INDIANA UNIVERSITY
TRANSPORTATION RESEARCH CENTER
School of Public and Environmental Affairs
222 West Second Street
Bloomington, Indiana 47403-1501
(812) 855-3908 Fax: (812) 855-3537

ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN01-018
LOCATION - NEBRASKA
VEHICLE - 1997 OLDSMOBILE SILHOUETTE
CRASH DATE - June, 2001

Submitted:

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Contract Number: DTNH22-94-D-17058

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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 child safety seat investigation involving a 1997 Oldsmobile Silhouette, three-door minivan, with manual safety belts and dual front air bags, and a 1990 Buick Regal Custom, two-door coupe

16. *Abstract*

This report covers an on-site child safety seat investigation of a crash that involved a 1997 Oldsmobile Silhouette (case vehicle) and a 1990 Buick Regal Custom (other vehicle). This crash is of special interest because the case vehicle's second seat left, infant passenger (1-year-old male), was restrained in a convertible child safety seat and did not sustain any injuries during the crash (i.e., side impact and subsequent rollover). The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street. The Buick was traveling north in the northbound through lane of a three-lane, undivided, city street (i.e., there was one through lane in both the north and southbound directions and one opposing left-hand turn lane). The crash occurred in the four-leg intersection of the two roadways. The right side of the case vehicle was impacted by the front of the Buick. As a result, the case vehicle rotated approximately 45 degrees clockwise while its center of gravity traveled in an east-northeasterly direction. Centrifugal forces caused the case vehicle to roll over two quarter turns toward the driver's side. The case vehicle slid on its right roof rail and on its upper right side prior to turning another quarter turn onto its right side where it slid before flipping another quarter turn back onto all four wheels. As the case vehicle was rolling over, it also continued to rotate clockwise as it traversed the grassy roadside. The case vehicle's supplemental restraints (air bags) did not deploy as a result of the either the right side impact or the subsequent rollover event. The case vehicle's second seat left passenger was seated in a convertible child safety seat, that was used in its forward facing configuration, on a seat for which the seat track was not adjustable. He was restrained in the child seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system. According to the interview with the case vehicle's driver, the second seat left passenger did not sustain any injuries as a result of this crash. The case vehicle's driver (25-year-old male) was seated with his seat track located between its middle and rearmost positions, and the tilt steering wheel was located in its down-most position. He was not using his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his interview only minor glass lacerations to both forearms. The second seat center passenger (5-year-old female) and the back left passenger (3-year-old male) were both seated and were not using their available, active, three-point, lap-and-shoulder, safety belt systems. Both were ejected from the vehicle during the rollover event and sustained, according to their father (i.e., driver), minor injuries which included: a laceration to her upper lip and a dislocated tooth–for the second seat center occupant, and a contusion to his forehead and a small laceration to his chin–for the back left occupant.

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on June 25, 2001 by a NHTSA Regional office. This crash involved a 1997 Oldsmobile Silhouette (case vehicle) and a 1990 Buick Regal Custom (other vehicle). The crash occurred in June, 2001, at 3:08 p.m., in Nebraska and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's second seat left, infant passenger [1-year-old, White (Hispanic) male], was restrained in a convertible child safety seat and did not sustain any injuries during the crash (i.e., side impact and subsequent rollover). This contractor inspected the scene and vehicles on 27-28 June, 2001. This contractor interviewed the driver for the case vehicle on June 27, 2001. Although the driver provided injury information, this contractor was not allowed access to occupant medical records. This report is based on the Police Crash Report, interviews with the case vehicle's driver and the investigating police officer, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street and was approaching a partially controlled four-leg intersection, intending to continue traveling eastbound (i.e., only the east and west legs of the intersection were controlled by regulatory STOP signs). The Buick was traveling north in the northbound through lane of a three-lane, undivided, city street and was approaching the same partially controlled intersection, intending to continue traveling northbound (i.e., there was one through lane in both the north and southbound directions and one opposing left-hand turn lane on both the north and south legs of the intersection). Upon entering the intersection, the case vehicle's driver observed the Buick and accelerated, in an attempt to avoid the crash. The crash occurred in the four-leg intersection of the two roadways; see **CRASH DIAGRAM** below.

The right side of the case vehicle, from approximately the "B"-pillar back, was impacted by the front of the Buick. The right side impact knocked off the case vehicle's right rear wheel and disintegrated the glazing from the two rearmost windows. As a result, the case vehicle rotated approximately 45 degrees clockwise and was heading southeast, while its center of gravity traveled in an east-northeasterly direction. The case vehicle traveled an additional 25.1 meters (82.5 feet) prior to centrifugal forces causing the case vehicle to roll over two quarter turns toward the driver's side. The rollover occurred just prior to departing the north edge of the east-west roadway. The case vehicle slid, first, on its left roof rail and, second, on its upper right side for approximately 10 meters (32.8 feet) prior to turning another quarter turn onto its right side, for less than 1 meter (3.3 feet), prior to flipping another quarter turn back onto all four wheels. As the case vehicle was rolling over, it also continued to rotate clockwise as it traversed the grassy roadside. The case vehicle's supplemental restraints (air bags) did not deploy as a result of the either the right side impact or the subsequent rollover event.

