

REPORT NUMBER: TWG-MGA-2007-002

**NEW CAR ASSESSMENT PROGRAM
SIDE AIRBAG OUT-OF-POSITION INJURY TESTING**

**KIA MOTORS CORPORATION
2006 KIA OPTIMA LX
NHTSA NUMBER: M60519TWG2**

**PREPARED BY:
MGA RESEARCH CORPORATION
5000 WARREN ROAD
BURLINGTON, WI 53105**



Test Date: May 1, 2007

Final Report Date: May 30, 2007

FINAL REPORT

**PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
RULEMAKING
OFFICE OF CRASHWORTHINESS STANDARDS
400 SEVENTH STREET, SW, ROOM 5311
WASHINGTON, D.C. 20590**

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Prepared by:



Jessica Gall, Project Engineer

Date: 5/30/07

Reviewed by:



David Winkelbauer, Facility Director

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Technical Report Documentation Page

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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 MGA Research Corporation in Burlington, Wisconsin, on May 1, 2007. <table style="margin-left: auto; margin-right: auto; border: none;"> <thead> <tr> <th style="text-align: center;">HIC 15</th> <th style="text-align: center;">HIC 36</th> <th style="text-align: center;">NIJ NTF</th> <th style="text-align: center;">NIJ NTE</th> <th style="text-align: center;">NIJ NCF</th> <th style="text-align: center;">NIJ NCE</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">12.0</td> <td style="text-align: center;">12.0</td> <td style="text-align: center;">0.18</td> <td style="text-align: center;">0.02</td> <td style="text-align: center;">0.28</td> <td style="text-align: center;">0.12</td> </tr> </tbody> </table>				HIC 15	HIC 36	NIJ NTF	NIJ NTE	NIJ NCF	NIJ NCE	12.0	12.0	0.18	0.02	0.28	0.12
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SECTION 1

PURPOSE AND SUMMARY OF TEST

PURPOSE

The purpose of this test was to obtain data in a static out-of-position side air bag deployment. 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 number DTNH22-03-D-12005.

SUMMARY

The effects of both a curtain and torso airbag deployment in a 2006 Kia Optima with an out-of-position SID-IIs Build Level D were evaluated. The test was performed by MGA Research Corporation on May 1, 2007. Pre and post test photographs of the vehicle and dummy can be found in Appendix A.

One real-time camera (24 fps) and three high-speed cameras (1000 fps) were used to document the side airbag deployment event. The following camera locations were used:

- Left Side Through Removed Driver Door
- Front Through Windshield
- Left Side $\frac{3}{4}$ View Through Windshield

One SID-IIs Build Level D dummy (Serial Number 032) was placed in the right front passenger seat situated in the inboard-facing position per Section 3.3.3.6 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 dummy was instrumented with the following instrumentation:

- Head Accelerations
- Upper Neck Load Cell
- Lower Neck Load Cell
- Upper Spine Accelerations
- Lower Spine Accelerations
- Rib Displacements
- Rib Accelerations
- Spine Box Accelerations
- Pelvic Accelerations

The 43 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy data traces. Appendix C contains the instrumentation calibration data.

The SID-IIs dummy's visible contact points were as follows: The curtain airbag to the top of the head and face. The torso bag to the left shoulder, torso, and pelvis of the dummy.

The SID-II's dummy was placed in the right front passenger seat facing toward the center of the vehicle with its arm against the seatback. The dummy's pelvis was adjusted until the dummy contacted the door trim panel. The arm was rotated to a horizontal orientation. The dummy's pelvis was then adjusted forward/rearward, with respect to the vehicle, to lean the dummy rearward to align the center of the first thoracic rib with the top edge of the airbag module. The dummy's spine was aligned such that a vertical plane through the centerline of the dummy's shoulder rib stiffener and shoulder bolt was parallel to the longitudinal plane of the vehicle. Masking tape was wrapped around the dummy's neck bracket to hold the dummy in place, if necessary.

This orientation complies with Section 3.3.3.6 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
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
TEST SUMMARY

	Test Data	Description
Seating Position	P2	Right Front Seating Position
Test	3.3.3.6*	Side-facing SID-IIs dummy
Curtain Airbag	Roof-Rail Mounted	Side airbag
Torso Airbag	Seat Mounted	Side airbag
ATD Type/Serial No.	SID-IIs Build Level D / 032	5 th Percentile Adult Female

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

Number of Data Channels	43
Number of Real-Time Video	1
Number of High-Speed Video	3

Visible Dummy Contact Points	
Head Contact	Curtain airbag to top of head and face
Left Shoulder Contact	Torso bag
Left Torso Contact	Torso bag
Left Pelvis Contact	Torso bag

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

Please note that this vehicle had previously been tested in an
NCAP Side Impact on September 22, 2006.

TEST VEHICLE INFORMATION

Manufacturer	Kia
Model	Optima LX
Body Style	Sedan
NHTSA No.	M60519TWG2
VIN	KNAGE123765073730
Color	Black
Delivery Date	9/06/06
Odometer Reading (mile)	33
Dealer	Ricart Automotive
Transmission	Automatic
Final Drive	Front
Number of Cylinders	4
Engine Displacement (L)	2.4
Engine Placement	Lateral
Automatic Door Lock (ADL)	Yes
Owners Manual Details Instructions on Disabling ADLs	No
Bucket Seats	N/A

TEST VEHICLE OPTIONS

Front Airbag	Yes
Driver Side Curtain Airbag	Yes
Driver Side Torso Airbag	Yes
Rear Passenger Side Curtain Airbag	Yes
Rear Passenger Side Torso Airbag	No
Force Limiter	Yes
Pretensioner	Yes
Power Steering	Yes
Power Door Locks	Yes
Tilt Wheel	Yes
Air Conditioning	Yes
Anti-lock Brakes	Yes
Traction Control	No
All Wheel Drive	No
Power Seats	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Kia Motors Corporation
Date of Manufacture	06/06

GVWR (kg)	1930
GAWR Front (kg)	1120
GAWR Rear (kg)	1020

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				375
Cargo Wt. (RCLW) (kg)				35

DATA SHEET NO. 3
DUMMY POSITIONING IN VEHICLE

Measurement		Value
Seat Position		Rearmost
Seat Height Position		Non-adjustable
Placed in Position No. 2		---
Seat Back Angle	SA (°)	25
Top of Airbag Module to Head/Neck Junction	AN (mm)	166
Head CG to Door Panel/Window	HD (mm)	169
Head to Seat Back Centerline	HSC (mm)	173
Chest to Dash	CD (mm)	---
Chest to Seatback	CS (mm)	---
Right Arm to Seat Back Centerline	RACL (mm)	---
Left Arm to Seat Back Centerline	LACL (mm)	---
Right Arm to Door Panel	RA (mm)	138
Left Arm to Door Panel	LA (mm)	98
Knee to Knee	KK (mm)	142
Toe to Toe	TT (mm)	56
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)	---
Top of Head to Headliner	HH (mm)	99

DATA SHEET NO. 4
DUMMY INJURY CRITERIA VALUES

NHTSA No. M60519TWG2

DESCRIPTION	UNIT	MAXIMUM VALUE			
		Position No. 2			
		MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Head X	g	24.4	101.7	-7.5	34.4
Head Y	g	6.3	38.3	-9.8	26.0
Head Z	g	20.6	14.2	-10.9	17.3
Head Resultant	g	24.9	101.7		
Head X Redundant	g	24.1	101.8	-7.5	34.0
Head Y Redundant	g	6.6	38.8	-10.1	25.9
Head Z Redundant	g	20.9	14.1	-10.9	17.1
Head Resultant Redundant	g	24.7	101.8		
Upper Neck Fx	N	289.5	21.9	-82.4	130.1
Upper Neck Fy	N	150.1	38.8	-69.8	219.7
Upper Neck Fz	N	223.5	20.7	-579.1	16.5
Upper Neck F Resultant	N	651.4	16.5		
Upper Neck Mx	N-m	12.4	27.6	-11.2	13.2
Upper Neck My	N-m	27.8	18.5	-4.8	227.9
Upper Neck Mz	N-m	11.3	32.5	-0.8	9.3
Upper Neck M Resultant	N-m	28.5	18.5		
Lower Neck Fx	N	372.0	20.1	-88.2	7.4
Lower Neck Fy	N	249.0	9.7	-107.0	25.4
Lower Neck Fz	N	263.0	21.0	-545.5	17.0
Lower Neck F Resultant	N	620.5	17.0		
Lower Neck Mx	N-m	18.2	14.1	-12.5	217.6
Lower Neck My	N-m	22.5	10.2	-35.6	20.8
Lower Neck Mz	N-m	12.2	35.1	-0.3	144.0
Lower Neck M Resultant	N-m	39.3	20.8		
Upper Spine X	g	24.4	12.0	-7.2	7.1
Upper Spine Y	g	20.8	9.3	-4.7	12.8
Upper Spine Z	g	4.0	12.1	-6.0	9.0
Upper Spine Resultant	g	26.2	10.2		

DATA SHEET NO. 4 (continued)
DUMMY INJURY CRITERIA VALUES

NHTSA No. M60519TWG2

		MAXIMUM VALUE			
		Position No. 2			
DESCRIPTION	UNIT	MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Lower Spine X	g	24.3	7.4	-13.4	12.5
Lower Spine Y	g	19.7	7.2	-8.6	19.1
Lower Spine Z	g	5.7	25.3	-8.0	7.0
Lower Spine Resultant	g	31.9	7.3		
Upper Thorax Spine Y	g	14.9	7.8	-4.8	19.6
Middle Thorax Spine Y	g	15.7	7.5	-5.9	19.5
Lower Thorax Spine Y	g	17.9	7.3	-7.2	19.3
Upper Abdomen Spine Y	g	19.7	7.2	-8.6	19.1
Lower Abdomen Spine Y	g	20.7	7.1	-9.6	19.3
Shoulder Rib DY	mm	0.3	33.8	-3.5	11.7
Upper Thorax Rib DY	mm	2.2	22.5	-6.4	13.3
Mid Thorax Rib DY	mm	1.6	22.8	-4.9	8.1
Lower Thorax Rib DY	mm	0.9	22.3	-5.5	8.6
Upper Abdominal Rib DY	mm	0.1	122.0	-6.6	12.6
Lower Abdominal Rib DY	mm	0.1	122.9	-8.2	12.6
Upper Thorax Rib Y	g	224.4	10.8	-152.0	8.4
Mid Thorax Rib Y	g	252.7	4.6	-178.9	8.3
Lower Thorax Rib Y	g	141.6	4.4	-120.8	9.7
Upper Abdominal Rib Y	g	182.7	4.8	-173.3	11.3
Lower Abdominal Rib Y	g	213.1	4.8	-214.7	12.0
Pelvis X	g	14.0	6.6	-2.7	60.1
Pelvis Y	g	14.9	6.5	-2.1	30.3
Pelvis Z	g	6.7	8.4	-3.6	28.8
Pelvis Resultant	g	20.7	6.5		

DATA SHEET NO. 4 (continued)
DUMMY INJURY CRITERIA VALUES

NHTSA No. M60519TWG2

ATD position	HEAD INJURY CRITERIA (HIC)					
	HIC15			HIC36		
	HIC	T ¹ (msec)	T ² (msec)	HIC	T ¹ (msec)	T ² (msec)
No. 2 Right Front	12.0	98.9	105.5	12.0	98.9	105.5

Position 2 Neck Injury Summary (SID-IIs Build Level D – Out-Of-Position)

	Nij	Time (msec)	Z Force (N) (CFC 600)	X Force (N) (CFC 600)	Y Moment (N-m) (CFC 600)
Ntf	0.18	20.70	218.19	210.53	23.69
Nte	0.02	6.70	46.75	0.08	-0.33
Ncf	0.28	16.70	-565.93	281.85	25.91
Nce	0.12	10.50	-334.92	-14.62	-2.31
Peak Tension (CFC1000)		223.5 N	Peak Compression (CFC 1000)		-579.1 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
Condyle Offset	0.01778 m				

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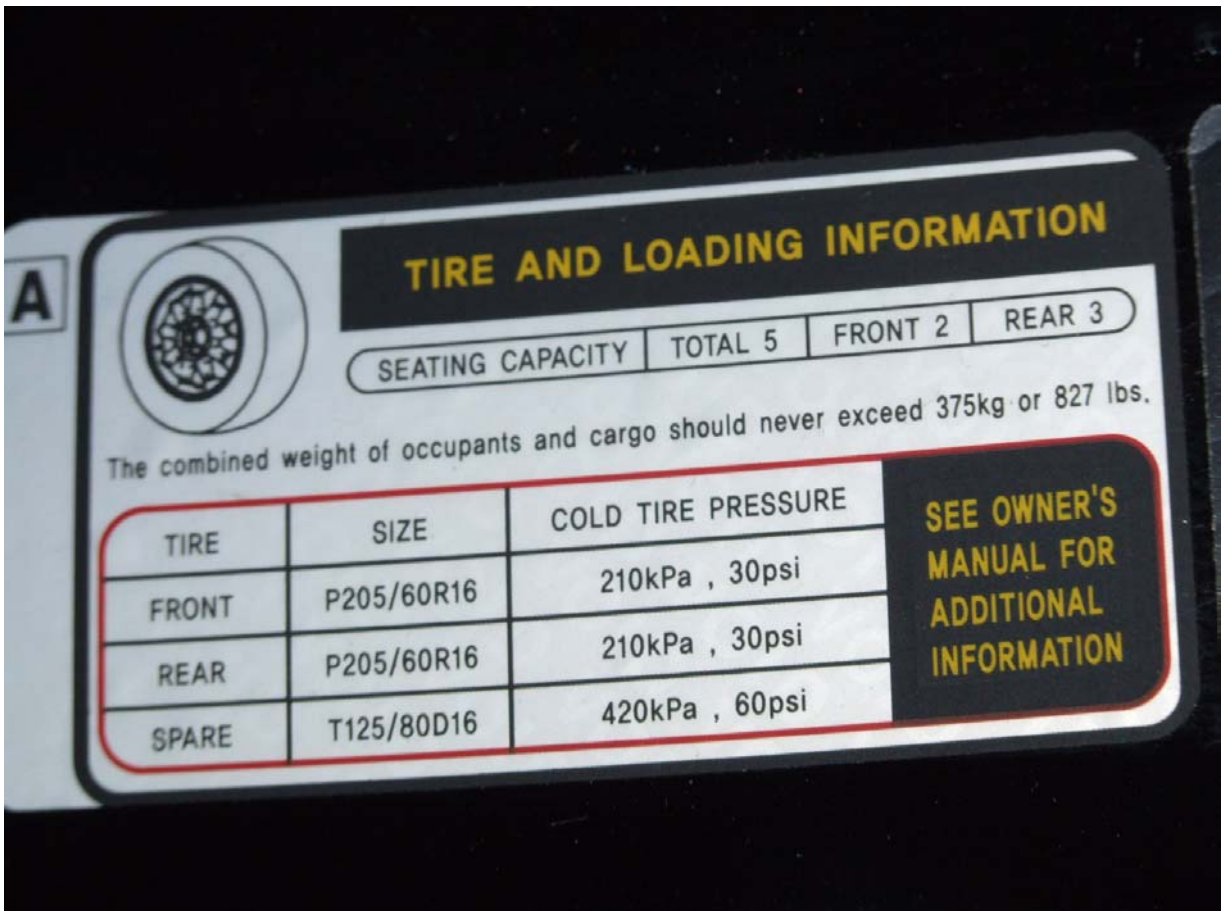
Pre-Test Vehicle Left Side View



