U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

NHTSA

DOT HS 812 685

May 2019

Special Crash Investigations On-Site Guardrail End Treatment Investigation Vehicle: 2015 Chevrolet Silverado 3500 Location: Missouri Crash Date: November 2016

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

Suggested APA Format Citation:

Crash Research & Analysis, Inc. (2019, May). *Special Crash Investigations On-Site Guardrail End Treatment Investigation; Vehicle: 2015 Chevrolet Silverado 3500; Location: Missouri; Crash Date: November 2016 (Report No. DOT 812 685).* Washington, DC: National Highway Traffic Safety Administration.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. DOT HS 812 685	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Special Crash Investigations On-Site Guardrail End Treatment Crash Investigation Vehicle: 2015 Chevrolet Silverado 3500 Location: Missouri Crash Date: November 2016		*5. Report Date*: May 2019 *6. Performing Organization Code*	
7. Author Crash Research & Analysis, Inc.		*8. Performing Organization Report No.* CR16031	
9. Performing Organization Name and Address Crash Research & Analysis, Inc. P.O. Box 302 Elma, NY 14059		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-12-C-00269	
12. Sponsoring Agency Name and Address National Highway Traffic Safety 1200 New Jersey Avenue SE Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: November 2016 *14. Sponsoring Agency Code*	
15. Supplementary Note An investigation of the impact to an ET-Plus guardrail end treatment involving a 2015 Chevrolet Silverado 3500.			
16. Abstract This report documents the on-site investigation of an impact to an ET-Plus guardrail end treatment by a 2015 Chevrolet Silverado 3500 that resulted in fatal injuries to the vehicle's 50-year-old unbelted male driver. The Chevrolet was traveling west when it departed the left side of the road and struck the ET-Plus guardrail end treatment located in the median of a two-lane, divided highway. The Chevrolet deformed and then overrode the guardrail, traveled along the median, and struck a non-breakaway pole and its concrete base. The vehicle was then redirected over the guardrail system back into the roadway, where it came to final rest. The driver was transported from the crash site by ambulance for police-reported incapacitating (A-level) injuries but succumbed to his injuries and was pronounced deceased at the hospital. Although the Chevrolet was equipped with frontal air bags, they did not deploy in the crash.			
17. Key Words Trinity, Inc. ET Plus 4-inch end terminal fixed object impact		*18. Distribution Statement* This document is available to the public through the National Technical Information Service, www.ntis.gov.	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 43	*22. Price*

Table of Contents

Special Crash Investigations
Case No.: CR16031
On-Site Guardrail End Treatment Crash Investigation
Vehicle: 2015 Chevrolet Silverado 3500
Location: Missouri
Crash Date: November 2016

BACKGROUND

This report documents the on-site investigation of an impact to an ET-Plus guardrail end treatment (**Figure 1**) by a 2015 Chevrolet Silverado 3500 that resulted in fatal injuries to the vehicle's 50-year-old unbelted male driver. The Chevrolet was traveling west when it departed the left side of the road and struck the ET-Plus guardrail end treatment located in the median of a two-lane, divided highway. The Chevrolet deformed and then overrode the guardrail, traveled along the median, and struck a non-breakaway pole and its concrete base. The vehicle was then redirected over the guardrail system back into the roadway, where it came to final rest. The driver was transported from the crash site by ambulance for police-reported incapacitating (A-level) injuries but succumbed to his injuries and was pronounced deceased at the hospital. Although the Chevrolet was equipped with frontal air bags, they did not deploy in the crash.

Figure 1: Northwest-facing view of the deformed ET-Plus guardrail end treatment and crash site.

The crash was identified by the Missouri Department of Transportation (MoDOT), which notified the Federal Highway Administration (FHWA) in November 2016. The FHWA determined the crash type and guardrail end treatment met the criteria for further research and forwarded the notification to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration. The CID then assigned an on-site investigation of the crash to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc. The SCI team initiated contact with MoDOT, and the on-site investigation took place in November 2016. The on-site investigation documented the guardrail system and the damage it sustained during the crash. The physical environment of the roadway and the guardrail were documented using a Nikon total station mapping system. Following inspection of the crash site, an inspection of the Chevrolet was conducted to document its exterior and interior damage and intrusion, identify points of occupant contact, and assess the manual and supplemental restraint systems. Although the Chevrolet was equipped with an event data recorder (EDR) that was reportedly supported by the Bosch Crash Data Retrieval (CDR) tool, the SCI investigator was unsuccessful in imaging any data from the Chevrolet's EDR.

CRASH SUMMARY

Crash Site

The crash occurred in the median of a divided interstate highway during dark, nighttime hours. The posted speed limit was 113 km/h (70 mph). At the time of the crash the National Weather Service reported a temperature at 6 ºC (43 ºF) and a relative humidity of 86 percent, with clear skies and south-southeast winds at 16.7 km/h (10.4 mph). The police-reported environmental conditions were clear and dry. In the vicinity of the crash site the divided trafficway was oriented in a northwest/southeast direction (**Figures 2 and 3**). The roadway was constructed of concrete and was straight and level. The respective travel directions were separated by a 15.2 m (50.0 ft) wide depressed grass median. The westbound portion consisted of two lanes. The widths of the right and left lanes measured 3.5 m (11.5 ft) and 3.7 m (12.1 ft) respectively. The traffic lanes were separated by broken white lines and delineated by a solid white line on the right and a solid yellow line on the left. The width of the right and left shoulders measured 2.8 m (9.2 ft) and 1.2 m (4.0 ft) wide, respectively. A rectangular rumble strip pattern was cut into each shoulder. The pattern measured 1.7 m x 0.8 m (5.6 ft x 2.6 ft), and each pattern was spaced approximately 9 m (30 ft) apart. Guardrails bordered both shoulders at the crash site.

Figure 2: Southeast-facing lookback image along the trajectory of the Chevrolet 46 m (150 ft) southeast of the impact.

Figure 3: Northwest-facing trajectory view approaching the crash site 15 m (50 ft) from of the point of impact.

In the median the guardrail installation was 45.7 m (150.0 ft) in length and consisted of 25 posts. The guardrail protected the non-breakaway pole and concrete base that supported a highway sign that spanned the westbound lanes. The guardrail installation began 37.6 m (120.4 ft) southeast of the pole. The non-breakaway pole was tapered with an elliptical cross-section that measured 30 cm x 46 m (12 in x 18 in) at its base. The pole was mounted to the center of a large elliptical concrete base. The concrete base measured 0.9 m x 2.4 m (3 ft x 8 ft) and was 61 cm (24 in) tall. In addition to the guardrail damage, physical evidence observed during the scene inspection included tire marks that defined the Chevrolet's trajectory through the median and impact damage to the concrete base and pole.

Pre-Crash

The Chevrolet was driven by a 50-year-old male traveling northwest in the left lane of the roadway at an estimated speed of 113 km/h (70 mph). The driver was unbelted, not using the available 3-point lap and shoulder seat belt. Although his trip plan was unknown, the location of his residence relative to the crash was indicative that he may have been returning to his home. During its travel, the Chevrolet departed the left lane for unknown reasons. The shallow departure angle was estimated at less than 5 degrees. Crash and impact diagrams are included at the end of this report.

Crash

The front plane/left aspect of the Chevrolet struck the ET-Plus end terminal (Event 1) and displaced it along the rail (**Figure 4**). The frontal air bags in the vehicle did not deploy. Displacement of the end terminal extruded 3.7 m (12.0 ft) of the W-beam. The wooden support posts (Post 1 to 3) fractured and were displaced into the median. The Chevrolet began to rotate counterclockwise in response to the left bias of the impact force. A tire scuff mark attributed to the right rear tire was identified on the roadway straddling the yellow line and directed along the vehicle's path of travel. The tire mark measured 3.9 m (12.8 ft) in length and is identified by the arrow in **Figure 4**.

Figure 4 : Northwest trajectory view at the end terminal impact. The location of the right rear tire mark is denoted by the red arrow.

Figure 5: Northwest-facing view of the W-beam in the vicinity of Post 7 and the black transfer of the Chevrolet's right front tire.

Due to the off-road impact trajectory of the vehicle, its momentum and the resultant lateral loading of the W-beam, a bending moment was created between Posts 3 and 4. The W-beam deformed by bending approximately 180 degrees along the Chevrolet's travel path, located approximately 6.1 m (20 ft) from Post 1. The left side and center of mass of the Chevrolet overrode the deformed guardrail; however, the right front wheel and tire became captured on the road side of the W-beam as the Chevrolet traveled into the median. A rubber transfer was observed on the W-beam (**Figure 5**). This transfer began in the area of Post 7 (approximately 10.9 m (35.8 ft) from Post 1) and ended at Post 15 (approximately 26.8 m [88.0 ft] from Post 1).

With the vehicle straddling the deformed guardrail and its right front tire/wheel captured on the road side of the guardrail, the Chevrolet initiated a clockwise rotation. Furrow marks attributed to the left side tires were observed in the median and are highlighted by the traffic cones in **Figure 6**. The length of the left front tire furrow (blue cones) measured 6.1 m (20.0 ft). The left rear dual marks (yellow and blue cones) measured 18.3 m (60.0 ft) in length. The Chevrolet's right front tire ultimately climbed over and separated from the W-beam at Post 15. The vehicle had rotated approximately 20 degrees clockwise relative to the heading of the roadway. Its momentum was directed toward the concrete base and pole.

