REPORT NUMBER: 214P-MGA-2010-002

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

KIA MOTORS CORPORATION
2010 KIA FORTE LX 4-DR SEDAN
NHTSA NUMBER: CA0505

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

Test Date: January 21, 2010

Report Date: January 26, 2010

FINAL REPORT

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
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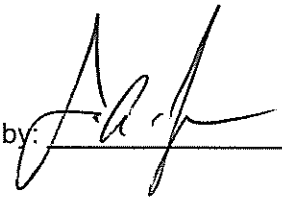
FINAL REPORT ACCEPTANCE BY OVSC:

Accepted by: 

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Technical Report Documentation Page

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4. Title and Subtitle Final Report of FMVSS 214P Compliance Test Side Impact Protection Testing of 2010 Kia Forte LX 4-Dr Sedan; NHTSA No.: CA0505		*5. Report Date* January 26, 2010 *6. Performing Organization Code* MGA
7. Author(s) Donna Janovicz, Project Manager Joe Fleck, Project Engineer		*8. Performing Organization Report No.* 214P-MGA-2010-002
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 1//21/2010 to 1/26/2010 *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 2010 Kia Forte 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 January 21, 2010.

The impact velocity was 31.1 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 360 mm at level 3. The test vehicle's performance follows:

Measurement Description	Units	Result
Head Injury Criteria (HIC_{36})	N/A	545
Max. Rib Deflection	mm	26
Sum of Abdomen Forces	N	1410
Pubic Symphysis Force	N	2570

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 2010 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 2010 Kia Forte 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 July 2009).

SUMMARY

A rigid pole side impact test was conducted on a 2010 Kia Forte LX 4-Dr Sedan. The subject vehicle was towed into the rigid pole at an angle of 75° and a velocity of 31.1 km/h. The test was conducted by MGA Research Corporation in Burlington, Wisconsin, on January 21, 2010. 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 July 2009. 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	545	Upper	25.6	Front	467.5	2570.0
		Middle	19.1	Mid	444.7	
		Lower	19.6	Rear	509.2	
		Max.	25.6	Sum	1409.9	

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

GENERAL COMMENTS

There was no valid data collected for:

Vehicle CG X, Y, Z after 150 msec.
Left Floor Sill Y
Left Lower B-Post Y after 15 msec.
Left Mid B-Post Y after 50 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: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

VEHICLE INFORMATION	
Make	Kia
Model	Forte LX
Body Style	Sedan
VIN	KNAFT4A24A5809253
Body Color	Bright Silver
Engine Displacement (L)	2.0
# of Cylinders	4
Engine Placement	Lateral
Transmission Type	Manual
Transmission Speeds	5-speed
Overdrive	Yes
Final Drive	Front
Odometer Reading	136 miles

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

DATA FROM CERTIFICATION LABEL

Manufactured By	Kia Motors Corporation
Date of Manufacture	08/09

GVWR (kg)	1710
GAWR Front (kg)	980
GAWR Rear (kg)	820

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)				385
Cargo Weight (RCLW) (kg)				45

DATA SHEET NO. 2

GENERAL TEST AND VEHICLE PARAMETER DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

TIRE PRESSURES

	Units	LF	RF	RR	LR
As Delivered	kPa	220	220	220	220
As Tested	kPa	220	220	220	220

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	382.8	238.6		416.4	286.7		410.5	281.2	
Right	kg	377.4	235.0		387.4	269.0		395.1	265.4	
Ratio	%	61.6	38.4		59.1	40.9		59.6	40.4	
Totals	kg	760.2	473.6	1233.8	803.8	555.7	1359.5	805.6	546.6	1352.2

TEST VEHICLE TARGET WEIGHT (TVTW) CALCULATION

Measured Parameter	Units	Value
As Delivered Weight	kg	1233.8
Weight of 1 P572U ATD (ES-2re) Dummy	kg	77.1
Rated Cargo/Luggage Weight (RCLW)	kg	45
Calculated Target Vehicle Test Weight (TVTW)	kg	1355.9

TEST VEHICLE ATTITUDES

	Units	LF	RF	RR	LR
Fully Loaded	mm	673	674	659	648
As Tested	mm	668	668	662	665
Difference	mm	5	6	-3	-17

CALCULATION OF THE VERTICAL IMPACT REFERENCE LINE

Measurement Parameter	Units	Value
Test Vehicle Wheel Base	mm	2649
Vertical Impact Reference Line (Aft of Front Axle)	mm	1230

WEIGHT of BALLAST and VEHICLE COMPONENTS REMOVED TO MEET TVTW

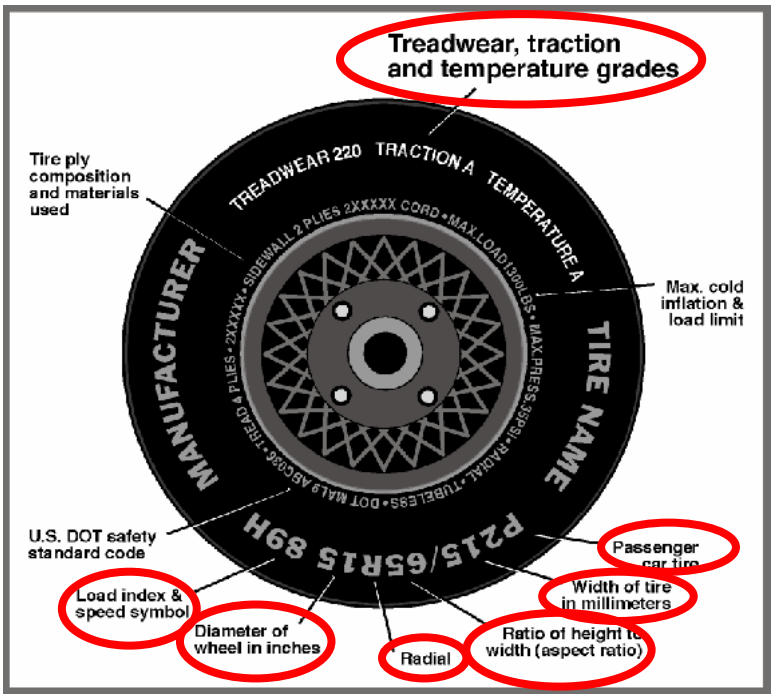
Description of Component	Weight (kg)
Ballast	0
LR/RR Taillights	2.7
RF/RR Windows and Trim	8.2
RR Door Panel/RR Speaker	2.3
Hub Caps/Trunk Carpet/Tools/Spare Tire	19.5
RF Passenger Headrest/RF Side Mirror	2.7

DATA SHEET NO. 3

VEHICLE TIRE INFORMATION

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

VEHICLE TIRE INFORMATION



Measured Parameter	Front	Rear
Max. Tire Pressure (kPa)	300	300
Cold Pressure (kPa)	220	220
Recommended Tire Size	P195/65R15	P195/65R15
Tire Size on Vehicle	P195/65R15	P195/65R15
Tire Manufacturer	NEXEN	NEXEN
Tire Name	Classe Premiere CP662	Classe Premiere CP662
Tire Type	Passenger	Passenger
Tire Width	195	195
Aspect Ratio	65	65
Radial	Yes	Yes
Wheel Diameter	15	15
Load Index/Speed Symbol	89T	89T
Treadwear	440	440
Traction Grade	A	A
Temperature Grade	A	A

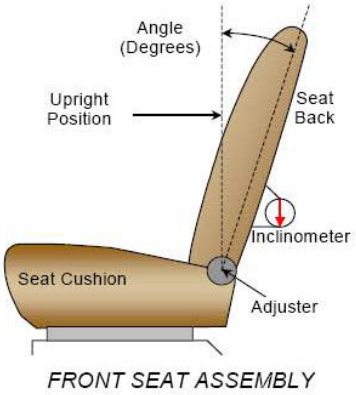
DATA SHEET NO. 4

SEAT AND SEAT BELT ADJUSTMENT DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

NORMAL DESIGN RIDING POSITION

The driver seat back is positioned to the manufacturer's designated angle. The procedure is as follows: Set seat back at 8.8 degrees with the seat in the full-down mid track position. Adjust angle by 7 pumps from the lowest position to reach test position.



FRONT SEAT ASSEMBLY

SEAT BACK ANGLES

	Degrees	Detents
Driver with Seated Dummy	5.0° at headrest post with seat at mid angle (7.5 pumps from lowest)	N/A

SEAT FORE/AFT POSITIONS

The method used for determining seat fore/aft positions is as follows: For manual seat track adjustments, test detent is measured from forward-most detent, which is defined as 0. Place in 11th detent for 50th percentile male.

SEAT FORE/AFT POSITIONING

	Total Fore/Aft Travel	Placed in Position #
Front Seat	22 detents	11th detent

SEAT BELT UPPER ANCHORAGES

The method of positioning the seat belt upper anchorages is as follows: Detents to the nominal design position are measured with respect to the upper-most detents, which is defined as 0. Place at 0 for the 50th percentile male.

SEAT BELT UPPER ANCHORAGES

	Total # of Positions	Placed in Position #
Driver Seat	100 mm / 4 detents	0 mm / uppermost detent

HEADREST RESTRAINT

The headrest was placed in the full forward and full up position.

DATA SHEET NO. 5

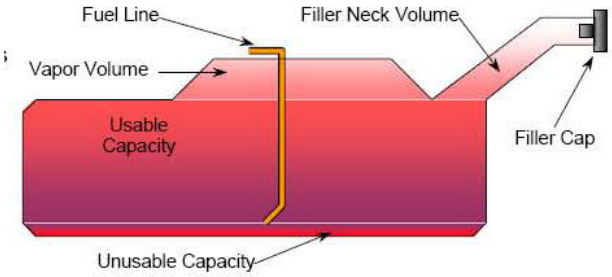
FUEL SYSTEMS AND STEERING WHEEL POSITION DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

FUEL TANK CAPACITY

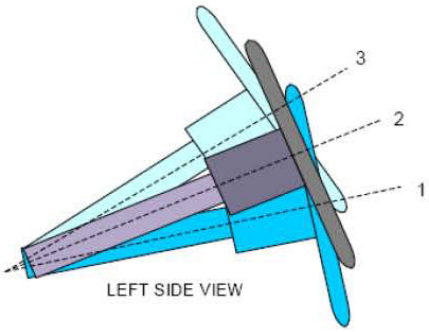
	Liters
Usable Capacity (Form 1)	52.0
Usable Capacity (Owner's Manual)	52.0
92-94% of Usable Capacity	47.8 to 48.9
Actual Amount of Solvent Used	48.4

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

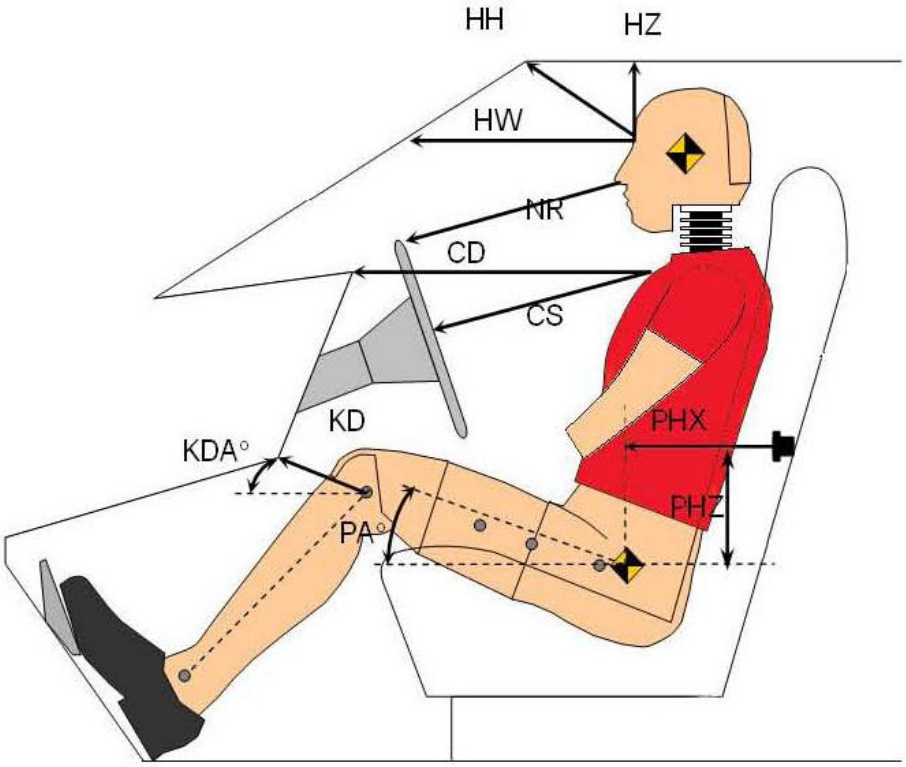
STEERING COLUMN POSITIONING

	Degrees	Fore/Aft Position (mm)
Lowermost - Position 1	69.5	
Geometric Center – Position 2	67.4	
Uppermost – Position 3	65.3	
Telescoping Steering Wheel Travel	Fixed	
Test Position	67.4	

.**DATA SHEET NO. 6**

DUMMY LONGITUDINAL CLEARANCE DIMENSIONS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

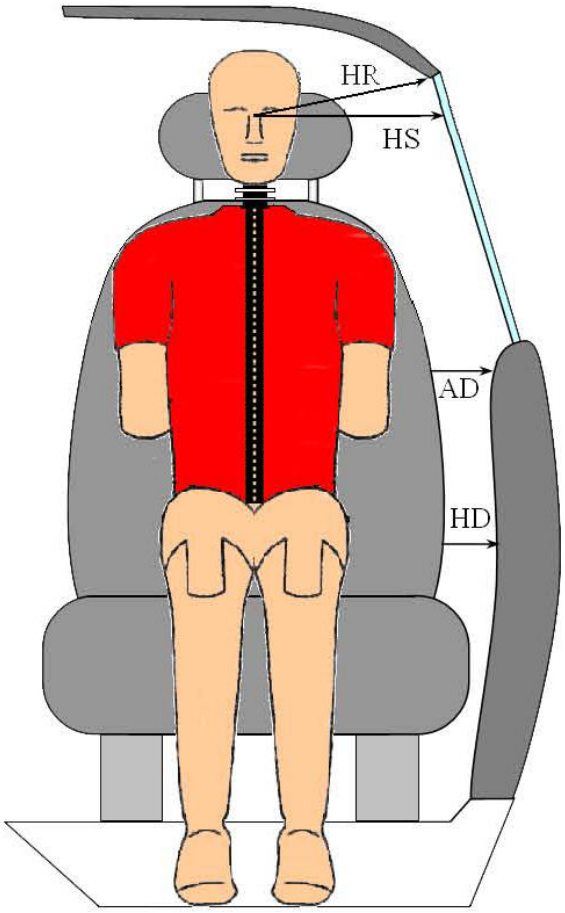


Driver Code	Measurement Description	Length (mm)	Angle (°)
HH	Head to Header	323	
HW	Head to Windshield	564	
HZ	Head to Roof	145	
NR	Nose to Rim	412	
CD	Chest to Dash	530	
CS	Chest to Steering Wheel	325	
KDL	Left Knee to Dash	165	30.0
KDR	Right Knee to Dash	132	28.7
PA	Pelvic Angle		23.8
PHX	H-Point to Striker (X-Axis)	211	
PHZ	H-Point to Striker (Z-Axis)	211	

DATA SHEET NO. 7

DUMMY LATERAL CLEARANCE DIMENSIONS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

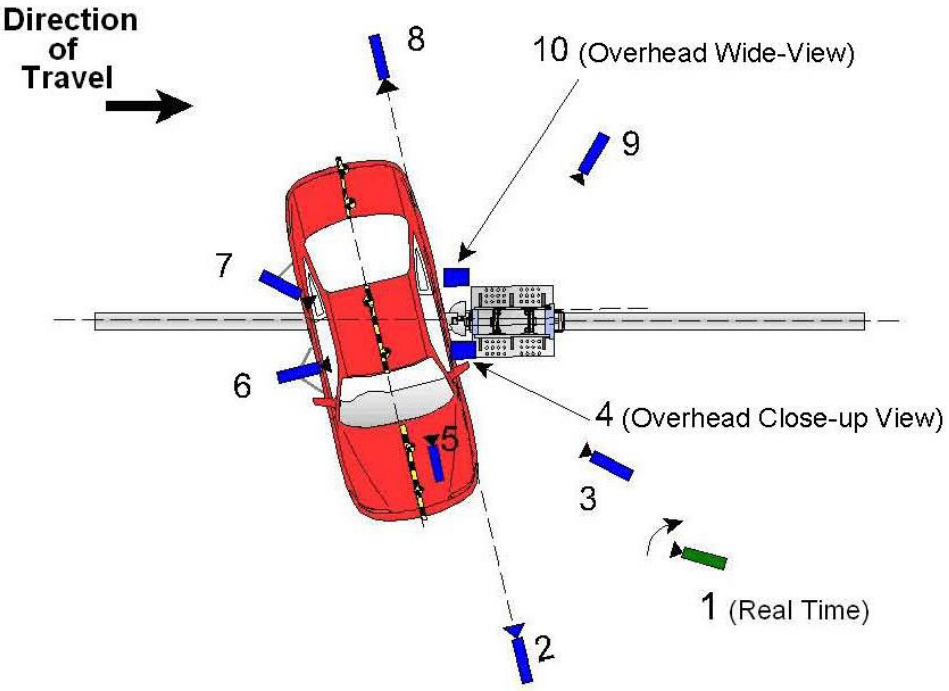


Code	Measurement Description	Units	Front Occupant
HR	Head to Side Header	mm	208
HS	Head to Side Window	mm	353
AD	Arm to Door	mm	101
HD	H-Point to Door	mm	173

DATA SHEET NO. 8

HIGH SPEED CAMERA LOCATIONS AND DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



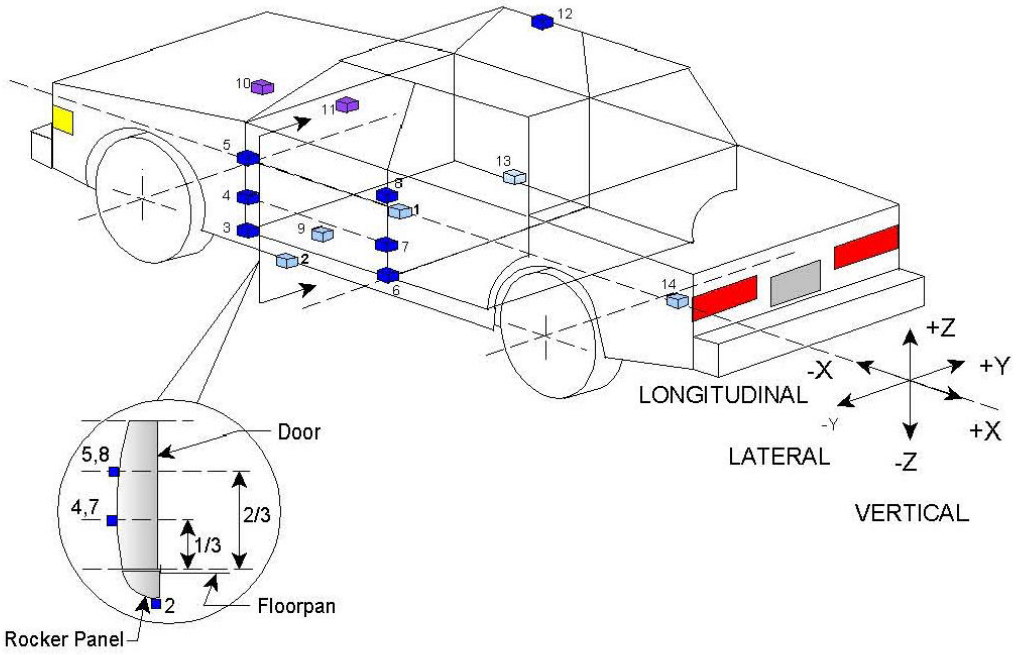
Reference: From Point of Impact for X and Y; from Ground for Z):
+X = Forward of Impact, + Y = Right of Impact, +Z = Down

Camera No.	View	Coordinates (mm)			Lens (mm)	Film Speed (fps)
		X	Y	Z		
1	Real-Time				13	24
2	Front Ground Level	-1460	5080	-1690	24	1000
3	Impact Side 45° Forward	-2950	2930	-1640	20	1000
4	Overhead Closeup	50	0	-4520	50	1000
5	Onboard – Driver Front				12.5	1000
6	Onboard – Driver Side				8	1000
7	Onboard – Driver Rear				8	1000
8	Rear Ground Level	1510	-5570	-1670	24	1000
9	Impact Side 45° Rearward	-2730	-3400	-1640	20	1000
10	Overhead Wide	490	0	-4890	14	1000

DATA SHEET NO. 9

TEST VEHICLE ACCELEROMETER LOCATIONS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



Loc. No.	Accelerometer Location			
	ID	Coordinates (mm)		
		X	Y	Z
1	Vehicle CG	2513	0	-370
2	Left Floor Sill	2695	-720	-200
3	A Pillar Sill	3100	-720	-200
4	A Pillar Low	3031	-703	-482
5	A Pillar Mid	3125	-765	-773
6	B Pillar Sill	2042	-720	-205
7	B Pillar Low	2178	-691	-532
8	B Pillar Mid	2133	-690	-766
9	Seat	2131	-560	-525
10	Engine	3823	0	-824
11	Firewall	3447	0	-821
12	Roof	2234	553	-1432
13	Floor Sill	2242	720	-202
14	Rear Deck	226	0	-309

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: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

Loc. No.	Description	Peak Values (g's)			
		Max	Time (ms)	Min	Time (ms)
1	Vehicle CG (X)	(1)	(1)	(1)`	(1)
	Vehicle CG (Y)	(1)	(1)	(1)`	(1)
	Vehicle CG (Z)	(1)	(1)	(1)`	(1)
	Resultant	(1)	(1)	(1)`	(1)
2	Left Floor Sill (Y)	(2)	(2)	(2)	(2)
3	A Pillar Sill (Y)	13.0	16.0	-3.7	7.5
4	A Pillar Low (Y)	24.1	20.6	-10.6	24.9
5	A Pillar Mid (Y)	16.2	12.6	-10.0	9.1
6	B Pillar Sill (Y)	44.7	15.9	-15.6	35.3
7	B Pillar Low (Y)	(3)	(3)	(3)	(3)
8	B Pillar Mid (Y)	(4)	(4)	(4)	(4)
9	Seat (Y)	58.8	23.0	-12.4	36.1
10	Engine (X)	7.4	106.7	-19.2	36.0
	Engine (Y)	11.1	69.4	-3.8	206.9
11	Firewall (Y)	9.2	60.0	-1.4	30.0
12	Roof (Y)	27.9	35.4	-2.7	41.5
13	Floor Sill (Y)	18.0	56.2	-0.6	185.1
14	Rear Deck (X)	3.5	132.8	-7.9	42.8
	Rear Deck (Y)	19.9	49.5	-3.1	199.1

(1) Vehicle CG X, Y, Z no valid data after 150 msec.
(2) Left Floor Sill Y – no valid data
(3) Left Lower B-Post Y no valid data after 15 msec.
(4) Left Mid B-Post Y no valid data after 50 msec.

DATA SHEET NO. 11

DUMMY INJURY RESPONSE DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

Dummy S/N	Positive		Negative	
	MAX	TIME (ms)	MAX	TIME (ms)
HEAD ACCELERATION (G)				
Longitudinal (X)	5.7	150.5	-30.7	54.9
Lateral (Y)	61.3	54.1	-12.8	100.2
Vertical (Z)	15.3	43.9	-2.9	67.0
Resultant (R)	68.2	54.9		
HIC36 (t1, t2)	545		t1 = 44.4	t2 = 68.6
THORAX DEFLECTION (mm)				
Upper Rib			25.6	53.1
Middle Rib			19.1	51.0
Lower Rib			19.6	48.5
ABDOMINAL FORCES (N)				
Front	467.5	50.1		
Middle	444.7	49.3		
Rear	509.2	49.3		
Sum	1409.9	49.2		
PELVIS FORCE (N)				
Pubic Symphysis			2570.0	54.3

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

DATA SHEET NO. 12

POST TEST OBSERVATIONS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

TEST DUMMY INFORMATION AND CONTACT

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

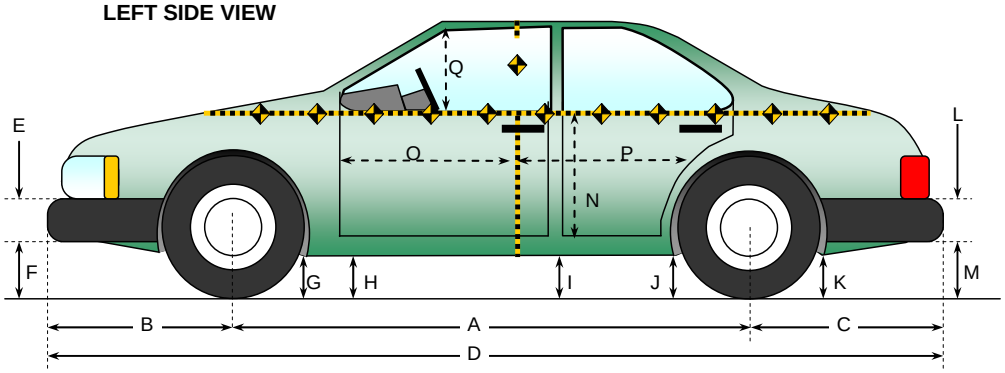
Restraint Type	Front Occupant	
	Installed	Operated
Frontal Airbag	Yes	No
Side Torso Airbag	Yes	Yes
Head Airbag	No	
Curtain Airbag	Yes	Yes
Seat Belt Pretensioner	Yes	Yes
Seat Belt Load Limiter	Yes	No

DATA SHEET NO. 13

VEHICLE PRE TEST AND POST TEST MEASUREMENTS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

LEFT SIDE VIEW

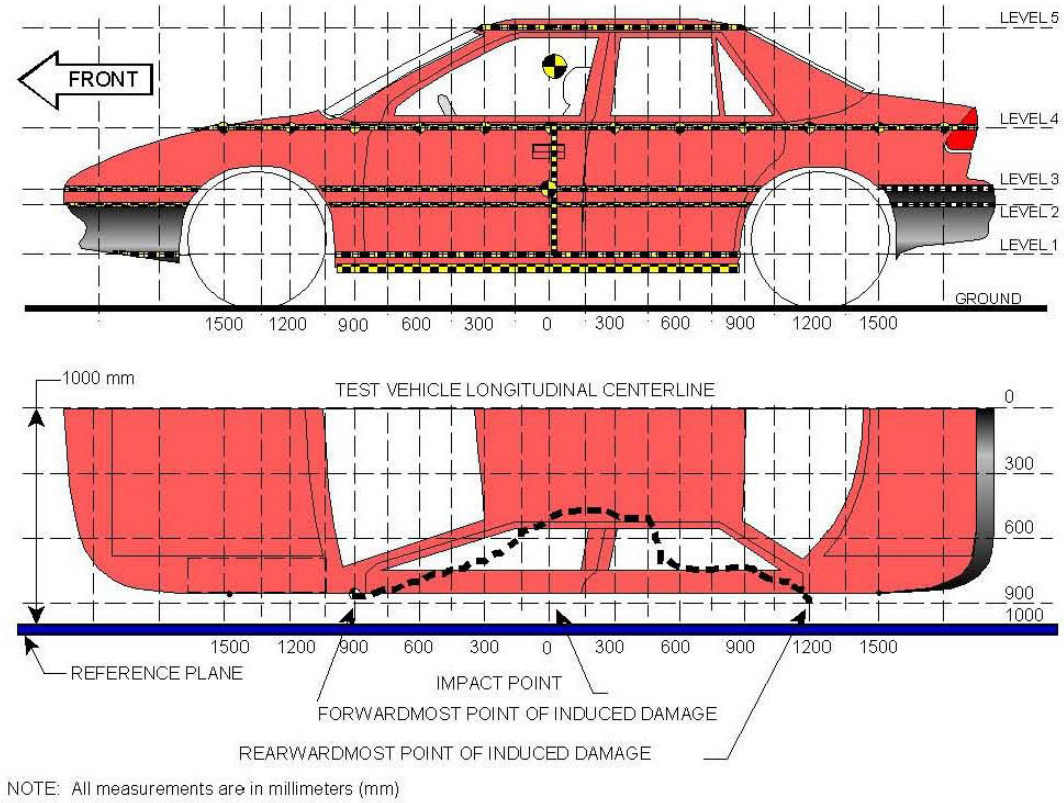


Code	Measurement Description	Pre-Test (mm)	Post-Test (mm)	Difference (mm)
A	Wheelbase	2649	2555	-94
B	Front Axle to FSOV	908	895	-13
C	Rear Axle to RSOV	979	1026	47
D	Total Vehicle Length at Centerline	4536	4476	-60
E	Front Bumper Thickness	145	145	0
F	Front Bumper Bottom to Ground	415	410	-5
G	Sill Height at Front Wheel Well	169	166	-3
H	Sill Height at Front Door Leading Edge	168	164	-4
I	Sill Height at B Pillar	173	184	11
J1	Sill Height at Rear Wheel Well	174	206	32
J2	Pinch Weld Height at Rear Wheel Well	169	190	21
K	Sill Height Aft of Rear Wheel Well	210	250	40
L	Rear Bumper Thickness	148	148	0
M	Rear Bumper Bottom to Ground	467	455	-12
N	Sill Height to Window Bottom Sill	690	682	-8
O	Front Door Leading Edge to Impact CL	871	840	-31
P	Rear Door Trailing Edge to Impact CL	1067	1091	24
Q	Front Window Opening	468	431	-37
R	Right Side Length	3429	3331	-98
S	Left Side Length	3429	3440	11
T	Vehicle Width at B Post	1750	1581	-169

DATA SHEET NO. 14

EXTERIOR CRUSH MEASUREMENTS

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



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	312	-75	280
2	Occupant H-Point	338	-75	353
3	Mid-Door	360	-75	638
4	Window Sill	323	-75	930
5	Window Top	135	-150	1410

DATA SHEET NO. 15

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

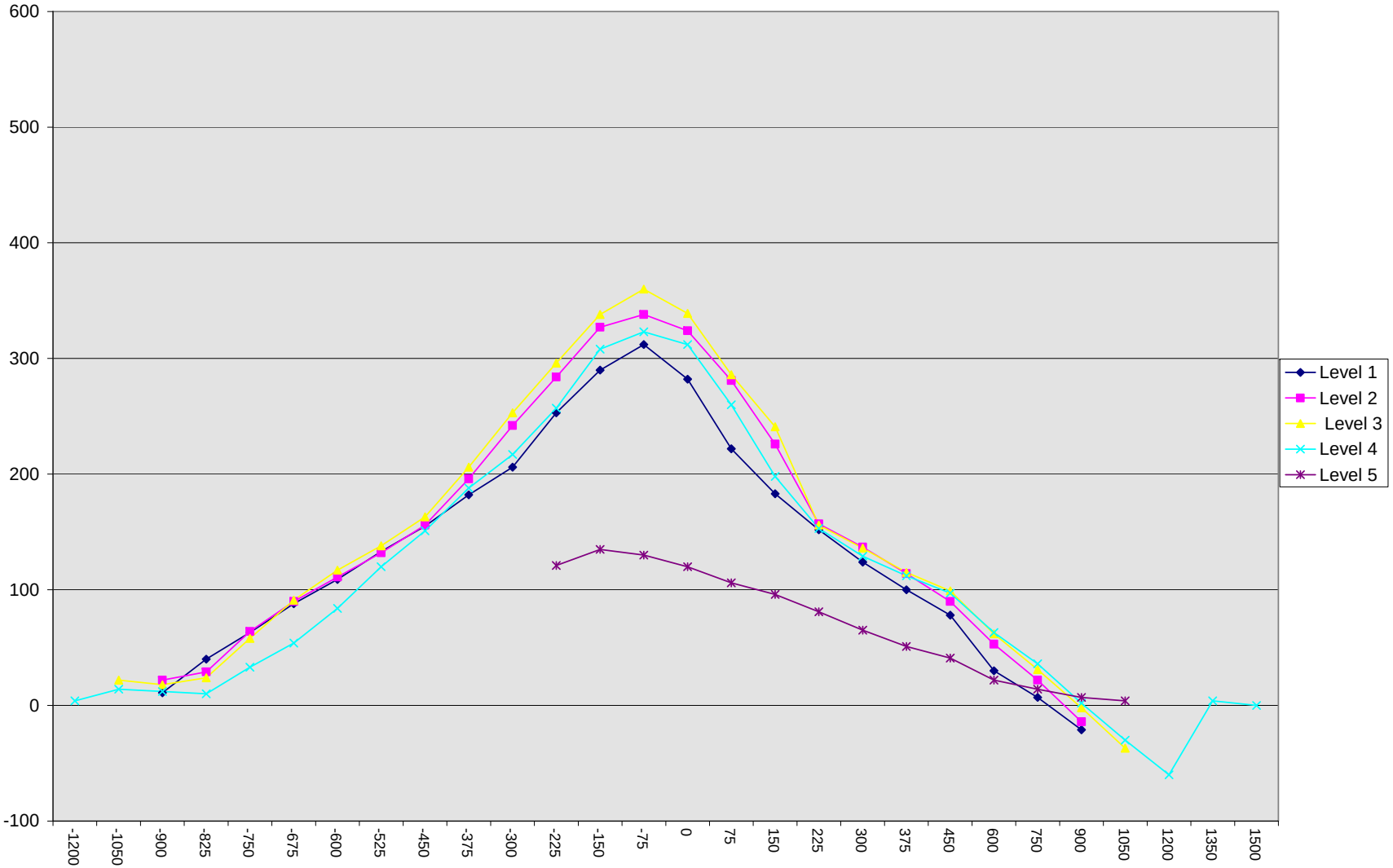
	Level 1	Level 2	Level 3	Level 4	Level 5
Maximum Crush (mm)	312	338	360	323	135
Distance From Impact (mm)	-75	-75	-75	-75	-150

	Pre-Test					Post-Test					Difference				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
-1200				324					328					4	
-1050			216	296				238	310				22	14	
-900	270	226	229	280		281	248	247	292		11	22	18	12	
-825	271	230	229	275		311	259	253	285		40	29	24	10	
-750	270	230	228	276		333	294	286	309		63	64	58	33	
-675	271	229	227	281		359	319	318	335		88	90	91	54	
-600	270	229	227	286		379	340	344	370		109	111	117	84	
-525	271	228	226	289		404	360	364	409		133	132	138	120	
-450	271	227	225	286		426	383	388	437		155	156	163	151	
-375	271	227	224	283		453	423	430	471		182	196	206	188	
-300	271	226	224	280		477	468	477	497		206	242	253	217	
-225	271	226	224	276	514	524	510	520	533	635	253	284	296	257	121
-150	271	225	223	272	511	561	552	561	580	646	290	327	338	308	135
-75	271	225	223	269	506	583	563	583	592	636	312	338	360	323	130
0	271	225	222	265	502	553	549	561	577	622	282	324	339	312	120
75	271	225	222	264	503	493	506	508	524	609	222	281	286	260	106
150	272	225	221	261	504	455	451	462	459	600	183	226	241	198	96
225	272	224	221	259	504	424	381	377	412	585	152	157	156	153	81
300	272	224	222	259	505	396	361	358	388	570	124	137	136	129	65
375	272	225	223	259	507	372	339	338	371	558	100	114	115	112	51
450	273	226	223	256	508	351	316	322	353	549	78	90	99	97	41
600	273	227	224	257	514	303	280	286	320	536	30	53	62	63	22
750	274	229	226	258	520	281	251	257	294	534	7	22	31	36	14
900	277	227	227	261	534	256	213	225	263	541	-21	-14	-2	2	7
1050			220	266	549			183	236	553			-37	-30	4
1200				270					210					-60	
1350				276					280					4	
1500				284					284					0	

DATA SHEET NO. 15 (CONTINUED)

VEHICLE EXTERIOR CRUSH PROFILES

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



DATA SHEET NO. 16

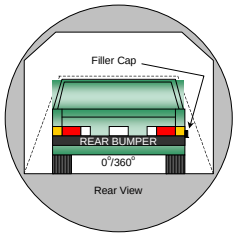
SUMMARY OF FMVSS 301 FUEL SYSTEM DATA

Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010

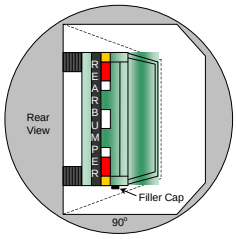
FUEL SYSTEM INTEGRITY POST IMPACT DATA

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

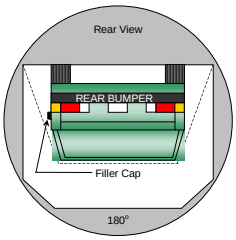
STATIC ROLLOVER DATA



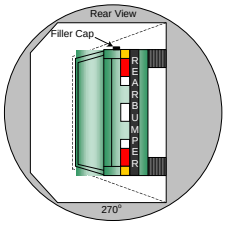
0/360



90



180



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°	2	minutes	09	seconds	5	minutes	7	minutes	09	seconds	8	minutes
180° - 270°	1	minutes	58	seconds	5	minutes	6	minutes	58	seconds	7	minutes
270° - 360°	2	minutes	03	seconds	5	minutes	7	minutes	03	seconds	8	minutes

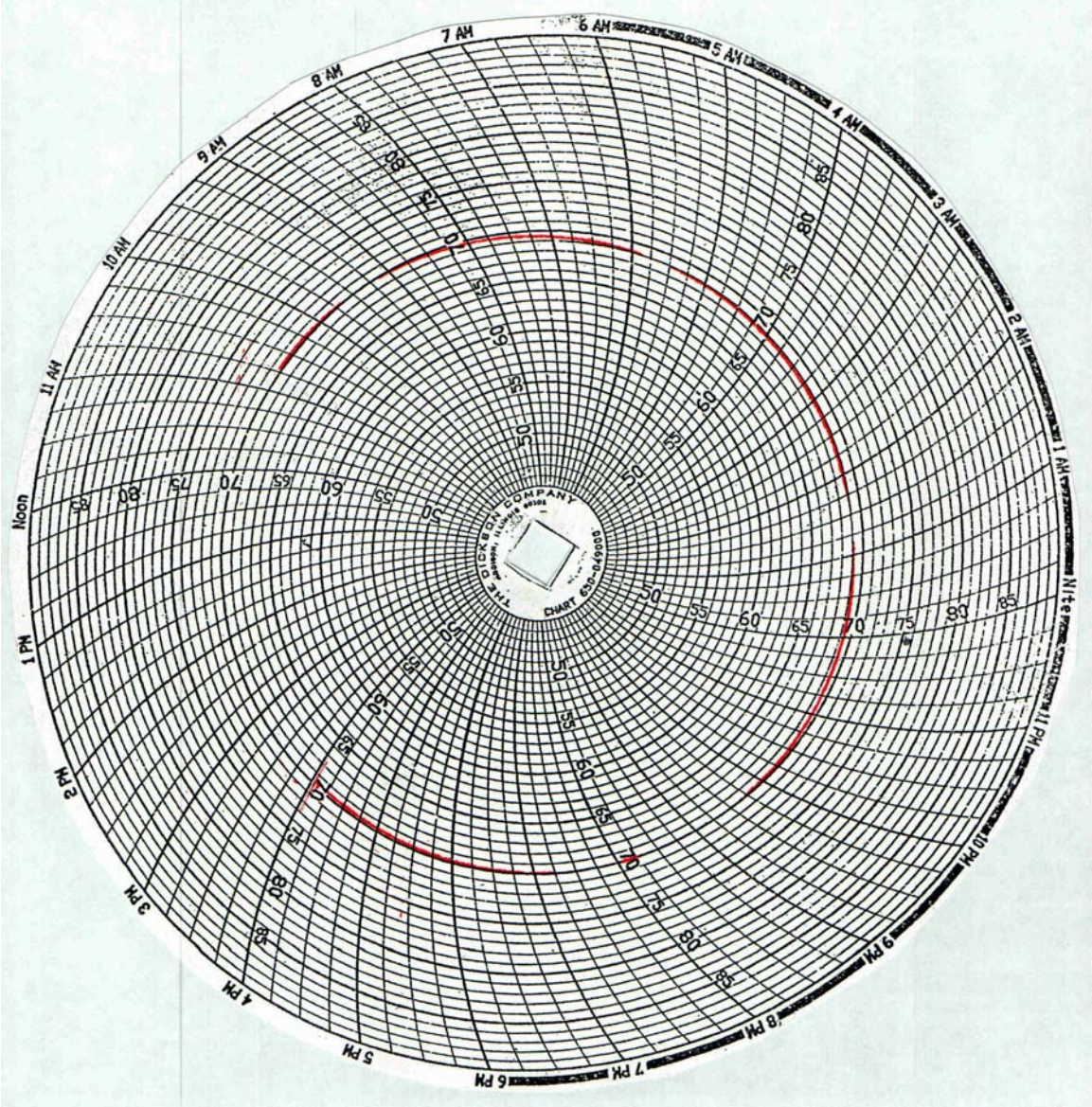
Rollover Stage	Spillage (g)			
	First 5 min. from onset of rotation	6th min.	7th min.	8th min. (if required)
0° - 90°	0	0	0	
90° - 180°	0	0	0	
180° - 270°	0	0	0	
270° - 360°	0	0	0	
FMVSS 301 Maximum Allowable (for each 90° stage)	142	28	28	28

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

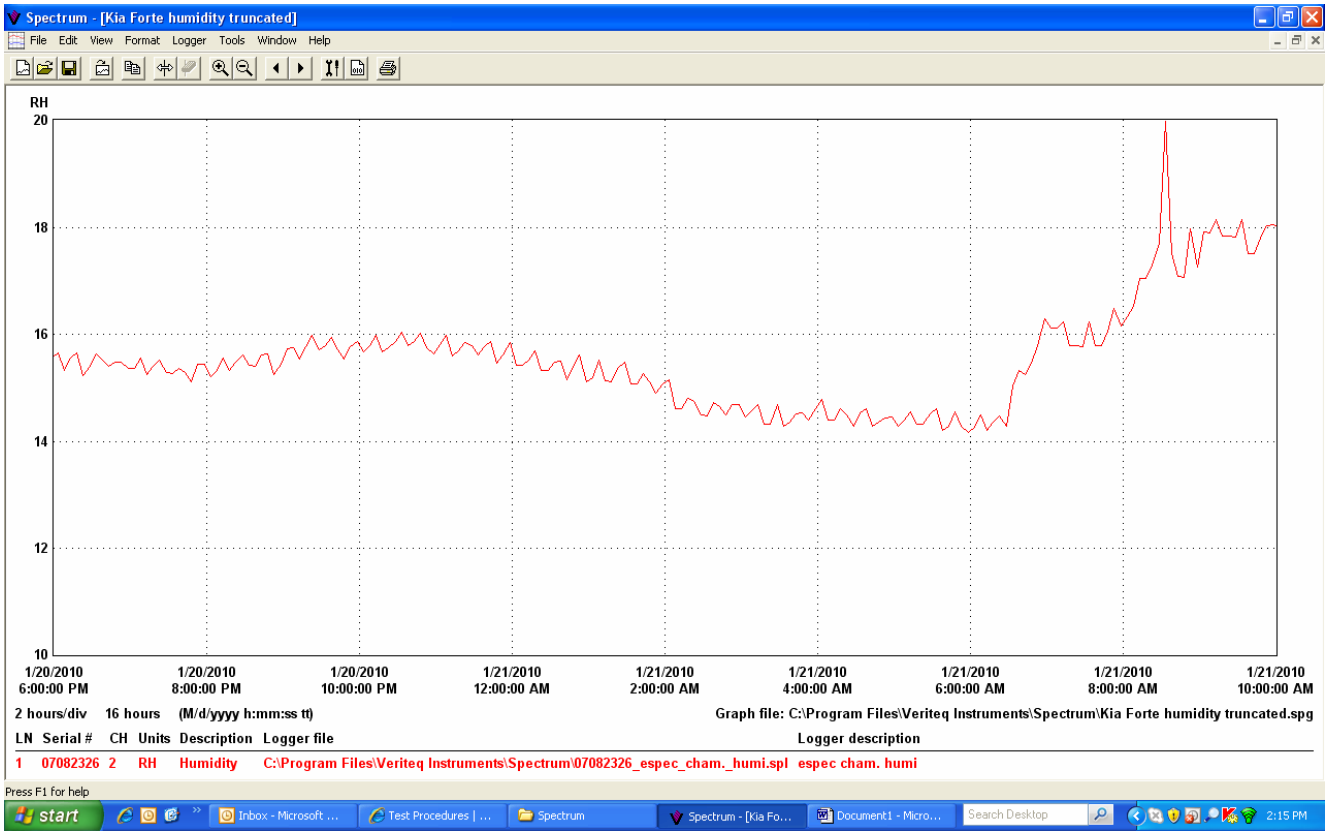
Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



DATA SHEET NO. 17 (CONTINUED)

