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

NHTSA

DOT HS 813 037

July 2021

Special Crash Investigations: On-Site Frontal Air Bag Non-Deployment Crash Investigation; Vehicle: 2002 Chevrolet Trailblazer; Location: Pennsylvania; Crash Date: January 2016

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Crash Research & Analysis, Inc. (2021, July). *Special Crash Investigations: On-Site Frontal Air Bag Non-Deployment Crash Investigation; Vehicle: 2002 Chevrolet Trailblazer; Location: Pennsylvania; Crash Date: January 2020* (Report No. DOT HS 813 037). National Highway Traffic Safety Administration.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
DOT HS 813 037			
4. Title and Subtitle Special Crash Investigations: On-Site Frontal Air Bag Non-Deployment Crash Investigation; Vehicle: 2002 Chevrolet Trailblazer; Location: Pennsylvania; Crash Date: January 2016		*5. Report Date*: July 2021 6. Performing Organization Code	
7. Author Crash Research & Analysis, Inc.		8. Performing Organization Report No. Case No. CR16005	
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 Administration 1200 New Jersey Avenue SE Washington, D.C. 20590		13. Type of Report and Period Covered Technical Report 14. Sponsoring Agency Code	
15. Supplementary Note Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles 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 the non-deployment of the frontal air bag system in a 2002 Chevrolet Trailblazer involved in a road departure/fixed object crash. The Chevrolet was equipped with dual-stage air bags for the driver and front right passenger positions. Neither air bag deployed during the crash. An unbelted 43-year-old male driver sustained internal abdominal injuries and was transported by ambulance to a local hospital where he expired 4 hours post-crash. An unbelted 40-year-old adult male front right occupant was transported, treated, and released with non-incapacitating (B-level) injuries from the same facility. Through the course of this investigation, it was determined that the air bag warning lamp in the Chevrolet's instrument cluster was "Off" at the time of the crash, indicative that the frontal air bag system was apparently operational. Data obtained from the vehicle's EDR indicated that the rate of velocity-change in the early stage of the crash pulse (0 to 60 milliseconds) appeared to be fairly constant, and it is possible that the sensing algorithm may have predicted that the overall severity of the crash would not exceed the deployment threshold. However, absent additional information regarding the manufacturer's proprietary deployment algorithm, the root cause of the air bag non-deployment could not be determined.			
17. Key Words non-deployment, frontal impact crash, EDR, deployment threshold		18. Distribution Statement Document is available to the public from 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 26	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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BACKGROUND

Figure 1: Front left oblique view of the crash-related damage to the 2002 Chevrolet Trailblazer.

This report documents the on-site investigation of the non-deployment of the frontal air bag system in a 2002 Chevrolet Trailblazer (**Figure 1**) involved in a road departure/fixed object crash. The Chevrolet was equipped with dual-stage air bags for the driver and front right passenger positions. Neither air bag deployed during the crash. An unbelted 43-year-old male driver sustained internal abdominal injuries and was transported by ambulance to a local hospital where he expired 4 hours post-crash. An unbelted 40-year-old adult male front right occupant was transported, treated, and released with non-incapacitating (B-level) injuries from the same facility. Notification of the crash was provided to the National Highway Traffic Safety Administration by the driver's family in February 2016 and forwarded to the Special Crash Investigations (SCI) group for further research. The on-site investigation was conducted during February 2016 and involved the exterior and interior documentation of the Chevrolet, the identification of occupant contact, and an evaluation of the manual and supplemental restraint systems. The Chevrolet was equipped with an event data recorder (EDR) that was imaged during the SCI vehicle inspection using the Bosch Crash Data Retrieval (CDR) tool and software. The crash site was documented using a Total Station electronic mapping system.

During a night in January 2016, the Chevrolet departed the left side of the road, sideswiped a W-beam guardrail, and then struck a wooden utility pole with its front plane. A witness passing by the crash site stopped to render aid. He reported that the driver and male front right passenger had exited the vehicle, and that both were conscious, but dazed. The driver had a forehead contusion and the front row right occupant reportedly sustained facial lacerations. Both injuries were related to windshield contact. Law enforcement and emergency medical service responders arrived at the crash site. The occupants were transported to a local hospital in stable condition. The driver subsequently died of internal abdominal bleeding 4 hours post-crash. Multiple requests to obtain the hospital medical records of the Chevrolet's occupants were denied; however, an autopsy report was provided by the driver's family.

Through the course of this investigation, it was determined that the air bag warning lamp in the Chevrolet's instrument cluster was "Off" at the time of the crash, indicative that the frontal air

bag system was apparently operational. Data obtained from the vehicle's EDR indicated that the rate of velocity-change in the early stage of the crash pulse (0 to 60 milliseconds) appeared to be fairly constant, and it is possible that the sensing algorithm may have predicted that the overall severity of the crash would not exceed the deployment threshold. However, absent additional information regarding the manufacturer's proprietary deployment algorithm, the root cause of the air bag non-deployment could not be determined.

CRASH SUMMARY

Crash Site

This crash occurred in an urban-residential environment on a two-lane roadway at night. At the time of the crash, the National Weather Service reported the conditions as clear and dry with a temperature of 7.7 ºC (46 ºF), 76 percent relative humidity and winds from the east/southeast at 20.4 km/h (12.7 mph). The physical environment of the crash site was documented during the SCI inspection using a Nikon Nivo 5.M+ total station mapping system. A crash diagram is included at the end of this report.

