

Redesigned Air Bag Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS05022
1998 Plymouth Breeze
Idaho
September, 2005

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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 This on-site investigation focused on the driver's air bag installed in a 1998 Plymouth Breeze. This two vehicle crash occurred in September 2005 at 1958 hours. The crash occurred within the confines of a four-leg intersection formed by two US highways. The case vehicle was a 1998 Plymouth Breeze. The other vehicle was a 1990 Geo Storm. The Plymouth Breeze was struck in the front end as the Geo Storm turned in front of the Plymouth Breeze. Both front air bags in the Plymouth Breeze deployed. The Breeze was deflected to the right and struck a metal light pole. The driver of the Plymouth Breeze sustained a C2 spinal fracture and abrasions to her chin and both cheeks. She was transported by ground ambulance to a local hospital where she underwent x-rays and a CatScan. She was then airlifted from the local hospital and transported to an area trauma center that was approximately 220 km (137 miles) from the crash scene.			
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BACKGROUND

This on-site investigation focused on the driver's air bag installed in a 1998 Plymouth Breeze. This case initially investigated as an air bag related serious injury case. The case was dropped as an air bag related serious injury case due to the case vehicle's high delta V. This two vehicle crash occurred in September 2005 at 1958 hours. The crash occurred within the confines of a four-leg intersection formed by two US highways. The case vehicle was a 1998 Plymouth Breeze. The other vehicle was a 1990 Geo Storm. The Plymouth Breeze was struck on the front end as the Geo Storm turned in front of the Plymouth Breeze. Both front air bags in the Plymouth Breeze deployed. The Breeze was deflected to the right and struck a metal light pole. The driver of the Plymouth Breeze sustained a C2 spinal fracture and abrasions to her chin and both cheeks. She was transported by ground ambulance to a local hospital where she underwent x-rays and a CatScan. She was then airlifted from the local hospital and transported to an area trauma center that was approximately 220 km (137 miles) from the crash scene.



Figure 1. Front, 1998 Plymouth Breeze

This air bag related driver injury investigation was initiated in response to a call to the SCI Hotline. The Hotline was notified by an emergency room doctor who had a patient that had apparently sustained a C2 spinal fracture during a vehicle crash and the subsequent air bag deployment. The patient was contacted by SCI on October 23, 2005. DSI was assigned the case on October 25, 2005. Field work was completed on October 26, 2005.

SUMMARY

Crash Site

This two vehicle crash occurred in September 2005 at 1958 hours in the state of Idaho. It was dark at the time of the crash but the roadway was lighted by overhead streetlights. The crash occurred within the confines of a four-leg intersection formed by two US highways. There are no traffic signals for east and westbound traffic. The eastbound leg of the intersection was comprised of two eastbound travel lanes, a left hand turn lane, and two westbound travel lanes. There are paved asphalt shoulder on both sides of the roadway. There is a positive 2.5% grade. The



Figure 2. Approach to area of impact (east)

asphalt roadway was straight and dry with no defects. The westbound leg of the intersection was comprised of two westbound travel lanes, a left hand turn lane, and two eastbound travel lanes. There are paved asphalt shoulders on both sides of the roadway. There is a negative 2.5% grade. The speed limit for east and westbound travel is 89 km/h (55 mph).

Pre-Crash

The case vehicle is a 1998 Plymouth Breeze that was being driven by a 35-year-old female (157 cm/62 in, 70 kg/155 lbs). The driver was wearing the 3-point lap and shoulder belt. The seat track was adjusted to the fully forward position. Both hands were on the steering wheel (10/2 o'clock positions). Her right foot was on the accelerator, the left on the floor. She was wearing prescription glasses with plastic lenses and frames. The Plymouth Breeze was traveling eastbound at a driver reported speed of 89 km/h (55 mph). The other vehicle was a 1990 Geo Storm three door hatchback that was being driven by an adult male. The Geo Storm was initially traveling westbound. The Geo had stopped in the left hand turn lane in preparation for a turn to the south.



