REPORT NUMBER: 214P-MGA-2011-005

SAFETY COMPLIANCE TESTING FOR FMVSS 214
DYNAMIC SIDE IMPACT PROTECTION
RIGID POLE

TOYOTA MOTOR MANUFACTURING, INDIANA, INC.
2011 TOYOTA HIGHLANDER SUV
NHTSA NUMBER: CB5105

PREPARED BY:
MGA RESEARCH CORPORATION
5000 WARREN ROAD
BURLINGTON, WI 53105

Test Date: March 16, 2011

Report Date: June 6, 2011

FINAL REPORT

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
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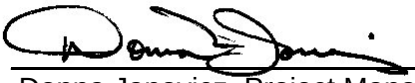
Prepared by: 
Donna Janovicz, Project Manager

Approved by: 
Joe Fleck, Project Engineer

Approval Date: June 6, 2011

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted by: James A. Jones

Acceptance Date: 6/14/2011

Technical Report Documentation Page

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4. Title and Subtitle Final Report of FMVSS 214P Compliance Test Side Impact Protection Testing of 2011 Toyota Highlander SUV; NHTSA No.: CB5105		*5. Report Date* June 6, 2011 *6. Performing Organization Code* MGA
7. Author(s) Donna Janovicz, Project Manager Joe Fleck, Project Engineer		*8. Performing Organization Report No.* 214P-MGA-2011-005
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-07-D-00062
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Vehicle Safety Compliance (NVS-220) 1200 New Jersey Ave, SE Washington, DC 20590		*13. Type of Report and Period Covered:* Final Test Report 3/16/2011 to 6/6/2011 *14. Sponsoring Agency Code* NVS-220
15. Supplementary Notes		

16. Abstract

A 32 km/h (20 mph), 75° oblique impact compliance test was conducted on the subject 2011 Toyota Highlander SUV in accordance with the specifications of the Office of Vehicle Safety Compliance TP-214P-01 for the determination of FMVSS No. 214 Side Impact Protection compliance. The test was conducted at MGA Research Corporation, in Burlington, Wisconsin, on March 16, 2011.

The impact velocity was 31.5 km/h, and the ambient temperature at the struck (driver's) side of the test vehicle at the time of impact was 21°C. The test vehicle post-test maximum crush was 355 mm at level 3. The test vehicle's performance follows:

Measurement Description	Units	Result
Head Injury Criteria (HIC_{36})	N/A	462
Max. Rib Deflection	mm	31
Sum of Abdomen Forces	N	1578
Pubic Symphysis Force	N	1918

The doors on the struck side of the vehicle did not separate from the body at the hinges or latches and the opposite side doors did not open during the side impact event.

17. Key Words Compliance Testing Side Impact Protection Pole Test ES-2re SID-IIs		*18. Distribution Statement* Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services (TIS) Room E12-100 East Building 1200 New Jersey Ave. Washington, D.C. 20590 Telephone No. (202) 366-2588	
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Form DOT F1700.7 (8-72)

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PURPOSE AND SUMMARY OF TEST

PURPOSE

This side impact test is part of the FY 2011 FMVSS 214 Side Impact Protection Compliance Test Program sponsored by the National Highway Traffic Safety Administration (NHTSA), under Contract No. DTNH22-07-D-00062. The purpose of this test was to evaluate side impact protection in a 2011 Toyota Highlander SUV. The side impact test was conducted in accordance with the Office of Vehicle Safety Compliance's Laboratory Test Procedure (TP-214P-01, dated January 2010).

SUMMARY

A rigid pole side impact test was conducted on a 2011 Toyota Highlander SUV. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.5 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin, on March 16, 2011. Pre-test and post-test photographs of the test vehicle and side impact dummy are included in Appendix A of this report.

One Part 572U dummy was placed in the left front outboard designated seating position according to instructions specified in TP-214P-01, dated January 2010. The side impact event was documented by ten (10) cameras.

The ES-2re male dummy was instrumented with a triaxial accelerometer pack located in the head, 3 rib displacement transducers located in the chest, 3 load cells located in the abdomen and a load cell located in the pubic symphysis.

A summary of the test results follows:

DUMMY INJURY VALUES

Dummy	HIC (36ms)	Thorax Deflection (mm)		Abdomen Forces (N)		Pubic Symphysis (N)
ES-2re 50th Percentile Male	462	Upper	31.2	Front	297.1	1917.9
		Middle	25.3	Mid	537.8	
		Lower	24.9	Rear	828.1	
		Max.	31.2	Sum	1577.8	

GENERAL COMMENTS

There was no valid data collected for:

B Pillar Sill Y after 40 msec.

B Pillar Low Y

SECTION 2

OCCUPANT AND VEHICLE INFORMATION

DATA SHEET NO. 1

TEST VEHICLE INFORMATION AND OPTIONS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

VEHICLE INFORMATION	
Make	Toyota
Model	Highlander
Body Style	MPV
VIN	5TDZA3EH4BS007599
Body Color	Classic Silver Met.
Engine Displacement (L)	2.7
# of Cylinders	4
Engine Placement	Lateral
Transmission Type	Automatic
Transmission Speeds	6
Overdrive	Yes
Final Drive	Front
Odometer Reading	111 miles

OPTIONS	
ESC	Yes
All Wheel Drive	No
Power Steering	Yes
Tilt Steering Wheel	Yes
Driver Side Curtain Airbag	Yes
Driver Side Torso/Pelvis Airbag	Yes
Driver Knee Bag	Yes
Driver Seat Belt Pretentioners	Yes
Driver Seat Belt Load Limiters	Yes
Driver Power Seat	No
Rear Pass. Curtain Airbag	Yes
Rear Pass. Side Torso Airbag	No
Rear Pass. Seat Belt Pretentioners	No
Rear Pass. Seat Belt Load Limiters	No
Rear Pass. Power Seats	No
Power Windows	Yes
Air Conditioning	Yes
AM/FM CD	Yes
Automatic Door Locks (ADL)	Yes
Does owner's manual provide instructions to disable ADL's?	No
Anti-Lock Brakes	Yes

DATA FROM CERTIFICATION LABEL

Manufactured By	Toyota Motor Manufacturing, Indiana, Inc.
Date of Manufacture	08/10

GVWR (kg)	2490
GAWR Front (kg)	1340
GAWR Rear (kg)	1405

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	60/40 Split	60/40	
Number of Occupants	2	3	2	7
Capacity Weight (VCW) (kg)				537
Cargo Weight (RCLW) (kg)				61

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	210	210	210	210
As Tested	kPa	210	210	210	210

TEST VEHICLE WEIGHTS

	Units	As Delivered			Fully Loaded			As Tested		
		Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total	Front Axle	Rear Axle	Total
Left	kg	500.3	425.9		537.6	483.6		528.0	477.6	
Right	kg	508.9	396.9		512.2	436.5		517.5	439.1	
Ratio	%	55.1	44.9		53.3	46.7		53.3	46.7	
Totals	kg	1009.2	822.8	1832.0	1049.8	920.1	1969.9	1045.5	916.7	1962.2

TEST VEHICLE TARGET WEIGHT (TVTW) CALCULATION

Measured Parameter	Units	Value
As Delivered Weight	kg	1832.0
Weight of 1 P572U ATD (ES-2re) Dummy	kg	77.1
Rated Cargo/Luggage Weight (RCLW)	kg	61
Calculated Target Vehicle Test Weight (TVTW)	kg	1970.1

TEST VEHICLE ATTITUDES

	Units	LF	RF	RR	LR
Fully Loaded	mm	828	840	833	838
As Tested	mm	836	840	843	848
Difference	mm	-8	0	-10	-10

CALCULATION OF THE VERTICAL IMPACT REFERENCE LINE

Measurement Parameter	Units	Value
Test Vehicle Wheel Base	mm	2786
Vertical Impact Reference Line (Aft of Front Axle)	mm	1320

WEIGHT of BALLAST and VEHICLE COMPONENTS REMOVED TO MEET VEHICLE TEST WEIGHT

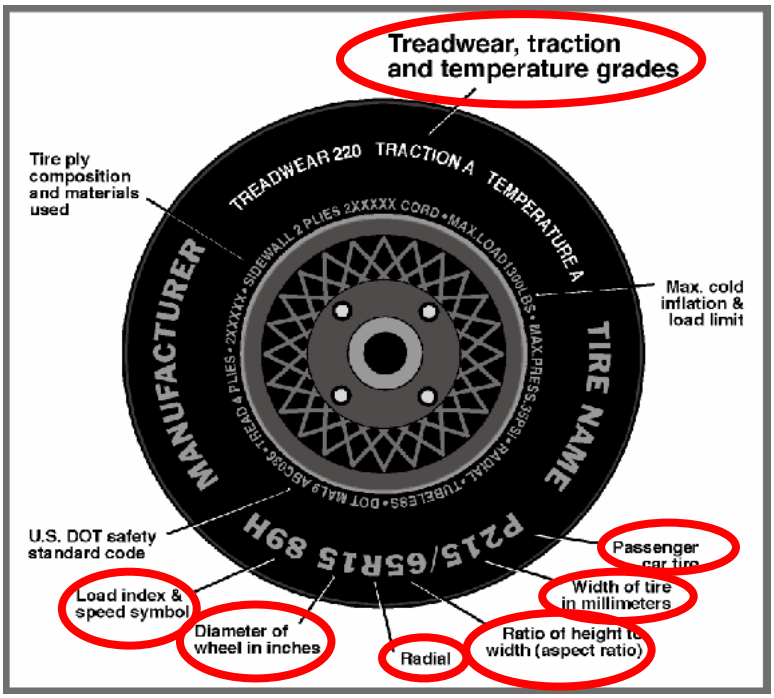
Description of Component	Weight (kg)
Ballast	0
No vehicle components removed to meet TVTW	0

DATA SHEET NO. 3

VEHICLE TIRE INFORMATION

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

VEHICLE TIRE INFORMATION

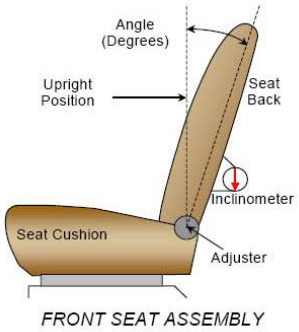


Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	210	210
Recommended Tire Size	P245/65R17	P245/65R17
Tire Size on Vehicle	P245/65R17	P245/65R17
Tire Manufacturer	Toyo	Toyo
Tire Name	Open Country	Open Country
Tire Type	Passenger	Passenger
Tire Width	245	245
Aspect Ratio	65	65
Radial	Yes	Yes
Wheel Diameter	17	17
Load Index/Speed Symbol	105S	105S
Treadwear	300	300
Traction Grade	A	A
Temperature Grade	A	A

DATA SHEET NO. 4

SEAT AND SEAT BELT ADJUSTMENT DATA

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011



FRONT SEAT ASSEMBLY

NORMAL DESIGN RIDING POSITION

The driver seat back is positioned to the manufacturer's designated angle. The procedure is as follows: Seat back angle is measured at the headrest post by using an inclinometer zeroed at the door sill. Set the seat back angle at 3.7 degrees.

SEAT BACK ANGLE

	Degrees	Detents
Driver with Seated Dummy	3.6° at headrest post	

SEAT FORE/AFT POSITION

The method used for determining seat fore/aft position is as follows: For seat track adjustments, set in mid track position.

SEAT FORE/AFT POSITIONING

	Total Fore/Aft Travel	Placed in Position #
Front Seat	240 mm	120 mm (forward-most as 0)

SEAT BELT UPPER ANCHORAGE

The method of positioning the seat belt upper anchorage is as follows: Detents to the nominal design position are measured with respect to the uppermost detent. Place at 1st detent for the 50th percentile male.

SEAT BELT UPPER ANCHORAGE

	Total # of Positions	Placed in Position #
Driver Seat	4 detents	1st detent (uppermost detent defined as 0)

HEADREST RESTRAINT

The headrest was placed in the uppermost position.

DATA SHEET NO. 5

FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

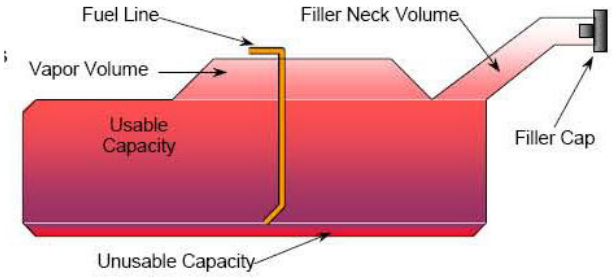
Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

FUEL TANK CAPACITY

	Liters
Usable Capacity (Form 1)	72.5
Usable Capacity (Owner's Manual)	72.5
92-94% of Usable Capacity	66.7 to 68.2
Actual Amount of Solvent Used	67.4

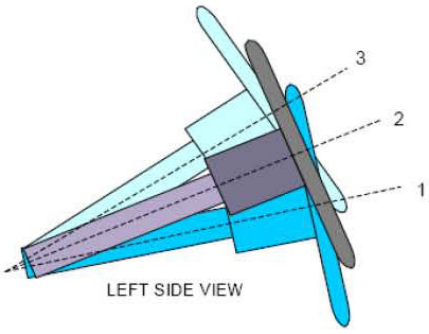
FUEL PUMP

Describe the fuel pump type, its behavior, and the location of the fuel filler pipe. The test vehicle is equipped with an electric fuel pump. The fuel pump is activated when the ignition is turned on. The fuel pipe is on the left side.



STEERING COLUMN ADJUSTMENT

Steering wheel and column adjustments are made so that the steering wheel hub is at the center of its geometric locus it describes when it moves 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 ASSEMBLY

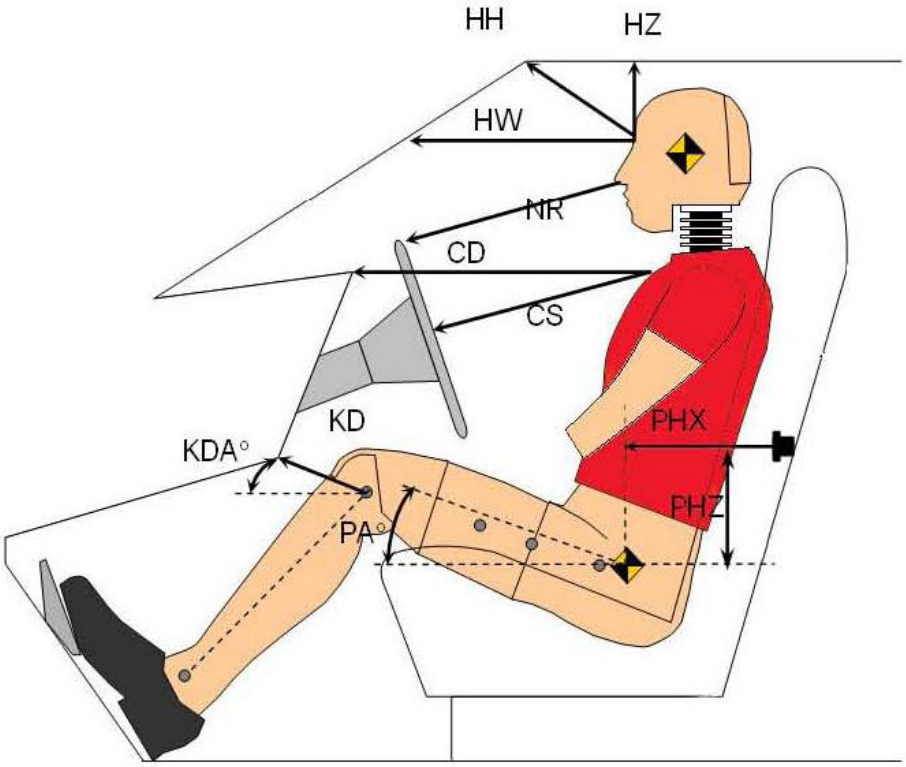
STEERING COLUMN POSITIONING

	Degrees	Fore/Aft Position (mm)
Lowermost - Position 1	65.1	189
Geometric Center – Position 2	63.6	169
Uppermost – Position 3	62.1	149
Telescoping Steering Wheel Travel		40
Test Position	63.6	169

.DATA SHEET NO. 6

DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

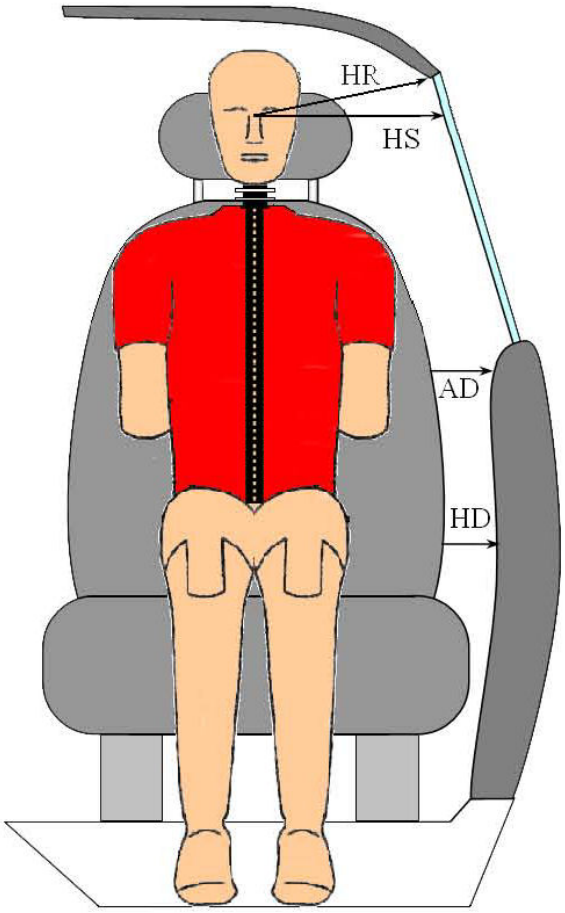


Driver Code	Measurement Description	Length (mm)	Angle (°)
HH	Head to Header	458	
HW	Head to Windshield	672	
HZ	Head to Roof	188	
NR	Nose to Rim	487	
CD	Chest to Dash	569	
CS	Chest to Steering Wheel	366	
KDL	Left Knee to Dash	177	25.0
KDR	Right Knee to Dash	148	27.2
PA	Pelvic Angle		
PHX	H-Point to Striker (X-Axis)	216	
PHZ	H-Point to Striker (Z-Axis)	181	

DATA SHEET NO. 7

DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

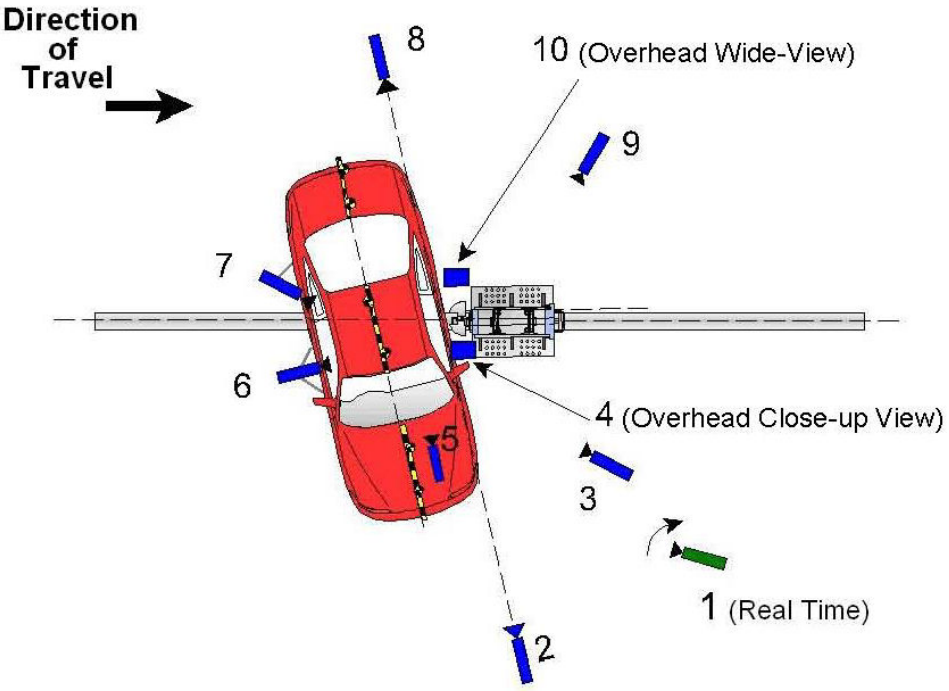


Code	Measurement Description	Units	Front Occupant
HR	Head to Side Header	mm	221
HS	Head to Side Window	mm	345
AD	Arm to Door	mm	115
HD	H-Point to Door	mm	151

DATA SHEET NO. 8

HIGH SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011



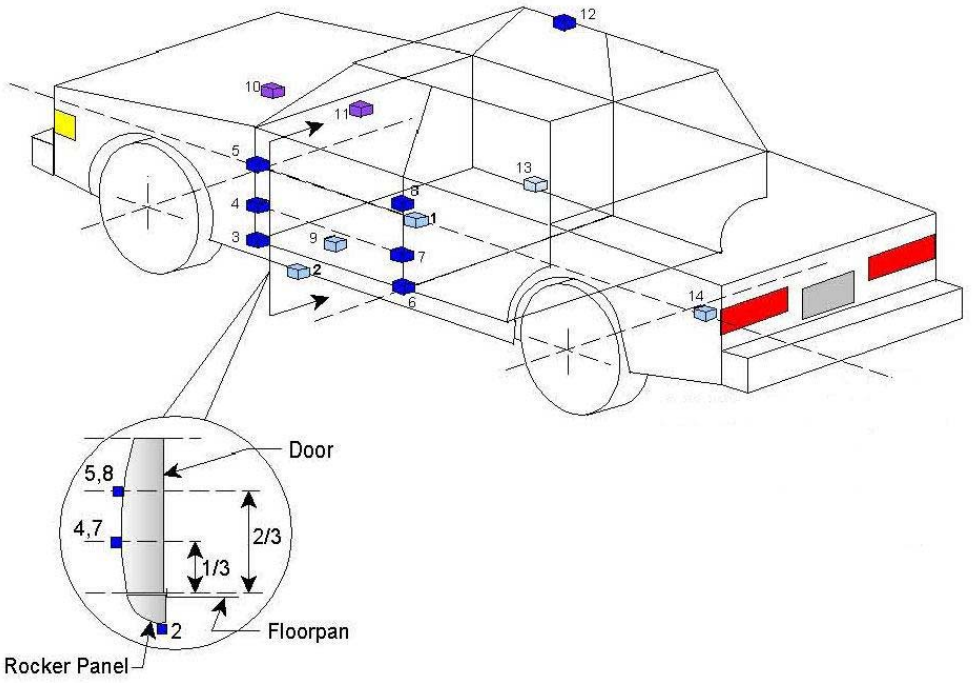
Reference: From Point of Impact for X and Y; from Ground for Z):
+X = Right of Impact, + Y = Forward of Impact, +Z = Up

Camera No.	View	Coordinates (mm)			Lens (mm)	Film Speed (fps)
		X	Y	Z		
1	Real-Time					30
2	Front Ground Level	6050	50	1760	24	1000
3	Impact Side 45° Forward	4590	2140	1840	20	1000
4	Overhead Closeup	0	-50	4520	50	1000
5	Onboard – Driver Front				16	1000
6	Onboard – Driver Side				8	1000
7	Onboard – Driver Rear				8	1000
8	Rear Ground Level	-5870	40	1750	24	1000
9	Impact Side 45° Rearward	-3920	3860	1830	20	1000
10	Overhead Wide	0	-340	4610	14	1000

DATA SHEET NO. 9

TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011



Loc. No.	Accelerometer Location			
	ID	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2300	-30	-380
2	Left Floor Sill	3315	-775	-305
3	A Pillar Sill	3251	-705	-735
4	A Pillar Low	3182	-774	-705
5	A Pillar Mid	3315	-842	-952
6	B Pillar Sill	2760	-738	-305
7	B Pillar Low	2225	-787	-713
8	B Pillar Mid	2240	-770	-965
9	Seat	2382	-625	-480
10	Engine	4058	-75	-900
11	Firewall	3845	-10	-1043
12	Roof	2080	615	-1710
13	Floor Sill	2085	770	-320
14	Rear Deck	260	0	-665

Reference: X – Test Vehicle Rear Bumper (+ forward)
Y – Test Vehicle Centerline (+ to right)
Z – Ground Plane (+ down)

DATA SHEET NO. 10

TEST VEHICLE ACCELEROMETER DATA SUMMARY

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

Loc. No.	Description	Peak Values (g's)			
		Max	Time (ms)	Min	Time (ms)
1	Vehicle CG (X)	3.6	47.0	-6.5	61.8
	Vehicle CG (Y)	17.7	14.7	-0.6	230.1
	Vehicle CG (Z)	8.6	37.7	-7.4	32.7
	Resultant	18.5	14.8		
2	Left Floor Sill (Y)	50.7	21.9	-21.6	60.2
3	A Pillar Sill (Y)	20.8	23.5	-0.7	249.9
4	A Pillar Low (Y)	22.7	45.8	-17.1	49.6
5	A Pillar Mid (Y)	58.5	37.0	-0.5	0.9
6	B Pillar Sill (Y)	(1)	(1)	(1)	(1)
7	B Pillar Low (Y)	(2)	(2)	(2)	(2)
8	B Pillar Mid (Y)	50.8	18.6	-12.8	51.0
9	Seat (Y)	42.3	26.2	-13.2	61.2
10	Engine (X)	6.0	114.1	-16.6	43.9
	Engine (Y)	15.3	54.0	-1.6	148.4
11	Firewall (Y)	13.0	46.2	-1.9	21.9
12	Roof (Y)	29.1	40.2	-2.2	44.4
13	Floor Sill (Y)	18.5	15.2	-0.8	224.9
14	Rear Deck (X)	3.9	130.0	-7.0	44.8
	Rear Deck (Y)	16.7	37.2	-2.0	163.2

(1) No valid data collected for B Pillar Sill Y after 40 msec.
(2) No valid data collected for B Pillar Low Y

DATA SHEET NO. 11

DUMMY INJURY RESPONSE DATA

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

Dummy S/N	Positive		Negative	
	MAX	TIME (ms)	MAX	TIME (ms)
HEAD ACCELERATION (G)				
Longitudinal (X)	4.2	102.4	23.3	50.6
Lateral (Y)	62.6	55.5	23.2	94.4
Vertical (Z)	11.8	78.5	8.0	144.5
Resultant (R)	65.2	54.9		
HIC36 (t1, t2)	462		t1 = 44.9	t2 = 69.0
THORAX DEFLECTION (mm)				
Upper Rib			31.2	51.5
Middle Rib			25.3	59.5
Lower Rib			24.9	52.2
ABDOMINAL FORCES (N)				
Front	297.1	52.2		
Middle	537.8	49.1		
Rear	828.1	50.1		
Sum	1577.8	50.1		
PELVIS FORCE (N)				
Pubic Symphysis			1917.9	46.6

Reference: Positive Direction -Longitudinal (X) = forward
-Lateral (Y) = to right
-Vertical (Z) = down

DATA SHEET NO. 12

POST TEST OBSERVATIONS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

TEST DUMMY INFORMATION AND CONTACT

Description	Front Occupant
Dummy Type / Serial No.	ES-2re / 016
Head Contact	Curtain Airbag, Headrest
Upper Torso Contact	Side Airbag, Door Panel
Lower Torso Contact	Side Airbag, Door Panel
Left Knee Contact	Door Panel
Right Knee Contact	Left Knee

POST TEST DOOR OPENING AND SEAT TRACK INFORMATION

Description	Front	Rear
Left Side Doors	Remained closed and jammed shut	Remained closed and jammed shut
Right Side Doors	Remained closed and operational	Remained closed and operational
Hatch and Other Doors	Remained closed and operational	Remained closed and operational
Seat Movement	0	0
Seat Back Failure	None	None

POST-TEST STRUCTURAL OBSERVATIONS

Critical Areas of Performance	Observations and Conclusions
Pillar Performance	No Separation
Sill Separation	None
Windshield Damage	Cracked
Window Damage	Left Front Window Broke
Other Notable Effects	None

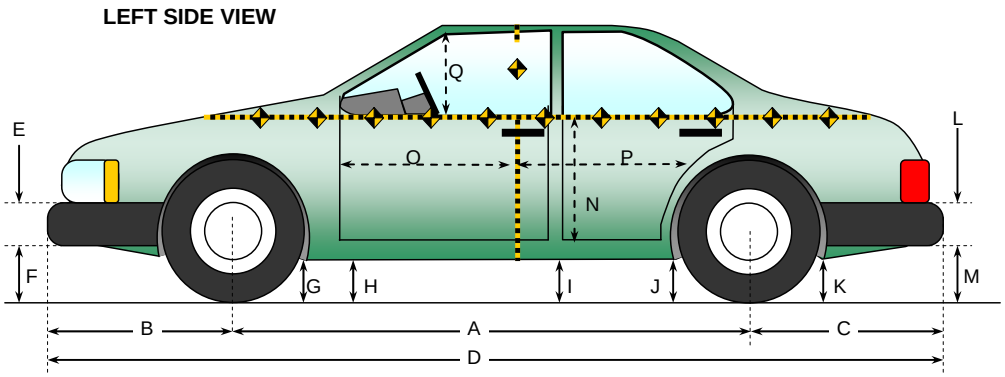
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

Restraint Type	Front Occupant	
	Installed	Operated
Frontal Airbag	Yes	No
Side Torso/Pelvis Airbag	Yes	Yes
Knee Airbag	Yes	No
Head Airbag	No	
Curtain Airbag	Yes	Yes
Seat Belt Pretensioner	Yes	Yes
Seat Belt Load Limiter	Yes	

DATA SHEET NO. 13

VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

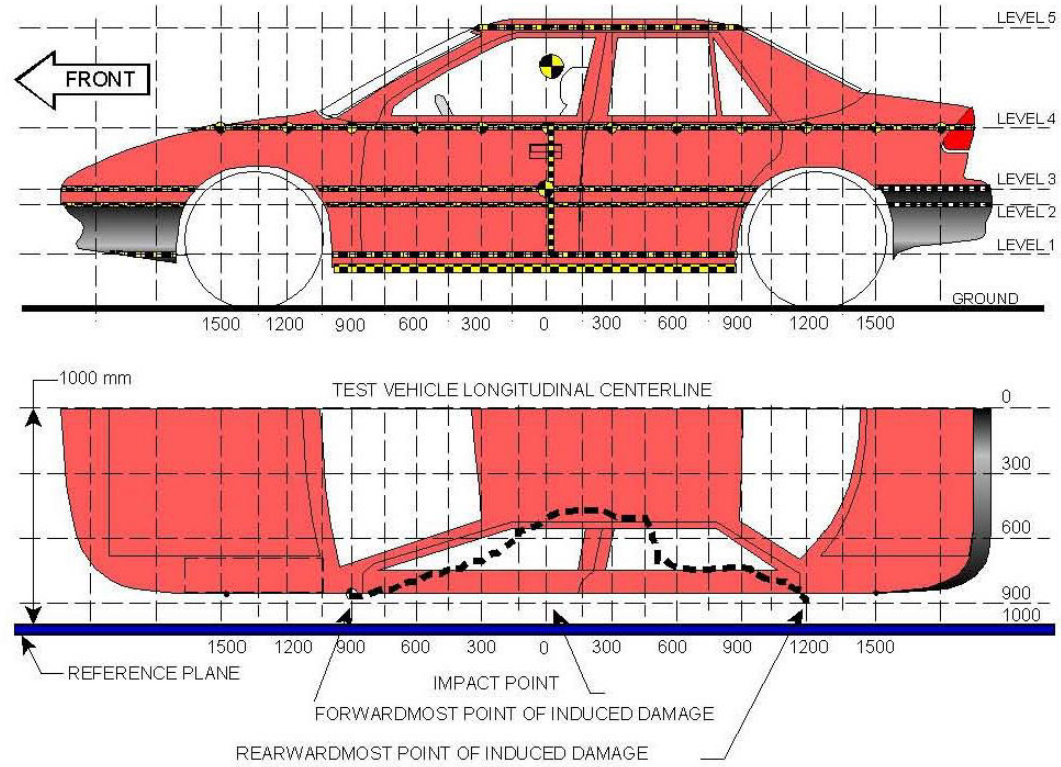


Code	Measurement Description	Pre-Test (mm)	Post-Test (mm)	Difference (mm)
A	Wheelbase	2786	2730	56
B	Front Axle to FSOV	933	931	2
C	Rear Axle to RSOV	1163	1120	43
D	Total Vehicle Length at Centerline	4882	4781	101
E	Front Bumper Thickness	172	172	0
F	Front Bumper Bottom to Ground	341	375	-34
G	Sill Height at Front Wheel Well	275	290	-15
H	Sill Height at Front Door Leading Edge	274	292	-18
I	Sill Height at B Pillar	284	330	-46
J1	Sill Height at Rear Wheel Well	272	287	-15
J2	Pinch Weld Height at Rear Wheel Well	277	285	-8
K	Sill Height Aft of Rear Wheel Well	360	370	-10
L	Rear Bumper Thickness	210	210	0
M	Rear Bumper Bottom to Ground	395	392	3
N	Sill Height to Window Bottom Sill	805	794	11
O	Front Door Leading Edge to Impact CL	914	908	6
P	Rear Door Trailing Edge to Impact CL	1145	1208	-63
Q	Front Window Opening	435	396	39
R	Right Side Length	3645	3665	-20
S	Left Side Length	3645	3550	95
T	Vehicle Width at B Post	1910	1596	314

DATA SHEET NO. 14

EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011



NOTE: All measurements are in millimeters (mm)

Maximum Exterior Crush Measurements

Level	Measurement Description	Maximum Exterior Static Crush	Distance from Impact	Height Above Ground (mm)
1	Sill Top	311	0	395
2	Mid Door	354	0	742
3	Occupant H-Point	355	0	768
4	Window Sill	282	0	1132
5	Window Top	125	0	1630

DATA SHEET NO. 15

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

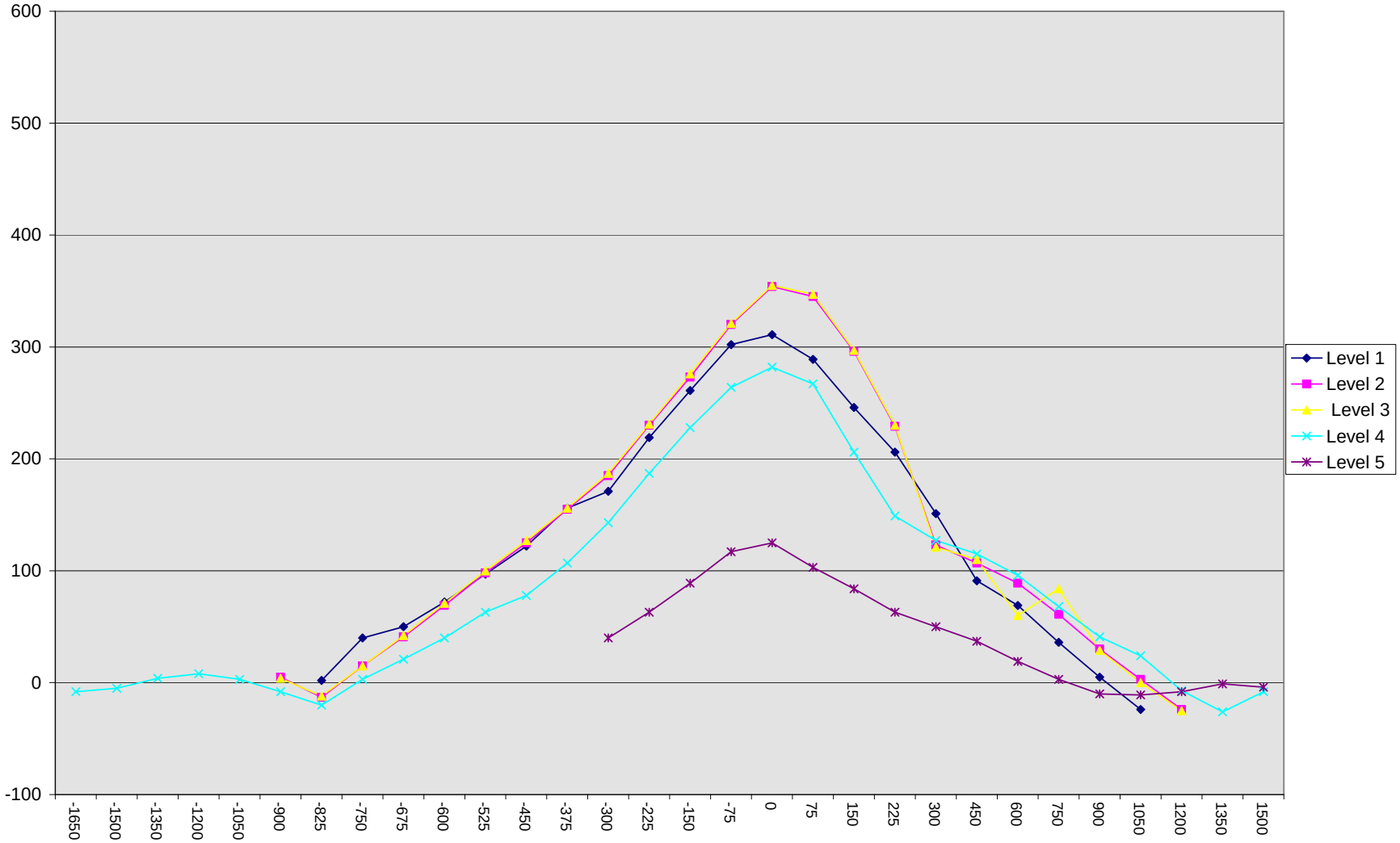
	Level 1	Level 2	Level 3	Level 4	Level 5
Maximum Crush (mm)	311	354	355	282	125
Distance From Impact (mm)	0	0	0	0	0

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1650				314					306					-8	
-1500				292					287					-5	
-1350				275					279					4	
-1200				270					278					8	
-1050				265					268					3	
-900		145	145	262			150	149	254			5	4	-8	
-825	170	145	145	252		172	132	133	232		2	-13	-12	-20	
-750	169	147	147	244		209	162	162	247		40	15	15	3	
-675	169	155	154	244		219	196	196	265		50	41	42	21	
-600	169	156	155	243		241	225	226	283		72	69	71	40	
-525	170	156	155	240		267	254	255	303		97	98	100	63	
-450	169	155	155	240		291	280	282	318		122	125	127	78	
-375	169	155	155	238		325	310	311	345		156	155	156	107	
-300	169	155	155	238	445	340	340	342	381	485	171	185	187	143	40
-225	169	155	155	235	440	388	385	386	422	503	219	230	231	187	63
-150	169	155	155	235	437	430	428	431	463	526	261	273	276	228	89
-75	168	155	155	235	436	470	475	476	499	553	302	320	321	264	117
0	168	155	155	234	437	479	509	510	516	562	311	354	355	282	125
75	168	155	155	234	437	457	500	502	501	540	289	345	347	267	103
150	168	155	155	232	437	414	451	452	438	521	246	296	297	206	84
225	168	156	155	232	440	374	385	385	381	503	206	229	230	149	63
300	169	156	157	234	440	320	279	278	361	490	151	123	121	127	50
450	169	159	157	232	440	260	266	267	347	477	91	107	110	115	37
600	169	162	161	232	442	238	251	245	328	461	69	89	60	96	19
750	170	165	165	232	442	206	226	225	300	445	36	61	84	68	3
900	172	161	163	234	445	177	191	192	275	435	5	30	29	41	-10
1050	172	150	153	234	447	148	153	153	258	436	-24	3	0	24	-11
1200		145	145	235	447		121	120	228	439		-24	-25	-7	-8
1350				235	454				209	453				-26	-1
1500				238	457				230	453				-8	-4

DATA SHEET NO. 15 (CONTINUED)

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011



DATA SHEET NO. 16

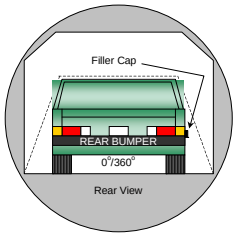
SUMMARY OF FMVSS 301 FUEL SYSTEM DATA

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

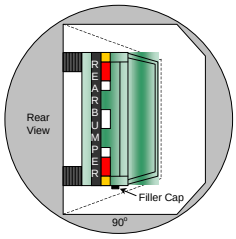
FUEL SYSTEM INTEGRITY POST IMPACT DATA

Time Interval	FMVSS 301 Maximum Allowable Spillage	Spillage (g)
Impact Until Motion Ceases	28 g	0
First Five Minutes Following Impact	142 g	0
Next 25 Minutes	28 g / 1 minute	0

STATIC ROLLOVER DATA



0/360



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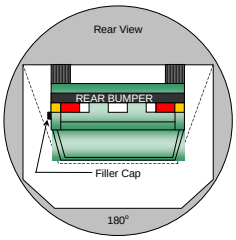

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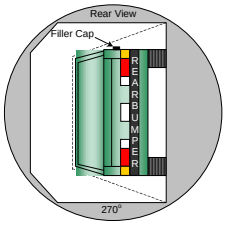


270

REAR VIEW

Rollover Stage	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	2	minutes	03	seconds	5	minutes	7	minutes	03	seconds	8	minutes
90° - 180°	1	minutes	46	seconds	5	minutes	6	minutes	46	seconds	7	minutes
180° - 270°	1	minutes	50	seconds	5	minutes	6	minutes	50	seconds	7	minutes
270° - 360°	1	minutes	58	seconds	5	minutes	6	minutes	58	seconds	7	minutes

Rollover Stage	Spillage (g)			
	First 5 min. from onset of rotation	6th min.	7th min.	8th min. (if required)
0° - 90°	0	0	0	
90° - 180°	0	0	0	
180° - 270°	0	0	0	
270° - 360°	0	0	0	
FMVSS 301 Maximum Allowable (for each 90° stage)	142	28	28	28

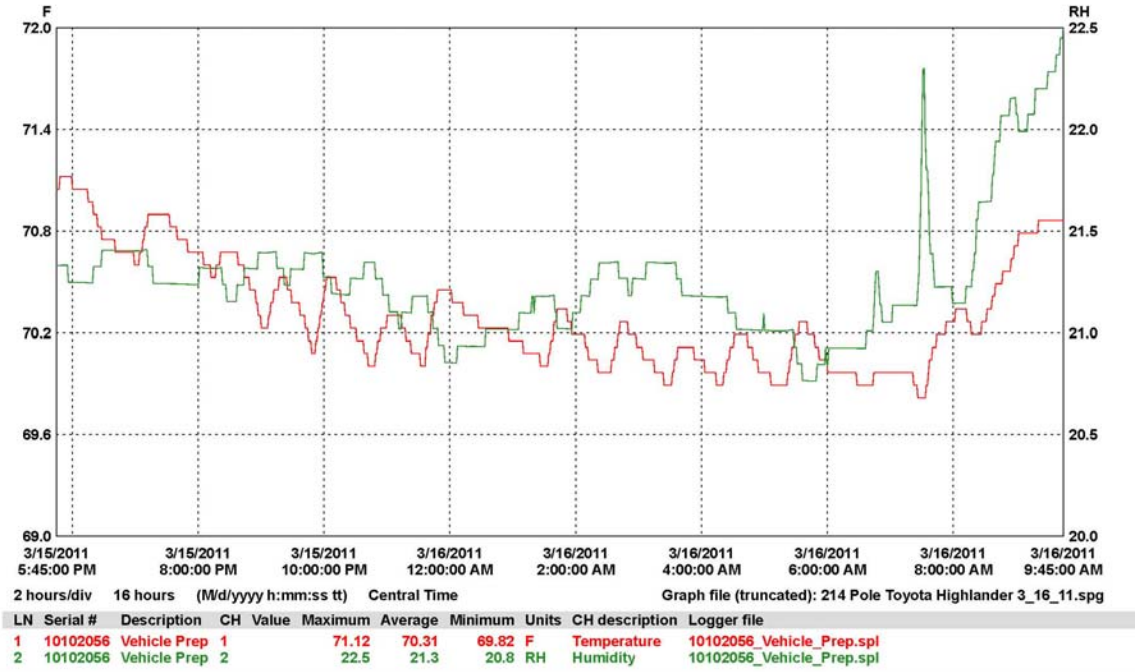
Rollover Stage	Spillage Location(s)
0° to 90°	None
90° to 180°	None
180° to 270°	None
270° to 360°	None

