Ford Explorer Sport Collision With Ford Windstar Minivan and Jeep Grand Cherokee on Interstate 95/495 Near Largo, Maryland February 1, 2002

Highway Accident Report

NTSB/HAR-03/02

PB2003-916202
Notation 7561

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Washington, D.C.

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Adopted June 3, 2003

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2003. ***Ford Explorer Sport Collision With Ford Windstar Minivan and Jeep Grand Cherokee on Interstate 95/495 Near Largo, Maryland, on February 1, 2002.*** **Highway Accident Report NTSB/HAR-03/02. Washington, DC.**

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The following safety issues were identified in this accident: the accident driver's speed, operating inexperience, and unfamiliarity with the vehicle; the use of a wireless telephone while operating a vehicle; the need for technology to aid vehicle stability; and the adequacy of the existing barrier system.

As a result of this accident investigation, the National Transportation Safety Board issued recommendations to the National Highway Traffic Safety Administration, 49 States (exclusion—New Jersey), the American Driver and Traffic Safety Education Association, and The Advertising Council, Inc. The Safety Board also reiterates Safety Recommendations H-98-12 and -24 to the Federal Highway Administration and the American Association of State Highway and Transportation Officials, respectively.

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Contents

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ABS	antilock braking systems
Andrews AFB	Andrews Air Force Base
BWI	Baltimore-Washington International Airport
DCA	Ronald Reagan Washington National Airport
DOT	U.S. Department of Transportation
ESC	electronic stability control
ESP	electric stability program
Explorer	Ford Explorer Sport
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
HVE	Human Vehicle Environment
I-95/495	Interstate 95/495
Jeep	Jeep Grand Cherokee
MMUCC	Model Minimum Uniform Crash Criteria
MTA	Maryland Transportation Authority
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NWS	National Weather Service
psi	pounds per square inch
SHA	(Maryland) State Highway Administration
SIMON	Simulation Model Non-linear
SUV	sport utility vehicle
Windstar	Ford Windstar minivan

Executive Summary

On February 1, 2002, about 8:00 p.m., on the outer lanes of Interstate 95/495 near Largo, Maryland, a 1998 two-door Ford Explorer Sport, traveling northbound at an estimated speed of 70 to 75 mph, veered off the left side of the roadway, crossed over the median, climbed up a guardrail, flipped over, and landed on top of a southbound 2001 four-door Ford Windstar minivan. Subsequently, a 1998 four-door Jeep Grand Cherokee ran into the minivan. Of the eight people involved in the accident, five adults were fatally injured, one adult sustained minor injuries, and two children were uninjured.

The National Transportation Safety Board determines that the probable cause of the February 1, 2002, collision of the Ford Explorer Sport with the Ford Windstar minivan and Jeep Grand Cherokee was the Explorer driver's failure to maintain directional control of her high-profile, short-wheelbase vehicle in the windy conditions due to a combination of inexperience, unfamiliarity with the vehicle, speed, and distraction caused by use of a handheld wireless telephone. Contributing to the severity of the accident was the lack of an effective median barrier at the accident site.

The following safety issues were identified in this accident: the accident driver's speed, operating inexperience, and unfamiliarity with the vehicle; the use of a wireless telephone while operating a vehicle; the need for technology to aid vehicle stability; and the adequacy of the existing barrier system.

As a result of this accident investigation, the National Transportation Safety Board makes recommendations to the National Highway Traffic Safety Administration, 49 States (exclusion—New Jersey), the American Driver and Traffic Safety Education Association, and The Advertising Council, Inc. The Safety Board also reiterates Safety Recommendations H-98-12 and -24 to the Federal Highway Administration and the American Association of State Highway and Transportation Officials, respectively.

Factual Information

Accident Narrative

About 4:00 p.m. on February 1, 2002, the accident driver left her workplace in Springfield, Virginia, accompanied by a male and a female friend.[1] The male friend drove them in his vehicle to a mall in Arlington, Virginia, and then to the Import Express automobile dealership in Arlington. The three arrived about 5:15 p.m. at the dealership, where the accident driver finalized the purchase of a two-door 1998 Ford Explorer Sport (Explorer). About 6:45 p.m., they left the automobile dealership in the two vehicles for the accident driver's home in Arlington. They left the male friend's vehicle there, and the accident driver drove with her two friends to another female friend's home to show her the Explorer. The three friends stayed there about 10 minutes and then went back to the accident driver's home, where the male friend retrieved his vehicle. The three set out for the female friend's home in Fort Washington, Maryland, in the two separate vehicles. The female friend rode with the accident driver. (See figure 1.)

Figure 1. Area map showing location of accident site and origin and destination points for the accident driver.

[1] The Safety Board interviewed the male friend on February 3, 2002, and the female friend on February 6, 2002. The accident events are reconstructed from these and other witness interviews.

According to the female friend, the male friend, using a wireless telephone, called the accident driver “a couple of times” during the trip on the accident driver’s wireless telephone. The female friend stated that she answered the telephone on these occasions and relayed the conversations to the accident driver. About 7:50 p.m., the two vehicles arrived at the female friend’s home.

According to the female friend, the accident driver, operating the accident vehicle alone, and the male friend, operating his vehicle, departed the female friend’s home about 7:55 p.m. for the male friend’s home in Glenn Dale, Maryland. (See figure 1.) The accident driver followed the male friend, and while traveling northbound on Interstate 95/495 (I-95/495), the two had a wireless telephone conversation, during which, according to the male friend, the accident driver told him she thought that her car needed a tune-up. While proceeding in the left (inside) lane, the male friend lost sight of the accident driver and said he called her[2] again to find out her location. He said the accident driver answered and, during a 2-minute conversation, indicated that she was “behind a big truck” and could not then see him. He also stated that “she suddenly yelled twice, and the call disconnected.”

A witness in a Lexus sedan, traveling northbound on I-95/495 three- to four-car lengths behind the Explorer, indicated that south of the accident site he had experienced several wind gusts, which seemed to come from the left. He stated that just before the accident, he felt a “strong gust of wind hit his vehicle from the left.” The witness said the wind was “so strong it scared him” and he decelerated his vehicle. He said that he saw the Explorer veer off the left side of the roadway, climb up the guardrail, and flip over, at which point he lost sight of it. He estimated that the speed of the Explorer at the time of the accident was between 70 and 75 mph and his own speed was between 60 and 65 mph.

Meanwhile, a 1998 Jeep Grand Cherokee (Jeep), occupied by the driver and two children, was southbound on I-95/495 in the left lane following a 2001 Ford Windstar minivan (Windstar), occupied by the driver and three adults. The Jeep driver stated that she was traveling three to four car lengths behind a white minivan. She said she saw the Explorer in the air (she could only see the undercarriage) and then it landed on top of the minivan. She stated that she did not have time to apply the brakes and her Jeep struck the minivan. The Jeep driver said that at impact, her air bag released and she hit her face on it. She indicated that her children in the back seat were her primary concern. She was unable to open the door so she “let the window down, crawled out, and got her children out.” She also stated that the wind was blowing very strongly just before the accident. She estimated her speed to be 65 mph. (See figure 2.)

[2] According to the wireless telephone records, the accident driver placed the last call.

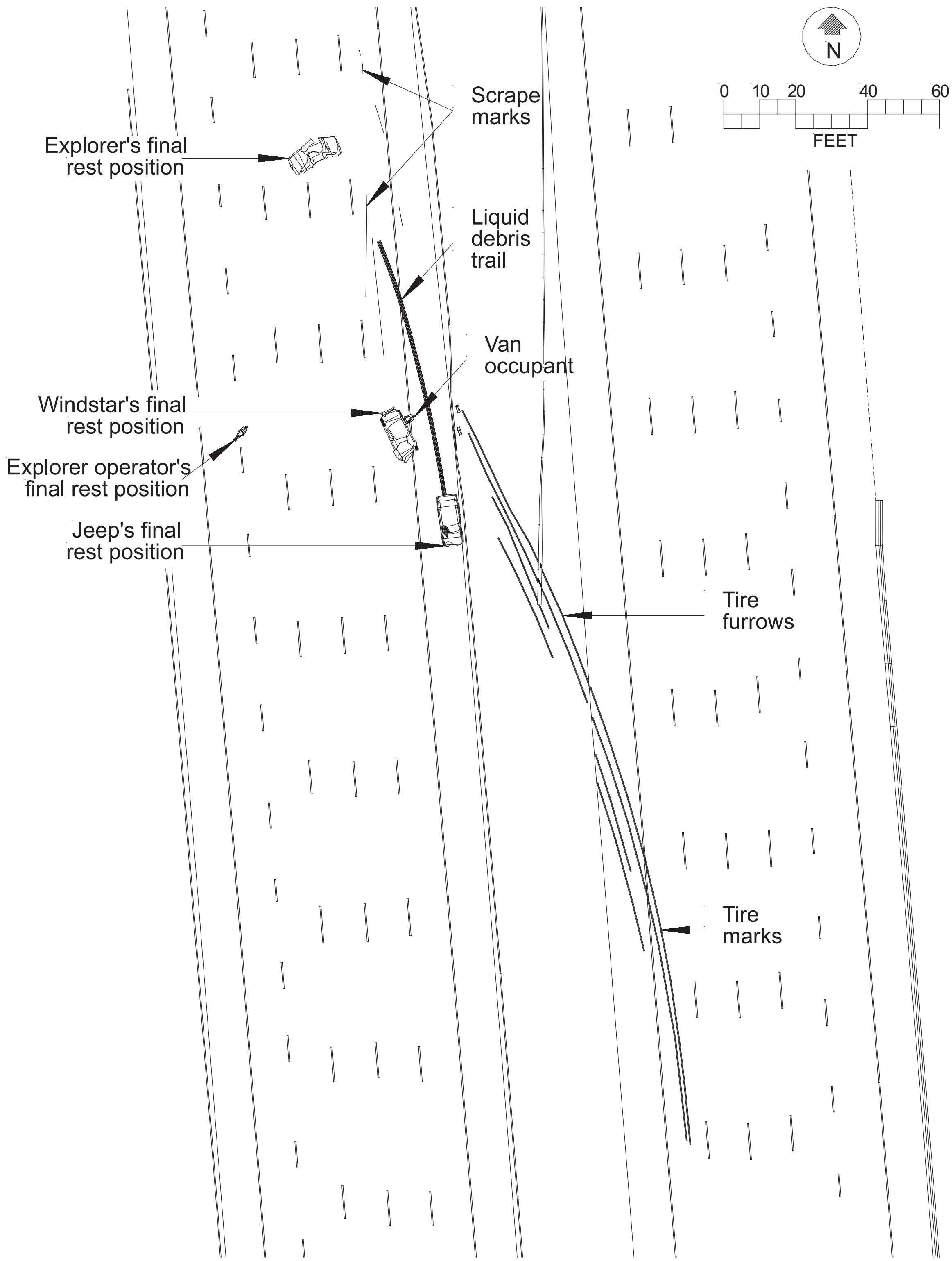

Figure 2. Accident scene.

Several witnesses, also traveling southbound on I-95/495, saw the Explorer become airborne and observed windy conditions. One witness, driving a 1995 Mitsubishi Galant, said that he saw the Explorer "go 10 to 15 feet in the air" and land in the inside lane. This witness also stated that the wind was very strong and "he could feel the pull of the wind." Another witness, driving a 1988 Oldsmobile Sierra, said that before the accident, the wind was "whipping her around." She indicated that before she left Pennsylvania, she had heard a weather alert with wind advisories. Another witness, driving a small sports car, said that he saw the Explorer at least 10 feet in the air and had to steer to avoid it. He also indicated that, at the time of the accident, "it was cold and windy."

The Windstar driver and three passengers and the accident driver, who was ejected, were fatally injured. The Jeep driver sustained minor injuries, and her two children were not injured.

Emergency Response

At 8:08 p.m., a citizen notified the Prince George's County Communication Center of the accident. About 8:15 p.m., Prince George's County Fire Station engine 46 arrived on scene, followed by two ambulances, a medical unit, and the Maryland State Police.

Injuries

The following table is based on the International Civil Aviation Organization's injury criteria, which the National Transportation Safety Board uses in accident reports for all transportation modes.

Table 1. Injuries.

Injury type	Drivers	Passengers	Others	Total
Fatal	2	3	0	5
Serious	0	0	0	0
Minor	1	0	0	1
None	0	2	0	2
Total	3	5	0	8

Title 49 *Code of Federal Regulations* 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident" and serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface."

Medical and Pathological Information

Accident Driver

The Explorer driver was not wearing her three-point lap/shoulder belt restraint, was ejected, and was fatally injured. According to the Office of the Chief Medical Examiner in Baltimore, Maryland, she sustained multiple injuries that included extensive lacerations of the left side of the forehead, multiple fractures of the skull, massive trauma to the torso, ribs, spinal column, and vital organs, and fractures of both arms.

Windstar Occupants

All of the occupants in the Windstar sustained fatal injuries. The restrained driver sustained multiple frontal skull fractures, lacerations of the neck, multiple rib fractures in the upper torso, and fractures of the upper arms. The unbelted front-seat passenger was ejected through the windshield. The restrained right rear seat passenger sustained multiple traumatic head injuries, multiple rib fractures, and other significant injuries. The restrained left rear seat passenger sustained multiple injuries, including a laceration to the front scalp and spinal and left rib fractures.

Jeep Occupants

The driver was secured with a lap/shoulder belt and sustained a minor bruise on her right leg. The passengers, a 3-year-old and an infant, were secured in child safety seats in the rear and were not injured.

Toxicological Information

The accident driver's toxicological specimens were split and examined by two laboratories: (1) the Maryland Office of the Chief Medical Examiner found the specimen negative for drugs and ethanol and reported that its carbon dioxide levels were normal, and (2) the Federal Aviation Administration's Civil Aeromedical Institute Toxicological Laboratory found the specimen negative for drugs and ethanol.

Survival Aspects

The accident driver was ejected during the accident sequence and sustained fatal injuries. The Explorer was equipped with three-point lap/shoulder belt restraints in the four outboard seat positions and a two-point lap belt in the rear center seat position. The driver's restraint system was equipped with a belt pretensioner in the retractor, which activated when the supplemental air bag restraints deployed. The driver's seat belt and the webbing showed no evidence of use[3] at the time of the accident. The driver and front right

[3] Evidence of use is usually crash-induced loading marks, such as stretch marks and abrasions.

seat positions were equipped with frontal supplemental air bags that deployed as a result of the accident.

The four occupants of the Windstar sustained fatal injuries. The front seat passenger was ejected during the accident sequence. The vehicle was equipped with three-point lap/shoulder belt restraints in the front and rear seats. The driver’s and both rear seat restraint systems exhibited signs of use. The front seat passenger’s restraint system did not show signs of use. An examination of the front seat tracks revealed significant damage; however, the tracks remained attached to their anchorage points. The Windstar was equipped with front dual-threshold air bags, which deployed.

The Jeep driver sustained minor injuries; the two rear seat occupants were uninjured. The Jeep was equipped with three-point lap/shoulder belt restraint systems in the outboard positions and a lap belt in the center rear seat, which were functional. The driver’s three-point lap/shoulder belt showed signs of use. The right rear seat occupant (the 3-year-old) was secured in a child safety seat that met U.S. Department of Transportation (DOT) standards, and the center rear seat occupant (the 11-week-old) was secured in an infant safety seat that met DOT standards. The child safety seat had been removed before the National Transportation Safety Board’s inspection. The base of the detachable infant safety seat was attached and connected to the center lap belt.

Accident Driver Information

At the time of the accident, the 20-year-old driver held a valid Virginia driver’s license issued February 2, 1999. (Her driving license instruction permit was issued July 1, 1997.) A review of her Virginia driving record revealed no history of previous traffic violations or accidents. The driver successfully completed a high school driver’s education class, which included classroom and on-the-road instruction, while in the 10th grade during the 1997-98 school year.

According to the driver’s mother, with whom she resided, the driver’s actual driving experience consisted of the infrequent use of vehicles that she borrowed from friends during the 3 years before the accident. She had not previously owned a motor vehicle, and her mother did not own one at the time of the accident. She had not driven the accident vehicle before picking it up from the automobile dealer 2 hours before the accident.

The driver’s mother said that her daughter was in good general health and was not using any type of medication. A review of the driver’s medical records found no history of chronic or acute ailments or illnesses. The Safety Board compiled a 72-hour work-rest history for the accident driver from interviews with her mother and male friend. On Tuesday, January 29, 2002, she worked for 7 hours and slept 7 hours Tuesday night. She had Wednesday off from work and slept 7 hours Wednesday night. On Thursday, she worked 8 hours and slept 7 hours Thursday night. On Friday, the day of the accident, she worked 7 hours.

Vehicle and Wreckage Information

Explorer

The 1998 two-door Ford Explorer Sport was manufactured in May 1998. The vehicle had an automatic transmission and four-wheel drive and was equipped with four-wheel antilock brakes and with driver and passenger air bags as standard equipment. Traction control and stability control were not available on this vehicle; it was not equipped with any event data recording capability. Table 2 displays the vehicle's dimensions, axle weight ratings, and tire size.

Table 2. Explorer dimensions, axle weight ratings, and tire size.

Description	Dimension
Overall length	179.6 inches
Width	70.2 inches
Height	67 inches
Wheelbase	101.7 inches
Curb weight	3,919 pounds
Front axle weight rating	2,510 pounds
Rear axle weight rating	2,650 pounds
Gross vehicle weight rating	4,900 pounds
Tire size	P255/70Rx16SL
Recommended tire pressure for both front and rear	30 pounds per square inch

The body damage was catastrophic; contact with the Windstar resulted in major loading to the right upper body structure. The A- and B-pillars and roof header were severely displaced rearward and downward. (See figures 3 and 4.) The wheelbase was 101 inches on the left (driver) side and 97 inches on the right (passenger) side. The interior space of the Explorer was severely compromised, particularly the front seat area. The windshield was destroyed. The driver's and right front seat anchorage and seat tracks were fractured.

The Safety Board examined the vehicle's brake systems and did not find any anomalies. The tires on the accident vehicle were new Dunlop Rover Touring LT, P255/70x16, 109S M&S, with 2,271 pounds maximum loading at 35 pounds per square inch (psi) maximum tire pressure. The four matching tires, 1 1/32-inch-deep across the full tread, were installed on factory alloy wheels. The spare tire was the original and was installed on the original equipment steel wheel. The left and right front and right rear tires were all deflated due to damage commensurate with wheel and tire impact damage. No evidence of a blowout or run-flat condition was found. The left rear tire was still inflated; postaccident pressure measured 25 psi. The accident damage to the rim in the bead seat area indicated possible loss of tire pressure during the collision.

Figure 3. Explorer body damage.