Post-Test Vehicle Left Side View



Vehicle Certification Placard



Vehicle Tire Placard



Pre-Test SID-IIs Dummy Frontal View



Post-Test SID-IIs Dummy Frontal View



Pre-Test SID-IIs Dummy Frontal Closeup View



Post-Test SID-IIs Dummy Frontal Closeup View



Pre-Test SID-III Dummy Right 3/4 Front View



Post-Test SID-III Dummy Right 3/4 Front View



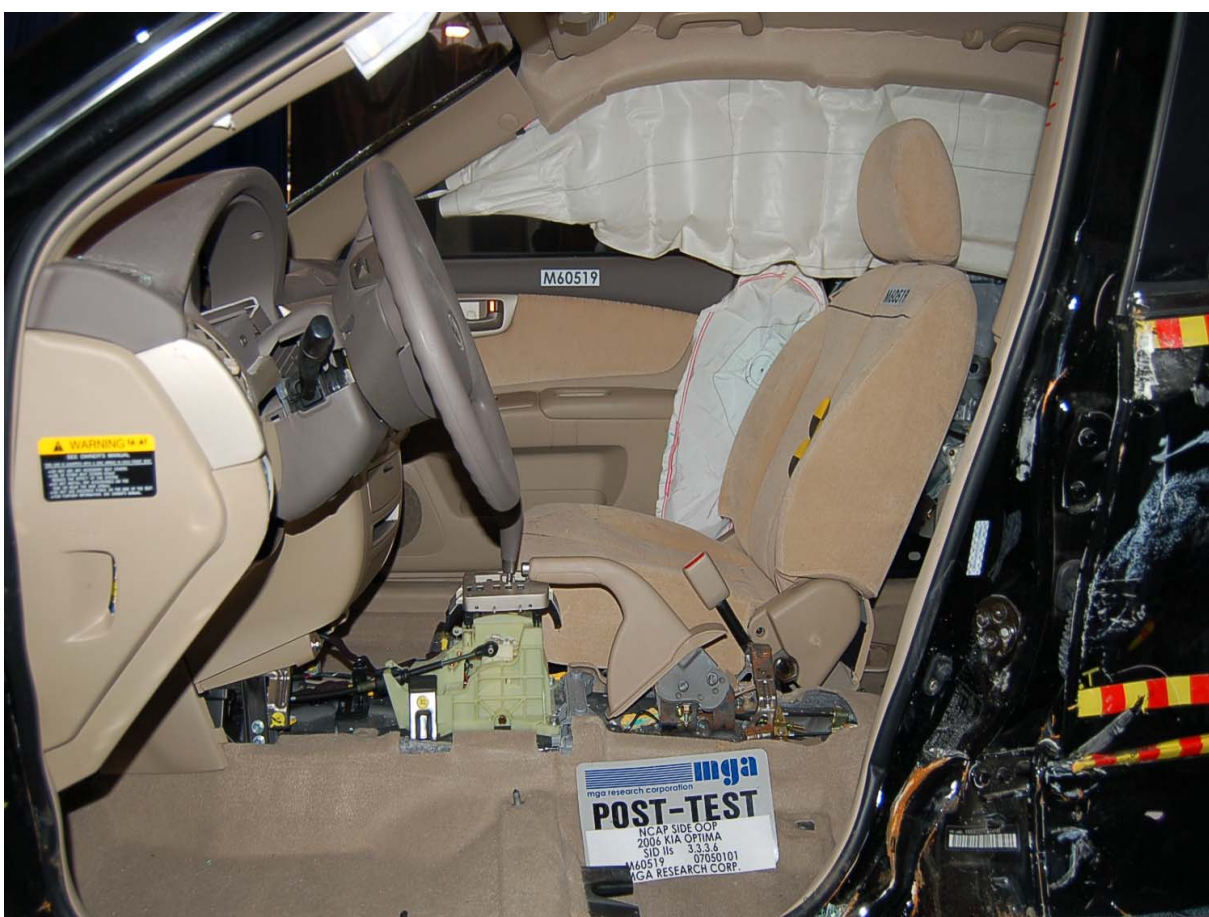
Pre-Test SID-III Dummy Right Side Head View



Post-Test SID-III Dummy Right Side Head View



Post-Test SID-11s Dummy View Through RF Window



Post-Test Right Front Passenger Compartment View



Post-Test Curtain and Torso Airbag View

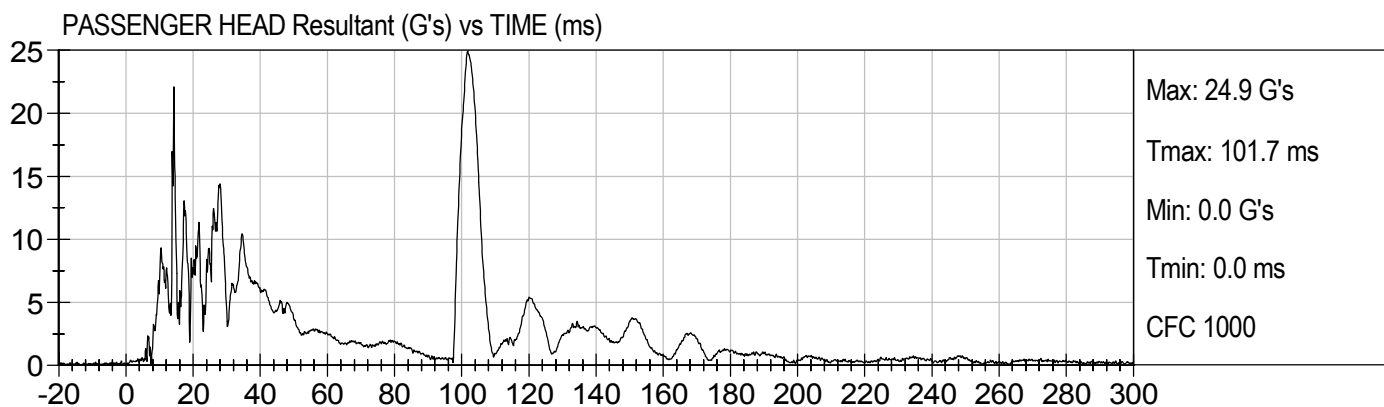
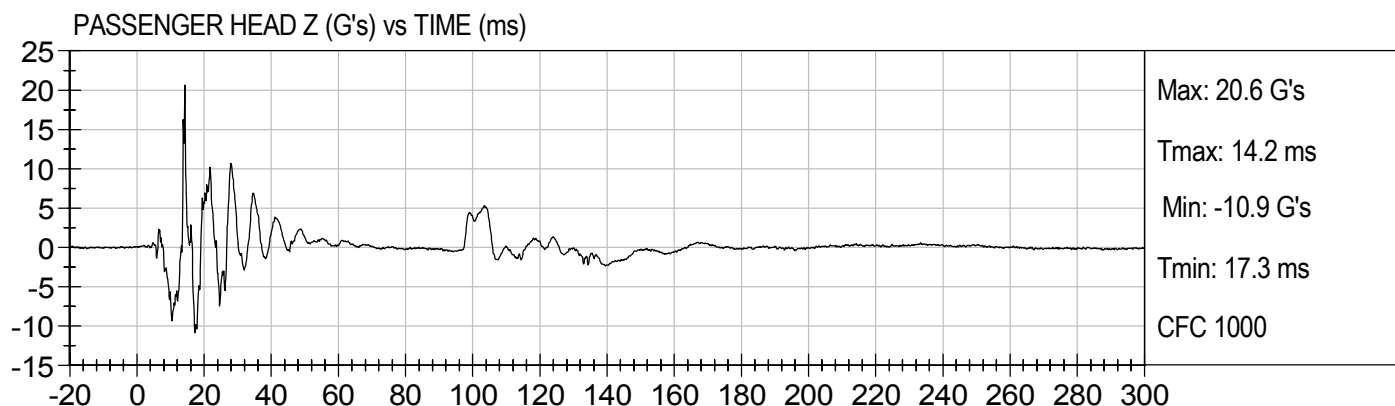
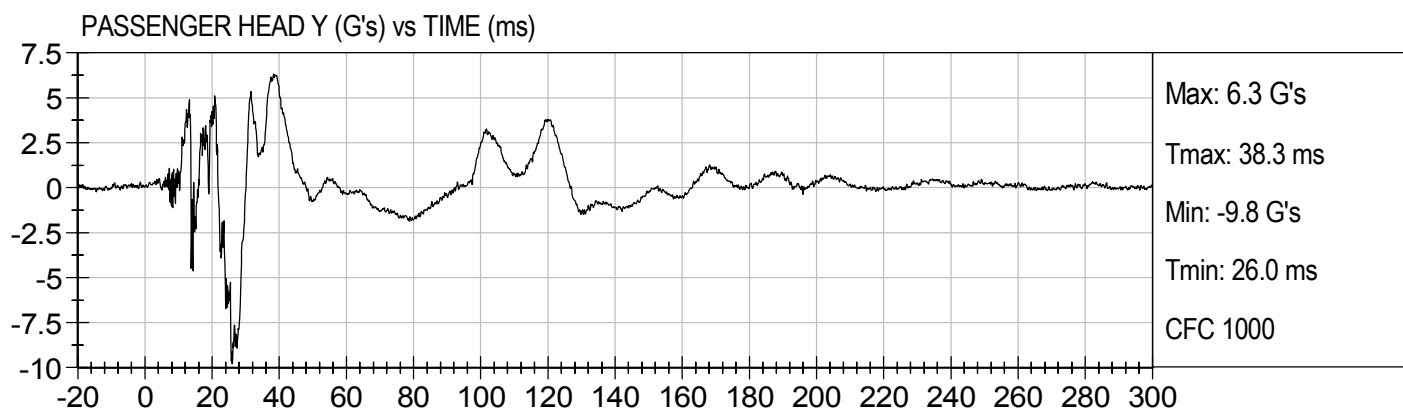
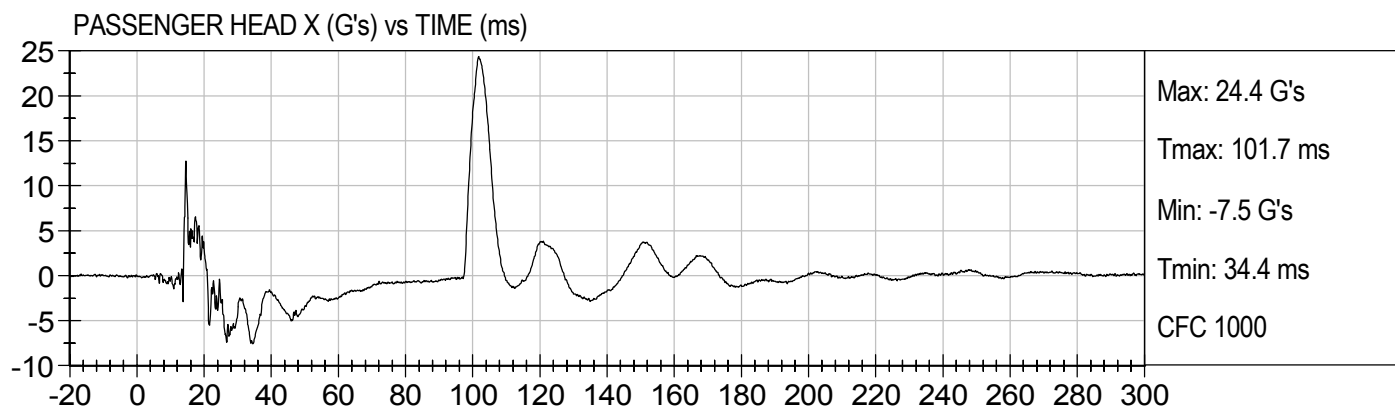
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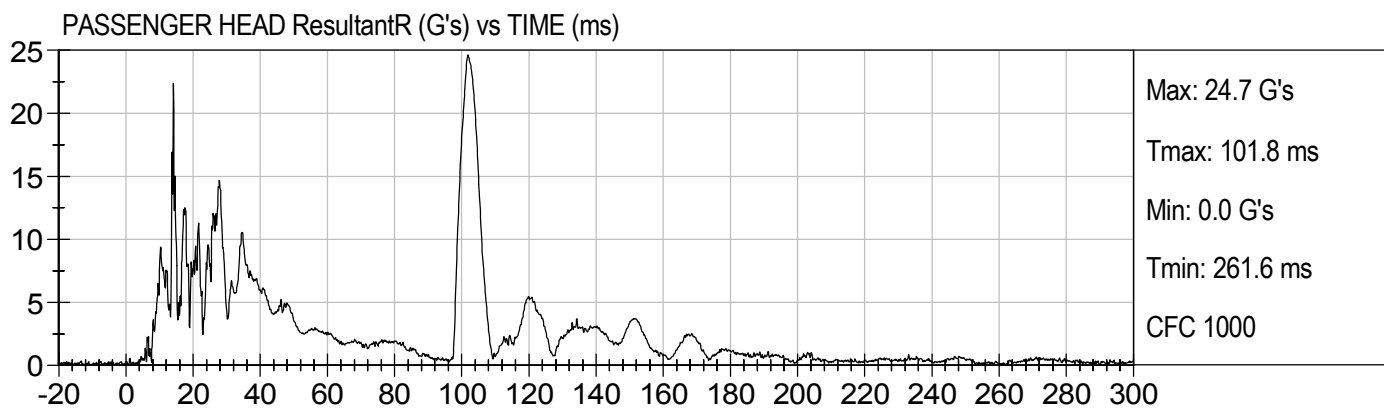
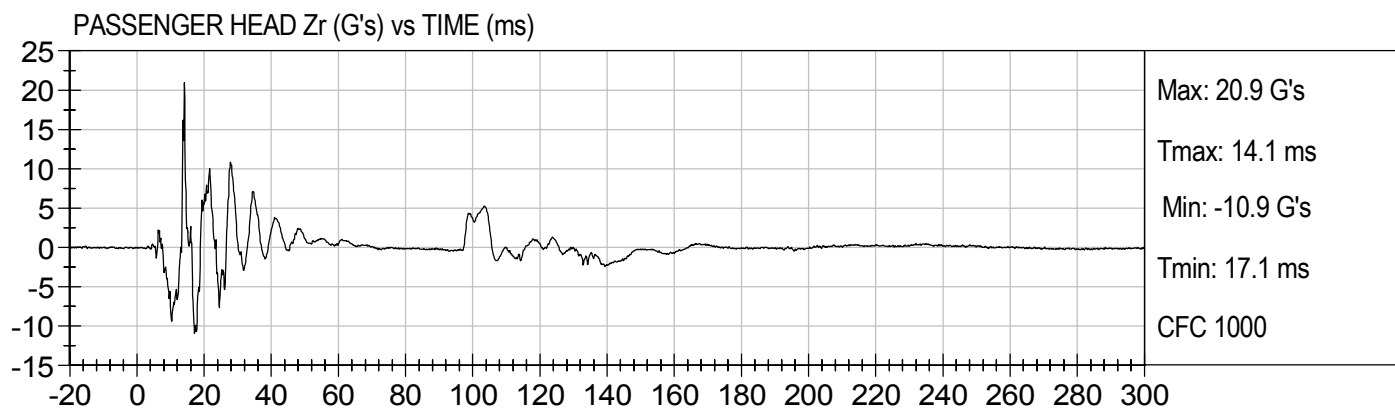
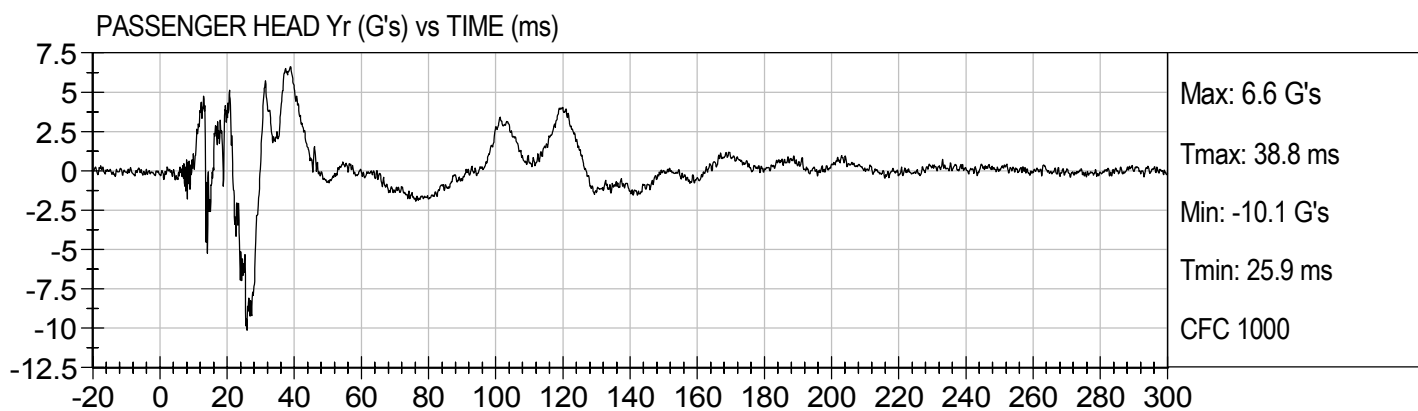
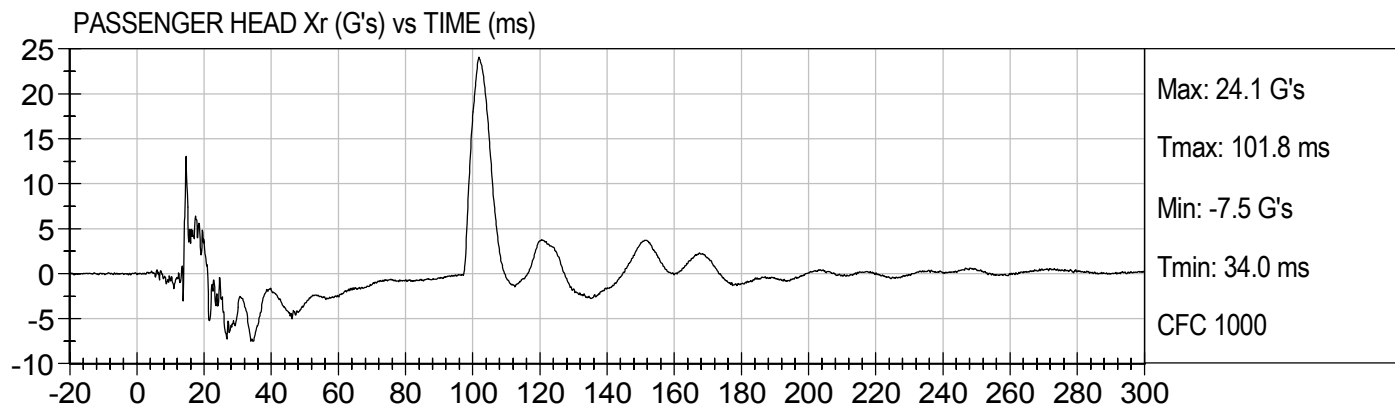
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NCAP SIDE OOP SID-IIsD POSITION 3.3.3.6
2006 KIA OPTIMA M60519

