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**Special Crash Investigations:
On-Site Driver's Frontal Air
Bag Non-Deployment
Investigation:
Vehicle: 2007 Chevrolet
Impala;
Location: New York;
Crash Date: February 2018**

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16. Abstract This report documents the on-site investigation of the non-deployment of the driver frontal air bag in a 2007 Chevrolet Impala involved in a road departure/fixed object crash. The Chevrolet was equipped with a certified advanced 208-compliant frontal air bag system and inflatable curtain air bags. The Chevrolet was traveling south operated by a belted 68-year-old male (sole occupant). The driver alleged to the police that the vehicle experienced an episode of unintended acceleration. He applied a left steering input, crossed the centerline and northbound lane, then departed the left (east) side of the roadway. The vehicle entered a commercial parking lot and struck the north wall of a building with the center and right aspects of its front plane. The driver's frontal air bag did not deploy in the crash. The driver complained of left leg and chest pain at the scene, but remained conscious, coherent, and oriented. An ambulance transported him to a regional trauma center. The police were later notified that the driver died of occult-type internal injuries 2.5 hours after the time of the crash. During the course of the investigation, the SCI team determined that the most probable cause of the air bag non-deployment and the lack of EDR recording was a loss of electrical power immediately prior to or at impact. This hypothesis was corroborated by the vehicle manufacturer's technical representatives. The specific cause of the power loss could not be determined.			
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Special Crash Investigations
On-Site Driver's Frontal Air Bag Non-Deployment Investigation
Office Of Defects Investigation
Case No: CR18004
Vehicle: 2007 Chevrolet Impala
Location: New York
Crash Date: February 2018

BACKGROUND

This report documents the on-site investigation of the non-deployment of the driver frontal air bag in a 2007 Chevrolet Impala (**Figure 1**) involved in a road departure/fixed object crash. The Chevrolet was equipped with a certified advanced 208-compliant frontal air bag system and inflatable curtain (IC) air bags. The Chevrolet was traveling south, driven by a belted 68-year-old male (sole occupant). The driver alleged to the police that the vehicle experienced an episode of unintended acceleration. He applied a left steering input, crossed the centerline and northbound lane, then departed the left (east) side of the roadway. The vehicle entered a commercial parking lot and struck the north wall of a building with the center and right aspects of its front plane. The driver frontal air bag did not deploy in the crash. The driver complained of left leg and chest pain at the scene, but remained conscious, coherent, and oriented. An ambulance transported him to a regional trauma center. The police were later notified that the driver died of occult-type internal injuries 2.5 hours after the time of the crash.



Figure 1. Front right oblique view depicting the frontal damage to the 2007 Chevrolet Impala

The investigating police officer of the crash notified the Zone Center of the Crash Investigation Sampling System, operated by the National Highway Traffic Safety Administration. The notification was identified for further research and forwarded to NHTSA's Crash Investigation Division (CID). NHTSA CID then assigned an on-site investigation to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in February 2018. The SCI team contacted and established cooperation with the police investigator the same day. NHTSA also notified the vehicle's manufacturer of the crash, which provided technical representatives to conduct a parallel investigation during the SCI vehicle inspection. The on-site portion of this investigation was conducted during March 2018. It included exterior and interior inspections of the Chevrolet to measure deformation and intrusion, document evidence of interior occupant contact, examine the manual and supplemental restraint systems, and assess the potential causes of the air bag non-deployment and the circumstances of the alleged unintended acceleration. Additionally, the SCI team documented the crash site using digital photographs and a total station mapping system.

The Chevrolet was equipped with an event data recorder (EDR) supported by the Bosch Crash Data Retrieval (CDR) tool and software. The police imaged the EDR as part of their investigation, but no crash event data was recorded by the module. The SCI team also imaged the EDR during the vehicle inspection process with the same result.

A review of the NHTSA web site www.safercar.gov identified three recalls pertaining to the 2007 Chevrolet Impala model as a whole. The recalls pertained to the fuel tank (NHTSA campaign no. 06V419000), the steering system (NHTSA campaign no. 09E005000), and the ignition system (NHTSA campaign no. 14V355000). The ignition system recall involved the possibility of ignition switch rotation out of the “run” position that could affect the safe operation of the vehicle’s air bag systems should a subsequent crash occur. A specific query of the database using the Chevrolet’s Vehicle Identification Number (VIN), however, did not identify any associated open recalls.

During the investigation, the SCI team determined that the most probable cause of the air bag non-deployment and the lack of EDR recording was a loss of electrical power immediately prior to or at impact. This hypothesis was corroborated by the vehicle manufacturer’s technical representatives. The specific cause of the power loss could not be determined.

