



REPORT NUMBER: TWG-MGA-2009-006

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

**FUJI HEAVY INDUSTRIES LTD.
2009 SUBARU FORESTER
NHTSA NUMBER: M95500TWG2**

TEST DATE: SEPTEMBER 21, 2009

FINAL REPORT DATE: DECEMBER 8, 2009

FINAL REPORT

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

**PREPARED FOR:
ALPHA TECHNOLOGY ASSOCIATE, INC.
519 H STREET, NW, SUITE 200
WASHINGTON, D.C. 20001**

SIGNATURE APPROVAL PAGE

Total Pages: 33

Prepared by: 
Jessica Gall, Project Engineer

Date: 12/08/2009

Reviewed by: 
David Winkelbauer, Director of Operations

Date: 12/08/2009

Test Engineer:	Alyssa Paul
Test Technician:	Wayne Dahlke
Instrumentation/Calibration:	David Wilcox
Secretary:	Donna Janovicz

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	A
B	Dummy Response Data Traces	B

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 2009 Subaru Forester 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 September 21, 2009. 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 front-facing position along the outboard edge of the seat per Section 3.3.3.5 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 top and right side of head
- Torso bag to right shoulder and right 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, aligning the upper spine with the deployment trajectory of the airbag. The dummy's head was placed in between the seat bolster and pillar/side trim. The head remained in its neutral orientation. The legs were aligned so that they cross the heel placement points that were previously marked on the seat cushion. The feet were held in place and the pelvis slid forward and parallel to the centerline of the vehicle until the dummy's head/neck junction was aligned vertically with the top edge of the airbag module. The legs were then repositioned so that they cross the heel placement points. With the vehicle door closed, the dummy's outboard arm was raised to clear the armrest and the pelvis and upper torso was slid outboard until the pelvis or torso contacted the door. The outboard arm was placed on the armrest. The inboard arm was flexed so that the upper arm contacted the seat back and the fingertips contacted the foam block.

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
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
TEST SUMMARY

	Test Data	Description
Seating Position	P2	Right Front Seating Position
Test	3.3.3.5*	Forward-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 Data Channels	23
Number of High-Speed Video	3

Visible Dummy Contact Points	
Head Contact	Curtain airbag to top and right side of head
Right Shoulder Contact	Torso bag
Right Torso Contact	Torso bag
Right Pelvis Contact	None

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

Please note that this vehicle had previously been tested in an
NCAP Frontal Impact on April 14, 2008.

TEST VEHICLE INFORMATION

Manufacturer	Subaru
Model	Forester
Body Style	MPV
NHTSA No.	M95500TWG2
VIN	JF2SH61619H703050
Color	Newport Blue Pearl
Delivery Date	3/28/2008
Odometer Reading (mile)	74
Dealer	Don Jacobs Subaru
Transmission	Automatic
Final Drive	AWD
Number of Cylinders	4
Engine Displacement (L)	2.5
Engine Placement	Longitudinal
Automatic Door Lock (ADL)	No
Owners Manual Details Instructions on Disabling ADLs	N/A
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	Yes
Power Seats	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Fuji Heavy Industries Ltd.
Date of Manufacture	1/08

GVWR (kg)	2035
GAWR Front (kg)	1050
GAWR Rear (kg)	1095

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				408
Cargo Wt. (RCLW) (kg)				68

DATA SHEET NO. 3
DUMMY POSITIONING IN VEHICLE

Measurement		Value
Seat Position		4 Forward from Rear
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)	118
Head CG to Door Panel/Window	HD (mm)	235
Head to Seat Back Centerline	HSC (mm)	122
Chest to Dash	CD (mm)	638
Chest to Seatback	CS (mm)	190
Right Arm to Seat Back Centerline	RACL (mm)	242
Left Arm to Seat Back Centerline	LACL (mm)	34
Right Arm to Door Panel	RA (mm)	Contact
Left Arm to B-Post	LA (mm)	236
Knee to Knee	KK (mm)	157
Toe to Toe	TT (mm)	172
Right Knee to Seat Cushion Centerline	KSCR (mm)	123
Left Knee to Seat Cushion Centerline	KSCL (mm)	20
Right Toe to Seat Cushion Centerline	TSCR (mm)	18
Left Toe to Seat Cushion Centerline	TSCL (mm)	127
Nose to Dash	ND (mm)	720
Nose to Seatback	NS (mm)	194
Top of Head to Headliner	HH (mm)	226

DATA SHEET NO. 4
DUMMY INJURY CRITERIA VALUES

NHTSA No. M95500TWG2

DESCRIPTION	UNIT	MAXIMUM VALUE			
		Position No. 2			
		MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Head X	g	45.9	12.8	-10.7	13.6
Head Y	g	13.7	13.0	-57.8	14.0
Head Z	g	87.1	13.0	-14.8	8.6
Head Resultant	g	88.3	13.0		
Upper Neck Fx	N	494.5	12.2	-40.5	5.0
Upper Neck Fy	N	54.6	138.1	-343.8	12.9
Upper Neck Fz	N	172.8	126.4	-637.2	13.0
Upper Neck F Resultant	N	765.6	13.0		
Upper Neck Mx	Nm	18.9	11.8	-34.9	22.8
Upper Neck My	Nm	44.0	12.2	-24.1	33.4
Upper Neck Mz	Nm	7.0	57.4	-10.7	13.1
Upper Neck M Resultant	Nm	48.8	12.1		
Lower Neck Fx	N	120.4	34.4	-880.0	11.2
Lower Neck Fy	N	179.2	5.8	-339.8	6.9
Lower Neck Fz	N	186.1	126.3	-563.0	7.9
Lower Neck F Resultant	N	910.2	11.2		
Lower Neck Mx	Nm	11.3	138.9	-41.2	11.4
Lower Neck My	Nm	6.0	266.3	-61.3	11.5
Lower Neck Mz	Nm	8.8	35.2	-42.3	11.2
Lower Neck M Resultant	Nm	84.5	11.4		
Chest X	G	106.4	4.6	-17.7	5.8
Chest Y	G	62.2	5.1	-73.7	4.8
Chest Z	G	30.2	7.2	-162.8	5.9
Chest Resultant	G	163.9	5.9		
Upper Spine X	G	66.1	4.3	-7.7	14.4
Upper Sternum X	G	490.5	5.0	-209.2	5.6
Lower Sternum X	G	559.9	5.3	-237.4	4.7
Upper Thorax @ Spine X	G	79.0	4.4	-15.5	13.3
Lower Abdominal @ Spine X	G	67.8	4.5	-9.6	16.2

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

NHTSA No. M95500TWG2

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	36.8	12.6	14.5	36.8	12.6	14.5

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	0.38	12.4	2.38	496.89	43.66
Nte	0.67	33.4	57.25	-11.02	-24.12
Ncf	0.49	13.0	-440.87	305.75	36.14
Nce	0.55	37.0	-1.14	62.37	-19.31
Peak Tension (CFC1000)	172.8 N		Peak Compression (CFC 1000)		-637.2 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				

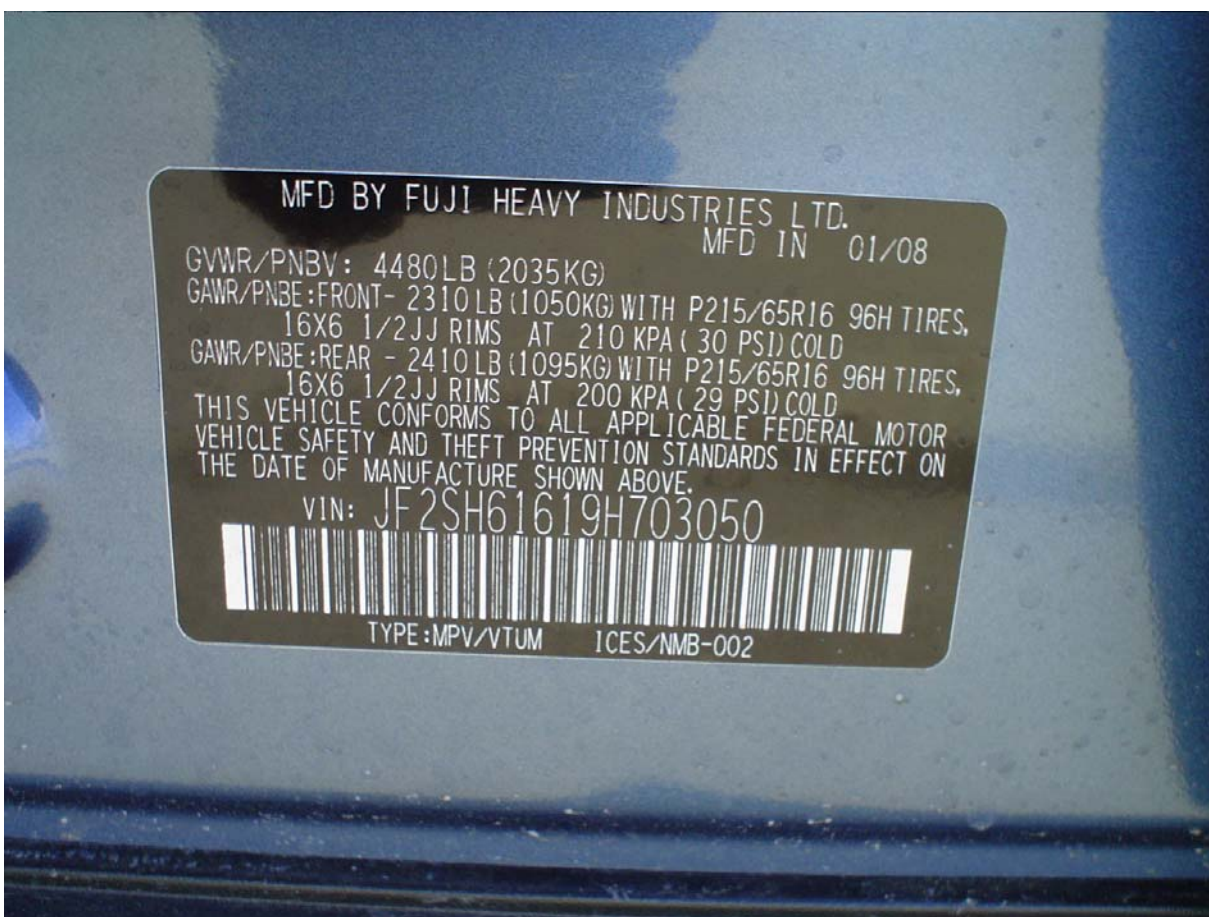
APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