DATA SHEET NO. 17

TEMPERATURE AND HUMIDITY TRACES

Test Vehicle: 2011 Toyota Highlander SUV NHTSA No. CB5105
Test Program: FMVSS 214 Pole Test Date: 3/16/2011

Time of Impact: 9:44 am



LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	10102056	Vehicle Prep	1		71.12	70.31	69.82	F	Temperature	10102056_Vehicle_Prep.spl
2	10102056	Vehicle Prep	2		22.5	21.3	20.8	RH	Humidity	10102056_Vehicle_Prep.spl

APPENDIX A

PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Pre-Test Frontal View of Test Vehicle

Post-Test Frontal View of Test Vehicle

Pre-Test Rear View of Test Vehicle

Post-Test Rear View of Test Vehicle

Pre-Test Impacted Side View of Test Vehicle

Post-Test Impacted Side View of Test Vehicle

Pre-Test Left ¾ Front View of Vehicle and Pole

Pre-Test Left ¾ Rear View of Vehicle and Pole

Pre-Test Overhead View of Test Vehicle

Post-Test Overhead View of Test Vehicle

Pre-Test Dummy Through Opposite Window

Post-Test Dummy Through Opposite Window

Pre-Test Close-up of Dummy with Door Closed (Impact Side)

Post-Test Dummy with Door Closed (Impact Side)

Pre-Test Dummy Door Open

Pre-Test Dummy Shoulder and Door Top View

Post-Test Dummy Shoulder and Door Top View

Pre-Test Interior of Front Door Closed

Post-Test Interior of Front Door Showing Dummy Impact Locations

Impact Event

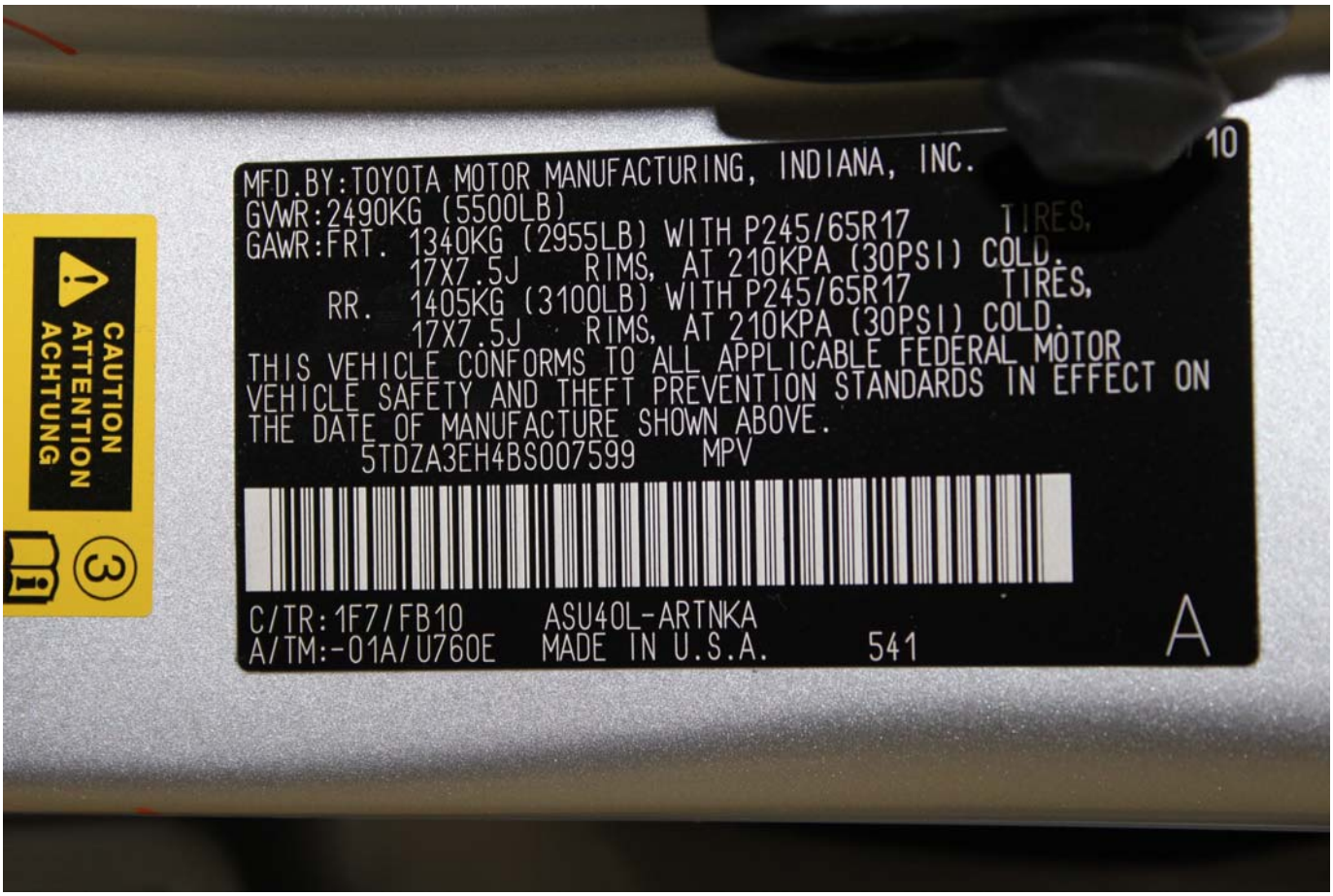
Post-Test Impact Zone Close-up View

Post-Test ¾ Front View of Impact Zone

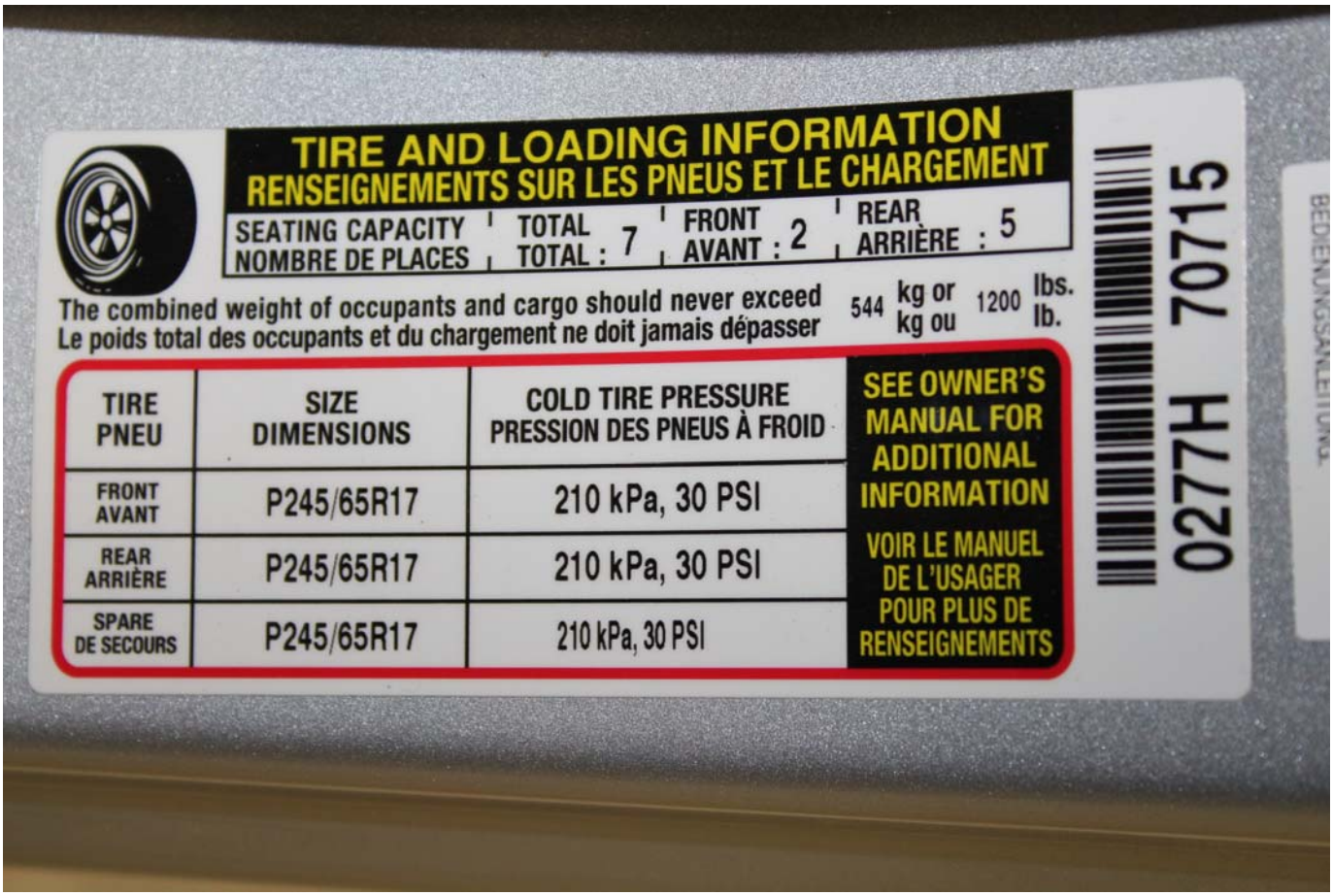
Post-Test ¾ Rear View of Impact Zone

Post-Test Close-up View of Impact Point Target

Close-up View of Vehicle's Load Carrying Capacity Reduced Label



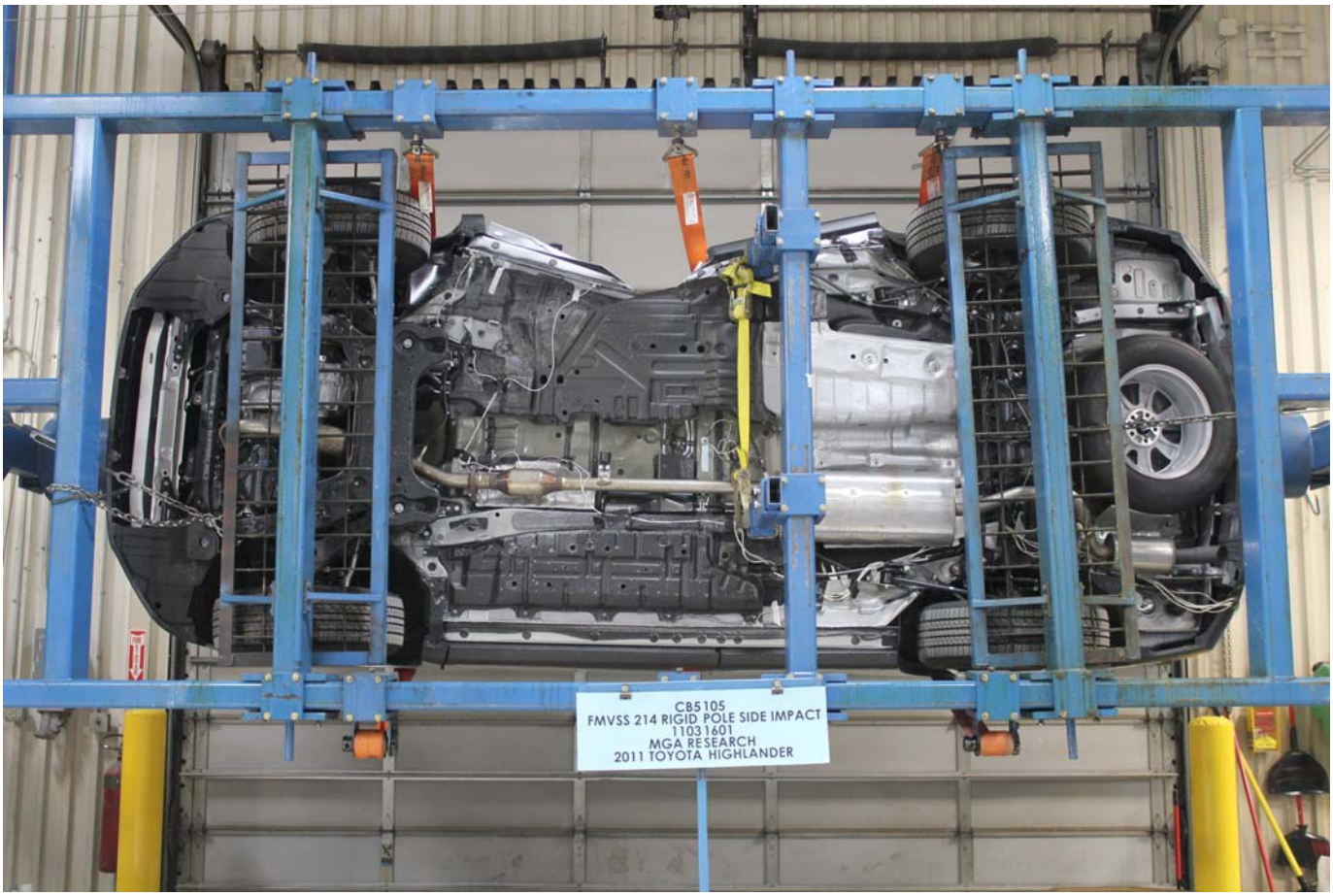
Close-up View of Vehicle's Certification Label



Close-up View of Vehicle's Tire Placard Label

Post-Test Vehicle at 90 Degree Rollover

Post-Test Vehicle at 180 Degree Rollover



Post-Test Vehicle at 270 Degree Rollover

Post-Test Vehicle at 360 Degree Rollover

APPENDIX B

DUMMY RESPONSE DATA

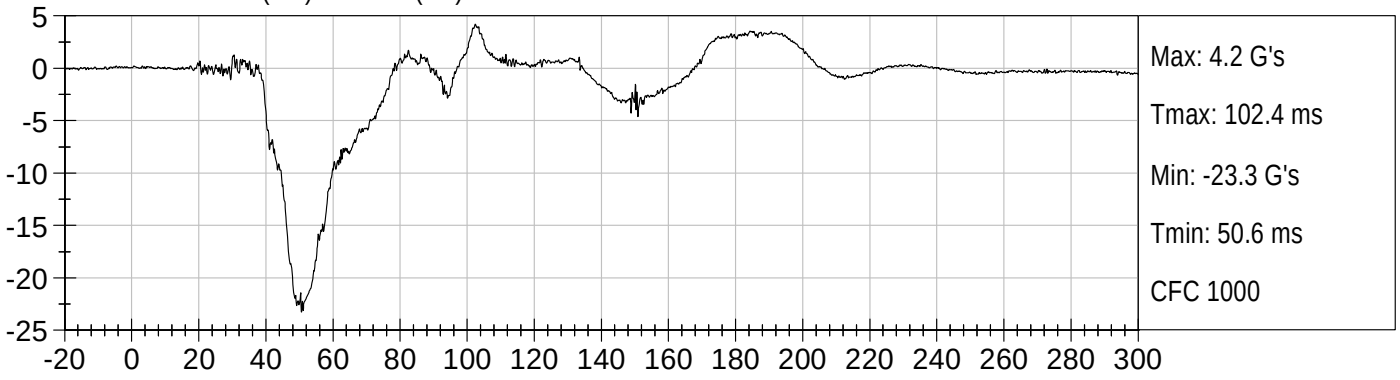
TABLE OF DATA PLOTS

Dummy Instrumentation Plots
FILTERED DATA

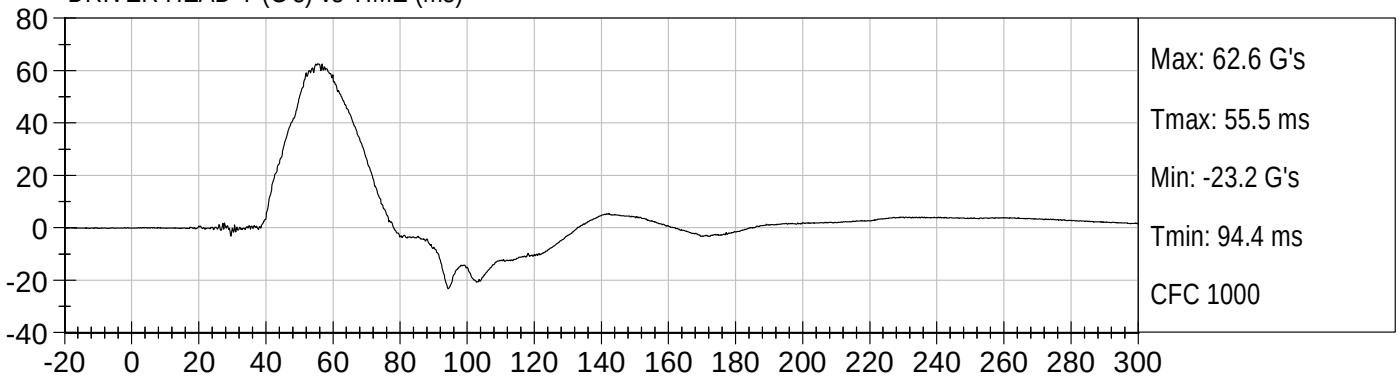
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

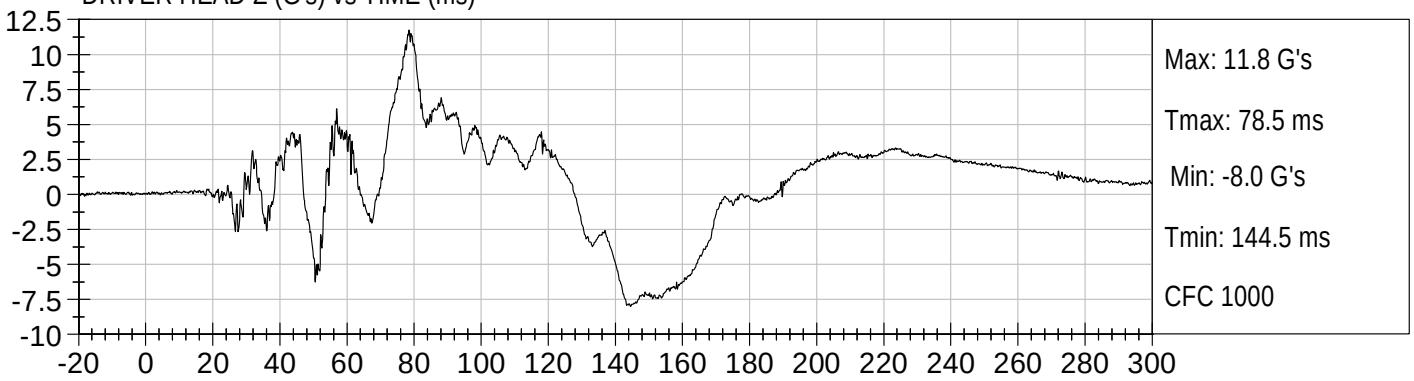
DRIVER HEAD X (G's) vs TIME (ms)



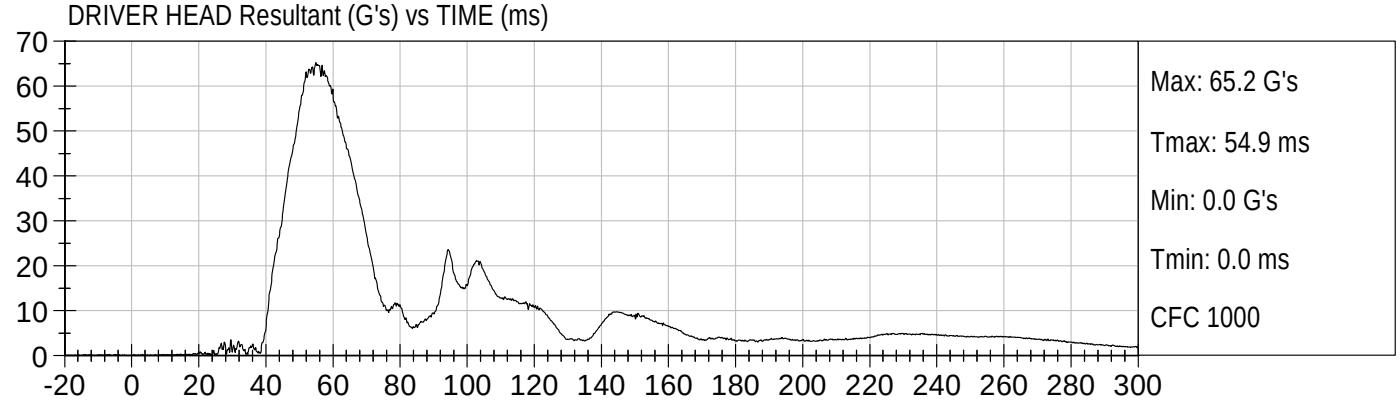
DRIVER HEAD Y (G's) vs TIME (ms)



DRIVER HEAD Z (G's) vs TIME (ms)



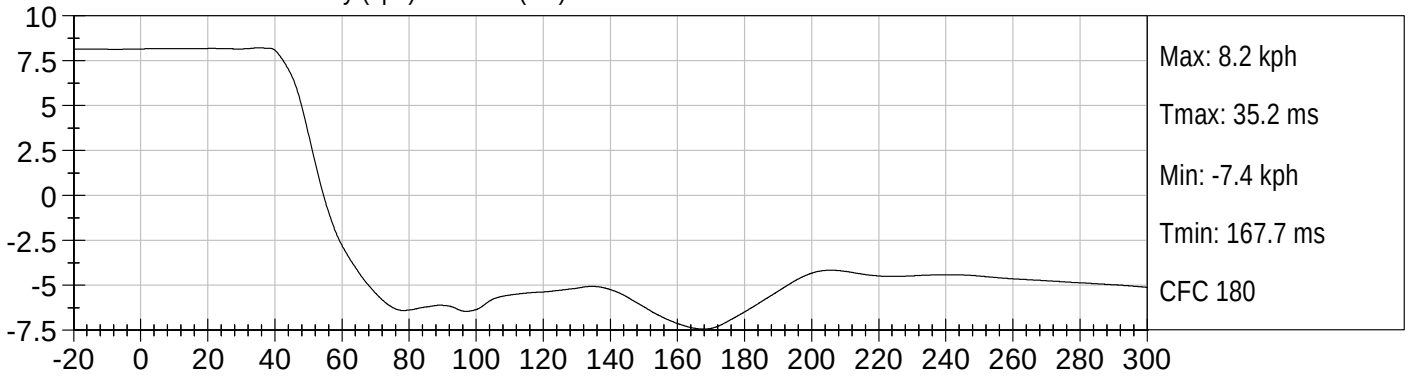
DRIVER HEAD Resultant (G's) vs TIME (ms)



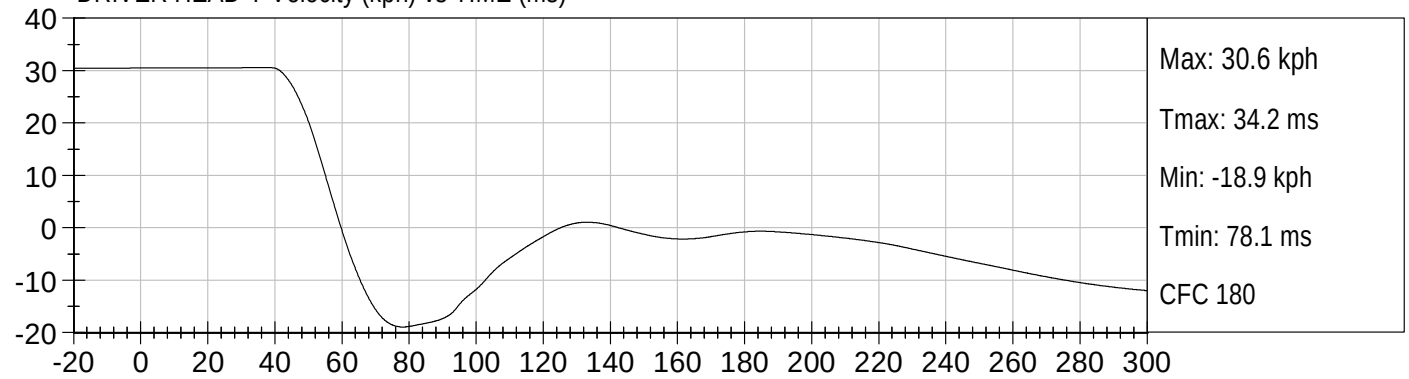
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

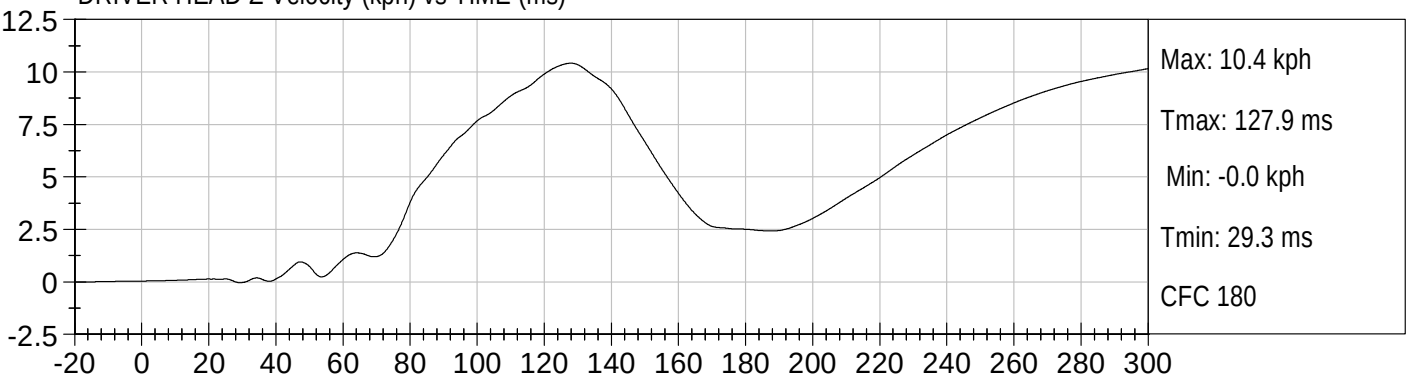
DRIVER HEAD X Velocity (kph) vs TIME (ms)



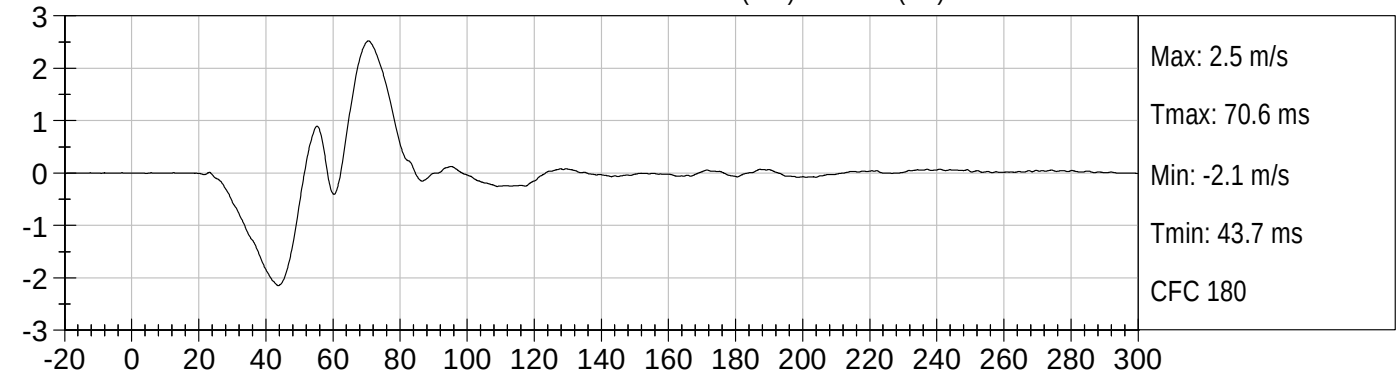
DRIVER HEAD Y Velocity (kph) vs TIME (ms)



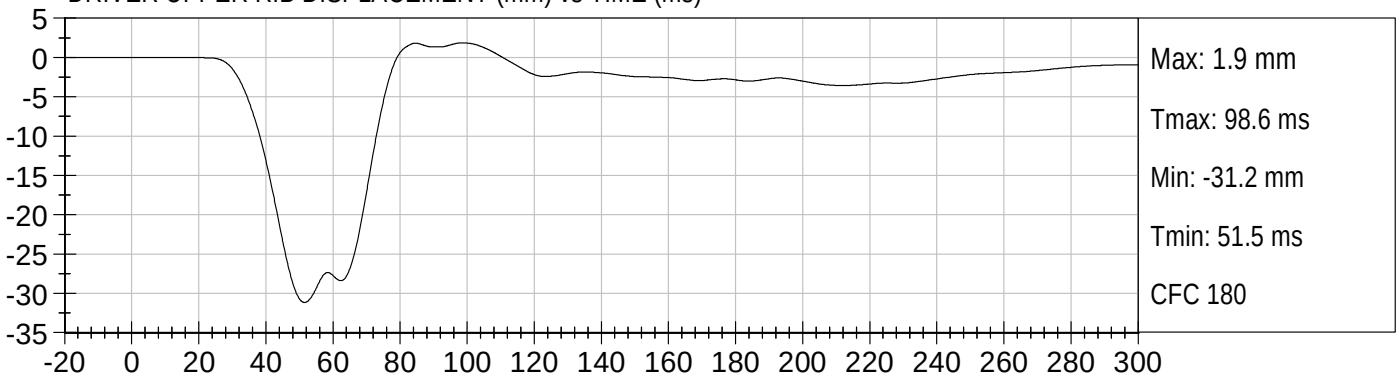
DRIVER HEAD Z Velocity (kph) vs TIME (ms)



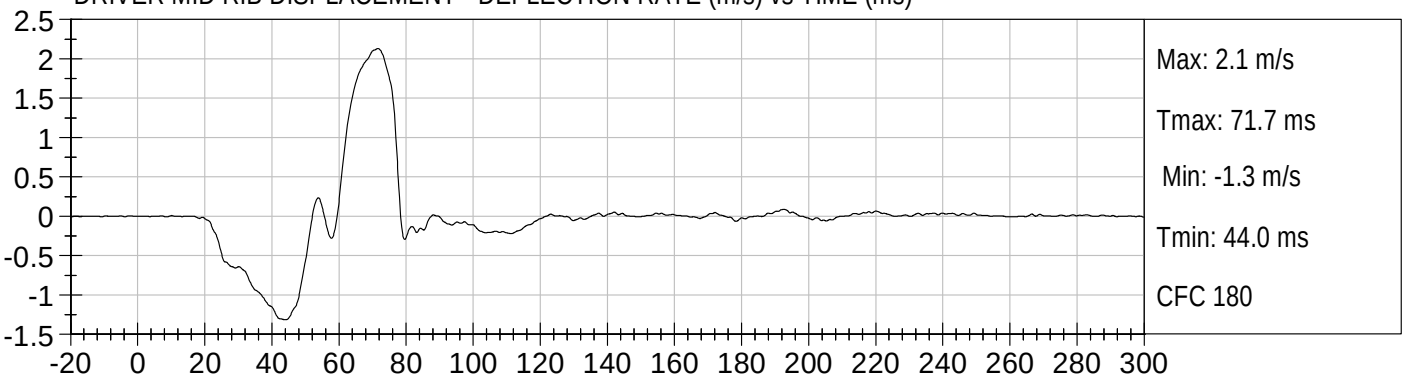
DRIVER UPPER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



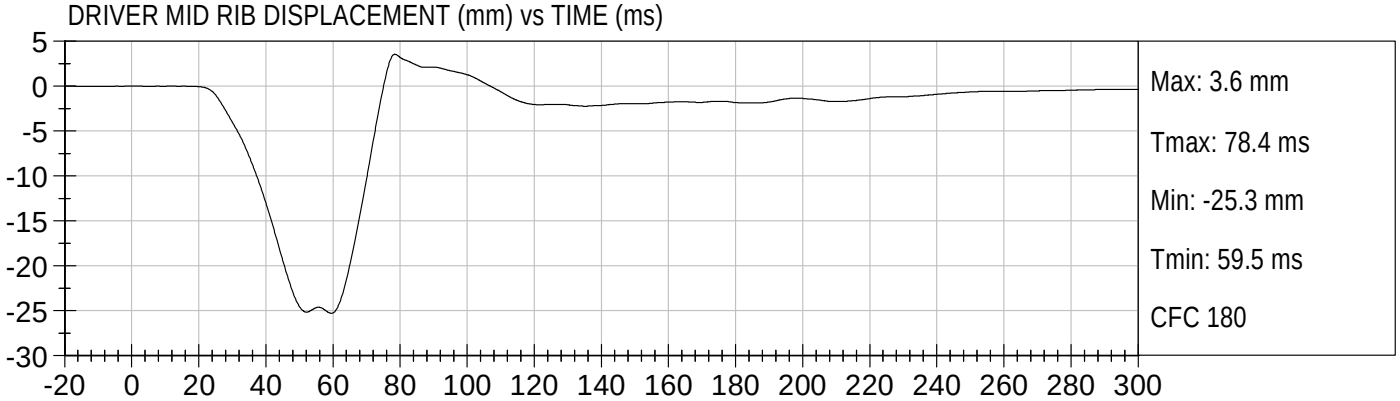
DRIVER UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



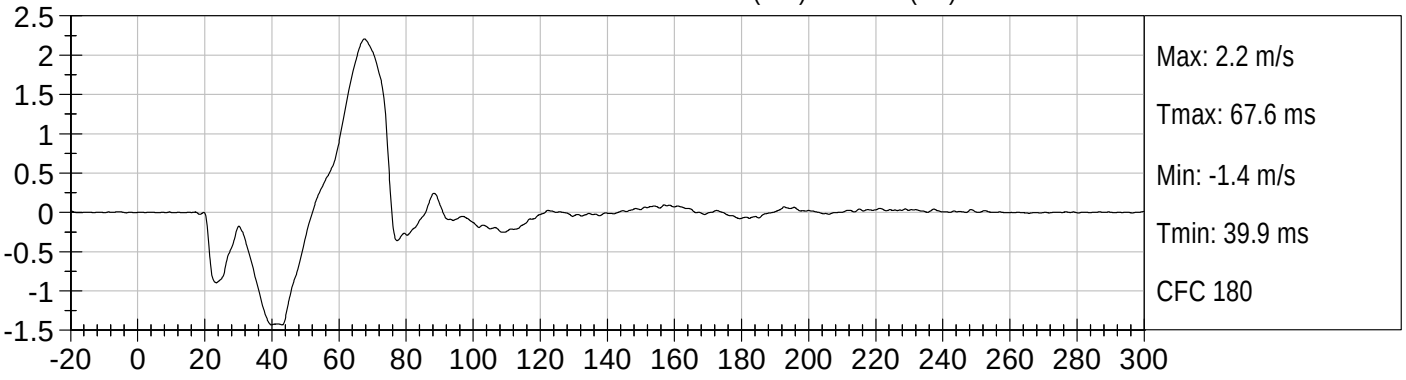
DRIVER MID RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



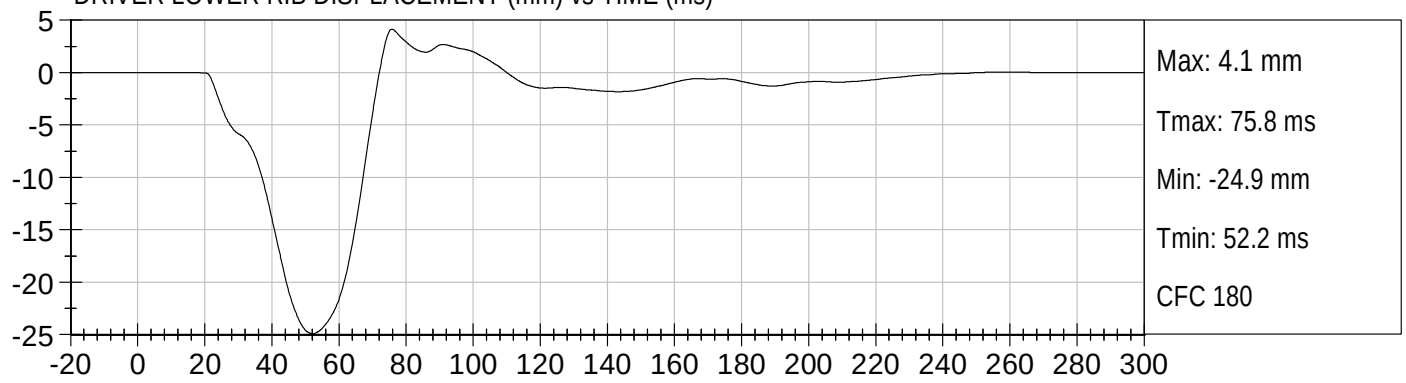
DRIVER MID RIB DISPLACEMENT (mm) vs TIME (ms)



DRIVER LOWER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



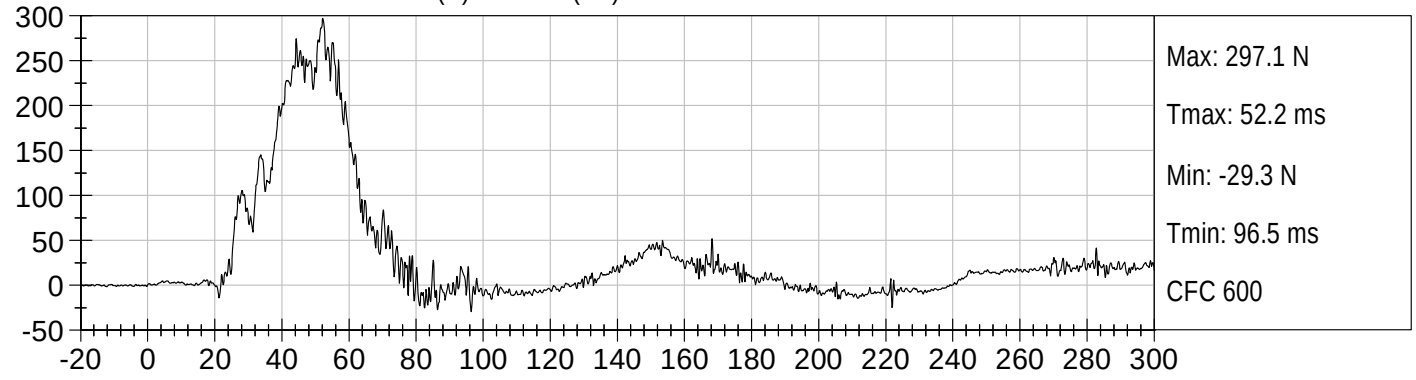
DRIVER LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



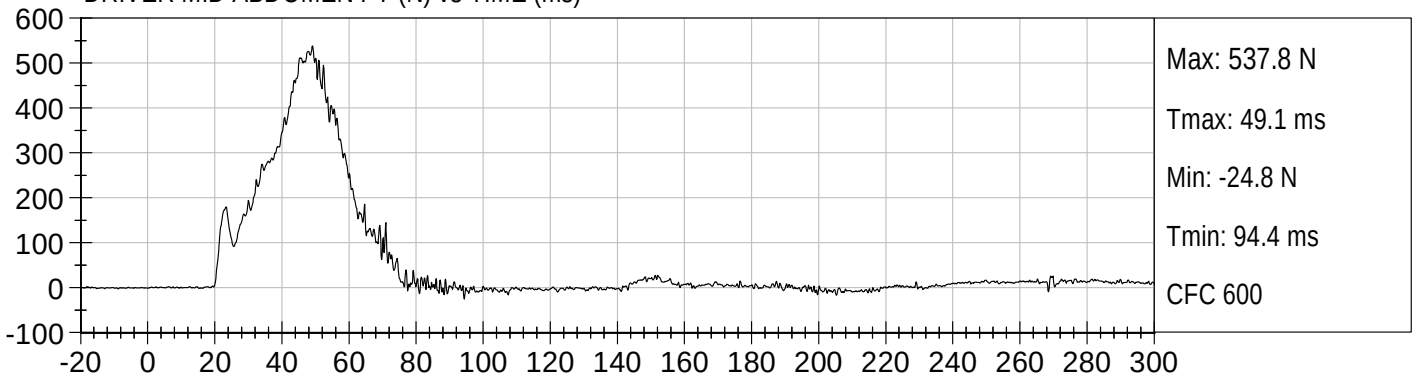
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

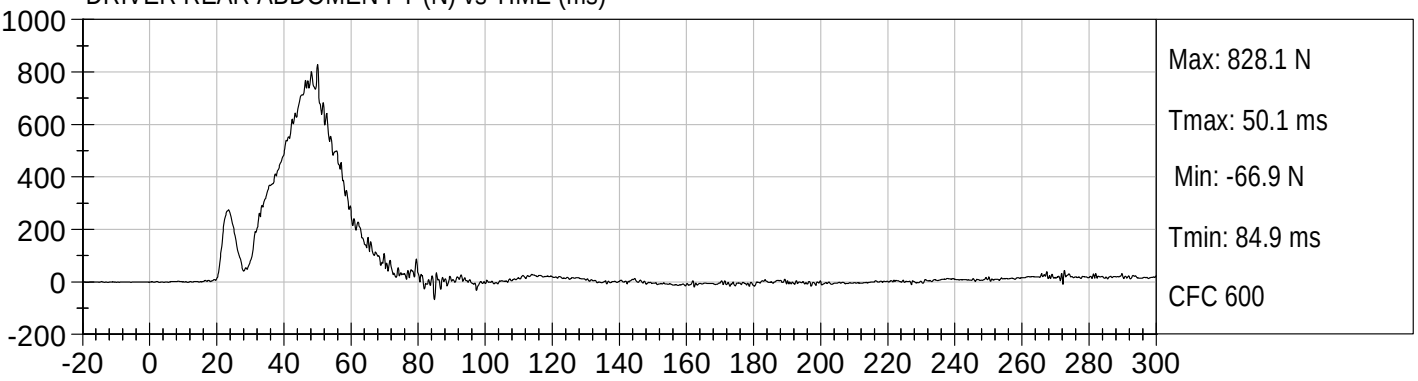
DRIVER FRONT ABDOMEN FY (N) vs TIME (ms)



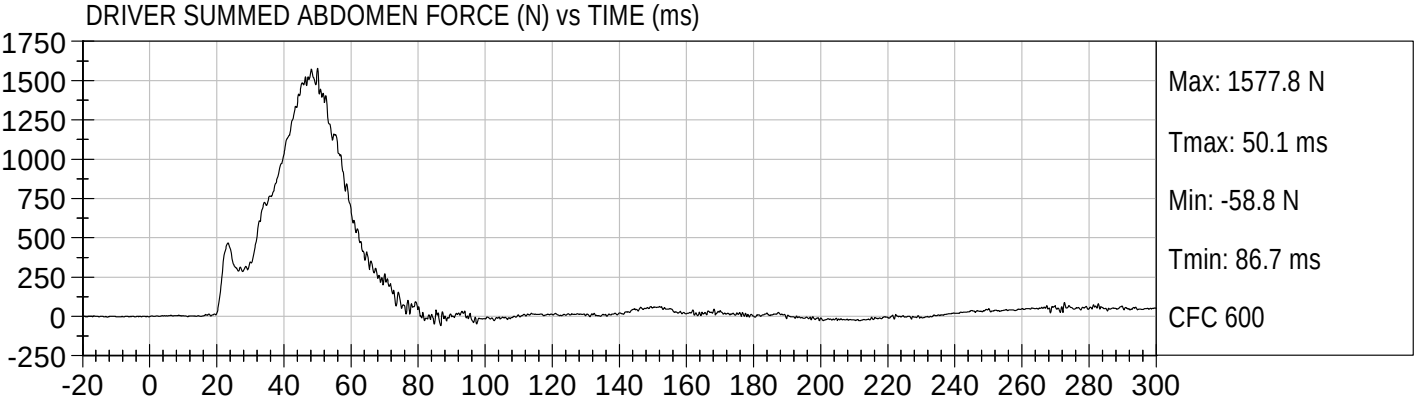
DRIVER MID ABDOMEN FY (N) vs TIME (ms)

