INDIANA UNIVERSITY

TRANSPORTATION RESEARCH CENTER

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

REDESIGNED AIR BAG REPORT

CASE NUMBER - IN97-058
LOCATION - TEXAS
VEHICLE - 1998 PONTIAC GRAND AM SE
CRASH DATE - December, 1997

Submitted:

March 8, 2000

Revised Submission:

March 27, 2000

Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

DISCLAIMERS

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

1. *Report No.* IN97-058	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* On-Site Redesigned Air Bag Report Vehicle - 1998 Pontiac Grand AM SE Location - Texas		5. *Report Date:* March 8, 2000; March 27, 2000 6. *Performing Organization Code*	
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.* Task #s 0140 and 0193	
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-94-D-17058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: December, 1997 14. *Sponsoring Agency Code*	

15. *Supplementary Notes*
On-site redesigned air bag deployment report involving a 1998 Pontiac Grand AM SE, four-door sedan, with manual safety belts and dual front air bags, and a 1984 Chevrolet Camaro, two-door sport coupe

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1998 Pontiac Grand Am SE (case vehicle) and a 1984 Chevrolet Camaro Sport Coupe (vehicle #2). This crash is of special interest because the case vehicle was equipped with redesigned air bags, and the case vehicle's driver (33-year-old male) sustained no known injuries from his deploying driver air bag. In addition, the front right passenger (11-year-old male) sustained possible ("C") injuries from his deploying front right air bag. The crash location involved a north-south, multi-use, state trafficway (i.e., divided trafficway with a railway between the roadways), with an east-west roadway intersecting in a "Tee" configuration from the east. Both the north and southbound roadways had three lanes (i.e., two through lanes and one left-hand turn lane, in each direction), separated by two sets of at-grade railroad tracks. The case vehicle had been traveling south in the southbound, left-hand, turn lane and turned left across the two sets of railroad tracks, intending travel east. Vehicle #2 was traveling north in the inside, northbound, through lane of the same trafficway, and intended to continue northward. The crash occurred within the "Tee"-intersection, in the inside northbound through lane. The right fender and right front door of the case vehicle were impacted by the front of vehicle #2, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated counterclockwise, and vehicle #2 rotated clockwise, resulting in a sideslap impact between the right back corner of the case vehicle and the forward half of vehicle #2's left front door. The case vehicle's driver was seated with his seat track located in its rearmost position, and the tilt steering wheel was located between its middle and upmost positions. The front right passenger was most likely seated with his seat track located between its middle and forward-most positions. The case vehicle's driver and front right passenger (son) were restrained by their available, active, three-point, lap-and-shoulder, safety belt systems. The available evidence indicates that the driver of the case vehicle was uninjured, and the front right occupant sustained a police-reported "C" (possible) injury. The case vehicle's back middle passenger (6-year-old male) was most likely seated, and his seat track was not adjustable. The back middle passenger (son) was restrained by his available, active, two-point, lap belt. He sustained, according to the Police Crash Report, possible ("C") injuries as a result of this crash.

17. *Key Words* Redesigned Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 9	22. *Price* $8,600

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

BACKGROUND

IN97-058

This on-site investigation was brought to NHTSA's attention in December, 1997, by GES sampling activities. This crash involved a 1998 Pontiac Grand Am SE (case vehicle) and a 1984 Chevrolet Camaro Sport Coupe (vehicle #2). The crash occurred in December, 1997, at 7:15 p.m., in Texas, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with redesigned air bags, and the case vehicle's driver [33-year-old, Black (unknown if Hispanic) male] sustained no known injuries from his deploying driver air bag. In addition, the front right passenger [11-year-old, (unknown race or ethnic origin) male] sustained possible ("C") injuries from his deploying front right air bag. This contractor's investigative consultant inspected the case vehicle on December 23, 1997, and vehicle #2 on March 2, 1998. Numerous attempts to contact the case vehicle's driver proved unsuccessful. This report is based on the Police Crash Report, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The crash location involved a north-south, multi-use, state trafficway (i.e., divided trafficway with a railway between the roadways), with an east-west roadway intersecting in a "Tee" configuration from the east; see **CRASH DIAGRAM** below. Both the north and southbound roadways had three lanes (i.e., two through lanes and one left-hand turn lane, in each direction), separated by two sets of at-grade railroad tracks. The case vehicle had been traveling south in the southbound, left-hand, turn lane and turned left across the two sets of railroad tracks and was attempting to travel east on the intersecting roadway (**Figure 1**). Vehicle #2 was traveling north in the inside, northbound, through lane of the same trafficway, and intended to continue in its northerly travel path (**Figure 2**). It is unknown if either the case vehicle's driver or vehicle #2's driver made any avoidance maneuvers prior to the crash. The crash occurred within the "Tee"-intersection, in the inside northbound through lane.