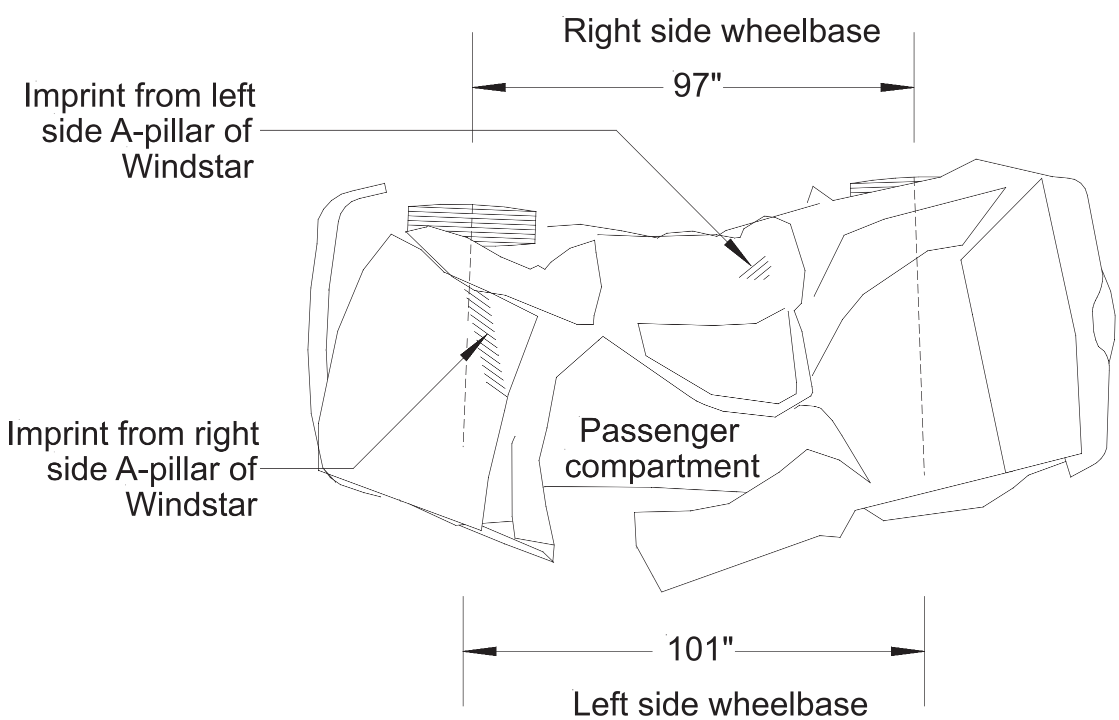

Figure 4. Overhead view of Explorer structural damage.

Safety Board investigators examined the suspension system and found damage consistent with the accident. The left tie rod connection and the left upper ball joint were severed at the steering knuckle and at the connection with the upper control arm, respectively, and the steering column slip joint was severed. These suspension system components were taken to the Safety Board's Materials Laboratory for fracture mode and impact analysis. In addition, the steering components were removed from the vehicle and taken to the supplier for bench testing and teardown. The postaccident examination revealed no anomalies in the steering or suspension systems. (See the Tests and Research section of this report for further information.)

The accident driver's male and female friends both stated that after she picked up the Explorer, the accident driver commented that the car made a grinding or humming noise when she turned the steering wheel. The Safety Board examined National Highway Traffic Safety Administration (NHTSA) and other sources for relevant service manuals, parts pictorials, recalls, Ford service bulletins, defect investigations, and owner complaints. The Safety Board reviewed more than 1,000 owner complaints on Explorers from all sources for sudden loss of control, particularly under windy conditions. The search yielded no similar complaints of loss of control from wind force. Staff did find notations from owners and media referencing a general "lack of precision in vehicle handling," as well as squeaks and groans while steering; such statements were not unique to Explorers.

Windstar

The 2001 four-door Ford LX Extended Sport Windstar minivan, manufactured in November 2000, was equipped with four-wheel antilock brakes and driver and passenger air bags as standard equipment. Table 3 displays information about dimensions, axle weight ratings, and tire size.

Table 3. Windstar original dimensions, axle weight ratings, and tire size.

Description	Dimension
Overall length	200.9 inches
Width	75.2 inches
Height	68.2 inches
Wheelbase	120.7 inches
Curb weight	4,058 pounds
Front axle weight rating	2,809 pounds
Rear axle weight rating	2,663 pounds
Gross vehicle weight rating	5,420 pounds
Tire size	P215/70R15
Recommended tire pressure for both front and rear	35 pounds per square inch

The Windstar sustained severe damage to its front, sides, rear, and roof, which was partially detached. The floor was fractured and collapsed rearward. The wheelbase measured 120 inches on the left side and 117 inches on the right side. The interior was severely compromised; the firewall and dash were collapsed aft. The front area of the roof was collapsed downward below the window frame and detached from the windshield to the rear passenger seats. In addition, the rear door and cargo area were deformed forward to the rear axle. (See figures 5 and 6.)

Figure 5. Windstar body damage.

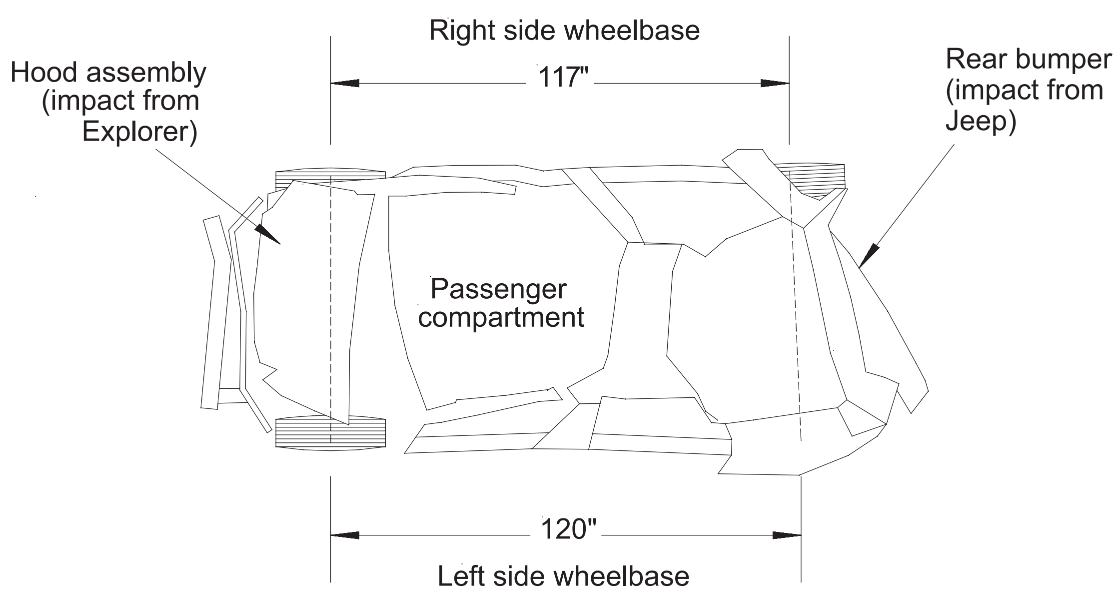

Figure 6. Overhead view of Windstar structural damage.

Postaccident examination revealed no anomalies with the steering, suspension, or brake systems. The Windstar was equipped with electronic event data recording as part of the air bag sensing and diagnostic module. In addition, tests were performed on the tachometer and speedometer. (See the Tests and Research section of this report for further information.)

Jeep

The 1998 four-door Jeep Grand Cherokee, manufactured in April 1998, was equipped with four-wheel antilock brakes and driver and passenger air bags as standard equipment. The tires installed on the vehicle were Kelly Safari SUV 225/70x16; tire pressures measured 28 psi (left front), 26 psi (left rear), 29 psi (right rear), and 27 psi (right front), and tread depth averaged 10/32 inch on the four tires. Table 4 displays the vehicle's dimensions and axle weight ratings.

Table 4. Jeep original dimensions, axle weight ratings, and tire size.

Description	Dimension
Overall length	167.7 inches
Width	69.3 inches
Height	63.8 inches
Wheelbase	101.6 inches
Curb weight	3,025 pounds
Front axle weight rating	2,500 pounds
Rear axle weight rating	2,950 pounds
Gross vehicle weight rating	5,000 pounds
Tire size	P225/70x16
Recommended tire pressure for both front and rear	36 pounds per square inch

The Jeep sustained substantial damage to the front and hood areas and to the right side of the windshield. The hood had fabric imprints leading up to the area of contact damage on the right side of the windshield. The interior sustained minor damage, primarily on the front right side. The windshield was broken and displaced aft with part of the A-pillar. The interior floor, sidewalls, and ceiling were intact. (See figures 7 and 8.) The postaccident examination revealed no suspension, brake, or steering system anomalies.

Figure 7. Jeep body damage.

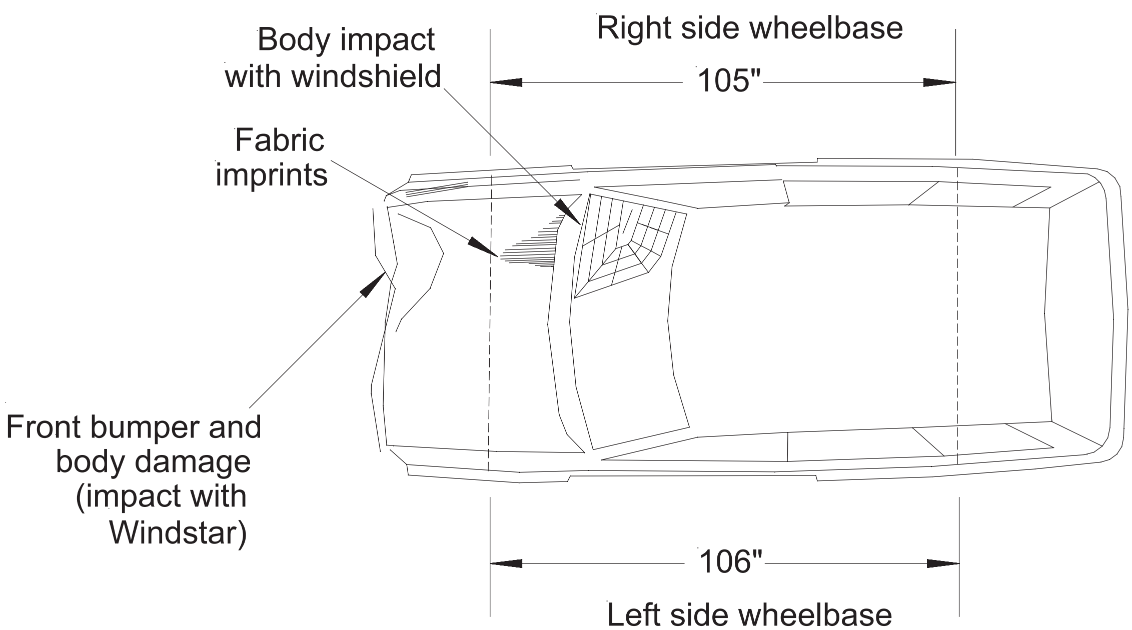

Figure 8. Overhead view of Jeep structural damage.

Highway Information

The accident began in the outer loop on the eastern side of I-95/495, also known as the Capital Beltway, about 0.2 mile south of Maryland State Highway 214 in Prince George's County, Maryland. (See figure 1.) Built in 1962, this section of I-95/495 is owned and operated by the Maryland State Highway Administration (SHA), an agency within the Maryland Department of Transportation. The 10-lane, divided, controlled-access, principal arterial highway had 8 through lanes, acceleration and deceleration lanes for State Highway 214, left and right shoulders in both directions, and a depressed earthen median.

The roadway ran north-south and was aligned at a compass heading of about 355°. The approximate grade for the northbound lanes was +2.5 percent with a 1.5-percent cross slope on the inside lanes. (See figure 9.) The pavement markings consisted of thermoplastic retroreflective white lane lines (10 feet long, spaced 30 feet apart) and yellow and white painted edgelines on the left and right, respectively. The annual average daily traffic count was 203,343 vehicles; 14 percent were trucks.[4] The posted speed limit on the Capital Beltway was 55 mph. According to a January 2002 speed survey, the median speed near the accident site was 66.75 mph and the 85th-percentile speed[5] was 75 mph.

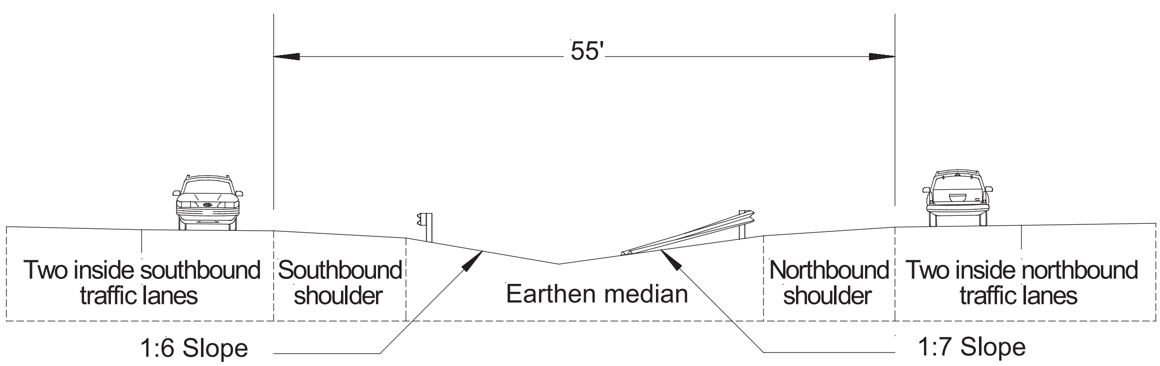

Figure 9. Interstate 95/495 cross section at accident site.

At the accident site, both sides of the depressed center median had semirigid roadside barriers.[6] (See figure 10.) The barriers were installed in 1962 to shield a drainage culvert and two metal posts supporting an overhead highway sign from errant traffic. On the northbound side, the single W-beam rail barrier was approximately 483 feet long; it incorporated a turned-down end treatment (also known as a "Texas twist") on the south terminal and a cable end treatment on the north terminal. On the southbound side, the single W-beam rail barrier continued about 0.4 mile south of the accident site, where it transitioned to a double-sided W-beam (a W-beam on both sides of the post) longitudinal barrier system. At the accident site, the barrier systems had blocked-out metal posts; both the posts and the blockouts consisted of 4- by 6-inch metal I-beams supporting a single W-beam metal rail. The top of the W-beam rail was mounted about 26 inches above the pavement surface; the rail faced the traffic lanes.

[4] The SHA conducted a 48-hour traffic count on March 6, 2002.

[5] Eighty-fifth percentile speed is the speed below which 85 percent of the traffic is traveling.

[6] A roadside barrier is a longitudinal system used to shield the motorist from hazards along the roadside or to shield hazards in the median of a divided highway. Typically, a roadside barrier is designed to redirect a passenger car's 60-mph impact at a 25°, or less, impact angle from one side only. Roadside barriers may be flexible, semirigid, or rigid.

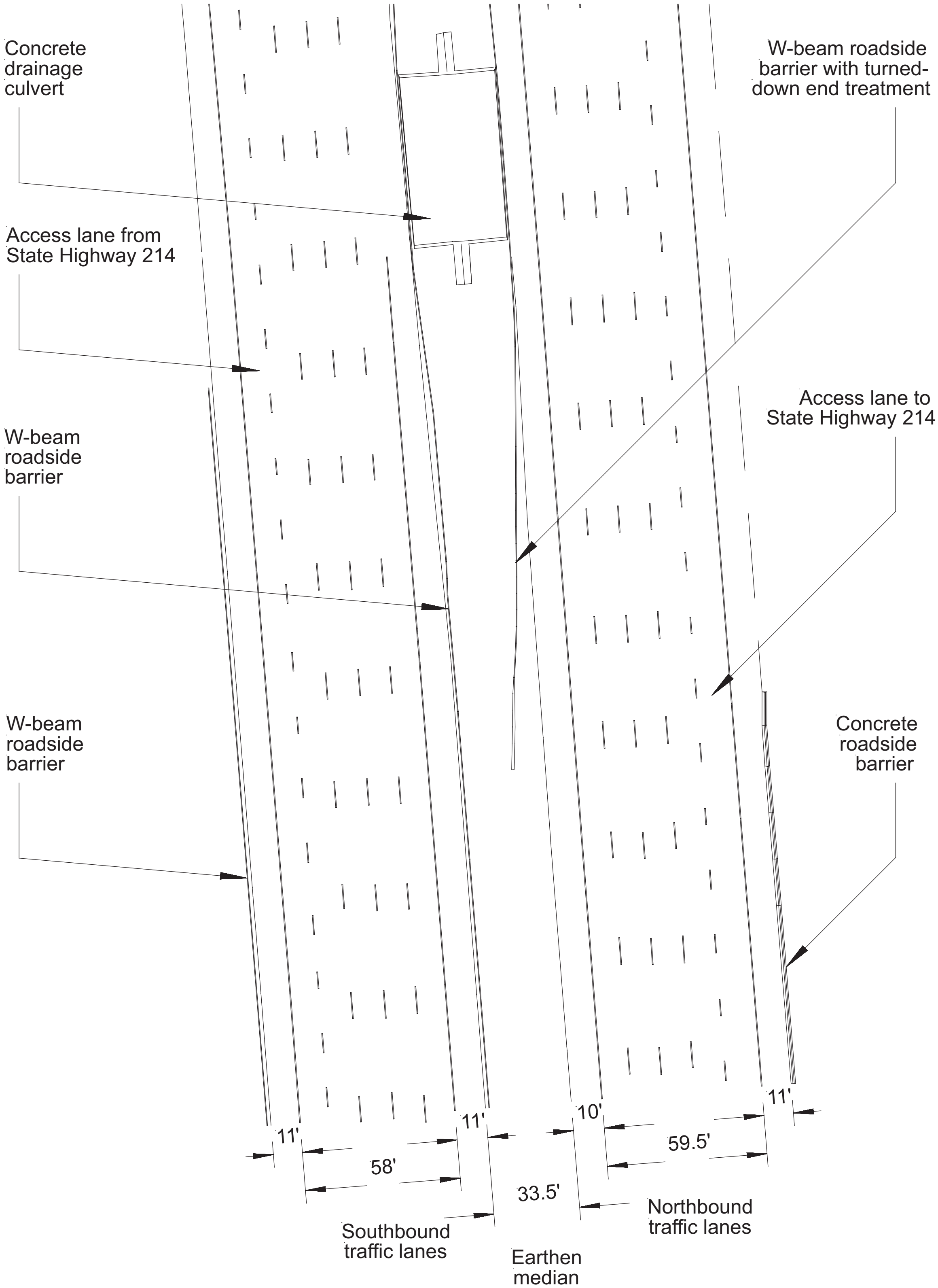

Figure 10. Roadway design features at accident site.

On April 24, 2002, Safety Board investigators conducted an informal driving survey of the median barrier systems on the Capital Beltway in both Virginia and Maryland. Virginia had almost exclusively concrete median barriers. The accident site was one of a few locations in Maryland that did not have either a double-sided guardrail or a concrete median barrier in place.

Accident History

The SHA accident records for the 7.76-mile section of I-95/495 between Maryland State Highway 4 and U.S. Highway 50, which includes the accident location, showed that 1,301 motor vehicle traffic crashes occurred between January 1, 1998, and September 30, 2001. These accidents resulted in 5 fatalities and 944 injuries (see table 5).

Table 5. Accident records for 7.76-mile section of I-95/495 that includes the accident site.

Year	Fatal accidents	Injury accidents	Property damage accidents	Total accidents	Number of fatalities	Number of injuries
1998	0	148	151	299	0	249
1999	1	136	178	315	1	212
2000	1	159	219	379	1	271
2001	3	132	173	308	3	212
Total	5	575	721	1,301	5	944

Of the 1,301 reported accidents, about 2 percent (30) involved vehicles that had encroached into the center median (see table 6). Two of the encroachment accidents involved vehicles that collided with the median barrier and continued into the opposing traffic lanes; one involved a minivan and the other involved a commercial motor vehicle.

Table 6. Center median accidents near the accident site.

