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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN01-003
LOCATION - MISSISSIPPI
VEHICLE - 2001 LEXUS GS300
CRASH DATE - February, 2001

Submitted:

February 13, 2003

Contract Number: DTNH22-94-D-17058

Prepared for:

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

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

Technical Report Documentation Page

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15. *Supplementary Notes*
On-site advanced air bag deployment investigation involving a 2001 Lexus GS300, four-door sedan, with manual safety belts, dual front and side air bags, and right and left inflatable curtains, that ran-off-road

16. *Abstract*
This report covers an on-site investigation of an air bag deployment crash that involved a 2001 Lexus GS300 (case vehicle) and an embankment/culvert. This crash is of special interest because the case vehicle was equipped with multiple, advanced, occupant protection system features, and three unrestrained passengers in the case vehicle were ejected and subsequently died while the case vehicle's, restrained driver (20-year-old male) sustained only minor injuries as a result of the crash. The case vehicle, which was stolen, had been traveling north at an extremely high rate of speed on the northbound roadway of a seven-lane, divided, U.S. trafficway and was approaching a four-leg intersection while attempting to flee from police (i.e., both the north and southbound roadways had two through lanes while the northbound roadway left- and right-hand turn lanes and the southbound roadway had one acceleration lane). The case vehicle's driver lost control while attempting to maneuver through the intersection. The crash occurred north of the intersection, off the northbound roadway on the east roadside of the trafficway. The case vehicle impacted a curb and a warning sign before entering a drainage ditch and impacting the culvert's embankment. The impact with the embankment caused the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Upon impacting the first culvert, the case vehicle: flipped end-over-end, vaulted over a driveway, and impacted a second culvert's embankment further to the north with its back left corner. The case vehicle continued in a northerly direction while rolling over and came to rest on its roof heading east. During the longitudinal rolls the case vehicle's driver seat back-mounted side air bag and side inflatable curtain deployed. The case vehicle's driver was seated with his seat track located near its middle position, and the tilt steering wheel was located in its middle position. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system–which was equipped with a pretensioner, and sustained, according to the police, only minor lacerations. The front right passenger (18-year-old female), back left passenger (19-year-old male), and back right passenger (14-year-old female) were all seated but not restrained by their available, active, three-point, lap-and-shoulder, safety belt systems, and they were ejected during the crash. According to their autopsies, the front right passenger sustained fatal injuries and the two back passengers sustained critical injuries but subsequently expired. The front right passenger's skull was crushed while the back passengers sustained critical brain injuries.

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on February 8, 2001 by a Lieutenant with a Mississippi police department. This crash involved a 2001 Lexus GS300 (case vehicle) and an embankment/culvert. The crash occurred in February, 2001, at approximately 2:47 p.m., in Mississippi and was investigated by the applicable city police department. This crash is of special interest because the case vehicle was equipped with multiple, advanced, occupant protection system features, and three unrestrained passengers in the case vehicle were ejected and subsequently died while the case vehicle's, restrained driver [20-year-old, Black (non-Hispanic) male] sustained only minor injuries as a result of the crash. This contractor inspected the scene and case vehicle on February 13, 2001. This contractor is unable to interview the case vehicle's driver because of his incarceration. This summary is based on the Police Crash Report, interviews with the investigating police officers, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle, which was stolen, had been traveling north at an extremely high rate of speed on the northbound roadway of a seven-lane, divided, U.S. trafficway and was approaching a controlled four-leg intersection while attempting to flee from police (i.e., both the north and southbound roadways had two through lanes while the northbound roadway had one left-hand turn lane and one right-hand turn lane; the southbound roadway had one acceleration lane). The case vehicle's driver drove into the left turn lane in order to pass stopped traffic in the two northbound lanes. As the case vehicle's driver steered back to the right while attempting to re-enter the northbound through lane, he encountered slower moving northbound traffic ahead. As a result he braked sharply and steered further to the right and successfully evaded the noncontact vehicle ahead, but he subsequently lost control. The case vehicle went into a slight clockwise yaw, crossed through the intersection and across both northbound through lanes, and departed the east edge of the northbound roadway. The driver's avoidance maneuvers just prior to the crash are unknown but, based on the physical evidence, the driver most likely steered leftward. The crash occurred north of the intersection, off the northbound roadway on the east roadside of the trafficway; see **CRASH DIAGRAM** below (i.e., page 37).

According to a witness and the Police Crash Report, the case vehicle impacted the curb along the east roadside with sufficient force to deflate the right front tire and damage the right front wheel. Next, the front of the case vehicle impacted a temporary warning sign, running it over. The case vehicle continued in a north-northeasterly direction, entering a drainage ditch, and impacting the culvert's embankment. The front right bumper of the case vehicle impacted the culvert's embankment, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Upon impacting the first culvert, the case vehicle: flipped end-over-end (i.e., rolled about the lateral axis), vaulting over the driveway without contacting it while rotating clockwise about the longitudinal axis, and impacted a second culvert 16.5 meters (54.1 feet) further to the north with its back left corner. The case vehicle continued in a northerly direction while rolling over a reported 6 quarter rolls prior to coming to rest on its roof heading east.

The 2001 Lexus GS300 was a rear wheel drive, four-door sedan (VIN: JT8BD69S510------). The case vehicle was equipped with four-wheel, anti-lock brakes. The case vehicle was towed due to damage.

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **00-BDAW-6**, for its most severe impact with the second culvert's embankment, **12-FZLW-2** (**350** degrees) for its impact with the first culvert's embankment, and **00-TDDO-3** for the remainder of the rollover activity. The CDCs for the case vehicle's initial impacts with the curb and the temporary warning sign are estimated as: **12-FRWN**-3 (**0** degrees) and **12-FYEW-1** (**0** degrees); however, the exact CDCs for these impacts are unknown because of masked damage. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle highest severity impact with the second culvert's embankment, even though the impact was non-horizontal. The results, although suspect, showed the case vehicle as having a Barrier Equivalent Speed (BES) of 22.4 km.p.h. (13.9 m.p.h.). This contractor believes these results are low and estimates that the actual Delta V is between 48 km.p.h. (30 m.p.h.) and 56 km.p.h. (35 m.p.h.). The WinSMASH reconstruction program, CDC only Barrier algorithm, was used on the case vehicle's deployment (i.e., second highest severity) impact with the first culvert's embankment. The results, although suspect, showed that the case vehicle had a Barrier Equivalent Speed (BES) of 20.4 km.p.h. (12.7 m.p.h.). This contractor believes these results are low and estimates that the actual Delta V is between 25 km.p.h. (15.5 m.p.h.) and 33.8 km.p.h. (21 m.p.h.).

The case vehicle's impact with the curb most likely involved the right front wheel but, because of the masking damage, the exact nature of the damage was not determinable. The case vehicle's impact with the metal temporary warning sign most likely involved the left two-thirds of the case vehicle's front. Once again, because of the masking damage, the exact location was not determinable. The case vehicle's horizontal impact with the 1st culvert's embankment (3rd event) involved the front right half of the bumper and its front undercarriage. Direct damage began 21 centimeters (8.3 inches) right of the vehicle's center and extended to the front right bumper corner, a measured distance of 61 centimeters (24.0 inches) along the front bumper. Maximum crush was measured as 31 centimeters (19.3 inches) at the front right bumper corner. The case vehicle's most severe, non-horizontal impact with the 2nd culvert's embankment involved its back left half. Direct damage began at the back left bumper corner and extended, a measured distance of 144 centimeters (56.7 inches), along the back bumper. The direct damage also extended down the left side and included the left "C"-pillar. Residual maximum crush was measured as 66 centimeters (26.0 inches) at C_1. The wheelbase on the case vehicle's left side was shortened 54 centimeters (21.3 inches) while the right side was shortened 16 centimeters (6.3 inches). As a result of this crash the case vehicle's front and back bumpers, front and back bumper fasciae, grille, hood, radiator, truck, roof, front headlight and turn signal assemblies, back left taillight and turn signal assemblies, both fenders, left quarter panel, and all four doors were directly damaged and crushed inward. Furthermore, all four of the case vehicle's tires were physically restricted, and both of the front tires were deflated from damage. The right taillight and turn signal assemblies sustained induced damage as well as the right quarter panel and both left side doors. The windshield was cracked and holed. The right front, right rear, backlite, and left rear window glazings were all disintegrated; however, the left front and roof glazings remained intact.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each 11 centimeters (4.3 inches) wide. The driver's air bag had two vent ports, approximately 1.5 centimeters (0.6 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with diameter 57 centimeters (22.4 inches). An inspection of the driver's air bag fabric revealed obvious contact evidence (i.e., two areas of bloody and oily smears) on the lower half of the air bag's fabric between the 6:30 and 7:30 o'clock positions.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 8 centimeters (3.1 inches) in diameter, located at the 7:30 and 4:30 clock positions. The deployed front right air bag was a rounded rectangle with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 58 centimeters (22.8 inches). An inspection of the front right passenger's air bag fabric revealed obvious contact evidence (i.e., an area of blood transfer) on the front surface of the air bag's fabric to the right of center toward the 3 o'clock position and obliquely oriented.

The case vehicle's driver side air bag was located in the outboard side of the driver's seat back. An inspection of the air bag module's fabric revealed that there was no evidence of damage during the deployment to the air bag. The left side air bag was designed without any tethers or vent ports. The deployed driver's side air bag was essentially rectangular with a height of 27 centimeters (10.6 inches) and an excursion of approximately 29 centimeters (11.4 inches). An inspection of the driver, seat back-mounted, side air bag's fabric revealed that there was no contact evidence apparent on the interior surface. The front right passenger's, seat back-mounted, side air bag did not deployed as a result of this crash.

The case vehicle's driver side inflatable curtain was located along the seam between the roof and left side roof rail, and the curtain was located from the left "A"-pillar rearwards to just beyond the left "B"-pillar. An inspection of the driver's side inflatable curtain revealed that there was no evidence of damage during the deployment to the curtain. The driver's inflatable curtain was designed with one tether, 30 centimeter (11.8 inches) in length, that connected between the rear of the curtain and the left "C"-pillar. The inflatable curtain was not designed with vent ports, but there were six baffles spread across the width of the curtain that acted as a type of tether. The deployed inflatable curtain measured 158 centimeters (62.2 inches) long and had 30 centimeters (11.8 inches) of excursion. An inspection of the driver inflatable curtain's fabric revealed obvious contact evidence (i.e., blood and oily transfers) to the interior surface near where the head of the case vehicle's driver would have been. The exterior surface had a minimal amount of mud and dirt.

Inspection of the case vehicle's interior revealed contact evidence on both the driver's and front right passengers knee bolsters. The latter was found just below the glove box door.

Furthermore, there was obvious contact evidence on the back surface of the front right passenger's seat back. Finally, there was intrusion to the driver's toe pan area, to all occupant seating positions from the roof being crush downward, and to the back left passenger's seating area.

Although the exact posture of the case vehicle's driver (of unknown height and weight) immediately prior to the crash is unknown, the case vehicle's driver was most likely seated in a slightly reclined posture with his back against the seat back, his left foot on the floor, his right foot near the brake but not on it, and both hands on the steering wheel. His seat track was located near its middle position, the seat back was sightly reclined, and the tilt steering wheel was located in its middle position.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system which was equipped with a pretensioner. The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed significant visible evidence of loading. Photographs taken by this contractor showed stretching to the belt webbing near the"D"-ring and the latch portion, and their were heat abrasions to the "D"-ring and belt latch.

