REPORT NUMBER TR-P27082-02-NC

SIDE AIRBAG OCCUPANT RISK PROGRAM
OCCUPANT OUT-OF-POSITION TESTS

HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC
2007 HYUNDAI SANTA FE SE
5-DOOR MPV

NHTSA NUMBER: M70500TWG2

PREPARED BY:
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APRIL 18, 2007

FINAL REPORT

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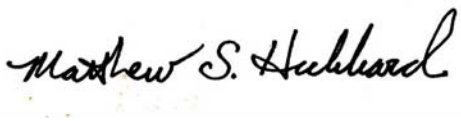

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Date of Acceptance

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15. Supplementary Notes

16. Abstract

A static side airbag deployment was conducted on a 2007 Hyundai Santa FE SE 5-Door MPV at KARCO Engineering, LLC on 4/18/2007. This test was conducted to obtain data indicant of TWG Side Airbag Out-of-Position Injury criteria.

Measurement Description	Units	Threshold	Hybrid III 6 Year Old ATD	
Head Injury Criteria (HIC_{15})		700	34.0	

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TABLE OF CONTENTS

LIST OF PHOTOGRAPHS

LIST OF DATA PLOTS

SECTION 1

PURPOSE AND SUMMARY OF TEST M70500TWG2

1.1 PURPOSE

This occupant out-of-position static side airbag deployment test is part of the Technical Working Group Occupant Injury Risk from Deploying Side Airbags Testing Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-03-D-32005. The purpose of this test was to obtain occupant injury data for a side airbag deployment.

The occupant out-of-position side airbag test was conducted in accordance with the Technical Working Group Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags.

1.2 SUMMARY

The effects of a seat mounted torso airbag and a roof mounted curtain airbag deployment in a 2007 Hyundai Santa FE SE 5-Door MPV with an out-of-position Hybrid III 6 Year-Old Child dummy were evaluated. The test was performed at Karco Engineering, LLC on April 18, 2007. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Two high-speed digital cameras were used to document the torso and curtain airbag deployment. Camera locations and other pertinent camera information can be found on Data Sheet No.1 and Data Sheet No.6.

One Part 572N, Hybrid III 6-Year old child anthropomorphic test device (ATD) was placed in the right front passenger seating position facing forward according to the dummy placement instructions (3.3.3.5) in the July 2003 Revision of the Technical Working Group's 'Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags'.

The Hybrid III 6-Year old ATD was instrumented with head tri-axial accelerometers, and upper neck transducers.

Nine (9) 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 front passenger side door remained closed during the deployment and was operable after the deployment.

The Hybrid III 6-Year-Old Child Dummy's visible contact points were as follows: The torso airbag contacted the ATD’s back. The curtain airbag contacted the ATD’s head.

OUT OF POSITION OCCUPANT DATA SUMMARY

ATD Position	HIC_{15}
Passenger	34.0

Orientation of the Hybrid III 6 Year-old Child Dummy was in the inboard facing position leaning against the front passenger door. The dummy's spine was aligned with the deploying trajectory of the torso airbag. The lower legs were extended. Synthetic foam was used to raise the dummy. This orientation complies with section 3.3.3.5 of the Technical Working Group (TWG) recommendation in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags.

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SECTION 2

OCCUPANT AND VEHICLE INFORMATION/DATA SHEETS

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2
Test Program: TWG 3.3.3.5. Test Date: 04/18/07

CONVERSION FACTORS USED IN THIS REPORT*

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	mile/h	km/h	1.609
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.573
Pressure	Tire Pressures	lbf/in^2	kPa	7.0
Volume	Liquid	gal	liter	3.785
Temperature	General Use	^oF	^oC	=(tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf/ft	Nm	1.355

* Based on the Recommended Practice in SAE J916, May 85

DATA SHEET NO. 1

TEST SUMMARY

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5. Test Date: 04/18/07

TEST DUMMY INFORMATION

Description	Passenger Seat Forward Facing
Dummy Type / Serial No.	Hybrid III 6 year old / 144
Head Contact	Yes
Chest Contact	None
Abdomen Contact	None
Pelvis	Yes
Left Knee Contact	None
Right Knee Contact	None

