

REPORT NUMBER TR-P26002-06-NC

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

**HYUNDAI MOTOR COMPANY
2005 HYUNDAI TUCSON
5-DOOR MPV**

NHTSA NUMBER: M50508TWG2

**PREPARED BY:
KARCO ENGINEERING, LLC
9270 HOLLY ROAD
ADELANTO, CALIFORNIA 92301**



JULY 5, 2006

FINAL REPORT

**PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
RULEMAKING
OFFICE OF CRASHWORTHINESS STANDARDS
MAIL CODE: NVS-111
400 SEVENTH STREET, SW, ROOM 5311
WASHINGTON, D.C. 20590**

This final test report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, in response to Contract Number DTNH22-01-D-02005.

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Prepared by: _____
Mr. Matthew S. Hubbard, Test Engineer
KARCO Engineering, LLC

Date: _____

Reviewed by: _____
Mr. Matthew A. Ivory, Engineering Manager
KARCO Engineering, LLC

Date: _____

Approved by: _____
Mr. Frank D. Richardson, President
KARCO Engineering, LLC

Date: _____

FINAL REPORT ACCEPTED BY:

Manager, New Car Assessment Program

Date of Acceptance

COTR, NCAP Frontal Impact Program

Date of Acceptance

Technical Report Documentation Page

1. Report No. TR-P26002-06-NC	2. Government Accession No.	3. Recipients Catalog No.	
4. Title and Subtitle Final Report of New Car Assessment Program Technical Working Group Side Airbag Risk Program 2005 Hyundai Tucson 5-Door MPV NHTSA No. M50508TWG2		5. Report Date July 5, 2006	
		6. Performing Organization Code KAR	
7. Authors Mr. Matthew S. Hubbard, Test Engineer, Karco Mr. Matthew A. Ivory, Engineering Manager, Karco		8. Performing Organization Report No. TR-P26002-05-NC	
9. Performing Organization Name and Address KARCO Engineering, LLC 9270 Holly Road Adelanto, CA 92301		10. Work Unit No.	
		11. Contract or Grant No. DTNH22-01-D-02005	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Rulemaking Office of Crashworthiness Standards Mail Code: NVS-111 400 Seventh Street, SW, Room 5311 Washington, D.C 20590		13. Type of Report and Period Covered Final Test Report Option Year 3	
		14. Sponsoring Agency Code DOT/NHTSA/NRMWCS/NVS-111	
15. Supplementary Notes			
16. Abstract A static side airbag deployment was conducted on a 2005 Hyundai Tucson 5-Door MPV at KARCO Engineering, LLC on 7/5/2006. 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	14.9
17. Key Words TWG Occupant Out-of-Position Test Section 3.3.5.1 New Car Assessment Program (NCAP) 2005 Hyundai Tucson 5-Door MPV NHTSA NO. M50508TWG2		18. Distribution Statement Copies of this report available from: NHTSA Technical Reference Division National Highway Traffic Safety Admin. 400 Seventh St., SW, Room 5111 Washington, D.C. 20590	
19. Security Classification (this report) Unclassified	20. Security Classification (this page) Unclassified	21. No. Pages 34	22. Price

Form DOT F1700.7 (8-72)

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SECTION 1

PURPOSE AND SUMMARY OF TEST M50508TWG2

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. DTNH22-01-D-02005. 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 and roof rail mounted airbag deployment in a 2005 Hyundai Tucson 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 July 5, 2006. Pre- and post-test photographs of the vehicle and dummy can be found in Appendix A.

Two high-speed digital and one real time camera were used to document the curtain and torso 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 inboard according to the dummy placement instructions (3.3.5.1) 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 and lower neck transducers.

Fifteen (15) 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 curtain airbag contacted the top of the ATD's head. The torso airbag contacted the left arm and left side of the chest and abdomen.

OUT OF POSITION OCCUPANT DATA SUMMARY

ATD Position	HIC ₁₅	Clip (g)	Chest Disp (mm)
Passenger	14.9	N/A	N/A

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 curtain and torso airbag. The lower legs were extended. Synthetic foam was used to raise the dummy. This orientation complies with section 3.3.5.1 of the Technical Working Group (TWG) recommendation in the Recommended Procedures for Evaluating Occupant Injury Risk from Deploying Side Airbags.

SECTION 2

OCCUPANT AND VEHICLE INFORMATION/DATA SHEETS

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2
Test Program: TWG 3.3.5.1. Test Date: 7/5/06

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	°F	°C	$=(tf - 32)/1.8$
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: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2

Test Program: TWG 3.3.5.1. Test Date: 7/5/06

TEST DUMMY INFORMATION

Description	Passenger Seat Inboard Facing
Dummy Type / Serial No.	Hybrid III 6 year old / 088
Head Contact	Curtain Airbag
Chest Contact	Torso
Abdomen Contact	Torso
Pelvis	None
Left Knee Contact	None
Right Knee Contact	None

MOVIE COVERAGE

High Speed Digital	2
Real Time	1
Total	3

DATA CHANNELS

Child ATD Sensors	15
Belt Assessment Sensors	0
Vehicle Structure Accelerometers	0
Total	15

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2
 Test Program: TWG 3.3.5.1. Test Date: 7/5/06

TEST VEHICLE INFORMATION

Make	Hyundai
Model	Tucson
Body Style	5-Door MPV
NHTSA No.	M50508TWG2
VIN	KM8JM12B25U080720
Color	Light Brown
Delivery Date	Aug. 18, 2005
Odometer Reading (mile)	36
Dealer	Romero Hyundai
Transmission	5-Speed Manual
Final Drive	Front
Type/Number Cylinders	4
Engine Displacement (L)	2
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	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Company	GVWR (kg)	2010
Date of Manufacture	Nov. 05, 2004	GAWR Front (kg)	1150
		GAWR Rear (kg)	1100

DATA FROM TIRE PLACARD

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	308	308
Cold Pressure (kPa)	210	210
Recommend Tire Size	P215/65R16	P215/65R16
Tire Size on Vehicle	P215/65R16	P215/65R16
Tire Manufacturer	Hankook	Hankook