Figure 2: Northbound trajectory view of the Chevrolet approximately 30 m south of the point of impact.

The roadway **(Figure 2)** was surfaced with asphalt and curved to the right with respect to the northbound direction of travel for the Chevrolet. The radius of curvature measured 46 m (150.0 ft). The grade was positive and varied from 7.1 to 7.8 percent along the vehicle's trajectory. The northbound travel lane was 2.8 m (9.2 ft) in width while the southbound lane measured 4.2 m (13.8 ft). The lanes were divided by a double yellow centerline. A shallow curb bordered the east edge of the northbound lane while a continuous W-beam guardrail system bordered the west edge of the southbound lane. The guardrail system consisted of I-beams that were spaced on 1.9 m (6.3 ft) centers. Two residential driveways were located at the west road edge with breaks in the guardrail system. A third driveway was located at the north termination of the guardrail. A 33 cm (13.0 in) diameter wooden utility pole located at the roadside 6.7 m (22.0 ft) north of the guardrail termination and 0.3 m (1.0 ft) west of the pavement edge. The posted speed limit was 40 km/h (25 mph).

Pre-Crash

An autopsy reported the driver of the Chevrolet had a BAC of .161 g/dl. He was traveling in a northbound direction on the two-lane road at a speed recorded by EDR of 84 km/h (52 mph) 5 seconds prior to algorithm enable (AE). While attempting to negotiate the right curve, the vehicle tracked left**,** crossed the double yellow centerline, and entered the southbound travel lane. Based on the trajectory of the vehicle and the absence of pre-crash physical evidence, the Chevrolet departed its original travel lane approximately 37 m (121.0 ft) south of the struck guardrail location. The EDR data recorded the services brakes as "Off" 8 to 6 seconds prior to AE, "On" at the 5 second interval of the pre-crash recording, "Off" 4 to 2 seconds prior to AE and "On" at 1 second prior to AE.

Crash

The front right corner area of the Chevrolet struck the W-beam guardrail system that paralleled the west road edge **(Figure 3)**. The length of engagement to the guardrail is unknown because four sections of the W-beam had been replaced prior to this SCI investigation. This Event 1 impact was not recorded as an event by the Chevrolet's EDR. The direct contact damage extended the full length of the left plane and consisted of sideswiping engagement with the body panels of the left plane. It did not involve the rigid structure of the vehicle. The estimated severity of this impact (velocity-change) was minor, estimated as less than 10 km/h (6 mph. Reconstruction of this sideswipe impact was outside the scope of the WinSMASH program. The vehicle's trajectory was redirected along the contour of the barrier to the termination of the system. It did not penetrate the guardrail system.

Figure 3: Northerly view of the struck (and replaced) W-beam guardrail system.

Figure 4: Northbound view of the struck utility pole depicting its location relative to the roadway.

The Chevrolet continued an additional 6.7 m (22.0 ft) along the left (west) roadside in a tracking mode to impact with the utility pole **(Figure 4)**. The center and right aspects of the frontal plane struck the 33 cm (13.0 in) diameter pole (Event 2) resulting in an impact with a 12 o'clock direction of force. The pole did not yield as the bumper system of the Chevrolet crushed to a maximum depth of 46 cm (18.1 in). This crash event was recorded by the EDR as a non-deployment event and captured a maximum longitudinal velocity change of 38.3 km/h (-23.8 mph) at 117.5 milliseconds after AE. The dual-stage frontal air bag system was not commanded to deploy.

Post-Crash

The Chevrolet came to rest fully engaged against the struck utility pole. A witness to the crash stopped to render aid and observed that the driver and front right occupant had exited the vehicle unassisted. Both were conscious and appeared dazed. The emergency responders included police, firefighters, and ambulance personnel. Both occupants had visible soft tissue injuries and were transported to the hospital in police-reported stable condition. While awaiting treatment, the driver lost blood pressure and his condition worsened. He was taken to the operating room for emergency surgery where the medical team discovered a splenic laceration and a tear of the superior mesentery. Due to the internal blood loss, the driver expired during the surgical procedures. An autopsy was conducted on the body the following day. The front row right occupant was treated for facial lacerations and released.

2002 CHEVROLET TRAILBLAZER

Figure 5: Overhead view of the Chevrolet depicting the frontal damage.

Description

The 2002 Chevrolet Trailblazer (**Figure 5**) was manufactured in October 2001 and was identified by Vehicle Identification Number 1GNDT13S922xxxxxx. The digital odometer reading was unknown due to lack of power. The 4-wheel drive sport utility vehicle (SUV) was built on a 287 cm (113.1 in) wheelbase and was powered by a 4.2 liter, V-6 gasoline engine linked to a 4-speed automatic transmission with a console-mounted shifter. The gross vehicle weight rating was 2,608 kg (5,750 lb) with gross axle weight ratings of 1,338 kg (2,950) front and 1,452 kg (3,200 lb) rear. The curb weight was 2,099 kg (4,627 lb). The service brakes were power-assisted 4-wheel disc with ABS and electronic brakeforce distribution. Exterior features included an OEM roof rack with lateral load bars, an operable sunroof, and a frame-mounted Class III receiver hitch. At the time of the crash, the Chevrolet was equipped with General Grabber AT2 all-season radial tires of the manufacturer recommended size P245/70R16 mounted on OEM 5-spoke alloy wheels. The tires had matching Tire Identification Numbers (TIN) of A39H 3NH. The vehicle manufacturer recommended cold tire pressures were 220 kPa (32 PSI) at both axle positions. Specific tire data at the time of the SCI inspection is presented in the following table.