CRASH SUMMARY

Crash Site

This single-vehicle crash occurred during the morning in February 2018 when the Chevrolet departed a two-lane roadway (**Figure 2**) and struck a brick building. Environmental conditions in the locale reported by the National Weather Service included a temperature of 3 °C (37.9 °F), 76 percent relative humidity, mostly cloudy skies and southwest winds at 35.2 km/h (21.9 mph). The police reported conditions were clear, daylight, and dry.

The brick building and adjacent parking lot were located in a suburban setting on the east side of a two-lane, north/south roadway. The roadway was straight, level, and constructed of asphalt. The width of the southbound lane measured 3.7 m (12.1 ft). The northbound lane measured 3.6 m (11.8 ft) wide. A double yellow centerline and white fog lines delineated the road. The east shoulder was 2.8 m (9.2 ft) wide and the width of the west shoulder measured 2.6 m (8.5 ft). Private residences with driveways lined both sides of the road. The posted speed limit was 64 km/h (40 mph).



Figure 2. Southbound view of the Chevrolet’s approach to the crash site

The brick building was set back 11.8 m (38.7 ft) east of the southbound roadway's edge line on the south side of a parking lot. The width of the building's north side measured 12.3 m (40.4 ft). At the center aspect of the structure was a 2.0 m (6.6 ft) wide chimney that protruded 35 cm (13.8 in) from the sidewall. A 1.5 m (4.9 ft) wide section of the chimney was the point of impact (**Figure 3**). Damage to the structure consisted only of surface abrasions and paint transfers to the bricks over an area that measured 1.5 m x 1.0 m (4.9 ft x 3.3 ft), width by height. None of the chimney bricks fractured in the impact.



Figure 3. Southerly view of the area of the building struck by the Chevrolet

Pre-Crash

The 68-year-old male driver of the Chevrolet was traveling in a southerly direction on the two-lane roadway. The driver alleged that he experienced an unintended acceleration of the vehicle, and responded by applying a left steering maneuver to depart the roadway and enter the parking lot of a local restaurant. The vehicle traversed the parking lot on a southeasterly trajectory and overrode several shallow potholes in the worn asphalt surface. Based on the 64 km/h (40 mph) speed limit of the roadway, likely travel speed of the Chevrolet, and the visual severity of the crash, it appeared that the driver was likely applying the brakes in an attempt to slow or stop the vehicle during its approach to the building. A crash diagram depicting the approximate vehicle trajectory is included at the end of this report.

Crash

The center and right aspects of the Chevrolet's front plane struck the brick chimney located at the center aspect of the building. The SCI crash reconstruction approximated that the Chevrolet approached the building at a relative impact angle of 40 degrees, resulting in a 1 o'clock direction of force. The frontal structure of the Chevrolet crushed to a maximum depth of 63 cm (24.8 in) at the right corner of the bumper reinforcement beam. The force of the impact and resulting deformation fractured/crushed the 12-volt lead acid battery, the engine compartment fuse box, and the electronic throttle control module located at the right aspect of the engine compartment.



Figure 4: Southeast-facing image of the chimney impact and approximate final rest location of the Chevrolet

None of the Chevrolet's air bag systems deployed. Damage to the building was limited to paint transfers on the brick surface and fracturing of a cast iron fireplace cleanout door (**Figure 4**). Due to the angle of impact, the Chevrolet deflected to its left and rotated counterclockwise as it rebounded approximately 4.5 m (14.8 ft) to final rest. At rest, the vehicle was facing east close to the wooden fence and the north face of the building.

Post-Crash

A witness to the crash used her cellphone to notify the emergency response system. Police, firefighters, and emergency medical services (EMS) personnel were dispatched to the crash scene. The driver remained conscious and coherent in the vehicle and was removed by the first responders. He was placed on a cot and transported by ambulance to a Level 1 trauma center, where he was evaluated and treatment for his injuries was initiated. During his examination, the attending physician ordered a computed tomography (CT) scan, which diagnosed that the driver had sustained multiple rib fractures and a hemothorax. Following this procedure and as hospital personnel were transferring him on a gurney to radiology, the driver lost consciousness and coded due to an occult internal injury. Efforts to resuscitate him were unsuccessful, and he expired approximately 2.5 hours after the crash.

The police initially investigated the incident as a routine injury-related crash, without expectations of it resulting in a fatality. The basic level of police reporting was initiated. No on-scene images of the vehicle or crash site were taken. A local tow service responded to the scene and removed the vehicle on a flatbed tow truck. After learning of the fatality, the police subsequently impounded the vehicle at the tow facility, where it was held for SCI inspection.