The exact sequence of pre-crash avoidance maneuvers attempted by the case vehicle's driver are unknown. Available evidence indicates that just prior to the impact with the curb he was trying to steer to the left and had been braking when the case vehicle was crossing through the intersection in its clockwise yaw. As a result and independent of the use of his available safety belts, the driver most likely leaned back and to the right just prior to the curb impact. The case vehicle's frontal impacts with the curb and temporary construction sign had little or no affect on the driver's seating posture. As the case vehicle slid into the drainage ditch, the case vehicle continue forward while tilting downward and rightward just prior to impacting the 1st culvert's embankment. The case vehicle's primary impact with the embankment/culvert enabled the case vehicle's driver to continue forward and upward as the case vehicle decelerated. The culvert impact not only deployed the driver's front air bag but also fired the driver's seat belt pretensioner. The driver's seat belt pretensioner retracted any slack the driver may have had in the seat belt's webbing.

As the front of the case vehicle decelerated from impacting the embankment and culvert, the case vehicle's back end lifted vertically and the case vehicle began to roll end-over-end (i.e., about the lateral axis). Because the embankment/culvert impact was primarily to the case vehicle's front right, the case vehicle also began to rotate clockwise (i.e., about the vertical axis). As the vehicle rolled over, the driver rebounded backwards off his deploying air bag and safety belts into his seat back. As previously mentioned, the case vehicle traveled 16.5 meters (54.1 feet) in the air, flipping and rotating, prior to impacting the 2nd culvert's embankment while landing upside down with the vehicle's back left bumper corner leading. Between the 1st and 2nd culverts the case vehicle rotated approximately 180 degrees about the lateral axis but only approximately 30-45 degrees about the vertical axis, while in the air, prior to impacting the 2nd culvert's embankment. The vehicle's non-horizontal impact with the 2nd culvert's embankment was the case vehicle's highest severity impact. This back impact resulted in the driver loading his seat back. As the case vehicle continued to roll over primarily about its longitudinal axis (a police reported six quarter turns), the case vehicle sustained significant damage to its right side and right roof area, in

addition to damage all over the vehicle as a part of its rolling over. The crush to left side resulted in the deployment of the case vehicle's driver side inflatable curtain and the driver's, seat back-mounted, side air bag. As the vehicle was rolling over, the driver's exact movement within the case vehicle is unknown. However, because the driver was properly restrained and his supplemental side air bags deployed, he was able to remain protected within the case vehicle. At final rest the driver was found conscious and hanging by his seat belts upside down.

The driver was removed and was transported by a police squad car first to a medical facility and subsequently to the county jail. According to police officials he sustained minor injuries and was treated and released from the medical facility and then taken to the jail infirmary. The injuries sustained by the case vehicle's driver included a bloody nose and minor lacerations to his head and mouth.

The case vehicle's front right passenger [18-year-old, Black (non-Hispanic) female; 170 centimeters and 77 kilograms (67 inches, 170 pounds)] was presumably seated in an upright posture with her back against the seat back and her feet on the floor; however, the exact position of her hands is unknown. Her seat track was located in its middle position, the seat back was sightly reclined.

The case vehicle's front right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. She was ejected during the crash. The front right passenger was transported by ambulance directly to the county morgue. She sustained fatal injuries and was pronounced dead at the scene. The injuries sustained by the case vehicle's front right passenger included: a crushed skull; fractures to her maxilla, mandible, left ribs (six), proximal right humerus, and distal tibia and fibula; bilateral lung contusions and lacerations; lacerations to her liver, spleen, and forehead; contusions to her liver, small bowel, large bowel, mesentery, omentum, and scalp; and multiple abrasions to her scalp, face, neck, chest, abdomen, back, and bilateral upper and lower extremities.

The case vehicle's back left passenger [19-year-old, Black (non-Hispanic) male; 165 centimeters and 68 kilograms (65 inches, 150 pounds)] was presumably seated in an upright posture with his back against the seat back and his feet on the floor; however, once again, the exact position of his hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, he was ejected during the crash. The back left passenger was transported by ambulance to the hospital. He sustained critical injuries and was pronounced dead approximately 2 hours and 45 minutes post-crash. The brain injuries sustained by the case vehicle's back left passenger included: compression and contusion of the brain stem, subdural hematoma, severe cerebral edema, bilateral cerebral contusions, and subarachnoid hemorrhage over both cerebral and cerebellar hemispheres. Furthermore, he had a complex basilar skull fracture and bilateral, anterior, proximal rib fractures. His lungs were contused and lacerated bilaterally, and he had a contused liver. In addition, he had lacerations: to his right posterior scalp, left cheek, superior right back, and posterior portion of his lower right upper extremity; contusions to his right scalp and right eye; and abrasions to his right posterior scalp,

bilateral eyes, chest, abdomen, lower back and buttocks, both shoulders, and bilateral upper and lower extremities.

The case vehicle's back right passenger [14-year-old, Black (non-Hispanic) female; 175 centimeters and 75 kilograms (69 inches, 165 pounds)] was presumably seated in an upright posture with her back against the seat back and her feet on the floor; however, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's back right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. She too was ejected during the crash. The back right passenger was transported by ambulance to the hospital. She sustained critical injuries and was pronounced dead approximately 10½ hours post-crash. The brain injuries sustained by the case vehicle's back right passenger included: a critical nonanatomic brain injury, severe cerebral edema, brain stem compression, subdural hematoma, and subarachnoid hemorrhage over both cerebral and cerebellar hemispheres. Furthermore, she had a complex basilar skull fracture and fractures to her left maxilla, left orbit, and bilateral, anterior, proximal rib fractures. Her lungs were contused and lacerated bilaterally, and she had contusions involving all four chambers of her heart, her liver, and the serosal surface of her small and large bowels, mesentery, and omentum. In addition, she had a complex laceration of her spleen and lacerations to the lower portion of her left upper extremity. There were contusions to her left cheek, bilateral eyes, right and left upper extremities, and bilateral ankles. Finally, she sustained abrasions to her head, forehead, right cheek, upper lip, right eye, right chest and abdominal walls, right back, and bilateral upper and lower extremities.

Figure 1: On-scene view showing critical curve scuff deposited in left-hand turn lane as case vehicle's driver swerved rightward, attempting to re-enter the roadway's through lanes during vehicle's attempt to flee from pursuing police vehicles (case photo #66)

CRASH CIRCUMSTANCES

The case vehicle, which was stolen, had been traveling north at an extremely high rate of speed on the northbound roadway of a seven-lane, divided, U.S. trafficway and was approaching a controlled four-leg intersection while attempting to flee from police (i.e., both the north and southbound roadways had two through lanes while the northbound roadway had one left-hand turn lane and one right-hand, channelized, turn lane; the southbound roadway had one acceleration lane). The case vehicle's driver drove into the left turn lane in order to pass stopped traffic in the two

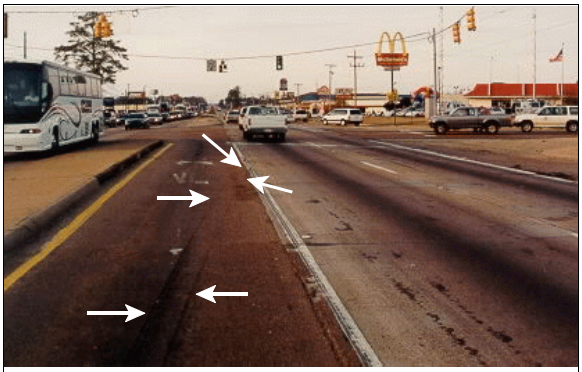


Figure 2: On-site view showing sharply turning critical curve scuff deposited in left-hand turn lane as case vehicle's driver swerved rightward into through lanes and began traveling northbound across roadway (case photo #67)

northbound lanes. As the case vehicle's driver steered back to the right while attempting to re-enter the northbound through lane, he encountered slower moving northbound traffic ahead. As a result he braked sharply and steered further to the right (**Figures 1** and **2** above) and successfully evaded the noncontact vehicle ahead, but he subsequently lost control. The case vehicle went into a slight clockwise yaw, crossed through the intersection and across both northbound through lanes, and departed the east edge of the northbound roadway. The driver's avoidance maneuvers just prior to the crash are unknown but, based on the physical evidence, the driver most likely steered leftward (**Figure 3**). The crash occurred north of the intersection, off the northbound roadway on the east roadside of the trafficway; see **CRASH DIAGRAM** below (i.e., page 37).

Figure 3: On-scene view of case vehicle's northward travel path from inside through lane onto eastern shoulder prior to departing road; Note: tire yaw marks leading off road toward curb indicate driver's attempt to steer leftward back toward roadway (case photo #69)

The northbound roadway of the U.S. highway was straight and level at the area of impact (**Figure 2** above). The pavement was concrete for the through lanes and bituminous for the right and left-hand turn lanes. The width of the northbound, left-hand, turn lane was approximately 2.7 meters (9 feet). The width of the outside, northbound, through lane–prior to departing the roadway, was approximately 4.0 meters (13 feet). The northbound left-hand turn lane was bordered on the west side by a short shoulder which was adjacent to a 3.6 meter (11.8 foot) wide raised, paved median. At the mouth of the intersection, the outside, northbound, through lane was bordered on the east side by a short shoulder which was adjacent to a raised, paved gore. The shoulders were improved (i.e., bituminous), and the roadway was border by barrier curbs. Pavement markings consisted of a single solid yellow "no passing" line for northbound traffic, boarding the left-hand turn lane, and a solid white edge line which was adjacent to the outside through lane. The through lanes were divided by a dashed white line, and single, solid, white lane lines separated the through lanes from the turn lanes. The estimated coefficient of friction was 0.70. Traffic controls consisted of two on-colors, pre-timed, vertically mounted traffic control signals. The signals were located between the left-hand turn lane the inside through lane and between the two through lanes. The legal speed limit was 72 km.p.h. (45 m.p.h.). No regulatory speed limit sign was posted near the crash site. At the time of the crash the light condition was daylight, the atmospheric condition was partially cloudy, and the road pavement was

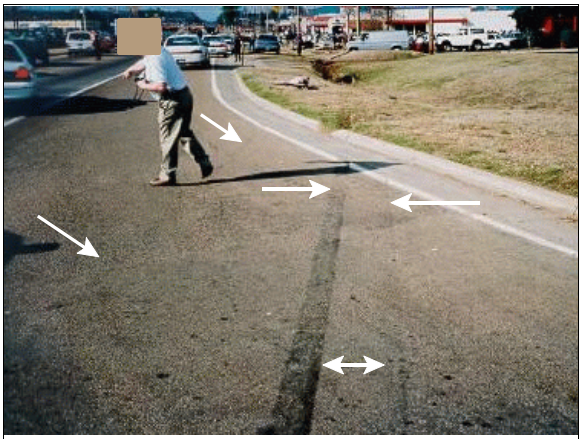


Figure 4: On-scene view of case vehicle's yaw marks leading off road and into curb impact (case photo #71)

dry. Traffic density was moderate, and the site of the crash was primarily urban commercial. In addition, there were multiple driveways within the area of the crash site.

According to a witness and the Police Crash Report, the case vehicle impacted the curb along the east roadside with sufficient force to deflate the right front tire and damage the right front wheel (**Figure 4** above). Next, the front of the case vehicle impacted a temporary warning sign, running it over. The case vehicle continued in a north-northeasterly direction, entering a drainage ditch, and impacting the culvert's embankment (**Figures 5** and **6**). The front right bumper of the case vehicle (**Figures 7** and **8**) impacted the culvert's embankment, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. Upon impacting the first culvert, the case vehicle: flipped end-over-end (i.e., rolled about the lateral axis), vaulting over the driveway without contacting it while rotating clockwise about the longitudinal axis, and impacted a second culvert's embankment (**Figure 9** below), 16.5 meters (54.1 feet) further to the north with its back left corner (**Figures 10** and **11** below). The case vehicle continued in a northerly direction while rolling over a reported 6 quarter rolls (**Figure 12**) prior to coming to rest on its roof heading east (**Figures 13** and **14** below).

