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REMOTE AIR BAG DEPLOYMENT REPORT

CASE NUMBER - IN99-104
LOCATION - MISSOURI
VEHICLE - 1998 CHEVROLET CAVALIER Z24
CRASH DATE - July 1998

Submitted:
March 28, 2000

Revised:
April 14, 2000
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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 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 performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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15. *Supplementary Notes*
Remote air bag deployment investigation involving a 1998 Chevrolet Cavalier Z24, with manual safety belts and dual, redesigned front air bags, and a 1991 Chevrolet Cavalier

16. *Abstract*
This report covers a remote investigation of an air bag deployment crash that involved a 1998 Chevrolet Cavalier Z24 (case vehicle) and a 1991 Chevrolet Cavalier (vehicle #2). This triple fatality crash is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events, and the restrained front right passenger [21-year-old female] was fatally injured and the restrained driver [21-year-old male] sustained police-reported “evident-not disabling” injuries. The case vehicle was traveling south in the inside, northbound lane (i.e., traveling in the wrong direction) of a four-lane roadway that was part of an eight-lane, divided, urban interstate highway. Vehicle #2 was traveling north in the same lane (i.e., traveling in the proper direction) of the same urban interstate highway. The crash occurred in the inside, northbound lane. The front of the case vehicle impacted the front of vehicle #2, causing the case vehicle's driver and front right passenger air bags to deploy. This was a very high speed crash, causing nearly catastrophic damage to both vehicles. There is no knowledge of the pre-crash posture or seat adjustments for the case vehicle occupants. There was massive intrusion into the front right seat area. No autopsy was performed but a non-invasive, external examination of her body was conducted. The restrained front right passenger probably contacted her air bag, the intruding instrument panel, the intruding floor, and the intruding right front door’s interior panel and sustained fractures of the first three cervical vertebrae, and numerous abrasions and contusions to her face, neck, and left chest wall. Other injuries included fractures of the left clavicle, the pelvis, and the left ankle, plus multiple abrasions, contusions, and lacerations. She was pronounced dead at the scene. Both occupants of vehicle #2 were killed and both vehicles were towed due to disabling damage.

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Additional photographs are available in SCI EDCS case IN99-104

BACKGROUND

This case was brought to the NHTSA's attention by a review of the Fatality Analysis Reporting System (FARS) in June 1999. The crash involved a 1998 Chevrolet Cavalier Z24 (case vehicle) and a 1991 Chevrolet Cavalier (vehicle #2). This triple fatality crash occurred in July 1998, at 4:45 a.m., in Missouri, and was investigated by the applicable municipal police department. This case is of special interest because the case vehicle was equipped with redesigned air bags that deployed as a result of collision events, and the restrained front right passenger [21-year-old, White (non-Hispanic) female] was fatally injured and the restrained driver [21-year-old male, race/ethnicity unknown] sustained police-reported "evident-not disabling" injuries. The Police Crash Report was received in December 1999, without a scene diagram, but with an attached Certificate of Death for the front right passenger. Police photographs were obtained in late January 2000. No autopsy was performed on the case vehicle's front right passenger, but a non-invasive, external examination of her body was conducted; that report was received in February 2000. This report is based on the Police Crash Report; a death certificate; an external, non-invasive body examination of the case vehicle's front right passenger; police photographs; occupant kinematic principles; and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

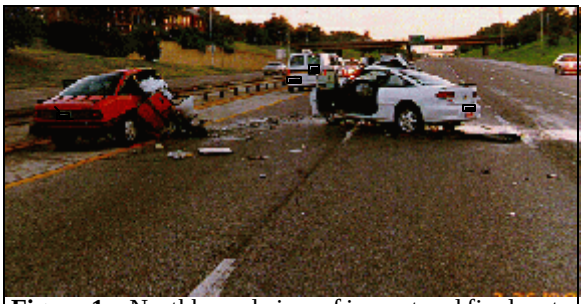

Figure 1: Northbound view of impact and final rest areas; Note: case vehicle is white (case photo #03)

The case vehicle was traveling south in the inside northbound lane (i.e., traveling in the wrong direction) of a four-lane roadway that was part of an eight-lane, divided, urban interstate highway (**Figure 1**). Vehicle #2 was traveling north in the same inside, northbound lane (i.e., traveling in the proper direction) of the same four-lane roadway of the same urban interstate highway. It was dark, with street lights, clear weather, and no vision obstructions noted. The roadway was bituminous, dry, straight, and level. Impact occurred immediately north of the exiting tangent point for a northbound, right-hand curve. The posted speed limit was 97 km.p.h. (60 m.p.h.). The crash occurred in the inside northbound lane. Investigating officers noted there were no pre-impact skidmarks and none were visible in the police on-scene photographs.

