TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS REMOTE SIDE IMPACT AIR BAG INFLATABLE OCCUPANT PROTECTION INVESTIGATION

GENERAL DYNAMICS CASE NO. – CA02-036

SUBJECT VEHICLE – 1999 PORSCHE 911 CARRERA

LOCATION - STATE OF FLORIDA

CRASH DATE – APRIL 1999

Contract No. DTNH22-01-C-17002

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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 air bag and the injury mechanisms for the front right occupant in a 1999 Porsche 911 Carrera. The Porsche was equipped with redesigned frontal air bags and door panel mounted head and torso side impact air bags for the front seating positions. The Porsche was involved in a run-off-road crash resulting in impacts with a curb, guy wire, hedge, and a concrete utility pole. The right door panel mounted side impact air bag deployed. The vehicle was occupied by an unrestrained 42-year old male driver and a restrained 52-year old male front right passenger. The unrestrained driver was ejected from the vehicle as it spun in a clockwise direction to final rest. The driver sustained police reported moderate severity injuries that consisted of an open laceration to the left leg, distal to the knee, a fractured right tibia, and lacerations to the upper lip. The driver was transported by ambulance to a local medical center for treatment. The front right passenger was transported by ambulance to a local trauma center for treatment. He sustained a contusion of the right lower leg, distal fracture of the left radius and ulna, subchondral fracture of the right tibia plateau, tear of the anterior horn of the right lateral meniscus, and a proximal end fracture of the left fifth metacarpal. A small superficial laceration of the right lobe of the liver was ruled out by the attending physician. The events of the crash were based on the Police Accident Report (PAR), on-scene police photographs of the vehicle and scene, and the hospital medical records.			
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LOCATION - STATE OF FLORIDA
CRASH DATE – APRIL 1999

BACKGROUND

This remote investigation focused on the performance of the side impact air bag and the injury mechanisms for the front right occupant in a 1999 Porsche 911 Carrera. The Porsche was equipped with redesigned frontal air bags and door panel mounted head and torso side impact air bags for the front seating positions. The Porsche **(Figure 1)** was involved in a run-off-road crash resulting in impacts with a curb, guy wire, hedge, and a concrete utility pole. The right door panel mounted side impact air bag deployed. The vehicle was occupied by an unrestrained 42-year old male driver and a restrained 52-year old male front right passenger. The unrestrained driver was ejected from the vehicle as it spun in a clockwise direction to final rest. The driver sustained police reported moderate severity injuries that consisted of an open laceration to the left leg, distal to the knee, a fractured right tibia, and lacerations to the upper lip. The driver was transported by ambulance to a local medical center for treatment. The front right passenger was transported by ambulance to a local trauma center for treatment. He sustained a contusion of the right lower leg, distal fracture of the left radius and ulna, subchondral fracture of the right tibia plateau, tear of the anterior horn of the right lateral meniscus, and a proximal end fracture of the left fifth metacarpal. A small superficial laceration of the right lobe of the liver was ruled out by the attending physician. The events of the crash were based on the Police Accident Report (PAR), on-scene police photographs of the vehicle and scene, and the hospital medical records.

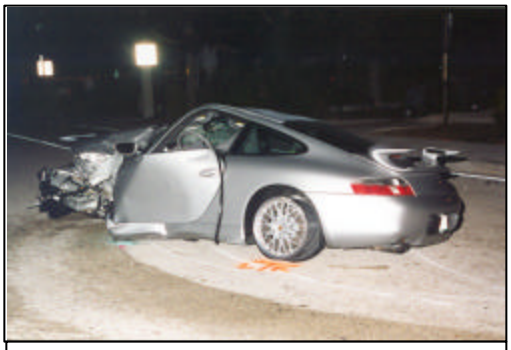

Figure 1. Final rest position of the 1999 Porsche 911 Carrera.

The National Highway Traffic Safety Administration (NHTSA) identified this April 1999 crash and obtained a copy of the PAR and the on-site police photographs. The data was forwarded to the SCI 1 team on September 28, 2002, and assigned as a remote investigative effort. The investigation was assigned based on a police reported liver laceration to the front right passenger that was suspected to be related to the deployment of the side impact air bag. Following the acquisition of the medical records, the liver laceration was ruled out by the attending physician.