During the rollover sequence the second seat center and third seat left passengers were ejected, presumably through the disintegrated right side glazing, and ended up on the grass–one north and one south (i.e., but unknown which) of the large tree, on the north roadside of the east-west roadway. The case vehicle came to rest on all-four wheels heading south-southwestward.

As a result of the initial impact, the Buick rotated clockwise approximately 190 degrees clockwise after impacting the case vehicle and came to rest off the northeast corner of the intersection heading south-southwestward.

The 1997 Oldsmobile Silhouette was a front wheel drive, three-door minivan (VIN: 1GHDX06E8VD------). The case vehicle was equipped with four-wheel, anti-lock brakes. Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **02-RZEW-2 (50)** and **00-TDDO-3**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity (i.e., 1st event) impact with the Buick. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.8 km.p.h. (9.2 m.p.h.), -9.5 km.p.h. (-5.9 m.p.h.), and -11.3 km.p.h. (-7.0 m.p.h.). The case vehicle was towed due to damage.

The case vehicle's contact with the Buick involved the back two-thirds of the right side with the direct and induced damage beginning just forward of the right "B"-pillar. Direct damage began 148 centimeters (58.3 inches) rearward from the right front axle and extended rearward, a measured distance of 203 centimeters (79.9 inches). Residual maximum crush was measured as 15 centimeters (5.9 inches) at C_5. The wheelbase on the case vehicle's left side was shortened 1 centimeter (0.4 inches) while the right side was extended 2 centimeters (0.8 inches). The case vehicle's right front and rear doors and right quarter panel were directly damaged and crushed inward from the initial impact. In addition, the case vehicle's right rear tire was torn off and deflated during the impact with the Buick.

The rollover event (2nd event) caused direct damage to the right half of the roof and the entire right side. Furthermore, there was direct damage laterally across the roof at the windshield header and laterally across the front of the hood. The case vehicle's left side remained unscathed from the rollover event. Maximum crush from the rollover was measured as 30 centimeters (11.8 inches) vertically near the right roof rail. The case vehicle's hood, right roof, windshield header area, and entire right side were directly damaged and crushed downward and/or inward during the rollover. Furthermore, the case vehicle's left rear tire was rotated inward at the bottom from the rollover event. The crash resulted in induced damage to the hood, grille, right front door, right fender, and right headlight and turn signal assemblies. As mention above, the glazing in the case vehicle's back two right windows was disintegrated during the initial impact with the Buick while the rollover event disintegrated the right front window glazing and caused the windshield's glazing to be "holed".

The case vehicle's driver air bag was located in the steering wheel hub. The front right passenger's air bag was located in the top of the instrument panel. The case vehicle's air bags did not deploy; therefore, the existence, number, and size of tethers and/or vent ports could not be assessed nor could the size of the driver's and front right passenger's air bags be described, respectively.

The child safety seat used by the case vehicle's second seat left passenger was a convertible child safety seat manufactured by Century on July 21, 2000, and the seat was identified by Model name Century 3000 STE convertible. The seat was equipped with a tray shield and three different height levels that the harness could be adjusted through (i.e., dependent on height and size of

child). It should be noted that the harness straps were located in the bottom slots. According to the manufacturer's recommendations, the harness should be located in the top slot when used in the forward facing position. In addition, the seat was designed with two different slots for the buckle. The buckle was located on the seating portion between the child's legs. The convertible child safety seat was equipped with an optional tether, which was not connected and hanging off the back of the plastic shell. The convertible child safety seat showed very little wear and tear to the padding or shell. There was only one visible area of stress evident on the plastic shell of the child seat. This evident area of stress was on the bottom portion of the child seat, which would have been positioned on the seat cushion.

Inspection of the case vehicle's interior revealed minimal evidence of occupant contact on the interior surfaces. Contact evidence was found on the driver's knee bolster, just to the right of the steering column and on the sun visor. Furthermore, there were some blood smears on the roof, approximately over the right second seat area. In addition, there was a scuff on the interior surface of the right side panel. There was vertical intrusion to the front seating area and along right side. The windshield header intruded into the front seating areas, and the right "A", "B", and "C"-pillars as well as the right side roof rail and the right roof intruded vertically into the right side occupant spaces. Lateral intrusion also occurred to the right rear sliding door and the right rear side panel. Finally, there was no evidence of compression to the energy absorbing sheer capsules in the steering column, and no deformation to the steering wheel rim.

The 1990 Buick Regal Custom Gran Sport was a front wheel drive, two-door coupe (VIN: 2G4WB14L3L1------). Based on the vehicle inspection, the CDC for the Buick was determined to be: **91-FDEW-2 (320)** [maximum crush was 31 centimeters (12.2 inches)] The Buick's front was shifted to the right greater than 12.7 centimeters (5 inches) resulting in an increment of 80 to the Direction of Principal Force (i.e., 11+80=91). The WinSMASH reconstruction program, damage only algorithm, was used on the Buick's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 18.1 km.p.h. (11.2 m.p.h.), -13.8 km.p.h. (-8.6 m.p.h.), and +11.6 km.p.h. (+7.2 m.p.h.). The Buick was towed due to damage.

