REPORT NUMBER: 214P-MGA-2011-010

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

KIA MOTORS CORPORATION
2011 KIA OPTIMA LX 4-DR SEDAN
NHTSA NUMBER: CB0510

PREPARED BY:
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Test Date: April 1, 2011

Report Date: June 28, 2011

FINAL REPORT

PREPARED FOR:
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Technical Report Documentation Page

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16. Abstract

A 32 km/h (20 mph), 75° oblique impact compliance test was conducted on the subject 2011 Kia Optima LX 4-Dr Sedan 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 April 1, 2011.

The impact velocity was 31.8 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 343 mm at level 3. The test vehicle's performance follows:

Measurement Description	Units	Result
Head Injury Criteria (HIC_{36})	N/A	367
Max. Rib Deflection	mm	32
Sum of Abdomen Forces	N	1561
Pubic Symphysis Force	N	2228

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.

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SECTION 1
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 Kia Optima LX 4-Dr Sedan. 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 Kia Optima LX 4-Dr Sedan. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.8 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin, on April 1, 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	367	Upper	26.0	Front	400.6	2228.1
		Middle	27.2	Mid	574.3	
		Lower	31.7	Rear	691.4	
		Max.	31.7	Sum	1561.0	

GENERAL COMMENTS

There was no valid data collected for:

B Pillar Mid Y after 10 msec.

Seat Y after 20 msec.

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

SECTION 2

OCCUPANT AND VEHICLE INFORMATION

DATA SHEET NO. 1

TEST VEHICLE INFORMATION AND OPTIONS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

VEHICLE INFORMATION	
Make	Kia
Model	Optima
Body Style	Sedan
VIN	KNAGM4A79B5086076
Body Color	Spicy Red
Engine Displacement (L)	2.4
# of Cylinders	4
Engine Placement	Lateral
Transmission Type	Manual
Transmission Speeds	6
Overdrive	Yes
Final Drive	Front
Odometer Reading	49 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	No
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	Kia Motors Corporation
Date of Manufacture	12/10

GVWR (kg)	1950
GAWR Front (kg)	1100
GAWR Rear (kg)	960

VEHICLE SEATING AND CAPACITY WEIGHT INFORMATION

Measured Parameter	Front	Rear	Third	Total
Type of Seats	Bucket	Bench		
Number of Occupants	2	3		5
Capacity Weight (VCW) (kg)				410
Cargo Weight (RCLW) (kg)				70

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	225	225	225	225
As Tested	kPa	225	225	225	225

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	431.4	313.9		455.4	380.1		446.3	372.4	
Right	kg	440.9	292.1		444.1	345.6		453.6	345.7	
Ratio	%	59.0	41.0		55.3	44.7		55.6	44.4	
Totals	kg	872.3	606.0	1478.3	899.5	725.7	1625.2	899.9	718.1	1618.0

TEST VEHICLE TARGET WEIGHT (TVTW) CALCULATION

Measured Parameter	Units	Value
As Delivered Weight	kg	1478.3
Weight of 1 P572U ATD (ES-2re) Dummy	kg	77.1
Rated Cargo/Luggage Weight (RCLW)	kg	70
Calculated Target Vehicle Test Weight (TVTW)	kg	1625.4

TEST VEHICLE ATTITUDES

	Units	LF	RF	RR	LR
Fully Loaded	mm	692	706	676	676
As Tested	mm	697	706	684	689
Difference	mm	-5	0	-8	-13

CALCULATION OF THE VERTICAL IMPACT REFERENCE LINE

Measurement Parameter	Units	Value
Test Vehicle Wheel Base	mm	2800
Vertical Impact Reference Line (Aft of Front Axle)	mm	1390

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

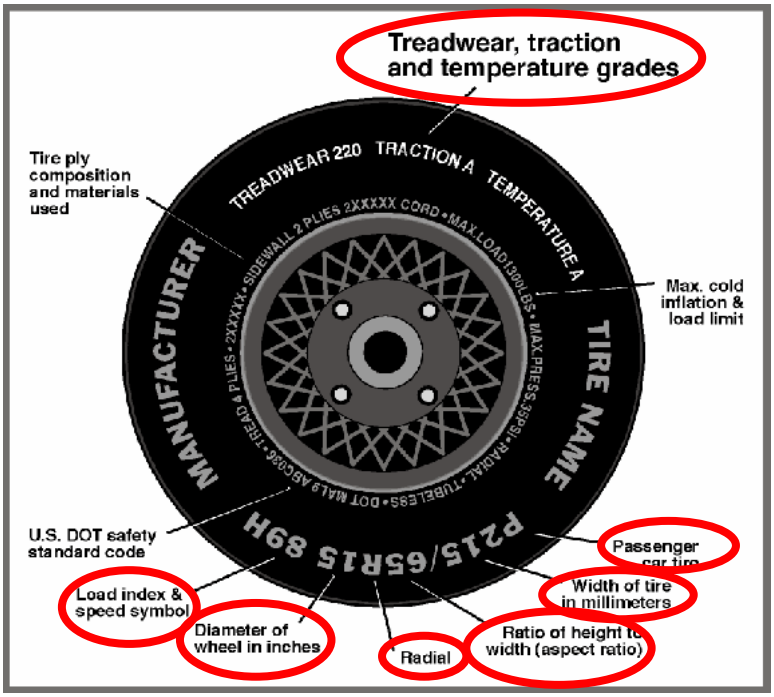
Description of Component	Weight (kg)
Ballast	0
No vehicle components removed to meet VTW	0

DATA SHEET NO. 3

VEHICLE TIRE INFORMATION

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. 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	NEXEN	NEXEN
Tire Name	Classe Premium	Classe Premium
Tire Type	Passenger	Passenger
Tire Width	205	205
Aspect Ratio	65	65
Radial	Yes	Yes
Wheel Diameter	16	16
Load Index/Speed Symbol	94H	94H
Treadwear	400	400
Traction Grade	A	A
Temperature Grade	A	A

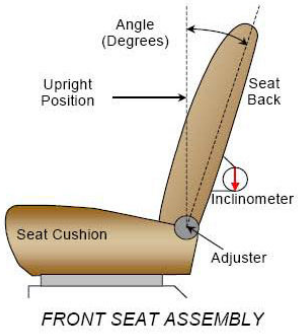
DATA SHEET NO. 4

SEAT AND SEAT BELT ADJUSTMENT DATA

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

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 with the inclinometer zeroed at the side sill. Set the seat back angle at 7.5 degrees.



FRONT SEAT ASSEMBLY

SEAT BACK ANGLE

	Degrees	Detents
Driver without Seated Dummy	6.7° at headrest post	10th detent (1st as 0)

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	24 detents	12th detent (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 the uppermost detent for the 50th percentile male.

SEAT BELT UPPER ANCHORAGE

	Total # of Positions	Placed in Position #
Driver Seat	4 detents	0 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

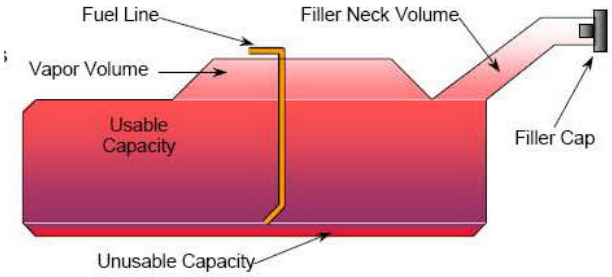
Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

FUEL TANK CAPACITY

	Liters
Usable Capacity (Form 1)	70.0
Usable Capacity (Owner's Manual)	70.0
92-94% of Usable Capacity	64.4 to 65.8
Actual Amount of Solvent Used	65.1

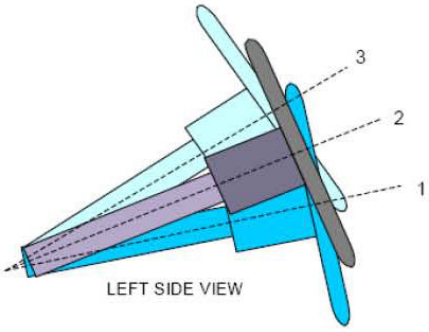
FUEL PUMP

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. Fuel pump will operate when engine system is normally operating. 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

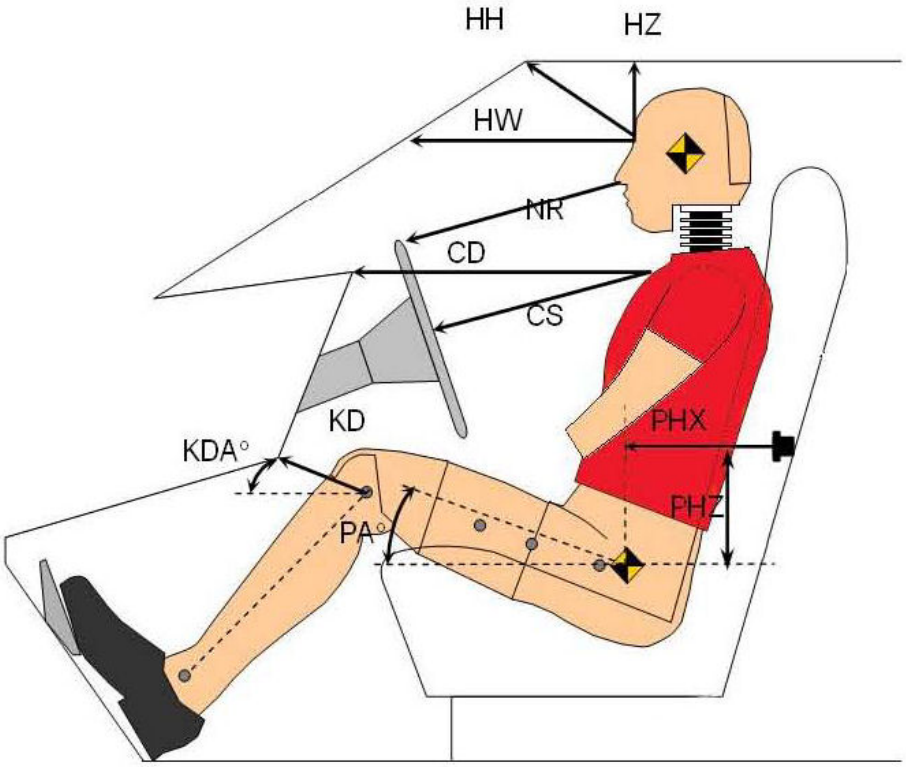
STEERING COLUMN POSITIONING

	Degrees	Fore/Aft Position (mm)
Lowermost - Position 1	68.5	130
Geometric Center – Position 2	66.5	110
Uppermost – Position 3	64.5	90
Telescoping Steering Wheel Travel		40
Test Position	66.5	110

.DATA SHEET NO. 6

DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

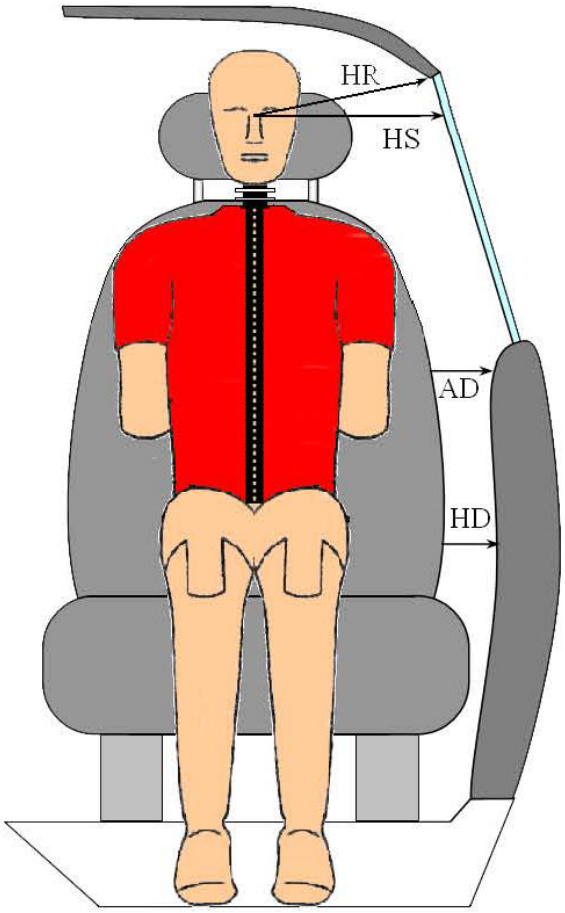


Driver Code	Measurement Description	Length (mm)	Angle (°)
HH	Head to Header	375	
HW	Head to Windshield	577	
HZ	Head to Roof	141	
NR	Nose to Rim	476	
CD	Chest to Dash	573	
CS	Chest to Steering Wheel	374	
KDL	Left Knee to Dash	181	41.2
KDR	Right Knee to Dash	155	34.8
PA	Pelvis Angle X		27.0
	Torso Angle Y		0.5
PHX	H-Point to Striker (X-Axis)	208	
PHZ	H-Point to Striker (Z-Axis)	270	

DATA SHEET NO. 7

DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

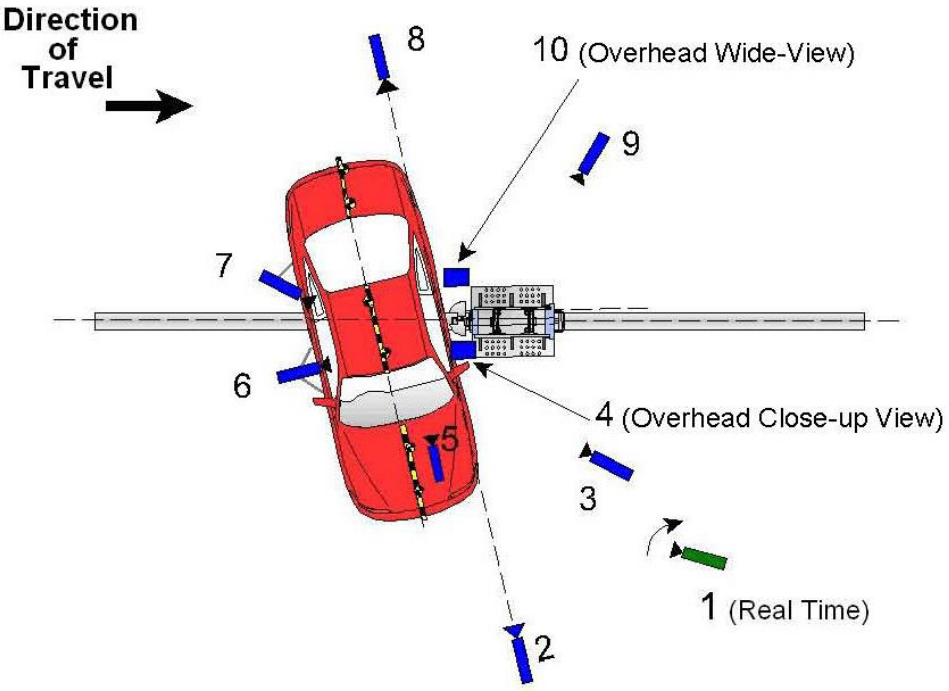


Code	Measurement Description	Units	Front Occupant
HR	Head to Side Header	mm	174
HS	Head to Side Window	mm	302
AD	Arm to Door	mm	112
HD	H-Point to Door	mm	151

DATA SHEET NO. 8

HIGH SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011



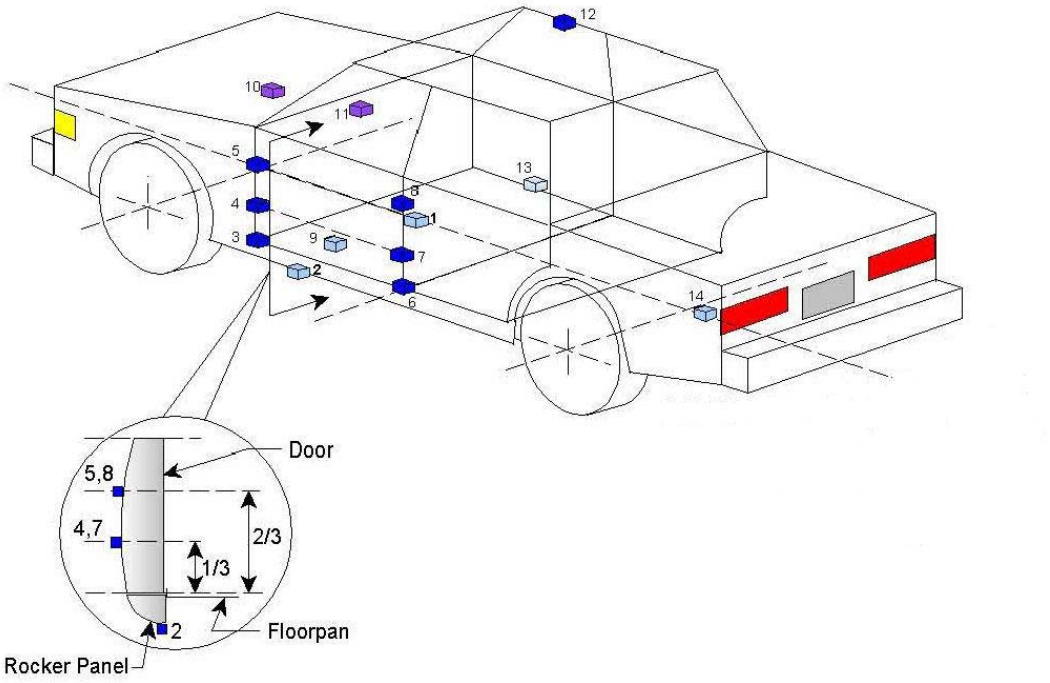
Reference: From Point of Impact for X and Y; from Ground for Z):
+X = Right of Impact, + Y = Forward of Impact, +Z = Up

Camera No.	View	Coordinates (mm)			Lens (mm)	Film Speed (fps)
		X	Y	Z		
1	Real-Time					30
2	Front Ground Level	5780	30	1720	24	1000
3	Impact Side 45° Forward	4460	2180	1850	20	1000
4	Overhead Closeup	0	90	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	-5700	40	1710	24	1000
9	Impact Side 45° Rearward	-3920	3970	1870	20	1000
10	Overhead Wide	0	-300	4610	14	1000

DATA SHEET NO. 9

TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011



Loc. No.	Accelerometer Location			
	ID	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2605	-170	-180
2	Left Floor Sill	2795	-723	-190
3	A Pillar Sill	3355	-723	-185
4	A Pillar Low	3260	-720	-545
5	A Pillar Mid	3310	-804	-780
6	B Pillar Sill	2160	-725	-195
7	B Pillar Low	2130	-715	-500
8	B Pillar Mid	2130	-718	-795
9	Seat	2370	-597	-300
10	Engine	4050	-18	-815
11	Firewall	3735	0	-885
12	Roof	1965	560	-1430
13	Floor Sill	2060	725	-195
14	Rear Deck	240	-35	-295

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 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

Loc. No.	Description	Peak Values (g's)			
		Max	Time (ms)	Min	Time (ms)
1	Vehicle CG (X)	2.5	16.9	-6.3	22.5
	Vehicle CG (Y)	31.2	10.1	-6.0	49.4
	Vehicle CG (Z)	12.0	9.7	-12.2	40.7
	Resultant	33.4	10.1		
2	Left Floor Sill (Y)	52.0	55.2	-9.6	34.2
3	A Pillar Sill (Y)	20.3	18.1	-6.0	22.2
4	A Pillar Low (Y)	19.2	18.4	-0.8	300.0
5	A Pillar Mid (Y)	23.6	20.3	-2.4	1.2
6	B Pillar Sill (Y)	36.7	26.9	-12.9	21.4
7	B Pillar Low (Y)	100.6	14.3	-13.3	66.8
8	B Pillar Mid (Y)	(1)	(1)	(1)	(1)
9	Seat (Y)	(2)	(2)	(2)	(2)
10	Engine (X)	14.7	95.4	-20.5	32.5
	Engine (Y)	10.1	102.0	-0.9	210.7
11	Firewall (Y)	11.5	88.2	-0.9	3.1
12	Roof (Y)	29.2	14.8	-0.8	293.9
13	Floor Sill (Y)	16.4	11.8	-1.0	199.9
14	Rear Deck (X)	5.8	58.5	-3.6	20.8
	Rear Deck (Y)	18.9	52.0	-2.7	192.3

(1) No valid data collected for B Pillar Mid Y after 10 msec.
(2) No valid data collected for Seat Y after 20 msec.

DATA SHEET NO. 11

DUMMY INJURY RESPONSE DATA

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

Dummy S/N	Positive		Negative	
	MAX	TIME (ms)	MAX	TIME (ms)
HEAD ACCELERATION (G)				
Longitudinal (X)	4.9	78.5	26.0	46.0
Lateral (Y)	46.3	59.5	14.9	113.6
Vertical (Z)	12.4	37.3	1.9	50.1
Resultant (R)	49.4	57.6		
HIC36 (t1, t2)	367		t1 = 40.7	t2 = 71.6
THORAX DEFLECTION (mm)				
Upper Rib			26.0	48.6
Middle Rib			27.2	46.8
Lower Rib			31.7	47.6
ABDOMINAL FORCES (N)				
Front	400.6	43.9		
Middle	574.3	42.2		
Rear	691.4	45.6		
Sum	1561.0	43.1		
PELVIS FORCE (N)				
Pubic Symphysis			2228.1	43.9

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

DATA SHEET NO. 12

POST TEST OBSERVATIONS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

TEST DUMMY INFORMATION AND CONTACT

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

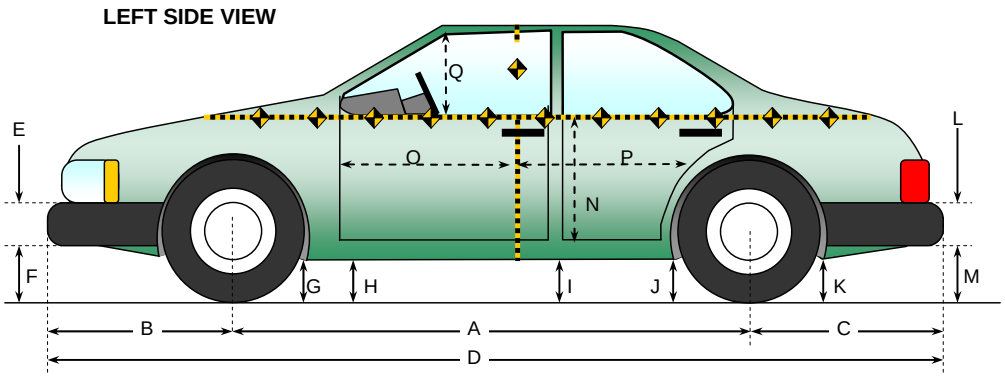
SUPPLEMENTAL RESTRAINT SYSTEM INFORMATION

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

DATA SHEET NO. 13

VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

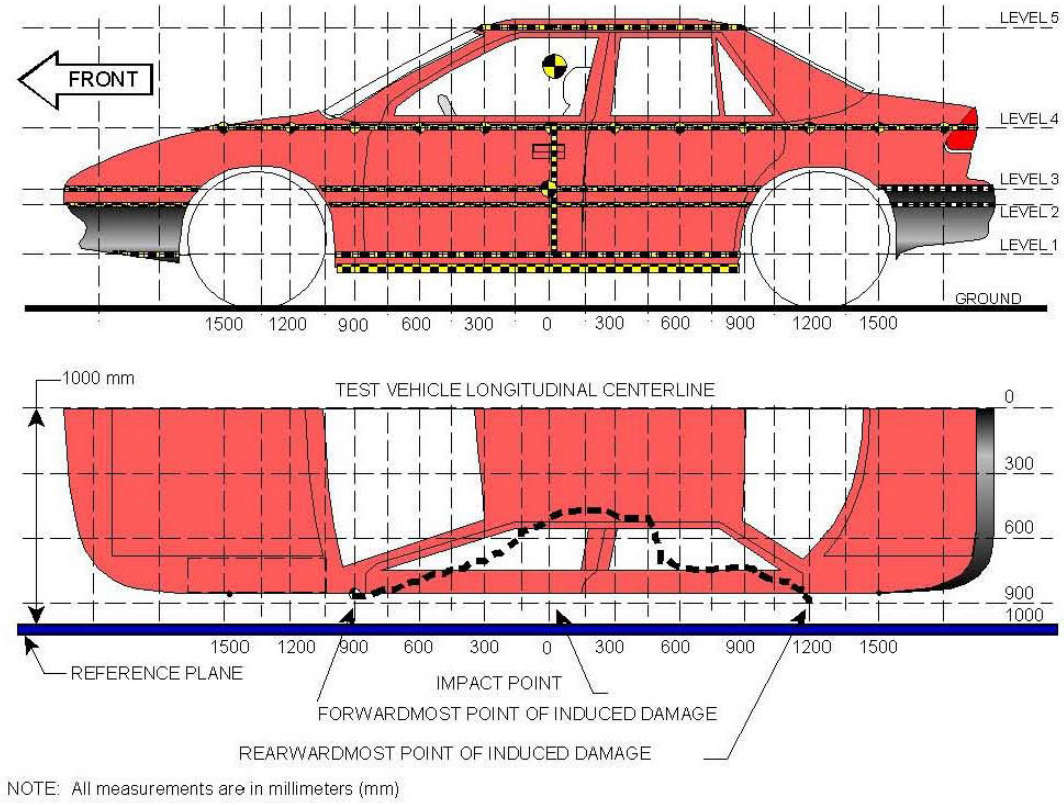


Code	Measurement Description	Pre-Test (mm)	Post-Test (mm)	Difference (mm)
A	Wheelbase	2800	2722	78
B	Front Axle to FSOV	975	980	-5
C	Rear Axle to RSOV	1080	1080	0
D	Total Vehicle Length at Centerline	4855	4782	73
E	Front Bumper Thickness	107	107	0
F	Front Bumper Bottom to Ground	193	215	-22
G	Sill Height at Front Wheel Well	167	158	9
H	Sill Height at Front Door Leading Edge	168	150	18
I	Sill Height at B Pillar	173	180	-7
J1	Sill Height at Rear Wheel Well	175	190	-15
J2	Pinch Weld Height at Rear Wheel Well	175	180	-5
K	Sill Height Aft of Rear Wheel Well	195	205	-10
L	Rear Bumper Thickness	165	165	0
M	Rear Bumper Bottom to Ground	282	290	-8
N	Sill Height to Window Bottom Sill	726	736	-10
O	Front Door Leading Edge to Impact CL	901	900	1
P	Rear Door Trailing Edge to Impact CL	1101	1127	-26
Q	Front Window Opening	395	362	33
R	Right Side Length	3892	3900	-8
S	Left Side Length	3892	3810	82
T	Vehicle Width at B Post	1801	1630	171

DATA SHEET NO. 14

EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011



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	297	0	282
2	Occupant H-Point	328	0	523
3	Mid-Door	343	0	651
4	Window Sill	279	-75	967
5	Window Top	116	-75	1386

DATA SHEET NO. 15

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

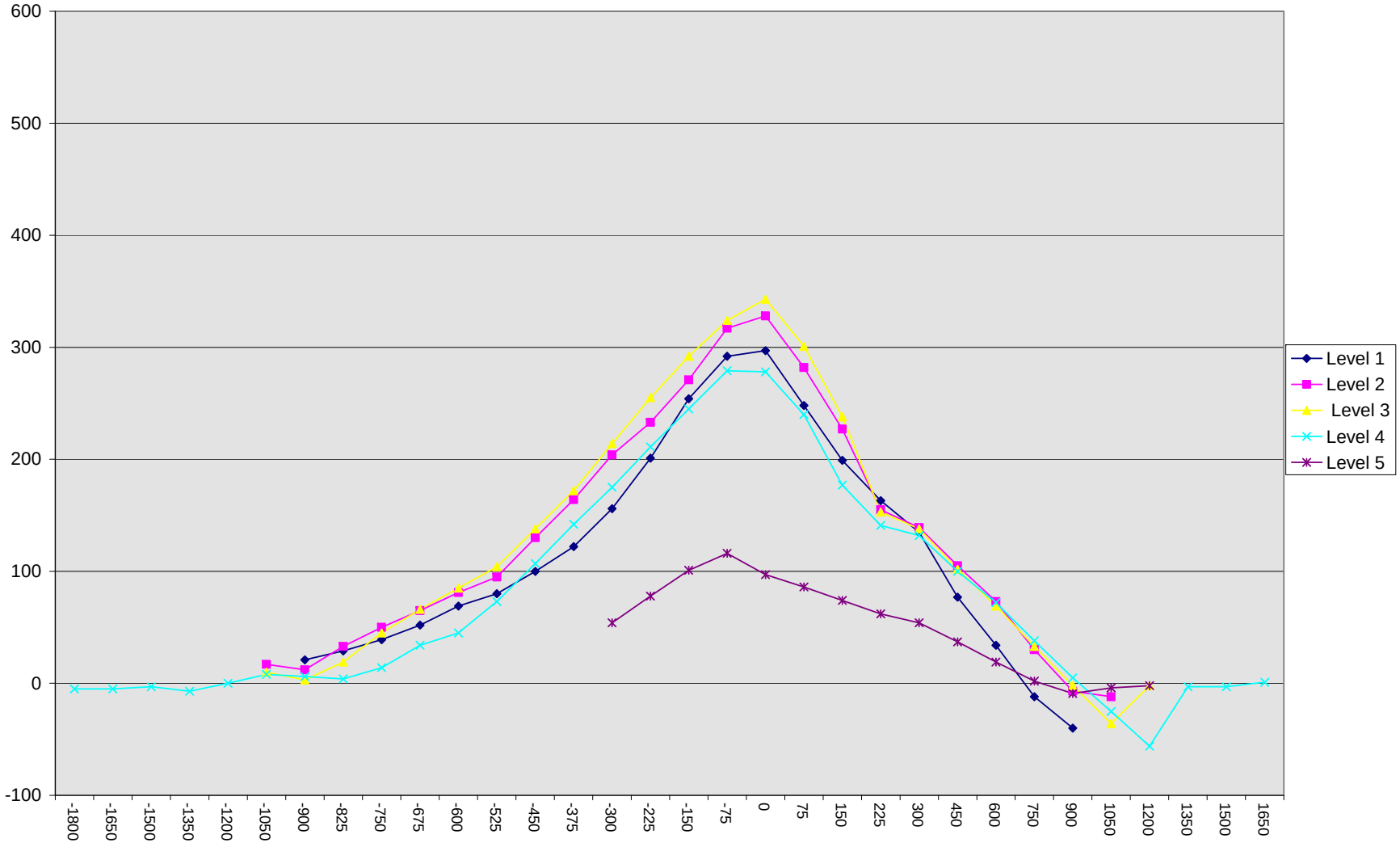
	Level 1	Level 2	Level 3	Level 4	Level 5
Maximum Crush (mm)	297	328	343	279	116
Distance From Impact (mm)	0	0	0	-75	-75

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1800				365					360					-5	
-1650				348					343					-5	
-1500				333					330					-3	
-1350				323					316					-7	
-1200				311					311					0	
-1050		192	199	300			209	209	308			17	10	8	
-900	232	214	210	295		253	226	213	301		21	12	3	6	
-825	232	217	210	291		261	250	229	295		29	33	19	4	
-750	234	217	209	290		273	267	254	304		39	50	45	14	
-675	234	216	208	287		286	281	274	321		52	65	66	34	
-600	233	215	208	285		302	296	293	330		69	81	85	45	
-525	231	214	207	281		311	309	311	354		80	95	104	73	
-450	230	213	206	279		330	343	344	386		100	130	138	107	
-375	228	212	205	276		350	376	377	418		122	164	172	142	
-300	226	211	204	275	505	382	415	418	450	559	156	204	214	175	54
-225	225	211	204	272	499	426	444	459	483	577	201	233	255	211	78
-150	223	211	203	270	496	477	482	495	515	597	254	271	292	245	101
-75	222	210	202	268	495	514	527	526	547	611	292	317	324	279	116
0	220	210	202	268	493	517	538	545	546	590	297	328	343	278	97
75	219	210	202	269	495	467	492	503	509	581	248	282	301	240	86
150	219	210	202	267	495	418	437	440	444	569	199	227	238	177	74
225	218	211	203	266	496	381	366	356	407	558	163	155	153	141	62
300	217	212	204	266	499	352	351	342	398	553	135	139	138	132	54
450	218	212	205	267	503	295	317	307	367	540	77	105	102	100	37
600	220	214	207	269	506	254	287	276	341	525	34	73	69	72	19
750	225	216	209	272	516	213	246	242	310	518	-12	30	33	38	2
900	225	213	211	277	531	185	206	209	282	522	-40	-7	-2	5	-9
1050		197	203	279	550		185	167	254	546		-12	-36	-25	-4
1200			190	287	573			188	231	571			-2	-56	-2
1350				294					291					-3	
1500				304					301					-3	
1650				315					316					1	

DATA SHEET NO. 15 (CONTINUED)

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011



DATA SHEET NO. 16

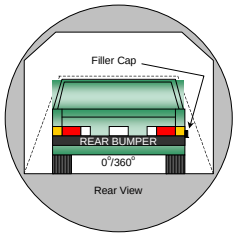
SUMMARY OF FMVSS 301 FUEL SYSTEM DATA

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

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



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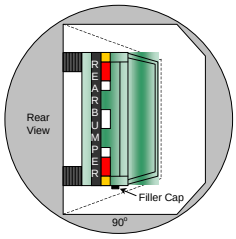

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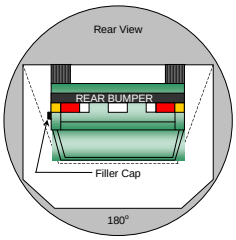

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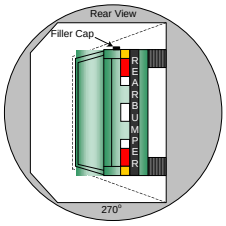


270

REAR VIEW

Rollover Stage	Rotation Time (spec. 1-3 min)				FMVSS 301 Hold Time		Total Time				Next Whole Minute Interval	
0° - 90°	1	minutes	58	seconds	5	minutes	6	minutes	58	seconds	7	minutes
90° - 180°	1	minutes	56	seconds	5	minutes	6	minutes	56	seconds	7	minutes
180° - 270°	1	minutes	47	seconds	5	minutes	6	minutes	47	seconds	7	minutes
270° - 360°	1	minutes	54	seconds	5	minutes	6	minutes	54	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

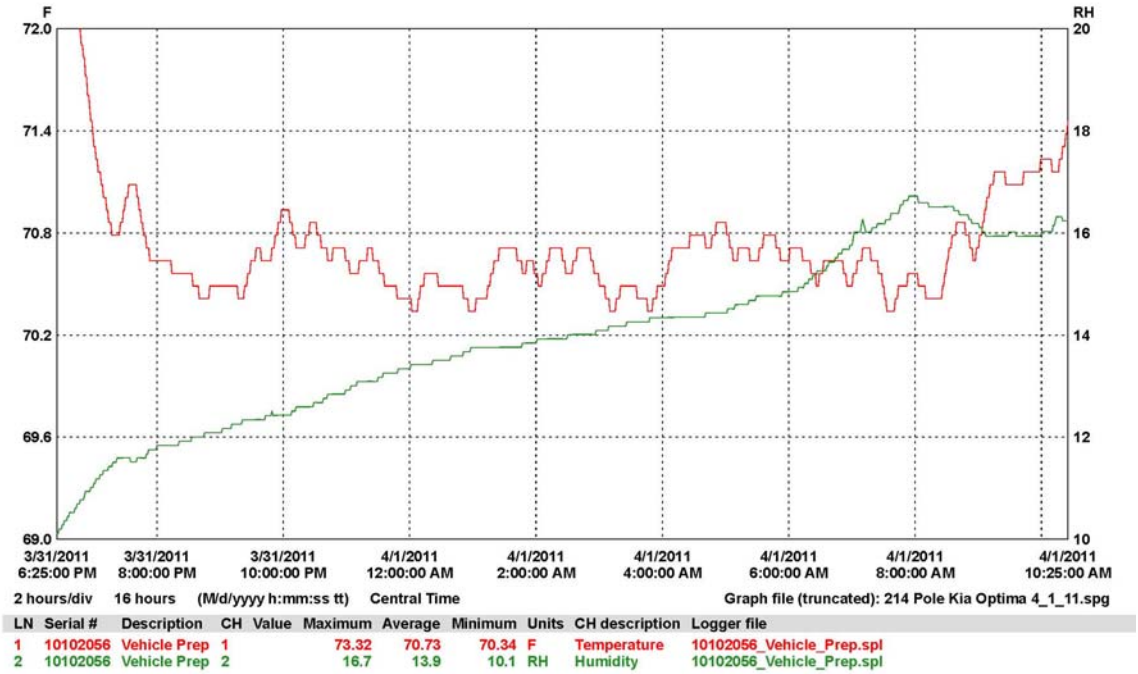
Rollover Stage	Spillage Location(s)
0° to 90°	None
90° to 180°	None
180° to 270°	None
270° to 360°	None

DATA SHEET NO. 17

TEMPERATURE AND HUMIDITY TRACES

Test Vehicle: 2011 Kia Optima LX 4-Dr Sedan NHTSA No. CB0510
Test Program: FMVSS 214 Pole Test Date: 4/01/2011

Time of Impact: 10:23 am



LN	Serial #	Description	CH	Value	Maximum	Average	Minimum	Units	CH description	Logger file
1	10102056	Vehicle Prep	1		73.32	70.73	70.34	F	Temperature	10102056_Vehicle_Prep.spl
2	10102056	Vehicle Prep	2		16.7	13.9	10.1	RH	Humidity	10102056_Vehicle_Prep.spl

APPENDIX A

PHOTOGRAPHS

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Pre-Test Frontal View of Test Vehicle

Post-Test Frontal View of Test Vehicle

Pre-Test Rear View of Test Vehicle

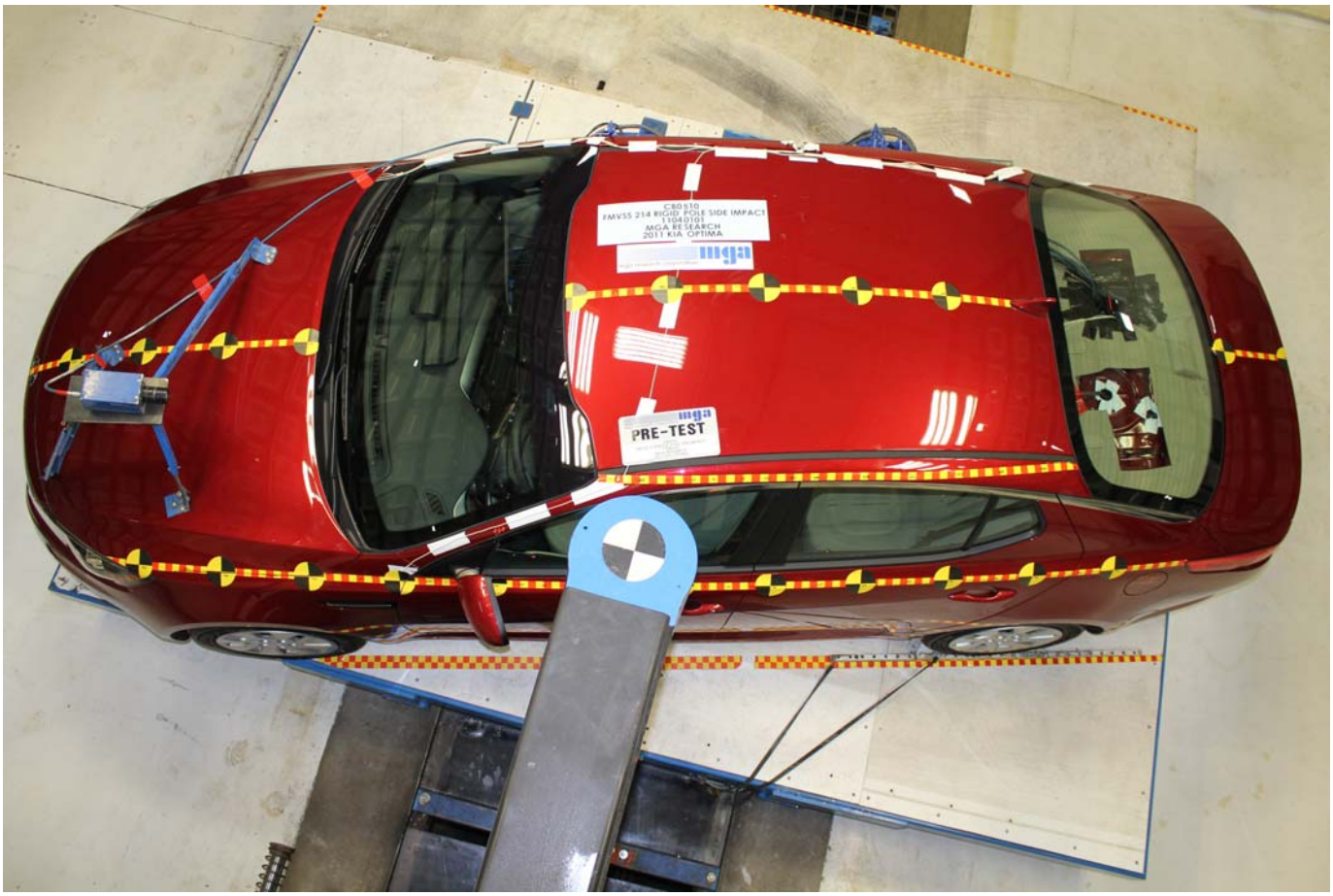
Post-Test Rear View of Test Vehicle

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

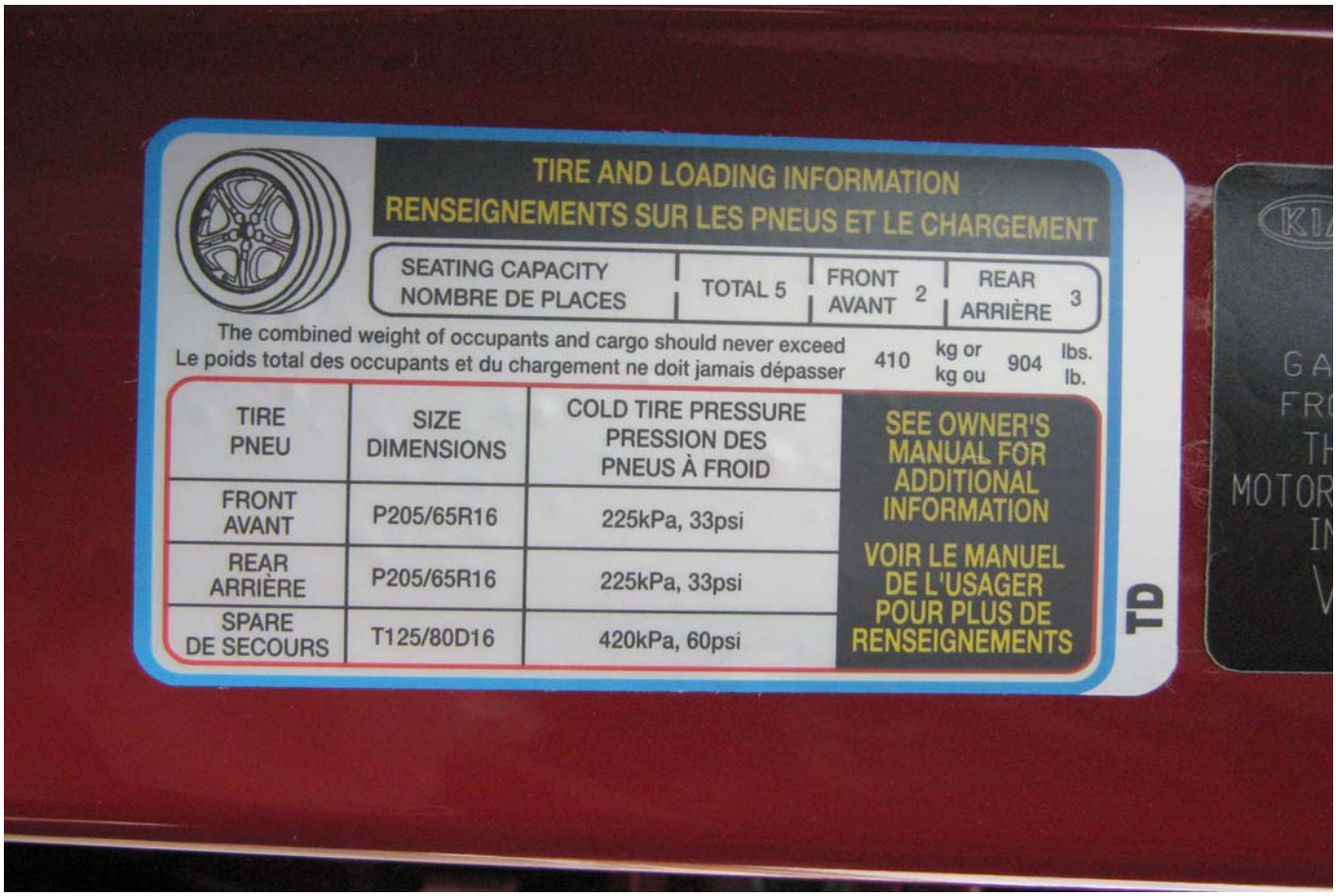
Post-Test Impact Zone Close-up View

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 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