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench	None	
Number of Occupants	2	3	0	5
Capacity Wt. (VCW) (kg)				390

* Vehicle had undergone New Car Assessment Program Frontal Impact Testing on August 24, 2005

DATA SHEET NO. 3

TEST VEHICLE INFORMATION

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2
 Test Program: TWG 3.3.5.1. Test Date: 7/5/06

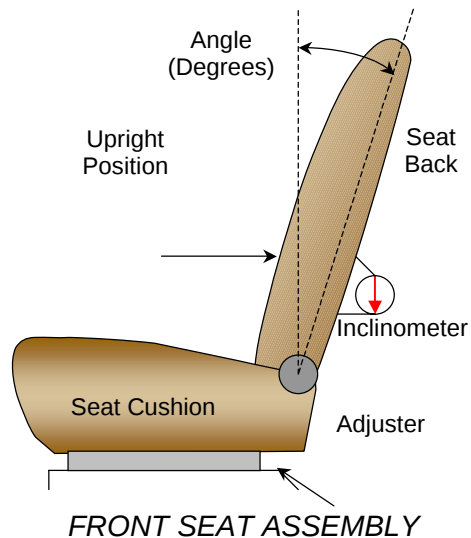
NOMINAL DESIGN RIDING POSITION

The passenger seat back is positioned to section 3.3.5.1. 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	8*

*Measurement was taken at head rest.



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: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2
 Test Program: TWG 3.3.5.1. Test Date: 7/5/06

TEST DUMMY POSITION MEASUREMENTS

Code	Measurement Description	Hybrid III 6-Year-Old Child Dummy	
		Length (mm)	Angle (°)
SA	Seat Back Angle		8
AMW	Side Airbag Module Diameter	N/A	
ABW	Side Airbag Width	1460	
AML	Side Airbag Module Length	N/A	
ABL	Side Airbag Length	N/A	
AN	Top of Airbag Module to Head/Neck Junction	280	
HD	Head CG to Door Panel/ Window	155	
HSC	Head to Seat Back Centerline	335	
HB	Head to B-Pillar	280	
HZ	Head to Roof (Z)	170	
HHD	Head to Header	325	
ND	Nose to Dash	515	
NS	Nose to Seat Back	334	
NR	Nose to Header	365	
CD	Chest to Dash	500	
CS	Chest to Seat Back	320	
RACL	Right Arm to Seat Back Centerline	490	
LACL	Left Arm to Seat Back Centerline	250	
RA	Right Arm to Door Panel	20	
LA	Left Arm to Door Panel	25	
KK	Knee to Knee	110	
TT	Toe to Toe	90	
KSCR	Right Knee to Seat Cushion Centerline	280	
KSCL	Left Knee to Seat Cushion Centerline	200	
TSCR	Right Toe to Seat Cushion Centerline	525	
TSCL	Left Toe to Seat Cushion Centerline	480	

DATA SHEET NO. 5 - HYBRID III ATD INJURY CRITERIA AND SENSOR DATATest Vehicle: 2005 Hyundai Tucson 5-Door MPVNHTSA No.: M50508TWG2Test Program: TWG 3.3.5.1Test Date: 7/5/06**HEAD PEAK ACCELERATIONS**

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Head CG	X	G's	24.7	144.6	-3.7	64.0
Head CG	Y	G's	6.4	10.8	-3.4	49.2
Head CG	Z	G's	5.1	24.1	-4.9	7.7
Head CG Resultant	N/A	G's	25.3	144.6		

UPPER NECK PEAK FORCES AND MOMENTS

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Neck Force	X	Newtons	124.3	133.9	-17.5	6.2
Neck Force	Y	Newtons	99.9	14.3	-13.6	225.7
Neck Force	Z	Newtons	28.7	5.5	-444.8	15.6
Neck Force Resultant	N/A	Newtons	462.1	15.6		
Neck Moment	X	Nm	11.8	36.0	-5.6	9.6
Neck Moment	Y	Nm	14.6	131.6	-2.9	224.1
Neck Moment	Z	Nm	4.6	23.7	-0.1	1.6
Neck Moment Resultant	N/A	Nm	15.3	131.6		

LOWER NECK PEAK FORCES AND MOMENTS

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Neck Force	X	Newtons	180.2	13.3	-179.3	138.3
Neck Force	Y	Newtons	167.3	12.7	-75.5	37.8
Neck Force	Z	Newtons	33.2	5.1	-372.5	15.3
Neck Force Resultant	N/A	Newtons	420.0	14.7		
Neck Moment	X	Nm	16.7	71.4	-2.1	232.0
Neck Moment	Y	Nm	6.9	110.9	-14.9	147.4
Neck Moment	Z	Nm	11.2	8.9	-1.8	49.9
Neck Moment Resultant	N/A	Nm	18.8	15.4		

DATA SHEET NO. 5...(CONTINUED)Test Vehicle: 2005 Hyundai Tucson 5-Door MPVNHTSA No.: M50508TWG2Test Program: TWG 3.3.5.1Test Date: 7/5/06**HEAD INJURY CRITERIA (HIC 36)**

Location	Passenger (P2)			
	HIC	T ¹	T ²	Avg G
Head CG	14.9	142.4	151.1	19.6

HEAD INJURY CRITERIA (HIC 15)

Location	Passenger (P2)			
	HIC	T ¹	T ²	Avg G
Head CG	14.9	142.4	151.1	19.6

UPPER NECK NIJ VALUES

Location	Passenger (P2)			
	Ntf	Nte	Ncf	Nce
Upper Neck	0.00	0.02	0.23	0.15

DATA SHEET NO. 6**CAMERA LOCATIONS**

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV NHTSA No.: M50508TWG2
TWG3

Test Program: TWG 3.3.5.1. Test Date: 7/5/06

No.	Camera View	Location (mm)			Angle (Deg.)	Lens (mm)	Speed (fps)
		X	Y	Z			
1	High Speed Digital Side View	0	-2800	180	0.0	35	1000
2	High Speed Digital Front View	700	170	15	-4.0	14	1000
3	Real Time	0	-2800	0	-7.0	N/A	30