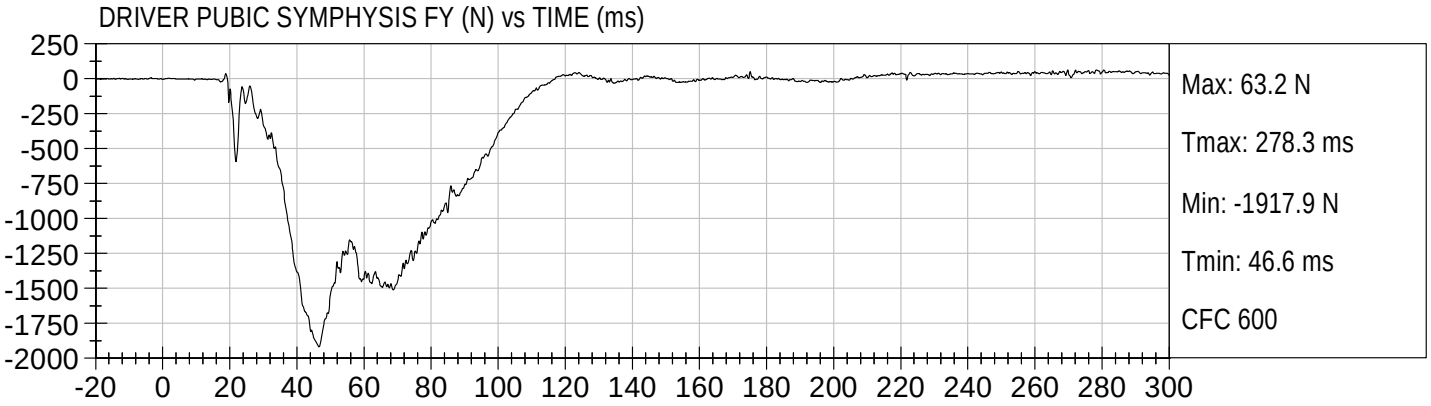


DRIVER REAR ABDOMEN FY (N) vs TIME (ms)



DRIVER SUMMED ABDOMEN FORCE (N) vs TIME (ms)




DRIVER PUBIC SYMPHYSIS FY (N) vs TIME (ms)
250
0
-250
-500
-750
-1000
-1250
-1500
-1750
-2000
-20
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Max: 63.2 N
Tmax: 278.3 ms
Min: -1917.9 N
Tmin: 46.6 ms
CFC 600

APPENDIX C

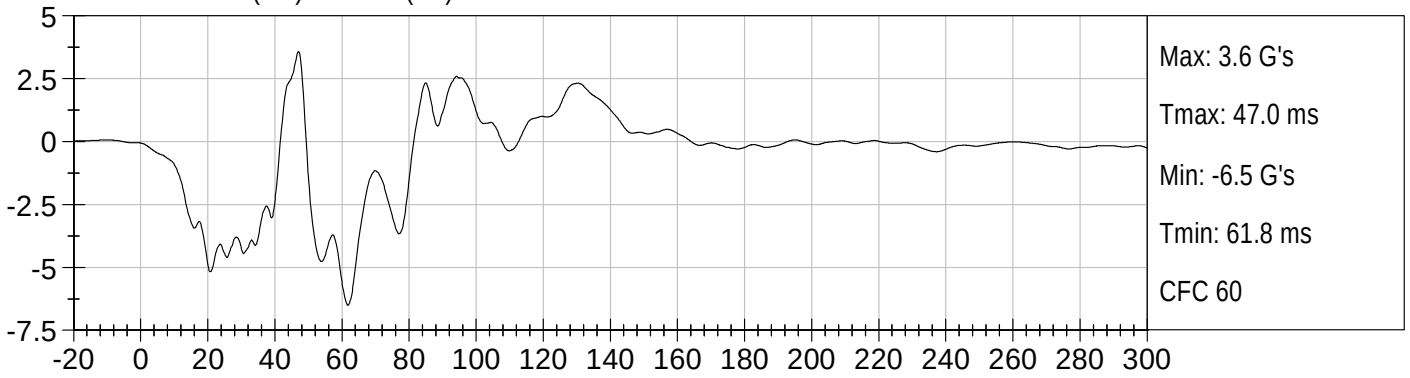
VEHICLE ACCELEROMETER RESPONSE DATA

TABLE OF DATA PLOTS

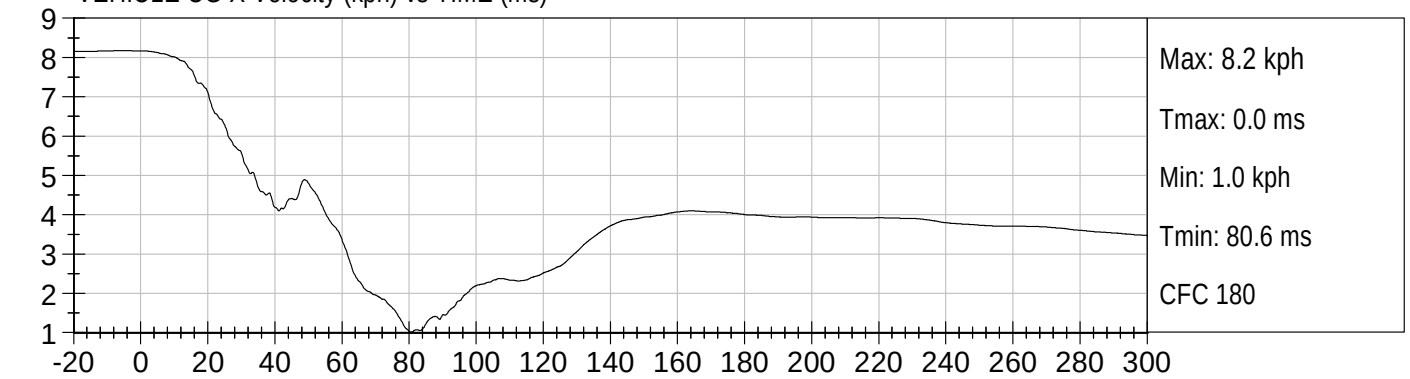
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

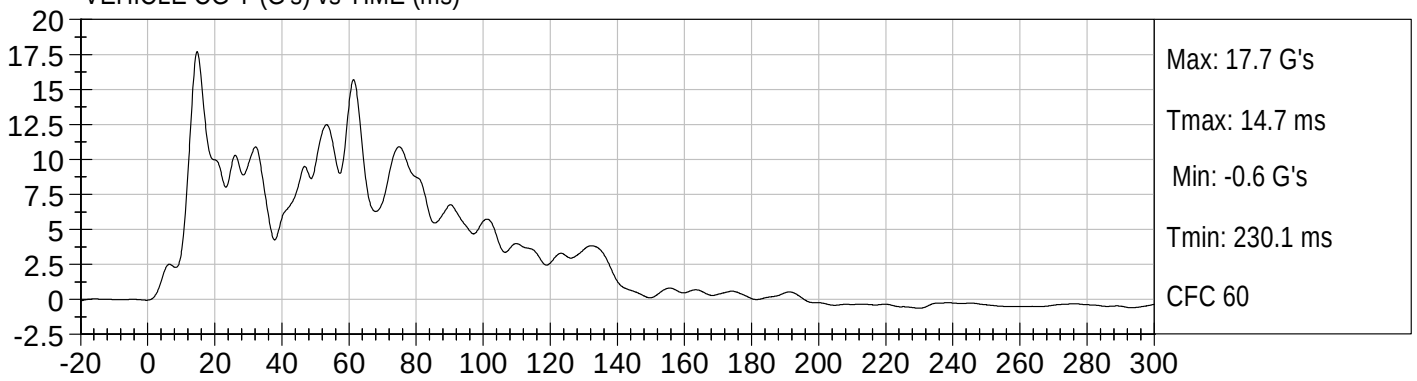
VEHICLE CG X (G's) vs TIME (ms)



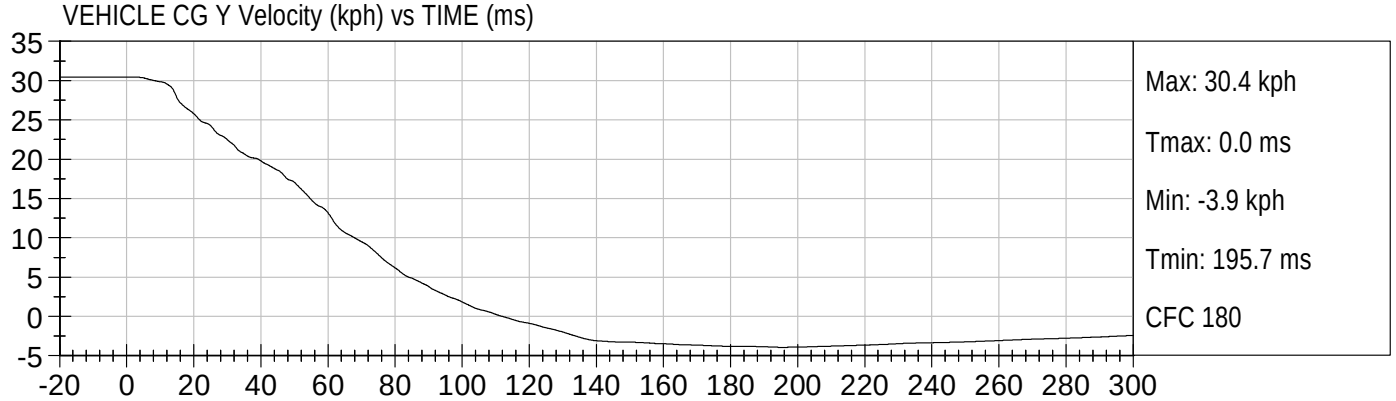
VEHICLE CG X Velocity (kph) vs TIME (ms)



VEHICLE CG Y (G's) vs TIME (ms)



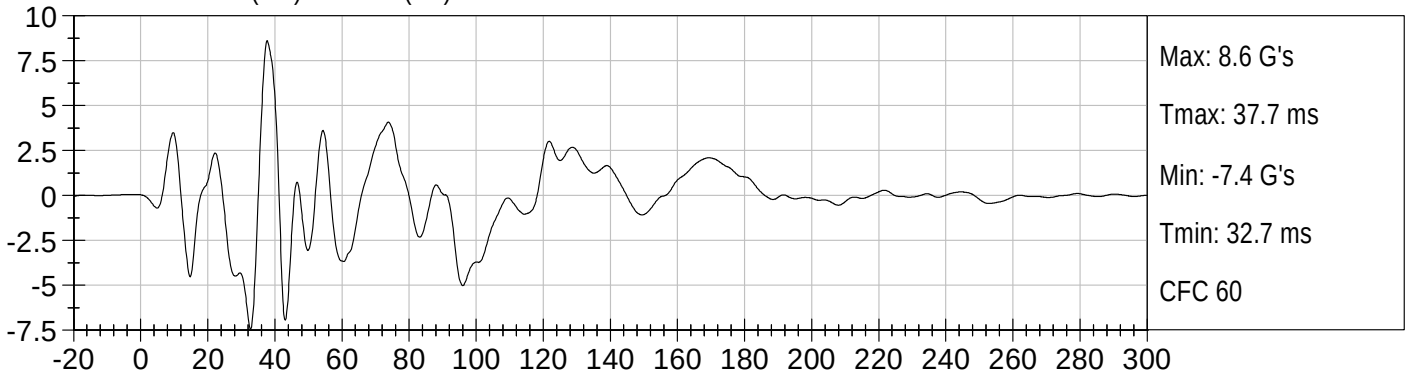
VEHICLE CG Y Velocity (kph) vs TIME (ms)



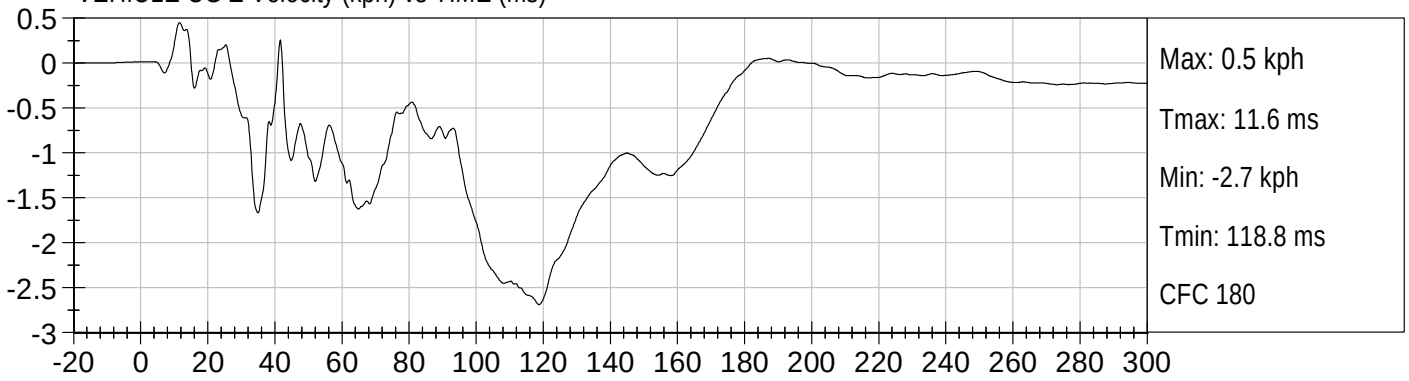
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

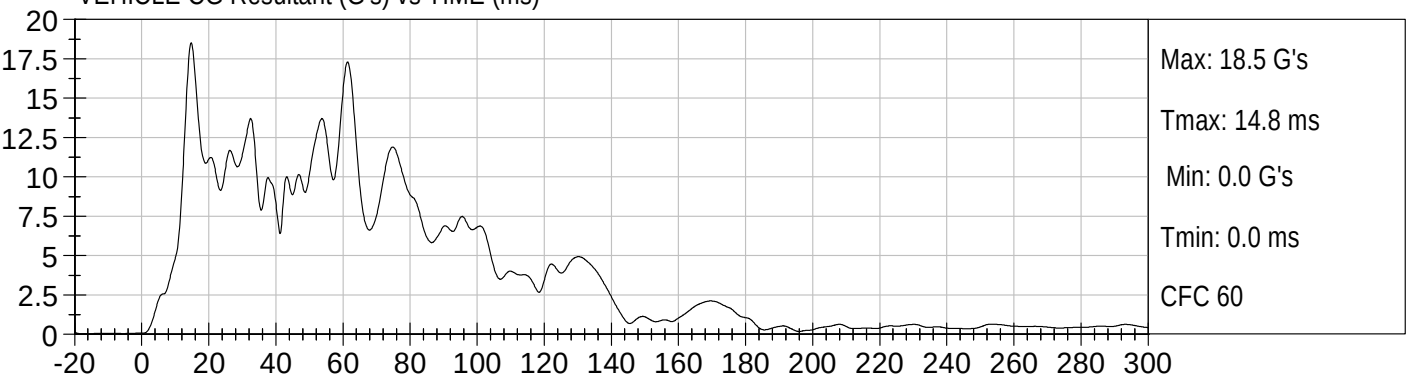
VEHICLE CG Z (G's) vs TIME (ms)



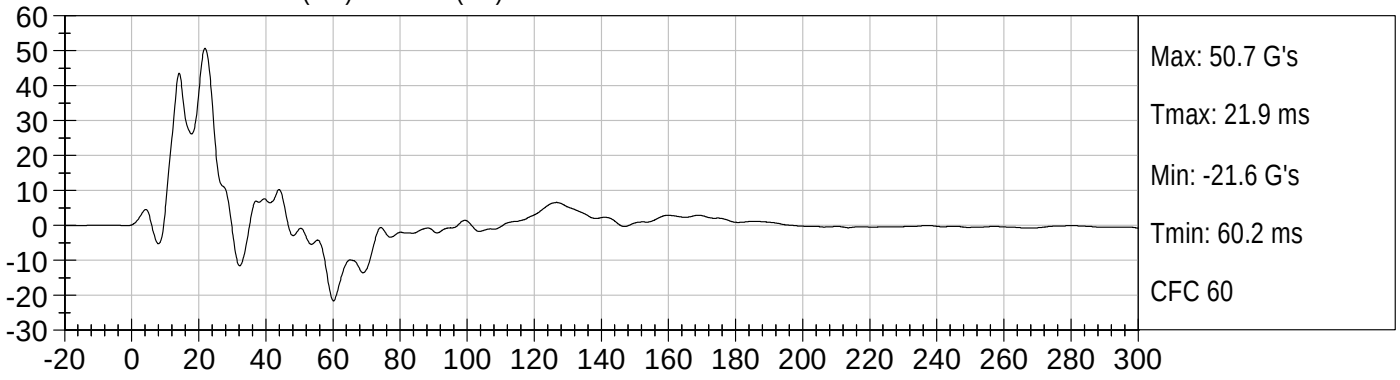
VEHICLE CG Z Velocity (kph) vs TIME (ms)



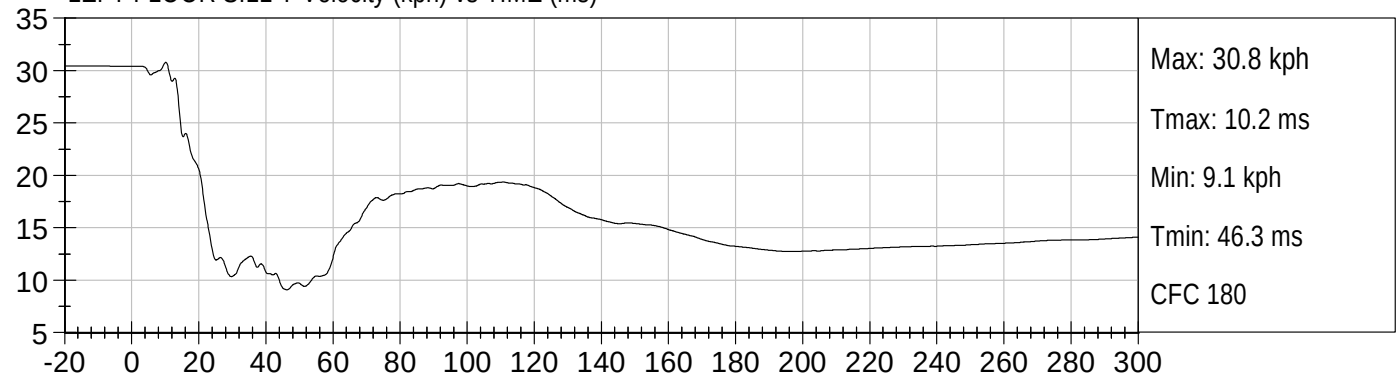
VEHICLE CG Resultant (G's) vs TIME (ms)



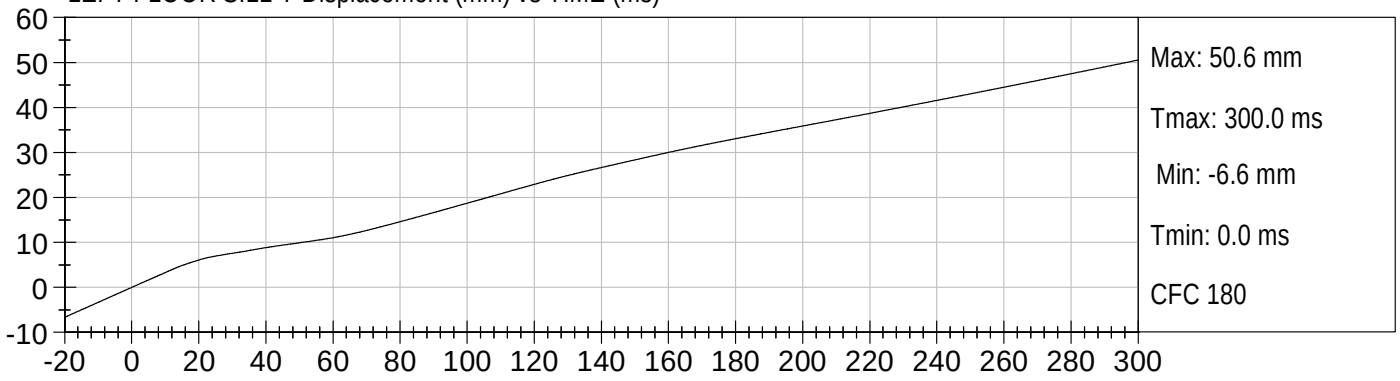
LEFT FLOOR SILL Y (G's) vs TIME (ms)



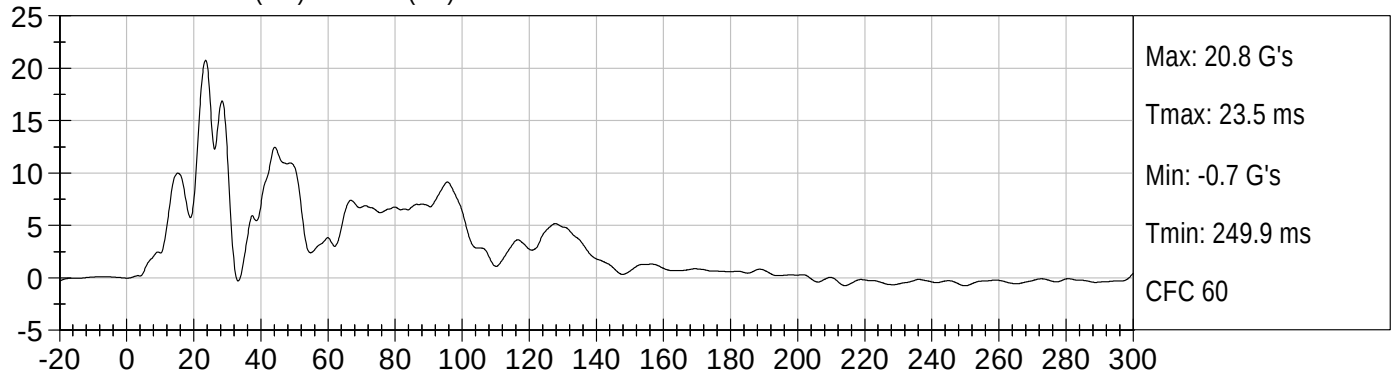
LEFT FLOOR SILL Y Velocity (kph) vs TIME (ms)



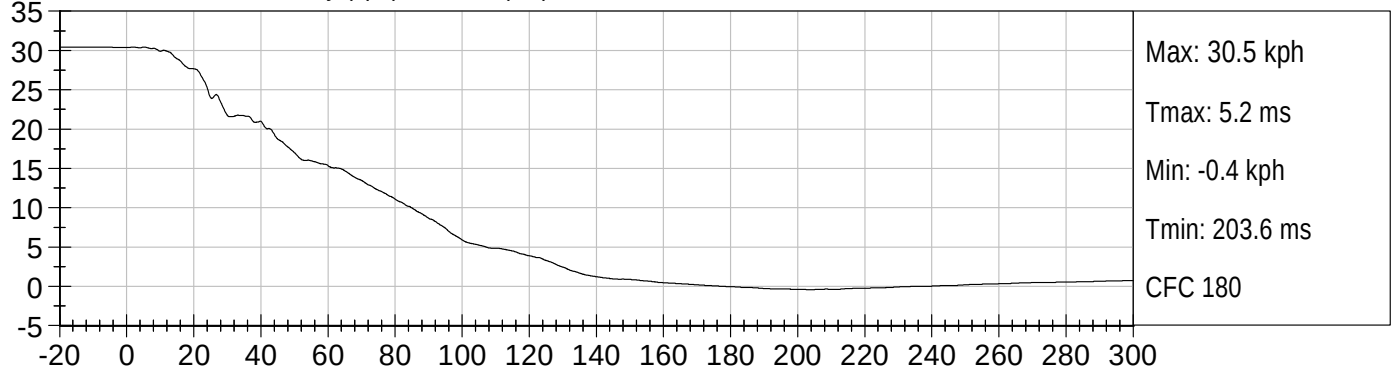
LEFT FLOOR SILL Y Displacement (mm) vs TIME (ms)



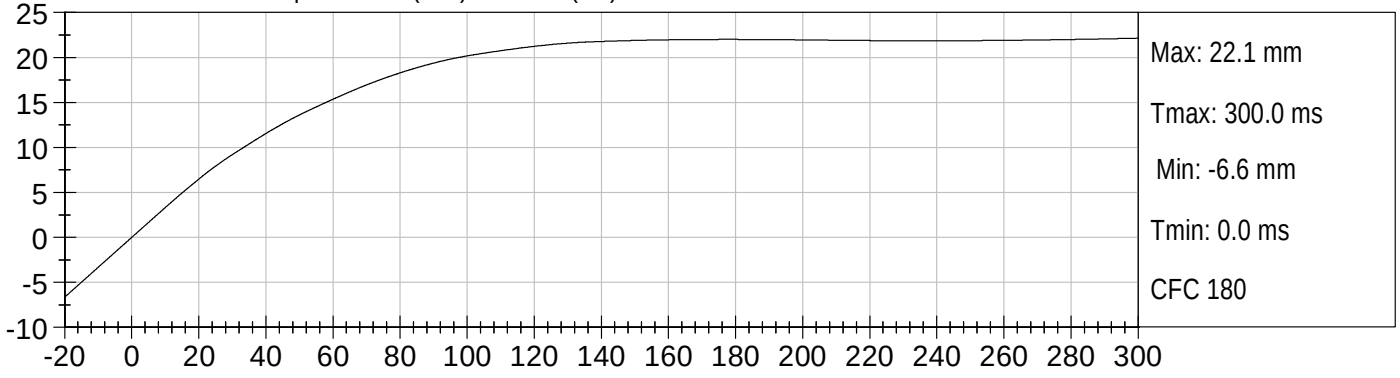
A PILLAR SILL Y (G's) vs TIME (ms)



A PILLAR SILL Y Velocity (kph) vs TIME (ms)



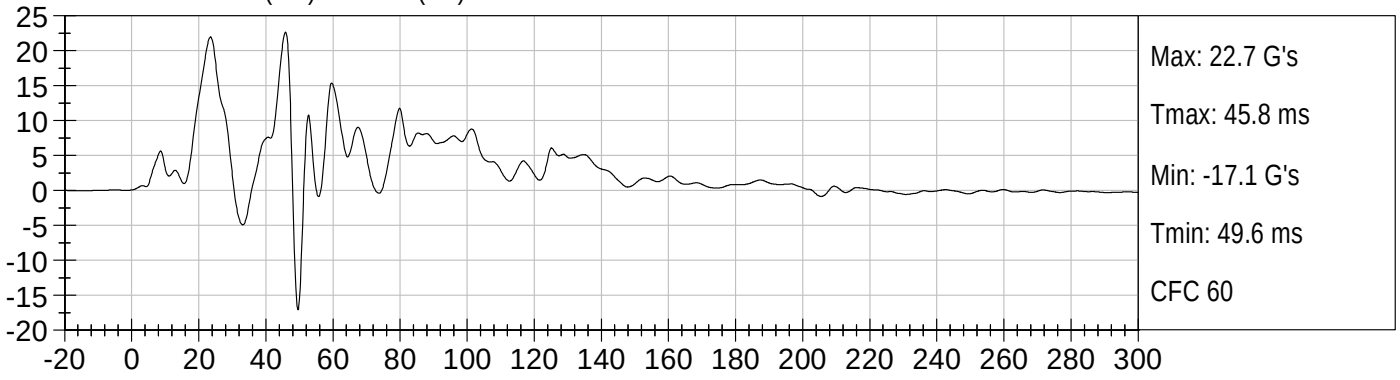
A PILLAR SILL Y Displacement (mm) vs TIME (ms)



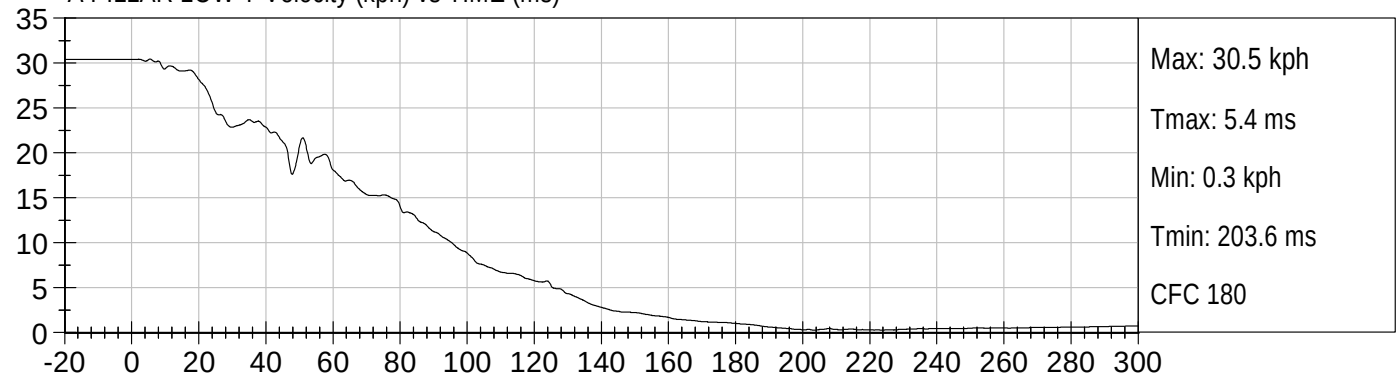
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

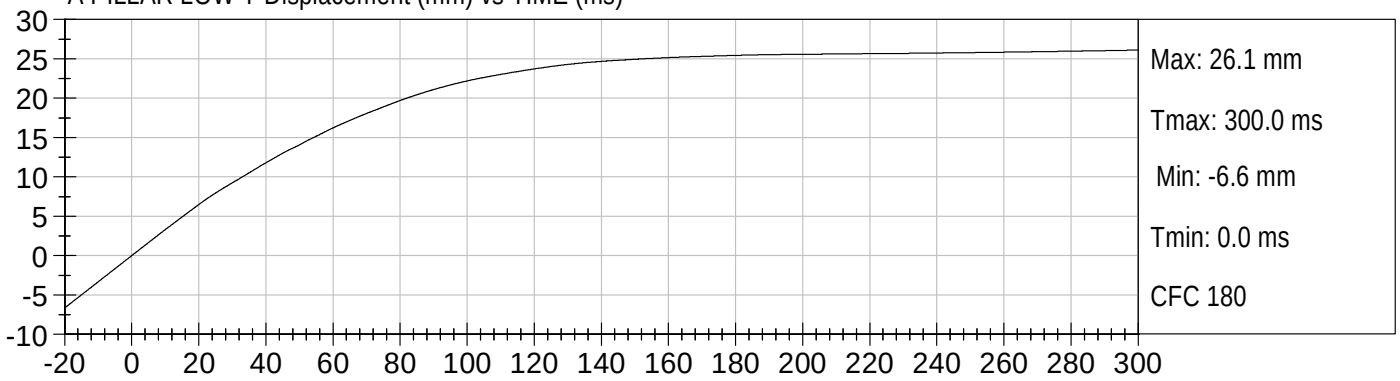
A PILLAR LOW Y (G's) vs TIME (ms)



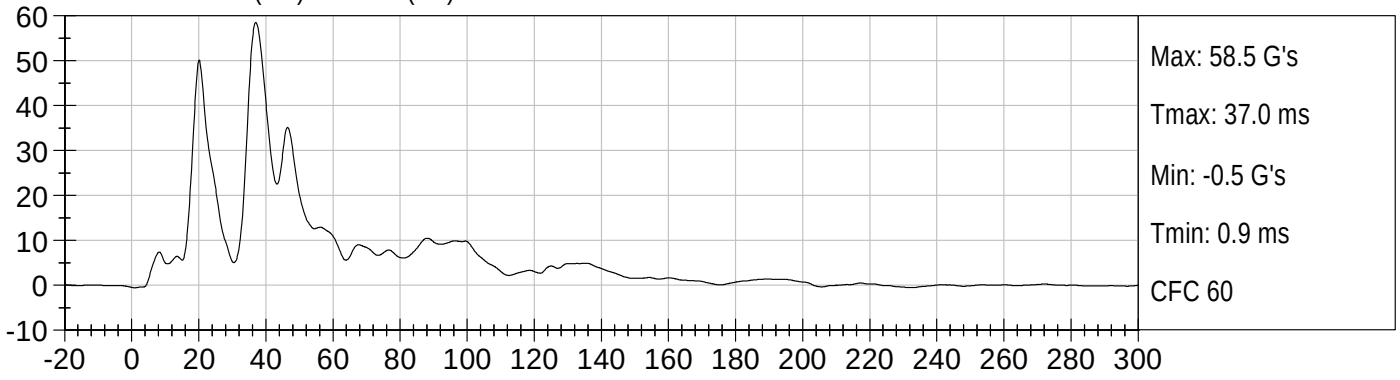
A PILLAR LOW Y Velocity (kph) vs TIME (ms)



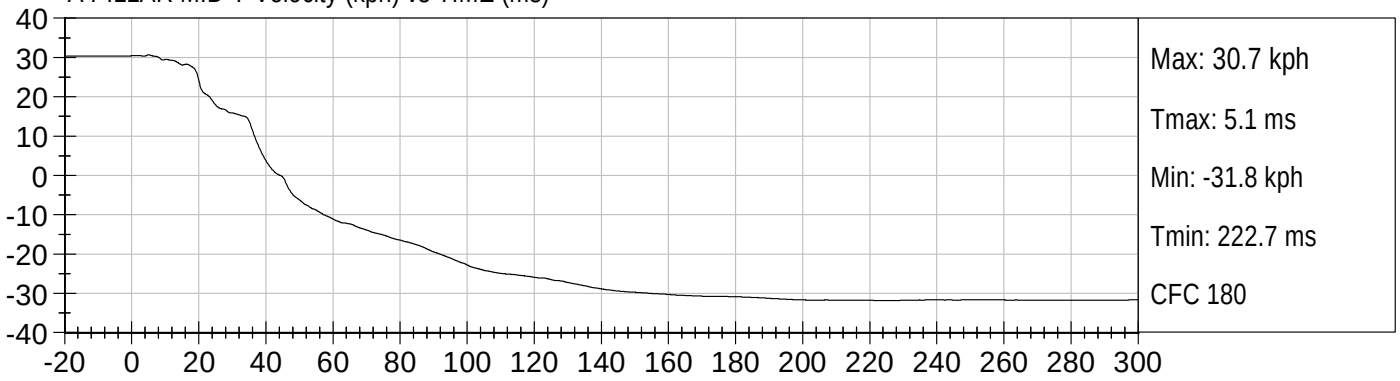
A PILLAR LOW Y Displacement (mm) vs TIME (ms)



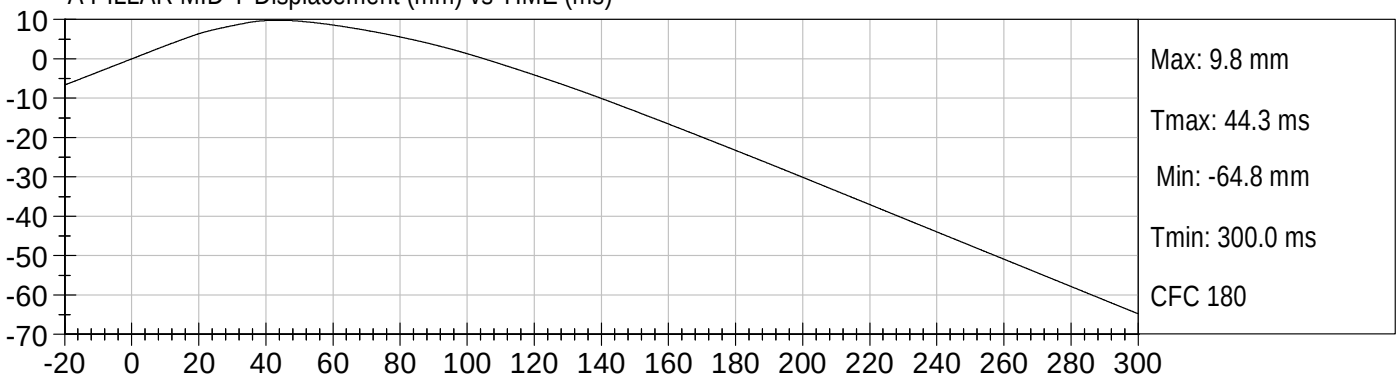
A PILLAR MID Y (G's) vs TIME (ms)



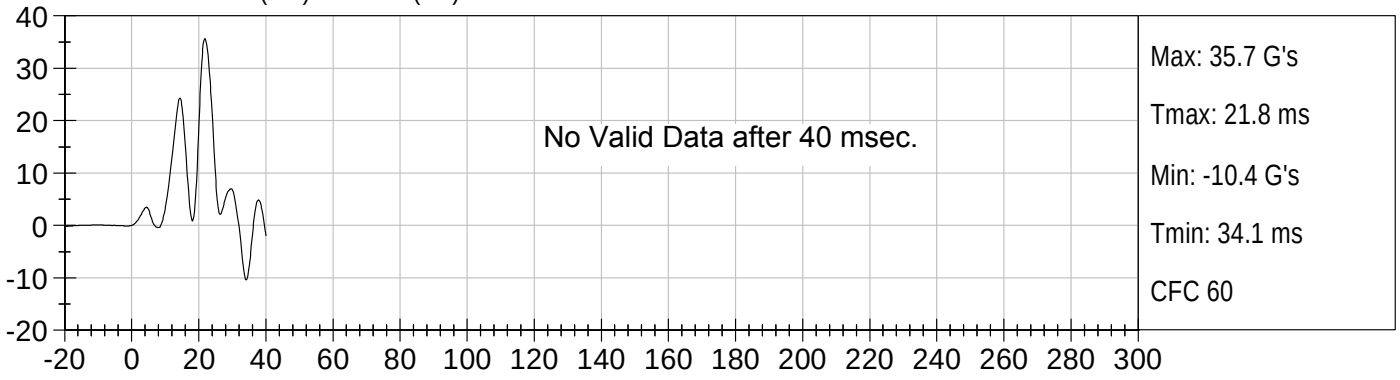
A PILLAR MID Y Velocity (kph) vs TIME (ms)



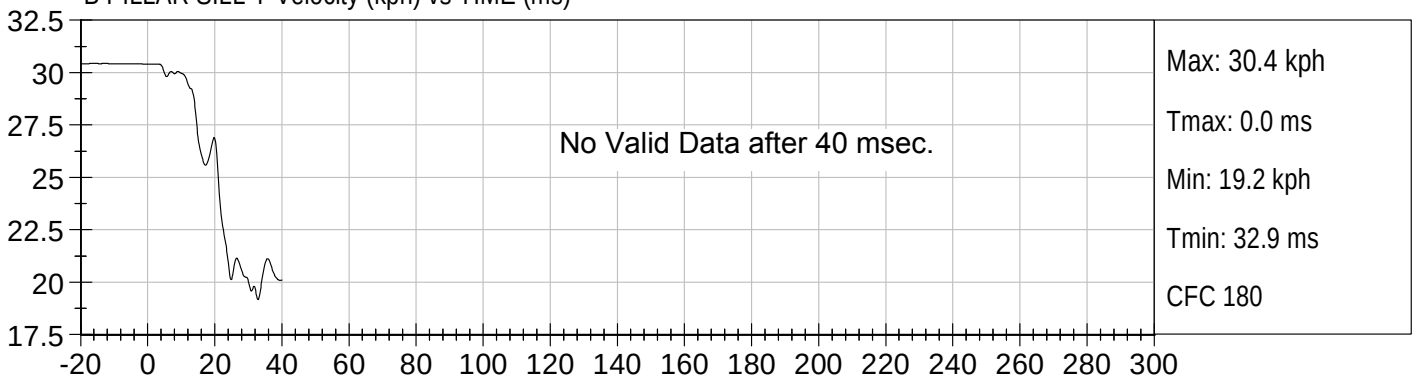
A PILLAR MID Y Displacement (mm) vs TIME (ms)



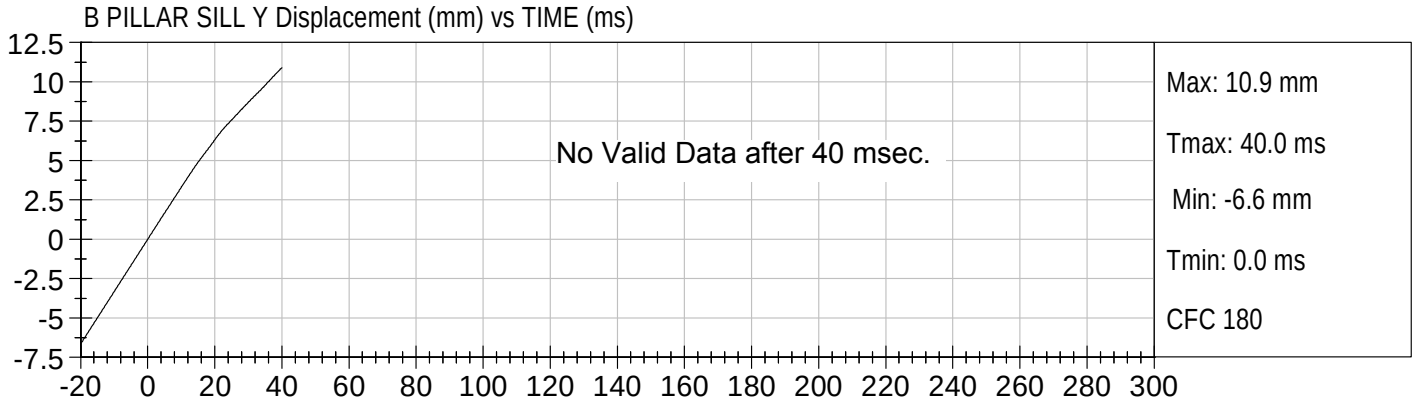
B PILLAR SILL Y (G's) vs TIME (ms)



B PILLAR SILL Y Velocity (kph) vs TIME (ms)



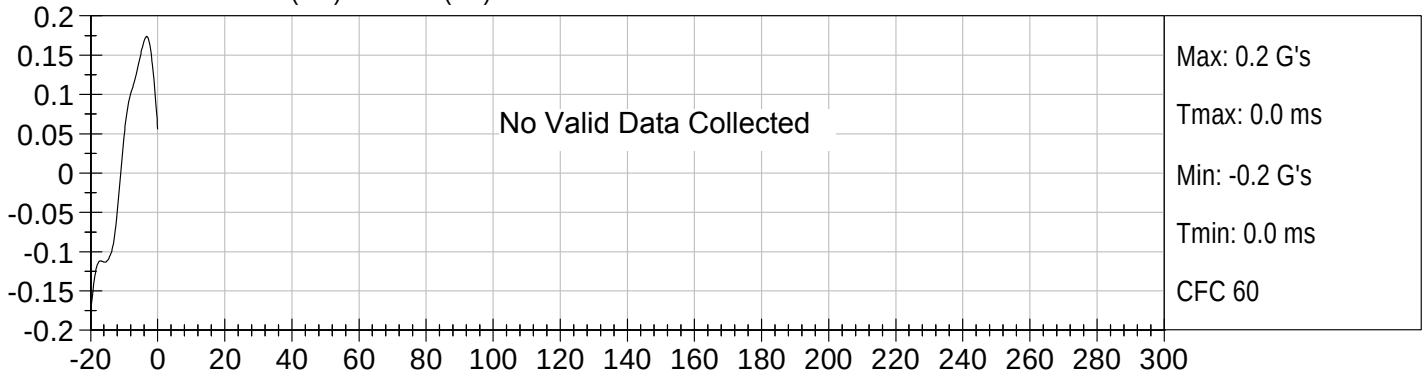
B PILLAR SILL Y Displacement (mm) vs TIME (ms)