MOVIE COVERAGE

High Speed Digital	2
Total	2

DATA CHANNELS

Child ATD Sensors	9
Belt Assessment Sensors	0
Vehicle Structure Accelerometers	0
Total	9

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5. Test Date: 04/18/07

TEST VEHICLE INFORMATION

Make	Hyundai
Model	Santa FE SE
Body Style	5-Door MPV
NHTSA No.	M70500TWG2
VIN	5NMSH13E97H007943
Color	Burgundy
Delivery Date	August 21, 2006
Odometer Reading (mile)	76
Dealer	Glendora Hyundai
Transmission	Automatic
Final Drive	Front
Type/Number Cylinders	V6
Engine Displacement (L)	3.3
Engine Placement	Transverse

TEST VEHICLE OPTIONS

Driver Front Airbag	Yes
Driver Side Airbag	Yes
Driver Side Curtain Airbag	Yes
Pass. Front Airbag	Yes
Pass.Side Airbag	Yes
Pass. Curtain Airbag	Yes
Power Brakes	Yes
Power Steering	Yes
Disc Brakes, Front	Yes
Disc Brakes, Rear	Yes
Anti-lock Brakes	Yes
Tilt Steering Wheel	Yes
Power Windows	Yes
Power Seats	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Manufacturing Alabama, LLC
Date of Manufacture	Jun. 06

GVWR (kg)	2320
GAWR Front (kg)	1350
GAWR Rear (kg)	1450

DATA FROM TIRE PLACARD

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	275	275
Cold Pressure (kPa)	210	210
Recommend Tire Size	P235/60R18	P235/60R18
Tire Size on Vehicle	P235/60R18	P235/60R18
Tire Manufacturer	Bridgestone	Bridgestone

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Wt. (VCW) (kg)				420

* Vehicle had undergone New Car Assessment Program Frontal Impact Testing on August 29, 2006

DATA SHEET NO. 3

TEST VEHICLE INFORMATION

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

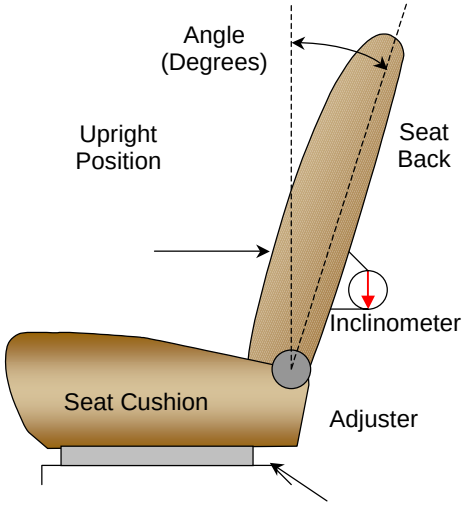
Test Program: TWG 3.3.3.5. Test Date: 04/18/07

NOMINAL DESIGN RIDING POSITION

The passenger seat back is positioned to section 3.3.3.5. of the Technical Working Group (TWG) recommendation in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags.

SEAT BACK ANGLES

Position	Deg.
Passenger w/ Dummy	25



FRONT SEAT ASSEMBLY

SEAT FORE/AFT POSITIONS

The first or forward most position is counted as number one (1). The fore/aft position is set aft of the middle position for the passenger seat.

SEAT FORE/AFT POSITIONING

	Total Fore/Aft Travel	Placed in Position #
Passenger Seat	25	13

DATA SHEET NO. 4

DUMMY POSITIONING INFORMATION

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5. Test Date: 04/18/07

TEST DUMMY POSITION MEASUREMENTS

Code	Measurement Description	Hybrid III 6-Year-Old Child Dummy	
		Length (mm)	Angle (^{o})
SA	Seat Back Angle		25
AMW	Side Airbag Module Width (Torso / Curtain)	50 / 45	
ABW	Side Airbag Width (Torso / Curtain)	400 / 410	
AML	Side Airbag Module Length (Torso / Curtain)	165 / 1860	
ABL	Side Airbag Length (Torso / Curtain)	340 / 1760	
AN	Top of Airbag Module to Head/Neck Junction (Curtain)	72	
HD	Head CG to Door Panel/ Window	82	
HSC	Head to Seat Back Centerline	175	
HB	Head to B-Pillar (first contact)	8	
HZ	Head to Roof (Z)	225	
HHD	Head to Header	424	
ND	Nose to Dash	610	
NS	Nose to Seat Back	243	
NR	Nose to Header	498	
CD	Chest to Dash	546	
CS	Chest to Seat Back	192	
RACL	Right Arm to Seat Back Centerline	335	
LACL	Left Arm to Seat Back Centerline	88	
RA	Right Arm to Door Panel	0	
LA	Left Arm to Door Panel	265	
KK	Knee to Knee	125	
TT	Toe to Toe	140	
KSCR	Right Knee to Seat Cushion Centerline	115	
KSCL	Left Knee to Seat Cushion Centerline	-10	
TSCR	Right Toe to Seat Cushion Centerline	-85	
TSCL	Left Toe to Seat Cushion Centerline	-133	

