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ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN08048
LOCATION - TEXAS
VEHICLE - 2006 CHEVROLET COBALT LEVEL 1
CRASH DATE - November 2008

Submitted:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. *Abstract*

This report covers an on-site investigation of an intersection crash that involved a 2006 Chevrolet Cobalt LS and a 2004 Chevrolet Silverado K2500 Crew Cab pickup truck. This investigation focused on the Cobalt, which was certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Cobalt was occupied by a restrained 21-year-old male driver and a restrained 19-year-old male front right passenger. The driver was traveling east on a 2-lane city street. The vehicle was passing through a 4-leg intersection when it was impacted on the left side plane by the front plane of the southbound Silverado. The impact force was sufficient to trigger stage 1 and 2 deployments of the Cobalt's driver's and front right passenger's frontal air bags. The Cobalt came to final rest on the southeast quadrant of the intersection heading southwest. The Silverado subsequently rolled over, right side leading, and came to final rest in a parking lot on the southeast quadrant of the intersection heading west. The Cobalt's driver was fatally injured and transported from the crash scene to a funeral home. The front right passenger was transported by ambulance to a hospital. He sustained serious injuries and was hospitalized for 8 days.

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This on-site investigation focused on a 2006 Chevrolet Cobalt LS (**Figure 1**), which was equipped with frontal air bags that were certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The driver of the vehicle sustained a fatal injury as a result of the crash. This crash was brought to the National Highway Traffic Safety Administration's attention on December 5, 2008 by the sampling activities of the National Automotive Sampling System–General Estimates System. This investigation was assigned on December 12, 2008. This intersection crash involved the Chevrolet Cobalt and a 2004 Chevrolet Silverado K2500 Crew Cab pickup truck. The crash occurred in November 2008 at 0001 hours, in Texas and was investigated by a city police department. This contractor inspected the Cobalt and downloaded the Event Data Recorders (EDR) of both vehicles on December 16, 2008. The Silverado and crash scene were inspected on December 17, 2008. This report is based on the police crash report, police on-scene photographs, scene and vehicle inspections, EDR data, occupant medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2006 Chevrolet Cobalt LS

CRASH CIRCUMSTANCES

Crash Environment: The trafficways on which both vehicles were traveling were two-lane, two-way, undivided, city streets, which formed a 4-leg intersection. The Cobalt's roadway traversed in an east-west direction and was uncontrolled. The roadway was 12.3 m (40.3 ft) in width and parking was allowed on both sides of the street. The roadway pavement markings consisted of a broken yellow center line. The Silverado's roadway traversed in a north-south direction and was controlled by a stop sign. The roadway was 11.3 m (37.1 ft) in width and parking was allowed on both side of the street. There were no roadway pavement markings. The speed limit for each vehicle was 48 km/h (30 mph). At the time of the crash, the light condition was dark and unlit, the atmospheric condition was clear, and the roadway pavement was dry bituminous. The Cobalt's roadway had a negative 1.4% grade and the Silverado's roadway was level. Traffic density was light and the site of the crash was urban. See the Crash Diagram on page 13 of this report.

Figure 2: Approach of the Cobalt to the intersection; arrow shows approach of the Silverado

Pre-Crash: The Cobalt was occupied by a restrained 21-year-old male driver and a restrained 19-year-old male front right passenger. The driver was traveling east approaching the 4-leg intersection (**Figure 2**) and intended to continue east. The Cobalt's EDR recorded its travel speed

as 64 km/h (40 mph) from 5 seconds to 1 second prior to Algorithm Enable (AE). It is not known if the driver took any actions to avoid the crash. The Silverado was occupied by a restrained 17-year-old male driver and a restrained 18-year-old male front right passenger. The driver was traveling south (**Figure 3**) and intended to continue south. The Silverado's EDR recorded its travel speed as 90 km/h (56 mph) 5 seconds prior to AE, which increased at 100% throttle to 101 km/h (63 mph) at 2 seconds prior to AE. The brake switch circuit was recorded as on at 1 second prior to AE, and the speed was recorded as 92 km/h (57 mph). The police crash report indicated that the Silverado's driver disregarded the stop sign. The crash occurred within the intersection (**Figure 4**).

Figure 3: Approach of the Silverado to the intersection; arrow shows approach of Cobalt

Figure 4: View of impact area from Silverado's approach

Figure 5: Damage to front of the Silverado from impact with the left side of the Cobalt

Crash: As both vehicles entered the intersection, the front of the Silverado (**Figure 5**) impacted the left side of the Cobalt (**Figure 6**, event 1). The Cobalt's direction of force was within the 10 o'clock sector and the impact force was sufficient to trigger stage 2 deployments of the driver's and front right passenger's frontal air bags. The Silverado's direction of force was within the 1 o'clock sector and the impact force was sufficient to trigger stage 1 deployments of the Silverado's driver and front right passenger frontal air bags. The Cobalt rotated clockwise and the Silverado rotated counterclockwise as both vehicles were redirected toward the southeast quadrant of the intersection. As the vehicles rotated, the Cobalt's left rear side plane (**Figure 7**) impacted the Silverado's right front side plane (**Figure 8**, event 2). The Silverado traveled 12 m (39 ft) and its right side wheels impacted a 15 cm (6 in) high curb (events 3 and 4) and it rolled over, right side leading (event 5). The Cobalt rotated 115 degrees and traveled 27 m (88.6 ft) from the initial impact and its left rear wheel (**Figure 9**) impacted the curb (**Figure 10**, event 6). The vehicle traveled an additional 25 m (82 ft) and came to final rest straddling the east edge of the southern roadway heading southwest (**Figure 11**). The Silverado came to rest on its left side heading southwest (**Figure 9**).