The front of the case vehicle impacted the front of vehicle #2, causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle rotated clockwise approximately 120 degrees as its center of gravity moved some 7 meters (20 feet) southeast, coming to rest facing northwest and diagonally blocking the third northbound lane. Vehicle #2 rotated clockwise approximately 60 degrees as its center of gravity moved some 7 meters (20 feet) southwest, coming to rest facing northeast and blocking the northbound lanes' west paved shoulder. The crash severity for the case vehicle was high [greater than 40 km.p.h. (25 m.p.h.)].

The case vehicle was a front wheel drive, 1998 Chevrolet Cavalier Z24, five-passenger, 2-

door coupe (VIN: 1G1JF12T0W7------) equipped with a 2.4 liter, I-4 gasoline engine and a four-speed automatic transmission with a console-mounted shift lever. It was equipped with four-wheel anti-lock brakes. The case vehicle's wheelbase was 264 centimeters (104.1 inches). No odometer reading was reported. The case vehicle was towed from the scene due to disabling damage.

Figure 2: Case vehicle's front damage; Note: arrow points to case vehicle's front bumper fascia embedded in vehicle #2's front bumper (case photo #02)

The case vehicle sustained direct contact damage across its entire front plane. The front bumper fascia separated from the case vehicle and was embedded in the front plane of vehicle #2 (**Figure 2**). The other damaged case vehicle front components were displaced rearward, including: front bumper reinforcement bar, front grille, left and right headlamp assemblies, front hood edge, left front fender, right front fender, and the left and right stub frame front bumper extensions. Induced damage included the engine pushed into the front cowl, the left front fender bowed out, left front wheel and tire pushed into the lower left A-pillar, left rocker panel cover distorted, the right front wheel and tire pushed into and under the right lower A-pillar, the right lower A-pillar detached from the right rocker panel and displaced rearward into the right front door opening, the right rocker panel deformed and its cover nearly separated, the right upper A-pillar straightened to nearly vertical, the right front roof rail slanted upwards (front high), right front door severely deformed, the sunroof deformed, the right side of the roof pushed upwards, and the windshield splintered. The CDC for the case vehicle, estimated from police photographs is: **12-FDEW-5** (principal direction of force 10 degrees). The WinSMASH reconstruction program, with CDC-only estimated crush profile, provided a borderline reconstruction, but the results appear reasonable. The case vehicle's estimated Total, Longitudinal, and Lateral Delta Vs are, respectively: 93.5 km.p.h. (58.1 m.p.h.), -92.1 km.p.h. (-57.2 m.p.h.), and -16.2 km.p.h. (-10.1 m.p.h.).

Figure 3: Case vehicle's induced right side damage; Note: shortened wheelbase and distortion of right front door opening (case photo #08)

Intrusion to the front right passenger's seating area was severe (**Figure 3**). The right upper A-pillar was displaced rearward, along with the right side of the windshield, and was nearly vertical. The right front corner, where the windshield header and the right roof rail meet, was buckled upwards, and actually increased the available vertical head room as the horizontal distance was decreased. The right lower A-pillar was pushed rearward and the passenger's toe pan and foot well areas were pushed up and rearward. The toe pan was nearly touching the forward edge of the front right passenger's seat cushion. The

right front door opening was reduced by half. The instrument panel in front of the passenger's seat was displaced rearward and its leading edge projected over the seat cushion. The glove compartment door's lower left corner was shattered and contents spilled onto the legs of the passenger. The cover flap of the top-mounted front right passenger's air bag contacted and splintered the right lower portion of the windshield when the module was activated by the crash forces.

CASE VEHICLE FRONT RIGHT PASSENGER

The case vehicle's front right passenger [21-year-old female, White (non-Hispanic), 165 centimeters, 64 kilograms (65 inches and 142 pounds)] was wearing her available, manual, three-point, lap-and-shoulder, safety belt system. Her pre-crash seat adjustments and posture are not known. She was declared dead at the scene and her body was transported directly to the medical examiner's office. There was no autopsy performed, but a non-invasive, external examination was conducted by a deputy medical examiner. Her BAC was reported as 0.278. The following discussion of the case vehicle's front right passenger is based on that non-invasive, external examination, on-scene photographs, and occupant kinematic principles.

