

On-scene Investigation / Vehicle to Object  
Dynamic Science, Inc. / Case Number: DS02028  
2001 Subaru Outback station wagon  
Colorado  
October, 2002

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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  <p>This was a single vehicle collision versus a fixed object. The crash occurred in October, 2002 at 0735 hours in a rural area of Colorado. The crash took place on a straight two-lane undivided country road. The roadway was covered with snow and ice at the time of the crash. There are no traffic controls and the speed limit is 56 km/h (35 mph). On the left side of the roadway there is a tightly bunched clump of three trees. The case vehicle is a 2001 Subaru Outback all-wheel drive station wagon driven by a restrained 33-year-old female. The rear right seat was occupied by a restrained 9-year-old female. The case vehicle was equipped with a dual stage driver's air bag, a dual stage front right passenger's air bag, and front seat belt pretensioners. The driver was traveling northbound around the left hand curve. As the vehicle entered the straight portion of the roadway the driver braked and lost control of her vehicle. The case vehicle veered to the left and struck the trees with its front end.</p> <p>The total velocity change calculated by the barrier algorithm of the WinSmash collision model was 40 km/h (25 mph). Both frontal air bags deployed as a result of the tree impact. The vehicle spun counterclockwise 90 degrees and came to rest facing west. The driver sustained minor contusions (AIS=1) to both hips from the lap and shoulder belt. She also sustained a bloody nose from contact with the deployed air bag and complained of overall pain. The rear right occupant sustained minor contusions (AIS=1) to both hips from the lap and shoulder belt. She also complained of overall pain. Both occupants were transported from the scene by ground ambulance to a local hospital where they were treated and released.</p> <p>The case vehicle sustained front end damage and was towed from the scene. It was later declared a total loss by the insurance company.</p>					
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**Dynamic Science, Inc.**  
**Accident Investigation**  
**Case Number: DS02028**

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## BACKGROUND:

**Description:** This Advanced Occupant Protection Systems (AOPS) case was reported to DSI by the National Highway Traffic Safety Administration (NHTSA) with instructions to locate the case vehicle for an on-scene investigation. DSI was able to locate the vehicle and obtained permission to conduct the investigation. DSI was assigned the case on November 23, 2002. The vehicle and scene inspections took place on November 26, 2002.

**Investigation Type:** On-scene  
**Crash Location:** Colorado  
**Crash Date:** October, 2002  
**Notification Date:** November 23, 2002  
**Field Work Completed:** November 26, 2002

## SUMMARY:

This was a single vehicle collision versus a fixed object. The crash occurred in October, 2002 at 0735 hours in a rural area of Colorado. The crash took place on a straight two-lane undivided country road. There is a -10.9% down hill grade at this location. The roadway was covered with snow and ice at the time of the crash. There is a left hand curve approximately 61 m (200 ft) south of the impact area. There are no traffic controls and the speed limit is 56 km/h (35 mph). On the left side of the roadway there is a tightly bunched clump of three trees ranging in size from 33 cm (13 in) to 7 cm (3 in) in diameter. The trees were offset from the roadway edge 200 cm (79 in).



**Figure 1.** Approach to area of impact (North)

The case vehicle is a 2001 Subaru Outback all-wheel drive station wagon driven by a restrained 33-year-old female (160 cm/63 in, 51 kg/112 lbs). The rear right seat was occupied by a restrained 9-year-old female (137 cm/54 in, 32 kg/70 lbs)<sup>1</sup>. The case vehicle was equipped with a dual stage driver's air bag, a dual stage front right passenger's air bag, and front seat belt retractor pretensioners. The vehicle comes standard with anti-lock brakes.

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<sup>1</sup>PAR states that child was in front seat. PAR is incorrect.

The driver was traveling northbound around the left hand curve. As the vehicle entered the straight portion of the roadway the driver braked and lost control of her vehicle. The case vehicle began a slight counter clockwise yaw. As the vehicle went to the left it departed the roadway on the left side and struck the trees with its front end (12FDEW3).

