

REPORT NUMBER TR-P26002-10-NC

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

**TOYOTA MOTOR CORPORATION
2006 TOYOTA PRIUS
5-DOOR HATCHBACK**

NHTSA NUMBER: M65100TWG2

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



AUGUST 1, 2006

FINAL REPORT

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Date of Acceptance

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Date of Acceptance

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16. Abstract A static side airbag deployment was conducted on a 2006 Toyota Prius 5-Door Hatchback at KARCO Engineering, LLC on 8/1/2006. 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	4.1
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SECTION 1

PURPOSE AND SUMMARY OF TEST M65100TWG2

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 2006 Toyota Prius 5-Door Hatchback with an out-of-position Hybrid III 6 Year-Old Child dummy were evaluated. The test was performed at Karco Engineering, LLC on August 1, 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 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 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 bag contacted the ATD's back.

OUT OF POSITION OCCUPANT DATA SUMMARY

ATD Position	HIC ₁₅	Clip (g)	Chest Defl. (mm)
Passenger	4.1	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 airbags. 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: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2
Test Program: TWG 3.3.5.1. Test Date: 8/1/06

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: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2

Test Program: TWG 3.3.5.1. Test Date: 8/1/06

TEST DUMMY INFORMATION

Description	Passenger Seat Inboard Facing
Dummy Type / Serial No.	Hybrid III 6 year old / 088
Head Contact	Curtain Airbag
Chest Contact	None
Abdomen Contact	None
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: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2
 Test Program: TWG 3.3.5.1. Test Date: 8/1/06

TEST VEHICLE INFORMATION

Make	Toyota
Model	Prius
Body Style	5-Door Hatchback
NHTSA No.	M65100TWG2
VIN	JTDKB20U367062476
Color	Silver
Delivery Date	Dec. 29, 2005
Odometer Reading (mile)	76
Dealer	Sierra
Transmission	4-Speed Automatic
Final Drive	Front
Type/Number Cylinders	Inline 4
Engine Displacement (L)	1.5
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	No
Anti-lock Brakes	Yes
Tilt Steering Wheel	Yes
Power Windows	Yes
Power Seats	No

DATA FROM CERTIFICATION LABEL

Manufactured By	Toyota Motor Corporation	GVWR (kg)	1721
Date of Manufacture	Sep. 2005	GAWR Front (kg)	1059
		GAWR Rear (kg)	1021

DATA FROM TIRE PLACARD

Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	240	240
Recommend Tire Size	P185/65R15	P185/65R15
Tire Size on Vehicle	P185/65R15	P185/65R15
Tire Manufacturer	Good Year	Good Year

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench	Bench	
Number of Occupants	2	3	N/A	5
Capacity Wt. (VCW) (kg)				365

* Vehicle had undergone New Car Assessment Program Frontal Impact Testing on January 19, 2006

DATA SHEET NO. 3

TEST VEHICLE INFORMATION

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2
Test Program: TWG 3.3.5.1. Test Date: 8/1/06

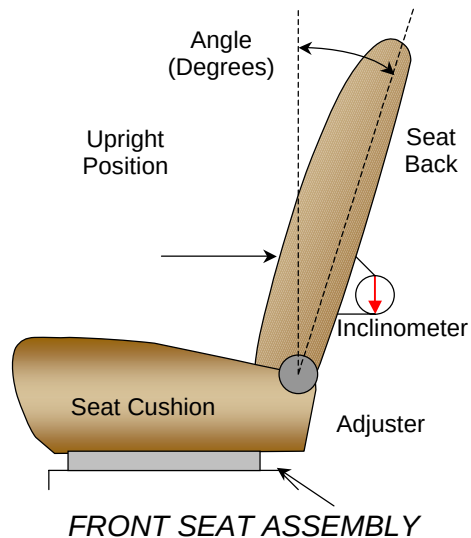
NOMINAL DESIGN RIDING POSITION

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	5*

*Measurement was taken at headrest.



