CRASH DATA RESEARCH CENTER
Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE HYBRID VEHICLE CRASH INVESTIGATION
SCI CASE NO.: CA09048

VEHICLE: 2006 TOYOTA PRIUS HATCHBACK

LOCATION: NORTH CAROLINA

CRASH DATE: JUNE 2009

Contract No. DTNH22-07-C-00043

Prepared for:

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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 are 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 on-site investigation focused on the intersection crash and subsequent rollover of a 2006 Toyota Prius. The Toyota was impacted on the rear aspect of the right plane by a 2005 Chevrolet Malibu. The Toyota subsequently initiated a clockwise (CW) rotation, tripped and rolled over 2-quarter turns. The Toyota Prius was a gasoline-electric hybrid vehicle powered by a 1.5 liter, in-line four cylinder internal combustion engine and a 50 kilowatt electric motor. The vehicle's electrical power was supplied by a stack of nickel-metal hydride batteries located behind the rear seat. The Toyota was equipped with Certified Advanced 208-Complaint (CAC) frontal air bags, front seat-mounted side impact air bags, and side impact Inflatable Curtain (IC) air bags located in the right and left roof side rails. A CAC vehicle has been certified by the manufacturer to be compliant to the Advanced Air Bag Portion of Federal Motor Vehicle Safety Standard No. 208. The CAC system included dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence sensor. The 27-year old restrained male driver of the Toyota sustained minor-severity injuries in this crash and was transported by ground ambulance to a regional trauma center. There was no damage to the Toyota's hybrid battery. Both vehicles were towed from the scene due to disabling damage.			
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BACKGROUND

This on-site investigation focused on the intersection crash and subsequent rollover of a 2006 Toyota Prius. The Toyota was impacted on the rear aspect of the right plane by a 2005 Chevrolet Malibu. The Toyota subsequently initiated a clockwise (CW) rotation, tripped and rolled over 2-quarter turns. **Figure 1** is a left front oblique view of the Toyota.

Figure 1: Left front oblique view of the 2006 Toyota Prius.

The Toyota Prius was a gasoline-electric hybrid vehicle powered by a 1.5 liter, in-line four cylinder internal combustion engine and a 50 kilowatt electric motor. The vehicle's electrical power was supplied by a stack of nickel-metal hydride batteries located behind the rear seat. The Toyota was equipped with Certified Advanced 208-Complaint (CAC) frontal air bags, front seat-mounted side impact air bags, and aide impact Inflatable Curtain (IC) air bags located in the right and left roof side rails. A CAC vehicle has been certified by the manufacturer to be compliant to the Advanced Air Bag Portion of Federal Motor Vehicle Safety Standard No. 208. The CAC system included dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence sensor. The 27-year old restrained male driver of the Toyota sustained minor-severity injuries in this crash and was transported by ground ambulance to a regional trauma center. There was no damage to the Toyota's hybrid battery. Both vehicles were towed from the scene due to disabling damage.

The vehicle was identified through a visit to a regional vehicle salvage facility on July 17, 2009. An image of the Toyota was forwarded to the Calspan Special Crash Investigations (SCI) team for review on the same day. Due to the interest in crashes involving hybrid vehicles, this case was assigned for an on-site investigation on July 20, 2009. The on-site investigation was initiated on July 23, 2009. The investigation involved the inspection and documentation of the Toyota and the Chevrolet, interviews with the driver of the Toyota, and the documentation of the crash site. Additionally, the Event Data Recorder (EDR) in the Chevrolet was imaged during the SCI inspection and is included in this technical report as ATTACHMENT A.

SUMMARY

Crash Site

This crash occurred during the daylight hours of June 2009 at a four-leg intersection of two one-way roadways. The intersection was controlled by overhead traffic signals. The 4-lane southbound roadway on which the Toyota was traveling was straight in the area in which the crash occurred and had a negative grade of -1.6 percent. The 3-lane eastbound roadway on which the Chevrolet was traveling was straight in the area in which the crash occurred and had a positive grade of 3.2 percent. Weather conditions were dry and clear at the time of the crash. The traffic lanes were surfaced with asphalt. The number one, three, and four southbound lanes were 4.2 m (13.8 ft) in width. The number two southbound lane was 3.5 m (11.5 ft) in width. The outboard eastbound lanes were 4.3 m (14.1 ft) in width. The center eastbound lane was 3.6 m (11.8 ft) in width. All roadsides were bordered by concrete curbs 14 cm (5.5 in) in height. The posted speed limit for both roadways was 56 km/h (35 mph). It should be noted that per local police, there is a high volume of crashes at this intersection. There were multiple unrelated skid marks and unrelated police-painted final rest symbols on the roadway. The Crash Schematic is included as **Figure 11** of this report.