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



Front ¾ 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 $\frac{3}{4}$ Front View



Post-Test 6-Year-Old Child Dummy Left $\frac{3}{4}$ Front View



Pre-Test 6-Year-Old Child Dummy Left $\frac{3}{4}$ Front Closeup View



Post-Test 6-Year-Old Child Dummy Left $\frac{3}{4}$ 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



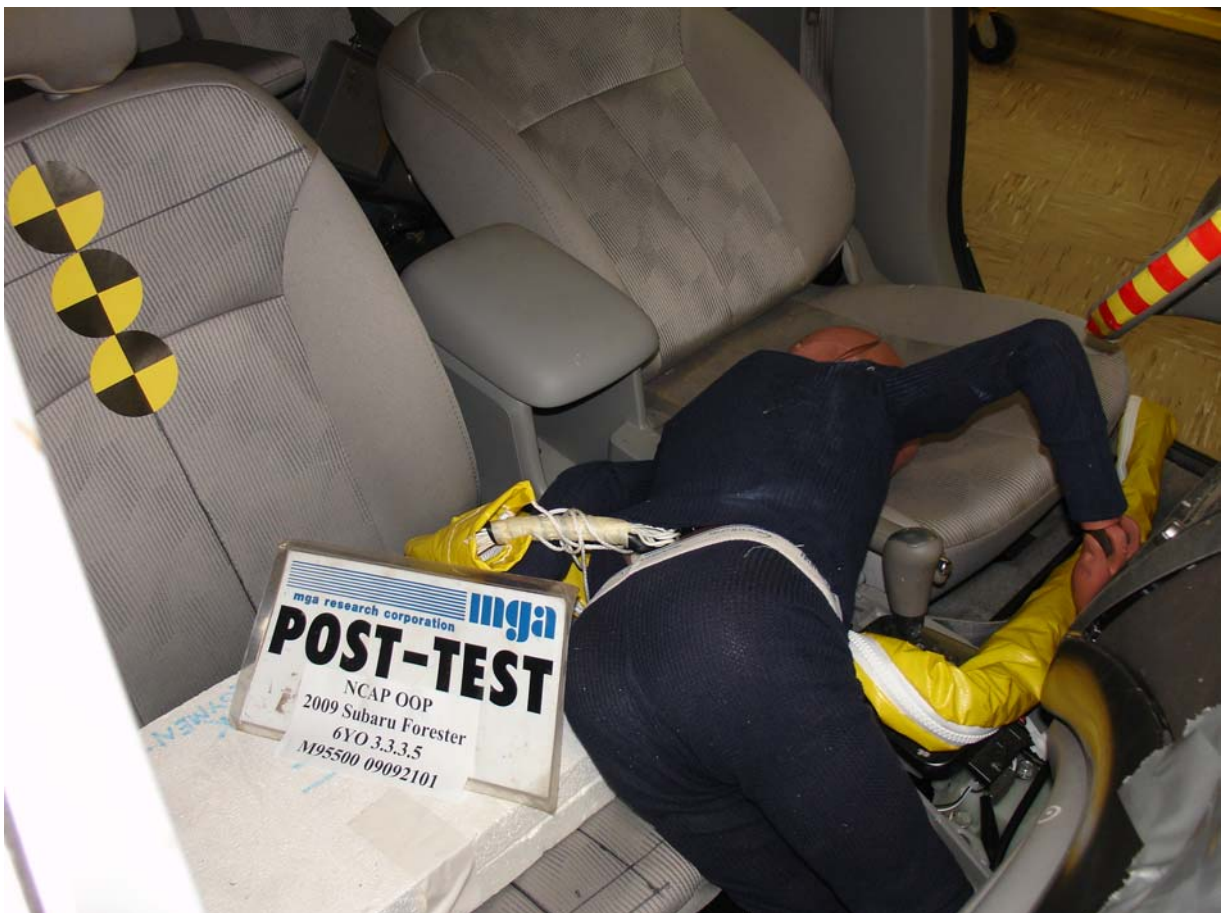
Pre-Test 6-Year-Old Child Dummy Right $\frac{3}{4}$ Front View



Post-Test 6-Year-Old Child Dummy Right $\frac{3}{4}$ Front View



Pre-Test 6-Year-Old Child Dummy View of Legs



Post-Test 6-Year-Old Child Dummy View of Legs



Post-Test Right Front Passenger Compartment View



Post-Test Curtain and Torso Airbag Front View

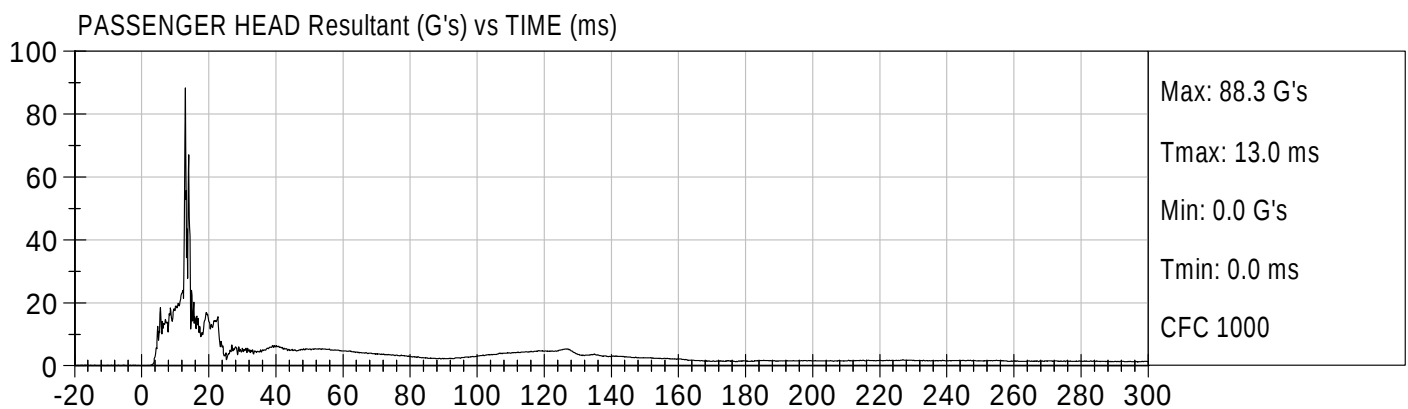
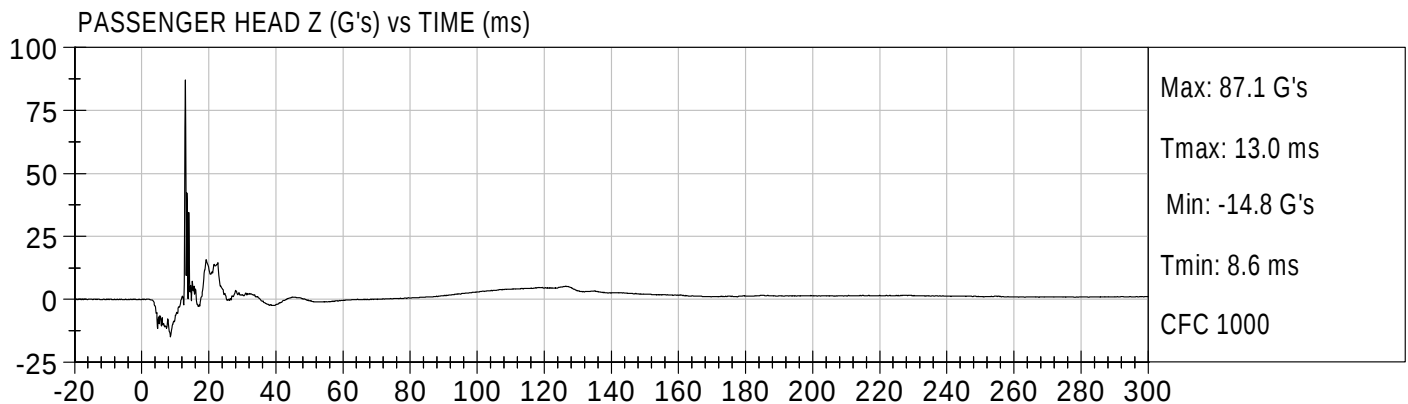
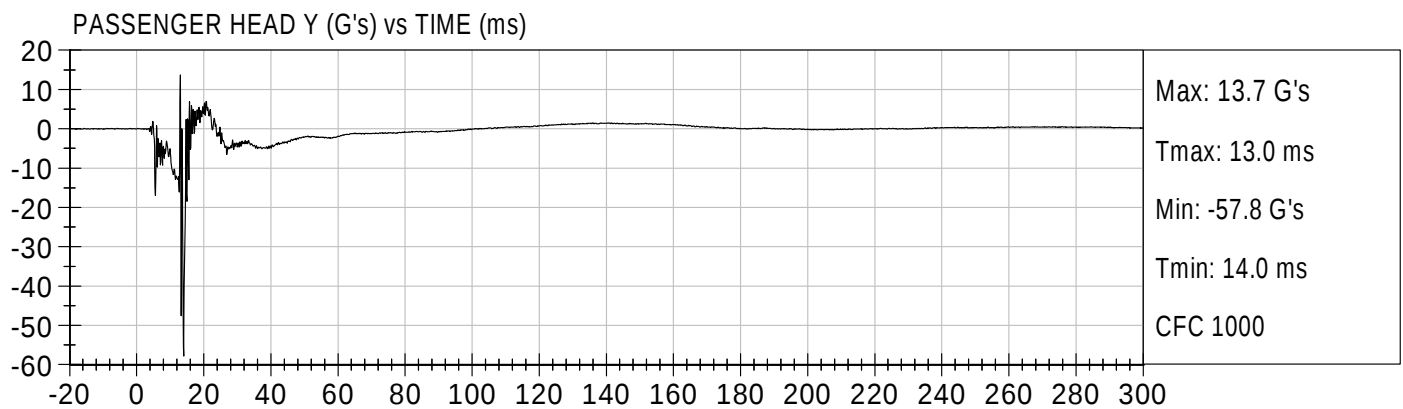
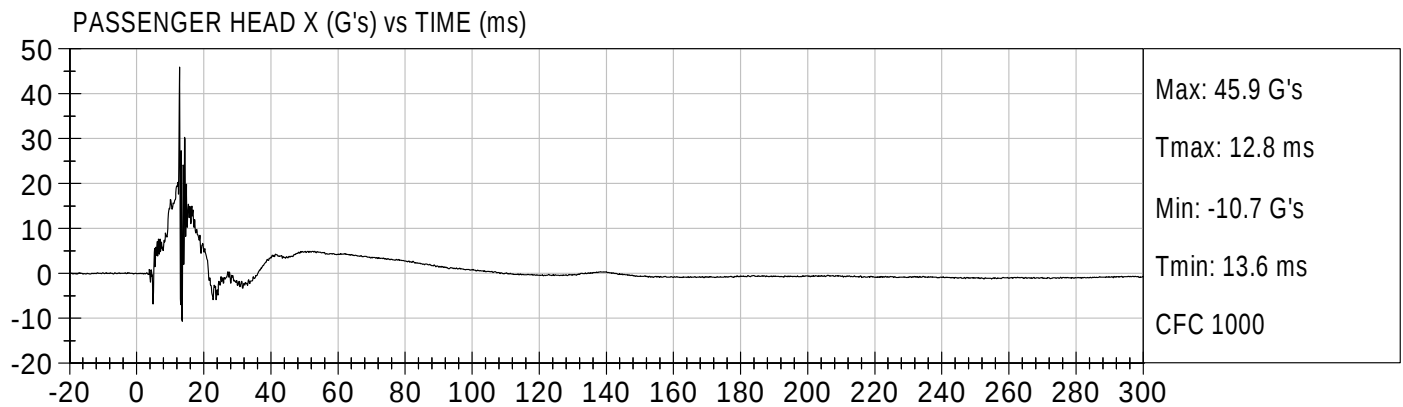
APPENDIX B

