



REPORT NUMBER: TWG-MGA-2009-008

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

**AUDI AG
2009 AUDI A4
NHTSA NUMBER: M95800TWG2**

TEST DATE: SEPTEMBER 23, 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: 28

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 Audi A4 with an out-of-position SID-IIs Build Level D were evaluated. The curtain airbag was fired remotely. The test was performed by MGA Research Corporation on September 23, 2008. 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 SID-IIs Build Level D dummy (Serial Number 296) was placed in the right rear passenger seat situated in the forward-facing position in the center of the seat per Section 3.3.5.2 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). Two small foam wedges were used to hold initial dummy position. One wedge was placed behind the mid back and seat bolster, the other was placed under the left hip and seat to level the dummy.

The dummy was instrumented with the following instrumentation:

- Head Accelerations
- Upper Neck Load Cell
- Lower Neck Load Cell

The 15 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy data traces.

The SID-IIs dummy's visible contact points were as follows:

- Curtain airbag to right side of head

The SID-IIs dummy was placed in the right rear passenger seat facing forward in the center of the seat with its arm rotated horizontal to clear the armrest. The seat track was adjusted forward. The dummy was moved outboard until contact with the door trim panel ensuring that the deployment trajectory of the airbag intersects with the centerline of the top of the head. Masking tape was wrapped around the dummy's neck bracket to hold the dummy in place.

This orientation complies with Section 3.3.5.2 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	P3	Right Rear Seating Position
Test	3.3.5.2*	Forward-facing SID-IIs dummy
Curtain Airbag	Roof-Rail Mounted	Side Airbag
ATD Type/Serial No.	SID-IIs Build Level D / 296	5 th Percentile Adult Female

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

Number of Data Channels	15
Number of High-Speed Video	3

Visible Dummy Contact Points	
Head Contact	Curtain airbag to right side of head
Left Shoulder Contact	None
Left Torso Contact	None
Left 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 September 22, 2008.

TEST VEHICLE INFORMATION

Manufacturer	Audi
Model	A4
Body Style	Sedan
NHTSA No.	M95800TWG2
VIN	WAULF78K69N013410
Color	Brilliant Black
Delivery Date	9/12/2008
Odometer Reading (mile)	96
Dealer	Laurel Audi of Westmont
Transmission	Automatic
Final Drive	AWD
Number of Cylinders	4
Engine Displacement (L)	2.0
Engine Placement	Longitudinal
Automatic Door Lock (ADL)	Yes
Owners Manual Details Instructions on Disabling ADLs	Yes
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	No
All Wheel Drive	Yes
Power Seats	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Audi AG
Date of Manufacture	07/08

GVWR (kg)	2225
GAWR Front (kg)	1125
GAWR Rear (kg)	1150

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				480
Cargo Wt. (RCLW) (kg)				140

DATA SHEET NO. 3
DUMMY POSITIONING IN VEHICLE

Measurement		Value
Seat Position (Right Rear Seat)		Non-Adjustable
Seat Height Position (Right Rear Seat)		Non-Adjustable
Placed in Position No. 3		---
Seat Back Angle	SA (°)	19
Top of Airbag Module to Head/Neck Junction	AN (mm)	152
Head CG to Door Panel/Window	HD (mm)	196
Head to Seat Back Centerline	HSC (mm)	105
Chest to Front Seat	CD (mm)	484
Chest to Seatback	CS (mm)	256
Right Arm to Seat Back Centerline	RACL (mm)	268
Left Arm to Seat Back Centerline	LACL (mm)	---
Right Arm to Door Panel	RA (mm)	Contact
Left Arm to B-Post	LA (mm)	---
Knee to Knee	KK (mm)	141
Toe to Toe	TT (mm)	210
Right Knee to Seat Cushion Centerline	KSCR (mm)	174
Left Knee to Seat Cushion Centerline	KSCL (mm)	33
Right Toe to Seat Cushion Centerline	TSCR (mm)	---
Left Toe to Seat Cushion Centerline	TSCL (mm)	---
Nose to Front Seat	ND (mm)	527
Nose to Seatback/Headrest	NS (mm)	247
Top of Head to Headliner	HH (mm)	36

DATA SHEET NO. 4
DUMMY INJURY CRITERIA VALUES

NHTSA No. M95800TWG2

		MAXIMUM VALUE			
		Position No. 3			
DESCRIPTION	UNIT	MAXIMUM	TIME (ms)	MINIMUM	TIME (ms)
Head X	g	6.3	8.9	-6.0	21.7
Head Y	g	4.1	65.1	-20.6	20.5
Head Z	g	8.6	6.7	-3.6	7.9
Head Resultant	g	21.3	21.3		
Upper Neck Fx	N	38.6	36.0	-56.4	17.4
Upper Neck Fy	N	349.9	25.7	-11.2	2.8
Upper Neck Fz	N	39.4	99.8	-621.7	25.1
Upper Neck F Resultant	N	711.4	25.1		
Upper Neck Mx	Nm	11.7	50.5	-20.7	25.1
Upper Neck My	Nm	2.7	36.2	-2.9	20.6
Upper Neck Mz	Nm	4.7	107.6	-4.3	39.5
Upper Neck M Resultant	Nm	20.8	25.1		
Lower Neck Fx	N	25.8	7.2	-64.0	22.9
Lower Neck Fy	N	249.5	25.9	-38.3	12.9
Lower Neck Fz	N	77.6	100.0	-618.7	25.5
Lower Neck F Resultant	N	667.9	25.9		
Lower Neck Mx	Nm	35.3	27.0	-0.3	6.9
Lower Neck My	Nm	35.1	25.5	-2.7	188.0
Lower Neck Mz	Nm	9.9	25.7	-1.8	12.7
Lower Neck M Resultant	Nm	50.2	26.4		

