Vehicle Research and Test Center

1993 Cadillac DeVille into

Rear of a 1996 Jeep Grand Cherokee Laredo

TRC Inc. Test Number: 131127

Prepared By:

Transportation Research Center Inc.

10820 State Route 347

East Liberty, OH 43319

Final Report

November - December 2013

Prepared For:

Vehicle Research and Test Center

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Test Performed By: John Shultz, Supervisor

Report Approved December 24, 2013 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 Grand Cherokee Laredo, 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 Grand Cherokee Laredo, 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 56.4 km/h 180° vehicle-to-vehicle rear impact test was conducted by TRC Inc. on November 27, 2013.

The target test vehicle, a 1996 Jeep Grand Cherokee Laredo, 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 1852.4 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 driver's front airbags. The bullet vehicle's test weight was 1761.0 kg. The bullet vehicle's impact speed was 56.4 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 27, 2013
Test time:	12:52 PM
Ambient temperature:	-1.7°C
Target vehicle year/make/ model/body style:	1996 Jeep/Grand Cherokee Laredo/MPV
Target vehicle test weight:	1852.4 kg
Bullet vehicle year/make/ model/body style:	1993/Cadillac/DeVille/ Sedan
Bullet vehicle test weight:	1761.0 kg
Impact angle[1]:	180°
Impact velocity[2]:	Bullet vehicle = 56.4 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/Grand Cherokee Laredo/MPV
VIN:	1J4GZ58S0TC237172
Model year:	1996
Body style:	MPV
Color:	White
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:	11/26/2013
Odometer reading:	157,020
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:		12/95
VIN:		1J4GZ58S0TC237172
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):	Toyo, Tranpath, P225/70R16
Tire pressure with maximum capacity vehicle load:	
Front:	44 psi (300 kPa)
Rear:	44 psi (300 kPa)
Spare tire (mfr., line, size):	Toyo, Radial, P225/75R15
Type of seats:	
Front	Bucket
Rear	Split Bench
Maximum width:	1810 mm
Wheelbase:	2690 mm

Location of "Recommended Tire Pressure" label:

Left B-Pillar

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

Recommended tire size:	P215/75R15
Recommended cold tire pressure:	Front: 36 psi (N/A kPa) Rear: 36 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 780 mm;	RF 792 mm;	LR 793 mm;	RR 814 mm
Post-test attitude:	LF 784 mm;	RF 771 mm;	LR 795 mm;	RR 765 mm

Table 2 Target Vehicle General Test and Vehicle Parameter Data Continued

Weight of test vehicle with required dummies and cargo weight:

Right front	494.2 kg	Right rear	396.6 kg
Left front	550.2 kg	Left rear	411.4 kg
Total front weight	1044.4 kg	(56.4% of total vehicle weight)	
Total rear weight	808.0 kg	(43.6% of total vehicle weight)	
Total test weight	1852.4 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1173 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:	1G6CD53B5P4301395
Model year:	1993
Body style:	Sedan
Color:	White
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:	11/25/2013
Odometer reading:	125,260
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	No
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:		4/93
VIN:		1G6CD53B5P4301395
GVWR:		4682 lbs. (2124 kg)
GAWR:	Front:	2619 lbs. (1188 kg)
	Rear:	2063 lbs. (936 kg)

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

Tires on vehicle (mfr., line, size):

Left Front:	Prestige, Radial Max, P205/70R15
Right Front:	Kenetica, Kenda, P205/70R15
Left Rear:	Prestige, Radial Max, P205/70R15
Right Rear:	Prestige, Radial Max, P205/70R15

Tire pressure with maximum capacity vehicle load:

Front:	35 psi (240 kPa)
Rear:	35 psi (240 kPa)

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

Type of seats:

Front	Split bench
Rear	Bench

Maximum width: 1863 mm

Wheelbase: 2883 mm

Location of "Recommended Tire Pressure" label:

Left B-Pillar

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 667 mm;	LR 631 mm;	RR 625 mm
Post-test attitude:	LF 652 mm;	RF 665 mm;	LR 668 mm;	RR 670 mm

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

Weight of test vehicle with required dummies and cargo weight:

Right front	499.8 kg	Right rear	365.6 kg
Left front	557.0 kg	Left rear	338.6 kg
Total front weight	1056.8 kg	(60.0% of total vehicle weight)	
Total rear weight	704.2 kg	(40.0% of total vehicle weight)	
Total test weight	1761.0 kg		

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1153 mm rearward of front wheel centerline

Fuel System Data:

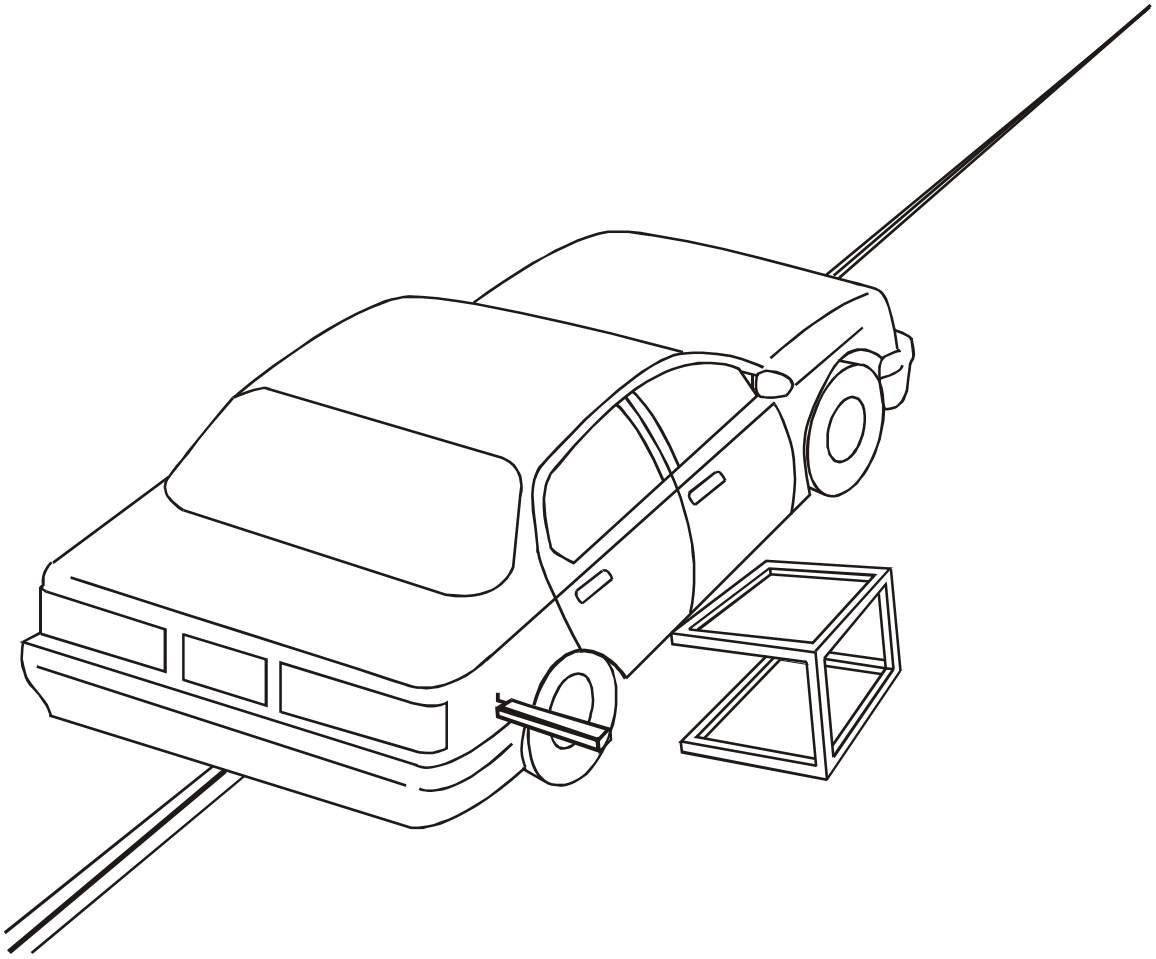
Usable fuel system capacity N/A liters (from owner's manual)

Actual test volume: 70.4 liters

Table 4 Post-Impact Data

Test number:	131127
Test date:	11/27/2013
Test time:	12:52 PM
Test type:	Vehicle to Vehicle Rear Impact
Impact angle:	180°
Ambient temperature at impact area:	-1.7°C
Impact velocity:	
Target vehicle:	0 km/h
Bullet vehicle:	56.4 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	13.1	16.0	-2.8	25.5
		Y	23.0	40.0	-20.4	35.4
		Z	22.3	25.5	-19.4	40.5
		R	31.4	40.1	---	---
2	Vehicle Center of Gravity Redundant	X	13.7	15.9	-2.4	25.4
		Y	22.9	40.0	-20.1	35.4
		Z	30.1	35.3	-36.2	40.2
		R	43.2	40.2	---	---

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	1.6	293.4	-14.1	72.2
		Y	3.2	89.4	-3.9	38.6
		Z	19.1	64.9	-13.1	127.7
		R	22.8	64.7	---	---
2	Vehicle Center of Gravity Redundant	X	1.0	279.6	-13.4	61.4
		Y	2.5	89.3	-3.9	38.7
		Z	16.9	64.6	-12.6	127.4
		R	20.7	64.3	---	---

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

Table 7 Target Vehicle Measurements

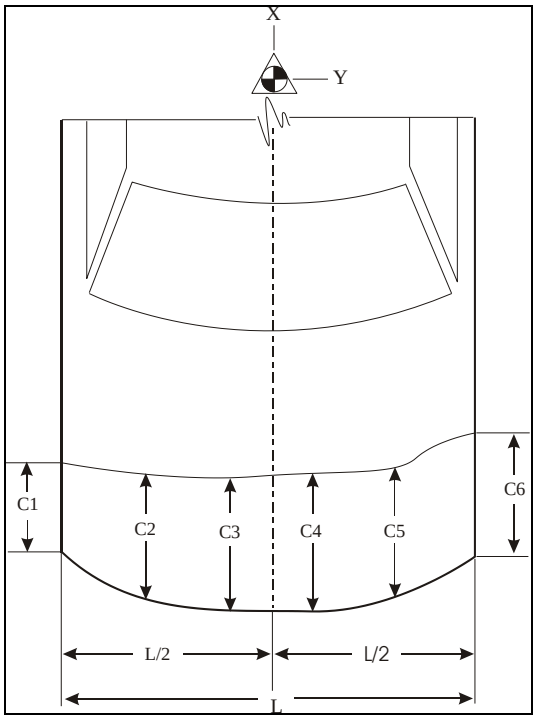
1996 Jeep Grand Cherokee Laredo

Test Number: 131127

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	4487	4237	250
X2	Front Surface of Vehicle to Front of Engine Block	555	557	-2
X3	Front Surface of Vehicle to Firewall	1083	1089	-6
X4	Front Surface of Vehicle to Upper Leading Edge of Right Door	1412	1414	-2
X5	Front Surface of Vehicle to Upper Leading Edge of Left Door	1415	1415	0
X6	Front Surface of Vehicle to Lower Leading Edge of Right Door	1452	1442	10
X7	Front Surface of Vehicle to Lower Leading Edge of Left Door	1457	1439	18
X8	Front Surface of Vehicle to Upper Trailing Edge of Right Door	2431	2432	-1
X9	Front Surface of Vehicle to Upper Trailing Edge of Left Door	2434	2437	-3
X10	Front Surface of Vehicle to Lower Trailing Edge of Right Door	2452	2440	12
X11	Front Surface of Vehicle to Lower Trailing Edge of Left Door	2453	2434	19
X12	Front Surface of Vehicle to Bottom of " A " Post on Right Side	1422	1442	-20
X13	Front Surface of Vehicle to Bottom of " A " Post on Left Side	1434	1462	-28
X14	Front Surface of Vehicle to Firewall-Right Side	1079	1067	12
X15	Front Surface of Vehicle to Firewall-Left Side	1112	1102	10
X16	Rear Surface of Vehicle to Steering Wheel Center	1947	1907	40
X17	Center of Steering Column to " A " Post	290	292	-2
X18	Center of Steering Column to Headliner	435	440	-5
X19	Front Surface of Vehicle to Right Side of Rear Bumper	4437	4147	290
X20	Front Surface of Vehicle to Left Side of Rear Bumper	4422	4302	120
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 Grand Cherokee Laredo

	Pre-test	Post-test	Crush
L	1524	N/A	N/A
C1	4422	4302	120
C2	4502	4307	195
C3	4482	4255	227
CL	4487	4237	250
C4	4482	4227	255
C5	4492	4197	295
C6	4437	4147	290

All measurements in millimeters.

Table 8 Bullet Vehicle Measurements

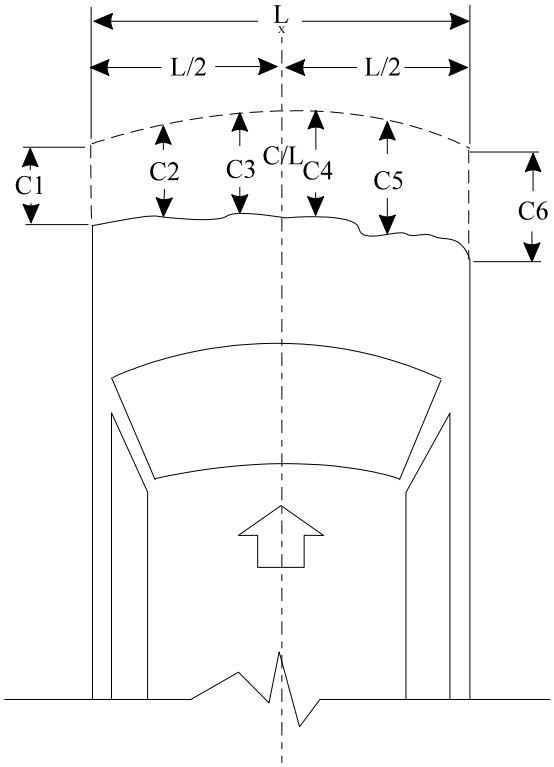
1993 Cadillac DeVille

Test Number: 131127

No.	Type of measurement	Pre-Test	Post-Test	Difference
X1	Total Length of Vehicle at Centerline	5193	5152	41
X2	Rear Surface of Vehicle to Front of Engine Block	4630	4522	108
X3	Rear Surface of Vehicle to Firewall	3868	3878	-10
X4	Rear Surface of Vehicle to Upper Leading Edge of Right Door	3514	3512	2
X5	Rear Surface of Vehicle to Upper Leading Edge of Left Door	3513	3512	1
X6	Rear Surface of Vehicle to Lower Leading Edge of Right Door	3492	3494	-2
X7	Rear Surface of Vehicle to Lower Leading Edge of Left Door	3489	3487	2
X8	Rear Surface of Vehicle to Upper Trailing Edge of Right Door	2496	2497	-1
X9	Rear Surface of Vehicle to Upper Trailing Edge of Left Door	2500	2498	2
X10	Rear Surface of Vehicle to Lower Trailing Edge of Right Door	2505	2506	-1
X11	Rear Surface of Vehicle to Lower Trailing Edge of Left Door	2504	2503	1
X12	Rear Surface of Vehicle to Bottom of " A " Post on Right Side	3502	3497	5
X13	Rear Surface of Vehicle to Bottom of " A " Post on Left Side	3507	3502	5
X14	Rear Surface of Vehicle to Firewall-Right Side	3786	3774	12
X15	Rear Surface of Vehicle to Firewall-Left Side	3825	3846	-21
X16	Rear Surface of Vehicle to Steering Wheel Center	3054	3052	2
X17	Center of Steering Column to " A " Post	390	345	45
X18	Center of Steering Column to Headliner	435	435	0
X19	Rear Surface of Vehicle to Right Side of Front Bumper	5118	5029	89
X20	Rear Surface of Vehicle to Left Side of Front Bumper	5119	5147	-28
X21	Length of Engine Block	500	500	0
	Left Front Overhang	1096	1045	51
	Right Front Overhang	1096	942	154
X26	Firewall to Engine or Transaxle	375	329	46
X27	Vertical Distance from Door Sill to Centerline of Steering Column	535	540	-5
X28	Left Wheelbase	2883	2885	-2
X28	Right Wheelbase	2883	2875	8
X29	Maximum Width	1863	1863	0
X30	Rear Surface of Vehicle to Engine Bottom Target	4318	4320	-2
X31	Rear Surface of Vehicle to Occupant Compartment Bottom Targets	2828	2820	8
X32	Rear Surface of Vehicle to Front Bumper Bottom Target	5108	5080	28
X33	Rear Surface of Vehicle to Frame Crossmember Bottom Target	4498	4495	3
RD	Rear Surface of Vehicle to Right Side of Dash Panel	3327	3322	5
CD	Rear Surface of Vehicle to Center of Dash Panel	3339	3342	-3
LD	Rear Surface of Vehicle to Left Side of Dash Panel	3329	3327	2