Figure 6: Damage to the left side plane of the Cobalt from impact with the front of the Silverado

Figure 8: Damage to Silverado's door and fender from impact with the Cobalt's left quarter panel and left rear door; tire debeaded from curb impact

Figure 10: Arrow shows tire mark and scrapes on the curb from impact by the Cobalt's left rear wheel

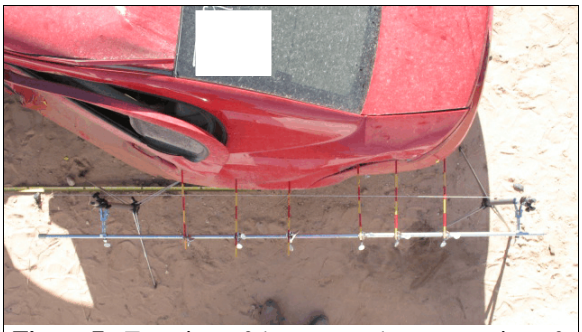


Figure 7: Top view of damage on the rear portion of the Cobalt's left rear door and the quarter panel from impact with the Silverado's right front door and fender

Figure 9: Police photo of Cobalt's left rear wheel showing abrasions to tire sidewall and rim scratches from curb impact; arrow shows final rest position of the Silverado

Figure 11: Police photo of final rest position of the Cobalt

Post-Crash: The police, emergency medical, and rescue services responded to the scene. The police received notification of the crash at 1216 hours and arrived on scene at 1219 hours. Rescue personnel removed the Cobalt's left front door and extricated the driver from the vehicle. He was fatally injured and transported from the scene to a funeral home. The front right passenger was

transported to a hospital. The Silverado's driver fled the scene and was subsequently arrested. The Silverado's front right passenger was not injured. Both vehicles were towed from the crash scene due to damage.

CASE VEHICLE

Case Vehicle: The 2006 Chevrolet Cobalt LS was a front wheel drive, 4-door sedan (VIN: 1G1AK55F167------) equipped with a 2.2L, 4-cylinder engine and automatic transmission. The front row was equipped with dual stage driver and front right passenger frontal air bags, bucket seats, adjustable head restraints, and lap-and-shoulder belts. The second row was equipped with a bench seat with folding backs, adjustable head restraints, lap-and-shoulder belts, and Lower Anchor and Tethers for Children (LATCH) in the outboard seating positions. Four wheel anti-lock brakes, side curtain air bags, and traction control were options on this vehicle, but it was not so equipped. The vehicle's mileage at the time of inspection could not be determined because the vehicle was equipped with an electronic odometer and was without power. The vehicle's specified wheelbase was 262 cm (103.1 in).

CASE VEHICLE DAMAGE

Exterior Damage: The Cobalt's initial impact (event 1) with the Silverado involved the Cobalt's left side plane. The left side of the bumper fascia, left fender, hood, left front door, left A- and B-pillars, roof side rail, and the left rear door were directly damaged. The direct damage began 96 cm (37.8 in) forward of the left rear axle and extended forward 222 cm (87.4 in). The crush measurements were taken at the mid-door level and the maximum residual crush was 63 cm (24.8 in) occurring at C_4 (**Figure 12**). It was necessary to estimate the crush at C_3 and C_4 based on the crush occurring at the A- and B- pillars because the damage to the left front door had been altered when it was removed from the vehicle during extraction of the driver. The vehicle's sill height was 31 cm (12.2 in) and the height of the maximum crush was 53 cm (20.9 in). The Door Sill Differential was 5 cm (2 in). The table below shows the vehicle's left side crush profile.

Figure 12: Top view of crush to the left side plane of the Cobalt

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	222	63	310	0	27	60	63	38	7	91	42
in		87.4	24.8	122.0	0.0	10.6	23.6	24.8	15.0	2.8	35.8	16.5

The Cobalt's second impact (event 2) with the Silverado also involved the vehicle's left side plane. The rear portion of the left rear door and the quarter panel were directly damaged. The direct damage began 26 cm (10.2 in) forward of the left rear axle and extended 99 cm (39 in) rearward. The crush measurements were taken at the upper quarter panel level and the maximum residual crush was 3 cm (1.2 in) occurring at C_3. Due to the partial overlap of the crush pocket from the initial left side impact, the crush values at C_5 and C_6 were estimated to zero. The table below shows the vehicle's crush profile for this impact.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	2	99	3	99	0	2	3	2	0	0	-142	-142
in		39.0	1.2	39.0	0.0	0.8	1.2	0.8	0.0	0.0	-55.9	-55.9

The Cobalt's left side wheelbase was shortened 29 cm (11.4 in) and the right side wheelbase was extended 3 cm (1.2 in). Induced damage involved the hood, roof, front bumper fascia and right fender.

Damage Classification: The Collision Deformation Classifications (CDC) for the Cobalt were **10-LYAW-5** (**290** degrees) for the left side impact (event 1), **09-LZEW-2** (**270** degrees) for the left quarter panel impact (event 2), and **11-LBWN-1** (**330** degrees) for the left rear wheel impact to the curb (event 6). The Damage algorithm of the WinSMASH program calculated the Cobalt's total Delta V for the left quarter panel impact as 71 km/h (44.1 mph). The longitudinal and lateral velocity changes were -24 km/h (-14.9 mph) and 67 km/h (41.6 mph), respectively. The WinSMASH results appeared reasonable. The vehicle's EDR recorded a maximum longitudinal velocity change of -21.82 km\h (-13.56 mph) at 220 msec after the deployment command was issued and a maximum lateral velocity change of 59.99 km/h (37.28 mph) at 140 msec.

For the second event, the Missing Vehicle algorithm of the WinSMASH program calculated the Cobalt's total Delta V for the left quarter panel impact as 6 km/h (3.7 mph). The longitudinal and lateral velocity changes were 0 km/h and 6 km/h (3.7 mph), respectively. The results were based only on the Cobalt's crush profile and should be considered borderline.

The manufacturer's recommended tire size was P195/60R15. The Cobalt was equipped with the P205/55R16 size tires on the back and P200/55R16 size tires on the front. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	Flat	Flat	207	30	6	7	Sidewall cut	Yes	Yes
LR	Flat	Flat	207	30	6	8	Sidewall abraded	No	Yes
RR	145	21	207	30	4	5	None	No	No
RF	276	40	207	30	5	6	None	No	No

Vehicle Interior: The extent of driver contact on the interior left front door panel could not be determined due to the extent of damage to the door during the extrication of the driver. The center console was also broken and displaced to the right due to loading by the left front seat as it was displaced to the right by the intruding left front door. The driver's right hip and lower right leg also probably loaded the center console. The gear shift lever was bent to the left, probably due to contact by the passenger. The left front seat back was also displaced rearward and deformed due to the intrusion of the B-pillar. There was a heavy abrasion on the left B-pillar and the upper anchor cover was broken with blood transfer present on the pillar. An unoccupied forward facing child safety seat was in the second row of the vehicle.

