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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-1999-09-032C
LOCATION - Maryland
VEHICLE - 1998 TOYOTA COROLLA LE
CRASH DATE - March 1999

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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.

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SCI/NASS combination investigation of a side air bag deployment crash involving a 1998 Toyota Corolla LE with manual safety belts and dual front and side air bags, and a 1986 BMW 325.

16. *Abstract*
This report covers a SCI/NASS combination investigation of a side air bag deployment crash that involved a 1998 Toyota Corolla LE, four-door sedan (case vehicle) and a 1986 BMW 325, two-door coupe (other vehicle). This crash is of special interest because the case vehicle was equipped with redesigned front air bags, seat back-mounted side air bags and pretensioners in the retractors of the front outboard safety belt system. The pretensioners actuated and both front air bags plus the driver's side air bag deployed as a result of a narrow front left corner impact. The case vehicle's restrained driver (19-year-old male) sustained non-incapacitating injuries. The case vehicle was traveling north in the northbound lane of a two-lane, two-way, undivided county roadway negotiating a curve left. The other vehicle was traveling south in the southbound lane of the same roadway, negotiating a curve right, and crossed the center line. The front left corner of the other vehicle impacted the case vehicle's front left corner and continued swiping down the left side, causing both of the case vehicle's front air bags and driver's seat back-mounted side air bag to deploy. The case vehicle's driver was seated with his seat track located in its middle position, the seat back slightly reclined, and the tilt steering wheel located in its upmost position. He was transported by ambulance to a hospital where he was treated and released. According to his medical records, he sustained multiple lacerations from flying glass and an upper chest wall strain. The case vehicle's restrained front right passenger (18-year-old female) was seated with her seat track located in its middle position. She was transported by ambulance to a hospital where she was treated and released. According to her medical records, she sustained a minor scalp laceration, left ear abrasion and contusion, right hand laceration, lower right leg laceration, and multiple chest wall strains as a result of this crash. Both vehicles were towed from the scene due to damage.

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BACKGROUND

NASS-1999-09-032C

This combination SCI/NASS crash investigation concerns a 1998 Toyota Corolla (case vehicle, NASS vehicle #2) and a 1986 BMW 325i (other vehicle, NASS vehicle #1). The crash occurred in March 1999, at 12:20 p.m., in Maryland and was investigated by the applicable police department. This crash is of special interest because the case vehicle was equipped with redesigned front air bags, seat back-mounted side air bags and safety belt pretensioners in the front outboard seat positions. Both front air bags and the left side air bag deployed and the pretensioners actuated as a result of a narrow front left corner impact with swiping down the left side, and the restrained driver (19-year-old male) sustained non-incapacitating injuries. The NASS researcher inspected the scene and both vehicles in March 1999. This report is based on the Police Crash Report, the NASS researcher's coded forms and scene photographs, scene and vehicle inspections, occupant kinematic principles, medical records, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling north in the northbound lane of a two-lane, two-way, undivided county roadway and was negotiating a curve left, intending to continue traveling north (**Figure 1**). The other vehicle was traveling south in the southbound lane of the same roadway and was negotiating a curve right when he crossed the center line. It is unknown whether the case vehicle driver was able to attempt any avoidance maneuvers prior to the crash. The crash occurred in the northbound lane just over the center line.

Figure 1: Case vehicle's northerly path of travel in left curve at point of impact

The front of the other vehicle impacted the front left bumper corner of the case vehicle, causing the case vehicle's front air bags and driver's side air bag to deploy. This impact redirected the case vehicle off the east edge of the roadway where the right front area swiped along a W-beam guardrail (**Figure 2**). This swiping-type engagement caused the front of the case vehicle to rebound such that the right back area also sustained a separate swiping-type impact with the guardrail. The case vehicle came to rest straddling the roadway edge and the shoulder, heading in a northerly direction. Both vehicles were towed from the scene due to damage.