2007 CHEVROLET IMPALA

Description

The 2007 Chevrolet Impala (**Figure 5**) was a four-door sedan manufactured in February 2007 and identified by VIN 2G1WT58K879xxxxxx. The front wheel-drive powertrain consisted of a 3.5-liter, transverse-mounted, 6-cylinder, Flex Fuel (E85), gasoline engine linked to a 4-speed automatic transmission with a steering-column-mounted shifter. Standard equipment included 4-wheel power-assisted disc brakes with ABS and electronic brakeforce distribution, traction control, and power-assisted speed proportional rack and pinion steering. The gross vehicle weight rating for this vehicle was 2,121 kg (4,676 lb), with gross axle weight ratings of 1,144 kg (2,523 lb) front and 977 kg (2,153 lb) rear. The Chevrolet was configured with Kelly Edge A/S all-season tires equivalent to the vehicle manufacturer's recommended tire size of P225/60R16. They were mounted on OEM 5-spoke alloy wheels. The vehicle manufacturer's recommended tire pressure was 207 kPa (30 PSI) for all four axle positions.



Figure 5. Left front oblique view of the 2007 Chevrolet

Specific tire data at the time of the SCI inspection were as follows.

Position	Tire Identification Number	Measured Tread Depth	Restriction	Damage
LF	M6X3 LRIR 2415	4 mm (5/32 in)	No	None
LR	M6X3 LRIR 3415	3 mm (4/32 in)	No	None
RR	M6X3 LRIR 2415	4 mm (5/32 in)	No	None
RF	M6X3 LR1R xxxx	3 mm (4/32 in)	Yes	Rim deformed, tire aired out

The interior of the Chevrolet was configured to seat six occupants with front row bucket seats, a flip-and-fold center armrest/seat, and a three-passenger rear bench seat. All seating surfaces were cloth. The head restraints in the front row were adjustable. The driver's head restraint was adjusted 1 cm (0.5 in) above the seat back. The front row right was in the full down position and all three second row head restraints were fixed/integrated into the seat backs. Manual restraint was provided by 3-point lap and shoulder seat belts for the front row left and right and the three second row positions. The front row center was equipped with a lap belt. Supplemental restraint consisted of certified advanced 208-compliant dual-stage front air bags and side impact-sensing roof side rail-mounted IC air bags.

NHTSA Recalls and Investigations

The 2007 model year Chevrolet Impala was subject to three potential recalls.

NHTSA Campaign No.	Recall	Date
14V355000	Ignition switch may turn off	06/23/2014
09E005000	Steering knuckle breaking/loss of steering control	02/17/2009
06V41900	Fuel tank adhesive missing	10/12/2006

A VIN-based query of the NHTSA database at www.nhtsa.gov/recalls and the manufacturer's database as of the date of this report did not identify any open recalls for this specific 2007 Chevrolet Impala at the time of the SCI investigation.

Vehicle History

The history for this 2007 Chevrolet Impala was obtained through a review of a commercially available vehicle history report, a global warranty summary provided by the vehicle's manufacturer, and several service records found inside the vehicle. The brother of the driver confirmed several of these reports from his discussions with the driver from previous complaints. The driver purchased the Chevrolet as a new vehicle from a local dealership in May 2007. The odometer reading at the time of purchase was 200 km (124 miles). Routine maintenance consisted of oil changes and tire rotations performed through August 2009.

During that month (mileage not reported), a four-wheel alignment was performed; brake pads and rotors were replaced along with four tires and replacement/repair of the steering shaft. The global warranty summary report detailed the steering shaft replacement as an intermediate

steering shaft at 45,291 km (28,143 miles). During this same service interval, the transmission oil cooler and lines were repaired/replaced and the rear brake rotors were replaced.

An emissions vent solenoid and a purge vent were replaced in April 2010. The battery was serviced in December 2011 at an odometer reading of 90,314 km (56,120 miles). Damage was reported to the front and left front of the vehicle in July 2010. This was not directly reported as crash-related.

A product safety recall for NHTSA campaign no. 14V355000 was performed on July 12, 2017, when the odometer reading was 165,179 km (102,640 mi). This recall required the installation of the ignition key insert and small diameter key ring. It should be noted that the ignition key found in the vehicle at the time of the SCI inspection was compliant with this recall (**Figure 6**). Continued routine maintenance was performed leading up to the date of the crash under investigation. The last reported odometer reading was 171,120 km (106,332 miles) in January 2018.