The left front and left rear doors were jammed shut and the right front and right rear doors remained closed and operational. The pre-crash status of the right front window glazing was open while the remaining window glazing was either fixed or closed. The left front and left rear window glazing were disintegrated from impact forces. The police on-scene photographs showed that the windshield glazing was in place and cracked from impact forces.

The vehicle sustained numerous passenger compartment intrusions on the left side. The most severe intrusions involved the lower left A-pillar, side panel forward of the A-pillar, and the left front door. The lower left A-pillar and side panel forward of the A-pillar both intruded laterally 44 cm (17.3 in) into the driver's occupant space. The left front door intrusion was estimated based on the intrusion of the lower left A-pillar and the police on-scene photographs, which showed the status of the left front door prior to removal. The estimated lateral intrusion of the door was 44 cm (17.3 in) into the driver's occupant space.

EVENT DATA RECORDER

The Cobalt's Sensing and Diagnostic Module, which contains the EDR, had been removed by the police. The data was imaged at the police using version 2.9 of the Bosch Crash Data Retrieval Tool and was subsequently read using version 3.2. The EDR recorded a deployment event. The event recoding was complete and no associated events were recorded. The SIR warning lamp was recorded as off and the driver's and front right passenger's seat belt switch circuits were recorded as buckled. Their seat belt pretensioners were also commanded to actuate.

The report indicated that both stages of the driver and front right passenger air bags were commanded to deploy. The time from AE to deployment command being met for the first stage was 30 msec and 46 msec for the second stage. The longitudinal velocity change reached -20.1 km/h (-12.88 mph) at the 150 msec point of recorded data, and the lateral velocity change reached 60.00 km\h (37.28 mph) at the 220 msec point. The EDR pre-crash data is discussed in the pre-crash section on page 1 of this report. The EDR report is attached at the end of this report[1].

AUTOMATIC RESTRAINT SYSTEM

The Cobalt was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that was certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The system consisted of dual stage driver and front right passenger air bags, driver seat position sensor, seat belt usage sensors, driver and front right passenger retractor-mounted pretensioners, and a front right passenger weight sensor. The vehicle's impact sensor was located on the upper radiator support.

The driver's frontal air bag was located within the steering wheel hub and the module cover was a two flap configuration constructed of pliable vinyl (**Figure 13**). The cover flaps were undamaged and opened at the designated tear points. Each flap was 11.5 cm (4.5 in) in height, 7 cm (2.8 in) in width at the top, and 6 cm (2.4 in) in width at the bottom. The deployed air bag (**Figure 14**) was round with a diameter of 62 cm (24.4 in) and was designed with two tethers and two vent ports. The vent ports were located on the back of the air bag at the 11 and 1 o'clock positions. There was no discernable occupant contact evidence on the air bag. Several blood transfers were present on the left half of the air bag, which were probably related to blood spatter from the driver. There also were numerous small punctures dispersed over the air bag, which were probably the result flying tempered glass fragments from the disintegrated left front window glazing.

Figure 13: The steering wheel and air bag module cover flaps; steering wheel rotated 90 degrees clockwise

Figure 14: The Cobalt driver's frontal air bag

The front right passenger's air bag was located within the top of the instrument panel and deployed through a single module cover flap (**Figure 15**), which was undamaged and opened at the designated tear points. The deployed air bag

[1] Please note that pages 7-10 of the EDR report have been omitted for confidentiality reasons.

(**Figure 16**) was 45 cm (17.8 in) in length and 60 cm (23.6 in) in height and was designed with two tethers and two vent ports. The vent ports were located at the 10 and 2 o'clock positions. There was no discernable evidence of occupant contact on the air bag. Two small blood transfers were present on the air bag's upper right quadrant, but they appeared to be related to blood spatter.

Figure 15: The front right passenger's frontal air bag cover flap and air bag module)

Figure 16: Cobalt's front right passenger air bag

MANUAL RESTRAINT SYSTEM

The Cobalt was equipped with lap-and-shoulder belts for the front and second row seating positions. The driver's seat belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and an adjustable upper anchor that was in the full-down position. The front right seat belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), sliding latch plate, and adjustable upper anchor that was located in the full-up position. Both seat belts were equipped with retractor-mounted pretensioners that actuated in this crash. The second row lap-and-shoulder belts were equipped with continuous loop belt webbing, switchable ELR/ALRs, sliding latch plates and fixed upper anchors. They were not equipped with pretensioners.

The inspection of the driver's seat belt assembly revealed that the belt was stretched and there were blood stains on the belt webbing in a location that would have been inside the retractor if the belt had not been in use. This evidence supported by the EDR data indicated that the driver was restrained by the lap-and-shoulder belt at the time of the crash.

The inspection of the front right passenger's seat belt assembly revealed blood stains on the belt webbing in a location that would have been inside the retractor if the belt had not been in use. The retractor was also jammed with a length of belt spooled out of the retractor consistent with usage. This evidence supported by the EDR data indicated that the front right passenger was restrained by the lap-and-shoulder belt at the time of the crash.

CASE VEHICLE DRIVER KINEMATICS

The Cobalt's driver (21-year-old, male; unknown height and weight) was seated in an unknown posture. The seat track was between the mid-to rear-track position, but the position of

the seat back could not be determined due to the damage to the seat. The head restraint was adjusted to mid-position, and the distance from the top of the seat back to the top of the head restraint was 24 cm (9.5 in). The position of the tilt steering column could not be determined due to the damage to the instrument panel and steering assembly.

The Silverado's initial impact to the left side plane of the Cobalt displaced the driver left and slightly forward opposite the Cobalt's 10 o'clock direction of force and he loaded the seat belt. The left side of the driver's body contacted the intruding left front door and it is possible his head contacted the Silverado's grille. The driver was entrapped within the vehicle between the intruded left front door and his seat. Emergency personnel removed the door in order to extricate the driver.

CASE VEHICLE DRIVER INJURIES

The driver was pronounced deceased at the crash scene 74 minutes following the crash. He was transported directly to a funeral home. No autopsy was conducted and there was no information regarding the driver's injuries.

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The front right passenger (19-year-old, male; unknown height and weight) was seated in an unknown posture. The seat track was adjusted to between the mid-to rear-track position and the seat back was slightly reclined.