TEMPERATURE AND HUMIDITY TRACES

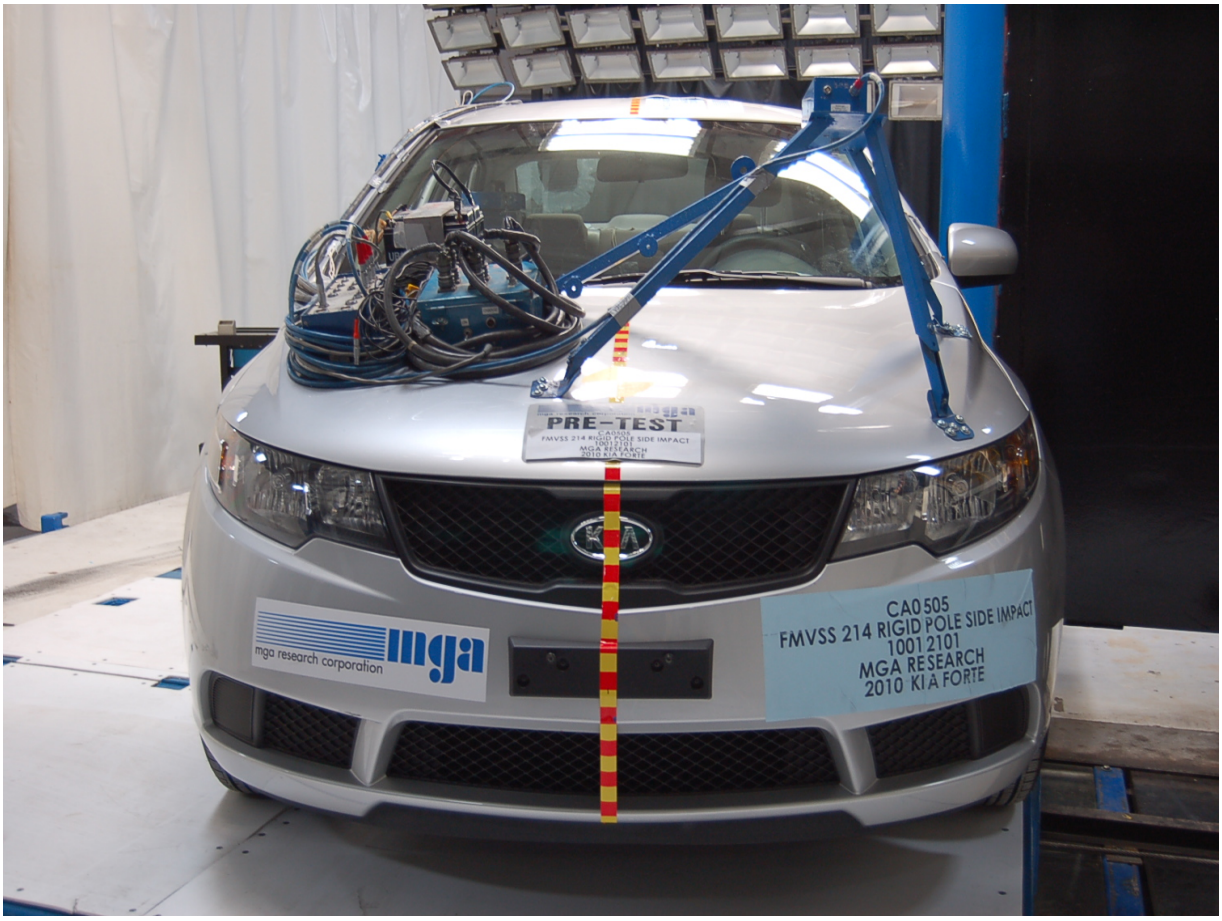
Test Vehicle: 2010 Kia Forte LX 4-Dr Sedan NHTSA No. CA0505
Test Program: FMVSS 214 Pole Test Date: 1/21/2010



APPENDIX A

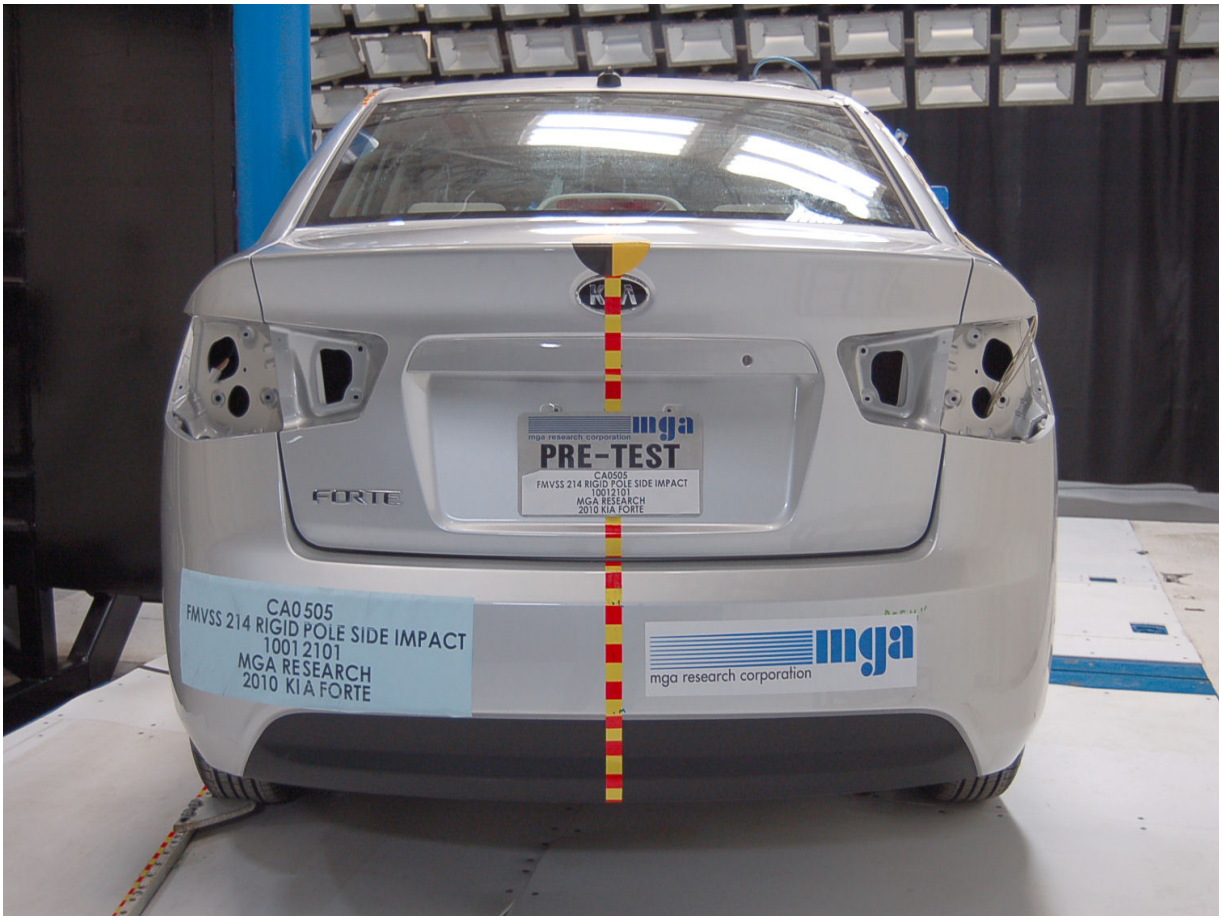
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS



Pre-Test Frontal View of Test Vehicle

Post-Test Frontal View of Test Vehicle



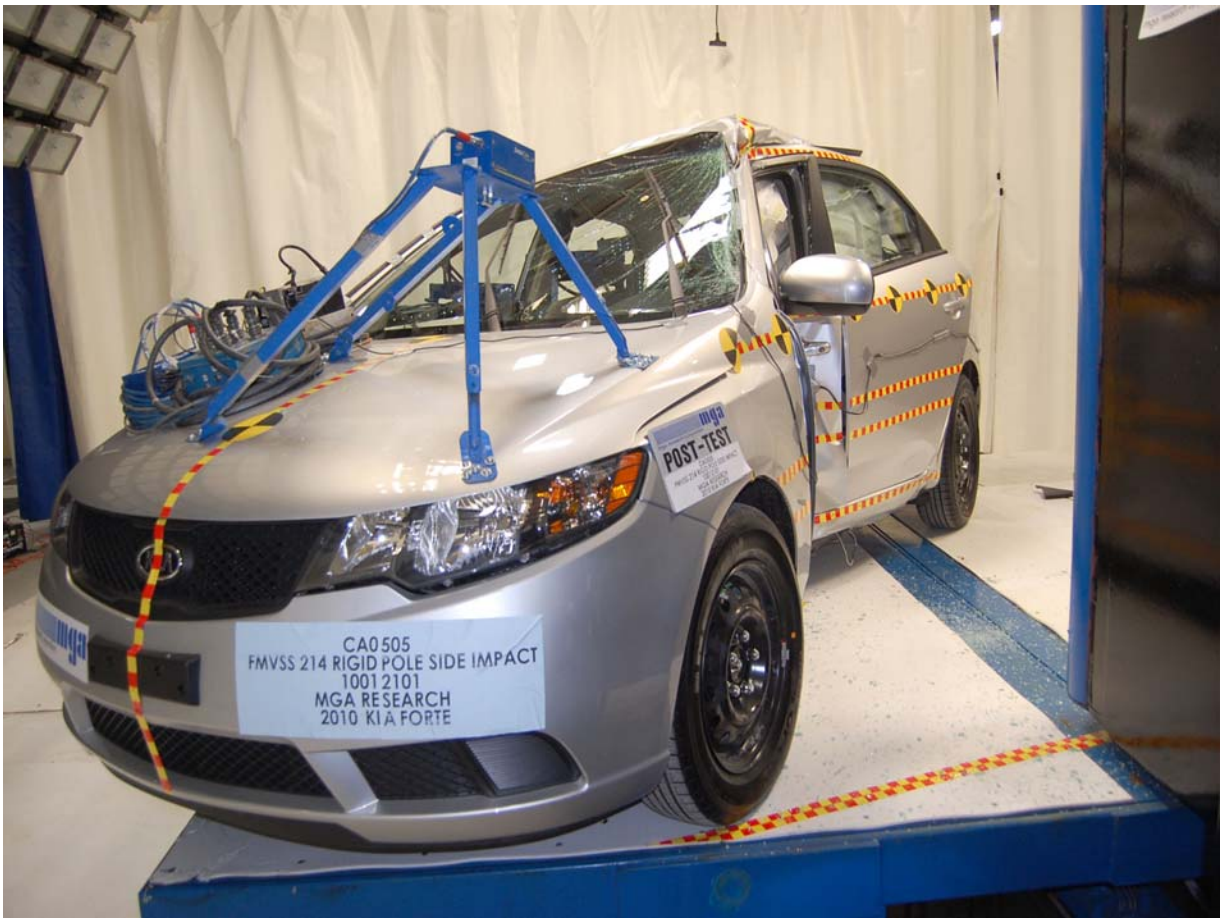
Pre-Test Rear View of Test Vehicle

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



Post-Test Left ¾ Front 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)

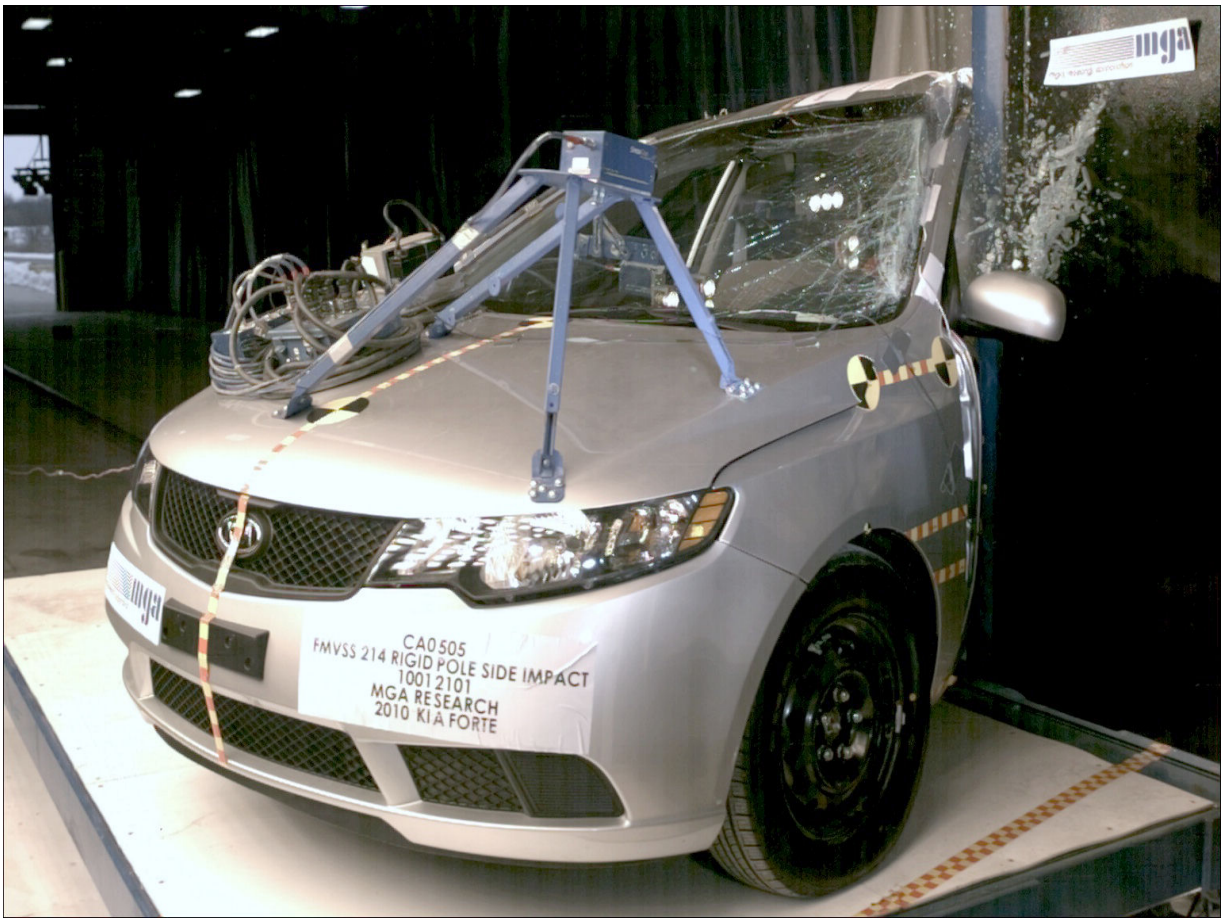
Pre-Test Dummy Door Open

Pre-Test Dummy Shoulder and Door Top View

Post-Test Dummy Shoulder and Door Top View

Pre-Test Interior of Front Door Closed (Through Opposite Window)

Post-Test Interior of Front Door Showing Dummy Impact Locations



Impact Event (Struck Side)

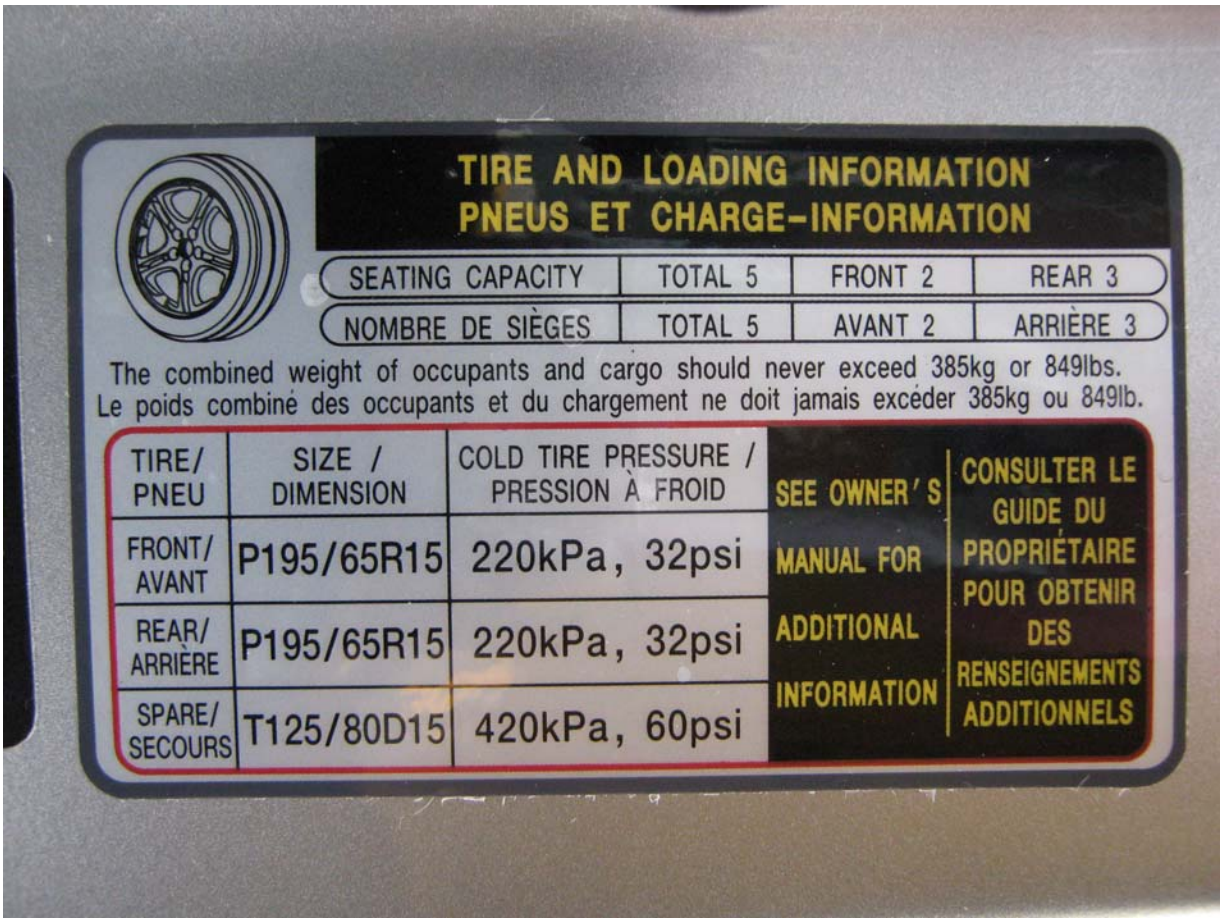
Post-Test Impact Zone Close-up View

Post-Test ¾ Front View of Impact Zone

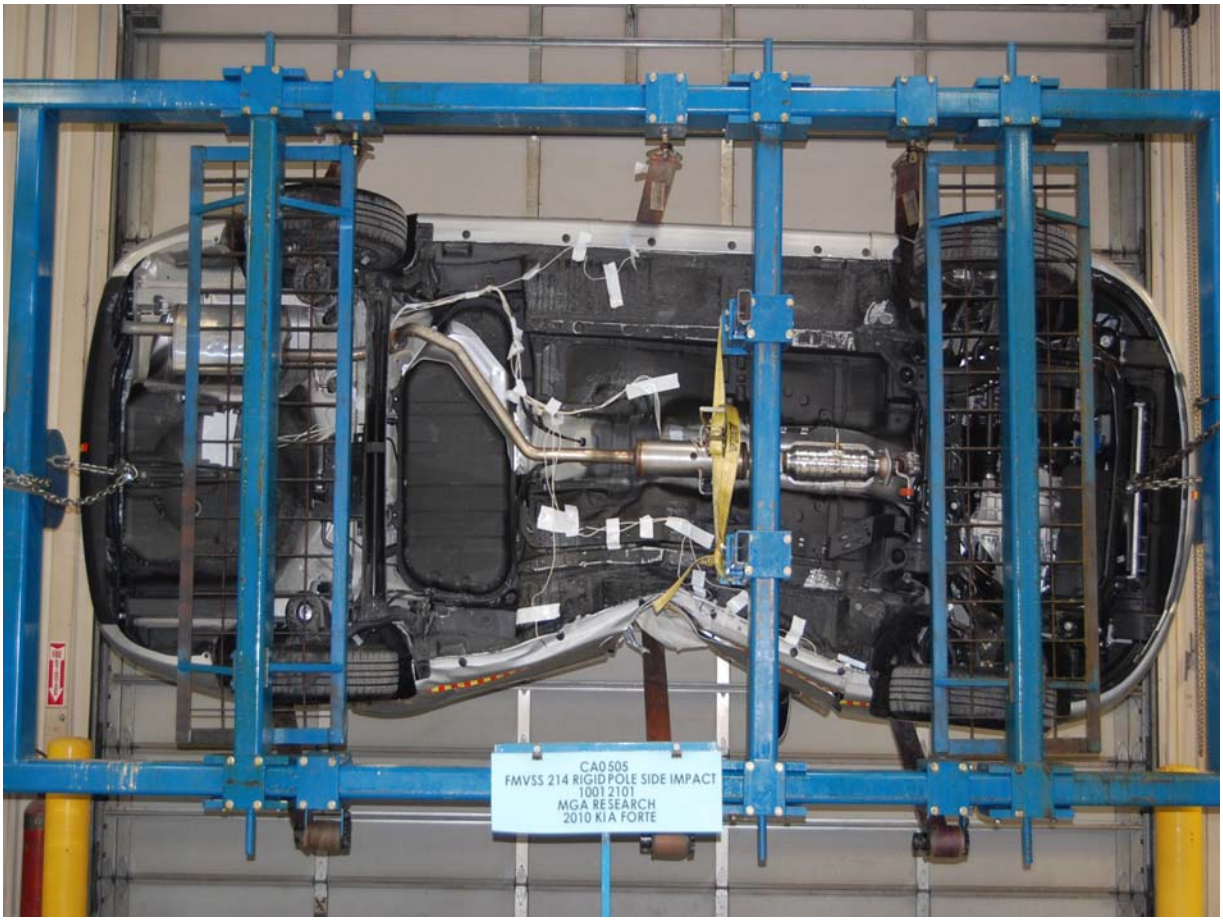
Post-Test ¾ Rear View of Impact Zone

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

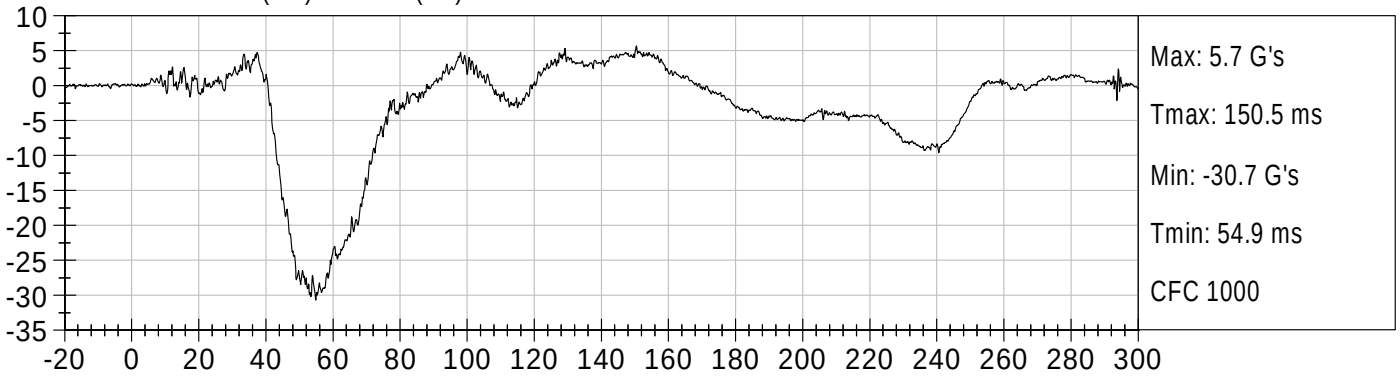
TABLE OF DATA PLOTS

Dummy Instrumentation Plots
FILTERED DATA

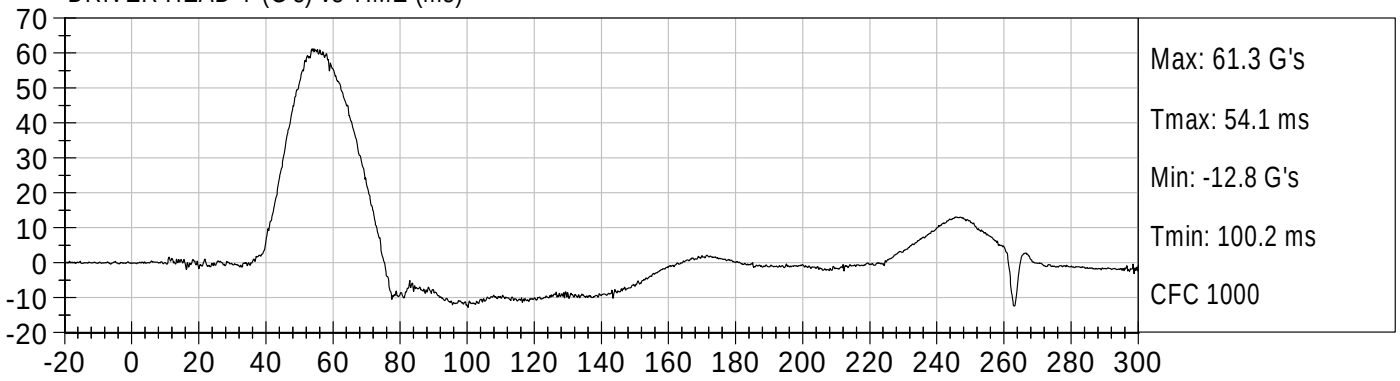
FMVSS 214 Rigid Pole Side Impact
2010 Kia Forte - CA0505

Test Date: 01/21/2010
Speed: 19.3 mph (31.1 km/h)

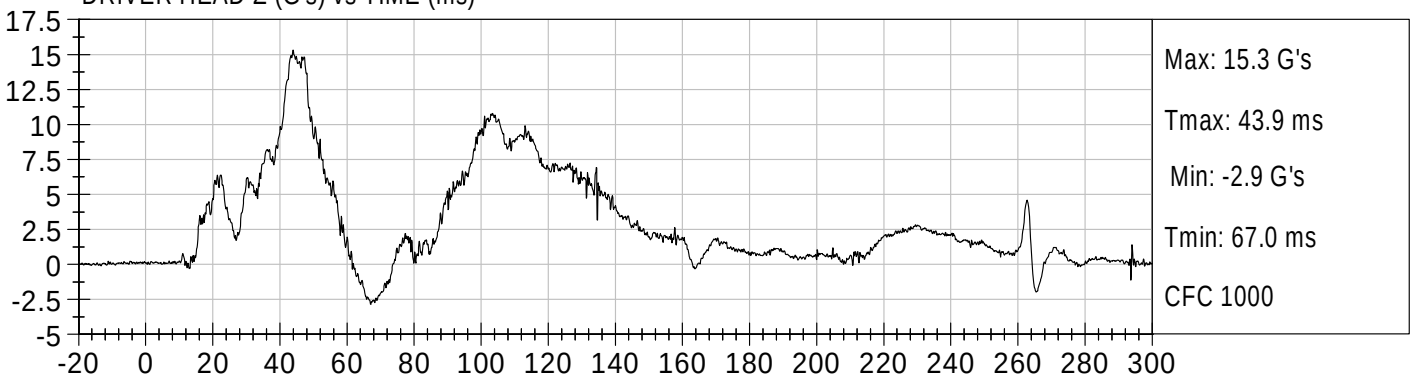
DRIVER HEAD X (G's) vs TIME (ms)



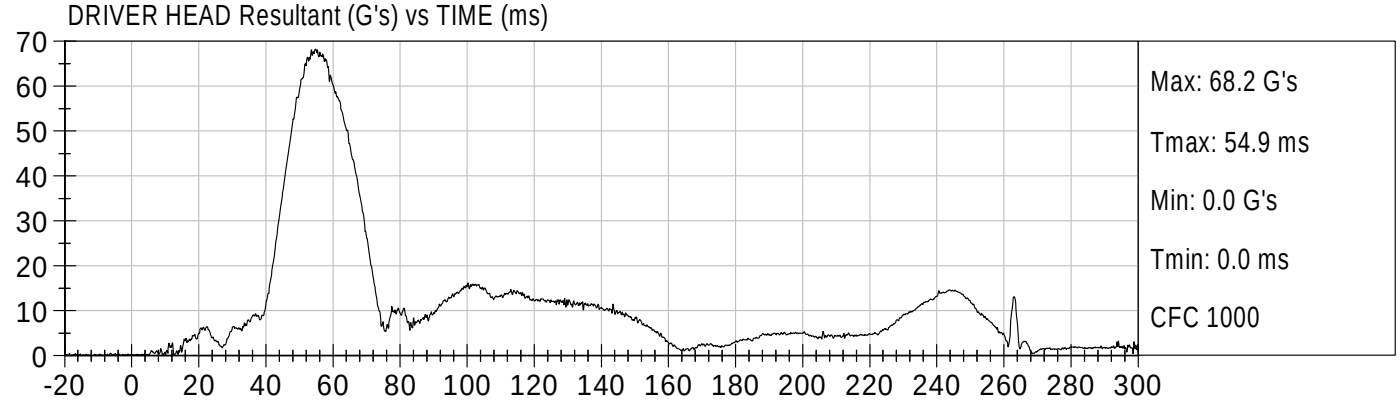
DRIVER HEAD Y (G's) vs TIME (ms)



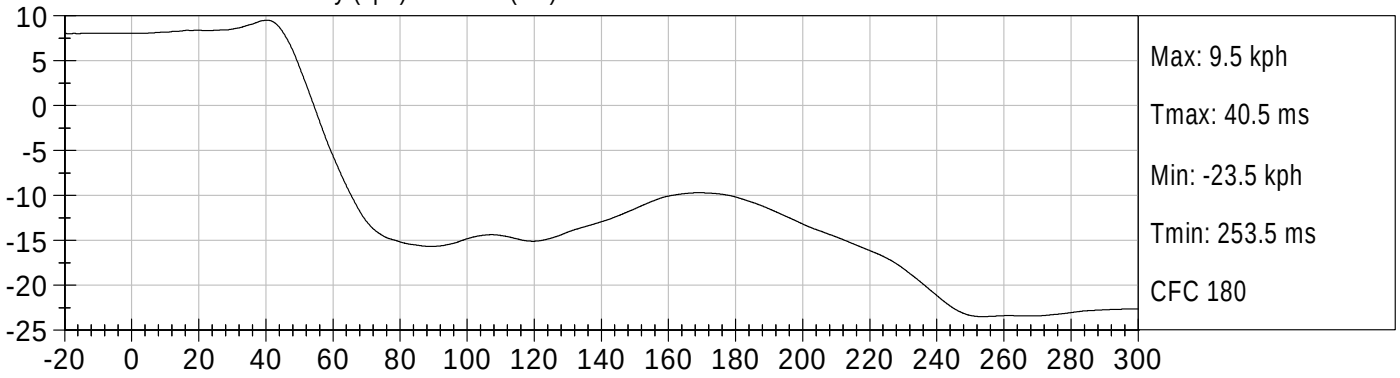
DRIVER HEAD Z (G's) vs TIME (ms)



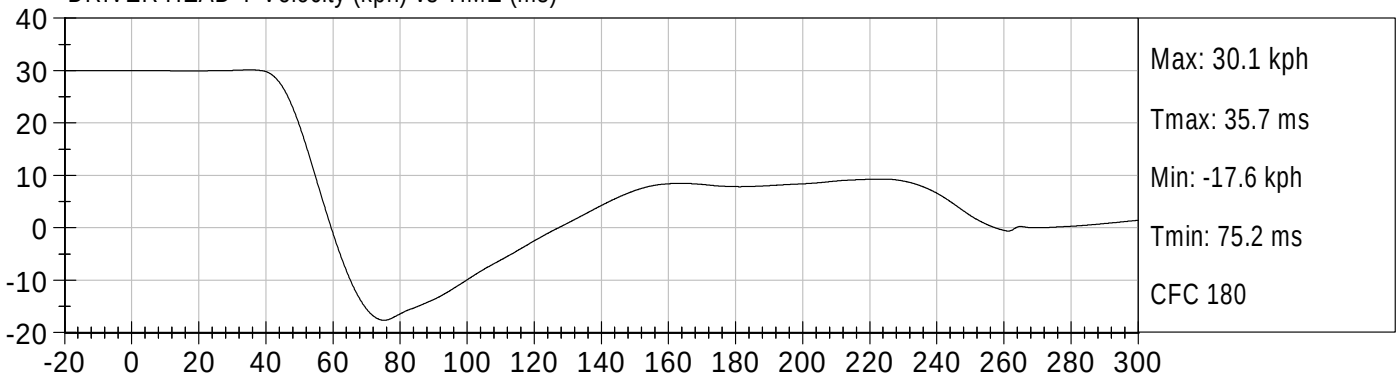
DRIVER HEAD Resultant (G's) vs TIME (ms)



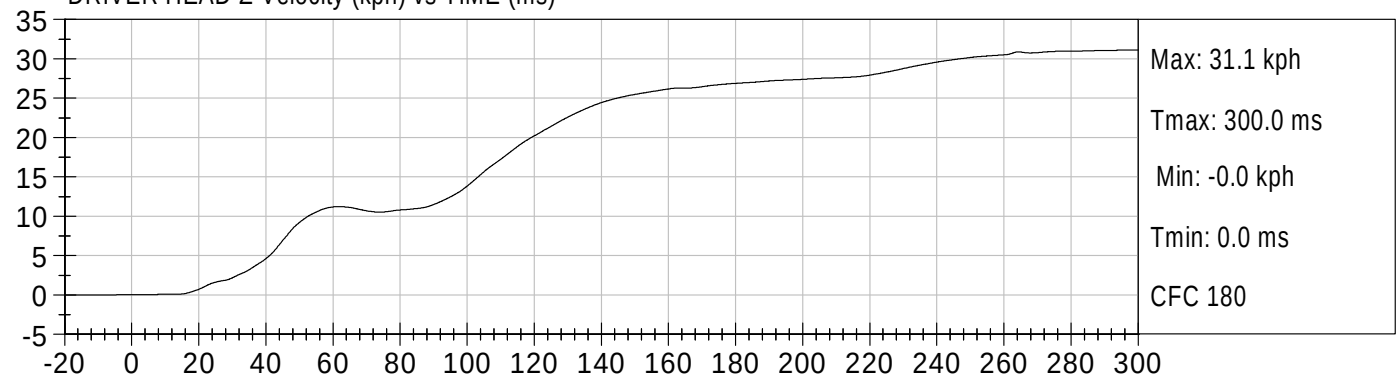
DRIVER HEAD X Velocity (kph) vs TIME (ms)



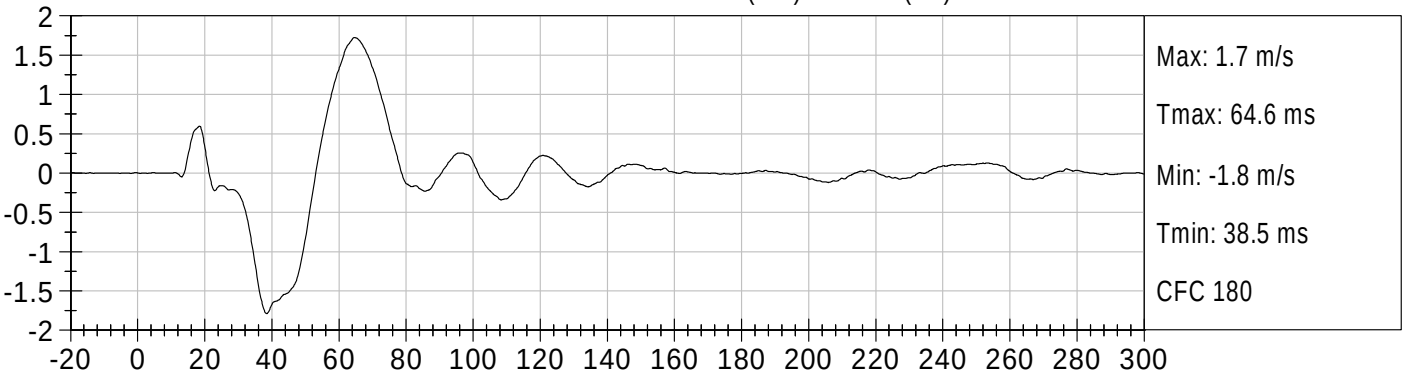
DRIVER HEAD Y Velocity (kph) vs TIME (ms)



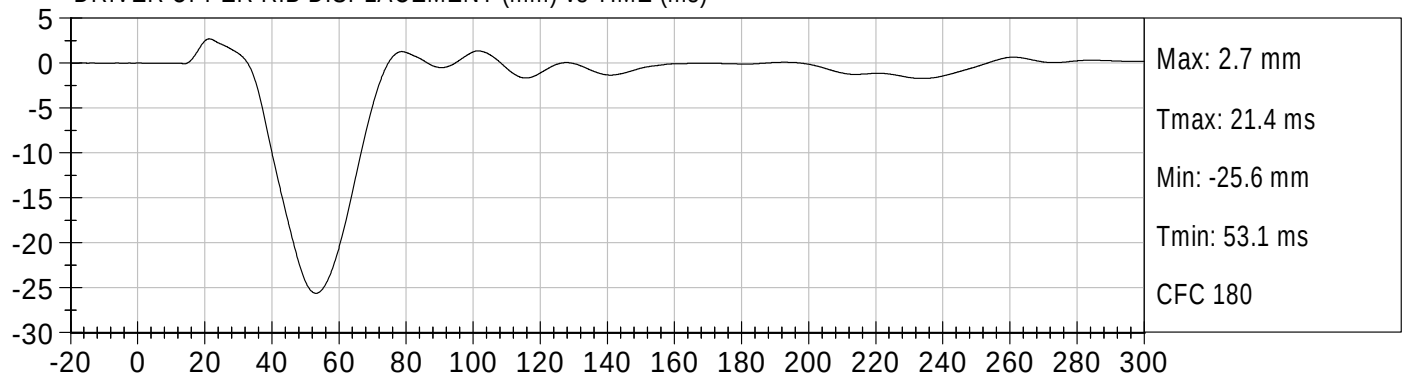
DRIVER HEAD Z Velocity (kph) vs TIME (ms)



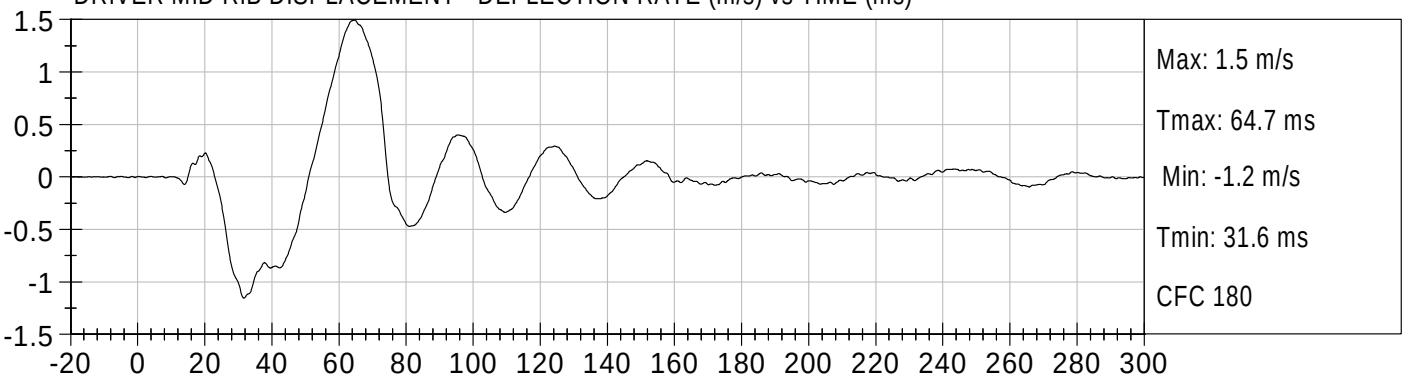
DRIVER UPPER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



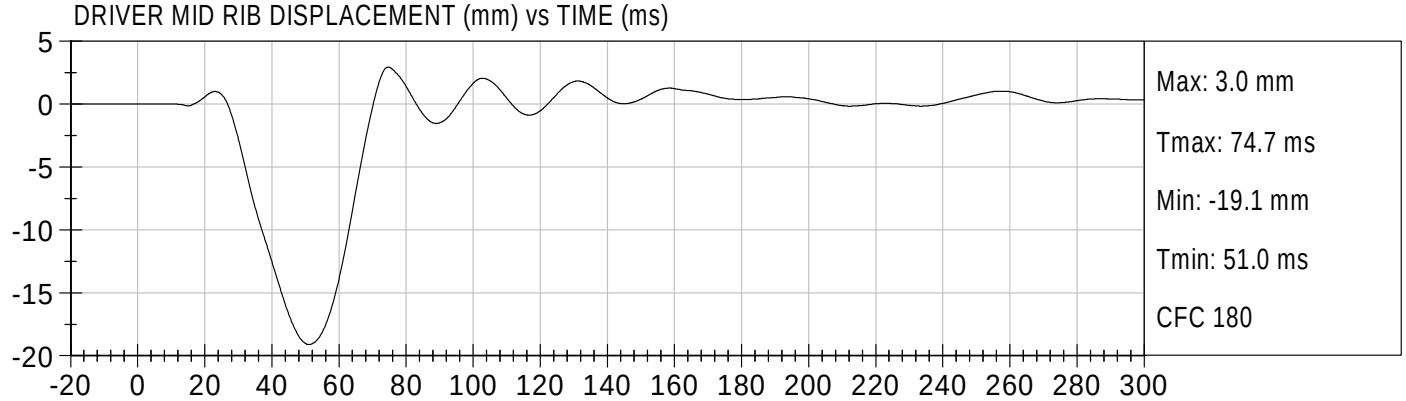
DRIVER UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



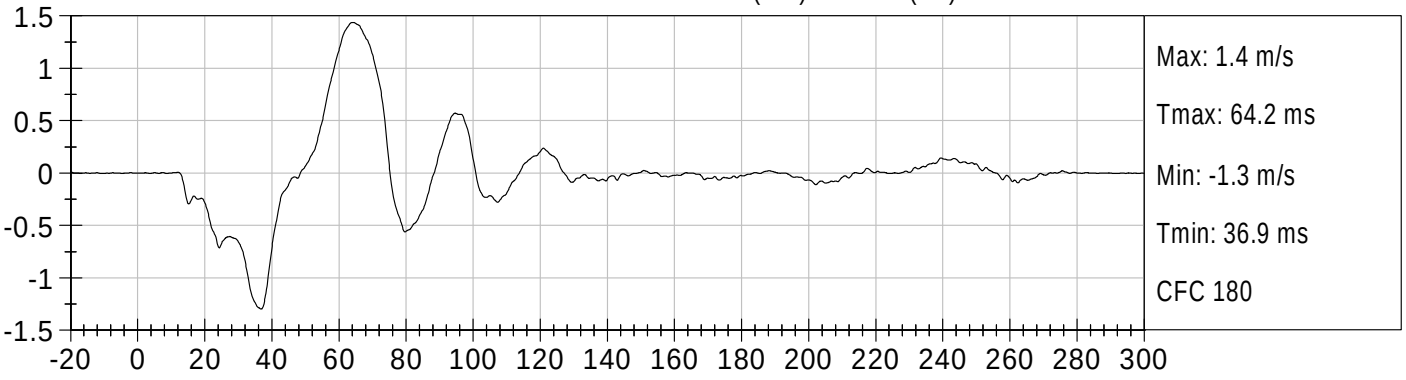
DRIVER MID RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



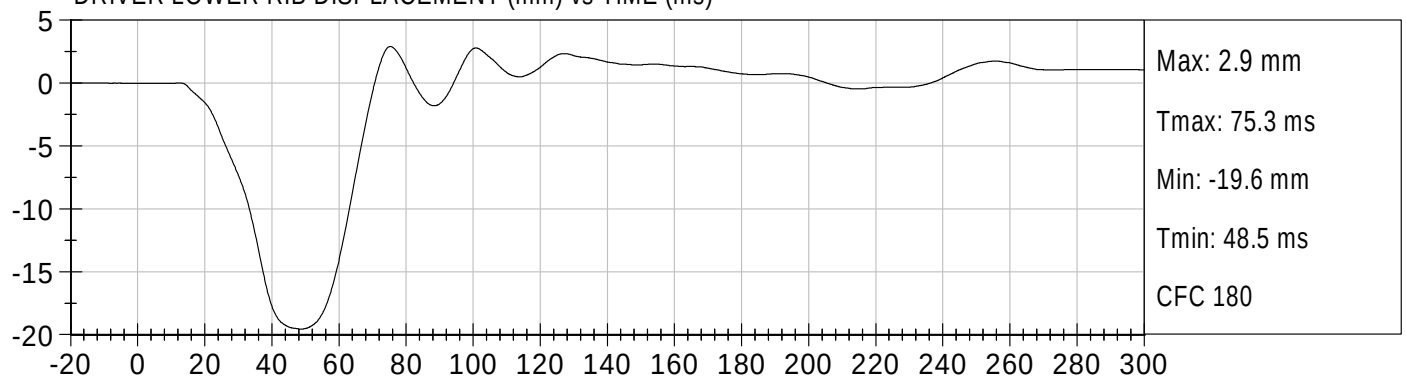
DRIVER MID RIB DISPLACEMENT (mm) vs TIME (ms)