Figure 6: Northwest trajectory view toward the concrete base/pole and the furrow marks of the left side tires.

The left front tire/wheel struck the concrete base, and the left doors of the Chevrolet struck the pole (Event 2). A 38 cm x 138 cm (15 in x 66 in) pattern of abrasions and paint transfer extended to a height of 229 cm (90.0 in) above the ground on the pole. The unbelted driver was partially ejected through the left front glazing opening and contacted the pole with his head during the vehicle's engagement with the pole. The left rear dually tires/wheels then struck and engaged the concrete base (Event 3). A pair of distinct black transfer patterns and fractures to the top edge of the base (**Figure 7**) evidenced the contact of the left side tires with the base. The associated forces induced a rapid counterclockwise rotation to the Chevrolet.

Figure 7: Northwest-facing view of the impact damage and physical evidence on the concrete base and pole.

Figure 8: Northwest-facing view of the deformed guardrail at Posts 21-25.

The Chevrolet again contacted and then overrode the guardrail from Post 20 to 24 (**Figure 8**). These guardrail posts were deformed in the vehicle's direction of travel and the W-beam was deformed downward, contacting and abrading the road shoulder. Direct contact was observed on

the field side of Post 23 and Post 24. A 2 m (6.7 ft) long scuff mark attributed to the right rear tire was observed in the left lane of the roadway and evidenced the vehicle's trajectory. The Chevrolet came to final rest facing westward in the roadway approximately 45.9 m (150.0 ft) from the initial impact with the end terminal. Its front plane was in close proximity to Posts 24 and 25 of the guardrail installation.

Post-Crash

Police, fire, and emergency medical services personnel responded to the crash site. The unbelted driver was unresponsive and found in cardiac arrest upon their arrival. He was removed from the vehicle and transported to a regional trauma center. Life support and resuscitation efforts during transport were unsuccessful and the driver was pronounced deceased upon arrival at the hospital. An autopsy was not performed. The Chevrolet was removed on a flatbed tow truck and transported to the local yard, where it was located at the time of the SCI inspection.

ET-PLUS END TREATMENT AND GUARDRAIL

The ET-Plus end treatment, manufactured by Trinity Highway Products, was an energy-absorbing end terminal used to terminate W-beam guardrail installations. The end treatment met the requirements for National Cooperative Highway Research Program (NCHRP) 350 Test Level 3. **Figure 9** is an oblique view of an exemplar ET-Plus installation. The end terminal was designed to be displaced along the W-beam by the force of the impact and dissipate the impact forces by flattening the W-beam during its movement. The flattened and deformed beam was projected out of the impact head toward the field (off-traffic) side. The feeder chute of the end terminal involved in this crash was 10 cm (4.0 in) wide. The manufacturer's literature and installation manuals can be found at www.highwayguardrail.com/products/etplus.html.

Figure 9: Oblique view of an exemplar 10 cm (4 in) ET-Plus installation.

The ET-Plus end treatment and guardrail system were inspected post-crash and documented by the SCI investigator through a combination of measurements and photographs. The overall guardrail installation consisted of 25 posts and spanned 45.7 m (150.0 ft). During the crash sequence, 24 posts and approximately 45.4 m (149.0 ft) of W-beam were damaged. A diagram depicting the deformed guardrail and the completed FHWA Guardrail Forms are included at the end of this report.

The end treatment consisted of the end terminal, foundation tubes, and a ground strut at post locations 1 and 2, a cable anchor, seven wooden controlled release terminal posts with wood block-outs at Posts 3 to 7, 7.6 m (25 ft) W-beam sections, and associated hardware. Beginning at

Post 8, the guardrail installation used standard 10 cm x 15 cm (4 in x 6 in) I-beams supports. Composite block-outs were used to attach the W-beam at Posts 8 to 11. Wooden block-outs were installed at Posts 12 to 25. Splices in the W-beam guardrail sections were located at Posts 5, 9, 13, 17, and 21. The height of the guardrail measured 67 cm (26.5 in) at Post 25.

Figures 10 and 11 depict the overall damaged guardrail system at the time of the SCI inspection.

Figure 10: Southeast-facing image along the deformed guardrail from Post 13.

Figure 11: Northwest-facing image along the deformed guardrail from Post 13.

Pre-impact, the end terminal was fastened to Post 1 by two lag screws through hanger brackets welded to the terminal. The left front corner of the Chevrolet struck the impact face of the end terminal. The width and height of the end terminal's impact face measured 38 cm x 71 cm (15.0 in x 28.0 in), respectively. Examination revealed a 14 cm x 57 cm (5.5 in x 22.5 in) area of direct contact damage to the face with an 8 cm (3.0 in) deflection of the traffic side edge. At impact the lag screws released and the displaced end terminal extruded approximately 3.7 m (12 ft) of W-beam. As the W-beam deformed to the field side by bending in the area of Post 3 and 4, the Chevrolet's bumper contacted the traffic side of the end terminal. Deformation and abrasive

Figure 12: South-facing image of the extruded W-beam and the impact face of the end terminal.

Figure 13: Overhead image of the end terminal depicting its deformation.

contact damage were noted to the weldment. All welds remained intact. **Figures 12 and 13** are images of the end terminal and extruded rail.

The wooden posts at locations 1 to 7 were fractured by the force of the impact and the subsequent off-road trajectory of the Chevrolet. The W-beam deformed into a U-shape by bending with the vertex between Post 3 and 4. This deformation was not considered a kink.

As the Chevrolet overrode the deformed rail, its right front tire/wheel was captured on the traffic side of the guardrail. Due to their contact with the vehicle's undercarriage, the steel I-beam posts at locations 8 to 11 deformed by bending at ground level. The posts were deflected approximately 60 degrees along the direction of the Chevrolet's travel. The carriage bolts, originally supporting the W-beam at each post, deformed the slot in the web and were pulled through, thus releasing the rail.

The deflection of the posts at location 12 to 14 diminished to approximately 30 degrees as the Chevrolet separated from the guardrail at Post 15. The W-beam remained attached to the post and block-out at Post 16. The post deflection then progressively increased from 40 degrees at Post 17 to approximately 70 degrees at Post 23, as the Chevrolet overrode the guardrail (a second time) after its impact with the concrete base and pole. Post 24 was rotated clockwise and bent approximately 10 degrees. Separated from the posts, the W-beam was deflected downward contacting the shoulder and bowed out toward the roadway (traffic side). Post 25 was relatively undamaged. The W-beam remained attached to this post with slight movement of the carriage bolt head within the hanger slot.

2015 CHEVROLET SILVERADO 3500

Description

The 2015 Chevrolet Silverado 3500 (**Figure 14**) was manufactured in April 2014 and identified by the vehicle identification number 1GC4KYC89FFxxxxxx. Its odometer indicated 77,048 km (47,877 mi) at the time of the inspection. This 4-door crew cab truck was configured on a 424 cm (167.0 in) wheelbase with a dual-wheel rear axle and had 4-wheel drive capabilities. The powertrain consisted of a 6.6-liter, turbo-diesel engine linked to a 6-speed automatic transmission. Service brakes were power-assisted hydraulic 4-wheel disc with ABS. Standard equipment included traction control, electronic stability control, and a tire pressure monitoring system. The Chevrolet was equipped with an aftermarket replacement front bumper. The all-steel replacement bumper was manufactured by Fab Fours, Inc. (www.fabfours.com)

Figure 14: Left side view of the Chevrolet.

and had a full brush guard incorporated into the design. A placard declared that the Chevrolet's gross vehicle weight rating (GVWR) was 5,908 kg (13,025 lb), with specific gross axle weight ratings of 2,450 kg (5,600 lb) front and 4,253 kg (9,375 lb) rear. The curb weight was 3,382 kg (7,454 lb). At the time of the SCI inspection, the Chevrolet was equipped with Hankook DynaPro ATM tires on the front axle and Michelin LTX tires on the rear axle. All were of the vehicle manufacturer's recommended size of LT235/80R17. Manufacturer recommended cold tire pressures were 480 kPa (70 PSI) front and 450 kPa (65 PSI) rear.

Specific tire data at the time of the SCI vehicle inspection is provided in the following table.

		Tire Pressure	Measured Tread Depth	Restricted	Damage
LF		501 kPa (73 PSI)	6 mm (7/32 in)	No	None
LR	Outer	310 kPa (57 PSI)	2 mm (2/32 in)	No	None
	Inner	Unknown	3 mm (4/32 in)		
RR	Outer	363 kPa (53 PSI)	2 mm (3/32 in)	No	None
	Inner	Unknown	2 mm (2/32 in)		
RF		507 kPa (74 PSI)	6 mm (7/32 in)	No	None

The interior of the Chevrolet was configured for seating of five occupants (2/3). The front row was equipped with manual bucket seats with adjustable head restraints. The driver seat was adjusted to a mid-track position that measured 12 cm (4.7 in) forward of full rear. The total seat track travel measured 26 cm (10.2 in). The seatback was adjusted 10 degrees aft of vertical and the head restraint was adjusted up 8 cm (3.1 in). The second row consisted of a non-adjustable 3-passenger split bench seat. Manual safety systems consisted of 3-point lap and shoulder seat belts in all seat positions. The front seat belts used retractor pretensioners. Supplemental safety systems consisted of advanced dual-stage frontal air bags for the driver and front row right positions. The GVWR of the Chevrolet exceeded the 4,536 kg (10,000 lb) weight limit stated in Federal Motor Vehicle Safety Standard No. 208; therefore, the frontal air bags were not required to meet the certified advanced 208-compliant requirements.

