On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS00-020
2000 Volvo V70XC AWD SE Station Wagon
Washington
October, 2000

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract

The collision occurred in Seattle in October, 2000 at 1355 hours. At the point of impact the roadways form a four leg intersection. The north-south roadway is a straight concrete roadway with a negative 3.5% grade. The east-west roadway is a straight concrete roadway with a negative 3.2% grade. There were no traffic controls present for either direction of travel, and the posted speed limit for both roadways leading into the intersection was 40 km/h (25 mph). This is a residential area and there were vehicles legally parked on both roadways.

This is a two vehicle, angle-broadside type collision at an intersection. The case vehicle is a 2000 Volvo V70XC AWD SE station wagon that was driven by a restrained 42-year-old male (170 cm-67 in./86 kg-190 lbs). The other vehicle is a 1994 Chevrolet S10 ½ ton pickup that was driven by a restrained 30-year-old. The case vehicle was traveling southbound, and the Chevrolet was traveling westbound. The police report indicates that the driver of the Chevrolet did not yield the right of way to the case vehicle. The driver of the case vehicle did not see the other vehicle until it was too late and he was unable to take any evasive action. The front of the Chevrolet (01FDEW1) struck the left side of the case vehicle (10LYEW2) in the middle of the intersection. At impact, the seat mounted driver's side air bag in the case vehicle deployed. Neither the driver's front nor the front right passenger's air bags deployed.

WinSmash calculated a total delta v of 10.0 km/h (6.2 mph), a longitudinal delta v of -7.1 km/h (-4.4 mph) and a latitudinal delta v of 7.1 km/h (4.4 mph) for the case vehicle. The other vehicle sustained a total delta v of 13.0 km/h (8.1 mph), a longitudinal delta v of -11.3 km/h (-7.0 mph) and a latitudinal delta v of -6.5 km/h (-4.0 mph). The results fit the collision model for both vehicles and appear reasonable. Both vehicles were towed from the scene. The case vehicle was repaired and the other vehicle was later declared a total loss and sold as a salvage vehicle.

17. Key Words	18. Distribution Statement
Side air bag, SIPS, deployment, injury, WHIPS	

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS00-020

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BACKGROUND:

Description:	This Inflatable Side Impact Protection System case was reported to the NHTSA by the on-site NASS team on October 16, 2000. DSI was assigned the case on October 23, 2000. An on-site investigation was conducted and all field work was completed on October 27, 2000.
Investigation Type:	On-scene
Crash Location:	Washington
Crash Date:	October, 2000
Notification Date:	October 23, 2000
Field Work Completed:	October 27, 2000

SUMMARY:

The collision occurred in Seattle in October, 2000 at 1355 hours. At the point of impact the roadways form a four leg intersection. The north-south roadway is a straight concrete roadway with a negative 3.5% grade. The east-west roadway is a straight concrete roadway with a negative 3.2% grade. There were no traffic controls present for either direction of travel, and the posted speed limit for both roadways leading into the intersection was 40 km/h (25 mph). This is a residential area and there were vehicles legally parked on both sides of the road.

Figure 1. Case vehicle direction of travel (south).

This is a two vehicle, angle-broadside type collision at an intersection. The case vehicle is a 2000 Volvo V70XC AWD SE station wagon that was driven by a restrained 42-year-old male (170 cm-67 in./86 kg-190 lbs). The other vehicle is a 1994 Chevrolet S10 ½ ton pickup that was driven by a restrained 30-year-old.

The case vehicle was traveling southbound, and the Chevrolet was traveling westbound. The police report indicates that the driver of the Chevrolet did not yield the right of way to the case vehicle. The driver of the case vehicle did not see the other vehicle until it was too late and he was unable to take any evasive action. The front of the Chevrolet (01FDEW1) struck the left side of the case vehicle (10LYEW2) in the middle of the intersection. At impact, the seat mounted driver's side air bag in the case vehicle deployed. Neither the driver's front nor the front right passenger's air bags deployed.

The case vehicle was assigned a Collision Deformation Classification (CDC) of 10LYEW2 and a Principle Direction of Force (PDOF) of 315 degrees. The combined direct and induced damage width was 158.5 cm (62.4 in.) [CRASH L = 158.5 cm (62.4 in.)], and the maximum crush depth was 4.6 cm (1.8 in.) located at C_3. Delta Vs were computed using WinSmash version 2.12. The stiffness and size were obtained from the NASS Coding Manual. The stiffness and size coefficients were calculated from an NCAP test for the other vehicle. A CDC of 10LYEW2 was used for the case vehicle and 01FDEW1 for the other vehicle. WinSmash calculated a total delta v of 10.0 km/h (6.2 mph), a longitudinal delta v of -7.1 km/h (-4.4 mph) and a latitudinal delta v of 7.1 km/h (4.4 mph) for the case vehicle. The other vehicle sustained a total delta v of 13.0 km/h (8.1 mph), a longitudinal delta v of -11.3 km/h (-7.0 mph) and a latitudinal delta v of -6.5 km/h (-4.0 mph). The results fit the collision model for both vehicles and appear reasonable.