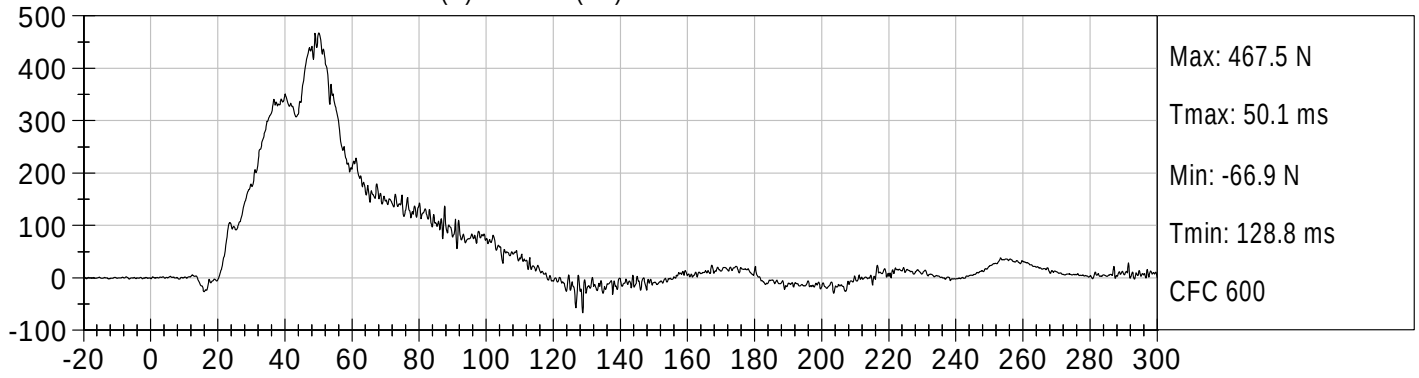
DRIVER LOWER RIB DISPLACEMENT - DEFLECTION RATE (m/s) vs TIME (ms)



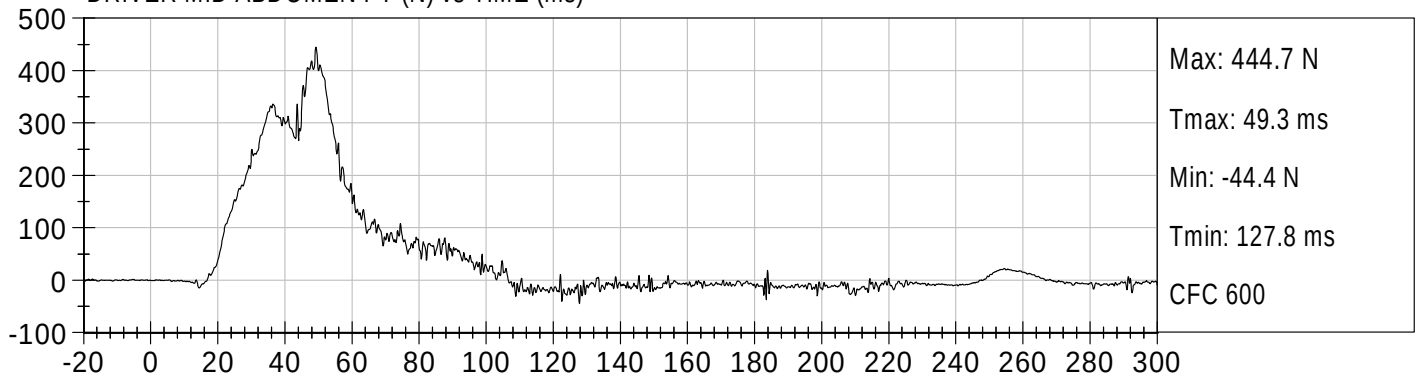
DRIVER LOWER RIB DISPLACEMENT (mm) vs TIME (ms)



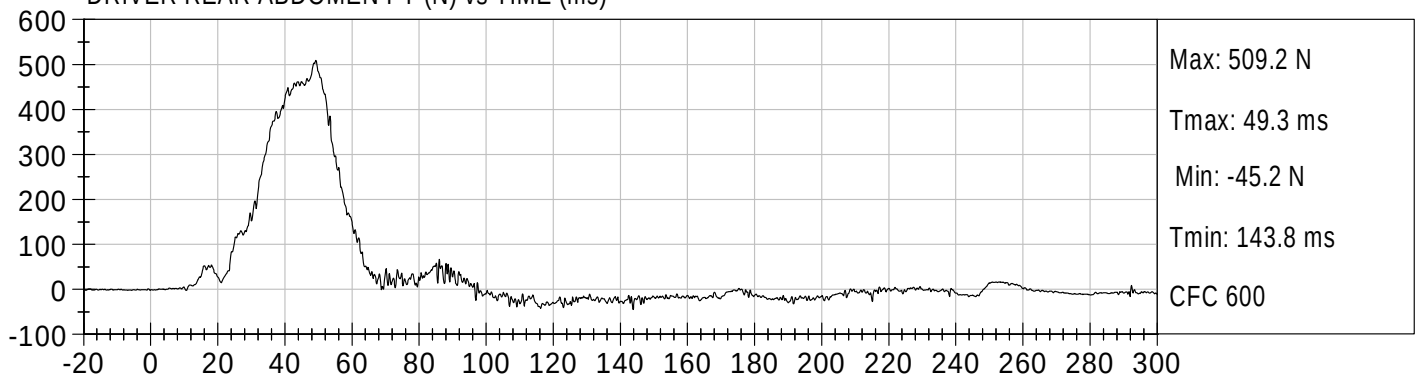
DRIVER FRONT ABDOMEN FY (N) vs TIME (ms)



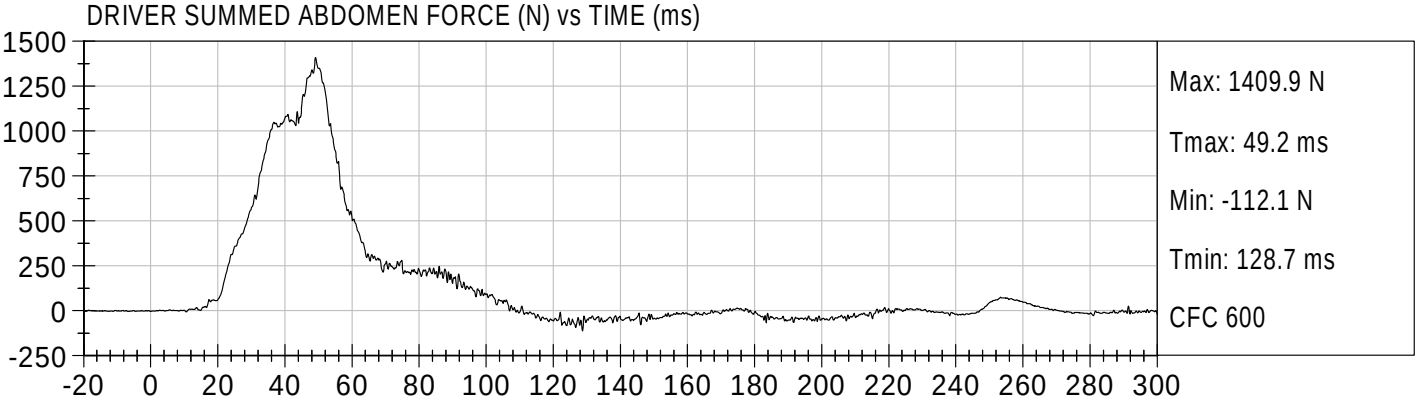
DRIVER MID ABDOMEN FY (N) vs TIME (ms)



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

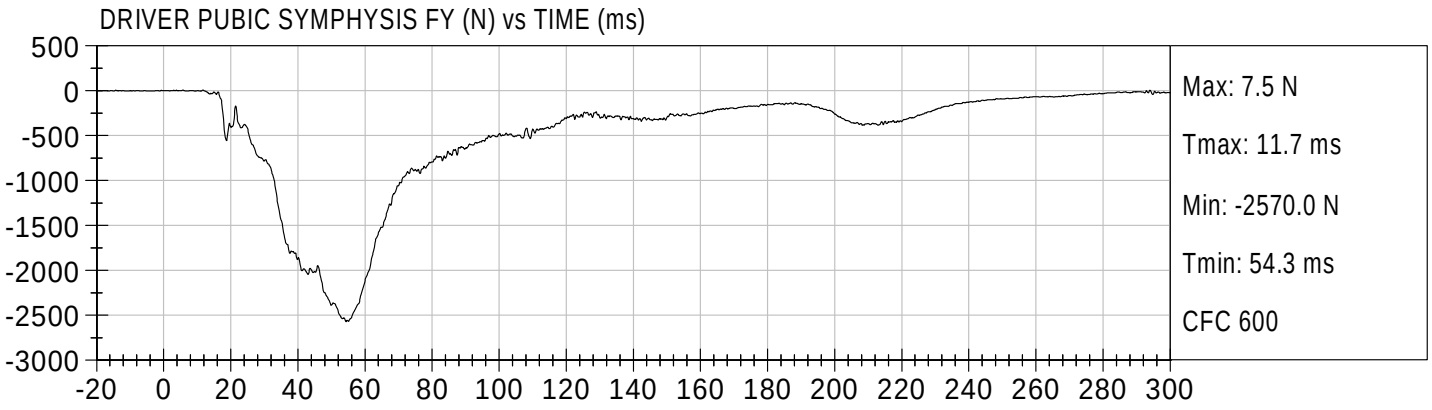


DRIVER SUMMED ABDOMEN FORCE (N) vs TIME (ms)



FMVSS 214 Rigid Pole Side Impact
2010 Kia Forte - CA0505

Test Date: 01/21/2010
Speed: 19.3 mph (31.1 km/h)



APPENDIX C

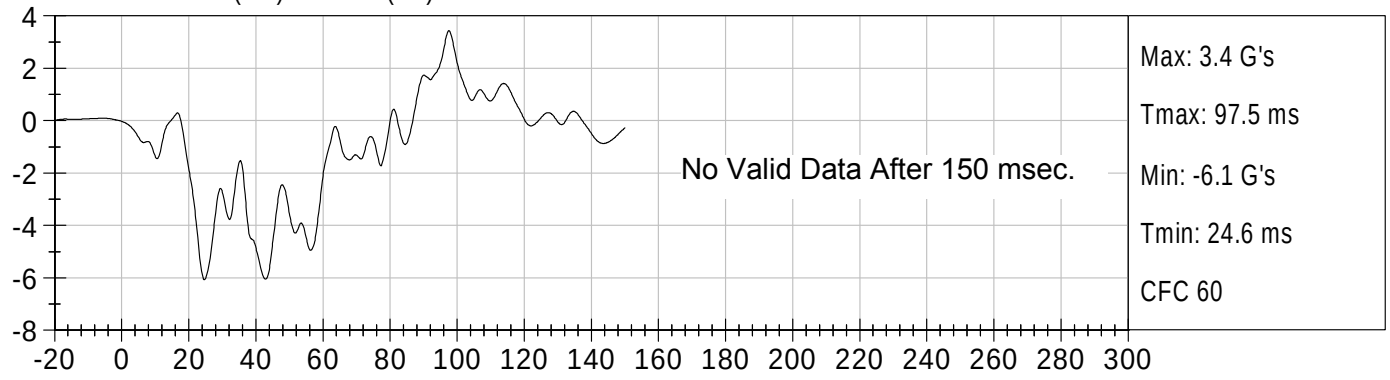
VEHICLE ACCELEROMETER RESPONSE DATA

TABLE OF DATA PLOTS

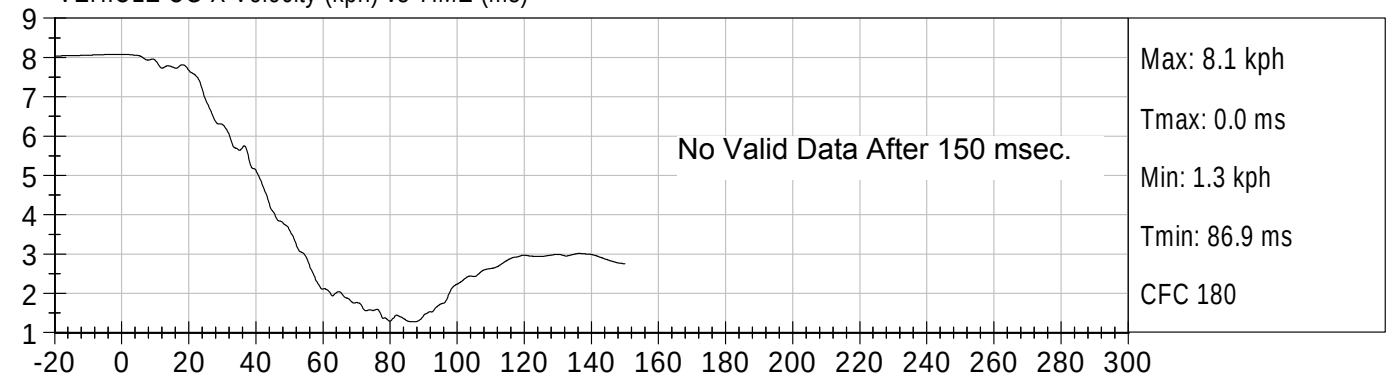
FMVSS 214 Rigid Pole Side Impact
2010 Kia Forte - CA0505

Test Date: 01/21/2010
Speed: 19.3 mph (31.1 km/h)

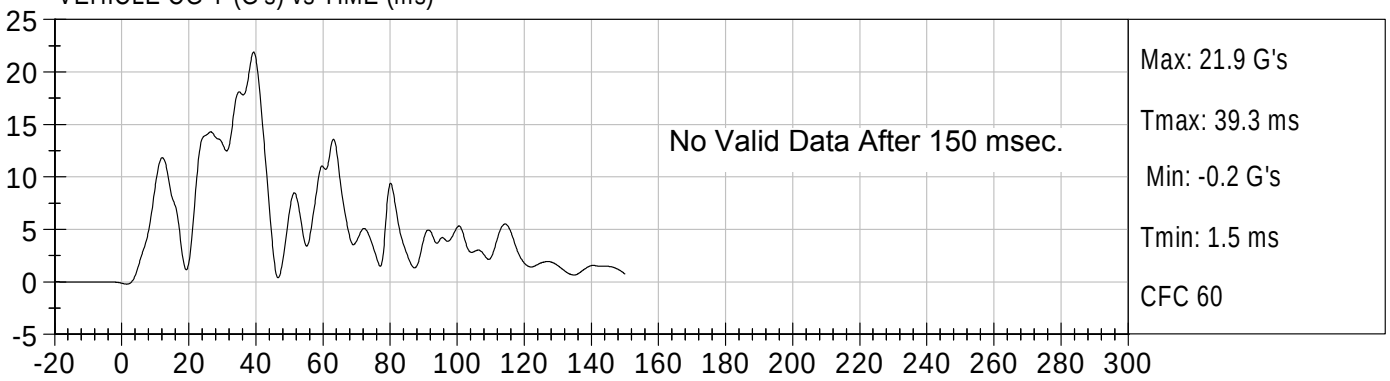
VEHICLE CG X (G's) vs TIME (ms)



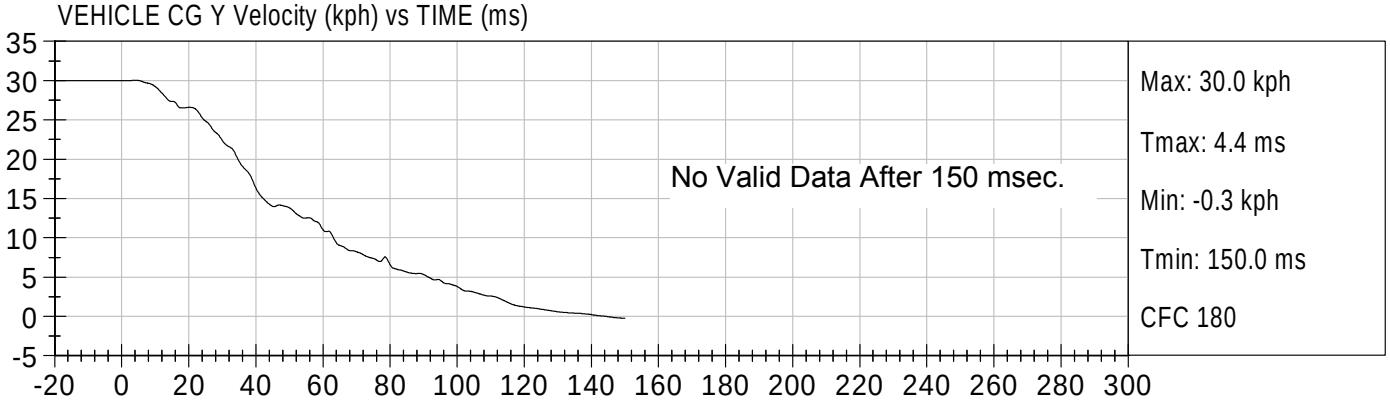
VEHICLE CG X Velocity (kph) vs TIME (ms)



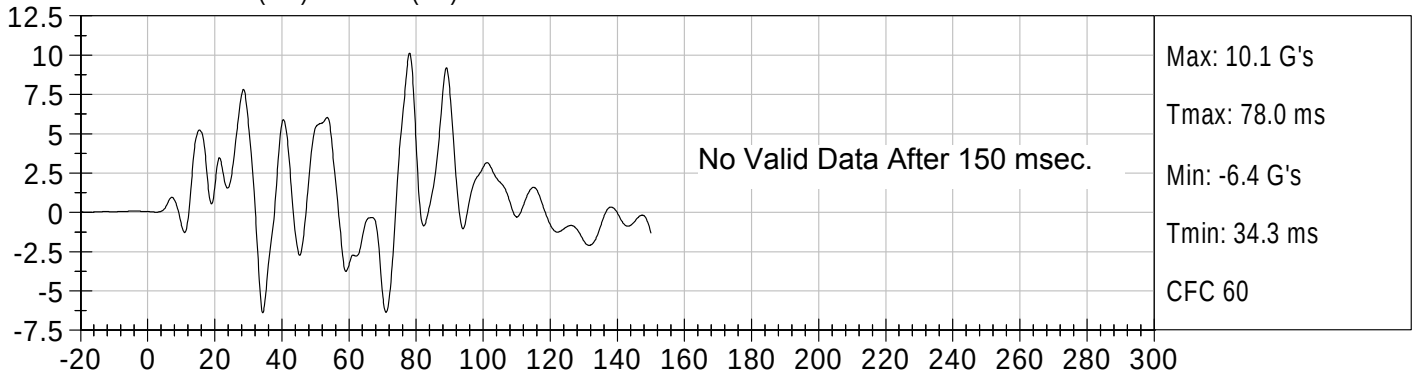
VEHICLE CG Y (G's) vs TIME (ms)



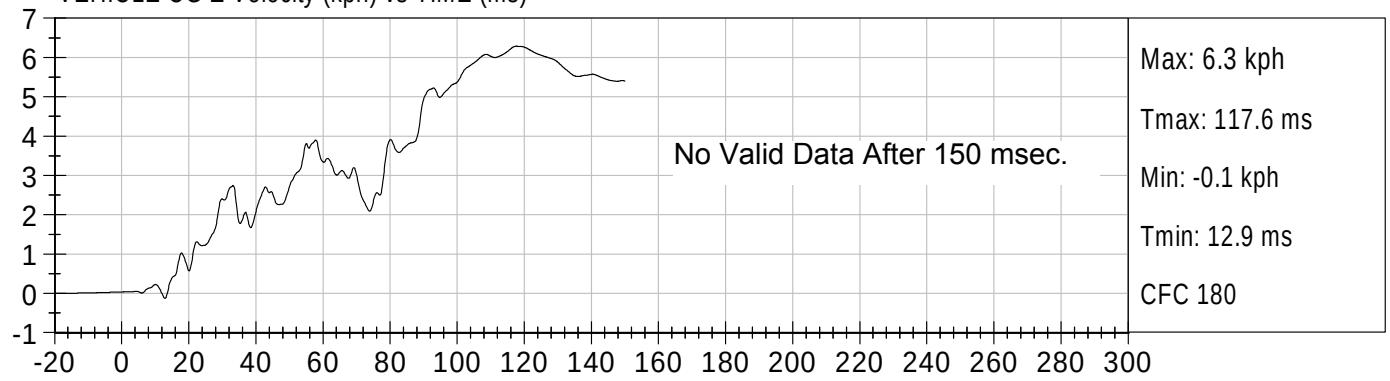
VEHICLE CG Y Velocity (kph) vs TIME (ms)



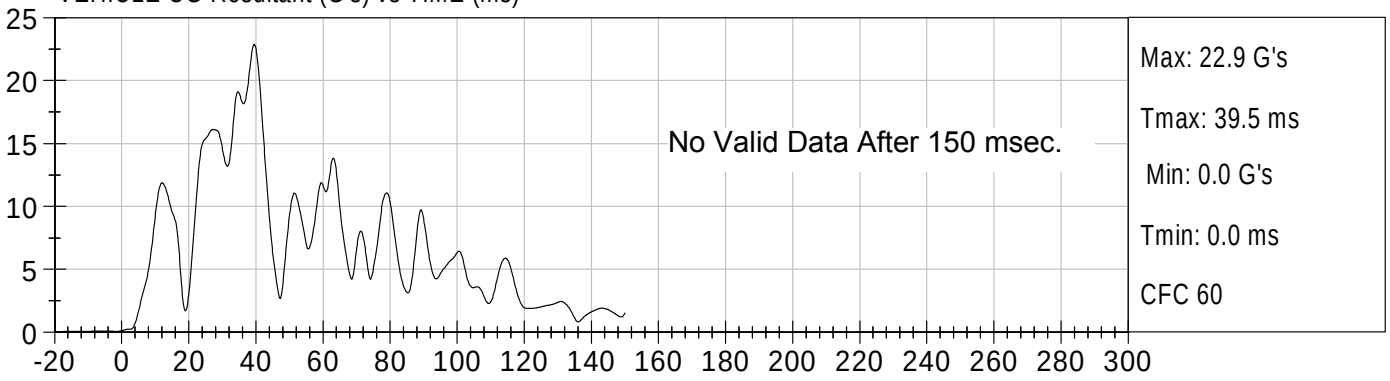
VEHICLE CG Z (G's) vs TIME (ms)



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

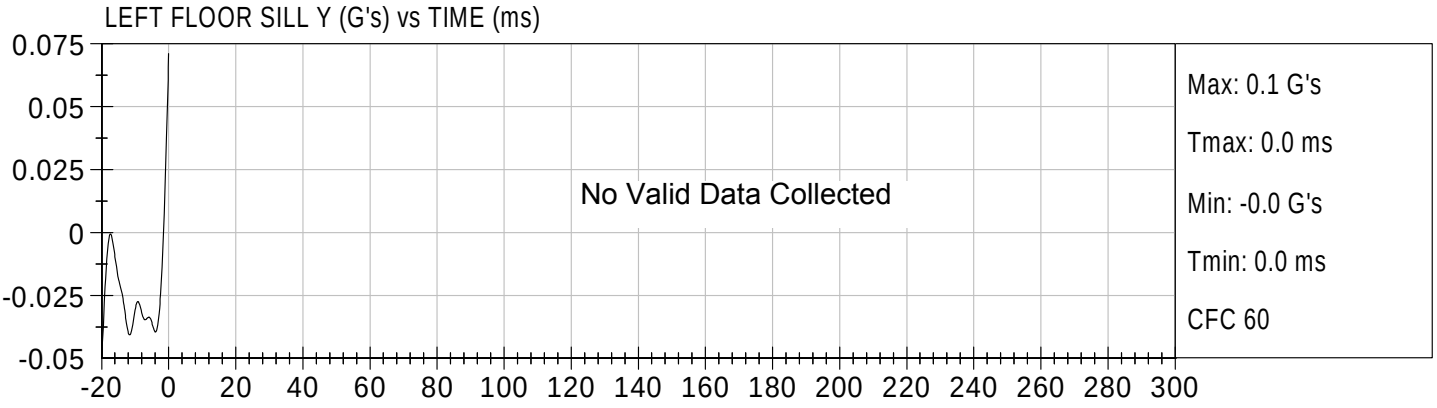


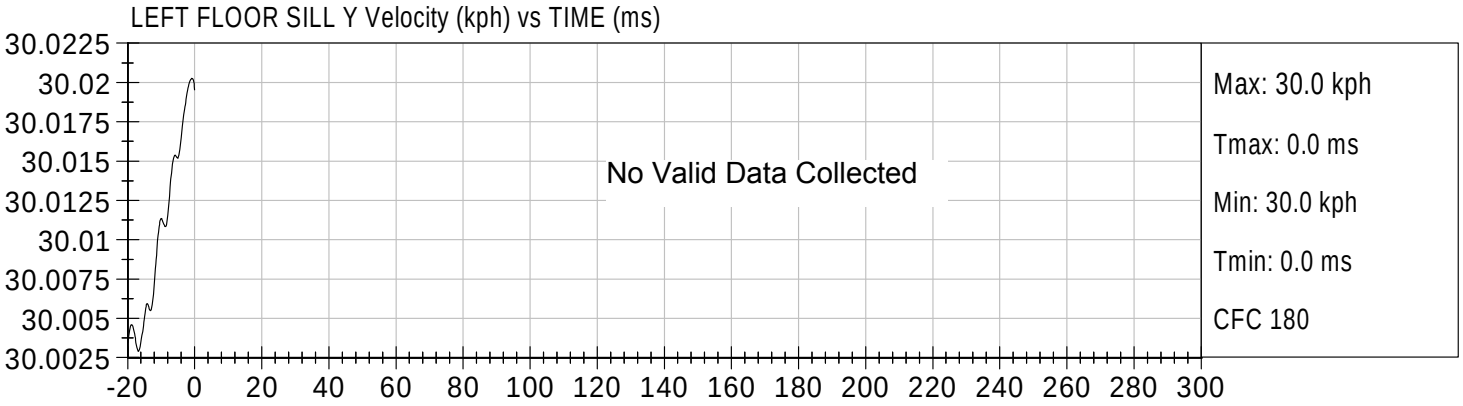
VEHICLE CG Resultant (G's) vs TIME (ms)

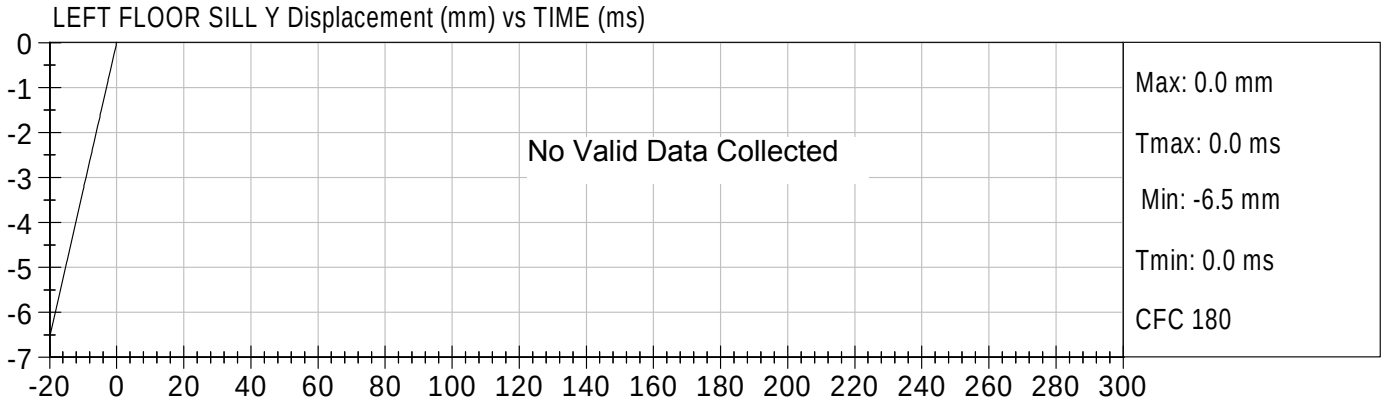


FMVSS 214 Rigid Pole Side Impact
2010 Kia Forte - CA0505

Test Date: 01/21/2010
Speed: 19.3 mph (31.1 km/h)



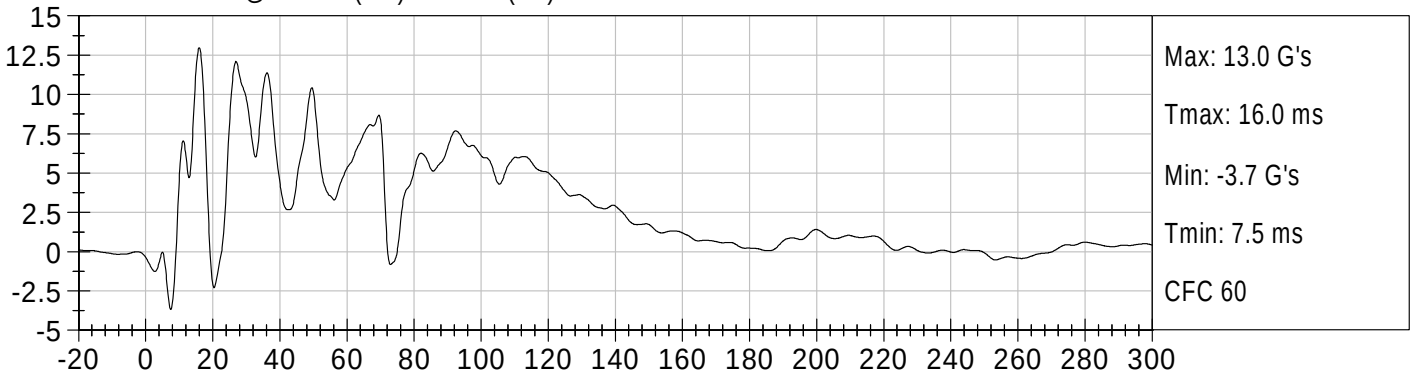




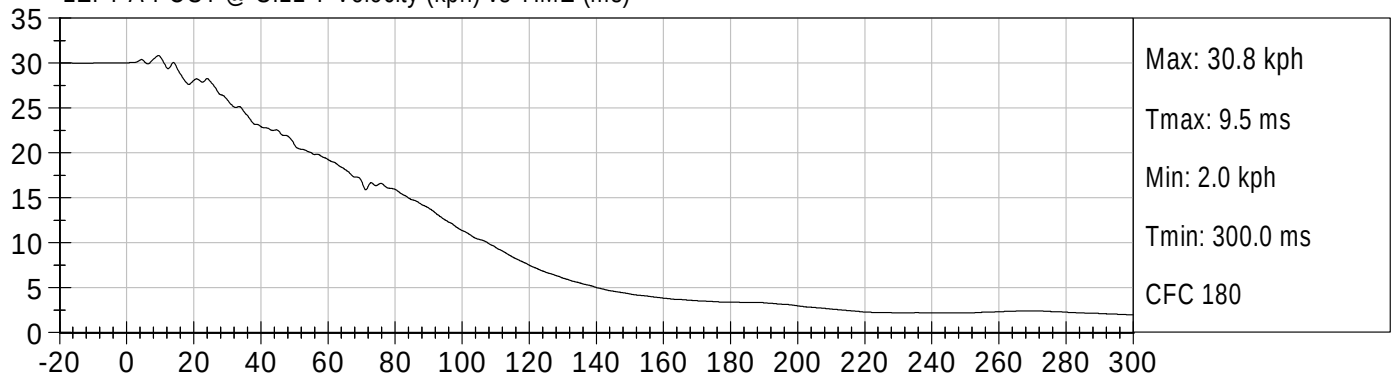
FMVSS 214 Rigid Pole Side Impact
2010 Kia Forte - CA0505

Test Date: 01/21/2010
Speed: 19.3 mph (31.1 km/h)

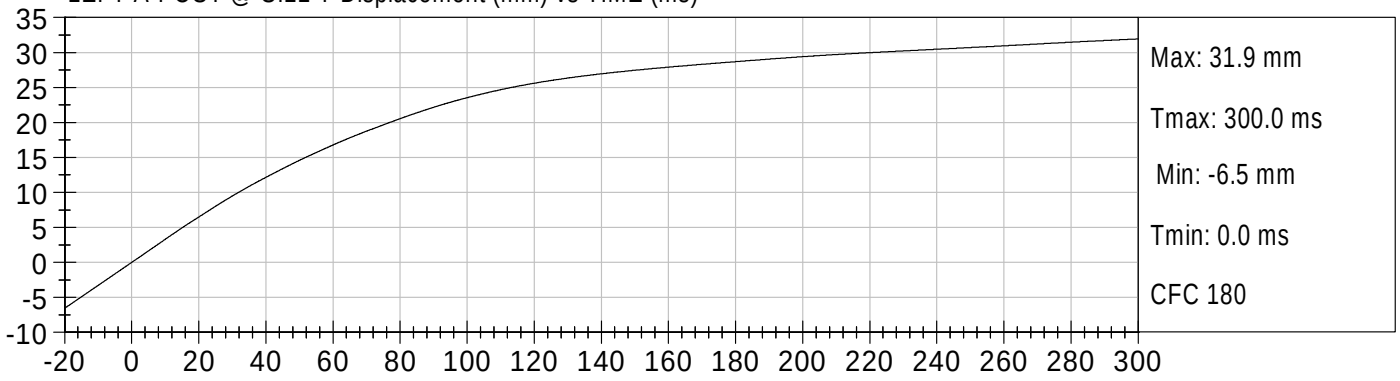
LEFT A-POST @ SILL Y (G's) vs TIME (ms)



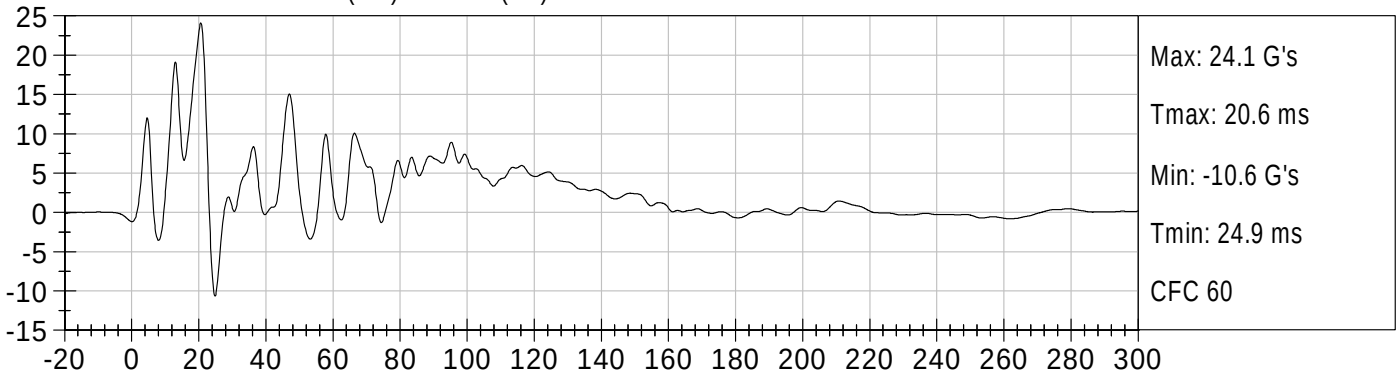
LEFT A-POST @ SILL Y Velocity (kph) vs TIME (ms)



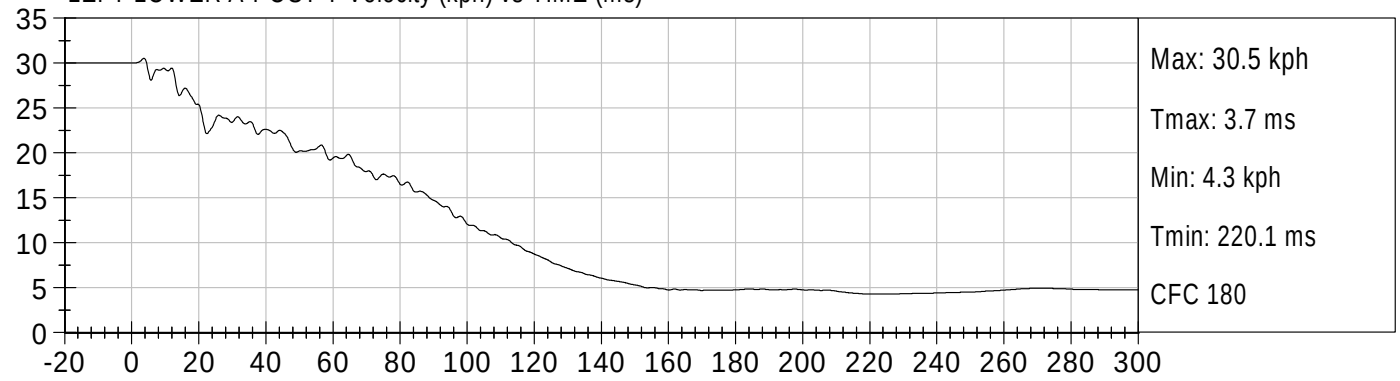
LEFT A-POST @ SILL Y Displacement (mm) vs TIME (ms)



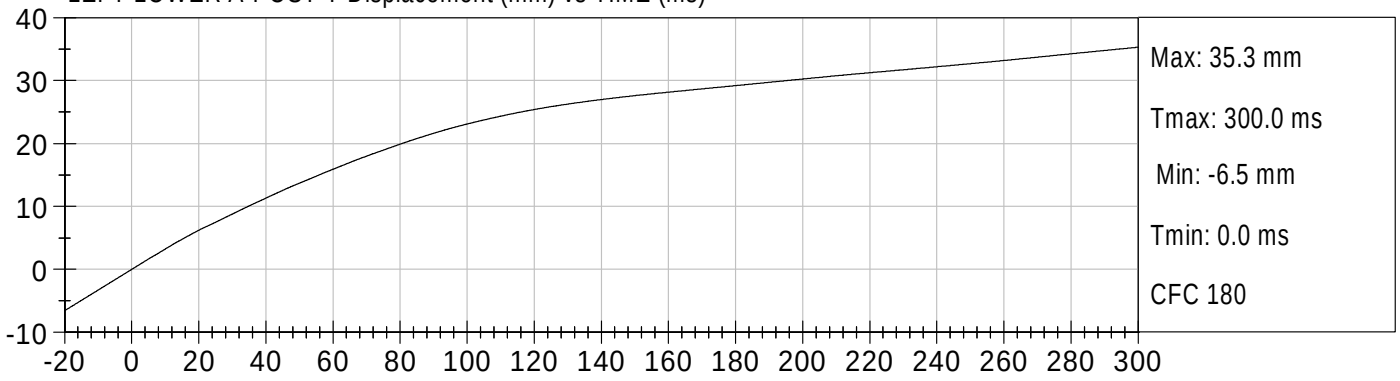
LEFT LOWER A-POST Y (G's) vs TIME (ms)



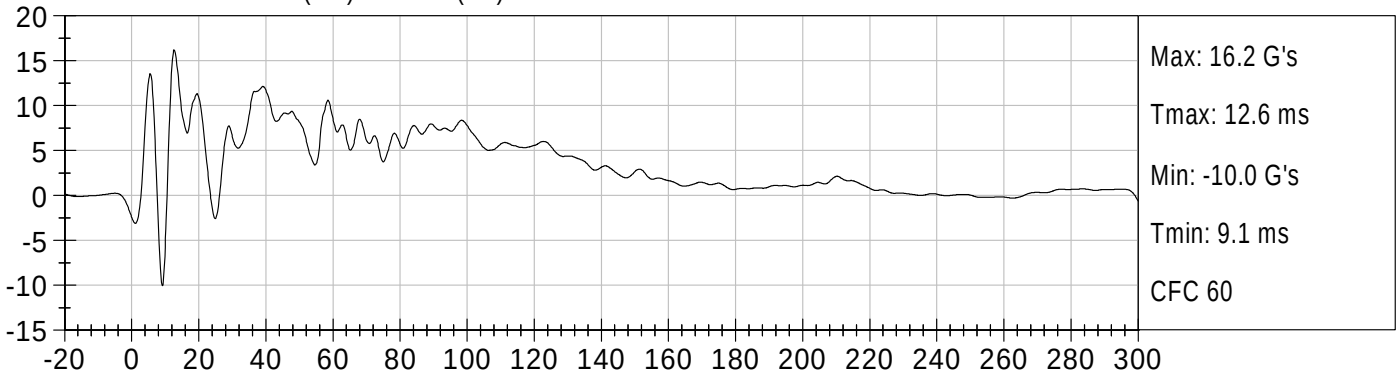
LEFT LOWER A-POST Y Velocity (kph) vs TIME (ms)



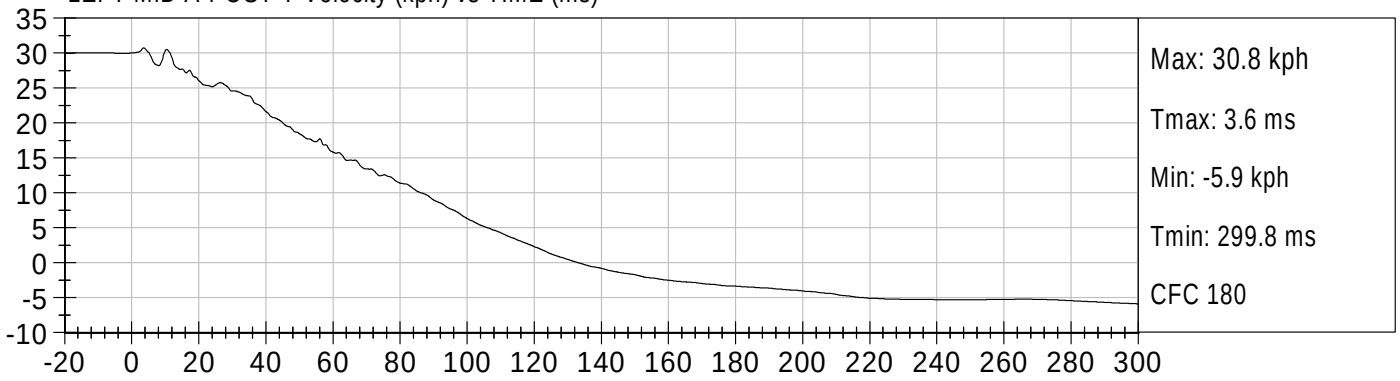
LEFT LOWER A-POST Y Displacement (mm) vs TIME (ms)



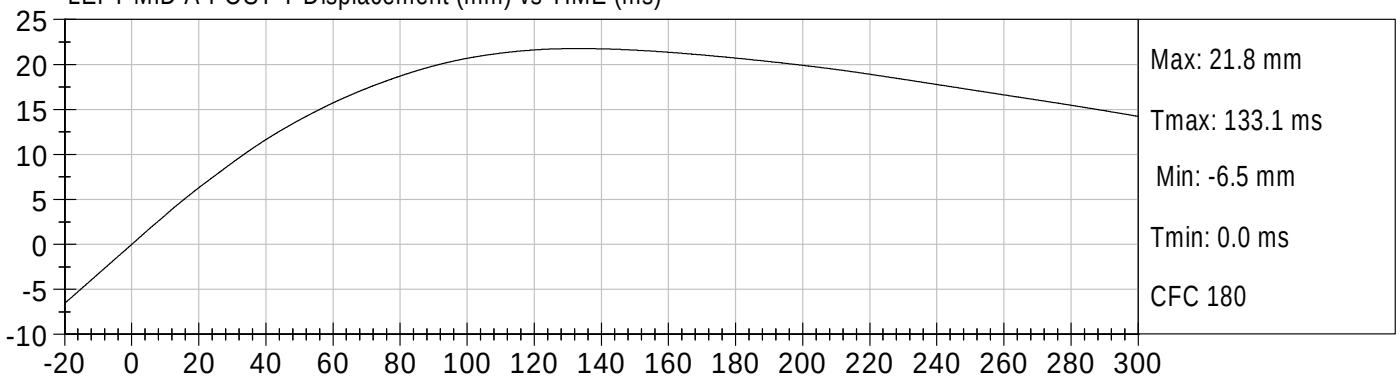
LEFT MID A-POST Y (G's) vs TIME (ms)



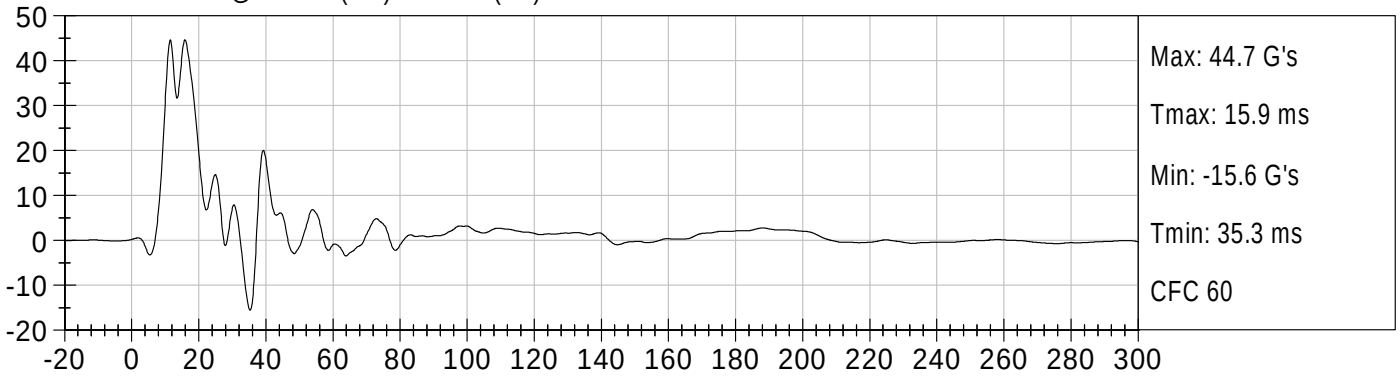
LEFT MID A-POST Y Velocity (kph) vs TIME (ms)