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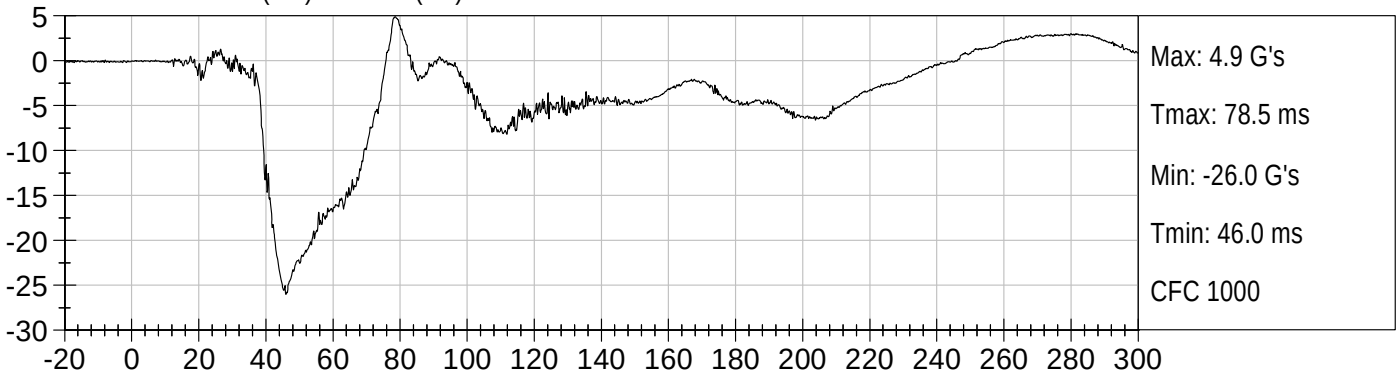
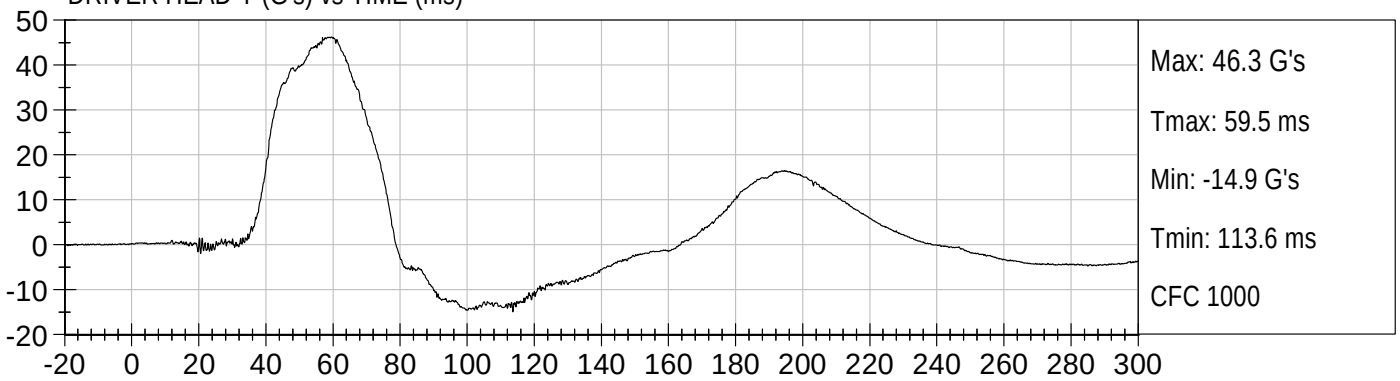
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

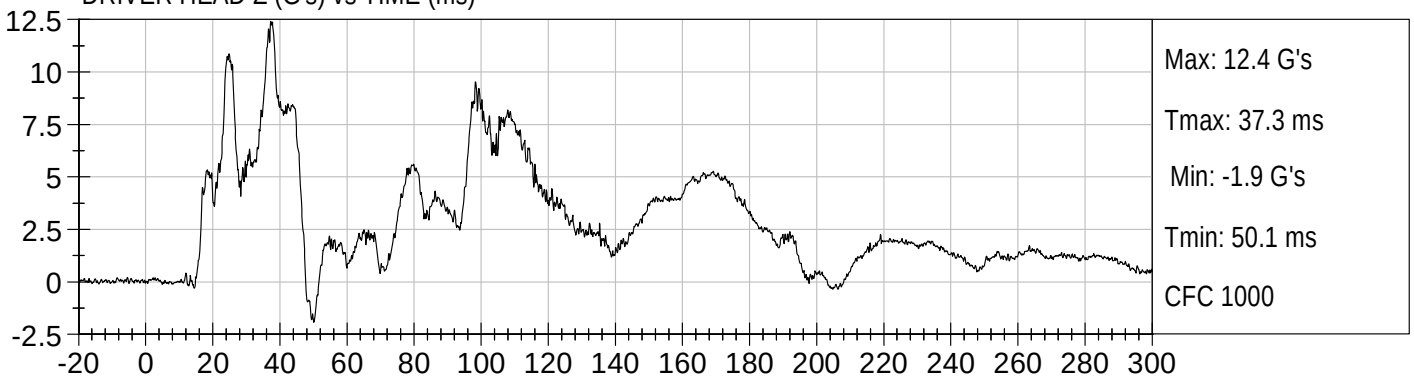
DRIVER HEAD X (G's) vs TIME (ms)



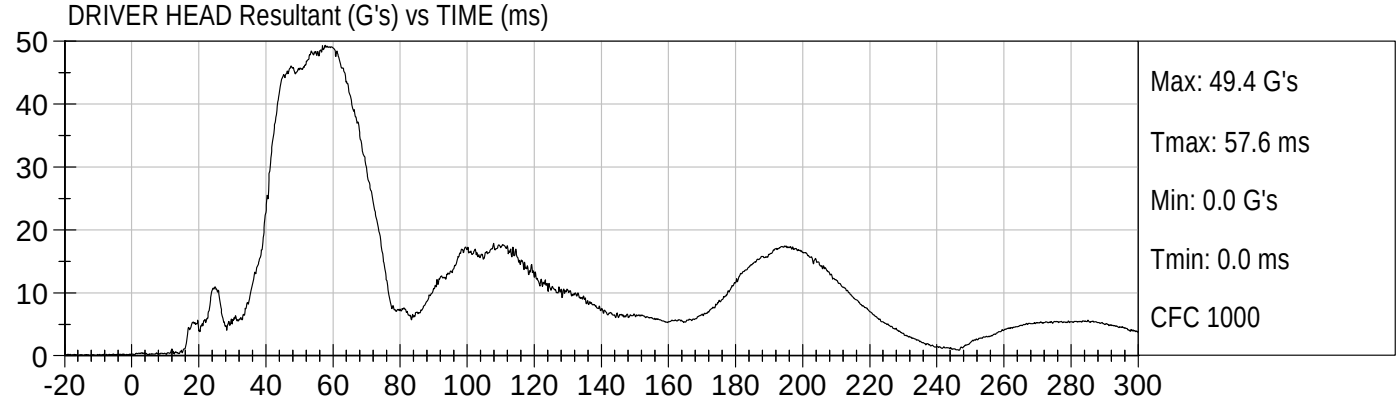
DRIVER HEAD Y (G's) vs TIME (ms)



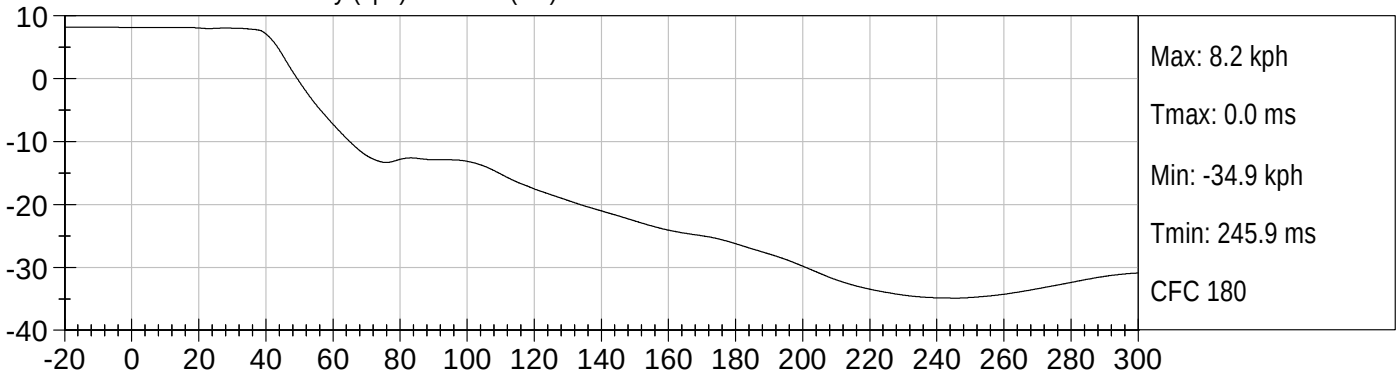
DRIVER HEAD Z (G's) vs TIME (ms)



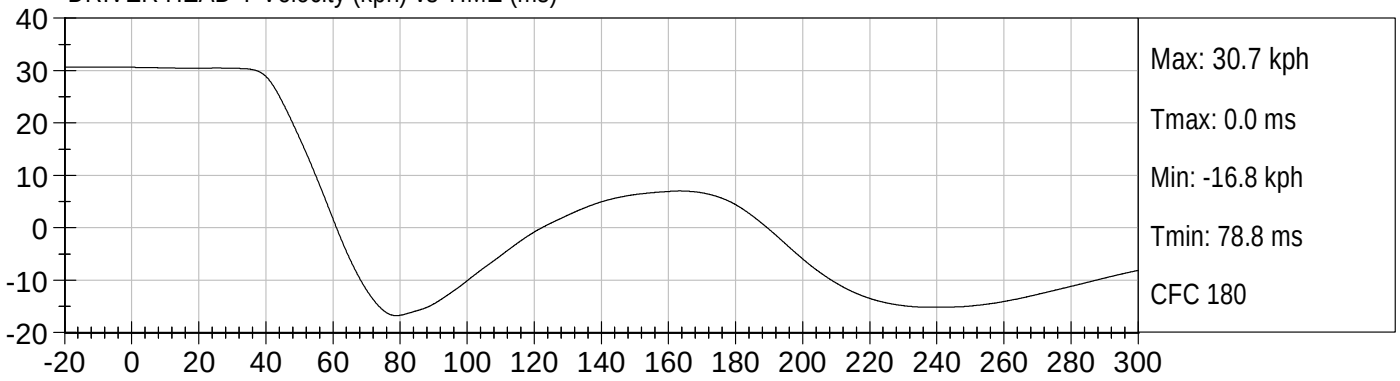
DRIVER HEAD Resultant (G's) vs TIME (ms)



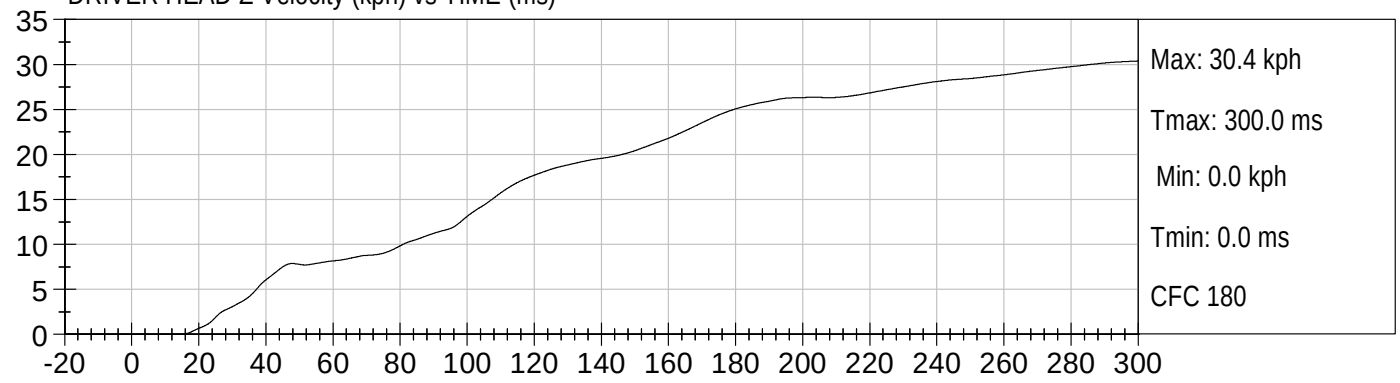
DRIVER HEAD X Velocity (kph) vs TIME (ms)



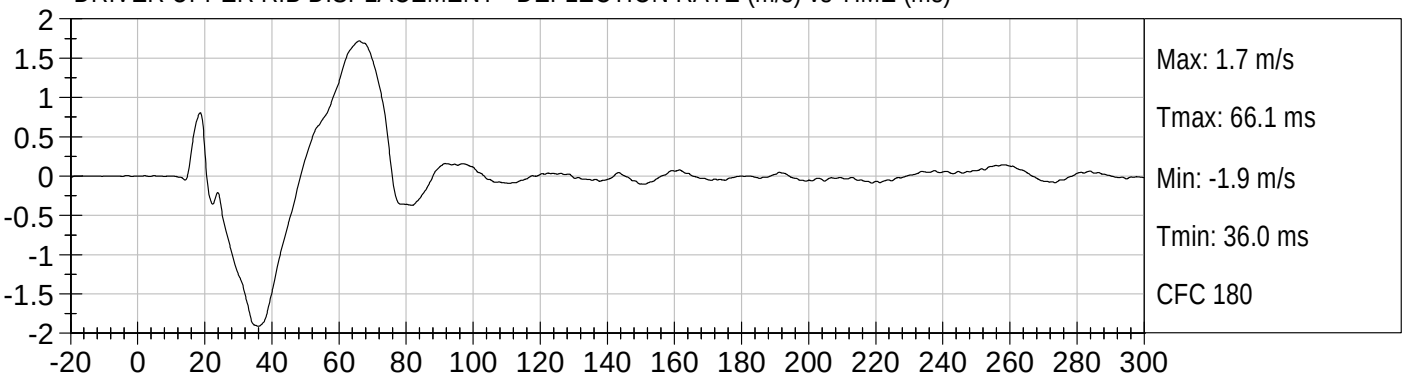
DRIVER HEAD Y Velocity (kph) vs TIME (ms)



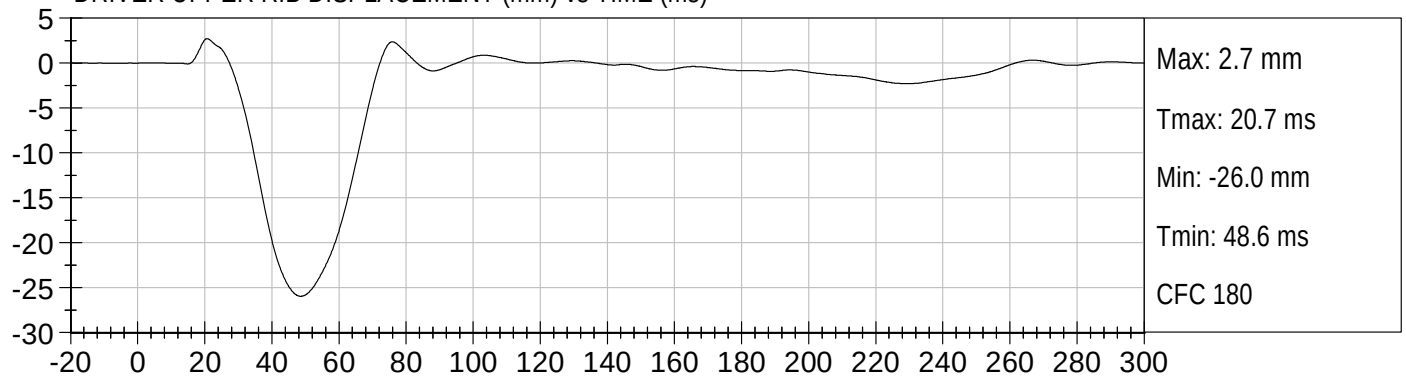
DRIVER HEAD Z Velocity (kph) vs TIME (ms)



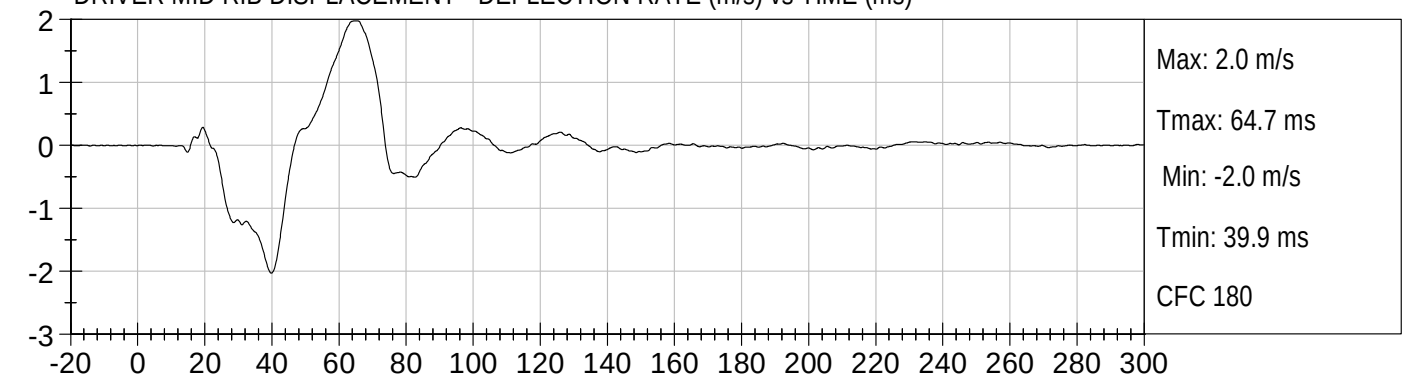
DRIVER UPPER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



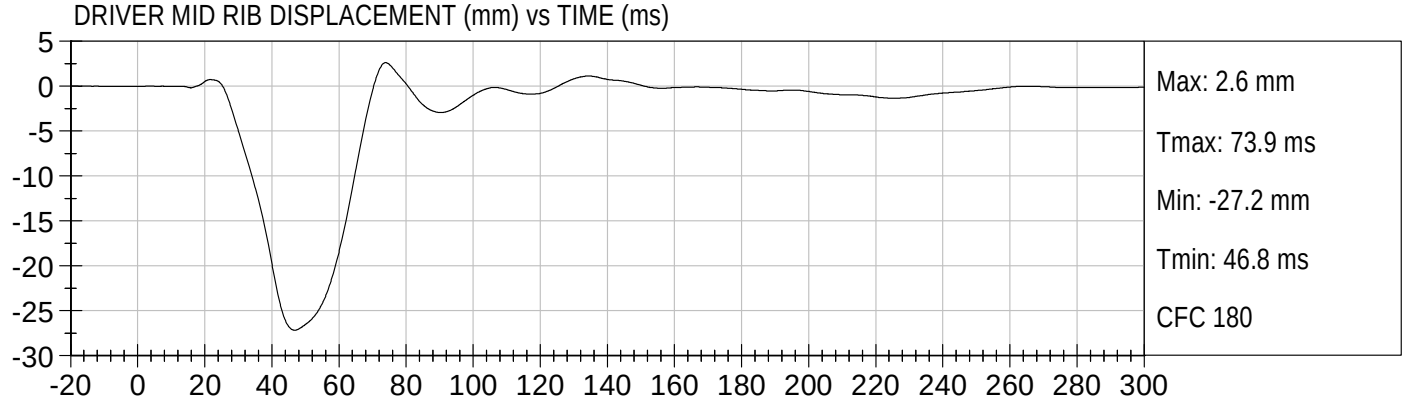
DRIVER UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



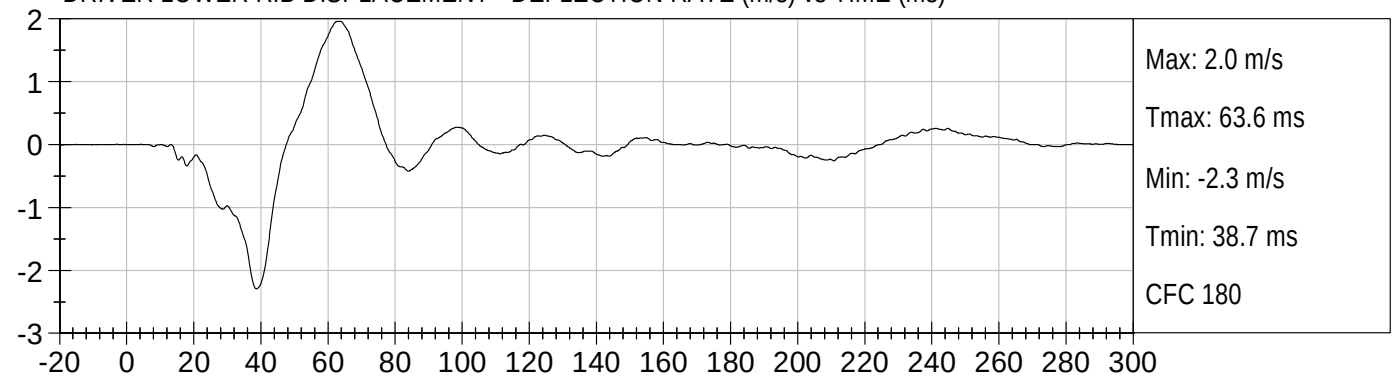
DRIVER MID RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



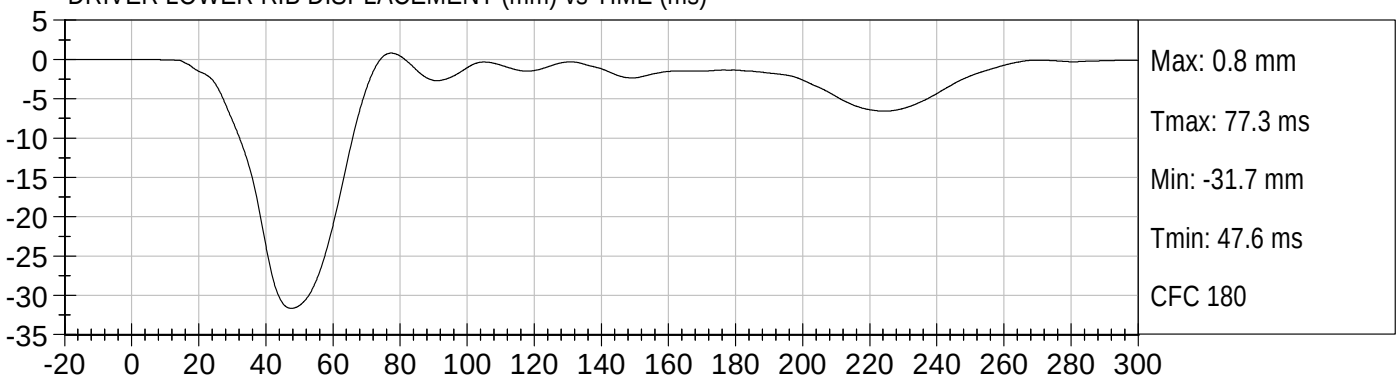
DRIVER MID RIB DISPLACEMENT (mm) vs TIME (ms)



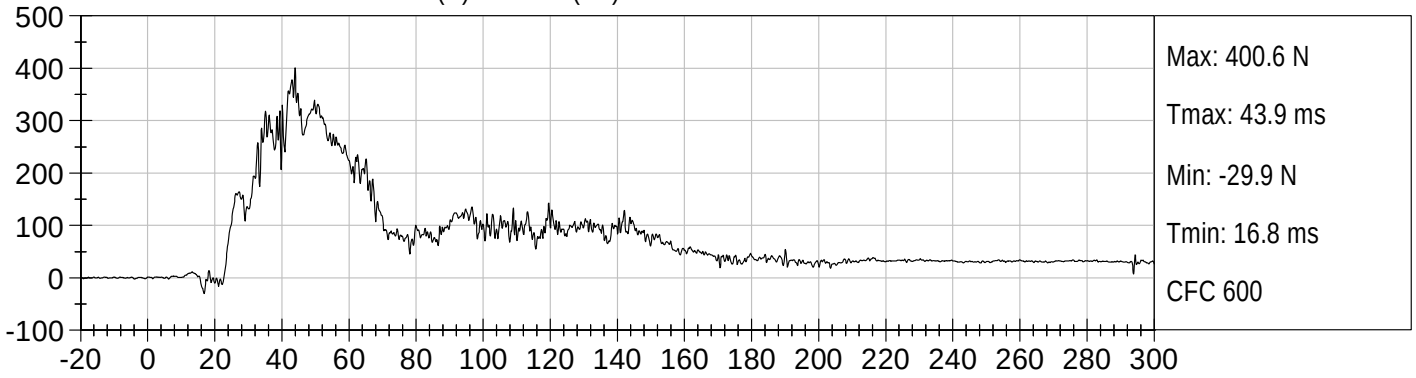
DRIVER LOWER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



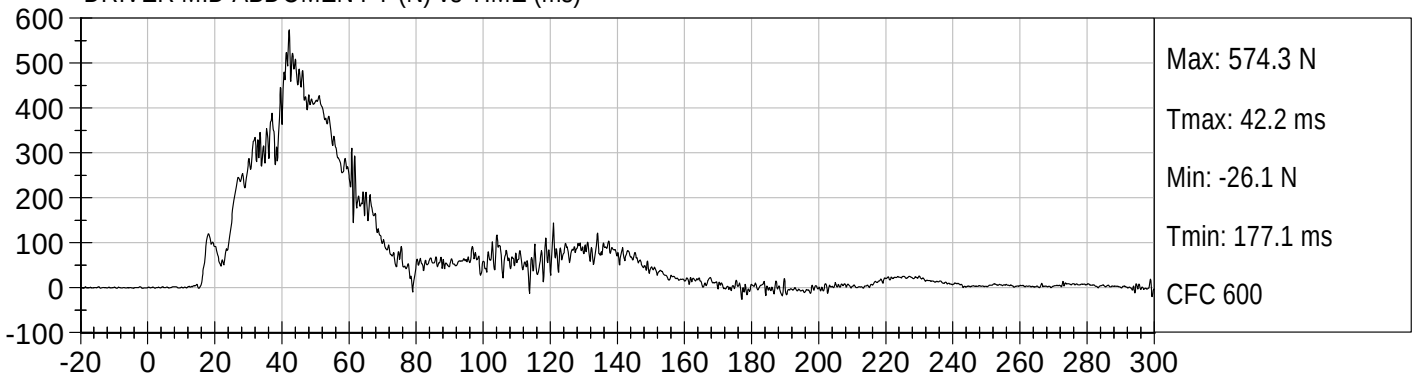
DRIVER LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



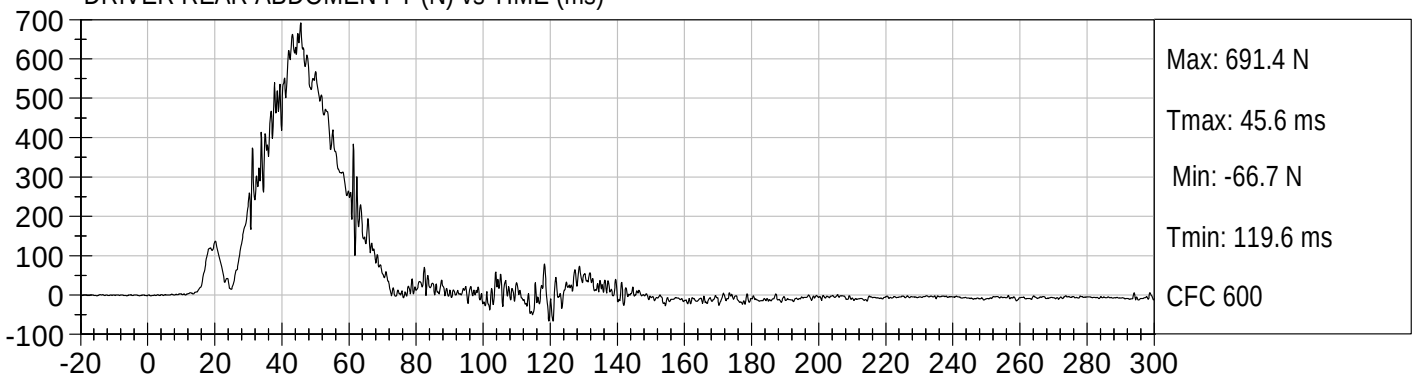
DRIVER FRONT ABDOMEN FY (N) vs TIME (ms)



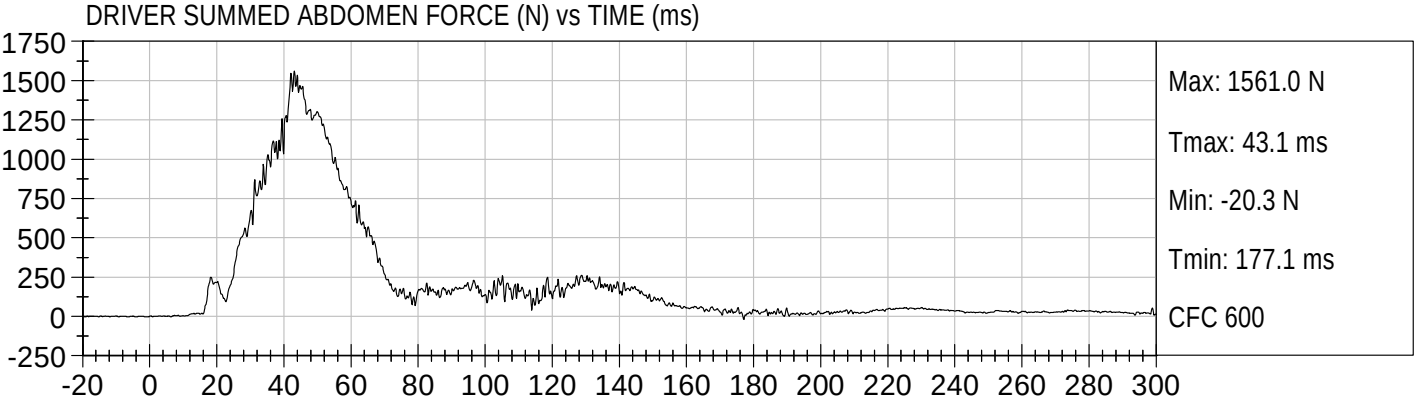
DRIVER MID ABDOMEN FY (N) vs TIME (ms)



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

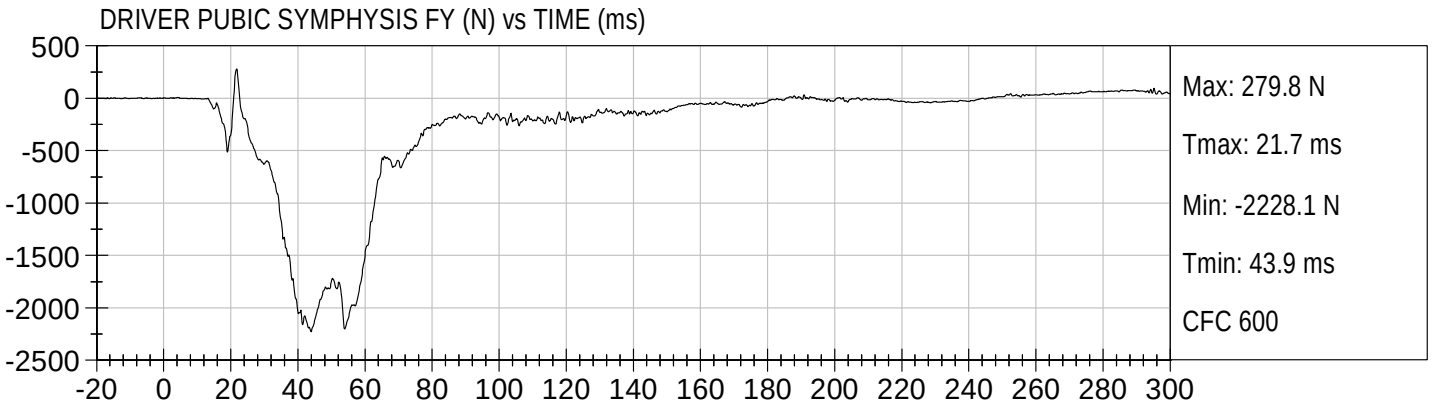


DRIVER SUMMED ABDOMEN FORCE (N) vs TIME (ms)



FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)



APPENDIX C

VEHICLE ACCELEROMETER RESPONSE DATA

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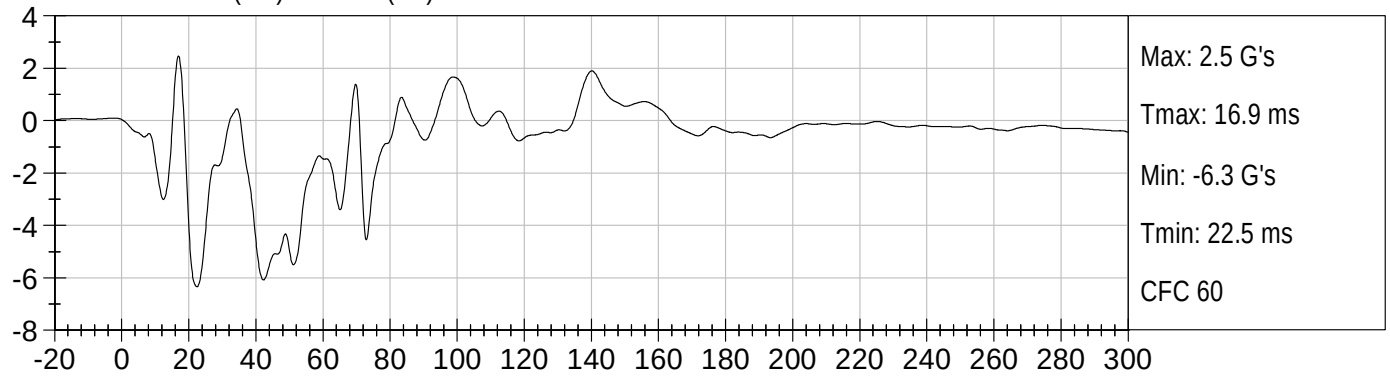
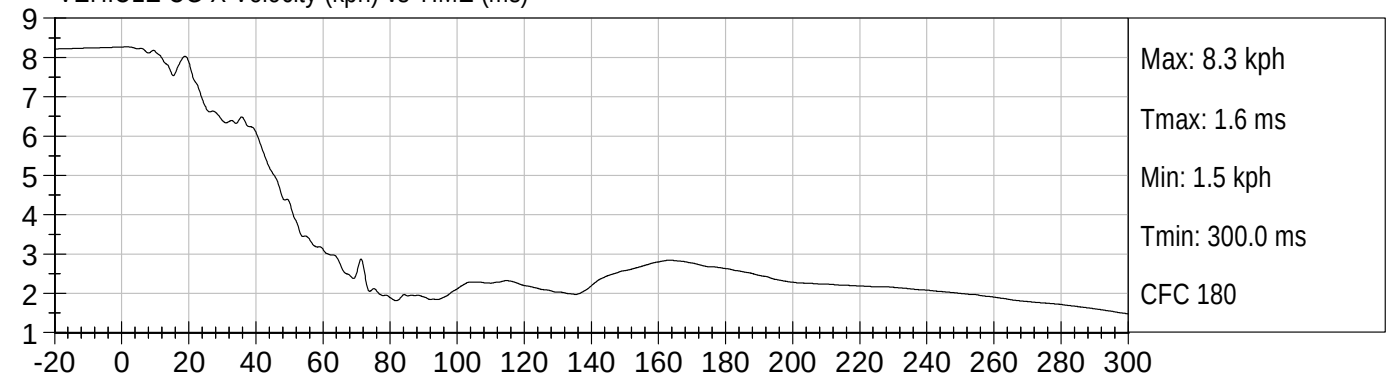
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

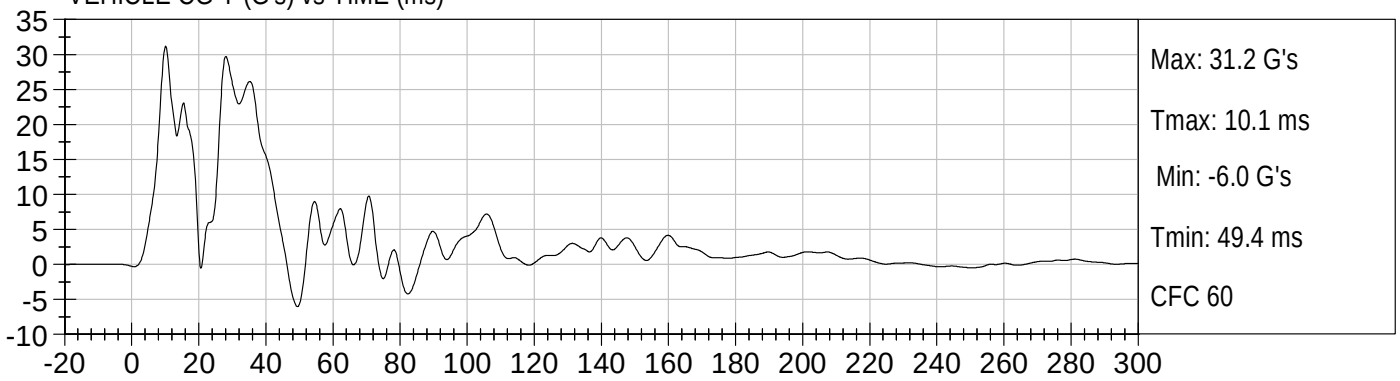
VEHICLE CG X (G's) vs TIME (ms)