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	17	8

DATA SHEET NO. 4

DUMMY POSITIONING INFORMATION

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2
 Test Program: TWG 3.3.5.1. Test Date: 8/1/06

TEST DUMMY POSITION MEASUREMENTS

Code	Measurement Description	Hybrid III 6-Year-Old Child Dummy	
		Length (mm)	Angle (°)
SA	Seat Back Angle		5
AMW	Side Airbag Module Diameter	N/A	
ABW	Side Airbag Width	1650	
AML	Side Airbag Module Length	90	
ABL	Side Airbag Length	420	
AN	Top of Airbag Module to Head/Neck Junction	300	
HD	Head CG to Door Panel/ Window	190	
HSC	Head to Seat Back Centerline	270	
HB	Head to B-Pillar	180	
HZ	Head to Roof (Z)	260	
HHD	Head to Header	360	
ND	Nose to Dash	580	
NS	Nose to Seat Back	270	
NR	Nose to Header	400	
CD	Chest to Dash	520	
CS	Chest to Seat Back	270	
RACL	Right Arm to Seat Back Centerline	370	
LACL	Left Arm to Seat Back Centerline	170	
RA	Right Arm to Door Panel	50	
LA	Left Arm to Door Panel	150	
KK	Knee to Knee	135	
TT	Toe to Toe	95	
KSCR	Right Knee to Seat Cushion Centerline	250	
KSCL	Left Knee to Seat Cushion Centerline	150	
TSCR	Right Toe to Seat Cushion Centerline	540	
TSCL	Left Toe to Seat Cushion Centerline	510	

DATA SHEET NO. 5 - HYBRID III ATD INJURY CRITERIA AND SENSOR DATATest Vehicle: 2006 Toyota Prius 5-Door HatchbackNHTSA No.: M65100TWG2Test Program: TWG 3.3.5.1Test Date: 8/1/06**HEAD PEAK ACCELERATIONS**

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Head CG	X	G's	12.9	13.6	-5.2	48.3
Head CG	Y	G's	9.4	12.4	-7.1	19.5
Head CG	Z	G's	9.2	24.1	-10.1	10.9
Head CG Resultant	N/A	G's	15.9	13.1		

UPPER NECK PEAK FORCES AND MOMENTS

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Neck Force	X	Newtons	253.8	14.5	-15.3	286.3
Neck Force	Y	Newtons	197.9	11.3	-6.0	289.2
Neck Force	Z	Newtons	3.4	3.1	-431.7	9.1
Neck Force Resultant	N/A	Newtons	476.9	9.1		
Neck Moment	X	Nm	21.6	23.0	-12.1	9.4
Neck Moment	Y	Nm	25.3	13.2	-5.6	49.7
Neck Moment	Z	Nm	6.6	14.6	-1.0	237.5
Neck Moment Resultant	N/A	Nm	26.7	13.1		

LOWER NECK PEAK FORCES AND MOMENTS

Location	Axis	Units	Passenger (P2)			
			Max	Time	Min	Time
Neck Force	X	Newtons	197.9	7.7	-191.8	11.0
Neck Force	Y	Newtons	344.1	11.0	-120.5	21.7
Neck Force	Z	Newtons	25.1	2.1	-353.5	11.3
Neck Force Resultant	N/A	Newtons	504.1	11.1		
Neck Moment	X	Nm	26.7	11.1	-0.1	209.6
Neck Moment	Y	Nm	8.0	203.4	-23.6	13.6
Neck Moment	Z	Nm	20.1	10.5	-4.1	35.6
Neck Moment Resultant	N/A	Nm	35.1	12.0		

DATA SHEET NO. 5...(CONTINUED)Test Vehicle: 2006 Toyota Prius 5-Door HatchbackNHTSA No.: M65100TWG2Test Program: TWG 3.3.5.1Test Date: 8/1/06**HEAD INJURY CRITERIA (HIC 36)**

Location	Passenger (P2)			
	HIC	T ¹	T ²	Avg G
Head CG	5.3	6.6	29.5	8.8

HEAD INJURY CRITERIA (HIC 15)

Location	Passenger (P2)			
	HIC	T ¹	T ²	Avg G
Head CG	4.1	9.3	24.3	9.4

UPPER NECK NIJ VALUES

Location	Passenger (P2)			
	Ntf	Nte	Ncf	Nce
Upper Neck	0.00	0.00	0.32	0.22

DATA SHEET NO. 6

CAMERA LOCATIONS

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback NHTSA No.: M65100TWG2
TWG3

Test Program: TWG 3.3.5.1. Test Date: 8/1/06

No.	Camera View	Location (mm)			Angle (Deg.)	Lens (mm)	Speed (fps)
		X	Y	Z			
1	High Speed Digital Side View	0	-2670	0	-1.0	35	1000
2	High Speed Digital Front View	840	-180	0	-5.0	20	1000
3	Real Time	0	2670	-200	-12.0	N/A	30

