TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

Veridian Engineering
Buffalo, NY 14225

REMOTE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA99-034

RABSS VEHICLES - 1998 CHEVROLET MONTE CARLO LS
1998 FORD WINDSTAR

LOCATION - STATE OF CONNECTICUT

CRASH DATE - JULY 1998

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
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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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15. *Supplementary Notes* Remote investigation of a head-on crash that resulted in air bag deployment and the death of the 35-year-old female front-right passenger in a 1998 Ford Windstar. The air bag was not a factor in the death of the Windstar's front-right passenger.			
16. *Abstract* This remote investigation focused on a two-vehicle crash that involved a 1998 Chevrolet Monte Carlo LS (subject vehicle) and a 1998 Ford Windstar minivan. Both vehicles were equipped with redesigned frontal air bags that deployed as a result of a severe offset head-on collision. The 46-year-old male driver of the Monte Carlo was restrained by the available 3-point lap and shoulder belt system. At impact with the Windstar, he initiated a forward trajectory and loaded the manual restraint and deployed redesigned driver's air bag. He sustained head and facial lacerations. He was transported to a local hospital for treatment but his admission status was not reported. The 37-year-old male driver, the 35-year-old female front right passenger, and the 11-year-old female rear right passenger of the Ford Windstar were all restrained by the available 3-point manual lap and shoulder belt systems. The vehicle occupants initiated a forward trajectory in response to the frontal impact force. The driver loaded the manual restraint system and contacted the deployed air bag, and sustained minor injuries. The front right passenger loaded the manual restraint and most likely contacted various lateral and longitudinal component intrusions including the expanding air bag, which resulted in bilateral ankle fractures, left thigh laceration, multiple abrasions on the anterior chest, abdomen, right arm, face, and forehead. The rear right passenger loaded the manual restraint and most likely contacted the intruding right B-pillar resulting in a head injury. The driver and rear passenger were transported to a local hospital for treatment of non-incapacitating injuries. The front right passenger of the Windstar was transported to a local hospital with serious injuries and expired one hour later.			
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BACKGROUND

This remote investigation focused on a two-vehicle crash that involved a 1998 Chevrolet Monte Carlo LS (subject vehicle) and a 1998 Ford Windstar minivan. Both vehicles were equipped with redesigned frontal air bags that deployed as a result of a severe offset head-on collision. The 46-year-old male driver of the Monte Carlo was restrained by the available 3-point lap and shoulder belt system. At impact with the Windstar, he initiated a forward trajectory and loaded the manual restraint and deployed redesigned driver's air bag. He sustained head and facial lacerations. He was transported to a local hospital for treatment but his admission status was not reported. The 37-year-old male driver, the 35-year-old female front right passenger, and the 11-year-old female rear right passenger of the Ford Windstar were all restrained by the available 3-point manual lap and shoulder belt systems. The vehicle occupants initiated a forward trajectory in response to the frontal impact force. The driver loaded the manual restraint system and contacted the deployed air bag, and sustained minor injuries. The front right passenger loaded the manual restraint and most likely contacted various lateral and longitudinal component intrusions including the expanding air bag, which resulted in bilateral ankle fractures, left thigh laceration, multiple abrasions on the anterior chest, abdomen, right arm, face, and forehead. The rear right passenger loaded the manual restraint and most likely contacted the intruding right B-pillar resulting in a head injury. The driver and rear passenger were transported to a local hospital for treatment of non-incapacitating injuries. The front right passenger of the Windstar was transported to a local hospital with serious injuries and expired one hour later.

This crash was identified through a search of the Fatal Analysis Reporting System (FARS) for fatalities that occurred in vehicles equipped with redesigned air bags. The crash occurred in July 1998 and was assigned to the Veridian Special Crash Investigation Team of September 2, 1999 as a remote investigation effort. Police photographs, police reconstruction report, witness statements and an autopsy report were obtained, which provided the basis for this narrative report.

