TRANSPORTATION SCIENCES
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VERIDIAN REMOTE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 03-41-128F

VEHICLE – 2003 MERCEDES-BENZ C240
LOCATION - STATE OF FLORIDA

CRASH DATE – JULY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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

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

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16. Abstract This remote investigation focused on the performance of the Side Impact Inflatable Occupant protection system in a 2003 Mercedes-Benz C240. The system included door panel mounted side impact air bags and inflatable curtain air bags for the four outboard seating positions. The Mercedes-Benz was also equipped with dual stage frontal air bags, occupant-sensing device for the front right seat, and retractor mounted safety belt pretensioners for the four outboard seating positions. The Mercedes-Benz was involved in an intersection collision with a 1995 BMW 325i. As a result of the crash, the driver's frontal air bag, safety belt pretensioner, front left and rear left door panel mounted side impact air bag, and front left and rear left side inflatable curtains deployed. The Mercedes-Benz was occupied by a restrained 67-year-old male driver. The BMW was occupied by a 30-year-old female driver and a 4-year-old female passenger that seated in the rear right position. The driver of the Mercedes-Benz was police reported as not injured, however, the driver stated to the NASS researcher that he sustained bilateral abrasions on the lower portion of his arms. The driver and rear right passenger of the BMW were police reported as sustaining non-incapacitating injuries and were transported to a local hospital where they were treated and released.			
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NASS/SCI COMBO CASE NO. 03-41-128F
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LOCATION - STATE OF FLORIDA
CRASH DATE – JULY 2003

BACKGROUND

This remote investigation focused on the performance of the Side Impact Inflatable Occupant Protection System in a 2003 Mercedes-Benz C240. The system included door panel mounted side impact air bags and inflatable curtain air bags for the four outboard seating positions. The Mercedes-Benz was also equipped with dual stage frontal air bags, an occupant-sensing device for the front right seat, and retractor mounted safety belt pretensioners for the four outboard seating positions. The Mercedes-Benz **(Figure 1)** was involved in an intersection collision with a 1995 BMW 325i. Subsequently, the Mercedes-Benz was redirected and departed the southwest corner of the intersection where it impacted a barrier curb with its front right wheel, fence with its right side and a utility pole with its center front. As a result of the impact with the BMW, the front left and rear left door panel mounted side impact air bags, and left side inflatable curtain deployed. As a result of the impact with the utility pole, the driver's frontal air bag deployed and the front safety belt pretensioners fired. The Mercedes-Benz was occupied by a restrained 67-year-old male driver. The BMW was occupied by a 30-year-old female driver and a 4-year-old female passenger who was seated in the rear right position. The driver of the Mercedes-Benz was police reported as not injured, however, the driver stated to the NASS researcher that he sustained bilateral forearm abrasions. The driver and rear right passenger of the BMW were police reported as sustaining non-incapacitating injuries and were transported to a local hospital where they were treated and released.

Figure 1. 2003 Mercedes-Benz C240.

This crash was initially selected for investigation by PSU 41 of the National Automotive Sampling System (NASS) as Case No: 2003-41-128F. The Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) assigned a combined investigative effort of the crash to the Veridian SCI team due to the Agency's interest in the field performance of vehicle's equipped with Side Impact Inflatable Occupant Protection Systems. This remote effort involved a review of the NASS EDCS file and the preparation of this narrative report.

SUMMARY

Crash Site

This two-vehicle crash occurred during the morning hours of July 2003 in the state of Florida. At the time of the crash, there were no adverse weather conditions and the asphalt road surface was dry. The crash occurred at the four-leg intersection of a southbound one-way state roadway and a four-lane east/west roadway. The southbound roadway was configured with three through traffic lanes and a left turn lane. The roadway was bordered with concrete barrier curbs on the west road edge and grass median on the east road edge. The east/west road was configured with four lanes. The outboard east/westbound lanes were for traffic passing through the intersection. The inboard east/westbound lanes were configured for left turning traffic. The lanes were divided by double yellow centerlines and were bordered with concrete barrier curbs. Railroad tracks crossed the east/west roadway prior to the intersection. Traffic flow through the intersection was controlled by three-phase overhead traffic lights. The posted speed limit for both roadways was 64 km/h (40 mph).