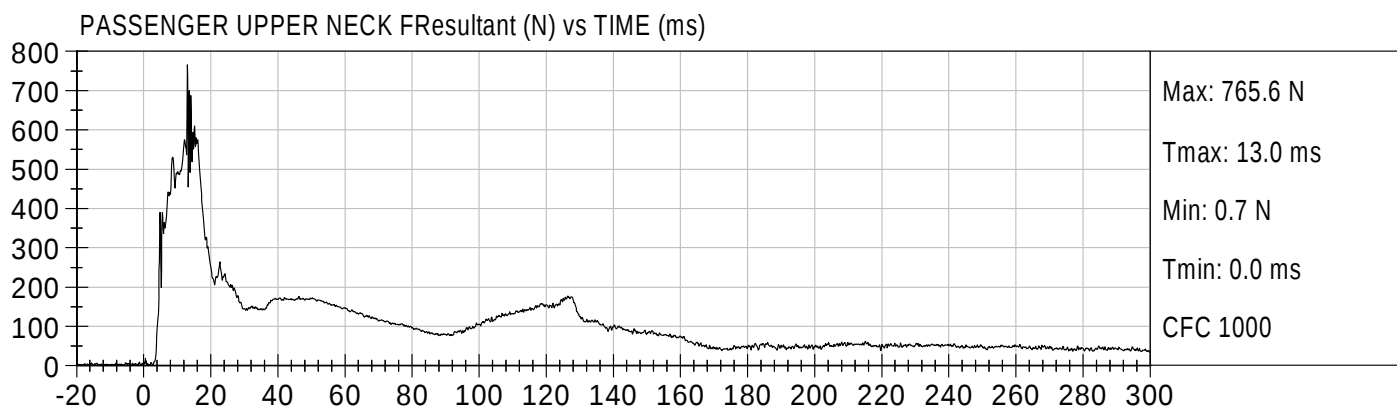
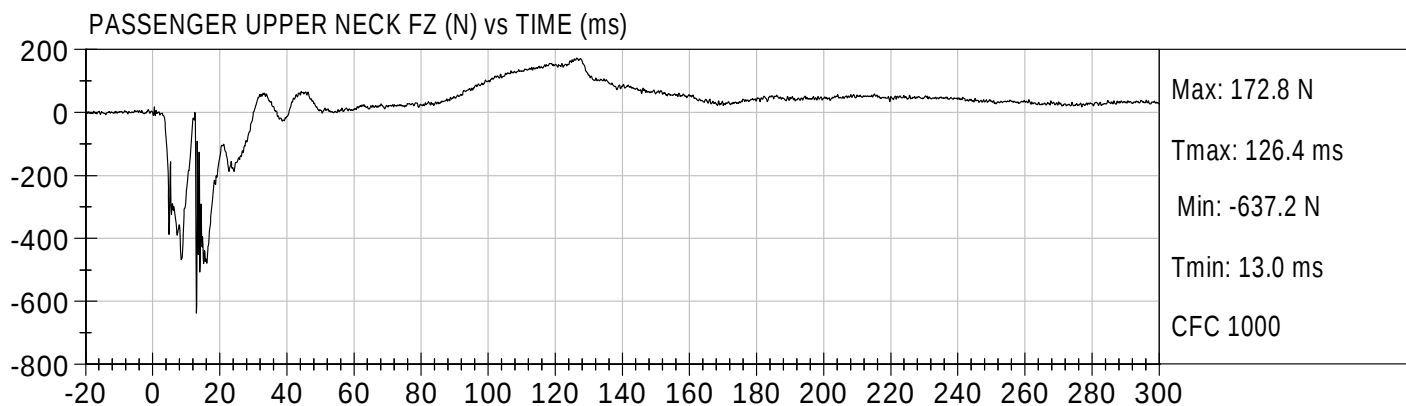
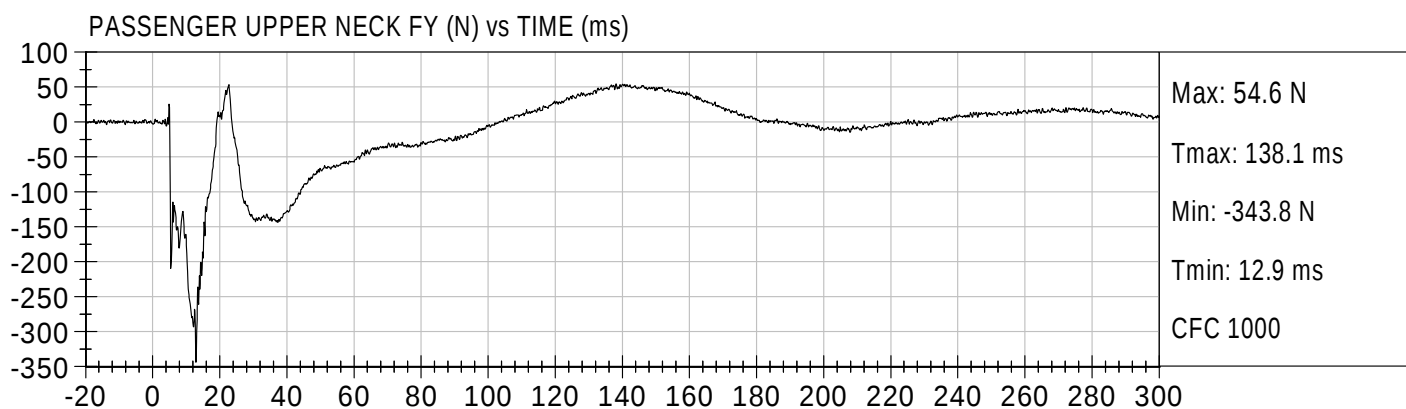
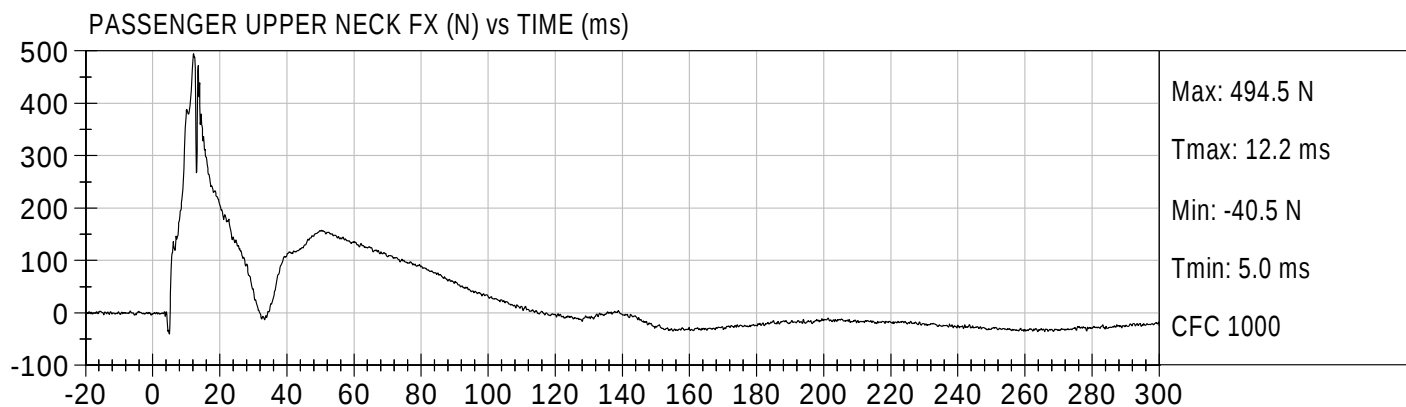
DUMMY RESPONSE DATA TRACES

