

ODI Tire Failure Investigation / Rollover
Dynamic Science, Inc. / Case Number: 2007-78-092B
1998 Plymouth Neon
Arizona
July 2007

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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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|---|--------------------------------------|---|-----------|
| 1. Report No. 2007-78-092B | 2. Government Accession No. | 3. Recipient Catalog No. | |
| 4. Title and Subtitle ODI Tire Failure Investigation | | 5. Report Date February 14, 2008 | |
| | | 6. Performing Organization Report No. | |
| 7. Author(s) Dynamic Science, Inc. | | 8. Performing Organization Report No. | |
| 9. Performing Organization name and Address Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805 | | 10. Work Unit No. (TRAIS) | |
| | | 11. Contract or Grant no. DTNH22-07-C-00045 | |
| 12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NRD-111) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590 | | 13. Type of report and period Covered [Report Month, Year] | |
| | | 14. Sponsoring Agency Code | |
| 15. Supplemental Notes | | | |
| 16. Abstract This single vehicle rollover crash occurred in July 2007 at 1140 hours. The crash occurred on a four-lane divided interstate highway. The case vehicle was a 1998 Plymouth Neon two-door sedan that was being driven by an 18-year-old female. The front right seat was occupied by an 18-year-old male. Both occupants were unrestrained. The Plymouth Neon was traveling westbound in the second lane from the right. The right rear tire tread separated. The driver stated that she had one hand on the steering wheel when the tread separated. The Plymouth Neon pulled to the right and pulled the steering wheel out of her hand. The vehicle began a clockwise rotation and crossed the adjacent westbound lane before departing the roadway on the north side. The vehicle continued rotating as it traveled across the grass/dirt area between the roadway and the on-ramp. Just prior to entering the on-ramp, the Neon began a left side leading rollover. As the Neon entered the on-ramp, the vehicle struck a delineator post. The Plymouth Neon came to rest north of the on-ramp on its roof facing northeast. During the rollover sequence both occupants were ejected from the vehicle. | | | |
| 17. Key Words Tire malfunction, rollover, ejection | | 18. Distribution Statement | |
| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No of pages | 22. Price |

Dynamic Science, Inc.
Crash Investigation
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BACKGROUND

This single vehicle rollover crash occurred in July 2007 at 1140 hours. The crash occurred on a four-lane divided interstate highway. The case vehicle was a 1998 Plymouth Neon two-door sedan that was being driven by an 18-year-old female (**Figure 1**). The front right seat was occupied by an 18-year-old male. Both occupants were unrestrained. The Plymouth Neon was traveling westbound in the second lane from the right. The right rear tire tread separated. The driver stated that she had one hand on the steering wheel when the tread separated. The Plymouth Neon pulled to the right and pulled the steering wheel out of her hand. The Plymouth Neon began a clockwise rotation. The vehicle crossed the adjacent westbound lane before departing the roadway on the north side. The vehicle continued rotating as it traveled across the grass/dirt area between the roadway and the on-ramp. Just prior to entering the on-ramp, the Neon began a left side leading rollover. As the Neon entered the on-ramp, the vehicle struck a delineator post. The Plymouth Neon came to rest north of the on-ramp on its roof facing northeast. During the rollover sequence both occupants were ejected from the vehicle.



Figure 1. 1998 Plymouth Neon

This Remote Combination Office of Defects Investigation (ODI) Tire Tread Separation Investigation was initiated in response to an SCI notification of a tread separation related crash involving a 1998 Plymouth Neon. DSI was notified of the case by email on October 29, 2007. An electronic copy of the case was downloaded to DSI from the Zone Center.