Figure 1: Case vehicle's southward travel path in left-hand turn lane approaching "Tee" intersection; Note: case vehicle turned left like exemplar vehicle (arrow) and crossed two sets of railroad tracks, just prior to impact (case photo #02)

Figure 2: Vehicle #2's northward travel path in inside northbound through lane approaching "Tee" intersection (case photo #09)

Both the north and southbound roadways of the state trafficway were straight and level at the area of impact. The pavement was concrete for both roadways, and the width of the left-hand turn lane on the southbound roadway was 3.1 meters (10.2 feet), while the width of the inside northbound lane was 3.35 meters (11.0 feet). Both the north and southbound roadways were bordered by barrier curbs on the east and west sides of their respective roadways. The width of the median-like area containing the two sets

of railroad tracks was approximately 11.9 meters (39.0 feet). Pavement markings at the mouth of both the north and southbound roadways consisted of a single broken white centerline separating the two through lanes and a solid white lane line separating the left-hand turn lane from the through lanes. The separation of the turn lanes was augmented by the presence of raised pavement markers. The turn lanes also had painted white left-turn arrows and painted white railroad crossing symbols. The estimated coefficient of friction was 0.80 for both roadways. There were four on-colors, pre-timed, vertically-mounted traffic control signals controlling each roadway at the "Tee" intersection. At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was clear/cloudy, and the road pavement was dry. Traffic density is unknown, and the site of the crash was urban commercial.

Figure 3: Case vehicle's right side damage with contour gauge present viewed from left of front (case photo #14)

Figure 4: Case vehicle's right side damage from initial impact with vehicle #2; Note: red tape (arrow) indicates length of direct damage (case photo #16)

Figure 5: Close-up of case vehicle's front right damage (case photo #17)

The right fender and right front door of the case vehicle (**Figures 3** through **5** and **Figure 6** below) were impacted by the front of vehicle #2 (**Figures 7** and **8** below), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle began an approximate 200 degree counterclockwise rotation during separation from the first impact with vehicle #2 to final rest, with the heading direction changing from the east-southeast to nearly due west. Vehicle #2 began an approximate 100 degree clockwise rotation during separation from the case vehicle, with its heading direction changing from the north to east-southeast. After the first impact occurred and during each vehicle's respective rotation, a second, sideslap impact occurred. The right back corner of the case vehicle (**Figure 9** below) impacted the forward half of vehicle #2's left front door (**Figures 10** and **11** below).