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	N/A	N/A
C1	5119	5147	-28
C2	5128	5112	16
C3	5174	5144	30
CL	5193	5152	41
C4	5174	5091	83
C5	5129	5054	75
C6	5118	5029	89

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/Grand Cherokee Laredo/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 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: 11/27/2013

Vehicle year/make/
model/body style: 1996/Jeep/Grand Cherokee Laredo/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)

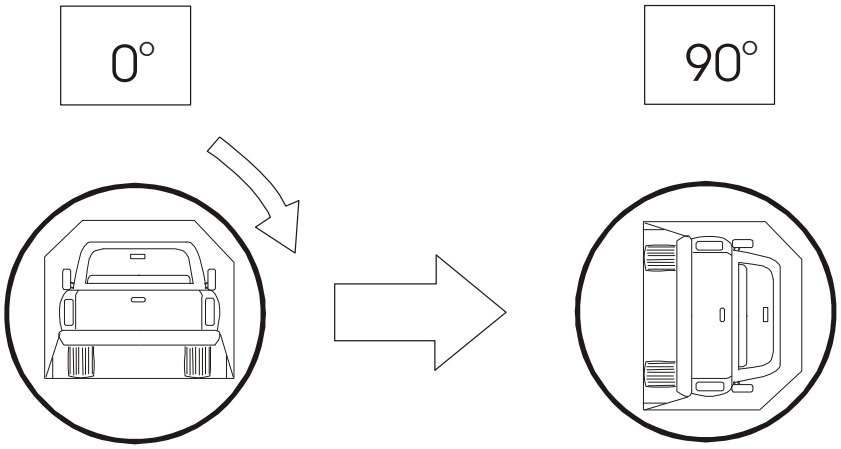
Fuel system fluid spillage measurements:

		Test Results	Maximum Allowable
1.	From impact until vehicle motion ceases	None	28 g
2.	5-minute period after vehicle motion ceases	None	142 g
3.	Next 25 minutes after 5-minute period	None	28 g/minute

Fuel system fluid spillage location(s): None

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		

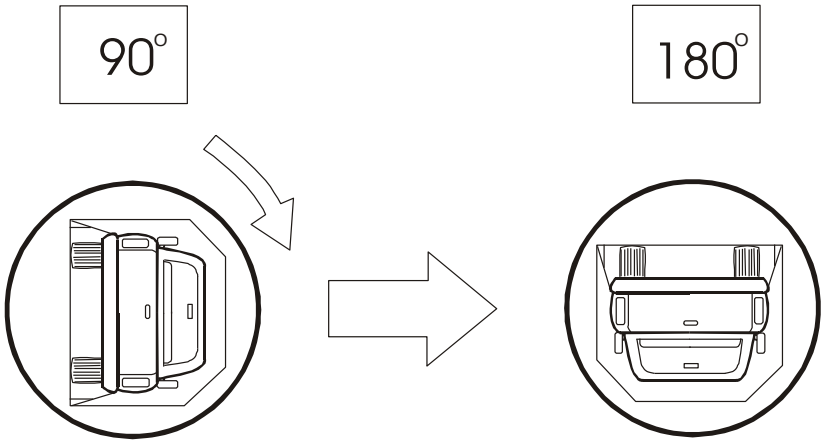
Fuel system fluid spillage measurements:

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

Fuel system fluid spillage location(s): None

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	0g	142 g
2.	Sixth minute from onset of rotation	0g	28 g
3.	Seventh minute from onset of rotation	0g	28 g

Fuel system fluid spillage location(s): None

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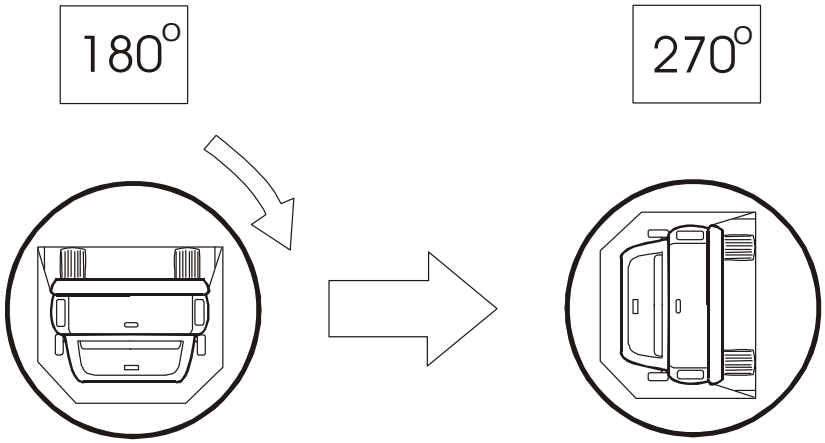
Figure 4 Target Vehicle FMVSS 301 Static Rollover Test Data, Continued

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		

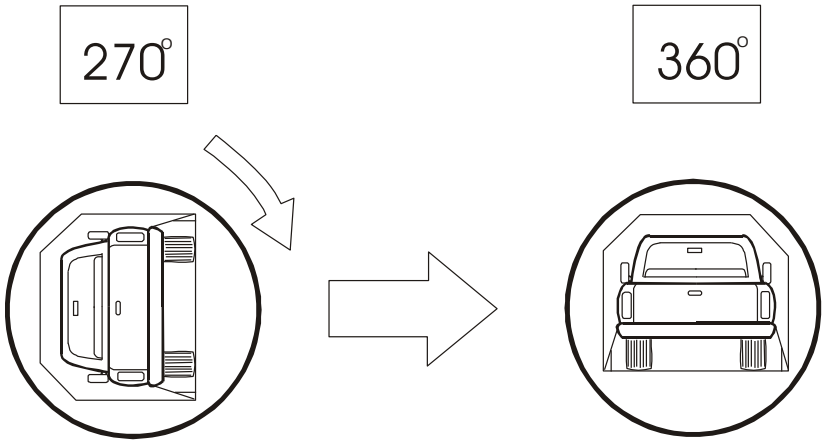
Fuel system fluid spillage measurements:

180 to 270° rotation	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	0g	142 g
2. Sixth minute from onset of rotation	0g	28 g
3. Seventh minute from onset of rotation	0g	28 g

Fuel system fluid spillage location(s): None

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	0g	142 g
2.	Sixth minute from onset of rotation	0g	28 g
3.	Seventh minute from onset of rotation	0g	28 g

Fuel system fluid spillage location(s): None

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Section 4.0

Camera Information

Figure 5 Camera Positions

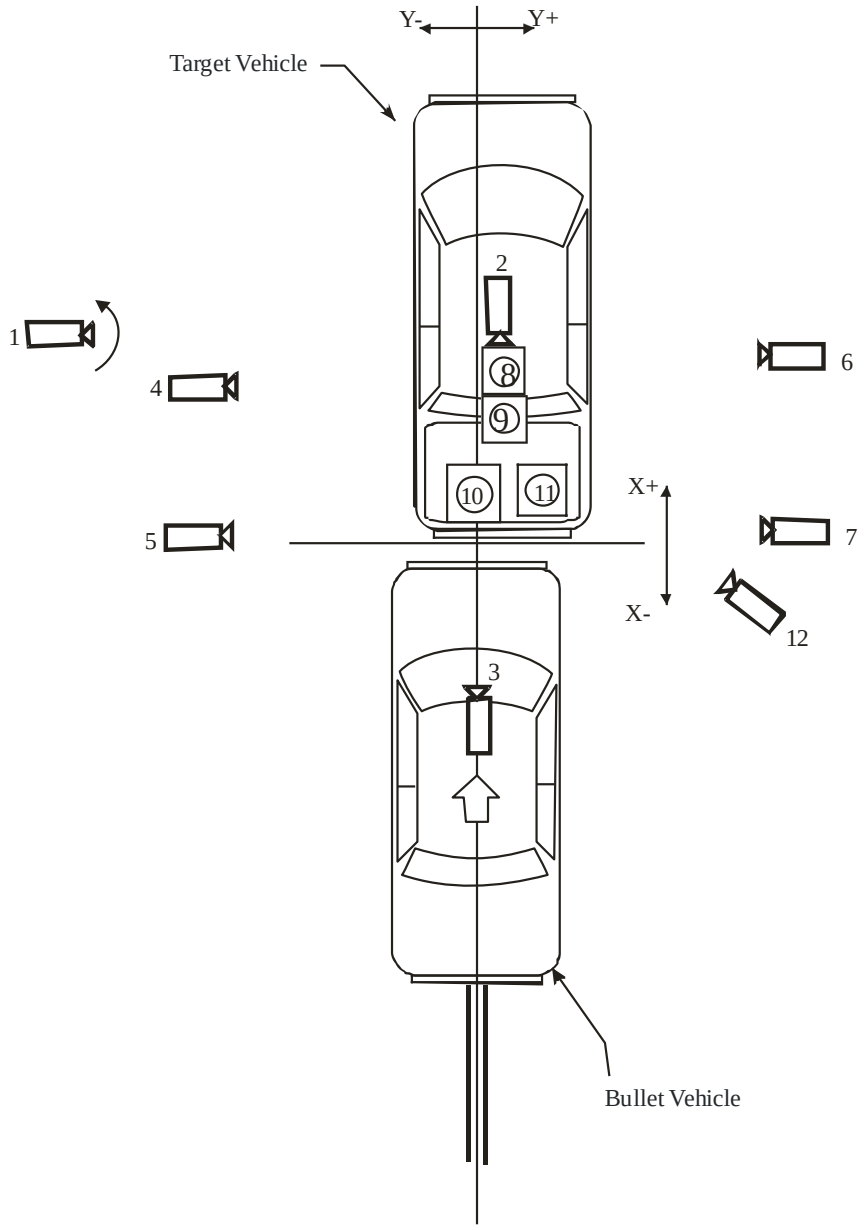


Table 11 Camera Information

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 [1]	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	1359	-6548	-1198	-4.0º	8.5	1000
5	Left side impact	533	-6370	-1013	-1.4º	25	1000
6	Right side target vehicle	1562	7041	-1096	-1.2º	8.5	1000
7	Right side impact	610	7041	-905	1.5º	25	1000
8	Overhead	305	380	-5669	N/A	8.5	1000
9	Pit wide	960	125	2837	89.0º	16	1000
10	Pit medium	695	10	2707	83.2º	25	1000
11	Pit tight	620	-215	2837	85.7º	Zoom	1000
12	Right ground level tight impact	-1829	3002	-63	11.2º	50	1000

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

[1] Camera failed to operate due to the low temperatures.

