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Special Crash Investigations On-Site Guardrail End Terminal Investigation Vehicle: 2005 Chevrolet Uplander Location: Missouri Crash Date: December 2017

DISCLAIMER

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Technical Report Documentation Page

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12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration National Center for Statistics and Analysis (NSA-110) 1200 New Jersey Avenue SE Washington, DC 20590		**13. Type of Report and Period Covered** Technical Report Crash Date: December 2017 **14. Sponsoring Agency Code**	
15. Supplementary Notes Each crash represents a unique sequence of events, and 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.			
16. Abstract This report documents the on-site investigation of a minivan impact to an ET-Plus (4.0 in. model) guardrail end terminal that is of interest to the Federal Highway Administration (FHWA). This crash occurred on the east side of the northeast-bound lanes of a four-lane, divided interstate highway. The Chevrolet was a 4-door minivan equipped with dual stage frontal air bags and an event data recorder (EDR). A belted 30-year-old female drove the vehicle. The Chevrolet was traveling northeast in the right through lane. The vehicle departed the right side of the roadway and the front plane struck the guardrail end terminal (Event 1) resulting in a stage-two deployment of the driver's frontal air bag. The vehicle then rolled over, right side leading, (Event 2) and sustained three additional impacts with the guardrail during the rollover (Events 3 to 5). The vehicle came to final rest on its top plane heading northeast. The driver sustained police-reported "B" (non-capacitating) injuries and was transported by ambulance to a hospital for treatment of unknown injuries. The Chevrolet was towed from the crash site due to damage.			
17. Key Words ET-Plus, guardrail end terminal, rollover, motor vehicle traffic crash, police-reported "B" (non-incapacitating) injury		**18. Distribution Statement** Document is available to the public from the National Technical Information Service, www.ntis.gov.	
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On-Site Guardrail End Terminal Investigation
Case Number: IN17036
Vehicle: 2005 Chevrolet Uplander
Location: Missouri
Crash Date: December 2017

BACKGROUND

This report documents the on-site investigation of a minivan impact to an ET-Plus [10.2 cm (4.0 in. model)] guardrail end treatment (**Figure 1**) that is of interest to the Federal Highway Administration (FHWA). This crash was identified by an engineer with the Missouri Department of Transportation (MoDOT), who submitted photographs of the damaged guardrail end treatment and vehicle to the FHWA. The FHWA determined that the guardrail end treatment and crash type were of interest. This crash investigation was then initiated by the National Highway Traffic Safety Administration in December 2017 and assigned to the Special Crash Investigation team at the Indiana University Transportation Research Center. This single vehicle crash involved a 2005 Chevrolet Uplander (**Figure 2**). The crash occurred in Missouri in December 2017 during dark, morning hours and was investigated by a local police agency. The crash site, guardrail, and vehicle were inspected in December 2017.

Figure 1. The damaged ET-Plus and guardrail.

Figure 2. The damaged 2005 Chevrolet Uplander.

This crash occurred on the east side of the northeast-bound lanes of a four-lane, divided interstate highway. The Chevrolet was a 4-door minivan equipped with dual stage frontal air bags and an event data recorder (EDR). A belted 30-year-old female was driving the vehicle northeast in the right through lane. The vehicle departed the right side of the roadway and the front plane struck the guardrail end terminal (Event 1), resulting in a stage-two deployment of the driver's frontal air bag. The vehicle then rolled over, right side leading, (Event 2) and sustained three additional impacts with the guardrail during the rollover (Events 3 to 5). The vehicle came to final rest on its top plane heading northeast. The driver sustained police-reported "B" (non-capacitating) injuries and was transported by ambulance to a hospital for treatment of unknown injuries. The Chevrolet was towed from the crash site due to damage.

SUMMARY

Crash Site

This crash occurred during dark morning hours on the east side of the northeast- bound lanes of a four-lane, divided interstate highway. The weather conditions were clear, calm wind, a temperature of 2.8 °C (37 °F), and a dew point of -4.4 °C (24 °F), according to local weather reports. The interstate traversed in a northeast/southwest direction and had two bituminous through lanes in each direction that were divided by a grass median. The roadway was curved to the right for northeast-bound traffic and the calculated radius of curvature was 367.2 m (1,204.4 ft). The northeast-bound roadway was bordered by a 1.5 m (4.9 ft) wide bituminous median shoulder with a rumble strip and a 2.6 m (8.5 ft) wide concrete right shoulder with a rumble strip. The right northeast-bound lane was 3.8 m (12.5 ft) wide and the left northeast-bound lane was 3.7 m (12.1 ft) wide. A blocked-out W-beam guardrail equipped with an ET-Plus (4 in. model) end terminal was located on the right side of the road adjacent to the shoulder. The roadway pavement markings consisted of a solid white edge line, broken white center line and solid yellow median line. The speed limit was 113 km/h (70 mph). The crash diagram is included at the end of this report.