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	262 kPa (38 PSI)	6 mm (7/32 in)	No	None
LR	248 kPa (36 PSI)	5 mm (6/32 in)	No	None
RR	262 kPa (38 PSI)	6 mm (7/32 in)	No	None
RF	262 kPa (38 PSI)	5 mm (6/32 in)	Yes	None

The interior of the Chevrolet was configured for seating of five occupants with front bucket seats and a split, forward folding three-passenger second row seat. All seating surfaces were cloth. The front seats had adjustable head restraints that were in the full-down positions. The driver seat was adjusted to the full-rear track position. The front row right seat was adjusted in a mid-to-rear track position. Both front row seatbacks were reclined 20 degrees aft of vertical. Manual safety systems consisted of 3-point lap and shoulder seat belts for the five seat positions. The front row and the second row center positions utilized integrated seat belts incorporated into the seat backs. The seat belt in the second row left and right positions were mounted to the C-pillars. The front seat belt systems were equipped with retractor pretensioners. The Chevrolet was also equipped with dual-stage frontal air bags for the driver and front row right occupant and front seat-mounted side impact air bags.

Vehicle History

The Chevrolet was sold and registered to three owners during its 14-year history. The current owner had purchased the vehicle used in June 2011 at the reported odometer reading of 133,082 km (82,693 mi). The CARFAX report listed mechanical service for the vehicle; however, no crashes were reported and no service work on the air bag system was performed. Service of note included reprogramming of the instrument panel (August 2003), ball joint and tie rod replacement (March 2012), and engine, power steering pump and hoses replaced (March 2013). The balance of the reported service pertained to routine maintenance.

NHTSA Recalls and Investigations

A March 2020 VIN-based query of NHTSA's www.NHTSA/recall database did not identify any open recalls or investigations for this specific 2002 Chevrolet Trailblazer.

Exterior Damage

The Chevrolet sustained minor damage to the left plane from the Event 1 impact sequence with the W-beam guardrail system and moderate front plane damage from the Event 2 impact with the wooden utility pole **(Figure 6)**. The initial impact with the curved guardrail section began at the left corner of the bumper fascia and extended onto the left plane, involving only the sheet metal of the left front fender, left doors, and the left quarter panel. There was no structural damage or engagement of the tires and wheels. The height of the left plane damage extended to 76 cm (30.0 in) above the ground consistent with the height of the guardrail. The Collision Deformation Classification assigned to this damage pattern was 12FLES9.

Figure 6: Front corner and left plane damage to the 2002 Chevrolet Trailblazer.

The Event 2 damage began at the centerline of the front plane and extended 36 cm (14.0 in) to the vehicle's right **(Figure 7 and 8)**. The pole impact deformed the bumper fascia, the

Figure 7: Frontal plane direct contact damage from the utility pole.

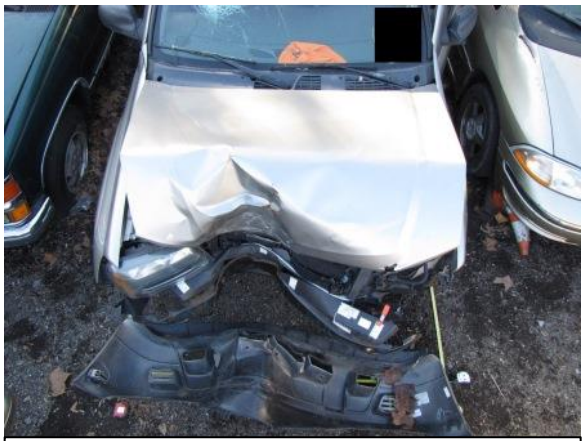


Figure 8: Overhead view depicting the depth of crush to the front bumper beam and its location between the frame rails.

underlying bumper beam, the radiator support, and the hood to a U-shape. The combined length of the direct and induced damage measured from corner-to-corner of the bumper beam was 142 cm (56.0 in). A crush profile was documented along the deformed bumper beam using the Nikon Total Station as a measurement tool. The profile minus free-space values for bumper taper was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 21 cm (8.3 in), C4 = 46 cm (18.1 in), C5 = 13 cm (5.1 in), C6 = 0 cm. The maximum crush measurement was located 14 cm (5.5 in) right of centerline. Although the impact was located between the frame rails, it still altered the wheelbase dimensions. The left wheelbase was lengthened by 1.5 cm (0.6 in) while the right wheelbase was reduced by 6.0 cm (2.4 in). The CDC for this damage profile was 12FZEN2.

The total delta V calculated by the damage algorithm of the WinSMASH program was 28 km/h (17 mph). The longitudinal and lateral components of the delta V were -28 km/h (-17 mph) and 0 km/h, respectively, which appeared reasonable.

All four doors remained closed during the crash and were operational post-crash. The laminated windshield had a single fracture line that originated at the bottom centerline that was associated with the exterior damage. Both unbelted occupants contacted and fractured the windshield directly forward of their seated positions. The front right occupant penetrated and holed the windshield. All door, quarter window, backlight, and roof glazing were closed at the time of the crash and were not damaged.

