



U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**



DOT HS 813 088

April 2021

**Special Crash Investigations:
On-Site Air Bag Non-Deployment
Crash Investigation;
Vehicle: 2010 Chevrolet Cobalt;
Location: Arkansas;
Crash Date: May 2013**

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Suggested APA Format Citation:

Indiana University Transportation Research Center. (2021, April). *Special crash investigations: On-site air bag non-deployment investigation; vehicle: 2010 Chevrolet Cobalt; location: Arkansas; crash date: May 2013* (Report No. DOT 813 088). National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No. DOT HS 813 088	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Special Crash Investigations: On-Site Air Bag Non-Deployment Investigation; Vehicle: 2010 Chevrolet Cobalt; Location: Arkansas; Crash Date: May 2013		5. Report Date April 2021	
		6. Performing Organization Code	
7. Author Indiana University, Transportation Research Center		8. Performing Organization Report No. IN14015	
9. Performing Organization Name and Address Indiana University Transportation Research Center 501 South Madison Street, Suite 105 Bloomington, Indiana 47403		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. DTNH22-12-C-00270	
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration National Center for Statistics and Analysis 1200 New Jersey Avenue SE Washington, DC 20590		13. Type of Report and Period Covered Technical Report	
		14. Sponsoring Agency Code NSA-110	
15. Supplementary Notes 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 a non-deployment of the left side impact inflatable curtain (IC) air bag in a 2010 Chevrolet Cobalt LT, which was involved in impacts with four trees. The Chevrolet was a 2-door coupe equipped with multi-stage frontal air bags and side impact IC air bags. An unbelted 37-year-old female driver was traveling west when the Chevrolet departed the right side of the roadway in a clockwise yaw. It then traveled down a steep embankment and into a wooded area, where the left plane struck four trees (Events 1-4). No air bags deployed during the crash. The driver sustained police-reported "A" (incapacitating) injuries and was transported by ambulance to a hospital. Due to the proprietary nature of the manufacturer's deployment criteria, it could not be determined or verified whether the tree impacts generated sufficient lateral deceleration in the required time constraints to trigger the deployment of the left IC air bag. Discussions between NHTSA and the vehicle manufacturer regarding the crash reconstruction and the non-deployment of the left IC air bag provided no further information as the vehicle was no longer available for inspection. The root cause of the non-deployment remains undetermined.			
17. Key Words inflatable curtain air bag, motor vehicle traffic crash, air bag non-deployment, serious injury		18. Distribution Statement The 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 29	22. Price

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Special Crash Investigations
On-Site Air Bag Non-Deployment Investigation
Office of Defects Investigation
Case Number: IN14015
Location: Arkansas
Vehicle: 2010 Chevrolet Cobalt
Crash Date: May 2013

Background

This report documents the on-site investigation of a non-deployment of the left side impact inflatable curtain (IC) air bag in a 2010 Chevrolet Cobalt LT (Figure 1), which was involved in impacts with four trees. This crash investigation was initiated by the National Highway Traffic Safety Administration in March 2014 and assigned to the Indiana University Transportation Research Center. This single-vehicle crash occurred in Arkansas in May 2013 after midnight and was investigated by a local police agency. The Chevrolet and the crash scene were inspected in July 2014 following a lengthy process to obtain the police crash report and then locate the vehicle and obtain permission for an inspection. Attempts to locate the driver for an interview were unsuccessful.



Figure 1. The damaged 2010 Chevrolet Cobalt

This crash occurred on the roadside of a divided, interstate highway. The Chevrolet was a 2-door coupe equipped with multi-stage frontal air bags and side impact IC air bags. An unbelted 37-year-old female was driving the Chevrolet west when it departed the right side of the roadway in a clockwise yaw. The vehicle then traveled down a steep embankment and into a wooded area, where the left plane struck four trees (Events 1 to 4). No air bags deployed during the crash. The driver sustained police-reported “A” (incapacitating) injuries and was transported by ambulance to a hospital. The vehicle was towed from the crash scene due to damage.

Summary

Crash Site

At the time of the crash, it was dark with no artificial lighting on the straight, divided, interstate highway. The weather conditions were dry with scattered clouds, 16 kilometers (10 miles) visibility, southerly winds at 14.8 km/h (9.2 mph), a temperature of 24 °C (75 °F), and a dew point of -64.9 °C (18.3 °F), according to local weather reports. The Chevrolet was westbound, and its roadway had one entrance ramp lane and three through lanes that were divided from the two eastbound lanes and one exit ramp lane by a concrete median barrier. Each lane was roughly 3.7 m (12.1 ft) wide. The interstate was bordered by bituminous shoulders. The median shoulder was roughly 3.7 m (12 ft) wide, and the north shoulder was roughly 2.1 m (7 ft) wide. A heavily wooded area was located on the north side of the interstate at the bottom of an embankment with a negative 33 percent grade perpendicular to the roadway. The speed limit was 113 km/h (70 mph). The crash diagram is included at the end of this report.

