Vehicle Research and Test Center

2008 Ford F150 into

Rear of a 2004 Jeep Liberty

TRC Inc. Test Number: 131212

Prepared By:

Transportation Research Center Inc.

10820 State Route 347

East Liberty, OH 43319

Final Report

December 2013 – January 2014

Prepared For:

Vehicle Research and Test Center

P. O. Box 37

East Liberty, OH 43319

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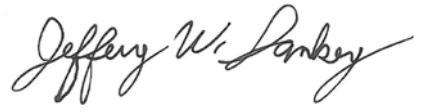
Test Performed By: John Shultz, Supervisor

Report Approved January 2, 2014 by:



Jeffery W. Sankey
Manager, Project Operations

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Section 1.0

Purpose and Test Procedure

Purpose

This vehicle-to-vehicle rear impact test was conducted for the National Highway Traffic Safety Administration (NHTSA) and Vehicle Research and Test Center (VRTC) by Transportation Research Center Inc. (TRC Inc.).

The test mode was defined as the bullet vehicle moving at 69.2 km/h to impact the target vehicle moving at 0 km/h at an impact angle of 180 degrees. The purpose of this test was to evaluate the aggressiveness of the bullet vehicle, a 2008 Ford F150, and the vehicle response of the target vehicle, a 2004 Jeep Liberty, in this vehicle-to-vehicle rear impact mode.

Test Procedure

This test was conducted in accordance with VRTC instructions for a vehicle-to-vehicle rear impact test. Data was obtained relative to FMVSS 301, "Fuel System Integrity," performance.

The target vehicle, a 2004 Jeep Liberty, was instrumented with six (6) accelerometers to measure longitudinal, lateral and vertical axis accelerations.

The bullet vehicle, a 2008 Ford F150, was instrumented with six (6) accelerometers to measure longitudinal, lateral and vertical axis accelerations. The vehicle's specified impact velocity range was 68.4 to 70.0 km/h.

The bullet vehicle impacted the rear of the target vehicle at an impact angle of 180 degrees. The intended impact point was the bullet vehicle's centerline aligned 283 millimeters left of the target vehicle's centerline.

One (1) Hybrid III 50th Male Ballast dummy was placed in the bullet vehicle's driver's seat. One (1) Hybrid III 50th Male Ballast dummy was placed in the target vehicle's driver's seat. Both dummies were restrained with seatbelts.

The twelve (12) data channels were digitally sampled and recorded at 12,500 samples per second and processed per SAE J211 March 1995.

The crash event was recorded by three (3) real-time panning motion picture cameras and nine (9) high-speed motion picture cameras.

The test summary data is presented in Section 2.0. The FMVSS 301 data is presented in Section 3.0. The camera and vehicle measurements are presented in Section 4.0. Appendix A contains the still photographic prints. Appendix B contains the vehicle data plots.

Section 2.0

Test Summary

Test Results Summary

This 69.2 km/h 180° vehicle-to-vehicle rear impact test was conducted by TRC Inc. on December 12, 2013.

The target test vehicle, a 2004 Jeep Liberty, was equipped with a 3.7-liter 6 cylinder engine, 3 speed automatic transmission, power steering, power brakes, and front airbags. The target vehicle's test weight was 1926.6 kg.

The bullet test vehicle, a 2008 Ford F150, was equipped with a 5.4-liter 8 cylinder engine, 3 speed automatic transmission, power steering, power brakes, and front airbags. The bullet vehicle's test weight was 2673.8 kg. The bullet vehicle's impact speed was 69.1 km/h.

Data Acquisition Explanations

The bullet vehicle CG X-axis acceleration data channel recorded no valid data throughout the test event. This affected the resultant acceleration calculation.

The bullet vehicle redundant CG Z-axis acceleration data channel recorded no valid data throughout the test event. This affected the resultant acceleration calculation.

Table 1 Crash Test Summary

Test mode:	Vehicle to Vehicle Rear Impact
Test date:	December 12, 2013
Test time:	13:23 PM
Ambient temperature:	-13°C
Target vehicle year/make/ model/body style:	2004 Jeep/Liberty/MPV
Target vehicle test weight:	1926.6 kg
Bullet vehicle year/make/ model/body style:	2008 Ford/F-150/Pickup
Bullet vehicle test weight:	2673.8 kg
Impact angle[1]:	180°
Impact velocity[2]:	Bullet vehicle = 69.1 km/h
Total number of data channels:	12
Number of cameras:	
High-speed:	9
Real-time:	3

[1] With respect to tow track centerline.
[2] Speed trap measurement (± .08 km/h accuracy)

Table 2 Target Vehicle General Test and Vehicle Parameter Data

Vehicle year/make/ model/body style:	2004 Jeep/Liberty/MPV
VIN:	1J4GL58K94W172386
Model year:	2004
Body style:	MPV
Color:	Silver
Engine data:	
Cylinders:	6
Displacement	3.7 liters
Type:	V
Placement:	Longitudinal
Transmission data:	_3_ speed, __ manual, _X_ automatic, _X__ overdrive
Final drive:	__ FWD, __ RWD, _X_ 4WD
Date vehicle received:	12/9/2013
Odometer reading:	122,213
Dealer's name	Customer Supplied

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	Yes
Power seats	No	Tilting steering wheel	Yes
Power windows	Yes	Telescoping steering wheel	No
Tinted glass	Yes	Air conditioning	Yes
Radio	Yes	Anti-skid brake	Yes
Clock	Yes	Rear window defroster	Yes
Other	None	Power door locks	Yes

Certification data from vehicle's label:

Vehicle manufactured by:		Daimler Chrysler Corporation
Date of manufacture:		10-03
VIN:		1J4GL58K94W172386
GVWR:		5600 lbs. (2541 kg)
GAWR:	Front:	2750 lbs. (1248 kg)
	Rear:	3150 lbs. (1429 kg)

Table 2 Target Vehicle General Test and Vehicle Parameter Data, Continued

Tires on vehicle (mfr., line, size):	Yokohama, Geolander, P235/70R16
Tire pressure with maximum capacity vehicle load:	
Front:	35 psi (240 kPa)
Rear:	35 psi (240 kPa)
Spare tire (mfr., line, size):	Summit, Trail Climber, P235/70R16
Type of seats:	
Front	Bucket
Rear	Split Bench
Maximum width:	1815 mm
Wheelbase:	2640 mm

Location of "Recommended Tire Pressure" label:

Driver Door

Data from vehicle's "Recommended Tire Pressure" label:

Recommended tire size:	P235/70R16
Recommended cold tire pressure:	Front: 33 psi (227 kPa) Rear: 33 psi (227 kPa)
Seating capacity:	Front: 2 Mid: 0 Rear: 3 Total: 5
Vehicle capacity weight:	N/A lbs. (N/A kg)
Rated cargo/luggage weight:	N/A lbs. (N/A kg)

Test vehicle attitude:

Pre-test attitude:	LF 785 mm;	RF 788 mm;	LR 814 mm;	RR 819 mm
Post-test attitude:	LF 730 mm;	RF ---[1] mm;	LR ---[1] mm;	RR 802 mm

[1] Measurement point missing post-test.

Table 2 Target Vehicle General Test and Vehicle Parameter Data Continued

Weight of test vehicle with required dummies and cargo weight:

Right front	504.2 kg	Right rear	421.4 kg
Left front	550.6 kg	Left rear	450.4 kg
Total front weight	1054.8 kg	(54.7% of total vehicle weight)	
Total rear weight	871.8 kg	(45.3% of total vehicle weight)	
Total test weight	1926.6 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1195 mm rearward of front wheel centerline

Fuel System Data:

Usable fuel system capacity N/A liters (from owner's manual)

Actual test volume: 37.9 liters

Table 3 Bullet Vehicle General Test and Vehicle Parameter Data

Vehicle year/make/ model/body style:	2008 Ford/F-150/Pickup
VIN:	1FTPX14V58FB91252
Model year:	2008
Body style:	Pickup
Color:	Red
Engine data:	
Cylinders:	8
Displacement	5.4 liters
Type:	V
Placement:	Longitudinal
Transmission data:	_3_ speed, __ manual, _X_ automatic, _X_ overdrive
Final drive:	___ FWD, __ RWD, _X_ 4WD
Date vehicle received:	12/11/2013
Odometer reading:	87,539
Dealer's name	Customer Supplied

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	Yes
Power seats - Driver	Yes	Tilting steering wheel	Yes
Power windows	Yes	Telescoping steering wheel	No
Tinted glass	Yes	Air conditioning	Yes
Radio	Yes	Anti-skid brake	Yes
Clock	Yes	Rear window defroster	No
Other	None	Power door locks	Yes

Certification data from vehicle's label:

Vehicle manufactured by:		Ford Motor Company
Date of manufacture:		4/08
VIN:		1FTPX14V58FB91252
GVWR:		7200 lbs. (3266 kg)
GAWR:	Front:	3750 lbs. (1701 kg)
	Rear:	3850 lbs. (1746 kg)

Table 3 Bullet Vehicle General Test and Vehicle Parameter Data, Continued

Tires on vehicle (mfr., line, size):	Mastercraft, Courser HTR, 275/55R20
Tire pressure with maximum capacity vehicle load:	
Front:	50 psi (340 kPa)
Rear:	50 psi (340 kPa)
Spare tire (mfr., line, size):	Goodyear, Fortera, P255/65R18
Type of seats:	
Front	Bucket
Rear	Bench
Maximum width:	2030 mm
Wheelbase:	3680 mm

Location of "Recommended Tire Pressure" label:

Left B-Pillar

Data from vehicle's "Recommended Tire Pressure" label:

Recommended tire size:	275/55R20
Recommended cold tire pressure:	Front: 35 psi (240 kPa) Rear: 35 psi (240 kPa)
Seating capacity:	Front: 2 Mid: 0 Rear: 3 Total: 5
Vehicle capacity weight:	N/A lbs. (N/A kg)
Rated cargo/luggage weight:	N/A lbs. (N/A kg)

Test vehicle attitude:

Pre-test attitude:	LF 884 mm;	RF 882 mm;	LR 991 mm;	RR 988 mm
Post-test attitude:	LF ---[1] mm;	RF ---[1] mm;	LR 989 mm;	RR 987 mm

[1] Measurement point missing post-test.

Table 3 Bullet Vehicle General Test and Vehicle Parameter Data, Continued

Weight of test vehicle with required dummies and cargo weight:

Right front	708.6 kg	Right rear	596.6 kg
Left front	789.4 kg	Left rear	579.2 kg
Total front weight	1498.0 kg	(56.0% of total vehicle weight)	
Total rear weight	1175.8 kg	(44.0% of total vehicle weight)	
Total test weight	2673.8 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1618 mm rearward of front wheel centerline

Fuel System Data:

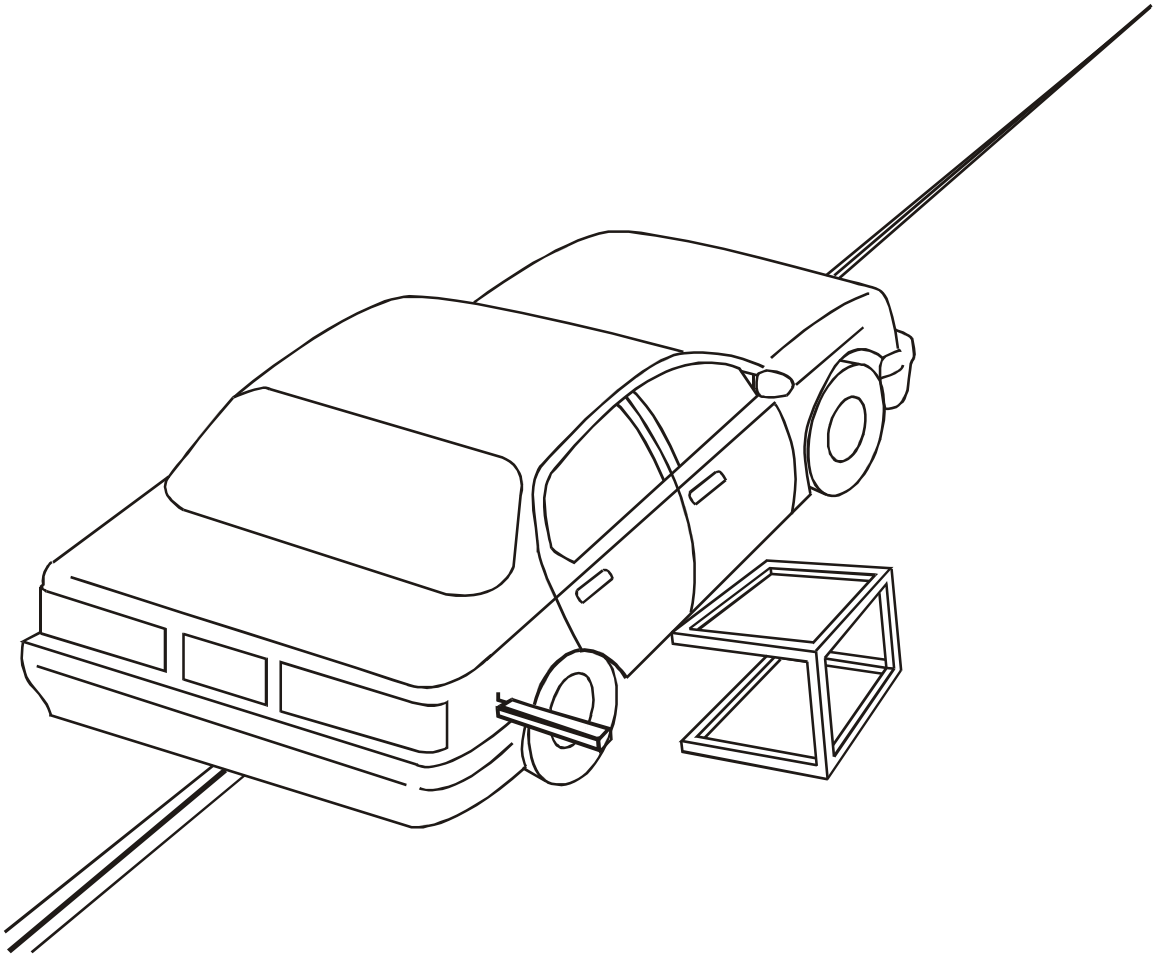
Usable fuel system capacity N/A liters (from owner's manual)

Actual test volume: 95.0 liters

Table 4 Post-Impact Data

Test number:	131212
Test date:	12/12/2013
Test time:	13:23 PM
Test type:	Vehicle to Vehicle Rear Impact
Impact angle:	180°
Ambient temperature at impact area:	-13°C
Impact velocity:	
Target vehicle:	0 km/h
Bullet vehicle:	69.1 km/h
Required impact velocity range:	
Bullet vehicle:	68.4 to 70.0 km/h
Distance from each vehicle to intended impact point:	
Entering velocity trap:	660 mm
Exiting velocity trap:	50 mm, approximately

Figure 1 Impact Velocity Measurement System



The vane clears the final emitter/receiver pair approximately 50 millimeters before impact.

The emitter/receiver pairs have 610-millimeter spacing.

