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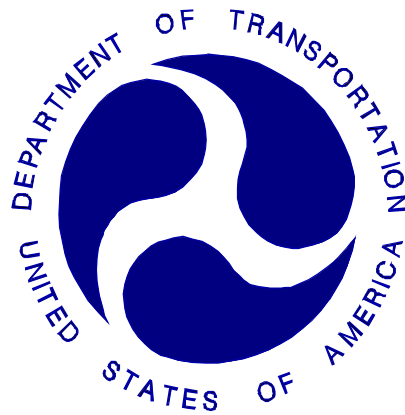
NEW CAR ASSESSMENT PROGRAM (NCAP)
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING

2007 SUBARU LEGACY
FOUR DOOR SEDAN

NHTSA NUMBER: M75500TWG2

CALSPAN CORPORATION TEST NUMBER: 8642-TWG-26

CALSPAN CORPORATION
TRANSPORTATION SCIENCES CENTER
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May 15, 2007

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 Calspan Corporation Crash Test Facility in Buffalo, New York, on May 15, 2007.							
Injury Summary							
HIC15	HIC36	Clip (g's)	Chest Displacement (mm)	NIJ NTF	NIJ NTE	NIJ NCF	NIJ NCE
27.8	36.3	37.2	-4.0	0.21	0.31	0.38	0.43
17. Key Words New Car Assessment Program (NCAP) Side Airbag Out-of-Position				18. Distribution Statement Copies of this report are available from: National Highway Traffic Safety Administration Technical Reference Division Room 5111 (NAD-52) 400 Seventh St., S.W. Washington, D.C. 20590 Telephone No. (202) 366-4946 ATTN: Robert Hornicle			
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SECTION 1

PURPOSE AND SUMMARY OF TEST M75500TWG2

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. DTNH22-03-D-22005.

1.2 SUMMARY

The effects of both a seat-mounted side airbag and a curtain airbag deployment in a 2007 Subaru Legacy four-door sedan with an out-of-position six-year-old child were evaluated. The test was performed by Calspan Corporation on May 15, 2007. 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 perpendicular to the right-front seat centerline to capture the deployment event. The recorded image rate is 1000 frames per second.

One part 572, Hybrid III six-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, upper and lower sternum and pelvic triaxial accelerometers. In addition six axial upper neck force and moment load cell sensors and left and right femur load cell sensors were utilized.

Twenty 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 six-year-old child dummy's visible contact points were as follows: The seat airbag to the right scapula and right side of the posterior thorax and pelvis and the curtain airbag to the top and the back of the head.

The six-year old child dummy was placed on the outboard edge of foam block, aligning the upper spine with the deployment trajectory of the airbag. The dummy's head was placed in between the seat bolster and pillar trim to minimize the fore-aft clearance between the neck and the seatback. The head remained in its neutral orientation. The legs were aligned such that they crossed the heel placement points but the feet did overhang the seat cushion. The dummy was then positioned so the dummy's neck/torso junction was aligned vertically with the top edge of the airbag module. While maintaining the neck/torso top of the airbag module alignment, the vehicle door was closed and the pelvis was moved outboard until it made contact the door trim/armrest. The outboard forearm was placed on the armrest. The inboard arm was positioned such that the upper arm contacted the seat back and the fingertips contacted the booster seat. The dummy's arms were then bent at the elbow until the fingers contacted the booster seat. This orientation complies with section 3.3.3.5 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:

	TEST DATA	DESCRIPTION
Seating Position:	P2	Right Front Seating Position
Test:	3.3.3.5*	Forward facing Hybrid-III six-year-old child dummy on booster block
Airbag:	Seat; Side Rail	Bolster mounted thorax side airbag and side curtain 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.:	P572N/186	Hybrid III six-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>	20	
<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 (occipital) and the top (parietal) of the head by the side curtain.
Upper Torso Contact:	Side airbag to the right scapula and right side of the posterior thorax
Lower Torso Contact:	Side airbag to the right side of the pelvis (ilium)
Left Knee Contact:	None
Right Knee Contact:	None

DATA SHEET NO. 2**VEHICLE PARAMETER DATA****TEST VEHICLE INFORMATION:**

Year/Make/Model/Body Style: 2007 Subaru Legacy 4-Door Sedan‡

NHTSA No. : M75500 ; VIN: KNAFE122775379847 ; Color: Red

Engine Data: 4 cylinders; - CID; 2.0 Liters; - cc

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

Transmission Data: 4 speeds; - Manual; X Automatic; X Overdrive

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

AUTOMATIC DOOR LOCKS:

Is test vehicle equipped with Automatic Door Locks (ADLs)? - Yes; X No;

Does vehicle owner's manual describe how to deactivate ADLs? - Yes; - No; - N/A

DEALER AND DELIVERY INFORMATION:

Date Received: 11/30/06 ; Odometer Reading 50 km

Selling Dealer: West-Herr KIA

Dealer Address: 5140 Camp Rd Hamburg, NY 14075

TEST VEHICLE OPTIONS:

X AC; X Power Steering; X Power Brakes; X Power Locks; - Power Seats

- ABS; X Tilt Wheel; - Stability Control - Traction Control - Anti-Theft

SAFETY BELT FEATURES:

Driver: X Pretensioner (Shoulder); X Load Limiter; X Adjustable Anchorage

Passenger: X Pretensioner (Shoulder); X Load Limiter; X Adjustable Anchorage

AIRBAG FEATURES:

Position	Frontal	Knee Bolster	Side Torso	Side Head/Torso Combination	Side Curtain
Driver:	X	-	X	-	X
Passenger:	X	-	X	-	X
Rear Passenger:	-	-	-	-	-

DATA FROM VEHICLE'S CERTIFICATION LABEL:

Vehicle Manufactured by: Kia Motors Corporation

Date of Manufacture 10/06

GVWR: 1780 kg; GAWR: 980 kg FRONT; 960 kg REAR

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) = 385.0 kg

No. of Occupants x 68.04 kg = 340.2 kg

Rated Cargo/Luggage Weight (RCLW) = 44.8 kg

‡ This vehicle had previously been tested in an NCAP frontal impact on December 14, 2006.

DATA SHEET NO. 3

CHILD DUMMY POSITIONING IN VEHICLE

NHTSA No. M75500TWG2

Measurement		Value
Total Fore/Aft Travel (mm)		220
Test Distance Rearward of Full-Forward (mm)		220
Total Fore/Aft Travel (Detents)		19
Placed in Position #		19
Seat Back Angle	SA (°)	11.5°
Airbag Module Width	AMW (mm)	50
Airbag Width	ABW (mm)	300
Airbag Module Length	AML (mm)	200
Airbag Length	ABL (mm)	580
Top of Airbag Module to Head/Neck Junction	AN (mm)	148
Head CG to Door Panel/Window	HD (mm)	117
Head to Seat Back Centerline	HSC (mm)	169
Head to B-Pillar (cg)	HB (mm)	17
Head to Roof, Z (top of the head)	HZ (mm)	192
Head to Header	HHH (mm)	438
Chest to Dash	CD (mm)	628
Chest to Seatback	CS (mm)	-
Right Arm to Seat Back Centerline	RACL (mm)	340
Right Arm to Seat Back Centerline	RACL (°)	35.4°
Left Arm to Seat Back Centerline	LACL (mm)	40
Left Arm to Seat Back Centerline	LACL (°)	9.2°
Right Arm to Door Panel	RA (mm)	0
Left Arm to Door Panel	LA (mm)	340
Knee to Knee	KK (mm)	100
Toe to Toe	TT (mm)	150
Right Knee to Seat Cushion Centerline	KSCR (mm)	0
Left Knee to Seat Cushion Centerline	KSCL (mm)	100
Right Toe to Seat Cushion Centerline	TSCR (mm)	0
Left Toe to Seat Cushion Centerline	TSCL (mm)	150
Nose to Dash	ND (mm)	650
Nose to Seatback	NS (mm)	-
Nose to Header	NR (mm)	438
Foam Block Depth	(mm)	300
Foam Block Width	(mm)	450
Foam Block Thickness	(mm)	75
HD36 foam density	(g/L)	44.8