Pre-Crash

The Chevrolet was traveling west (Figure 2) in the third lane from the right. The police crash report (PCR) stated that the vehicle “veered to the left” and the driver overcorrected with a right steering maneuver, and the vehicle began to rotate clockwise. The PCR gave no reason why the driver veered to the left. The PCR reported that the driver was not impaired. The EDR reported the vehicle’s speed as 111 km/h(69 mph) at -5 sec prior to algorithm enable (AE) with the brake switch circuit reported as “Off.” The vehicle traveled across the roadway in a northwest direction and departed the right side of the roadway. It continued to rotate clockwise as it traveled 30 m (98 ft) along the negative 16 percent grade of a grass-covered embankment and entered a heavily wooded area (Figure 3). The vehicle’s pre-crash speed, engine speed, percent throttle, brake status, accelerator pedal position, and antilock brake system status reported by the EDR are presented in the table on the next page.



Figure 2. Westbound approach of the Chevrolet; the arrow shows area of roadway departure



Figure 3. Northwest approach of the Chevrolet down the embankment to the wooded area

Time	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Speed km/h (mph)	111 (69)	111 (69)	90 (56)	56 (35)	16 (10)
Engine speed	3,456	3,456	2,816	2,816	1,600
% throttle	21	100	18	21	20
Brake switch circuit state	Off	Off	Off	Off	Off
Accel pedal position	0	0	0	0	0
Antilock brake system active	No	No	Yes	Yes	Yes

It should be noted that the speed reported at -3.0 sec to -1.0 sec pre-crash interval may not accurately reflect the speed of the vehicle across the ground because the reported vehicle speed was measured from a wheel speed sensor. Since the vehicle was in a yaw, the rotation of the wheels could be restricted and slowed due to side forces on the wheels as the yaw increased and could possibly affect the accuracy of the speed captured by the wheel speed sensor. Additionally, the vehicle's ABS was active, and ESC could also have affected the rotation of the tires.

Crash

The vehicle rotated clockwise roughly 140 degrees from its original westerly travel direction on the roadway, and the left quarter panel struck two trees roughly 8 cm (3 in) in diameter and knocked them down (Events 1 and 2). The left front door (Figure 4) then struck a tree 15 cm (5.9 in) in diameter, which yielded, and a tree 18 cm (7.1 in) in diameter, which did not yield (Figure 5, Events 3 and 4). Hair transfer from the driver's head (Figure 6) was found on the exterior of the vehicle at the top of the left front window frame during the SCI vehicle inspection, suggesting that the driver's head was partially ejected through the disintegrated left front glazing and contacted the window frame during the crash (refer to the Interior Damage section of the report).

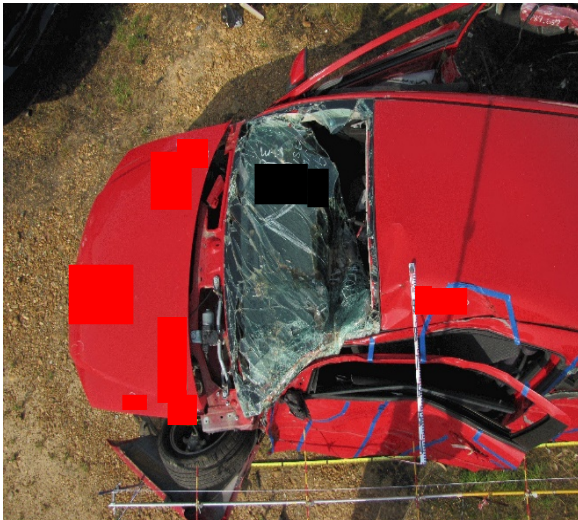


Figure 4. Top view of damage to the driver's door from impacts with 15 cm (5.9 in) and 18 cm (7.1 in) diameter trees



Figure 5. Area of impact with the two larger trees (Events 3 and 4)

The vehicle came to final rest against the 15 cm (5.9 in) and 18 cm (7.1 in) diameter trees, facing east. The force direction for all the impacts was in the 8 o'clock sector, and the multiple impacts resulted in overlapping damage. The vehicle's left IC air bag did not deploy. The vehicle's EDR reported the velocity change (delta V) experienced during the crash for a period of 300 msec. The maximum longitudinal and lateral velocity changes were 34.90 km/h (21.69 mph) at 280 msec and 55.62 km/h (34.56 mph) at 290 msec, respectively. The maximum resultant delta V was 66.03 km/h (41.03 mph) at 320 msec after AE. It could not be determined why the left IC air bag did not deploy.



Figure 6. Hair transfer from the driver's head on the outside of the top of the left front window frame, located 30 cm (11.8 in) forward of the driver's head restraint

Post-Crash

A passerby noticed headlights off the roadway and called 9-1-1, according to the driver's medical records. The police were notified of the crash at 0143 hours and arrived on scene at 0151 hours. Emergency responders forced open the right front door with a mechanical rescue tool and removed the driver from the vehicle. The driver's medical records reported that extrication time was 20 minutes. The driver sustained severe injuries and was transported by ambulance to a trauma center and hospitalized for 27 days. The vehicle was towed from the crash scene due to damage.

2010 Chevrolet Cobalt

Description

The Chevrolet (Figure 7), a front-wheel drive, five-passenger, two-door coupe with the Vehicle Identification Number 1G1AD1F52A7xxxxxx, was manufactured in March 2010. The vehicle was equipped with a 2.2-liter, I-4 engine, 4-speed automatic transmission; traction control; and 4-wheel antilock brakes. The vehicle was also equipped with multi-stage frontal air bags and a tilt steering column. The column tilt position could not be determined at the SCI vehicle inspection since the column lock was disengaged, and the column was probably moved when the frontal air bag module was removed during salvage operations. The specified wheelbase was 262 cm (103.1 in). The vehicle manufacturer's recommended tire size was P205/55R16. The vehicle was equipped with Hankook Optimo tires of the recommended size on the left front and left rear. The right side tires had been removed. The manufacturer's recommended cold tire pressure for the front and rear tires was 207 kPa (30 psi).