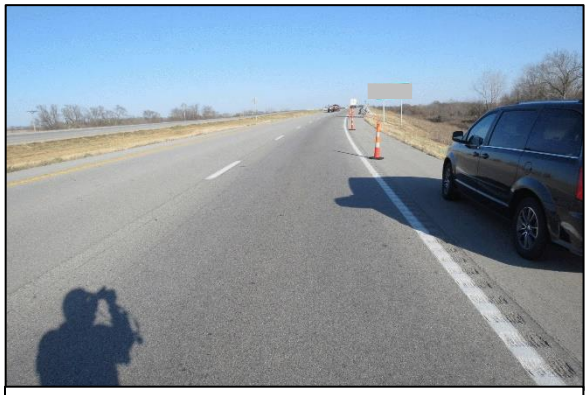


Figure 3. Northeast-bound approach of the Chevrolet.

Figure 4. Damage to the front plane of the Chevrolet.

Pre-Crash

The Chevrolet was traveling northeast in the right lane (**Figure 3**) at an EDR-reported speed of 137 km/h (85 mph) from -5.0 to -2.0 sec prior to algorithm enable (AE) slowing slightly to 134 km/h (83 mph) at -1.0 sec, which was the end of the pre-crash reporting. The brake switch circuit was reported as "Off" for the entire 5 sec of pre- crash reporting. The vehicle departed the right side of the lane onto the shoulder approximately 72 m (236 ft) prior to impact with the end terminal. The police crash report provided no information regarding the reason for the roadway departure.

Crash

The left portion of the vehicle's front plane (**Figure 4**) struck the end terminal (**Figure 5**, event 1) extruding 7.4 m (24.3 ft) of guardrail to the field side. The impact speed of the vehicle was estimated to be 129 km/h (80 mph).[1] The force direction on the Chevrolet was in the 12 o'clock

[1] Based on the EDR-reported speed of 134 km/h (83 mph) at -1.0 sec prior to AE and assuming no braking from 1.0 sec to AE, and deducting a calculated 5 km/h (3 mph) speed loss during that time due to rolling resistance.

sector and the impact resulted in a stage-two deployment of the driver's frontal air bag. The vehicle's EDR reported the maximum longitudinal velocity change as -11.38 km/h (-7.07 mph). No lateral velocity change was reported. WinSMASH could not be used to calculate delta V since an impact with a yielding object is out of scope for the program. However, WinSMASH was used to calculate a barrier equivalent speed (BES) of 26 km/h (16 mph) based on the crush to the front bumper.

The vehicle began to rotate counterclockwise from the impact as the guardrail deformed and rolled over (Event 2), right side leading, onto the guardrail. The right, top, and left planes were damaged by contact with the guardrail (Event 3 - 5). The vehicle then separated from the guardrail and came to final rest on its top plane on the field side of the guardrail heading northeast after rolling over an estimated six quarter turns across approximately 16 m (53 ft).

Figure 5. The face of damaged ET-Plus.

Post-Crash

The police were notified of the crash and arrived on scene 30 minutes later. The driver sustained police-reported "B" (non-incapacitating) injuries and was transported by ambulance to a hospital. The Chevrolet was towed from the crash site due to damage.

Figure 6. Kinks in the damaged guardrail.

END TERMINAL AND GUARDRAIL DAMAGE

The front plane impact of the Chevrolet to the end terminal extruded 7.4 m (24.3 ft) of guardrail to the field side and damaged 21.0 m (68.9.0 ft) of guardrail and 10 posts. The direct damage involved the full height and width [71 cm (28.0 in) and 38 cm (15.0 in)] of the face of the end terminal. All the posts were constructed of steel. Posts 1 and 2 were not equipped with offset blocks. The remaining posts had composite offset blocks. Post 1 was rotated about the pivot bolt downstream to the ground. Posts 2, 3, 4, and 6 were bent downstream to the ground. Posts 5, 7, and 9 were bent downstream approximately 85, 75, and 40 degrees off vertical, respectively. Posts 9 and 10 were bent downstream approximately 10 and 25 degrees off vertical, respectively. The offset blocks were separated from posts 3 – 5 and 8. The guardrail was separated from posts 1 – 8. The guardrail was kinked

in four locations (**Figures 6**) with one kink located at the entrance to the feeder channel. The width of the feeder channel was 10.2 cm (4.0 in) and the guide chute exit height was 38.1 cm (15.0 in). The connection of the feeder channel to the head was not damaged and no welds were broken. The anchor cable was present but was disconnected from its anchor. The height of the undamaged guardrail was 44.5 cm (17.5 in). The FHWA guardrail form is attached to the end of this report as **Appendix A**.