Figure 2: View of damaged guardrail section from case vehicle's right side impacts

The roadway for the case vehicle was curved left and level at the point of the crash. It was bordered by a solid white fog line on the east edge which was adjacent to a earthen/gravel shoulder (unknown width) and the struck W-beam guardrail (**Figure 2**). The north and southbound lanes were divided by a painted double yellow lines. The roadway for the other vehicle was curved right and level at the point of the crash. It was bordered by a solid white fog line on the west edge which was adjacent to a earthen/gravel shoulder (unknown width) and a W-beam guardrail. It was daylight at the time of the crash and the roadway was dry with no defects. The posted speed limit was 64 km.p.h. [40 m.p.h.].

CASE VEHICLE

The case vehicle was a front wheel drive 1998 Toyota Corolla LE, five-passenger, four-door sedan (VIN: 2T1BR18E6WC------) equipped with a 1.8 liter V4 engine, power-assisted rack-and-pinion steering, and a 4-speed automatic transmission with a console-mounted selector lever. Braking was achieved by a power-assisted, four-wheel anti-lock system. The wheelbase was 246 centimeters [97.0 inches]. The case vehicle had a recorded mileage of 33,701 kilometers [20,941 miles].

The front seat of the case vehicle was equipped with adjustable front bucket seats with adjustable head restraints with manual three-point lap-and-shoulder safety belts which were equipped with pretensioners in the retractors which fired as a result of the crash. The vehicle was equipped with rigid knee bolsters for the driver and front right passenger seat positions. The back row had a bench seat with adjustable head restraints for the outward seat positions. The front safety belt systems were equipped with manually operated height adjusters for the D-rings, with both in the full-up position. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of redesigned front air bags and seat-mounted side air bags for the driver and front right seat positions.

Figure 3: Frontal view of case vehicle; Note: narrow corner damage and windshield damage

Figure 4: Front left oblique view of damage to case vehicle's front left corner which extended down left side

CASE VEHICLE DAMAGE

The case vehicle's initial contact with the other vehicle involved the front left bumper corner and extended down the left side (**Figures 3-4**). The case vehicle's right side impact with the W-beam guardrail involved the entire right side. Direct damage from the case vehicle's impact with the other vehicle, which deployed the front and left side air bags, extended from the front left bumper corner inwards 20

centimeters [7.9 inches] with swiping-type damage extending down the left side. The direct damage for the case vehicle's second impact involving the guardrail began slightly rearward of the right front bumper corner and extended rearward to the right B-pillar. The maximum crush impact #2 was a measured as 16 centimeters [6.3 inches] at C6. The direct damage from the third impact began at the right B-pillar and extended rearward to the right rear bumper corner (**Figure 5**), with maximum crush measured as 25 centimeters [9.8 inches], near the center of the right quarter panel. The wheelbase was shortened by 2 centimeters [0.8 inches] on both sides. The windshield glazing sustained multiple stress cracks and the driver's door glazing was disintegrated from the left side impact.

Based on the vehicle inspection, the CDCs were determined to be: impact one, **12-FLAE-9 (350)**, impact two **01-RYMW-1 (20)** and impact three **01-RZMS-1 (20)** for the case vehicle. Maximum crush was 7 centimeters [2.8 inches] at the front left corner, with 301 centimeters [118.5 inches] of swiping-type contact along the left side. The WinSMASH reconstruction program, damage algorithm based on the measured crush profile for both vehicles, was used on the case vehicle's narrow frontal impact. The Total, Longitudinal and Lateral Delta Vs are, respectively: 46 km.p.h. [29 m.p.h.], -45 km.p.h. [-28 m.p.h.], and +8 km.p.h. [+5 m.p.h.]. Because this impact involved a swiping-type engagement, these results should be considered as a borderline reconstruction.

Figure 5: Case vehicle's right side damage; stands set for event #3

An examination of the case vehicle's interior showed evidence of contact by the vehicle's occupants to the driver's door panel including the side hardware and armrest, left A-pillar, and center instrument panel. The energy absorbing steering column was not inspected. The case vehicle driver's knee bolster showed evidence of minor deformation. There was visible evidence of minor intrusion to the case vehicle's driver door panel which measured 5 centimeters [1.9 inches] and the left side panel forward of the A-pillar which measured 4 centimeters [1.6 inches].

