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Special Crash Investigations On-Site Air Bag Non-Deployment Crash Investigation Vehicle: 2004 Lexus GX470 Location: Massachusetts Crash Date: August 2017

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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 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 vehicles or their safety systems.

This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

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16. Abstract This report documents the on-site investigation of the non-deployment of all air bag systems in a 2004 Lexus GX470. According to a person who reported the crash to NHTSA, the Lexus was traveling downhill when a malfunction of the vehicle's braking system occurred. The claimant alleged that this resulted in a loss of control in which the Lexus departed the roadway and struck multiple large diameter trees. None of the air bags in the Lexus deployed during the crash. The Lexus was equipped with dual-stage frontal air bags for the driver and front right passenger positions, as well as inflatable curtain air bags in both roof side rails. A belted 70-year-old female driver occupied the Lexus at the time of the crash. She was transported by ambulance to a local hospital post-crash for the treatment of reported possible (C-level) injuries. A dog, positioned loose in the vehicle's front row right seat position, sustained multiple injuries and was euthanized post-crash. Through the course of this investigation the SCI investigator ultimately concluded that the fluid in the vehicle's braking system leaked from a corroded hose connection near the right front axle position. This significantly reduced the fluid contents in the reservoir, which led to a depressurization of the system while the driver operated the vehicle. The unexpected diminished braking ability of the vehicle resulted in the driver's loss of control and subsequent crash. A review of the data imaged from the Lexus' EDR revealed that, for undetermined reasons, the multiple longitudinal and lateral impact events of the crash were not recognized or recorded by the vehicle's air bag control module. Because the events were not recognized, no actuation/deployment of the vehicle's supplemental restraint systems was commanded.			
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BACKGROUND

Figure 1: Front right oblique view of the 2004 Lexus GX470.

This report documents the on-site investigation of the non-deployment of all air bag systems in a 2004 Lexus GX470 (**Figure 1**). According to a person who reported the crash to the National Highway Traffic Safety Administration, the Lexus was traveling downhill when a malfunction of the vehicle's braking system occurred. The claimant alleged that this resulted in a loss of control in which the Lexus departed the roadway and struck multiple large-diameter trees. None of the air bags in the Lexus deployed during the crash. The Lexus was equipped with dual-stage frontal air bags for the driver and front right passenger positions, as well as inflatable curtain (IC) air bags in both roof side rails. A belted 70-year-old female driver occupied the Lexus at the time of the crash. She was transported by ambulance to a local hospital post-crash for the treatment of reported possible (C-level) injuries. A dog, positioned loose in the vehicle's front row right seat position, sustained multiple injuries and was euthanized post-crash.

This crash was reported to NHTSA by the vehicle's owner in September, 2017. The notification and on-site investigation assignment was forwarded to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in September, 2017. The SCI investigator established cooperation with the vehicle's insurer and subsequently inspected the vehicle in October, 2017. The on-site investigation included the documentation and measurement of the Lexus' exterior and interior damage and intrusion, identification of occupant contact, and assessment and documentation of the manual and supplemental restraint systems. During the vehicle inspection process, data was imaged from the Lexus' event data recorder (EDR) using the Bosch Crash Data Retrieval (CDR) tool and software. A telephone interview of the driver was conducted, and the crash site was documented. On-scene images and a police crash report (PAR) were obtained from the investigating law enforcement agency. Multiple requests for records concerning the driver's injuries (if any) and treatment course were denied by the medical facility to which she was transported.

Through the course of this investigation, the SCI investigator ultimately concluded that the fluid in the vehicle's braking system leaked from a corroded hose connection near the right front axle position. This significantly reduced the fluid contents in the reservoir, which led to a depressurization of the system while the driver operated the vehicle. The unexpected diminished braking ability of the vehicle resulted in the driver's loss of control and subsequent crash. A review of the data imaged from the Lexus' EDR revealed that, for undetermined reasons, the multiple longitudinal and lateral impact events of the crash were not recognized or recorded by the vehicle's air bag control module (ACM). Because the events were not recognized, no actuation/deployment of the vehicle's supplemental restraint systems was commanded.

SUMMARY

Crash Site

The crash occurred on a rural two-lane roadway during mid-day in September 2017. According to the National Weather Service, conditions in the locale at the time of the crash included clear skies with a temperature of 21.1 °C (70 °F), an east-northeast breeze of 13.0 km/h (8.1 mph), and relative humidity of 78 percent. The physical environment of the roadway and roadside were documented during the SCI crash site inspection using a Nikon Nivo 5.M+ total station mapping system.

The east/west roadway consisted of two 3.2 m (10.5 ft) wide travel lanes that were divided by a faded double-solid yellow centerline. Single solid-white fog lines delineated the roadway's edges. There were no shoulders. The roadway traversed a hillside through a forest, with multiple curves along its winding path. In the area of the crash, the south roadside consisted of numerous large-diameter trees, with an old wooden fence that paralleled the roadway. Speed on the rural roadway was regulated by a posted limit of 56 km/h (35 mph). **Figure 2** provides a west-facing view for the Lexus' approach. A crash diagram is included in this technical report.

Figure 2: West-facing trajectory view of the roadway in the vicinity of the crash.

Pre-Crash

The 70-year-old female driver occupied the Lexus with her small dog on the front right seat. The driver was belted, using the vehicle's available 3-point lap and shoulder seat belt. The dog was unbelted. The driver reported during interview that she had been driving the vehicle for the majority of the morning as she ran multiple errands. Prior to the crash, she had detected a progressive sense that the vehicle was having difficulty stopping. While entering a business, the driver reported that the vehicle nearly ran into a building despite her application of the brakes.

At that point, the driver decided to return to her residence and park the vehicle. She departed the business, and began to travel westbound on the rural roadway. The vehicle descended a lengthy, curvy downgrade through the hillside. The driver soon realized that she was unable to control the speed of the vehicle, as her application of the brake pedal did not illicit a response from the system. See the *Braking System Discussion* of this report for detailed information concerning the Lexus' brake system and the driver's pre-crash braking loss.

The driver reported during interview that the vehicle continued to gain speed along the downgrade, and the antilock braking system (ABS) warning light illuminated on the vehicle's instrument cluster. She stated that she passed multiple vehicles and began to panic while attempting to negotiate the series of curvatures in the roadway. The driver lost control when the vehicle initiated a counterclockwise yaw after exiting a left curve. Tire marks on the asphalt surface of the roadway provided evidence that the Lexus had drifted left across the centerline and yawed slightly counterclockwise as the roadway transitioned to a right curve. The Lexus then departed the left (south) roadway edge. The driver reported that the vehicle's speed was in excess of 113 km/h (70 mph).

Crash

The first crash event occurred as the right front corner aspect of the Lexus struck at least one large-diameter tree (Event #1). This impact resulted in deformation to the right aspect of the Lexus' bumper beam and right front fender area. The tree sheared approximately 2.5 m (8.2 ft) above ground level as the trunk was slightly displaced by the vehicle. Nearly simultaneous to the tree impact, the Lexus' front plane also struck an old wooden fence (Event #2). Several panels of the old wooden picket fence were fractured and displaced by the impact forces. **Figure 3** depicts the area of the multiple impacts. As can be seen in the image, excavation at the crash site hindered the SCI investigator's ability to reconstruct the crash scene and explicitly identify each specific impact event sustained by the Lexus during the crash sequence. Note that the yellow line in the image represents the original location of the fence.

Figure 3: West-facing view of the crash site and location of multiple overlapping events. Note that the yellow line in the image represents the original location of the wooden fence.

The Lexus maintained its momentum and engaged at least two more large-diameter trees with its right front corner aspect (Event #3). This damage overlapped the previous (Event #1) tree impacts and produced significant deformation to the right front corner area as the vehicle engaged the trees. Crash forces sheared/uprooted the large diameter trees, and were of significant magnitude such that the vehicle's counterclockwise rotation was reversed. The Lexus began to rapidly rotate clockwise and was redirected toward the southwest.

As the vehicle achieved approximately 90-degrees of clockwise rotation, its left plane struck a small-diameter tree in the area of the driver's door (Event #4). Forces associated with the impact produced moderate lateral deformation to the left front door area of the Lexus, and uprooted the tree. The vehicle maintained its rotation and completed approximately 270-degrees of total clockwise rotation before it slid to rest in the wooded area. At final rest, the Lexus was positioned on a downslope and facing generally southeast (**Figure 4**), approximately 15 m (50 ft) south of the roadway edge.