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

APPENDIX A

PHOTOGRAPHS

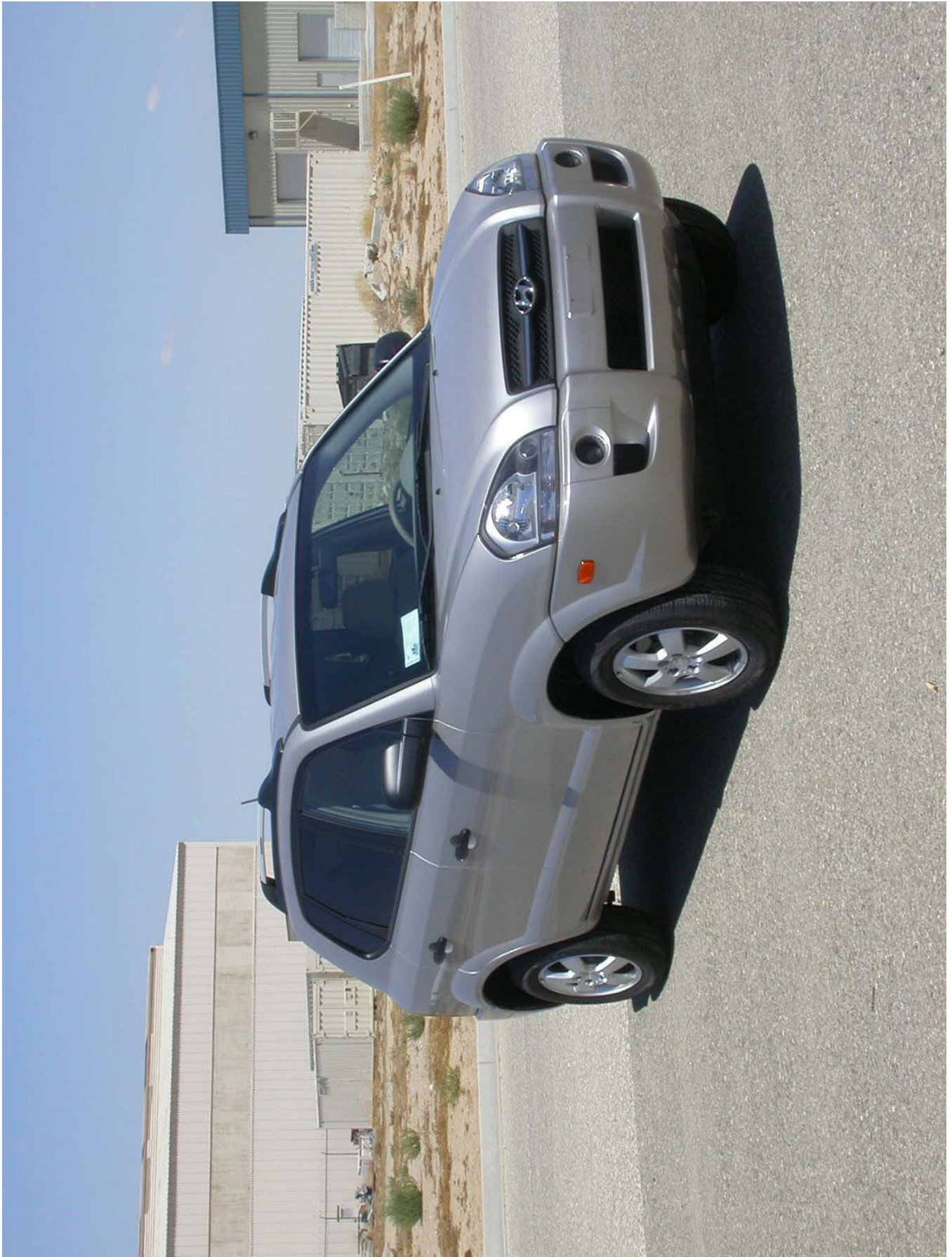


Figure A-1: Right Front $\frac{3}{4}$ View, As Received



MANUFACTURED IN KOREA BY

HYUNDAI MOTOR COMPANY

NOV/05/04

GVWR 4431 lbs

PAYNT YK

TRIM DD

GAWR

TIRES

RIMS

COLD TIRE INFL

FRONT 2535 lbs

P215/65R16

6.5JX16

30 psi

SINGLE

REAR 2425 lbs

P215/65R16

6.5JX16

30 psi

SINGLE

THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S.A. FEDERAL

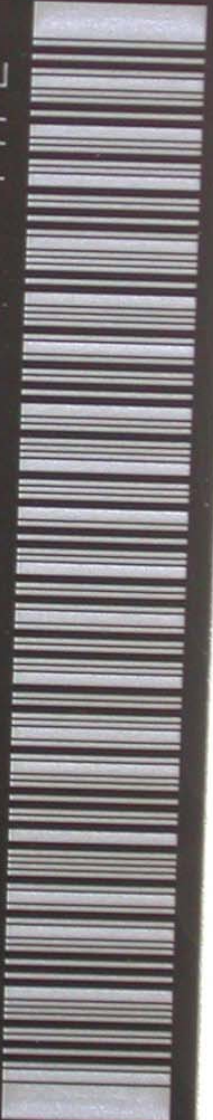
MOTOR VEHICLE SAFETY AND THEFT PREVENTION STANDARDS

IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

V.I.N

KM8JM12B25U080720

TYPE : MPV



J1



ORIGINAL TIRE
P215/65R16
P235/60R16
COMPACT SPARE
T155/90R16

Figure A-2: Vehicle Certification Label



Figure A-3: Post-Test Right Front $\frac{3}{4}$ 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