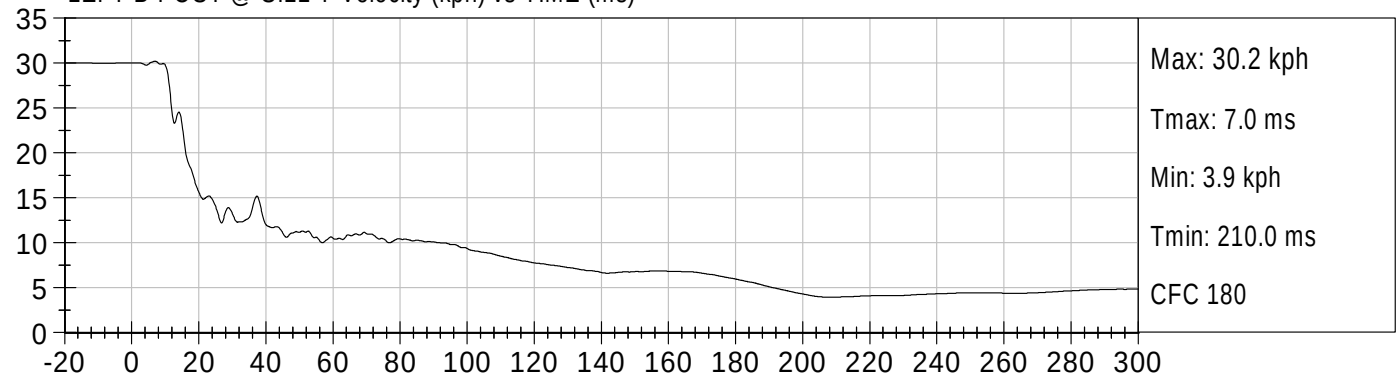
LEFT MID A-POST Y Displacement (mm) vs TIME (ms)



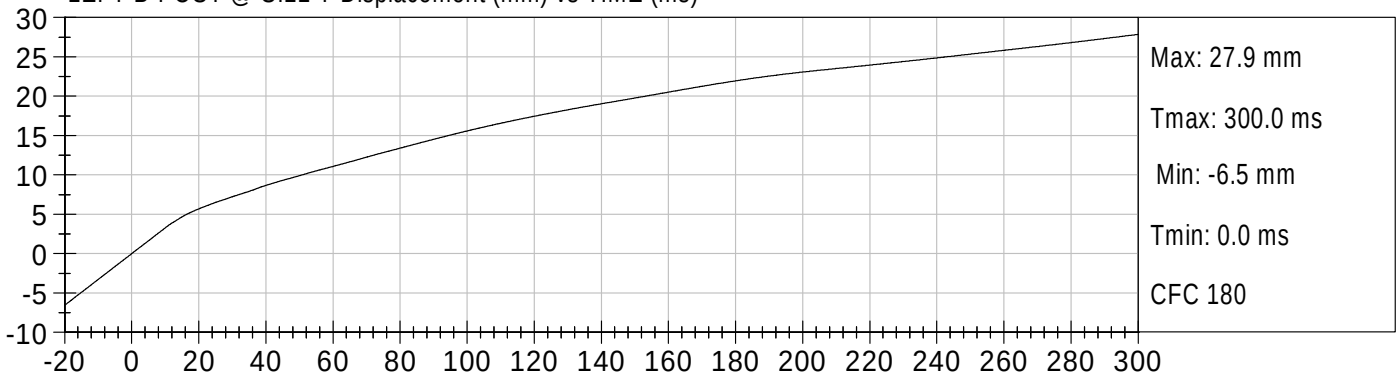
LEFT B-POST @ SILL Y (G's) vs TIME (ms)



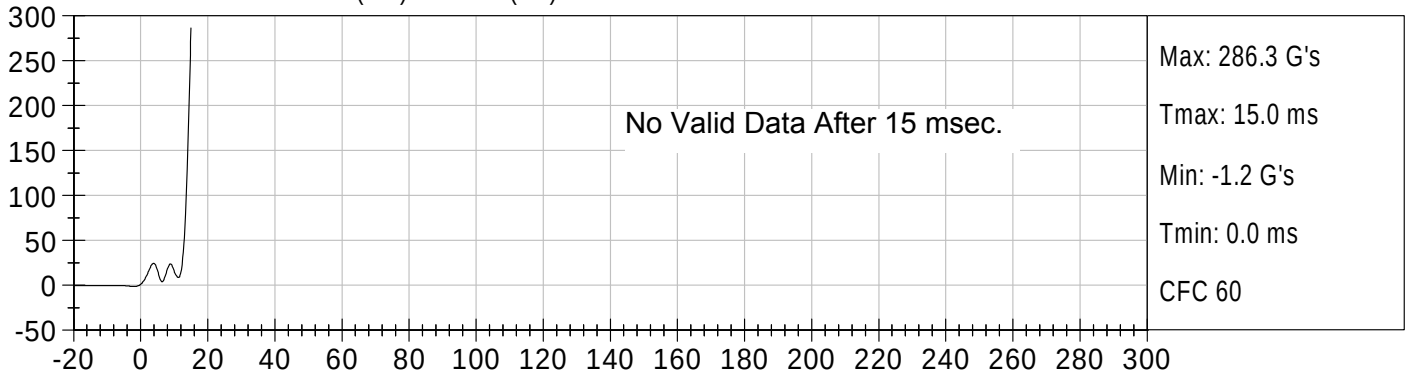
LEFT B-POST @ SILL Y Velocity (kph) vs TIME (ms)



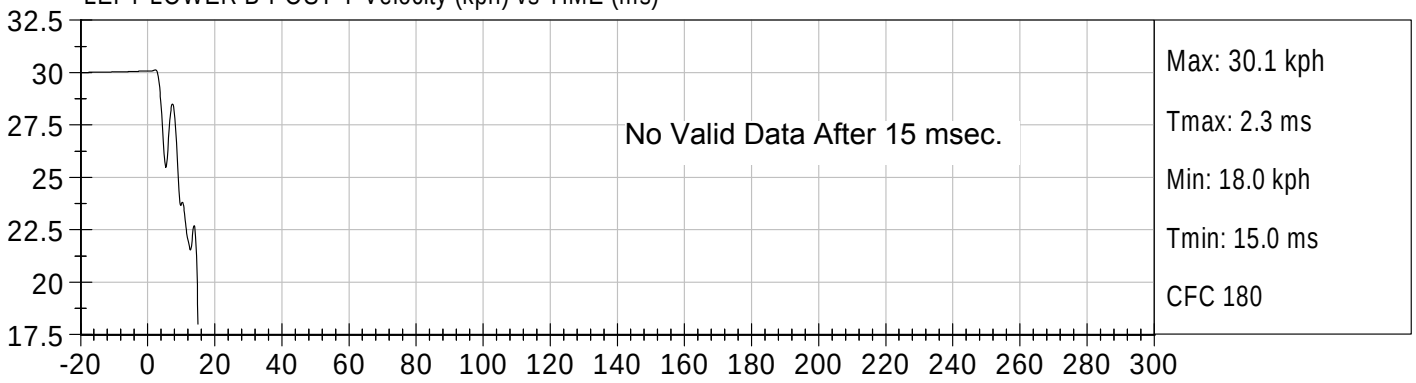
LEFT B-POST @ SILL Y Displacement (mm) vs TIME (ms)



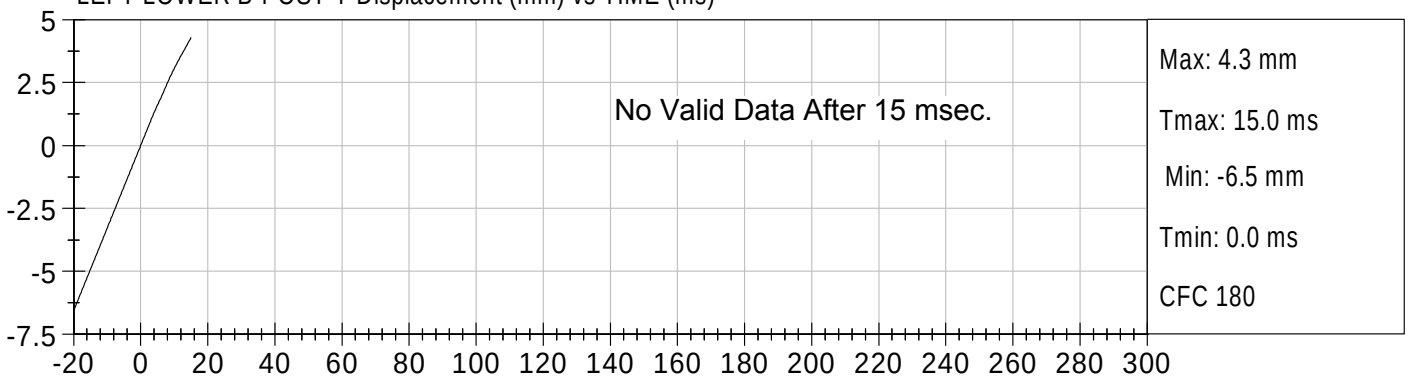
LEFT LOWER B-POST Y (G's) vs TIME (ms)



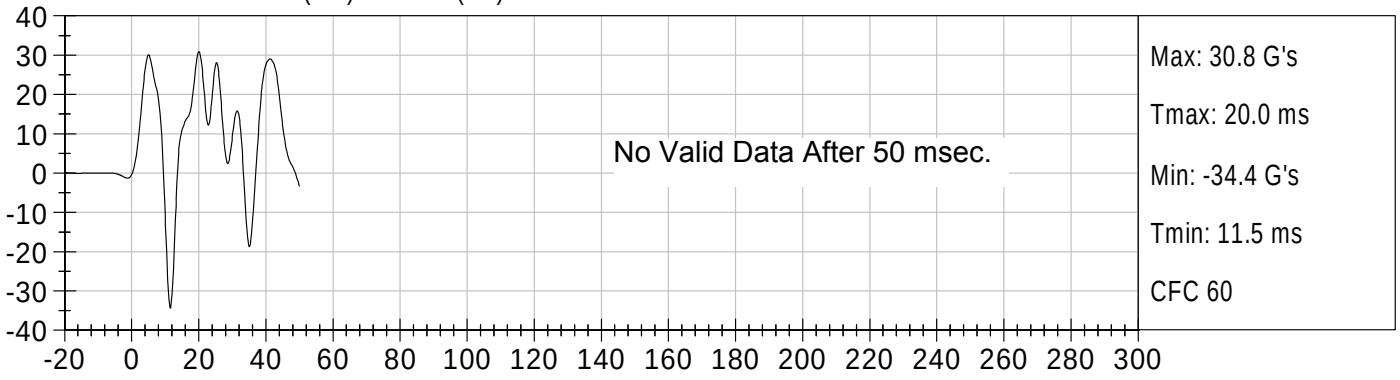
LEFT LOWER B-POST Y Velocity (kph) vs TIME (ms)



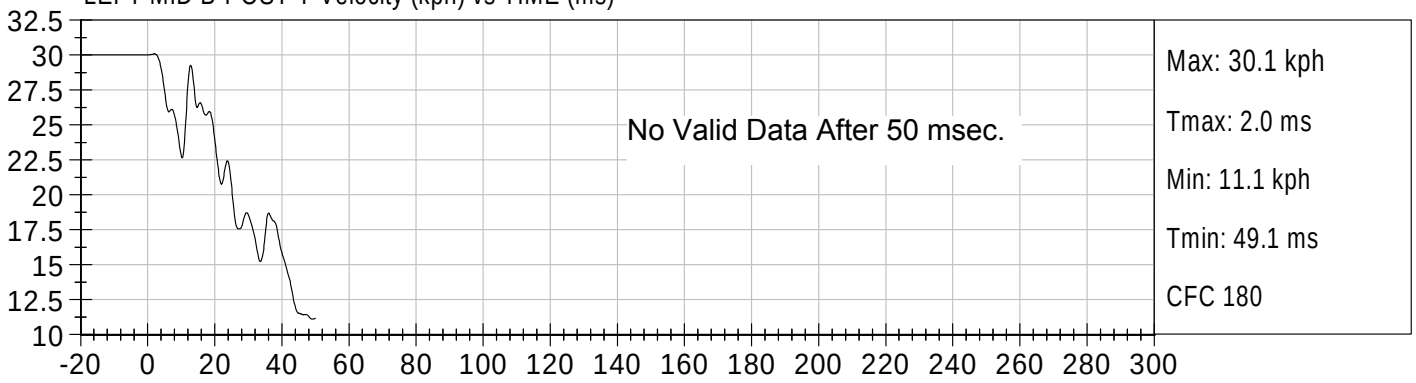
LEFT LOWER B-POST Y Displacement (mm) vs TIME (ms)



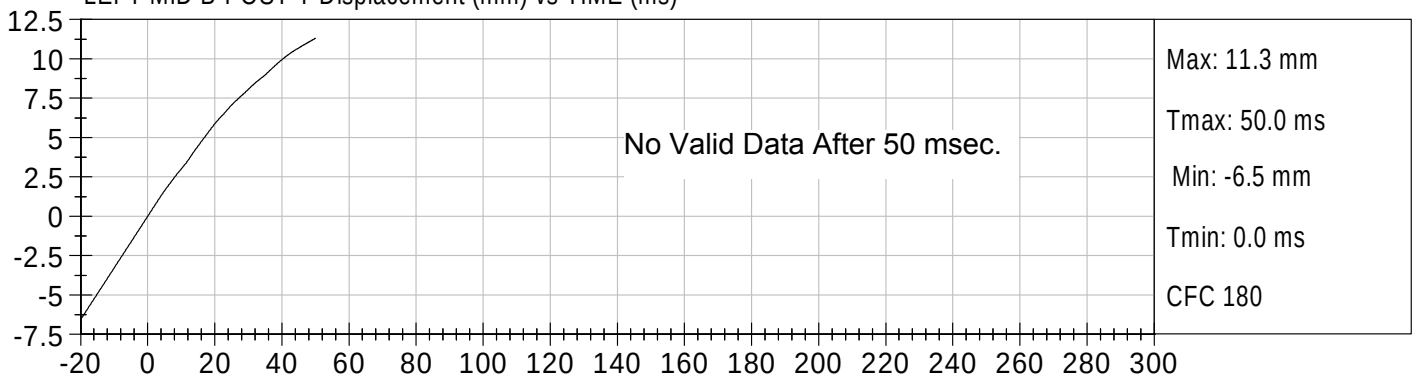
LEFT MID B-POST Y (G's) vs TIME (ms)



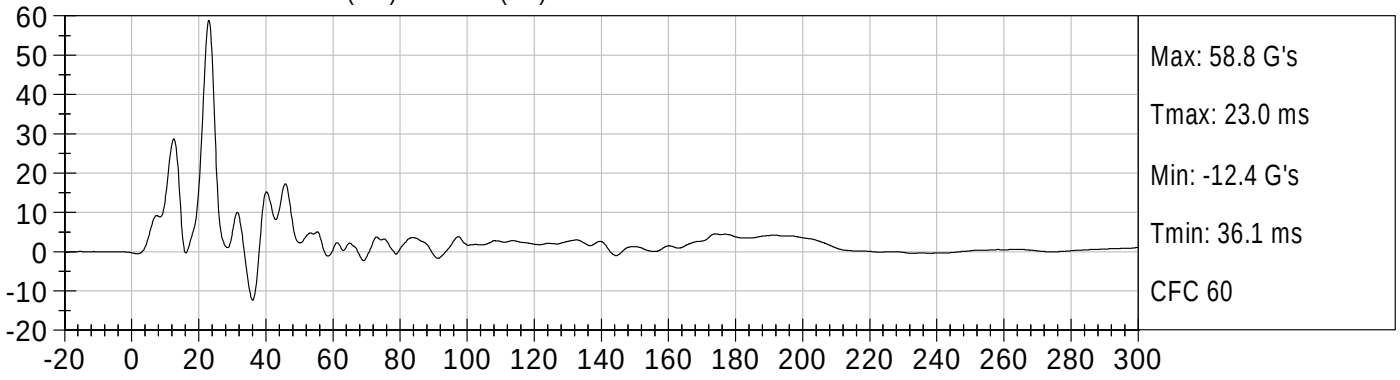
LEFT MID B-POST Y Velocity (kph) vs TIME (ms)



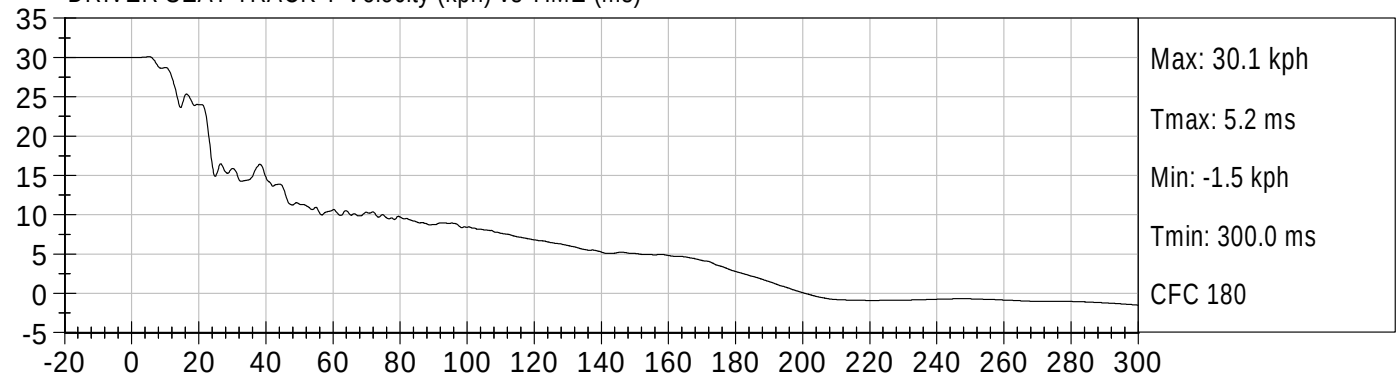
LEFT MID B-POST Y Displacement (mm) vs TIME (ms)



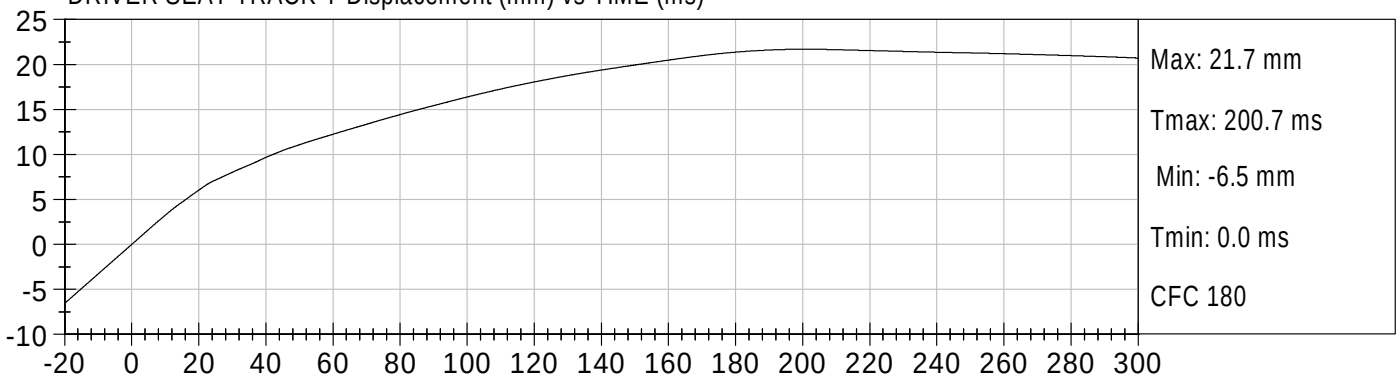
DRIVER SEAT TRACK Y (G's) vs TIME (ms)



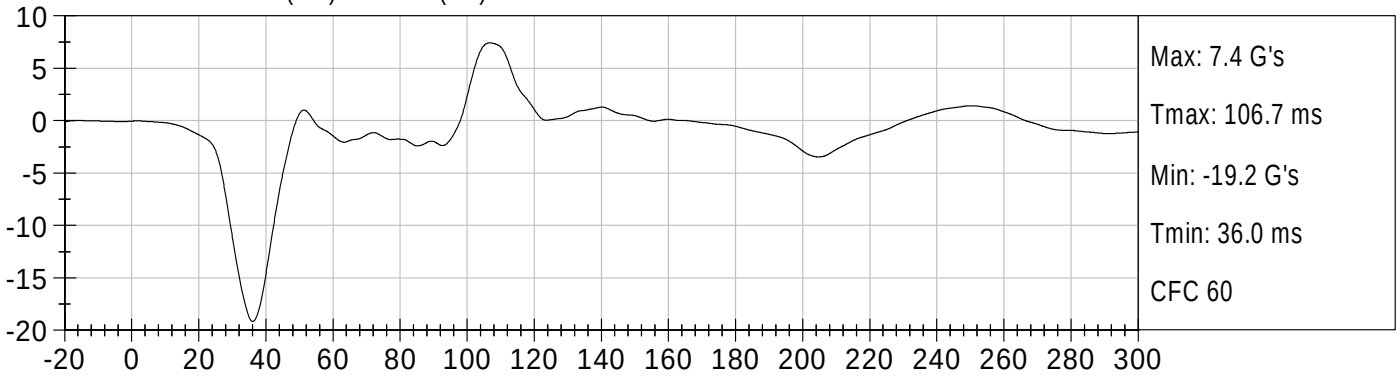
DRIVER SEAT TRACK Y Velocity (kph) vs TIME (ms)



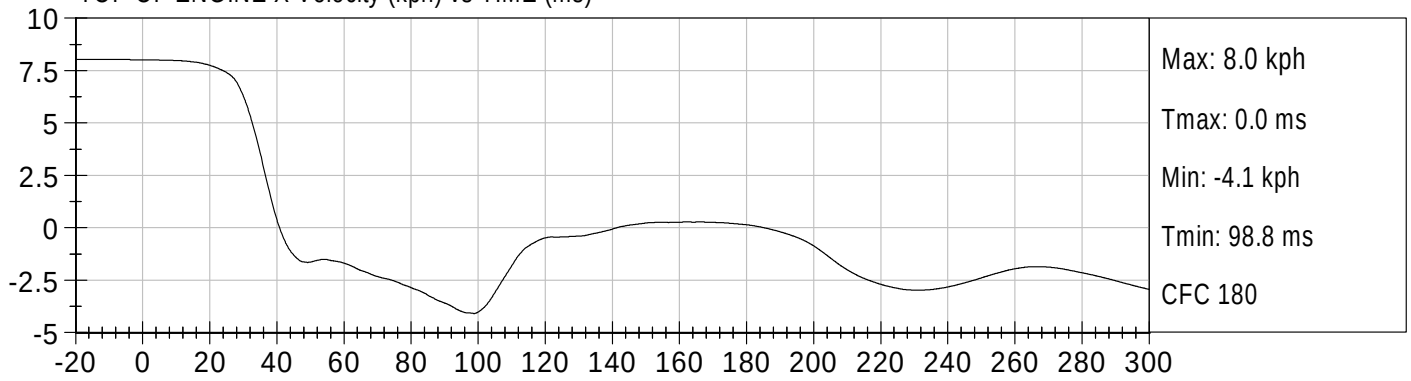
DRIVER SEAT TRACK Y Displacement (mm) vs TIME (ms)



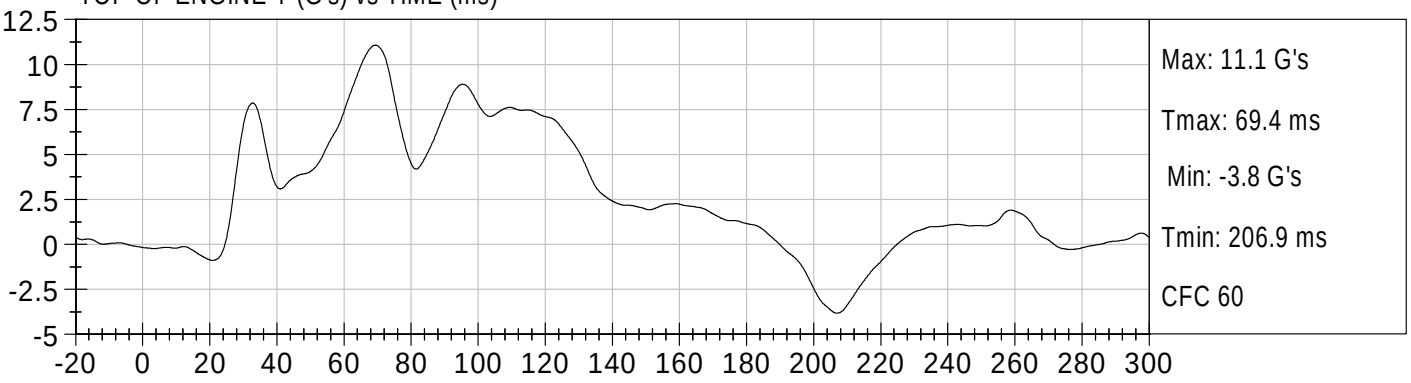
TOP OF ENGINE X (G's) vs TIME (ms)



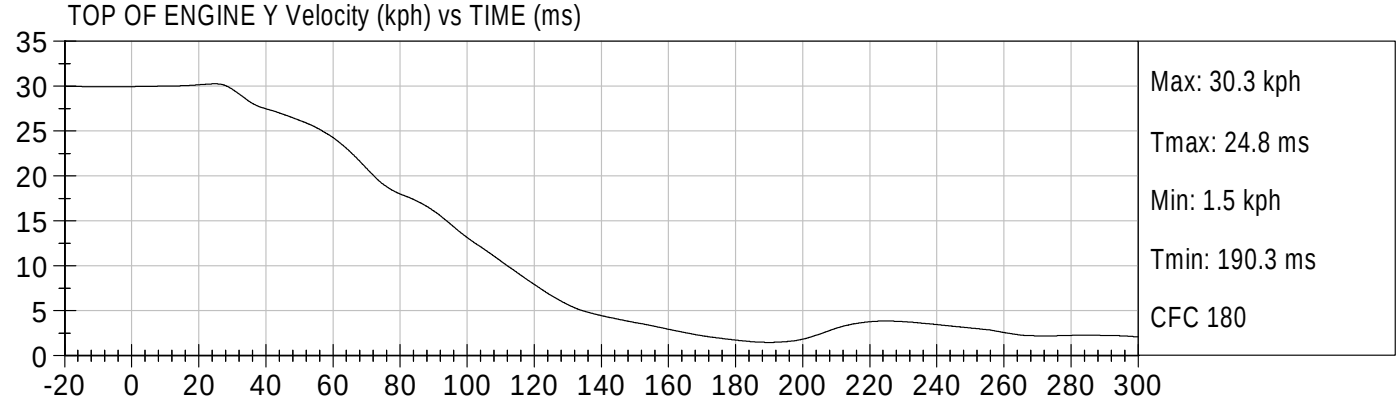
TOP OF ENGINE X Velocity (kph) vs TIME (ms)



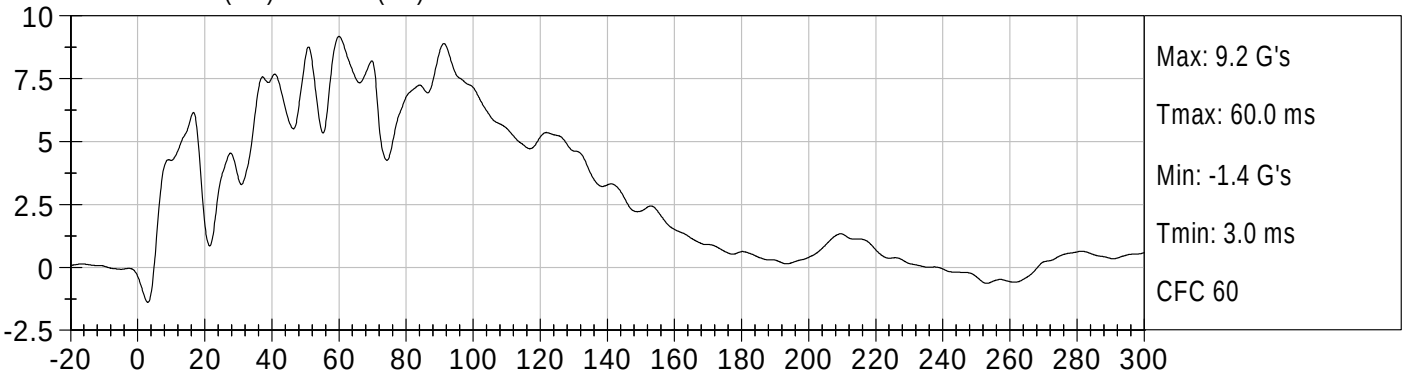
TOP OF ENGINE Y (G's) vs TIME (ms)



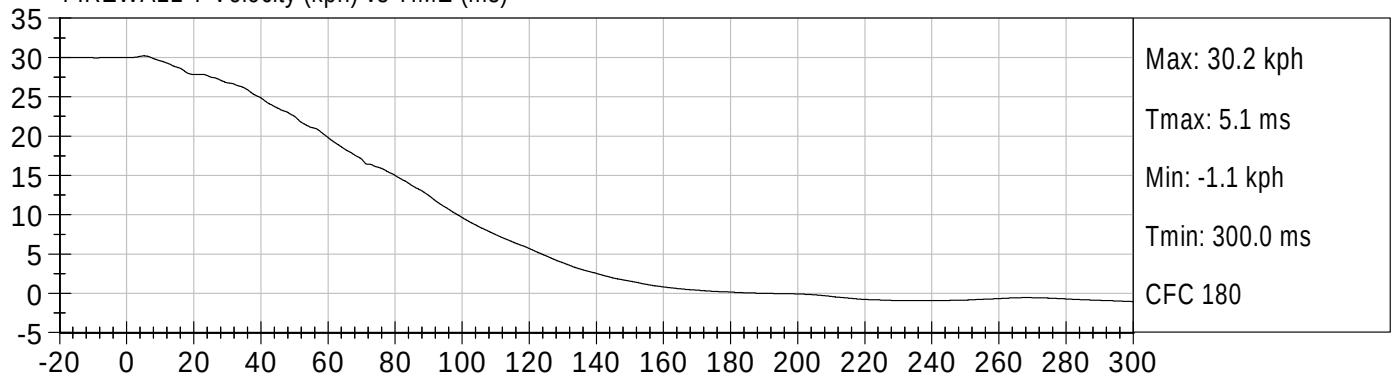
TOP OF ENGINE Y Velocity (kph) vs TIME (ms)



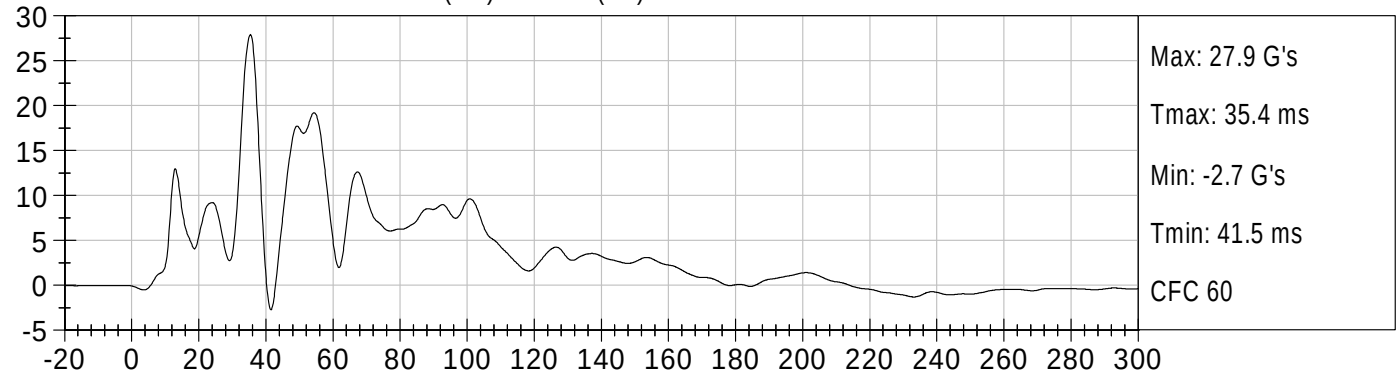
FIREWALL Y (G's) vs TIME (ms)



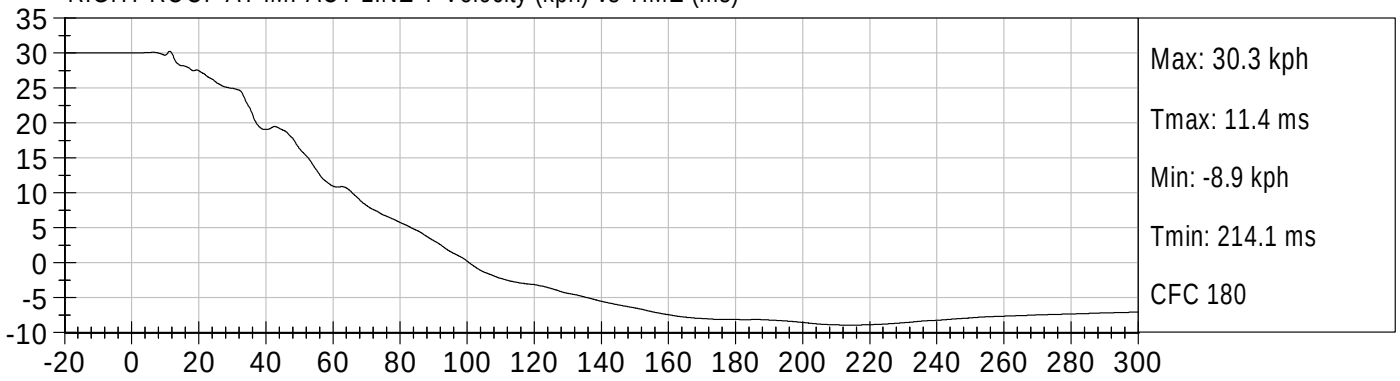
FIREWALL Y Velocity (kph) vs TIME (ms)



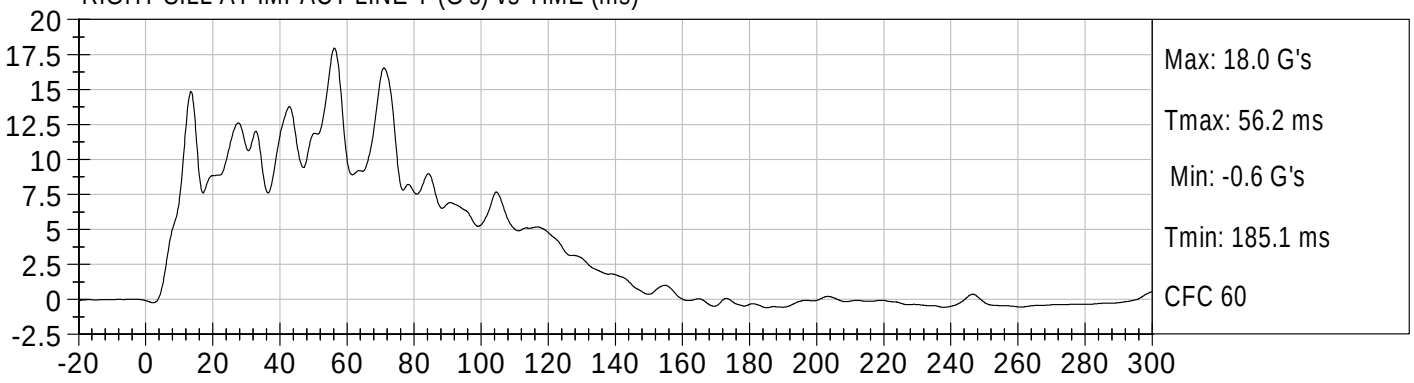
RIGHT ROOF AT IMPACT LINE Y (G's) vs TIME (ms)



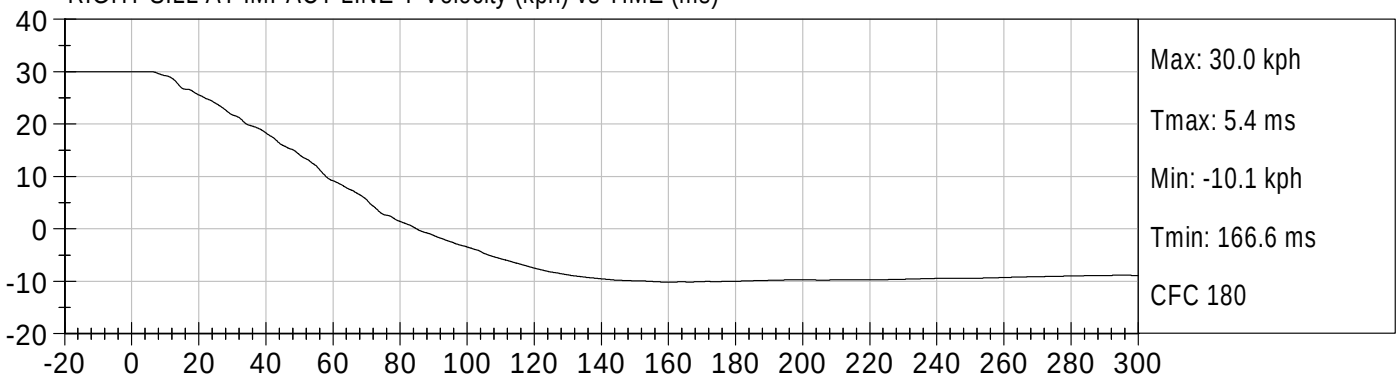
RIGHT ROOF AT IMPACT LINE Y Velocity (kph) vs TIME (ms)



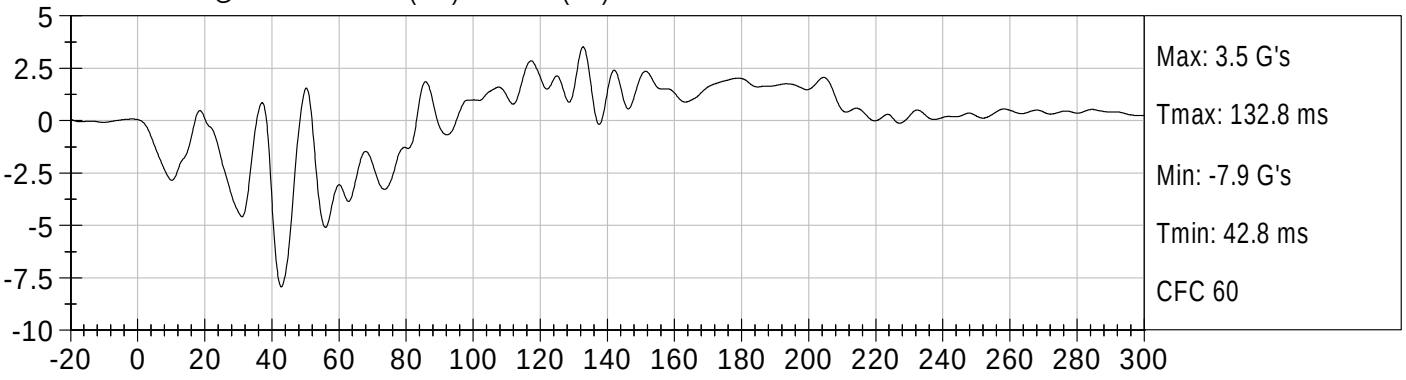
RIGHT SILL AT IMPACT LINE Y (G's) vs TIME (ms)



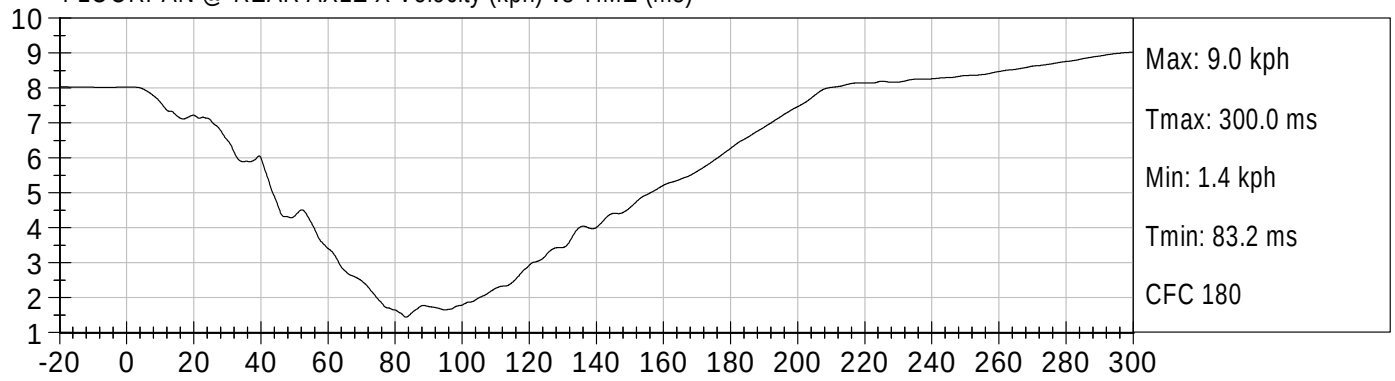
RIGHT SILL AT IMPACT LINE Y Velocity (kph) vs TIME (ms)



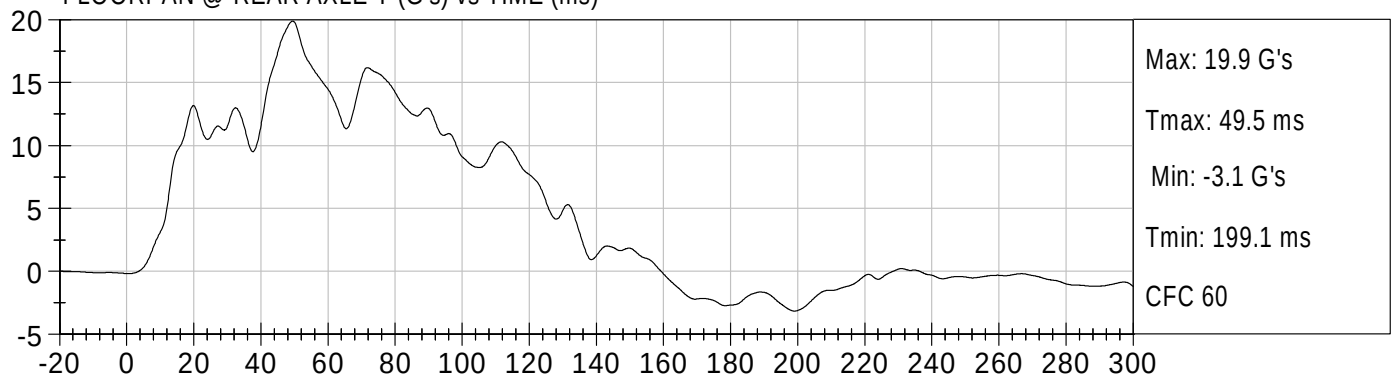
FLOORPAN @ REAR AXLE X (G's) vs TIME (ms)



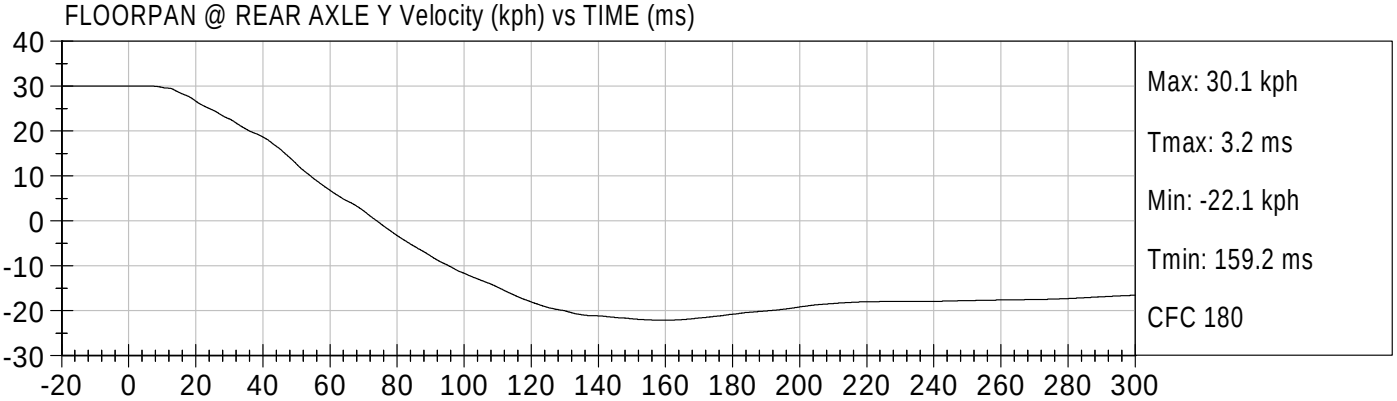
FLOORPAN @ REAR AXLE X Velocity (kph) vs TIME (ms)