Figure 6. The Chevrolet's ignition key compliant to Recall No. 14V355000

Exterior Damage

The center and right aspects of the Chevrolet's front plane struck the building with a resultant direction of force in the 1 o'clock sector. The impact fractured the front bumper fascia, the polymer grille and both headlamp assemblies, and deformed the right fender structure. All doors remained closed and were operational post-crash. Direct contact damage on the hood face began 7 cm (2.8 in) left of the vehicle's centerline and continued 72 cm (28.5 in) to the front right corner (**Figure 7**). The combined width of the direct and induced damage extended across the entire 152 cm (60 in) end width of the Chevrolet. A crush profile documented at the level of the bumper beam produced the following resultant measurements: C1 = 1 cm (0.5 in), C2 = 12 cm (4.7 in), C3 = 26 cm (10.2 in), C4 = 39 cm (15.3 in), C5 = 49 cm (19.3 in), C6 = 63 cm (24.8 in).



Figure 7: Front plane damage to the Chevrolet

Maximum crush was 63 cm (24.8 in), located at the right corner of the bumper beam (**Figure 8**). The right front wheel rim was deformed, and the right wheelbase was reduced 10 cm (4.0 in). The collision deformation classification (CDC) assigned to the Chevrolet's front plane damage pattern was 01FZEW3. The damage only algorithm of the WinSMASH program was utilized to compute the severity (delta V) of the crash. The total delta V was 38 km/h (23.6 mph) with a longitudinal component of -35 km/h (-21.7 mph) and a lateral component of -13 km/h (-8.1 mph). The barrier equivalent speed was 38 km/h (23.6 mph), with an energy absorption of 106,039 joules.



Figure 8: Overhead image depicting the frontal damage to the Chevrolet

Event Data Recorder

The Chevrolet was equipped with a sensing and diagnostic control module (SDM) that performed the diagnostic, sensing, and deployment command functions for the vehicle's supplemental restraint systems. This module was fastened to the floor pan under the front row right seat and had EDR capabilities. The police removed the SDM from the vehicle during the course of their investigation. When they imaged the module, they discovered that no data had been recorded by the EDR. The module was then placed into evidence.

The SCI investigator also imaged the module while it was in police possession. This process involved the use of the Bosch CDR tool, software version 17.6.1, and a direct-to-module connection. Electrical power was supplied from a 120-volt source. The imaged file confirming that no events were recorded is included at the end of this report as **Appendix A** and is reported with software version 21.0.

The file's data limitations stated that the EDR was capable of recording two event types, namely non-deployment events and deployment events. A non-deployment recorded data, did not deploy air bags, and required a minimum velocity change (delta V) of 8 km/h (5 mph) for qualification. Pretensioner-only actuation, battery cut-off, and head restraint actuation were considered non-deployment events. An unlocked non-deployment event could be overwritten. A non-deployment event that occurred in 5 seconds of a deployment event became locked and could not be overwritten. Deployment events, by definition, deployed air bags. The recorded data from a deployment event became locked and could not be overwritten. This EDR could store a total of two events. A 5-second pre-crash buffer that described various vehicle performance parameters (including vehicle speed, accelerator pedal position, brake status, engine performance) was recorded for each event record. These performance parameters were recorded asynchronously in 0.5-second intervals.

Interior Damage

The interior of the Chevrolet sustained damage from exterior crash force that resulted in occupant compartment intrusion and occupant induced damage (**Figure 9**) from contact with interior components. The front row right occupant space was reduced in size by longitudinal displacement of the right toe pan 10 cm (4.0 in). The right A-pillar and instrument panel remained intact and undamaged. There was no glazing damage to the Chevrolet. A black athletic-type left shoe, size 10.5M, was found in the front interior.



Figure 9: Overall view of the Chevrolet's interior and occupant related damage



Figure 10: Driver contact damage to the lower instrument panel and knee bolster of the Chevrolet

The driver loaded the seat belt system that produced frictional abrasions on the latch plate and scuffing on the webbing. His left knee/lower extremity contacted the left lower instrument panel. The polymer panel was scuffed with fabric transfer and displaced approximately 4 cm (1.6 in) forward. The area of contact was 6 cm (2.5 in) in width and 24 cm (9.5 in) vertically. His right lower extremity scuffed the left aspect of the protruding lower mid instrument panel and the adjacent knee bolster. Scuff marks and fabric transfers evidenced the contact area that measured 5x8 cm (2x3 in) with forward displacement of the bolster panel and underlying steel backer panel. **Figure 10** depicts the knee bolster and lower instrument panel contact points.

His torso and abdominal regions engaged the steering wheel rim, deforming the lower rim 4 cm (1.5 in) forward and bending the lower steering wheel spokes. Engagement of the steering assembly compressed the energy absorbing steering column approximately 4 cm (1.5 in) causing complete separation of the shear capsules (**Figure 11**).