The Silverado's initial impact to the left side plane of the Cobalt displaced the front right passenger left and slightly forward opposite the Cobalt's 10 o'clock direction of force. The passenger's left hip contacted the center console, which caused a comminuted fracture of the left iliac wing of the pelvis. His abdomen contacted the gear shift lever and bent it to the left (**Figure 17**), which caused lacerations of the small bowl and contusions of the colon and mesentery. His head probably contacted the steering wheel rim, which caused a nonanatomic brain injury, cervical cord contusion, and comminuted fracture of the mandibular mentum.

Figure 17: Gear shift lever bent to left due to contact by the front left passenger; curved line on left illustrates approximate extent of left front door intrusion

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by ambulance and hospitalized for 8 days. The table below shows his injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness of unknown duration, responsive to painful stimuli, GCS=12 with some nausea and disconjugate gaze of orbits[2]	serious 160408.3,0	Steering wheel rim	Probable	Emergency room records
2	Lacerations x 2 {complete transections}, small bowel first 30.5 cm (1 foot) distal to ligament of Treitz[3] with 25-30 cm (10-12 in) between lesions	serious 541424.3,8	Console-mounted transmission selector lever	Certain	Hospitalization records
3	Contusions {antimesenteric hematomas} of colon in cecal and sigmond colon areas	moderate 540810.2,8	Console-mounted transmission selector lever	Certain	Hospitalization records
4	Contusions {hematomas}, small, of mesentery overlying left kidney and sigmoid colon	moderate 542010.2,8	Console-mounted transmission selector lever	Certain	Hospitalization records
5	Fracture left occipital condyle with mild shift of craniocervical junction to right	serious 150200.3,8	Steering wheel rim	Probable	Emergency room records
6	Contusion {epidural hematoma} of cervical cord, 4 mm maximum, along anterior spinal cord with incomplete, nondisplaced fracture of odontoid and transient neurological signs, not further specified	serious 640204.3,6	Steering wheel rim {Indirect injury}	Probable	Emergency room records
7 8	Fracture, comminuted of mandibular mentum, centrally and to right of midline with fracture through right lateral incisor/canine area with loose teeth (#26)	moderate 250612.2,3 250200.2,8	Steering wheel rim	Probable	Hospitalization records
9	Fracture, comminuted, left iliac wing of pelvis	serious 852604.3,2	Interior, center console first row	Probable	Hospitalization records
10	Contusion {hematoma} of scalp, not further specified	minor 190402.1,9	Steering wheel rim	Probable	Emergency room records

[2] A disconjugate gaze is a visual field defect.

[3] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
ligament of Treitz: *musculus suspensorius duodeni*.
musculus suspenso/rius duode/ni: suspensory muscle of duodenum: a flat band of smooth muscle originating from the left crus of the diaphragm, and continuous with the muscular coat of the duodenum at its junction with the jejunum. Called also *ligamentum suspensorius duodeni*.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
11 12	Abrasions, tiny, due to glass, on extremities	minor 790202.1,9 890202.1,9	Noncontact injury: flying glass, left front glazing	Certain	Emergency room records

OTHER VEHICLE

The 2004 Chevrolet Silverado K2500 was a 4-wheel drive, 4-door crew cab pickup truck (VIN: 1GCHK23U54F------) equipped with a 6.0L, V8 engine, automatic transmission, 4-wheel anti-lock brakes and driver and front right passenger redesigned frontal air bags.

Exterior Damage: The Silverado's initial impact with the Cobalt (event 1) involved the Silverado's front plane. The front bumper, grille, both headlamp/turn signal assemblies, and the hood were directly damaged. The direct damage began at the front left bumper corner and extended 163 cm (64 in) across the bumper. The crush measurements were taken at the bumper level and the maximum residual crush was 39 cm (15.4 in) occurring at C_5. The vehicle's left side wheelbase was reduced 8 cm (3.1 in) and the right side wheelbase was reduced 11 cm (4.3 in). The table below shows the vehicle's front crush profile.

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	163	39	163	17	20	32	37	39	31	0	0
in		64.2	15.4	64.2	6.7	7.9	12.6	14.6	15.4	12.2	0.0	0.0

The Silverado's second impact with the Cobalt involved the right side plane. The direct damage involved the right front door and the right fender. It began 227 cm (89.4 in) forward of the right rear axle and extended onto the right fender. There was overlapping damage to the fender from the front impact and the rollover and the total length of direct damage could not be determined.

The damage from the rollover involved the left and right side planes. There was no direct damage to the top plane. The direct damage extended the full length and height of both sides of the vehicle. There was no lateral or vertical crush to the passenger compartment.

Damage Classification. The CDCs for the Silverado were **01-FDEW-2** (**20** degrees) for the front impact (event 1) and **03-RYEW-1** (**90** degrees) for the impact to the right front door and fender (event 2). The CDCs for the right side wheel impacts (event 3 and 4) to the curb were **03-RFWN-1** (**90** degrees) and **03 RBWN-1** (**90** degrees), and the CDC for the rollover (event 5) was **00-RDAO-2**. The Damage algorithm of the WinSMASH program calculated the Silverado's total

Delta V for the front impact as 35 km/h (21.7 mph). The longitudinal and lateral velocity changes were -33 km/h (-20.5 mph) and -12 km/h (-7.5 mph), respectively. The vehicle's EDR recorded the maximum longitudinal velocity change as -37.19 km/h (-23.11 mph) occurring at 175 msec after AE on page 3 of the EDR report.

The Missing Vehicle algorithm of the WinSMASH program calculated the Silverado's total Delta V for the right side impact (event 2) as 3.0 km/h (1.9 mph). The longitudinal and lateral velocity changes were 0.0 km/h (0.0 mph) and -3.0 km/h (-1.9 mph), respectively. The results are based only on the crush to the Cobalt and are considered borderline. The severity of the rollover damage minor based on the extent of damage.