Immediately prior to the crash the case vehicle's second seat left passenger [81 centimeters and 11 kilograms (32 inches, 24 pounds)] was seated in an upright posture in a convertible child safety seat, that was used in its forward facing configuration, with his back against the safety seat's back and his feet dangling over the front edge of the seat's cushion. In addition, the exact position of his hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's second seat left passenger (i.e., son) was restrained in a child seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, the inspection of the second seat left passenger's seat belt webbing, "D"-ring, and latch plate showed evidence of loading.

The case vehicle's driver accelerated, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the combined use of his child safety seat's restraints and the available safety belts, the second seat left passenger most likely moved slightly rearward just prior to impact. The case vehicle's impact with the Buick enabled the case vehicle's

second seat left passenger to move slightly forward and to the right toward the case vehicle's **50** degree Direction of Principal Force as the case vehicle decelerated. Because of the uncertainty of the case vehicle's dynamics during the rollover event this passenger's exact kinematics are unknown; however, this passenger was almost certainly thrown to the left, right, forward, backward, and upward, yet remained essentially near his pre-crash position because of the use of his available restraint systems. At final rest the second seat left passenger remained in his child safety seat.

The second seat left occupant was transported by ambulance to the hospital for precautionary measures only. He was examined and released. According to the interview with the case vehicle's driver, the second seat left passenger did not sustain any injuries as a result of this crash.

The case vehicle's driver [25-year-old, White (Hispanic) male; 180 centimeters and 105 kilograms (71 inches, 232 pounds)] was seated primarily in an upright posture but leaning slightly to the right with his back against the seat back, his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel at the 12 and 6 o'clock position. His seat track was located between its middle and rearmost positions, the seat back was sightly reclined, and the tilt steering wheel was located in its down-most position.

The case vehicle's driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. The driver was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his interview, the case vehicle's driver sustained only glass lacerations to both forearms.

According to the case vehicle's driver, the second seat center passenger [5-year-old, White (Hispanic) female; 104 centimeters and 18 kilograms (41 inches, 40 pounds)] was seated in an upright posture with her back against the seat back and her feet dangling over the front edge of the seat's cushion. In addition, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's second seat center passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. As a result, she was ejected from the vehicle during the rollover event, most likely through the disintegrated right side glazing.

She was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the father (i.e., driver), the injuries sustained by the case vehicle's second seat center passenger included a laceration to her upper lip and a dislocated tooth.

According to the case vehicle's driver, the back left passenger [3-year-old, White (Hispanic) male; 94 centimeters and 18 kilograms (37 inches, 39 pounds)] was seated in an upright posture with his back against the seat back and his feet on the seat's cushion. In addition, the exact position of his hands is unknown. His seat track was located in its middle position, and the seat back was upright.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. As a result, he was also ejected from the vehicle during the rollover event, again, most likely through the disintegrated right side glazing.

The back left passenger was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his father (i.e., driver), the injuries sustained by the case vehicle's third seat left passenger included a contusion to his forehead and a small laceration to his chin.

CRASH CIRCUMSTANCES

Figure 1: Case vehicle's eastward travel path into four-leg intersection (case photo #01)

Figure 2: Buick's northward travel path in north-bound through lane; Note: pre-crash skid marks from all four wheels (case photo #09)

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided, city street (**Figure 1**) and was approaching a partially controlled four-leg intersection, intending to continue traveling eastbound (i.e., only the east and west legs of the intersection were controlled by regulatory STOP signs). The Buick was traveling north in the northbound through lane of a three-lane, undivided, city street (**Figure 2**) and was approaching the same partially controlled intersection, intending to continue traveling northbound (i.e., there was one through lane in both the north and southbound directions and one opposing left-hand turn lane on both the north and south legs of the intersection). Upon entering the intersection, the case vehicle's driver observed the Buick and accelerated, in an attempt to avoid the crash. The Buick's driver braked, attempting to avoid the crash (**Figure 2**). The Buick deposited 11.0 meters (36.2 feet) of left side skid marks and 14.9 meters (49.0 feet) of right side skid marks. The crash occurred in the four-leg intersection of the two roadways; see **CRASH DIAGRAM** below.

The case vehicle's city roadway was straight and level (i.e., actual slope was 0.3%, positive to the east) at the area of impact. The roadway was also straight and level (i.e., actual slope was 0.8% negative to the east) between the case vehicle's initial impact and the approximate location where the rollover event was initiated. The pavement was bituminous, but traveled, and the width of the roadway was 8.75 meters (28.7 feet). The shoulders were not improved (i.e., gravel). Pavement markings on the west leg of the intersection consisted of a single broken yellow centerline for both east and westbound traffic, augmented by a single solid yellow "no passing" line for eastbound traffic, and no edge lines were present. The estimated coefficient of friction was 0.70. Traffic controls consisted of a regulatory STOP sign (Manual on Uniform Traffic

Control Devices, R1-1). The signs were located on both the east and west legs of the intersection. The posted speed limit was 56 km.p.h. (35 m.p.h.).