Vehicle Data

2006 Toyota Prius

The 2006 Toyota Prius four-door hatchback was manufactured in June 2006 and was identified by the Vehicle Identification Number (VIN) JTDKB20U967 (production sequence deleted). The vehicle was purchased new by the driver in 2006.

The front-wheel drive Toyota was equipped with a 1.5 liter, transverse-mounted four-cylinder gasoline engine linked to an electric hybrid motor and a continuously variable transmission (CVT). There was a console-mounted shift lever selecting forward, neutral, reverse or engine braking to charge the hybrid battery pack. The hybrid electric motor was powered by a 200 volt nickel-metal hydride battery pack using potassium hydroxide electrolyte. The hybrid battery was located in the cargo area of the vehicle, behind the second row seat. The hybrid battery was concealed within an aluminum cover and a carpeted panel that forms the forward section of the cargo area floor. The service brakes were front wheel disc and rear drum with four-wheel antilock. All four windows were closed at the time of the crash. The vehicle manufacturer recommended tire size was P185/65R15 at 241kPa (35 PSI) of cold tire pressure in the front tires and 228 kPa (33 PSI) for the rear. The tires were mounted on OEM alloy wheels. The Toyota was equipped with an indirect Tire Pressure Monitoring System (TPMS), the driver reported in the interview that the TPMS warning light was not on prior to the crash. The Toyota was equipped with four Falken Ziex ZE912 tires in size P185/65R15. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	221 kPa (32 PSI)	6 mm (8/32 in)	None
Left Rear	193 kPa (28 PSI)	7 mm (9/32 in)	None
Right Front	214 kPa (31 PSI)	6 mm (8/32 in)	None
Right Rear	200 kPa (29 PSI)	7 mm (9/32 in)	None

The interior of the Toyota Prius Hybrid was configured with cloth-surfaced five-passenger that consisted of front bucket seats separated by a center console and a rear bench seat with 60/40 split forward folding seat backs. The front seats had adjustable head rests, both of which were found in the full-down position. The front left seat back measured 25 degrees aft of vertical; the front right seat back was measured 23 degrees aft of vertical. Both front seat tracks were adjusted to the full-rear position at the time of the SCI inspection.

The interior occupant safety systems consisted of three-point lap and shoulder belts for all five designated seating positions, front retractor mounted pretensioners, a CAC frontal air bag system, front seat back mounted side impact air bags, and curtain air bags that provided protection for the four outboard seating positions.

2005 Chevrolet Malibu

The 2005 Chevrolet Malibu LS four-door sedan was manufactured in March 2005 and identified by the VIN 1G1ZT52855F (production sequence deleted). The front-wheel drive Chevrolet was powered by a 3.5-liter, V-6 engine linked to a four-speed automatic transmission. The braking system consisted of front disc and rear drum with four-wheel antilock. All windows were closed at the time of the crash. The Chevrolet was equipped with an indirect Tire Pressure Monitoring System (TPMS). The vehicle was equipped with four Bridgestone B450 tires in size P205/65R15. The manufacturer recommended tire size was P205/65R15. The tires were mounted on OEM five-spoke alloy wheels. The vehicle manufacturer recommended cold tire pressure was 207 kPa (30 PSI) for the front and rear. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	186 kPa (27 PSI)	2 mm (3/32 in)	None
Left Rear	179 kPa (26 PSI)	5 mm (6/32 in)	None
Right Front	179 kPa (26 PSI)	2 mm (3/32 in)	None
Right Rear	179 kPa (26 PSI)	3 mm (4/32 in)	None

Crash Sequence

Pre-Crash

The 27-year-old male driver of the 2006 Toyota Prius was operating the vehicle southbound approaching the intersection in lane two of the four-lane, one-way roadway **(Figure 2)**. The Toyota was traveling at a driver estimated speed of 56 km/h (35 mph). The driver of the Toyota was familiar with the intersection. The 2005 Chevrolet Malibu was traveling eastbound towards the same intersection in lane two of the three-lane, one-way roadway. The Chevrolet was traveling at an EDR reported speed of 56 km/h (35 mph) five seconds prior to Algorithm Enable (AE). Both vehicles entered the intersection. The Chevrolet slowed to 53 km/h (33 mph) one second prior AE.