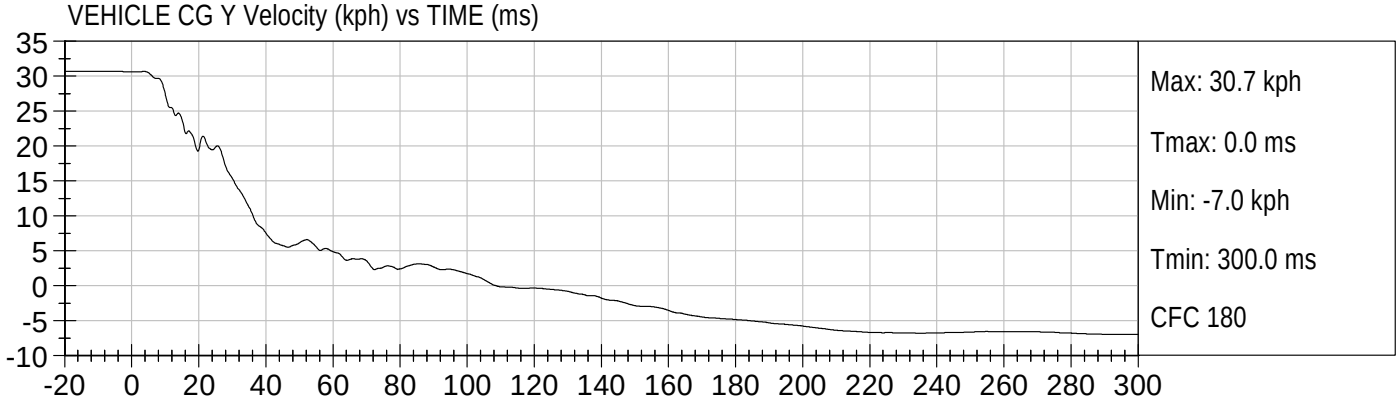
VEHICLE CG X Velocity (kph) vs TIME (ms)



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



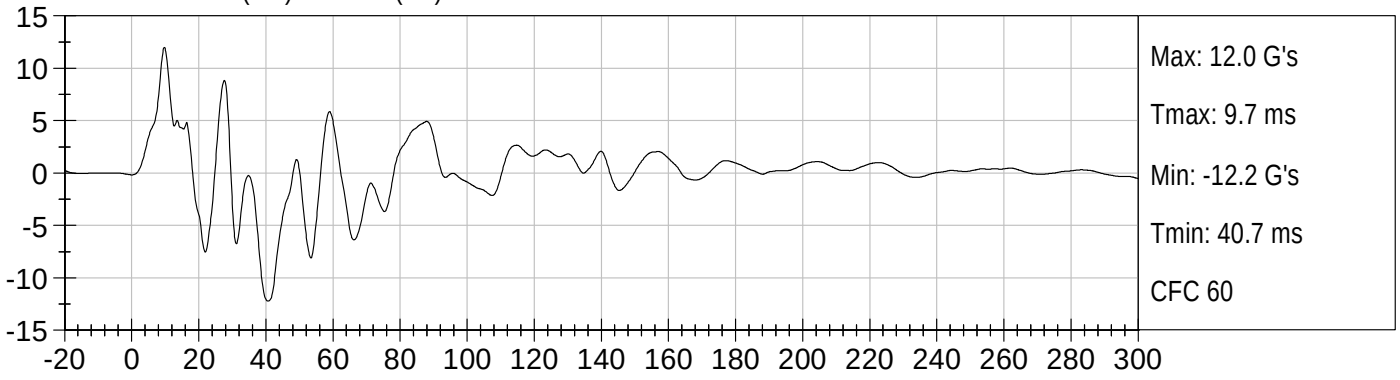
VEHICLE CG Y Velocity (kph) vs TIME (ms)



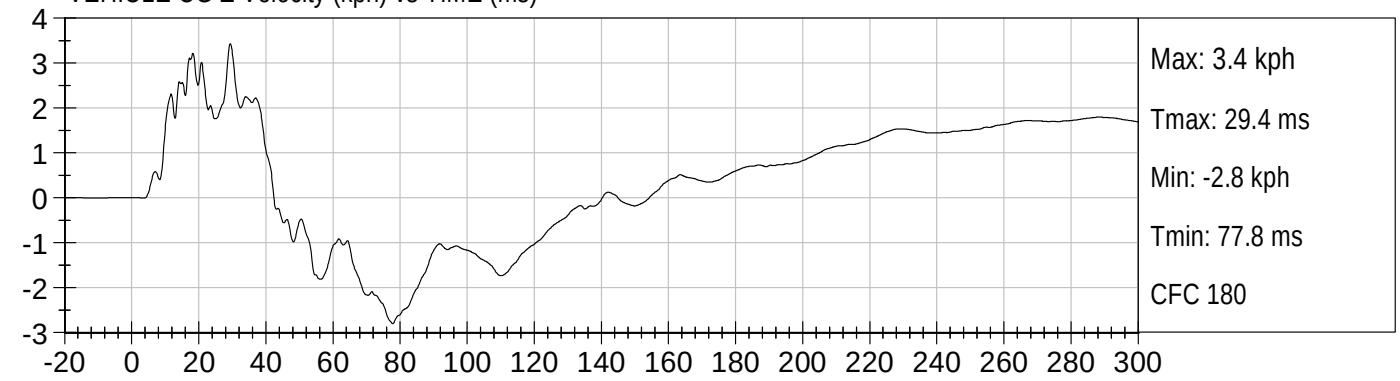
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

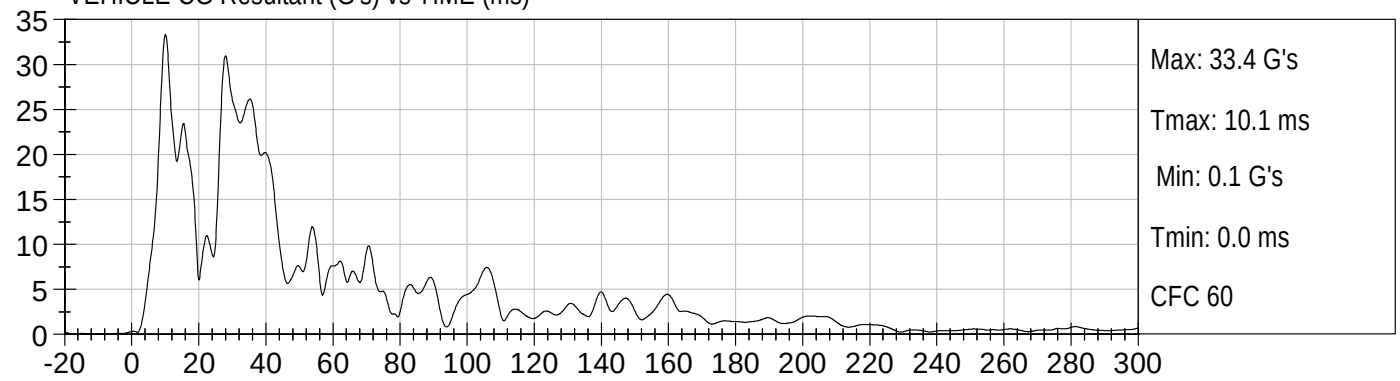
VEHICLE CG Z (G's) vs TIME (ms)



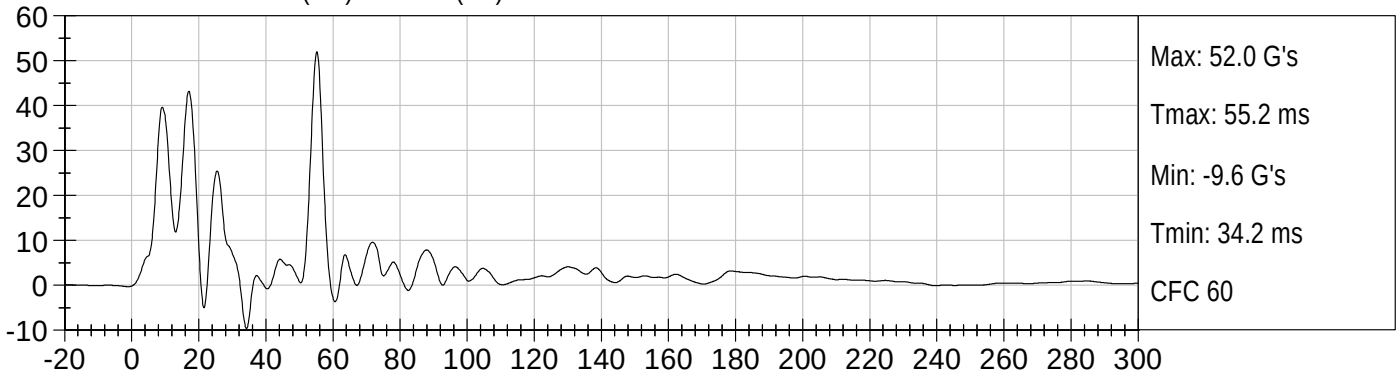
VEHICLE CG Z Velocity (kph) vs TIME (ms)



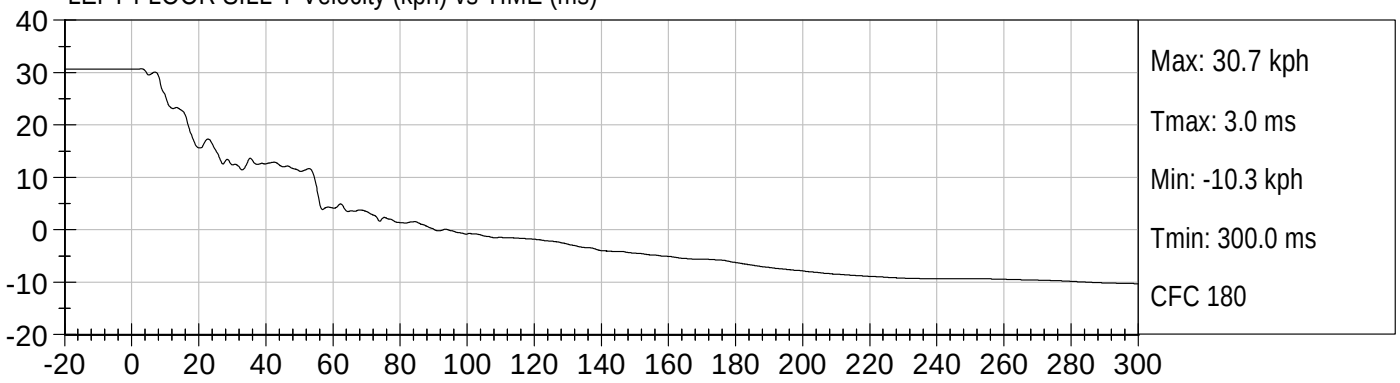
VEHICLE CG Resultant (G's) vs TIME (ms)



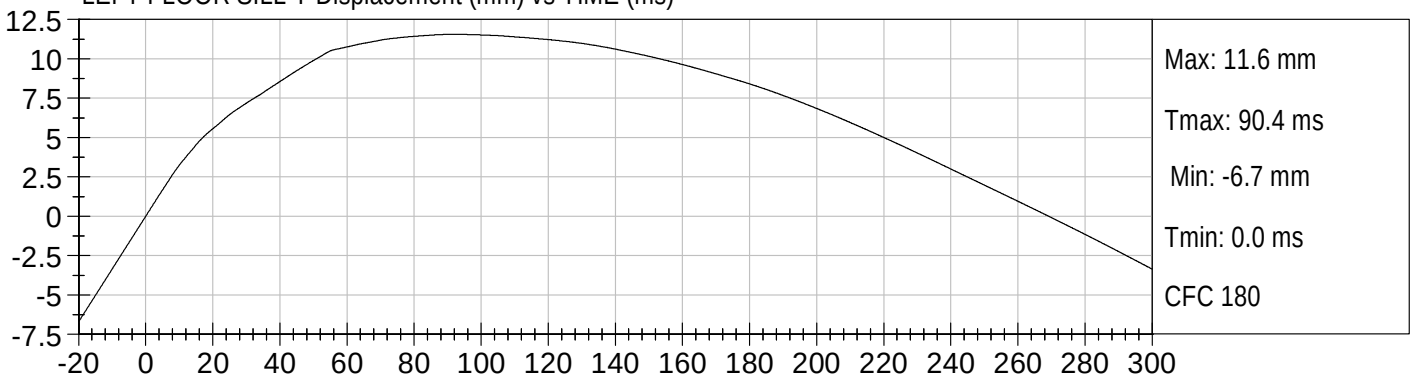
LEFT FLOOR SILL Y (G's) vs TIME (ms)



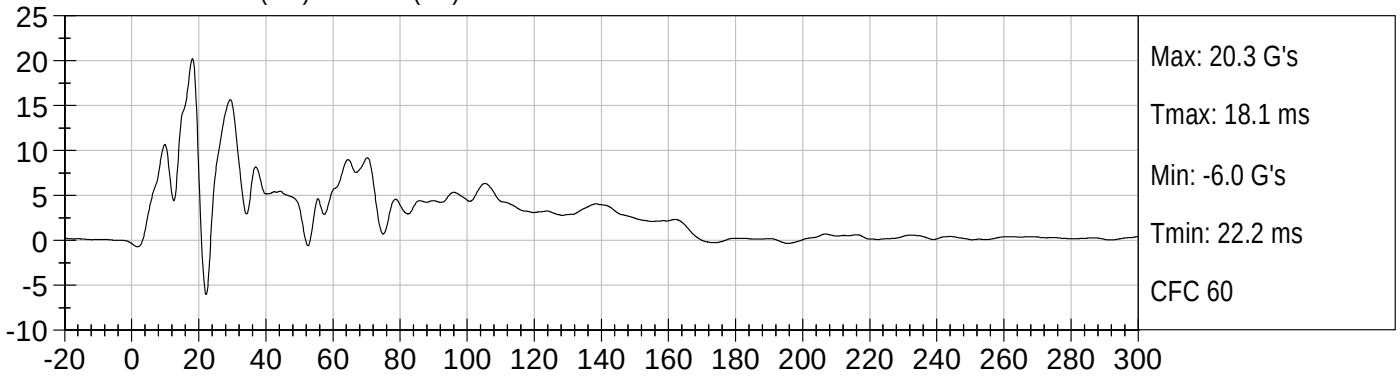
LEFT FLOOR SILL Y Velocity (kph) vs TIME (ms)



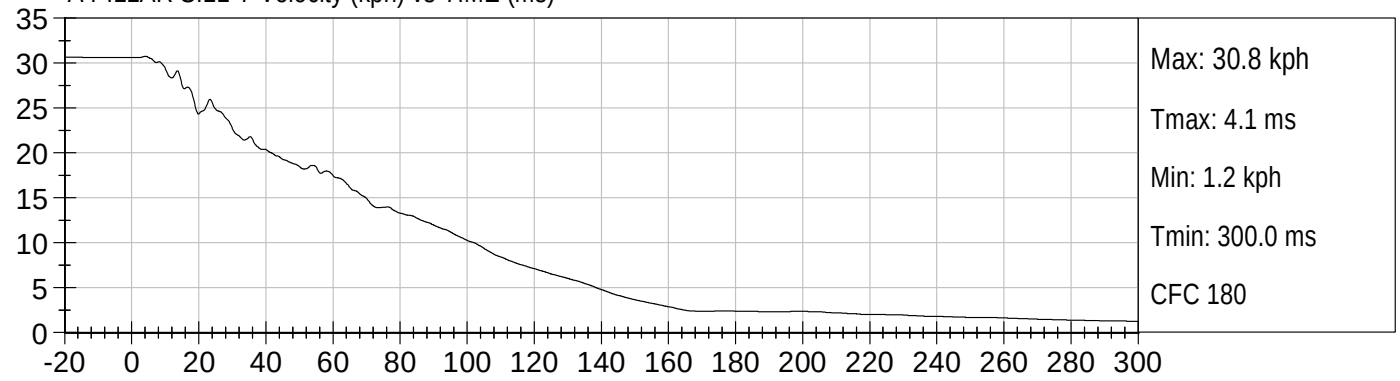
LEFT FLOOR SILL Y Displacement (mm) vs TIME (ms)



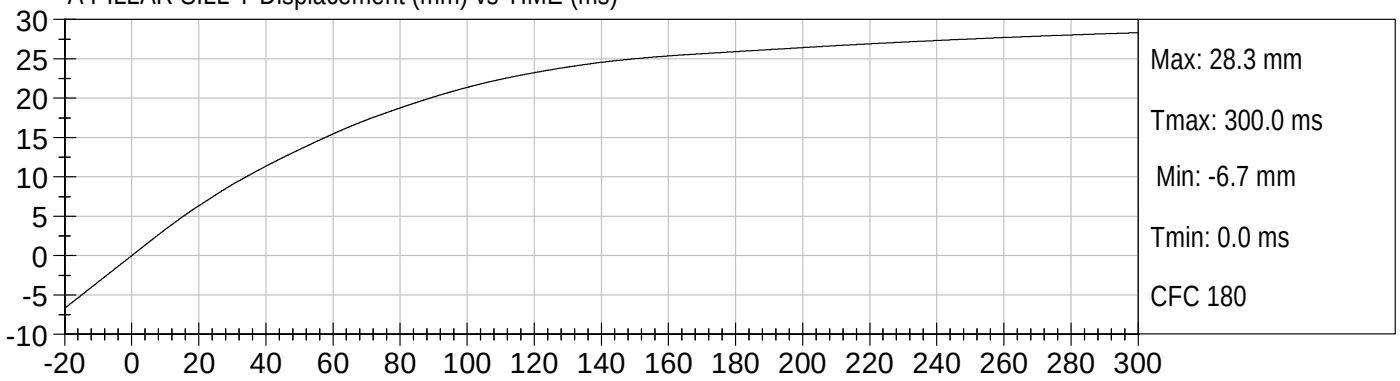
A PILLAR SILL Y (G's) vs TIME (ms)



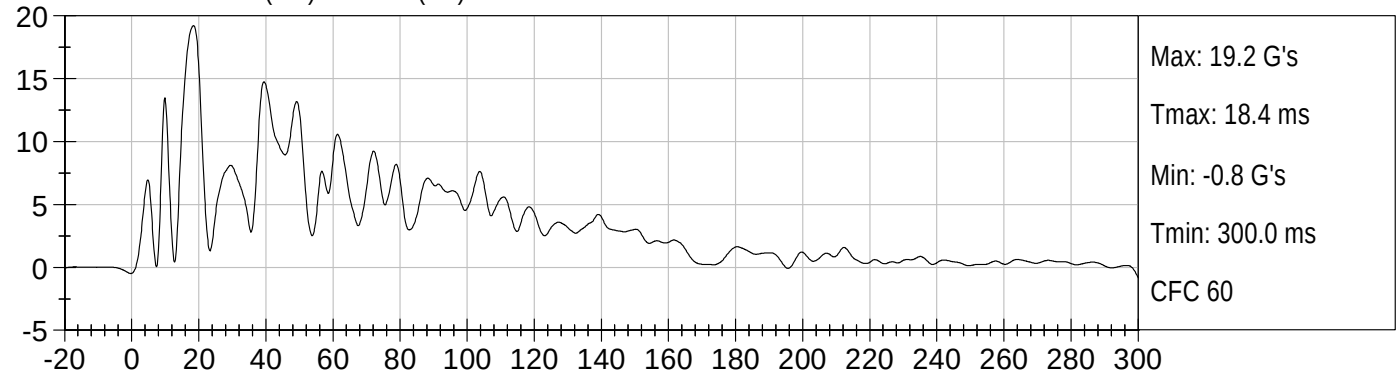
A PILLAR SILL Y Velocity (kph) vs TIME (ms)



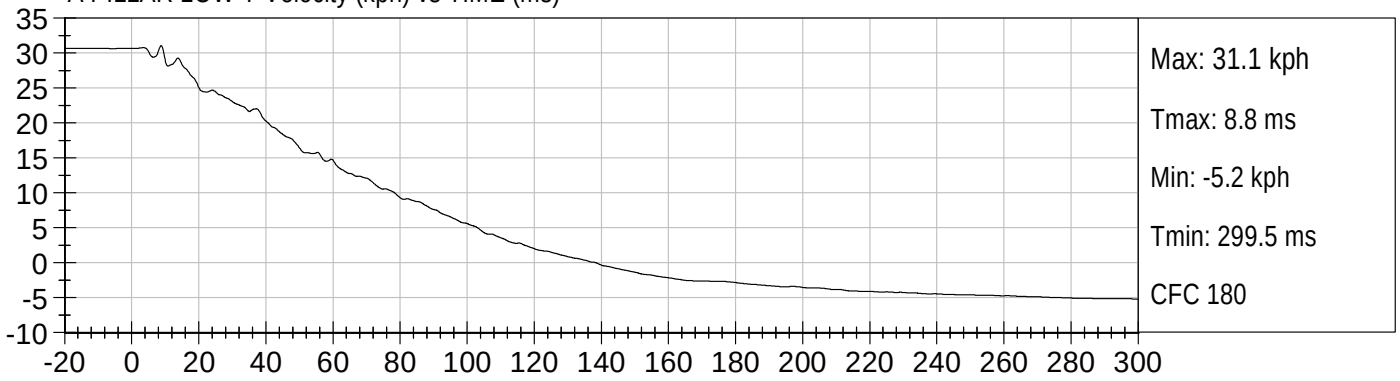
A PILLAR SILL Y Displacement (mm) vs TIME (ms)



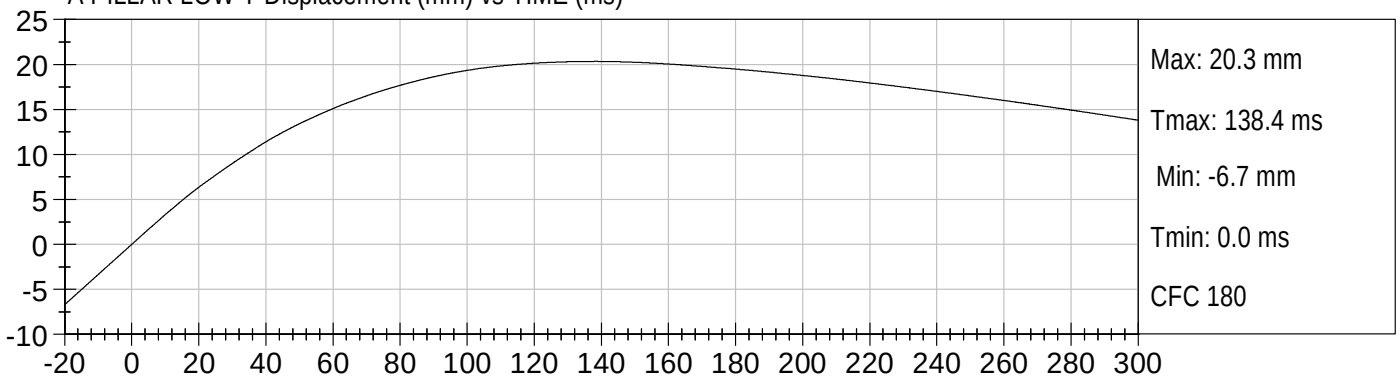
A PILLAR LOW Y (G's) vs TIME (ms)



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



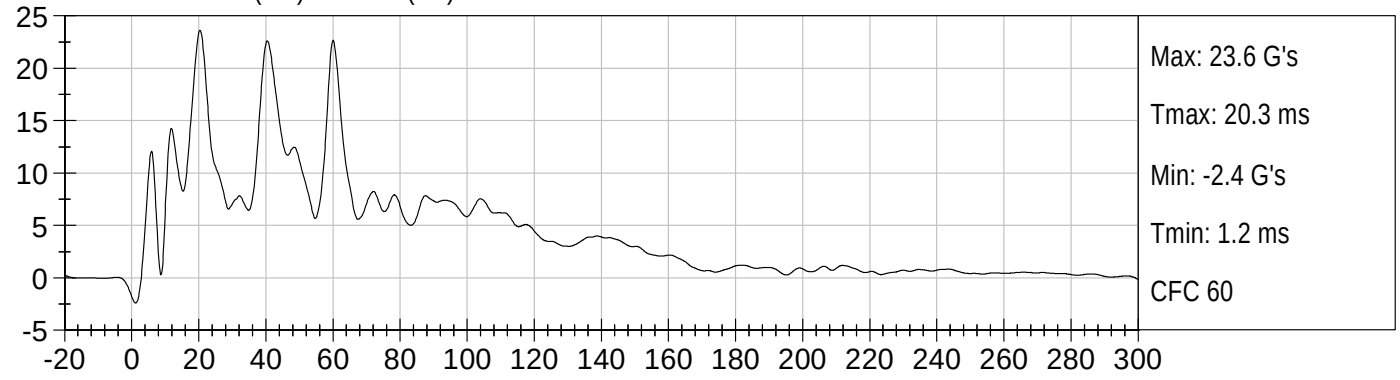
A PILLAR LOW Y Displacement (mm) vs TIME (ms)



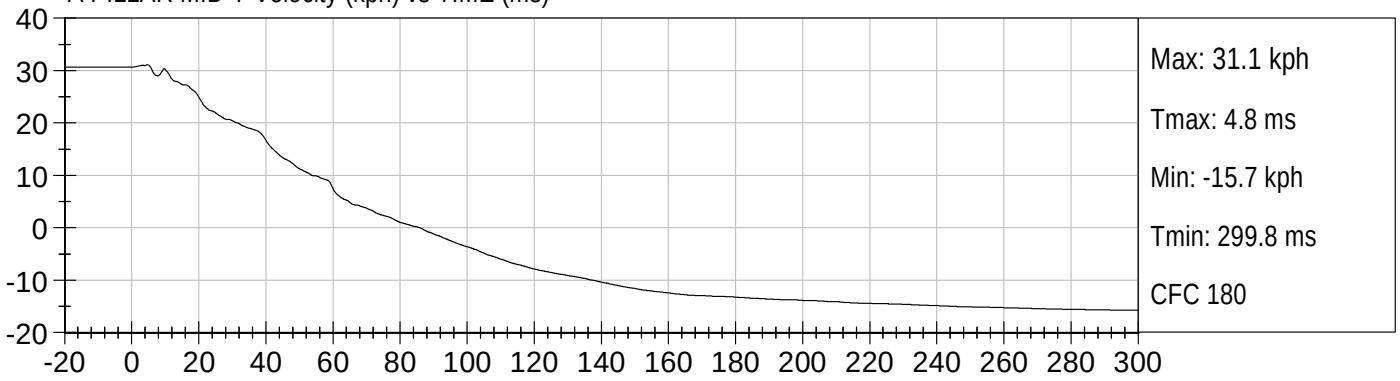
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

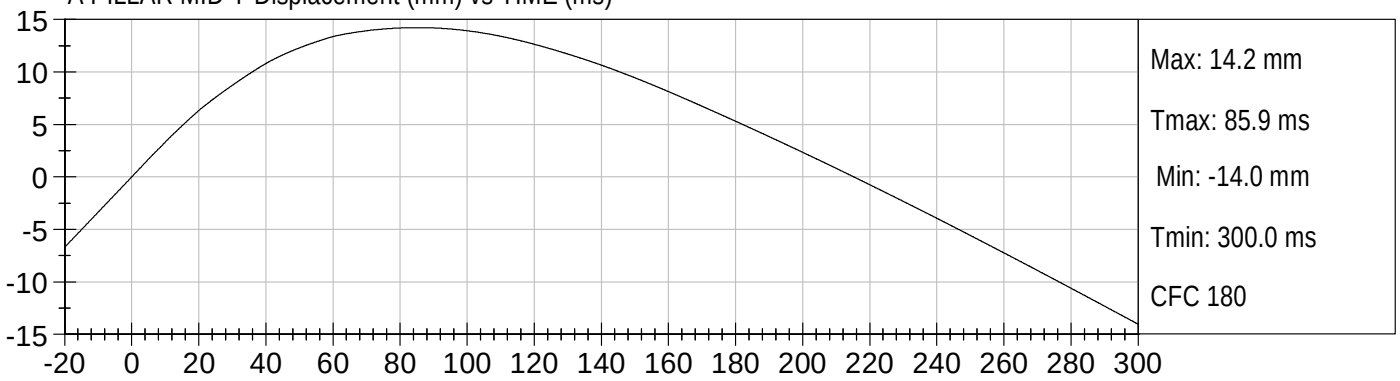
A PILLAR MID Y (G's) vs TIME (ms)



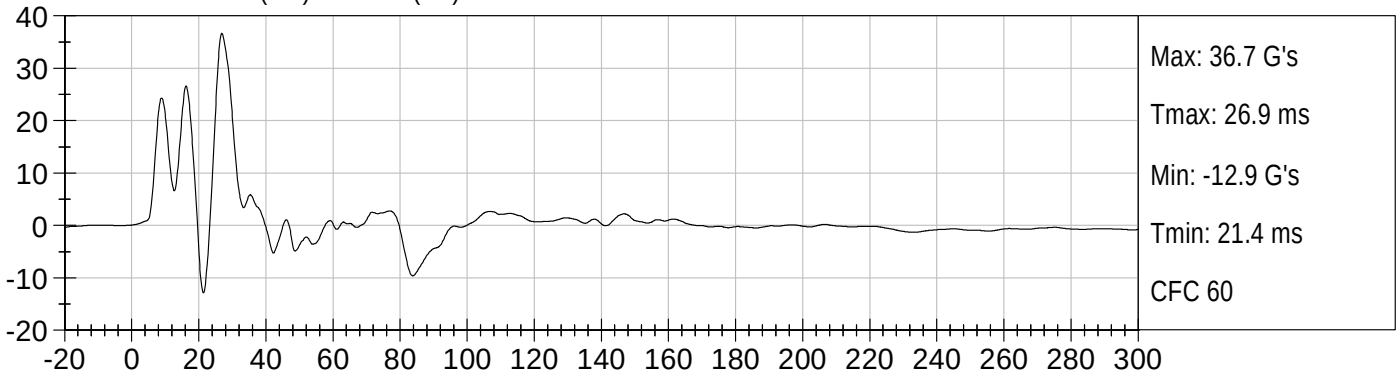
A PILLAR MID Y Velocity (kph) vs TIME (ms)



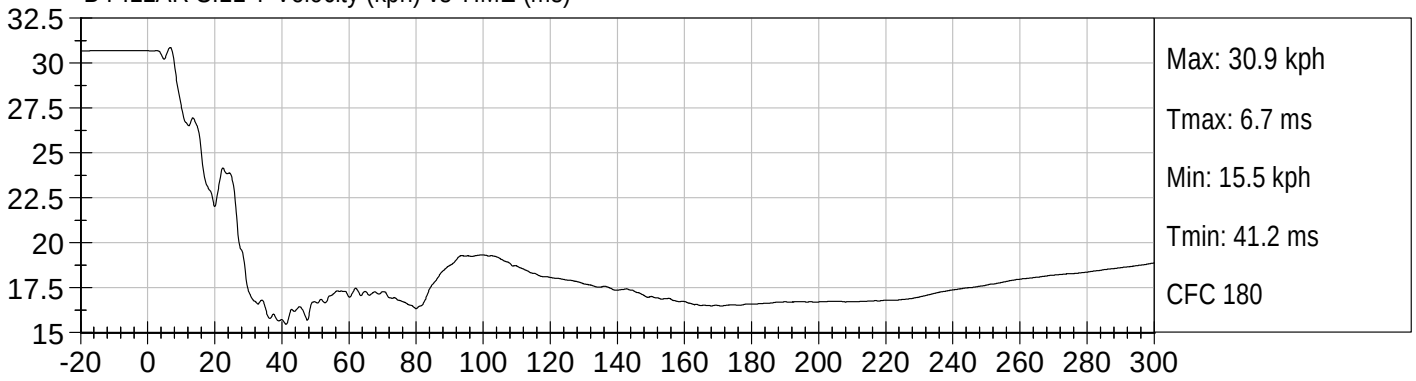
A PILLAR MID Y Displacement (mm) vs TIME (ms)



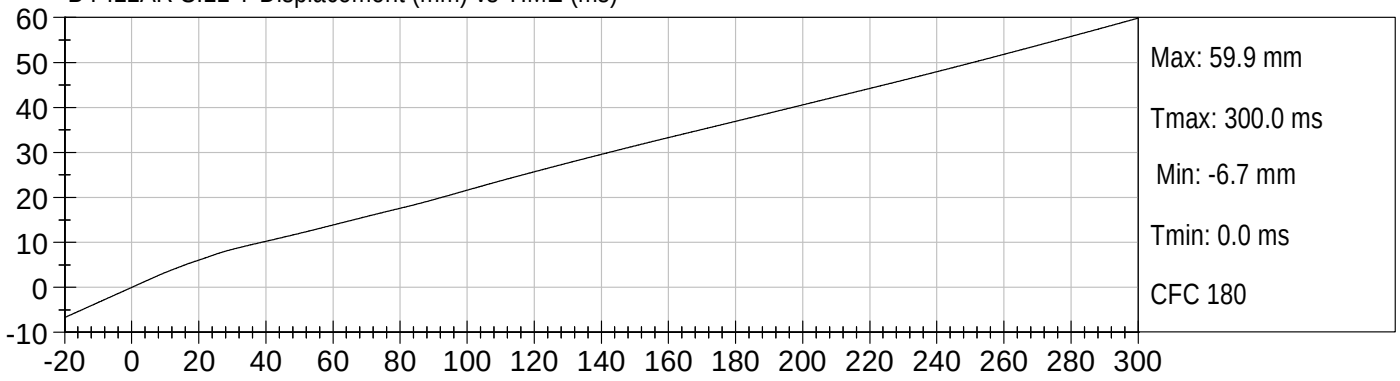
B PILLAR SILL Y (G's) vs TIME (ms)



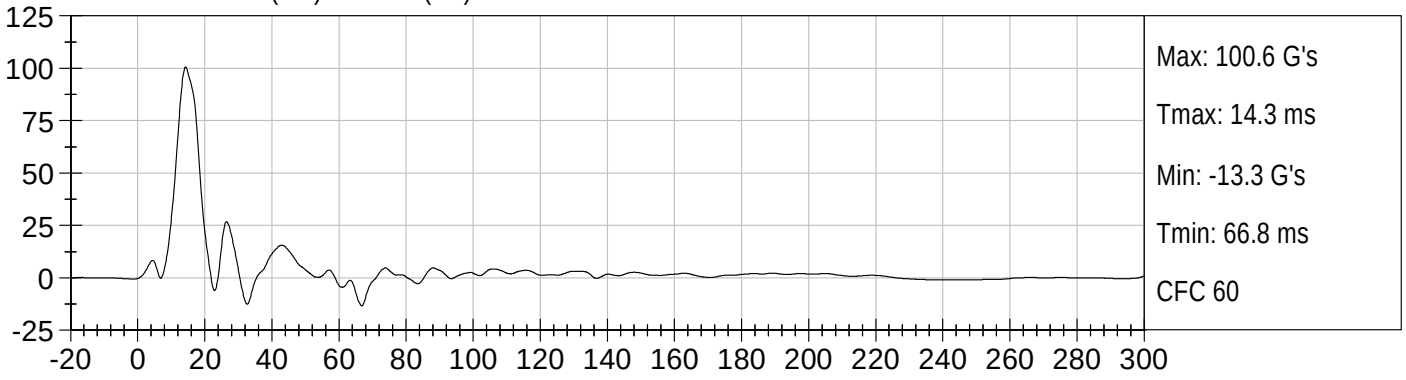
B PILLAR SILL Y Velocity (kph) vs TIME (ms)



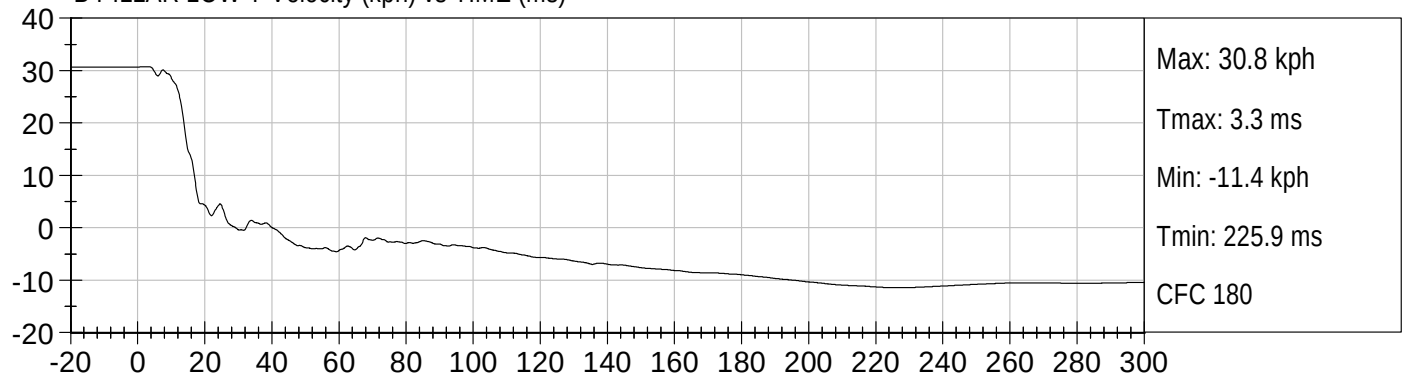
B PILLAR SILL Y Displacement (mm) vs TIME (ms)



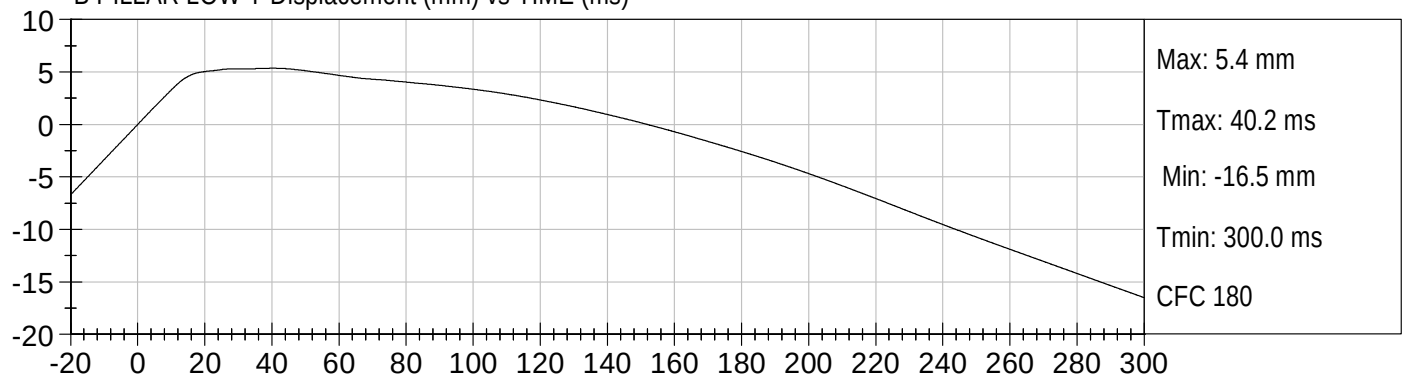
B PILLAR LOW Y (G's) vs TIME (ms)



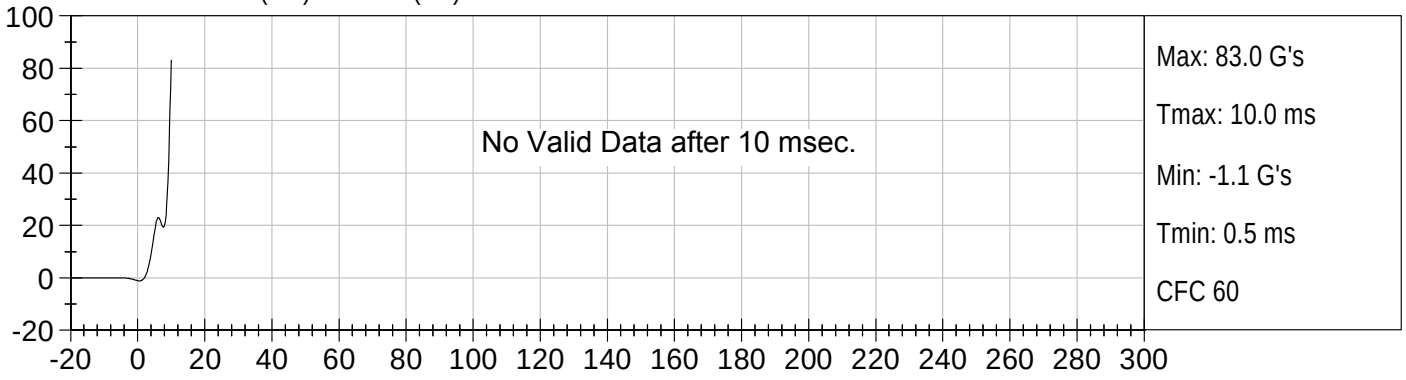
B PILLAR LOW Y Velocity (kph) vs TIME (ms)



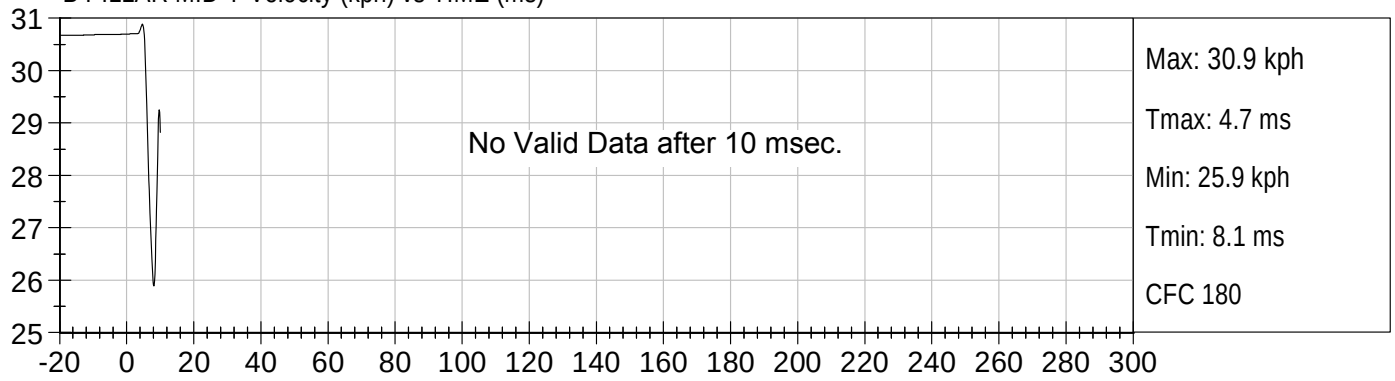
B PILLAR LOW Y Displacement (mm) vs TIME (ms)