Table 5 Target Vehicle Accelerometer Data Summary

Accel. No.	Location		Positive Direction Max. (g)	Positive Direction Time (ms)	Negative Direction Max. (g)	Negative Direction Time (ms)
1	Vehicle Center of Gravity	X	30.9	75.2	-2.5	115.6
		Y	7.1	90.2	-7.0	62.7
		Z	8.7	60.2	-14.1	42.3
		R	31.0	75.0	---	---
2	Vehicle Center of Gravity Redundant	X	31.5	75.4	-2.5	115.5
		Y	7.9	90.1	-5.4	62.8
		Z	11.5	50.7	-15.4	42.7
		R	31.6	75.3	---	---

Reference:
X: + Forward From Rear Bumper
Y: + Rightward From Vehicle Centerline
Z: + Downward From Ground Level

Table 6 Bullet Vehicle Accelerometer Data Summary

Accel. No.	Location		Positive Direction Max. (g)	Positive Direction Time (ms)	Negative Direction Max. (g)	Negative Direction Time (ms)
1	Vehicle Center of Gravity	X[1]	---	---	---	---
		Y	2.9	111.7	-1.6	169.9
		Z	7.2	60.9	-10.6	115.4
		R[1]	---	---	---	---
2	Vehicle Center of Gravity Redundant	X	3.0	127.4	-22.3	73.3
		Y	1.6	21.1	-2.6	111.8
		Z[1]	---	---	---	---
		R[1]	---	---	---	---

Reference:
X: + Forward From Rear Bumper
Y: + Rightward From Vehicle Centerline
Z: + Downward From Ground Level

[1] See Data Acquisition Explanations

Table 7 Target Vehicle Measurements [1]

2004 Jeep Liberty

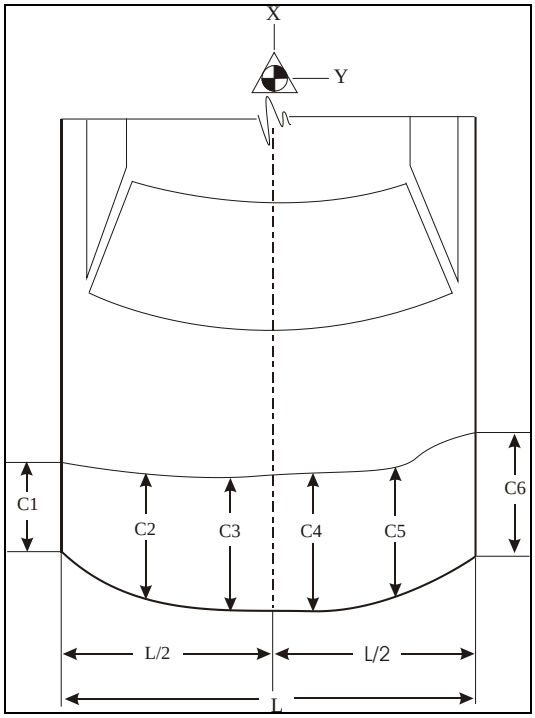
Test Number: 131212

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	4213	---[1]	---[1]
X2	Front Surface of Vehicle to Front of Engine Block	620	630	-10
X3	Front Surface of Vehicle to Firewall	1107	1125	-18
X4	Front Surface of Vehicle to Upper Leading Edge of Right Door	1396	1404	-8
X5	Front Surface of Vehicle to Upper Leading Edge of Left Door	1394	1404	-10
X6	Front Surface of Vehicle to Lower Leading Edge of Right Door	1409	1409	0
X7	Front Surface of Vehicle to Lower Leading Edge of Left Door	1410	1405	5
X8	Front Surface of Vehicle to Upper Trailing Edge of Right Door	2385	2395	-10
X9	Front Surface of Vehicle to Upper Trailing Edge of Left Door	2384	2396	-12
X10	Front Surface of Vehicle to Lower Trailing Edge of Right Door	2368	2370	-2
X11	Front Surface of Vehicle to Lower Trailing Edge of Left Door	2368	2362	6
X12	Front Surface of Vehicle to Bottom of " A " Post on Right Side	1429	1430	-1
X13	Front Surface of Vehicle to Bottom of " A " Post on Left Side	1427	1440	-13
X14	Front Surface of Vehicle to Firewall-Right Side	1067	1078	-11
X15	Front Surface of Vehicle to Firewall-Left Side	1070	1085	-15
X16	Rear Surface of Vehicle to Steering Wheel Center	1814	1823	-9
X17	Center of Steering Column to " A " Post	345	348	-3
X18	Center of Steering Column to Headliner	477	473	4
X19	Front Surface of Vehicle to Right Side of Rear Bumper	4166	4153	13
X20	Front Surface of Vehicle to Left Side of Rear Bumper	4517	---[1]	---[1]
X21	Length of Engine Block	640	640	0

All measurements are in millimeters.

[1] Measurement point missing post-test.

Figure 2 Target Vehicle Crush [1]



Notes: L is pre-test length of contact surface.
C1 through C6 are spaced equally apart.
CL is vehicle centerline.

Vehicle: 2004 Jeep Liberty

	Pre-test	Post-test	Crush
L	1524	N/A	N/A
C1	4152	---[1]	---[1]
C2	4224	4170	54
C3	4224	---[1]	---[1]
CL	4213	---[1]	---[1]
C4	4222	---[1]	---[1]
C5	4225	---[1]	---[1]
C6	4166	4153	13

All measurements in millimeters.

[1] Measurement point missing post-test.

Table 8 Bullet Vehicle Measurements

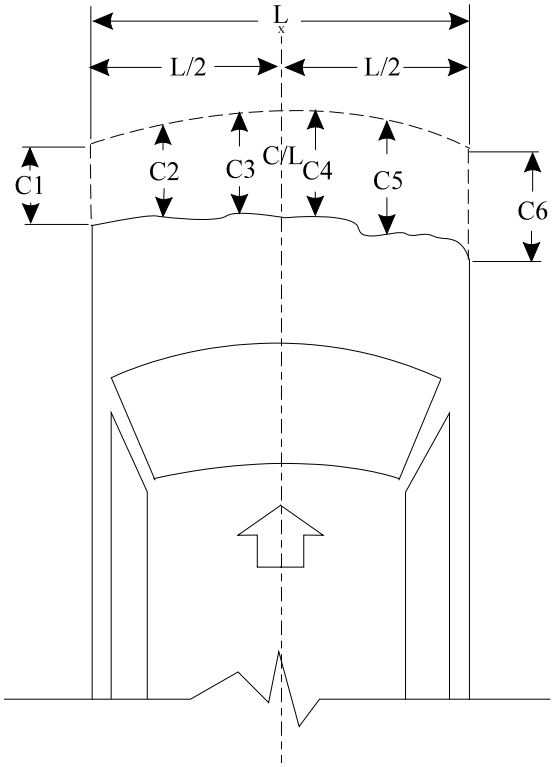
2008 Ford F150

Test Number: 131212

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	5829	5381	448
X2	Rear Surface of Vehicle to Front of Engine Block	5004	4961	43
X3	Rear Surface of Vehicle to Firewall	4719	4711	8
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	4284	4274	10
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	4294	4288	6
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	4330	4235	95
X7	Rear Surface of Vehicle to Lower Leading Edge of Left Door	4240	4249	-9
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	3069	3055	14
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	3084	3076	8
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	3044	3043	1
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	3054	3057	-3
X12	Rear Surface of Vehicle to Bottom of " A " Post on Right Side	4236	4230	6
X13	Rear Surface of Vehicle to Bottom of " A " Post on Left Side	4246	4240	6
X14	Rear Surface of Vehicle to Firewall-Right Side	4689	4690	-1
X15	Rear Surface of Vehicle to Firewall-Left Side	4689	4700	-11
X16	Rear Surface of Vehicle to Steering Wheel Center	3850	3825	25
X17	Center of Steering Column to " A " Post	350	332	18
X18	Center of Steering Column to Headliner	420	440	-20
X19	Rear Surface of Vehicle to Right Side of Front Bumper	5704	5420	284
X20	Rear Surface of Vehicle to Left Side of Front Bumper	5704	5552	152
X21	Length of Engine Block	700	700	0
	Left Front Overhang	930	646	284
	Right Front Overhang	930	530	400
X26	Firewall to Engine or Transaxle	65	25	40
X27	Vertical Distance from Door Sill to Centerline of Steering Column	725	717	8
X28	Left Wheelbase	3680	3677	3
X28	Right Wheelbase	3680	3684	-4
X29	Maximum Width	2030	2245	-215
X30	Rear Surface of Vehicle to Engine Bottom Target	4632	4391	241
X31	Rear Surface of Vehicle to Occupant Compartment Bottom Targets	3164	2923	241
X32	Rear Surface of Vehicle to Front Bumper Bottom Target	5744	5371	373
X33	Rear Surface of Vehicle to Frame Crossmember Bottom Target	5174	4926	248
RD	Rear Surface of Vehicle to Right Side of Dash Panel	4109	4087	22
CD	Rear Surface of Vehicle to Center of Dash Panel	4079	4070	9
LD	Rear Surface of Vehicle to Left Side of Dash Panel	4109	4092	17

All measurements are in millimeters.

Figure 3 Bullet Vehicle Crush



Notes: L is pre-test length of contact surface.
C1 through C6 are spaced equally apart.
CL is vehicle centerline.

Vehicle: 2008 Ford F150

	Pre-test	Post-test	Crush
L	1524	N/A	N/A
C1	5704	5552	152
C2	5804	5505	299
C3	5824	5420	404
CL	5829	5381	448
C4	5824	5322	502
C5	5809	5560	249
C6	5704	5420	284

All measurements are in millimeters.

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Section 3.0

FMVSS 301 Data

Table 9 Target Vehicle Fuel System Data

Vehicle year/make/ model/body style:	2004/Jeep/Liberty Limited/MPV
Actual test volume:	37.9 liters
Test fluid type:	Stoddard
Specific gravity:	0.764
Kinematic viscosity:	0.99 centistoke
Test fluid color:	Purple
Type of fuel pump:	Electric
Did electric fuel pump operate with ignition switch "on" and the engine not operating.	Yes
Details of fuel system:	The fuel tank is located behind the rear axle. The fuel filler neck enters the top left side of the fuel tank. The fuel filler cap is located on the left rear quarter panel. The fuel lines run along the inside of the left frame rail.

Table 10 Target Vehicle FMVSS 301 Post-Impact Test Data

Test date: 12/4/2013

Vehicle year/make/
model/body style: 2004/Jeep/Liberty Limited/MPV

Test requirements:

Test vehicle fuel tank filled was filled with 68.5 liters of Stoddard and had an electric fuel pump operating (if it will operate without engine operation). Part 572 test dummies located at each front designated seating position.

Test vehicle impact type:

____ Frontal (30 mph)

____ Oblique (30 mph) with __ barrier face first contacting (driver's/passenger's) side

_X_ Rear vehicle to vehicle impact

____ Lateral moving barrier (20 mph)

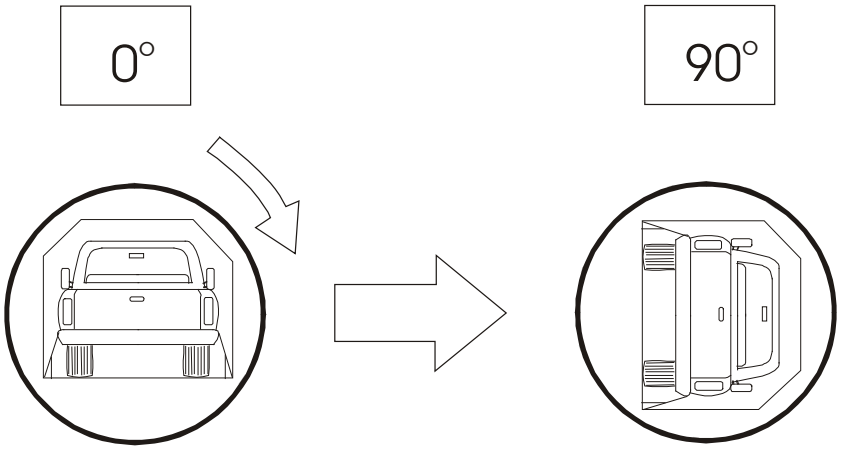
Fuel system fluid spillage measurements:

		Test Results	Maximum Allowable
1.	From impact until vehicle motion ceases	Trace	28 g
2.	5-minute period after vehicle motion ceases	Trace	142 g
3.	Next 25 minutes after 5-minute period	Trace	28 g/minute

Fuel system fluid spillage location(s): Unable to determine

Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2 minutes,	0 seconds
FMVSS 301 position hold time	=	5 minutes,	0 seconds
Total	=	7 minutes,	0 seconds
Next whole minute interval	=	7 minutes	

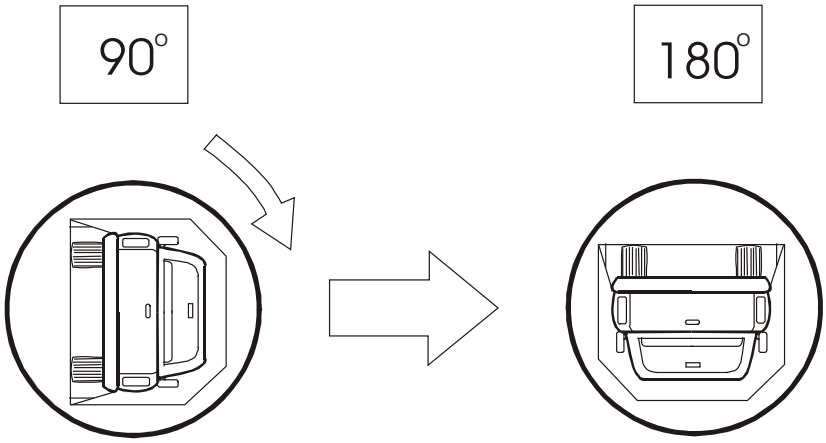
Fuel system fluid spillage measurements:

0° to 90° rotation (fuel filler cap down)	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	Large Spillage	142 g
2. Sixth minute from onset of rotation	Large Spillage	28 g
3. Seventh minute from onset of rotation	Large Spillage	28 g

Fuel system fluid spillage location(s): Fuel filler area

Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data, Continued

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0	seconds
FMVSS 301 position hold time	=	5	minutes,	0	seconds
Total	=	7	minutes,	0	seconds
Next whole minute interval	=	14	minutes		

Fuel system fluid spillage measurements:

90° to 180° rotation		Test Results	Maximum Allowable
1.	First five minutes from onset of rotation	Tank emptied	142 g
2.	Sixth minute from onset of rotation	N/A[1]	28 g
3.	Seventh minute from onset of rotation	N/A[1]	28 g

Fuel system fluid spillage location(s): Fuel filler area.

[1] A major leak occurred during this portion of the rollover and the fuel tank emptied. No further rollover was conducted.

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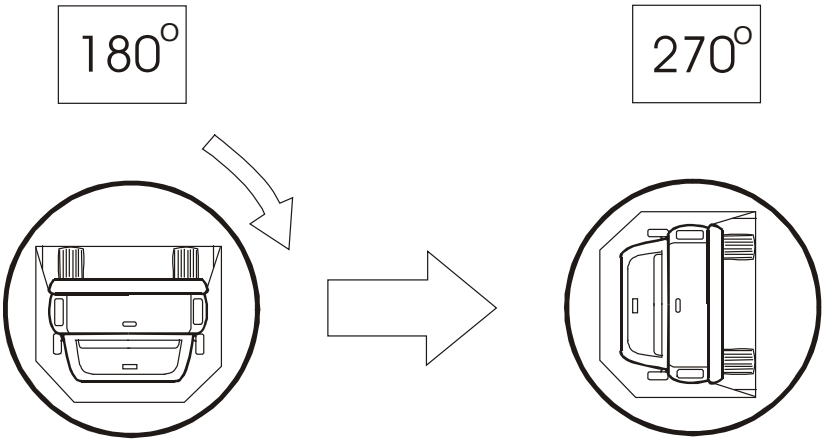
Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data, Continued

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0	seconds
FMVSS 301 position hold time	=	5	minutes,	0	seconds
Total	=	7	minutes,	0	seconds
Next whole minute interval	=	21	minutes		

Fuel system fluid spillage measurements:

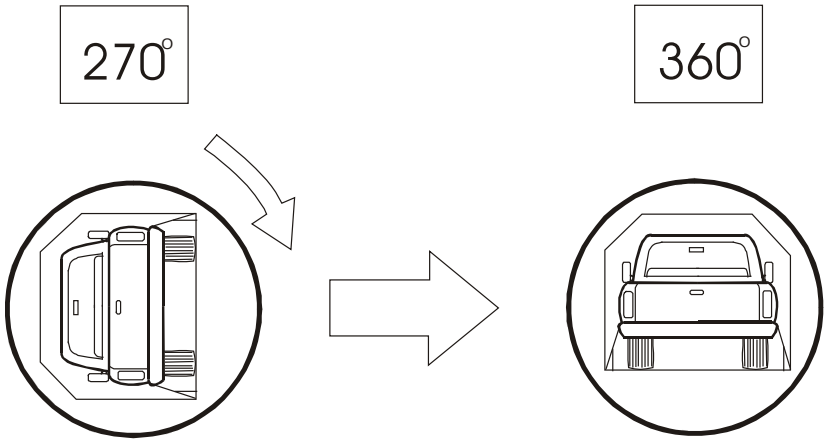
180 to 270° rotation		Test Results	Maximum Allowable
1.	First five minutes from onset of rotation	N/A[1]	142 g
2.	Sixth minute from onset of rotation	N/A[1]	28 g
3.	Seventh minute from onset of rotation	N/A[1]	28 g

Fuel system fluid spillage location(s): N/A[1]

[1] Rollover test stopped after 180º roll.

Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data, Continued

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0	seconds
FMVSS 301 position hold time	=	5	minutes,	0	seconds
Total	=	7	minutes,	0	seconds
Next whole minute interval	=	28	minutes		

Fuel system fluid spillage measurements:

270° to 360° rotation		Test Results	Maximum Allowable
1.	First five minutes from onset of rotation	N/A[1]	142 g
2.	Sixth minute from onset of rotation	N/A[1]	28 g
3.	Seventh minute from onset of rotation	N/A[1]	28 g

Fuel system fluid spillage location(s): N/A[1]

[1] Rollover test stopped after 180º roll.

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Section 4.0

Camera Information

Figure 5 Camera Positions

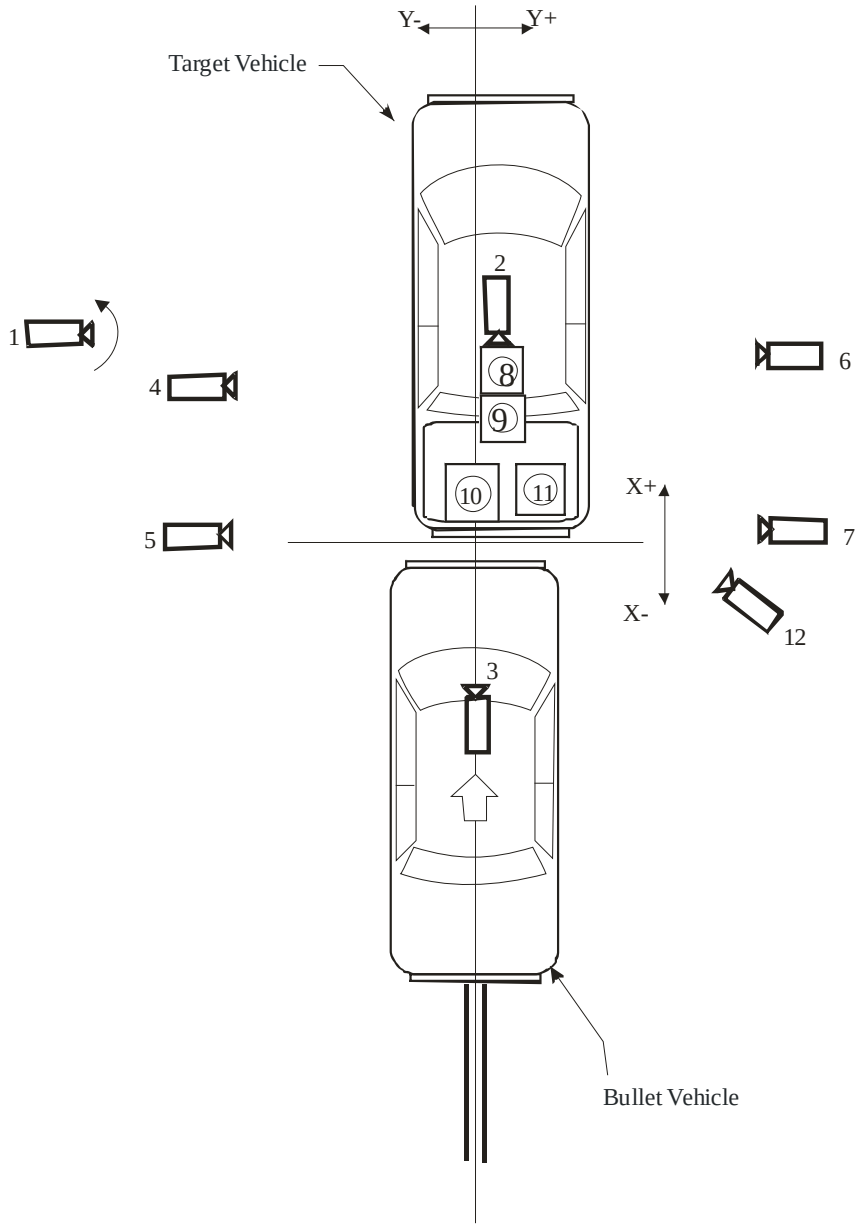


Table 11 Camera Information

Camera Number	Location	Location, mm X	Y	Z	Angle (deg.)	Lens (mm)	Speed (fps)
1	Realtime Panning	N/A	N/A	N/A	N/A	Zoom	30
2	Realtime onboard target vehicle	N/A	N/A	N/A	N/A	Zoom	30
3	Realtime onboard bullet vehicle	N/A	N/A	N/A	N/A	Zoom	30
4	Left side target vehicle	1524	-7569	-644	0.2º	Zoom	1000
5	Left side impact	76	-7087	-764	-0.4º	Zoom	1000
6	Right side target vehicle	1194	7214	-655	1.4º	Zoom	1000
7	Right side impact	432	7163	-654	1.3º	Zoom	1000
8	Overhead	0	1372	-6035	N/A	8.5	1000
9	Pit wide	2433	409	2791	72.2º	12.5	1000
10	Pit medium	700	208	2931	81.1º	25	1000
11	Pit tight	1306	-224	2905	85.8º	50	1000
12	Right ground level tight impact	-1524	3048	-63	6.8º	50	1000

+X: Forward (referenced to Target) from impact point
+Y: Rightward (referenced to Target) from impact point
+Z: Downward from ground level