The Buick's city roadway was straight and level (i.e., actual slope was 0.4%, positive to the north) at the area of impact. The pavement was bituminous, but traveled, and the width of the roadway was 11.2 meters (36.7 feet). The shoulders were not improved (i.e., gravel). Pavement markings on the south leg of the intersection consisted of a double solid yellow centerline for both north and southbound traffic, and the northbound through lane was separated from the left-hand turn lane by a solid white lane line. In addition, no edge lines were present. The estimated coefficient of friction was 0.70. There were no visible traffic controls for the north and south legs of the intersection. The posted speed limit was 72 km.p.h. (45 m.p.h.).

At the time of the crash the light condition was daylight, the atmospheric condition was overcast, and the road pavement was dry. There was no other traffic present, and the site of the crash was urban industrial.

Figure 3: Case vehicle viewed from front right showing rollover and right side impact damage; Note: holed windshield (case photo #29)

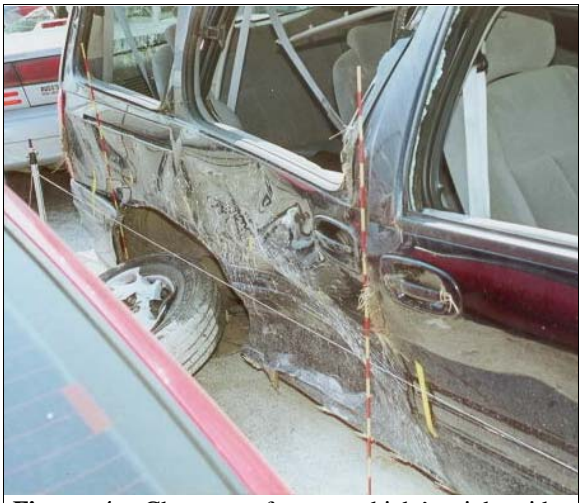


Figure 4 Close-up of case vehicle's right side damage from impact with Buick; Note: broken off right rear tire on ground (case photo #27)

Figure 5: Frontal damage to Buick from impacting case vehicle's right side (case photo #57)

Figure 6: On-scene east-northeasterly view showing case vehicle's tire marks leading to rollover and final rest positions (case photo #66)

The right side (**Figures 3** and **4**) of the case vehicle, from approximately the "B"-pillar back, was impacted by the front of the Buick (**Figure 5**).

The right side impact knocked off the case vehicle's right rear wheel and disintegrated the glazing from the two rearmost windows (**Figure 4** above). As a result, the case vehicle rotated approximately 45 degrees clockwise and was heading southeast, while its center of gravity traveled in an east-northeasterly direction (**Figure 6** above). The case vehicle traveled an additional 25.1 meters (82.5 feet) prior to centrifugal forces causing the case vehicle to roll over two quarter turns toward the driver's side. The rollover occurred just prior to departing the north edge of the east-west roadway (**Figure 7**). The case vehicle slid, first, on its right roof rail and, second, on its upper right side for approximately 10 meters (32.8 feet) prior to turning another quarter turn onto its right side, for less than 1 meter (3.3 feet), prior to flipping another quarter turn back onto all four wheels. As the case vehicle was rolling over, it also continued to rotate clockwise as it traversed the grassy roadside. The case vehicle's supplemental restraints (air bags) did not deploy as a result of the either the right side impact or the subsequent rollover event.

Figure 7: On-scene east-northeasterly view showing case vehicle at final rest; Note: gouges in grass from roll over (case photo #67)

Figure 8: On-scene northeasterly view of case vehicle at final rest (case photo #68)

Figure 9: On-scene north-northeasterly view of Buick's pre-impact skid marks and Buick's final rest position on northeast corner (case photo #65)

During the rollover sequence the second seat center and third seat left passengers were ejected, presumably through the disintegrated right side glazing, and ended up on the grass–one north and one south (i.e., but unknown which) of the large tree, on the north roadside of the east-west roadway. The case vehicle came to rest on all-four wheels heading south-southwestward (**Figure 8**). As a result of the initial impact, the Buick rotated clockwise approximately 190

degrees clockwise after impacting the case vehicle and came to rest off the northeast corner of the intersection heading south-southwestward (**Figure 9** above).

CASE VEHICLE

The 1997 Oldsmobile Silhouette was a front wheel drive, seven-passenger, three-door, extended minivan (VIN: 1GHDX06E8VD------) equipped with a 3.4L, V-6 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 305 centimeters (120.0 inches), and the odometer reading at inspection was 111,817 kilometers (69,480miles).

Inspection of the vehicle's interior revealed adjustable front bucket seats with adjustable head restraints; a non-adjustable second bench seat with separate back cushions and integral head restraints for the second seat left and right seating positions; an adjustable back bench seat with separate back cushions and integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front, second seating, and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. The driver upper anchorage adjuster was located in the down-most position and the front right upper anchorage adjuster was located in the upmost position. The vehicle was equipped with knee bolsters for both the driver and front right passenger positions, neither of which were deformed. 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. Neither frontal air bag deployed as a result of either the case vehicle's right side impact with the Buick or the rollover event.