CASE VEHICLE'S AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a SRS that consisted of front air bags and seat back-mounted side air bags at the driver and front right passenger seat positions. The driver and front right passenger front air bags deployed as a result of the narrow frontal engagement, and the left side air bag deployed as a result of the swiping action along the vehicle's left side involving the front left bumper of the other vehicle. The driver's air bag deployed from the steering wheel

Figure 6: View of case vehicle driver's deployed front air bag

hub were it was mounted. The module cover consisted of H-configuration cover flaps made of thick vinyl with overall dimensions of 16 centimeters [6.3 inches] at the center horizontal seam and 6 centimeters [2.4 inches] vertically for the upper flap and 9 centimeters [3.5 inches] for the lower flap. The driver's air bag was designed without tethers. The driver's air bag was round with diameter 52 centimeters [20.5 inches] and was designed with two vent ports (unknown diameter) located at the eleven and one o'clock positions. Inspection of the case vehicle driver's front air bag revealed no visible evidence of contact by the case vehicle driver (**Figure 6**). In addition, the driver's air bag module cover flaps showed no visible evidence of direct contact from the driver.

The front right passenger air bag was mounted on the top of the front right instrument panel. The cover flaps appear to be made of a thick vinyl-like substance. The flap's angled dimensions were 23 centimeters [9.1 inches] at the horizontal seam, 5 centimeters [2.0 inches] for the left upper vertical seam, 7 centimeters [2.8 inches] for the lower left vertical seam and 5 centimeters [2.0 inches] for the lower right vertical seam. The profile of the case vehicle's instrument panel with the leading edge of the cover flap was not measured. The front right passenger's air bag module cover flaps opened properly along the tear points. Inspection of the cover flaps revealed no damage. Examination of the front right passenger air bag showed no evidence of damage or contact other than what the investigator thought was a food splatter to the lower right corner of the air bag (**Figure 7**). The front right passenger air bag had no tethers but did have two vent ports at the nine and three o'clock positions. The air bag's front face was 64 centimeters [25.2 inches] wide and 60 centimeters [23.6 inches] tall.

Figure 7: View of front right passenger's deployed front air bag; NOTE: food evidence not visible

The driver's seat back-mounted side air bag (**Figure 8**) deployed as a result of the swiping-type damaged along the case vehicle's left side during the impact with vehicle #2. The driver's side air bag deployed through a seam on the outboard side of the driver's seat back. The side air bag was 33 centimeters [13 inches] longitudinally and 22 centimeters [8.7 inches] vertically. The driver's side air bag had no vent ports and was not tethered. An inspection of the case vehicle driver's side air bag revealed no visible evidence of direct contact from the driver.

Figure 8: Case vehicle's deployed seat back-mounted left side air bag

The case vehicle's (19-year-old male, unknown race and ethnicity, 163 centimeters, 54 kilograms [64 inches, 119 pounds]) driver was restrained by his available, active, three-point, lap-and-shoulder safety belt system, which was equipped with a pretensioner that did actuate.

The case vehicle's driver was probably seated in an upright posture with his back against the seat back, his left foot was on the floor, his right foot on the accelerator, and both hands on the steering wheel. His seat track was located in its middle position, the seat back was slightly reclined, and the tilt steering wheel was in the full-up position.

Figure 9: Interior view of case vehicle driver's seating area and instrument panel

The case vehicle's driver made no known avoidance maneuvers and his pre-impact posture probably remained unchanged prior to impact. The case vehicle's impact with the other vehicle resulted in the case vehicle's driver moving primarily forward and slightly leftward. His seat belt pretensioner in the retractor fired, keeping him in a relatively unchanged seated position, limiting his forward motion and preventing him from absorbing the full power of the deploying front air bag. The deploying air bag most likely contacted him knocking him back and to the left as the other vehicle swiped down the left side. The case vehicle driver most likely contacted the intruding side arm rest) with his abdomen as the case vehicle was redirected to the right towards the guardrail. The case vehicle's subsequent impact with the guardrail resulted in the driver moving back to the right and slightly forward. At final rest the driver was conscious and remained in his seat.

