TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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REMOTE REDESIGNED AIR BAG RELATED CHILD PASSENGER FATALITY INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA00-046

RABSS VEHICLE - 1998 FORD F150 PICKUP TRUCK

LOCATION - STATE OF ARIZONA

CRASH DATE - DECEMBER 1999

Contract No. DTNH22-94-D-07058

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 a two vehicle crash that involved a 1998 Ford F150 pickup truck (subject vehicle) and the 1981 Freightliner articulated tractor trailer (Figure 1). The Ford pickup truck was equipped with redesigned frontal air bags that deployed as a result of an intersection collision with a tractor trailer. The Ford pickup truck was occupied by a 53-year-old male driver, a 48-year-old female front center passenger with a 3-year-old female on her lap, and an 11-year-old female front right passenger with a 5-year-old female on her lap. The driver was the only restrained occupant. The driver of the pickup truck was operating the vehicle northbound on approach to a 3-leg intersection when he detected the tractor trailer turning left across the path of the pickup truck. He steered right and braked which caused the occupants to initiate forward and lateral trajectories. The front area of the pickup truck impacted the leading axle of the trailer on the left side. Impact resulted in moderate damage to the pickup truck. At impact, the redesigned frontal air bag system deployed and the occupants continued forward trajectories. The driver loaded the manual restraint and contacted the deployed redesigned driver's air bag. He was uninjured and refused treatment at the scene. Both unrestrained front center passengers may have partially contacted the deployed redesigned front right passenger's air bag which mitigated contact with the center instrument panel. They had no visible injuries. The adult passenger refused treatment at the scene. The 3-year-old was transported to a local hospital where she was treated and released. The 5-year-old was positioned over the top of the front right passenger's air bag cover flap from pre-crash braking. As the redesigned front right passenger's air bag deployed, the air bag expanded against her head and chest. The 5-year-old sustained an abrasion to the left side of her face, an abrasion to the left cheek, diffuse subscalpular hemorrhage, a contusion of the inferior gyrus, a contusion to the upper right chest, abrasions to the upper left chest, hemorrhage to the anterior mediastinal soft tissues, a laceration to the right fifth finger, and lacerations to the left third and fourth fingers. The 11-year-old sustained a forehead contusion from the occupant-to-occupant contact with the 5-year-old. Both front right occupants were transported by ambulance to a local hospital. The 11-year-old was admitted and the 5-year-old was transferred by helicopter to a regional trauma center where she died 10 hours after the crash.			
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BACKGROUND

Figure 1. 1998 Ford F150 pickup truck

This remote investigation focused on a two vehicle crash that involved a 1998 Ford F150 pickup truck **(Figure 1)**(subject vehicle) and the 1981 Freightliner articulated tractor trailer **(Figure 5)**. The Ford pickup truck was equipped with redesigned frontal air bags that deployed as a result of an intersection collision with a tractor trailer. The Ford pickup truck was occupied by a 53-year-old male driver, a 48-year-old female front center passenger with a 3-year-old female on her lap, and an 11-year-old female front right passenger with a 5-year-old female on her lap. The driver was the only restrained occupant. The driver of the pickup truck was operating the vehicle northbound on approach to a 3-leg intersection when he detected the tractor trailer turning left across the path of the pickup truck. He steered right and braked which caused the occupants to initiate forward and lateral trajectories. The front area of the pickup truck impacted the leading axle of the trailer on the left side. Impact resulted in moderate damage to the pickup truck. At impact, the redesigned frontal air bag system deployed and the occupants continued forward trajectories. The driver loaded the manual restraint and contacted the deployed redesigned driver's air bag. He was uninjured and refused treatment at the scene. Both unrestrained front center passengers may have partially contacted the deployed redesigned front right passenger's air bag which mitigated contact with the center instrument panel. They had no visible injuries. The adult passenger refused treatment at the scene. The 3-year-old was transported to a local hospital where she was treated and released. The 5-year-old was positioned over the top of the front right passenger's air bag cover flap from pre-crash braking. As the redesigned front right passenger's air bag deployed, the air bag expanded against her head and chest. The 5-year-old sustained an abrasion to the left side of her face, an abrasion to the left cheek, diffuse subscalpular hemorrhage, a contusion of the inferior gyrus, a contusion to the upper right chest, abrasions to the upper left chest, hemorrhage to the anterior mediastinal soft tissues, a laceration to the right fifth finger, and lacerations to the left third and fourth fingers. The 11-year-old sustained a forehead contusion from the occupant-to-occupant contact with the 5-year-old. Both front right occupants were transported by ambulance to a local hospital. The 11-year-old was admitted and the 5-year-old was transferred by helicopter to a regional trauma center where she died 10 hours after the crash.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for child fatalities that occurred in vehicles equipped with air bags. The crash occurred in December 1999 and was assigned to the Veridian Special Crash Investigation Team on November 3, 2000 as a remote investigation effort. Police photographs and an autopsy report were obtained, which provide the basis for this narrative report.