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

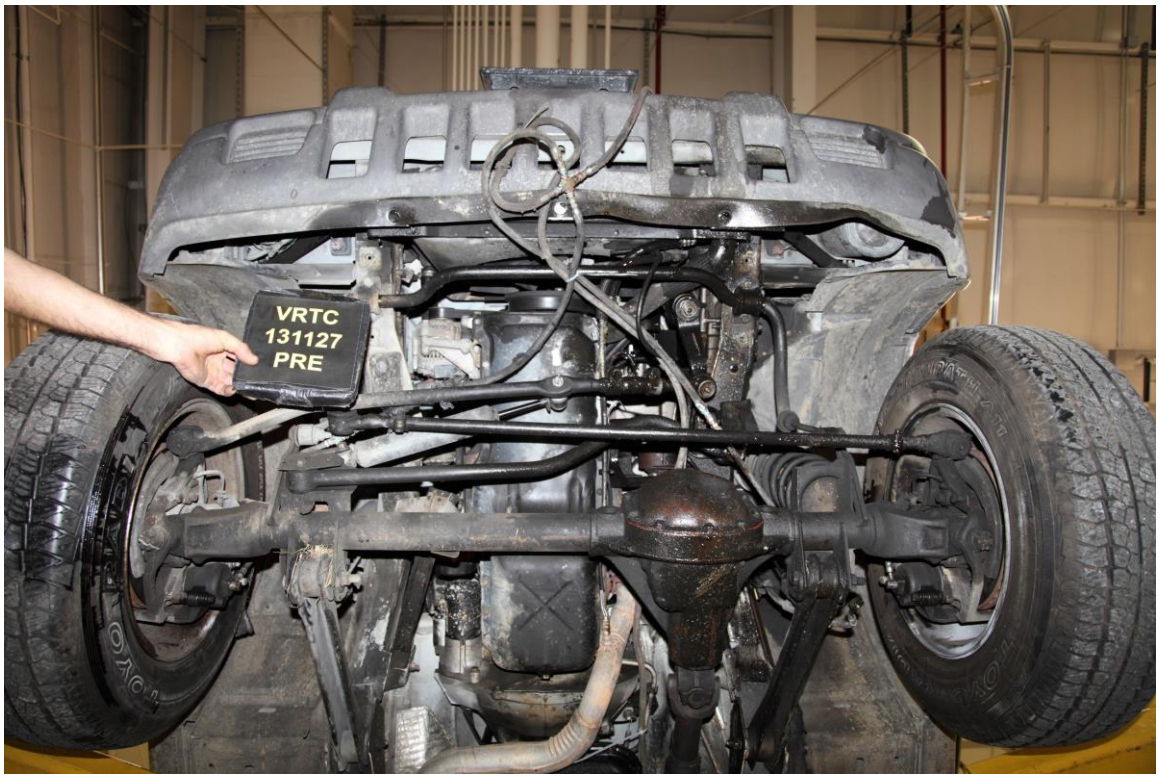


Figure A-13 Pre-Test Target Vehicle Front Underbody View

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

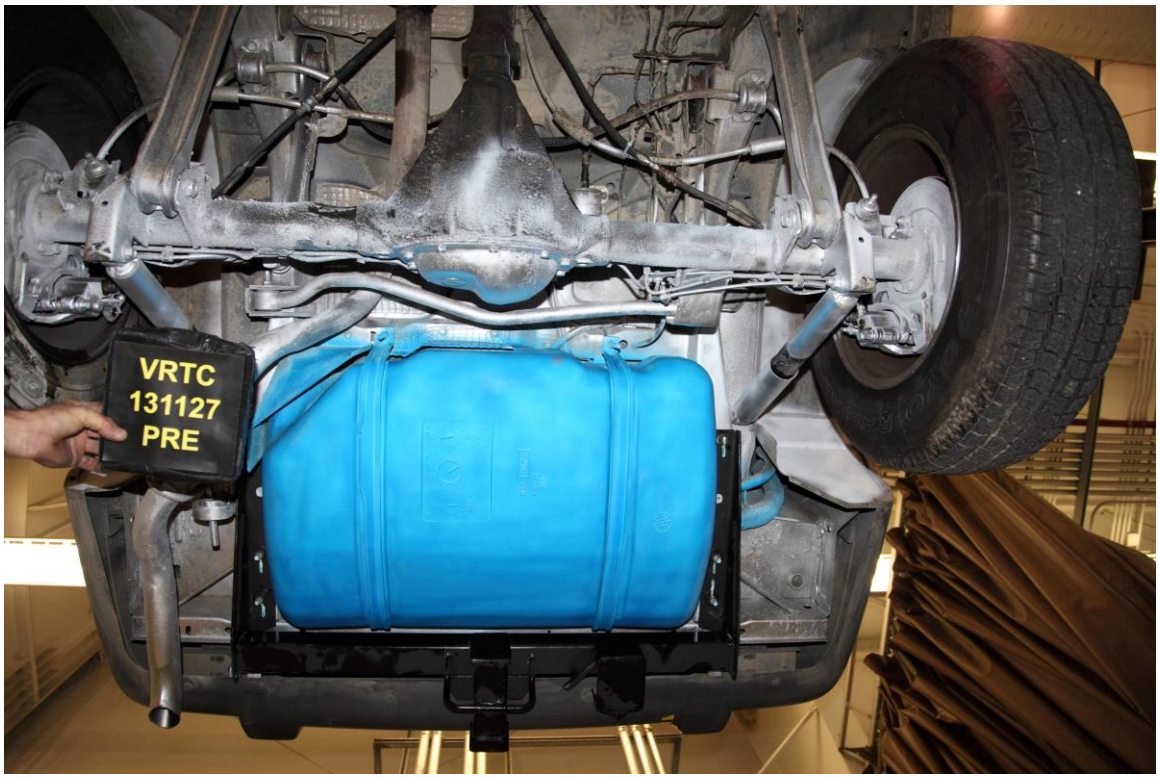


Figure A-15 Pre-Test Target Vehicle Rear Underbody View

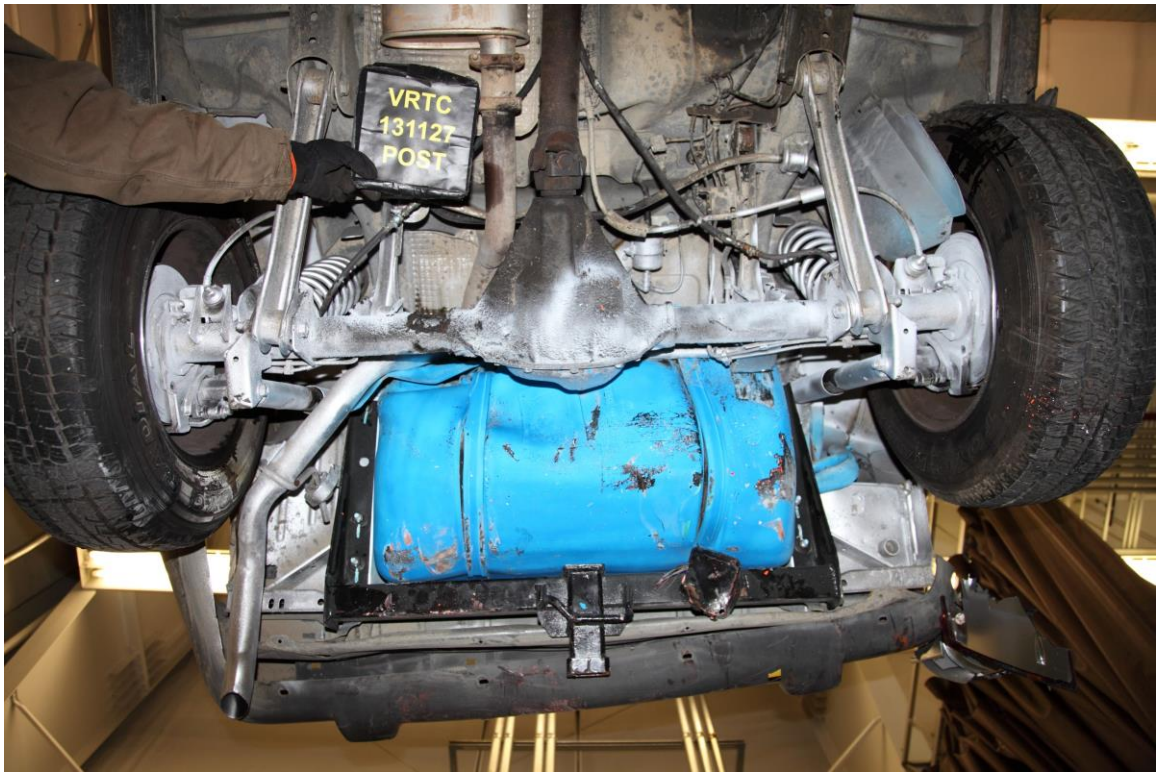


Figure A-16 Post-Test Target Vehicle Rear Underbody View

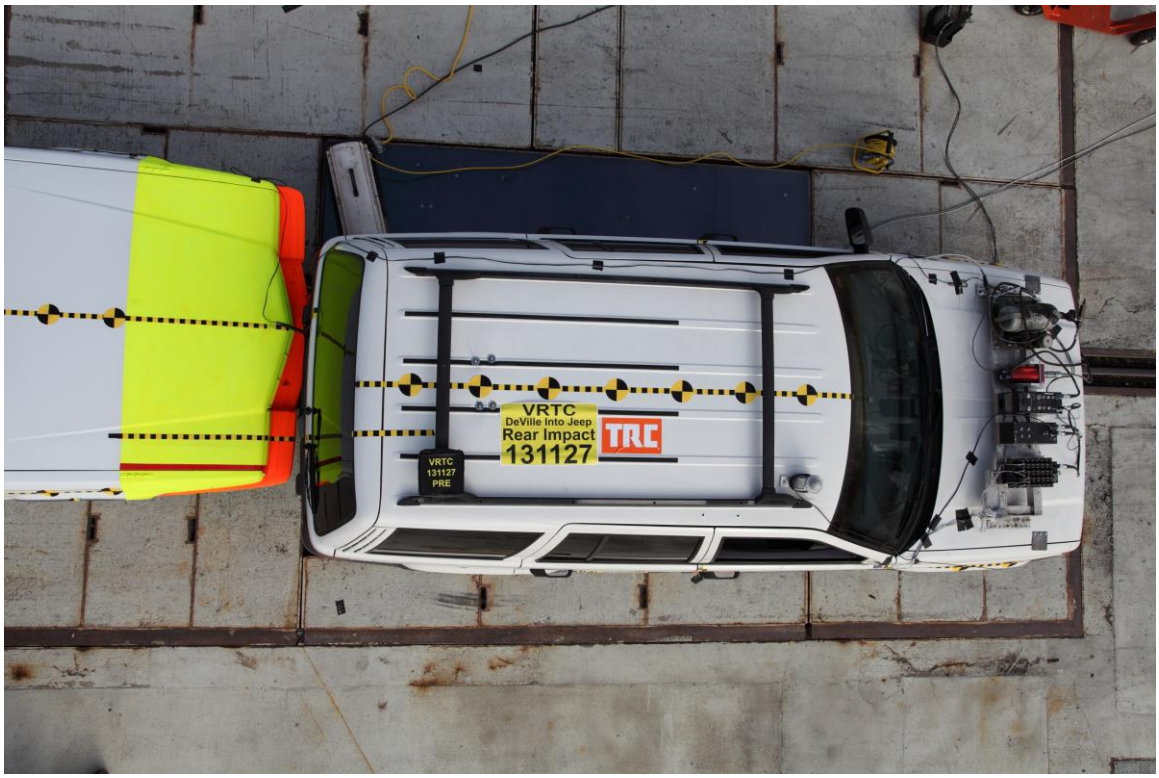


Figure A-17 Pre-Test Target Vehicle Overhead View

Photo Not Available

Figure A-18 Post-Test Target Vehicle Overhead View

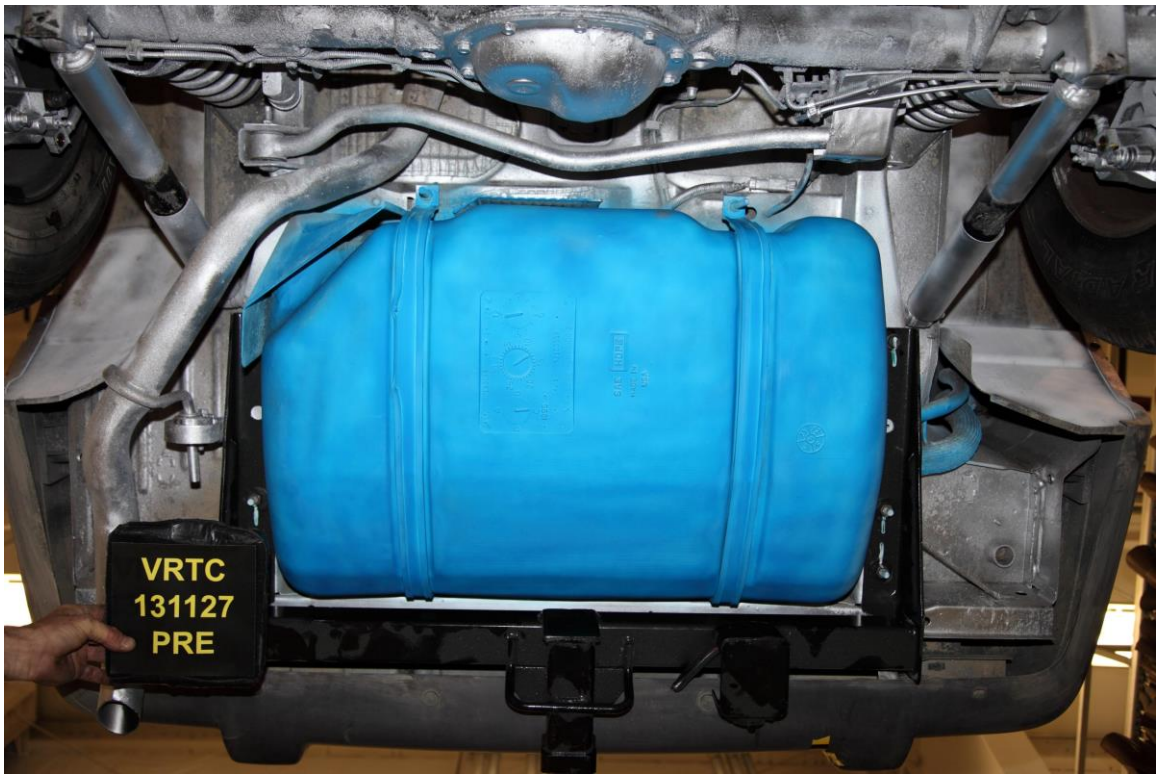


Figure A-19 Pre-Test Target Vehicle Fuel Tank Close-up View

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 Pre-Test Target Vehicle Fuel Filler Close-up View