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

NHTSA No. M95800TWG2

ATD position	HEAD INJURY CRITERIA (HIC)					
	HIC15			HIC36		
	HIC	T ¹ (msec)	T ² (msec)	HIC	T ¹ (msec)	T ² (msec)
No. 3 Right Rear	8.2	16.5	27.0	9.96	6.6	34.1

Position 3 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	0.01	99.8	30.53	-20.52	0.10
Nte	0.02	188.3	29.13	2.67	-1.0
Ncf	0.16	25.6	-615.77	7.05	0.23
Nce	0.16	24.3	-604.58	0.09	-0.50
Peak Tension (CFC1000)		39.4 N	Peak Compression (CFC 1000)		-621.7 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				

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

		<u>Page No.</u>
Photo No. 1.	Front $\frac{3}{4}$ 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 SID-IIs Dummy Left Side View	A-4
Photo No. 6.	Post-Test SID-IIs Dummy Left Side View	A-4
Photo No. 7.	Pre-Test SID-IIs Dummy Left Side Closeup View	A-5
Photo No. 8.	Post-Test SID-IIs Dummy Left Side Closeup View	A-5
Photo No. 9.	Pre-Test SID-IIs Dummy Left $\frac{3}{4}$ Front View	A-6
Photo No. 10.	Post-Test SID-IIs Dummy Left $\frac{3}{4}$ Front View	A-6
Photo No. 11.	Pre-Test SID-IIs Dummy Left $\frac{3}{4}$ Front Closeup View	A-7
Photo No. 12.	Post-Test SID-IIs Dummy Left $\frac{3}{4}$ Front Closeup View	A-7
Photo No. 13.	Pre-Test SID-IIs Dummy Front View	A-8
Photo No. 14.	Post-Test SID-IIs Dummy Front View	A-8
Photo No. 15.	Pre-Test SID-IIs Dummy Front Closeup View	A-9
Photo No. 16.	Post-Test SID-IIs Dummy Front Closeup View	A-9
Photo No. 17.	Pre-Test SID-IIs Dummy Right $\frac{3}{4}$ Front View	A-10
Photo No. 18.	Post-Test SID-IIs Dummy Right $\frac{3}{4}$ Front View	A-10
Photo No. 19.	Post-Test SID-IIs Dummy Right Side Closeup View	A-11
Photo No. 20.	Post-Test Right Front Passenger Compartment View	A-11