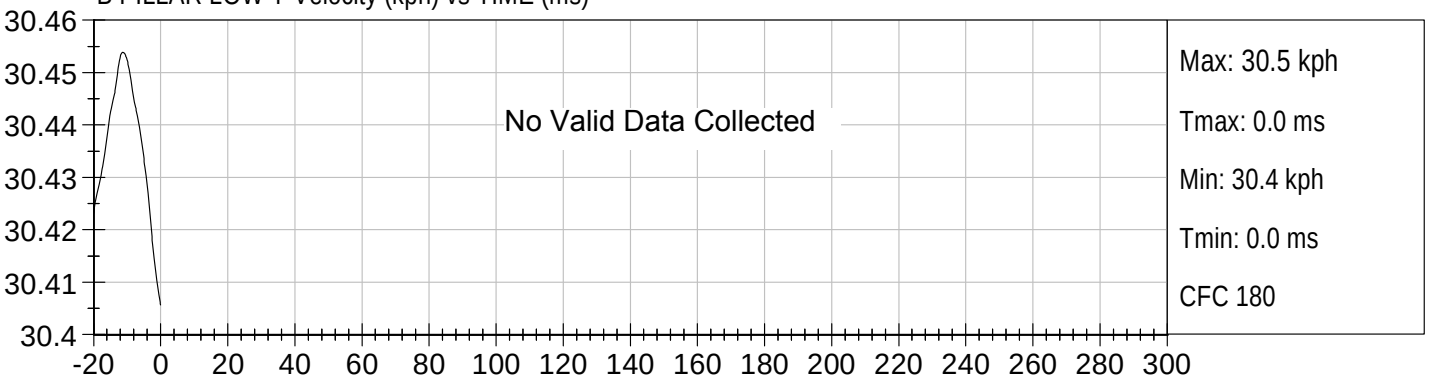
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

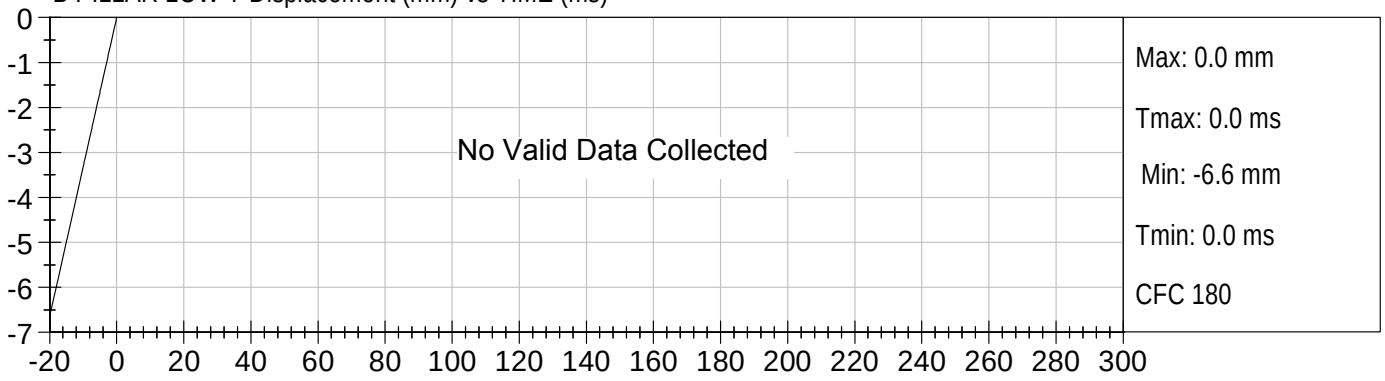
B PILLAR LOW Y (G's) vs TIME (ms)



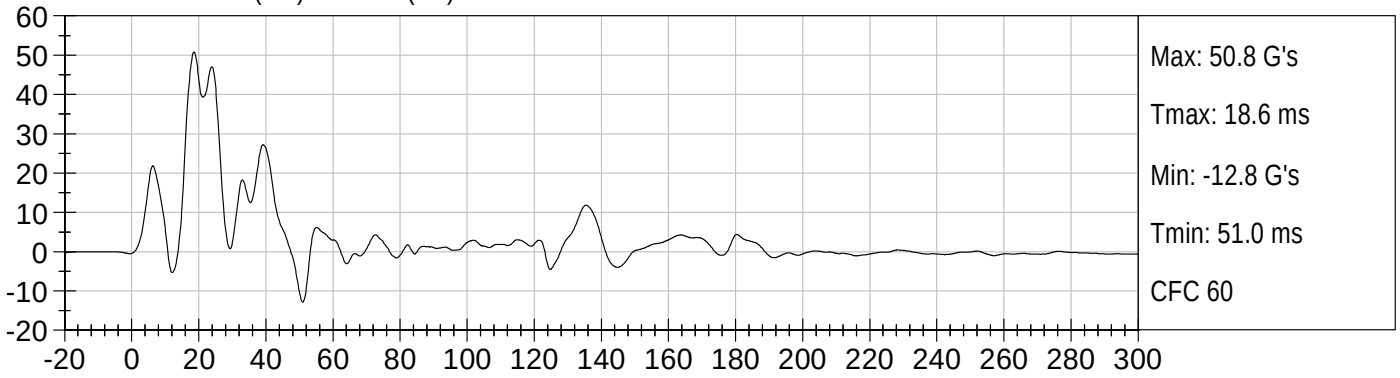
B PILLAR LOW Y Velocity (kph) vs TIME (ms)



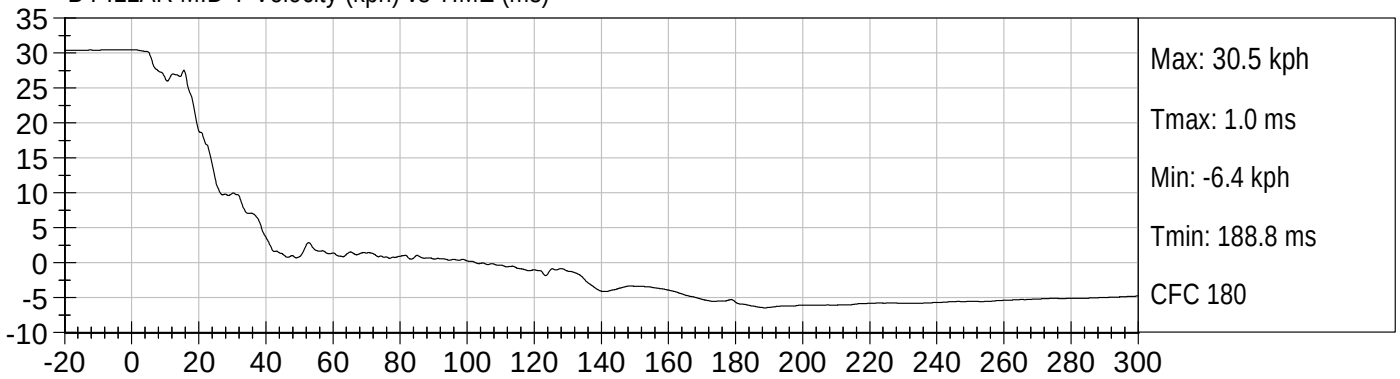
B PILLAR LOW Y Displacement (mm) vs TIME (ms)



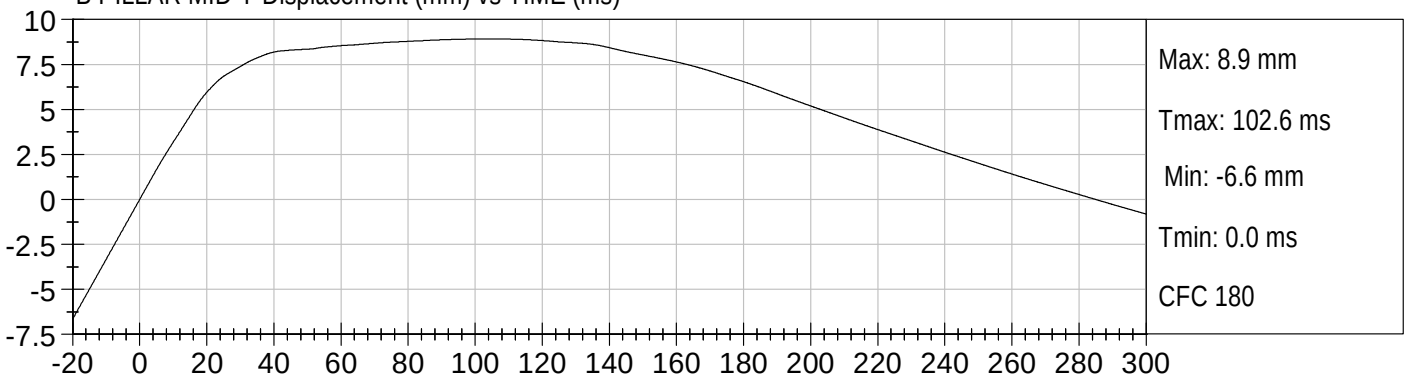
B PILLAR MID Y (G's) vs TIME (ms)



B PILLAR MID Y Velocity (kph) vs TIME (ms)



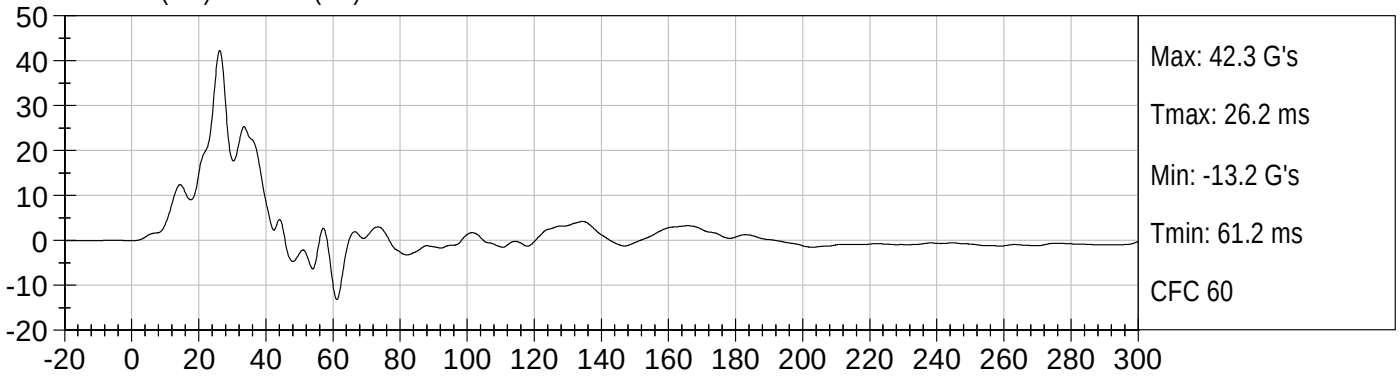
B PILLAR MID Y Displacement (mm) vs TIME (ms)



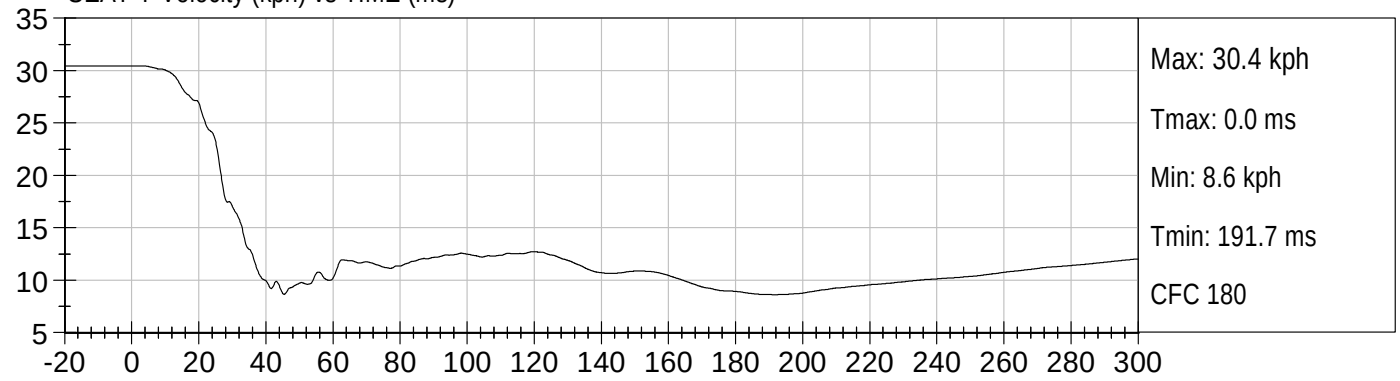
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

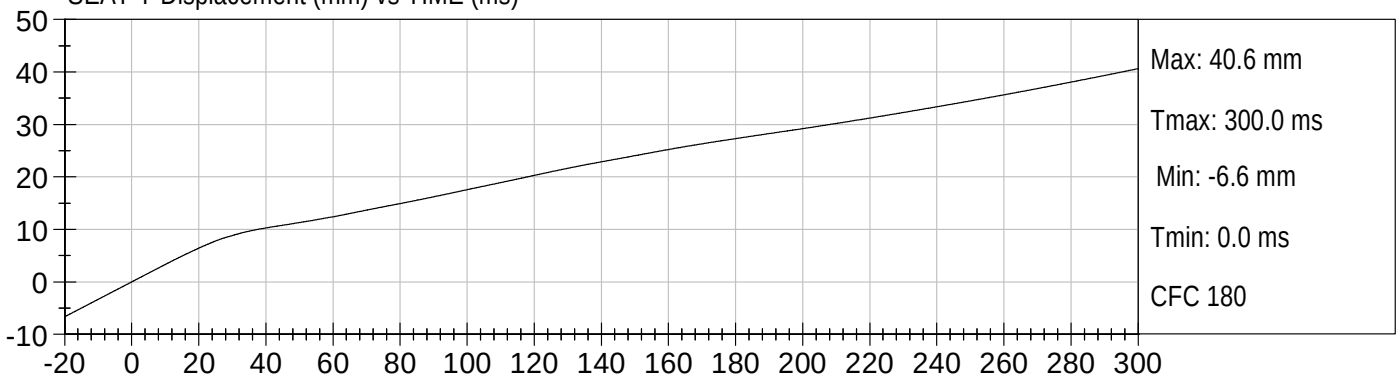
SEAT Y (G's) vs TIME (ms)



SEAT Y Velocity (kph) vs TIME (ms)



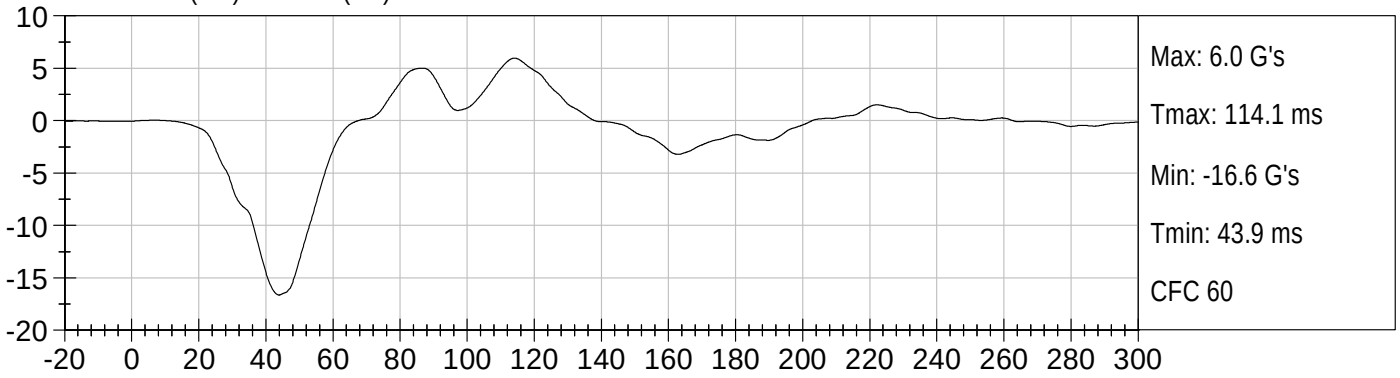
SEAT Y Displacement (mm) vs TIME (ms)



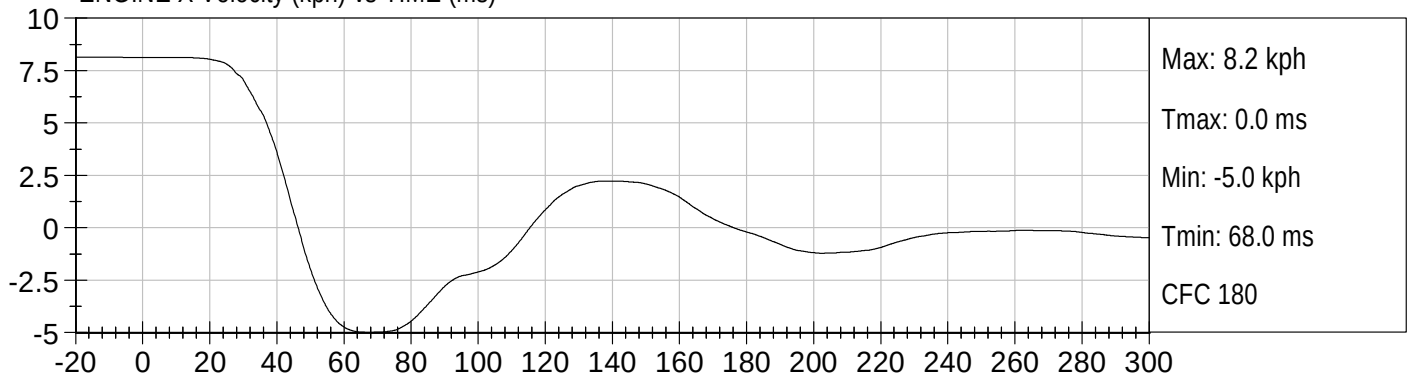
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

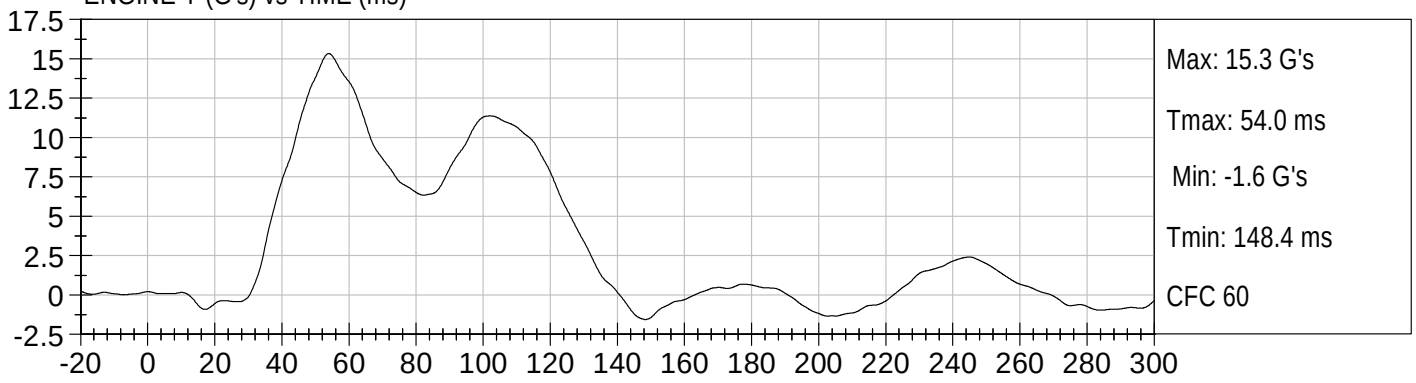
ENGINE X (G's) vs TIME (ms)



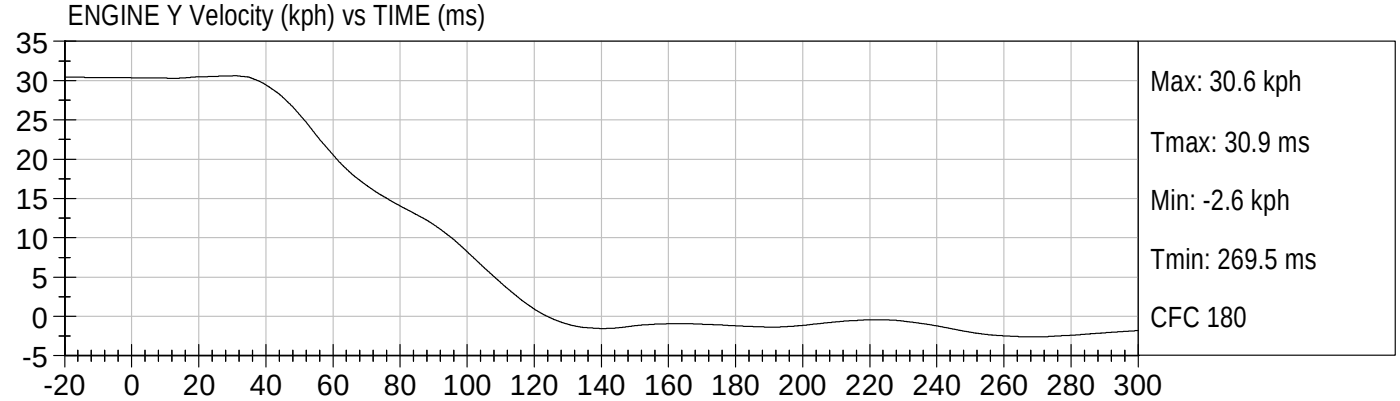
ENGINE X Velocity (kph) vs TIME (ms)



ENGINE Y (G's) vs TIME (ms)

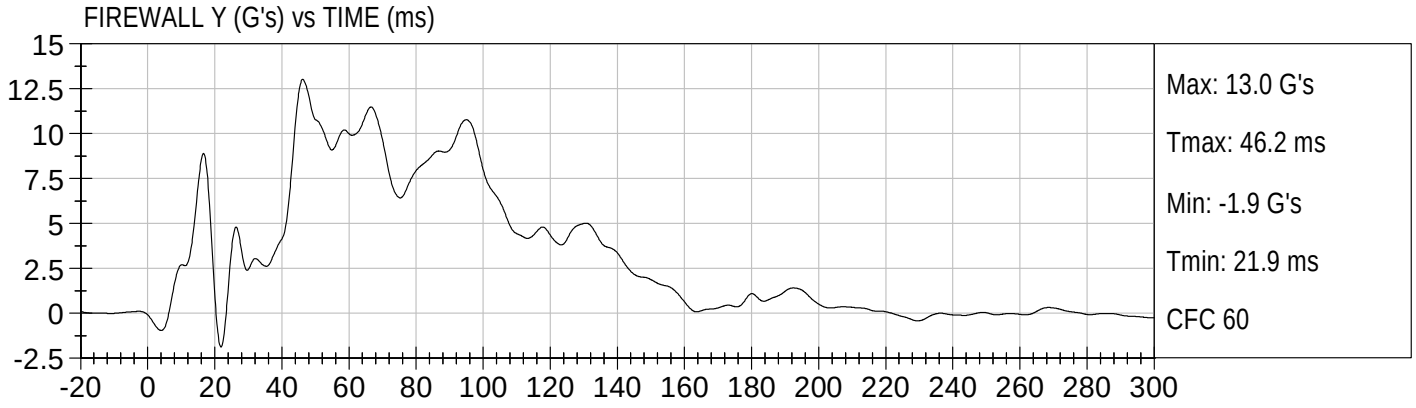


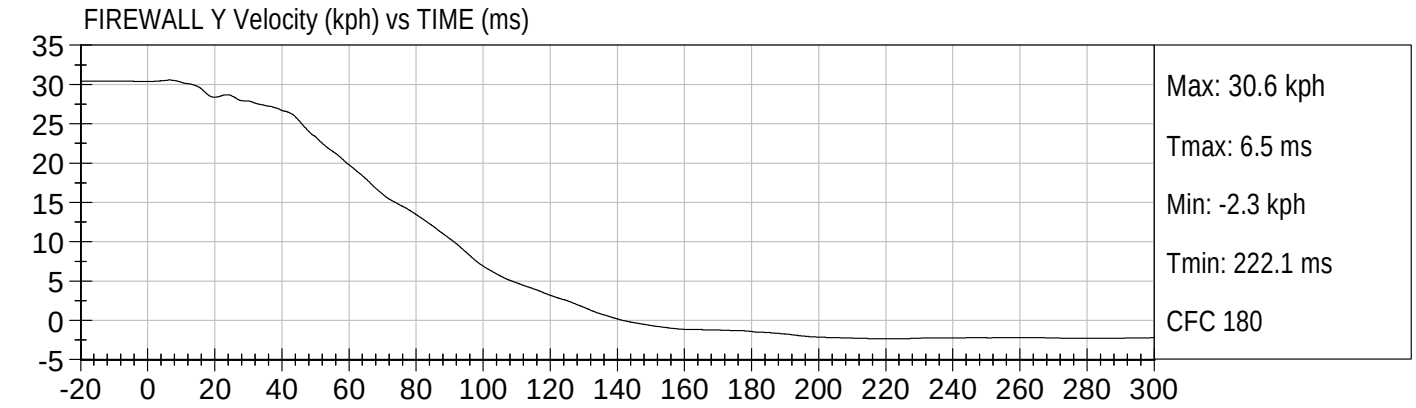
ENGINE Y Velocity (kph) vs TIME (ms)



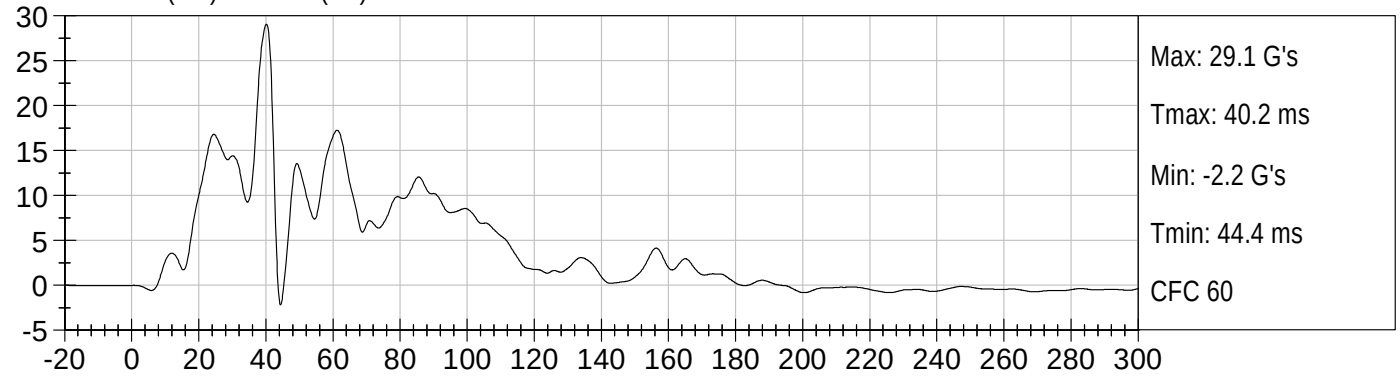
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

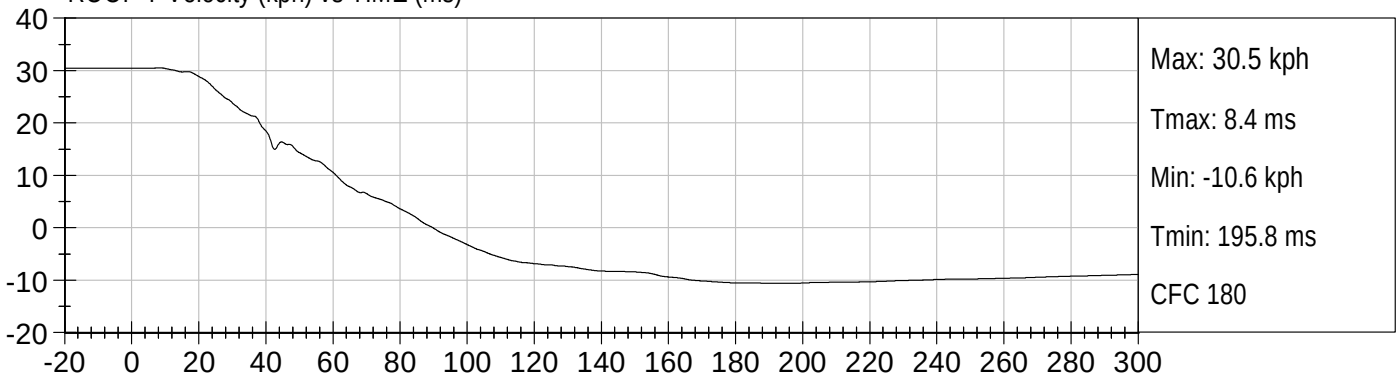




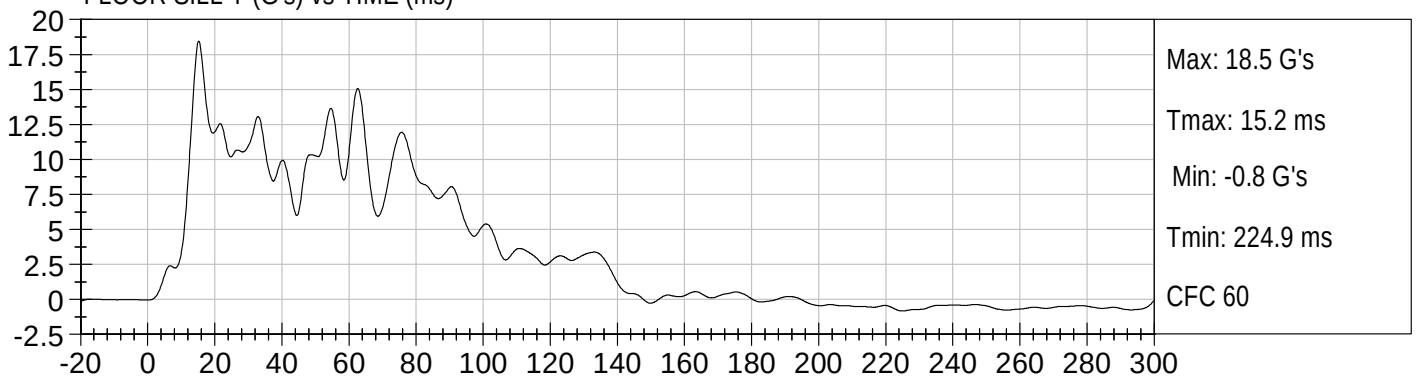
ROOF Y (G's) vs TIME (ms)



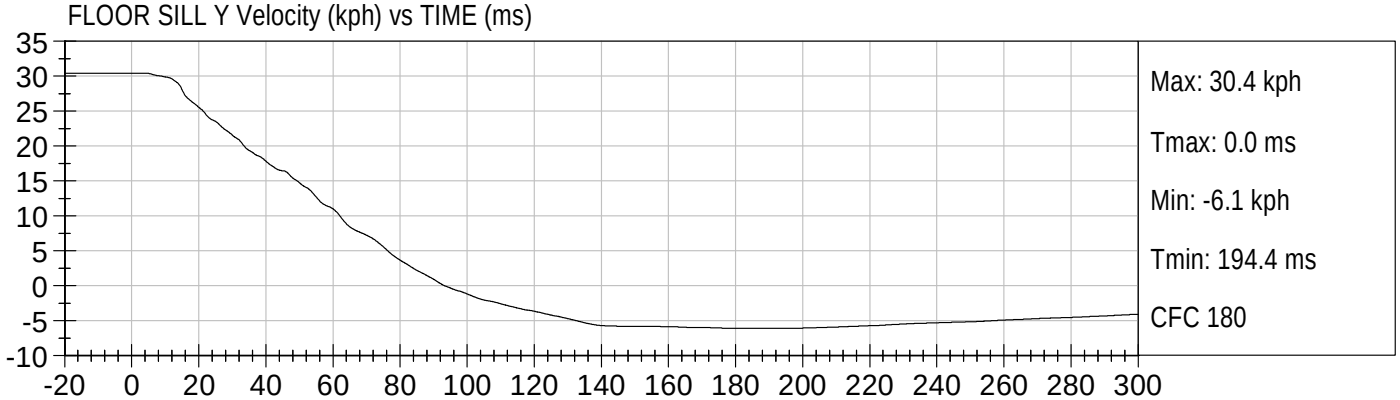
ROOF Y Velocity (kph) vs TIME (ms)



FLOOR SILL Y (G's) vs TIME (ms)



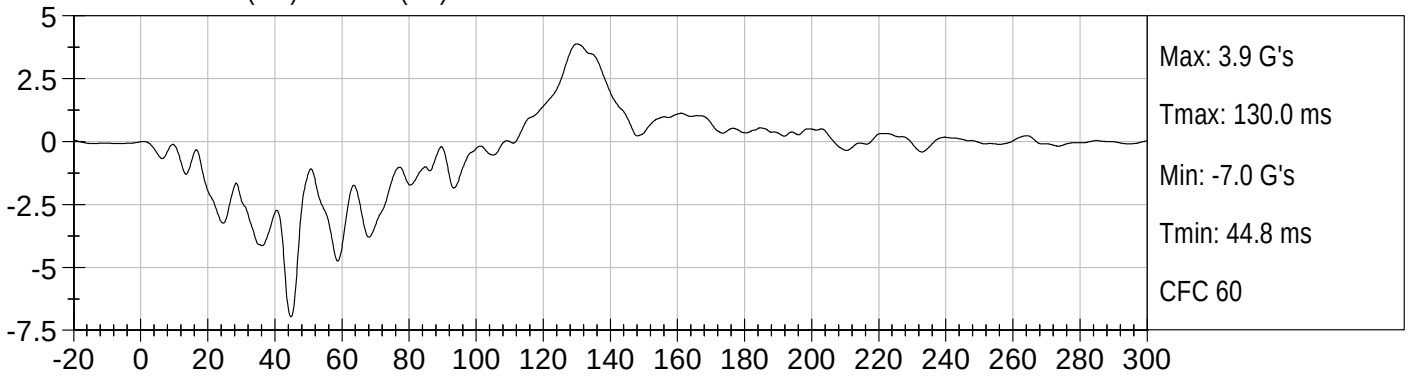
FLOOR SILL Y Velocity (kph) vs TIME (ms)



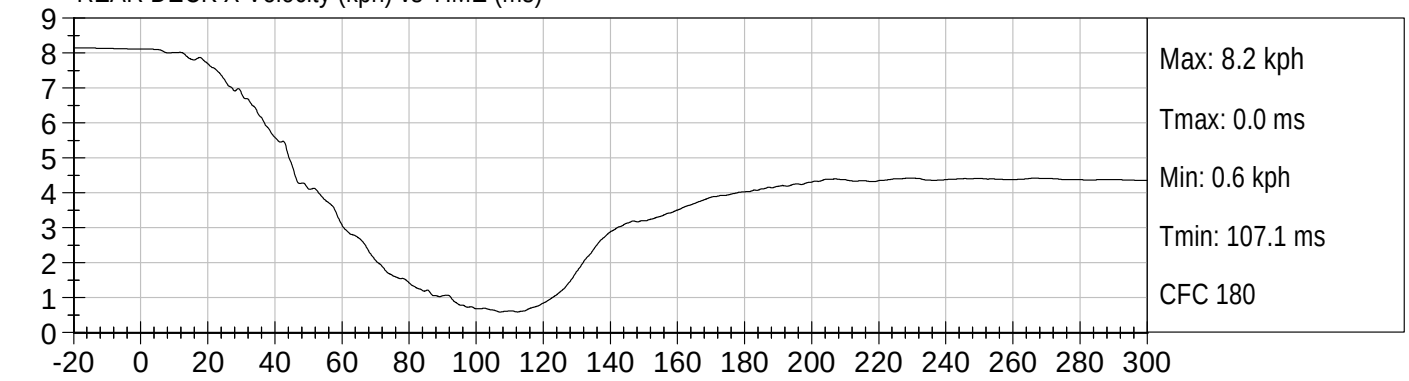
FMVSS 214 Rigid Pole Side Impact
2011 Toyota Highlander - CB5105

Test Date: 03/16/2011
Speed: 19.6 mph (31.5 km/h)

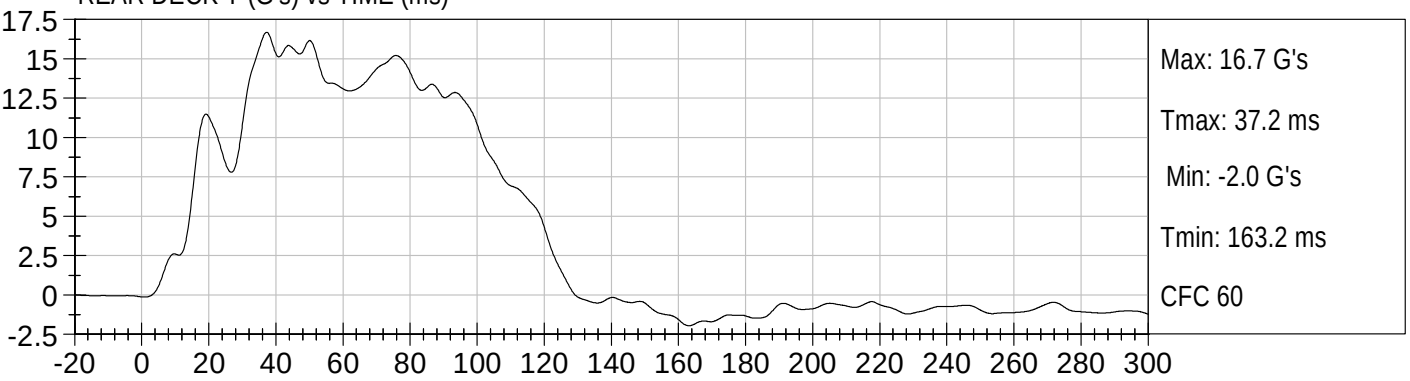
REAR DECK X (G's) vs TIME (ms)



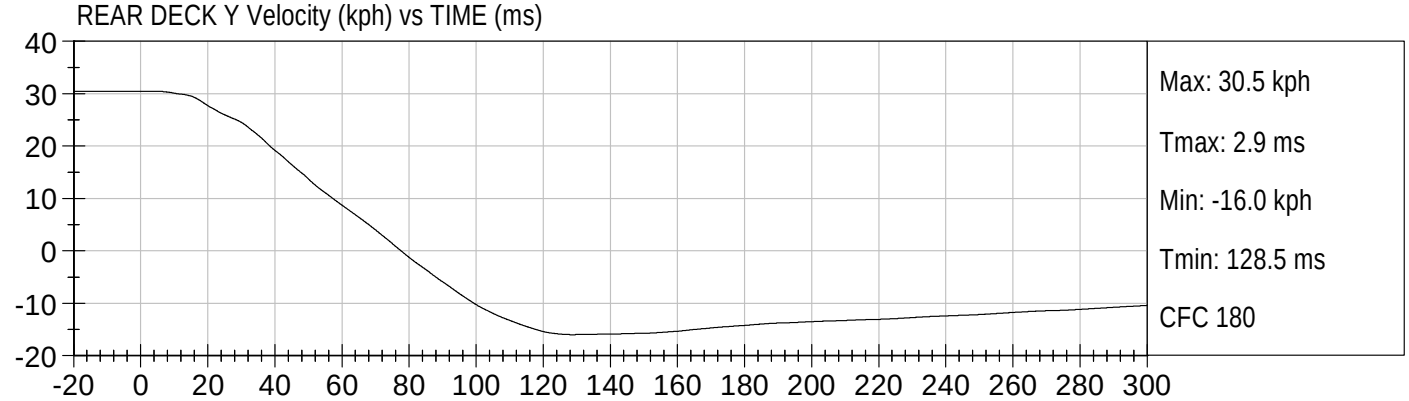
REAR DECK X Velocity (kph) vs TIME (ms)



REAR DECK Y (G's) vs TIME (ms)



REAR DECK Y Velocity (kph) vs TIME (ms)



APPENDIX D

DUMMY PERFORMANCE CALIBRATION TEST DATA

MGA RESEARCH CORPORATION

HEAD DROP TEST

ES-2re DUMMY

ATD Serial No: 016 **Test ID:** D11961

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	20.9	Pass
Laboratory Relative Humidity	%	10 to 70	24	Pass
Peak Resultant Acceleration	G's	125 to 155	147	Pass
Peak Lateral Acceleration	G's	+/- 15	-9.4	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

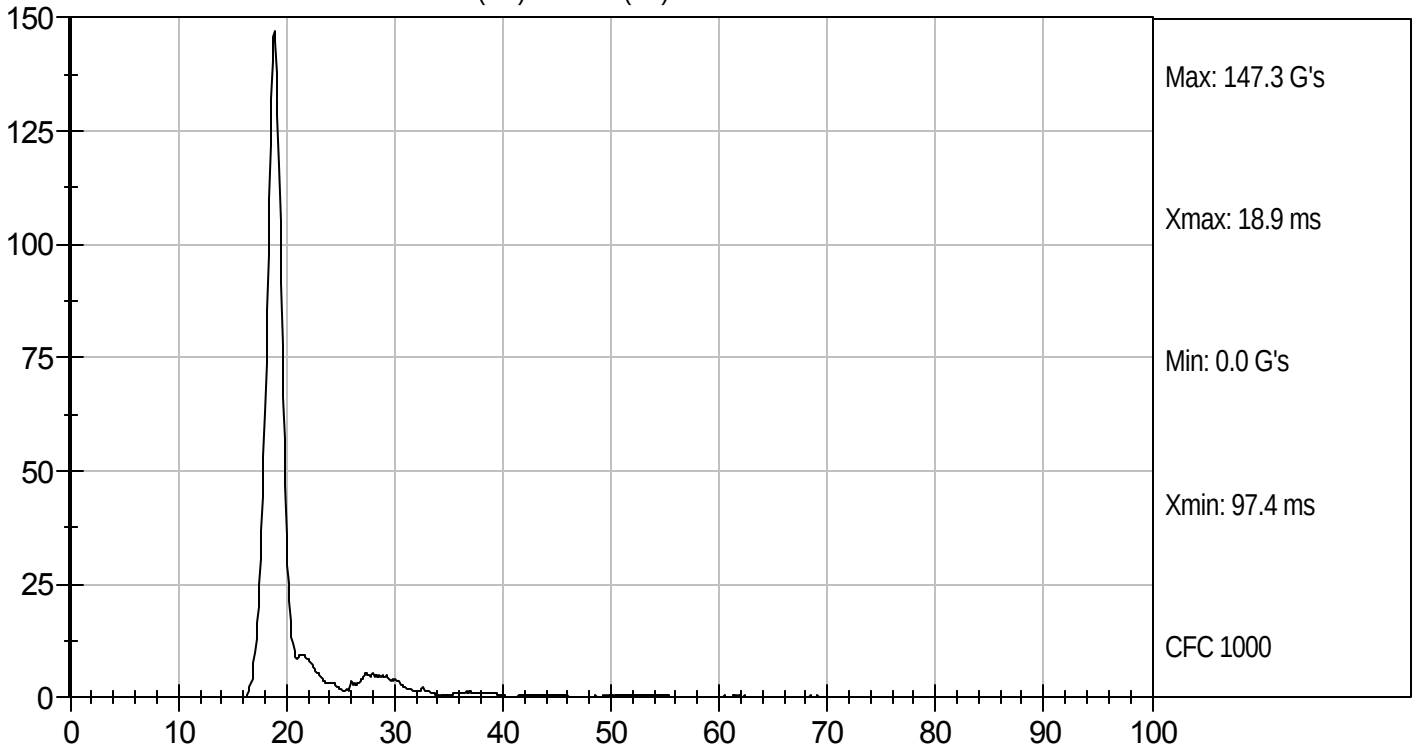
3/14/11
Test Date

David Winkelbauer
Approved By

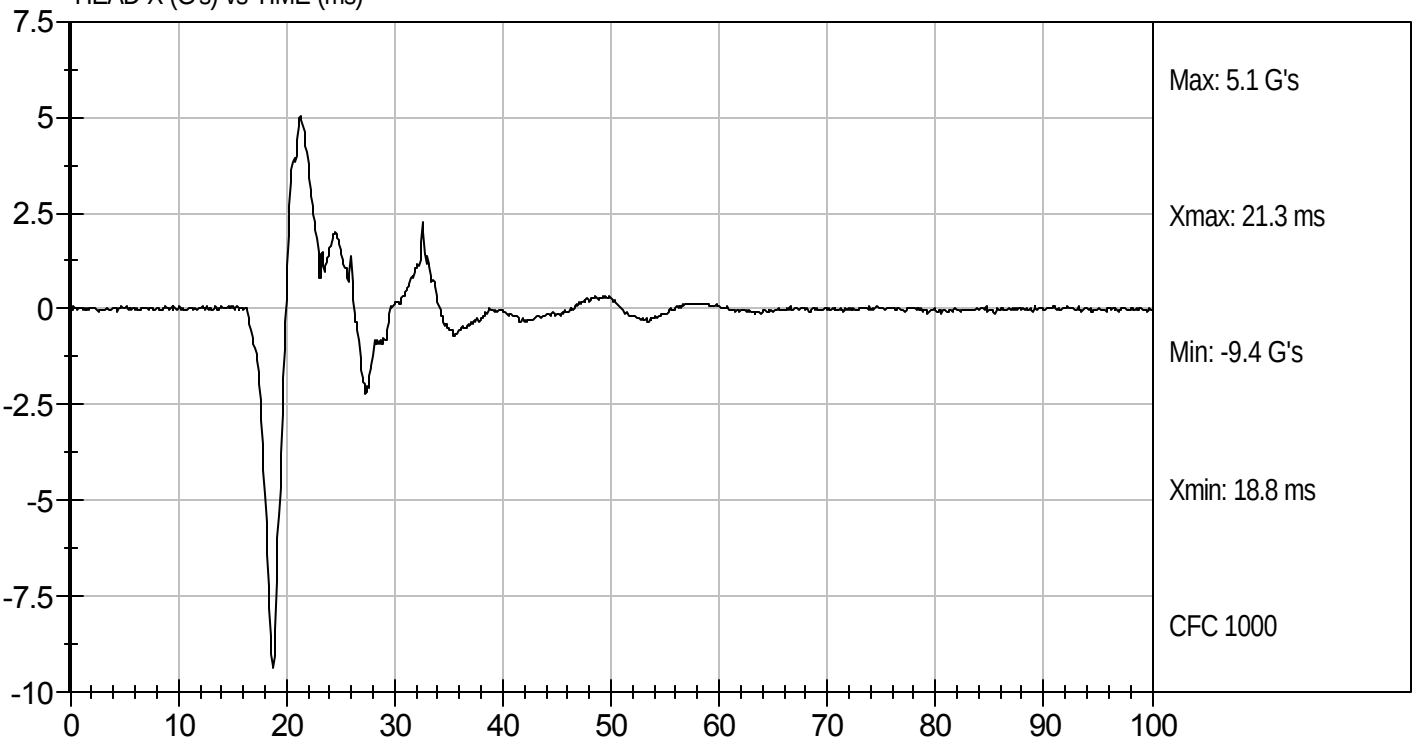
Test Desc: Head Drop
Component ID: D11961