FLOORPAN @ REAR AXLE Y (G's) vs TIME (ms)



FLOORPAN @ REAR AXLE 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:** D092861

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	29	Pass
Peak Resultant Acceleration	G's	125 to 155	140	Pass
Peak Lateral Acceleration	G's	+/- 15	-6.7	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

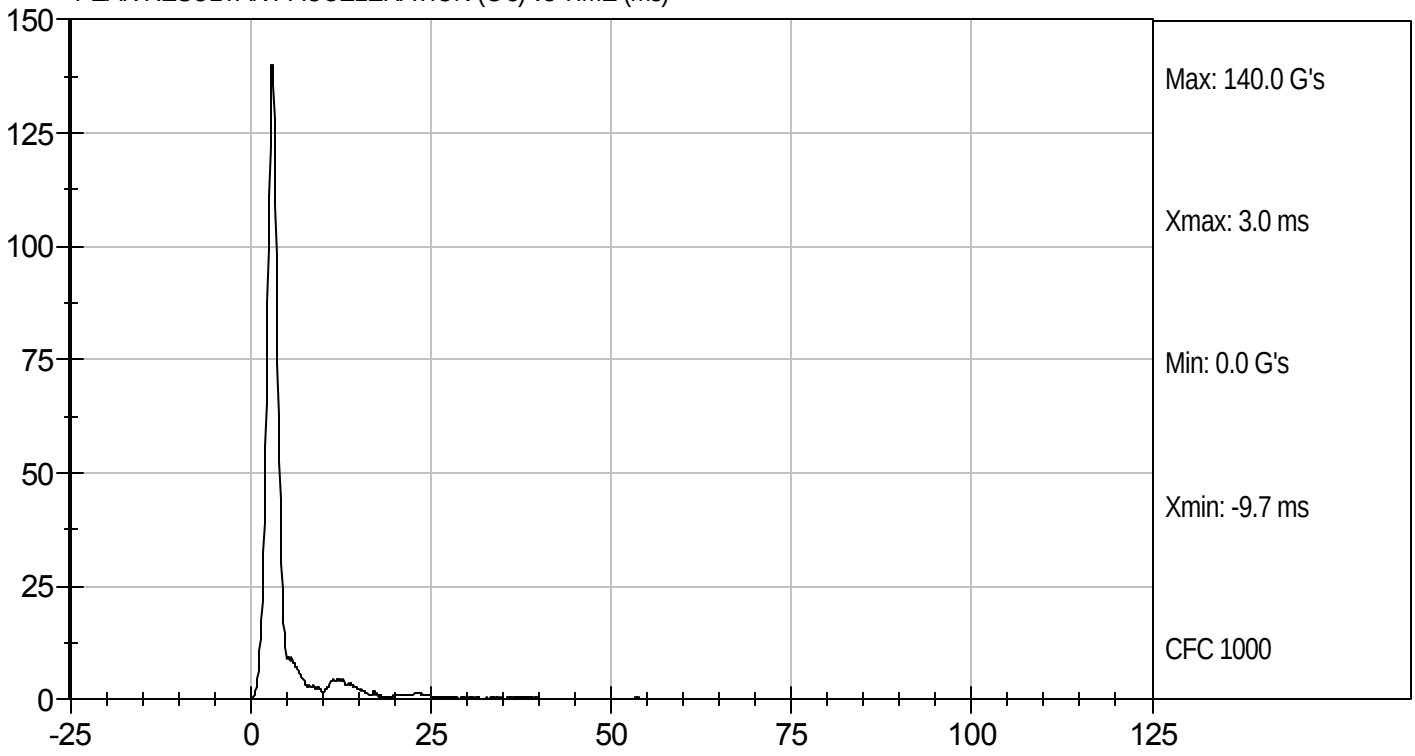
11/17/09
Test Date

David Winkelbauer
Approved By

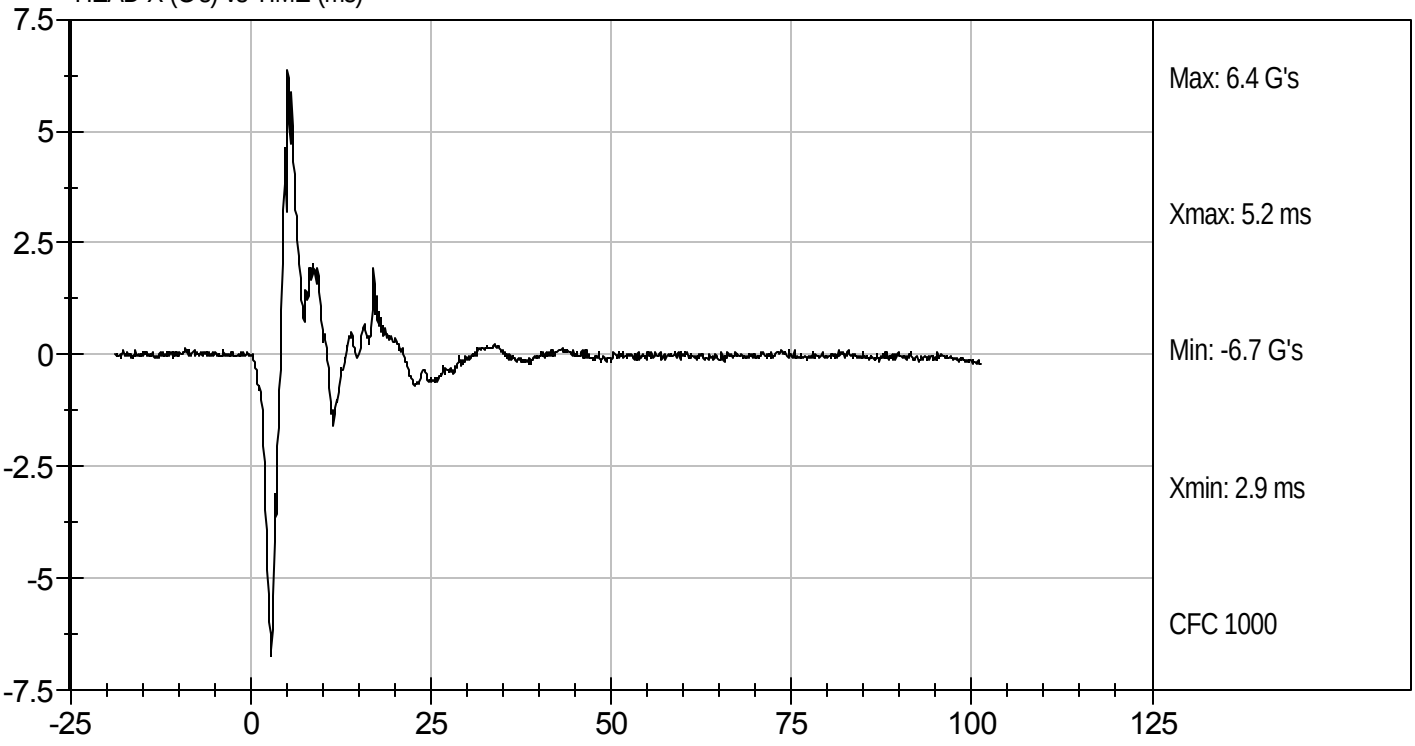
Test Desc: Head Drop
Component ID: D092861

Test Date: 11/17/09
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: 003 **Test I.D:** D092862

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	20.8	Pass
Laboratory Relative Humidity		%	10 to 70	30	Pass
Pendulum Speed		m/s	3.3 to 3.5	3.5	Pass
Pendulum Deceleration	1 ms	m/s	0.00 to -0.05	-0.03	Pass
	3 ms	m/s	-0.25 to -0.375	-0.33	Pass
	14 ms	m/s	-3.20 to -3.70	-3.37	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	51.3	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	63.4	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	56.1	Pass
			Overall Test Results		Pass

Jessica Gall
Laboratory Technician

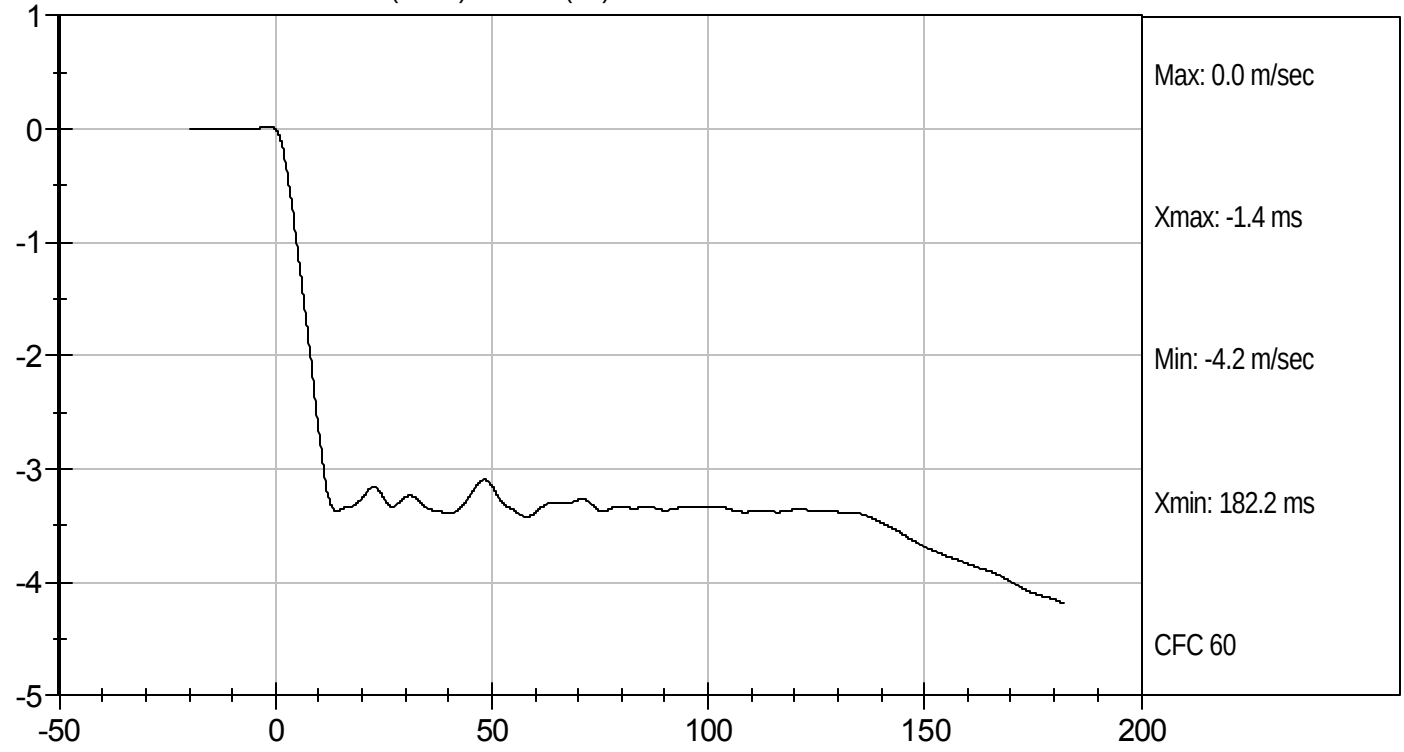
11/17/09
Test Date

David Winkelbauer
Approved By

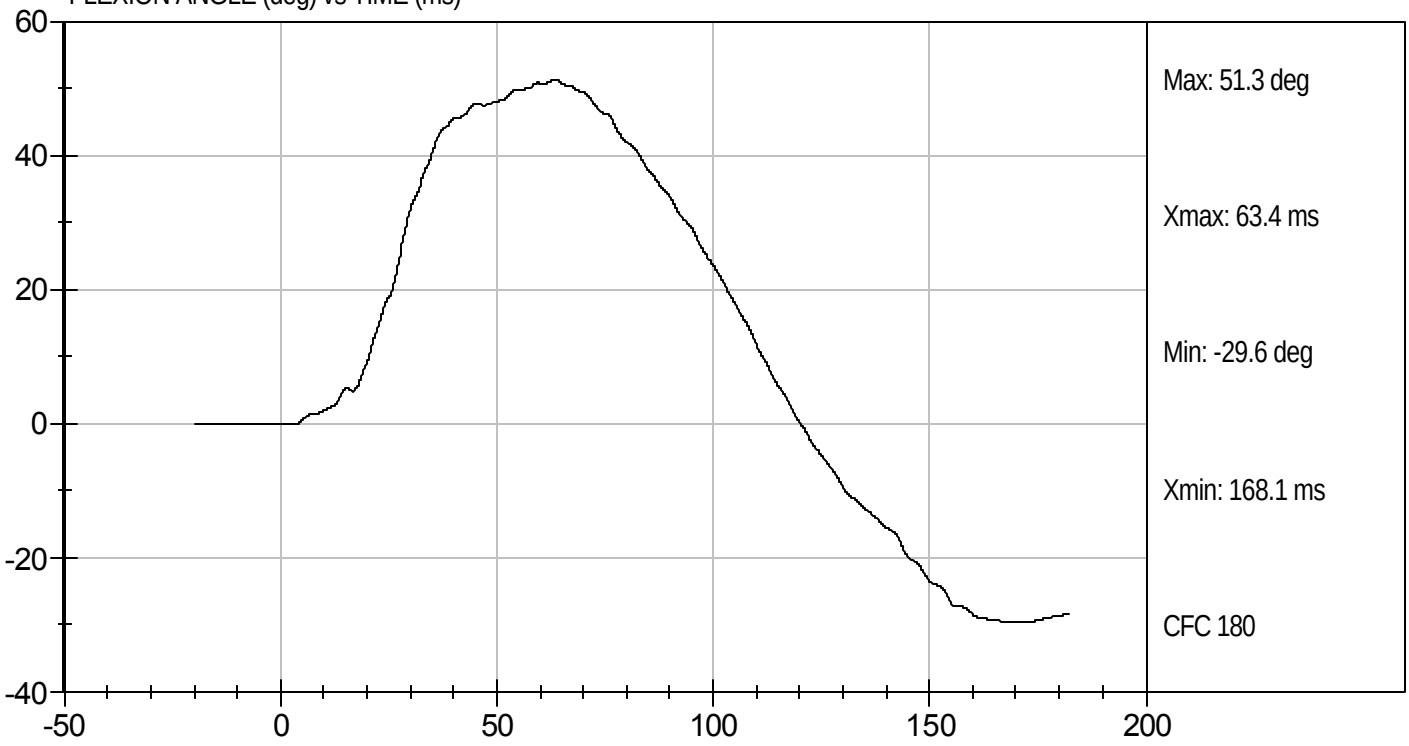
Test Desc: Neck Bending
Component ID: D092862

Test Date: 11/17/09
Velocity: 11.42 ft/s, 3.5 m/s

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

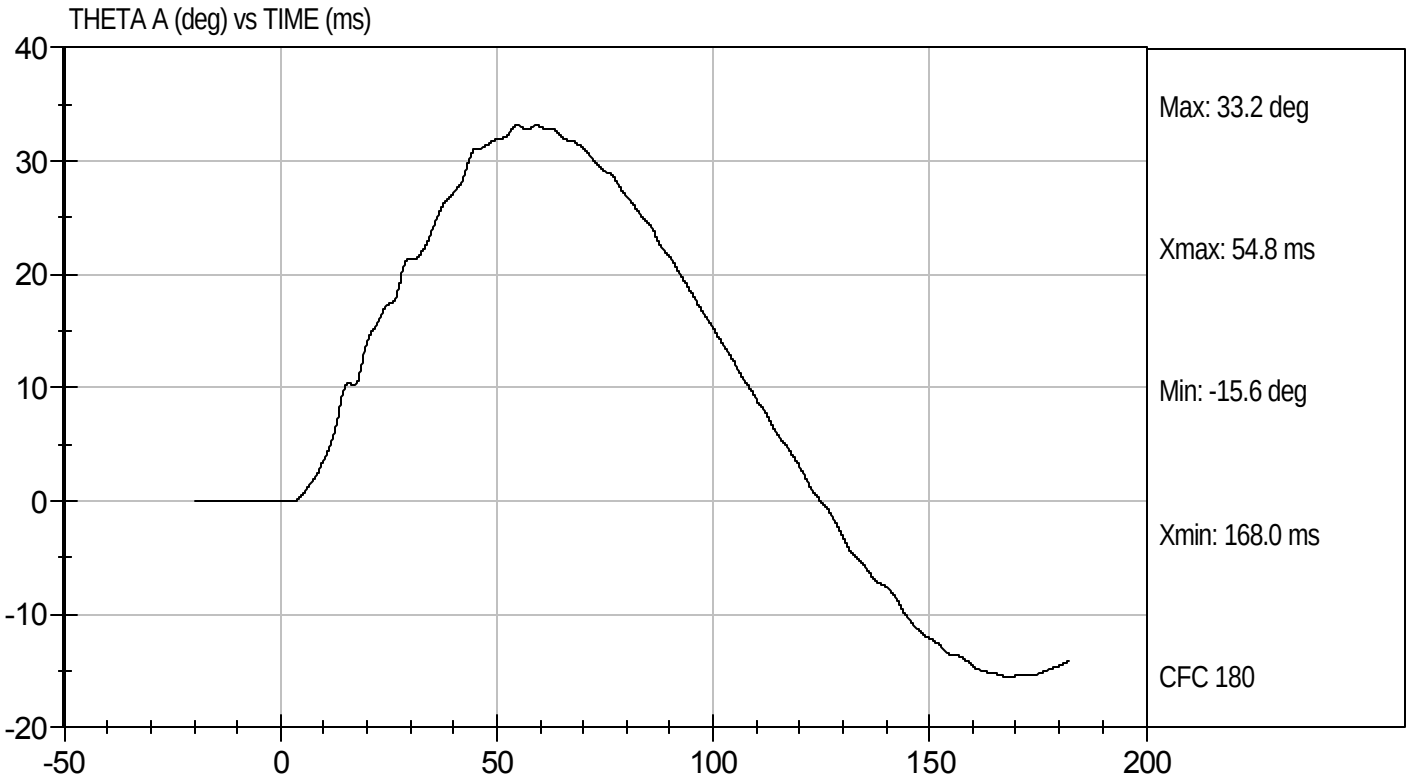


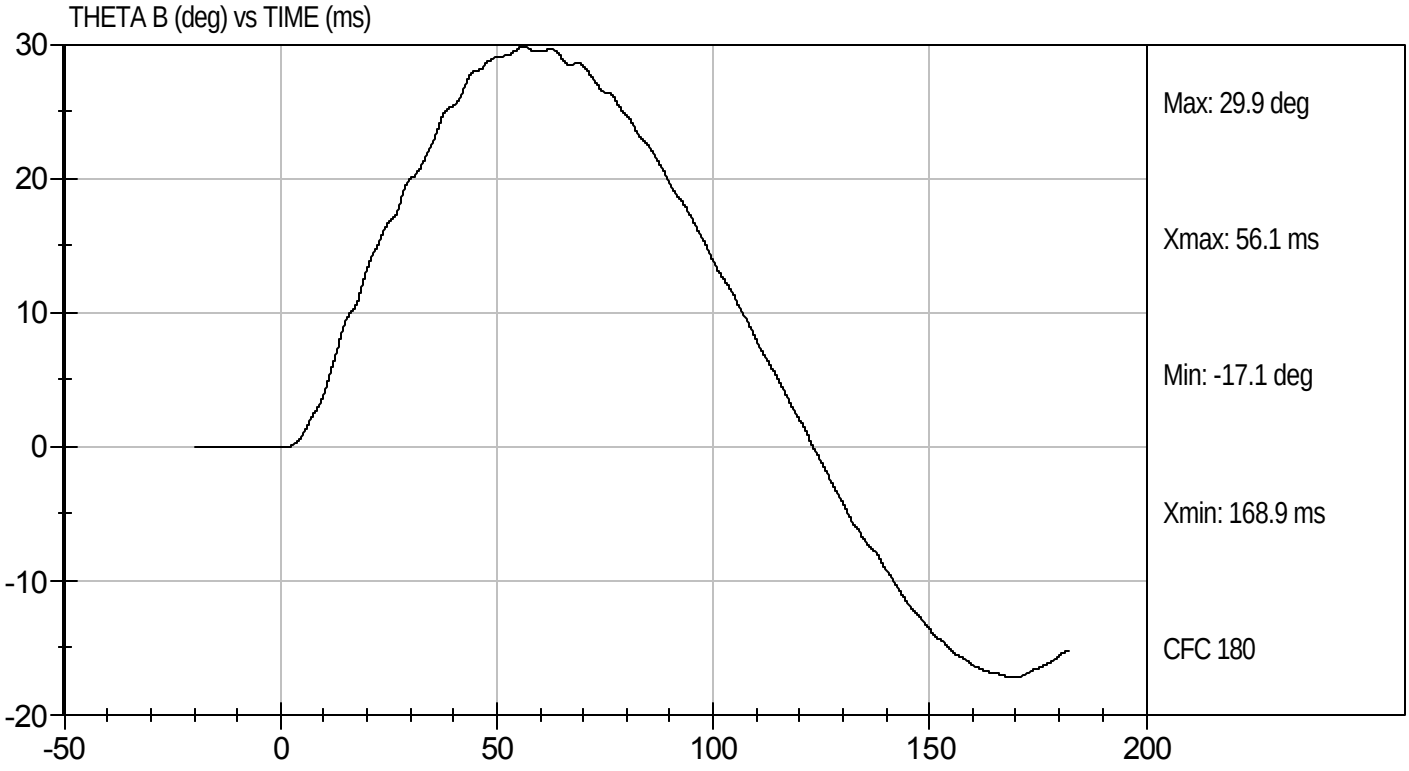
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D092862

Test Date: 11/17/09
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:** D092863

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.0	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	8.0	Pass
Time of Peak Shoulder Acceleration	ms	NA	13.0	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

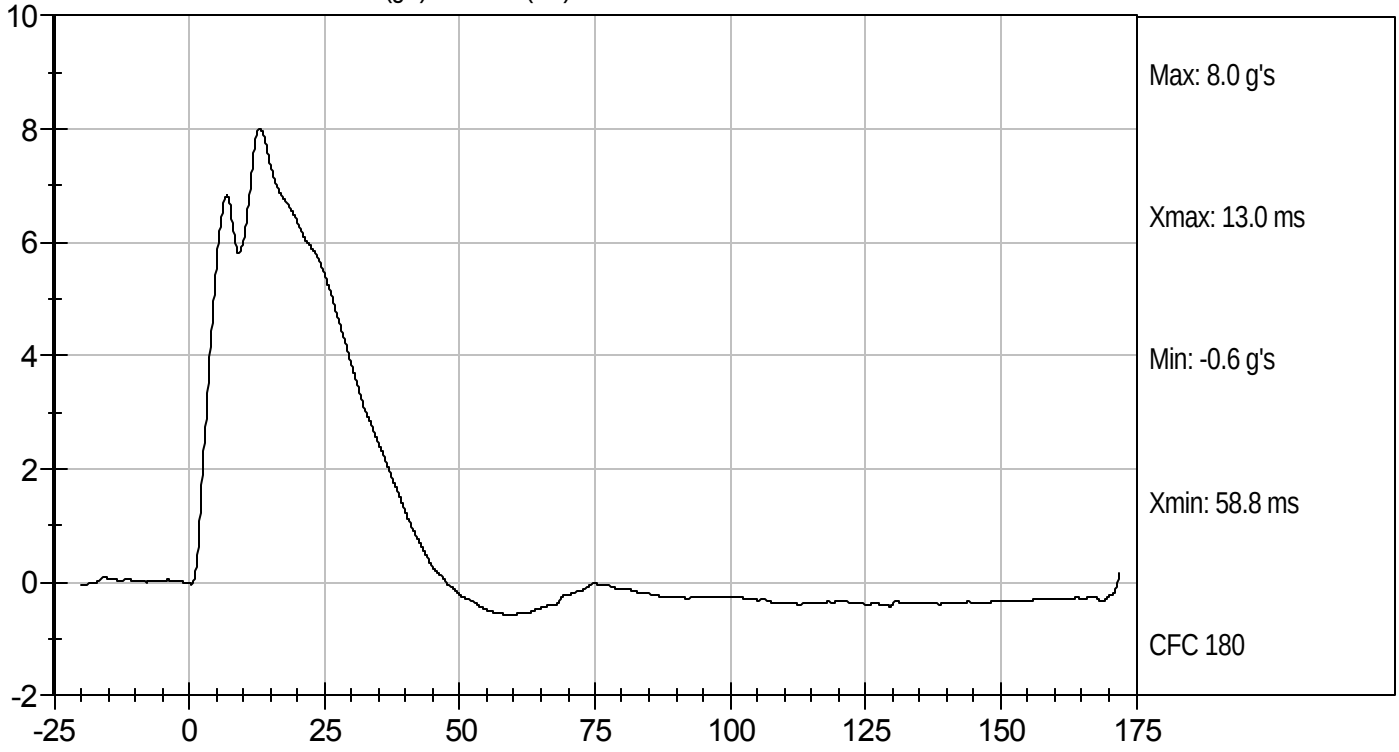
11/17/09
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D092863

Test Date: 11/17/09
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:** D092864

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.9	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	37.5	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.0	Pass
		Overall Test Results		Pass

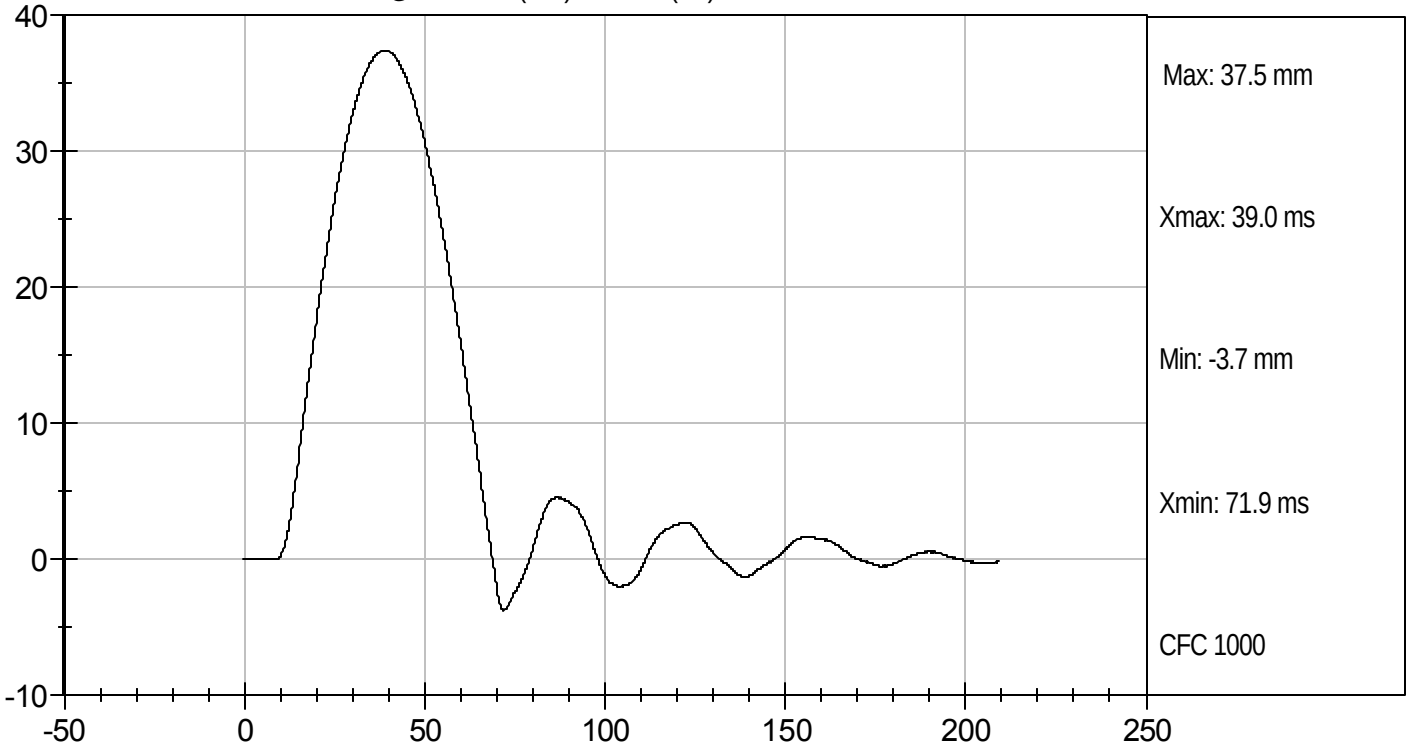
Jessica Hall
Laboratory Technician

11/17/09
Test Date

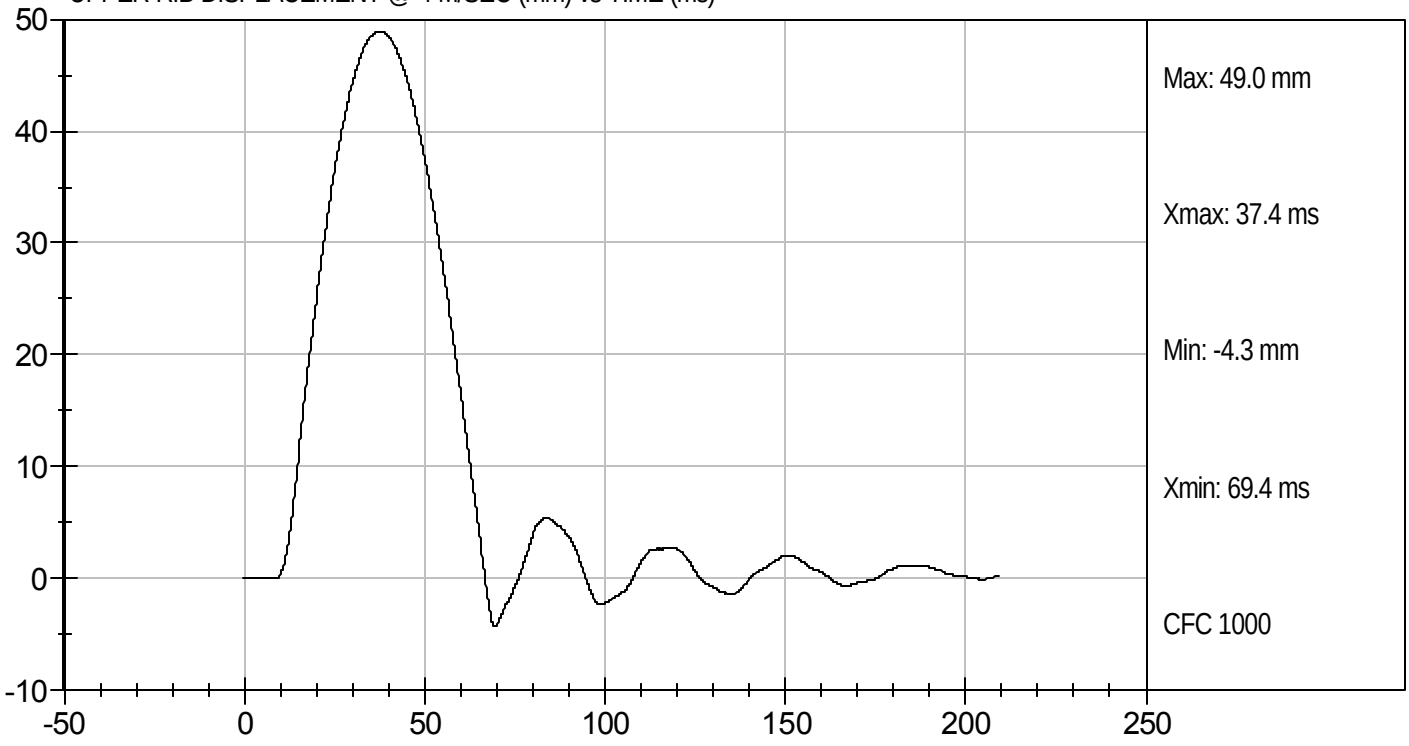
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D092864
Test Date: 11/17/09

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:** D092865

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	37.1	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.7	Pass
		Overall Test Results		Pass

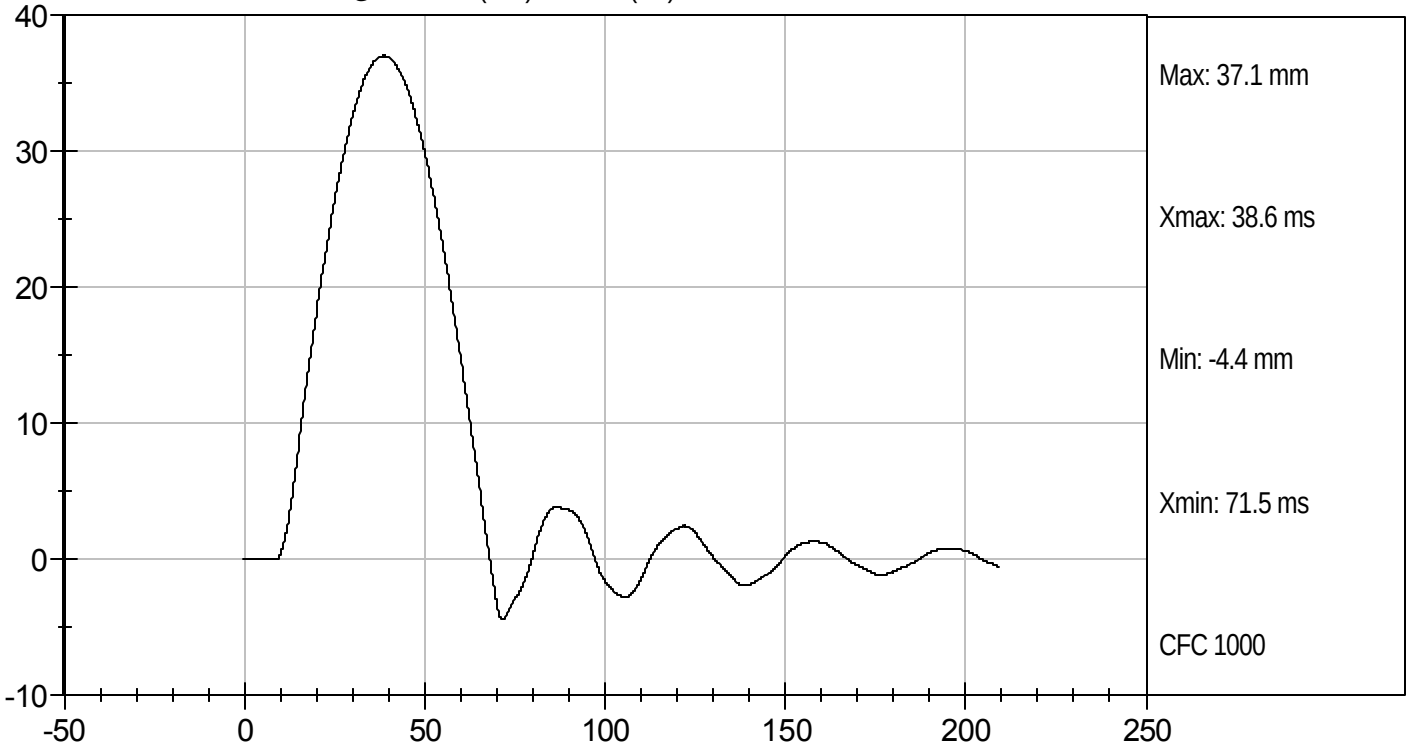
Jessica Gall
Laboratory Technician

11/17/09
Test Date

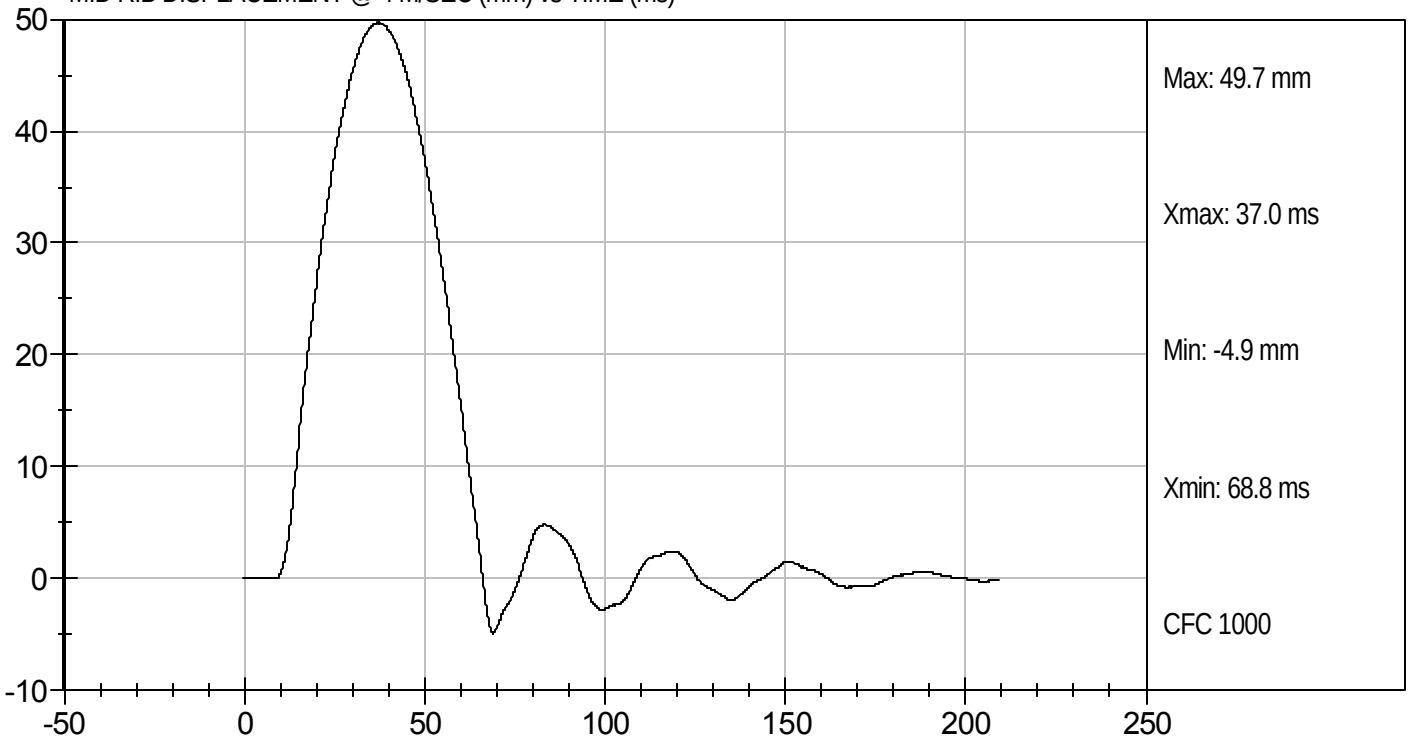
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D092865
Test Date: 11/17/09

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:** D092866

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	36.0	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	47.8	Pass
		Overall Test Results		Pass

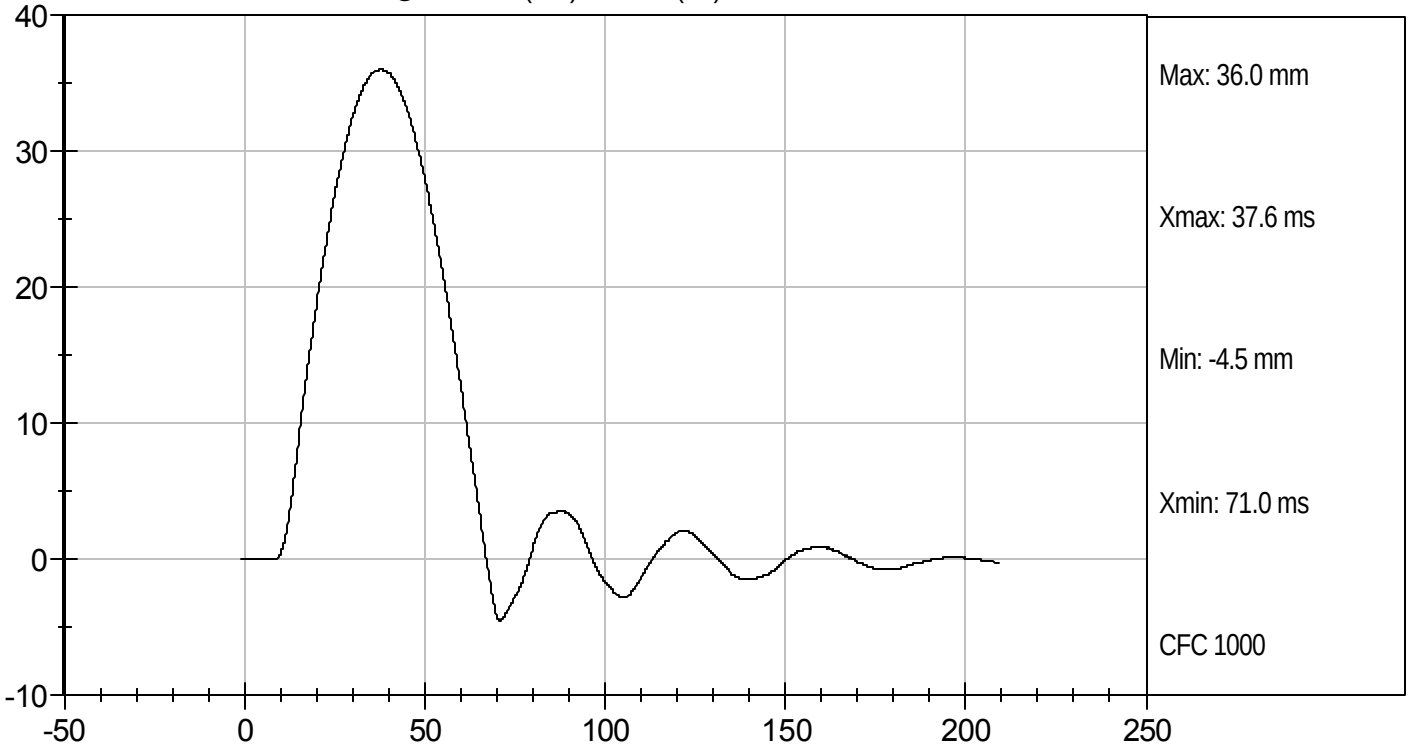
Jessica Gall
Laboratory Technician

11/17/09
Test Date

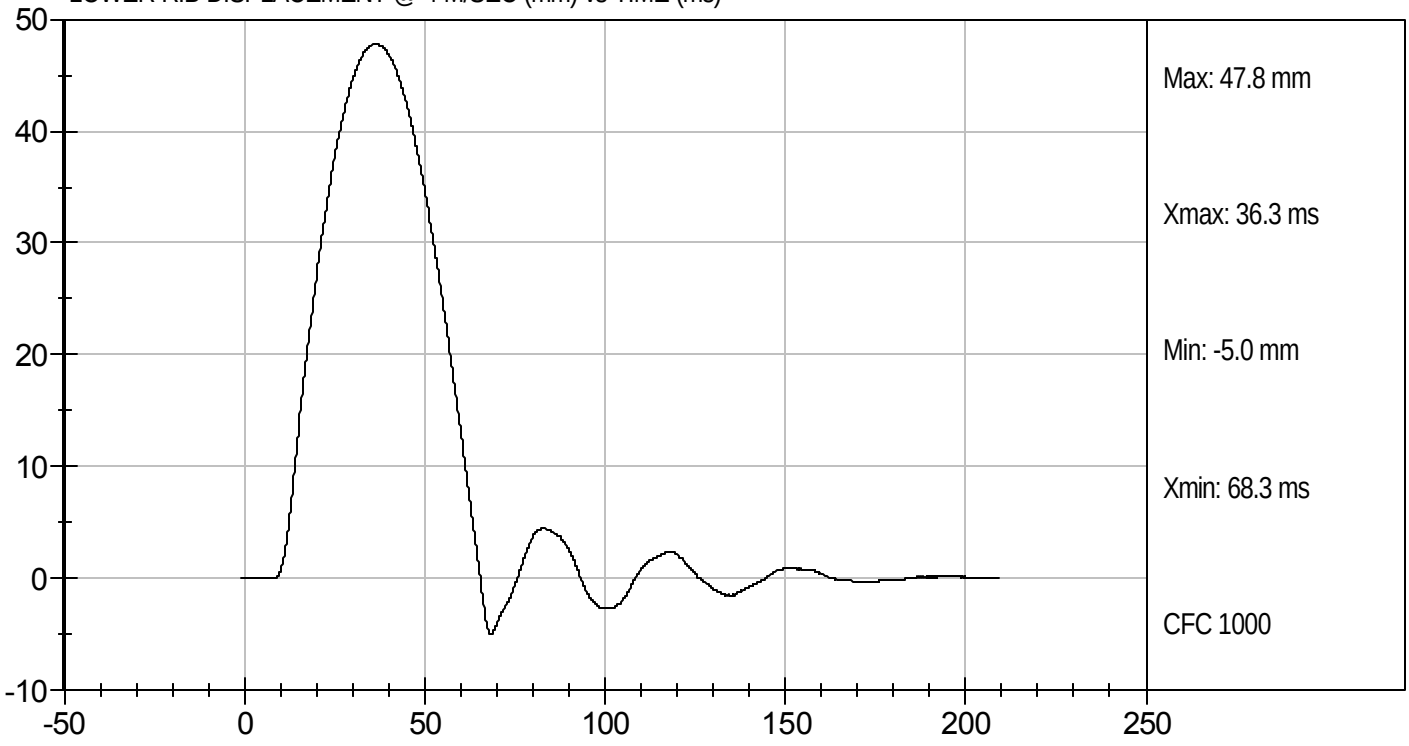
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D092866
Test Date: 11/17/09