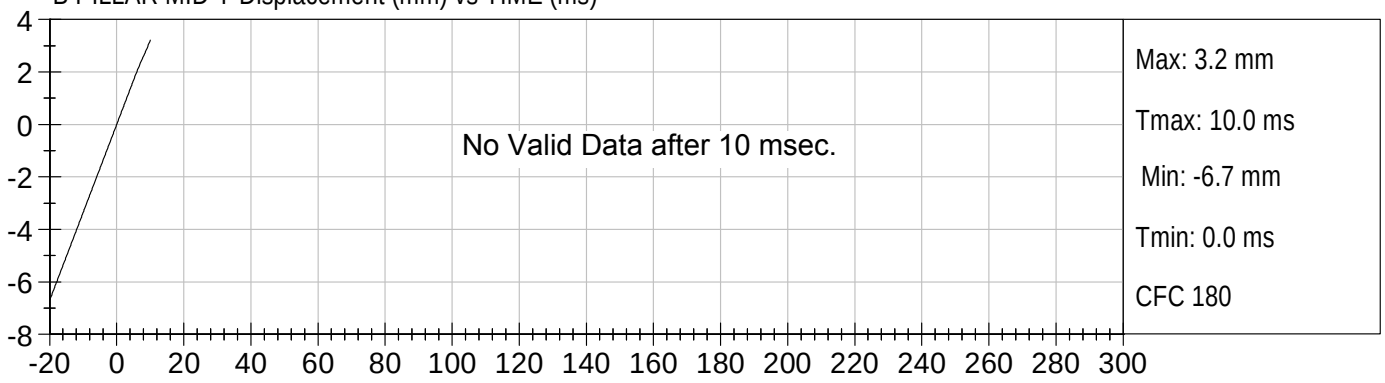
B PILLAR MID Y (G's) vs TIME (ms)



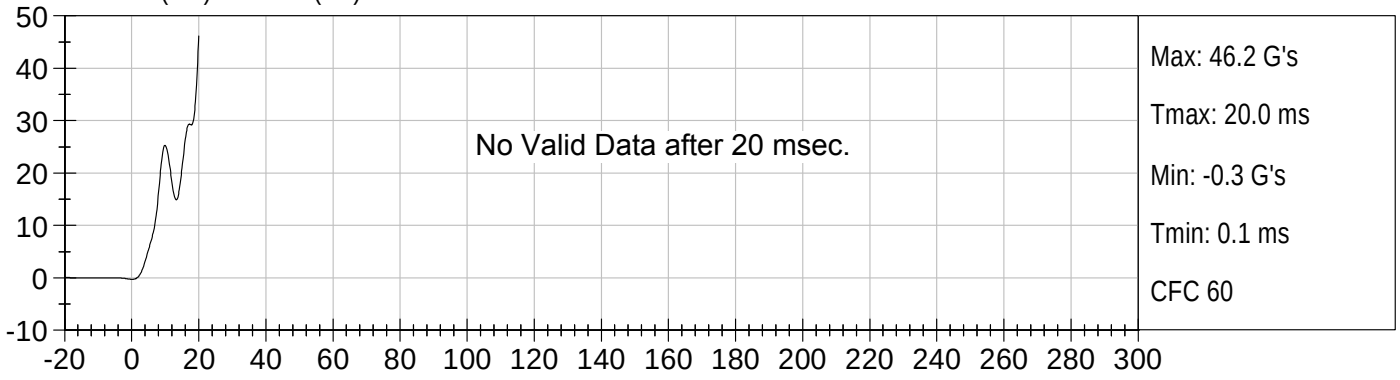
B PILLAR MID Y Velocity (kph) vs TIME (ms)



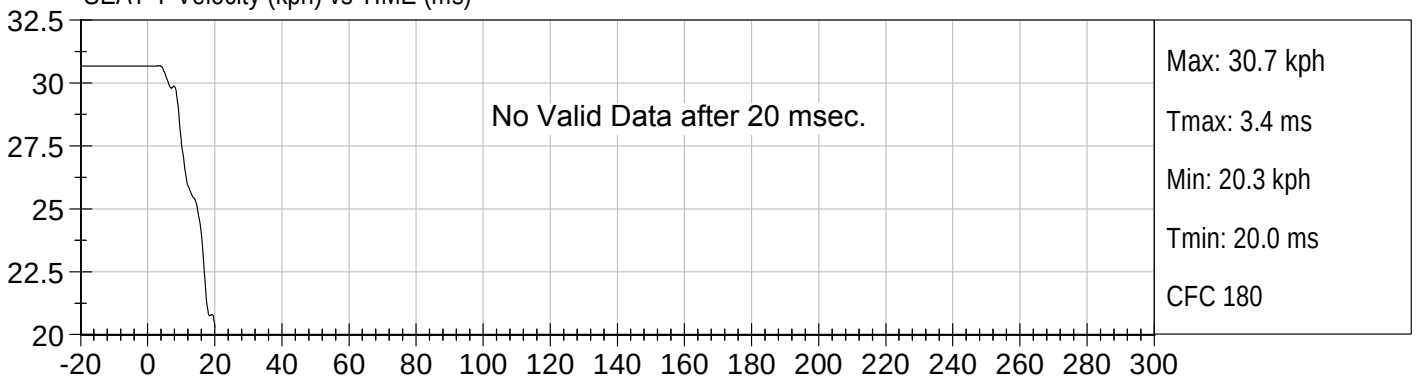
B PILLAR MID Y Displacement (mm) vs TIME (ms)



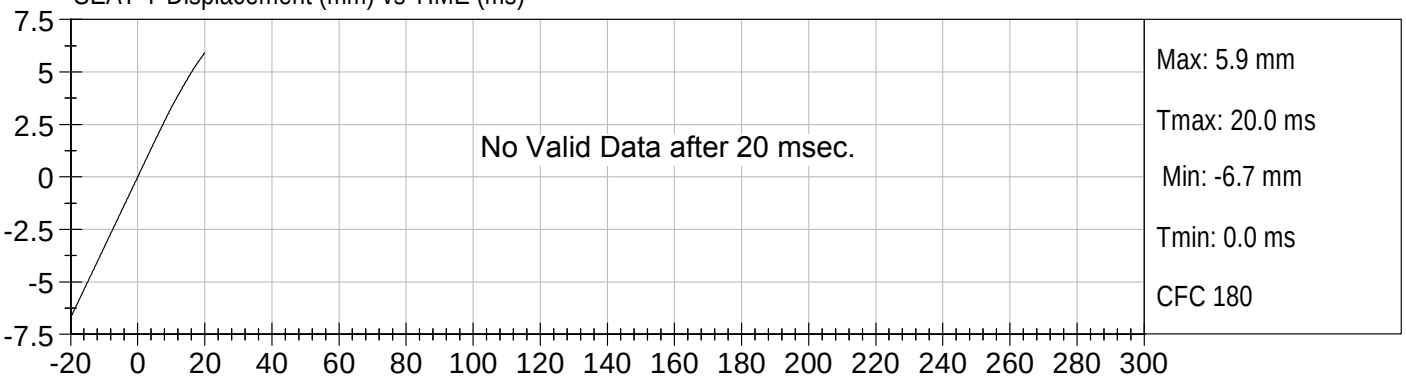
SEAT Y (G's) vs TIME (ms)



SEAT Y Velocity (kph) vs TIME (ms)



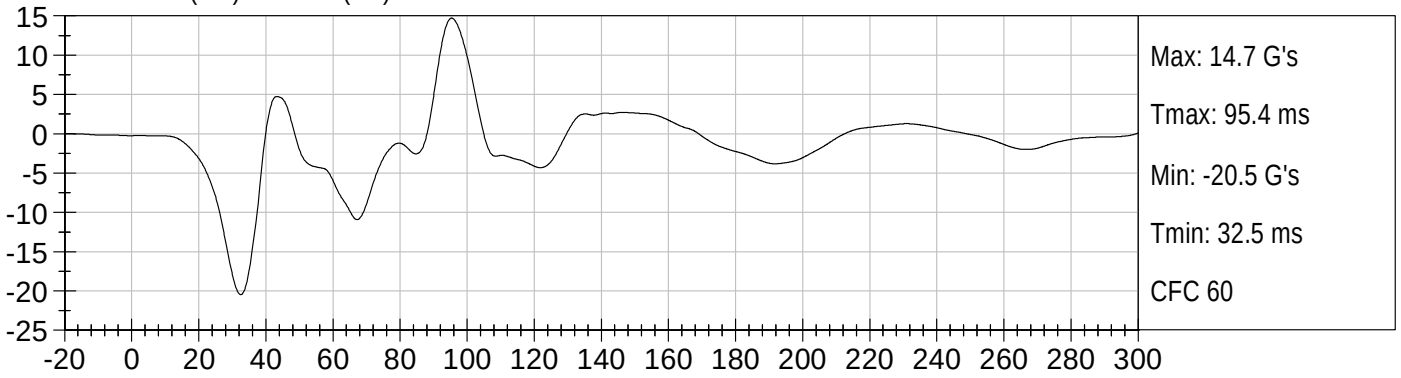
SEAT Y Displacement (mm) vs TIME (ms)



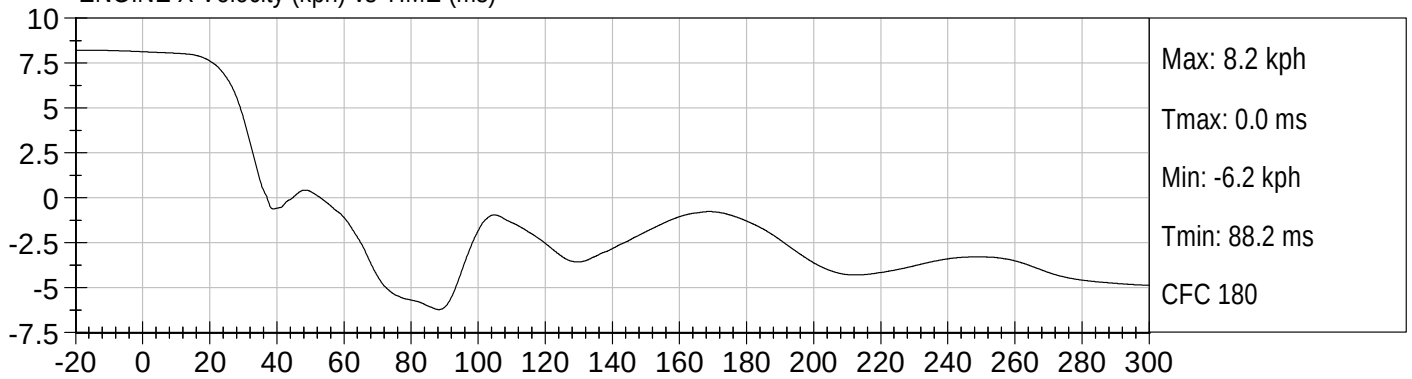
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

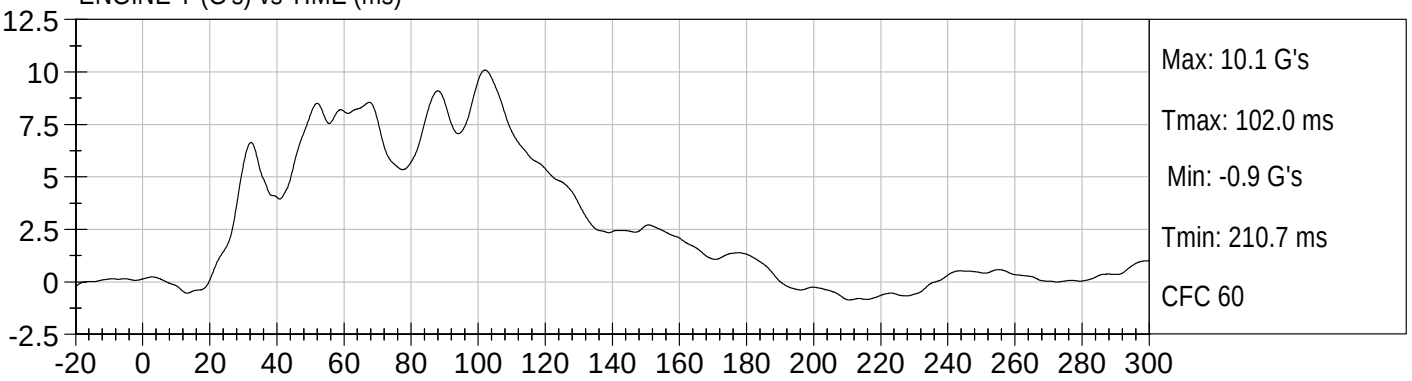
ENGINE X (G's) vs TIME (ms)



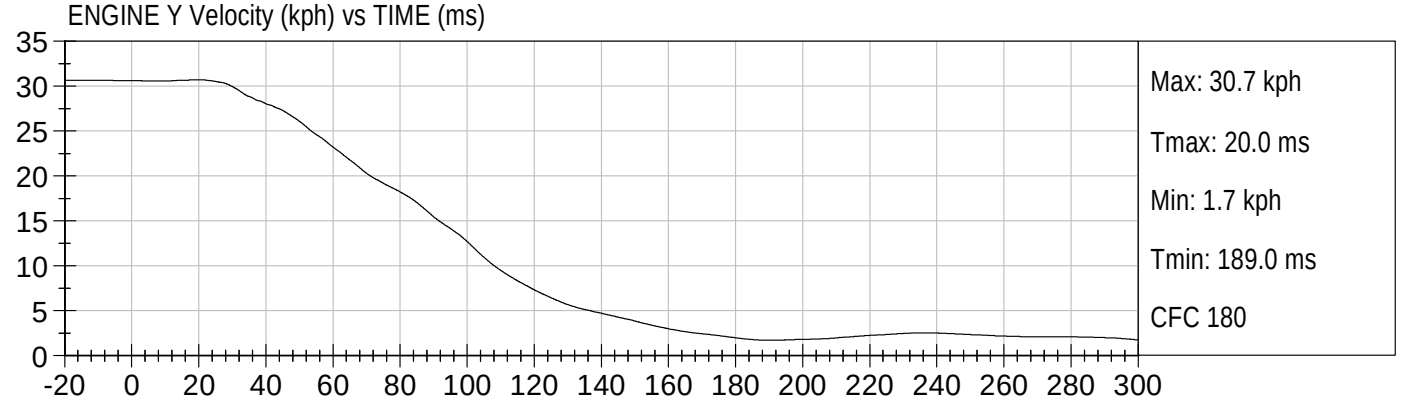
ENGINE X Velocity (kph) vs TIME (ms)



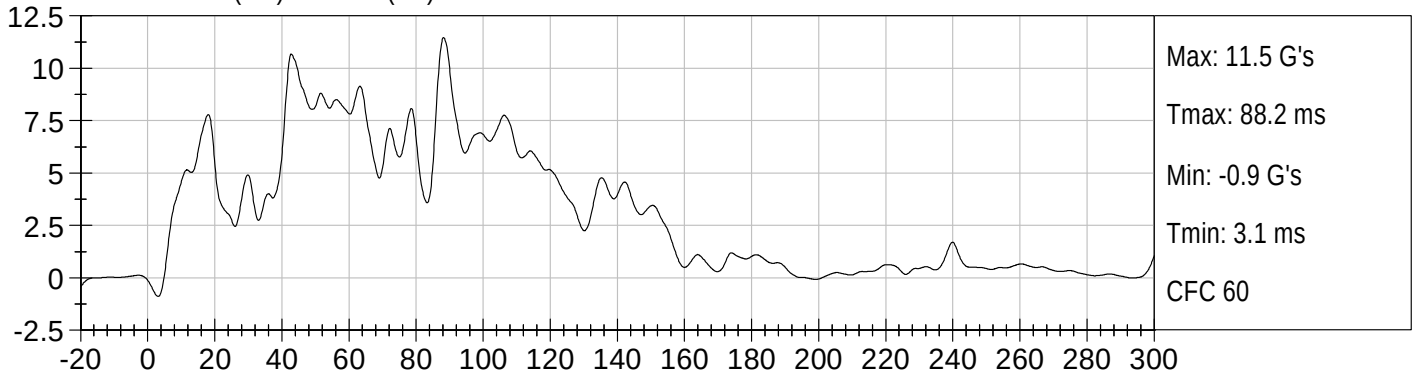
ENGINE Y (G's) vs TIME (ms)



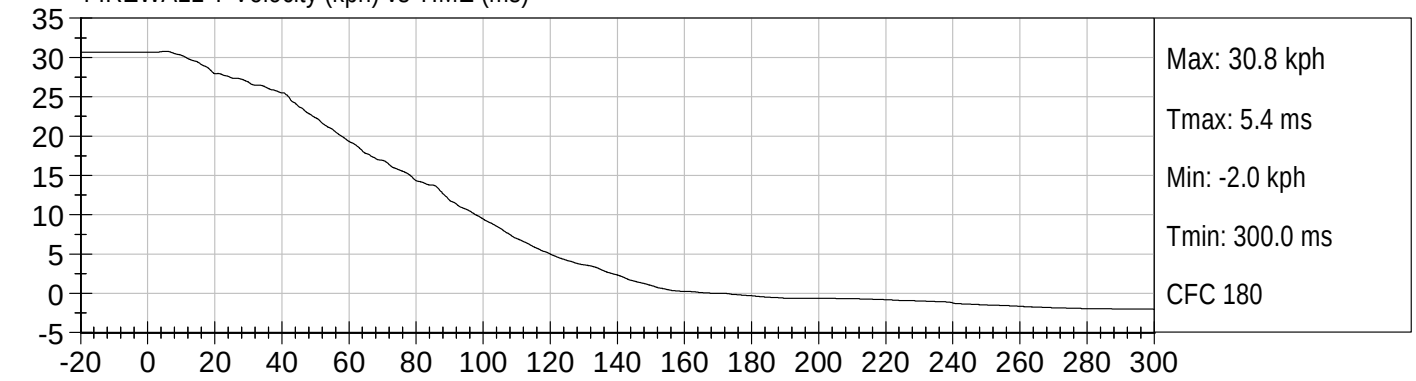
ENGINE Y Velocity (kph) vs TIME (ms)



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



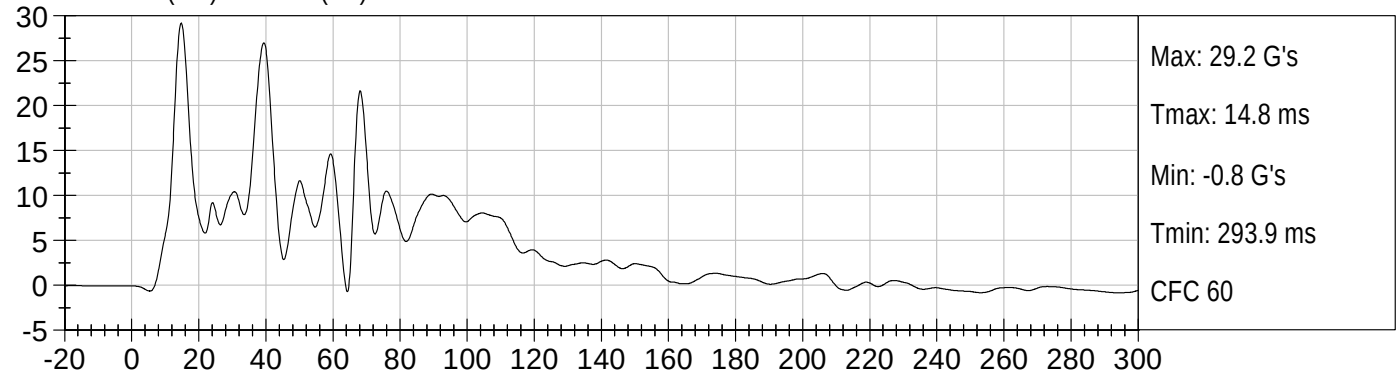
FIREWALL Y Velocity (kph) vs TIME (ms)



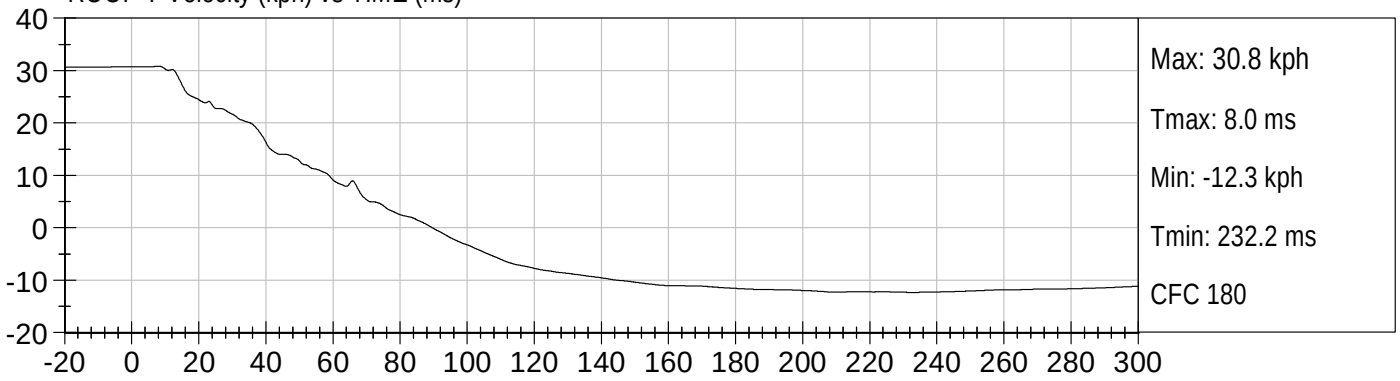
FMVSS 214 Rigid Pole Side Impact
2011 Kia Optima - CB0510

Test Date: 04/01/2011
Speed: 19.7 mph (31.8 km/h)

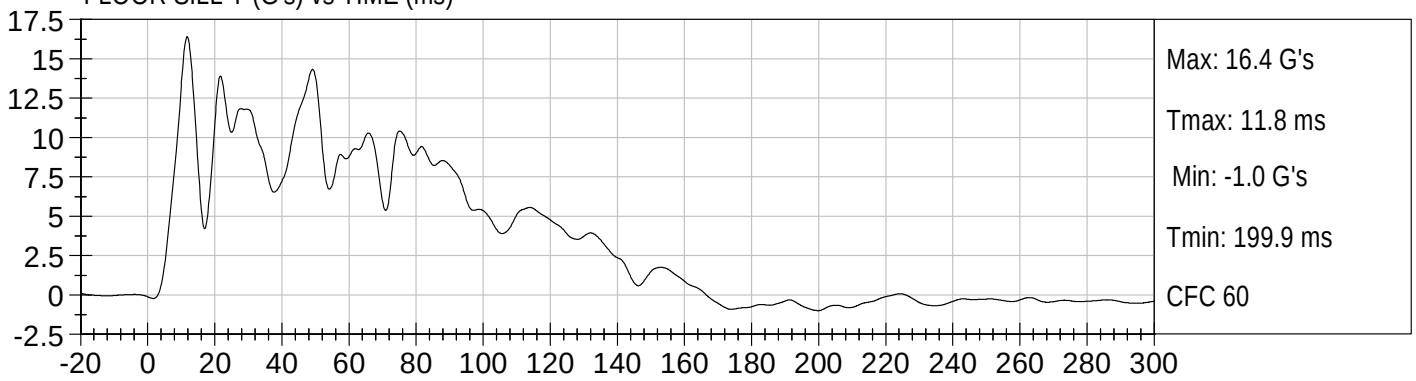
ROOF Y (G's) vs TIME (ms)



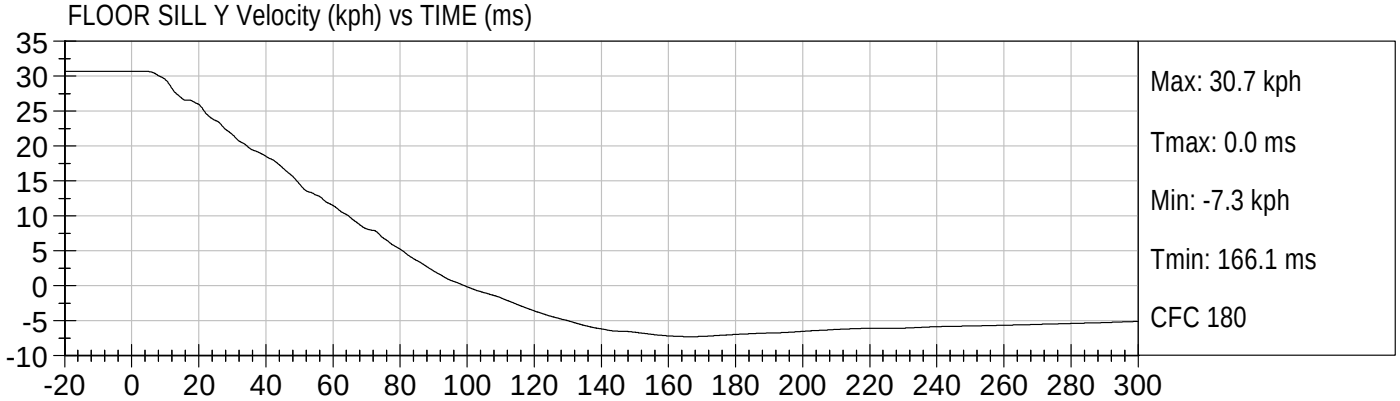
ROOF Y Velocity (kph) vs TIME (ms)



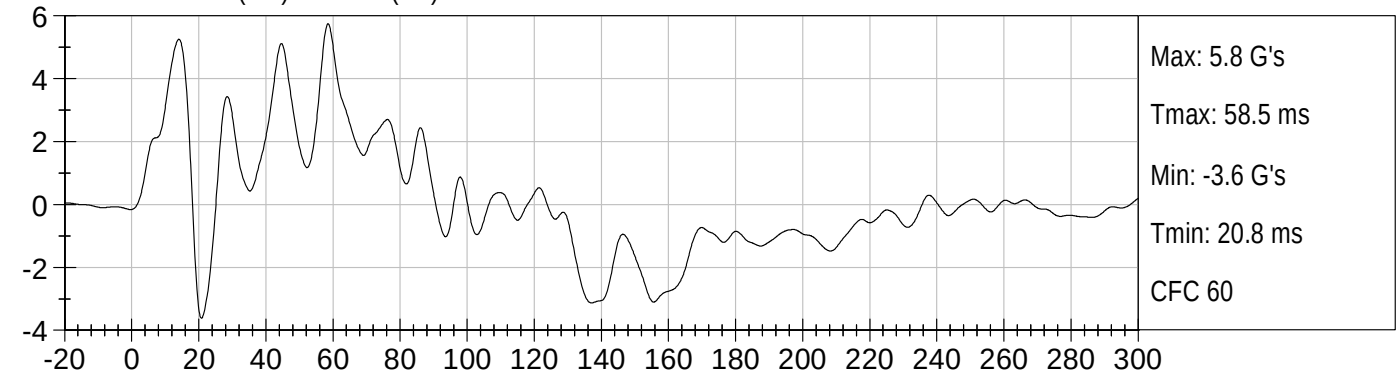
FLOOR SILL Y (G's) vs TIME (ms)



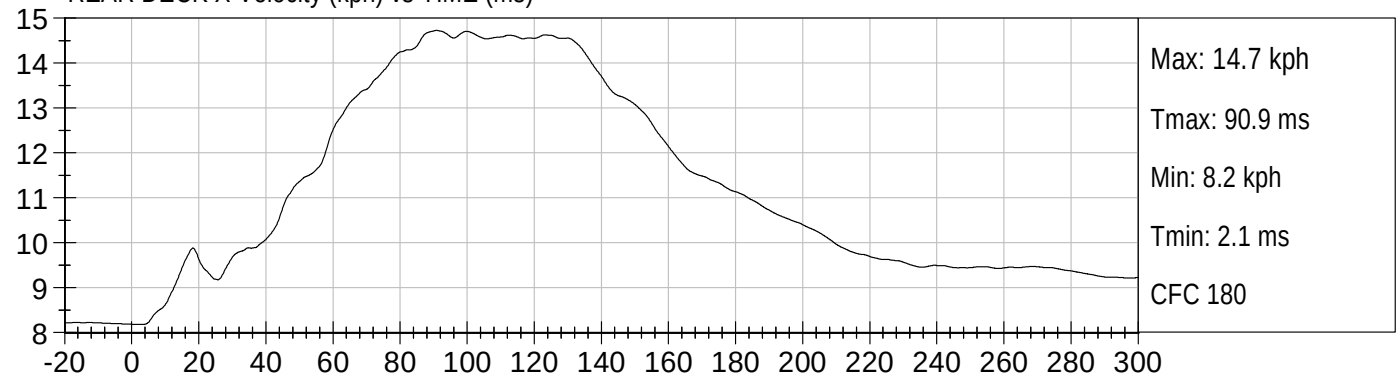
FLOOR SILL Y Velocity (kph) vs TIME (ms)



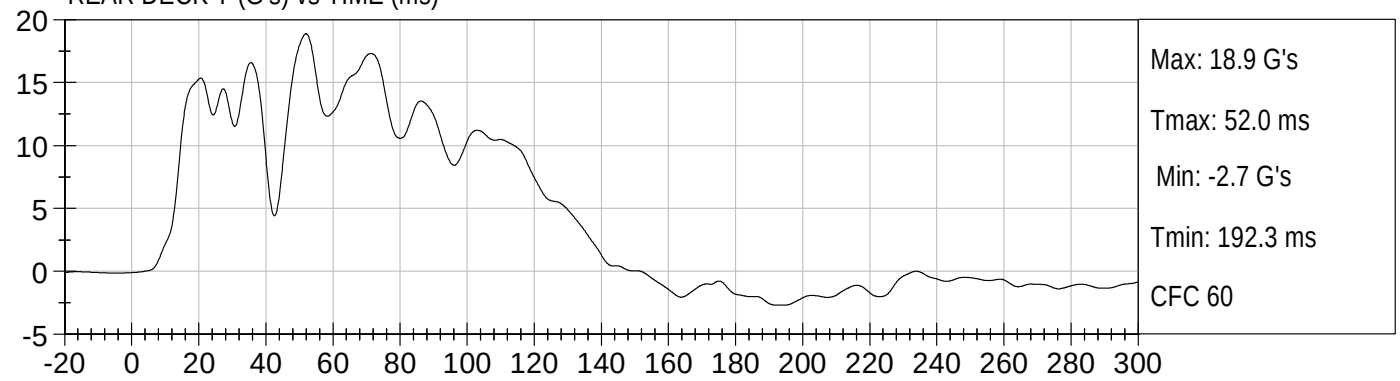
REAR DECK X (G's) vs TIME (ms)



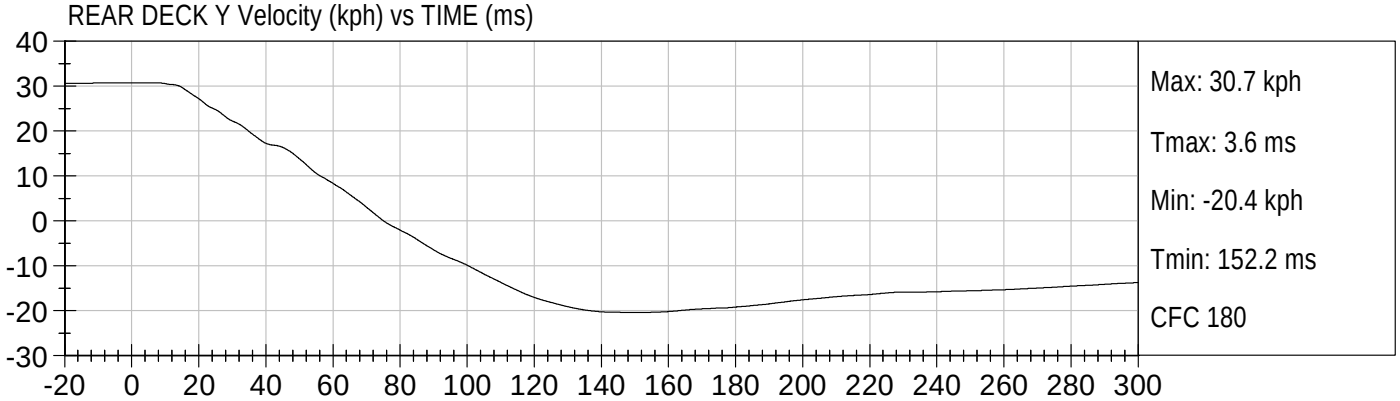
REAR DECK X Velocity (kph) vs TIME (ms)



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:** D111231

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.8	Pass
Laboratory Relative Humidity	%	10 to 70	17	Pass
Peak Resultant Acceleration	G's	125 to 155	139	Pass
Peak Lateral Acceleration	G's	+/- 15	6.5	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

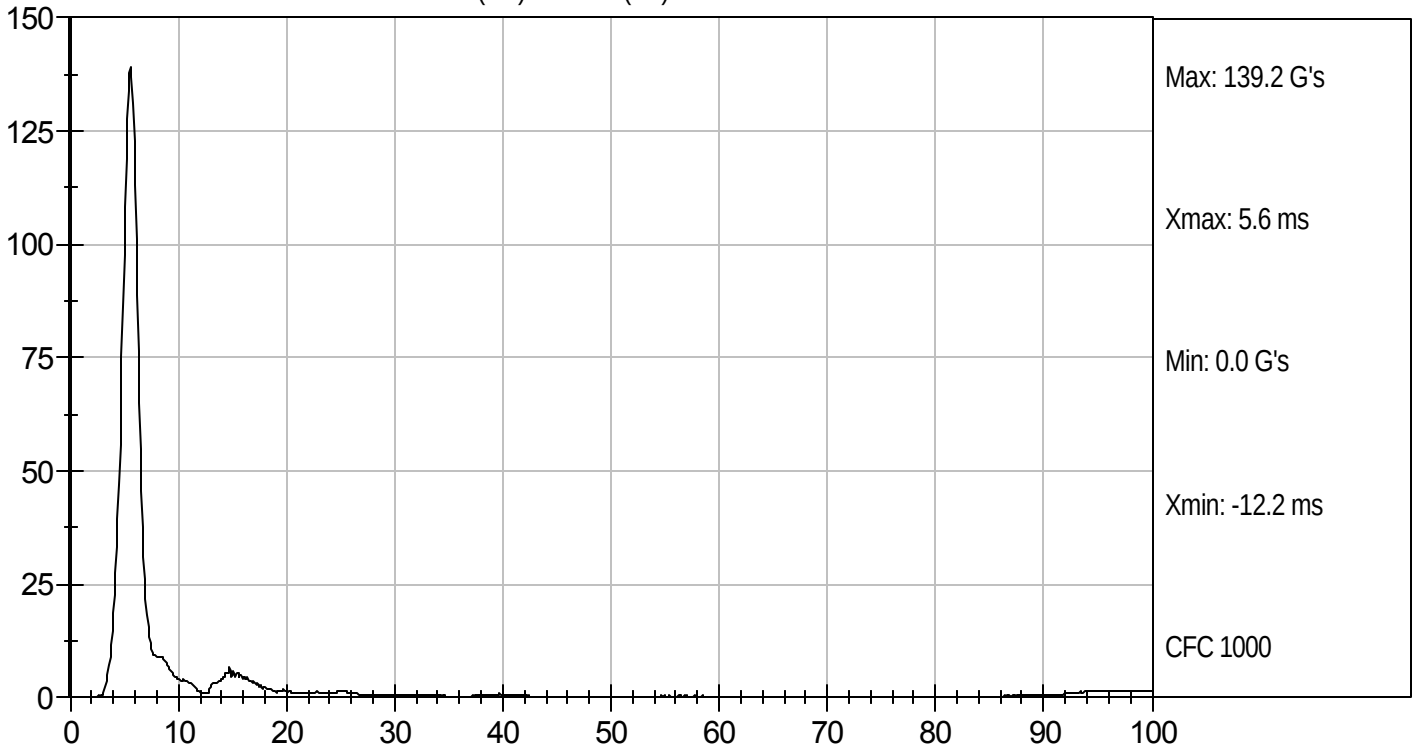
3/31/11
Test Date

David Winkelbauer
Approved By

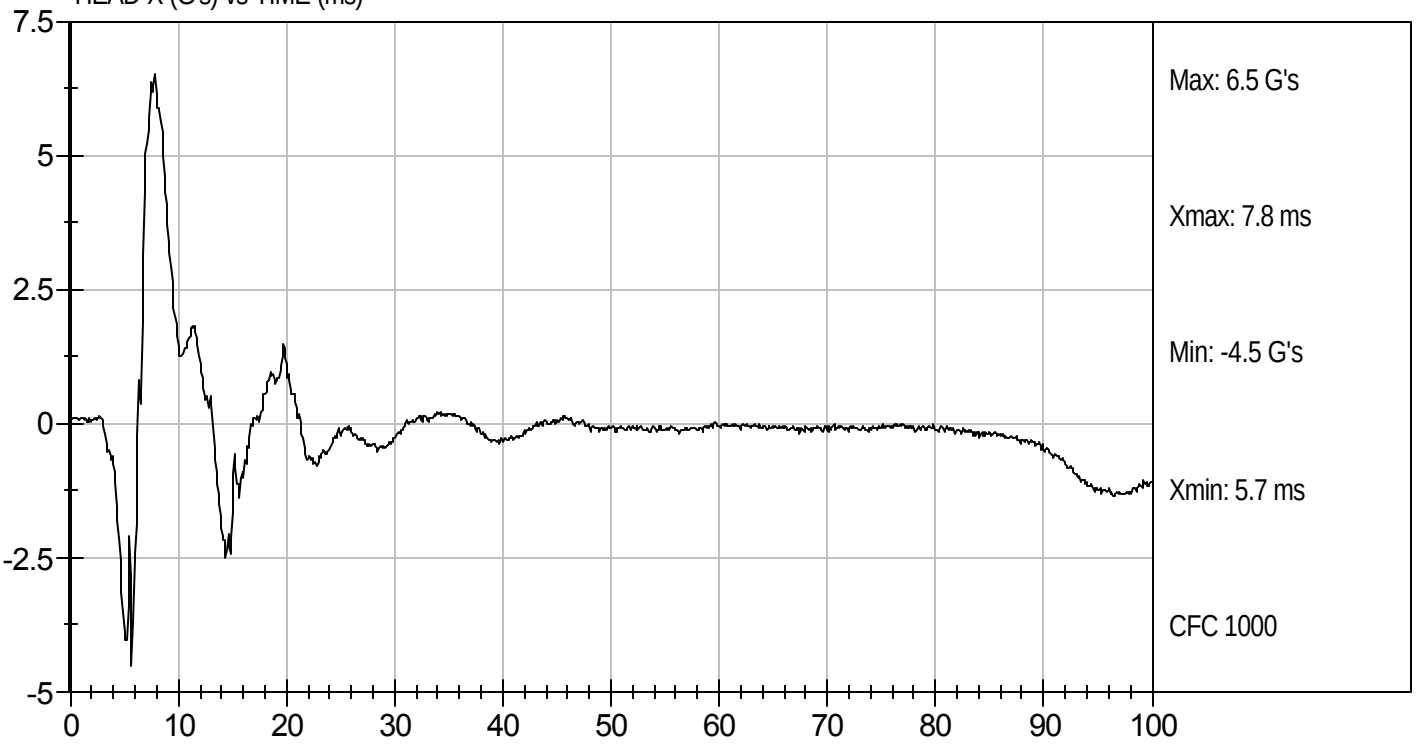
Test Desc: Head Drop
Component ID: D111231

Test Date: 3/31/11
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:** D111232

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	21.8	Pass
Laboratory Relative Humidity		%	10 to 70	17	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	-0.31	Pass
	14 ms	m/s	-3.20 to -3.70	-3.38	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	50.0	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	59.5	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	61.7	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