DATA SHEET NO. 5
HYBRID III ATD INJURY CRITERIA AND SENSOR DATA

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5 Test Date: 4/18/07

HEAD PEAK ACCELERATIONS

Location	Axis	Units	Pass. (6 Yr.)			
			Max	Time	Min	Time
Head CG	X	G's	28.2	7.0	-12.9	342.0
Head CG	Y	G's	6.2	769.8	-12.2	8.9
Head CG	Z	G's	14.2	15.7	-20.3	8.0
Head CG Resultant	N/A	G's	33.3	7.4		

UPPER NECK PEAK FORCES AND MOMENTS

Location	Axis	Units	Pass. (6 Yr.)			
			Max	Time	Min	Time
Neck Force	X	Newtons	698.6	10.4	-80.9	142.9
Neck Force	Y	Newtons	301.4	343.4	-168.8	15.3
Neck Force	Z	Newtons	766.0	16.2	-1198.5	347.1
Neck Force Resultant	N/A	Newtons	1242.2	347.1		
Neck Moment	X	Nm	8.5	9.6	-36.8	351.0
Neck Moment	Y	Nm	51.1	9.1	-23.5	26.8
Neck Moment	Z	Nm	3.4	869.2	-15.4	34.2
Neck Moment Resultant	N/A	Nm	51.6	9.1		

DATA SHEET NO. 5…(CONTINUED)

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5 Test Date: 4/18/07

HEAD INJURY CRITERIA (HIC 15)

Location	Pass. (6 Yr.)			
	HIC15	T^1	T^2	Avg G
Head CG	34.0	5.9	20.9	21.9

UPPER NECK NIJ VALUES

Location	Pass. (6 Yr.)			
	Ntf	Nte	Ncf	Nce
Upper Neck	0.39	0.77	0.73	0.66

DATA SHEET NO. 6

CAMERA LOCATIONS

Test Vehicle: 2007 Hyundai Santa FE SE 5-Door MPV NHTSA No.: M70500TWG2

Test Program: TWG 3.3.3.5. Test Date: 04/18/07

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No.	Camera View	Location (mm)			Angle (Deg.)	Lens (mm)	Speed (fps)
		X	Y	Z			
1	High Speed Digital Side View	-340	-3200	-170	2.0	50	1000
2	High Speed Digital Front View	-1975	-160	260	-9.0	50	1000

* Cameras aligned to the CG of dummy's head as reference.

APPENDIX A

PHOTOGRAPHS

Figure A-1: Right Front ¾ View, As Received

Figure A-2: Vehicle Certification Label

Figure A-3: Post-Test Right Front ¾ View of Frontal NCAP Test

Figure A-4: Post-Test Right Side View of Frontal NCAP Test

Figure A-5: Pre-Test Dummy Position, Left Side View

Figure A-6: Pre-Test Dummy Position, ¾ View

Figure A-7: Pre-Test Dummy Position, Front View

Figure A-8: Post-Test Dummy Position and Airbags, Left Side View

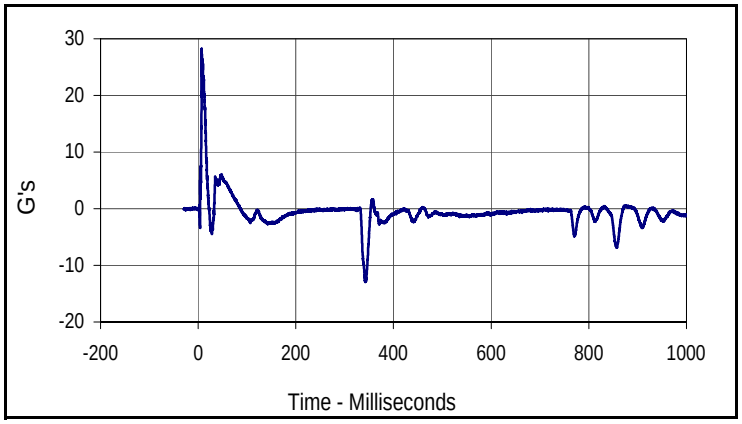
Figure A-9: Post-Test Airbags, Left Side View