Figure 7. Top view of the Chevrolet

The front row was equipped with driver and front right passenger cloth-covered bucket seats with adjustable head restraints. The second row was equipped with a cloth-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 positions, and the seat back was slightly reclined. The top of the driver's head restraint was located 25 cm (9.8 in) above the top of the seat back.

Exterior Damage

Exterior Damage Event 1: The left quarter panel sustained direct damage from impact with a tree roughly 8 cm (3.0 in) in diameter that involved the sheet metal above the left rear wheel and the C-pillar. The direct damage began 16 cm (6.3 in) rear of the left rear axle and extended forward 33 cm (13.0 in) on the quarter panel. The crush profile for this impact overlapped the crush profile from impact (event 2) with a second tree 8 cm (3.0 in) in diameter. The collision deformation classification (CDC) was 08LBAN99 (240 degrees). The 99 designation for the extent zone represents an "unknown" due to the overlapping damage. The WinSMASH program could not be used to calculate delta V since the tree yielded, and there was overlapping damage from Event 2. The severity of the damage was minor.

Exterior Damage Event 2: The left quarter panel immediately rear of the left door was directly damaged by the impact with a tree roughly 8 cm (3.0 in) in diameter. The direct damage extended to the roof side rail, onto the left C-pillar, and disintegrated the left rear glazing. The direct damage began 18 cm (7.1 in) forward of the left rear axle and extended forward 65 cm (25.6 in). The crush profile from this impact overlapped the crush profile from the impact with the tree from Event 1 and the tree from Event 3. The CDC was 08LPAW99. The WinSMASH program could not be used to calculate delta V since the tree yielded and there was overlapping damage. The severity of the damage was moderate.

Exterior Damage Event 3: The front portion of the left front door and the left A-pillar were directly damaged during the impact with a tree 15 cm (5.6 in) in diameter. The direct damage began 179 cm (70.0 in) forward of the left rear axle and extended forward 37 cm (14.6 in). The damage from this impact overlapped the damage from Event 4. The CDC was 08LPAN99. The WinSMASH program could not be used to calculate delta V since there was overlapping damage from Event 4 and the tree yielded. The severity of the damage was moderate.

Exterior Damage Event 4: The left front door was directly damaged by the impact with a tree 18 cm (7.1 in) in diameter and the damage extended onto the roof side rail and roof. The direct damage began 91 cm (35.8 in) forward of the left rear axle and extended forward 72 cm (28.3 in). The damage from this impact overlapped the damage from Event 3. The maximum crush to the mid-aspect of the left front door measured 40 cm (15.7 in). The damage profile of the overlapping damage pattern was as follows: C1 = 17 cm (6.7 in), C2 = 20 cm (7.9 in), C3 = 31 cm (12.2 in), C4 = 32 cm (12.6 in), C5 = 40 cm (15.7 in), and C6 = 6 cm (2.4 in). The CDC was 08LPAW3. For reference, the WinSMASH program was used to analyze the overall crash severity in terms of the barrier equivalent speed (BES). The calculated BES was 46 km/h (28 mph). This analysis was considered borderline, and the results were low based on SCI experience.

Event Data Recorder

The Chevrolet Cobalt was equipped with a sensing diagnostic control module (SDM) that provided the sensing, diagnostic, and control of the vehicle's supplemental restraint systems. The SDM also had event data recording capabilities. The Chevrolet's EDR component was imaged during the SCI vehicle inspection with version 12.3 of the Bosch Crash Data Retrieval software via a direct-to-module connection to the SDM. An external 12-volt battery was used to power the SDM and image the data. The imaged data, reported with version 19.6.3, is attached at the end of this report as Appendix A.

The EDR had recorded one non-deployment event, and the event recording was complete. No other events were reported as associated with this event. The supplemental inflatable restraint warning lamp status was reported as "off," and no diagnostic trouble codes were reported. The seat belt switch circuit status for the driver was reported as "unbuckled." The vehicle's EDR reported the velocity change (delta V) experienced during the crash for a period of 300 msec. The maximum longitudinal and lateral velocity changes were 34.90 km/h (21.69 mph) at 280 msec and 55.62 km/h (34.56 mph) at 290 msec, respectively. The maximum resultant delta V was 66.03 km/h (41.03 mph) at 320 msec after AE. The 5.0-seconds of pre-crash data elements were presented in the pre-crash section of this report on page 3.

Interior Damage

The interior of the Chevrolet sustained moderate damage from intrusion. The most severe intrusions into the driver's space were the left roof side rail and left A-pillar intruded laterally 22 cm (8.7 in) and 21 cm (8.3 in), respectively. The rear upper quadrant of the left door intruded an estimated 17 cm (7 in). Both doors were jammed shut and had been forced open. The windshield was cracked and had collapsed due to weathering. The left front and rear glazing were disintegrated. The right front and right rear glazing were also disintegrated, but this probably occurred when emergency responders were working to open the right front door. The backlight was undamaged. During the crash, the driver's head was partially ejected through the left front window opening and struck a tree. Hair transfer from the driver's head was found on the exterior of the vehicle at the top of the left front window frame (Figure 6). The driver's left shoulder contacted the left door at the beltline leaving two scuff marks in the plastic. Her left thigh contacted and cracked the plastic of the left door armrest, and her left hip contacted and scuffed the plastic in the rear lower quadrant of the left door. There was no deformation to the steering wheel.