Accident location	Vehicle direction	Collision with barrier	Barrier description	Resulted in crossover
MP 10.78	Southbound	Yes	Single-sided W-beam (facing NB)	No
MP 10.78	Southbound	Yes	Single-sided W-beam (facing NB)	Yes
MP 10.79	Northbound	Yes	Single-sided W-beam (facing NB)	No
MP 10.82	Southbound	Yes	Single-sided W-beam (facing NB)	No
MP 10.84	Northbound	Yes	Single-sided W-beam (facing NB)	No
MP 10.87	Northbound	Yes	Single-sided W-beam (facing NB)	No
MP 11.28	Northbound	No	Single-sided W-beam (facing SB)	No
MP 11.28	Northbound	Yes	Single-sided W-beam (facing SB)	No
MP 11.70	Northbound	Yes	Single-sided W-beam (facing SB)	No
MP 12.45	Southbound	Yes	Single-sided W-beam (facing NB)	No
MP 13.04	Southbound	Yes	Double-sided W-beam	No
MP 13.08	Northbound	No	Double-sided W-beam	No
MP 13.10	Northbound	No	Double-sided W-beam	No
MP 13.14	Northbound	No	Double-sided W-beam	No
MP 13.15	Northbound	Yes	Double-sided W-beam	No
MP 13.16	Southbound	Yes	Double-sided W-beam	No
MP 13.17	Southbound	Yes	Double-sided W-beam	No
MP 13.18	Southbound	Yes	Double-sided W-beam	No
MP 13.20	Northbound	Yes	Double-sided W-beam	No
MP 13.64	Southbound	Yes	Double-sided W-beam	No
MP 14.68	Northbound	Yes	Single-sided W-beam (facing SB)	No
MP 14.72	Northbound	Yes	Single-sided W-beam (facing SB)	No
MP 14.75	Southbound	Yes	Single-sided W-beam (facing SB)	Yes
*MP 14.78	Northbound	Yes	Single-sided W-beam (facing SB)	No
*MP 14.78	Southbound	Yes	Single-sided W-beam (facing SB)	No
MP 14.82	Northbound	Yes	Single-sided W-beam (facing SB)	No
MP 17.64	Northbound	Yes	Double-sided W-beam	No
MP 17.86	Southbound	Yes	Double-sided W-beam	No
MP 17.88	Southbound	Yes	Double-sided W-beam	No
MP 18.45	Southbound	Yes	Concrete wall	No

*Accident location

Physical Evidence

On February 3, 2002, Safety Board investigators, assisted by personnel from the SHA, conducted a detailed mapping of the accident location. (See figure 2.) In the northbound inside lane and left shoulder, they found four distinct tire marks. Two of the tire marks began in the inside lane; the longest started about 6 feet east of the left shoulder edgeline. Both tire marks curved off to the northwest and terminated at the western edge of the paved surface. The remaining two tire marks were on the left shoulder; the longest of these started 2 feet west of the edgeline, and both followed the same path, terminating at the edge of the pavement. An examination of the tire marks revealed a series of striations running perpendicular to the direction of the tire marks.

In the center median, a set of four tire furrows were found beginning adjacent to the termination points of the pavement tire marks. The furrows traversed the median in a northwest direction. Tire imprints from the Explorer were documented on the turned-down end treatment of the longitudinal barrier that was adjacent to the northbound traffic lane. The tire furrows terminated near the roadside barrier at the east side of the center median. (See figures 11 and 12.)

Figure 11. Explorer path down the northbound cross slope, over the turned-down guardrail end treatment, through the depressed earthen median, and over the backside of the southbound guardrail.

Figure 12. Backside of the southbound guardrail.

The Explorer struck and deformed a 50-foot section of the southbound barrier's metal W-beam, pushing it out in a westerly direction. Four metal support posts were detached from the W-beam rail and pushed over toward the southbound traffic lanes. The southernmost post, bent at a 33-degree angle, was the most severely deformed. The W-beam rail was attached to the metal blockouts with a single nut and bolt assembly. Three of the four posts detached from the W-beam when the attachment bolt's head was pulled through the W-beam's mounting hole. The fourth post detached when the mounting hole in the blockout split, allowing the bolt to pull through the blockout.

The evidence in the southbound traffic lanes, as documented by the Maryland State Police, included pavement scrape marks and a liquid debris trail. The scrape marks began in the inside lane, approximately 102 feet north of the termination point of the center median tire furrows. The scrape marks continued south about 86 feet. The liquid debris trail began in the inside lane, approximately 49 feet north of the termination point of the center median tire furrows. The trail continued southeast about 72 feet and ended on the left shoulder, about 8 feet east of the edgeline near the final rest position of the Jeep.

Median Barrier Guidelines

In 1962, when this segment of the Capital Beltway was built, no specific warrants for median barriers were in effect. Traditionally, barriers have not been used in medians that were 30 feet or more in width. According to the Federal Highway Administration (FHWA), the 1967 American Association of State Highway Officials[7] report, *Highway Design and Operational Practices Related to Highway Safety,*[8] suggested that median barriers be used in medians up to 30 feet wide when traffic volume exceeded 20,000 vehicles per day. Specific guidelines relating median barrier warrants to median width and traffic volumes first appeared in the 1977 American Association of State Highway and Transportation Officials (AASHTO) *Guide for Selecting, Locating, and Designing Traffic Barriers.* The guidelines were incorporated, unchanged, into the 1989, 1996, and 2002 editions of the AASHTO *Roadside Design Guide.*

The AASHTO 2002 *Roadside Design Guide,* which is the most recent edition, suggests guidelines for the installation of median barriers on high-speed roadways based on a combination of the average daily traffic count and the center median widths. In light of the 2002 *Roadside Design Guide* criteria, both the 203,343 average daily traffic count and the 55-foot-wide median at the accident location place the site in the category in which a "median barrier would not normally be considered." (See figure 13.)

The *2002 Roadside Design Guide* acknowledges that several States have developed guidelines more stringent than its own. For example, Florida has considered median widths under 64 feet as candidates for a median barrier. In addition, a 1997 California study suggested that medians as wide as 75 feet on roadways with traffic volumes up to 60,000 vehicles per day would be candidates for a median barrier review.

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[7] This association has been renamed and is now the American Association of State Highway and Transportation Officials.

[8] The report is often referred to as the "Yellow Book."

California also used a study warrant to identify sections of freeways that might require installation of a median barrier. This warrant required a minimum of three cross-median accidents within a 5-year period on a 1-mile segment of highway.

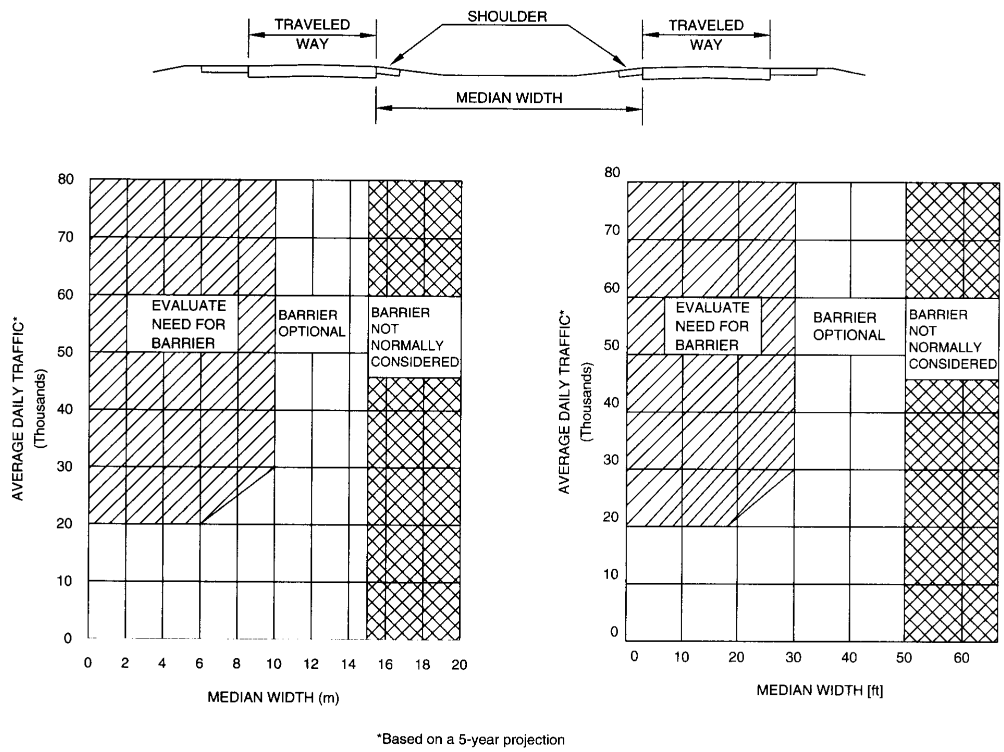

Figure 13. "Median Barrier Warrants for Freeways and Expressways," American Association of State Highway and Transportation Officials, *Roadside Design Guide*, 2002.

Maryland's Median Barrier Policies

In 1990, according to SHA officials, because of concerns resulting from median crossover accidents, the SHA reviewed its policy on median barriers on the Maryland interstate system. The SHA found that the number of such accidents was "fairly small." Regardless, the SHA still considered it beneficial to install additional median barriers on its highway system, given the severity of opposite-direction accidents. The SHA decided to position barriers along sections of highway having median widths of less than 75 feet. The first installations were targeted for those sections of highway that had a history of median crossover accidents.

The SHA has used various median barrier systems, including concrete barriers and single- and double-sided W-beam barriers. During the 1990 policy revision, the agency developed specific criteria regarding the use of single-sided W-beam rail as a median barrier. Among the factors considered were results of an analysis of the existing highway features and the construction costs associated with median installation. Part of the decision-making process also involved an assessment of median width. Since the SHA had identified several studies indicating that 80 to 90 percent of errant vehicles leaving the roadway recovered within a distance of 30 to 35 feet, the agency believed that if the width of existing medians met these criteria, a single-sided W-beam system could be used, since a vehicle driver would most likely recover before striking the barrier. The SHA has since revised its policy concerning the use of single-sided W-beam rail as a median barrier. Double-sided barriers provide protection on both sides of the post so that errant vehicles that traverse the median encounter the W-beam rail instead of the semi-rigid support post. According to agency officials, they have mandated the use of double-sided barriers in all new W-beam, median barrier system installations in the last 8 to 10 years.

In 2002, the Maryland General Assembly asked the SHA to provide an inventory of all "Texas twist" guardrails in the State and to specify the schedule and cost to replace these guardrails. In November 2002, the SHA estimated the cost of replacing or upgrading the 3,400 turned-down terminals and upgrading the guardrail system along high-speed highways at $34.3 million.[9] In addition, the Maryland Department of Transportation committed $2 million in fiscal year 2003 to a program to eliminate turned-down terminals and upgrade guardrails along the Baltimore and Capital Beltways (I-695 and I-95/-495, respectively), the remaining SHA portion of I-95, and the Baltimore-Washington Parkway (MD 295). Contracts to upgrade these terminals and guardrails were let in May 2003 and are expected to be completed during fiscal year 2003.

After the Largo accident, as was its policy, the SHA replaced the damaged guardrail, including the northbound end treatment, at the accident site "in kind," that is, with the same type of installation that was in place before the accident. In its November 2002 report to the General Assembly, the SHA also indicated that it has changed its policy and now replaces obsolete terminals that have any damage, even cosmetic; previously, the agency replaced only heavily damaged terminals.

Meteorology

Wind Advisories

Traffic on bridges is more exposed to the effects of wind. On the day of the accident, the Maryland Transportation Authority (MTA)[10] placed a wind-warning advisory in effect at all MTA bridges from 9:45 a.m., February 1, 2002, until 7:16 a.m., February 2, 2002, due to high winds in the region. Wind advisories were broadcast over the local media.

[9] Maryland Department of Transportation, *Report to the Maryland General Assembly Senate and Taxation Committee and House Appropriations Committee*, "Study of Guardrail End Treatment and Height Deficiencies," November 1, 2002.

[10] Established in 1971, the MTA is responsible for constructing, managing, and operating Maryland's toll facilities. The MTA oversees seven toll facilities: a turnpike (a 50-mile section of I-95), two tunnels (Fort McHenry Tunnel and Baltimore Harbor Tunnel), and four bridges (Thomas J. Hatem Memorial Bridge; Francis Scott Key Bridge; William Preston Lane, Jr. Memorial Bridge; and Governor Harry W. Nice Memorial Bridge).

Surface Weather Observations

The National Weather Service (NWS) issued a Surface Analysis Chart for 7:00 p.m. on February 1, 2002, showing that the accident site was on the western, or cold-air, side of a complex-occluded frontal system.[11]

The closest surface weather observation stations to the accident site were at Andrews Air Force Base (Andrews AFB), about 5.5 miles south; Ronald Reagan Washington National Airport (DCA), about 10 miles to the southwest; and Baltimore-Washington International Airport (BWI), about 22 miles to the northeast. (See figure 14.)

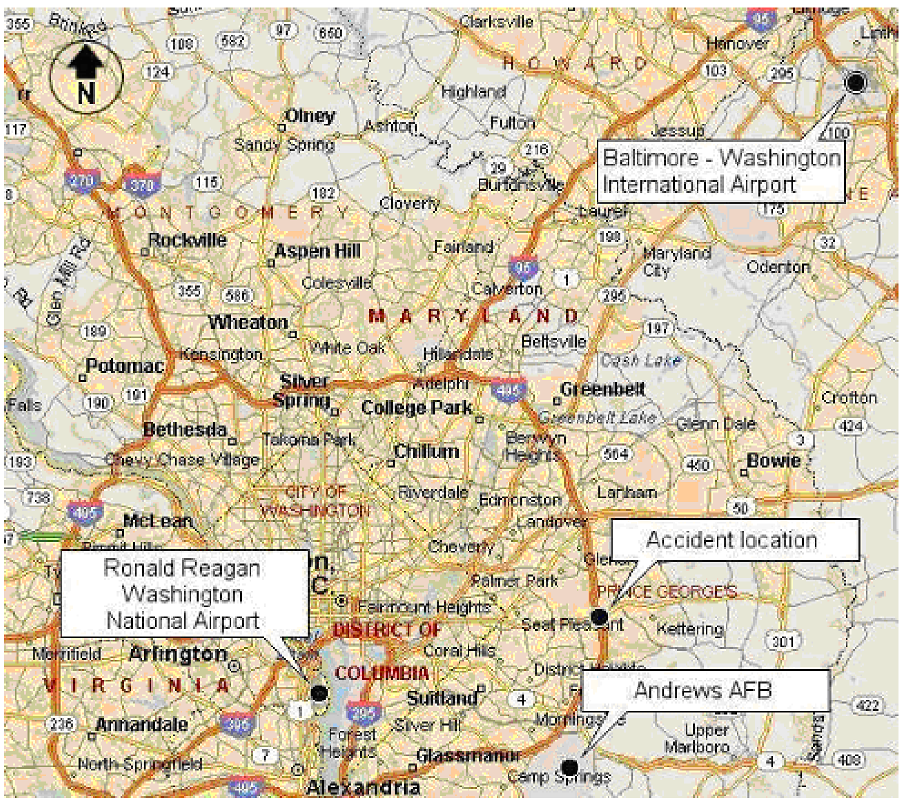

Figure 14. Area map showing location of surface weather observation facilities relative to the accident location.

Andrews Air Force Base. Andrews AFB reported the following weather conditions at 7:55 p.m.: wind from 310° sustained at 23 mph, gusting to 39 mph; visibility 7 miles; few clouds at 3,000 feet, scattered clouds at 10,000 and 20,000 feet; temperature of 46° F; dew point 27° F; and altimeter 29.98 inches of mercury. Remarks: peak wind recorded from 300° at 41 mph at 7:17 p.m.; peak wind from 300° at 44 mph reported at 7:56 p.m.; wind from 310° sustained at 24 mph, gusting to 32 mph, reported at 8:55 p.m.; and visibility and sky conditions unchanged.

[11] A front formed by a cold front overtaking a warm front and lifting the warm air above the earth's surface.

Ronald Reagan Washington National Airport. DCA reported the following weather conditions at 7:51 p.m.: wind from 310° sustained at 29 mph, gusting to 40 mph; visibility unrestricted at 10 miles; few clouds at 10,000 feet; temperature 47° F; dew point 27° F; and altimeter 30.02 inches of mercury. Remarks: peak wind from 310° at 41 mph at 7:34 p.m., and pressure rising rapidly. Peak wind from 300° at 44 mph at 8:03 p.m.

Baltimore International Airport. BWI reported the following conditions at 7:54 p.m.: wind from 290° sustained at 26 mph, gusting to 41 mph; visibility unrestricted at 10 statute miles; few clouds at 15,000 feet; temperature 46° F; dew point 28° F; and altimeter 29.98 inches of mercury. Remarks: peak wind from 320° at 41 mph at 7:47 p.m. Peak wind from 300° at 39 mph at 8:02 p.m.

NWS Weather Advisories

On February 1, 2002, the NWS forecast office in Sterling, Virginia, which is responsible for the Baltimore/Washington area, issued two weather advisories warning of high winds. The advisory current at the time of the accident was issued at 3:30 p.m. and indicated that a strong cold front was crossing the region that afternoon with strong west to northwest winds that would continue into the evening. The winds were expected to gradually decrease after midnight. The wind advisory warned of "west to northwest winds at 25 to 35 mph that will continue late this afternoon and this evening. Wind gusts to 45 mph at times through the early evening hours." The NWS warned citizens "to secure loose objects" and that the wind gusts could bring down small trees and branches and possibly cause isolated power outages.

Tests and Research

Vehicle Component Examinations

Explorer Suspension Components. The Safety Board's Materials Laboratory examined the Explorer suspension components and determined that the fractured steering knuckle and ball joint were the result of overload failure from crash forces. Evidence indicated that crash-induced deformation caused the severing of the steering column slip joint. All other front and rear suspension attachment points were tight and fully connected, and all attachment hardware was in place. The front suspension sway bar links were in place, tight, and fully connected, and all attachment hardware was in place.

Explorer Steering Components. The rack-and-pinion steering gear, power steering pump, and steering column were removed from the vehicle. The steering column was unbolted from the vehicle after the steering wheel and air bag had been removed. The other components were torch-cut from the vehicle under Safety Board supervision, taking care not to heat the components. The rack-and-pinion steering gear, pump, and steering column were subsequently taken to Visteon (a Ford steering component supplier) in Dearborn, Michigan, for bench testing and teardown under Safety Board supervision.

The steering gear aluminum housing was fractured due to internal overpressuring caused by crash forces consistent with extensive damage from impact with the second guardrail. Teardown of the rack and pinion revealed an absence of contamination; all components showed negligible wear, and damage to the rack was consistent with high-force impact with the guardrail. The power steering pump was operational on the Visteon pump test fixture and exhibited flow rates, output pressure as a function of pump rpm, and pulse frequencies consistent with new pump specifications. The power steering pump teardown revealed no wear patterns, scoring, galling, or evidence of operation with insufficient fluid.

Windstar Tachometer and Speedometer. The Fairfax County, Virginia, Police Department Accident Reconstruction Unit laboratory conducted variable-frequency ultraviolet examination to test for tachometer and speedometer needle slap.[12] The laboratory analysis showed a precrash tachometer needle position of 2,800 rpm.

Using Ford data on Windstar gear ratios and tire revolutions per mile, staff calculated a speed of 88.2 mph at 2,800-rpm engine speed. Examination of the speedometer showed an initial needle slap mark interpolated between 83 and 85 mph, based on mph scribes on the cluster of 80 and 120 mph, respectively. As a Canadian-specified vehicle, the Windstar had a metric (kph) speedometer and mph as the subordinate scale. The speedometer needle postcrash was fixed at 180 kph, corresponding to an approximate speed of 110 mph.

Windstar Air Bag Event Recording Data Retrieval. The Windstar had an electronic event-recording device as part of the air bag sensing and diagnostic system. This system was designed primarily to assess crash severity, to decide whether a crash warrants air bag deployment, and to store that information, rather than to capture information necessary to analyze the total event. The electronic device was taken to Takata (a Ford restraint supplier) in South Field, Michigan, for data retrieval. Output from the sensor was minimal due to a power severance to the device early in the crash. The downloaded data indicated a high-severity crash, warranting air bag deployment, and revealed belt use for the driver and no belt use for the right front passenger.