SUMMARY

Crash Site

This two-vehicle crash occurred during the nighttime hours of July 1998. At the time of the crash, it was dark with overhead lighting illuminating the roadway. The asphalt roadway was dry. The crash occurred on a northbound entrance ramp to the northbound travel lanes of an interstate highway. The roadway consisted of one straight travel lane that began to curve to the east as it intersected with the interstate highway. The initial 274 meters (900') of the entrance ramp had a police reported 2.73 percent grade negative to the north. The remaining portion of the entrance ramp had a 1.50 percent grade positive to the

north until it merged with the interstate highway. The roadside environment included asphalt shoulders, the left approximately 1 m (3') wide, and the right approximately 2 m (7') wide. Traffic control at the scene included a yellow merging left sign on the right shoulder of the interstate for the northbound interstate traffic.

Pre-Crash

The 46-year-old male driver of the Chevrolet Monte Carlo was operating the vehicle the wrong way on the northbound entrance ramp at a high rate of speed when he failed to detect the approaching Ford Windstar **(Figure 1)**. The 37-year-old male driver of the Ford Windstar was operating the vehicle northbound on the entrance ramp to the northbound travel lanes of an interstate highway when he detected the 1998 Chevrolet Monte Carlo traveling the wrong way in the opposite direction at a high rate of speed **(Figure 2)**. Upon recognition of the impending harmful event, the driver of the Ford Windstar braked and attempted to steer left. Although the 1998 Ford Windstar was equipped with 4-wheel ABS (anti-lock brakes), the investigating officer documented 13.1 m (43.0') of pre-impact skid marks left by the Windstar **(Figure 3)**.

Figure 1. Southbound approach for the 1998 Chevrolet Monte Carlo

Figure 2. Northbound approach for the 1998 Ford Windstar

Figure 3. Pre-impact skid marks from Ford Windstar

Crash

As the Monte Carlo continued south on the entrance ramp, the front right area of the Chevrolet Monte Carlo impacted the front right area of the Ford Windstar **(Figure 4)**. Impact resulted in severe damage to both the Monte Carlo and the Windstar. The resultant directions of force were in the 12 o'clock sectors for each vehicle. The damage algorithm of the WinSMASH program computed total velocity changes of 80.1 km/h (50.0 mph) for the Monte Carlo and 68.6 km/h (42.9 mph) for the Windstar based on estimated crush profiles. The longitudinal and latitudinal components were -78.8 km/h (-49.3 mph) and -13.9 km/h (-8.7 mph), respectively for the Monte Carlo. The longitudinal and latitudinal components were -67.6 km/h (-42.3 mph) and -11.9 km/h (-7.4 mph), respectively for the Windstar. The impact induced deceleration was sufficient to deploy the frontal air bag systems in both vehicles. The Monte Carlo deflected off of the Windstar and rotated in a CW direction approximately 280 degrees while it traveled in a south direction onto the east

Figure 4. Point of impact looking northbound

shoulder. The Monte Carlo impacted a luminaire with a frangible base approximately 20 cm (8") in diameter with the right rear quarter panel, above the right rear wheel, which caused the luminaire to fracture at the base. This impact caused the vehicle to tip onto its right side approximately 20 degrees. The Monte Carlo continued in a south direction through the luminaire and rotated an additional 350 degrees in a CW direction and subsequently rolled four quarter turns to final rest, which caused the front right wheel to fracture from the vehicle. The vehicle came to rest on the east shoulder facing east. The Windstar rotated approximately 100 degrees and came to rest on the on-ramp facing east.

Post-Crash

The driver of the Chevrolet Monte Carlo could not exit the vehicle due to a jammed left door. The door was removed by rescue personnel and the driver removed thereafter. The police report stated that he was found seated in the driver's seat and was restrained by the 3-point lap and shoulder belt system. He was transported by ambulance to a local hospital for treatment, but his admission status was not reported. The driver of the Ford Windstar exited the vehicle under his own power. The rear right passenger was assisted from the vehicle by the driver. The front right passenger was physically restrained in the seat position by intruding vehicle components and was extricated by rescue personnel. All occupants of the Windstar were transported by ambulance to a local hospital for treatment. Both vehicles were towed from the scene.