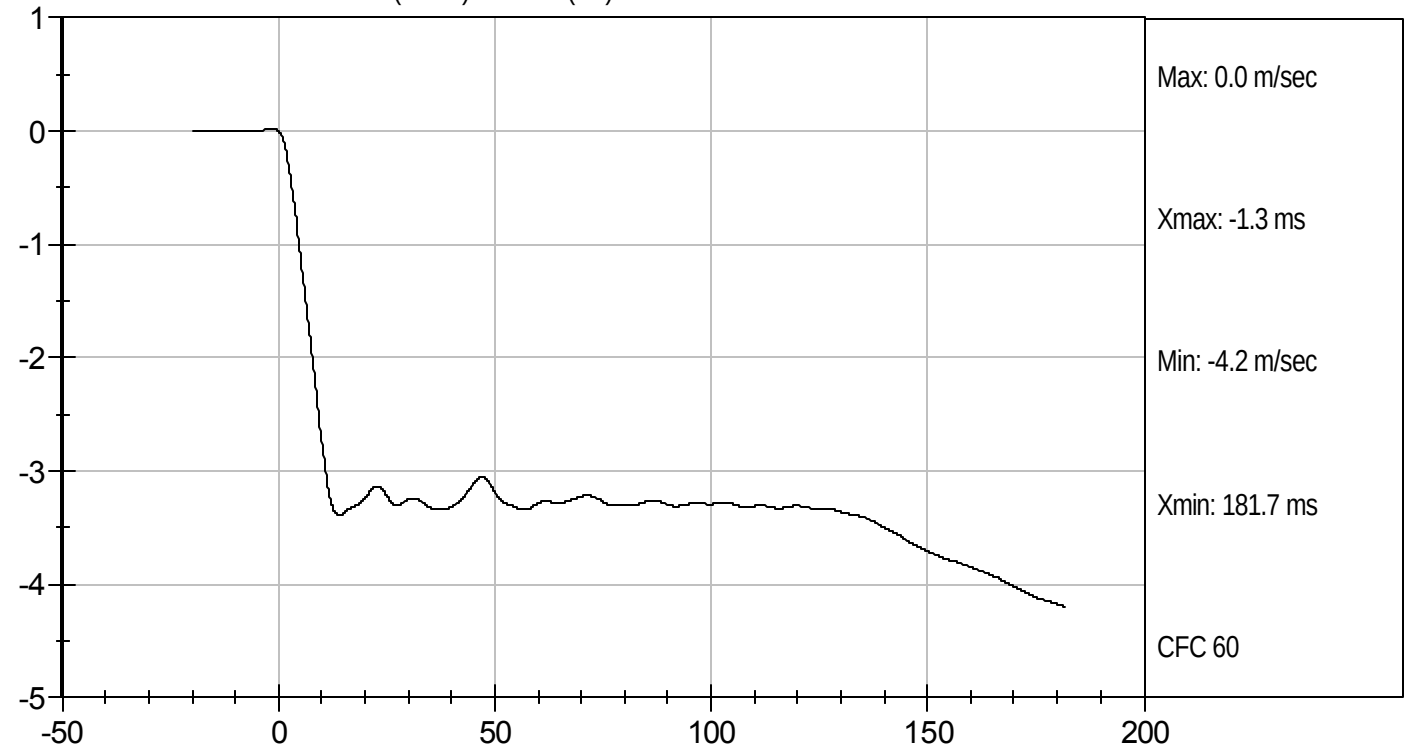
3/31/11
Test Date

David Winkelbauer
Approved By

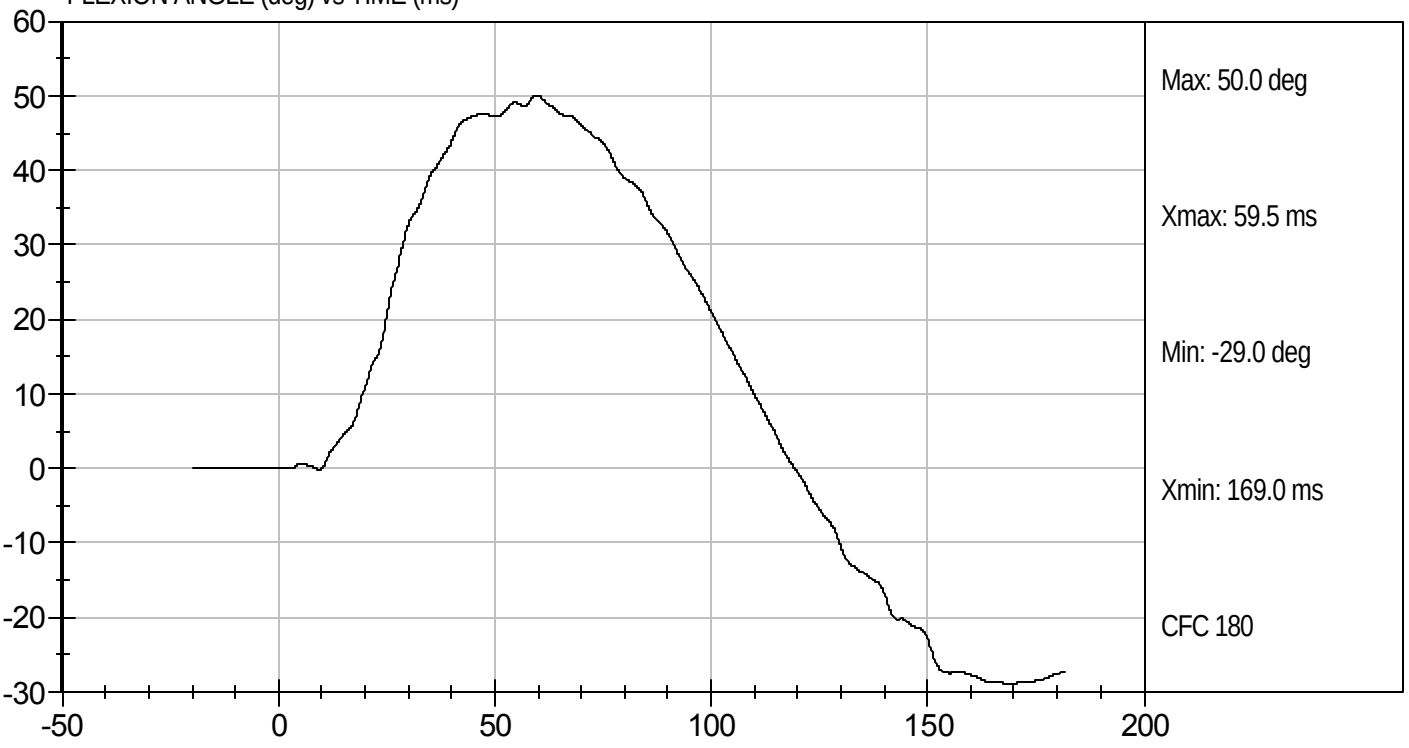
Test Desc: Neck Bending
Component ID: D111232

Test Date: 3/31/11
Velocity: 11.42 ft/s, 3.5 m/s

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

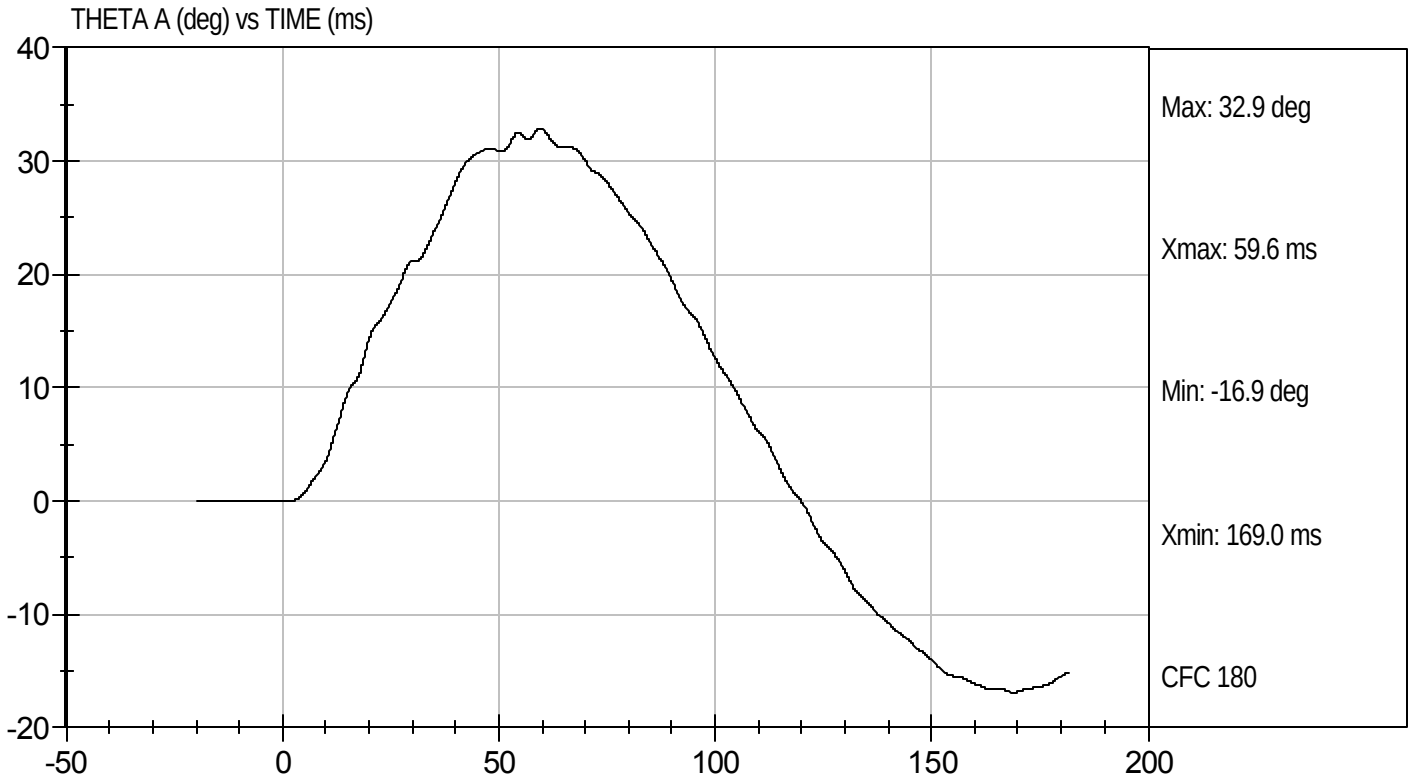


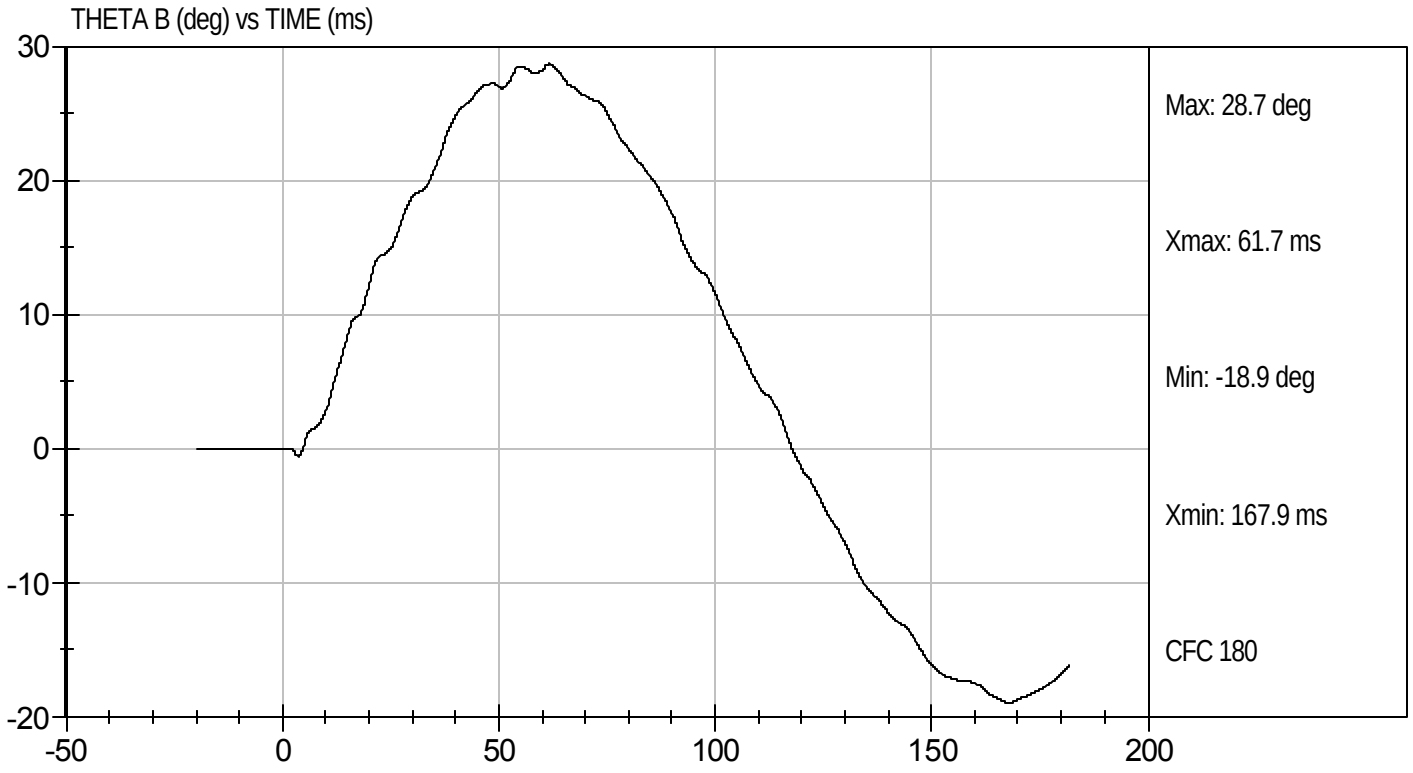
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111232

Test Date: 3/31/11
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:** D111233

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	17	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	9.2	Pass
Time of Peak Shoulder Acceleration	ms	NA	18.0	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

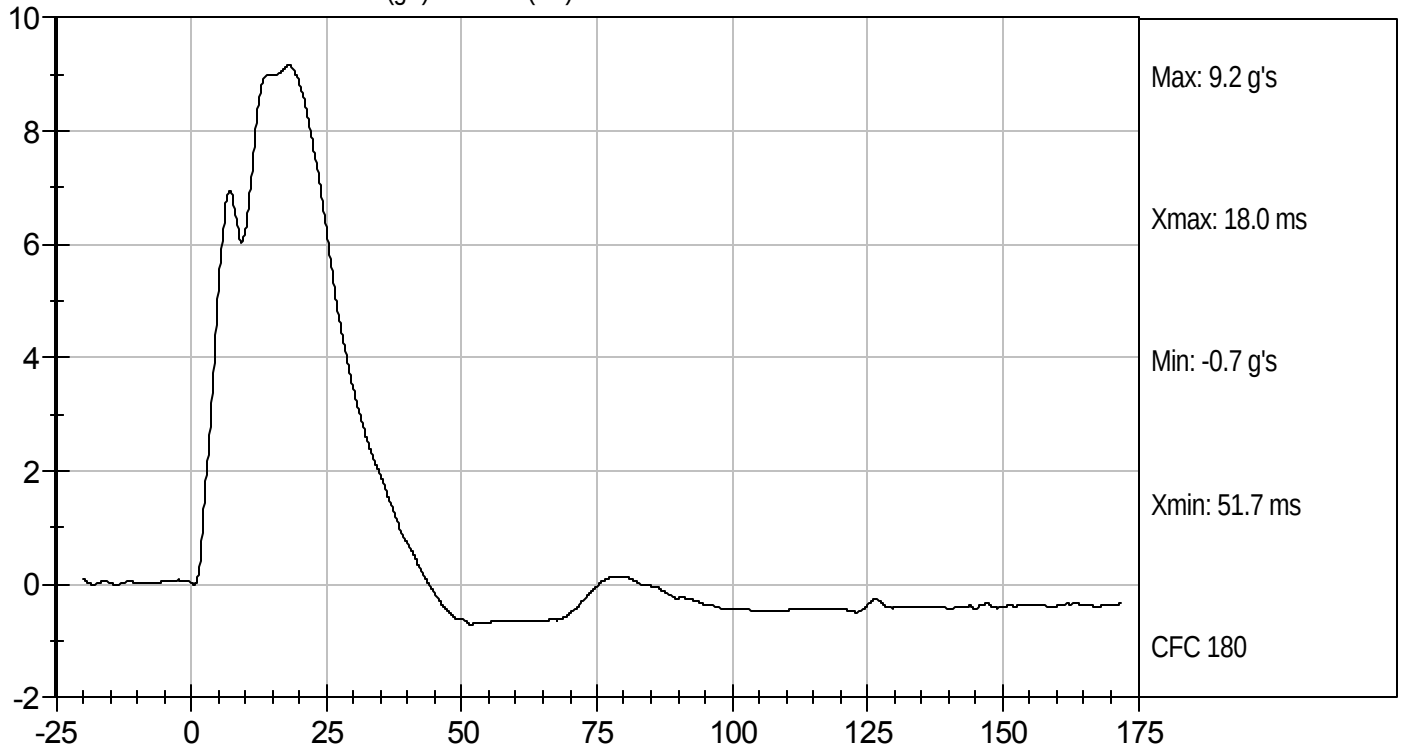
3/31/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111233

Test Date: 3/31/11
Velocity: 14.12 ft/s, 4.3 m/s

SHOULDER ACCELERATION (g's) vs TIME (ms)



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111234

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	17	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.5	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.5	Pass
		Overall Test Results		Pass

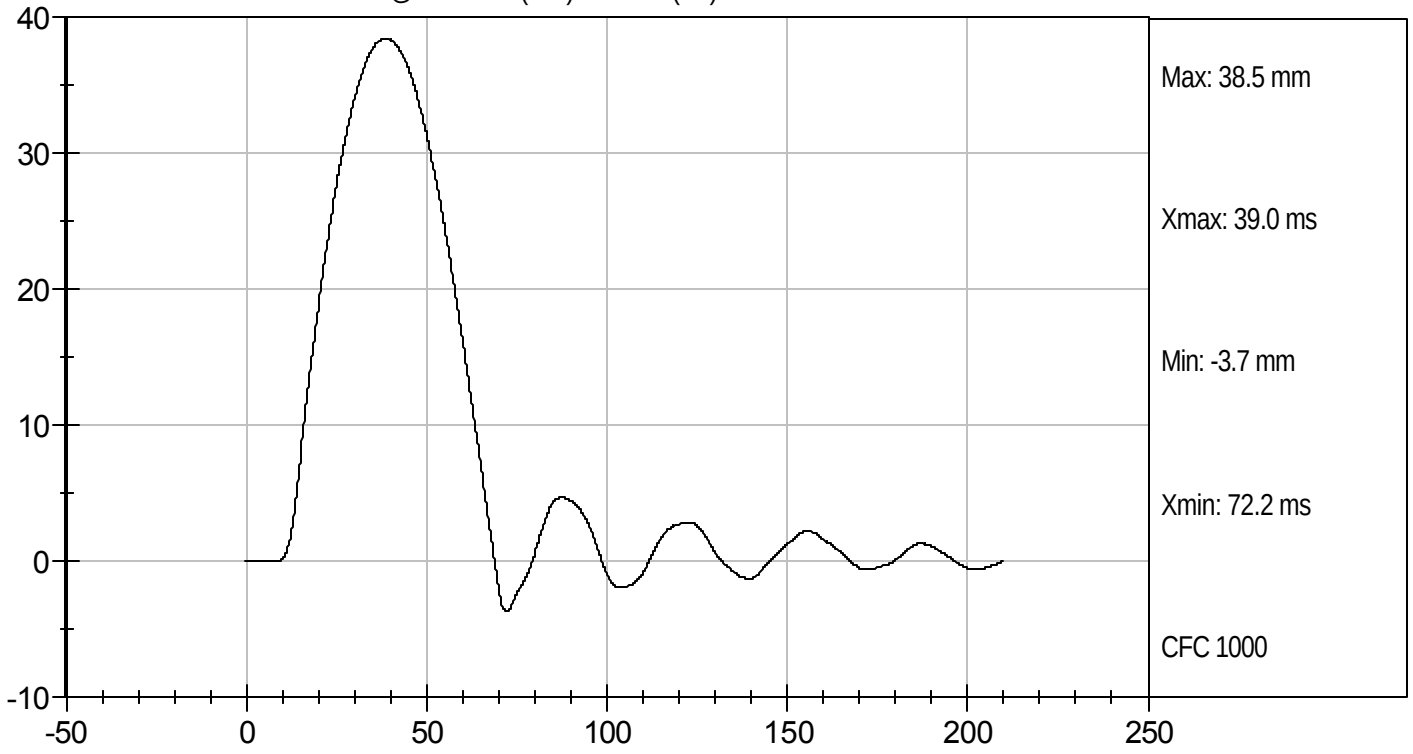
Jessica Gall
Laboratory Technician

3/31/11
Test Date

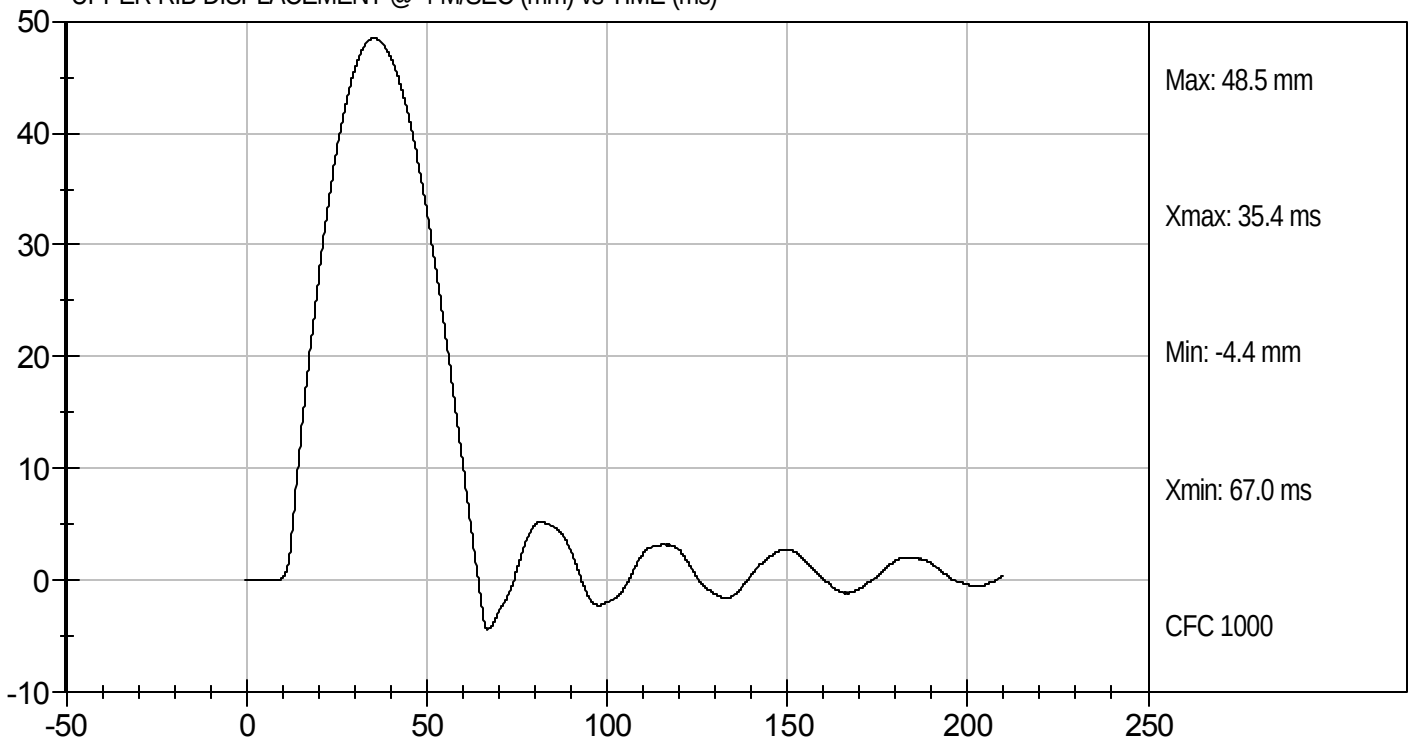
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111234
Test Date: 3/31/11

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:** D111235

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	17	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	38.7	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.5	Pass
		Overall Test Results		Pass

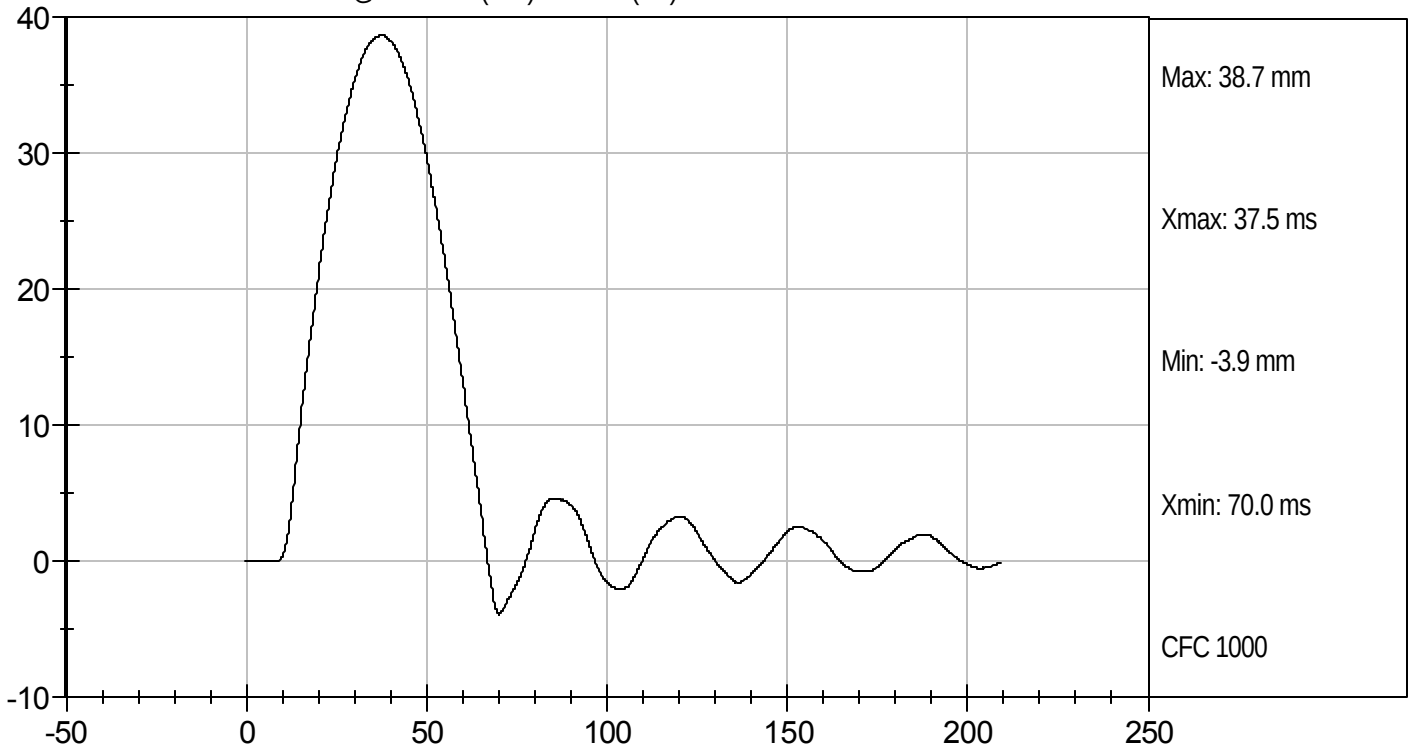
Jessica Hall
Laboratory Technician

3/31/11
Test Date

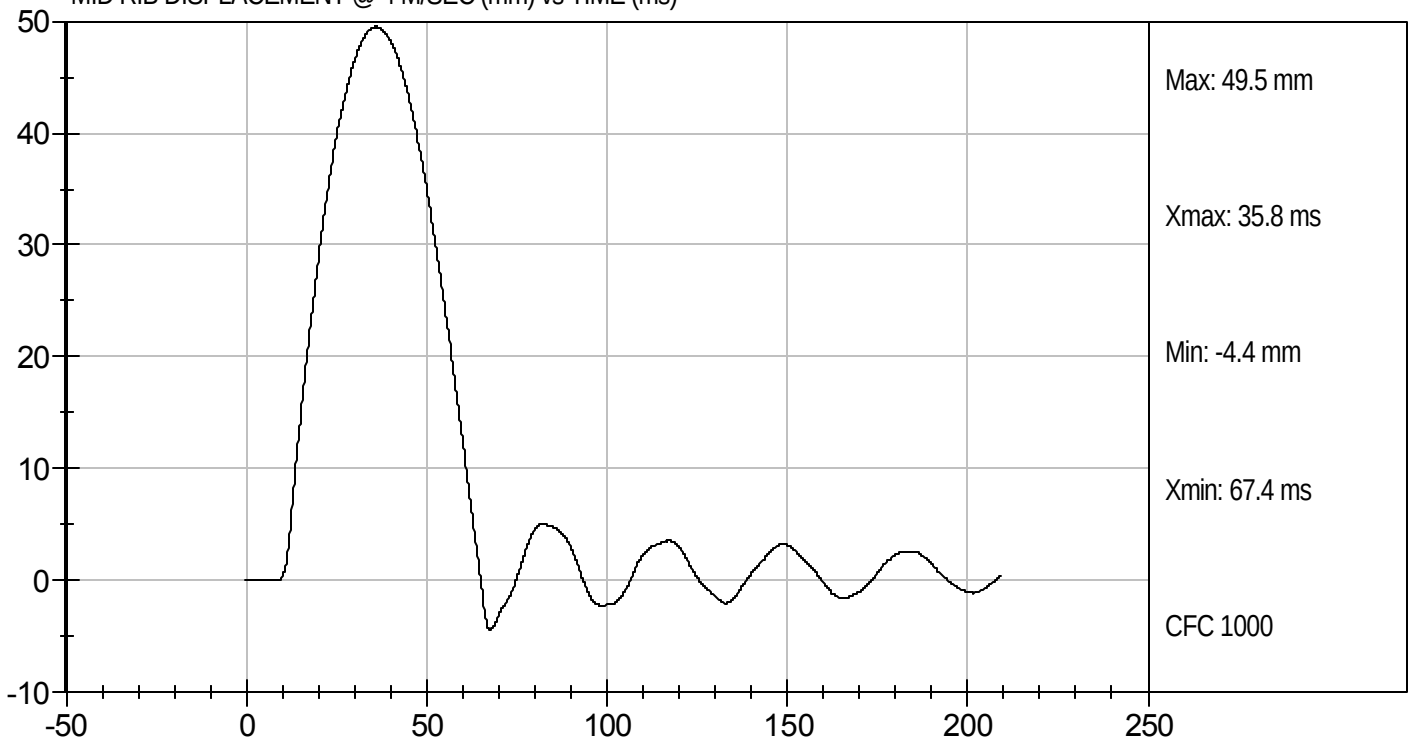
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111235
Test Date: 3/31/11

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:** D111236

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	17	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	49.0	Pass
		Overall Test Results		Pass

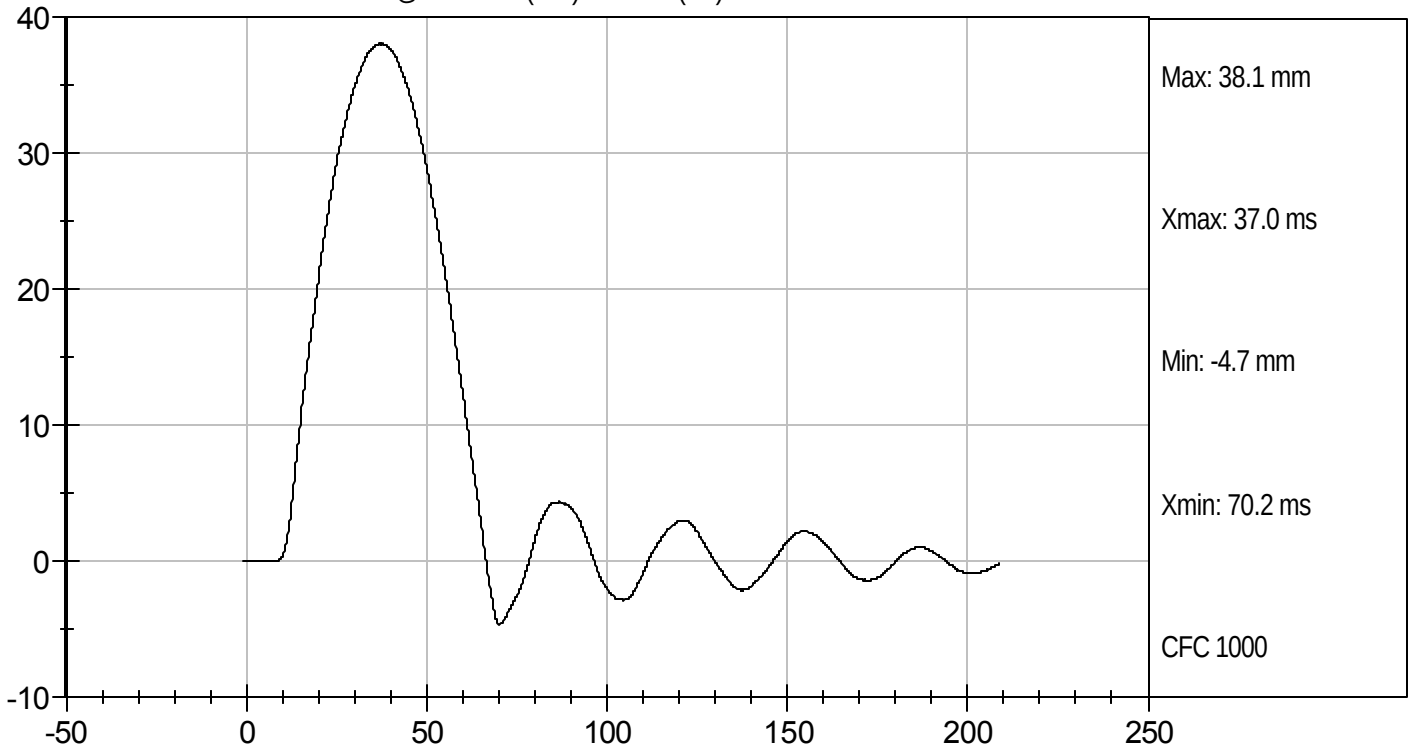
Jessica Gall
Laboratory Technician

3/31/11
Test Date

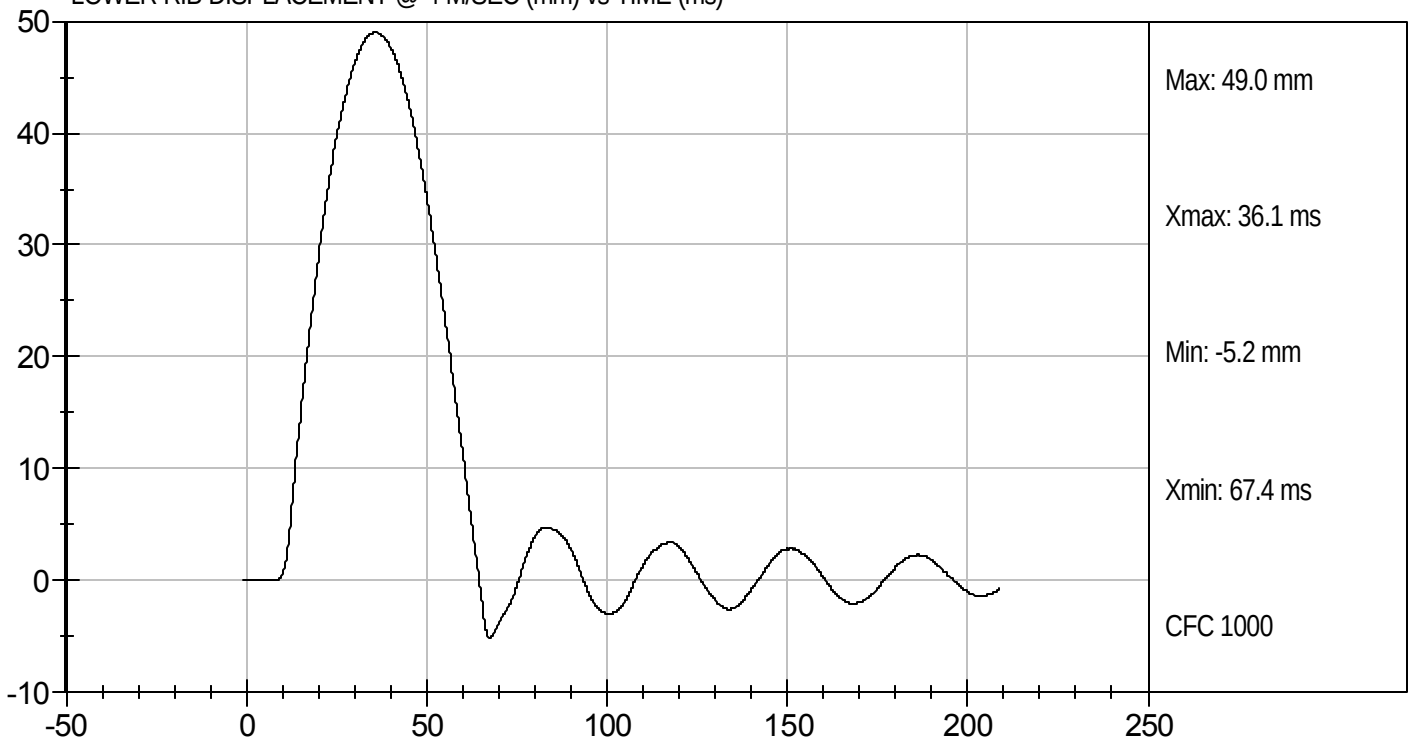
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111236
Test Date: 3/31/11

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:** D111237

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	17	Pass
Probe Speed	m/s	3.90 to 4.10	4.06	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.42	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	10.80	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.60	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	10.40	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

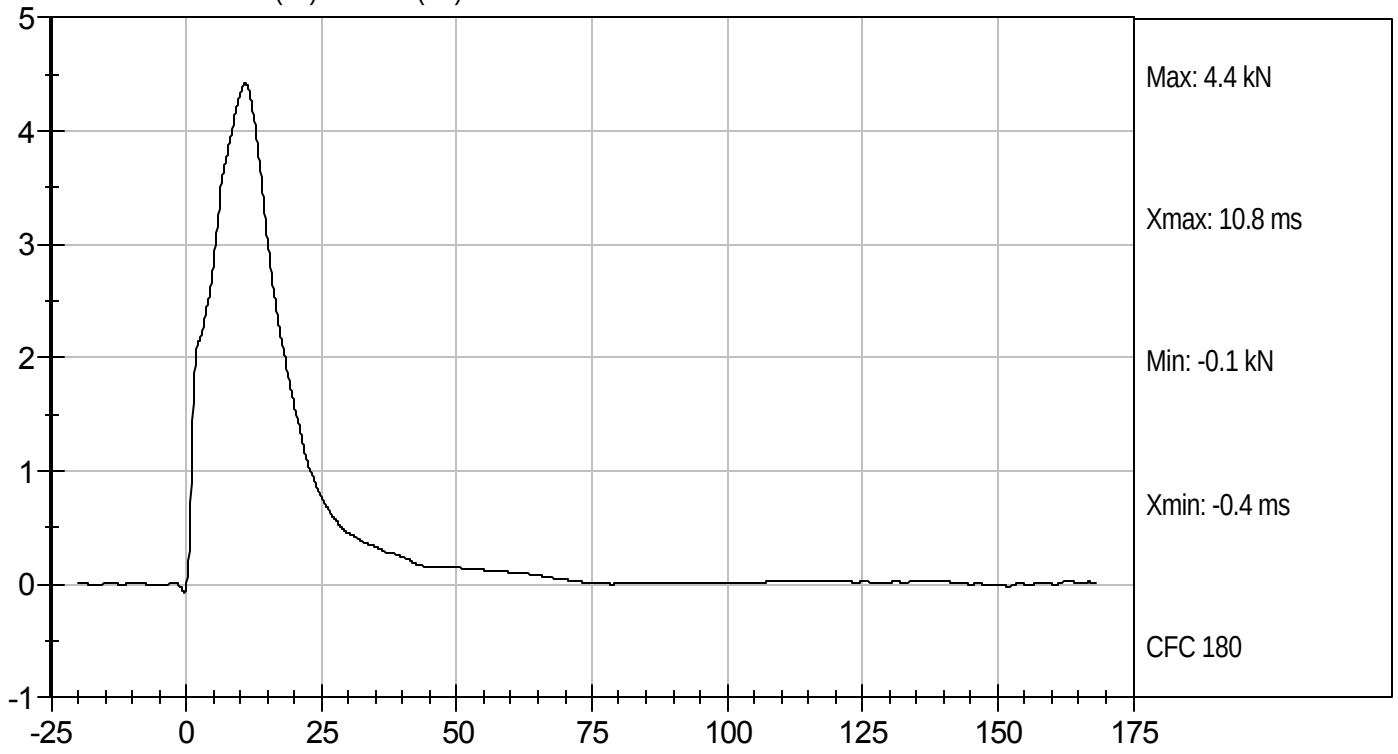
3/31/11
Test Date

David Winkelbauer
Approved By

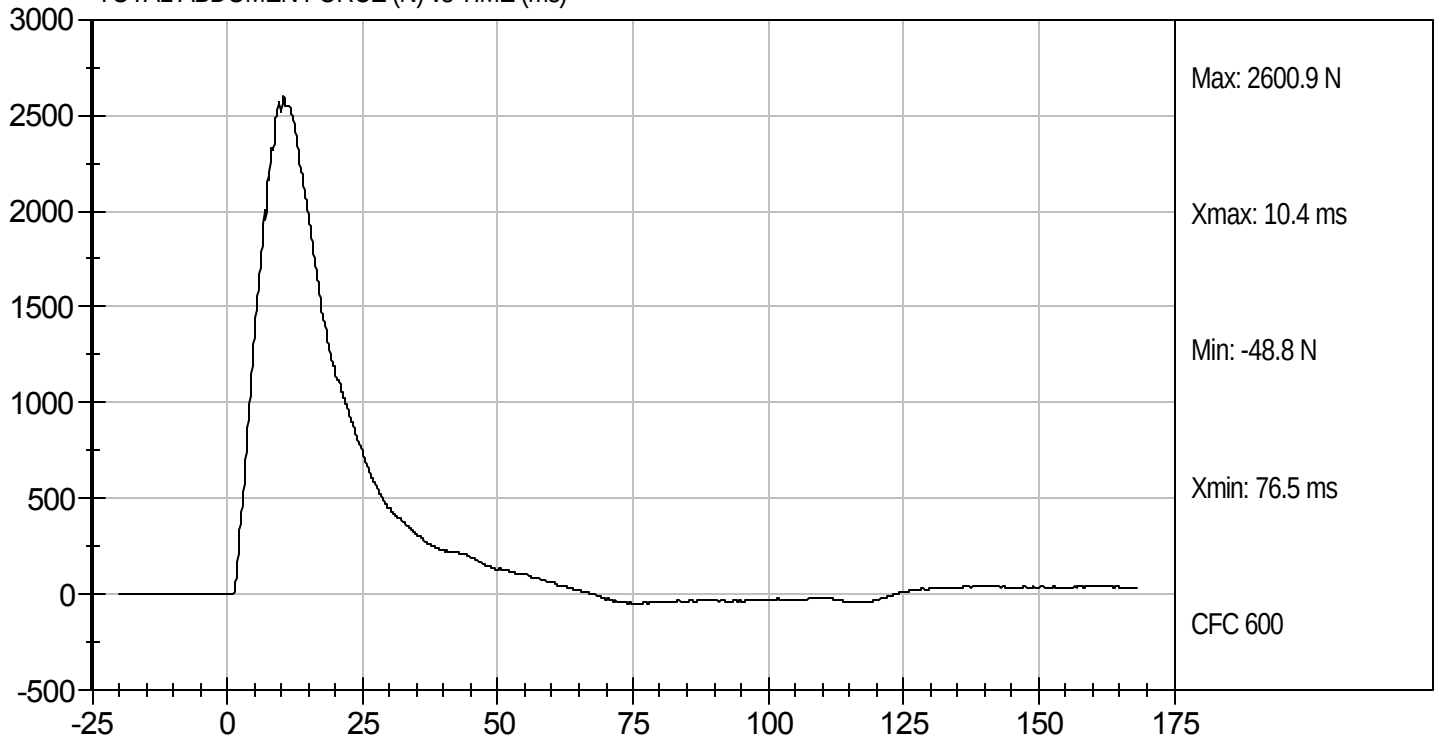
Test Desc: Abdomen Impact
Component ID: D111237