Appendix A

Photographs

Figure A-1 Pre-Test Target Vehicle Frontal View

Figure A-2 Post-Test Target Vehicle Frontal View

Figure A-3 Pre-Test Target Vehicle Left Front 3/4 View

Figure A-4 Post-Test Target Vehicle Left Front 3/4 View

Figure A-5 Pre-Test Target Vehicle Left Side View

Figure A-6 Post-Test Target Vehicle Left Side View

Figure A-7 Pre-Test Target Vehicle Rear View

Figure A-8 Post-Test Target Vehicle Rear View

Figure A-9 Pre-Test Target Vehicle Right Rear 3/4 View

Figure A-10 Post-Test Target Vehicle Right Rear 3/4 View

Figure A-11 Pre-Test Target Vehicle Right Side View

Figure A-12 Post-Test Target Vehicle Right Side View

Figure A-13 Pre-Test Target Vehicle Front Underbody View

Figure A-14 Post-Test Target Vehicle Front Underbody View

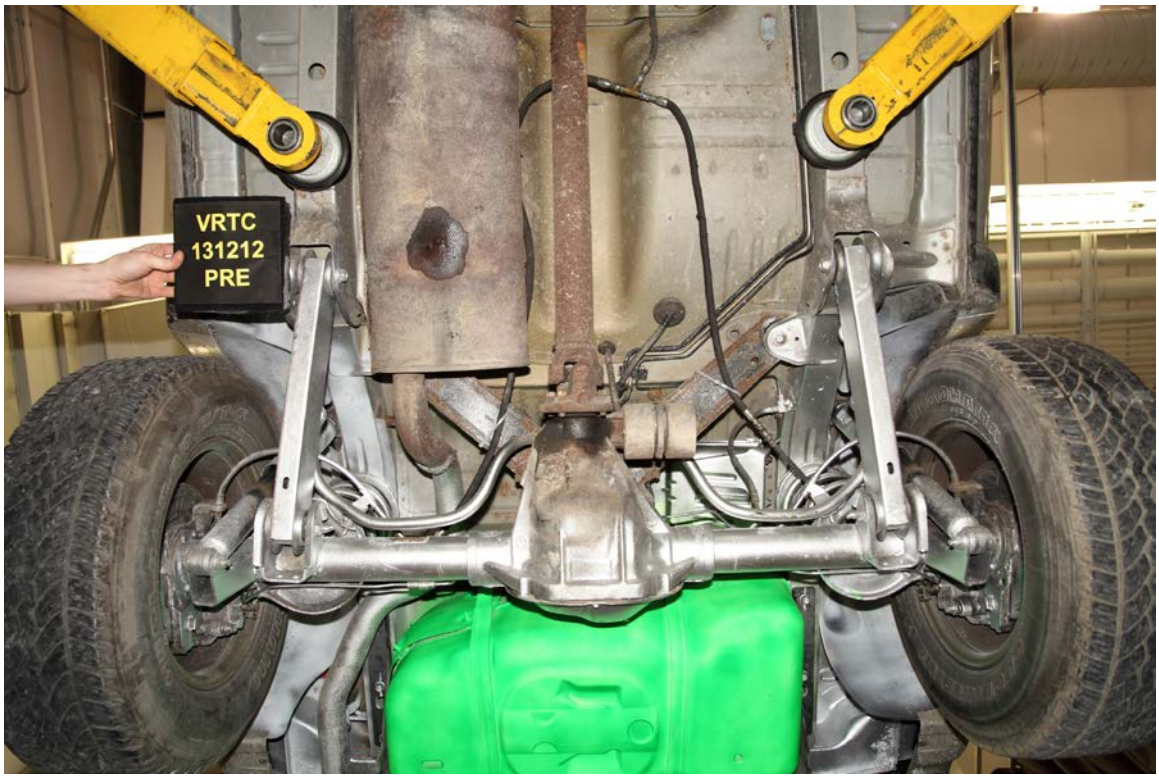


Figure A-15 Pre-Test Target Vehicle Rear Underbody View

Figure A-16 Post-Test Target Vehicle Rear Underbody View

Photo Not Available

Figure A-17 Pre-Test Target Vehicle Overhead View

Photo Not Available

Figure A-18 Post-Test Target Vehicle Overhead View

Figure A-19 Pre-Test Target Vehicle Fuel Tank Close-up View

Figure A-20 Post-Test Target Vehicle Fuel Tank Close-up View

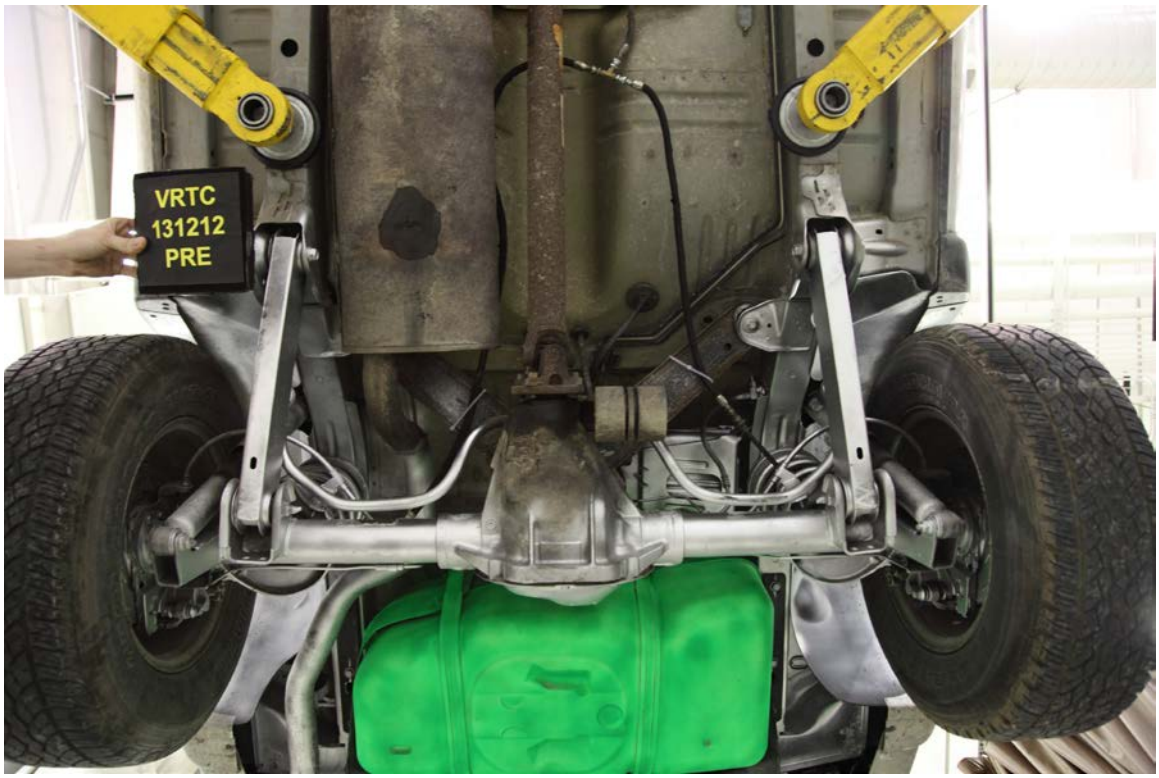


Figure A-21 Pre-Test Target Vehicle Fuel Line Close-up – View 1

Figure A-22 Pre-Test Target Vehicle Fuel Filler Close-up – View 2

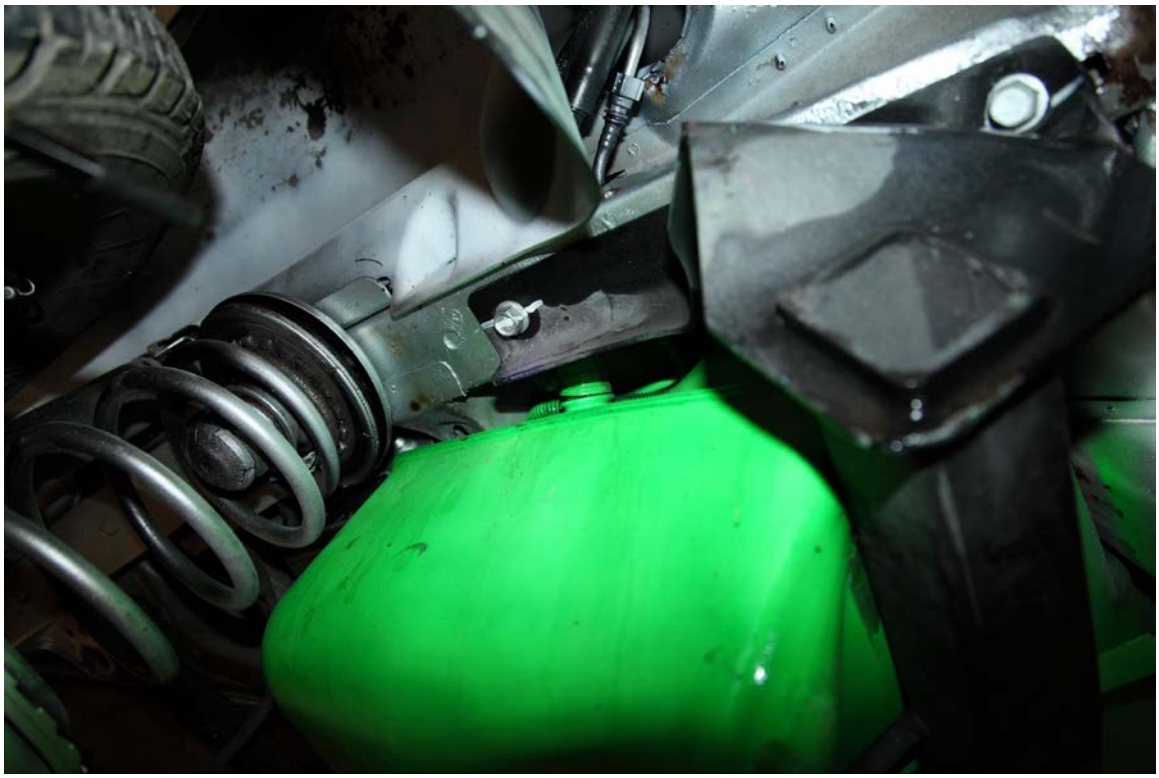


Figure A-23 Post-Test Target Vehicle Fuel Filler Close-up – View 1

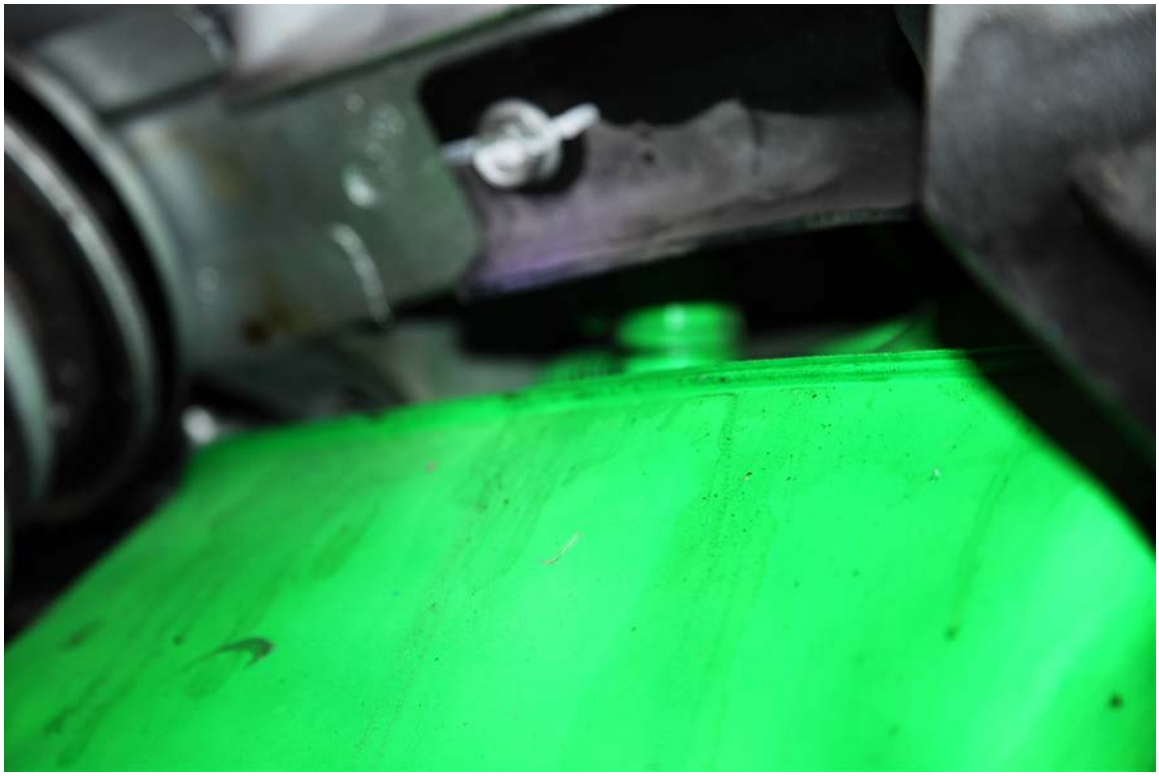


Figure A-24 Post-Test Target Vehicle Fuel Filler Close-up – View 2

Photo Not Available

Figure A-25 Pre-Test Target Vehicle Fuel Cap View

Photo Not Available

Figure A-26 Post-Test Target Vehicle Fuel Cap View

Figure A-27 Close-Up View of Target Certification Label

Intentionally Left Blank

Figure A-28 Pre-Test Bullet Vehicle Frontal View

Figure A-29 Post-Test Bullet Vehicle Frontal View

Figure A-30 Pre-Test Bullet Vehicle Left Front 3/4 View

Figure A-31 Post-Test Bullet Vehicle Left Front 3/4 View

Figure A-32 Pre-Test Bullet Vehicle Left Side View

Figure A-33 Post-Test Bullet Vehicle Left Side View

Figure A-34 Pre-Test Bullet Vehicle Rear View

Figure A-35 Post-Test Bullet Vehicle Rear View

Figure A-36 Pre-Test Bullet Vehicle Right Rear 3/4 View

Figure A-37 Post-Test Bullet Vehicle Right Rear 3/4 View

Figure A-38 Pre-Test Bullet Vehicle Right Side View

Figure A-39 Post-Test Bullet Vehicle Right Side View

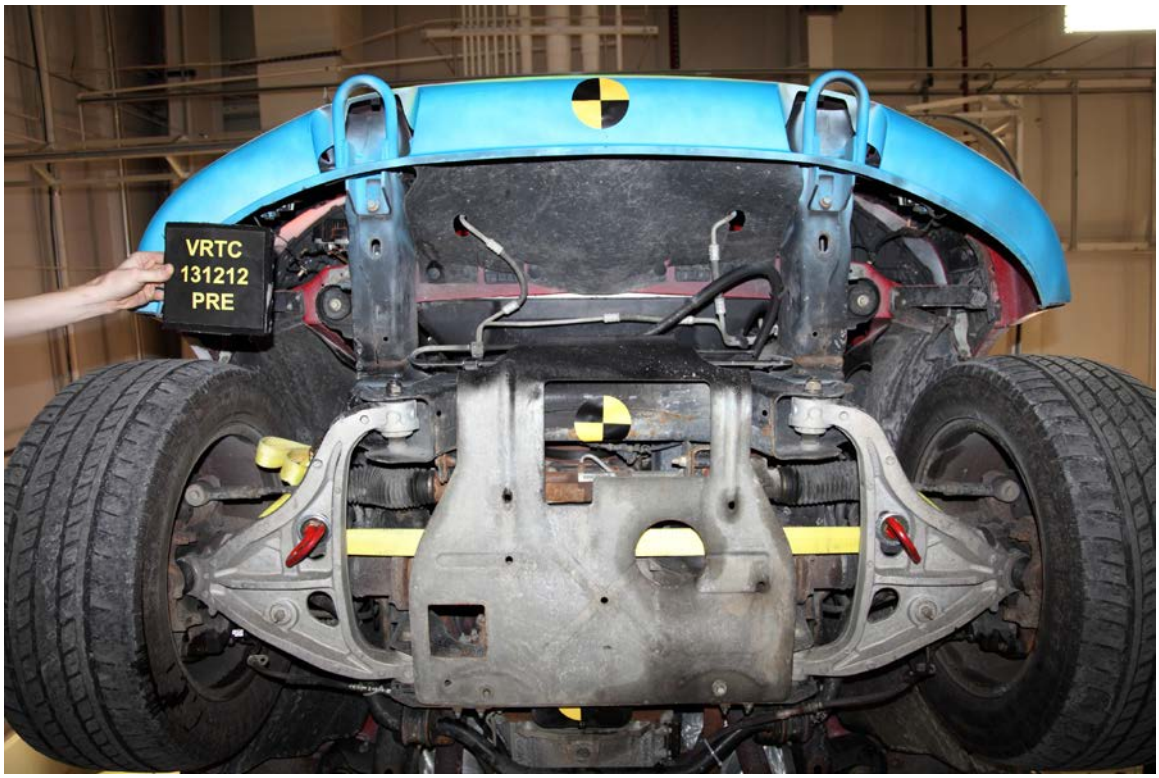


Figure A-40 Pre-Test Bullet Vehicle Front Underbody View