Figure 5: On-scene view looking in a northerly direction at case vehicle's path of travel through warning sign (2nd impact) and into culvert's embankment (3rd impact); Note: ground dugout during embankment impact and final rest position (highlighted) of case vehicle (case photo #74)

Figure 6: On-scene view of impact between case vehicle's front right (3rd event) and 1st culvert's embankment (case photo #77)

Figure 7: Deformation to case vehicle's front from impacts with sign, 1st culvert's embankment, and subsequent rollover impacts, viewed from right of front (case photo #23)

Figure 8: Reference line view from right of deformation to case vehicle's front right corner as a result of impact with 1st culvert's embankment (case photo #22)

Figure 9: On-scene view of non-horizontal impact between case vehicle's back left (4th event) and 2nd culvert's embankment; this impact most likely caused the ejection of the case vehicle's front right and back left passengers (case photo #80)

Figure 11: Deformation to case vehicle's back viewed from right of back; Note: damage occurred during vehicle's end-over-end rollover impact with 2nd culvert's embankment (case photo #14)

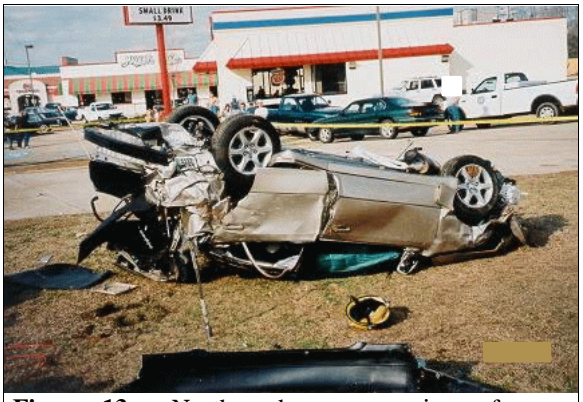


Figure 13: Northward on-scene view of case vehicle's final rest position on its roof, heading in an easterly direction, between the 3rd and 4th driveways north of the four-leg intersection (case photo #90)

Figure 10: Deformation to case vehicle's back left corner viewed from left of back; Note: mud and grass stuck in left "C"-pillar (case photo #09)

Figure 12: On-scene view of area where case vehicle landed after rolling over (i.e., rotation about both longitudinal and lateral axes) following its impact with the 2nd culvert's embankment (closest arrow); case vehicle continued to roll about its longitudinal axis, coming to rest on the north side (farthest arrow) of the 3rd driveway (case photo #86)

Figure 14: On-scene view just prior to completion of crash scene clean-up from north of case vehicle's final rest position looking southwards along case vehicle's off-road travel path; Note: arrow indicates traffic signal light at intersection where off road travel began (case photo #106)

The 2001 Lexus GS300 was a rear wheel drive, five-passenger, four-door sedan (VIN: JT8BD69S510------) equipped with a 3.0L, I-6 engine, and a five-speed automatic transmission. Braking was achieved by a power-assisted, front and rear disc, four-sensor, four-channel, four-wheel, anti-lock system. In addition, the case vehicle was equipped with electronic Vehicle Skid Control (VSC) and all speed Traction Control (TRAC) systems that work in conjunction with the anti-lock system. These systems help keep the vehicle in better control in unstable pavement conditions. The case vehicle's wheelbase was 280 centimeters (110.2 inches) and, according to the dealership from which the case vehicle was stolen, the odometer reading prior to the crash was less than 1,609 kilometers (1,000 miles). The exact odometer reading is unknown because the case vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable back bench seat with separate back cushions and adjustable head restraints for all three seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the two front and three back positions; and the front belt systems were equipped with pretensioners, load limiters, and manually operated height adjusters for the D-rings. The vehicle had an electronic sunroof which was not retracted at the time of the crash. The vehicle was equipped with knee bolsters for both the driver and front right passenger, both of which showed occupant contact evidence. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. In addition, the vehicle was equipped with front seat back-mounted, side impact air bags and side-inflatable curtain air bags which extend from each of the roof side rails. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the 1st culvert's embankment. The driver's seat back-mounted side air bag and side inflatable curtain deployed as a result of the case vehicle's rotation about its longitudinal axis during the elongated rollover event (4th event).

CASE VEHICLE DAMAGE

The case vehicle's impact with the curb most likely involved the right front wheel but, because of the masking damage, the exact nature of the damage was not determinable (**Figure 8** above). The case vehicle's impact with the metal temporary warning sign most likely involved the left two-thirds of the case vehicle's front. Once again, because of the masking damage, the exact location was not determinable (**Figure 7** above). The case vehicle's horizontal impact with the 1st culvert's embankment (3rd event) involved the front right half of the bumper and its front undercarriage (**Figure 15**). Direct damage began 21 centimeters (8.3 inches) right of the vehicle's center and extended to the front right bumper corner, a measured distance of 61 centimeters (24.0 inches) along the front bumper. Maximum

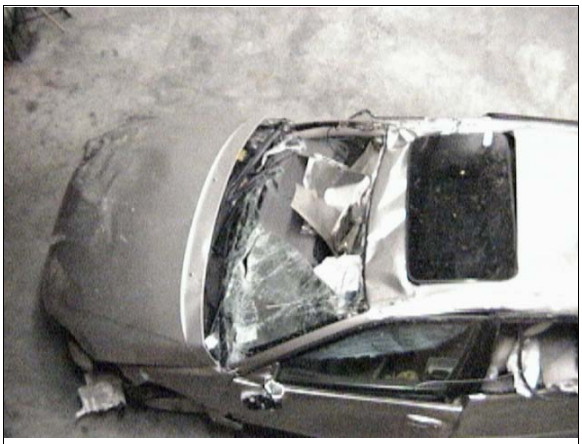


Figure 15: Overhead view of deformation to case vehicle's front; Note: rightward shift of hood in response to impact with 1st culvert's embankment (case photo #107)

crush was measured as 31 centimeters (19.3 inches) at the front right bumper corner. The case vehicle's most severe impact, a non-horizontal impact with the 2nd culvert's embankment (4th event) involved its back left half (**Figure 16**). Direct damage began at the back left bumper corner and extended, a measured distance of 144 centimeters (56.7 inches), along the back bumper (**Figure 10** above). The direct damage also extended down the left side and included the left "C"-pillar. Residual maximum crush was measured as 66 centimeters (26.0 inches) at C_1. The wheelbase on the case vehicle's left side was shortened 54 centimeters (21.3 inches) while the right side was shortened 16 centimeters (6.3 inches). As a result of this crash the case vehicle's front and back bumpers, front and back bumper fasciae, grille, hood, radiator, truck, roof, front headlight and turn signal assemblies, back left taillight and turn signal assemblies, both fenders, left quarter panel, and all four doors were directly damaged and crushed inward. Furthermore, all four of the case vehicle's tires were physically restricted, and both of the front tires were deflated from damage. The right taillight and turn signal assemblies sustained induced damage as well as the right quarter panel and both left side doors. The windshield was cracked and holed. The right front, right rear, backlite, and left rear window glazings were all disintegrated; however, the left front (**Figure 17**) and roof glazings remained intact (**Figure 15** above).

Figure 16: Overhead view of deformation to case vehicle's back showing non-horizontal impact direction to back left corner from impact with 2nd culvert's embankment (case photo #108)

Figure 17: Deformation to case vehicle from frontal and multiple rollover impacts viewed from front portion of left side (case photo #05)

Inspection of the case vehicle's interior revealed contact evidence on both the driver's (**Figure 18**) and front right passengers knee bolsters (**Figure 19** below). The latter was found just below the glove box door. Furthermore, there was obvious contact evidence on the back surface of the front right passenger's seat back (**Figure 20** below), and the turn signal/windshield wiper stalk was broken off the steering column. Finally, there was intrusion to the driver's toe pan area, to all occupant seating positions from the roof being crush downward, and to the back left passenger's seating area (**Figure 21** below).

Figure 18: Case vehicle's driver seating area showing driver's deployed front air bag and side inflatable curtain; Note: minimal floor pan intrusion and left knee contact to driver's knee bolster (case photo #28)

Figure 19: Contact evidence (highlighted) on case vehicle's front right knee bolster, just below glove box door from front right passenger's knees (case photo #46)

Figure 20: Damage to back surface of case vehicle's front right seat back from loading by back right passenger (case photo #58)

Figure 21: Case vehicle's back seats viewed from right rear door showing intrusion to back left seating position; Note: deployed driver side inflatable curtain (case photo #61)

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **00-BDAW-6** (**220** degrees), for its most severe impact with the second culvert's embankment, **12-FZLW-2** (**350** degrees) for its impact with the first culvert's embankment, and **00-TDDO-3** for the remainder of the rollover activity. The CDCs for the case vehicle's initial impacts with the curb and the temporary warning sign are estimated as: **12-FRWN**-3 (**0** degrees) and **12-FYEW-1** (**0** degrees); however, the exact CDCs for these impacts are unknown because of masked damage. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle highest severity impact with the second culvert's embankment, even though the impact was non-horizontal. The results, although suspect, showed the case vehicle as having a Barrier Equivalent Speed (BES) of 22.4 km.p.h. (13.9 m.p.h.). This contractor believes these results are low and estimates that the actual Delta V is between 48 km.p.h. (30 m.p.h.) and 56 km.p.h. (35 m.p.h.). The WinSMASH reconstruction program, CDC only Barrier algorithm, was used on the case vehicle's deployment (i.e., second highest severity) impact with the first culvert's embankment. The results, although suspect, showed that the case vehicle had a Barrier Equivalent Speed (BES) of 20.4 km.p.h. (12.7 m.p.h.). This contractor believes these results are low and estimates that the actual Delta V is between 25 km.p.h. (15.5 m.p.h.) and 33.8 km.p.h. (21 m.p.h.). The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with Advance Occupant Protection System features that included front Supplemental Restraint System (SRS) air bags at the driver and front right passenger seating positions. In addition, the driver and front right passenger positions had seat back-mounted side air bags and side inflatable curtains. The curtains were located along the left and

right roof side rails. Both front air bags deployed as a result of the frontal impact with the 1st culvert's embankment. The driver's seat back-mounted side air bag and side inflatable curtain deployed during the longitudinal component (4th event) of the rollover event.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of three asymmetrical cover flaps made of thick vinyl. The top and largest flap was somewhat semicircular in design while the left and right lower flaps were hexagonal and obliquely oriented. The top cover flap had overall dimensions of 17 centimeters (6.7 inches) horizontally and 12 centimeters (4.7 inches) vertically at their widest points. The two bottom flaps were mirror imaged and each measured 7 centimeters (2.8 inches) horizontally and had an overall height of 10 centimeters (3.9 inches) vertically. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each 11 centimeters (4.3 inches) wide. The driver's air bag had two vent ports, approximately 1.5 centimeters (0.6 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with diameter 57 centimeters (22.4 inches). An inspection of the driver's air bag fabric revealed obvious contact evidence (i.e., two areas of bloody and oily smears) on the lower half of the air bag's fabric between the 6:30 and 7:30 o'clock positions (**Figure 22**).