VEHICLE DATA – 2003 Mercedes-Benz C240

The 2003 Mercedes-Benz C240 was identified by the Vehicle Identification Number (VIN): WDBRF61J03 (production sequence omitted). The odometer reading was unknown due to lack of power to the vehicle at the time of the inspection. The vehicle was a four-door sedan that was equipped with a 2.6-liter, six-cylinder engine, with rear wheel drive and a 5-speed automatic transmission. The vehicle was equipped with 4-wheel disc brakes with ABS, emergency braking assist, stability control, and traction control. The 2003 Mercedes-Benz was configured with front bucket seats and a second row bench seat with adjustable head restraints for all five seating positions. The vehicle was equipped with P205/55R16 Continental Conti Touring Contact tires. The tire placard was not located; therefore the vehicle manufacturers recommended tire pressure was unknown. The maximum pressure for these tires was 303 kpa (44.0 psi).

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kpa (0.0 psi)	7.0 mm (9/32)	No	De-beaded
LR	234 kpa (34psi)	7.0 mm (9/32)	No	None
RF	0.0 kpa (0.0 psi)	7.0 mm (9/32)	No	Torn Sidewall
RR	234 kpa (34 psi)	7.0 mm (9/32)	No	None

VEHICLE DATA – 1995 BMW 325i

The 1995 BWM was identified by the Vehicle Identification Number (VIN): WBACB4320S (production sequence omitted). The odometer reading was unknown due to lack of power to the vehicle at the time of the inspection. The vehicle was a four-door sedan that was equipped with a 2.5-liter, six-cylinder engine, rear-wheel drive and a 4-speed automatic transmission. The BMW was configured with front bucket seats and a second row bench seat.

Crash Sequence

Pre-Crash

The 67-year-old male driver of the 2003 Mercedes-Benz C240 was operating the vehicle southbound in the third lane approaching the intersection **(Figure 2)**. The driver of the 1995 BMW 325i was operating the vehicle westbound **(Figure 3)** approaching the same intersection. The driver of the BMW stated to the NASS researcher that she crossed the railroad tracks and was traveling at approximately 40 kmh (25 mph) as she approached the intersection on a green signal phase. The police reported stated that the driver of the Mercedes-Benz entered the intersection against the red traffic signal. No pre-impact avoidance evidence for either vehicle was identified at the crash site. The NASS scene schematic is included as **Figure 18** of this report.

Figure 2. Mercedes-Benz approach to intersection.

Figure 3. BMW approach to intersection.

Crash

The frontal area of the BWM impacted the forward aspect of the Mercedes-Benz's left side **(Figure 4)**. The resultant directions of force were within the 10 o'clock sector for the Mercedes-Benz and 1 o'clock for the BMW. This impact was sufficient to deploy the front left and rear left door panel mounted side air bags and left side curtain air bag in the Mercedes-Benz. The impact resulted in the BMW's driver's frontal air bag deployment. The missing vehicle algorithm of the WinSMASH program computed a total velocity change of 13.0 km/h (8.1 mph) for the Mercedes-Benz. The longitudinal and lateral components were -11.0 km/h (-6.8 mph) and 7.0 km/h (4.3 mph) respectively. The total velocity change for the BMW was 16.0 kmh (9.9 mph). The longitudinal and lateral components were -13.9 kmh (-8.6 mph) and -8.0 kmh (-5.0 mph) respectively.

Figure 4. Area of impact from the Mercedes-Benz approach.

The Mercedes-Benz was subsequently deflected into the southwest corner of the intersection where it impacted a curb with its front right wheel. The vehicle continued forward and struck a fence with its right side, and a utility pole with its center frontal area. The subsequent impacts resulted in moderate frontal and minor right side damage to the Mercedes-Benz. The force of the pole impact was sufficient to warrant the deployment of the frontal air bags and safety belt pretensioners. The WinSMASH program computed a barrier equivalent speed of 26.0 kmh (16.2 mph) for the utility impact to the front of the Mercedes-Benz.

The Mercedes-Benz traveled approximately 24.0 m (45.9') from the impact with the BMW to final rest against the utility pole. The BMW rotated approximately 30 degrees counter clockwise and came to rest in the intersection near the point of impact.

Post-Crash

The driver of the Mercedes-Benz was reported by the police as not injured or transported. The driver and rear right passenger of the BMW were injured and transported to a local hospital where they were treated and released. Both vehicles were towed from the scene due to disabling damage.