Figure 4: South-facing view from the old wooden fence line of the Lexus at final rest (*on-scene image provided by the investigating law enforcement agency*).

Post-Crash

There were several witnesses to the crash, who notified the local emergency response system. Fire department, emergency medical services (EMS), and law enforcement personnel were dispatched to the crash scene. The female driver exited the Lexus under her own power. Upon the arrival of emergency personnel, she was transported by ambulance to a local hospital.

The investigating law enforcement agency documented the crash site. The Lexus was recovered and towed to a local yard, then deemed a total loss by its insurer. It was then transferred to a regional vehicle salvage facility, where it was inspected for this SCI investigation.

2004 LEXUS GX470

Description

The 2004 Lexus GX470 (**Figure 5**) was manufactured in Japan in November 2003 and was identified by the Vehicle Identification Number JTJBT20X640xxxxxx. It was a 4-door sport utility vehicle built on a 280 cm (110.2 in) wheelbase with a 4.7 liter V-8 gasoline engine and all-wheel drive. The Lexus had a gross vehicle weight rating of 2,970 kg (6,150 lb). Front and rear axle ratings were 1,290 kg (2,850 lb) and 1,520 kg (3,350 lb), respectively. The curb weight was 2,150 kg (4,740 lb). Placarding on the frame of the left front door declared that the vehicle manufacturer's recommended tire size and cold tire pressure for all four axle positions was P265/65R17 at 220 kPa (32 psi).

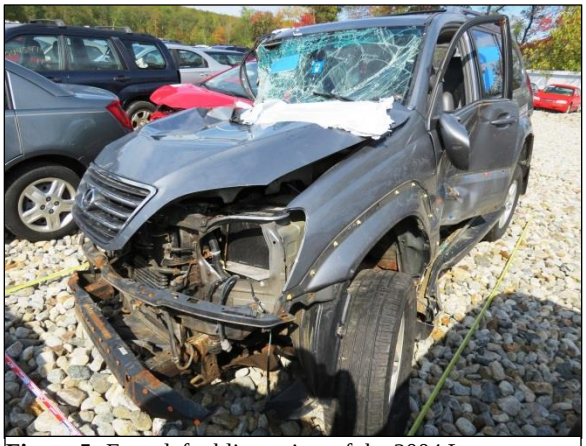


Figure 5: Front left oblique view of the 2004 Lexus GX470 at the time of the SCI vehicle inspection.

At the time of the SCI inspection, the right front wheel assembly was missing. All remaining tires were Firestone Destination LE2 of the recommended size with matching tire identification numbers of VNAH DE1. Specific data measured during the SCI inspection included:

Position	Tire Make/Model	Tire Identification Number	Tread Depth	Restriction	Damage
LF	Firestone Destination LE[2]	VNAH DE1	4 mm (5/32 in)	No	Tire flat
LR	Firestone Destination LE[2]	VNAH DE1	6 mm (7/32 in)	No	None
RR	Firestone Destination LE[2]	VNAH DE1	5 mm (6/32 in)	No	None
RF	Unknown	Unknown	Unknown	Unknown	Unknown

The interior of the Lexus was configured for the seating of five occupants (2/3). The front row consisted of forward-facing bucket seats with adjustable head restraints. At the time of the SCI inspection, the driver's seat was adjusted to a middle track position, with the seat back slightly reclined and the adjustable head restraint 2 cm (0.8 in) upward. The Lexus's second row consisted of a non-adjustable bench seat.

Vehicle History

According to a vehicle history report obtained from a commercial service based on National Motor Vehicle Title Information System data, this specific 2004 Lexus GX470 had two separate owners during its lifetime. The vehicle was first purchased, titled, and registered in New Jersey in December 2003. Routine service and maintenance were reported during 2004 and 2005, with a reported odometer reading in April 2005 of 16,015 km (9,951 mi). Then, in May 2005, the Lexus was involved in a crash. The vehicle was repaired, then traded in to an authorized manufacturer dealership in October 2005, with an odometer reading of 20,979 km (13,036 mi).

The second (current) owner purchased, titled, and registered the Lexus in Vermont in November 2005. At that time, the odometer reading was reported as 23,352 km (14,510 mi). Numerous routine maintenance and service visits were recorded in the vehicle's history report. A recall was issued in February 2016 in reference to the NHTSA campaign #16V065, which concerned possible inadvertent deployment of the vehicle's IC air bags. This recall is discussed in the *NHTSA Recalls and Investigations* section of this report. The most recent reported odometer reading was 202,262 km (125,680 mi) in April 2017, when the vehicle received routine service, which included examinations of the vehicle's brake system.

A total loss of the vehicle was reported in Massachusetts during August 2017, relative to the incident crash. According to the current owner of the Lexus, the vehicle had been involved in two other minor crashes that were not identified by the vehicle history report. The owner stated that 10 years prior (during 2007), a deer ran into the right side of the vehicle and caused approximately $2,000 in damage to the body. Then, in February 2017, the vehicle struck the back plane of another vehicle in a traffic jam, but did not sustain damage. Neither crash involved supplemental restraint system actuation/deployment.

Exterior Damage

Damage to the exterior of the Lexus was located on the front, right, and left planes, associative to the multiple impact events of the crash. Deformation and damage associated with the Event #1 (tree) and Event #2 (fence) impacts were overlapped by subsequent events. Specific damage sustained by the Lexus relative to these events therefore remains unknown. The Collision Deformation Classifications (CDCs) assigned to the Lexus for the Event #1 and Event #2 damage patterns were 12FREE99 and 12FDEW1, respectively. No WinSMASH calculations could be performed due to the overlapping nature of the damage.

The third impact event with the multiple large-diameter trees produced severe deformation to the front right corner and right plane of the Lexus. Although the damage overlapped prior impact damage, the extent of the damage along the right plane began at the right front bumper corner and extended to beyond the right A-pillar. The right front fender and right A-pillar were deformed rearward, and the right front door was completely collapsed. Front plane damage included the separation of the bumper fascia and minor deformation to the bumper beam. Crush to the bumper beam was observed with direct contact damage primarily outboard of the right frame rail. There was also minor deformation to the right aspect of the hood. **Figure 6** depicts a view from the front plane down the right side, while **Figure 7** depicts a lateral view of the right plane and Event #3 deformation.

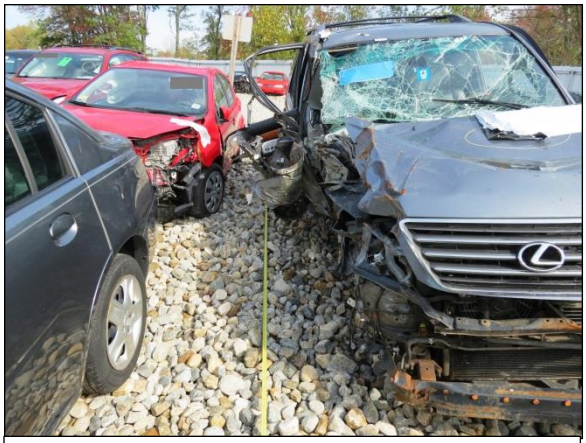


Figure 6: View of the Event #3 damage pattern to the 2004 Lexus GX470 sedan.

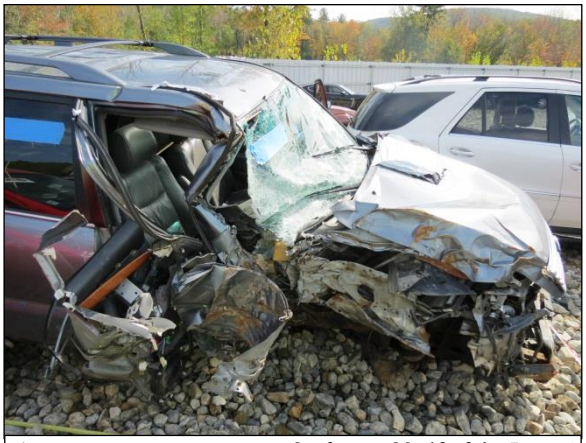


Figure 7: Damage pattern to the forward half of the Lexus' right plane.

