



REPORT NUMBER: TWG-MGA-2010-004

**SIDE AIRBAG OUT-OF-POSITION INJURY
TECHNICAL WORKING GROUP**

**HYUNDAI MOTOR COMPANY
2010 HYUNDAI GENESIS 2-DR COUPE
NHTSA NUMBER: MA0500TWG2**

TEST DATE: AUGUST 5, 2010

FINAL REPORT DATE: JANUARY 13, 2011

FINAL REPORT

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

**PREPARED FOR:
ALPHA TECHNOLOGY ASSOCIATE, INC.
2810 OLD LEE HIGHWAY, SUITE 120
FAIRFAX, VA 22031**

SIGNATURE APPROVAL PAGE

Prepared by: Jessica Gall
Jessica Gall, Project Engineer

Date: 1/13/2011

Reviewed by: David Winkelbauer
David Winkelbauer, Director of Operations

Date: 1/13/2011

Test Engineer: Ben Williams

Test Technician: Matt Jacobsen
Wayne Dahlke

Instrumentation/Calibration: Tim Grochowske

Secretary: Donna Janovicz

FINAL REPORT ACCEPTANCE BY:

Date: _____

The results presented in this report relate only to the specified test items.

TABLE OF CONTENTS

<u>Section</u>		<u>Page No</u>
1	Purpose and Summary of Test	1
2	Occupant and Vehicle Information / Data Sheets	3
<u>Data Sheet No.</u>		<u>Page No.</u>
1	Test Summary	3
2	Test Vehicle Information	4
3	Dummy Positioning in Vehicle	5
4	Dummy Injury Criteria Values	6
<u>Appendix</u>		
A	Photographs	8
B	Dummy Response Data Traces	20

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 Alpha Technology Associate, Inc.

SUMMARY

The effects of both a curtain and torso airbag deployment in a 2010 Hyundai Genesis 2-Dr Coupe with an out-of-position Hybrid III 6-Year-Old child dummy were evaluated. The curtain and seat airbags were fired remotely. The test was performed by MGA Research Corporation on August 5, 2010. Pre and post test photographs of the vehicle and dummy can be found in Appendix A.

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 Hybrid III 6-Year-Old child dummy (Serial Number 144) was placed in the right front passenger seat situated in the inboard-facing position along the outboard edge of the seat per Section 3.3.5.1 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 Spine Acceleration |
| • Upper Neck Load Cell | • Upper Sternum Acceleration |
| • Lower Neck Load Cell | • Lower Sternum Acceleration |
| • Chest Accelerations | • Lower Abdominal @ Spine |
| • Upper Thorax @ Spine Acceleration | Acceleration |

The 23 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy data traces.

The Hybrid III 6-Year-Old child dummy's visible contact points were as follows:

- Curtain airbag to back of head
- Torso bag to left shoulder and left torso

The Hybrid III 6-Year-Old child dummy was placed in the right front passenger seat along the outboard edge of the foam block, facing inboard with its legs extended and arms hanging at its sides. The seat track was positioned forward to minimize the cushion to head interaction. The dummy's pelvis was slid outboard until the dummy's back contacted the door trim panel or armrest and the center of gravity of the head was centered in the deployment trajectory of the airbag. The head remained in its neutral orientation. A vertical plane through the centerline of the dummy's shoulder bolts was parallel to the vehicle centerline. The dummy's arms were bent at the elbow until the fingertips contacted the foam block.

The dummy's skullcap seam was taped with 4mm electrical tape to prevent the airbag from getting caught in the seam. The dummy's headskin was cleaned with alcohol and dusted with baby powder to achieve acceptable frictional characteristics.

This orientation complies with Section 3.3.5.1 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 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	3.3.5.1*	Inboard-facing child dummy
Curtain Airbag	Roof-Rail Mounted	Side Airbag
Torso Airbag	Seat Mounted	Side Airbag
ATD Type/Serial No.	Hybrid III 6 Year Old / 144	Child Dummy

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

Number of Dummy Data Channels	23
Number of Airbag Channels	4
Number of High-Speed Video	3

Visible Dummy Contact Points	
Head Contact	Curtain airbag to back of head
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 Frontal Impact on August 14, 2009.

TEST VEHICLE INFORMATION

Manufacturer	Hyundai
Model	Genesis
Body Style	Coupe
NHTSA No.	MA0500TWG2
VIN	KMHHT6KD7AU011063
Color	Bathurst Black
Delivery Date	7/14/2009
Odometer Reading (mile)	19
Dealer	Northtown Hyundai
Transmission	Automatic
Final Drive	Rear
Number of Cylinders	4
Engine Displacement (L)	2.0
Engine Placement	Longitudinal
Automatic Door Lock (ADL)	Yes
Owners Manual Details Instructions on Disabling ADLs	No
Bucket Seats	Yes

TEST VEHICLE OPTIONS

Driver 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	Yes
All Wheel Drive	No
Power Seats	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Company
Date of Manufacture	APR/17/09

GVWR (kg)	1930
GAWR Front (kg)	1000
GAWR Rear (kg)	1050

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bucket		
Number of Occupants	2	2		4
Capacity Wt. (VCW) (kg)				322
Cargo Wt. (RCLW) (kg)				50

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 (°)	26
Top of Curtain Airbag Module to Head/Neck Junction	AN (mm)	252
Top of Seat Airbag Module to Head/Neck Junction	AN (mm)	112
Head CG to Door Panel/Window	HD (mm)	168
Head to Seat Back Centerline	HSC (mm)	263
Chest to Dash	CD (mm)	636
Chest to Seatback	CS (mm)	277
Right Arm to Seat Back Centerline	RACL (mm)	393
Left Arm to Seat Back Centerline	LACL (mm)	162
Right Arm to Door Panel	RA (mm)	107
Left Arm to B-Post	LA (mm)	88
Knee to Knee	KK (mm)	112
Toe to Toe	TT (mm)	90
Right Knee to Seat Cushion Centerline	KSCR (mm)	48
Left Knee to Seat Cushion Centerline	KSCL (mm)	48
Right Toe to Seat Cushion Centerline	TSCR (mm)	365
Left Toe to Seat Cushion Centerline	TSCL (mm)	365
Nose to Dash	ND (mm)	718
Nose to Headrest	NS (mm)	290
Top of Head to Headliner	HH (mm)	106

DATA SHEET NO. 4
DUMMY INJURY CRITERIA VALUES

NHTSA No. MA0500TWG2

DESCRIPTION	UNIT	MAXIMUM VALUE			
		Position No. 2			
		MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Head X	g	24.4	13.6	-2.2	50.6
Head Y	g	15.7	13.1	-16.4	16.7
Head Z	g	11.6	12.3	-10.9	15.7
Head Resultant	g	28.8	13.6		
Upper Neck Fx	N	35.5	0.5	-234.5	16.1
Upper Neck Fy	N	40.8	2.9	-136.0	13.1
Upper Neck Fz	N	73.2	0.6	-597.2	14.2
Upper Neck F Resultant	N	635.1	14.2		
Upper Neck Mx	Nm	9.6	16.1	-2.3	0.7
Upper Neck My	Nm	5.2	57.7	-11.7	21.0
Upper Neck Mz	Nm	1.0	87.0	-4.6	29.6
Upper Neck M Resultant	Nm	14.2	16.1		
Lower Neck Fx	N	14.3	2.8	-154.8	23.6
Lower Neck Fy	N	38.6	8.5	-97.2	15.6
Lower Neck Fz	N	45.6	167.8	-601.5	14.1
Lower Neck F Resultant	N	605.5	14.1		
Lower Neck Mx	Nm	6.1	31.5	-9.1	15.4
Lower Neck My	Nm	27.6	14.4	-0.5	1.7
Lower Neck Mz	Nm	3.6	10.7	-4.7	28.0
Lower Neck M Resultant	Nm	28.9	15.3		
Chest X	G	4.9	19.9	-3.0	13.8
Chest Y	G	5.7	10.1	-22.6	8.6
Chest Z	G	11.0	10.3	-3.5	25.0
Chest Resultant	G	22.8	8.6		
Upper Spine X	G	6.1	10.7	-2.8	8.1
Upper Sternum X	G	16.3	13.1	-11.7	16.2
Lower Sternum X	G	17.6	9.3	-16.0	19.0
Upper Thorax @ Spine X	G	9.3	10.6	-5.2	8.0
Lower Abdominal @ Spine X	G	4.0	7.8	-3.6	10.0

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

NHTSA No. MA5500TWG2

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	10.3	10.5	17.7	10.3	10.5	17.7

Position 2 Neck Injury Summary (6-Year-Old – Out-Of-Position)

	Nij	Time (msec)	Z Force (N) (CFC 600)	X Force (N) (CFC 600)	Y Moment (N-m) (CFC 600)
Ntf	0.05	79.5	0.66	-59.97	3.24
Nte	0.16	24.9	56.87	-165.90	-7.99
Ncf	0.08	59.4	-48.18	-55.73	5.09
Nce	0.36	14.9	-560.96	-192.70	-9.22
Peak Tension (CFC1000)	73.2 N		Peak Compression (CFC 1000)		-597.2 N

Critical Values

Nij Intercepts				Peak Limits	
Tension (CVt)	2800 N	Extension (mCVe)	37 N-m	Tension	1490 N
Compression (CVc)	2800 N	Flexion (mCVf)	93 N-m	Compression	1820 N
Condyle Offset	0.01778 m				