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

APPENDIX A

PHOTOGRAPHS



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



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



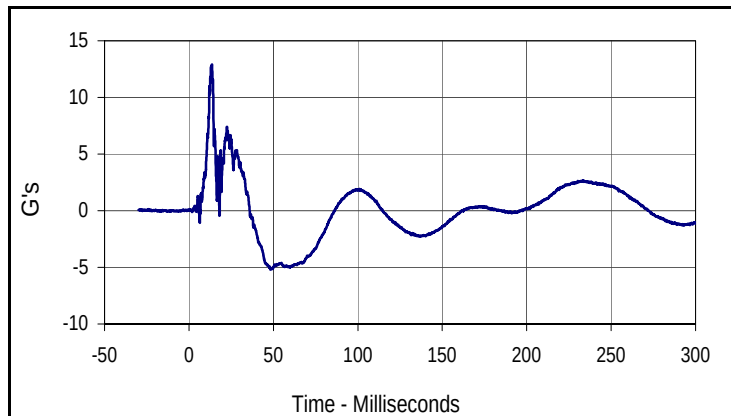
Figure A-10: Post-Test Airbags, Close-up View

APPENDIX B

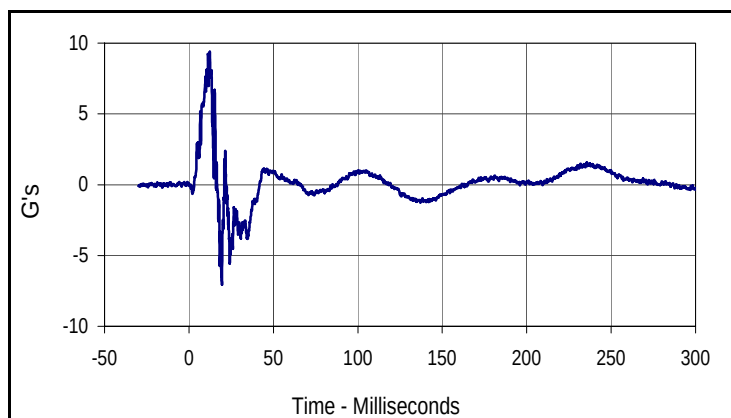
DATA PLOTS

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback
 Test Program: TWG 3.3.5.1

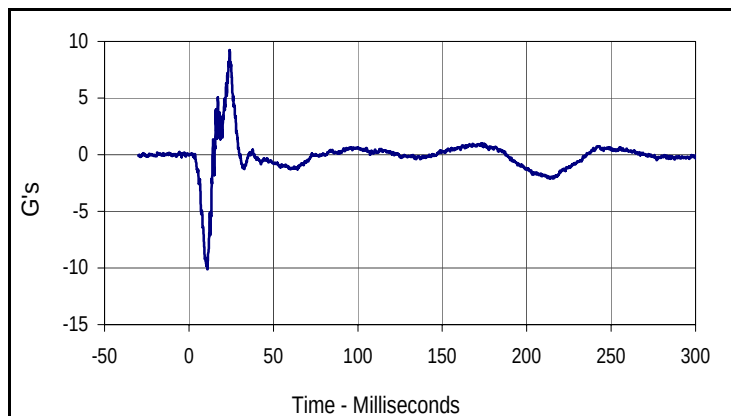
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 NHTSA No.: M65100TWG2



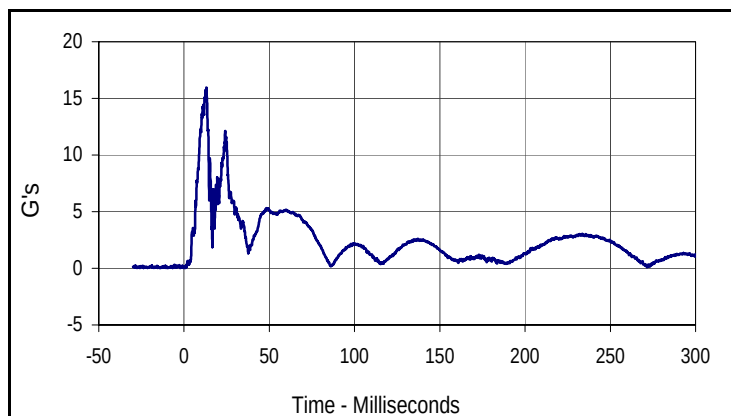
Curve Description			
Passenger (P2) Head X			
CURNO	Type	SAE Class	Units
001	FIL	1000	G's
Max	Time	Min	Time
12.9	13.6	-5.2	48.3