Direct contact began 50 cm (19.7 in) right of center and extended to the right front bumper corner. From a front plane perspective, the width of the direct and induced damage (Field-L) for the crush profile measured 150 cm (59.1 in) from bumper corner to bumper corner. This produced the following resultant measurements: C1 & C2 = 0 cm (0 in), C3 = 5 cm (2.0 in), C4 = 11 cm (4.3 in), C5 = 16 cm (6.3 in), and C6 = 35 cm (13.8 in). Maximum crush was located at the right front bumper corner. The CDC assigned for the Event 3 impact with the large-diameter trees was 12FRAE7. WinSMASH calculations could not be performed because the yielded status of the

trees and overlapping damage were beyond the scope of the model's capabilities, and would not have produced representative results.

Figure 8 depicts an overhead view of the front damage profile and its extent along the right plane.

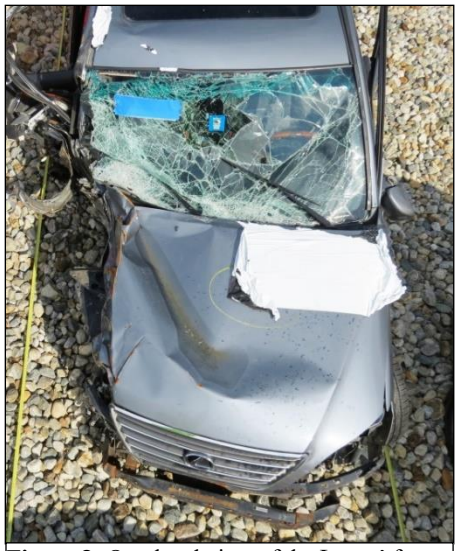


Figure 8: Overhead view of the Lexus' front crush profile and deformation pattern.

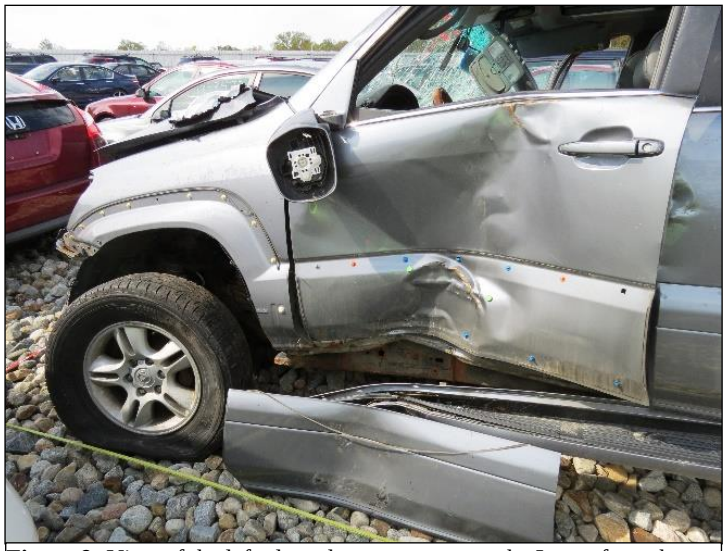


Figure 9: View of the left plane damage pattern to the Lexus from the Event 4 tree impact.

Damage associative to Event #4 was located on the left plane, in the area of the driver's door. This consisted of a distinct U-shaped deformation pattern to the vehicle that began on the running board and at sill level, extending diagonally upward and rearward to the beltline (**Figure 9**). Although the directional nature of the pattern began at 315 cm (124.0 in) on the baseline and extended 95 cm (37.4 in) rearward to 220 cm (86.6 in) on the baseline, the overall maximum width of the damage pattern measured just 26 cm (10.2 in) wide. The most significant crush was observed at sill level, with a maximum depth of 10 cm (3.9 in). An accurate residual crush profile of the damage could not be obtained due to the inability to completely close and latch the driver's door. The CDC assigned to the damage pattern of the Event 4 tree impact was 09LPAN2. No WinSMASH calculation was performed because the yielded status of the impacted tree was beyond the scope of the model's capabilities, and would not have produced representative results.

Event Data Recorder

The 2004 Lexus GX470 was equipped with an air bag control module (ACM) mounted to the floor on the center tunnel beneath the center instrument panel. The ACM monitored the diagnostic functions of the vehicle's supplemental restraint systems (air bags and seat belt pretensioners) and controlled the deployment/actuation of those devices dependent upon crash event trigger severity. The ACM also had EDR capabilities to record crash event data for longitudinal, lateral, and rollover crash events. During the SCI vehicle inspection, the EDR component of the Lexus'

ACM was imaged using the Bosch Crash Data Retrieval (CDR) software and tool, version 17.4.2. A connection was made to the ACM via the diagnostic link connector (DLC), using external power supplied through the vehicle's fuse panel.

The imaged data was read using version 17.7.2, and is included at the end of this report as **Appendix A**. Following data retrieval and review, the ACM was removed from the Lexus and retained by the SCI investigator. It was then forwarded to the agency for further examination. As of the date of this report, no further information concerning the Lexus' ACM was available to the SCI investigator. The data imaged from the Lexus contained two front/rear crash event records and one rollover event record. All three records were non-deployment event types. The reader is cautioned that the delta-V data presented in the EDR report is not related to the incident crash, due to the reasons explained hereafter.

The two front/rear events had occurred 920 milliseconds apart. The first occurring event had a longitudinal delta-V of 14.1 km/h (8.8 mph), while the subsequent event had a longitudinal delta-V of -5.5 km/h (-3.4 mph). For both events, the driver and passenger buckle switch status were both "Buckled." These two events appeared to resemble an inline crash where the Lexus was struck in the rear by a vehicle, then displaced forward and into the rear of another vehicle. The force direction, delta-V magnitude, and passenger buckle status did not match the incident crash. The SCI investigator conclusively determined that neither of the front/rear events reported in the imaged EDR report were related to the incident crash.

The occurrence in time of the rollover data recorded by the EDR in relation to the two front/rear events could not be determined by the data presented in the EDR report. No trigger counter number was assigned to the rollover record. The maximum roll angle was -8.3 degrees, indicative of counterclockwise roll about the horizontal axis (left side-leading). Associated with the roll angle was minor lateral deceleration. Although it is possible that this data was related to the incident crash, the SCI investigator was unable conclusively determine the relevancy of the rollover record to the incident crash due to the limited data presented in the EDR report. Regardless of its relation to the incident crash, the rollover record was not associated with any supplemental restraint system actuation/deployment.

Interior Damage

The interior of the Lexus was inspected for crash-related damage, including intrusion and occupant contact. Associative to the Event #1 impact on the left plane of the vehicle was minor lateral intrusion of the left front door and left sill. Significant intrusion of the instrument panel and right A-pillar was observed at the front row right position, associative to the frontal impact, right plane engagement with the multiple large diameter trees (Event #3).

Intrusions documented during the SCI inspection were summarized as follows:

Location	Component	Magnitude	Direction
1,1	Left front door, rear lower quadrant	12 cm (4.7 in)	Lateral
1,1	Left sill	14 cm (5.5 in)	Lateral
1,3	Right instrument panel	38 cm (15.0 in)	Longitudinal
1,3	Right lower A-pillar	59 cm (23.2 in)	Longitudinal
1,3	Toe pan	77 cm (30.3 in)	Longitudinal
1,3	Right front door, forward lower quadrant	15 cm (5.9 in)	Lateral

The only discernable occupant contact evidence in the Lexus was an area of scuffing and deformation to the left lower instrument panel (**Figure 10**). This contact was attributed to loading by the driver's knees during the multiple event crash sequence. The windshield was fractured by crash forces, but not contacted by the occupant or holed. The fully-opened left front glazing and partially-opened right front glazing were both disintegrated by crash forces. All other glazing remained intact. The right front door was completely collapsed and crushed in the damage/deformation pattern on the right plane. All other doors remained closed during the crash and were operational at the time of the SCI vehicle inspection.

Figure 10: Deformation and scuffing on the left lower instrument panel from loading by the driver's knees.

Manual Restraint Systems

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

Figure 11: Latch plate of the Lexus driver's seat belt with minor loading abrasion evidence.

At the time of the SCI inspection, the driver's D-ring was adjusted fully downward. The webbing was stowed in a retracted position, but spooled freely from the retractor. An area of loading abrasions on the webbing corresponding to the

latch plate was located from 85 to 90 cm (33.5 to 35.4 in) above the lower anchor. There was also an area of loading abrasions on the webbing that corresponded to the D-ring, located 180 to 185 cm (70.9 to 72.8 in) above the lower anchor. Minor abrasions along the belt path in the polymer surface of the latch plate further evidenced the driver's use of the system (**Figure 11**). It was apparent to the SCI investigator that the driver was restrained by the seat belt at the time of the crash.