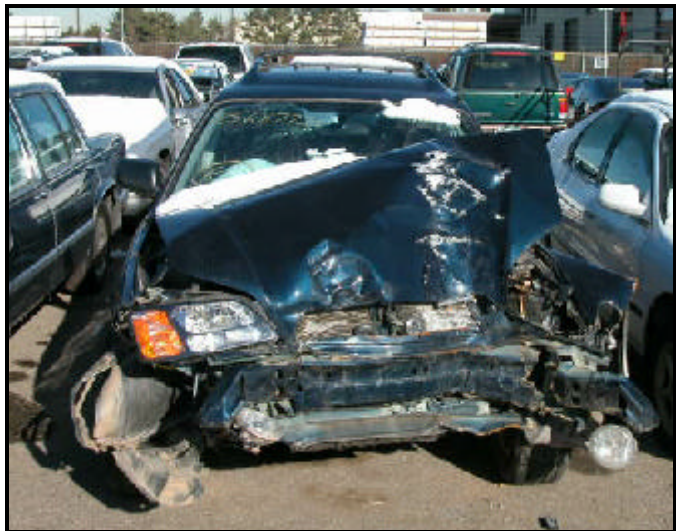
The total velocity change calculated by the barrier algorithm of the WinSmash collision model was 40 km/h (25 mph). The longitudinal and lateral delta V components were -39 km/h (-25 mph) and -7 km/h (-4 mph), respectively. Both frontal air bags deployed as a result of the tree impact. The driver's seat belt pretensioner was found locked in the used position. The front right passenger seat belt pretensioner was found locked in the stowed position. The vehicle spun counterclockwise 90 degrees and came to rest facing west.

The driver sustained minor contusions (AIS=1) to both hips from the lap and shoulder belt. She also sustained a bloody nose from contact with the deployed air bag and complained of overall pain. The rear right occupant sustained minor contusions (AIS=1) to both hips from the lap and shoulder belt. She also complained of overall pain. Both occupants were able to exit the vehicle without assistance. Both occupants were transported from the scene by ground ambulance to a local hospital where they were treated and released after a short time.

The case vehicle sustained front end damage and was towed from the scene. It was later declared a total loss by the insurance company.