Aftermarket Front Bumper

An aftermarket front bumper was installed on the Chevrolet at the time of the crash. The bumper was manufactured and sold by Fab Fours, Inc. The all-steel bumper was constructed of 5 mm (3/16 in) diamond plate and 5 cm (2 in) formed tubing. The bumper measured 108 cm (82.0 in) wide. The bumper's straight center aspect was 97 cm (38.0 in) wide. Each corner tapered rearward 20 cm (8.0 in) forming a wide V-pattern. The brush guard grill extended vertically to the hood. The installation guide (**Appendix B**) stated that the replacement bumper attached to the truck's frame with an aftermarket mount. The bumper was not tested for crashworthiness or evaluated to understand how it may affect the crash sensing of the vehicle's supplemental restraints.

NHTSA Recalls and Investigations

A search for product safety recalls on the NHTSA website www.safercar.gov indicated that there

were 14 recalls for the 2015 Chevrolet Silverado. One of these recalls, identified as NHTSA #16V- 651, stated that the sensing and diagnostic module (SDM) in affected vehicles contained a software glitch that in rare cases could prevent deployment/actuation of supplemental restraints. However, a VIN-specific search of the Safercar website for recall data indicated that there were no open recalls concerning this specific Chevrolet Silverado. Warranty data obtained from the Chevrolet dealer indicated that service for the aforementioned air bag recall service was conducted on November 10, 2016. At that time, the vehicle's odometer indicated 76,595 km (47,595 miles).

Exterior Damage

The exterior damage to the Chevrolet consisted of crush deformation on the front and left planes which was consistent with the events of the crash. Two distinct regions of direct damage contact were present on the front plane (**Figure 15**). The direct damage related to contact with the impact face of the end terminal began at the left corner and extended to the right 14 cm (5.5 in). This bumper corner deflected rearward approximately 13 cm (5 in) and contacted the body structure at the leading aspect of the left fender and forward left aspect of the hood (**Figure 16**). The damage profile at the fender and hood, caused by the dynamic deflection of the end terminal impact, matched the shape of the bumper guard. The bumper then rebounded through restitution.

Figure 15: Front view of the Chevrolet and the deformation of the aftermarket bumper.

Figure 16: Overhead view of the front left corner of the Chevrolet depicting the impact deformation.

The second region of front damage extended from the end terminal damage across the left and center aspect of the bumper and ended 46 cm (18.0 in) right of center. This second region was related to contact with the side of the end terminal and W-beam as the guardrail deformed by bending. The Chevrolet then overrode the guardrail evidenced by the damage to the lower aspect of the replacement bumper and abrasions to the undercarriage. The collision deformation classification (CDC) of the overall frontal damage pattern was 12FDEW1.

A residual crush profile of the bumper measured with the Nikon total station and accounting for freespace produced the following measurements: C1 = 18 cm (7.1 in), C2 = 13 cm (5.2 in), C3 = 5 cm (2.0 in), and C4 – C6 = 0. The untested properties of the replacement bumper and yielding properties of the guardrail impact were beyond the scope of analysis by the WinSMASH program. However, for comparative purposes, a borderline analysis of the crash severity (delta-V) was calculated using the barrier algorithm. The calculated total delta-V was 16 km/h (10 mph), with longitudinal and lateral components of -16 km/h (-10 mph) and 0 km/h, respectively.

Impact damage from the concrete base began at the left front wheel and tire. The heads of two lug nuts securing the wheel to the rotor were sheared. Abrasions and concrete dust covered the wheel. The left front axle position was deformed rearward 5 cm (2.0 in).

Damage on the left plane associated with contact from the pole itself began at the A-pillar, 77 cm (30.3 in) aft of the front axle, and extended rearward 184 cm (72.4 in) to the left C-pillar area. The most significant lateral deformation was sustained above the beltline. The most representative crush was observed to the left roof side rail. A residual crush documented to this profile produced the following resultant measurements: C1 = 15 cm (5.9 in), C2 = 26 cm (10.2 in), C3 = 27 cm (10.6 in), C4 = 21 cm (8.3 in), C5 = 15 cm (5.9 in), C6 = 0. The left rear door was shifted rearward 38 cm (15.0 in) and overlapped the C-pillar. The forward left corner of the cargo bed was deformed rearward 6 cm (2.5 in). The CDC assigned to the Chevrolet for the impact with the pole was 10LDEW3. A borderline analysis of the delta-V was calculated using the Barrier Algorithm of the WinSMASH model. The calculated total delta-V was 19 km/h (12 mph), with longitudinal and lateral components of -10 km/h (-6 mph) and 16 km/h (10 mph), respectively.

Figure 17: Left side of the Chevrolet depicting the Event 2 pole impact damage.

The left rear dually tires/wheels also struck the concrete base (Event 3), evidenced by the large black transfer on the concrete. This impact force displaced the left rear axle position 24 cm (9.5 in) rearward. Corresponding engagement also induced rapid counterclockwise rotation to the Chevrolet. The CDC assigned to this damage pattern was 10LBWW1. An analysis of this impact was beyond the scope of the WinSMASH model.

Event Data Recorder

The 2015 Chevrolet Silverado 3500 was equipped with an SDM, which controlled the sensing, diagnostic and deployment/actuation command functions of the vehicle's Supplemental Restraint Systems. The SDM also had EDR capabilities. The Help File in the Bosch CDR tool indicated

that this vehicle's EDR was supported. The software available at the time of the inspection was version 17.0. During the SCI inspection, it was determined that there was no damage to the vehicle's electrical system or its 12-volt battery. Battery power was reconnected and the CDR tool was connected to the communication buss via the diagnostic link connector (DLC). Several attempts to image the EDR were made, and all were unsuccessful. Communication with the EDR could not be established. The error message returned stated: "This vehicle module is not supported. Software ID not recognized. ID: CE446." No crash data was recovered from the Chevrolet. It should be noted that the CDR Help File combined all Chevrolet C/K Silverado pickup trucks into one category, regardless of GVWR. It is probable that this 3500 series (Class 3) truck was not supported due to its weight rating (in excess of 4,536 kg (10,000 lb). The FVMSS No. 563 EDR Rule was applicable to vehicles weighing less than 3,856 kg (8,500 lb).

Interior Damage

The interior damage to the Chevrolet consisted of the component-intrusion of the left plane and driver contacts to the interior. There was no deployment of the front air bags. The lateral intrusion of the left front and rear doors measured 10 cm (4.0 in) and 15 cm (6.0 in), respectively. The left B-pillar intruded 8 cm (3.1 in). The lateral intrusion of the left roof side rail measured 8 cm (3.1 in) at row 1 and 17 cm (6.7 in) at row 2. At impact, the driver contacted components forward and left of his position (**Figure 18**). Occupant contact was identified on the knee bolster, left instrument panel, center hub (driver air bag module) of the steering wheel evidenced by scuffs to the components. The driver contacted these components with his lower extremities, his left upper extremity, and chest, respectively. His left upper extremity also contacted the door at the A-pillar. The driver's head scuffed the upper door frame evidenced by a 13 cm x 3 cm (4.1 in x 1.1 in) contact area on the weather stripping. His head was partially ejected through the window opening and struck the pole. Rebound contacts were observed at the left roof side rail, B-pillar door frame, and head restraint. Hair and tissue were embedded in the scuffed areas of contact (**Figure 19**).

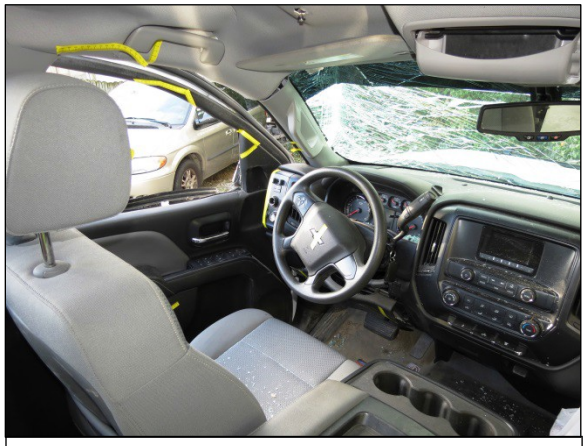


Figure 18: Left interior view depicting the driver contact evidence.

Figure 19: Interior view of the driver's rebound contact evidence.

Manual Restraint Systems

The Chevrolet was configured with manual 3-point lap and shoulder seat belt systems for the five seat positions. The seat belts in the front row used retractor and buckle pretensioners. All seat belt systems used continuous loop webbing and sliding latch plates. The driver's seat belt retracted onto an emergency locking retractor (ELR) while the other systems used dual mode ELR/automatic locking retractors (ALR). The driver's adjustable D-ring was in the full-up position. At inspection, the driver's seat belt was stowed and the retractor was locked. There was approximately 8 cm (3.1 in) of slack in the webbing. The retractor was locked due to deformation of the lower B-pillar which engaged the inertia-locking feature of the retractor. Examination of the webbing and latch plate revealed evidence of historical wear. There was no crash-related evidence. Based on the observations of the inspection, it was determined that the driver was not restrained by the manual seat belt at the time of the crash.