Test Date: 05/01/2007
Speed: 0.0 mph (0.0 km/h)

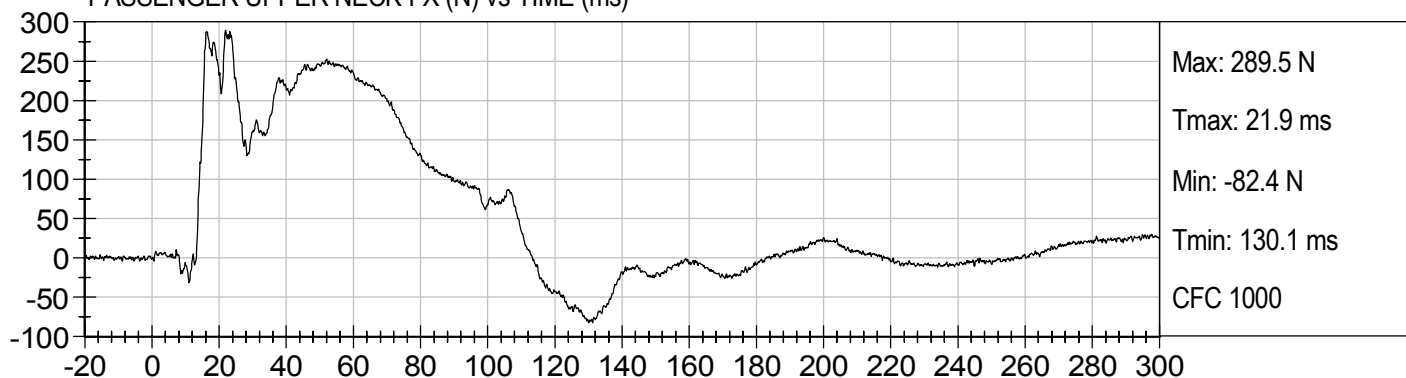




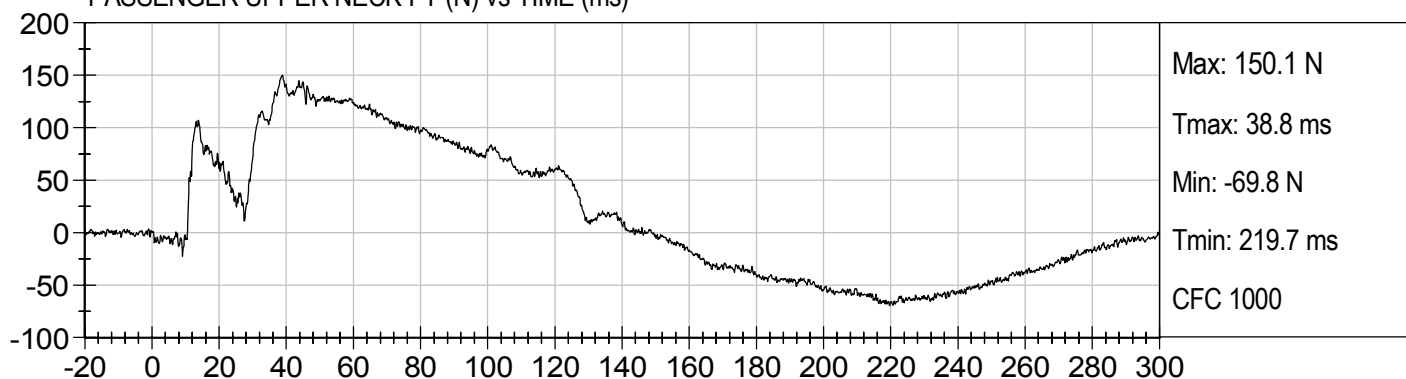
NCAP SIDE OOP SID-IIsD POSITION 3.3.3.6
2006 KIA OPTIMA M60519

Test Date: 05/01/2007
Speed: 0.0 mph (0.0 km/h)

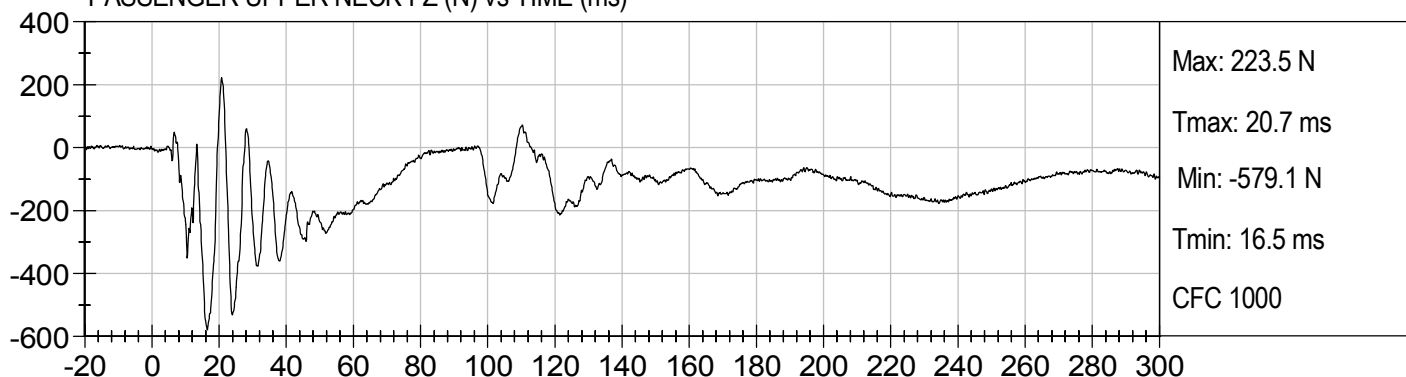
PASSENGER UPPER NECK FX (N) vs TIME (ms)



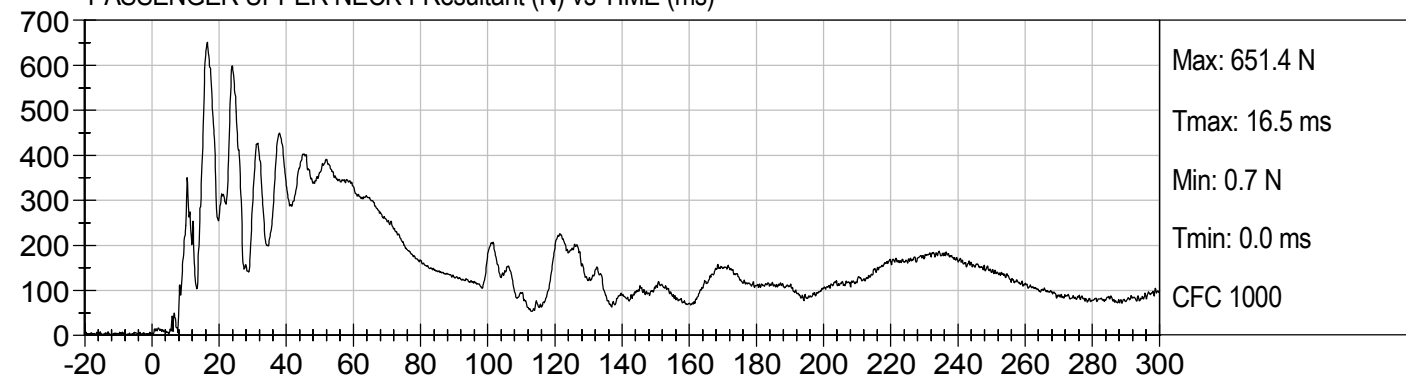
PASSENGER UPPER NECK FY (N) vs TIME (ms)

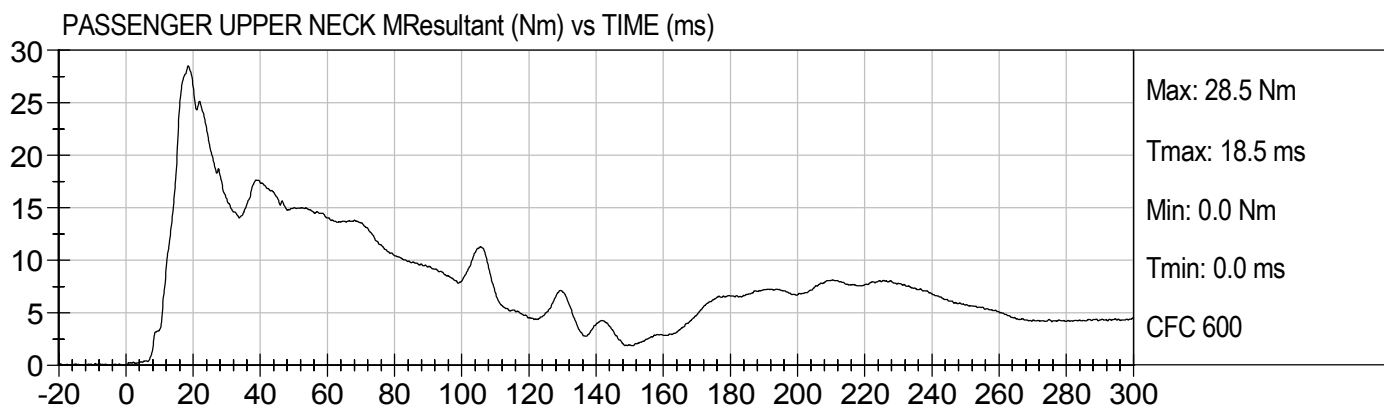
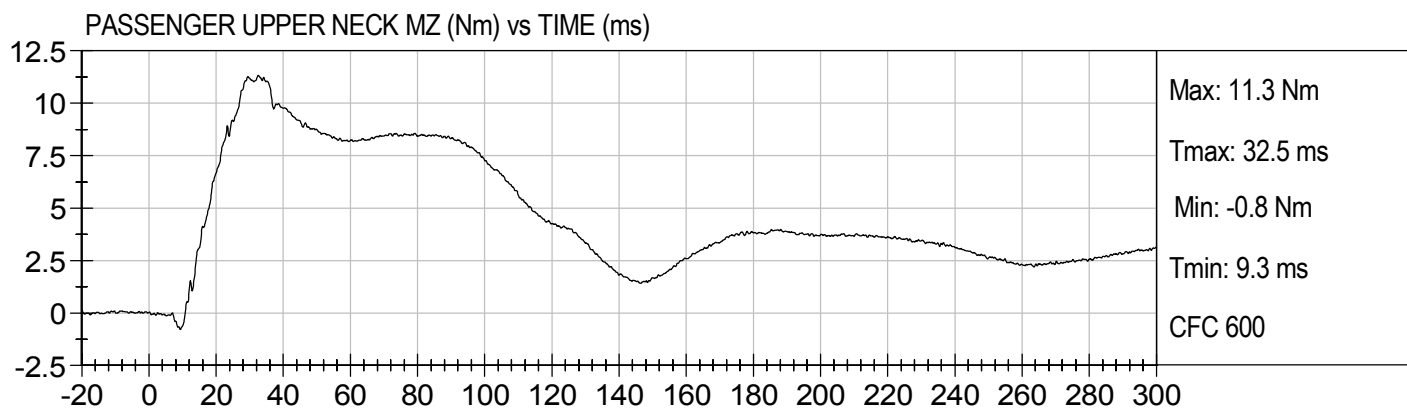
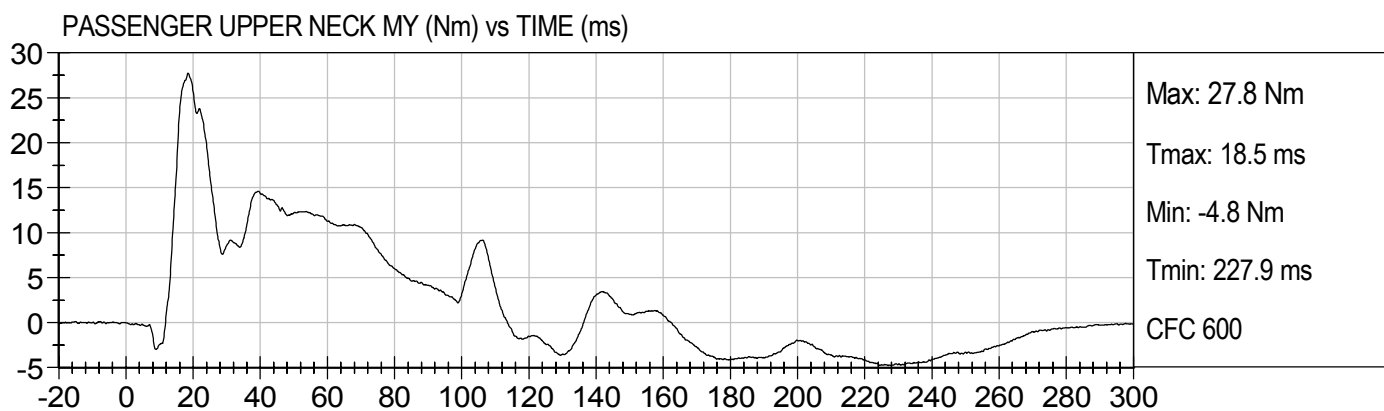
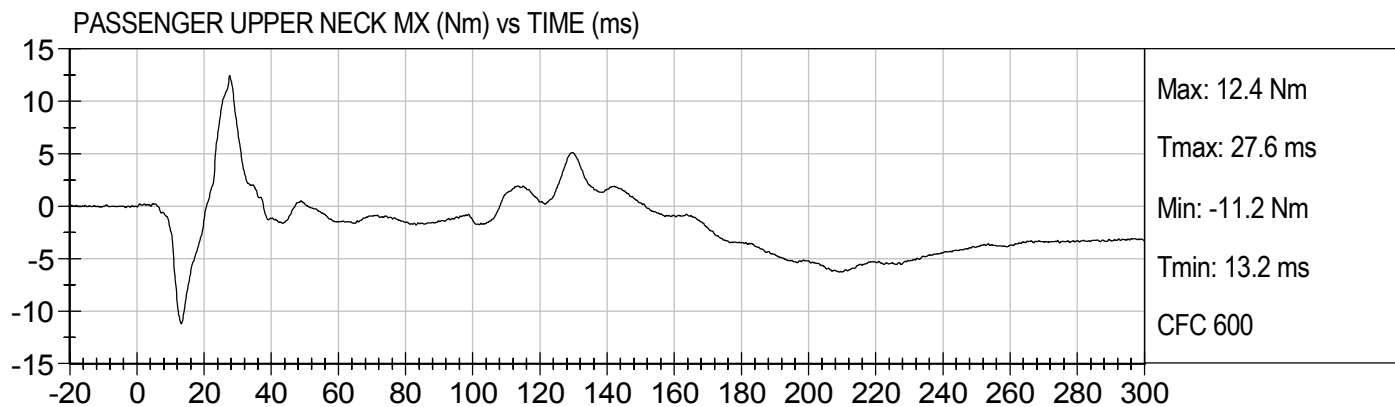