Event Data Recorder

The Chevrolet Trailblazer was equipped with an air bag control module (ACM) that performed the diagnostic, sensing and deployment command functions for the vehicle's supplemental restraint systems. This module had EDR capabilities and was located on the center tunnel of the vehicle.

The EDR component was imaged using the Bosch Crash Data Retrieval tool and software version 16.4 via a hardware link to the Diagnostic Link Connector (DLC) located under the left aspect of the instrument panel. Booster 12-volt electrical power was applied through the vehicle's fuse block to image the data. The imaged data was later read using version 19.3.1, and is included at the end of this report as an appendix.

The data limitations reported that the EDR was capable of recording two event types, namely non-deployment events and deployment events. The EDR could store one non-deployment event record. This record could be overwritten by a subsequent non-deployment event of greater severity or would be cleared after approximately 250 ignition cycles. This type of non-deployment event was considered to be unlocked. A non-deployment event that occurred within 5 seconds of a deployment event became locked and could not be overwritten. Deployment events by definition deployed air bags. The recorded data from a Deployment event became locked and could not be overwritten. This EDR could store two deployment events.

The imaged data indicated that the Chevrolet's EDR recognized and recorded one non-deployment event. Data fields in the recording indicated that there were no other associated events that were not recorded. The event was unlocked and was completely recorded. The system status at the time of the recording indicated that the event occurred on ignition cycle

25,574. The ignition cycle at the time of the SCI investigation was 25,576. The two-count difference in the ignition cycles was likely due to the post-crash tow operations and the SCI imaging of the data. At the time of the event, the air bag warning lamp in the instrument cluster was Off. The seat belt for the driver was "Unbuckled." The maximum recorded longitudinal velocity change (delta V) was -38.37 km/h (-23.84 mph) at 117.5 milliseconds. This event was attributed to the impact with the utility pole (Event 2). No seat belt pretensioners were commanded to actuate and no air bags were commanded to deploy.

The EDR also recorded 5 seconds of pre-crash vehicle performance parameters and 8 seconds of brake switch circuit status which described the operation of the vehicle. The Pre-Crash data were measured data were measured asynchronously relative to algorithm enable (AE). The recorded pre-crash data are listed in the following table. Note, only 5 seconds of brake data are shown here for clarity. The brakes were reported as "Off" for the -8, -7 and -6-second intervals:

	-5 seconds	**-4 seconds**	**-3 seconds**	**-2 seconds**	**-1 second**
Vehicle Speed	84 km/h (52 mph)	80 km/h (50 mph)	77 km/h (48 mph)	85 km/h (53 mph)	56 km/h (35 mph)
Throttle Percentage	0	8	95	0	0
Engine RPM	2176	2176	2880	3904	1728
Brake Switch Circuit Status	On	Off	Off	Off	On

Examination of the data trends indicated a recorded reduction in speed from -5 to -3-second interval prior to AE. This speed reduction related to the positive grade of the roadway. In response to this speed reduction, the driver applied the throttle with a corresponding increase in engine rpm and vehicle speed during the -4 to -2-second interval prior to AE and the brakes were reported as "On" during the -1-second pre-crash interval.

Interior Damage

The interior of the Chevrolet sustained damage that was attributable to contact from the unbelted occupants. There was no intrusion associated to the exterior force of the crash. The frontal and

Figure 9: Driver loading and compression of the Chevrolet's steering column.

Figure 10: Front row right occupant's head impacts and holing of the Chevrolet's laminated windshield.

seat-mounted side air bag systems did not deploy in this crash. The unbelted driver initiated a forward trajectory and loaded the steering assembly with his chest and abdomen. He compressed the energy absorbing column **(Figure 9)** and completely separated the column from the shear capsules. His knees contacted and scuffed the bolster panel. The driver's head struck and fractured the windshield 33 cm (13.0 in) right of the upper left A-pillar and 20 cm (8.0 in) below the windshield header.

The unbelted front row right occupant initiated a forward trajectory and engaged the glove box door with his knees. His loading scuffed and deformed the door, which released the latch assembly. He attempted to brace against the upper and mid instrument panel with his right hand, and contacted and displaced the right vent louver at the right edge of the mid-instrument panel. Although there was no contact evidence, his chest probably contacted the non-deployed mid-mount air bag module cover. The occupant's scalp contacted the sun visor during his initial forward movement and again on his subsequent rebound. The visor was scuffed at the leading edge and displaced rearward from its mounting point. The occupant's head also struck and fractured the windshield 8 cm (3.0 in) below the header and 28 cm (11.0 in) left of the right upper A-pillar. A secondary head/face contact was located 15 cm (6.0 in) below the header which holed the windshield, centered 32 cm (12.5 in) right of the A-pillar. The hole was 13 x 23 cm (5.0 x 9.0 in) and was large enough for a partial ejection of his face/head **(Figure 10)**.

Embedded hair strands were observed in the fracture site. The occupant's deformed and damaged wire framed eyeglasses were found outside the occupant compartment at the base of the right windshield wiper. It is believed that these separated from his face during the partial ejection sequence.

Manual Safety Systems

The Chevrolet was configured with manual 3-point lap and shoulder seat belt systems for the five seated positions. All of the seat belt systems consisted of continuous loop webbing with sliding latch plates. The front row and second row center systems were integrated into the seat backs. The front seat belts utilized retractor pretensioners. The driver's system retracted onto an ELR retractor while the other systems utilized switchable ELR/ALR retractors. The webbing of both front restraints freely spooled out and returned. Minimal historical use evidence was present. Based on the observations of the seat belt systems, the current and previous owners and occupants did not regularly use the seat belts. There was no loading evidence to support seat belt use at the time of the crash. Additionally, the EDR data recorded that the driver belt system was "Unbuckled."