Figure 2. Left side damage to case vehicle.

Figure 3. Frontal damage to other vehicle.

The case vehicle sustained minor damage to the left side of the vehicle–primarily to the driver's door. The driver's side window disintegrated on impact with the other vehicle. The left sill intruded 4.5 cm (1.8 in.) into the driver's compartment area. There was no measurable intrusion of the driver's door panel area. The other vehicle sustained moderated damage to the front bumper, hood, grille, and both front fenders. Both vehicles were towed from the scene. The case vehicle was repaired and the other vehicle was later declared a total loss and sold as a salvage vehicle.

The driver of the case vehicle of the case vehicle was seated in a normal, upright position with both of his hands on the steering wheel and his right foot on the accelerator pedal and his left foot on the floorboard. He was wearing the available manual 3-point lap and shoulder belt. The seat track of the grey colored, leather-covered bucket seat equipped with Whiplash Injury Prevention System(WHIPS) could not be determined due the seat being electrically powered and no power was available at the time of the inspection. The seat back recline was upright. At impact, the driver responded to the 315 degrees direction of force by moving laterally to the left and slightly forward. The manual 3-point lap and shoulder belt restricted his forward motion. The driver's seat mounted side air bag deployed it contacted the driver's upper torso in some fashion although there is no direct evidence of contact on the side air bag itself. The deployment pattern of the side air bag probably pushed the driver's upper torso laterally back to the right and may have caused the neck strain (whiplash) and the back strain. The driver came to final rest seated upright. He

was able to exit the vehicle without any assistance. The police report indicates that the driver of the case vehicle sustained a non-disabling-evident type injury; a neck injury (whiplash) as a result of the side impact and side air bag activation. He was treated at the scene by fire rescue personnel and was taken home by a friend. Three hours later he was taken to a chiropractor for medical treatment. He received deep soft tissue massages for about three months for the neck strain (whiplash) and a strain to his posterior back that extended diagonally from the top of his left shoulder to his right lower back.

The driver of the Chevrolet did not report any injuries.