SUMMARY

Crash Site

This two vehicle crash occurred during the daylight hours of December 1999. At the time of the crash, there were no adverse conditions as the asphalt road surface was dry. The crash occurred at a 3-leg intersection of a four-lane north/south roadway that was divided by a center left turn lane and a two-lane east/west roadway **(Figure 2)**. Both roadways were straight with level grades. The north/south roadway was bordered by a 4.1 m (13.5') wide shoulder on the west side and a 2.6 m (8.5') wide shoulder on the east side. Traffic control consisted of a stop sign for westbound traffic entering the north/south roadway. The posted speed limit for the north/south roadway was 80 km/h (50 mph).

Figure 2. Northbound view of the 3-leg intersection

Pre-Crash

The 53-year-old driver of the 1998 Ford F150 pickup truck was operating the vehicle in the inboard northbound lane on approach to the 3-leg intersection at a police reported speed of 74 km/h (46 mph). The driver of the tractor trailer failed to recognize the close proximity of the Ford pickup truck and initiated a left turn across the path of the pickup truck. The driver of the pickup truck realized the impending harmful event and steered right and braked with sufficient force to lock the front wheels of the vehicle. The investigating officer documented 32.8 m (107.7') of skid marks from the right front tire **(Figure 3)**. The driver's steering input directed the pickup truck into the outboard lane as it entered the intersection. The equivalent velocity loss due to braking was 74 km/h (46 mph) using a .65 coefficient of friction.

Figure 3. Northbound approach for the Ford pickup truck showing pre-impact skid marks

Crash

As the Ford F150 pickup truck entered the intersection, the front left area impacted the leading axle of the trailer on the trailer's left side. Due to the continued forward motion of the tractor trailer, the pickup truck became snagged by the wheels of the trailer which caused it to rotate counterclockwise (CCW) approximately 20 degrees before the vehicles disengaged. The principal direction of force was in the 12 o'clock sector for the Ford pickup truck and impact resulted in moderate damage. There was minor

damage to the leading left wheel of the trailer. Although outside the scope of WinSMASH, the damage algorithm was utilized to compute a barrier equivilant Delta-V of 23.3 km/h (14.5 mph) for the Ford pickup truck based on the estimated crush profile. The specific longitudinal and lateral components were -22.9 km/h (-14.2 mph) and -4.0 (-2.5 mph), respectively. The results appear consistent with the damage.

Post-Crash

The Ford F150 pickup truck remained in the intersection after the crash **(Figure 4)**. The driver of the tractor trailer completed the left turn and parked the tractor trailer on the west shoulder of the north/south roadway **(Figure 5)**. Police reported that when they arrived, the occupants of the Ford pickup truck were standing outside the vehicle and the 5-year-old female passenger was lying on the roadway outside of the right front door. A passerby who had stopped to assist determined the 5-year-old was not breathing and revived her with CPR. The police reported the child was breathing when they arrived. The driver and adult center passenger of the pickup truck refused treatment at the scene. The three child passengers were transported by ambulance to a local hospital. The 3-year-old was treated and released, the 11-year-old was admitted for treatment, and the 5-year-old was transferred by helicopter to a regional trauma center where she died 10 hours after the crash.

Figure 4. Final rest position for the Ford pickup truck

Figure 5. Tractor trailer truck parked on the shoulder

RABSS VEHICLE - 1998 Ford F150 Pickup Truck

The 1998 Ford F150 series pickup truck was identified by the Vehicle Identification Number (VIN): 1FTZF1724WK (production sequence omitted). The vehicle was a 2-door full-size 4 x 2 regular cab, pickup truck. It was equipped with a 4.2 liter, V-6 engine, anti-lock brakes, and automatic transmission. The seating was configured with a 40/60 split bench seat with a folding back and integrated head restraints for the outboard seating positions. A trailer hitch was noted on the rear of the pickup truck.

VEHICLE DAMAGE - 1998 Ford F150 Pickup Truck

Exterior Damage

The 1998 Ford F150 pickup truck sustained moderate frontal damage as a result of the impact with the tractor trailer. The direct contact damage began approximately 30 cm (12") to the left of the centerline of the bumper and extended to the left bumper corner. The combined direct and induced damage involved the entire frontal plane of the pickup truck **(Figure 6)**. The Collision Deformation Classification (CDC) was 12-FLEW-2. The left bumper fascia was torn and displaced, the left headlamp assembly was fractured, and the grille was deformed on the left side. The left fender was buckled rearward and outward and the hood was buckled at the designated fold points **(Figure 7)**. A crush profile was estimated from police photographs and was as follows: C1 = 41 cm (16"), C2 = 25 cm (10"), C3 = 15cm (6"), C4 = 10 cm (4"), C5 = 5 cm (2"), C6 = 0cm.