VEHICLE DAMAGE

Exterior Damage – 2003 Mercedes-Benz C240

The 2003 Mercedes-Benz C240 sustained moderate left side damage **(Figure 5)** as a result of the impact with the 1995 BMW 325i. The direct contact damage width measured 274.0 cm (107.8") and began 83.0 cm (32.6") forward of the left rear axle and extended rearward where it terminated beyond the forward edge of the left rear door. The maximum crush was 12.0 cm (4.7") and was located 179.0 cm (70.5") forward of the left rear axle. The damage from the impact with BMW consisted of lateral crush to the left front fender, left front door, and shattered left front glazing. The researcher noted that the left wheelbase was reduced 4.0 cm (1.6"). Six crush measurements were documented along the mid-door level using a combined direct and induced damaged width of 329.0 cm (129.5") and were as follows: C1 = 0.0 cm, C2 = 4.0 cm (1.6"), C3 = 10.0 cm (3.9"), C4 = 10.0 cm (3.9"), C5 = 12.0 cm (4.7"), C6 = 5.0 cm (1.9"). The Collision Deformation Classification (CDC) for the impact with the BWM was 10-LYEW-1.

Figure 5. Left side damage from impact with the BMW.

The Mercedes-Benz sustained minor damage from the curb impact. The damaged consisted of a deformed alloy wheel and a cut to the sidewall of the tire. The CDC for the curb impact was 12-FRWN-3.

The Mercedes-Benz sustained minor damage to the right rear aspect from the impact with the chain link fence. The damage consisted of scratches that began at the rear right corner and extended forward 132.0 cm (51.9”). The CDC for this impact was 12-RZES-1.

The Mercedes-Benz impacted a utility pole with its front and sustained moderate damage **(Figure 6)**. The direct contact damage began 36.0 cm (14.2”) inboard of the front right bumper corner and measured 33.0 cm (13.0”) in length. The maximum crush from this impact was located 49.0 cm (19.3”) inboard of the front right bumper corner and measured 44.0 cm (17.3”). Six crush measurements were documented on the front bumper using a combined direct and induced damage width of 111.0 cm (43.7”) and were as follows: C1 = 0.0, C2 = 0.0, C3 = 23.0 cm (9.1”), C4 = 37.0 cm (14.6”), C5 = 11.0 cm (4.3”), C6 = 0.0. The CDC for this impact was 12-FZEN-2.

Figure 6. Pole impact damage to the front center area of the Mercedes-Benz.

Exterior Damage – *1995 BMW 325i*

The 1995 BMW 325i sustained moderate severity damage as a result of the impact with Mercedes-Benz. The BMW was under repair at the time of the inspection **(Figure 7)**. The damage involved the front left and right fenders, hood, grille, and bumper fascia. Due to the repair status, a crush profile could not be obtained. The Collision Deformation Classification for this impact was 01-F999-99.

Figure 7. Under repaired section of BMW.

Interior Damage – 2003 Mercedes-Benz C240

The 2003 Mercedes-Benz sustained minor interior damage **(Figures 8 and 9)** as a result of air bag deployment and occupant contacts. No intrusions were present in the Mercedes-Benz. At impact, the driver initiated a left and forward trajectory. The driver’s left hip contacted the door panel armrest resulting in a scuff to the armrest. The driver’s left knee contacted the lower portion of the door panel resulting in a crack to the lower door panel. The driver’s right knee scuffed the knee bolster, his right hand contacted the rear view mirror and detached it from its mounting point. His right knee dented the center console. The driver’s face contact to the frontal air bag resulted in the skin oil transfer to the air bag, and the driver’s left arm contacted the door panel mounted side air bag resulting in a skin oil transfer. The steering wheel was deformed 1.0 cm (0.4”) from the driver’s loading of the air bag against the steering wheel.

Figure 8. Driver contact to the knee bolster.

Figure 9. Driver contacts to the front left door panel and armrest.

MANUAL RESTRAINT SYSTEMS – 2003 Mercedes-Benz C240

The 2003 Mercedes-Benz C240 was equipped with manual 3-point lap and shoulder belts for all five seating positions. The front safety belts were equipped with retractor-mounted pretensioners. The driver's safety belt pretensioner fired as a result of the crash. The driver's safety belt **(Figure 10)** was configured with a sliding latch plate and a belt-sensitive, Emergency Locking Retractor (ELR). The front safety belts were also equipped with height adjustable D-rings. The front left was adjusted in the full-up position and the front right was adjusted in the full-down position. The driver utilized the safety belt in this crash. The remaining safety belts were configured with sliding latch plates and belt-sensitive switchable ELR/Automatic Locking Retractors (ALR).