CASE VEHICLE DRIVER'S INJURIES

The driver was transported by ambulance to a hospital where he was treated for police-reported non-incapacitating injuries and released.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	multiple cuts and laceration to his whole body	990600.1 minor	Flying glass	Probable	E.R Records
2.	Right upper thoracic chest wall strain	442214.1 minor	Driver's air bag	Probable	E.R. Records

The case vehicle's front right passenger (18-year-old female, unknown race and ethnicity, unknown height and weight) was wearing her available, active, three-point, lap-and-shoulder, safety belt which was equipped with a pretensioner that did actuate as a result of the crash.

The case vehicle's front right passenger was probably seated in an upright posture with her feet on the floor and both hands on her lap (**Figure 10**). Her seat track was located in its middle position with the seat back sightly reclined.

Figure 10: Case vehicle's front right passenger seating area

The case vehicle's driver made no avoidance maneuvers and the front right passenger's pre-impact posture remained unchanged prior to impact. The case vehicle's impact with the other vehicle resulted in the front right passenger continuing primarily forward and sightly leftward, with her seat belt and the pretensioner keeping essentially in the pre-impact position. Her left lower leg contacted the center instrument panel, with the deploying air bag knocking her backward. As the case vehicle was redirected to the right into the guardrail she moved slightly leftward. The case vehicle's subsequent impact with the guardrail resulted in her moving back forward and slightly to her right hand flailing and contacting the right A-pillar. At final rest the front right passenger remained in her seat near her original seating position.

CASE VEHICLE'S FRONT RIGHT PASSENGER INJURIES

The front right passenger was transported by ambulance to a hospital where she was treated for police-reported incapacitating injuries and released.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Abrasion, left ear	290202.1 minor	Passenger air bag	Probable	E.R. Record
2.	Laceration, left ear	290602.1 minor	Passenger air bag	Probable	E.R. Record
3.	Laceration, left parietal scalp	190602.1 minor	Flying glass	Probable	E.R. Record
4.	Laceration, right hand	790602.1 minor	Right A-pillar	Probable	E.R. Record