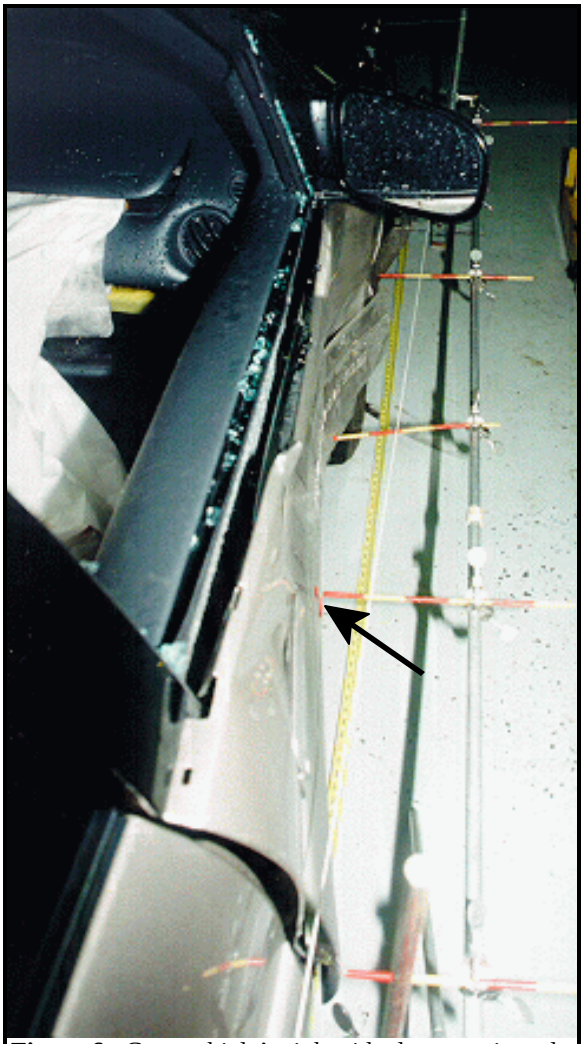

Figure 6: Case vehicle's right side damage viewed along right reference line from back; Note: red tape (arrow) marks length of direct damage and disintegrated right front glazing (case photo #21)

Figure 7: Vehicle #2's frontal damage with contour gauge present from initial impact with case vehicle (case photo #47)

Figure 8: Close-up of vehicle #2's frontal damage with contour gauge present (case photo #48)

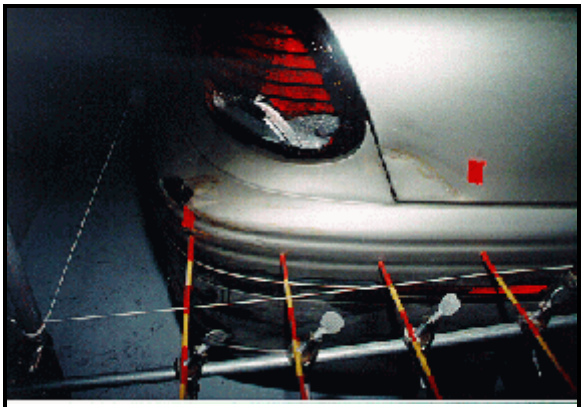

Figure 9: Case vehicle's back right damage with contour gauge present from sideslap impact with vehicle #2's left side (case photo #23)

CASE VEHICLE

The case vehicle was a front wheel drive, 1998 Pontiac Grand Am SE, five-passenger, four-door sedan (VIN: 1G2NE52TXWC------) equipped with a 2.4L, DOHC SPFI, L-4 engine and a four-speed automatic transmission. The case vehicle was equipped with four-wheel, anti-lock brakes. The case vehicle's wheelbase was 263 centimeters (103.4 inches), and the odometer reading at inspection was 7,825 kilometers (4,862 miles).

Based on the vehicle inspection, the CDC for the case vehicle's initial impact was determined to

be: **02-RYAW-2 (+50)** [maximum crush was 13 centimeters (5.1 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 39.2 km.p.h. (24.4 m.p.h.), -25.2 km.p.h. (-15.7 m.p.h.), and -30.0 km.p.h. (-18.6 m.p.h.). The CDC for the second, sideslap collision was determined to be: **05-RBEE-1 (+160)** [maximum crush was 1 centimeter (0.4 inches)]. The WinSMASH reconstruction program, damage only algorithm, was also used on the case vehicle's second highest severity impact. The Total, Longitudinal, and Lateral Delta V results are, respectively: 4.7 km.p.h. (2.9 m.p.h.), +4.5 km.p.h. (+2.8 m.p.h.), and -1.6 km.p.h. (-1.0 m.p.h.). The case vehicle was towed due to disabling damage.