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

	<u>Page No.</u>
Photo No. 1. Right ¾ Front View of Vehicle, As Received	9
Photo No. 2. Vehicle Certification Placard	9
Photo No. 3. Pre-Test Vehicle Left Side View	10
Photo No. 4. Post-Test Vehicle Left Side View	10
Photo No. 5. Pre-Test 6-Year-Old Child Dummy Left Side View	11
Photo No. 6. Post-Test 6-Year-Old Child Dummy Left Side View	11
Photo No. 7. Pre-Test 6-Year-Old Child Dummy Left Side Closeup View	12
Photo No. 8. Post-Test 6-Year-Old Child Dummy Left Side Closeup View	12
Photo No. 9. Pre-Test 6-Year-Old Child Dummy Left ¾ Front View	13
Photo No. 10. Post-Test 6-Year-Old Child Dummy Left ¾ Front View	13
Photo No. 11. Pre-Test 6-Year-Old Child Dummy Left ¾ Front Closeup View	14
Photo No. 12. Post-Test 6-Year-Old Child Dummy Left ¾ Front Closeup View	14
Photo No. 13. Pre-Test 6-Year-Old Child Dummy Front View	15
Photo No. 14. Post-Test 6-Year-Old Child Dummy Front View	15
Photo No. 15. Pre-Test 6-Year-Old Child Dummy Front Closeup View	16
Photo No. 16. Post-Test 6-Year-Old Child Dummy Front Closeup View	16
Photo No. 17. Pre-Test 6-Year-Old Child Dummy Right ¾ Front View	17
Photo No. 18. Post-Test 6-Year-Old Child Dummy Right ¾ Front View	17
Photo No. 19. Pre-Test 6-Year-Old Child Dummy Right Side View	18
Photo No. 20. Post-Test 6-Year-Old Child Dummy Right Side View	18
Photo No. 21. Post-Test Curtain and Torso/Pelvis Airbag Left View	19
Photo No. 22. Post-Test Curtain and Torso/Pelvis Airbag Left ¾ Front View	19



Right ¾ Front View of Vehicle, As Received



Vehicle Certification Placard



Pre-Test Vehicle Left Side View



Post-Test Vehicle Left Side View



Pre-Test 6-Year-Old Child Dummy Left Side View



Post-Test 6-Year-Old Child Dummy Left Side View



Pre-Test 6-Year-Old Child Dummy Left Side Closeup View



Post-Test 6-Year-Old Child Dummy Left Side Closeup View



Pre-Test 6-Year-Old Child Dummy Left ¾ Front View



Post-Test 6-Year-Old Child Dummy Left ¾ Front View



Pre-Test 6-Year-Old Child Dummy Left 3/4 Front Closeup View



Post-Test 6-Year-Old Child Dummy Left 3/4 Front Closeup View



Pre-Test 6-Year-Old Child Dummy Front View



Post-Test 6-Year-Old Child Dummy Front View



Pre-Test 6-Year-Old Child Dummy Front Closeup View



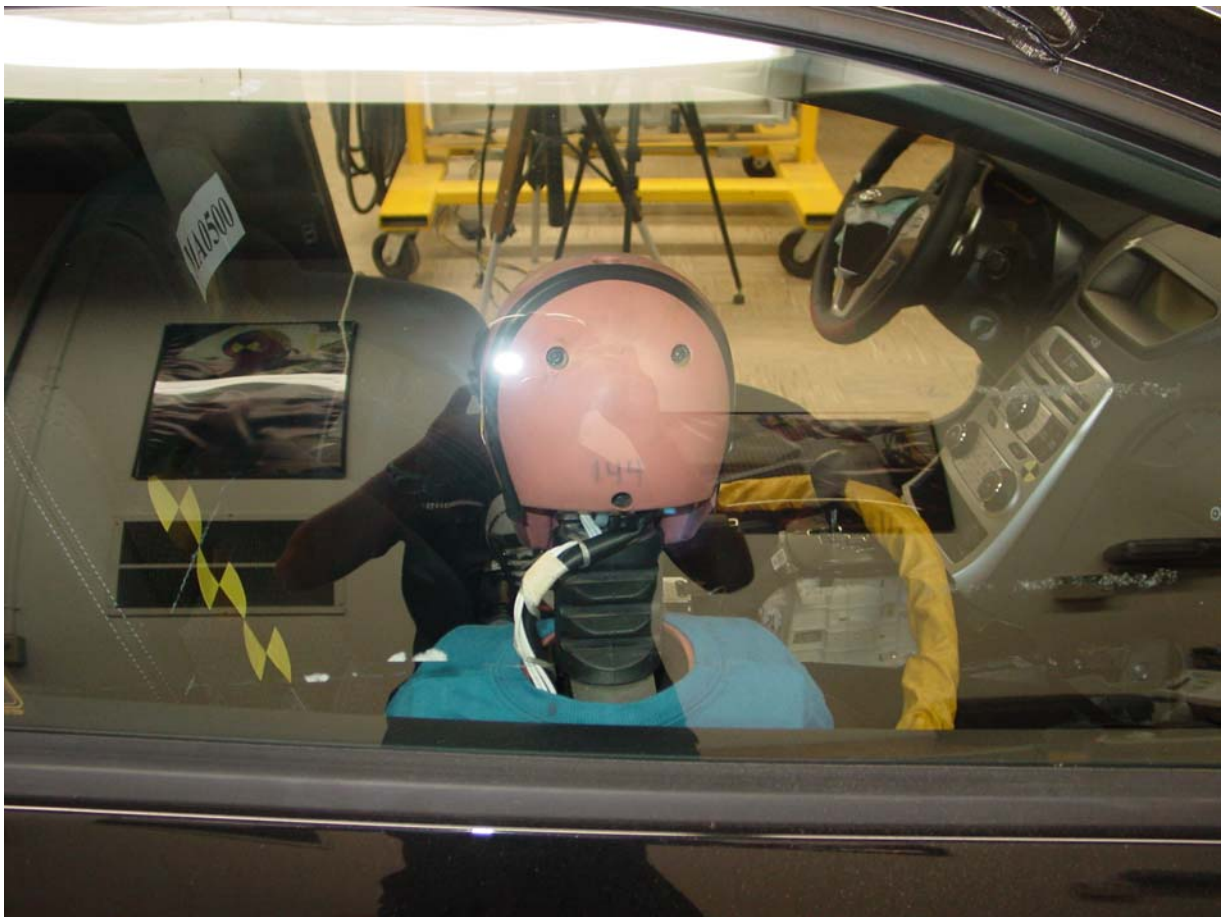
Post-Test 6-Year-Old Child Dummy Front Closeup View



Pre-Test 6-Year-Old Child Dummy Right ¾ Front View



Post-Test 6-Year-Old Child Dummy Right ¾ Front View



Pre-Test 6-Year-Old Child Dummy Right Side View



Post-Test 6-Year-Old Child Dummy Right Side View



Post-Test Curtain and Torso/Pelvis Airbag Left View



Post-Test Curtain and Torso/Pelvis Airbag Left ¾ Front View

APPENDIX B

DUMMY RESPONSE DATA TRACES

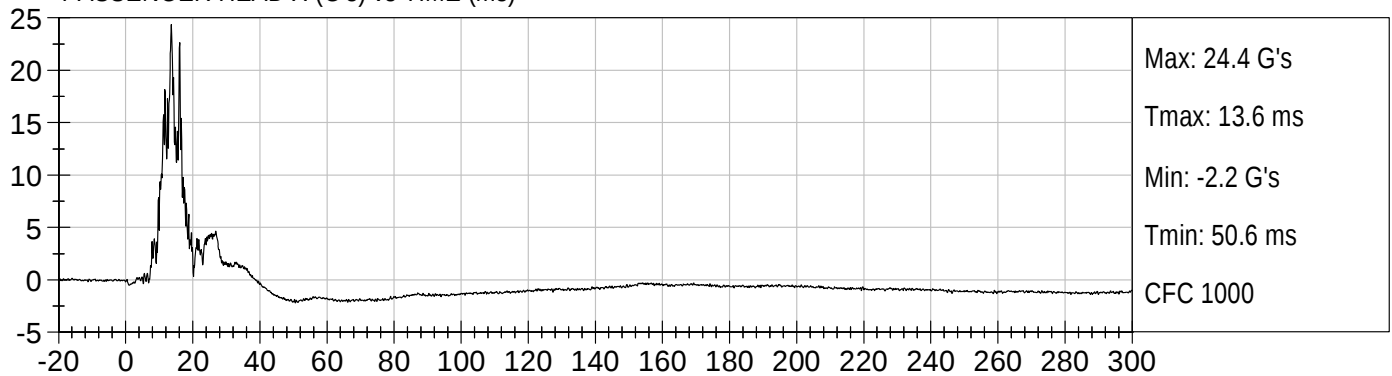
TABLE OF DATA PLOTS

	<u>Page No.</u>
Figure No. 1. Passenger Head X Acceleration vs. Time	22
Figure No. 2. Passenger Head Y Acceleration vs. Time	22
Figure No. 3. Passenger Head Z Acceleration vs. Time	22
Figure No. 4. Passenger Head Resultant Acceleration vs. Time	22
Figure No. 5. Passenger Upper Neck X Force vs. Time	23
Figure No. 6. Passenger Upper Neck Y Force vs. Time	23
Figure No. 7. Passenger Upper Neck Z Force vs. Time	23
Figure No. 8. Passenger Upper Neck Resultant Force vs. Time	23
Figure No. 9. Passenger Upper Neck X Moment vs. Time	24
Figure No. 10. Passenger Upper Neck Y Moment vs. Time	24
Figure No. 11. Passenger Upper Neck Z Moment vs. Time	24
Figure No. 12. Passenger Upper Neck Resultant Moment vs. Time	24
Figure No. 13. Passenger Lower Neck X Force vs. Time	25
Figure No. 14. Passenger Lower Neck Y Force vs. Time	25
Figure No. 15. Passenger Lower Neck Z Force vs. Time	25
Figure No. 16. Passenger Lower Neck Resultant Force vs. Time	25
Figure No. 17. Passenger Lower Neck X Moment vs. Time	26
Figure No. 18. Passenger Lower Neck Y Moment vs. Time	26
Figure No. 19. Passenger Lower Neck Z Moment vs. Time	26
Figure No. 20. Passenger Lower Neck Resultant Moment vs. Time	26
Figure No. 21. Passenger Chest X Acceleration vs. Time	27
Figure No. 22. Passenger Chest Y Acceleration vs. Time	27
Figure No. 23. Passenger Chest Z Acceleration vs. Time	27
Figure No. 24. Passenger Chest Resultant Acceleration vs. Time	27

