

REPORT NUMBER: NCAP-MGA-2011-015

**NEW CAR ASSESSMENT PROGRAM (NCAP)
Frontal Barrier Impact Test**

**HYUNDAI MOTOR MANUFACTURING ALABAMA, LLC
2011 Hyundai Sonata GLS 4-Dr Sedan
NHTSA No.: UB0500**

**MGA RESEARCH CORPORATION
5000 Warren Road
Burlington, WI 53105**



Test Date: August 31, 2010

Final Report Date: October 1, 2010

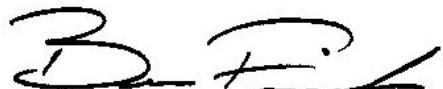
FINAL REPORT

**U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crashworthiness Standards
1200 New Jersey Ave, SE
Mail Code: NVS 111, Room W43-410
Washington, DC 20590**

This final test report was prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, in response to Contract Number DTNH22-06-D-00028.

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Approval Date: October 1, 2010

FINAL REPORT ACCEPTANCE BY OCWS:

Division Chief, New Car Assessment Program
NHTSA, Office of Crashworthiness Standards

Date: _____

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NHTSA, Office of Crashworthiness Standards

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16. Abstract A 56.3 km/h NCAP Frontal Impact Test was conducted on the 2011 Hyundai Sonata GLS 4-Dr Sedan in accordance with the specifications of the Office of Crashworthiness Standards Frontal NCAP Laboratory Test Procedure for the generation of consumer information on vehicle frontal crash protection. This test was conducted to obtain data indicant of FMVSS 208, 212, 219 (partial), 301, and foot well intrusion performance. The test was conducted at MGA Research Corporation in Burlington, Wisconsin, on August 31, 2010. The impact velocity was 56.3 km/h and the ambient temperature at the barrier face at the time of impact was 21°C. The target vehicle post-test maximum crush was 385 mm located to the right of the vehicle's centerline. The test vehicle's performance was as follows: <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th rowspan="2">Measurement Description</th> <th rowspan="2">Units</th> <th colspan="2">Threshold</th> <th rowspan="2">Driver ATD</th> <th rowspan="2">Passenger ATD</th> </tr> <tr> <th>50th</th> <th>5th</th> </tr> </thead> <tbody> <tr> <td>Head Injury Criteria (HIC₁₅)</td> <td>N/A</td> <td>700</td> <td>700</td> <td>306</td> <td>219</td> </tr> <tr> <td>Maximum Chest Compression</td> <td>mm</td> <td>63</td> <td>52</td> <td>18</td> <td>14</td> </tr> <tr> <td>Nij</td> <td>N/A</td> <td>1</td> <td>1</td> <td>0.25</td> <td>0.63</td> </tr> <tr> <td>Neck Tension</td> <td>N</td> <td>4170</td> <td>2620</td> <td>1356</td> <td>915</td> </tr> <tr> <td>Neck Compression</td> <td>N</td> <td>4000</td> <td>2520</td> <td>102</td> <td>159</td> </tr> <tr> <td>Left Femur Force</td> <td>N</td> <td>10008</td> <td>6805</td> <td>376</td> <td>944</td> </tr> <tr> <td>Right Femur Force</td> <td>N</td> <td>10008</td> <td>6805</td> <td>2117</td> <td>77</td> </tr> </tbody> </table>				Measurement Description	Units	Threshold		Driver ATD	Passenger ATD	50 th	5 th	Head Injury Criteria (HIC ₁₅)	N/A	700	700	306	219	Maximum Chest Compression	mm	63	52	18	14	Nij	N/A	1	1	0.25	0.63	Neck Tension	N	4170	2620	1356	915	Neck Compression	N	4000	2520	102	159	Left Femur Force	N	10008	6805	376	944	Right Femur Force	N	10008	6805	2117	77
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SECTION 1

PURPOSE AND SUMMARY OF TEST

PURPOSE

This 56.3 km/h frontal barrier impact test is part of the Vehicle Barrier Impact Testing Program sponsored by the National Highway Traffic Safety Administration (NHTSA) under contract number DTNH22-06-D-00028. The purpose of this test was to obtain vehicle crashworthiness and occupant restraint system performance data for consumer information purposes.

The 56.3 km/h frontal barrier impact was conducted in accordance with the Office of Crashworthiness Standard's NCAP Frontal Laboratory Test Procedure dated January 2010.

SUMMARY

A load cell barrier was impacted by a 2011 Hyundai Sonata GLS 4-Dr Sedan at a velocity of 56.3 kph. The test was performed at MGA Research Corporation on August 31, 2010. Pre-and post-test photographs of the vehicle and dummies can be found in Appendix A.

Two real-time cameras and fourteen (14) high-speed cameras were used to document the frontal barrier impact event. Camera locations and other pertinent camera information can be found in this report.

One Part 572E, 50th percentile male anthropomorphic test device (ATD), was placed in the driver seating position and one Part 572O 5th percentile female test device (ATD) was placed in the right-front passenger seating position according to dummy placement instructions specified in the Frontal NCAP Laboratory Test Procedure.

Both ATDs were fully instrumented with head, chest and pelvis tri-axial accelerometers, chest displacement potentiometers, upper neck transducers, right/left femur load cells, and lower leg instrumentation. Seat belt load cells were on the driver's lap and shoulder belts and the passenger's lap belt to measure dummy torso and pelvic section loading. The driver (position 1) ATD (Serial No. 351) and the right-front passenger (position 2) ATD (Serial No. 138) were calibrated previous to this test. Certification details, along with verification data, are found in Appendix C of this report.

The 102 channels of data were recorded on an on-board data acquisition system. Appendix B contains the dummy head, chest displacement, neck, and femur response data traces.

There was 100 percent windshield retention and no intrusion into the protected zone of the windshield during the event. There was no Stoddard Solvent leakage after the event or during any phase of the static rollover.

The maximum static crush of the vehicle was 385 mm and both the driver and passenger side doors remained closed during the impact event and were operable after the impact.

The driver's head and chest contacted the airbag. The driver's head also contacted headrest. The driver's knees contacted the knee bolster. The passenger's head and chest contacted the airbag. The passenger's head also contacted the headrest. There was no contact to the glove box from the passenger's knees.

The occupant data is summarized below:

ATD position	HIC ₁₅	T ¹	T ²	Chest Disp. (mm)	Nij	Neck Tension (N)	Neck Comp. (N)	Left Femur (N)	Right Femur (N)
Driver (50 th)	306	66.8	81.8	18	0.25	1356	102	376	2117
Passenger (5 th)	219	67.0	82.0	14	0.63	915	159	944	77

The test data can be found on the NHTSA website at www.nhtsa.dot.gov.

TEST NOTES

None

MGA does not endorse or certify products. The manufacturer's name appears solely for identification purposes.

SECTION 2
OCCUPANT AND VEHICLE INFORMATION / DATA SHEETS

DATA SHEET NO. 1
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

TEST VEHICLE INFORMATION AND OPTIONS

NHTSA No.	UB0500	Anti-Lock Brakes	Yes
Model Year	2011	All Wheel Drive	No
Make	Hyundai	Power Steering	Yes
Model	Sonata	Driver Front Airbag	Yes
Body Style	Sedan	Driver Curtain Airbag	Yes
VIN	5NPEB4AC8BH109084	Driver Head/Torso Airbag	No
Body Color	Iridescent Silver Blue Pearl	Driver Torso Airbag	No
Delivery Date	8/24/2010	Driver Torso/Pelvis Airbag	Yes
Odometer (mi)	76	Driver Pelvis Airbag	No
Odometer (km)	122	Driver Knee Airbag	No
Dealer	Wilkins Buick, Inc.	Pass. Front Airbag	Yes
Transmission	Automatic	Pass. Curtain Airbag	Yes
Final Drive	Front	Pass. Head/Torso Airbag	No
Type/No. Cylinders	4	Pass. Torso Airbag	No
Engine Displacement (L)	2.4	Pass. Torso/Pelvis Airbag	Yes
Engine Placement	Lateral	Pass. Pelvis Airbag	No
Roof Rack	No	Pass. Knee Airbag	No
Sunroof/T-Top	No	Pretensioners	Yes
Tinted Glass	No	Load Limiters	Yes
Traction Control	Yes	Automatic Door Locks	Yes
Power Brakes	Yes	Bucket Seats	Yes
Front Disc	Yes	Tilt Steering	Yes
Rear Disc	Yes	Other	
Does owner's manual provide instructions to turn off automatic door locks?	No		

DATA FROM CERTIFICATION LABEL

Manufactured By	Hyundai Motor Manufacturing Alabama, LLC	GVWR (kg)	1950
Date of Manufacture	Jul/10/10	GAWR Front (kg)	1100
		GAWR Rear (kg)	960

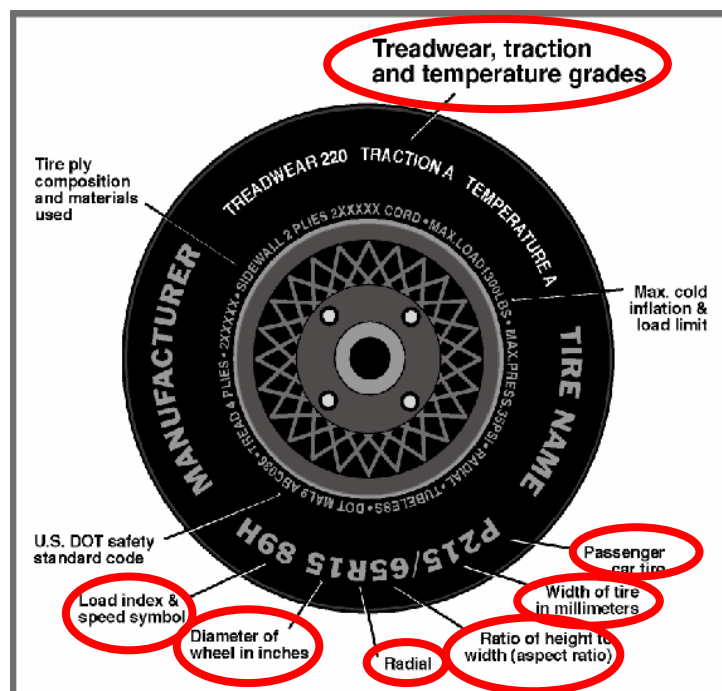
VEHICLE SEATING AND WEIGHT CAPACITY DATA

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	60/40 Split-Folding		
Designated Seating Capacity (DSC)	2	3		5
Capacity Weight (VCW) (kg)				410
Cargo Weight (RCLW) (kg)				70

DATA SHEET NO. 1 (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010



Measured Parameter	Front	Rear
Maximum Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	225	225
Recommended Tire Size	P205/65R16	P205/65R16
Tire Size on Vehicle	P205/65R16	P205/65R16
Tire Manufacturer	Kumho	Kumho
Tire Model	Solus KH25	Solus KH25
Treadwear	430	430
Traction	A	A
Temperature Grades	A	A
Tire Plies Sidewall	1 poly	1 poly
Tire Plies Body	2 steel / 1 poly / 1 nylon	2 steel / 1 poly / 1 nylon
Load Index & Speed Symbol	94H	94H
Tire Material	Rubber	Rubber
DOT Safety Code Right	DOT Y0LA YPL8	DOT Y0LA YPL8
DOT Safety Code Left	DOT Y0LA YPL8	DOT Y0LA YPL8

DATA SHEET NO. 1 (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

TEST VEHICLE WEIGHTS

	Units	As Delivered (UVW)			As Tested (ATW)		
		Front	Rear	Total	Front	Rear	Total
Left	kg	446.8	299.4		490.3	374.2	
Right	kg	451.8	278.9		458.6	357.9	
Ratio	%	60.8	39.2		56.4	43.6	
Totals	kg	898.6	578.3	1476.9	948.9	732.1	1681.0

TARGET TEST WEIGHT CALCULATION

Measured Parameter	Units	Value
Total Delivered Weight (UVW)	kg	1476.9
Weight of 1 P572E ATD & 1 P572O ATD	kg	140.6
Rated Cargo/Luggage Weight (RCLW)	kg	70
Calculated Target Vehicle Target Weight (TVTW)	kg	1687.5

TEST VEHICLE ATTITUDES AND CG

	Units	LF	RF	LR	RR	CG (aft of front axle)
As Delivered	mm	687	702	703	695	1095
As Tested	mm	685	694	664	672	1218
Post Test	mm	671	682	668	669	

GENERAL TEST VEHICLE DATA

Measurement Description	Units	Value
Total Vehicle Wheel Base	mm	2796
Total Vehicle Length at Left Side	mm	4620
Total Vehicle Length at Centerline	mm	4820
Total Vehicle Length at Right Side	mm	4620
Weight of Ballast in Cargo Area	kg	50.8
Weight of Vehicle Components Removed	kg	18.6
Amount of Stoddard Solvent in Fuel Tank	L	65.1

List of components removed to meet test weight: Right rear tail light, trunk carpet, spare tire, jack & tools, rear floor mats.

DATA SHEET NO. 1 (CONTINUED)
GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

TARGET VEHICLE STRUCTURAL MEASUREMENT

	Elements	Pre-Test (mm)
1	Total Length	4820
2	Total Width	1821
3	Bumper Top Height	531
4	Bumper Bottom Height	418
5	Longitudinal Member Top Height	530
6	Distance between Longitudinal Members	928
7	Longitudinal Member Width	82
8	Engine Top Height	804
9	Engine Bottom Height	170
10	Engine and Gearbox Width	816
11	Front Bumper-Engine Distance	450
12	Front Shock Absorber Fixing Height	873
13	Bonnet Leading Edge Height	698
14	Front Shock Absorber Fixing Width	1213
15	Front Bumper – Front Axle Distance	934
16	Front Axle – A-Pillar Distance	485
17	A-Pillar – B-Pillar Distance	1164
18	B-Pillar – Rear Axle Distance	1147
19	B-Pillar – C-Pillar Distance	711
20	Roof Sill Bottom Height	1309
21	Roof Sill Top Height	1422
22	Floor Sill bottom Height	184
23	Floor Sill Top Height	326

DATA SHEET NO. 2

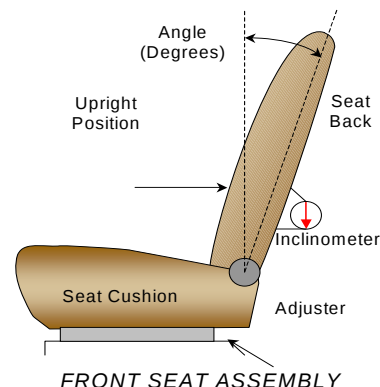
SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

NOMINAL DESIGN RIDING POSITION

The driver seat back is positioned as close as possible to the manufacturer's design angle. For the passenger seat back, seat back is adjusted following Appendix F, "Driver & Passenger Seating & Positioning Procedures" in the NCAP Test Procedure dated January 2010.



SEAT BACK ANGLE	Degrees
Driver Seat Back Angle	9.3° on headrest post
Passenger Seat Back Angle	3.3° on headrest post

SEAT FORE/AFT POSITIONS

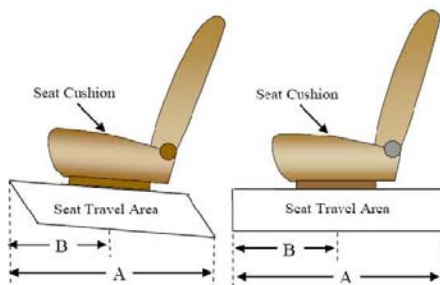
The driver and passenger seat fore/aft positions are adjusted following Appendix F, "Driver & Passenger Seating & Positioning Procedures" in the NCAP Test Procedure dated January 2010.

SEAT FORE/AFT POSITIONS	Total Fore/Aft Travel	Placed in Position #
Driver Seat	24 detents	10 th detent (forward-most as 0)
Passenger Seat	24 detents	0 mm (forward-most as 0)

SEAT BELT UPPER ANCHORAGES

The seat belt upper anchorages are positioning following the manufacturer's specified position as listed in Form 1.

SEAT BELT UPPER ANCHORAGES	Total # of Positions	Placed in Position #
Driver Seat	4	0 (uppermost as 0)
Passenger Seat	4	1 (uppermost as 0)



DATA SHEET NO. 2 (CONTINUED)

SEAT ADJUSTMENT, FUEL SYSTEM, AND STEERING WHEEL DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan

NHTSA No.: UB0500

Test Program: NCAP Frontal Barrier Impact Test

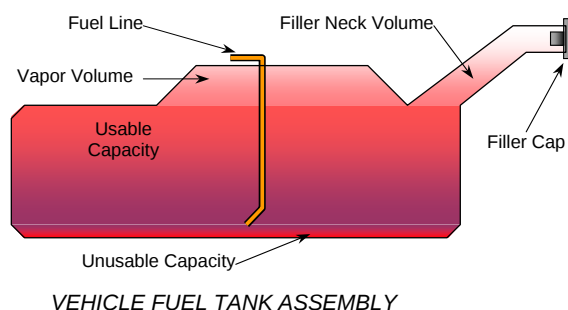
Test Date: 8/31/2010

FUEL TANK CAPACITY DATA

	Liters
Usable Capacity of "Standard Tank"	70.0
Usable Capacity of "Optional" Tank	
92-94% of Usable Capacity	64.4 to 65.8
Actual Amount of Solvent used	65.1
1/3 of Usable Capacity	23.3

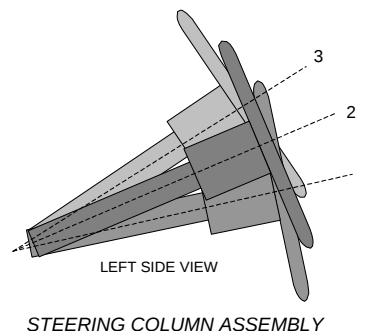
Describe the fuel pump type, its behavior, and the location of the fuel filler pipe.

The vehicle is equipped with an electric fuel pump. Fuel pump will operate when engine system is normally operating. The fuel filler pipe is located on the left side.



STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the geometric center of the locus it describes when moved through its full range of motion. An aluminum plate is placed across the rim of the steering wheel, an inclinometer is placed on the plate and the angle is measured.



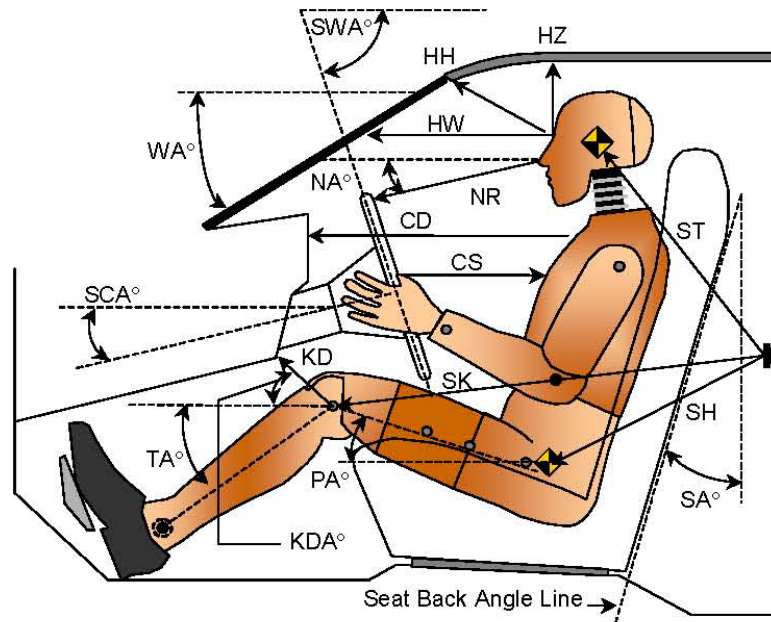
STEERING COLUMN POSITION

	Degrees	Fore/Aft Position (mm)
Lowermost – Position 1	63.4	115
Geometric Center – Position 2	65.4	135
Uppermost – Position 3	67.4	155
Telescoping Steering Wheel Travel		40
Test Position	65.4	135

DATA SHEET NO. 3
DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

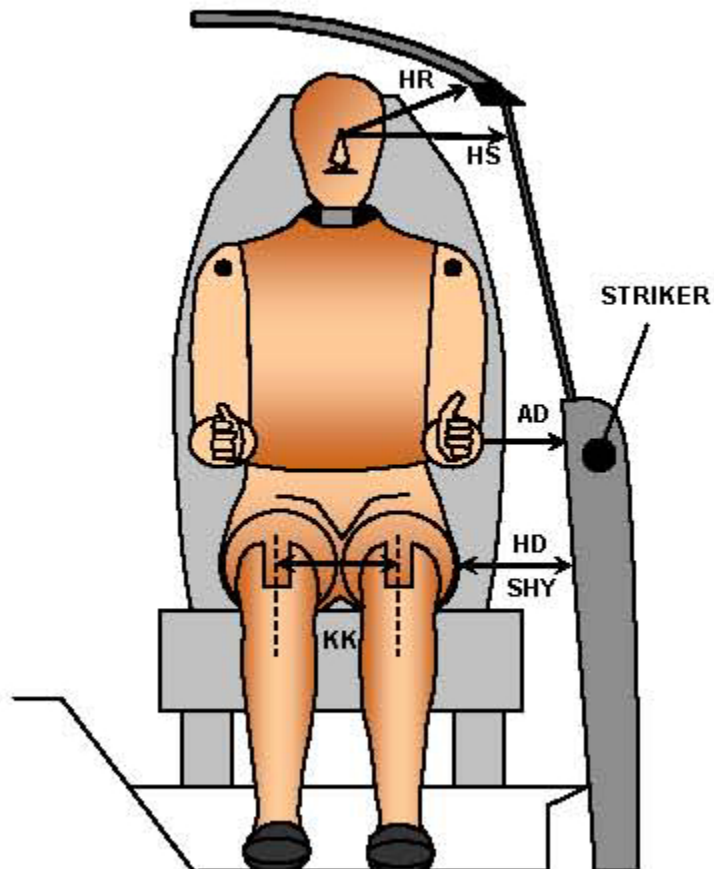


Code	Measurement Description	Driver S/N 351		Passenger S/N 138	
		Length (mm)	Angle (°)	Length (mm)	Angle (°)
WA	Windshield Angle		23.0		
SWA	Steering Wheel Angle		65.4		
SCA	Steering Column Angle		24.6		
SA	Seat Back Angle (headrest bezel)		9.3		3.3
HZ	Head to Roof (Z)	182	90	252	90
HH	Head to Header	364	23.3	329	37.2
HW	Head to Windshield	669	0	772	0
NR	Nose to Rim	435	11.4		
CD	Chest to Dash	568		460	
CS	Chest to Steering Hub	361	2.7		
RA	Rim to Abdomen	226	0		
KDL	Left Knee to Dash	217	24.2	143	36.1
KDR	Right Knee to Dash	169	28.4	158	34.6
PA	Pelvic Angle		24.8		20.3
TA	Tibia Angle		39.1		47.5
SK	Striker to Knee	641	106.3	705	108.3
ST	Striker to Head	375	15.9	367	44.4
SH	Striker to H-Point	352	139.7	453	128.9

DATA SHEET NO. 4
DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010



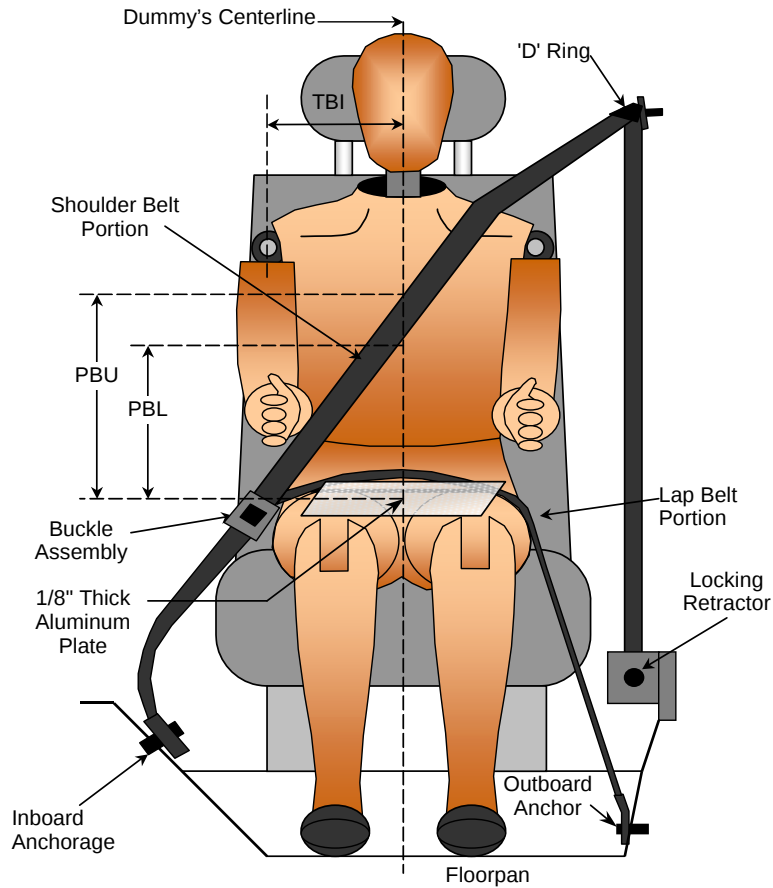
Code	Measurement Description	Driver S/N 351	Passenger S/N 138
		Length (mm)	
AD	Arm to Door	144	106
HD	H-Point to Door	149	183
HR	Head to Side Header	203	282
HS	Head to Side Window	326	373
KK	Knee to Knee	338	213
SHY	Striker to H-Point (Y Direction)	335	310
AA	Ankle to Ankle	362	175

DATA SHEET NO. 5

SEAT BELT POSITIONING DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010



FRONT VIEW OF DUMMY

SEAT BELT POSITIONING MEASUREMENTS

Measurement Description	Units	Driver	Passenger
PBU - Top surface of reference to belt upper edge	mm	405	360
PBL - To surface of reference to belt lower edge	mm	335	280

BELT LENGTH DATA

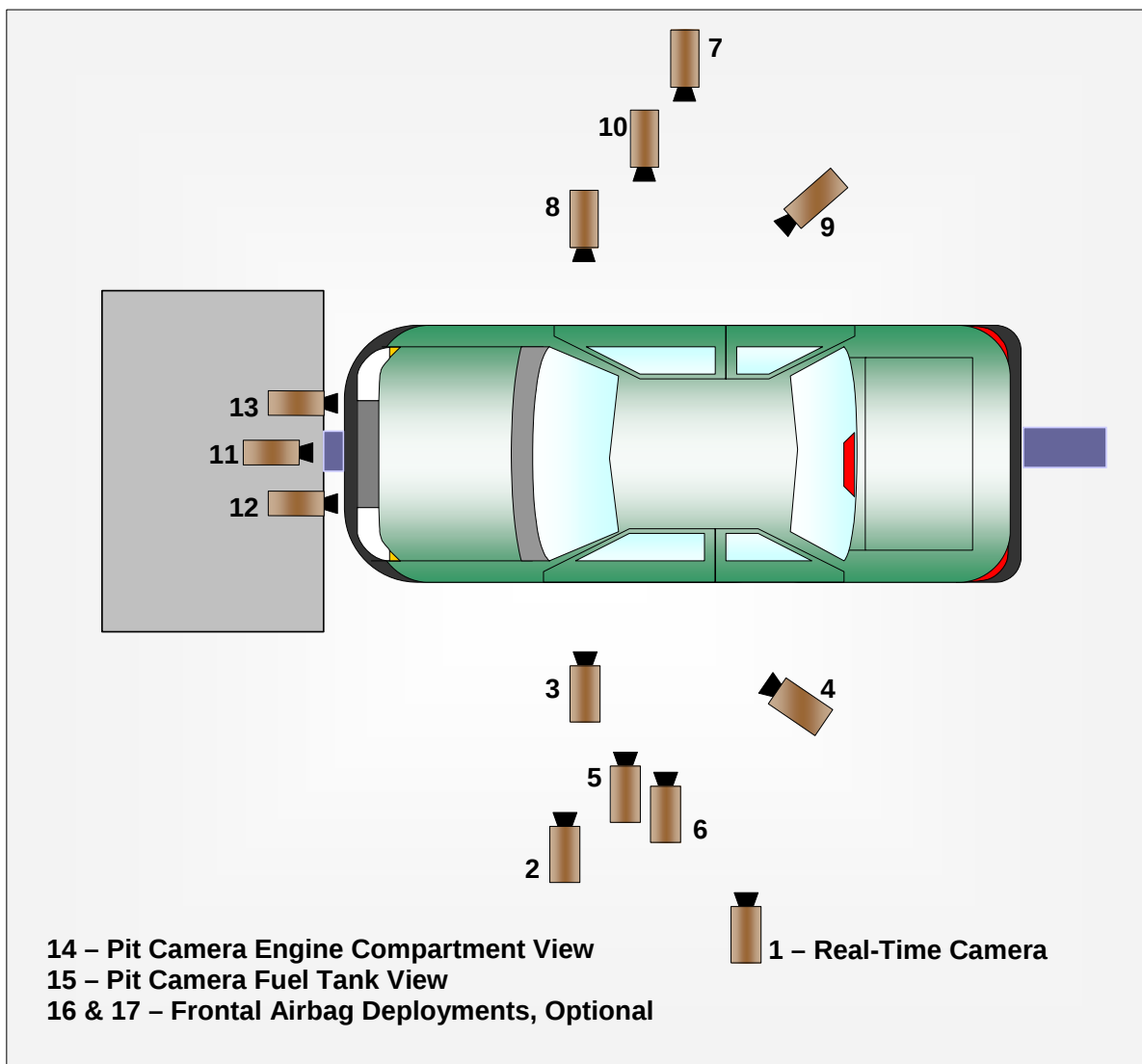
Measurement Description	Units	Driver	Passenger
Shoulder Belt Length as measured on ATD	mm	910	920
Lap Belt Length as measured on ATD	mm	870	700
Remainder of belt of reel	mm	670	860
Total Belt Length for Continuous Webbing Systems	mm	2450	2480

DATA SHEET NO. 6
HIGH-SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
Test Date: 8/31/2010

CAMERA POSITIONS FOR FRONTAL IMPACTS



DATA SHEET NO. 6 (CONTINUED)

CAMERA LOCATIONS AND DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

CAMERA LOCATIONS

No.	Camera View	Coordinates (mm)			Lens (mm)	Speed (fps)
		X*	Y*	Z*		
1	Real-Time Left Side View					30
2	Left Front Half	1310	-5150	-1180	24	1000
3	Driver Close-Up	1660	-6250	-1490	35	1000
4	Driver Angle	5390	-4860	-1930	50	1000
5	Steering Column Top	860	-5160	-1250	25	1000
6	Steering Column Bottom	830	-5140	-870	25	1000
7	Right Overall	2210	6710	-1290	20	1000
8	Passenger Close-Up	1680	6200	-1520	35	1000
9	Passenger Angle	5420	4930	-1900	50	1000
10	Right Front Half	1350	5190	-1210	24	1000
11	Windshield	-260	0	-2860	24	1000
12	Top Driver	-30	-360	-2270	16	1000
13	Top Passenger	-30	360	-2270	16	1000
14	Pit Front	1290	0	3150	24	1000
15	Pit Rear	3210	0	3150	24	1000
16	Onboard Driver Side (optional)					
17	Onboard Passenger Side (optional)					
18	Real-Time Pan View					30

***COORDINATES:**

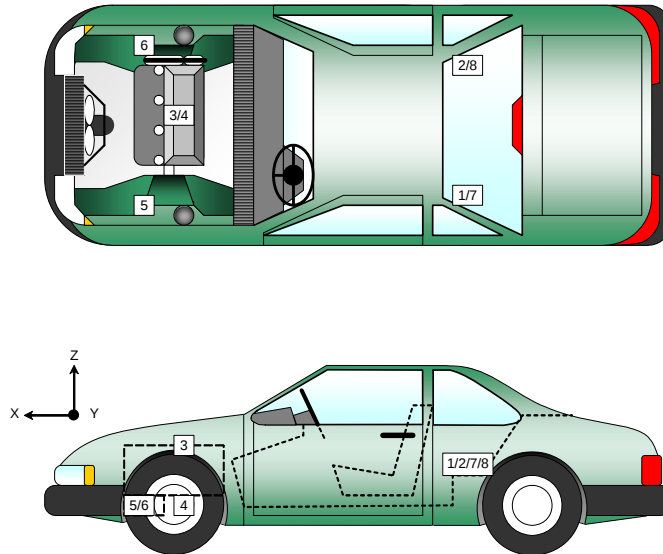
- +X = forward of impact plane
- +Y = right of monorail centerline
- +Z = below ground level

Cameras 16 & 17 were not used for this test.

DATA SHEET NO. 7
VEHICLE ACCELEROMETER DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010



VEHICLE ACCELEROMETER PRE-TEST LOCATIONS

No.	Accelerometer Location	Measurements (mm)		
		X	Y	Z
1	Left Rear X-Member X	1935	-365	-220
2	Right Rear X-Member X	1935	395	-220
3	Engine Top X	4051	0	-805
4	Engine Bottom X	4060	0	-283
5	Left Brake Caliper X	3677	-705	-265
6	Right Brake Caliper X	3677	705	-265
7	Left Rear X-Member Z	1935	-365	-220
8	Right Rear X-Member Z	1935	395	-220

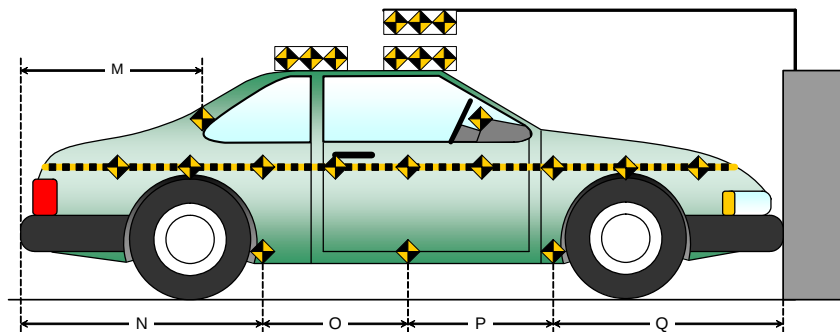
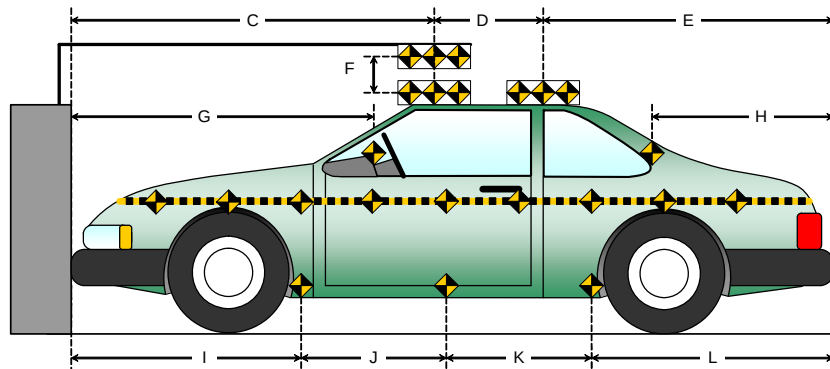
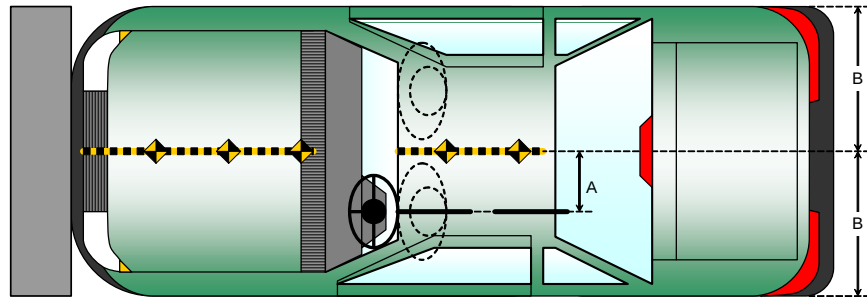
Reference Points: X - Rear Surface of Vehicle (+ forward)
 Y - Vehicle Centerline (+ to right)
 Z - Ground Plane (+ down)

DATA SHEET NO. 8
PHOTOGRAPHIC REFERENCE TARGET LOCATIONS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

Item	Value (mm)
A	360
B	910
C	2377
D	665
E	1778
F	175
G	
H	1206
I	1454
J	946
K	948
L	1472
M	1220
N	1476
O	947
P	947
Q	1450



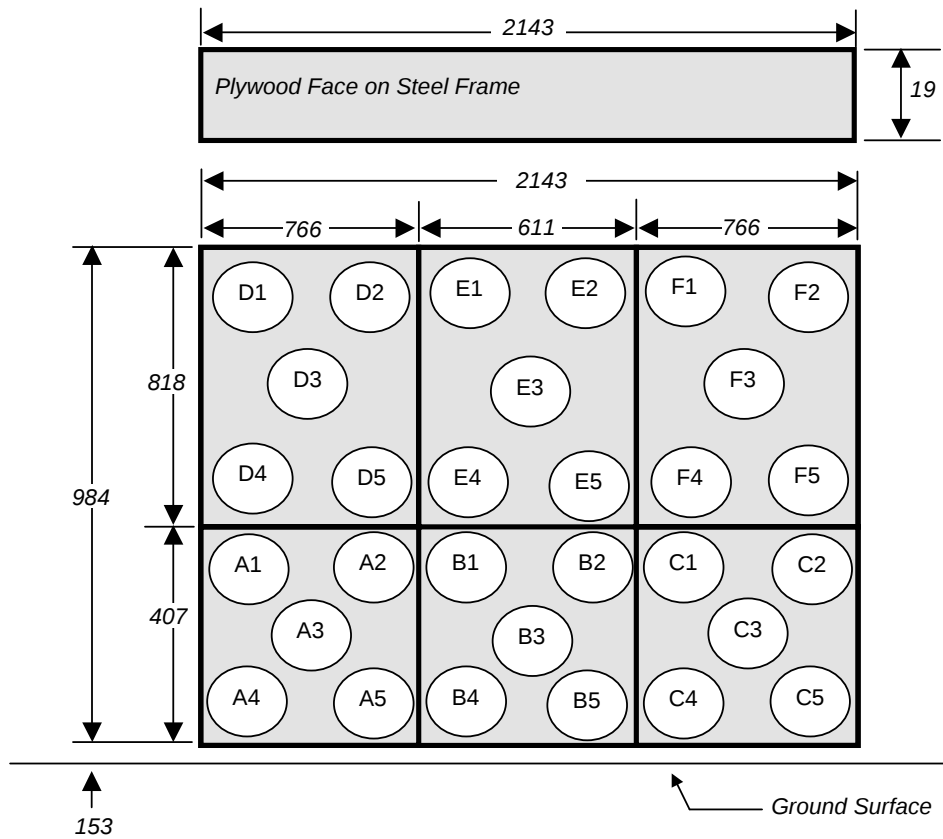
DATA SHEET NO. 9

LOAD CELL LOCATIONS ON FIXED BARRIER

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

30 Load Cell Rigid Barrier Load Cell Locations on Fixed Barrier



Group 4 D1-D5	Group 5 E1-E5	Group 6 F1-F5
Group 1 A1-A5	Group 2 B1-B5	Group 3 C1-C5

6 Groups of 5 Load Cells Each

DATA SHEET NO. 10
TEST VEHICLE SUMMARY OF RESULTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
Test Date: 8/31/2010

INSTRUMENTATION

Driver Dummy Data Channels	44
Passenger Dummy Data Channels	44
Vehicle Structure Accelerometers	8
Barrier Channels	6
Total	102

CAMERA COVERAGE

High-Speed Vehicle Onboard	0
High-Speed Offboard	14
Real-Time	2
Total	16

DATA SHEET NO. 11**POST-TEST OBSERVATIONS**

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

TEST DUMMY INFORMATION AND CONTACT

Description	Driver	Passenger
Dummy Type / Serial No.	HIII 50% / 351	HIII 5% / 138
Head Contact	Airbag, Headrest	Airbag, Headrest
Upper Torso Contact	Airbag	Airbag
Lower Torso Contact	Airbag	Airbag
Left Knee Contact	Knee Bolster	None
Right Knee Contact	Knee Bolster	None

DOOR OPENING AND SEAT TRACK INFORMATION

Description	Driver	Passenger
Locked/Unlocked Doors	Doors were locked	Doors were locked
Front Door Opening	Door remained closed and latched; Door opened without tools	Door remained closed and latched; Door opened without tools
Rear Door Opening	Door remained closed and latched; Door opened without tools	Door remained closed and latched; Door opened without tools
Seat Track Shift (mm)	0	0
Seat Back Failure	None	None

POST TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Windshield Damage	None
Window Damage	None
Other Notable Effects	None

VEHICLE REBOUND FROM BARRIER

Measured Parameter	Units	Value
Left Side	mm	3537
Center	mm	3416
Right Side	mm	3496
Average	mm	3483

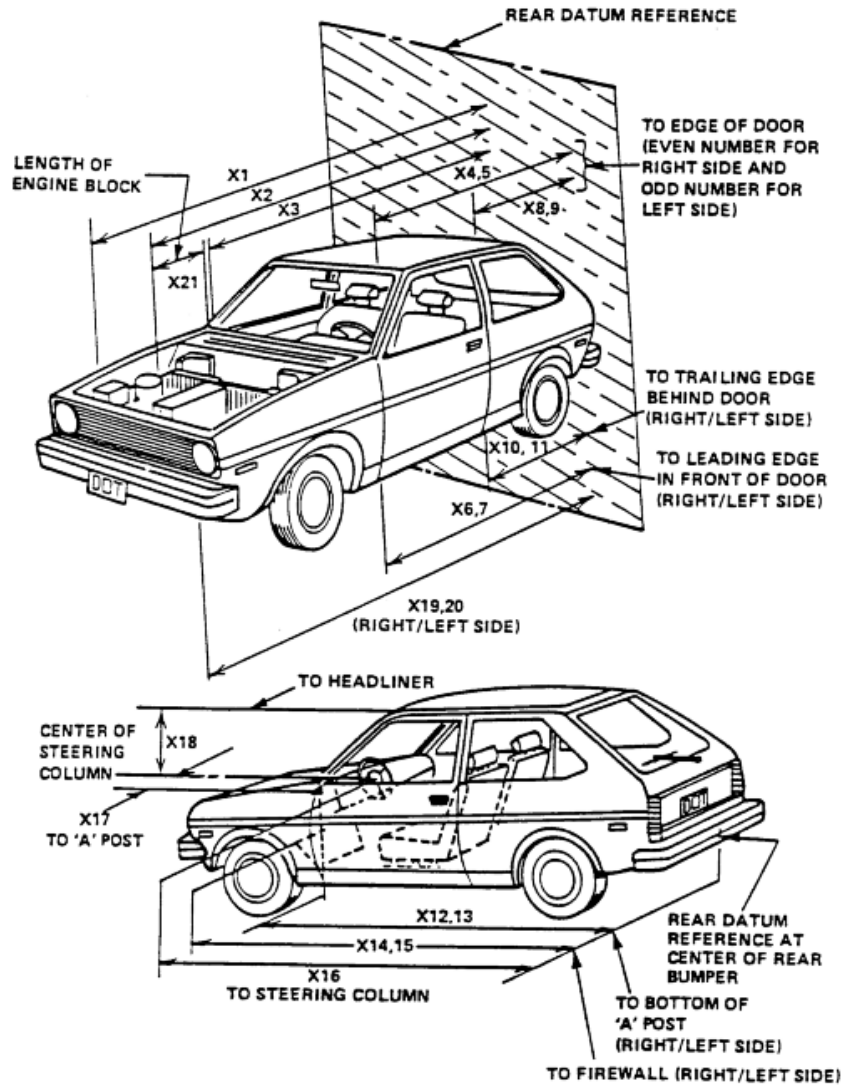
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Left Front (Driver) P1		Left Front (Passenger) P2	
	Mounted	Deployed	Mounted	Deployed
Frontal Airbag	Yes	Yes	Yes	Yes
Knee Airbag	No		No	
Curtain Side Airbag	Yes	No	Yes	No
Torso/Pelvis Side Airbag	Yes	No	Yes	No
Seat Belt Pretensioner	Yes	Yes	Yes	Yes
Seat Belt Load Limiter	Yes		Yes	

DATA SHEET NO. 12
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
Test Date: 8/31/2010



DATA SHEET NO. 12 (CONTINUED)
VEHICLE PROFILE MEASUREMENTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

RSOV (Rear Surface of Vehicle)

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
1	Total Length of Vehicle at Centerline	mm	4820	4464	356
2	RSOV to Front of Engine	mm	4301	4152	149
3	RSOV to Firewall	mm	3697	3692	5
4	RSOV to Upper Leading Edge of Right Door	mm	3295	3291	4
5	RSOV to Upper Leading Edge of Left Door	mm	3295	3300	-5
6	RSOV to Lower Leading Edge of Right Door	mm	3296	3291	5
7	RSOV to Lower Leading Edge of Left Door	mm	3298	3293	5
8	RSOV to Upper Trailing Edge of Right Door	mm	2171	2175	-4
9	RSOV to Upper Trailing Edge of Left Door	mm	2168	2170	-2
10	RSOV to Lower Trailing Edge of Right Door	mm	2200	2201	-1
11	RSOV to Lower Trailing Edge of Left Door	mm	2199	2198	1
12	RSOV to Bottom of "A" Post of Right Side	mm	3306	3301	5
13	RSOV to Bottom of "A" Post of Left Side	mm	3306	3298	8
14	RSOV to Firewall, Right Side	mm	3694	3689	5
15	RSOV to Firewall, Left Side	mm	3709	3691	18
16	RSOV to Steering Column	mm	2834	2893	-59
17	Center of Steering Column to "A" Post	mm	375	363	12
18	Center of Steering Column to Headliner	mm	433	423	10
19	RSOV to Right Side of Front Bumper	mm	4604	4354	250
20	RSOV to Left Side of Front Bumper	mm	4604	4382	222
21	Length of Engine Block	mm	490	490	0
RD	RSOV to Right Side of Dash Panel	mm	3021	3034	-13
CD	RSOV to Center of Dash Panel	mm	3033	3022	11
LD	RSOV to Left Side of Dash Panel	mm	3021	3021	0

