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

NHTSA

DOT HS 812 837

November 2019

Special Crash Investigations On-Site Alleged Air Bag Non-Deployment Crash Investigation Vehicle: 2011 Hyundai Sonata Location: Pennsylvania Date: January 2018

DISCLAIMER

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Suggested APA Format Citation:

Crash Research & Analysis, Inc. (2019, November). *Special Crash Investigations:* O*n-Site Alleged Air Bag Non-Deployment Crash Investigation*; *Vehicle: 2011 Hyundai Sonata; Location: Pennsylvania; Crash Date: January 2018* (Report No. DOT HS 812 837). National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No. DOT HS 812 837	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Special Crash Investigations: On-Site Alleged Air Bag Non-Deployment Crash Investigation Vehicle: 2011 Hyundai Sonata Location: Pennsylvania Crash Date: January 2018		5. Report Date: November 2019 6. Performing Organization Code	
7. Author Crash Research & Analysis, Inc.		8. Performing Organization Report No. CR18002	
9. Performing Organization Name and Address Crash Research & Analysis, Inc. PO Box 302 Elma, NY 14059		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTNH22-12-C-00269	
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration National Center for Statistics and Analysis (NVS-411) 1200 New Jersey Avenue SE Washington, DC 20590		13. Type of Report and Period Covered Technical Report Crash Date: January 2018 14. Sponsoring Agency Code	

15. Supplementary Notes

Each crash represents a unique sequence of events and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the on-site investigation of a crash of a 2011 Hyundai Sonata sedan and the non-deployment of its air bag systems. The Hyundai was involved in a minor frontal impact with a 2009 Chevrolet Impala while being driven by a belted 67-year-old female. The crash occurred when the Hyundai entered an intersection and struck the Chevrolet on its left plane. The Hyundai's driver stated that the vehicle was traveling approximately 32- to 49 km/h (20- to 30 mph) when the crash occurred. The Hyundai was equipped with front seat belt pretensioners, a Certified Advanced 208-Compliant (CAC) frontal air bag system, roof-side-rail-mounted inflatable curtain (IC) air bags, and front seat-mounted side impact air bags. The pretensioners did not actuate and none of the air bag systems in the vehicle deployed as a result of the crash. The Hyundai's driver was not injured.

Through the course of this investigation, the SCI investigator concluded that the crash was not of sufficient severity to result in the actuation of the Hyundai's pretensioner systems or the deployment of any of its supplemental restraint devices (air bags). A damage assessment of the Hyundai revealed minor severity deformation, with no significant structural deformation in either the longitudinal or lateral direction. Similarly, data imaged from the Chevrolet's EDR indicated that delta-V of the focal crash event was of insufficient magnitude to meet threshold for supplemental restraint actuation/deployment in the Chevrolet. The combination of the minor severity crash forces and the Hyundai driver's use of the manual restraint system did not displace the driver during the crash, and she did not sustain injury. The SCI investigator concluded that supplemental restraint actuation/deployment in the Hyundai for this crash was not warranted. No malfunction of the system was indicated.

17. Key Words non-deployment, threshold, minor severity		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 28	22. Price

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

Table of Contents

SPECIAL CRASH INVESTIGATIONS
ON-SITE ALLEGED AIR BAG NON-DEPLOYMENT
CRASH INVESTIGATION
CASE NUMBER: CR18002
OFFICE OF DEFECTS INVESTIGATION
VEHICLE: 2011 HYUNDAI SONATA
LOCATION: PENNSYLVANIA
CRASH DATE: JANUARY 2018

BACKGROUND

This report documents the on-site investigation of a crash involving a 2011 Hyundai Sonata (**Figure 1**) sedan and the non-deployment of its air bag systems. The Hyundai was involved in a minor frontal impact with a 2009 Chevrolet Impala while being driven by a belted 67-year-old female. The crash occurred when the Hyundai entered an intersection and struck the Chevrolet on its left plane. The Hyundai's driver stated that the vehicle was traveling approximately 32- to 49 km/h (20- to 30 mph) when the crash occurred. The Hyundai was equipped with front seat belt pretensioners, a Certified Advanced 208-Compliant (CAC) frontal air bag system, dual-sensing (side impact and rollover) inflatable curtain (IC) air bags, and front-seat-mounted side impact air bags. The pretensioners did not actuate and none of the air bag systems in the vehicle deployed as a result of the crash. The Hyundai's driver was not injured.

Figure 1. Front right oblique view of the Hyundai at the time of the SCI vehicle inspection.

Notification of the crash was provided to the National Highway Traffic Safety Administration by the vehicle's owner in January 2018. The notification was forwarded to the Special Crash Investigations (SCI) group and assigned for on-site investigation to the team at Crash Research & Analysis (CRA). The SCI team located the vehicle at a regional salvage facility and established cooperation to inspect the vehicle. The on-site SCI investigation took place during February 2018, and included inspections of the Hyundai, Chevrolet, and crash site. Inspection of the Hyundai included documentation of its exterior and interior damage, and an assessment of the manual and supplemental restraint systems. The Hyundai's air bag control module (ACM) was removed from the vehicle and retained by the SCI investigator with the permission of the vehicle's insurer. Following the on-site inspection, the ACM was forwarded to NHTSA for potential data retrieval. However, the Hyundai's manufacturer indicated that the 2011 Sonata was not supported by the software, and no valid data could be retrieved. The Chevrolet's event data recorder (EDR) was imaged using the Bosch Crash Data Retrieval (CDR) tool. After completing the vehicle inspections, the SCI investigator documented the crash site with photographs and a Nikon Nivo 5+M total station mapping system. A complete telephone interview of the Hyundai's driver was conducted prior to the on-site SCI investigation.

Through the course of this investigation, the SCI investigator concluded that the crash was not of sufficient severity to result in the actuation of the Hyundai's pretensioner systems or the deployment of any of its supplemental restraint devices (air bags). An assessment of the damage to the Hyundai revealed minor severity deformation, with no significant structural deformation in either the longitudinal or lateral direction. Similarly, data imaged from the Chevrolet's EDR indicated that delta-V of the focal crash event was of insufficient magnitude to meet threshold for supplemental restraint actuation/deployment in the Chevrolet. The combination of the minor severity crash forces and the Hyundai driver's use of the manual restraint system did not displace the driver during the crash, and she did not sustain injury. The SCI investigator concluded that supplemental restraint actuation/deployment in the Hyundai for this crash was not warranted. No malfunction of the system was indicated.