Pavement Coefficient of Friction

On February 5, 2002, the SHA Structures and Pavement Inspection Division performed dry pavement friction tests at the accident site. Using a trailer-mounted testing device, personnel conducted five dry pavement friction tests in each direction. On May 15, 2002, the SHA carried out both wet and dry pavement tests using a treaded tire that conformed to American Society for Testing and Materials standard E274-97.[13] Before the accident, as part of its annual pavement performance-monitoring program, the SHA had

[12] A transfer of phosphorus from the needle to the dial at impact.

[13] Standard test method for skid resistance of paved surfaces using a full-scale tire. This test method uses a measurement representing the steady-state friction force on a locked test wheel as the wheel is dragged over a wet paved surface under constant load and at constant speed while its major plane is parallel to its direction of motion and perpendicular to the pavement.

conducted friction tests at three locations within a mile of the accident site. Table 7 shows the results of these tests.

Table 7. Pavement friction tests.

Date	Direction	Friction number*
February 5, 2002	Northbound	61.0 (dry)
	Southbound	57.0 (dry)
May 15, 2002	Northbound	72.0 (dry)
	Northbound	43.0 (wet)
2000	Northbound	46, 47, 50 (wet)
	Southbound	45, 45, 47 (wet)

*A friction number represents the frictional properties of the pavement. These numbers are used to evaluate the pavement's skid resistance relative to other pavements and/or to evaluate the change in the pavement's skid resistance over time. The higher the number, the more skid resistance the pavement provides.

Simulation

The Safety Board evaluated the Explorer's controllability in crosswinds and the potential effects of a driver-delayed reaction time due to wireless telephone use. Investigators used Simulation Model Non-linear (SIMON) software[14] to calculate the vehicle's movement, Human Vehicle Environment (HVE) software[15] to visualize the vehicle's movement, and AutoCAD Land Development Desktop software[16] to build the accident scene based on three-dimensional mapping data obtained at the accident site.

Safety Board staff modeled the two-door accident vehicle using the 1991-1994 four-door Explorer in the HVE vehicle library and modifying its wheelbase, fore and aft center of gravity, vehicle weight, and sprung mass moments of inertia to match data provided by Ford Motor Company for a 1998 two-door Explorer. The two wind speeds used in the simulations were the 23-mph-sustained wind measured at Andrews AFB and the 44-mph wind gust. Investigators used various wind gust durations in the simulation, since the exact duration of the gusts at the time of the accident was unknown. Ford Motor Company also provided wind tunnel-derived aerodynamic coefficient data.

The two ranges of driver reaction times used in the simulation were (1) for an alert driver reaction (0.30 to 0.59 second) based on the median reaction times of young drivers to abrupt wind gusts[17] and (2) for a wireless telephone user driver reaction (0.685 to 1.15

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[14] SIMON allows users to simulate the response of one or more vehicles to driver inputs and factors related to the environment, including terrain, atmosphere, and wind. The SIMON software is three-dimensional and includes 6° of freedom for both independent and solid-axle suspension systems.

[15] HVE allows users to study vehicle and occupant kinematics.

[16] The scene was built with AutoCAD Land Development Desktop release 2i and AutoCAD release 2000.

[17] Walter W. Wierville, John G. Casali, and Brian S. Repa, "Driver Steering Reaction Time to Abrupt-Onset Crosswinds, as Measured in a Moving-Base Driving Simulator," 1983, *Human Factors*, 25(1), 103-116.

seconds) based on delays in simple reaction situations such as braking response to a braking maneuver in a lead vehicle (0.385 to 0.560 seconds).[18] The effects of having only one hand on the steering wheel while using a handheld wireless telephone could not be quantified and were not included in the simulation.

In this computer simulation study, Safety Board staff evaluated the controllability of the Explorer traveling at 70 mph in crosswinds of 23 mph, gusting to 44 mph. The results indicated that:

- the winds would have initially caused the Explorer to move to the right and rotate clockwise;
- the exact amount of lateral movement caused by the wind depended on the duration of the gust, the driver reaction time, and the steering input;
- the wind gusts would not have made the Explorer uncontrollable for an alert driver who had two hands on the steering wheel; and
- the delays in driver reaction time could have increased the lateral movement of the Explorer to such an extent that the vehicle intruded into the next lane.

Other Information

Wireless Telephone Use

Accident Driver. After the accident, Safety Board investigators found the accident driver's wireless telephone, without any hands-free apparatus, in the median. The accident driver's mother stated that her daughter had used the same wireless telephone for 2 years before the accident and that it was programmed with frequently called numbers. The Safety Board obtained the telephone records for both the accident driver and the male friend. The records show that on February 1, 2002, starting at 4:00 p.m., the accident driver placed or received 15 telephone calls, 12 of which were either to or from the male friend's wireless telephone number. (See table 8.)

[18] (a) Hakan Alm and Lena Nilson, "Changes in Driver Behavior as a Function of Hands-Free Mobile Phones–A Simulator Study," 1994, *Accident Analysis and Prevention*, Vol. 26, No. 4, 441-451 and (b) Hakan Alm and Lena Nilson, "The Effects of a Mobile Telephone Task on Driver Behavior in a Car Following Situation," 1995, *Accident Analysis and Prevention*, Vol. 27, No. 5, 707-715.

Table 8. Accident driver's wireless telephone record for February 1, 2002.

Number	Time	Incoming or Outgoing	Length in Minutes
1	4:00 p.m.	Outgoing to a number in Arlington	1
2	4:03 p.m.	Outgoing to voice mailbox	3
3	4:43 p.m.	Outgoing to a number in Occoquan, Virginia	3
4	6:16 p.m.	Incoming from the male friend's number	1
5	6:22 p.m.	Incoming from the male friend's number	1
6	6:23 p.m.	Outgoing to the male friend's number	1
7	6:33 p.m.	Outgoing to the male friend's number	1
8	6:34 p.m.	Outgoing to the male friend's number	1
9	6:57 p.m.	Incoming from the male friend's number	1
10	6:59 p.m.	Outgoing to the male friend's number	1
11	7:07 p.m.	Incoming from the male friend's number	1
12	7:23 p.m.	Outgoing to the male friend's number	1
13	7:24 p.m.	Outgoing to the male friend's number	1
14	7:55 p.m.	Incoming from the male friend's number	2
15	*8:00 p.m.	Outgoing to the male friend's number	3

*The accident occurred about 8:00 p.m.

Nationwide and Worldwide. According to the Cellular Telecommunications & Internet Association, the number of wireless telephone subscribers in the United States in April 2003 was 144,770,650.[19] This figure represented about 76 percent of the 191 million licensed U.S. drivers.[20] (Not all wireless telephone subscribers were driver's license holders.) Also, according to the association, nearly 118,000 wireless telephone calls are made to 9-1-1 and other emergency numbers each day, totaling more than 43 million calls annually.

In its 1997 study, *An Investigation of the Safety Implications of Wireless Communications in Vehicles*, NHTSA estimated that at any given time during daylight hours, 3 percent of U.S. drivers were talking on a handheld wireless telephone. Observational studies[21] in Dallas, Texas, (during an afternoon rush hour) found a 5-percent use rate and in Washington State a 3.5-percent use rate. In a 2002 North Carolina study,[22]

[19] Information accessed on May 19, 2003, from <http:www.wow-com.com>.

[20] U.S Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 2001* (Washington, DC: NHTSA, 2002).

[21] Anne T. McCartt, Elisa R. Braver, and Lori L. Geary, *Drivers' Use of Handheld Cell Phones Before and After New York State's Cell Phone Law,* Insurance Institute for Highway Safety (Arlington, VA: June 2002).

[22] Jane C. Stutts, Herman F. Huang, and William W. Hunter, "Cell Phone Use While Driving in North Carolina: 2002 Update Report," University of North Carolina, Highway Safety Research Center, December 2002.

the authors estimated that 58.8 percent of the State's licensed drivers had used a wireless telephone while driving. A recent survey[23] performed by The Gallup Organization for NHTSA indicated that 25 percent of the 4,010 drivers interviewed had used a wireless telephone while driving.

According to a U.S. General Accounting Office report[24] on wireless telephone health issues, the number of wireless subscribers increased from 16 million in 1994 to 110 million in 2001. The report also states that some experts project that worldwide wireless telephone use will reach 1.2 billion subscribers in 2005. In Austria, Finland, Italy, Norway, South Korea, and Sweden, more than half of the populations subscribe now.

Wireless Telephone Use and Driving

In its 1997 report, NHTSA characterizes wireless telephone use while driving a form of driver distraction. According to NHTSA research, driver distraction occurs when a driver "is delayed in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compels or induces the driver's shifting attention away from the driving task."[25] Other researchers have defined driver distraction as "any activity that takes a driver's attention away from the task of driving"[26] and have identified four categories of distraction: visual, auditory, biomechanical, and cognitive. For example, talking on a handheld wireless telephone might involve auditory, biomechanical, and cognitive distraction.

During the 1990s, the use of wireless telephones and other wireless communication devices while driving became the subject of debate as government agencies considered restrictive legislation. Research established that when auditory and visual tasks are performed simultaneously, performance on both tasks is degraded through slowed responses, reduced accuracy, or both.[27] Research performed in driving simulators[28] and in actual driving environments[29] suggested that the cognitive demands of wireless telephone conversations may lead to driver distraction. A Canadian study concluded that wireless telephone units that allow hands-free operation offer little, if any, safety

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[23] Dawn Royal, *National Survey of Distracted and Drowsy Driving Attitudes and Behaviors: 2002*, Volume 1-Findings Report, The Gallup Organization, DOT NHTSA 809566, March 2003.

[24] U.S. General Accounting Office, *Telecommunications: Research and Regulatory Efforts on Mobile Phone Health Issues*, May 2001 (GAO-01-545).

[25] J.C. Stutts, D.W. Reinfurt, L. Staplin, and E.A. Rodgman, "The Role of Driver Distraction in Traffic Crashes," University of North Carolina Highway Safety Research Center, 2001. Prepared for AAA Foundation for Traffic Safety.

[26] T.A. Ranney, E. Mazzae, R. Garrott, and M. Goodman, "NHTSA Driver Distraction Research: Past, Present and Future," 2000. Submitted to the NHTSA Driver Distraction Internet Forum.

[27] M.A. Just, P.A. Carpenter, T.A. Keller, L. Emery, H. Zajac, and K.R. Thulborn, "Interdependence of Nonoverlapping Cortical Systems in Dual Cognitive Tasks," 2000, *NeuroImage*, 14, 417-426.

[28] D.L. Strayer and W.A. Johnston, "Driven to Distraction: Dual-Task Studies of Simulated Driving and Conversing on a Cellular Telephone," *Psychological Science*, 12(6), 2001, 462-466.

[29] T. Hagiwara, R.A. Tokunaga, K. Nonami, S. Kagaya, and A. Shimojyo, "Effects of Using a Cellular Telephone While Driving on Reaction Time and Subjective Mental Workload," Transportation Research Board 78th Annual Meeting, January 10-14, 1999, Washington, DC.

advantage over handheld units.[30] Other researchers found that laws restricting handheld devices are not likely to reduce driver distraction because the distraction is due to the cognitive impact of the conversation, as well as the physical aspects of holding the telephone and dialing.[31] Additional simulator research[32] conducted at the University of Utah suggested that using a wireless telephone disrupts performance by diverting attention from the external environment, immediately associated with driving, toward an engaging cognitive context, resulting in "inattention blindness."

The use of wireless telephones (both handheld and hands-free) while driving has been shown to significantly increase drivers' reaction times,[33] speed variability,[34] subjective mental workload,[35] and risk of collision,[36] as well as to degrade situational awareness.[37] In the 2001 Parkes and Hooijmeijer study in a simulated road environment, subjects engaged in a telephone conversation were unaware of traffic movements around them.

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[30] D.A. Redelmeier and R.J. Tibshirani, "Association Between Cellular-Telephone Calls and Motor Vehicle Collisions," *New England Journal of Medicine*, 1997.

[31] D. Strayer, F. Drews, R. Albert, and W. Johnston, "Does Cell Phone Conversation Impair Driving Performance?" University of Utah, *Psychological Science*, 2001.

[32] David L. Strayer, Frank A. Drews, and William Johnston, "Cell Phone-Induced Failures of Visual Attention During Simulated Driving," 2003, *Journal of Experimental Psychology: Applied*, University of Utah.

[33] (a) H. Alm and L. Hilsson, "The changes of a mobile telephone task on driver behavior in a car following situation," 1995, *Accident Analysis & Prevention*, 27, 707-716. (b) D. Lamble et al, "Cognitive Load and Detection Thresholds in Car Following Situations: Safety Implications for Using Mobile (Cellular) Telephones While Driving," 1999, *Accident Analysis & Prevention*, 617-623.

[34] G. Pachiaudi and A. Chapon, "Car Phone and Road Safety," XIVth International Technical Conference on the Enhanced Safety of Vehicles, 1994, Munich, Germany, No. 94-S2-0-09.

[35] K.A. Brookhuis, G. De Vries, and D. De Waard, "The Effects of Mobile Telephoning on Driving Performance," 1991, *Accident Analysis & Prevention*, 23, 309-316.

[36] Redelmeier and Tibshirani, 453-458.

[37] A.M Parkes, and V. Hooijmeijer, "Driver Situation Awareness and Carphone Use," First Human-Centered Transportation Simulation Conference, 2001, University of Iowa, Iowa City, Iowa, November 4-7, 2001.

The relationship between poor situational awareness and poor performance has been documented in several modes of transportation.[38] Safety Board investigations have shown that when airline pilots, railroad engineers, and ship crews lose situational awareness, they make operational errors that lead to accidents.

In addition, The Royal Society for the Prevention of Accidents, which completed a study[39] of research commissioned by the British Department for Transport, Local Government and the Regions, found that using a mobile telephone while driving impairs driving performance. The study states:

> Many studies, using a variety of different research techniques, have reached the same conclusions. Using a mobile telephone while driving adversely affects driver performance in a number of different ways. It impairs: maintenance of lane position, maintenance of appropriate and predicted speed, maintenance of appropriate following distances from vehicles in front, reaction times, judgment and acceptance of safe gaps in traffic and general awareness in traffic.

The same study concluded "there is evidence that using a mobile telephone while driving causes greater problems for those drivers who already have a higher accident risk, namely young, novice drivers and elderly drivers."

Recent research[40] conducted on the Ford Motor Company's Virtual Test Track Experiment (a large, 6-degree-of-freedom moving base simulator) provided further evidence of the vulnerability of young, novice drivers to distractions while driving. The experiment involved 63 test participants: 48 subjects between the ages of 25 and 66 and 15 teenagers recently licensed to drive (ages 16, 17, and one 18-year-old). The researchers observed:

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[38] (a) National Transportation Safety Board, *Derailment of Amtrak Train No. 2 on the CSXT Big Bayou Canot Bridge Near Mobile, Alabama, September 22, 1993*, Railroad-Marine Accident Report NTSB/RAR-94/01 (Washington, DC: NTSB, 1994). (b) National Transportation Safety Board, *Aircraft Accident in Guantanamo Bay, Cuba, August 18, 1993*, Aviation Accident Report NTSB/AAR-94/04 (Washington, DC: NTSB, 1994). (c) National Transportation Safety Board, *Controlled Flight Into Terrain, Korean Air Flight 801, Boeing 747-300, HL7468, Nimitz Hill, Guam, August 6, 1997*, Aviation Accident Report NTSB/AAR-00/01 (Washington, DC: NTSB, 2000). (d) Aeronautica Civil of the Government of Colombia, *Controlled Flight Into Terrain, American Airlines Flight 965, Boeing 757-223, N651AA, Near Cali, Colombia, December 20, 1995*, Aircraft Accident Report. (e) National Transportation Safety Board, *Ramming of the Spanish Bulk Carrier URDULIZ by the USS DWIGHT D. EISENHOWER (CVN 69), Hampton Roads, Virginia, August 29, 1988*, Marine Accident Report NTSB/MAR-90/01 (Washington, DC: NTSB, 1990). (f) National Transportation Safety Board, *Grounding of the U.S. Tank Ship STAR CONNECTICUT, Pacific Ocean, Near Barbers Point, Hawaii, November 6, 1990*, Marine Accident Report NTSB/MAR-92/01 (Washington, DC: NTSB, 1992). (g) National Transportation Safety Board, *Grounding of the Panamanian Passenger Ship ROYAL MAJESTY on Rose and Crown Shoal Near Nantucket, Massachusetts, June 10, 1995*, Marine Accident Report NTSB/MAR-97/01 (Washington, DC: NTSB, 1992). (h) National Transportation Safety Board, Collision *of Two Burlington Northern Santa Fe Freight Trains Near Clarendon, Texas, on May 28, 2002*, Railroad Accident Report NTSB/RAR-03/01 (Washington, DC: NTSB, 2003).

[39] "The Risk of Using a Mobile Phone While Driving," July 18, 2002, The Royal Society for the Prevention of Accidents, Birmingham, England.

[40] J. Greenberg et al, "Evaluation of Driver Distraction Using an Event Detection Paradigm," Presented in Session 320, Transportation Research Board Annual Meeting, January 13, 2003, Ford Research Laboratory, Ford Motor Company, Dearborn, Michigan.

> The teen drivers exhibited behaviors that may place them at higher risk even when no distraction was present and . . . distraction from the secondary tasks [retrieving voice mail, dialing and answering both handheld and hands-free wireless telephones] was more pronounced with this group.

Also, the researchers concluded:

> The combination of poor judgment in following distance, poor vehicle control skills and more severe distraction seen in teen drivers is a serious cause for concern. Cellular telephones, pagers and other devices are popular among teens. The results of this study indicate that, at a minimum, driver education curricula should be revised to address the use of communication technology while driving. The use of handheld telephones by teens, in particular, should be strongly discouraged.

Regulations Regarding Wireless Telephone Use While Driving

Federal. The Federal Government has no regulations on the use of mobile telephones or wireless technologies in motor vehicles. In 2001, Federal lawmakers proposed legislation to curb wireless telephone use in automobiles (Senate Bill 927 and House of Representatives Bill 1837) that would require States to prohibit handheld wireless telephone devices in motor vehicles or risk losing Federal highway funds. The Congress did not pass that legislation.

In March 2002, the U.S. General Services Administration recommended that Federal agencies discourage employees from using a handheld device while driving Government-owned or -leased vehicles.[41] It also recommended that employees be provided access to hands-free devices and safety information.

State and Local. On November 1, 2001, New York became the first State to prohibit drivers from talking on handheld wireless telephones while operating a motor vehicle unless the driver is calling for assistance or to report a dangerous situation. Additionally, New York passed legislation that banned taxi drivers from using any type of a wireless telephone. California requires that rental cars equipped with wireless telephones include written instructions for the safe operation of a wireless telephone while driving. Florida and Illinois permit wireless telephone use as long as the device does not impair sound to both ears of the driver. Arizona and Massachusetts prohibit school bus drivers from using wireless telephones while operating a school bus. In 2001, 43 State legislatures, the District of Columbia, and Puerto Rico considered approximately 140 bills regarding the use of wireless telephones while driving. The legislation varied in each jurisdiction and none of the bills passed, either failing in committee or carrying over to 2002. This number of legislatures was an increase from the 27 that considered wireless telephone measures in 2000 and the 15 that did so in 1999.

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[41] GAO-01-545.