Figure 3. Path to impact with light pole

Crash

According to the driver of the Plymouth Breeze, the Geo Storm turned in front of her to go south. The front of the Geo Storm struck the front of the Plymouth Breeze. The missing vehicle algorithm of the WinSmash program computed a total V of 43.0 km/h (26.70 mph). The longitudinal and lateral components were -40.4 km/h (-25.1 mph) and 14.7 km/h (9.1 mph), respectively. Both front air bags in the Plymouth Breeze deployed at this time.

The Breeze was deflected to the right and struck a metal light pole in the southeast corner of the intersection. The light pole sheared at the base. The Geo Storm came to rest east of the intersection facing northeast.



Figure 4. Damaged light pole

Post-Crash

The driver of the Plymouth Breeze has no memory of the crash itself. Her first memory is of other motorists coming to her window to check on her condition. She was unable to exit the vehicle on her own and rescue personnel were needed to pry open the driver's door. This took approximately 30 minutes according to the paramedic's report.

The driver of the Plymouth Breeze sustained acute bilateral C-2 pedicle fractures with minimal distraction, multiple facial abrasions, ecchymosis over the left clavicle area, ecchymosis over both knees, bilateral lower leg contusions, and a right hand laceration. She was transported from the scene by ground ambulance. The transport times were as follows:

Time of crash:	1958
Ambulance en route:	1958
Arrived on scene:	2005
Departed scene:	2038
Arrived at ER:	2052
Admitted to ER:	2055

She arrived at the hospital with a Glasgow Coma Scale (GCS) score of 15. She underwent x-rays and a CatScan after arrival. She was then airlifted from the local hospital and transported 220 km (137 miles) from the crash scene to an area trauma center for possible surgery. It was later determined that surgery would not be required. She was released at 1300 hours on the following day.

The driver of the Geo Storm sustained "B" type, non incapacitating injuries.

The case vehicle was towed from the scene due to damage and was later declared a total loss. The other vehicle was also towed from the scene due to damage.

VEHICLE DATA -1998 Plymouth Breeze

The 1998 Plymouth Breeze was identified by the Vehicle Identification Number (VIN): 1P3EJ46X9WNxxxxxx. The Plymouth Breeze was a four-door sedan that was equipped with a 2.4 liter, four-cylinder engine, four speed automatic transmission, front disk/rear drum brakes, and power steering. The Breeze was configured with Daytona P195/70R14 tires. The vehicle manufacturer's recommended cold tire pressure was 207 kPa (30 psi). The specific tire data is as follows:

Tire	Tread	Measured pressure	Restricted	Damage
LF	5.3 mm (7/32 in)	Flat	Yes	None
LR	5.3 mm (7/32 in)	193 kPa (28 psi)	No	None
RR	4.5 mm (6/32 in)	186 kPa (27 psi)	No	None
RF	4.5 mm (5/32 in)	186 kPa (27 psi)	No	Rim dented

The seating in the Plymouth Breeze was configured with fabric covered front bucket seats with adjustable head restraints and a rear bench seat. The driver's seat was located in the fully forward track position. The seat back angle was 72 degrees, the seat cushion angle was 10 degrees. The front right passenger seat was in the fully rearward track position. The seat back angle was 72 degrees, the seat cushion angle was 11 degrees. The rear bench seat back angle was 73 degrees, the seat cushion was 14 degrees.

VEHICLE DAMAGE

Exterior Damage - 1998 Plymouth Breeze

Damage Description: The 1998 Plymouth Breeze sustained major front end damage as a result of the impact with the Geo Storm. The left side wheelbase was shortened by 32.0 cm (12.6 in). Both left side doors were deformed and jammed shut. The roof was cut off the vehicle during the extrication of the driver. The windshield sustained fracture damage from impact forces. The driver's side window disintegrated during the impact.