Figure A-10: Post-Test Airbags, Close-up View

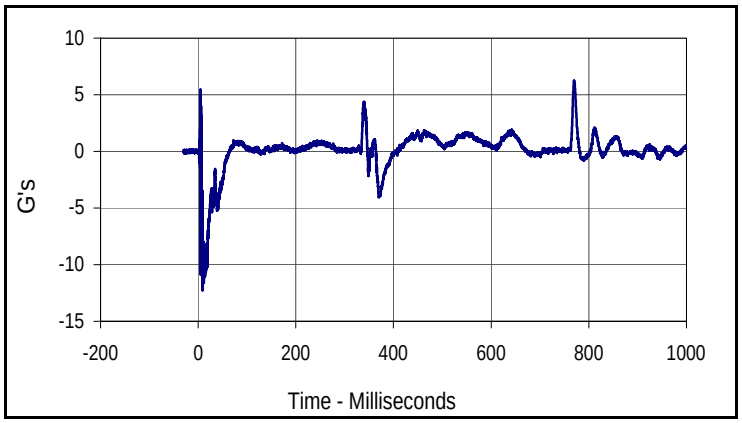
APPENDIX B

DATA PLOTS

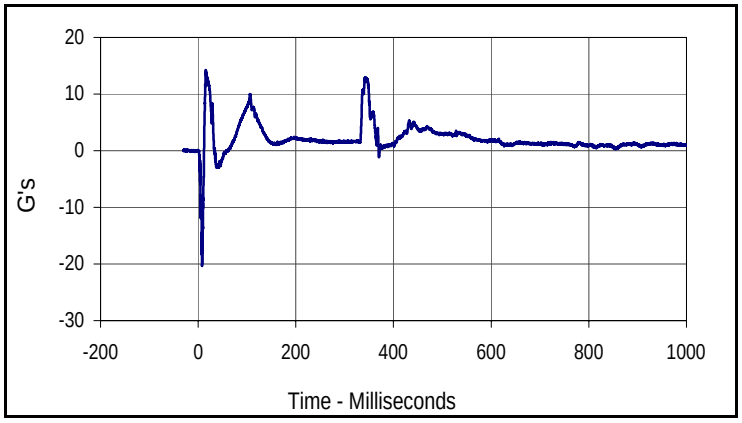
Test Vehicle:	2007 Hyundai Santa FE SE 5-Door MPV	Test Date:	4/18/07
Test Program:	TWG 3.3.3.5	NHTSA No.:	M70500TWG2



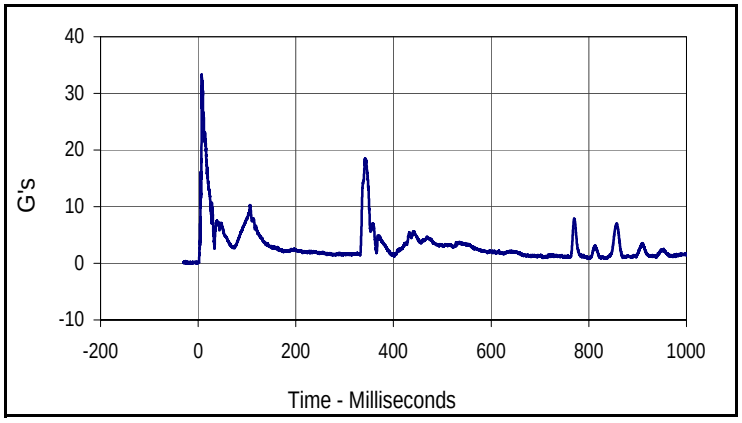
Curve Description			
Pass. (6 Yr.) Head X			
CURNO	Type	SAE Class	Units
001	FIL	1000	G's
Max	Time	Min	Time
28.2	7.0	-12.9	342.0