CASE VEHICLE DAMAGE

The case vehicle's contact with the Buick involved the back two-thirds of the right side with the direct and induced damage beginning just forward of the right "B"-pillar (**Figure 4** above). Direct damage began 148 centimeters (58.3 inches) rearward from the right front axle and extended rearward, a measured distance of 203 centimeters (79.9 inches). Residual maximum crush was measured as 15 centimeters (5.9 inches) at C_5. The wheelbase on the case vehicle's left side was shortened 1 centimeter (0.4 inches) while the right side was extended 2 centimeters (0.8 inches). The case vehicle's right front and rear doors and right quarter panel were directly damaged and crushed inward from the initial impact. In addition, the case vehicle's right rear tire was torn off and deflated during the impact with the Buick (**Figure 4** above).

The rollover event (2nd event) caused direct damage to the right half of the roof and the entire right side (**Figure 10** below). Furthermore, there was direct damage laterally across the roof at the windshield header and laterally across the front of the hood. The case vehicle's left side remained unscathed from the rollover event. Maximum crush from the rollover was measured as 30 centimeters (11.8 inches) vertically near the right roof rail. The case vehicle's hood, right roof, windshield header area, and entire right side were directly damaged and crushed downward and/or inward during the rollover. Furthermore, the case vehicle's left rear tire was

rotated inward at the bottom from the rollover event. The crash resulted in induced damage to the hood, grille, right front door, right fender, and right headlight and turn signal assemblies. As mention above, the glazing in the case vehicle's back two right windows was disintegrated during the initial impact with the Buick while the rollover event disintegrated the right front window glazing and caused the windshield's glazing to be "holed" (**Figure 8** above).

Figure 10: Overhead view of rollover damage to case vehicle's top and right side; Note: dis-integrated glazing on entire right side (case photo #25)

Inspection of the case vehicle's interior revealed minimal evidence of occupant contact on the interior surfaces. Contact evidence was found on the driver's knee bolster, just to the right of the steering column and on the sun visor (**Figure 11**). Furthermore, there were some blood smears on the roof, approximately over the right second seat area. In addition, there was a scuff on the interior surface of the right side panel. There was vertical intrusion to the front seating area and along right side. The windshield header intruded into the front seating areas–including damage to the front right seat's adjustable head restraint, and the right "A", "B", and "C"-pillars as well as the right side roof rail and the right roof intruded vertically into the right side occupant spaces. Lateral intrusion also occurred to the right rear sliding door and the right rear side panel. Finally, there was no evidence of compression to the energy absorbing sheer capsules in the steering column, and no deformation to the steering wheel rim.

Figure 11: Vertical view of case vehicle's front seating area showing non-deployment of air bags; Note: driver's contact (yellow tape) to sun visor (case photo #31)

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **02-RZEW-2 (50)** and **00-TDDO-3**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity (i.e., 1st event) impact with the Buick. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 14.8 km.p.h. (9.2 m.p.h.), -9.5 km.p.h. (-5.9 m.p.h.), and -11.3 km.p.h. (-7.0 m.p.h.). The case vehicle was towed due to damage.

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Neither frontal air bag deployed as a result of either the right side impact with the Buick or the rollover event. The case vehicle's driver air bag was located in the steering wheel hub. The front right passenger's air bag was located in the top of the instrument panel. Because the air bags did not deploy, the existence, number, and size of tethers and/or vent ports could not be assessed nor could the size of the driver's and front right passenger's air bags be described, respectively.

CHILD SAFETY SEAT

Figure 12: Convertible child safety seat used by case vehicle's second seat left passenger; Note: harness straps in bottom slots and should have been in top slots (case photo #61)

Figure 13: Back and bottom of case vehicle's convertible child safety seat used by second seat left passenger; Note: black tether strap (case photo #62)

The child safety seat used by the case vehicle's second seat left passenger was a convertible child safety seat manufactured by Century on July 21, 2000, and the seat was identified by Model name Century 3000 STE convertible (**Figure 12**). The seat was equipped with a tray shield and three different height levels that the harness could be adjusted through (i.e., dependent on height and size of child). It should be noted that the harness straps were located in the bottom slots (**Figure 12**). According to the manufacturer's recommendations, the harness should be located in the top slot when used in the forward facing position. In addition, the seat was designed with two different slots for the buckle. The buckle was located on the seating portion between the

child's legs. The convertible child safety seat was equipped with an optional tether, which was not connected and hanging to the back of the plastic shell (**Figure 13** above). The convertible child safety seat showed very little wear and tear to the padding or shell. There was only one visible area of stress evident on the plastic shell of the child seat. This evident area of stress was on the bottom portion of the child seat, which would have been positioned on the seat cushion (**Figure 14** and **Figure 15**).