CDC: Impact 1 (Geo): 11FDEW3
Impact 2 (pole): 12FYEN1

Delta V (Impact 1):	Total	43.0 km/h (26.7 mph)
	Longitudinal	-40.4 km/h (-25.1 mph)
	Latitudinal	14.7 km/h (9.1 mph)
	Energy	79,046 joules (58,301 ft lbs)

The direct damage began at the front left bumper corner and extended laterally 104.0 cm (40.9 in) along the frontal plane. Six crush measurements were documented at the bumper level as follows: C1 = 54.0 cm (21.3 in), C2 = 48.0 cm (18.9 in), C3 = 40.0 cm (15.7 in), C4 = 30.0 cm (11.8 in), C5 = 25.0 cm (9.8 in), C6 = 3.0 cm (1.2 in). The Breeze appeared to have sustained only minor damage due to the impact with the pole.

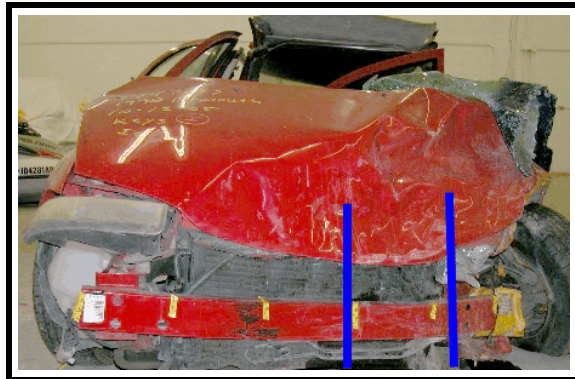


Figure 5. Area of contact with pole



Figure 6. Left side view, Plymouth Breeze

Interior Damage - 1998 Plymouth Breeze

The 1998 Plymouth Breeze sustained moderate interior damage as a result of passenger compartment intrusion and occupant contacts. There was longitudinal intrusion to the driver's seated area from the instrument panel and the toe pan.

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
LF	Left instrument panel	3.5 cm (1.4 in)	Longitudinal
LF	Toe pan	3.0 cm (1.1 in)	Longitudinal

The steering column was loaded and collapsed approximately 8.0 cm (3.1 in) to a point almost touching the top of the instrument panel. The distance from the steering wheel center to the B pillar was 55.0 cm (21.6 in). The steering wheel rim was found rotated 180 degrees (with the top facing down) and had a 65 degree angle. The distance from the top of the rim (as found in the vehicle) to the seat back was 50.0 cm (19.7 in). The distance from the bottom of the rim to the seat back was 28.0 cm (11.0 in).

There were bilateral knee contacts to the lower instrument panel.

MANUAL RESTRAINT SYSTEMS - 1998 Plymouth Breeze

The 1998 Plymouth Breeze was configured with manual 3-point lap and shoulder belts for each of the outboard seating positions and a manual lap belt for the rear seat middle position. Both front seat safety belts were equipped with adjustable D rings. The driver's D ring was adjusted to the full down position. The front right D ring was adjusted to the full up position. The lap and shoulder belts were all configured with emergency locking retractors and cinching latch plates. The manual lap belt was configured with a fixed latch plate.



Figure 7. Steering column movement

Supplemental Restraint System - 1998 Plymouth Breeze

The 1998 Plymouth Breeze was equipped with Plymouth's next generation depowered front air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of the longitudinal deceleration of the Breeze during the impact with the Geo Storm.

The driver's air bag deployed from the center of the steering wheel hub through H configuration module cover flaps. The top flap measured 23.0 cm (9.0 in) wide by 8.0 cm (3.1 in) high. The lower flap measured 23.0 cm (9.0 in) wide by 7.0 cm (2.8 in) high. The top flap was found trapped behind the steering wheel rim. The deployed driver's air bag measured 52.0 cm (20.5 in) in diameter in its deflated state. There was a patterned abrasion to the left upper quadrant that was likely from the module cover flap. There were blood droplets found along the edges of the air bag face and a blood/saliva smear was found near the center of the air bag just below the tether stitching. There was blood found on the back of the air bag near the vent port. There was a single tether that was attached to an 18.0 cm (7.0 in) diameter center stitch in the center of the air bag face. There was a single circular vent port on the back of the air bag at the 12 o'clock position. The maximum post-deployment excursion for the air bag was 24.0 cm (9.4 in) from the air bag module. The distance from the maximum excursion to the seat back was 16.0 cm (6.3 in).