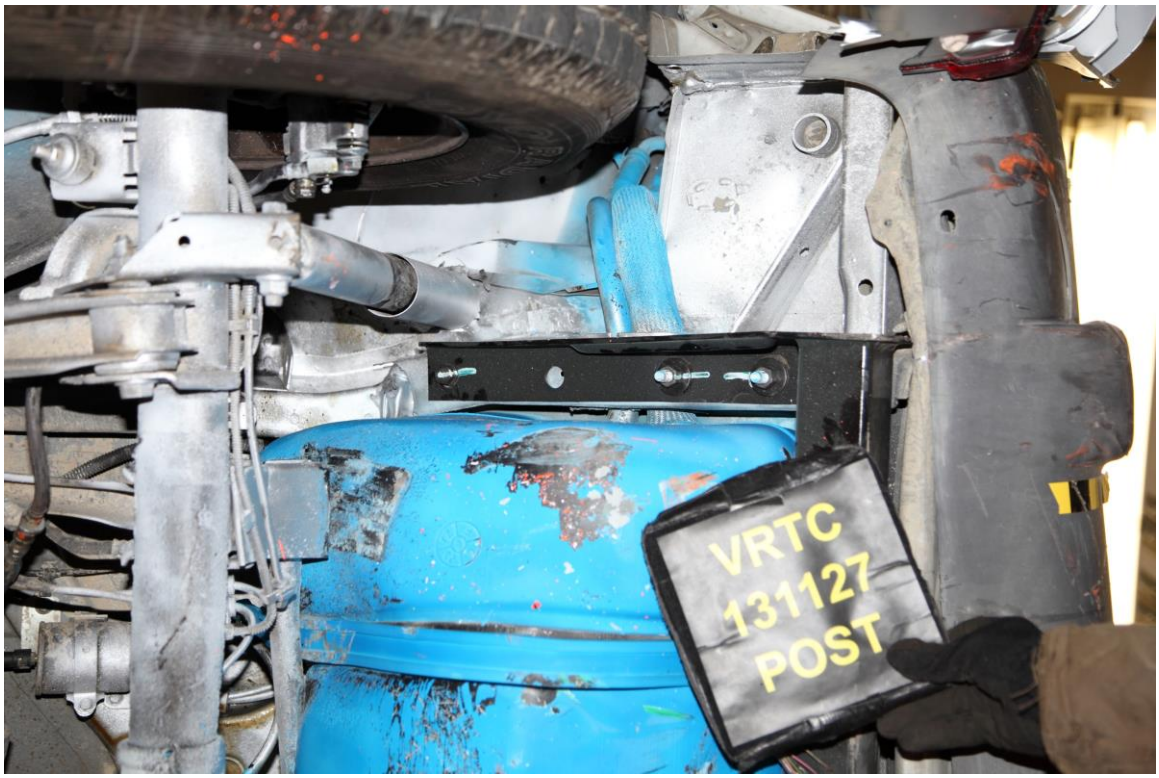


Figure A-23 Post-Test Target Vehicle Fuel Filler Close-up – View 1

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

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

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

Figure A-27 Close-Up View of Target Vehicle Tire Information

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

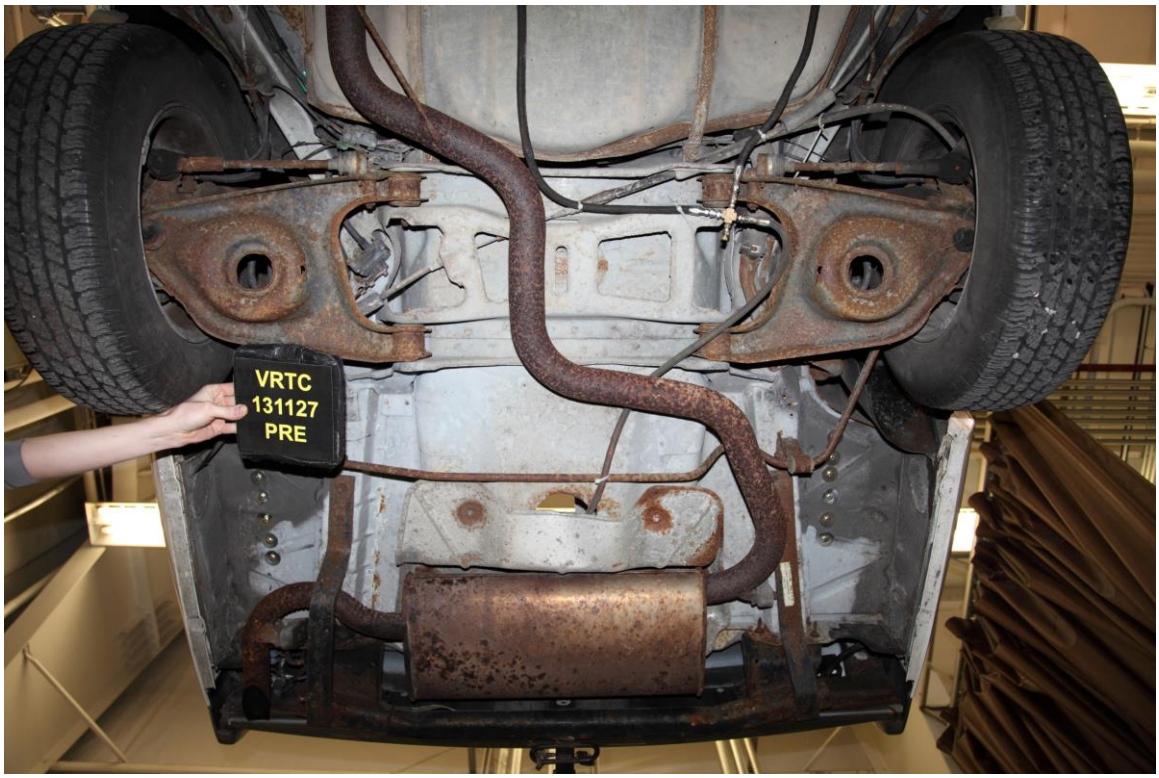


Figure A-42 Pre-Test Bullet Vehicle Rear Underbody View

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

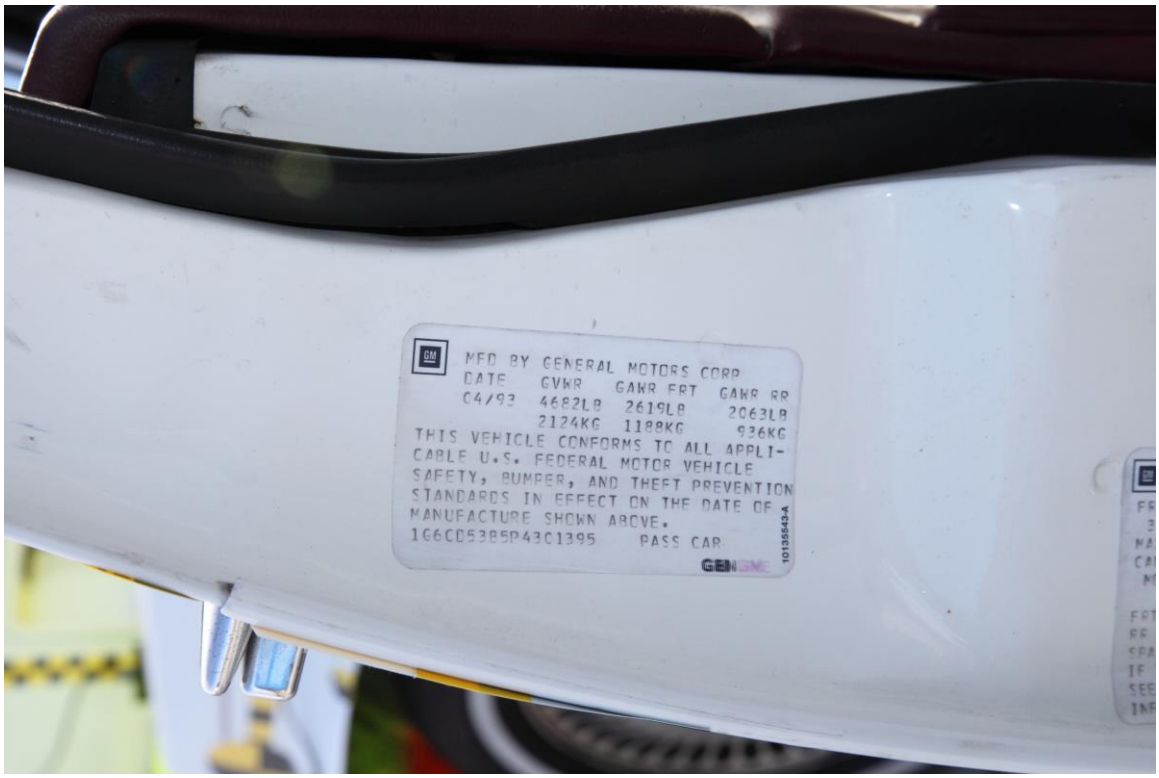


Figure A-50 Close-Up View of Bullet Vehicle Certification Label

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

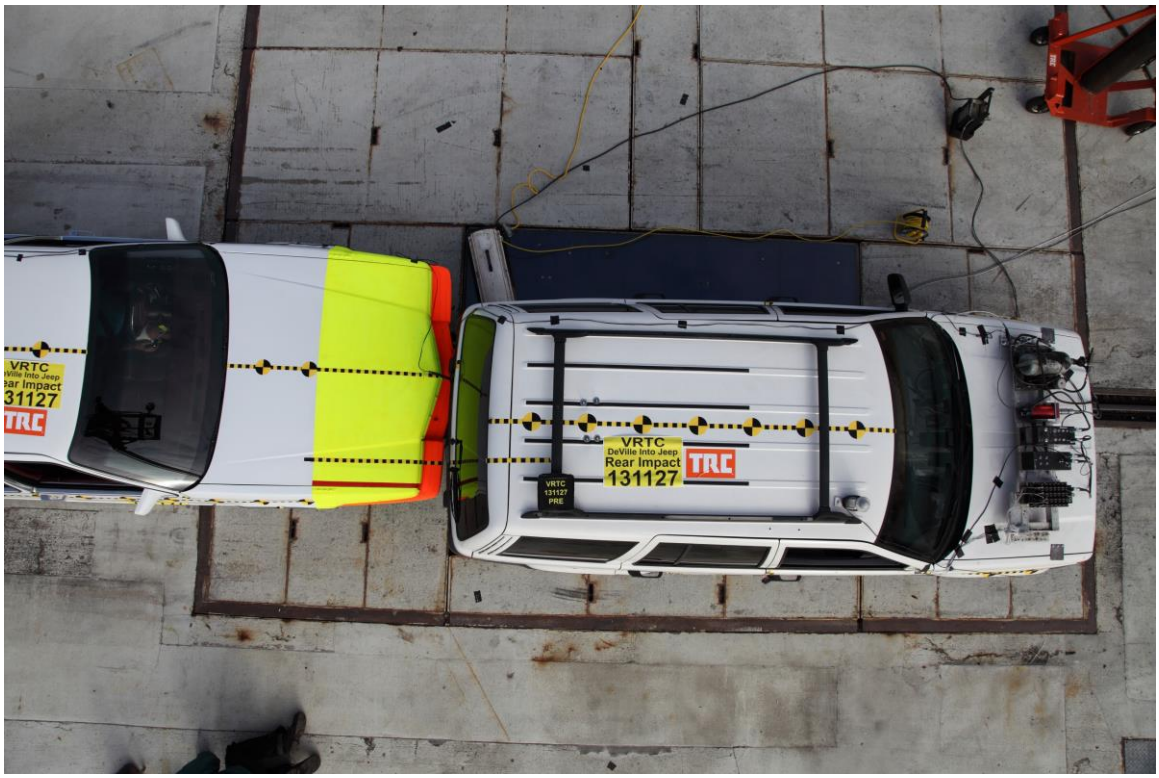


Figure A-56 Pre-Test Bullet and Target Vehicles Overhead View

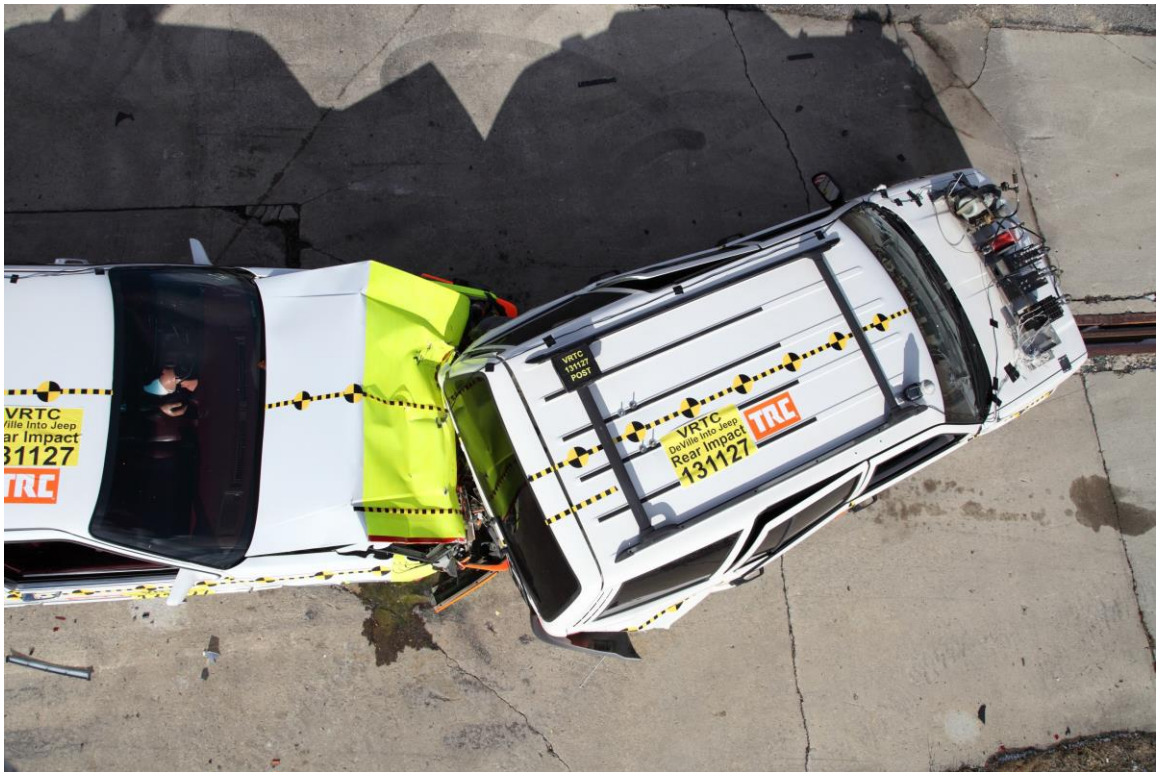


Figure A-57 Post-Test Bullet and Target Vehicles Overhead View

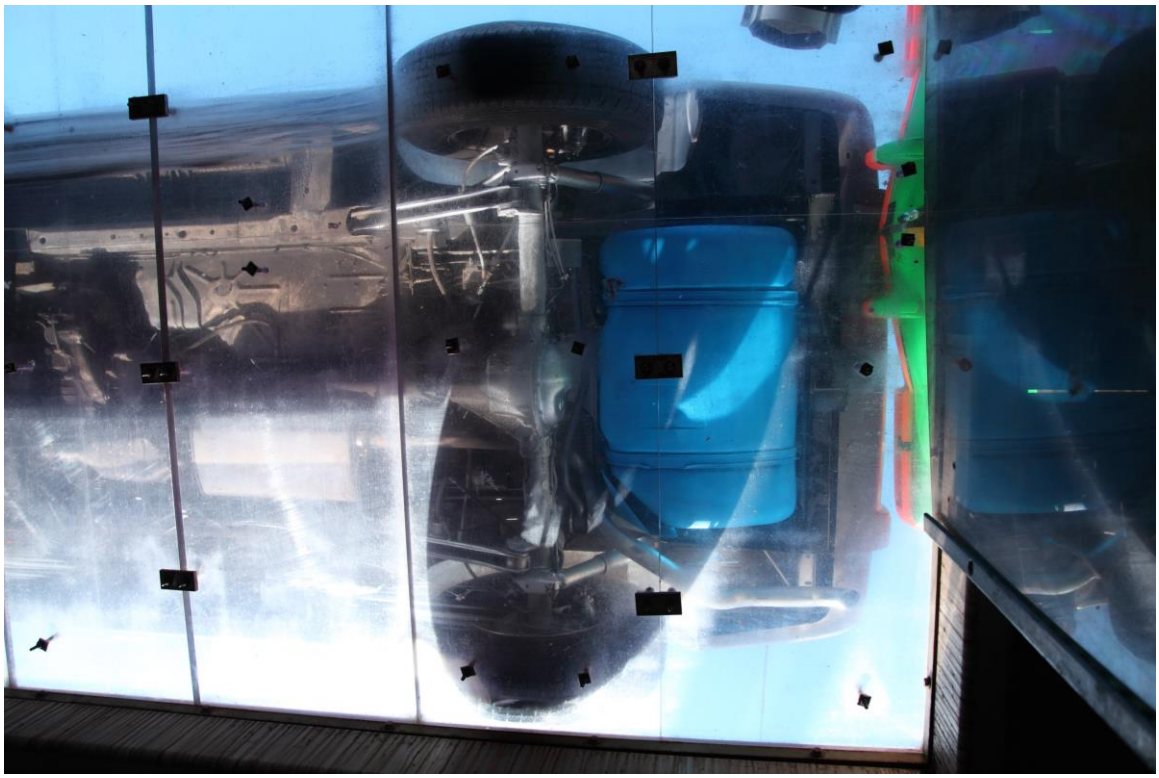


Figure A-58 Pre-Test Impact Alignment – Bullet and Target Vehicles Pit View