DATA SHEET 4

CHILD DUMMY INJURY CRITERIA VALUES

NHTSA No. M75500TWG2

		MAXIMUM VALUE			
		Position #2			
DESCRIPTION	Unit	Maximum	Time (ms)	Minimum	Time (ms)
Head X	g	19.1	15.0	-3.9	7.3
Head Y	g	8.3	28.0	-10.5	13.3
Head Z	g	29.5	13.3	-18.0	7.9
Head Resultant	g	34.4	13.3	0.0	2.0
Upper Neck Fx	N	392.0	13.4	-56.1	173.2
Upper Neck Fy	N	45.8	23.8	-208.0	51.5
Upper Neck Fz	N	193.5	124.9	-595.9	9.1
Upper Neck F Resultant	N	632.2	9.1	0.3	0.1
Upper Neck Mx	N-m	12.0	11.0	-24.0	29.5
Upper Neck My	N-m	28.7	11.8	-13.9	46.4
Upper Neck Mz	N-m	1.3	178.5	-4.8	37.2
Upper Neck M Resultant	N-m	31.1	12.0	0.0	0.9
Chest X	g	43.8	7.3	-4.5	21.6
Chest Y	g	4.0	49.9	-22.6	5.5
Chest Z	g	4.9	9.5	-12.8	6.0
Chest Resultant	g	46.4	7.3	0.0	0.0
Chest Displacement	mm	0.9	62.5	-4.0	10.9
Upper Sternum Ax	g	87.7	6.7	-22.8	15.0
Lower Sternum Ax	g	90.5	6.8	-20.0	5.6
Pelvic X	g	24.4	7.2	-4.6	9.4
Pelvic Y	g	4.2	89.3	-20.4	8.1
Pelvic Z	g	13.5	8.7	-18.9	9.5
Pelvic Resultant	g	29.2	7.7	0.0	0.4
Left Femur	N	88.4	39.3	-431.2	10.0
Right Femur	N	77.0	121.8	-292.2	9.0

DATA SHEET 4

CHILD DUMMY INJURY CRITERIA VALUES (CONTINUED)

NHTSA No. M75500TWG2

	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	27.8	6.8	20.3	19.8	36.3	6.8	28.8

	CLIP SUMMARY*			
	CLIP (g's)	t ₁ (msec)	t ₂ (msec)	CSI
Position #2 – Right Front	37.2	5.0	8.0	47.1

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

Position 2 Neck Injury Summary (HIII 6 year old – Out of Position)

Nij V10	Nij	Time (ms)	Z Force (N)	X Force (N)	Y Moment (N-m)
Ntf	0.21	14.7	62.83	366.6	17.9
Nte	0.31	55.1	1.1	129.4	-11.5
Ncf	0.38	9.9	-502.1	257.3	18.6
Nce	0.43	46.4	-54.3	80.1	-15.4

Peak Tension (CFC1000) 193.5 N

Peak Compression (CFC1000) -595.9 N

Critical Values

Nij Intercepts			Peak Limits	
Tension (CVt)	2880 N	Extension (mCVe)	37 N-m	Tension 1890 N
Compression (CVc)	2880 N	Flexion (mCVf)	93 N-m	Compression -1820 N