Front ¾ View of Vehicle, As Received



Vehicle Certification Placard



Pre-Test Vehicle Left Side View



Post-Test Vehicle Left Side View



Pre-Test SID-11s Dummy Left Side View



Post-Test SID-11s Dummy Left Side View



Pre-Test SID-IIs Dummy Left Side Closeup View



Post-Test SID-IIs Dummy Left Side Closeup View



Pre-Test SID-IIs Dummy Left $\frac{3}{4}$ Front View



Post-Test SID-IIs Dummy Left $\frac{3}{4}$ Front View



Pre-Test SID-11s Dummy Left $\frac{3}{4}$ Front Closeup View



Post-Test SID-11s Dummy Left $\frac{3}{4}$ Front Closeup View



Pre-Test SID-IIs Dummy Front View



Post-Test SID-IIs Dummy Front View



Pre-Test SID-IIs Dummy Front Closeup View



Post-Test SID-IIs Dummy Front Closeup View



Pre-Test SID-IIs Dummy Right $\frac{3}{4}$ Front View



Post-Test SID-IIs Dummy Right $\frac{3}{4}$ Front View



Post-Test SID-II's Dummy Right Side Closeup View

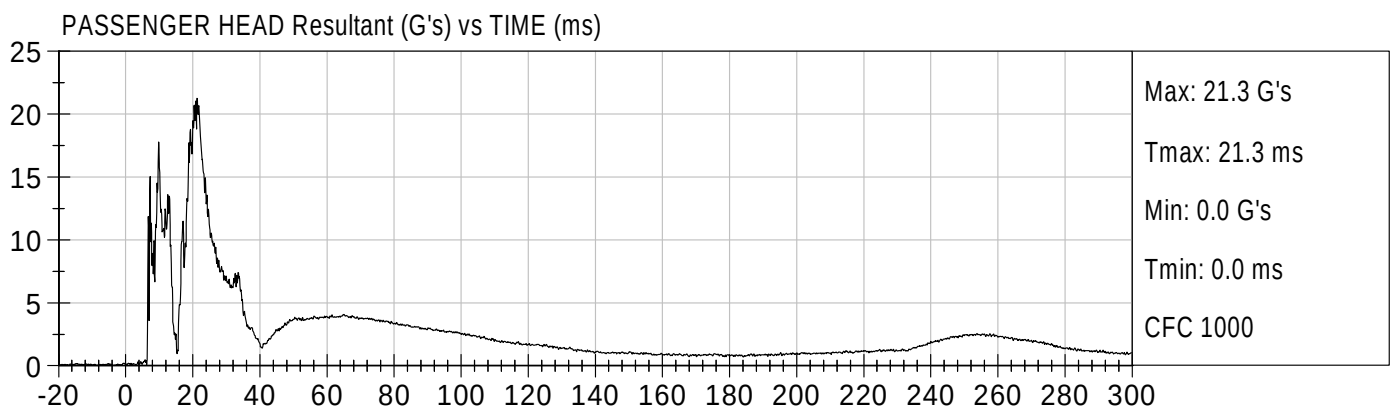
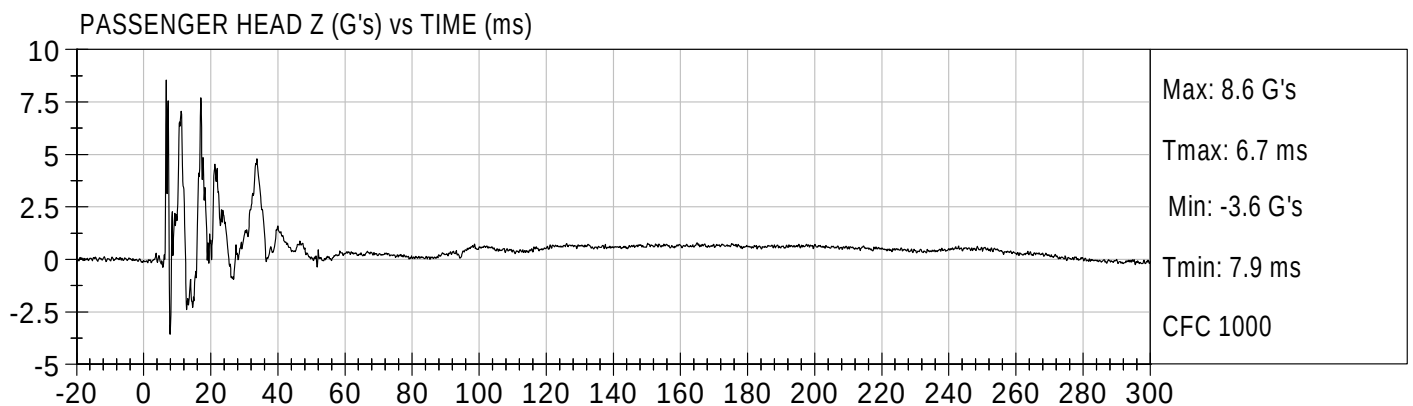
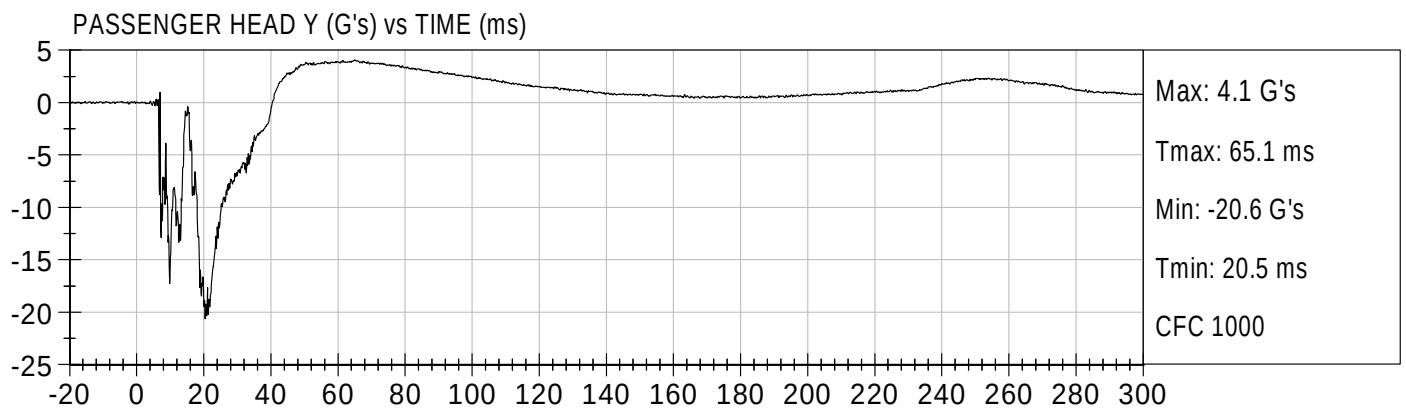
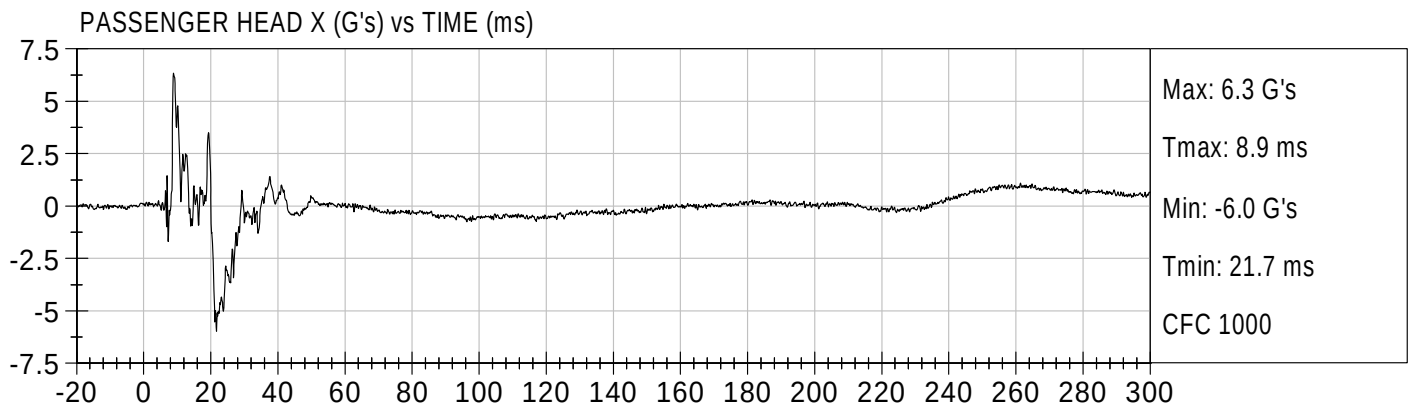