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:** D092867

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.9	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Probe Speed	m/s	3.90 to 4.10	4.1	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.35	Pass
Time of Maximum Impactor Force	ms	10.60 to 13.00	11.40	Pass
Maximum Total Abdomen Force	kN	2.20 to 2.70	2.24	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	11.40	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

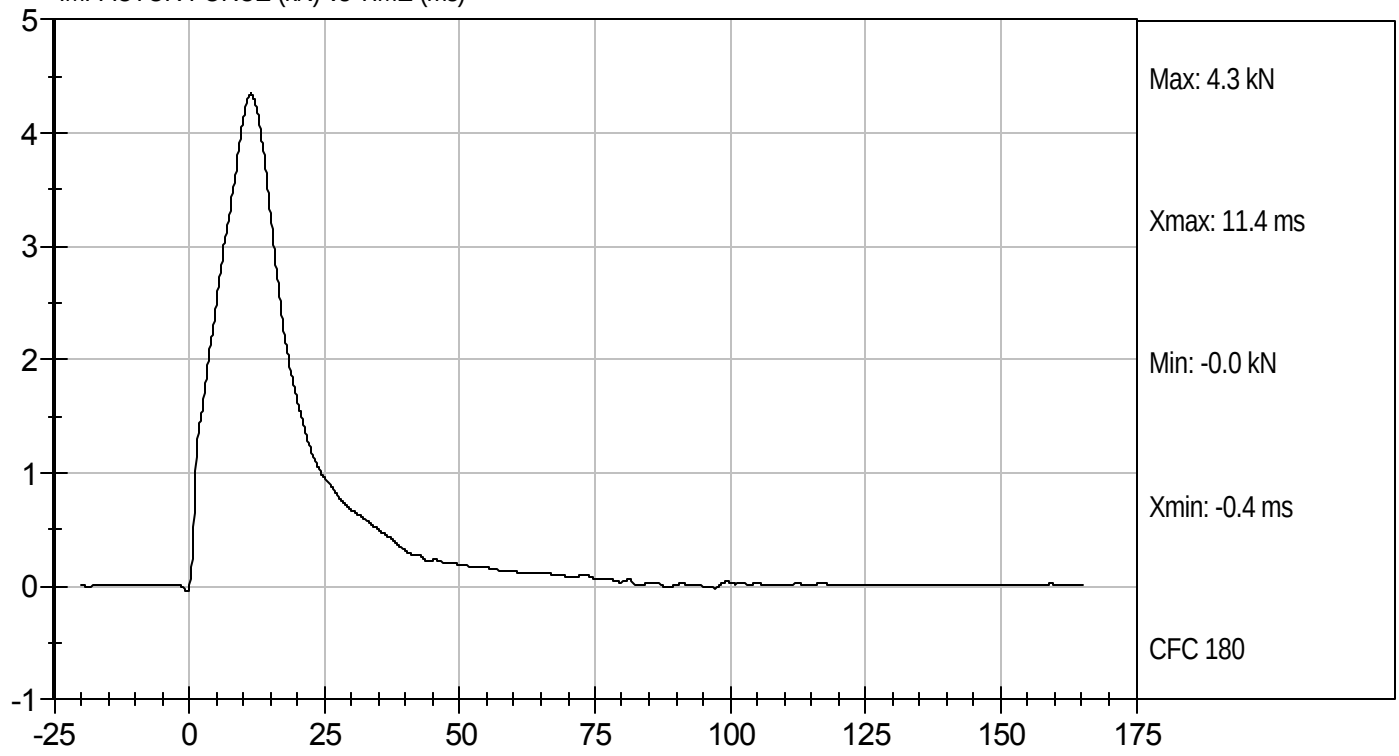
11/17/09
Test Date

David Winkelbauer
Approved By

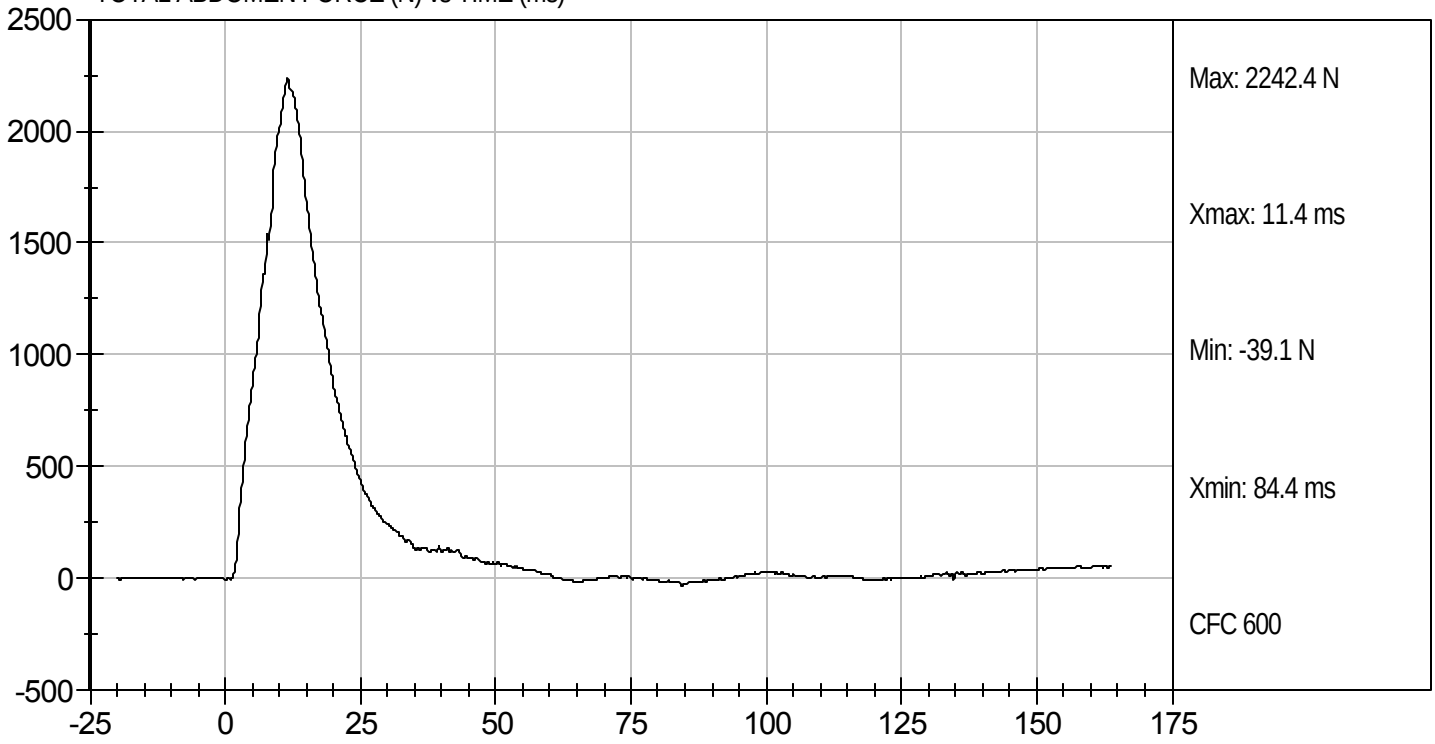
Test Desc: Abdomen Impact
Component ID: D092867

Test Date: 11/17/09
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:** D092868

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	20.8	Pass
Laboratory Relative Humidity		%	10 to 70	30	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	-5.84	Pass
	30 ms	m/s	>= -6.5	-6.02	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	46.7	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	46.6	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	46	Pass
			Overall Results		Pass

Jessica Gall
Laboratory Technician

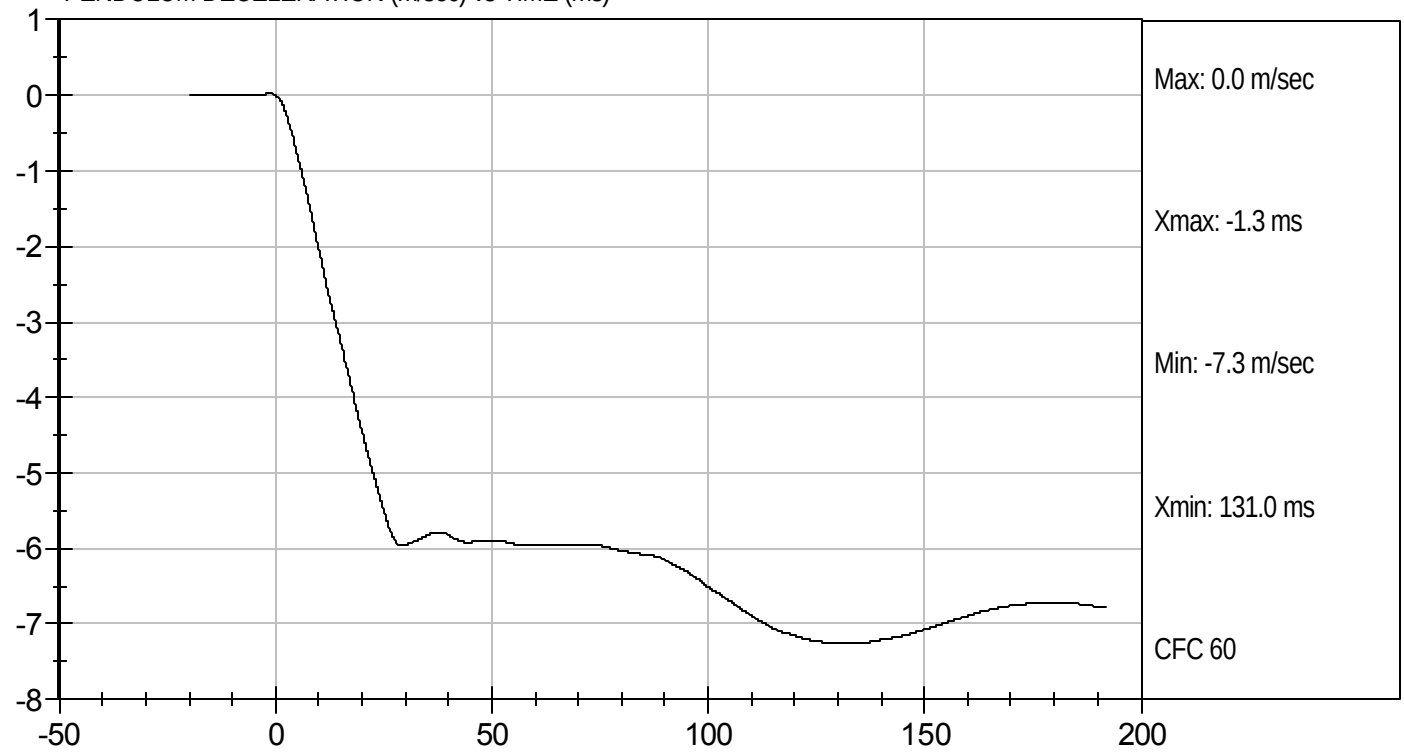
11/17/09
Test Date

David Winkelbauer
Approved By

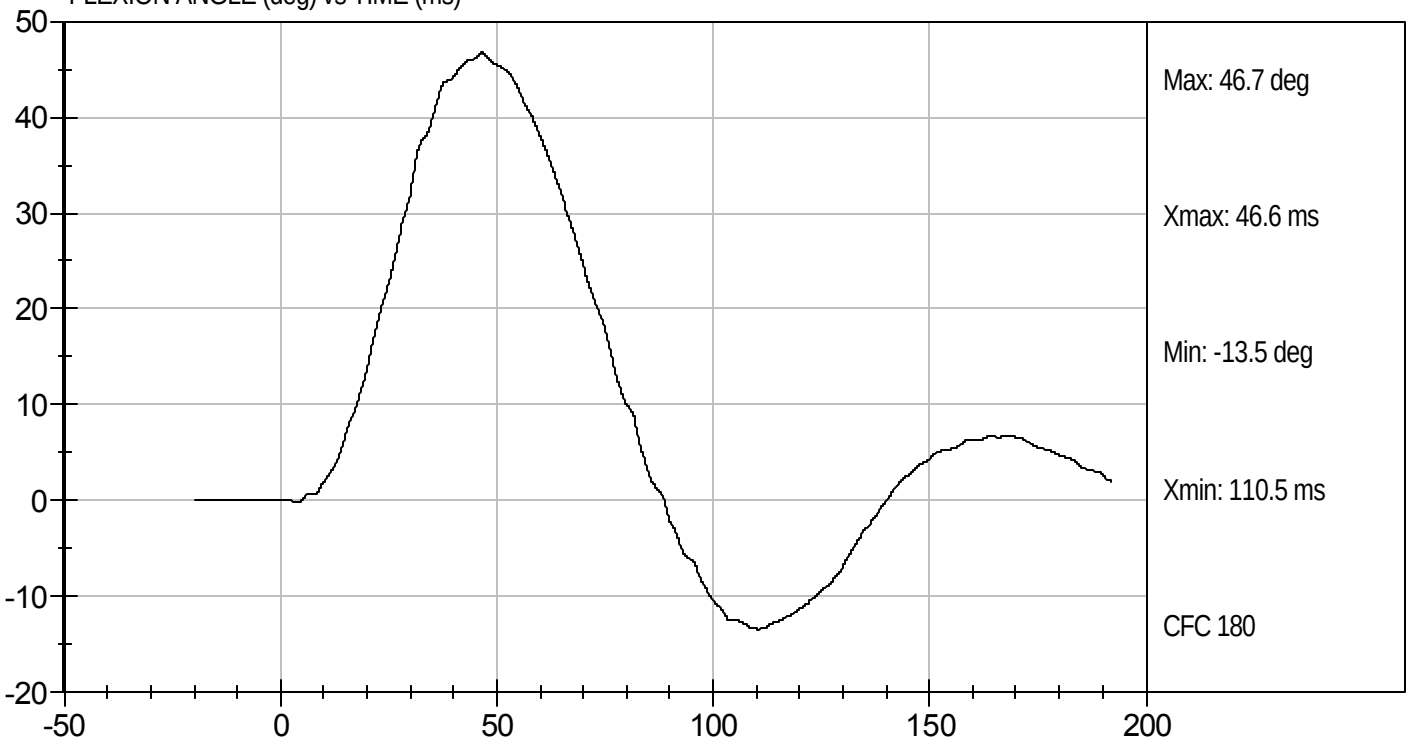
Test Desc: Lumbar Bending
Component ID: D092868

Test Date: 11/17/09
Velocity: 20.08 ft/s, 6.12 m/s

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

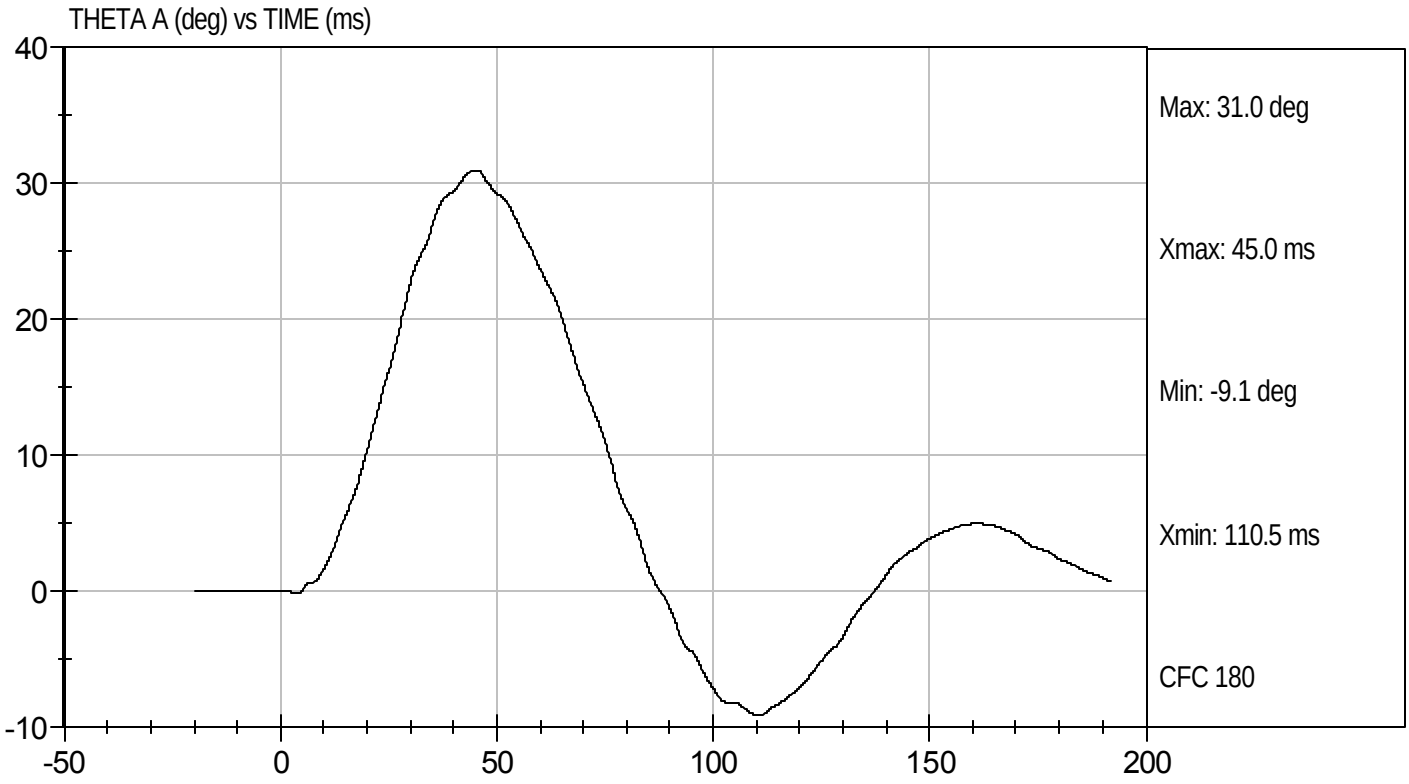


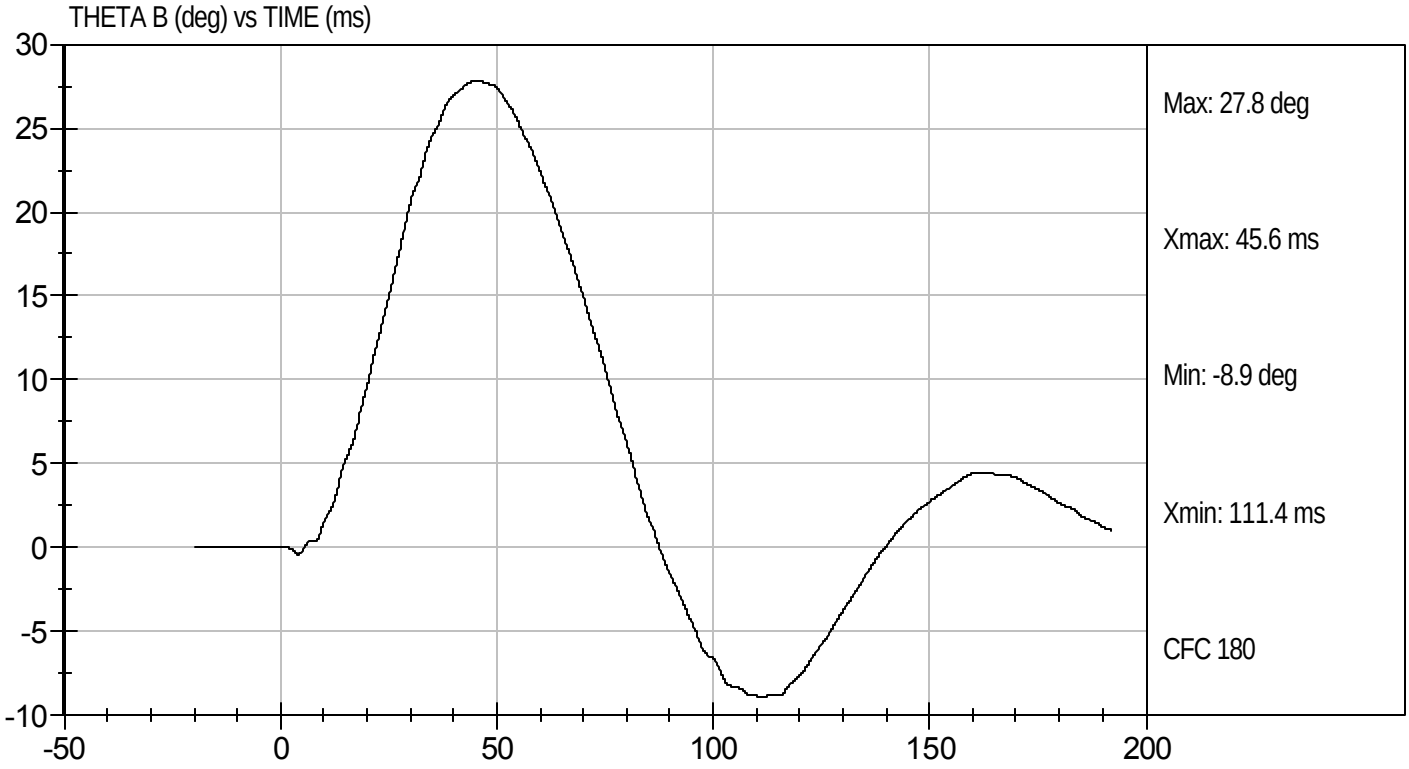
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D092868

Test Date: 11/17/09
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D092869

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	20.9	Pass
Laboratory Relative Humidity	%	10 to 70	29	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.73	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	12.80	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.38	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	13.70	Pass
		Overall Test Results		Pass

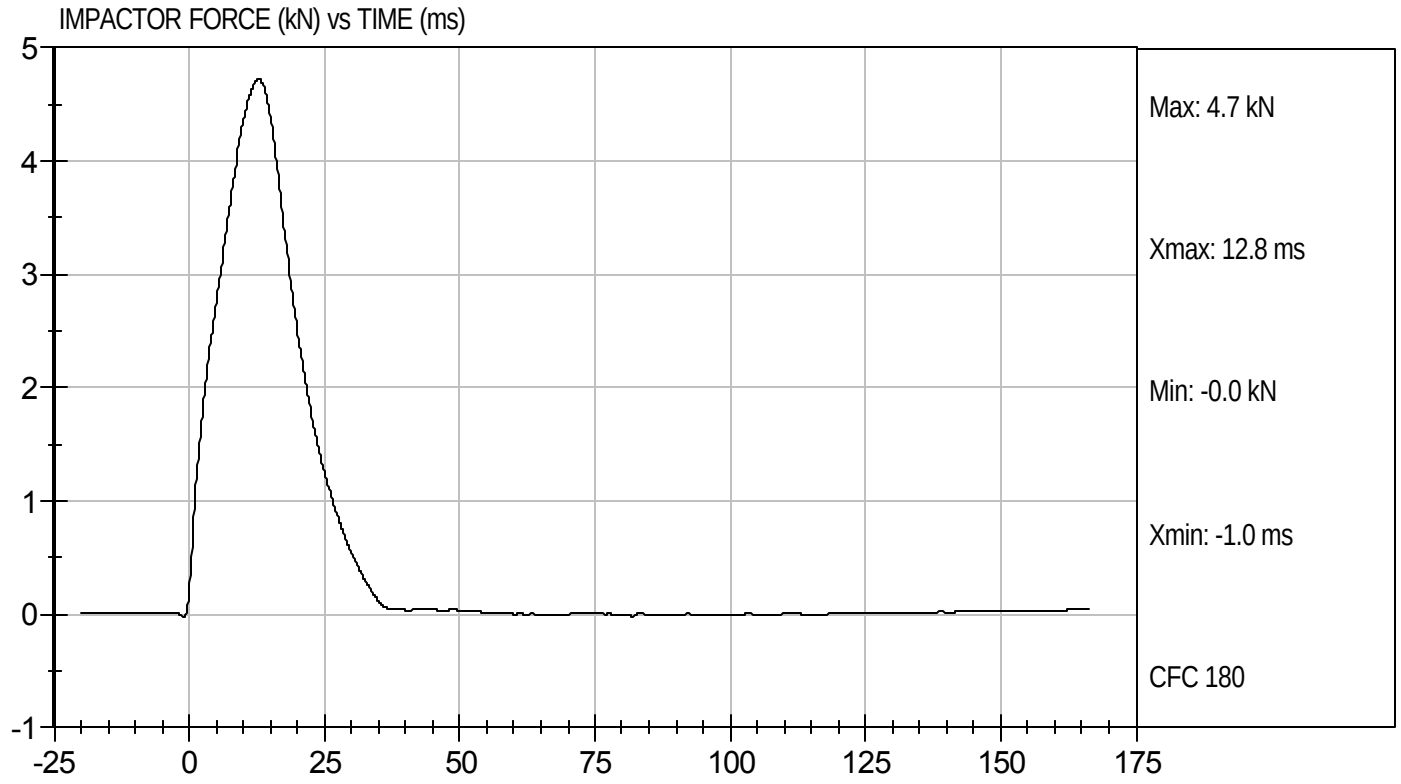
Jessica Hall
Laboratory Technician

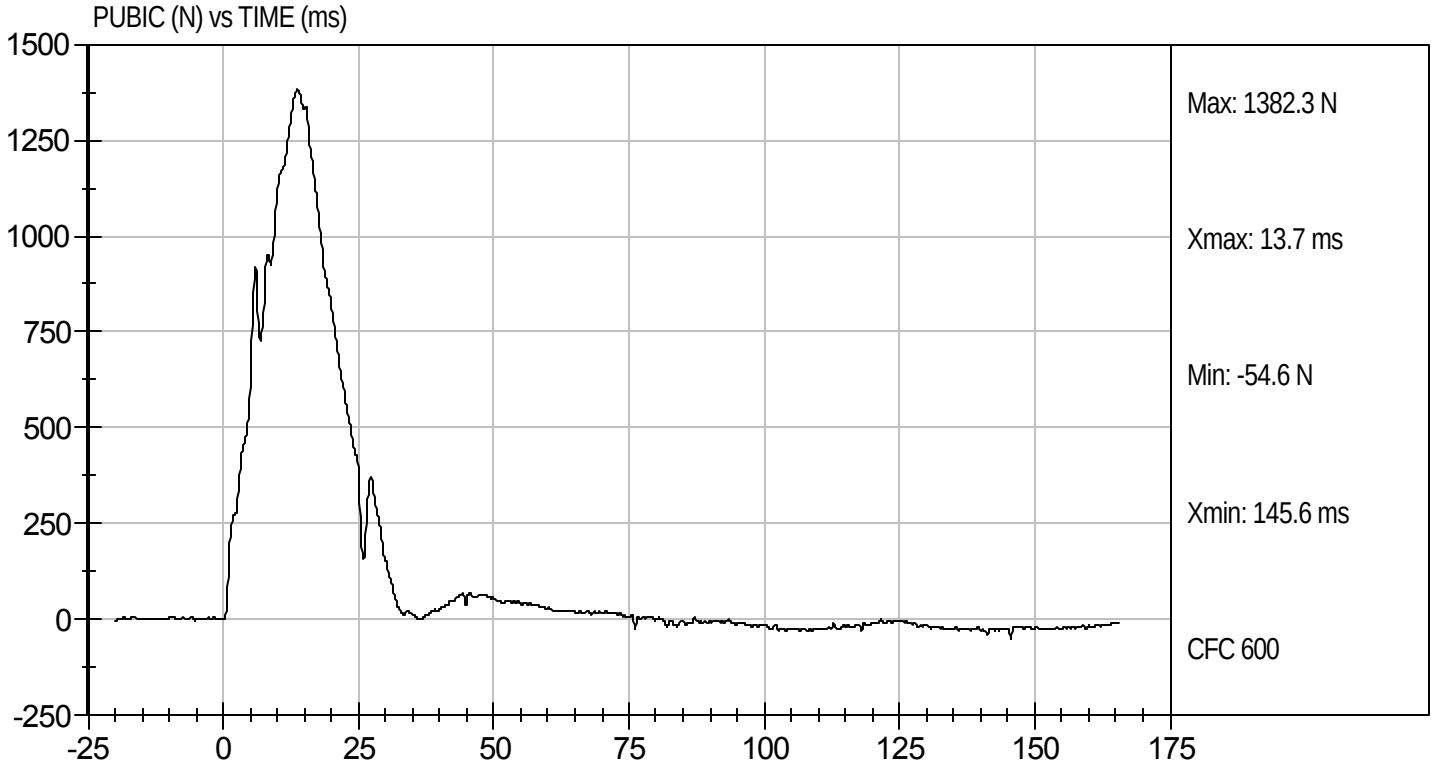
11/17/09
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D092869

Test Date: 11/17/09
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:** D092860

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	20.9	Pass
Humidity	%	10 to 70	29	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	5.21	Pass
Upper Rib Displacement	mm	34.0 to 41.0	39.1	Pass
Middle Rib Displacement	mm	37.0 to 45.0	40.9	Pass
Lower Rib Displacement	mm	37.0 to 44.0	39.5	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

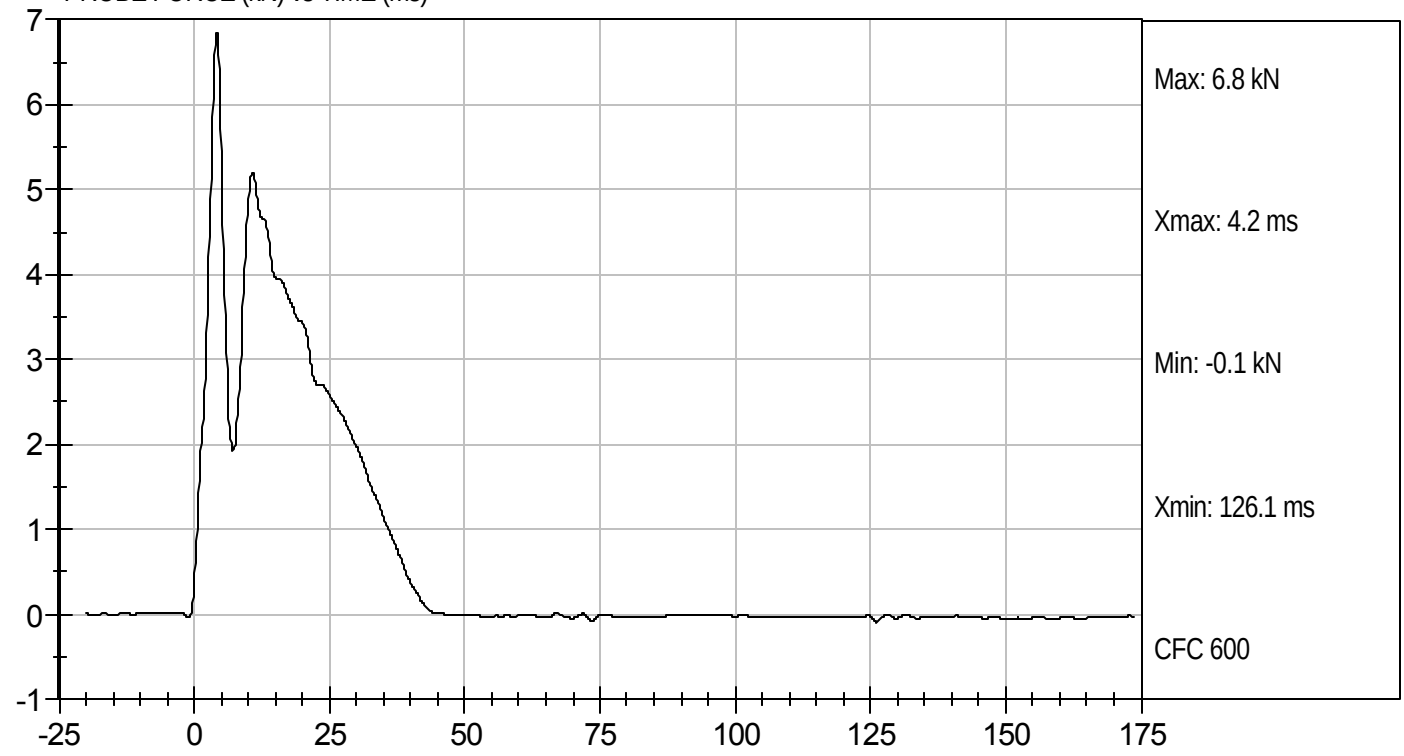
11/17/09
Test Date

David Winkelbauer
Approved By

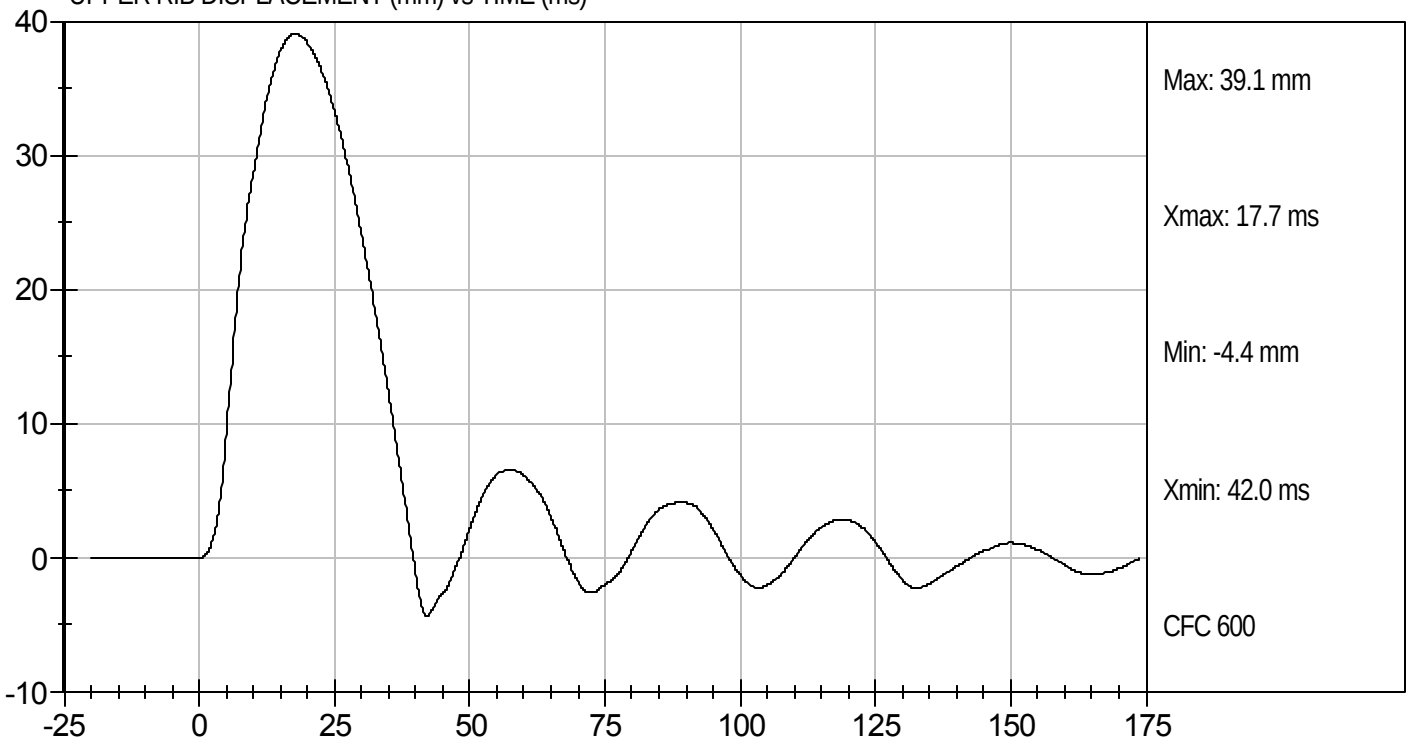
Test Desc: Thorax Impact
Component ID: D092860

Test Date: 11/17/09
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



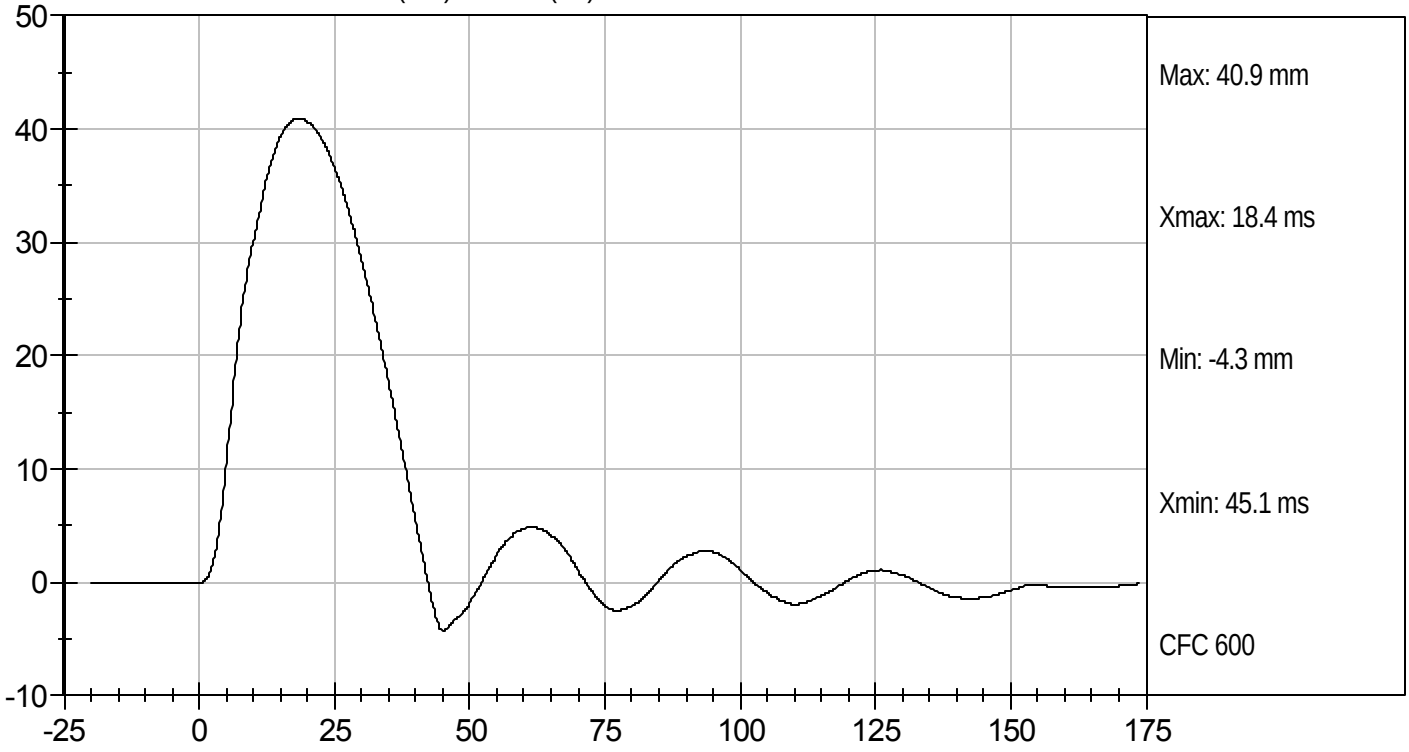
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



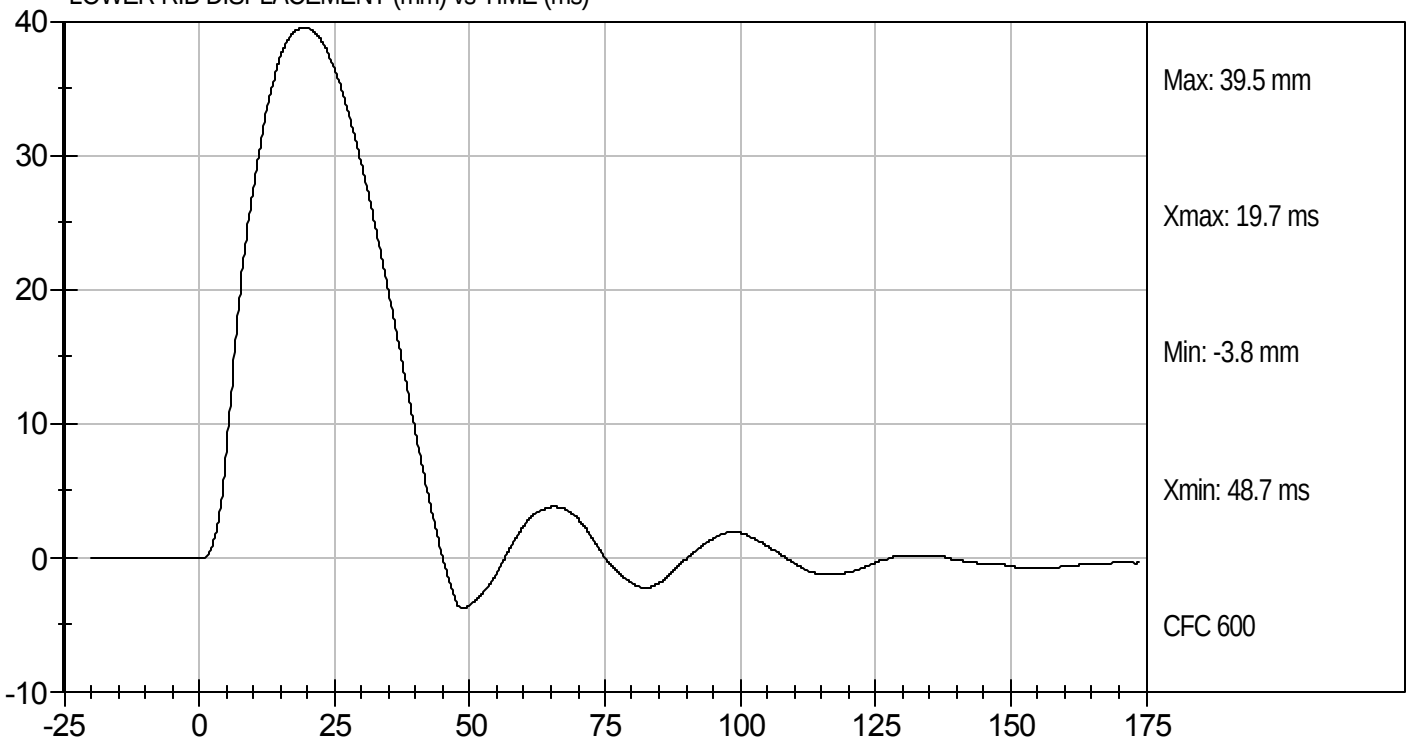
Test Desc: Thorax Impact
Component ID: D092860

Test Date: 11/17/09
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:** D10161

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	18.9 to 25.6	21.0	Pass
Laboratory Relative Humidity	%	10 to 70	24	Pass
Peak Resultant Acceleration	G's	125 to 155	149	Pass
Peak Lateral Acceleration	G's	+/- 15	5.9	Pass
Unimodal	N/A	Yes	Yes	Pass
Oscillations	N/A	within 15% of peak	Yes	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