RABSS VEHICLES

1998 Chevrolet Monte Carlo

The 1998 Chevrolet Monte Carlo was identified by the VIN: 2G1WW12M3W9 (production sequence omitted). The vehicle was a 2-door coupe equipped with front wheel drive and a 3.1 liter 6 cylinder engine. The vehicle's odometer reading at the time of the crash was 23,709 km (14,818 miles). The police report listed an automotive financing company as the owner of the vehicle. The seating was configured with front bucket seats with folding backs, and a rear bench seat.

1998 Ford Windstar

The 1998 Ford Windstar was identified by the Vehicle Identification Number (VIN): 2FMDA51U9WB (production sequence omitted). The vehicle was a 3-door minivan equipped with front wheel drive and a 3.0 liter, 6 cylinder engine. The vehicle's odometer reading at the time of the crash was 33,670 km (21,044 miles). The police report listed the driver as the owner of the vehicle. The seating was configured with box mounted (van type) front bucket seats and bench seats with folding backs for the second and third rows.

VEHICLE DAMAGE

Exterior Damage - *1998 Chevrolet Monte Carlo*

The 1998 Chevrolet Monte Carlo sustained severe frontal damage as a result of the impact with the Ford Windstar **(Figure 5)**. The CDC for this impact to the Chevrolet Monte Carlo was 12-FREE-8. The direct contact damage began at the right bumper corner and extended approximately 36 cm (14") toward the center of the bumper. The direct damage for this corner impact extended down the right side of the vehicle, extending approximately 152 cm (60") rearward from the right front bumper corner and approximately 60

cm (24") vertically from the lower sill. The maximum crush was at the right bumper corner and estimated to be approximately 152 cm (60"). The CDC for the second impact was 00-RBHN-3. The direct contact damage for the second event (impact with the luminaire) began directly above the center of the right rear axle and extended approximately 38 cm (15") longitudinally toward the front of the vehicle. Direct damage and was approximately 20 cm (8") in depth laterally across the center of the backlight, which was disintegrated from impact forces **(Figure 6)**. Paint transfers and deformation were noted on the luminaire **(Figure 7)**. The CDC for the rollover was 00-TPDO-3. The direct contact damage attributed to the third event (rollover) included scratches and dents in the roof, vertical displacement of the roof, and lateral shift of both C-pillars to the right. Vertical abrasions and buckling were visible on both side planes of the vehicle. The vertical displacement of the roof was estimated to be approximately 10 cm (4"). The front axle fractured during the rollover sequence, resulting separation of the right front wheel. According to the police report, the fuel tank had ruptured due to the crash and was leaking.

Figure 5. Frontal damage to Chevrolet Monte Carlo

Figure 6. Right side damage to Chevrolet Monte Carlo

Figure 7. Fractured luminaire showing deformation and paint transfers

Interior Damage - ***1998 Chevrolet Monte Carlo***

Interior damage to the Chevrolet Monte Carlo was severe and was attributed to exterior deformation and passenger compartment intrusion. Intruded components included the roof, center and right side instrument panel, toe pan, and A-pillar. According to the police report, the right front seat was partially separated due to the crash.