Figure A-41 Post-Test Bullet Vehicle Front Underbody View

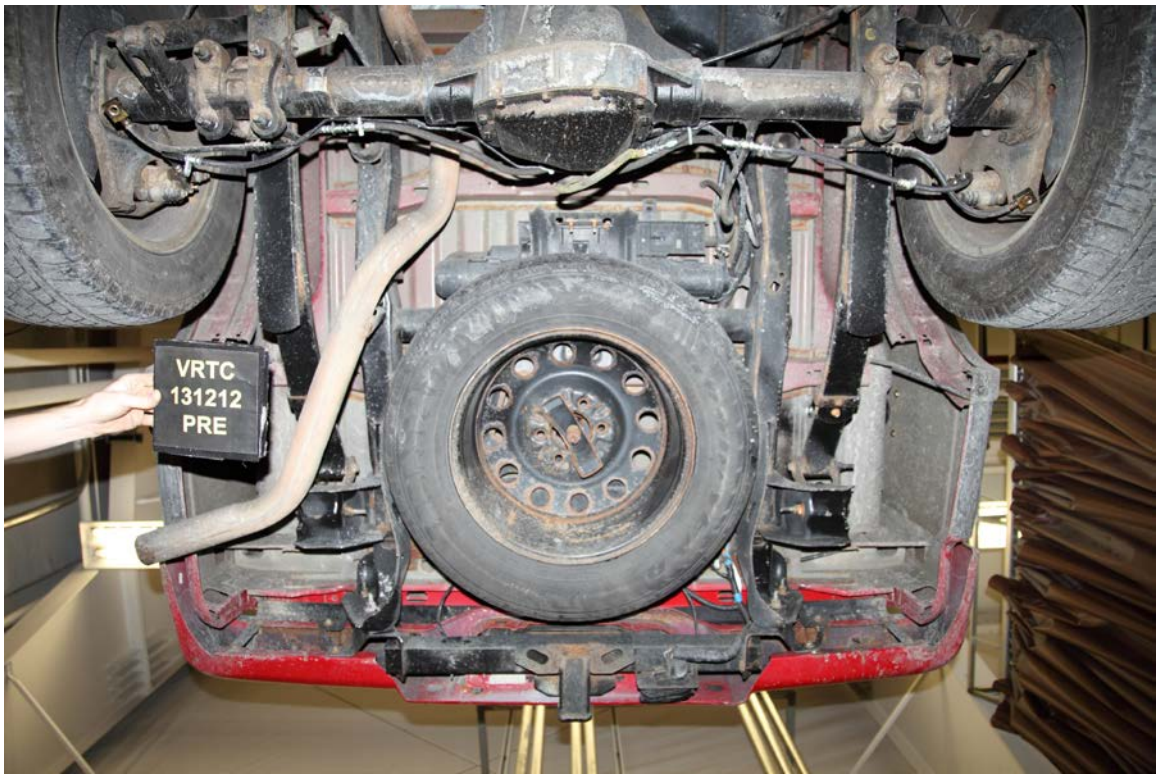


Figure A-42 Pre-Test Bullet Vehicle Rear Underbody View

Photo Not Available

Figure A-43 Post-Test Bullet Vehicle Rear Underbody View

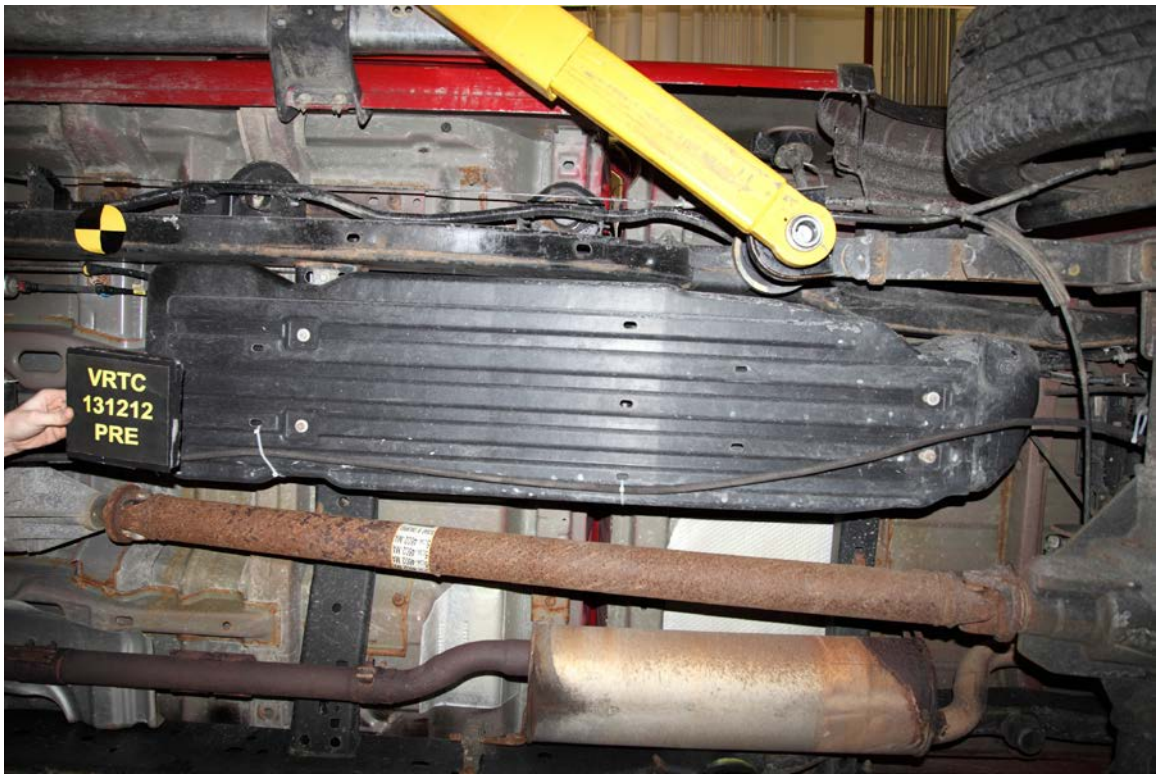


Figure A-44 Pre-Test Bullet Vehicle Fuel Tank View

Figure A-45 Post-Test Bullet Vehicle Fuel Tank View

Figure A-46 Pre-Test Bullet Vehicle Fuel Line Close-up View

Figure A-47 Post-Test Bullet Vehicle Fuel Line Close-up View

Figure A-48 Pre-Test Bullet Vehicle Fuel Filler Close-up View

Photo Not Available

Figure A-49 Post-Test Bullet Vehicle Fuel Filler Close-up View

Figure A-50 Close-Up View of Bullet Vehicle Certification Label

Figure A-51 Close-Up View of Bullet Vehicle Tire Information Placard or Label

Figure A-52 Pre-Test Bullet and Target Vehicles Overall Left Side View

Figure A-53 Post-Test Bullet and Target Vehicles Overall Left Side View

Figure A-54 Pre-Test Bullet and Target Vehicles Overall Right Side View

Figure A-55 Post-Test Bullet and Target Vehicles Overall Right Side View

Figure A-56 Pre-Test Bullet and Target Vehicles Overhead View

Figure A-57 Post-Test Bullet and Target Vehicles Overhead View

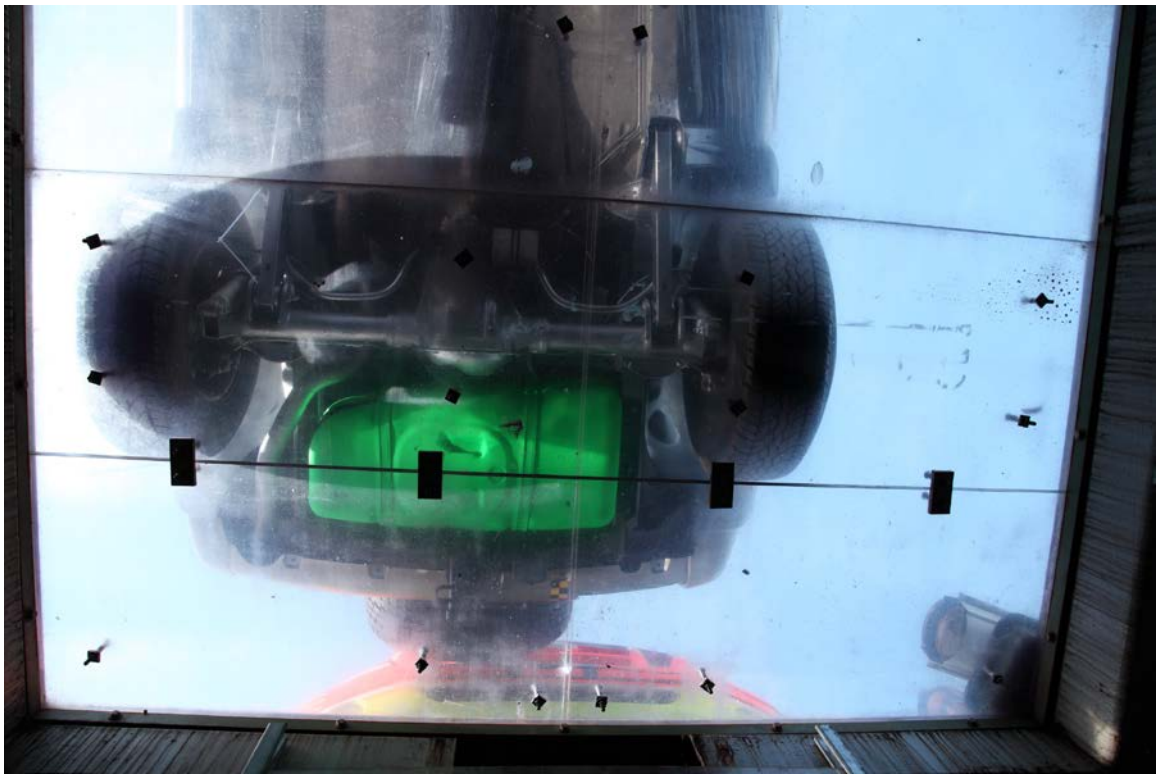


Figure A-58 Pre-Test Impact Alignment – Bullet and Target Vehicles Pit View

Intentionally Left Blank

Figure A-59 Target Vehicle at 90º on Static Rollover Device

Figure A-60 Target Vehicle at 180º on Static Rollover Device

Photo Not Available

Figure A-61 Target Vehicle at 270º on Static Rollover Device

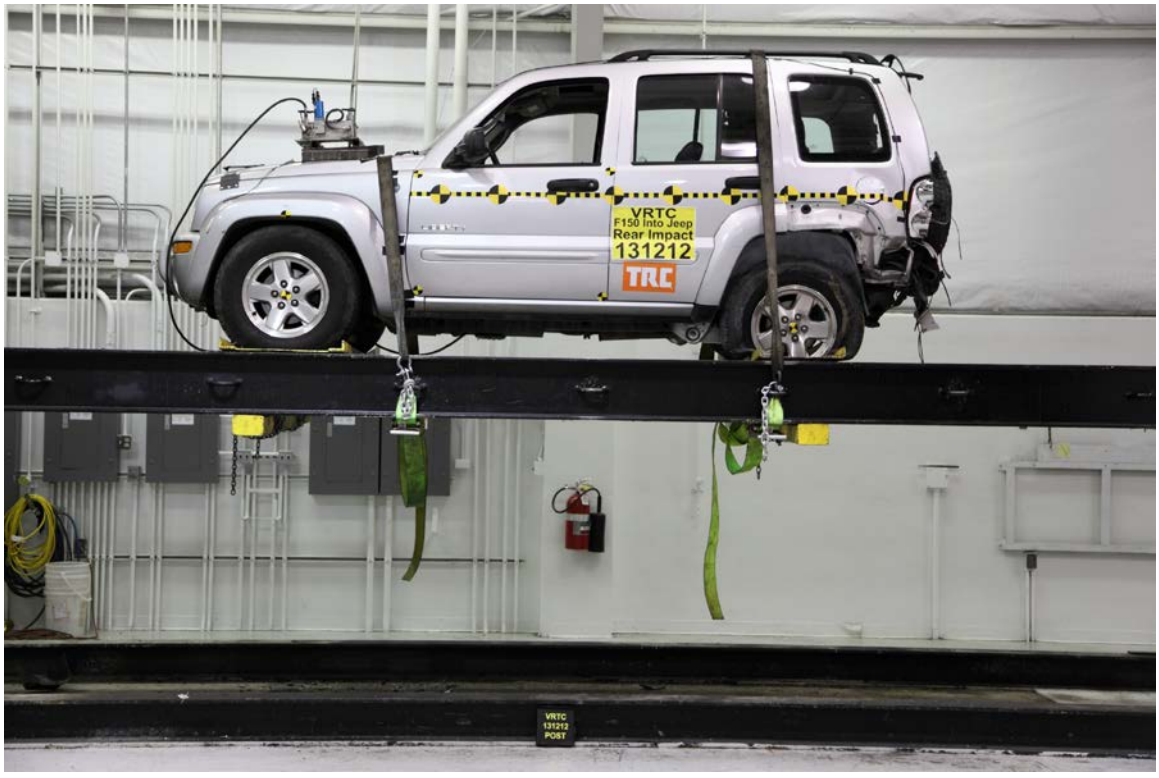


Figure A-62 Target Vehicle at 360º on Static Rollover Device

Appendix B

Data Plots

2008 Ford F150 Into Rear of 2004 Jeep Liberty

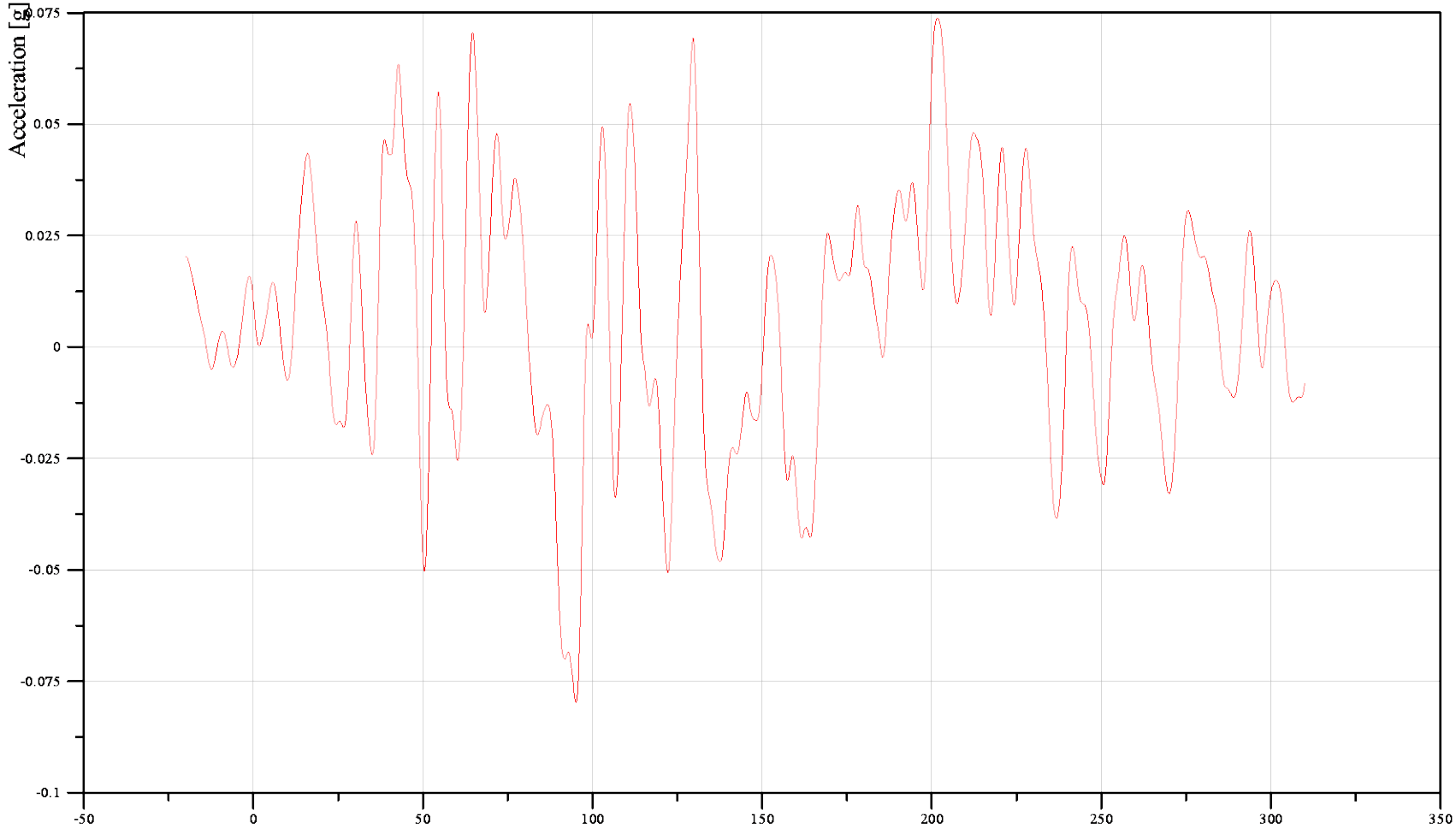
Bullet Bullet Vehicle CG X

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-0.08 g at 95.12 ms

Max. Value
0.07 g at 201.68 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

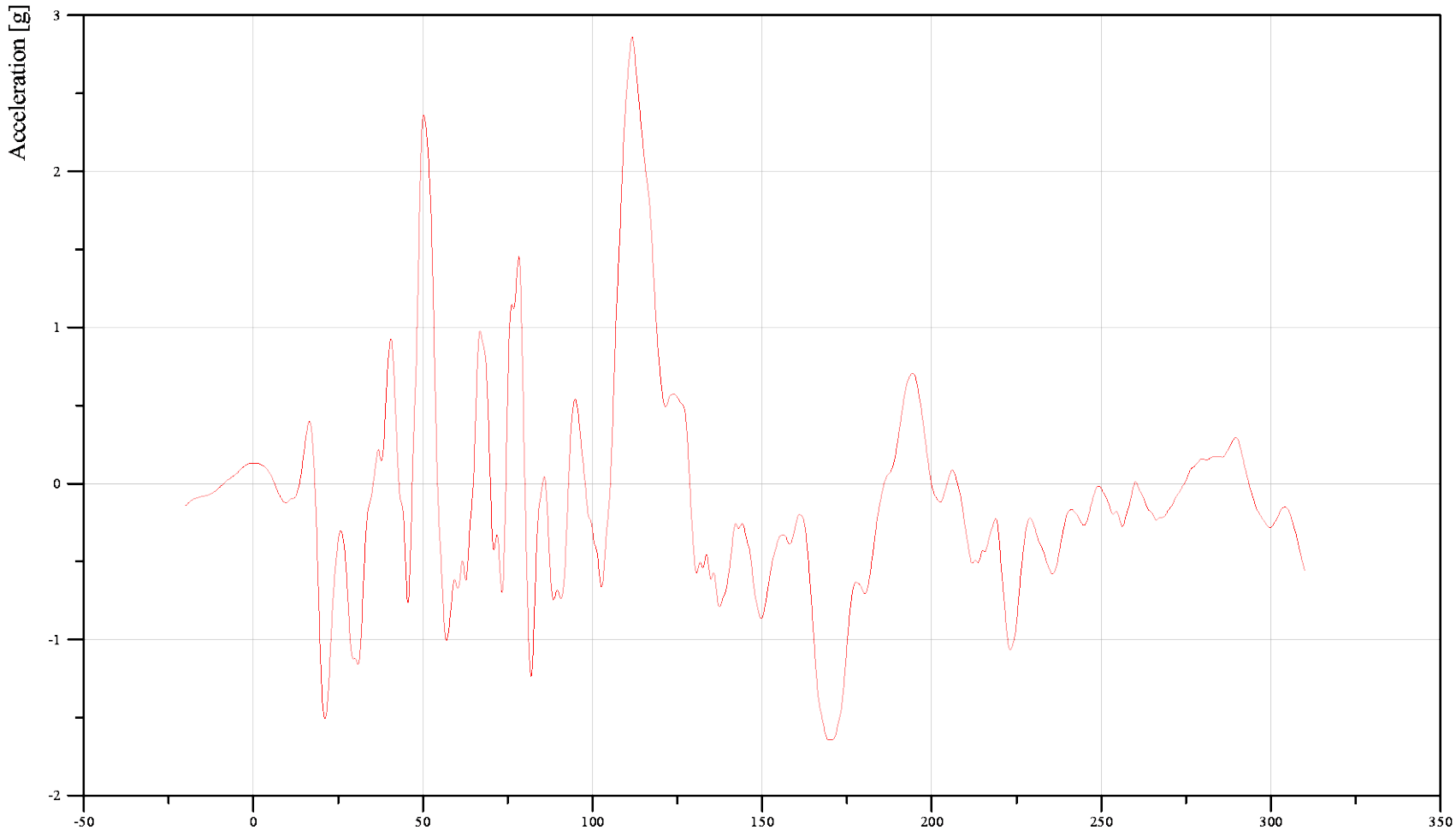
Bullet Bullet Vehicle CG Y

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-1.65 g at 169.92 ms

Max. Value
2.86 g at 111.68 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

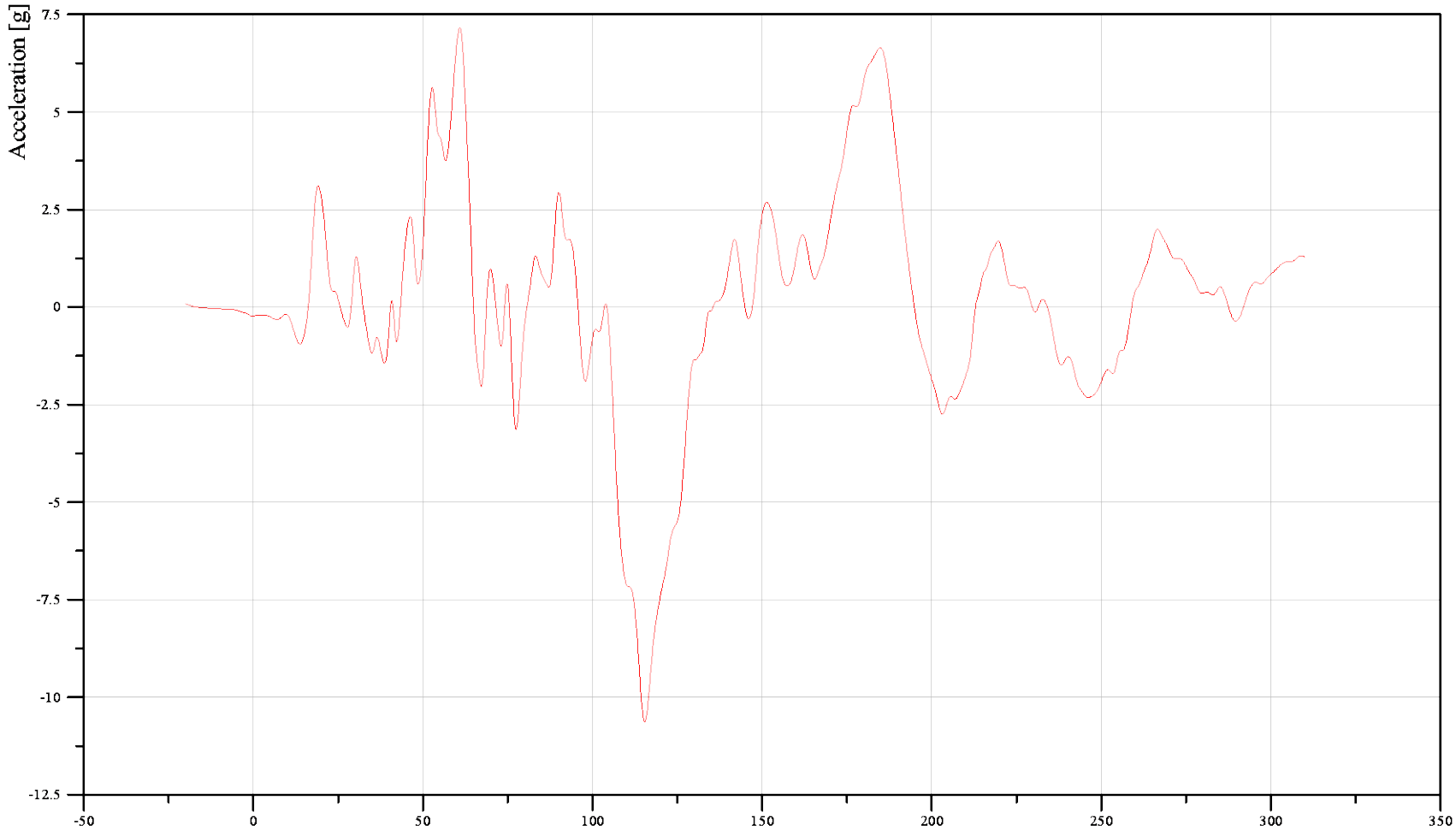
Bullet Bullet Vehicle CG Z

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-10.64 g at 115.36 ms

Max. Value
7.16 g at 60.88 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

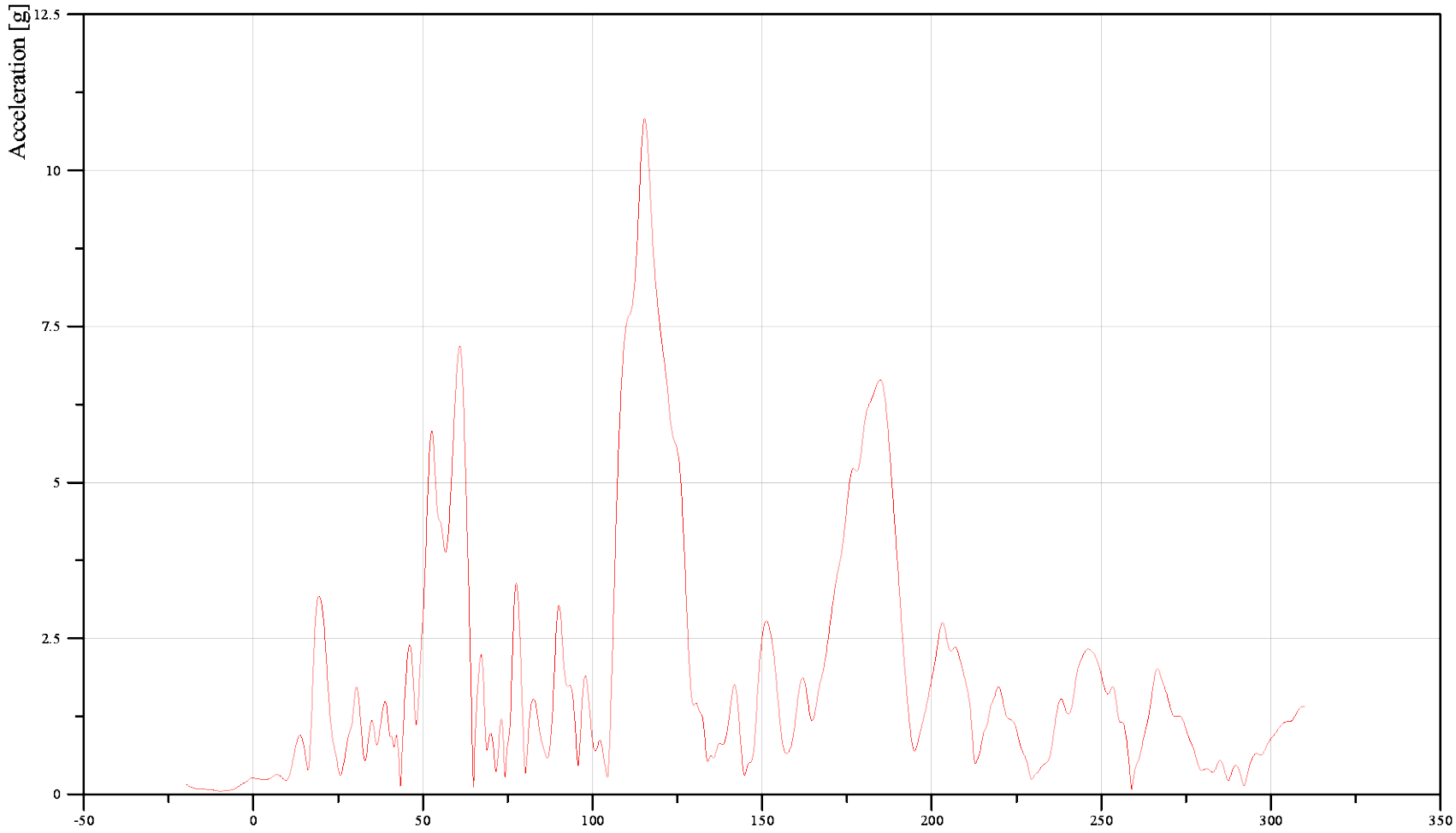
Bullet Vehicle CG Acceleration Resultant