Figure 2: Southbound approach to the intersection.

Crash

The front of the Chevrolet impacted the rear aspect of the right side of the Toyota (Event 1), within the center of the intersection. The damage to the Toyota began aft of the B-pillar and included the right rear wheel. The direction of force was within the 2 o'clock sector for the Toyota and within the 11 o'clock sector for the Chevrolet. The damage algorithm of the WinSMASH program was used to calculate the crash severity (delta-V) of the crash. The total delta-V for the Toyota Prius was 11 km/h (6.8 mph). The longitudinal and lateral components for the Toyota were -8.4 km/h (-5.2 mph) and -7.1 km/h (-4.4 mph), respectively. The total delta-V for the Chevrolet Malibu was 10 km/h (6.2 mph) with longitudinal and lateral components of -7.7 km/h (-4.8 mph) and +6.4 km/h (+4.0 mph), respectively. The EDR reported delta-V components for the Chevrolet were -6.6 km/h (-4.1 mph) longitudinal and 1.1 km/h (0.7 mph) lateral. **Figure 3** is a view of the initial impact location.

The force of the impact rearward of the Toyota's center of gravity induced a clockwise (CW) rotation to the Toyota within the intersection. The Toyota rotated approximately 80 degrees CW and traveled approximately 14 m (45.9 ft) south of the impact where the left side tires folded under the alloy wheels exposing the rim beads to the asphalt road surface. The rim beads contacted the road surface and tripped the vehicle into a left side leading rollover event (Event 2). The Toyota rolled two-quarter turns to the left over a distance of 6 m (19.7 ft), coming to rest on its roof. The rollover was not interrupted. **Figure 4** is a view of the location of the rollover of the Toyota. The Toyota came to rest on its roof on the roadway facing west. The Chevrolet came to rest at the east curb line, facing south.

Figure 3: Southbound trajectory view of the area of initial impact.

Figure 4: Southbound view at the location of the Toyota rollover.

Post-Crash

Police, emergency medical, and tow personnel responded to the crash site. The driver of the Toyota was transported to a local trauma center where he was treated and released from the emergency department. The Toyota was towed from the scene due to disabling damage. The tow operator was contacted and he stated that his precautions for towing the hybrid vehicle were to be certain that the ignition was switched off and inspect the interior and exterior of the vehicle for leaking battery fluid, to not touch any orange colored high-voltage wiring and avoid working in the area of the battery compartment. The Toyota was towed from the scene on a rollback-type tow truck and held in the tow company's storage lot until it was transported to a regional vehicle salvage facility, where it was inspected.

2006 Toyota Prius

Exterior Damage

The exterior of the Toyota Prius sustained moderate severity damage to the right, top and left planes as a result of this multiple event crash. The rear aspect of the right plane sustained damage in the initial impact **(Figure 5)**. Both right side door latches remained engaged, and all doors remained closed during the crash and operational after the crash. The direct damage measured 147 cm (57.9 in) and began 182 cm (71.7 in) rear of the right front axle and extended rearward to the rear right bumper corner area. The maximum crush measured 8 cm (3.1 in) and was located at C4,

Figure 5: Initial impact damage to the Toyota.

241 cm (94.9 in) aft of the right front axle. The documented crush profile for the initial impact was as follows: C1 = 0 cm, C2 = 5 cm (2 in), C3 = 3 cm (1.2 in), C4 = 8 cm (3.1 in), C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) assigned for this impact was 02RZEW1.

As a result of the rollover event, the Toyota sustained moderate severity damage to the left and top planes. The windshield glazing was 60 percent fractured with significant damage to the upper aspect. The left front, left rear quarter window, and backlight disintegrated as a result of the rollover event. The left rear door window and all right side glazing were undamaged. The scratches on the roof were oriented laterally. The direct contact damage to the roof extended 121 cm (47.6 in) laterally from the left roof side rail to the right roof side rail. The longitudinal direct contact damage extended 347 cm (136.6 in) from the leading edge of the hood to the approximate center of the C-pillars. The maximum vertical crush was located on the windshield header 24 cm (9.4 in) left of the right A-pillar. The maximum vertical crush measured 6 cm (2.4 in). The maximum lateral crush was located on the left roof side rail 26 cm (10.2 in) forward of the C-pillar and measured 4 cm (1.6 in). **Figures 6 and 7** depict the rollover damage sustained by the Toyota. The CDC assigned for the rollover was 00TDDO2.

Figure 6: Toyota rollover damage from above, right front.