Test Date: 3/14/11
Velocity: 0 ft/s, 0 m/s

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



HEAD X (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

NECK PENDULUM TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11962

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	20.6	Pass
Laboratory Relative Humidity		%	10 to 70	22	Pass
Pendulum Speed		m/s	3.3 to 3.5	3.5	Pass
Pendulum Deceleration	1 ms	m/s	0.00 to -0.05	-0.02	Pass
	3 ms	m/s	-0.25 to -0.375	-0.33	Pass
	14 ms	m/s	-3.20 to -3.70	-3.44	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	51.1	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	61.0	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	55.8	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

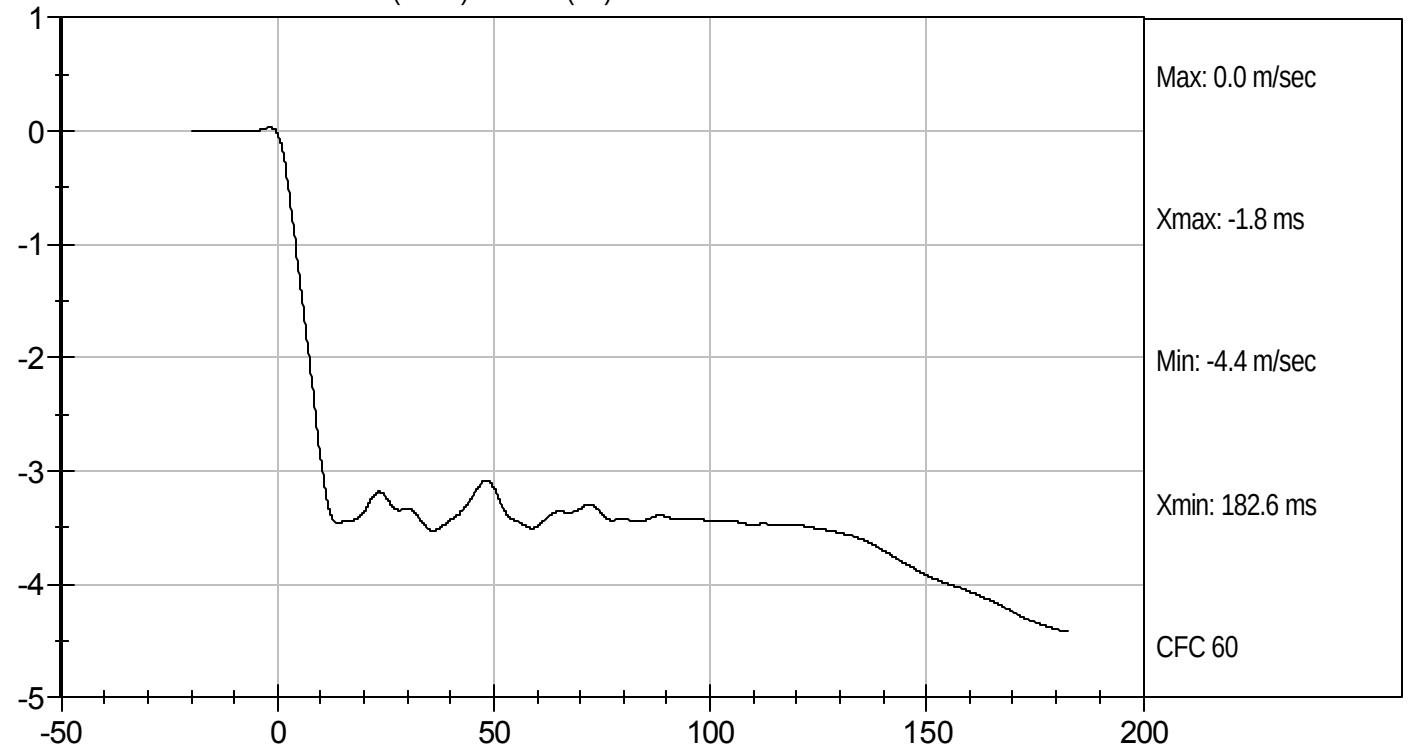
3/15/11
Test Date

David Winkelbauer
Approved By

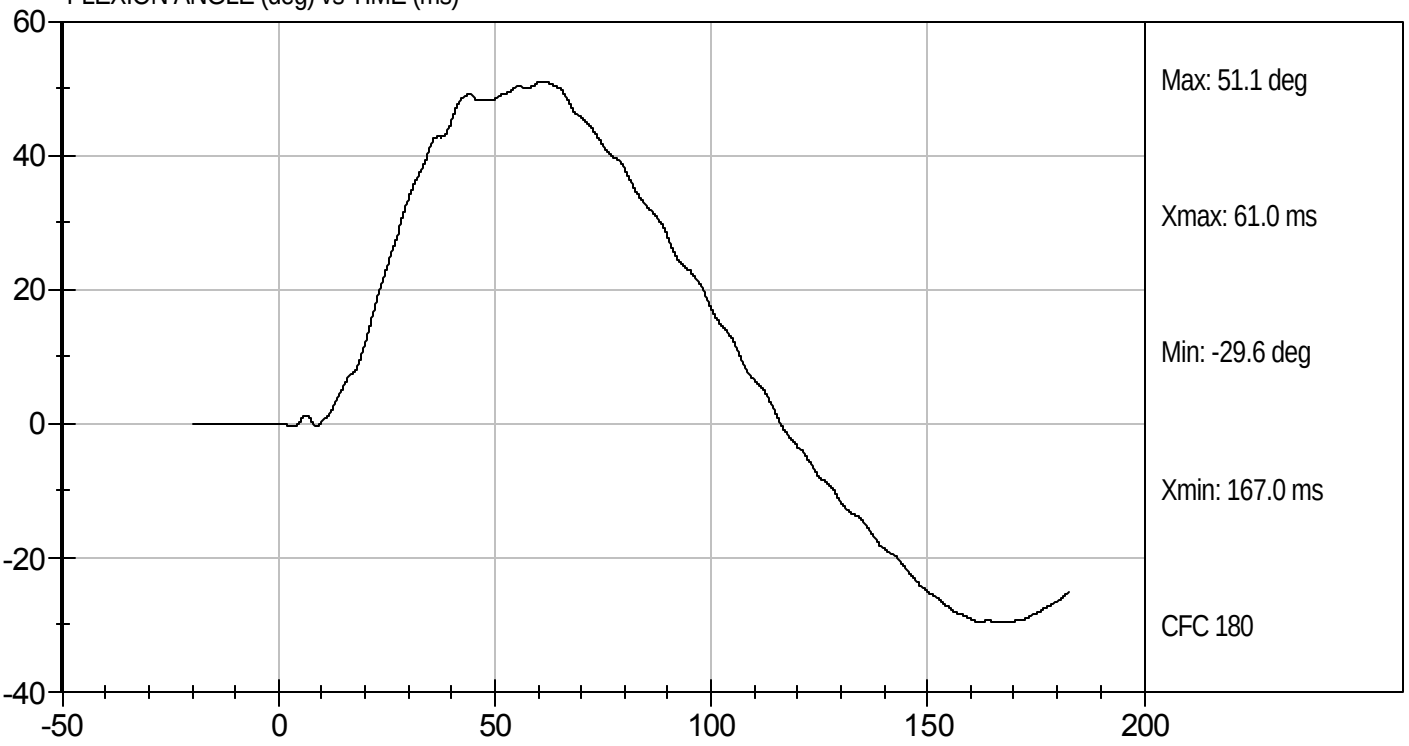
Test Desc: Neck Bending
Component ID: D11962

Test Date: 3/15/11
Velocity: 11.42 ft/s, 3.5 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

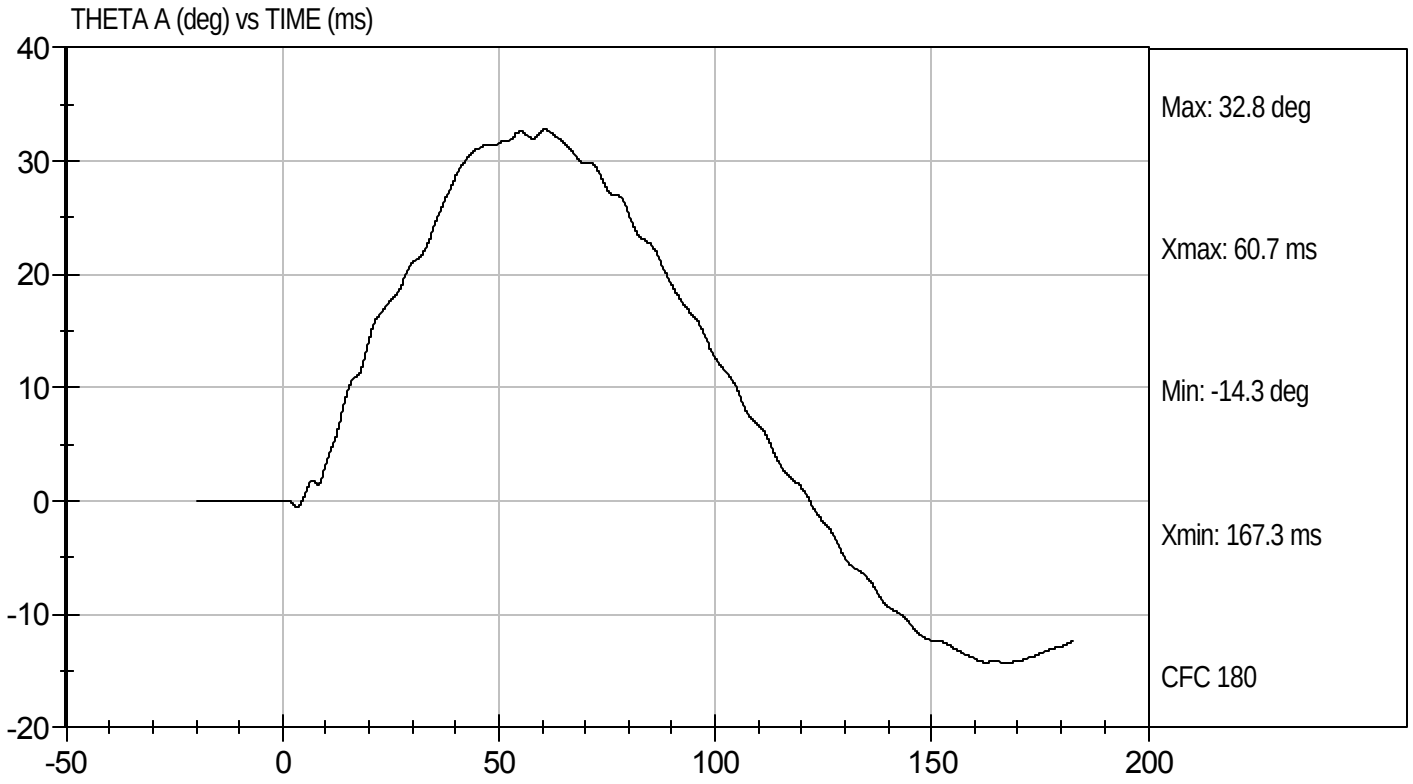


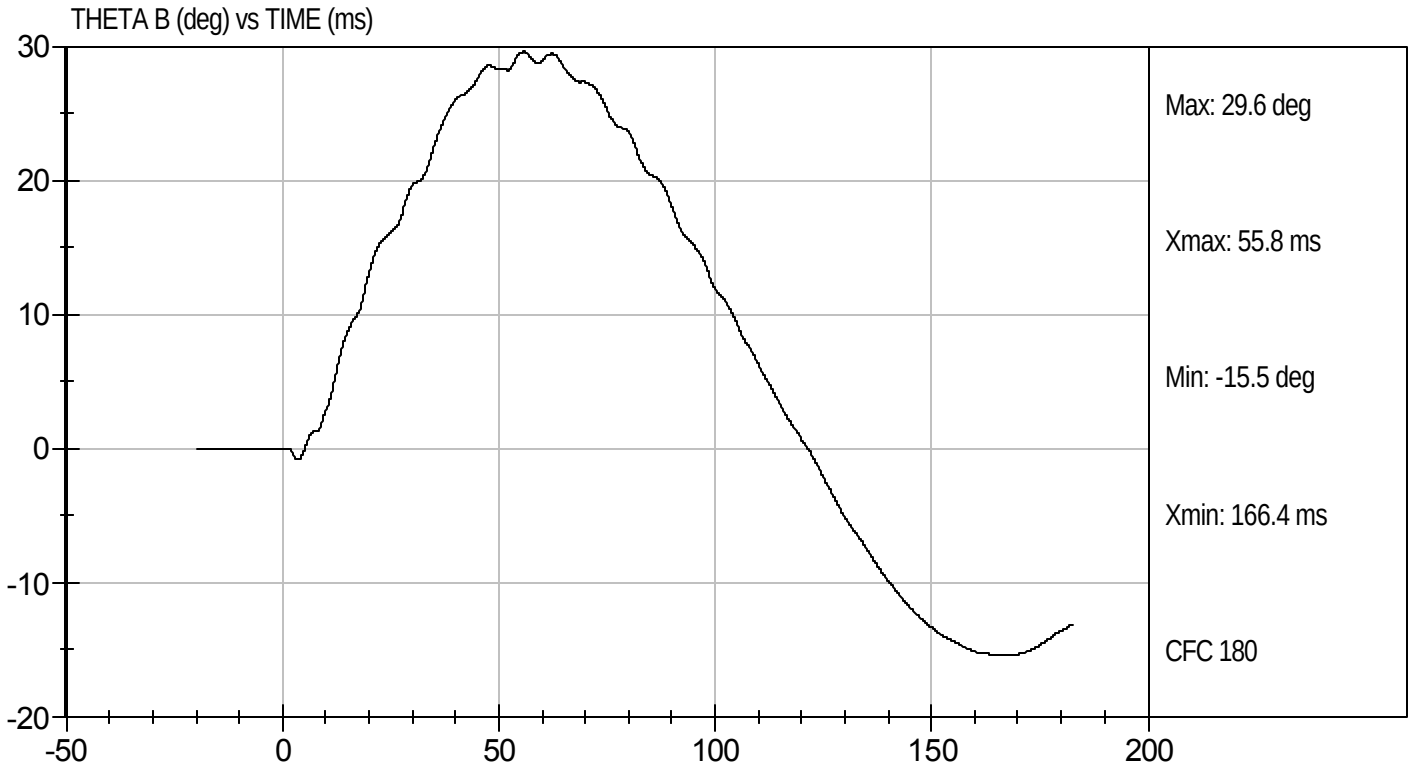
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D11962

Test Date: 3/15/11
Velocity: 11.42 ft/s, 3.5 m/s





MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11963

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	21	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	7.9	Pass
Time of Peak Shoulder Acceleration	ms	NA	12.5	Pass
		Overall Test Results		Pass

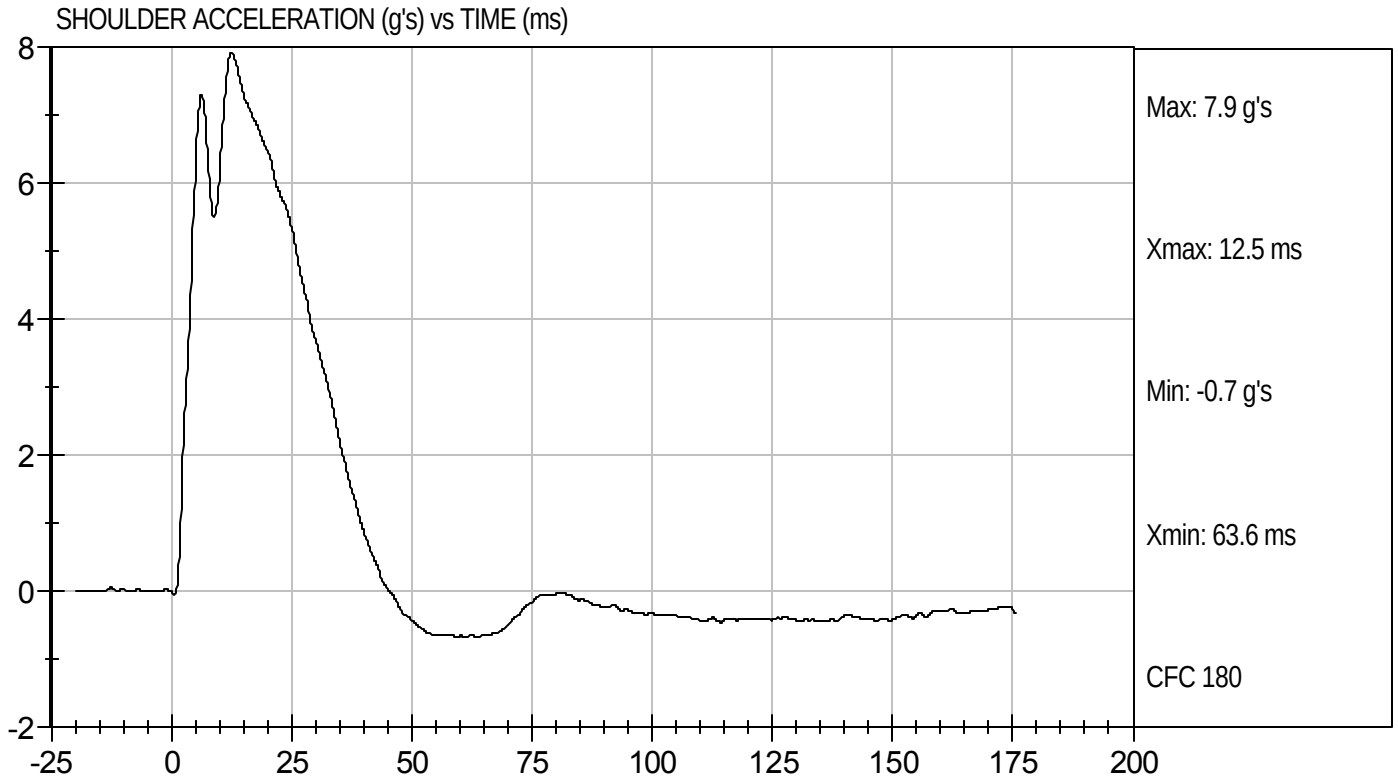
Jessica Gall
Laboratory Technician

3/15/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D11963

Test Date: 3/15/11
Velocity: 14.25 ft/s, 4.3 m/s



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11964

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.7	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.2	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.0	Pass
		Overall Test Results		Pass

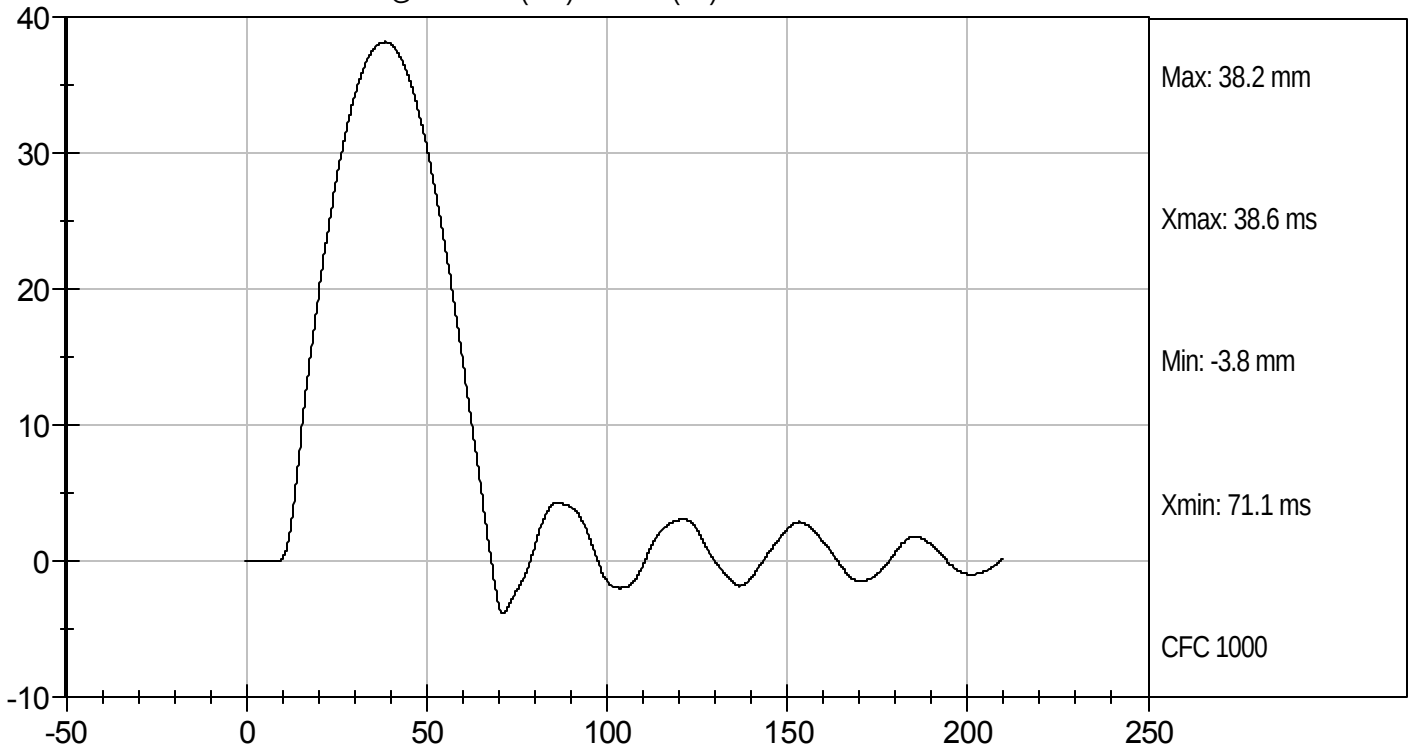
Jessica Gall
Laboratory Technician

3/14/11
Test Date

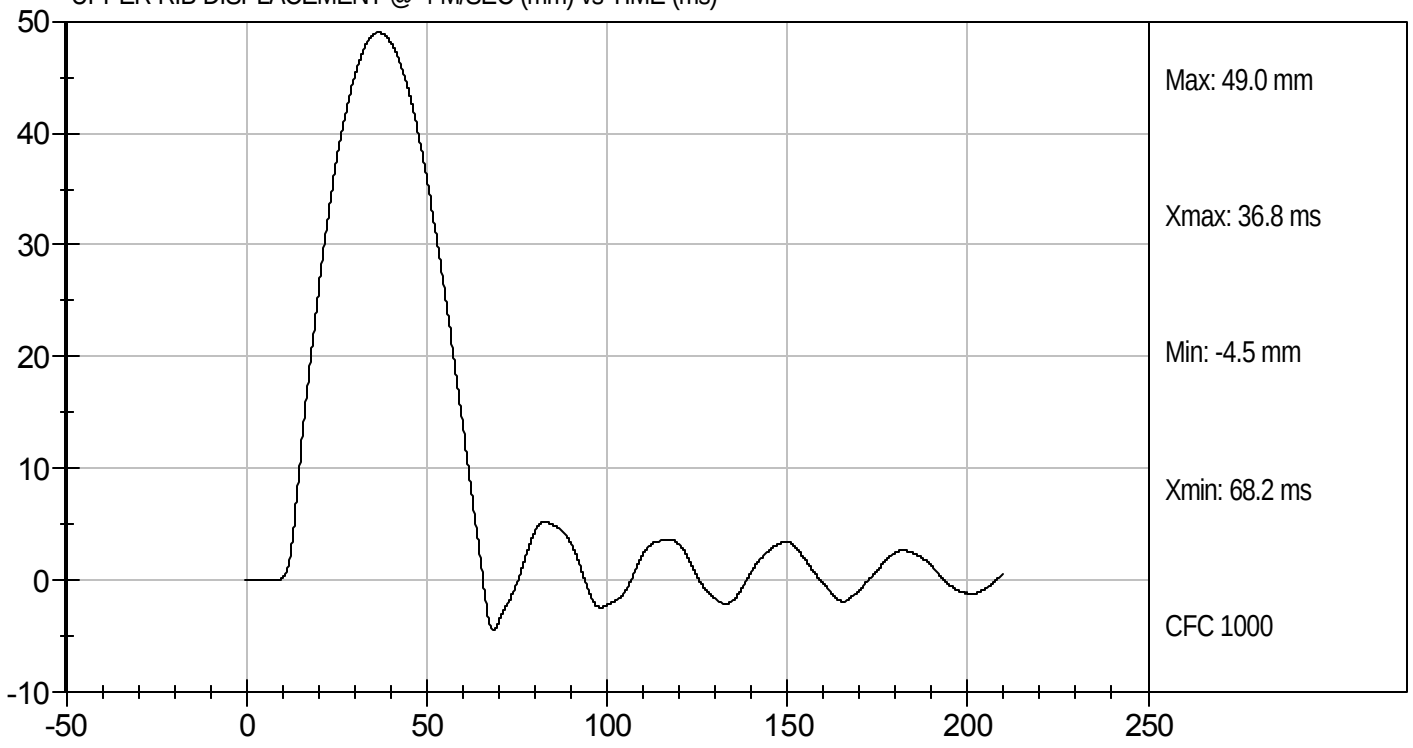
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D11964
Test Date: 3/14/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

MID RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11965

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.7	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.0	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.3	Pass
		Overall Test Results		Pass

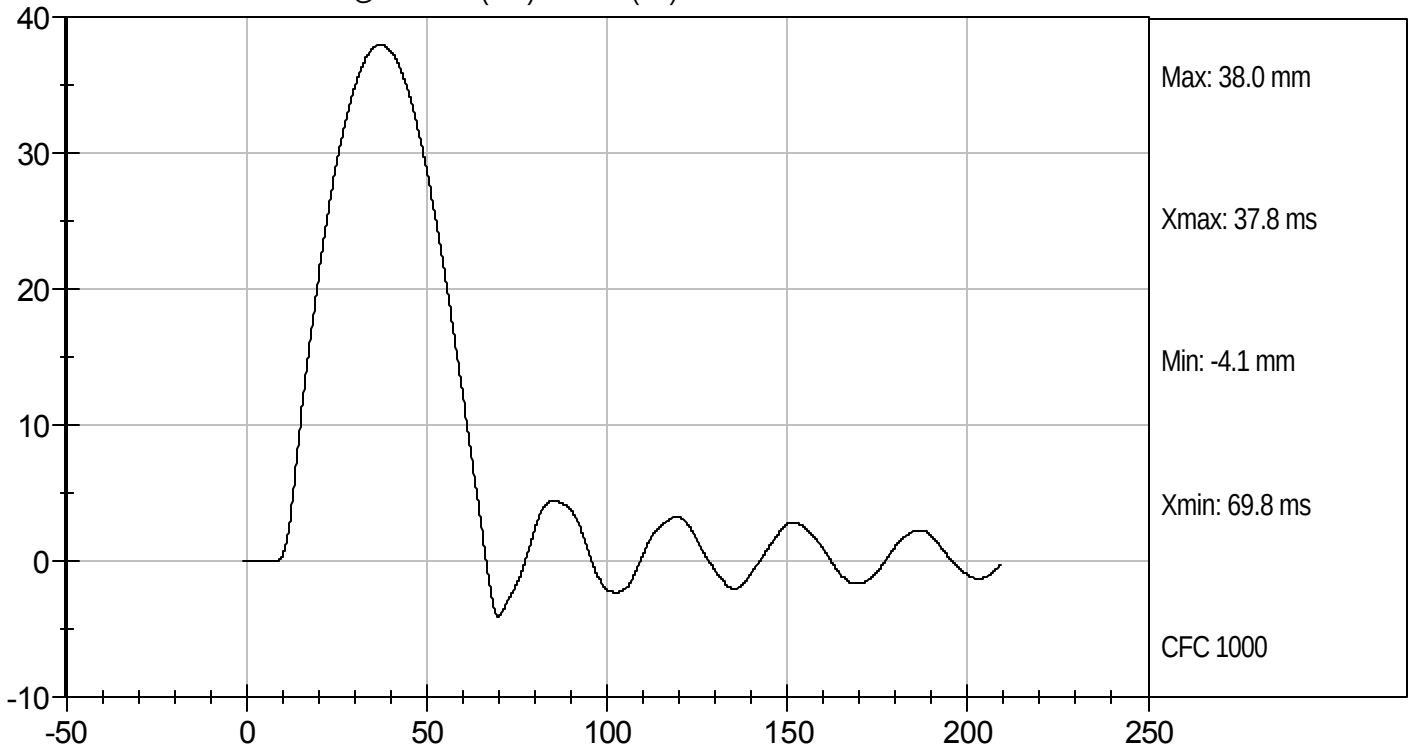
Jessica Gall
Laboratory Technician

3/14/11
Test Date

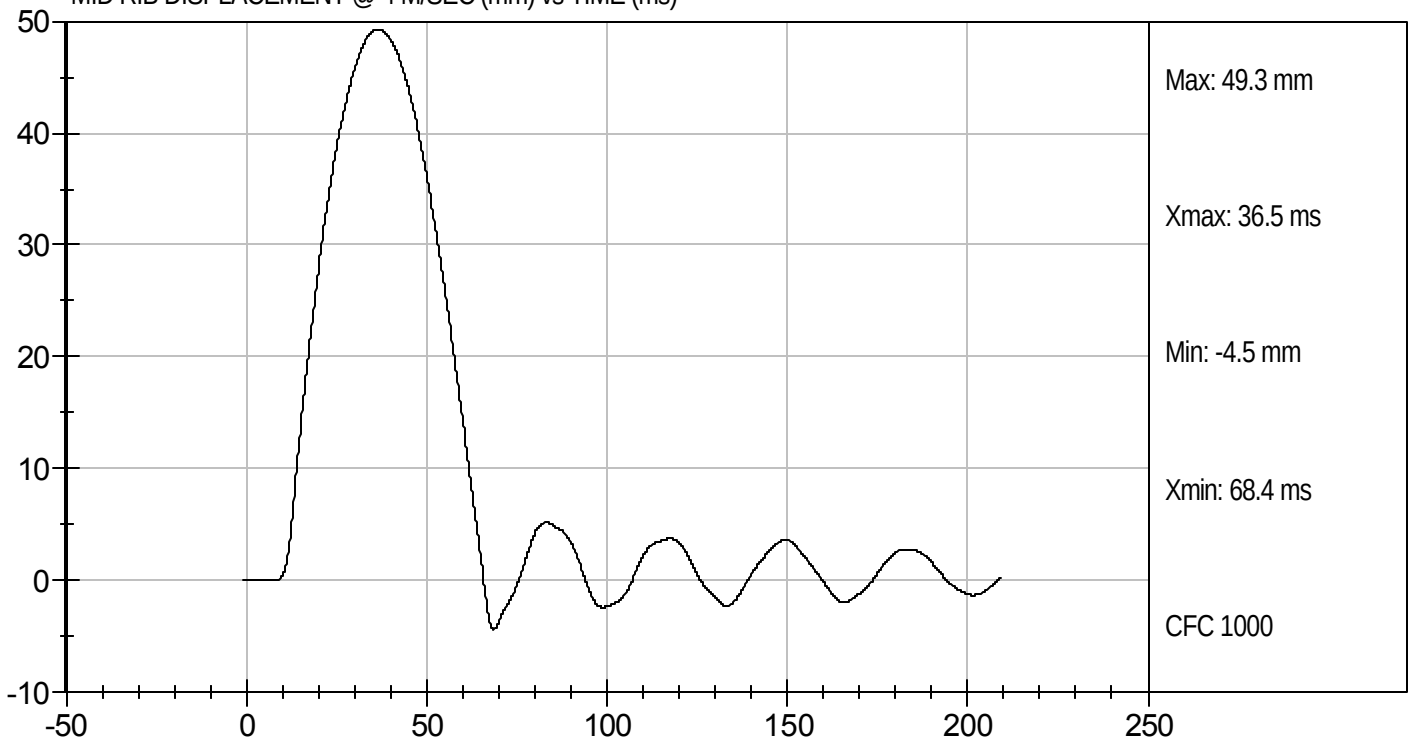
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D11965
Test Date: 3/14/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

LOWER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11966

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.7	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.1	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.5	Pass
		Overall Test Results		Pass

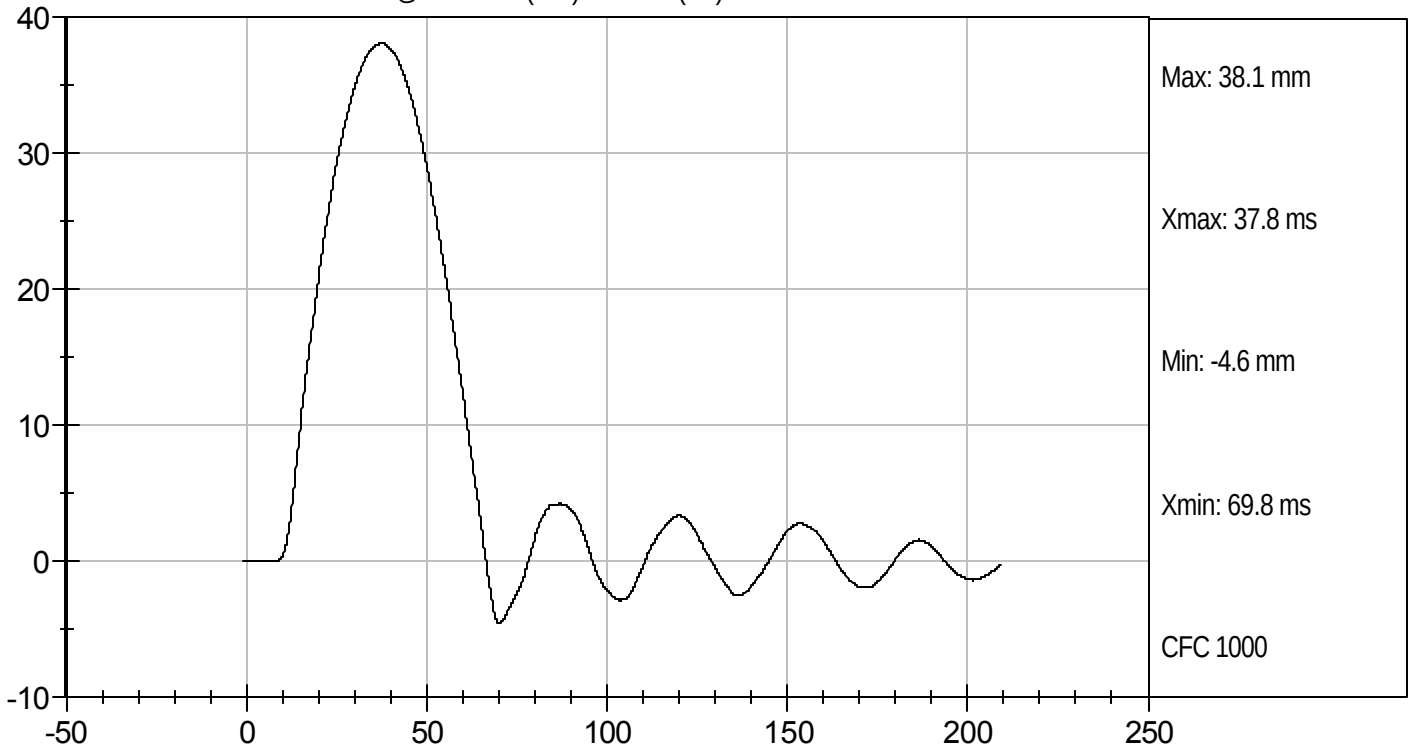
Jessica Gall
Laboratory Technician

3/14/11
Test Date

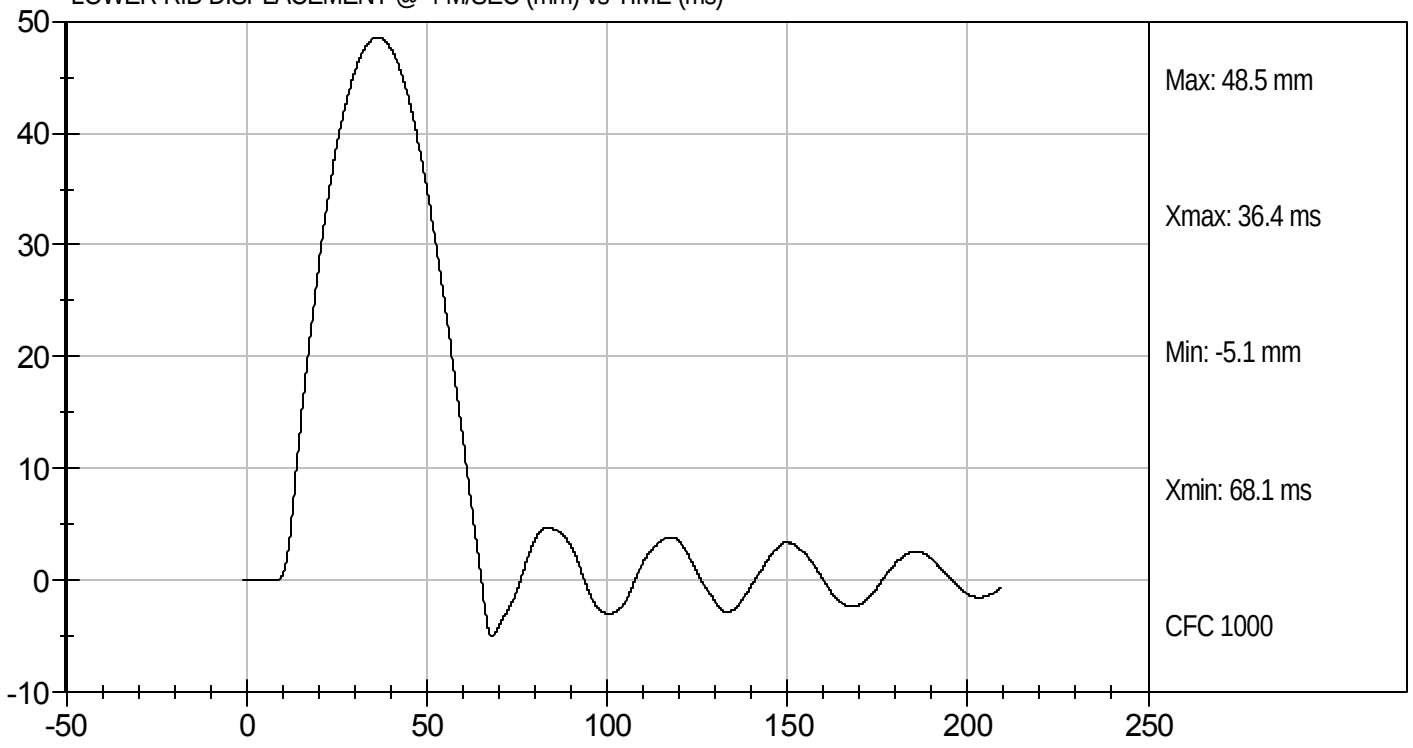
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D11966
Test Date: 3/14/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

ABDOMEN TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11967

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	3.90 to 4.10	4.06	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.30	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	10.70	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.51	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	10.10	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