Manual Restraint Systems

The front and second row seating positions were equipped with lap and shoulder seat belts. The front seat belts were equipped with belt guides on the top of the seat back, sliding latch plates, and fixed upper anchors. The driver was not restrained. The belt webbing was in the retracted position, and the retractor was locked from damage to the B-pillar. The vehicle's EDR reported the driver's seat belt switch status as "unbuckled." The pretensioner did not actuate.

Supplemental Restraint Systems

The Chevrolet was equipped with multi-stage driver and passenger frontal air bags and side impact IC air bags. No air bags deployed in this crash. The vehicle's headliner was pulled away from each roof side rail during the SCI vehicle inspection, and IC air bags were present on each side.

NHTSA Recalls and Investigations

At the time of this report, a search of the NHTSA recall database, www.nhtsa.gov/recalls, identified three unrepaired recalls. All three recalls were issued in 2014, after the date of the vehicle's crash. Two of the recalls involved an ignition switch defect. One recall concerned the potential for the ignition switch to move from the "run" position to the "accessory" position due to weight on the key ring or some "jarring event." The potential result was that the air bags would not deploy in the event of a crash. A second recall identified the possibility that the ignition key could be removed when the ignition switch was not in the "off" position. The third recall involved the potential loss of electric power steering assist while the vehicle was in operation. The recall history of the vehicle was also checked through a Chevrolet dealership, and it showed no recall work had been performed on the vehicle.

A vehicle history report, which was obtained on the Chevrolet, indicated that the vehicle had three owners over its lifetime. There were no reported issues or crashes for the first two owners. The third owner was involved in the crash that was the subject of this investigation. Issues reported for the third ownership were this total loss crash, an odometer problem, and an unspecified manufacturer's recall.

Air Bag Non-Deployment Discussion

None of the vehicle's supplemental restraint systems deployed in the side-impact crash. The vehicle's EDR reported the vehicle power mode status as "run." Inspection of the ignition switch during the SCI vehicle inspection revealed that the key was still present in the ignition and that the switch was in the "run" position (Figure 8). The driver's frontal air bag did not deploy since the force direction was in the 8 o'clock sector, and the resulting longitudinal velocity change was positive as indicated by the vehicle's EDR longitudinal velocity change graph. Frontal air bags are designed to deploy when the vehicle is subjected to a negative longitudinal deceleration that meets the vehicle's deployment threshold criteria.



Figure 8. Initial status of the Chevrolet's ignition switch at the SCI vehicle inspection

The non-deployment of the left IC air bag is the primary issue in this case. The vehicle's IC air bags, which were designed to deploy independently, deployed during a lateral impact on the struck side of the vehicle. From a visual perspective, the barrier equivalent damage to the vehicle's left plane from the tree impacts was moderately severe, suggesting the severity of the crash would have been sufficient to require deployment of the left IC air bag. However, examination of the lateral crash pulse indicated that the pulse was elongated, occurring over a long duration, relative to a barrier equivalence. The initial slope of the lateral velocity change remained shallow over for the first 80 milliseconds reaching 14.18 km/h (8.81 mph) at 80 msec. The slope then flattened reaching 19.63 km/h (12.20 mph) at 160 msec. The profile of this velocity change may be related to the yielding properties of the impacts. The slope of the velocity change then significantly increased reaching its maximum-recorded value of 55.62 km/h (34.56 mph) at 300 msec. Due to the proprietary nature of the manufacturer's deployment criteria, it could not be determined or verified if the four tree impacts generated sufficient lateral deceleration in the required time constraints to trigger deployment of the left IC air bag. Discussions between NHTSA and the vehicle manufacturer regarding the crash reconstruction and the non-deployment of the left IC air bag provided no further information as the vehicle was no longer available for inspection. The root cause of the non-deployment remains undetermined.

2010 Chevrolet Cobalt Occupant

Driver Demographics

Age/sex: 37 years/female
 Height: 163 cm (64 in)
 Weight: 86 kg (190 lb)
 Eyewear: Unknown
 Seat type: Bucket
 Seat track position: Between middle and rear
 Manual restraint usage: None
 Usage source: Vehicle inspection, EDR
 Air bags: Frontal and IC available, not deployed
 Alcohol/drug data: None
 Egress from vehicle: Removed through right front door by emergency responders.
 Transport from scene: Ambulance
 Type of medical treatment: Hospitalized for 27 days

