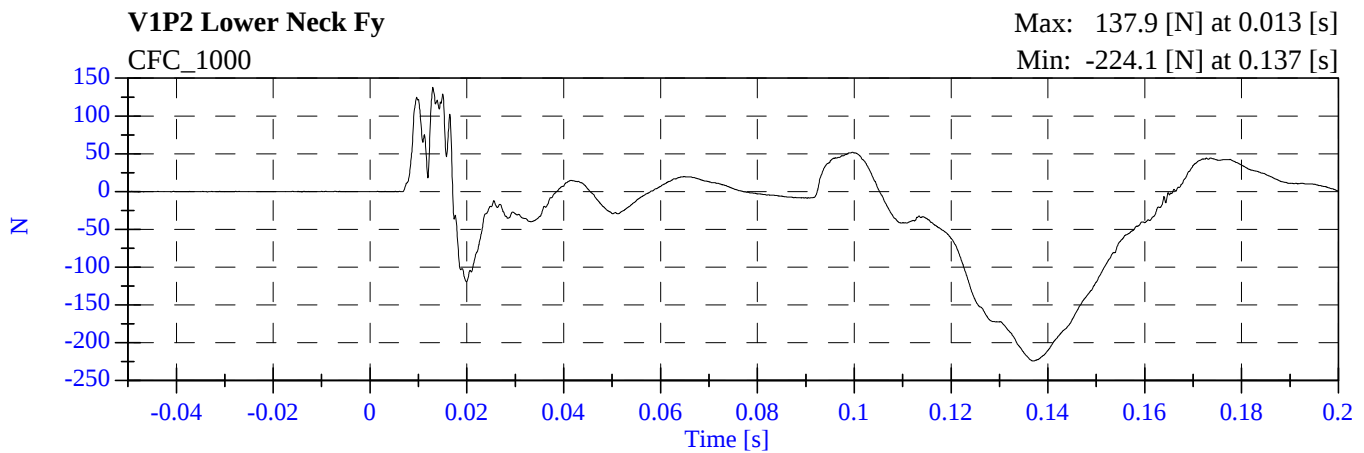
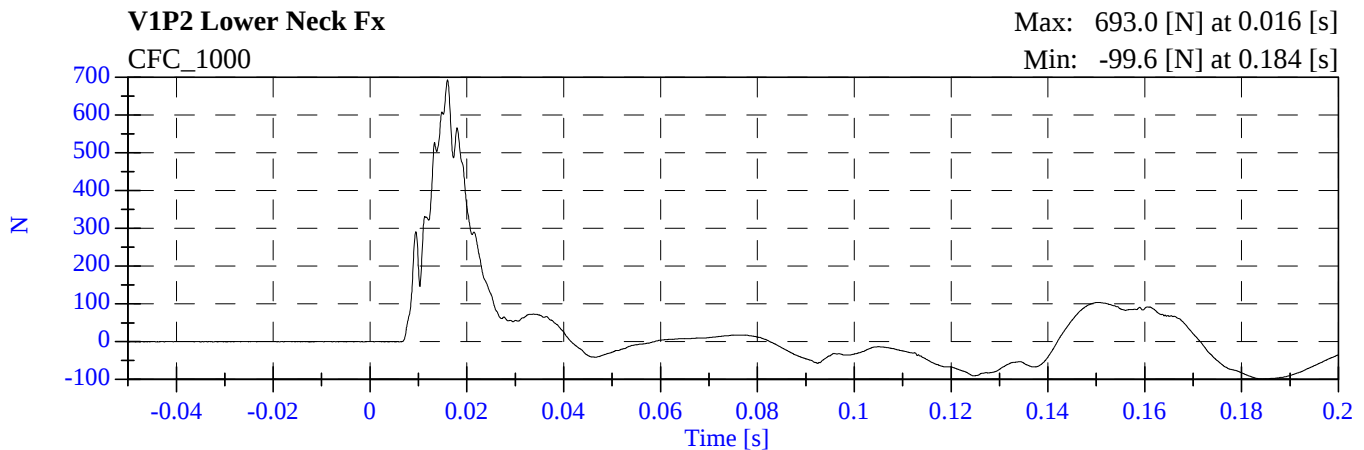
TWG06 - 2004 Hyundai XG 350

M40503TWG2 - April 07, 2004



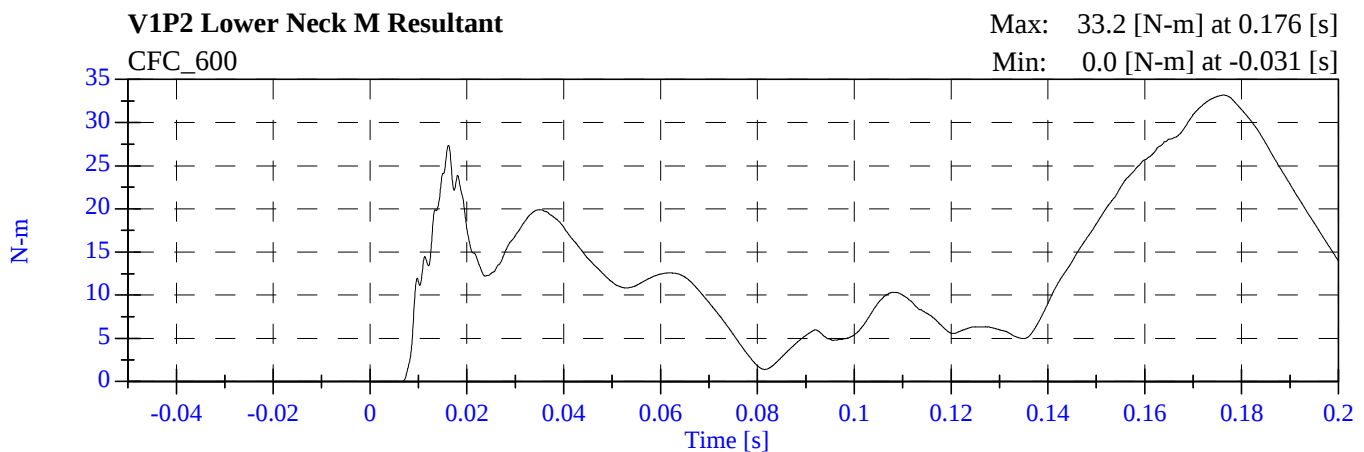
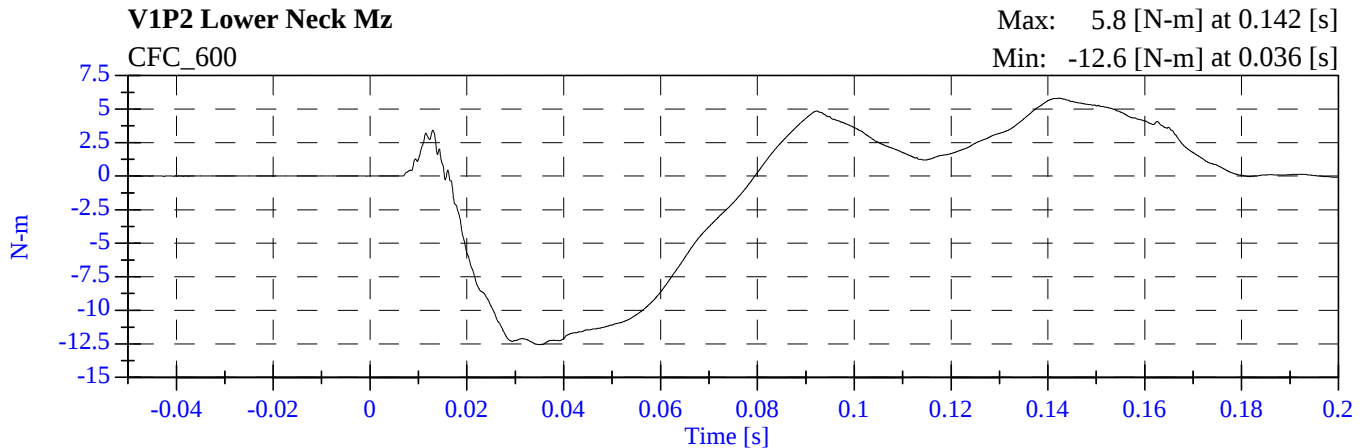
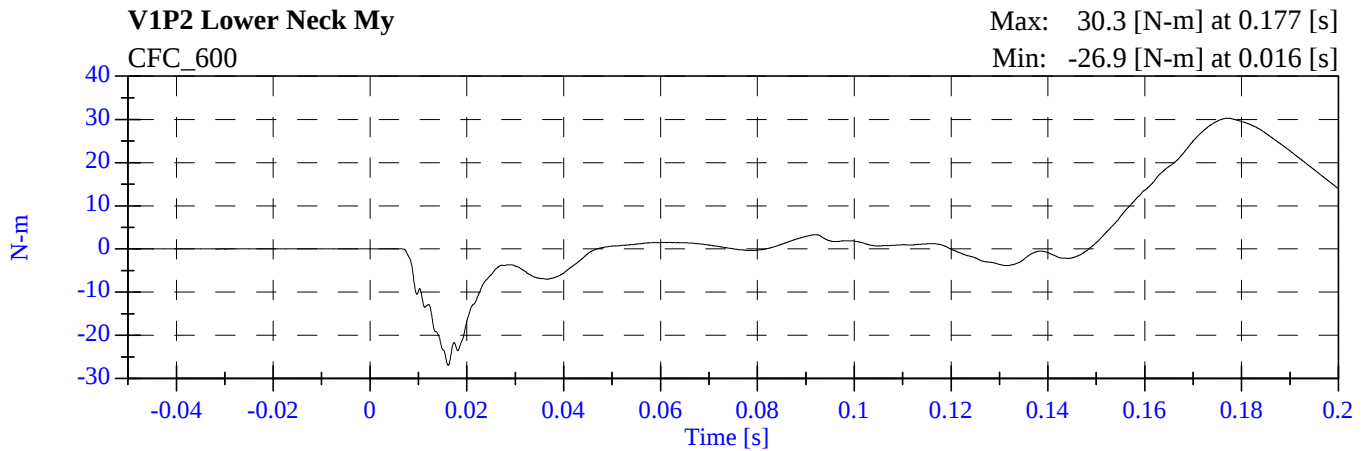