Test Date: 3/31/11
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:** D111238

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	17	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	-0.42	Pass
	27 ms	m/s	-6.50 to -5.80	-5.84	Pass
	30 ms	m/s	>= -6.5	-6.05	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	46.2	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	45.8	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	45	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

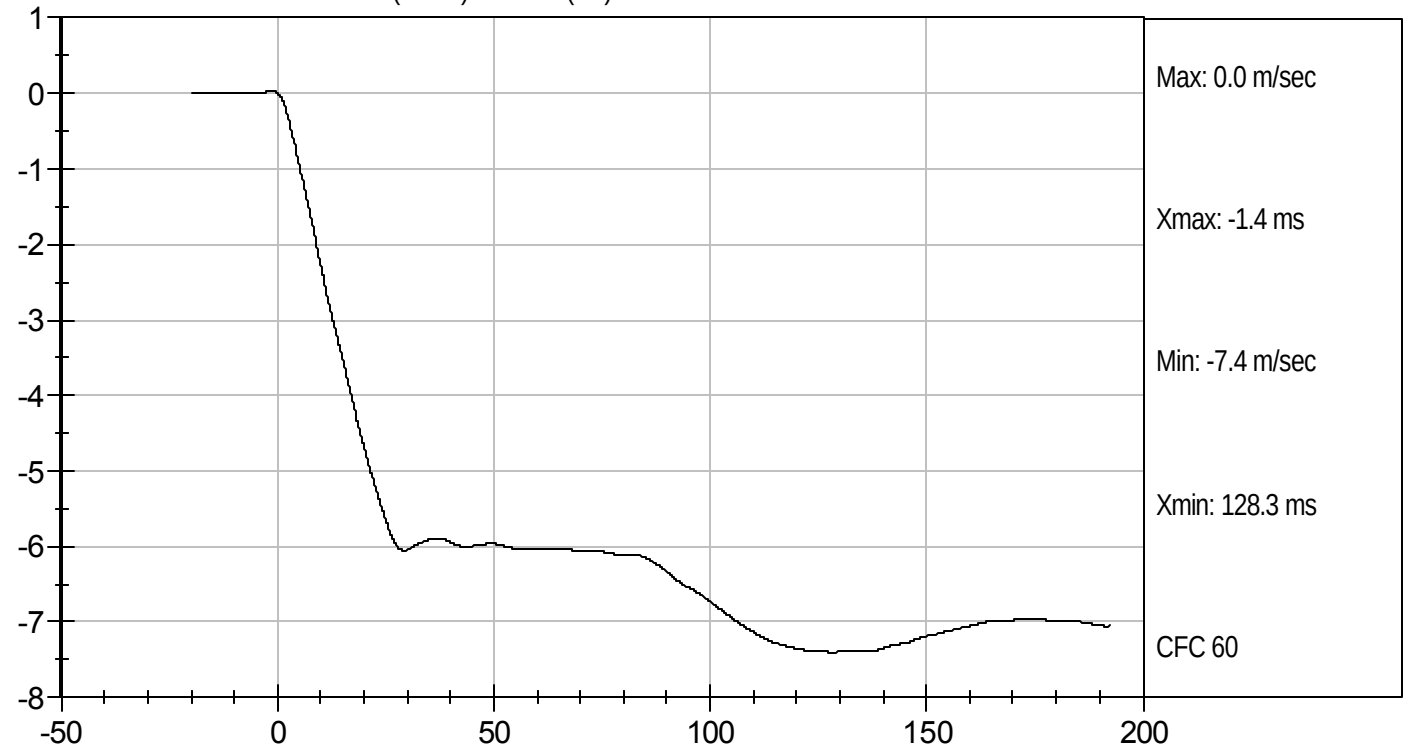
3/31/11
Test Date

David Winkelbauer
Approved By

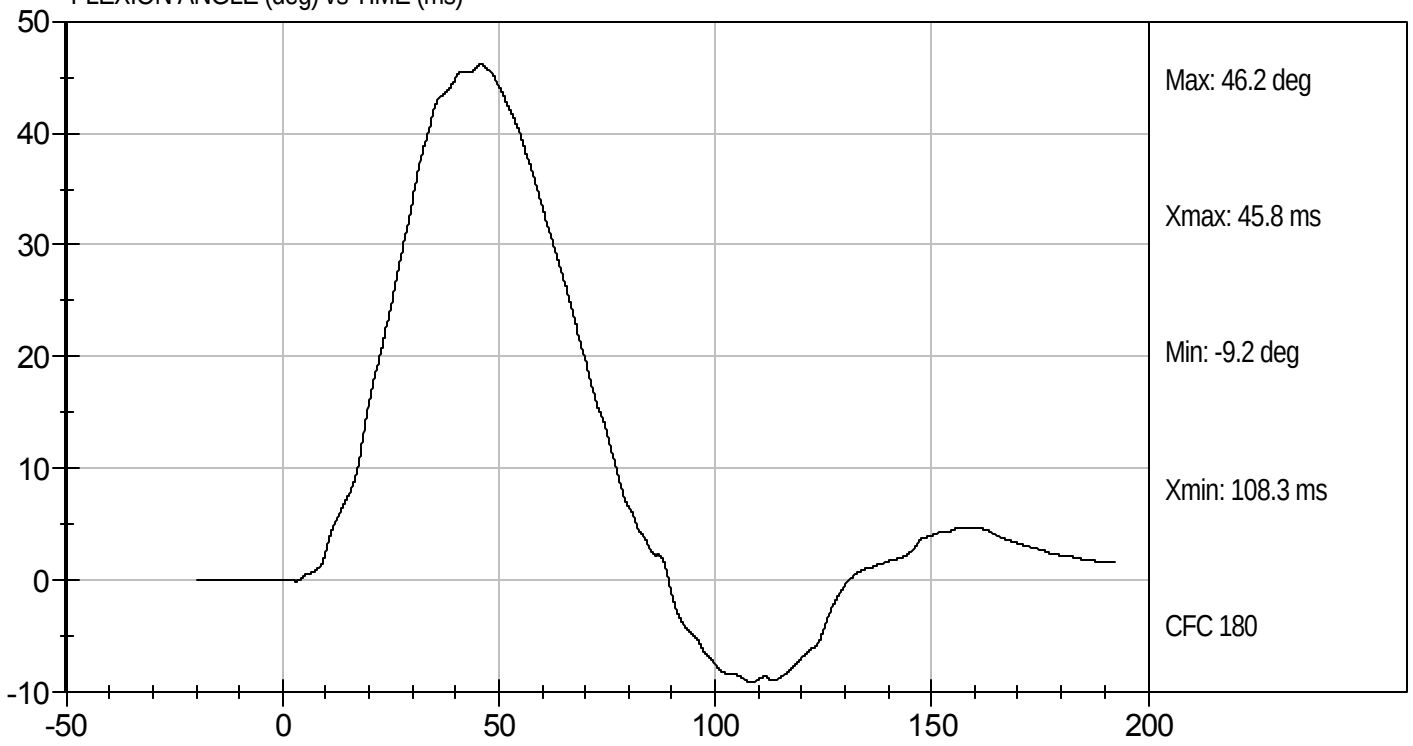
Test Desc: Lumbar Bending
Component ID: D111238

Test Date: 3/31/11
Velocity: 20.08 ft/s, 6.12 m/s

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

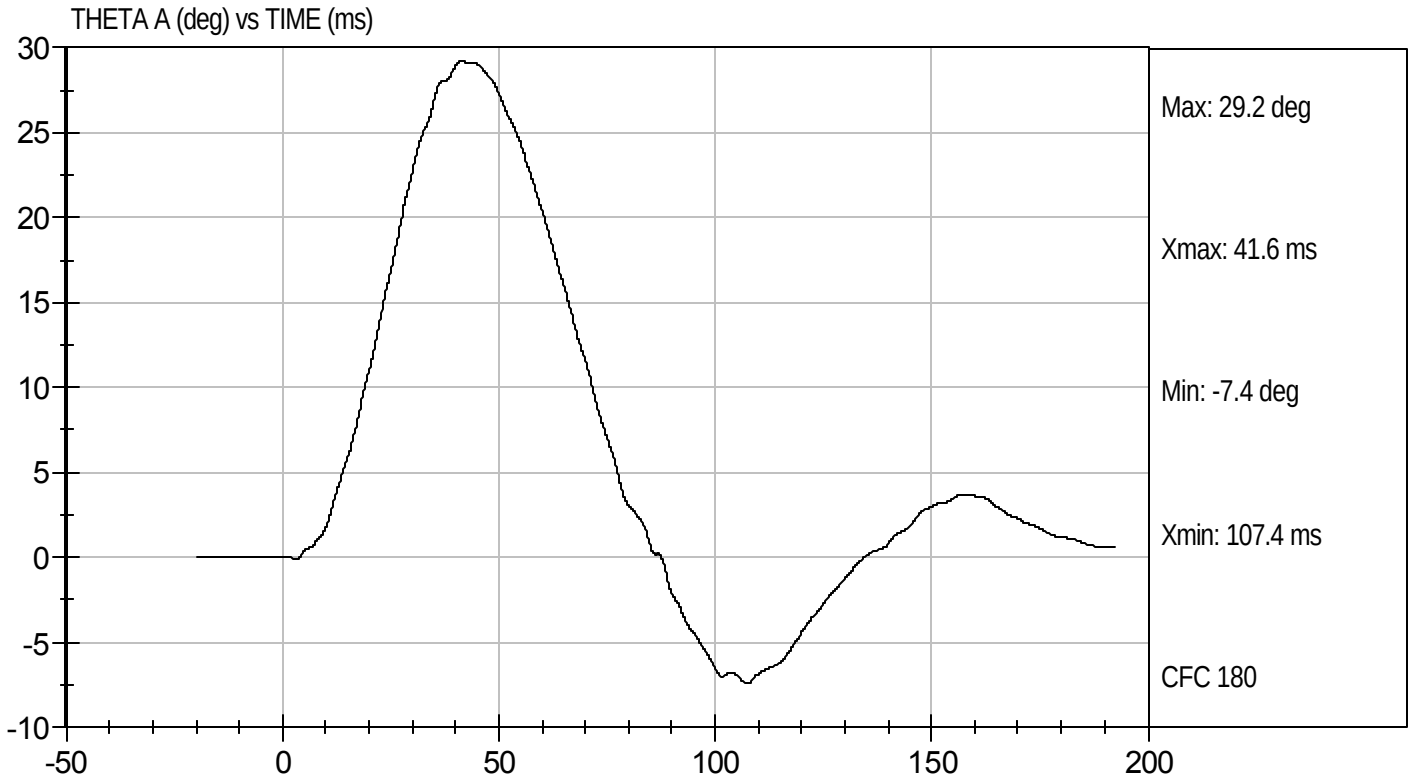


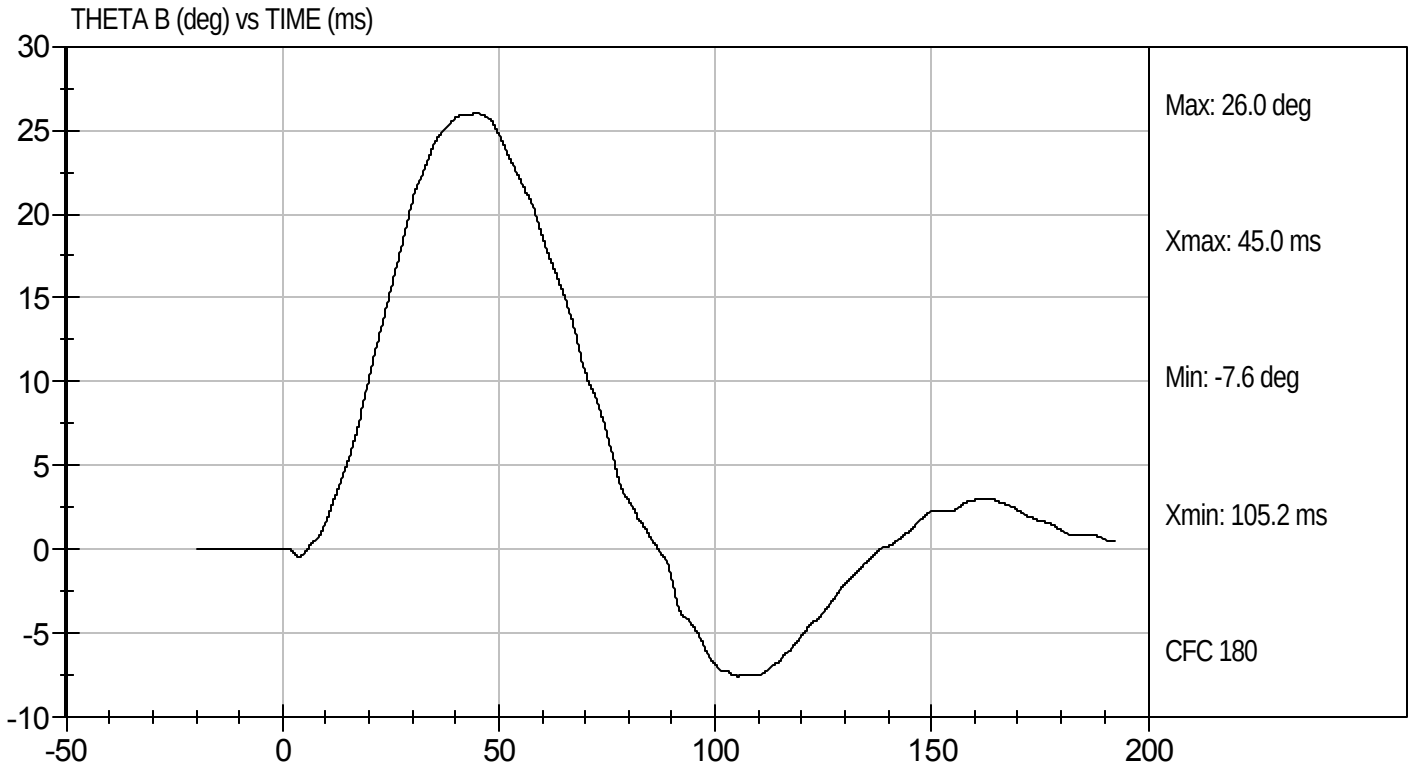
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111238

Test Date: 3/31/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111239

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	18	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.79	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	13.20	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.42	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	15.20	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

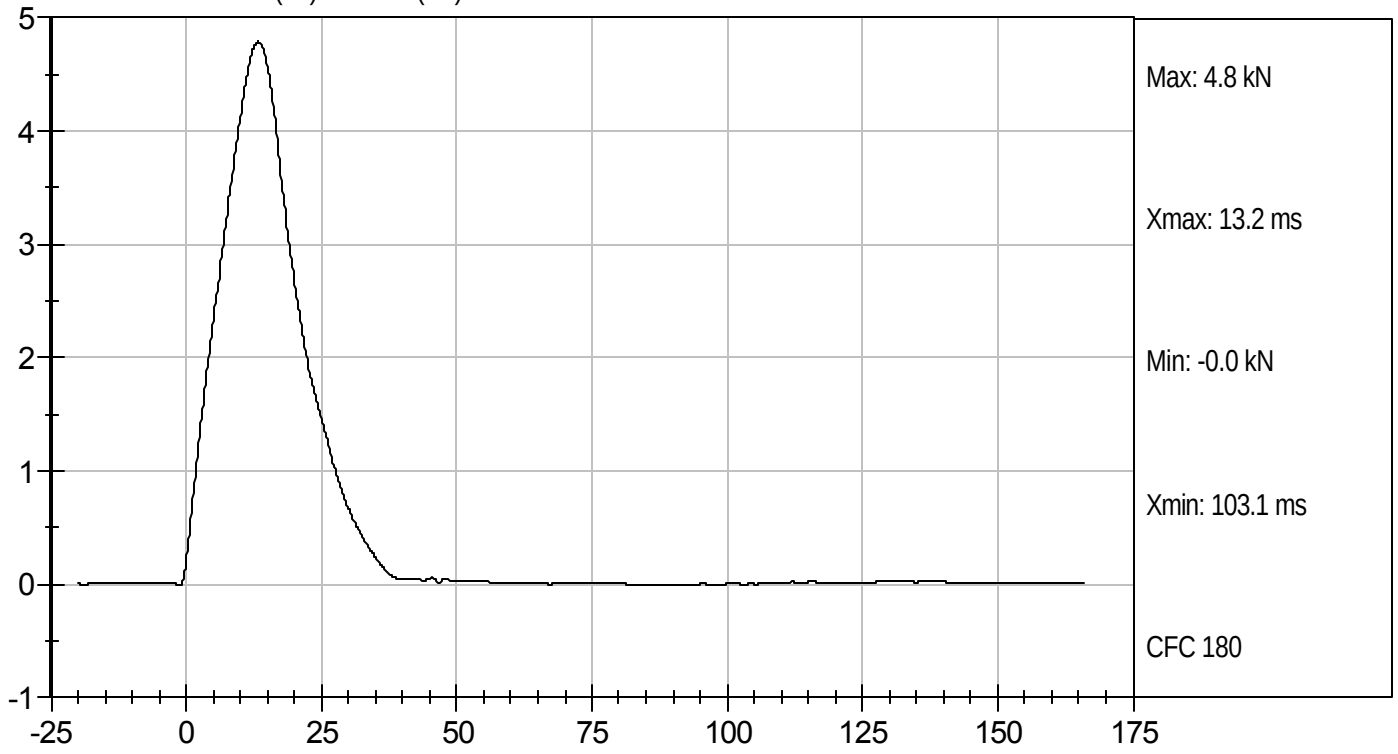
3/31/11
Test Date

David Winkelbauer
Approved By

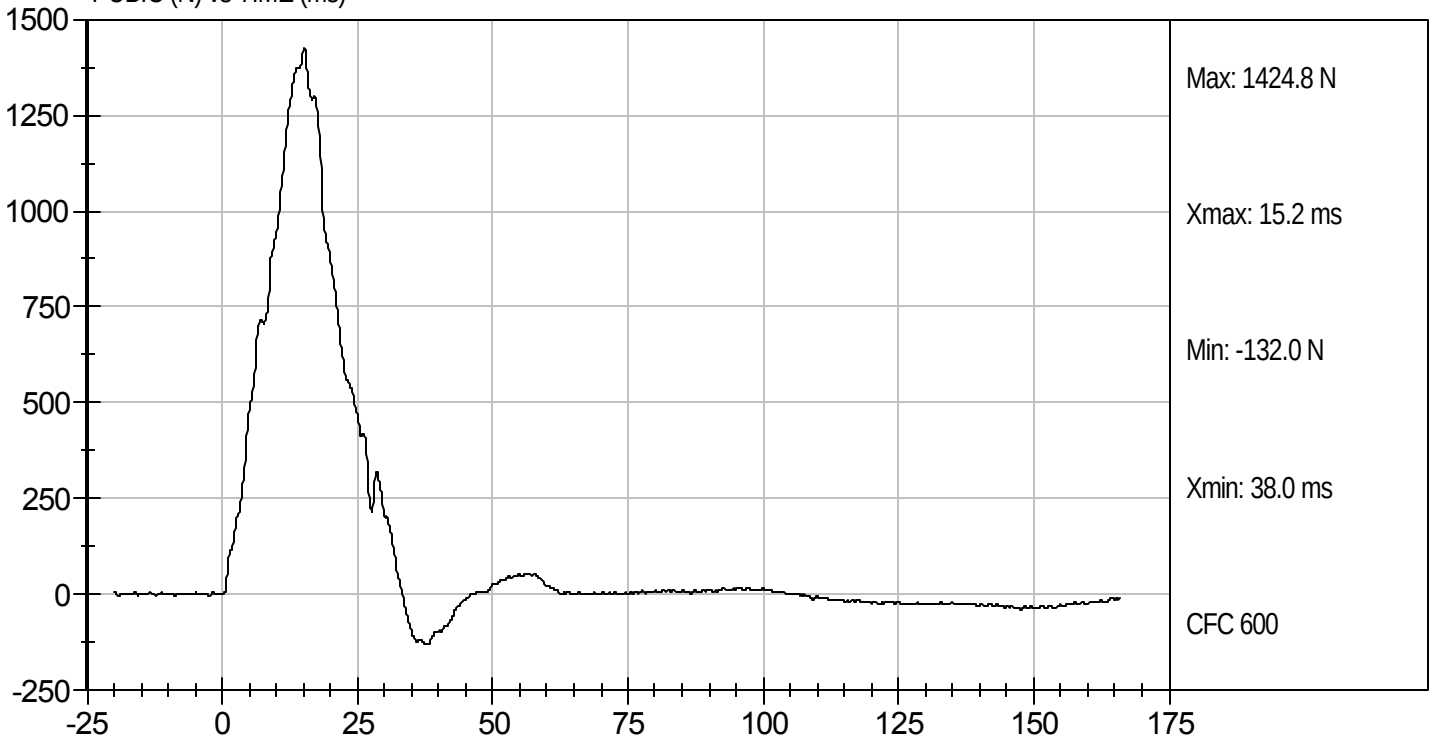
Test Desc: Pelvis Impact
Component ID: D111239

Test Date: 3/31/11
Velocity: 14.25 ft/s, 4.34 m/s

IMPACTOR FORCE (kN) vs TIME (ms)



PUBIC (N) vs TIME (ms)



MGA RESEARCH CORPORATION

FULL BODY THORAX IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111230

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	22.0	Pass
Humidity	%	10 to 70	18	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	5.11	Pass
Upper Rib Displacement	mm	34.0 to 41.0	38.4	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.1	Pass
Lower Rib Displacement	mm	37.0 to 44.0	40.7	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

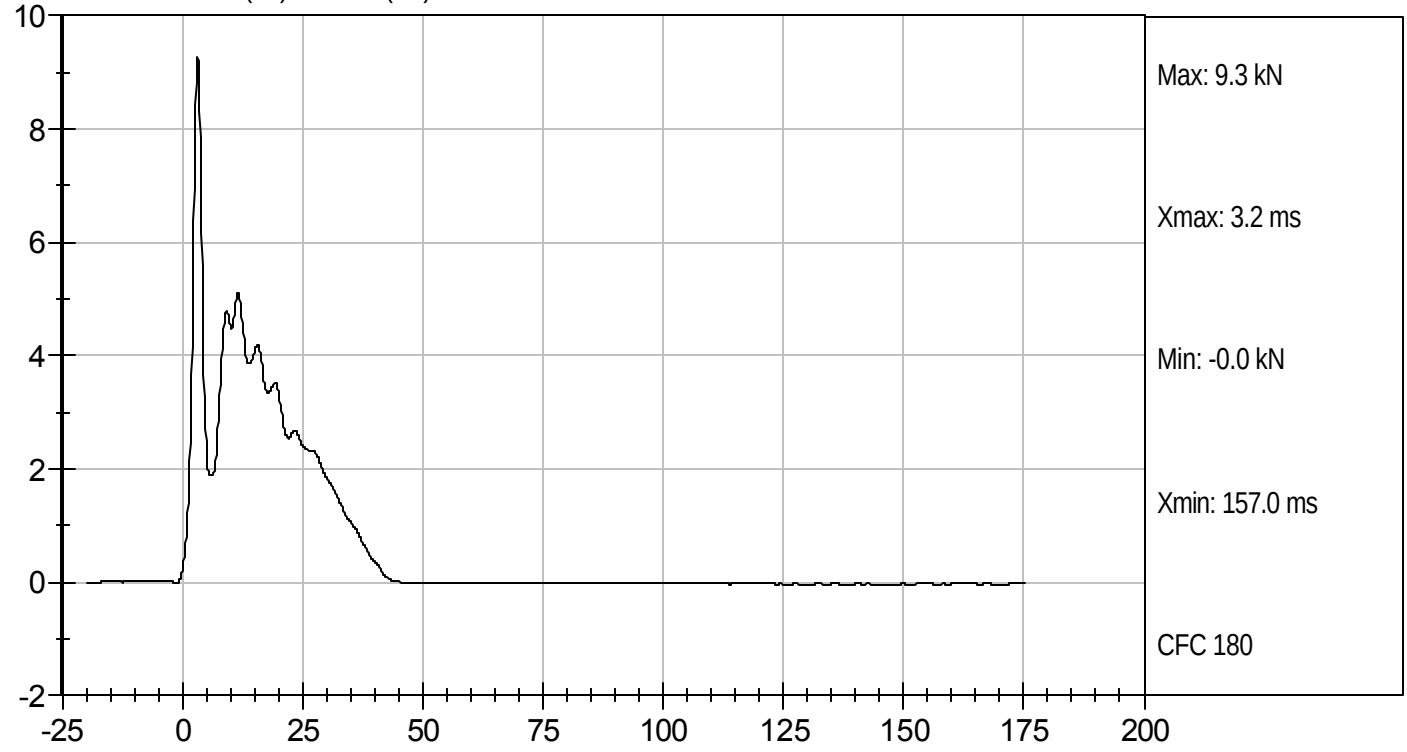
3/31/11
Test Date

David Winkelbauer
Approved By

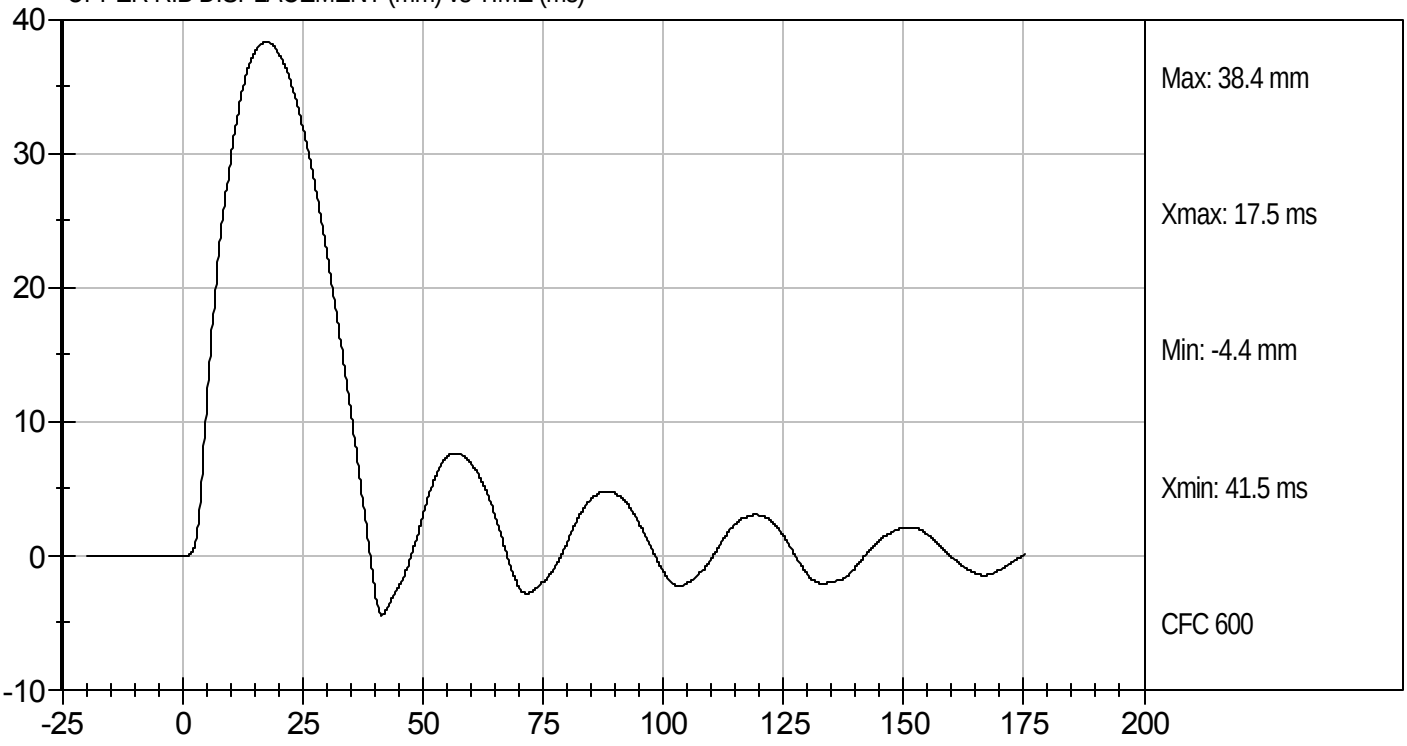
Test Desc: Thorax Impact
Component ID: D111230

Test Date: 3/31/11
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



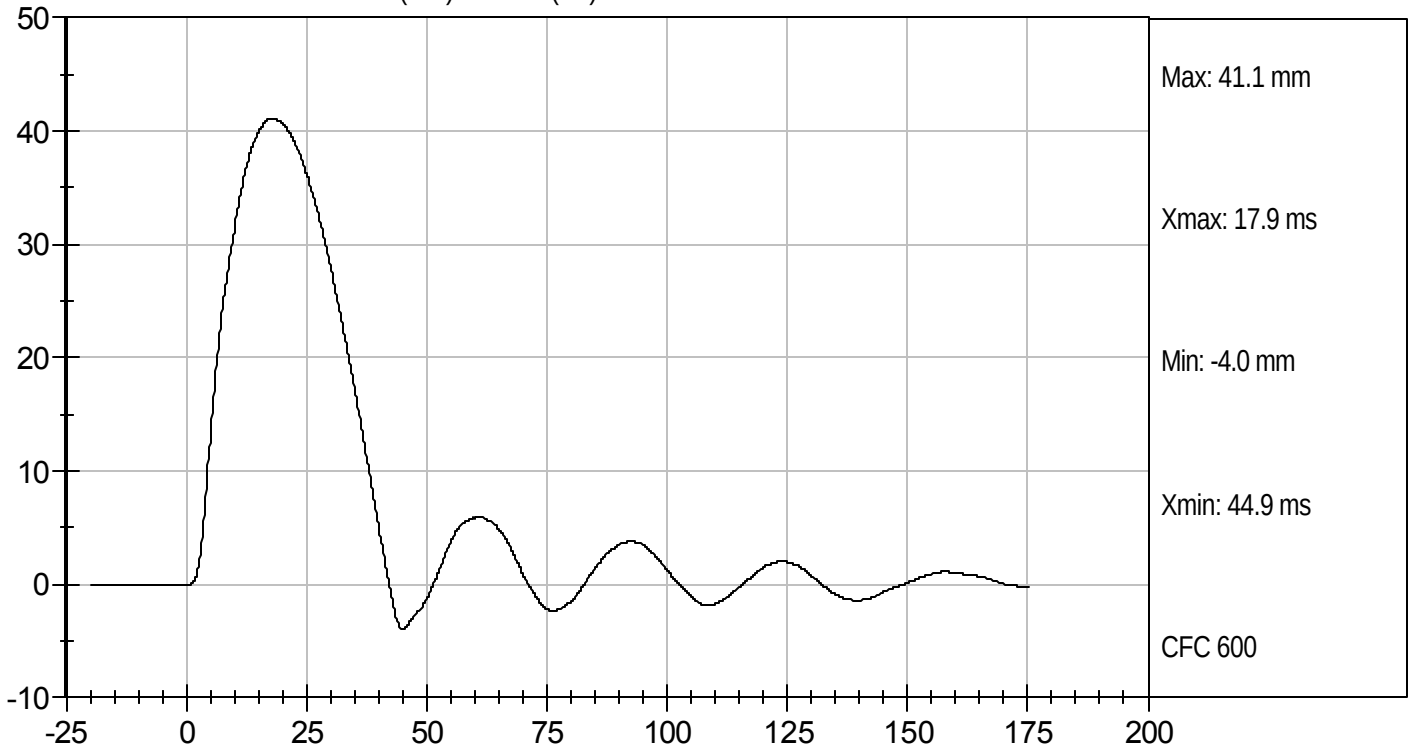
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



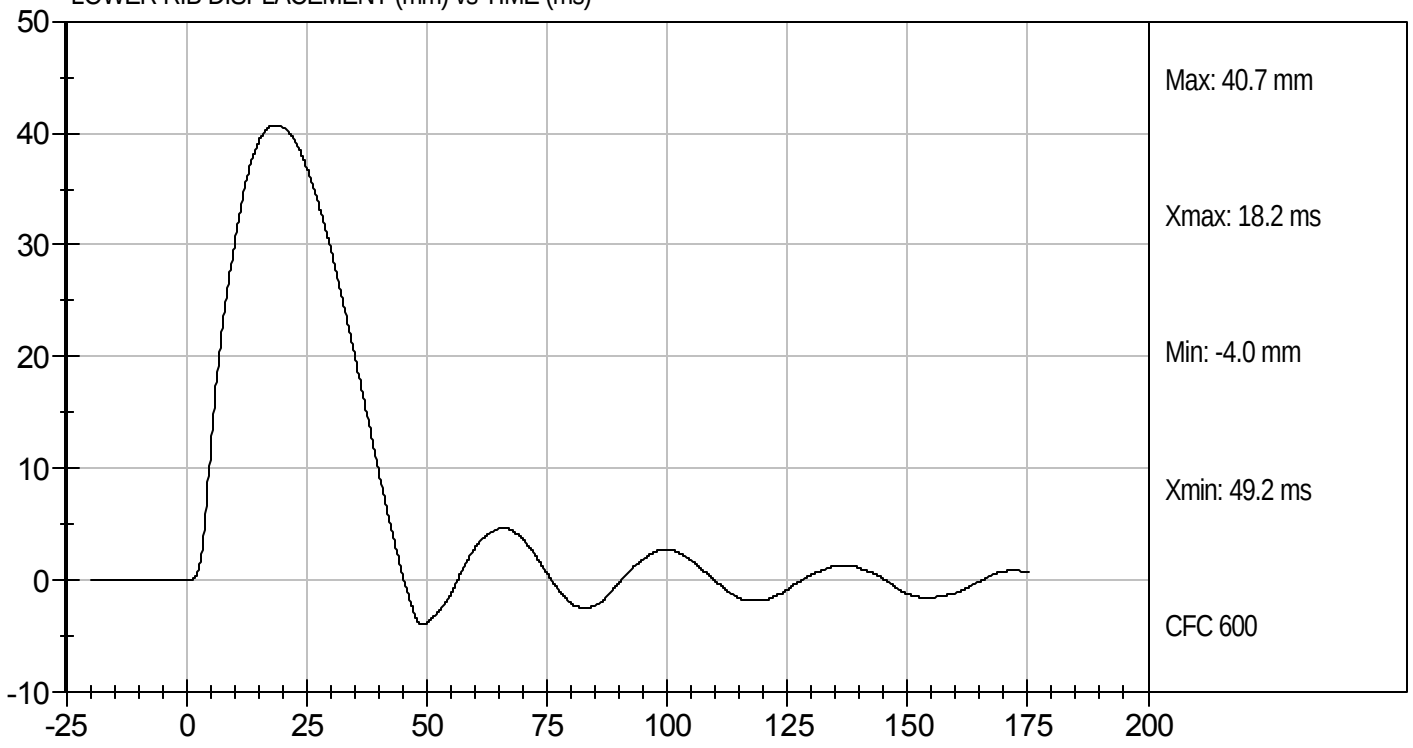
Test Desc: Thorax Impact
Component ID: D111230

Test Date: 3/31/11
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:** D111261

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	26	Pass
Peak Resultant Acceleration	G's	125 to 155	151	Pass
Peak Lateral Acceleration	G's	+/- 15	-8.1	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

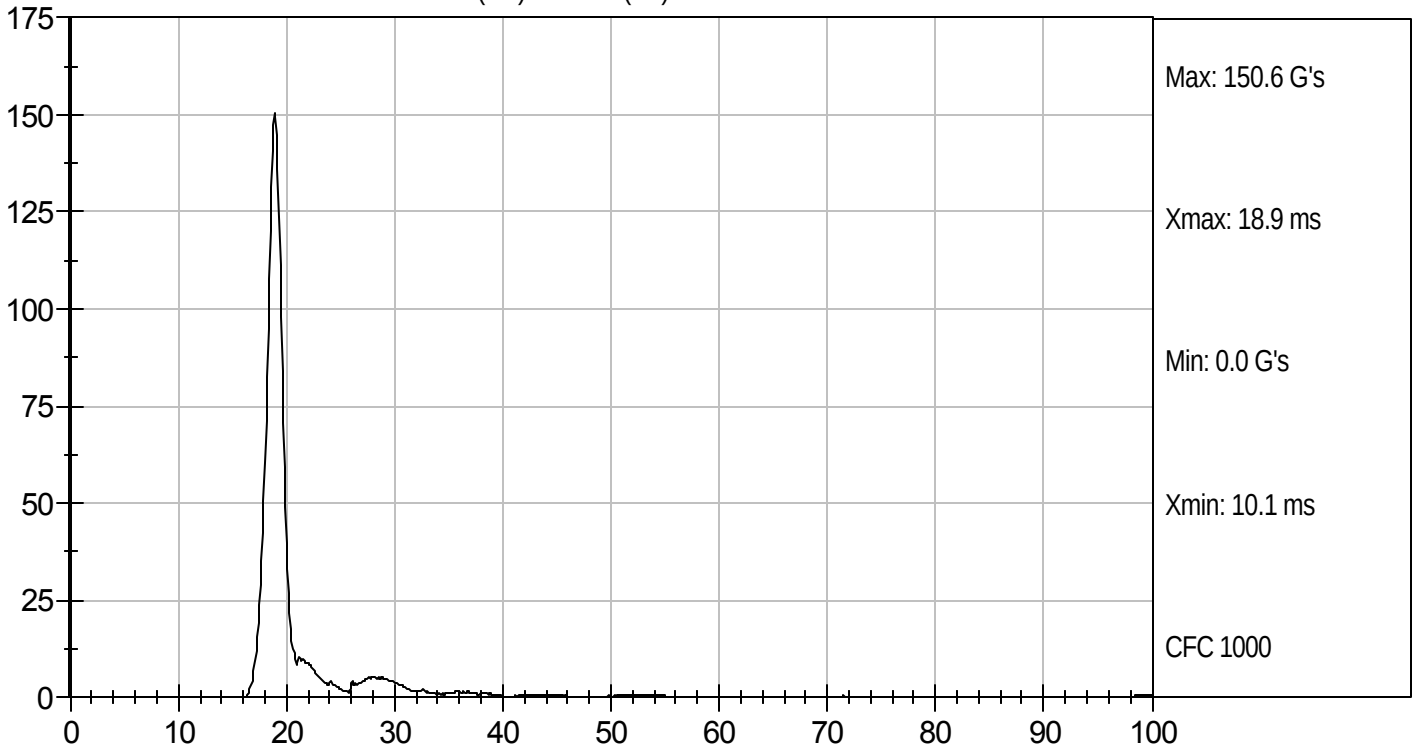
4/1/11
Test Date

David Winkelbauer
Approved By

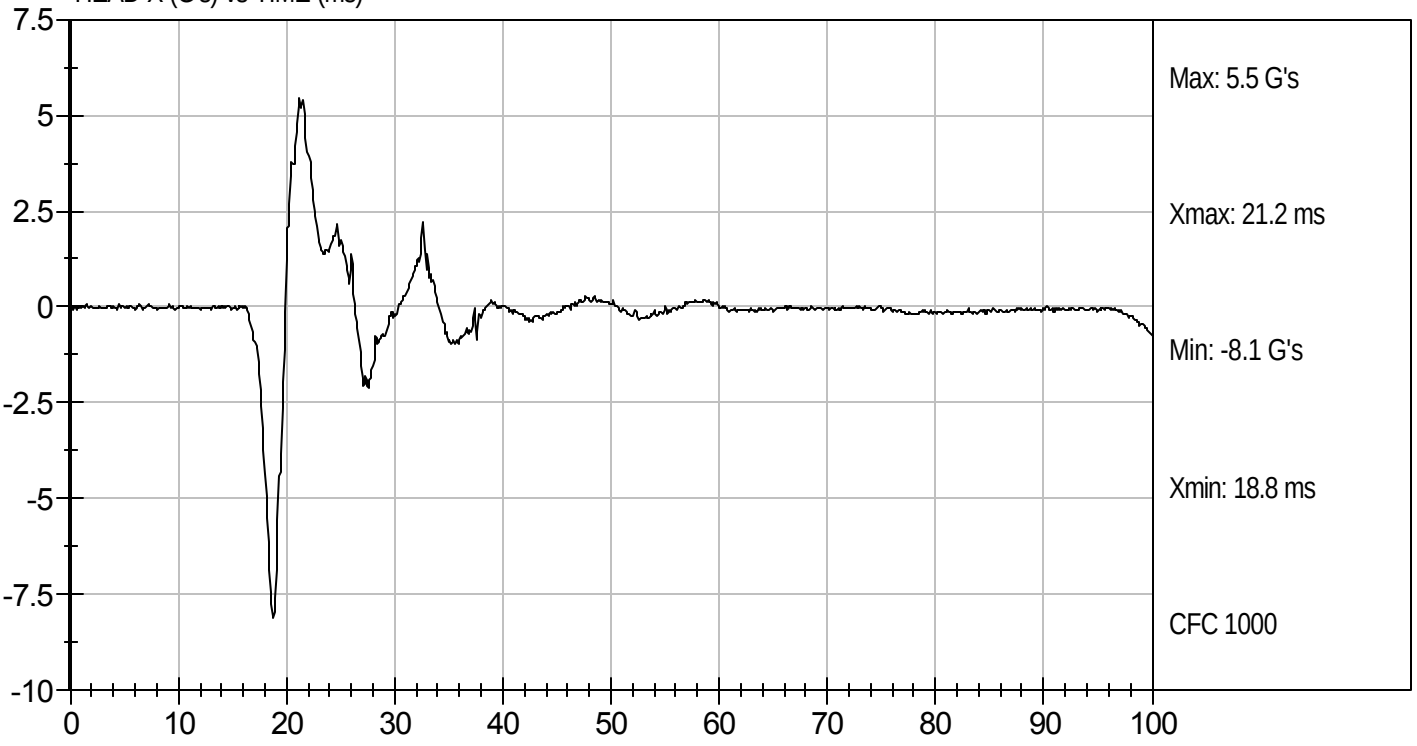
Test Desc: Head Drop
Component ID: D111261