CRASH SITE

The crash occurred off-road, at a three-leg "T" intersection of a north/south roadway that intersected an east/west roadway. At the time of the crash, it was dark and the asphalt road surface was dry. There were no adverse weather conditions. The area was illuminated by a series of overhead lights that were positioned outboard of the sidewalk. The east/west roadway was configured with two travel lanes in each direction that were separated by a raised concrete curbed median. The roadway curved left for westbound travel. The east/west roadway was bordered by white fog lines and barrier curbs. The roadside consisted of a sidewalk, light poles, utility poles, and trees. The struck concrete utility pole was located immediately outboard of the concrete sidewalk. The posted speed limit for the east/west roadway was 48 km/h (30 mph). The police scene schematic is included as **Figure 10** of this report.

Vehicle Data – 1999 Porsche 911 Carrera

The 1999 Porsche 911 Carrera was identified by the Vehicle Identification Number (VIN): WP0AA2995X (production sequence omitted). The police did not report the odometer reading. The Porsche was a two-door coupe that was equipped with a rear mounted 3.6-liter, 6-cylinder engine, 4-wheel disc brakes with anti-lock, rear-wheel drive, and a 6-speed manual transmission. The vehicle was equipped with the optional 225/40ZR18 front tires and 265/35ZR18 rear tires mounted on multi-spoke alloy wheels. The interior of the Porsche was configured with front bucket seats with integral head restraints and a two-passenger rear bench seat with a spilt, forward folding seat back. All four seated positions were equipped with manual 3-point lap and shoulder safety belts. In addition to the safety belt systems, supplemental crash protection was provided by redesigned frontal air bags and door mounted side impact air bags for the driver and front right passenger positions. The right side impact air bag deployed during this crash.

Crash Sequence

Pre-Crash

The 42-year old unrestrained male driver of the Porsche was traveling in a westerly direction on the two-lane road. He was attempting to negotiate a left curve in a posted 48 km/h (30 mph) speed zone. The vehicle broke traction and drifted to the right in a slight counterclockwise (CCW) yaw as evidenced by the right side tires marks on the asphalt road surface. The police computed a speed of 98 km/h (61 mph) based on the critical curve tire scuffmarks noted in **Figure 2**. The Porsche drifted across the mouth of the intersection and into the curb at the northwest quadrant of the intersection **(Figure 2)**.

Figure 2. Westbound approach to the curb impacts. Note the pre-impact tire mark(s).

Crash

The right front wheel of the Porsche impacted the barrier curb resulting in an air out and de-beading of the tire from the alloy wheel. Due to the low profile of the tires, the alloy wheel engaged the curb, which fractured the wheel **(Figure 3)**. The vehicle continued its forward trajectory and mounted the curb. The right sill of the Porsche impacted the curb followed by a right rear tire/wheel impact to the curb. The latter tire/wheel impact fractured the alloy wheel and de-beaded the low profile tire.

The right aspect of the Porsche mounted the curb and traveled on the concrete sidewalk for a police measured distance of 235.0 meters (93.0'). During this trajectory, the Porsche transitioned from a slight CCW yaw to a tracking attitude based on probable driver steering inputs.

Figure 3. Initial curb right side curb impacts.

Figure 4. Area of impact with guy wire, hedge and concrete utility pole.

Based on the trajectory of the vehicle, the front right aspect of the Porsche impacted a cable guy wire that snagged the vehicle and induced a rapid clockwise (CCW) rotation. The damage to the vehicle from this impact was masked by a subsequent pole impact and separation of the bumper fascia. In addition, the available police photographs for this remote investigation did not document the guy wire impact damage. The guy wire fractured under tension during this impact event.

The Porsche rotated rapidly approximately 90 degrees in a CW direction. During this rotation, the inboard aspect of the left front wheel impacted and mounted the barrier curb. The vehicle's center of gravity continued in a westerly direction as the left front fender area impacted a hedge and the left front fender/tire/wheel area impacted a square concrete utility pole **(Figure 4)**. This impact resulted in severe damage to the left front area.