2005 CHEVROLET UPLANDER

Description

The Chevrolet was a front-wheel-drive, 7-passenger, 4-door minivan with the VIN 1GNDV33L35Dxxxxxx. The vehicle was equipped with a 3.5-liter, V-6 engine, 4-speed automatic transmission, 4-wheel antilock brakes with electronic brake force distribution, and a tilt steering column that was adjusted between the full-up and center positions. The vehicle was also equipped with multi-stage frontal air bags and an EDR. The specified wheelbase was 307 cm (120.9 in).

The vehicle manufacturer's recommended tire size was P225/60R17. The vehicle was equipped with Nexen Aria AH7 tires of the recommended size on the left front, left rear, and right front wheels. The right rear wheel was displaced from the vehicle and not present at the SCI vehicle inspection. The manufacturer's recommended cold tire pressure for the front and rear tires was 241 kPa (35 psi).

The front and second rows were equipped with leather-covered bucket seats with adjustable head restraints. The third row was equipped with a leather-covered bench seat with folding backs and adjustable head restraints in the outboard seating positions. The driver's seat track was adjusted between the middle and rear-most positions. The recline position of the seatback at the time of the crash is not known. The remaining seating positions were not occupied at the time of the crash.

Exterior Damage

Exterior Damage Event 1

The Chevrolet sustained damage to the front plane during the impact with the end terminal and guardrail. The direct damage from the end terminal began 5 cm right of the left end of the bumper reinforcement and extended 39 cm (15.4 in) to the right. As the guardrail was deformed by the impact, it contacted the remaining portion of the front bumper resulting in a total length of the direct damage of 154 cm (60.6 in). The direct damage also involved both headlamp/turn signal assemblies, grille, and hood. The Field L was 120 cm (47.2 in). Crush measurements were taken at the bumper level and the maximum residual crush was 25 cm (9.8 in) occurring 15 cm (5.9 in) left of the vehicle's centerline. The bumper bar was displaced from the vehicle during the crash and was taped back in place on the ends of frame members the crush measurements. The crush values were C_1 = 19 cm, (7.5 in), C_2 = 21 cm (8.3 in), C_3 =25 cm (9.8 in), C_4 = 21 cm (8.3 in), C_5 = 15 cm (5.9 in), and C_6 = 0 cm.

Damage Classification Event 1

The Collision Deformation Classifications (CDC) was 12FDEW2 (0 degree). The severity of the damage was moderate.

Exterior Damage Event 2 – 5
The vehicle sustained damaged to the top, left, and back planes during the rollover (Event 2). The direct damage to the top plane extended from the front of the hood to the rear of the roof. The direct damage also involved the full width of the roof, 166 cm (45.7 in). The maximum vertical and lateral crush was 28 cm (11.0 in) and 8 cm (3.1 in), respectively occurring at the right roof side rail between the C- and D-pillars. The direct damage to the left plane involved the sill, lower portion of both doors, roof side rail, and quarter panel. The damage to the back plane involved the back hatch. Abrasions on the right portion of the back hatch indicated it contacted the pavement surface, suggesting an end over component to the rollover. The right, top, and left planes also sustained damage from contact with the guardrail during the rollover (Events 3 - 5). These damages were treated as separated events based on CDC coding rules for contact with man-made structures during a rollover.

Damage Classification Event 2 – 5
The CDC for the rollover (Event 2) was 00TDDO4. The severity of the damage was severe based on the extent of the roof crush. The CDCs for the guardrail contact to the right, top, and left planes during the rollover (Events 3 to 5) were 00RZAW2, 00TZDW2, and 00LBAW2.

Event Data Recorder
The Chevrolet's EDR was imaged with version 17.5.1 of the Bosch Crash Data Retrieval software and reported with version 19.3 The vehicle was without power and the data was imaged via direct connection to air bag control module. The EDR reported a deployment event and a non-deployment event. Both events were recorded on the same ignition cycle indicating that the non-deployment event was related to this crash. The ignition cycles at the time of the crash and when the data were imaged were 27,624 and 27,627, respectively. The EDR report is attached at the end of this report as **Appendix B**.