DATA SHEET NO. 13
ACCIDENT INVESTIGATION DIVISION DATA

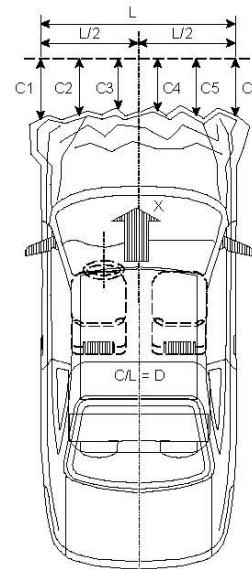
Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan NHTSA No.: UB0500
 Test Program: NCAP Frontal Barrier Impact Test Test Date: 8/31/2010

VEHICLE INFORMATION

VIN: 5NPEB4AC8BH109084 Wheelbase (mm): 2796
 Vehicle Size Category: Sedan Test Weight (kg): 1681.0

ACCELEROMETER DATA

Accelerometer Locations: As per measurements on Page 16
 Cal. Procedure/Interval: MGA procedure / 6 month
 Integration Algorithm: Trapezoidal Linearity: > 99%
 Impact Velocity (km/h): 56.3
 Velocity Change (km/h): 63.3
 Time of Separation (msec): 91.4



CRUSH PROFILE

Collision Deformation Classification: Frontal
 Midpoint of Damage: Centerline
 Damage Region Length (mm): 1456
 Impact Mode: Frontal

No.	Measurement Description	Units	Pre-Test	Post-Test	Difference
C1	Crush zone 1 at left side	mm	4604	4382	222
C2	Crush zone 2 at left side	mm	4709	4426	283
C3	Crush zone 3 at left side	mm	4766	4422	344
C4	Crush zone 4 at right side	mm	4766	4381	385
C5	Crush zone 5 at right side	mm	4709	4368	341
C6	Crush zone 6 at right side	mm	4604	4354	250
L	C1 TO C6	mm	1456	1435	21

DATA SHEET NO. 14
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

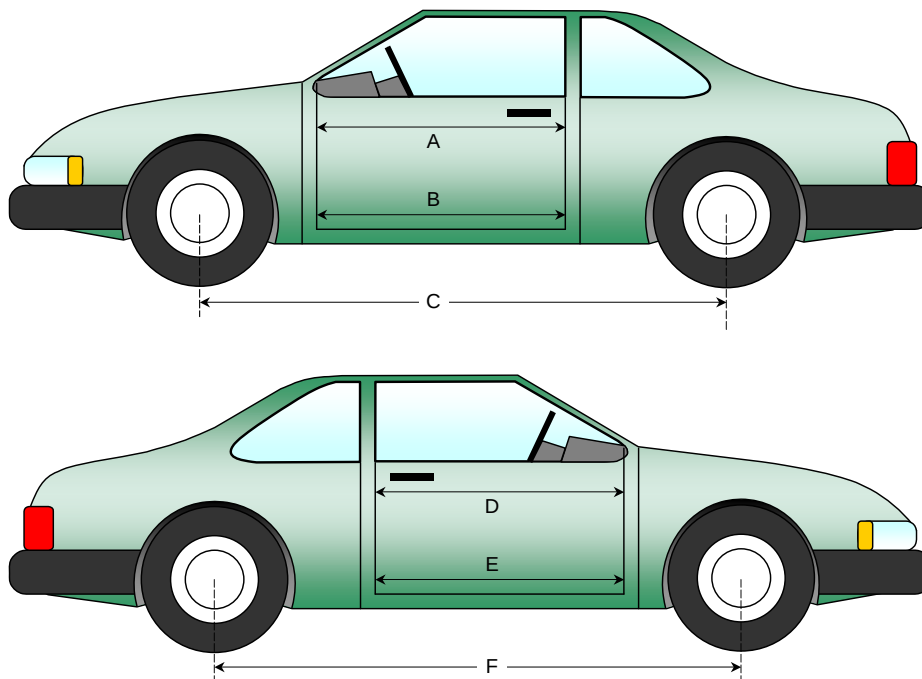
NHTSA No.: UB0500
 Test Date: 8/31/2010

DOOR OPENING WIDTH

Item	Description	Units	Pre-Test	Post-Test	Difference
A	Left Side Upper	mm	1025	1025	0
B	Left Side Lower	mm	983	978	5
D	Right Side Upper	mm	1025	1022	3
E	Right Side Lower	mm	983	978	5

WHEELBASE MEASUREMENTS

Item	Description	Units	Pre-Test	Post-Test	Difference
C	Left Side Wheelbase	mm	2796	2725	71
F	Right Side Wheelbase	mm	2796	2740	56



DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

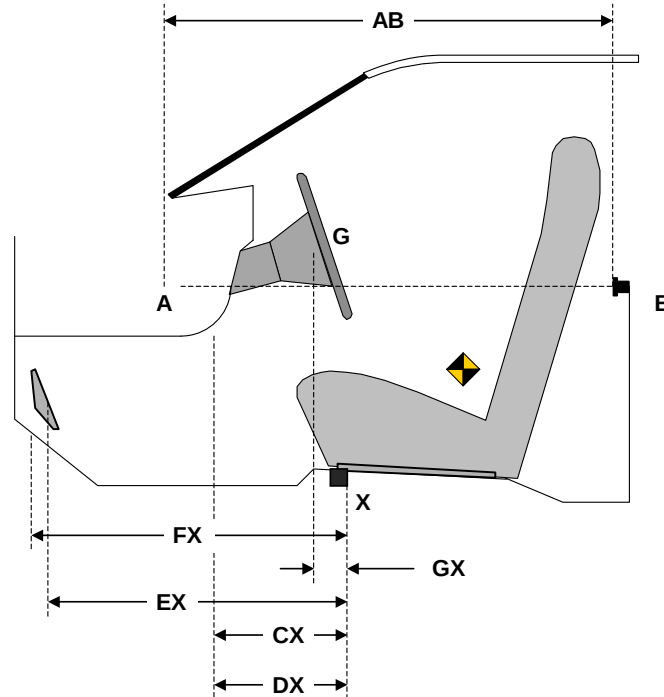
Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

DRIVER COMPARTMENT INTRUSION

Item	Description	Units	Pre-Test	Post-Test	Difference
AB	Door Opening (Inside window jam)	mm	864	864	0
CX	Left Knee Bolster to X	mm	282	298	-16
DX	Right Knee Bolster to X	mm	245	260	-15
EX	Brake Pedal to X	mm	565	550	15
FX	Foot Rest to X	mm	560	562	-2
GX	Center of Steering Column Wheel Hub to X	mm	92	122	-30

X = Front of Seat Track (stationary)

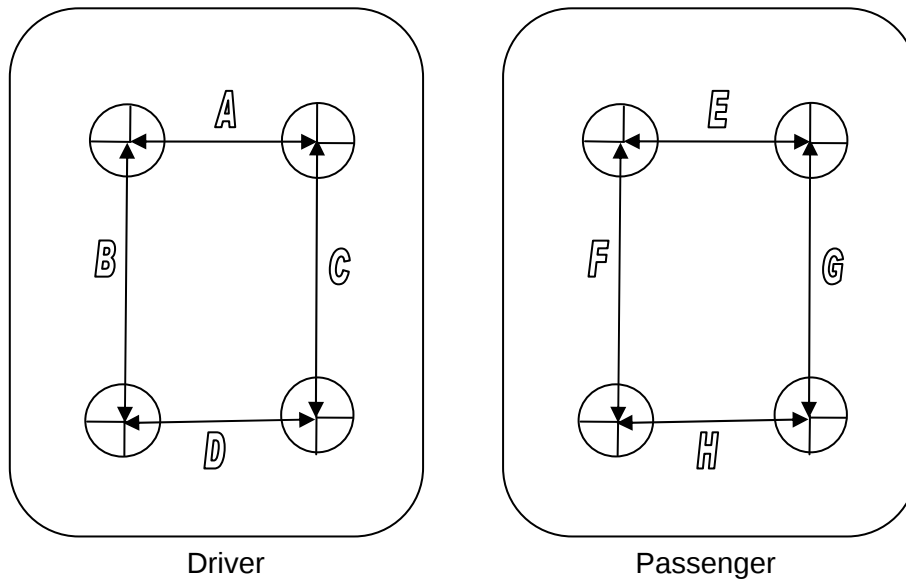


DRIVER COMPARTMENT

DATA SHEET NO. 14 (CONTINUED)
VEHICLE INTRUSION MEASUREMENTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010



TOP VIEW THROUGH FLOOR PAN

UNDERBODY FLOORBOARD DEFORMATION

Measurement	Units	Pre-Test	Post-Test	Difference
A	mm	300	296	4
B	mm	300	299	1
C	mm	300	299	1
D	mm	300	300	0
E	mm	300	299	1
F	mm	300	296	4
G	mm	300	296	4
H	mm	300	299	1

DATA SHEET NO. 15
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

Windshield Mounting Details:

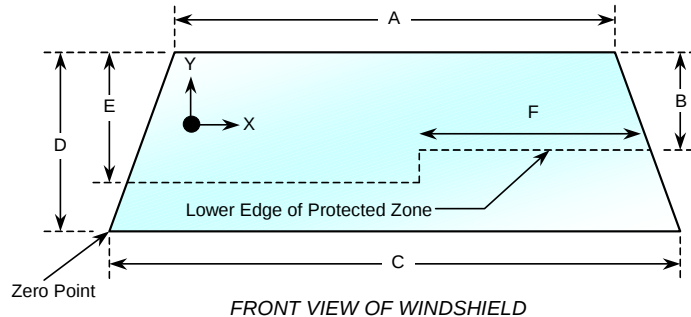
Windshield glass is secured to the vehicle frame with a rubber trim and glue.

The standard requires that the post-test retention measurement be a minimum of 75 percent of the pretest total periphery measurement for vehicles not equipped with occupant passive restraints and 50 percent for each side of the windshield for vehicles, which are equipped with occupant passive restraints.

Temperature of windshield molding during test: 21°C

WINDSHIELD PERIPHERY MEASUREMENTS

Measurement	Pre-Test (mm)	Post-Test (mm)	% of Retention
Left Side	2155	2155	100
Right Side	2155	2155	100
Total	4310	4310	100



Item	Units	Value
A	mm	1192
B	mm	486
C	mm	1464
D	mm	827
E	mm	549
F	mm	485

AREA OF PROTECTED ZONE FAILURES - NONE

A. Provide coordinates of the area that the protected zone was penetrated more than 0.25 inches by a vehicle component other than one that is normally in contact with the windshield. **None**

X	Y

B. Provide coordinates of the area beneath the protected zone that the inner surface of the windshield was penetrated by a vehicle component. **None**

X	Y

DATA SHEET NO. 15 (CONTINUED)
SUMMARY OF FMVSS 212, 219 (PARTIAL), AND 301 DATA

Test Vehicle:	<u>2011 Hyundai Sonata GLS 4-Dr Sedan</u>	NHTSA No.:	<u>UB0500</u>
Test Program:	<u>NCAP Frontal Barrier Impact Test</u>	Test Date:	<u>8/31/2010</u>

FMVSS 301 FUEL SYSTEM INTEGRITY POST IMPACT DATA

Test Time:	<u>10:34 am</u>	Temperature:	<u>21° C</u>
------------	-----------------	--------------	--------------

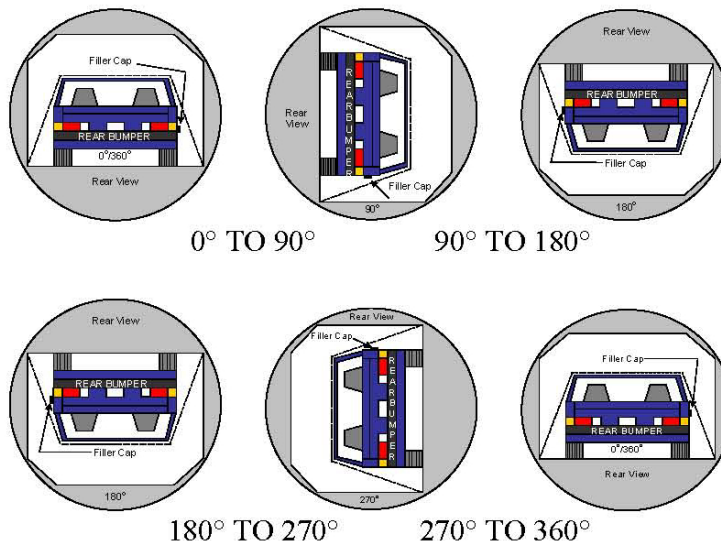
- | | |
|---|--------------|
| A. From impact until vehicle motion ceases:
(Maximum Allowable = 1 ounce) | <u>0</u> oz. |
| B. For the 5 minute period after motion ceases:
(Maximum allowable = 5 ounces) | <u>None</u> |
| C. For the following 25 minutes:
(Maximum allowable = 1 oz./minute) | <u>None</u> |
| D. Spillage Details: | <u>None</u> |

DATA SHEET NO. 16
FMVSS 301 STATIC ROLLOVER RESULTS

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
 Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
 Test Date: 8/31/2010

1. The specified fixture rollover rate for each 90° of rotation is 60 to 180 seconds.
2. The position hold time at each position is 300 seconds (minimum).
3. Details of Stoddard Solvent spillage: **None**



SOLVENT COLLECTION TIME TABLE IN SECONDS

Test Phase	Rotation Time	Hold Time	Total Time
0° to 90°	108	300	408
90° to 180°	110	300	410
180° to 270°	103	300	403
270° to 360°	115	300	415

FMVSS 301 ROLLOVER SPILLAGE TABLE (units in ounces)

Test Phase	First 5 Minutes	Sixth Minute	Seventh Minute	Eight Minute
0° to 90°	0	0	0	0
90° to 180°	0	0	0	0
180° to 270°	0	0	0	0
270° to 360°	0	0	0	0

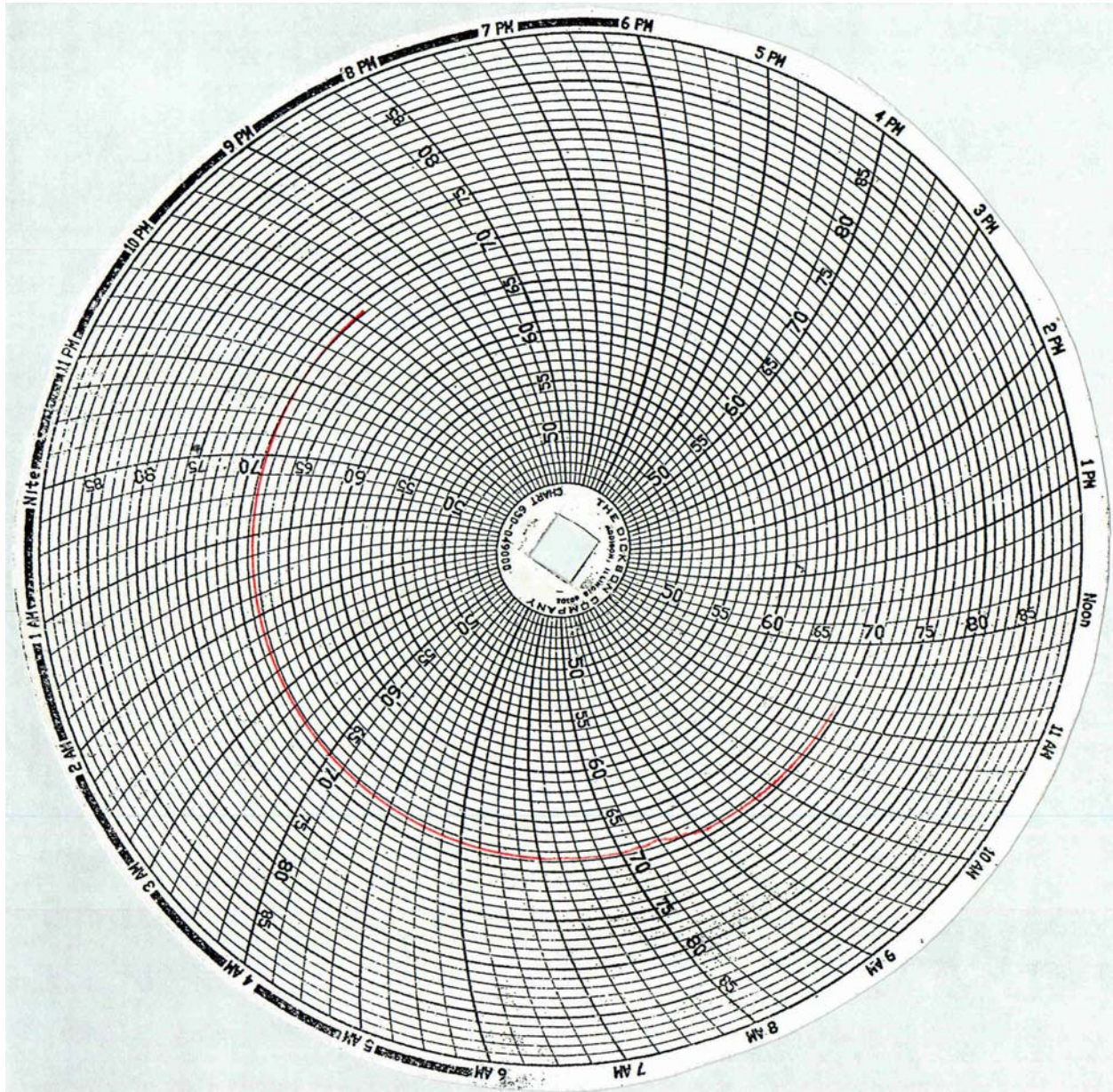
ROLLOVER SOLVENT SPILLAGE LOCATION TABLE

Test Phase	Spillage Location
0° to 90°	
90° to 180°	
180° to 270°	
270° to 360°	

DATA SHEET NO. 17
DUMMY/VEHICLE TEMPERATURE STABILIZATION DATA

Test Vehicle: 2011 Hyundai Sonata GLS 4-Dr Sedan
Test Program: NCAP Frontal Barrier Impact Test

NHTSA No.: UB0500
Test Date: 8/31/2010



APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

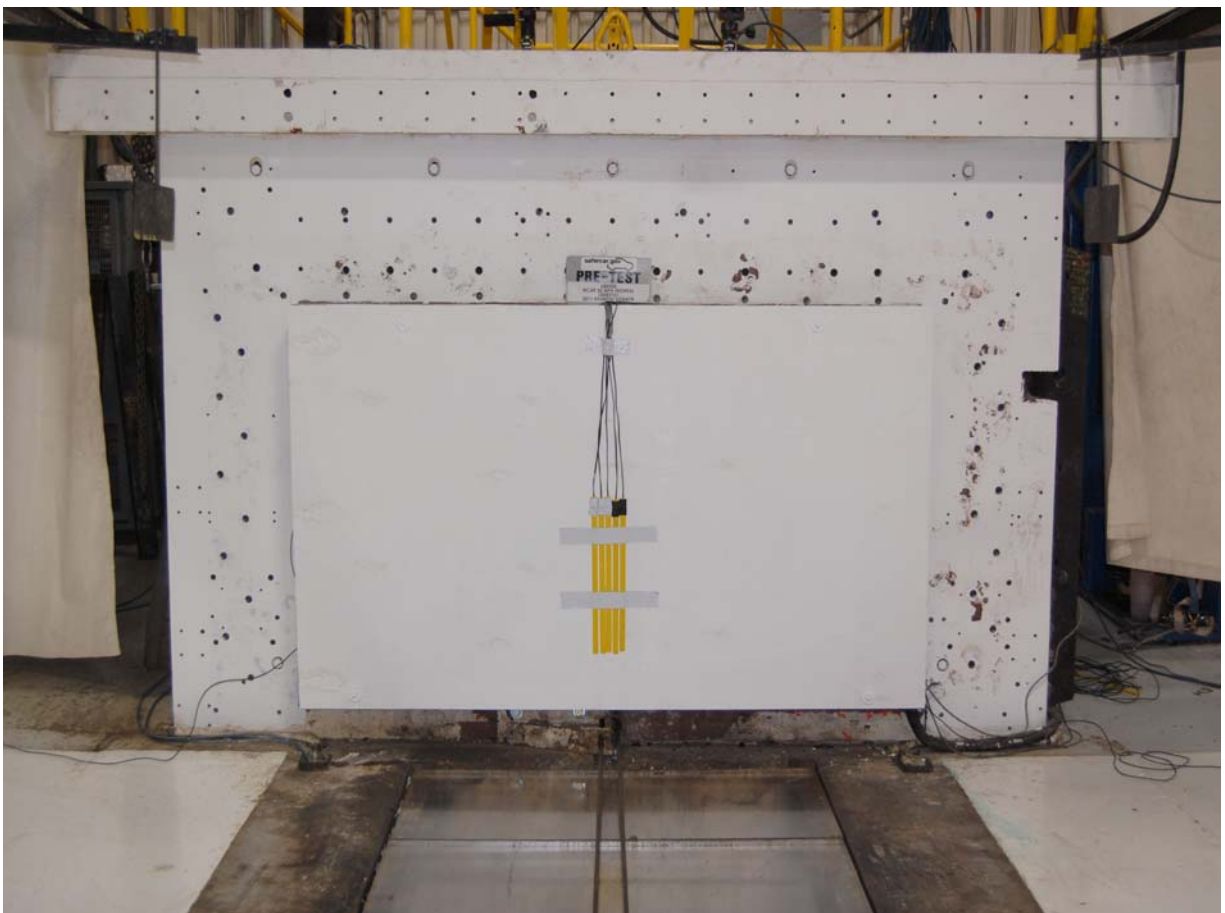
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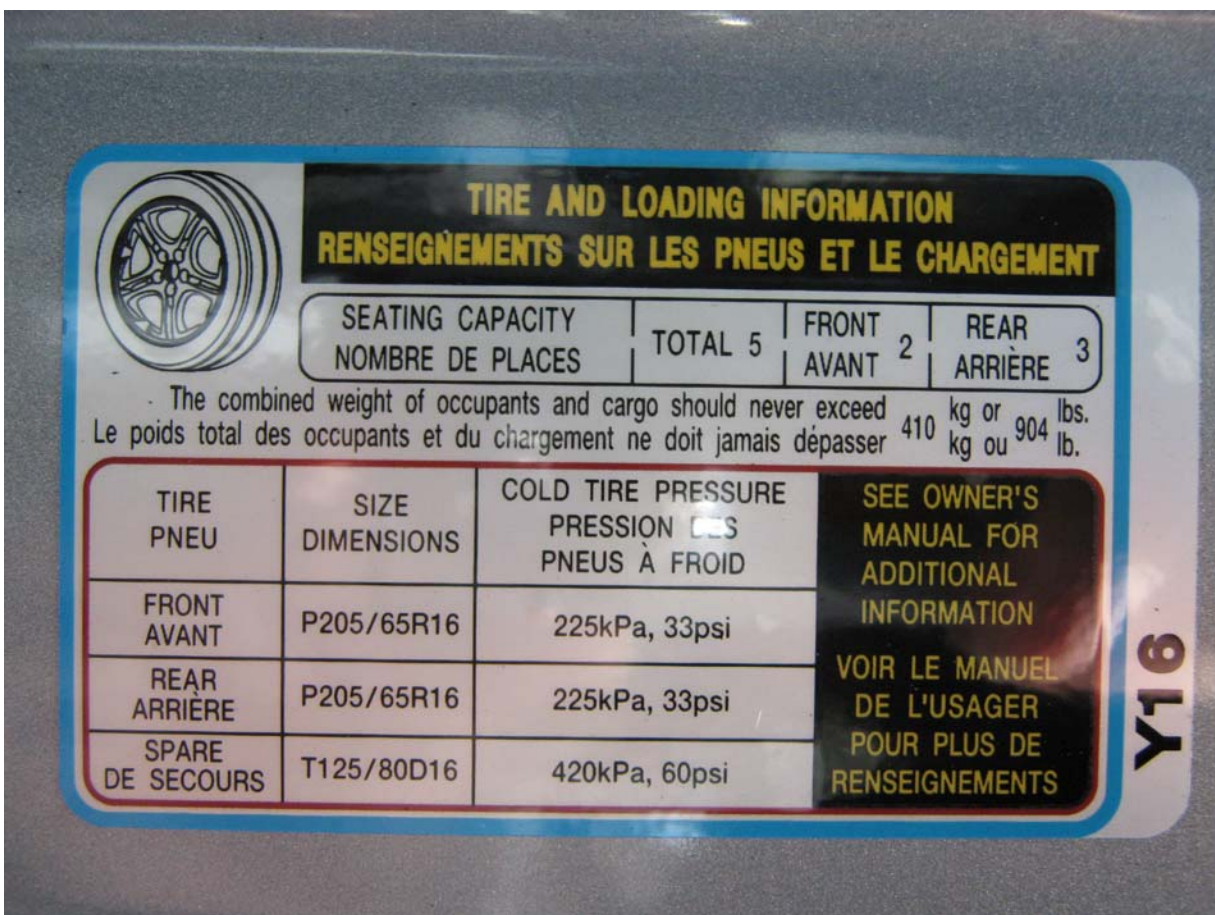
Load Cell Location



Load Cell Wall



Manufacturer's Label



Tire Placard



Right Front Three-Quarter View, As Received



Left Rear Three-Quarter View, As Received



Pre-Test Front View



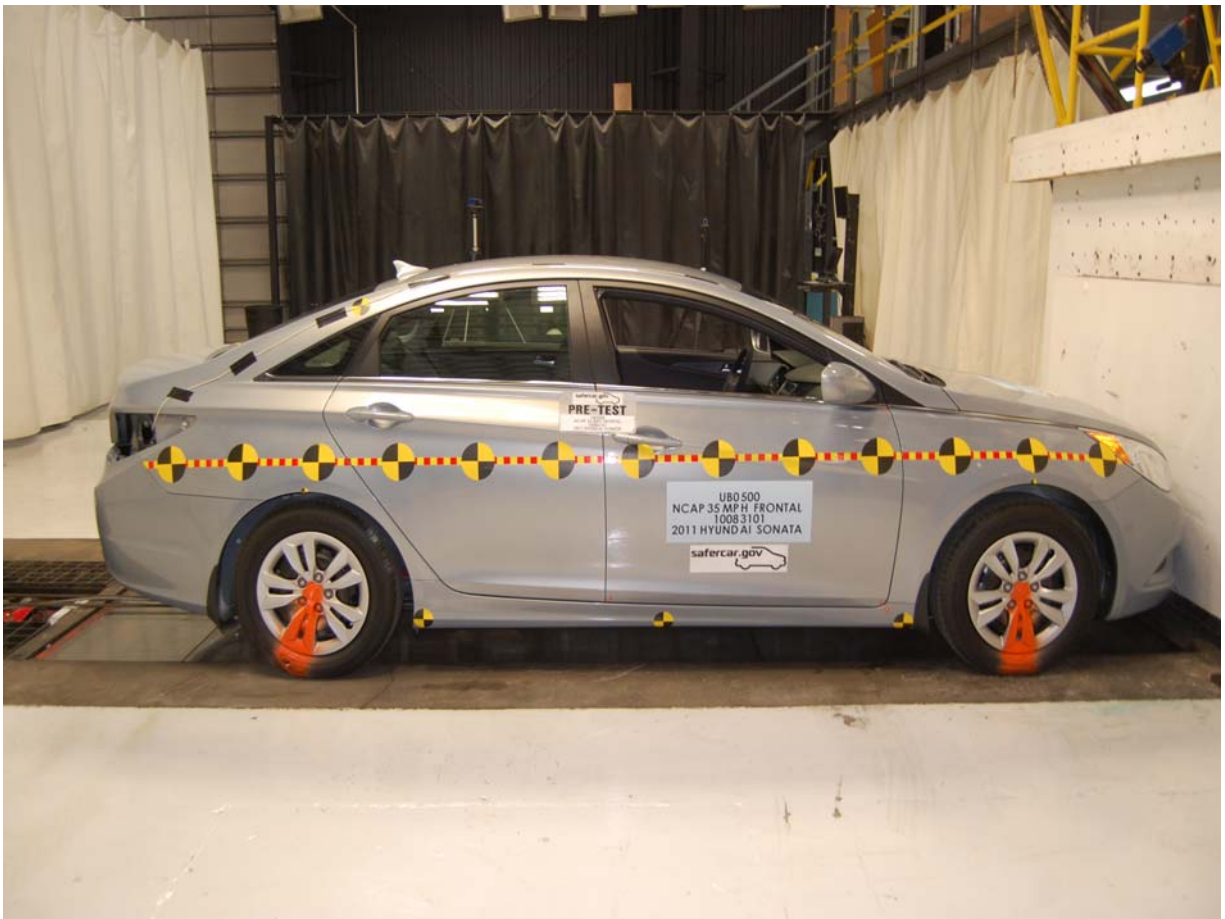
Post-Test Front View



Pre-Test Left Side View (with vehicle at barrier)



Post-Test Left Side View



Pre-Test Right Side View (with vehicle at barrier)



Post-Test Right Side View



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



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



Pre-Test Left Rear $\frac{3}{4}$ View (with vehicle at barrier)



Post-Test Left Rear $\frac{3}{4}$ View



Pre-Test Windshield View



Post-Test Windshield View



Pre-Test Engine Compartment View



Post-Test Engine Compartment View



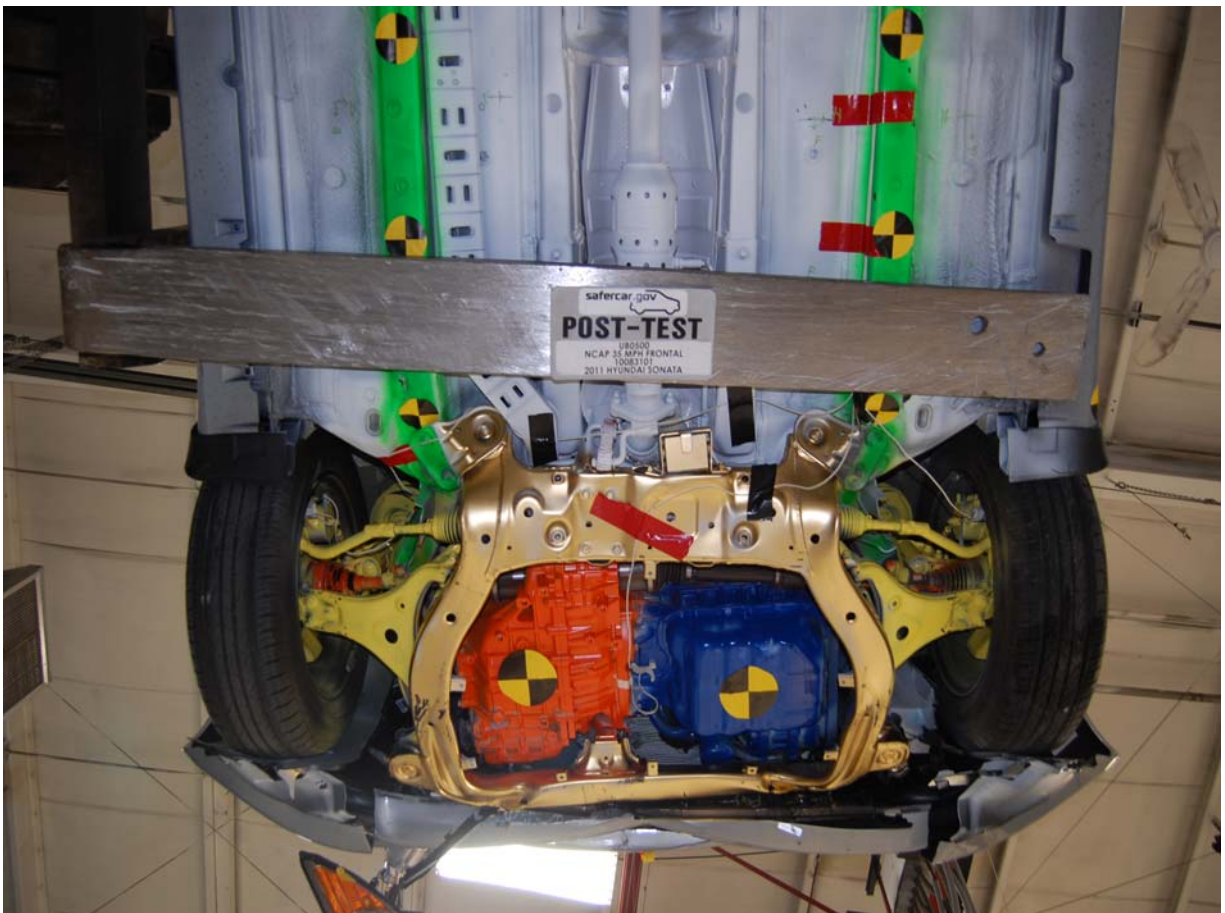
Pre-Test Fuel Cap View



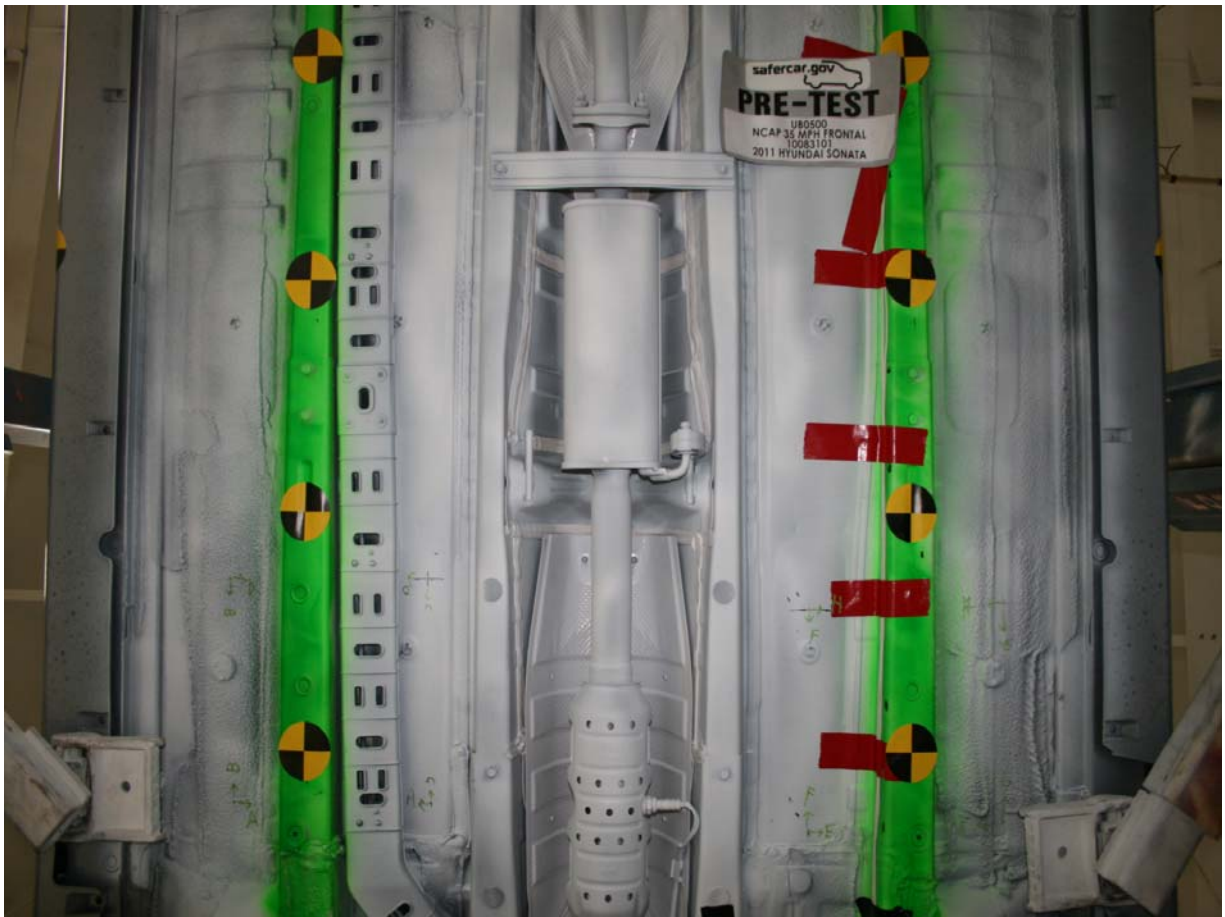
Post-Test Fuel Cap View



Pre-Test Front Underbody View



Post-Test Front Underbody View



Pre-Test Mid Underbody View



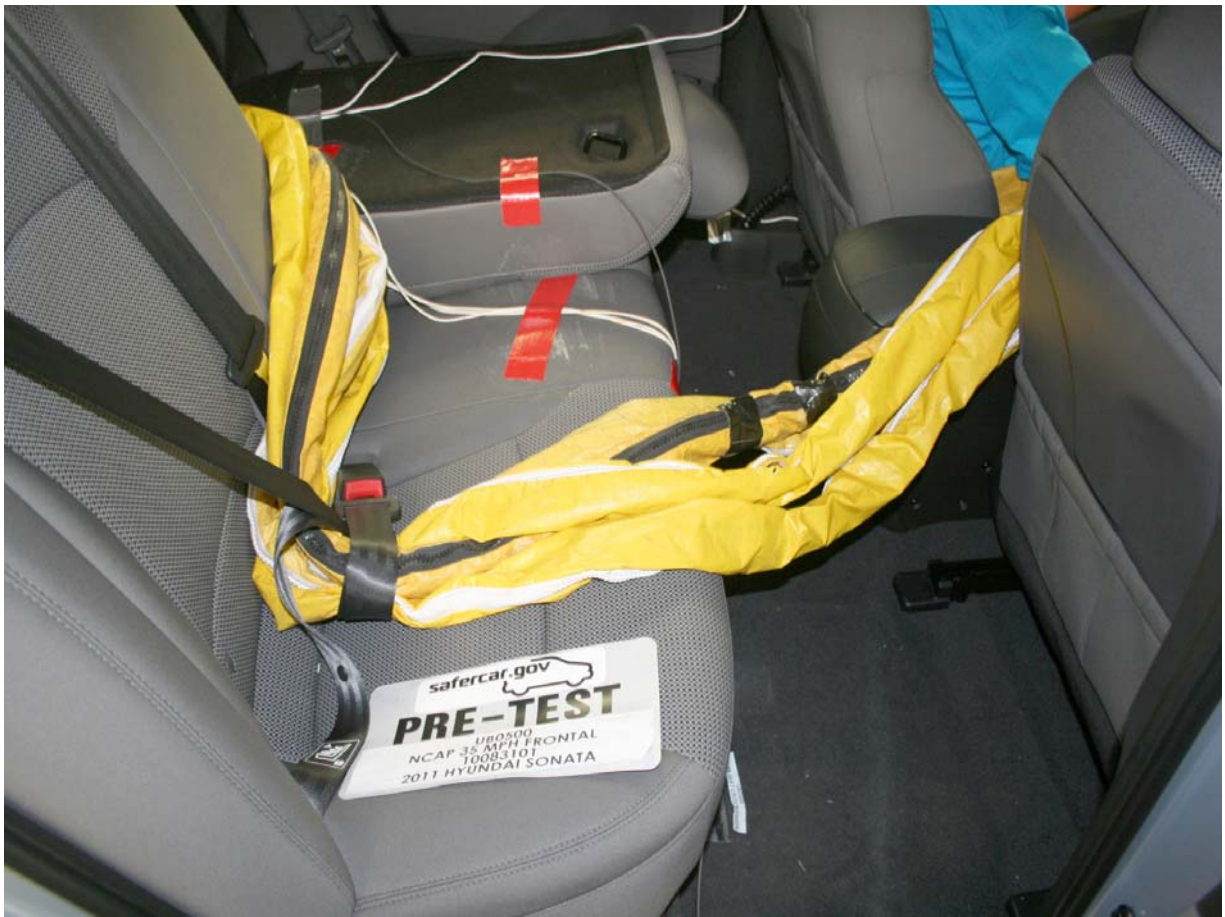
Post-Test Mid Underbody View



Pre-Test Rear Underbody View



Post-Test Rear Underbody View



Pre-Test Dummy Cable Routing



Post-Test Dummy Cable Routing



Pre-Test Driver Dummy Front View



Post-Test Driver Dummy Front View



Pre-Test Driver Dummy Window View



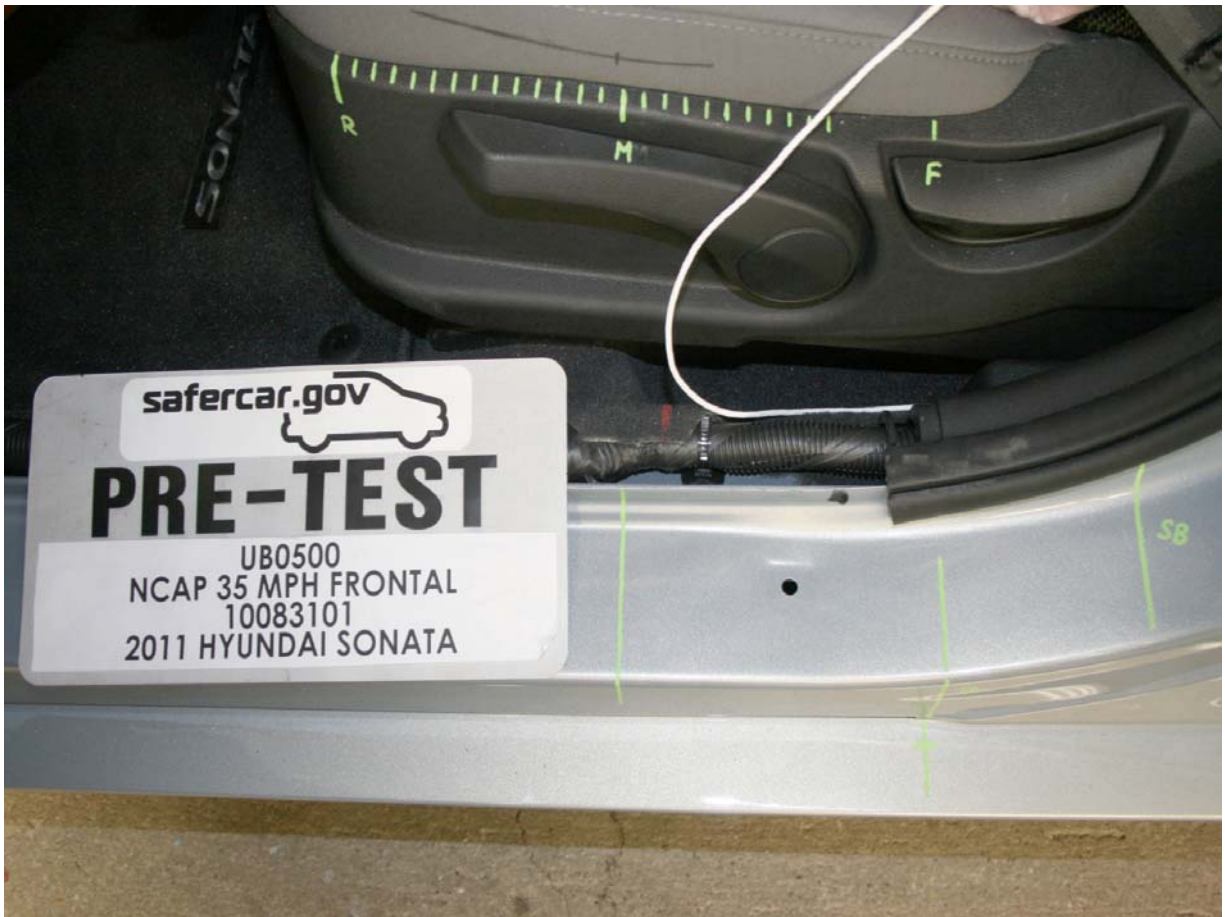
Post-Test Driver Dummy Window View



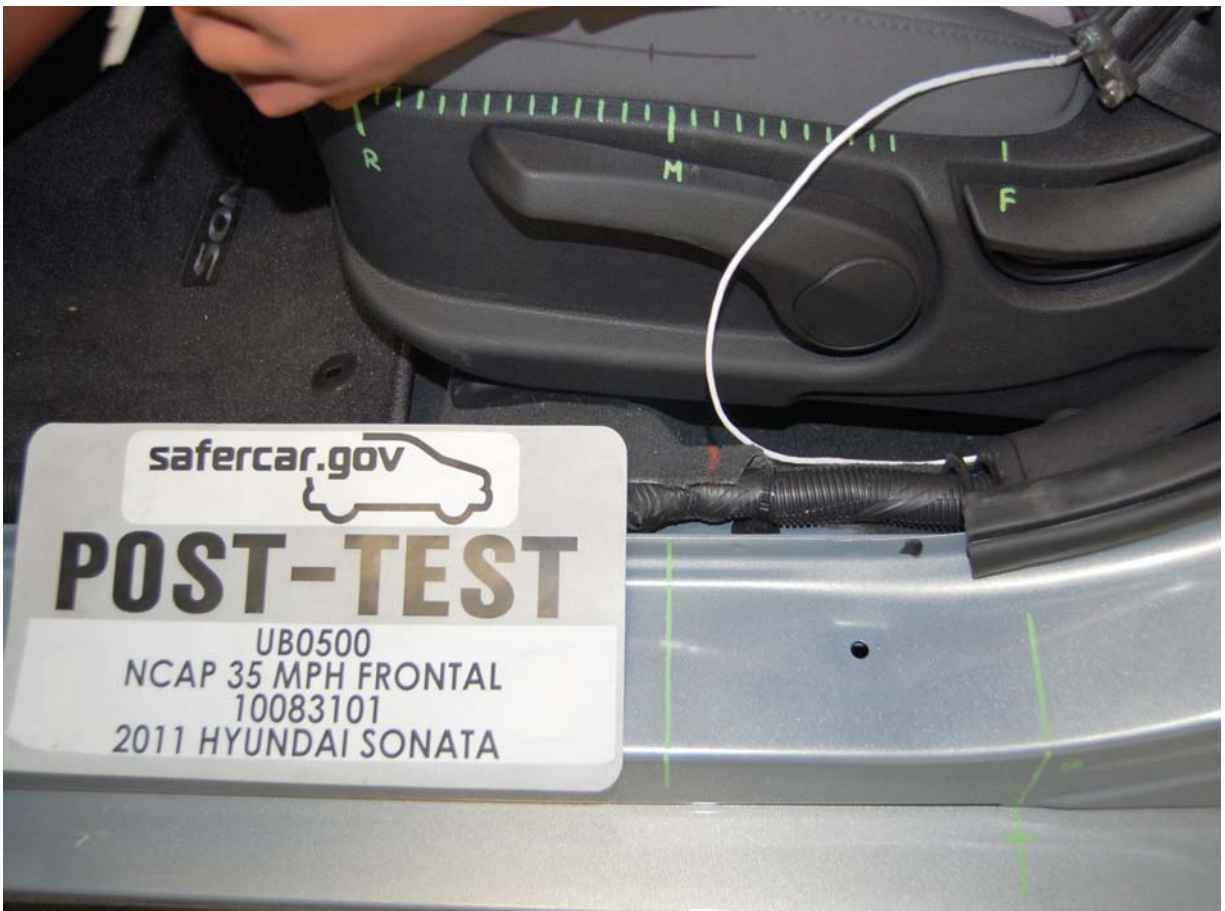
Pre-Test Driver Dummy and Vehicle Interior (Door Open)