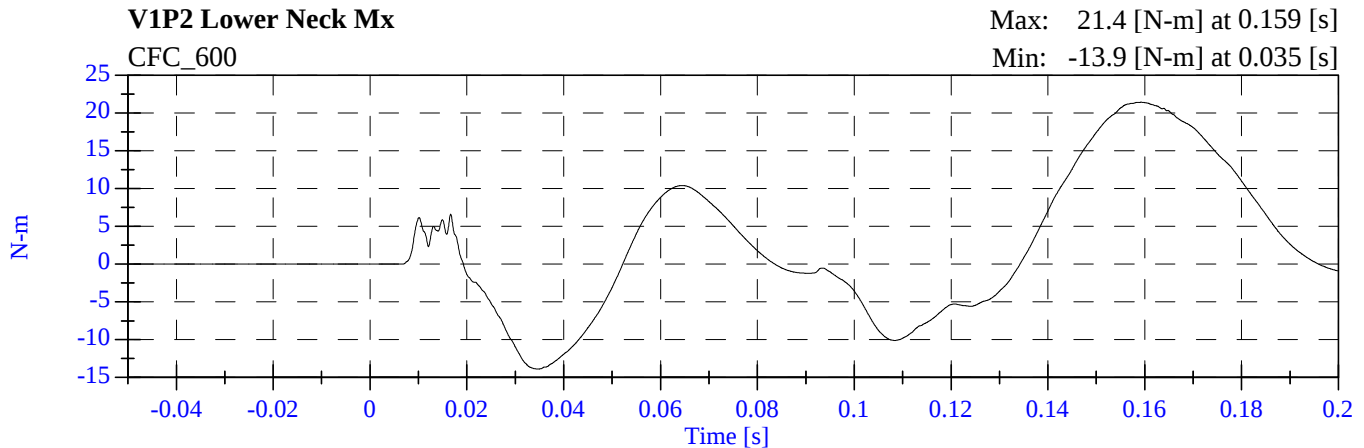
TWG06 - 2004 Hyundai XG 350

M40503TWG2 - April 07, 2004



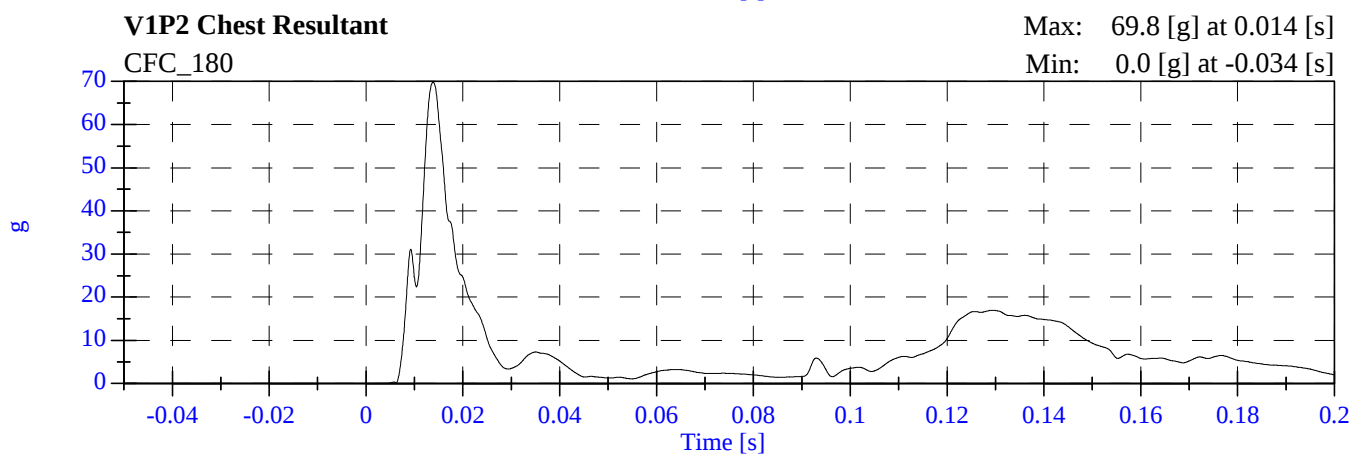
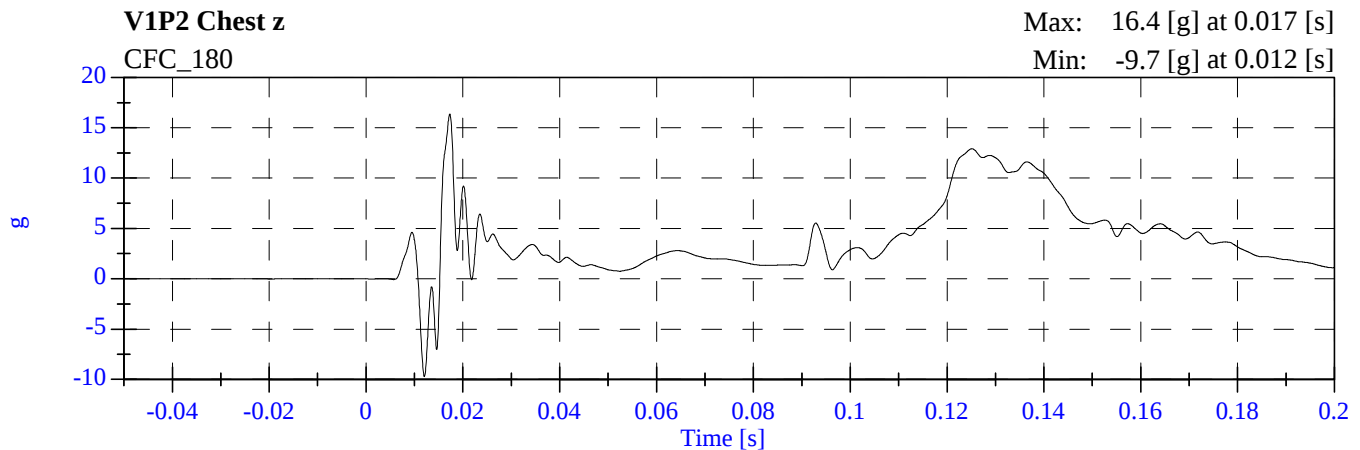
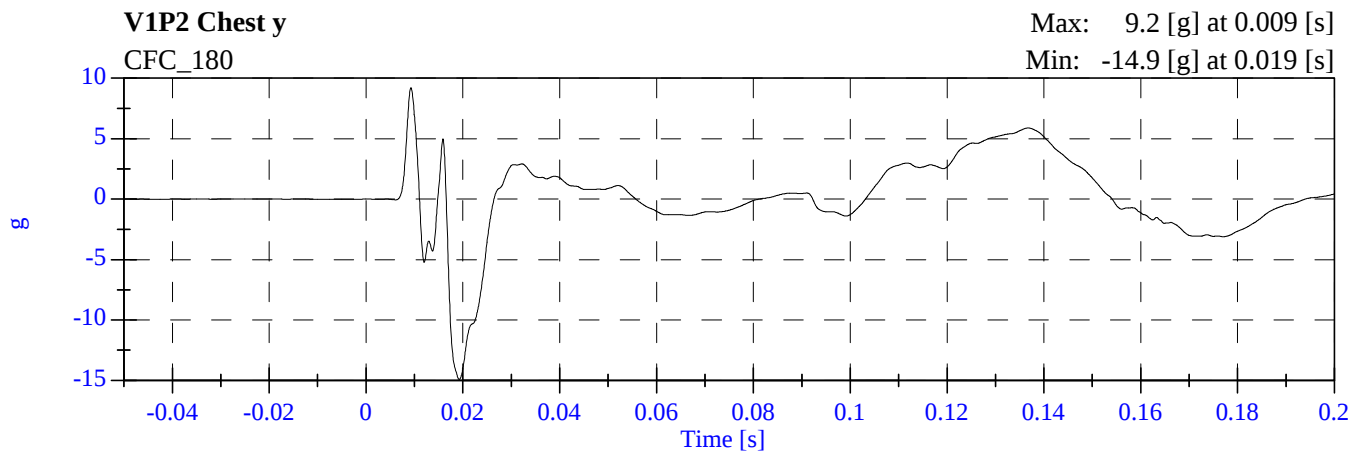
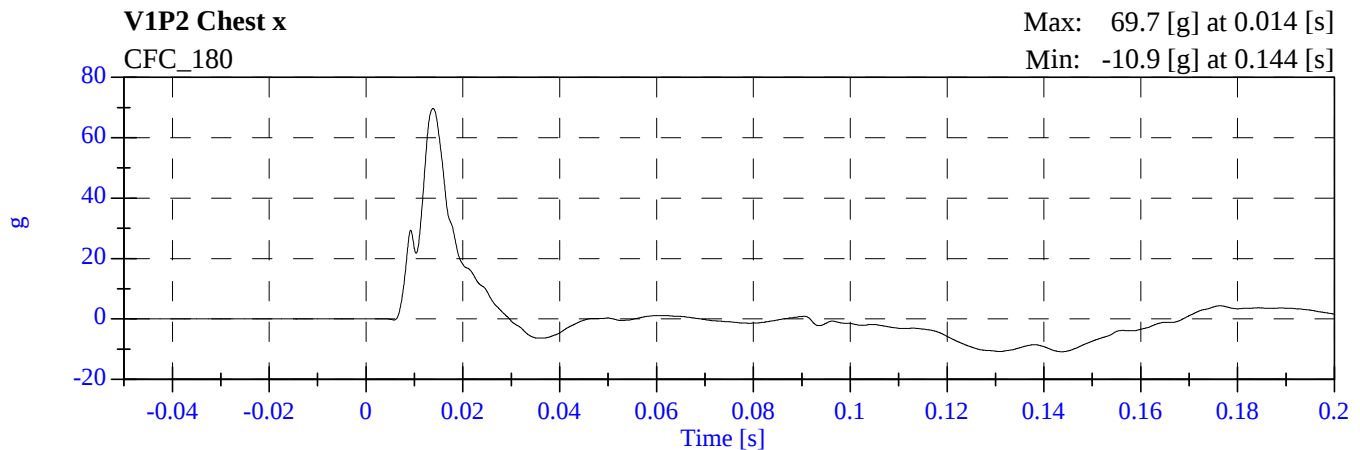