Condyle Offset -0.01778

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

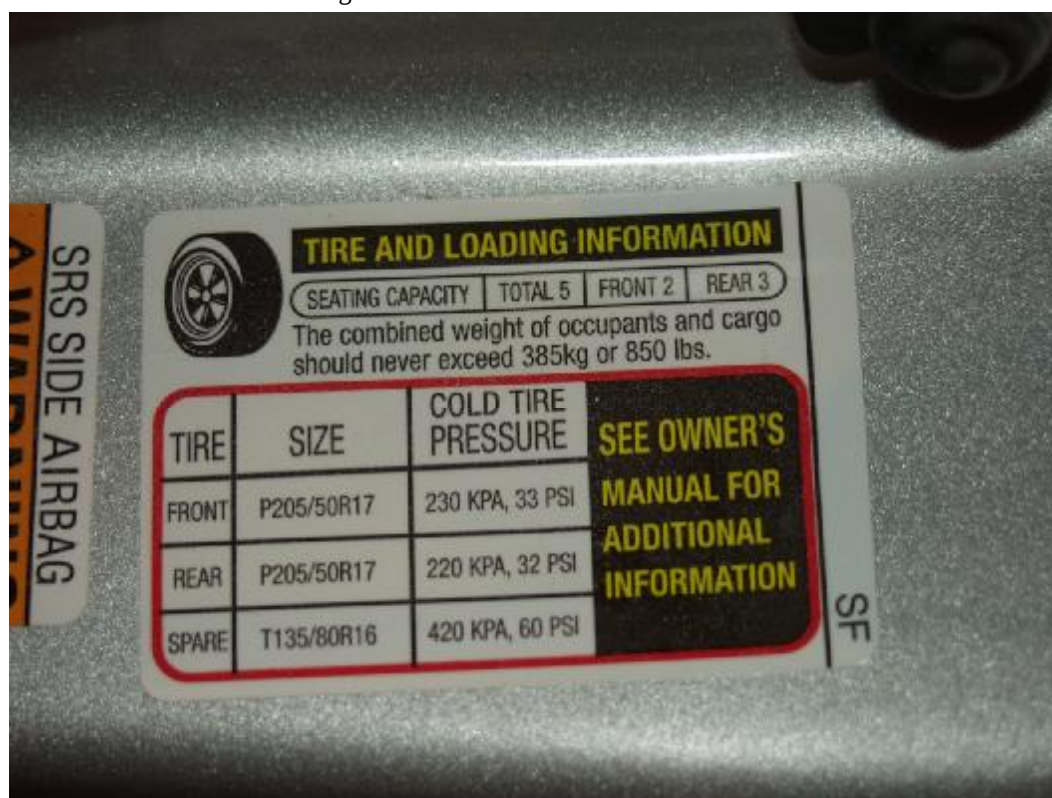


Figure A-4: Vehicle Tire Placard



Figure A-5: Pre-Test Dummy Frontal View



Figure A-6: Post-Test Dummy Frontal View



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



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



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



Figure A-10: Post-Test Right Side of Dummy View

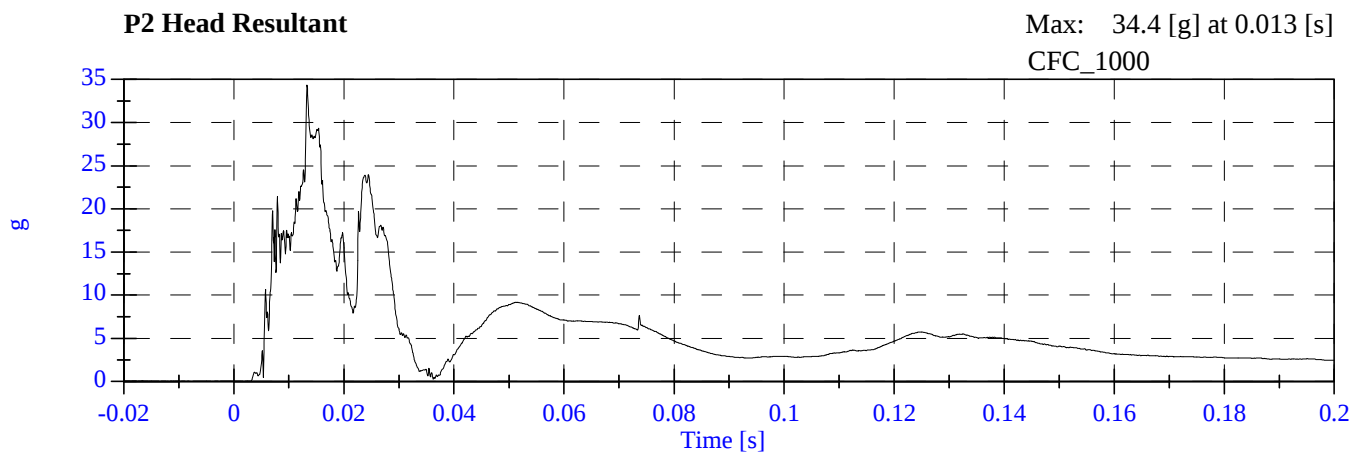
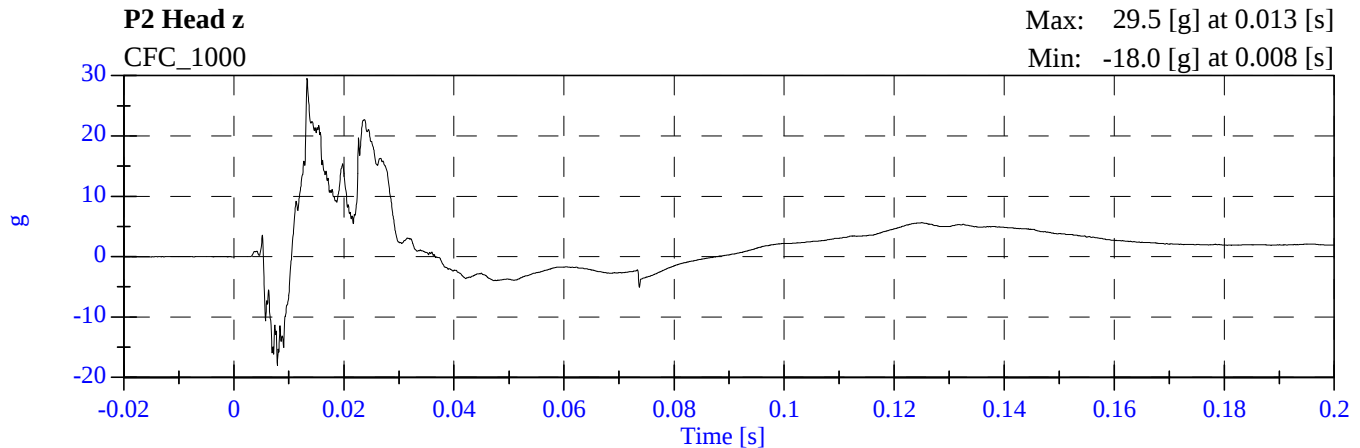
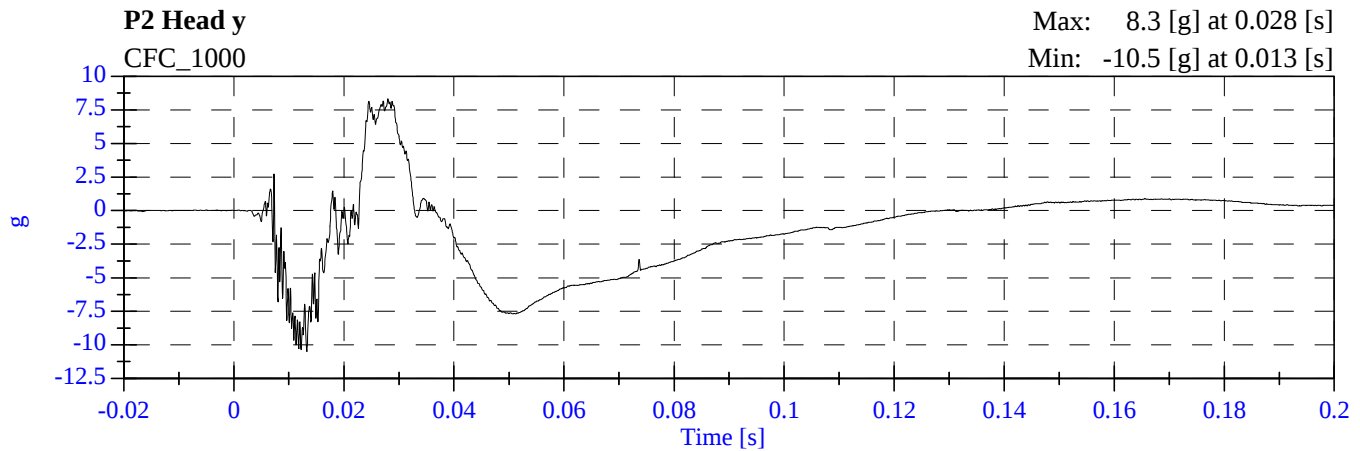
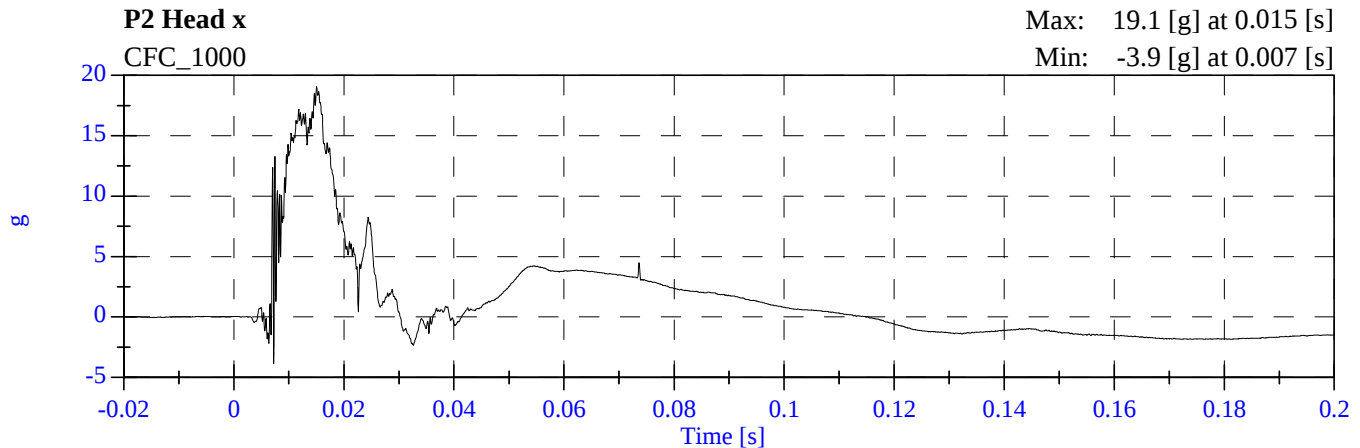
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CHILD DUMMY RESPONSE DATA TRACES