Supplemental Restraint Systems

The Chevrolet was equipped with advanced frontal air bags for the driver and passenger. The driver's frontal air bag module was located in the center hub of the steering wheel, while the passenger's frontal air bag module was a top-mount design located in the right aspect of the instrument panel. Neither air bag deployed in the crash. During the inspection, the instrument panel was energized by rotating the ignition key to Run. It was noted that a "Service Air Bag" message was displayed in the driver's instrument cluster, and the air bag warning lamp was illuminated. It could not be determined if these warnings existed pre-crash, or if they were now displayed as a result of the crash.

Air Bag Non-Deployment Discussion

The frontal air bags did not deploy during the crash sequence for undetermined reasons. Based on SCI field experience, frontal air bag deployment is typically commanded during a front impact with an end terminal. An air bag deployment would also be expected given the severity of the deceleration generated during an impact equivalent to the concrete base/pole impacts of this sequence. However, multiple confounding factors and circumstances regarding the vehicle and air bag system existed in this particular crash.

The vehicle's GVWR was in excess of 4,536 kg (10,000 lb). The advanced air bag portion of FVMSS No. 208 did not apply, and the Chevrolet was not subject to the FMVSS No. 563 ruling. EDR crash data (if available) could not be imaged from the vehicle due to a communication error. The module was not recognized by the Bosch CDR tool. Absent the EDR data, it is not known if the crash was recognized by the air bag sensing system.

A product safety recall was issued for this vehicle on September 8, 2016. The remedy for the recall required a reprogramming of the SDM to eliminate a software defect in the crash sensing algorithm. However, warranty data indicated the Chevrolet was serviced for this recall on November 10, 2016, by a manufacturer dealership. This service was conducted 454 km (282 mi) prior to the crash.

During the SCI inspection, it was observed that an air bag service warning was illuminated on the driver's instrument cluster. However, it could not be determined if this warning was present prior to the crash or appeared as an artifact of the crash.

The Chevrolet struck the end terminal at the extreme left end of the bumper. The direct contact damage did not involve the frame rail. Additionally, the original bumper had been replaced with an (untested) aftermarket bumper. The combination of these factors, particularly the location of the impact and the stiffness properties of the bumper, may have affected the ability of the SDM to recognize the crash.

2015 CHEVROLET SILVERADO 3500 OCCUPANT DATA

Driver Demographics

Age/Sex:	50 years/male
Height:	Unknown (Not documented within records)
Weight:	Unknown (Not documented within records)
Eyewear:	Prescription glasses
Seat Type:	Forward-facing bucket seat with adjustable head restraint
Seat Track Position:	Mid track
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection
Air Bags:	Front air bag available, not deployed
Alcohol/Drug Involvement:	Unknown
Egress From Vehicle:	Removed by EMS due to perceived serious injury
Transport From Scene:	Ambulance to a Level 1 trauma center
Type of Medical Treatment:	None; pronounced dead on arrival

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence
1	Unsurvivable head injury, NFS	100999.9	Non-breakaway pole	Certain
2	Multiple rib fractures, NFS	450210.2	Left door panel	Probable
3	Crepitus of pelvis, NFS	856100.2	Left door panel	Probable
4	Multiple facial lacerations	210600.1	Non-breakaway pole	Certain
5	Lacerations on scalp	110600.1	Non-breakaway pole	Certain
6	Laceration on left ear	210600.1	Non-breakaway pole	Certain
7	Multiple lacerations bilateral arms	710600.1	Left instrument panel	Probable
8	Multiple abrasions bilateral arms	710202.1	Left instrument panel	Probable

Source – Emergency Room records, Medical Examiner summary

Driver Kinematics

The unbelted 50-year-old male was seated in an unknown posture with the driver seat adjusted to a mid-track position. He was operating the Chevrolet in the left lane of the roadway when the vehicle departed the left side of the road at a shallow angle estimated at less than 5 degrees.

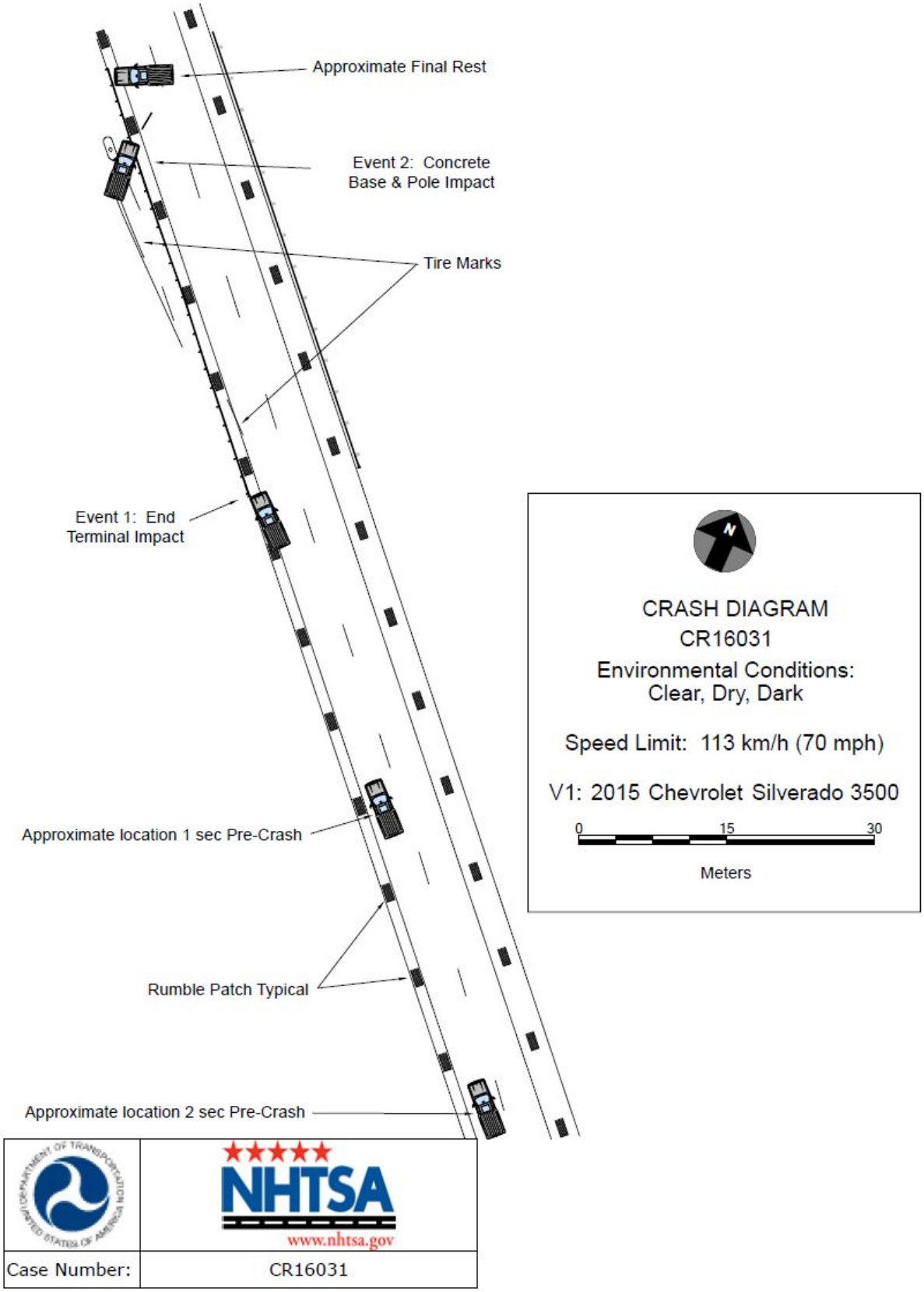
The front left corner of the Chevrolet struck the end terminal and subsequently overrode the deformed guardrail. The driver air bag was deployed. The driver responded to the 12 o'clock direction of this impact force with a forward trajectory. His lower extremities contacted the knee bolster, evidenced by scuffing to the left lower instrument panel. The driver's chest loaded the center hub of the steering wheel, and his upper extremities contacted the mid-aspect of the instrument panel. Although these contacts may have produced injuries, subsequent contacts of greater severity occurred.

As the Chevrolet traveled through the median, it initiated a clockwise rotation. The driver remained in a forward position and his trajectory was directed to the left as the vehicle decelerated. The left plane of the vehicle then struck the concrete base with its left front tire/wheel, the pole with the center aspect of the left plane, and the concrete base with the left rear tires/wheels. The glazing of the left windows disintegrated. The driver responded to the 10 o'clock direction of the impact forces with a left and forward trajectory. He loaded the intruding door panel with his left flank, resulting in the multiple rib and pelvic fractures. His head scuffed the left roof side rail and window frame as it became partially ejected through the left front glazing opening. The driver's partially ejected head contacted the pole, resulting in an unsurvivable closed-head injury.