SUMMARY

Crash Site

The crash occurred in an urban area at the intersection of two surface streets during mid-day in January 2018. According to the National Weather Service, conditions at the time of the crash included clear skies with a temperature of 1.1 °C (34 °F), a north-northwest wind of 33.0 km/h (20.5 mph), and relative humidity of 50 percent. The physical environment of the roadway and intersection was documented during the SCI crash site inspection using photographs and a Nikon Nivo 5.M+ total station mapping system. The intersection was configured with a single-lane, one-way northbound roadway and a two-lane, two-way east/west roadway. The Hyundai's pre-crash travel trajectory was straight along the level 8.0 m (26.2 ft) wide northbound roadway that was bordered by concrete curbs. Although the one-way roadway had no lane markings, it was wide enough for a center single lane-width of through traffic with outboard curbside parking. **Figure 2** depicts a lookback view of the Hyundai's pre-crash approach, while **Figure 3** depicts its northbound approach to the intersection.

Figure 2. South-facing lookback view toward the Hyundai's pre-crash approach.

Figure 3. North-facing view of the Hyundai's pre-crash travel trajectory.

The two-way roadway had a total width of 12.0 m (39.4 ft) and was divided by a double-solid yellow centerline. It was bordered by concrete curbs. Both directions had widths that supported a single lane of through traffic with outboard parking. An additional feature of the east/west roadway was that it also contained embedded rails for the locale's mass-transit rail car system. The surface of the east/west road consisted of both concrete and bituminous (asphalt) mediums. **Figure 4** provides a west-facing view for the Chevrolet's approach. Speed in all directions was controlled by a posted limit of 56 km/h (35 mph). Several utility poles populated the corners of the intersection, many of which supported the equipment and wires of the electronic traffic control signals. A crash diagram is included at the end of this technical report.

Pre-Crash

The sole occupant of the Hyundai was a 67-year-old female driver. She was belted by the vehicle's 3-point manual lap and shoulder seat belt system. The driver reported during interview that she was driving north on the one-way street. She recalled that she had been driving the vehicle at approximately 32- to 49 km/h (20- to 30 mph) when she lost focus on the driving task and stopped paying attention. Then she suddenly looked up and recognized that she was entering the intersection against the steady red phase of the electronic traffic signal. The driver stated that she did not believe that she applied the brakes prior to the crash.

Figure 4. West-facing view of the intersection for the Chevrolet's pre-crash travel trajectory.

The Chevrolet approached the intersection from the east, occupied by a 27-year-old belted female driver and a 50-year-old belted male front row right occupant. The driver intended to proceed west through the steady-green traffic signal and continue west on the two-lane roadway. Pre-crash data imaged from the Chevrolet's EDR indicated that the vehicle was traveling 51 km/h (32 mph) at 2.5 seconds prior to algorithm enable (AE). Braking was initiated by the Chevrolet's driver at the 0.5-second pre-crash interval, indicative that the Chevrolet's driver recognized the encroachment of the Hyundai into the intersection and attempted evasive action.

Crash

The first crash event occurred as the front plane of the Hyundai struck the left plane of the Chevrolet. Directions of force were in the 2 o'clock sector for the Hyundai and the 11 o'clock sector for the Chevrolet. Minor deformation resulted to both vehicles' affected planes, and the trajectories of the vehicles were redirected toward the northwest. The Chevrolet approached the northwest corner of the intersection and began to depart the roadway. The second crash event then occurred as the extreme right aspect of the Chevrolet's front plane struck a steel large-diameter utility pole that supported the overhead electronic traffic control signals. This impact was in the 12 o'clock sector for the Chevrolet.

As the Chevrolet came to final rest against the utility pole, a third impact event occurred as the front plane of the Hyundai struck the rear aspect of the Chevrolet's left plane. Minor severity forces were in the 12 o'clock sector for the Hyundai and the 8 o'clock sector for the Chevrolet.

The vehicles came to final rest with the front plane of the Hyundai engaged against the left rear of the Chevrolet, and the front right corner of the Chevrolet engaged against the steel utility pole.

Post-Crash

There were several witnesses to the crash, who notified the local emergency response system. Fire department, emergency medical services (EMS), and law enforcement personnel were dispatched to the crash scene. The female driver exited the Hyundai under her own power. She denied injury at the crash site and did not seek medical care. The driver of the Chevrolet complained of pain and was transported by ambulance to a local hospital for evaluation of possible (C-level) injuries, while the male front right occupant of the Chevrolet was not injured.

The investigating law enforcement agency documented the crash site. Both vehicles were recovered and towed to a local yard, then deemed total losses by their respective insurers. They were then transferred to the regional vehicle salvage facility where they were located and inspected for this SCI investigation.

2011 HYUNDAI SONATA

Description

The Hyundai (**Figure 5**) was manufactured in Alabama in March 2010 and was identified by the Vehicle Identification Number (VIN) 5NPEB4AC6BHxxxxxx. It was a 4-door sedan built on a 280 cm (110.2 in) wheelbase with a 2.4 liter, inline, 4-cylinder gasoline engine. The Hyundai's electronic odometer reading remains unknown due to system inoperability. It had a gross vehicle weight rating (GVWR) of 1,950 kg (4,299 lb). Front and rear axle ratings were 1,100 kg (2,425 lb) and 960 kg (2,116 lb), respectively. The curb weight was 1,454 kg (3,206 lb).

Figure 5. Front left oblique view of the 2011 Hyundai Sonata at the time of the SCI vehicle inspection.

Placarding on the frame of the left front door indicated that the vehicle manufacturer's recommended tire size and cold tire pressure for all four axle positions was P205/65R16 at 225 kPa (33 PSI). At the time of the SCI inspection, the vehicle was equipped with Kumho Solus KH25 tires of the recommended size at all four axle positions. All tires had ample tread, and remained inflated without damage or restriction. Matching tire identification numbers (TINs) were "Y0L4 YPL8."

The interior of the Hyundai was configured for the seating of up to five occupants (2/3). The front row consisted of forward-facing bucket seats with adjustable head restraints. At the time of the SCI inspection, the driver's seat was adjusted to a middle track position, with the seat back slightly reclined and the adjustable head restraint 6 cm (2.4 in) upward. The Hyundai's second row consisted of a non-adjustable bench seat that had a capacity of three occupants. Manual safety features included 3-point lap and shoulder seat belts for all five seat positions. The front seat belts were equipped with retractor and lower anchor pretensioners. The Hyundai was further

equipped with supplemental restraint systems that consisted of a CAC frontal air bag system, front seat-mounted side impact air bags, and IC air bags mounted in the vehicle's roof side rails.

