**Vehicle Research and Test Center**

**1993 Cadillac DeVille into**

**Rear of a 1998 Jeep Cherokee**

**TRC Inc. Test Number: 131031**


**Prepared By:**

**Transportation Research Center Inc.**

**10820 State Route 347**

**East Liberty, OH 43319**

**Final Report**

**October - December 2013**

**Prepared For:**

**Vehicle Research and Test Center**

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Report Approved December 9, 2013 by:

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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 56.6 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 1998 Jeep Cherokee, 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 1998 Jeep Cherokee, 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 center on the target vehicle.

One (1) Hybrid III 50$^{th}$ Male Ballast dummy was placed in the bullet vehicle's driver's seat. One (1) Hybrid III 50$^{th}$ 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 56.6 km/h 180° vehicle-to-vehicle rear impact test was conducted by TRC Inc. on October 31, 2013.

The target test vehicle, a 1998 Jeep Cherokee, 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 1860.0 kg.

The bullet test vehicle, a 1993 Cadillac DeVille, was equipped with a 4.9-liter 8 cylinder transverse engine, 3 speed automatic transmission, power steering, power brakes and front airbags. The bullet vehicle's test weight was 1738.2 kg. The bullet vehicle's impact speed was 56.58 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: | October 31, 2013 |
| Test time: | 12:00 PM |
| Ambient temperature: | 17.3° C |
| Target vehicle year/make/ model/body style: | 1998/Jeep/Cherokee/MPV |
| Target vehicle test weight: | 1860.0 kg |
| Bullet vehicle year/make/ model/body style: | 1993/Cadillac/DeVille/ Sedan |
| Bullet vehicle test weight: | 1738.2 kg |
| Impact angle[1]: | 180° |
| Impact velocity[2]: | Bullet vehicle = 56.6 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: | 1998/Jeep/Cherokee/MPV |
| VIN: | 1J4GZ48S1WC211243 |
| Model year: | 1998 |
| Body style: | MPV |
| Color: | Black |
| 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: | 10/28/2013 |
| Odometer reading: | 182,426 |
| 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: | | Chrysler Corporation |
| Date of manufacture: | | 12/97 |
| VIN: | | 1J4GZ48S1WC211243 |
| 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): | Temporary |
| Type of seats: | |
| Front | Bucket |
| Rear | Split Bench |
| Maximum width: | 1802 mm |
| Wheelbase: | 2685 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: 36 psi (248 kPa)<br>Rear: 36 psi (248 kPa) |
| Seating capacity: | Front: 2<br>Mid: 0<br>Rear: 3<br>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 773 mm; | LR 789 mm; | RR 802 mm |
| Post-test attitude: | LF 769 mm; | RF 768 mm; | LR 800 mm; | RR 735 mm |

Table 2 Target Vehicle General Test and Vehicle Parameter Data Continued

Weight of test vehicle with required dummies and cargo weight:

| | | | |
|---|---|---|---|
| Right front | 510.4 kg | Right rear | 388.8 kg |
| Left front | 546.4 kg | Left rear | 414.4 kg |
| Total front weight | 1056.8 kg | (56.8% of total vehicle weight) | |
| Total rear weight | 803.2 kg | (43.2% of total vehicle weight) | |
| Total test weight | 1860.0 kg | | |

Weight of ballast secured in vehicle: None

Components removed to meet target test weight: None

Location of Vehicle's CG: 1159 mm rearward of front wheel centerline

Fuel System Data:

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

Actual test volume: 81.0 liters

Table 3 Bullet Vehicle General Test and Vehicle Parameter Data

| | |
|---|---|
| Vehicle year/make/ model/body style: | 1993/Cadillac/DeVille/Sedan |
| VIN: | 1G6CD53B7P4326329 |
| Model year: | 1993 |
| Body style: | Sedan |
| Color: | Gray |
| 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: | 10/28/2013 |
| Odometer reading: | 130,834 |
| 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 | No | 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: | | 6/93 |
| VIN: | | 1G6CD53B7P4326329 |
| 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: | Generac, Ameri-G4S, 205/70R15 |
| Right Front: | Generac, Ameri-G4S, 205/70R15 |
| Left Rear: | Generac, Ameri-G4S, 205/70R15 |
| Right Rear: | Continental, Contipro Contact, 205/70R15 |

Tire pressure with maximum capacity vehicle load:

| | |
|---|---|
| Front: | 44 psi (300 kPa) |
| Rear: | 44 psi (300 kPa) |

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

Type of seats:

| | |
|---|---|
| Front | Bucket |
| Rear | Bench |

Maximum width: 1860 mm

Wheelbase: 2885 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)<br>Rear: 30 psi (210 kPa) |
| Seating capacity: | Front: 3<br>Mid: 0<br>Rear: 3<br>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 709 mm; | RF 704 mm; | LR 645 mm; | RR 637 mm |
| Post-test attitude: | LF 714 mm; | RF 746 mm; | LR 624 mm; | RR 637 mm |

Table 3 Bullet 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 | 345.6 kg |
| Left front | 536.0 kg | Left rear | 352.4 kg |
| Total front weight | 1040.2 kg | (59.8% of total vehicle weight) | |
| Total rear weight | 698.0 kg | (40.2% of total vehicle weight) | |
| Total test weight | 1738.2 kg | | |

Weight of ballast secured in vehicle: 0 kg

Components removed to meet target test weight: None

Location of Vehicle's CG: 1065 mm rearward of front wheel centerline

Fuel System Data:

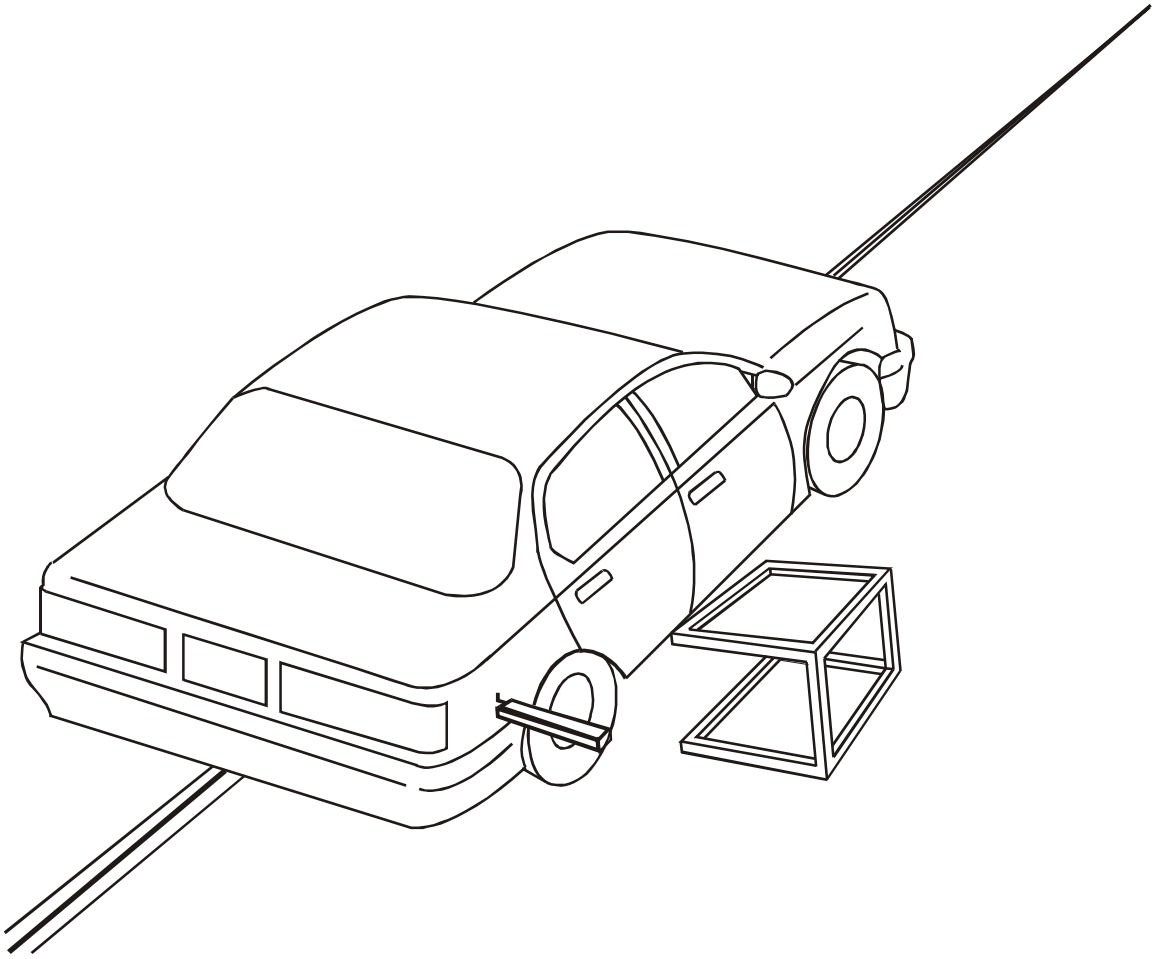
Usable fuel system capacity N/A liters (from owner's manual)

Actual test volume: 70.4 liters

Table 4 Post-Impact Data

| | |
|---|---|
| Test number: | 131031 |
| Test date: | 10/31/2013 |
| Test time: | 12:00 PM |
| Test type: | Vehicle to Vehicle Rear Impact |
| Impact angle: | 180° |
| Ambient temperature at impact area: | 17.3° C |
| Impact velocity: | |
| Target vehicle: | 0 km/h |
| Bullet vehicle: | 56.6 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 | 15.2 | 65.8 | -1.5 | 275.5 |
| | | Y | 10.8 | 39.0 | -9.4 | 65.4 |
| | | Z | 18.4 | 43.4 | -16.4 | 69.0 |
| | | R | 20.6 | 69.1 | --- | --- |
| 2 | Vehicle Center of Gravity Redundant | X | 15.2 | 65.8 | -1.5 | 275.7 |
| | | Y | 10.3 | 39.0 | -11.9 | 65.4 |
| | | Z | 20.8 | 43.3 | -20.7 | 69.2 |
| | | R | 23.8 | 69.2 | --- | --- |

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 | 0.6 | 245.5 | -15.0 | 73.8 |
| | | Y | 3.0 | 139.6 | -3.8 | 74.5 |
| | | Z | 14.7 | 143.8 | -12.6 | 137.7 |
| | | R | 15.7 | 73.8 | --- | --- |
| 2 | Vehicle Center of Gravity Redundant | X | 0.7 | 245.8 | -15.1 | 73.8 |
| | | Y | 2.3 | 141.5 | -3.3 | 74.0 |
| | | Z | 16.5 | 144.0 | -13.2 | 138.2 |
| | | R | 16.6 | 144.0 | --- | --- |

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

Table 7 Target Vehicle Measurements

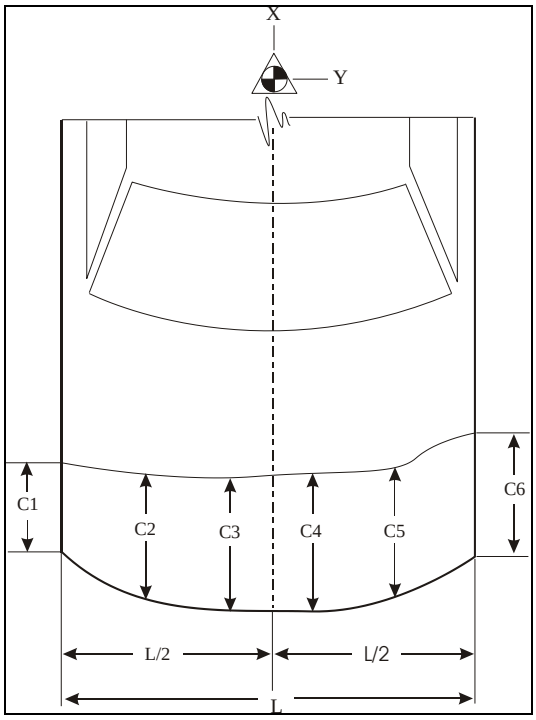
1998 Jeep Cherokee

Test Number: 131031

| No. | Type of measurement | Pre-Test | Post-Test | Difference |
|---|---|---|---|---|
| X1 | Total Length of Vehicle at Centerline | 4151 | 3775 | 376 |
| X2 | Rear Surface of Vehicle to Front of Engine Block | 220 | 230 | -10 |
| X3 | Rear Surface of Vehicle to Firewall | 743 | 745 | -2 |
| X4 | Rear Surface of Vehicle to Upper Leading Edge of Right Door | 1070 | 1075 | -5 |
| X5 | Rear Surface of Vehicle to Upper Leading Edge of Left Door | 1073 | 1083 | -10 |
| X6 | Rear Surface of Vehicle to Lower Leading Edge of Right Door | 1117 | 1100 | 17 |
| X7 | Rear Surface of Vehicle to Lower Leading Edge of Left Door | 1105 | 1111 | -6 |
| X8 | Rear Surface of Vehicle to Upper Trailing Edge of Right Door | 2090 | 2095 | -5 |
| X9 | Rear Surface of Vehicle to Upper Trailing Edge of Left Door | 2090 | 2100 | -10 |
| X10 | Rear Surface of Vehicle to Lower Trailing Edge of Right Door | 2120 | 2100 | 20 |
| X11 | Rear Surface of Vehicle to Lower Trailing Edge of Left Door | 2110 | 2112 | -2 |
| X12 | Rear Surface of Vehicle to Bottom of " A " Post on Right Side | 1095 | 1095 | 0 |
| X13 | Rear Surface of Vehicle to Bottom of " A " Post on Left Side | 1085 | 1105 | -20 |
| X14 | Rear Surface of Vehicle to Firewall-Right Side | 740 | 740 | 0 |
| X15 | Rear Surface of Vehicle to Firewall-Left Side | 763 | 772 | -9 |
| X16 | Rear Surface of Vehicle to Steering Wheel Center | 1555 | 1545 | 10 |
| X17 | Center of Steering Column to " A " Post | 284 | 273 | 11 |
| X18 | Center of Steering Column to Headliner | 435 | 455 | -20 |
| X19 | Rear Surface of Vehicle to Right Side of Front Bumper | 4108 | 3915 | 193 |
| X20 | Rear Surface of Vehicle to Left Side of Front Bumper | 4112 | 3727 | 385 |
| 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: 1998 Jeep Cherokee

| | Pre-test | Post-test | Crush |
|---|---|---|---|
| L | 1524 | | |
| C1 | 4112 | 3727 | 385 |
| C2 | 4165 | 3740 | 425 |
| C3 | 4149 | 3763 | 386 |
| CL | 4151 | 3775 | 376 |
| C4 | 4150 | 3810 | 340 |
| C5 | 4140 | 3870 | 270 |
| C6 | 4108 | 3915 | 193 |

All measurements in millimeters.