Figure 7: Toyota rollover damage from above, left rear.

Interior Damage

The Toyota Prius sustained moderate severity interior damage attributed to passenger compartment intrusion. There were no identified occupant contact points.

The intrusion to the Toyota is listed on the following table:

Position	Component	Direction	Magnitude
Row 1 Left	B-pillar (upper)	Lateral	4 cm (1.6 in)
Row 1 Left	Roof	Vertical	4 cm (1.6 in)
Row 1 Left	Windshield header	Vertical	2 cm (0.8 in)

Position	Component	Direction	Magnitude
Row 1 Left	Roof side rail	Lateral	2 cm (0.8 in)
Row 1 Center	Roof	Vertical	2 cm (0.8 in)
Row 1 Center	Windshield header	Vertical	4 cm (1.6 in)
Row 1 Right	Roof	Vertical	3 cm (1.2 in)
Row 1 Right	Windshield header	Vertical	5 cm (2 in)
Row 2 Left	Roof	Vertical	3 cm (1.2 in)
Row 2 Left	Roof side rail	Lateral	3 cm (1.2 in)
Row 2 Center	Roof	Vertical	5 cm (2 in)
Row 2 Right	Roof	Vertical	2 cm (0.8 in)

Manual Restraint Systems

The Toyota was equipped with 3-point manual lap and shoulder belts for the five designated seating positions. All belt systems utilized continuous loop webbing. The driver's safety belt system utilized a sliding latch plate and a retractor-mounted pretensioner. The retractor did not actuate during the crash. The front left upper D-ring was height adjustable and found in the mid position, 4 cm (1.6 in) down from the full-up position. The driver's belt retracted onto an Emergency Locking Retractor (ELR). The driver used the safety belt at the time of the crash, which was supported by loading evidence on the belt webbing. This evidence consisted of a frictional abrasion on the belt webbing near the latch plate. The abrasion was located 91 to 94 cm (35.8 to 37.0 in) above the lower seat anchor. The belt moved smoothly onto and from the retractor.

The front right and second row safety belt systems utilized a switchable ELR/Automatic Locking Retractor (ALR) and a sliding latch plate. In addition, the front right belt system contained a retractor pretensioner which did not actuate during the crash.

Frontal Air Bag System

The Toyota was equipped with a CAC frontal air bag system. The manufacturer of the vehicle has certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system includes dual-stage frontal air bags for the driver and right front passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence (weight) sensor. The driver's air bag was concealed within the center hub of the four-spoke steering wheel. The front right passenger's air bag was concealed within the top aspect of the right instrument panel. The frontal air bags did not deploy in this crash.

Side Impact Air Bag System

The Toyota was equipped with side impact air bags mounted in the upper outboard aspect of the front seat backs, and curtain air bags mounted in both roof side rails of the vehicle. The left and

right seat back air bags did not deploy in this crash. Neither curtain air bag deployed in this crash. The vehicle was not equipped with rollover sensing.

Hybrid Power System

The 2006 Toyota Prius was equipped with a hybrid battery system used to drive an electric motor that assists the gasoline engine. This system improves fuel efficiency while the gasoline engine is in use, or to provide power for vehicle movement at lower speeds without use of the gasoline engine. The battery pack was a Panasonic Metal Case Prismatic Module consisting of 168 cells in 28 modules. It has a nominal voltage of 201.6 V with a capacity of 6.5 Ah using nickel-metal hydride and a potassium hydroxide electrolyte. The battery compartment and the battery were inspected for damage due to the crash and from possible intrusion of the right side of the cargo area. The hybrid battery was located over the rear axle, centered under the cargo area of the vehicle **(Figure 8)**. The battery was covered by an aluminum cover and a carpeted panel that made up the forward section of the cargo area floor. The battery was inspected and photographed with the carpet panel removed and the aluminum cover elevated **(Figure 9)**.

Figure 8: Toyota hybrid battery with aluminum cover in place.

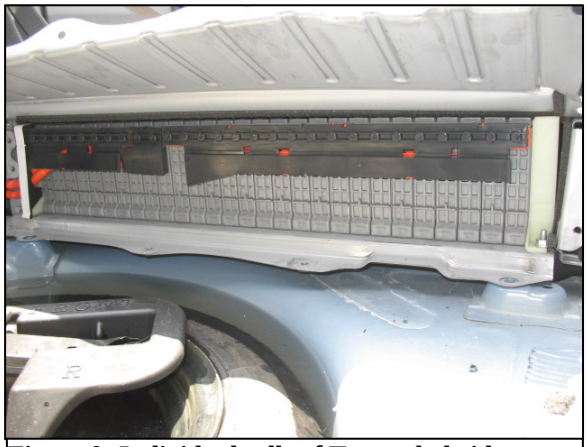

Figure 9: Individual cells of Toyota hybrid battery with cover elevated.