Figure 5. Post-crash spin-out and final rest of the Porsche.

The Porsche continued its CW rotation and separated from the pole, traveling back onto the westbound travel lanes of the roadway as

its center of gravity continued in a westerly direction. The physical evidence at the crash scene suggested the vehicle rotated approximately 225 degrees from the pole impact to final rest **(Figure 5)**. The unrestrained driver of the Porsche was ejected from the left front door window opening onto the concrete sidewalk, west of the struck pole. The Porsche came to rest on the center westbound lane, facing in a southwesterly direction.

Post-Crash

A witness, who observed the departure of the vehicle and the subsequent impacts, stated to the investigating officer that he proceeded to the vehicle as it came to rest. Within the vehicle, he observed the front right passenger restrained by the vehicle's 3-point safety belt system. As he surveyed the crash site, the witness observed the driver lying on the sidewalk approximately 9-12 meters (30-40') west of the struck pole.

Police and rescue personnel arrived on-scene within minutes of the crash. Rescue personnel provided emergency treatment to the injured occupants. Both occupants of the Porsche were transported to a local medical center for treatment. It should be noted that based on the police report, both occupants were uncooperative with hospital and police personnel.

Vehicle Damage

Exterior Damage – 1999 Porsche 911 Carrera

The 1999 Porsche Carrera sustained severe damage as a result of the multiple event crash. All damage assessments were derived from the on-scene police photographs of the vehicle and the crash site.

The initial impact involved the right front tire and wheel against the barrier curb. The damage consisted of a fracture to the wheel rim bead area and the air out and de-beading of the front right tire.

The second impact involved the right sill area of the Porsche as the vehicle impacted and overrode the barrier curb. The damage consisted of abrasions and slight deformation to the lower sill.

The third impact was to the Porsche's right rear wheel impacting the curb. The damage consisted of a fracture to the outer edge of the alloy wheel and the de-beading of the tire.

The fourth impact involved the front right corner area of the Porsche against the cable guy wire. The forward edge of the front fender appeared to be buckled rearward from the probable cable impact. The remaining damage was masked by the subsequent pole impact, which deformed the frontal structure and separated the bumper fascia.

The fifth impact was the inboard aspect of the left front wheel impacting the curb as the Porsche rotated clockwise following the guy wire impact. The extent of the damage is unknown due to overlapping pole damage and separation of the wheel and suspension components.

The sixth impact was to the left front fender impacting a hedge. This superficial impact resulted in green vegetation transfers and abrasions to the painted surfaces of the left front fender. The damage from this event was overlapped from the pole impact.

The seventh and most significant impact to the Porsche involved the left front side area contacting the square concrete utility pole **(Figure 6)**. The damage from this event consisted of a fractured left front axle, extensive lateral deformation of the left front fender, hood, left frame rail, lateral and longitudinal displacement of the A-pillar, induced deformation of the front left door, fractured windshield, and shattered front left glazing. The Collision Deformation Classifications (CDC) for this multiple event crash is identified in the following **Table 1**.

Figure 6. Left side damage to the Porsche.

Table 1. Collision Deformation Classifications

Event No.	CDC	Object Struck
1	12-FRWN-3	Curb
2	12-RPLS-1	Curb
3	12-FRWN-9	Curb
4	12-FREN-2	Cable guy wire
5	01-FLWN-3	Curb
6	10-LFEW-1	Hedge
7	10-LFEW-3	Concrete utility pole

Interior Damage – 1999 Porsche 911 Carrera

The 1999 Porsche 911 Carrera sustained severe interior damage as a result of intrusion and occupant contacts. The most significant intrusion appeared to be the vertical and longitudinal displacement of the left side instrument panel **(Figure 7)**. Other intrusions include longitudinal displacement of the left toe pan, lateral displacement of the left side-kick panel forward of the A-pillar, and vertical and longitudinal displacement of the steering assembly.

