TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian/Calspan Operations
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CALSPAN ON-SITE AIR BAG NON-DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA98-037

VEHICLE - 1995 FORD E350 CARGO VAN

LOCATION - NEW YORK

CRASH DATE - JUNE, 1998

Contract No. DTNH22-94-07058

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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 of the involved vehicle(s) or their safety systems.

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17. *Abstract*

This investigation focused on the non-deployment issues of the Supplemental Restraint System (SRS) in a 1995 Ford E350 4x2 cargo van. The SRS of the Ford consisted of a driver air bag that failed to deploy in a frontal crash with a concrete bridge support column. The vehicle's 38 year old male driver and 38 year old male right front passenger were both unrestrained and sustained multiple injuries as a result of the crash.

The crash occurred when the Ford drifted off the left side of the travel lane, into the median, and struck the concrete column with the front left aspect of the vehicle. The vehicle came to rest in contact with the column. There was no post-impact rotation. The Collision Deformation Classification (CDC) of the vehicle was 12-FYEW-4. The barrier equivalent delta V of the van calculated by the barrier model of the WINSMASH model was approximately 45 km/h (28 mph).

It was noted during the vehicle inspection that two after-market toggle switches (function unknown) and an alarm had been incorporated into the vehicle's electrical wiring. This necessitated a modification to the vehicle's interior electrical wiring. The alarm was mounted, under the instrument panel, by double-sided tape to the enclosure of the SRS diagnostic module. Inspection of the (visible) wiring harness leading to and from the SRS module was unremarkable. The SRS wiring appeared to be isolated and intact. The alarm and accessory wiring appeared to have been spliced into an adjacent wiring harness. The police investigator indicated a cellular phone was also in the vehicle at the time of the crash. It could not be determined if these modifications had any effect on the SRS performance. Evaluation of the fault codes stored in the SRS diagnostic module indicated a Code 51 - open internal thermal fuse. The open circuit prevented the deployment of the air bag system.

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CRASH DATE: JUNE 1998

BACKGROUND

This investigation focused on the non-deployment issues of the Supplemental Restraint System (SRS) in a 1995 Ford E350 4x2 cargo van. The van was involved in a frontal crash with a concrete bridge support column. The SRS of the Ford consisted of a driver air bag that failed to deploy in the impact. The vehicle's driver and right front passenger were both unrestrained and sustained multiple injuries as a result of the crash.

The Special Crash Investigations team at Veridian/Calspan was informed of the crash by a local police jurisdiction on Friday June 26, 1998. Calspan informed the Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) of the air bag non-deployment the same day. An on-site investigation was assigned to the SCI team on Monday June 29, 1998. The vehicle was impounded by the investigating officer pending the SCI inspection.

SUMMARY

This single vehicle crash occurred during the nighttime hours of June, 1998. At the time of the crash, it was dark with street lights illuminating the area. The weather was cloudy and the road surfaces were dry. The crash occurred in an urban section of an asphalt four lane east/west roadway that was divided by a paved median strip. There was an overpass at the crash scene supported by concrete columns. Traffic was channelized by construction cones at the time of the crash. The speed limit in the area of the crash was 64 km/h (40 mph). A

The 1995 Ford E350 cargo van was eastbound in the in-board travel lane, driven by an unrestrained 38 year old male. The vehicle's right front passenger was an unrestrained 38 year old male. The van was owned by a local construction company and was loaded at the time of the crash with unrestrained cargo. The cargo consisted of miscellaneous hand tools and construction equipment. The cargo filled the entire volume of the van's cargo area. The weight of the cargo was 680 kg approximately (1500 lbs).

The crash occurred when the Ford drifted off the left side of the travel lane, into the median, and struck the concrete column with the front left aspect of the vehicle. The vehicle came to rest in contact with the column. There was no post-impact rotation. The unrestrained cargo was displaced forward by the impact, deformed the front seat backs and effectively pinned the occupants in the vehicle. The right front passenger had his feet resting on the dash at the time of impact and was also partially ejected. **Figure 1 and 2** are left front and right front views of the Ford's final rest position taken during the police investigation.

Figure 1: Right view of the Ford's final rest position.

Figure 2: Left view of the Ford's final rest position.

AIR BAG VEHICLE

The 1995 Ford E350 4x2 cargo van was identified by the Vehicle Identification Number (VIN): 1FTJE34H6SH (production sequence deleted). The date of manufacture was 9/94. The vehicle was equipped with a 5.8 liter, V-8 engine linked to a 4-speed automatic transmission. The van's gross vehicle weight rating was 4318 kg (9500 lb). The braking system was hydraulic and consisted of front disc/rear drum ABS. The electronic odometer was inoperative. The front seating system was equipped with bucket seats with reclining seat backs and integral head restraints. The manual restraint system consisted of 3-point lap and shoulder belts with a continuous loop webbing and a sliding latch plate.

