TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1998-45-121B

RABSS VEHICLE - 1998 CHEVROLET K-1500 PICKUP TRUCK

LOCATION - STATE OF TENNESSEE

CRASH DATE - SEPTEMBER, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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Washington, D.C. 20590

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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 investigation focused on a two vehicle crash involving a 1998 Chevrolet K-1500 pickup truck (subject vehicle) and a 1986 Ford Escort Pony 2-door hatchback. The Chevrolet pickup was equipped with redesigned frontal air bags that deployed as a result of a narrow end engagement with the Ford Escort. The Ford driver was operating the vehicle southbound and negotiating a left curve on a 4-lane roadway when she apparently had fallen asleep and allowed the vehicle to enter the northbound lanes. As the Ford entered the northbound lanes, the front left area struck the front left area of the Chevrolet pickup resulting in moderate damage. The Chevrolet pickup came to rest on the east shoulder facing northeast. The Ford Escort came to rest in the southbound lanes facing southwest. The 23 year old male driver of the Chevrolet pickup was seated in an upright posture and restrained by the available 3-point manual lap and shoulder belt system. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. He sustained a contusion to the posterior aspect of the left forearm from contact to the left door panel. The driver was not transported to a local hospital for treatment. The unrestrained 20 year old female front right passenger was asleep and out of position leaning to the right. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned passenger air bag resulting in a contusion to the chest and posterior aspect of the right forearm. Her knees struck the glove compartment door which resulted in bilateral contusions. The front right passenger was transported to a local hospital for treatment and released.			
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CRASH DATE - SEPTEMBER, 1998

BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Chevrolet K-1500 pickup truck (subject vehicle) and a 1986 Ford Escort Pony 2-door hatchback. The Chevrolet pickup was equipped with redesigned frontal air bags that deployed as a result of a narrow end engagement with the Ford Escort. The Ford driver was operating the vehicle southbound and negotiating a left curve on a 4-lane roadway when she apparently had fallen asleep and allowed the vehicle to enter the northbound lanes. As the Ford entered the northbound lanes, the front left area struck the front left area of the Chevrolet pickup resulting in moderate damage. The Chevrolet pickup came to rest on the east shoulder facing northeast. The Ford Escort came to rest in the southbound lanes facing southwest. The 23 year old male driver of the Chevrolet pickup was seated in an upright posture and restrained by the available 3-point manual lap and shoulder belt system. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. He sustained a contusion to the posterior aspect of the left forearm from contact to the left door panel. The driver was not transported to a local hospital for treatment. The unrestrained 20 year old female front right passenger was asleep and out of position leaning to the right. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned passenger air bag resulting in a contusion to the chest and posterior aspect of the right forearm. Her knees struck the glove compartment door which resulted in bilateral contusions. The front right passenger was transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-45-121B and also included in the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the early evening hours of July, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the northbound lanes of an asphalt 4-lane state roadway **(see Figure 7 - page 6)** which curved right for northbound traffic with a negative grade to the north. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph). The roadside environment featured paved shoulders and W-beam guardrails.

Pre-Crash

The 17 year old female driver of the 1986 Ford Escort was operating the vehicle southbound and negotiating a left curve in the inboard lane when she apparently had fallen asleep and allowed the vehicle to enter the

northbound lanes **(Figure 1)**. The 23 year old male driver of the 1998 Chevrolet pickup was operating the vehicle northbound **(Figure 2)** and negotiating a right curve in the inboard lane at a driver reported speed of 89 km/h (55 mph). There were no brake marks within either vehicle's trajectory indicative of driver avoidance maneuvers.

Figure 1. Southbound approach for the 1986 Ford Escort Pony.

Figure 2. Northbound approach for the 1998 Chevrolet K-1500 pickup truck.