Figure 4: Intrusion into case vehicle's front right passenger seat area (case photo #11)

The case vehicle's front right passenger was probably seated in a normal passenger posture with her back against the seat back and her feet on the floorboard. Her hand positions are not known. Investigating officers found no pre-impact evidence that the case vehicle's driver attempted any avoidance maneuvers. Police on-scene photographs contained no evidence of pre-impact avoidance maneuvers by the case vehicle. The impact caused the case vehicle's driver and front right passenger air bags to deploy. At impact, the passenger moved forward and slightly to the right. She contacted her deploying air bag and deflated it as the windshield, instrument panel, toe pan, foot well, and the right upper and lower A-pillars all intruded into the front right passenger's seating area. She impacted the air bag with her face and upper torso causing numerous abrasions and contusions to her nose, between the eyebrows, lips, chin, neck, and left chest wall as well as lacerations to the scalp. It is likely that the combination of the deploying air bag and the rearward displacement of the instrument panel caused a hyperflexion of her neck that resulted in fractures to the first three cervical vertebrae. Her forward movement also resulted in a fractured left clavicle and a fractured pelvis from contact with the instrument panel. The rearward and upper displacement of the front right passenger's toe pan and foot well caused a fractured left ankle and a multiplicity of abrasions, contusions, and lacerations to both legs. Her hands and arms flailed forward, contacted the instrument panel and sustained abrasions and contusions to those extremities. When the case vehicle rotated clockwise post-impact, she contacted the right front door, sustaining numerous lacerations to the scalp from the front right door window glazing. She

contacted the interior panel of the intruding front right door and received an abrasion to the right abdomen, abrasions to the posterior body, contusions to the right buttock, and a laceration to the perineum. At final rest, she was found turned to her left (towards the driver) in a near fetal position with her safety belt still in place (**Figure 4** above and **Figure 5** below). This collision is considered virtually nonsurvivable by this contractor for the front right passengers in each vehicle, with the total Delta V estimated at 93.5 km.p.h. (58.1 m.p.h.) for the case vehicle and 109.0 km.p.h. (67.7 m.p.h.) for vehicle #2.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Fracture, C1 vertebra, NFS	650216.2 moderate	Right instrument panel, A-pillar and windshield	probable	non-invasive death exam
2.	Fracture, C2 vertebra, NFS	650216.2 moderate	Right instrument panel, A-pillar and windshield	probable	non-invasive death exam
3.	Fracture, C3 vertebra, NFS	650216.2 moderate	Right instrument panel, A-pillar and windshield	probable	non-invasive death exam
4.	Fracture, pelvis, NFS	853404.2 moderate	Right instrument panel	possible	non-invasive death exam
5.	Fracture, left ankle	853404.2 moderate	Floor	probable	non-invasive death exam
6.	Fracture, left clavicle	752200.2 moderate	Right instrument panel	possible	non-invasive death exam
7.	Abrasion between the eyebrows	2902021 minor	Front right air bag	probable	non-invasive death exam
8.	Abrasions, nose	290202.1 minor	Front right air bag	probable	non-invasive death exam
9.	Contusions, both lips, inside and out	290402.1 minor	Front right air bag	probable	non-invasive death exam
10.	Abrasions, both lips, inside and out	290202.1 minor	Front right air bag	probable	non-invasive death exam
11.	Abrasions, under chin	290202.1 minor	Front right air bag	probable	non-invasive death exam
12.	Abrasions, right lower anterior neck	390202.1 minor	Front right air bag	possible	non-invasive death exam
13.	Abrasion, left anterior chest wall	490202.1 minor	Front right air bag	possible	non-invasive death exam

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
14.	Contusion, left anterior chest wall	490402.1 minor	Front right air bag	possible	non-invasive death exam
15.	Abrasion, large, right side of abdomen	590202.1 minor	Right front interior surface	possible	non-invasive death exam
16.	Abrasions, posterior body NFS	490202.1 minor	Right front interior surface	possible	non-invasive death exam
17.	Contusions, right buttock	890402.1 minor	Right front interior surface	probable	non-invasive death exam
18.	Lacerations, multiple, small, scalp	190602.1 minor	Right front door glazing	possible	non-invasive death exam
19.	Contusion, inside of right thigh	890402.1 minor	Right instrument panel	possible	non-invasive death exam
20.	Abrasions, bilateral knees	890202.1 minor	Right instrument panel	probable	non-invasive death exam
21.	Abrasions, bilateral anterior lower legs	890202.1 minor	Right instrument panel	probable	non-invasive death exam
22.	Lacerations, malleolar region, left ankle	890602.1 minor	Floor	probable	non-invasive death exam
23.	Contusion, dorsum of left leg	890402.1 minor	Floor	probable	non-invasive death exam
24.	Contusion, dorsum of right foot	890402.1 minor	Floor	probable	non-invasive death exam
25.	Abrasions, many, posterior right leg	890202.1 minor	Right front interior surface	possible	non-invasive death exam
26.	Contusions, many, posterior right leg	890402.1 minor	Right front interior surface	possible	non-invasive death exam
27.	Contusions, dorsum of hands, bilateral	790402.1 minor	Right instrument panel	possible	non-invasive death exam
28.	Broken fingernail with hemorrhage, right hand	790402.1 minor	Right instrument panel	possible	non-invasive death exam
29.	Abrasion, posterior right forearm	790202.1 minor	Right A-pillar	possible	non-invasive death exam
30.	Abrasions, posterior right elbow	790202.1 minor	Right A-pillar	possible	non-invasive death exam
31.	Abrasions, dorsum of left hand	790202.1 minor	Right instrument panel	possible	non-invasive death exam
32.	Abrasion, left upper arm	790202.1 minor	Front right air bag	possible	non-invasive death exam