The battery compartment was vented to right side of the vehicle by a plastic duct that extended to the right side of the rear bumper fascia. The electrical connections and fuse were under a service panel on the left side of the hybrid battery. There was no movement of the plastic venting duct from the rollover or initial impact damage that was adjacent to the right side of the battery and the duct.

Federal Motor Vehicle Safety Standard (FMVSS) No. 305, Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection is the standard applied to vehicles that use more than 48 nominal volts of electricity as propulsion and whose speed on a level paved surface is more than 40 km/h (25 mph). FMVSS No. 305 specifies performance requirements of electrolyte spillage, retention of propulsion batteries, and electrical isolation of the chassis from

the high-voltage system during a crash event. The standard test requirements are summarized as follows:

- Not more than 5.0 liters (1.3 gal) of electrolyte from propulsion batteries shall spill outside the passenger compartment, and none shall spill in the passenger compartment, within 30 minutes after a barrier impact test.
- No propulsion battery system component located inside the passenger compartment shall move from its installed location.
- No propulsion battery system component located outside the passenger compartment shall enter the passenger compartment.
- Electrical isolation shall exist between the propulsion battery system and the vehicle electricity-conducting structure.

The Toyota was visually inspected for compliance with FMVSS No. 305. The right side impact damage did not involve the area of the propulsion battery. There was no intrusion into the battery compartment, or damage to the battery or battery cover. There was no leakage detected during the SCI vehicle inspection. The battery propulsion system components were not displaced or damaged by this impact event. The electrical isolation test was not conducted.

2005 Chevrolet Malibu

Exterior Damage

The front plane of the Chevrolet Malibu sustained moderate-severity damage in the initial impact with the Toyota. The direct contact damage extended from bumper corner to bumper corner on the front plane and measured 112 cm (44 in) in width **(Figure 10)**. The maximum crush to the bumper beam measured 5 cm (2 in) and was located at C2, 26 cm (10.2 in) left of the centerline of the Chevrolet. A crush profile was documented along the full length of the damaged front bumper beam. This crush profile was as follows: C1 = 4 cm (1.6 in), C2 = 5 cm (2 in), C3 = 4 cm (1.6 in), C4 = 4 cm (1.6 in), C5 = 5 cm (2 in), C6 = 2 cm (0.8 in). The CDC assigned for this impact was 11FDEW1.

Figure 10: Overall view of the frontal damage to the Chevrolet.

Event Data Recorder

The Event Data Recorder (EDR) of the Chevrolet was imaged at the time of the SCI inspection by applying power to the air bag system and imaging the data through the Diagnostic Link Connector (DLC) port under the left instrument panel. The data was imaged utilizing software version 3.2 of the Bosch Crash Data Retrieval Tool. The data has been reported utilizing version

3.4. The recovered data showed a deployment event had been stored in the module, consistent with the observations of the vehicle inspection.

The system status at Algorithm Enable (AE) showed the TPMS warning lamp "Off", the vehicle power mode as "Run" and the brake system warning light "Off". One second prior to AE, the data recorder held the following data: the engine was not in reduced power mode, the automatic transmission selector was in the Drive position, the transmission was shifting gears, the traction control system was not active and the outside air temperature was 82 degrees Fahrenheit (27 degrees Celsius).

At deployment, the number of ignition cycles was 12017 (12023 at investigation). The driver's safety belt was shown in the CDR data as buckled. There were no diagnostic trouble codes stored at the time of the deployment. **Attachment A,** at the end of this report, is the data file imaged from the EDR of the Chevrolet.