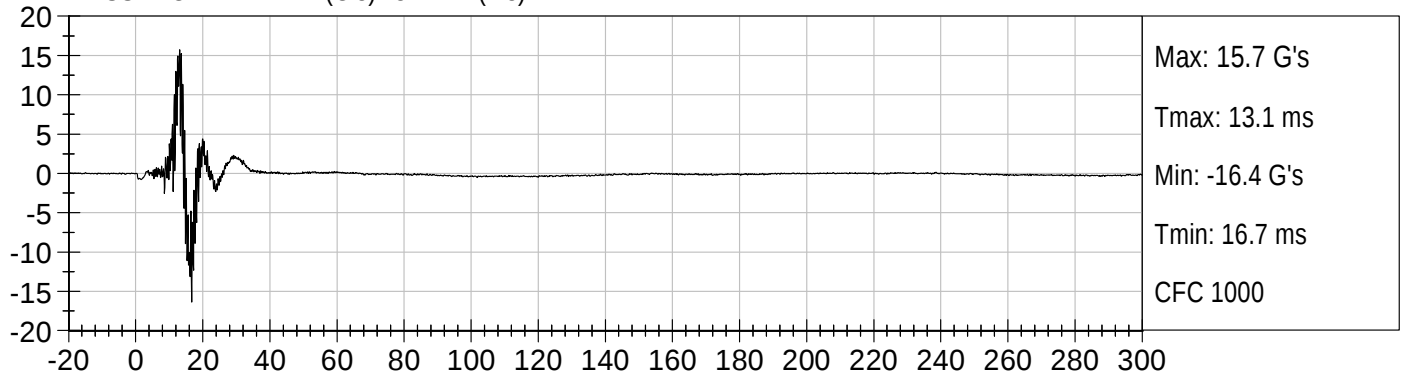
		<u>Page No.</u>
Figure No. 25.	Passenger Upper Spine X Acceleration vs. Time	28
Figure No. 26.	Passenger Upper Sternum X Acceleration vs. Time	28
Figure No. 27.	Passenger Lower Sternum X Acceleration vs. Time	28
Figure No. 28.	Passenger Upper Thorax @ Spine X Acceleration vs. Time	29
Figure No. 29.	Passenger Lower Abdominal @ Spine X Acceleration vs. Time	29
Figure No. 30.	Passenger Curtain Airbag – Fire Voltage vs. Time	30
Figure No. 31.	Passenger Curtain Airbag – Fire Current vs. Time	30
Figure No. 32.	Passenger Seat Airbag – Fire Voltage vs. Time	30
Figure No. 33.	Passenger Seat Airbag – Fire Current vs. Time	30



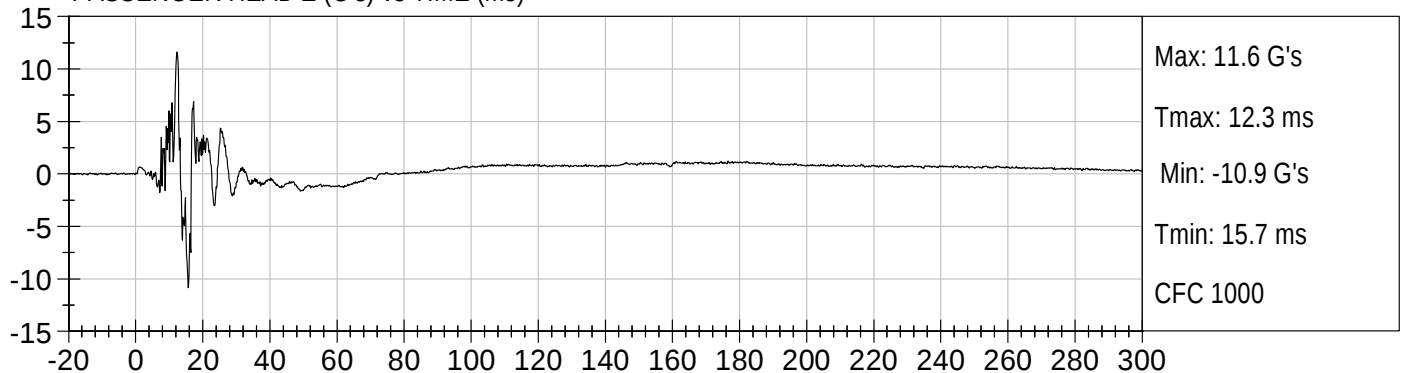
PASSENGER HEAD X (G's) vs TIME (ms)



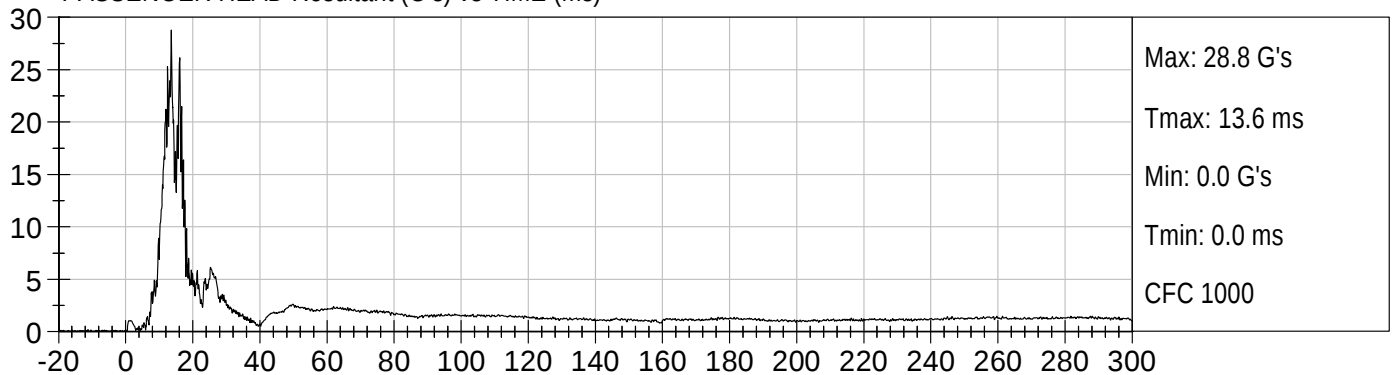
PASSENGER HEAD Y (G's) vs TIME (ms)