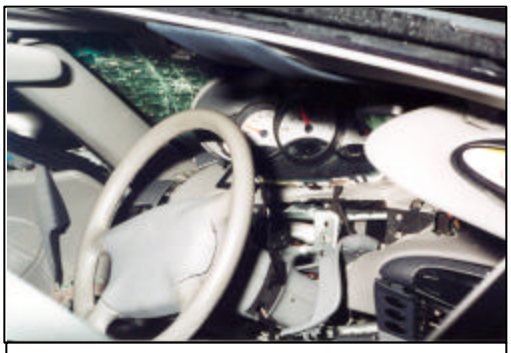

Figure 7.Vertical and longitudinal intrusion of the left instrument panel.

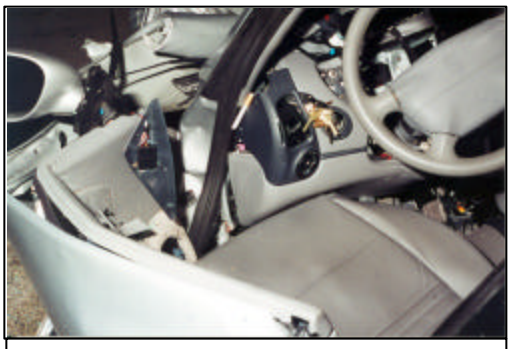

Figure 8. Driver's left leg contact to instrument panel mounting bracket.

The driver's lower left leg contacted the edge of the intruding mounting bracket for the left instrument panel **(Figure 8)**. A tissue transfer and body fluid evidenced the contact point. The driver's left hip and torso loaded the left side door panel, which resulted in outward bowing of the door panel. The front right occupant contacted and loaded the center console with his left hip and left thigh, displacing the center console laterally left. It appeared from the photographs that the console was also fractured from occupant loading.

Side Impact Air Bag System - 1999 Porsche 911 Carrera

The 1999 Porsche 911 Carrera was equipped with door mounted side impact air bags for the front seat positions. The sensors for the side impact air bags were located on the driver and passenger side rocker panels. Although the Porsche sustained a significant left side impact, the front left door side impact air bag did not deploy. The front right door panel mounted air bag did deploy. The police images of the deployed side impact air bag depict a large bag **(Figure 9)**, typical of providing torso and head protection. There were no lateral impacts to the right side of the vehicle; however, the sill of the Porsche contacted the barrier curb early in the crash sequence. This impact may have resulted in deployment of the bag, or the side impact air bag could have deployed from the rapid CW rotation following the pole impact.

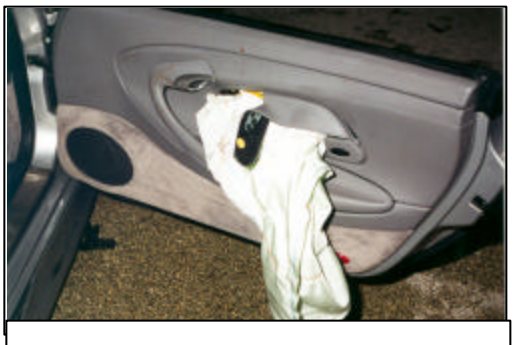

Figure 9. Deployed front right side impact air bag.

Manual Restraint Systems – 1999 Porsche 911 Carrera

The 1999 Porsche Carrera was equipped with manual 3-point lap and shoulder belts for each seating position. The safety belts were equipped with unknown type latch plates and retractors. The driver did not utilize the safety belt and was consequently ejected from the vehicle. The front right passenger was restrained by the manual 3-point safety belt system; however, there were no police photographs of the belt system.