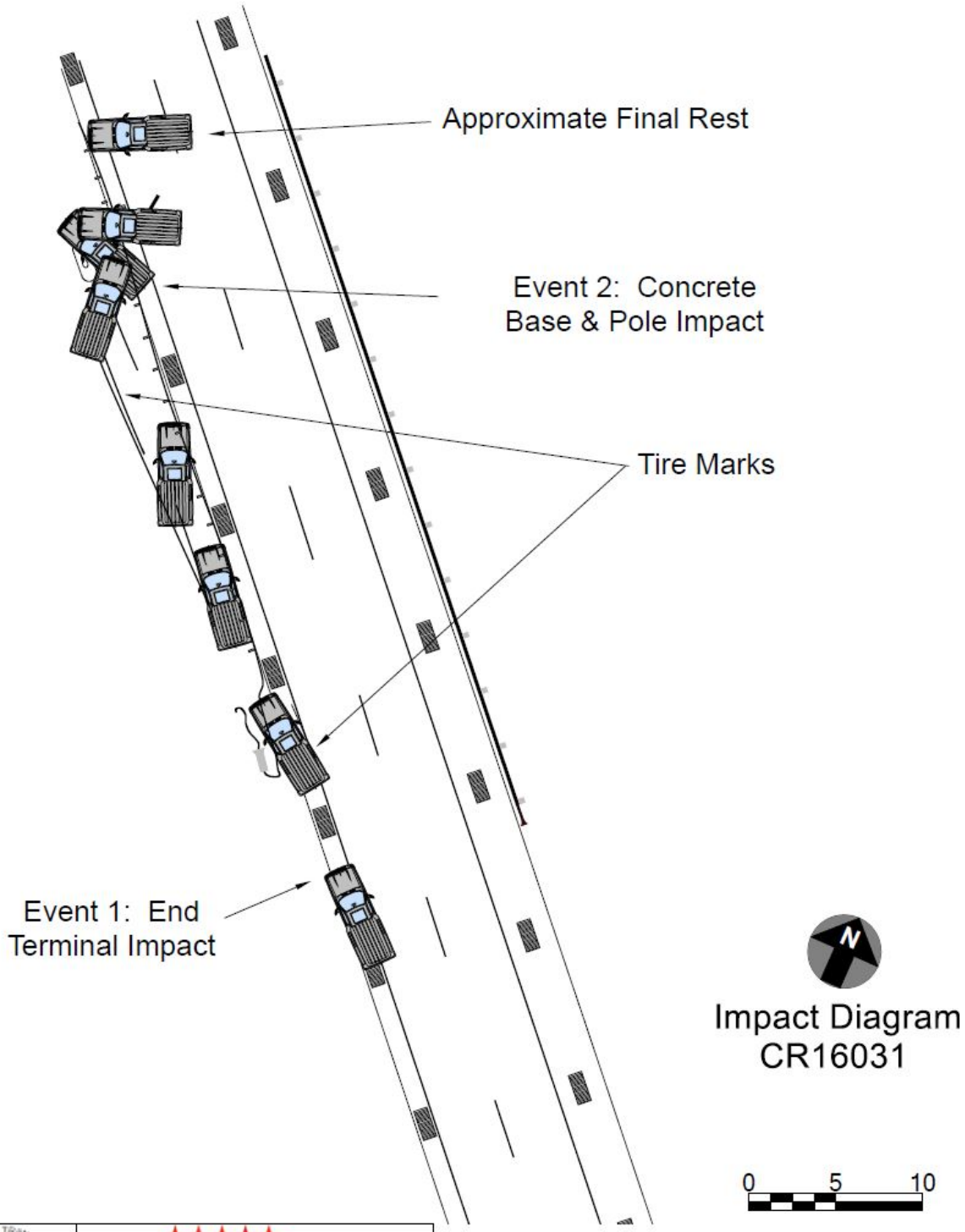
Engagement of the Chevrolet's left rear dually tires/wheels with the concrete base induced a rapid counterclockwise rotation to the vehicle. It again overrode the guardrail, before coming to rest in the roadway. The driver rebounded to his right, scuffing the roof side rail and head restraint with his head. His body contorted over the center console and he came to rest with his head lying on the front right seat (**Figure 20**). An area of dried blood on the seat cushion provided evidence of his final rest position. He was found to be unresponsive and in cardiac arrest upon the arrival of the police and EMS personnel. He was removed from the vehicle and transported by ambulance to a regional trauma center but pronounced deceased upon his arrival. Only a brief external survey of the driver's body was conducted; an autopsy was not performed.

Figure 20: Right interior view of the Chevrolet.

CRASH DIAGRAM

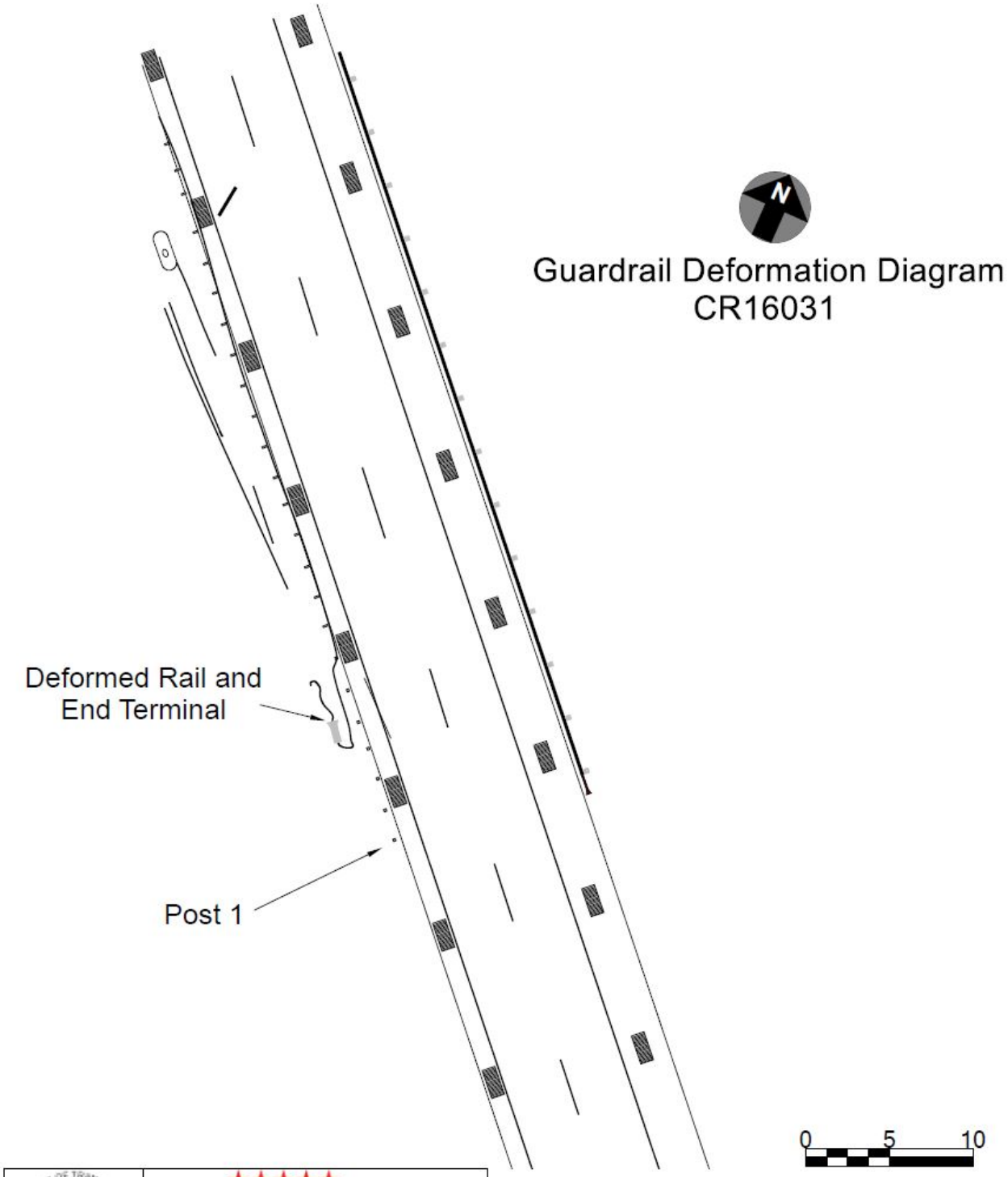


IMPACT DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	CR16031

POST-IMPACT GUARDRAIL DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	CR16031