Post-Test Driver Dummy and Vehicle Interior (Door Open)



Pre-Test Driver's Seat Fore-Aft Markings



Post-Test Driver's Seat Fore-Aft Markings



Pre-Test Driver Dummy Feet



Post-Test Driver Dummy Feet



Pre-Test Driver's Side Knee Bolster (without dummy)



Post-Test Driver's Side Knee Bolster (without dummy)



Pre-Test Driver's Side Floorpan



Post-Test Driver's Side Floorpan



Post-Test Driver Dummy Contact with Airbag



Post-Test Driver Dummy Contact with Headrest



Post-Test Driver Dummy Contact with Knee Bolster



Pre-Test View of Steering Column Shear Capsule



Post-Test View of Steering Column Shear Capsule



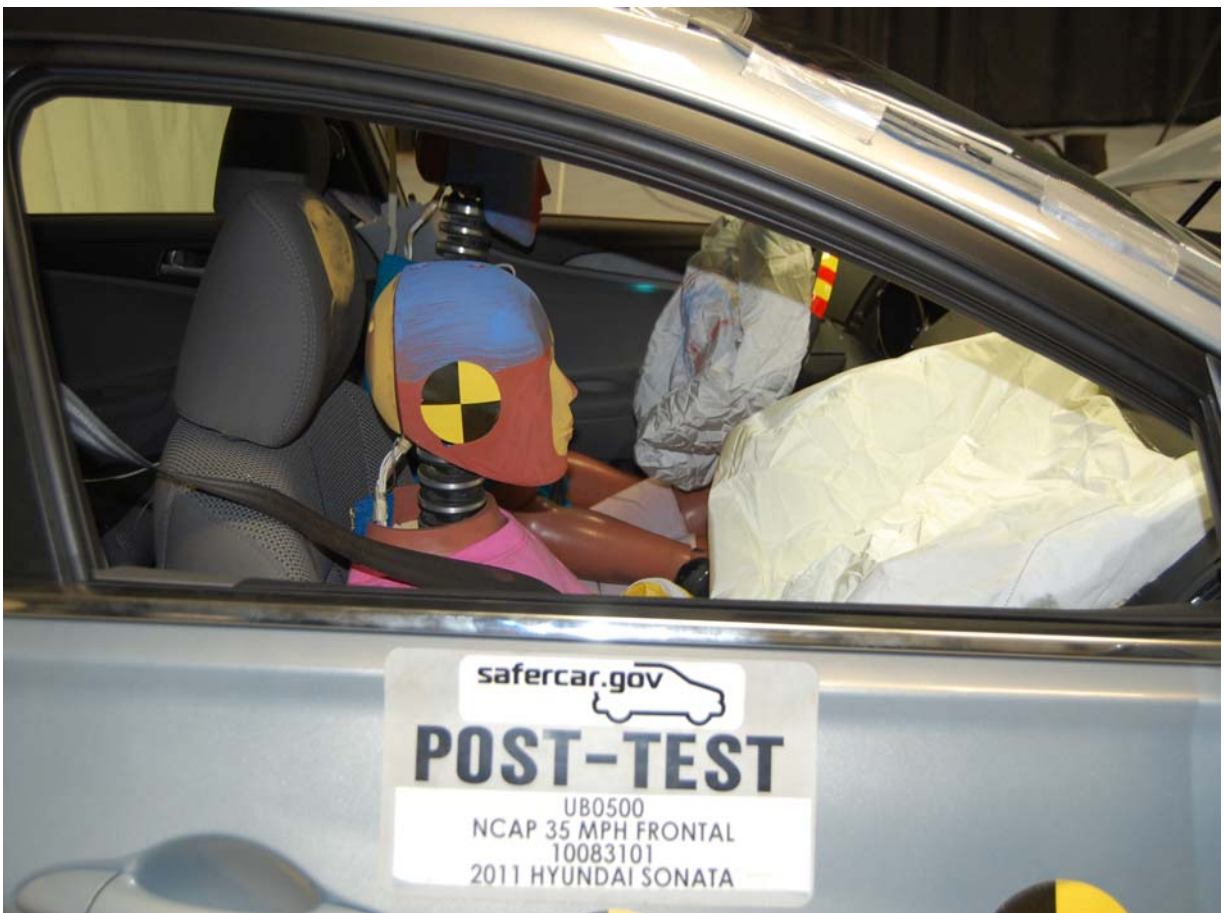
Pre-Test Passenger Dummy Front View



Post-Test Passenger Dummy Front View



Pre-Test Passenger Dummy Window View



Post-Test Passenger Dummy Window View



Pre-Test Passenger Dummy and Vehicle Interior (Door Open)



Post-Test Passenger Dummy and Vehicle Interior (Door Open)



Pre-Test Passenger's Seat Fore-Aft Markings



Post-Test Passenger's Seat Fore-Aft Markings



Pre-Test Passenger Dummy Feet



Post-Test Passenger Dummy Feet



Pre-Test Passenger's Side Knee Bolster (without dummy)



Post-Test Passenger's Side Knee Bolster (without dummy)



Pre-Test Passenger's Side Floorpan



Post-Test Passenger's Side Floorpan



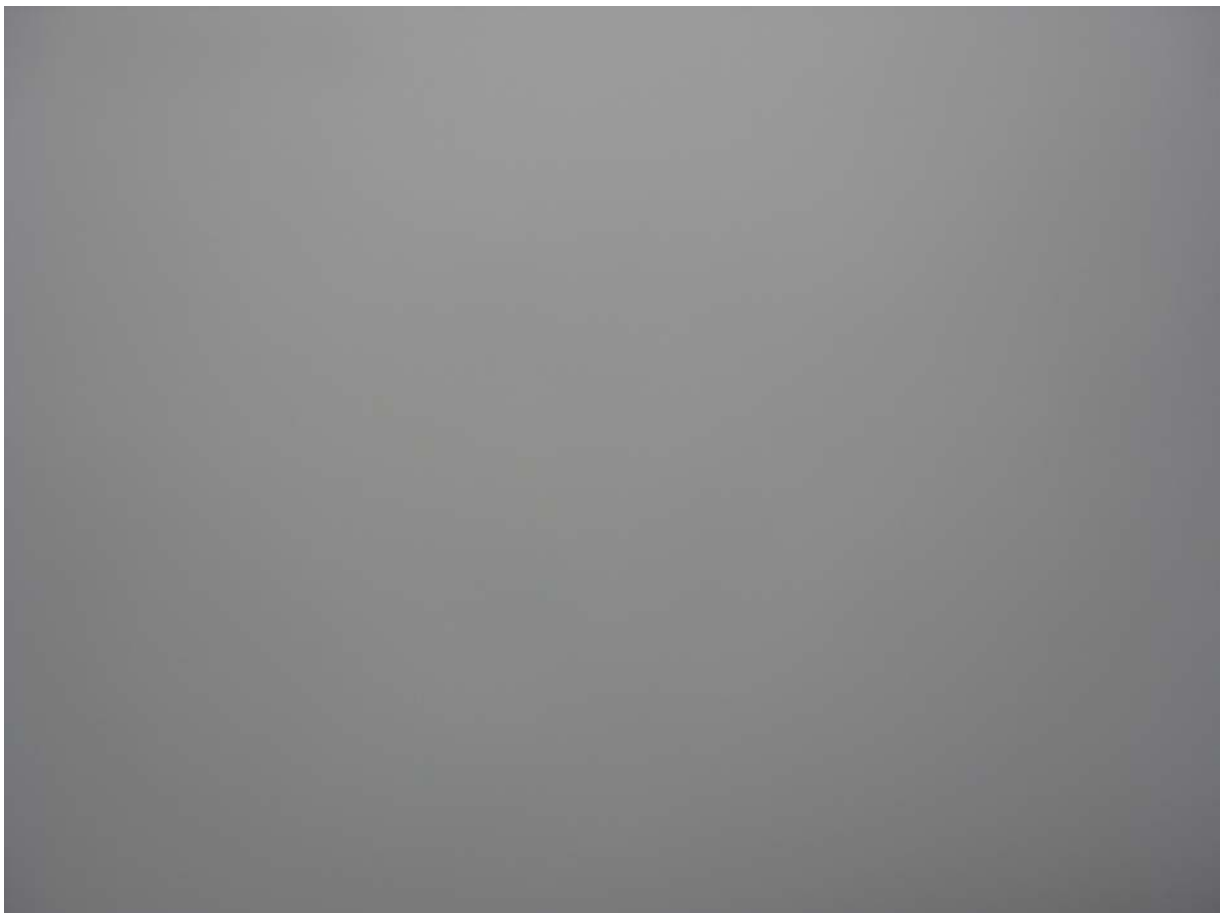
Post-Test Passenger Dummy Contact with Airbag



Post-Test Passenger Dummy Contact with Headrest



Ballast Installed in Vehicle



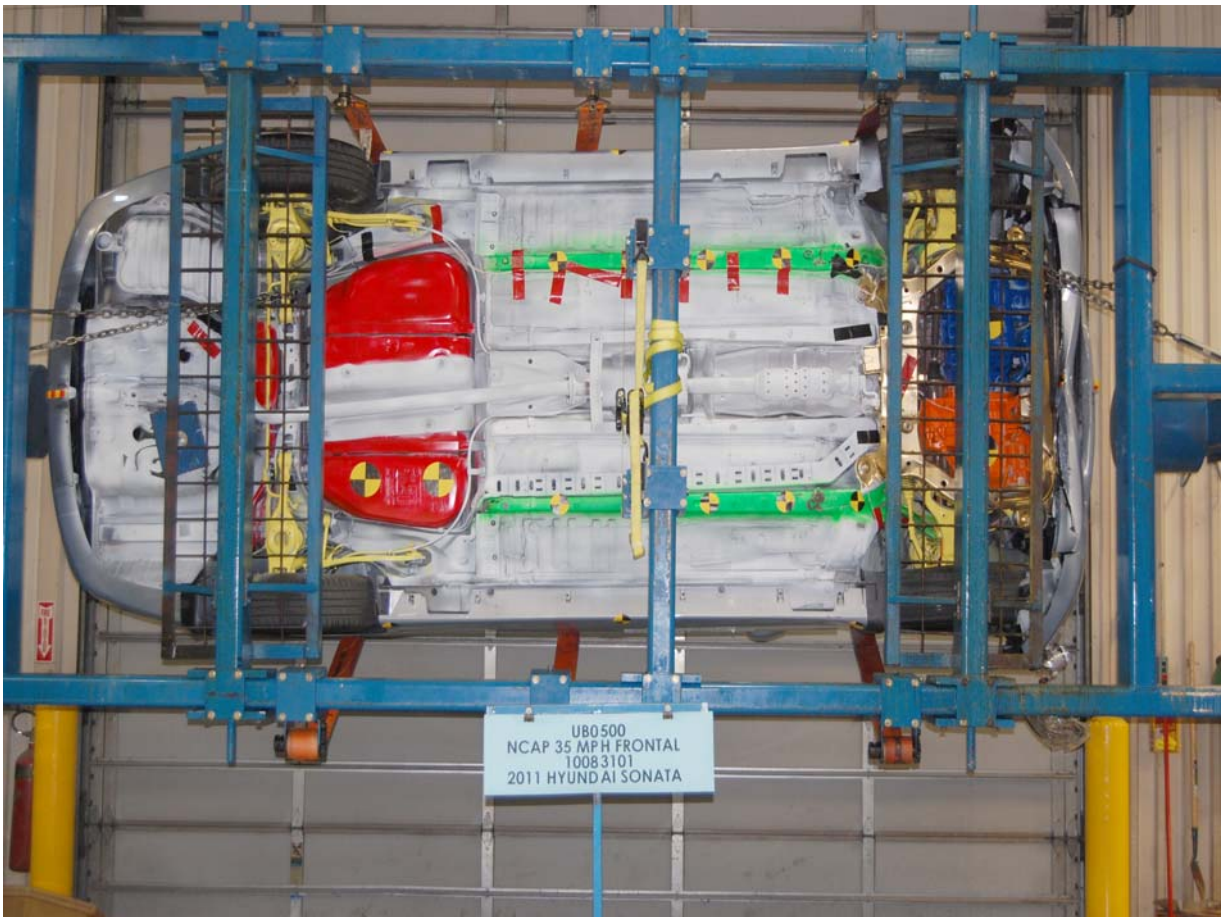
Post-Test Stoddard Solvent Spillage Location View, Not Applicable



Post-Test Speed Trap Read-Out



Vehicle at 0 Degrees on Static Rollover Device



Vehicle at 90 Degrees on Static Rollover Device



Vehicle at 180 Degrees on Static Rollover Device



Vehicle at 270 Degrees on Static Rollover Device



Vehicle at 360 Degrees on Static Rollover Device



Vehicle Impact



HYUNDAI

2011 SONATA GLS



Fuel Economy, Safety, Design, and Technology

VIN: 5NPEB4AC8BH109084
MODEL: 2740Z
ENGINE: G4KJAK110483

SOLD TO: IL076
WILKINS HYUNDAI
750 N. YORK STREET
ELMHURST, IL 60126

PORT OF ENTRY: MA
COLOR: Iridescent Silver Blue Pearl
MODE OF TRANSPORT: Truck
ACCESSORY WEIGHT: 17 lbs.
SHIPPED TO: IL076

Manufacturer's suggested retail price includes manufacturer's recommended pre-delivery service, Gasoline license and title fees, state and local taxes and dealer installed options and accessories are not included in the manufacturer's suggested retail price.

This label has been affixed to this vehicle by Hyundai Motor America, pursuant to the requirements of 35 U.S.C. 1231 et seq, which prohibits its removal or alteration prior to delivery to the ultimate purchaser.

PART CONTENT INFORMATION

FOR VEHICLES IN THIS CARLINE: U.S./CANADIAN PARTS CONTENT: 41 %
MAJOR SOURCES OF FOREIGN PARTS CONTENT: 58 %

FOR THIS VEHICLE: FINAL ASSEMBLY, DISTRIBUTION, OR OTHER NON-PARTS COSTS.

FOR THIS VEHICLE: FINAL ASSEMBLY POINT: Montgomery, Alabama U.S.A.

COUNTRY OF ORIGIN: ENGINE: U.S.A. TRANSMISSION: Korea

EPA Fuel Economy Estimates

CITY MPG

22

Expected range for most drivers
18 to 26 MPG

HIGHWAY MPG

35

Expected range for most drivers
29 to 41 MPG

Estimated Annual Fuel Cost

\$1,501.00
based on 15,000 miles at \$2.60 per gallon

Combined Fuel Economy

26
This Vehicle
All Large Cars



See the Free Fuel Economy Guide at dealers or www.fueleconomy.gov

STANDARD FEATURES:

- 5-year/60,000-mile New Vehicle Warranty*
- 10-year/100,000-mile Powertrain Warranty*
- 7-year/Unlimited-mile Anti-rust Protection
- 5-year/Unlimited-mile Roadside Assistance
- *Unlimited warranties, see dealer for details
- **ADVANCED SAFETY TECHNOLOGY**
- Electronic Stability Control (ESC) w/ Traction Control
- ABS w/ Electronic Brake Force Distribution & Brake Assist
- 4-Wheel Disc Brakes
- Front Side-Impact Protection
- Front Active Head Restraints
- Front Seatbelt Pre-Tensioners
- Tire Pressure Monitoring System
- Daytime Running Lights
- **POWERTRAIN TECHNOLOGY**
- 2.4L Gasoline Direct Injection (GDI) 4-Cylinder Engine
- Continuous Variable Valve Timing
- 16-Speaker Premium Sound System w/ SHIFTRONICS®
- **COMFORT & CONVENIENCE**
- 16-Inch Wheels w/ Full Covers and P205/65R16 Tires
- Chrome Window Belt-Line Molding
- Solar Control Window Glass
- Remote Keyless Entry w/ Alarm
- Power Heated Outside Mirror
- Power Windows, Locks & Mirrors
- Power Door Locks
- Metalgrain Interior Accents
- 60/40 Split-Folding Rear Seat
- Tilt-and-Telescopic Steering Column
- Steering Wheel Mounted Cruise, Audio & Phone Controls
- Air Conditioning
- Cabin Air Filter
- XM Satellite Radio w/ 30-Day Trial; Not Available in AK & HI
- iPod®/USB & Auxiliary Input Jacks
- Integrated Bluetooth® Hands-free Phone System
- Advanced Trip Computer w/ Custom Settings
- ECO Indicator Light
- EZ Lane Change Assist (Three-Blink Turn Signal Programming)
- Full Tank of Gas

ADDED FEATURES:

- Carpeted Floor Mats
- Cargo Mat
- Cargo Net
- iPod® Cable
- Mud Guards

Manufacturer's Suggested Retail Price:

\$20,195.00

*Emissions are certified to meet emission requirements in all 50 states.

Inland Freight & Handling:

\$720.00

TOTAL PRICE:

\$21,280.00

GOVERNMENT SAFETY RATINGS

Frontal Crash Driver Not Rated
Passenger Not Rated

Star ratings based on the risk of injury in a frontal impact. Frontal ratings should ONLY be compared to other vehicles of similar size and weight.

Side Crash Front seat Not Rated
Rear seat Not Rated

Star ratings based on the risk of injury in a side impact.

Rollover Not Rated

Star ratings based on the risk of rollover in a single vehicle crash.

Star ratings range from 1 to 5 stars, with 5 being the highest. Source: National Highway Traffic Safety Administration (NHTSA).

www.safercar.gov or 1-888-327-4236

Environmental Performance

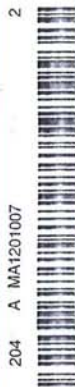
Protect the environment, choose vehicles with higher scores:

Global Warming Score



Vehicle emissions are a primary contributor to global warming and smog. Scores are determined by the California Air Resources Board based on this vehicle's measured emissions. Please visit www.DriveClean.ca.gov for more information. **AIR RESOURCES BOARD**

204 A MA1201007



APPENDIX B
DUMMY RESPONSE DATA

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The following dummy and vehicle response data can be found in the R&D section of the NHTSA website at www.nhtsa.dot.gov

Driver Head X Redundant

Driver Head Y Redundant

Driver Head Z Redundant

Driver Upper Neck Force Y

Driver Upper Neck Moment X

Driver Upper Neck Moment Z

Driver Chest X Redundant

Driver Chest Y Redundant

Driver Chest Z Redundant

Driver Pelvis X

Driver Pelvis Y

Driver Pelvis Z

Driver Shoulder Belt Force

Driver Lap Belt Force

Driver Left Upper Tibia Moment X

Driver Left Upper Tibia Moment Y

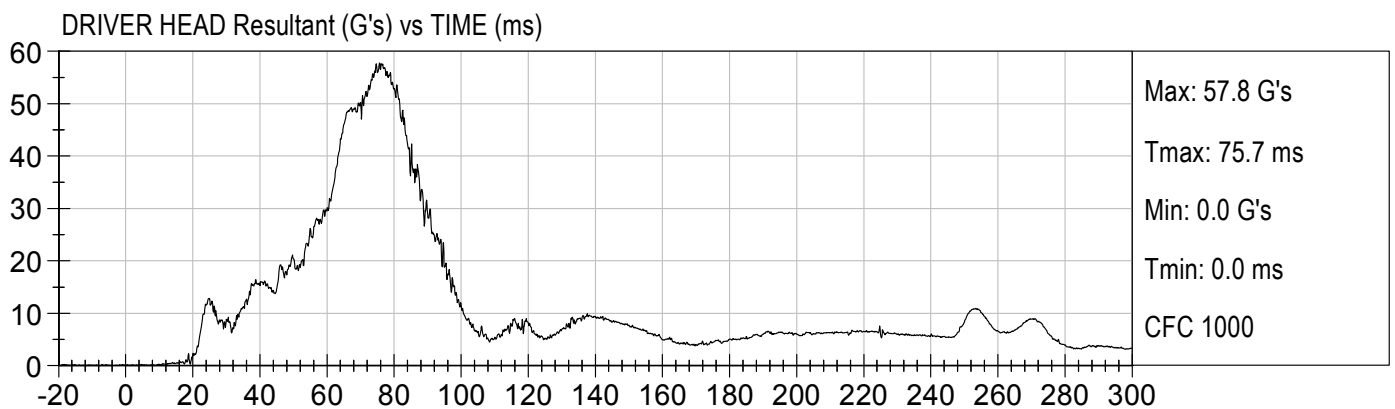
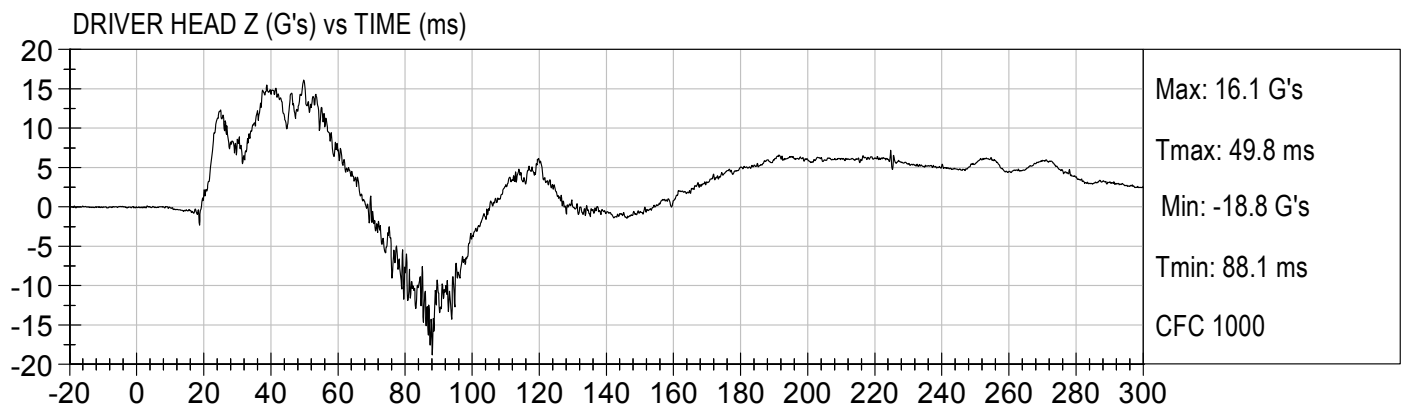
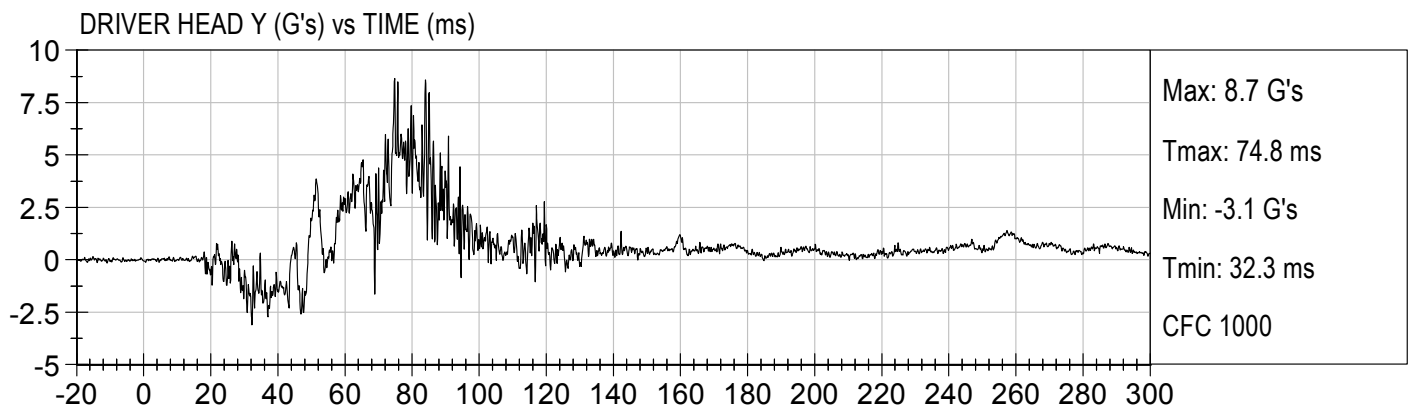
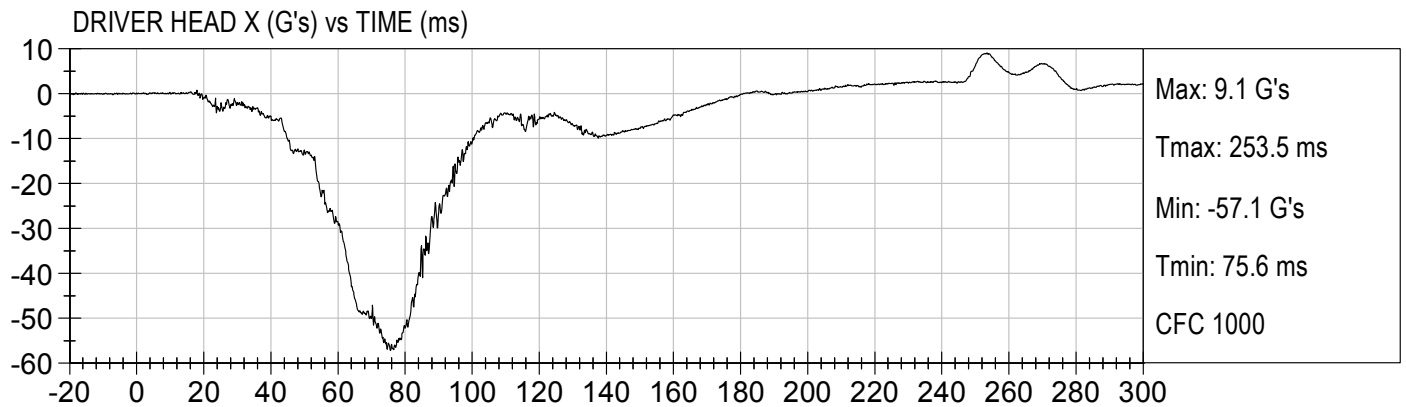
Driver Left Upper Tibia Force Z

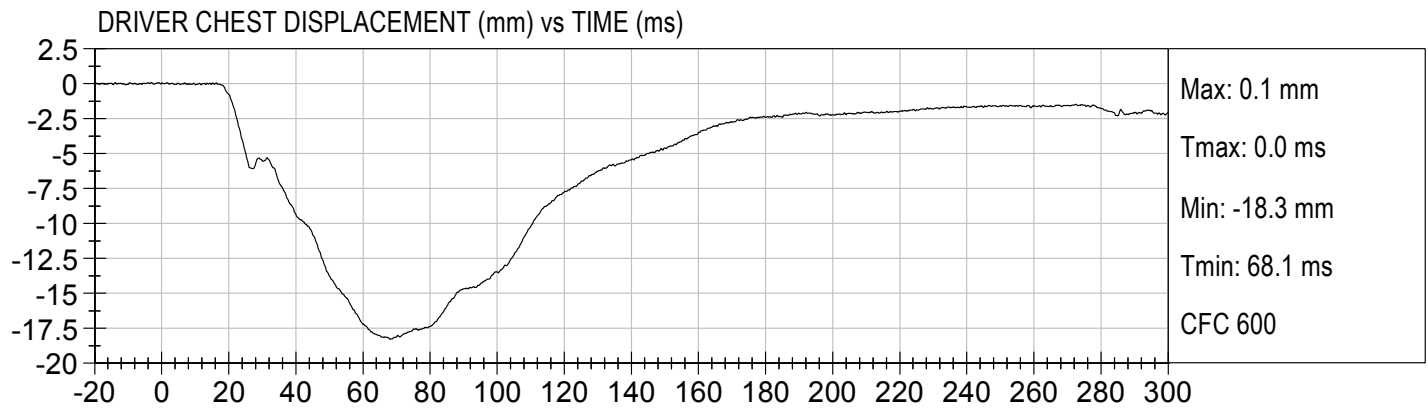
Driver Left Lower Tibia Moment X

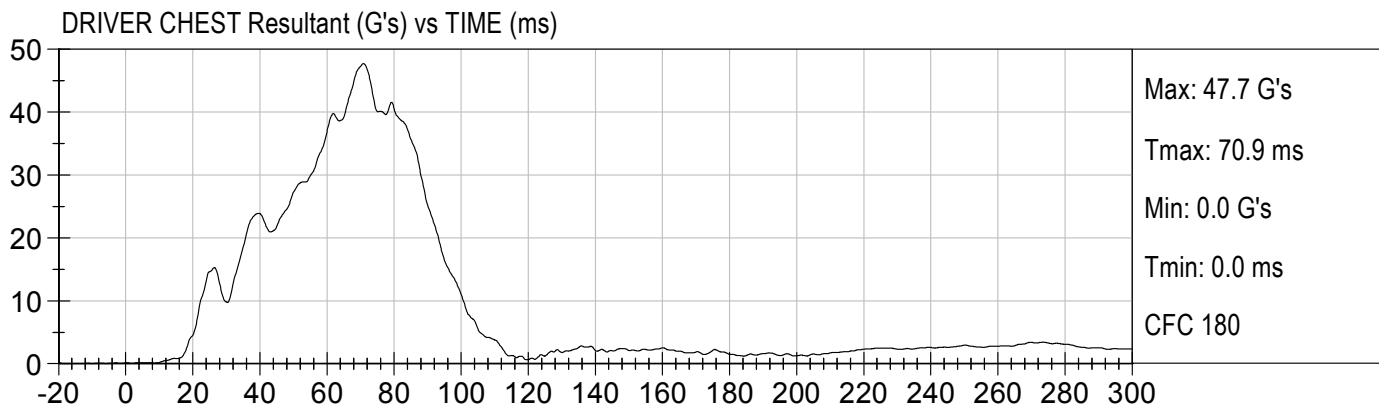
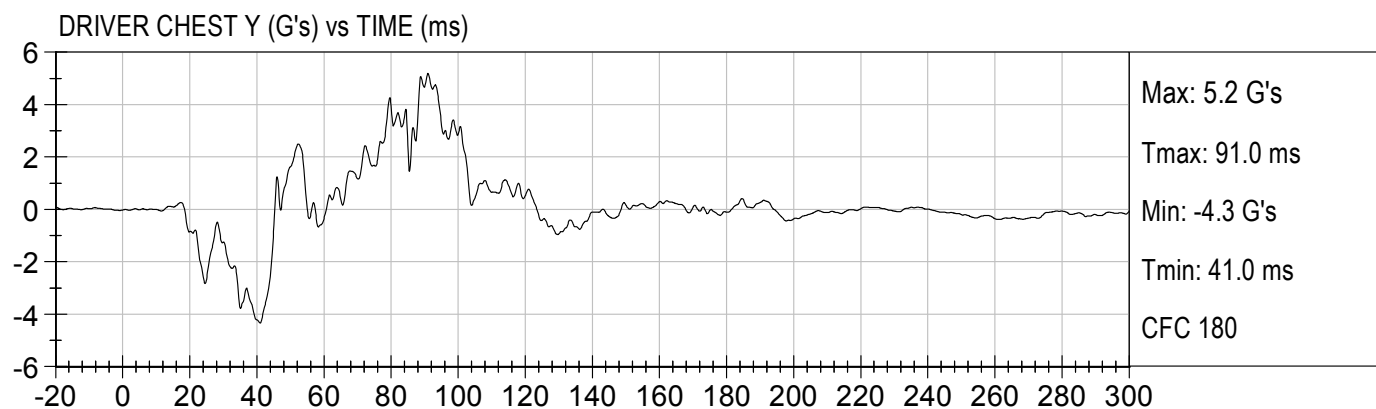
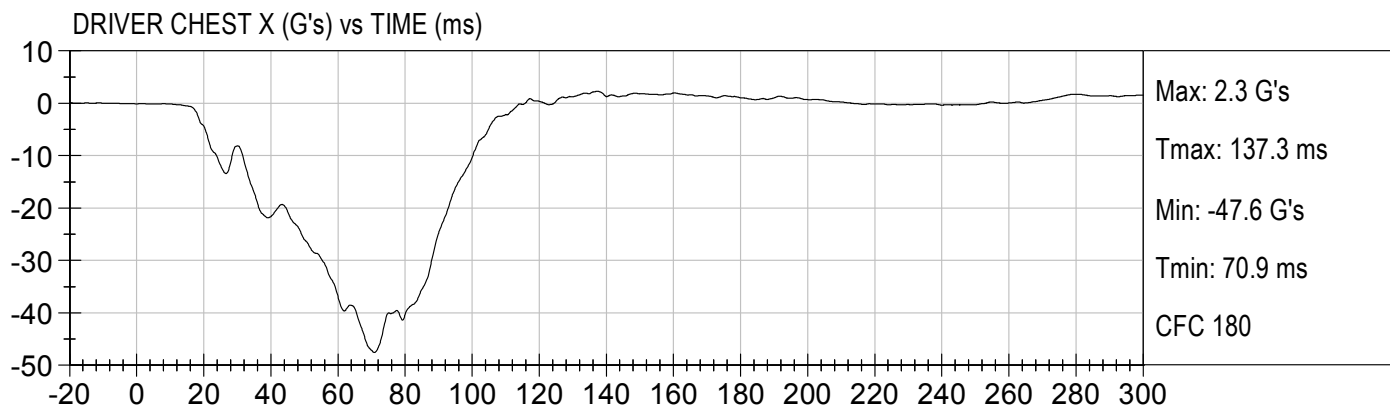
Driver Left Lower Tibia Moment Y

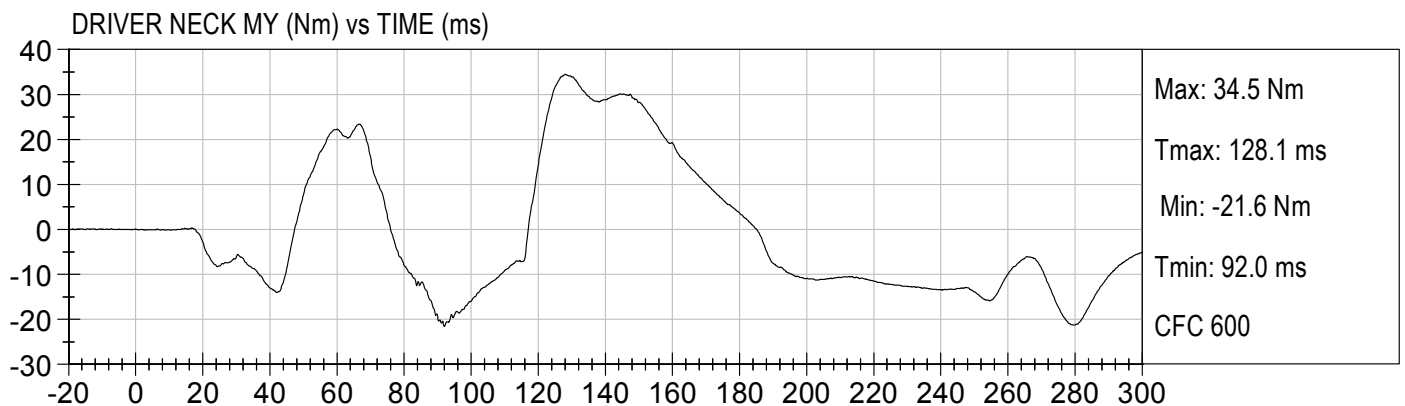
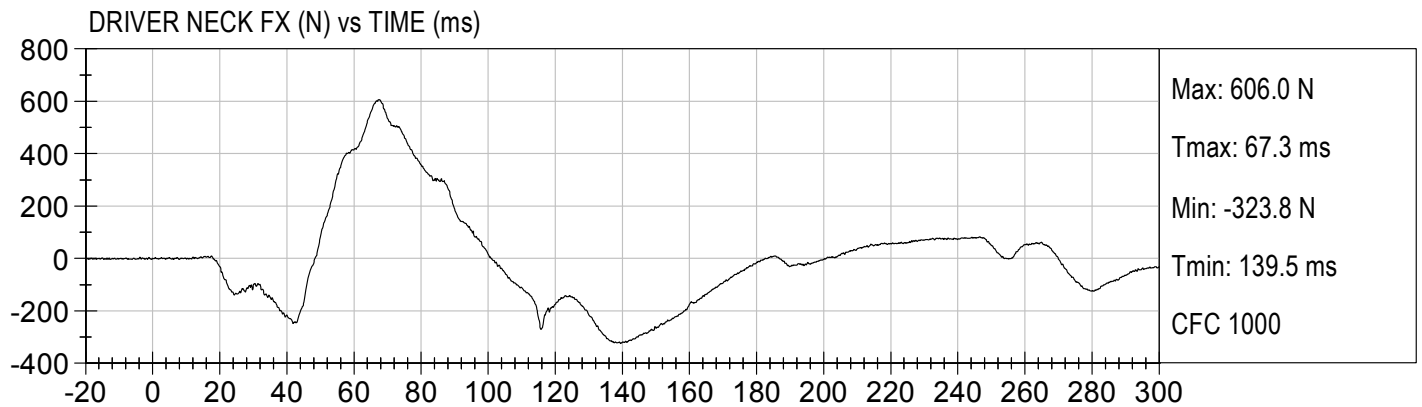
Driver Left Lower Tibia Force Z
Driver Right Upper Tibia Moment X
Driver Right Upper Tibia Moment Y
Driver Right Upper Tibia Force Z
Driver Right Lower Tibia Moment X
Driver Right Lower Tibia Moment Y
Driver Right Lower Tibia Force Z
Driver Left Foot Fore Z
Driver Left Foot Aft X
Driver Left Foot Aft Z
Driver Right Foot Fore Z
Driver Right Foot Aft X
Driver Right Foot Aft Z
Passenger Head X Redundant
Passenger Head Y Redundant
Passenger Head Z Redundant
Passenger Upper Neck Force Y
Passenger Upper Neck Moment X
Passenger Upper Neck Moment Z
Passenger Chest X Redundant
Passenger Chest Y Redundant
Passenger Chest Z Redundant
Passenger Pelvis X
Passenger Pelvis Y
Passenger Pelvis Z
Passenger Lap Belt Force
Passenger Shoulder Belt Force – not installed
Passenger Left Upper Tibia Moment X
Passenger Left Upper Tibia Moment Y
Passenger Left Upper Tibia Force Z
Passenger Left Lower Tibia Moment X

Passenger Left Lower Tibia Moment Y
Passenger Left Lower Tibia Force Z
Passenger Right Upper Tibia Moment X
Passenger Right Upper Tibia Moment Y
Passenger Right Upper Tibia Force Z
Passenger Right Lower Tibia Moment X
Passenger Right Lower Tibia Moment Y
Passenger Right Lower Tibia Force Z
Passenger Left Foot Fore Z
Passenger Left Foot Aft X
Passenger Left Foot Aft Z
Passenger Right Foot Fore Z
Passenger Right Foot Aft X
Passenger Right Foot Aft Z
Left Rear Seat Crossmember X
Left Rear Seat Crossmember Z
Right Rear Seat Crossmember X
Right Rear Seat Crossmember Z
Vehicle Engine Top X
Vehicle Engine Bottom X
Vehicle Left Brake Caliper X
Vehicle Right Brake Caliper X
Barrier Force – Upper Left
Barrier Force – Upper Center
Barrier Force – Upper Right
Barrier Force – Lower Left
Barrier Force – Lower Center
Barrier Force – Lower Right



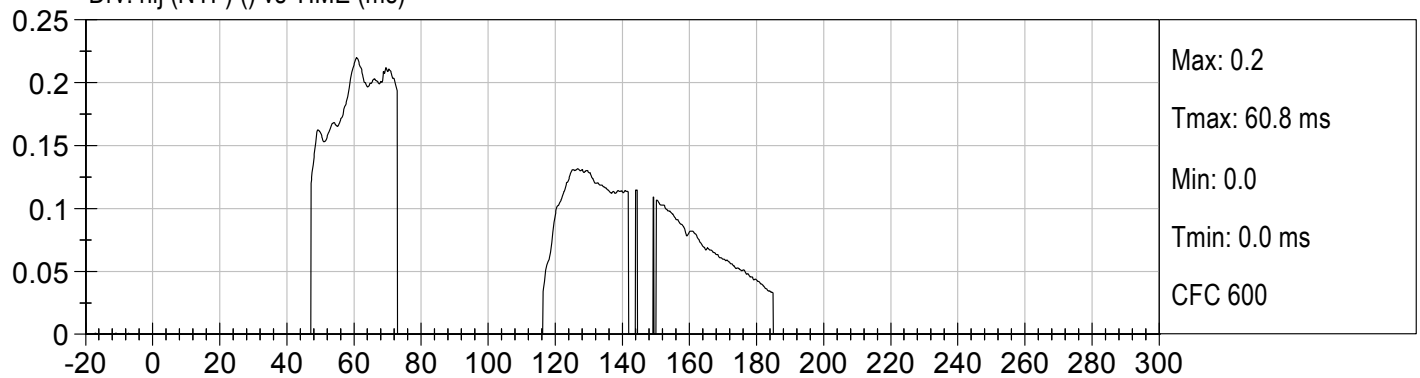




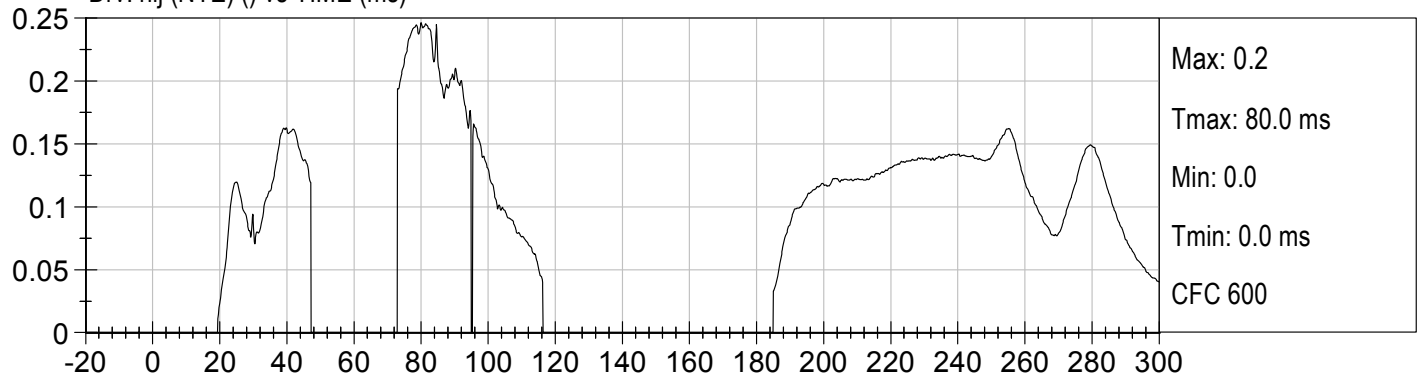




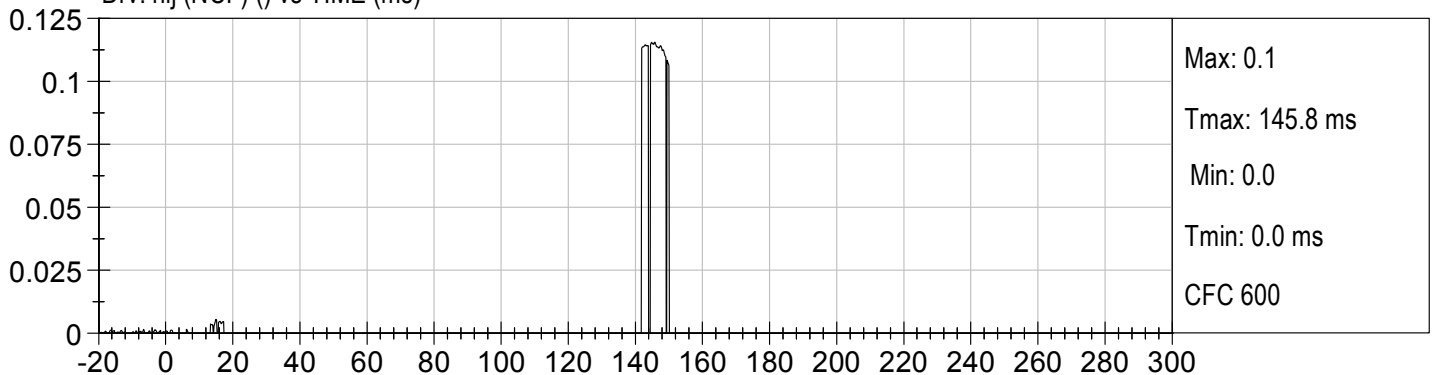
Drv. nij (NTF) () vs TIME (ms)