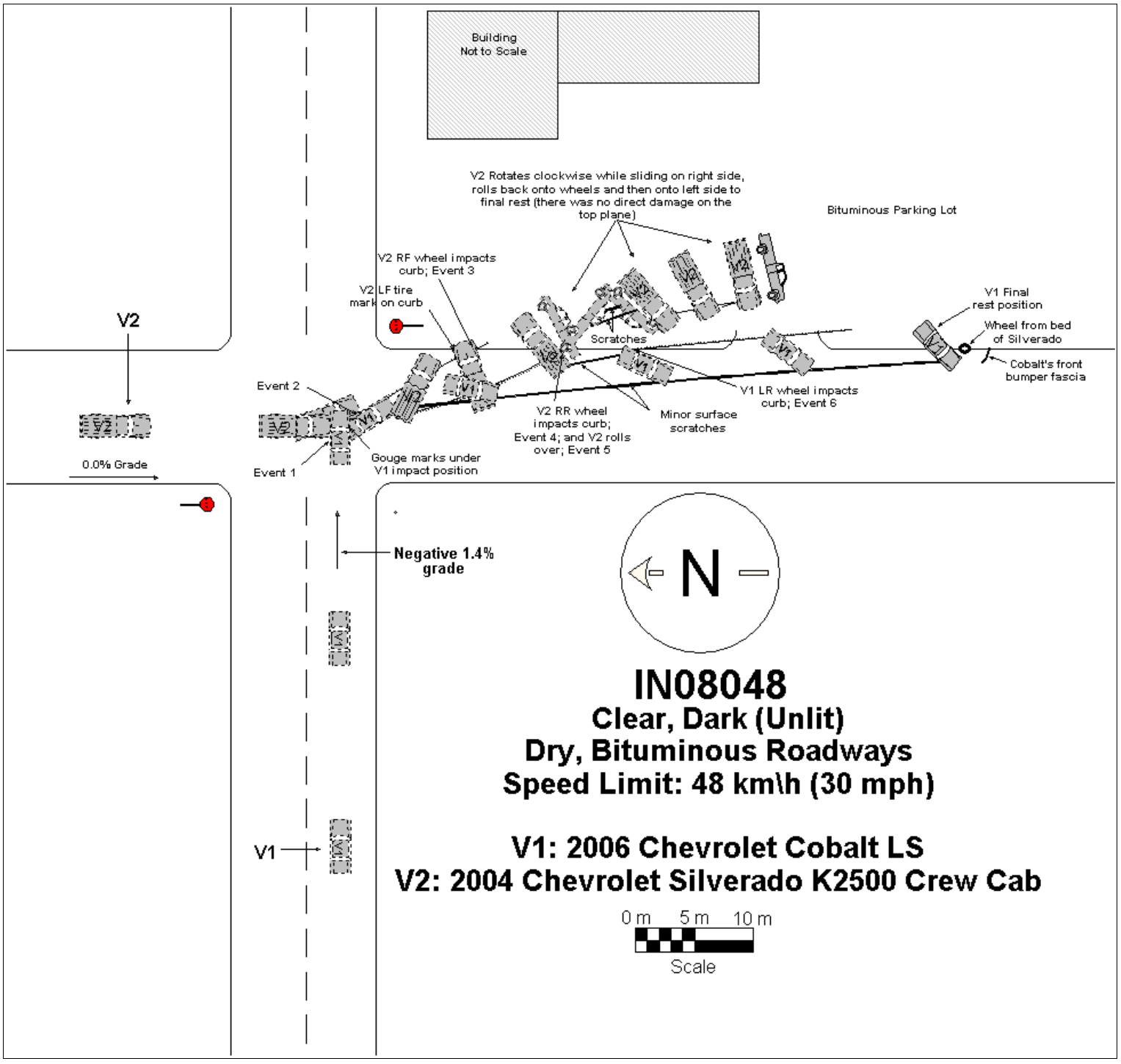
The manufacturer's recommended tire size was LT245/75R16. The Silverado was equipped with an LT245/75R16 size tire on the left front and LT315/70R17 size tires on the remaining wheels. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	200	29	379	55	11	14	None	Yes	No
LR	Flat	Flat	379	55	6	8	None	No	Yes
RR	97	14	552	80	6	7	None	No	Yes
RF	Flat	Flat	552	80	6	8	None	Yes	Yes

Event Data Recorder: The Silverado's Sensing and Diagnostic Module, which contains the EDR, had been removed by the police. The download was performed at the police department using version 2.9 of Bosch Crash Data Retrieval Tool and was subsequently read using version 3.2. The EDR recorded a stage 1 deployment event and a non-deployment event. The EDR's deployment event data indicated that the SIR warning lamp was recorded as off and the driver's seat belt switch circuit was recorded as buckled. The time from AE to the deployment command being met was 12.5 msec for both the driver and front right passenger air bags. The maximum longitudinal velocity change was recorded on page 3 of the EDR report as -37.19 km/h (-23.11 mph) occurring at 175 msec after AE. The pre-crash data is discussed in the pre-crash section of this report on page 2. The EDR report is attached at the end of this report[4].

Other Vehicle's Driver: According to the police crash report, the Silverado's driver (17-year-old, male) and front right passenger (18-year-old, male) were restrained by their lap-and-shoulder belts. Neither occupant sustained a police reported injury.

[4] Pages 7-9 of the EDR report have been omitted for confidentiality reasons.


Building
Not to Scale
V2 Rotates clockwise while sliding on right side, rolls back onto wheels and then onto left side to final rest (there was no direct damage on the top plane)
Bituminous Parking Lot
V2 RF wheel impacts curb; Event 3
V2 LF tire mark on curb
V2
Scratches
V1 Final rest position
Wheel from bed of Silverado
Cobalt's front bumper fascia
Event 2
V1 LR wheel impacts curb; Event 6
V2 RR wheel impacts curb; Event 4; and V2 rolls over; Event 5
Minor surface scratches
Gouge marks under V1 impact position
Event 1
0.0% Grade
Negative 1.4% grade
N
IN08048
Clear, Dark (Unlit)
Dry, Bituminous Roadways
Speed Limit: 48 km\h (30 mph)
V1: 2006 Chevrolet Cobalt LS
V2: 2004 Chevrolet Silverado K2500 Crew Cab
V1
0 m 5 m 10 m
Scale

CDR File Information

User Entered VIN	1G1AK55F167******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	IN08048_COBALT.CDR
Saved on	Wednesday, December 17 2008 at 03:55:02 PM
Collected with CDR version	Crash Data Retrieval Tool 2.900
Reported with CDR version	Crash Data Retrieval Tool 3.2
EDR Device Type	airbag control module
Event(s) recovered	Deployment