TWG06 - 2004 Hyundai XG 350

M40503TWG2 - April 07, 2004

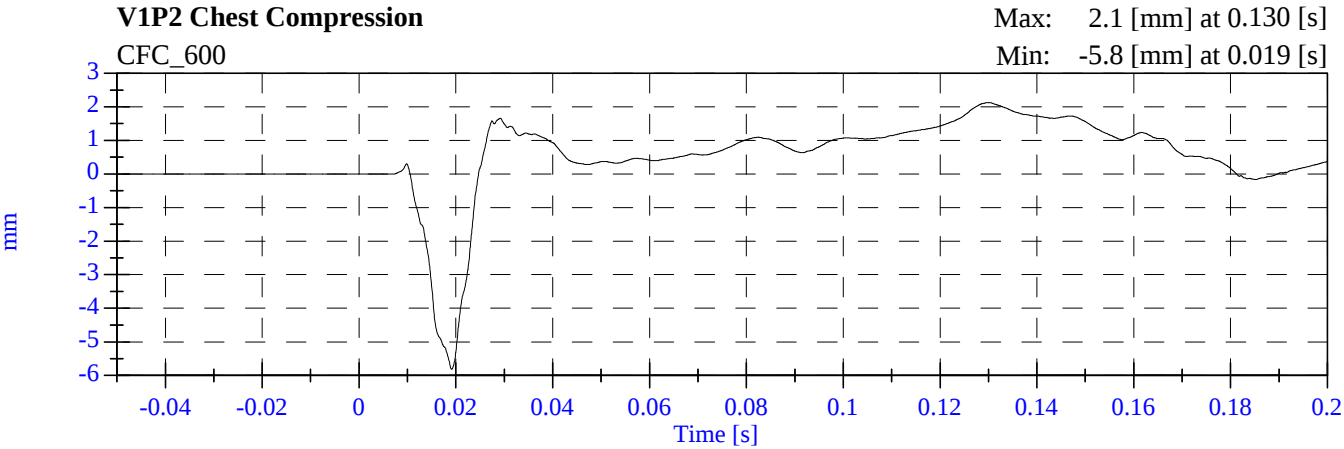


TWG06 - 2004 Hyundai XG 350

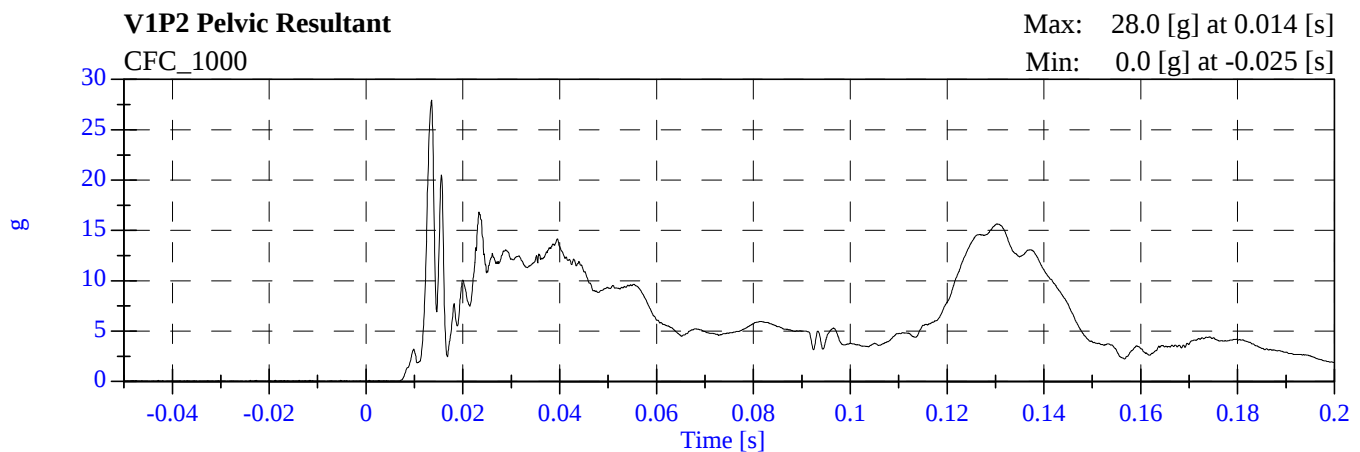
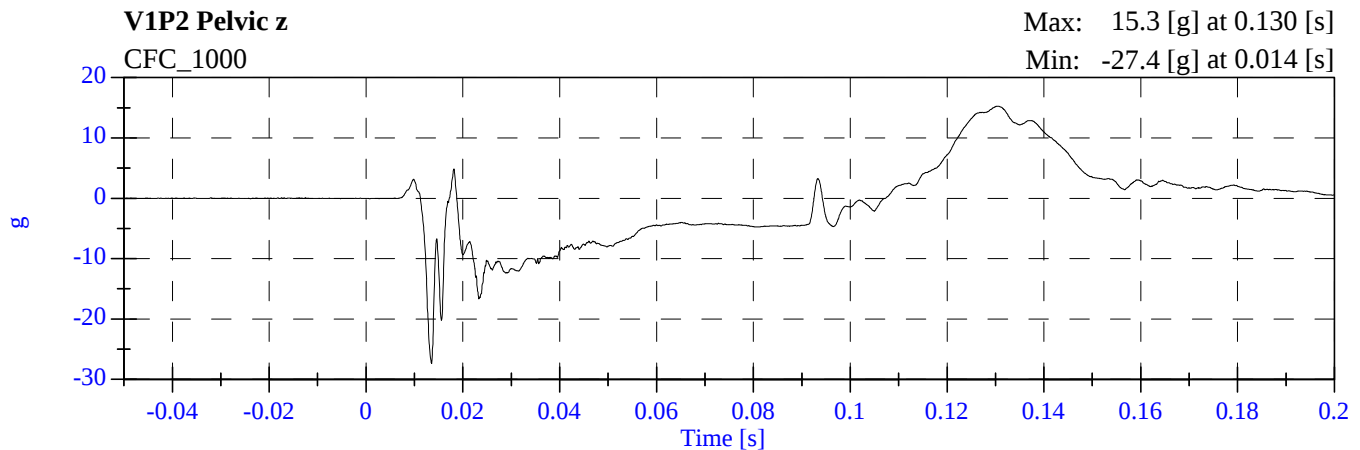
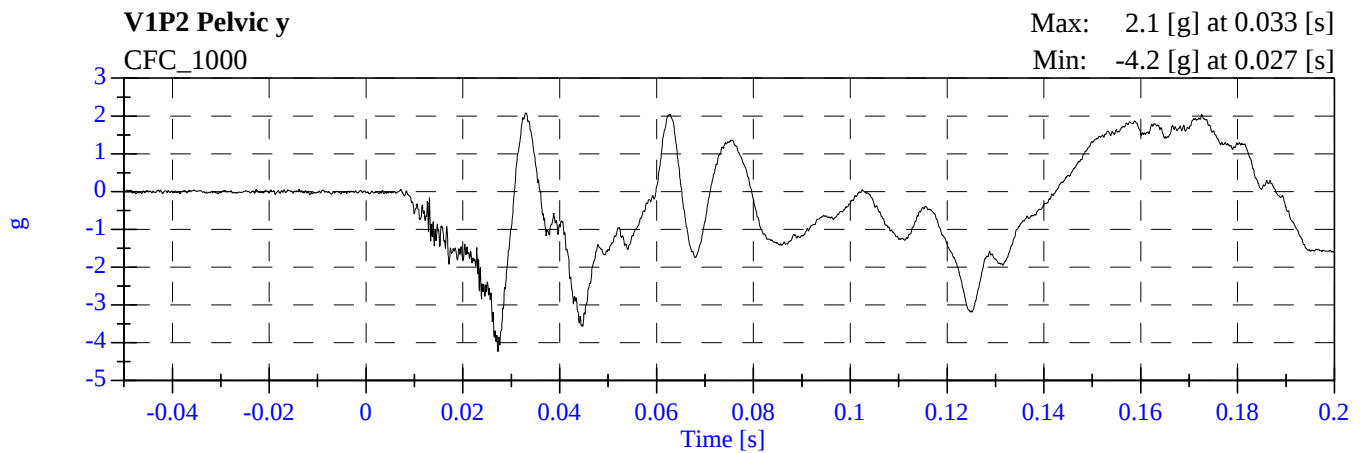