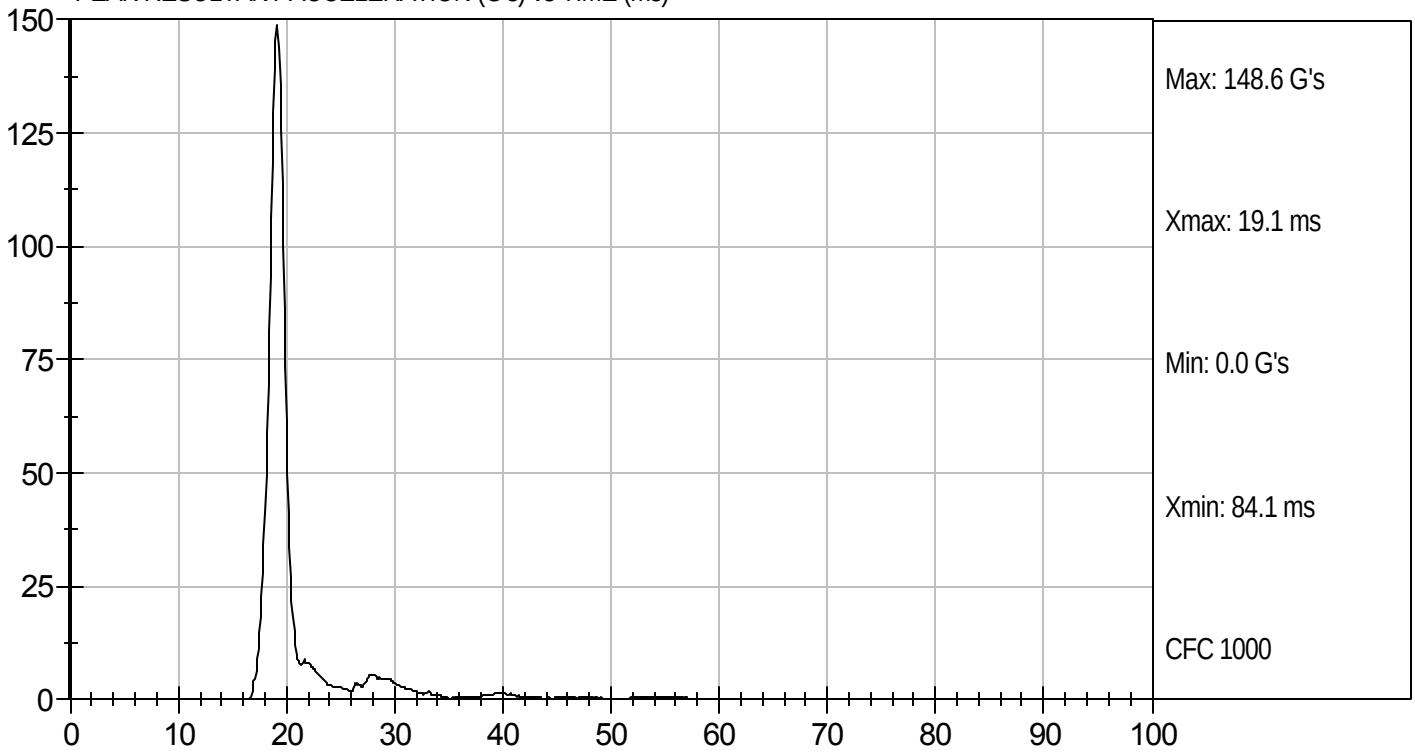
1/22/10
Test Date

David Winkelbauer
Approved By

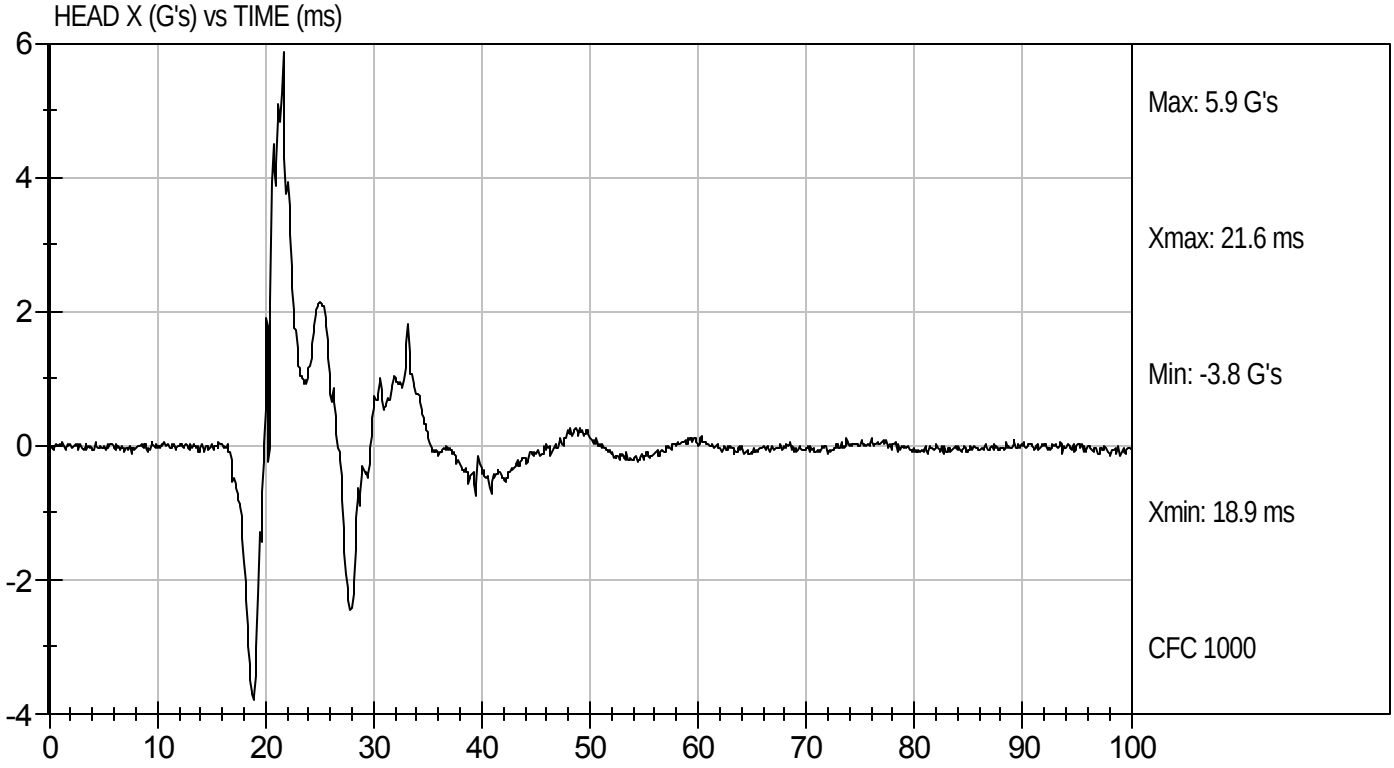
Test Desc: Head Drop
Component ID: D10161

Test Date: 1/22/10
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:** D10162

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	18.0 to 22.0	21.4	Pass
Laboratory Relative Humidity		%	10 to 70	23	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	-3.32	Pass
Maximum Flexion Angle		deg	49.0 to 59.0	51.6	Pass
Time of Maximum Flexion Angle		ms	54.0 to 66.0	60.5	Pass
Head Rotation Decay Time to 0 degree		ms	53.0 to 88.0	56.3	Pass
			Overall Test Results		Pass

Jessica Hall
Laboratory Technician

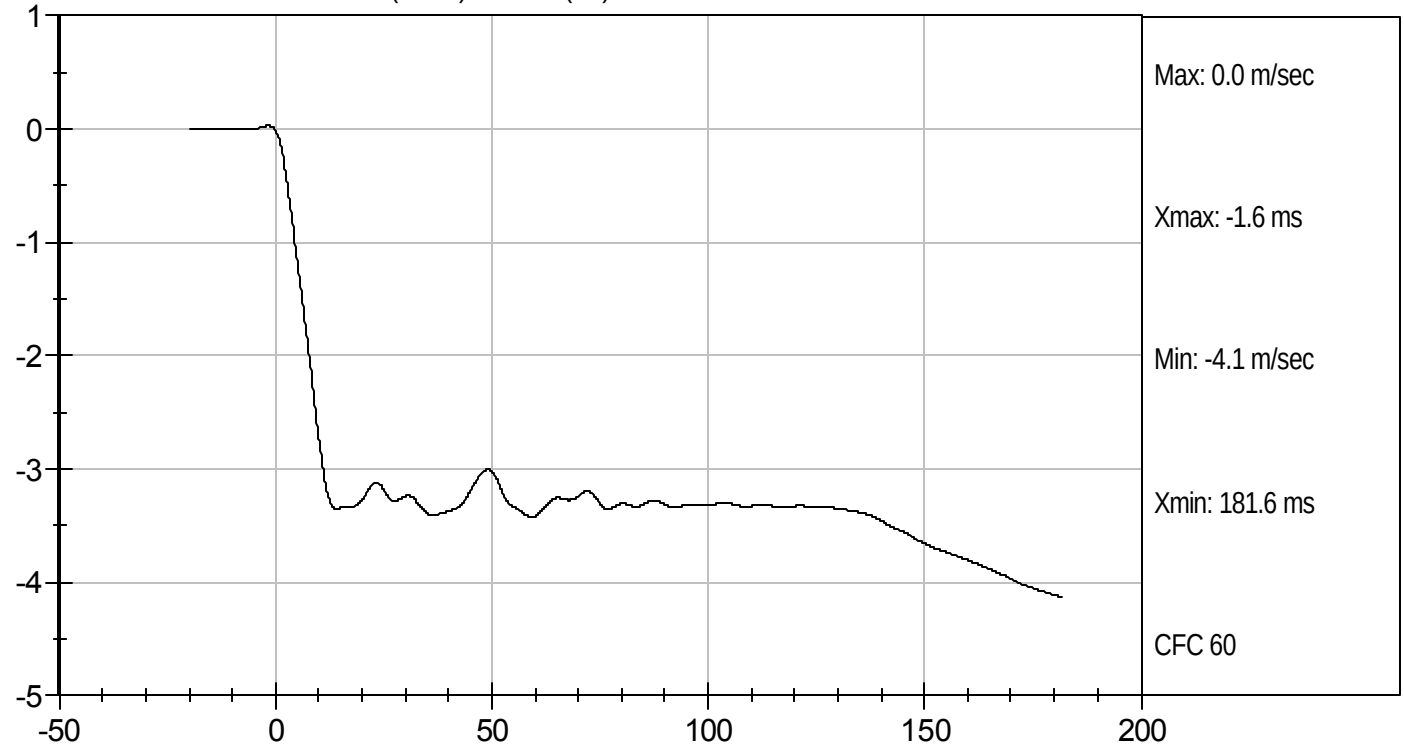
1/22/10
Test Date

David Winkelbauer
Approved By

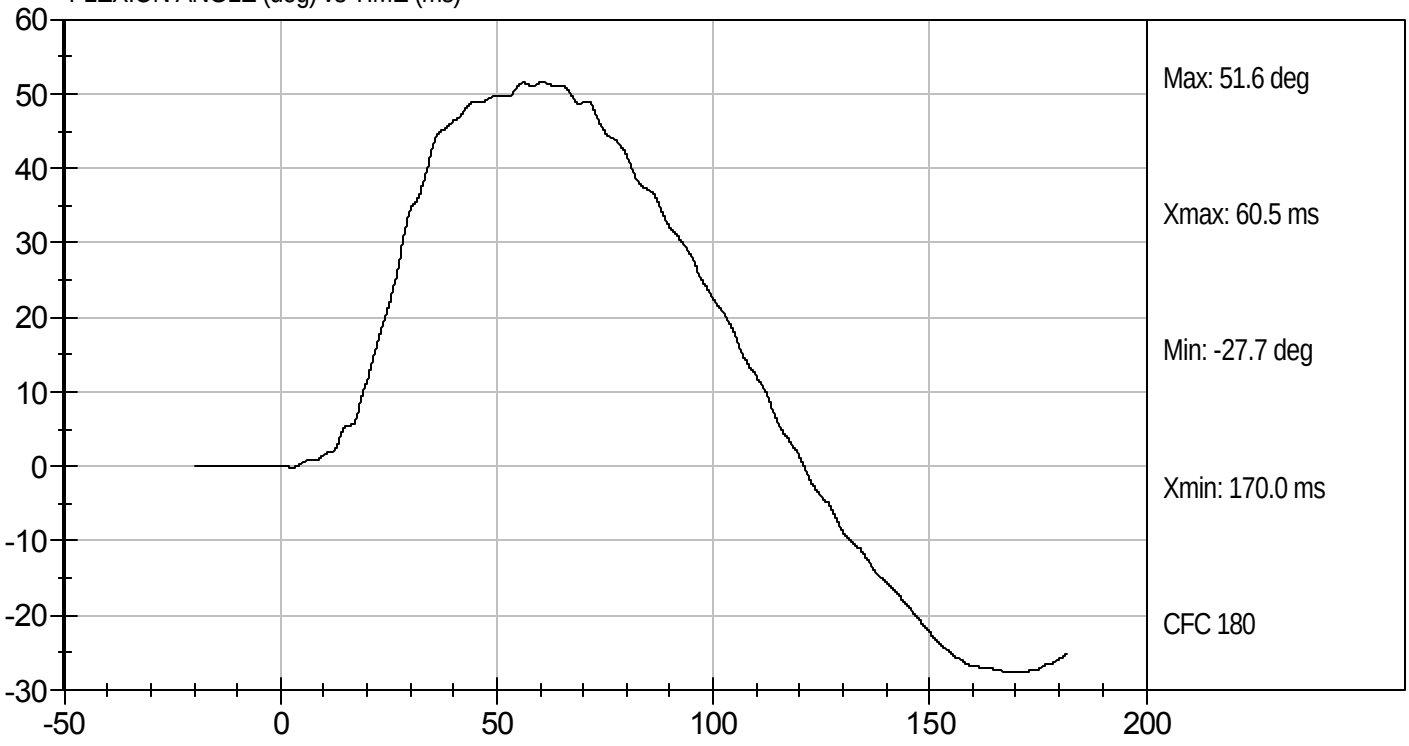
Test Desc: Neck Bending
Component ID: D10162

Test Date: 1/22/10
Velocity: 11.42 ft/s, 3.5 m/s

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

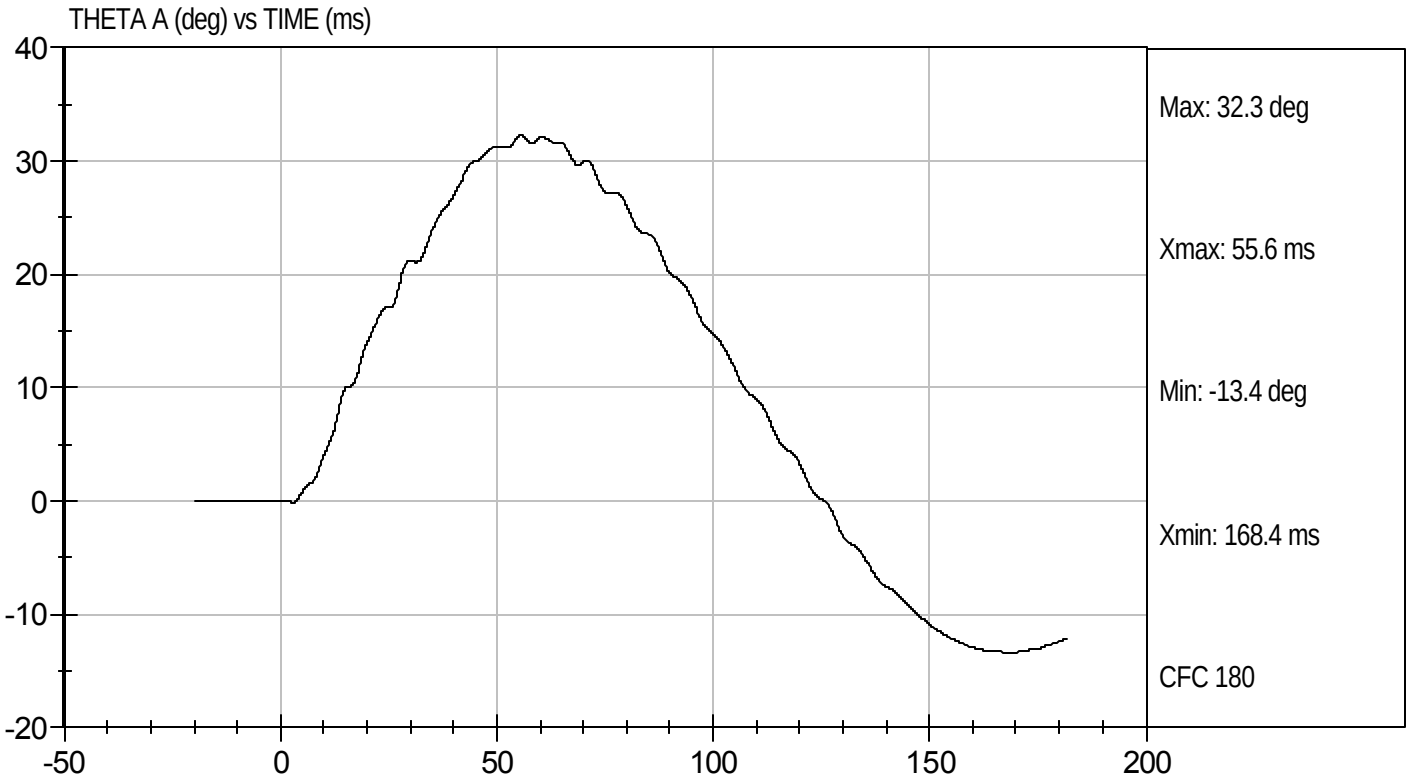


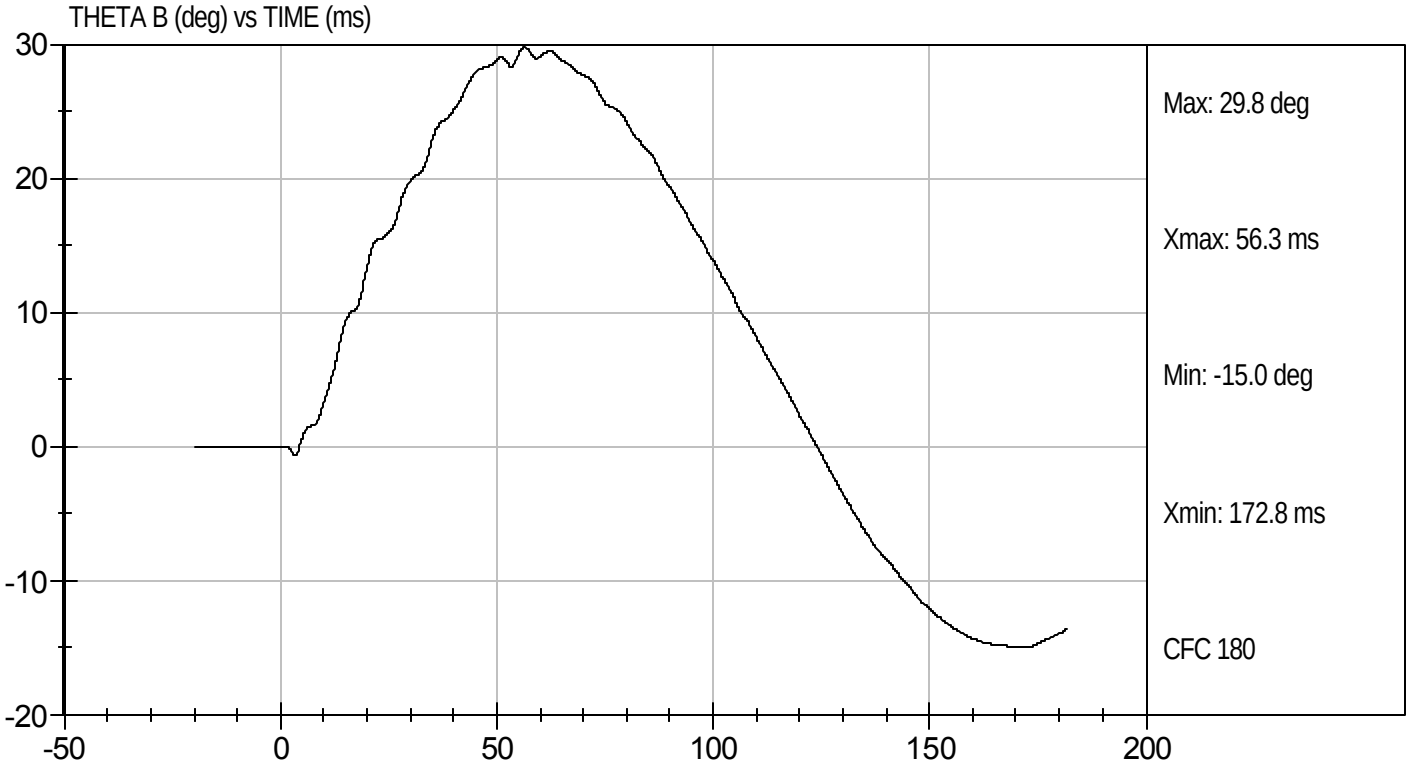
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Neck Bending
Component ID: D10162

Test Date: 1/22/10
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:** D10163

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	23	Pass
Pendulum Speed	m/s	4.2 to 4.4	4.3	Pass
Peak Shoulder Acceleration	G's	7.5 to 10.5	7.8	Pass
Time of Peak Shoulder Acceleration	ms	NA	13.4	Pass
		Overall Test Results		Pass

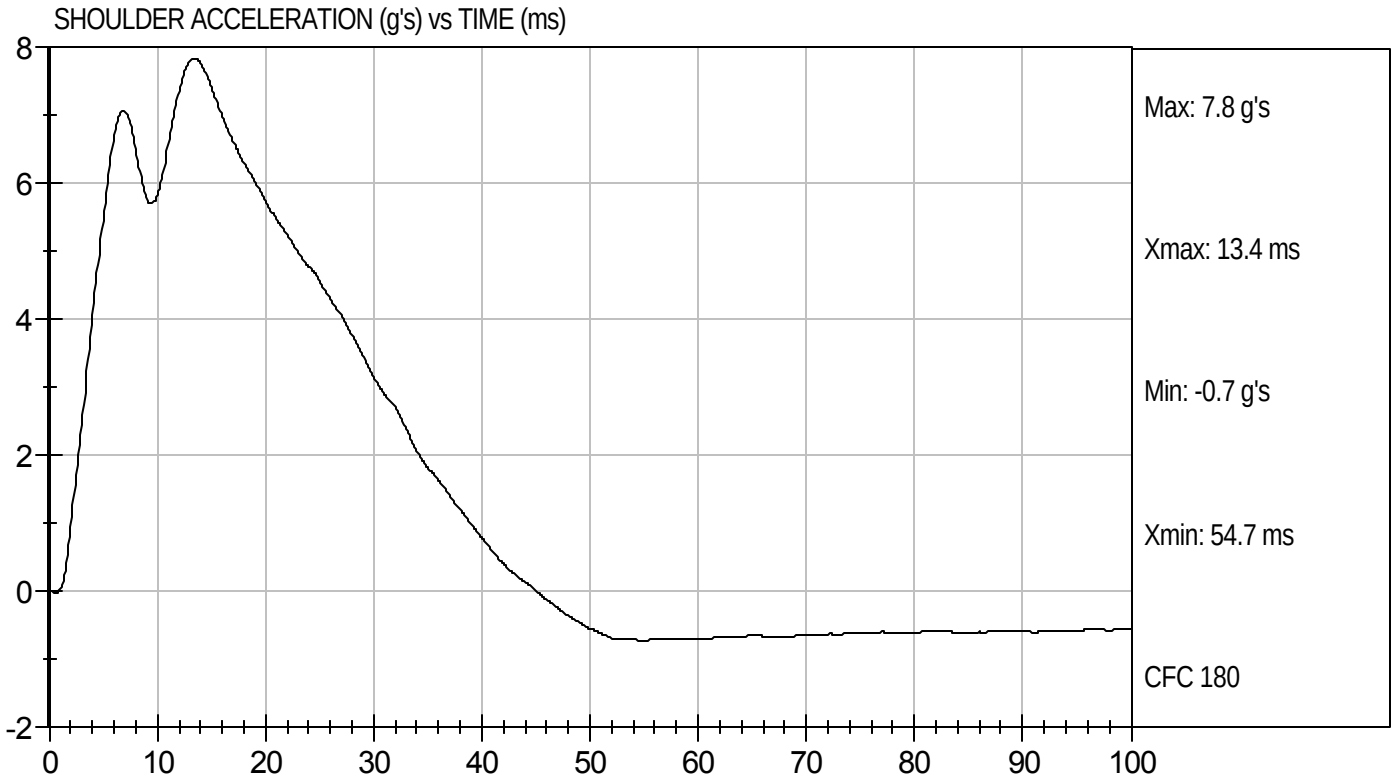
Jessica Hall
Laboratory Technician

1/22/10
Test Date

David Winkelbauer
Approved By

Test Desc: Shoulder Impact
Component ID: D10163

Test Date: 1/22/10
Velocity: 14.12 ft/s, 4.3 m/s



MGA RESEARCH CORPORATION

UPPER RIB TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D10164

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	37.5	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.0	Pass
		Overall Test Results		Pass

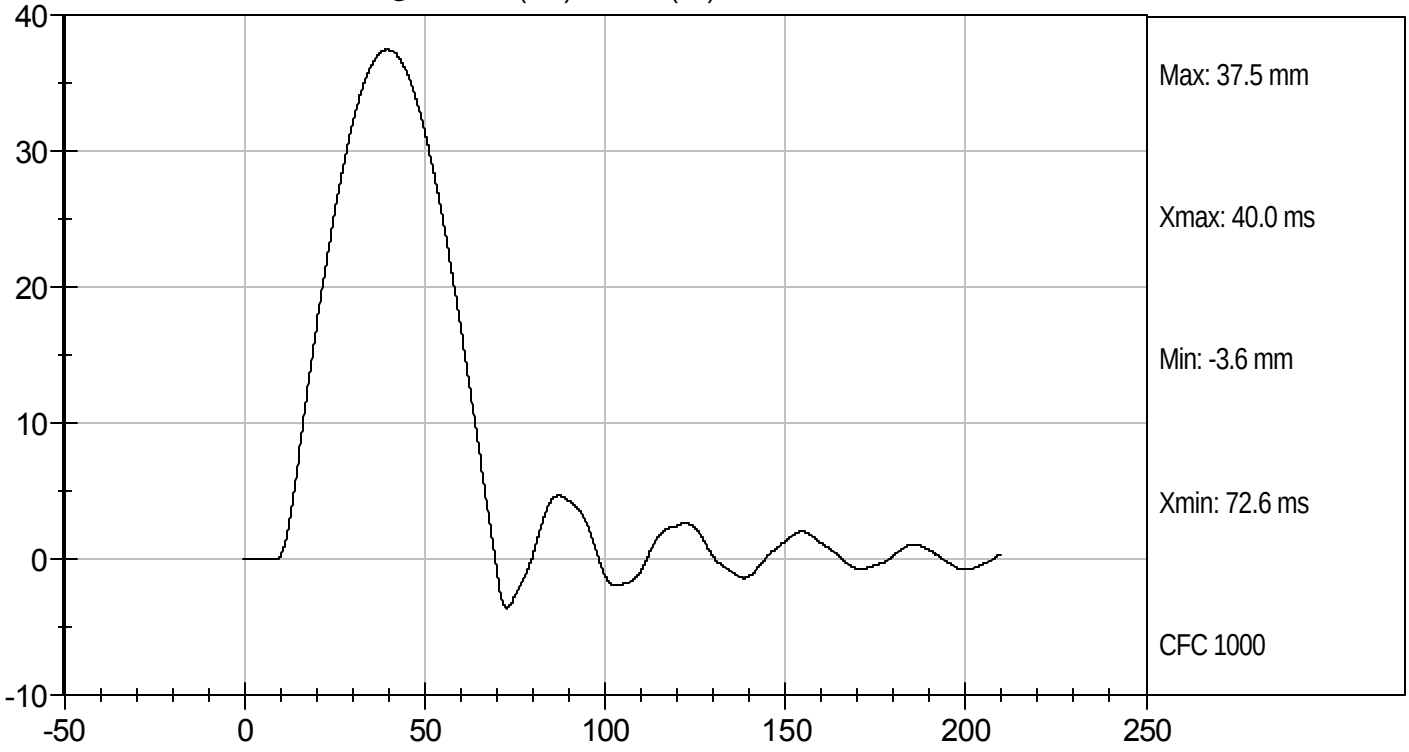
Jessica Gall
Laboratory Technician

1/22/10
Test Date

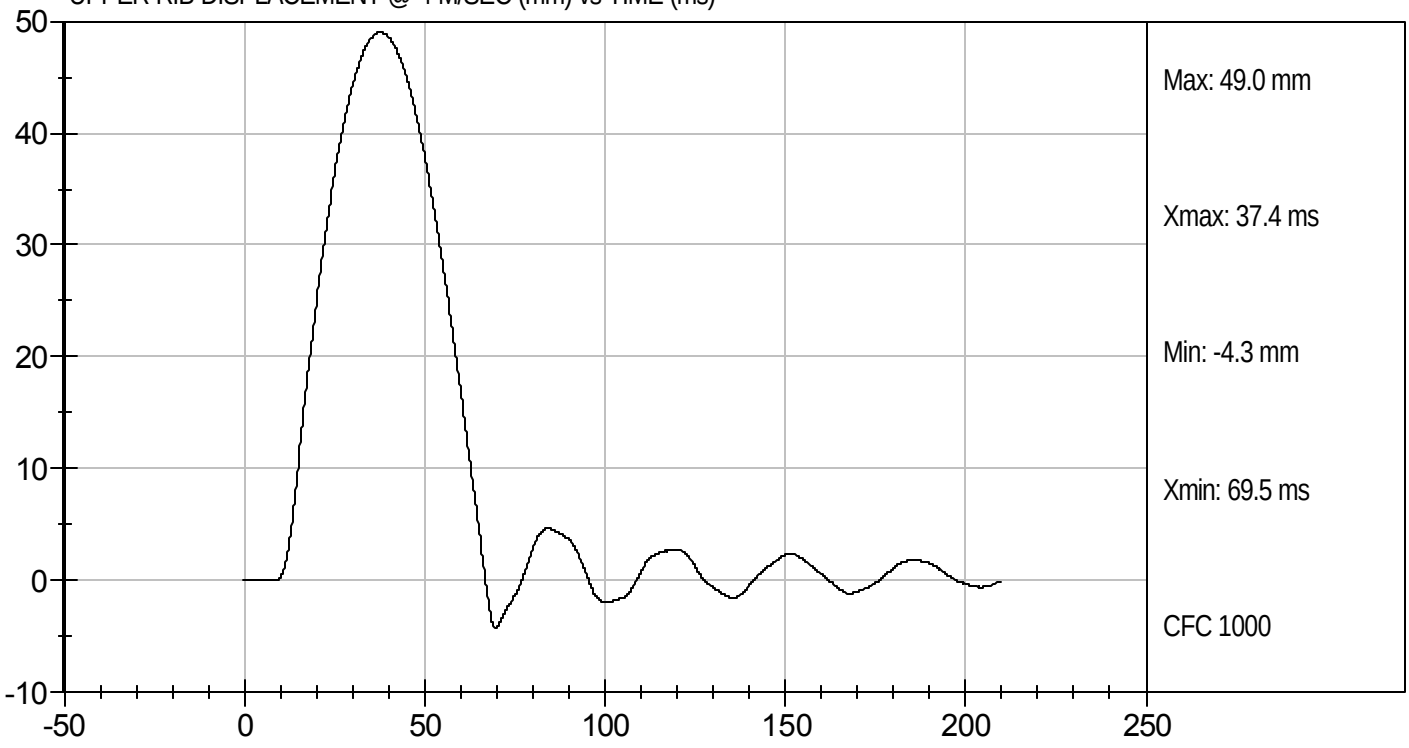
David Winkelbauer
Approved By

Test Desc: Rib Impact - Upper
Component ID: D10164
Test Date: 1/22/10

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:** D10165

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	37.7	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	49.6	Pass
		Overall Test Results		Pass

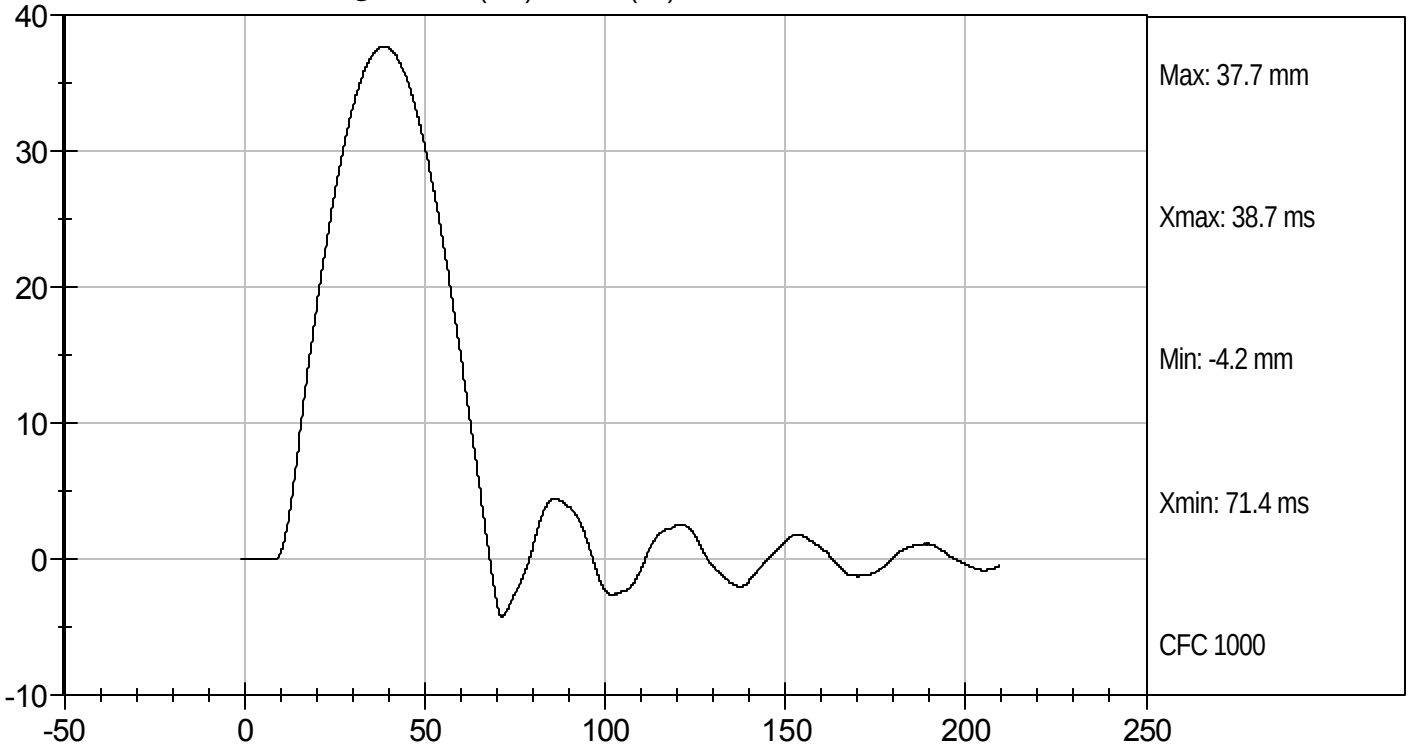
Jessica Gall
Laboratory Technician

1/22/10
Test Date

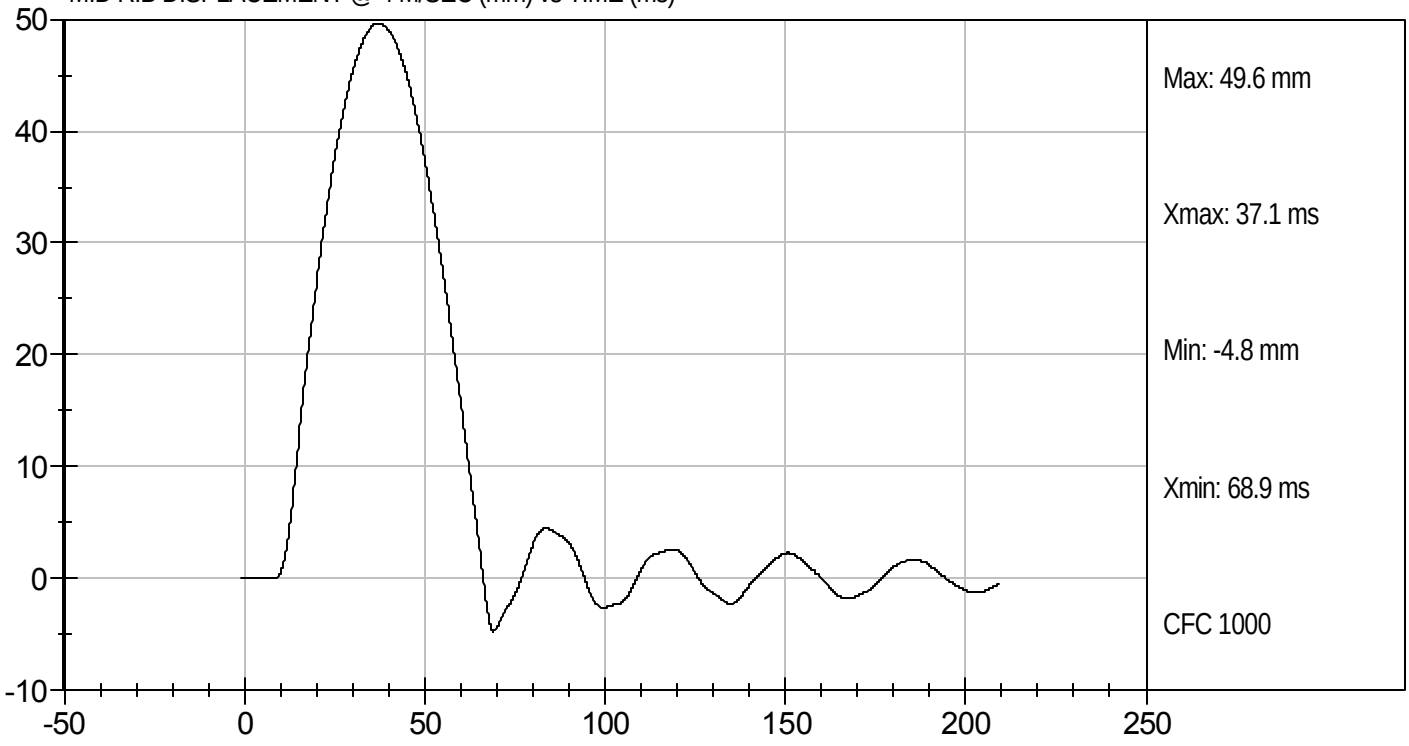
David Winkelbauer
Approved By

Test Desc: Rib Impact - Mid
Component ID: D10165
Test Date: 1/22/10

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:** D10166

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity	%	10 to 70	23	Pass
Displacement at 3 m/s	mm	36.0 to 40.0	36.6	Pass
Displacement at 4 m/s	mm	46.0 to 51.0	48.3	Pass
		Overall Test Results		Pass

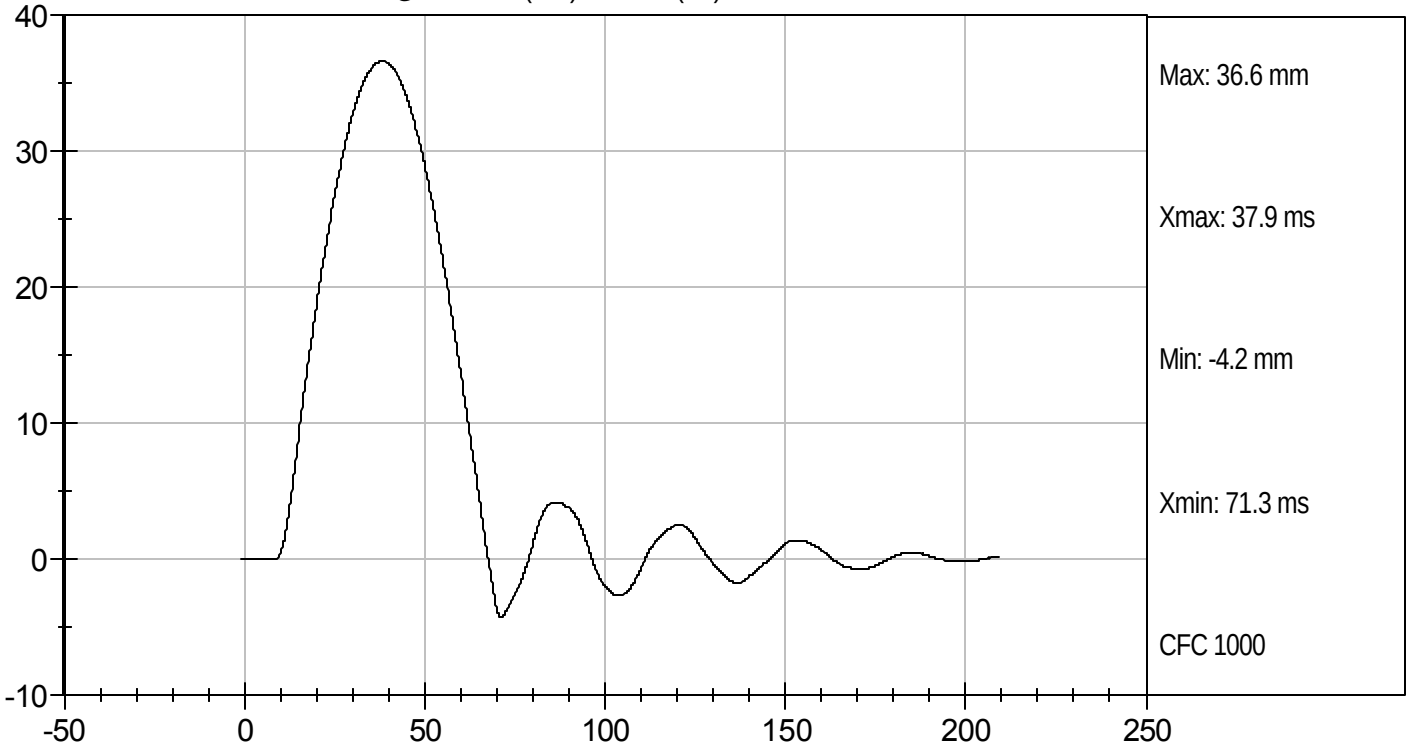
Jessica Hall
Laboratory Technician

1/22/10
Test Date

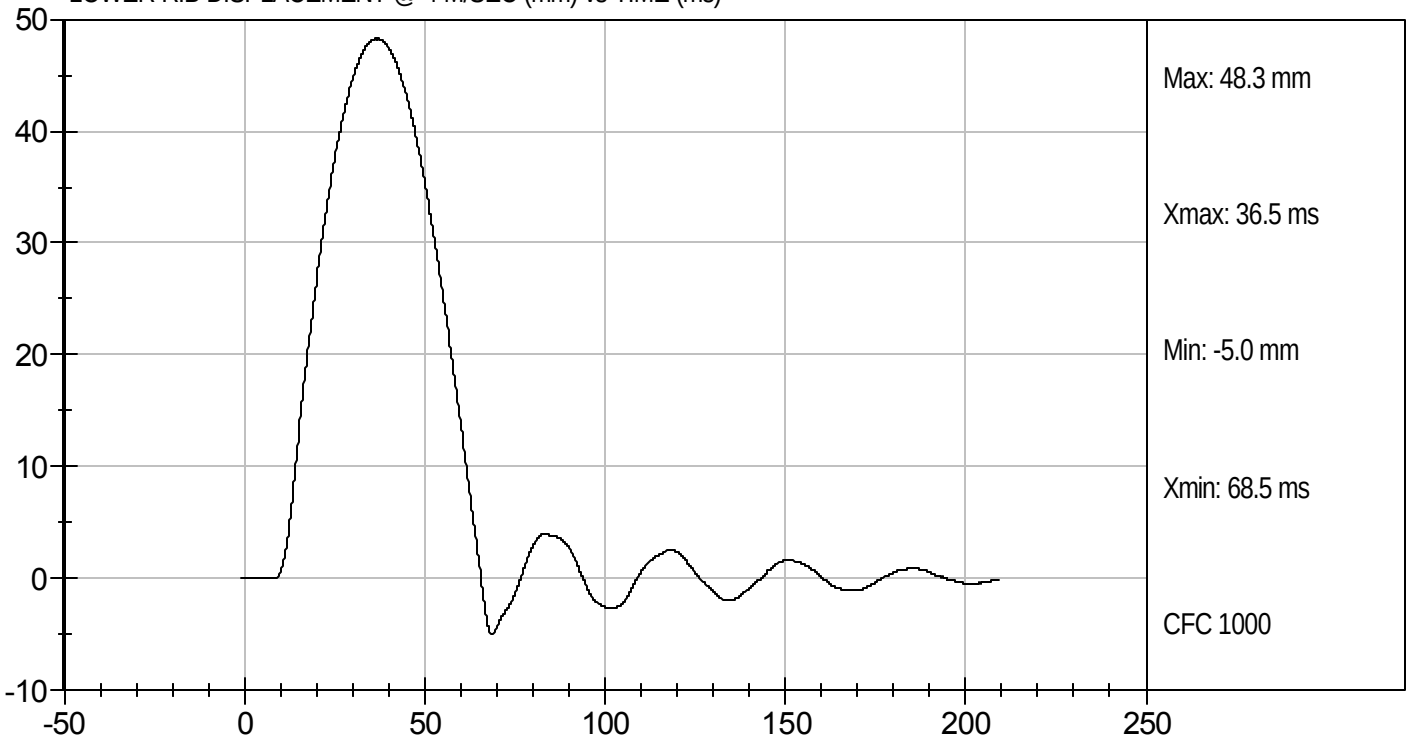
David Winkelbauer
Approved By

Test Desc: Rib Impact - Lower
Component ID: D10166
Test Date: 1/22/10

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:** D10167

Tested Parameter	Units	Specification	Result	Pass/Fail
Laboratory Temperature	deg C	20.6 to 22.2	21.1	Pass
Laboratory Relative Humidity	%	10 to 70	25	Pass
Probe Speed	m/s	3.90 to 4.10	4.03	Pass
Maximum Impact Force	kN	4.00 to 4.80	4.24	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	2.53	Pass
Time of Maximum Abdomen Force	ms	10.00 to 12.30	11.00	Pass
		Overall Test Results		Pass