Figure 11: Interior view of the Chevrolet and its non-deployed dual-stage frontal air bags.

Supplemental Restraint Systems

The Chevrolet was equipped with dual-stage frontal air bags for the driver and front row right occupant positions (**Figure 11**). The driver's frontal air bag was incorporated in a module that had I-configuration cover flaps positioned in the

four-spoke steering wheel rim. The spokes were positioned at the 3 and 9, and 5 and 7 o'clock positions. The mid-mounted passenger's frontal right air bag was concealed with a top-hinged module with the flap measuring 13 cm (5.0 in) in height and 33 cm (13.0 in) in overall width. The front plane impact was recorded by the EDR as a non-deployment event and the air bags were not commanded to deploy.

The Chevrolet was also equipped with front-seat-mounted side impact air bags. These air bags were incorporated into the outboard side surface of the seat backs. The vehicle did not undergo a side impact crash, therefore these air bags did not deploy.

Air Bag Non-Deployment Discussion

The center and right aspect of the Chevrolet's front plane struck the utility pole. The location of the direct contact damage was located between the rigid members of the vehicle's sub-frame. Real-world field research of the center-pole impact crashes has found that there is difficulty in accurately sensing the severity of this type of crash, particularly in consideration of the time frame when this model year vehicle was designed (mid/late 1990's). The decision whether or not to actuate/deploy supplemental safety systems is achieved through the use of a predictive sensing algorithm processed during the early stages of the impact (typically 0-30 milliseconds). For supplemental safety device actuation/deployment to occur, the rate (and predicted rate) of the change in the acceleration imparted to the vehicle has to be in excess of the threshold unique to the design of the vehicle make/model in question.

The SCI investigator reviewed the velocity change (delta V) data reported by the data imaged from the Chevrolet's EDR. It is important to note that delta V data is not acceleration data. However, the acceleration data can be derived from the rate of the change in velocity. That is, acceleration is equivalent to the slope of the velocity change over time. For the available delta V data, the rate of change in the early stage of the crash pulse (0 to 60 milliseconds) appeared to be fairly constant. The sensing algorithm may have predicted that the overall severity of the crash would not exceed the deployment threshold during this time. The slope of the pulse then gradually became steeper approximately 70 milliseconds after AE. It has been shown that a late-deployment of the frontal air bags can cause harm to the occupant, particularly if the occupant is unbelted, and theorized that the frontal air bag deployment threshold has been designed such that late-air bag deployment is prevented. However, due to its proprietary nature, information concerning the manufacturer's deployment algorithm is not available to the SCI investigator. It is unknown if this increased rate of change occurred too late in the overall crash pulse to deploy the air bags. It was not possible to compare the measured crash pulse to the threshold algorithm. Therefore, the root cause of the air bag non-deployment could not be determined.

2002 CHEVROLET TRAILBLAZER OCCUPANT DATA

Driver Demographics

Age/sex:	43 years / male
Height:	183 cm (72 in)
Weight:	112 kg (248 lb)
Eyewear:	Unknown
Seat type:	Forward-facing bucket seat with adjustable head restraint
Seat track position:	Full-rear track
Manual restraint usage:	None
Usage source:	Vehicle inspection, EDR
Air bags:	Dual-stage driver frontal and seat-mounted side impact air bags; None deployed
Alcohol/drug involvement:	BAC = .161 g/dl
Egress from vehicle:	Exited vehicle under own power
Transport from scene:	Ambulance to a local hospital
Type of medical treatment:	Evaluated and admitted, deceased within 4 hours

Driver Injuries

Inj No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Bleeding from the superior mesentery vein	521699.3	Steering wheel rim/ spoke/hub	Certain
2	Right subdural hemorrhage	140650.3	Windshield	Certain
3	Fracture of left 5th to 8th ribs anteriorly	450203.3	Steering wheel rim/ spoke/hub	Certain
4	Extended right hemicolectomy	540899.2	Steering wheel rim/ spoke/hub	Certain
5	Resection of distal small bowel	541499.2	Steering wheel rim/ spoke/hub	Certain
6	Laceration of the spleen	544220.2	Steering wheel rim/ spoke/hub	Certain
7	Subcutaneous hemorrhage of the left aspect of frontal scalp 10 x 15 cm; 5 x 3 cm purple contusion on left frontal scalp	110402.1	Windshield	Certain
8	6 x 7 cm muscular hematoma on left lower quadrant of chest wall	410402.1	Steering wheel rim/ spoke/hub	Certain
9	Three contusions, purple, on right knee, measuring 2 x 1.3 cm, 1 x 0.5 cm, and 2 x 1.8 cm	810402.1	Lower left instrument panel/knee bolster	Certain
10	Multiple red abrasions on right knee, longest is 1.5 cm	810202.1	Lower left instrument panel/knee bolster	Certain

Source – Autopsy report (internal)

Driver Kinematics

The 43-year old male driver of the Chevrolet was seated in an upright posture and operating the vehicle unbelted, although an integrated 3-point lap and shoulder seat belt system was available for his use. He was seated in a full-rear track position with the seat back reclined 20 degrees aft of vertical and the adjustable head restraint set to the full-down position.