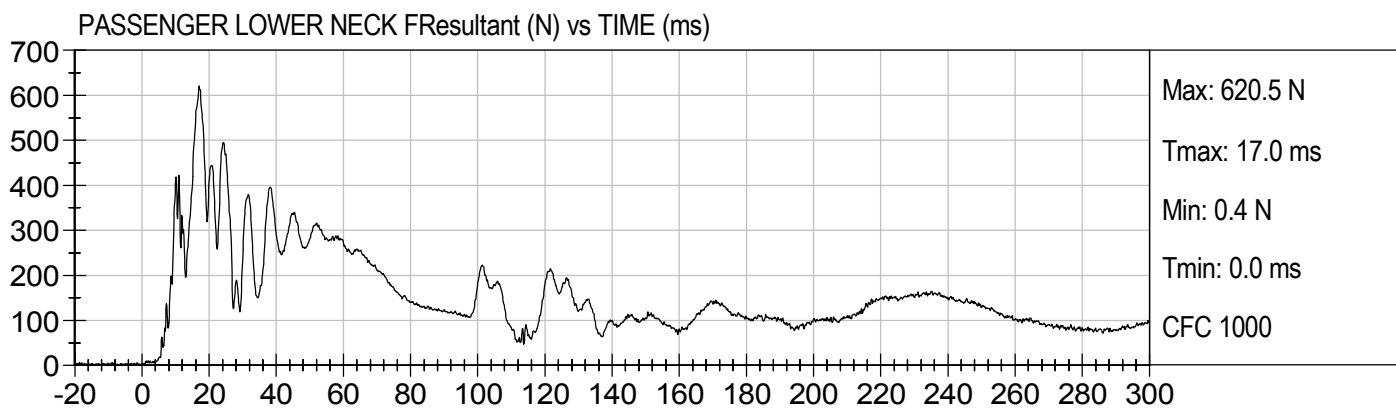
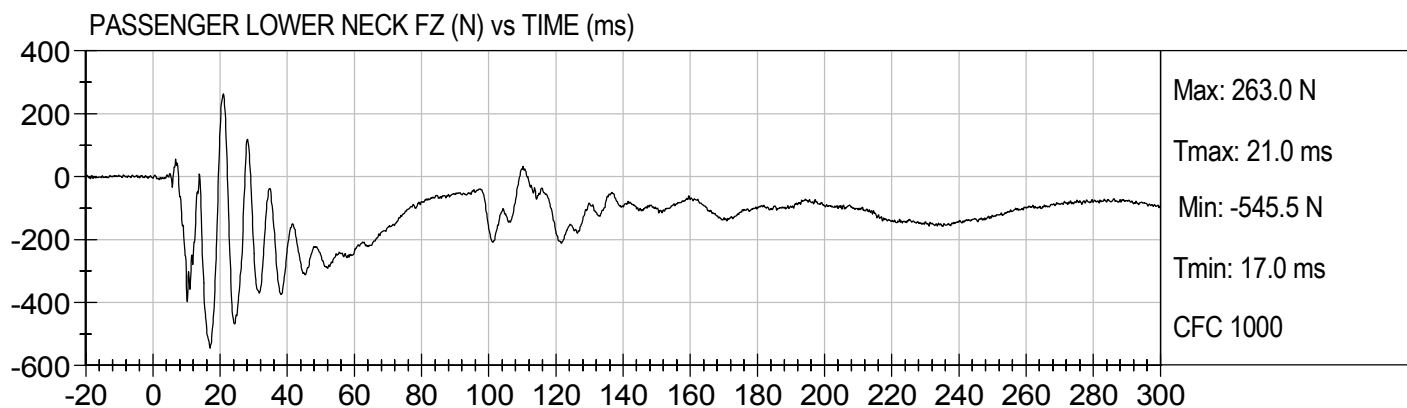
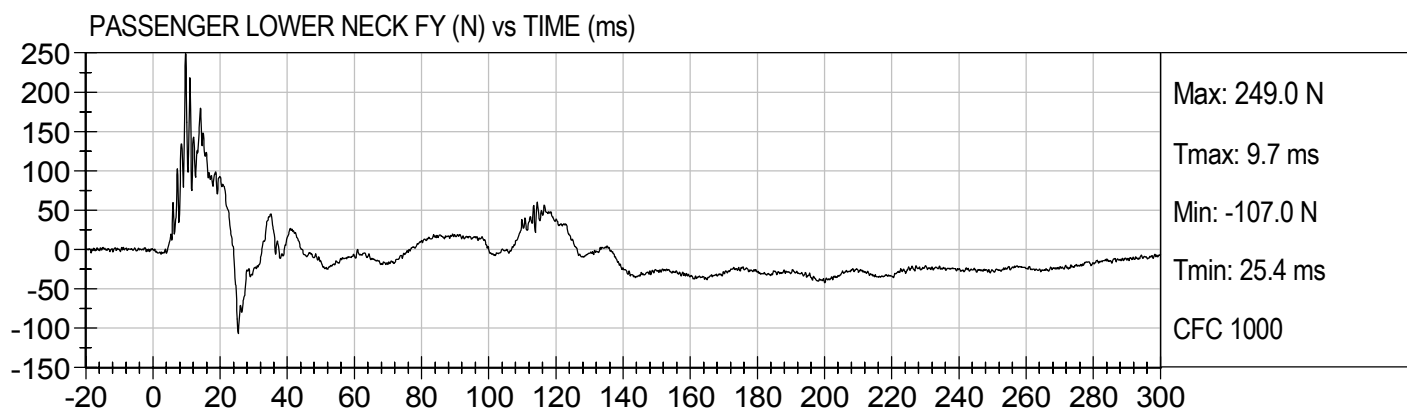
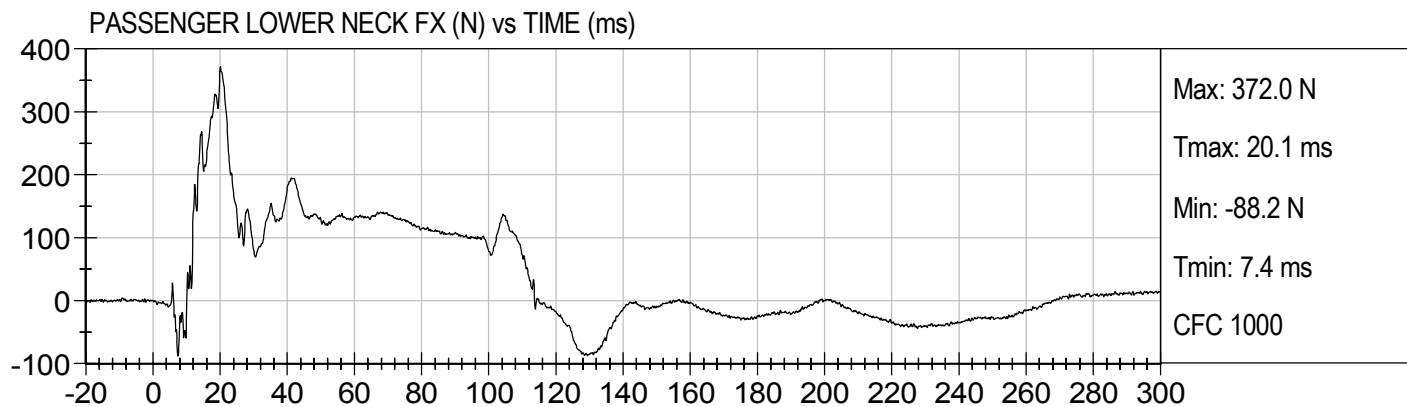
PASSENGER UPPER NECK FZ (N) vs TIME (ms)

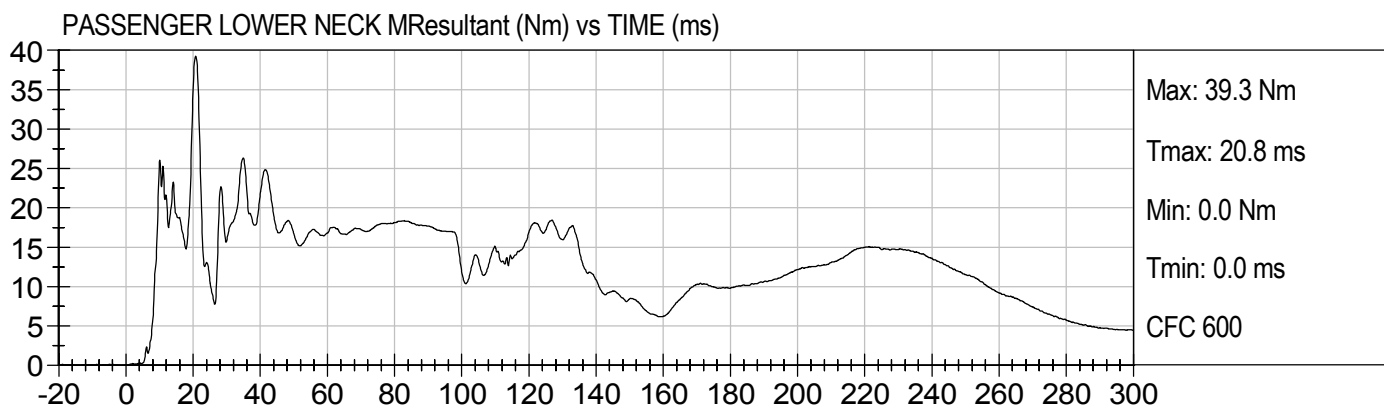
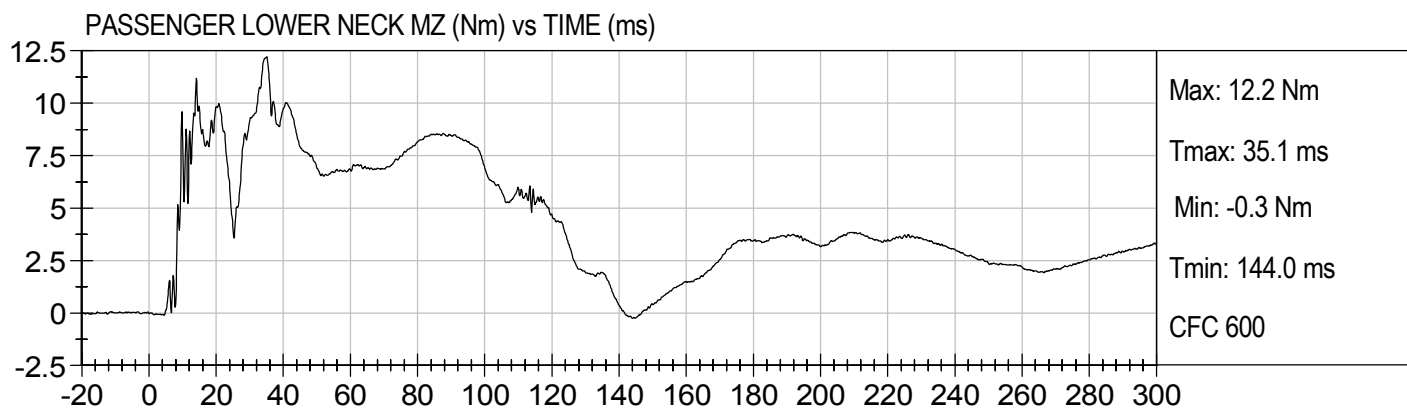
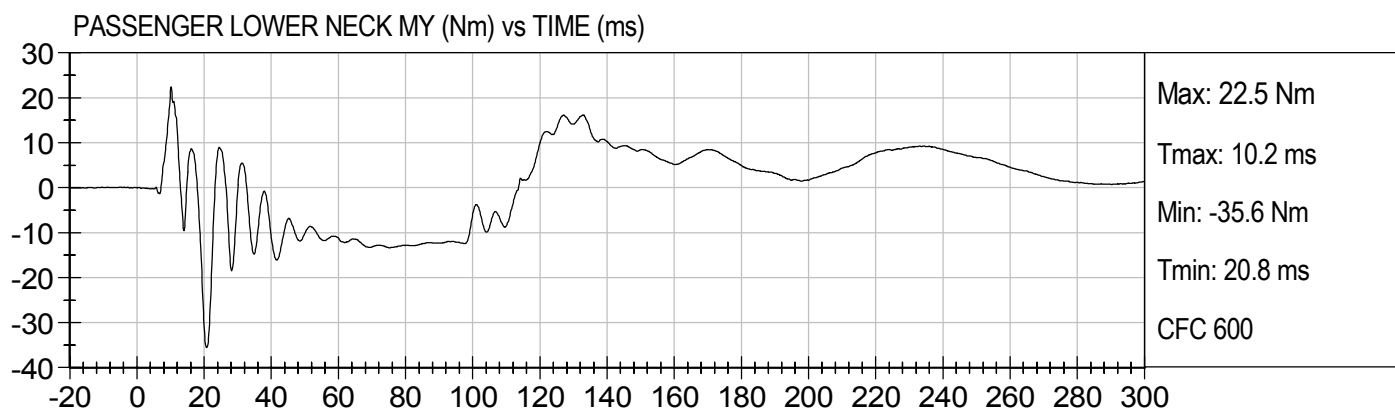
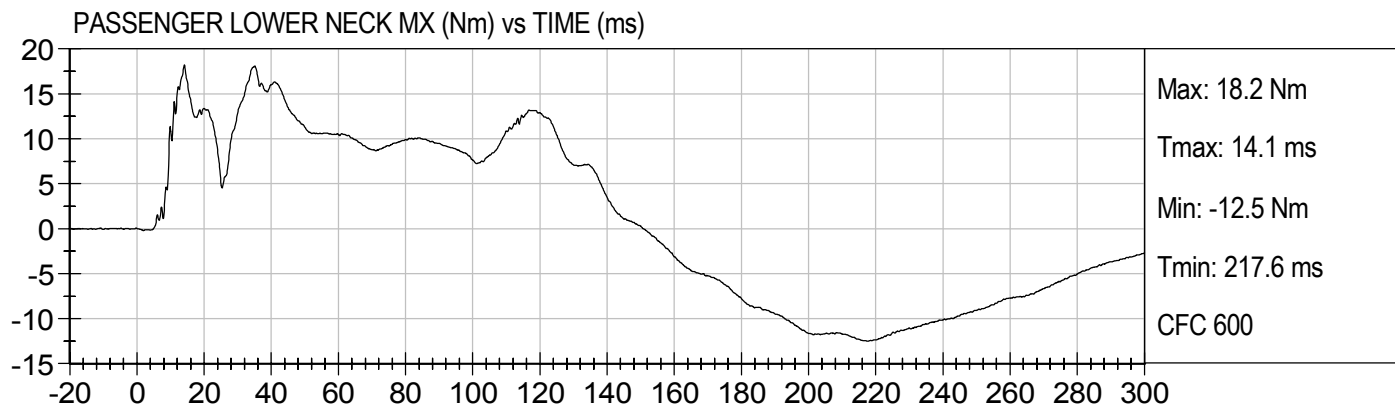