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

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 contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.
The second type of SDM recorded crash event is the Deployment Event. It also contains 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 will 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.
-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 open/closed state of the brake switch circuit.
-Pre-Crash data is recorded asynchronously.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:
- -the SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -no data is received from the module sending the pre-crash data
- -no module is present to send the pre-crash data

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit, except: The Passenger Belt Switch Circuit Status for 2005 vehicles is available only on the Cadillac STS. The Passenger Belt Switch Circuit Status for 2006 Chevrolet Cobalt Sport Coupe (AP) model vehicles, with the option package that includes Recaro brand seats (RPO ALV), always reports a default value of "Buckled," because there is no passenger belt switch with the Recaro seat option.
-The 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 counter.
-Steering Wheel Angle data is displayed as a positive value when the steering wheel is turned to the right and a negative value when the steering wheel is turned to the left, except for Cadillac STS model vehicles with StabiliTrak 3.0 systems (RPO JL7). For Cadillac STS model vehicles with StabiliTrak 3.0 systems (RPO JL7), when the steering wheel is turned to the right, a negative value will be displayed and when the steering wheel is turned to the left, a positive value will be displayed. The Steering Wheel Angle data is reported in 16 degree increments.

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.

Multiple Event Data

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

System Status At AE

Vehicle Identification Number	**1AK55F*6*******
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
Brake System Warning Lamp (If Equipped)	OFF

System Status At 1 second

Transmission Range (If Equipped)	Fourth Gear
Transmission Selector Position (If Equipped)	Fourth Gear
Traction Control System Active (If Equipped)	Invalid
Service Engine Soon (Non-Emission Related) Lamp	OFF
Service Vehicle Soon Lamp	OFF
Outside Air Temperature (degrees F) (If Equipped)	62
Left Front Door Status (If Equipped)	Closed
Right Front Door Status (If Equipped)	Closed
Left Rear Door Status (If Equipped)	Unused
Right Rear Door Status (If Equipped)	Unused
Rear Door(s) Status (If Equipped)	Closed

Pre-crash data

Parameter	-2 sec	-1 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	Invalid	Invalid
Cruise Control Resume Switch Active (If Equipped)	Invalid	Invalid
Cruise Control Set Switch Active (If Equipped)	Invalid	Invalid

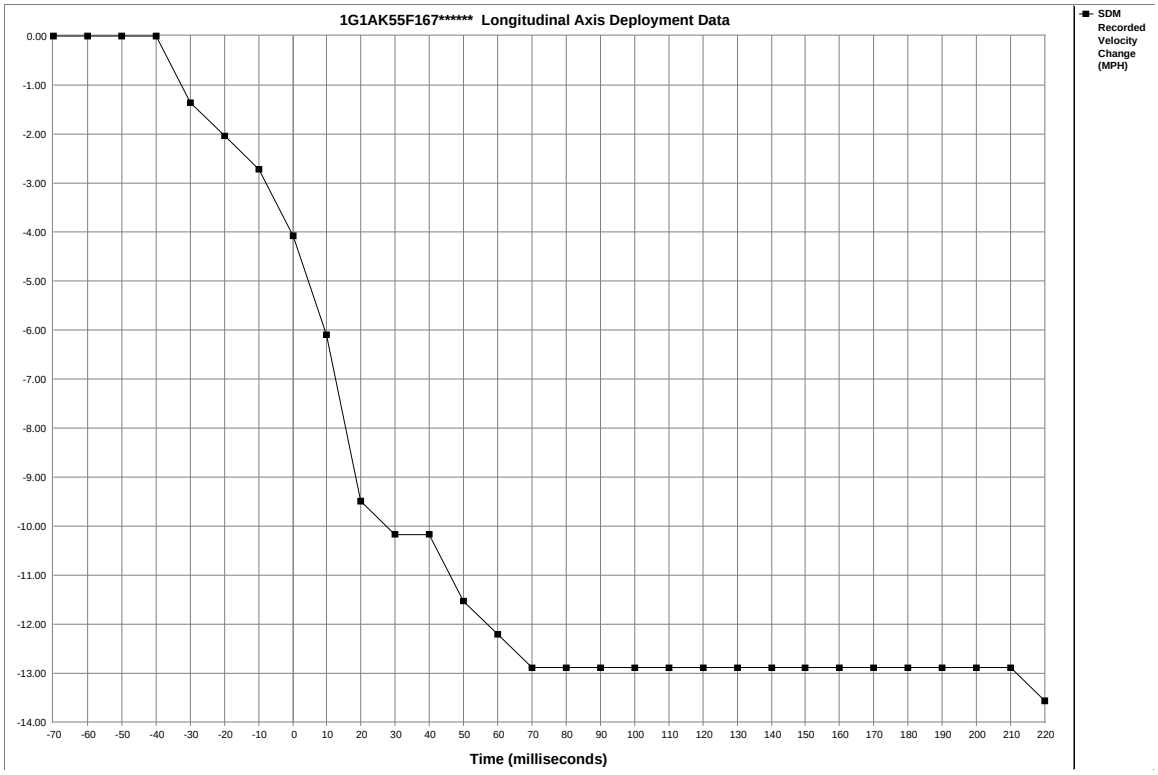
Pre-Crash Data

Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	40	40	40	40	40
Engine Speed (RPM)	1600	1856	1536	1472	1472
Percent Throttle	37	33	19	18	13
Accelerator Pedal Position (percent)	15	11	4	3	0
Antilock Brake System Active (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Lateral Acceleration (feet/s²)(If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Yaw Rate (degrees per second) (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