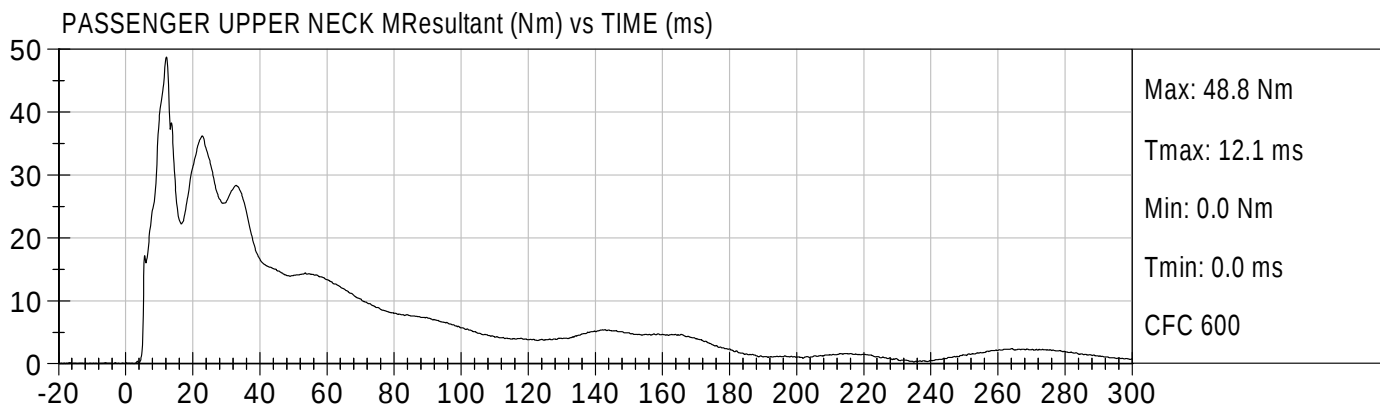
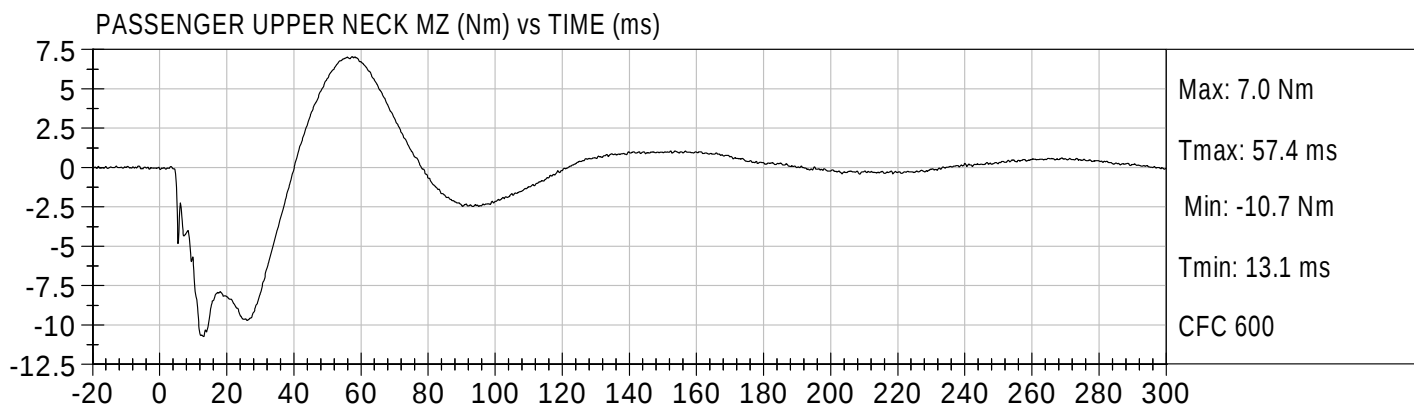
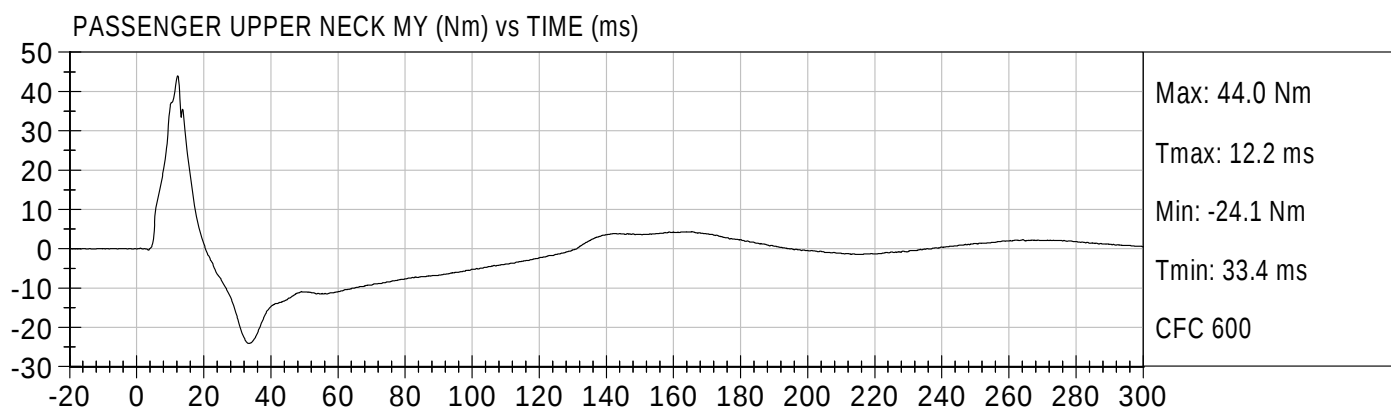
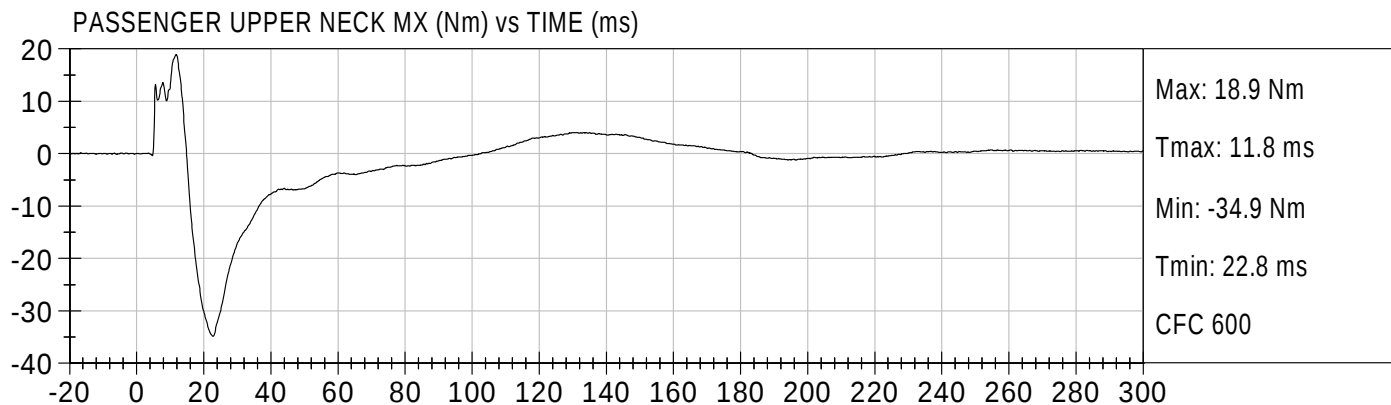
TABLE OF DATA PLOTS