Deployment Event: This event was recorded when the front plane struck the end terminal. The driver's safety belt switch circuit status was reported as "Buckled" and the supplemental inflatable restraint (SIR) warning lamp status was reported as "Off." The time from AE to deployment command criteria being met for both stages of the driver's frontal air was reported as 32.5 msec. The maximum longitudinal velocity change was reported as -11.27 km/h (-7.07 mph) occurring 127.5 msec following AE.

Non-Deployment Event: The time between the non-deployment event and the deployment event was reported as 0.1 sec. The maximum longitudinal velocity change was reported as -0.17 km/h (-0.11 mph) occurring 47.5 msec following AE.

Interior Damage
The interior of the Chevrolet sustained moderate damage from intrusion. The most severe intrusions into the driver's seating position involved the roof and left B-pillar, which intruded vertically 10 and 9 cm (3.9 and 3.5 in), respectively. Evidence of occupant contact consisted of a scuff on the lower left instrument panel from contact by the driver's right knee. The driver's head contacted the left front D-ring assembly as evidenced by the displacement of the mounting bolt cover and blood and hair transfer on the D-ring assembly. Blood transfer on the roof above the left front D-ring assembly indicated the driver's head also contacted the roof. There was an

area of light scuffing on lower portion of the frontal air bag indicating possible contact by the driver's abdomen. All the doors were jammed shut during the crash sequence.

Manual Restraint Systems
The front, second, and third row seating positions were equipped with lap and shoulder safety belts with sliding latch plates. The front row safety belts had adjustable upper anchors, while the second and third row safety belts had fixed upper anchors. The driver was restrained by the lap and shoulder safety belt as evidenced by a 5 cm (2.0 in) long scuff mark on the belt webbing from the D-ring. The EDR also reported the driver's safety belt switch circuit status as "Buckled."

Supplemental Restraint Systems
The Chevrolet was equipped with multi-stage frontal air bags. The driver's frontal air bag deployed during the impact with the guardrail head. There was an area of light scuffing on lower portion of the frontal air bag indicating possible contact by the driver's abdomen.