SUMMARY

Crash Site

This single vehicle rollover crash occurred in July 2007 at 1140 hours. The crash occurred on a four-lane divided interstate highway (**Figure 2**). At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The east/west highway was configured with two lanes in each direction. The westbound lanes were separated by a dashed white center line. The left road edge was separated from the depressed, grassy median by a solid yellow line, a grooved rumble strip, and a gravel shoulder. The right road edge was marked by a solid white line. Beyond the white line was a grooved rumble strip and a gravel shoulder. The crash occurred within an interchange area. To the right (north) of the

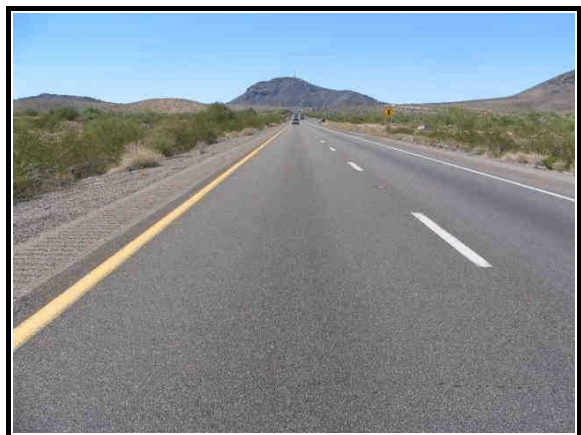


Figure 2. Approach to area of tire tread separation (west)

roadway was a grassy area that separates the east/west roadway from a westbound on-ramp. The posted speed limit was 121 km/h (75 mph). The temperature at the nearest reporting station at 1151 hours was 39 degrees C (102 degrees F).

Pre-Crash

The case vehicle was a 1998 Plymouth Neon two-door sedan that was being driven by an 18-year-old female. The driver did not possess a valid driver's license and the vehicle was uninsured. The front right seat was occupied by an 18-year-old male. Both occupants were unrestrained. The air conditioning in the Neon was not working so both side windows were in the down position. The Plymouth Neon was traveling westbound in the second lane from the right at a driver reported speed of 135 km/h (84 mph). DSI calculated a minimum travel speed of 138 km/h (86 mph) based on a combined speed formula¹.



Figure 3. Right side roadway departure

The Plymouth Neon was initially configured with 205/40ZR17 tires on 17 inch custom rims. The right rear tire had been losing air during the trip between Texas and Arizona. The driver and her husband tried to get the tire fixed. A nail was found in the tire but the nail was so close to the sidewall that the tire could not be patched. This tire was replaced by a Futura Super Sport P195/60R14 tire on a 14 inch steel rim. The driver reported that the Futura tire was one of the tires originally on the vehicle. The tire was replaced while they were in Texas. They had traveled approximately 1,931 km (1,200 miles) before the crash. According to the driver, they had a tire gauge and were checking the tire pressure every time they stopped for gas. She also indicated that they had stopped for gas and food approximately 10 minutes prior to the crash.

The driver stated that she had one hand on the steering wheel when the tread separated. The vehicle pulled to the right and pulled the steering wheel out of her hand. She grabbed the driver's door with her left hand, began braking and grabbed the passenger's hand with her right hand.

Crash

The Plymouth Neon began a clockwise rotation. The vehicle crossed the adjacent westbound lane and traveled approximately 66 m (219 ft) before departing the roadway on the north side (**Figure 3**). The vehicle continued rotating as it traveled approximately 22 m (71 ft) across the grass/dirt area between the roadway and the on-ramp. Just prior to entering the on-ramp, the Neon began a left side leading rollover (Event 1). As the Neon entered the on-ramp, the vehicle struck a delineator post (Event 2). The Neon continued overturning. The NASS investigator reported a total of 10 quarter turns. The Plymouth Neon came to rest north of the on-ramp on its roof facing northeast. During

¹Calculated using distances vehicle skidded across different surfaces.

the rollover sequence the front right passenger was completely ejected. He came to rest approximately 5 m (18 ft) north of the Plymouth Neon (**Figure 4**). The driver was also ejected and was found trapped beneath the vehicle.

Post-Crash

The driver was assisted from beneath the vehicle by witnesses to the crash. A portion of the vehicle had trapped her head. The witnesses were able to lift the vehicle enough to get her out. She was unsteady on her feet and began to feel pain everywhere in her body. She sustained abrasions to her right cheek, right and left shoulders, upper left back and left foot. She also sustained contusions to her left shoulder. She was transported to a local hospital where she was treated and hospitalized for one day.