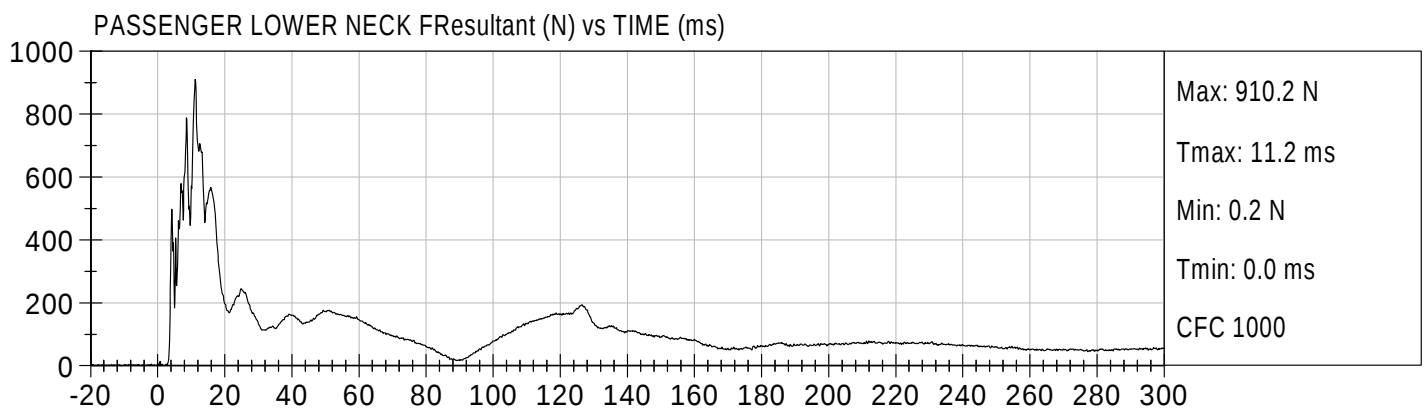
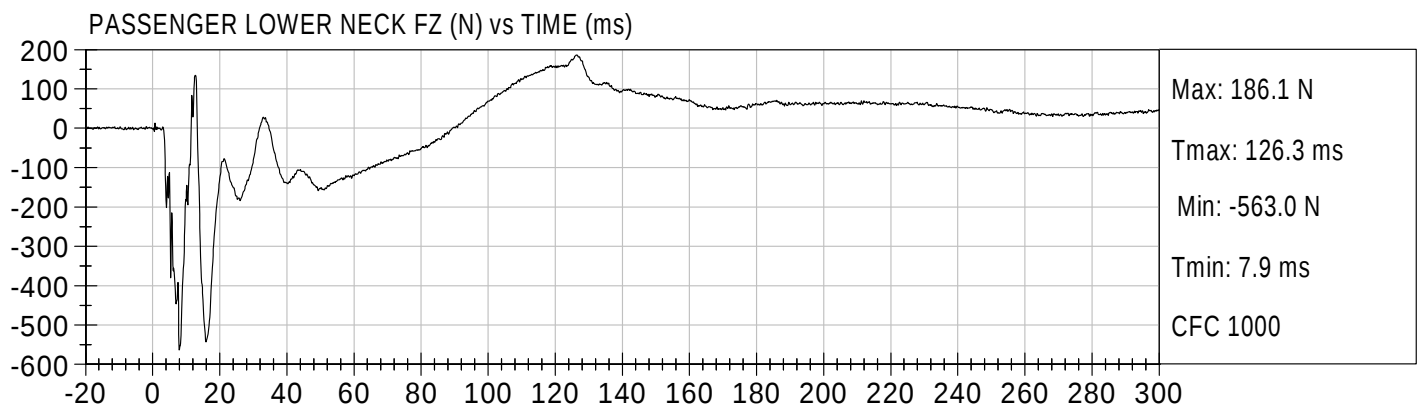
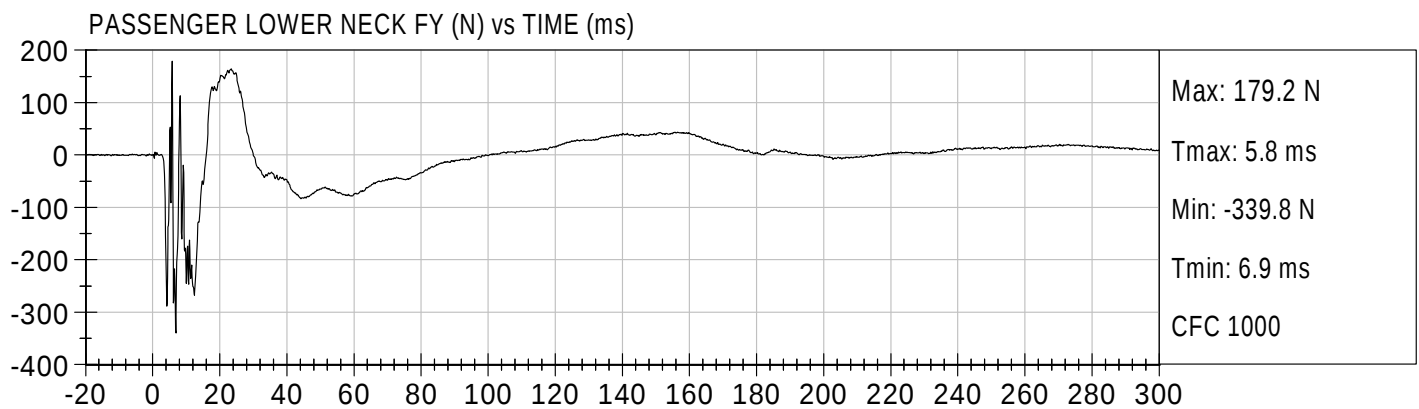
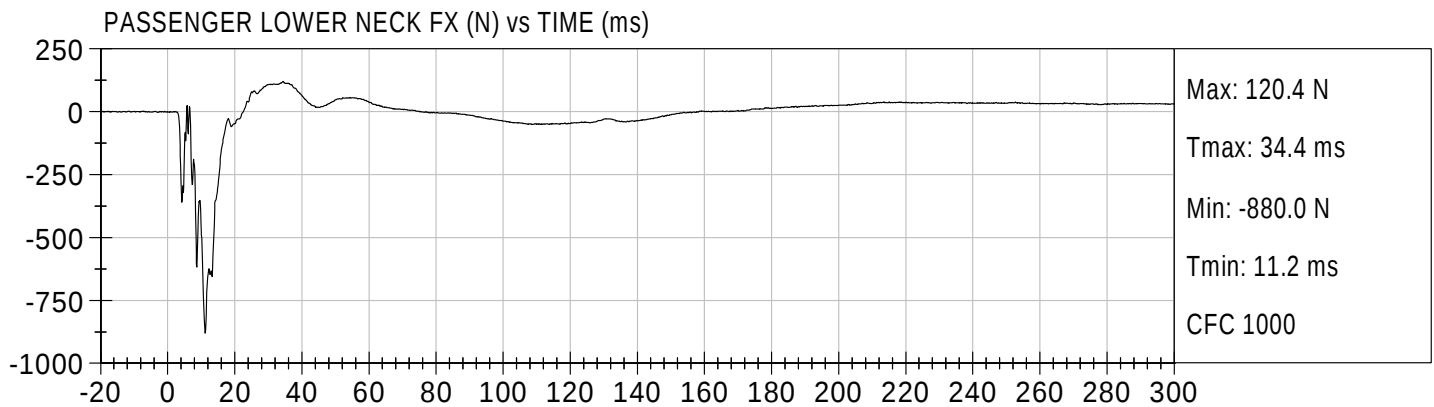
		<u>Page No.</u>
Figure No. 1.	Passenger Head X Acceleration vs. Time	B-3
Figure No. 2.	Passenger Head Y Acceleration vs. Time	B-3
Figure No. 3.	Passenger Head Z Acceleration vs. Time	B-3
Figure No. 4.	Passenger Head Resultant Acceleration vs. Time	B-3
Figure No. 5.	Passenger Upper Neck X Force vs. Time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