Curve Description			
Passenger (P2) Head Y			
CURNO	Type	SAE Class	Units
002	FIL	1000	G's
Max	Time	Min	Time
9.4	12.4	-7.1	19.5



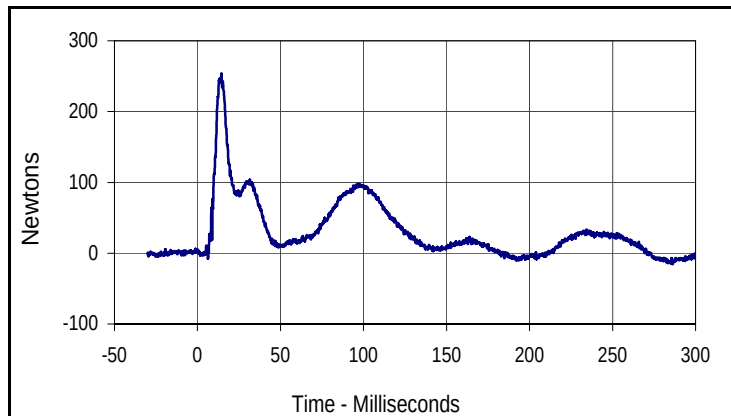
Curve Description			
Passenger (P2) Head Z			
CURNO	Type	SAE Class	Units
003	FIL	1000	G's
Max	Time	Min	Time
9.2	24.1	-10.1	10.9



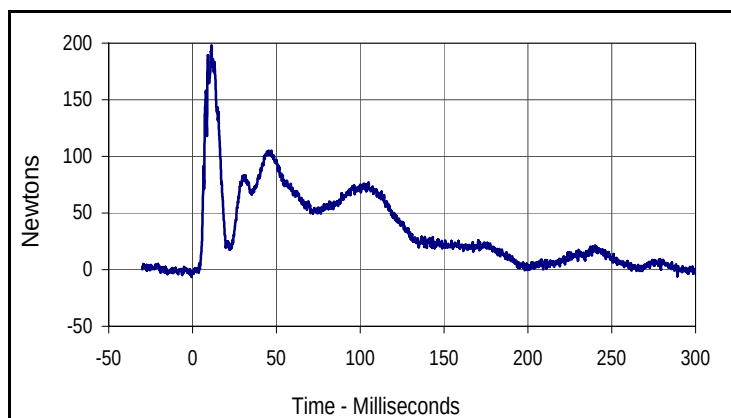
Curve Description			
Passenger (P2) Head Resultant			
CURNO	Type	SAE Class	Units
001	RES	1000	G's
Max	Time	Min	Time
15.9	13.1	0.0	500.4

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback
 Test Program: TWG 3.3.5.1

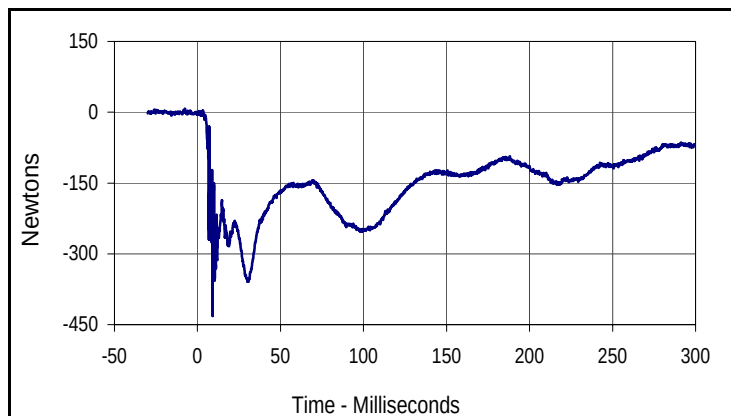
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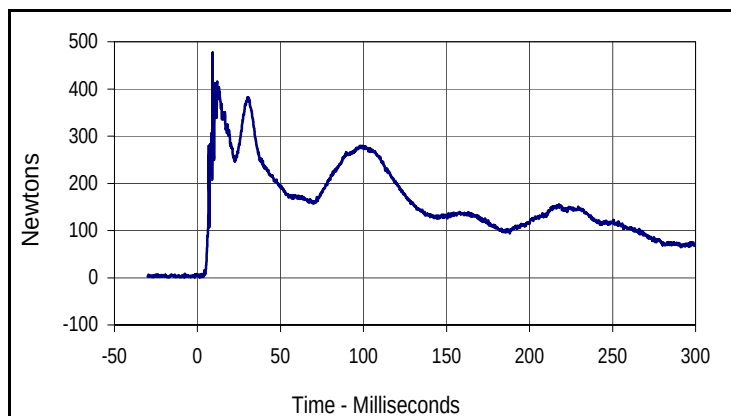
Curve Description			
Passenger (P2) Upper Neck Force X			
CURNO	Type	SAE Class	Units
004	FIL	1000	Newtons
Max	Time	Min	Time
253.8	14.5	-15.3	286.3