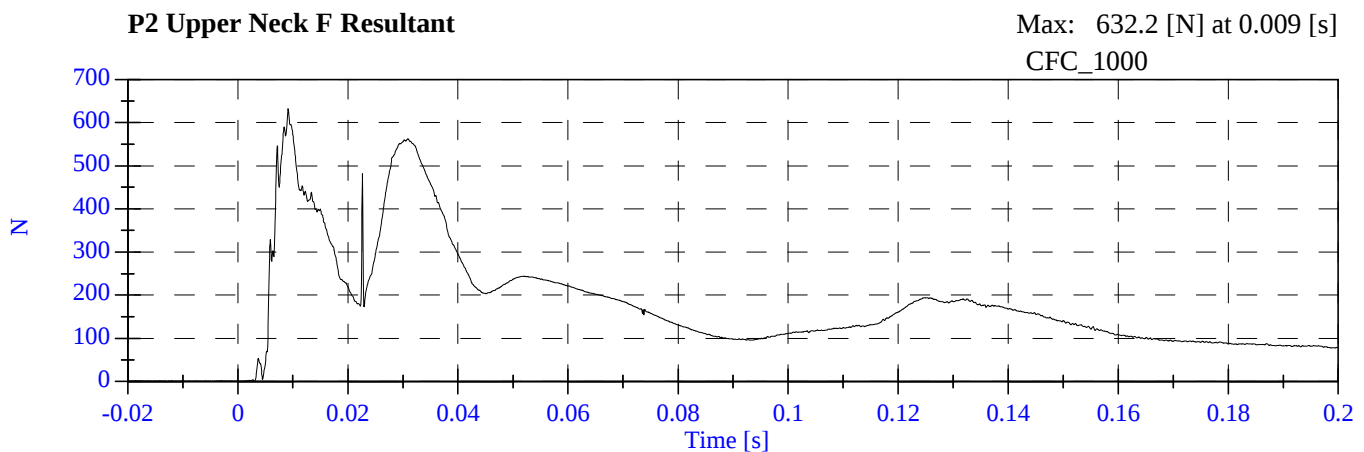
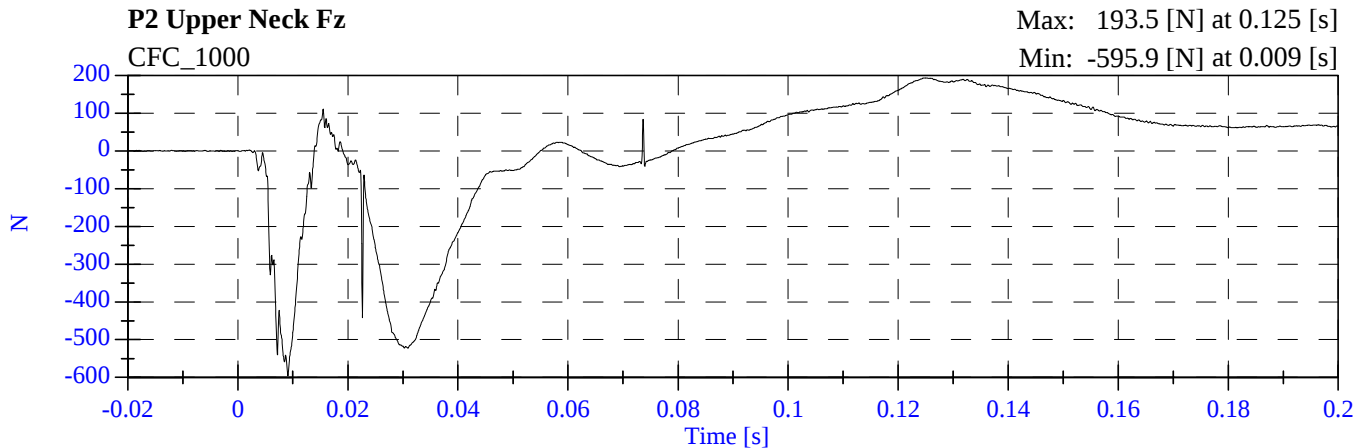
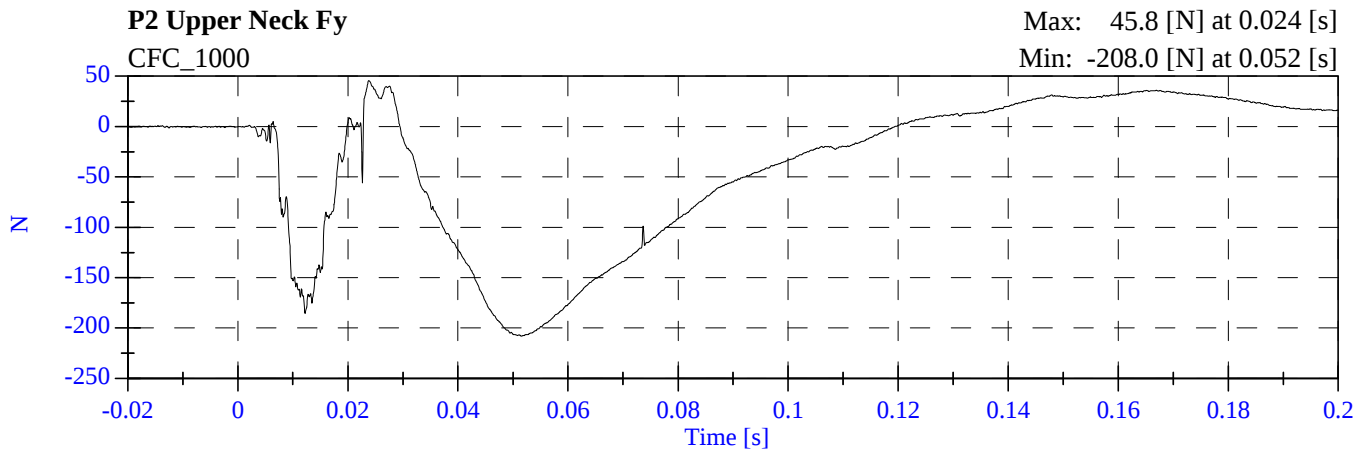
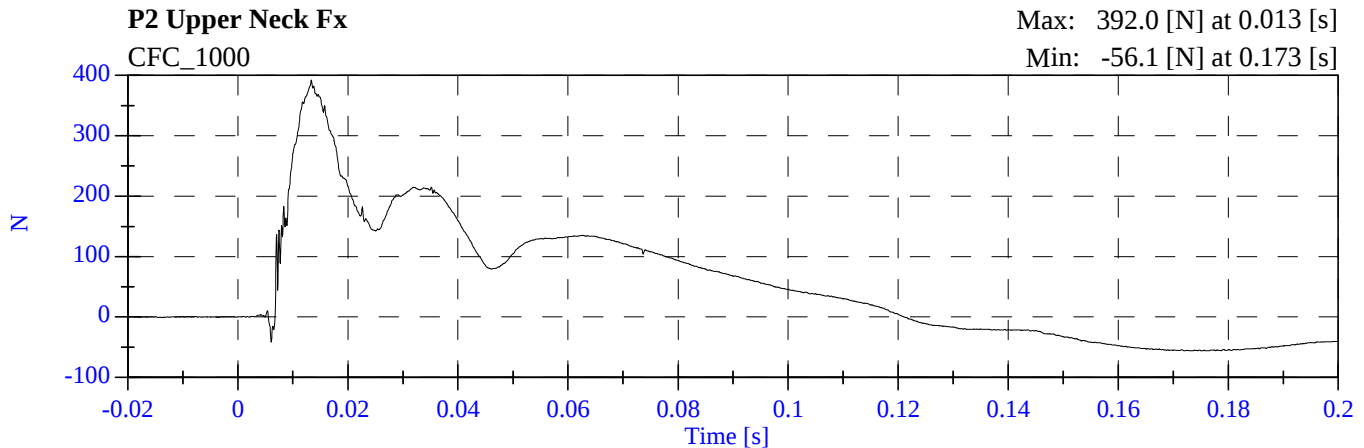
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8	P2 Upper Neck F Resultant [N, CFC_1000]	B-4
9	P2 Upper Neck Mx [N-m, CFC_600]	B-5
10	P2 Upper Neck My [N-m, CFC_600]	B-5