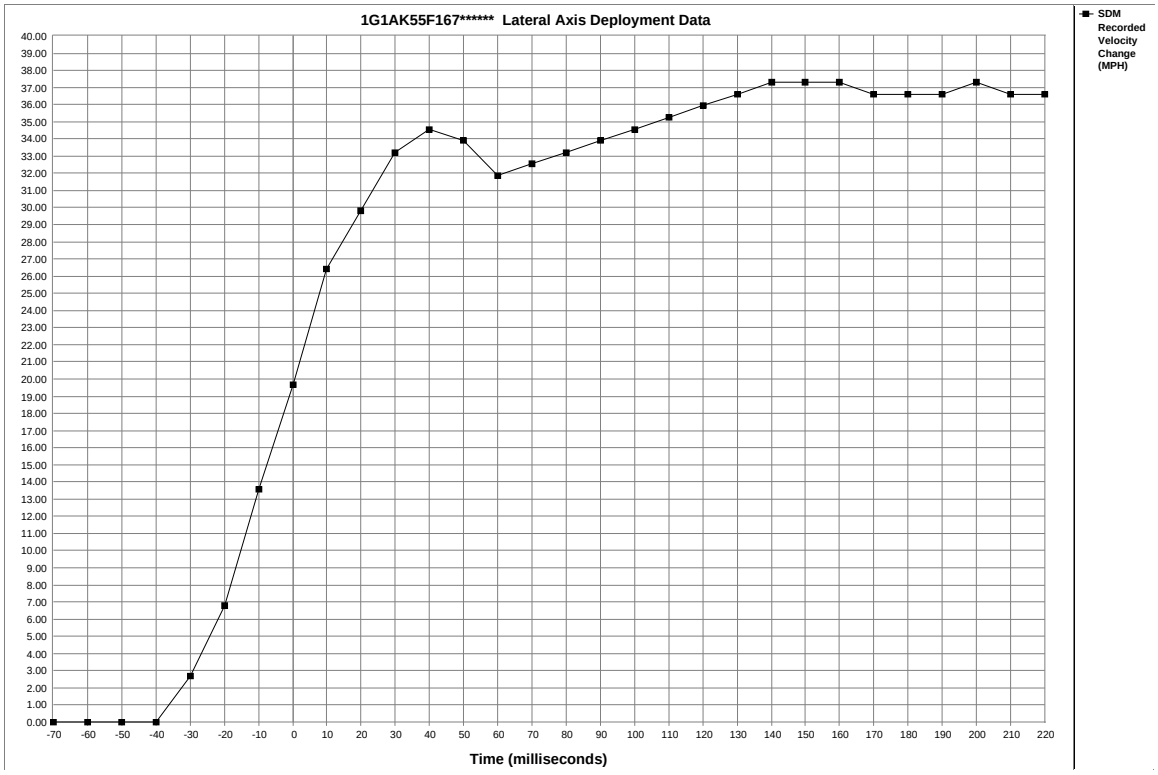
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Steering Wheel Angle (degrees) (If Equipped)	0	0	0	0	0
Vehicle Dynamics Control Active (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

System Status At Deployment

Ignition Cycles At Investigation	12412
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	655200
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	12386
Ignition Cycles At Event	12412
Ignition Cycles Since DTCs Were Last Cleared	254
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	BUCKLED
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
Automatic Passenger SIR Suppression System Validity Status at AE	Valid
Automatic Passenger SIR Suppression System Status at AE	Air Bag Not Suppressed
Automatic Passenger SIR Suppression System Validity Status at First Deployment Command	Valid
Automatic Passenger SIR Suppression System Status at First Deployment Command	Air Bag Not Suppressed
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	30
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	46
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	30
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	46
Time Between Events (sec)	N/A
Driver First Stage Deployment Loop Commanded	Yes
Driver Second Stage Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	Yes
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	Yes
Passenger Second Stage Deployment Loop Commanded	Yes
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	Yes
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Driver Anchor Pretensioner Deployment Loop Commanded (If Equipped)	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Third Row Left Roof Rail/Head Curtain Loop Commanded	No
Passenger Anchor Pretensioner Deployment Loop Commanded (If Equipped)	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Third Row Right Roof Rail/Head Curtain Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Event Recording Complete	Yes



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	-1.36	-2.03	-2.71	-4.07	-6.10	-9.49	-10.17	-10.17	-11.52	-12.20	-12.88
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-12.88	-13.56



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	2.71	6.78	13.56	19.66	26.44	29.82	33.21	34.57	33.89	31.86	32.54
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	33.21	33.89	34.57	35.25	35.93	36.60	37.28	37.28	37.28	36.60	36.60	36.60	37.28	36.60	36.60

CDR File Information

User Entered VIN	1GCHK23U54F******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	IN08048_SILVERADO.CDR
Saved on	Wednesday, December 17 2008 at 03:48:45 PM
Collected with CDR version	Crash Data Retrieval Tool 2.900
Reported with CDR version	Crash Data Retrieval Tool 3.2
EDR Device Type	airbag control module
Event(s) recovered	Deployment Non-Deployment

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

Data Limitations

Recorded Crash Events:

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

The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. If multiple Non-Deployment Events occur within five seconds prior to a Deployment Event, then the most severe Non-Deployment Event will be recorded and locked. If multiple Non-Deployment Events precede a Deployment Event, and occur within five seconds of each other (but not necessarily all within five seconds of the Deployment Event), then the most severe of the Non-Deployment Events (which may have occurred more than five seconds prior to the Deployment Event) will be recorded and locked. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. If multiple Non-Deployment Events occur within five seconds prior to a Deployment Event, and one or more of those events was a Pretensioner Deployment Event, then the most recent Pretensioner Deployment Event will be recorded and locked. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

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

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

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

- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

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

-Pre-Crash data is recorded asynchronously.

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

- -the SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -no data is received from the module sending the pre-crash data
- -no module present to send the pre-crash data

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-The Time between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-Multiple Events will indicate whether one or more associated events preceded the recorded event.
-Multiple Events Not Recorded can be used in the following senieos:
    -If a single event is recorded, this parameter will indicate whether one or more associated events prior to the recorded event was not recorded due to insufficient record space (because there were more events than there were available event records).
    -If two associated events are recorded, this parameter for the first event will indicate whether one or more associated events prior to the first event was not recorded due to insufficient record space.
    -If two associated events are recorded, this parameter for the second event will indicate whether one or more associated events between the first and second events was not recorded due to insufficient record space.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