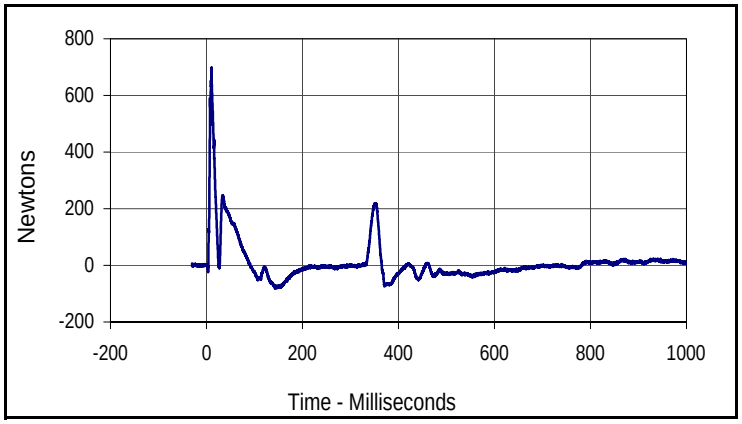
Curve Description			
Pass. (6 Yr.) Head Y			
CURNO	Type	SAE Class	Units
002	FIL	1000	G's
Max	Time	Min	Time
6.2	769.8	-12.2	8.9



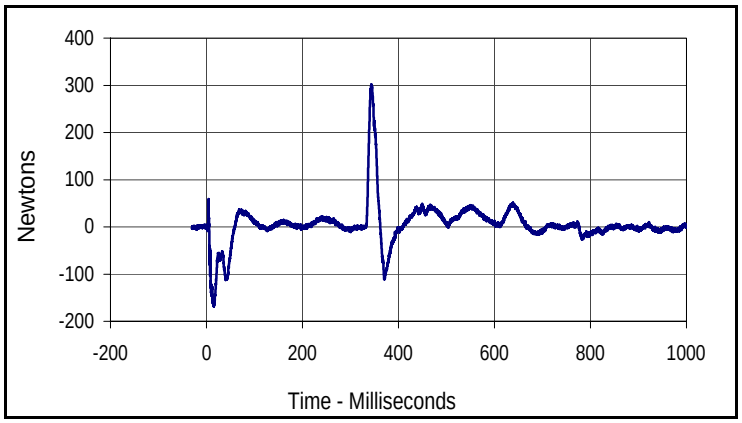
Curve Description			
Pass. (6 Yr.) Head Z			
CURNO	Type	SAE Class	Units
003	FIL	1000	G's
Max	Time	Min	Time
14.2	15.7	-20.3	8.0



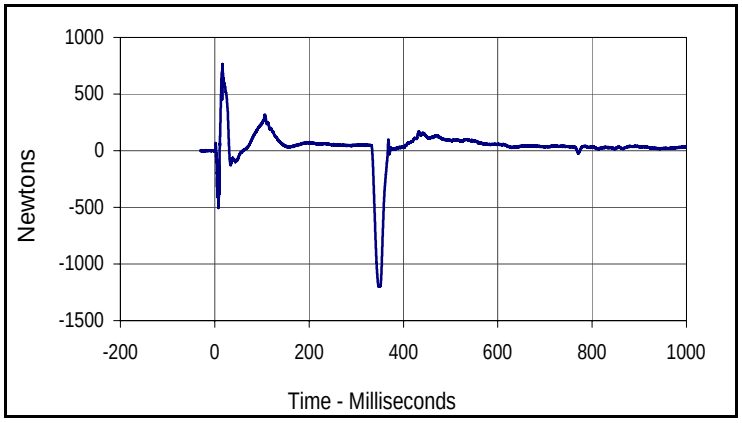
Curve Description			
Pass. (6 Yr.) Head Resultant			
CURNO	Type	SAE Class	Units
001	RES	1000	G's
Max	Time	Min	Time
33.3	7.4	0.1	0.9