2005 CHEVROLET UPLANDER OCCUPANT

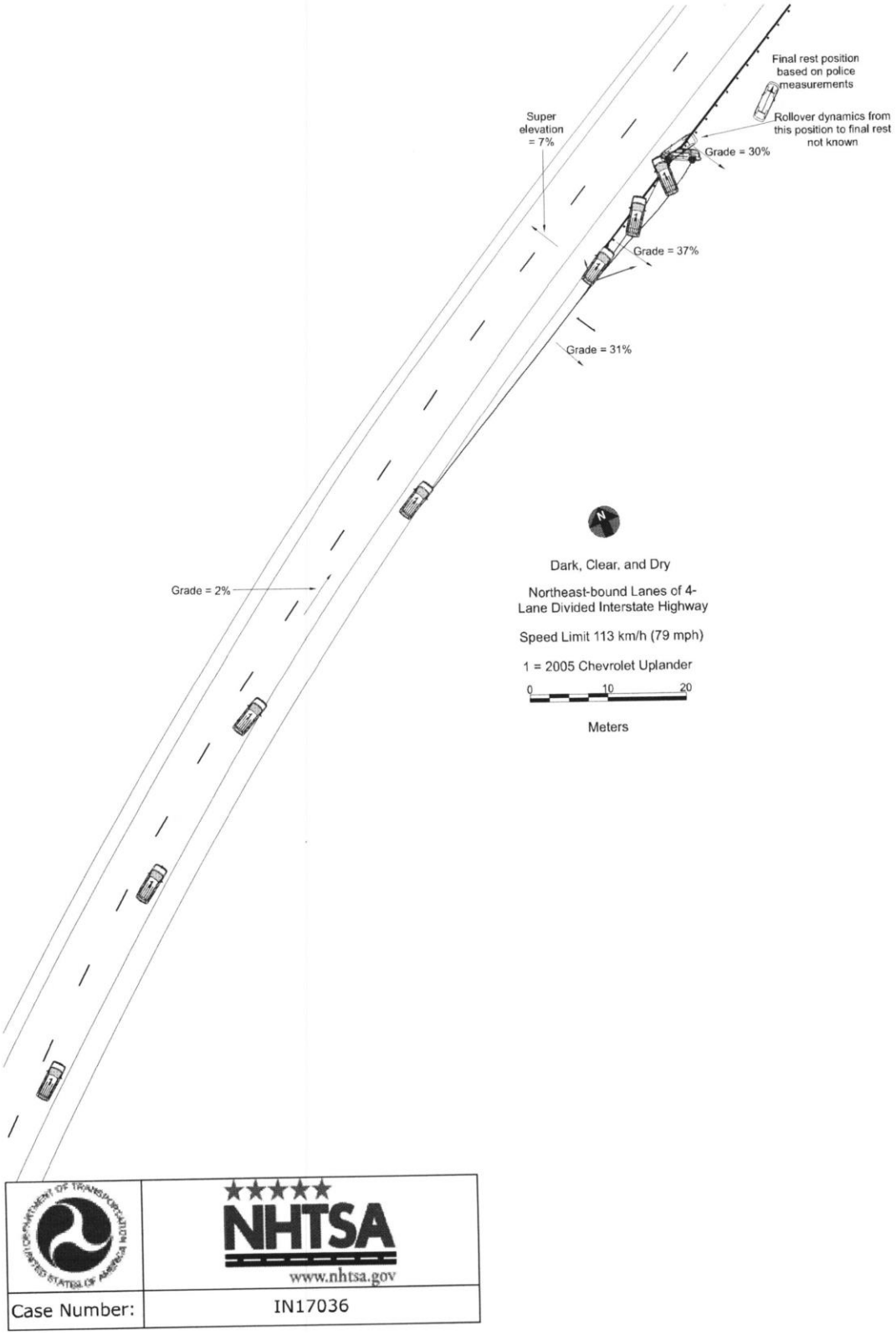
Driver Demographics

Age/sex:	30 years/female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Bucket
Seat track position:	Between middle and rear-most
Manual restraint usage:	Lap and shoulder safety belt
Usage source:	Vehicle inspection and EDR
Air bags:	Frontal, deployed
Alcohol/drug data:	None
Egress from vehicle:	Unknown
Transport from scene:	Ambulance
Medical treatment:	Unknown

Driver Injuries
No injury information was available for the driver.

Driver Kinematics
The driver was restrained by a lap and shoulder safety belt. Her seat track was adjusted between the middle and rear-most positions. The recline adjustment of the seatback is not known. The front plane impact with the end terminal resulted in a stage two deployment of the driver's frontal air bag. The driver was displaced forward and loaded the safety belt. Her chest and possibly her lower abdomen contacted the frontal air bag while her right knee contacted the lower left instrument panel. The driver was redirected in multiple directions during the rollover and she contacted her head on the left front D-ring assembly. She also contacted her head on the roof above the D-ring assembly. The driver sustained police-reported "B" (non-incapacitating) injuries and was transported by ambulance to a hospital. The driver's injuries and treatment status are not known.

CRASH DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	IN17036

APPENDIX A: FHWA Guardrail Form

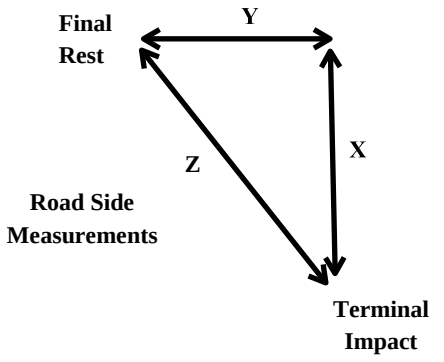
Case No.: IN17036

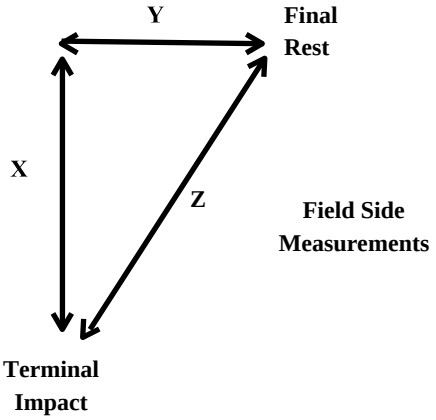
PREPOPULATED DATA (BY OTHERS)			
Date of Crash	December 2017	**TIME OF CRASH (MILITARY)**	Morning
Case Number	IN17036	**State**	Missouri
Traffic Route	Interstate	**Direction (Southbound = SB)**	NB
Ambient Conditions (at time of crash)			
Temperature (°F)	37	**Lighting**	Dark
Atmospheric	Clear		