Test Date: 4/1/11
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:** D111262

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	-0.02	Pass
	3 ms	m/s	-0.25 to -0.375	-0.33	Pass
	14 ms	m/s	-3.20 to -3.70	-3.41	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	50.9	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	60.2	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	59.7	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

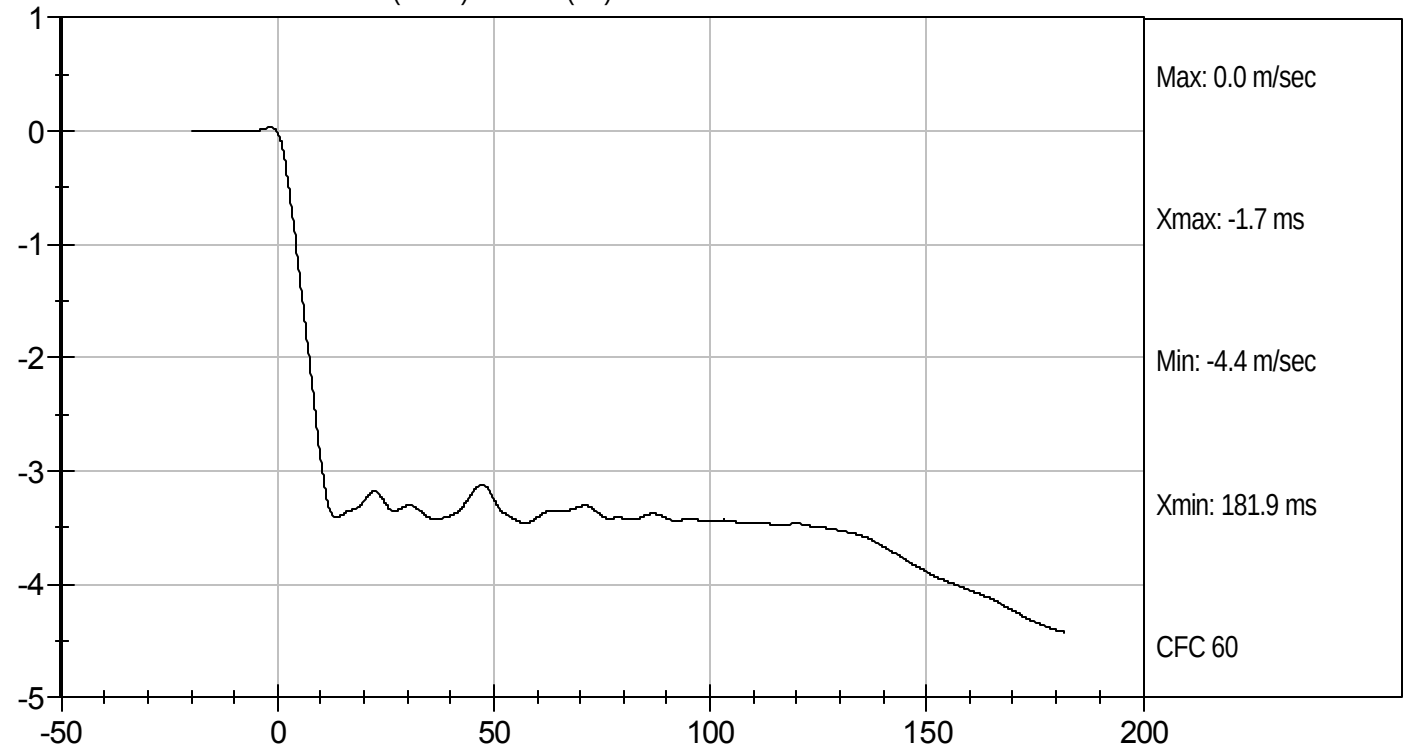
4/1/11
Test Date

David Winkelbauer
Approved By

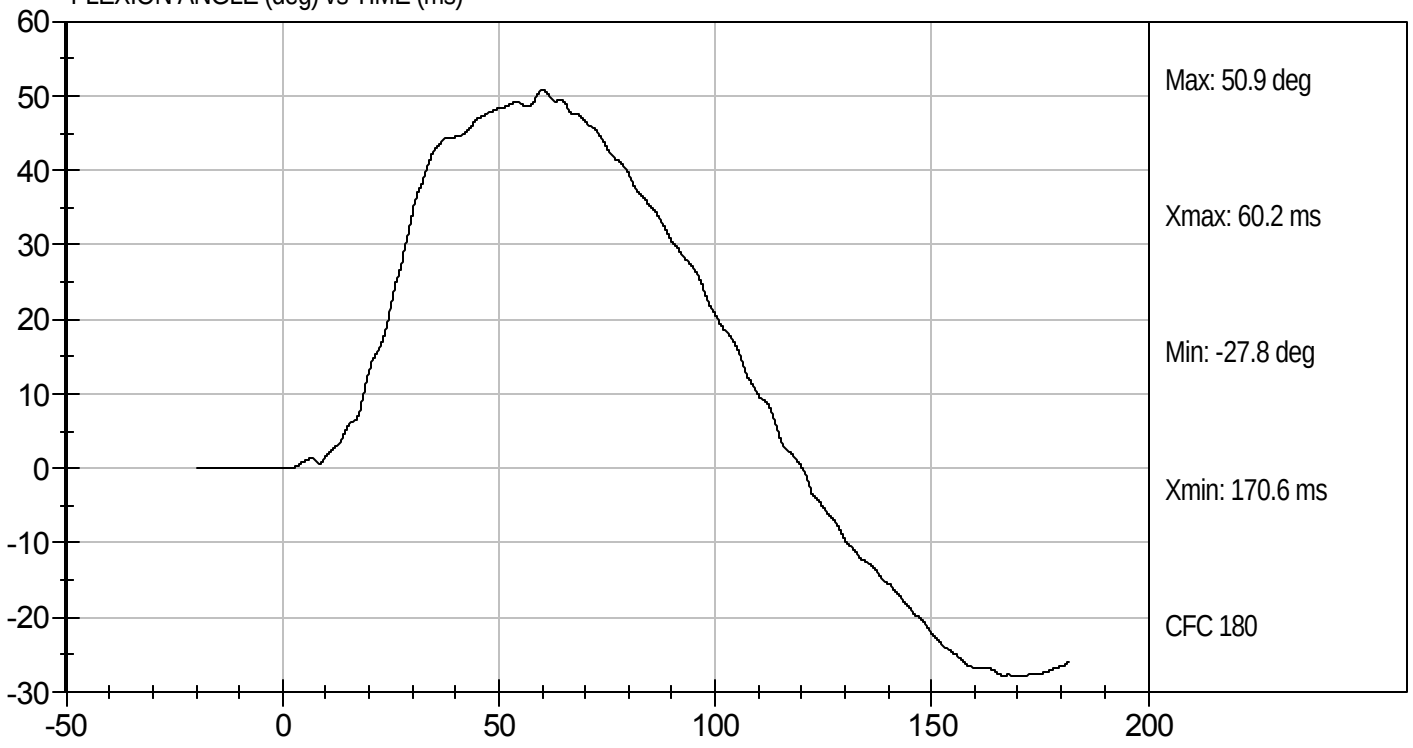
Test Desc: Neck Bending
Component ID: D111262

Test Date: 4/1/11
Velocity: 11.34 ft/s, 3.5 m/s

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

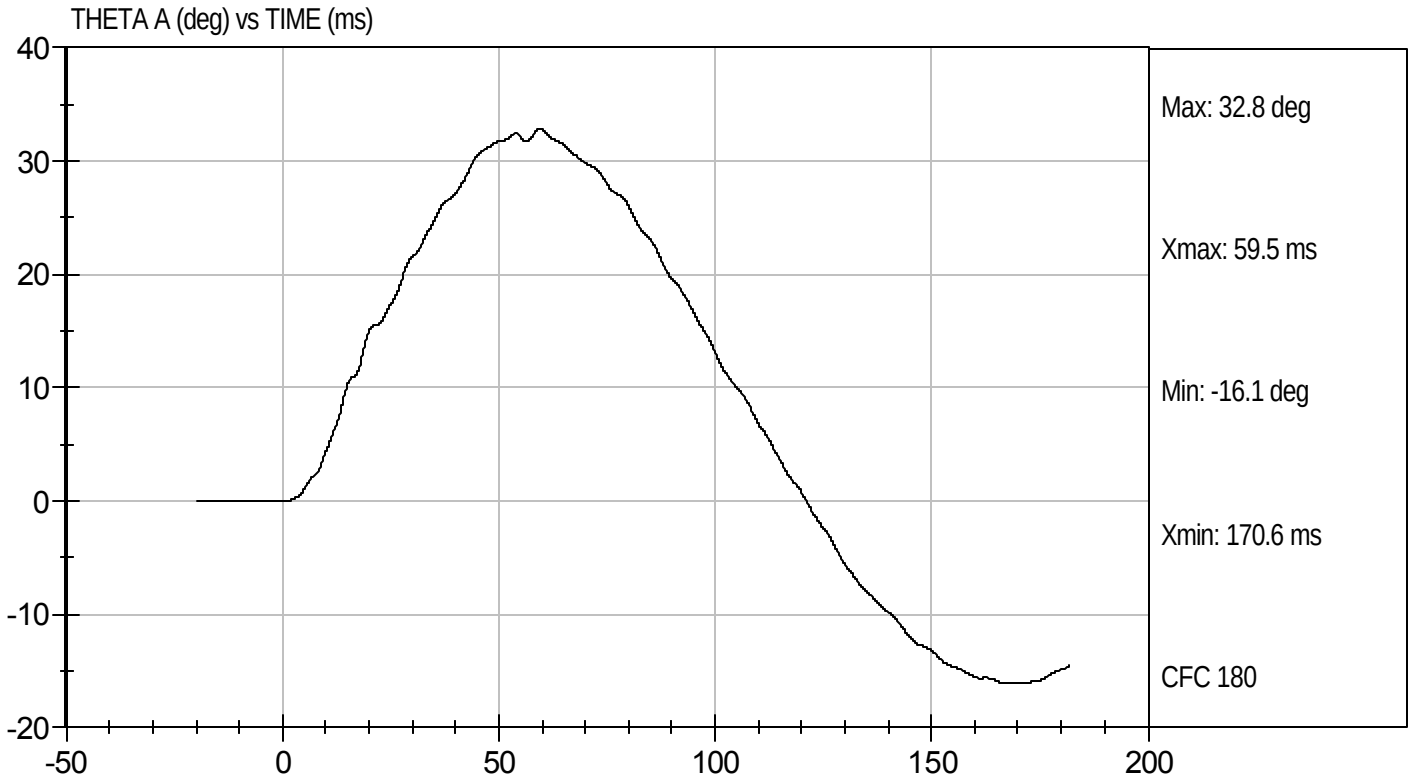


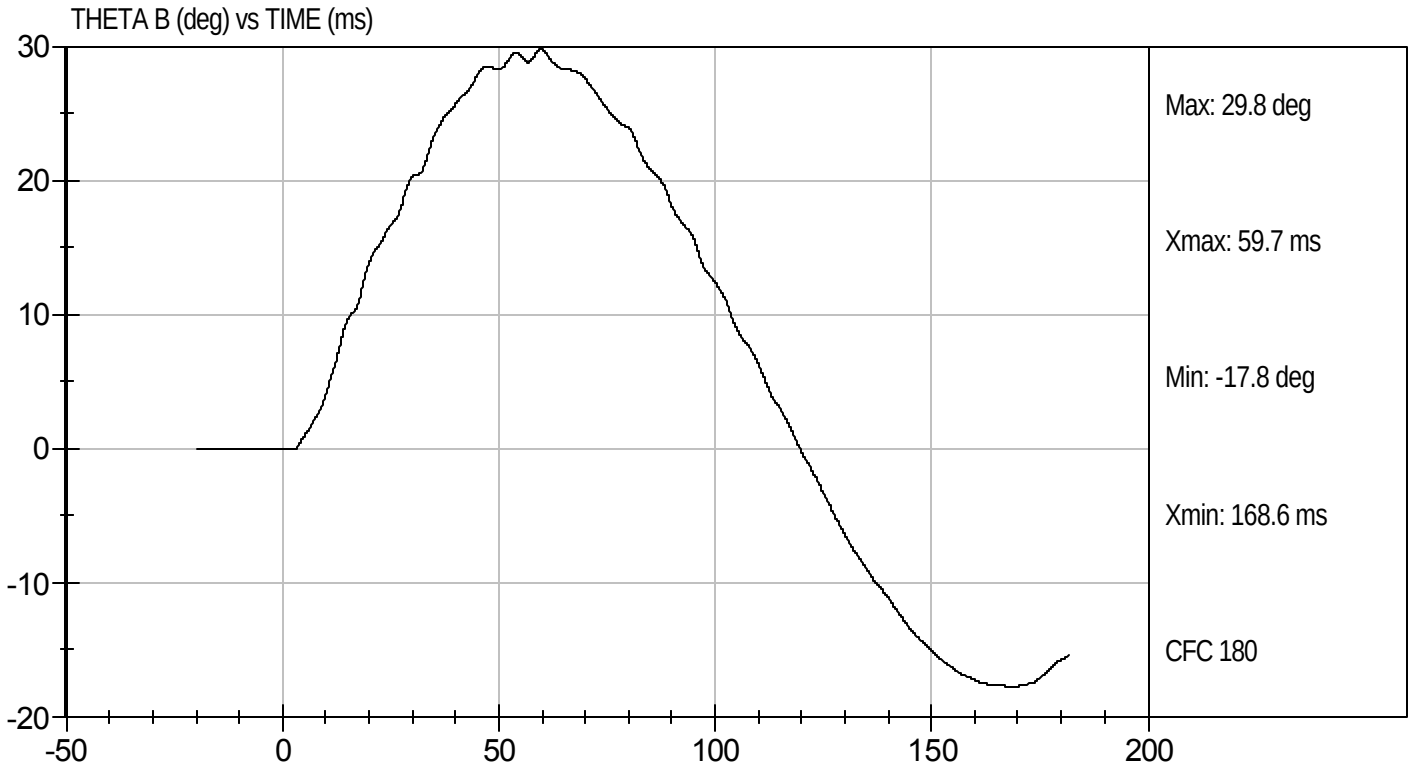
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D111262

Test Date: 4/1/11
Velocity: 11.34 ft/s, 3.5 m/s





MGA RESEARCH CORPORATION

SHOULDER IMPACT TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111263

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	23	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	9.1	Pass
Time of Peak Shoulder Acceleration	ms	NA	13.6	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

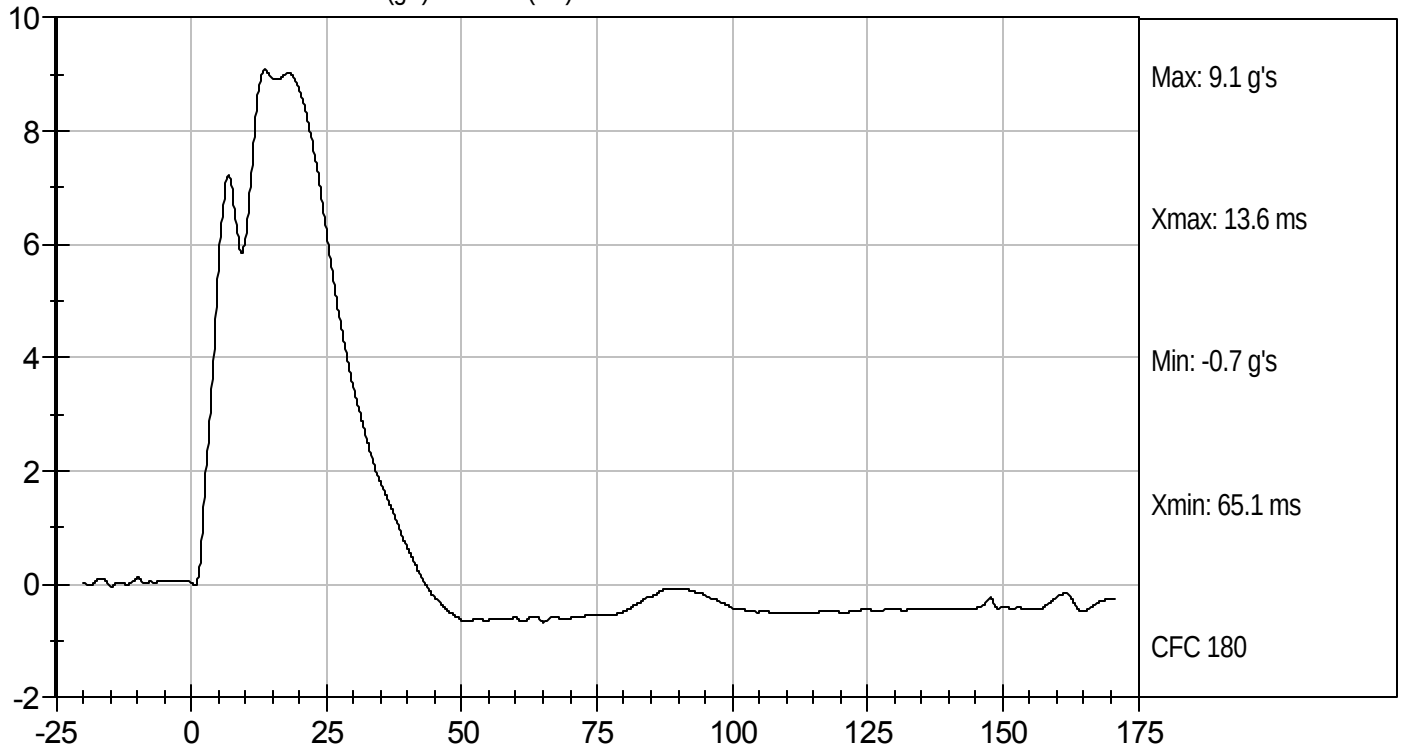
4/1/11
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D111263

Test Date: 4/1/11
Velocity: 14.25 ft/s, 4.3 m/s

SHOULDER ACCELERATION (g's) vs TIME (ms)



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111264

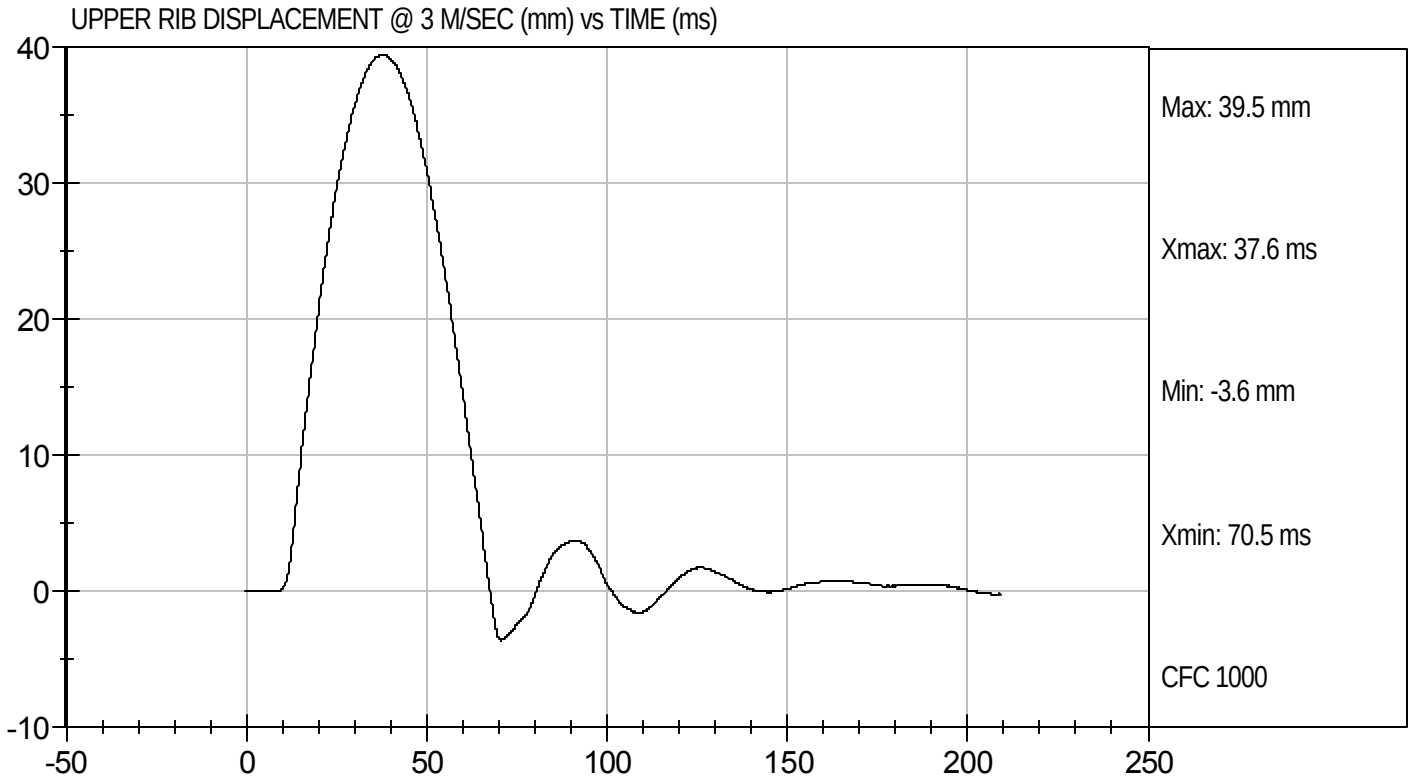
Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	22.0	Pass
Laboratory Relative Humidity	%	10 to 70	26	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	39.5	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.7	Pass
		Overall Test Results		Pass

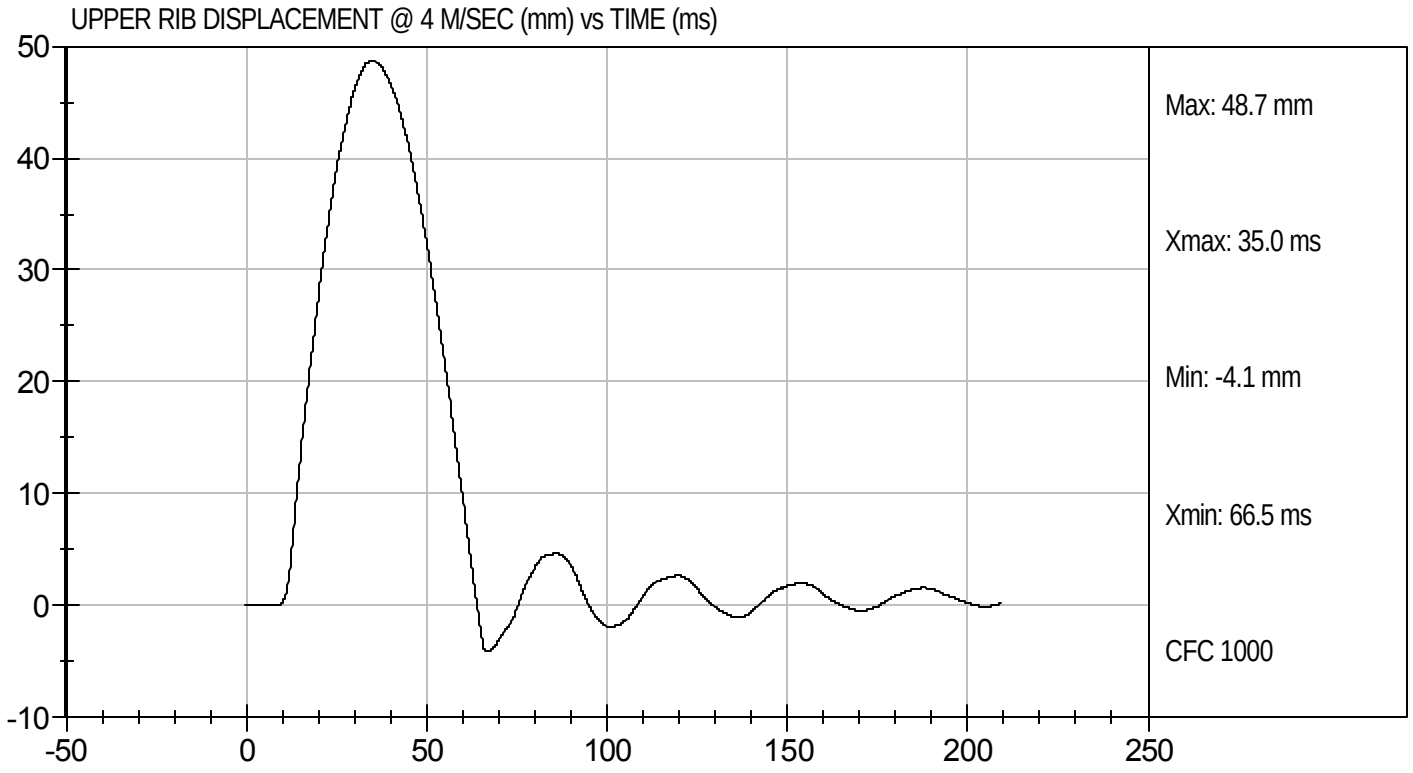
Jessica Gall
Laboratory Technician

4/1/11
Test Date

David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D111264
Test Date: 4/1/11





MGA RESEARCH CORPORATION

MID RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111265

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
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	49.2	Pass
		Overall Test Results		Pass

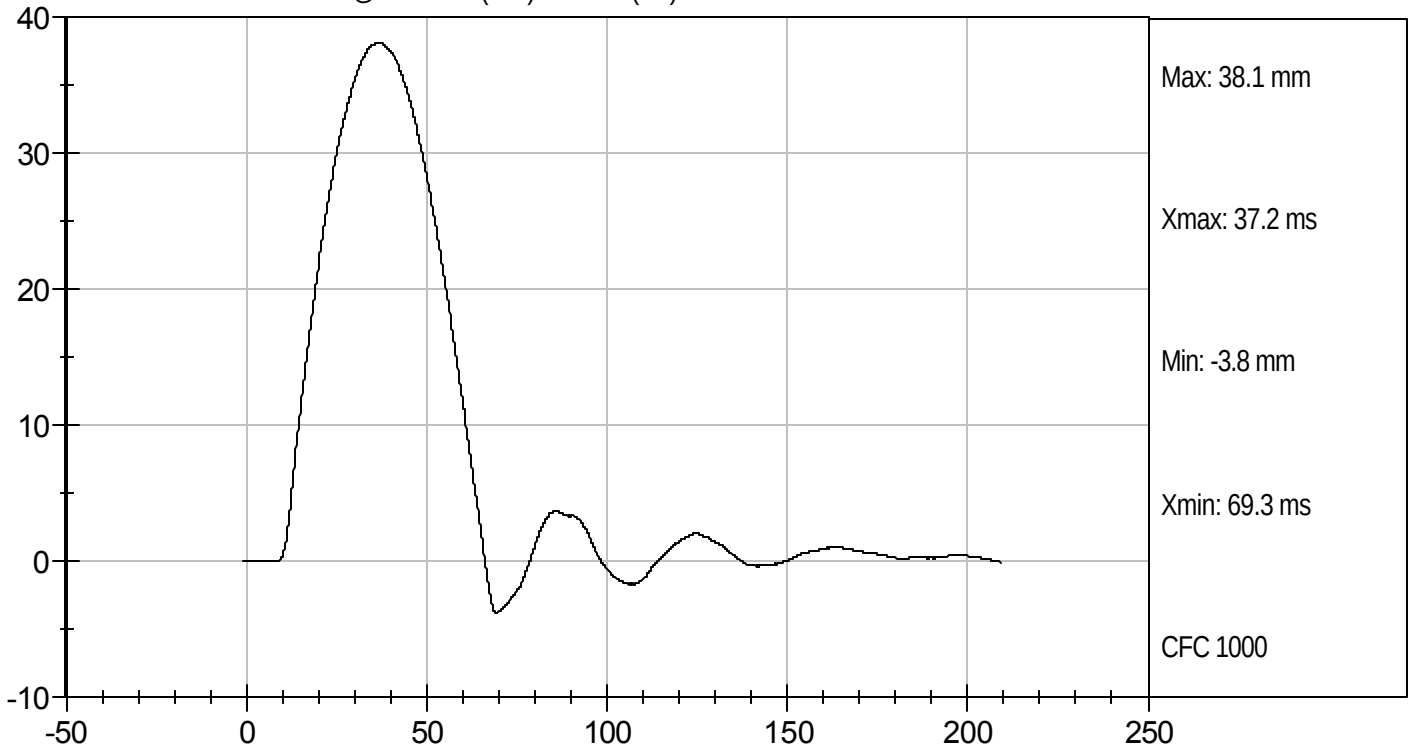
Jessica Gall
Laboratory Technician

4/1/11
Test Date

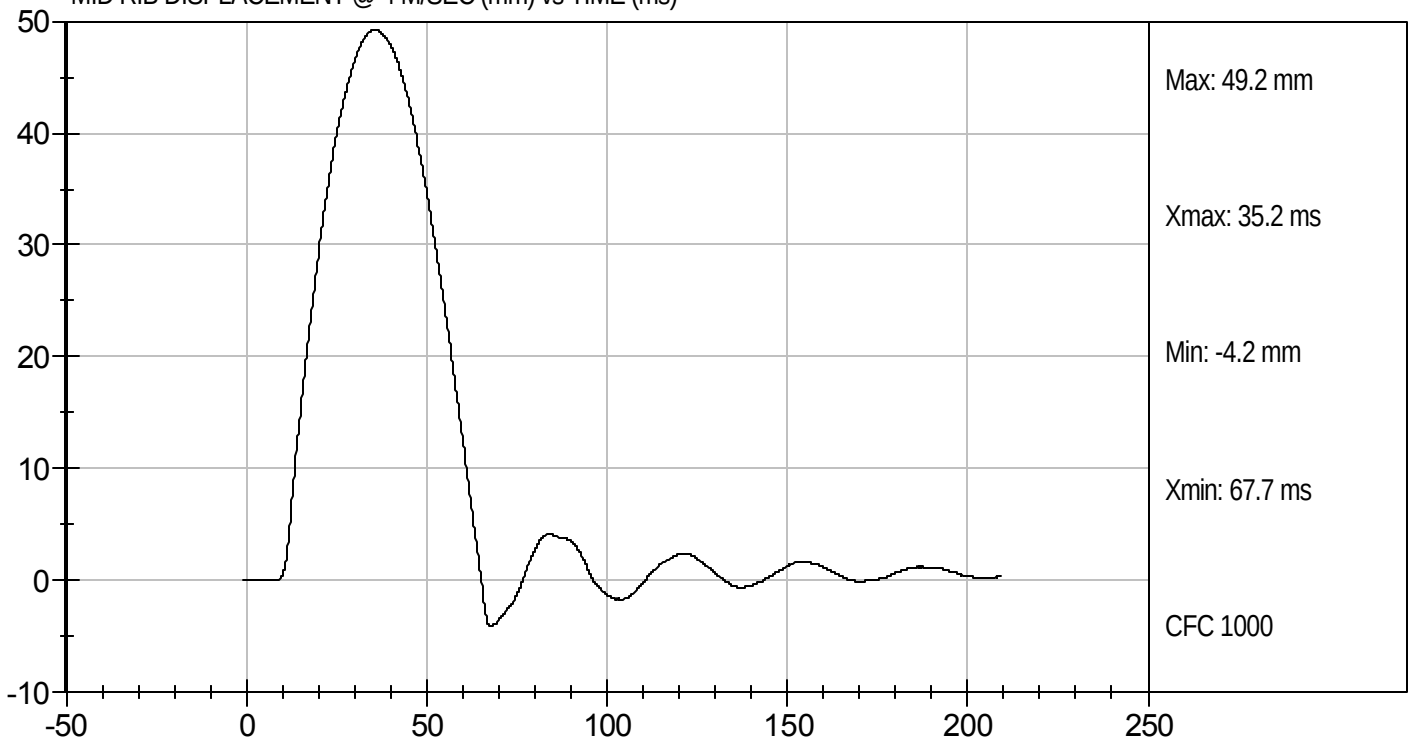
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D111265
Test Date: 4/1/11

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:** D111266

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
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	49.0	Pass
		Overall Test Results		Pass

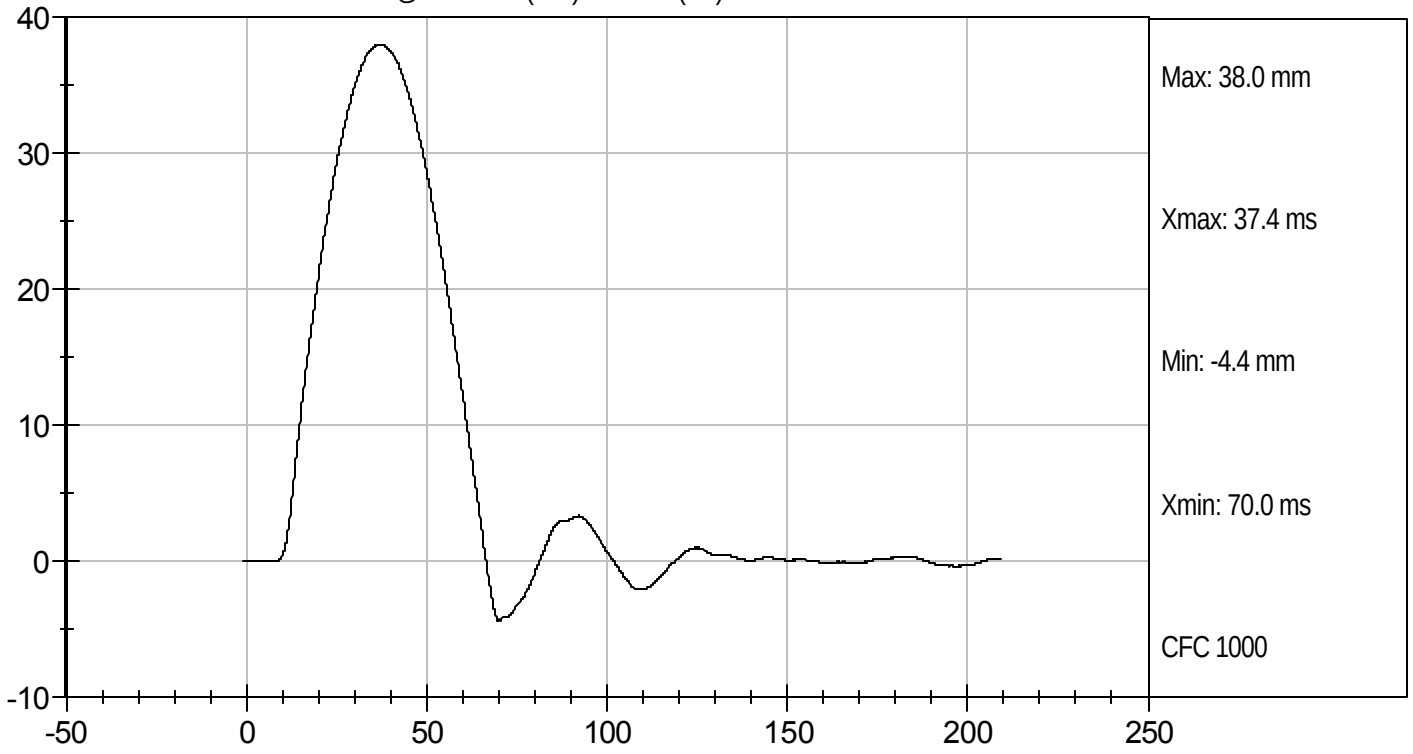
Jessica Hall
Laboratory Technician

4/1/11
Test Date

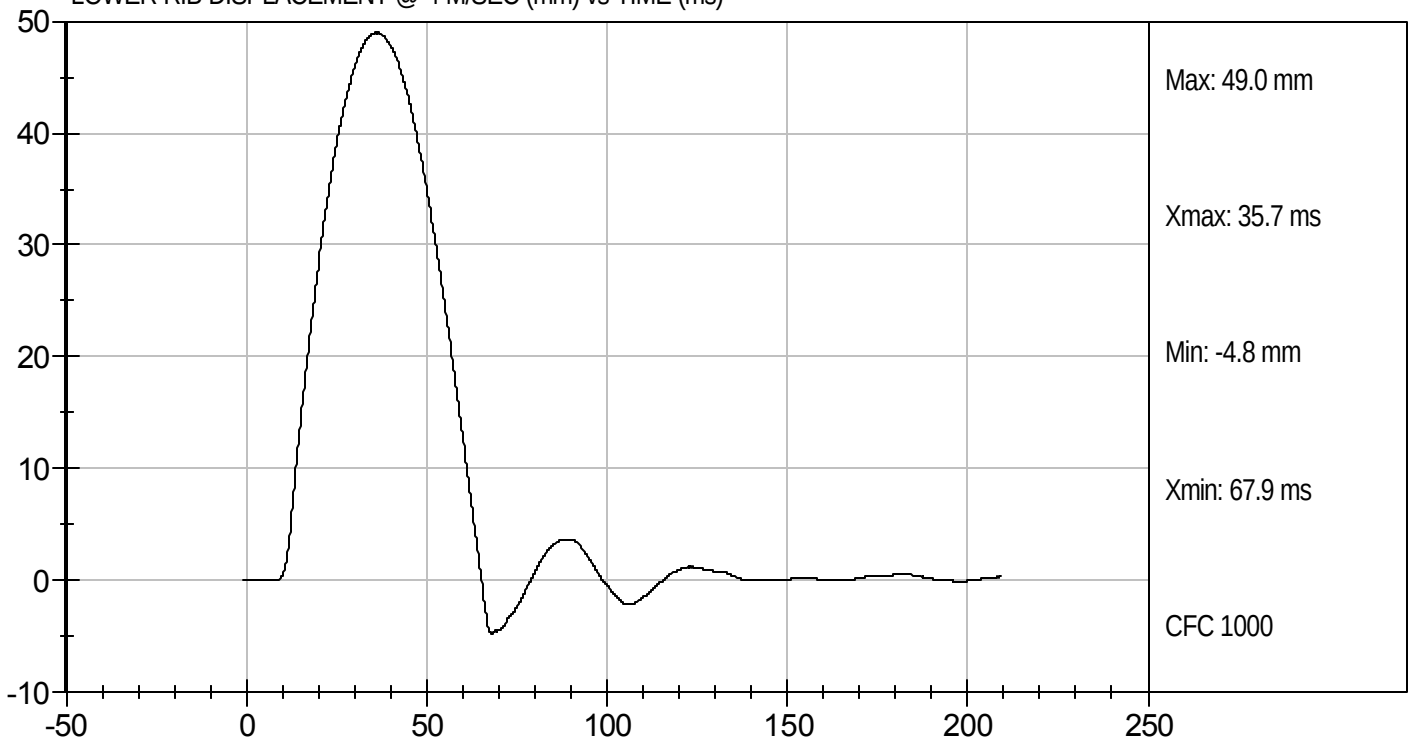
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D111266
Test Date: 4/1/11

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:** D111267

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	23	Pass
Probe Speed	m/s	3.90 to 4.10	4.06	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.38	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	10.90	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.64	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	10.10	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