Table 8 Bullet Vehicle Measurements

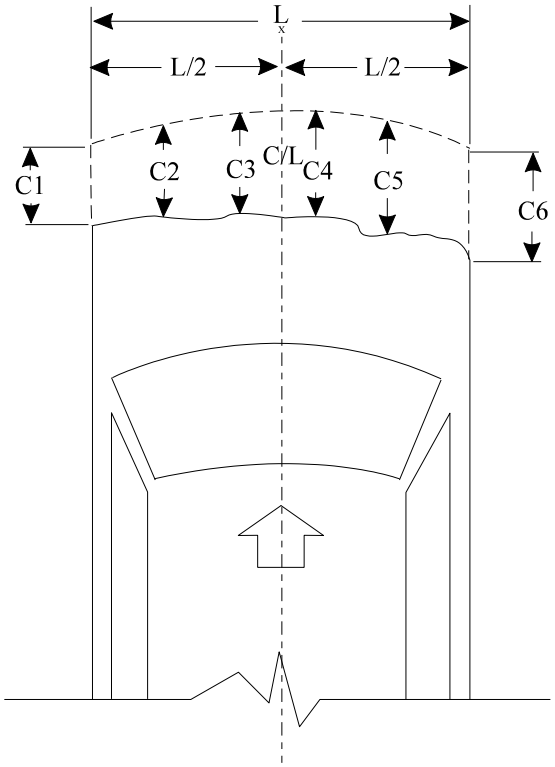
1993 Cadillac DeVille

Test Number: 131031

| No. | Type of measurement | Pre-Test | Post-Test | Difference |
|---|---|---|---|---|
| X1 | Total Length of Vehicle at Centerline | 5200 | 5130 | 70 |
| X2 | Rear Surface of Vehicle to Front of Engine Block | 4608 | 4540 | 68 |
| X3 | Rear Surface of Vehicle to Firewall | 3990 | 3990 | 0 |
| X4 | Rear Surface of Vehicle to Upper Leading Edge of Right Door | 3500 | 3498 | 2 |
| X5 | Rear Surface of Vehicle to Upper Leading Edge of Left Door | 3504 | 3510 | -6 |
| X6 | Rear Surface of Vehicle to Lower Leading Edge of Right Door | 3482 | 3490 | -8 |
| X7 | Rear Surface of Vehicle to Lower Leading Edge of Left Door | 3484 | 3492 | -8 |
| X8 | Rear Surface of Vehicle to Upper Trailing Edge of Right Door | 2490 | 2492 | -2 |
| X9 | Rear Surface of Vehicle to Upper Trailing Edge of Left Door | 2492 | 2490 | 2 |
| X10 | Rear Surface of Vehicle to Lower Trailing Edge of Right Door | 2497 | 2502 | -5 |
| X11 | Rear Surface of Vehicle to Lower Trailing Edge of Left Door | 2495 | 2505 | -10 |
| X12 | Rear Surface of Vehicle to Bottom of " A " Post on Right Side | 3495 | 3495 | 0 |
| X13 | Rear Surface of Vehicle to Bottom of " A " Post on Left Side | 3500 | 3502 | -2 |
| X14 | Rear Surface of Vehicle to Firewall-Right Side | 3793 | 3780 | 13 |
| X15 | Rear Surface of Vehicle to Firewall-Left Side | 3842 | 3835 | 7 |
| X16 | Rear Surface of Vehicle to Steering Wheel Center | 3044 | 3035 | 9 |
| X17 | Center of Steering Column to " A " Post | 333 | 342 | -9 |
| X18 | Center of Steering Column to Headliner | 431 | 415 | 16 |
| X19 | Rear Surface of Vehicle to Right Side of Front Bumper | 5118 | 5035 | 83 |
| X20 | Rear Surface of Vehicle to Left Side of Front Bumper | 5120 | 5140 | -20 |
| X21 | Length of Engine Block | 600 | 600 | 0 |
| | Left Front Overhang | 1110 | 1018 | 92 |
| | Right Front Overhang | 1112 | 1072 | 40 |
| X26 | Firewall to Engine or Transaxle | 200 | 100 | 100 |
| X27 | Vertical Distance from Door Sill to Centerline of Steering Column | 548 | 555 | -7 |
| X28 | Left Wheelbase | 2885 | 2900 | -15 |
| X28 | Right Wheelbase | 2890 | 2845 | 45 |
| X29 | Maximum Width | 1860 | 1860 | 0 |
| X30 | Rear Surface of Vehicle to Engine Bottom Target | 4290 | 4288 | 2 |
| X31 | Rear Surface of Vehicle to Occupant Compartment Bottom Targets | 2822 | 2820 | 2 |
| X32 | Rear Surface of Vehicle to Front Bumper Bottom Target | 5115 | 5113 | 2 |
| X33 | Rear Surface of Vehicle to Frame Crossmember Bottom Target | 4492 | 4488 | 4 |
| RD | Rear Surface of Vehicle to Right Side of Dash Panel | 3317 | 3315 | 2 |
| CD | Rear Surface of Vehicle to Center of Dash Panel | 3340 | 3332 | 8 |
| LD | Rear Surface of Vehicle to Left Side of Dash Panel | 3312 | 3317 | -5 |

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 | 5120 | 5140 | -20 |
| C2 | 5127 | 5120 | 7 |
| C3 | 5200 | 5130 | 70 |
| CL | 5200 | 5130 | 70 |
| C4 | 5200 | 5115 | 85 |
| C5 | 5138 | 5080 | 58 |
| C6 | 5118 | 5035 | 83 |

All measurements are in millimeters.

Section 3.0

FMVSS 301 Data

Table 9 Target Vehicle Fuel System Data

| | |
|---|---|
| Vehicle year/make/ model/body style: | 1998/Jeep/Cherokee/MPV |
| Actual test volume: | 81.0 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 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: 10/31/2013

Vehicle year/make/
model/body style: 1998/Jeep/Cherokee/MPV

Test requirements:

Test vehicle fuel tank was filled to 81 liters with 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:

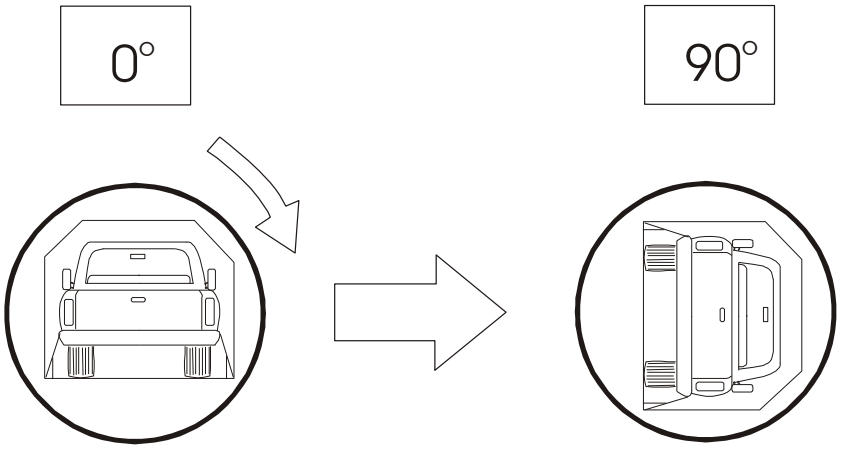
| | | Test Results | Maximum Allowable |
|---|---|---|---|
| 1. | From impact until vehicle motion ceases | Leakage[1] | 28 g |
| 2. | 5-minute period after vehicle motion ceases | Leakage[1] | 142 g |
| 3. | Next 25 minutes after 5-minute period | Leakage[1] | 28 g/minute |

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

[1] Large leak where filler neck enters fuel tank; too much to accurately catch and measure.

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:

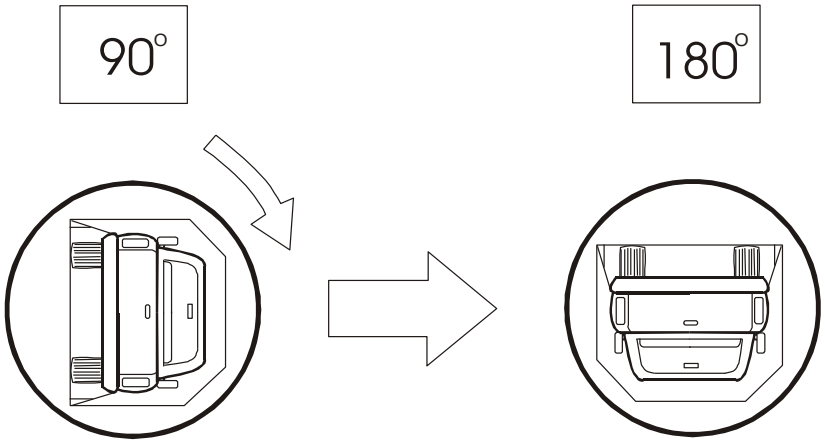
| 0° to 90° rotation (fuel filler cap down) | | Test Results | Maximum Allowable |
|---|---|---|---|
| 1. | First five minutes from onset of rotation | Leakage[1] | 142 g |
| 2. | Sixth minute from onset of rotation | Leakage[1] | 28 g |
| 3. | Seventh minute from onset of rotation | Leakage[1] | 28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

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

[1] The tank began leaking during the rotation and eventually drained completely at the 90° stage.

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:

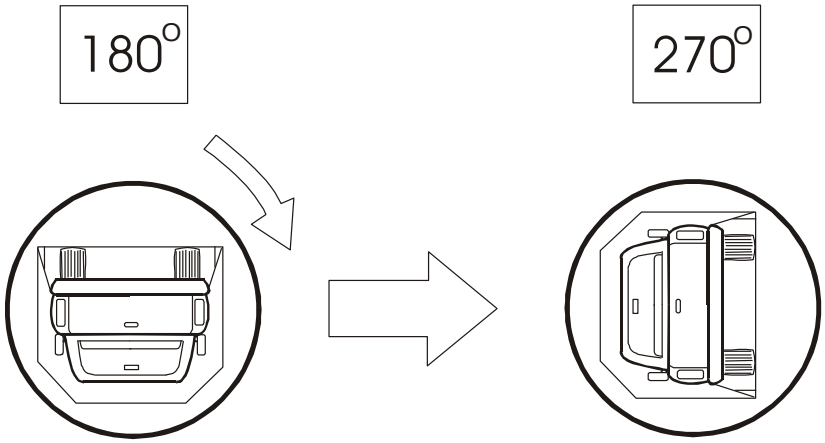
| 90° to 180° rotation | | Test Results | Maximum Allowable |
|---|---|---|---|
| 1. | First five minutes from onset of rotation | N/A[1] | 142 g |
| 2. | Sixth minute from onset of rotation | N/A[1] | 28 g |
| 3. | Seventh minute from onset of rotation | N/A[1] | 28 g |

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

[1] Did not perform this rotation due to tank leakage.

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:

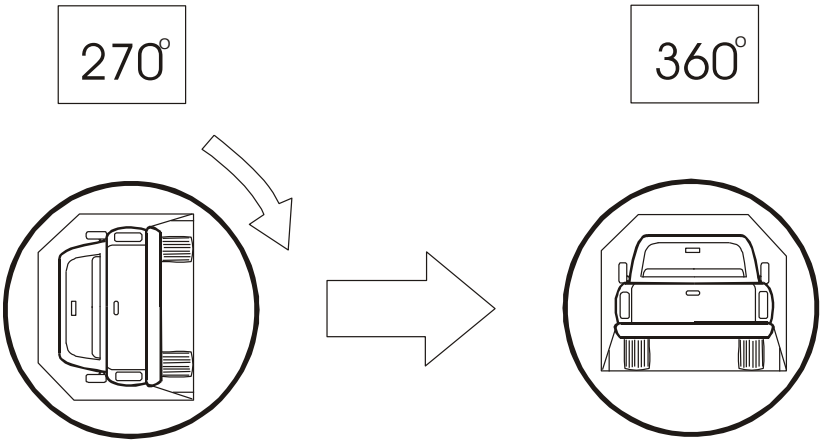
| 180 to 270° rotation | | Test Results | Maximum Allowable |
|---|---|---|---|
| 1. | First five minutes from onset of rotation | N/A[1] | 142 g |
| 2. | Sixth minute from onset of rotation | N/A[1] | 28 g |
| 3. | Seventh minute from onset of rotation | N/A[1] | 28 g |

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

[1] Did not perform this rotation due to tank leakage.

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] Did not perform this rotation due to tank leakage.

# Section 4.0

# Camera Information

Figure 5  Camera Positions

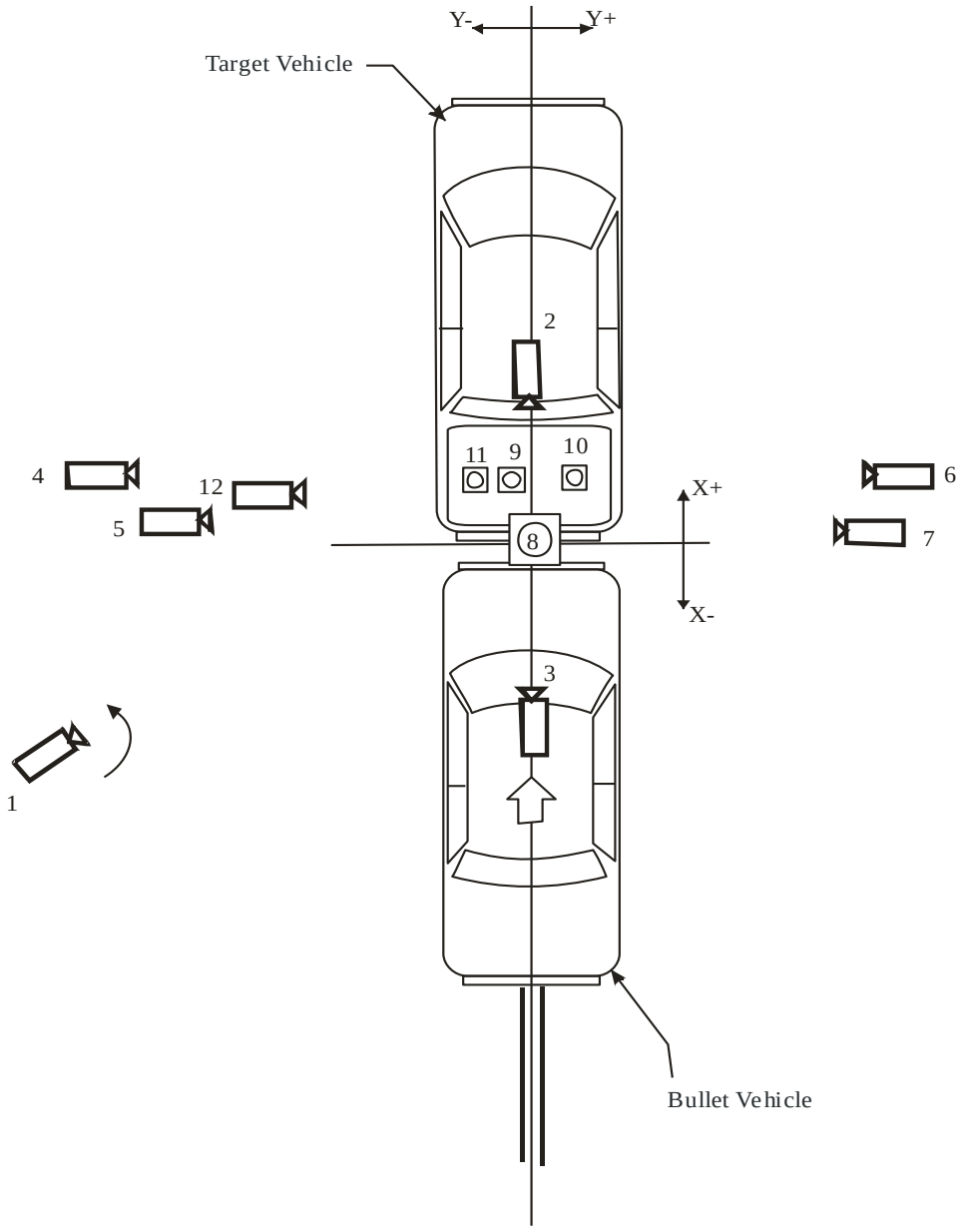


Table 11 Camera Information

| 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 | -1270 | -6611 | 1135 | -0.7º | 8.5 | 1000 |
| 5 | Left side impact | 0 | -5671 | 825 | 0º | 25 | 1000 |
| 6 | Right target vehicle | -1365 | 6923 | 1099 | -1.8º | 8.5 | 1000 |
| 7 | Right side impact | 0 | 6563 | 848 | -0.2º | 25 | 1000 |
| 8 | Overhead | -275 | 300 | 5414 | N/A | 12.5 | 1000 |
| 9 | Pit wide | -530 | 200 | -2744 | 86.5º | 12.5 | 1000 |
| 10 | Pit medium | -565 | -200 | -2608 | 86.7º | Zoom | 1000 |
| 11 | Pit tight | -865 | 270 | -2645 | 88.2º | 25 | 500 |
| 12 | Left ground level tight impact | -355 | -2295 | 125 | 7.8 | 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**