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
	Concussion with loss of consciousness of unknown duration; GCS=3; traumatic brain injury with acute hypoxemic respiratory failure	Not coded	Exterior environmental object: tree	Certain
1	Fracture, non-displaced, left temporoparietal bone involving squamous and petrous portions and extending across the left middle cranial fossa, through the sella turcica and involving the roof of the sphenoid sinus, mastoid sinus, clivus, and vomer	150206.4	Isolated IPC Other Vehicle or Object - Tree	Certain
2	Contusions cerebral involving primarily right temporal lobe parenchyma, large, and to lesser extent, the posterior portion of right frontal lobe and left temporal lobe	140624.4	Isolated IPC Other Vehicle or Object - Tree	Certain
3	Hemorrhage, subdural, overlying convexity of right temporal lobe	140650.3	Isolated IPC Other Vehicle or Object - Tree	Certain
4	Brain swelling, right, with diffuse effacement of sulci, compression of right ventricle, slight effacement of suprasellar cistern, and subfalcine herniation (image	140664.4	Isolated IPC Other Vehicle or Object - Tree	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
4 (cont.)	below) with 2 to 7 mm (0.08-0.28 in) of right-to-left midline shift; ICP placed in right frontal region			
5	Hemorrhage, subarachnoid, overlying convexity of right temporal lobe and along Sylvian fissure	140693.2	Isolated IPC Other Vehicle or Object - Tree	Certain
6	Contusion, left lung (pulmonary), not further specified	441406.2	Isolated IPC Left Door Panel - Left rear upper quadrant	Certain
7	Fracture posteromedial left 2nd rib, not further specified	450201.1	Isolated IPC Left Door Panel - Left rear upper quadrant	Certain
8	Fracture, comminuted, displaced, mid third left clavicle requiring ORIF	750671.2	Isolated IPC Left Door Panel - Left rear upper quadrant	Certain
9	Fracture, transverse, mid-diaphysis left humerus with mild displacement; requiring ORIF	751251.2	Isolated IPC Left Door Panel - Left rear upper quadrant	Certain
10	Contusion (hematoma) and swelling along left frontoparietal scalp, extending to vertex	110402.1	Isolated Other Vehicle or Object - Tree	Certain
11	Laceration, 8 cm (3.1 in), stellate, complex, left scalp	110602.1	Isolated Other Vehicle or Object - Tree	Certain
12	Contusion (hematoma) to occipital area, not further specified	110402.1	Isolated Exterior of Occupant's Vehicle - Left roof side rail	Probable

Sources: Emergency room records and hospitalization records. Injury Number 12 came only from emergency room records. Injury numbers 1 to 11 came from a combination of emergency room and hospitalization records.

The third type of herniation is subfalcial or transfalcial herniation (Figure 9). This occurs when there is a rapidly expanding mass in one cerebral hemisphere or at least in the subdural space on one side. This causes herniation of the cerebral hemisphere across the midline below the edge of the falx. The herniating tissue is most often the cingulate or supracingulate gyrus.

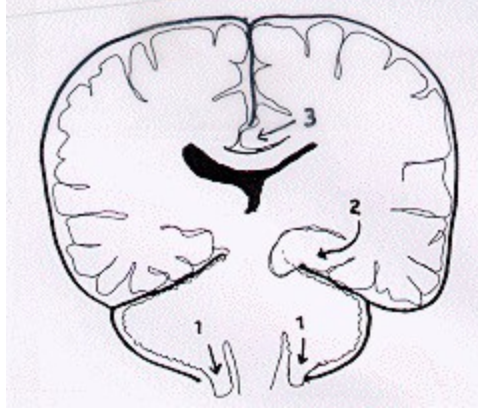
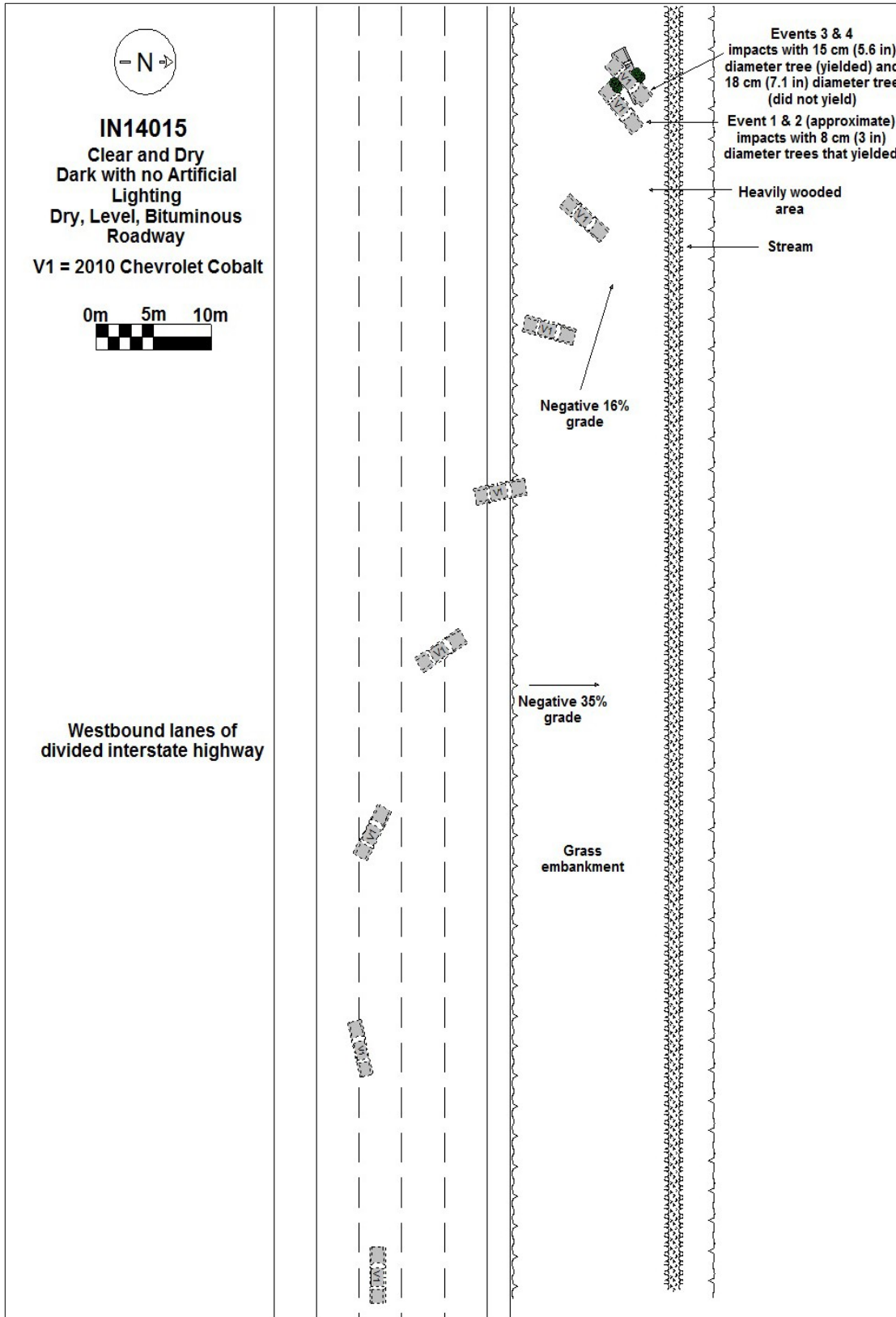