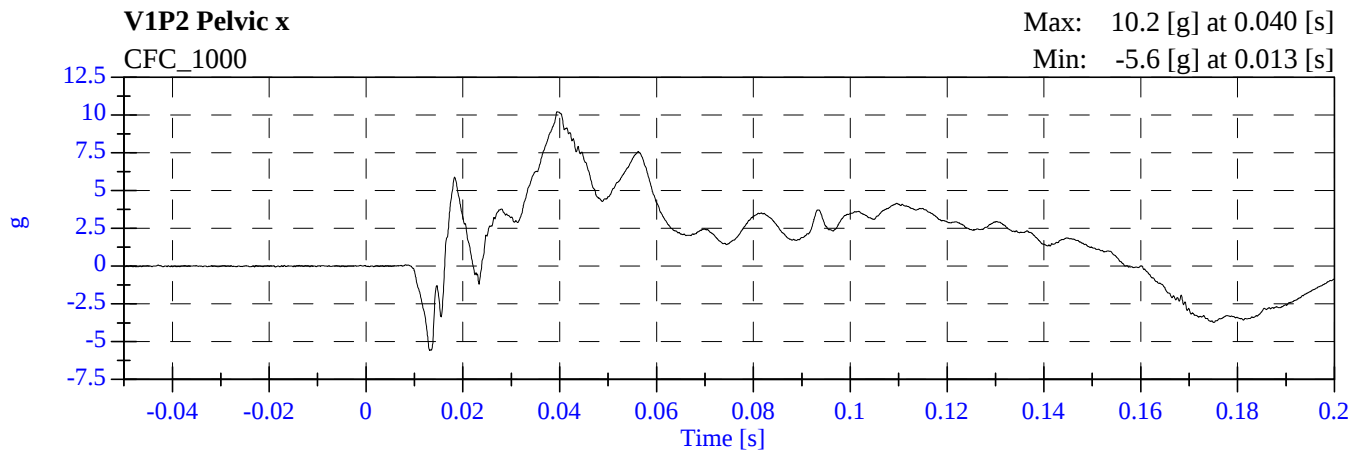
M40503TWG2 - April 07, 2004



TWG06 - 2004 Hyundai XG 350
M40503TWG2 - April 07, 2004



TWG06 - 2004 Hyundai XG 350
M40503TWG2 - April 07, 2004



APPENDIX C

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