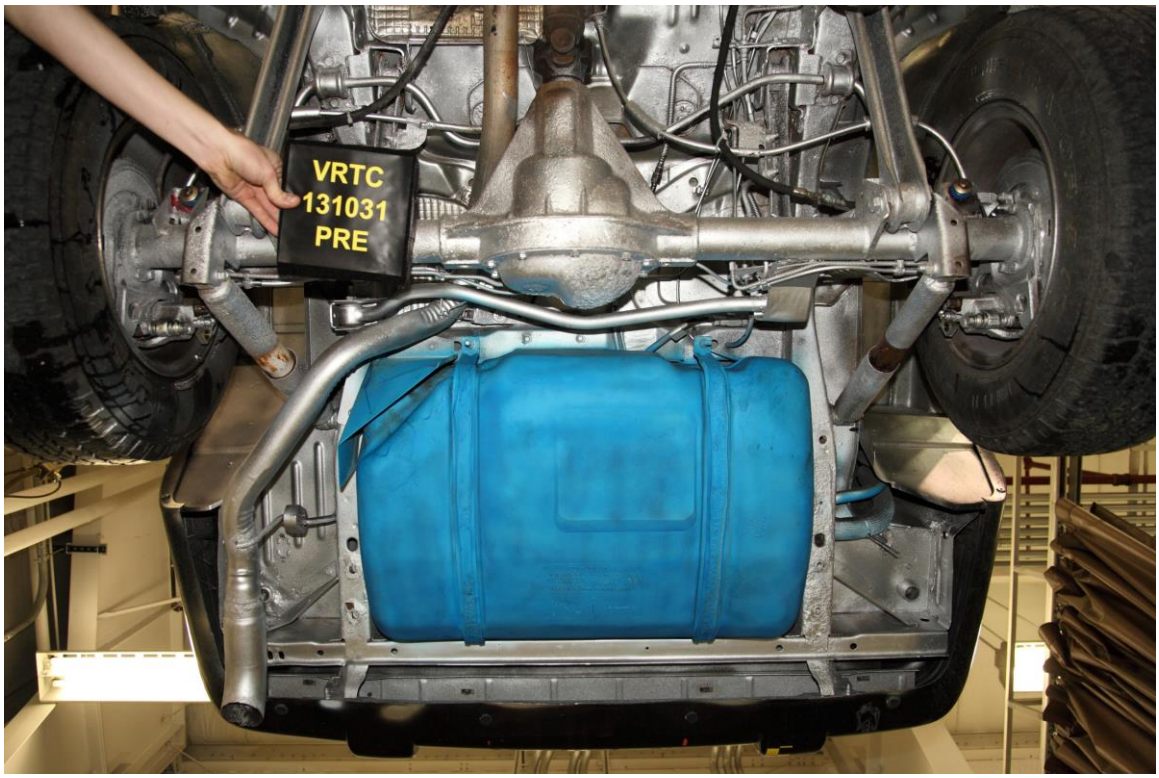



**Figure A-15 Pre-Test Target Vehicle Rear Underbody View**

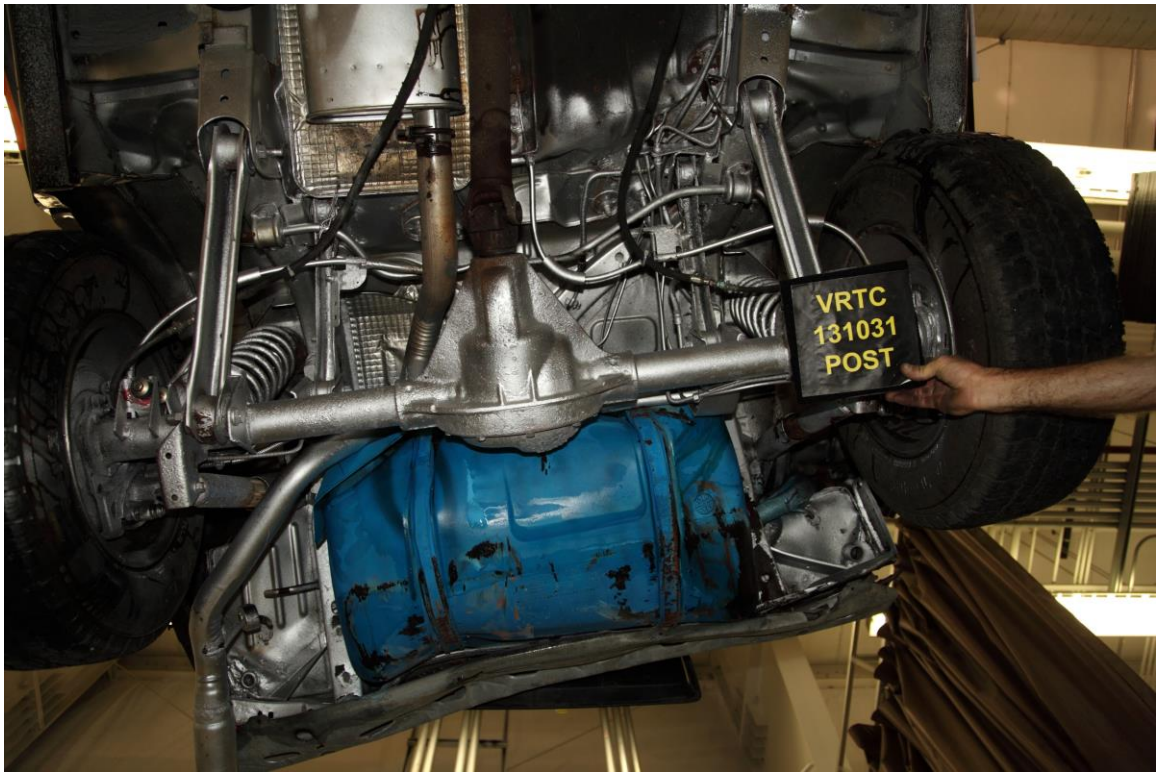



**Figure A-16 Post-Test Target Vehicle Rear Underbody View**


**Figure A-17 Pre-Test Target Vehicle Overhead View**

**Photo Not Available**

**Figure A-18 Post-Test Target Vehicle Overhead View**

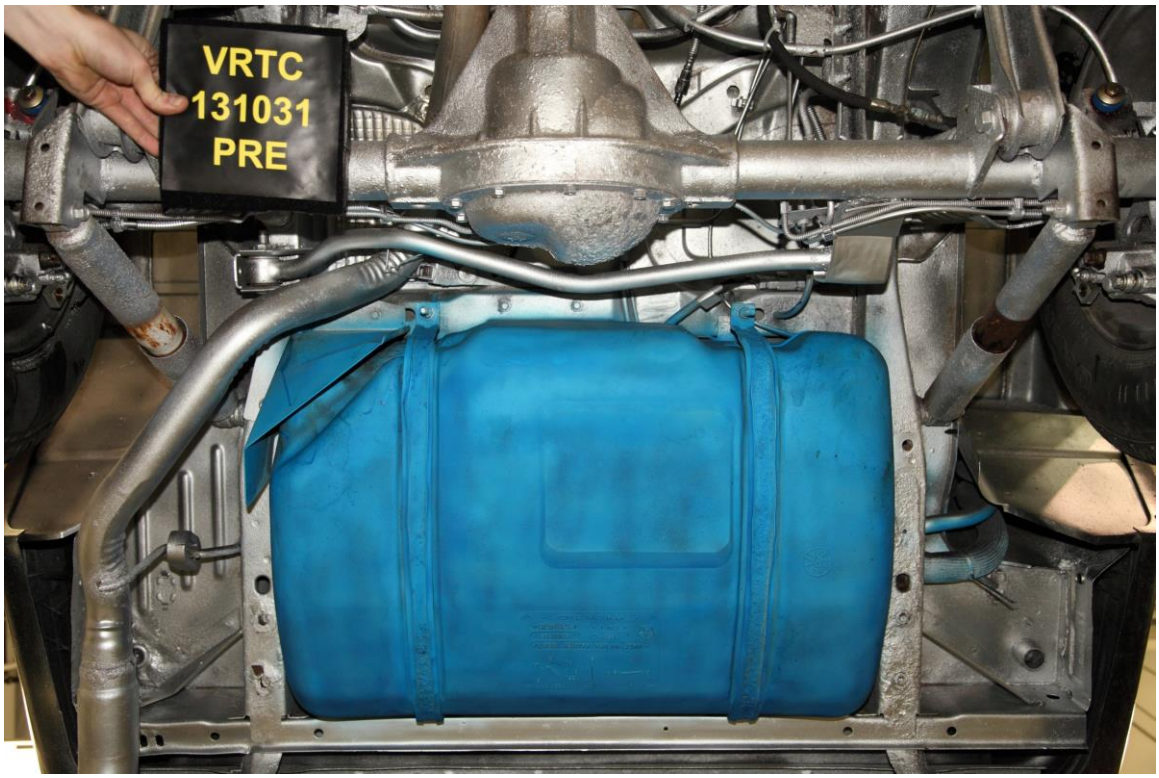



**Figure A-19 Pre-Test Target Vehicle Fuel Tank Close-up View**

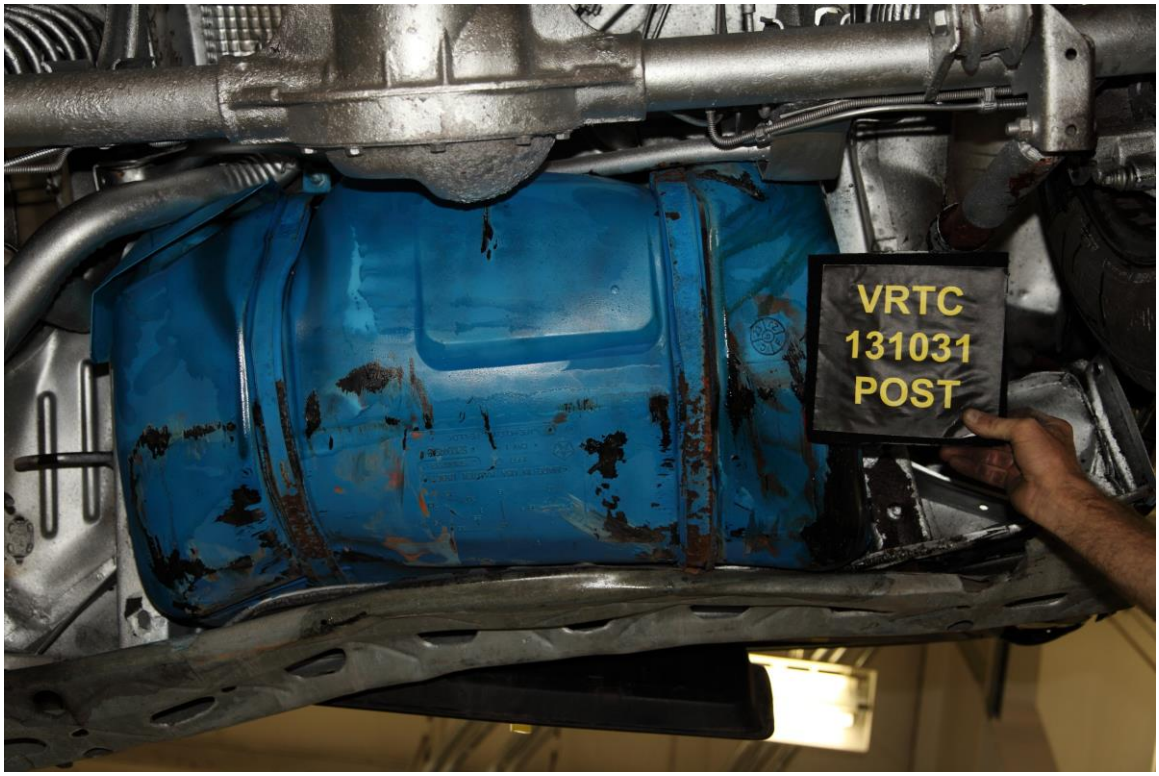



**Figure A-20 Post-Test Target Vehicle Fuel Tank Close-up View**

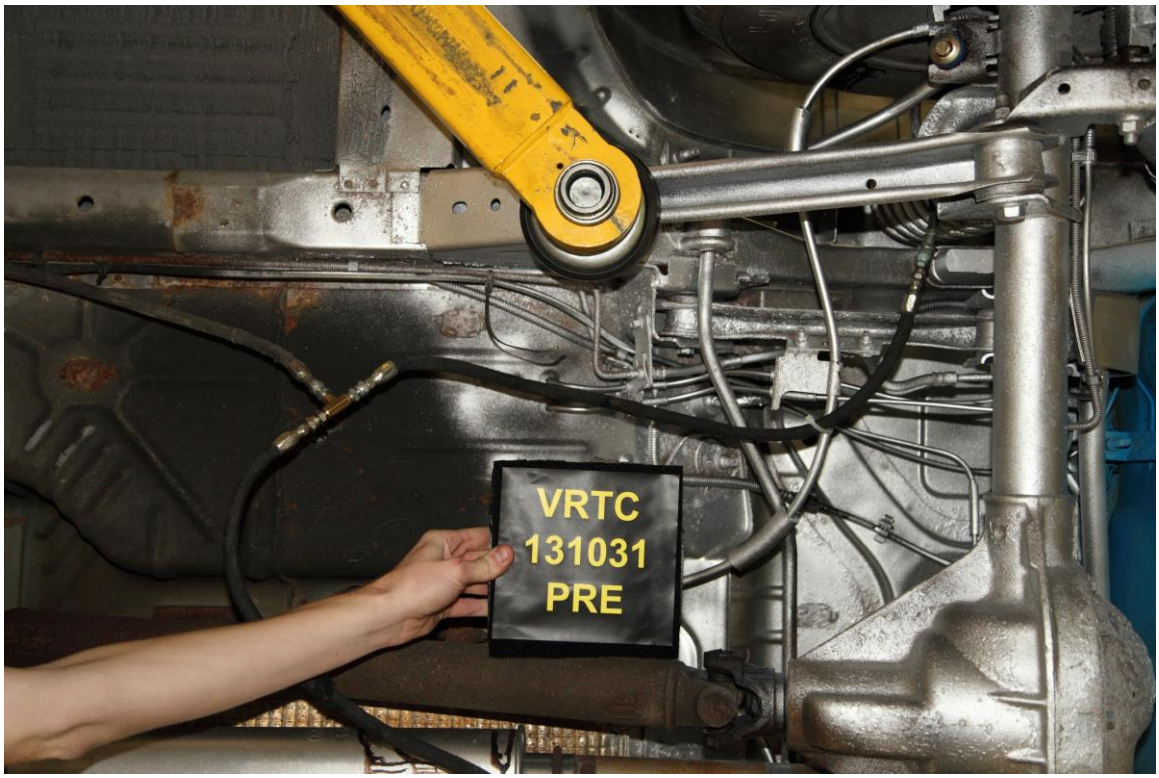



**Figure A-21 Pre-Test Target Vehicle Fuel Line Close-up View**

**Photo Not Available**

**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**


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


**Figure A-28 Post-Test Target Vehicle Fuel System Fluid Spillage – View 1**

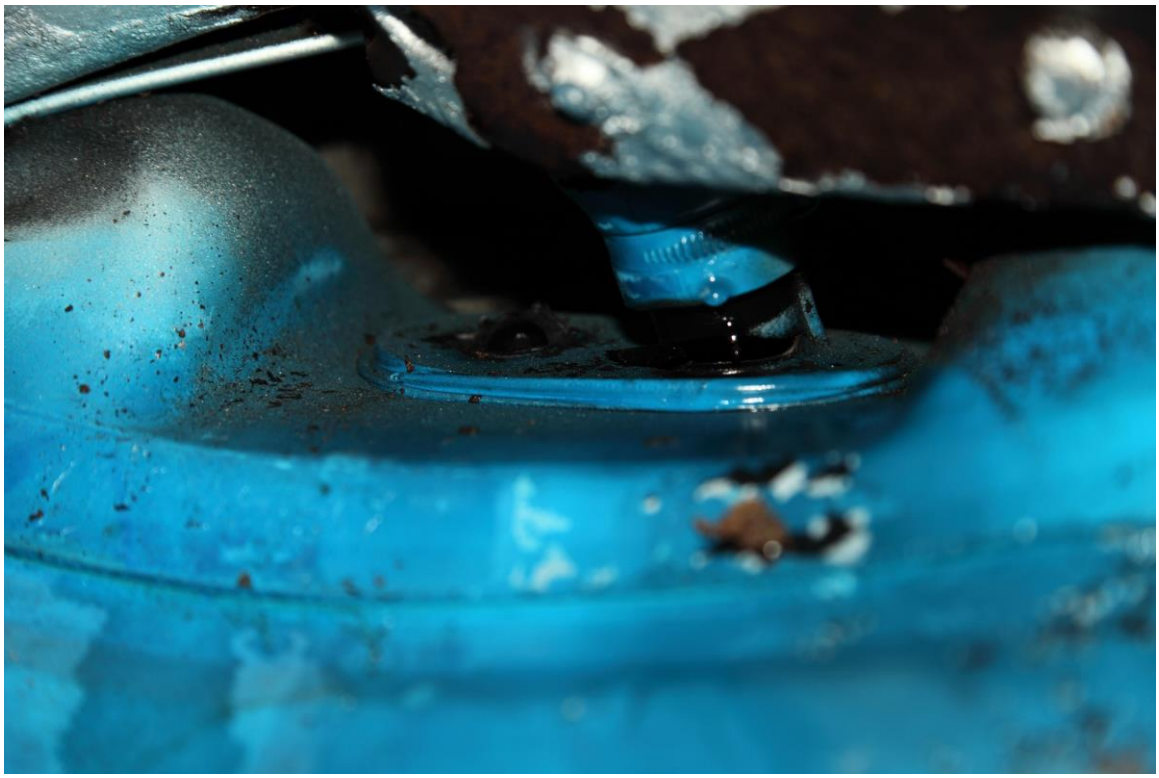


**Figure A-29 Post-Test Target Vehicle Fuel System Fluid Spillage – View 2**

**Figure A-30 Post-Test Target Vehicle Fuel System Fluid Spillage – View 3**


**Figure A-31 Pre-Test Bullet Vehicle Frontal View**


**Figure A-32 Post-Test Bullet Vehicle Frontal View**


**Figure A-33 Pre-Test Bullet Vehicle Left Front 3/4 View**


**Figure A-34 Post-Test Bullet Vehicle Left Front 3/4 View**


**Figure A-35 Pre-Test Bullet Vehicle Left Side View**


**Figure A-36 Post-Test Bullet Vehicle Left Side View**


**Figure A-37 Pre-Test Bullet Vehicle Rear