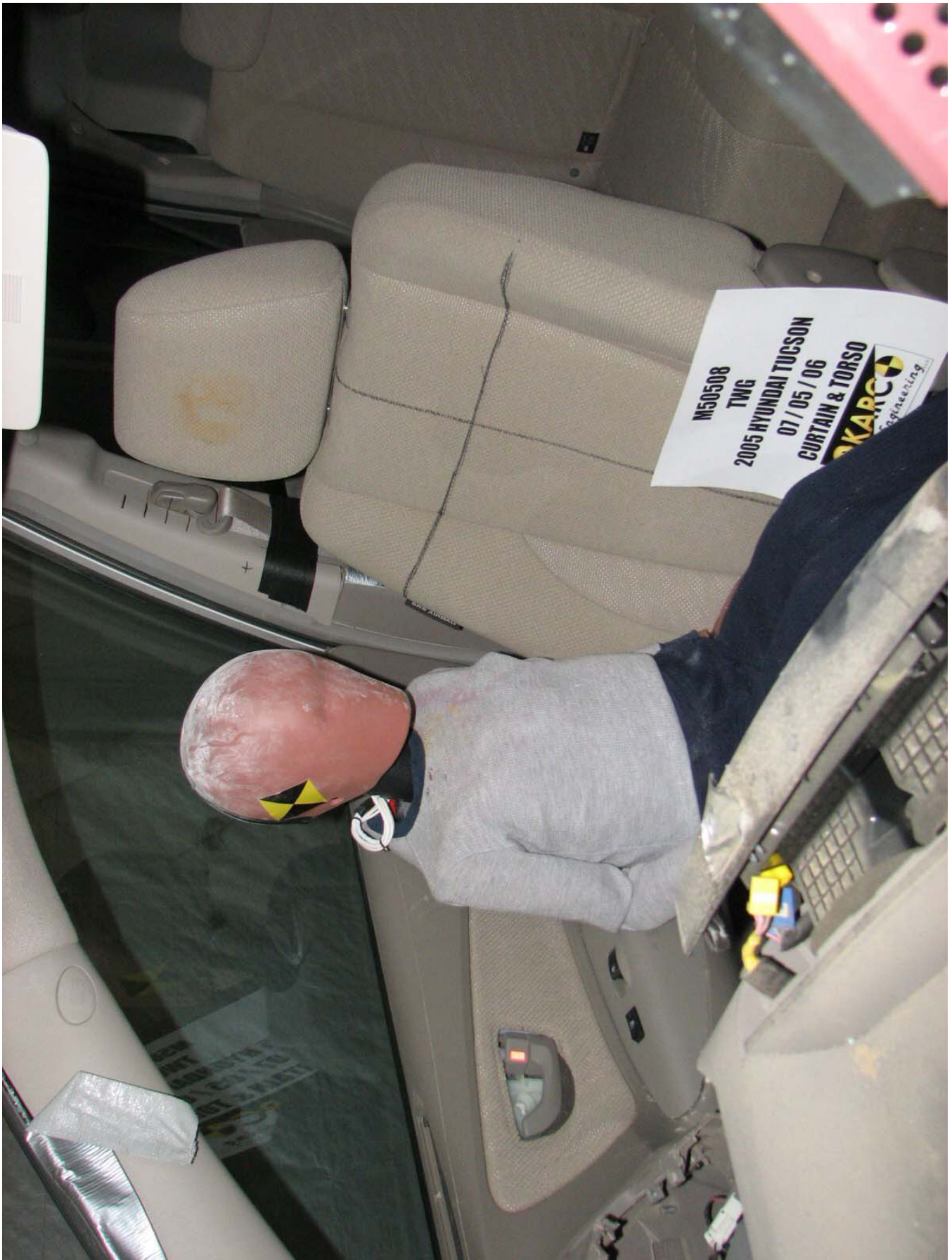


Figure A-6: Pre-Test Dummy Position, ¾ View



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



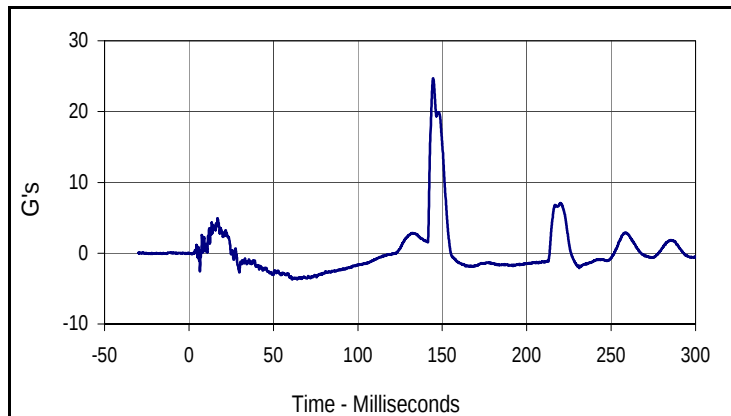
Figure A-10: Post-Test Airbags, Close-up View

APPENDIX B

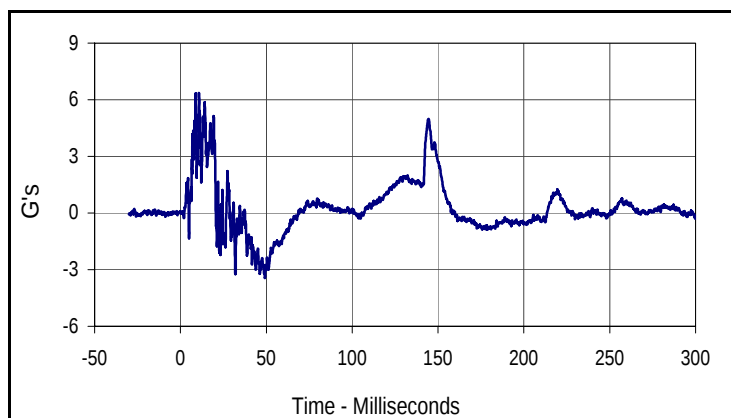
DATA PLOTS

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV
 Test Program: TWG 3.3.5.1

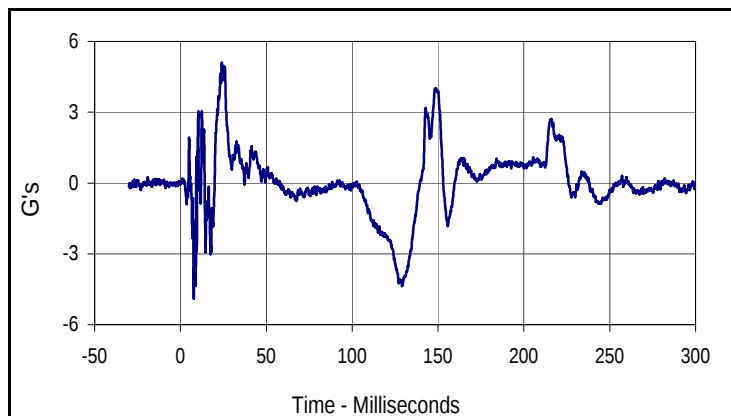
Test Date: 7/5/06
 NHTSA No.: M50508TWG2