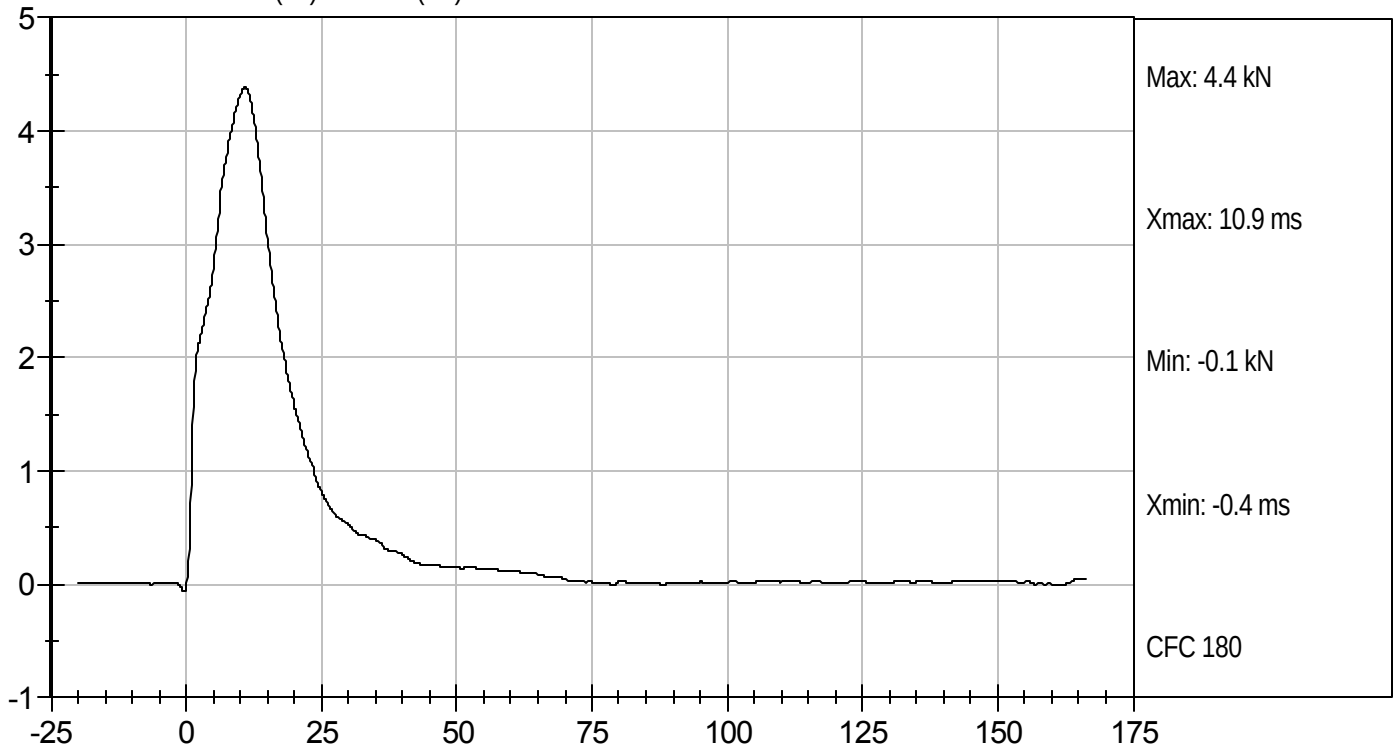
4/1/11
Test Date

David Winkelbauer
Approved By

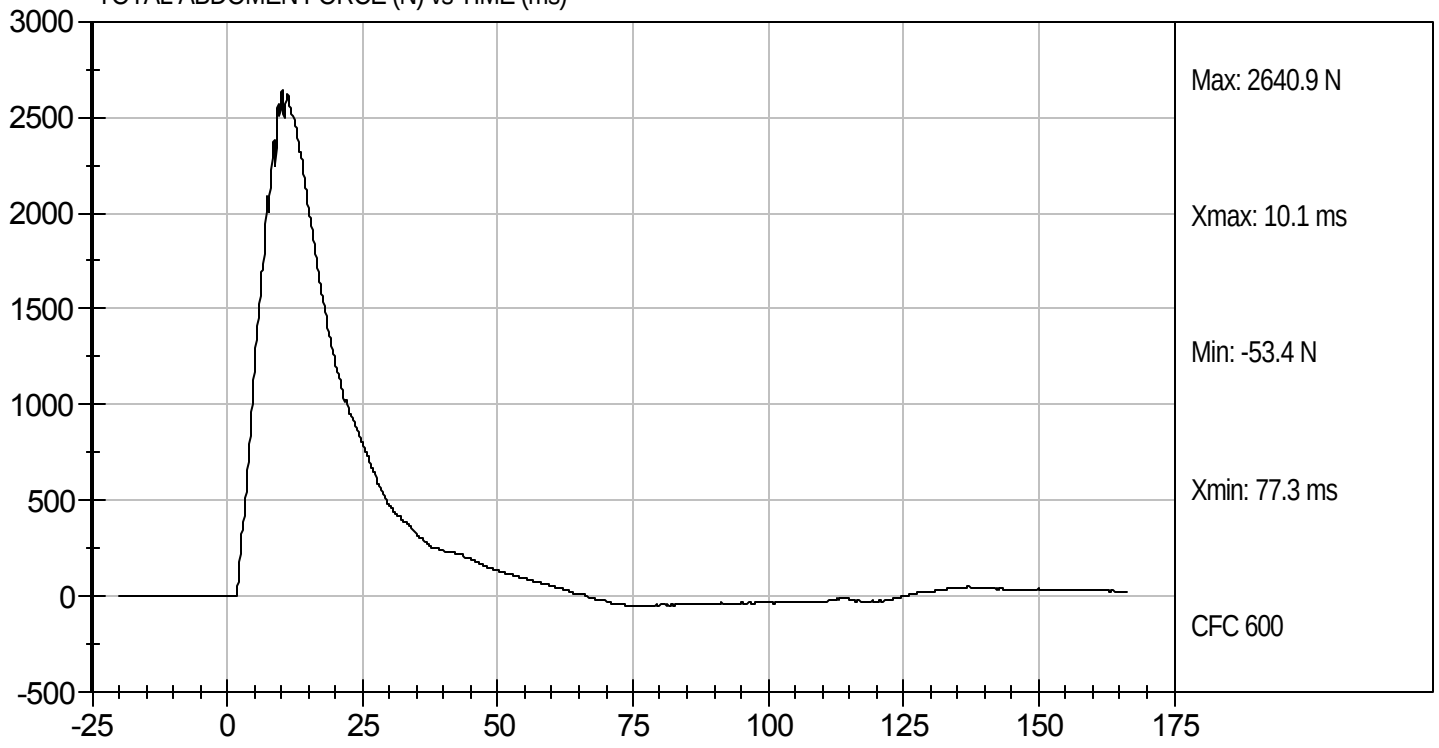
Test Desc: Abdomen Impact
Component ID: D111267

Test Date: 4/1/11
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:** D111268

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	-0.02	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	-6.14	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	45.9	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	46.2	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	45	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

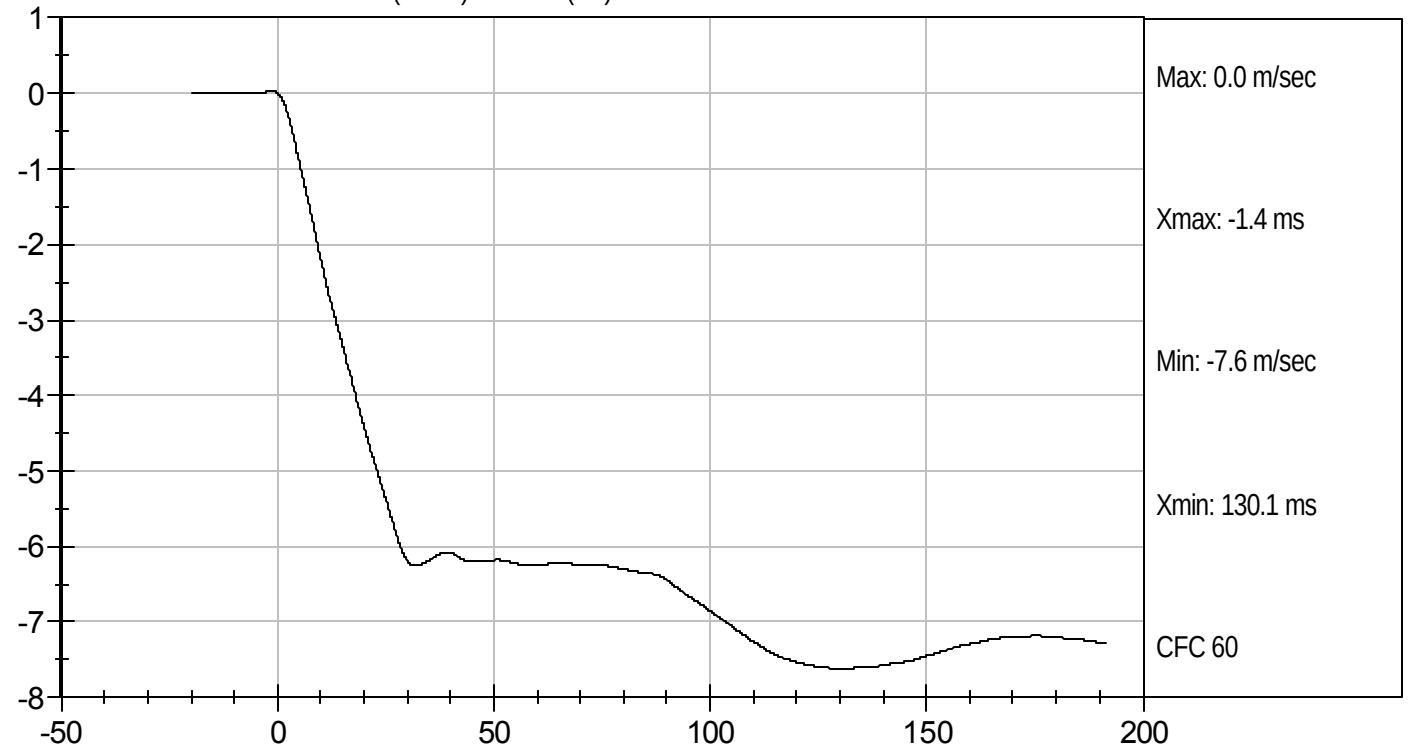
4/1/11
Test Date

David Winkelbauer
Approved By

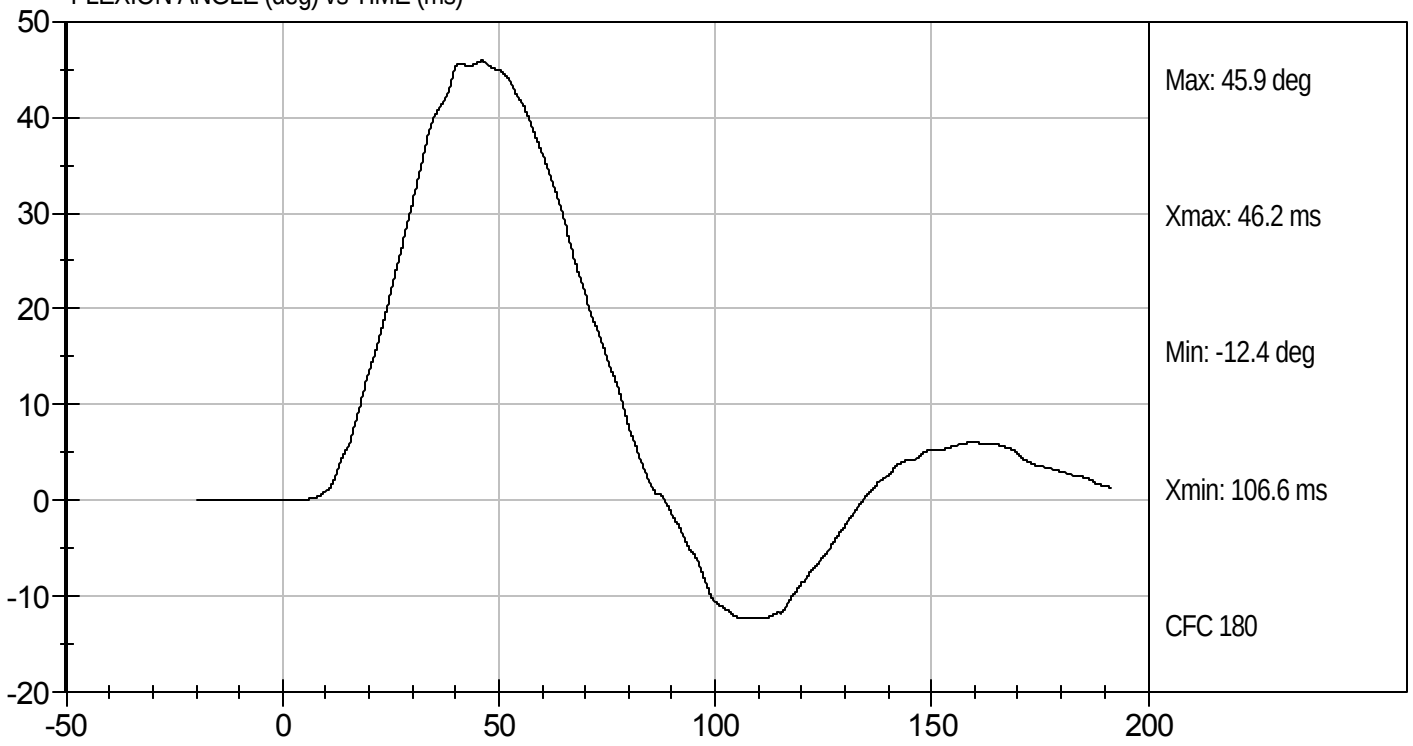
Test Desc: Lumbar Bending
Component ID: D111268

Test Date: 4/1/11
Velocity: 20.08 ft/s, 6.12 m/s

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

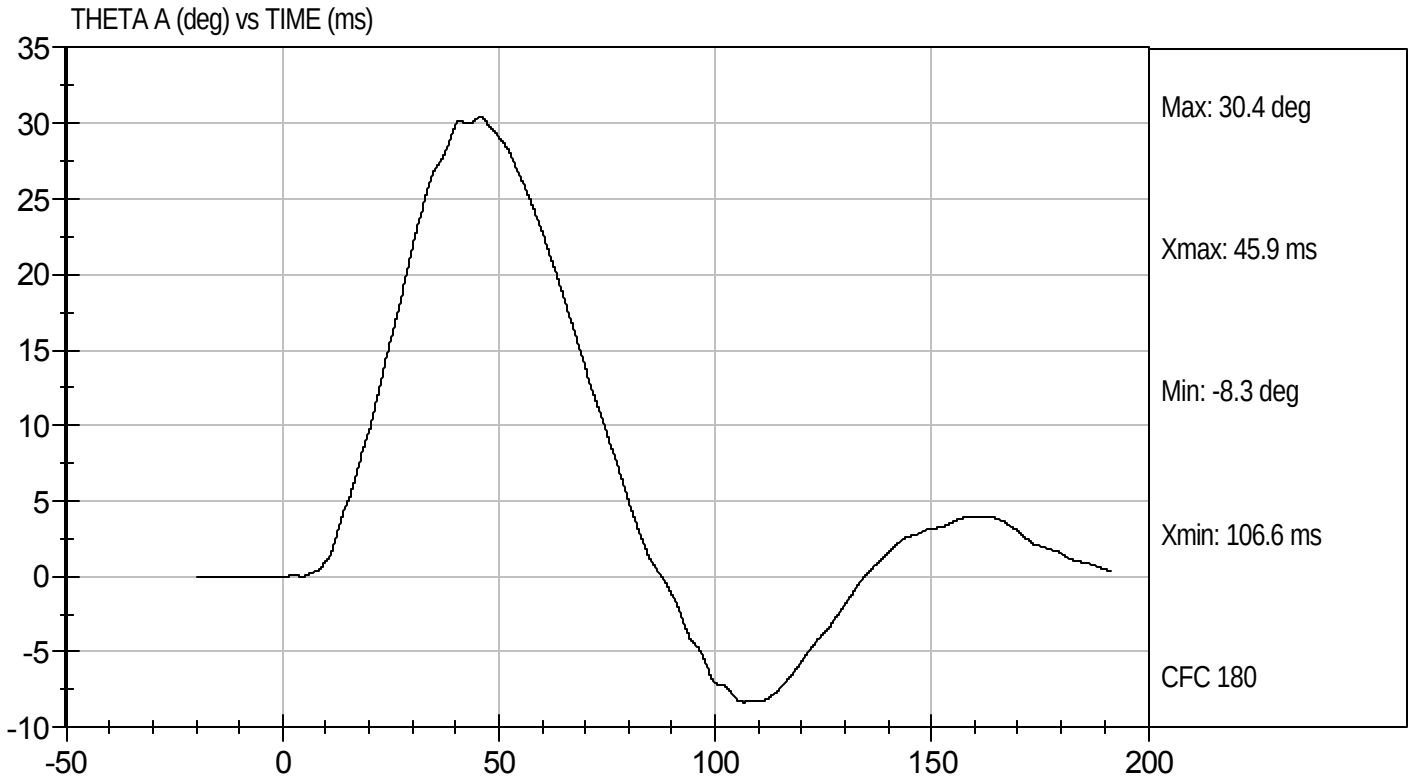


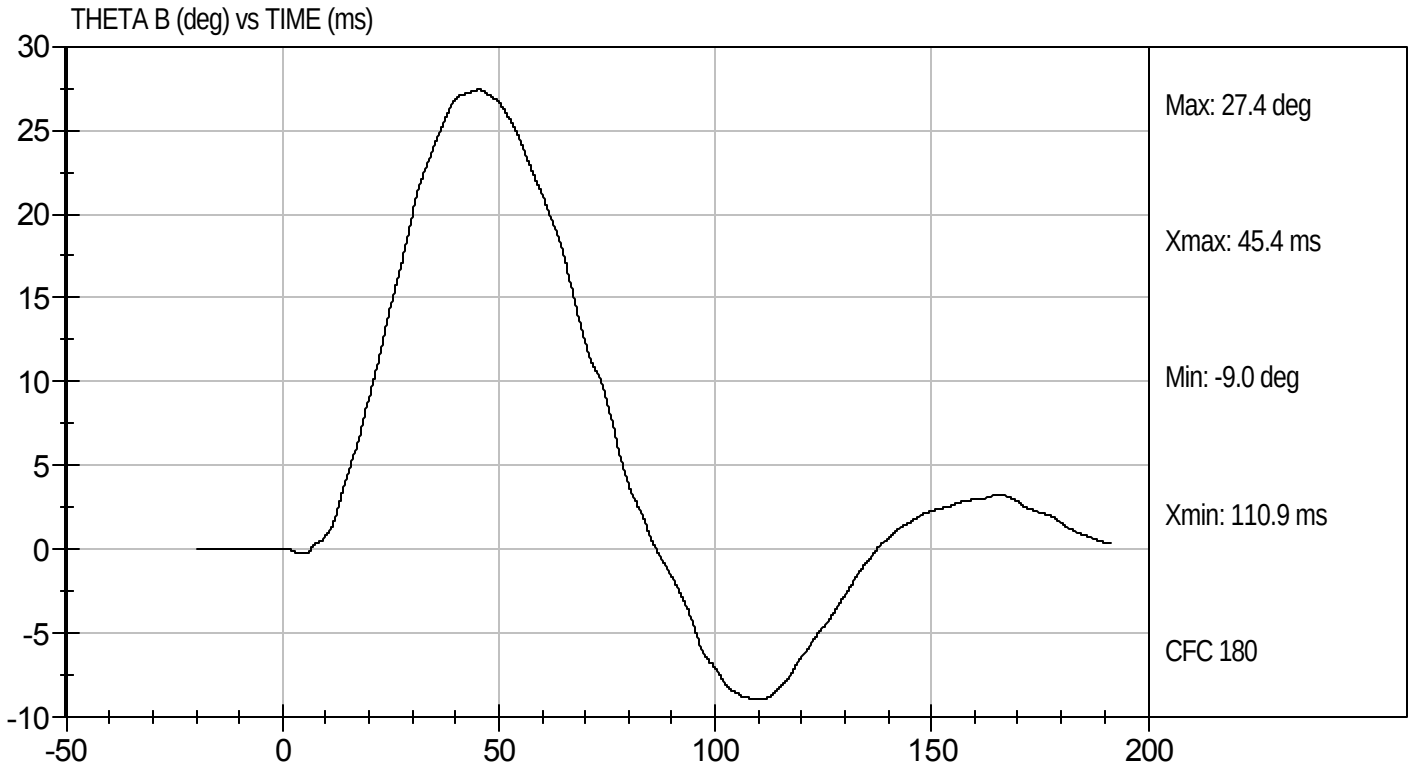
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D111268

Test Date: 4/1/11
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D111269

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	4.77	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	13.80	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.42	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	14.70	Pass
		Overall Test Results		Pass

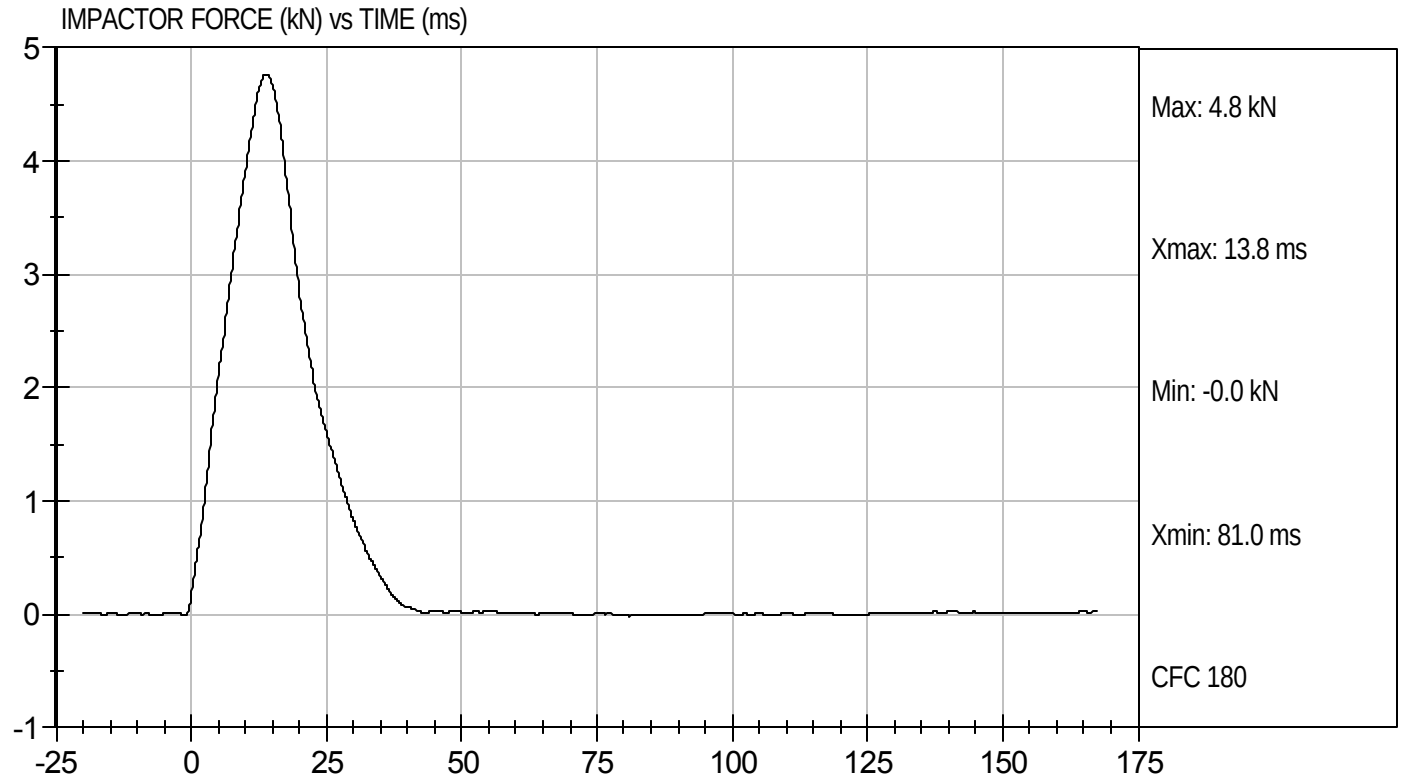
Jessica Gall
Laboratory Technician

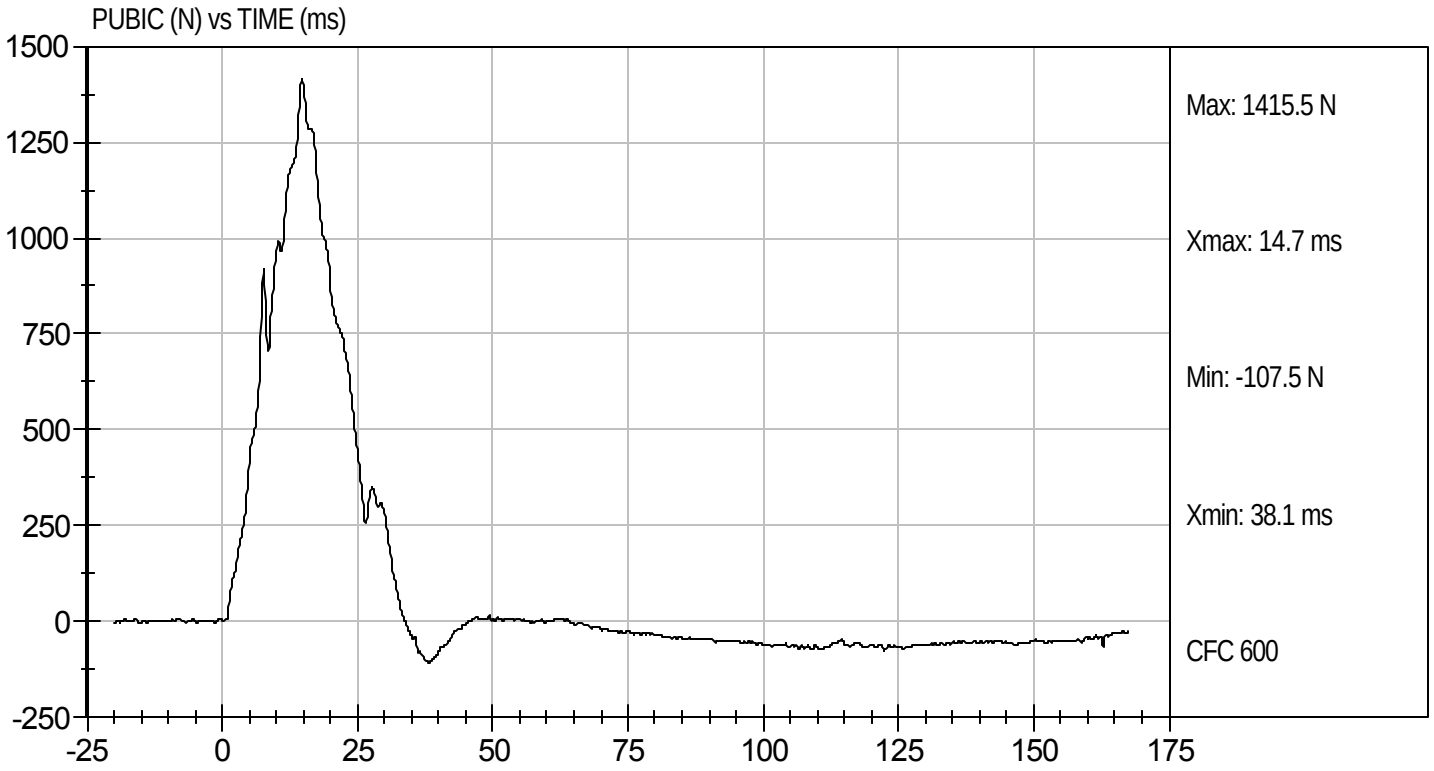
4/1/11
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D111269

Test Date: 4/1/11
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:** D111260

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	22.0	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	5.14	Pass
Upper Rib Displacement	mm	34.0 to 41.0	39.9	Pass
Middle Rib Displacement	mm	37.0 to 45.0	41.3	Pass
Lower Rib Displacement	mm	37.0 to 44.0	39.5	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

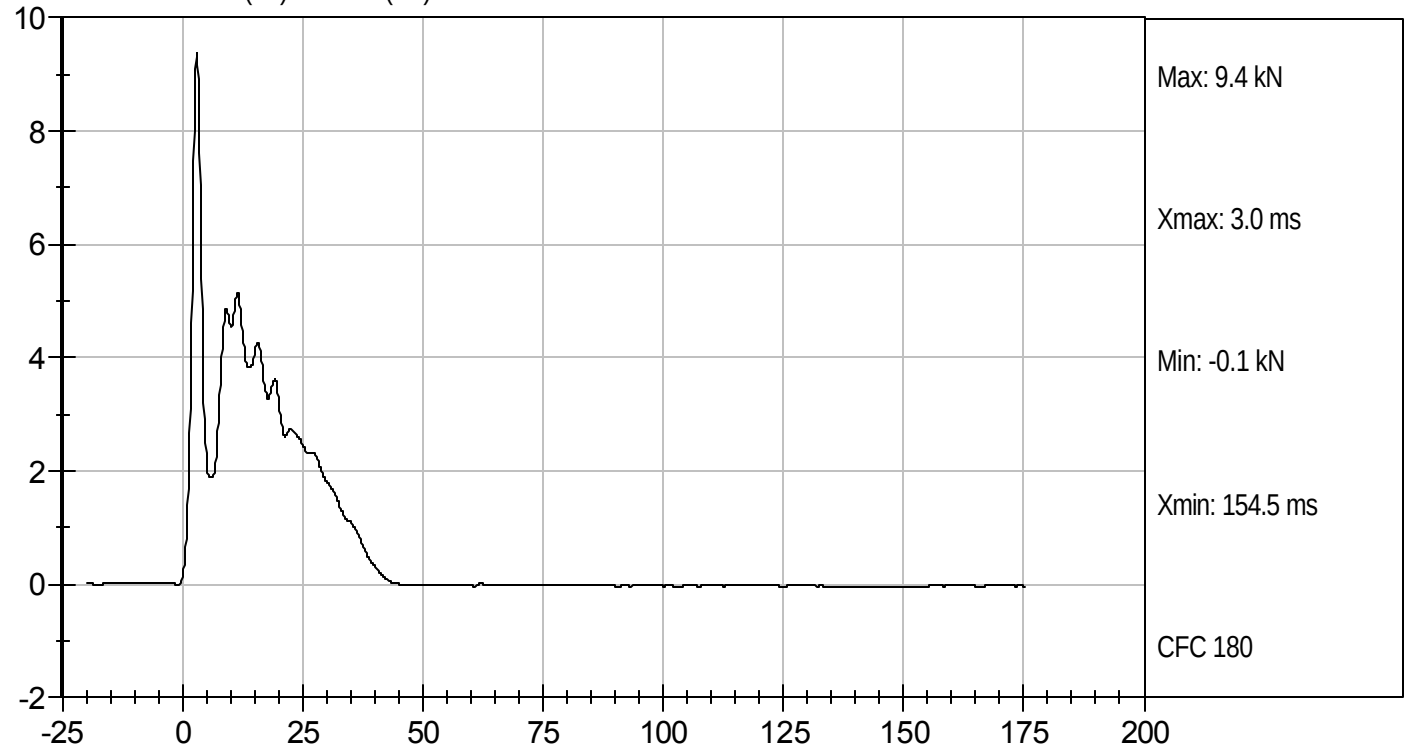
4/1/11
Test Date

David Winkelbauer
Approved By

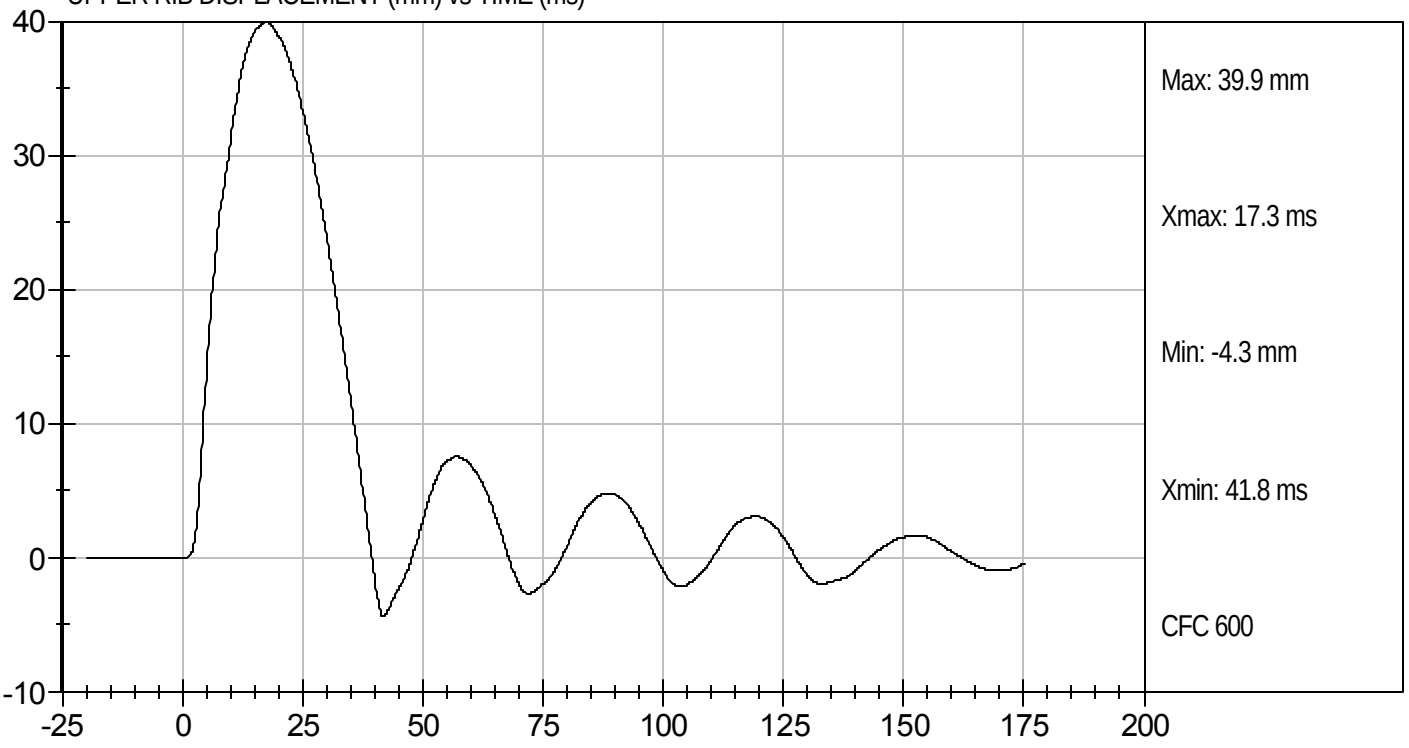
Test Desc: Thorax Impact
Component ID: D111260

Test Date: 4/1/11
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



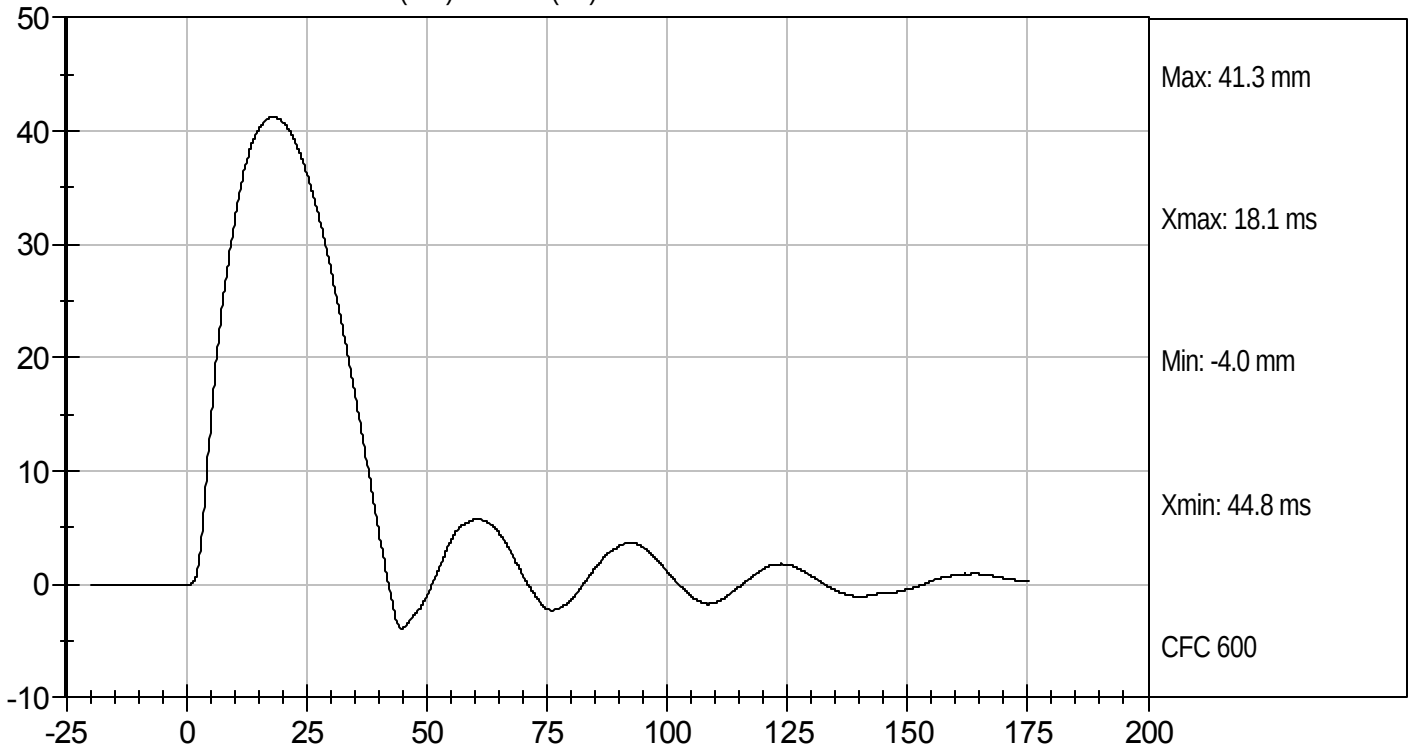
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



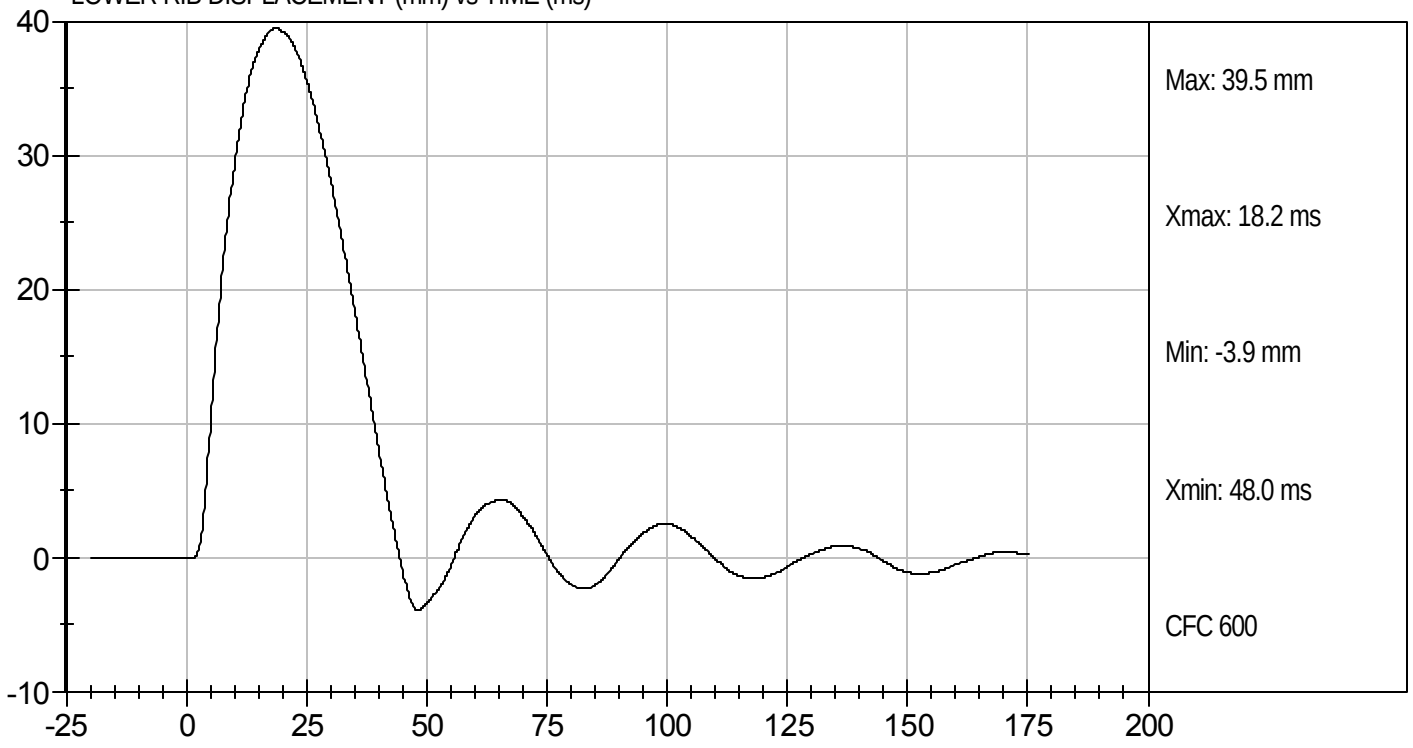
Test Desc: Thorax Impact
Component ID: D111260

Test Date: 4/1/11
Velocity: 18.32 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)	P59385	Endevco	3/16/2011
Vehicle CG (Y)	P59384	Endevco	3/16/2011
Vehicle CG (Z)	P59383	Endevco	3/16/2011
Left Floor Sill (Y)	P50050	Endevco	12/13/2010
A Pillar Sill (Y)	P59217	Endevco	11/05/2010
A Pillar Low (Y)	P52290	Endevco	3/15/2011
A Pillar Mid (Y)	P59667	Endevco	3/15/2011
B Pillar Sill (Y)	P49503	Endevco	1/13/2011
B Pillar Low (Y)	P52198	Endevco	3/15/2011
B Pillar Mid (Y)	P59397	Endevco	3/15/2011
Seat (Y)	P55670	Endevco	11/05/2010
Engine (X)	P49510	Endevco	1/14/2011
Engine (Y)	P49511	Endevco	12/22/2010
Firewall (Y)	P52142	Endevco	3/15/2011
Roof (Y)	P45126	Endevco	11/05/2010
Floor Sill (Y)	P59634	Endevco	11/05/2010
Rear Deck (X)	P52268	Endevco	12/13/2010
Rear Deck (Y)	P52269	Endevco	12/13/2010