View**


**Figure A-38 Post-Test Bullet Vehicle Rear View**


**Figure A-39 Pre-Test Bullet Vehicle Right Rear 3/4 View**


**Figure A-40 Post-Test Bullet Vehicle Right Rear 3/4 View**


**Figure A-41 Pre-Test Bullet Vehicle Right Side View**


**Figure A-42 Post-Test Bullet Vehicle Right Side View**


**Figure A-43 Pre-Test Bullet Vehicle Front Underbody View**


**Figure A-44 Post-Test Bullet Vehicle Front Underbody View**


**Figure A-45 Pre-Test Bullet Vehicle Rear Underbody View**

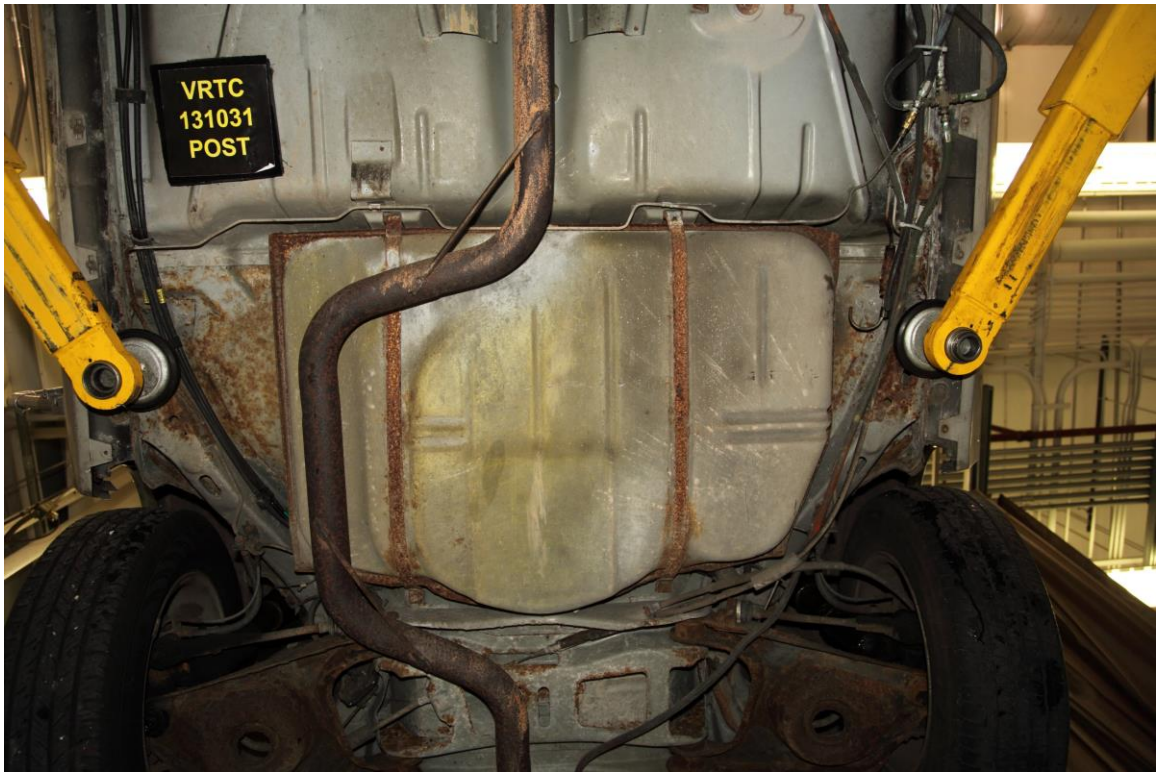



**Figure A-46 Post-Test Bullet Vehicle Rear Underbody View**


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


**Figure A-48 Post-Test Bullet Vehicle Fuel Line Close-up View**


**Figure A-49 Pre-Test Bullet Vehicle Fuel Filter Close-up View**


**Figure A-50 Post-Test Bullet Vehicle Fuel Filter Close-up View**


**Figure A-53 Close-Up View of Bullet Vehicle Certification Label**

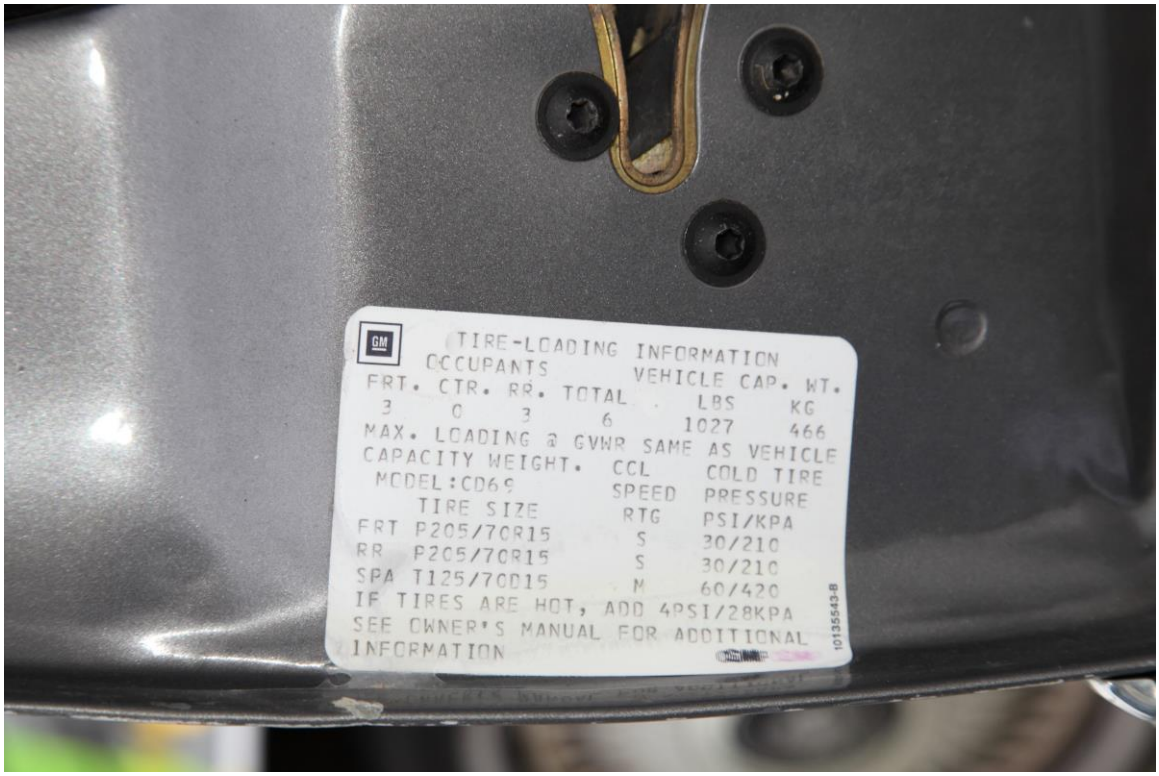



**Figure A-54 Close-Up View of Bullet Vehicle Tire Information Placard or Label**


**Figure A-55 Pre-Test Bullet and Target Vehicles Overall Left Side View**


**Figure A-56 Post-Test Bullet and Target Vehicles Overall Left Side View**


**Figure A-57 Pre-Test Bullet and Target Vehicles Overall Right Side View**


**Figure A-58 Post-Test Bullet and Target Vehicles Overall Right Side View**

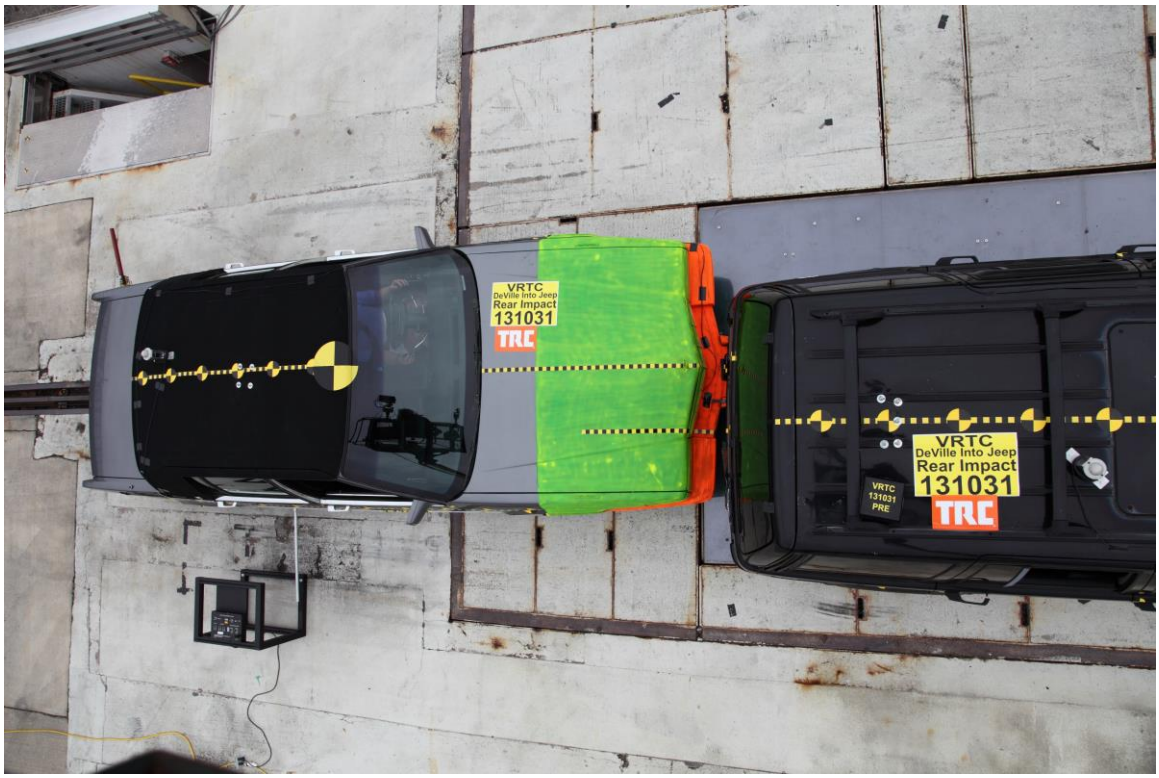