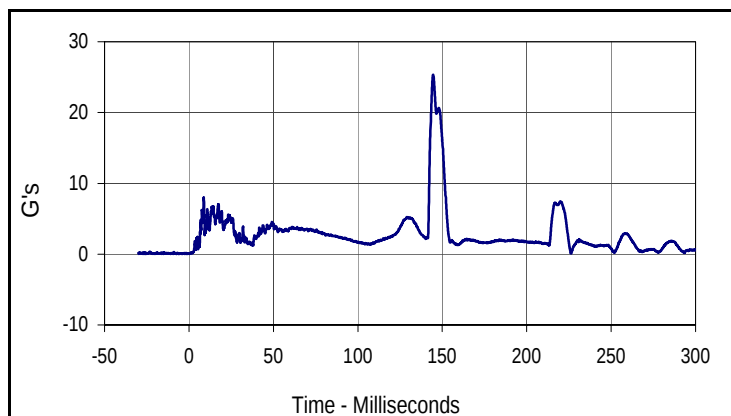
Curve Description			
Passenger (P2) Head X			
CURNO	Type	SAE Class	Units
001	FIL	1000	G's
Max	Time	Min	Time
24.7	144.6	-3.7	64.0



Curve Description			
Passenger (P2) Head Y			
CURNO	Type	SAE Class	Units
002	FIL	1000	G's
Max	Time	Min	Time
6.4	10.8	-3.4	49.2



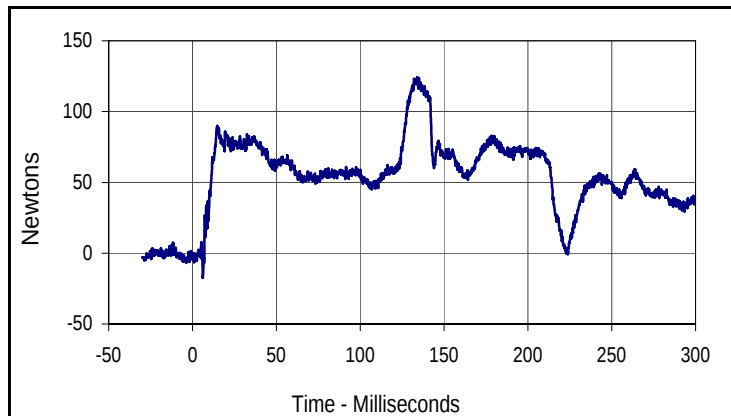
Curve Description			
Passenger (P2) Head Z			
CURNO	Type	SAE Class	Units
003	FIL	1000	G's
Max	Time	Min	Time
5.1	24.1	-4.9	7.7



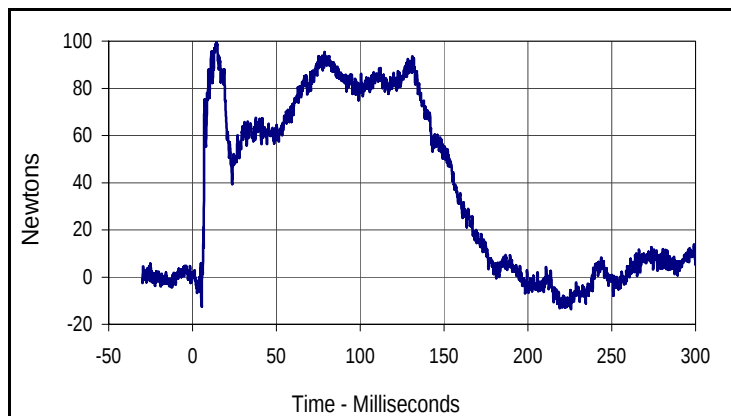
Curve Description			
Passenger (P2) Head Resultant			
CURNO	Type	SAE Class	Units
001	RES	1000	G's
Max	Time	Min	Time
25.3	144.6	0.0	0.1

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV
 Test Program: TWG 3.3.5.1

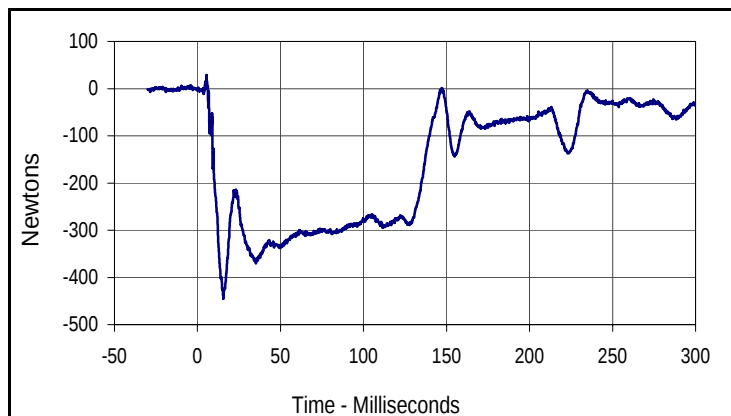
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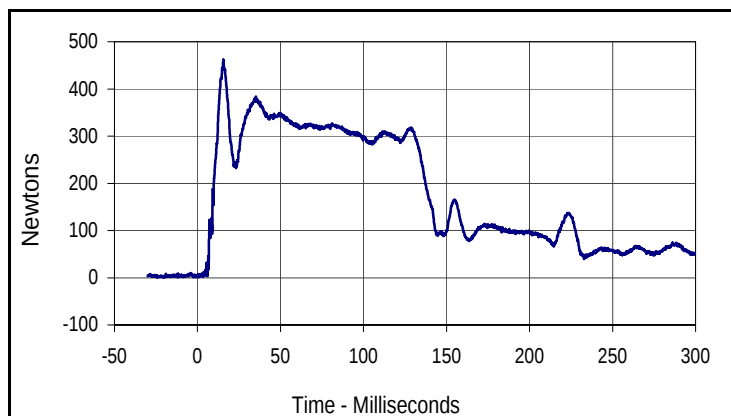
Curve Description			
Passenger (P2) Upper Neck Force X			
CURNO	Type	SAE Class	Units
004	FIL	1000	Newtons
Max	Time	Min	Time
124.3	133.9	-17.5	6.2