Eight States[42] have introduced legislation to prohibit young drivers from using wireless telephones while driving.[43] In 2002, New Jersey enacted a law[44] prohibiting holders of driver examination permits from using any interactive wireless device while operating a motor vehicle. A similar law, which would prohibit drivers holding only a driver's permit from using a wireless telephone while driving, was introduced in the Pennsylvania legislature.[45] On May 23, 2003, the Governor of Maine signed a law restricting drivers under age 18, including persons with an instruction permit and holders of a restricted license, from "operating a motor vehicle while using a mobile phone." [46]

At least 22 municipalities or counties[47] have limited their drivers to using only hands-free devices while operating a motor vehicle. Several other large cities, including Chicago, Illinois; Cleveland, Ohio; Philadelphia, Pennsylvania; and San Francisco, California, have considered or are considering wireless telephone legislation.

International. Many countries have restricted or prohibited use of wireless telephone or other wireless technology in motor vehicles. Some countries fine drivers who are involved in a crash while talking on a wireless telephone, and other countries' drivers lose their insurance coverage if they are involved in an accident while talking on a wireless telephone. Japan and Ireland impose a penalty of up to 3 months in jail, as well as a fine. France and New Zealand are considering legislation that would restrict wireless telephone use. Table 9 lists countries and their legislative limitations on the use of wireless telephones while operating a motor vehicle.

[42] Illinois, Iowa, Massachusetts, New York, Oklahoma, South Carolina, Tennessee, and Virginia.

[43] Susan A. Ferguson, "Other High-Risk Factors for Young Drivers—How Graduated Licensing Does, Doesn't, or Could Address Them," 2003, *Journal of Safety Research*, 34, 71-77.

[44] Bill AB 3241 was enacted January 14, 2002.

[45] The Governor vetoed Bill HB 1553 on December 16, 2002.

[46] Legislative Document 1439.

[47] Miami Dade County, Pembroke Pines, and Westin, Florida; Brookline, Massachusetts; Carteret, Marlboro, and Nutley, New Jersey; Santa Fe, New Mexico; Suffolk County, Nassau County, Rockland County, and Westchester County, New York; Brooklyn, North Olmstead, and Walnut Hills, Ohio; Conshohocken, Hilltown, Lebanon, West Conshohocken, and York, Pennsylvania; and Sandy, Utah.

Table 9. Countries and their legislative limitations on the use of wireless telephones while operating a motor vehicle.

Country	Legislation
Australia	Can only use hands-free device and only when vehicle is parked with engine turned off.
Austria	Handheld telephone use banned.
Belgium	Handheld telephone use banned, except in a stationary (parked) vehicle.
Brazil	Prohibits use of handheld telephone while driving.
Czech Republic	Prohibits use of handheld telephone while driving.
Chile	Prohibits use of handheld telephone while driving
Denmark	Prohibits use of handheld telephone while driving.
England	Prohibits use of handheld telephone while driving.
Germany	Handheld telephone use banned, except in a stationary vehicle with the engine turned off.
Greece	Prohibits use of handheld telephone while driving.
Hong Kong	Prohibits use of handheld telephone while driving.
Hungary	Prohibits use of handheld telephone while driving.
Ireland	Prohibits use of handheld telephone while driving.
Israel	Prohibits use of handheld telephone while driving.
India (New Delhi only)	Prohibits use of any wireless telephone while driving.
Italy	Prohibits use of handheld telephone while driving.
Isle of Man	Prohibits use of handheld telephone while driving.
Japan	Prohibits use of handheld telephone unless vehicle is stationary or in an emergency situation.
Isle of Jersey	Prohibits use of handheld telephone while driving.
Jordan	Prohibits use of handheld telephone while driving.
Malaysia	Prohibits use of handheld telephone while driving.
Norway	After March 15, 2000, all telephones in cars must be hands-free and firmly mounted on dashboard.
Philippines	Prohibits use of handheld telephone while driving.
Poland	Prohibits use of handheld telephone while driving.
Portugal	Prohibits use of handheld telephone while driving.
Romania	Prohibits use of handheld telephone while driving.
Russia	Prohibits use of handheld telephone while driving.
Singapore	Prohibits use of handheld telephone while driving.
Slovak Republic	Prohibits use of handheld telephone while driving.
Slovenia	Prohibits use of handheld telephone while driving.
South Africa	Prohibits use of handheld telephone while driving.

South Korea	Prohibits use of handheld telephone while driving.
Spain	Prohibits use of handheld telephone while driving.
Switzerland	Prohibits use of handheld telephone while driving.
Taiwan	Prohibits use of handheld telephone while driving.
Thailand	Prohibits use of handheld telephone while driving.
Turkey	Prohibits use of handheld telephone while driving.
Sources: (a) The Royal Society for the Prevention of Accidents, "The Risk of Using a Mobile Phone While Driving," Birmingham, England, July 18, 2002, and (b) National Conference of State Legislatures, "Along for the Ride: Reducing Driver Distractions," March 2002 (ISBN 1-58024-207-3).	

Effectiveness. A recent observational study[48] of the effectiveness of the New York law examined use of handheld wireless telephones before and after November 1, 2001, when the law was implemented. The researchers found that the handheld wireless telephone use rate decreased from 2.3 percent of observed drivers (before) to 1.1 percent (after); the researchers did not examine crash rates.

In fall 2003, the Institute for Traffic Safety Management and Research at the University at Albany, State University of New York, plans to conduct a crash analysis of the State's wireless telephone accidents for the 18-month period from July 2001 through December 2002.[49] New York started coding such accidents for data collection purposes on July 1, 2001.

Wireless Telephone Use Warnings and Training

Most wireless telephone manufacturers include warnings in their product user guides regarding safe use of a wireless telephone while operating a vehicle. For example, the AT&T wireless product welcome guide warns consumers to carefully consider whether they should use their telephone while driving and to avoid accidents by not reaching for the telephone or talking on the device. The guide states that factors to consider while using a wireless telephone include driving skill and experience, familiarity with the vehicle, and traffic and weather conditions.

State Farm Insurance Company recently included with its insurance renewal notices a warning about wireless telephone use while driving. The warning indicates that drivers using wireless telephones are more likely to be involved in automobile accidents than those not using them. Also, the warning states that even telephones with hands-free features may not offer safety advantages over traditional handheld units. The warning concludes that to "protect yourself and others, don't become distracted while driving."

[48] McCartt, Braver, and Geary.

[49] Anne M. Dowling, "Distracted Driving: The New York State Experience," March 10, 2003, presentation at Lifesavers 2003, Chicago, Illinois.

The Shell Oil Company published an eight-page pamphlet[50] on “Deadly Distractions” that warned drivers about the use of wireless telephones and other distractions in vehicles while driving.

On behalf of the American Automobile Association, Glencoe/McGraw Hill published *Responsible Driving*, a driver education book[51] for high school students, that includes the chapter, “Distractions Can Increase Driving Risk.” It states that using a wireless telephone while driving is not recommended because statistics show that wireless telephones are distracting and increase the risk of accidents and that dialing and talking divert a driver’s attention from controlling the vehicle and watching the road. In addition, it recommends keeping the wireless telephone in the glove compartment with the ringer off and states that if the driver must place a call, he or she should stop the vehicle off the road.

Virginia Driver’s Education Curriculum

The 1997-1998 State of Virginia’s Driver’s Education curriculum did not address wireless telephone use or driver distraction. The 1991 Virginia Driver’s Education Standards of Learning, which were in effect during the 1997-1998 school year, did not include a driver distraction objective. In 2001, Virginia updated its Driver’s Education Standards of Learning and added the following objective: “The student will identify distractions that contribute to driver error. Key concepts include (a) passengers and pets, (b) vehicle accessories, and (c) cell phones and other portable technology devices.” The instructor’s guidebook does not have specific information on driver distraction. A driver education instructor in the Fairfax County school system indicated that he used the Shell Oil Company pamphlet, noted above, to teach the risks of driver distraction.

The 2003-2004 program of studies for the accident driver’s high school indicates that the driver education course comprises 90 periods of instruction. This instruction is divided between theory, provided in a classroom setting, and laboratory work, which includes student experiences in simulators and at the controls of a driver education car, either on the road or in an off-street driving area.

NHTSA Activities

In 1997, NHTSA compiled *An Investigation of the Safety Implications of Wireless Communications in Vehicles,* a report that discusses the scientific research on use of wireless devices, as well as the limited crash data then available. The report also offers a number of recommendations for addressing the issues identified:

- Improving data collection and reporting.
- Improving consumer education.
- Initiating a broad range of research to better define and understand the problem.

[50] Available at <www.countonshell.com>.

[51] Accessed from the Web site <www.glencoe.com>.

- Addressing issues associated with use of wireless telephones to access emergency services.
- Encouraging enforcement of existing State laws to address inattentive driving behavior.
- Working with States on legislative options.
- Using the National Advanced Driving Simulator[52] and recording-instrumented vehicles to study optimal driver-vehicle interfaces.
- Developing a sound basis for carrying out cost-benefit analyses.

In August 2001, Virginia Tech Transportation Institute began a 3-year study, "100-Car Naturalistic Driving," funded by NHTSA, the Virginia Department of Transportation, and Virginia Polytechnic Institute and State University. The project, using 100 recording-instrumented vehicles on the road for 1 year, is expected to provide a meaningful sample of crash and near-crash data. NHTSA hopes to use the data collected to address issues involving different crash types and safety concerns, including distraction, fatigue, lane change maneuvers, and other driver behaviors.

According to the study's experimental design statement,[53] data collection in a "naturalistic" setting is a preferred approach for obtaining necessary human factors data to develop crash countermeasures and the associated supporting models of driver behavior and performance. The study plan calls for equipping 100 vehicles (20 leased vehicles and 80 privately owned) with 5 cameras and 23 sensors. The vehicles are being driven in the Washington, D.C., and northern Virginia area by high-mileage drivers, whose occupations, such as real estate agent and salesperson, require driving at least 27,000 miles per year. The age and gender distribution of the 100 drivers is:

- 18-20 years – 18 males and 12 females,
- 21-24 years – 18 males and 12 females,
- 25-34 years – 6 males and 4 females,
- 35-44 years – 6 males and 4 females,
- 45-54 years – 6 males and 4 females, and
- 55-64 years – 6 males and 4 females.

Data from the vehicle sensors are being downloaded periodically, and NHTSA and Virginia Tech Transportation Institute researchers respond to accident sites to collect additional data. To date, more than 80 of the 100 vehicles are on the road. This study was initially designed to collect rear-end collision information in support of collision

[52] The National Advanced Driving Simulator, located at the University of Iowa's Oakdale Research Park, is a national, shared-use facility owned by NHTSA and operated by the University of Iowa.

[53] V.L. Neale, S.G. Klauer, R.R. Knipling, T.A. Dingus, G.T. Holbrooke, and A. Peterson, *The 100 Car Naturalistic Driving Study, Phase I-Experimental Design*, U.S. Department of Transportation, National Highway Traffic Safety Administration, DOT-HS-809-536, December 2002.

avoidance countermeasures; the researchers believe that the study will also provide valuable human factors information on the effects of wireless communication devices.

In 2002, NHTSA awarded a $1.5 million contract to the University of Iowa to conduct two National Advanced Driving Simulator projects on driver distraction and the use of wireless telephones. The first project will address issues relating to the effects of telephone interface on driver performance. The second project will study how distraction caused by wireless telephone usage varies, depending on the content, length, and intensity of the telephone call.

Also, NHTSA began developing a public education and information campaign in fall 2002 to inform drivers and the public at large about the risks of distracted driving. In addition, NHTSA is working with the American Driver and Traffic Safety Education Association and the American Association of Motor Vehicle Administrators to develop a generic driving manual for the States' use. It expects that this manual and an accompanying parent-teen guide will be available December 2003. The American Driver and Traffic Safety Education Association is developing a new drivers education manual as well.

Accident Statistics

Young Drivers. In 2001, 6.8 percent of the driving population was age 20 years or younger (13 million drivers of 191 million total drivers).[54] Of all drivers involved in fatal accidents, 14.3 percent were age 20 years or younger (8,253 of 57,480 total drivers).[55] According to NHTSA, when driver fatality rates are calculated on the basis of estimated annual travel, teen drivers (16 to 19 years old) have a fatality rate about four times higher than the fatality rate for drivers 25 to 69 years old. In addition, NHTSA estimated that all highway crashes cost society about $231 billion a year, which includes $42 billion for crashes involving drivers between 15 and 20 years old.

Distraction, Particularly, Wireless Telephone Use. The reported incidence of wireless telephone use in accidents is low. According to Congressional testimony,[56] NHTSA Fatality Analysis Reporting System (FARS)[57] data for the year 2000 indicated that 37,409 fatal crashes occurred; in 101 of those crashes a wireless telephone was present. At the time of the testimony, only Minnesota and Oklahoma included on their accident reports a data field for wireless telephone use as a contributing factor.

[54] U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2001* (Washington, DC: FHWA, 2002).

[55] NHTSA, *Traffic Safety Facts.*

[56] NHTSA testimony before the House Committee on Transportation and Infrastructure, Subcommittee on Highways and Transit, on May 9, 2001.

[57] FARS, maintained by NHTSA, is a census of all crashes involving a motor vehicle traveling on a traffic way customarily open to the public that results in the death of a person (occupant or nonmotorist) within 30 days of the crash.

According to the NHTSA testimony, before a data field for wireless telephone use was added to accident reports, the data were obtained from accident report narratives, provided the investigating officer had added that information to the report. Now, driver distractions are included in the *Model Minimum Uniform Crash Criteria Guideline 2003*.[58] The codes for these data elements are for a driver who is:

- Not distracted.
- Distracted by an:
- Electronic communication device (wireless telephone or pager),
- Other electronic communication device (navigation device or palm pilot),
- Other distraction inside the vehicle (radio or another passenger), and
- Object outside the vehicle (road sign or another vehicle).

According to the Governors Highway Safety Association, as of November 2002, 16 States[59] code wireless telephone use as a data element on their accident investigation forms.

The AAA Foundation for Traffic Safety funded a study by the University of North Carolina Highway Safety Research Center[60] to examine the role of driver distraction in traffic crashes. This study, issued in 2001, used 1995 through 1999 narrative data from the NHTSA crashworthiness data system and 2 years of North Carolina police-reported crash narratives. Researchers found that driver distraction was involved in 8.3 percent of accidents and that the reported cases of using or dialing a wireless telephone were 1.5 percent of the distractions among distracted drivers. In addition, the researchers reported that young drivers (under 20 years of age) were the most likely to be involved in distraction-related crashes.

In a 2002 North Carolina study,[61] researchers did a computerized narrative search of all reported crashes that occurred in the State from January 1, 1996, through August 31, 2000. They identified 452 wireless telephone-related crashes and nearly 1.1 million that did not involve wireless telephones.

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[58] The Model Minimum Uniform Crash Criteria (MMUCC) represent a "model" minimum crash data set and have specific attributes for each data element. The Governors Highway Safety Association, NHTSA, the FHWA, and the Federal Motor Carrier Safety Administration jointly developed the MMUCC in collaboration with State and local agencies.

[59] California, Florida, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Jersey, New York, Oklahoma, Oregon, Pennsylvania, Tennessee, and Texas.

[60] Stutts, Reinfurt, Staplin, and Rodgman.

[61] Stutts, Huang, and Hunter.

Pennsylvania crash data[62] for 1999 and 2000 indicated that 10,315, or 3.5 percent, of all traffic crashes involved citations for driver distractions. Using or dialing a wireless telephone accounted for 5.2 percent of driver distractions.

The California Highway Patrol examined driver distraction and inattention accident data in California for the 6-month period from January 1 to June 30, 2002.[63] The law enforcement agency found that 6 percent (5,677 of 491,083) of drivers in all accidents were inattentive. Of the accidents related to inattention, the largest category (611 of 5,677), or 11 percent, involved wireless telephones.

According to Virginia's accident records, 12.5 and 12.1 percent of drivers involved in accidents in 2000 and 2001, respectively, were inattentive at the time of the crash. A Virginia study[64] examined driver distraction accidents from June 15 to November 30, 2002, in which the police had reported the type of distraction in driver inattention crashes. The study included information on 2,792 crashes involving 4,494 drivers, of whom 2,822 were distracted drivers. Driver fatigue or drivers who fell asleep accounted for 17 percent of the distractions reported, and wireless telephone use accounted for 3.9 percent.

The Safety Board analyzed the 1991-2000 FARS data to identify driver distraction factors and utility vehicle[65] involvement in accidents. Driver distraction factors, as coded under FARS and used in this analysis, included wireless telephones, fax machines, computers, on-board navigation systems, two-way radios, and heads-up displays. Distraction factors accounted for about 0.09 percent of the coded factors (553 of 601,002); wireless telephones accounted for 88.5 percent of the distraction factors (489 of 553).

Driver distraction factors accounted for about 0.15 percent of the coded driver factors in both single-vehicle accidents involving a utility vehicle (38 of 28,140 coded driver factors) and all utility vehicle accidents (66 of 43,195 coded driver factors). Wireless telephone use accounted for all distraction factors in the single-vehicle accidents involving a utility vehicle and all but two of the coded distraction factors for utility vehicle accidents overall.

Other Accidents Involving Wireless Telephone Use

The Safety Board investigated three other 2002 accidents in support of the Largo accident investigation. All three involved drivers who were engaged in a wireless telephone conversation at the time of the accident.

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[62] "Driver Distractions and Traffic Safety," Staff Report Pursuant to 2000 Senate Resolution No. 127, General Assembly of the Commonwealth of Pennsylvania, Joint State Government Commission, December 2001.

[63] California Highway Patrol, "Driver Distractions and Inattention Data Summary," Report to the Governor and Legislature, November 2002.

[64] Andrea L. Glaze and James M. Ellis, "Pilot Study of Distracted Drivers," Center for Public Policy at Virginia Commonwealth University, Virginia, January 2003.

[65] Utility vehicle categories are compact utility, large utility, utility station wagon, and utility unknown body type.

About 9:10 a.m. on April 11, 2002, a 1998 Chevrolet passenger car was traveling southbound on State Route 5 near Korona, Florida, when the driver lost control and the vehicle ran off the road, colliding with two trees.[66] The unbelted 16-year-old driver, unbelted 14-year-old left rear seat passenger, unbelted 14-year-old center rear seat passenger (ejected), and unbelted 7-year-old right rear seat passenger (ejected) all sustained fatal injuries. The lap/shoulder-belted 6-year-old right front seat passenger sustained serious injuries. At the time of the accident, the Chevrolet was following another vehicle, and the accident driver was engaged in a wireless telephone conversation with that vehicle's driver.

About 8:08 a.m. on June 24, 2002, southbound Amtrak train 68 struck an eastbound 1996 Toyota Camry on the highway-rail grade crossing at Baseline Road near Little Rock, Arkansas.[67] None of the 142 passengers and 11 crewmembers aboard the train sustained injures. The 44-year-old Toyota driver sustained fatal injuries. Witnesses reported that the crossing gates were down and that the Toyota driver was talking on a handheld wireless telephone as she approached the crossing, changed lanes to go around a stopped vehicle, and drove around the crossing gates into the path of the approaching train. Her wireless telephone records indicated that she had placed three calls between 8:02:31 a.m. and 8:08:01 a.m.

About 7:13 p.m. on November 10, 2002, a 2002 Dodge Dakota pickup truck was traveling northbound on North Road, in Raymond Township, Illinois, when the vehicle failed to stop at a stop sign, entered the intersection with North 21st Avenue, and collided with an eastbound 1996 Freightliner tractor-semitrailer.[68] The 55-year-old pickup truck driver sustained fatal injuries, and the tractor-semitrailer driver sustained minor injuries. Witnesses and wireless telephone records indicated that the pickup truck driver was engaged in a wireless telephone conversation at the time of the accident.