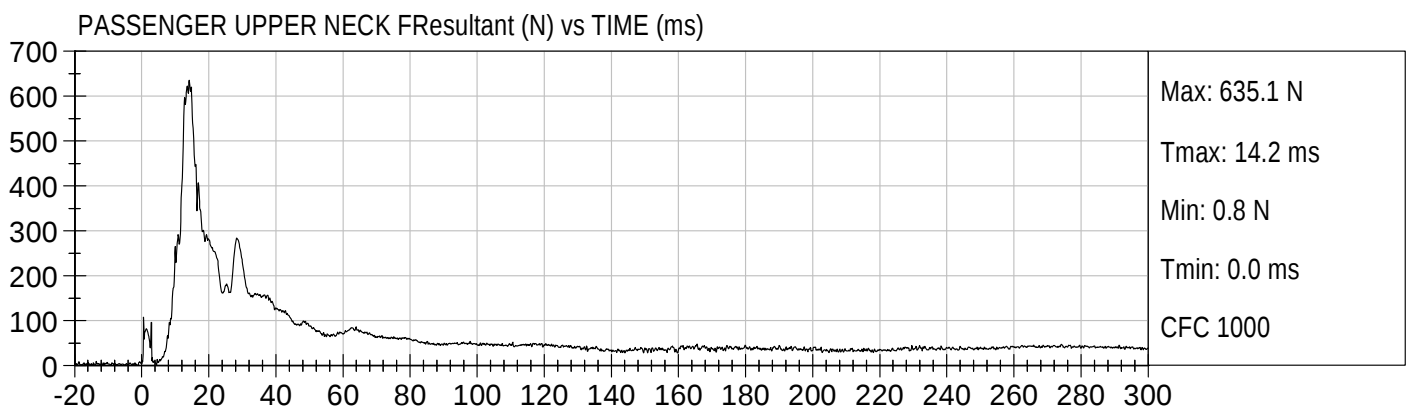
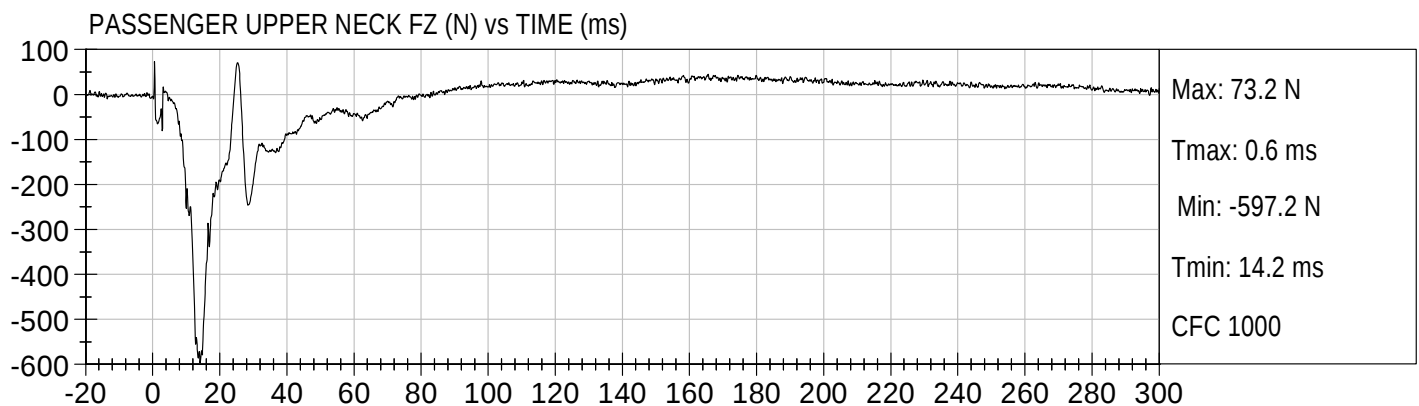
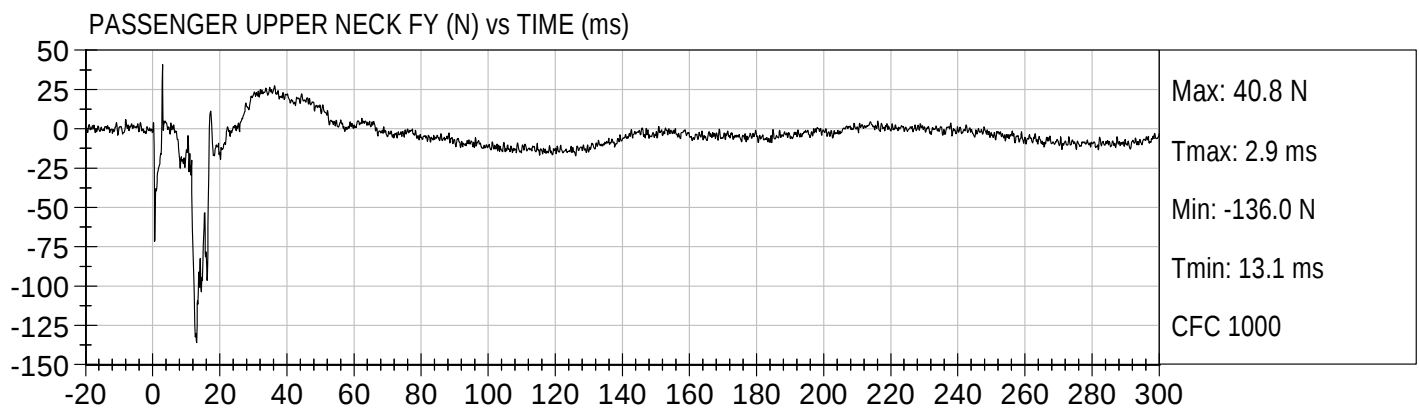
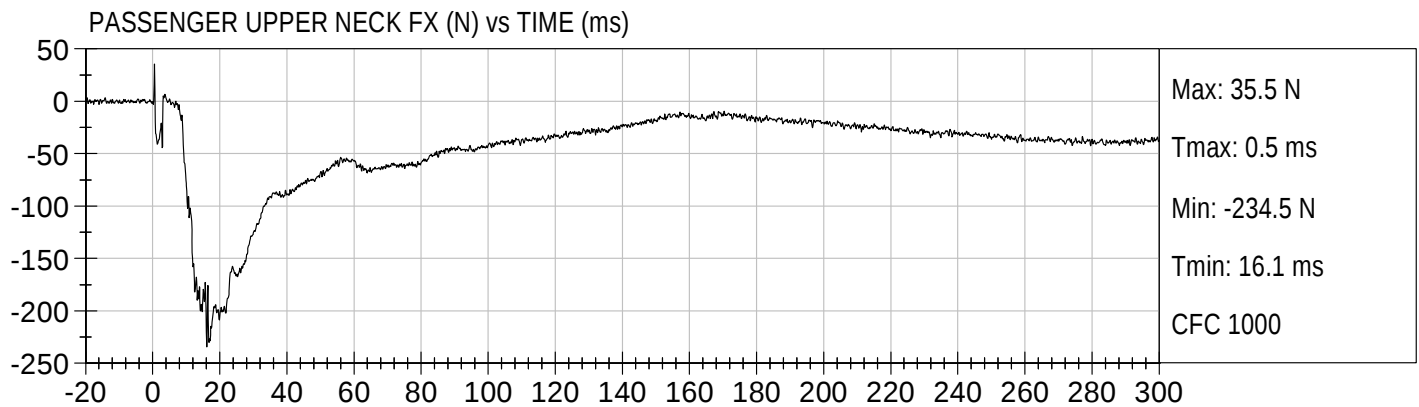


PASSENGER HEAD Z (G's) vs TIME (ms)



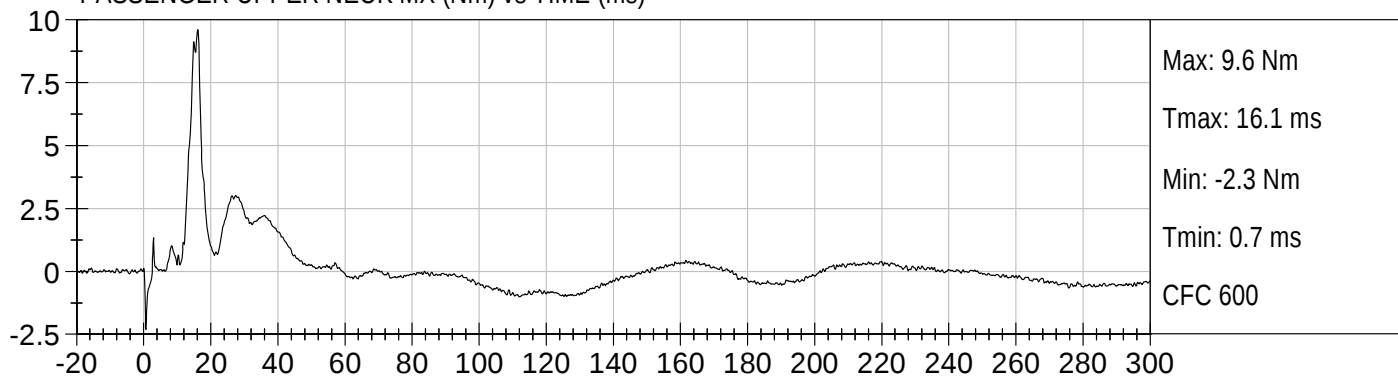
PASSENGER HEAD Resultant (G's) vs TIME (ms)



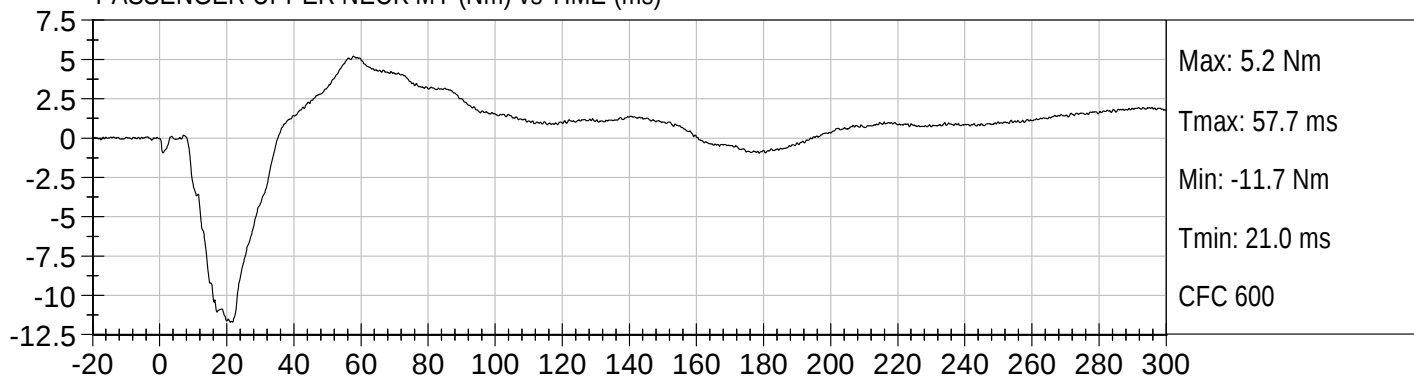




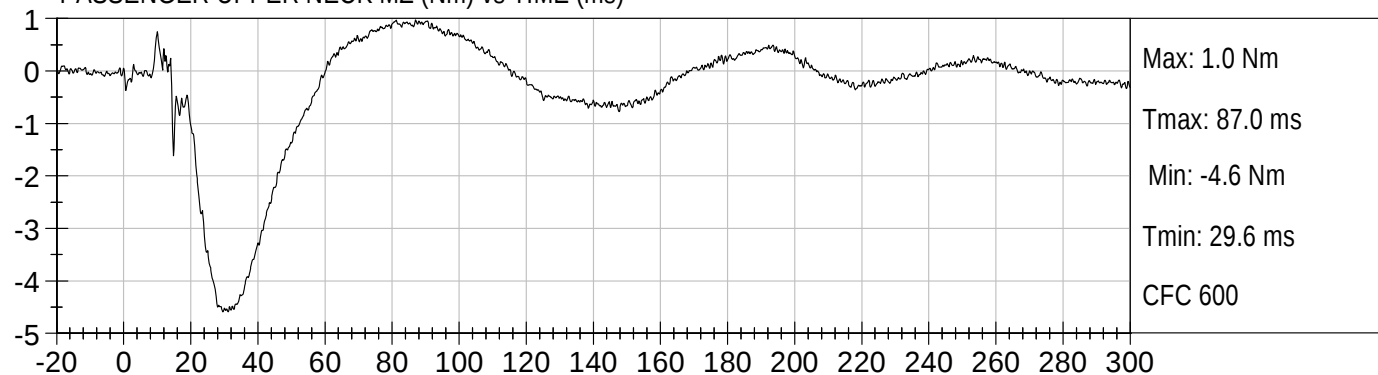
PASSENGER UPPER NECK MX (Nm) vs TIME (ms)