Figure 9. Drawing illustrating (1) tonsillar, (2) transtentorial, and (3) subfalcial herniation of brain

Driver Kinematics

The driver was not restrained by the lap and shoulder seat belt, and the seat track was adjusted between the middle and rear positions. The driver was displaced to the left and rearward during the tree impacts, and her left arm and chest contacted the intruded left front door, causing a left lung contusion, fracture of the left second rib, comminuted and displaced fracture of the left clavicle, and a fracture of the left humerus. Her head was partially ejected through the disintegrated left front glazing and contacted a tree, causing an 8 cm (3.1 in) long laceration to the left scalp, contusion to the left fronto-parietal scalp, fracture of the left temporo-parietal bone, cerebral contusions, subdural and subarachnoid hemorrhage, and brain swelling. She also sustained a contusion to the occipital area of her head from contact with the exterior surface of the left roof side rail. Emergency responders forced open the right front door with a mechanical rescue tool and removed the driver from the vehicle. She was transported by ambulance to a trauma center, where she was hospitalized for 27 days.

Crash Diagram



Appendix A: Event Data Recorder Report for 2010 Chevrolet Cobalt¹

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	1G1AD1F52A7*****
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	IN14015_V1-ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 12.3
Reported with CDR version	Crash Data Retrieval Tool 19.6.3
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). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. 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 Deployment Event #2, 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 of 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 may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 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 Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle 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 can record up to 220 milliseconds of data after Deployment criteria is met and up to 70 milliseconds before Deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.
- The CDR tool displays time from Algorithm Enable (AE) to time of Deployment command in a Deployment event and AE to time of maximum SDM recorded vehicle velocity change in a Non-Deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when Deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the Deployment time of another air bag system.
- Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity. If a CDR Printout user were to calculate resultant velocity change using X and Y axis time history data, the calculated value may be different than the Maximum SDM Recorded Velocity Change parameter value displayed in the CDR report. This is due to the rounding that occurs within the SDM while calculating the Maximum SDM Recorded Velocity Change value.
- 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 is present to send the pre-crash data
- Vehicle speed, Transmission Gear Select, and Transmission Actual Gear will be marked as invalid for manual transmission vehicles
- Pre-crash data associated with this event will always be for the first event even if it is not recorded.
- Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit, except: The Passenger Belt Switch Circuit Status for 2005 vehicles is available only on the Cadillac STS. The Passenger Belt Switch Circuit Status for 2006 Chevrolet Cobalt Sport Coupe (AP) model vehicles, with the option package that includes Recaro brand seats (RPO ALV), always reports a default value of "Buckled," because there is no passenger belt switch with the Recaro seat option. The Passenger Belt Switch Circuit Status for 2010 Chevrolet Cobalt and 2010 Pontiac G5 vehicles, with RPO Z49, will report a default value of "Buckled". The Passenger Belt Switch Circuit Status for 2010 and 2011 Chevrolet HHR, with the LS or LT trim package and RPO Z49, will report a default value of "Buckled".
- 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 the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first. Time Between events is measured from end of one event to the beginning of a next event. An event may occur within 5 seconds of another event, known as an extended event. This occurs when three or more sequential events are separated by more than 5 seconds but each event in the sequence is no more than 5 seconds apart from a subsequent event. Pre-crash data is locked to the first event in an extended event.
- If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
- The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-modding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition counter.
- Steering Wheel Angle data is reported in 16 degree increments. 2005 through 2010 Chevrolet Cobalt, 2005 and 2006 Pontiac Pursuit, 2007 through 2010 Pontiac G5, and 2006 through 2011 Chevrolet HHR, do not record Steering Wheel Angle data and should not be relied upon.
- If more than one event is recorded, use the follow to determine which event the Multiple Event Data is associated with:
 - If a Deployment event and not locked Non-Deployment event are recorded, the Multiple Event Data is associated with the Deployment event.
 - If a Deployment event and a locked Non-Deployment event are recorded, then the Multiple Event Data is associated with both events.
 - If a Deployment event and Deployment event #2 are recorded, then the Multiple Event Data is associated with both events.
- 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 Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle's communication network.
 - The Belt Switch Circuit is wired directly to the SDM.