Supplemental Restraint Systems

The Lexus was equipped with front seat belt retractor pretensioners, dual-stage frontal air bags for both the driver and front right positions, and IC air bags along each roof side rail. Based on a combination of a review of the vehicle's history report and interview of the Lexus's current owner, the vehicle had been involved in a total of three prior crashes. Two were of minor severity, and were not identified by the vehicle history report. The crash identified in the vehicle history report did not indicate supplemental restraint system deployment, and there was no reported service or maintenance concerning the vehicle's supplemental restraint systems. None of the supplemental restraint systems actuated or deployed in the incident crash.

NHTSA Recalls and Investigations

The commercially obtained vehicle history report indicated that 2004 Lexus GX470 models were subject to a manufacturer recall issued on February 2, 2016, NHTSA campaign #16V065, and concerned the possible inadvertent deployment of the vehicle's IC air bags. A query of this specific 2004 Lexus GX470's VIN on www.safercar.gov, also identified the aforementioned recall. There were no open investigations concerning this or any other 2004 Lexus GX470s.

Air Bag Non-Deployment Discussion

None of the Lexus' available supplement restraint systems actuated or deployed in the crash. The SCI investigator's inspection of the vehicle was unable to identify any anomaly with the supplemental restraint systems. Due to the age of the Lexus' ACM, minimal data was presented in the EDR report. However, the lack of front/rear crash record data relative to the events of the incident crash indicated that the vehicle did not detect the multiple tree impacts. Because the ACM did not recognize the events, it was therefore unable to command actuation/deployment of any supplemental restraint devices. The root cause of the inability of the ACM to recognize the events of the incident crash could not be determined.

The driver reported during interview that there was a warning light illuminated on the instrument cluster leading up to the crash. However, she accurately described the ABS warning light as being the illuminated light, and further reported that the air bag warning light was not illuminated prior to the crash. No warning lamp or diagnostic trouble code (DTC) data at the time of data retrieval was presented in the EDR report. Due to the lack of event recognition, no warning lamp or DTC data relative to the events of the crash under investigation was reported.

Braking System Discussion

The driver alleged in her notification of the crash to NHTSA that a problem with the vehicle's braking system precipitated the crash. As discussed in the *Pre-Crash*, the driver reported during interview that she experienced reduction in responsiveness prior to the crash that progressed into a complete lack of response by the vehicle's brake system. She also recalled that the ABS warning light illuminated shortly prior to her loss-of-control of the vehicle.

As discussed in the *Vehicle History* section, the Lexus was serviced in April 2017 at a manufacturer dealership. This included tire rotation, an alignment check, oil filter change, cabin filter change, an emissions/safety inspection, and a check of the vehicle's braking system. Of further note, the vehicle had passed a State inspection in November 2016.

The SCI investigator inspected the vehicle's braking system, and observed that the fluid reservoir was nearly empty. After tracing the distribution lines of the system, the SCI investigator identified that separation of the entire right front wheel assembly had separated the brake line from the caliper. The SCI investigator clamped the severed hose connection closed using a pair of vice grips, and then refilled the reservoir using brake fluid purchased at an auto parts retail store. The new fluid did not immediately mix with the old fluid in the reservoir, and a layering effect occurred that showed the original level and refilled level (**Figure 12**). The SCI investigator then pumped the brake pedal with his foot approximately 12 to 14 times in an attempt to pressurize the system. By the final pumps, pressure returned to the system, and resistance was felt immediately upon depressing the pedal.

Figure 12: View of the layered brake fluids (dark – old, light – new) following refill of the reservoir by the SCI investigator.

Figure 13: View of the corroded connection and leaking brake fluid during the SCI brake system test.

The successful pressurization of the system by the SCI investigator indicated that the Lexus' braking system was still intact, and was capable of performing properly. Recognizing that the severed line to the right front caliper simply drained the system post-crash, the SCI investigator again traced the distribution lines of the now pressurized system in an attempt to locate an anomaly. The SCI investigator located a severely corroded connection adjacent to the right front axle

position that was now leaking steadily from the pressurized system. Brake fluid dripped consistently from tiny holes in the circumference of the corroded joint, and quickly produced a large visible area of leaked fluid (**Figure 13**).

It was apparent to the SCI investigator as a result of the inspection that the driver's allegations concerning the loss of response from the Lexus' brake system were likely valid. The evidence indicated that a corroded connection allowed a slow but consistent leak of fluid from the system.

The driver stated during interview that there had been no indication of braking system deficiency prior to the crash. As the driver operated the vehicle, fluid continued to leak from the system and slowly reduced the volume in the reservoir. This ultimately led to the development of a depressurization of the system once the volume became too low, which triggered the illumination of the warning light on the instrument cluster. The depressurized system was unable to respond to the driver's depression of the brake pedal, thus confirming her allegation and resulting in her inability to control the vehicle's speed.

2004 LEXUS GX470 OCCUPANT DATA

Driver Demographics

Age/Sex:	70 years/female
Height:	165 cm (65 in)
Weight:	68 kg (150 lb)
Eyewear:	Unknown
Seat Type:	Forward-facing bucket seat with adjustable head restraint
Seat Track Position:	Middle
Manual Restraint Usage:	3-point lap and shoulder seat belt system
Usage Source:	Vehicle inspection
Air Bags:	Dual-stage frontal and IC air bags available; None deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Exited vehicle under own power
Transport From Scene:	Ambulance to a local hospital
Type of Medical Treatment:	Evaluated and released within hours of the crash

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence
-	Complaints of head, neck, and back pain	N/A	N/A	N/A

Source – Driver interview; Multiple requests for records denied by the treating facility

Driver Kinematics

The 70-year-old female was in the driver's seat of the 2004 Lexus GX470. She had adjusted the seat to a middle track position, with the seat back slightly reclined and the adjustable head re-

straint approximately 2 cm (0.8 in) upward. She used the available 3-point lap and shoulder seat belt for manual restraint, evidenced by the post-crash condition of the seat belt as observed by the SCI investigator during the vehicle inspection.

The driver attempted to maintain control of the Lexus after recognizing the loss of brake system response. As the vehicle gained speed, she provided a back-and-forth steering input while negotiating the multiple curves along the downgrade.

