Vehicle Research and Test Center

1993 Cadillac DeVille into

Rear of a 1996 Jeep GC-ZJ

TRC Inc. Test Number: 131107

Prepared By:

Transportation Research Center Inc.

10820 State Route 347

East Liberty, OH 43319

Final Report

November 2013 – January 2014

Prepared For:

Vehicle Research and Test Center

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Test Performed By: John Shultz, Supervisor

Report Approved January 23, 2014 by:

Jeffery W. Sankey
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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 56.3 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 1993 Cadillac DeVille, and the vehicle response of the target vehicle, a 1996 Jeep GC-ZJ, 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 1996 Jeep GC-ZJ, was instrumented with six (6) accelerometers to measure longitudinal, lateral and vertical axis accelerations.

The bullet vehicle, a 1993 Cadillac DeVille, was instrumented with six (6) accelerometers to measure longitudinal, lateral and vertical axis accelerations. The vehicle's specified impact velocity range was 55.5 to 57.1 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 381 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 56.3 km/h 180° vehicle-to-vehicle rear impact test was conducted by TRC Inc. on November 7, 2013.

The target test vehicle, a 1996 Jeep GC-ZJ, was equipped with a 4.0-liter 6 cylinder engine, 3 speed automatic transmission, power steering, power brakes, and front airbags. The target vehicle's test weight was 1830.2 kg.

The bullet test vehicle, a 1993 Cadillac DeVille, was equipped with a 4.9-liter 8 cylinder transverse engine, 4 speed automatic transmission, power steering, power brakes, and front airbags. The bullet vehicle's test weight was 1760.4 kg. The bullet vehicle's impact speed was 56.3 km/h.

Data Acquisition Explanations

There are no anomalies to report.

Table 1 Crash Test Summary

Test mode:	Vehicle to Vehicle Rear Impact
Test date:	November 7, 2013
Test time:	13:49 PM
Ambient temperature:	5.7° C
Target vehicle year/make/ model/body style:	1996Jeep/GC-ZJ/MPV
Target vehicle test weight:	1830.2 kg
Bullet vehicle year/make/ model/body style:	1993/Cadillac/DeVille/ Sedan
Bullet vehicle test weight:	1760.4 kg
Impact angle[1]:	180°
Impact velocity[2]:	Bullet vehicle = 56.3 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:	1996/Jeep/GC-ZJ/MPV
VIN:	1J4GZ58S1TC166497
Model year:	1996
Body style:	MPV
Color:	Tan
Engine data:	
Cylinders:	6
Displacement	4.0 liters
Type:	Straight
Placement:	Longitudinal
Transmission data:	_3_ speed, __ manual, _X_ automatic, _X_ overdrive
Final drive:	__ FWD, __ RWD, _X_ 4WD
Date vehicle received:	11/5/2013
Odometer reading:	250,992
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:		Chrysler Corporation
Date of manufacture:		7/96
VIN:		1J4GZ58S1TC166497
GVWR:		5300 lbs. (2405 kg)
GAWR:	Front:	2750 lbs. (1248 kg)
	Rear:	2950 lbs. (1339 kg)

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

Tires on vehicle (mfr., line, size):	Uniroyal, Liberator A/T, P215/75R15
Tire pressure with maximum capacity vehicle load:	
Front:	44 psi (300 kPa)
Rear:	44 psi (300 kPa)
Spare tire (mfr., line, size):	Goodyear, Temporary, T155/90D16
Type of seats:	
Front	Bucket
Rear	Split Bench
Maximum width:	1800 mm
Wheelbase:	2690 mm

Location of "Recommended Tire Pressure" label:

Left front door

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

Recommended tire size:	P215/75R15
Recommended cold tire pressure:	Front: 33 psi (N/A kPa) Rear: 33 psi (N/A 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 758 mm;	RF 780 mm;	LR 787 mm;	RR 799 mm
Post-test attitude:	LF 716 mm;	RF 840 mm;	LR 645 mm;	RR 740 mm

Table 2 Target Vehicle General Test and Vehicle Parameter Data Continued

Weight of test vehicle with required dummies and cargo weight:

Right front	503.8 kg	Right rear	381.8 kg
Left front	548.6 kg	Left rear	396.0 kg
Total front weight	1052.4 kg	(57.5% of total vehicle weight)	
Total rear weight	777.8 kg	(42.5% of total vehicle weight)	
Total test weight	1830.2 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1143 mm rearward of front wheel centerline

Fuel System Data:

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

Actual test volume: 68.5 liters

Table 3 Bullet Vehicle General Test and Vehicle Parameter Data

Vehicle year/make/ model/body style:	1993/Cadillac/DeVille/Sedan
VIN:	1G6CD53B4P4203815
Model year:	1993
Body style:	Sedan
Color:	Black
Engine data:	
Cylinders:	8
Displacement	4.9 liters
Type:	V
Placement:	Transverse
Transmission data:	_4_ speed, __ manual, _X_ automatic, _X_ overdrive
Final drive:	_X_ FWD, __ RWD, ___ 4WD
Date vehicle received:	11/5/2013
Odometer reading:	105,894
Dealer's name	Customer Supplied

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	Yes
Power seats	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	Yes
Other	None	Power door locks	Yes

Certification data from vehicle's label:

Vehicle manufactured by:		General Motors Corporation
Date of manufacture:		8/92
VIN:		1G6CD53B4P4203815
GVWR:		4694 lbs. (2129 kg)
GAWR:	Front:	2628 lbs. (1192 kg)
	Rear:	2066 lbs. (937 kg)

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

Tires on vehicle (mfr., line, size): Michelin, Symetry, P205/70R15

Tire pressure with maximum capacity vehicle load:
Front: 30 psi (210 kPa)
Rear: 30 psi (210 kPa)

Spare tire (mfr., line, size): Uniroyal, Temporary, T125/70D15

Type of seats:
Front: Split bench
Rear: Bench

Maximum width: 1870 mm

Wheelbase: 2900 mm

Location of "Recommended Tire Pressure" label:

Driver Door

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

Recommended tire size: P205/70R15

Recommended cold tire pressure: Front: 30 psi (210 kPa)
Rear: 30 psi (210 kPa)

Seating capacity: Front: 3
Mid: 0
Rear: 3
Total: 6

Vehicle capacity weight: 1027 lbs. (466 kg)

Rated cargo/luggage weight: N/A lbs. (N/A kg)

Test vehicle attitude:

Pre-test attitude:	LF 667 mm;	RF 673 mm;	LR 663 mm;	RR 663 mm
Post-test attitude:	LF 667 mm;	RF 638 mm;	LR 633 mm;	RR 647 mm

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

Weight of test vehicle with required dummies and cargo weight:

Right front	526.0 kg	Right rear	388.6 kg
Left front	544.0 kg	Left rear	351.8 kg
Total front weight	1070.0 kg	(60.8% of total vehicle weight)	
Total rear weight	690.4 kg	(39.2% of total vehicle weight)	
Total test weight	1760.4 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1137 mm rearward of front wheel centerline

Fuel System Data:

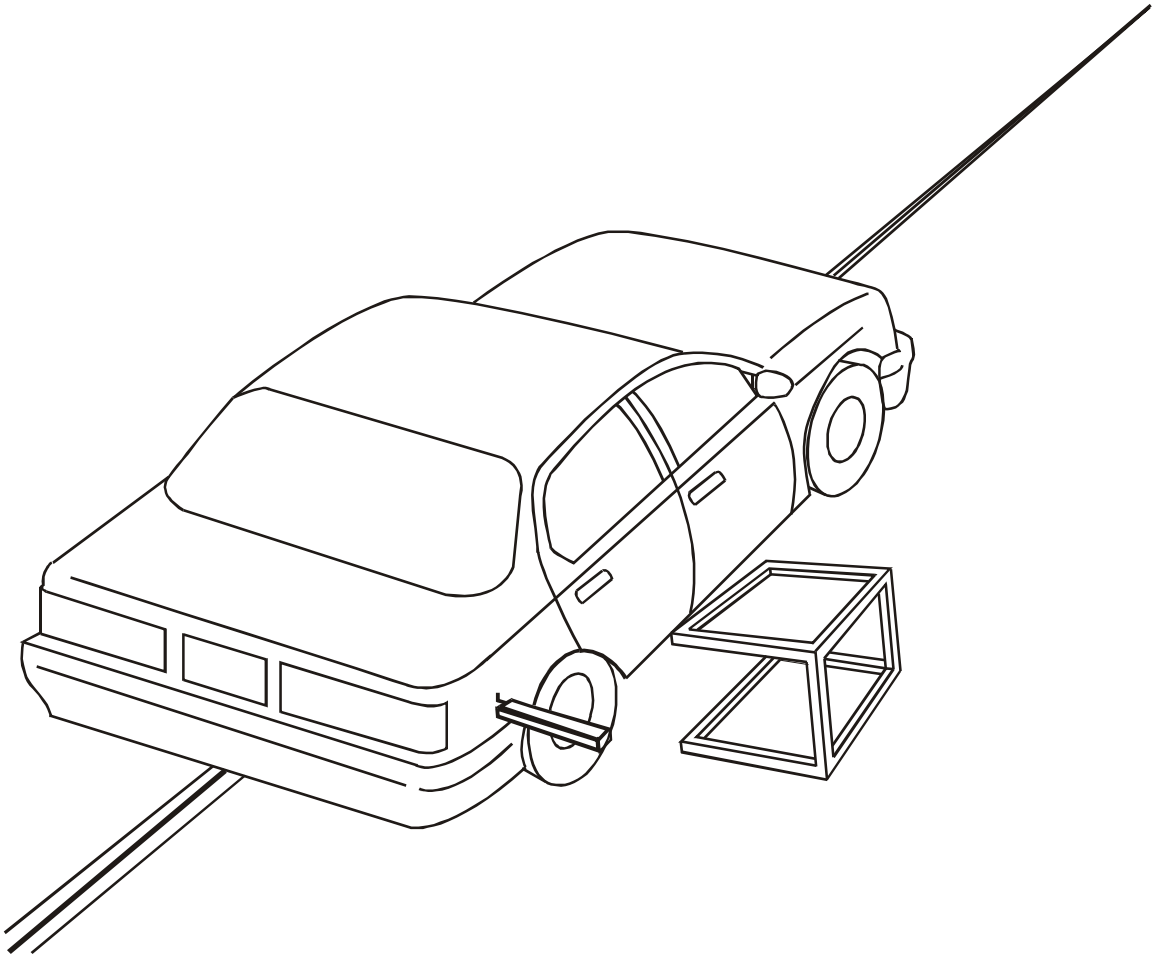
Usable fuel system capacity N/A liters (from owner's manual)

Actual test volume: 70.4 liters

Table 4 Post-Impact Data

Test number:	131107
Test date:	11/7/2013
Test time:	13:49 PM
Test type:	Vehicle to Vehicle Rear Impact
Impact angle:	180°
Ambient temperature at impact area:	5.7° C
Impact velocity:	
Target vehicle:	0 km/h
Bullet vehicle:	56.3 km/h
Required impact velocity range:	
Bullet vehicle:	55.5 to 57.1 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	12.2	61.4	-1.2	287.6
		Y	12.9	50.7	-10.1	54.7
		Z	17.7	46.5	-24.3	59.3
		R	28.7	59.3	---	---
2	Vehicle Center of Gravity Redundant	X	12.6	60.7	-1.2	287.6
		Y	12.5	50.7	-10.0	54.7
		Z	11.7	46.2	-20.7	59.3
		R	25.6	59.4	---	---

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	0.2	1.9	-14.0	80.4
		Y	1.0	102.2	-2.2	71.6
		Z	7.8	62.0	-4.6	119.2
		R	14.2	79.1	---	---
2	Vehicle Center of Gravity Redundant	X	0.1	2.6	-14.3	79.5
		Y	0.9	146.1	-2.8	71.5
		Z	7.5	62.0	-5.3	119.3
		R	14.4	79.4	---	---

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

Table 7 Target Vehicle Measurements

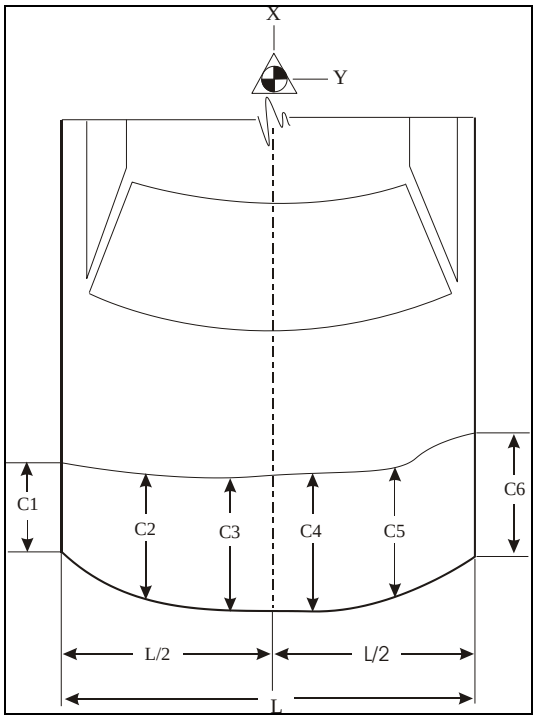
1996 Jeep GC-ZJ

Test Number: 131107

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	4475	4031	444
X2	Rear Surface of Vehicle to Front of Engine Block	563	575	-12
X3	Rear Surface of Vehicle to Firewall	1078	1098	-20
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	1419	1425	-6
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	1419	1434	-15
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	1450	1442	8
X7	Rear Surface of Vehicle to Lower Leading Edge of Left Door	1454	1443	11
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	2435	2448	-13
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	2436	2453	-17
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	2450	2441	9
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	2457	2449	8
X12	Rear Surface of Vehicle to Bottom of " A " Post on Right Side	1440	1460	-20
X13	Rear Surface of Vehicle to Bottom of " A " Post on Left Side	1440	1464	-24
X14	Rear Surface of Vehicle to Firewall-Right Side	1075	1095	-20
X15	Rear Surface of Vehicle to Firewall-Left Side	1110	1130	-20
X16	Rear Surface of Vehicle to Steering Wheel Center	1870	1935	-65
X17	Center of Steering Column to " A " Post	300	312	-12
X18	Center of Steering Column to Headliner	450	500	-50
X19	Rear Surface of Vehicle to Right Side of Front Bumper	4430	4200	230
X20	Rear Surface of Vehicle to Left Side of Front Bumper	4430	3903	527
X21	Length of Engine Block	700	700	0

All measurements are in millimeters.