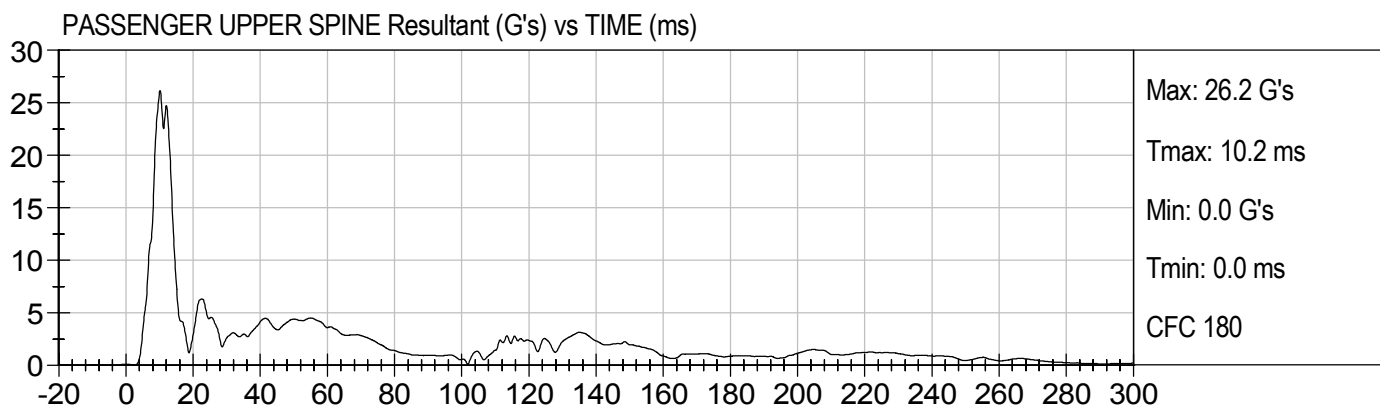
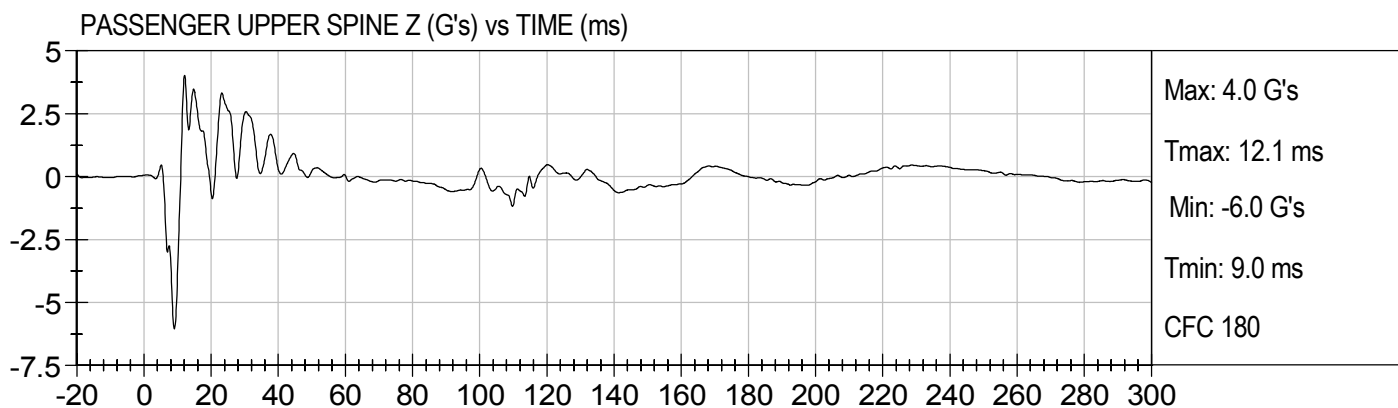
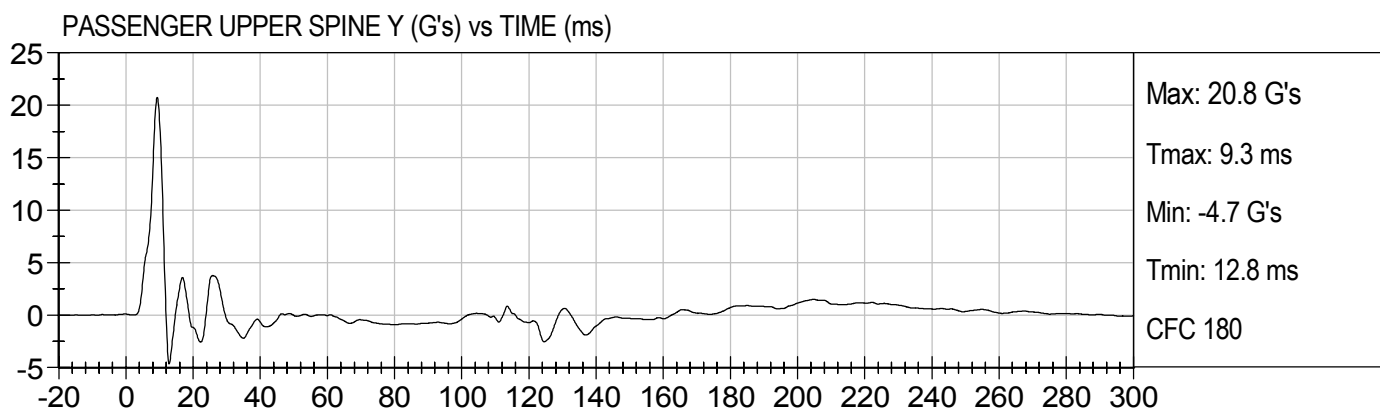
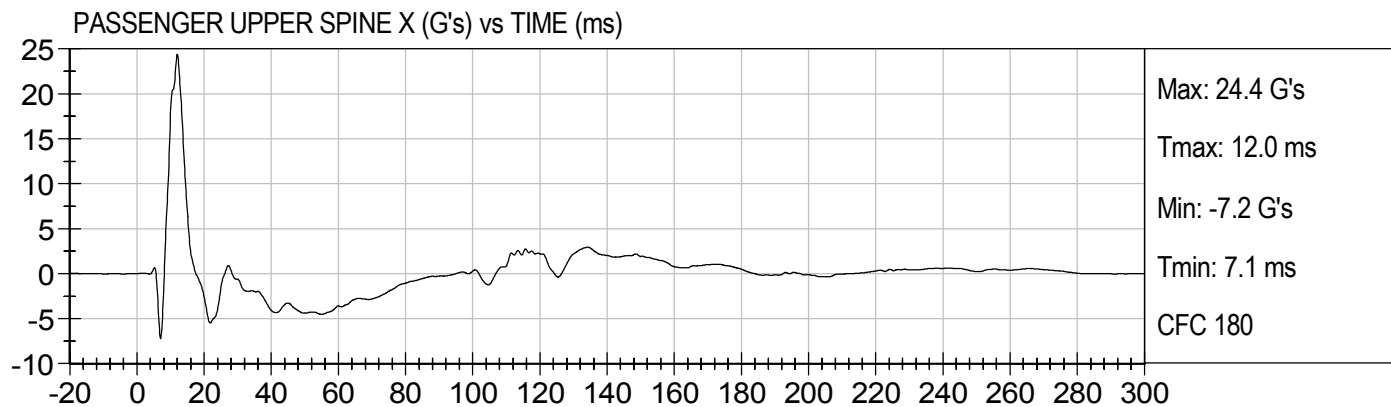
PASSENGER UPPER NECK FResultant (N) vs TIME (ms)

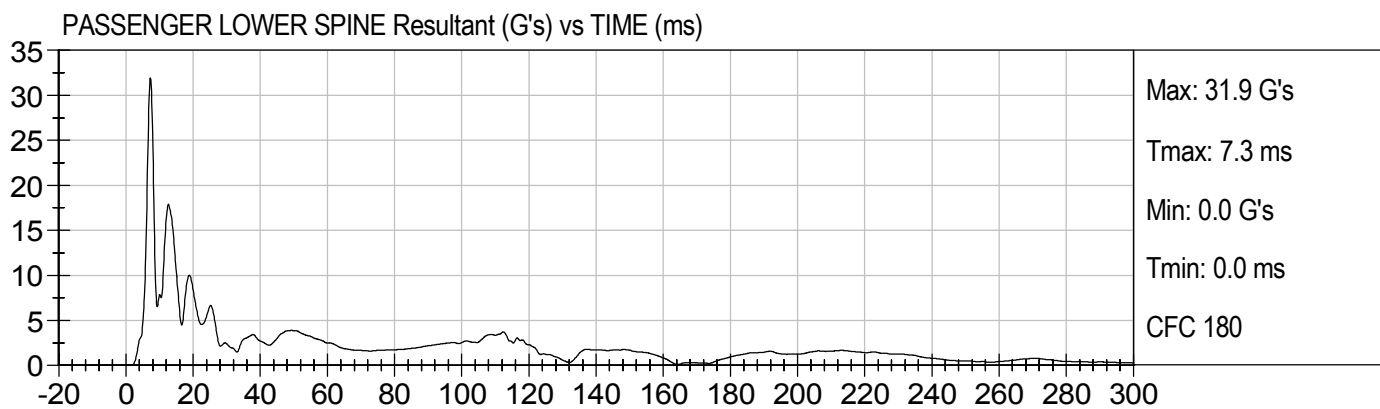
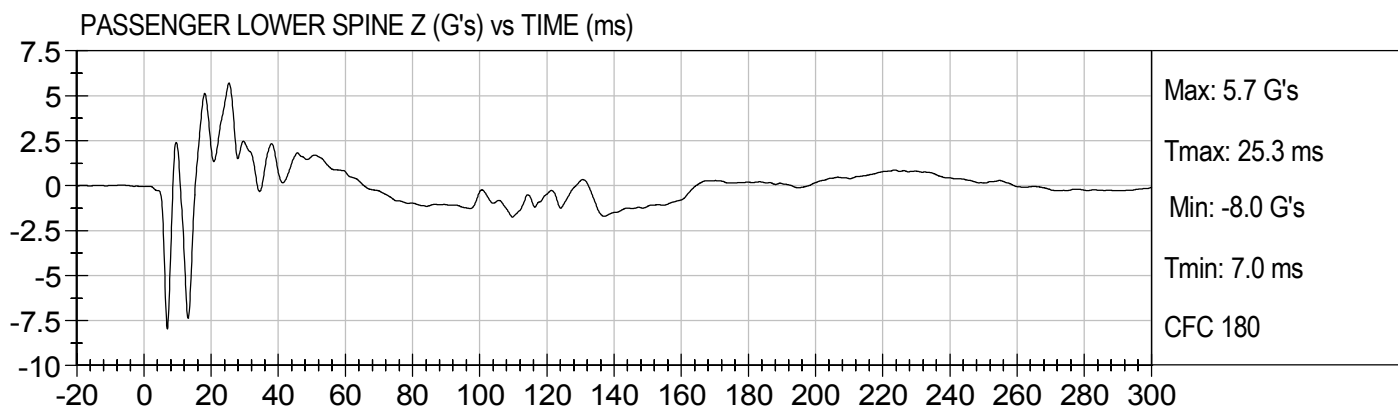
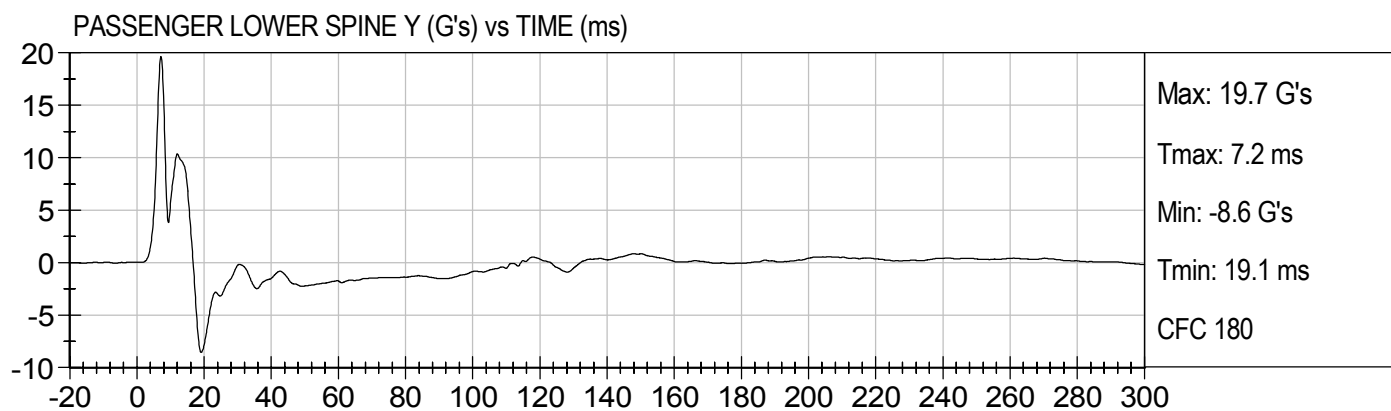
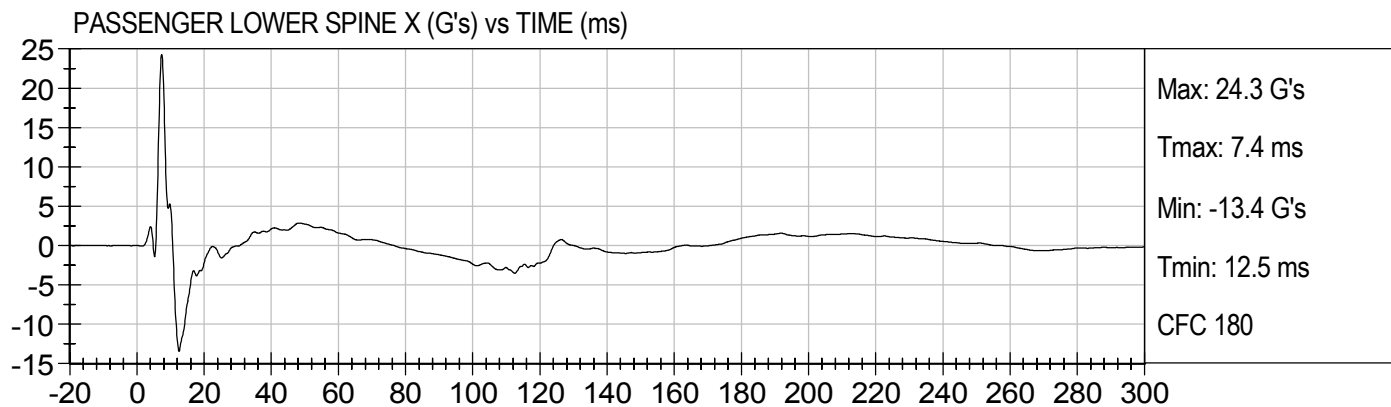