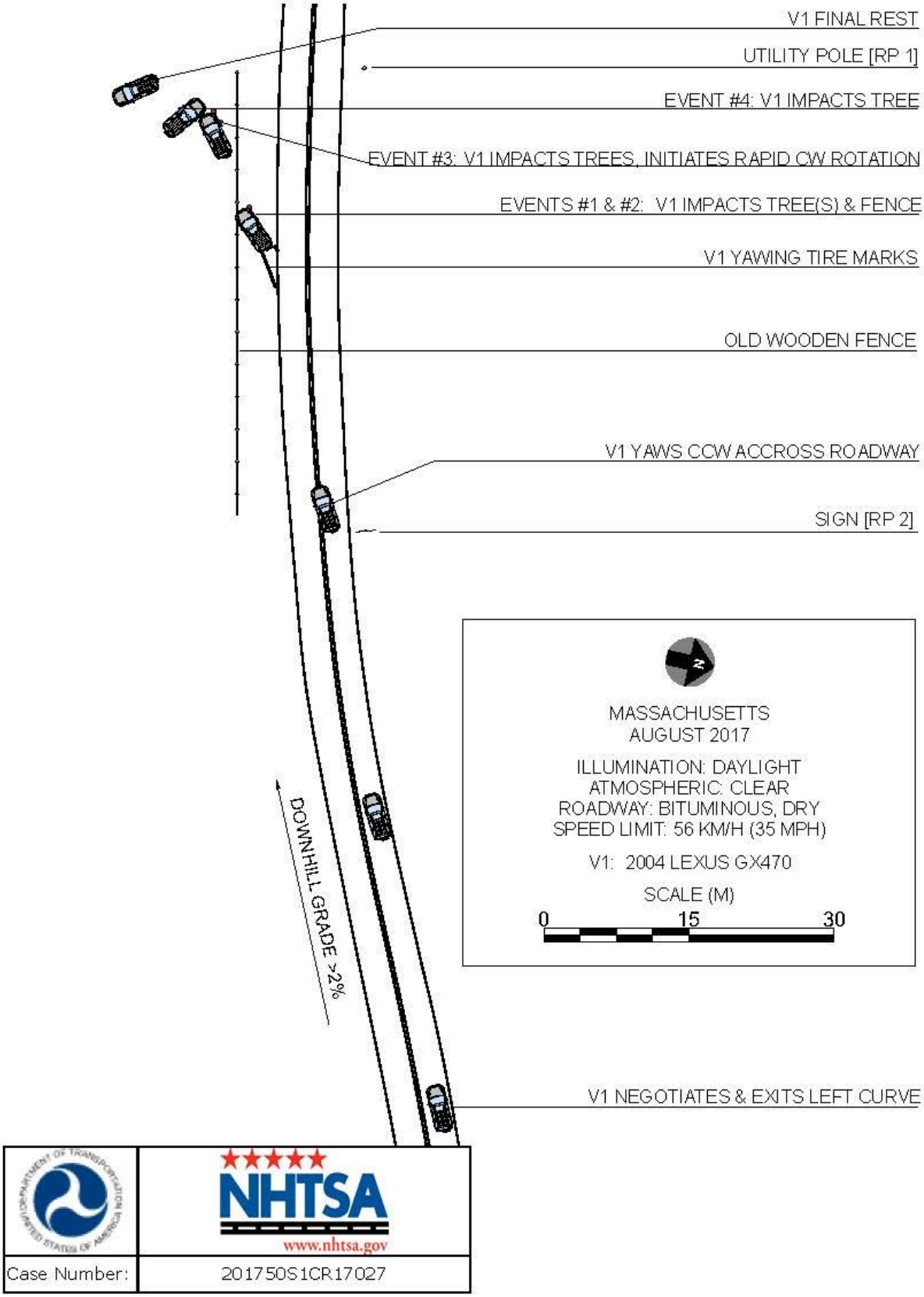
According to the driver during interview, she felt as though she had traveled several miles while simply holding on and being unable to control the vehicle's speed. The driver remained belted in the left front seat position as the Lexus negotiated the left curve, initiated the counterclockwise yaw, and departed the left edge of the roadway at the onset of the right curve. Based on her pre-crash operation and recollection, the driver likely gripped the steering wheel tightly as she steered right in an attempt to maintain the roadway. At impact with the large-diameter trees, the driver initiated a forward and slightly right trajectory. The ELR mode of the seat belt engaged, and the driver's forward movement was restricted. She remained in the vehicle as it maintained its momentum and sheared the trees and fence.

The second impact event with the old wooden fence was of insufficient severity to affect the driver's kinematic response. She maintained her forward trajectory as the Lexus struck the additional multiple large-diameter trees (Event #3). The offset of the impact and engagement increased the right lateral component of the driver's response. As she loaded the seat belt, the driver's knees also extended forward and contacted the left lower instrument panel. These contacts produced the deformation and scuffing identified during the SCI vehicle inspection. Although contact evidence was documented, the driver did not sustain corresponding injury.

Forces of the Lexus' engagement with the trees induced a rapid clockwise rotation to the Lexus, which redirected the driver toward the left. She maintained this lateral response away from the vehicle's center of mass as the Lexus struck, sheared, and overrode the small coniferous tree (Event #4). Although no contact evidence was identified during the SCI inspection to support such contact, the combination of the driver's lateral response and the intrusion of the left door likely caused the driver's left flank to contact the interior aspect of the left front door panel.

The driver remained restrained by the seat belt as the vehicle completed its clockwise rotation and came to rest in the wooded area. She unbuckled the seat belt and exited the vehicle through the left front door under her own power. Emergency response personnel provided on-scene evaluation and then transported the driver via ambulance to a local hospital. She was evaluated and released from the hospital's emergency department within hours of the crash. The driver maintained complaints of head, neck, and back pain, but was unable to describe specific physical injuries. Multiple requests for records concerning the driver's evaluation and discharge from the treating facility were denied.

CRASH DIAGRAM



APPENDIX: 2004 Lexus GX470 Event Data Recorder Report

The EDR Report contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the investigation. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN/Frame Number	JTJBT20X640******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	201750S1CR17027_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.4.2
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 17.7.2
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Front/Rear (2), Rollover (1)

Comments

No comments entered.

Data Limitations

CDR Record Information:

- Due to limitations of the data recorded by the airbag ECU, such as the resolution, data range, sampling interval, time period of the recording, and the items recorded, the information provided by this data may not be sufficient to capture the entire crash.
- Pre-Crash data is recorded in discrete intervals. Due to different refresh rates within the vehicle's electronics, the data recorded may not be synchronous to each other.
- Airbag ECU data should be used in conjunction with other physical evidence obtained from the vehicle and the surrounding circumstances.
- If the airbags did not deploy or the pretensioners did not operate during an event that meets a specified recording threshold, it is called a Non-Deployment Event. Data from a Non-Deployment Event can be overwritten by a succeeding event that meets the specified recording threshold. If the airbag(s) deploy or the pretensioners are operated, it is called a Deployment Event. Deployment Event data cannot be overwritten or deleted by the airbag ECU following that event.
- If power supply to the airbag ECU is lost during an event, all or part of the data may not be recorded.
- "Diagnostic Trouble Codes" are information about faults when a recording trigger is established. Various diagnostic trouble codes could be set and recorded due to component or system damage during an accident.
- The airbag ECU records only diagnostic information related to the airbag system. It does not record diagnostic information related to other vehicle systems.
- The TaSCAN, Global Tech Stream, or Intelligent Tester II devices (or any other Toyota genuine diagnostic tool) can be used to obtain detailed information on the diagnostic trouble codes from the airbag system, as well as diagnostic information from other systems. However, in some cases, the diagnostic trouble codes of the airbag system recorded by the airbag ECU when the event occurred may not match the diagnostic trouble codes read out when the diagnostic tool is used.

General Information:

- The data recording specifications of Toyota's airbag ECUs are divided into the following categories. The specifications for 12EDR or later are designed to be compatible with NHTSA's 49CFR Part 563 rule.
  - 00EDR / 02EDR / 04EDR / 06EDR / 10EDR / 12EDR / 13EDR / 15EDR / 17EDR
- The airbag ECU records data for all or some of the following accident types: frontal crash, rear crash , side crash, and rollover events. Depending on the installed airbag ECU, data for side crash and/or rollover events may not be recorded.
- The airbag ECU records post-crash data and may record pre-crash data in the event of a frontal/rear crash. In addition, it may record post-crash data in the event of a side crash or rollover.
- The airbag ECU has the following recording pages (memory maps) for each accident type to store event data: three pages for frontal or rear crash, one page for a side crash (if airbag ECU is applicable) , and one page for rollover events. (if airbag ECU is applicable)
- The data recorded by the airbag ECU in the event of a frontal/rear crash includes information that indicates the sequence and interval of each previously-occurring frontal/rear crash event.
  - Time from Previous TRG
  - TRG Count
- The point in time at which the recording trigger is established is regarded as time zero for the recorded data. For the time indicated in "Lateral Delta-V", "Roll Angle" or "Lateral Acceleration", the first sampling point after the recording trigger establishment is regarded as time zero. The time zero of the data and the recording trigger establishment do not always occur simultaneously.
- The recording trigger judgment threshold value differs depending on the collision type (i.e., frontal crash, rear crash, side crash, or rollover event).

- Some of the data recorded by the airbag ECU is transmitted to the airbag ECU from various vehicle control modules by the vehicle's Controller Area Network (CAN).
- In some cases, the airbag ECU part number printed on the ECU label may not match the airbag ECU part number that the CDR tool reports. The part number retrieved by the CDR tool should be considered as the official ECU part number.
- The sampling interval of "Roll Angle" and "Lateral Acceleration" is 8 [ms] or 128 [ms]. A field indicating the sampling interval is not provided. The graph scaling can assist with derterming the sample rate. The time zero is indicated by count (0).
- "Prior Event" is the event that occurred before the "1st Prior Event" that reached the greatest MAX Delta-V. Therefore, "Prior Event" is not always the prior event of "1st Prior Event".

Data Element Sign Convention:
The following table provides an explanation of the sign notation for data elements that may be included in this CDR report.