**Figure A-59 Pre-Test Bullet and Target Vehicles Overhead View**

**Photo Not Available**

**Figure A-60 Post-Test Bullet and Target Vehicles Overhead View**

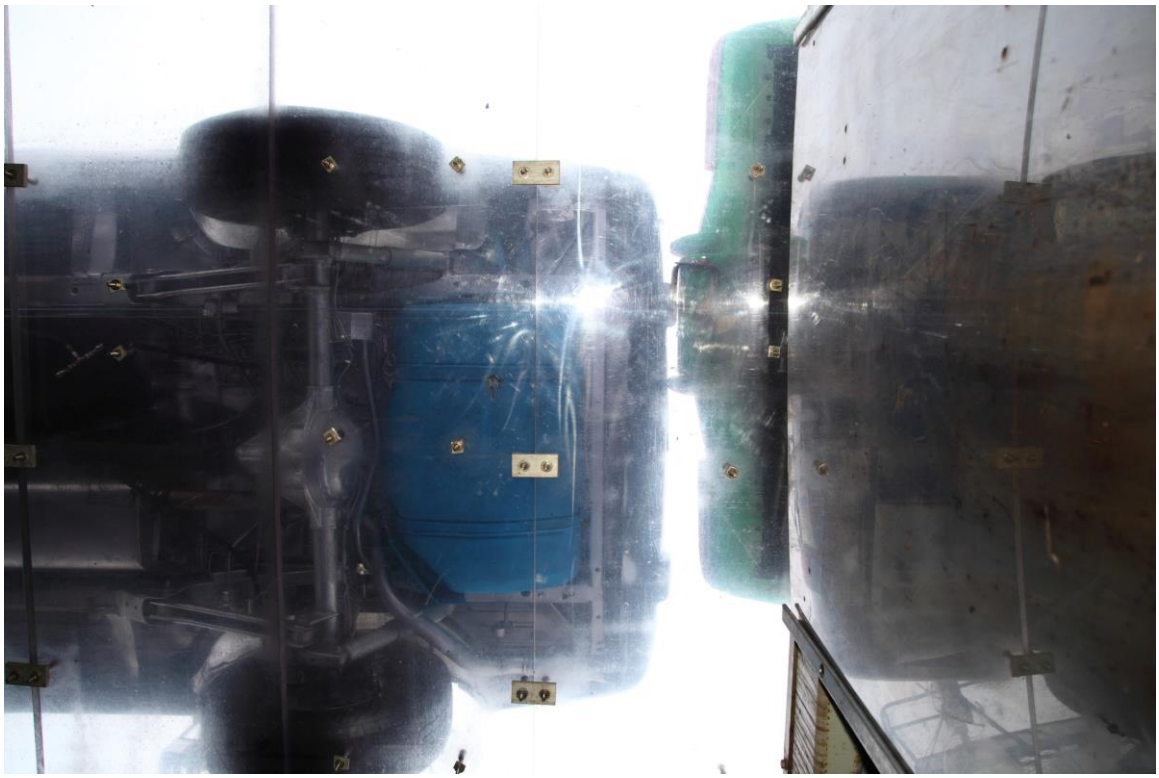


**Figure A-61 Pre-Test Impact Alignment – Bullet and Target Vehicles Pit View**

**Intentionally Left Blank**


**Figure A-62 Pre-Test Impact Area Close-Up View**


**Figure A-63 Post-Test Impact Area Close-Up View**

# Appendix B

Data Plots

# 1993 DeVille into Rear of 1998 Jeep Cherokee

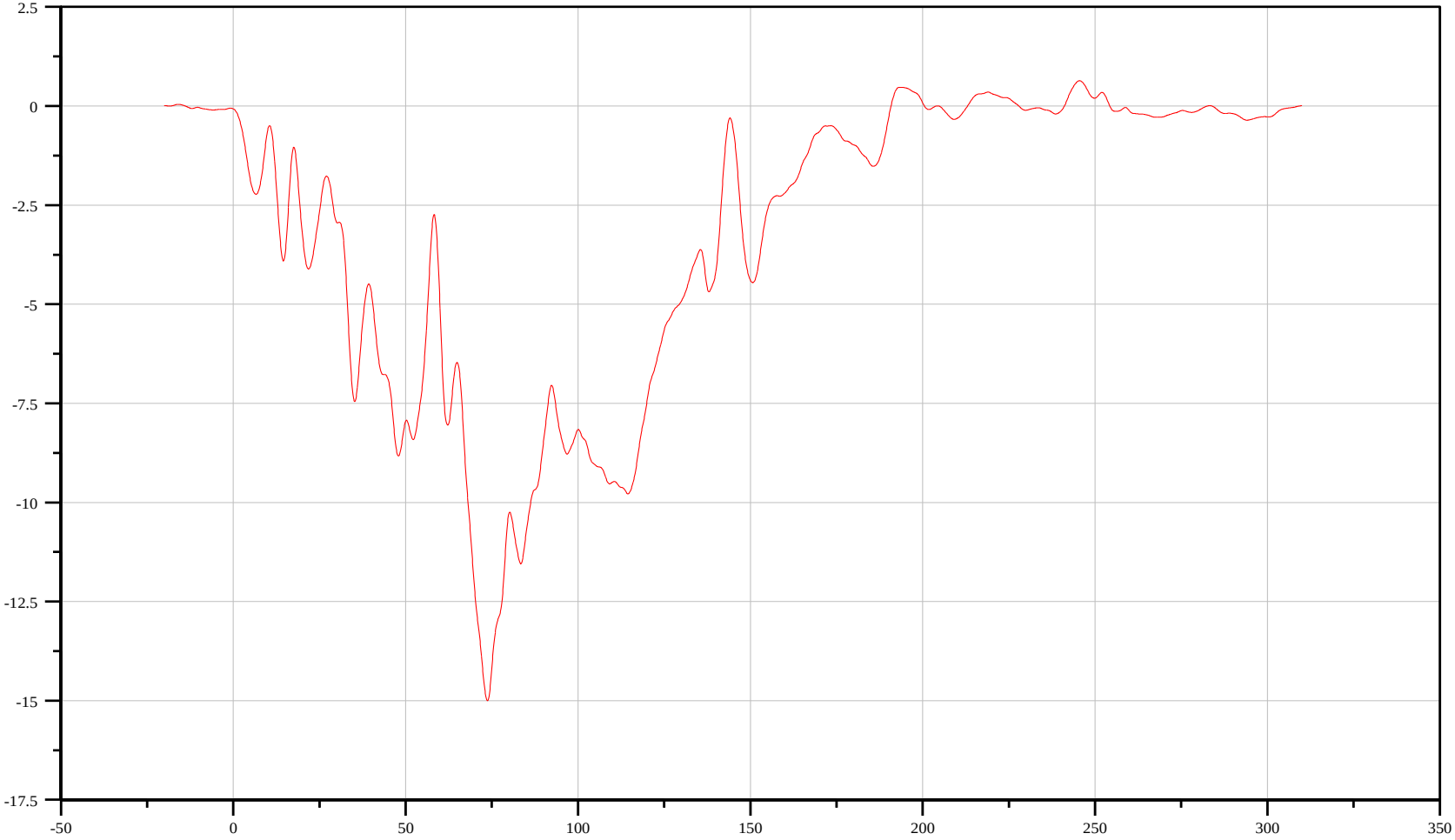
Bullet Vehicle CG X-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCG0000ACXD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-15.00 g at 73.76 ms

**Max. Value**
0.64 g at 245.52 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

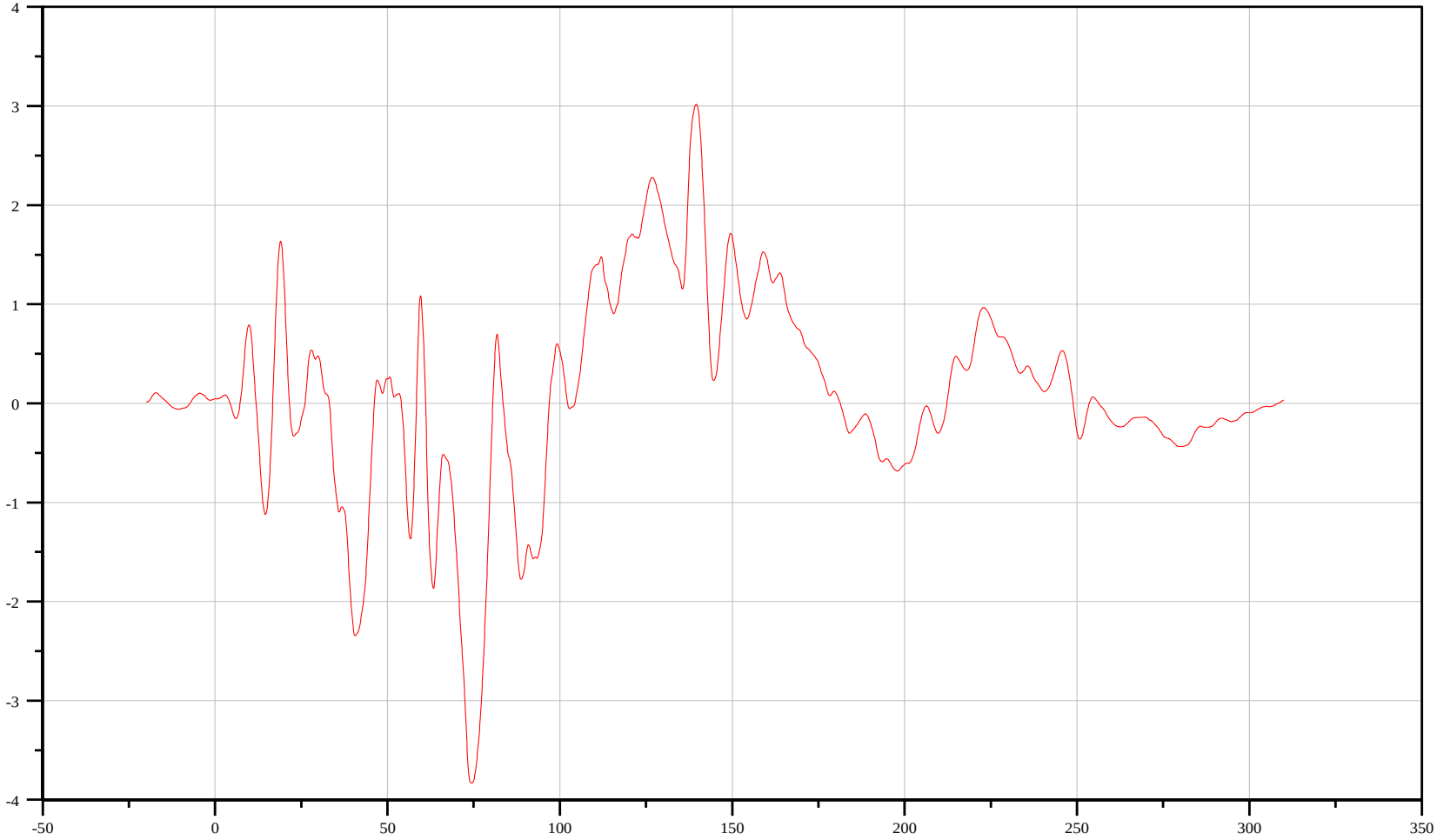
Bullet Vehicle CG Y-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCG0000ACYD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-3.83 g at 74.48 ms

**Max. Value**
3.02 g at 139.60 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

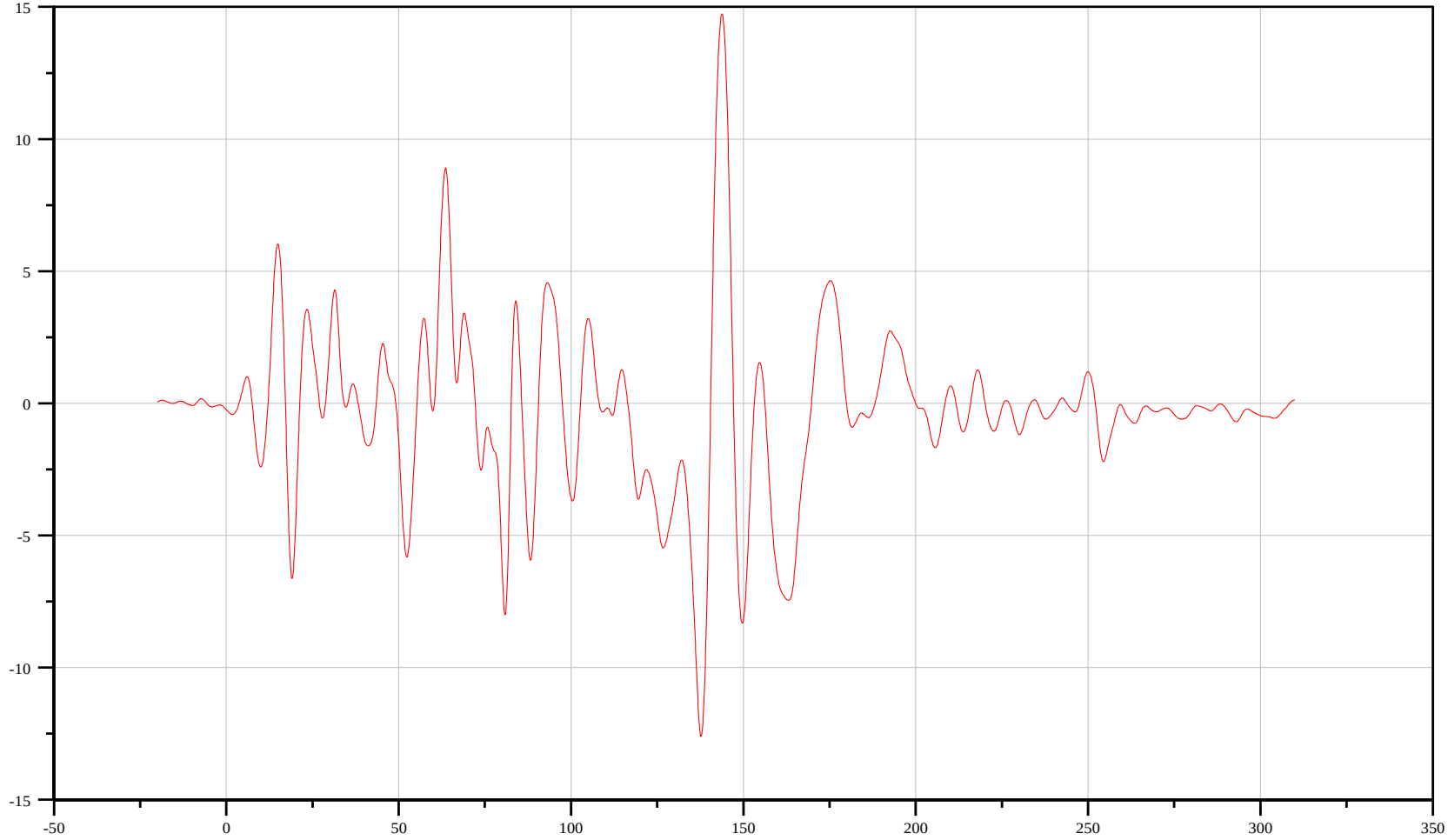
Bullet Vehicle CG Z-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCG0000ACZD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-12.61 g at 137.68 ms

**Max. Value**
14.74 g at 143.84 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

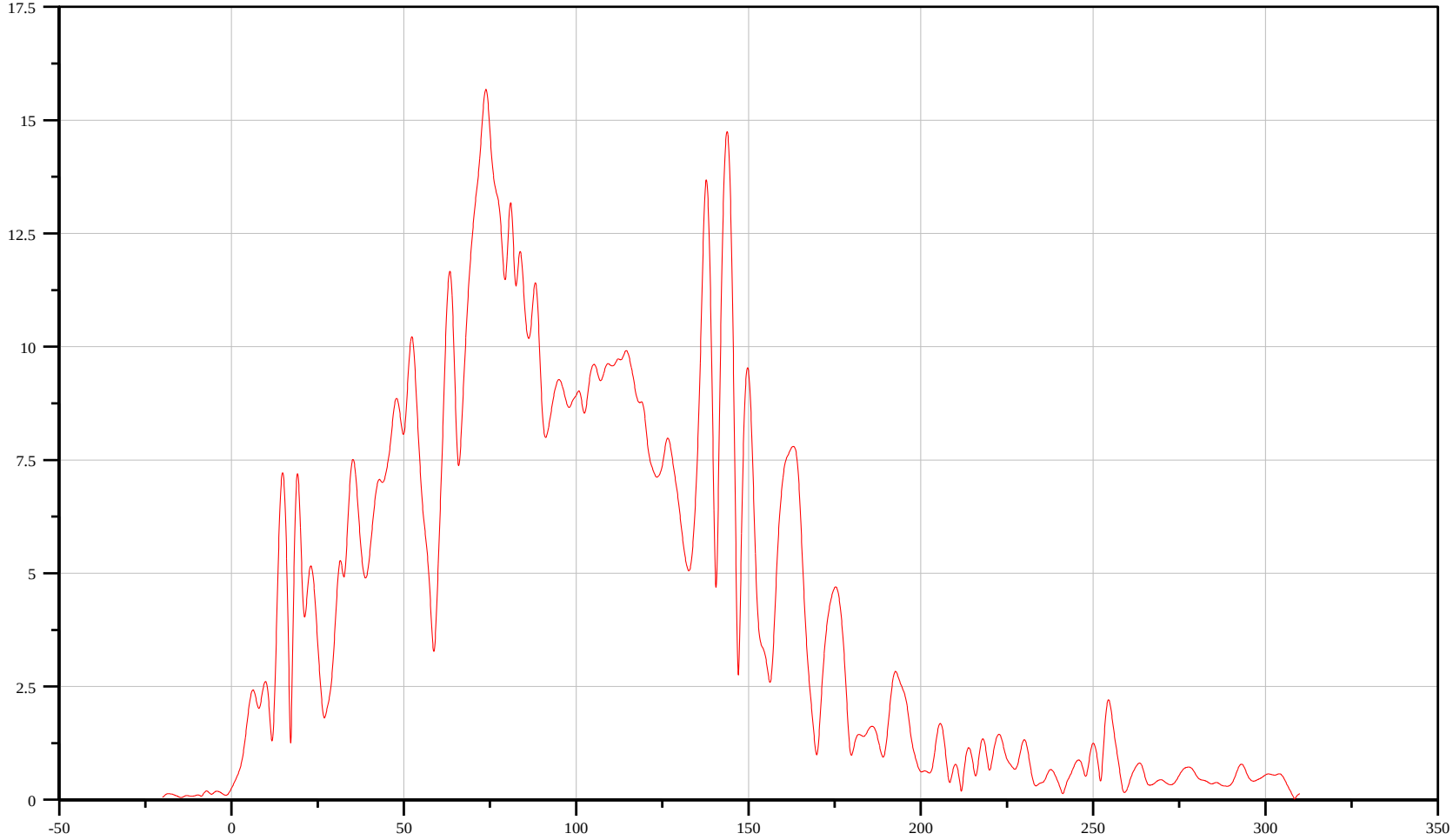
Bullet Vehicle CG Acceleration Resultant

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCG0000ACRD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
0.02 g at 308.48 ms