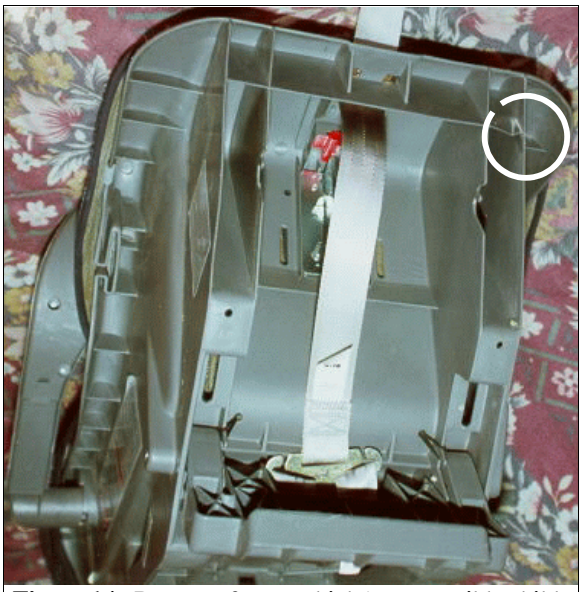


Figure 14: Bottom of case vehicle's convertible child safety seat used by second seat left passenger, highlighting stressed area (case photo #63)

Figure 15: Close-up of stress evidence to bottom of convertible child safety seat used by case vehicle's second seat left passenger (case photo #64)

Figure 16: Case vehicle's second seat where left and center passengers were sitting; Note: extended belt used to secure forward facing child safety seat (case photo #41)

CASE VEHICLE SECOND SEAT LEFT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's second seat left passenger [[1-year-old, White (Hispanic) male; 81 centimeters and 11 kilograms (32 inches, 24 pounds)] was seated in an upright posture in a convertible child safety seat, that was used in its forward facing configuration, with his back against the safety seat's back and his feet dangling over the front edge of the seat's cushion. In addition; the exact position of his hands is unknown. His seat track and seat back were not adjustable.

The case vehicle's second seat left passenger (i.e., son) was restrained in a child seat which was secured by the available, active, three-point, lap-and-shoulder, safety belt system (**Figure 14**). Furthermore, the inspection of the second seat left passenger's seat belt webbing, "D"-ring, and latch plate showed evidence of loading (**Figure 15** and **Figure 16** below).

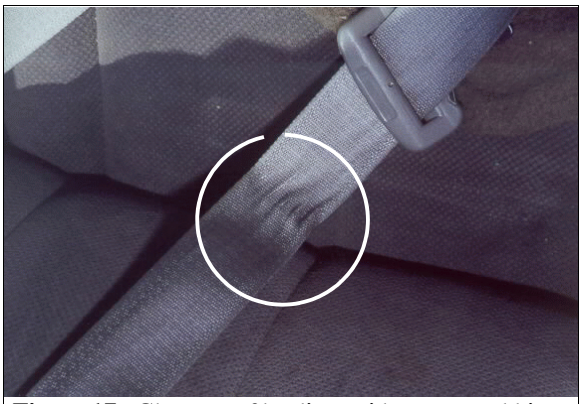


Figure 17: Close-up of loading evidence on webbing of case vehicle's second seat left passenger seat belt (case photo #45)

Figure 18: Close-up of "D"-ring for case vehicle's second seat left passenger showing friction rub and particles caused by loading (case photo #43)

The case vehicle's driver accelerated, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the combined use of his child safety seat's restraints and the available safety belts, the second seat left passenger most likely moved slightly rearward just prior to impact. The case vehicle's impact with the Buick enabled the case vehicle's second seat left passenger to move slightly forward and to the right toward the case vehicle's **50** degree Direction of Principal Force as the case vehicle decelerated. Because of the uncertainty of the case vehicle's dynamics during the rollover event this passenger's exact kinematics are unknown; however, this passenger was almost certainly thrown to the left, right, forward, backward, and upward, yet remained essentially near his pre-crash position because of the use of his available restraint systems. At final rest the second seat left passenger remained in his child safety seat.

CASE VEHICLE SECOND SEAT LEFT PASSENGER INJURIES

The second seat left occupant was transported by ambulance to the hospital for precautionary measures only. He was examined and released. According to the interview with the case vehicle's driver, the second seat left passenger did not sustain any injuries as a result of this crash.

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [25-year-old, White (Hispanic) male; 180 centimeters and 105 kilograms (71 inches, 232 pounds)] was seated primarily in an upright posture but leaning slightly to the right with his back against the seat back, his left foot on the floor, his right foot on the accelerator, and both hands on the steering wheel at the 12 and 6 o'clock position. His seat track was located between its middle and rearmost positions, the seat back was sightly reclined, and the tilt steering wheel was located in its down-most position.

The case vehicle's driver was not using his available, active, three-point, lap-and-shoulder, safety belt system. Furthermore, the driver reported no evidence of belt pattern bruising and/or abrasions to his body, and the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading.

The case vehicle's driver accelerated, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the nonuse of his available safety belts, the driver most likely moved slightly rearward just prior to impact. The case vehicle's impact with the Buick enabled the case vehicle's driver to move slightly forward and to the right toward the case vehicle's **50** degree Direction of Principal Force as the case vehicle decelerated. Because of the uncertainty of the case vehicle's dynamics during the rollover event, the driver's exact kinematics are unknown; however, the driver most likely remained in his seat following the initial impact since he recalls the vehicle "fish-tailing" prior to the vehicle's rollover event. During the rollover the driver was almost certainly thrown to the left, right, forward, backward, and upward. The driver does not recall his exact posture at final rest, but he exited the vehicle under his own power.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his interview, the case vehicle's driver sustained only glass lacerations to both forearms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Lacerations {scratches} to left and right forearms	790602.1 minor	Noncontact injury: flying glass, windshield glazing	Probable	Interviewee (same person)

CASE VEHICLE SECOND SEAT CENTER PASSENGER KINEMATICS

According to the case vehicle's driver, the second seat center passenger [5-year-old, White (Hispanic) female; 104 centimeters and 18 kilograms (41 inches, 40 pounds)] was seated in an upright posture with her back against the seat back and her feet dangling over the front edge of the seat's cushion. In addition, the exact position of her hands is unknown. Her seat track and seat back were not adjustable.