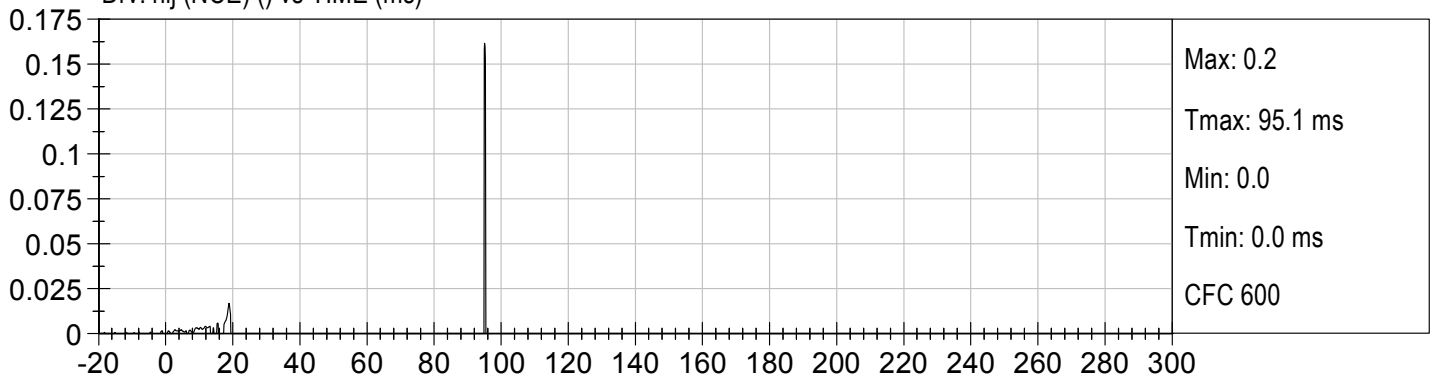
Drv. nij (NTE) () vs TIME (ms)



Drv. nij (NCF) () vs TIME (ms)

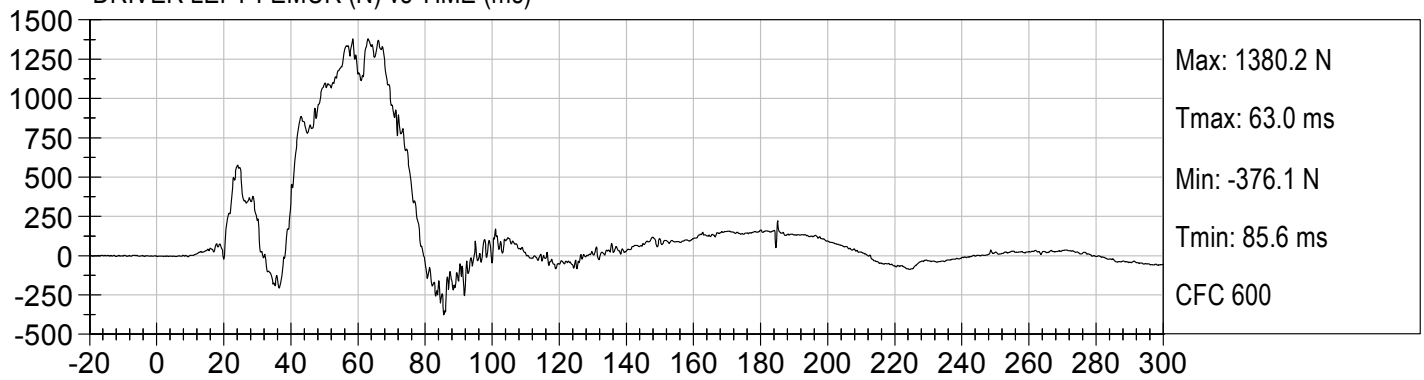


Drv. nij (NCE) () vs TIME (ms)

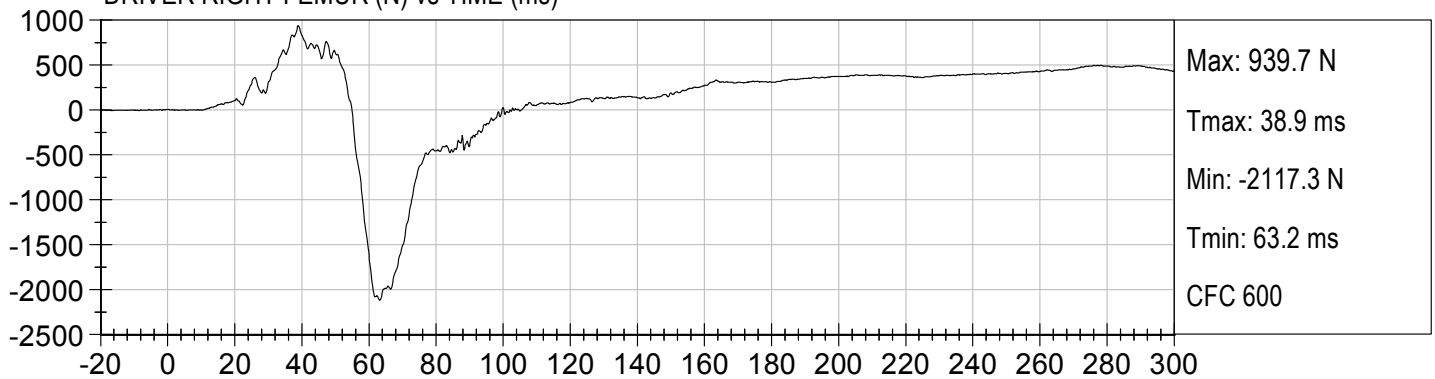


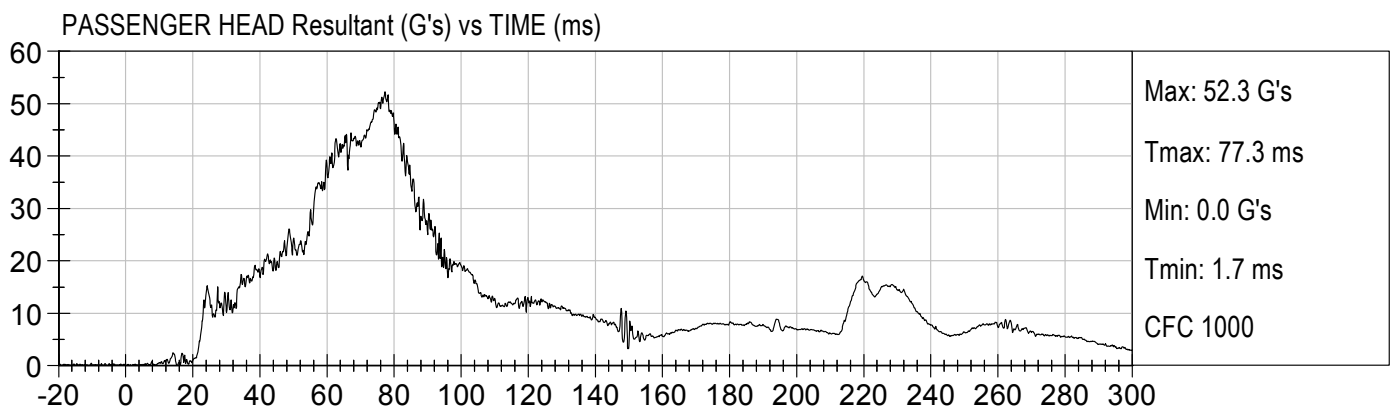
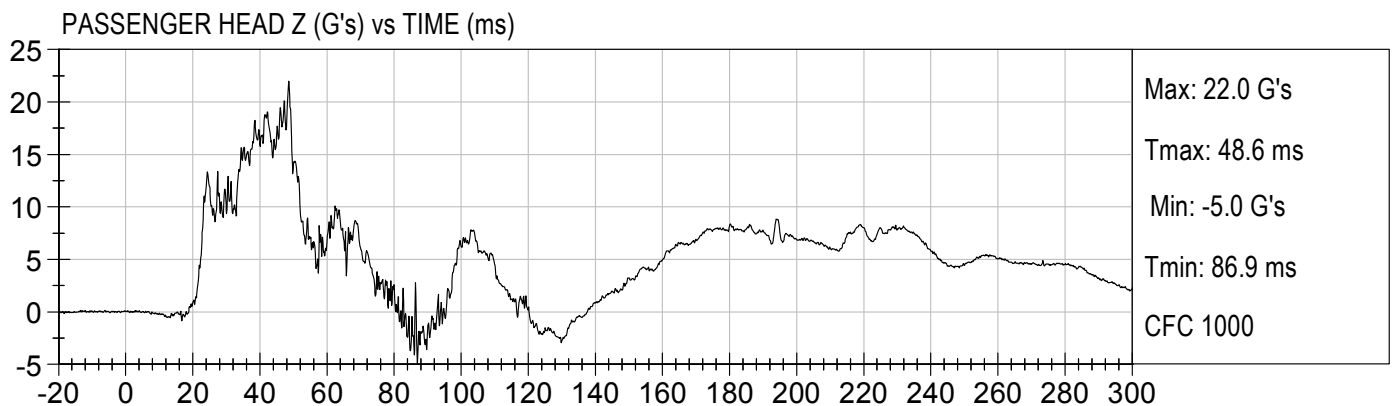
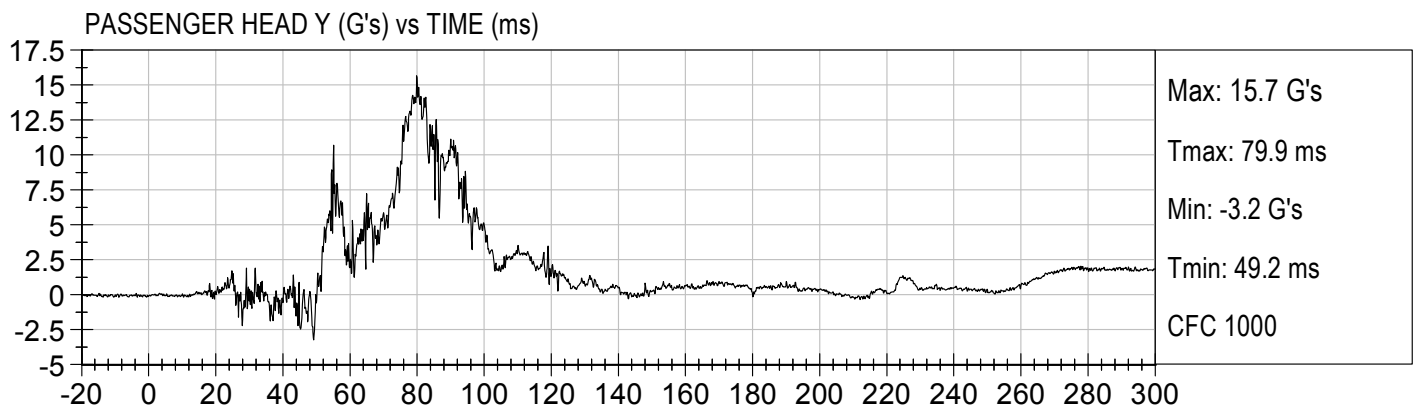
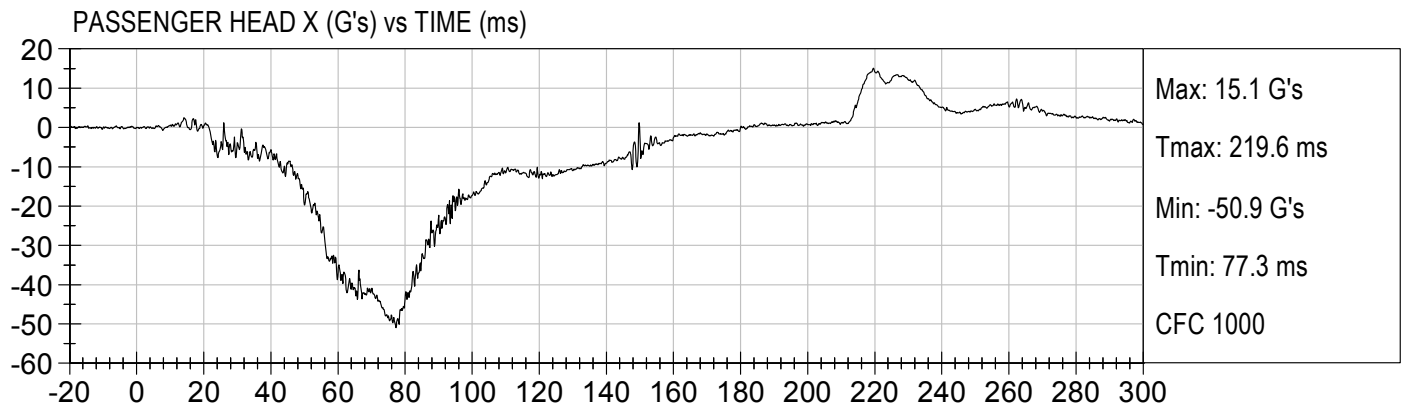


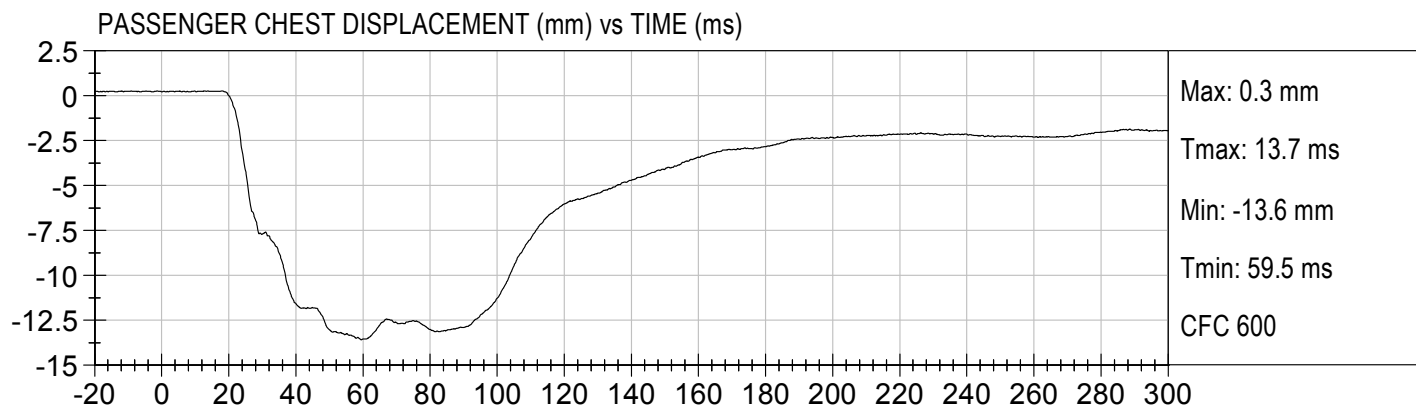
DRIVER LEFT FEMUR (N) vs TIME (ms)

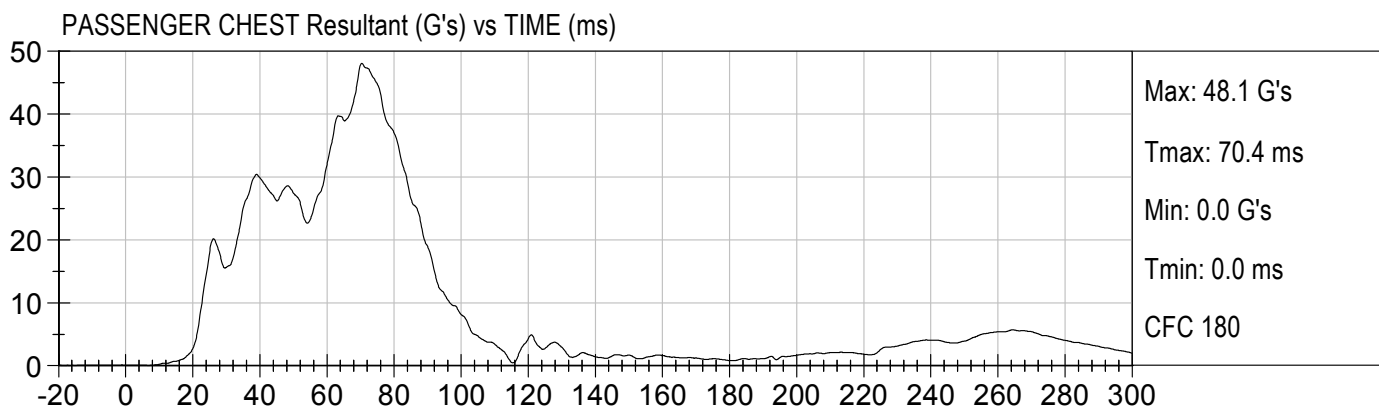
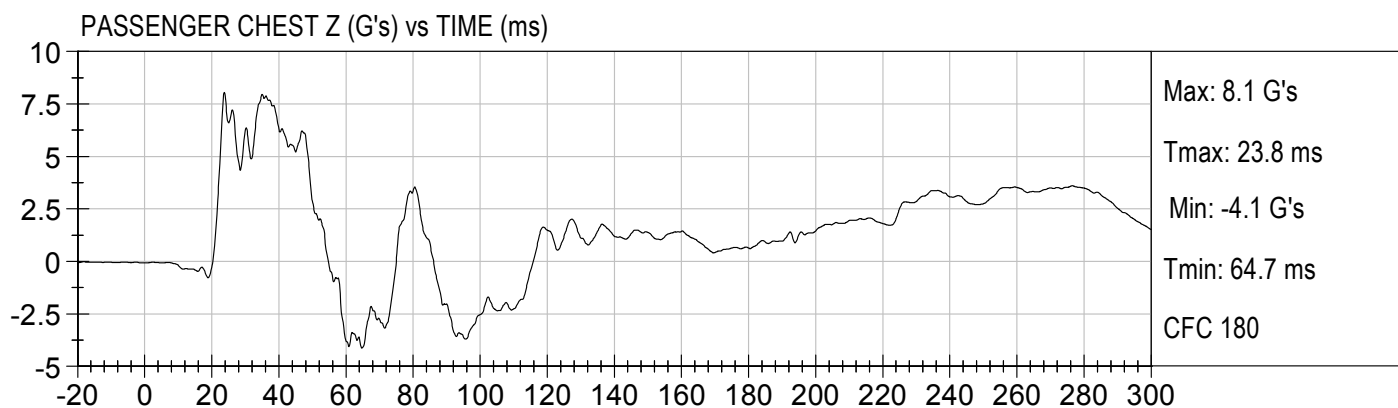
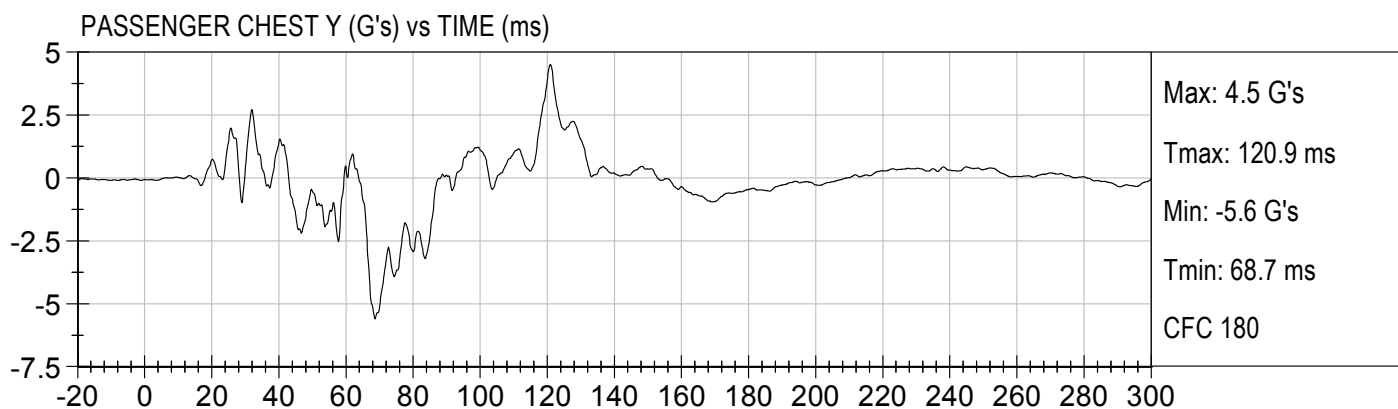
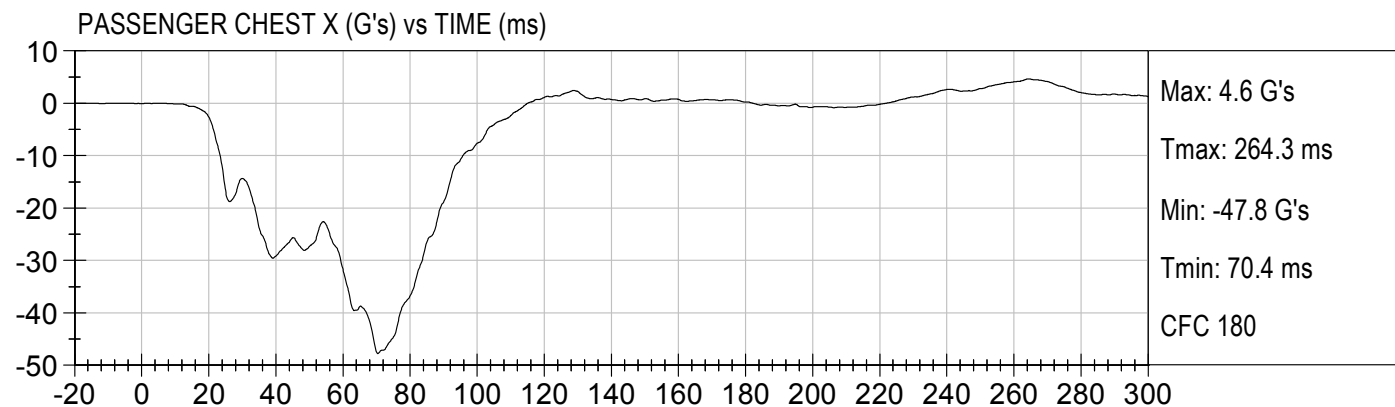


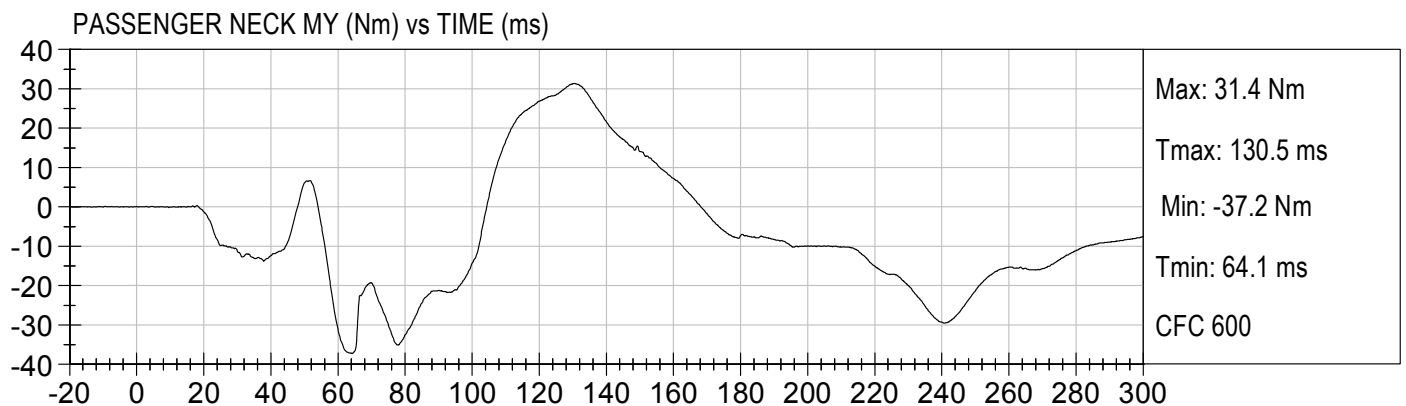
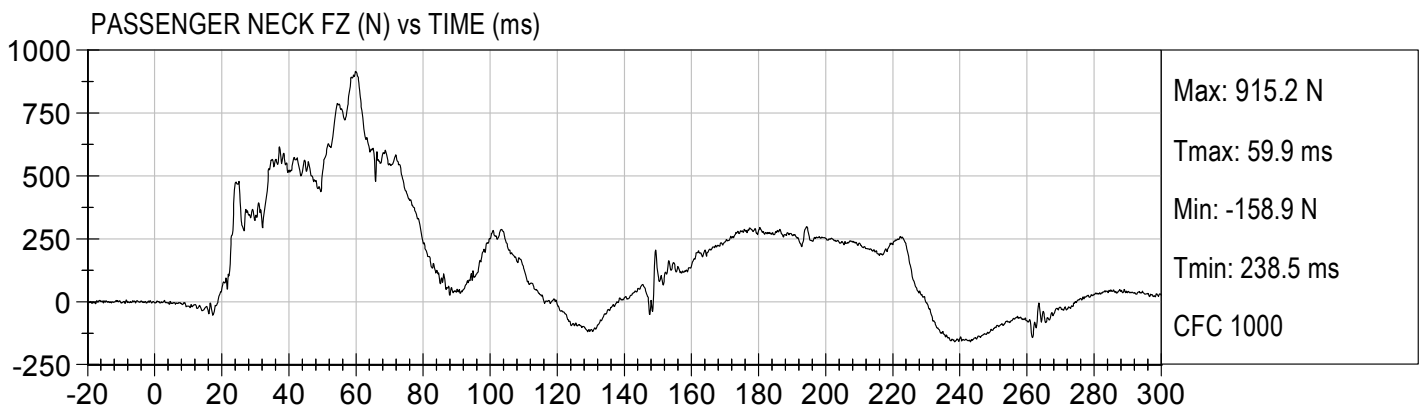
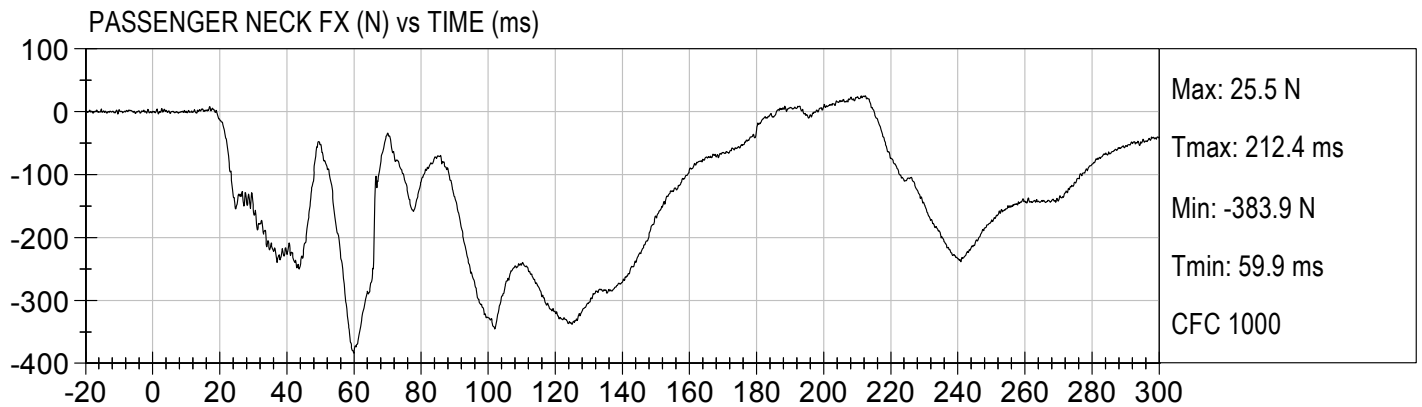
DRIVER RIGHT FEMUR (N) vs TIME (ms)

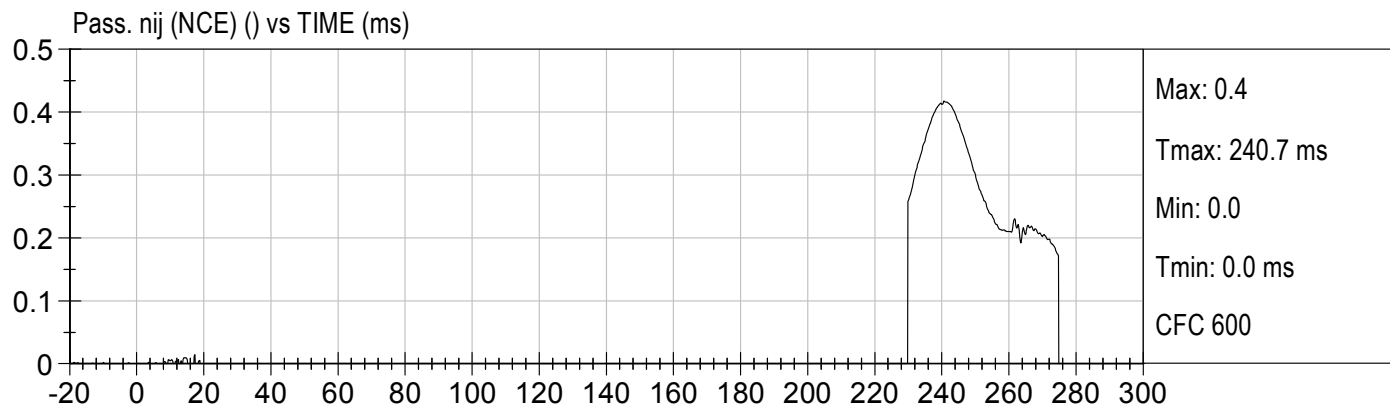
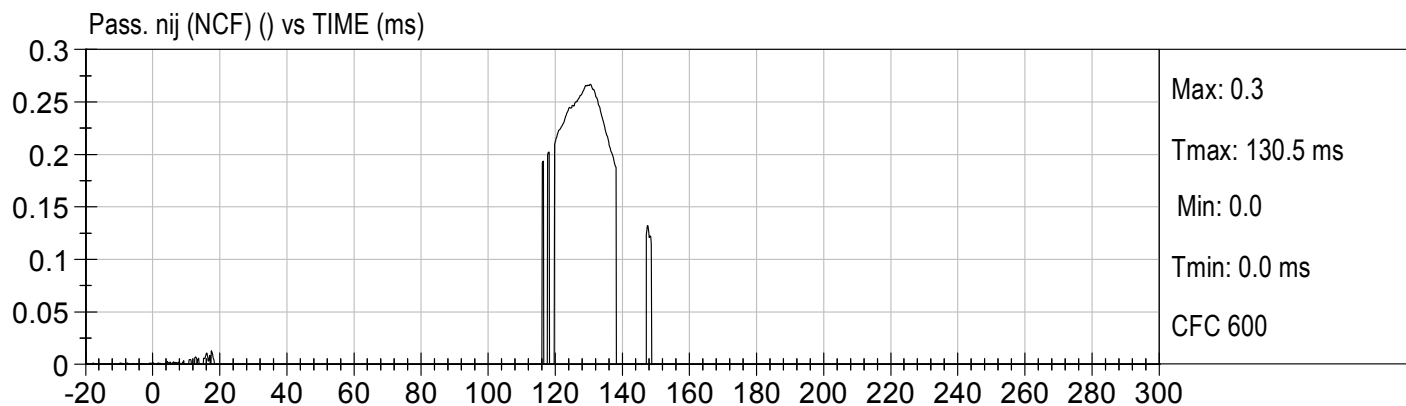
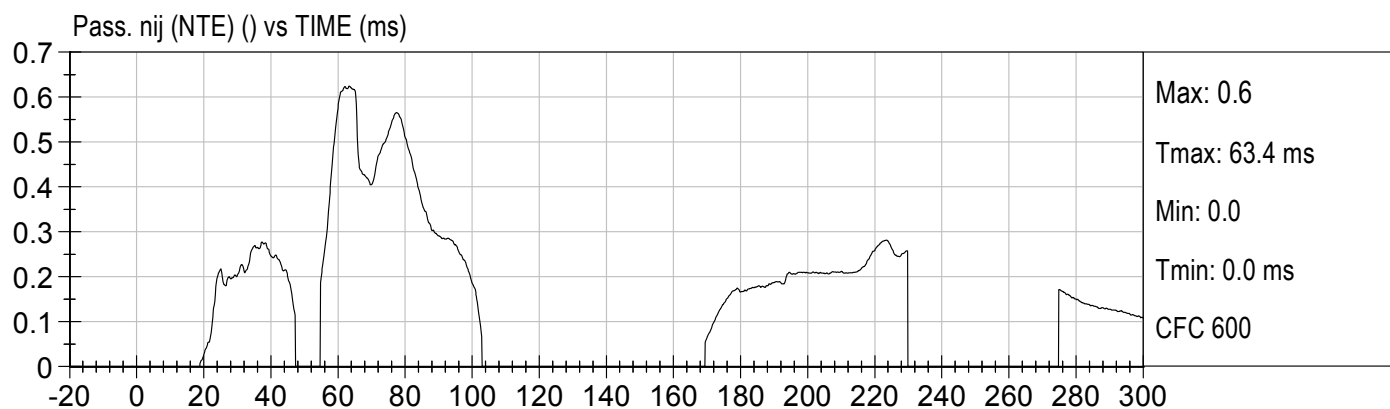
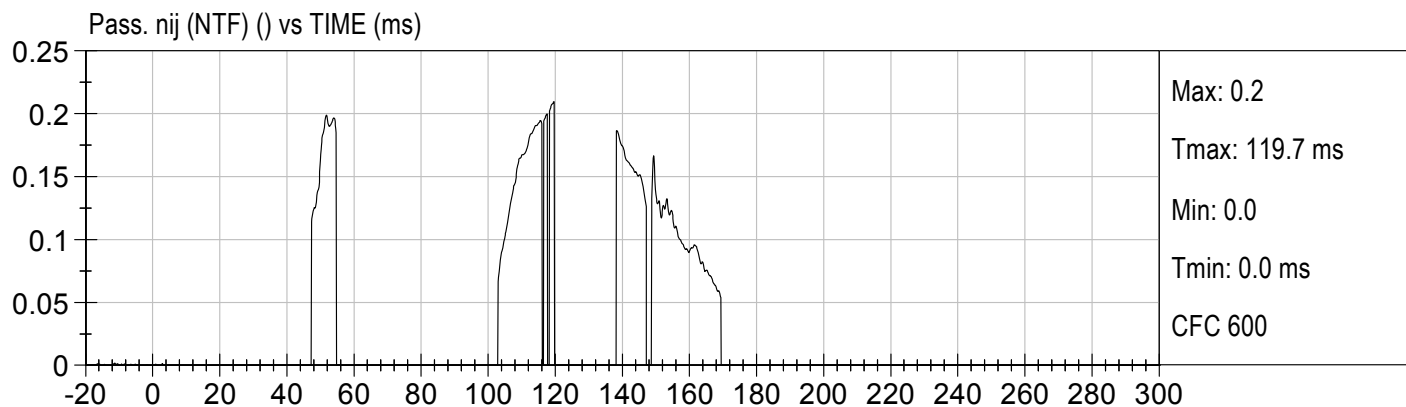


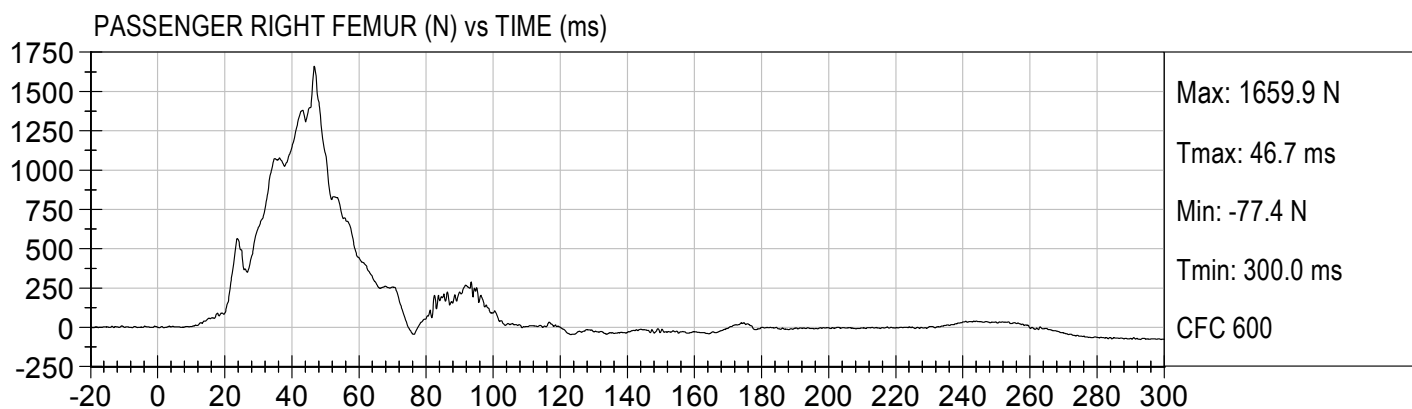
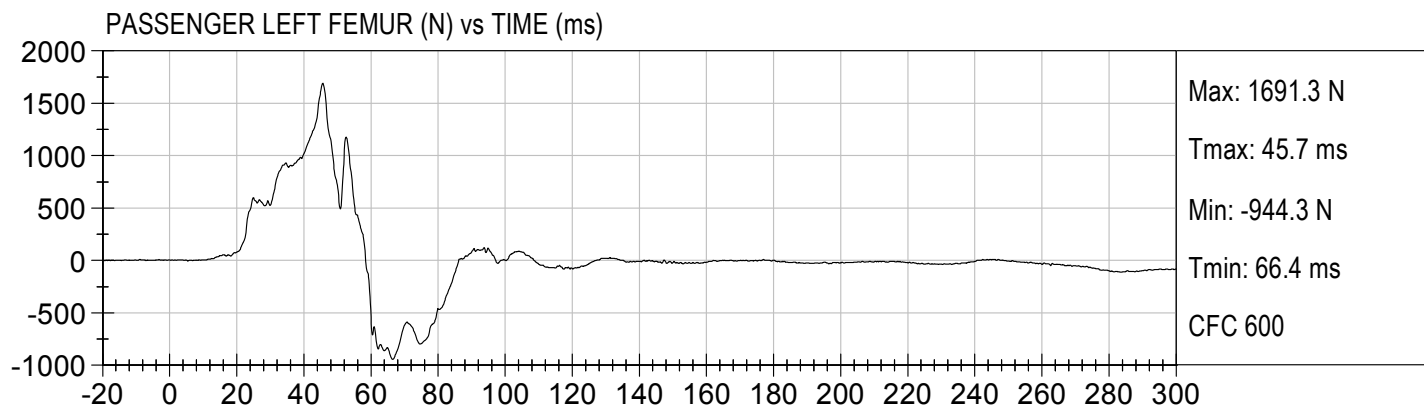












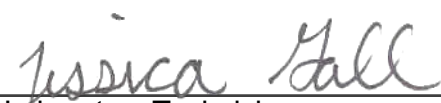
APPENDIX C
DUMMY CALIBRATION DATA

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test ID: D102781

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 - 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	47	Pass
Peak Resultant Acceleration	G's	225 - 275	248	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	-12.4	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass


Laboratory Technician

8/27/10
Test Date

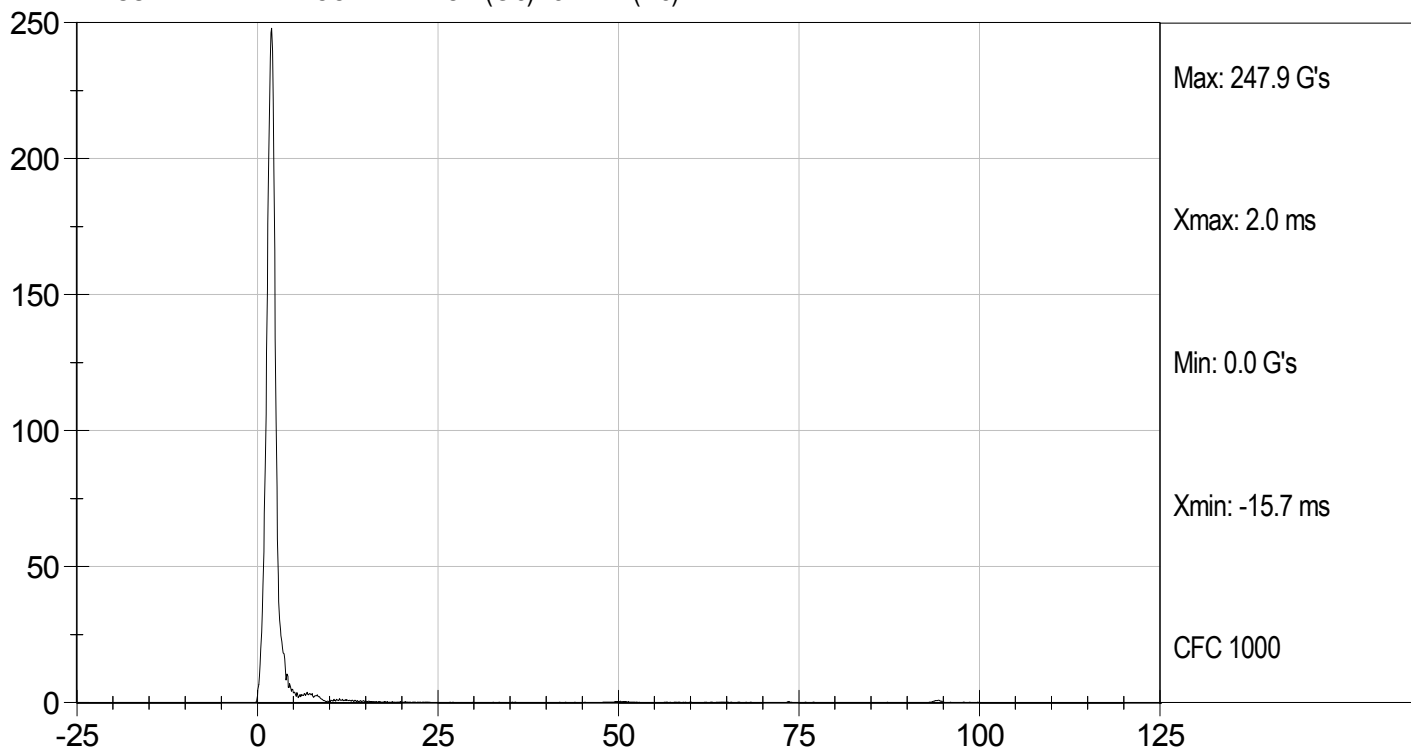

Approved By



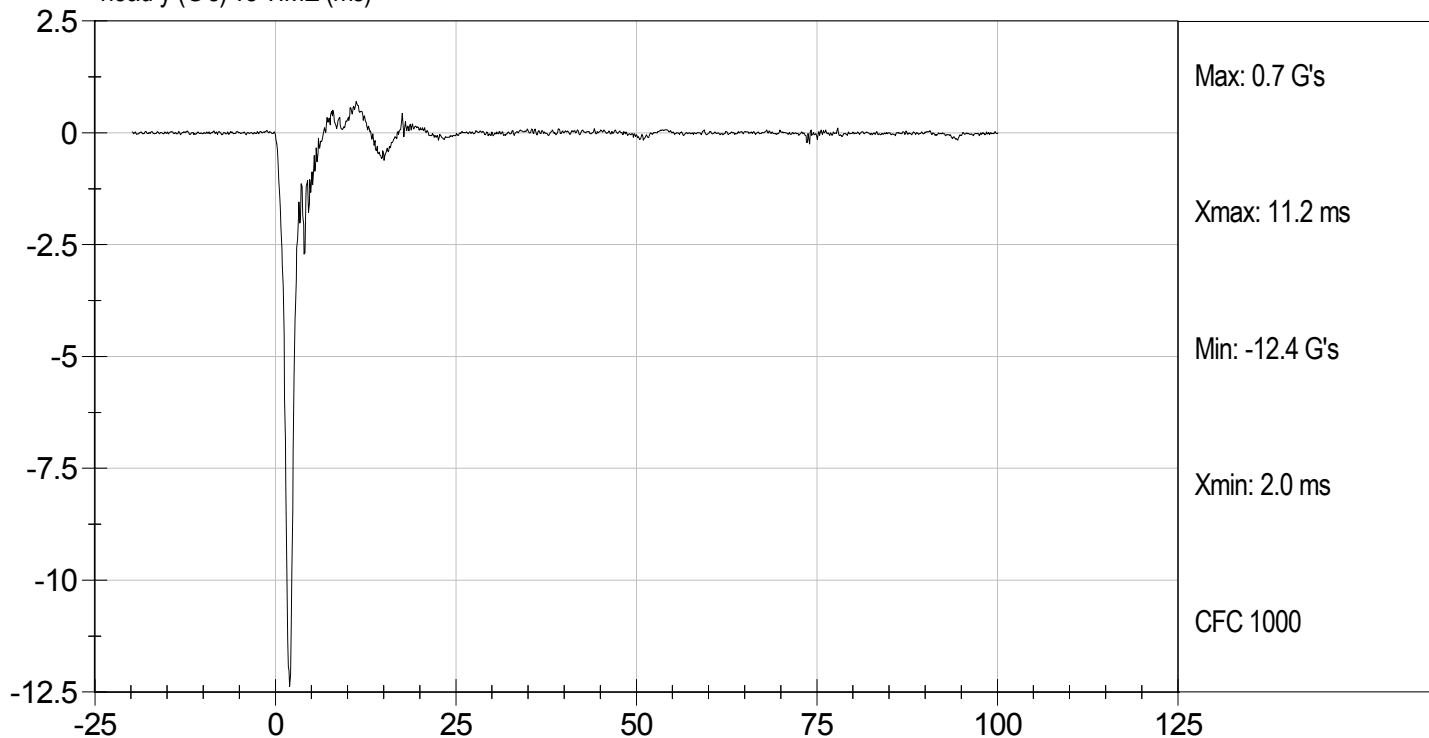
Test Desc: Head Drop
Component ID: D102781