Curve Description			
Passenger (P2) Upper Neck Force Y			
CURNO	Type	SAE Class	Units
005	FIL	1000	Newtons
Max	Time	Min	Time
197.9	11.3	-6.0	289.2



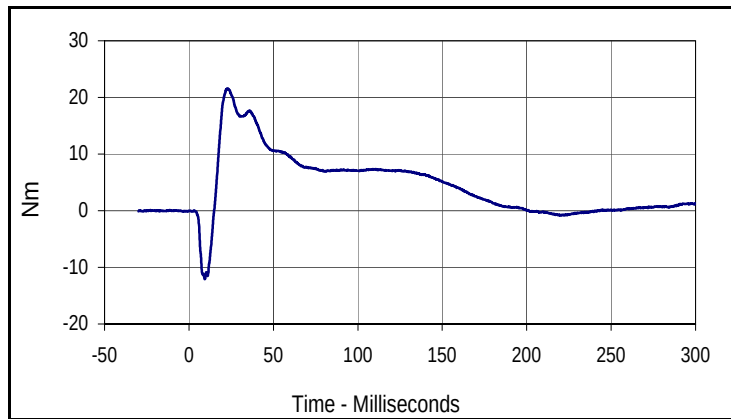
Curve Description			
Passenger (P2) Upper Neck Force Z			
CURNO	Type	SAE Class	Units
006	FIL	1000	Newtons
Max	Time	Min	Time
3.4	3.1	-431.7	9.1



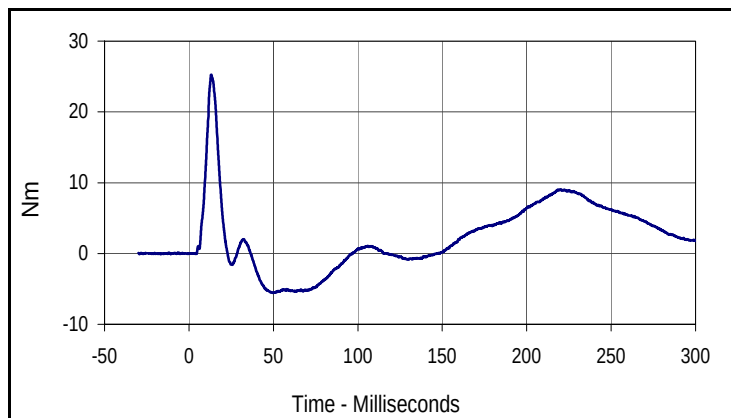
Curve Description			
Passenger (P2) Upper Neck Force Resultant			
CURNO	Type	SAE Class	Units
004	RES	1000	Newtons
Max	Time	Min	Time
476.9	9.1	1.2	1.5

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback
 Test Program: TWG 3.3.5.1