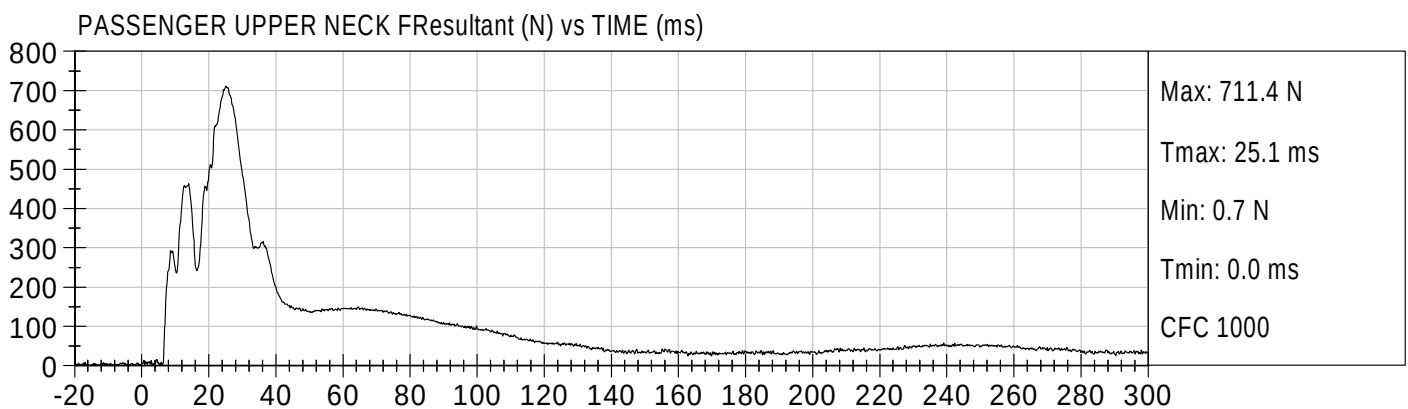
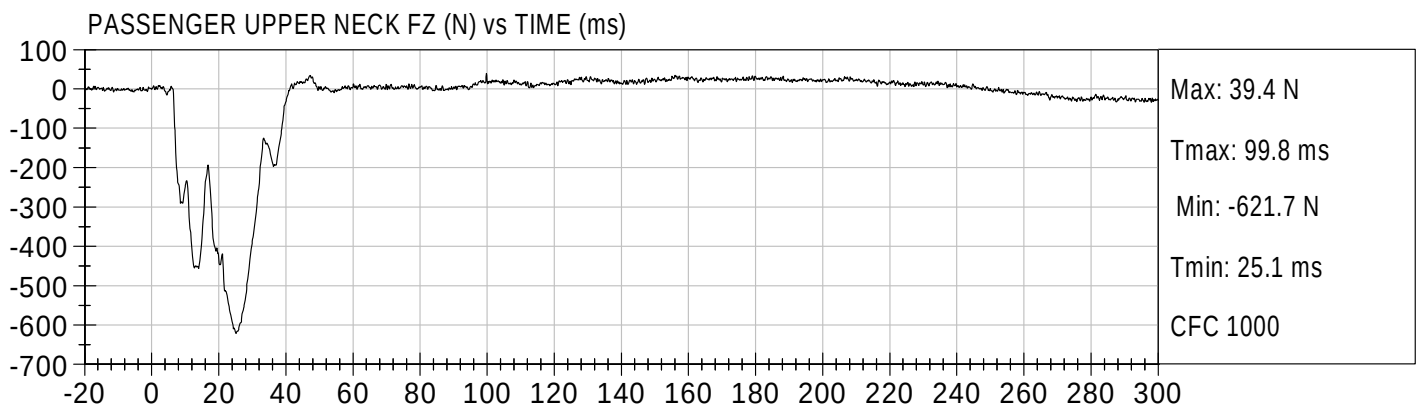
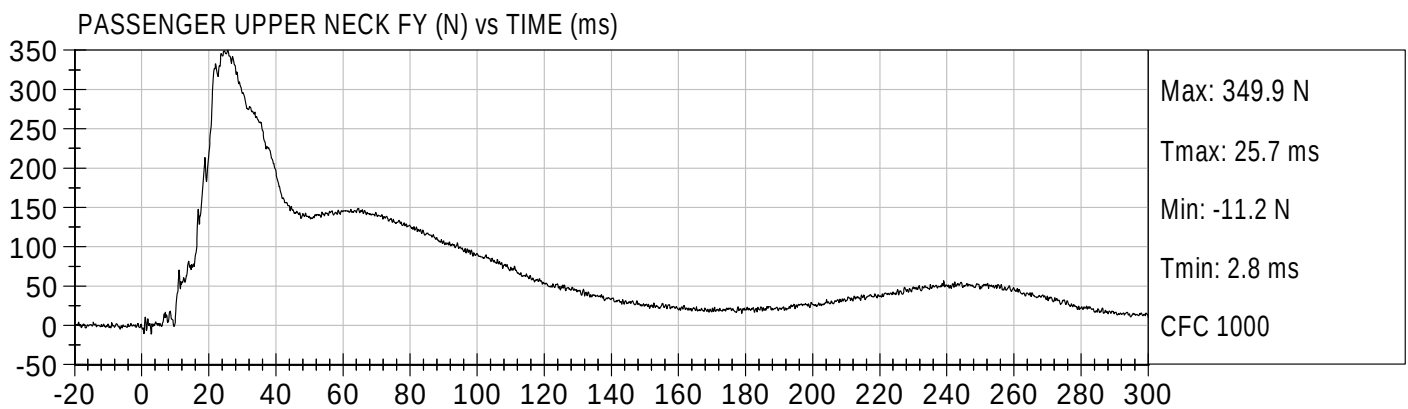
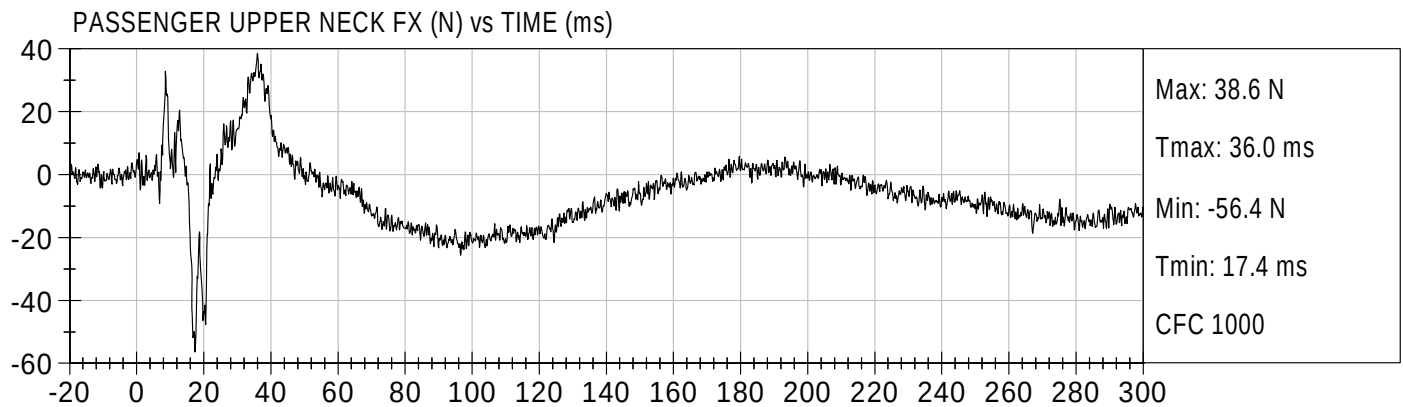
Post-Test Right Front Passenger Compartment View