Test Date: 8/27/10
Velocity: 0 ft/s, 0.00 m/s

RESULTANT HEAD ACCELERATION (G's) vs TIME (ms)



head y (G's) vs TIME (ms)



MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102782

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity		%	10 to 70	46	Pass
Pendulum Velocity		m/s	6.89 to 7.13	6.96	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.30	Pass
	20 ms	G's	17.60 to 22.60	19.71	Pass
	30 ms	G's	12.50 to 18.50	15.23	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	15.21	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	35.4	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	64.0 to 78.0	67.6	Pass
	Time	ms	57.0 to 64.0	58.7	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	113.8	Pass
Moment About Occipital Condyle	Maximum	N m	88.1 to 108.5	90.0	Pass
	Time	ms	47.0 to 58.0	47.2	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	100.3	Pass
Overall Test Results					Pass


Laboratory Technician

8/26/10
Test Date

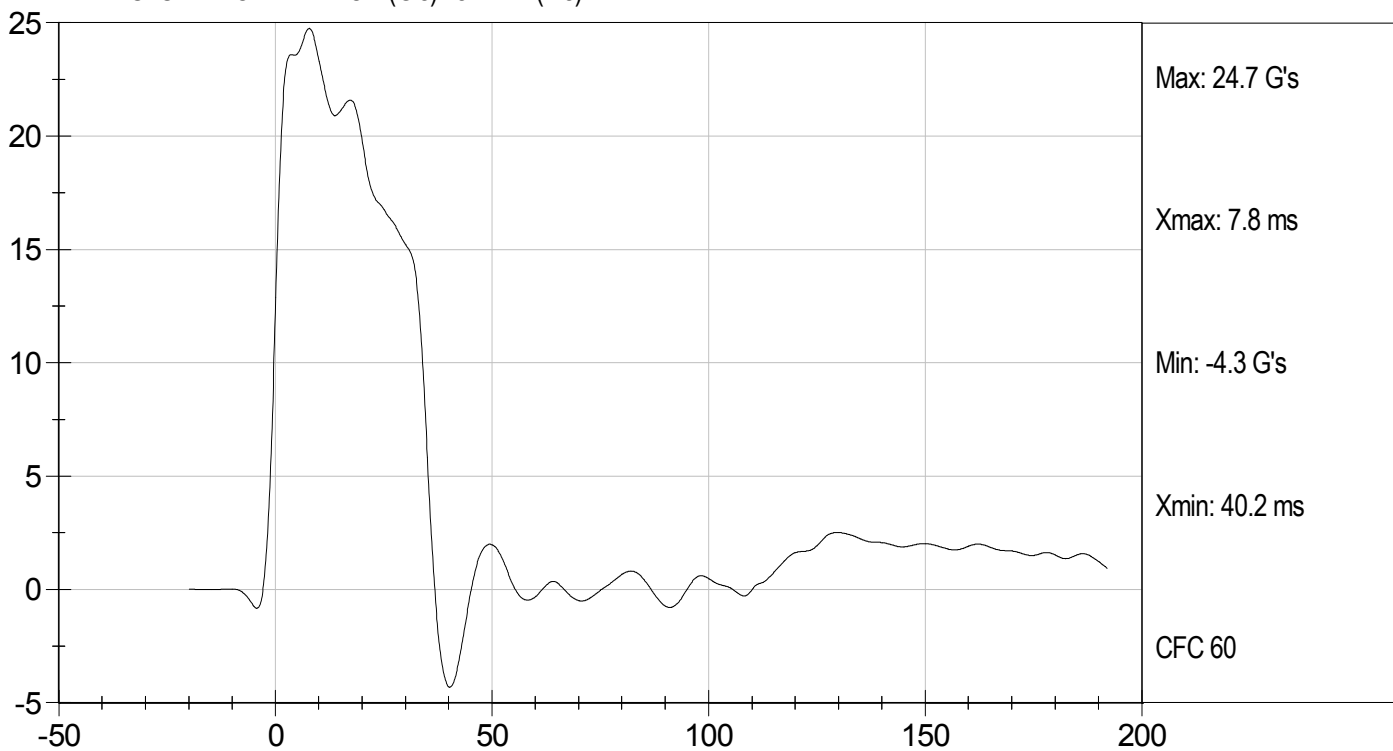

Approved By



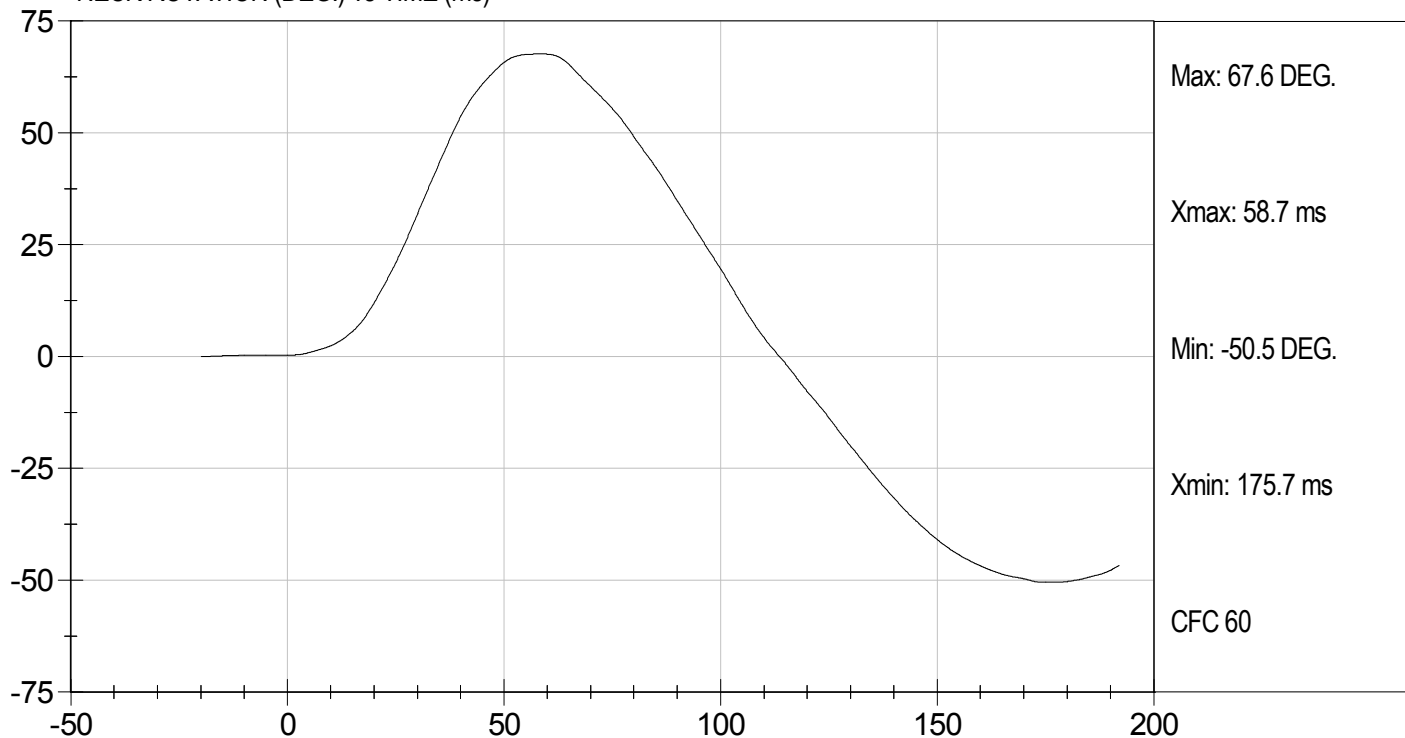
Test Desc: Neck Flexion
Component ID: D102782

Test Date: 8/26/10
Velocity: 22.83 ft/s, 6.96 m/s

PENDULUM DECELERATION (G's) vs TIME (ms)



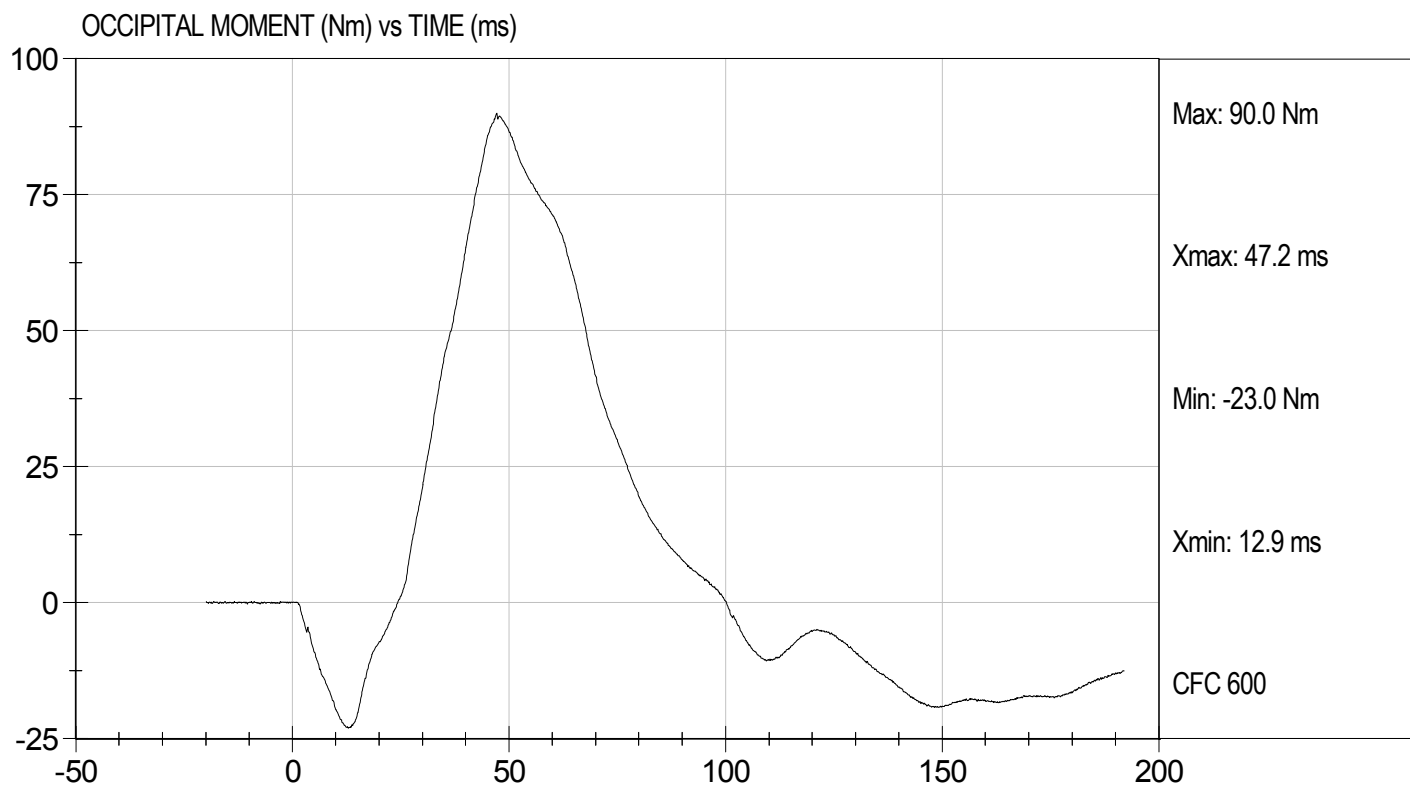
NECK ROTATION (DEG.) vs TIME (ms)





Test Desc: Neck Flexion
Component ID: D102782

Test Date: 8/26/10
Velocity: 22.83 ft/s, 6.96 m/s



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102783

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity		%	10 to 70	46	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	19.67	Pass
	20 ms	G's	14.00 to 19.00	18.10	Pass
	30 ms	G's	11.00 to 16.00	15.97	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	15.89	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	38.4	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	92.0	Pass
	Time	ms	72.0 to 82.0	75.1	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	151.6	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-61.4	Pass
	Time	ms	65.0 to 79.0	68.0	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	139.3	Pass
Overall Test Results					Pass


Laboratory Technician

8/26/10
Test Date

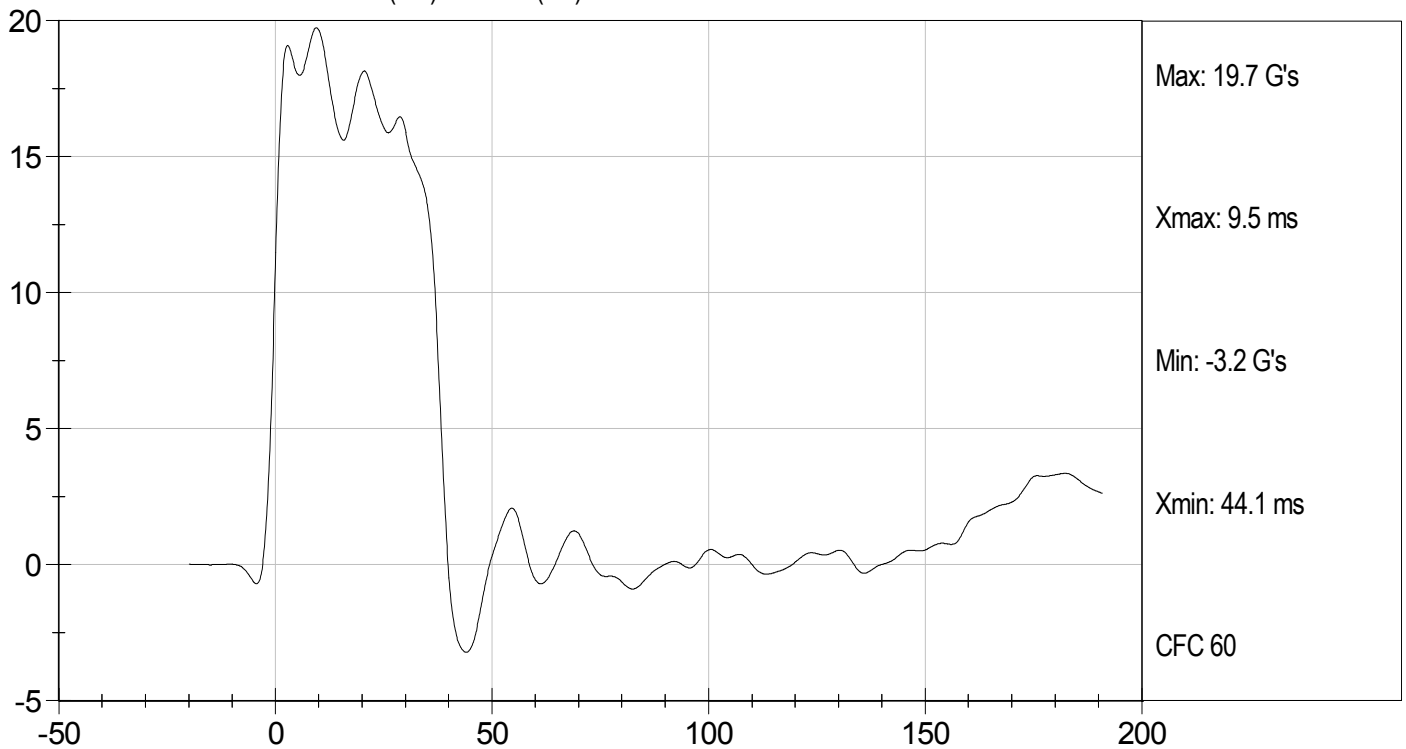

Approved By



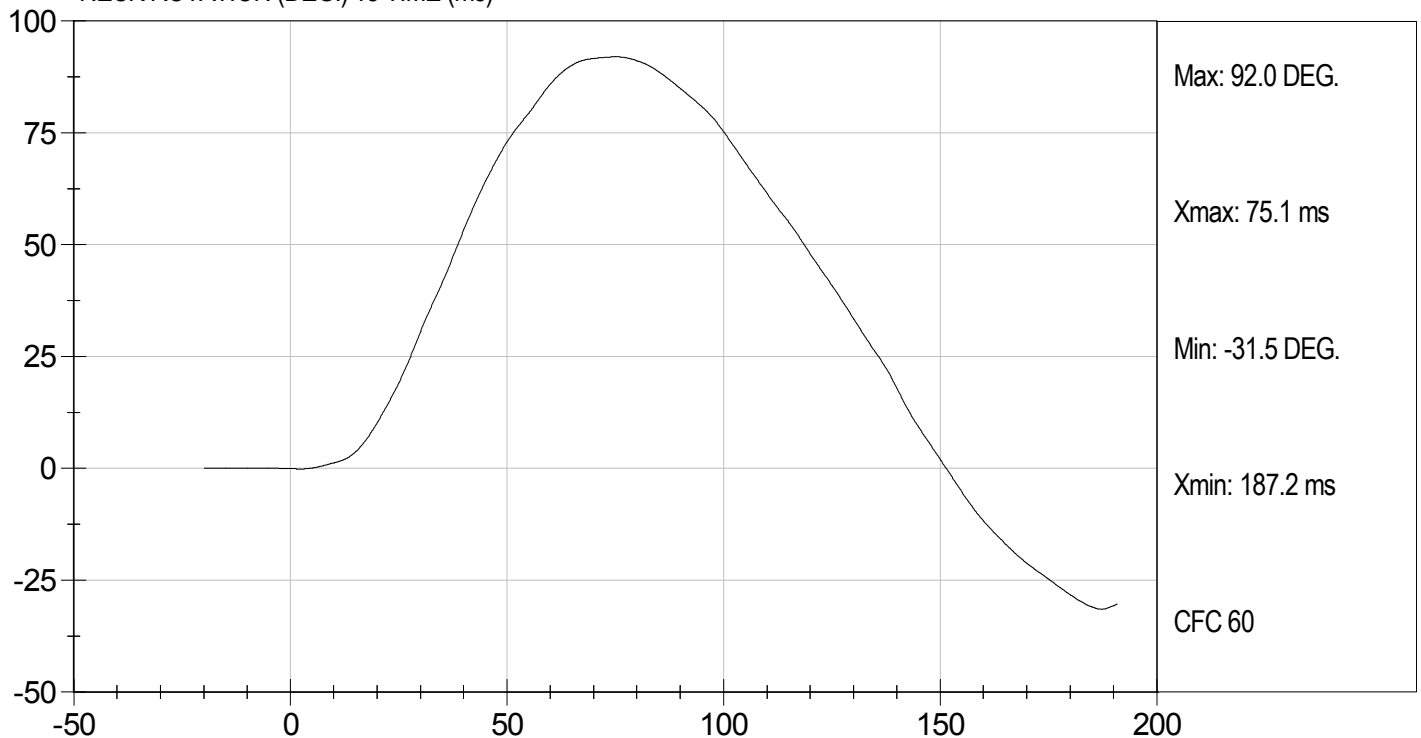
Test Desc: Neck Extension
Component ID: D102783

Test Date: 8/26/10
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (G's) vs TIME (ms)



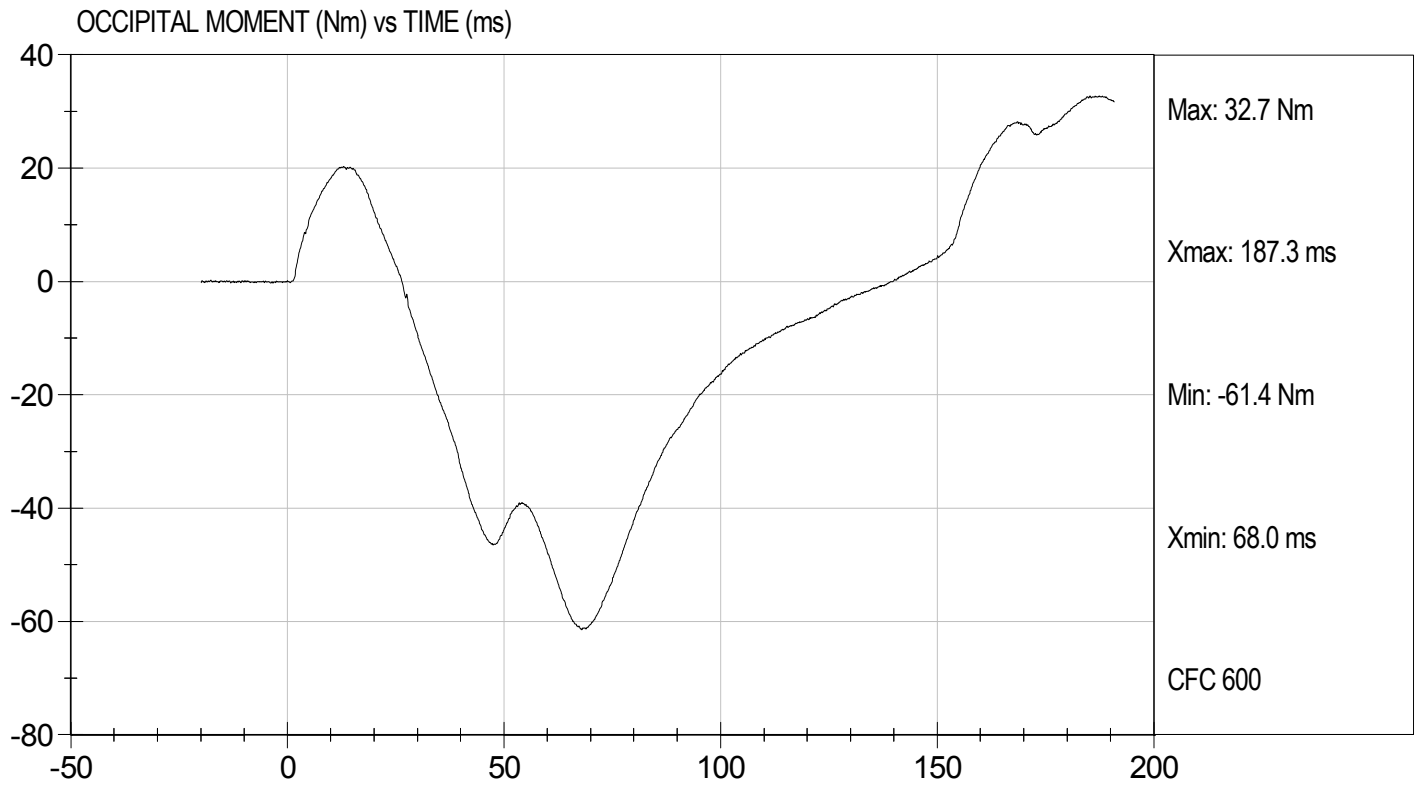
NECK ROTATION (DEG.) vs TIME (ms)





Test Desc: Neck Extension
Component ID: D102783

Test Date: 8/26/10
Velocity: 20.08 ft/s, 6.12 m/s



MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102784

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	50	Pass
Probe Velocity	m/s	6.58 to 6.82	6.77	Pass
Peak Probe Force	N	5159 to 5893	5,443	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.44	Pass
Internal Hysteresis	%	69 to 85	72	Pass
			Overall Test Results	Pass


Laboratory Technician

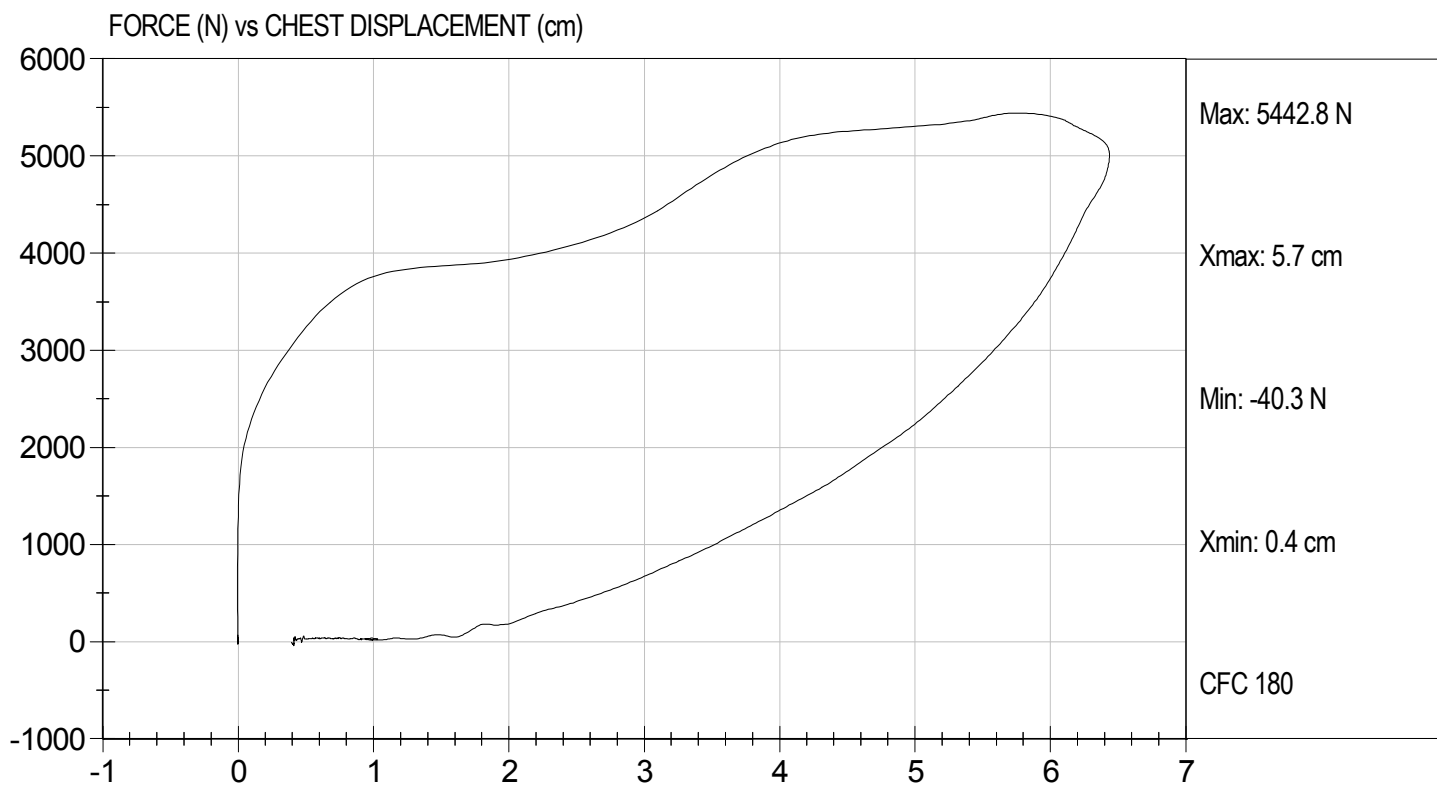
8/30/10
Test Date


Approved By



Test Desc: Thorax Impact
Component ID: D102784

Test Date: 8/30/10
Velocity: 22.22 ft/s, 6.77 m/s



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102785

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	54	Pass
Probe Velocity	m/s	2.07 to 2.13	2.08	Pass
Peak Probe Force	Newtons	4715 to 5782	5,253	Pass
Overall Test Results				Pass

Jessica Hall
Laboratory Technician

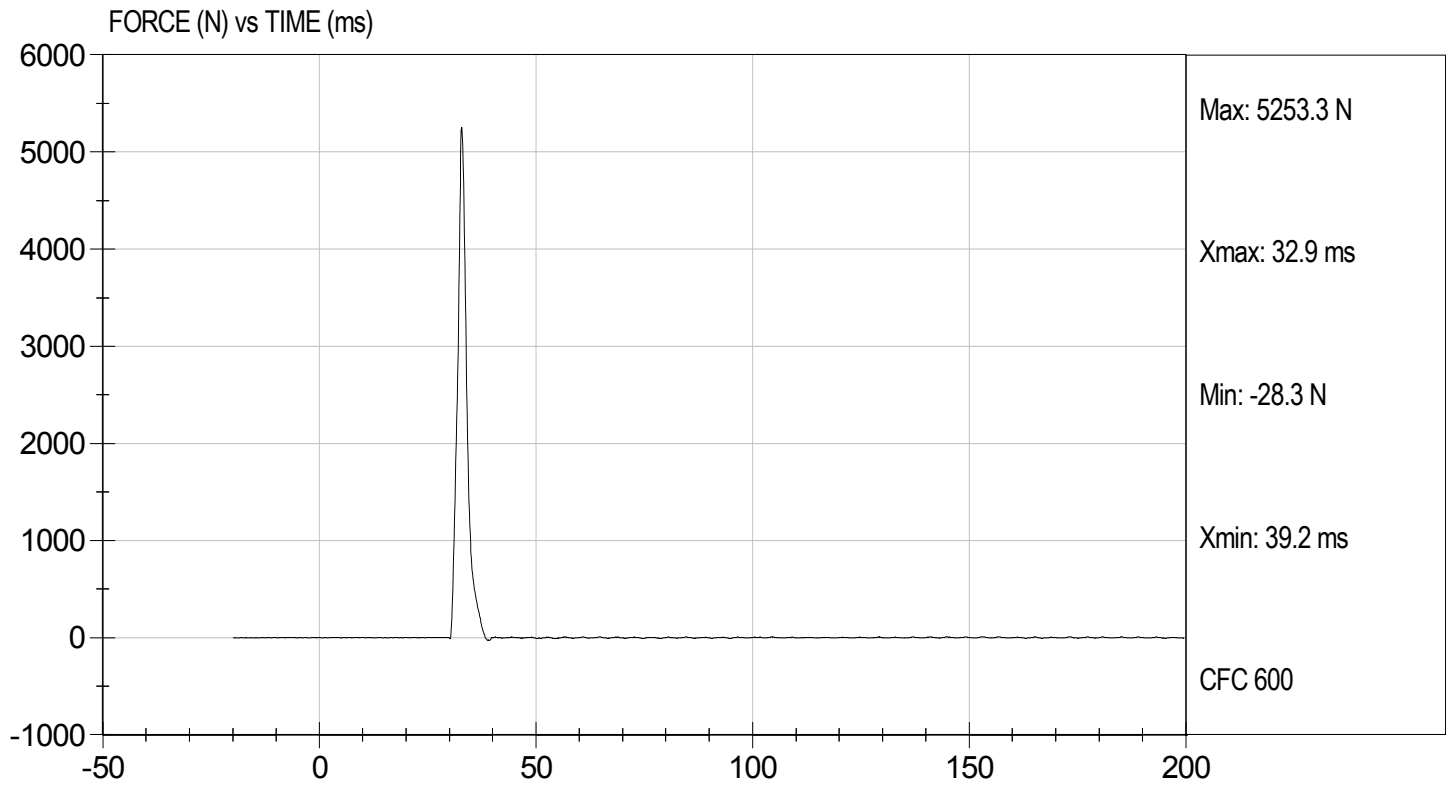
8/30/10
Test Date

David Winkelbauer
Approved By



Test Desc: Right Knee
Component ID: D102785

Test Date: 8/30/10
Velocity: 6.83 ft/s, 2.08 m/s

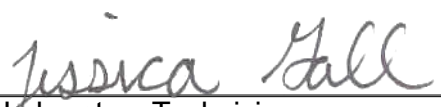


MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102786

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	54	Pass
Probe Velocity	m/s	2.07 to 2.13	2.07	Pass
Peak Probe Force	Newtons	4715 to 5782	5,279	Pass
			Overall Test Results	Pass


Laboratory Technician

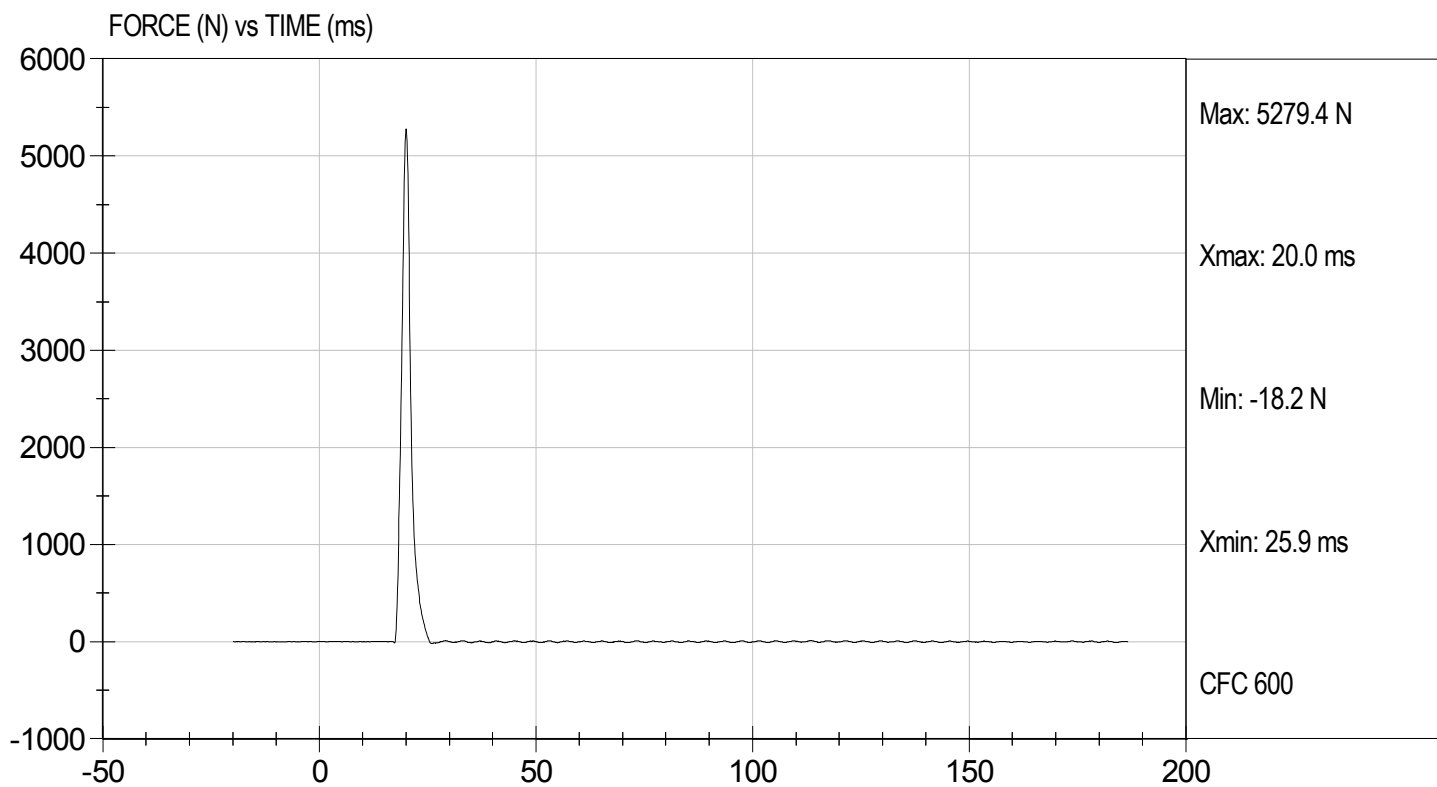
8/30/10
Test Date


Approved By



Test Desc: Left Knee
Component ID: D102786

Test Date: 8/30/10
Velocity: 6.80 ft/s, 2.07 m/s



MGA RESEARCH CORPORATION
HIP-FEMUR FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102780

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.3	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	47	47	Pass
Rotation Rate	deg/s	5 -10	8	8	Pass
30 Degrees	Nm	94.9 Nm Max	52.1	49.1	Pass
150 ft-lbf / 203.4 Nm	Deg	40- 50 Degree Max Rotation	46	47	Pass
Overall Test Results					Pass


 Laboratory Technician

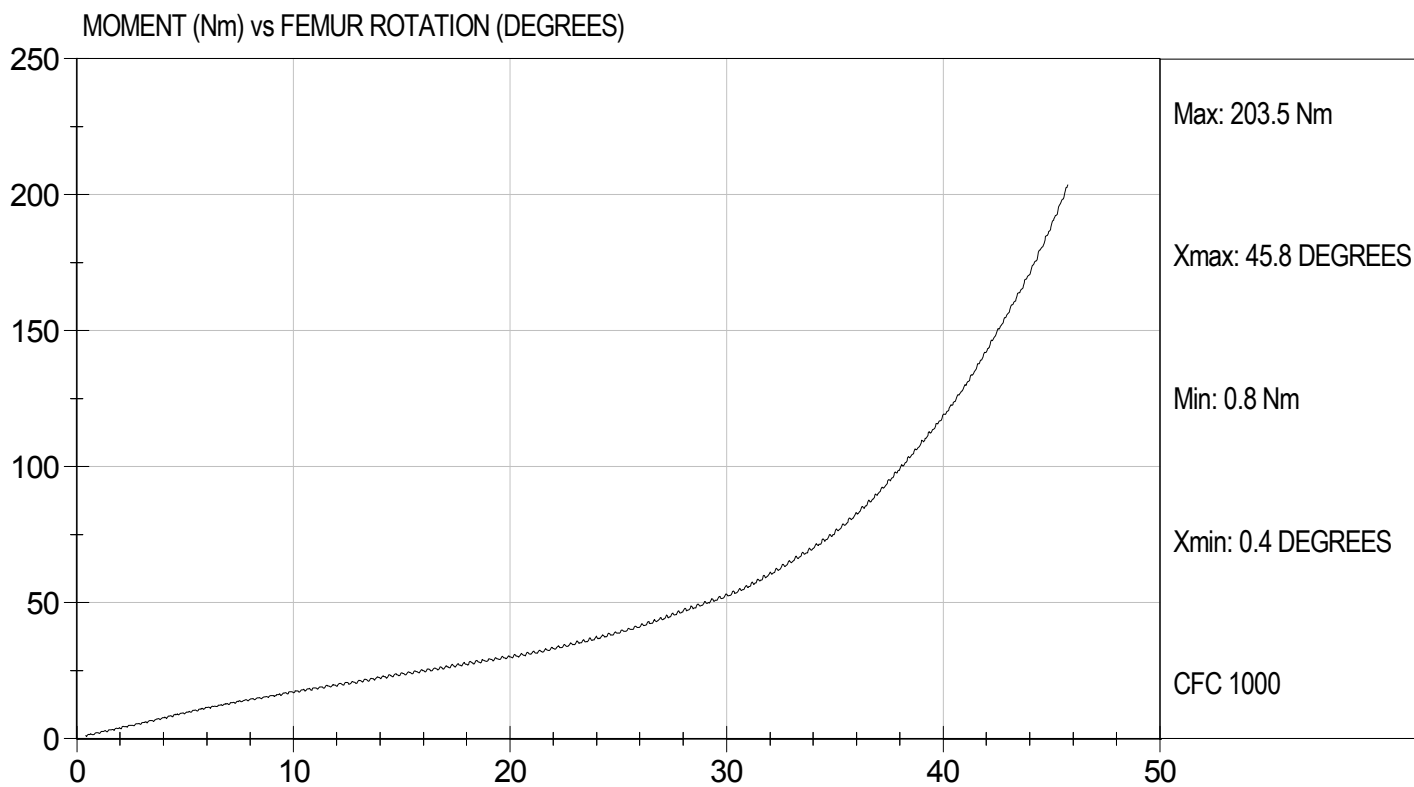
8/27/10
 Test Date


 Approved By



Test Desc: Hip Femur Flexion
Component ID: D102789

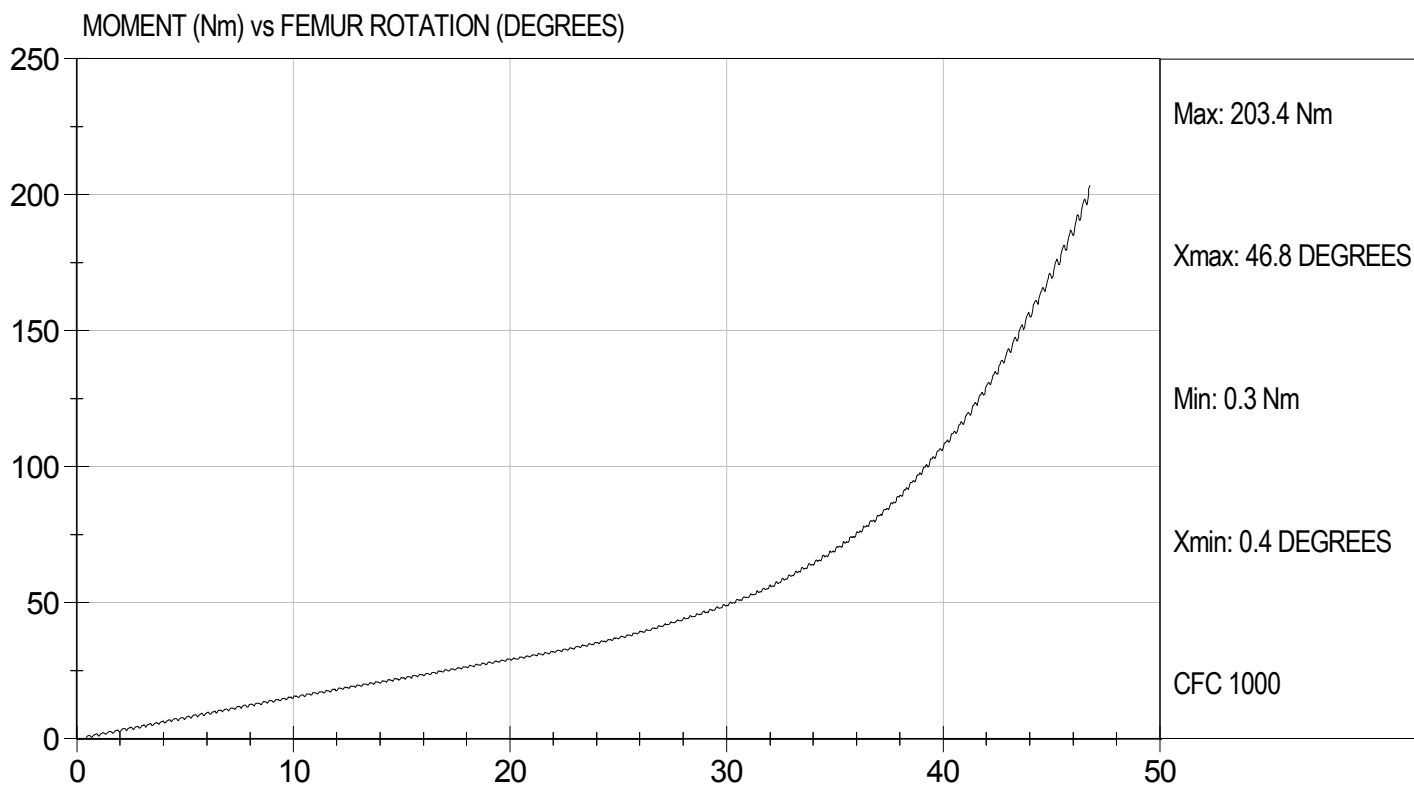
Test Date: 8/27/10
Velocity: 0 ft/s, 0.00 m/s





Test Desc: Hip Femur Flexion
Component ID: D102780

Test Date: 8/27/10
Velocity: 0 ft/s, 0.00 m/s



MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test ID: D102821

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 - 25.6	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Peak Resultant Acceleration	G's	225 - 275	249	Pass
Peak Lateral Acceleration	G's	<= +/- 15.0	4.0	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass

Jessica Hall
Laboratory Technician

8/31/10
Test Date

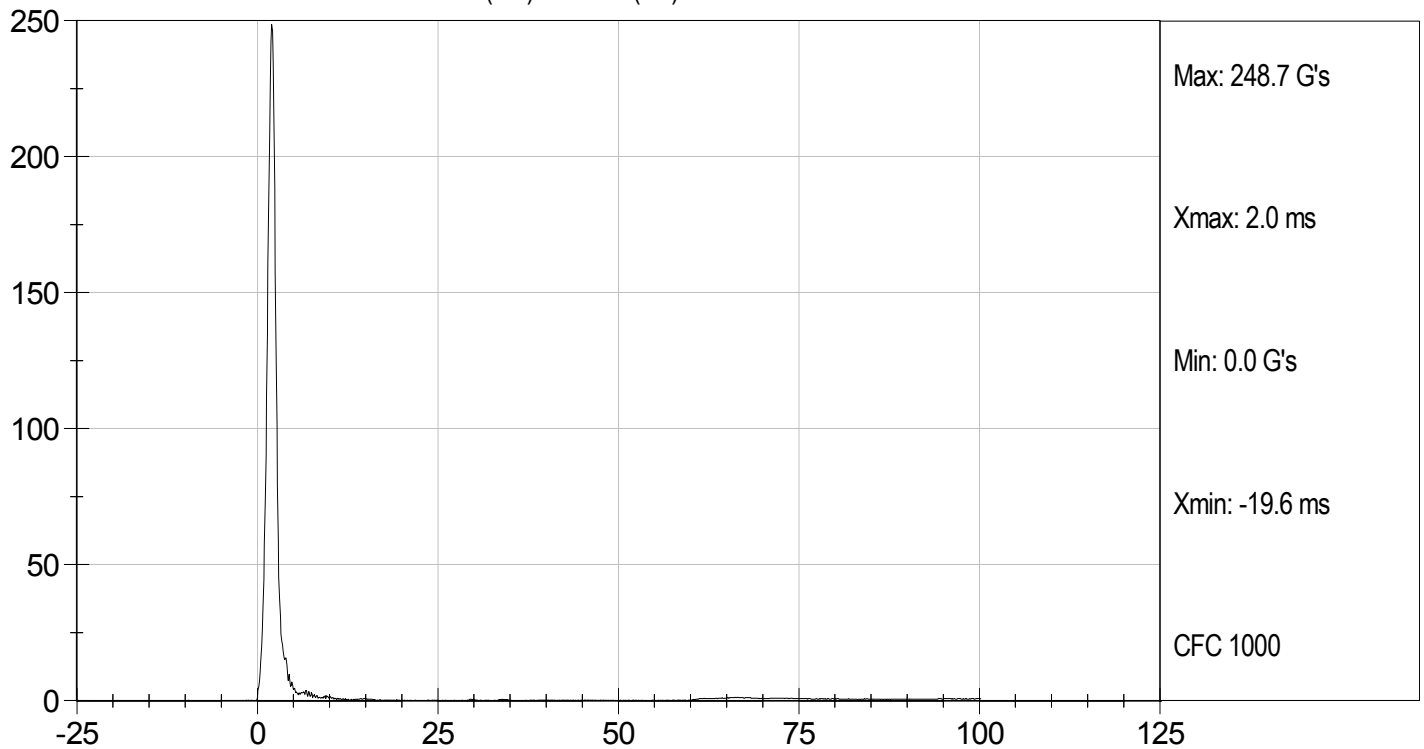
David Winkelbauer
Approved By



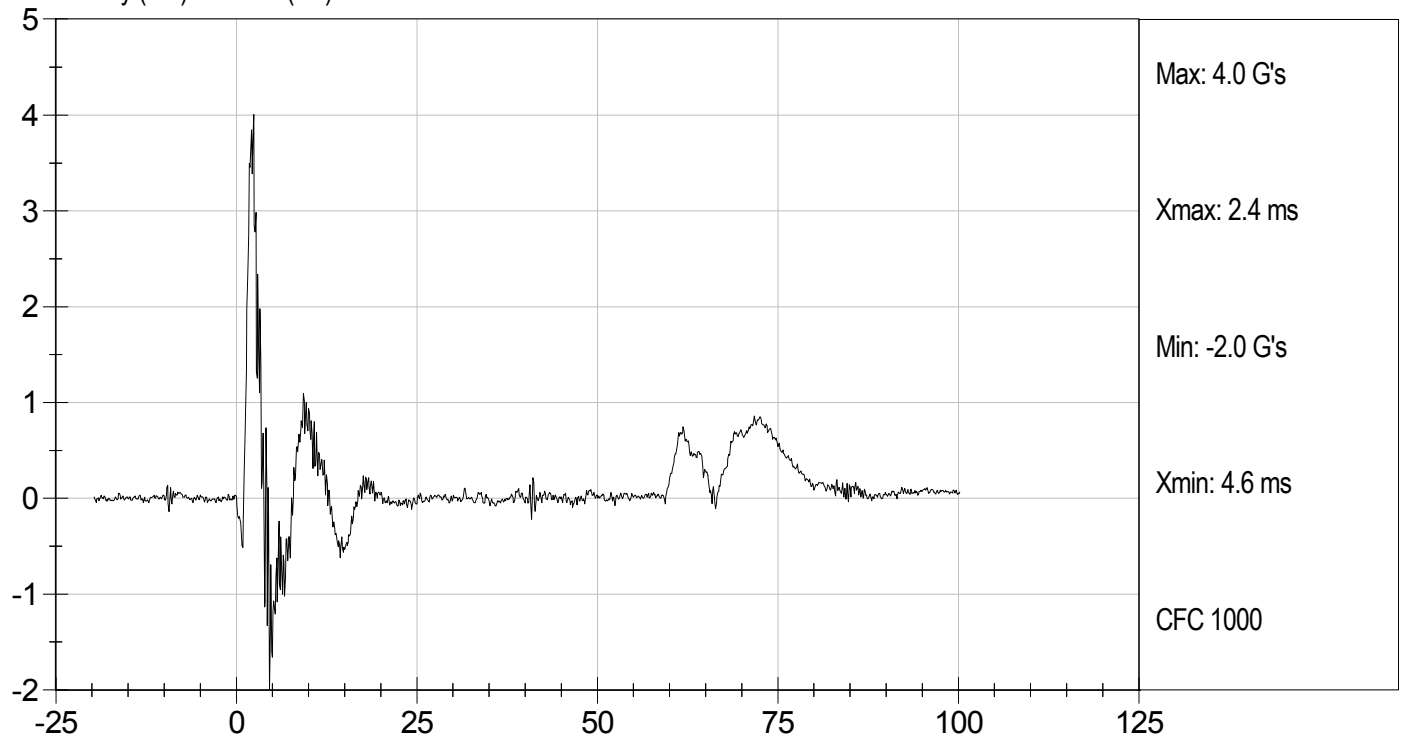
Test Desc: Head Drop
Component ID: D102821

Test Date: 8/31/10
Velocity: 0 ft/s, 0.00 m/s

RESULTANT HEAD ACCELERATION (G's) vs TIME (ms)



head y (G's) vs TIME (ms)



MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102822

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Velocity		m/s	6.89 to 7.13	6.96	Pass
Pendulum Deceleration	10 ms	G's	22.50 to 27.50	23.82	Pass
	20 ms	G's	17.60 to 22.60	19.38	Pass
	30 ms	G's	12.50 to 18.50	14.57	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 29.0	14.51	Pass
Deceleration Decay Time to Cross 5 G's		ms	34.0 to 42.0	34.5	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	64.0 to 78.0	68.0	Pass
	Time	ms	57.0 to 64.0	57.2	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	113.0 to 128.0	113.3	Pass
Moment About Occipital Condyle	Maximum	N m	88.1 to 108.5	95.8	Pass
	Time	ms	47.0 to 58.0	47.7	Pass
Positive Moment Decay Time To Zero Crossing		ms	97.0 to 107.0	99.0	Pass
Overall Test Results					Pass


 Laboratory Technician

8/31/10
 Test Date

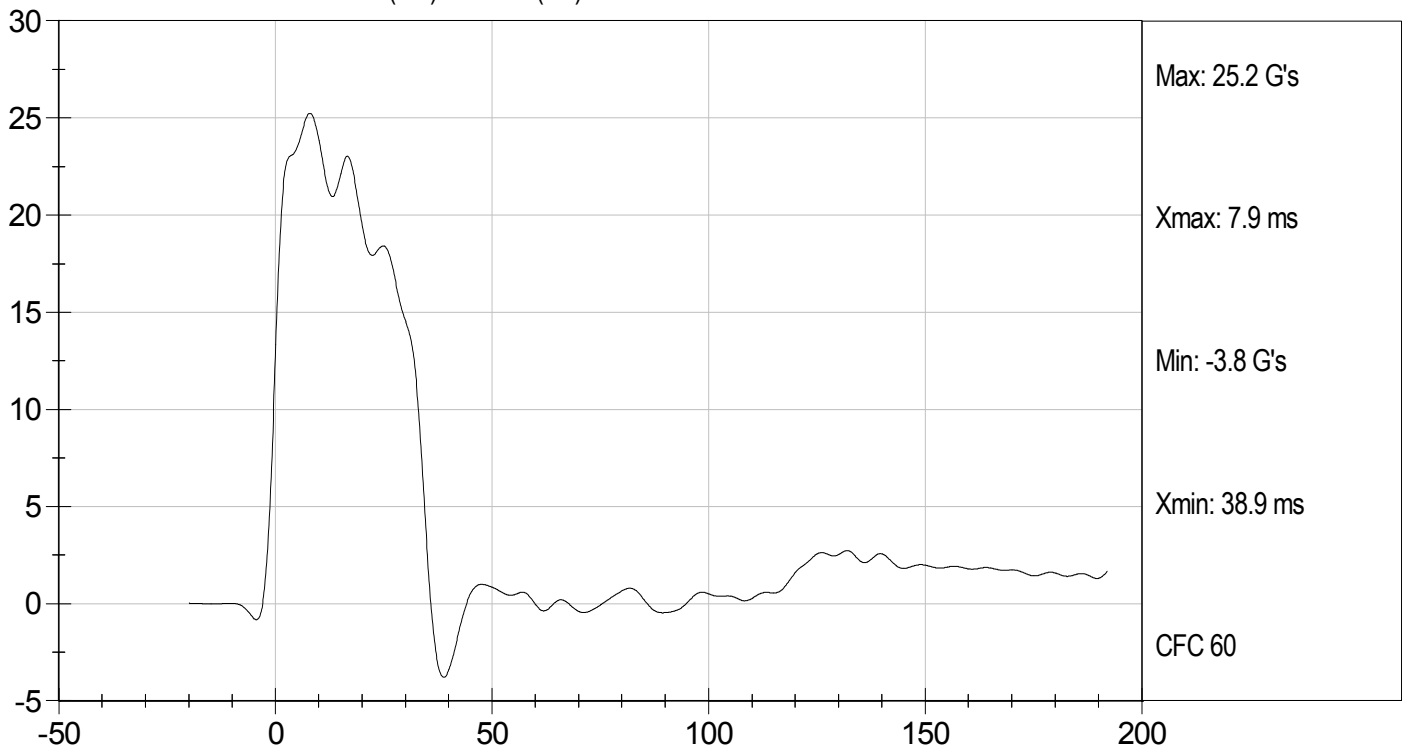

 Approved By



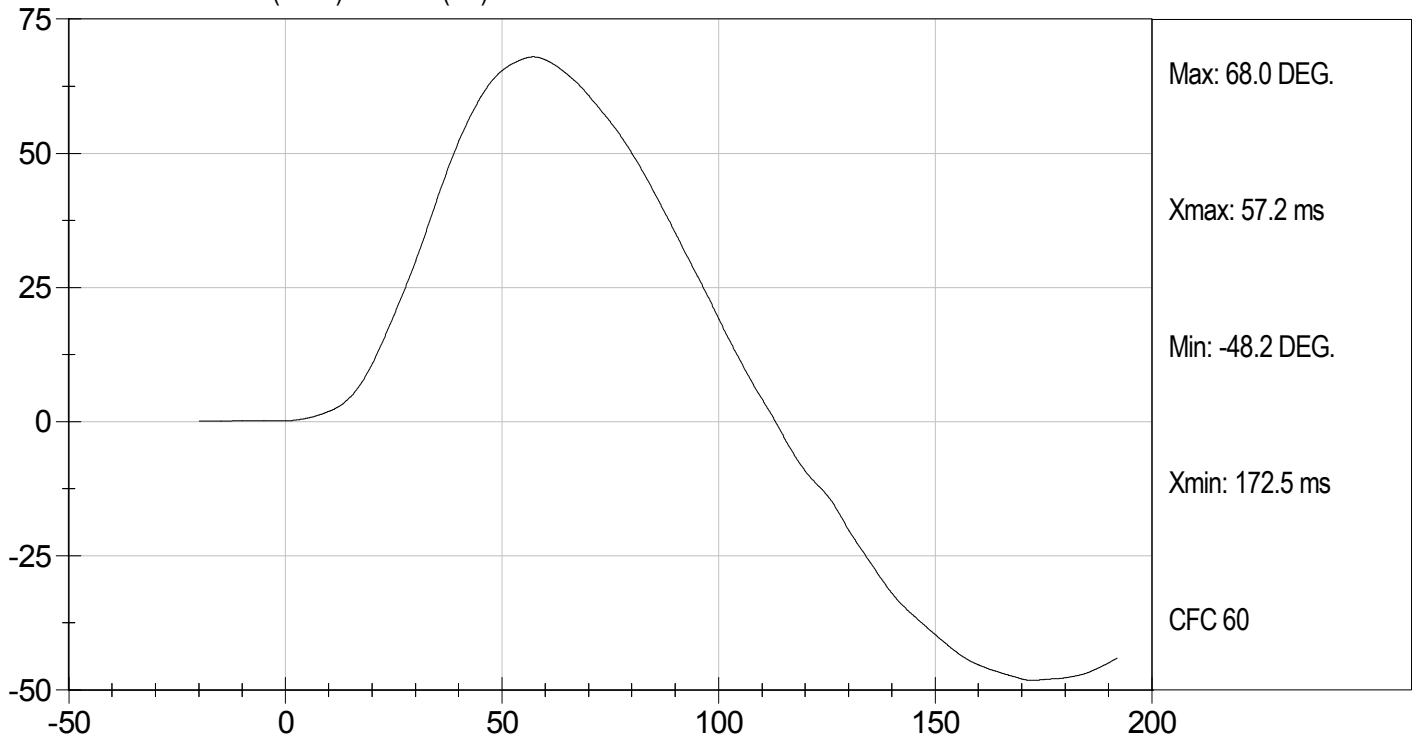
Test Desc: Neck Flexion
Component ID: D102822

Test Date: 8/31/10
Velocity: 22.83 ft/s, 6.96 m/s

PENDULUM DECELERATION (G's) vs TIME (ms)



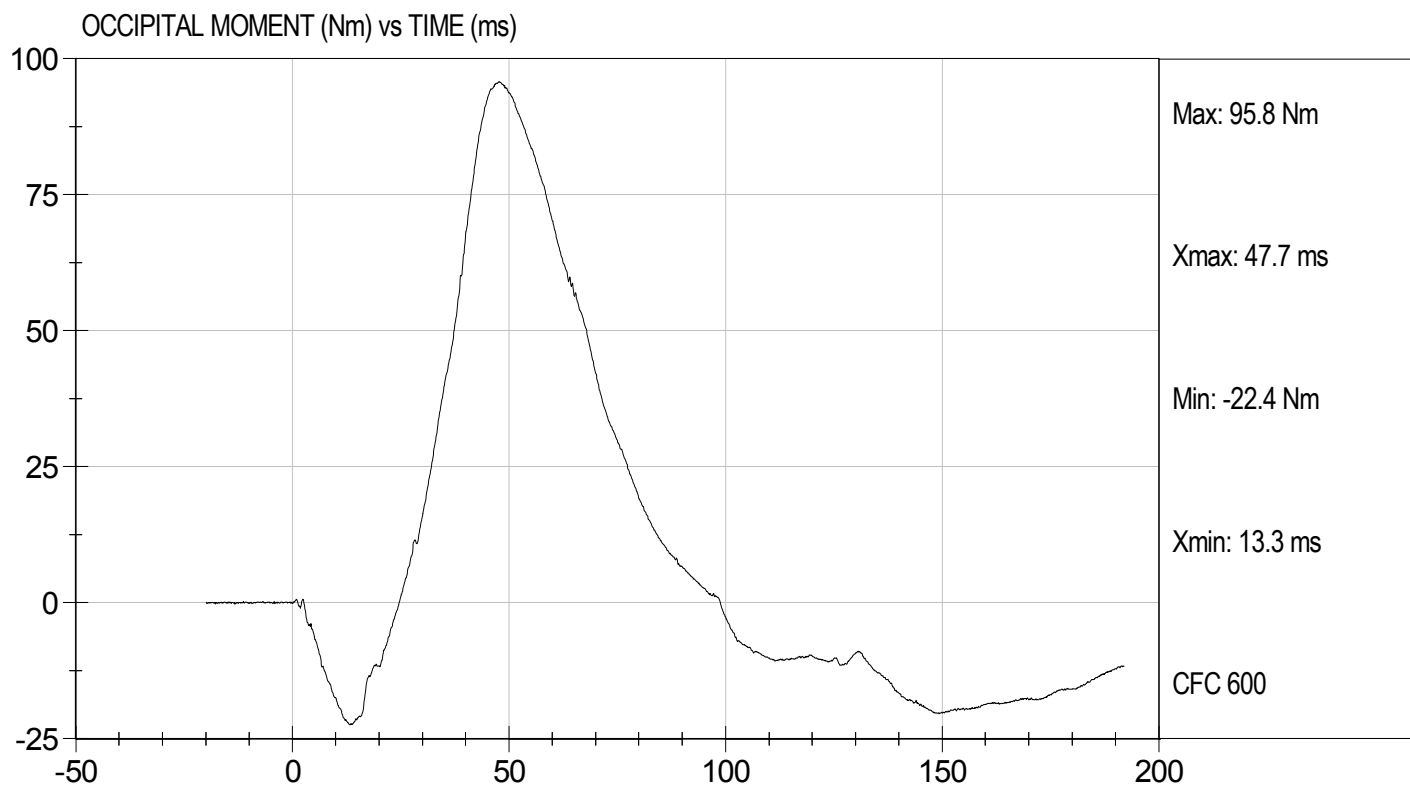
NECK ROTATION (DEG.) vs TIME (ms)





Test Desc: Neck Flexion
Component ID: D102822

Test Date: 8/31/10
Velocity: 22.83 ft/s, 6.96 m/s



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102823

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Velocity		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	G's	17.20 to 21.20	20.51	Pass
	20 ms	G's	14.00 to 19.00	16.74	Pass
	30 ms	G's	11.00 to 16.00	15.82	Pass
Peak Pendulum Deceleration After 30 ms		G's	<= 22.0	15.76	Pass
Deceleration Decay Time to Cross 5 G's		ms	38.0 to 46.0	38.1	Pass
Maximum "D" Plane Rotation	Maximum	Degrees	81.0 to 106.0	92.9	Pass
	Time	ms	72.0 to 82.0	72.9	Pass
"D" Plane Rotation Decay Time To Zero Crossing		ms	147.0 to 174.0	153.6	Pass
Moment About Occipital Condyle	Maximum	Nm	-52.9 to -79.9	-59.6	Pass
	Time	ms	65.0 to 79.0	68.2	Pass
Negative Moment Decay Time To Zero Crossing		ms	120.0 to 148.0	139.9	Pass
Overall Test Results					Pass


 Laboratory Technician

8/31/10
 Test Date

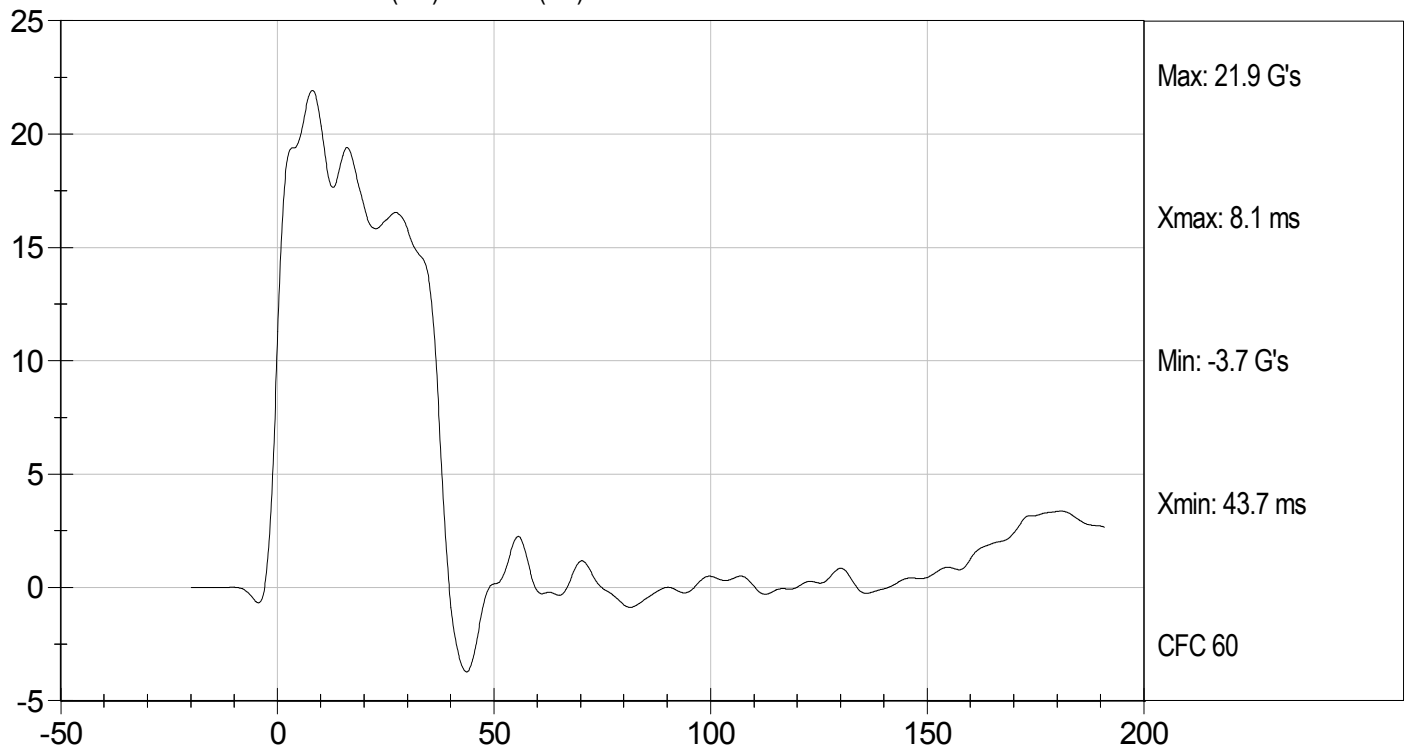

 Approved By



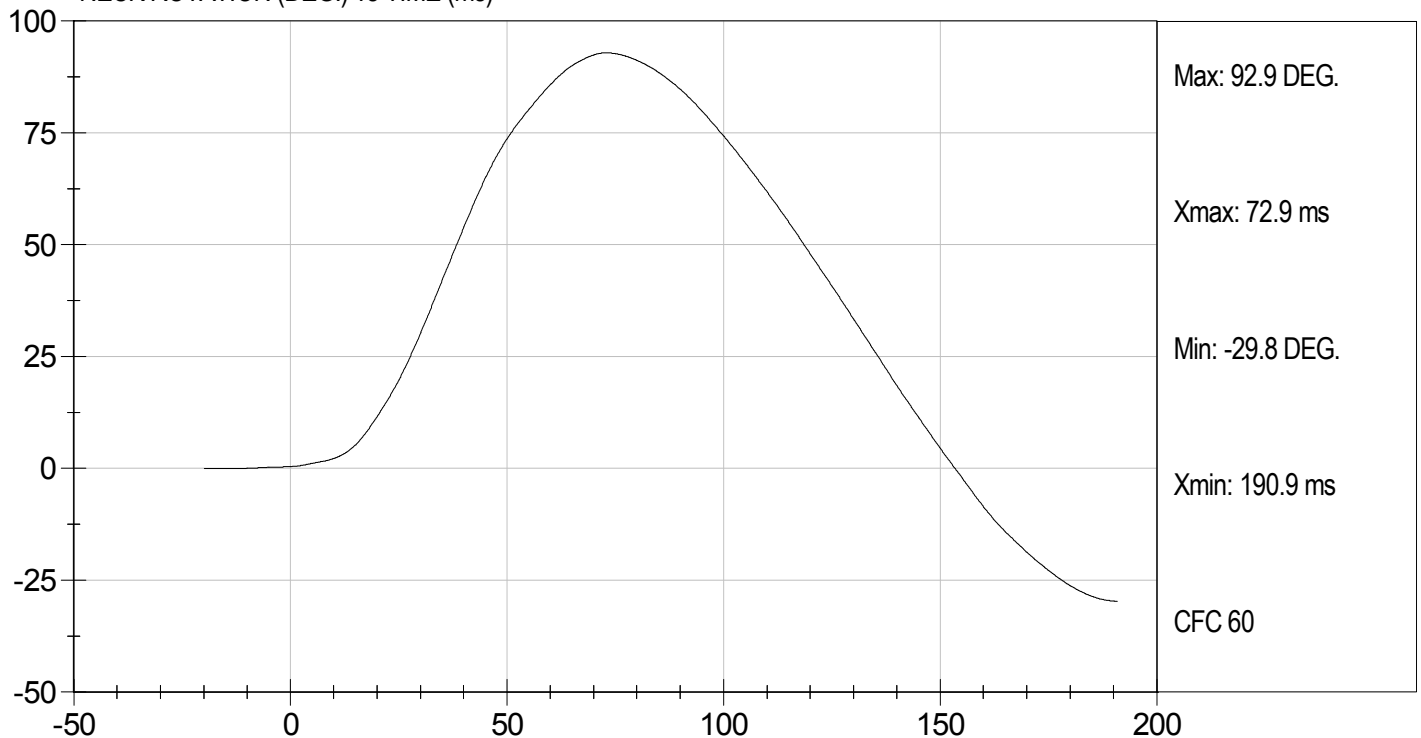
Test Desc: Neck Extension
Component ID: D102823

Test Date: 8/31/10
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (G's) vs TIME (ms)



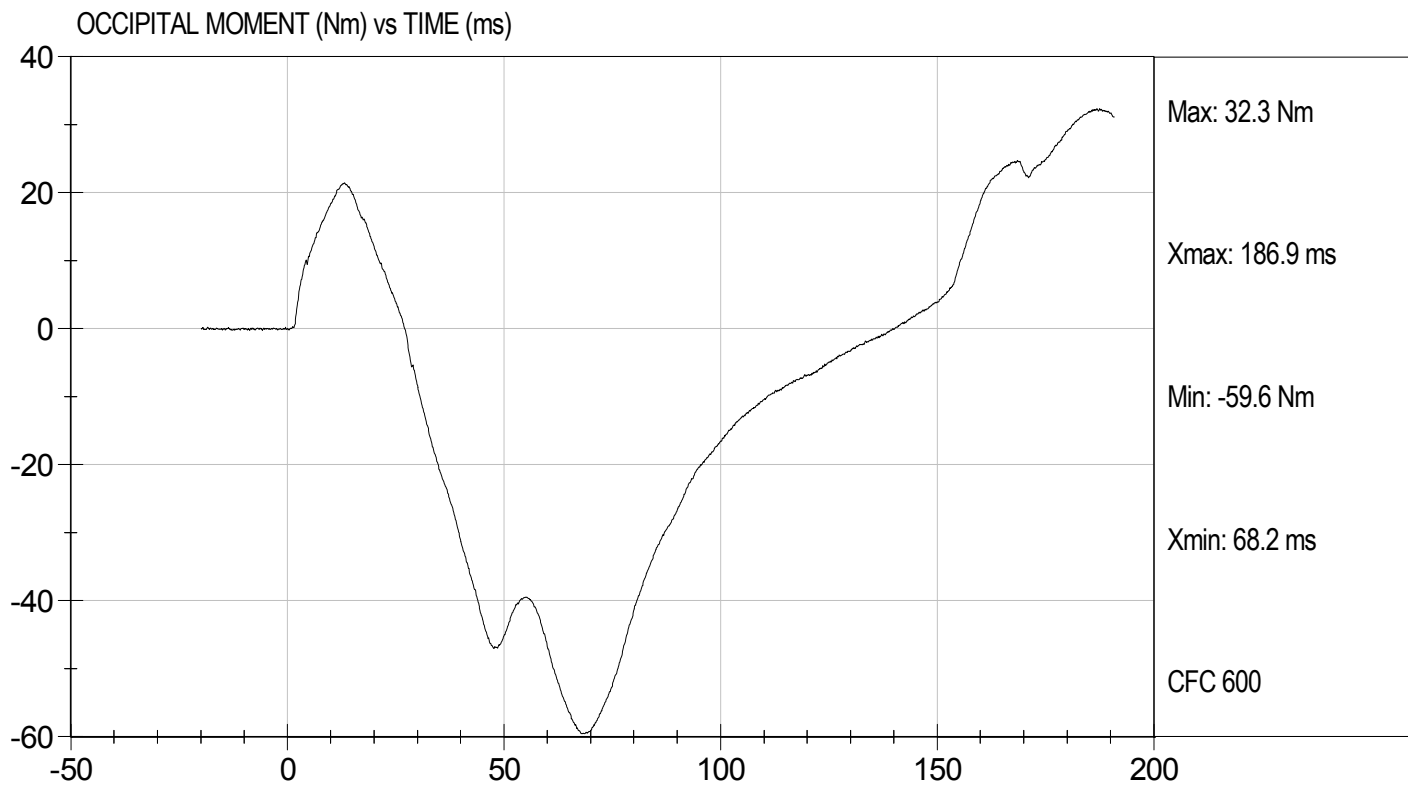
NECK ROTATION (DEG.) vs TIME (ms)





Test Desc: Neck Extension
Component ID: D102823

Test Date: 8/31/10
Velocity: 20.08 ft/s, 6.12 m/s



MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102824

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Velocity	m/s	6.58 to 6.82	6.77	Pass
Peak Probe Force	N	5159 to 5893	5,283	Pass
Peak Sternum Displacement	cm	6.35 to 7.26	6.66	Pass
Internal Hysteresis	%	69 to 85	70	Pass
Overall Test Results			Pass	


Laboratory Technician

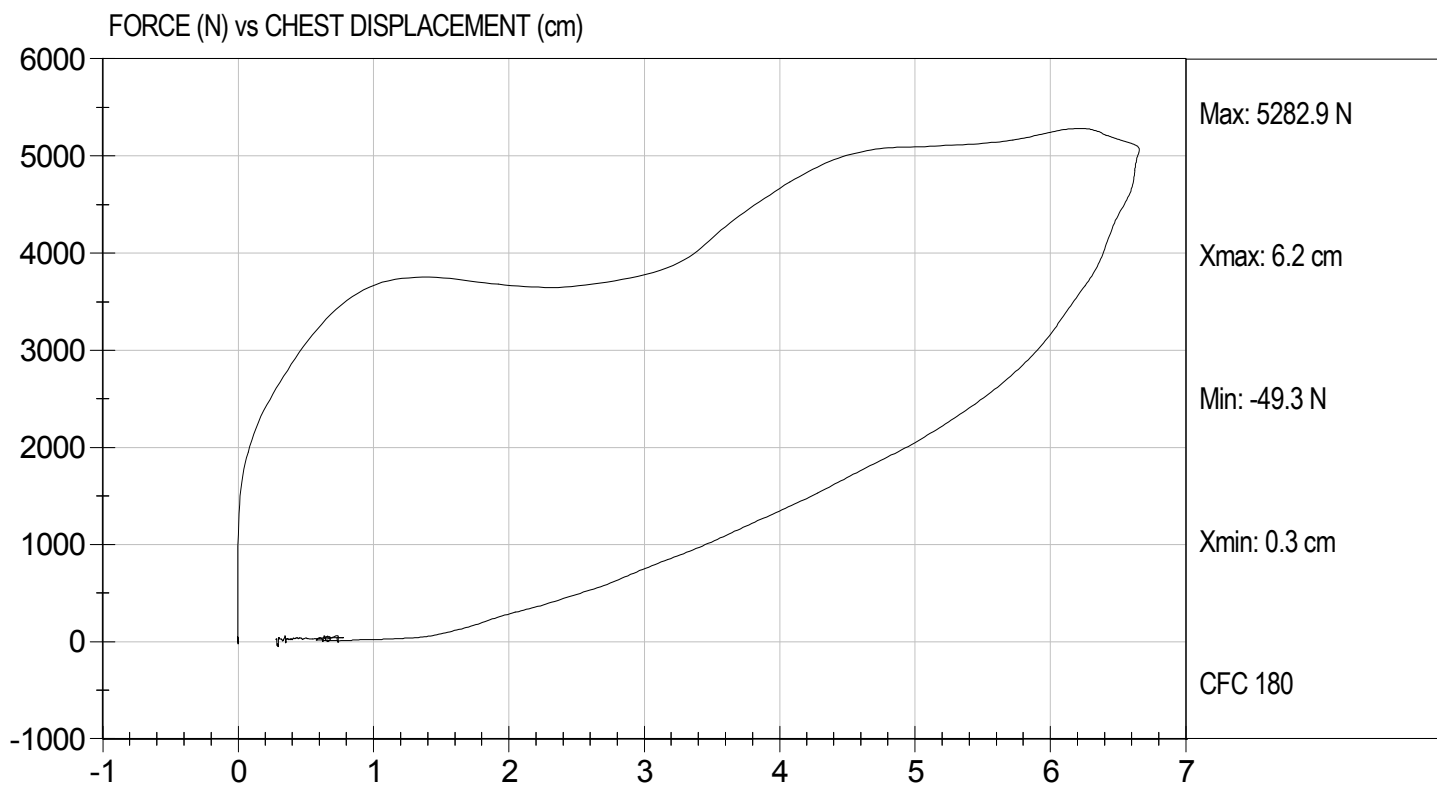
8/31/10
Test Date


Approved By



Test Desc: Thorax Impact
Component ID: D102824

Test Date: 8/31/10
Velocity: 22.22 ft/s, 6.77 m/s



MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102825

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	Newtons	4715 to 5782	5,087	Pass
Overall Test Results				Pass

Jessica Hall
Laboratory Technician

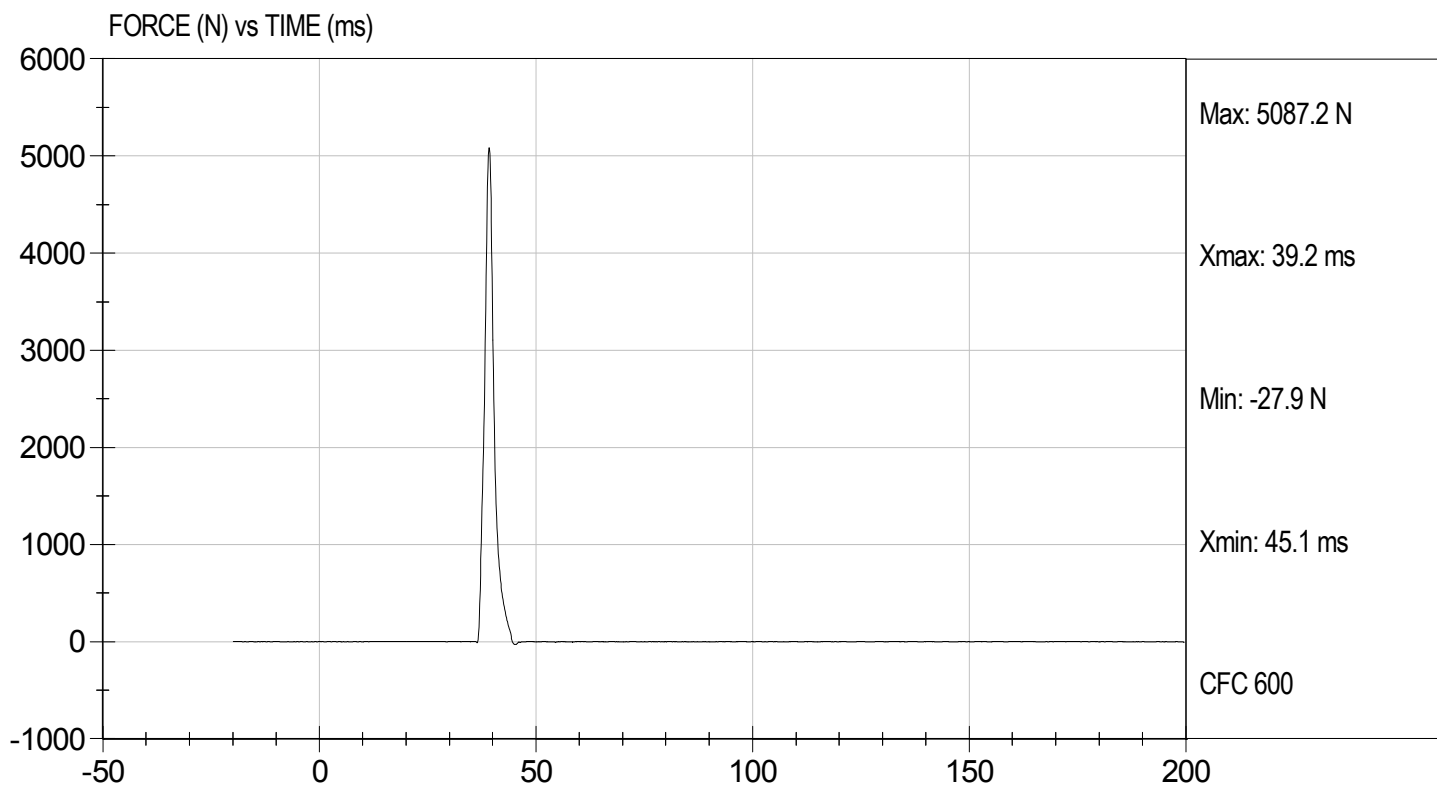
8/31/10
Test Date

David Winkelbauer
Approved By



Test Desc: Right Knee
Component ID: D102825

Test Date: 8/31/10
Velocity: 6.92 ft/s, 2.11 m/s



MGA RESEARCH CORPORATION
LEFT KNEE IMPACT TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102826

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Velocity	m/s	2.07 to 2.13	2.11	Pass
Peak Probe Force	Newtons	4715 to 5782	5,180	Pass
Overall Test Results				Pass

Jessica Hall
Laboratory Technician

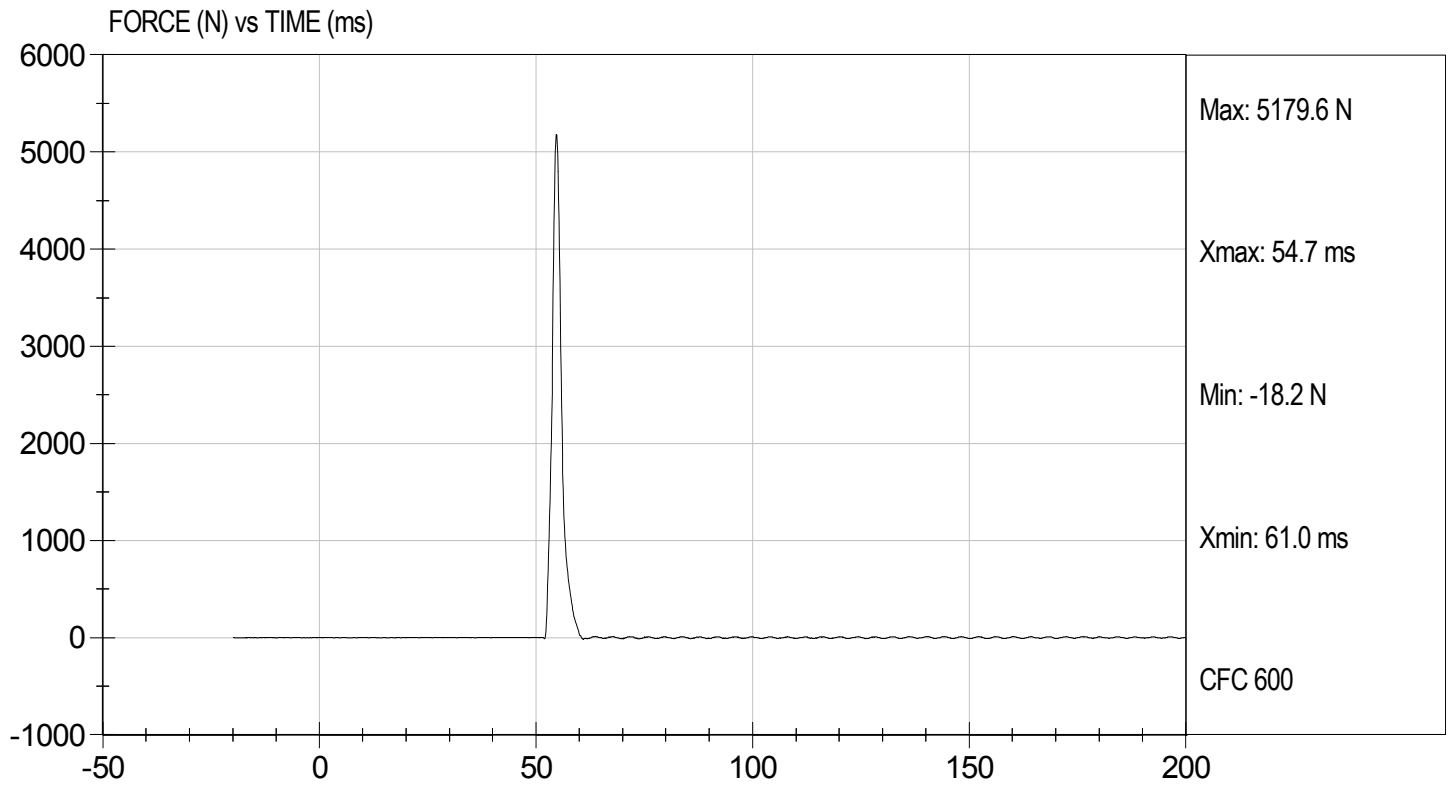
8/31/10
Test Date

David Winkelbauer
Approved By



Test Desc: Left Knee
Component ID: D102826

Test Date: 8/31/10
Velocity: 6.92 ft/s, 2.11 m/s

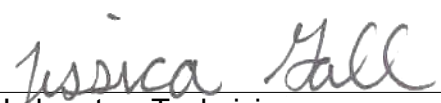


MGA RESEARCH CORPORATION
HIP-FEMUR FLEXION TEST
HYBRID III 50TH PERCENTILE MALE

ATD Serial No: 351

Test I.D: D102820

Tested Parameter	Units	Specification	Result		Pass/Fail
			Right	Left	
Laboratory Temperature	deg C	18.9 to 25.6	21.7	21.7	Pass
Laboratory Relative Humidity	%	10 to 70	49	49	Pass
Rotation Rate	deg/s	5 -10	8	8	Pass
30 Degrees	Nm	94.9 Nm Max	55.9	64.1	Pass
150 ft-lbf / 203.4 Nm	Deg	40- 50 Degree Max Rotation	45	47	Pass
Overall Test Results					Pass