Data Element Name	Positive Sign Notation Indicates
Max. Longitudinal Delta-V	Forward
Longitudinal Delta-V	Forward
Roll Angle Peak	Clockwise Rotation
Roll Angle	Clockwise Rotation
Lateral Acceleration , Airbag ECU Sensor *	Right to Left

* For sensing a rollover

Data Definitions:
1)
- The "ON" setting for the "Freeze Signal" indicates a state in which the non-volatile memory can not be overwritten or deleted by the airbag ECU. After "Freeze Signal" has been turned ON, subsequent events will not be recorded.
- "Recording Status" indicates a state in which all recorded event data has been written into the non-volatile memory, or a state in which this process was interrupted and not fully written into the non-volatile memory. If "Recording Status" is "Incomplete", recorded event data may not be valid.
- "Time to Deployment Command" indicates the time between recording trigger establishment and the determination of airbag deployment. This value may differ from the actual time it takes for the airbag to fully deploy.
- Even if an airbag/pretensioner did not deploy due to the "front passenger airbag disable switch and/or "RSCA Disable Switch" in the ON position or other disabling criteria are met, the "Time to deployment command" data element for that airbag/pretensioner may still be recorded.
- "Engine RPM" indicates the number of engine revolutions, not the number of motor revolutions. The recorded value has an upper limit of 6,000 rpm. Resolution is 400 rpm and the value is rounded down and recorded. For example, if the actual engine speed is 799 rpm, the recorded value will be 400 rpm.
- The upper limit for the recorded "Vehicle Speed" value is 126 km/h (78.3mph). Resolution is 2km/h (1.2mph) and the value is rounded down and recorded. The accuracy of the "Vehicle Speed" value can be affected by various factors. These include, but not limited, to the following.
  - Significant changes in the tire's rolling radius
  - Wheel lock and wheel slip
- The "Accelerator Rate" value is recorded as a voltage or level. In the case of voltage, the voltage increases as the driver depresses the accelerator. In case of the level, the following three levels are recorded.
  - FULL / MIDDLE / OFF
- "Accelerator Rate" may be recorded as "OFF" even if the accelerator pedal is depressed lightly. In addition, "FULL" may be recorded when the accelerator pedal is depressed strongly but not fully.
- The "Drive" setting for the "Shift Position" value indicates the shift position state is other than "R,"(Reverse), "N" (Neutral), or "P" (Park). It also includes communication disruption. Regardless of an actual shift position, "Drive" is always set for M/T vehicles because the shift position signal is not available.
- Depending on the type of occupant sensor installed in the vehicle, one of the following three recording formats for "Occupancy Status, Passenger" will be utilized.
  - Occupied / Not Occupied
  - Adult / Child / Not Occupied
  - AM50 / AF05 / Child / Not Occupied
- Resolution of the "Air Bag Warning Lamp ON Time Since DTC was Set" is 15 minutes, and the value is rounded down and recorded.
- "Longitudinal Delta-V" indicates the change in forward speed after establishment of the recording trigger. This does not refer to vehicle speed, and it does not include the change in speed during the period from the start of the actual collision to establishment of the recording trigger.
- "Roll Angle peak" may not always match the peak value within the "Roll Angle" sampling points due to differences in data calculation method.
- For "Lateral Delta-V", the sensor location (B-pillar, front door, C-pillar, and slide door) shows the outline of a typical sensor position. Sensory location can be confirmed using the repair manual.
- "TRG Count" indicates the number of frontal/rear recording triggers that have been established. The calculated value does not include the number of times side or rollover recording triggers have been established. The sequence in which each frontal/rear event occurred can be verified from the "TRG Count". The lesser the "TRG Count" value, the older the data. The upper limit for the recorded value is 255 times. When more than one event reaches the upper limit, the actual "TRG Count" may be greater than what is displayed for that event.
- Resolution of the "Time from Pre-Crash to TRG" is 100 [ms], and the value is rounded down and recorded.
- For "Time from Previous TRG", the recording trigger of side crash and rollover is not considered. The upper limit for the recorded value is 5000 [ms] or 5100 [ms] depending on the ECU part number. Resolution is 20 [ms] and the value is rounded down and recorded. When it's displayed as 5100ms, the actual "Time from Previous TRG" may be longer than what is displayed for that event.
- If 2 or more frontal/rear events occur successively within a period of 5000ms (or 5120ms for ECUs with 1.024 data sampling intervals), the actual sample time before the trigger is not displayed for subsequent events. The sample time before trigger will only be displayed for the first event of the successive events. For subsequent events (i.e second event or later events), the pre-crash "Time (sec)" data is replaced by integers -5 through -1 and the heading "Time (sec)" is replaced with "Sample Count". The time between "Sample Count" integers (-5 through -1) cannot be determined. The time between the last integer and TRG cannot be determined.
- "Pre-Crash Data Status" indicates data communication status of the vehicle. If communication disruption or other failure is occur, "Invalid" is set. Moreover, "Invalid" is set for some M/T vehicles because the shift position signal is not transmitted for them even if the other data is valid.

05002_ToyotaDENSO_r026

System Status at Time of Retrieval

ECU Part Number	89170-60250
ECU Generation	02EDR
Recording Status, All Pages	Complete
Diagnostic Trouble Codes Exist	No
Total Number of Front/Rear Crash Events	2
Freeze Signal	OFF

Front/Rear Event Record Summary at Retrieval

Events Recorded	TRG Count	Crash Type	Time (msec)	Event & Crash Pulse Data Recording Status
Most Recent Frontal/Rear Event	2	Front/Rear Crash	0	Complete (Front/Rear Page 1)
1st Prior Frontal/Rear Event	1	Front/Rear Crash	-920	Complete (Front/Rear Page 0)

Side/Rollover Event Record Summary at Retrieval

Events Recorded	Recording Status
Rollover	Not Supported

System Status at Front Airbag Deployment

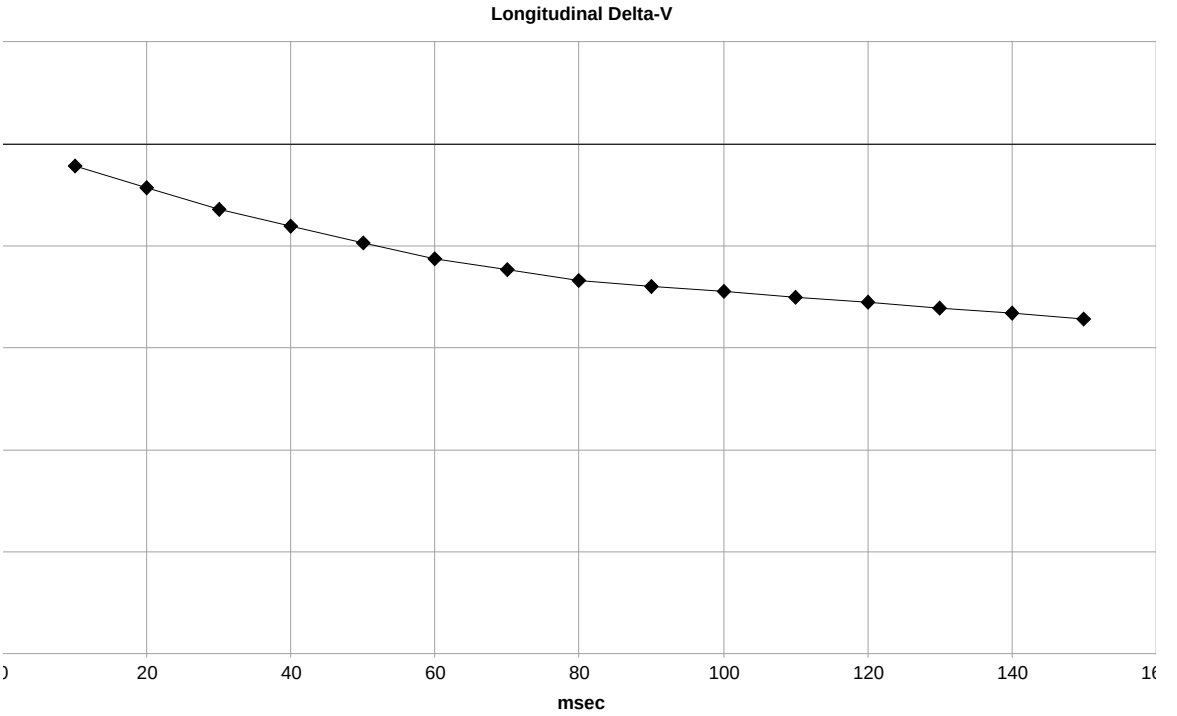
Time to Deployment Command, Front Airbag, Driver (msec)	Not Commanded
Time to Deployment Command, Front Airbag, Passenger (msec)	Not Commanded
Event Severity Status, Driver	N/A
Event Severity Status, Passenger	N/A