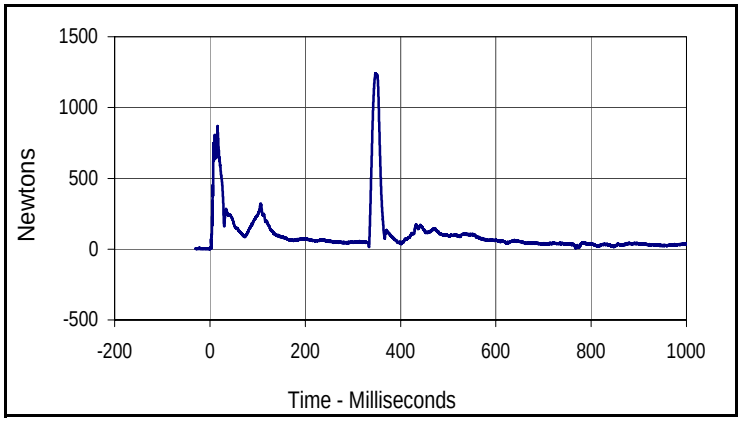
Curve Description			
Pass. (6 Yr.) Upper Neck Force X			
CURNO	Type	SAE Class	Units
001	FIL	1000	Newtons
Max	Time	Min	Time
698.6	10.4	-80.9	142.9



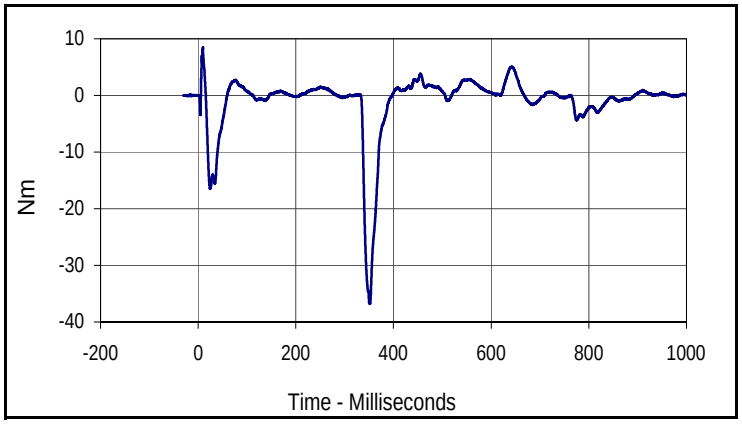
Curve Description			
Pass. (6 Yr.) Upper Neck Force Y			
CURNO	Type	SAE Class	Units
002	FIL	1000	Newtons
Max	Time	Min	Time
301.4	343.4	-168.8	15.3



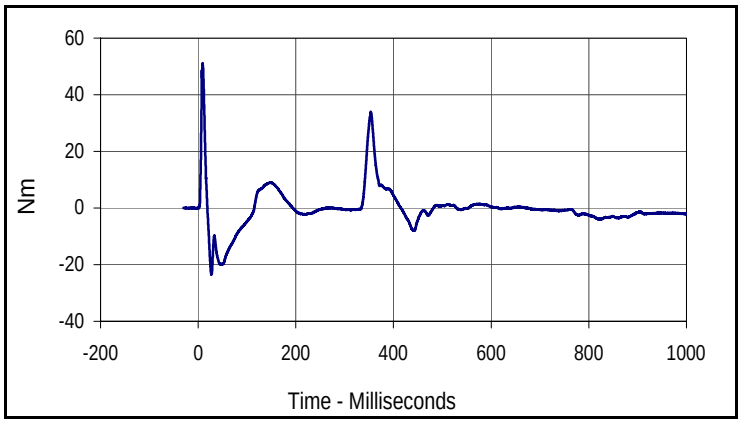
Curve Description			
Pass. (6 Yr.) Upper Neck Force Z			
CURNO	Type	SAE Class	Units
003	FIL	1000	Newtons
Max	Time	Min	Time
766.0	16.2	-1198.5	347.1