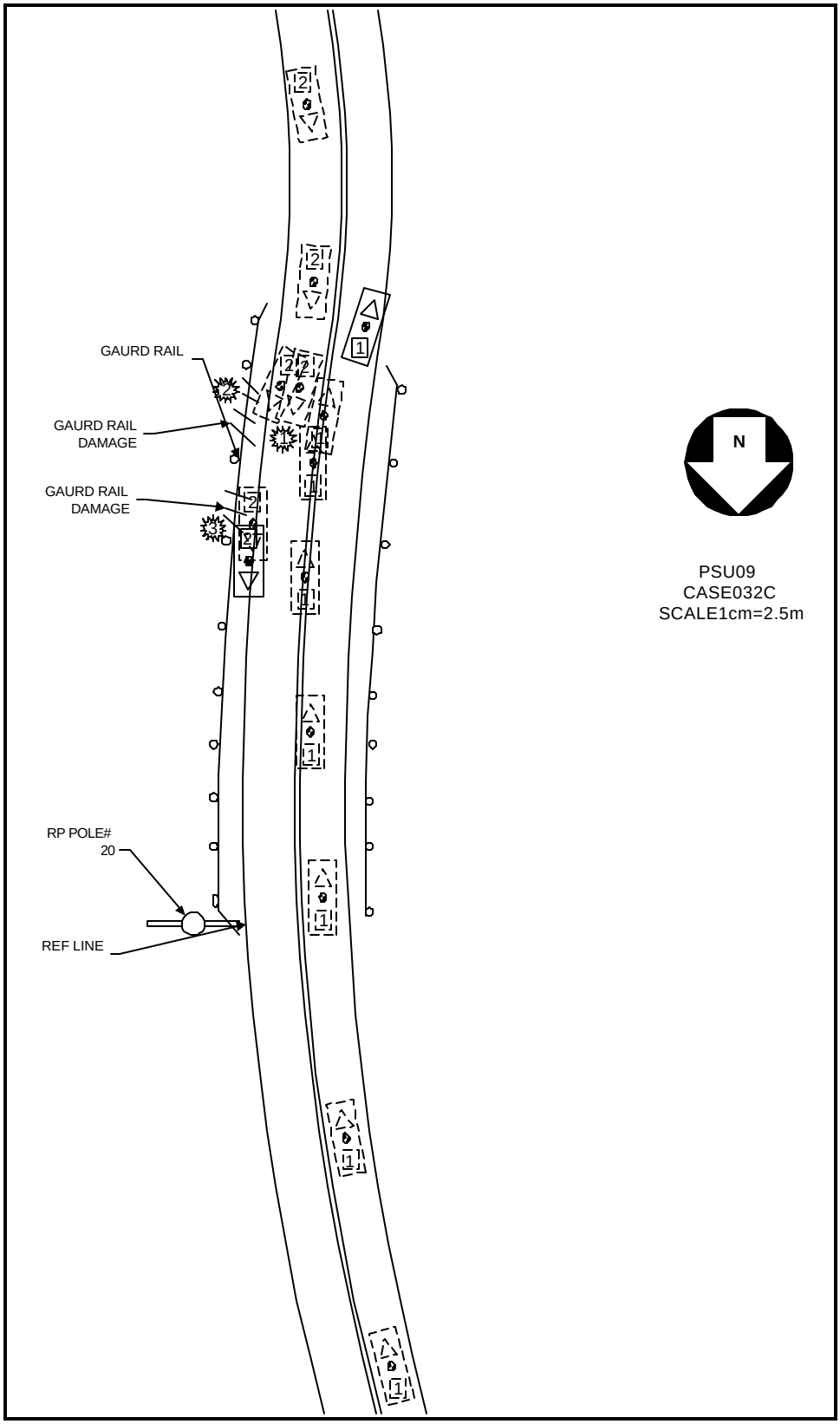
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
5.	Multiple chest wall strains	442214.1 minor	Passenger air bag	Probable	E.R. Record
6.	Contusion, Right lower leg	890402.1 minor	Center Instr. panel	Certain	E.R. Record

OTHER VEHICLE

The other vehicle was a rear wheel drive 1986 BMW 325, five-passenger, two-door, coupe (VIN: WBAAB6404G1------) equipped with a 4-speed automatic transmission and a 2.7 liter,V6 engine vehicle. The BMW's wheelbase was 257 centimeter wheelbase [101.2 inches]. Braking was achieved using a, self adjusting front disk and rear drum system. The vehicle's odometer reading was 164,400 kilometers [102,156 miles].

The vehicle was equipped with three-point lap-and-shoulder safety belts for the front outboard seat positions. The interior was equipped with a adjustable bucket seats with integral head restraints for the driver and front right passenger. Damage to the other vehicle was to the front end, primarily to the left half of the vehicle (**Figure 11**). The vehicle's front bumper was torn off its mounts and the left front wheel and tire assembly was torn off the vehicle's chassis. The vehicle's entire front end sustained induced damage with the maximum crush being 70 centimeters [27.6 inches] at the front left corner. The WinSMASH reconstruction program, damage algorithm based on the measured profiles of both vehicles, was used. The Total, Longitudinal and Lateral Delta Vs were, respectively: 45 km.p.h. [28 m.p.h.], -45 km.p.h. [-28 m.p.h.] and 0 km.p.h. [0 m.p.h.].

Figure 11: Front left oblique view of deformation to the other vehicle's front end; NOTE: torn away front left tire in foreground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