Crash

As the Ford Escort entered the northbound lanes of the 4-lane roadway, the front left area struck the front left area of the Chevrolet pickup resulting in moderate damage. The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. The missing vehicle algorithm of the WinSMASH program (author re-ran program given errors in the NASS case file) computed velocity changes of 30.6 km/h (19.0 mph) for the subject vehicle and 62.7 km/h (39.0 mph) for the striking Ford. The specific longitudinal components were -30.1 km/h (-18.7 mph) and -62.7 km/h (-39.0 mph). The Collision Deformation Classification (CDC) for this impact to the Chevrolet pickup was 12-FLEE-9 with a principal direction of force of (-)10 degrees [incorrectly coded as 12-FLEK-3 at (+)10 degrees in the NASS case file]. Contact continued rearward along the left side surface as the left front wheel/tire of the Ford engaged (snagged) the left rear wheel/tire of the Chevrolet pickup which redirected the vehicles back into their respective lanes. The Ford Escort traveled approximately 12.0 meters (39.4 feet) and came to rest in the southbound lanes facing southwest. The Chevrolet pickup traveled approximately 36.0 meters (118.1 feet) and came to rest on the east shoulder facing northeast. A multitude of post-impact physical evidence was evident in the case images, however, the NASS researcher failed to identify the evidence during the scene inspection.

Post-Crash

The driver of the Chevrolet exited the vehicle with some assistance as the front right passenger was removed by rescue personnel due to perceived serious injury. The driver of the Ford was removed from the vehicle and reported to have expired at the scene. Treatment for the pickup occupants was rendered at the scene by fire department personnel and emergency medical technicians (EMT). The driver of the Chevrolet was not transported for treatment, however, the front right passenger was transported by ambulance to a local hospital for treatment and released. Although reported to have expired at the scene, the driver of the Ford was transported by ambulance to a local hospital and *pronounced dead* approximately 90 minutes following the crash. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Chevrolet K-1500 pickup truck was identified by the Vehicle Identification Number (VIN): 2GCEK19R9W1 (production sequence deleted). The vehicle was a 3-door pickup (2-door coded in the case file) equipped with four wheel drive and a 5.7 liter, V-8 engine. The vehicle's odometer reading was 29,598 km (18,392 miles) at the time of the crash. The police report listed an unspecified relative as the owner of the vehicle. The seating was configured with a front split bench and a rear (folding back) bench. The driver reported no previous crashes or maintenance on the air bag system (original equipment). A cutoff switch was documented to the center mid-instrument panel area and was set to the "on" position. No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

Figure 3. Frontal damage to the 1998 Chevrolet K-1500 pickup truck.

The 1998 Chevrolet K-1500 pickup sustained moderate frontal damage as a result of the impact with the Ford Escort **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 27.0 cm (10.6 in) inboard (incorrectly identified as 48.0 cm in the NASS case file). The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 135.0 cm (53.1 in). Six crush measurements were documented at the level of the bumper: C1= 88.0 cm (34.6 in), C2= 30.0 cm (11.8 in), C3= 15.0 cm (5.9 in), C4= 10.0 cm (3.9 in), C5= 4.0 cm (1.6 in), C6= 0 cm. The contact damage extended rearward along the left side surface which deformed the fender, deflated/restricted the left front wheel/tire, jammed the left door and shattered the left side glazings. The left rear wheel was also restricted/deflated from rearward displacement against the frame (snagging effect prior to vehicle separation). Induced buckling was noted to the roof area with bed/cab contact noted to the left side. Extension of the left side wheelbase measured 2.0 cm (0.8 in). The windshield fractured from exterior impact forces (only).

Interior Damage

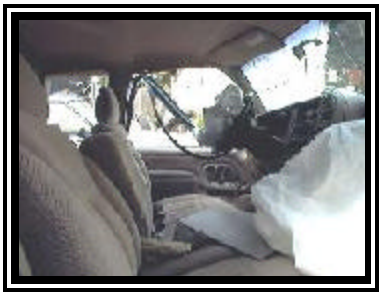

Figure 4. Interior view.