Exterior Damage - ***1998 Ford Windstar***

The 1998 Ford Windstar sustained severe front and right side damage as a result of the impact with the Chevrolet Monte Carlo. The direct contact damage to the frontal plane began at the right front bumper corner and extended approximately 38 cm (15") toward the center of the bumper **(Figure 8)**. The Collision Deformation Classification (CDC) for this initial impact to the Ford Windstar was 12-FREE-9. The direct contact for this corner impact extended down the entire right side of the vehicle as evidenced by displaced and torn sheet metal **(Figure 9)**. The direct contact damage along the right side extended vertically approximately 60 cm (24") from the lower sill. The combined direct and indirect damage involved the full frontal width of the Windstar. The maximum crush was located at the front right bumper corner, and

estimated to be approximately 200 cm (78"). The right front tire was deflated and restricted from rearward displacement. The windshield was cracked and all of the right side tempered glazing was shattered from impact forces.

Figure 8. Frontal damage to Ford Windstar

Figure 9. Right side damage to Ford Windstar

Interior Damage - ***1998 Ford Windstar***

Interior damage to the Ford Windstar was severe and was attributed to exterior deformation and passenger compartment intrusion. Intruded components included the entire upper and lower instrument panel, steering column, left, center, and right toepan. The greatest extent of intrusion was located at the front right passenger position. Components from the engine compartment intruded into the passenger compartment, and the right A-pillar was also intruded. According to the police vehicle inspection, the front right seat of the Windstar was deformed and the seat belt was cut by rescue personnel. The rear view mirror was separated from the windshield due to impact forces. Blood smears were noted on the right front seat and seat belt assembly.

REDESIGNED AIR BAG SYSTEM

1998 Chevrolet Monte Carlo

The 1998 Chevrolet Monte Carlo 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 impact with the Ford Windstar. The driver's air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). Various blood smears were visible on the air bag. There was no identification of vent ports or tether straps.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. No contact evidence was visible on this air bag or the cover flaps.

1998 Ford Windstar

The 1998 Ford Windstar was equipped with redesigned frontal air bags for the driver and right front passenger positions. The air bags had deployed as a result of the impact with the Chevrolet Monte Carlo. The driver air bag was housed in the center of the steering wheel with H-configuration module cover flaps. No contact evidence was visible in the police photographs on the air bag or exterior surface of the module cover flaps. Based on measurements taken from an exemplar vehicle, the flaps were asymmetrical in shape

as the upper flap measured 19.0 cm (7.5") in width and 11.0cm (4.3") in height while the lower flap measured 19.0cm (7.5") in width and 6.0 cm (2.4") in height. There was no identification made as to vent ports or tether straps.

The front right passenger air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. No contact evidence was visible on the air bag or exterior surface of the module cover flap. Based on measurements from an exemplar vehicle, the cover flap was rectangular in shape and measured 33.0 cm (13.0") in width and 13.0 cm (5.1") in height. There was no identification as to vent ports or tether straps.

OCCUPANT DEMOGRAPHICS

Driver -*1998 Chevrolet Monte Carlo*

Age/Sex:	46-year-old-male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Not reported
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to hospital and admitted for treatment

Driver Injuries -*1998 Chevrolet Monte Carlo*

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Laceration head (unspecified)	Minor (190600.1,5)	Flying glass
Laceration face	Minor (290600.1,9)	Flying glass

*Injury source: police accident report

Driver Kinematics -*1998 Chevrolet Monte Carlo*

The 46-year-old male driver of the Chevrolet Monte Carlo was presumed to be seated in an upright posture. He was restrained by the available 3-point lap and shoulder belt system. At impact with the Ford Windstar, he loaded the manual restraint system and probably contacted the deployed redesigned driver's air bag. Following the initial impact, he was redirected throughout the vehicle during the clockwise rotation, impact with the luminaire, and subsequent rollover. He sustained minor head injuries as a result of the sequence of impacts as well as lacerations to the head and face probably due to flying glass. Documentation from police stated that the driver was found slumped in the front left seat and restrained by the 3-point lap and shoulder belt system. He was transported by ambulance to a local hospital and admitted for treatment.