Provisional or Graduated Licenses

A provisional license system is a three-stage graduated licensing system comprising a learner's permit; a provisional, probationary, or intermediate licensed period;[69] and, eventually, full, unrestricted driving. The duration of time for the intermediate stage varies from State to State but is less than 2 years in all States. According to the Insurance Institute for Highway Safety,[70] 35 States, the District of Columbia, and 4 Canadian provinces have adopted three-stage graduated licensing systems.

If certain conditions are violated under a provisional license system, the provisional license can be suspended or revoked or issuance of an unrestricted license can

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[66] Docket Number HWY-02-IH-016.

[67] Docket Number HWY-02-IH-027.

[68] Docket Number HWY-02-IH-008.

[69] The terms "provisional," "probationary," and "intermediate" are used interchangeably to describe the second stage of the three-stage graduated licensing system throughout the States.

[70] Information accessed on February 13, 2003, from <http://wwwhighwaysafety.org.>.

be deferred. A three-stage system imposes restrictions that limit teenage driving to less dangerous circumstances until the driver has had an opportunity to gain driving experience. Examples of such restrictions include limiting driving to daytime or to driving with adult supervision, mandatory seat belt usage, passenger restrictions, and remaining accident or violation free during the learner and intermediate stages.

Virginia adopted a graduated licensing system in 2001. It sets the minimum age for a learner's permit at 15 years 6 months, and the driver must hold the learner's permit for at least 9 months. During the learner's permit phase the driver must complete at least 40 hours of supervised driving (10 hours at night). After passing a driver's test, the provisional or intermediate phase lasts until the driver is age 18 and includes a night driving restriction from midnight to 4:00 a.m. and a passenger restriction (one passenger under age 18 if the driver is under age 17 and three passengers under age 18 if the driver is 17 or older).

The Safety Board has been a proponent of provisional or graduated licensing. On March 11, 1993, the Board issued Safety Recommendations H-93-1 through -9 asking the States to take action to reduce the number of youth-related highway crashes and fatalities. The Board identified several actions the States could take, including improving minimum drinking age laws and enforcement, instituting a zero blood alcohol content requirement for drivers under age 21, and crafting changes in driver licensing and restrictions. The Safety Board urged the States to:

> H-93-8
>
> Enact laws to provide for a provisional license system for young novice drivers.
>
> H-93-9
>
> Enact laws that prohibit driving by young novice drivers between certain hours, especially midnight to 5:00 a.m.

In addition, on November 8, 2002, the Safety Board issued Safety Recommendations H-02-30 and -31 asking the States[71] to expand graduated licensing programs as follows:

[71] The Safety Board also issued Safety Recommendations H-02-31 and -32 to the 14 States (Alaska, Arizona, Connecticut, Hawaii, Kansas, Kentucky, Minnesota, Montana, Nebraska, Nevada, North Dakota, Oklahoma, Utah, and Wyoming) that have not implemented the three-stage graduated licensing system and the passenger restrictions recommended by the Safety Board. For these 14 states, Safety Recommendation H-93-8 has been classified "Closed –Superseded" by these new recommendations.

H-02-30

Restrict young, novice drivers with provisional (intermediate) licenses, unless accompanied by a supervising adult driver who is at least 21 years old, from carrying more than one passenger under the age of 20 until they receive an unrestricted license or for at least 6 months (whichever is longer).

H-02-31

Require that the supervising adult driver in the learner's permit stage of your graduated licensing law is age 21 or older.

A paper[72] presented at the Graduated License Symposium on November 6, 2002, summarized several research projects in States with graduated licensing systems that show the effectiveness of these systems in reducing accidents and fatalities. California, Connecticut, Florida, Kentucky, Michigan, North Carolina, and Ohio all recorded substantial reductions (ranging from 9 to 33 percent) in crashes and fatalities.

Electronic Stability Control[73]

The automotive industry has developed various technological systems to assist drivers in maintaining control of their vehicles. In recent decades, antilock braking systems (ABS) and traction control have become commonplace in both heavy- and light-duty vehicles. These systems function by monitoring wheel rotational speeds and selectively releasing or applying the braking force, when necessary, to control wheel lockup or wheel spin. When the wheel speed exceeds preset slippage values, the systems engage.

Another system, electronic stability control (ESC), which builds upon existing ABS and traction control hardware, has recently become available. The ESC feature increases vehicle stability through electronic processing of the vehicle's motion and precise application of brake force at selected wheels, when necessary. Currently, ESC systems are most commonly found on some luxury passenger cars and sport utility vehicles.

ESC systems utilize the ABS hardware and provide two additional sensors for steering wheel angle and yaw.[74] The steering wheel angle sensor, which measures driver input through the steering wheel, monitors the driver's intended path. The yaw sensor,

[72] Herb M. Simpson, "The Evolution and Effectiveness of Graduated Licensing," *Journal of Safety Research* (34), 2003.

[73] The Safety Board is using the Society of Automotive Engineers' term for this system, which is also known as electronic stability program (Mercedes), as seen in figure 15; roll stability control (Volvo); vehicle stability enhancement system or StabiliTrak, Precision Control, and Active Traction (General Motors); AdvanceTrac (Ford); and vehicle skid control (Toyota).

[74] Yaw is the movement of an object rotating about its vertical axis. For example, when a vehicle turns, it rotates, or continually changes its heading angle, and is yawing. If a vehicle spins out of control on a slick roadway, the yaw rate is excessive and would be noted by an ESC yaw sensor.

which measures rotation of the vehicle around its vertical axis, monitors how quickly a vehicle is beginning to rotate, or spin out of control. The ESC computer algorithm then brings the vehicle's actual path in line with the driver's intended path, unless the yaw acceleration is so severe that it cannot be corrected.

ESC systems act by selectively applying braking force at the appropriate wheel to return the vehicle to driver control. For example, when a vehicle is beginning to spin out (oversteering), the ESC momentarily brakes the outside front wheel to straighten the vehicle and prevent spinning, and when a vehicle is not turning quickly enough for the driver's steer input (understeering), the ESC momentarily brakes the inside rear wheel to provide greater path curvature. (See figure 15.) In addition to selective brake control, some systems incorporate throttle control to reduce engine power, as necessary, and each system is tuned to the individual vehicle. The ESC's intervention requires no active driver participation, and most drivers do not realize that the ESC has intervened.

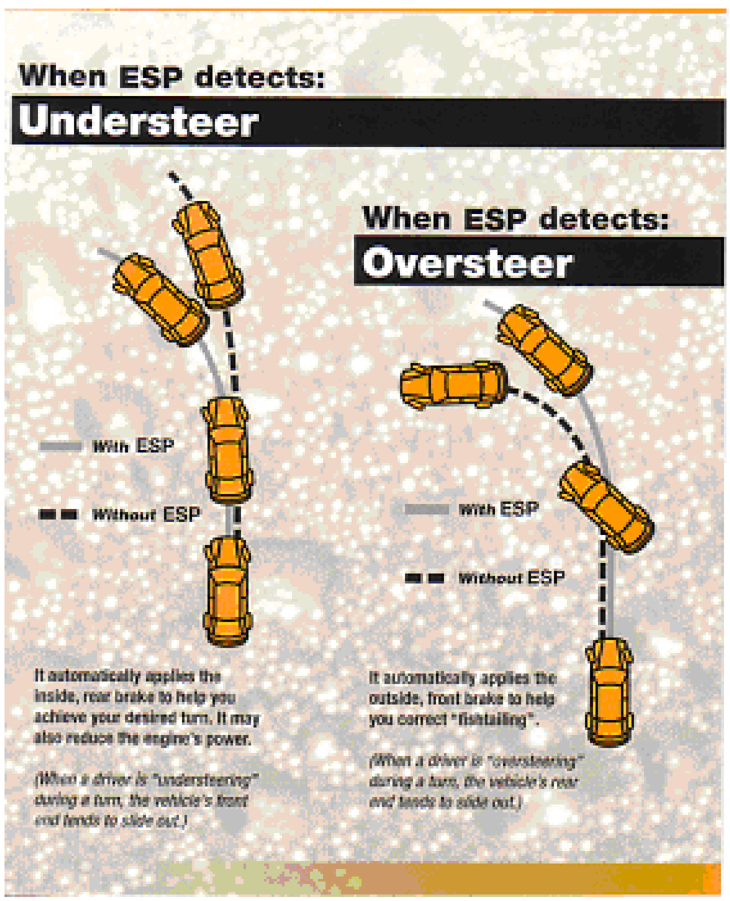

Figure 15. Detection of oversteer and understeer by the ESC system known as the electronic stability program (ESP). (Illustration courtesy of Continental Teves.)

According to the Electronic Stability Control Coalition, an organization of ESC manufacturers, the cost of installing ESC as standard equipment on vehicles ranges from $150 to $400 depending on the existing standard equipment ($350 to $400 for vehicles that do not have ABS, $250 to $300 for vehicles that have ABS, and $150 to $200 for vehicles that have ABS and traction control). Currently, 6 percent of vehicles produced in the United States have ESC. For the 2003 model year, most European passenger cars sold in the United States have ESC as standard equipment, and ESC is offered on many Japanese cars as optional equipment. ESC is also optional equipment on some Ford Motor Company and General Motors Corporation luxury models.

Daimler-Chrysler Corporation recently completed an accident study that compared Mercedes products in European service equipped and not equipped with ESC systems.[75] Researchers examined statistics from more than 1.5 million accidents that had been compiled by the German Government Statistics Office. They compared 1998-1999 accidents involving Mercedes models without ESC to 2000-2001 accidents involving Mercedes models with ESC. The results indicated a 15-percent reduction in overall accidents, a 10-percent reduction in rollover accidents, and a 12-percent reduction in the most serious injury accidents.

[75] November 26, 2002, press release.

Analysis

General

This accident involved multiple risk factors, some of which are associated with young drivers. A 20-year-old, inexperienced, unbelted driver was operating a high-profile, short-wheelbase, sport utility vehicle, with which she was unfamiliar, 15 to 20 miles over the speed limit, while talking on a handheld wireless telephone. The driver encountered wind gusts, oversteered for a number of reasons that will be discussed below, and lost control. The vehicle yawed off the left side of the roadway, drove over an obsolete guardrail end treatment through a depressed median, hit the back of a guardrail, and vaulted into an oncoming minivan.

This analysis first discusses the factors and conditions that the Safety Board was able to exclude as neither causing nor contributing to the accident. It then provides a brief overview of the accident events and a detailed discussion of the issues.

The major safety issues identified were: the accident driver's speed, operating inexperience, and unfamiliarity with the vehicle; the use of a wireless telephone while operating a vehicle; the need for technology to aid vehicle stability; and the adequacy of the existing barrier system.

Exclusions

The accident driver's postaccident toxicological tests were negative for alcohol and drugs, and she appeared to have received adequate rest in the 72 hours before the accident. Postaccident inspection of the Explorer revealed no mechanical anomalies. The Safety Board specifically examined the Explorer components that could have contributed to the vehicle's rapid swerving motion. Although severely damaged as a result of the accident, the steering and suspension apparatus showed no signs of preaccident defects. Likewise, the tires were closely examined. Although they too were severely damaged as a result of the accident, the tires showed no signs of preaccident shredding or tearing that would indicate tire failure. While accident damage prevented investigators from determining the pressure in three of the four tires, none of the tires exhibited wear due to low tire pressure prior to the accident. The Prince George's County Fire Department was on scene within 7 minutes of notification. Therefore, the Safety Board concludes that the accident driver was not impaired due to alcohol, drugs, or fatigue; the mechanical condition of the Explorer did not contribute to the accident; and the emergency response was adequate and timely.

Neither the driver of the Explorer nor the right front passenger of the Windstar was using the available restraint systems. However, the collision forces between the two vehicles, as well as the occupant compartment intrusions for both vehicles, were severe. The Injury Assessment Reference Values found in 49 *Code of Federal Regulations* 571.208, Federal Motor Vehicle Safety Standard 208, indicate that in a 30-mph barrier crash, the typical forces occur in 85 to 100 milliseconds. These values further indicate that forces exceeding 60 g's (acceleration of gravity) on the chest, chest compression of more than 3 inches, a femur load of more than 2,250 pounds, and head injury criteria [HIC] above 1,000 are considered to exceed human tolerances. In this accident, the Explorer's vault speed off the guardrail was at least 40 mph, and the Windstar was traveling between 80 and 90 mph. The closing speed in such circumstances would have been approximately 120 mph, the equivalent of a 60-mph barrier crash, or about twice as much as that required to exceed human tolerances. Furthermore, the Explorer collided with the Windstar while inverted and struck the Windstar in its windshield and A-pillar area, causing major intrusion of the occupant compartments. The Safety Board concludes that the collision forces and intrusion into the occupant compartments of both the Explorer and Windstar rendered the vehicles' occupant spaces unsurvivable.

The Accident

Weather Conditions

On the day of the accident, the NWS issued weather advisories warning of high wind conditions, including strong west to northwest winds expected into the evening hours. Wind speeds of 25 to 35 mph and wind gusts of up to 45 mph were predicted. About 10 minutes before the accident, Andrews AFB recorded winds of 23 to 24 mph and gusts of 39 mph from a heading of 310°. These winds would have come from an angle about 35° to the left of the Explorer.[76] Shortly thereafter, Andrews AFB recorded a wind gust of 44 mph from a heading of 300°, about 45° to the left of the Explorer's direction of travel. (See figure 16.) Additionally, a witness traveling behind the Explorer at the time of the accident described wind gusts that were sufficiently severe to cause him to reduce his vehicle's speed. Therefore, the Safety Board concludes that at the time of the accident, the Explorer experienced strong winds, including potential gusts between 39 and 44 mph, from the left at an approximate angle of 35° to 45°.

[76] At the time of the accident, the Explorer was traveling at a heading of 355° magnetic or 345° true.

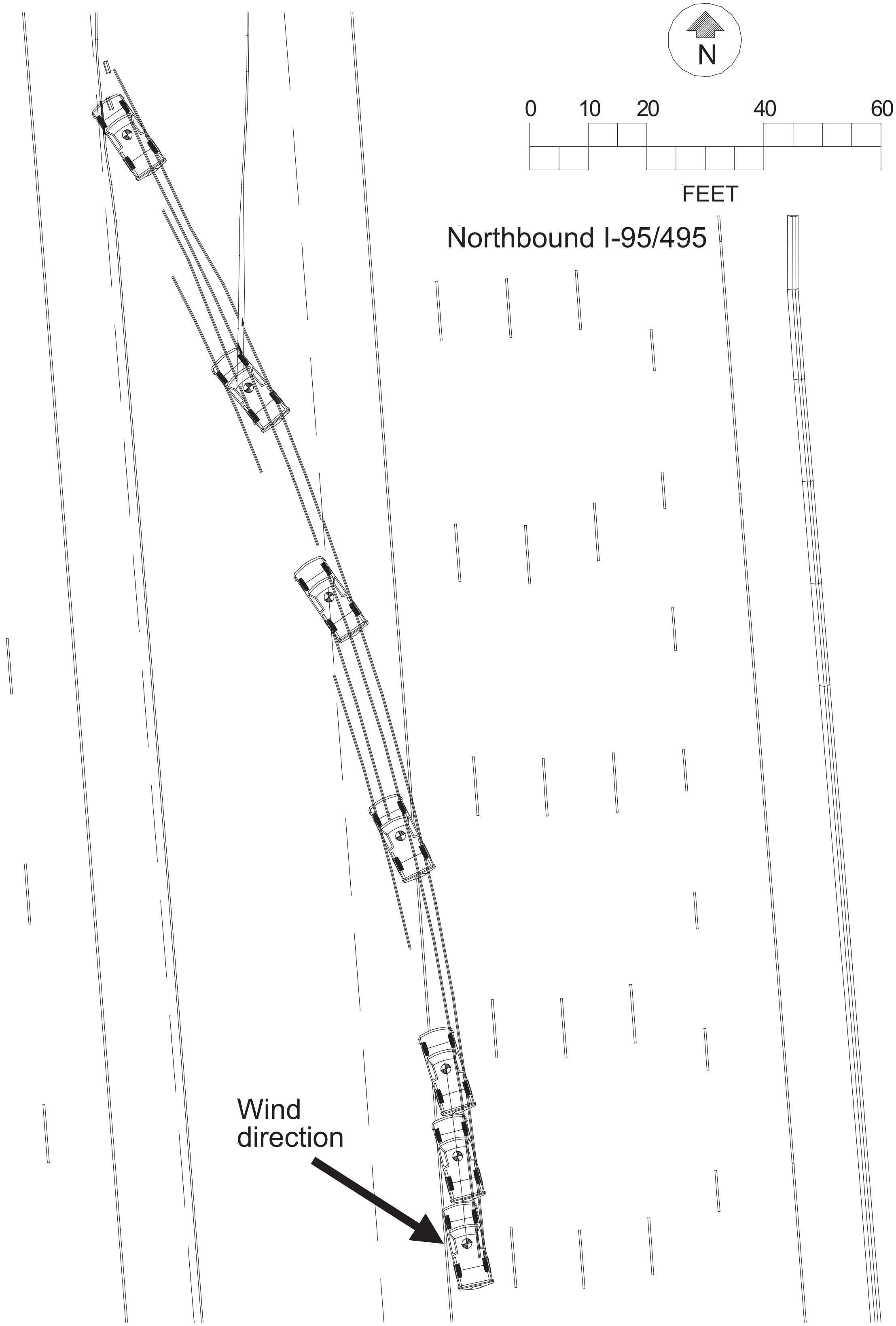

Figure 16. Explorer's path from the northbound lanes through the median.

Collision Events

The Explorer was proceeding northbound in the left lane of I-95/495, when it abruptly departed the roadway. A witness traveling behind the Explorer reported that the accident vehicle was traveling between 70 and 75 mph at the time.

Shortly before the Explorer left the roadway, it probably encountered severe wind gusts from the left that would have pushed it to the right. Tire marks on the roadway indicated that a sharp swerve to the left preceded the vehicle's departure from the roadway. Investigators found no mechanical anomalies that would account for the swerve. In response to the wind gust, which would have pushed the vehicle to the right, the driver apparently made a sharp steering maneuver to the left. This sharp steering maneuver was quite likely the culmination of several factors, as outlined below.

Shortly before the accident, the driver made a wireless telephone call to her male friend and was talking on the telephone when the accident occurred. Since no hands-free devices were found with the telephone, the driver was probably holding the telephone in one hand and steering with the other hand at the time of the accident. Given the content of the telephone conversation as reported by the male friend, the driver was probably scanning the roadway ahead and searching for his vehicle, which was somewhere on the highway ahead of her. Therefore, not only did the cognitive process of the conversation probably distract her, but her attention was likely to have been redirected from the driving task to a searching task. As a result, when the Explorer encountered the wind gust, the driver was most likely not attending to the driving task, was instead focused on the conversation and a searching task, and was further hampered by physically holding the wireless telephone, which left only one hand for driving this unfamiliar vehicle.

The driver, not expecting the wind gust that probably pushed her vehicle to the right, would have had to perceive what was happening and then react. Typical driver perception-reaction time[77] ranges from 0.9 to 2.1 seconds[78] and the 95th-percentile[79] reaction time is 1.6 seconds. Previously noted research suggests that drivers may respond more quickly to crosswinds than to other driving tasks. Conversely, a driver's perception-reaction time can be greater if other factors, including surprise, inexperience, and distraction, are present. Because the accident driver was distracted, may not have been expecting the wind gust, and was inexperienced, 1 to 2 seconds may have elapsed before she reacted to the wind gust. If she was driving 70 mph at the time of the wind gust, the driver may have traveled 100 to 200 feet before she reacted.