The case vehicle's second seat center passenger was not using her available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the second seat center passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of usage during this crash. As a result, she was ejected from the vehicle during the rollover event, most likely through the disintegrated right side glazing (**Figure 17** below).

Figure 19: Case vehicle's right side roof rail and probable avenue of ejection for second seat passenger; Note: tape on roof indicates blood spots (case photo #30)

The case vehicle's driver accelerated, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the nonuse of her available safety belts, the second seat center passenger most likely moved slightly rearward just prior to impact. The case vehicle's impact with the Buick enabled the case vehicle's second seat center passenger to move slightly forward and to the right toward the case vehicle's **50** degree Direction of Principal Force as the case vehicle decelerated. Because of the uncertainty of the case vehicle's dynamics during the rollover event, this passenger's exact kinematics are unknown; however, this passenger was almost certainly thrown to the right where she may have contacted the interior surface of the right rear sliding door and/or right roof and/or right side rail prior to being completely ejected out the right rear door's disintegrated window glazing. Based on conversations with the investigating police officers, at final rest the second seat center passenger was found outside the vehicle on the north roadside, but this child's exact location is unknown.

CASE VEHICLE SECOND SEAT CENTER PASSENGER INJURIES

She was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to the father (i.e., driver), the injuries sustained by the case vehicle's second seat center passenger included a laceration to her upper lip and a dislocated baby tooth.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Avulsion {knocked out} tooth (i.e., baby tooth)	251406.1 minor	Roof, right	Possible	Interviewee (driver)
2	Laceration lip, not further specified	290602.1 minor	Roof, right	Possible	Interviewee (driver)

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

According to the case vehicle's driver, the back left passenger [3-year-old, White (Hispanic) male; 94 centimeters and 18 kilograms (37 inches, 39 pounds)] was seated in an upright posture with his back against the seat back and his feet on the seat's cushion. In addition, the exact position of his hands is unknown. His seat track was located in its middle position, and the seat back was upright.

The case vehicle's back left passenger was not using his available, active, three-point, lap-and-shoulder, safety belt system. In addition, the inspection of the back left passenger's seat belt webbing, "D"-ring, and latch plate showed no evidence of usage during this crash. As a result, he was also ejected from the vehicle during the rollover event, again, most likely through the disintegrated right side glazing (**Figure 20**).

Figure 20: Right side of case vehicle's roof showing intrusion and probable avenue of ejection for back left seat passenger (case photo #48)

The case vehicle's driver accelerated, attempting to avoid the crash. As a result of this attempted avoidance maneuver and independent of the nonuse of his available safety belts, the back left passenger most likely moved slightly rearward just prior to impact. The case vehicle's impact with the Buick enabled the case vehicle's back left passenger to move slightly forward and to the right toward the case vehicle's **50** degree Direction of Principal Force as the case vehicle decelerated. Because of the uncertainty of the case vehicle's dynamics during the rollover event, this passenger's exact kinematics are unknown; however, this passenger was almost certainly thrown to the right where he may have contacted the interior surface of the right side panel (**Figure 21**) and/or right roof and/or right side rail prior to being completely ejected out the right back window's disintegrated glazing. Based on conversations with the investigating police officers, at final rest the back left passenger was found outside the vehicle on the north roadside but, once again, this child's exact location is unknown.

Figure 21: Case vehicle's right rear door and back seat interior panels showing absence of visible contact evidence during rollover and ejection by case vehicle's second and third seat passengers; Note: panel covering second seat's safety belt retractor has been knocked out (case photo #40)

CASE VEHICLE BACK LEFT PASSENGER INJURIES

The back left passenger was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. According to his father (i.e., driver), the injuries sustained by the case vehicle's third seat left passenger included a contusion to his forehead and a small laceration to his chin.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion forehead, not further specified	290402.1 minor	Right back window glazing, including frame, sill, "C"-pillar, or right side roof rail	Possible	Interviewee (driver)
2	Laceration {scratch} chin, not further specified	290602.1 minor	Right back window's glazing	Possible	Interviewee (driver)