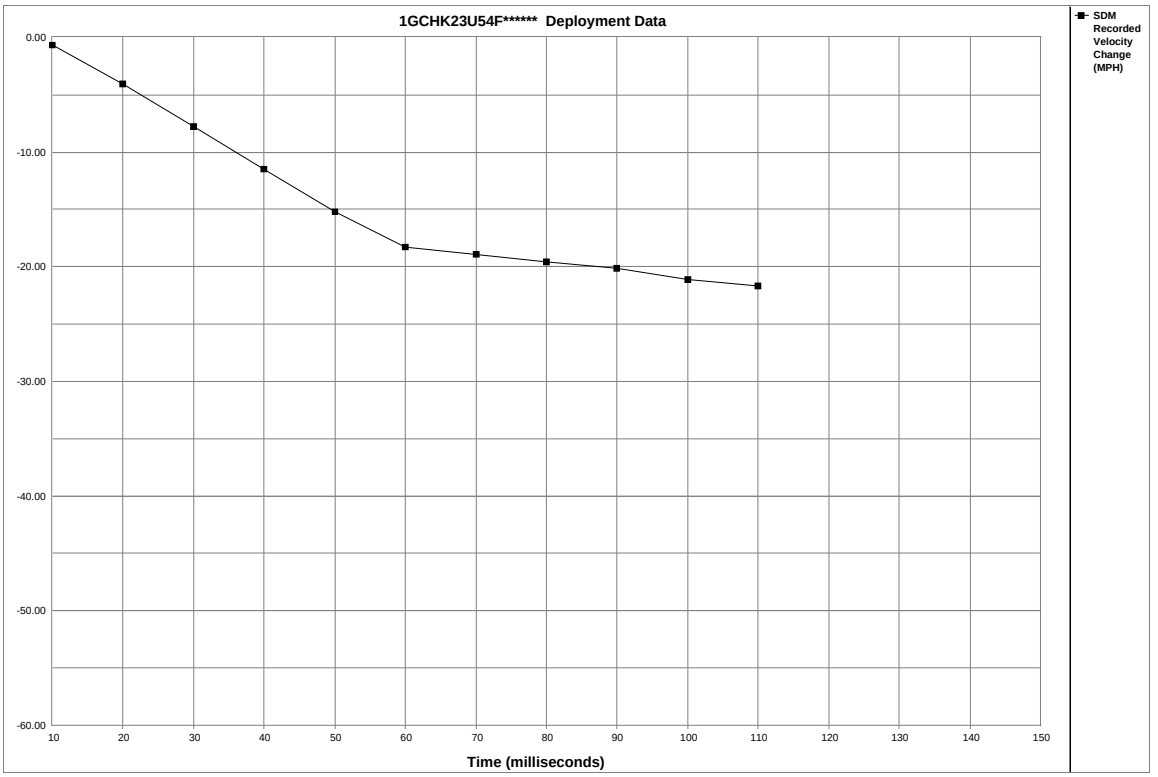
Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The Belt Switch Circuit is wired directly to the SDM.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	18113
Ignition Cycles At Investigation	18116
Maximum SDM Recorded Velocity Change (MPH)	-23.11
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	175
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	12.5
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	12.5
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	.2
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events	Yes
Multiple Events Not Recorded	No

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	56	4096	100
-4	62	4352	100
-3	62	4544	100
-2	63	4672	100
-1	57	3456	0

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



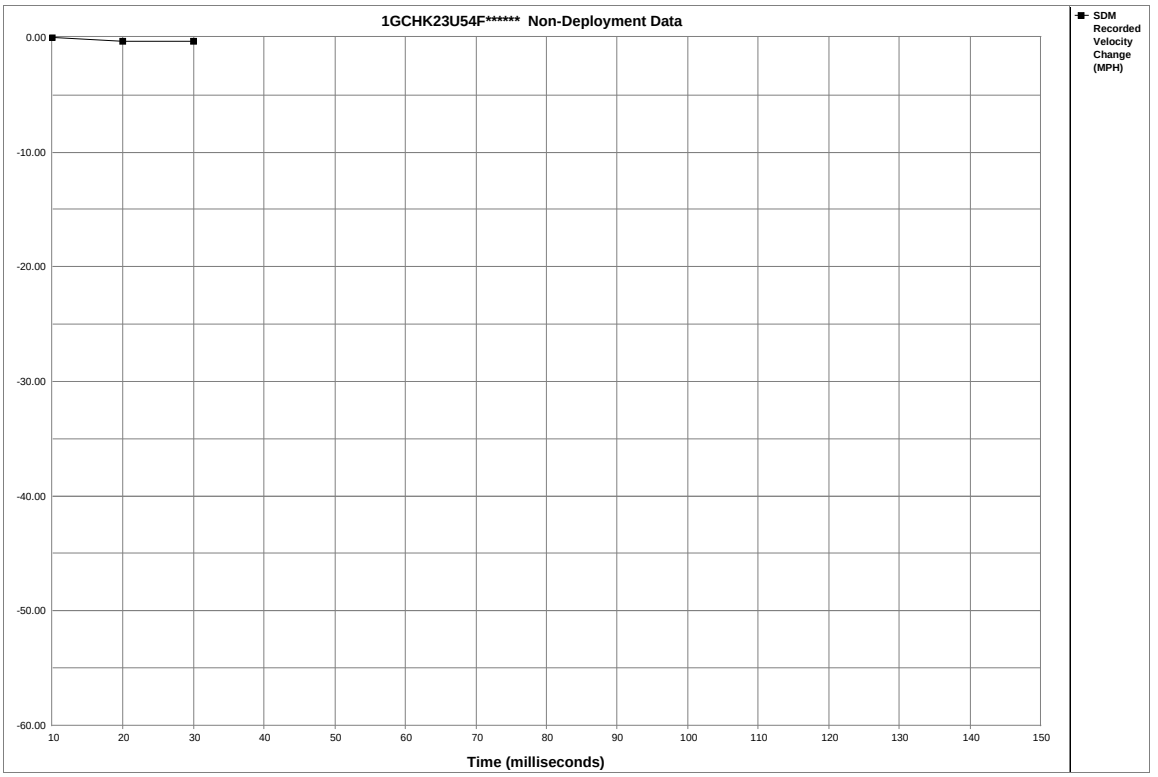
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-4.03	-7.75	-11.47	-15.19	-18.29	-18.91	-19.53	-20.15	-21.08	-21.70	N/A	N/A	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	18113
Ignition Cycles At Investigation	18116
Maximum SDM Recorded Velocity Change (MPH)	-0.41
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	22.5
Crash Record Locked	Yes
Event Recording Complete	Yes
Multiple Events	No
Multiple Events Not Recorded	No

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	53	3968	100
-4	56	4096	100
-3	62	4352	100
-2	62	4544	100
-1	63	4672	100

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



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	-0.31	-0.31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A