Figure 11: Separation of the steering column shear capsules in the Chevrolet

The driver's right upper extremity swiped the top surface of the center instrument panel evident by a 13x46 cm (5.1x18.1 in) area of wiping to the dusty surface of the instrument panel (**Figure 12**). His head and/or right upper extremity possibly contacted and fractured the rearview mirror from the windshield header mount.



Figure 12: Interior view of the Chevrolet depicting the contact to the top surface of the instrument panel and center mirror

Alleged Unintended Acceleration

The driver stated to his family member that he had experienced two separate events involving alleged unintended acceleration (UA). These allegations correlated to two service records in the vehicle's history, in which the driver sought service relative to his alleged UA events.

The first event occurred on July 10, 2017. The circumstances surrounding the event are unknown; however, the driver allegedly experienced the UA event and was able to control and stop the vehicle. He called an independent auto repair center and had the vehicle towed to its facility. The vehicle's odometer reading at that time was 165,088 km (102,584 miles). The service invoice referenced an inspection of the vehicle and engine components; however, the repair center was unable to replicate the alleged UA. The Chevrolet's throttle body was cleaned, the air conditioning unit was recharged, and the rear brakes were replaced. The total repair cost was \$521.71. The independent repair center recommended to the driver that he have the vehicle inspected by a Chevrolet dealership.

The driver drove the Chevrolet to a local Chevrolet dealership on July 12, 2017. The recorded odometer reading was 165,179 km (102,640 mi). The service order complaint read as follows: *Vehicle is accelerating on its own, was at 64 km/h (40 mph) and vehicle accelerated, has to be put in "N" (neutral) and then vehicle shuts down. Restarts and is OK, then it happens again. Intermittent.*

The service technician road tested the Chevrolet and could not replicate the UA issue. He did note extremely loud noise from the right front and severe pulsation while braking. The dealership replaced the right front wheel hub/bearing assembly and test drove the vehicle for a total of 35 km (22 mi). Additionally, the dealership completed the remedy for NHTSA campaign no. 14V355000 by installing the ignition key insert and key ring on two keys.

The driver again had the Chevrolet towed to the independent repair facility on July 19, 2017. The odometer reading was 165,256 km (102,688 mi). There was no reported replication of the UA incident by the service center. This service facility replaced the accelerator pedal sensor at a cost of \$308.10. They also test drove the Chevrolet for a total of 14 km (9 mi).

Foot Controls

The Chevrolet was equipped with fixed (non-adjustable) foot pedals for accelerator and brake applications (**Figure 13**). Both pedals were mounted to formed steel levers and hinged at the upper aspects. The face of the brake pedal measured 5 cm (2.0 in) in height with a top measurement of 13 cm (5.1 in) and a bottom width of 11 cm (4.3 in). A rubber pad was mounted over the steel pedal. The lower right corner of the pad was worn through to the steel pedal. There was no apparent deformation or bending of the brake pedal or level arm. The location of the wear on the brake pedal pad indicated that the driver likely used little leg movement to operate the pedals and primarily relied on a pivot-type motion (rotation) of his foot from pedal to pedal. It was possible that both pedals could have been actuated at the same time and was the source of the driver's perception of the alleged unintended acceleration.



Figure 13: Overall image of the Chevrolet's foot pedals



Figure 14: Step over height of the brake pedal from the accelerator pedal

The accelerator pedal of the Chevrolet was electronic with throttle response controlled by an accelerator pedal sensor. There was no direct cable between the pedal and the throttle body. The pedal was suspended and was configured with a vertically positioned rubber pad over a steel pedal mounted to a rigid lever arm. The pedal was 6 cm (2.2 in) in width at the top surface and 7 cm (2.8 in) wide at the bottom aspect. The height of the pedal was 13 cm (5.1 in). The pedal was hinged on the backside with spring tension for positioning. A return spring was also configured to the top aspect of the lever arm. Both springs were intact and functional. The accelerator pedal lever arm was deformed approximately 1-2 cm (0.5-0.75 in) laterally right from occupant foot loading during the crash. The full movement of the accelerator pedal from the returned off-position to the full-throttle position was 6 cm (2.5 in).