Scene Diagram

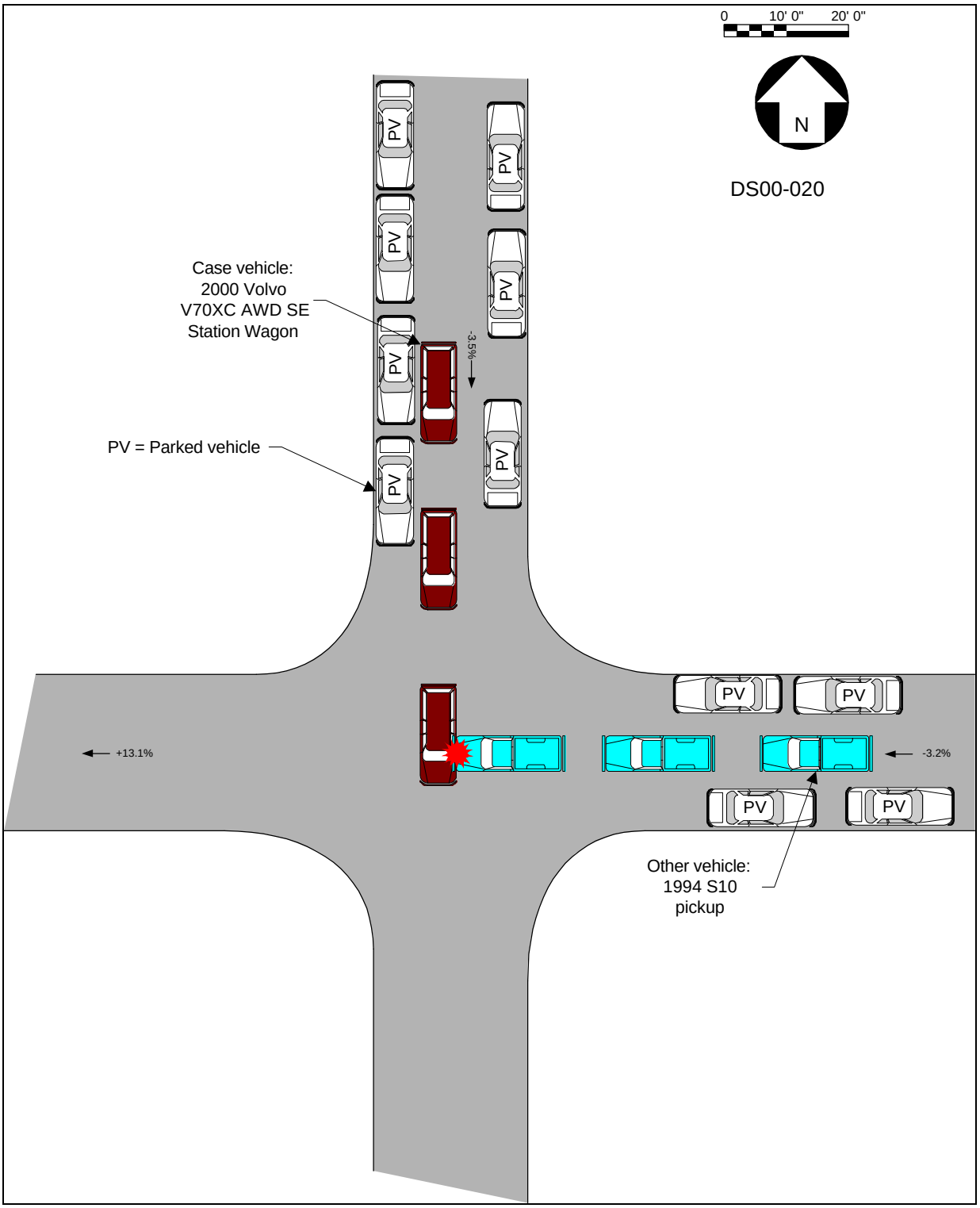

Figure 4. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2000 Volvo V70XC AWD SE Station Wagon	
VIN:	YV1LZ56D4Y2XXXXXX	
Odometer:	Between 11,265-12,874 kilometers (7,000-8,000 miles)--per driver (digital display--no power at time of inspection)	
Engine:	2.4 L, 5 cylinders	
Reported Defects:	None	
Cargo:	None	
Damage Description:	The case vehicle sustained minor damage to the left side of the vehicle–primarily to the driver's door. The driver's side window disintegrated on impact with the other vehicle. The left sill intruded 4.5 cm (1.8 in.) into the driver's compartment area. There was no measurable intrusion of the driver's door panel area. Vehicle towed from scene, but not due to damage.	
CDC:	10LYEW2	
Delta V:	Total	10.0 km/h (6.2 mph)
	Longitudinal	- 7.1 km/h (-4.4 mph)
	Latitudinal	7.1 km/h (4.4 mph)
	Energy	5,640 joules (4,160 ft-lbs)

Figure 5. Case vehicle–crush stands.

AOPS Discussion

This vehicle was equipped with an advanced occupant protection system. The system consists of passive safety features that include dual stage inflators in the driver's and front passenger's air bags, seat belt pretensioners at all five seat positions, side impact protection system (SIPS), and (WHIPS) at both front seats.

Figure 6. Case vehicle driver's side air bag.

The SIPS consists of specially designed structural members of the passenger cabin, reinforcement inside the doors and seat mounted side air bags. The SIPS design transfers crash energy to the opposite side of the car via the reinforced cross members in the floor and roof. The entire seat mounted side air bags system is built into the seat and has no electrical components. A mechanical sensor mounted in the seat base triggers the system when an impact moves the door into contact with the seat. A firing charge in the sensor sends an ignition pulse. The driver's door intruded on impact with the other vehicle and the driver's seat mounted side air bag deployed. The single module cover measured 6 cm (2.4 in.) by 38.5 cm (15.2 in.). There was no visible damage to the module or the cover. The air bag was vaguely rectangular in shape. It measured 40 cm (15.7 in.) by 68 cm (26.8 in.). The side air bag was not tethered and did not contain any vent ports. There was no damage to the side air bag.

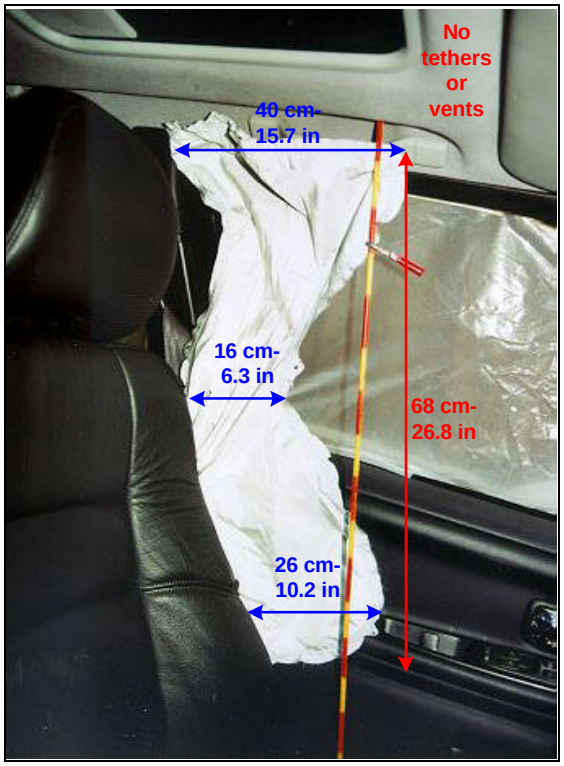

Figure 7. Case vehicle driver's side air bag dimensions.