The combination of the vehicle's speed that was too great for the roadway curvature and the driver's late steering maneuver resulted in the Chevrolet crossing the centerline and sideswiping the guardrail along the north roadside. This guardrail impact (Event 1) did not significantly displace the driver or cause injury. He probably remained in his upright seated position with his hands on the steering wheel rim as he attempted to regain control of the vehicle. The Chevrolet was redirected along the guardrail and struck a wooden utility pole (Event 2) with its front plane. The frontal air bag did not deploy during the crash event.

The unbelted driver responded to the 12 o'clock direction of the impact force with a forward direction. His knees contacted the lower instrument panel and scuffed the polymer surface of the rigid panel. Abrasions and contusions to the right knee were identified during autopsy. The driver's chest and abdomen loaded the center hub, spokes and rim of the steering wheel. This loading force compressed the energy absorbing steering column evidenced by complete forward separation of the shear capsules. He sustained anterior fractures of the left 5th to 8th ribs and a muscular contusion of the left lower chest. As his torso engaged the hub and wheel, his abdomen loaded the lower aspect of the wheel rim resulting in a splenic laceration, a tear of the superior mesentery, and a small bowel injury. The driver's head struck and fractured the windshield directly over the steering assembly. The head contact was centered 33 cm (13.0 in) right of the left A-pillar and 20 cm (8.0 in) below the windshield header. He sustained a left frontal scalp contusion and a right subdural hemorrhage from the windshield contact.

The driver rebounded into his seat where he came to rest. He exited the vehicle unassisted and was observed by a witness as conscious, but dazed. When the EMS arrived on-scene, he denied significant injury. He was prepared for transport by ambulance to a local hospital in police-reported stable condition. On arrival to the emergency room, the driver was initially evaluated and treated for his visible injuries. The driver subsequently lost blood pressure and was taken to the operating room where the spleen and mesentery injuries were discovered. He succumbed to these occult injuries approximately 4 hours after the crash. An autopsy was performed on the body on the following day.

Front Row Right Occupant Demographics

Age/sex:	40 years/male
Height:	Unknown
Weight:	Unknown
Eyewear:	Wire framed prescription eyeglasses
Seat type:	Forward-facing bucket with adjustable head restraint
Seat track position:	Mid-to-rear track
Manual restraint usage:	None
Usage source:	Vehicle inspection, EDR

Air bags:	Dual-stage passenger frontal and seat-mounted side impact air bags; none deployed
Alcohol/drug involvement:	Alcohol (surrogate interview), BAC unknown
Egress from vehicle:	Exited vehicle unassisted
Transport from scene:	Ambulance to a local hospital
Type of medical treatment:	Treated and released

Front Row Right Occupant Injuries

Inj No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Facial lacerations, NFS	210600.1	Windshield	Certain

Source - PAR

Front Row Right Occupant Kinematics

The male front row right occupant was seated unbelted in a mid-to-rear seat track position with an upright posture based on his points of interior contact. The lack of seat belt use was determined from the stowed position of the belt system and the lack of loading evidence on the webbing and system hardware. Although the vehicle was equipped with a dual-stage frontal air bag for this occupant position, the air bag did not deploy during crash sequence.

The first event crash with the guardrail resulted in minor severity damage to the Chevrolet and did not result in a velocity change of significant magnitude to displace the unbelted front row right occupant from his pre-crash seated position. At impact with the utility pole (Event 2), the vehicle experienced a force direction of 12 o'clock. During the vehicle's engagement with the pole, it pitched downward. The unbelted front row right occupant initiated a forward trajectory as he responded to the frontal impact force. He likely extended his arms as he attempted to brace against the upper instrument panel. His right hand braced against the vent louver located in the upper right mid instrument panel and this loading displaced the vent louver from its mount. His left hand probably braced against the center mid instrument panel, however there was no physical contact evidence to support this action.

As the frontal plane of the Chevrolet pitched downward, the unbelted occupant continued forward on a straight line trajectory. The right occupant's frontal scalp/head contacted and scuffed the right sun visor.