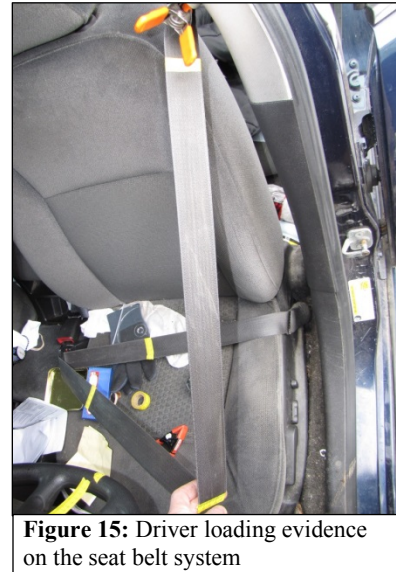
The lateral offset between the pedals was 10 cm (4.1 in). The brake pedal was mounted higher than the accelerator pedal. This step over height differential from accelerator to brake pedal (**Figure 14**) measured 7 cm (2.8 in). Both pedals remained mechanically functional post-crash. It should be noted that the brake pedal was firm on application, suggesting an intact hydraulic braking system. The hydraulic brake fluid in the brake master cylinder reservoir was at the full level. No brake leaks were observed.

Manual Restraint Systems

The Chevrolet was equipped with manual 3-point continuous loop seat belt systems for the front row left and right positions and the three second row seat positions. All 3-point point seat belt systems used sliding latch plates. The driver's seat belt retracted onto an emergency locking retractor (ELR) while the other systems were equipped with switchable ELR/automatic locking retractors (ALR). Both front row retractors were configured with pretensioners that did not actuate in the crash. The B-pillar-mounted D-rings were adjusted to the full-down positions. The front center position was equipped with a manual lap belt.

The driver utilized the seat belt system during the crash. The ELR retractor was not locked. Initial inspection of the seat belt system found the webbing stowed against the B-pillar. Historical usage consisted of frayed edges of the webbing from frequent routing through the latch plate and frictional wear marks on the chrome-plated surface of the latch plate.

Although in use during the crash, it appeared that there was excessive slack in the system possibly due to bulky clothing and forward movement by the driver prior to the ELR locking at the on-set of the impact force. The driver loaded the seat belt webbing evidenced by frictional abrasions to the polymer surface of the latch plate and abrasions and scuffing to the surface of the seat belt webbing (**Figure 15**). An area of abrasion from chest loading began 6 cm (2.5 in) below the D-ring and extended 57 cm (22.5 in) toward the latch plate. A second area of abrasions and waffling of the belt webbing was present in the area of the latch plate and was 39 cm (15.5 in) in length. This area of loading originated 38 cm (15.0 in) below the torso loading evidence and extended downward in relation to the seat belt system. A length of seat belt webbing that was free of loading evidence extended from the lower anchorage at the left aspect of the driver's seat frame 44 cm (17.5 in) to the latch plate area loading. In all, approximately 185 cm (73.0 in) of seat belt webbing was exposed between the D-ring and the lower anchor.



Supplemental Restraint Systems

The Chevrolet was equipped with supplemental restraint systems that provided occupants with additional frontal and side impact protection. The frontal system consisted of a CAC air bag system for the driver and front row right occupant positions. Both air bags were dual-stage; the driver's frontal air bag was contained in the center hub/module of the four-spoke steering wheel and the passenger's frontal air bag was located in the top portion of the right instrument panel. The front right seat was configured with an occupant classification sensor that turned the air bag "on" or "off" dependent on occupant presence and weight.

Additional features of the CAC system included seat belt buckle switches, seat track positioning sensors and seat belt retractor pretensioners. The driver's frontal air bag did not deploy during this crash event and the retractor pretensioners did not actuate. The passenger's frontal air bag was suppressed due to the lack of an occupant in that seat position. The side impact supplemental

air bag system consisted of roof side rail-mounted IC air bags. The IC air bags provided supplemental protection to both front and second row occupant positions. None of the air bags deployed in this singular frontal crash event.

The air bags systems were controlled and monitored by the SDM, which had crash sensing and diagnostic functions. Two satellite frontal crash sensors were mounted to the forward aspect of the upper radiator support. The left sensor was identified by the nomenclature 15250331 (IT) AZE001794E00 01292007. The right sensor was identified by 15250331 (IT) AZE0018C45FF 01262007. The wiring harness for the right sensor was routed on the outside of the radiator support and cut at the left aspect of the sensor during the frontal deformation (**Figure 16**). Any potential signals from the sensor would have transmitted to the SDM during the early portion of the crash, prior to the cut in the wiring harness which occurred in the later stage of the crash event.