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)	80 mph
Est. distance (straight line) from terminal impact to COM final rest position (ft.)	Z = 93 ft
Est. distance (longitudinal) along guardrail from terminal impact to COM final resting location (ft.)	X = 90 ft
Est. distance (normal) from either 1. the white paint line; or 2. roadway/shoulder/pavement edge to COM rest position (ft.)	Y = 27 ft
Super elevation	☒+2% ❒-2% ❒ NONE or FLAT
Curve Radius (ft.)	1,204.4

KEY:

- COM - Center of Mass of Vehicle
- Distance Measurements





Case No.: IN17036

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:		

GUARDRAIL INSTALLATION

Post No.	Post		Offset Block		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.)					
0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	Steel	6x4	N/A	N/A	Unk		9.8	N/A	6’3”
2	Steel	6x4	N/A	N/A	Unk		9.7	N/A	6’2”

Case No.: IN17036

Post No.	Post		Offset Block		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.)					
3	Steel	6x4	Composite	Unk	Unk		10.2	N/A	6’5”
4	Steel	6x4	Composite	Unk	Unk		10.0	N/A	6’1”
5	Steel	6x4	Composite	Unk	Unk		10.1	N/A	6’3”
6	Steel	6x4	Composite	7.5x4	Unk		10.1	N/A	6’1”
7	Steel	6x4	Composite	7.5x4	Unk		10.1	N/A	6’1”
8	Steel	6x4	Unk	Unk	Unk		9.8	N/A	6’0”

Case No.: IN17036

Post No.	Post		Offset Block		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.)					
9	Steel	6x4	Composite	7.5x4	Unk		9.8	N/A	6’2”
10	Steel	6x4	Composite	7.5x4	Unk		9.9	N/A	6’1”
11	Steel	6x4	Composite	7.5x4	No		9.8	N/A	6’3”
12	Steel	6x4	Composite	7.5x4	No		9.8	N/A	6’3”

Additional Comments:

Case No.: IN17036

EXTRUDER			
Feeder Channel Width at impact head	☒4inches ❒5 inches ❒Other _____		
Guide Chute Exit Height (in.)	15		
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.)	24'5"
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.]	68.9		

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: 4
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	Ground		

ALL-SYSTEM PERFORMANCE ENVIRONMENT			
SIDESLOPE	**50 ft in Advance of Post 1**	**At Post 1**	**50 ft Past Post 1**
Percent - %	31	37	30
Adjacent Lane Width (ft)	12.1		
Lane Type (NAS EDS Variable: Sur. Type)	Bituminous		
Shoulder Type	Bituminous		

Case No.: IN17036

Shoulder Width (ft)	8.5
Guardrail Height (in)	17.5

VEHICLE INFORMATION		
Vehicle Type (NHTSA Input)	Minivan	
Vehicle Identification Number (VIN)	1GNDV33L35Dxxxxxx	
Vehicle Mass (NASS var.: veh.wgt)	3,904	
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		
Collision Deformation Classification	12FDEW2	
Delta V	7.07 mph (EDR)	
Occupant Compartment Penetration of rail	☒ No	❒ Yes; Describe:
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)	Ground	
Rollover Type, Terhune Scale, (NASS EDS variable: rolintyp)	Trip-over	

APPENDIX B: 2005 Chevrolet Uplander Event Data Recorder (EDR) Report[2]

[2] The EDR report contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1GNDV33L35D******
User	
Case Number	
EDR Data Imaging Date	12/15/2017
Crash Date	
Filename	201850S217036_V1_ACM.CDRX
Saved on	Friday, December 15 2017 at 10:58:41
Imaged with CDR version	Crash Data Retrieval Tool 17.5.1
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 19.3
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Deployment Non-Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of Recorded Crash Events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event may be overwritten by another Non-Deployment Event. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as a Deployment Level Event, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds before a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.

The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Longitudinal Velocity Change reflects the change in longitudinal velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Longitudinal Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM will record 100 milliseconds of data after Deployment criteria is met and up to 50 milliseconds before Deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 150 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:

- -Significant changes in the tire's rolling radius
- -Final drive axle ratio changes
- -Wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.

-Pre-Crash data is recorded asynchronously. The 1.0 second Pre-crash data value (most recent recorded data point) is the data point last sampled before AE. That is to say, the last data point may have been captured just before AE but no more than 1.0 second before AE. All subsequent Pre-crash data values are referenced from this data point.