Figure 22: Case vehicle's deployed driver air bag showing area (highlighted) of bloody and oily smears (case photo #33)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, asymmetrical, top-mounted, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 31 centimeters (12.2 inches) at the lower horizontal seam, 15 centimeters (5.9 inches) along the right vertical seam, and 17 centimeters (6.7 inches) along the left vertical seam. The profile of the case vehicle's instrument panel resulted in a 10 centimeter (3.9 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed without any tethers. The front right

Figure 23: Overhead view looking down at front surface of case vehicle's deployed front right passenger air bag; Note: air bag module's cover flap is visible in bottom of photo and bottom of front surface of air bag is located towards top of photo (case photo #49)

air bag had two vent ports, approximately 8 centimeters (3.1 inches) in diameter, located at the 7:30 and 4:30 clock positions. The deployed front right air bag was a rounded rectangle with a height of approximately 57 centimeters (22.4 inches) and a width of approximately 58 centimeters (22.8 inches). An inspection of the front right passenger's air bag fabric revealed obvious contact evidence (i.e., an area of blood transfer) on the front surface of the air bag's fabric to the right of center toward the 3 o'clock position and obliquely oriented (**Figure 23** above).

The case vehicle's driver side air bag was located in the outboard side of the driver's seat back. An inspection of the air bag module's fabric revealed that there was no evidence of damage during the deployment to the air bag. The left side air bag was designed without any tethers or vent ports. The deployed driver's side air bag was essentially rectangular with a height of 27 centimeters (10.6 inches) and an excursion of approximately 29 centimeters (11.4 inches). An inspection of the driver, seat back-mounted, side air bag's fabric revealed that there was no contact evidence apparent on the interior surface (**Figure 24**). The front right passenger's, seat back-mounted, side air bag did not deployed as a result of this crash.

Figure 24: Close-up of interior portion of case vehicle's deployed, driver seat back-mounted, side air bag showing no visible contact evidence (case photo #39)

Figure 25: Case vehicle's deployed driver side inflatable curtain viewed from back right seat; Note: collapsed roof and left "A"-pillar (case photo #31)

Figure 26: Close-up of front interior portion of case vehicle's deployed driver side inflatable curtain showing blood evidence (case photo #32)

The case vehicle's driver side inflatable curtain was located along the seam between the roof and left side roof rail, and the curtain was located from the left "A"-pillar rearwards to just beyond the left "B"-pillar (**Figure 25**). An inspection of the driver's side inflatable curtain revealed that there was no evidence of damage during the deployment to the curtain. The driver's inflatable curtain was designed with one tether, 30 centimeter (11.8 inches) in length, that connected between the rear of the curtain and the left "C"-pillar. The inflatable curtain was not designed with vent ports, but there were six baffles spread across the width of the curtain that acted as a type of tether. The deployed inflatable curtain measured 158 centimeters (62.2 inches)

long and had 30 centimeters (11.8 inches) of excursion. An inspection of the driver inflatable curtain's fabric revealed obvious contact evidence (i.e., blood and oily transfers) to the interior surface near where the head of the case vehicle's driver would have been (**Figure 26** above). The exterior surface had a minimal amount of mud and dirt.

The front right passenger's side inflatable curtain did not deployed as a result of this crash even though there was extensive crush to the case vehicle's right "A"-pillar and right side of the roof; see **SELECTED PHOTOGRAPHS** section below, specifically **Figures 32**, **33**, and **34** (i.e., page 33). The side impact sensors were located in the lower "B"-pillars. This system is intended to provide occupant protection in a side impact and one would not expect the system to deploy considering the significant longitudinal versus lateral forces experienced along the right doors and lower right "B"-pillar area of the vehicle during this rollover event.

ELECTRONICS CONTROL UNIT

The results of this vehicle's **E**lectronics **C**ontrol **U**nit (ECU) were forwarded to this contractor by NHTSA Special Crash Investigations. Apparently the module was recovered from the vehicle on behalf of the manufacturer; see **ELECTRONICS CONTROL UNIT DATA** (**Figures 35**, **36**, and **37**) below (i.e., pages 34-36).

According to information provided by Toyota, the ECU is able to monitor and record data from frontal crashes only. Furthermore, there is no way to tell when the side air bags and/or curtains deploy. The side crash sensing is a totally separate system. The side impact detection is by sensors located normally in the "B"-pillars; some times an additional sensor is in the center of the door panel. There is no single point sensing for side protection. There is no lateral crash pulse information recorded.

The ECU recording device is able to record any near deployment events the case vehicle has incurred throughout its driving lifetime. This system enables and writes at any "**2g**" longitudinal deceleration. It records for 150 milliseconds, and gives 5 seconds of pre-crash data. Three events are capable of being recorded and are recorded in three memory banks: "**0**", "**1**", and "**2**". The memory banks are moved and dumped as higher Delta V's are recorded until a deployment event occurs. The most current (or deployment) event is stored in memory bank "**0**". The maximum Delta V is stored in memory bank "**1**", and the event prior to the most current event is stored in memory bank "**2**".

When deciphering the downloaded data, the key terms and their definitions are:

Diagnostics: Recorded only in the "**0**" memory bank. Identifies if any air bag system abnormalities were identified.

Lamp on term: Identifies how many minutes that the air bag warning light was illuminated in 15-minute intervals up to 511 hours. Recorded only in the "**0**" memory bank.

Ignition Cycles: Identifies how many times the key was in the on position after the diagnostics lamp was on. The key must be "on" for at least 15 minutes to record a cycle. Recorded only in the "**0**" memory bank.

Shift Position: Indicates the position of the transmission selector. P, N, R or other; **other** signifies any forward drive gear.

Deployment Time: The time (in milliseconds) from a triggering event (AE) to the fire command. Recorded only in the "**0**" memory bank.

Time from last Pre-Crash data: Identifies the amount of time that transpired from the last recorded pre-crash data to the triggering event. The pre-crash data is recorded every second.

Time from Previous Event: Identifies the amount of time of this recording from the previous recording of information. This is measured in milliseconds up to 5000 milliseconds.

Furthermore the ECU is capable of recording the safety belt status for both the driver and front right passenger just prior to the most current (or deployment) event. In addition, the ECU records pre-crash data for each event, including brake switch status and the vehicle's travel speed; however, it must be noted that the maximum pre-crash speed that can be recorded by the ECU is 126.0 km.p.h. (78.3 m.p.h.). A pre-crash recorded speed of 126.0 km.p.h. (78.3 m.p.h.) means that the vehicle was traveling at **that speed or higher**. Finally, the ECU records the post-crash Delta V for each event and presents that data in both graphical and tabular formats.

The ECU **does not** record any other functions that are not displayed in the data readouts, specifically, for example, the status (i.e., on/off) of any stability control mechanisms (i.e., VSC/TRAC–**V**ehicle **S**kid **C**ontrol and all speed **Tra**ction **C**ontrol).

The data downloaded from the case vehicle's **ECU** showed that a **crash event** and two near deployment events were recorded. In this contractors opinion, the crash event (i.e., memory bank "**0**") occurred when the case vehicle's front right bumper contacted the 1st culvert's embankment. The case vehicle's two near deployment impacts were the frontal impact with the temporary warning sign, recorded in memory bank "**2**", and the case vehicle's impact with the curb, recorded in memory bank "**1**". For the deployment impact, the downloaded data indicate that ECU system was clean (i.e., no diagnostic abnormalities were noted, the Warning Light was OFF prior to the deployment, and that the ignition had not been engaged when the lamp was ON). The case vehicle's front air bags were commanded to deploy 24 milliseconds into the deployment event (i.e., after the collision was first detected by the ECU), the driver's safety belt was latched at the time the deployment occurred, and the front right passenger's safety belt was not latched at the time of the deployment. The ECU recorded a change in velocity (Delta V) of 40.6 km.p.h. (25.2 m.p.h.). The Delta V reached this value at 150 milliseconds (i.e., the latest time recorded) after the crash was first detected. Because the Delta V was still climbing at the end of the 150 milliseconds, the actual total Delta V was greater than 40.6 km.p.h. (25.2 m.p.h.). Additional downloaded data of interest indicated the following. The case vehicle's impact with the temporary warning sign occurred approximately 300-400 milliseconds prior to the deployment event. The case vehicle's impact with the curb occurred approximately 800-900 milliseconds prior to the impact with the temporary warning sign. The case vehicle's driver braked momentarily as he approached the curb but released the brake and was on the throttle when the vehicle impacted the curb, the sign post, and the 1st culvert's embankment. The case vehicle's speed throughout the three recorded events was never less than the default speed of 126.0 km.p.h. (78.3 m.p.h.). This contractor believes that the recorded Delta V for the deployment event seems reasonable considering the amount of deformation to the case vehicle's front.

Although the exact posture of the case vehicle's driver [20-year-old, Black (non-Hispanic) male; of unknown height and weight] immediately prior to the crash is unknown, the case vehicle's driver was most likely seated in a slightly reclined posture with his back against the seat back, his left foot on the floor, his right foot near the brake but not on it, and both hands on the steering wheel. His seat track was located near its middle position, the seat back was sightly reclined, and the tilt steering wheel was located in its middle position.

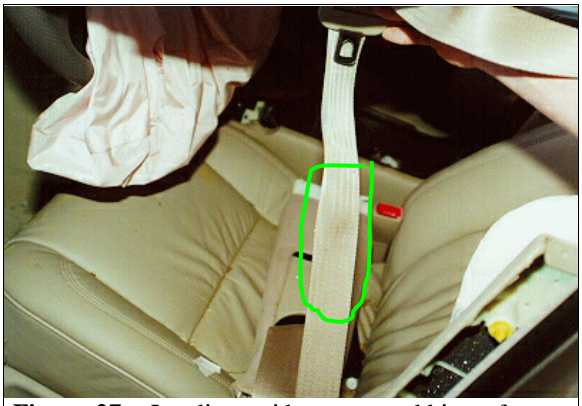


Figure 27: Loading evidence on webbing of case vehicle's driver seat belt (case photo #41)

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system which was equipped with a pretensioner. The inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed significant visible evidence of loading. Photographs taken by this contractor showed stretching to the belt webbing near the"D"-ring and the latch portion (**Figure 27**), and their were heat abrasions to the "D"-ring and belt latch (**Figure 28**).

Figure 28: Close-up of heavy friction mark on plastic latch of case vehicle's driver seat belt (case photo #44)

The exact sequence of pre-crash avoidance maneuvers attempted by the case vehicle's driver are unknown. Available evidence indicates that just prior to the impact with the curb he was trying to steer to the left and had been braking when the case vehicle was crossing through the intersection in its clockwise yaw. As a result and independent of the use of his available safety belts, the driver most likely leaned back and to the right just prior to the curb impact. The case vehicle's frontal impacts with the curb and temporary construction sign had little or no affect on the driver's seating posture. As the case vehicle slid into the drainage ditch, the case vehicle continue forward while tilting downward and rightward just prior to impacting the 1st culvert's embankment. The case vehicle's primary impact with the embankment/culvert enabled the case vehicle's driver to continue forward and upward as the case vehicle decelerated. The culvert impact not only deployed the driver's front air bag but also fired the driver's seat belt pretensioner. The driver's seat belt pretensioner retracted any slack the driver may have had in the seat belt's webbing.