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
0.05 g at -9.84 ms

Max. Value
10.84 g at 115.28 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

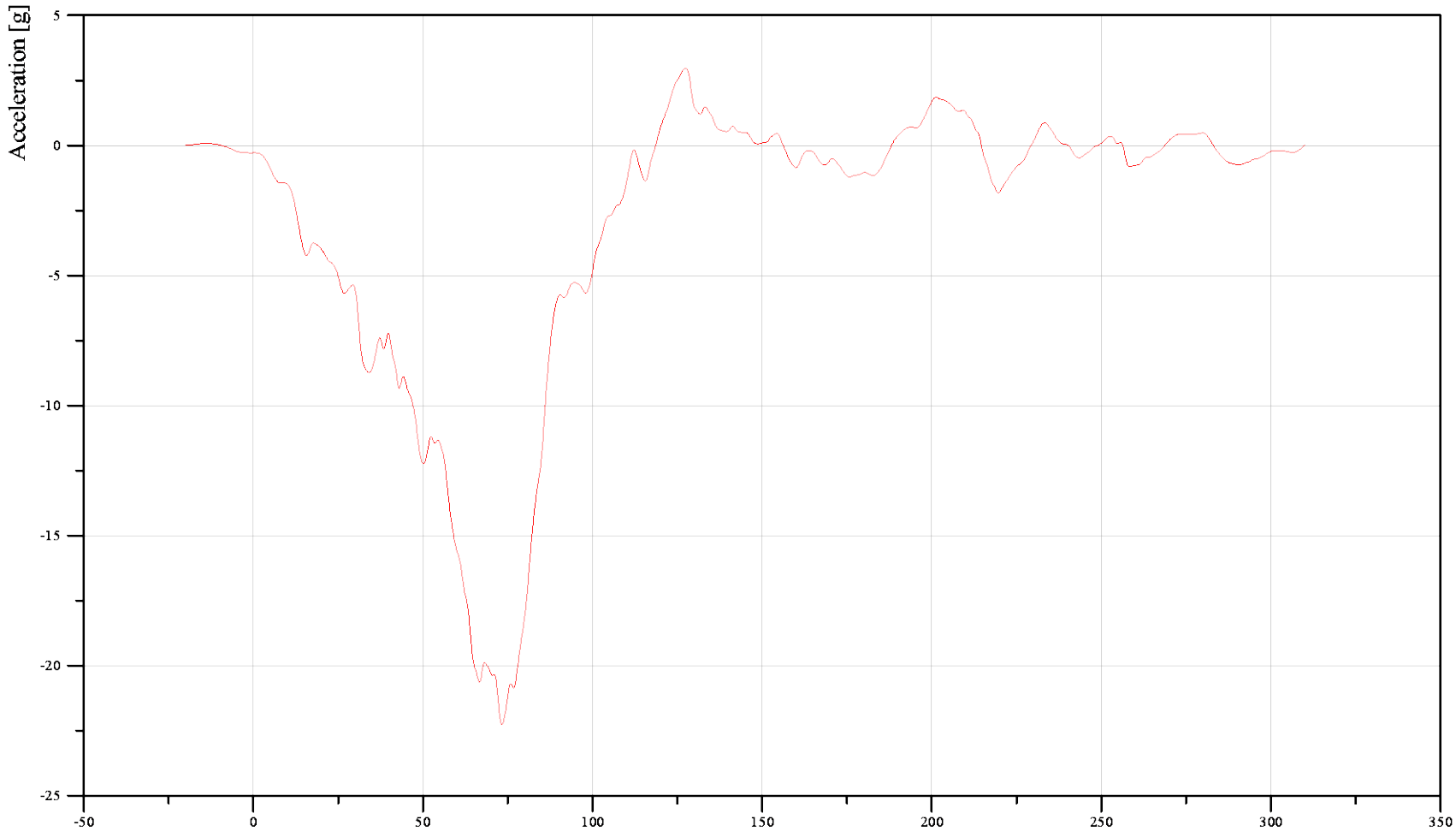
Bullet Vehicle CG Redundant X

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-22.26 g at 73.28 ms

Max. Value
2.95 g at 127.36 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

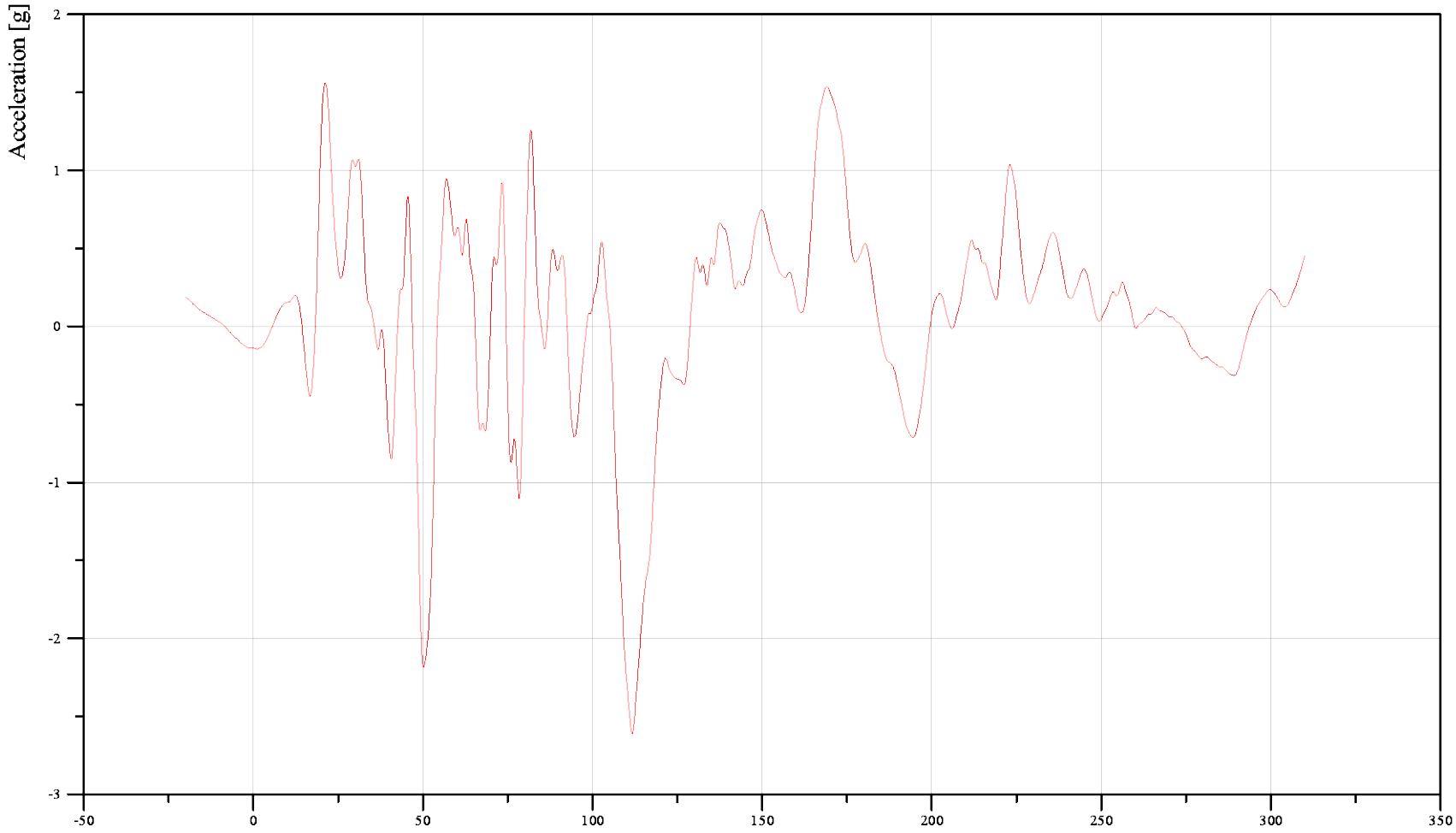
Bullet Vehicle CG Redundant Y

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-2.61 g at 111.76 ms

Max. Value
1.56 g at 21.12 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

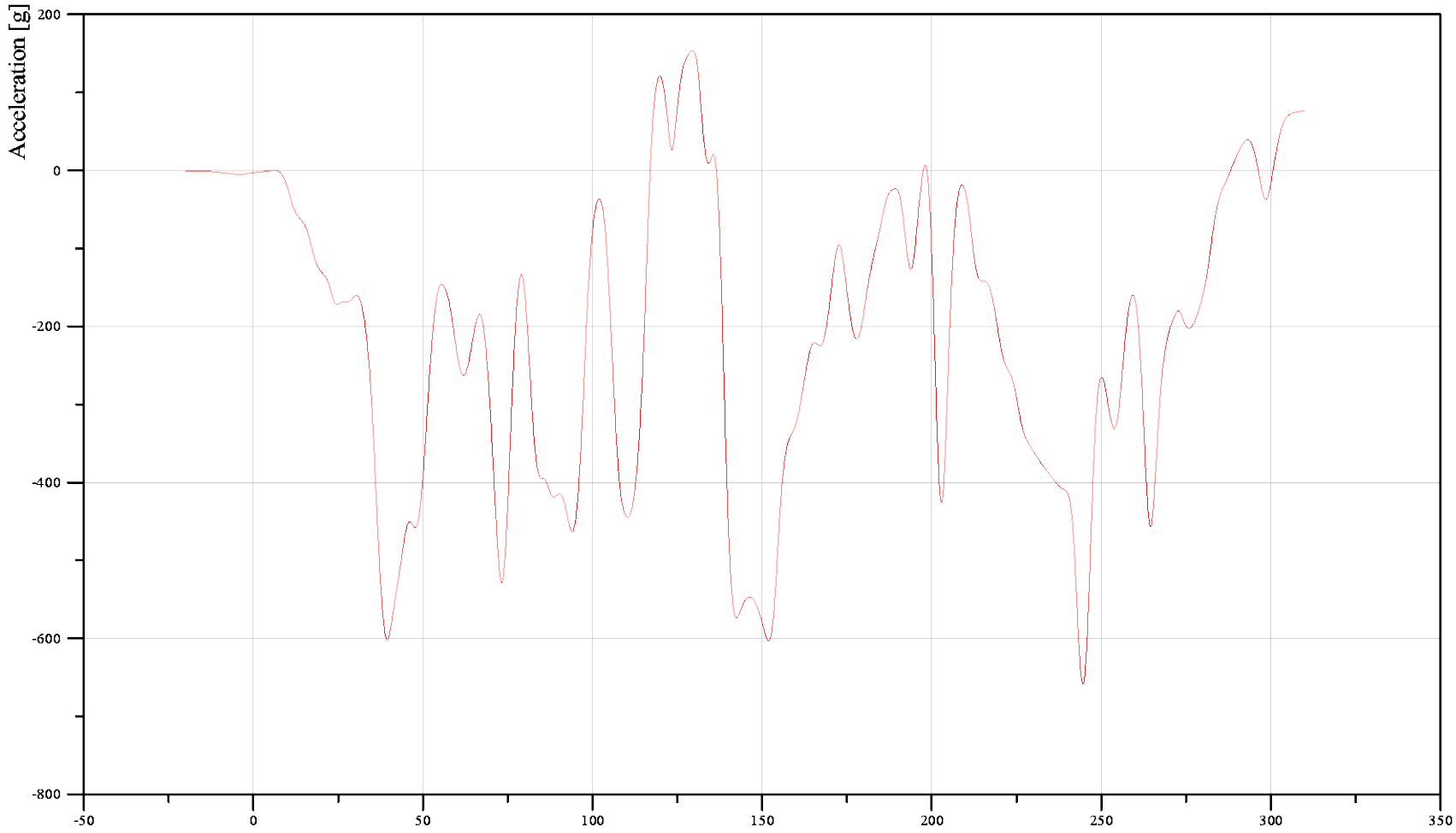
Bullet Vehicle CG Redundant Z

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-658.84 g at 244.64 ms

Max. Value
153.68 g at 129.60 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

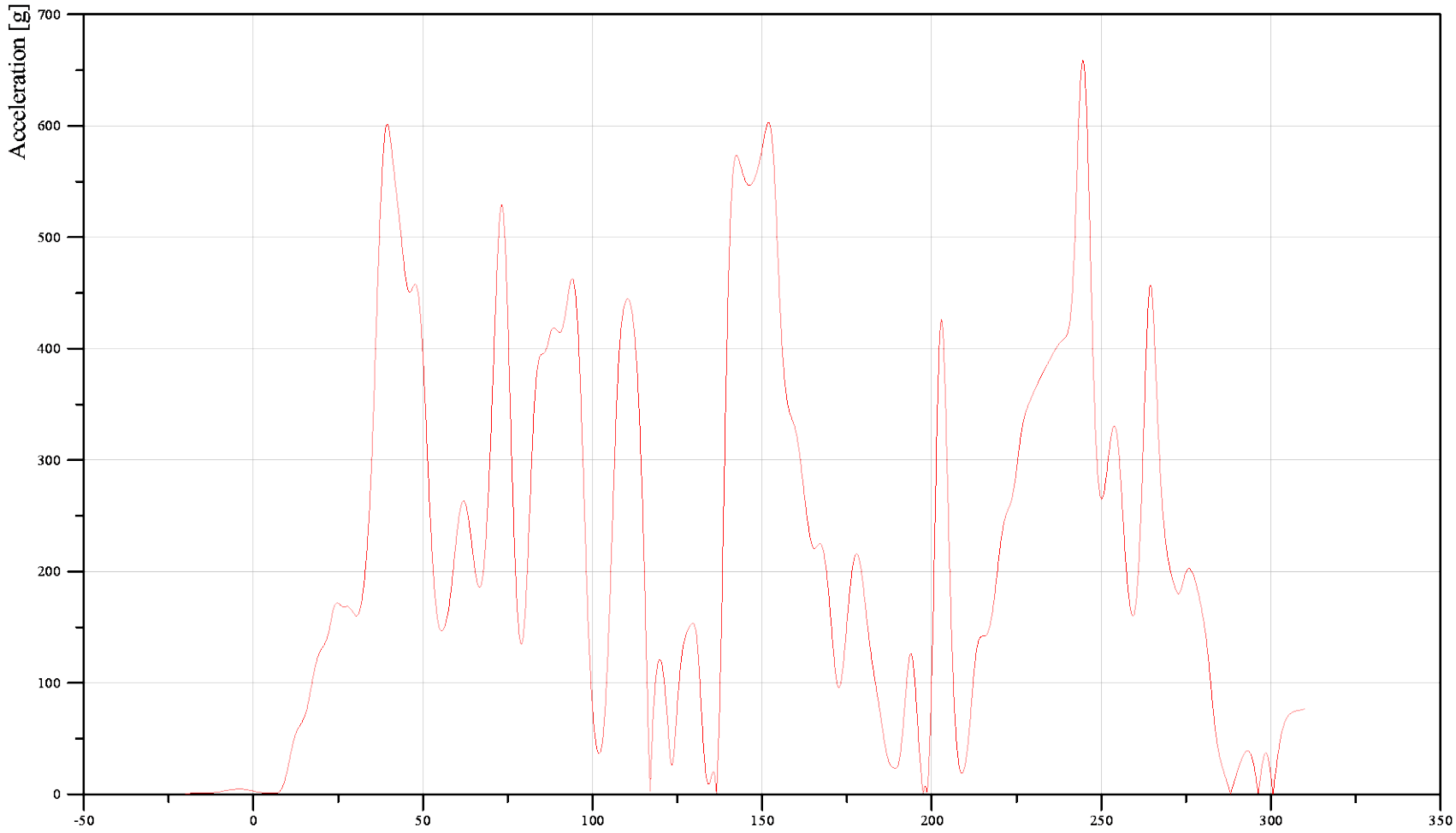
Bullet Vehicle CG Redundant Acceleration Resultant