Figure 2 Target Vehicle Crush



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

Vehicle: 1996 Jeep GC-ZJ

	Pre-test	Post-test	Crush
L	1524		
C1	4430	3903	527
C2	4500	3987	513
C3	4475	4018	457
CL	4475	4031	444
C4	4477	4056	421
C5	4495	4126	369
C6	4430	4200	230

All measurements in millimeters.

Table 8 Bullet Vehicle Measurements

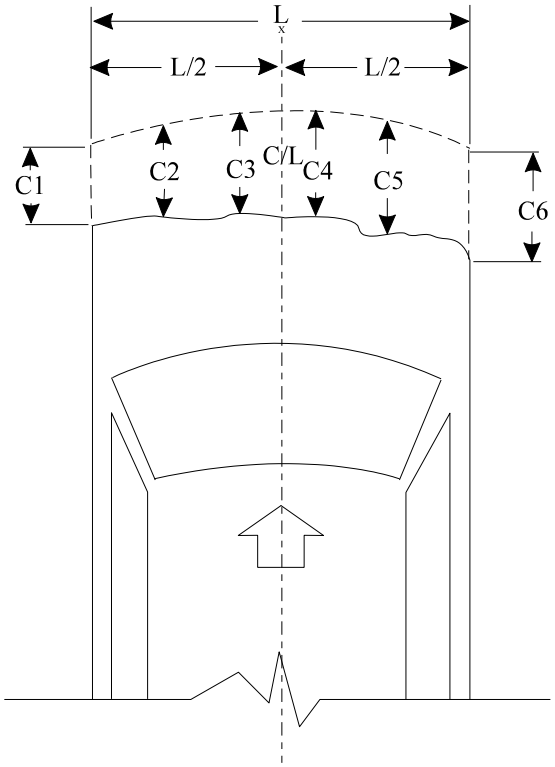
1993 Cadillac DeVille

Test Number: 131107

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	5208	5168	40
X2	Rear Surface of Vehicle to Front of Engine Block	4643	4574	69
X3	Rear Surface of Vehicle to Firewall	3925	3925	0
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	3514	3514	0
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	3503	3503	0
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	3518	3518	0
X7	Rear Surface of Vehicle to Lower Leading Edge of Left Door	3491	3499	-8
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	2493	2493	0
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	2498	2493	5
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	2513	2513	0
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	2502	2508	-6
X12	Rear Surface of Vehicle to Bottom of " A " Post on Right Side	3498	3500	-2
X13	Rear Surface of Vehicle to Bottom of " A " Post on Left Side	3496	3506	-10
X14	Rear Surface of Vehicle to Firewall-Right Side	4178	3769	409
X15	Rear Surface of Vehicle to Firewall-Left Side	3835	3835	0
X16	Rear Surface of Vehicle to Steering Wheel Center	3046	3040	6
X17	Center of Steering Column to " A " Post	355	355	0
X18	Center of Steering Column to Headliner	415	460	-45
X19	Rear Surface of Vehicle to Right Side of Front Bumper	5128	5099	29
X20	Rear Surface of Vehicle to Left Side of Front Bumper	5118	5106	12
X21	Length of Engine Block	500	500	0
	Left Front Overhang	1105	1060	45
	Right Front Overhang	1105	1075	30
X26	Firewall to Engine or Transaxle	280	260	20
X27	Vertical Distance from Door Sill to Centerline of Steering Column	553	530	23
X28	Left Wheelbase	2900	2898	2
X28	Right Wheelbase	2900	2883	17
X29	Maximum Width	1870	1865	5
X30	Rear Surface of Vehicle to Engine Bottom Target	4323	4205	118
X31	Rear Surface of Vehicle to Occupant Compartment Bottom Targets	2903	2818	85
X32	Rear Surface of Vehicle to Front Bumper Bottom Target	5128	5093	35
X33	Rear Surface of Vehicle to Frame Crossmember Bottom Target	4494	4476	18
RD	Rear Surface of Vehicle to Right Side of Dash Panel	3328	3333	-5
CD	Rear Surface of Vehicle to Center of Dash Panel	3335	3338	-3
LD	Rear Surface of Vehicle to Left Side of Dash Panel	3318	3319	-1

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: 1993 Cadillac DeVille

	Pre-test	Post-test	Crush
L	1524		
C1	5118	5106	12
C2	5138	5083	55
C3	5208	5168	40
CL	5208	5168	40
C4	5208	5178	30
C5	5138	5088	50
C6	5128	5099	29

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:	1996/Jeep/GC-ZJ/MPV
Actual test volume:	68.5 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 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: 11/07/2013

Vehicle year/make/
model/body style: 1996Jeep/GC-ZJ/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:

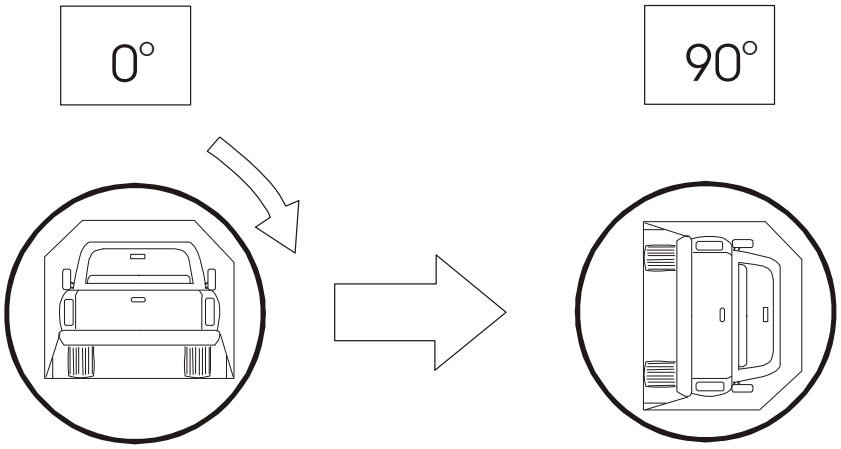
		Test Results	Maximum Allowable
1.	From impact until vehicle motion ceases	Trace	28 g
2.	5-minute period after vehicle motion ceases	N/A[1]	142 g
3.	Next 25 minutes after 5-minute period	N/A[1]	28 g/minute

Fuel system fluid spillage location(s): Fuel filler neck tank connection.

[1] Rollover cancelled due to fuel filler neck disconnecting from fuel tank during the impact event.

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:

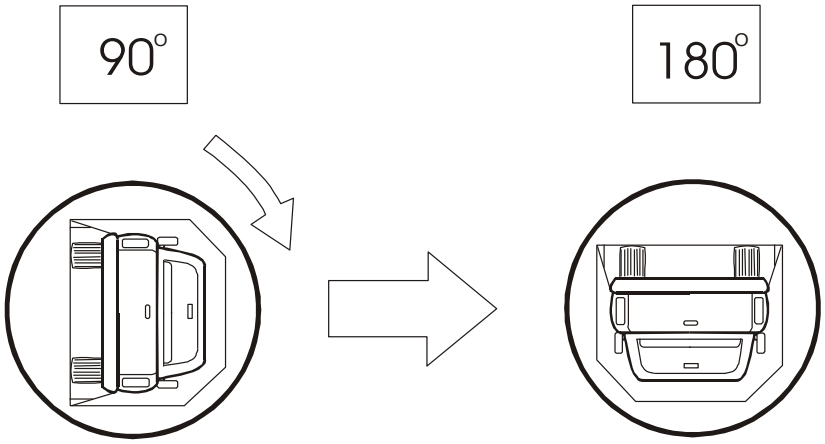
0° to 90° rotation (fuel filler cap down)	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	N/A[1]	142 g
2. Sixth minute from onset of rotation	N/A[1]	28 g
3. Seventh minute from onset of rotation	N/A[1]	28 g

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

[1] Rollover cancelled due to fuel filler neck disconnecting from fuel tank during the impact event.

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	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 cancelled due to fuel filler neck disconnecting from fuel tank during the impact event.

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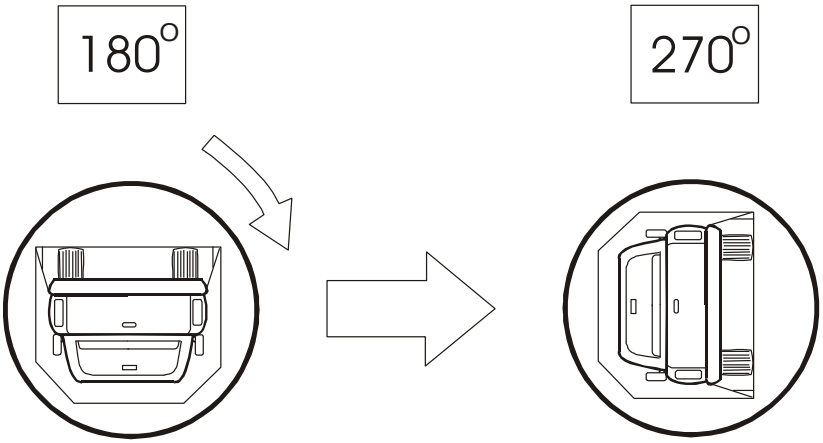
Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data, Continued

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:

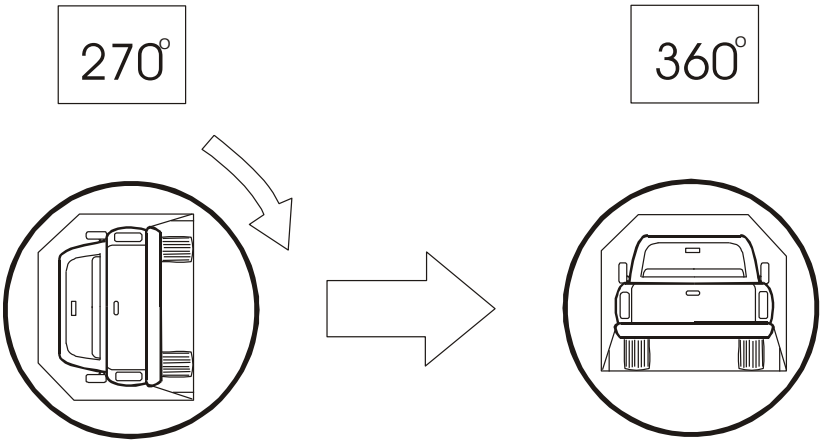
180 to 270° rotation		Test Results	Maximum Allowable
1.	First five minutes from onset of rotation	N/A[1]	142 g
2.	Sixth minute from onset of rotation	N/A[1]	28 g
3.	Seventh minute from onset of rotation	N/A[1]	28 g

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

[1] Rollover cancelled due to fuel filler neck disconnecting from fuel tank during the impact event.

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 cancelled due to fuel filler neck disconnecting from fuel tank during the impact event.

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Section 4.0

Camera Information

Figure 5 Camera Positions

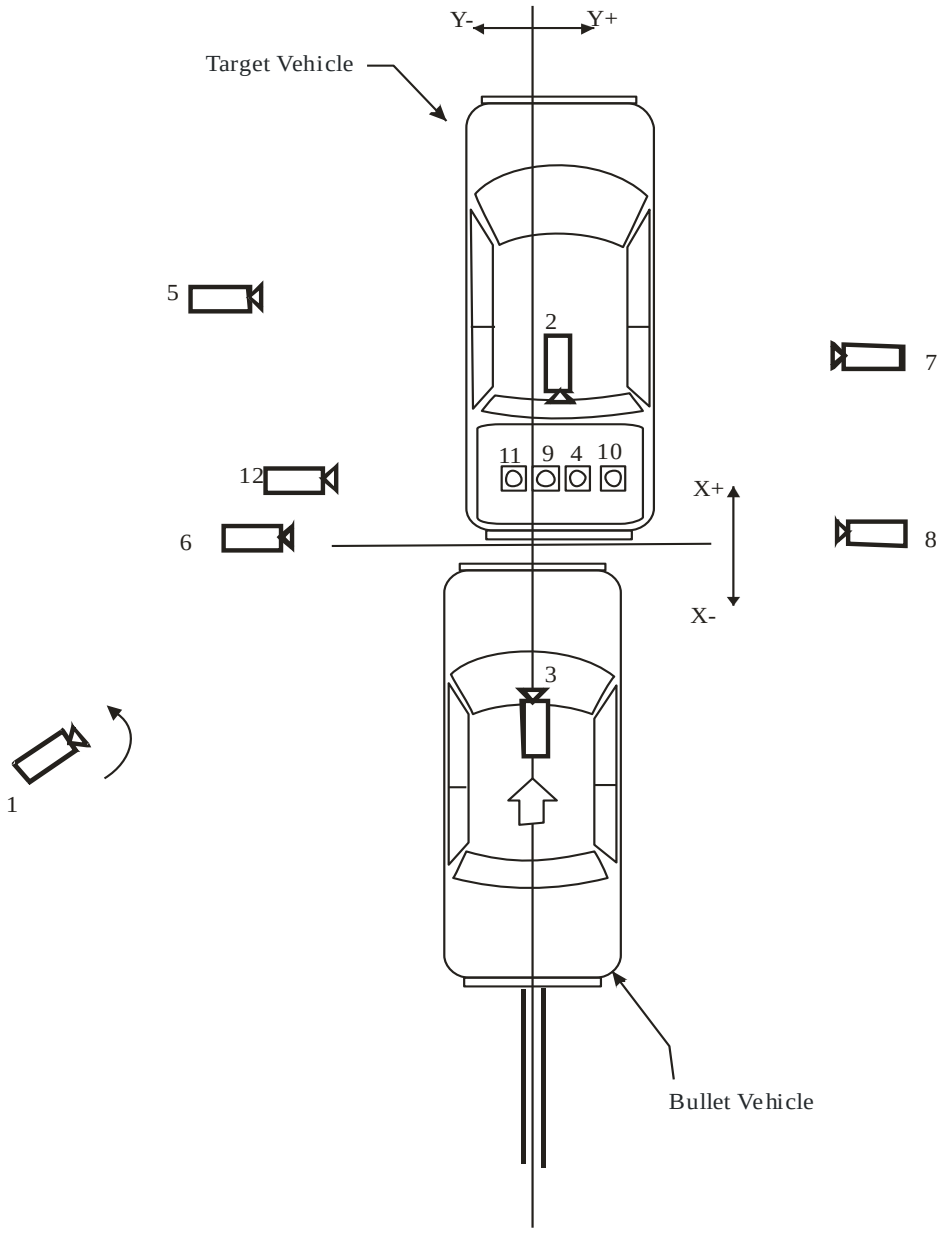

Table 11 Camera Information

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 target vehicle	-1778	-5944	-1295	-5.2º	8.5	1000
5	Left side impact	-575	-6767	-1129	-2.3º	25	1000
6	Right target vehicle	-1080	-6797	-1353	-0.6º	8.5	1000
7	Right side impact	-500	7010	-1092	1.4º	25	1000
8	Overhead	-300	290	-5624	N/A	8.5	1000
9	Pit wide	-375	50	3019	85.2º	8.5	1000
10	Pit medium	-545	40	2908	85.8º	16	1000
11	Pit tight	-345	-250	2900	78.5º	25	1000
12	Left ground level tight impact	-485	-2393	-150	4.8	25	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