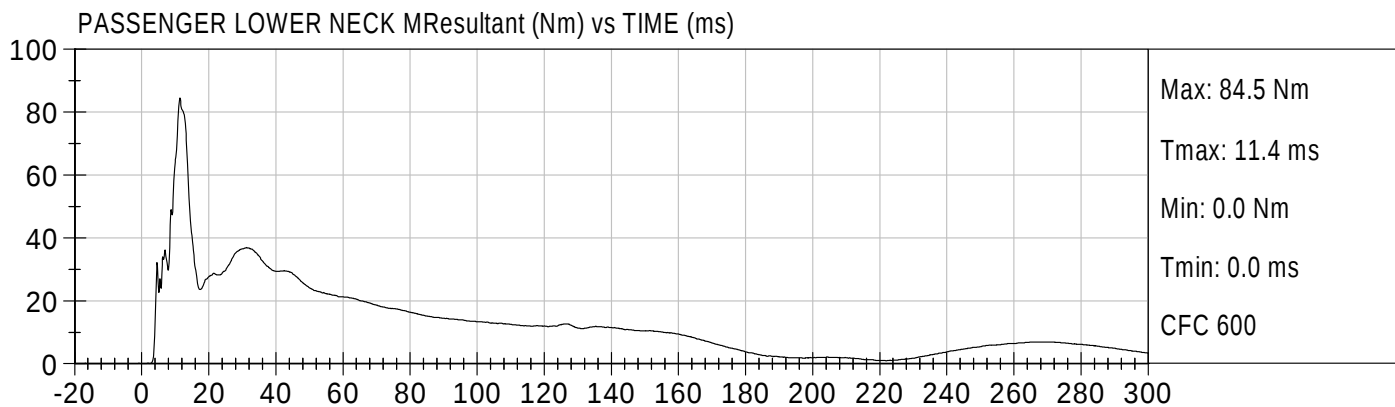
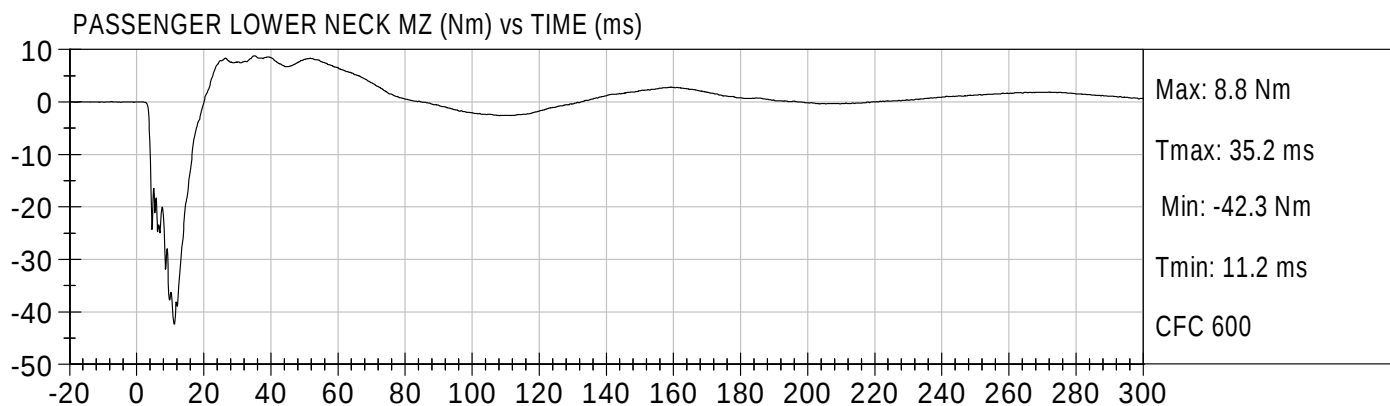
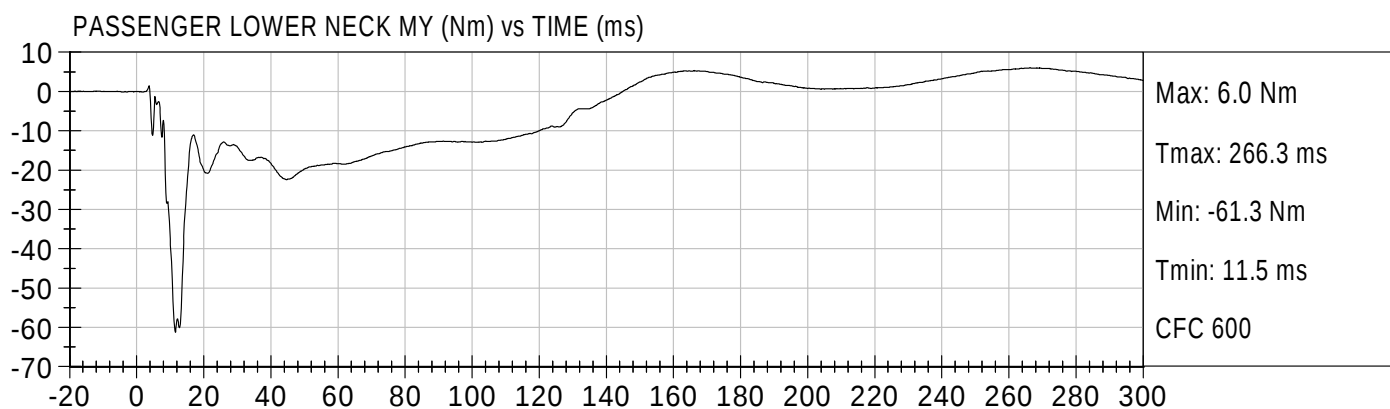
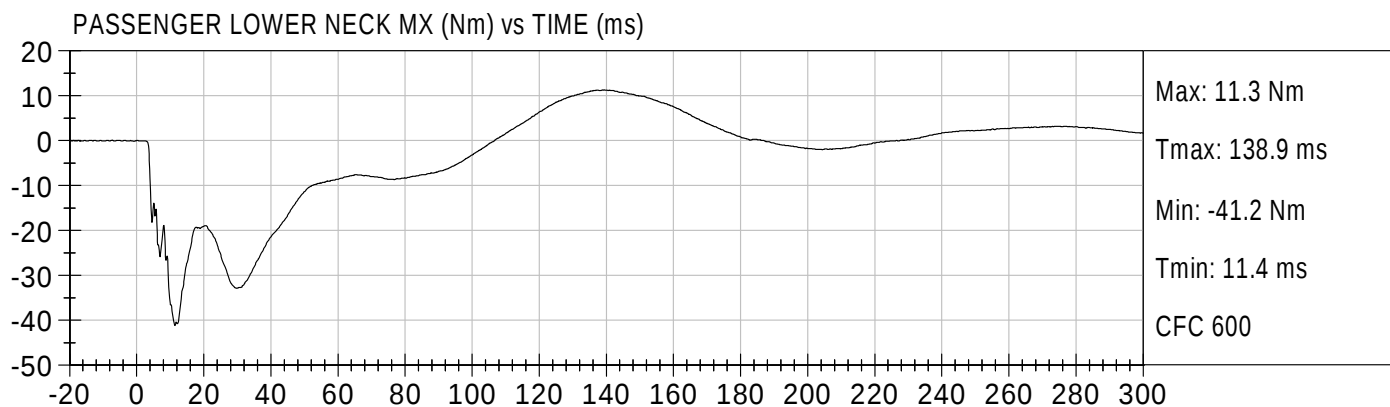
		<u>Page No.</u>
Figure No. 25.	Passenger Upper Spine X Acceleration vs. Time	B-9
Figure No. 26.	Passenger Upper Sternum X Acceleration vs. Time	B-9
Figure No. 27.	Passenger Lower Sternum X Acceleration vs. Time	B-9
Figure No. 28.	Passenger Upper Thorax @ Spine X Acceleration vs. Time	B-10
Figure No. 29.	Passenger Lower Abdominal @ Spine X Acceleration vs. Time	B-10
Figure No. 30.	Passenger Curtain Airbag – Fire Voltage vs. Time	B-11
Figure No. 31.	Passenger Curtain Airbag – Fire Current vs. Time	B-11
Figure No. 32.	Passenger Seat Airbag – Fire Voltage vs. Time	B-11
Figure No. 33.	Passenger Seat Airbag – Fire Current vs. Time	B-11