Date: 12/12/2013
Time: 13:27

Customer: VRTC

10VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
0.51 g at 300.64 ms

Max. Value
658.84 g at 244.64 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

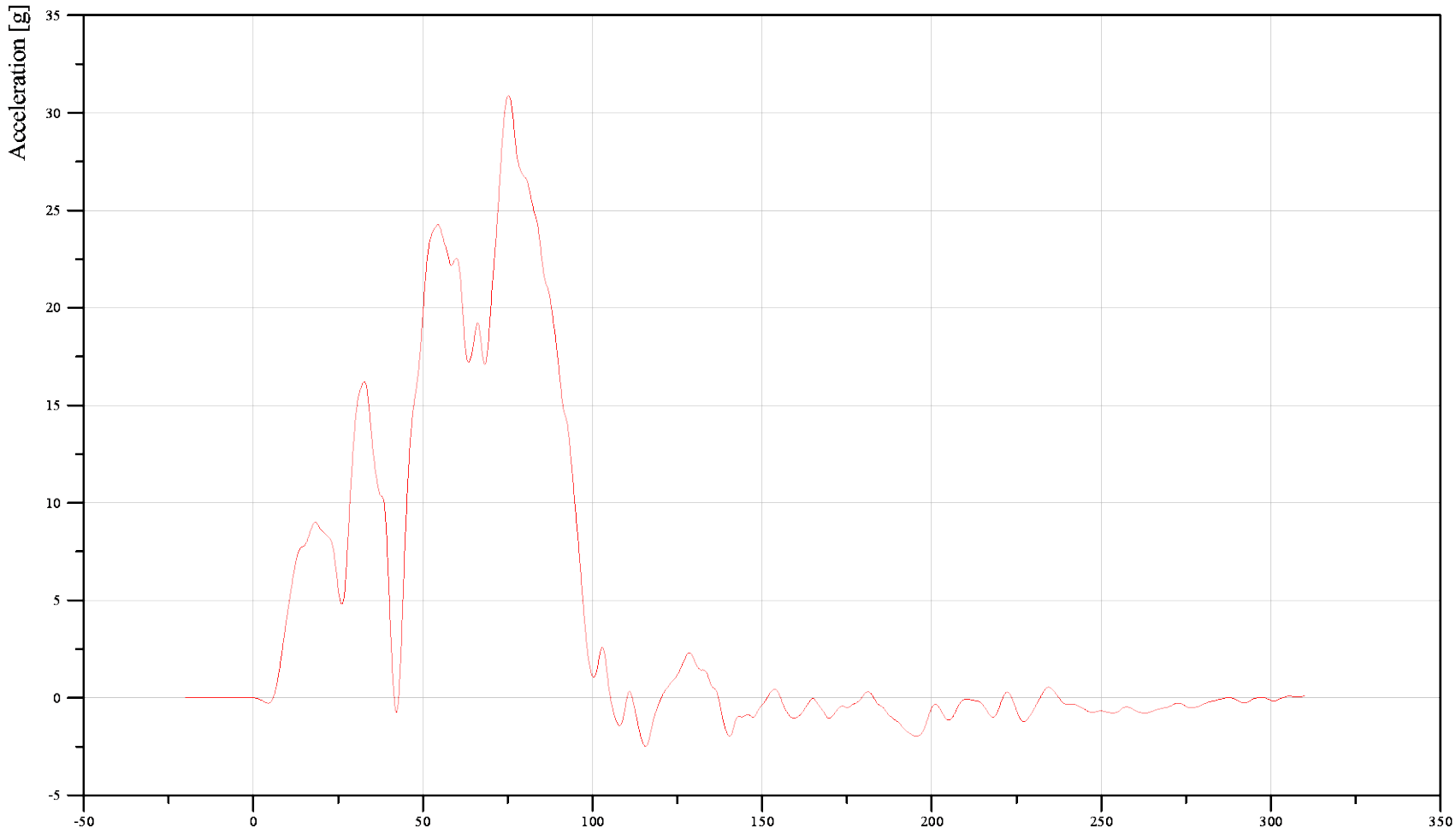
Target Target Vehicle CG X

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-2.50 g at 115.60 ms

Max. Value
30.89 g at 75.20 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

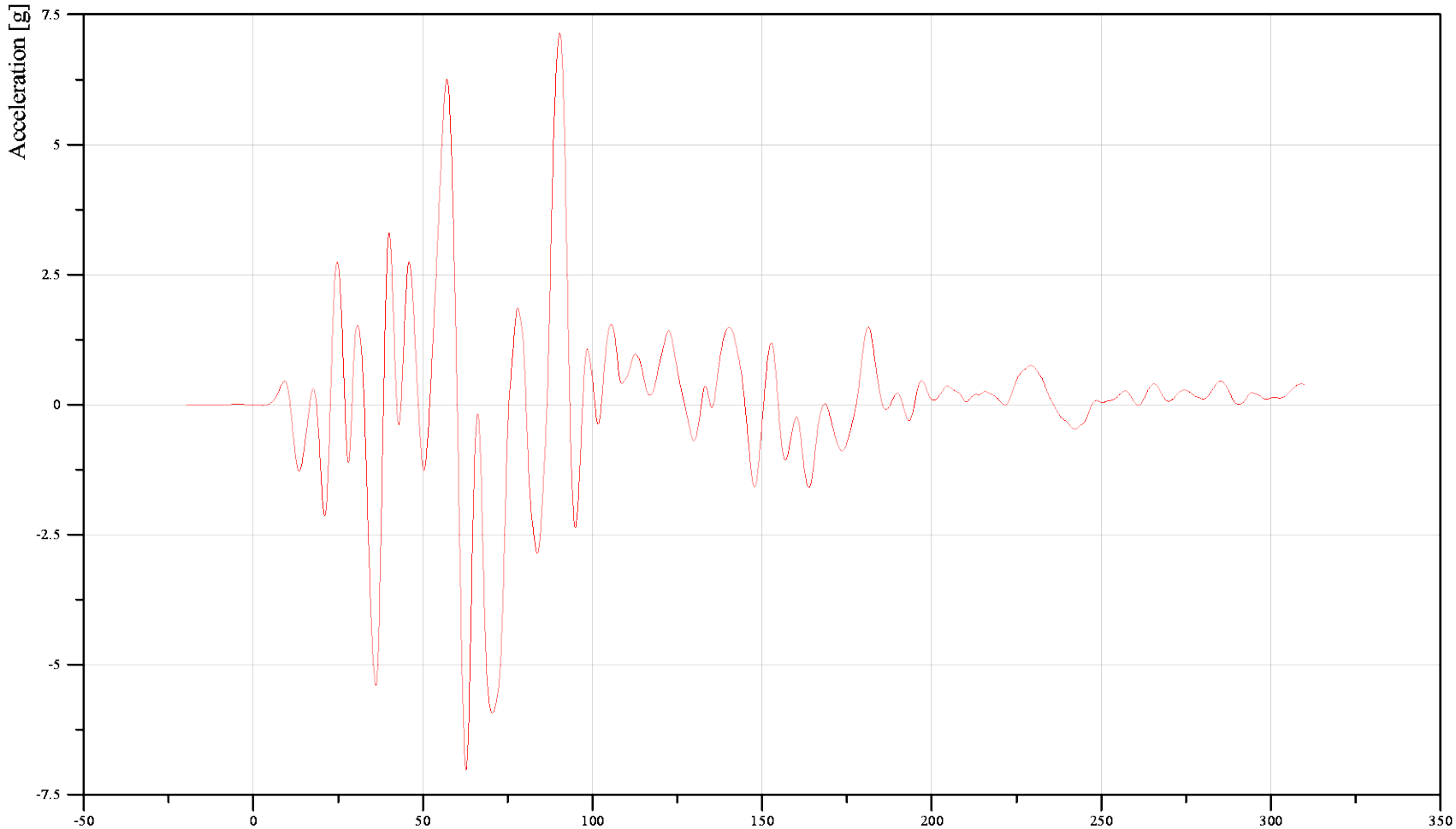
Target Target Vehicle CG Y

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-7.03 g at 62.72 ms

Max. Value
7.14 g at 90.24 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

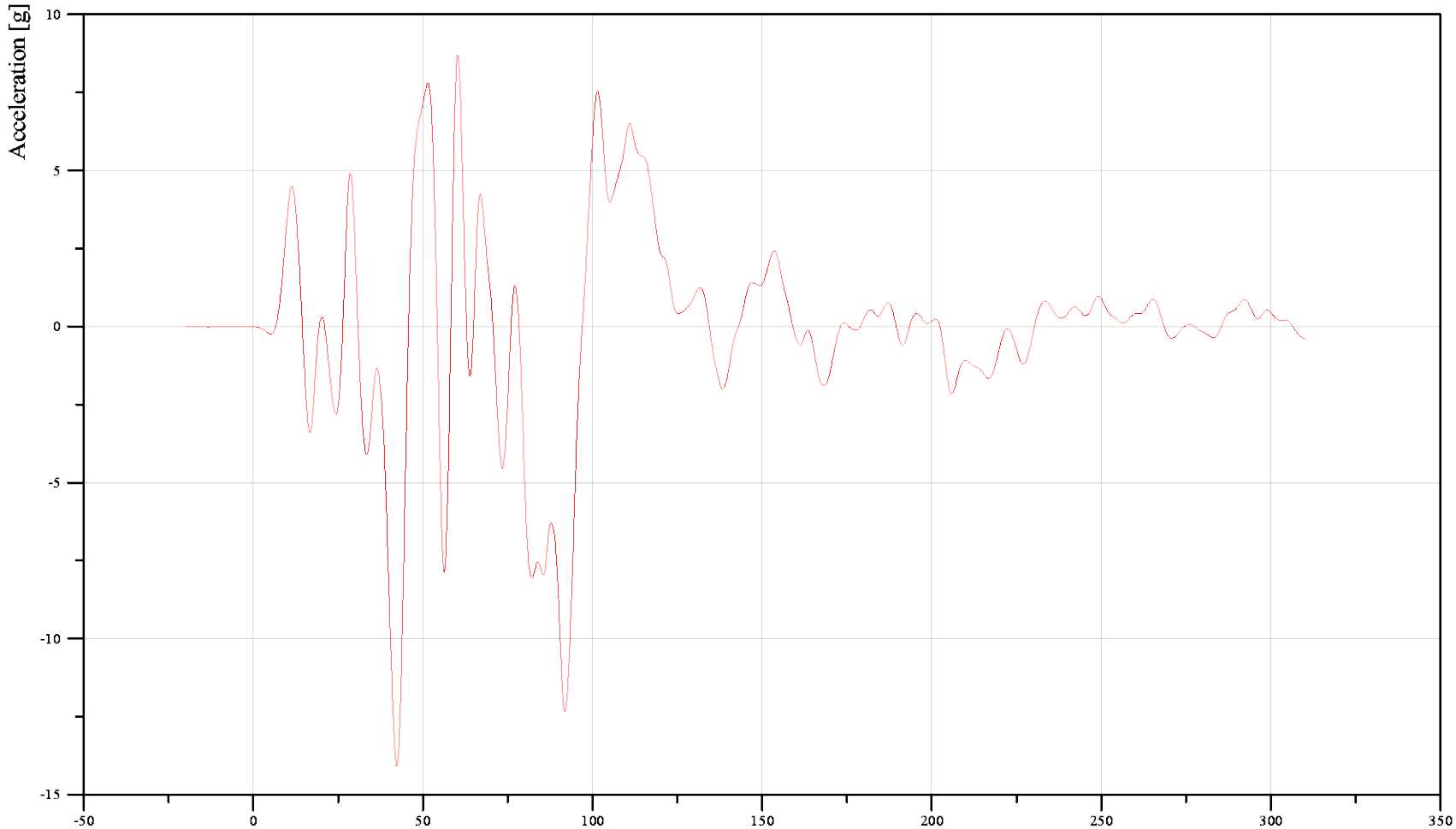
Target Target Vehicle CG Z

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-14.08 g at 42.32 ms

Max. Value
8.70 g at 60.24 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

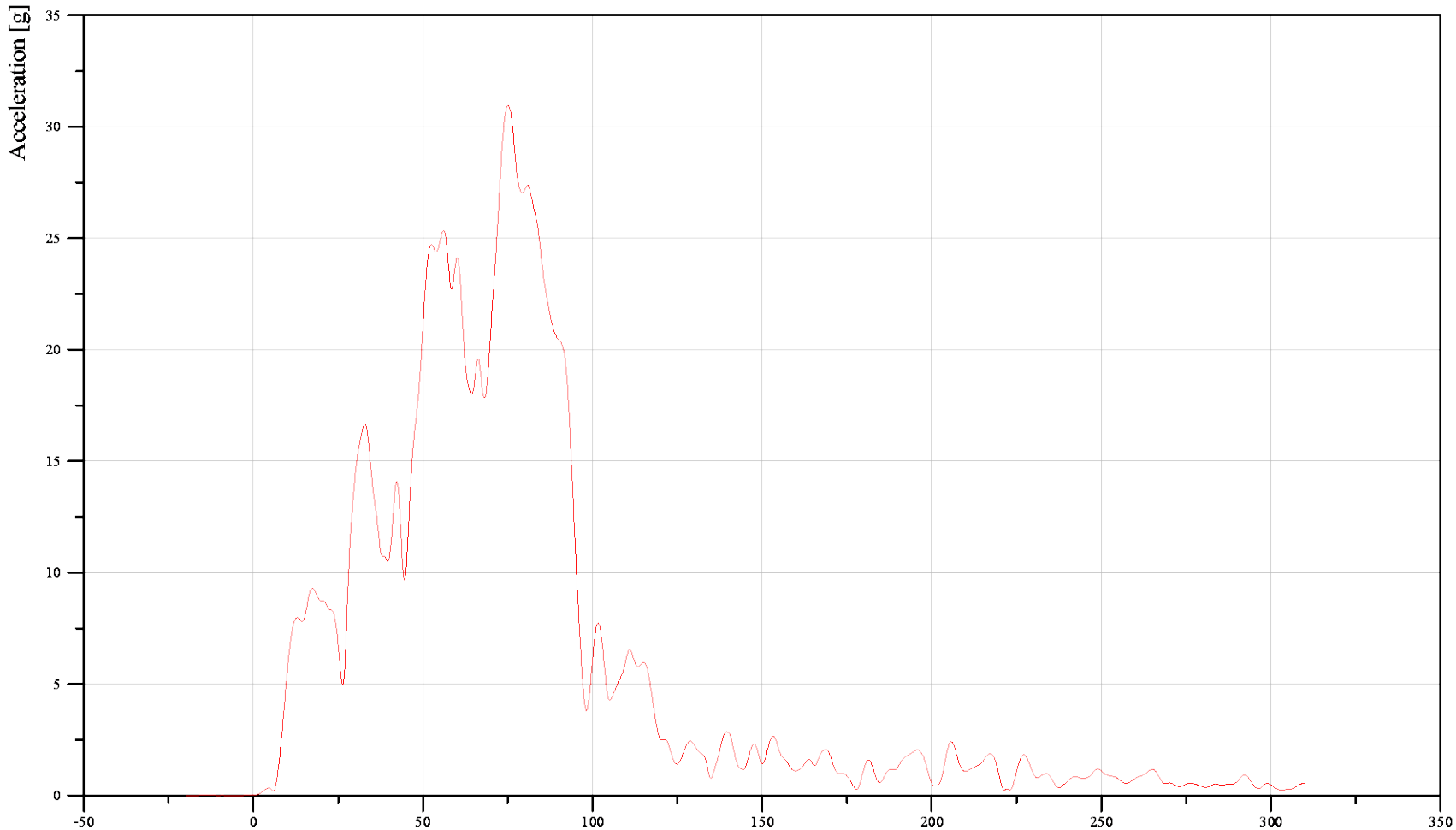
Target Vehicle CG Acceleration Resultant