Appendix A:
Federal Highway Administration Guardrail Forms

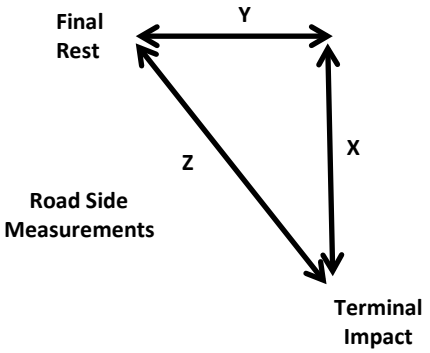
Case No.: CR16031

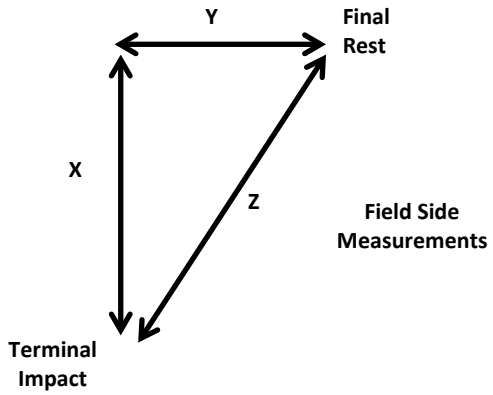
PREPOPULATED DATA (BY OTHERS)			
Crash Date	November 2016	**Time of Crash**	Overnight
Case Number	CR16031	**State**	Missouri
Traffic Route	Limited access roadway	**Direction (Southbound = SB)**	WB
Ambient Conditions (at time of crash)			
Temperature (°F)	48 °F	**Lighting**	Dark, not lighted
Atmospheric	Clear		

SCENE INFORMATION	
Type of area where crash occurred	☐Urban ☒Rural ☐Suburban
Terminal on a horizontal curve?	☒No ☐Curve/LT ☐Curve/RT
Estimated or Reconstructed Speed at Impact (mph)	70 mph
Est. distance (straight line) from terminal impact to COM final rest position (ft.)	Z = 136.3 ft ☒Road side ☐Field Side
Est. distance (longitudinal) along guardrail from terminal impact to COM final resting location (ft.)	X = 136 ft
Est. distance (normal) from either 1. the white paint line; or 2. roadway/shoulder/pavement edge to COM rest position (ft.)	Y = 8.3 ft
Super elevation	☐+2% ☐-2% ☒NONE or FLAT
Curve Radius (ft.)	N/A

KEY:

- COM - Center of Mass of Vehicle
- Distance Measurements





ON-SCENE INFORMATION		
End Treatment Type	☒Extruder	☐ET2000 ☒ET-PLUS 4in ☐ET-PLUS 5in ☐SKT ☐FLEAT ☐SOFT STOP
	☐Telescope	☐X-LITE ☐X-TENSION
Curb?	☒No ☐Yes	❒AASHTO Type A ❒AASHTO Type B ☐AASHTO Type C ☐AASHTO Type D ☐AASHTO Type E ❒AASHTO Type F ❒AASHTO Type G ☐AASHTO Type H
Curb Height: N/A		

GUARDRAIL INSTALLATION									
Post No.	**Post**		**Block-Out**		**PRE-Existing Damage**		**Offset to post or post hole (ft.)**		**Spacing to next post (ft. -in.)**
	Type	**Dim.**	**Type**	**Dim.**	**Yes No Unknown**	**Describe**	**Travel way**	**Curb**	
	Steel Wood Other	**D x W (in.) or Dia. (in.)**	**Steel Wood Composite**	**D x W (in.)**					
1	Wood	7.5 x 5.5	None	N/A	No	N/A	1 ft 2 in	N/A	6 ft 2 in
2	Wood	7.5 x 5.5	None	N/A	No	N/A	1 ft 1 in	N/A	6 ft 2 in
3	Wood	7.5 x 5.5	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 7 in	N/A	6 ft 4 in
4	Wood	7.5 x 5.5	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 7 in	N/A	6 ft 4 in

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type Steel Wood Other	Dim. D x W (in.) or Dia. (in.)	Type Steel Wood Composite	Dim. D x W (in.)	Yes No Unknown	Describe	Travel way	Curb	
5	Wood	7.5 x 5.5	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 7 in	N/A	6 ft 10 in
6	Wood	7.5 x 5.5	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 7 in	N/A	6 ft 4 in
7	Wood	7.5 x 5.5	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 6 in	N/A	6 ft 4 in
8	Steel	6 x 4	Composite	3.8 x 7.5 x 14	No	N/A	1 ft 6 in	N/A	6 ft 8 in
9	Steel	6 x 4	Composite	3.8 x 7.5 x 14	No	N/A	1 ft 4 in	N/A	6 ft 4 in
10	Steel	6 x 4	Composite	3.8 x 7.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 3 in
11	Steel	6 x 4	Composite	3.8 x 7.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 4 in

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
12	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 4 in
13	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 6 in
14	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 2 in
15	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 4 in
16	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 1 in	N/A	6 ft 4 in
17	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 4 in
18	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 4 in

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
19	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 3 in	N/A	6 ft 3 in
20	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 4 in	N/A	6 ft 4 in
21	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 6 in
22	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 1 in	N/A	6 ft 6 in
23	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 5 in
24	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 2 in	N/A	6 ft 7 in
25	Steel	6 x 4	Wood	7.5 x 5.5 x 14	No	N/A	1 ft 4 in	N/A	6 ft 3 in

Additional Comments:

NONE

Case No.: CR16031

EXTRUDER			
Feeder Channel Width at impact head	☒4 inches ☐5 inches ☐Other ___		
Guide Chute Exit Height (in.)	20 in		
Connection of feeder channels to head damaged?	☒No ☐Yes	Are Welds Broken?	☒No ☐Yes
Anchor Cable Present?	☐No ☒Yes	Connected?	☐No ☒Yes
Rail Extrusion?	☐No ☒Yes	Length (ft. in.)	12 ft
Rail Extrusion Direction	☐Traffic Side ☒Field Side		
Total Length of Rail Damaged (ft.) [total length would include extruded rail plus damaged rail downstream from head.]	149 ft (*entire system*)		

TELESCOPE				
Rail Displacement	❒No	❒Yes Length:	No of Panels Displaced	❒1 ❒2 ❒3 ❒4 ❒5 ❒6

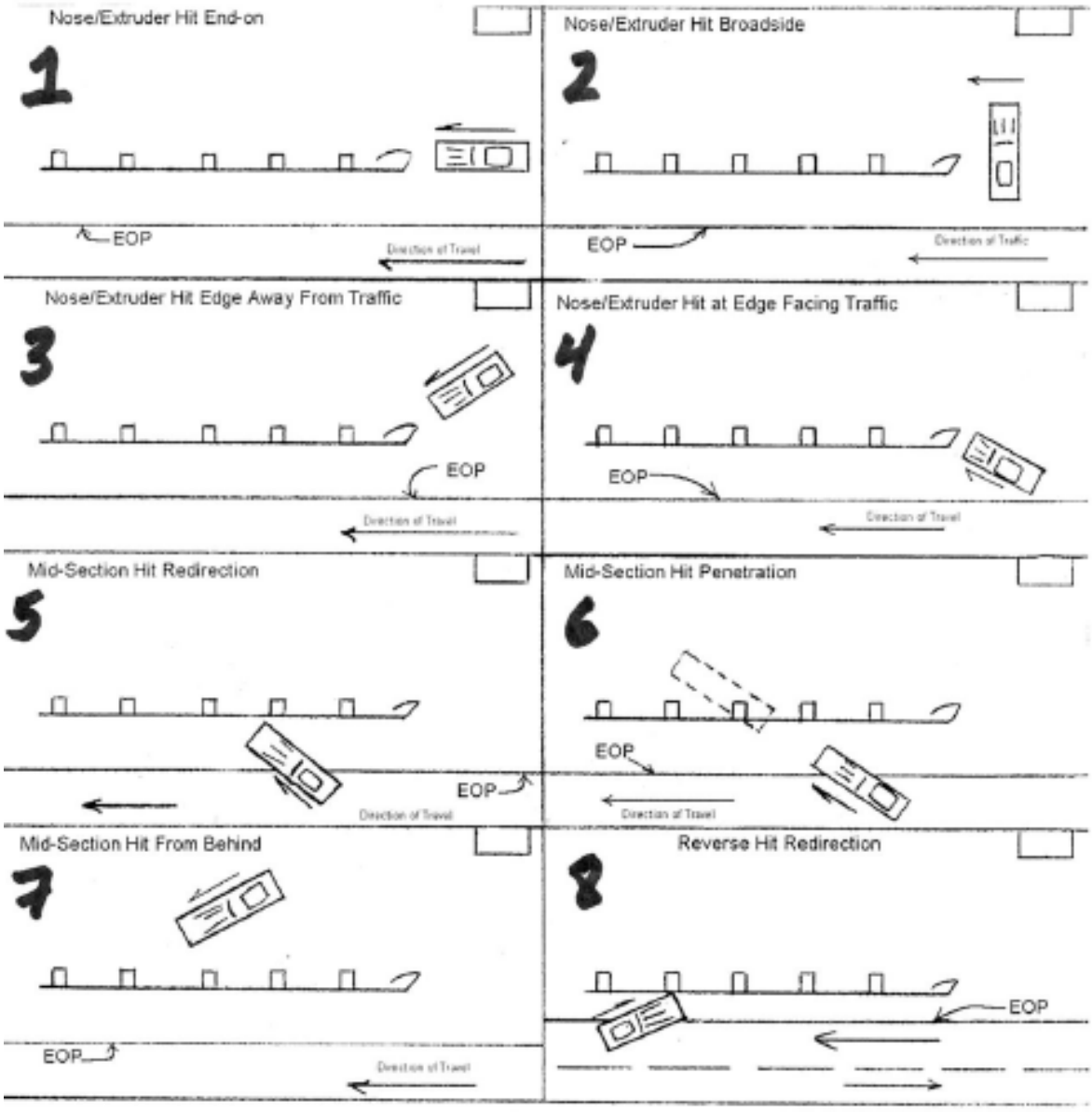
ALL-SYSTEM PERFORMANCE			
Railkinks Downstream of Head?	☒No	☐Yes	No. of Kinks in Rail: N/A
Was there intrusion into the Occupant Compartment by foreign object (guardrail)?	☒No ☐Yes		
Did vehicle impact other objects after impact with terminal?	☐No ☒Yes		
Object Contacted	Large highway sign post and concrete base		