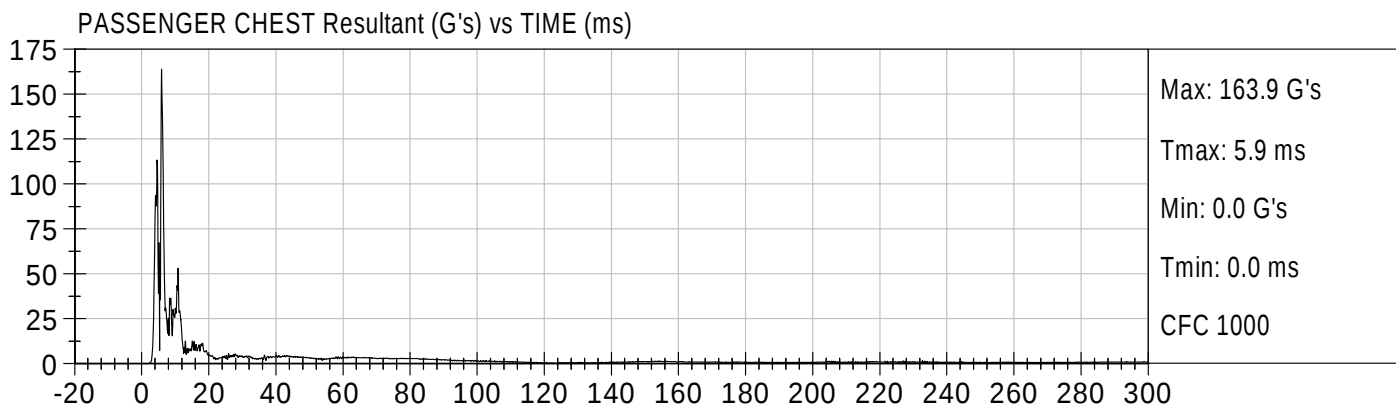
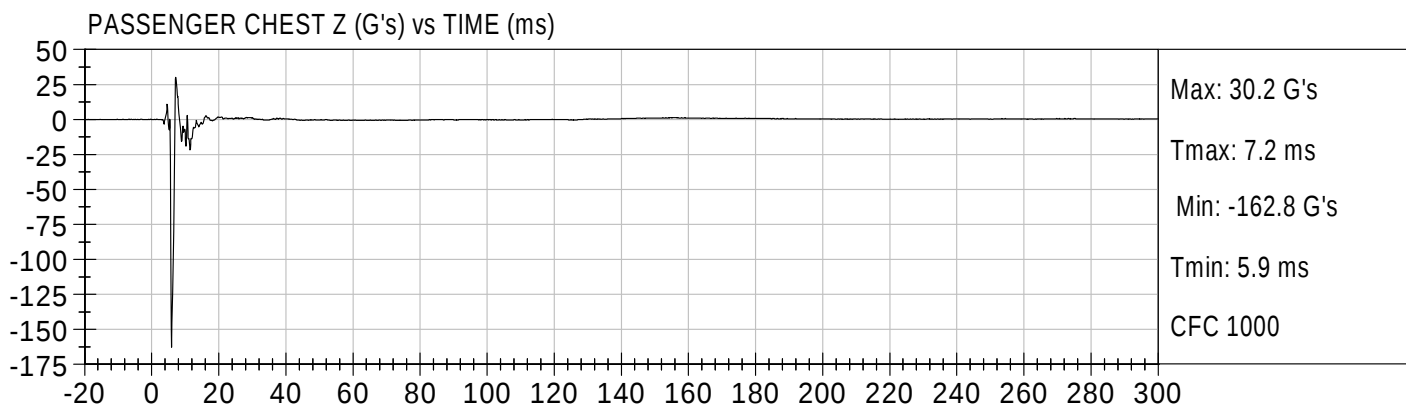
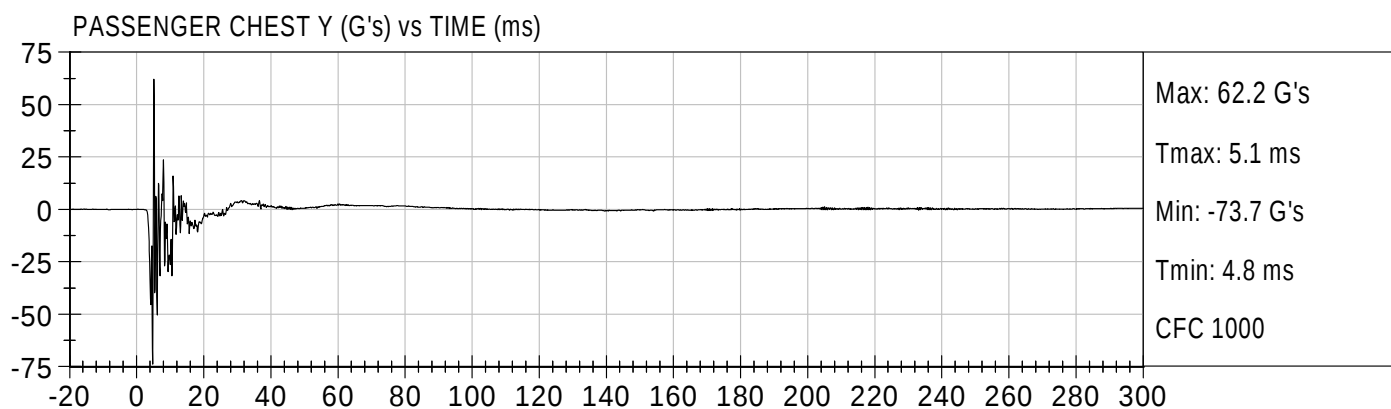
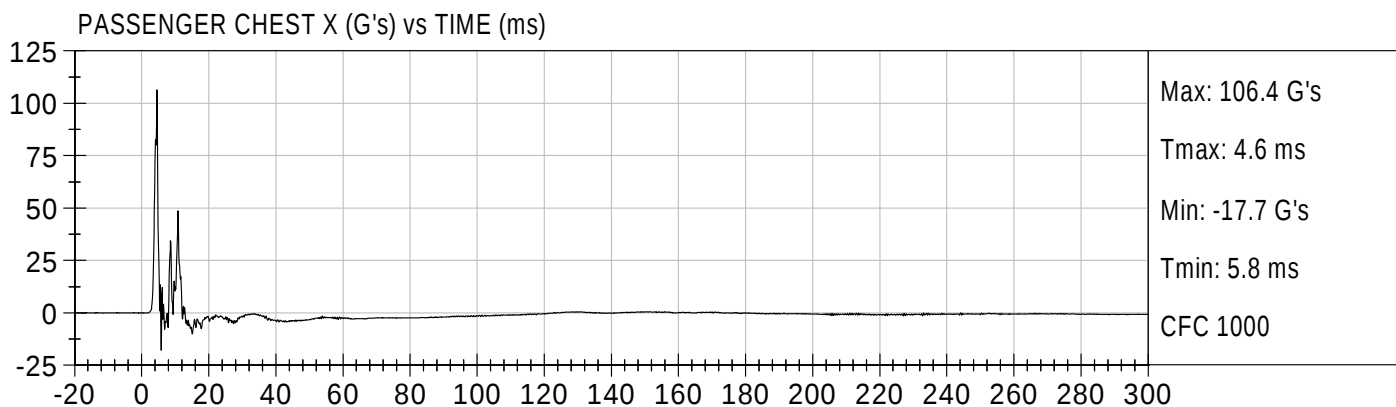






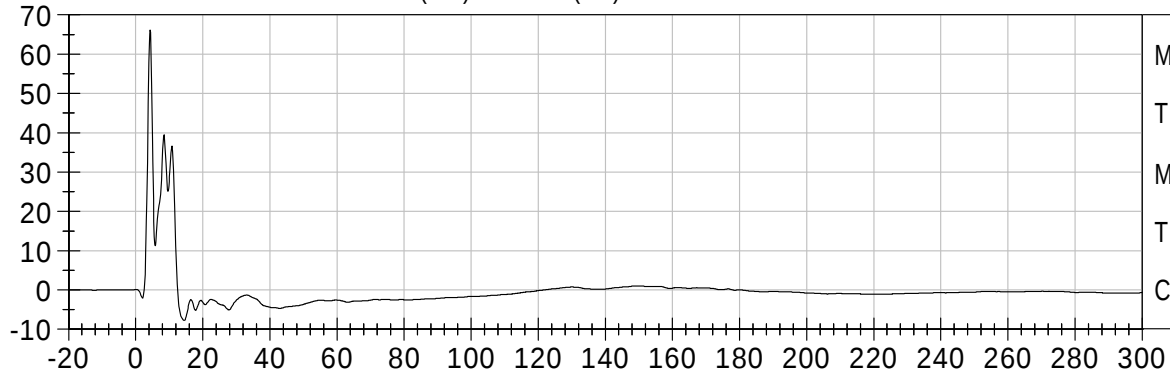






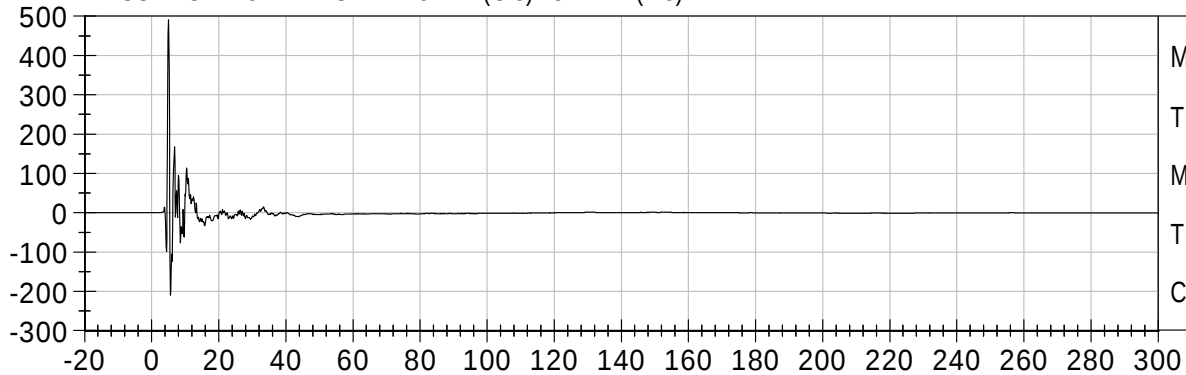


PASSENGER UPPER SPINE X (G's) vs TIME (ms)



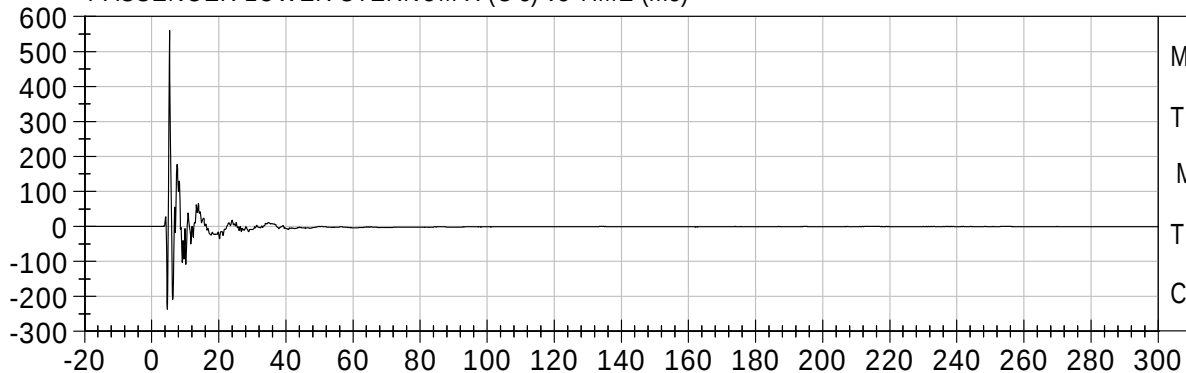
Max: 66.1 G's
Tmax: 4.3 ms
Min: -7.7 G's
Tmin: 14.4 ms
CFC 180