Figure 4. Vehicle at final rest

The front right passenger had been fully ejected and was fatally injured. He sustained a depressed/comminuted skull fracture, multiple fractures to the right orbit, multiple brain injuries, and multiple contusions, abrasions, and lacerations. One of the responding witnesses had medical training. The witnesses stabilized the passenger's neck until the ambulance arrived. He was treated at the scene and was then flown from the scene to an area trauma center. He was pronounced dead shortly after arrival.

VEHICLE DATA - 1998 Plymouth Neon

The Plymouth Neon was identified by the Vehicle Identification Number (VIN): 1P3ES42C4WDxxxxx. The Neon was purchased in March 1998 and was sold to the current owner in 2003. The odometer reading at the time of the vehicle inspection was 197,023 km (122,424 miles). The Neon had been driven 11,051 km (6,867 miles) in the two and one-half months prior to the crash. The Plymouth Neon was a two-door coupe that was equipped with a 2.0 liter, four-cylinder engine, a 3-speed automatic transmission, front wheel drive, front disc/rear drum brakes, and power steering.

The Plymouth Neon was initially configured with Nexen N3000 205/40R17 tires on 17 inch custom rims. The tire manufacture's maximum pressure was 345 kPa (50 psi). The right rear tire was losing air during the trip. That tire was replaced by a Futura Super Sport P195/60R14 tire on a 14 inch steel rim. The tire manufacture's maximum pressure was 303 kPa (44 psi). The tire had been replaced in Texas. The driver reported that this was one of the tires originally on the vehicle. The Tire Identification Number (TIN) was U9R4 86F249. The build date as printed on the tire (249) was the 24th week of 1999, or June 1999 (**Figure 5**). The tread on the right rear tire separated prior to the rollover (**Figure 6**). The left rear tire/wheel appear to have separated from the vehicle during the rollover event. The specific tire information is as follows:

| Position | Measured Pressure | Measured Tread Depth | Restricted | Damage |
|----------|-------------------|----------------------|------------|-----------------------|
| LF | Flat | 4 mm (0.15 in) | Yes | Debeaded |
| RF | 317 kPa (46 psi) | 2 mm (0.08 in) | Yes | Yes |
| LR | Flat | 6 mm (0.24 in) | No | Debeaded |
| RR | Flat | Unknown | No | Tire tread separation |



Figure 5. Tire build date



Figure 6. Right rear tire

VEHICLE DAMAGE

Exterior Damage -1998 Plymouth Neon

The Plymouth Neon sustained moderate damage to all sides from the rollover event. There was 436.0 cm (171.6 in) of direct damage to the right side of the vehicle (**Figure 7**). The maximum crush was located at the right C pillar and measured 21.0 cm (8.3 in) laterally. The Collision Deformation Classification (CDC) for the rollover was incremented for left shift and was 80RDAO3.

There was an impact with a delineator post, but its location and extent was masked by the rollover damage. Both front doors were jammed shut. The side glass and backlight glass disintegrated during the rollover. The windshield was largely out of place. The left rear tire/rim were separated from the vehicle.



Figure 7. Right side, Plymouth Neon

Interior Damage -1998 Plymouth Neon

The 1998 Plymouth Neon sustained moderate interior damage as a result of passenger compartment intrusion (**Figure 8**). The right B-C pillars sustained lateral intrusions. The right A pillar, roof and roof side rail sustained vertical intrusions (**Figure 9**). The hood was deformed and intruded into the vehicle through the windshield. The specific passenger compartment intrusions were documented as follows:

| Row/Position | Intruded Component | Magnitude of Intrusion | Direction |
|--------------|--------------------|---|--------------|
| 1R | A pillar | 14.0 cm (5.5 in) | Vertical |
| 1R | Roof side rail | 15.0 cm (5.9 in) | Vertical |
| 1R | B pillar | 19.0 cm (7.5 in) | Lateral |
| 2R | C pillar | 23.0 cm (9.0 in) | Lateral |
| 1R | Roof | 4.0 cm (1.6 in) | Vertical |
| 2R | Roof | 9.0 cm (3.5 in) | Vertical |
| 1M | Roof | 5.0 cm (1.9 in) | Vertical |
| 2R | Backlight header | 15.0 cm (5.9 in) | Vertical |
| 1L | Exterior (hood) | $\geq 8.0 < 15.0$ cm ($\geq 3.1 < 5.9$ in) | Longitudinal |
| 1M | Exterior (hood) | $\geq 8.0 < 15.0$ cm ($\geq 3.1 < 5.9$ in) | Longitudinal |
| 1R | Exterior (hood) | $\geq 3.0 < 8.0$ cm ($\geq 1.2 < 3.1$ in) | Longitudinal |
| 2M | Backlight header | $\geq 8.0 < 15.0$ cm ($\geq 3.1 < 5.9$ in) | Vertical |

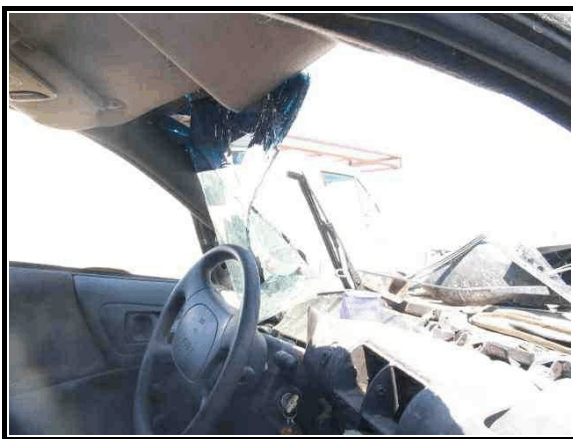


Figure 8. Driver's seated position



Figure 9. Front right passenger's seated position

Manual Restraints -1998 Plymouth Neon

The 1998 Plymouth Neon was configured with manual 3-point lap and shoulder belts for each of the outboard seating positions. The second row middle seat was equipped with a lap belt. There were no seat belts used in the crash.

Supplemental Restraint Systems - 1998 Plymouth Neon

The 1998 Plymouth Neon was equipped with dual frontal air bags. There were no air bag deployments.

OCCUPANT DEMOGRAPHICS - 1998 Plymouth Neon

| | Driver | Front right passenger |
|---------------------------|---|---|
| Age/Sex: | 18/Female | 18/Male |
| Seated Position: | Front left | Front right |
| Seat Type: | Bucket | Bucket |
| Height: | 163 cm (64 in) | 165 cm (65 in) |
| Weight: | 59 kg (130 lbs) | 68 kg (150 lbs) |
| Alcohol/Drug Involvement: | None | N/A |
| Body Posture: | Upright | Upright |
| Hand Position: | Left hand on steering wheel initially, then came off. Right hand possibly grabbing passenger's left hand. | Right hand unknown, left possibly grabbing driver's right hand. |
| Foot Position: | Right on accelerator | Unknown |
| Restraint Usage: | Lap and shoulder belt available, not used | Lap and shoulder belt available, not used |
| Air bag: | Frontal air bag available, did not deploy | Frontal air bag available, did not deploy |

OCCUPANT INJURIES

Driver: Injuries obtained from emergency room records and interview.

| <u>Injury</u> | <u>OIC Code</u> | <u>Injury Mechanism</u> | <u>Confidence Level</u> |
|------------------------------|-----------------|-------------------------|-------------------------|
| Right cheek abrasion | 290202.1,1 | Ground | Certain |
| Bilateral shoulder abrasions | 790202.1,3 | Ground | Certain |
| Left foot abrasion | 890202.1,2 | Ground | Certain |
| Left upper back abrasion | 690202.1,2 | Exterior of vehicle | Certain |
| Left shoulder contusion | 790402.1,2 | Ground | Certain |