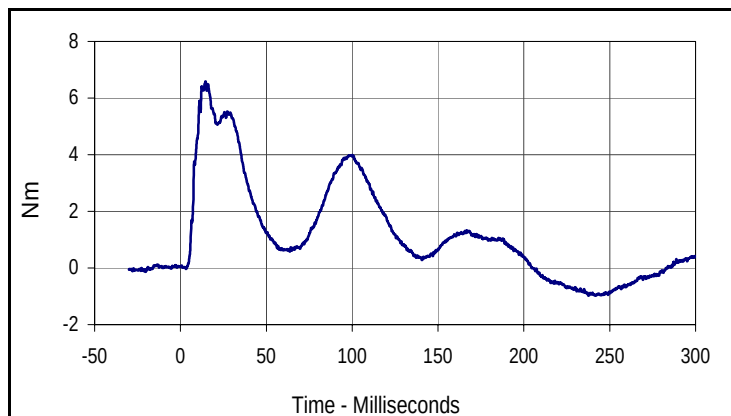
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 NHTSA No.: M65100TWG2



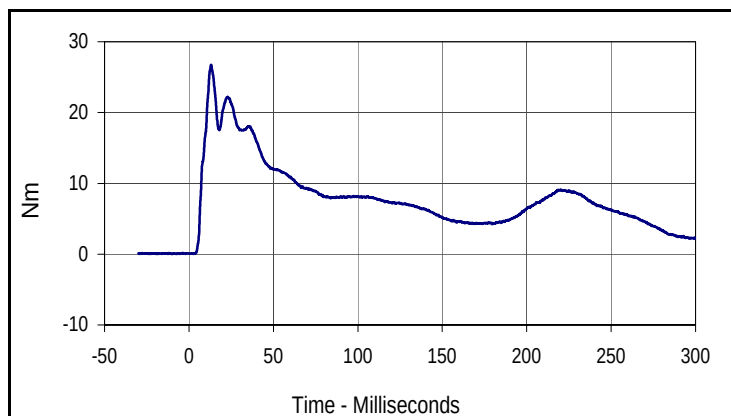
Curve Description			
Passenger (P2) Upper Neck Moment X			
CURNO	Type	SAE Class	Units
007	FIL	600	Nm
Max	Time	Min	Time
21.6	23.0	-12.1	9.4



Curve Description			
Passenger (P2) Upper Neck Moment Y			
CURNO	Type	SAE Class	Units
008	FIL	600	Nm
Max	Time	Min	Time
25.3	13.2	-5.6	49.7



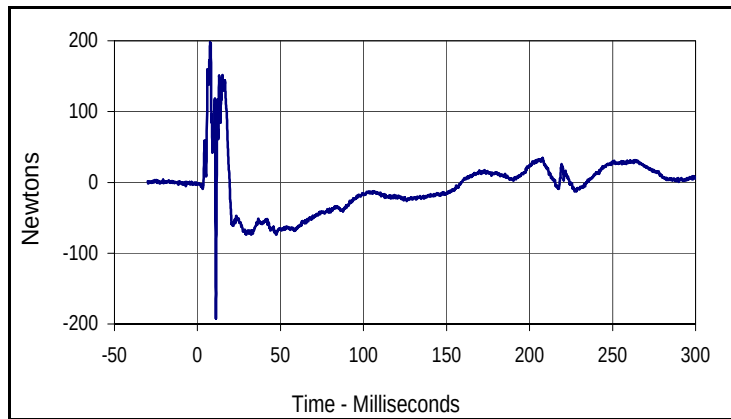
Curve Description			
Passenger (P2) Upper Neck Moment Z			
CURNO	Type	SAE Class	Units
009	FIL	600	Nm
Max	Time	Min	Time
6.6	14.6	-1.0	237.5



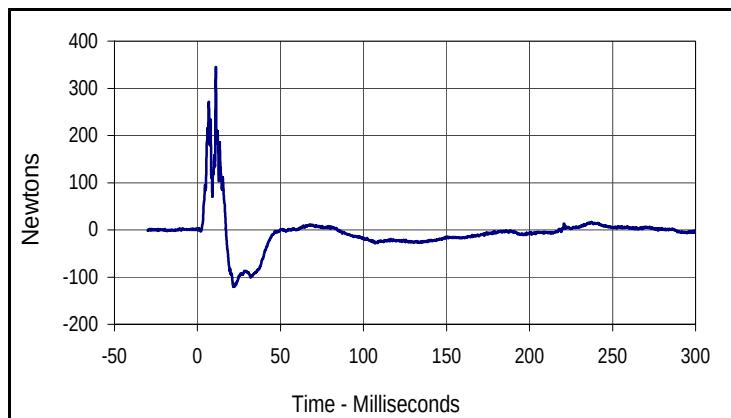
Curve Description			
Passenger (P2) Upper Neck Moment Resultant			
CURNO	Type	SAE Class	Units
007	RES	600	Nm
Max	Time	Min	Time
26.7	13.1	0.0	2.8