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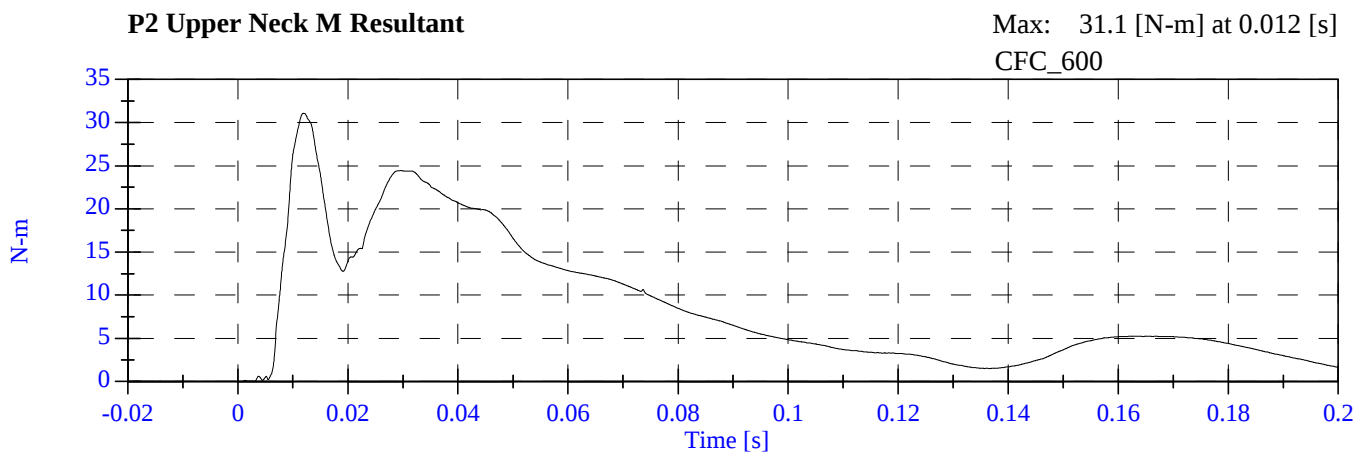
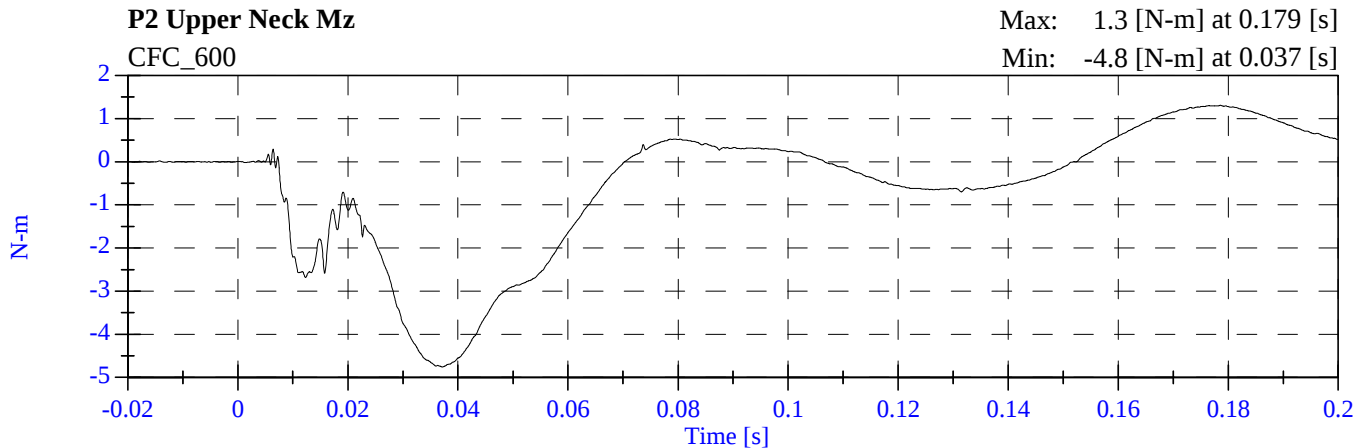
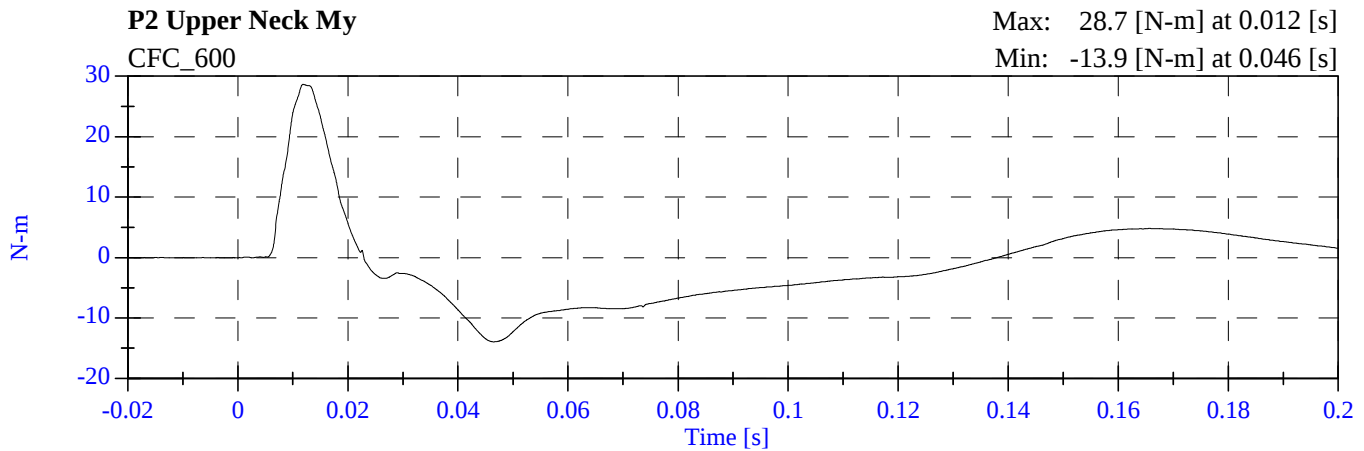
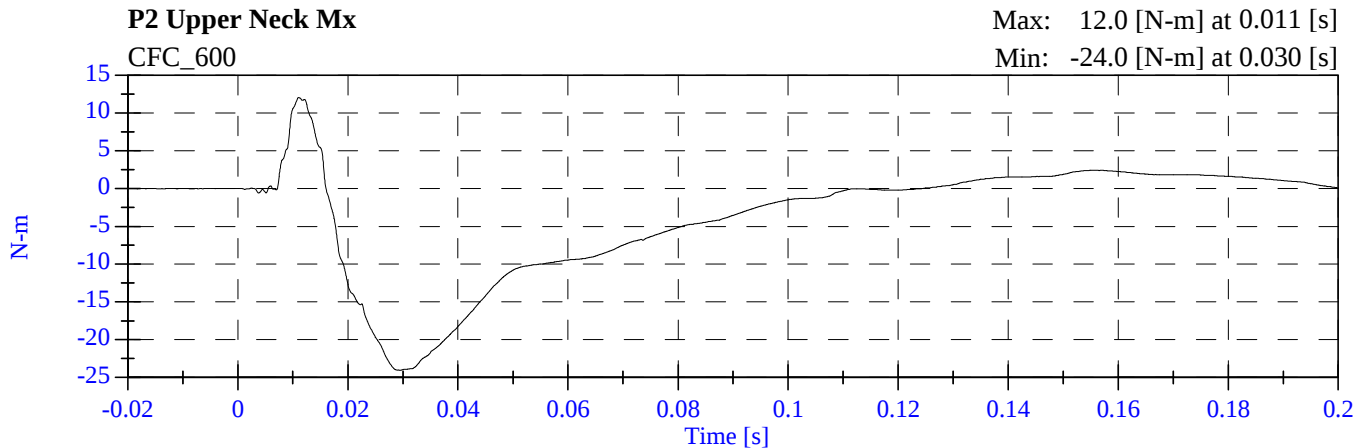
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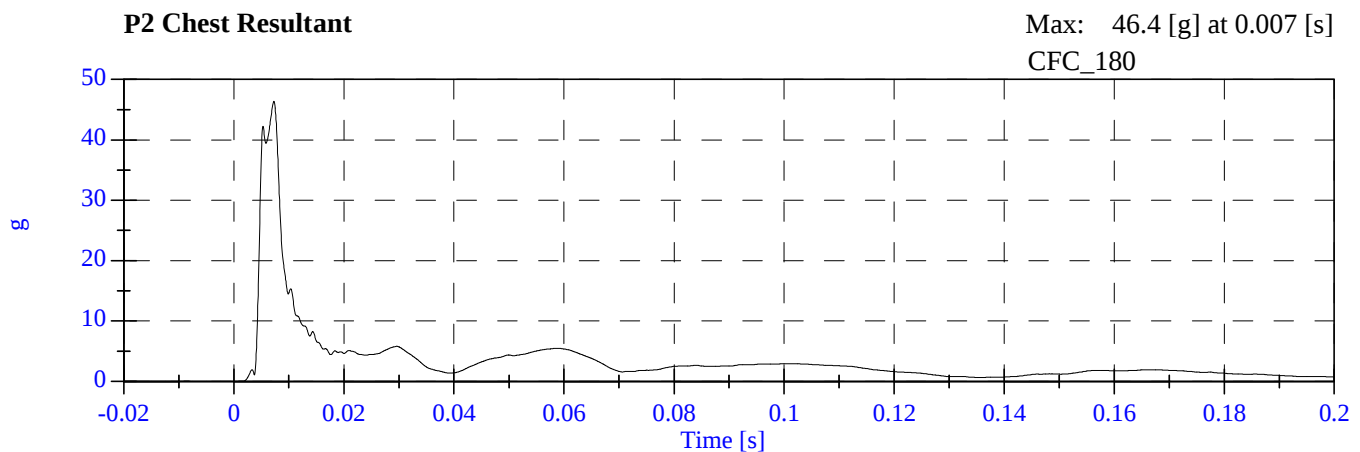
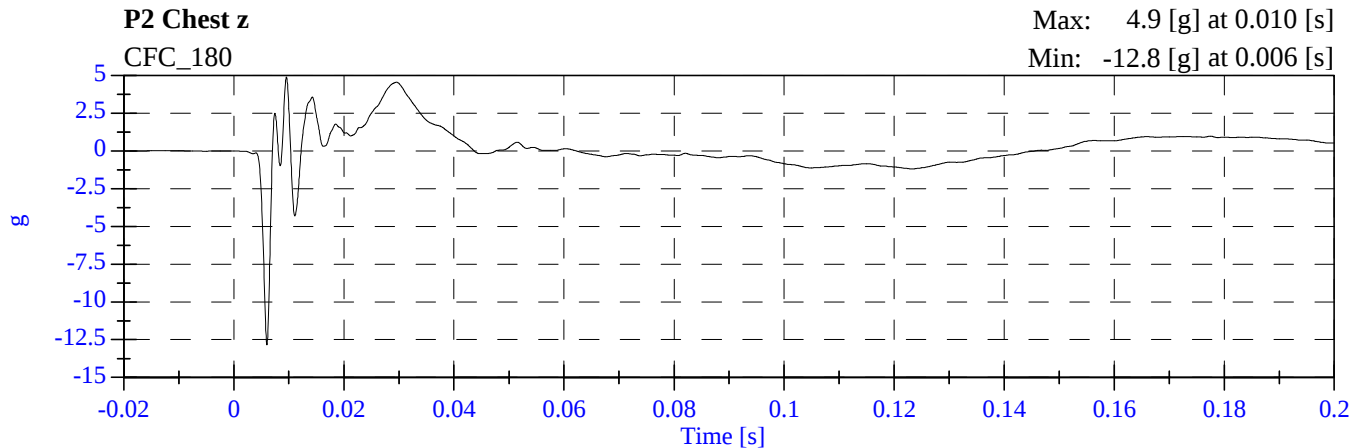