Driver Kinematics

The 18-year-old female driver was sitting in an upright posture. Her right foot was on the accelerator, the left on the floor. She was not wearing the available lap and shoulder belt. The bucket seat was adjusted to the middle track position and the seat back was slightly reclined. The driver stated that she had one hand on the steering wheel when the tread separated. The Plymouth Neon pulled to the right and pulled the steering wheel out of her hand. She grabbed the driver's door with her left hand, began braking and grabbed the passenger's hand with her right hand. As the Neon began the clockwise rotation, the driver began pitching to the left against the driver's door. As the Neon tripped and began to roll, the driver came out of her seat. Towards the end of the rollover sequence, the driver appears to have been ejected through the right front window. She was trapped under the vehicle in some manner. The driver was assisted from beneath the vehicle by witnesses to the crash. A portion of the vehicle had trapped her head. The witnesses were able to lift the vehicle enough to get her out. She was unsteady on her feet and began to feel pain everywhere in her body. She sustained abrasions to her right cheek, right and left shoulders, upper left back and left foot. She also sustained contusions to her left shoulder. She was transported to a local hospital where she was treated and hospitalized for one day.

Front Right Passenger: Injuries obtained from autopsy report.

| <u>Injury</u> | <u>OIC Code</u> | <u>Injury Mechanism</u> | <u>Confidence Level</u> |
|--|-----------------|-------------------------|-------------------------|
| Bilateral cerebrum diffuse hemorrhage, subdural, small | 140654.5,3 | Ground | Certain |
| Left frontal cerebrum hemorrhage | 140642.4,2 | Ground | Certain |
| Left cerebrum contusions, multiple on same side | 140614.3,2 | Ground | Certain |
| Right frontal cerebrum laceration | 140688.4,1 | Ground | Certain |
| Left cerebrum subarachnoid hemorrhage | 140684.3,2 | Ground | Certain |

| | | | |
|---|-------------|--------|---------|
| Right cerebrum subarachnoid hemorrhage | 140684.3,1 | Ground | Certain |
| Right frontal parietal vault skull fracture, depressed/comminuted | 150404.3,5 | Ground | Certain |
| Multiple right orbit fractures, displaced/comminuted | 251204.3,1 | Ground | Certain |
| Rib fracture, unknown aspect | 450211.3,9 | Ground | Certain |
| Clavicle fracture | 752200.2,2 | Ground | Certain |
| Clavicle fracture | 752200.2,1 | Ground | Certain |
| Scalp laceration | 190602.1,6 | Ground | Certain |
| Right eyelid contusion | 297402.1,2 | Ground | Certain |
| Left eyelid contusion | 297402.1,1 | Ground | Certain |
| Right forehead abrasion | 290202.1,7 | Ground | Certain |
| Right forehead laceration | 290602.1,7 | Ground | Certain |
| Left cheek abrasion | 290202.1,2 | Ground | Certain |
| Left cheek laceration | 290602.1,2 | Ground | Certain |
| Right cheek abrasion | 290202.1,1 | Ground | Certain |
| Right cheek laceration | 290602.1,1 | Ground | Certain |
| Multiple chest abrasions | 490202.1,9 | Ground | Certain |
| Brush burn type abrasion, back | 690202.1,9 | Ground | Certain |
| Bilateral lower leg abrasions | 890202.1,3 | Ground | Certain |
| Lower abdomen/scrotal sac abrasion | 590202.1, 8 | Ground | Certain |
| Right leg abrasion | 790202.1,1 | Ground | Certain |

Front Right Passenger Kinematics

The 18-year-old male right front passenger was sitting in an upright posture. The bucket seat was adjusted to the rear most track position and the seat back was slightly reclined. The driver had grabbed the driver's door with her left hand, began braking and grabbed the front right passenger's hand with her right hand. As the Neon began the clockwise rotation, the front right passenger began pitching to the left. As the Neon tripped and began to roll, the front right passenger came out of his seat. Towards the end of the rollover sequence, the front right passenger appears to have been ejected through the right front window. He came to rest approximately 5.4 m (18 ft) north of the Plymouth Neon. He sustained a depressed/comminuted skull fracture, multiple fractures to the right orbit, multiple brain injuries, and multiple contusions, abrasions, and lacerations. One of the responding witnesses had medical training. The witnesses stabilized the passenger's

neck until the ambulance arrived. He was treated at the scene and was then flown from the scene to an area trauma center. He was pronounced dead shortly after arrival.

Scene Diagram