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

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

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

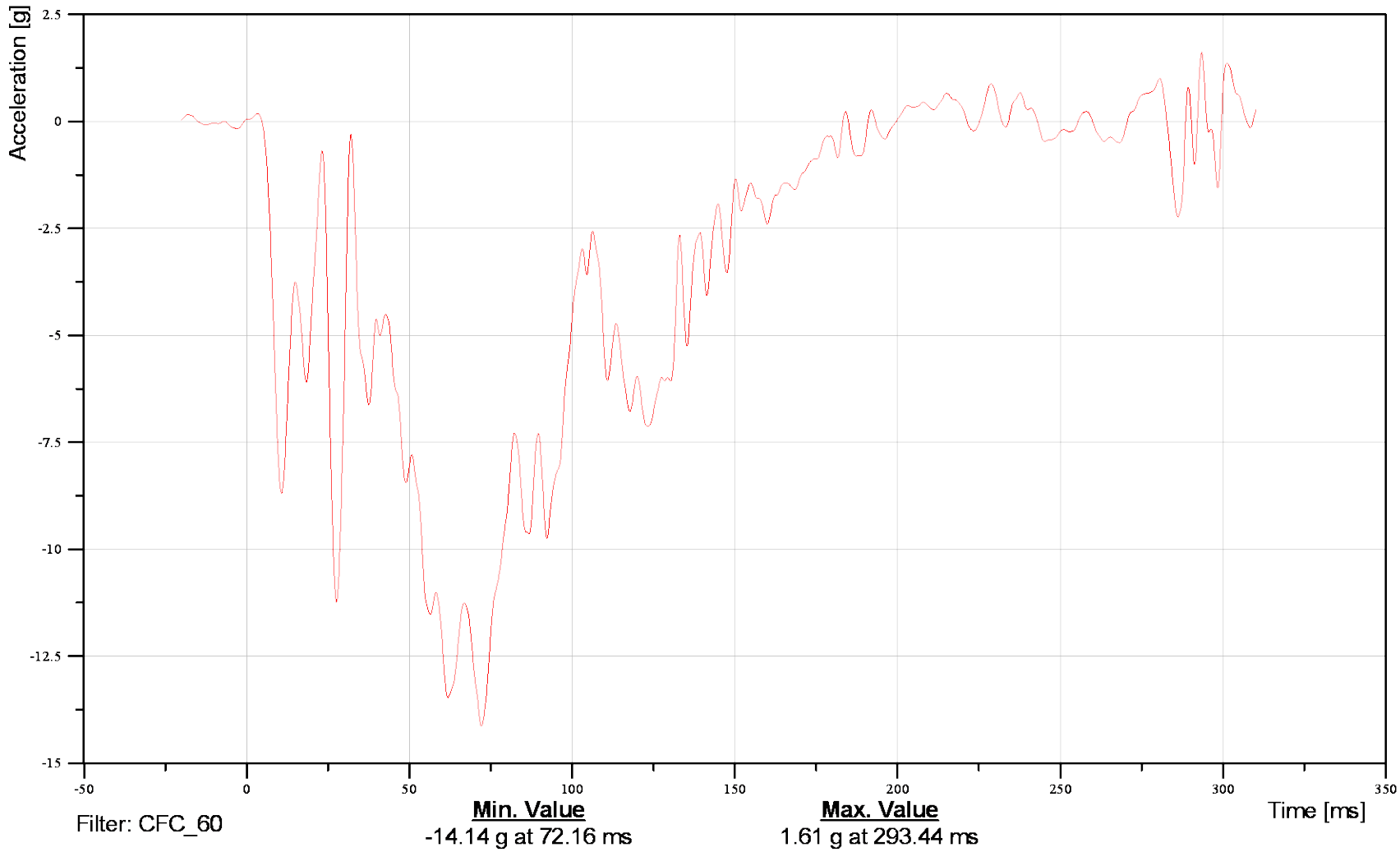
Bullet Bullet Vehicle CG X

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-14.14 g at 72.16 ms

Max. Value
1.61 g at 293.44 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

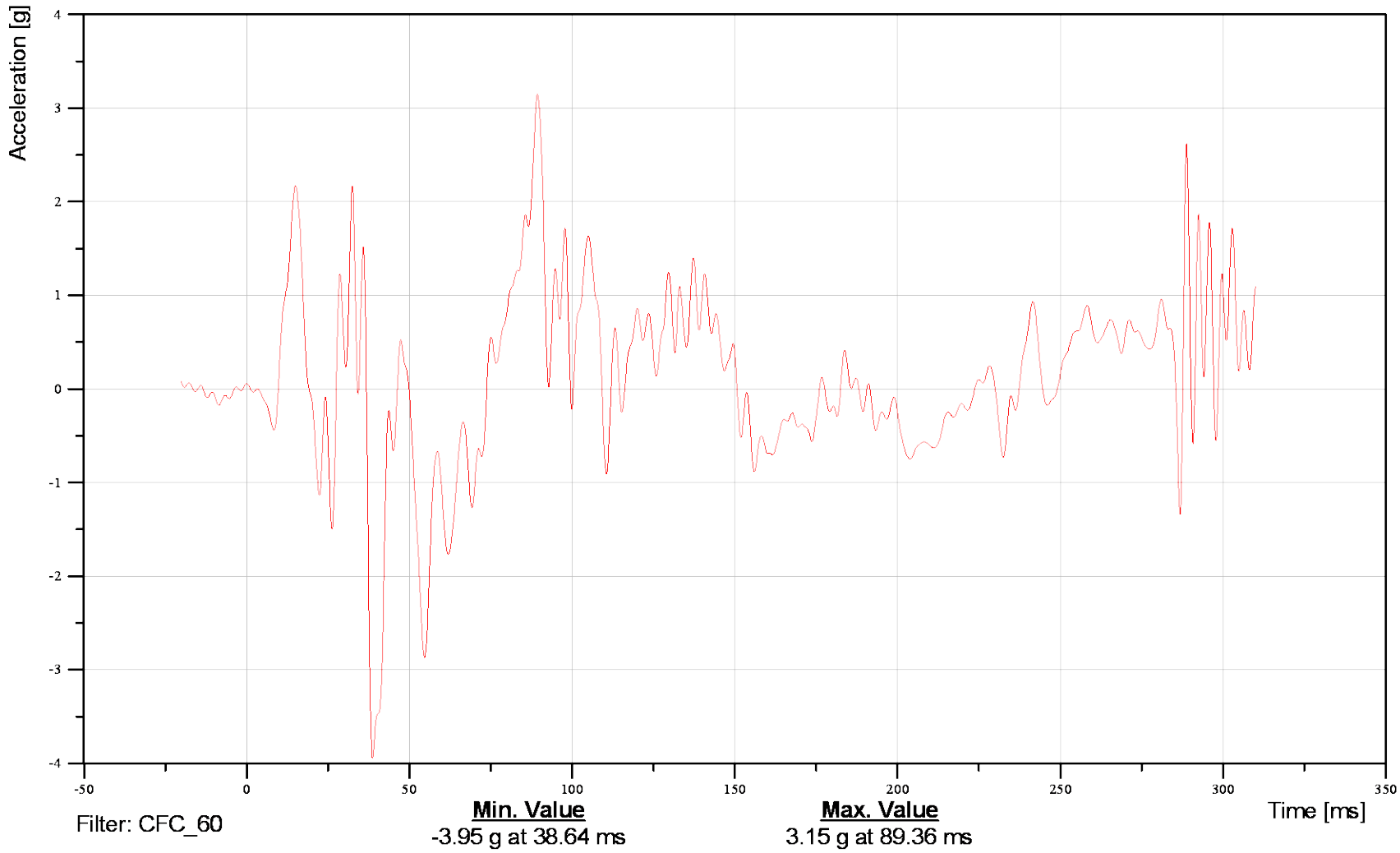
Bullet Bullet Vehicle CG Y

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-3.95 g at 38.64 ms

Max. Value
3.15 g at 89.36 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

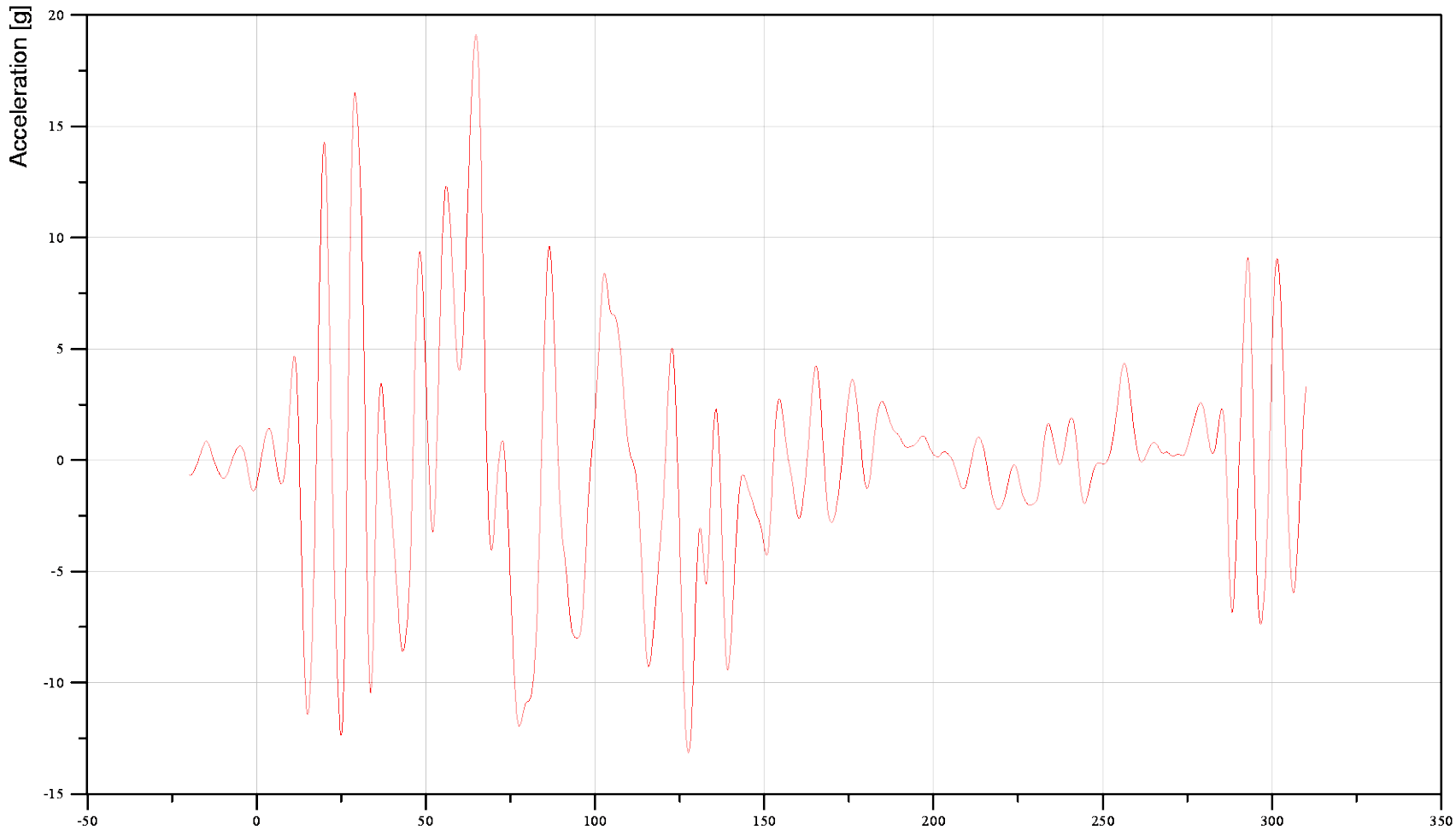
Bullet Bullet Vehicle CG Z

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-13.15 g at 127.68 ms

Max. Value
19.12 g at 64.88 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

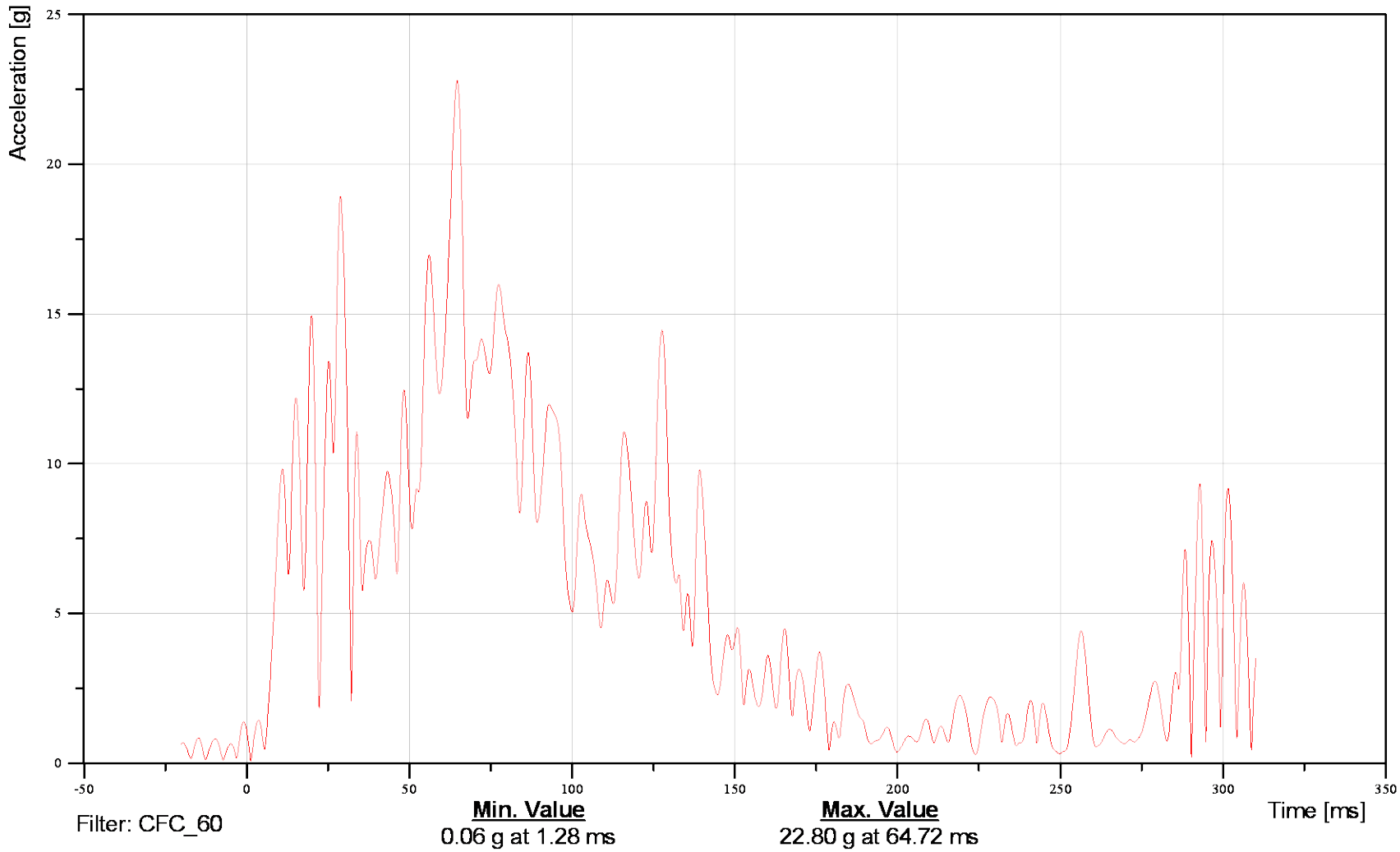
Bullet Vehicle CG Acceleration Resultant

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
0.06 g at 1.28 ms

Max. Value
22.80 g at 64.72 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