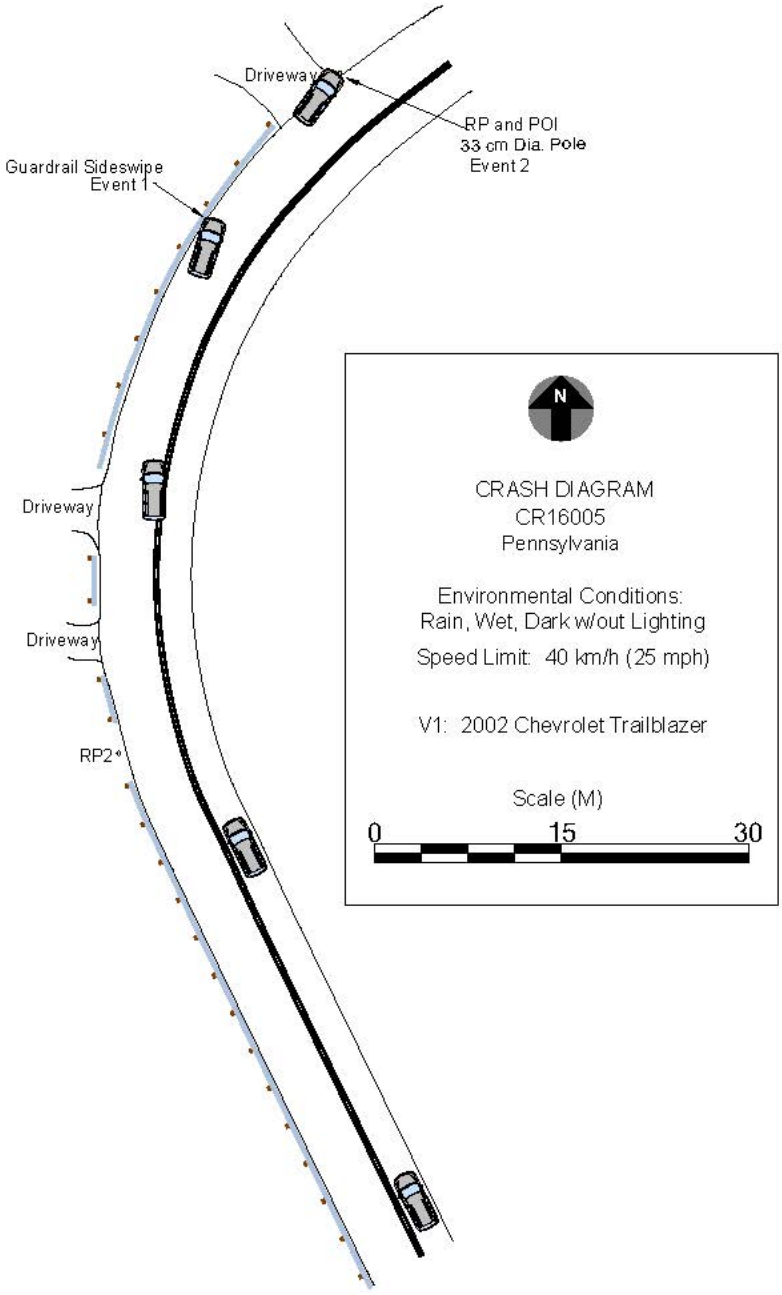
His frontal scalp/forehead then continued forward and struck the upper aspect of the laminated windshield 6 cm (2.5 in) below the header. This contact rotated his head rearward as his body continued forward. His forehead and face contacted and penetrated the windshield laminate 5 cm (2.0 in) below the initial contact evidenced by tissue and hair. The occupant's head was partially ejected through the windshield. As a result of the windshield contact, the occupant sustained multiple lacerations of the face and head.

The occupant's knees contacted the closed glove box door. The surface of the door was scuffed from the knee contact and the door was deformed which released the latching mechanism. The

occupant's torso contacted the mid instrument panel and the mid-mount air bag module cover flap. There was no distinct contact evidence on the cover flap.

The front row right occupant rebounded rearward. His head disengaged from the holed windshield and the posterior aspect of his scalp contacted the leading edge of the sun visor, displacing the sun visor rearward. The occupant came to rest in his seated area. Following the crash, he exited the vehicle unassisted and waited with the driver for police and emergency personnel to arrive on scene. He was evaluated at the scene and transported to a local hospital for treatment of his injuries.

CRASH DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	CR16005

APPENDIX A:

2002 Chevrolet Trailblazer Event Data Recorder (EDR) Report[1]

[1] 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	1GNDT13S922******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	201750S116005_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 16.4
Reported with CDR version	Crash Data Retrieval Tool 19.3.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	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 multiple Non-Deployment Events occur within five seconds prior to a Deployment Event, then the most severe Non-Deployment Event will be recorded and locked. If multiple Non-Deployment Events precede a Deployment Event, and occur within five seconds of each other (but not necessarily all within five seconds of the Deployment Event), then the most severe of the Non-Deployment Events (which may have occurred more than five seconds prior to the Deployment Event) will be recorded and locked. 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. If multiple Non-Deployment Events occur within five seconds prior to a Deployment Event, and one or more of those events was a Pretensioner Deployment Event, then the most recent Pretensioner Deployment Event will be recorded and locked. 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 25.4 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.
-Multiple Events will indicate whether one or more associated events preceded the recorded event.
-Multiple Events Not Recorded can be used in the following scenarios:
    -If a single event is recorded, this parameter will indicate whether one or more associated events prior to the recorded event was not recorded due to insufficient record space (because there were more events than there were available event records).
    -If two associated events are recorded, this parameter for the first event will indicate whether one or more associated events prior to the first event was not recorded due to insufficient record space.
    -If two associated events are recorded, this parameter for the second event will indicate whether one or more associated events between the first and second events was not recorded due to insufficient record space.
-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.
-The Belt Switch Circuit is wired directly to the SDM.

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.