Curve Description			
Passenger (P2) Upper Neck Force Y			
CURNO	Type	SAE Class	Units
005	FIL	1000	Newtons
Max	Time	Min	Time
99.9	14.3	-13.6	225.7



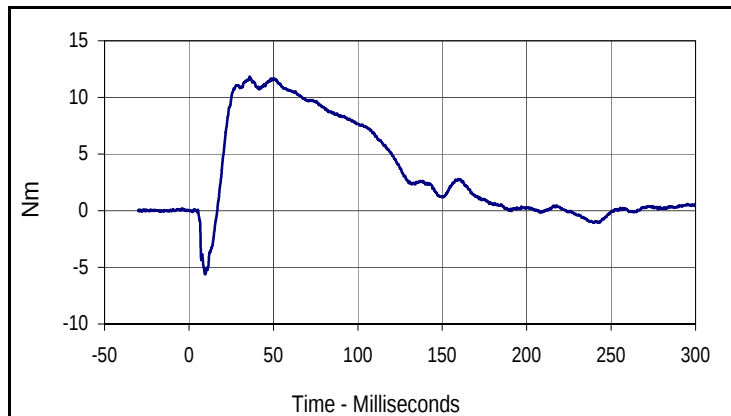
Curve Description			
Passenger (P2) Upper Neck Force Z			
CURNO	Type	SAE Class	Units
006	FIL	1000	Newtons
Max	Time	Min	Time
28.7	5.5	-444.8	15.6



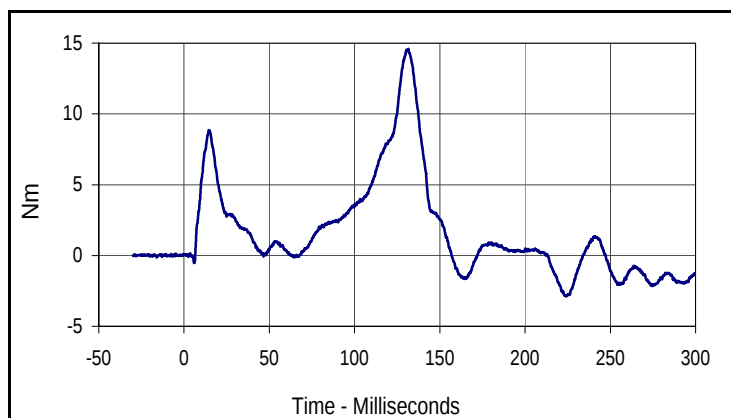
Curve Description			
Passenger (P2) Upper Neck Force Resultant			
CURNO	Type	SAE Class	Units
004	RES	1000	Newtons
Max	Time	Min	Time
462.1	15.6	1.2	0.6

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV
 Test Program: TWG 3.3.5.1

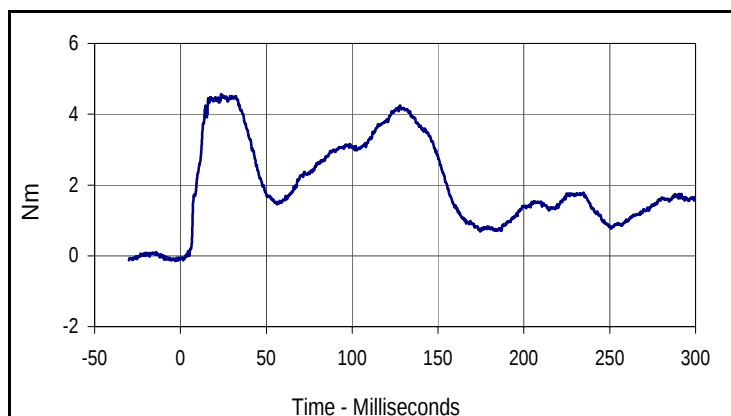
Test Date: 7/5/06
 NHTSA No.: M50508TWG2



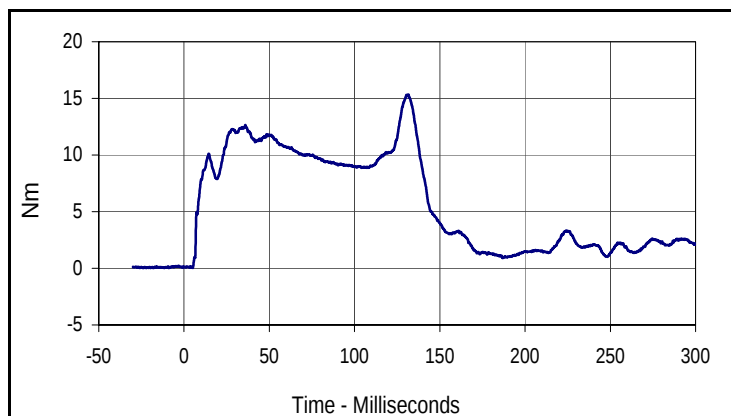
Curve Description			
Passenger (P2) Upper Neck Moment X			
CURNO	Type	SAE Class	Units
007	FIL	600	Nm
Max	Time	Min	Time
11.8	36.0	-5.6	9.6



Curve Description			
Passenger (P2) Upper Neck Moment Y			
CURNO	Type	SAE Class	Units
008	FIL	600	Nm
Max	Time	Min	Time
14.6	131.6	-2.9	224.1