Vehicle History

The owner of the Hyundai reported that the vehicle had been involved in one other crash prior to the focal crash. The previous crash occurred at low speeds and consisted of minor side-swiping body damage on the right plane of the vehicle, with no structural damage and no actuation/deployment of supplemental restraint devices. The vehicle's air bag systems had not received any prior service or maintenance. There were no further details concerning the history of the Hyundai at the time of the completion of this technical report.

Figure 6. View of the front plane damage profile to the 2011 Hyundai Sonata.

Exterior Damage

Damage to the exterior of the Hyundai was located on the front plane, associative to the respective primary and secondary frontal impacts with the left plane and left rear corner of the Chevrolet. Deformation and damage associated with the Event #1 impact was distributed across the entire width of the front plane. The bumper fascia and underlying bumper beam were separated from the vehicle, with minor longitudinal and slight lateral deformation to the front plane components (**Figure 6**). The hood's leading edge was deformed rearward, while both frame rail extensions (bumper beam mounts) were deformed at a sharp angle toward the left. Direct contact spanned the Hyundai's entire 150 cm (59.0 in) undeformed end width (**Figure 7**).

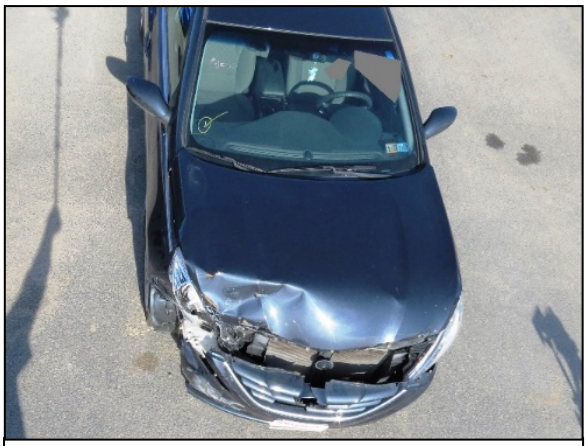


Figure 7. Damage pattern to the front plane of the Hyundai from an overhead perspective.

From a front plane perspective, the width of the direct and induced damage (Field-L) for the crush profile measured 121 cm (47.6 in). Due to the complete separation of the front bumper beam, in order to calculate a representative crush profile, the SCI investigator obtained a crush profile to the leading edge of the hood. This produced the following resultant measurements: C1 = 5 cm (2.0 in), C2 = 3 cm (1.2 in), C3 = 3 cm (1.2 in), C4 = 6 cm (2.4 in), C5 = 4 cm (1.6 in), and C6 = 15 cm (5.9 in). Maximum crush was located at the front right corner. Based on the visible damage, the CDC assigned to the Hyundai for the Event 1 impact with the left plane of the Chevrolet was 02FDEW1.

The damage algorithm of the WinSMASH model was used to calculate the severity of the crash for analysis purposes. The total calculated delta-V of the Hyundai for the front crash event with the Chevrolet's left plane was 11 km/h (7 mph). Longitudinal and lateral components of the

calculated delta-V were -7 km/h (-4 mph) and -9 km/h (-6 mph), respectively. These results appeared reasonable.

The secondary impact of the Hyundai's front plane with the rear aspect of the Chevrolet's left plane (Event 3) was a minor severity impact. Minimal additional damage occurred to the right half of the Hyundai's front plane, which overlapped the initial distributed front plane impact damage. No corresponding crush profile could be documented or attributed to this event. The estimated CDC assigned to the Hyundai for this secondary impact was 12FZEW1.

The Missing Vehicle algorithm of the WinSMASH model was used to calculate the severity of the secondary event for analysis purposes. The total calculated delta-V of the Hyundai for the secondary front plane crash event with the Chevrolet's left plane was 8 km/h (5 mph). Longitudinal and lateral components of the calculated delta-V were -7 km/h (-4 mph) and -4 km/h (2 mph), respectively. These borderline results appeared reasonable.

Event Data Recorder

The Hyundai was equipped with an ACM that was mounted to the center tunnel beneath the center instrument panel. The ACM monitored the diagnostic functions of the vehicle's supplemental restraint systems (air bags and seat belt pretensioners) and controlled the deployment/actuation of those devices dependent upon crash event trigger severity.

The ACM did not have EDR capabilities supported by the Bosch CDR software and tool; therefore, the SCI investigator could not image any data from the Hyundai during inspection. However, permission was obtained from the vehicle's insurance owner to remove the ACM during the SCI Inspection and retain it for subsequent inspection by NHTSA. The ACM was removed from the Hyundai by the SCI investigator and sent to NHTSA headquarters for possible further analysis. According to the vehicle's manufacturer, software support for the Sonata began with the 2012 model year. Therefore, this 2011 Hyundai Sonata was not supported by the software, and no valid data could be retrieved.

Interior Damage

The interior of the Hyundai was inspected for crash-related damage, including intrusion and occupant contact. There was no occupant compartment intrusion associated with the two minor frontal crash impacts (Events 1 and 2). In conjunction with the minor severity of the crash impacts, there was no displacement of the occupant or contact by the occupant with interior components. All doors and glazing remained intact, operational, and undamaged.

Manual Restraint Systems

The Hyundai was equipped with 3-point lap and shoulder seat belt systems for all five seating positions. The front seat belt systems used continuous loop webbing with sliding latch plates and adjustable D-rings. The driver's seat belt system retracted onto an emergency locking retractor (ELR), while the front right passenger's seat belt used an ELR/automatic locking retractor (ALR). Both front seat belt systems were equipped with retractor and lower anchor pretensioners, neither of which was actuated as a result of the crash.

At the time of the SCI inspection, the driver's D-ring was adjusted fully upward. The webbing was stowed in a retracted position, but spooled freely from the retractor. Evidence of historical wear was discernable to both the latch plate and webbing of the driver's seat belt system. No visible loading evidence could be detected along the length of the exposed webbing. However, a subtle area of loading abrasions was discernable in the belt path on the latch plate (**Figure 8**). It was apparent to the SCI investigator that the driver was restrained by the driver's seat belt system at the time of the crash.

Figure 8. Latch plate of the Hyundai driver's seat belt system with minor loading abrasion evidence.