As the front of the case vehicle decelerated from impacting the embankment and culvert, the case vehicle's back end lifted vertically and the case vehicle began to roll end-over-end (i.e., about the lateral axis). Because the embankment/culvert impact was primarily to the case vehicle's front right, the case vehicle also began to rotate clockwise (i.e., about the vertical axis). As the vehicle

rolled over, the driver rebounded backwards off his deploying air bag and safety belts into his seat back. As previously mentioned, the case vehicle traveled 16.5 meters (54.1 feet) in the air, flipping and rotating, prior to impacting the 2nd culvert's embankment while landing upside down with the vehicle's back left bumper corner leading. Between the 1st and 2nd culverts the case vehicle rotated approximately 180 degrees about the lateral axis but only approximately 30-45 degrees about the vertical axis, while in the air, prior to impacting the 2nd culvert's embankment. The vehicle's non-horizontal impact with the 2nd culvert's embankment was the case vehicle's highest severity impact. This back impact resulted in the driver loading his seat back. As the case vehicle continued to roll over primarily about its longitudinal axis (a police reported six quarter turns), the case vehicle sustained significant damage to its right side and right roof area, in addition to damage all over the vehicle as a part of its rolling over. The crush to left side resulted in the deployment of the case vehicle's driver side inflatable curtain and the driver's, seat back-mounted, side air bag. As the vehicle was rolling over, the driver's exact movement within the case vehicle is unknown. However, because the driver was properly restrained and his supplemental side air bags deployed, he was able to remain protected within the case vehicle. At final rest the driver was found conscious and hanging by his seat belts upside down.

CASE VEHICLE DRIVER INJURIES

The driver was removed and was transported by a police squad car first to a medical facility and subsequently to the county jail. According to police officials he sustained minor injuries and was treated and released from the medical facility and then taken to the jail infirmary. The injuries sustained by the case vehicle's driver included a bloody nose and minor lacerations to his head and mouth.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Lacerations {cuts}, minor, on head, not further specified	190600.1 minor	Unknown contact mechanism	Unknown	Other: Police Crash Report
2	Laceration to mouth, not further specified	290600.1minor	Air bag, driver's	Possible	Other: Police Crash Report

CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle's front right passenger [18-year-old, Black (non-Hispanic) female; 170 centimeters and 77 kilograms (67 inches, 170 pounds)] was presumably seated in an upright posture with her back against the seat back and her feet on the floor; however, the exact position of her hands is unknown. Her seat track was located in its middle position, the seat back was sightly reclined.

The case vehicle's front right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the front right passenger's seat belt webbing,

"D"-ring, and latch plate showed no evidence of loading; in addition, the pretensioner did not fire. She was ejected during the crash.

The exact sequence of pre-crash avoidance maneuvers attempted by the case vehicle's driver are unknown. Available evidence indicates that just prior to the impact with the curb he was trying to steer to the left and had been braking when the case vehicle was crossing through the intersection in its clockwise yaw. As a result of these attempted avoidance maneuvers and the nonuse of her available safety belts, the front right passenger most likely moved slightly forward and to her right just prior to the curb impact. The case vehicle's frontal impacts with the curb and temporary construction sign had little or no affect on the front right passenger's seating posture. As the case vehicle slid into the drainage ditch, the case vehicle continue forward while tilting downward and rightward just prior to impacting the 1st culvert's embankment. The case vehicle's primary impact with the embankment/culvert enabled the case vehicle's front right passenger to continue forward and upward as the case vehicle decelerated. The culvert impact deployed the front right passenger's front air bag and sent her into the front right knee bolster and deploying air bag. As the front of the case vehicle decelerated from impacting the embankment and culvert, the case vehicle's back end lifted vertically and the case vehicle began to roll end-over-end (i.e., about the lateral axis). Because the embankment/culvert impact was primarily to the case vehicle's front right, the case vehicle also began to rotate clockwise (i.e., about the vertical axis). As previously mentioned, the case vehicle traveled 16.5 meters (54.1 feet) in the air, flipping and rotating, prior to impacting the 2nd culvert's embankment while landing upside down with the vehicle's back left bumper corner leading. As the vehicle rolled over between the 1st and 2nd culverts, the case vehicle rotated approximately 180 degrees about the lateral axis but only approximately 30-45 degrees about the vertical axis, while in the air, prior to impacting the 2nd culvert's embankment. According to an eyewitness, this occupant was ejected through the windshield and was observed impacting first the ground and then a concrete driveway before approaching the parked pickup truck (**Figure 29**). In this contractor's opinion, this occupant was most likely ejected after the case vehicle's back impacted the 2nd culvert's embankment as the front of the vehicle flipped and rolled over on its northward course. At final rest the front right passenger was found obliquely oriented

Figure 29: Southward on-scene view of case vehicle's final rest position on ground between the 3rd and 4th driveways, heading east; Note: shoes on 4th driveway are most likely from back right passenger who came to rest on driveway and pickup truck at left (arrow) which was contacted (i.e., front right passenger came to rest south of pickup and back left passenger came to rest north of pickup) by ejected occupants (case photo #96)

Figure 30: Northward on-scene view of parked pickup truck that was struck by case vehicle's ejected occupants; front right passenger came to rest near right front door (case photo #97)

underneath the south side of the parked pickup truck that was heading east in the third driveway north of the four-leg intersection (**Figure 30** above).

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by ambulance directly to the county morgue. She sustained fatal injuries and was pronounced dead at the scene. The injuries sustained by the case vehicle's front right passenger included: a crushed skull; fractures to her maxilla, mandible, left ribs (six), proximal right humerus, and distal tibia and fibula; bilateral lung contusions and lacerations; lacerations to her liver, spleen, and forehead; contusions to her liver, small bowel, large bowel, mesentery, omentum, and scalp; and multiple abrasions to her scalp, face, neck, chest, abdomen, back, and bilateral upper and lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Crushed skull including: Cerebral laceration with diffuse subtotal avulsion of brain; Hemorrhage, subdural, 40 cc; Hemorrhage, intracerebral; Hemorrhage, intraventricular; Hemorrhage, subarachnoid over left and right cerebral hemispheres Contusions, multiple, over right and left cerebral hemispheres Fracture, complex basilar involving all six fossa (i.e., anterior, middle, posterior **and** right and left) and with a hinge fracture through the middle cranial fossa Fracture, complex[1], vault with torn dura and exposed and lost brain tissue	113000.6 untreatable	Ground	Certain	Autopsy
2	Fracture mandible, not further specified	250600.1 minor	Ground	Certain	Autopsy
3	Fracture maxilla, not further specified	250800.2 moderate	Ground	Certain	Autopsy
4	Contusions bilateral lungs, up to 10 cm (3.9 in) right lung, up to 12 cm (4.7 in) left lung	441410.4 severe	Right instrument panel and below	Possible	Autopsy

[1] A gaping 14 centimeter (5.5 inch) laceration was present along the left scalp above the ear.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
5	Lacerations bilateral lungs, up to 6 cm (2.4 in) right lung, up to 8 cm (3.1 in) left lung with bilateral hemothorax[2]: 800 cc right pleural cavity and 700 cc left pleural cavity	441456.5 critical	Right instrument panel and below	Possible	Autopsy
6	Fractures left 5th, 6th, 7th, 8th, 9th, and 10th ribs, fracture locations not specified	450230.3 serious	Right instrument panel and below	Possible	Autopsy
7	Contusions right lobe of liver, up to 10 cm (3.9 in)	541812.2 moderate	Right instrument panel and below	Possible	Autopsy
8	Lacerations liver, up to 8 cm (3.1 in) on capsular surface, extending 3 cm (1.2 in) in depth	541822.2 moderate	Right instrument panel and below	Possible	Autopsy
9	Lacerations spleen, up to 6 cm (2.4 in) with 800 cc of hemoperitoneum	544220.2 moderate	Right instrument panel and below	Possible	Autopsy
10	Contusions small bowel, not further specified	541410.2 moderate	Ground	Probable	Autopsy
11	Contusions large bowel, not further specified	540810.2 moderate	Ground	Probable	Autopsy
12	Contusions mesentery, not further specified	542010.2 moderate	Ground	Probable	Autopsy
13	Contusions omentum, not further specified	542210.2 moderate	Ground	Probable	Autopsy
14	Fracture proximal right humerus (palpable)	752602.2moderate	Ground	Probable	Autopsy
15	Fracture distal right tibia (palpable)	853404.2 moderate	Ground	Probable	Autopsy
16	Fracture distal right fibula (palpable)	851605.2 moderate	Ground	Probable	
17	Laceration, 4 cm (1.6 in) over forehead	290602.1 minor	Ground	Probable	Autopsy
18	Abrasions, up to 2 cm (0.8 in) posterior scalp	190202.1minor	Ground	Certain	Autopsy
19	Contusion {cephalohematoma}, diffuse, scalp	190402.1 minor	Ground	Certain	Autopsy

[2] The blood loss in the peritoneal cavity (i.e., 800 cc) is added to the bilateral hemothorax reported here for the purposes of establishing "blood loss greater than 20% by volume".

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
20	Abrasions whole face including, tip of nose, right ear lobe and anterior to right ear, right cheek, left cheek, and chin	290202.1 minor	Front right windshield's glazing	Probable	Autopsy
21	Abrasions, up to 5 cm (2.0 in) anterior neck	390202.1 minor	Air bag, front right passenger's	Possible	Autopsy
22	Abrasions, up to 19 cm (7.5 in) over chest {whole}	490202.1 minor	Air bag, front right passenger's	Probable	Autopsy
23	Abrasions, up to 19 cm (7.5 in) over abdomen[3] {whole}	590202.1 minor	Ground	Probable	Autopsy
24	Abrasions, extensive over back {whole} and superior lateral right buttock	690202.1 minor	Ground	Certain	Autopsy
25	Abrasions over anterior right shoulder and over anterior right arm and forearm, up to 16 cm (6.3 in)	790202.1 minor	Ground	Probable	Autopsy
26	Abrasions right posterior arm and forearm, extending to dorsal hand, up to 9 cm (3.5 in)	790202.1 minor	Ground	Probable	Autopsy
27	Abrasions, 7 cm (2.8 in) left anterior lateral arm	790202.1 minor	Ground	Probable	Autopsy
28	Abrasions left elbow and over dorsal surface of hand and 2nd, 3rd, 4th, and 5th digits	790202.1 minor	Ground	Probable	Autopsy
29	Abrasions right thigh, anterior to anterolateral surface and proximal lateral shin, up to 12 cm (4.7 in)	890202.1 minor	Ground	Probable	Autopsy
30	Abrasions, up to 12 cm (4.7 in) right calf and posterior ankle	890202.1 minor	Ground	Probable	Autopsy
31	Abrasion, 6 cm (2.4 in) anterior left knee and instep of left foot, up to 4 cm (1.6 in)	890202.1 minor	Ground	Probable	Autopsy

[3] Road grease was noted over the right lateral abdomen.

The case vehicle's back left passenger [19-year-old, Black (non-Hispanic) male; 165 centimeters and 68 kilograms (65 inches, 150 pounds)] was presumably seated in an upright posture with his back against the seat back and his feet on the floor; however, once again, the exact position of his hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the back right passenger's seat belt webbing and latch plate showed no evidence of loading. He was also ejected during the crash.