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

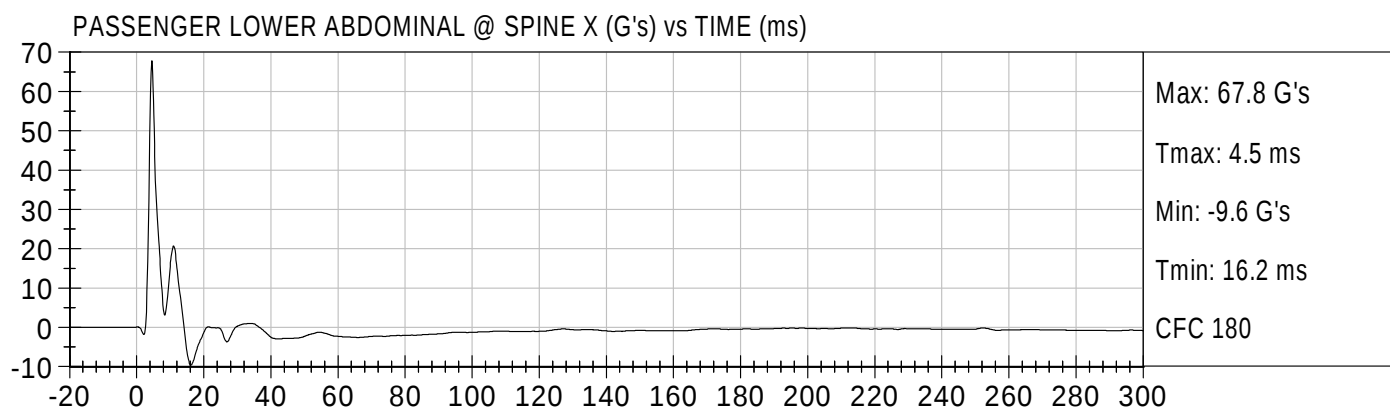
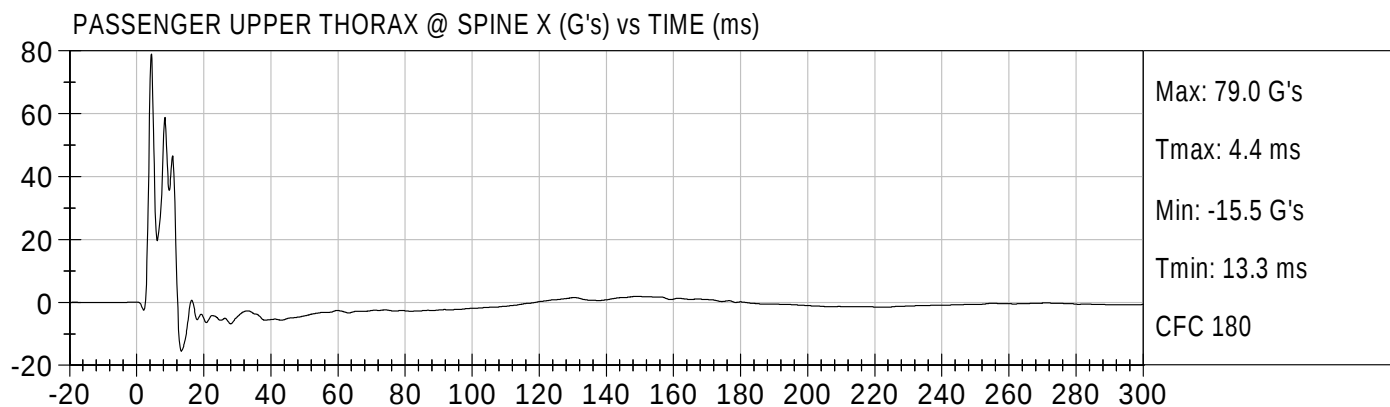


Max: 490.5 G's
Tmax: 5.0 ms
Min: -209.2 G's
Tmin: 5.6 ms
CFC 1000

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

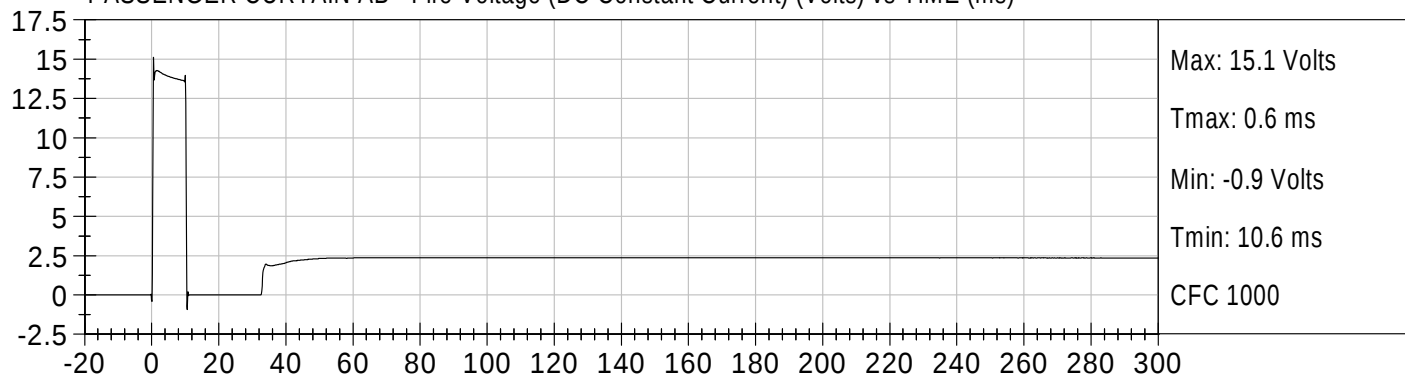


Max: 559.9 G's
Tmax: 5.3 ms
Min: -237.4 G's
Tmin: 4.7 ms
CFC 1000

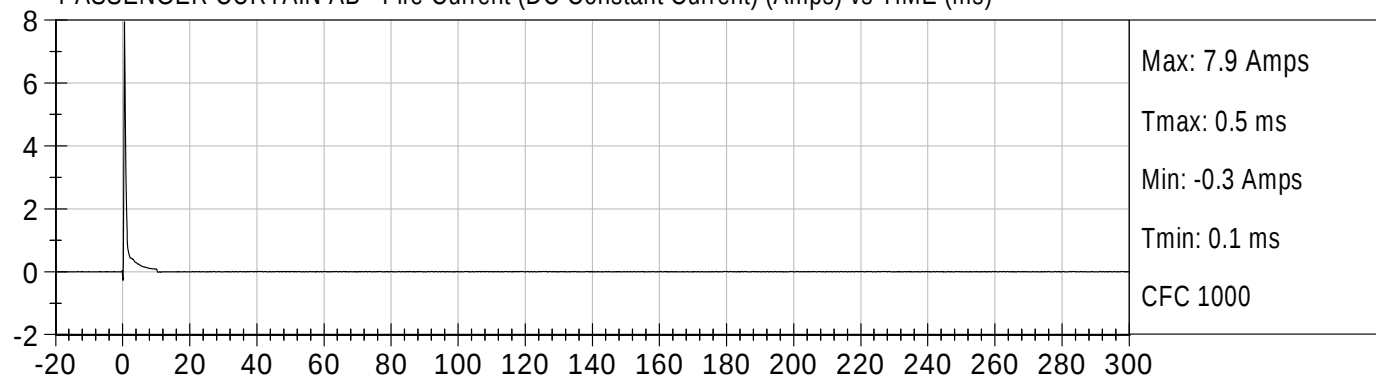




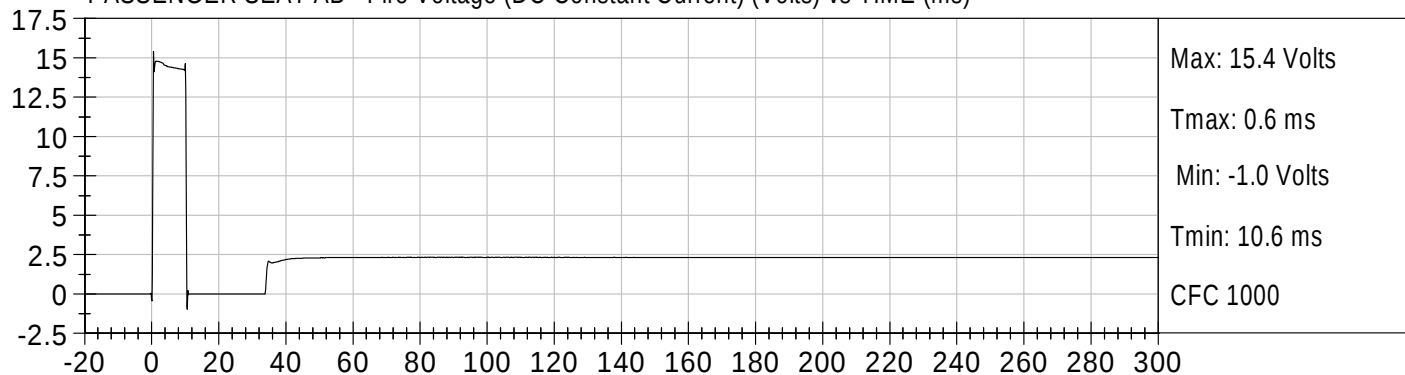
PASSENGER CURTAIN AB - Fire Voltage (DC Constant Current) (Volts) vs TIME (ms)



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)