Jessica Hall
Laboratory Technician

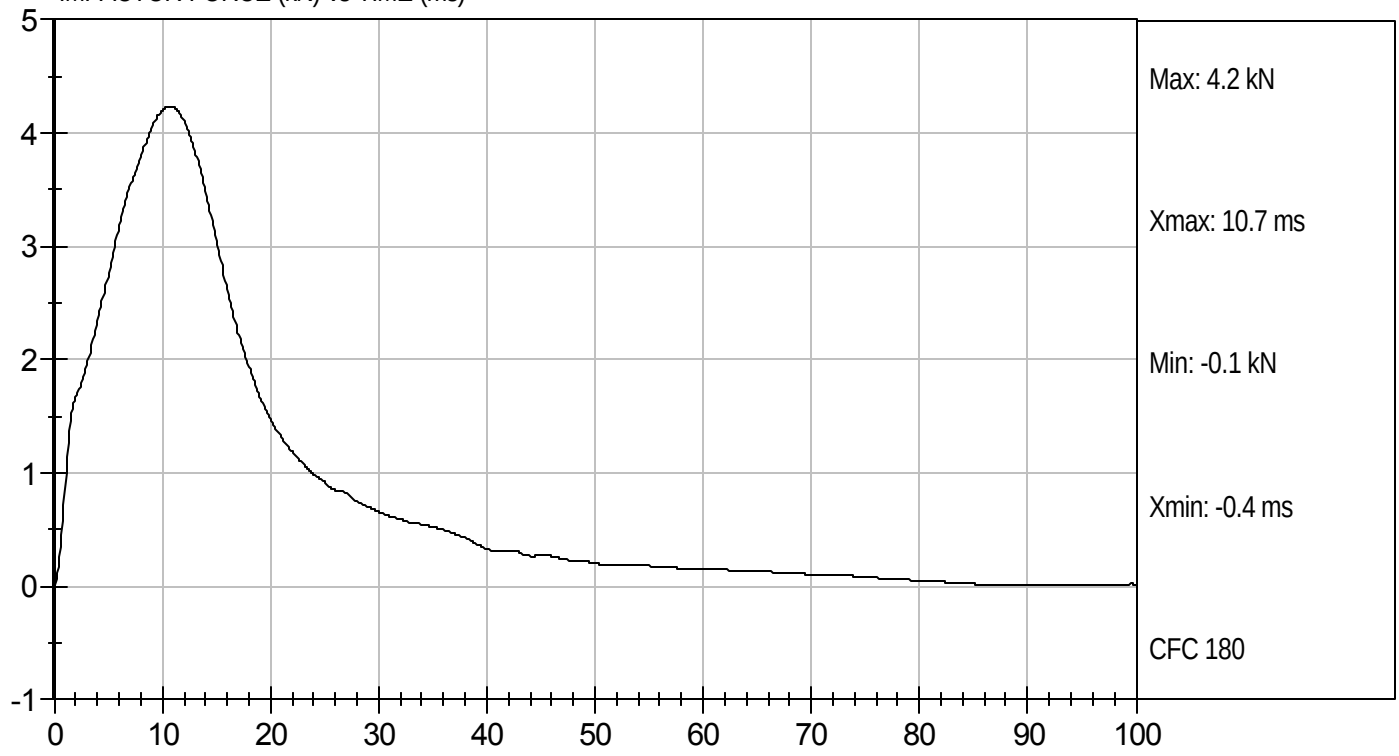
1/22/10
Test Date

David Winkelbauer
Approved By

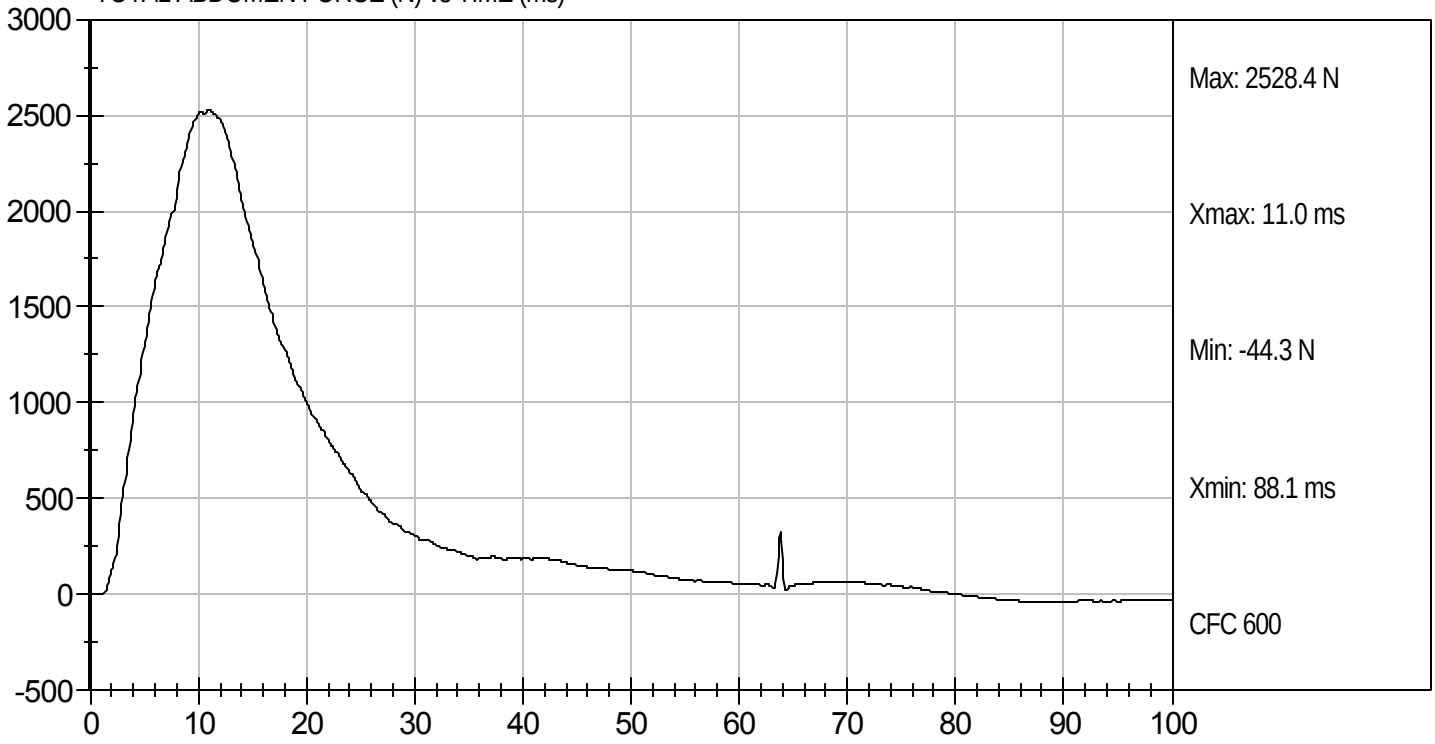
Test Desc: Abdomen Impact
Component ID: D10167

Test Date: 1/22/10
Velocity: 13.23 ft/s, 4.03 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:** D10168

Tested Parameter		Units	Specification	Result	Pass/Fail
Laboratory Temperature		deg C	20.6 to 22.2	21.4	Pass
Laboratory Relative Humidity		%	10 to 70	23	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	-0.416	Pass
	27 ms	m/s	-6.50 to -5.80	-5.97	Pass
	30 ms	m/s	>= -6.5	-5.99	Pass
Maximum Flexion Angle		deg	45.0 to 55.0	45.9	Pass
Time of Maximum Flexion Angle		ms	39.0 to 53.0	43.4	Pass
Headform Rotation Decay to Initial Position		ms	37 to 57	44	Pass
			Overall Results		Pass

Jessica Hall
Laboratory Technician

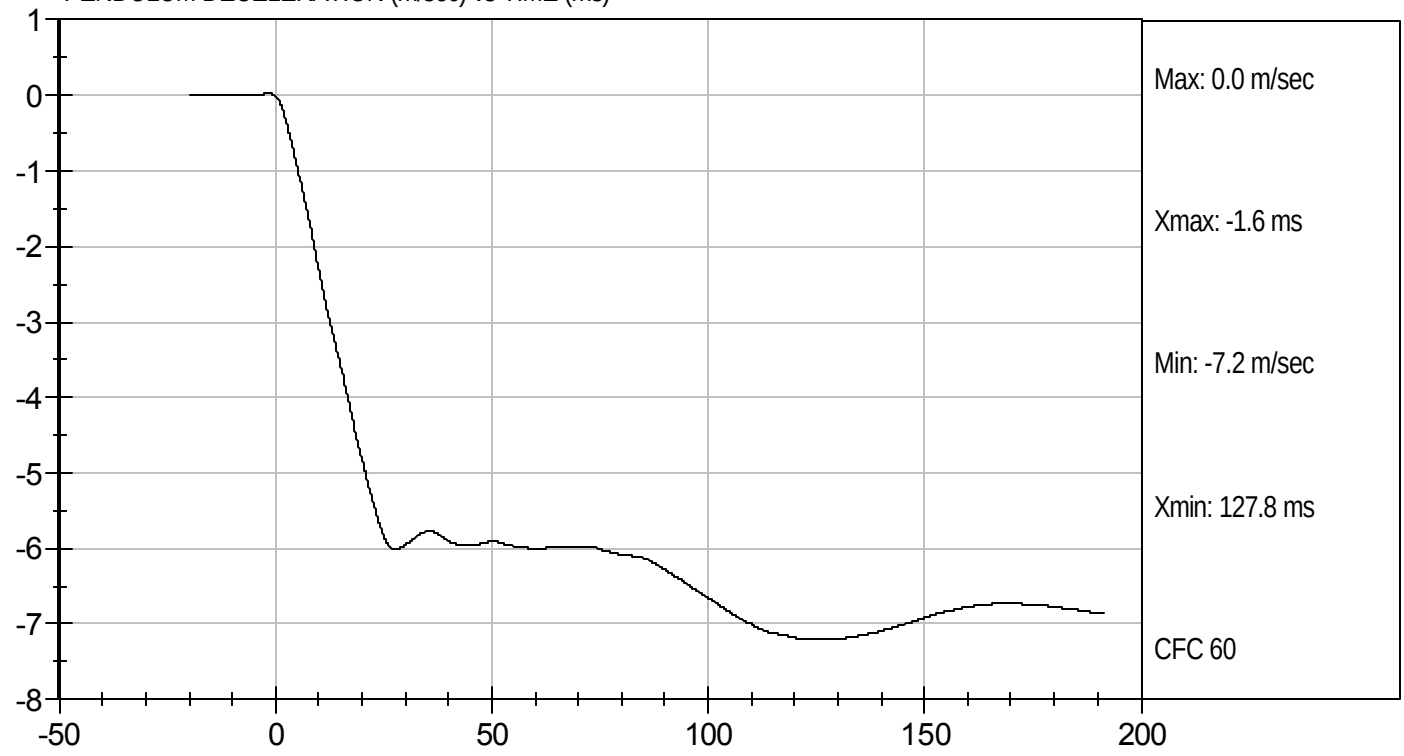
1/22/10
Test Date

David Winkelbauer
Approved By

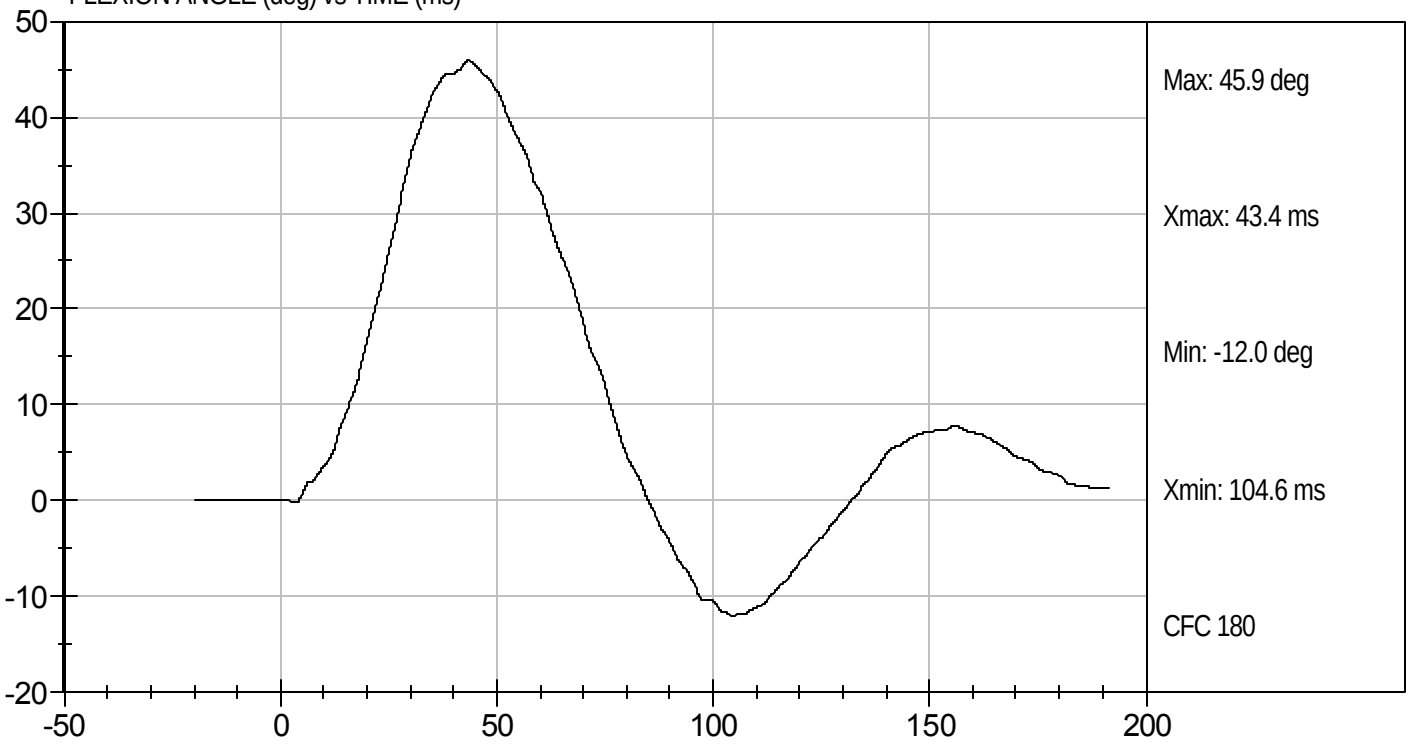
Test Desc: Lumbar Bending
Component ID: D10168

Test Date: 1/22/10
Velocity: 20.08 ft/s, 6.12 m/s

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

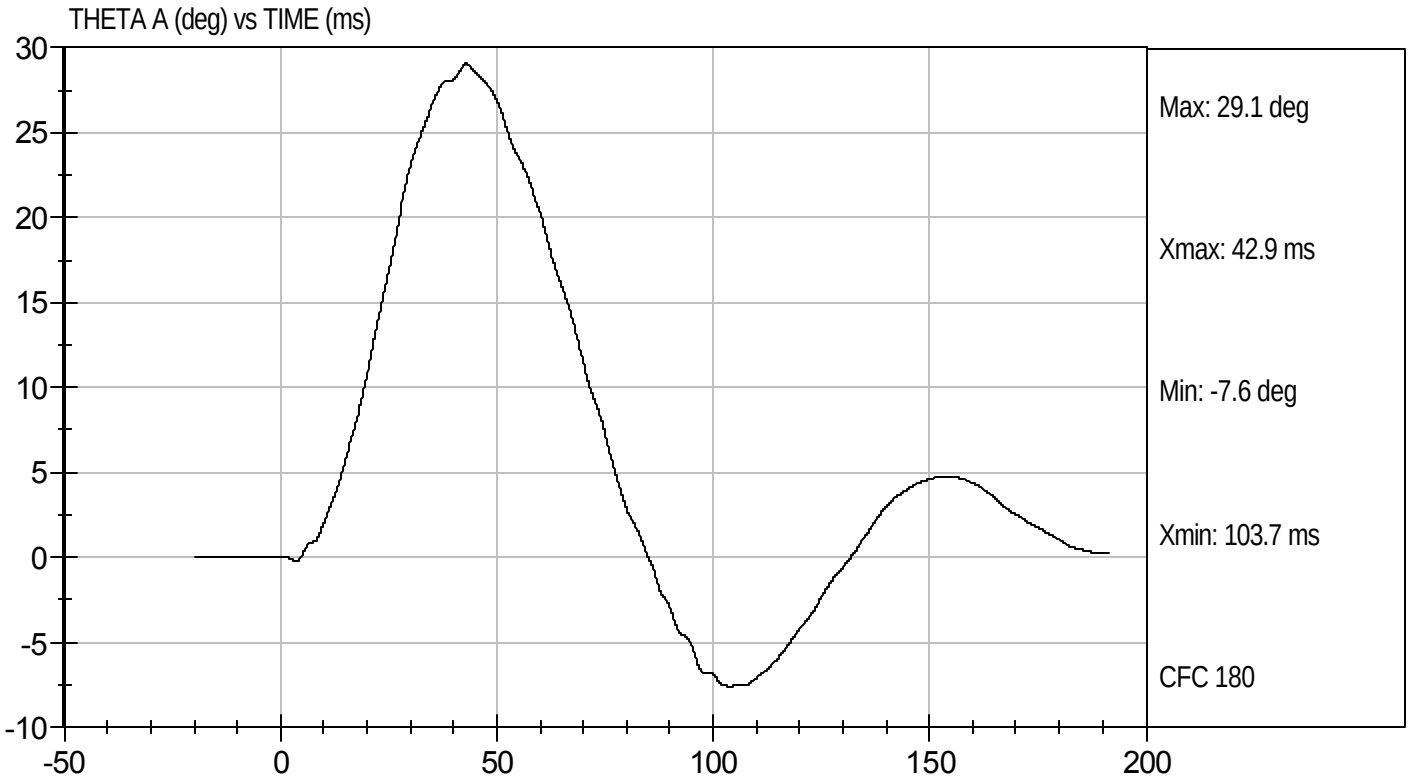


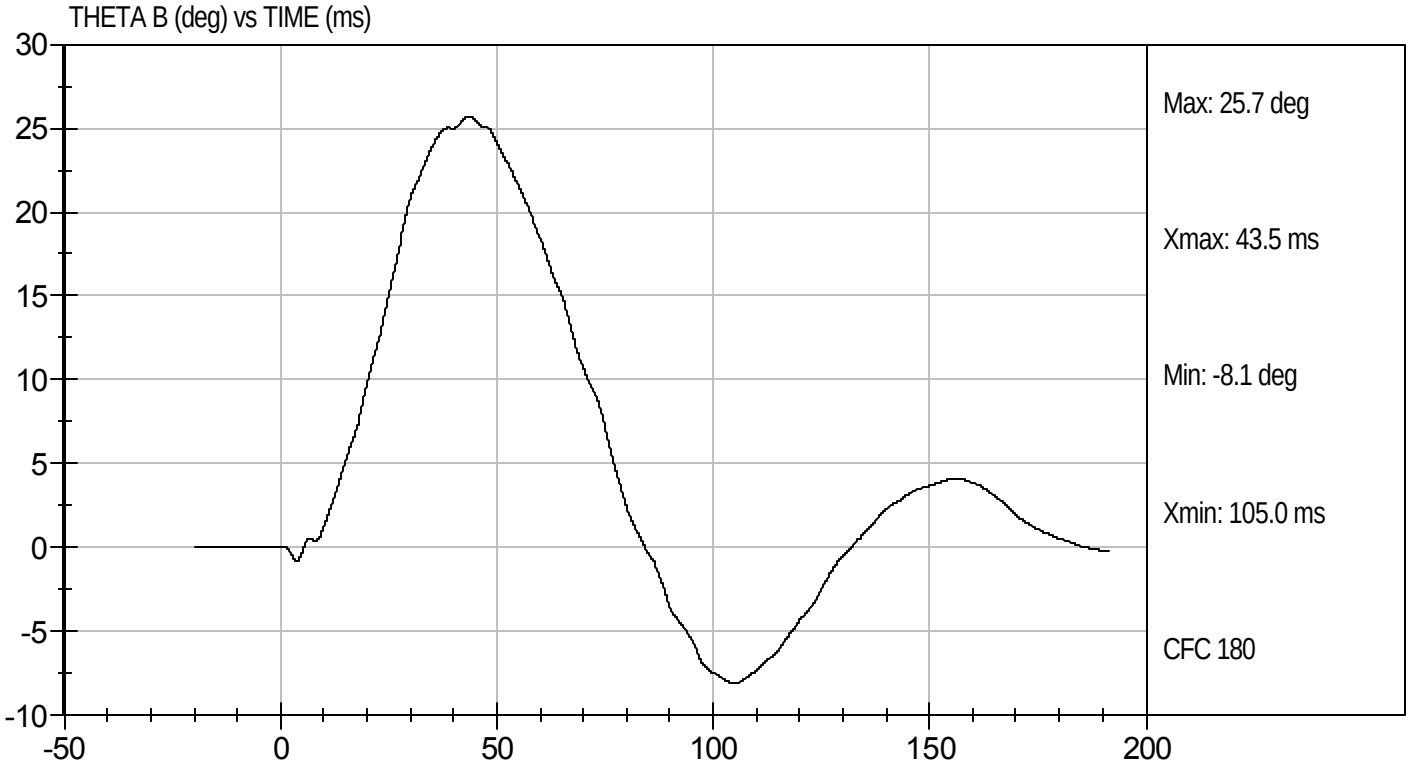
FLEXION ANGLE (deg) vs TIME (ms)



Test Desc: Lumbar Bending
Component ID: D10168

Test Date: 1/22/10
Velocity: 20.08 ft/s, 6.12 m/s





MGA RESEARCH CORPORATION

PELVIS TEST

ES-2re DUMMY

ATD Serial No: 016 **Test I.D:** D10169

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	23	Pass
Probe Speed	m/s	4.20 to 4.40	4.34	Pass
Maximum Impactor Force	kN	4.70 to 5.40	4.81	Pass
Time of Maximum Impactor Force	ms	11.80 to 16.10	12.90	Pass
Maximum Pubic Force	kN	1.23 to 1.59	1.37	Pass
Time of Maximum Pubic Force	ms	12.20 to 17.00	13.90	Pass
		Overall Test Results		Pass

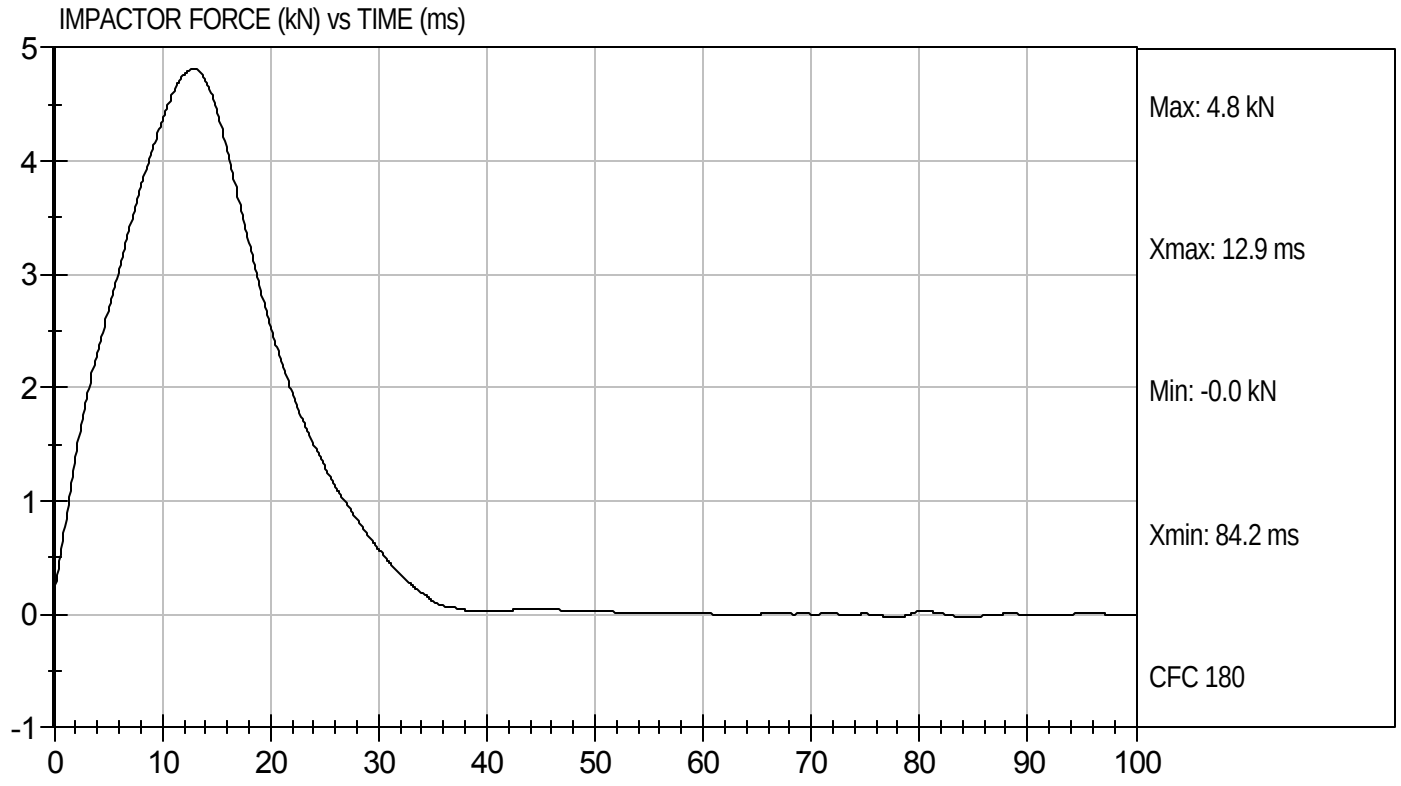
Jessica Hall
Laboratory Technician

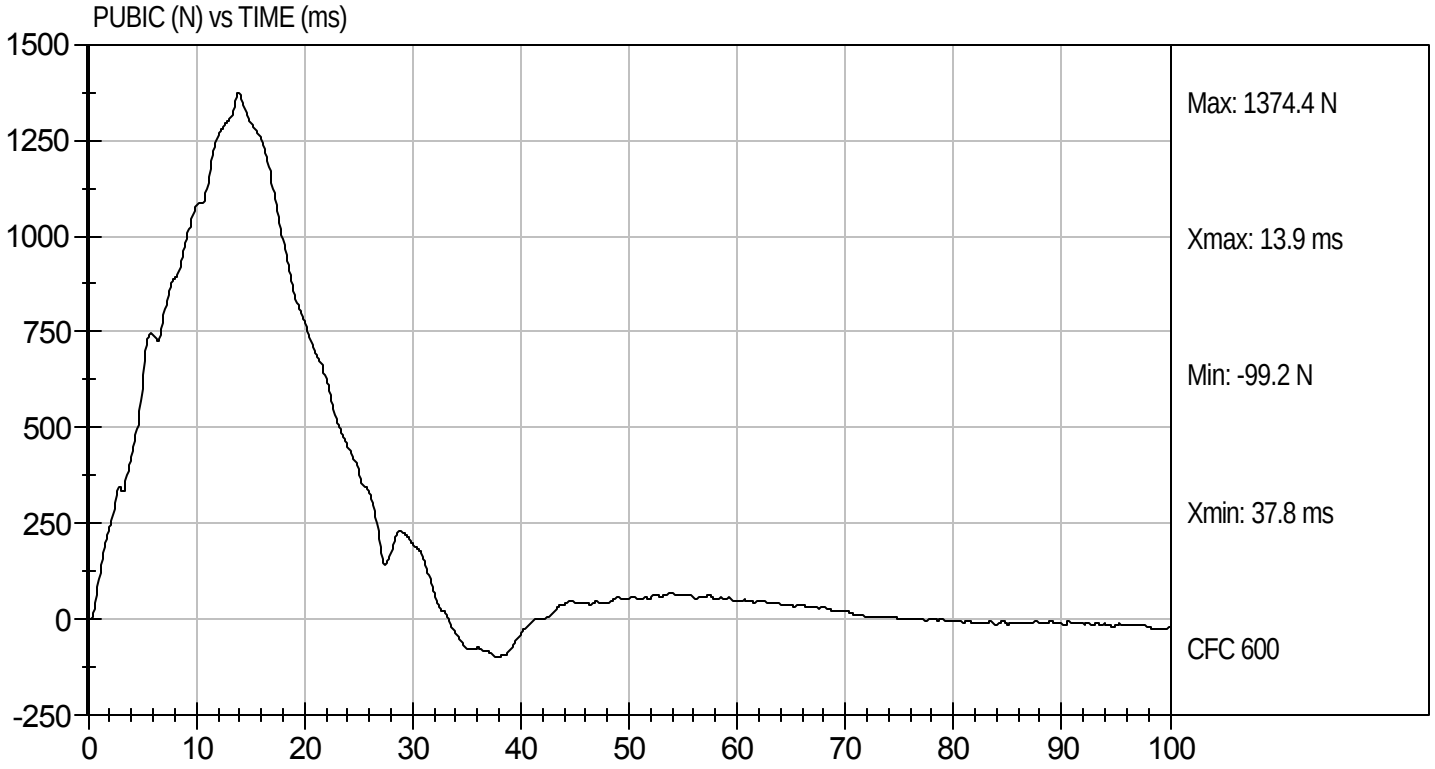
1/22/10
Test Date

David Winkelbauer
Approved By

Test Desc: Pelvis Impact
Component ID: D10169

Test Date: 1/22/10
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:** D10160

Tested Parameter	Units	Specification	Result	Pass/Fail
Temperature	deg C	20.6 to 22.2	21.8	Pass
Humidity	%	10 to 70	23	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	5.28	Pass
Upper Rib Displacement	mm	34.0 to 41.0	38.6	Pass
Middle Rib Displacement	mm	37.0 to 45.0	40.7	Pass
Lower Rib Displacement	mm	37.0 to 44.0	40.2	Pass
		Overall Test Results		Pass

Jessica Gall
Laboratory Technician

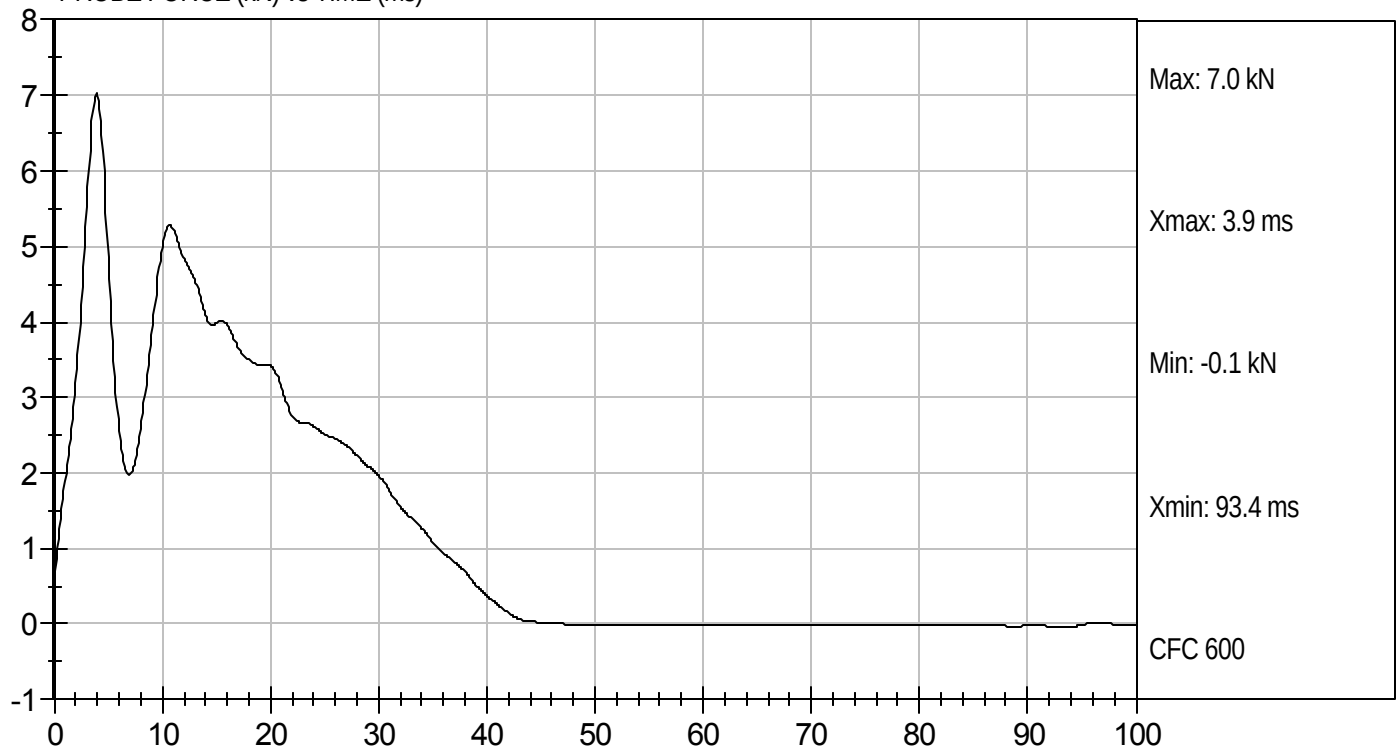
1/22/10
Test Date

David Winkelbauer
Approved By

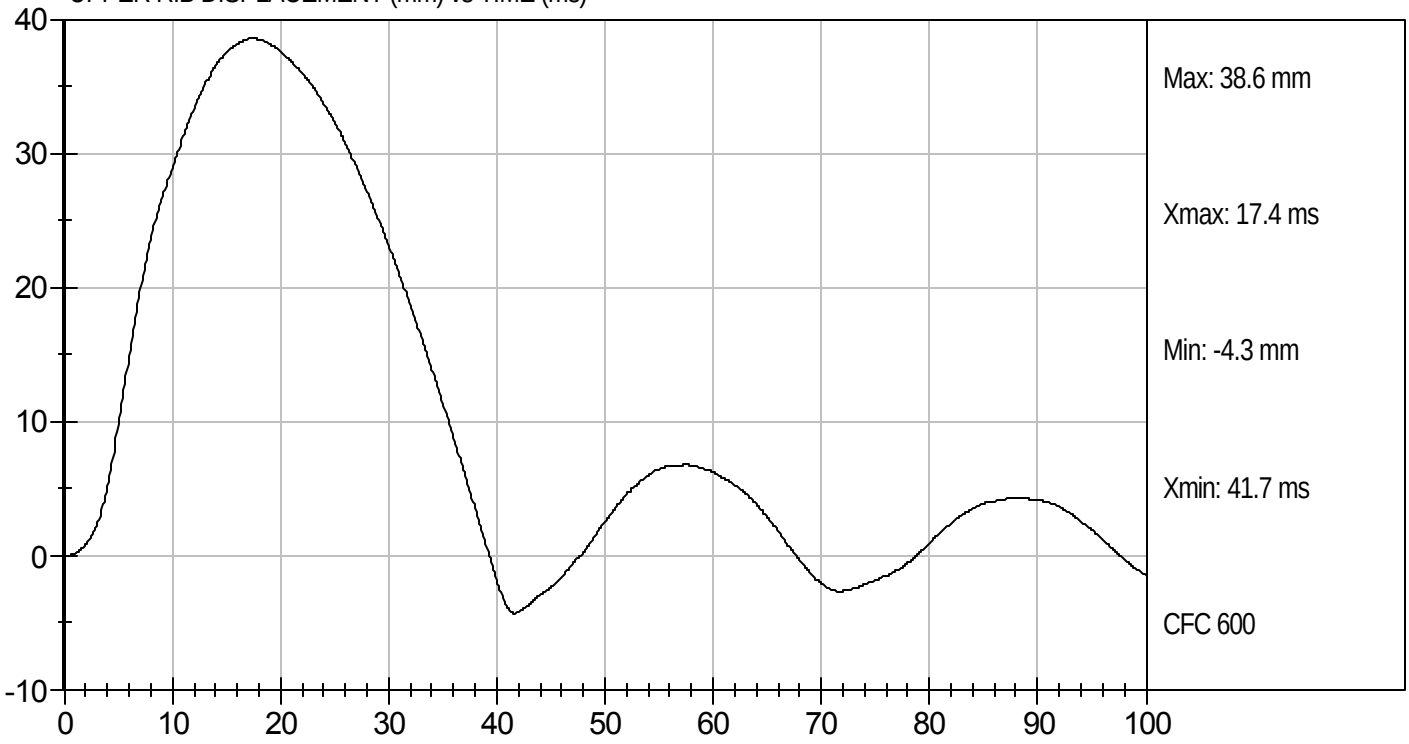
Test Desc: Thorax Impact
Component ID: D10160

Test Date: 1/22/10
Velocity: 18.32 ft/s, 5.58 m/s

PROBE FORCE (kN) vs TIME (ms)



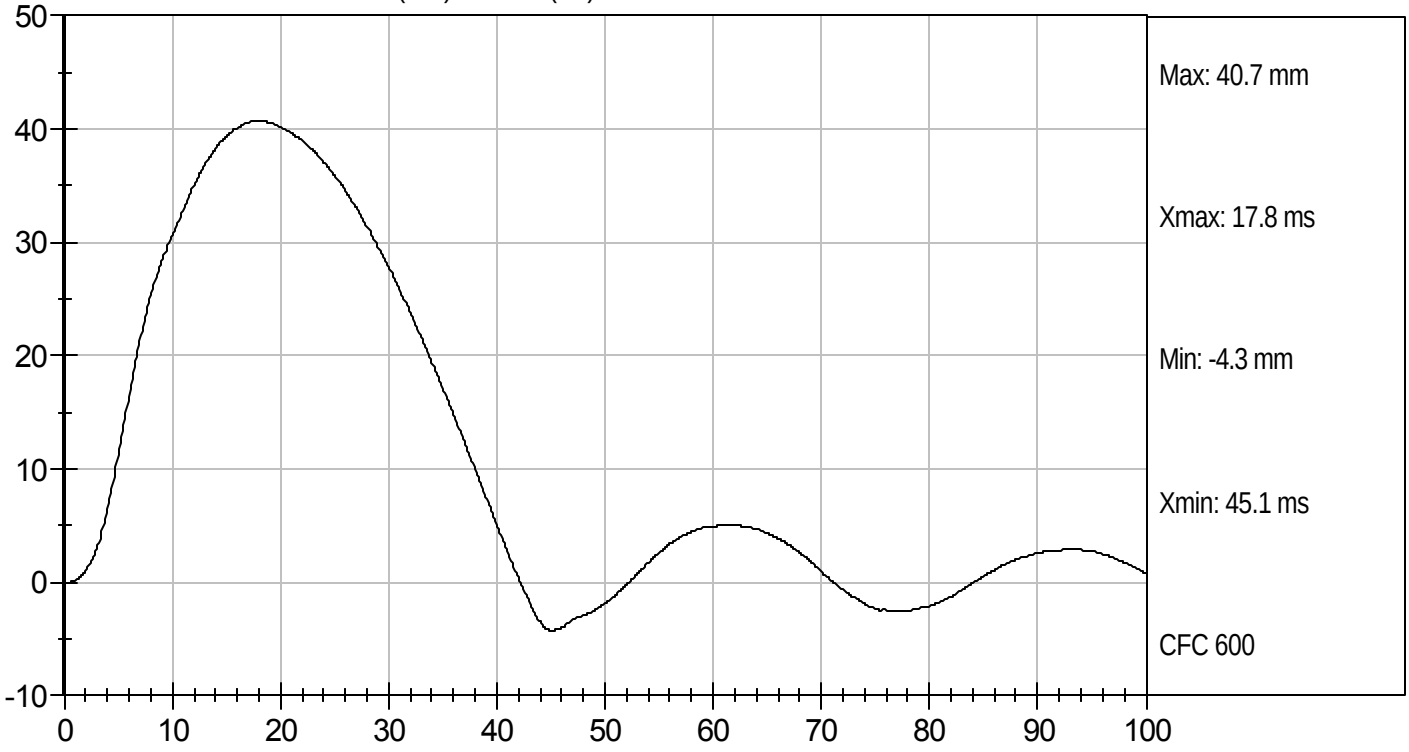
UPPER RIB DISPLACEMENT (mm) vs TIME (ms)



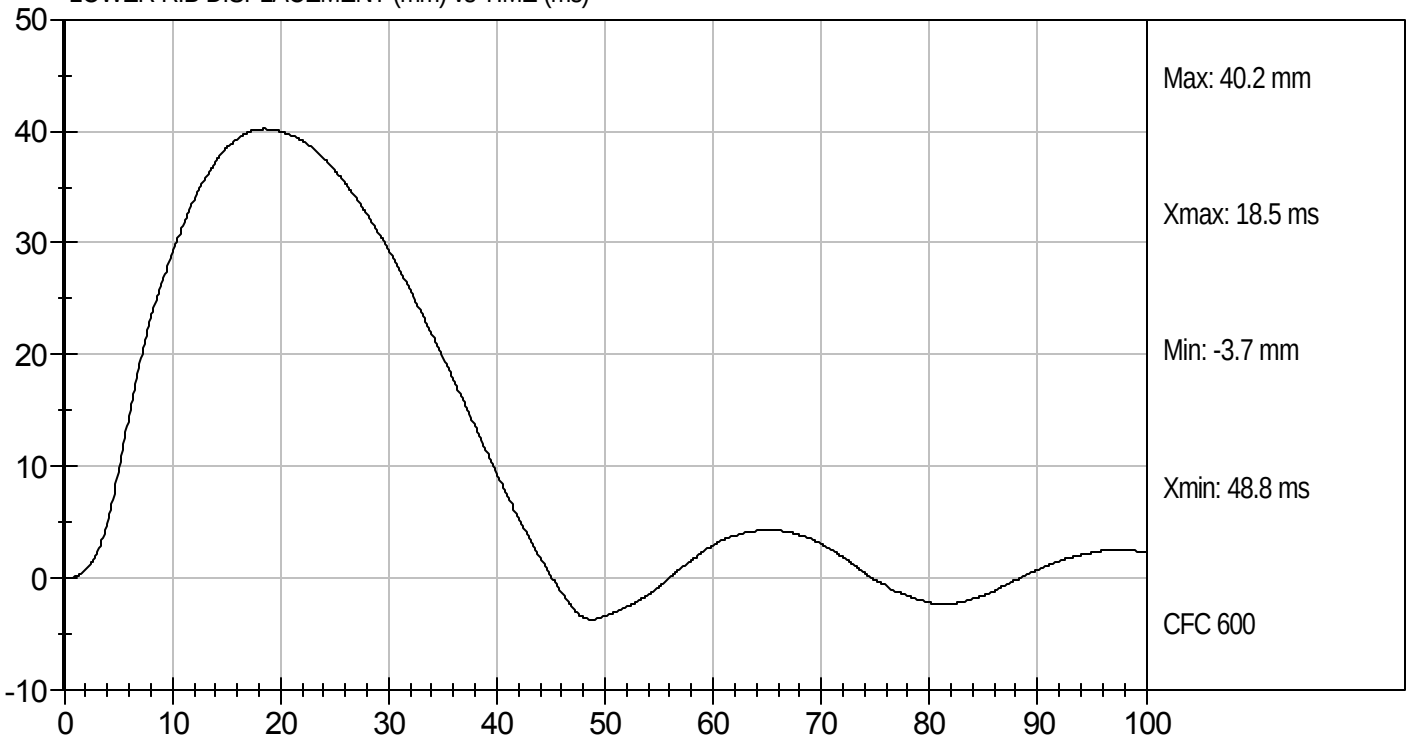
Test Desc: Thorax Impact
Component ID: D10160

Test Date: 1/22/10
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 CALIBRATON

Table 1 – Dummy Instrumentation

		ES-2re S/N: F016		
		Serial Number	Manufacturer	Calibration Date
Head Accelerometers	X	P63402	Endevco	1/05/2010
	Y	P63403	Endevco	1/05/2010
	Z	P63404	Endevco	1/05/2010
Thorax Potentiometers	Upper Rib (Y)	G144	Honeywell	11/17/2009
	Middle Rib (Y)	G143	Honeywell	11/17/2009
	Lower Rib (Y)	G142	Honeywell	11/17/2009
Abdomen Load Cells	Forward (Y)	ABG119	FTSS	3/19/2009
	Middle (Y)	ABG120	FTSS	3/19/2009
	Rear (Y)	ABG121	FTSS	3/19/2009
Pubic Symphysis Load Cell (Y)		PG431	Denton	3/19/2009

Table 2 – Vehicle Instrumentation

	Serial Number	Manufacturer	Calibration Date
Vehicle CG (X)	P55675	Endevco	10/20/2009
Vehicle CG (Y)	P55673	Endevco	10/20/2009
Vehicle CG (Z)	P55674	Endevco	10/20/2009
Left Floor Sill (Y)	P55716	Endevco	11/23/2009
A Pillar Sill (Y)	P47825	Endevco	9/15/2009
A Pillar Low (Y)	J23-M06	Entran	10/18/2009
A Pillar Mid (Y)	A29-M05	Entran	8/10/2009
B Pillar Sill (Y)	P48181	Endevco	11/21/2009
B Pillar Low (Y)	C24-A03	Entran	11/23/2009
B Pillar Mid (Y)	P47810	Endevco	8/07/2009
Seat (Y)	F15-M11	Entran	9/15/2009
Engine (X)	L02-Z21	Entran	10/18/2009
Engine (Y)	A05-A20	Entran	10/18/2009
Firewall (Y)	P48176	Endevco	11/21/2009
Roof (Y)	P60347	Endevco	11/21/2009
Floor Sill (Y)	P48154	Endevco	10/18/2009
Rear Deck (X)	D12-X02	Entran	9/15/2009
Rear Deck (Y)	D12-X19	Entran	11/21/2009