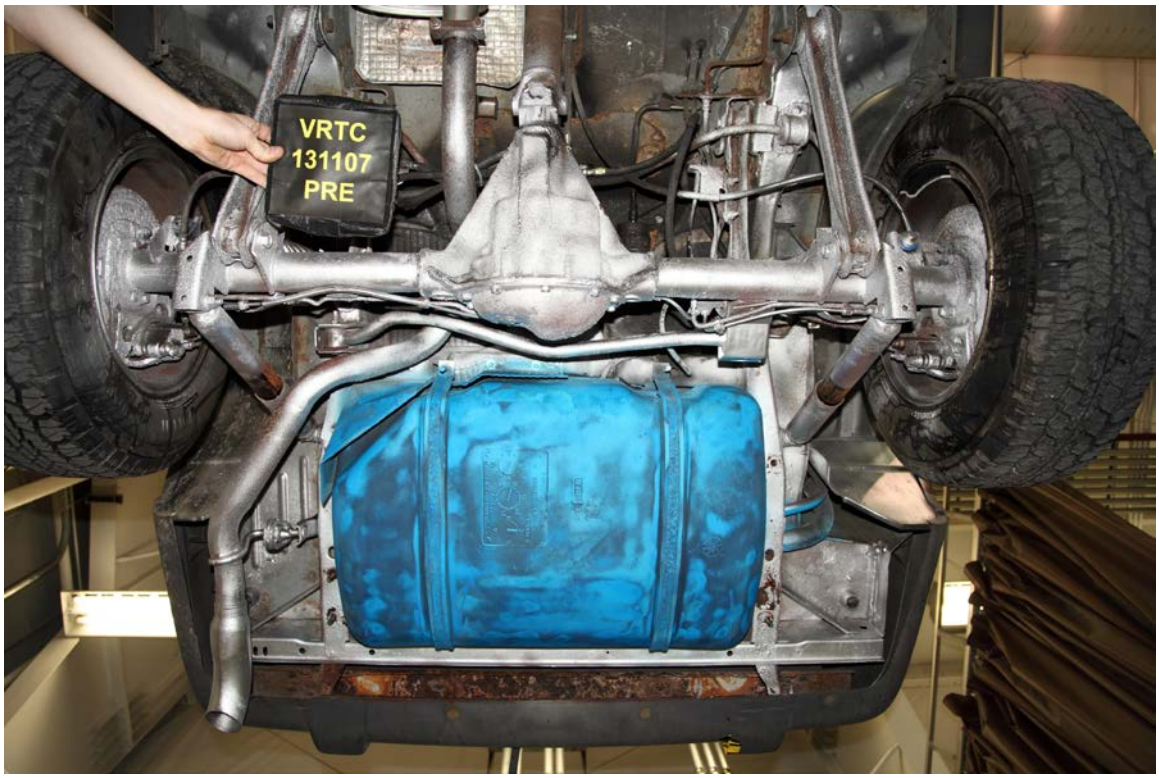

Figure A-15 Pre-Test Target Vehicle Rear Underbody View

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

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

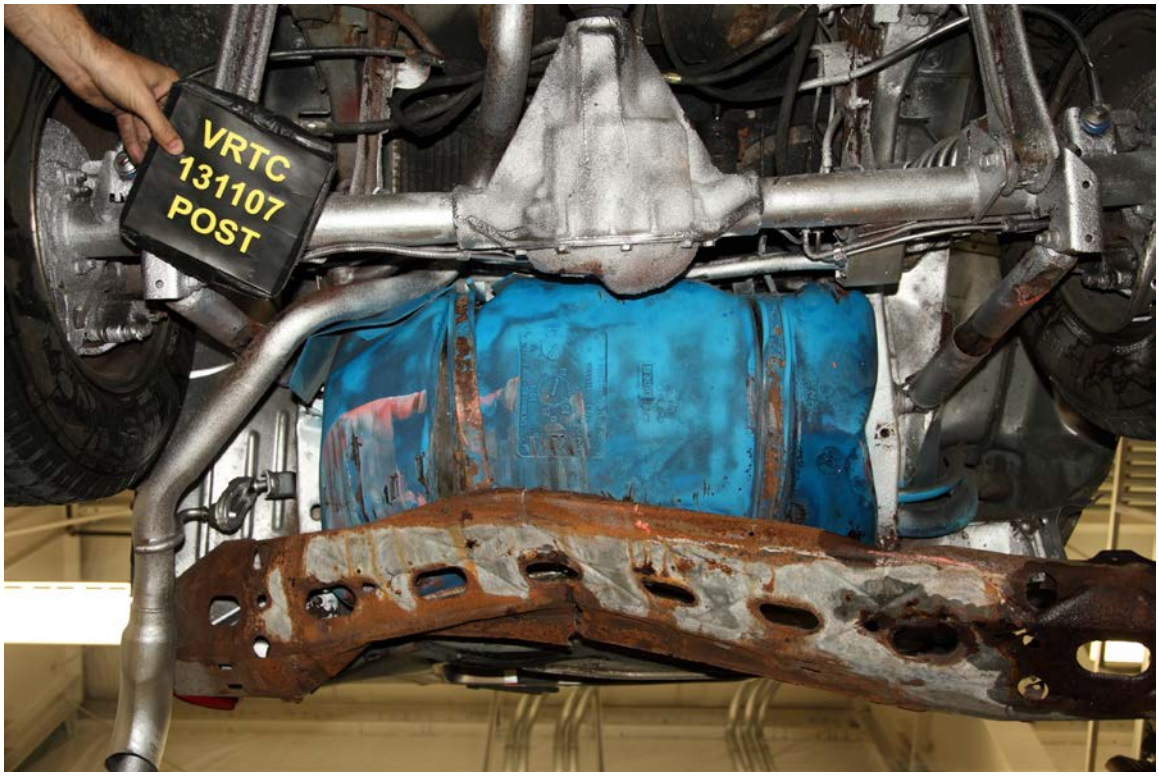

Figure A-20 Post-Test Target Vehicle Fuel Tank Close-up View

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

Figure A-22 Post-Test Target Vehicle Fuel Line Close-up View

Figure A-23 Pre-Test Target Vehicle Fuel Filler Close-up View

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

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

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

Photo Not Available

Figure A-27 Close-Up View of Target Vehicle 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