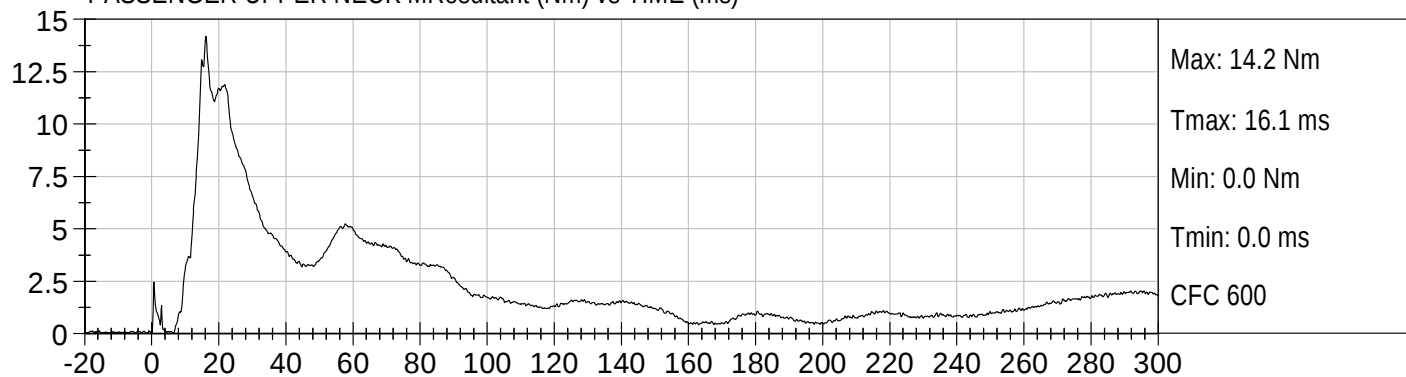
PASSENGER UPPER NECK MY (Nm) vs TIME (ms)



PASSENGER UPPER NECK MZ (Nm) vs TIME (ms)

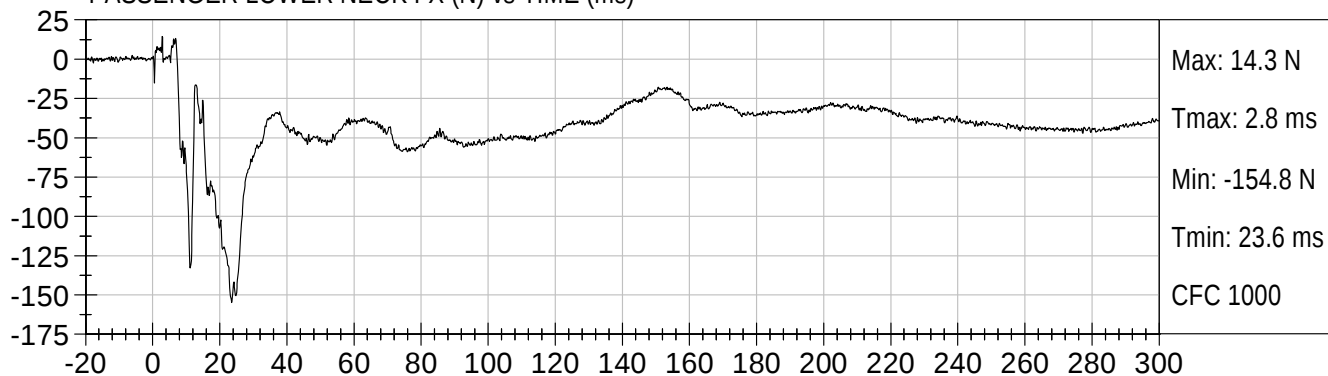


PASSENGER UPPER NECK MResultant (Nm) vs TIME (ms)

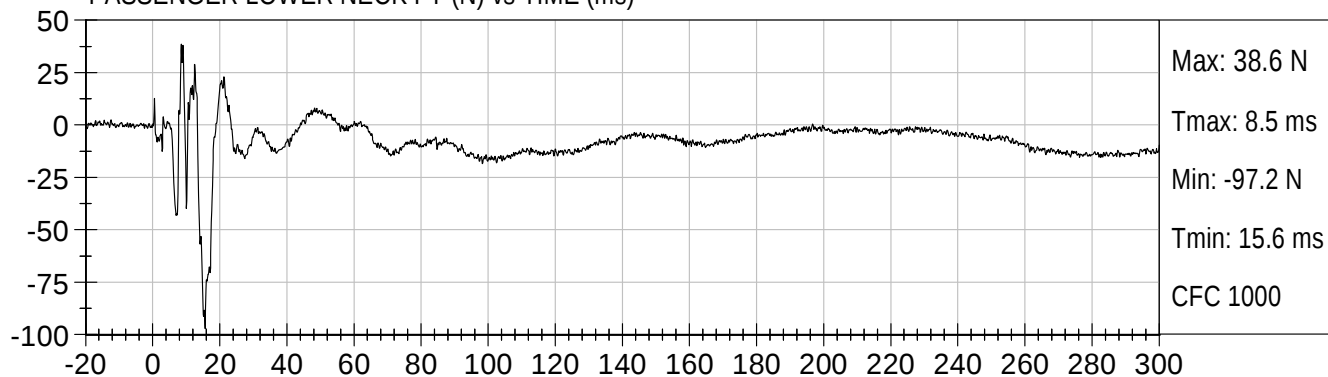




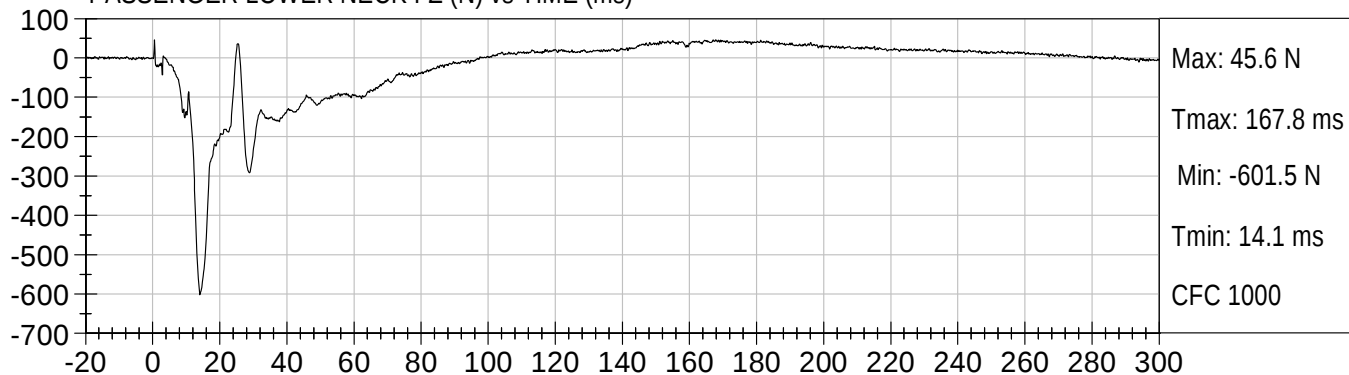
PASSENGER LOWER NECK FX (N) vs TIME (ms)



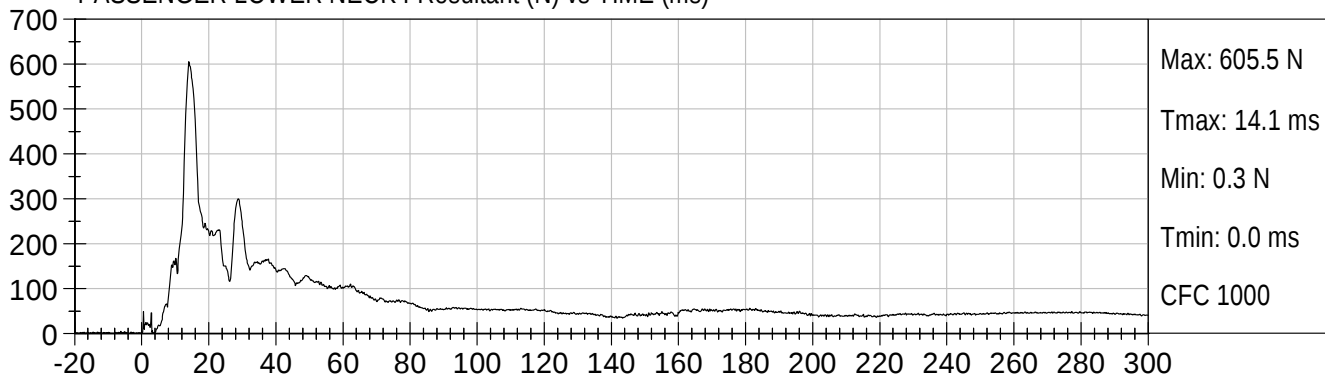
PASSENGER LOWER NECK FY (N) vs TIME (ms)