-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:

- -The SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -No data is received from the module sending the pre-crash data

-No module present to send the pre-crash data
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-The Time between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted by either the ABS module or the PCM, via the vehicle's communication network, to the SDM. Depending on vehicle option content, the Brake Switch Circuit Status data may not be available.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.

Hexadecimal Data:
Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR tool.

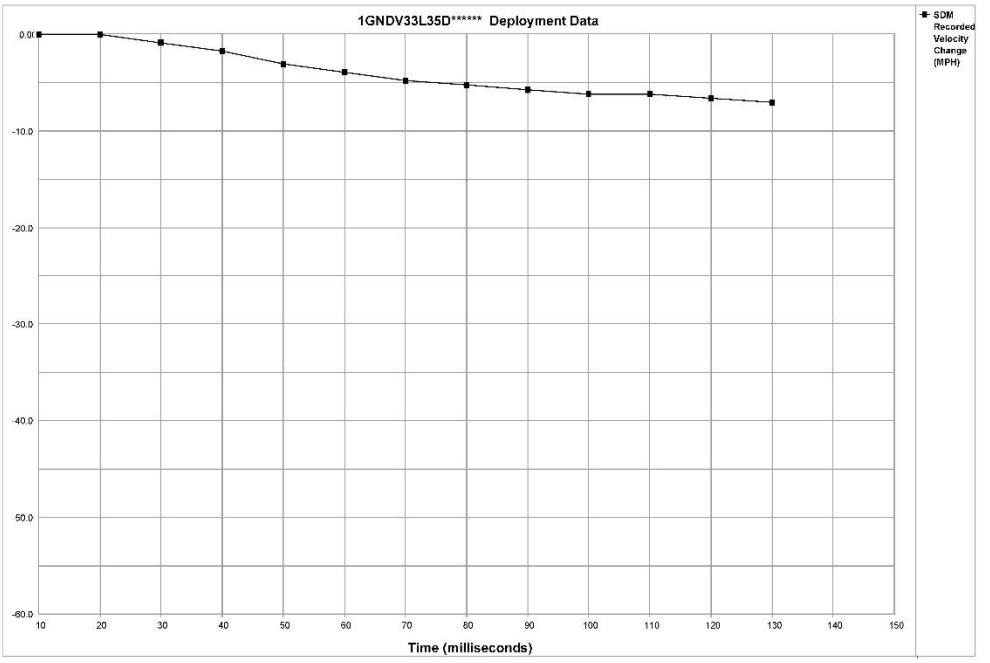
01014_SDMDW_r004

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Belt Switch Circuit Status (If Equipped)	UNBUCKLED
Driver Seat Position Status (If Equipped)	Rearward
Passenger Seat Position Status (If Equipped)	Rearward
Ignition Cycles At Deployment	27624
Ignition Cycles At Investigation	27627
Maximum SDM Recorded Velocity Change (MPH)	-7.07
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	127.5
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	32.5
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	32.5
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	32.5
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Time Between this Event and the Previous Event (sec)	0.1
AOS Status at Event Enable (If Equipped)	Suppressed
Event Recording Complete	Yes

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	85	2432	0
-4	85	2432	0
-3	85	2432	0
-2	85	2432	0
-1	83	2496	0

Seconds Before AE	Brake Switch Circuit State
-8	OFF
-7	OFF
-6	OFF
-5	OFF
-4	OFF
-3	OFF
-2	OFF
-1	OFF