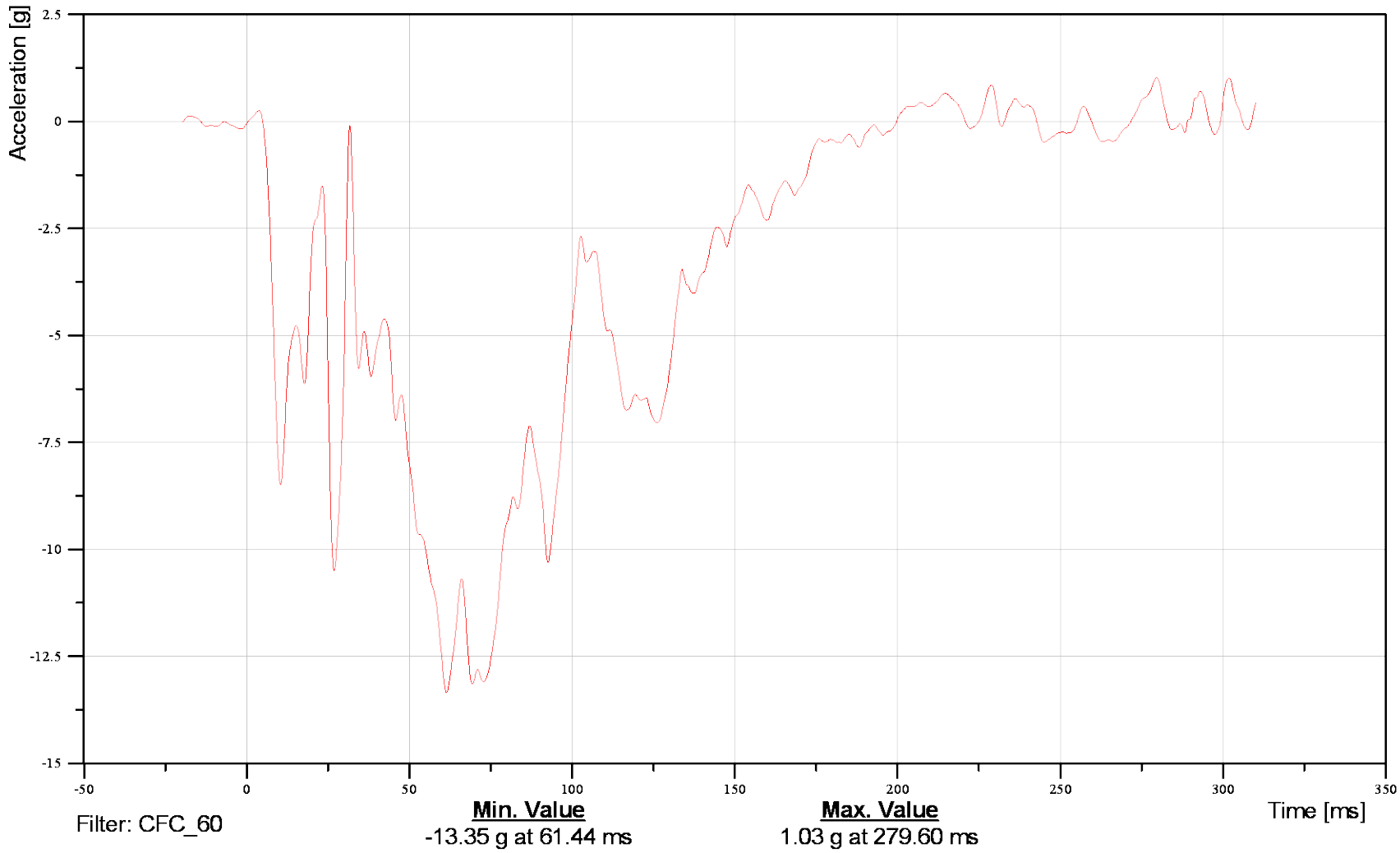
Bullet Vehicle CG Redundant X

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-13.35 g at 61.44 ms

Max. Value
1.03 g at 279.60 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

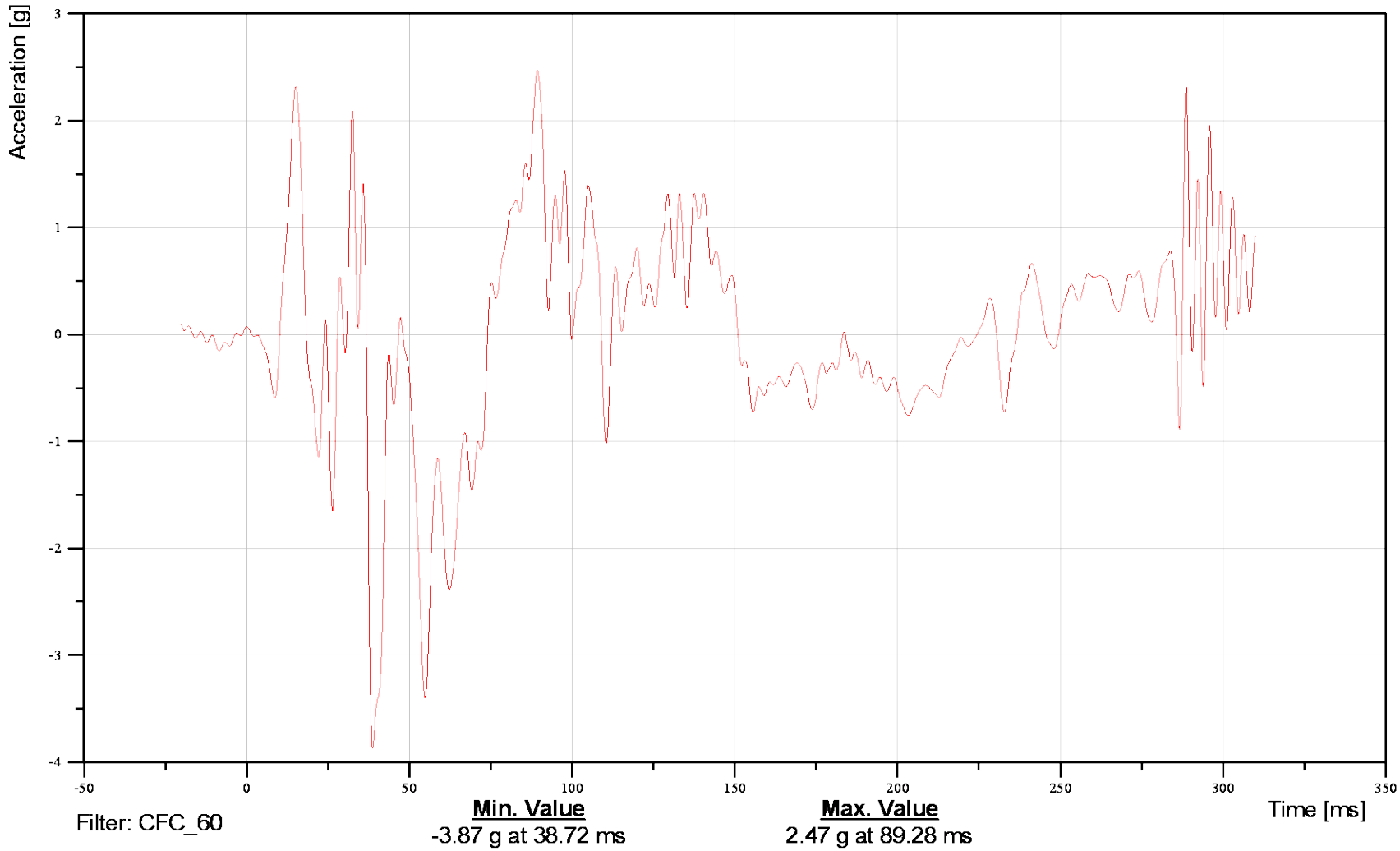
Bullet Vehicle CG Redundant Y

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-3.87 g at 38.72 ms

Max. Value
2.47 g at 89.28 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

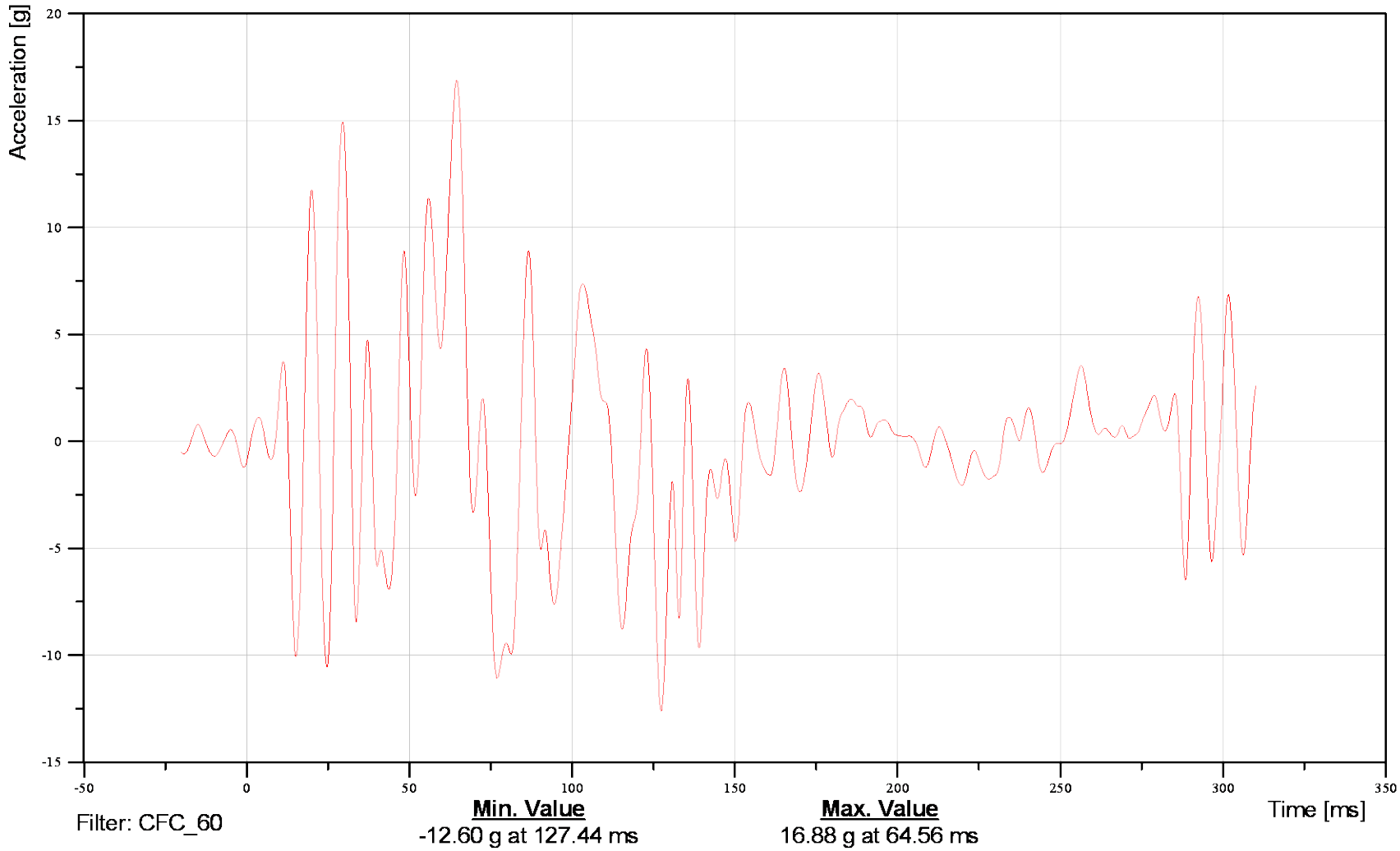
Bullet Vehicle CG Redundant Z

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-12.60 g at 127.44 ms

Max. Value
16.88 g at 64.56 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

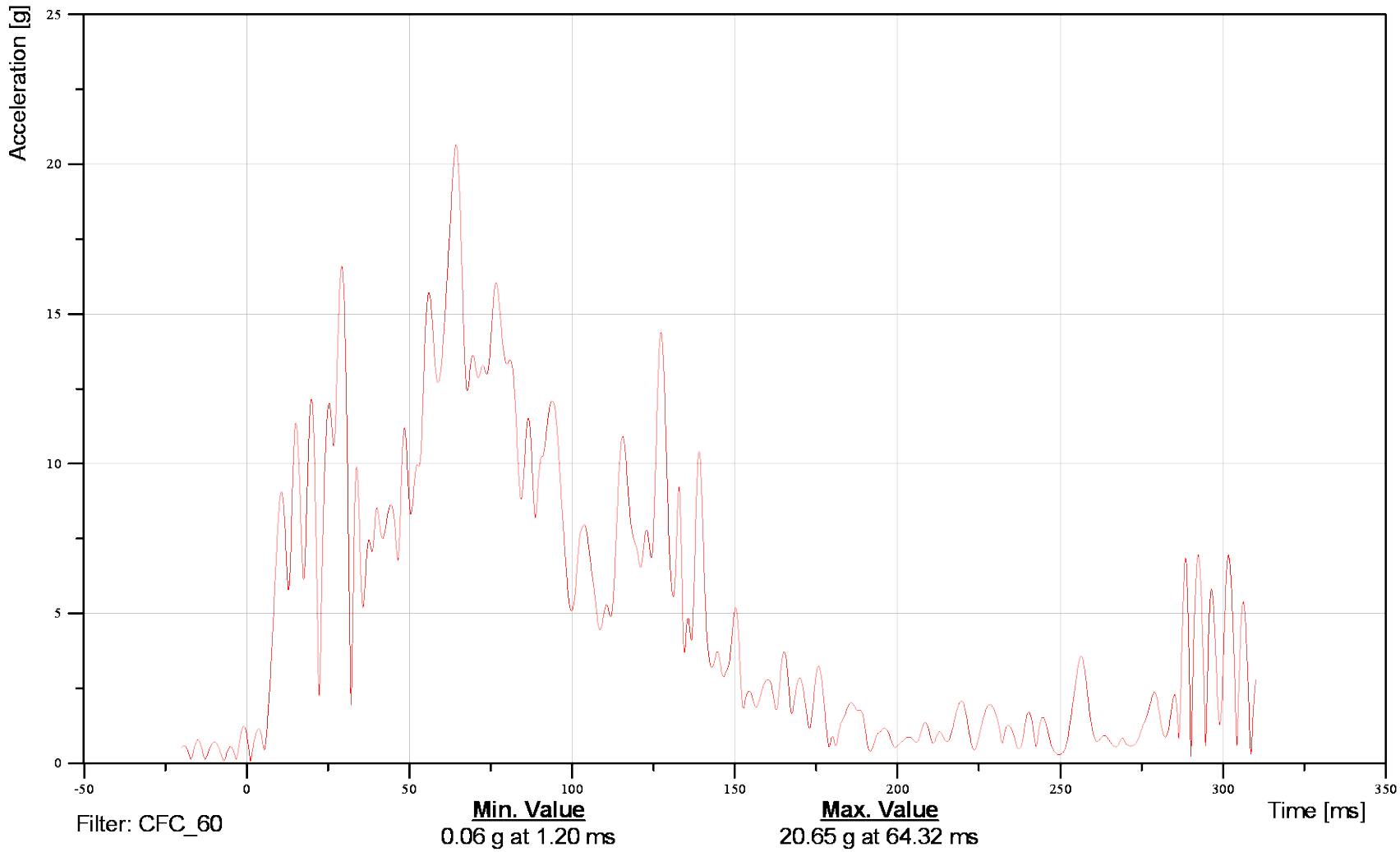
Bullet Vehicle CG Redundant Acceleration Resultant

Date: 11/27/2013
Time: 12:54

Customer: VRTC

10VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
0.06 g at 1.20 ms

Max. Value
20.65 g at 64.32 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