Figure 10: Vehicle #2's driver door damaged from sideslap impact with case vehicle (case photo #51)

Figure 11: Close-up of damage to vehicle #2's driver door from sideslap impact with case vehicle (case photo #53)

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of "I"-configuration cover flaps made of thick vinyl with overall dimensions of 9 centimeters (3.5 inches) at the upper horizontal seams and 10 centimeters (3.9 inches) vertically. An inspection of the air bag module's cover flaps and air bag 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 (**Figure 12**); although, the top half of the steering wheel rim was bent forward 5 centimeters (2.0 inches).

Figure 12: Case vehicle's steering wheel-mounted driver air bag module showing "I" configuration cover flaps without evidence of damage or occupant contact (case photo #33)

Figure 13: Case vehicle's deployed driver air bag; Note: yellow tape identifies possible contact points (case photo #29)

The driver's air bag was designed without any tethers. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 3 and 9 o'clock positions. The deployed driver's air bag was round with a diameter of 52 centimeters (20.5 inches). Inspection of the driver air bag fabric revealed two scuffs (**Figure 13** above), one above the bag's horizontal midline and the other below the horizontal midline.

The front right passenger's air bag was located in the top of the instrument panel. There was a single, asymmetrical, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 37 centimeters (14.6 inches) along the horizontal seams, forward and at the rear (i.e., toward the windshield), 21 centimeters (8.3 inches) along the right vertical seam, and 26 centimeters (10.2 inches) along the left vertical seam. The profile of the case vehicle's instrument panel/dash resulted in a 6 centimeter (2.4 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 flaps and air bag 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 (**Figure 14**).

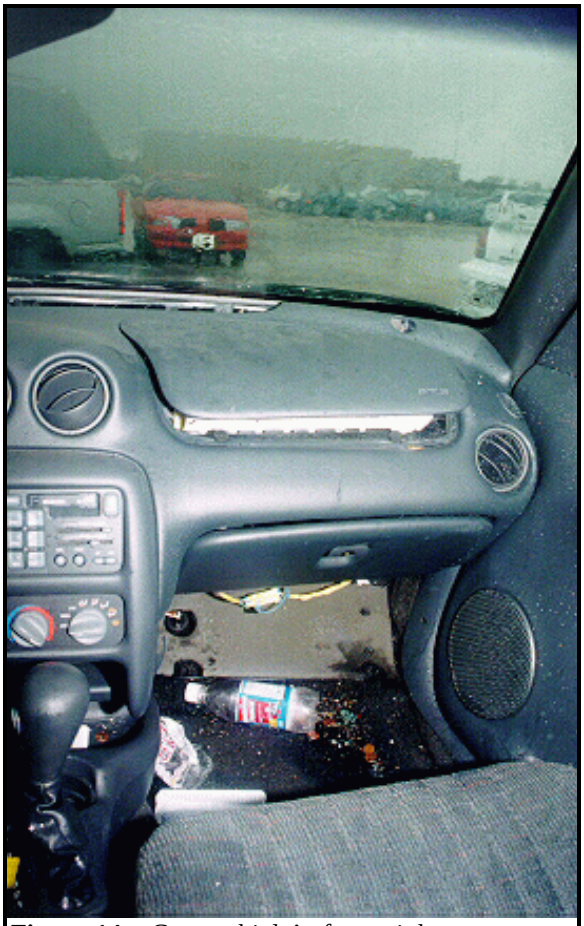

Figure 14: Case vehicle's front right passenger seat-ing area showing front right air bag module's cover flap without evidence of damage or occupant contact; Note: floor-mounted, automatic transmission selector lever (case photo #35)

The front right passenger's air bag was designed with two tethers, with each tether strap 5 centimeters (2.0 inches) wide. The front right air bag had no vent ports. The deployed passenger air bag was rectangular with a height of approximately 46 centimeters (18.1 inches) and a width of approximately 48 centimeters (18.9 inches). Inspection of the front right passenger air bag fabric (**Figure 15**) revealed a small transfer at the bottom center and contact marks at the bottom right corner. The only other evidence of occupant contact on the interior surfaces involved the windshield-mounted rearview mirror, which was knocked out of position, and the center console which may have been contacted by the driver.