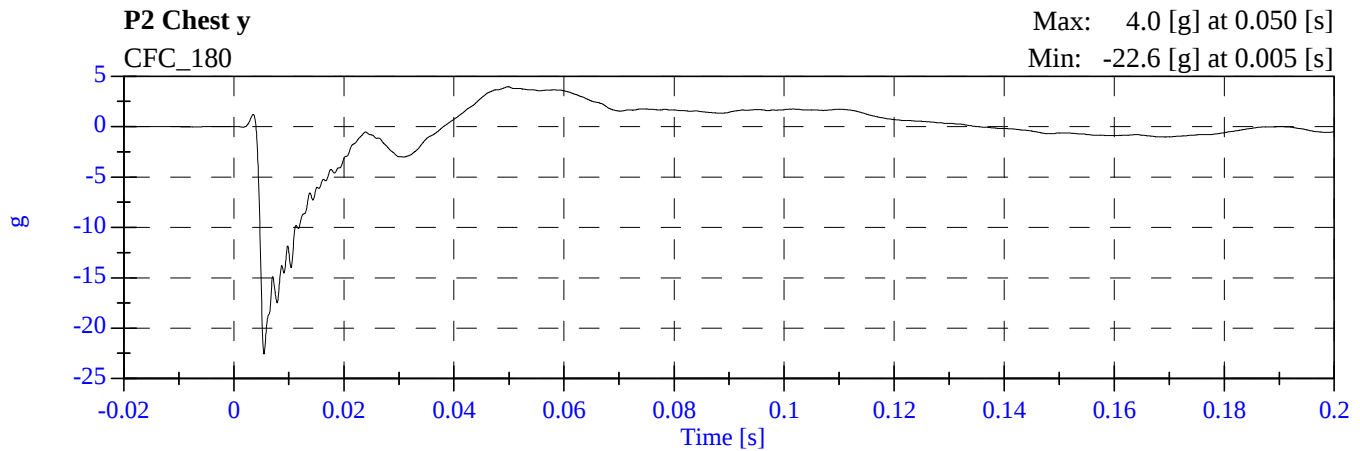
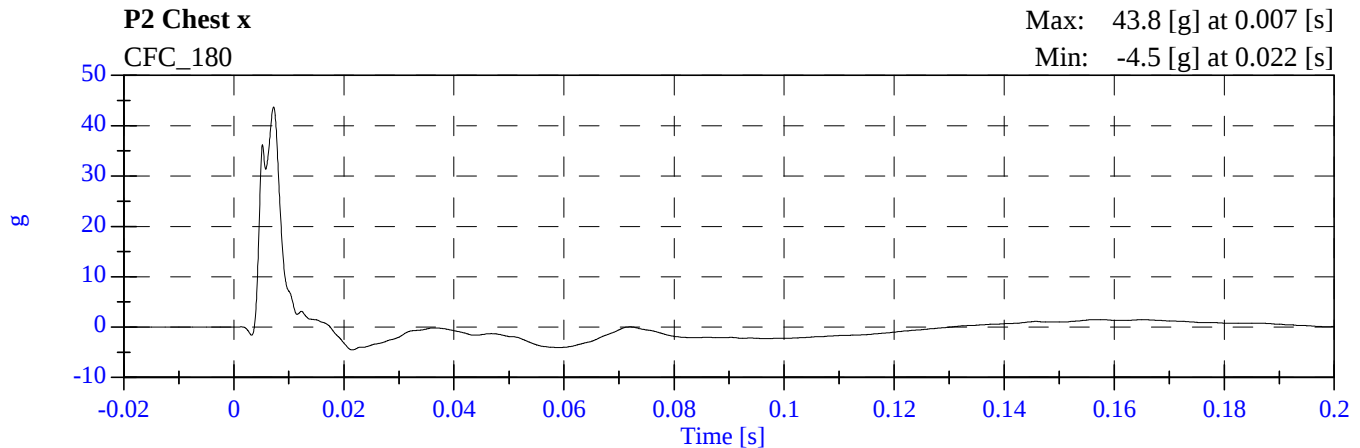
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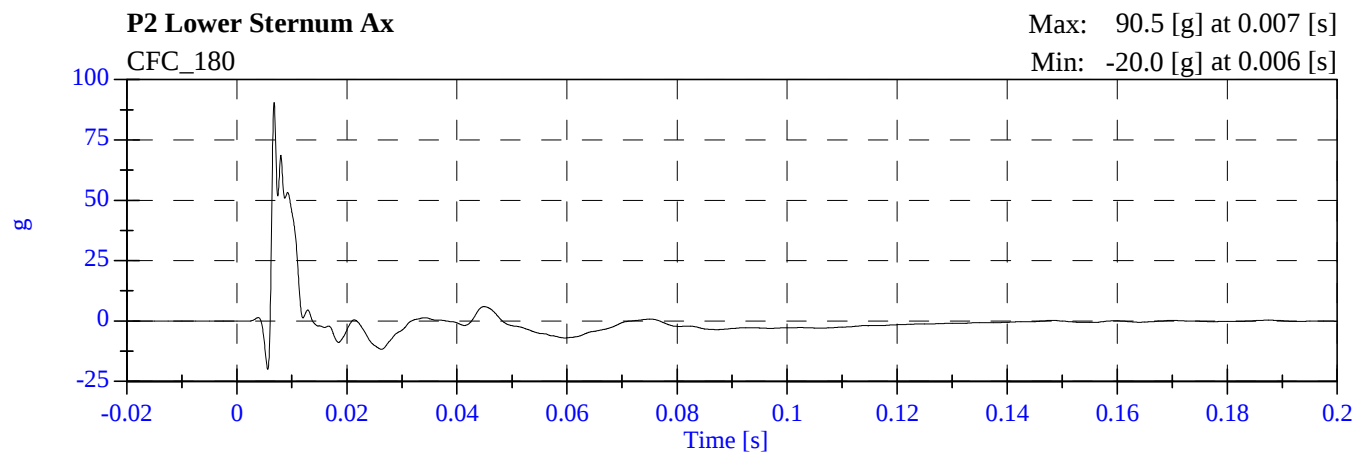
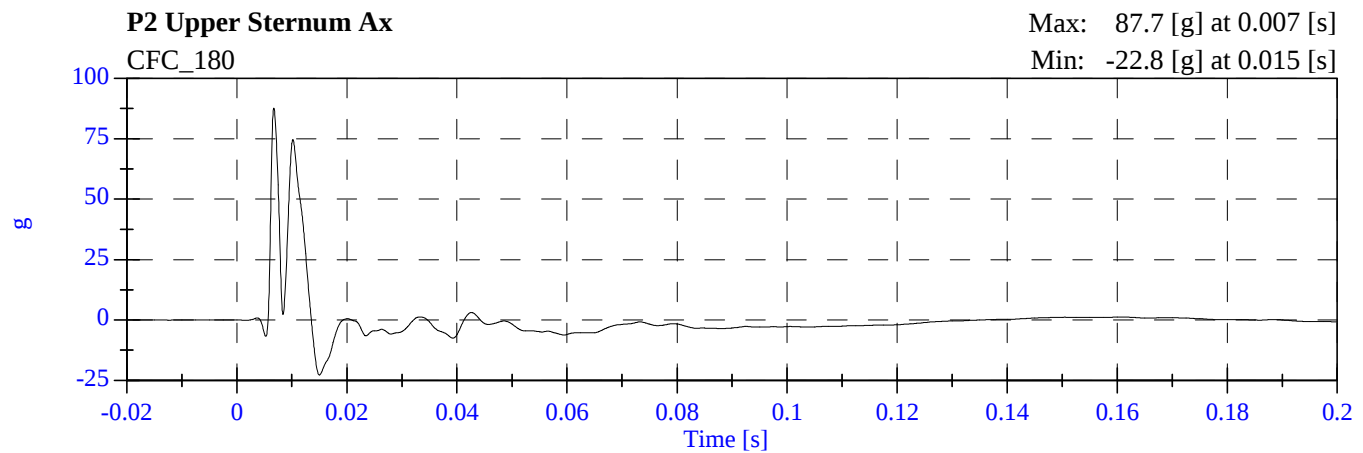
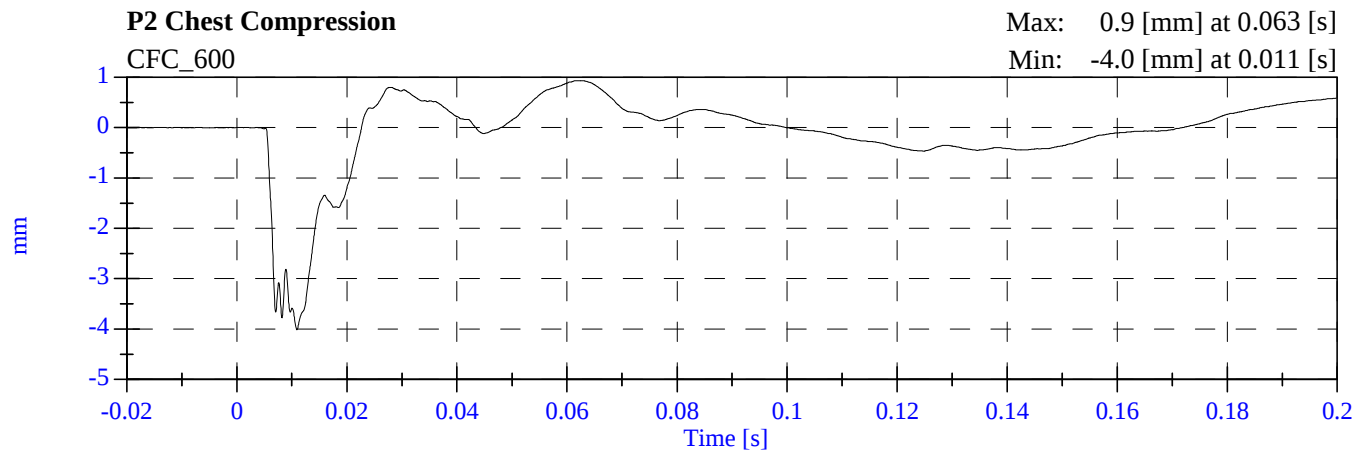
2007 TWG Test 4 2007 Subaru Legacy M75500TWG2 - May 15, 2007