The case vehicle's steering wheel mounted driver's air bag and the front right passenger's mid-mounted instrument panel air bag did not deploy. None of the five seat belt pretensioners deployed.

The key component of the WHIPS is a hinge at the base of the seat back. This hinge yields and partially rotates when an occupant's torso makes the sort of impact associated with a rear collision, moving the seat back rearward–thus reducing forward motion of the torso. WHIPS also features a fixed head restraint with effective geometry, meaning one that sits high and close to the head: this restraint catches the head in a crash, enabling it to move forward with the torso.

Other vehicle (Chevrolet S-10)

Description:	1994 Chevrolet S-10 4x2 Pickup	
VIN:	1GCCS14ZXR8XXXXXX	
Odometer:	124,244 km (77,204 miles)	
Engine:	4.3L, 6 cylinder	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Other vehicle sustained moderated damage to the front bumper, hood, grille, and both front fenders. Vehicle towed from scene due to damage.	
CDC :	01FDEW1	
Delta V (Impact 1 v. case vehicle):	Total	13.0 km/h (8.1 mph)
	Longitudinal	-11.3 km/h (-7.0 mph)
	Latitudinal	-6.5 km/h (-4.0 mph)
	Energy	13,928 joules (10,273 ft-lbs)

Figure 8. Other vehicle–crush stands.

Occupants

Case vehicle (Volvo V70XC)	Occupant 1
Age/Sex:	42/Male
Seated Position:	Front left
Seat Type:	Gray colored, leather covered WHIPS bucket seat. Seat track could not be assessed due to the lack electrical power for the power adjusted seat track.
Height:	170 cm (67 in.)
Weight:	86 kg (190 lbs)
Occupation:	Self employed as a musician
Pre-existing Medical Condition:	None
Alcohol/Drug Involvement:	Not involved/no test performed
Driving Experience:	Unknown but presumed to be greater than 20 years.
Body Posture:	Normal, upright.
Hand Position:	Both hands on the steering wheel
Foot Position:	Right foot on accelerator gas-pedal, left foot on floorboard.
Restraint Usage:	Manual 3-point lap and shoulder belt equipped with pretensioner; belt used, pretensioner did not deploy
Air bag:	Seat mounted side air bag (SIPS), deployed. Steering wheel mounted air bag, did not deploy

Other vehicle (Chevrolet S-10)

Age/Sex:	30/Male
Seated Position:	Front left
Seat Type:	Bench seat with folding back
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	Not involved/no test performed
Driving Experience:	Unknown, presumed to be greater than ten years
Body Posture:	Probably normal, upright
Hand Position:	Unknown
Foot Position:	Right foot probably on gas-accelerator pedal
Restraint Usage:	Manual 3-point lap and shoulder belt used
Air bag:	Not equipped

Injuries and Injury Mechanisms

Case vehicle (Ford Taurus)

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Neck strain–cervical spine (whiplash)	640278.1, 6	847.0	Driver's side air bag
	Back strain Thoracic spine Lumbar spine	 640478.1, 7 640678.1, 8	 847.1 847.2	 Driver's side air bag

Other vehicle (Chevrolet S10)

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Not injured			

Occupant Kinematics

The 42-year-old male driver (167 cm-67 in./86 kg-190 lbs) of the case vehicle was seated in a normal, upright position with both of his hands on the steering wheel and his right foot on the accelerator pedal and his left foot on the floorboard. He was wearing the available manual 3-point lap and shoulder belt. The seat track of the grey colored, leather-covered bucket seat (WHIPS equipped) could not be determined due the seat being electrically powered and no power was available at the time of the inspection. The seat back recline was upright. At impact, the driver responded to the 315 degrees direction of force by moving laterally to the left and slightly forward. The manual 3-point lap and shoulder belt restricted his forward motion. As the driver's seat mounted side air bag deployed it contacted the driver's upper torso in some fashion although there is no direct evidence on the side air bag itself. The deployment pattern of the side air bag probably pushed the driver's upper torso laterally back to the right and may have caused the neck strain (whiplash) and the back strain.

The driver came to final rest seated upright. He was able to exit the vehicle without any assistance. He was taken home by a friend and three hours later he was taken to a chiropractor for medical treatment.