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback
 Test Program: TWG 3.3.5.1

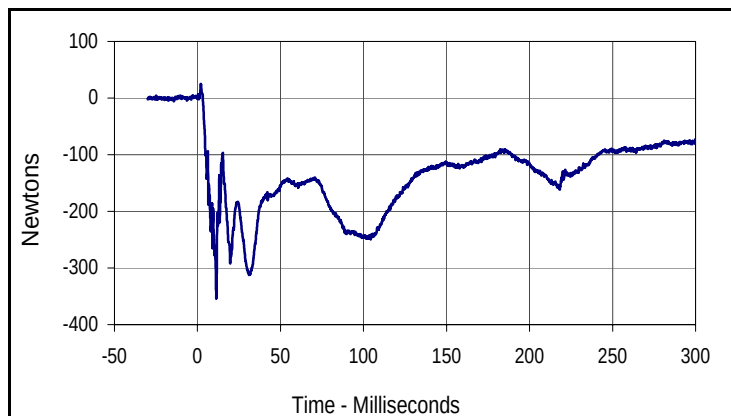
Test Date: 8/1/06
 NHTSA No.: M65100TWG2



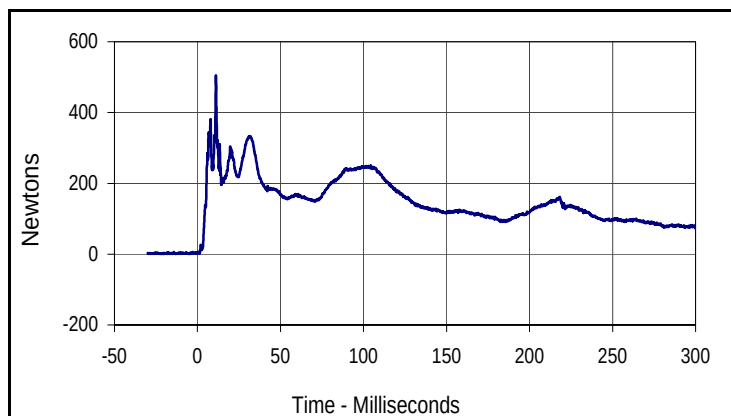
Curve Description			
Passenger (P2) Lower Neck Force X			
CURNO	Type	SAE Class	Units
010	FIL	1000	Newtons
Max	Time	Min	Time
197.9	7.7	-191.8	11.0



Curve Description			
Passenger (P2) Lower Neck Force Y			
CURNO	Type	SAE Class	Units
011	FIL	1000	Newtons
Max	Time	Min	Time
344.1	11.0	-120.5	21.7



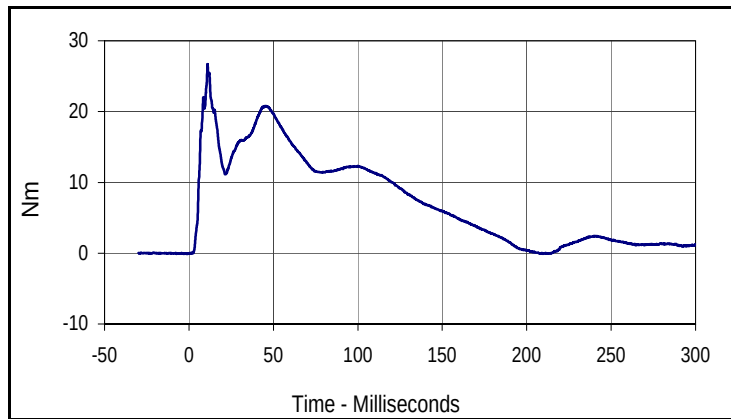
Curve Description			
Passenger (P2) Lower Neck Force Z			
CURNO	Type	SAE Class	Units
012	FIL	1000	Newtons
Max	Time	Min	Time
25.1	2.1	-353.5	11.3