Supplemental Restraint Systems

The Hyundai was equipped with front seat belt pretensioners and multiple inflatable supplemental restraints. These included a CAC frontal air bag system that consisted of frontal air bags for the driver and front right passenger positions, with seat belt buckle switch sensors, seat track position sensors, and a front right occupant presence (weight) sensor. The Hyundai was further equipped with front seat-mounted side impact air bags mounted in the outboard aspect of the front seat backs, as well as dual-sensing (side impact and rollover) IC air bags along each roof side rail. None of the supplemental restraint systems actuated or deployed in the incident crash. Based on an interview of the Hyundai's current owner, the vehicle had been involved in one prior crash that consisted of low-speed, minor severity damage. There was no reported prior supplemental restraint system deployment, and there was also no reported prior service or maintenance concerning the vehicle's supplemental restraint systems.

NHTSA Recalls and Investigations

A query of this specific 2011 Hyundai Sonata's VIN on www.safercar.gov identified one manufacturer recall and no investigations as of the date of this report. The recall was issued in March 2017 and was identified by the NHTSA Recall Number 17V152000. The status based on the VIN was listed as "Incomplete." The recall pertained to certain Sonata model vehicles in which the linkages for the driver and front right seat belt systems could potentially detach from the lower anchor pretensioners. If the affected vehicle was involved in a crash, the detachment of the seat belts could increase the risk of occupant injury.

Air Bag Non-Deployment Discussion

None of the Hyundai's available supplement restraint systems actuated or deployed in the incident crash. The SCI investigator's inspection of the vehicle was unable to identify any anomaly with the supplemental restraint systems. Due to the make and model of the vehicle, it was not supported by the Bosch CDR software/tool and the SCI investigator had no means by which to obtain any data from the vehicle's ACM. The ACM was removed from the vehicle during the SCI inspection with the permission of the vehicle's insurer owner, then sent to NHTSA for further analysis. Ultimately, no valid data could be retrieved from the Hyundai's ACM because the 2011 model year was not supported by the manufacturer's software/tool, or any other available software/tool.

It was evident to the SCI investigator during inspection of the vehicle that the focal frontal crash event with the Chevrolet was likely not of sufficient severity to meet the vehicle's threshold for actuation/deployment criteria. That is, the minor severity of the crash forces did not warrant actuation of the vehicle's pretensioner systems or deployment of its supplemental inflatable restraint devices. This was supported by the fact that the driver, who was restrained, remained in position during the crash sequence and did not contact interior components or sustain injury. It was the SCI investigator's opinion that supplemental device actuation/deployment would not be expected in other crash events with similar magnitude. No performance anomaly of the Hyundai's supplemental restraint systems was suspected or detected by this SCI investigation.

2011 HYUNDAI SONATA OCCUPANT DATA

Driver Demographics

Age/sex:	67 years/female
Height:	155 cm (61 in)
Weight:	86 kg (190 lb)
Eyewear:	None
Seat type:	Forward-facing bucket seat with adjustable head restraint
Seat track position:	Middle
Manual restraint usage:	3-point lap and shoulder seat belt system
Usage source:	Vehicle inspection
Air bags:	Front, seat-mounted side impact, and IC air bags available None deployed
Alcohol/drug involvement:	None
Egress from vehicle:	Exited vehicle under own power
Transport from scene:	None
Type of medical treatment:	None; denied injury and did not seek care

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
-	None	N/A	N/A	N/A

Source: Driver interview.

Driver Kinematics

The 67-year-old female was positioned in the driver's seat of the Hyundai. She had adjusted the seat to a middle track position, with the seat back slightly reclined and the adjustable head restraint approximately 6 cm (2.4 in) upward. She used the available 3-point lap and shoulder seat belt system for manual restraint, evidenced by the post-crash condition of the seat belt system as observed by the SCI investigator during the vehicle inspection.

The driver described to the SCI investigator during interview that she lost focus on the driving task as she approached the intersection. She recalled glancing up toward the traffic light and recognizing that she was proceeding into the intersection against the steady red phase of the signal. The driver believed that she did not apply the vehicle's brakes prior to impact.

At impact with the Chevrolet, the driver initiated a forward trajectory. She loaded the seat belt system, evidenced by the minor abrasion in the belt path on the latch plate observed during the SCI vehicle inspection. The combination of the low severity of the crash forces and the driver's use of the manual restraint system did not result in driver interaction with interior components. The driver remained in the driver's seat as the vehicle was redirected toward the northwest.

The secondary impact of the Hyundai with the left rear corner of the Chevrolet was of insufficient magnitude to affect the vehicle's trajectory or illicit a kinematic response from the driver. She remained restrained and in the driver's seat position as the vehicle came to final rest.

The driver unbuckled the seat belt system and exited the Hyundai after the crash under her own power. She denied injury at the crash site and did not receive any medical treatment/transport.

2009 CHEVROLET IMPALA

Description

The Chevrolet (**Figure 9**) was identified by the VIN 2G1WU57M091xxxxxx. It was a 4-door sedan manufactured in Canada in May 2009, built on a 281 cm (110.6 in) wheelbase and powered by a 3.9 liter, V-6 gasoline engine. The Chevrolet's electronic odometer reading at the time of the SCI inspection was 137,116 km (85,200 mi). It had a GVWR of 2,142 kg (4,723 lb). Front and rear axle ratings were 1,145 kg (2,525 lb) and 997 kg (2,198 lb), respectively. The curb weight was 1,684 kg (3,713 lb). Placarding on the frame of the left front door indicated that the vehicle manufacturer's recommended tire size and cold tire pressure for all four axle positions was P235/50R18 at 220 kPa (32 psi). At the time of the SCI inspection, the vehicle was equipped with various make/model tires at each of the four axle positions. However, all were of the recommended size. The left front tire had only 2 mm (2/32 in) of tread, but the remaining three positions all had ample tread. The right front tire was flat, de-beaded, and restricted. The left front, left rear, and right rear tires all remained inflated, undamaged, and unrestricted.

Figure 9. Front left oblique view of the 2009 Chevrolet Impala at the time of the SCI vehicle inspection.

The interior of the Chevrolet was configured for the seating of up to five occupants (2/3). The front row consisted of forward-facing bucket seats with adjustable head restraints, while the second row consisted of a non-adjustable bench seat that had a capacity of three occupants. All interior seating surfaces were a leather-like material. Manual safety features included 3-point lap and shoulder seat belts for all five seat positions. The front seat belts were equipped with retractor pretensioners. The Chevrolet was further equipped with supplemental restraint systems that consisted of a CAC frontal air bag system, front seat-mounted side impact air bags, and IC air bags mounted in the vehicle's roof side rails.