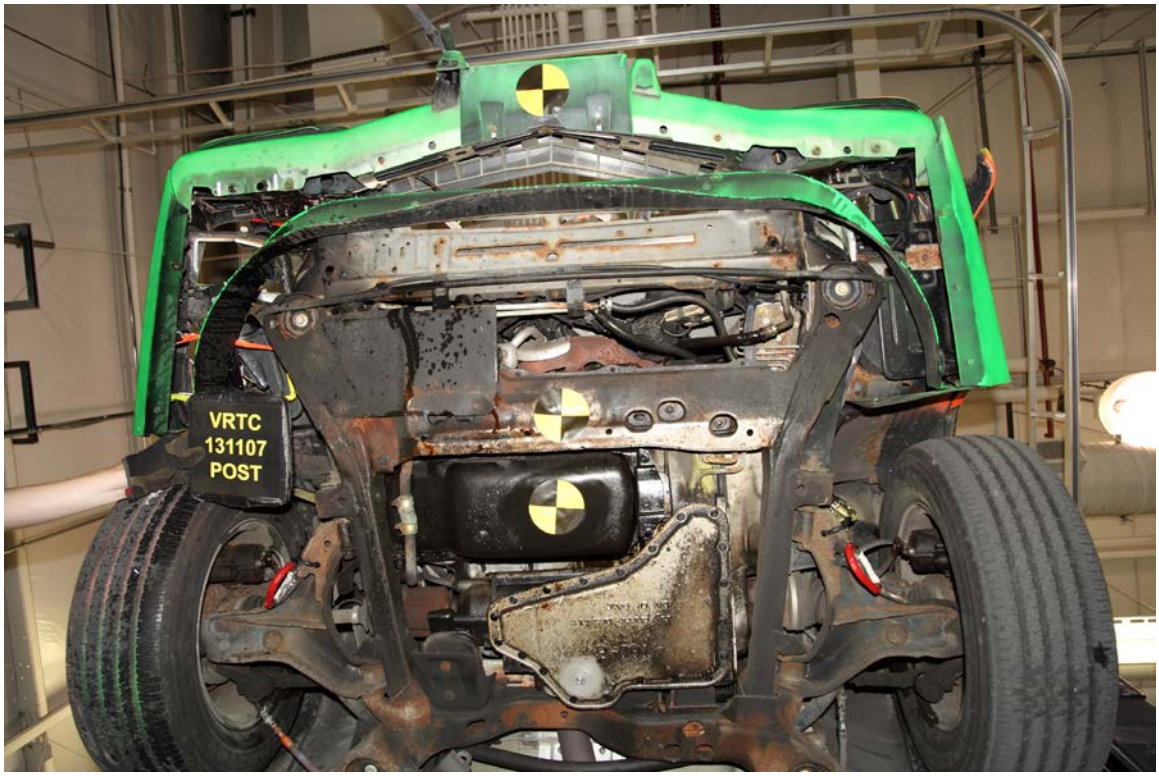

Figure A-41 Post-Test Bullet Vehicle Front Underbody View

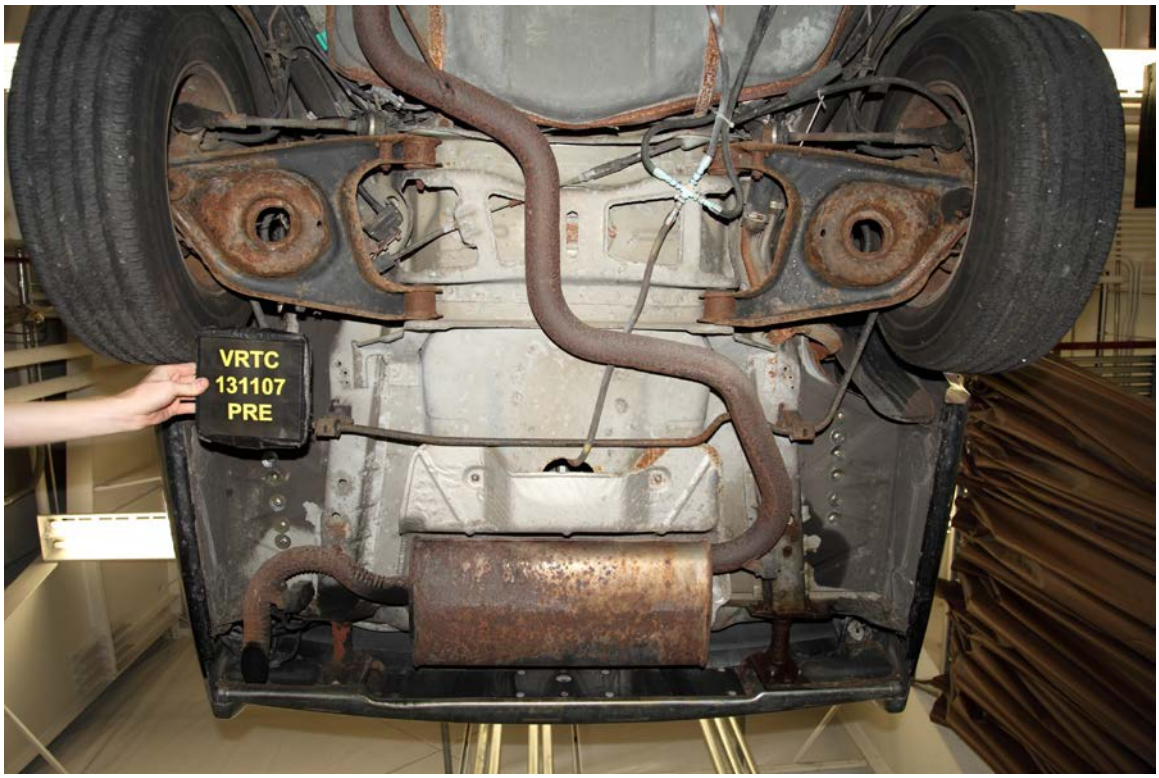

Figure A-42 Pre-Test Bullet Vehicle Rear Underbody View

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

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

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

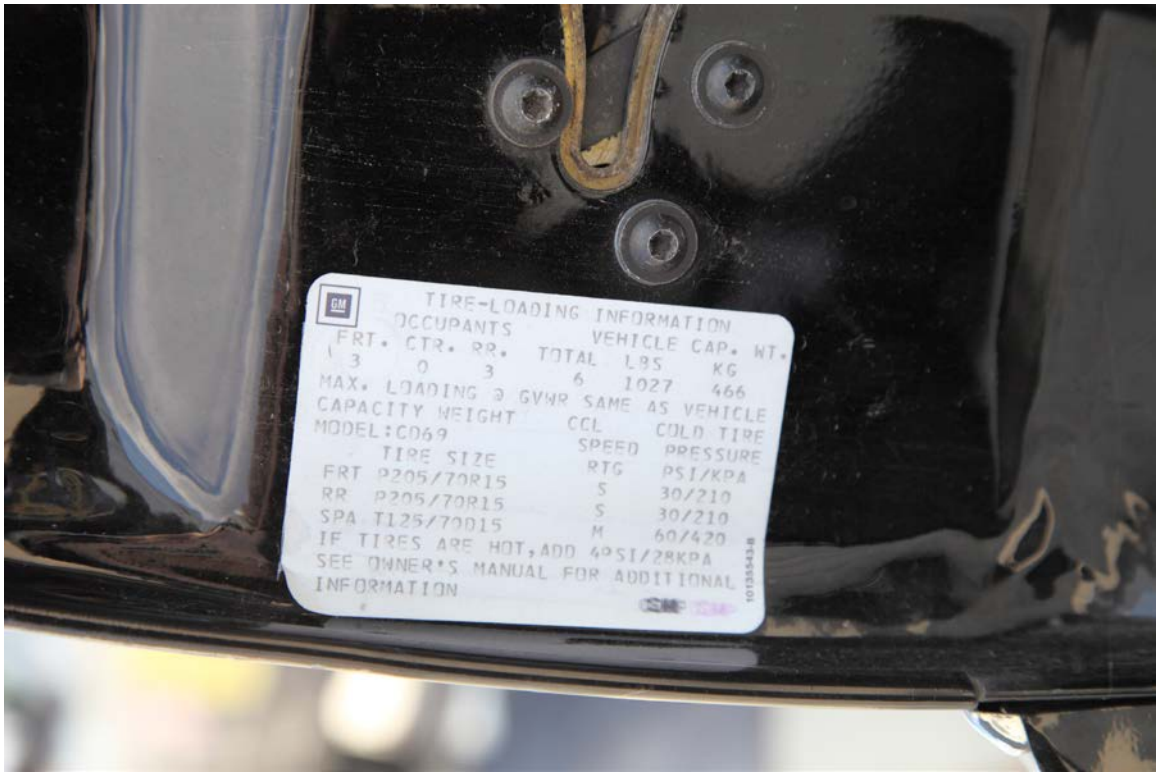

Figure A-51 Close-Up View of Bullet Vehicle Tire Information Placard or Label

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

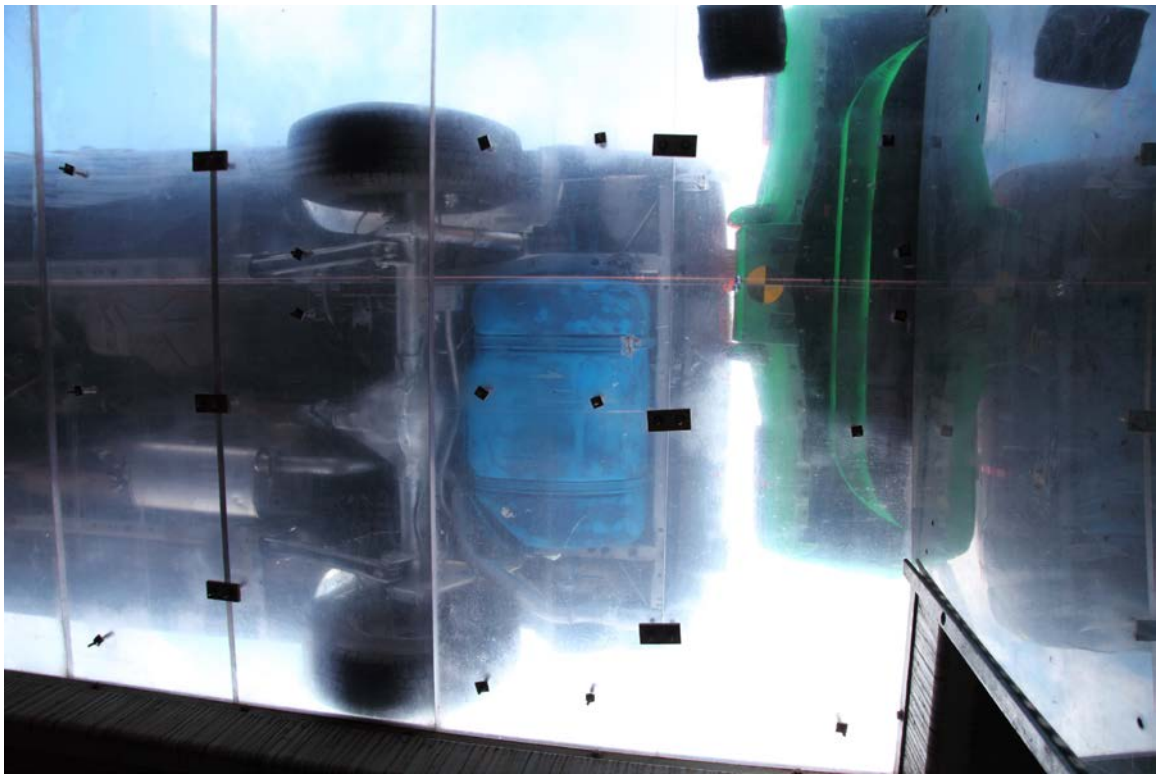

Figure A-58 Pre-Test Impact Alignment – Bullet and Target Vehicles Pit View

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Appendix B

Data Plots

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

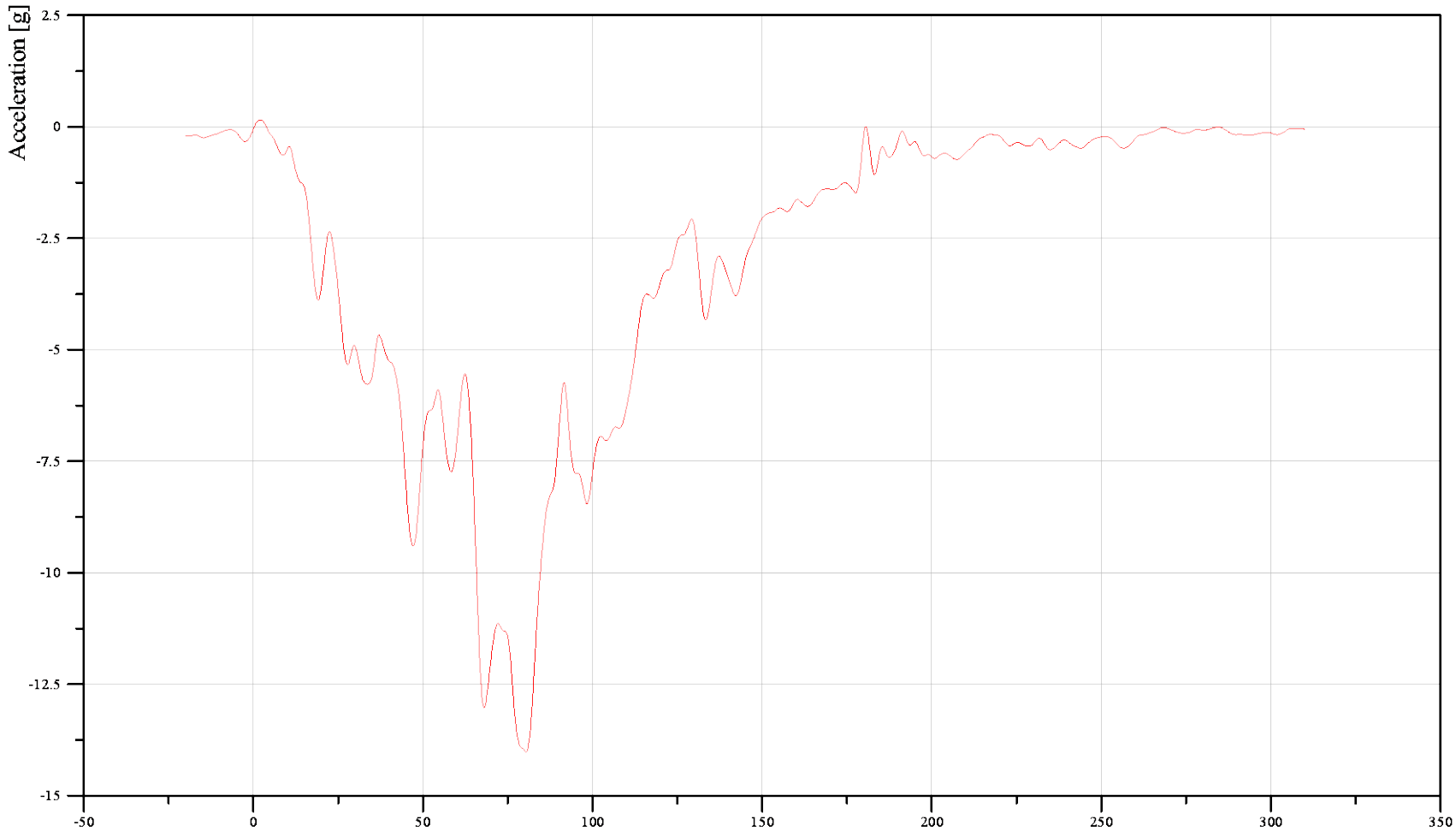
Bullet Vehicle CG X-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-14.02 g at 80.40 ms

Max. Value
0.15 g at 1.92 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

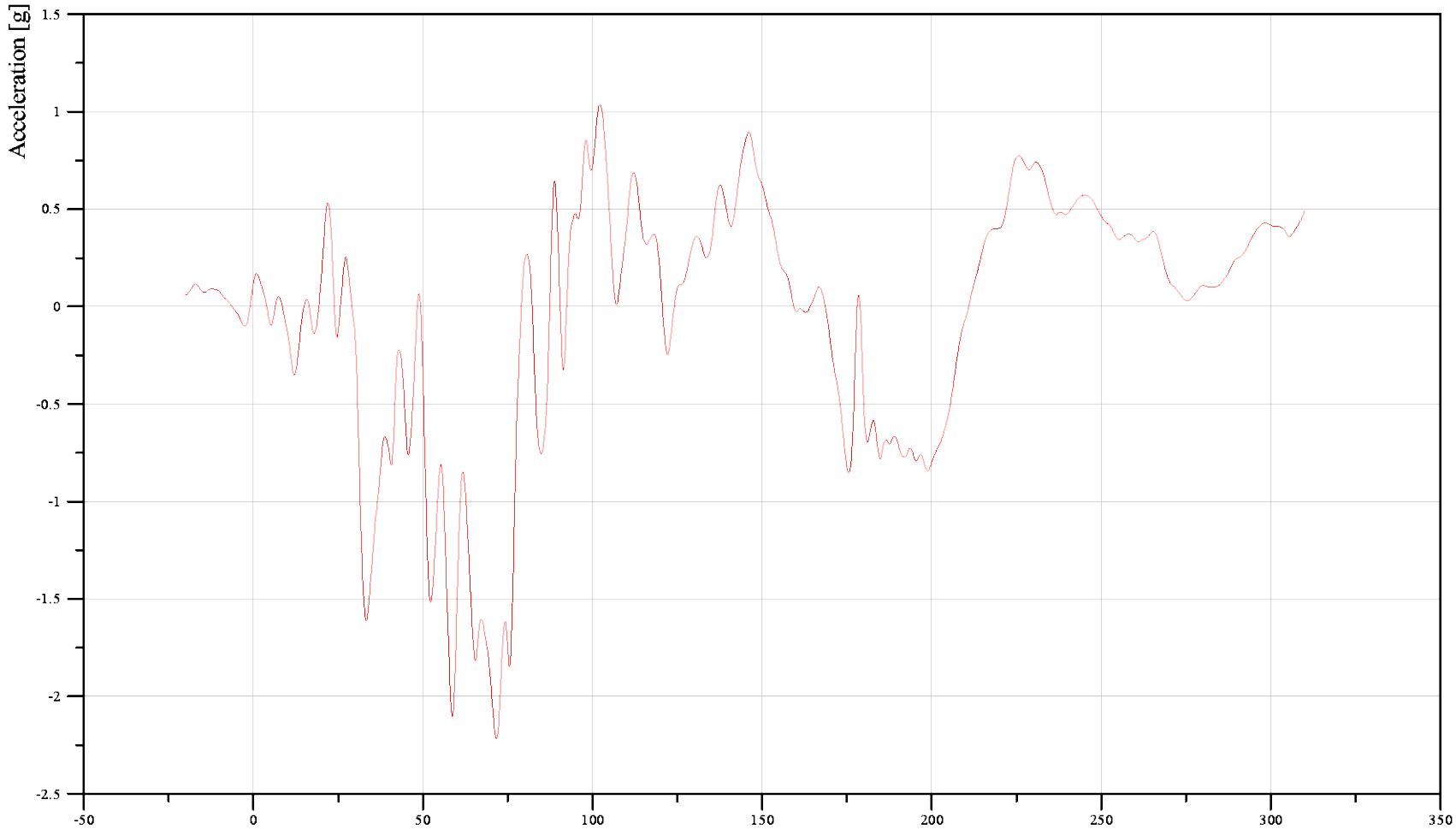
Bullet Vehicle CG Y-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-2.22 g at 71.60 ms