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
33.	Laceration, perineum	590600.1 minor	Right front interior surface	possible	non-invasive death exam

CASE VEHICLE DRIVER

The case vehicle's driver (21-year-old male, unknown race/ethnicity, unknown height and weight) was wearing his available, active, three-point, lap-and-shoulder, safety belt system (**Figure 5**). His pre-crash seat adjustments, steering wheel position, and posture are not known. He was transported from the scene by ambulance to a medical facility. Police assessed his injuries as "evident-not disabling." It is suspected that his body kinematics would mirror those of the front right passenger. Police detected a "strong odor of an intoxicating liquor" while interviewing the case vehicle's driver (recall that the front right passenger had a BAC of 0.278).

Figure 5: Case vehicle driver's seat area; Note: cut end of driver's seat belt (case photo #10)

VEHICLE #2

Vehicle #2 was a front wheel drive, 1991 Chevrolet Cavalier, five-passenger, two-door sedan (VIN: 1G1JC14G3MJ------) equipped with a 2.2 liter, I-4 gasoline engine and a three-speed automatic transmission with the shift lever console-mounted. Vehicle #2 was not equipped with an anti-lock braking system. Its wheelbase was 257 centimeters (101.3 inches). No odometer reading was recorded. Vehicle #2 was towed from the scene due to disabling damage.

Figure 6: Vehicle #2's front damage; Note: arrow denotes case vehicle's front bumper fascia embedded in vehicle #2's front bumper (case photo #15)

From the collision with the case vehicle, direct contact damage to vehicle #2 included: the front bumper, the front reinforcement bar, and fascia displaced rearward, with the front right corner pushed past the cowl and into the lower right A-pillar; the grille pushed rearward; the front hood edge shoved rearward, causing a buckling at its middle and the rear edge contacting the lower edge of the windshield; the right front fender pushed rearward into and past the lower

Figure 7: Vehicle #2's induced right side damage; Note: shortened right wheelbase (case photo #19)

A-pillar; the upper right A-pillar virtually straightened; and the right front wheel and tire shoved to a position under the front right passenger's bucket seat (**Figure 6** above). Induced damage included the left front fender pulled to the right and buckled at its rear seam; the left rear quarterpanel's sheet metal buckled forward and rearward of the left rear wheel well; the right rear quarterpanel bent downward; the right front door buckled, with a downward "V" at the mid-sill area; the right front door and right rear glazing shattered (kernelized); the right side rocker panel shortened and pushed downward; the windshield splintered, most severely at the right side; and the right roof rail pushed upward at the front and buckled at the B-pillar (**Figure 7**). Intrusion into the greenhouse area consisted of the instrument panel, toe pan, and foot wells being shoved rearward, most severely at the front right passenger's position.

Based on police photographs, a CDC for vehicle #2 was estimated as: **12-FDEW-6** (principal direction of force 10 degrees). The WinSMASH reconstruction program, with CDC-only estimated crush profile, provided a borderline reconstruction, but the results appear reasonable. Vehicle #2's estimated Total, Longitudinal, and Lateral Delta Vs are, respectively: 109.0 km.p.h. (67.7 m.p.h.), -107.3 km.p.h. (-66.7 m.p.h.), and -18.9 km.p.h. (-11.7 m.p.h.). Vehicle #2's driver [18-year-old, White (unknown if Hispanic) female; unknown height and weight] was not wearing her available, active, three-point, lap-and-shoulder, safety belt system. Her pre-crash seat adjustments, steering wheel position, and posture are not known. She was transported from the scene by ambulance and was pronounced dead on arrival at a medical facility. Vehicle #2's front right passenger [19-year-old, White (unknown if Hispanic) male; unknown height and weight] was not wearing his available, manual, three-point, lap-and-shoulder, safety belt system. His pre-crash seat adjustments and posture are not known. He was pronounced dead at the scene.