It was noted during the inspection that two after-market toggle switches and an alarm had been incorporated into the vehicle's electrical wiring. This necessitated a modification to the vehicle's interior electrical wiring, **Figure 3**. The function of the toggle switches was unknown. The alarm was mounted by double-sided tape to the enclosure of the SRS diagnostic module, **Figure 4**. Inspection of the (visible) wiring harness leading to and from the SRS control module was unremarkable. The SRS wiring appeared to be isolated and intact. The alarm and accessory wiring appeared to have been spliced into an adjacent wiring harness. The police investigator indicated a cellular phone was also in the vehicle at the time of the crash. It could not be determined if these modifications had any effect on the SRS performance.

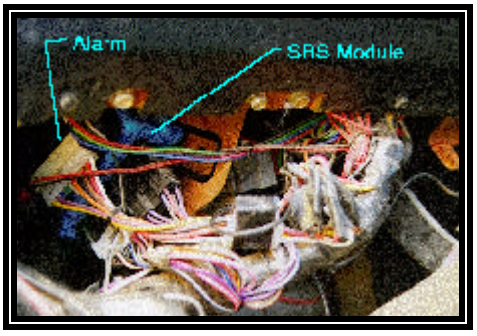

Figure 3: View of the modified electrical wiring.

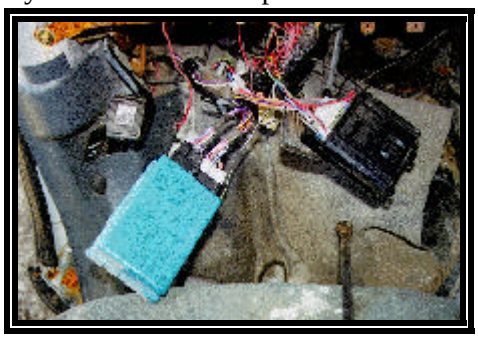

Figure 4: View of the SRS module and after-market alarm.

VEHICLE DAMAGE

Figures 5 and 6 are the front and left lateral views of the Ford. The van sustained 100.3 cm (39.5 in) of direct contact damage to the center and left portions of the vehicle's front plane. The direct damage began 10 cm (4 in) right of center and extended to the left corner of the front bumper. The Field L used in the measurement of the crush profile was 114.3 cm (45.0 in). The crush profile of the front bumper was as follows: C1=50.2 cm (19.75 in), C2=55.9 cm (22.0 in), C3=58.4 cm (23.0 in), C4=58.4 cm (23.0 in), C5=57.8 cm (22.75 in), C6=0. The left and right front fenders buckled in the crash and restricted the operation of the front doors respectively. The left front door and right second door were removed during the extrication of the occupants. The Collision Deformation Classification (CDC) of the vehicle was 12-FYEW-4. The barrier equivalent delta V of the van calculated by the barrier model of the WINSMASH model was approximately 45 km/h (28 mph). The delta V of the vehicle was above the SRS deployment threshold.

Figure 5: Front view of the 1995 Ford E350 cargo van.

Figure 6: Left lateral view across the damaged frontal plane.

At inspection, the steering wheel was rotated 180 degrees and the upper rim was deformed forward and in contact with the steering column, **Figure 7**. The rim deformation was a result of loading from the driver's abdomen.

Figure 7: View of the steering wheel rim deformation.

SUPPLEMENTAL RESTRAINT SYSTEM

The Supplemental Restraint System in the 1995 Ford E350 was inspected by the SCI with the assistance of a independent trained mechanic in an effort to determine the root cause of the system's non-

deployment. The Ford Motor Company was contacted regarding inspection of the vehicle and its Supplemental Restraint System, however they declined to participate.

The vehicle's SRS consisted of: driver air bag module, sliding contact (clock spring), two primary crash sensors, one safing sensor, diagnostic monitor, indicator light, tone generator and the associated electrical wiring. The driver air bag module was configured in the typical manner located in the center hub of the steering wheel. The driver air bag module was identified by the following nomenclature located on the back side of the module:

F5UB-15043B13-AAJABZ
1PZZ3263H101411
NDPM235H10058

The sliding contact, located under the steering wheel, completed the electrical circuit to the driver air bag module from the main wiring harness, while also providing a means for steering wheel rotation. The sliding contact appeared in-tact and properly connected to the driver air bag module. The contact was identified by the follow serial number: *F5UA-14A664-ED*.

The primary crash sensors were located on the upper radiator support approximately on the vehicle's center line and on the right frame rail below the B-pillar, respectively. The safing sensor was located in the front cowl behind the kick panel in the right front foot well. The forward primary sensor was directly involved in the vehicle deformation and could not be located. Inspection of the right primary sensor and safing sensor indicated the sensors were properly mounted and the electrical wiring was in-tact. The SRS diagnostic module was mounted under the instrument panel, left of the steering column. The module was identified by the following nomenclature embossed on the unit's enclosure:

F5AF14B0566
GA2A677FOA
94-09-023

SRS Fault Code Testing

In an effort to determine the cause of the non-deployment it was necessary to determine if the SRS diagnostic module had stored any fault codes. The fault codes were read as a flash sequence from the air bag indicator light mounted in the instrument cluster. The vehicle's owner reported that the van was purchased new and that only ordinary service had been performed on the vehicle prior to the crash. The air bag indicator light, to their knowledge, was not illuminated at the time of the crash. The results of this examination revealed that a Code 51 - internal thermal fuse open - was stored in the diagnostic module and prevented the deployment of the SRS. The root cause of the open fuse could not be determined. The procedure used in reading the indicator light is outlined below.