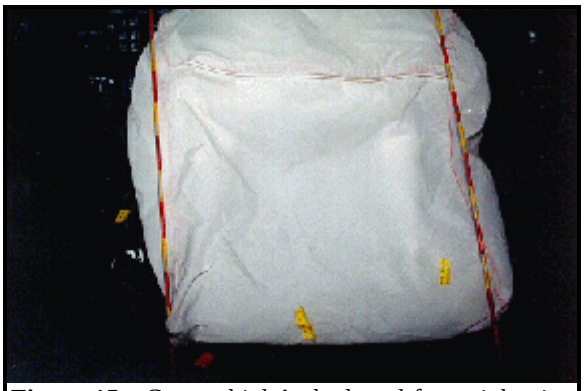

Figure 15: Case vehicle's deployed front right air bag; Note: yellow tape identifies possible contact points (case photo #38)

Based on the available evidence and occupant kinematic principles, the case vehicle's driver [33-year-old, Black (unknown if Hispanic) male], immediately prior to the crash, was slightly reclined 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 during his attempted left turn maneuver. The vehicle inspection indicates that his seat track was located in its rearmost position, the seat back was slightly reclined, and the tilt steering wheel was located between its middle and upmost positions.

The height and posture of the case vehicle's front right passenger [son; 11-year-old, (unknown race or ethnic origin) male], including the positions of his feet and hands, are unknown. The case vehicle inspection indicates that his seat back was slightly reclined, and the seat track was located between its middle and forward-most positions.

The case vehicle's driver (unknown height and weight) and front right passenger (unknown height and weight) were restrained by their available, active, three-point, lap-and-shoulder, safety belt systems. There was no evidence reported by this contractor's investigative consultant that the case vehicle's driver or front right passenger loaded their respective seat belt webbing, "D"-ring, or latch plate. It is also unknown where, or if, the torso portion of the front right safety belt system came in contact with the front right passenger's right shoulder area.

The height and posture of the case vehicle's back middle passenger [6-year-old, (unknown race or ethnic origin) male], including the positions of his feet and hands, are unknown. His seat back and seat track were not adjustable.

The back middle passenger (unknown height and weight) was restrained by his available, active, two-point, lap belt. Additionally, there was no evidence reported by this contractor's investigative consultant that the back middle passenger loaded his seat belt webbing or latch plate.

Based on the available evidence, the case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of their available safety belts, the driver's and front right passenger's pre-impact body positions shifted slightly to their right haunches during the case vehicle's left turn maneuver from a southbound to an anticipated eastbound travel path. The case vehicle's primary impact with vehicle #2 enabled the case vehicle's driver and front right passenger to continue forward and rightward toward the +50 degree Direction of Principal Force, as the case vehicle decelerated. In addition, the driver's body rotated slightly counterclockwise and moved slightly upward, resulting (most likely) in his right hand striking and displacing the interior rearview mirror. The initial impact also caused the case vehicle to rotate counterclockwise, causing the driver to move further to the right. Because he was using his lap-and-shoulder, safety belt system, his forward motion was restricted, and he encountered the deployed air bag in a right-of-center alignment, most likely with his face and chest. The acute angle of the case vehicle's right side impact most likely delayed the system sensors from reading a longitudinal deceleration of sufficient magnitude to reach the air bag system's deployment threshold. As a result, when the driver's air bag did deploy, the driver's body caused the air bag to expand towards the instrument panel, bending the upper portion of the steering wheel's rim (**Figure 16**). The driver was then thrust backwards and a little right by

the air bag, such that the driver's right hip struck the left side of the console and the transmission shift lever. The second (sideslap) impact served to slow the case vehicle's counterclockwise rotation and most likely caused the driver to move rightward and rearward toward the +160 degree Direction of Principle Force. The sideslap impact was relatively negligible, and its effect upon the occupants kinematics may have been only minimal. The counterclockwise rotation by the case vehicle from the first impact to final rest would have kept all occupants leaning to their right. Finally, the driver rebounded back leftward, into his seat, as the case vehicle came to rest.