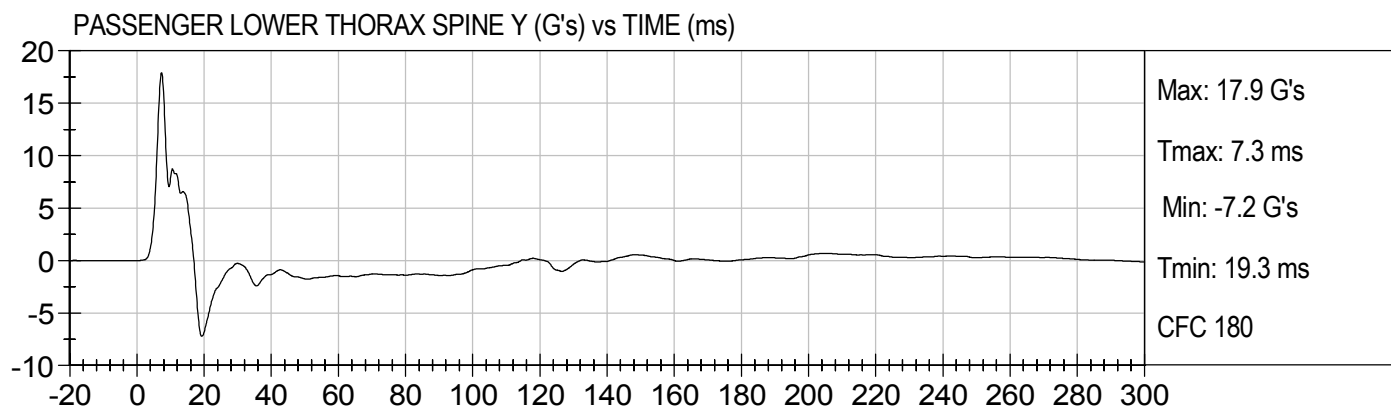
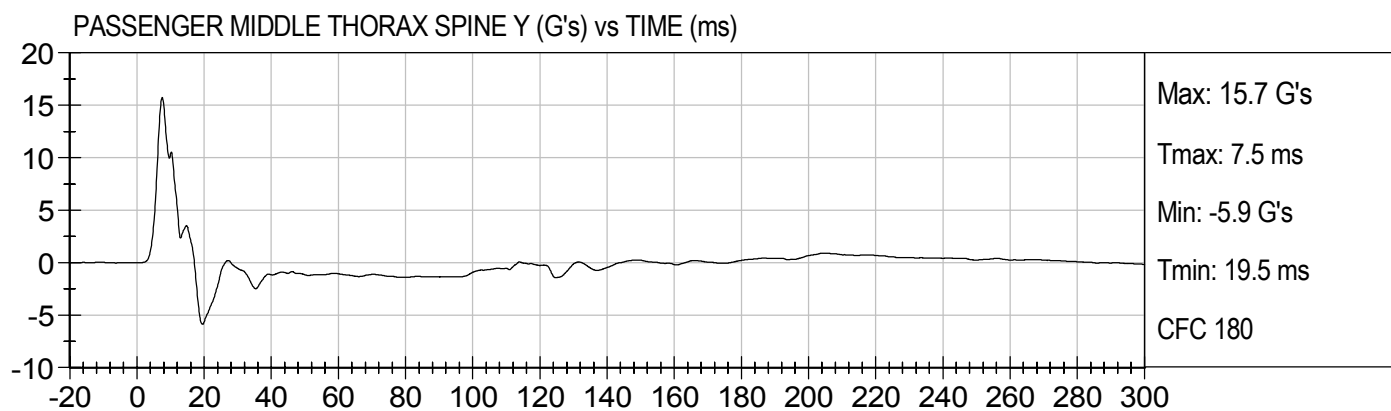
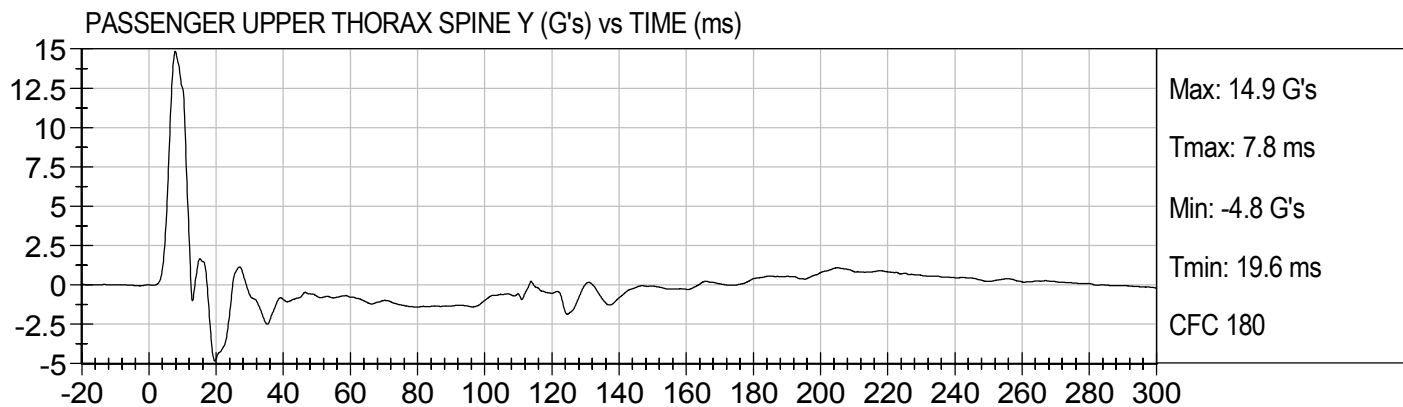


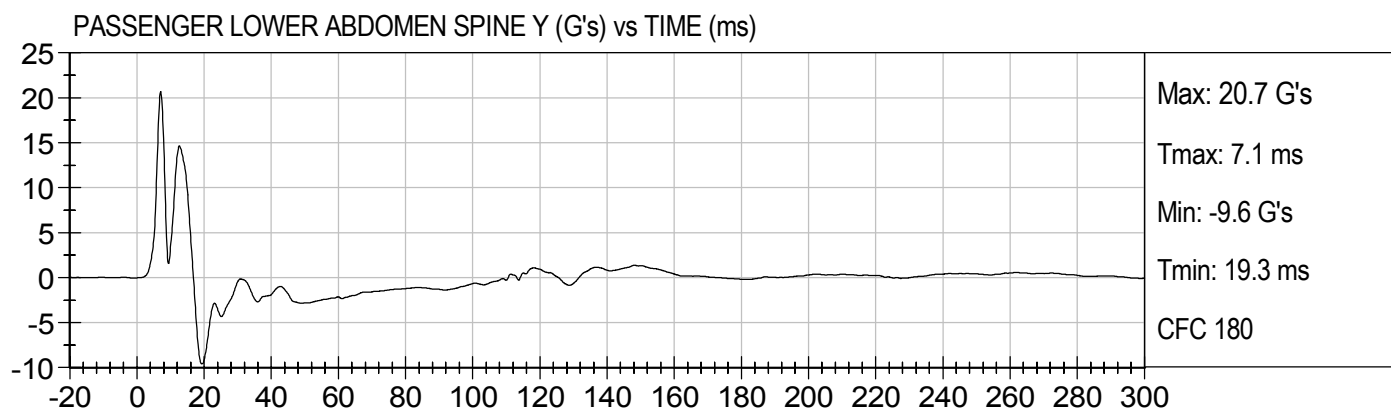
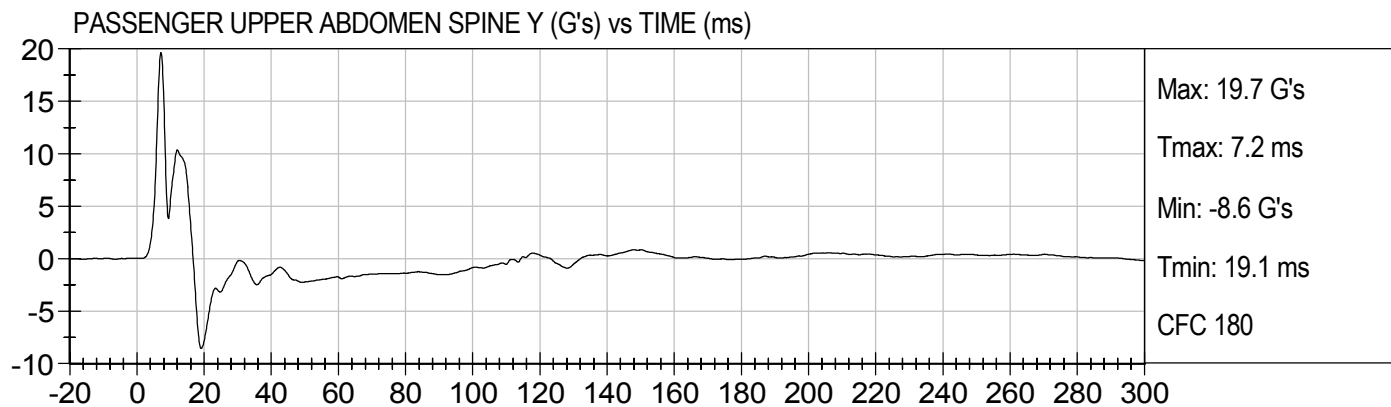


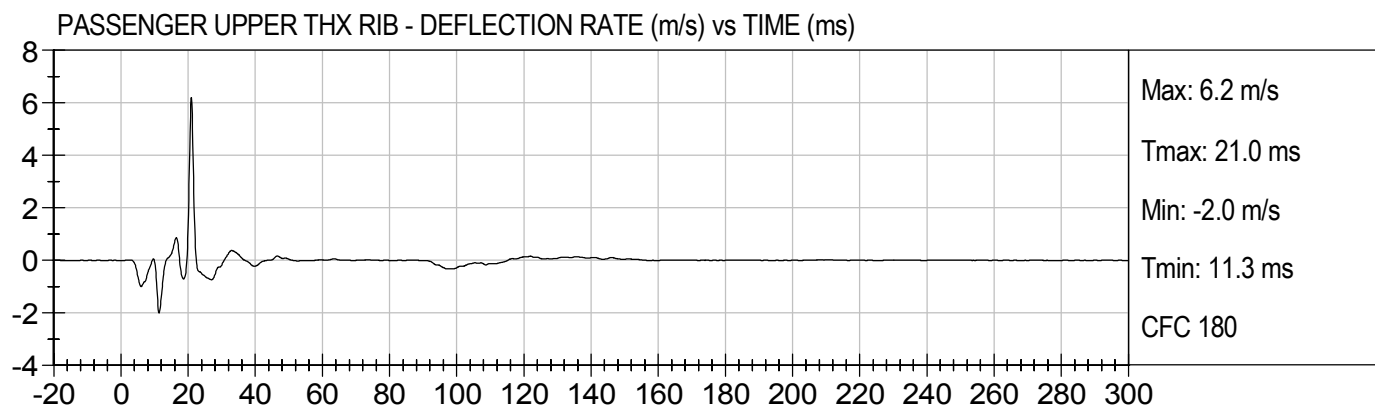
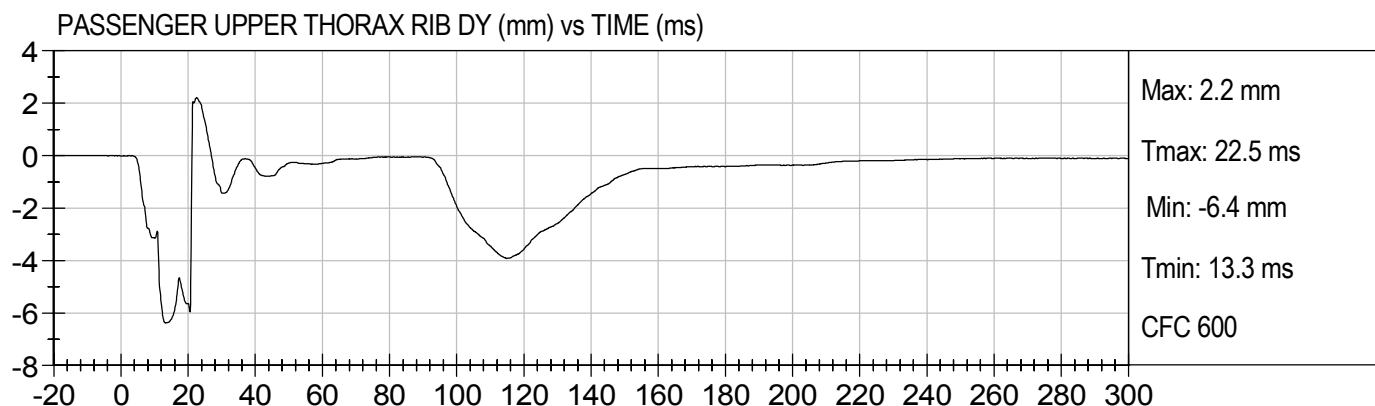
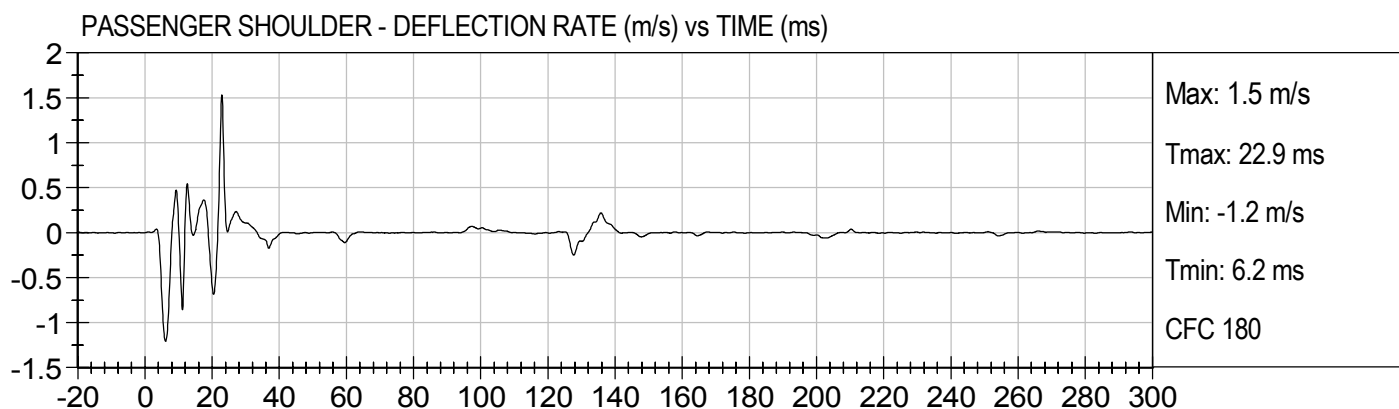
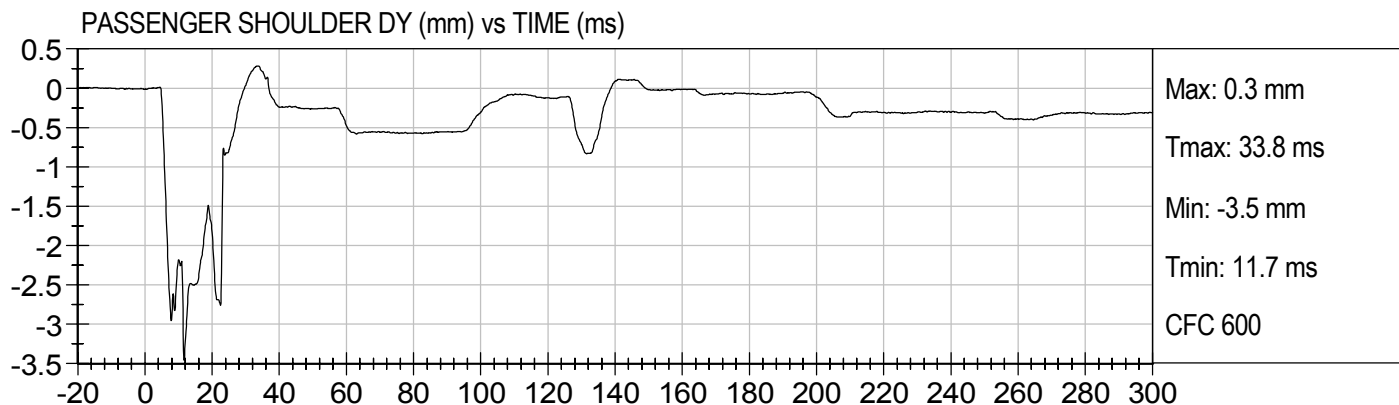