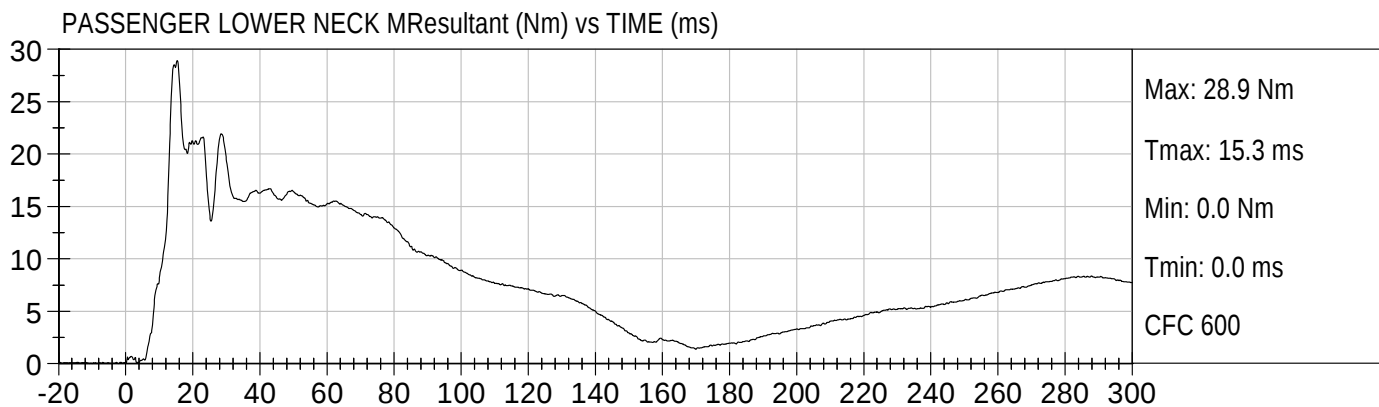
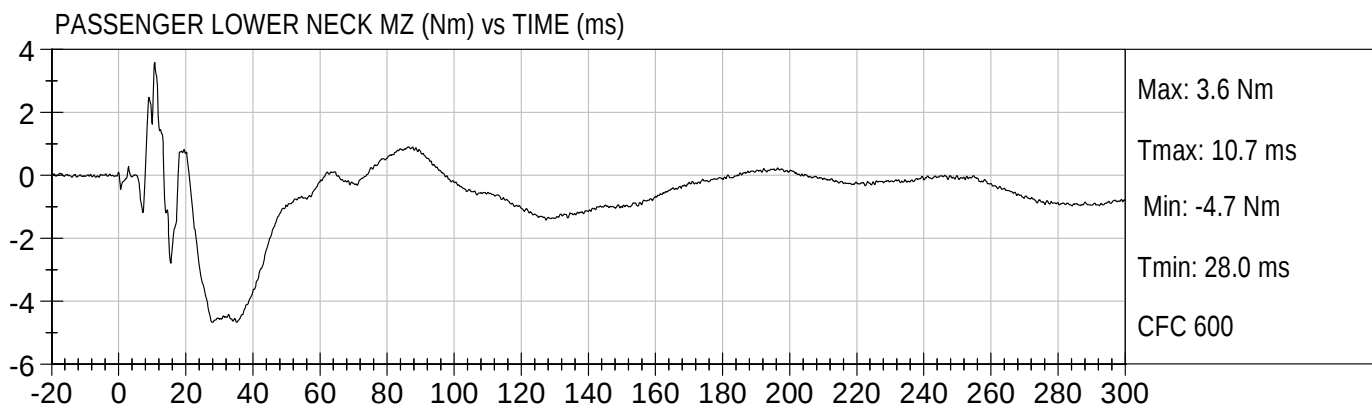
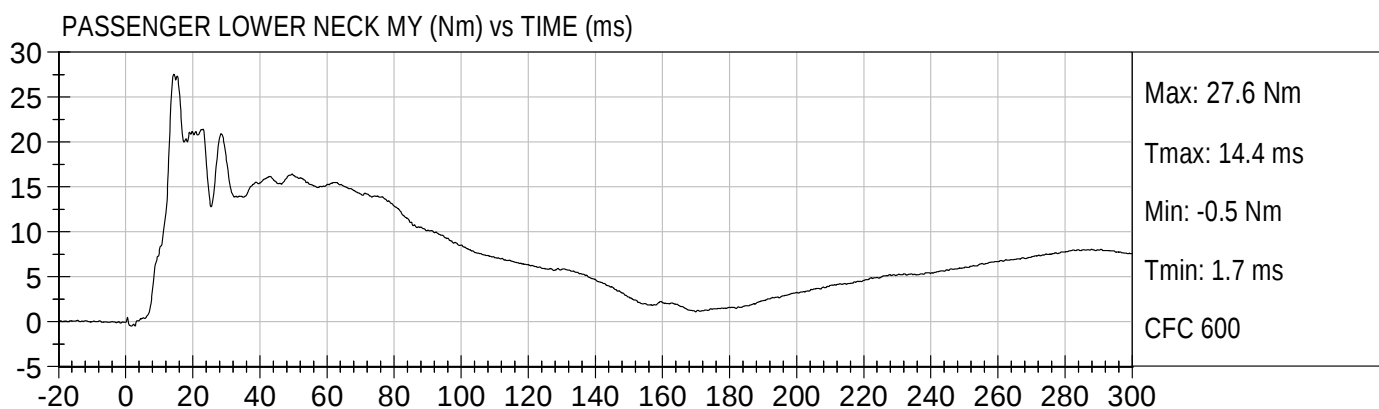
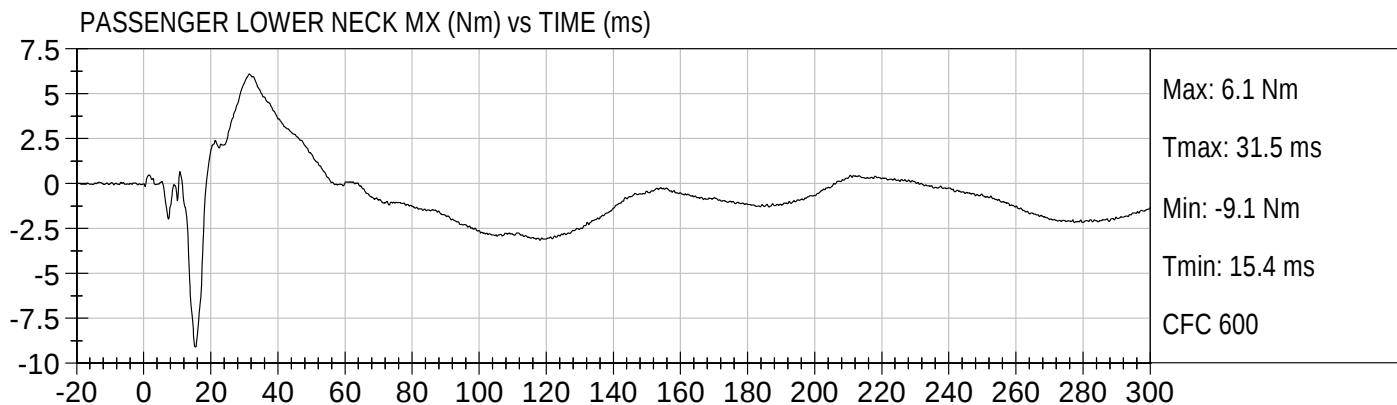


PASSENGER LOWER NECK FZ (N) vs TIME (ms)



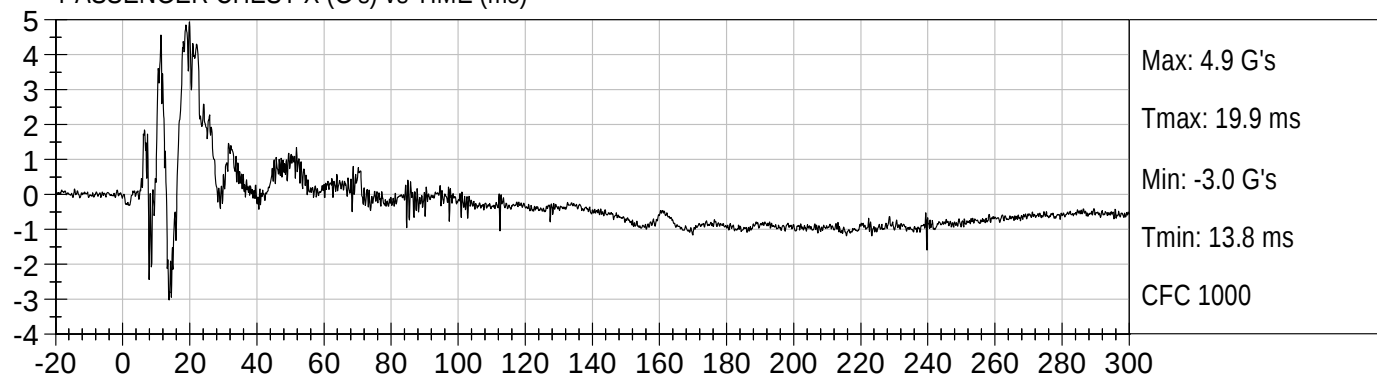
PASSENGER LOWER NECK FResultant (N) vs TIME (ms)