The exact sequence of pre-crash avoidance maneuvers attempted by the case vehicle's driver are unknown. Available evidence indicates that just prior to the impact with the curb he was trying to steer to the left and had been braking when the case vehicle was crossing through the intersection in its clockwise yaw. As a result of these attempted avoidance maneuvers and the nonuse of his available safety belts, the back left passenger most likely moved slightly forward and to his right just prior to the curb impact. The case vehicle's frontal impacts with the curb and temporary construction sign had little or no affect on the back left passenger's seating posture. As the case vehicle slid into the drainage ditch, the case vehicle continue forward while tilting downward and rightward just prior to impacting the 1st culvert's embankment. The case vehicle's primary impact with the embankment/culvert enabled the case vehicle's back left passenger to continue forward and upward loading the back of the driver's seat back as the case vehicle decelerated. As the front of the case vehicle decelerated from impacting the embankment and culvert, the case vehicle's back end lifted vertically and the case vehicle began to roll end-over-end (i.e., about the lateral axis). Because the embankment/culvert impact was primarily to the case vehicle's front right, the case vehicle also began to rotate clockwise (i.e., about the vertical axis). As the back of the case vehicle lifted upwards, this occupant slid upwards, head first into the roof (**Figure 31**). As previously mentioned, the case vehicle traveled 16.5 meters (54.1 feet) in the air, flipping and rotating, prior to impacting the 2nd culvert's embankment while landing upside down with the vehicle's back left bumper corner leading. Between the 1st and 2nd culverts the case vehicle rotated approximately 180 degrees about the lateral axis but only approximately 30-45 degrees about the vertical axis, while in the air, prior to impacting the 2nd culvert's embankment. As the vehicle rotated about its lateral axis, this occupant most likely moved head first toward the front right of the vehicle. When the back left of the vehicle impacted the 2nd culvert's embankment, this occupant most likely moved backwards along the roof, re-contacting the roof and/or driver's seat back support (**Figure 31**). According to an eyewitness, this occupant was ejected through the windshield and, the witness who was near a pickup truck that was parked in the 3rd driveway, reported hearing a "thud" that he "knew" was the sound of a body impacting the pickup. In this contractor's opinion, this occupant

Figure 31: Case vehicle's roof viewed from driver's seating position showing numerous marks and blood stains; Note: adjustable head restraints and front upper anchorages (case photo #64)

was most likely ejected after the case vehicle's back impacted the 2nd culvert's embankment as the front of the vehicle flipped and rolled over on its northward course. At final rest the back left passenger was found on the north side of the parked pickup truck that was heading east in the third driveway north of the four-leg intersection (**Figures 29** and **30** above).

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The back left passenger was transported by ambulance to the hospital. He sustained critical injuries and was pronounced dead approximately 2 hours and 45 minutes post-crash. The brain injuries sustained by the case vehicle's back left passenger included: compression and contusion of the brain stem, subdural hematoma, severe cerebral edema, bilateral cerebral contusions, and subarachnoid hemorrhage over both cerebral and cerebellar hemispheres. Furthermore, he had a complex basilar skull fracture and bilateral, anterior, proximal rib fractures. His lungs were contused and lacerated bilaterally, and he had a contused liver. In addition, he had lacerations: to his right posterior scalp, left cheek, superior right back, and posterior portion of his lower right upper extremity; contusions to his right scalp and right eye; and abrasions to his right posterior scalp, bilateral eyes, chest, abdomen, lower back and buttocks, both shoulders, and bilateral upper and lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Compression {transtentorial (uncal) herniation} brain stem with prominent uncal notching	140202.5 critical	Unknown contact mechanism[4]	Unknown	Autopsy
2	Contusion, up to 3 cm (1.2 in), involving brain stem	140204.5 critical	Unknown contact mechanism[4]	Unknown	Autopsy
3	Hemorrhage, subarachnoid over right and left cerebellar hemispheres and brain stem	140466.3 serious	Unknown contact mechanism[4]	Unknown	Autopsy
4	Contusions, up to 0.2 cm (0.08 in) over right and left cerebral hemispheres	140620.3 serious	Unknown contact mechanism[4]	Unknown	Autopsy
5	Hematoma, subdural, large (80 cc), location not specified [Aspect = Unknown]	140656.5 critical	Unknown contact mechanism[4]	Unknown	Autopsy

[4] In this contractor's opinion there are at least four (4) potential impacts to this occupant's head that could have caused the critical brain and skull injuries. Based on occupant kinematic principles, when the case vehicle impacted the 1st culvert's embankment, this occupant loaded the driver's seat back possibly causing his rib, lung, and liver injuries. As the back of the back of the case vehicle lifted upwards, this occupant slid upwards, head first into the roof. As the vehicle rotated about its lateral axis, this occupant most likely moved head first toward the front right of the vehicle. When the back left of the vehicle impacted the 2nd culvert's embankment, this occupant most likely moved backwards along the roof, re-contacting the roof and/or driver's seat back support. After being ejected, this occupant certainly impacted the ground and most likely, based on witness reports, the right front door area of the parked, pickup truck that was heading east. This occupant's momentum most likely enable him to flip over the top of the parked pickup and land at his documented final rest position on the pickup's north side.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
6	Edema, cerebral, severe, location and specifics not specified [Aspect = Unknown]	140666.5 critical	Unknown contact mechanism[4]	Unknown	Autopsy
7 8	Hemorrhage, subarachnoid over convexities of right and left cerebral hemispheres	140684.3 140684.3 serious	Unknown contact mechanism[4]	Unknown	Autopsy
9	Lacerations lungs, bilaterally, up to 1 cm (0.4 in) right lung and up to 2 cm (0.8 in) left lung and with bilateral hemithorax, 300 ml residual in both right and left pleural cavities	441450.4 severe	Seat back, driver's	Possible	Autopsy
10	Contusions visceral surface lungs, bilaterally, up 12 cm (4.7 in) right lung, up to 14 cm (5.5 in) left lung	441410.4 severe	Seat back, driver's	Possible	Autopsy
11	Contusions, up to 2 cm (0.8 in), capsular surface of liver, location not further specified	541810.2 moderate	Seat back, driver's	Possible	Autopsy
12	Fracture, basilar, complex, involving a small fracture of right petrous ridge of temporal bone and extensive fractures involving left petrous ridge of temporal bone and left posterior cranial fossa	150206.4 severe	Unknown contact mechanism[4]	Unknown	Autopsy
13	Fractures bilateral ribs including: left 1st through 4th ribs, anterior, proximal, and right 1st through 3rd ribs, anterior, proximal	450230.3 serious	Seat back, driver's	Possible	Autopsy
14	Abrasions, 12 cm (4.7 in), right posterior scalp	190202.1 minor	Ground	Probable	Autopsy
15	Contusion {cephalohematoma} right scalp upon scalp reflection	190402.1 minor	Unknown contact mechanism[4]	Unknown	Autopsy
16	Lacerations, up to 7 cm (2.8 in), right posterior scalp	190602.1 minor	Ground	Possible	Autopsy
17	Contusion {hematoma} right eye {periocular}	297402.1 minor	Ground	Possible	Autopsy
18 19	Abrasions lateral to both eyes, up to 2 cm (0.8 in) on right and up to 1 cm (0.4 in) on left	290202.1 290202.1 minor	Ground	Possible	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
20	Lacerations, up to 2 cm (0.8 in), medial left cheek	290602.1 minor	Noncontact injury: flying glass	Possible	Autopsy
21	Abrasions, up to 10 cm (3.9 in), over chest, locations not specified	490202.1 minor	Ground	Probable	Autopsy
22	Abrasions, up to 10 cm (3.9 in), over abdomen, locations not specified	590202.1 minor	Ground	Probable	Autopsy
23	Abrasions, up to 19 cm (7.5 in), lower back extending to involved left and right buttocks	690202.1 minor	Ground	Probable	Autopsy
24	Lacerations, up to 9 cm (3.5 in), involving superior right back	690602.1 minor	Ground	Probable	Autopsy
25	Abrasions, up to 12 cm (4.7 in), over anterior surface right shoulder	790202.1minor	Ground	Probable	Autopsy
26	Abrasions over left shoulder: 3 cm (1.2 in) on anterior surface, 8 cm (3.1 in) on posterior surface	790202.1 minor	Ground	Probable	Autopsy
27	Abrasion, 7 cm (2.8 in) on anterior right arm	790202.1 minor	Ground	Probable	Autopsy
28	Abrasion, 2 cm (0.8 in) on posterior right arm	790202.1 minor	Ground	Probable	Autopsy
29	Abrasions, up to 2 cm (0.8 in), on dorsal surface of left 3rd, 4th, and 5th digits	790202.1 minor	Ground	Probable	Autopsy
30	Abrasion, 7 cm (2.8 in), posterior left forearm	790202.1 minor	Ground	Probable	Autopsy
31	Lacerations posterior right forearm and elbow and extending to dorsal surface of hand and digits	790602.1 minor	Ground	Probable	Autopsy
32	Abrasions, up to 1 cm (0.4 in), right shin	890202.1 minor	Ground	Probable	Autopsy
33	Abrasion, 12 cm (4.7 in) right calf	890202.1 minor	Ground	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
34	Abrasions left leg including proximal anterolateral thigh, anterior knee, shin, and instep of foot, individually measuring up to 12 cm (4.7 in)	890202.1 minor	Ground	Probable	Autopsy
35	Abrasion, 2 cm (0.8 in), left calf	890202.1 minor	Ground	Probable	Autopsy
36	Abrasion lateral left ankle	890202.1 minor	Ground	Probable	Autopsy

CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS

The case vehicle's back right passenger [14-year-old, Black (non-Hispanic) female; 175 centimeters and 75 kilograms (69 inches, 165 pounds)] was presumably seated in an upright posture with her back against the seat back and her feet on the floor; however, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's back right passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the back right passenger's seat belt webbing and latch plate showed no evidence of loading. She too was ejected during the crash.

The exact sequence of pre-crash avoidance maneuvers attempted by the case vehicle's driver are unknown. Available evidence indicates that just prior to the impact with the curb he was trying to steer to the left and had been braking when the case vehicle was crossing through the intersection in its clockwise yaw. As a result of these attempted avoidance maneuvers and the nonuse of her available safety belts, the back right passenger most likely moved slightly forward and to her right just prior to the curb impact. The case vehicle's frontal impacts with the curb and temporary construction sign had little or no affect on the back right passenger's seating posture. As the case vehicle slid into the drainage ditch, the case vehicle continue forward while tilting downward and rightward just prior to impacting the 1st culvert's embankment. The case vehicle's primary impact with the embankment/culvert enabled the case vehicle's back right passenger to continue forward and upward loading the back of the front right passenger's seat back as the case vehicle decelerated (**Figure 20** above). The back right passenger's knees penetrated the seat back, and her chest most likely impacted the top of the seat back just below the adjustable headrest. As the front of the case vehicle decelerated from impacting the embankment and culvert, the case vehicle's back end lifted vertically and the case vehicle began to roll end-over-end (i.e., about the lateral axis). Because the embankment/culvert impact was primarily to the case vehicle's front right, the case vehicle also began to rotate clockwise (i.e., about the vertical axis). As the back of the case vehicle lifted upwards, this occupant slid upwards, head first into the roof. As previously mentioned, the case vehicle traveled 16.5 meters (54.1 feet) in the air, flipping and

rotating, prior to impacting the 2nd culvert's embankment while landing upside down with the vehicle's back left bumper corner leading. Between the 1st and 2nd culverts the case vehicle rotated approximately 180 degrees about the lateral axis but only approximately 30-45 degrees about the vertical axis, while in the air, prior to impacting the 2nd culvert's embankment. This back impact resulted in the back right passenger moving backwards along the roof toward the back center of the vehicle and most likely impacting the intruding roof with her head. The case vehicle continued to roll over primarily about its longitudinal axis. As the case vehicle was rolling over, the back right passenger's exact movement of within the case vehicle is unknown. However, according to a witness, this occupant was ejected through an unidentified side window, most likely the right rear. This scenario is consistent because this occupant's final rest position was north of where the case vehicle came to rest and on a perpendicular to the case vehicle's eastward heading. At final rest the back right passenger was found lying in the fourth driveway north of the four-leg intersection.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger was transported by ambulance to the hospital. She sustained critical injuries and was pronounced dead approximately 10½ hours post-crash. The brain injuries sustained by the case vehicle's back right passenger included: a critical nonanatomic brain injury, severe cerebral edema, brain stem compression, subdural hematoma, and subarachnoid hemorrhage over both cerebral and cerebellar hemispheres. Furthermore, she had a complex basilar skull fracture and fractures to her left maxilla, left orbit, and bilateral, anterior, proximal rib fractures. Her lungs were contused and lacerated bilaterally, and she had contusions involving all four chambers of her heart, her liver, and the serosal surface of her small and large bowels, mesentery, and omentum. In addition, she had a complex laceration of her spleen and lacerations to the lower portion of her left upper extremity. There were contusions to her left cheek, bilateral eyes, right and left upper extremities, and bilateral ankles. Finally, she sustained abrasions to her head, forehead, right cheek, upper lip, right eye, right chest and abdominal walls, right back, and bilateral upper and lower extremities.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Compression {transtentorial (uncal) herniation} of brain stem	140202.5 critical	Ground	Probable	Autopsy