System Status at Event (Most Recent Frontal/Rear Event, TRG 2)

Recording Status, Front/Rear Crash Info.	Complete
TRG Count	2
Time From Previous TRG (msec)	920
Buckle Switch, Driver	Buckled
Buckle Switch, Passenger	Buckled
Seat Position, Driver	Rearward

Longitudinal Crash Pulse (Most Recent Frontal/Rear Event, TRG 2 - table 1 of 2)

Max Longitudinal Delta-V (MPH [km/h])	-3.4 [-5.5]



Longitudinal Crash Pulse (Most Recent Frontal/Rear Event, TRG 2 - table 2 of 2)

Time (msec)	
10	-0.4 [-0.7]
20	-0.9 [-1.4]
30	-1.3 [-2.1]
40	-1.6 [-2.6]
50	-1.9 [-3.1]
60	-2.2 [-3.6]
70	-2.5 [-4.0]
80	-2.7 [-4.3]
90	-2.8 [-4.5]
100	-2.9 [-4.7]
110	-3.0 [-4.8]
120	-3.1 [-5.0]
130	-3.2 [-5.2]
140	-3.3 [-5.3]
150	-3.4 [-5.5]

DTCs Present at Start of Event (Most Recent Frontal/Rear Event, TRG 2)

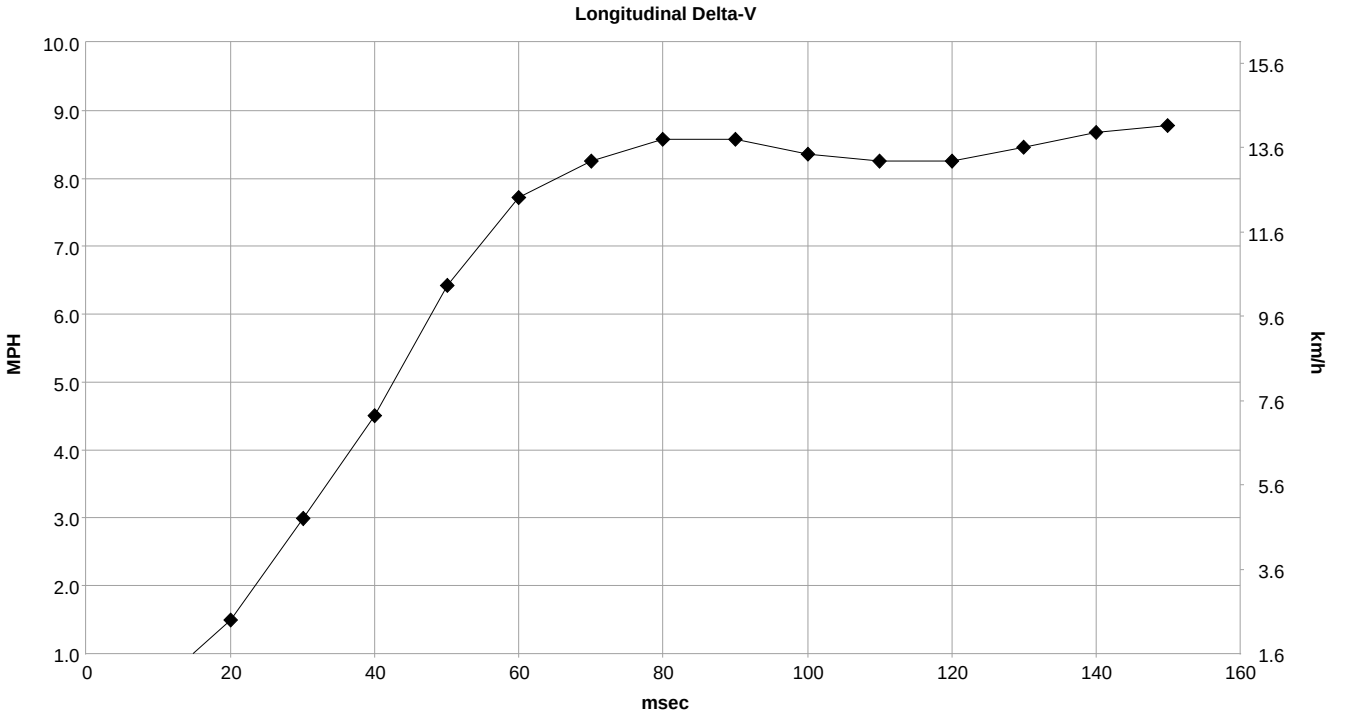
Ignition Cycle Since DTC was Set (times)	0
Airbag Warning Lamp ON Time Since DTC was Set (min)	0
Diagnostic Trouble Codes	None

System Status at Event (1st Prior Frontal/Rear Event, TRG 1)

Recording Status, Front/Rear Crash Info.	Complete
TRG Count	1
Time From Previous TRG (msec)	5,100
Buckle Switch, Driver	Buckled
Buckle Switch, Passenger	Buckled
Seat Position, Driver	Rearward

Longitudinal Crash Pulse (1st Prior Frontal/Rear Event, TRG 1 - table 1 of 2)

Max Longitudinal Delta-V (MPH [km/h])	8.8 [14.1]



Longitudinal Crash Pulse (1st Prior Frontal/Rear Event, TRG 1 - table 2 of 2)

Time (msec)	Longitudinal Delta-V (MPH [km/h])
10	0.5 [0.9]
20	1.5 [2.4]
30	3.0 [4.8]
40	4.5 [7.2]
50	6.4 [10.3]
60	7.7 [12.4]
70	8.2 [13.3]
80	8.6 [13.8]
90	8.6 [13.8]
100	8.4 [13.4]
110	8.2 [13.3]
120	8.2 [13.3]
130	8.5 [13.6]
140	8.7 [14.0]
150	8.8 [14.1]

DTCs Present at Start of Event (1st Prior Frontal/Rear Event, TRG 1)

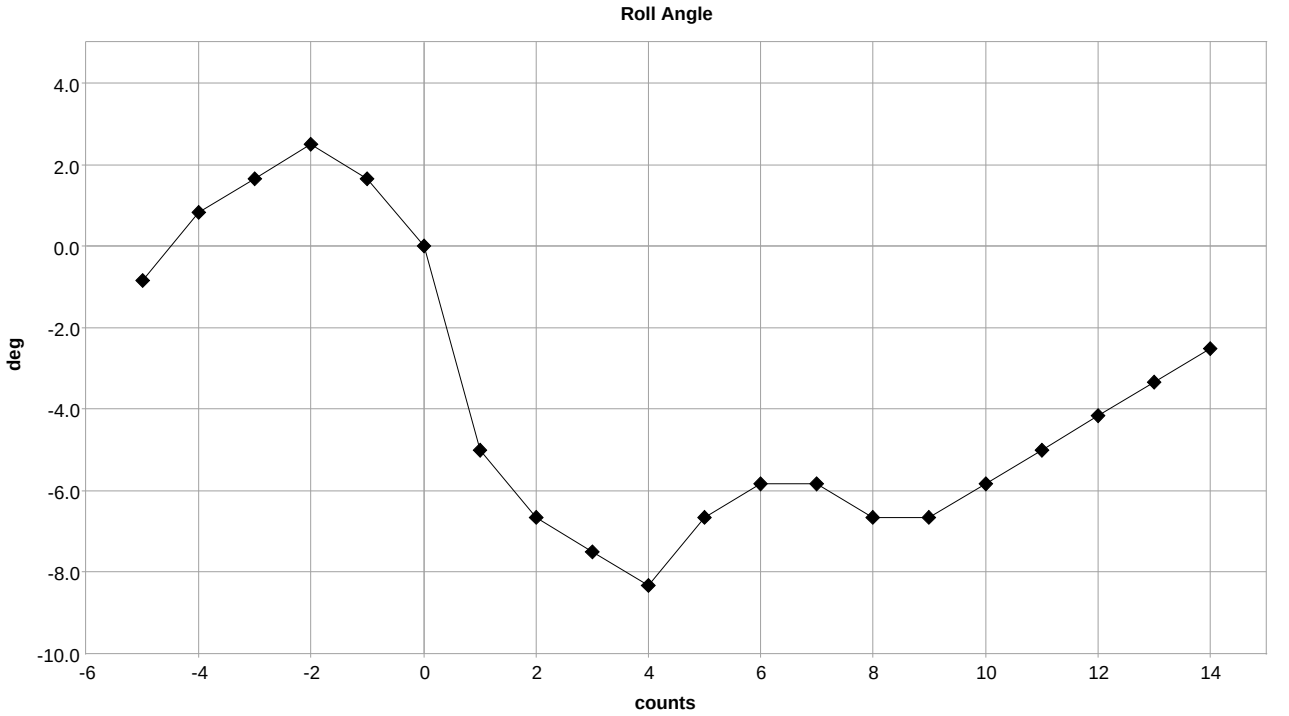
Ignition Cycle Since DTC was Set (times)	0
Airbag Warning Lamp ON Time Since DTC was Set (min)	0
Diagnostic Trouble Codes	None