ALL-SYSTEM PERFORMANCE ENVIRONMENT			
SIDESLOPE	**50 ft in advance of Post 1**	**At Post 1**	**50 ft Past Post 1**
Percent - %	8.5%	3.4%	13.1%
Adjacent Lane Width (ft)	11.8 ft		
Lane Type (NAS EDS Variable: Sur. Type)	Concrete		
Shoulder Type	Concrete with rumble strips		
Shoulder Width (ft)	3.0 ft		
Guardrail Height (in)	26.5 in (*top, measured at post 25*)		

Case No.: CR16031

VEHICLE INFORMATION		
Vehicle Type (NHTSA Input)	2015 Chevrolet Silverado 3500	
Vehicle Identification Number (VIN)	1GC4KYC89FFxxxxxx	
Vehicle Mass (NASS var.: veh.wgt)	6,695 lbs	
Vehicle orientation upon impact	☐ Case Type 1 ☐ Case Type 2 ☐ Case Type 3 ☒ Case Type 4 ☐ Case Type 5 ☐ Case Type 6 ☐ Case Type 7 ☐ Case Type 8 ☐ Other	
If 'Other', describe	N/A	
Collision Deformation Classification	12FDEW1, 10LDEW3	
Delta-V	10 mph (WinSMASH calculated)	
Occupant Compartment Penetration of rail	☒No	☐Yes; Describe:
Did the Vehicle Rollover?	☒Yes ☐No	
Quarter Turns (NASS EDS variable: Rollover)	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 ☐11 ☐12 ☐13 ☐14 ☐15 ☐16 ☐17+	
Object Precipitating Rollover, (NASS EDS variable: Rollobj)	N/A	
Rollover Type, Terhune Scale, (NASS EDS variable: rolintyp)	N/A	

Case No.: CR16031



Appendix B:
Aftermarket Bumper Installation Guide

Installation Instructions
'15 Chevy HD Black Steel Front Bumper
Product Number: S3060, S3061, S3062, Q3060, Q3061, Q3062
Application: '15 CHEVY HD

SAFETY

Your safety and the safety of others is very important.

- **In order to help you make informed decisions about safety, we have provided installation instructions and other information.**
- **These instructions alert you to potential hazards that could hurt you or others.**
- **Please do a job safety analysis (JSA) before each task to identify potential hazards for your situation and remove/protect against them.**
- **You must use your own good judgment, and take your time.**

Read and understand all safety precautions and instructions before installing this product.

THIS PRODUCT IS FOR OFFROAD USE ONLY. ALL LIABILITY FOR INSTALLATION AND USE RESTS WITH THE OWNER.

CARELESS INSTALLATION AND OPERATION CAN RESULT IN SERIOUS INJURY OR EQUIPMENT DAMAGE.

Injury hazard

Failure to observe these instructions could lead to severe injury or death.

- ❑ **Always remove jewelry and wear eye protection.**
- ❑ **Always use extreme caution when jacking up a vehicle for work. Set emergency brake and use tire blocks. Locate and use the vehicle manufacturers designated lifting points. Use jack stands.**
- ❑ **Always use appropriate and adequate care in lifting components into place.**
- ❑ **Always insure components will remain secure during installation and operation.**
- ❑ **Always wear safety glasses when installing this kit. A drilling operation will cause flying metal chips. Flying chips can cause serious eye injury.**
- ❑ **Always use extreme caution when drilling on a vehicle. Thoroughly inspect the area to be drilled (on both sides of material) prior to drilling, and relocate any objects that may be damaged.**
- ❑ **Always use extreme caution when cutting and trimming during fitting.**
- ❑ **Always tighten all nuts and bolts securely per installation instructions.**
- ❑ **Always route electrical cables carefully. Avoid moving parts, components that become hot and rough or sharp edges.**
- ❑ **Always insulate and protect all exposed wiring and electrical terminals.**
- ❑ **Always perform regular inspections and maintenance on mounts and related hardware.**

I. Overview

Congratulations on your new purchase of the industries' best and most stylish Front Bumper available for the 2015 Chevy Heavy Duty! This Bumper has been engineered for strength while keeping the weight down.

Your Front Bumper designed in 3-D from digitized data, CNC laser cut, fabricated, and powder coated… all in the U.S.A.

Enjoy the fit and finish of a quality CHEVY HD Front Bumper from FabFours Inc.

Parts List

- S306X replacement bumper
- S306X-HW fastener kit
- 20260 lower guard
- 20260-HW fastener kit
- 2x tow hooks
- Instruction Manual

Tools Required

- Socket Wrench with Extension (Ratcheting wrenches may also be convenient)
- 7mm , 15mm , 18mm, 19mm, 3/4 Sockets and Box End Wrenches
- Flat Head Screw Drivers
- Floor Jack and wood block.
- 9/16 drill bit w/ drill

II. Removal of OEM Bumper

Note: Save all OEM parts until installation is complete!

A. Open hood and locate push pins on radiator cover. Using a flat head screw driver, pull the head of the push pins up, remove push pin and lift radiator cover off. This will allow access to top Grille bolts (Ref. Figure 1).

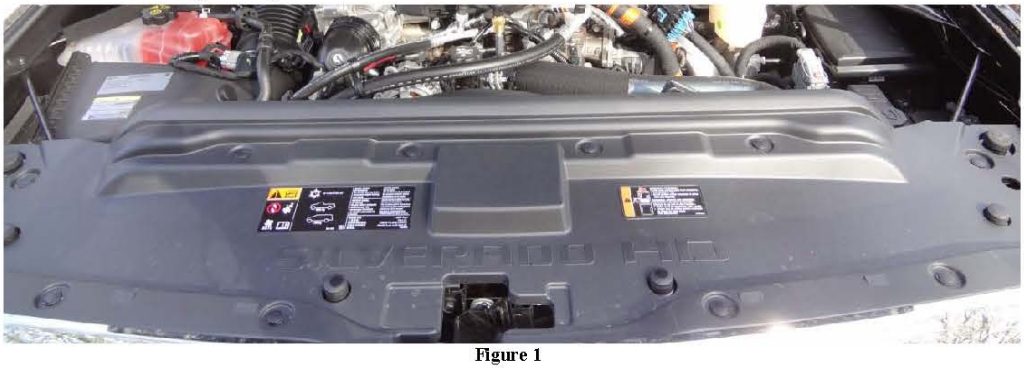


Figure 1

B. Remove the fasteners connecting the grille to the frame. Four bolts, are located at the top of the grille, two on each side (Ref. Figure 2a-b). Two bolts and two clips are located behind the grille and are indicated by the ovals and triangles respectively (Ref. Figure 2c).

Figure 2a

Figure 2b

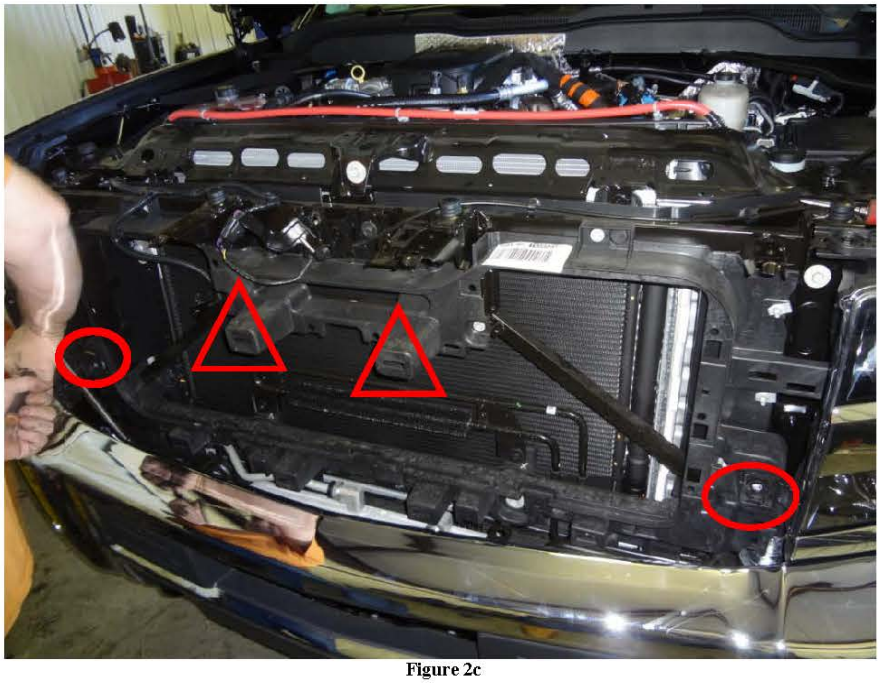


Figure 2c

C. Disconnect electrical harness (Ref. Figure 3a) from vehicle and remove tow hooks. Tow hooks are mounted with one cross bolt through the side and a bolt through the bottom of the frame (Ref. Figure 3b).