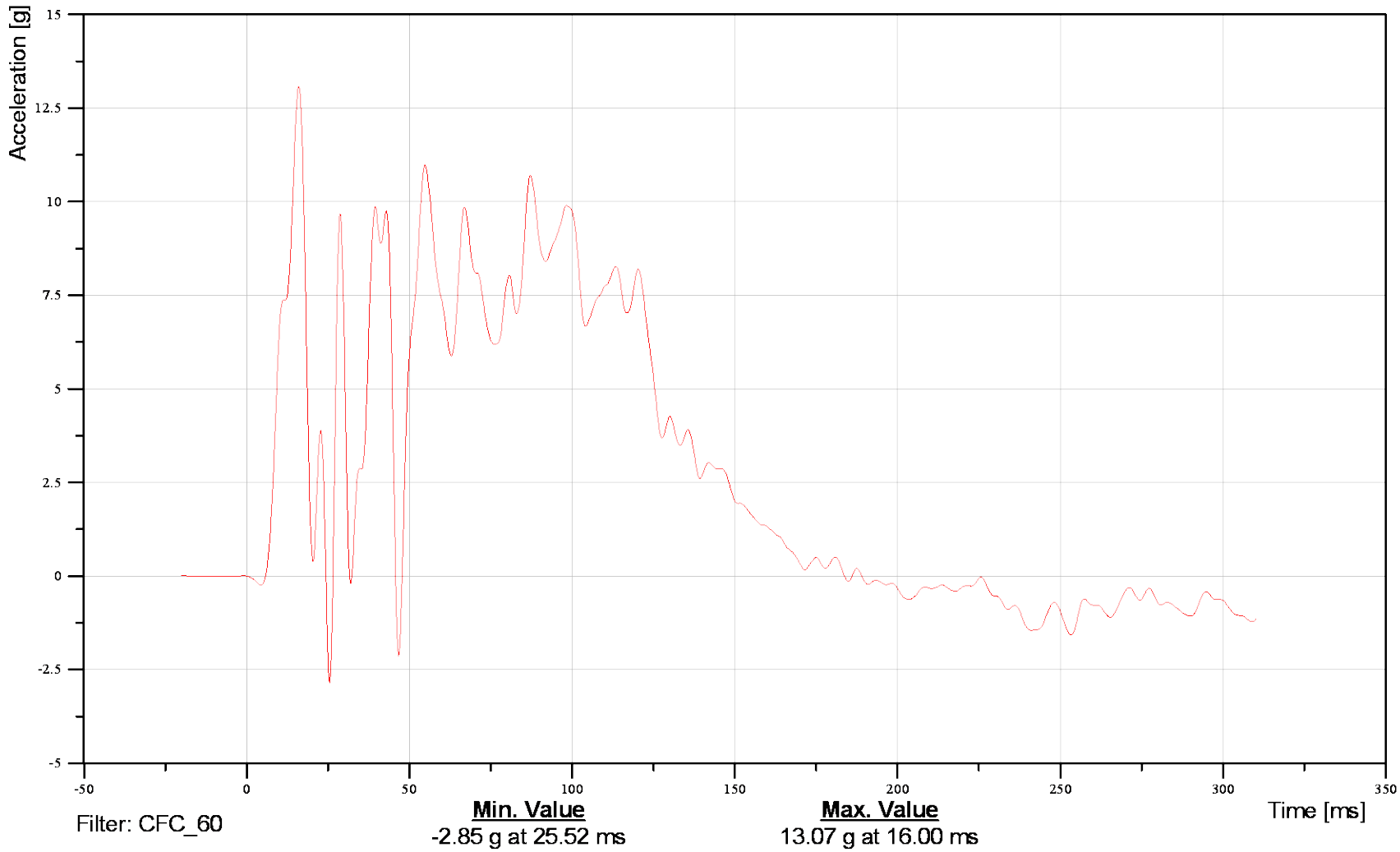
Target Target Vehicle CG X

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCG0000ACXD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-2.85 g at 25.52 ms

Max. Value
13.07 g at 16.00 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

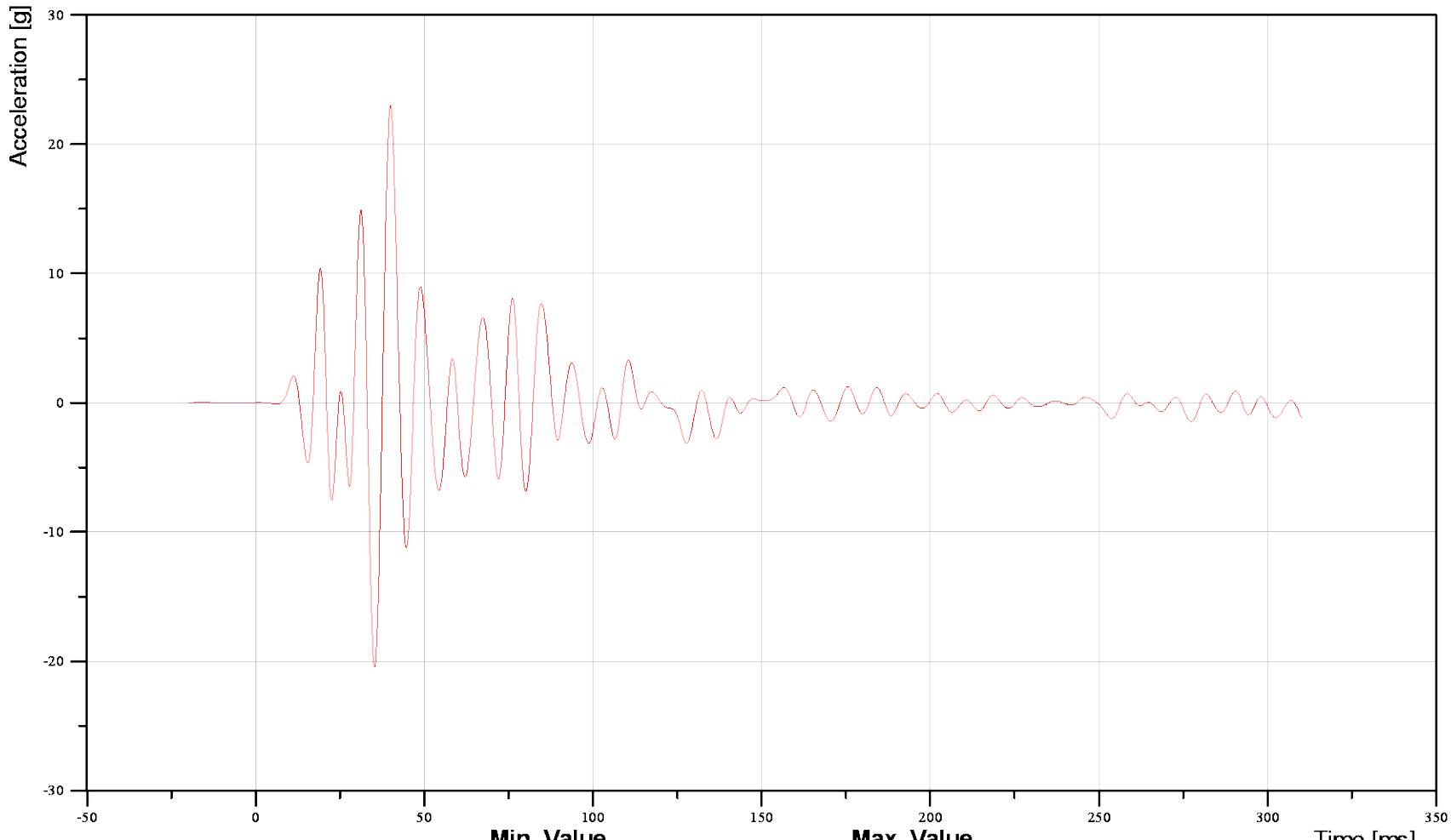
Target Target Vehicle CG Y

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCG0000ACYD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-20.44 g at 35.36 ms

Max. Value
23.02 g at 40.00 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

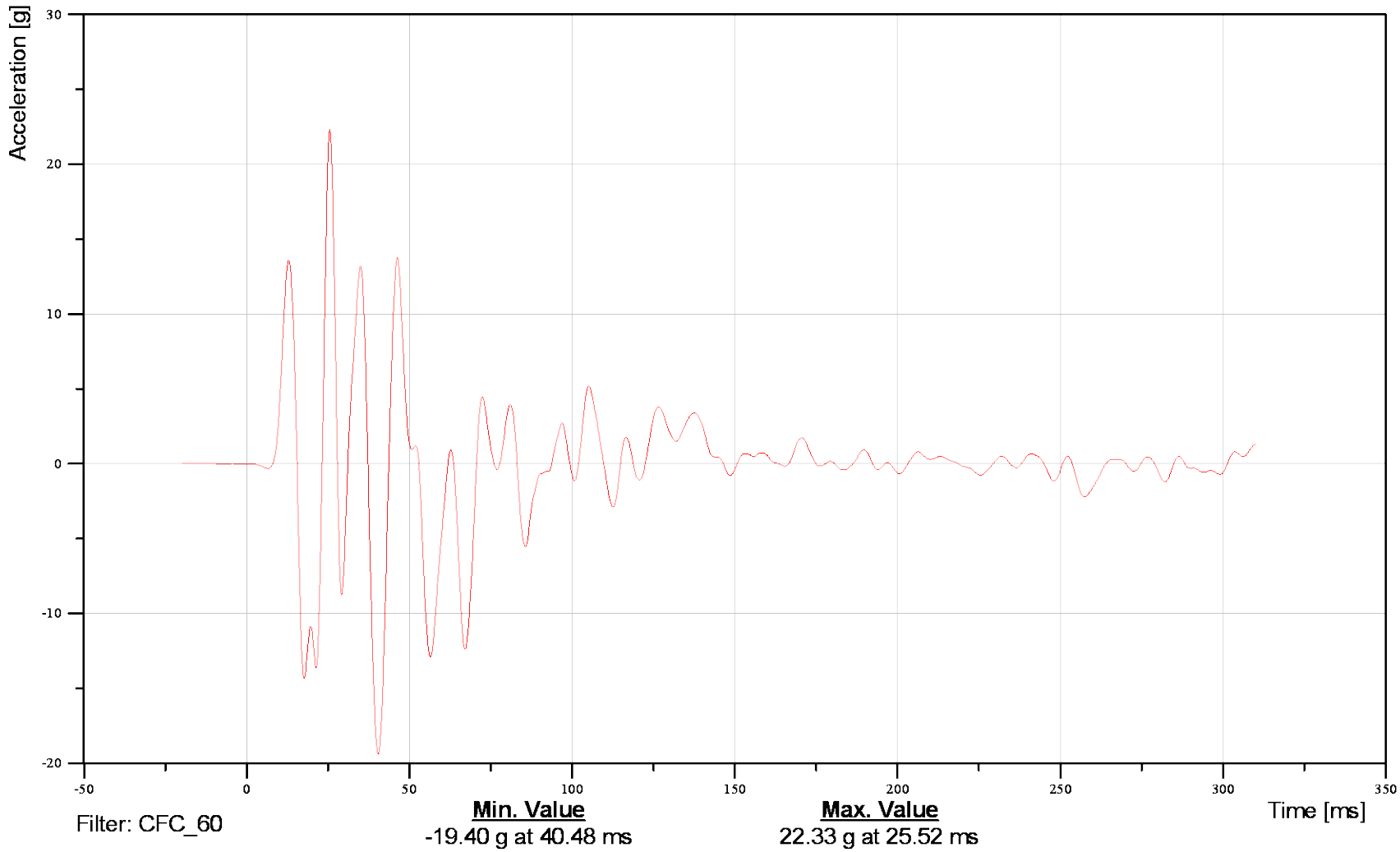
Target Target Vehicle CG Z

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCG0000ACZD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-19.40 g at 40.48 ms

Max. Value
22.33 g at 25.52 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

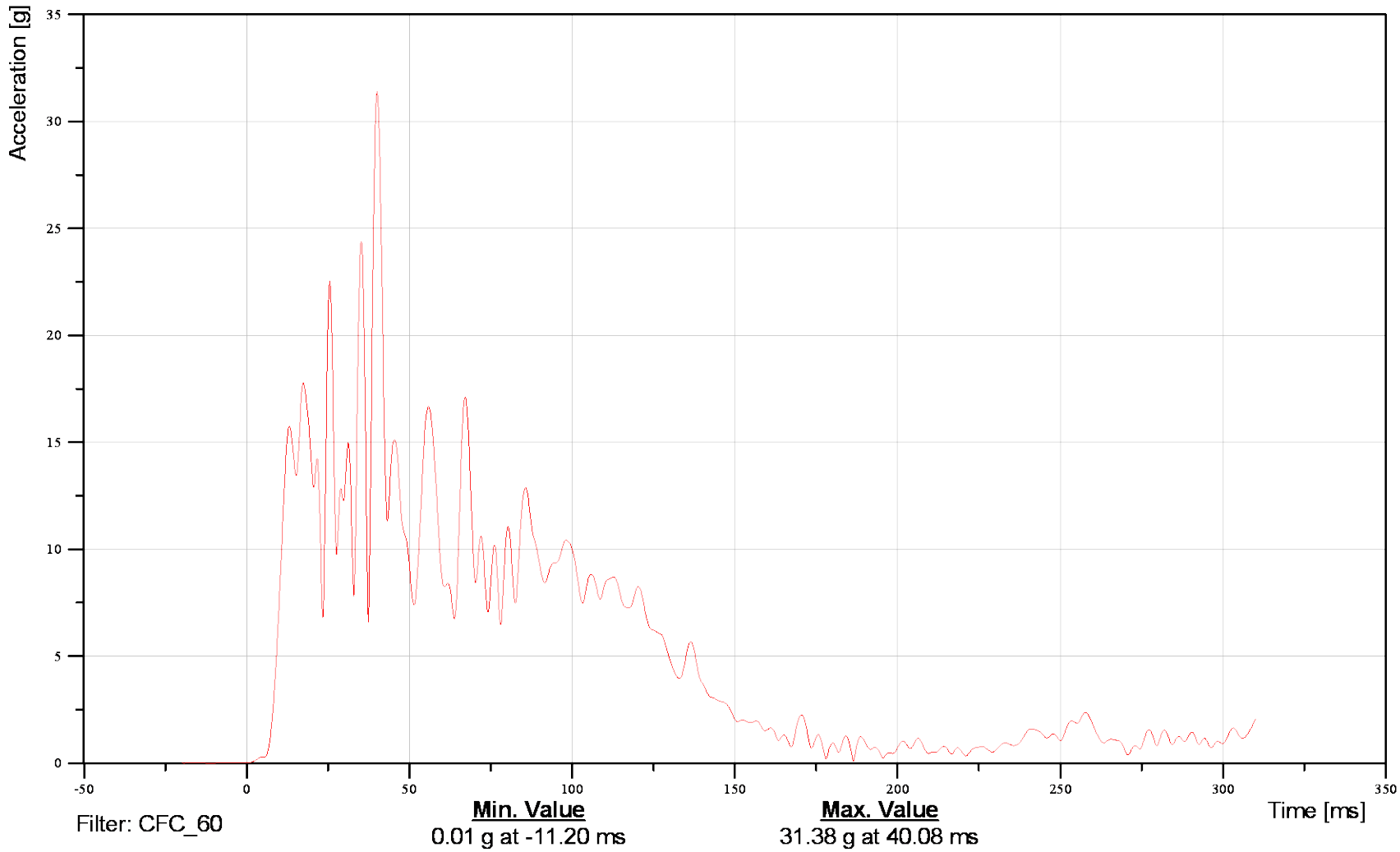
Target Vehicle CG Acceleration Resultant

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCG0000ACRD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
0.01 g at -11.20 ms

Max. Value
31.38 g at 40.08 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