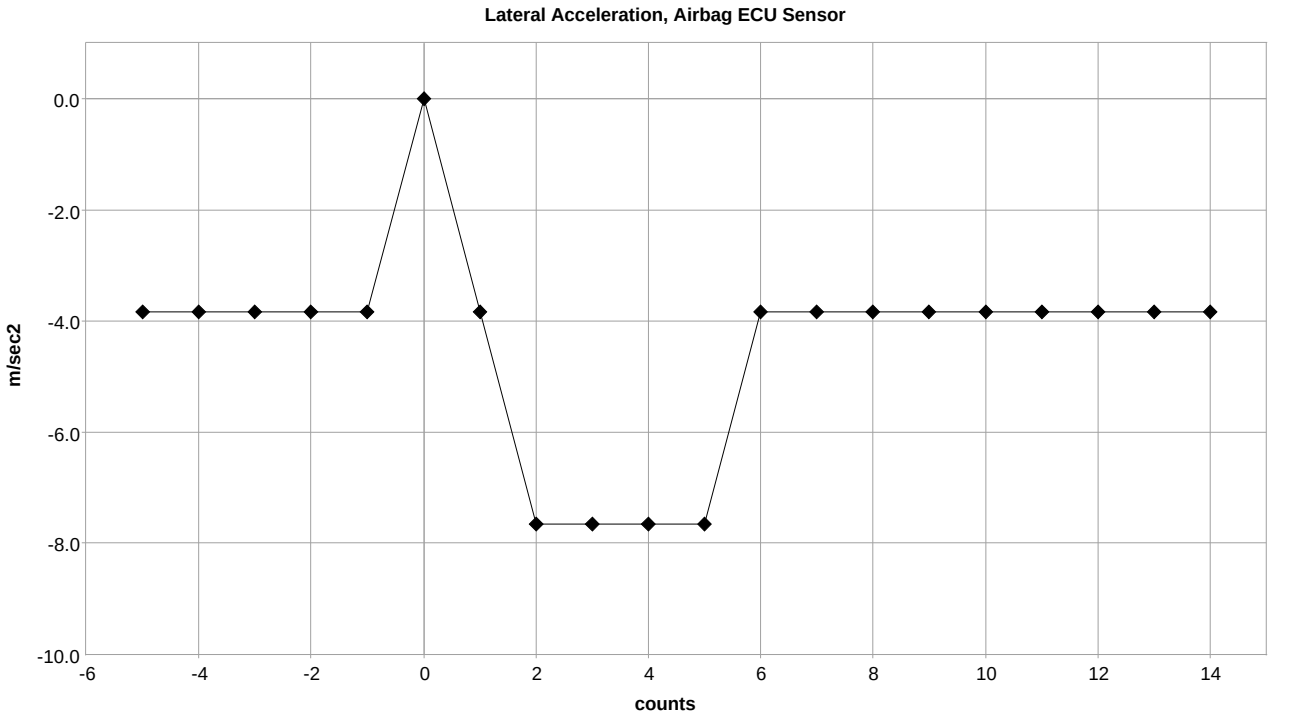
System Status at Rollover Event

RSCA Disable Switch	OFF
Time to Deployment Command, Rollover Airbag (msec)	No

Rollover Crash Pulse for Rollover Event (table 1 of 2)

Roll Angle Peak (degrees)	-8





Rollover Crash Pulse for Rollover Event (table 2 of 2)

Counts	Roll Angle (degrees)	Lateral Acceleration, Airbag ECU Sensor (m/sec^2)
-5	-0.8	-3.8
-4	0.8	-3.8
-3	1.7	-3.8
-2	2.5	-3.8
-1	1.7	-3.8
0	0.0	0.0
1	-5.0	-3.8
2	-6.7	-7.7
3	-7.5	-7.7
4	-8.3	-7.7
5	-6.7	-7.7
6	-5.8	-3.8
7	-5.8	-3.8
8	-6.7	-3.8
9	-6.7	-3.8
10	-5.8	-3.8
11	-5.0	-3.8
12	-4.2	-3.8
13	-3.3	-3.8
14	-2.5	-3.8

Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

PIDs	PID	Data
	00	B0 FE 00 00
	01	00 00 00 00
	02	(no response)
	03	00
	04	02 00 02 01
	09	36 30 30 31 30
	0A	36 30 30 31 30
	0B	30 30 30 30 30
	0C	30 30 30 46 42
	0D	36 30 32 35 30
	0E	36 30 30 32 30
	0F	36 30 30 32 30
	11	44 4E
	12	36 30 32 35 30
	13	01
	14	0E
	15	(no response)
	16	(no response)
	17	(no response)
	18	(no response)
	19	(no response)
	1A	(no response)
	1B	(no response)
	1C	(no response)
	1D	(no response)
	1E	(no response)
	1F	(no response)
	20	(no response)
	21	(no response)
	22	(no response)
	23	(no response)
	24	(no response)
	25	(no response)
	26	(no response)
	27	(no response)
	28	(no response)
	29	(no response)
	2A	(no response)
	2B	(no response)
	2C	(no response)
	31	(no response)
	32	(no response)
	33	(no response)
	34	(no response)
	35	(no response)
	36	(no response)
	37	(no response)
	38	(no response)
	39	(no response)
	3A	(no response)
	3B	(no response)
	3C	(no response)
	3D	(no response)
	3E	(no response)
	3F	(no response)
	40	44 4E
	41	36 30 30 32 30
	42	01
	43	01
	44	(no response)
	45	44 4E

```
46    36 30 30 32 30
47    01
48    01
49    ( no response )
4A    ( no response )
4B    ( no response )
51    ( no response )
52    ( no response )
53    ( no response )
54    ( no response )
55    ( no response )
56    ( no response )
57    ( no response )
58    ( no response )
59    ( no response )
5A    ( no response )
5B    ( no response )
5C    ( no response )
5D    ( no response )
5E    ( no response )
5F    ( no response )
60    ( no response )
61    FF 01 02 03 02 00
62    FA F8 F7 F6 F8 F9
63    F9 F8 F8 F9 FA FB
64    FC FD
65    FF 01 02 03 02 00
66    FA F8 F7 F6 F8 F9
67    F9 F8 F8 F9 FA FB
68    FC FD
69    FF FF FF FF FF 00
6A    FF FE FE FE FE FF
6B    FF FF FF FF FF FF
6C    FF FF
6F    FF FF F6 96 00
B0    00 00 00 00 00 00
B1    00 00 00 00 00 00
B2    00 00 00 00 FF 00
B3    FF FF FF FF FF FF
B4    FF FF FF FF FF FF
B5    FF FF FF FF FF FF
B6    00 00 00 00 00 00
B7    00 00 00 00 00 00
B8    00 00 00 00 00 00
B9    00 00 00 00 00 00
BA    04 04 04 03 03 03
BB    02 02 01 01 01 01
BC    01 01 01 02 FF 2E
BD    FF FF FF FF FF FF
BE    FF FF FF FF FF FF
BF    FF FF FF FF FF FF
C0    AA 02 00 00 00 00
C1    00 00 00 00 00 00
C2    00 00 00 00 00 00
C3    01 00 00 00 00 00
C4    FB F7 F2 F2 EE F4
C5    FB FD 00 02 01 00
C6    FE FE FF 01 FF FF
C7    FF FF FF FF FF FF
C8    FF FF FF FF FF FF
C9    FF FF FF FF FF FF
CA    AA FA 00 00 00 00
CB    00 00 00 00 00 00
CC    00 00 00 00 00 00
CD    01 00 00 00 00 00
CE    00 05
CF    00 00 00
D0    ( no response )
D1    00
D2    00 03 10
```

```
D3    ( no response )
E0    C0 10 00 00
E1    02 02
E2    02 02
EC    FF
```

Disclaimer of Liability

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

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U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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