Data Element Sign Convention:

The following table provides an explanation of the sign notation for data elements that may be included in this CDR report. Directional references to sign notation are all from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.

Data Element Name	Positive Sign Notation Indicates
Longitudinal Velocity Change	Forward
Lateral Velocity Change	Left to Right
Lateral Acceleration	Left to Right
Yaw Rate	Clockwise *
Steering Wheel Angle	Clockwise *

*For Cadillac STS model vehicles with StabiliTrak 3.0 systems (RPO JL7), the positive sign notation Indicates a counterclockwise rotation.

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.



01016_SDMEps_r011

Multiple Event Data

Associated Events Not Recorded	0
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	No
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	No

System Status At AE

Vehicle Identification Number	**1AD1F5*A*****
Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active
Brake System Warning Lamp (If Equipped)	OFF

System Status At 1 second

Transmission Range (If Equipped)	First Gear
Transmission Selector Position (If Equipped)	Second Gear
Traction Control System Active (If Equipped)	No
Service Engine Soon (Non-Emission Related) Lamp	OFF
Service Vehicle Soon Lamp	OFF
Outside Air Temperature (degrees F) (If Equipped)	80
Left Front Door Status (If Equipped)	Closed
Right Front Door Status (If Equipped)	Closed
Left Rear Door Status (If Equipped)	Unused
Right Rear Door Status (If Equipped)	Unused
Rear Door(s) Status (If Equipped)	Closed

Pre-crash data

Parameter	-2 sec	-1 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No

Pre-Crash Data

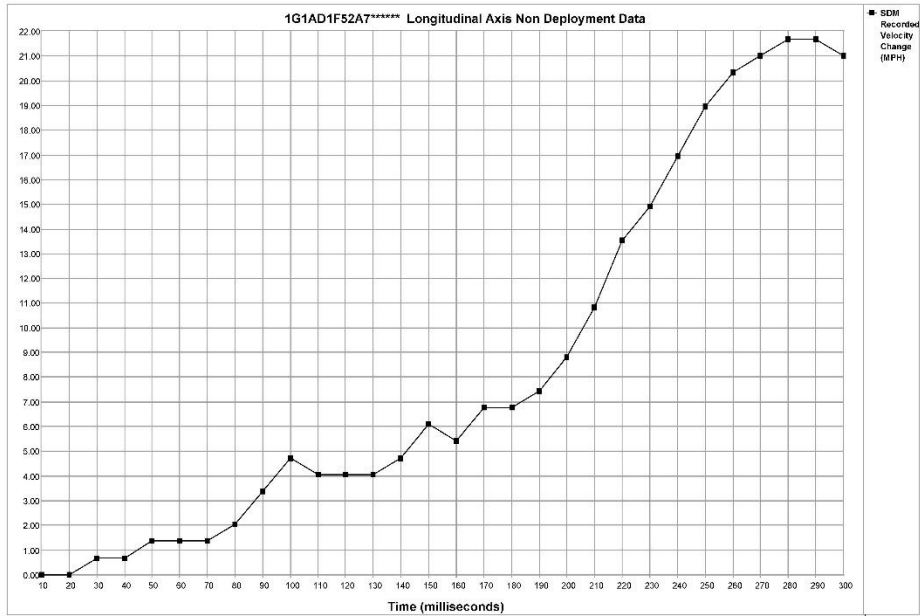
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	69	69	56	35	10
Engine Speed (RPM)	3456	3456	2816	2816	1600
Percent Throttle	21	100	18	21	20
Brake Switch Circuit State	OFF	OFF	OFF	OFF	OFF
Accelerator Pedal Position (percent)	0	78	0	0	0
Antilock Brake System Active (If Equipped)	No	No	Yes	Yes	Yes
Lateral Acceleration (feet/s ²)(If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid



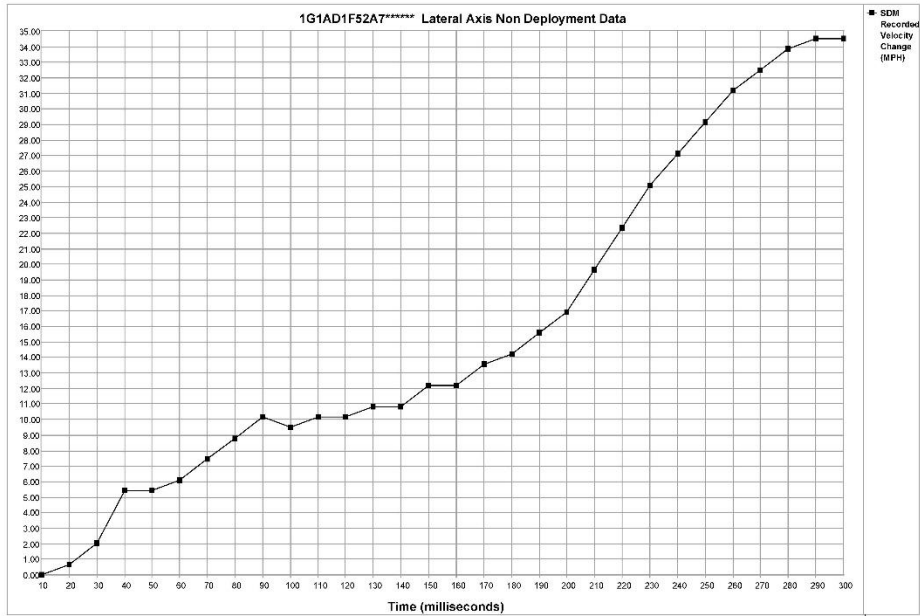
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Yaw Rate (degrees per second) (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Steering Wheel Angle (degrees) (If Equipped)	0	0	0	0	0
Vehicle Dynamics Control Active (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