Max. Value
1.04 g at 102.16 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

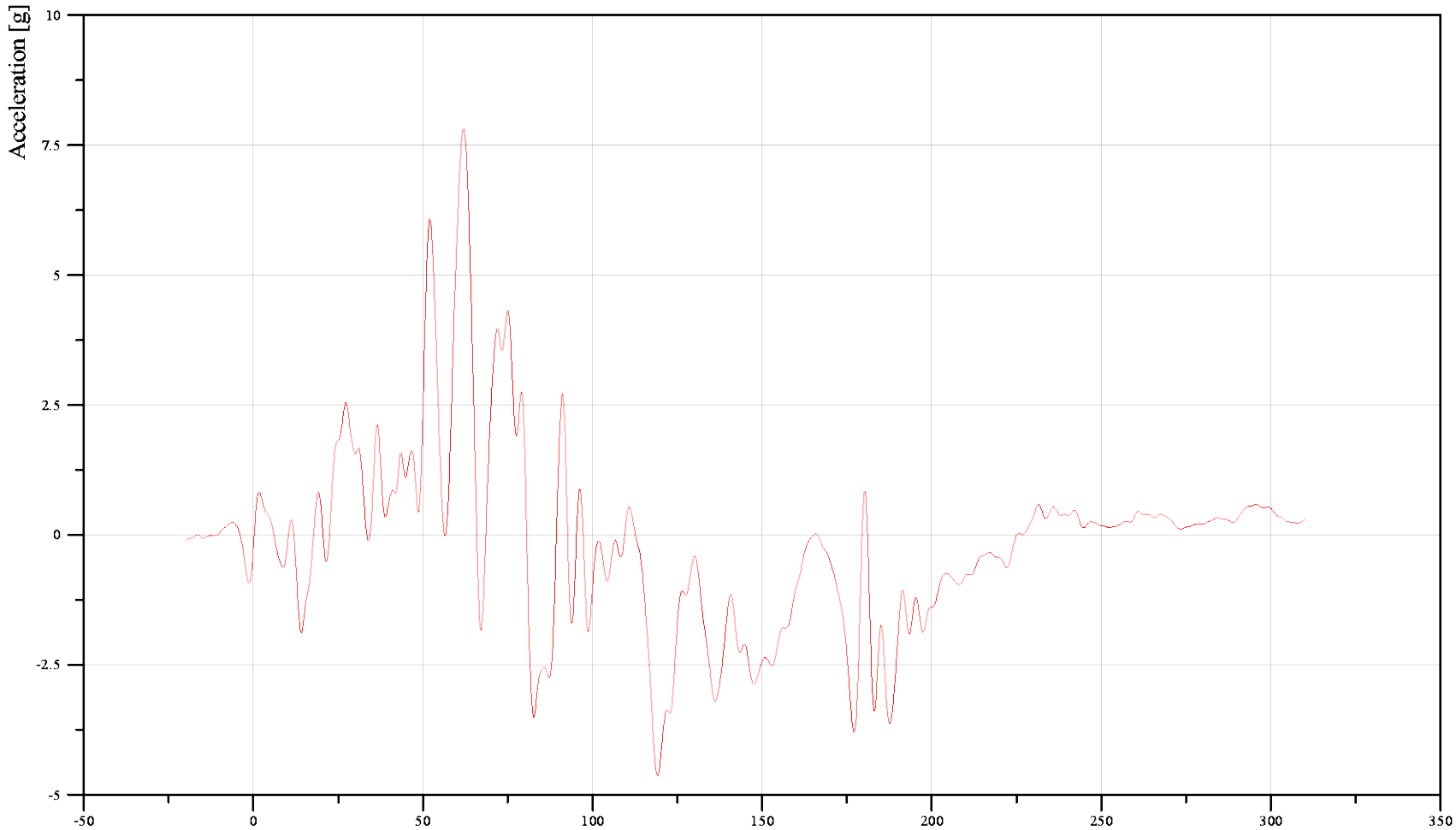
Bullet Vehicle CG Z-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-4.64 g at 119.20 ms

Max. Value
7.81 g at 62.00 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

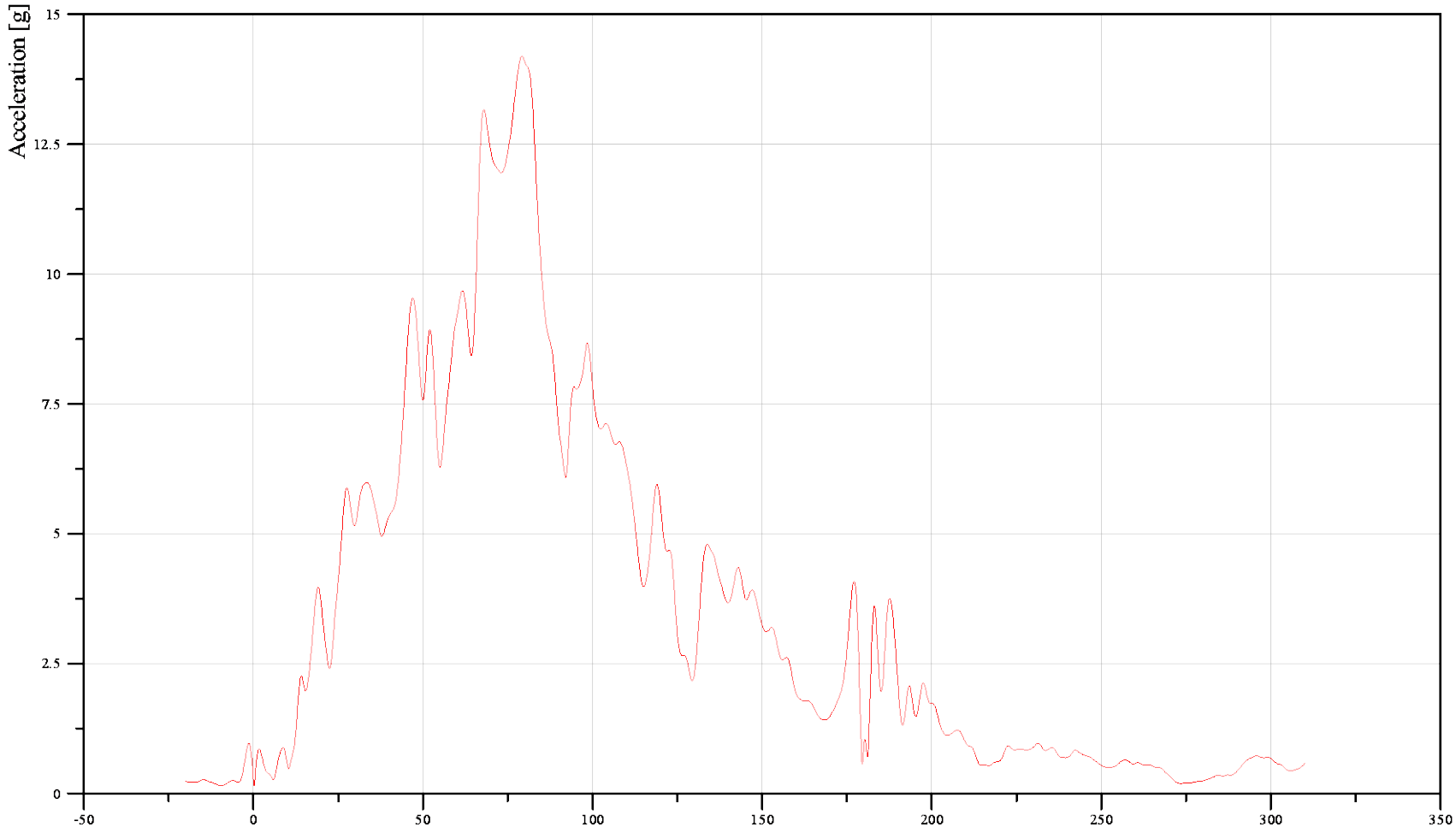
Bullet Vehicle CG Acceleration Resultant

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
0.14 g at 0.24 ms

Max. Value
14.19 g at 79.12 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

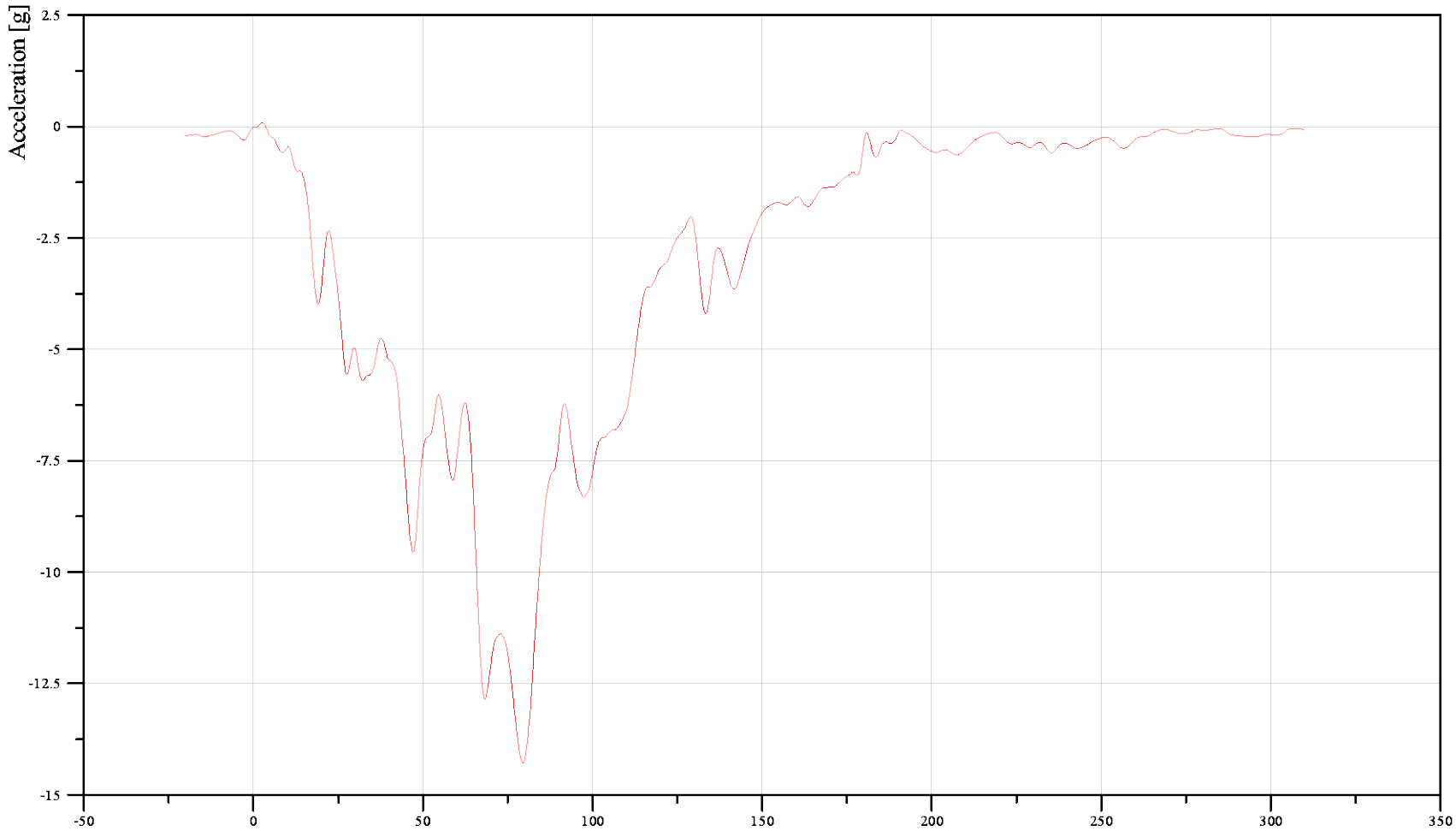
Bullet Vehicle CG Redundant X-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-14.28 g at 79.52 ms

Max. Value
0.08 g at 2.56 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

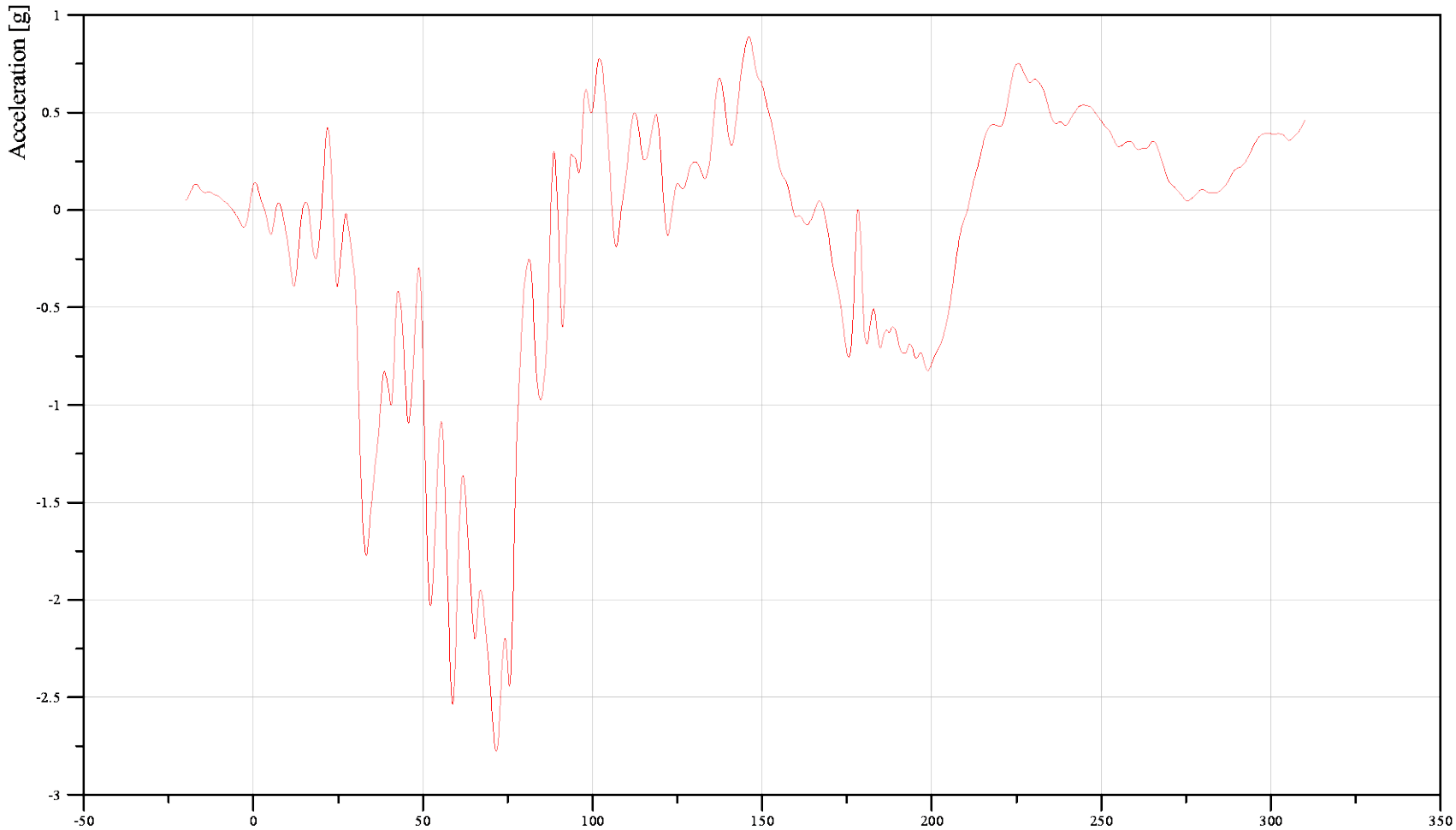
Bullet Vehicle CG Redundant Y-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-2.78 g at 71.52 ms