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
0.00 g at -18.24 ms

Max. Value
30.96 g at 75.04 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

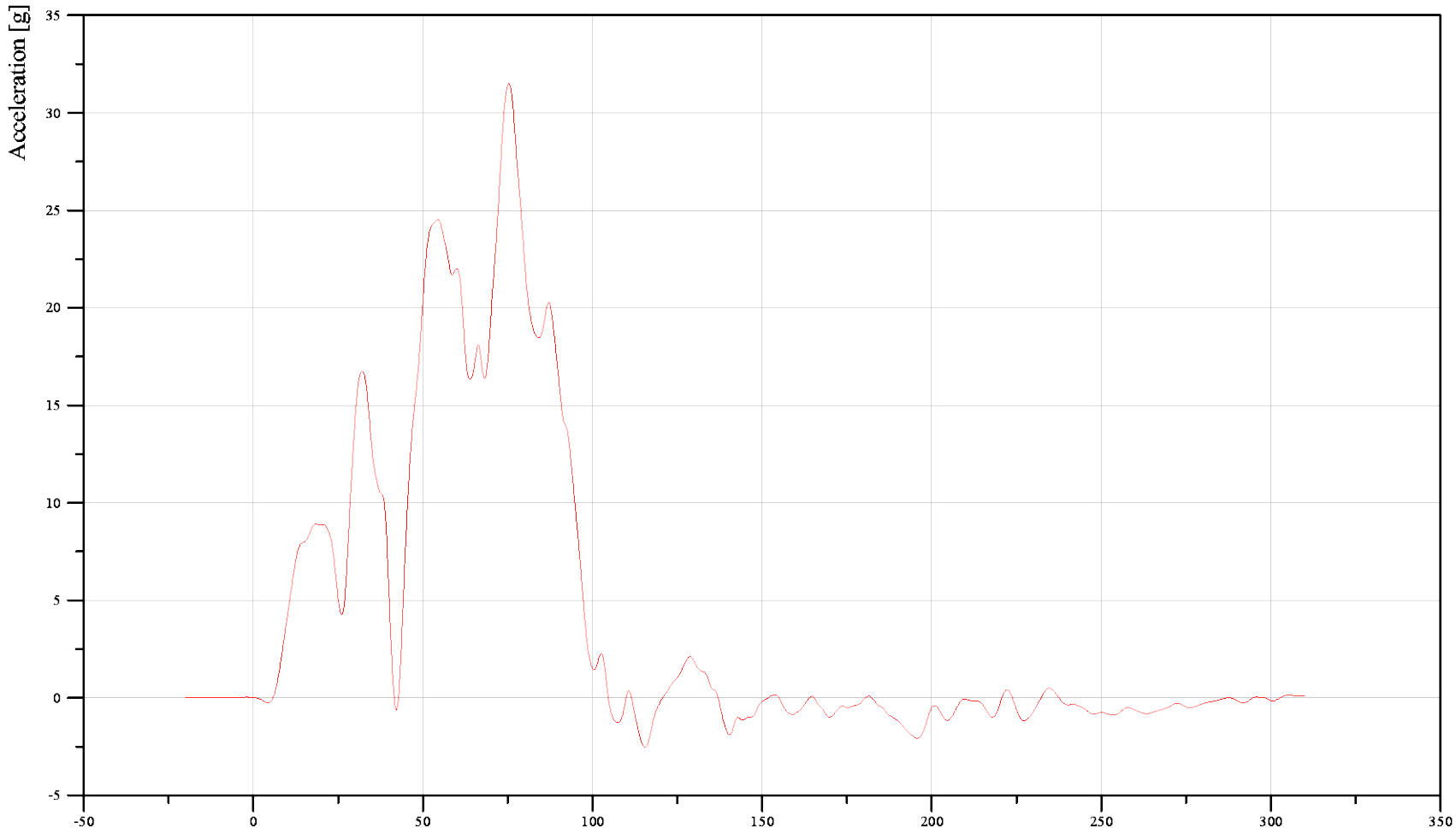
Target Vehicle CG Redundant X

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-2.51 g at 115.52 ms

Max. Value
31.50 g at 75.36 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

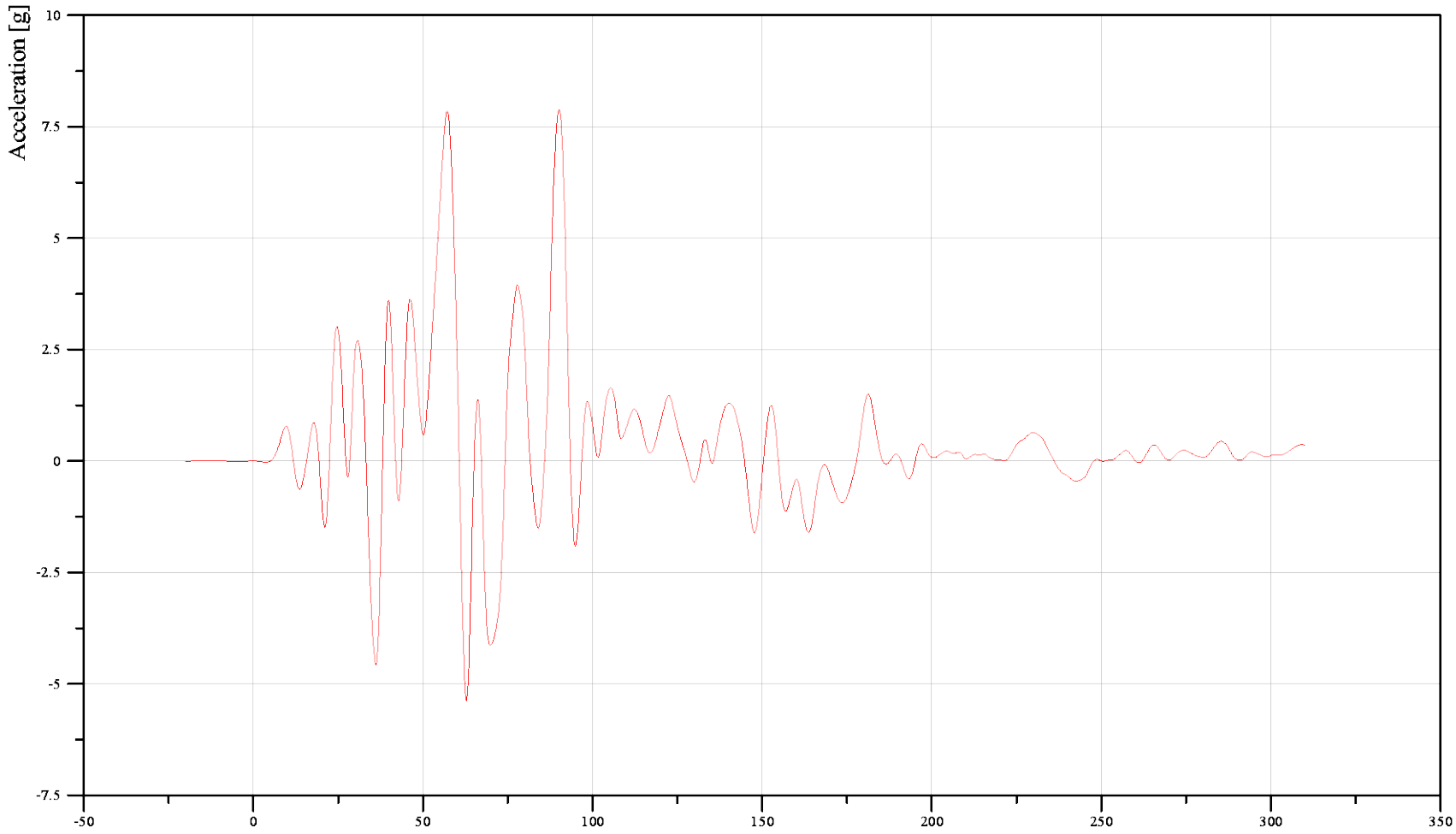
Target Vehicle CG Redundant Y

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-5.39 g at 62.80 ms

Max. Value
7.89 g at 90.08 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

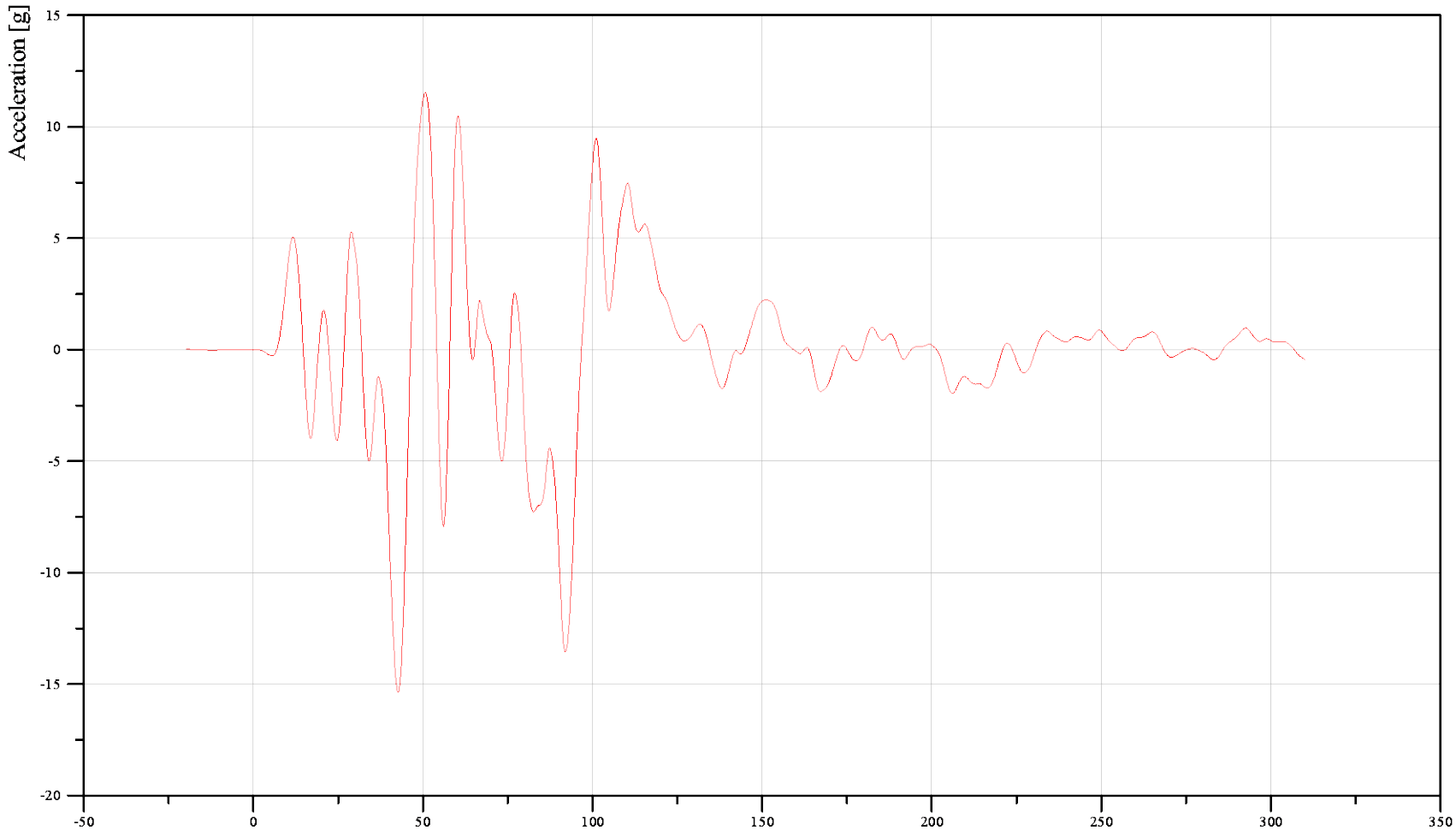
Target Vehicle CG Redundant Z

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
-15.38 g at 42.72 ms

Max. Value
11.53 g at 50.72 ms

2008 Ford F150 Into Rear of 2004 Jeep Liberty

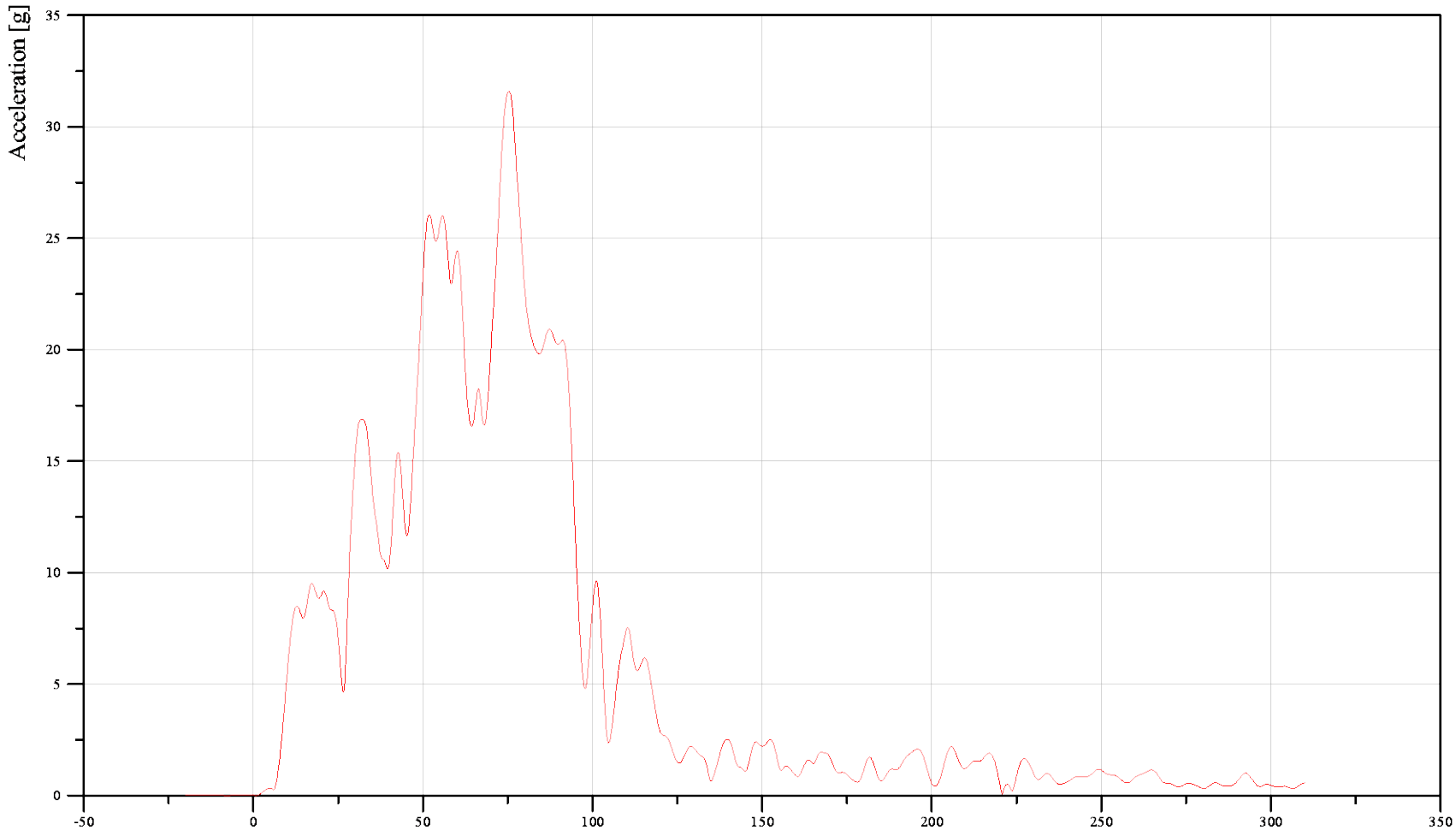
Target Vehicle CG Redundant Acceleration Resultant

Date: 12/12/2013
Time: 13:27

Customer: VRTC

20VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131212



Filter: CFC_60

Min. Value
0.01 g at 0.80 ms

Max. Value
31.60 g at 75.28 ms