2007 TWG Test 4 2007 Subaru Legacy M75500TWG2 - May 15, 2007

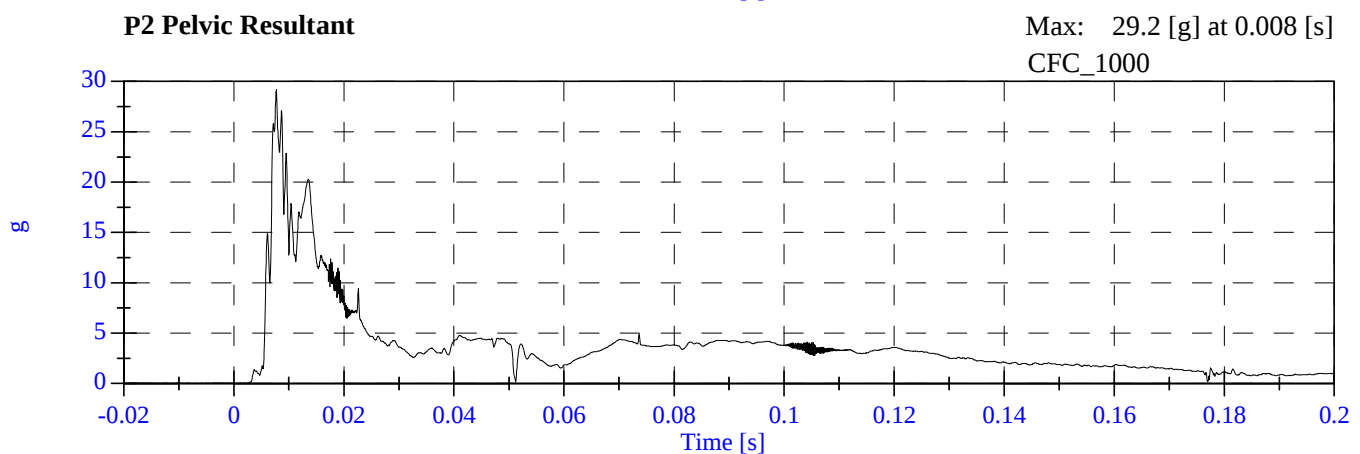
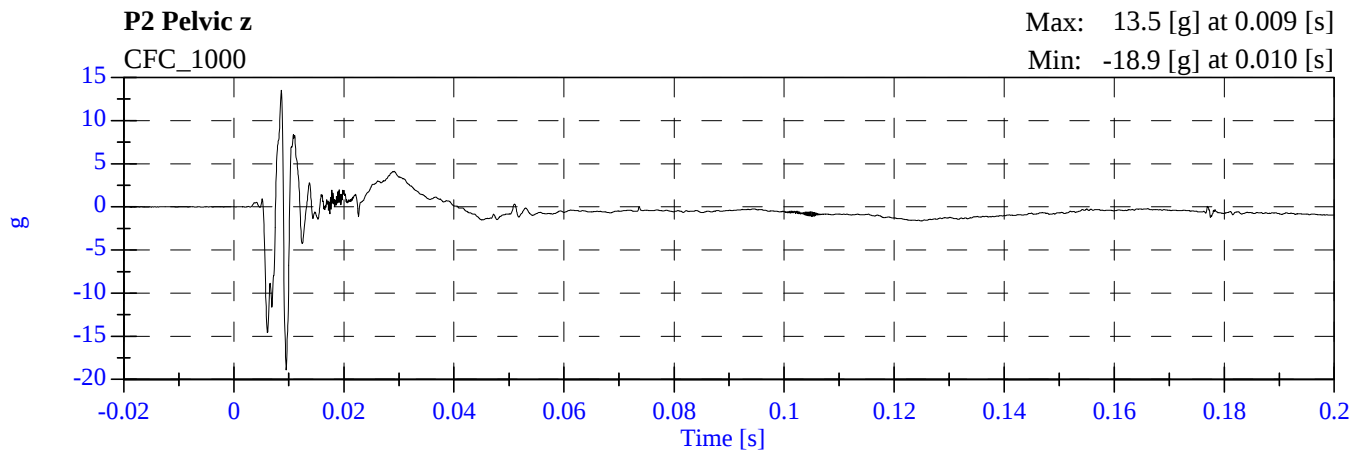
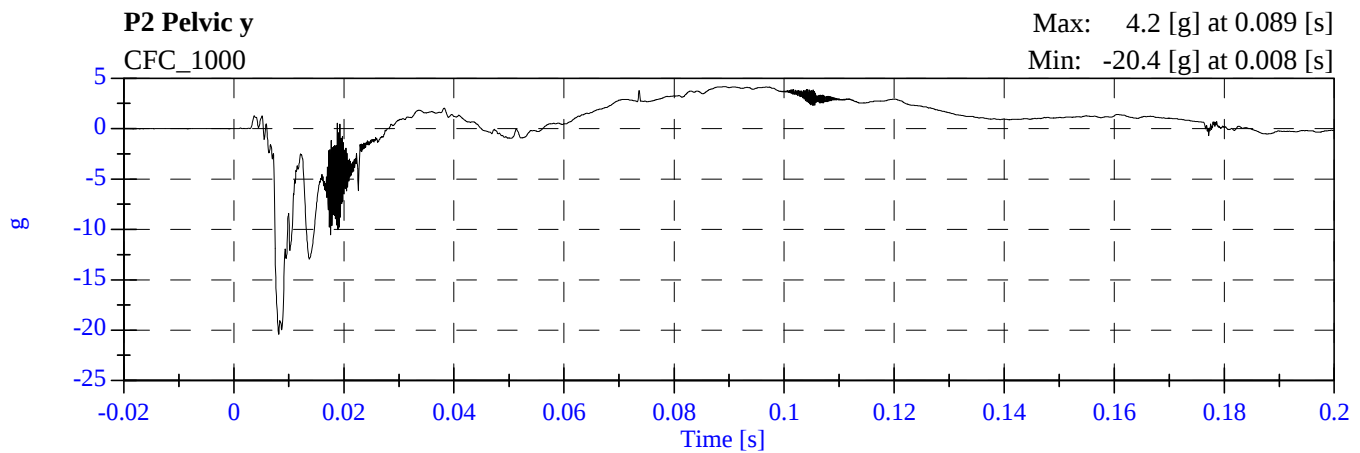
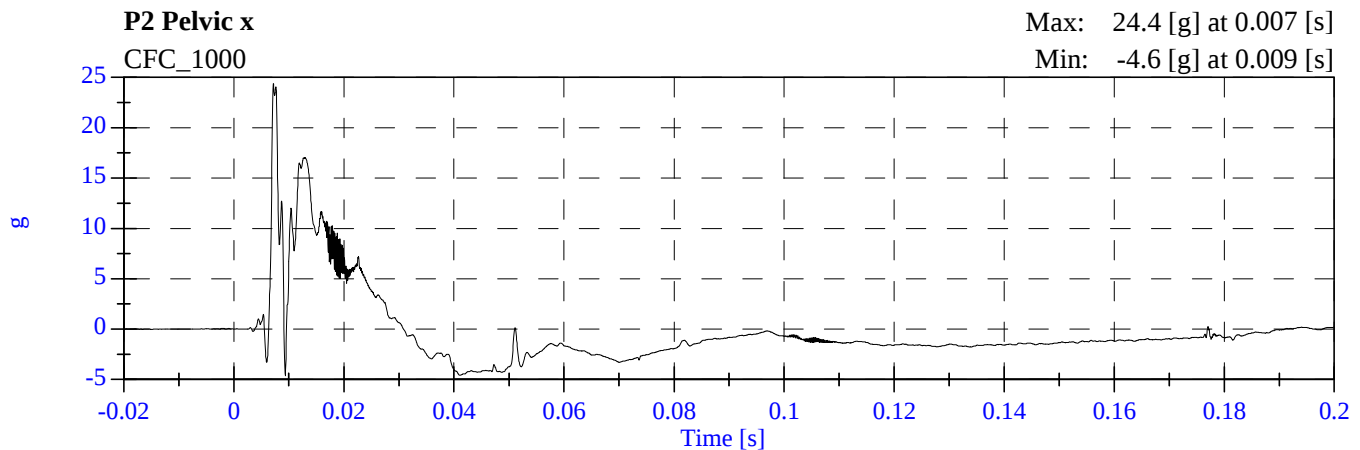