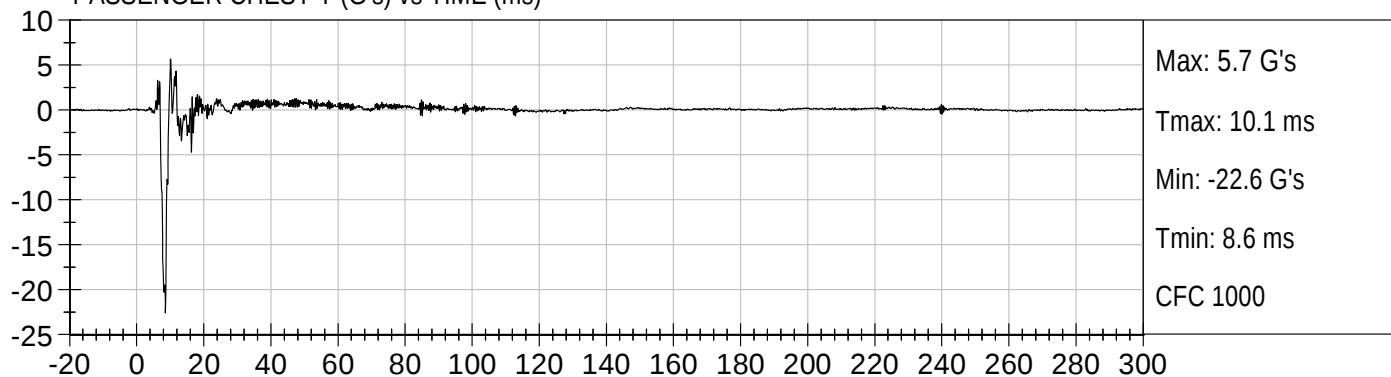




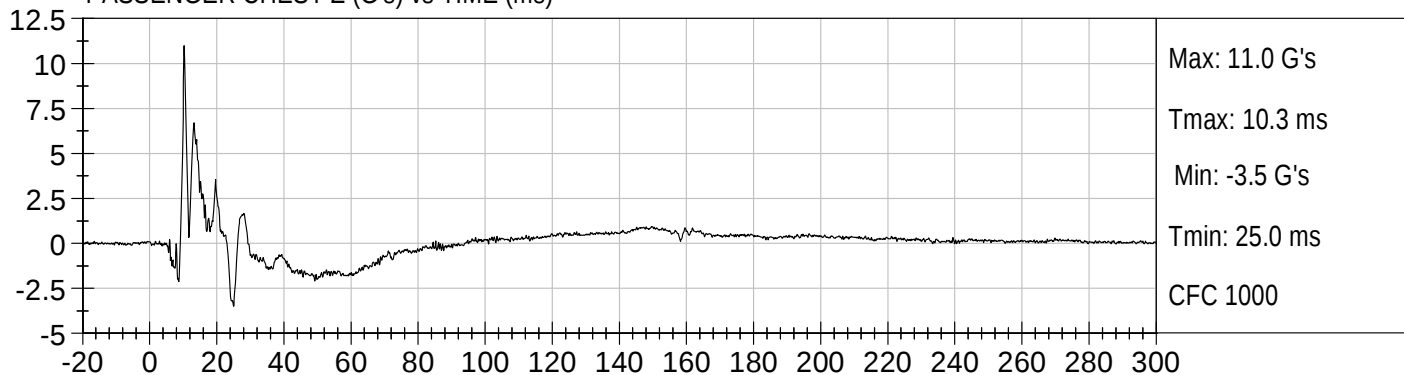
PASSENGER CHEST X (G's) vs TIME (ms)



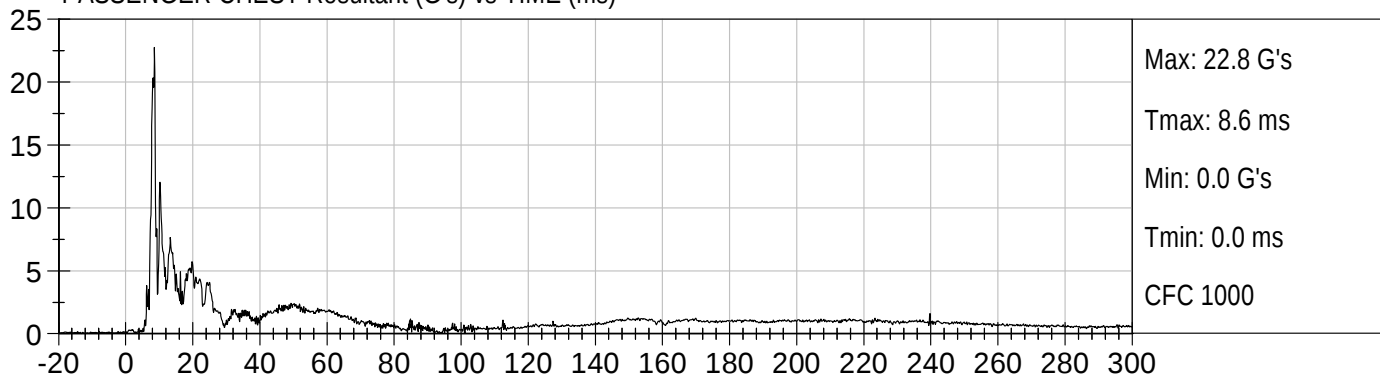
PASSENGER CHEST Y (G's) vs TIME (ms)



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

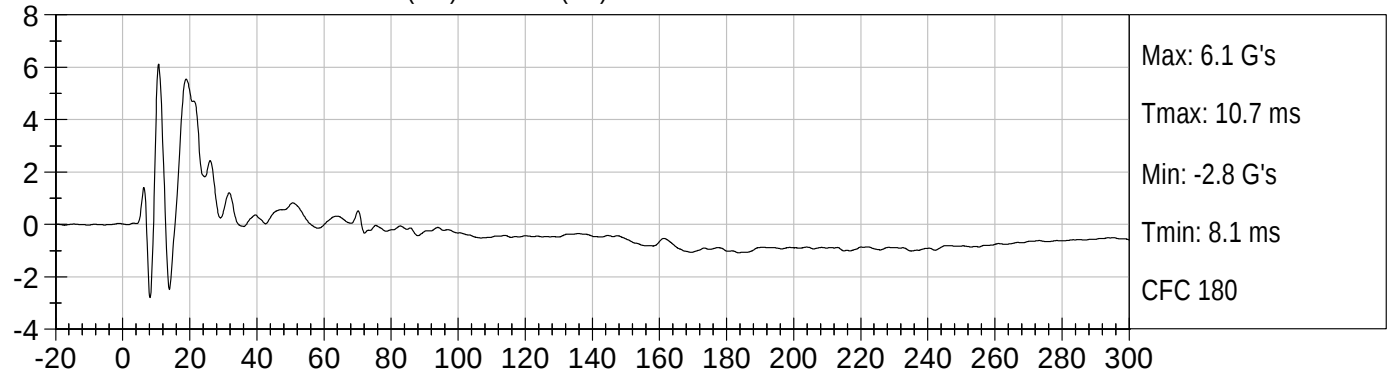


PASSENGER CHEST Resultant (G's) vs TIME (ms)

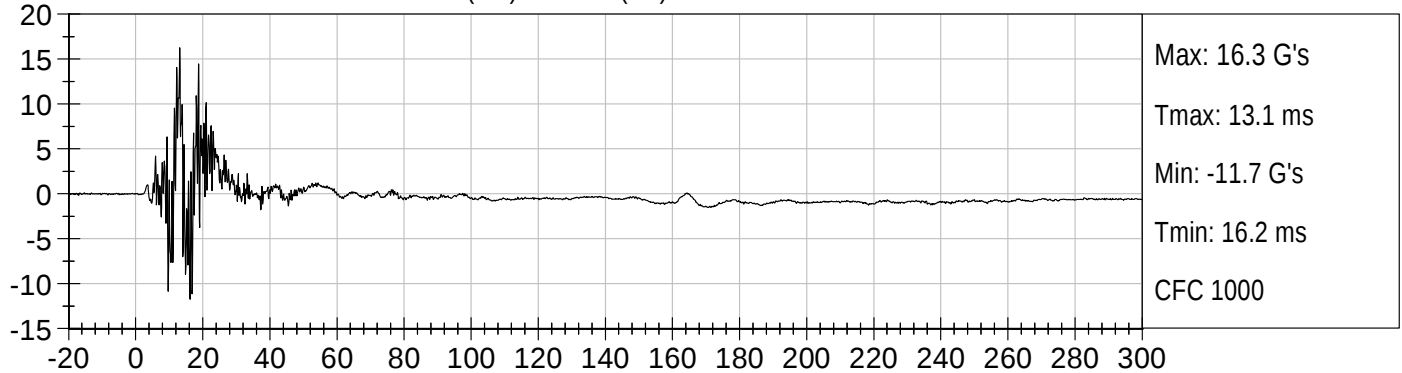




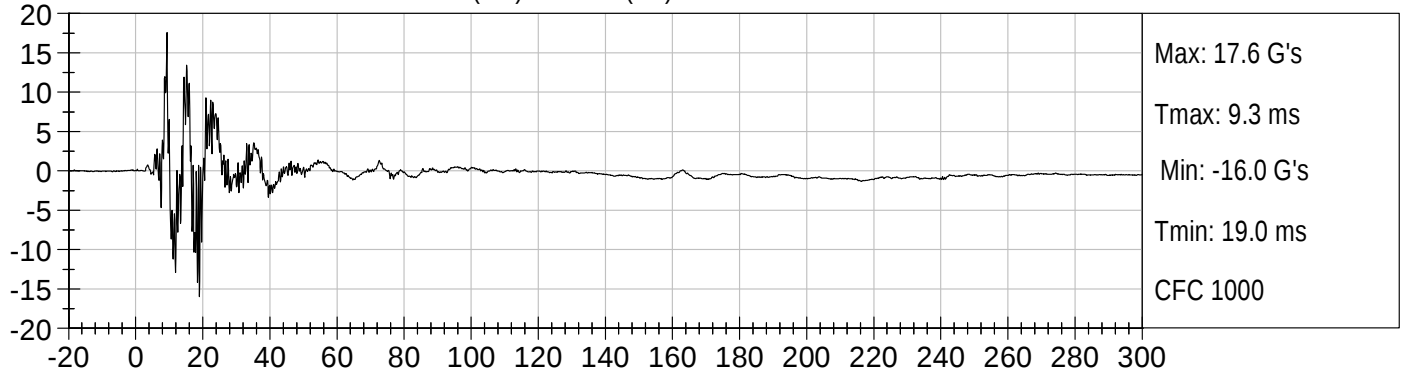
PASSENGER UPPER SPINE X (G's) vs TIME (ms)