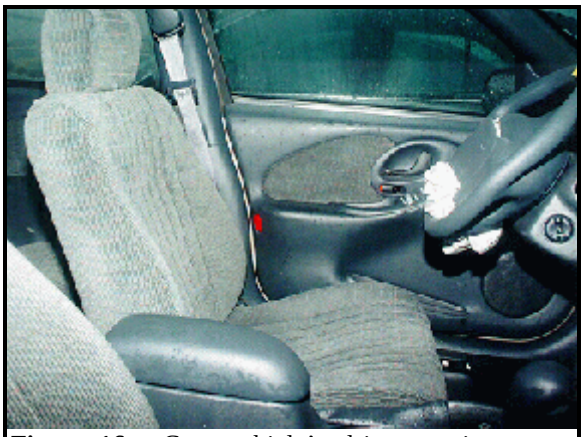

Figure 16: Case vehicle's driver seating area showing deformation to upper portion of steering wheel rim (case photo #39)

The available evidence indicates that the front right passenger's upper torso jackknifed over the lap belt portion sufficiently to contact the lower center and right portions of the front right passenger's deployed air bag. As mentioned previously, there was a second, sideslap impact, and its effect on the front right passenger would be similar to its effect on the case vehicle's driver.

During the crash, the back middle passenger's body jackknifed over his lap belt, moving toward the +50 degree Direction of Principle Force. There is no evidence to indicate that he made contact with any interior components. The above mentioned second, slideslap impact would have caused the back middle passenger to move toward the right "C"-pillar and back right seat back before correcting back toward his original seating position as the case vehicle moved to final rest.

OCCUPANT INJURIES

The available evidence indicates that the driver of the case vehicle was uninjured and, thus, he was not transported to a local hospital because of medical reasons. The front right occupant was transported by ambulance to the hospital. According to the Police Crash Report, he sustained a possible ("C") injury. The injuries sustained by the case vehicle's front right passenger are unknown. It is entirely possible that the case vehicle's driver may have accompanied his son when they transported him from the scene to a hospital. According to the Police Crash Report, the back middle passenger was also transported by ambulance to a medical facility. He sustained possible ("C") injuries from this crash sequence; however, once again, the exact nature of his injuries is unknown.

VEHICLE #2

Vehicle #2 was a rear wheel drive, 1984 Chevrolet Camaro Sport Coupe, four-passenger, two-door coupe (VIN: 1G1AP8712EL------) equipped with a 2.8L, 2bbl., V-6 engine and a three-speed automatic transmission. Anti-lock brakes were not an option for this model. Vehicle #2's wheelbase was 257 centimeters (101.0 inches), and the odometer reading at inspection was not recorded.

Based on the vehicle inspection, the CDC for vehicle #2's initial impact was determined to be: **12-FDEW-2 (-10)** [maximum crush was 60 centimeters (23.6 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on vehicle #2's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 38.2 km.p.h. (23.7 m.p.h.), -37.7 km.p.h. (-23.4 m.p.h.), and +6.6 km.p.h. (+4.1 m.p.h.). The CDC for the second, sideslap collision was determined to be: **11-LPMW-1 (-40)** [maximum crush was 2 centimeters (0.8 inches)]. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's second highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 4.6 km.p.h. (2.9 m.p.h.), -3.5 km.p.h. (-2.2 m.p.h.), and +3.0 km.p.h. (+1.9 m.p.h.). Vehicle #2 was towed due to disabling damage.

Vehicle #2's driver [16-year-old, Black (unknown if Hispanic) male; unknown height and weight] was reportedly restrained by his available, active, three-point, lap-and-shoulder, safety belt system. Vehicle #2's front right passenger [23-year-old (unknown race or ethnic origin) male; unknown height and weight] was not wearing the available, active, three-point, lap-and-shoulder, safety belt system. Vehicle #2 was not equipped with air bags or anti-lock brakes. According to the Police Crash Report, vehicle #2's driver was uninjured in this crash and, thus, he was not transported to a medical facility; the front right passenger reportedly sustained possible (“C”) injuries and was transported by ambulance to a medical facility.

CRASH DIAGRAM IN97-058