Max. Value
0.89 g at 146.08 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

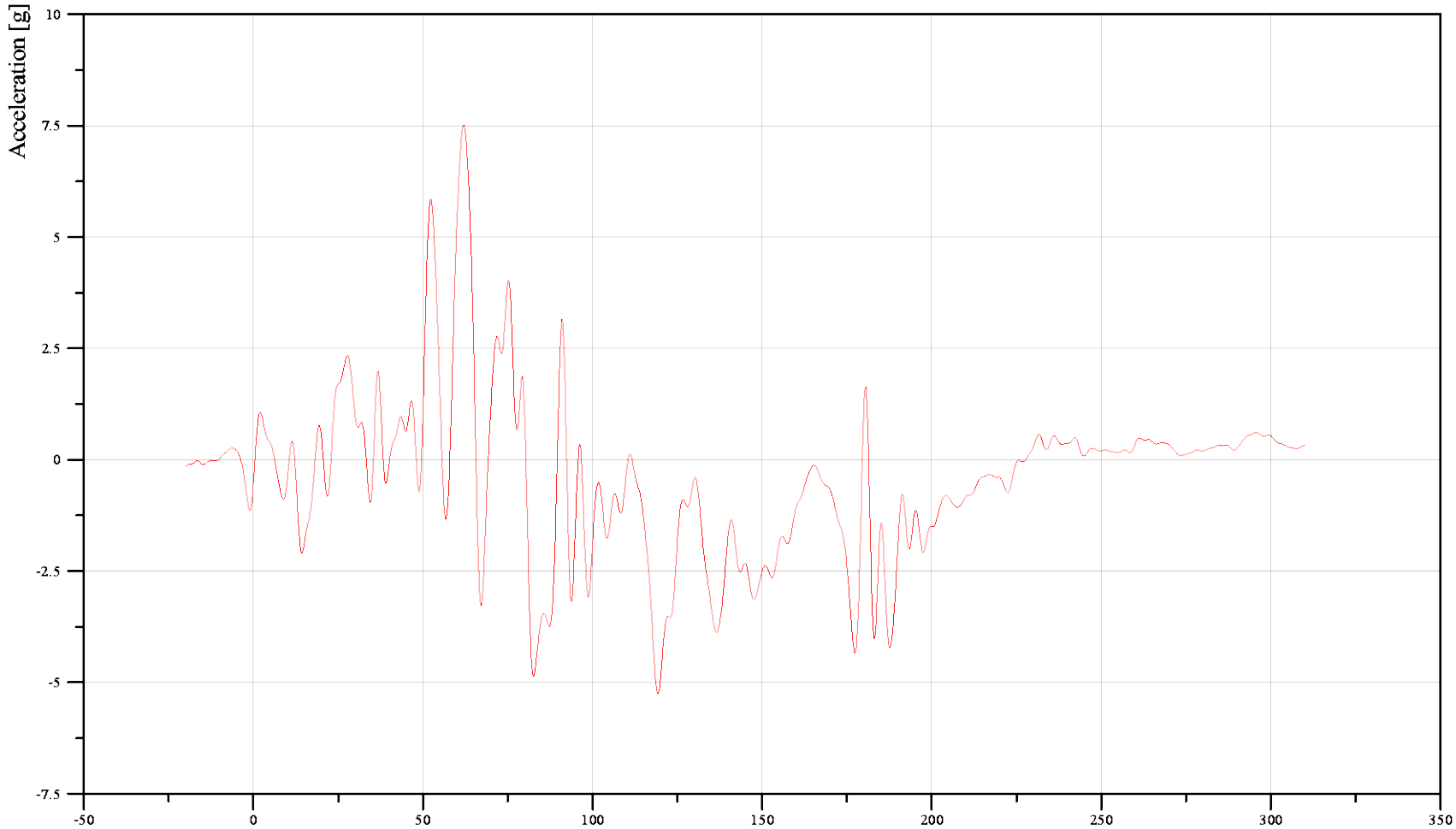
Bullet Vehicle CG Redundant Z-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-5.25 g at 119.28 ms

Max. Value
7.52 g at 62.00 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

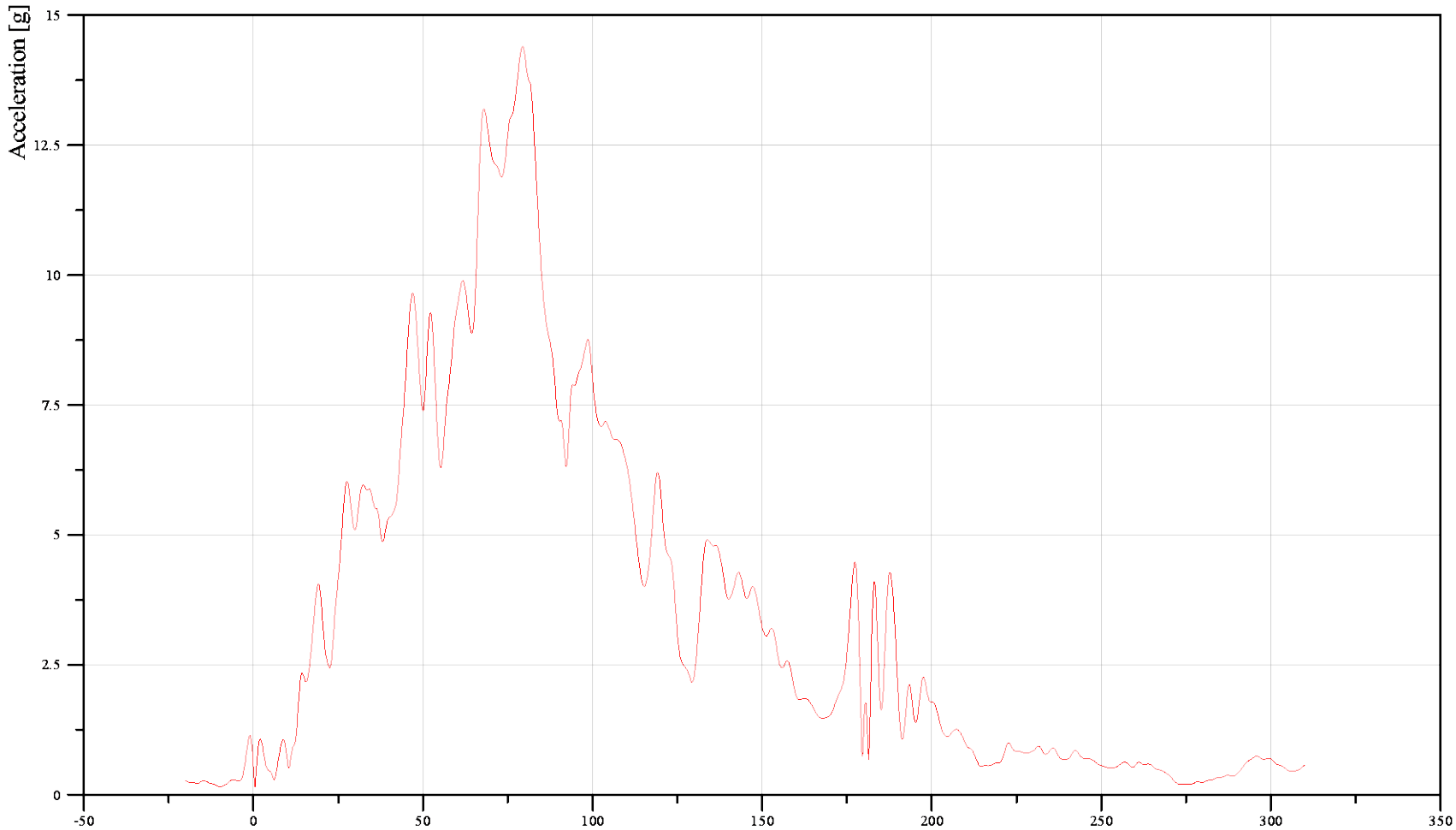
Bullet Vehicle CG Redundant Acceleration Resultant

Date: 11/07/2013
Time: 13:53

Customer: VRTC

10VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
0.14 g at 0.48 ms

Max. Value
14.40 g at 79.36 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

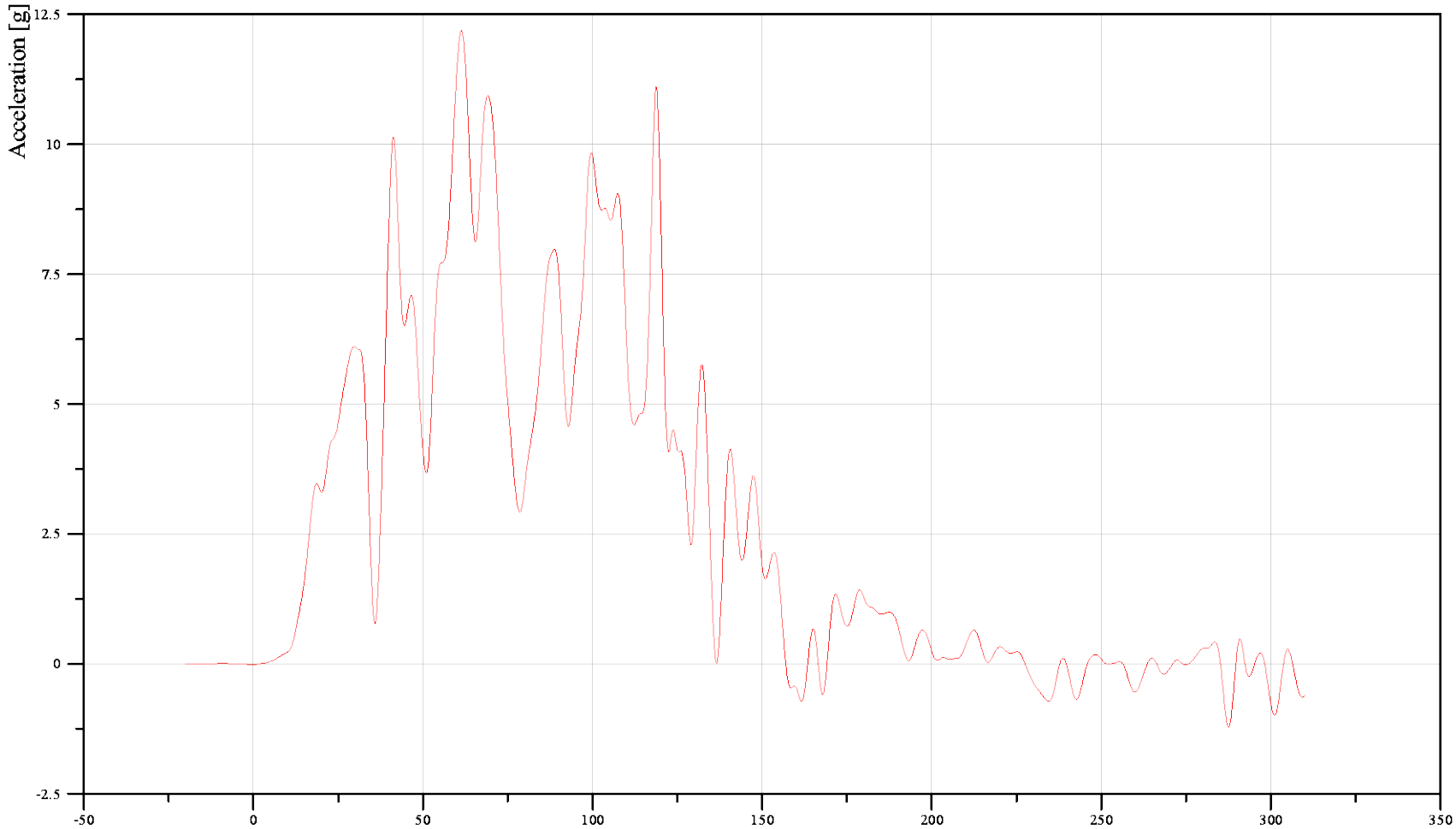
Target Vehicle CG X-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-1.21 g at 287.60 ms

Max. Value
12.19 g at 61.36 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