Exterior Damage

Damage to the exterior of the Chevrolet was located on the left and front planes, associative to the multiple events of the crash. Deformation from the Event #1 impact was distributed across the front half of the left plane, specifically beginning in the area of the left front axle position and extending rearward to the forward aspect of the left rear door. Within the damage pattern was minor lateral deformation to the left front fender and left front door. The left front axle position was also canted inward, a result of the fracture of the suspension arms and damage to the wheel from the impact. Direct contact began 4 cm (1.6 in) rearward of the left front axle position and extended 171 cm (67.3 in) rearward. This dimensionally matched the direct and induced damage width (Field-L) used to document the residual crush profile (**Figure 10**) of the Event 1 impact damage from the Hyundai. The resultant measurements included: C1 = 3 cm (1.2 in), C2 = 4 cm (1.6 in), C3 = 2 cm (0.8 in), C4 = 3 cm (1.2 in), C5 = 2 cm (0.8 in), and C6 = 3 cm (1.2 in). Maximum crush measured 4 cm (1.6 in) and was located at the rear aspect of the left front fender below the left A-pillar. Based on the visible damage, the CDC assigned to the Chevrolet for the Event 1 impact by the front plane of the Hyundai was 11LYEW1.

The damage algorithm of the WinSMASH model was used to calculate the severity of the crash for analysis purposes. The total calculated delta-V of the Chevrolet for the left plane crash event with the Hyundai's front plane was 11 km/h (7 mph). Longitudinal and lateral components of the calculated delta-V were -8 km/h (5 mph) and 7 km/h (4 mph), respectively, which appeared reasonable.

Figure 10. View of the Event #1 damage pattern to the 2009 Chevrolet Impala.

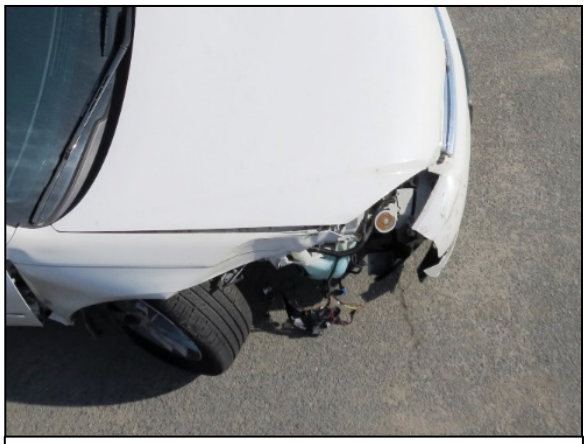


Figure 11. Utility pole damage pattern to the Chevrolet from an overhead perspective.

The second impact with the utility pole occurred at the right front corner aspect of the Chevrolet. Damage included longitudinal displacement of frontal components, outboard of the right frame rail. The right front tire/wheel was deflated and displaced rearward, shortening the vehicle's right wheelbase by 13 cm (5.1 in). No crush profile could be obtained due to the location of the damage outside of the vehicle's front plane structure (**Figure 11**). The CDC assigned to the Chevrolet for the Event 2 utility pole impact was 12FREE3. The corner impact configuration was beyond the scope of the WinSMASH program.

The third impact event, consisting of secondary contact from the Hyundai's front plane, was located at the rear aspect of the Chevrolet's left plane. Direct contact began 22 cm (8.7 in) rearward of the left rear axle position and extended 92 cm (36.2 in) rearward to the left rear bumper corner. Within the damage pattern was minor lateral deformation to the left rear quarter panel and the wrap-around of the rear bumper fascia (**Figure 12**). The resultant residual crush was as follows: C1 = 16 cm (6.3 in), C2 = 16 cm (6.3 in), C3 = 8 cm (3.1 in), C4 = 5 cm (2.0 in), C5 = 2 cm (0.8 in), and C6 = 0 cm (0 in). Maximum crush was located at the left rear bumper corner. Based on the visible damage, the CDC assigned to the Chevrolet for the Event 3 impact by the front plane of the Hyundai was 08LBEW2.

Figure 12. View of the Event #3 damage pattern to the 2009 Chevrolet Impala.

The missing vehicle algorithm of the WinSMASH model was used to calculate the severity of the secondary event for analysis purposes. The total calculated delta-V of the Chevrolet for the secondary left plane crash event with the Hyundai's front plane was 7 km/h (4 mph). Longitudinal and lateral components of the calculated delta-V were 2 km/h (1 mph) and 7 km/h (4 mph), respectively, which appeared reasonable.

Event Data Recorder

The Chevrolet was equipped with an air bag sensing and diagnostic control module (SDM) mounted to the floor of the vehicle beneath the front right seat. The SDM monitored acceleration in the longitudinal and lateral directions and commanded the actuation/deployment of pretensioners and inflatable supplemental restraints dependent upon crash severity. The SDM also had EDR capabilities to record data for longitudinal and lateral crash event types. The EDR component of the Chevrolet's SDM was imaged during the SCI vehicle inspection using the Bosch CDR scan tool and software version 17.6.1, via a direct connection to the SDM. The data was reported with software version 19.0, included at the end of this report as **Appendix A**.

The EDR was capable of recording event records that it termed "Deployment" or "Non-Deployment" event types. By definition, a "Deployment" event was any recognized event in which the SDM commanded deployment of any air bag system. A "Non-Deployment" event did not deploy air bags, but included pretensioner actuation command events. Unlocked non-deployment events were subject to overwrite by subsequent events of greater severity or after approximately 250 ignition cycles, whereas deployment event types could not be overwritten. The EDR had the capacity to store up to one Non-Deployment event and two Deployment event records.

If power supply to the SDM was lost following a crash event, all or part of the data may not have been recorded to the EDR's memory. The EDR had the capacity to record a total of 300 milliseconds of data, including 70 milliseconds prior to deployment threshold achievement and 220 milliseconds after deployment threshold criteria was met. Associated to the recording of each respective event was a 2.5 second pre-crash buffer that recorded multiple pre-crash data

points in 0.5-second intervals. Data recorded included accelerator pedal (% full), vehicle speed (mph), engine speed (rpm), engine throttle (% full), and service brake (On/Off) status. System status data, inclusive of reported Diagnostic Trouble Codes (DTCs), seat belt usage of front row occupants, and vehicle ignition cycle at the time of the event were also recorded.