**Max. Value**
15.68 g at 73.84 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

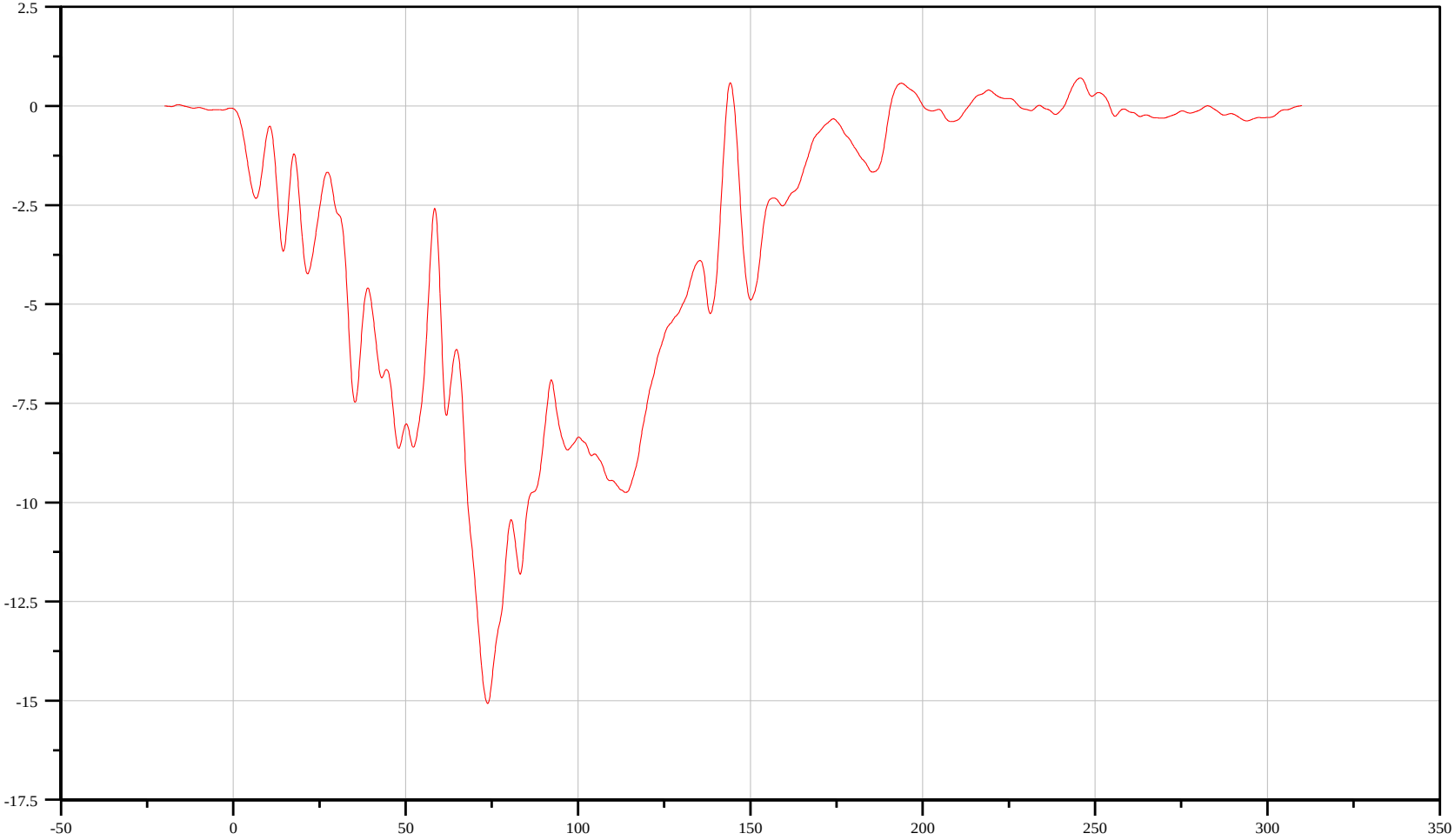
Bullet Vehicle CG Redundant X-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCGRD00ACXD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-15.07 g at 73.84 ms

**Max. Value**
0.71 g at 245.76 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

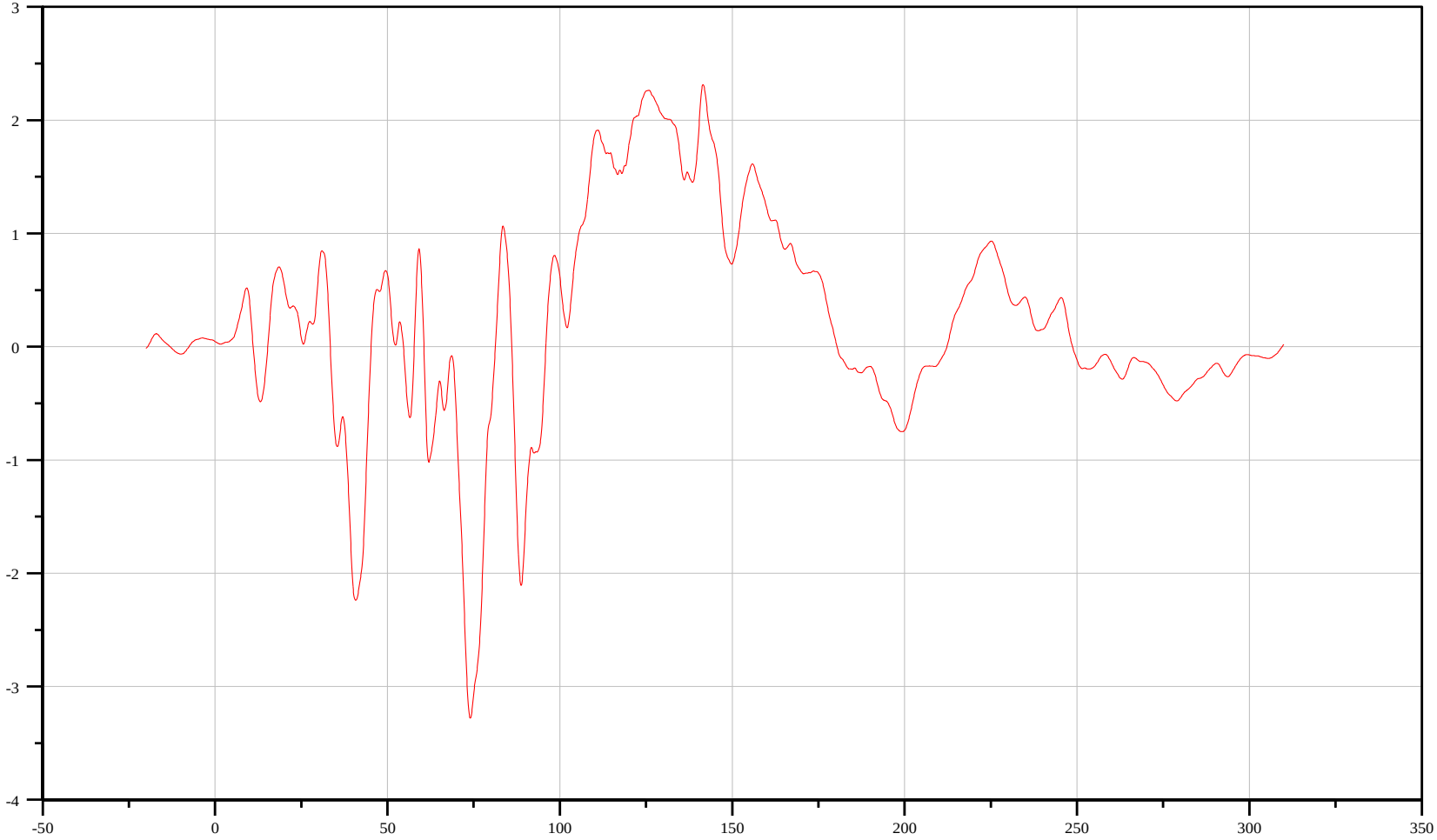
Bullet Vehicle CG Redundant Y-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCGRD00ACYD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-3.28 g at 74.00 ms

**Max. Value**
2.31 g at 141.52 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

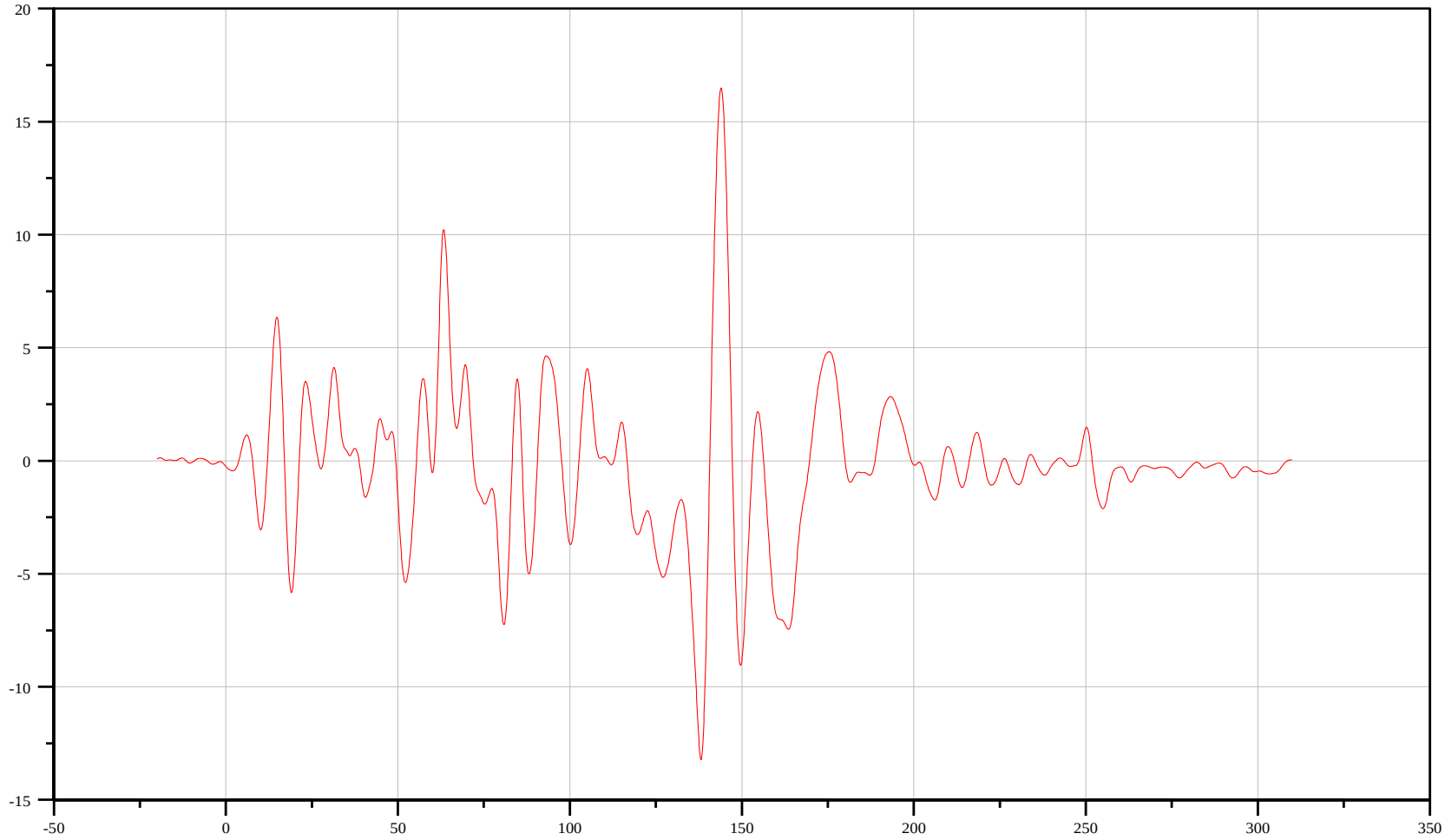
Bullet Vehicle CG Redundant Z-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCGRD00ACZD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-13.22 g at 138.16 ms

**Max. Value**
16.50 g at 144.00 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

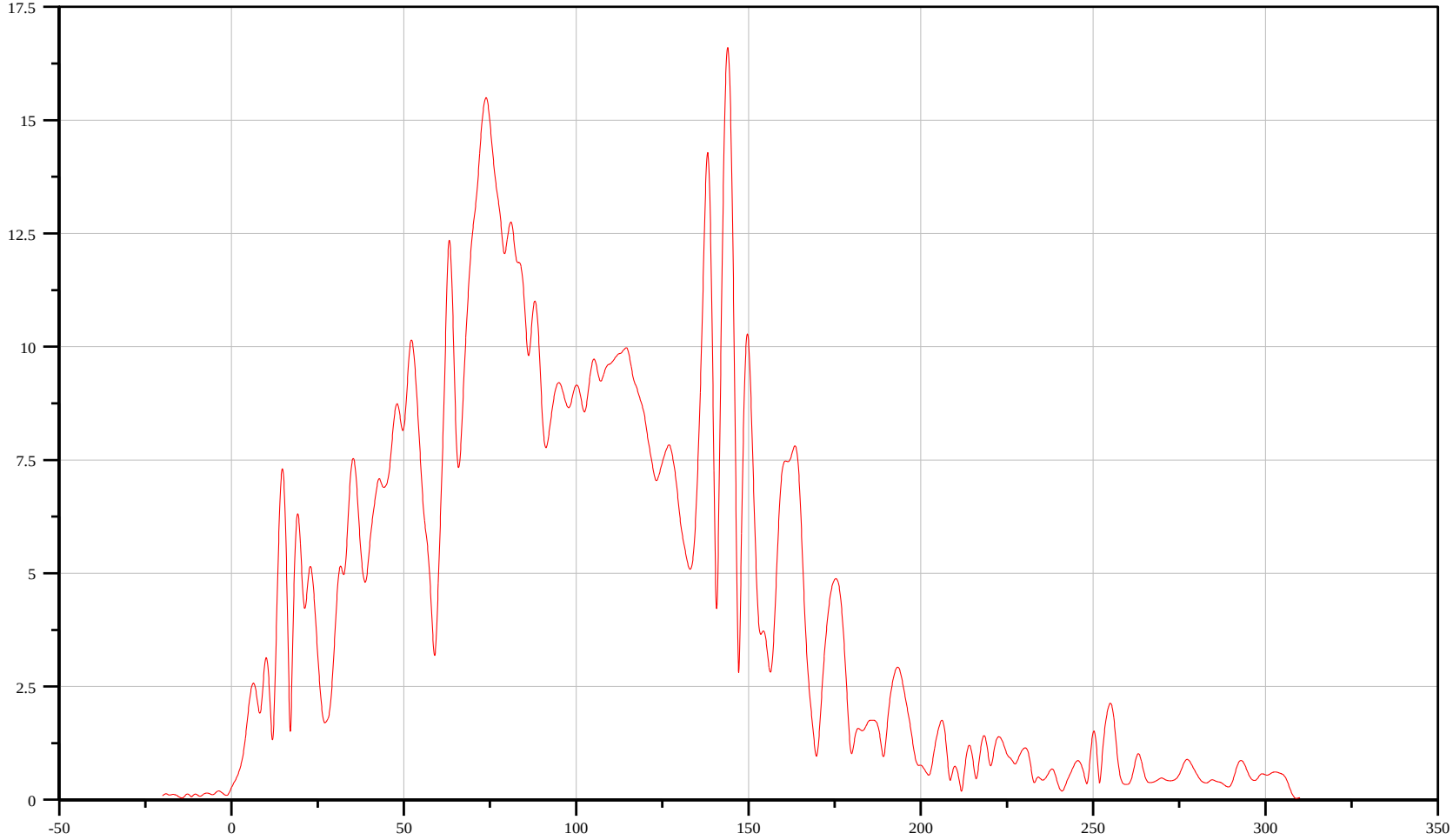
Bullet Vehicle CG Redundant Acceleration Resultant

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 10VEHCCGRD00ACRD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
0.03 g at 308.88 ms