2006 Toyota Prius Occupant Demographics

Driven Data

Driver Age/Sex:	27-year-old/Male
Height:	178 cm (70 in)
Weight:	85 kg (188 lb)
Eyewear:	Prescription glasses
Seat Track Position:	Full-rear track
Manual Safety Belt Use:	Lap and shoulder belt
Usage Source:	Vehicle Inspection
Egress from Vehicle:	Exited with some assistance from bystanders
Mode of Transport from Scene:	Ground ambulance
Type of Medical Treatment:	Treated in emergency department and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Left forearm abrasions (1)	Minor (790202.1,2)	Door panel – rear upper quadrant
Left head contusion (2)	Minor (190402.1,2)	Left B-pillar

Source: (1) – Emergency room records; (2) – Interview

Driver Kinematics

The 27-year-old male driver was seated in a full-rear track position and was restrained by the manual 3-point lap and shoulder belt system. When the initial impact occurred, the driver initiated a right trajectory within the front left seating position and loaded the lap belt. The

Toyota separated from the initial impact with a CW rotation, tripped and rolled over. After the vehicle began to roll to the left, the driver initiated a trajectory to the left within the front left seating position. The curtain air bags and the left side air bag did not deploy. The driver loaded the left door with his left arm and hip. His contact to the door resulted in the forearm abrasion (confidence = probable). The left side of the driver's head possibly impacted the B-pillar resulting in the contusion (confidence = probable).

The Toyota Prius came to rest on its roof. The driver was inverted, hanging in the front left seat, but was able to open the left door to exit the vehicle. He released the seat belt and was assisted from the vehicle and to the curb by a citizen who stopped to render aid. He was transported by ground ambulance to a local hospital where he was treated in the emergency department and released.

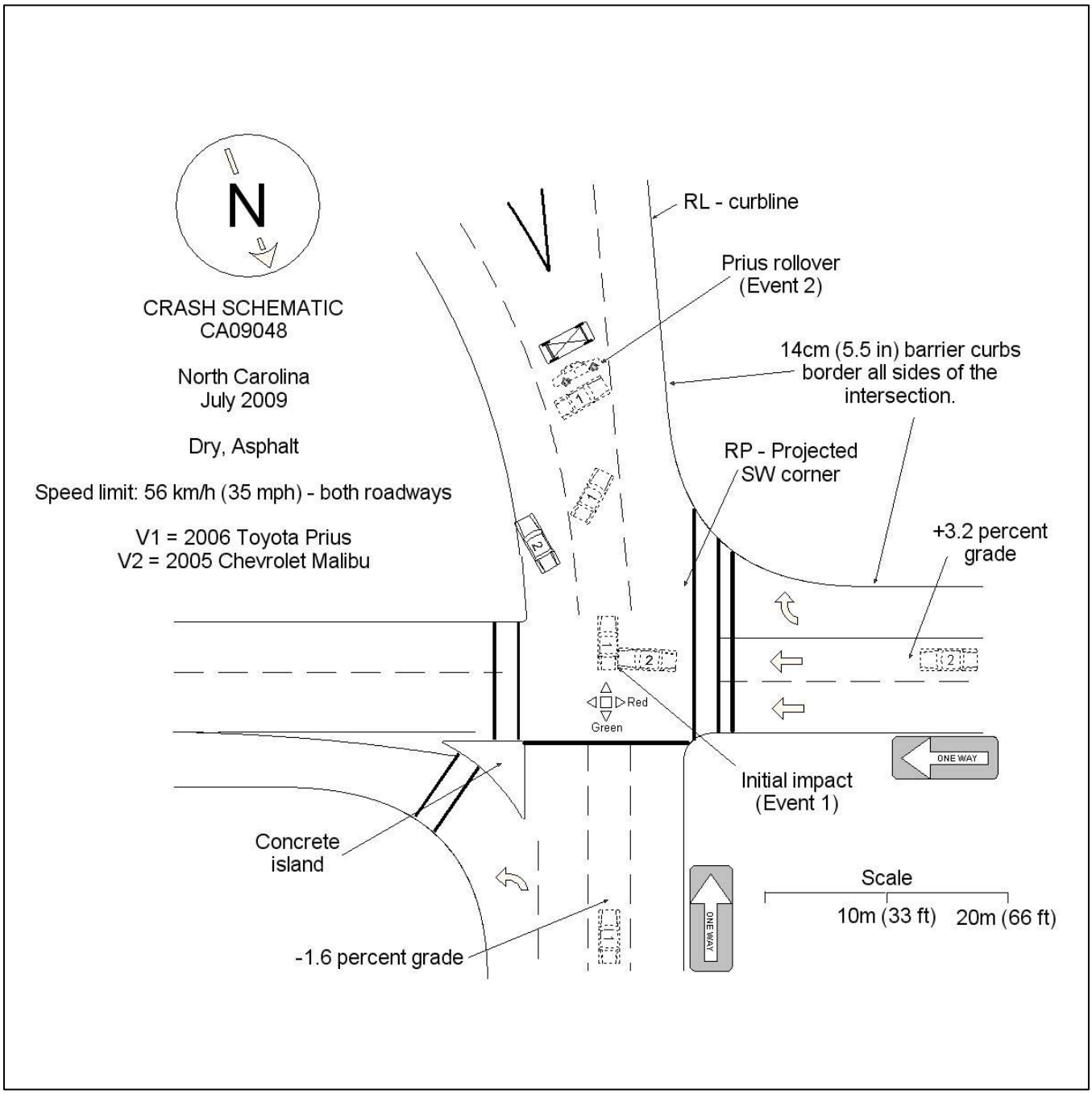

Figure 11: Crash Schematic

ATTACHMENT A:

2005 Chevrolet Malibu EDR Data

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	1G1ZT52855F******
User	
Case Number	
EDR Data Imaging Date	Thursday, July 23 2009
Crash Date	
Filename	
Saved on	Thursday, July 23 2009 at 10:07:17 AM
Collected with CDR version	Crash Data Retrieval Tool 3.2
Reported with CDR version	Crash Data Retrieval Tool 3.4
EDR Device Type	airbag control module
Event(s) recovered	Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.
The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM 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.

-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 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.

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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	**1ZT528*5*******
Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active
Brake System Warning Lamp (If Equipped)	OFF

System Status At 1 second

Transmission Range (If Equipped)	Shift in Progress
Transmission Selector Position (If Equipped)	Drive
Traction Control System Active (If Equipped)	No
Service Engine Soon (Non-Emission Related) Lamp	OFF
Service Vehicle Soon Lamp	OFF
Outside Air Temperature (degrees F) (If Equipped)	82
Left Front Door Status (If Equipped)	Closed
Right Front Door Status (If Equipped)	Closed
Left Rear Door Status (If Equipped)	Unused
Right Rear Door Status (If Equipped)	Unused
Rear Door(s) Status (If Equipped)	Closed

Pre-crash data

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

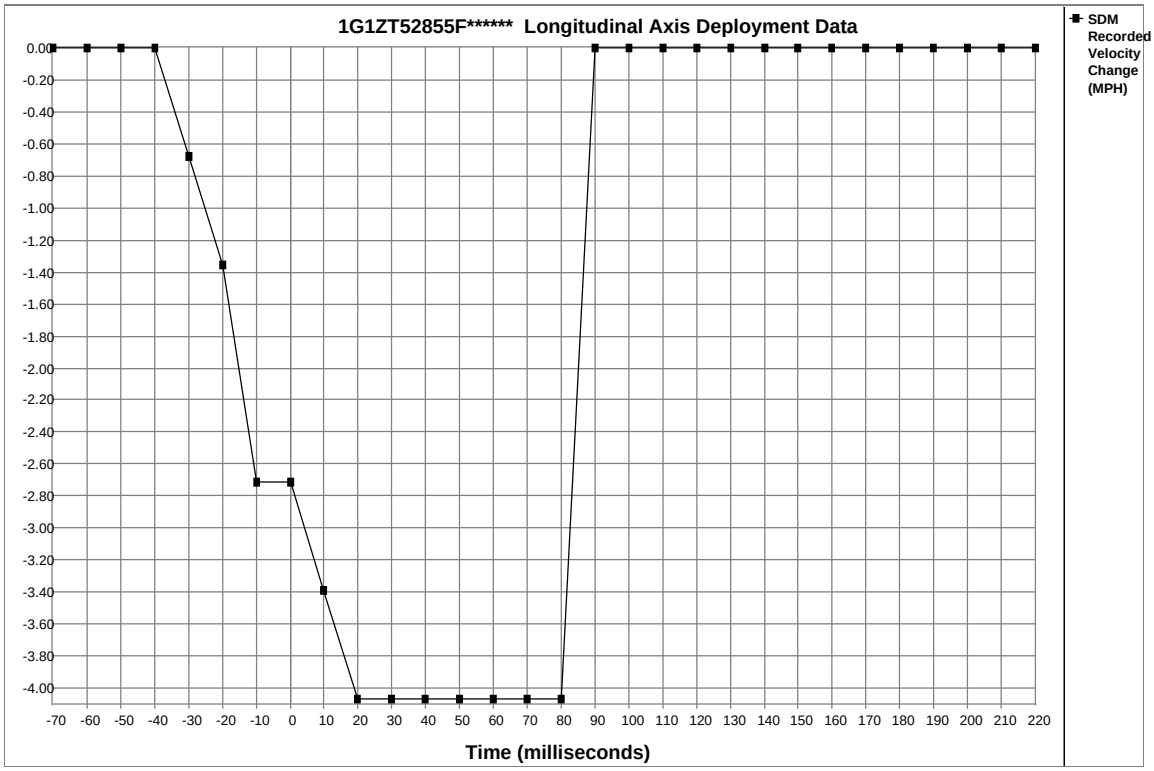
Pre-Crash Data

Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	35	34	34	34	33