P572P INSTRUMENTATION

	POSITION #2 (RIGHT FRONT) SERIAL NO.: 044		
	SERIAL NUMBER	MANUFACTURER	CALIBRATION DATE
HEAD AX	AC-P32218	ENDEVCO	17-Feb-04
HEAD AY	AC-P17743	ENDEVCO	21-Oct-03
HEAD AZ	AC-P15319	ENDEVCO	21-Oct-03
HEAD REAR AZ	AC-02I02I10-N06	ENTRAN	08-Dec-03
UPPER NECK FX	LC-248-FX	Denton	01-Oct-03
UPPER NECK FY	LC-248-FY	Denton	01-Oct-03
UPPER NECK FZ	LC-248-Fz	Denton	01-Oct-03
UPPER NECK MX	LC-248-Mx	Denton	01-Oct-03
UPPER NECK MY	LC-248-My	Denton	01-Oct-03
UPPER NECK MZ	LC-248-Mz	Denton	01-Oct-03
LOWER NECK FX	LC-249Fx	Denton	01-Oct-03
LOWER NECK FY	LC-249Fy	Denton	01-Oct-03
LOWER NECK FZ	LC-249Fz	Denton	01-Oct-03
LOWER NECK MX	LC-249Mx	Denton	01-Oct-03
LOWER NECK MY	LC-249My	Denton	01-Oct-03
LOWER NECK MZ	LC-249Mz	Denton	01-Oct-03
CHEST AX	AC-P15334	ENDEVCO	21-Oct-03
CHEST AY	AC-P15321	ENDEVCO	21-Oct-03
CHEST AZ	AC-P17758	ENDEVCO	21-Oct-03
CHEST DISPLACEMENT X	DS-044	SERVO	22-Nov-03
PELVIS AX	AC-P16755	ENDEVCO	21-Oct-03
PELVIS AY	AC-P15591	ENDEVCO	21-Oct-03
PELVIS AZ	AC-P16155	ENDEVCO	21-Oct-03