**Figure 2.** Tree impact



**Figure 3.** Front of vehicle

# Scene Diagram

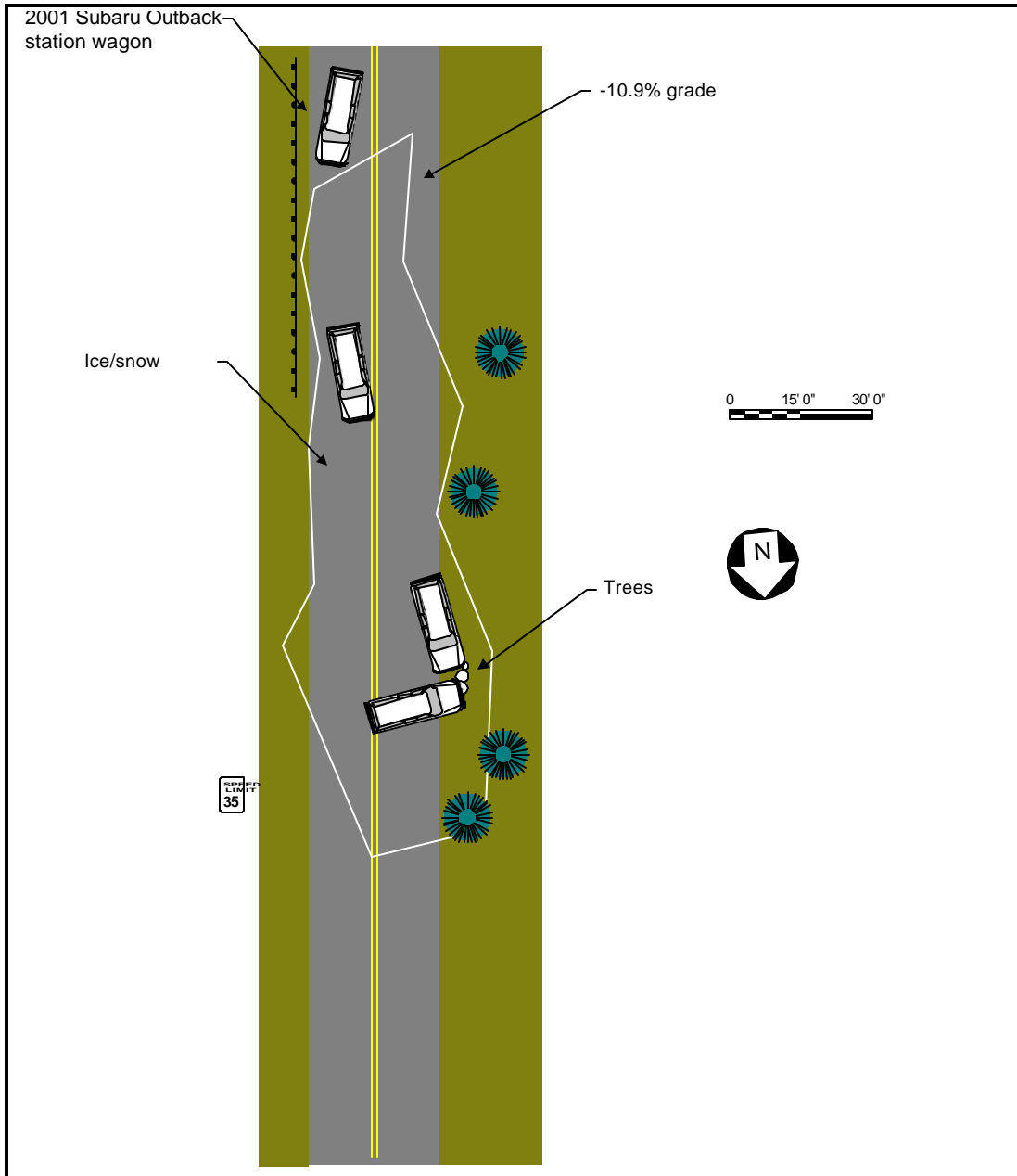


Figure 4. Scene diagram

**DETAILED INFORMATION****Vehicles**Case vehicle

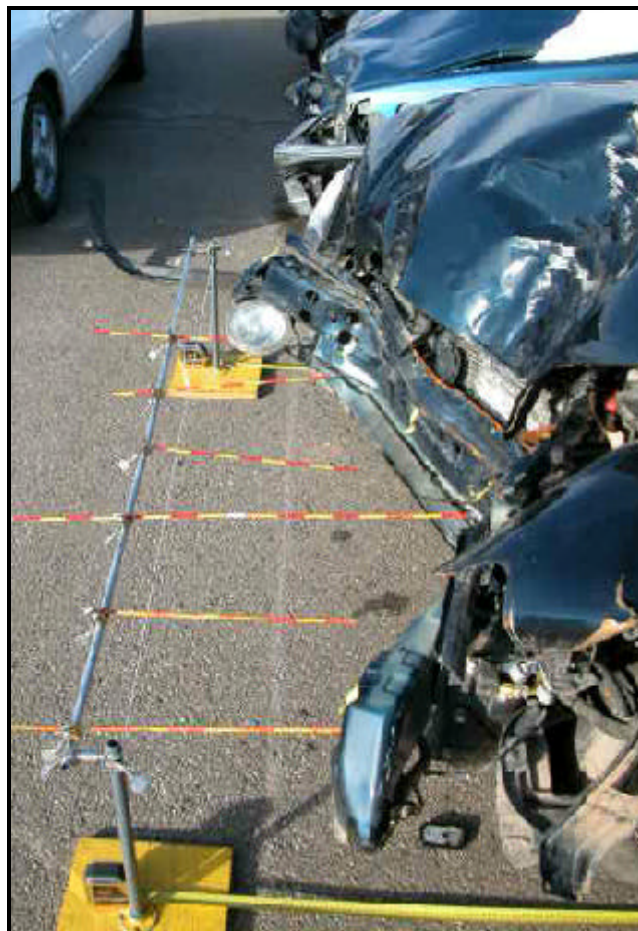
Description:	2001 Subaru Outback station wagon, all wheel drive, manual transmission	
VIN:	4S3BH665816XXXXX	
Odometer:	Unknown	
Engine:	4 cylinder, 150 CID	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Bumper, reinforcement bar, hood, radiator. Vehicle declared a total loss by insurance company.	
CDC:	12FDEW3	
Delta V:	Total	40 km/h (25 mph)
	Longitudinal	-39 km/h (-25 mph)
	Latitudinal	-7 km/h (-4 mph)
	Energy	109,465 joules (80,737 ft-lbs)



**Figure 5.** Front left, case vehicle



The case vehicle sustained 74 cm (29 in) of direct contact across the front. The residual crush measured along the bumper reinforcement bar was as follows: C1=22 cm (9 in), C2=45 cm (18 in), C3=53 cm (21 in), C4=43 cm (17 in), C5=31 cm (12 in), C6=8 cm (3 in). The maximum crush was located between C2 and C3 and measured 60 cm (24 in). The principle direction of force was within the 12 o'clock sector and was an estimated 10 degrees. The damaged components included the bumper fascia and reinforcement bar, the grille, hood, and the upper and lower radiator supports. The wheelbase was shortened by 1 cm (0.4 in) on the left side. There was glazing damage to the right side of the windshield from the deploying passenger air bag. There was no intrusion.