The imaged data contained one recorded event, which was a "Non-Deployment" event type. It occurred on ignition cycle 14,230, and the data was imaged on ignition cycle 14,236. Based on the cycle count, the recorded event was related to this investigated crash. Both the driver and front right passenger's seat belt buckle switch status data were reported as "Unbuckled." Pre-crash data associative to the event was summarized as follows:

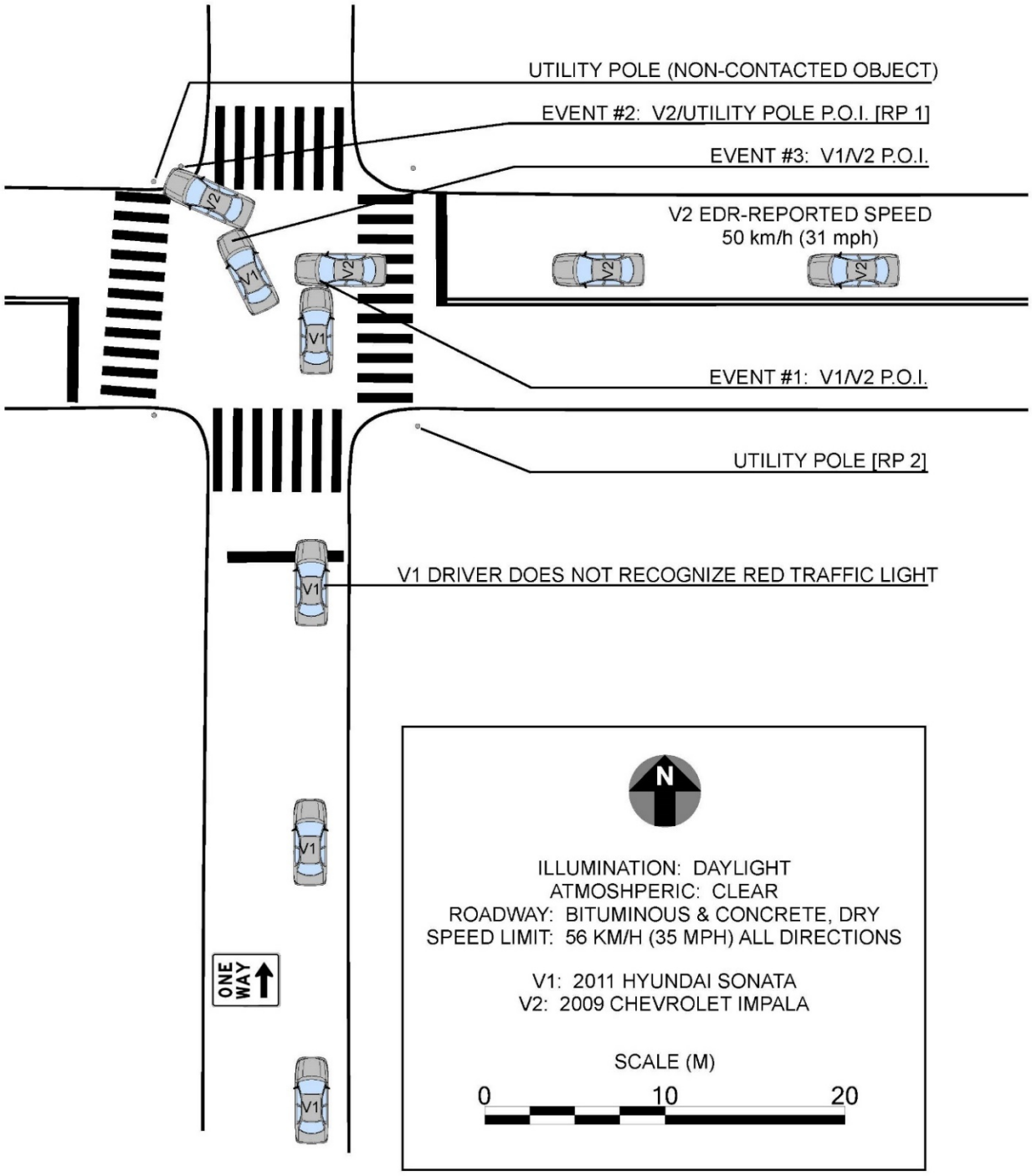
Time	Accelerator Pedal (% Full)	Vehicle Speed	Engine RPM	Engine Throttle (% Full)	Service Brake
-2.5	5	51 km/h (32 mph)	1,344	22	OFF
-2.0	5	50 km/h (31 mph)	1,344	22	OFF
-1.5	6	50 km/h (31 mph)	1,408	24	OFF
-1.0	7	50 km/h (31 mph)	1,344	24	OFF
-0.5	0	49 km/h (30 mph)	1,152	17	ON

The recorded event included a maximum vehicle velocity change (delta-V) of 8 km/h (5.31 mph) at 190 milliseconds. Components of the measured delta-V data included a longitudinal delta-V of -5.7 km/h (-3.56 mph) and a lateral delta-V +5.7 km/h (+3.56 mph). There were no supplemental restraint device actuation/deployment commands transmitted by the Chevrolet's SDM for the recorded event.

Occupant Data

The Chevrolet was occupied by a 27-year-old female driver and a 50-year-old male front row right occupant at the time of the crash. According to a police crash report documenting the circumstances of the crash, both occupants of the Chevrolet were restrained by the vehicle's lap and shoulder seat belt systems at the time of the crash. Of note, the data imaged from the Chevrolet's EDR indicated that neither of the Chevrolet's occupants were belted. The driver complained of pain and was transported by ambulance to a local hospital for evaluation of possible (C-level) injuries, while the front right occupant was not injured. The Chevrolet driver's level of care/treatment remains unknown.

CRASH DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	CR18002

APPENDIX A:
2009 Chevrolet Impala Event Data Recorder (EDR) Report[1]

[1] The EDR report 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 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	2G1WU57M091******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	201850S1CR18002_V2_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.6.1
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 19.0
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 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. If a Non-Deployment occurs within 5 seconds of a deployment event, the ND will be locked to the deployment and cannot be overwritten. A locked Non Deployment Event cannot be overwritten by the SDM. A Non-Deployment can also be locked if two or more Non-Deployment Events occur within five seconds of one another. The recorded pre-crash data will be from the first Non-Deployment Events. 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 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.

-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 status of the brake switch circuit.

-Pre-Crash data is recorded asynchronously. The 0.5 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 0.5

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
-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.
-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.
-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-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-Once a firing loop has been commanded to be deployed, it will not be commanded to be deployed again during the same ignition cycle. Firing loop times for subsequent deployment type events, during the same ignition cycle, will record the deployment times as N/A.
-If more than one event is recorded, use the following 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.

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.