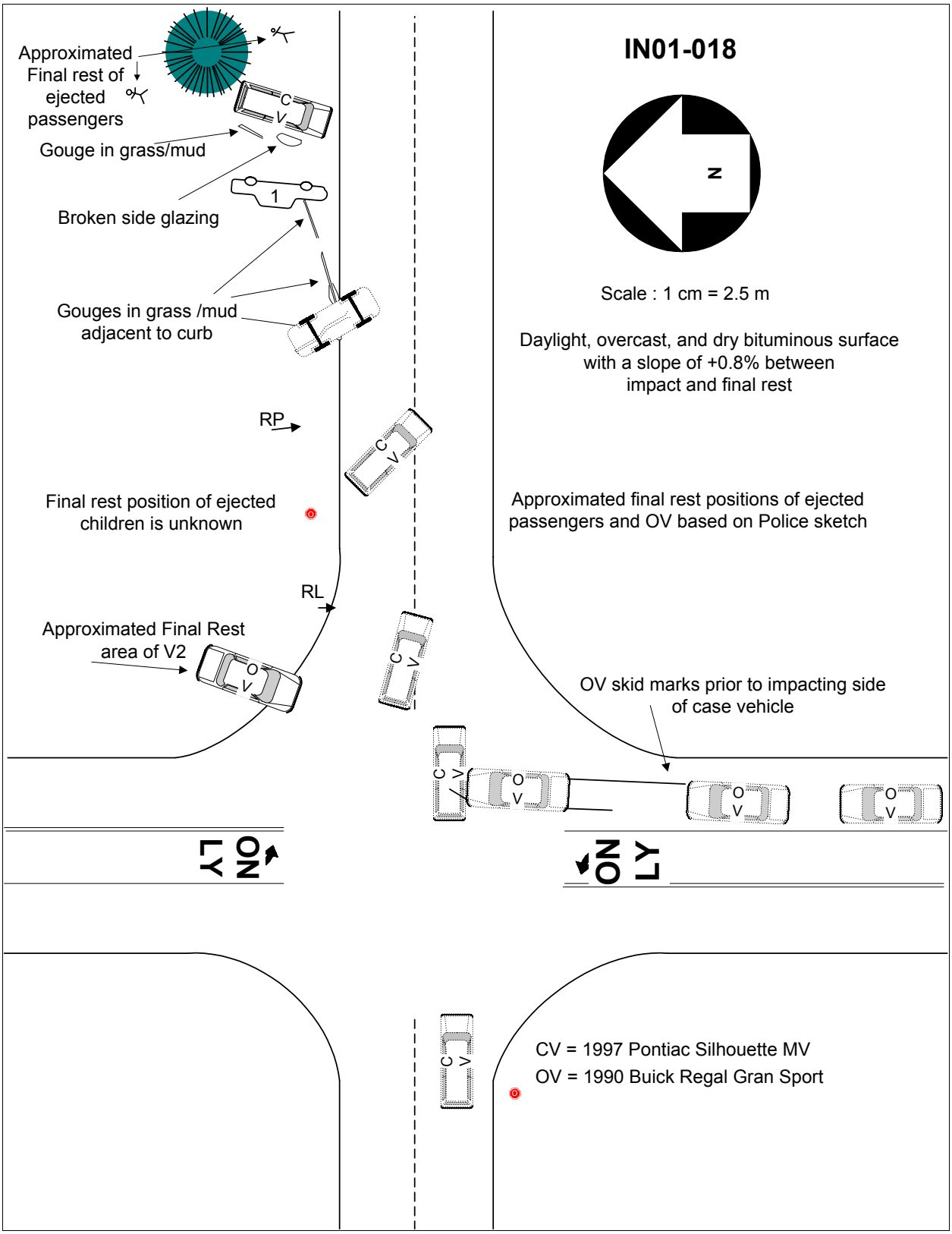
OTHER VEHICLE

The 1990 Buick Regal Custom Gran Sport was a front wheel drive, five-passenger, two-door coupe (VIN: 2G4WB14L3L1------) equipped with a 3.8L, V-8 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum system. The case vehicle's wheelbase was 273 centimeters (107.5 inches), and the odometer reading is unknown because the Buick's interior was not inspected.

The Buick's contact with the case vehicle involved its entire front. Direct damage began at the front left bumper corner and extended, a measured distance of 150 centimeters (59.1 inches), along the front bumper to the front right bumper corner. Residual maximum crush was measured as 31 centimeters (12.2 inches) at C_3. The wheelbase on the Buick's left side was extended 4 centimeters (1.6 inches) while the right side was shortened 3 centimeters (1.2 inches).

Figure 22: Overhead view of Buick's frontal deformation from impacting case vehicle's right side (case photo #52)

Based on the vehicle inspection, the CDC for the Buick was determined to be: **91-FDEW-2 (320)**. The Buick's front was shifted to the right (**Figure 22**) greater than 12.7 centimeters (5 inches) resulting in an increment of 80 to the Direction of Principal Force (i.e., 11+80=91). The WinSMASH reconstruction program, damage only algorithm, was used on the Buick's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 18.1 km.p.h. (11.2 m.p.h.), -13.8 km.p.h. (-8.6 m.p.h.), and +11.6 km.p.h. (+7.2 m.p.h.). The Buick was towed due to damage.


IN01-018
N
Scale : 1 cm = 2.5 m
Daylight, overcast, and dry bituminous surface with a slope of +0.8% between impact and final rest
Approximated Final rest of ejected passengers
Gouge in grass/mud
Broken side glazing
Gouges in grass /mud adjacent to curb
RP
Final rest position of ejected children is unknown
RL
Approximated Final Rest area of V2
Approximated final rest positions of ejected passengers and OV based on Police sketch
OV skid marks prior to impacting side of case vehicle
C V
O V
1
ONLY
CV = 1997 Pontiac Silhouette MV
OV = 1990 Buick Regal Gran Sport