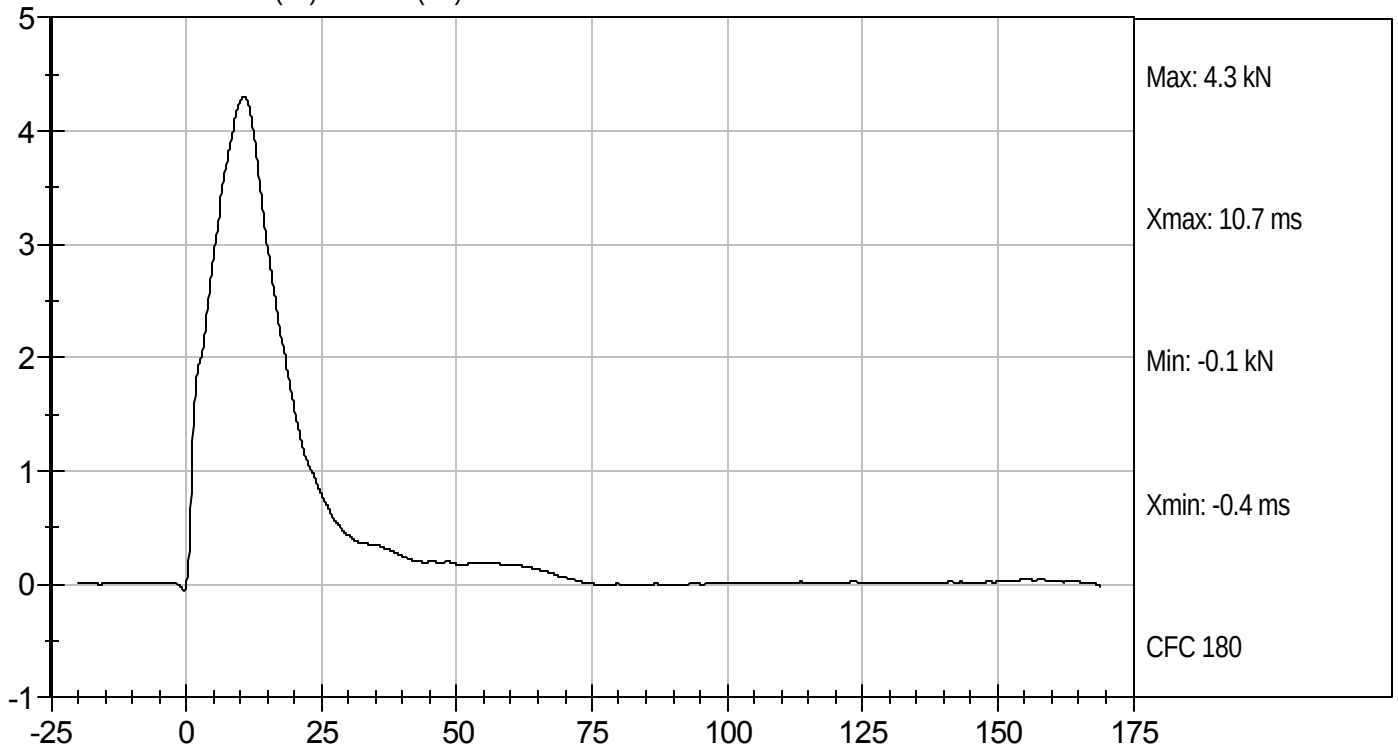
3/15/11
Test Date

David Winkelbauer
Approved By

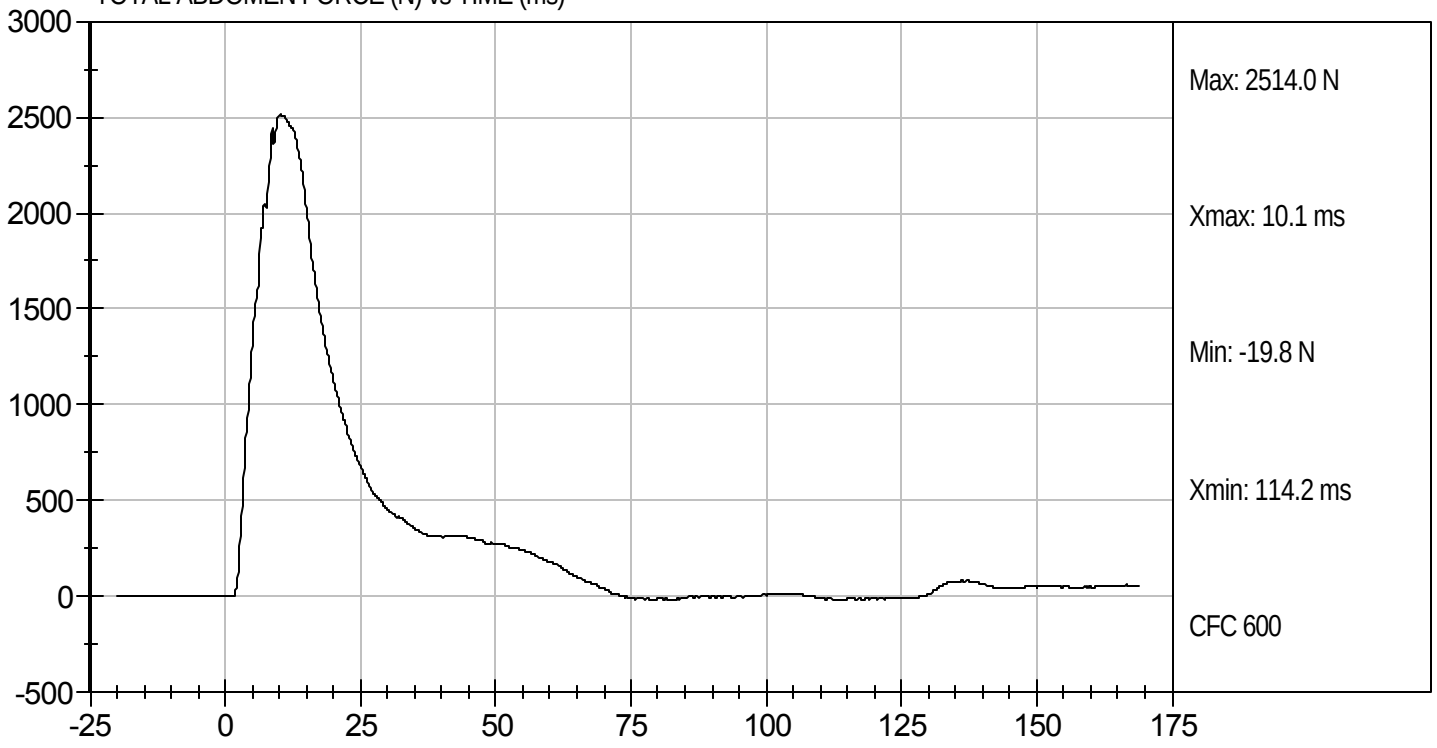
Test Desc: Abdomen Impact
Component ID: D11967

Test Date: 3/15/11
Velocity: 13.33 ft/s, 4.06 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



TOTAL ABDOMEN FORCE (N) vs TIME (ms)



MGA RESEARCH CORPORATION

LUMBAR SPINE TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11968

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	22	Pass
Pendulum Speed		m/s	5.95 to 6.15	6.12	Pass
Pendulum Deceleration	1 ms	m/s	-0.05 to 0.00	-0.03	Pass
	3.7 ms	m/s	-0.425 to -0.24	-0.41	Pass
	27 ms	m/s	-6.50 to -5.80	-5.81	Pass
	30 ms	m/s	>= -6.5	-5.81	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	48.0	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	45.1	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	45	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

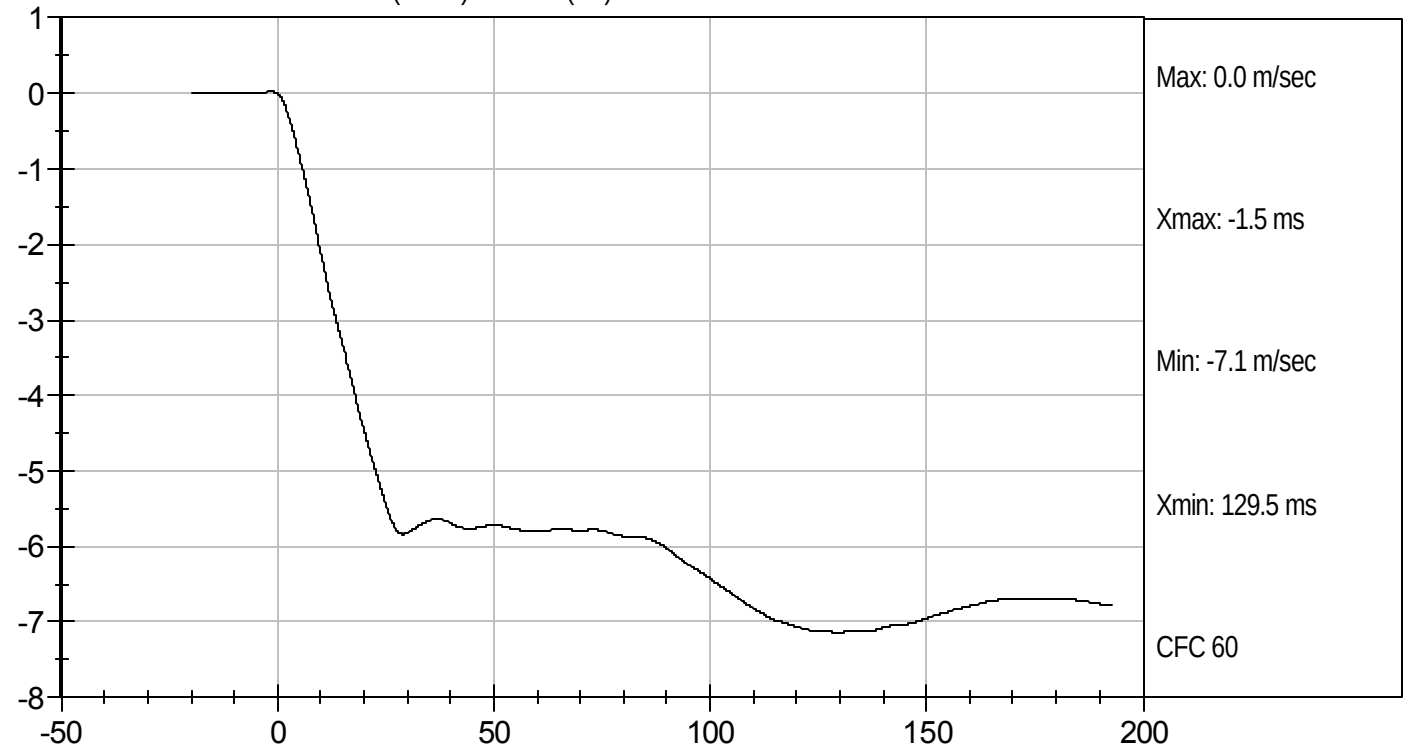
3/14/11
Test Date

David Winkelbauer
Approved By

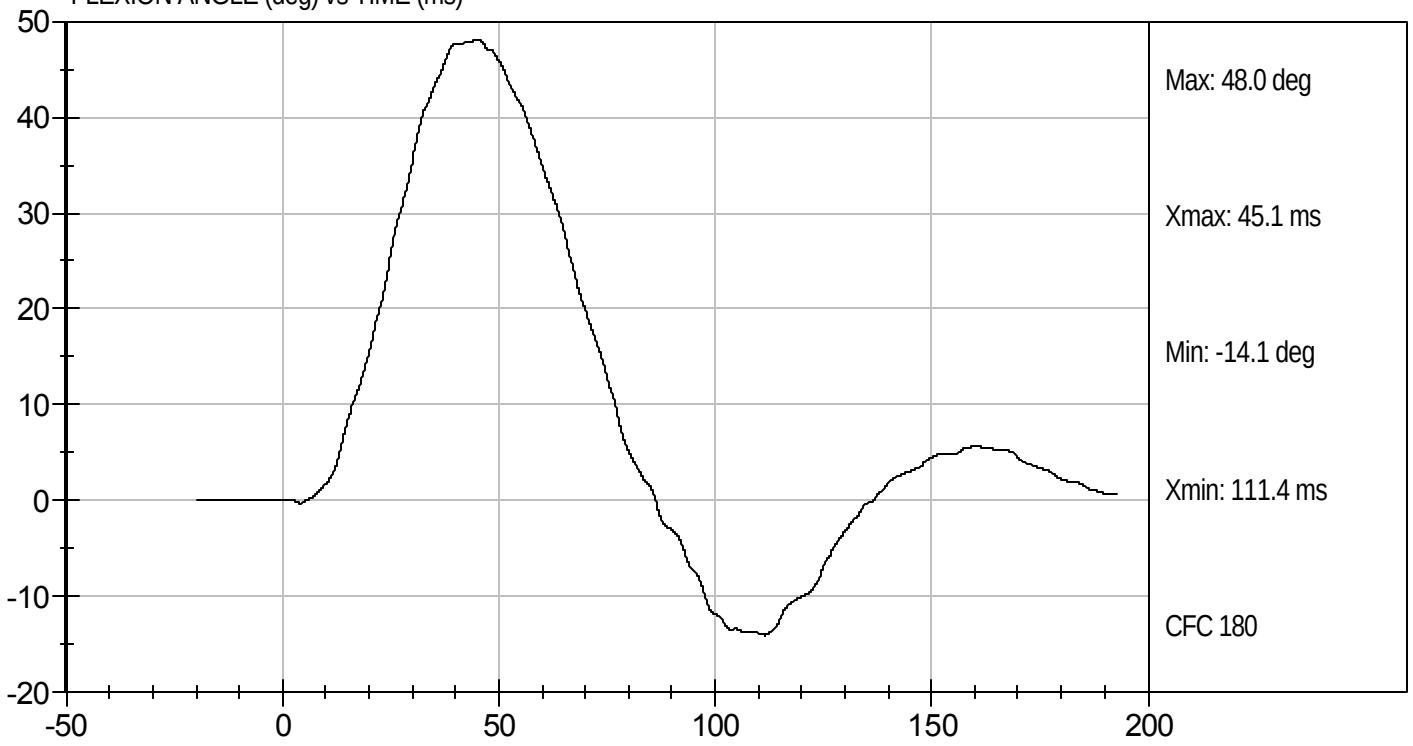
Test Desc: Lumbar Bending
Component ID: D11968

Test Date: 3/14/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

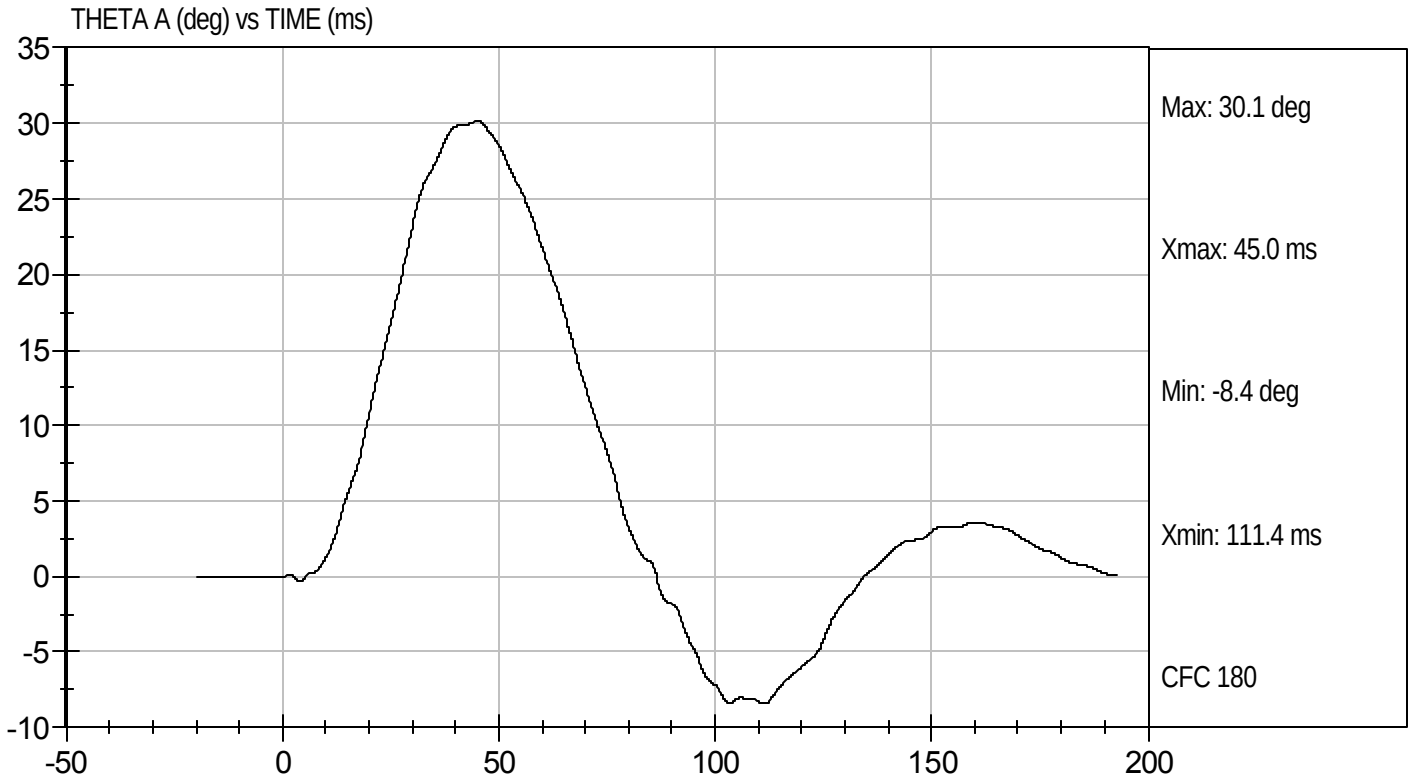


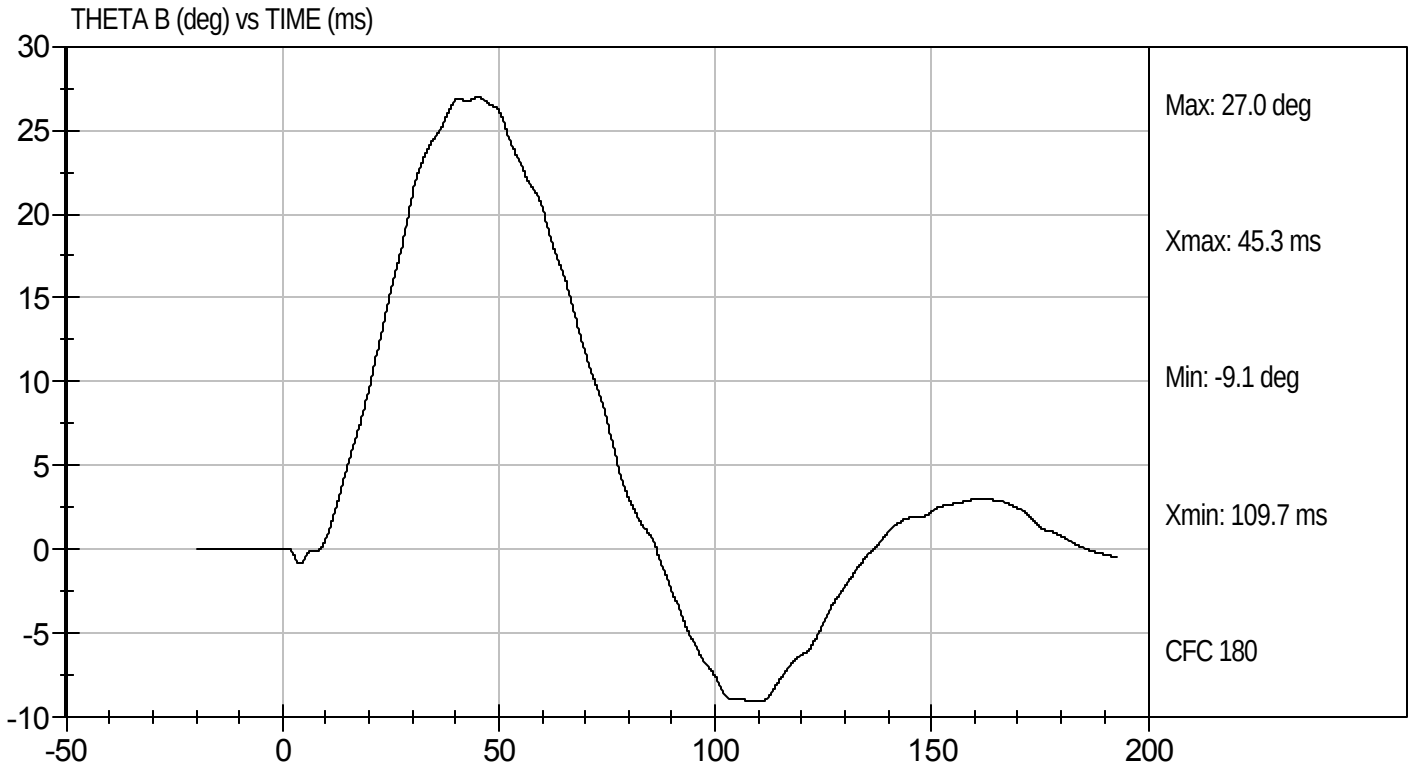
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D11968

Test Date: 3/14/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11969

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.9	Pass
Laboratory Relative Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.74	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	12.90	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.31	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	13.90	Pass
		Overall Test Results		Pass

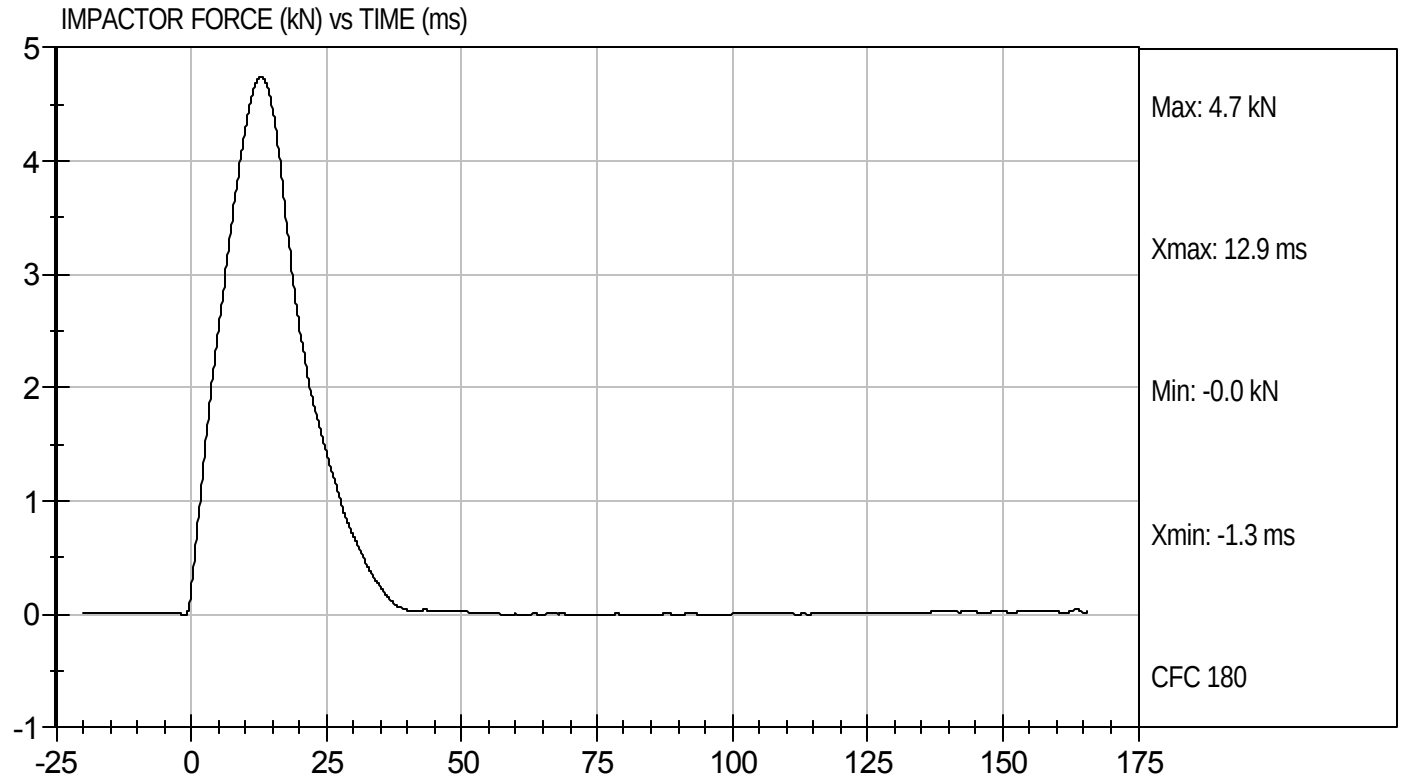
Jessica Gall
Laboratory Technician

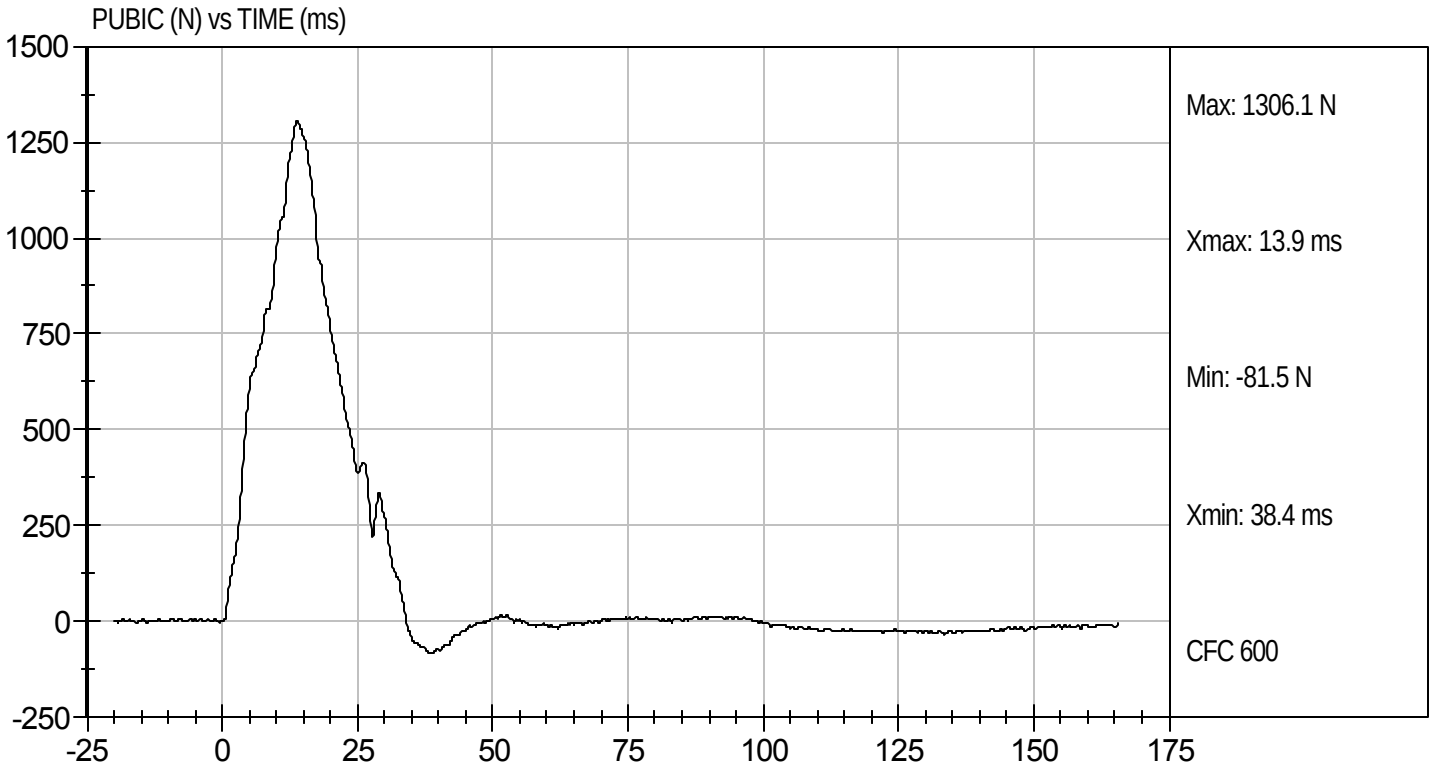
3/15/11
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D11969

Test Date: 3/15/11
Velocity: 14.25 ft/s, 4.34 m/s





MGA RESEARCH CORPORATION

FULL BODY THORAX IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D11960

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	21	Pass
Probe Speed	m/s	5.40 to 5.60	5.58	Pass
Maximum Impactor Force (after 6 ms)	kN	5.10 to 6.20	5.18	Pass
Upper Rib Displacement	mm	34.0 to 41.0	39.6	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.7	Pass
Lower Rib Displacement	mm	37.0 to 44.0	39.8	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

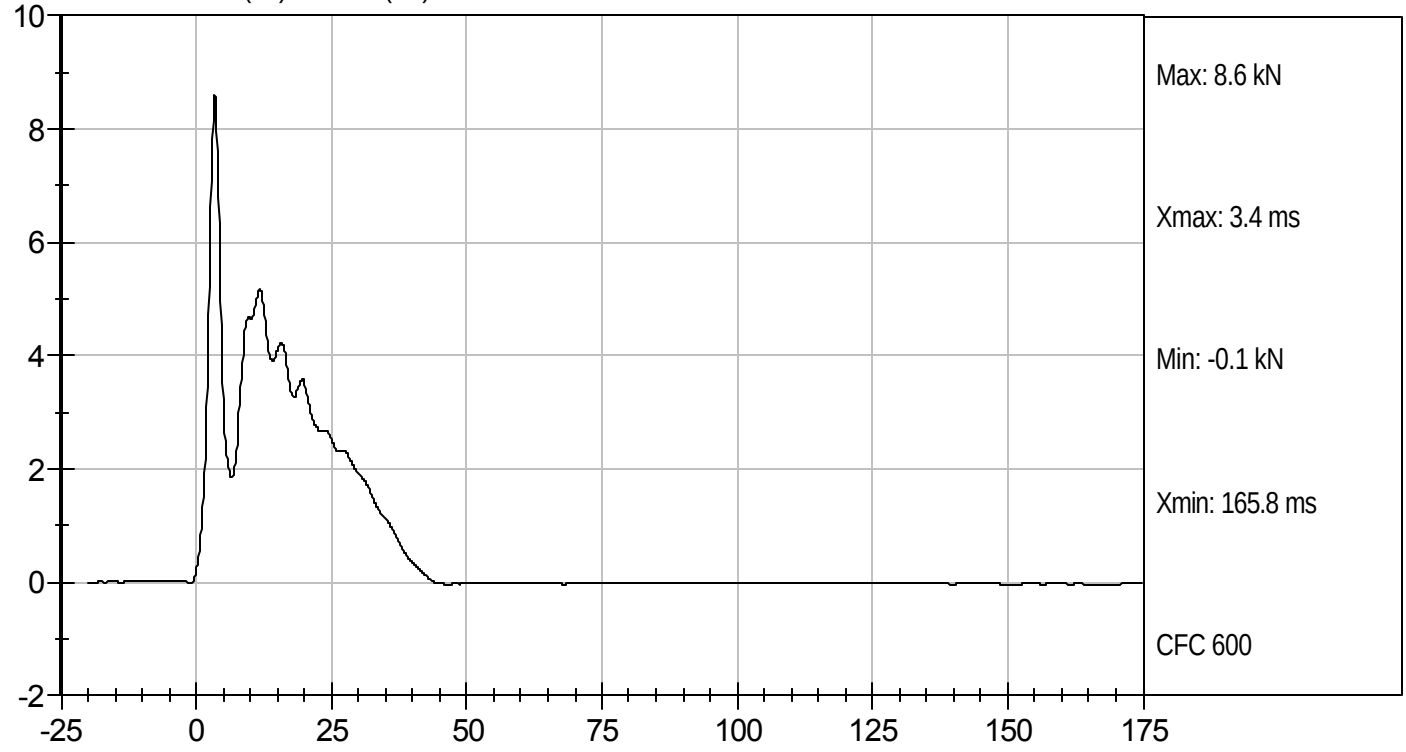
3/15/11
Test Date

David Winkelbauer
Approved By

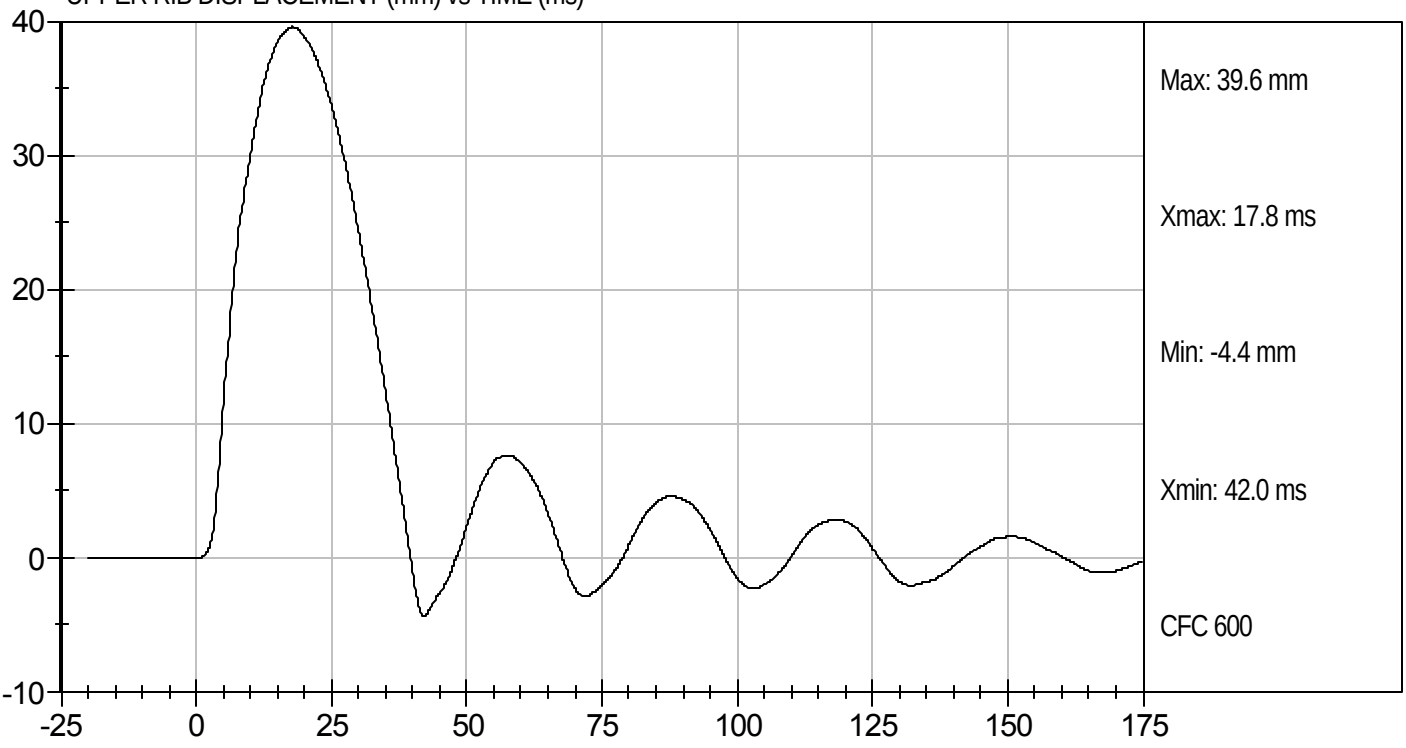
Test Desc: Thorax Impact
Component ID: D11960

Test Date: 3/15/11
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



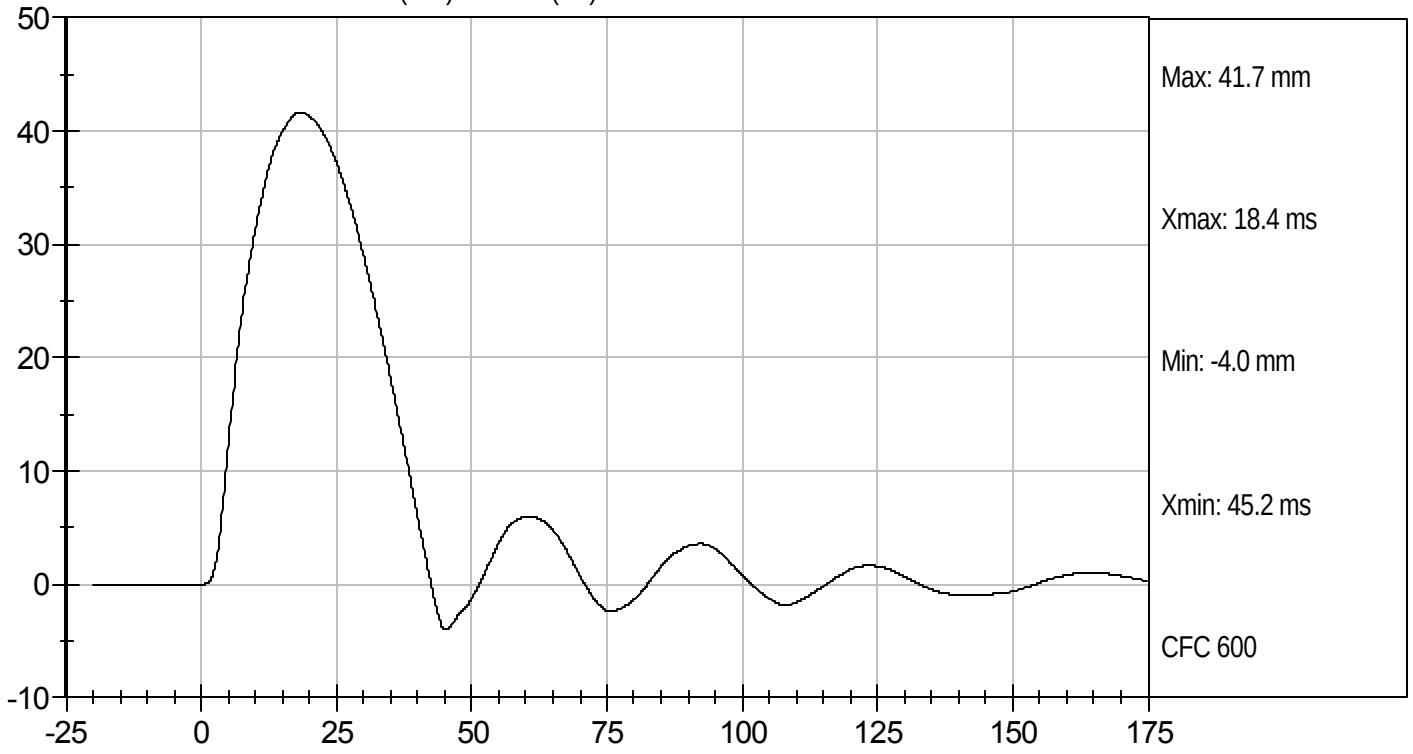
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



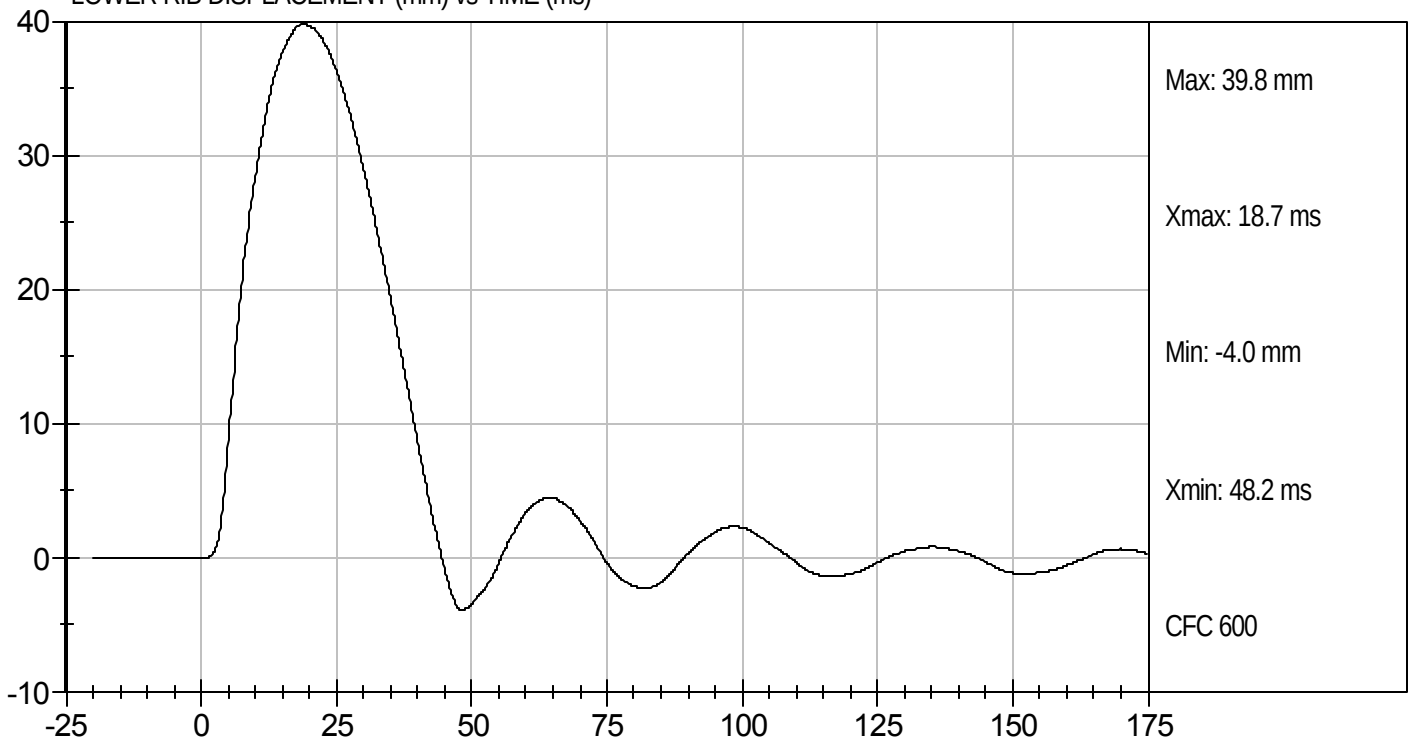
Test Desc: Thorax Impact
Component ID: D11960

Test Date: 3/15/11
Velocity: 18.32 ft/s, 5.58 m/s

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

HEAD DROP TEST

ES-2re DUMMY

ATD Serial No: 016 **Test ID:** D111001

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Peak Resultant Acceleration	G's	125 to 155	144	Pass
Peak Lateral Acceleration	G's	+/- 15	-8.5	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