2007 TWG Test 4 2007 Subaru Legacy M75500TWG2 - May 15, 2007

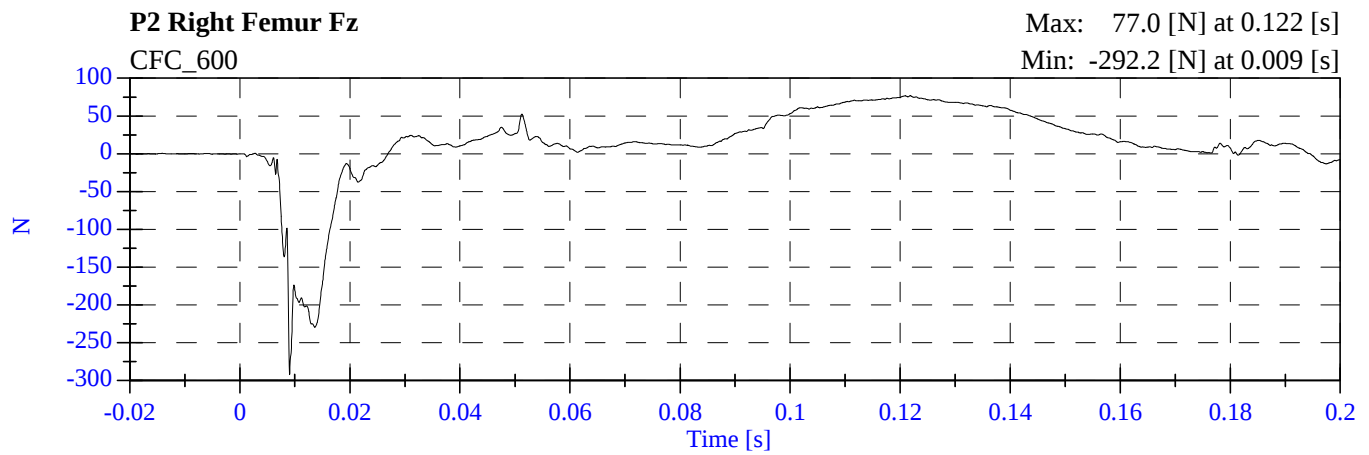
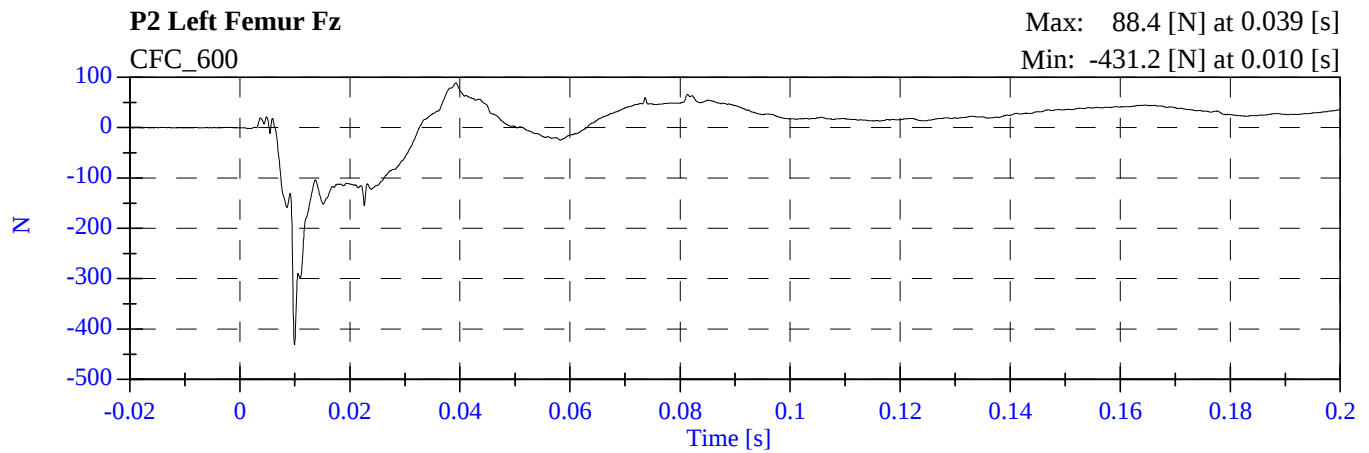


2007 TWG Test 4 2007 Subaru Legacy

M75500TWG2 - May 15, 2007



2007 TWG Test 4 2007 Subaru Legacy M75500TWG2 - May 15, 2007



APPENDIX C

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

P572N INSTRUMENTATION

	POSITION #2 (RIGHT FRONT) SERIAL NO.: 186		
	SERIAL NUMBER	MANUFACTURER	CALIBRATION DATE
HEAD AX	AC-04J04I20-Z23	ENTRAN	3/13/2007
HEAD AY	AC-04J04I01-R12	ENTRAN	3/13/2007
HEAD AZ	AC-02I02I16-A08	ENTRAN	3/13/2007
UPPER NECK FX	LC-175Fx	DENTON	5/2/2007
UPPER NECK FY	LC-175Fy	DENTON	5/2/2007
UPPER NECK FZ	LC-175Fz	DENTON	5/2/2007
UPPER NECK MX	LC-175Mx	DENTON	5/2/2007
UPPER NECK MY	LC-175My	DENTON	5/2/2007
UPPER NECK MZ	LC-175Mz	DENTON	5/2/2007
CHEST AX	AC-04J04I08-F25	ENTRAN	3/13/2007
CHEST AY	AC-03E03E20-N05	ENTRAN	3/13/2007
CHEST AZ	AC-03E03D30-N08	ENTRAN	3/13/2007
CHEST DISPLACEMENT X	DS-186	SERVO	5/10/2006
UPPER STERNUM AX	AC-02A16-A26	ENTRAN	3/13/2007
LOWER STERNUM AX	AC-99H12-F24	ENTRAN	3/13/2007
PELVIS AX	AC-04J04I01-R06	ENTRAN	3/13/2007
PELVIS AY	AC-03E03D30-N03	ENTRAN	3/13/2007
PELVIS AZ	AC-03D03D16-F04	ENTRAN	3/13/2007
LEFT FEMUR FZ	LC-247	DENTON	5/18/2006
RIGHT FEMUR FZ	LC-248	DENTON	5/16/2006