Figure 6. Frontal damage to the Ford pickup truck

Figure 7. Left side view of the frontal damage

Interior Damage

Interior damage to the Ford F150 pickup truck was minor and was attributed to occupant contact **(Figure 8)**. Based on police photographs, there were no intruded components. The windshield was cracked from occupant contact above the front right passenger's air bag cover flap and the left sun visor was displaced. Blood spattering was visible on the right door interior.

Figure 8. Interior view of the Ford pickup truck

VEHICLE DAMAGE - 1981 Freightliner Articulated Tractor Trailer

The 1981 Freightliner articulated tractor trailer sustained minor damage as a result of the impact with the pickup truck **(Figure 9)**. The 1984 trailer was a 14 m (46') long refrigerated van utility type. A scuff mark was visible on the left outboard tire of the leading axle of the trailer. According to the police inspection, the spring hanger on the left side of the leading axle of the trailer was damaged.

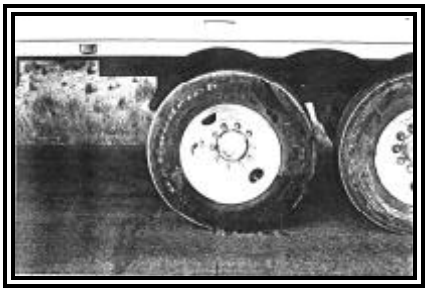

Figure 9. Area of impact to the left side of the trailer

REDESIGNED AIR BAG SYSTEM

The 1998 Ford F150 pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the impact with the tractor trailer. Air bag warning labels were affixed to the sun visors. The driver's redesigned air bag was housed in the center of the steering wheel with asymmetrical H-configuration module cover flaps **(Figure 10)**.

Figure 10. Driver's redesigned air bag

The redesigned front right passenger's air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect **(Figure 11)**. The cover flap was rectangular in shape and was distorted/twisted on the left side from occupant contact. Due to the black and white nature of the police photographs, contact evidence on the cover flap and the air bag surface could not be determined. A cut off switch was noted to the right of the climate controls on the right aspect of the center instrument panel. The position of the switch could not be determined from the available police photographs.

Figure 11. Front right passenger's redesigned air bag

OCCUPANT DEMOGRAPHICS - 1998 Ford F150 Pickup Truck

Driver

Age/Sex:	53-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear (based on police photographs)
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report, driver's statement
Eyewear:	Unknown
Type of Medical Treatment:	Refused treatment at the scene

Driver Kinematics

The driver of the 1998 Ford F150 was presumed to be seated in an upright posture with the bench seat adjusted to the mid-to-full rear position. The seat back was slightly reclined in its post crash state in the police photographs. The driver was properly restrained by the available 3-point lap and shoulder belt system which prevented him from traveling forward in response to the pre-crash braking. At impact, he loaded the manual restraint and probably contacted the deployed redesigned driver's air bag which offered additional protection from the frontal impact forces. He exited the vehicle under his own power and refused treatment at the scene.

Front Center Adult Passenger

Age/Sex:	48-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear (based on police photographs)
Manual Restraint Use:	Unrestrained
Usage Source:	Police report, passenger statements
Eyewear:	Unknown
Type of Medical Treatment:	Refused treatment at the scene

Front Center Adult Passenger Kinematics

The 48-year-old front center adult passenger was presumed to be seated in an upright posture and was holding the 3-year-old female child passenger on her lap. She was unrestrained. Belt non-usage was reported by the police and confirmed by passenger statements. Pre-crash braking caused her to initiate a forward and left lateral trajectory. She may have tried to brace as she realized the impending impact. At impact, she continued the forward trajectory. Although there was no contact evidence, she may have contacted the deployed redesigned front right passenger's air bag which mitigated contact with the center instrument panel. She sustained no visible injuries and refused treatment at the scene.

Front Center Child Passenger (on lap)

Age/Sex:	3-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	On lap of front center adult passenger
Manual Restraint Use:	Unrestrained
Usage Source:	Police report, passenger statements
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released

Front Center Child Passenger Kinematics

The 3-year-old female front center child passenger was seated on the lap of the front center adult passenger. She was unrestrained. Belt non-usage was reported by the police and confirmed by passenger statements. Pre-crash braking caused her to initiate a forward and lateral trajectory with the adult passenger. At impact both occupants continued the forward trajectory. Although there was no contact evidence, she may have contacted the deployed redesigned front right passenger's air bag which mitigated contact with the center instrument panel. She sustained no visible injuries and was transported by ambulance to a local hospital where she was treated and released.