Interior damage to the Chevrolet identified through the NASS vehicle inspection was minimal and was attributed to occupant contact **(Figure 4)**. A scuff mark was documented to the left knee bolster (rigid plastic type). Although the NASS researcher documented 5.0 cm (2.0 in) of upper steering wheel rim deformation, it was not evident in the images (tilt column set to the center position). The glove compartment door was loaded by the unrestrained front right passenger. The knee contacts deformed the door and opened the latch. Intrusions into the driver space included 25.0 cm (9.8 in) of lateral door panel intrusion, 9.0 cm (3.5 in) of lateral sill intrusion, 9.0 cm (3.5 in) of longitudinal toepan intrusion and 9.0 cm (3.5 in) of longitudinal instrument panel intrusion.

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet K-1500 pickup truck was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The flaps were symmetrical in shape and measured 8.0 cm (3.1 in) in width and 11.0 cm (4.3 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, a scuff mark was documented to the lower portion of the air bag. The NASS researcher measured the diameter of the driver air bag at 68.0 cm (26.8 in) in its deflated state **(Figure 5)**. The bag was tethered by two internal straps and vented by two ports located at the 10 o'clock and 2 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The cover flaps were symmetrical and rectangular in shape which measured 33.0 cm (13.0 in) in width and 6.0 cm (2.4 in) in height. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) square in its deflated state **(Figure 6)**. No internal tether straps were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. A cutoff switch was noted to the center mid-instrument panel area and was set to the "on" position.

Figure 5. 1998 Chevrolet K-1500 pickup redesigned driver air bag.

Figure 6. 1998 Chevrolet K-1500 pickup redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	23 year old male
Height:	175 cm (69 in)
Weight:	70 kg (155 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Contusion posterior left forearm (5.0 in)	Minor (790402.1,2)	Left door panel (indirect air bag "fling" injury)

Driver Kinematics

The 23 year old male driver of the 1998 Chevrolet K-1500 pickup truck was seated in an upright posture with his hands placed at the 10 o'clock and 2 o'clock sectors on the steering wheel rim and the seat track adjusted to the mid-to-rear position. He was properly restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the lack of significant injury and contact points within the vehicle. At impact, he initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag propelled the left arm into the door panel, resulting in a contusion to the posterior aspect of the forearm. This mechanism was evidenced by the location of the injury in conjunction with the pre-crash placement of the hands on the steering wheel rim. He subsequently loaded the manual restraint and deployed redesigned driver air bag. No other injury was reported. The redesigned driver air bag provided additional restraint against contact to the steering wheel hub/rim. The driver was not transported to a local hospital for treatment.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	20 year old female
Height:	170 cm (67 in)
Weight:	62 kg (137 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	Contact lenses
Type of Medical Treatment:	Transported to a local hospital and released

Front Right Passenger Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Contusion chest	Minor (490402.1,0)	Front right air bag
Contusion posterior right forearm (4.0 in)	Minor (790402.1,1)	Front right air bag
Contusion bilateral knees	Minor (890402.1,3)	Glove compartment door

Front Right Passenger Kinematics

The unrestrained 20 year old female front right passenger of the 1998 Chevrolet K-1500 pickup truck was asleep and out of position leaning to the right with her arms crossed. The seat back was slightly reclined and the seat track was adjusted to the mid-to-rear position. Lack of belt usage was confirmed by the injuries

sustained relative to the seat track position and rearward extent of the fully deployed air bag. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed redesigned passenger air bag. Contact to the deployed air bag resulted in a contusion to the chest area and posterior aspect of the right forearm (injury source identified as the right door surface in the NASS case file). This mechanism was evidenced by the location of the injury in conjunction with the occupant's pre-impact posture and kinematic response pattern. Her knees struck the glove compartment door resulting in bilateral contusions as evidenced by the displacement of this component. The front right passenger was transported to a local hospital for treatment.