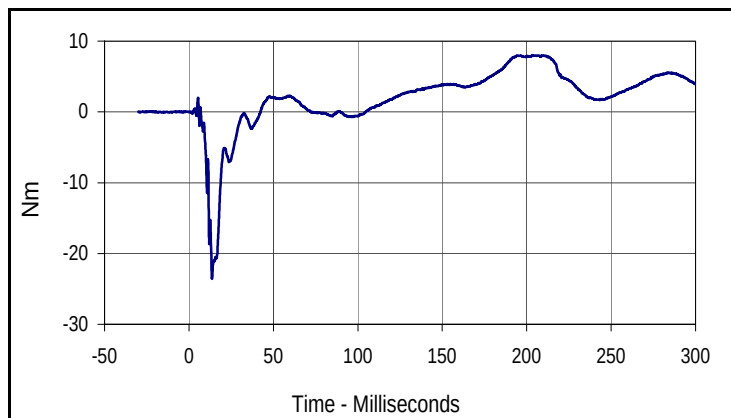
Curve Description			
Passenger (P2) Lower Neck Force Resultant			
CURNO	Type	SAE Class	Units
010	RES	1000	Newtons
Max	Time	Min	Time
504.1	11.1	1.9	0.9

Test Vehicle: 2006 Toyota Prius 5-Door Hatchback
 Test Program: TWG 3.3.5.1

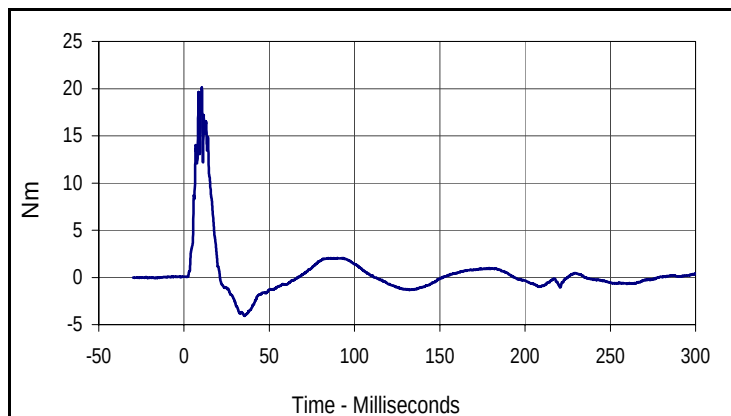
Test Date: 8/1/06
 NHTSA No.: M65100TWG2



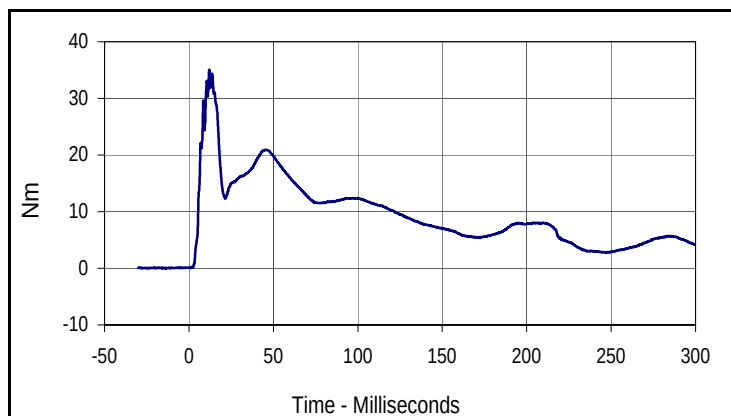
Curve Description			
Passenger (P2) Lower Neck Moment X			
CURNO	Type	SAE Class	Units
013	FIL	600	Nm
Max	Time	Min	Time
26.7	11.1	-0.1	209.6



Curve Description			
Passenger (P2) Lower Neck Moment Y			
CURNO	Type	SAE Class	Units
014	FIL	600	Nm
Max	Time	Min	Time
8.0	203.4	-23.6	13.6



Curve Description			
Passenger (P2) Lower Neck Moment Z			
CURNO	Type	SAE Class	Units
015	FIL	600	Nm
Max	Time	Min	Time
20.1	10.5	-4.1	35.6



Curve Description			
Passenger (P2) Lower Neck Moment Resultant			
CURNO	Type	SAE Class	Units
013	RES	600	Nm
Max	Time	Min	Time
35.1	12.0	0.1	1.4

APPENDIX C

INSTRUMENTATION DATA CHANNEL ASSIGNMENTS

TWG 3.3.5.1
Instrumentation Data Channel Assignments
A.T.D. Serial Number 088
8/1/06
2006 Toyota Prius 5-Door Hatchback

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