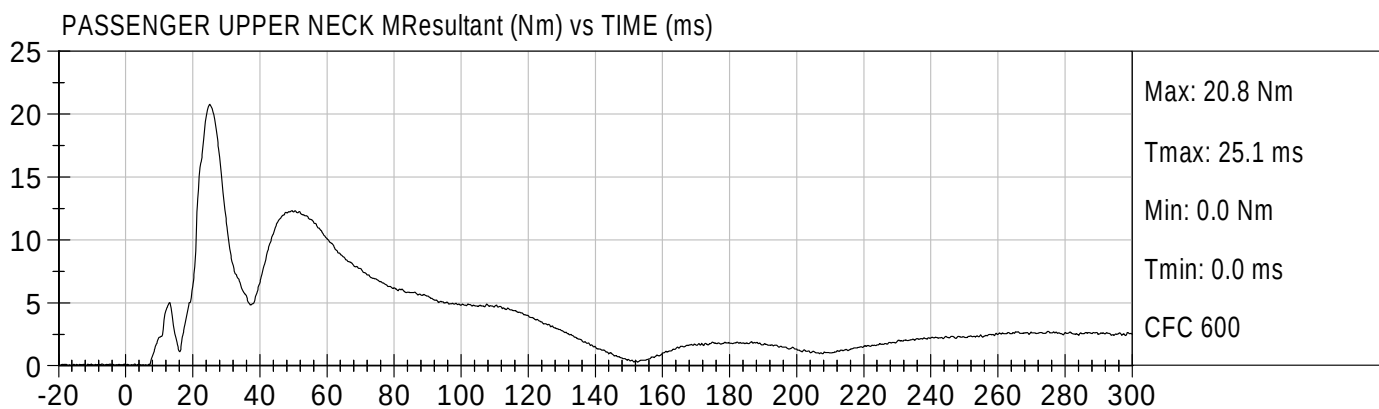
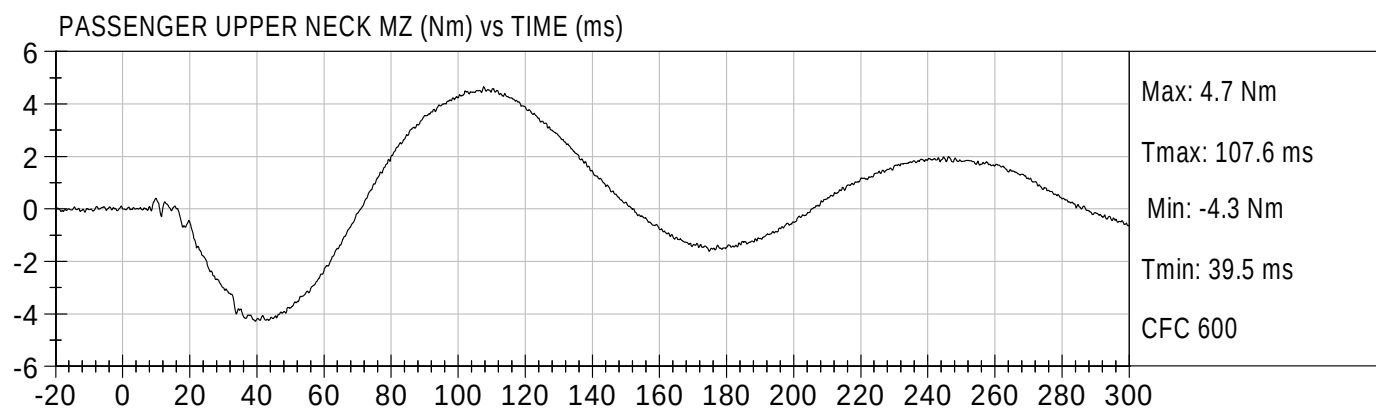
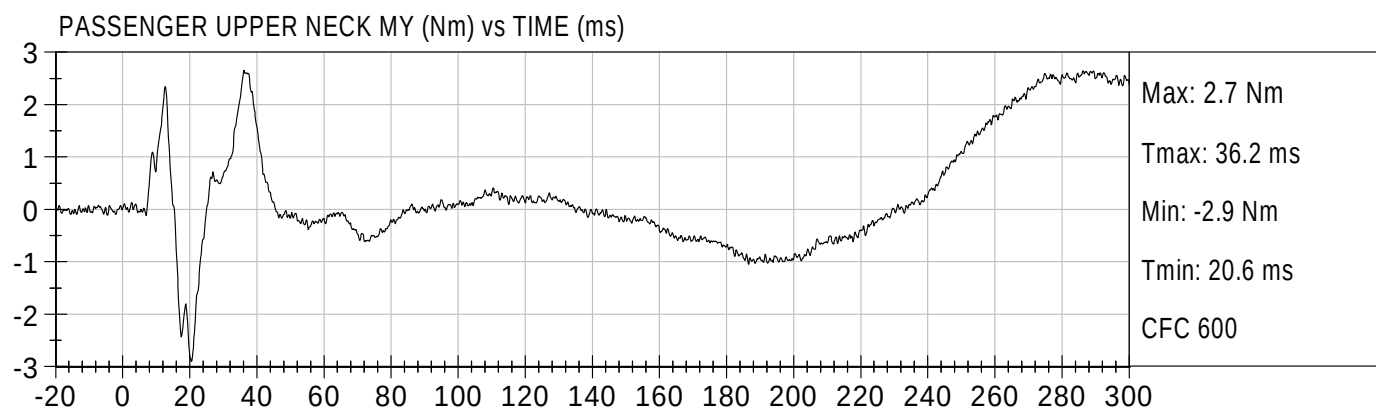
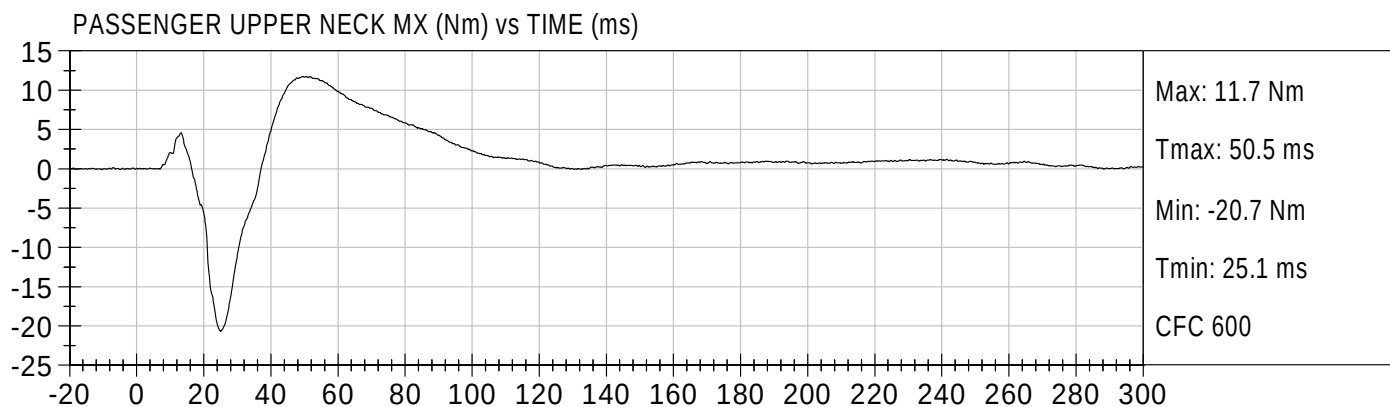
APPENDIX B
DUMMY RESPONSE DATA TRACES