 Laboratory Technician

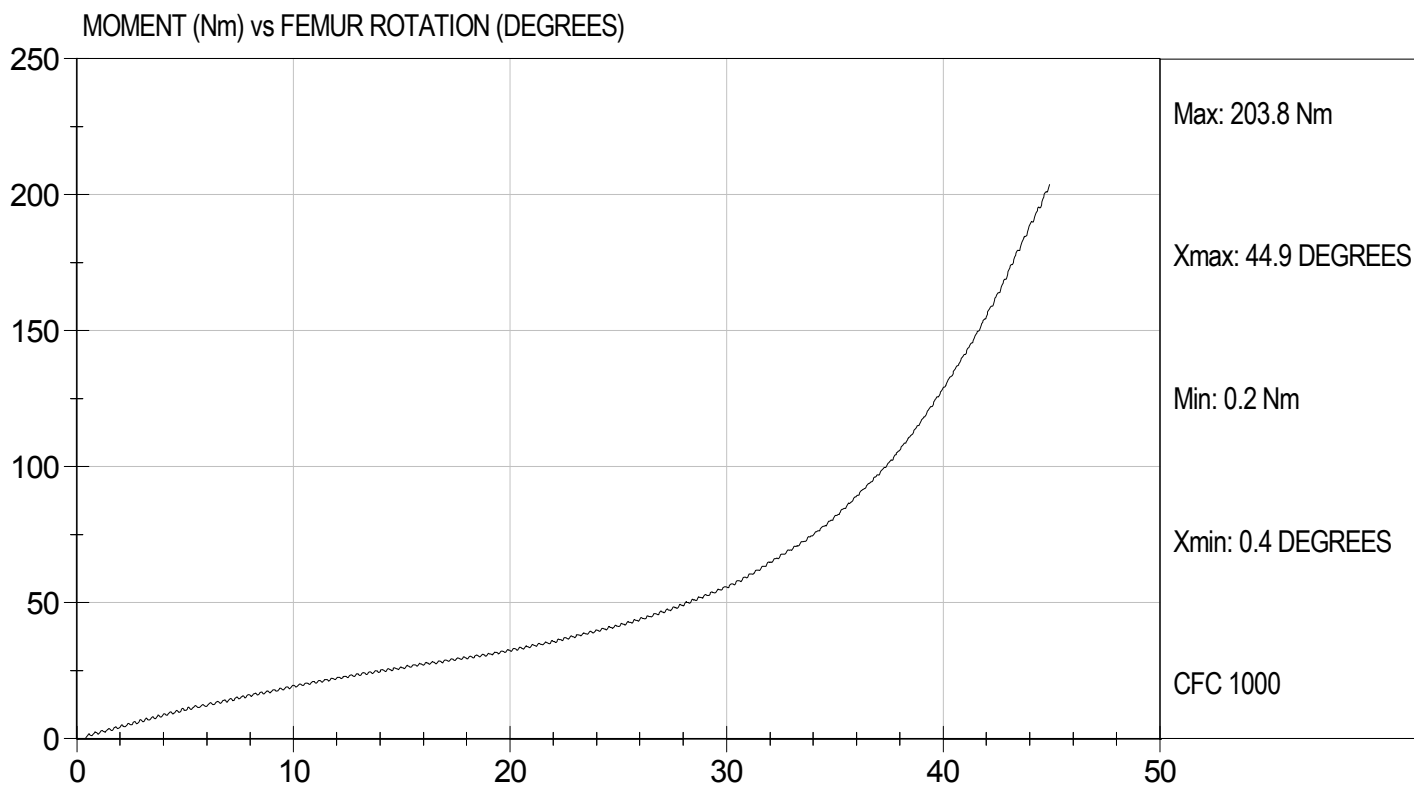
9/1/10
 Test Date


 Approved By



Test Desc: Hip Femur Flexion
Component ID: D102829

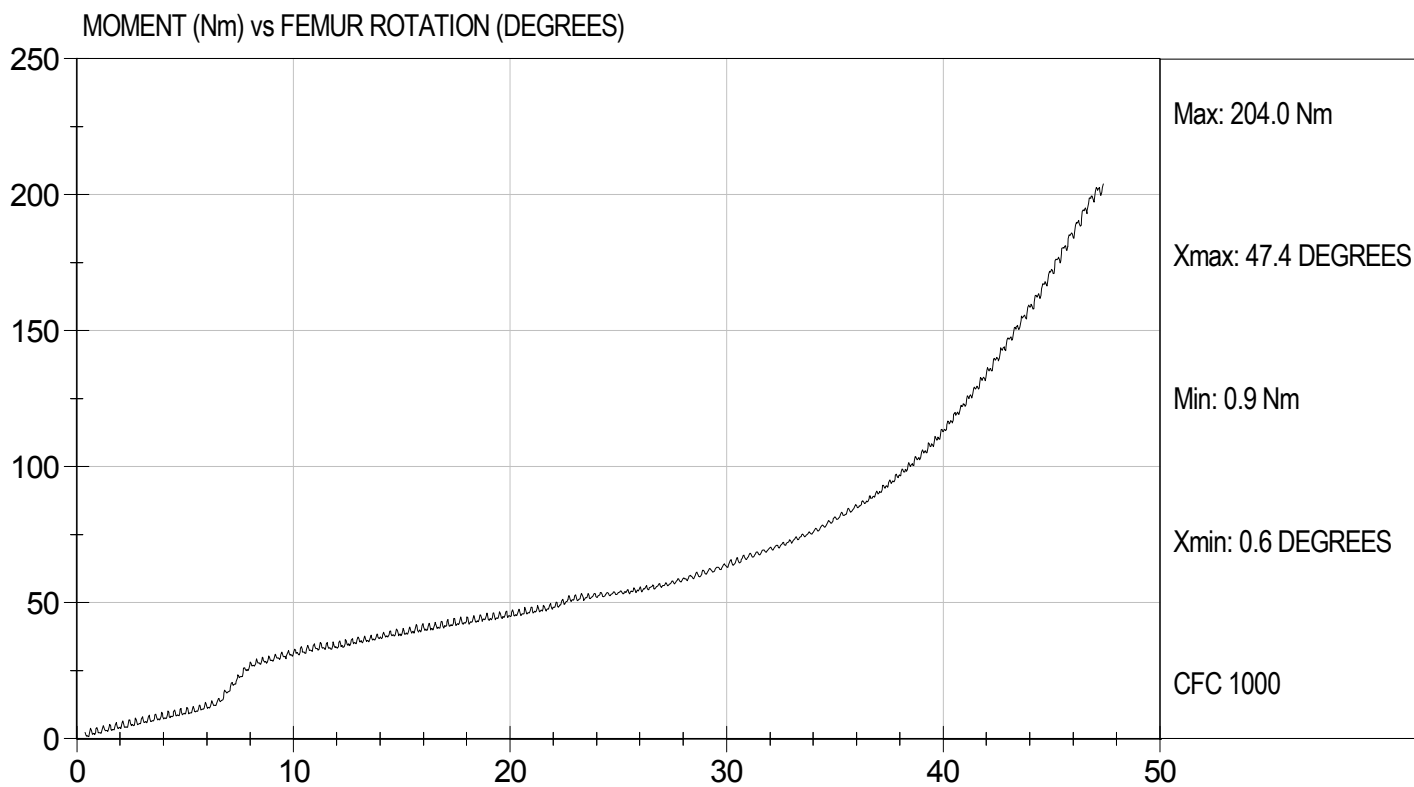
Test Date: 9/1/10
Velocity: 0 ft/s, 0.00 m/s





Test Desc: Hip Femur Flexion
Component ID: D102820

Test Date: 9/1/10
Velocity: 0 ft/s, 0.00 m/s

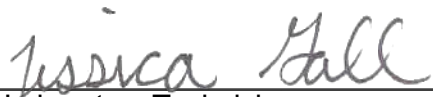


MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test ID: D102651

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.3	Pass
Laboratory Relative Humidity	%	10 to 70	56	Pass
Peak Resultant Acceleration	G's	250 to 300	283	Pass
Peak Lateral Acceleration	G's	+/- 15	7.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass


Laboratory Technician

8/18/10
Test Date

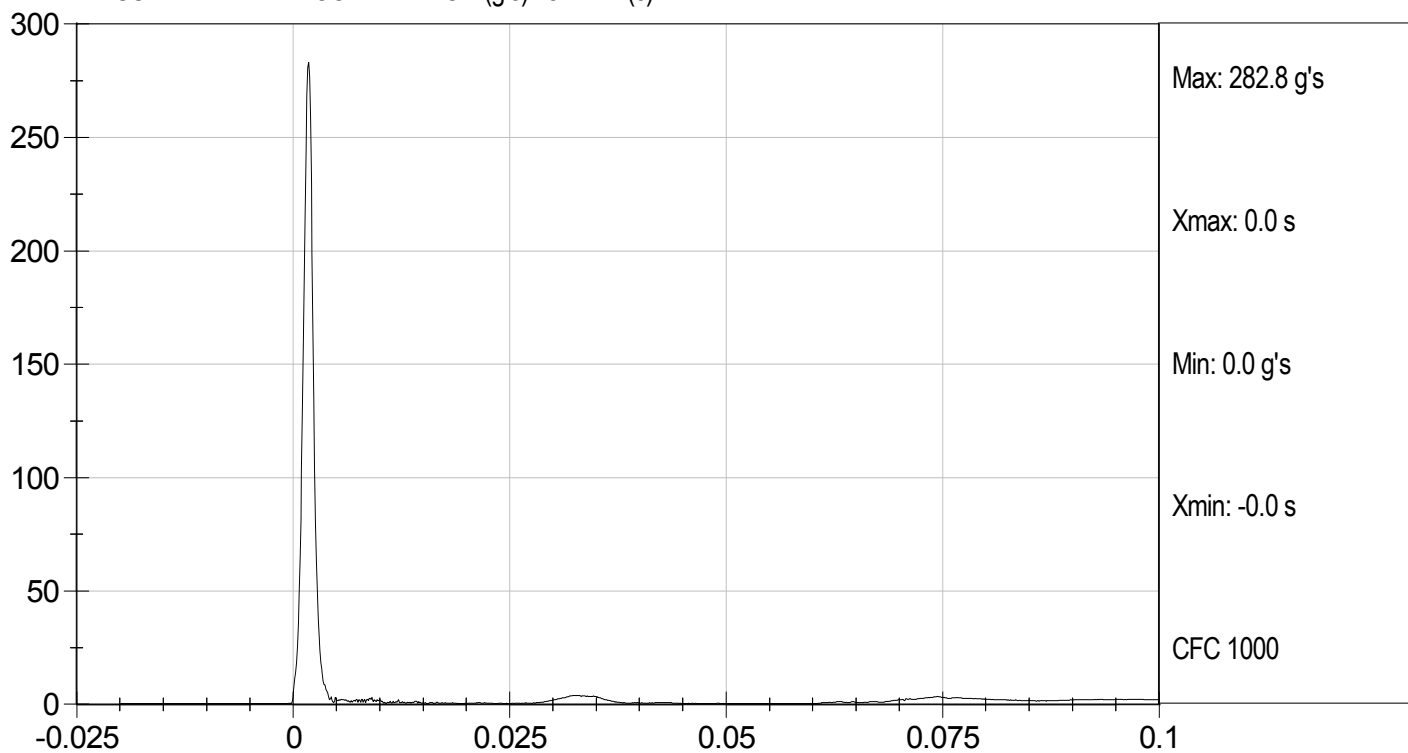

Approved By



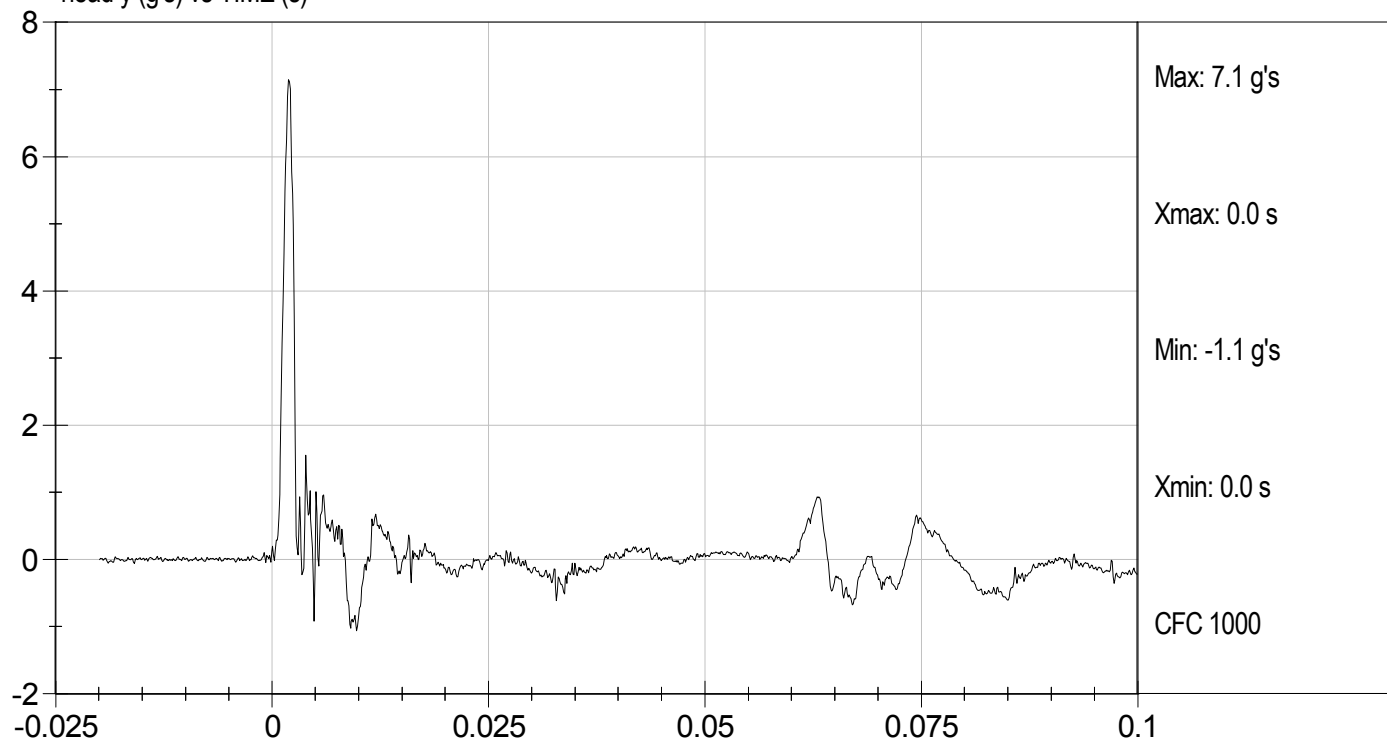
Test Desc: Head Drop
Component ID: D102651

Test Date: 8/18/10
Velocity: 0 ft/s, 0 m/s

RESULTANT HEAD ACCELERATION (g's) vs TIME (s)



head y (g's) vs TIME (s)

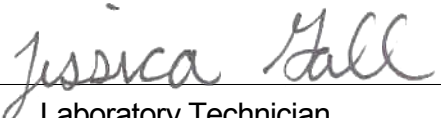


MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102652

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	m/s	2.1 to 2.5	2.4	Pass
	20 ms	m/s	4.0 to 5.0	4.6	Pass
	30 ms	m/s	5.8 to 7.0	6.6	Pass
D Plane Rotation	Max	deg	77 to 91	79	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	69 to 83	75	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	83	Pass
Overall Results					Pass


Laboratory Technician

8/19/10
Test Date

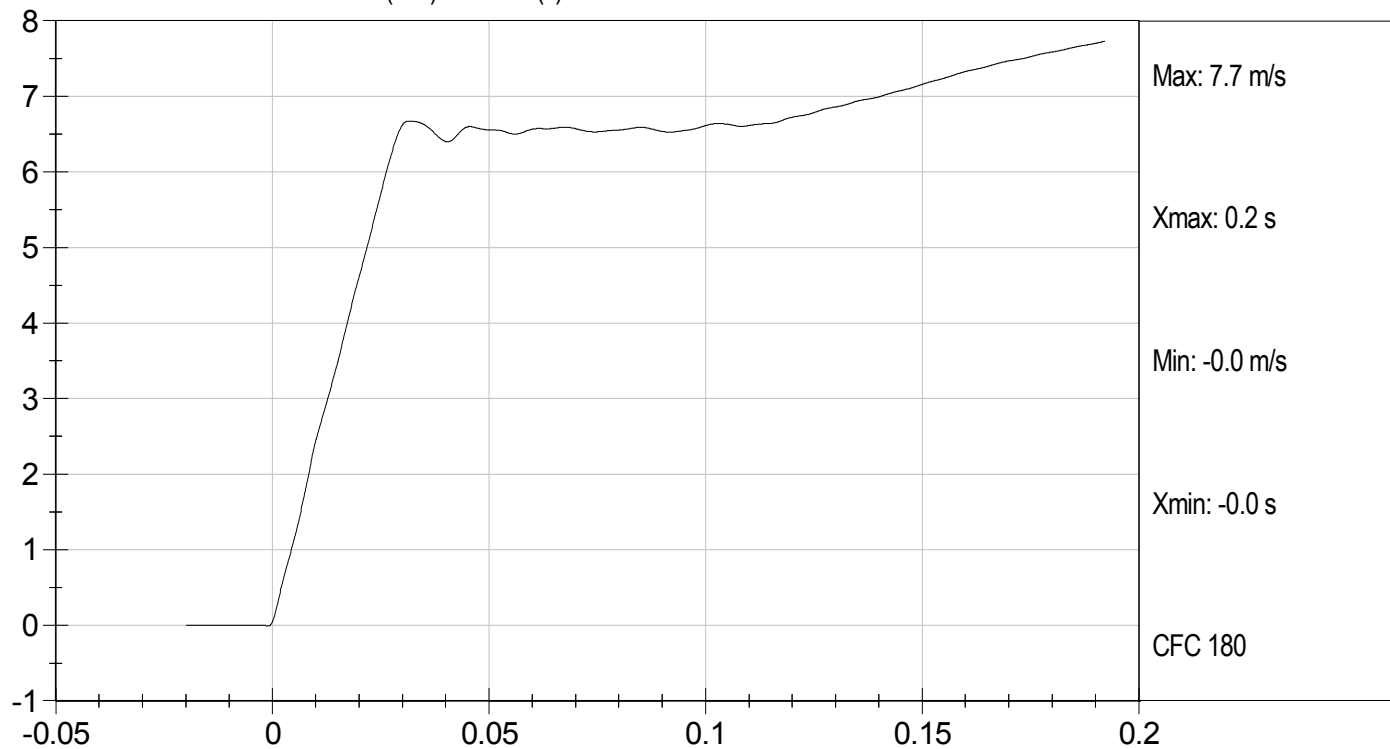

Approved By



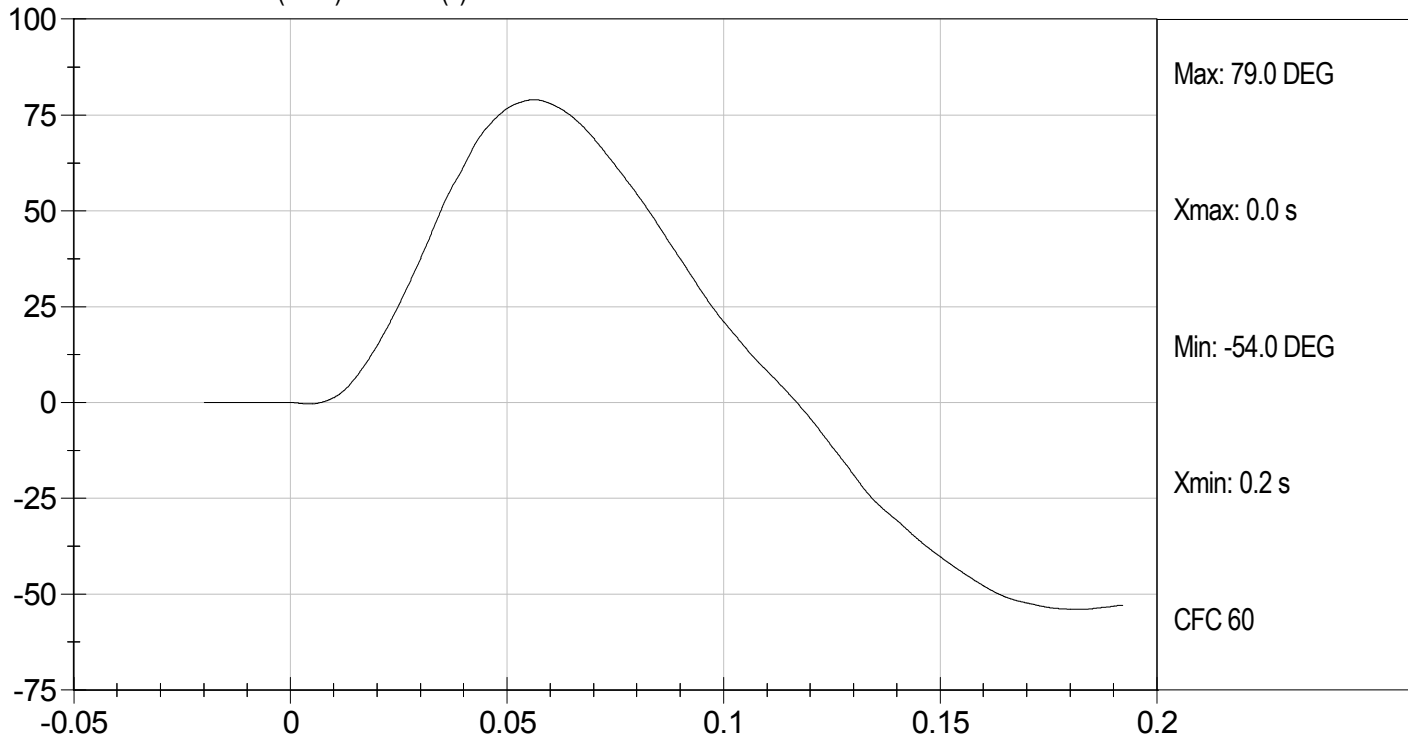
Test Desc: Neck Flexion
Component ID: D102652

Test Date: 8/19/10
Velocity: 23.15 ft/s, 7.06 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



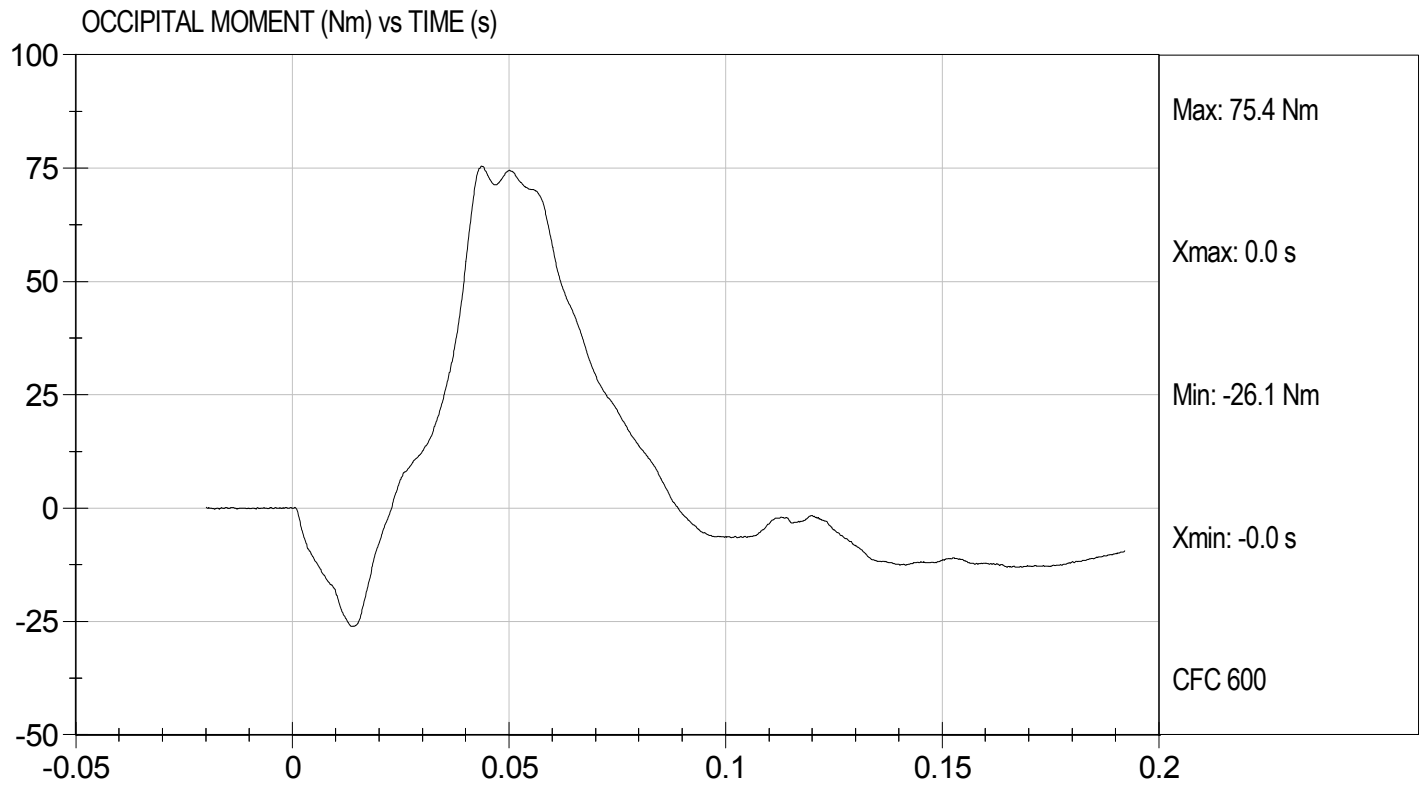
NECK ROTATION (DEG) vs TIME (s)





Test Desc: Neck Flexion
Component ID: D102652

Test Date: 8/19/10
Velocity: 23.15 ft/s, 7.06 m/s



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102653

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.3	Pass
Laboratory Relative Humidity		%	10 to 70	52	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.16	Pass
Pendulum Deceleration	10 ms	m/s	1.5 to 1.9	1.9	Pass
	20 ms	m/s	3.1 to 3.9	3.7	Pass
	30 ms	m/s	4.6 to 5.6	5.3	Pass
D Plane Rotation	Max	deg	99 to 114	102	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	-65 to -53	-55	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	100	Pass
Overall Results					Pass


Laboratory Technician

8/19/10
Test Date

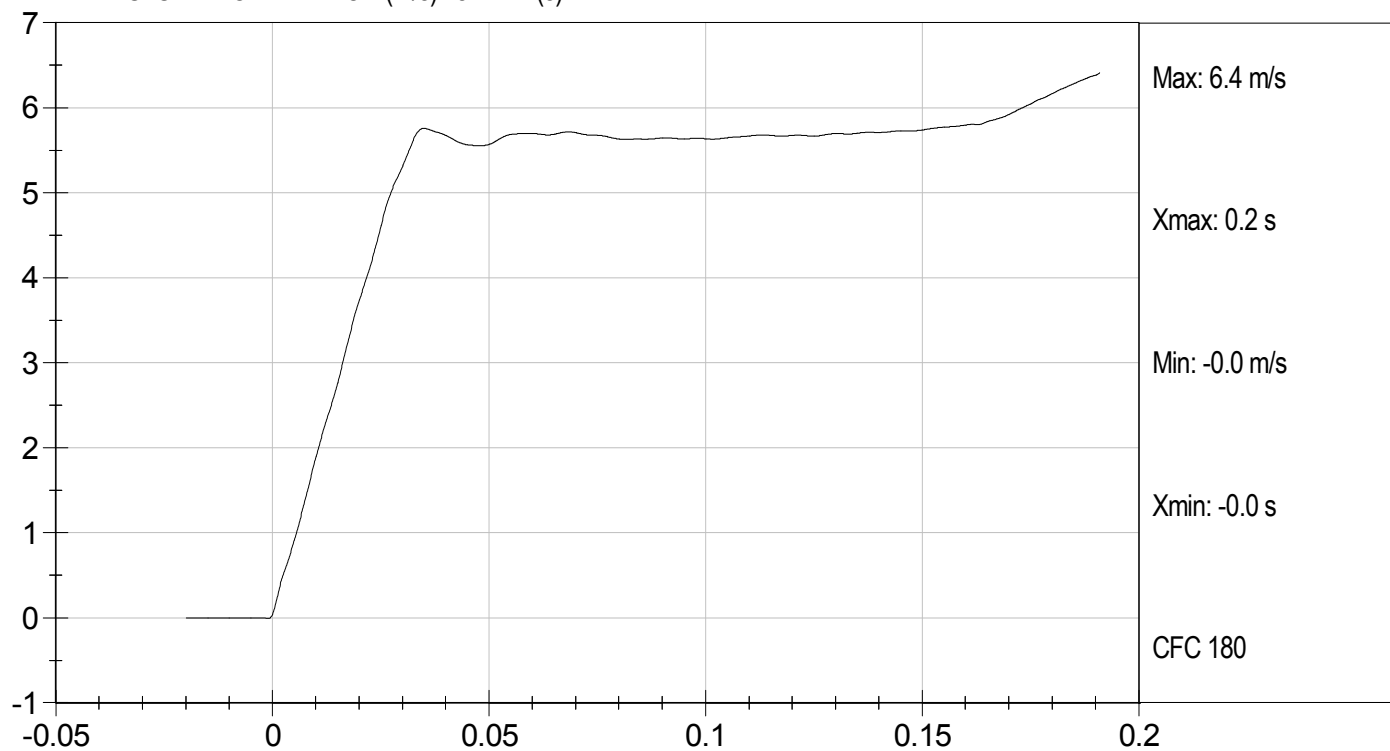

Approved By



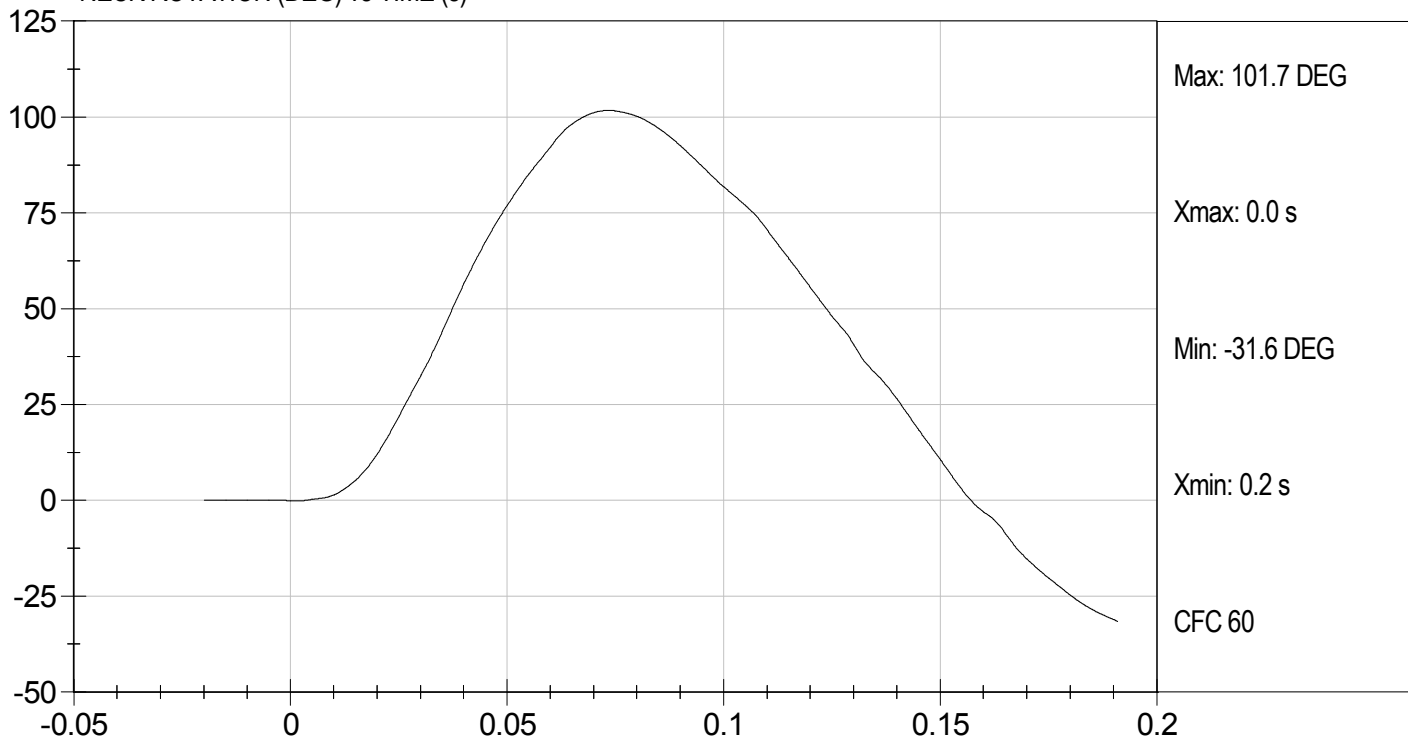
Test Desc: Neck Extension
Component ID: D102653

Test Date: 8/19/10
Velocity: 20.20 ft/s, 6.16 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



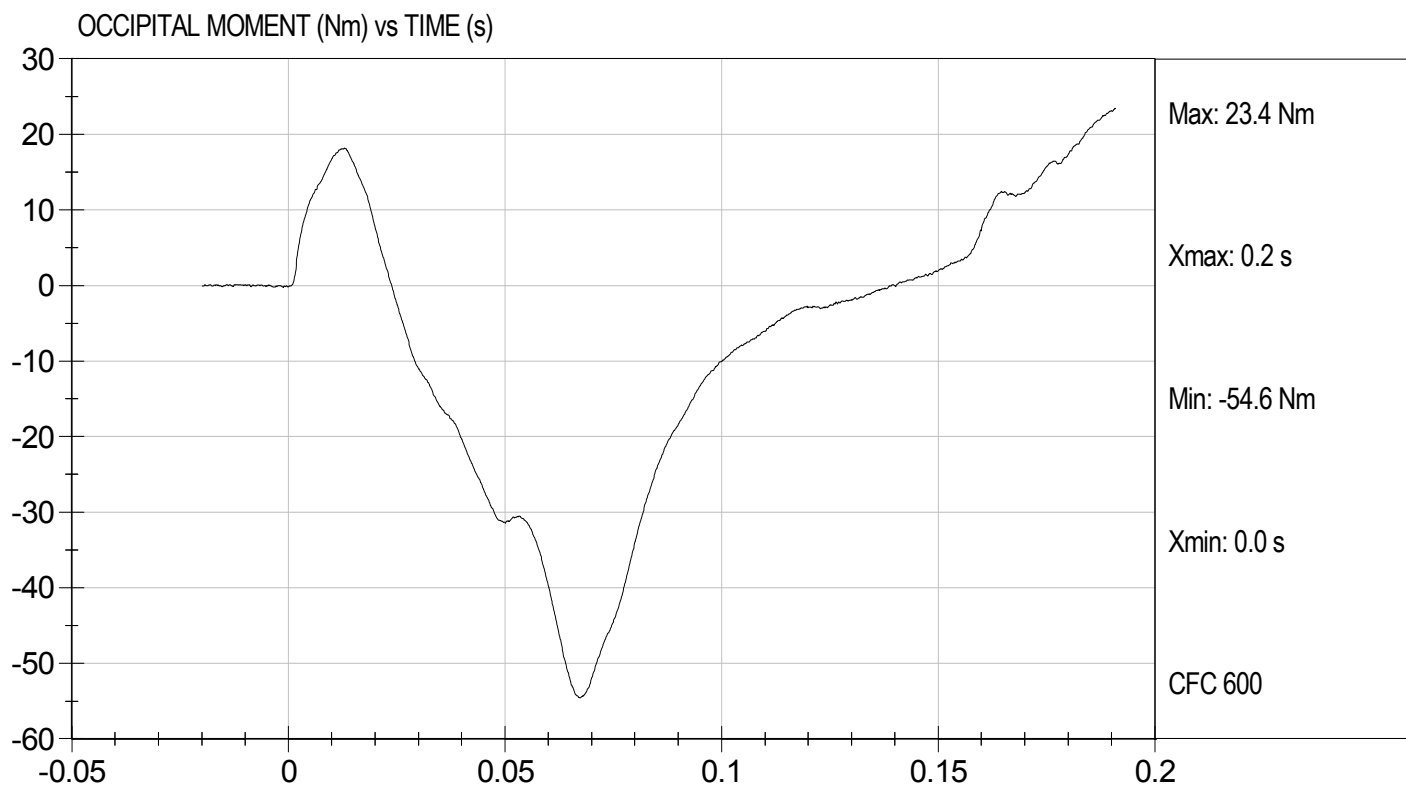
NECK ROTATION (DEG) vs TIME (s)





Test Desc: Neck Extension
Component ID: D102653

Test Date: 8/19/10
Velocity: 20.20 ft/s, 6.16 m/s



MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102654

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.4	Pass
Relative Humidity	%	10 to 70	53	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	54	Pass
Peak Resistive Force w/in Deflection Corridor	kN	3.9 to 4.4	4.17	Pass
Internal Hysteresis	%	69 to 85	70	Pass
Peak Force 18 mm - 50 mm	N	<= 4,600 N	4156	Pass
Overall Test Results				Pass

Jessica Hall
Laboratory Technician

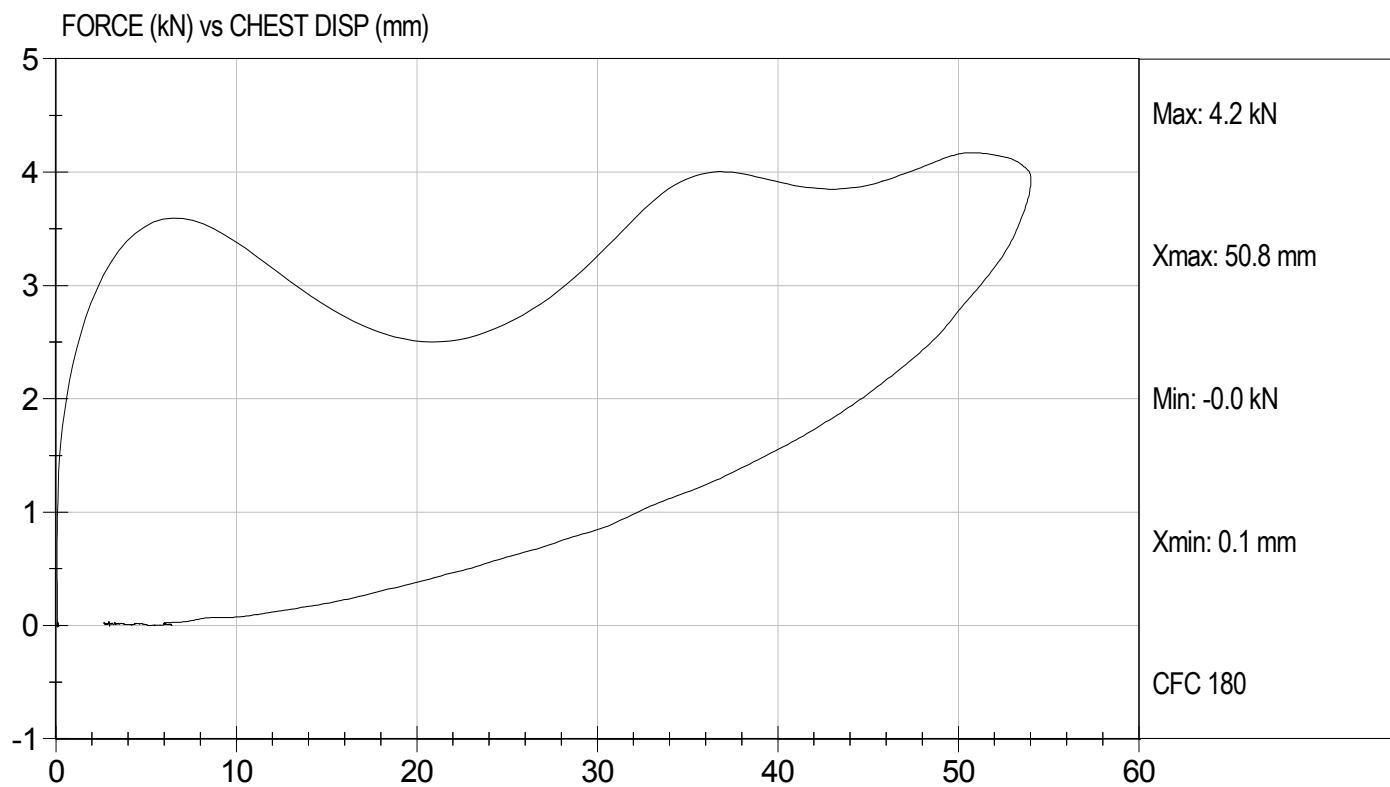
8/19/10
Test Date

David Winkelbauer
Approved By



Test Desc: Thorax Impact
Component ID: D102654

Test Date: 8/19/10
Velocity: 22.2 ft/s, 6.77 m/s

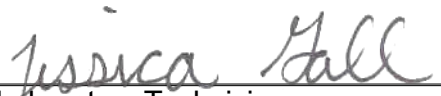


MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102655

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	51	Pass
Probe Speed	m/s	2.07 to 2.13	2.13	Pass
Maximum Force	kN	3.45 to 4.06	3.81	Pass
Overall Test Results			Pass	


Laboratory Technician

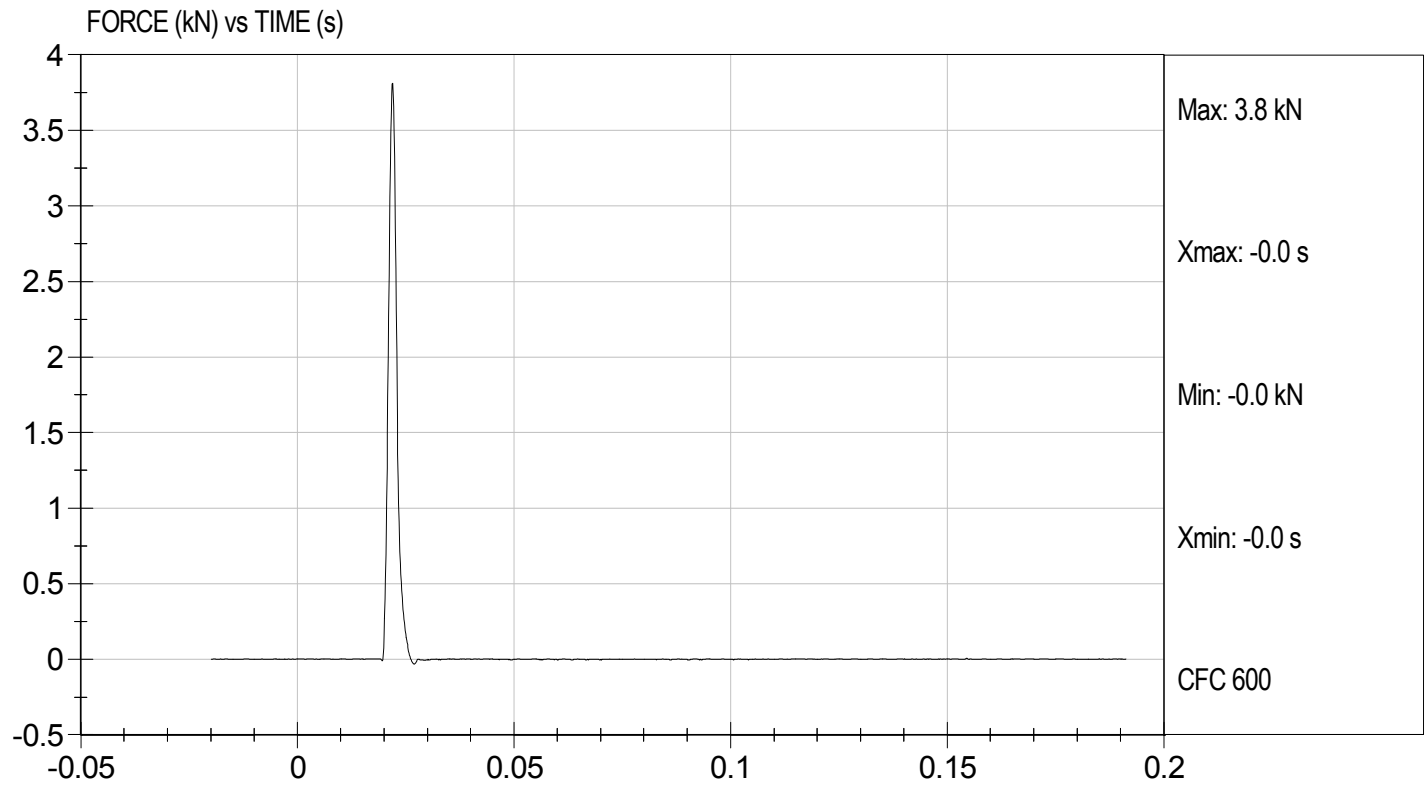
8/19/10
Test Date


Approved By



Test Desc: Left Knee
Component ID: D102655

Test Date: 8/19/10
Velocity: 7.0 ft/s, 2.13 m/s



MGA RESEARCH CORPORATION

**LEFT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE**

ATD Serial No: 138

Test I.D: D102656

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	51	Pass
Probe Speed	m/s	2.07 to 2.13	2.10	Pass
Maximum Force	kN	3.45 to 4.06	3.59	Pass
Overall Test Results				Pass

Jessica Gall
Laboratory Technician

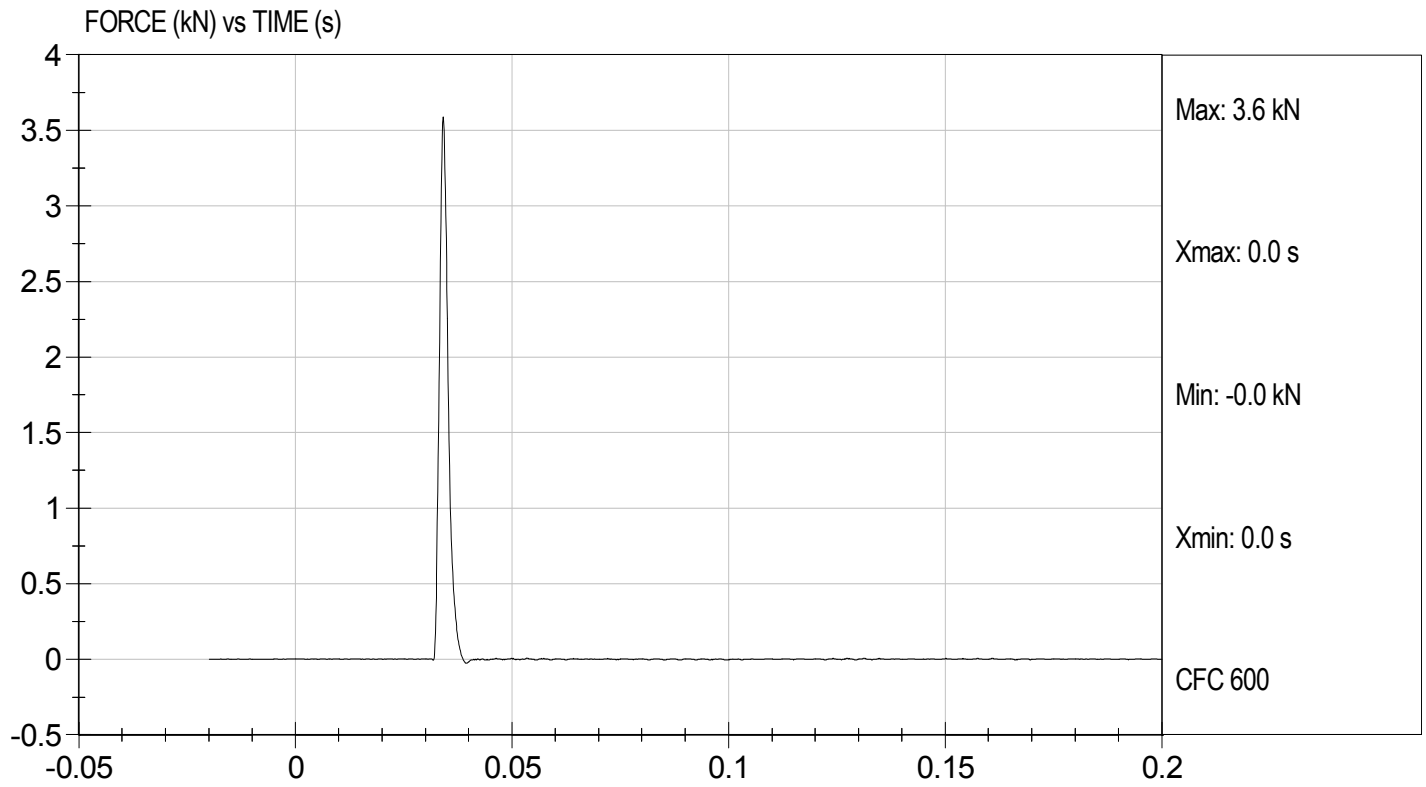
8/19/10
Test Date

David Winkelbauer
Approved By



Test Desc: Left Knee
Component ID: D102656

Test Date: 8/19/10
Velocity: 6.9 ft/s, 2.10 m/s



MGA RESEARCH CORPORATION
TORSO FLEXION TEST
HYBRID III 5TH PERCENTILE

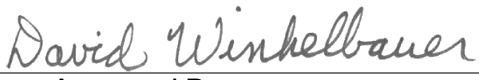
ATD Serial No: 138

Test I.D: D102657

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	53	Pass
Initial Angle	deg	0 to 20	18	Pass
Return Angle	deg	+/- 8	5	Pass
Force at 45 deg	N	320 to 390	345	Pass
Upper Torso Deflection Rate	Deg/sec	0.5 to 1.5	1.0	Pass
Overall Result				Pass