Due to the lack of physical evidence, the Safety Board was unable to determine precisely how far the wind may have pushed the Explorer during this 1- to 2-second period; however, given the length of time and the velocity of the wind, the Explorer may have intruded into the adjacent lane. Because the driver was focused on the telephone

[77] Thomas A. Dingus, Steven K. Jahns, Abraham D. Horowitz, and Ronald Knipling, "Human Factors Design Issues for Crash Avoidance Systems," eds. Woodrow Barfield and Thomas A Dingus, *Human Factors in ITS* (New Jersey: Lawrence Erlbaum & Associates, 1998).

[78] The time a person needs to perceive the object ahead and react to it.

[79] The 95th percentile means that 95 percent of all drivers will react in this amount of time or less.

conversation and the searching task, she may have lost situational awareness and been unaware of the proximity of traffic to the right. All of these factors, in combination with her relative inexperience and unfamiliarity with the vehicle, may have led the driver to steer abruptly to the left in an effort to correct the vehicle's movement, or perceived movement, to the right. Further, she may have had reduced control of the steering wheel because she only had one hand on it. Once she made the steering maneuver, the resulting lateral forces may have been severe enough to dislodge her from her seating position, since she was not using her lap/shoulder belt restraint system, limiting her ability to regain control of the vehicle.

The accident driver quite likely took her foot off the gas pedal as she steered to compensate for the crosswind. This throttle release and the speed loss from steering-induced tire forces would have reduced the Explorer's speed slightly before it left the roadway. Using evidence gathered on scene, the Safety Board calculated the Explorer's speed, when it left the road, at 68 to 69 mph. As the vehicle traveled through the center median, it rotated counterclockwise. After the vehicle had traveled about 38 feet through the median, the right front tire struck the turned-down end treatment of the roadside barrier adjacent to the northbound traffic lanes. At this point, the vehicle was aligned about 41° to the barrier and 36° to the edge of the northbound pavement. Subsequently, both the left and right side rear tires also struck the turned-down end treatment, and the vehicle began rotating in a clockwise direction, as evidenced by the change in spacing between the four tire marks in the median leading up to the barrier impact area. That spacing, which had continually increased, indicating a counterclockwise rotation, increasingly diminished after impact with the barrier, indicating a clockwise rotational direction. Both right side tires struck a more elevated section of the barrier end treatment than the left rear tire did, causing the change in direction.

The vehicle continued an additional 48 feet through the center median before colliding with the back of the W-beam barrier system adjacent to the southbound lanes. At this point, the Explorer was aligned about 30° to the southbound pavement edge. At so shallow an angle, had the barrier not been in place, the vehicle most likely would have proceeded into the southbound lanes and remained upright. During impact with the backside of the barrier system, the W-beam railing became detached from the support posts. The vehicle struck three support posts, which were bent approximately 33 to 37° and acted as a ramp, launching the Explorer into the air. (See figure 17.)

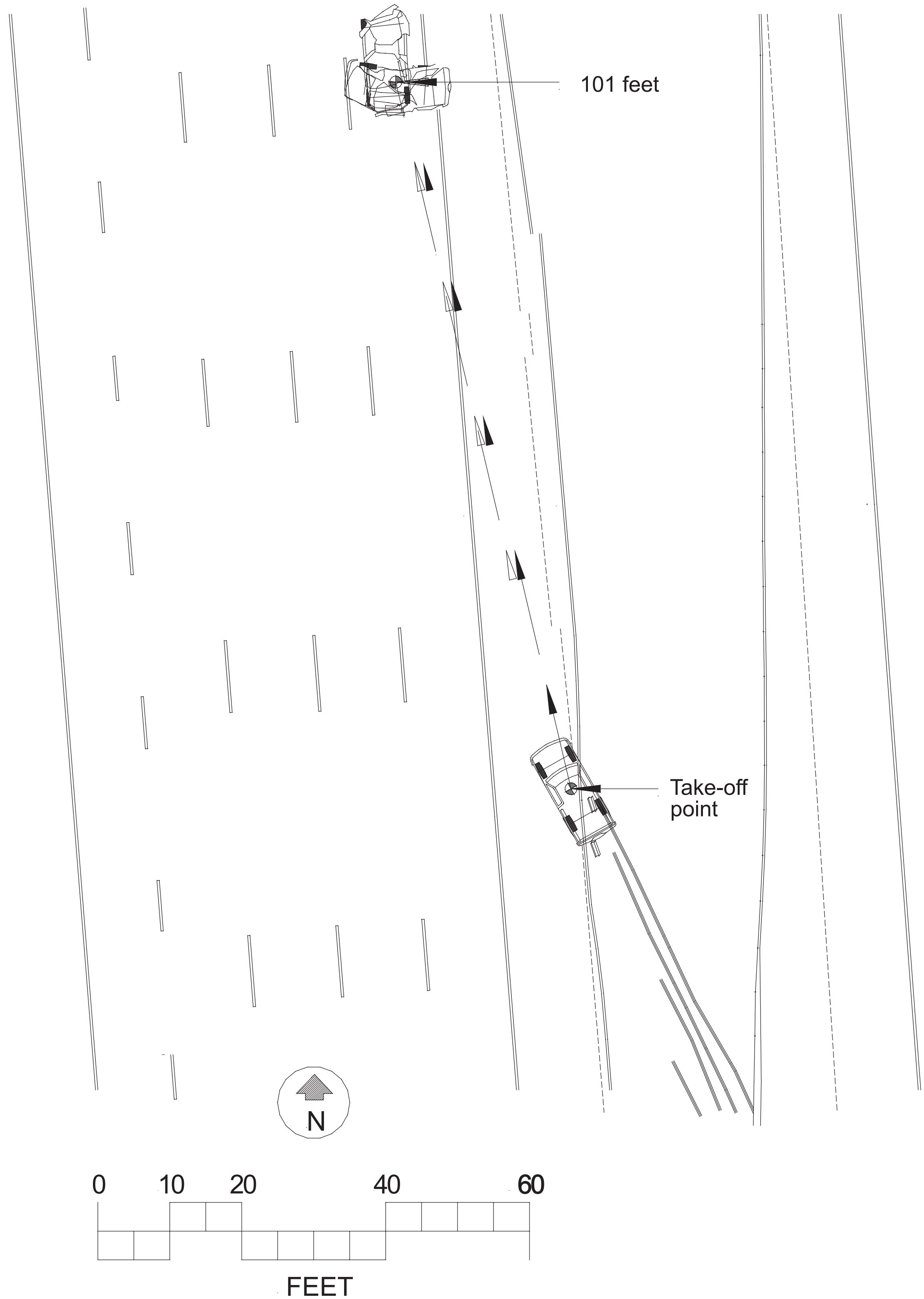

Figure 17. Explorer's vault path.

The Explorer traveled about 101 feet through the air before striking the Windstar, which was southbound in the left lane of the interstate. While airborne, the Explorer rotated counterclockwise about its vertical axis and clockwise about its longitudinal axis. As a result of this rotation, the right passenger side and roof struck the front of the Windstar at an angle. The area of impact was above the minivan's frame and engine compartment. The Windstar's two A-pillars left distinct indentations on the sheet metal along the Explorer's right side door and front hood panel. The configuration of the vehicles at impact resulted in extreme crush to the passenger compartments of both vehicles. (See figure 18.)

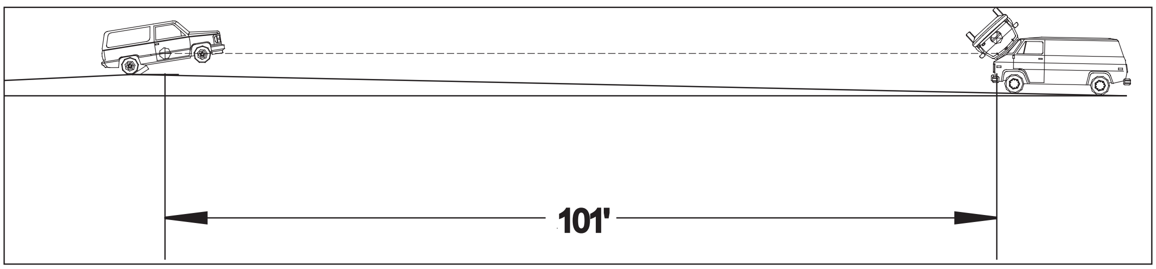

Figure 18. Side view of Explorer's vault path showing collision with Windstar.

Taking into account the horizontal distance that the Explorer traveled through the air, the vertical distance between its takeoff and landing points, and the possible takeoff angles indicated by the damaged guardrail posts, the Safety Board calculated airborne vehicle speeds of 40 to 41 mph. Postcrash analysis of the Windstar's tachometer and speedometer showed that the minivan was traveling 80 to 90 mph at the time of impact with the Explorer.

Driver Speed, Inexperience, and Unfamiliarity With Vehicle

One witness, whose vehicle was following the Explorer, estimated that the accident driver was traveling 70 to 75 mph before she lost control. The Safety Board calculated the accident driver's speed to be about 69 mph when her vehicle left the roadway. Thus, at the time of the accident, she was traveling 15 to 20 mph over the 55-mph speed limit. The older, more experienced Lexus driver, who was following in a vehicle less prone to the effects of wind forces, said he was "scared" by the wind gusts and had reduced his speed to 60 or 65 mph.

The accident driver may have been speeding, despite the windy conditions, for several reasons. She was young (20 years old), and research has shown that younger drivers (16 to 20 years old) are more likely to be involved in speed-related fatal accidents.[80] Also, although the accident driver had presumably visited her male friend's

[80] U.S. General Accounting Office, *Highway Safety Research Continues on a Variety of Factors That Contribute to Motor Vehicle Crashes*, GAO-03-436, March 2003.

home before this trip, she is unlikely to have driven there herself; at the time of the accident, she was following and probably trying to keep up with him. Her youth and focus on not losing the lead driver may have affected her decisions concerning speed, even in windy conditions.

In addition, the accident driver had limited driving experience. Although she had been licensed for 3 years, she did not own an automobile until purchasing the Explorer. Her mother, with whom she resided, also did not own an automobile. The driver had occasionally borrowed a vehicle, and her driving experience apparently did not extend beyond that. She was, in effect, a novice driver.

The accident driver was also unfamiliar with the Explorer. The night of the accident was the first time she had driven this vehicle, and during the approximately 2 hours before the collision, she drove the car less than 50 miles. A 1983 NHTSA study[81] examined the relationship between vehicle unfamiliarity and safety. One of its findings was:

> Drivers having less than 500 miles familiarity with their vehicles are about 2 to 3 times more likely to become involved in a crash than familiar drivers. In the case of very young or novice drivers, their limited overall driving experience may interact with limited vehicle familiarity to contribute to accident causation.

In the Largo accident, the driver traveled at a high rate of speed, oversteered, and failed to maintain directional control. A landmark study of accident causation[82] found that "unfamiliarity with the vehicle was associated with accidents where maintaining adequate directional control could have prevented the crash" and unfamiliarity was "also associated with excessive speed and improper evasive action." The Safety Board concludes that due to her unfamiliarity with the vehicle, operating inexperience, and distraction, the accident driver exercised poor judgment in maintaining a speed too fast for the existing, windy conditions and was unable to maintain directional control of her vehicle.

Wireless Telephone Use

At the time of the collision, the accident driver was engaged in a handheld wireless telephone conversation. Her male friend stated that "she suddenly yelled twice, and the call disconnected." Wireless telephone records confirm that the accident driver placed a call moments before the accident. She was following her male friend and lost sight of him. The cognitive effect of this conversation may have been greater than that of a casual conversation. Additionally, she was probably scanning the traffic ahead, looking for her male friend, and her attention to the task of driving was probably diverted.

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[81] M. Perel, "Vehicle Familiarity and Safety," *NHTSA Technical Note*, National Highway Traffic Safety Administration, DOT HS-806-509, July 1983.

[82] J.R. Treat and others, "Tri-Level Study of the Causes of Traffic Accidents: Final Report," Institute for Research in Public Safety, Indiana University, NHTSA Contract DOT-HS-034-3-535, May 1979.

Research has shown that the cognitive effects of conducting a conversation on a wireless telephone can decrease situational awareness and that wireless telephone use can increase reaction time. In their 2001 study, Parkes and Hooijmeijer reported that drivers engaged in wireless telephone conversations were unaware of traffic movements around them. Safety Board accident investigations in several transportation modes have documented the relationship between poor situational awareness and poor performance. These investigations found that when airline pilots, railroad engineers, and ship crews lose situational awareness, they sometimes make operational errors that lead to accidents. In the case of the Largo accident driver, the potential decrease in situational awareness is likely to have delayed her awareness of the effects of the wind on her vehicle. This delayed recognition of and reaction to the effects of wind probably precipitated her steering overreaction. Therefore, the Safety Board concludes that the accident driver's distraction due to the wireless telephone conversation with her friend contributed to her loss of control of the vehicle.

This accident involved multiple risk factors, and the Safety Board could not determine the exact extent of the role of distraction due to wireless telephone use. However, use of a wireless telephone while driving is inherently dangerous, as is any distraction that diverts one's attention from the driving task. Young, inexperienced drivers are particularly vulnerable to accidents, are easily distracted, and are known to engage in risk-taking behavior. In 2002, the Safety Board investigated two accidents, Largo and Korona,[83] in which young drivers were following another vehicle, lost control, and ran off the road. The Largo and Korona accident drivers were 20 and 16 years old, respectively; both were unbelted and engaged in wireless telephone conversations when they lost control of their vehicles. Young drivers continue to be overrepresented in traffic crashes and deaths. In 2001, according to NHTSA, drivers under age 20 constituted only 6.8 percent of the driving population but were involved in 14.3 percent of fatal accidents. While the Board recognizes that having access to communication in one's vehicle can be valuable, drivers in this age group, in particular, should attend only to the task of driving.

Eight States[84] have introduced legislation to prohibit young drivers from using wireless telephones while driving.[85] In 2002, New Jersey enacted a law[86] prohibiting holders of driver examination permits from using any interactive wireless device while operating a motor vehicle. A similar law, which would prohibit drivers holding only a driver's permit from using a wireless telephone while driving, was introduced in the Pennsylvania legislature.[87] On May 23, 2003, the Governor of Maine signed a law restricting drivers under age 18, including persons with an instruction permit and holders of a restricted license, from "operating a motor vehicle while using a mobile phone." The Safety Board concludes that current State laws are inadequate to protect young, novice

[83] HWY-02-IH-016.

[84] Illinois, Iowa, Massachusetts, New York, Oklahoma, South Carolina, Tennessee, and Virginia.

[85] Susan A. Ferguson, "Other High-Risk Factors for Young Drivers—How Graduated Licensing Does, Doesn't, or Could Address Them," 2003, *Journal of Safety Research*, 34, 71-77.

[86] Bill AB 3241 was enacted January 14, 2002.

[87] The Governor vetoed Bill HB 1553 on December 16, 2002.

drivers from distractions that can lead to accidents. Therefore, the Safety Board believes that the other 48 States should enact legislation to prohibit holders of learner's permits and intermediate licenses from using interactive wireless communication devices while driving.

The use of wireless communication devices is becoming increasingly prevalent. In May 2003, according to the Cellular Telecommunications & Internet Association, the number of U.S. wireless telephone subscribers was approximately 145 million. The 2003 Gallup Organization study[88] and the 2002 North Carolina study,[89] which indicated that 25 percent and 58 percent of drivers interviewed, respectively, had used a wireless telephone while driving, suggest that the public may not be aware of the dangers associated with using a wireless telephone while driving. Considering the widespread use of wireless communication devices in vehicles today and the associated risks of an accident, the Safety Board concludes that all drivers should be educated about the risks of distracted driving, including the cognitive demands associated with use of interactive communication devices. This instruction can be accomplished through media campaigns and driver education courses. NHTSA is already developing a public information campaign. The Advertising Council, Inc., represents the media in public service advertising and has worked with NHTSA before in disseminating public safety messages, particularly regarding drunk driving and seat belt use. Therefore, the Safety Board believes that NHTSA and The Advertising Council, Inc., should jointly develop a media campaign stressing the dangers associated with distracted driving.

Although the Virginia 2001 Driver's Education Standards of Learning has an objective regarding distractions that contribute to driver error, including wireless telephones and other portable technology devices, the instructor's handbook provides no specific guidance or materials. Other driver education course materials discuss the risks of distractions while driving, but the material is general in nature and does not stress the cognitive demands of using a wireless telephone, whether handheld or hands-free. This accident underscores the vulnerability of young, inexperienced drivers and involves many risk factors commonly present in accidents involving 16- to 20-year-old drivers. The importance of not engaging in distracting behavior is critical, especially for this age group, given its low experience level. Therefore, the Safety Board concludes that driver education materials should emphasize the risks of distracted driving, including the cognitive demands associated with use of interactive communication. The American Driver and Traffic Safety Education Association represents the providers of driver's education and is compiling a new driver's education curriculum. NHTSA is developing a generic driver's manual for the States' use. The Safety Board believes that the American Driver and Traffic Safety Education Association and NHTSA should jointly develop a module for driver education curriculums that emphasizes the risks of engaging in distracting behavior.

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[88] Royal.

[89] Stutts, Huang, and Hunter.

Since NHTSA compiled its 1997 study of the safety implications of wireless communications in vehicles, the use of wireless devices has more than doubled (from 60 million subscribers in 1998 to more than 144 million in 2003), and further research has confirmed the detrimental effects of wireless telephone use while driving. This research has shown that drivers who use a wireless telephone while driving can lose situational awareness and experience “inattention blindness,” suggesting that the cognitive effects, as well as the physical demands, of handheld telephone use are dangerous. Existing accident data pertaining to driver distraction, particularly wireless telephone use, may be misleadingly low.

Several reasons could account for this apparent discrepancy: (1) drivers are unlikely to self-report wireless telephone use during an accident; (2) police officers are not necessarily trained to detect wireless telephone use, nor are they required to report it in the majority of State accident reports; (3) obtaining and analyzing wireless telephone records is time consuming; (4) culling wireless telephone use from existing accident reports is difficult; and (5) currently, only 16 States have codes for driver distraction, including codes for wireless telephone use, on their traffic accident investigation forms. The Safety Board therefore concludes that available data are insufficient to determine the magnitude of risks associated with wireless telephone use. Given the growing use of wireless telephones while driving and the need for greater research regarding the associated risks of such activity, the Safety Board believes that the 34 States that do not have distraction codes should add them, including codes for interactive wireless communication device use, to their traffic accident investigation forms.

Additionally, the traditional method of establishing public policy based on accident statistics alone may not be appropriate for the issue of driver distraction resulting from wireless telephone use. This safety risk is not the first to be substantially underrepresented in the available data sources because of underreporting by investigating agencies. In its 1992 safety study,[90] *Heavy Vehicle Airbrake Performance*, the Safety Board reported that in 9 of its 15 brake-related accident investigations, State and local agencies had failed to identify deficient brakes as a factor in their final accident reports. Thus, the available data did not permit the role of braking deficiencies in accidents to be accurately evaluated.

A new approach may be necessary to develop appropriate and effective accident countermeasures. Many researchers believe that data collection in a naturalistic setting is the preferred means for obtaining human factors data, particularly on precrash driver behavior. The NHTSA, Virginia Department of Transportation, and Virginia Polytechnic Institute and State University study, “100-Car Naturalistic Driving,” which uses data collected for 1 year on 100 drivers in vehicles instrumented with 5 cameras and 23 recording sensors, should provide the more accurate precrash driver behavior information needed to develop accident countermeasures. In addition, the NHTSA and University of Iowa National Advanced Driving Simulator projects should provide specific and more reliable information on distraction and wireless telephone use. Such research will help redress the underreporting of wireless telephone use and other driver distractions.

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[90] National Transportation Safety Board, *Heavy Vehicle Airbrake Performance,* Highway Safety Study, NTSB/SS-92/01 (Washington, DC: NTSB, 1992).