TABLE OF DATA PLOTS

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

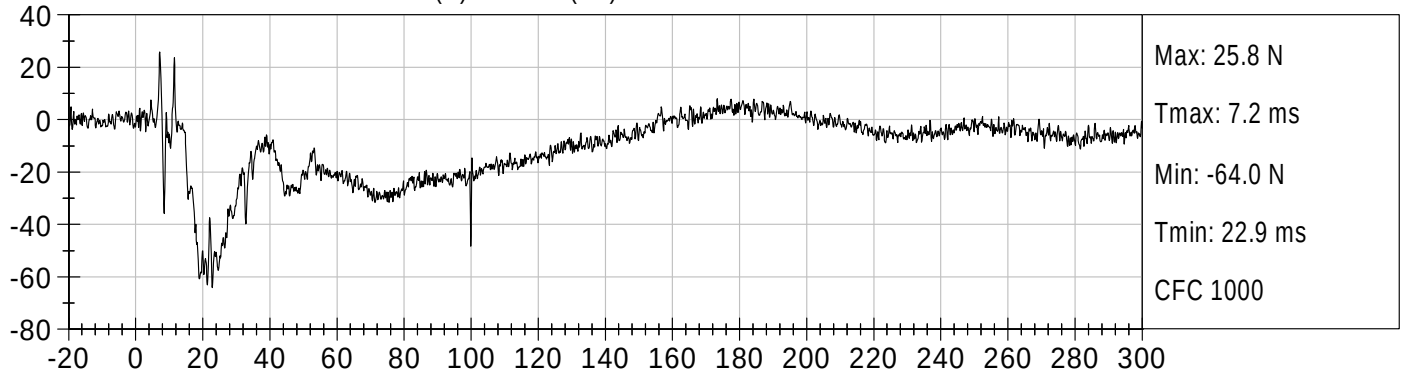




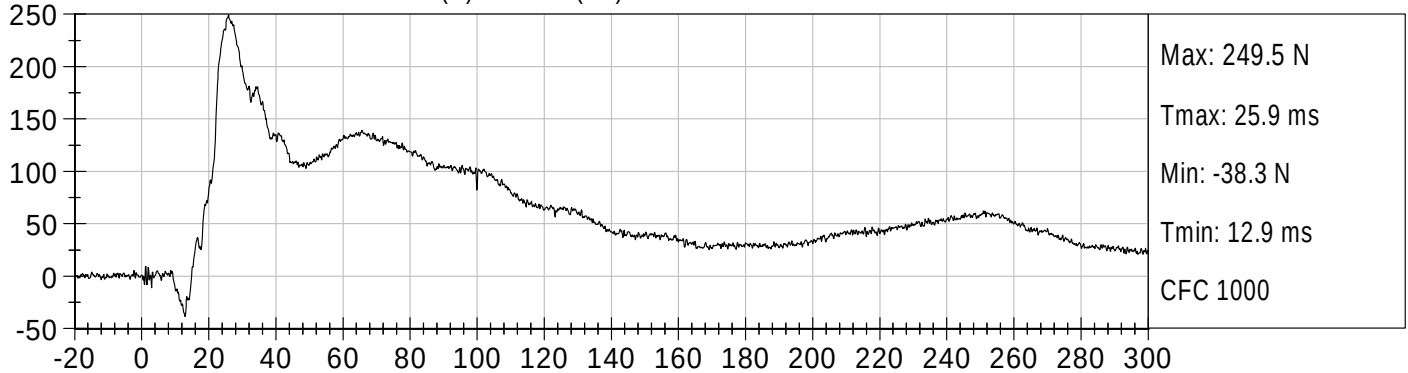




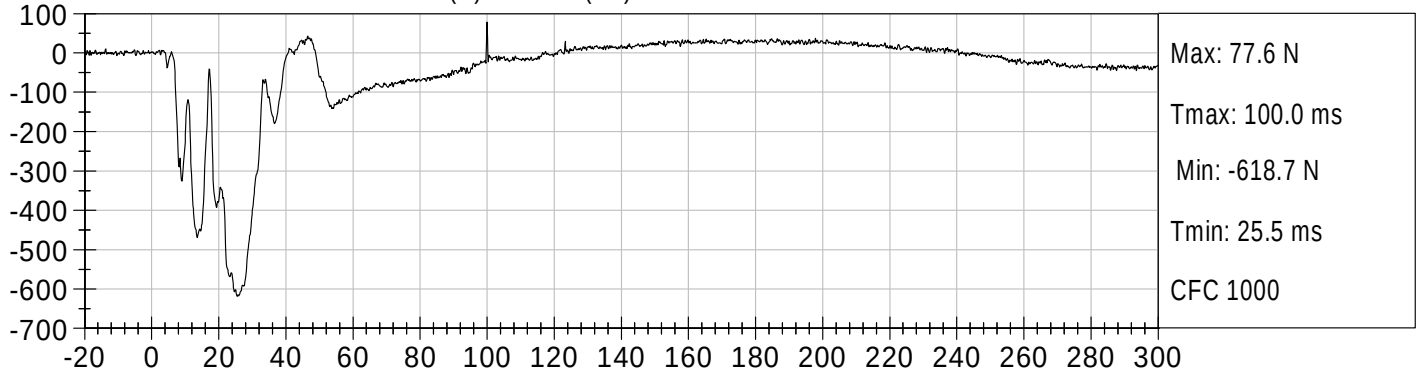
PASSENGER LOWER NECK FX (N) vs TIME (ms)



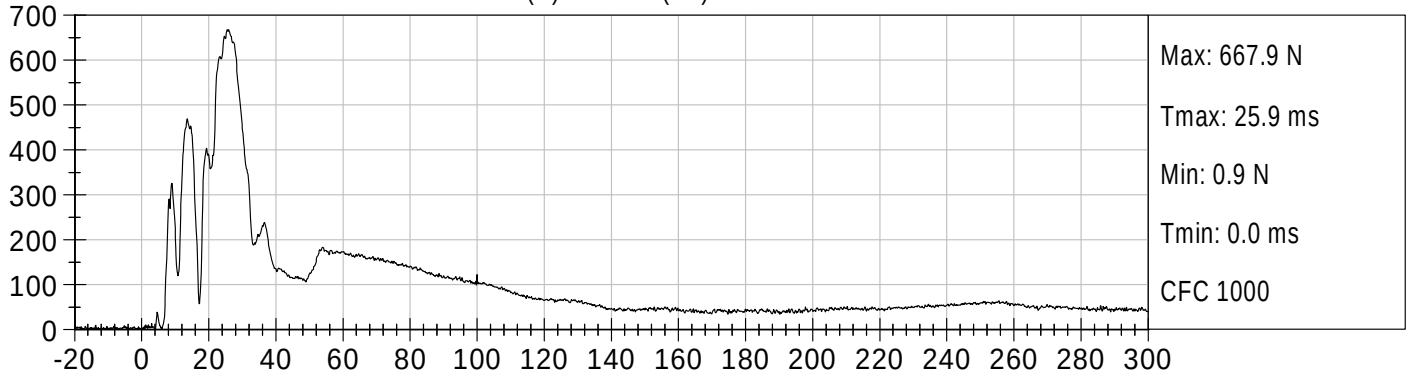
PASSENGER LOWER NECK FY (N) vs TIME (ms)