Engine Speed (RPM)	896	1216	1088	960	896
Percent Throttle	0	6	1	0	0
Accelerator Pedal Position (percent)	0	20	10	0	0
Antilock Brake System Active (If Equipped)	No	No	No	No	No
Lateral Acceleration (feet/s^2)(If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Yaw Rate (degrees per second) (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

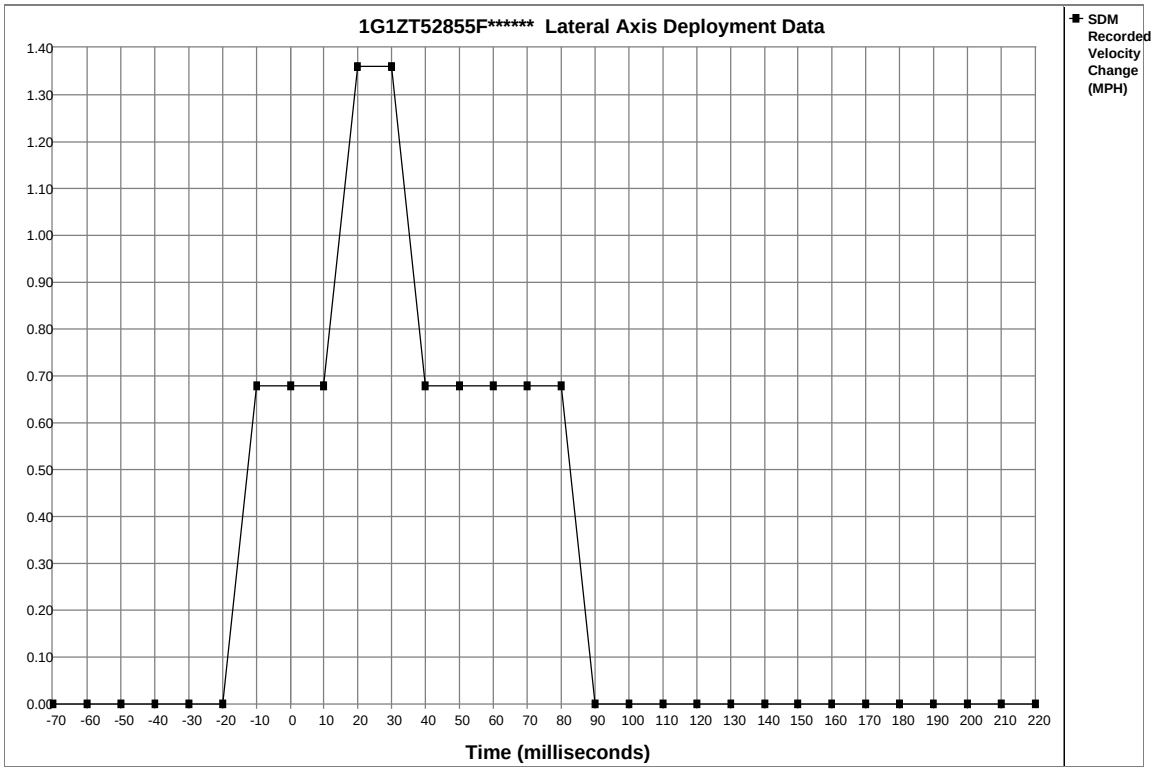
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Steering Wheel Angle (degrees) (If Equipped)	-32	-16	-16	-16	-16
Vehicle Dynamics Control Active (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

System Status At Deployment

Ignition Cycles At Investigation	12023
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	655200
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	11957
Ignition Cycles At Event	12017
Ignition Cycles Since DTCs Were Last Cleared	254
Driver'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
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	26
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	128
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	26
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	128
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	Yes
Passenger 2nd Stage Deployment Loop Commanded for Disposal	Yes
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	-0.68	-1.36	-2.71	-2.71	-3.39	-4.07	-4.07	-4.07	-4.07	-4.07	-4.07
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-4.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



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	0.00	0.00	0.68	0.68	0.68	1.36	1.36	0.68	0.68	0.68	0.68
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00