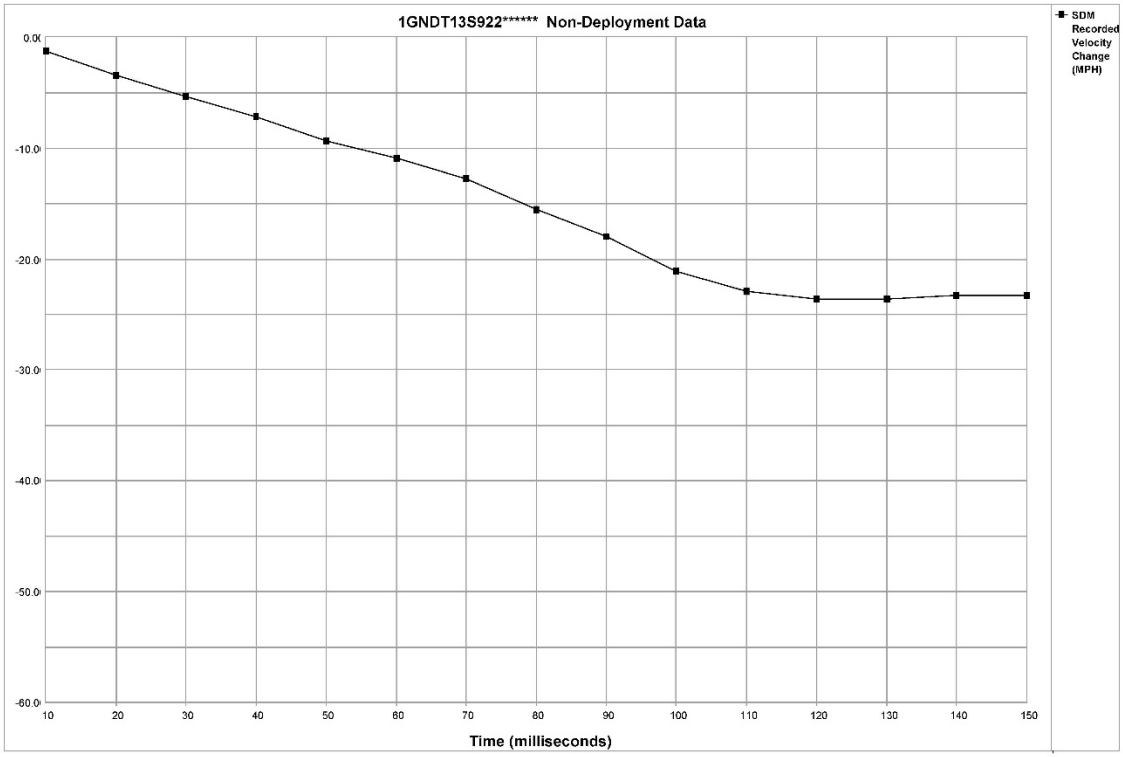
01030_SDMGT-2002_r006

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	25574
Ignition Cycles At Investigation	25576
Maximum SDM Recorded Velocity Change (MPH)	-23.84
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	117.5
Crash Record Locked	No
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	52	2176	0
-4	50	2176	8
-3	48	2880	95
-2	53	3904	0
-1	35	1728	0

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



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.24	-3.41	-5.27	-7.13	-9.30	-10.85	-12.71	-15.50	-17.98	-21.08	-22.94	-23.56	-23.56	-23.25	-23.25

Hexadecimal Data

```
$01   08 31 46 B7 AE FB
$02   D1 D1 38 38 00 00
$03   41 53 31 32 37 37
$04   4B 34 38 58 46 31
$06   15 08 08 60 00 00
$10   F3 82 FF 00 00 00
$11   80 7F 80 80 80 81
$12   B2 00 00 00 00 00
$13   FF 02 00 00 00 00
$14   1D 1D 05 05 00 00
$15   FA FA FA FA FA FA
$16   FA FA FA FA FA FA
$17   FA FA 00 00 00 00
$18   3F 00 55 AC 01 00
$1F   FF 00 00 00 00 00
$20   12 FD 00 00 FF FF
$21   FF FF FF FF FF FF
$22   FF FF FF FF FF FF
$23   FF FF FF FF FF FF
$24   00 04 CD 5E 2F 5E
$25   2F 00 00 00 FF FF
$26   04 0B 11 17 1E 23
$27   29 32 3A 44 4A 4C
$28   4C 4B 4B 00 F3 83
$29   C0 A5 FF FF FF FF
$2A   FF FF FF FF FF FF
$2B   FF FF FF FF FF FF
$2C   FF FF FF FF FF FF
$2D   FF FF 00 00 00 00
$30   FF FF FF FF FF FF
$31   FF FF FF FF FF FF
$32   FF FF FF FF FF FF
$33   FF FF FF FF FF FF
$34   FF FF FF FF FF FF
$35   FF FF FF FF FF FF
$36   FF FF FF FF FF FF
$37   FF FF FF FF FF FF
$38   FF FF FF FF FF FF
$39   FF FF FF FF FF FF
$3A   FF FF FF FF FF FF
$3B   FF FF FF FF FF FF
$3C   FF FF FF FF FF FF
$3D   FF FF 00 00 00 00
$40   00 00 00 00 00 00
$41   FE 00 00 00 00 00
$42   00 00 12 12 12 13
$43   13 00 7D 80 00 00
$44   39 55 4E 50 54 00
$45   88 00 00 00 F2 15
$46   00 00 1B 3D 2D 22
$47   22 00 7D 80 00 00
$48   FF FF FF FF FF FF
$49   FF FF FF FF FF FF
$4A   FF FF FF FF FF FF
$4B   FF FF FF FF 00 00
$4C   FF FF FF FF FF FF
$4D   FF FF FF FF FF FF
$4E   FF FF FF FF FF FF
$4F   FF FF FF FF 00 00
$50   FF FF FF FF FF FF
$51   FF FF FF FF FF FF
```

```
$52   FF FF FF FF FF FF
$53   FF FF FF FF FF FF
$54   FF FF FF FF FF FF
```

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 directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

DOT HS 813 037
July 2021

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14768-062821-v5