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

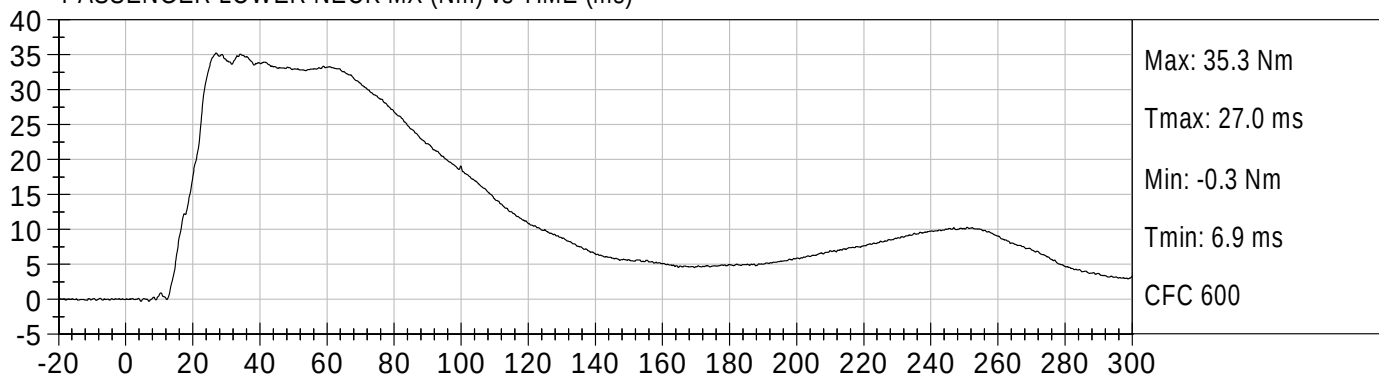


PASSENGER LOWER NECK FResultant (N) vs TIME (ms)

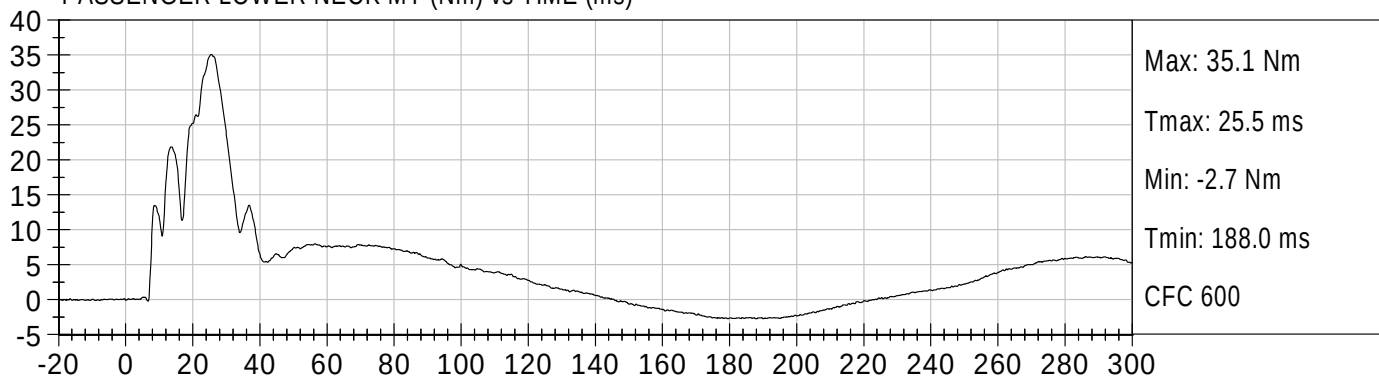




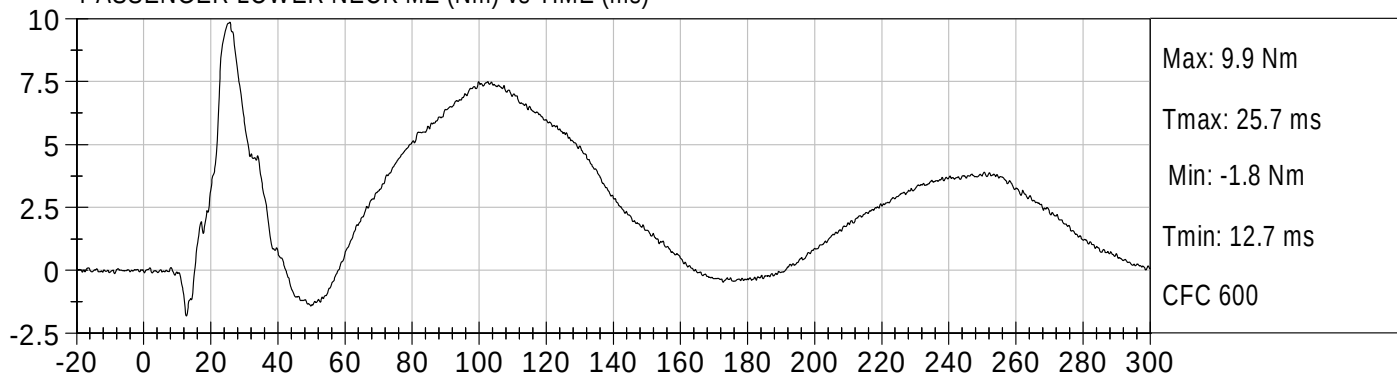
PASSENGER LOWER NECK MX (Nm) vs TIME (ms)



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



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



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