Figure 16: Right satellite air bag sensor mounted to the upper radiator support of the Chevrolet and the cut wiring harness

2007 CHEVROLET IMPALA OCCUPANT DATA

Driver Demographics

Age/sex:	68 years/male
Height:	180 cm (71 in)
Weight:	136 kg (300 lb)
Eyewear:	Unknown
Seat type:	Forward-facing split bench seat with adjustable head restraint
Seat track position:	Between mid and rear track
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	Vehicle inspection
Air bags:	Frontal and IC air bags available, none deployed
Alcohol/drug involvement:	None
Egress from vehicle:	Assisted from vehicle by first responders
Transport from scene:	Ambulance
Type of medical treatment:	Transported to a Level 1 trauma center where he expired due to an occult injury during diagnostic evaluation

Driver Injuries

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Right hemothorax	442200.3	Steering wheel rim/ center hub of column	Certain
2	Flail chest – right side, NFS	450211.3	Steering wheel rim/ center hub of column	Certain
3	Left rib fractures, NFS	450200.1	Steering wheel rim/ center hub of column	Certain
4	C2 fracture, NFS	650216.2	Induced fracture from loading of the steering wheel rim/column	Possible
5	Right acetabular fracture	856200.2	Lower instrument panel	Certain
6	Left distal lower extremity fracture; Obvious deformity from the mid- tibia to left distal tibia, ankle and foot swollen and purple	852002.2	Toe pan	Certain
7	Left forehead contusion	210402.1	Center mirror	Probable
8	Left neck contusion	310402.1	Seat belt webbing	Certain
9	Left upper chest contusion	410402.1	Seat belt webbing	Certain
10	Right lower chest contusion	410402.1	Seat belt webbing	Certain
11	Abdominal ecchymosis	510402.1	Steering wheel rim	Certain

Source: Emergency room and EMS records

Driver Kinematics

The 68-year-old male driver of the Chevrolet was operating the vehicle seated in mid-to-rear seat track position with the seat back slightly reclined and the adjustable head restraint adjusted 1 cm (0.5 in) above the seat back. The driver was restrained by the manual seat belt system. Seat belt use was supported by loading evidence on the webbing and hardware of the system. It was believed that the seat belt webbing was positioned over his left shoulder supported by observed habits of a family member. Due to the probable bulk of a winter coat and a possible forward position as he tried to maintain control of the vehicle, the driver introduced additional slack into the seat belt.

At impact with the building, the ELR mode of the seat belt retractor locked and the driver translated forward and right in response to the 1 o'clock direction of force. His torso initially loaded the seat belt, producing abrasions to the webbing in the torso and latch plate regions of the seat belt system. The slack in the seat belt system allowed his pelvic region and torso to translate forward. Frictional abrasions were present on the forward aspect of the right seat cushion indicating the pelvic movement that allowed his knees and lower extremities to contact the lower left instrument panel/knee bolster. His left knee/lower leg contacted the left edge of the knee bolster panel and the left aspect of the lower instrument panel. Scuff marks with embedded fabric transfers evidenced the contact to the polymer surface of the panel.