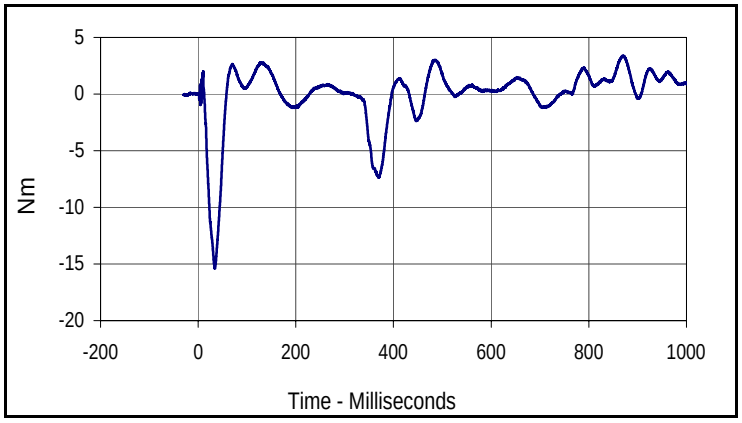
Curve Description			
Pass. (6 Yr.) Upper Neck Force Resultant			
CURNO	Type	SAE Class	Units
001	RES	1000	Newtons
Max	Time	Min	Time
1242.2	347.1	1.7	1.4



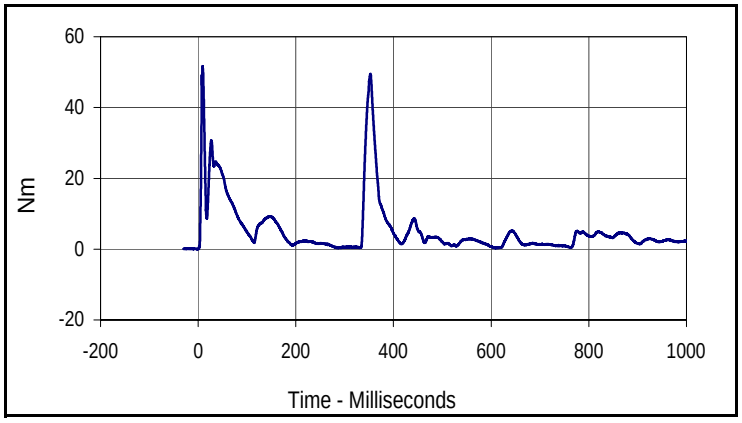
Curve Description			
Pass. (6 Yr.) Upper Neck Moment X			
CURNO	Type	SAE Class	Units
004	FIL	600	Nm
Max	Time	Min	Time
8.5	9.6	-36.8	351.0



Curve Description			
Pass. (6 Yr.) Upper Neck Moment Y			
CURNO	Type	SAE Class	Units
005	FIL	600	Nm
Max	Time	Min	Time
51.1	9.1	-23.5	26.8



Curve Description			
Pass. (6 Yr.) Upper Neck Moment Z			
CURNO	Type	SAE Class	Units
006	FIL	600	Nm
Max	Time	Min	Time
3.4	869.2	-15.4	34.2



Curve Description			
Pass. (6 Yr.) Upper Neck Moment Resultant			
CURNO	Type	SAE Class	Units
004	RES	600	Nm
Max	Time	Min	Time
51.6	9.1	0.0	1.1

APPENDIX C

INSTRUMENTATION DATA CHANNEL ASSIGNMENTS

TWG 3.3.3.5

Instrumentation Data Channel Assignments

A.T.D. Serial Number 144

4/18/07

2007 Hyundai Santa FE SE 5-Door MPV

CH.	LOCATION	AXIS	IDENT. NO.	DESCRIPTION	MFR	MODEL	UNITS
1	HEAD	X	J32884	Accel.,full bridge	ENDEVCO	7264-2000	G
2	HEAD	Y	J19925	Accel.,full bridge	ENDEVCO	7264-2000	G
3	HEAD	Z	J35560	Accel.,full bridge	ENDEVCO	7264-2000	G
4	UPPER NECK FORCE	X	810 FX	Load cell, six axis neck	R. A. Denton	IF-234	N
5	UPPER NECK FORCE	Y	810 FY	Load cell, six axis neck	R. A. Denton	IF-234	N
6	UPPER NECK FORCE	Z	810 FZ	Load cell, six axis neck	R. A. Denton	IF-234	N
7	UPPER NECK MOMENT	X	810 MX	Load cell, six axis neck	R. A. Denton	IF-234	Nm
8	UPPER NECK MOMENT	Y	810 MY	Load cell, six axis neck	R. A. Denton	IF-234	Nm
9	UPPER NECK MOMENT	Z	810 MZ	Load cell, six axis neck	R. A. Denton	IF-234	Nm