**Figure 6.** Left view of case vehicle showing depth of crush

### Safety systems discussion

The driver's and front right passenger manual restraint system consisted of continuous loop 3-point lap and shoulder belts with sliding latch plates. The left seat belt retractor pretensioner had fired as a result of the impact. The seat belt was locked in the used/deployed position. The left manual shoulder belt upper anchorage was in the full up position. The right passenger seat belt retractor pretensioner had fired as a result of the impact. The seat belt was locked in the stowed position. The right manual shoulder belt upper anchorage was in the full up position. The rear seat was equipped with continuous loop 3-point lap and shoulder belts at all three seating locations. The belts were equipped with sliding latch plates and the two outboard seats had switchable retractors. The two outboard rear seat positions were equipped with LATCH connections.



**Figure 7.** Driver's and front right passenger air bag



**Figure 8.** Driver's air bag

The supplemental restraint system for the case vehicle consisted of dual stage driver and front right passenger air bags that deployed as a result of the crash. It is not known if this was a first or second stage deployment. The driver air bag was designed in the typical manner and located in the center hub of the steering wheel. The module cover opened in an H-configuration. There was no contact evidence on the cover flap. The air bag measured 55 cm (21.6 in) in its deflated state. There was a single tether and two vent ports that were located at the 3 and 9 o'clock positions. There was no



**Figure 9.** Air bag contact to windshield

contact evidence on the face of the air bag. The front right passenger air bag was located at the top of the right instrument panel. The H-configuration module cover measured 26 cm (10 in) wide by 9 cm (4 in) high on the top and 4 cm (1 in) high on the bottom. The passenger air bag measured 66 cm (26 in) wide by 55 cm (22 in) high with a maximum deployed excursion of 55 cm (22 in). The air bag was vented at the 3 and 9 o'clock positions. There was no occupant contact evidence on either the air bag or the module covers. The deploying passenger air bag did fracture the windshield on the right side. There was evidence of bag contact to the windshield.

**Occupants**

<u>Case vehicle</u>	Occupant 1	Occupant 2
Age/Sex:	33/Female	9/Female
Seated Position:	Front left	Rear right
Seat Type:	Fabric covered bucket seat. The seat back was slightly reclined. Seat adjusted to the forward most track position.	Fabric covered bench seat with folding back.
Height:	160 cm (63 in)	137 (54 in)
Weight:	51 kg (112 lbs)	32 kg (70 lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	> 10 years	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on wheel, location unclear	Unknown
Foot Position:	Left foot on floor, right on brake	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Driver's air bag available, deployed	None available.

**Injuries and Injury Mechanisms**

Case vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Bilateral pelvic contusions	890402.1,1 890402.1,2	924.01 924.01	Lap belt
Right rear Occupant:	Bilateral pelvic contusions	890402.1,1 890402.1,2	924.01 924.01	Lap belt

## Occupant Kinematics

The 33-year-old female driver of the case vehicle was seated in a normal, upright fashion. She was wearing the available 3-point lap and shoulder belt. The fabric-covered bucket seat had been adjusted to the forward most position. Both hands were on the steering wheel. She was steering to the left, so the right hand was higher than the left. Her right foot was on the brake, and the left was on the floorboard. Upon impact, both front seat belt retractor pretensioners fired and the frontal air bags deployed. The driver responded to the 12 o'clock direction of force by exhibiting a forward trajectory and loading the pretensioned and locked manual restraint system. The driver's face contacted the deployed air bag. Her lower body loaded the seat belt—causing bilateral contusions to her hips. During the subsequent rotation, the driver's right leg contacted and dislodged the center console trim panel. This contact did not result in any injury.

The 9-year-old female right rear seat occupant was seated in a normal, upright fashion. She was wearing the available 3-point lap and shoulder belt. Upon impact, this occupant responded to the 12 o'clock direction of force by exhibiting a forward trajectory and loaded the manual restraint system. Her lower body loaded the seat belt—causing bilateral contusions to her hips. There were no indications of any contacts to any surfaces in the rear seating area.



Figure 10. Driver's seat



Figure 11. Displaced console trim



**Figure 12.** Right rear seating area