It was not possible to power the instrument cluster and SRS indicator light through the van's electrical harness due to the extent of engine compartment damage. Power was supplied directly to the SRS diagnostic module by an external 12 volt battery. Section 01-20B (Restraints, Passive, Supplemental Air Bag System) of the 1995 Ford E350 van's service manul was used as a reference in the procedure.

Upon application of power through the connector on the diagnostic module, the air bag indicator light was inactive. Power was removed and the indicator bulb was removed from the instrument cluster. The filaments of the bulb were checked for continuity and were found intact. The bulb was then placed back into the circuit. Upon re-application of the voltage, the indicator light began flashing code 51. Code 51 indicated the internal thermal fuse on-board the diagnostic module was open. According to page 01-20B-12 of the Service Manual the thermal fuse is built into the SRS circuit for the following reason: *"If a short to ground should occur in the air bag deployment circuit, the microcomputer in the air bag diagnostic monitor will send a signal to the fuse causing it to open. The open fuse removes all firing power (battery/back-up power) from the deployment circuits. This prevents unwanted air bag deployments due to damaged vehicle wiring."*

It was hypothesized by the mechanic that the indicator did not initially work because the instrument cluster had lost electrical continuity (ground). The instrument cluster was "loose" and had been jarred due to the force of the impact. Removing and replacing the indicator bulb probably re-established a proper ground to the SRS indicator circuit yielding the flash code.

It should be noted that the Supplemental Restraint System of a 1996 Ford Crown Victoria failed to deploy in an October 1998 frontal pole crash. Calspan investigated this crash under a separate task, refer to case CA98-62. The delta V of that crash was approximately 33 km/h (21 mph). The fault code stored in that vehicle's SRS diagnostic module also indicated an open internal thermal fuse.

DRIVER DEMOGRAPHICS

Age/Sex:	38 year old/male
Height:	unknown
Weight:	unknown
Restraint usage:	unrestrained
Usage source:	vehicle inspection, driver kinematics, police investigation
Medical transport:	ambulance
Extent of hospitalization	4 days

DRIVER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Fracture of left ribs 6 & 7 and left pneumothorax	Serious (450222.3,2)	Steering Wheel/Column
Contusion of the left chest wall	Minor (490402.1,2)	Steering Wheel/Column
Multiple contusions of the right abdominal wall	Minor (590402.1,1)	Steering Wheel/Column

DRIVER KINEMATICS

The 38 year old male driver was amnestic to the events of the crash. He was seated in a presumed normal posture at the time of the crash and was not restrained by the vehicle's 3-point lap and shoulder belt. Upon impact, the driver initiated a forward trajectory and loaded the seating wheel with his chest and abdomen. This contact resulted in the aforementioned deformation of the steering wheel rim, **Figure 7** and fracture of the driver's ribs and pneumothorax. The force of the impact deformed the vehicle's floor pan and the van's unrestrained cargo shifted forward at-impact and contacted the seat back. This contact coupled with the floor pan deformation and the driver's forward trajectory pitched the seat forward and down. The driver was entrapped and required extrication. The driver was hospitalized 4 days following the crash. The medical records indicated the driver's recovery was rapid and unremarkable.

RIGHT FRONT PASSENGER DEMOGRAPHICS

Age/Sex:	38 year old/male
Height:	unknown
Weight:	unknown
Restraint usage:	unrestrained
Usage source:	vehicle inspection, driver kinematics, police investigation
Medical transport:	ambulance
Extent of hospitalization	3 days

RIGHT FRONT PASSENGER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Small focal hemorrhagic contusion of frontal lobe	Serious (140606.3,9)	Jack-knife and inertial contact with lower extremities
Fracture of axillary portion of the left 8^{th} rib	Minor (450212.1,2)	Jack-knife and inertial contact with lower extremities
Nasal fracture	Minor (251000.1,4)	Jack-knife and inertial contact with lower extremities
Lip laceration	Minor (290600.1,9)	Jack-knife and inertial contact with lower extremities
Multiple bilateral ankle abrasions	Minor (890202.1,3)	Fractured windshield

RIGHT FRONT PASSENGER KINEMATICS

The 38 year old male right front passenger was seated unrestrained in the vehicle's right front seat. He was amnestic to the events of the crash and may have been asleep. The passenger's legs were elevated and his feet were resting on the right aspect of the instrument panel. Upon impact, he initiated a forward trajectory and slid forward off the seat cushion onto the floor. The passenger's feet contacted and fractured the windshield. His ankles sustained minor multiple abrasions from the fractured windshield at that time. The force of the impact shifted the van's unrestrained cargo forward, deforming the seat back. The seat back contacted the passenger's torso and caused the passenger to jack-knife. The passenger's head contacted his lower extremities causing head and facial injuries at that time. The passenger became entrapped due to the seat deformation. The right front passenger was hospitalized 3 days following the crash. The medical record indicated the passenger recovered without complication.