Figure 10. Driver's safety belt.

Side Impact Air Bag System-2003 Mercedes-Benz C240

The 2003 Mercedes-Benz was equipped with side impact air bags that consisted of door panel mounted side air bags and curtain air bags for the four outboard seating positions. The front left and rear left door panel air bags and left side curtain air bag deployed as result of the crash with the BMW. The air bag module contained a single cover flap that consisted of the leather door panel cover and measured 43.0 cm (16.9") in width. The front left door panel air bag measured 20.0 cm (7.9") in height and 43.0 cm (16.9") in width **(Figure 11)**. The researcher documented a skin oil transfer on the front lower right aspect of the air bag and a bloodstain on the rear top right aspect of the air bag. The air was not tethered and was vented internally. The air bag module contained a single cover flap that consisted of the leather door panel cover and measured 48.0 cm (18.9") in width. The rear left door panel side air bag measured 20.0 cm (7.9") in height and 44.0 cm (17.3") width **(Figure 12)**. The air bag was not tethered and was vented internally.

Figure 11. Driver's door panel mounted side impact air bag (not fully extended).

Figure 12. Rear left door panel mounted side air bag.

The left side curtain air bag deployed from the roof side rail and extended from the A-pillar to the C-pillar protecting both front and rear outboard seated positions **(Figures 13 and 14)**. The air bag measured 29.0 cm (11.4") in height and 128.0 cm (50.4") length. The air bag was tensioned by two tethers that were connected to the left A-pillar and left C-pillar. The air bag fabric was fused to form a series of chambers and was internally vented. No contact evidence was noted to the curtain air bag. The right curtain and side air bags did not deploy during the crash.

Figure 13. Front left section of the inflatable curtain.

Figure 14. Rear left section of the inflatable curtain.

Frontal Air Bag System 2003 Mercedes-Benz C240

The 2003 Mercedes-Benz C240 was equipped with dual-stage frontal air bags. The driver's frontal air bag deployed as result of the crash. The air bag module contained two cover flaps. The top cover flap was 8.0 cm (3.1) in height and 17.0 cm (6.7") in width and the lower flap was 7.0 cm (2.8") in height and 17.0 cm (6.7") in width. The air bag was 53.0 cm (20.9") in diameter **(Figure 16)**. The researcher noted skin oil transfers. The air bag contained two tethers and a single vent port at the 12 o'clock position on the rear aspect of the air bag. The front right air bag did not deploy **(Figure 17)** due to the front right seat not being occupied at the time of the crash.

Figure 16. Deployed driver's frontal air bag.

Figure 17. Non-deployed front right frontal air bag.

OCCUPANT DEMOGRAPHICS – 2003 Mercedes-Benz C240

Driver

Age/Sex:	67-year-old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Mid-to-rear
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Not medically treated

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Bilateral forearm abrasions 5.1 cm x 5.1 cm (2.0" x 2.0")	Minor (790202.1,3)	Front left air bag expansion