01004_SDMC-autoliv_r008

Multiple Event Data

Associated Events Not Recorded	1
Event(s) was an Extended Concatenated Event	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	Yes

System Status At AE

Low Tire Pressure Warning Lamp (If Equipped)	Invalid
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

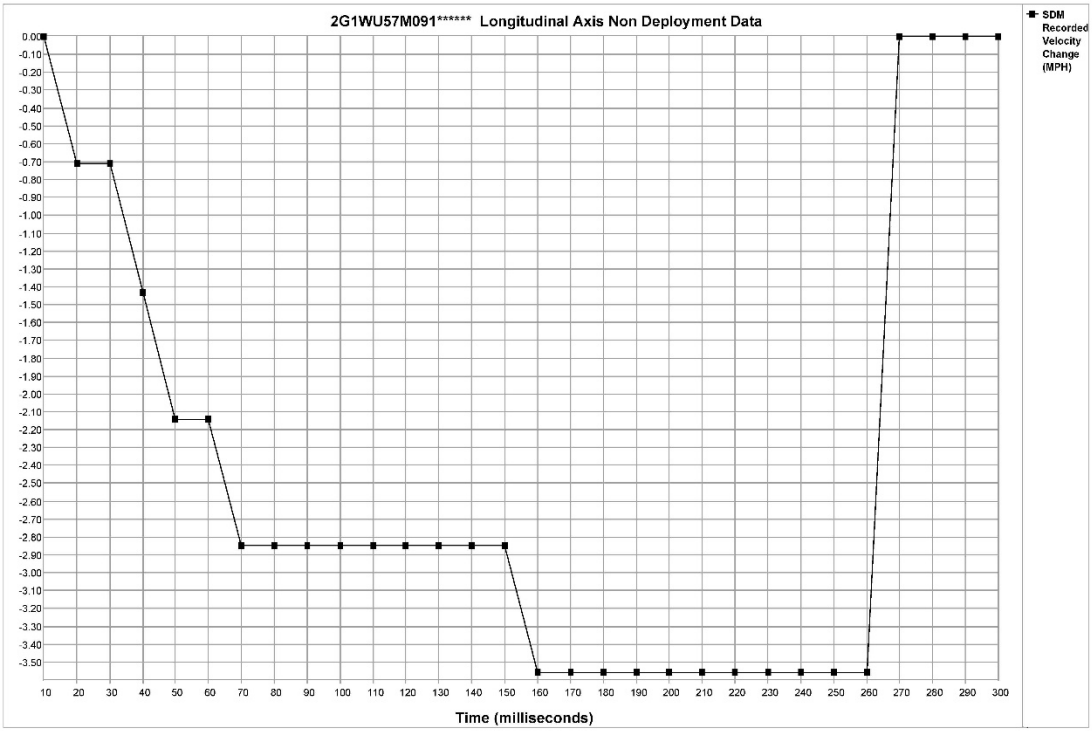
Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	ON	ON
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	Invalid	Invalid

Pre-Crash Data

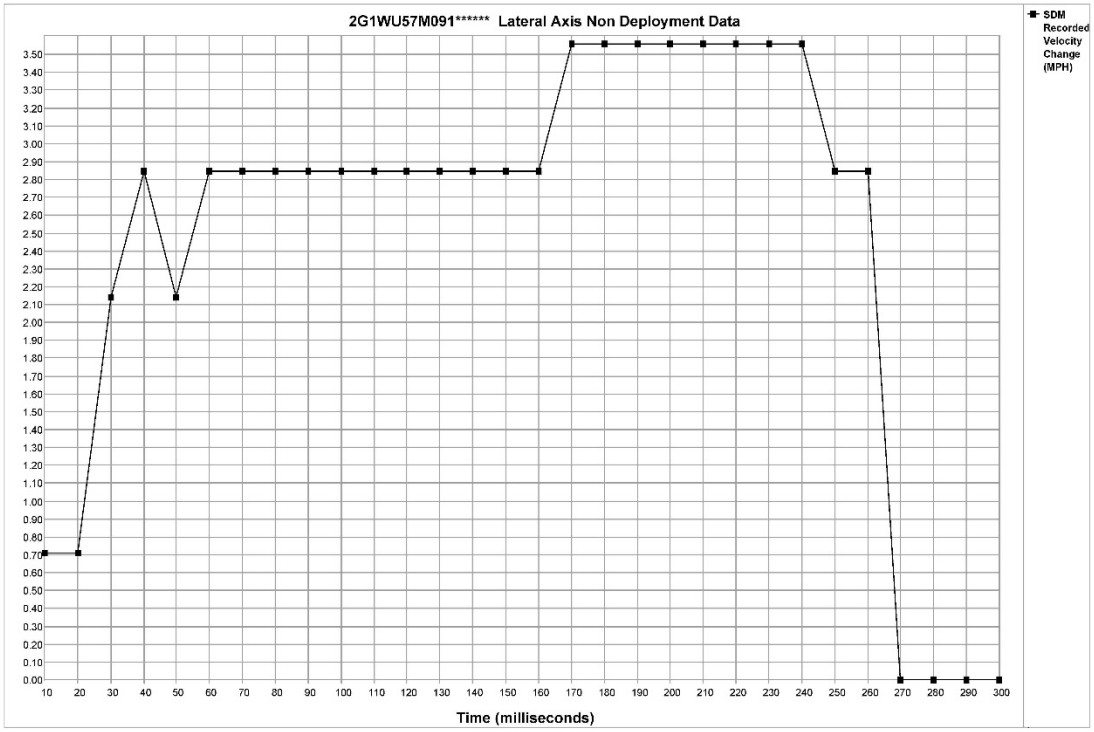
Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Accelerator Pedal Position (percent)	5	5	6	7	0
Vehicle Speed (MPH)	32	31	31	31	30
Engine Speed (RPM)	1344	1344	1408	1344	1152
Percent Throttle	22	22	24	24	17
Brake Switch Circuit State	OFF	OFF	OFF	OFF	ON

System Status At Non-Deployment

Ignition Cycles At Investigation	14236
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON Time Continuously (seconds)	0
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	14083
Ignition Cycles At Event	14230
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Maximum Resultant SDM Recorded Vehicle Velocity Change (MPH)	6.09
Time From Algorithm Enable to Maximum Resultant SDM Recorded Vehicle Velocity Change (msec)	190
Crash Record Locked	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
SDM Synchronization Counter	14229
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Driver Pretensioner Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