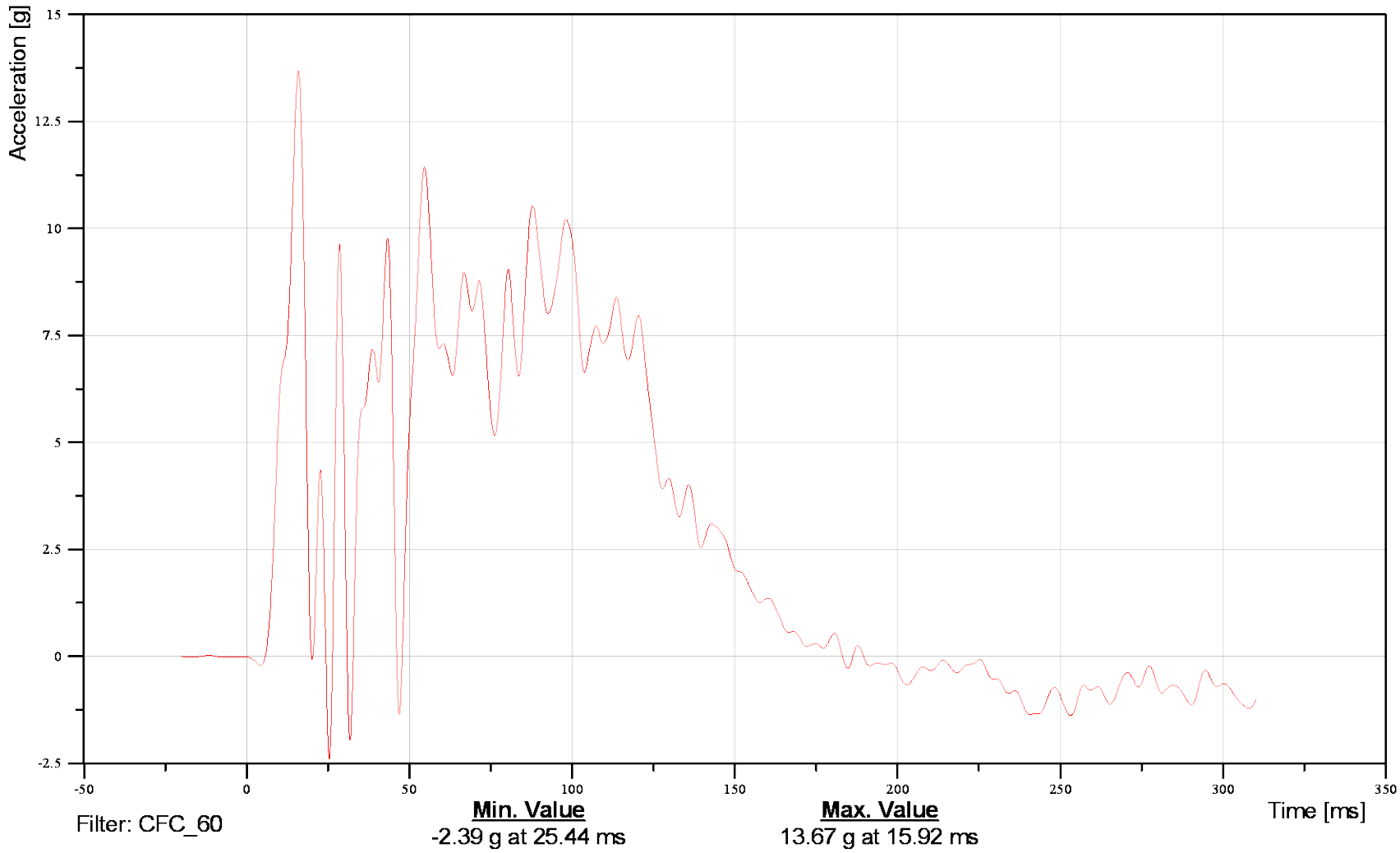
Target Vehicle CG Redundant X

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCGRD00ACXD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-2.39 g at 25.44 ms

Max. Value
13.67 g at 15.92 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

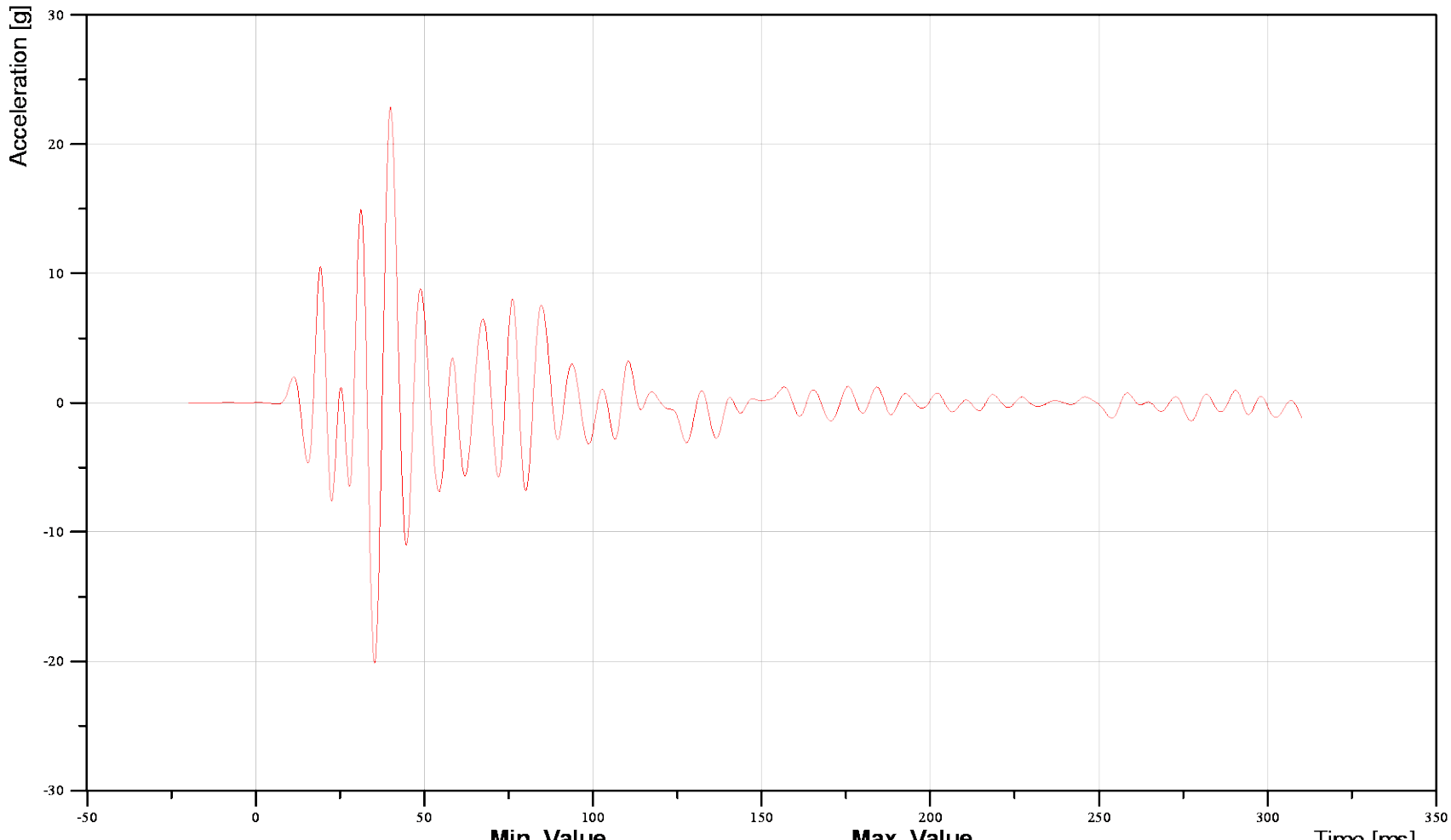
Target Vehicle CG Redundant Y

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCGRD00ACYD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-20.13 g at 35.36 ms

Max. Value
22.87 g at 40.00 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

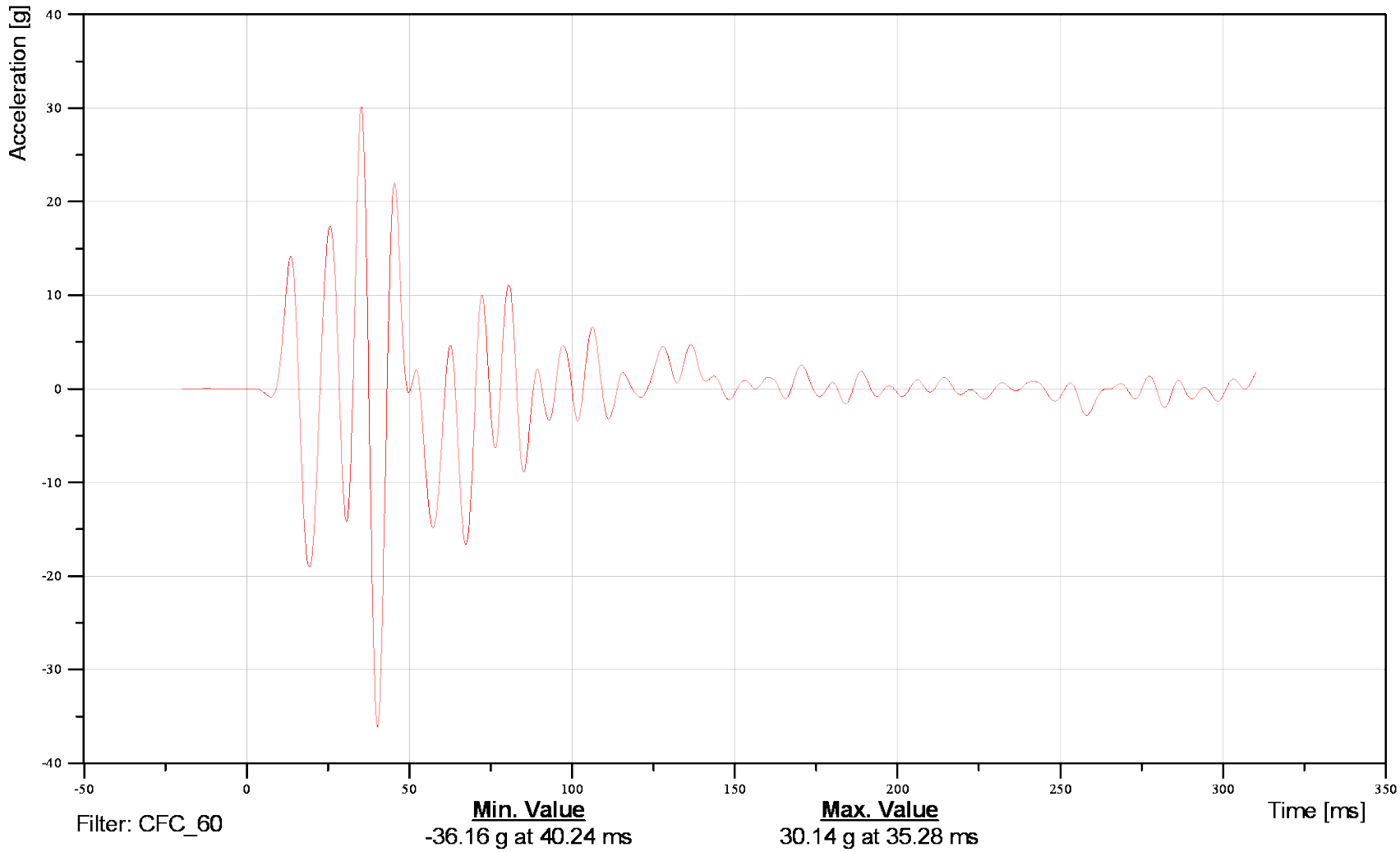
Target Vehicle CG Redundant Z

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCGRD00ACZD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
-36.16 g at 40.24 ms

Max. Value
30.14 g at 35.28 ms

1993 Cadillac Deville Into Rear of 1996 Jeep GC-ZJ

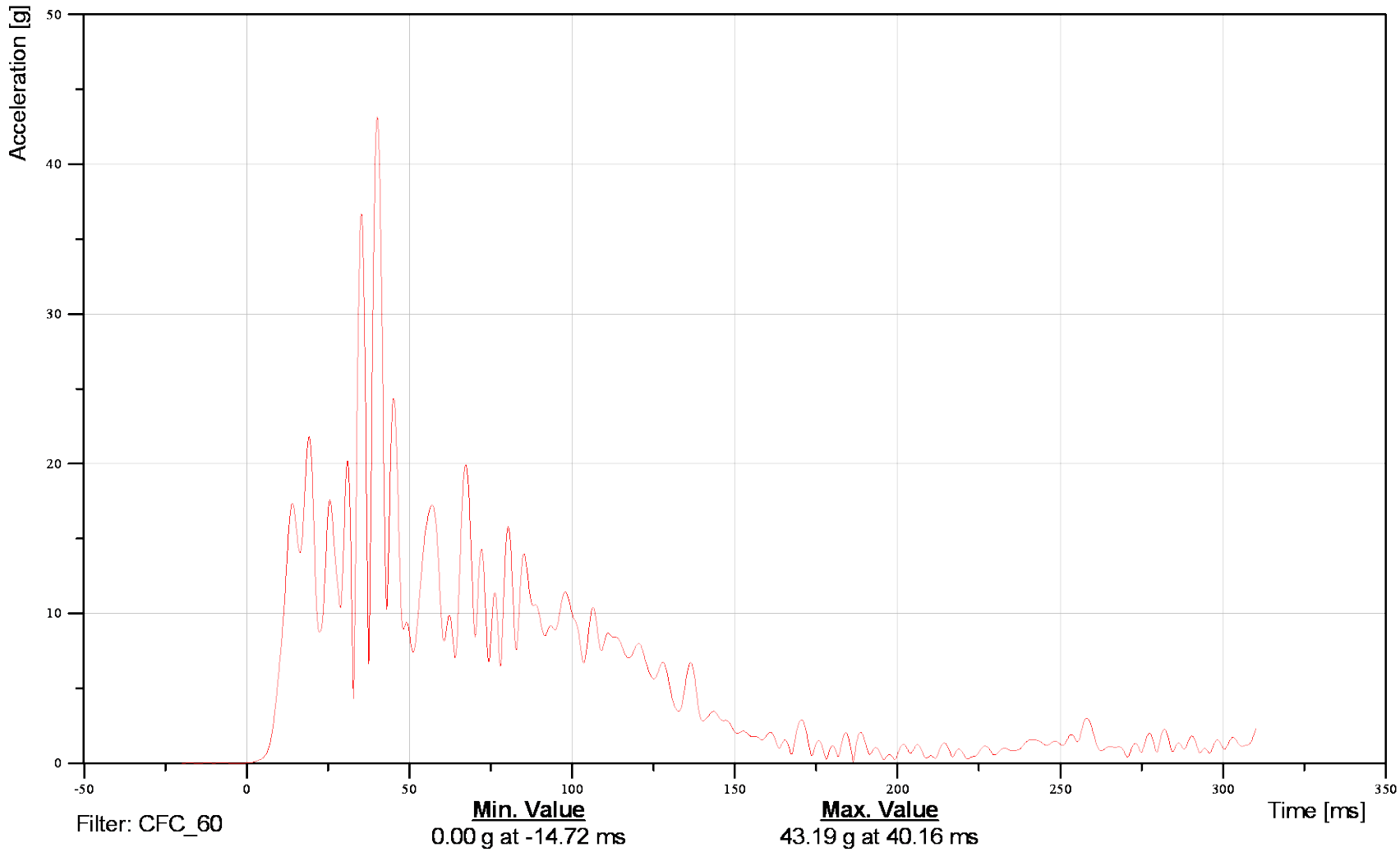
Target Vehicle CG Redundant Acceleration Resultant

Date: 11/27/2013
Time: 12:54

Customer: VRTC

20VEHCCGRD00ACRD

TRC Inc. Test Lab: CTF
Test Number: 131127



Filter: CFC_60

Min. Value
0.00 g at -14.72 ms

Max. Value
43.19 g at 40.16 ms