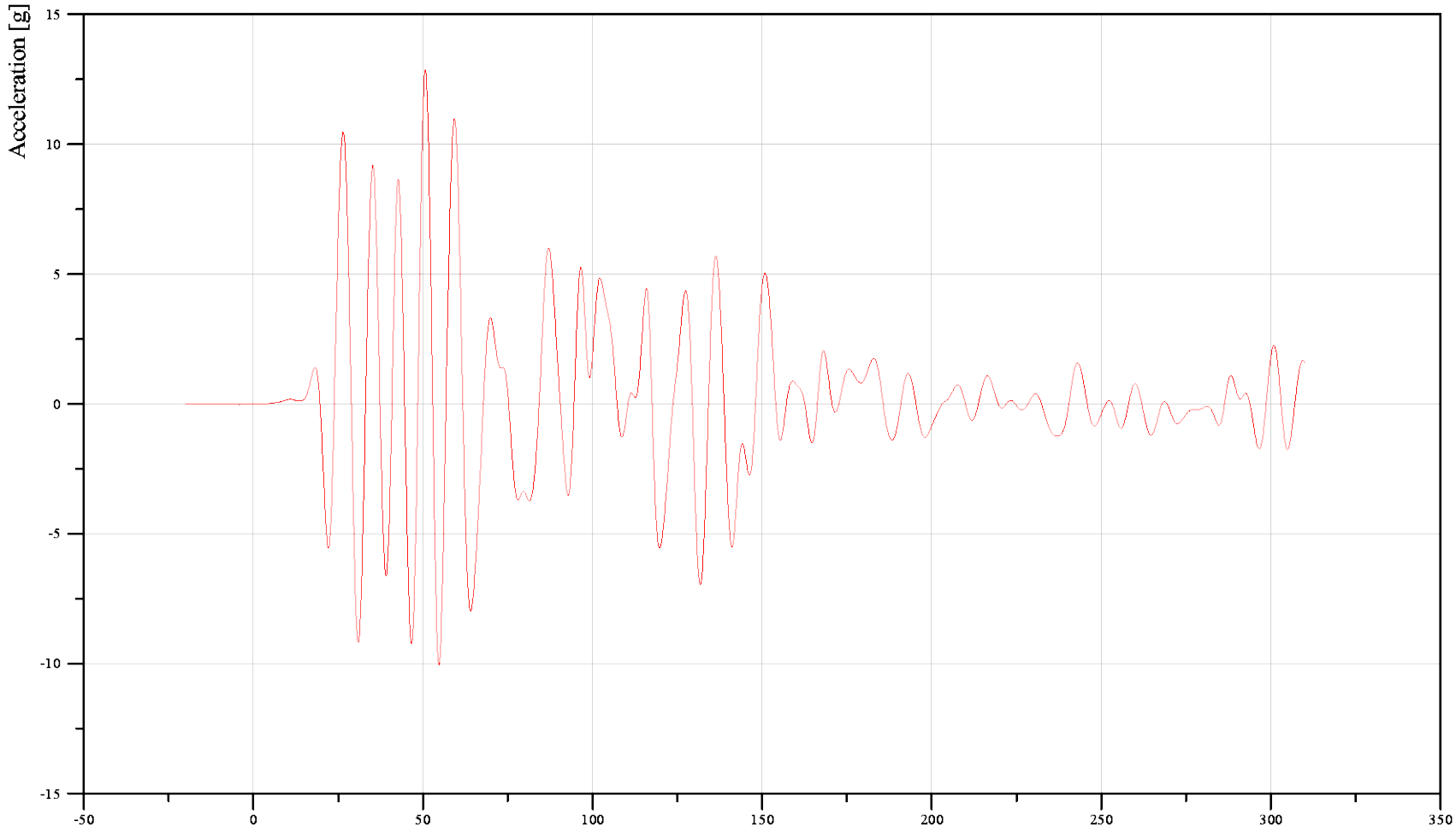
Target Vehicle CG Y-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-10.08 g at 54.72 ms

Max. Value
12.88 g at 50.72 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

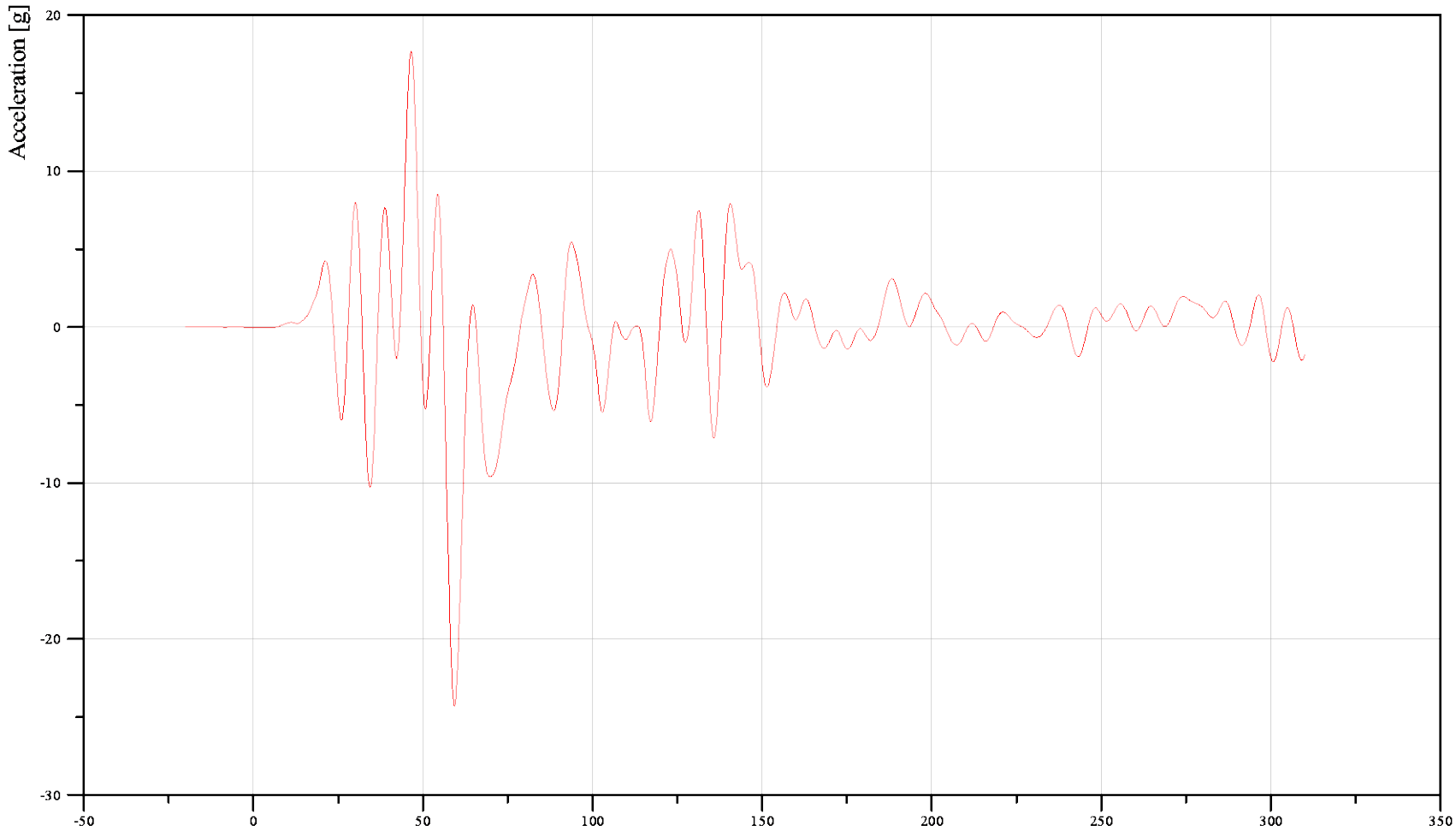
Target Vehicle CG Z-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-24.30 g at 59.28 ms

Max. Value
17.70 g at 46.48 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

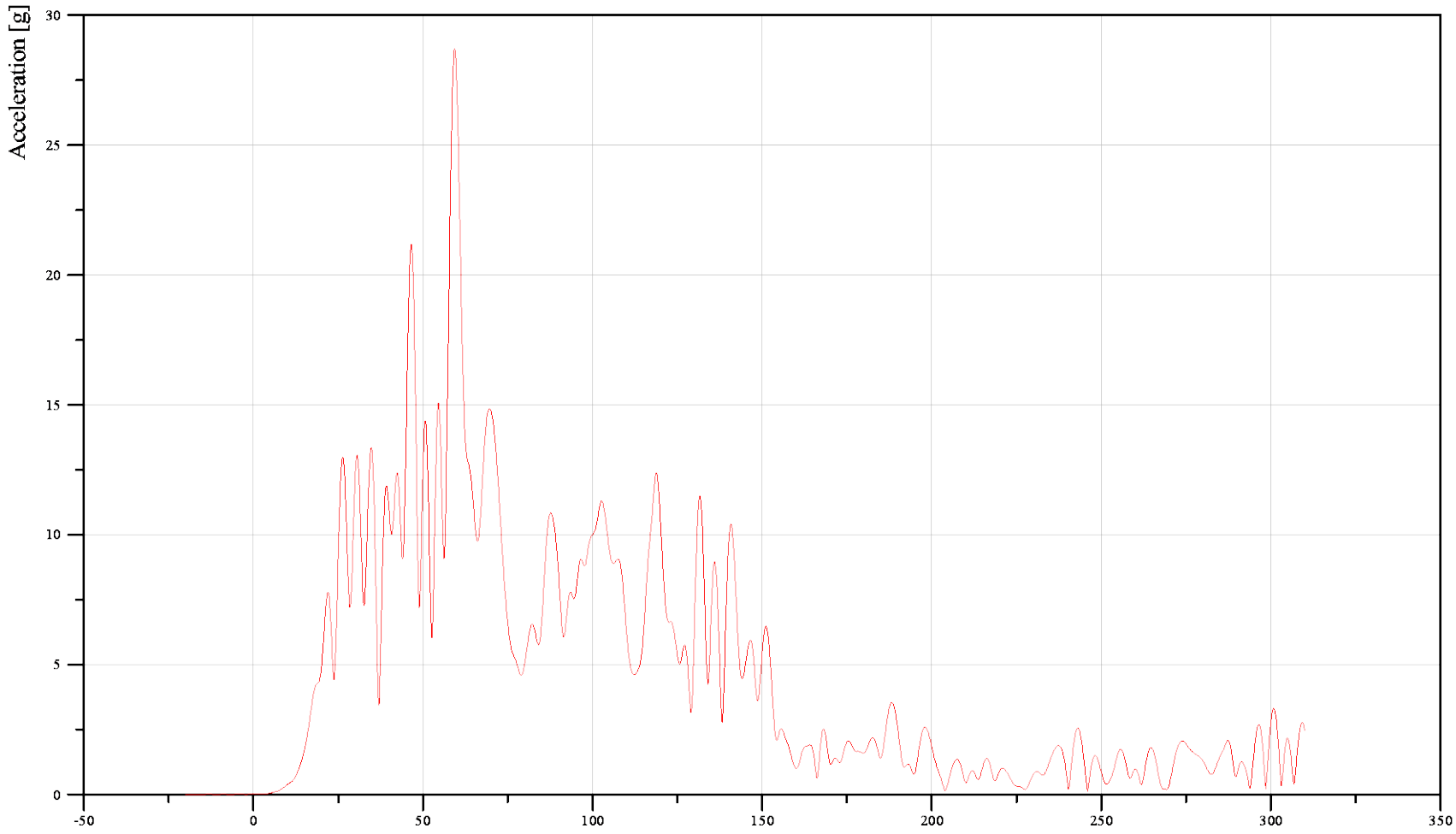
Target Vehicle CG Acceleration Resultant

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
0.00 g at -6.80 ms

Max. Value
28.70 g at 59.28 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

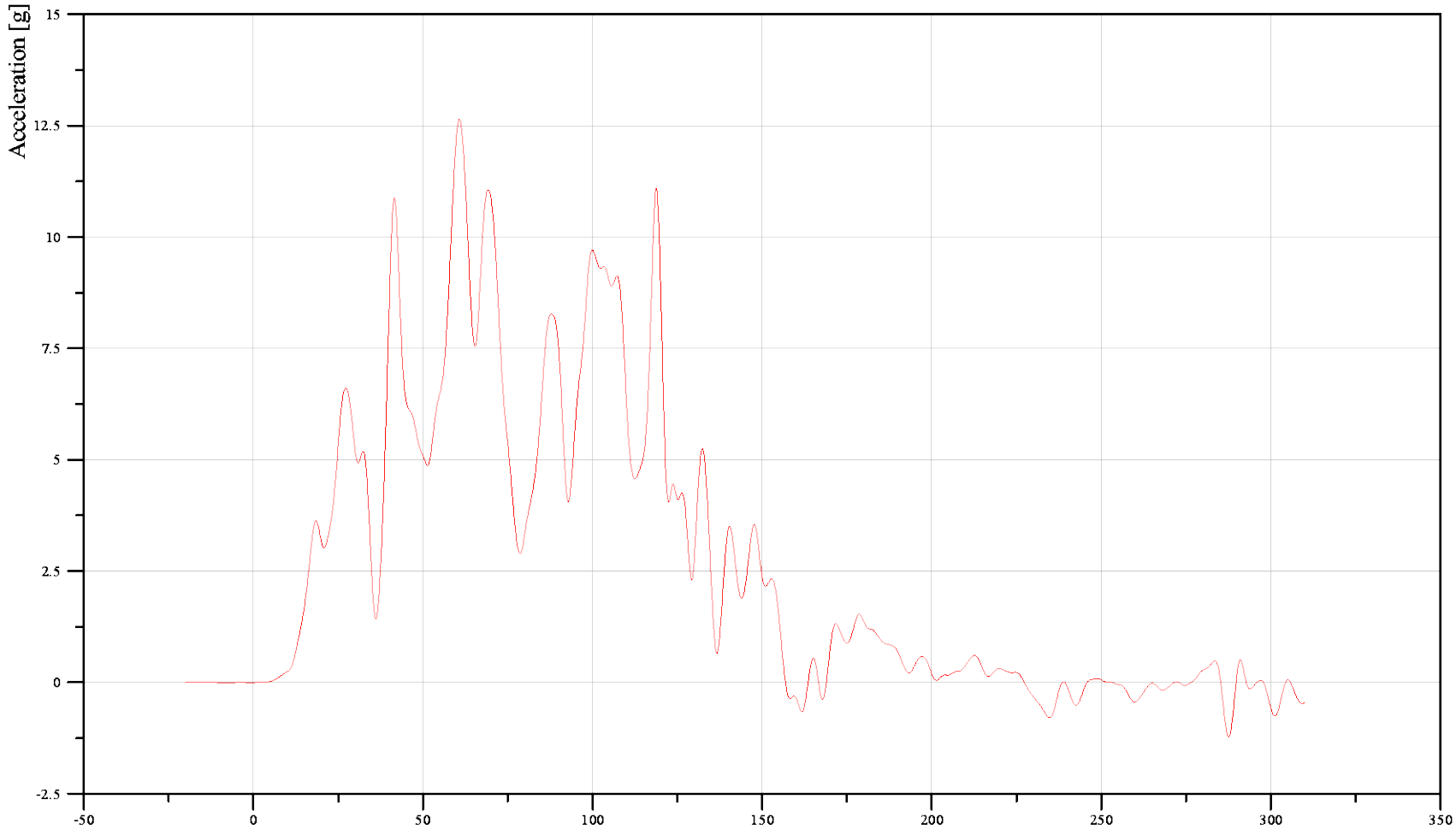
Target Vehicle CG Redundant X-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-1.22 g at 287.60 ms