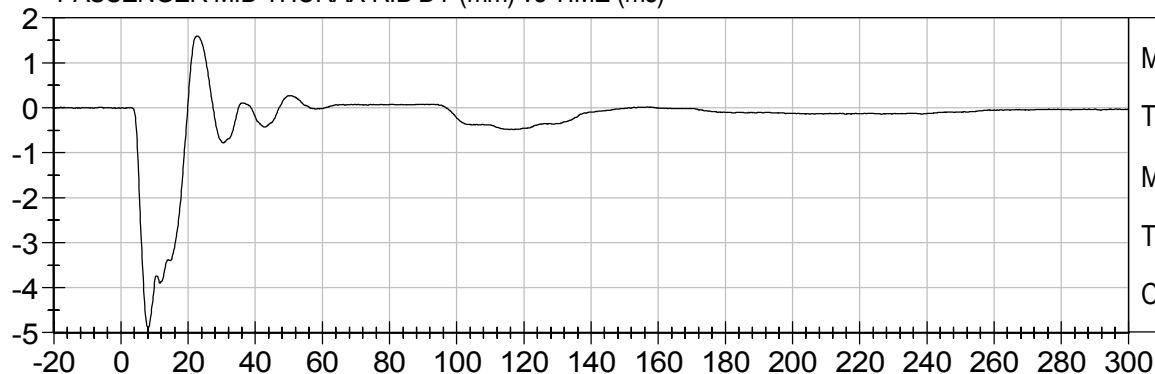






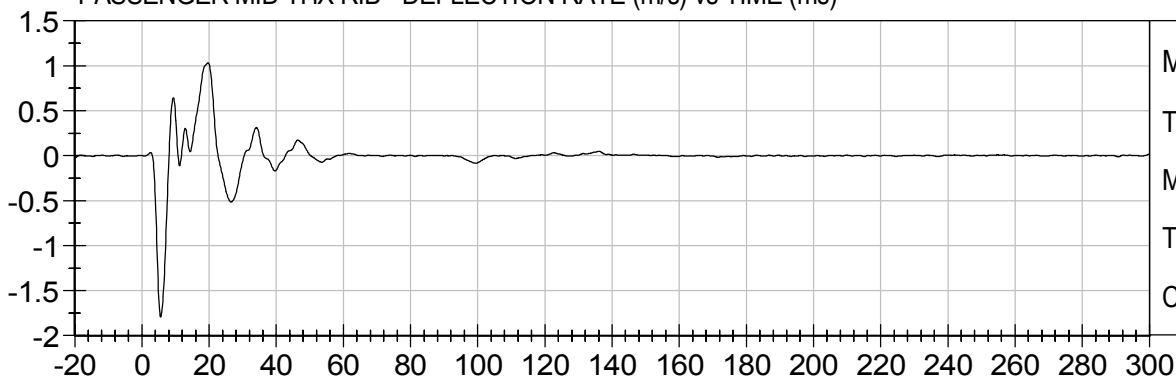


PASSENGER MID THORAX RIB DY (mm) vs TIME (ms)



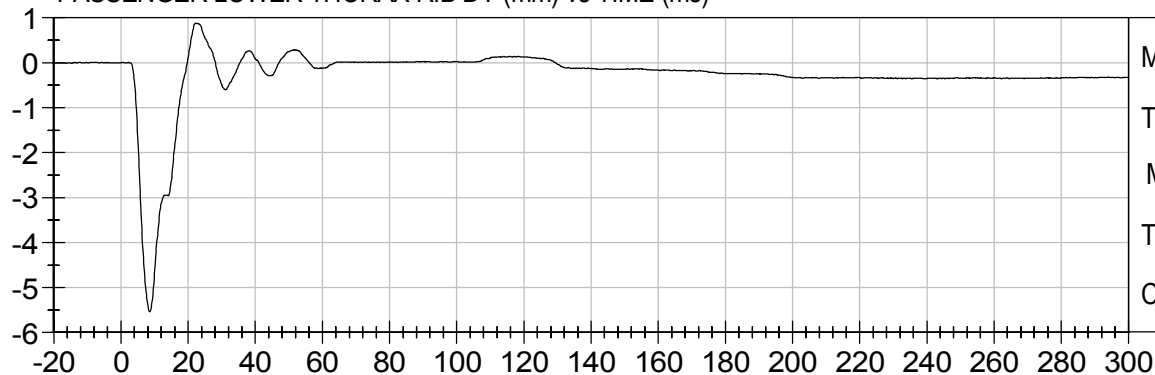
Max: 1.6 mm
Tmax: 22.8 ms
Min: -4.9 mm
Tmin: 8.1 ms
CFC 600

PASSENGER MID THX RIB - DEFLECTION RATE (m/s) vs TIME (ms)



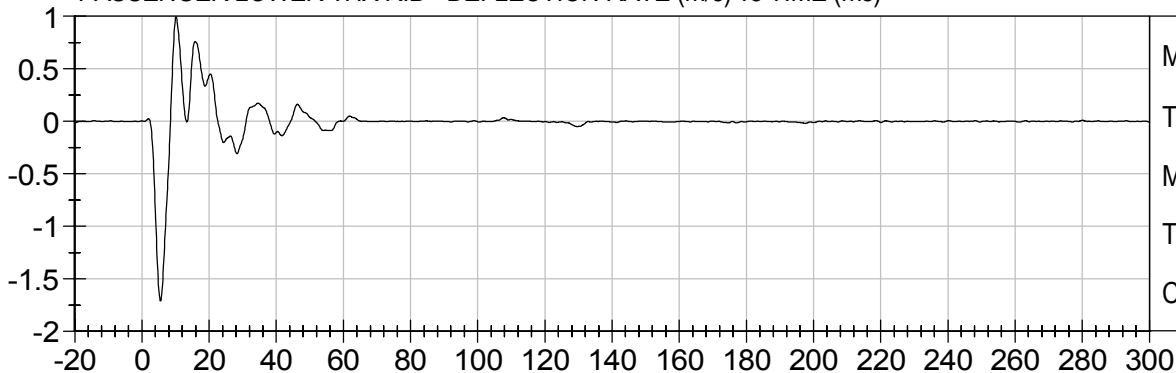
Max: 1.0 m/s
Tmax: 19.7 ms
Min: -1.8 m/s
Tmin: 5.6 ms
CFC 180

PASSENGER LOWER THORAX RIB DY (mm) vs TIME (ms)



Max: 0.9 mm
Tmax: 22.3 ms
Min: -5.5 mm
Tmin: 8.6 ms
CFC 600

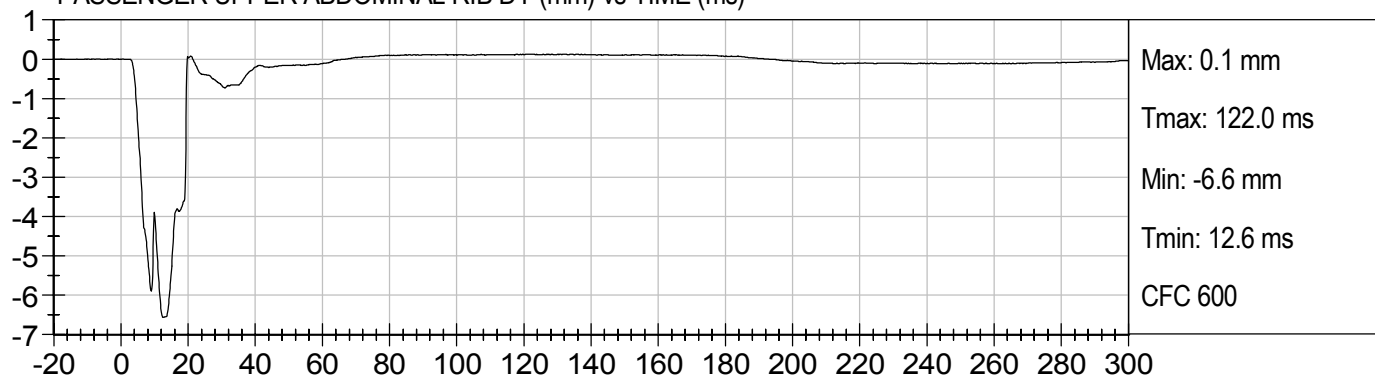
PASSENGER LOWER THX RIB - DEFLECTION RATE (m/s) vs TIME (ms)



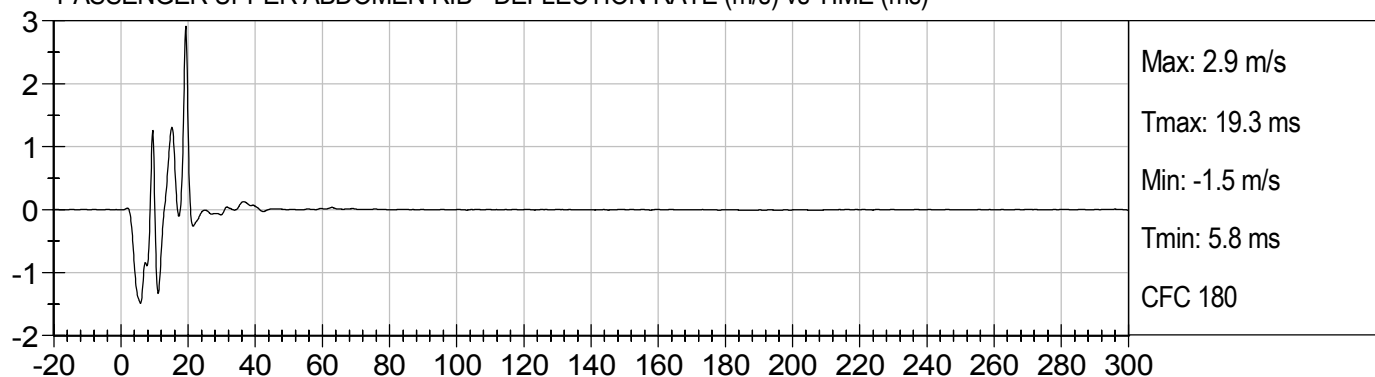
Max: 1.0 m/s
Tmax: 10.2 ms
Min: -1.7 m/s
Tmin: 5.5 ms
CFC 180



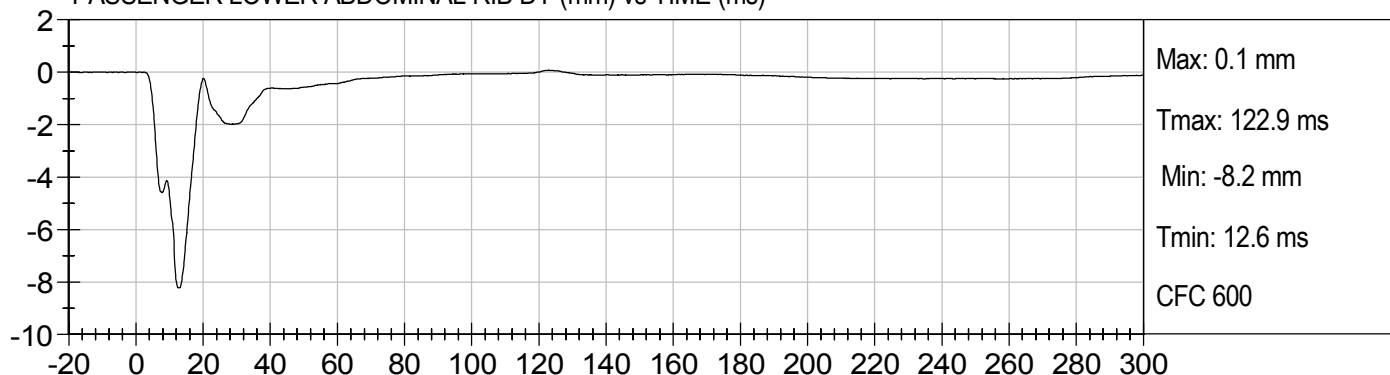
PASSENGER UPPER ABDOMINAL RIB DY (mm) vs TIME (ms)



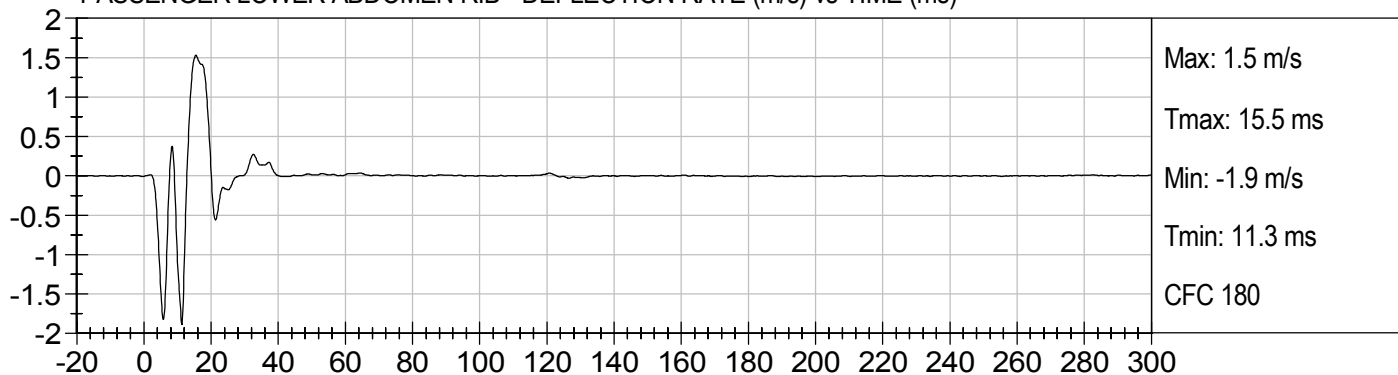
PASSENGER UPPER ABDOMEN RIB - DEFLECTION RATE (m/s) vs TIME (ms)



PASSENGER LOWER ABDOMINAL RIB DY (mm) vs TIME (ms)

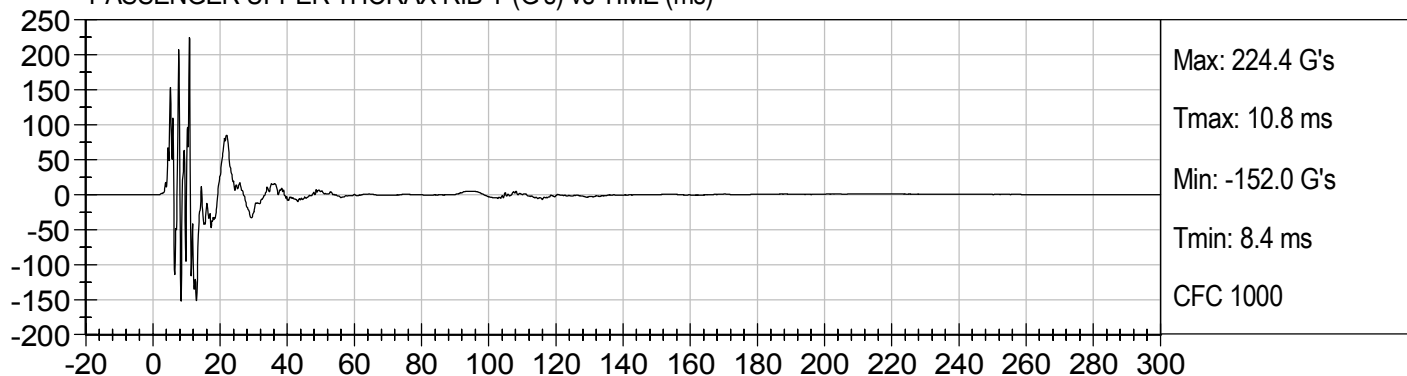


PASSENGER LOWER ABDOMEN RIB - DEFLECTION RATE (m/s) vs TIME (ms)