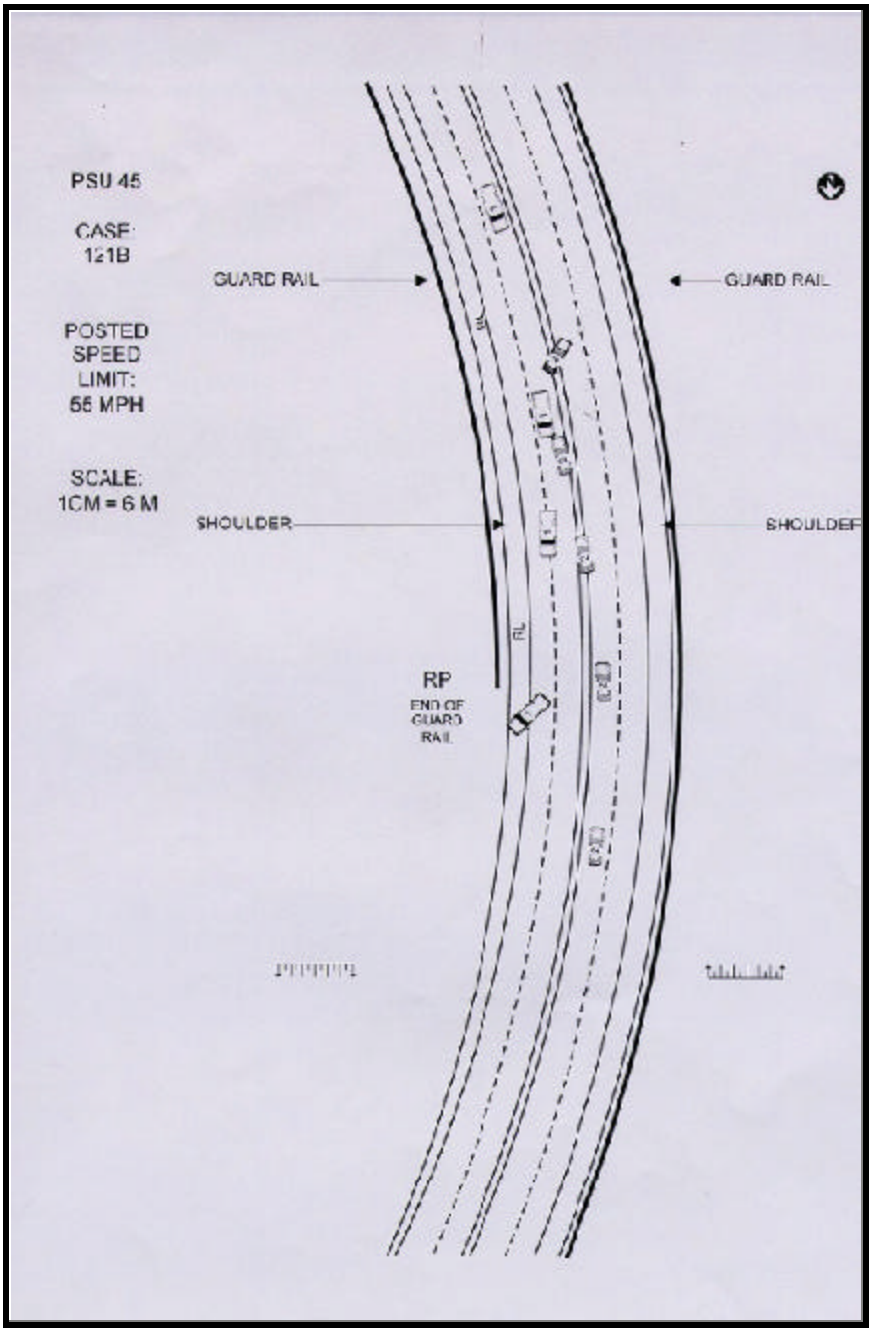

Figure 7. NASS Scene Diagram.