Driver - 1998 Ford Windstar

Age/Sex:	37-year-old-male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Not reported
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Driver statement, police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to hospital and released

Driver Kinematics - 1998 Ford Windstar

The 37-year-old driver of the Ford Windstar was presumed to be seated in an upright posture. He was restrained by the available 3-point lap and shoulder belt system. At impact with the Monte Carlo, the driver initiated a forward trajectory in response to the 12 o'clock impact force, loaded the manual restraint system and contacted the deployed driver's air bag. The combination of restraint systems provided additional crash protection to the driver. He received police reported minor injuries and was transported by ambulance to a local hospital and released.

Front-Right Passenger - ***1998 Ford Windstar***

Age/Sex:	35-year-old female
Height:	150 cm (59")
Weight:	86 kg (189 lbs)
Seat Track Position:	Not reported
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report, autopsy report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to hospital and expired within 1 hour of arrival

Front Right Passenger Injuries - ***1998 Ford Windstar***

Injury	*Injury Severity (AIS 90)*	*Injury Mechanisms*
Laceration aorta, major with transection	Critical (420210.5,4)	Shoulder belt webbing
Laceration 1 cm right ventricle	Critical (441012.5,4)	Shoulder belt webbing
Laceration left lung, multiple hilar tears	Serious (441414.3,2)	Shoulder belt webbing
Lacerations liver, linear	Moderate (541820.2,1)	Shoulder belt webbing
Fractures multiple anterior ribs	Moderate (450210.2,9)	Shoulder belt webbing

Injury	*Injury Severity (AIS 90)*	*Injury Mechanisms*
Fracture sternum	Moderate (450804.2,4)	Shoulder belt webbing
Fractures bilateral ankle	Moderate (852002.2,1) Moderate (852002.2,2)	Right toepan
Abrasion face and forehead	Minor (290202.1,9)	Front right passenger's air bag
Abrasion anterior right arm	Minor (790202.1,1)	Front right passenger's air bag
Abrasion posterior right arm	Minor (790202.1,1)	Right front door interior
Abrasion anterior chest	Minor (490202.1,9)	Shoulder belt webbing
Abrasion anterior abdomen	Minor (590202.1,9)	Lap belt webbing
Laceration 10 cm posterior/lateral left thigh	Minor (890602.1,2)	Front seat center console

*Injury source: autopsy report

Front Right Passenger Kinematics - ***1998 Ford Windstar***

The 35-year-old female front right was presumed to be seated in an upright posture. She was restrained by the available 3-point lap and shoulder belt system. At impact with the Monte Carlo, she initiated a forward trajectory in response to the 12 o'clock impact force. She loaded the manual restraint system, and most likely contacted the deployed front right passenger's air bag. She sustained right and left ankle fractures from loading the intruding floor/toepan, and a gaping laceration on the left thigh most likely due to contact with the front seat center console. She sustained multiple abrasions to the anterior chest, abdomen, multiple anterior rib fractures, fractured sternum, left hemothorax, and a laceration of the aorta most likely from the loading to the manual lap and shoulder belt system. She sustained abrasions to the anterior right arm, face, and forehead most likely from contact with the front right passenger's air bag membrane. She also sustained abrasions to the posterior right arm most likely from the interior surface of the right front door. She was transported by ambulance to a local hospital and expired within 1 hour of arrival.

Rear Right Passenger - ***1998 Ford Windstar***

Age/Sex:	11-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Not reported
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to hospital and admitted for treatment

Rear Right Passenger Injuries - *1998 Ford Windstar*

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Unspecified Head Injury	Unknown Severity (115099.7,0)	Right B-pillar

*Injury source: police accident report

Right Rear Passenger Kinematics - *1998 Ford Windstar*

The 11-year-old female rear right passenger was presumed to be seated in an upright posture. She was restrained by the available 3-point lap and shoulder belt system. At impact with the Monte Carlo, she initiated a forward trajectory in response to the 12 o'clock impact force, and loaded the manual restraint system. She sustained a head injury most likely attributed to the contact of her head with the right B-pillar. She was transported by ambulance to a local hospital where she was admitted for treatment.