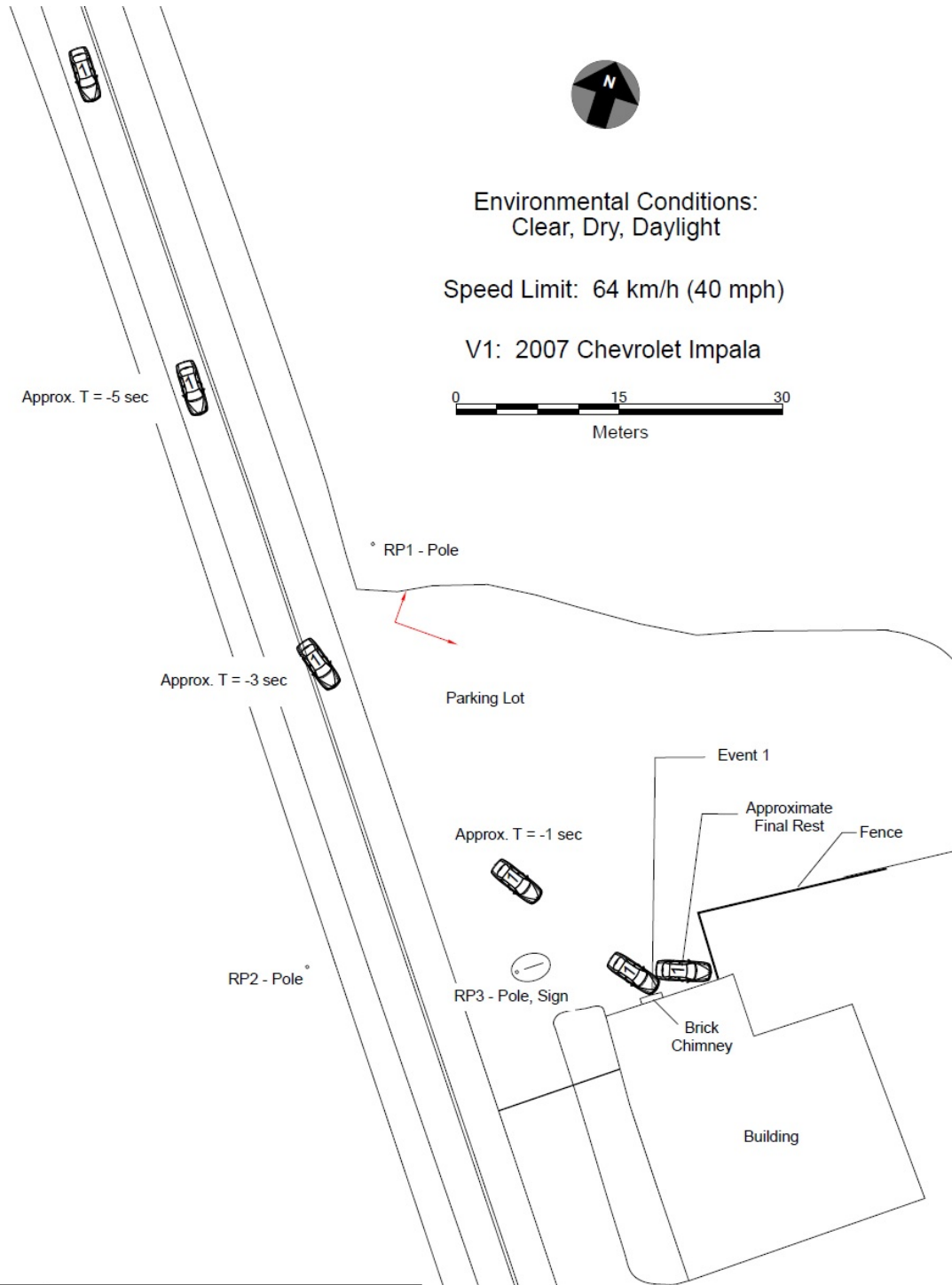
The driver's left foot loaded against the toe pan, resulting in a fracture of the left ankle. The driver's right knee contacted the left aspect of the lower center instrument panel and continued forward into the right aspect of the knee bolster. Scuff marks with fabric fibers evidenced the contact. The energy transmitted through the femur from the right knee loading resulted in a fracture of the right hip.

The driver's torso and abdomen loaded the steering wheel rim and center hub of the column. His loading force against the steering wheel rim deformed the lower aspect of the four-spoke rim forward and bent the lower spokes. Torso loading was sufficient to compress the energy absorbing steering column resulting in complete separation of the supporting shear capsules. The driver sustained multiple rib fractures and a hemothorax from his loading of the steering assembly.

The angular component of the 1 o'clock direction of force displaced the driver to his right. A large wipe mark (area where the dust was removed) was noted to the top surface of the instrument panel. The windshield-mounted rear view mirror was separated from its ball mount at the windshield from probable head contact and forehead contusion.

The driver rebounded into his seat position and came to rest. He remained conscious and coherent while the responding Firefighters and EMS personnel removed him from the vehicle. He was transported by ambulance to a local Level 1 trauma center and was evaluated at the hospital for his obvious injuries. A portable CT scan determined that the driver sustained multiple rib fractures and a hemothorax. As the driver was being transferred in the hospital for additional diagnostic procedures, his vital signs deteriorated due to internal blood loss. Efforts to resuscitate him were unsuccessful and he was pronounced deceased 2.5 hours after the crash. No autopsy was performed.

CRASH DIAGRAM



	
<p>Case Number:</p>	<p>CR18004</p>

**APPENDIX:
2007 CHEVROLET IMPALA EVENT DATA RECORDER REPORT**

The EDR report contained in this technical report was imaged using the version of the Bosch CDR software current 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 User Case Number EDR Data Imaging Date	2G1WT58K879*****
Crash Date Filename Saved on Imaged with CDR version	201850S1CR18004_V1_ACM.CDRX Crash Data Retrieval Tool 17.6.1
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version Reported with Software Licensed to (Company Name)	Crash Data Retrieval Tool 21.0 NHTSA
EDR Device Type Event(s) recovered	Airbag Control Module None

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 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_r009

Hexadecimal Data

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$03 00 00 00 00 00 00 00
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$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
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$12 FF 00 F0 F0 C0 00 00
$13 FF 00 F0 30 40 00 00
$14 FF 00 F0 30 40 00 00
$15 01 02 03 04 0B 0C 05
$16 06 00 00 00 00 00 00
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$DC 48 41
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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.

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