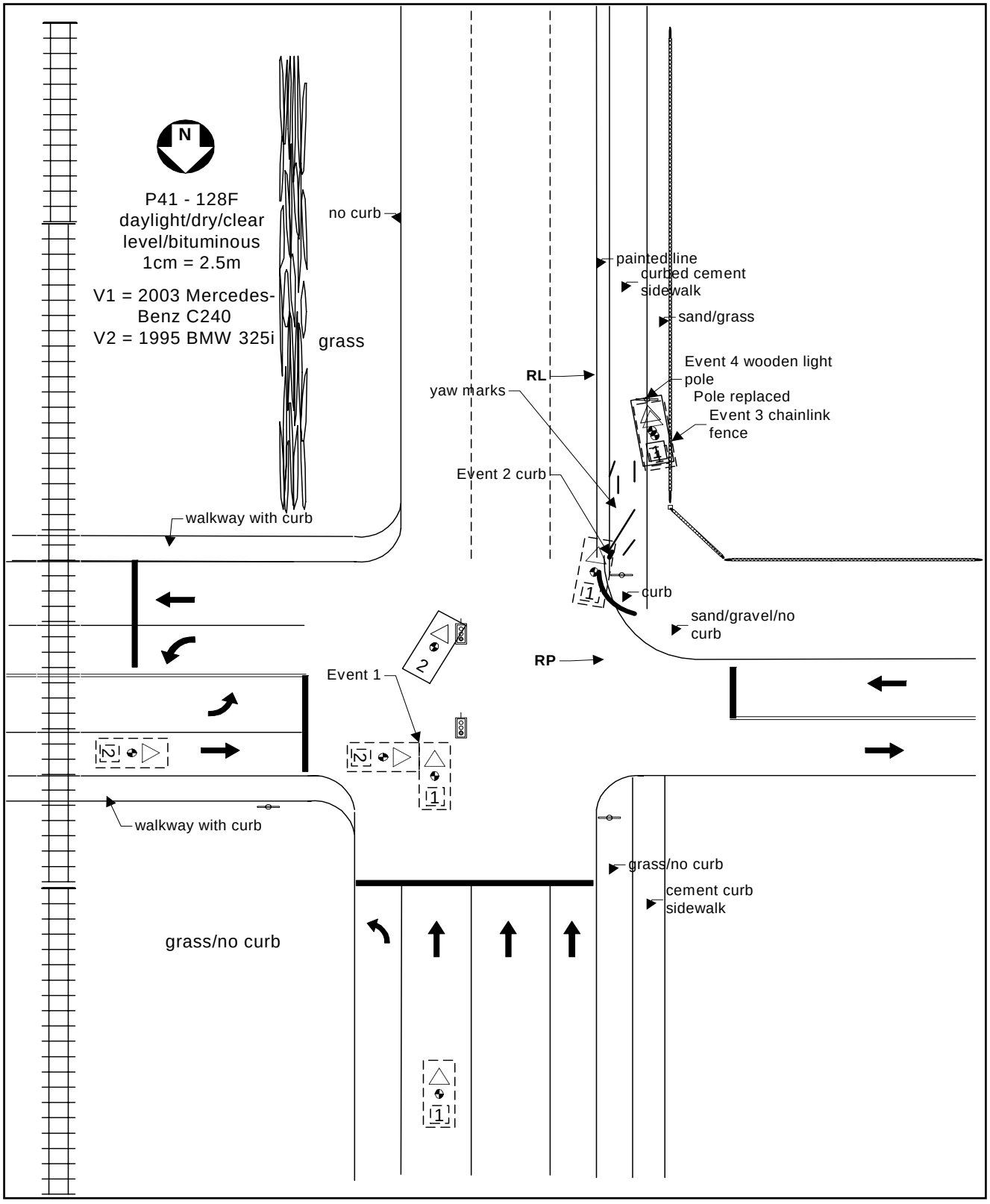
Injury source: Driver interview

Driver Kinematics

The 67-year-old male driver of the 2003 Mercedes-Benz C240 was seated in a presumed upright posture and was restrained by the vehicle's lap and shoulder belt. The seat track was adjusted to a mid-to-rear track position. At impact with the BMW, the left side door panel mounted side air bags and left side curtain air bag deployed. The driver initiated a lateral trajectory towards the door panel resulting in the driver's left hip contact to the door panel armrest resulting in a scuff to the door panel armrest. The driver's left knee contacting the lower portion of the door panel resulting in a crack to the lower door panel and the driver's left arm contacting the door panel mounted side air bag resulting in a skin oil transfer. The combination of the door panel mounted side air bag and curtain air bag deployment protected the driver from possible injury.

The vehicle then departed the southwest corner of the intersection and contacted a curb with its front right wheel and fence with its right side. The vehicle continued off road

and impacted a utility pole with its front bumper. At impact with the pole, the driver's frontal air bag deployed and the driver's safety belt pretensioner fired. The driver's forearms were contacted by the deploying frontal air bag, resulting in the 5.1 cm x 5.1 cm (2.0" x 2.0") bilateral forearm abrasions. The driver initiated a forward trajectory in response to the 12 o'clock impact force. The combination of safety belt usage and frontal air bag deployment protected the driver from contact with frontal components, thus preventing possible injury. The driver was reported by the police as not injured and was not transported.



NASS Scene Schematic: **Figure 18**