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
2	Edema, severe, cerebral with 4+ uncal notching and loss of gray-white matter junction, including increased intracranial pressure and the establishment of a ventriculostomy[5] [Aspect = Unknown]	140666.5 critical	Ground	Probable	Autopsy
3	Nonantomic brain injury with loss of consciousness, eyes dilated and non-reactive, unresponsive to painful stimuli, and decorticate posturing	160824.5 critical	Ground	Probable	Hospitalization records
4	Hemorrhage, subdural, small (i.e., only 20 cc residual), right	140652.4 severe	Ground	Probable	Autopsy
5 6	Hemorrhage, subarachnoid, over both cerebral convexities [Aspects = Left and Right]	140684.3 140684.3 severe	Ground	Probable	Autopsy
7	Hemorrhage, subarachnoid, over both cerebellar convexities [Aspect = Posterior]	140466.3 serious	Ground	Probable	Autopsy
8	Fracture, complex, basilar skull involving the right and left middle cranial fossa and the right orbital plate (i.e., right anterior cranial fossa)	150206.4 severe	Ground	Probable	Autopsy
9	Fracture left maxilla, not further specified	250800.2 moderate	Ground	Probable	Autopsy
10	Fracture, blowout[6], left orbit (i.e., inferior left periocular structure)	251204.3 moderate	Ground	Probable	Autopsy
11	Fractured ribs anteriorly on both left and right sides; ribs not explicitly[7] specified	450220.2 moderate	Seat back, front right passenger's	Probable	Autopsy

[5] The following term is defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
ventriculostomy (ven-trik"u-los'te-me): the operation of establishing a free communication or shunt between the floor of the third ventricle and the underlying cisterna interpeduncularis; for the treatment of hydrocephalus.

[6] This adjective (i.e., "blowout") was ascribed to this lesion during this occupant's initial hospitalization and not during the autopsy.

[7] Based upon the autopsy sketch it appears that at most two ribs on each side were fractured. The fractured ribs were the left 1st and 2nd and the right 1st and 2nd.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Laceration, #1 cm (#0.4 in) lungs, bilaterally with bilateral hemothoraces and left pneumothorax	441450.4 severe	Seat back, front right passenger's	Probable	Autopsy
13	Contusion lungs bilaterally [i.e., #10 cm (#3.9 in) right lung; #12 cm (4.7 in) left lung]	441410.4 severe	Seat back, front right passenger's	Probable	Autopsy
14	Contusions, #10 cm (#3.9 in), heart involving all four chambers, not further specified	441002.1 minor	Seat back, front right passenger's	Probable	Autopsy
15	Contusion, #10 cm (3.9 in) involving capsular surface of liver	541812.2 moderate	Seat back, front right passenger's	Probable	Autopsy
16	Laceration {rupture} spleen, complex, with hilar disruption, including 4 liters of total estimated blood loss and hemorrhagic shock	544228.5 critical	Seat back, front right passenger's	Possible	Hospitalization records
17	Contusion serosal surface large bowel (i.e., colon)	540810.2 moderate	Seat back, front right passenger's	Probable	Autopsy
18	Contusion serosal surface small bowel (i.e., jejunum-ileum)	541410.2	Seat back, front right passenger's	Probable	Autopsy
19	Contusion serosal surface mesentery	542010.2 moderate	Seat back, front right passenger's	Probable	Autopsy
20	Contusion serosal surface omentum	542210.2 moderate	Seat back, front right passenger's	Probable	Autopsy
21	Abrasions head: #2 cm (#0.8 in) left temple and from right eye	190202.1 minor	Ground	Probable	Autopsy
22	posteriorly along right side of head[8], #11 cm (#4.3 in)	190202.1 minor	Ground	Probable	
23	Abrasions, #1 cm (#0.4 in) forehead	290202.1 minor	Ground	Probable	Autopsy
24	Abrasion, 2 cm (0.8 in) anterior right cheek	290202.1 minor	Ground	Probable	Autopsy
25	Abrasion upper lip	290202.1 minor	Ground	Probable	Autopsy
26	Abrasions, periorbital {circumferentially}, about right eye	297202.1 minor	Ground	Probable	Autopsy

[8] This abrasion was described on this occupant's initial medical records as an avulsion.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
27	Contusion, 14 cm (5.5 in) left cheek	290402.1 minor	Ground	Probable	Autopsy
28	Contusion {hematoma}, periorbital {periocular} left eye	297402.1 minor	Ground	Probable	Autopsy
29	Contusion {ecchymosis} right eye (i.e., periorbital)	297402.1 minor	Ground	Probable	Emergency room records
30 31	Abrasions over chest and abdominal walls, predominantly right side, #22 cm (#8.7 in)	490202.1 minor 590202.1 minor	Ground	Probable Probable	Autopsy
32	Abrasions, #9 cm (#3.5 in) superior lateral right back	690402.1 minor	Ground	Probable	Autopsy
33	Abrasions right arm including: shoulder, elbow, dorsal wrist, #4 cm (#1.6 in), and 3rd and 4th digits	790202.1 minor	Ground	Probable	Autopsy
34	Contusions right arm including: anterior shoulder, #16 cm (#6.3 in), extending to upper arm; elbow; and dorsal wrist, #9 cm (#3.5 in)	790402.1 minor	Ground	Probable	Autopsy
35	Abrasion, #5 cm (#2.0 in) distal left posterior forearm and/or elbow	790202.1 minor	Ground	Probable	Autopsy
36	Abrasion left hand[9], not further specified	790202.1 minor	Ground	Probable	Emergency room records
37	Contusions left arm including: posterior upper arm, #14 cm (#5.5 in); elbow; proximal forearm; and left hand, #14 cm (#5.5 in) and wrist	790402.1 minor	Ground	Probable	Autopsy
38	Lacerations left arm including: #2 cm (#0.8 in) left elbow, dorsal left hand, and 3rd and 4th digits	790602.1 minor	Ground	Probable	Autopsy

[9] This lesion is most likely one and the same as the lacerations described during the autopsy.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
39	Abrasions right leg including: both anterior and posterior thigh; anterior knee and shin, #16 cm (#6.3 in); posterior calf, #14 cm (#5.5 in), extending to posterior ankle, and in step right foot	890202.1 minor	Ground	Probable	Autopsy
40	Contusion, #12 cm (#4.7 in) posterior right ankle	890402.1 minor	Ground	Probable	Autopsy
41	Abrasions left leg including: knee and proximal left shin, #11 cm (#4.3 in) and distal calf, 2 cm (0.8 in)	890202.1 minor	Ground	Probable	Autopsy
42	Abrasion left ankle, not further specified	890202.1 minor	Ground	Probable	Emergency room records
43	Contusions, #16 cm (#6.3 in), left ankle–anteriorly, posteriorly, laterally, and medially, and in step left foot	890402.1 minor	Ground	Probable	Autopsy

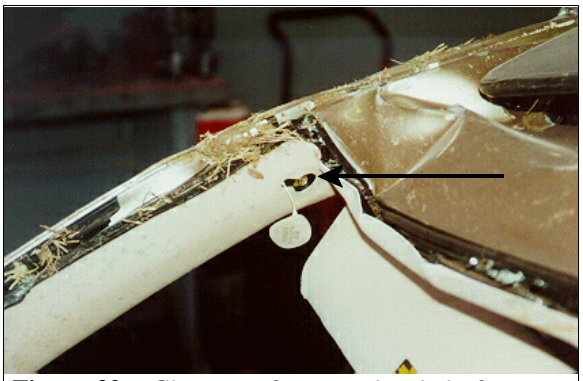


Figure 32: Close-up of open tether hole for case vehicle's, non-deployed, right side inflatable curtain, which was located in right "A"-pillar (case photo #53)

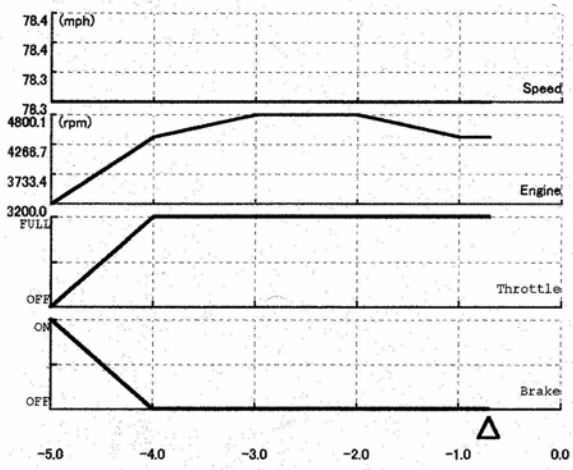
Figure 34: Case vehicle's exposed, non-deployed, right side inflatable curtain which was stored between right side rail and roof (case photo #54)

Figure 33: Close-up of exposed exhaust cannister stored in base of right "A"-pillar for case vehicle's non-deployed, right side inflatable curtain (case photo #52)

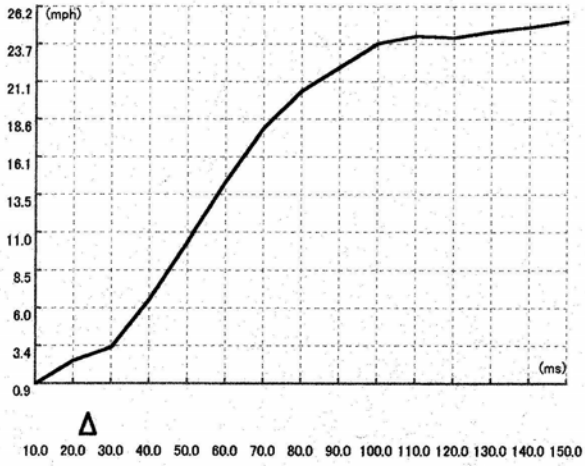
Investigation Date	
Investigator	
Accident Date	
Vehicle	GS300
Model Year	2001
VIN Number	JT8BD69S510
ECU Maker	TOYOTA
ECU No	

Memory Bank	0
Belt Switch Status	D: Belted P: UnBelted
Diagnostic	Not Detected
Lamp On Term	0minutes
Ignition Cycles	0
Shift Position	Other
Deployment Time	24ms
Time From Last PreCrash Data	300ms
Time From Previous Event	400ms

PRE-CRASH DATA



POST-CRASH DATA



Secs.	Speed	Engine	Throttle	Brake
-5	78.3	3200.0	OFF	ON
-4	78.3	4400.0	FULL	OFF
-3	78.3	4800.0	FULL	OFF
-2	78.3	4800.0	FULL	OFF
-1	78.3	4400.0	FULL	OFF
-0.700	78.3	4400.0	FULL	OFF