Occupant Demographics

Driver

Age/Sex:	42-year old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Unknown track position
Manual Restraint Use:	Not restrained
Usage Source:	Police report, occupant ejection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local medical center

Driver Injuries

Injury	Injury Severity (AIS 90 Update 98)	Injury Mechanism
Fractured right tibia, NFS	Moderate (853404.2,1)	Steel mounting bracket for the left instrument panel
Left leg laceration distal to the knee, NFS	Minor (890600.1,2)	Steel mounting bracket for the left instrument panel
Laceration of the upper lip, NFS	Minor (290600.1,8)	Flying glass

Source - Police report

Driver Kinematics

The driver of the Porsche was presumed to have been seated in an upright driving posture. He was not restrained by the manual 3-point safety belt system. The lack of belt usage was derived from the police report and the complete ejection status of the driver. The initial curb impacts to the right side sill and wheels probably displaced the driver forward and slightly to the right. As the vehicle continued forward, it contacted a guy wire with its front right fender, which redirected the driver forward and left as the vehicle rotated in a CW direction. The Porsche continued forward while rotating and the left front side of the vehicle impacted the concrete utility pole. The driver continued in a left lateral trajectory. The concrete utility pole impact resulted in the intrusion and separation of the metal mounting bracket for the left instrument panel. The driver's lower left leg contacted the mounting bracket that resulted in the left leg laceration distal to the knee and a fracture of his right tibia. The impact also shattered the front left glazing and the flying glass probably resulted in the upper lip laceration. The driver loaded the left door in response to the lateral impact force and deformed the door outward. Due to his unrestrained status, the driver was ejected from the vehicle. He came to rest on the sidewalk, west of the struck pole. No apparent injury resulted from the ejection.

The driver was transported by ambulance to a regional medical center. The SCI team contacted this medical center to obtain a copy of his medical records. The facility did not have a record of his treatment for this crash, therefore his injures were obtained from the PAR.

Front Right Passenger

Age/Sex:	52-year old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Unknown track position
Manual Restraint Use:	3-point manual lap and shoulder belt
Usage Source:	Police report, witness observations
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a regional medical center where he was admitted to the Trauma unit for treatment of his injuries.

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90 Update 98)	Injury Mechanism
Left distal radius fracture	Moderate (752802.2,2)	Steering assembly/upper instrument panel (possible)
Left distal ulna fracture	Moderate (753202.2,2)	Steering assembly/upper instrument panel (possible)
Non-displaced fracture of the proximal end of the left 5th metacarpal,	Moderate (752002.2,2)	Steering assembly/upper instrument panel (possible
Tear of the anterior right lateral meniscus horn	Minor (850822.2,1)	Glove box door (probable)
Subchondral fracture of the right lateral tibia plateau	Minor (853406.2,1)	Glove box door (probable)
Contusion over the right lower leg	Minor (890402.1,1)	Glove box door (probable)

Source – Medical Records

Front Right Passenger Kinematics

The front right passenger of the Porsche was presumed to have been seated in an upright posture at the on-set of the crash due in part to the small occupant space of this performance sports car. He was restrained by the manual safety belt system, however, it was unknown if the belt system was properly worn. Belt usage was police reported and observed by a witness to the crash. The police report listed a small laceration of the liver and a broken bone in his right hand which initiated this remote level SCI investigation.

Based on the dynamics of the crash, the front right passenger would have initiated a forward and lateral trajectory to his left in response to the multiple events associated with this crash. His right leg probably loaded against the glove box door which could have contributed to the tibial plateau fracture, the right meniscus tear, and the contusion of the lower leg. In addition to the leg injury, the front right passenger sustained a fracture of the left 5th metacarpal, and left distal fractures of the radius and ulna. Although no specific contact points were visible within the vehicle, these fractures possibly resulted from contact against the intruding steering assembly or the upper instrument panel.

The passenger was removed from the vehicle by rescue personnel and transported to a trauma facility of a regional medical center where he was admitted for treatment of his injuries.

The medical records (Discharge Summary and Radiology) for this passenger were obtained by the SCI 1 team for this remote level investigation. A CAT-scan of the passenger's abdominal regional was performed following his arrival to the hospital. This scan noted a small defect in the anterior aspect of the right lobe of the liver that could represent a minimal laceration to the anterior right lobe of the liver. A second CAT-scan was performed on the day following the crash. This scan noted a persistent tiny superficial laceration of the right lobe of the liver. This injury was ruled out by the

attending physician in his Discharge Summary. The physician noted that the passenger had a questionable liver laceration that on further work-up was demonstrated not to be there. Based on this Discharge Summary, the liver laceration was not listed as an injury for this passenger.

Figure 10: Police Scene Schematic