System Status At Non-Deployment

Ignition Cycles At Investigation	8550
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	655200
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	8549
Ignition Cycles At Event	8550
Ignition Cycles Since DTCs Were Last Cleared	254
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Belt Switch Circuit Status (If Equipped)	UNBUCKLED
Automatic Passenger SIR Suppression System Validity Status at AE	Valid
Automatic Passenger SIR Suppression System Status at AE	Air Bag Suppressed
Diagnostic Trouble Code at Event Enable, fault number: 1	N/A
Diagnostic Trouble Code at Event Enable, fault number: 2	N/A
Diagnostic Trouble Code at Event Enable, fault number: 3	N/A
Diagnostic Trouble Code at Event Enable, fault number: 4	N/A
Diagnostic Trouble Code at Event Enable, fault number: 5	N/A
Diagnostic Trouble Code at Event Enable, fault number: 6	N/A
Maximum Resultant SDM Recorded Vehicle Velocity Change (MPH)	41.03
Time From Algorithm Enable to Maximum Resultant SDM Recorded Vehicle Velocity Change (msec)	320
Driver First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Third Row Left Roof Rail/Head Curtain Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Third Row Right Roof Rail/Head Curtain Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Crash Record Locked	No
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Event Recording Complete	Yes



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.68	0.68	1.36	1.36	1.36	2.03	3.39	4.74	4.07	4.07	4.07	4.74	6.10
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Longitudinal Axis Recorded Velocity Change (MPH)	5.42	6.78	6.78	7.45	8.81	10.84	13.55	14.91	16.94	18.98	20.33	21.01	21.69	21.69	21.01



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.68	2.03	5.42	5.42	6.10	7.45	8.81	10.17	9.49	10.17	10.17	10.84	10.84	12.20
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Lateral Axis Recorded Velocity Change (MPH)	12.20	13.55	14.23	15.59	16.94	19.65	22.36	25.07	27.11	29.14	31.17	32.53	33.88	34.56	34.56



Hexadecimal Data

```
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$02 30 00 00 00 00 00 00
$03 00 00 00 00 00 00 00
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$05 00 00 00 00 00 00 00
$06 00 0A 00 03 0A 00 00
$07 00 20 00 00 00 00 00
$08 00 00 00 00 00 00 00
$09 00 00 00 00 00 00 00
$0A 00 00 00 00 00 00 00
$0B 00 00 0F 0F 03 00 00
$0C 00 00 00 00 00 00 00
$0D 00 00 40 00 00 00 00
$0E 00 00 00 00 00 00 00
$0F 00 00 00 00 00 00 00
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$1F 28 00 00 00 00 00 00
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$2F 00 FE 21 66 00 00 00
$30 9D 00 00 00 00 00 00
$31 00 00 00 C7 00 00 00
$32 00 00 00 00 00 00 00
$33 34 35 2D FE 35 00 00
$34 19 2C 2C 36 36 00 00
$35 10 38 5A 6F 6F 00 00
$36 00 00 00 00 00 00 00
$37 E0 00 00 01 02 00 20
$38 85 00 40 00 03 C0 00
$39 00 00 00 00 00 80 00
$3A 00 00 00 00 00 80 00
$3B 0D 05 1D 04 0D 00 00
$3C DB E1 C0 7E E8 60 00
$3D 31 41 44 31 46 35 00
$3E 41 FF FF FF 00 00 00
$3F 00 00 90 00 00 00 00
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$41 00 00 00 00 00 00 00
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```
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$4B 10 06 10 07 12 09 00
$4C 12 08 14 0A 15 0A 00
$4D 17 0B 19 0D 1D 10 00
$4E 21 14 25 16 28 19 00
$4F 2B 1C 2E 1E 30 1F 00
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$18 FF FF FF FF
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$23 31 41 FA FA FA FA FA
$24 31 41 FA FA FA FA FA
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$26 32 41 FA FA FA FA FA
$40 00 00
```



```
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$43 00 00 8E 80
$44 D6 00 00 FC C0 C0
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$46 EC 1C 1C 64 28
$47 0A 64 02 04 04 05 0A 06 04 0A 00 00 FA 00 00 FF 04 64
$48 18 08 08
$B0 58
$B1 FD FE 00
$B2 FF FF FF FF FF
$B4 41 53 30 30 30 35 32 34 31 4B 59 32 20 20 20 20
$B7 50 AA 01 02 09
$B8 44 45 84 03 03
$C1 30 32 30 39
$CA 30 32 30 39
$CB 01 8C 93 75
$CC 01 8C 93 75
$D1 00 00
$DB 00 00
$DC 00 00
```

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DOT HS 813 088
April 2021



U.S. Department
of Transportation
**National Highway
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