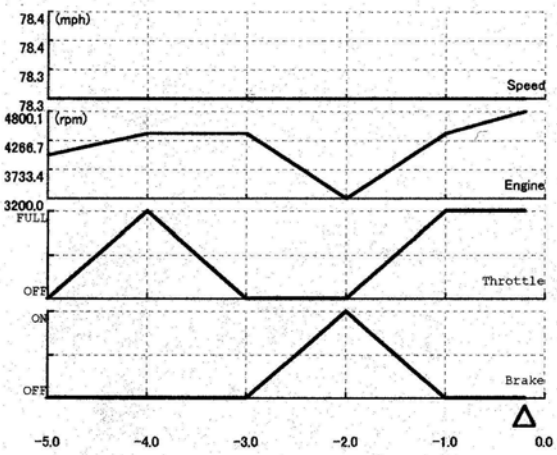
ms	Vel chg	ms	Vel chg	ms	Vel chg
10.0	0.9	60.0	14.4	110.0	24.2
20.0	2.4	70.0	18.0	120.0	24.1
30.0	3.3	80.0	20.5	130.0	24.5
40.0	6.5	90.0	22.1	140.0	24.8
50.0	10.4	100.0	23.7	150.0	25.2

Figure 35: Case vehicle's deployment event showing pre-crash speed, brake switch status, and restraint system status at deployment, and the case vehicle's change in velocity (Delta V) over the first 150 milliseconds post deployment

Investigation Date	
Investigator	
Accident Date	
Vehicle	GS300
Model Year	2001
VIN Number	JT8BD69S510
ECU Maker	TOYOTA
ECU No	

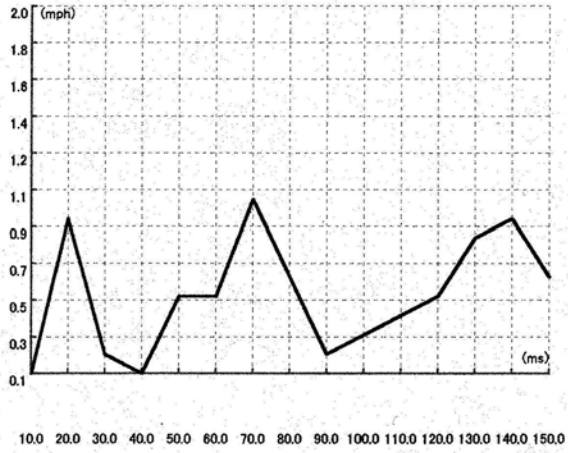
Memory Bank	1
Belt Switch Status	D: P:
Diagnostic	
Lamp On Term	
Ignition Cycles	
Shift Position	Other
Deployment Time	
Time From Last PreCrash Data	800ms
Time From Previous Event	5000ms

PRE-CRASH DATA



Secs.	Speed	Engine	Throttle	Brake
-5	78.3	4000.0	OFF	OFF
-4	78.3	4400.0	FULL	OFF
-3	78.3	4400.0	OFF	OFF
-2	78.3	3200.0	OFF	ON
-1	78.3	4400.0	FULL	OFF
-0.200	78.3	4800.0	FULL	OFF

POST-CRASH DATA



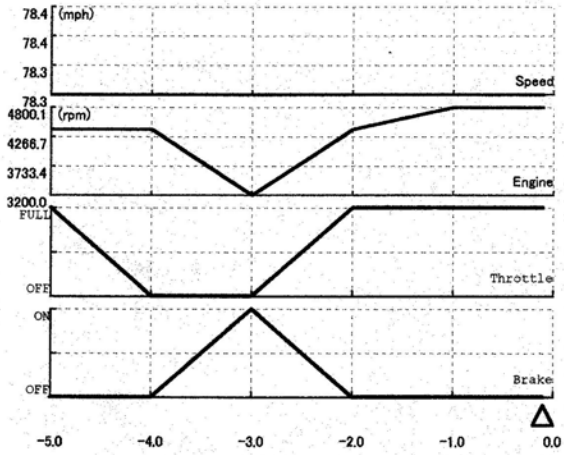
ms	Vel chg	ms	Vel chg	ms	Vel chg
10.0	0.1	60.0	0.5	110.0	0.4
20.0	0.9	70.0	1.0	120.0	0.5
30.0	0.2	80.0	0.6	130.0	0.8
40.0	0.1	90.0	0.2	140.0	0.9
50.0	0.5	100.0	0.3	150.0	0.6

Figure 36: Case vehicle's near deployment event that had the highest change in velocity (Delta V). Shown are the pre-crash speed, brake switch status, and the case vehicle's change in velocity (Delta V) over the first 150 milliseconds of the event; this event corresponds to the case vehicle's impact with the curb

Investigation Date	
Investigator	
Accident Date	
Vehicle	GS300
Model Year	2001
VIN Number	JT8BD69S510
ECU Maker	TOYOTA
ECU No	

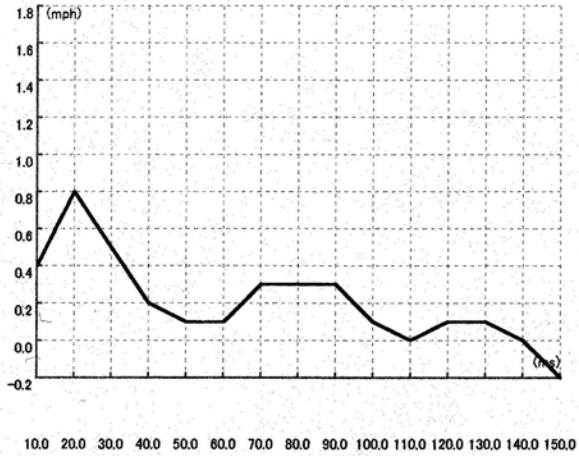
Memory Bank	2
Belt Switch Status	D: P:
Diagnostic	
Lamp On Term	
Ignition Cycles	
Shift Position	Other
Deployment Time	
Time From Last PreCrash Data	900ms
Time From Previous Event	160ms

PRE-CRASH DATA



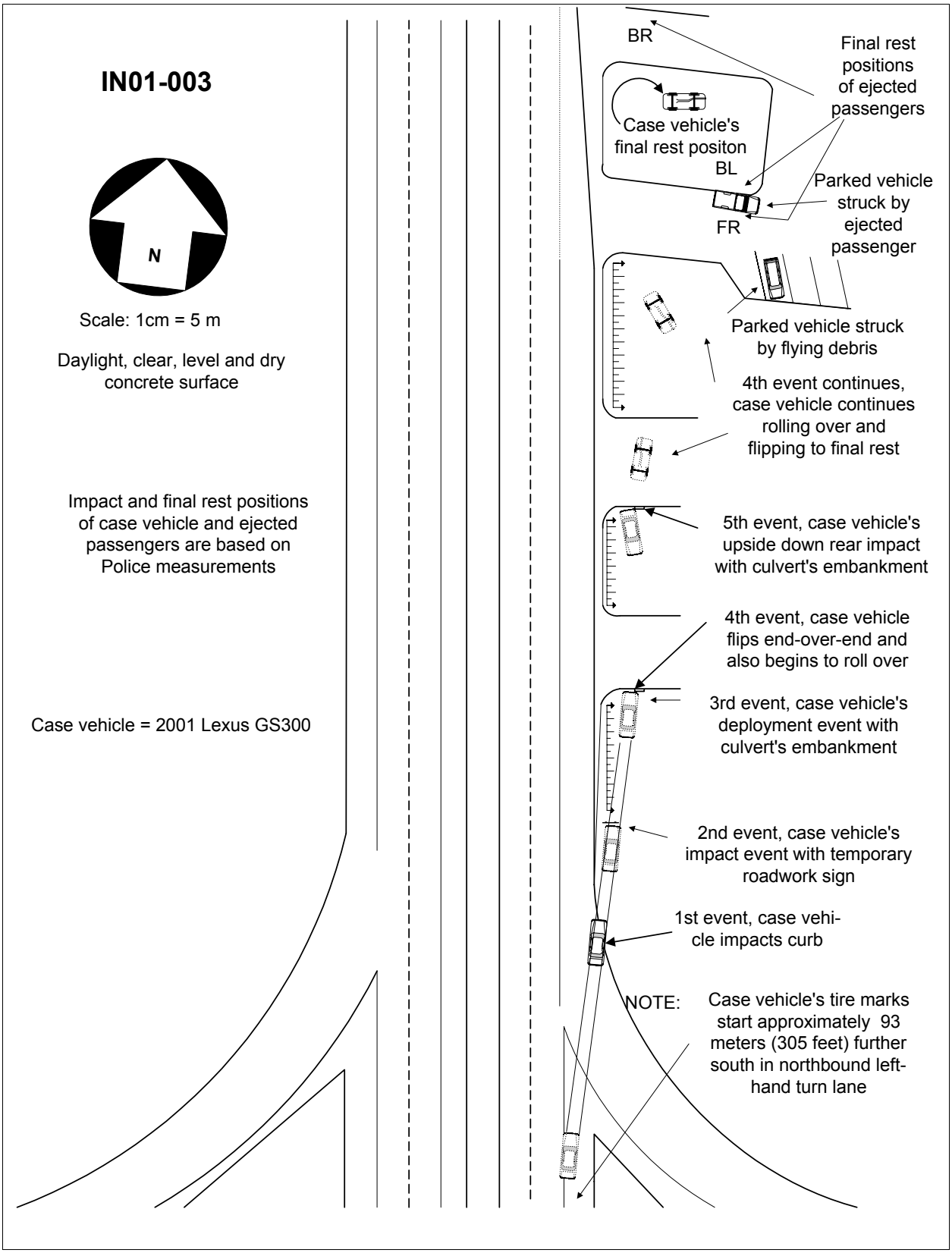
Secs	Speed	Engine	Throttle	Brake
-5	78.3	4400.0	FULL	OFF
-4	78.3	4400.0	OFF	OFF
-3	78.3	3200.0	OFF	ON
-2	78.3	4400.0	FULL	OFF
-1	78.3	4800.0	FULL	OFF
-0.100	78.3	4800.0	FULL	OFF

POST-CRASH DATA



ms	Vel chg	ms	Vel chg	ms	Vel chg
10.0	0.4	60.0	0.1	110.0	0.0
20.0	0.8	70.0	0.3	120.0	0.1
30.0	0.5	80.0	0.3	130.0	0.1
40.0	0.2	90.0	0.3	140.0	0.0
50.0	0.1	100.0	0.1	150.0	-0.2

Figure 37: Case vehicle's near deployment event that occurred immediately prior to the on-set of the deployment event. Shown are pre-crash speed, brake switch status, and the case vehicle's change in velocity (Delta V) over the first 150 milliseconds of the event; this event corresponds to the case vehicle's impact with the temporary warning sign


IN01-003
N
Scale: 1cm = 5 m
Daylight, clear, level and dry concrete surface
Impact and final rest positions of case vehicle and ejected passengers are based on Police measurements
Case vehicle = 2001 Lexus GS300
BR
Final rest positions of ejected passengers
Case vehicle's final rest positon
BL
Parked vehicle struck by ejected passenger
FR
Parked vehicle struck by flying debris
4th event continues, case vehicle continues rolling over and flipping to final rest
5th event, case vehicle's upside down rear impact with culvert's embankment
4th event, case vehicle flips end-over-end and also begins to roll over
3rd event, case vehicle's deployment event with culvert's embankment
2nd event, case vehicle's impact event with temporary roadwork sign
1st event, case vehicle impacts curb
NOTE:
Case vehicle's tire marks start approximately 93 meters (305 feet) further south in northbound left-hand turn lane