The Congress and State and local legislative bodies have expressed heightened concern regarding the growth of wireless communication device use and the effects it has on highway safety. The proliferation of restrictions on wireless telephone use worldwide shows similar concern. NHTSA can provide guidance to policymakers regarding the safety implications of wireless communication devices by updating the 1997 report, *An Investigation of the Safety Implications of Wireless Communications in Vehicles,* and combining its findings with preliminary results from both the "100-Car Naturalistic Driving" study and National Advanced Driving Simulator research. The Safety Board believes that NHTSA should determine the magnitude and impact of driver-controlled, in-vehicle distractions, including the use of interactive wireless communication devices, on highway safety and report its findings to the U. S. Congress and the States.

Vehicle Stability

The Explorer involved in this accident is an example of vehicle design that is inherently susceptible to wind gusts because of its relatively short wheelbase[91] and large side area, or profile, compared with most passenger cars. As previously discussed, the Safety Board conducted computer simulations to evaluate the controllability of the Explorer traveling at 70 mph in crosswinds of 23 mph, gusting to 44 mph. The simulations showed that the wind gusts were not severe enough to have made the Explorer uncontrollable for an alert driver who had two hands on the steering wheel. But the accident driver was distracted and, most likely, holding the telephone in one hand. Under these circumstances, the winds would have initially caused the Explorer to move to the right and rotate clockwise away from the driver's intended path of travel. However, the amount of lateral movement depended on the duration of the gust, the driver reaction time, and the steering input, none of which could be precisely determined from the available evidence. The driver most likely attempted to compensate for the wind gust by steering sharply to the left, causing the vehicle to swerve off the road.

The Explorer was not equipped with an ESC system, nor was one available for the vehicle. Such a system may have assisted the driver in maintaining control of the vehicle. Hence, the Safety Board assessed whether such a system might have made a difference in this accident. In collaboration with Continental Teves, a manufacturer of ESC systems, the Safety Board initiated several simulations to evaluate how an ESC system might have responded to a series of vehicle movements and wheel inputs similar to that of the accident sequence. The simulations compared a standard sport utility vehicle (SUV) with an ESC-equipped SUV.[92]

[91] Vehicle stability, or the tendency to continue traveling in a straight line, is directly affected by the vehicle's wheelbase, or length between the front and rear axles. The greater the wheelbase, the less the vehicle is affected by wind perturbations or sharp steering inputs.

[92] The simulation modeled a generic SUV that had a wheelbase similar to that of the accident vehicle; however, the ESC system applied was not specifically tailored to the vehicle model. Therefore, the results represent the minimum benefits of the ESC system.

The first comparison evaluated both vehicle models traveling straight at 70 mph with a driver-initiated quick left steering input, followed by a counter-steer to the right, then hard left steering, and, finally, quickly reducing the steering angle to zero, or straight. In this comparison, the standard SUV continued to sideslip and yaw at the end of the simulation, even though the driver steering input was straight ahead. This yawing and sideslip indicated that the vehicle was not yet under control or stable when the simulation ended. However, in the ESC-equipped vehicle, the sideslip and yaw velocities were zero at the end of the simulation, indicating that the stability control system brought the vehicle under control and that the vehicle was steering along the path intended by the driver.

In the second comparison, the same type of steering maneuver was assumed (left steer, right steer, left steer); however the final steering input was modified to return the vehicle to its original path. The standard SUV was unable to regain its original path but instead crossed that path, and the sideslip increased and the vehicle yawed, indicating that the vehicle would be very difficult to control through steering alone. In contrast, the ESC-equipped vehicle intersected its original path at a slight angle with essentially zero yaw velocity and sideslip, and the vehicle could be easily steered back onto that path.

The simulations demonstrated that ESC systems can reduce sideslip and yaw in situations in which steering or lateral movements are encountered, allowing a driver to regain control of a vehicle. Additionally, the simulations showed that ESC may assist drivers of errant vehicles to not only regain control, but also return to their intended path. In both cases, the amount of time available to a driver to steer the under-control vehicle to avoid an accident increased significantly.

Moments before the actual crash, the accident driver probably had the steering wheel positioned so that the Explorer would remain in its travel lane as the wind gust began pushing it to the right. Had the Explorer been equipped with ESC, once the vehicle was pushed to the right by the wind, and assuming the sideslip and yaw rotation associated with the path deviation to the right were great enough, the sensors would have signaled the ESC's computer that a correction was necessary to maintain the driver's intended path straight ahead. The ESC system would then have applied the appropriate braking to intervene and reduce the yaw acceleration, thereby greatly increasing the vehicle's responsiveness to steering inputs. Such an ESC intervention may have been sufficient to allow the driver to maintain control of her vehicle.

Following the wind gust, the driver probably attempted to steer sharply to the left, causing the vehicle to swerve off the road. As the Explorer departed the road, an ESC system would have been monitoring the vehicle's rotational motion and in this situation, as in the wind gust situation, may have applied braking to compensate. Such an ESC intervention could have provided the driver with enough additional reaction-response time to steer her vehicle back onto the roadway.

The Safety Board cannot conclusively determine the degree to which an ESC system might have affected either the vehicle's initial reaction to the wind gust or the vehicle's reaction to the driver's sharp, high-speed steering input. Detailed driver inputs, exact wind forces, and precise vehicle dynamics are unknown. Additionally, ESC system design is tailored to each individual vehicle. An ESC application was not available for the Explorer. Nonetheless, ESC systems can make a difference in accidents by providing drivers with added stability and tracking control that may prevent loss of control. As demonstrated by the simulations, ESC systems can increase vehicle stability and control so that drivers in situations such as this accident may have more time to react and regain control of their vehicle. The driver's loss of control in this accident is similar to many such occurrences each year. The Safety Board concludes that an ESC system may have helped the accident driver maintain control of her vehicle during the Explorer's initial response to the wind gust and during the subsequent reaction by the driver.

As noted earlier, European experience with ESC-equipped vehicles suggests that this technology may provide safety benefits to drivers in the United States. NHTSA has not analyzed accident data related to ESC-equipped vehicles in the U.S. fleet; consequently, the benefits of ESC in reducing crashes cannot be determined. The composition of the U.S. fleet is somewhat different from the European fleet because the former includes more SUVs, light trucks, and vans, which are more susceptible to rollover and to the effects of wind than passenger cars.[93] Thus, the potential benefits of ESC are quite likely greater in the United States. For the 2003 model year, most European passenger cars sold in the United States have an ESC system as standard equipment; however, non-European manufacturers only offer ESC systems as optional equipment on some luxury models or, sporadically, on other models in their fleets.

On October 15, 2002, as a result of its 15-passenger van safety report,[94] the Safety Board issued Safety Recommendation H-02-28 to NHTSA and an identical recommendation (H-02-29) to Ford Motor Company and General Motors Corporation asking them to:[95]

[93] According to NHTSA, in 2001, the rollover occupant fatality rate per 100,000 registered sport utility vehicles was three times higher than that for passenger cars. Rollover fatalities represented more than 60 percent of sport utility vehicle fatalities and 22 percent of passenger car fatalities. In addition, 46 percent of sport utility vehicle serious injuries took place in rollover crashes, and 16 percent of passenger car serious injuries took place in rollover crashes. (Dr. Jeffrey W. Runge, Administrator, NHTSA, from his speech, "Meeting the Safety Challenge," Automotive News World Congress, Dearborn, Michigan, January 14, 2003.)

[94] National Transportation Safety Board, *Evaluation of the Rollover Propensity of 15-Passenger Vans*, Safety Report NTSB/SR-02/03 (Washington, DC: NTSB, 2002).

[95] Dodge no longer manufactures 15-passenger vans, effective model year 2002.

H-02-28 and -29

> Evaluate, in conjunction with [each other], and test as appropriate, the potential of technological systems, particularly electronic stability control systems, to assist drivers in maintaining control of 15-passenger vans.

NHTSA responded on December 23, 2002, that it was considering how to best accomplish the tests and was refining test protocols. Safety Recommendation H-02-28 to NHTSA was classified “Open—Acceptable Response” on June 30, 2003. General Motors Corporation and Ford Motor Company responded on February 14, 2003, and February 21, 2003, respectively. General Motors Company indicated that it will implement an ESC system, known as the Vehicle Stability Enhancement System, in the near future for its 15-passenger vans. Consequently, on May 6, 2003, Safety Recommendation H-02-29 to General Motors was classified “Closed—Reconsidered.” Ford Motor Company reported that it had researched ESC technology, but it did not state any intention of applying the technology to 15-passenger vans. Safety Recommendation H-02-29 to Ford Motor Company was classified “Open—Acceptable Response” on June 30, 2003, pending receipt of further information.

In light of the potential for accident reduction and the comparatively low cost of installing ESC on vehicles ($150 to $400, depending on existing standard equipment), the Safety Board believes that NHTSA should expand its current evaluation of ESC systems and determine their potential for assisting drivers in maintaining control of passenger cars, light trucks, SUVs, and vans. NHTSA should include in this evaluation an accident data analysis of ESC-equipped vehicles in the U.S. fleet. Furthermore, the Safety Board believes that if the results of the evaluation of ESC systems are favorable, NHTSA should initiate a phased-in ESC mandate for passenger cars, light trucks, SUVs, and vans.

Existing Barrier System

When the accident driver lost control of her vehicle and the Explorer left the roadway, it swerved to the left, struck, and traveled over the obsolete guardrail end treatment. The impact with the end treatment caused the vehicle to change rotational direction, and it proceeded another 48 feet through the median, struck the back of the guardrail for the southbound lanes, and vaulted 101 feet into the left lane of opposing traffic. The existing barrier system was inadequate to redirect the Explorer and prevent the incursion into the opposing lanes of travel. If the existing system had been upgraded to incorporate an adequate end treatment designed to redirect or stop vehicles, or if an effective median barrier had been in place, the vehicle might have been redirected and the accident outcome might have been less severe. The Safety Board concludes that the barrier system in place at the accident site was ineffective because it failed to redirect the accident vehicle and prevent it from entering the opposing lanes of traffic.

The Safety Board identified three issues related to the ineffective barrier system at the accident location: the turned-down end treatment, the replacement “in kind” of the damaged end treatment, and the use of a single-sided guardrail as a median barrier. In 1962, when this segment of the Capital Beltway was constructed, the turned-down end treatment was an accepted guardrail terminus. Today, however, that end treatment does not meet the National Cooperative Highway Research Program (NCHRP) 350 evaluation criteria for a crashworthy end treatment, and both AASHTO and the FHWA consider it unacceptable for installation on new or reconstruction projects. Urged by the Maryland General Assembly, the SHA has started a statewide program to replace turned-down end treatments with terminals that meet NCHRP 350 criteria. In May 2003, the Maryland Department of Transportation let a contract to eliminate turned-down terminals and upgrade the guardrails along the Baltimore and Capital Beltways, the SHA portion of I-95, and the Baltimore-Washington Parkway; that project should ameliorate this condition at the accident site.

Shortly after the accident, however, the SHA replaced the turned-down guardrail end treatment "in kind," and thus lost an opportunity to upgrade the installation. Subsequently, the SHA changed its policy and now replaces obsolete terminals that have any damage. The Safety Board is encouraged by the SHA's new policy.

This section of the Capital Beltway did not have an effective median barrier system in place. The guardrail at the accident site was originally installed not as a median barrier, but to protect north and southbound traffic from the drainage structure. The single-sided guardrail on the southbound side was not intended to redirect vehicles that hit it from behind. The Safety Board's survey of the Capital Beltway indicates that this location is one of very few that lacked a median barrier system. Under the May 2003 contract, according to the SHA, the guardrail on the southbound side of the Capital Beltway at the accident location will be upgraded to a double-sided guardrail.

Specific guidelines relating median barrier warrants to median width and traffic volumes first appeared in the 1977 AASHTO *Guide for Selecting, Locating, and Designing Traffic Barriers.* The guidelines were incorporated, unchanged, into the 1989, 1996, and 2002 editions of the AASHTO *Roadside Design Guide.* These 26-year-old warrants would place the 55-foot median width at the accident location in the "barrier not normally considered" category. Yet the average daily traffic count at the accident site was more than 200,000, 14 percent of which was truck traffic. And although the median barrier warrants do not address speed, the 85th percentile speed at this location was 75 mph. In addition, SHA accident records indicate that two other median accidents occurred at this location. Thus, traffic volumes, speed, and the history of median encroachment accidents warrant the installation of an effective median barrier system at the accident location. The Safety Board concludes that the median barrier warrant guidance in the AASHTO 2002 *Roadside Design Guide* is inadequate to cover today's high-speed, high-volume roadways.

The Safety Board addressed the issue of median barrier warrants in its report of the Slinger, Wisconsin, accident investigation.[96] On February 12, 1997, a doubles truck with empty trailers was traveling on a four-lane, limited-access highway when it lost control. The truck crossed a 50-foot depressed median and struck a flatbed loaded with lumber

[96] National Transportation Safety Board, *Multiple Vehicle Crossover Accident, Slinger, Wisconsin, February 12, 1997*, Highway Accident Report NTSB/HAR-98/01 (Washington, DC: NTSB, 1998).

that, in turn, lost control, crossed the median, and was hit by a passenger van and a refrigerator truck. Eight of the nine passenger van occupants were fatally injured. As a result of the investigation, the Safety Board issued Safety Recommendation H-98-12 to the FHWA and the identical Safety Recommendation H-98-24 to AASHTO to:

> H-98-12
>
> Review, with the American Association of State Highway and Transportation Officials, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadway.
>
> H-98-24
>
> Review, with the Federal Highway Administration, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadway.

On November 18, 1998, the FHWA responded that it and AASHTO were awaiting the completion of two NCHRP projects that would specifically address the median barrier warrant issue: NCHRP Project 17-14, "Improved Guidelines for Median Safety," and NCHRP Project 22-12, "Guidelines for the Selection, Installation, and Maintenance of Highway Safety Features." The FHWA expected these projects to be completed before the *2002 Roadside Design Guide* was issued. On February 2, 1999, the Safety Board classified Safety Recommendation H-98-12 "Open—Acceptable Response."

To date, the NCHRP projects have not been completed, and the *2002 Roadside Design Guide* was issued with virtually no changes to the median barrier warrants. "Median Barriers," chapter 6 of the new guide, states that "a more definitive study is currently underway, through NCHRP, to more clearly define warrants for median barriers. Completion of this study is not expected until sometime after publication of this guide." The FHWA indicated that it expects completion of Project 17-14 in fall 2003. The second phase of Project 22-12 was scheduled to begin in spring 2003.

The tragic consequences of this accident and the number of fatalities occurring nationally in median crossover accidents on high-speed, high-volume roadways add urgency to the Safety Board's 1998 recommendations to revise the median barrier warrants. Therefore, the Safety Board reiterates Safety Recommendation H-98-12 and the companion Safety Recommendation H-98-24, quoted above, to the FHWA and AASHTO, respectively.

Conclusions

Findings

1. The accident driver was not impaired due to alcohol, drugs, or fatigue; the mechanical condition of the Explorer did not contribute to the accident; and the emergency response was adequate and timely.

2. The collision forces and intrusion into the occupant compartments of both the Explorer and Windstar rendered the vehicles' occupant spaces unsurvivable.

3. At the time of the accident, the Explorer experienced strong winds, including potential gusts between 39 and 44 mph, from the left at an approximate angle of 35° to 45°.

4. Due to her unfamiliarity with the vehicle, operating inexperience, and distraction, the accident driver exercised poor judgment in maintaining a speed too fast for the existing, windy conditions and was unable to maintain directional control of her vehicle.

5. The accident driver's distraction due to the wireless telephone conversation with her friend contributed to her loss of control of the vehicle.

6. Current State laws are inadequate to protect young, novice drivers from distractions that can lead to accidents.

7. All drivers should be educated about the risks of distracted driving, including the cognitive demands associated with use of interactive communication devices.

8. Driver education materials should emphasize the risks of distracted driving, including the cognitive demands associated with use of interactive communication devices.

9. Available data are insufficient to determine the magnitude of risks associated with wireless telephone use.

10. An electronic stability control system may have helped the accident driver maintain control of her vehicle during the Explorer's initial response to the wind gust and during the subsequent reaction by the driver.

11. The barrier system in place at the accident site was ineffective because it failed to redirect the accident vehicle and prevent it from entering the opposing lanes of traffic.

12. The median barrier warrant guidance in the American Association of State Highway and Transportation Officials 2002 *Roadside Design Guide* is inadequate to cover today's high-speed, high-volume roadways.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the February 1, 2002, collision of the Ford Explorer Sport with the Ford Windstar minivan and Jeep Grand Cherokee was the Explorer driver's failure to maintain directional control of her high-profile, short-wheelbase vehicle in the windy conditions due to a combination of inexperience, unfamiliarity with the vehicle, speed, and distraction caused by use of a handheld wireless telephone. Contributing to the severity of the accident was the lack of an effective median barrier at the accident site.

Recommendations

As a result of this accident, the National Transportation Safety Board makes the following safety recommendations:

To the National Highway Traffic Safety Administration:

Develop, in conjunction with The Advertising Council, Inc., a media campaign stressing the dangers associated with distracted driving. (H-03-03)

Develop, in conjunction with the American Driver and Traffic Safety Education Association, a module for driver education curriculums that emphasizes the risks of engaging in distracting behavior. (H-03-04)

Determine the magnitude and impact of driver-controlled, in-vehicle distractions, including the use of interactive wireless communication devices, on highway safety and report your findings to the U. S. Congress and the States. (H-03-05)

Expand your current evaluation of electronic stability control systems and determine their potential for assisting drivers in maintaining control of passenger cars, light trucks, sport utility vehicles, and vans. Include in this evaluation an accident data analysis of electronic stability control-equipped vehicles in the U.S. fleet. (H-03-06)

If the results of your evaluation of electronic stability control systems are favorable, initiate a phased-in electronic stability control mandate for passenger cars, light trucks, sport utility vehicles, and vans. (H-03-07)

To the 48 States that do not have legislation prohibiting holders of learner's permits and intermediate licenses from using interactive wireless communication devices:

Enact legislation to prohibit holders of learner's permits and intermediate licenses from using interactive wireless communication devices while driving. (H-03-08)

To the 34 States that do not have driver distraction codes on their traffic accident investigation forms:

Add driver distraction codes, including codes for interactive wireless communication device use, to your traffic accident investigation forms. (H-03-09)

To the American Driver and Traffic Safety Education Association:

Develop, in conjunction with the National Highway Traffic Safety Administration, a module for driver education curriculums that emphasizes the risks of engaging in distracting behavior. (H-03-10)

To The Advertising Council, Inc.:

> Develop, in conjunction with the National Highway Traffic Safety Administration, a media campaign stressing the dangers associated with distracted driving. (H-03-11)

The National Transportation Safety Board also reiterates the following recommendations:

To the Federal Highway Administration:

> Review, with the American Association of State Highway and Transportation Officials, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadway. (H-98-12)

To the American Association of State Highway and Transportation Officials:

> Review, with the Federal Highway Administration, the median barrier warrants and revise them as necessary to reflect changes in the factors affecting the probability of cross-median accidents, including changes in the vehicle fleet and the percentage of heavy trucks using the roadway. (H-98-24)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Richard F. Healing
Member

Adopted: June 3, 2003

Appendix A

The Investigation

The National Transportation Safety Board was notified of the Largo, Maryland, accident about 6:00 a.m. on February 2, 2002. An investigative team was dispatched that included members from the Washington, D.C.; Atlanta, Georgia; and Arlington, Texas, offices. Groups were established to investigate human performance aspects; highway, vehicle, and survival factors; and motor carrier operations (wireless telephone use issues).

Participating in the investigation were representatives of the Federal Highway Administration, the Maryland State Highway Administration, and the Maryland State Police.

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