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	-0.71	-0.71	-1.43	-2.14	-2.14	-2.85	-2.85	-2.85	-2.85	-2.85	-2.85	-2.85	-2.85	-2.85
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	-3.56	0.00	0.00	0.00	0.00



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Lateral Axis Recorded Velocity Change (MPH)	0.71	0.71	2.14	2.85	2.14	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
SDM Lateral Axis Recorded Velocity Change (MPH)	2.85	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	2.85	2.85	0.00	0.00	0.00	0.00

Hexadecimal Data

$01	00	08	00	00	00	00	00
$02	00	00	00	00	00	00	00
$03	00	00	00	00	00	00	00
$04	00	00	00	00	00	00	00
$05	00	00	00	00	00	00	00
$06	40	00	00	00	00	00	00
$0A	08	00	00	20	00	00	00
$0B	00	00	00	00	00	00	00
$0C	00	00	00	00	00	00	00
$0D	00	00	00	00	00	00	00
$0E	00	00	00	00	00	00	00
$0F	00	00	00	00	00	00	00
$10	00	00	00	00	00	00	00
$11	29	15	15	00	00	00	00
$12	FF	F0	F0	F0	C0	00	00
$13	FF	F0	F0	30	40	00	00
$14	FF	F0	F0	30	40	00	00
$15	01	02	03	04	0B	0C	05
$16	06	16	17	07	08	00	00
$17	00	00	00	00	00	00	00
$18	01	03	04	05	00	00	00
$19	07	07	07	07	07	07	07
$1A	07	07	07	07	07	00	00
$1B	00	00	00	00	00	00	00
$1C	00	00	00	00	00	00	00
$1D	00	00	00	00	00	00	00
$1E	01	00	00	00	00	00	00
$1F	00	00	00	00	00	00	00
$20	00	00	00	00	00	00	00
$21	00	00	00	00	00	00	00
$22	00	00	00	00	00	00	00
$23	00	00	00	00	00	00	00
$24	00	00	00	00	00	00	00
$25	00	00	00	00	00	00	00
$26	00	6B	B2	24	95	4A	09
$27	00	38	00	00	00	00	00
$28	00	00	00	00	00	00	00
$29	00	00	00	00	00	00	00
$2A	00	8A	00	00	00	00	00
$2B	00	00	50	00	00	00	00
$2C	FF	00	00	00	00	00	00
$2D	FF	FF	FF	FF	FF	80	00
$2E	00	80	00	80	00	80	00
$2F	FF	FF	FF	FF	FF	80	00
$30	0F	FF	0F	FF	80	00	00
$31	FF	FF	FF	FF	FF	80	00
$32	FF	FF	FF	FF	FF	80	00
$33	00	00	00	00	00	00	00
$34	00	00	00	00	00	00	00
$35	00	00	00	00	00	00	00
$36	00	00	00	00	00	00	00
$37	00	00	00	00	00	00	00
$38	00	00	00	00	00	00	00
$39	00	00	00	00	00	00	00
$3A	00	FF	00	00	00	00	00
$3B	00	00	00	37	07	00	00
$3C	00	FF	37	9C	06	37	9C
$3D	B4	C0	00	00	00	00	00
$40	00	12	10	0D	0D	00	00
$41	80	00	03	00	80	80	90
$42	12	15	16	15	15	00	00
$43	0F	FF	0F	FF	80	00	00
$44	2B	3C	3C	38	38	00	00

```
$45  30 32 32 32 33 00 00
$46  29 B4 C0 00 00 00 00
$50  A0 A5 00 00 00 00 00
$51  00 00 00 00 00 00 00
$52  00 00 00 37 03 00 00
$53  FF 37 96 37 95 00 00
$54  00 00 00 00 00 00 00
$55  00 00 00 00 00 00 00
$56  00 00 00 00 00 00 00
$57  00 00 00 00 00 00 00
$58  00 00 00 00 00 00 00
$59  00 01 01 01 01 03 00
$5A  02 04 03 03 03 04 00
$5B  04 04 04 04 04 04 00
$5C  04 04 04 04 04 04 00
$5D  04 04 04 04 04 04 00
$5E  05 04 05 05 05 05 00
$5F  05 05 05 05 05 05 00
$60  05 05 05 05 05 05 00
$61  05 04 05 04 00 00 00
$62  00 00 00 00 00 00 00
$63  04 54 54 50 00 00 00
$64  13 00 49 00 00 00 00
$65  00 00 01 A0 02 20 00
$66  00 00 00 00 00 00 00
$90  00 00 00 00 00 00 00
$91  00 00 00 00 00 00 00
$92  00 00 00 00 00 00 00
$93  00 00 00 00 00 00 00
$94  00 00 00 00 00 00 00
$95  00 00 00 00 00 00 00
$96  00 00 00 00 00 00 00
$97  00 00 00 00 00 00 00
$98  00 00 00 00 00 00 00
$99  00 00 00 00 00 00 00
$9A  00 00 00 00 00 00 00
$9B  00 00 00 00 00 00 00
$9C  00 00 00 00 00 00 00
$9D  00 00 00 00 00 00 00
$9E  00 00 00 00 00 00 00
$9F  00 00 00 00 00 00 00
$A0  00 00 00 00 00 00 00
$A1  00 00 00 00 00 00 00
$A2  00 00 00 00 00 00 00
$A3  00 00 00 00 00 00 00
$A4  00 00 00 00 00 00 00
$A5  00 00 00 00 00 00 00

$01  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$02  00 00 00 00
$03  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$04  00 00 00 00
$05  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$06  00 00 00 00
$07  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$08  00 00 00 00
$09  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$0A  00 00 00 00
$0B  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$0C  00 00 00 00
$0D  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
$0E  00 00 00 00
$0F  94 84 00 00
$22  86 36
$23  47 31 57 FA 35 FA FA FA
$24  47 31 57 FA 35 FA FA FA
$25  47 31 57 FA 35 FA FA FA
$26  47 31 57 FA 35 FA FA FA
```

```
$40  00 00
$42  D4 10 10
$43  00 00 FC 9F
$44  C6 00 00 FC 80 C0
$45  00 00 1E 1E 64 64 64 64 04 64
$46  00 00 00 00 00 00 00 00 00 04 64
$47  18 08 08
$B4  41 53 37 32 37 34 45 39 39 30 54 58 5A 35 34 30
$C1  01 8B 94 48
$C2  01 3E 6E 1C
$CB  01 8B 9E 6A
$CC  01 8B 9E 6A
$DB  41 41
$DC  41 41
```

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 812 837
November 2019

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14545-111819-v3