Figure 3a (ELECTRICAL HARNESS DISCONNECTED)

Figure 3b (TOW HOOK & OEM MOUNTING BRACKET)

D. Remove bolts connecting bumper to mounting bracket. There is one bolt on each side which requires a socket wrench with an extension to easily reach (Ref. Figure 4). Carefully Pull bumper away from vehicle.

Figure 4

E. Remove the fasteners connecting the OEM mounting bracket to the frame. Using a socket/wrench remove bolts from front of bracket connected to the bumper. Repeat process on each side of vehicle.

Figure 5

F. Remove OEM electrical harness from bumper. Disconnect harness from fog lights and sensors. Pop out the three plastic clips holding fog lights to fog light housing and carefully pull away, the plastic clips are indicated by a circle. Unbolt bumper support frames as necessary to more easily access sensors, start with the bottom bolts indicated by squares (Ref. Figure 6).

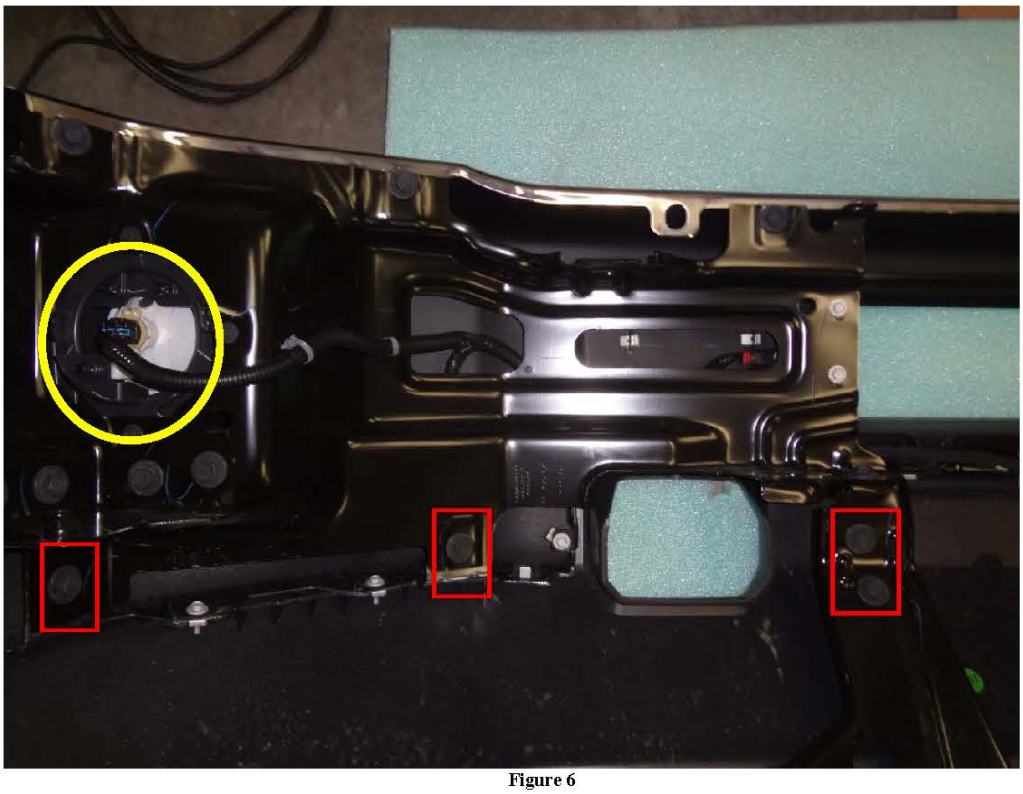


Figure 6

III. Pre-Installation

NOTE: The Following Installation steps apply to the installation of the Front Bumper. PLEASE READ THE ENTIRE MANUAL BEFORE ATEMPTING INSTALLATION! Ignoring these steps will increase your probability of scratching the vehicle during product

A. Remove the Bumper from the shipping carton. Lay all items out on a blanket to prevent damage to the powder coating.

B. Install the OEM fog lights onto the mounting brackets as shown below.

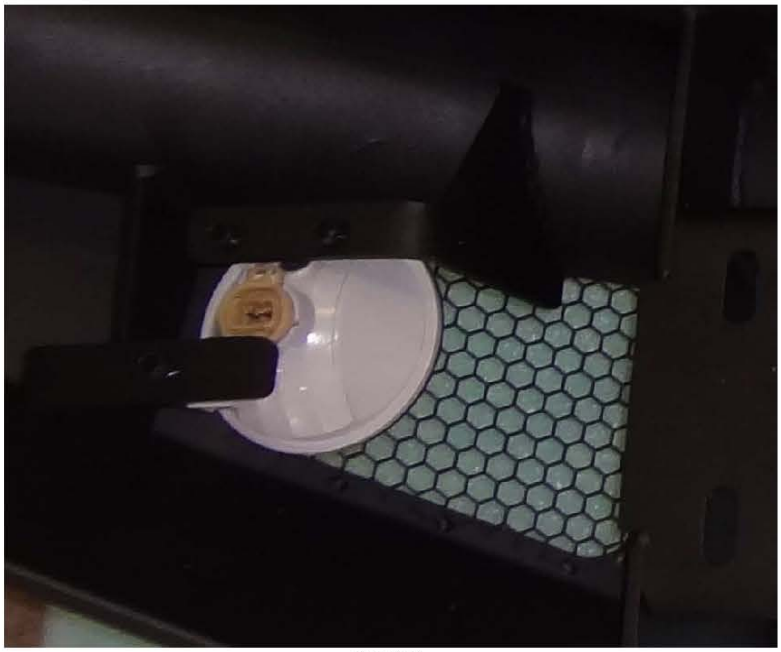


Figure 7

- Optional: If installing winch and roller fairlead into bumper, do it at this time. Follow the winch manufacturer's instructions for installation.

  If not installing a winch, the lower guard may be installed at this time.

IV. Front Bumper Installation

A. Mount bracket to truck frame. Two bolts pass through the side of the frame. One bolt passes through the bottom of the frame (Ref. 8a-b). Mount on both sides. If holes on the side of frame are out of tolerance then enlarge hole with 9/16 drill as needed on side of frame.

Figure 8a

Figure 8b

B. Mount bracket to bumper. With the help of at least two others, and possibly a floor jack, to support the center of the bumper, lift the Fab Fours bumper into place (Ref. 9a-c).

Figure 9a

Figure 9b

Figure 9c

C. Insert the bolts from the outside facing in and tighten (Ref. 9a-c). Do Not Fully Tighten, Hand Tighten Only!

D. Align the bumper side to side and top to bottom to ensure a perfect fit to the truck. Allow clearance to all painted surfaces, this is to allow for frame flex.

E. Fully tighten all fasteners between bumper and bracket.

F. Install the lower guard and tow hooks. Two bolts on each side for each item are required (Ref. 10a-b).

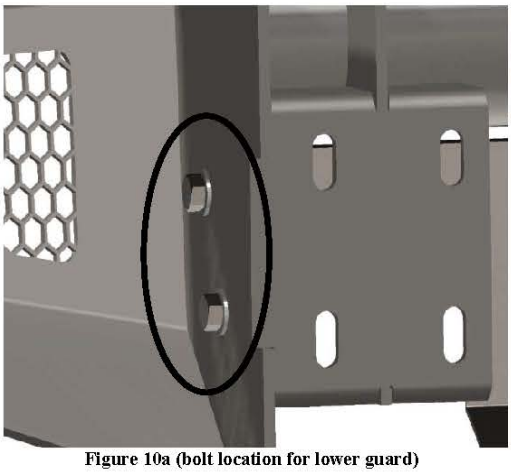


Figure 10a (bolt location for lower guard)

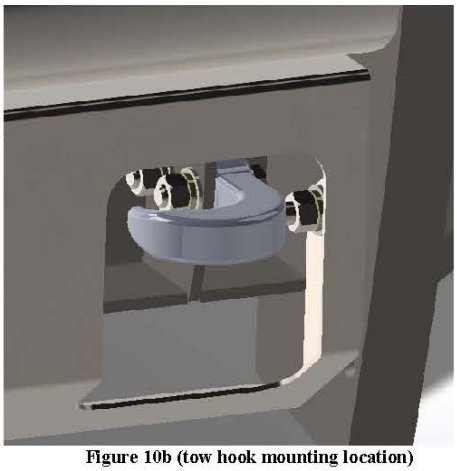


Figure 10b (tow hook mounting location)

G. The fog light may be connected at this time. To do so, connect OEM Harness back to OEM fog lights and secure excess wiring to bumper.

H. Enjoy your New Front Replacement Bumper from Fab Fours!

Maintenance/Care

- ❑ Periodically check and tighten all fasteners.
- ❑ Stripped, fractured, or bent bolts or nuts need to be replaced.
- ❑ After washing of the vehicle make sure to fully dry all surfaces

V. Contact Information

Fab Fours Inc.
1312 Camp Creek Rd
Lancaster, SC 29720

Phone (866)-385-1905
Fax (866)-574-1424
Email Support@fabfours.com

More than expected... Better than expected

DOT HS 812 685
May 2019

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14066-041019-v2