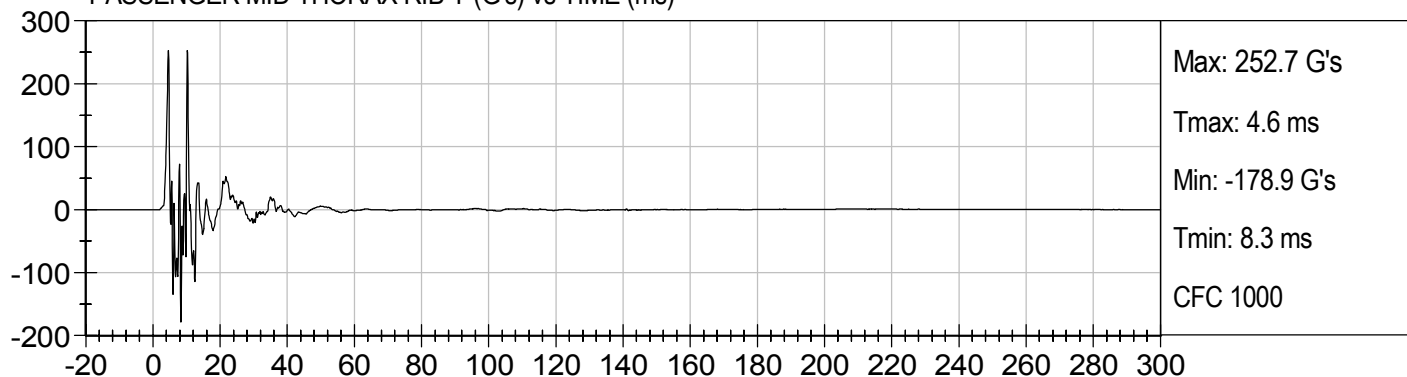




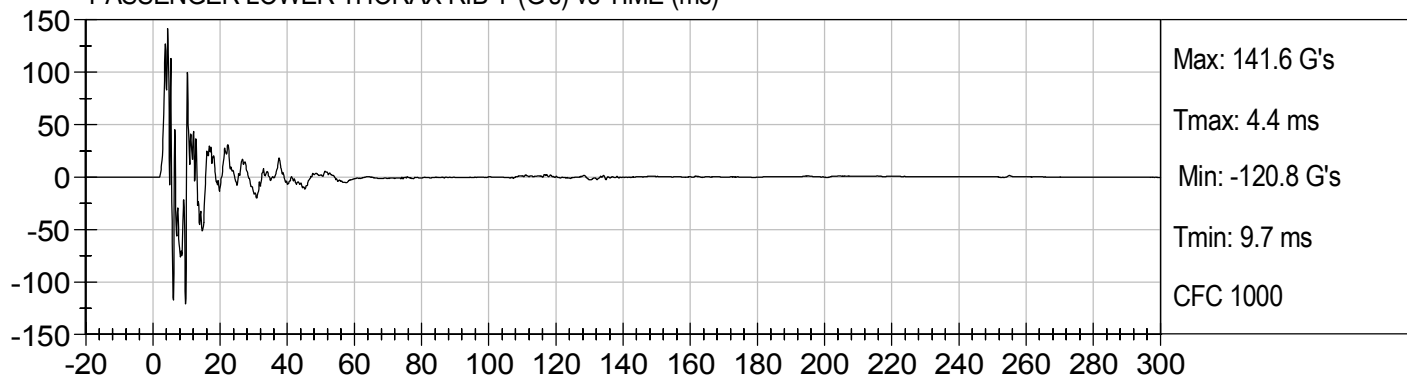
PASSENGER UPPER THORAX RIB Y (G's) vs TIME (ms)

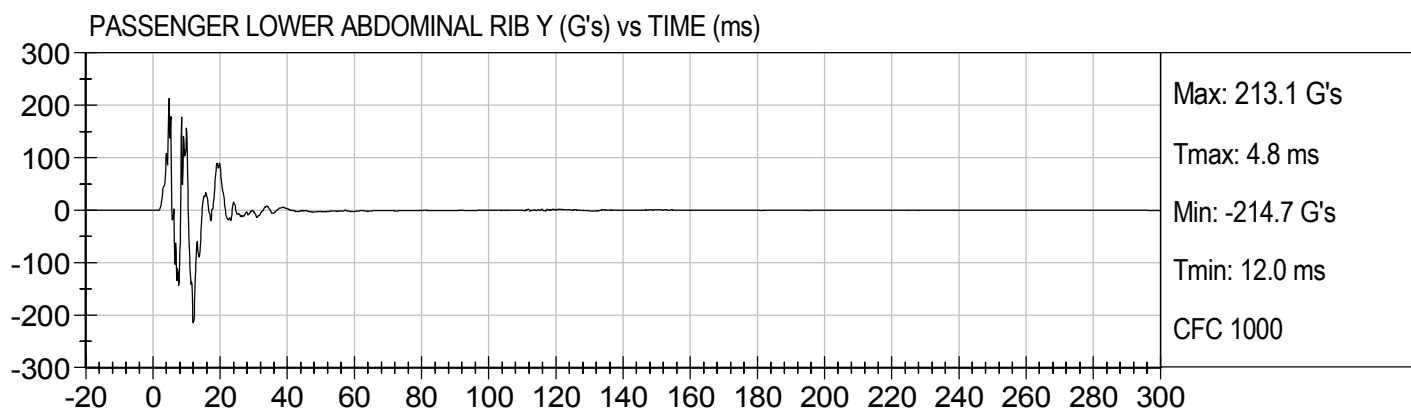
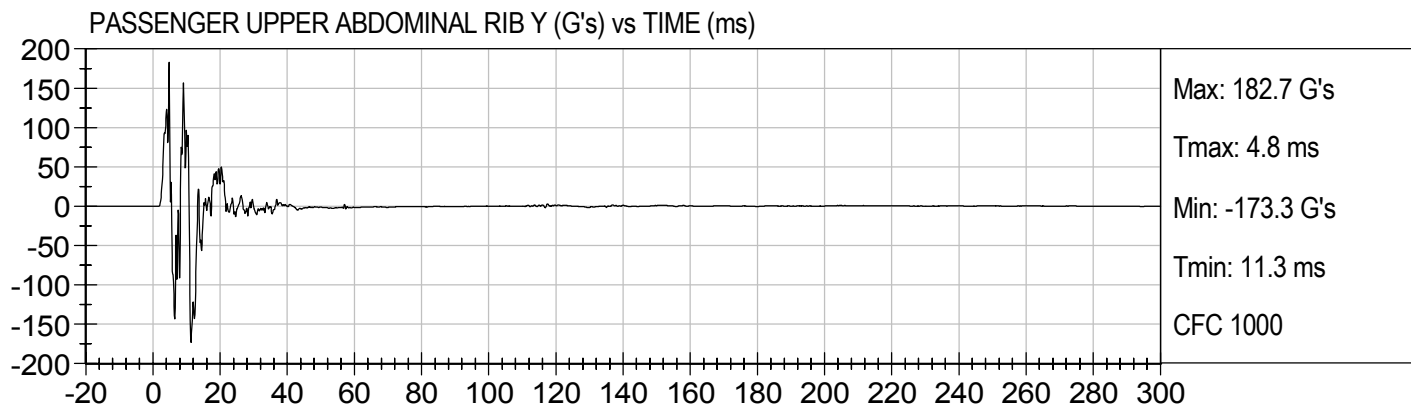


PASSENGER MID THORAX RIB Y (G's) vs TIME (ms)



PASSENGER LOWER THORAX RIB Y (G's) vs TIME (ms)



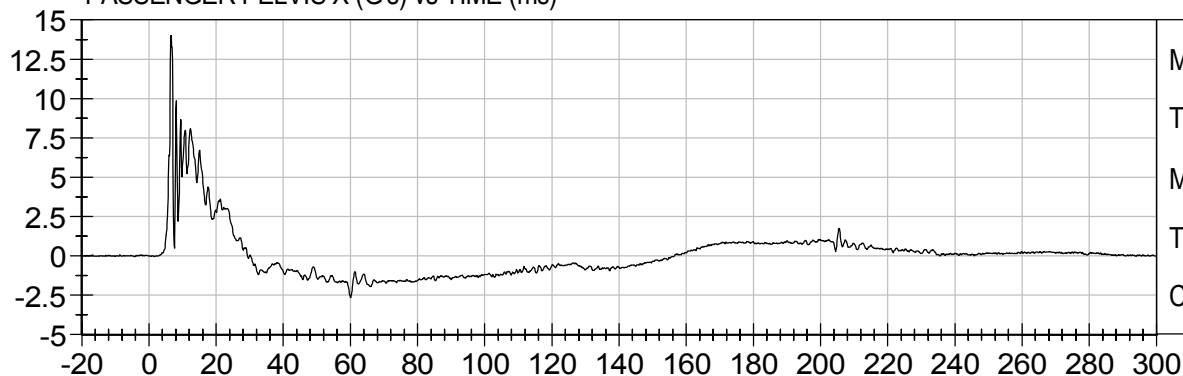




NCAP SIDE OOP SID-IIsD POSITION 3.3.3.6
2006 KIA OPTIMA M60519

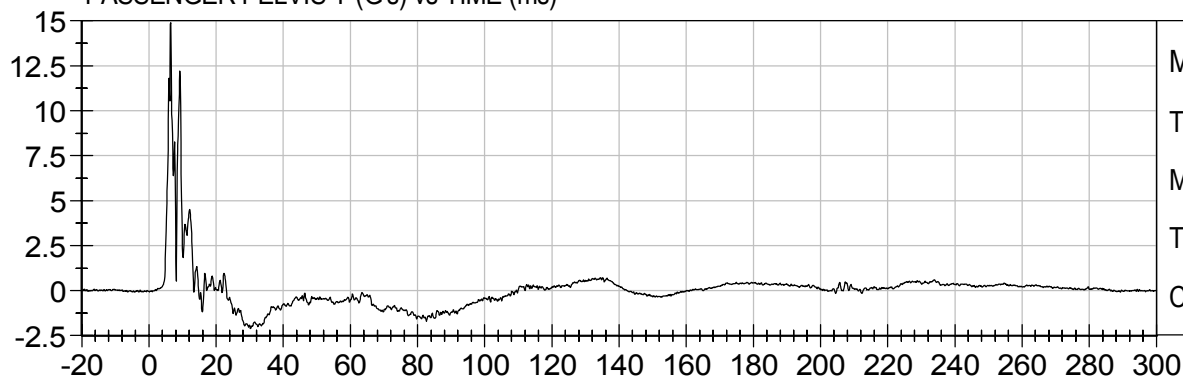
Test Date: 05/01/2007
Speed: 0.0 mph (0.0 km/h)

PASSENGER PELVIS X (G's) vs TIME (ms)



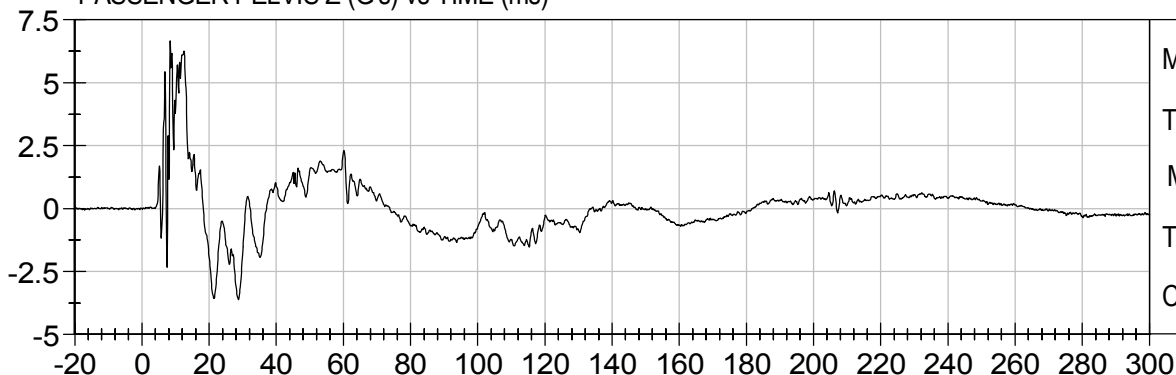
Max: 14.0 G's
Tmax: 6.6 ms
Min: -2.7 G's
Tmin: 60.1 ms
CFC 1000

PASSENGER PELVIS Y (G's) vs TIME (ms)



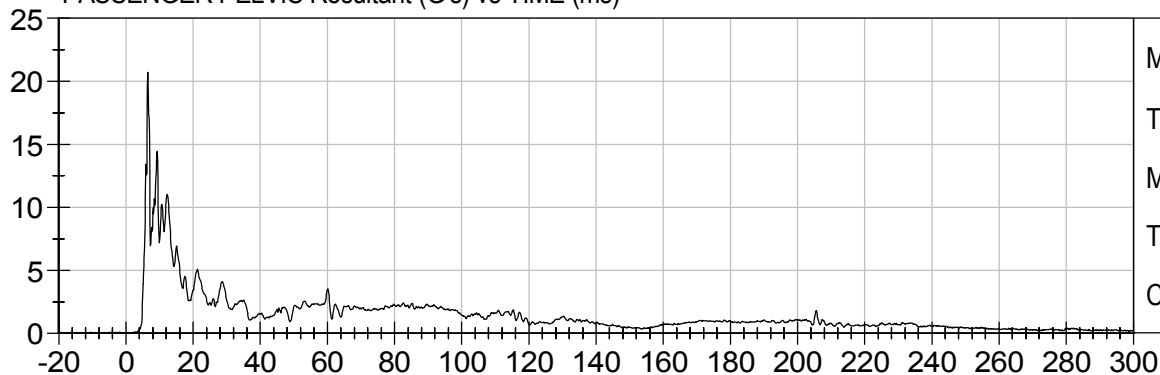
Max: 14.9 G's
Tmax: 6.5 ms
Min: -2.1 G's
Tmin: 30.3 ms
CFC 1000

PASSENGER PELVIS Z (G's) vs TIME (ms)



Max: 6.7 G's
Tmax: 8.4 ms
Min: -3.6 G's
Tmin: 28.8 ms
CFC 1000

PASSENGER PELVIS Resultant (G's) vs TIME (ms)



Max: 20.7 G's
Tmax: 6.5 ms
Min: 0.0 G's
Tmin: 0.0 ms
CFC 1000

APPENDIX C

INSTRUMENTATION CALIBRATION DATA

SID-IIs Build Level D – Serial Number 032

	SERIAL NO.	MANUFACTURER	CALIBRATION DATE
Head X	P47837	Endevco	4/19/2007
Head Y	P47845	Endevco	4/19/2007
Head Z	P47835	Endevco	4/19/2007
Upper Neck Load Cell	NG180	FTSS	3/13/2007
Lower Neck Load Cell	LNG101	FTSS	3/19/2007
Upper Spine X	A12-A11	Entran	3/30/2007
Upper Spine Y	A05-A23	Entran	3/30/2007
Upper Spine Z	A27-Z07	Entran	3/30/2007
Lower Spine X	P52174	Endevco	1/19/2007
Lower Spine Y	P52172	Endevco	1/19/2007
Lower Spine Z	P52173	Endevco	1/19/2007
Shoulder Displacement	032SHLD	Servo	4/25/2007
Upper Thorax Rib Displacement	032RIB1	Servo	4/25/2007
Mid Thorax Rib Displacement	032RIB2	Servo	4/25/2007
Lower Thorax Rib Displacement	032RIB3	Servo	4/25/2007
Upper Abdominal Rib Displacement	032RIB4	Servo	4/25/2007
Lower Abdominal Rib Displacement	032RIB5	Servo	4/25/2007
Upper Thorax Rib Y	L17-Z13	Entran	4/03/2007
Mid Thorax Rib Y	C15-Z01	Entran	4/19/2007
Lower Thorax Rib Y	ET21191	Entran	4/03/2007
Upper Abdominal Rib Y	ET21248	Entran	3/30/2007
Lower Abdominal Rib Y	ET21158	Entran	3/30/2007
Upper Thorax Spine Y	P47109	Endevco	3/30/2007
Middle Thorax Spine Y	P47108	Endevco	3/30/2007
Lower Thorax Spine Y	P47110	Endevco	3/30/2007
Upper Abdomen Spine Y	P52172	Endevco	1/19/2007
Lower Abdomen Spine Y	L20-B17	Entran	4/02/2007
Pelvis X	P52171	Endevco	1/19/2007
Pelvis Y	P52169	Endevco	1/19/2007
Pelvis Z	P52170	Endevco	1/19/2007
Head X Redundant	P47846	Endevco	4/19/2007
Head Y Redundant	P47844	Endevco	4/19/2007
Head Z Redundant	P47838	Endevco	4/19/2007