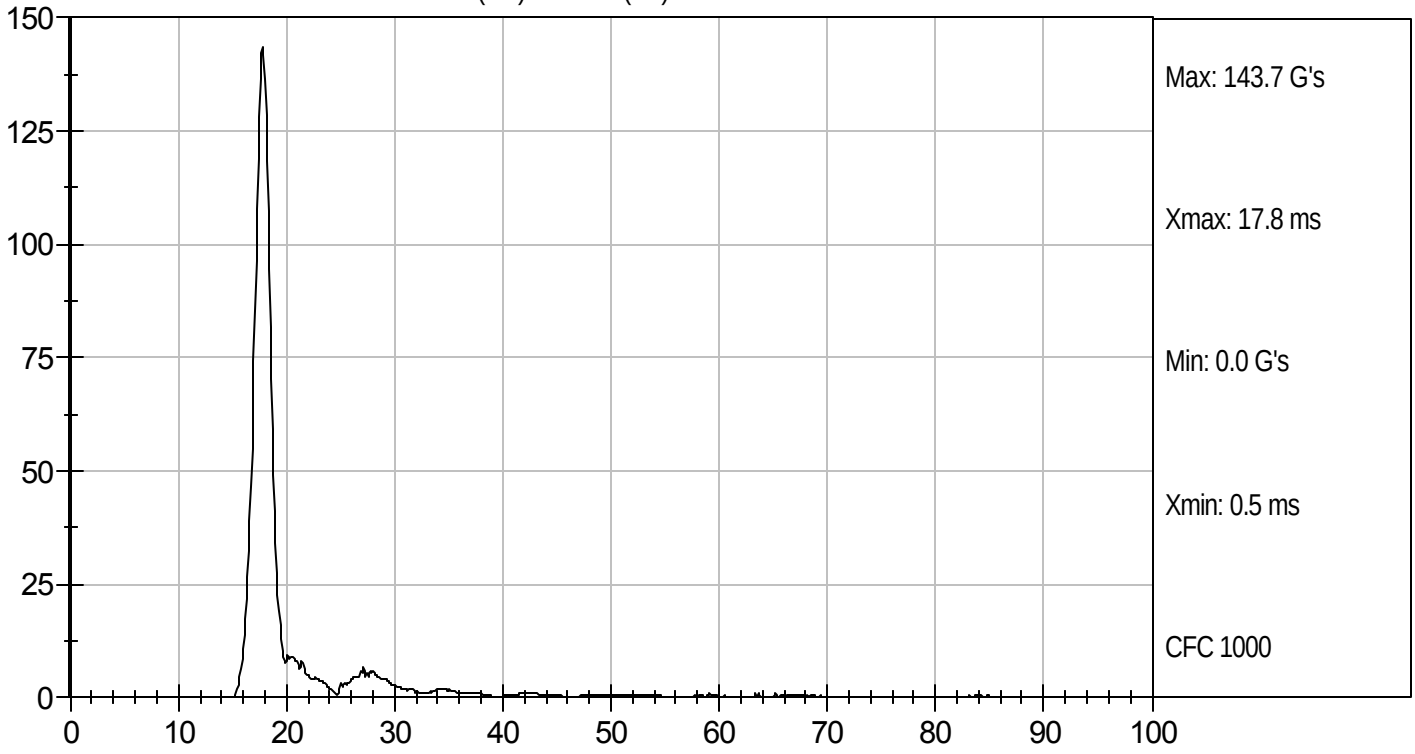
3/16/11
Test Date

David Winkelbauer
Approved By

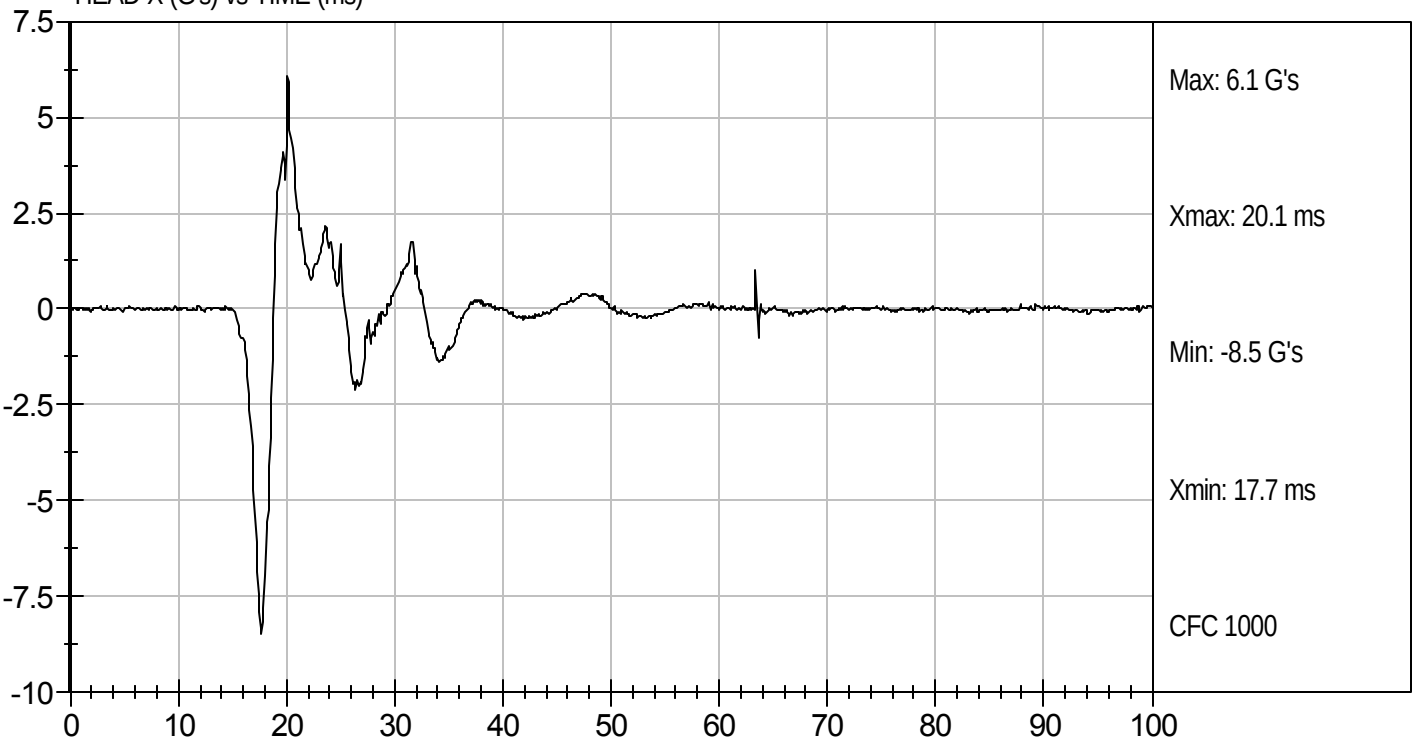
Test Desc: Head Drop
Component ID: D111001

Test Date: 3/16/11
Velocity: 0 ft/s, 0 m/s

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



HEAD X (G's) vs TIME (ms)



MGA RESEARCH CORPORATION

NECK PENDULUM TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111002

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	22.0	Pass
Laboratory Relative Humidity		%	10 to 70	26	Pass
Pendulum Speed		m/s	3.3 to 3.5	3.5	Pass
Pendulum Deceleration	1 ms	m/s	0.00 to -0.05	-0.01	Pass
	3 ms	m/s	-0.25 to -0.375	-0.29	Pass
	14 ms	m/s	-3.20 to -3.70	-3.42	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	51.1	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	54.9	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	55.3	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

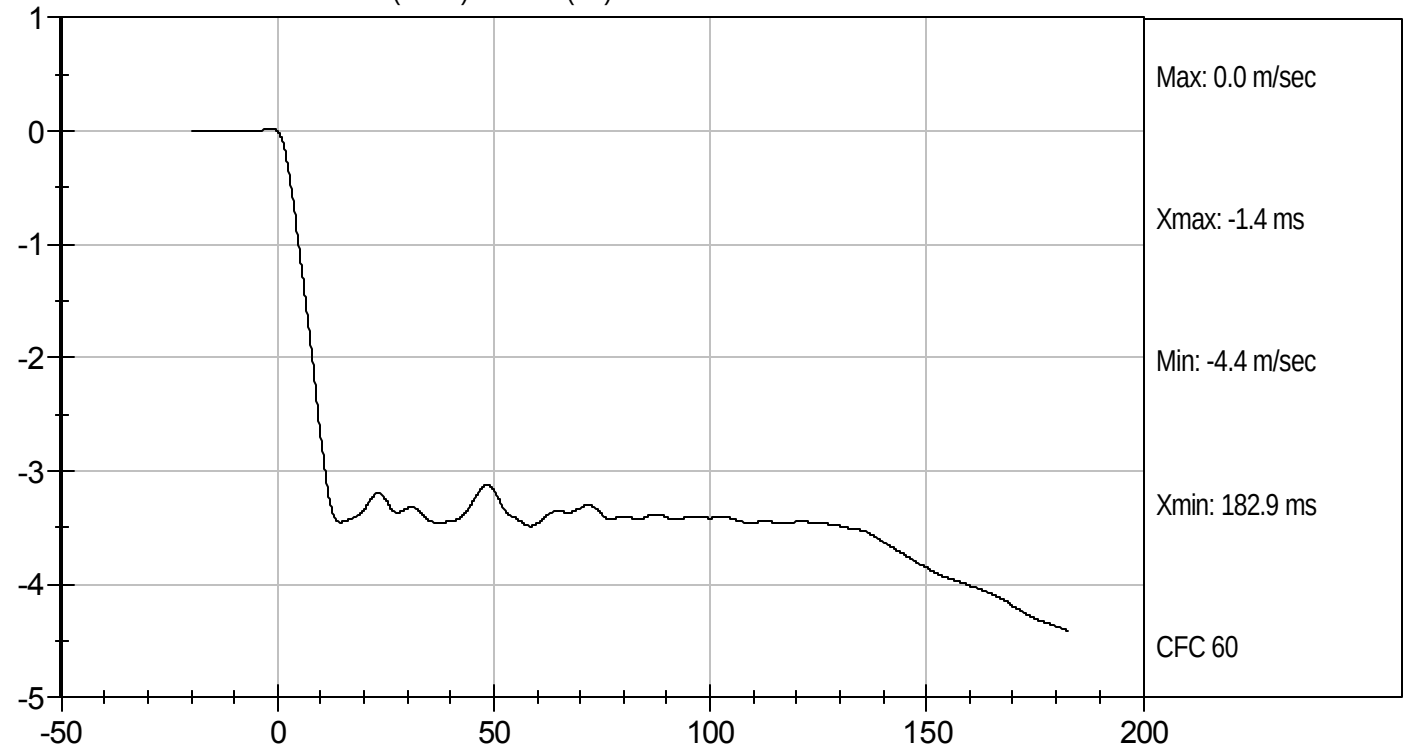
3/16/11
Test Date

David Winkelbauer
Approved By

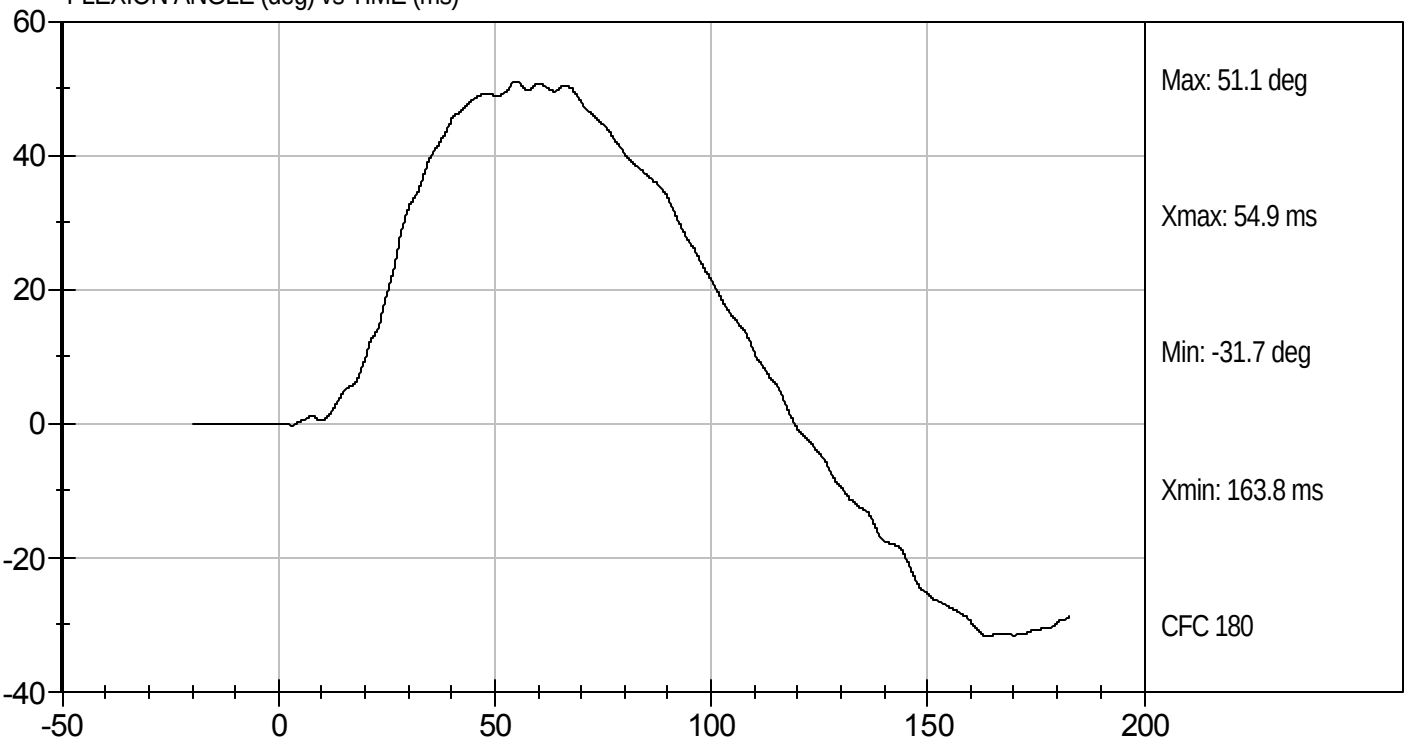
Test Desc: Neck Bending
Component ID: D111002

Test Date: 3/16/11
Velocity: 11.42 ft/s, 3.48 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

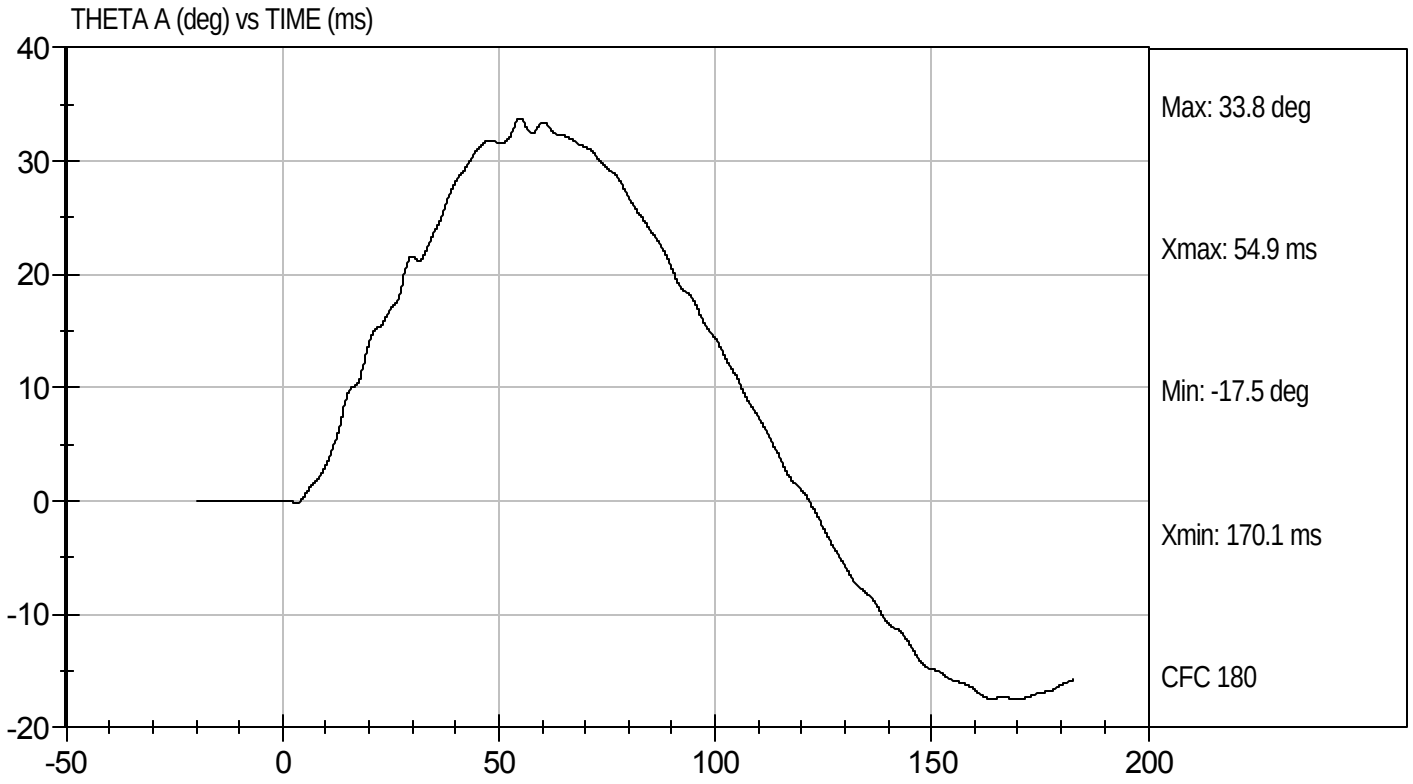


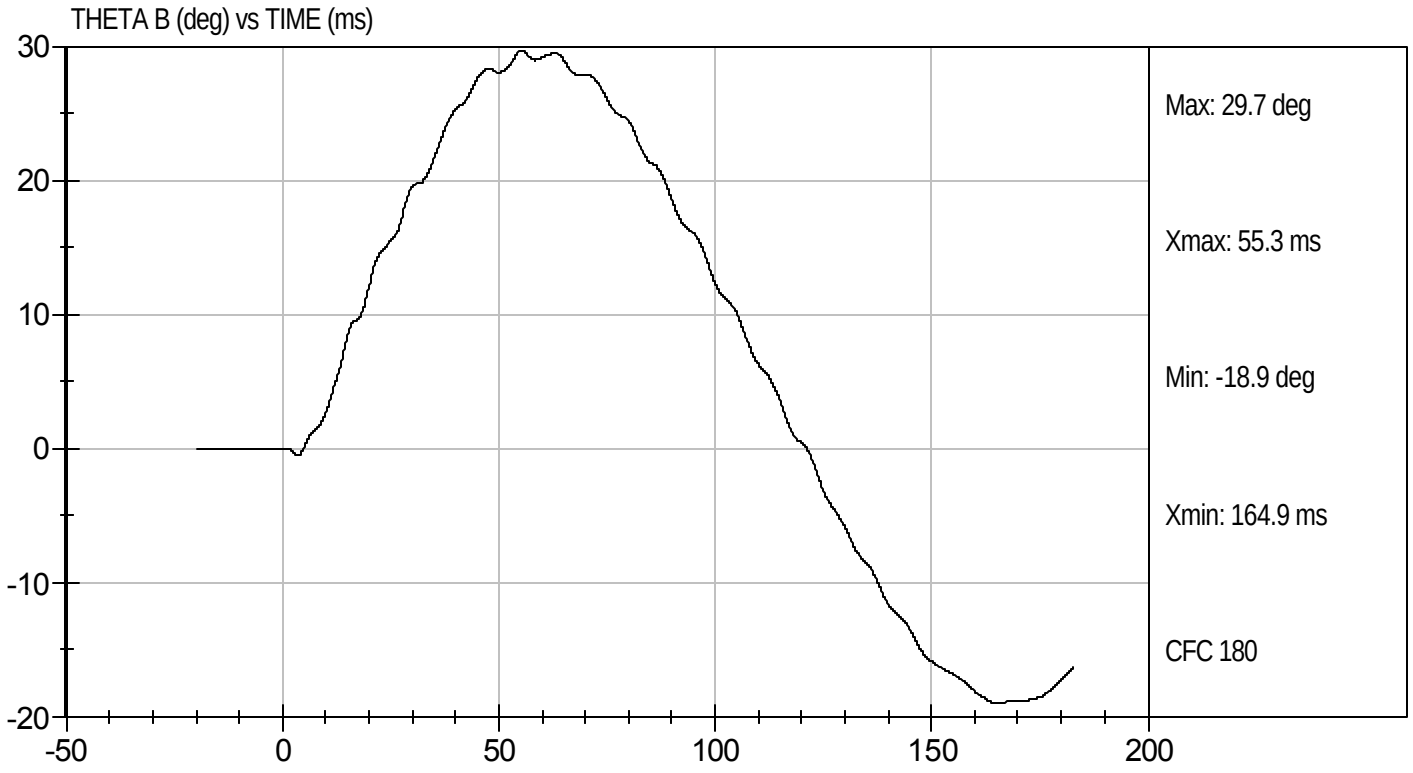
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111002

Test Date: 3/16/11
Velocity: 11.42 ft/s, 3.48 m/s





MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111003

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.4	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	9.5	Pass
Time of Peak Shoulder Acceleration	ms	NA	17.7	Pass
		Overall Test Results		Pass

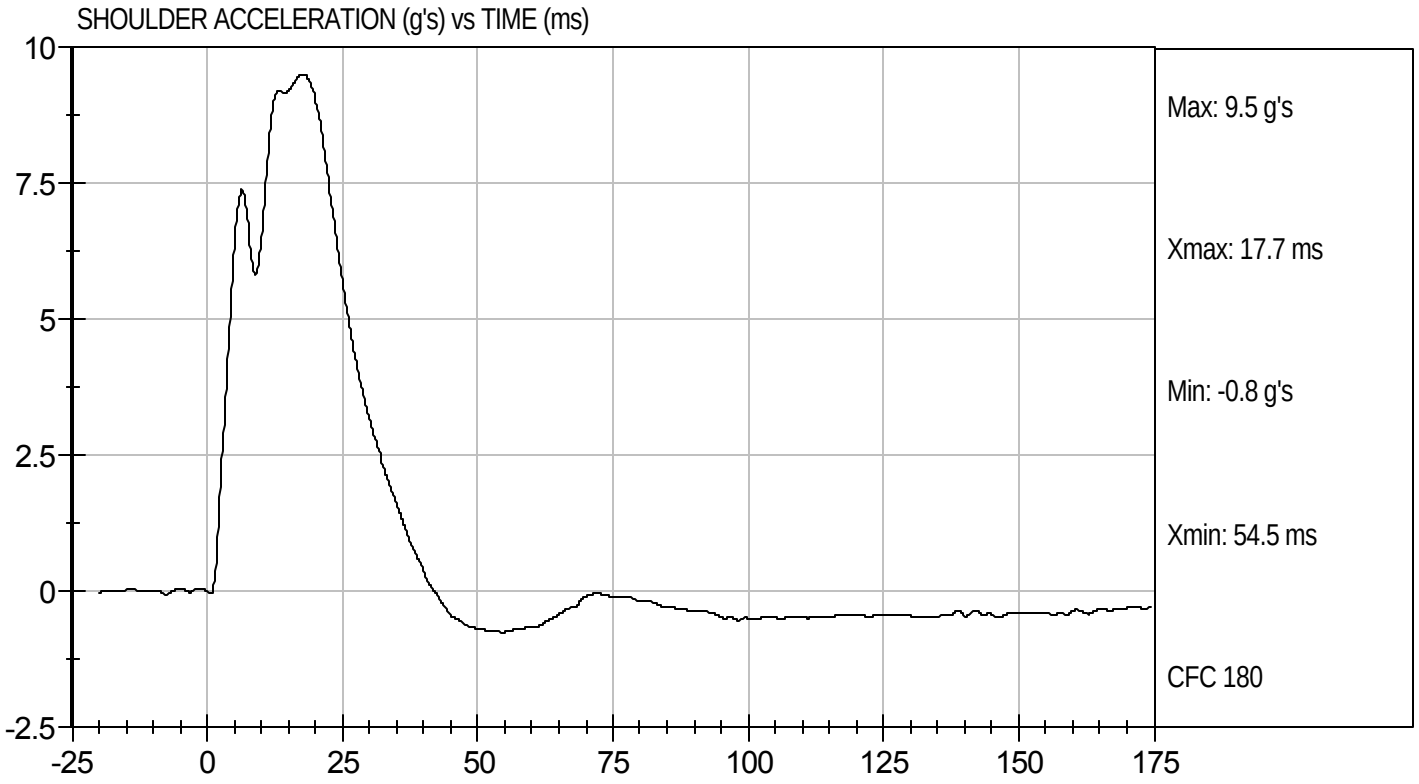
Jessica Gall
Laboratory Technician

3/16/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111003

Test Date: 3/16/11
Velocity: 14.36 ft/s, 4.4 m/s



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111004

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.9	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.1	Pass
		Overall Test Results		Pass

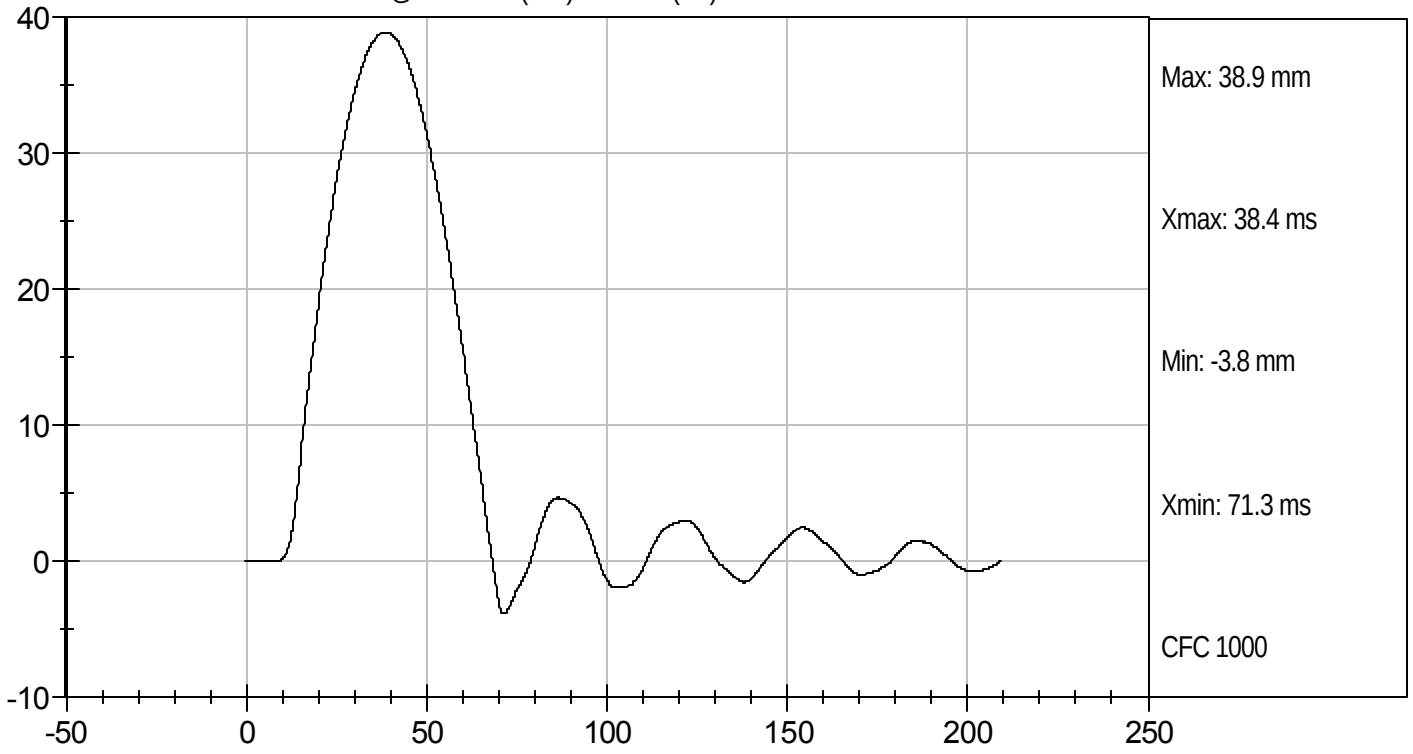
Jessica Gall
Laboratory Technician

3/16/11
Test Date

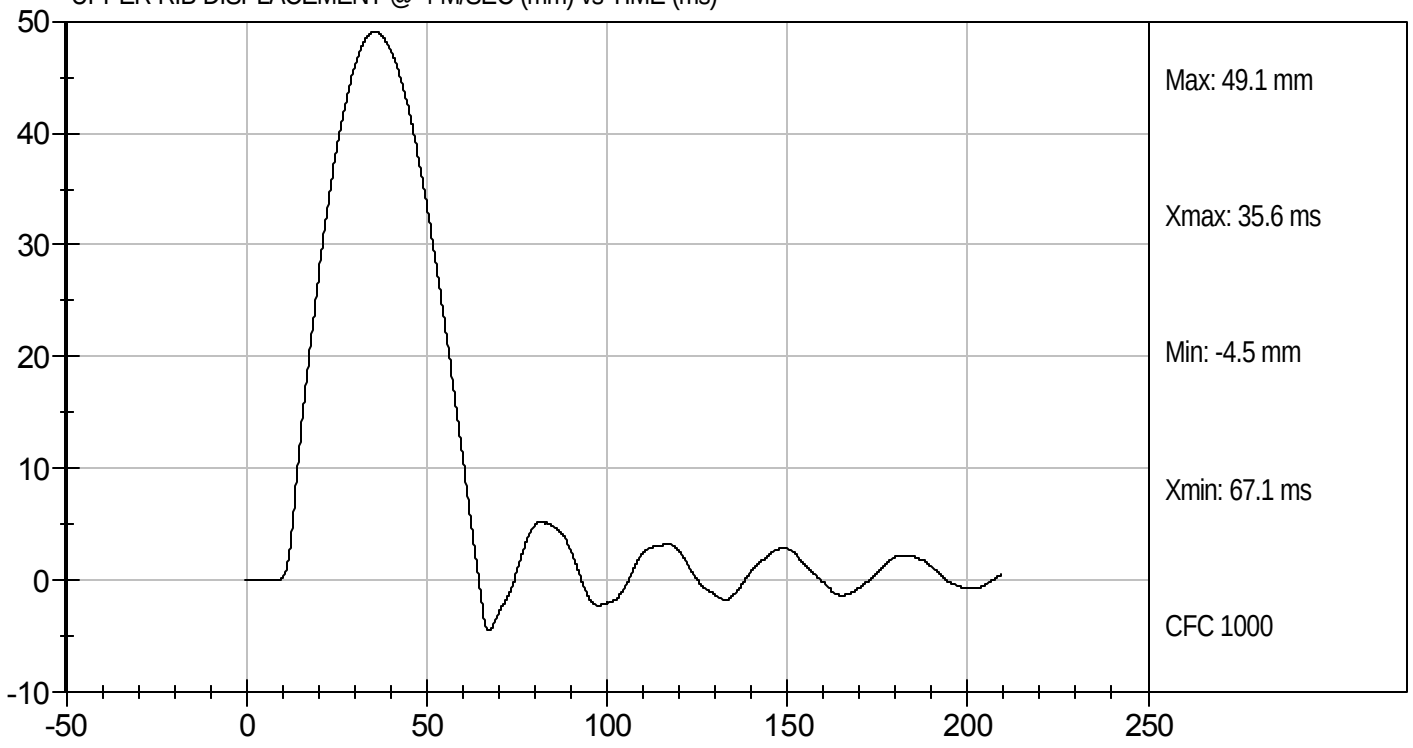
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111004
Test Date: 3/16/11

UPPER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



UPPER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

MID RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111005

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.6	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.4	Pass
		Overall Test Results		Pass

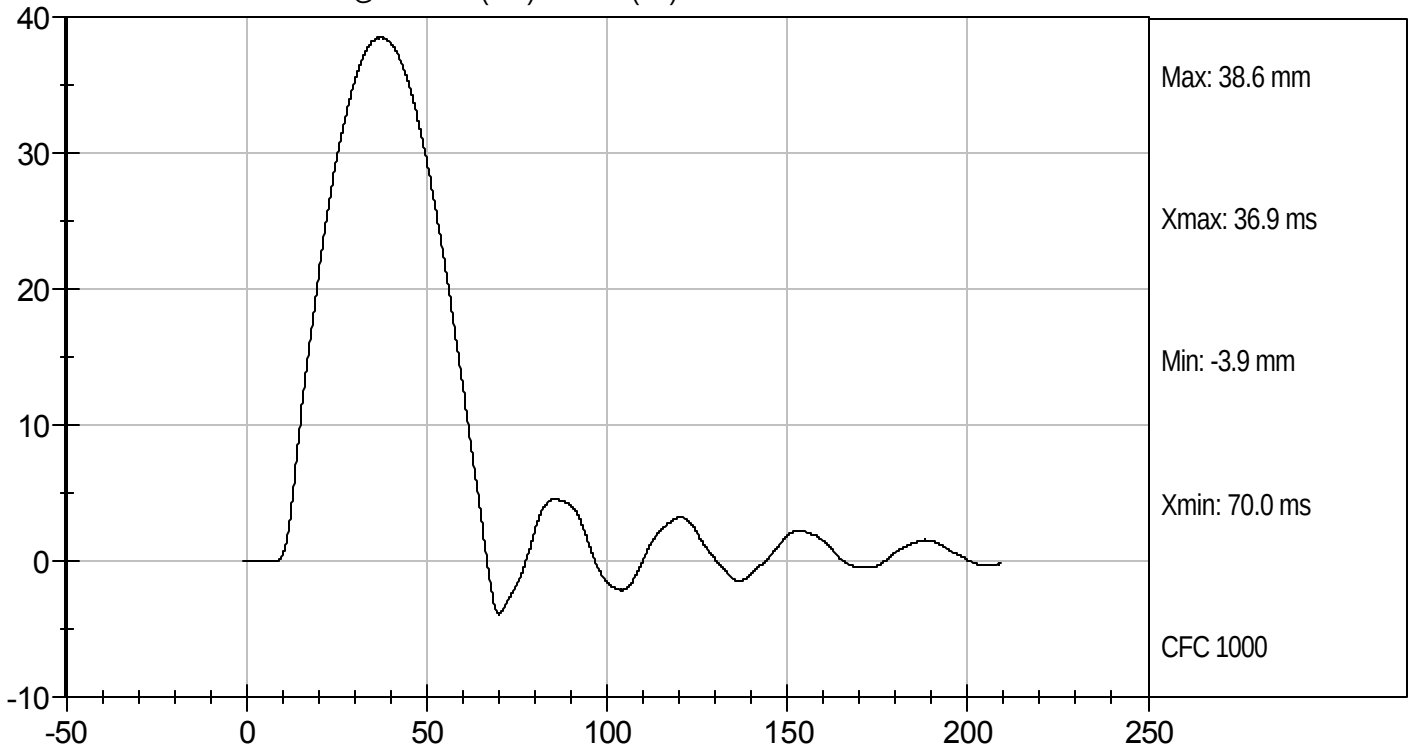
Jessica Gall
Laboratory Technician

3/16/11
Test Date

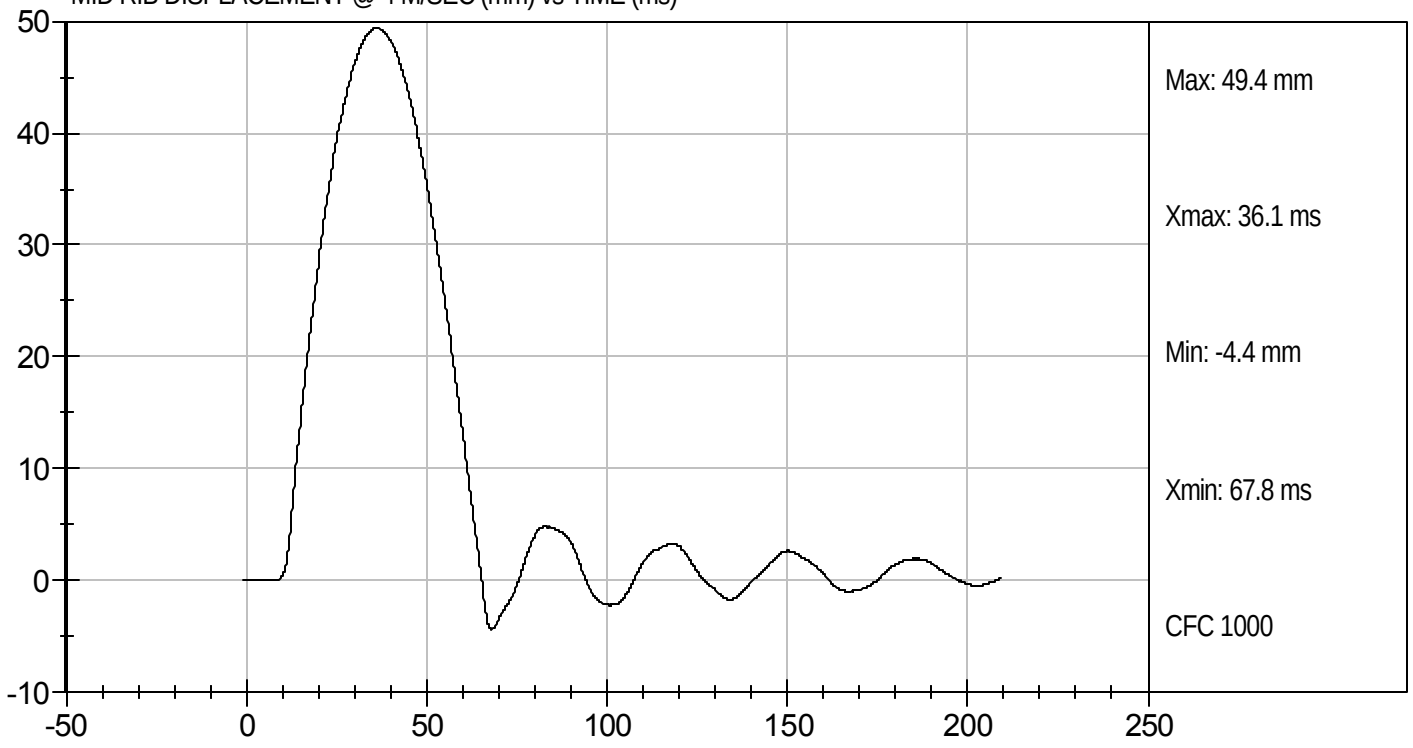
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111005
Test Date: 3/16/11

MID RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



MID RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

LOWER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111006

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.1	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	37.9	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.6	Pass
		Overall Test Results		Pass

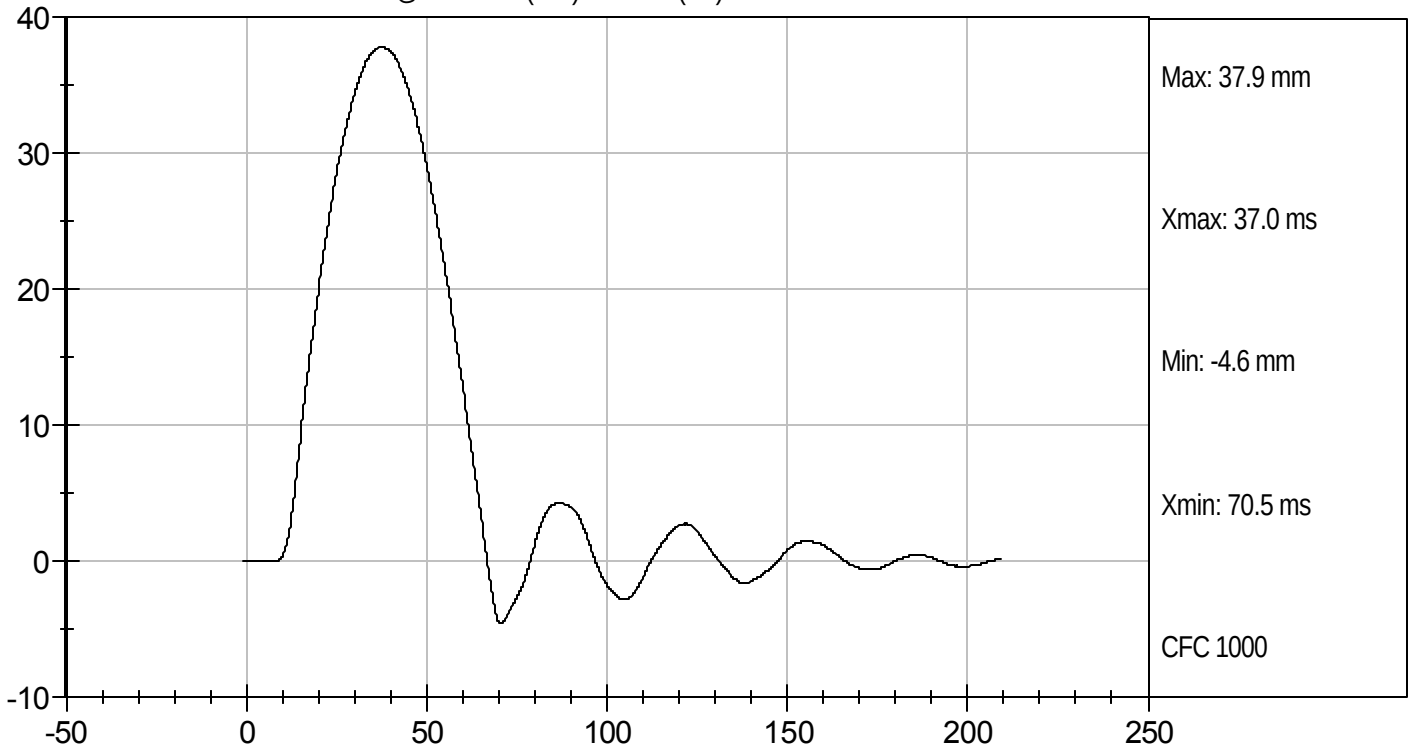
Jessica Gall
Laboratory Technician

3/16/11
Test Date

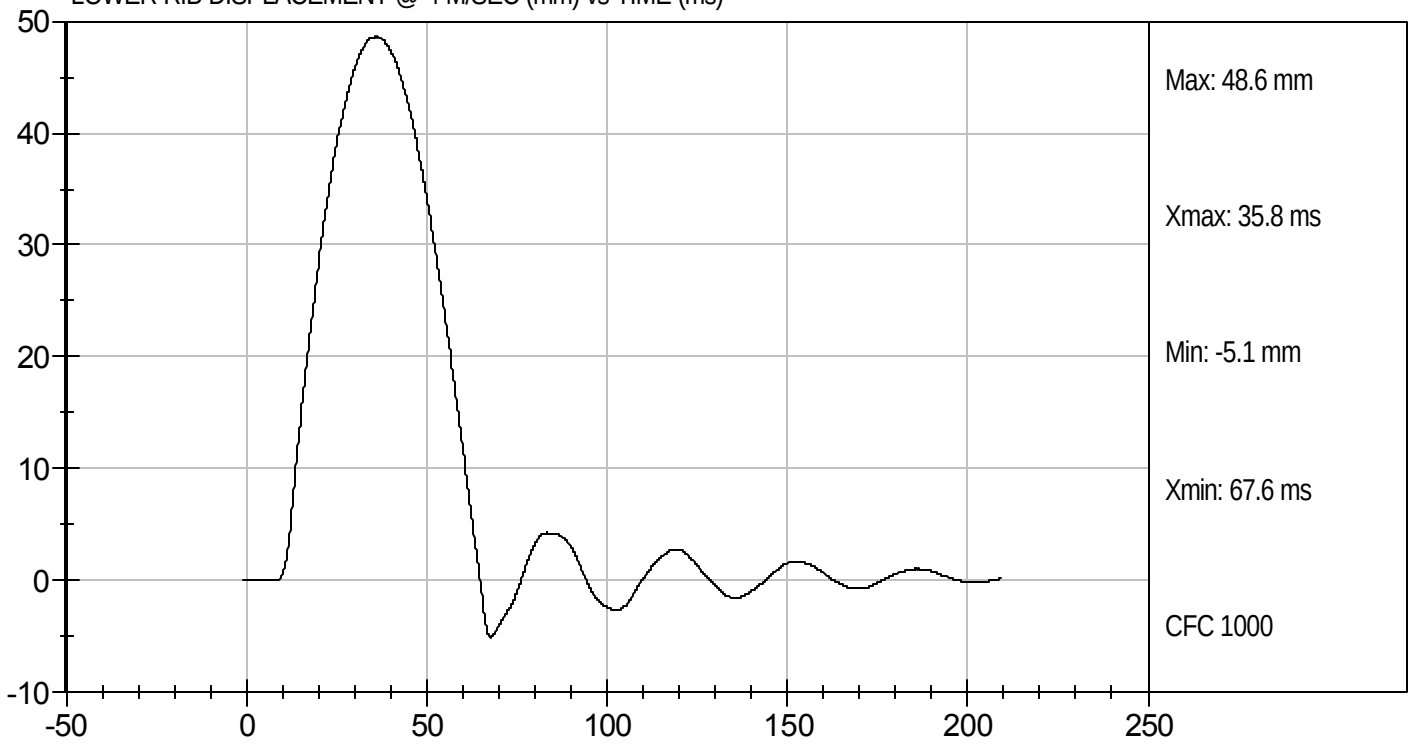
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111006
Test Date: 3/16/11

LOWER RIB DISPLACEMENT @ 3 M/SEC (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT @ 4 M/SEC (mm) vs TIME (ms)



MGA RESEARCH CORPORATION

ABDOMEN TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111007

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.6	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Speed	m/s	3.90 to 4.10	4.10	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.19	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	11.20	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.42	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	11.10	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