Figure 8. Driver's air bag



Figure 9. Front right passenger air bag

The front right passenger air bag deployed from a top-mount module cover that was hinged at the forward aspect. The module cover measured 38.0 cm (14.9 in) along the top seam, 22.0 cm (8.7 in) on the left, 16.0 cm (6.3 in) on the right, and 36.0 cm (14.2 in) along the bottom. The deployed front right passenger air bag measured 49.0 cm (19.3 in) wide seam to seam, 53.0 cm (20.9 in) high, and had a maximum excursion of 51.0 cm (20.5 in).

VEHICLE DATA - 1990 Geo Storm

Description:	1990 Geo Storm three door hatchback	
VIN:	J81RF2363L7xxxxxx	
Odometer:	Unknown	
Engine:	1.6 liter, 4 cylinder	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Right front. Damage estimated at \$3000 by police	
CDC:	Unknown	
Delta V:	Total	47.0 km/h (29.2 mph)
	Longitudinal	-16.1 km/h (-10.0 mph)
	Latitudinal	-44.2 km/h (-27.4 mph)
	Energy	148,664 joules (109,649 ft lbs)

OCCUPANT DEMOGRAPHICS - 1998 Plymouth Breeze

	Driver
Age/Sex:	35/Female
Seated Position:	Front left
Seat Type:	Bucket seat at forward most track position
Height:	157 cm (62 in)
Weight:	70 kg (154 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	>10 years
Body Posture:	Normal, upright
Hand Position:	Both hands on wheel, 10/2 o'clock position
Foot Position:	Right foot on accelerator, left on floor
Restraint Usage:	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted from air bag available, deployed

OCCUPANT DEMOGRAPHICS - 1990 Geo Storm

Age/Sex:	18/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Air bag deployed, belts used

OCCUPANT INJURIES -1998 Plymouth Breeze

Driver: Injuries obtained from radiology report, emergency room records, and discharge summary.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Acute bilateral C-2 pedicle fractures with minimal distraction	650226.3,6	Air bag, hyperflexion	Certain
Facial abrasions (chin, both cheeks)	290202.1,0	Air bag	Certain
Ecchymoses over left clavicle area	790402.1,2	Seat belt webbing	Certain
Ecchymoses, bilateral knees	890402.1,3	Knee bolster	Certain
Contusion, bilateral lower legs	890402.1,3	Knee bolster	Certain
Laceration, right hand	790600.1,1	Unknown	Unknown

OCCUPANT KINEMATICS - 1998 Plymouth Breeze

The 35-year-old female driver was seated in an upright posture and restrained by the 3-point manual lap and shoulder belt. The seat was in the fully forward track position. Both hands were on the steering wheel (10/2 o'clock positions). Her right foot was on the accelerator, the left on the floor. She was wearing prescription glasses with plastic lenses and frames. At impact, the frontal air bags deployed. The female driver initiated a forward and slightly left lateral trajectory. She loaded the safety belt and engaged the deployed air bag with her torso and lower face. Her legs transitioned forward and both knees struck the



Figure 10. Overhead view of driver's seated position

lower instrument panel/knee bolster. Her head was forced rearward as she loaded the air bag/steering column and her neck was hyperextended—causing the C2 fracture. The driver's glasses were knocked off. The frame was bent but the lenses remained intact. There were no eye injuries of any kind. The driver rebounded to some degree. She remained in her initial sitting position due to the seat belt. The case vehicle continued forward and struck a metal light pole with its front end. This did not appear to be a substantial impact. The driver likely pitched forward to some degree but remained held in place by the lap and shoulder belt.

Attachment 1. Scene Diagram