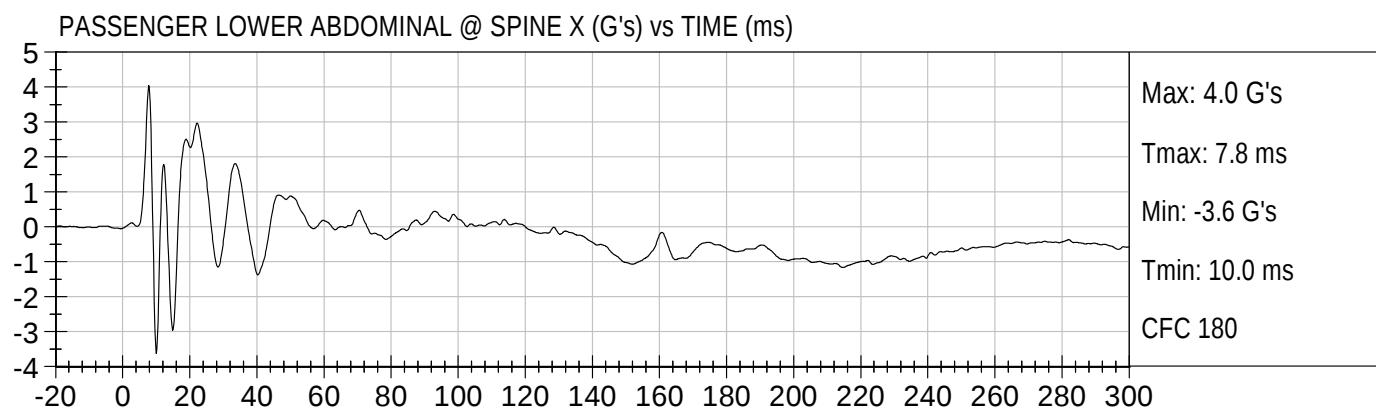
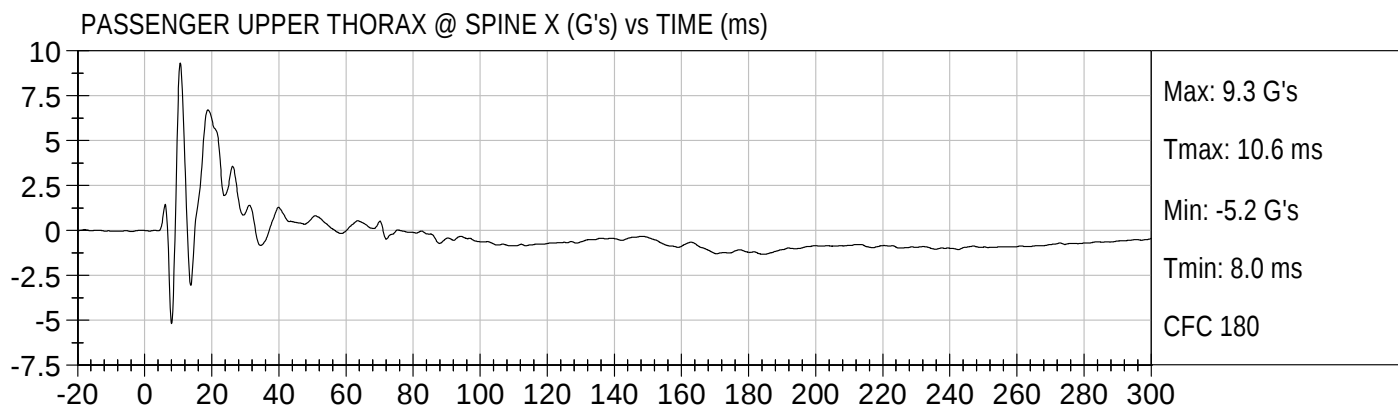


PASSENGER UPPER STERNUM X (G's) vs TIME (ms)



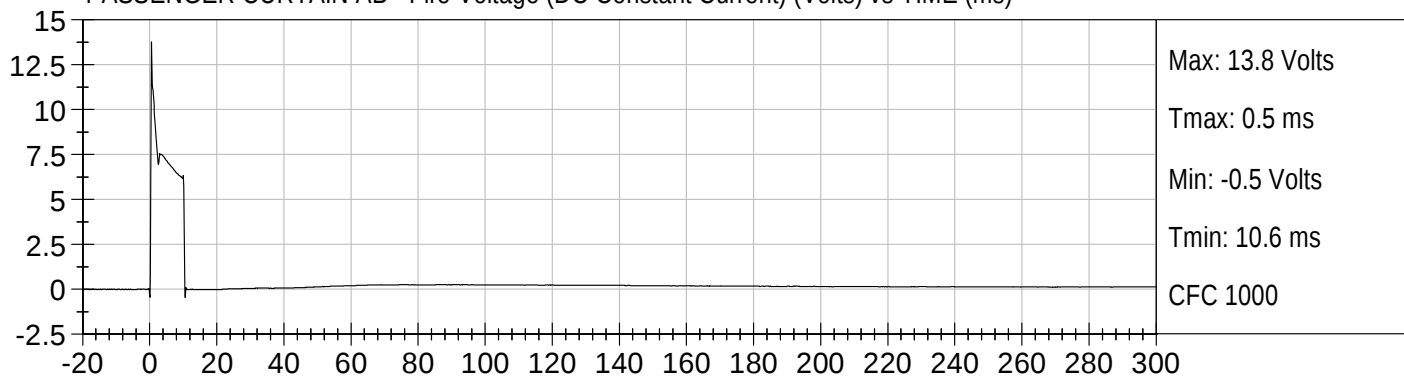
PASSENGER LOWER STERNUM X (G's) vs TIME (ms)



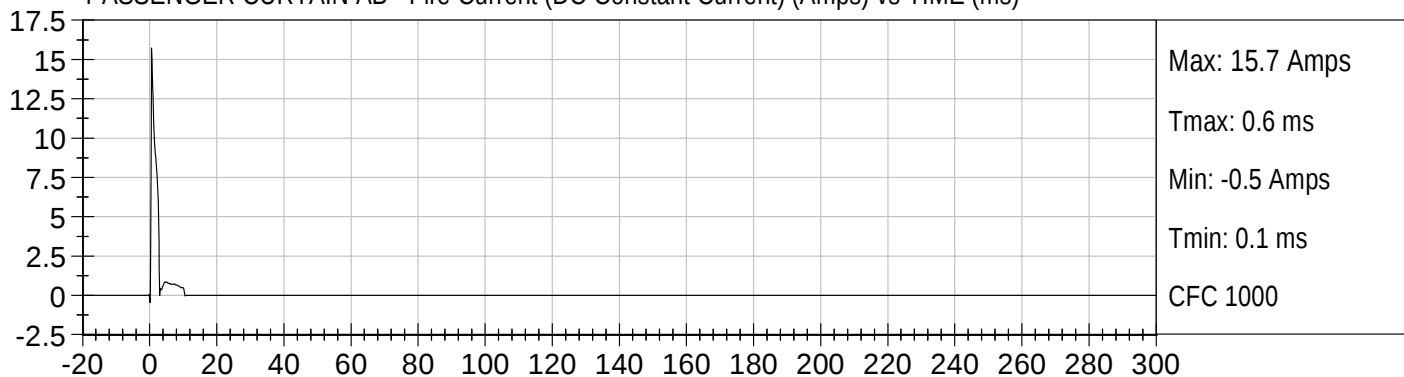




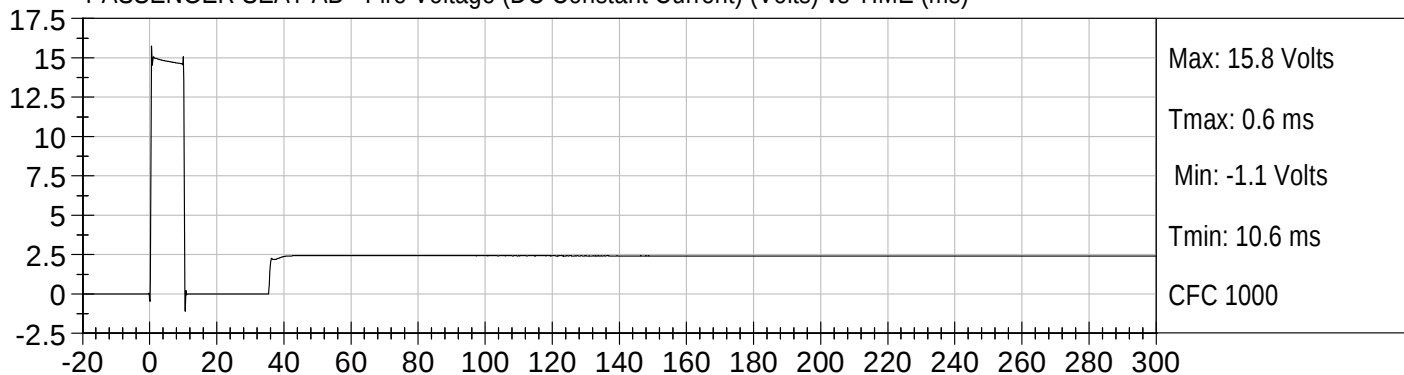
PASSENGER CURTAIN AB - Fire Voltage (DC Constant Current) (Volts) vs TIME (ms)



PASSENGER CURTAIN AB - Fire Current (DC Constant Current) (Amps) vs TIME (ms)



PASSENGER SEAT AB - Fire Voltage (DC Constant Current) (Volts) vs TIME (ms)



PASSENGER SEAT AB - Fire Current (DC Constant Current) (Amps) vs TIME (ms)