Max. Value
12.65 g at 60.72 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

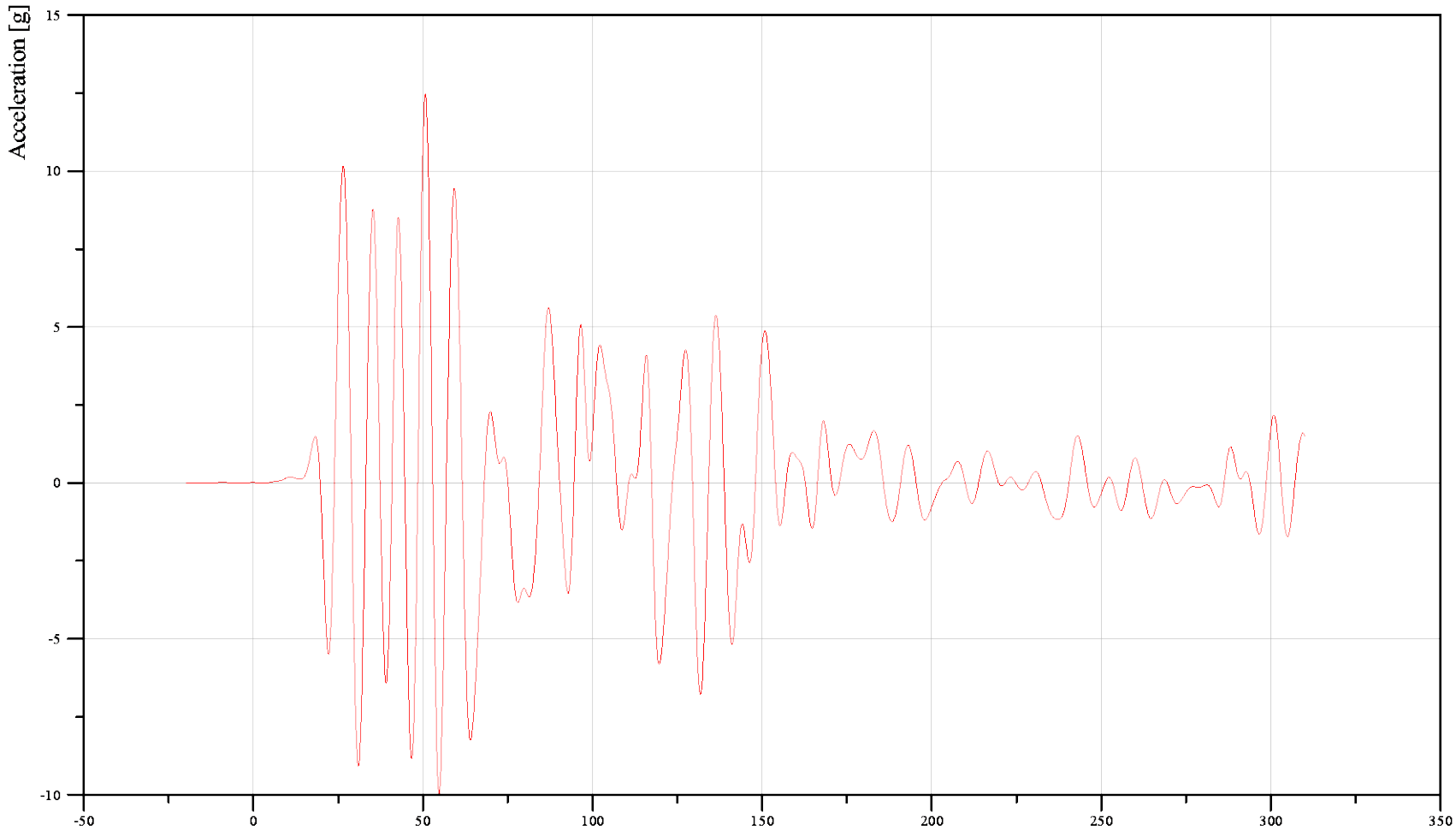
Target Vehicle CG Redundant Y-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-9.97 g at 54.72 ms

Max. Value
12.48 g at 50.72 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

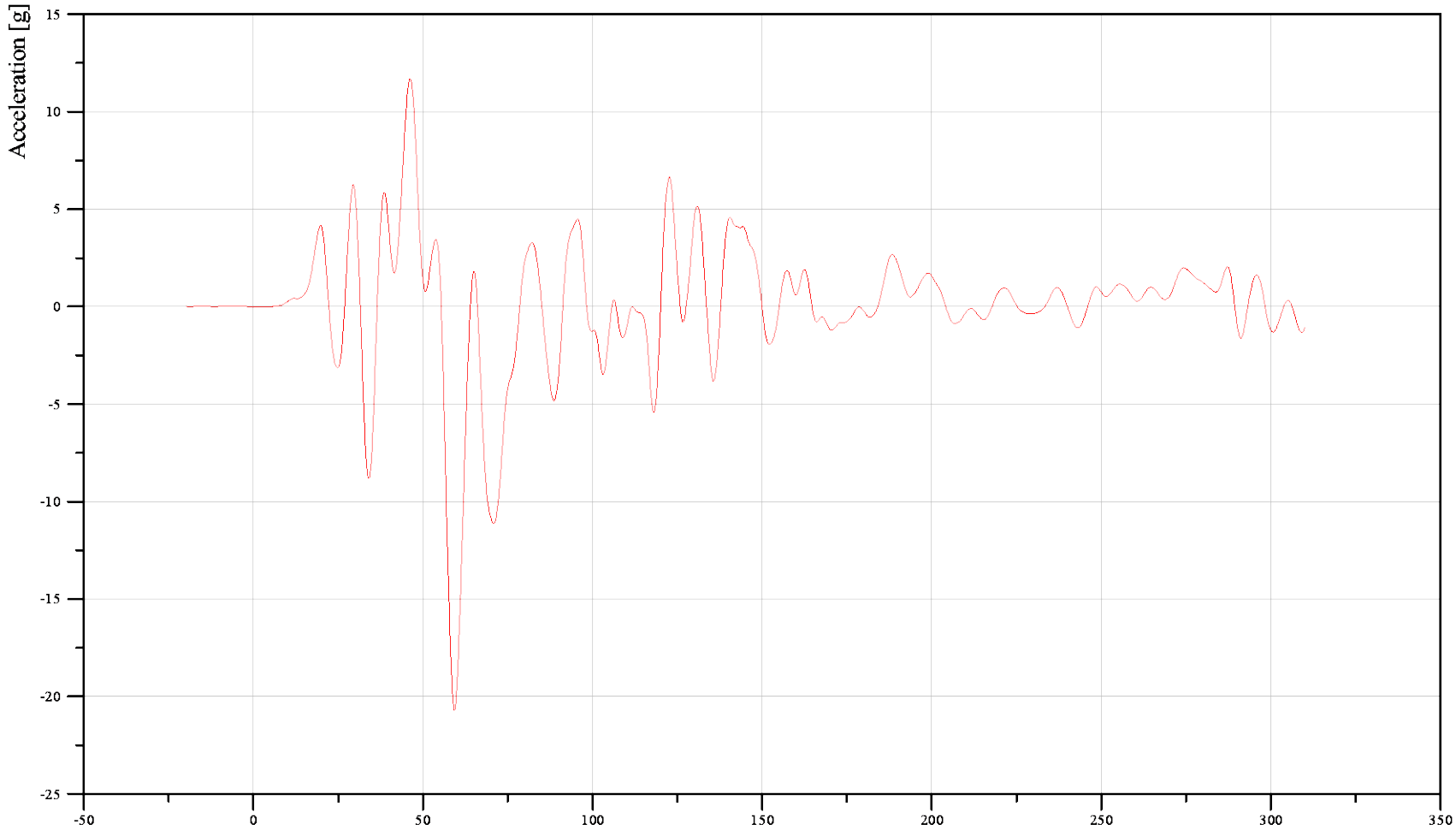
Target Vehicle CG Redundant Z-axis Acceleration

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
-20.72 g at 59.28 ms

Max. Value
11.69 g at 46.16 ms

1993 DeVille Into Rear of 1996 Jeep GC-ZJ

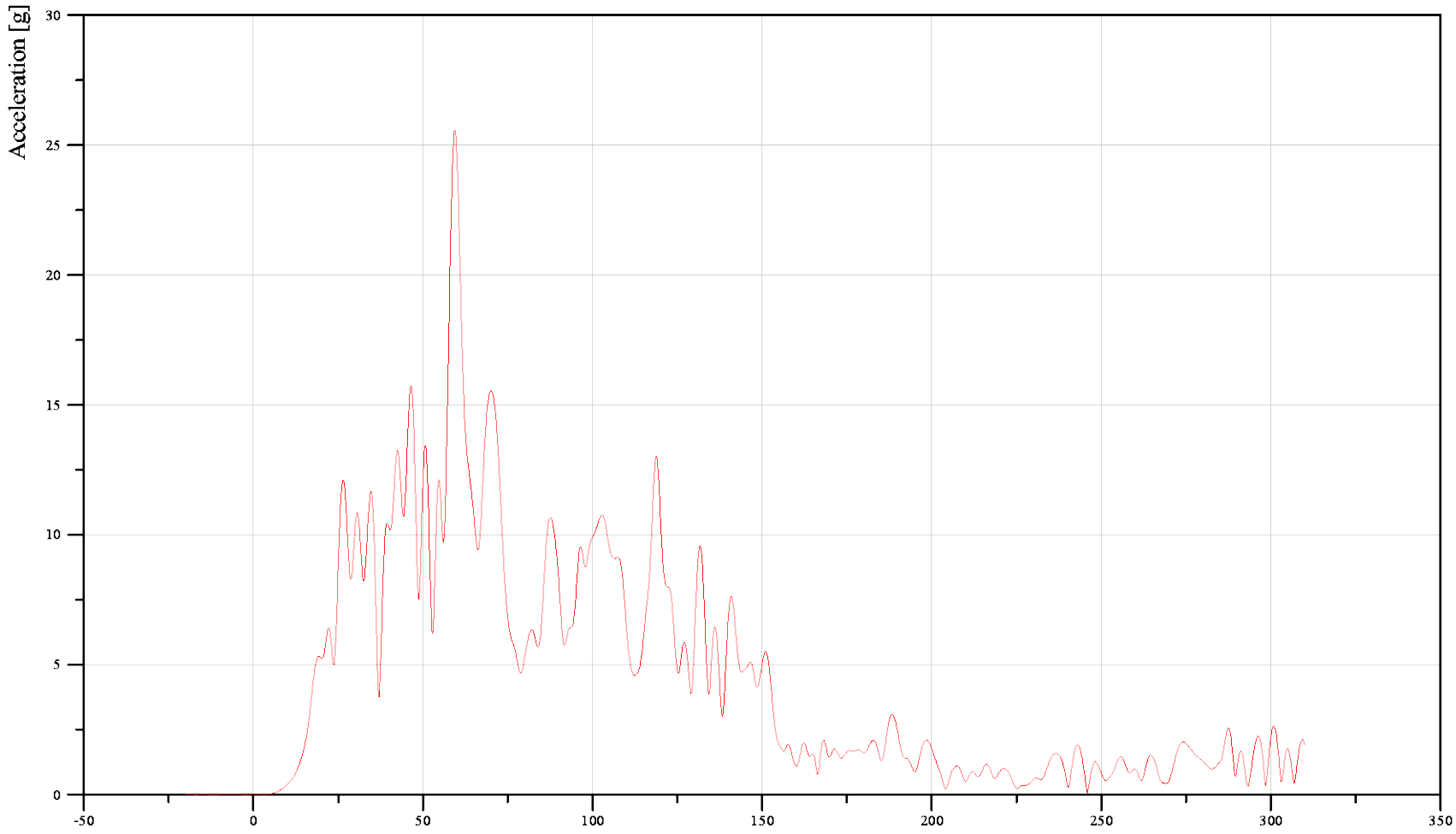
Target Vehicle CG Redundant Acceleration Resultant

Date: 11/07/2013
Time: 13:53

Customer: VRTC

20VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131107



Filter: CFC_60

Min. Value
0.00 g at -2.32 ms

Max. Value
25.59 g at 59.36 ms