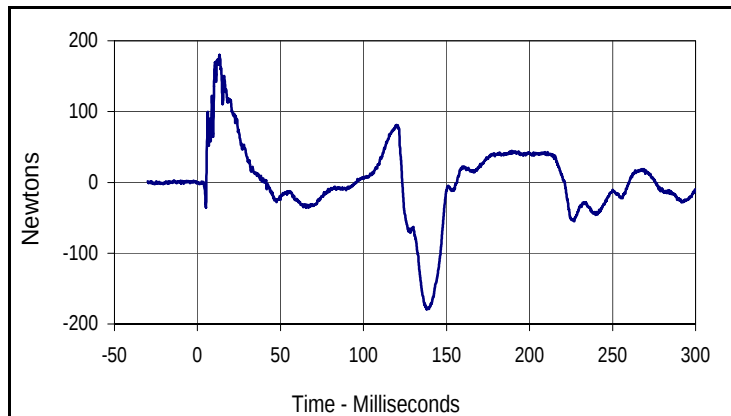
Curve Description			
Passenger (P2) Upper Neck Moment Z			
CURNO	Type	SAE Class	Units
009	FIL	600	Nm
Max	Time	Min	Time
4.6	23.7	-0.1	1.6



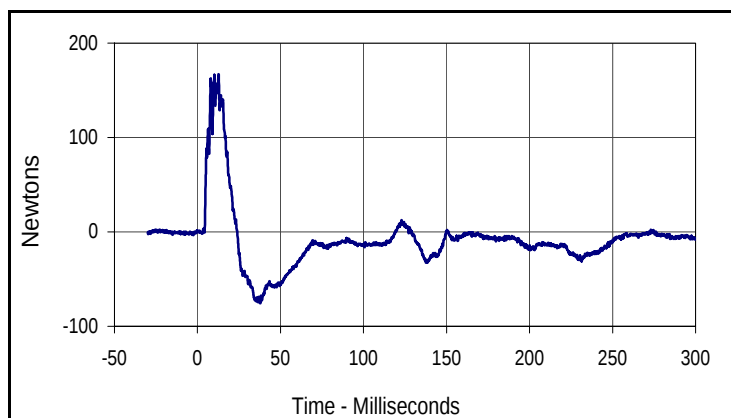
Curve Description			
Passenger (P2) Upper Neck Moment Resultant			
CURNO	Type	SAE Class	Units
007	RES	600	Nm
Max	Time	Min	Time
15.3	131.6	0.0	5.1

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV
 Test Program: TWG 3.3.5.1

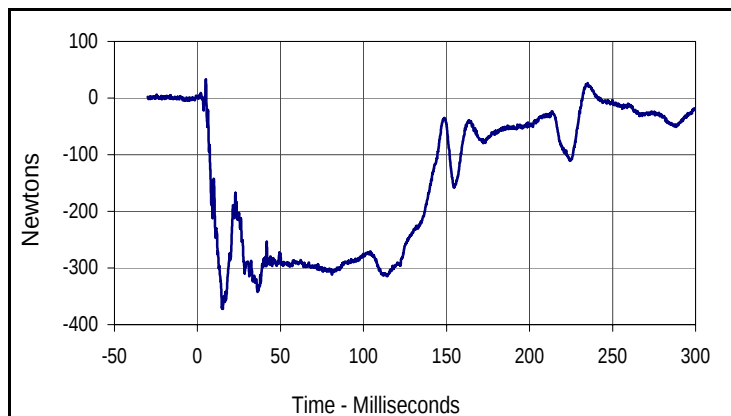
Test Date: 7/5/06
 NHTSA No.: M50508TWG2



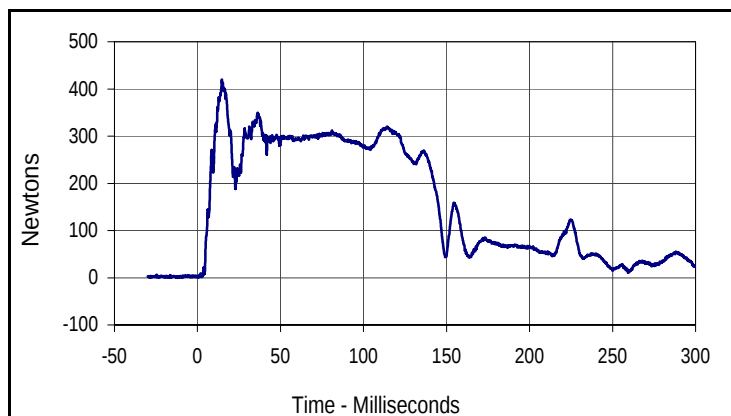
Curve Description			
Passenger (P2) Lower Neck Force X			
CURNO	Type	SAE Class	Units
010	FIL	1000	Newtons
Max	Time	Min	Time
180.2	13.3	-179.3	138.3



Curve Description			
Passenger (P2) Lower Neck Force Y			
CURNO	Type	SAE Class	Units
011	FIL	1000	Newtons
Max	Time	Min	Time
167.3	12.7	-75.5	37.8



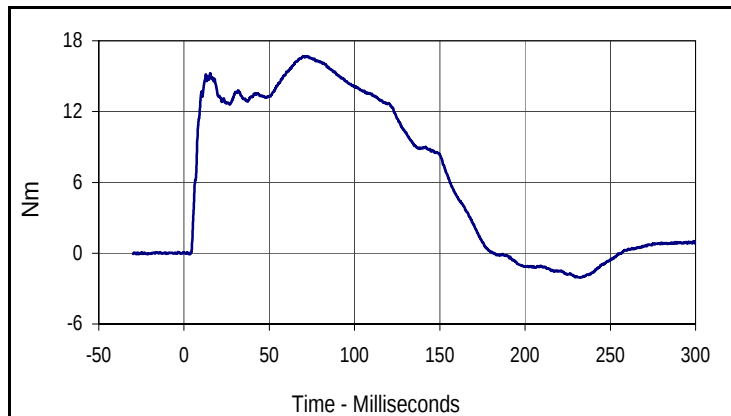
Curve Description			
Passenger (P2) Lower Neck Force Z			
CURNO	Type	SAE Class	Units
012	FIL	1000	Newtons
Max	Time	Min	Time
33.2	5.1	-372.5	15.3