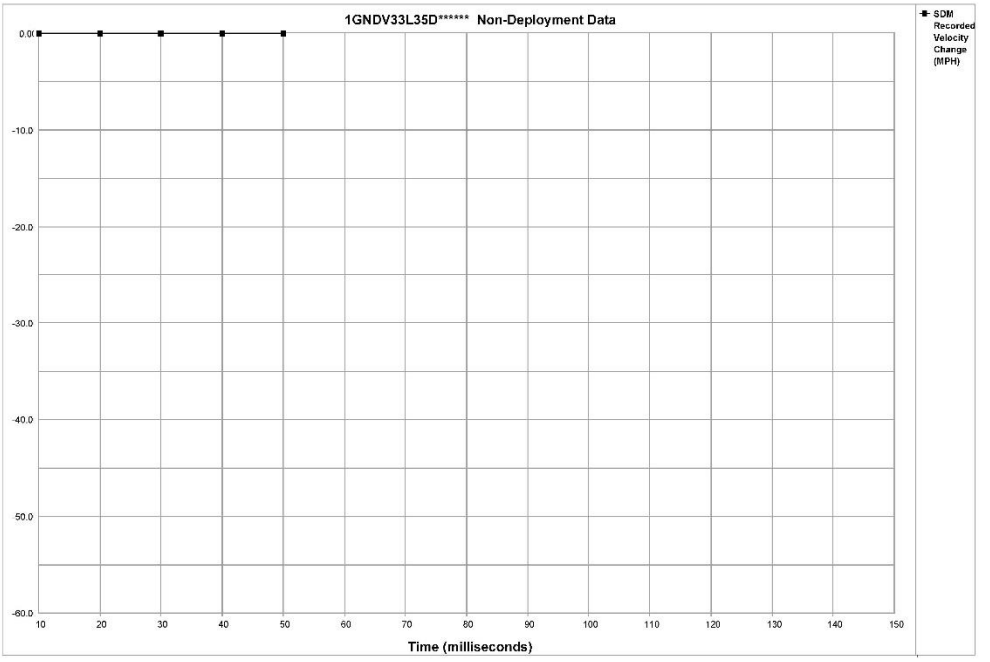
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	-0.88	-1.76	-3.07	-3.95	-4.83	-5.27	-5.70	-6.14	-6.14	-6.58	-7.02	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Belt Switch Circuit Status (If Equipped)	UNBUCKLED
Driver Seat Position Status (If Equipped)	Rearward
Passenger Seat Position Status (If Equipped)	Rearward
Ignition Cycles At Non-Deployment	27624
Ignition Cycles At Investigation	27627
Maximum SDM Recorded Velocity Change (MPH)	-0.11
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	47.5
Time Between this Event and the Previous Event (sec)	0.1
Event Recording Complete	Yes

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	85	2432	0
-4	85	2432	0
-3	85	2432	0
-2	85	2432	0
-1	83	2496	0

Seconds Before AE	Brake Switch Circuit State
-8	OFF
-7	OFF
-6	OFF
-5	OFF
-4	OFF
-3	OFF
-2	OFF
-1	OFF



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	0.00	0.00	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Hexadecimal Data

```
$01  A0 3B 63 63 00 00
$02  C3 DE 00 00 00 00
$03  41 53 35 30 35 33
$04  4B 35 36 58 4D 33
$05  02 41 4F 4F 4A 00
$06  15 19 32 70 00 00
$10  F2 82 F8 00 00 00
$11  8B 7C 7C 00 00 80
$12  68 00 00 00 00 00
$13  0F 00 00 00 00 00
$14  FF 55 ED 85 55 00
$18  80 7F 81 81 80 81
$1C  FA FA FA FA FA FA
$1D  FA FA FA FA FA FA
$1E  FA FA 00 00 00 00
$1F  FF 02 00 00 00 00
$20  40 00 00 43 FE 00
$21  FF FF FF FF FF FF
$22  FF FF FF FF 00 00
$23  00 00 00 00 00 FF
$24  FF FF FF FF FF FF
$25  FF FF FF 05 00 00
$26  85 88 88 88 88 00
$27  00 00 00 00 00 00
$28  27 26 26 26 26 00
$29  F2 82 FF 00 00 00
$2A  00 00 00 31 00 00
$2B  00 00 00 00 00 00
$2C  00 00 FF 00 00 08
$2D  00 00 00 00 00 00
$2E  00 00 2A 00 00 00
$30  40 00 00 43 FE 00
$31  FF FF FF FF FF FF
$32  FF FF FF FF 00 00
$33  08 08 09 00 03 00
$34  04 00 00 00 02 04
$35  07 09 0B 0C 0D 0E
$36  0E 0F 10 FF FF 0D
$37  85 88 88 88 88 00
$38  00 00 00 00 00 00
$39  27 26 26 26 26 00
$3A  F2 82 FF 31 00 00
$3B  00 00 11 00 00 00
$3C  19 02 04 FF FF AA
$3D  30 30 30 00 00 00
$3E  00 00 2A 00 00 00
$40  FF FF FF FF FF 00
$41  FF FF FF FF FF FF
$42  FF FF FF FF 00 00
$43  FF FF FF 00 00 00
$44  FF 00 00 00 00 00
$50  00 00 00 00 04 04
$51  13 AA 00 00 00 00
$60  0D 0D 0D 00 27 24
$61  33 00 00 00 00 00
```

Disclaimer of Liability

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its

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of Transportation

**National Highway
Traffic Safety
Administration**

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