Laboratory Technician

8/19/10
Test Date

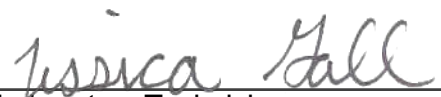

Approved By

MGA RESEARCH CORPORATION
HEAD DROP TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test ID: D102811

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Peak Resultant Acceleration	G's	250 to 300	264	Pass
Peak Lateral Acceleration	G's	+/- 15	-1.5	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 10% of peak	Yes	Pass
Overall Test Results				Pass


Laboratory Technician

8/31/10
Test Date

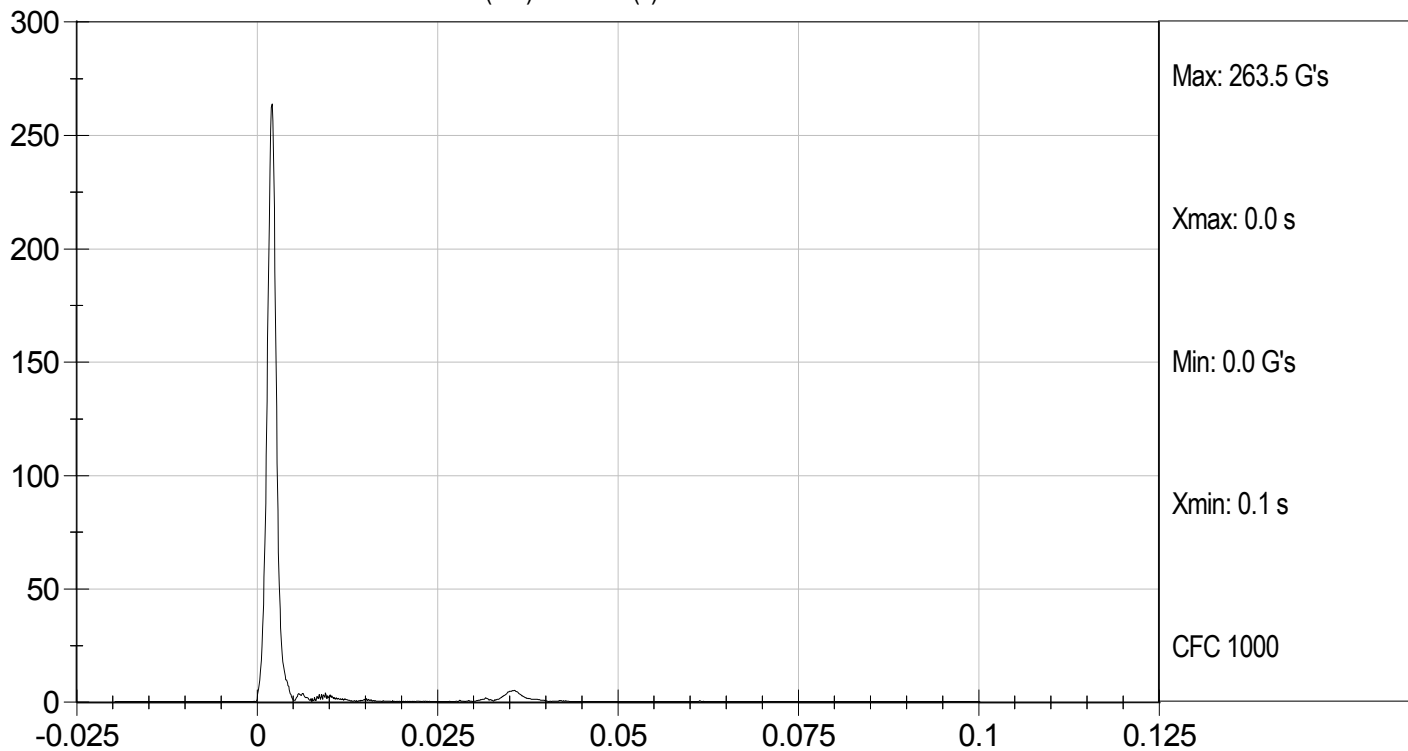

Approved By



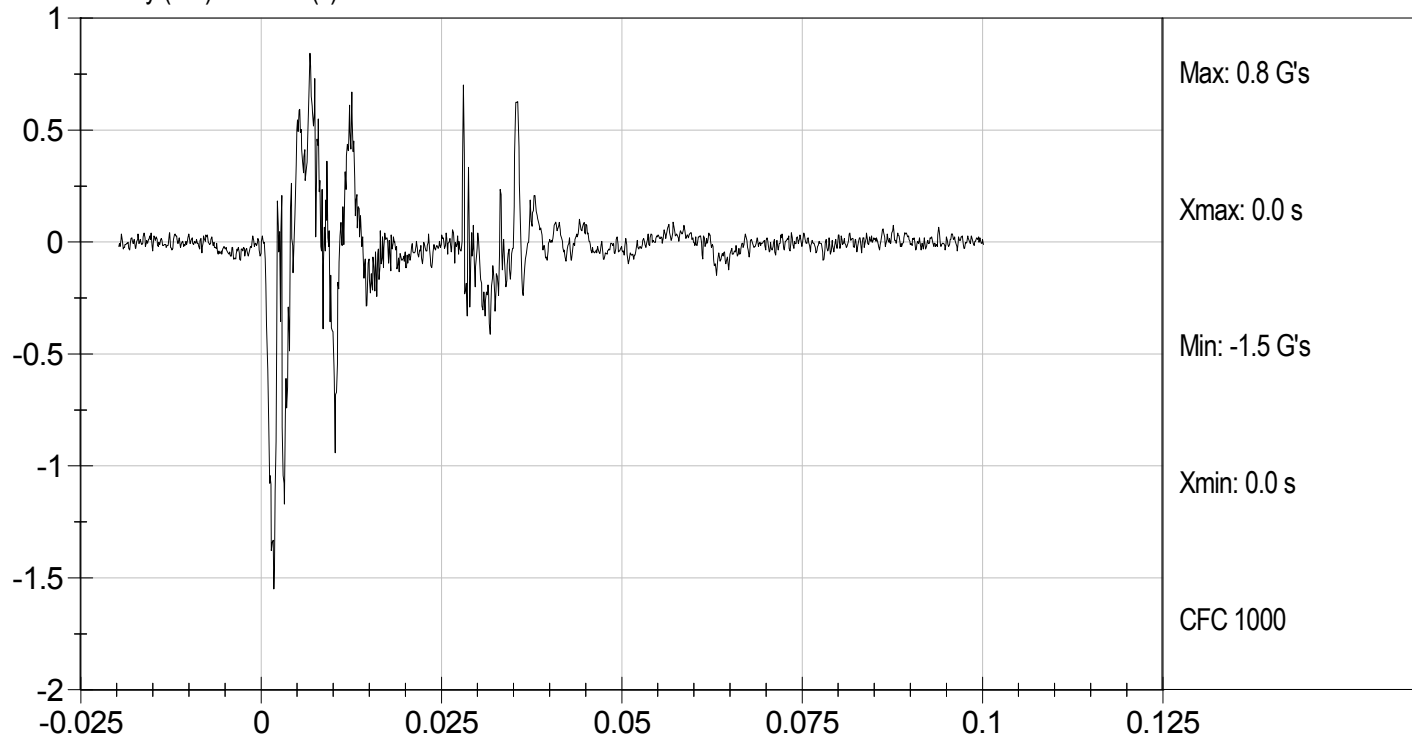
Test Desc: Head Drop
Component ID: D102811

Test Date: 8/31/10
Velocity: 0 ft/s, 0 m/s

RESULTANT HEAD ACCELERATION (G's) vs TIME (s)



head y (G's) vs TIME (s)



MGA RESEARCH CORPORATION
NECK FLEXION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102812

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.7	Pass
Laboratory Relative Humidity		%	10 to 70	50	Pass
Pendulum Speed		m/s	6.89 to 7.13	7.06	Pass
Pendulum Deceleration	10 ms	m/s	2.1 to 2.5	2.3	Pass
	20 ms	m/s	4.0 to 5.0	4.4	Pass
	30 ms	m/s	5.8 to 7.0	6.1	Pass
D Plane Rotation	Max	deg	77 to 91	78	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	69 to 83	76	Pass
Positive Moment Time Curve Decay to 10 Nm		ms	80 to 100	86	Pass
Overall Results					Pass

Jessica Hall
Laboratory Technician

9/1/10
Test Date

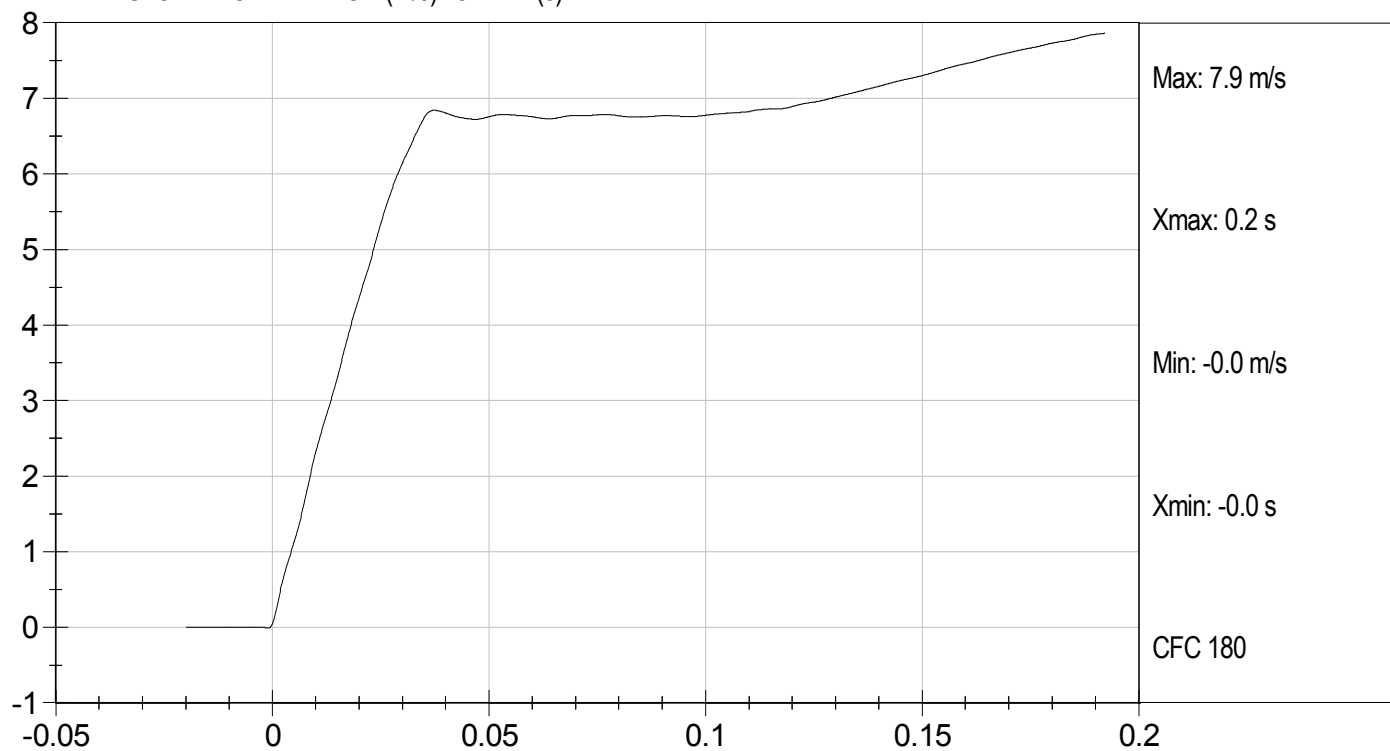
David Winkelbauer
Approved By



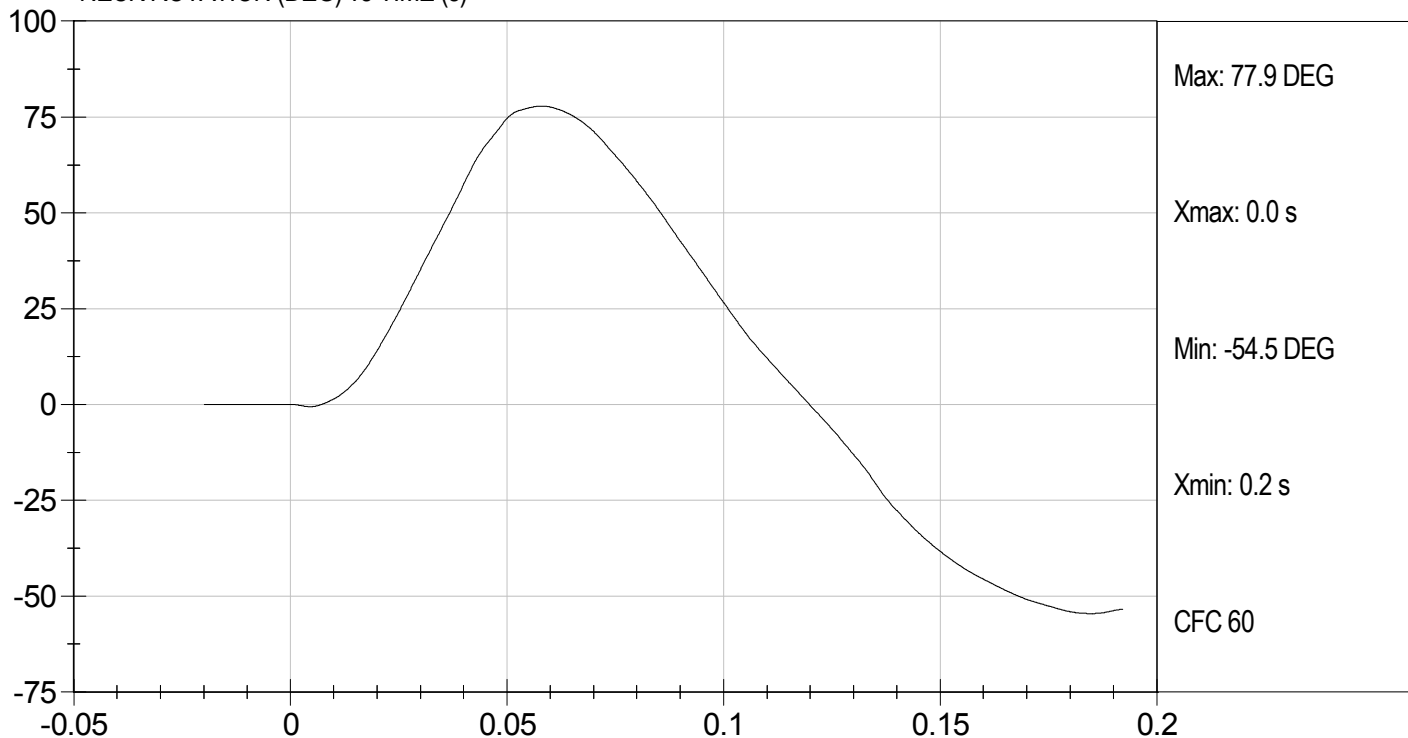
Test Desc: Neck Flexion
Component ID: D102812

Test Date: 9/1/10
Velocity: 23.15 ft/s, 7.06 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



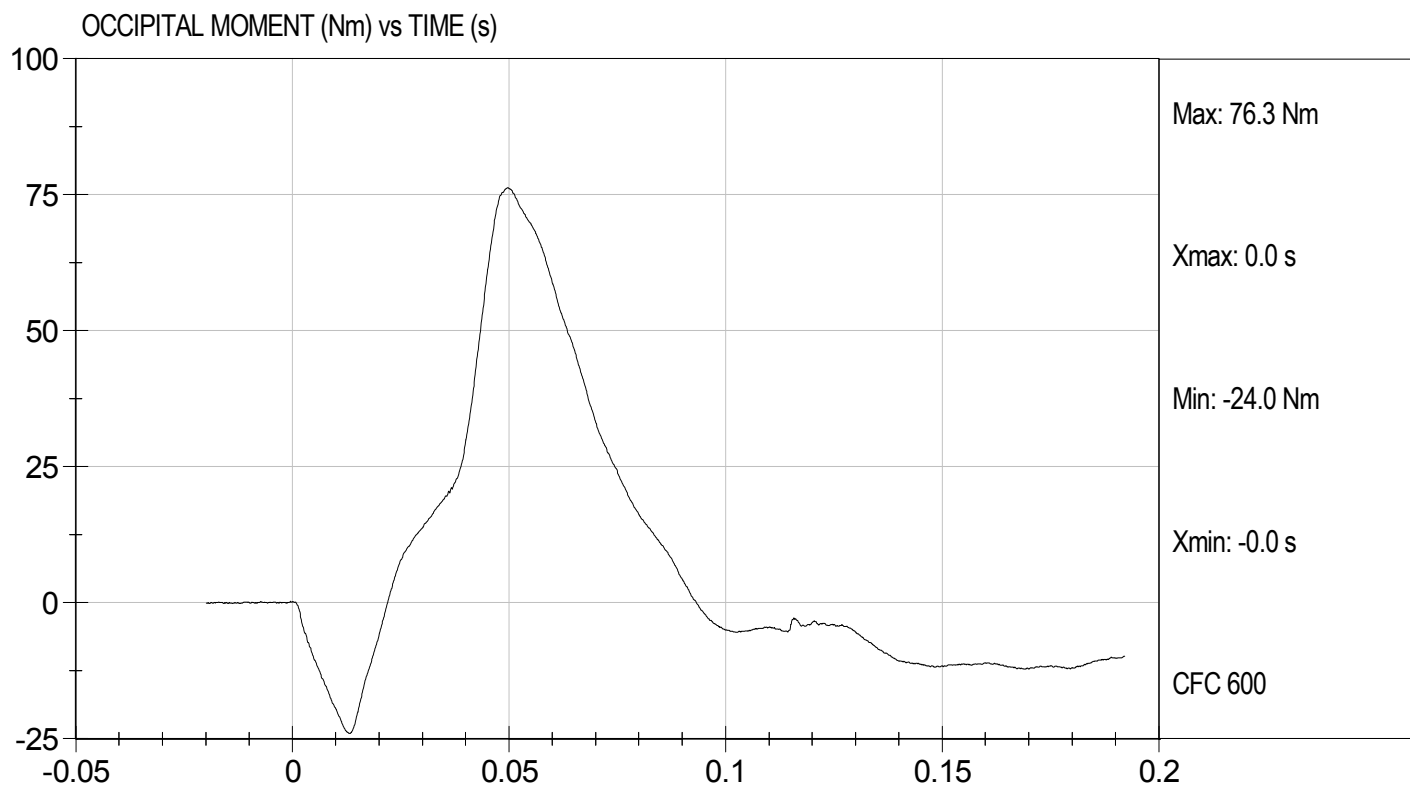
NECK ROTATION (DEG) vs TIME (s)





Test Desc: Neck Flexion
Component ID: D102812

Test Date: 9/1/10
Velocity: 23.15 ft/s, 7.06 m/s



MGA RESEARCH CORPORATION
NECK EXTENSION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102813

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.7	Pass
Laboratory Relative Humidity		%	10 to 70	50	Pass
Pendulum Speed		m/s	5.95 to 6.19	6.12	Pass
Pendulum Deceleration	10 ms	m/s	1.5 to 1.9	1.8	Pass
	20 ms	m/s	3.1 to 3.9	3.6	Pass
	30 ms	m/s	4.6 to 5.6	5.2	Pass
D Plane Rotation	Max	deg	99 to 114	105	Pass
Occipital Condyle Moment within Deflection Corridor		Nm	-65 to -53	-54	Pass
Negative Moment Time Curve Decay to -10 Nm		ms	94 to 114	101	Pass
Overall Results					Pass

Jessica Hall
Laboratory Technician

9/1/10
Test Date

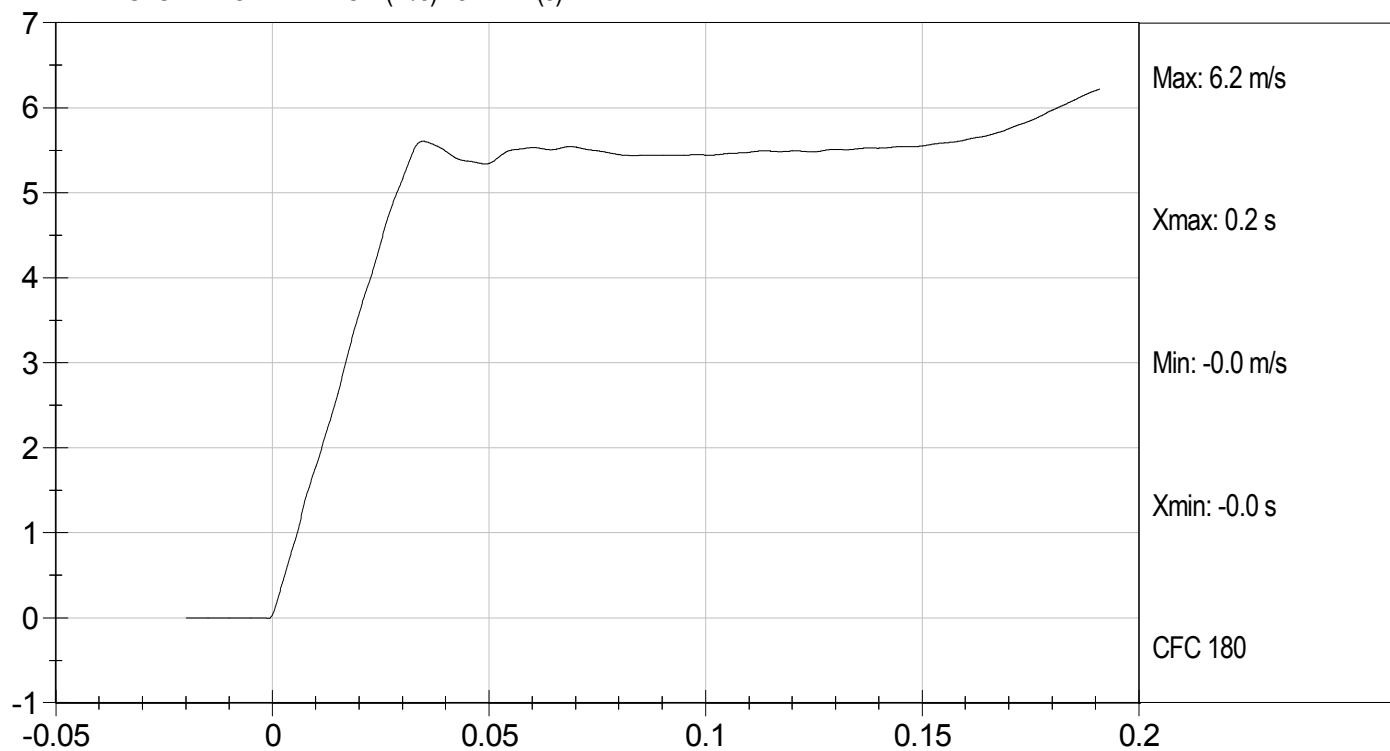
David Winkelbauer
Approved By



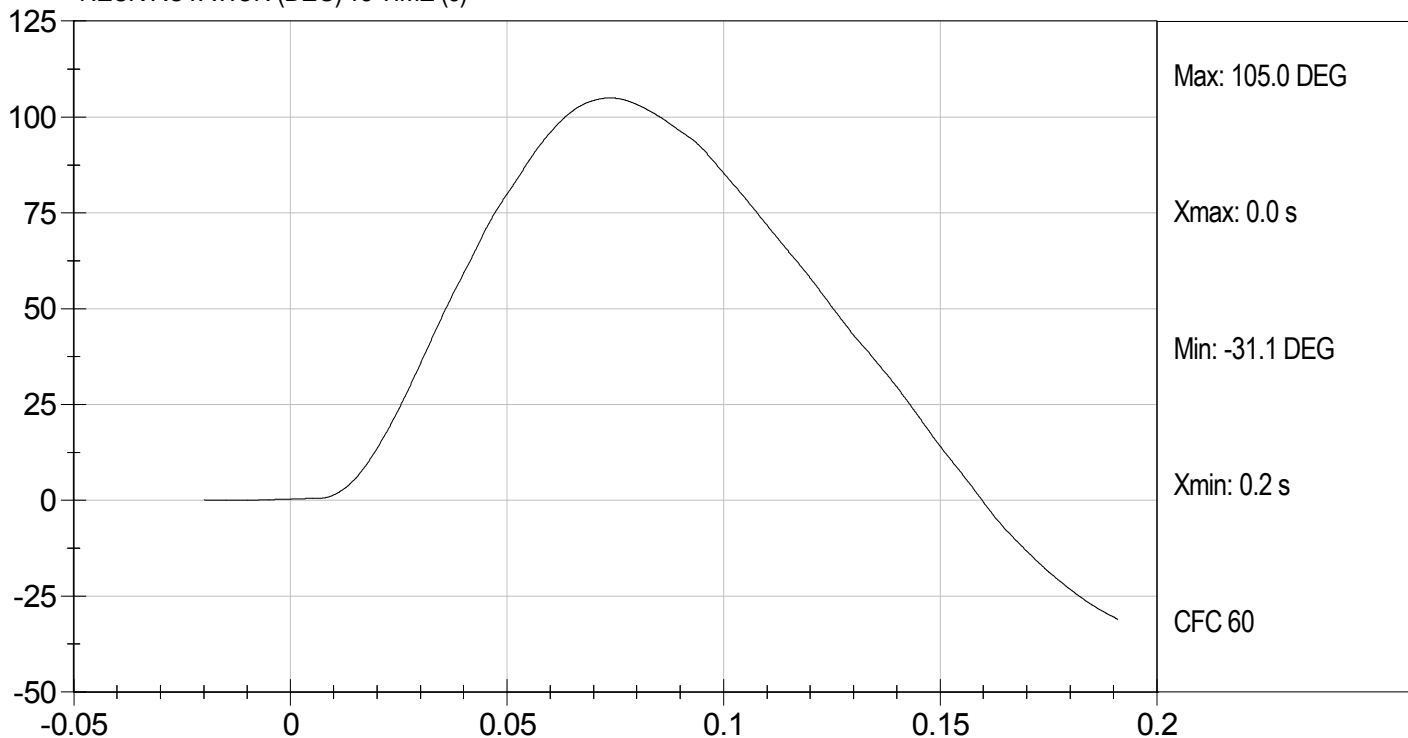
Test Desc: Neck Extension
Component ID: D102813

Test Date: 9/1/10
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/s) vs TIME (s)



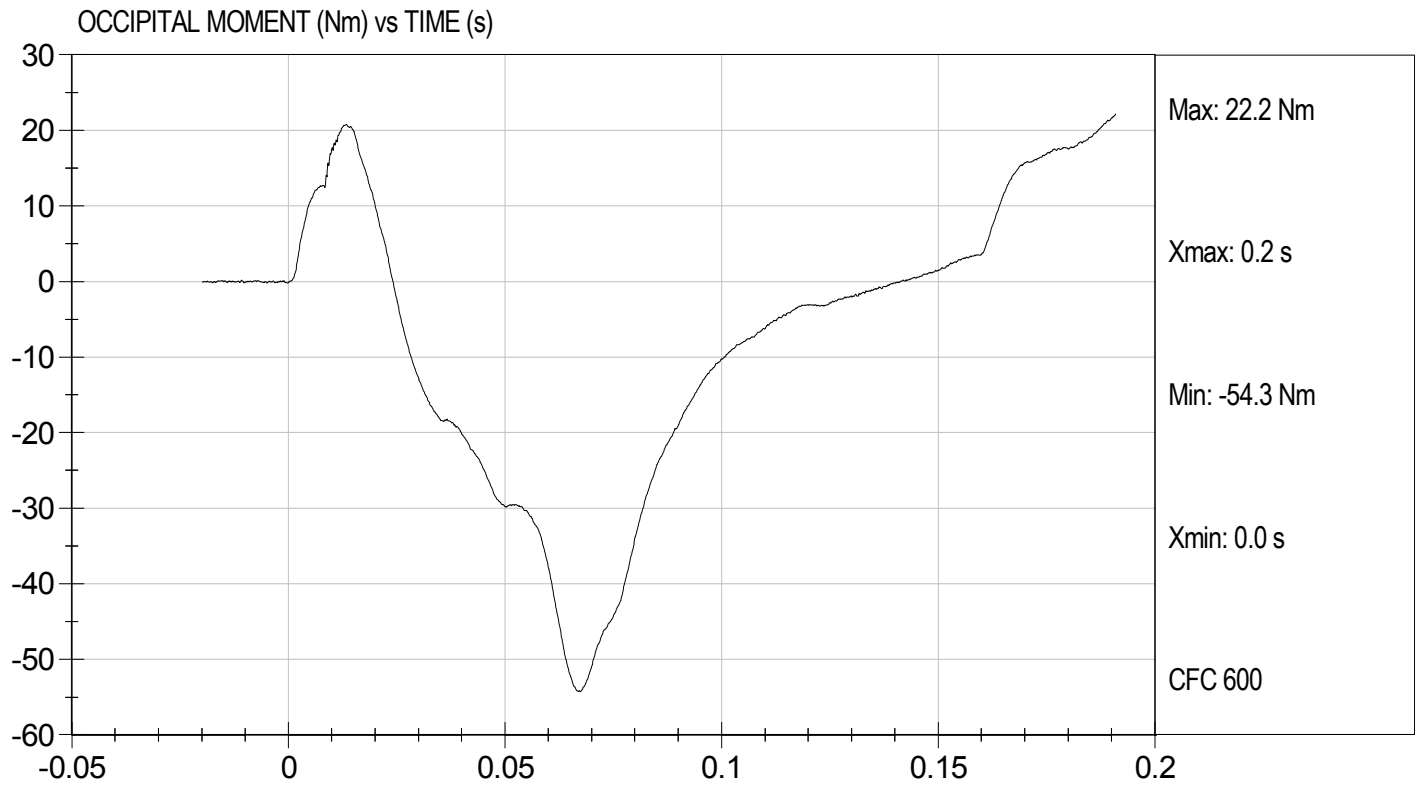
NECK ROTATION (DEG) vs TIME (s)





Test Desc: Neck Extension
Component ID: D102813

Test Date: 9/1/10
Velocity: 20.08 ft/s, 6.12 m/s



MGA RESEARCH CORPORATION
THORAX IMPACT
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102814

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.4	Pass
Relative Humidity	%	10 to 70	53	Pass
Probe Speed	m/s	6.59 to 6.83	6.77	Pass
Peak Deflection	mm	50 to 58	54	Pass
Peak Resistive Force w/in Deflection Corridor	kN	3.9 to 4.4	4.10	Pass
Internal Hysteresis	%	69 to 85	71	Pass
Peak Force 18 mm - 50 mm	N	<= 4,600 N	4051	Pass
Overall Test Results				Pass


Laboratory Technician

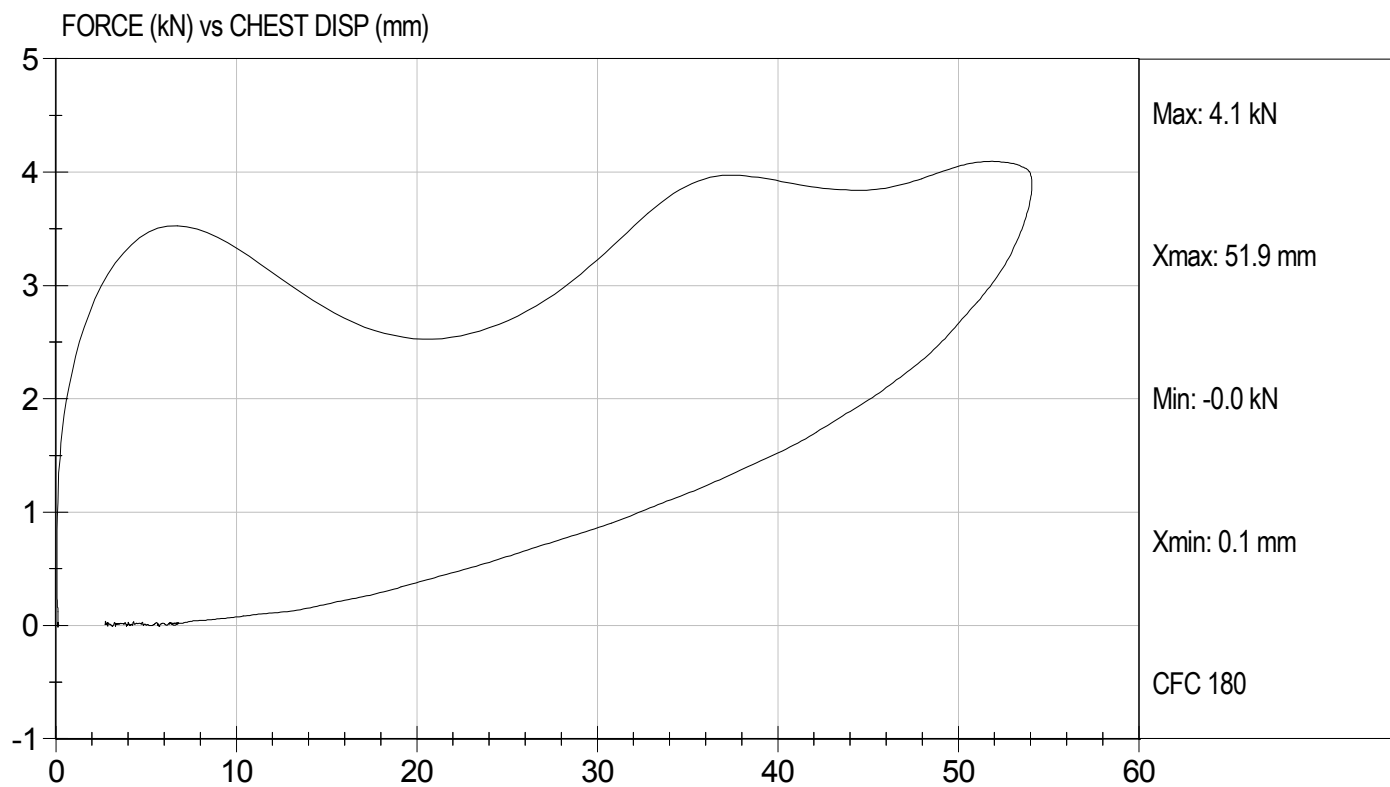
8/31/10
Test Date


Approved By



Test Desc: Thorax Impact
Component ID: D102814

Test Date: 8/31/10
Velocity: 22.22 ft/s, 6.77 m/s

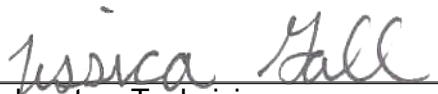


MGA RESEARCH CORPORATION
RIGHT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102815

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	kN	3.45 to 4.06	3.59	Pass
Overall Test Results			Pass	


Laboratory Technician

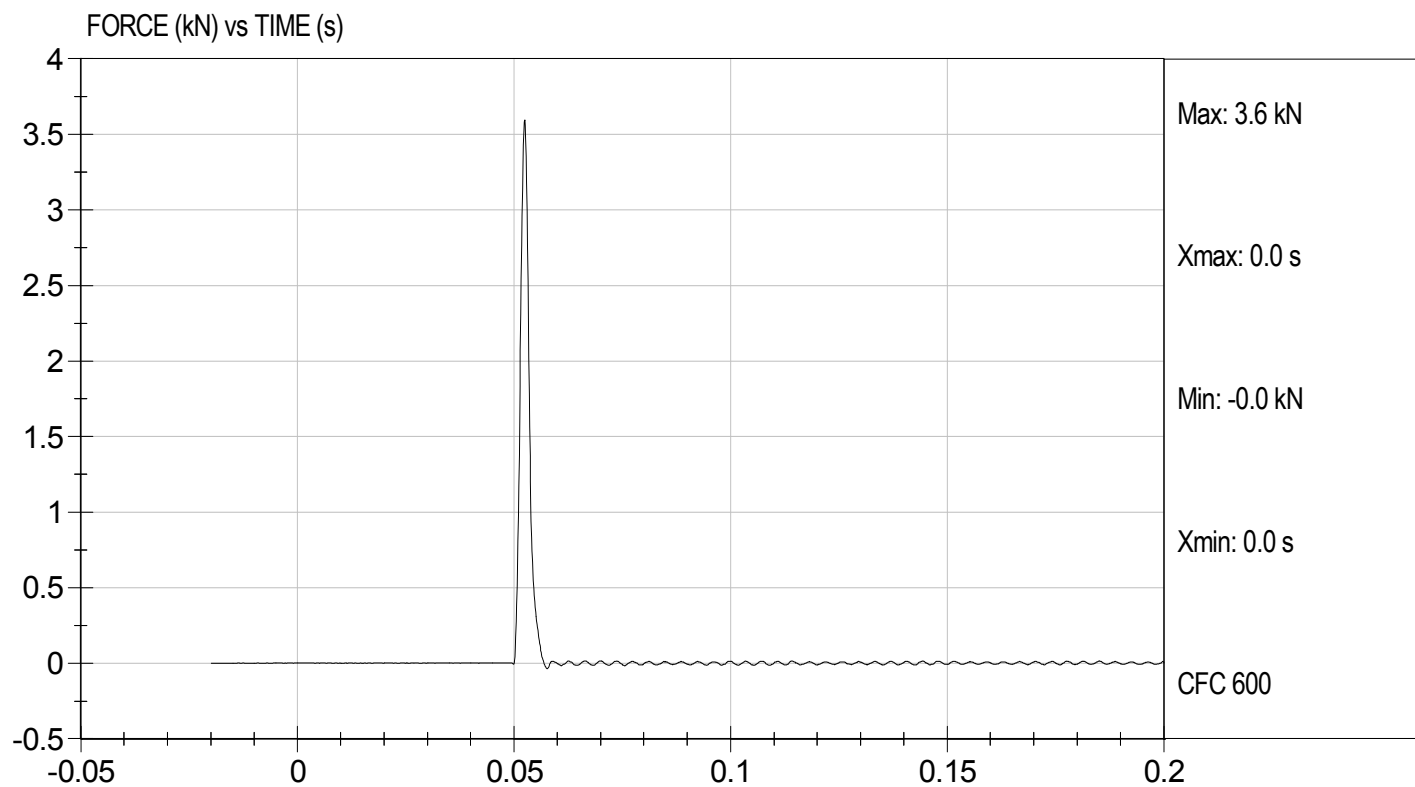
8/31/10
Test Date


Approved By



Test Desc: Right Knee
Component ID: D102815

Test Date: 8/31/10
Velocity: 6.97 ft/s, 2.12 m/s



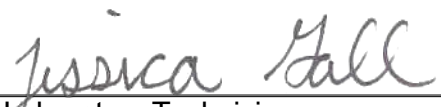
MGA RESEARCH CORPORATION

**LEFT KNEE IMPACT TEST
HYBRID III 5TH PERCENTILE**

ATD Serial No: 138

Test I.D: D102816

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.5	21.2	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Probe Speed	m/s	2.07 to 2.13	2.12	Pass
Maximum Force	kN	3.45 to 4.06	3.68	Pass
Overall Test Results				Pass


Laboratory Technician

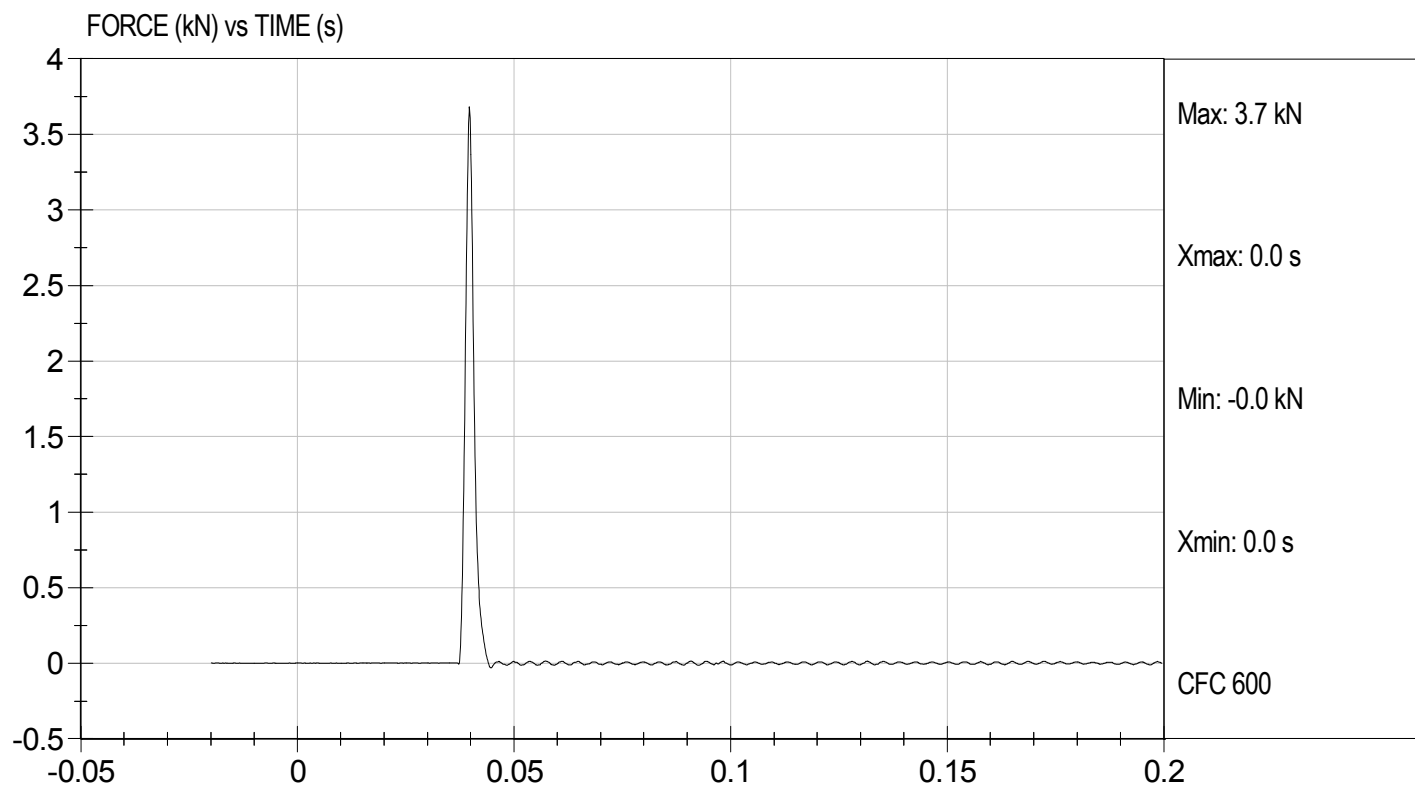
8/31/10
Test Date


Approved By



Test Desc: Left Knee
Component ID: D102816

Test Date: 8/31/10
Velocity: 6.97 ft/s, 2.12 m/s



MGA RESEARCH CORPORATION
TORSO FLEXION TEST
HYBRID III 5TH PERCENTILE

ATD Serial No: 138

Test I.D: D102817

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	52	Pass
Initial Angle	deg	0 to 20	16	Pass
Return Angle	deg	+/- 8	4	Pass
Force at 45 deg	N	320 to 390	347	Pass
Upper Torso Deflection Rate	Deg/sec	0.5 to 1.5	1.0	Pass
Overall Result				Pass


Laboratory Technician

8/31/10
Test Date


Approved By