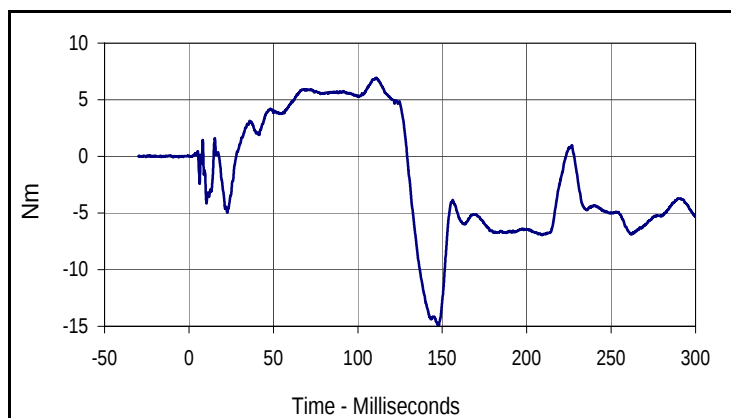
Curve Description			
Passenger (P2) Lower Neck Force Resultant			
CURNO	Type	SAE Class	Units
010	RES	1000	Newtons
Max	Time	Min	Time
420.0	14.7	1.0	0.4

Test Vehicle: 2005 Hyundai Tucson 5-Door MPV
 Test Program: TWG 3.3.5.1

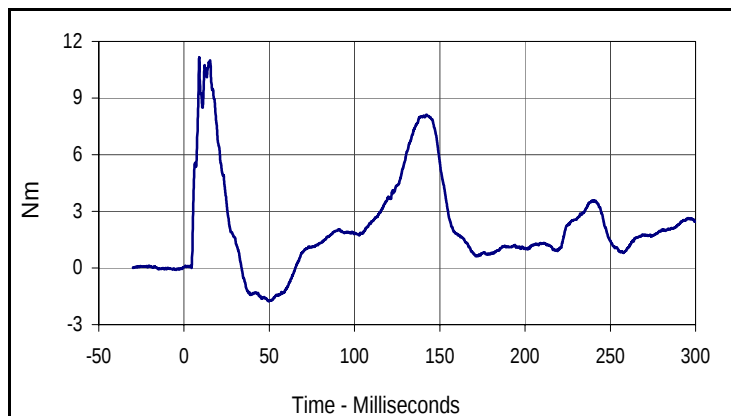
Test Date: 7/5/06
 NHTSA No.: M50508TWG2



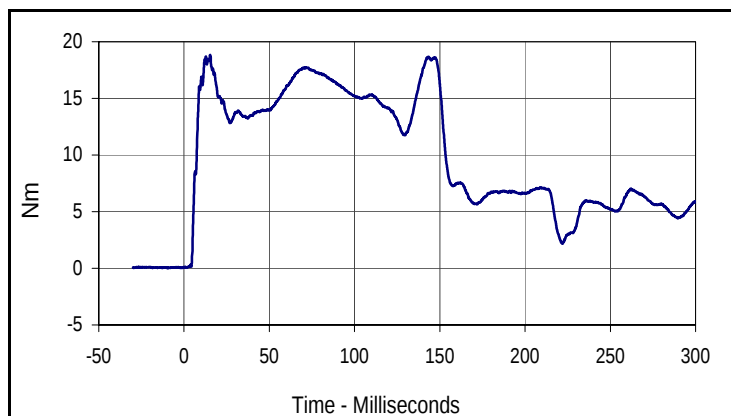
Curve Description			
Passenger (P2) Lower Neck Moment X			
CURNO	Type	SAE Class	Units
013	FIL	600	Nm
Max	Time	Min	Time
16.7	71.4	-2.1	232.0



Curve Description			
Passenger (P2) Lower Neck Moment Y			
CURNO	Type	SAE Class	Units
014	FIL	600	Nm
Max	Time	Min	Time
6.9	110.9	-14.9	147.4



Curve Description			
Passenger (P2) Lower Neck Moment Z			
CURNO	Type	SAE Class	Units
015	FIL	600	Nm
Max	Time	Min	Time
11.2	8.9	-1.8	49.9



Curve Description			
Passenger (P2) Lower Neck Moment Resultant			
CURNO	Type	SAE Class	Units
013	RES	600	Nm
Max	Time	Min	Time
18.8	15.4	0.0	0.2

APPENDIX C

INSTRUMENTATION DATA CHANNEL ASSIGNMENTS

TWG 3.3.5.1
Instrumentation Data Channel Assignments
A.T.D. Serial Number 088
7/5/06
2005 Hyundai Tucson 5-Door MPV

CH.	LOCATION	AXIS	IDENT. NO.	DESCRIPTION	MFR	MODEL	UNITS
1	HEAD	X	A15	Accel.,full bridge	Entrans	7264-2000	G
2	HEAD	Y	A13	Accel.,full bridge	Entrans	7264-2000	G
3	HEAD	Z	F01	Accel.,full bridge	Entrans	7264-2000	G
4	UPPER NECK FORCE	X	1035 FX	Load cell, six axis neck	R. A. Denton	IF-234	N
5	UPPER NECK FORCE	Y	1035 FY	Load cell, six axis neck	R. A. Denton	IF-234	N
6	UPPER NECK FORCE	Z	1035 FZ	Load cell, six axis neck	R. A. Denton	IF-234	N
7	UPPER NECK MOMENT	X	1035 MX	Load cell, six axis neck	R. A. Denton	IF-234	Nm
8	UPPER NECK MOMENT	Y	1035 MY	Load cell, six axis neck	R. A. Denton	IF-234	Nm
9	UPPER NECK MOMENT	Z	1035 MZ	Load cell, six axis neck	R. A. Denton	IF-234	Nm
10	LOWER NECK FORCE	X	139FX	Load cell, six axis neck	R. A. Denton	IF-234	N
11	LOWER NECK FORCE	Y	139FY	Load cell, six axis neck	R. A. Denton	IF-234	N
12	LOWER NECK FORCE	Z	139FZ	Load cell, six axis neck	R. A. Denton	IF-234	N
13	LOWER NECK MOMENT	X	139MX	Load cell, six axis neck	R. A. Denton	IF-234	Nm
14	LOWER NECK MOMENT	Y	139MY	Load cell, six axis neck	R. A. Denton	IF-234	Nm
15	LOWER NECK MOMENT	Z	139MZ	Load cell, six axis neck	R. A. Denton	IF-234	Nm