**Max. Value**
16.61 g at 144.00 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

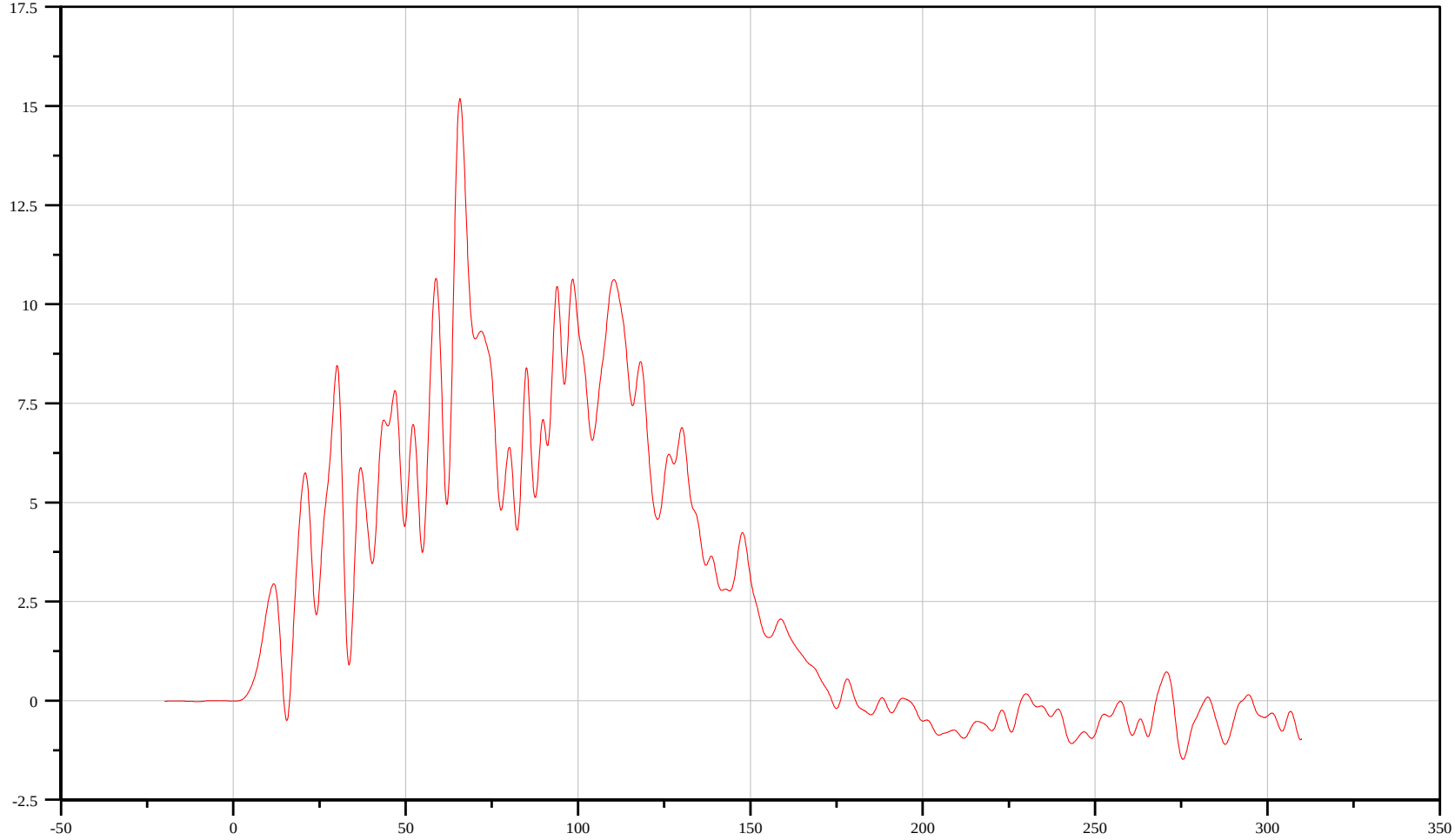
Target Vehicle CG X-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCG0000ACXD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-1.48 g at 275.52 ms

**Max. Value**
15.19 g at 65.76 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

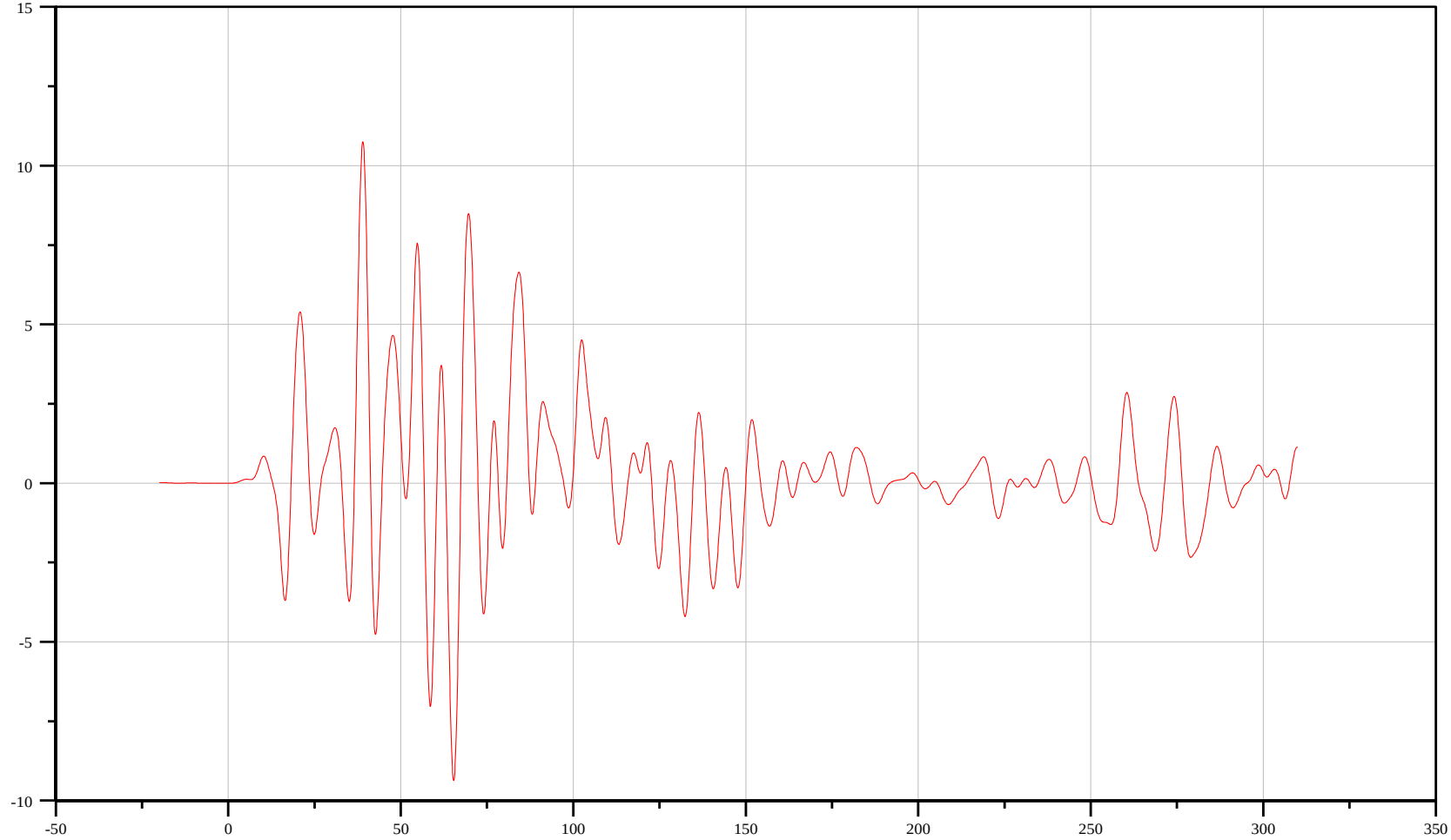
Target Vehicle CG Y-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCG0000ACYD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-9.37 g at 65.36 ms

**Max. Value**
10.76 g at 39.04 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

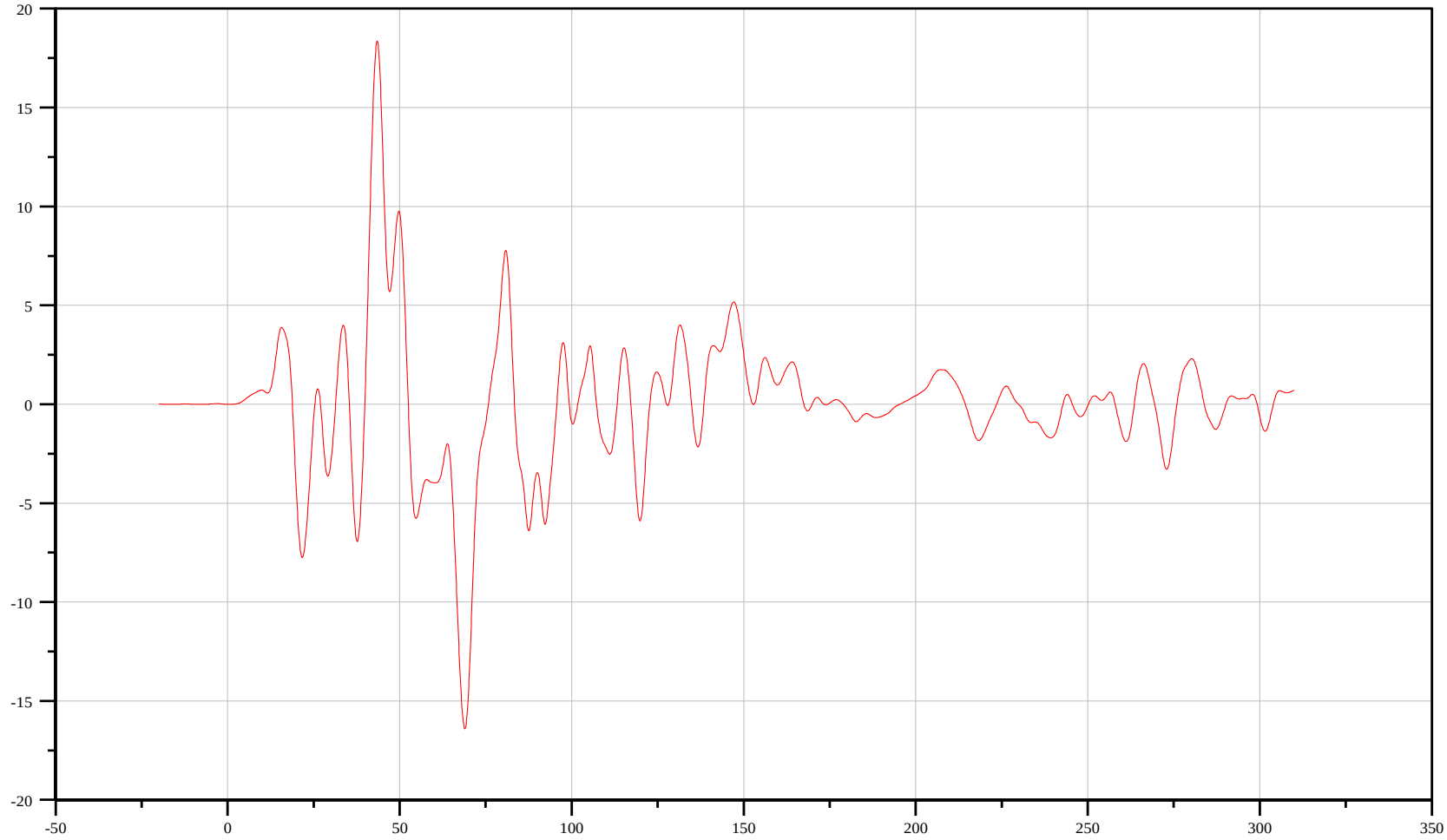
Target Vehicle CG Z-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCG0000ACZD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-16.41 g at 68.96 ms

**Max. Value**
18.36 g at 43.44 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

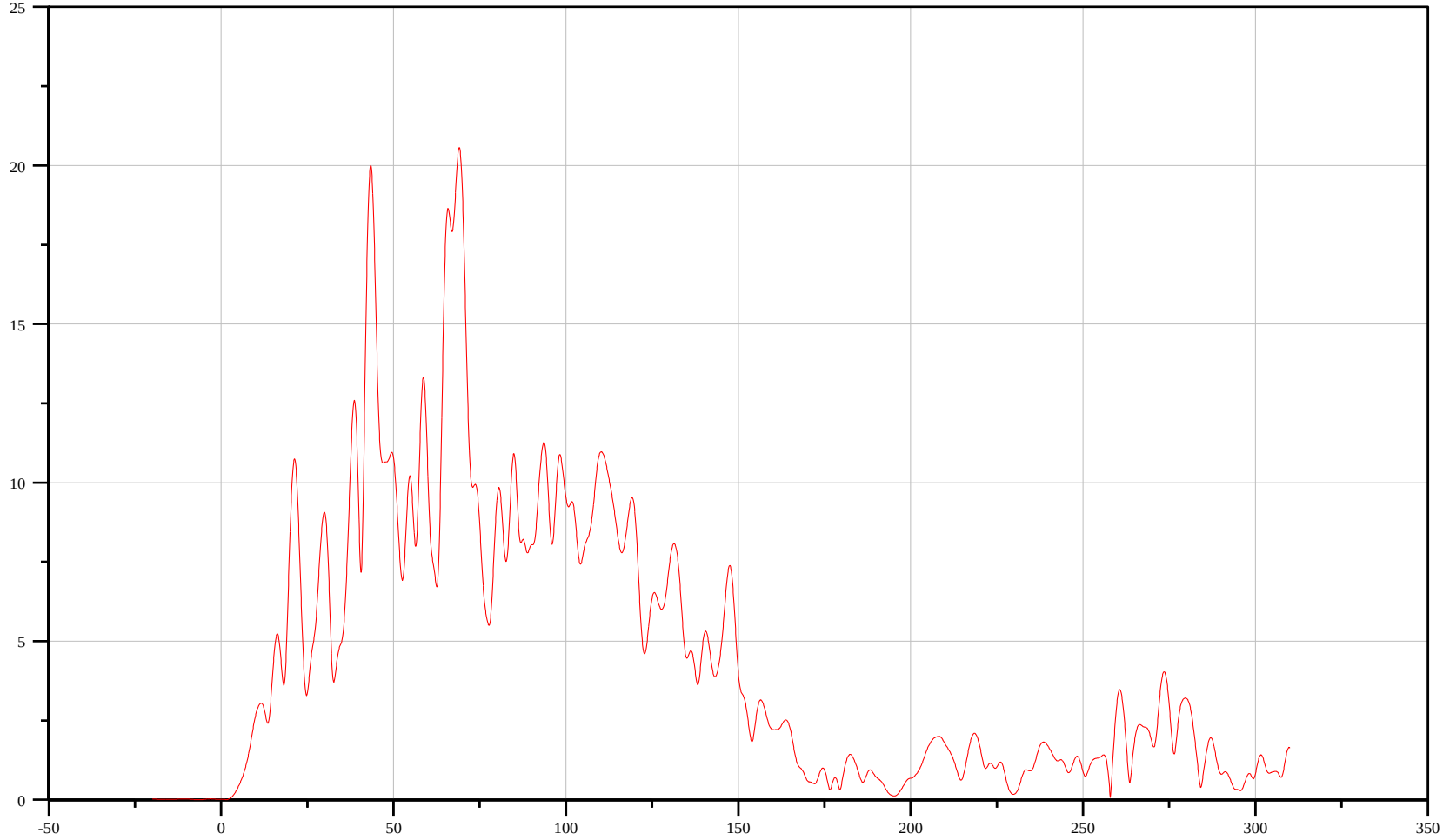
Target Vehicle CG Acceleration Resultant

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCG0000ACRD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
0.00 g at 1.60 ms