Front Right Passenger

Age/Sex:	11-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear
Manual Restraint Use:	Unrestrained
Usage Source:	Police report, passenger statements
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and admitted

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanisms
Hematoma on forehead	Minor (290402.1,7)	Front right seat occupant on lap (occupant-to-occupant interaction)

Injury source: police report

Front Right Passenger Kinematics

The 11-year-old female front right passenger was presumed to be seated in an upright posture while holding the 5-year-old female passenger on her lap. The 11-year-old was unrestrained. Pre-crash braking caused her to initiate a forward and left lateral trajectory. At impact, the redesigned front right air bag deployed and she continued the forward trajectory. The 5-year-old seated on her lap prevented the 11-year-old from contacting the redesigned front right passenger's air bag. The 5-year-old was projected into the windshield by the air bag cover flap and rebounded rearward as the air bag expanded against her chest. The 11-year-old was still traveling forward as the 5-year-old rebounded rearward, which caused the two occupants to collide. The 11-year-old was struck in the forehead by the 5-year-old. The 11-year-old sustained a hematoma on her forehead from the occupant-to-occupant interaction. She was transported by ambulance to a local hospital and admitted for her injuries.

Front Right Child Passenger (on lap)

Age/Sex:	5-year-old female
Height:	119 cm (47")
Weight:	21 kg (47 lb)
Seat Track Position:	On lap of front right passenger
Manual Restraint Use:	Unrestrained
Usage Source:	Police report, passenger statements
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital and transferred by helicopter to a regional trauma center where she died 10 hours after the crash

Front Right Child Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Probable Injury Mechanisms
Contusion to the left inferior gyrus with diffuse subarachnoid hemorrhage	Serious (140684.3,2)	Front right passenger's air bag
Diffuse subscalpular hemorrhage	Minor (190402.1,9)	Front right passenger's air bag
11.4 x1.0 cm (4.5 x 0.5") abrasion to the left side of the face	Minor (290202.1,2)	Front right passenger's air bag membrane
5.0 x 1.0 cm (2.0 x 0.5") abrasion to the left cheek	Minor (290202.1,2)	Front right passenger's air bag membrane
10.0 x 1.0 cm (4.0 x 0.5") curvilinear contusion to the upper right chest	Minor (490402.1,1)	Front right passenger's air bag cover flap
Abrasions to the upper left chest	Minor (490202.1,2)	Front right passenger's air bag membrane
1 cm (.25") laceration to lateral right fifth finger	Minor (790602.1,1)	Windshield glazing
4cm (1.5") laceration to anterior left third finger	Minor (790602.1,2)	Windshield glazing

Injury	Injury Severity (AIS 90/Update 98)	Probable Injury Mechanisms
2 cm (.75") laceration to anterior left fourth finger	Minor (790602.1,2)	Windshield glazing
Hemorrhage to anterior mediastinal soft tissues with presumed thymus	N/A (not coded under AIS 90/98)	Indirect - front right passenger's air bag expansion

Injury source: Autopsy report

Front Right Passenger Kinematics

The 5-year-old female passenger was seated on the lap of the 11-year-old front right passenger and was unrestrained. Pre-crash braking caused her to initiate a forward and left lateral trajectory which placed her over the left side of the cover flap and in the deployment zone of the redesigned front right passenger's air bag. The 11-year-old may have tried to restrain her by locking her arms around the 5-year-old's waist, which may have caused her to jackknife forward. Her head was most likely rotated clockwise. At impact, the redesigned front right passenger's air bag deployed. The cover flap struck the 5-year-old on the right upper aspect of the chest which resulted in a 10.0 x 1.0 cm (4.0 x 0.5") curvilinear contusion. Her arms were probably extended in an effort to brace and probably contacted the windshield which resulted in 1 cm (.25") laceration to lateral right fifth finger, a 4 cm (1.5") laceration to anterior left third finger, and a 2 cm (.75") laceration to anterior left fourth finger. The redesigned air bag expanded against her chest and the left side of her head which caused a contusion to the left inferior gyrus with diffuse subarachnoid hemorrhage and diffuse subscalpular hemorrhage, an 11.4 x1.0 cm (4.5 x 0.5") abrasion to the left side of the face, a 5.0 x 1.0 cm (2.0 x 0.5") abrasion to the left cheek, abrasions to the upper left chest, and hemorrhage to anterior mediastinal soft tissues with presumed thymus. She rebounded rearward and struck the forehead of the 11-year-old. Although she did not have an injury indicative of the occupant-to-occupant contact, the contact is probable given the injury to the 11-year-old. She was not breathing when she was removed from the vehicle. A passer-by initiated CPR and revived the 5-year-old prior to arrival of rescue personnel. She was transported by ambulance to a local hospital and transferred by helicopter to a regional trauma center where she died 10 hours following the crash.

A post exam was performed on the 5-year-old however, the exam was evasive in that there was no sectioning of internal organs. Therefore, additional injuries may have been present that were not reported or discovered during the post exam.