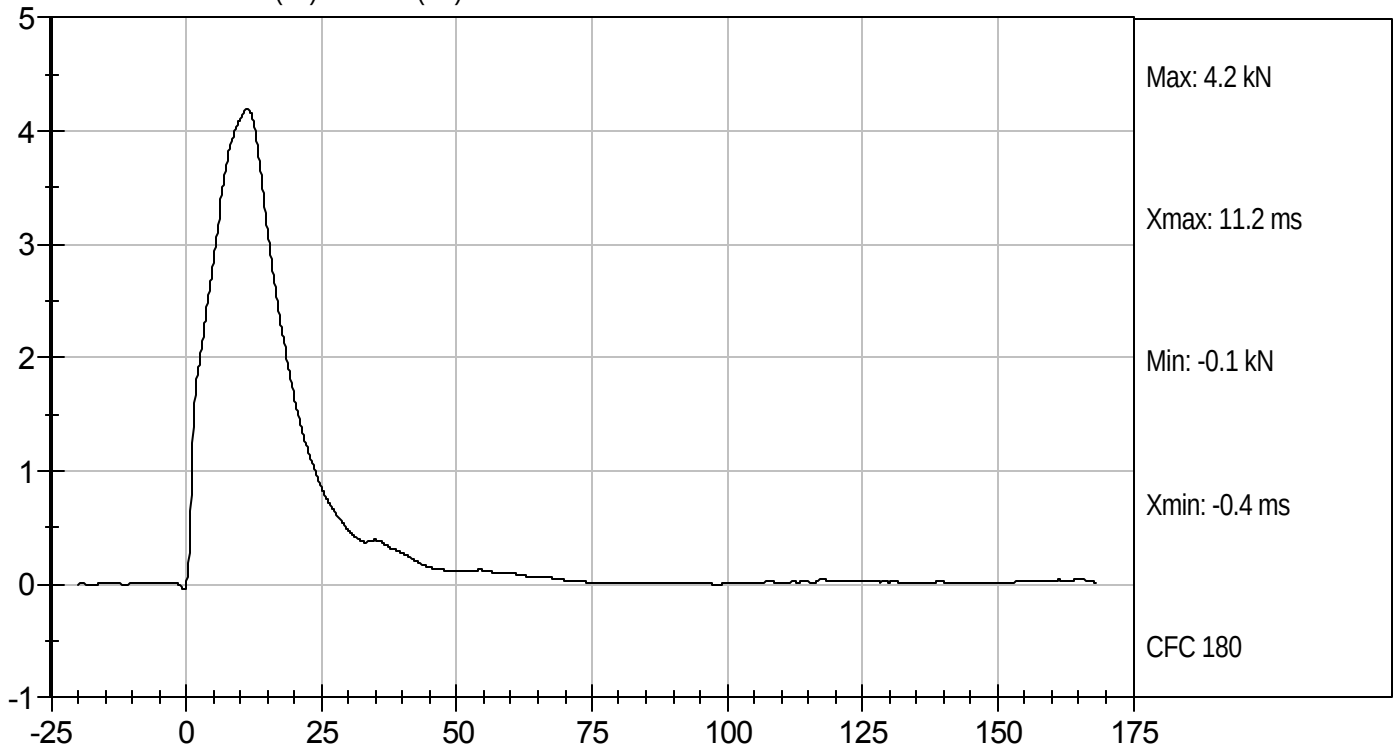
3/16/11
Test Date

David Winkelbauer
Approved By

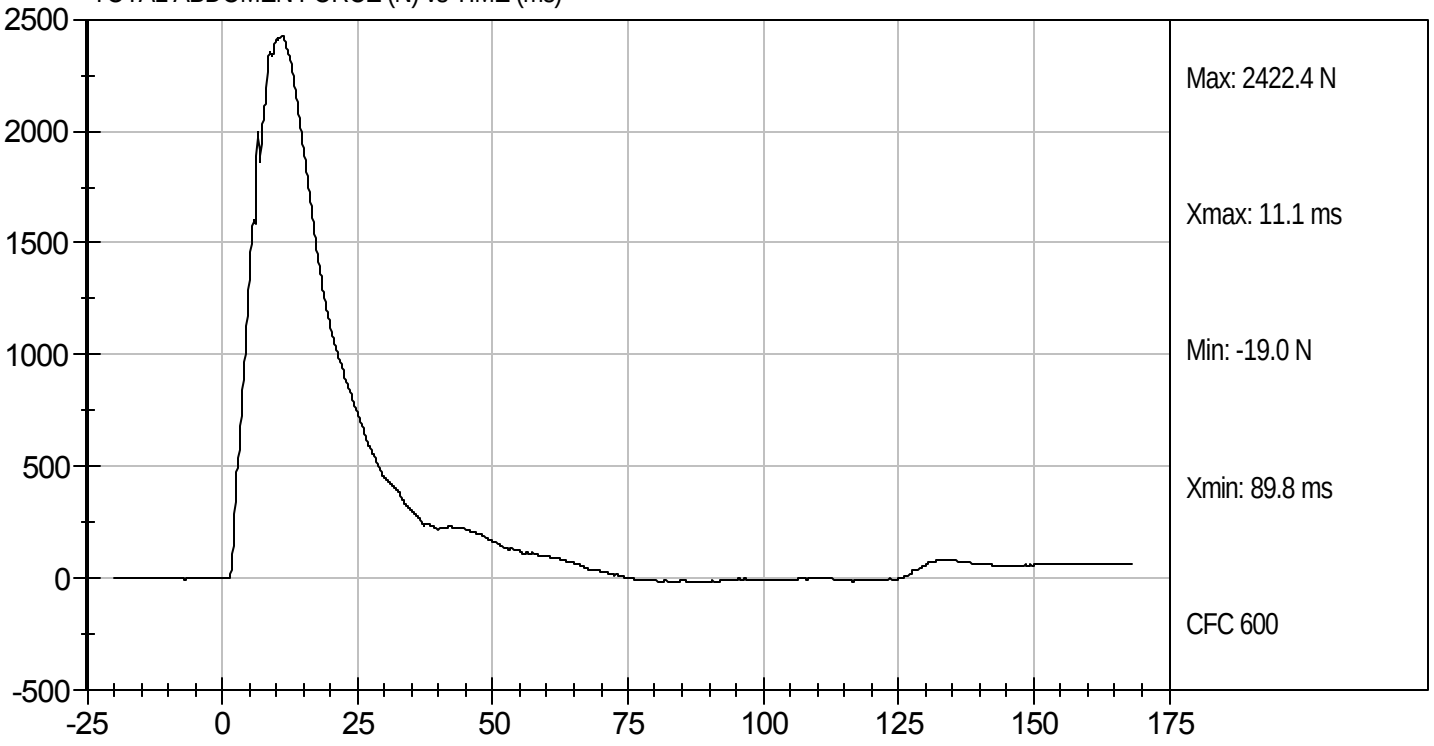
Test Desc: Abdomen Impact
Component ID: D111007

Test Date: 3/16/11
Velocity: 13.44 ft/s, 4.1 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



TOTAL ABDOMEN FORCE (N) vs TIME (ms)



MGA RESEARCH CORPORATION

LUMBAR SPINE TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111008

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity		%	10 to 70	26	Pass
Pendulum Speed		m/s	5.95 to 6.15	6.12	Pass
Pendulum Deceleration	1 ms	m/s	-0.05 to 0.00	-0.01	Pass
	3.7 ms	m/s	-0.425 to -0.24	-0.41	Pass
	27 ms	m/s	-6.50 to -5.80	-5.89	Pass
	30 ms	m/s	>= -6.5	-5.88	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	47.3	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	42.5	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	43	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

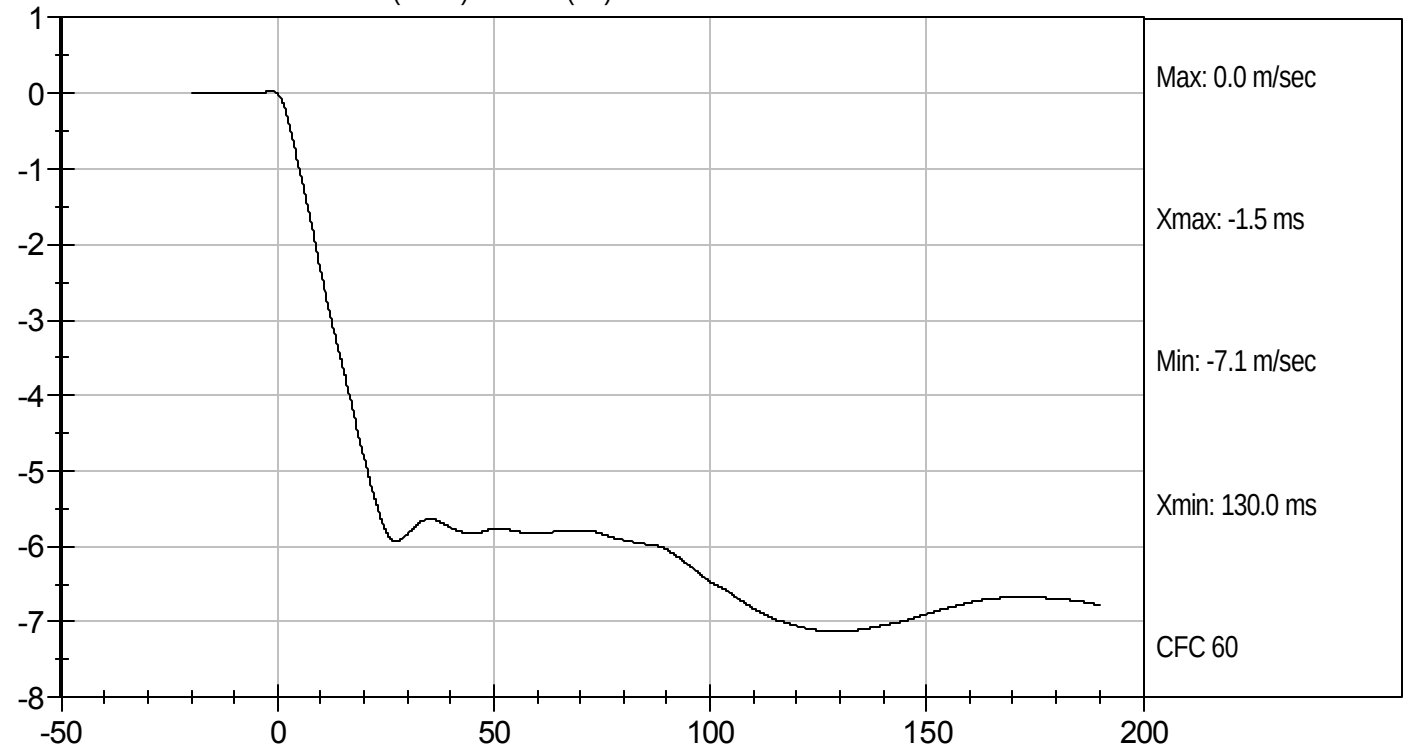
3/16/11
Test Date

David Winkelbauer
Approved By

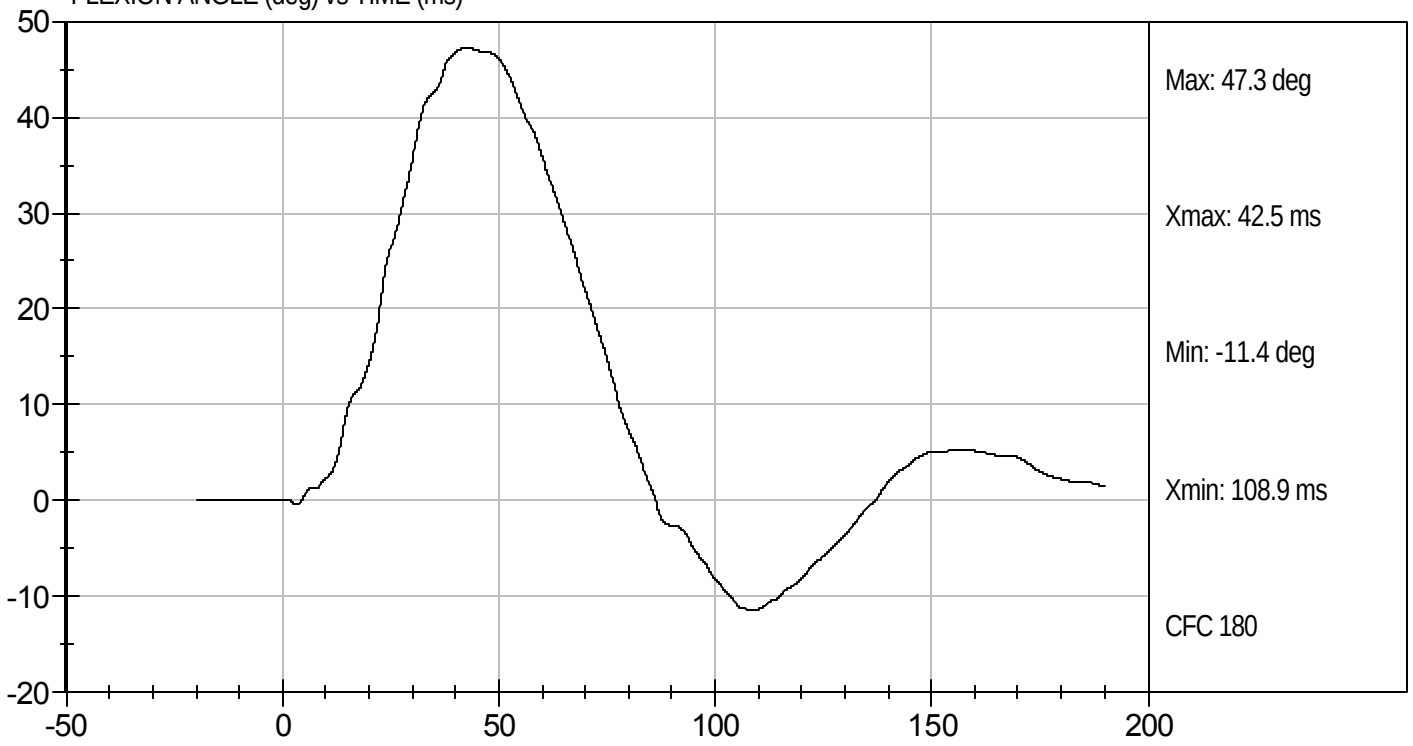
Test Desc: Lumbar Bending
Component ID: D111008

Test Date: 3/16/11
Velocity: 20.08 ft/s, 6.12 m/s

PENDULUM DECELERATION (m/sec) vs TIME (ms)

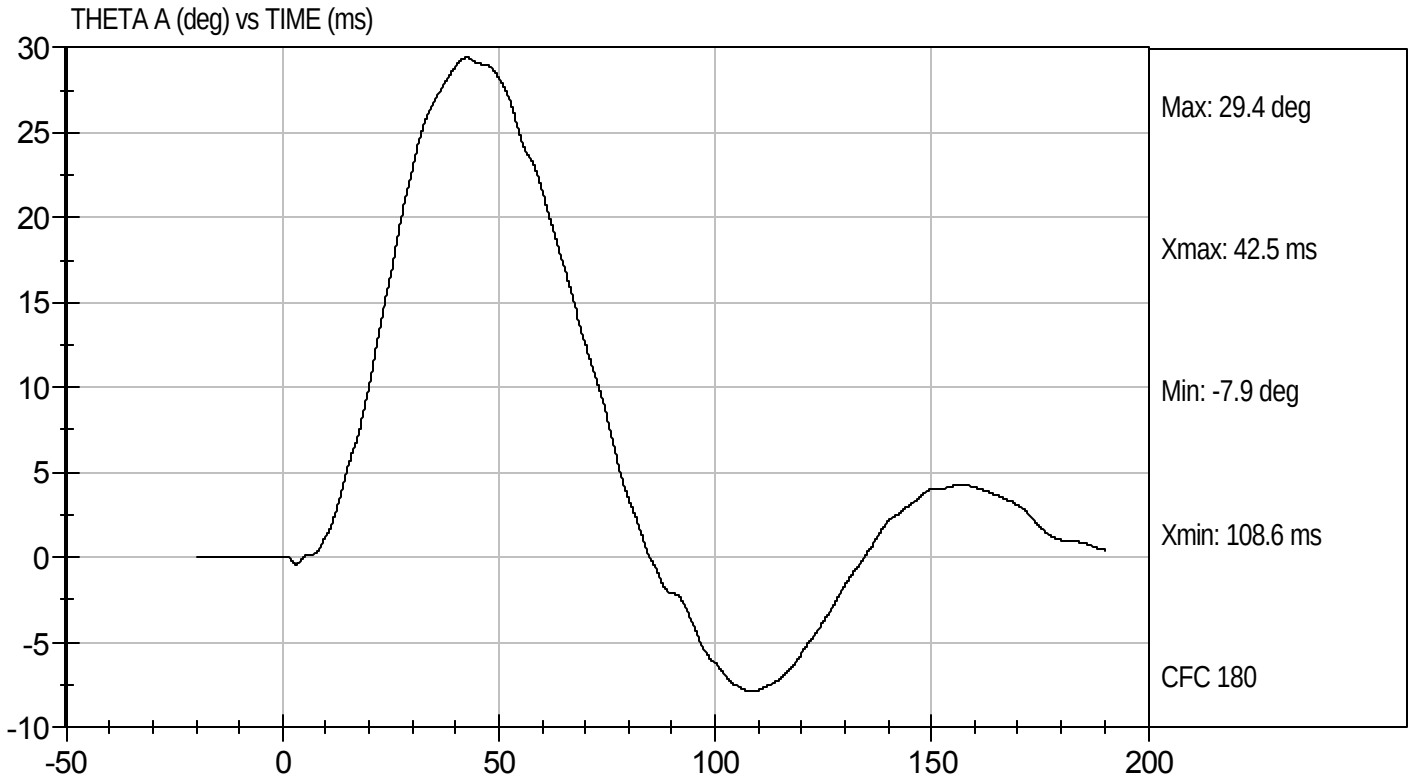


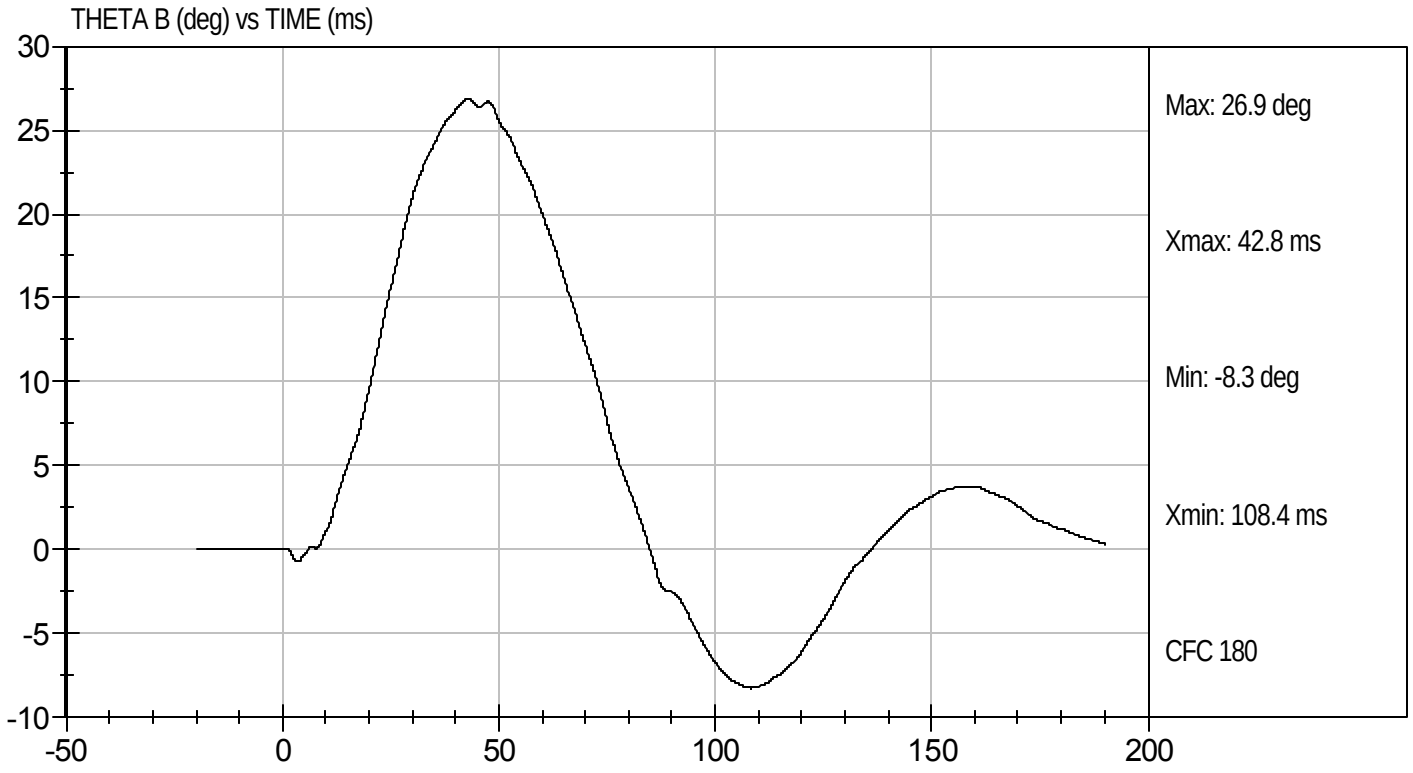
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111008

Test Date: 3/16/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111009

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	22	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.71	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	13.30	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.31	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	13.80	Pass
		Overall Test Results		Pass

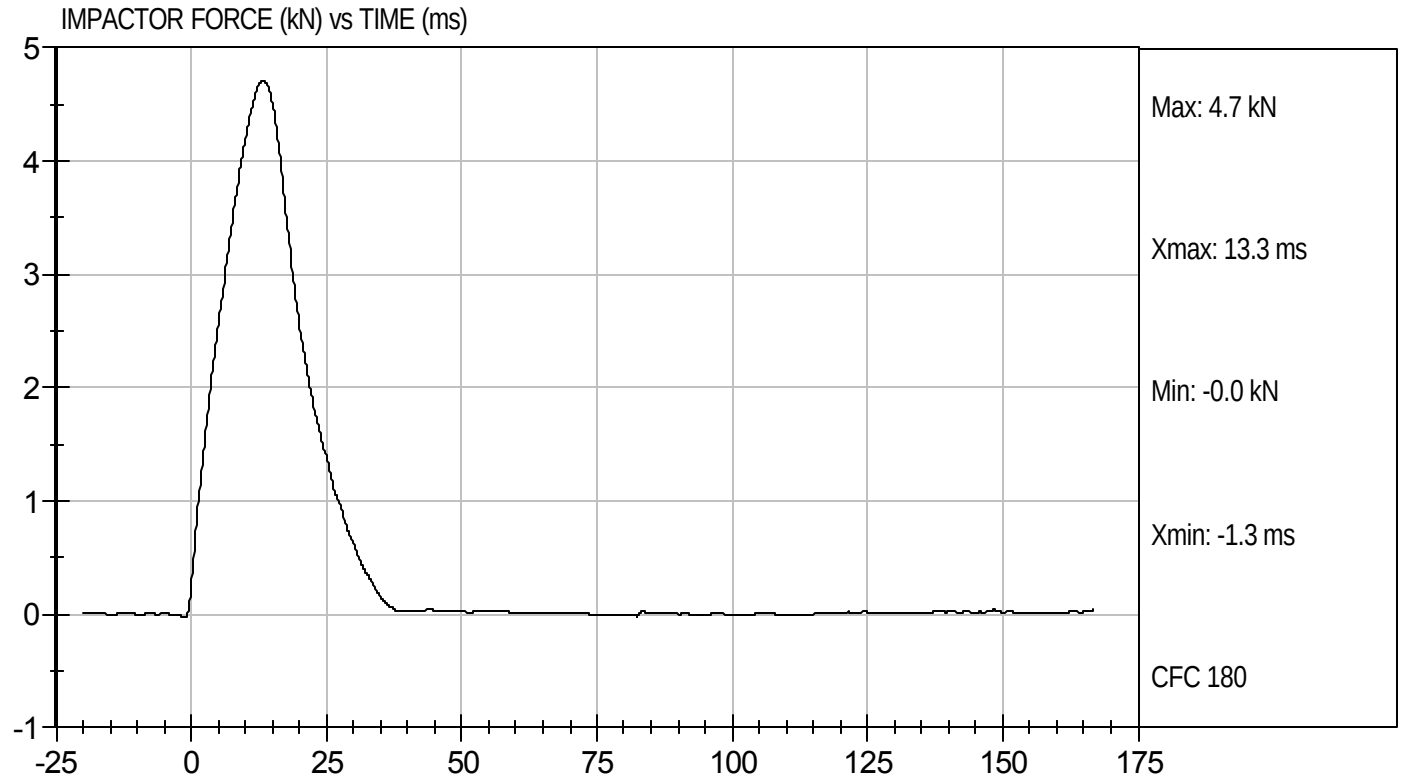
Jessica Hall
Laboratory Technician

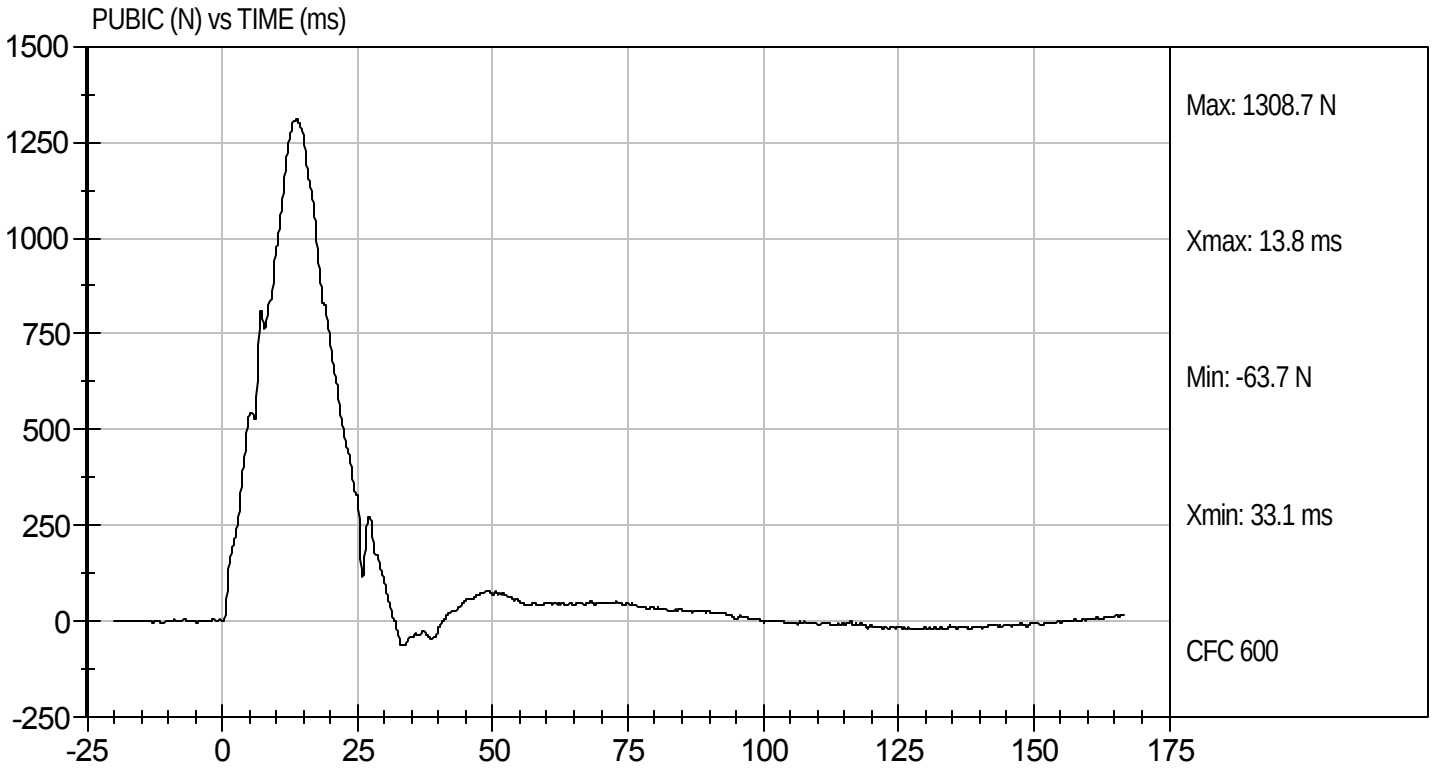
3/17/11
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D111009

Test Date: 3/17/11
Velocity: 14.24 ft/s, 4.34 m/s





MGA RESEARCH CORPORATION

FULL BODY THORAX IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111000

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.2	Pass
Humidity	%	10 to 70	22	Pass
Probe Speed	m/s	5.40 to 5.60	5.58	Pass
Maximum Impactor Force (after 6 ms)	kN	5.10 to 6.20	5.18	Pass
Upper Rib Displacement	mm	34.0 to 41.0	38.8	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.1	Pass
Lower Rib Displacement	mm	37.0 to 44.0	40.0	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

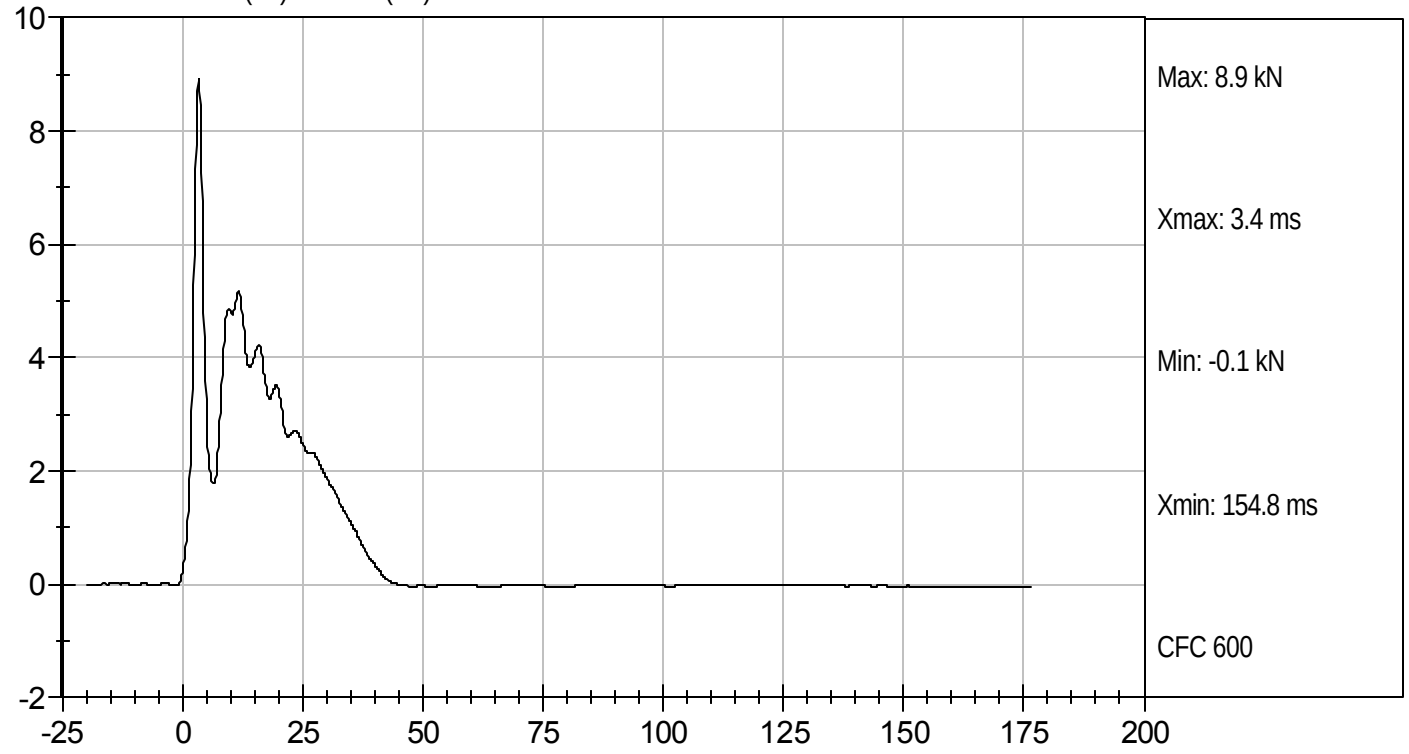
3/17/11
Test Date

David Winkelbauer
Approved By

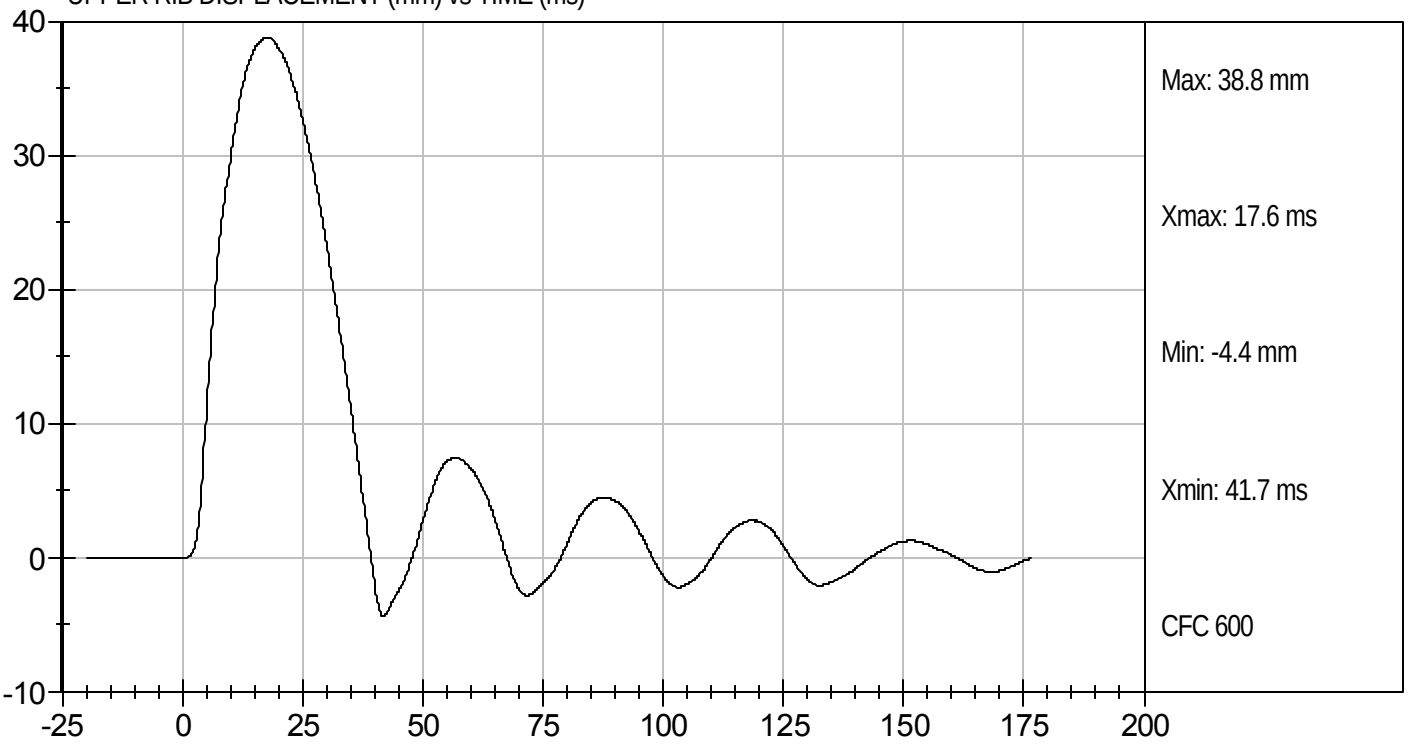
Test Desc: Thorax Impact
Component ID: D111000

Test Date: 3/17/11
Velocity: 18.31 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



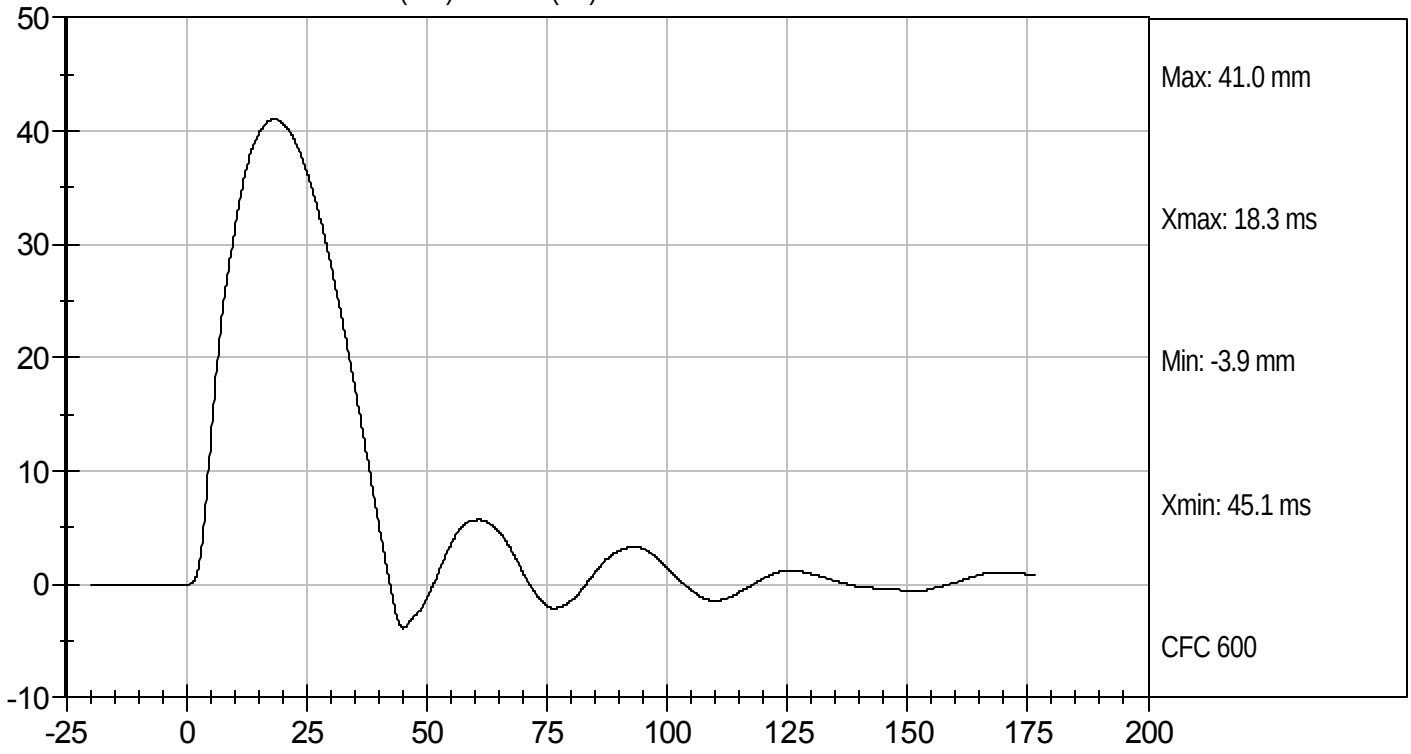
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



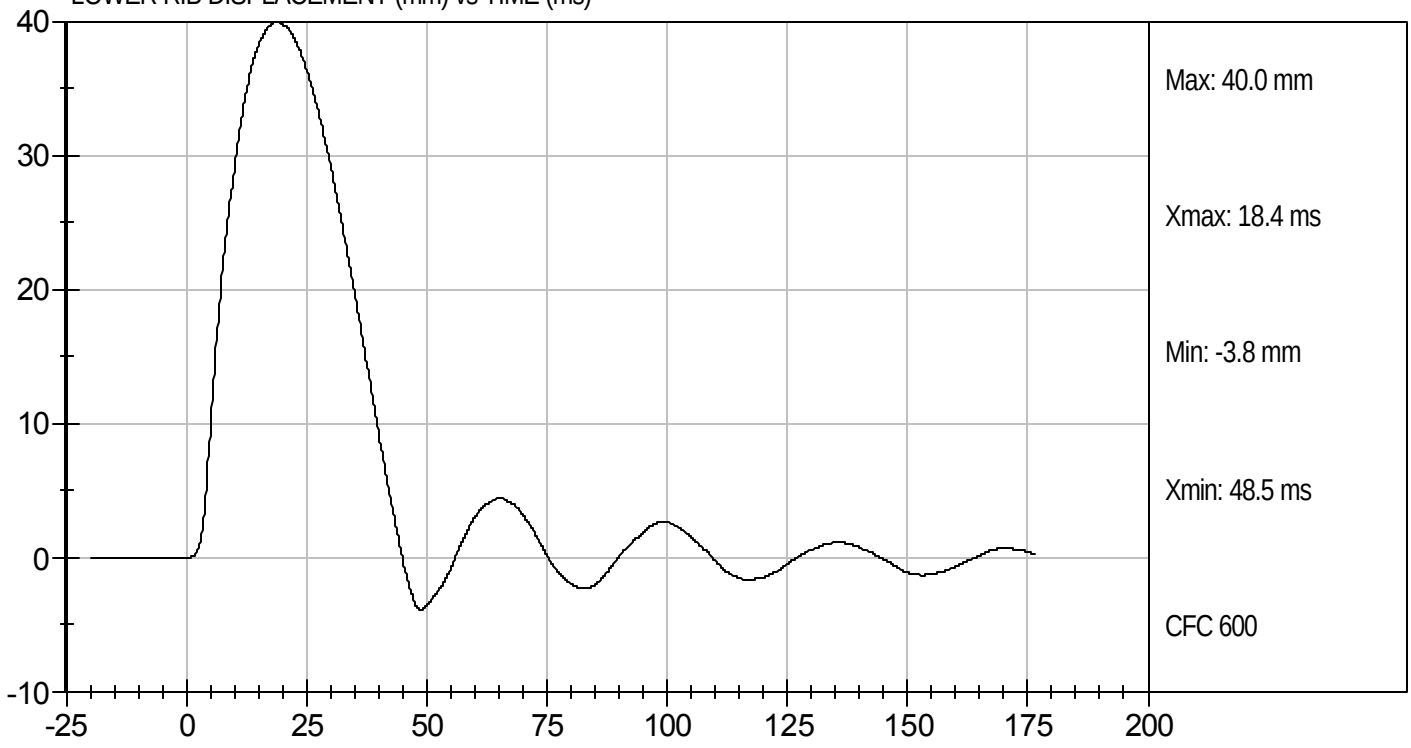
Test Desc: Thorax Impact
Component ID: D111000

Test Date: 3/17/11
Velocity: 18.31 ft/s, 5.58 m/s

MIDDLE RIB DISPLACEMENT (mm) vs TIME (ms)



LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



APPENDIX E

TEST EQUIPMENT AND INSTRUMENTATION CALIBRATION

Table 1 – Dummy Instrumentation

		ES-2re S/N: 016		
		Serial Number	Manufacturer	Calibration Date
Head Accelerometers	X	P66854	Endevco	2/14/2011
	Y	P66855	Endevco	2/14/2011
	Z	P66856	Endevco	2/14/2011
Thorax Potentiometers	Upper Rib (Y)	G144	Honeywell	2/17/2011
	Middle Rib (Y)	G143	Honeywell	2/17/2011
	Lower Rib (Y)	G142	Honeywell	2/17/2011
Abdomen Load Cells	Forward (Y)	ABG119	FTSS	11/01/2010
	Middle (Y)	ABG120	FTSS	11/01/2010
	Rear (Y)	ABG121	FTSS	11/01/2010
Pubic Symphysis Load Cell (Y)		PG431	Denton	11/01/2010

Table 2 – Vehicle Instrumentation

	Serial Number	Manufacturer	Calibration Date
Vehicle CG (X)	P55706	Endevco	12/22/2010
Vehicle CG (Y)	P55705	Endevco	12/22/2010
Vehicle CG (Z)	P55704	Endevco	12/22/2010
Left Floor Sill (Y)	P49503	Endevco	1/13/2011
A Pillar Sill (Y)	P50050	Endevco	12/13/2010
A Pillar Low (Y)	P47834	Endevco	2/19/2011
A Pillar Mid (Y)	P55684	Endevco	10/11/2010
B Pillar Sill (Y)	P59342	Endevco	12/22/2010
B Pillar Low (Y)	P55670	Endevco	11/05/2010
B Pillar Mid (Y)	P47094	Endevco	2/19/2011
Seat (Y)	P59249	Endevco	12/13/2010
Engine (X)	P52222	Endevco	10/01/2010
Engine (Y)	P52223	Endevco	10/01/2010
Firewall (Y)	P55687	Endevco	10/11/2010
Roof (Y)	P45126	Endevco	11/05/2010
Floor Sill (Y)	P59634	Endevco	11/05/2010
Rear Deck (X)	P49520	Endevco	2/19/2011
Rear Deck (Y)	P49521	Endevco	2/19/2011