**Max. Value**
20.56 g at 69.12 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

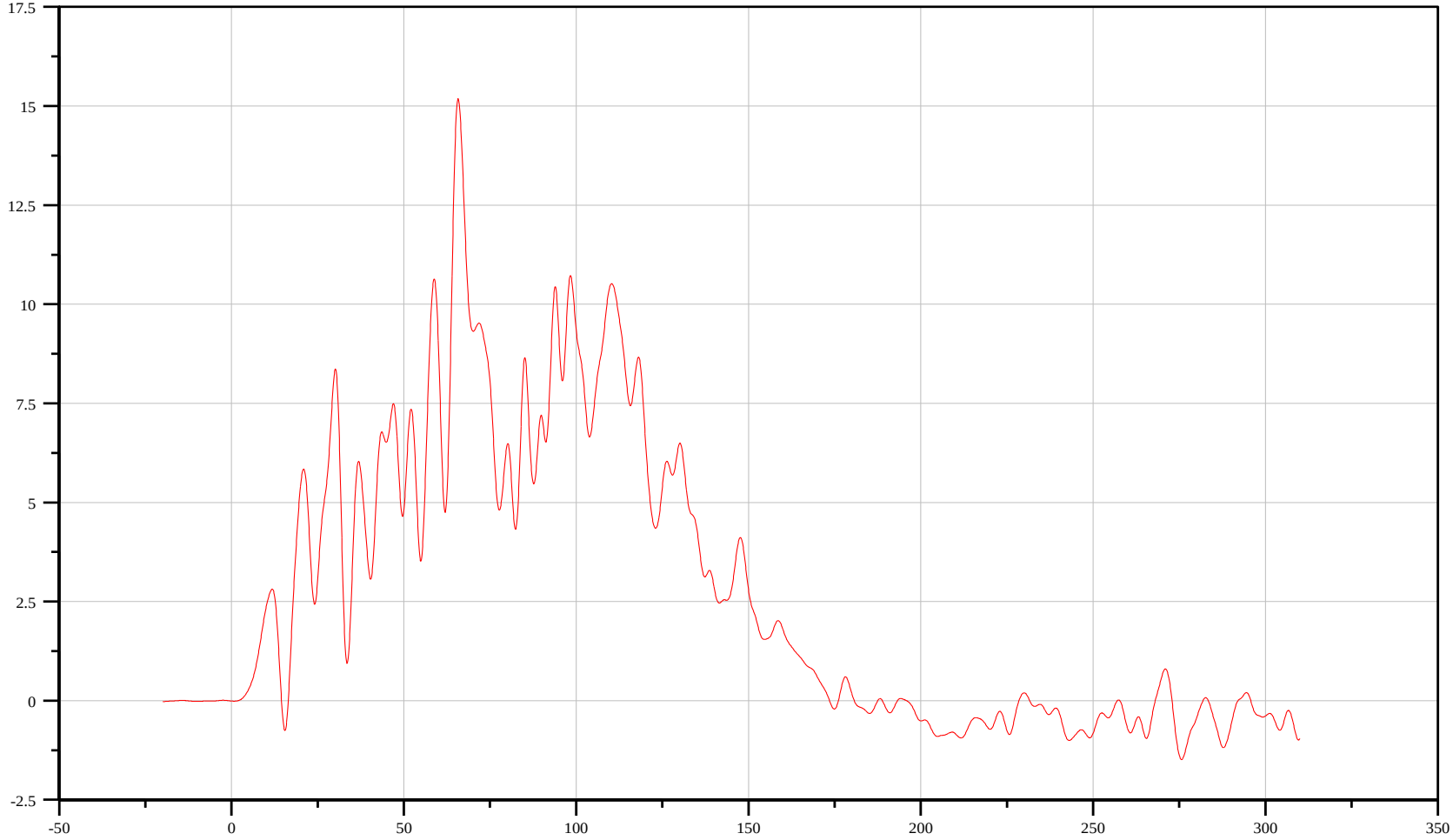
Target Vehicle CG Redundant X-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCGRD00ACXD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-1.49 g at 275.68 ms

**Max. Value**
15.19 g at 65.76 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

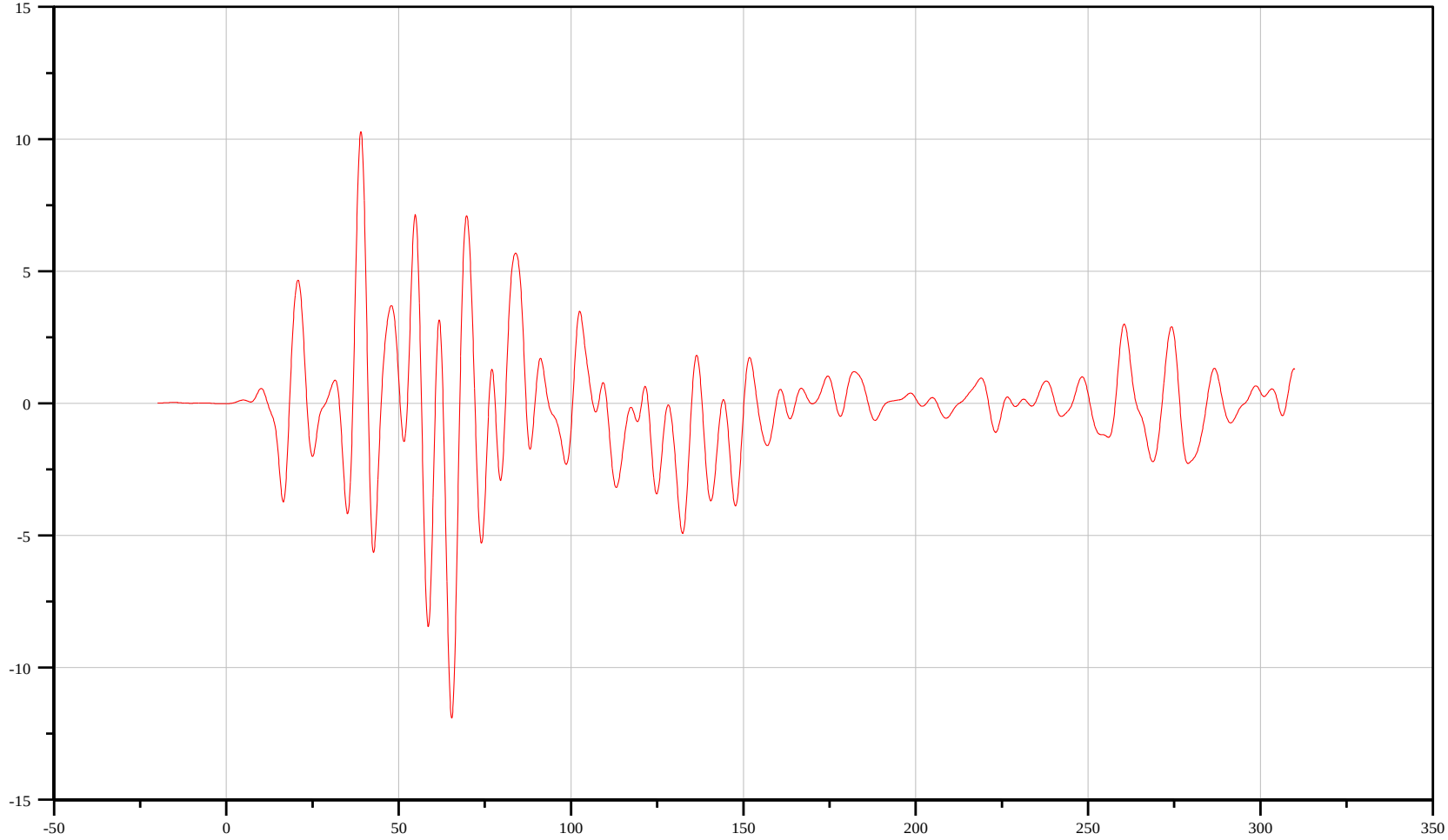
Target Vehicle CG Redundant Y-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCGRD00ACYD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
-11.91 g at 65.44 ms

**Max. Value**
10.28 g at 39.04 ms

# 1993 DeVille into Rear of 1998 Jeep Cherokee

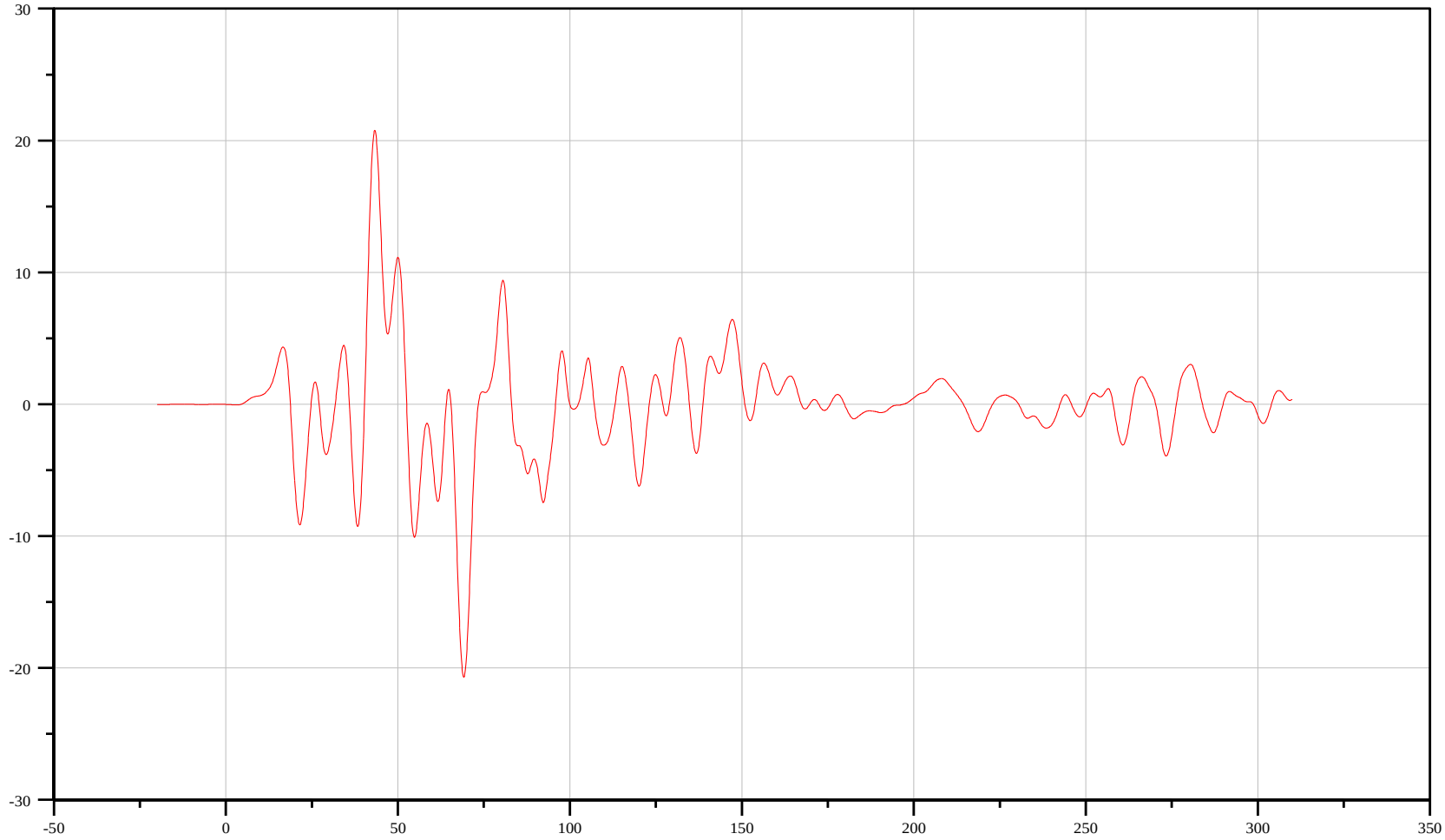
Target Vehicle CG Redundant Z-axis Acceleration

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCGRD00ACZD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

| | Min. Value | Max. Value |
|---|---|---|
| | -20.70 g at 69.20 ms | 20.77 g at 43.28 ms |

# 1993 DeVille into Rear of 1998 Jeep Cherokee

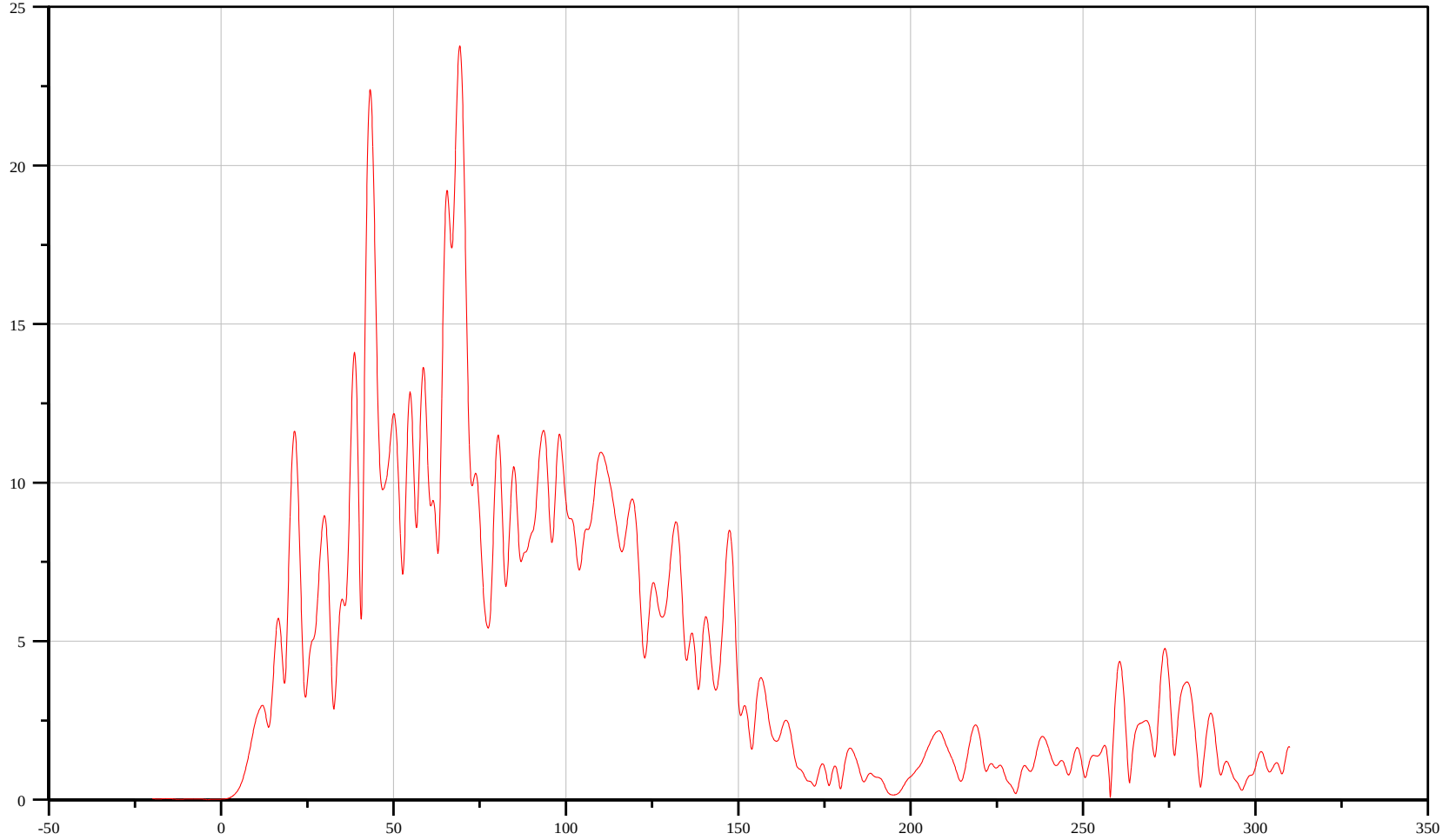
Target Vehicle CG Redundant Acceleration Resultant

Date: 10/31/2013
Time: 12:03

**Customer: VRTC**

## 20VEHCCGRD00ACRD

**TRC Inc. Test Lab: CTF**
**Test Number: 131031**




Filter: CFC_60

**Min. Value**
0.00 g at -3.84 ms

**Max. Value**
23.77 g at 69.20 ms

Time [ms]