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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN09004
LOCATION - Wisconsin
VEHICLE - 2007 SUBARU FORESTER X
CRASH DATE - January 2009

Submitted:

March 24, 2009

Contract Number: DTNH22-07-C-00044

Prepared for:

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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.

Technical Report Documentation Page

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15. *Supplementary Notes* On-site rollover investigation involving a 2007 Subaru Forester X.			
16. *Abstract* This report covers an on-site rollover investigation that involved a 2007 Subaru Forester X, which departed the roadway and rolled over. The focus of this on-site investigation was the Subaru's rollover. The Subaru's restrained 48-year-old male driver was traveling west on a 2-lane county roadway while a snowplow was approaching from the east. The Subaru's driver applied the brakes and steered to the right partially onto the north shoulder to allow the snowplow to pass and the Subaru began to rotate clockwise. The vehicle traveled down a small embankment as it continued to rotate and rolled over left side leading 3 quarter turns. The vehicle came to final rest on its right side in the front yard of a residence heading northeast. The driver was not injured.			
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BACKGROUND

This crash was brought to the National Highway Traffic Safety Administration's (NHTSA) attention on February 20, 2009 by the sampling activities of the National Automotive Sampling System-General Estimates System and was assigned on February 26 2009. This crash involved a 2007 Subaru Forester X (**Figure 1**), which departed the roadway and rolled over. The crash occurred in January, 2009 at 0848 hours, in Wisconsin and was investigated by the applicable Sheriff's department. The focus of this on-site investigation was the Subaru's rollover. This contractor inspected the crash scene and the Subaru on March 2, 2009 and interviewed the driver on March 20, 2009. This report is based on the police crash report, crash scene and vehicle inspections, driver interview, exemplar vehicle inspection, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2007 Subaru Forester X

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Subaru was traveling was a 2-lane county roadway that traversed in an east-west direction. The trafficway was straight and had one travel lane in each direction. Each travel lane was nominally 3.2 m (10.5 ft) in width. The north side of the roadway was bordered by a gravel shoulder 1.2 m (3.9 ft) in width. There was no shoulder on the south side of the roadway. The roadway pavement markings consisted of solid white edge lines and a broken yellow center line. The roadway was level on the Subaru's approach and had a positive 1% grade in the area of roadway departure. Beyond the north shoulder, the roadside dropped 40 cm (16 in) to a level residential front yard. The posted speed limit was 56 km/h (35 mph). At the time of the crash the light condition was daylight and the atmospheric condition was cloudy and snowing. The roadway was bituminous and was covered with snow and slush. The traffic density was light and the site of the crash was rural residential. See the Crash Diagram on page 6 of this report.

Pre-Crash: The Subaru's restrained 48-year-old male driver was traveling west (**Figure 2**) at a driver estimated speed of 48 km/h (30 mph), and he intended to continue west. A snowplow was approaching the vehicle from the east. The Subaru's driver applied the brakes and steered to the right partially onto the north shoulder to allow

Figure 2: Subaru's approach to the area of roadway departure (arrow)

the snowplow to pass. As the Subaru entered the shoulder, it began to rotate clockwise.

Figure 3: Estimated area of roadway departure, rollover, and final rest

Crash: As the Subaru rotated clockwise it departed the north shoulder and traveled a short distance across a negative 20% grade, at which point the left side wheels plowed into the snow and the vehicle tripped and rolled over left side leading 3 quarter turns across an estimated distance of 6 m (19.7 ft). The vehicle came to final rest on its right side heading northeast in the front yard of a residence (**Figure 3**). Due to the snow covered ground at the time of the crash and subsequent snow melt since the crash, there was no physical evidence present at the time of the crash scene inspection. The police took no photographs of the crash scene. The number of quarter turns was based on the damage to the vehicle and the police crash schematic. The rollover distance was estimated based on the police crash schematic and the vehicle's height and width specifications.

Post-Crash: Police and rescue personnel were notified at 0848 hours and arrived on scene at 0856 hours. The driver exited the vehicle through the left front door prior to the arrival of the emergency responders. The driver was not injured or transported for medical treatment.

CASE VEHICLE

The 2007 Subaru Forrester was an all wheel drive, 4-door, station wagon (VIN: JF1SG63617H------) equipped with a 2.5L, 4-cylinder engine, 4-speed automatic transmission, and 4-wheel anti-lock brakes with electronic break force distribution. The vehicle was not equipped with electronic stability control. The front row was equipped with bucket seats, adjustable head restraints, dual stage driver and front right passenger frontal air bags, lap-and-shoulder seat belts, and active head restraints. The vehicle was also equipped with Lower Anchors and Tethers for Children (LATCH) in the rear outboard seating positions. The NHTSA has given this vehicle a rollover rating of four out of five stars, a static stability factor of 1.25, and a chance of rollover rating of 15%. The vehicle's mileage at the time of the inspection was 41,459 kilometers (25,762 miles) and its wheelbase was 252 cm (99.2 in).

CASE VEHICLE DAMAGE

Exterior Damage: The Subaru's residual damage was located on its top and right side planes. Because the vehicle rolled over onto heavy snow, there were none of the typical rollover-type scratches found on the vehicle. The damage to the right side plane started 44 cm (17.3 in) forward of the right front axle and extended 334 cm (131.5 in) rearward along the fender and door panels (**Figure 4**). The damage to the top plane began at the front of the hood and extended onto the front portion of the roof. The damage to the roof extended across its full width, 108 cm (43 in). The maximum residual vertical crush was 4 cm (1.6 in) and occurred on the roof (**Figure 5**) 28

cm (11 in) left of the top of the right A-pillar and 10 cm (4 cm) rear of the windshield header. The roof structure sustained no lateral crush. The induced damage involved the roof, hood, both fenders, and the right rear door.

Figure 4: Right side damage

Figure 5: Subaru's maximum roof crush

Damage Classification: The Subaru's Collision Deformation Classification was **00-TYDO-3**. The severity of the rollover damage was moderate.

The vehicle manufacturer's recommended tire size was P215/60R16. The Subaru was equipped with tires of the recommended size. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	193	28	200	[1]29	5	6	None	No	No
LR	214	31	193	28	5	6	None	No	No
RR	214	31	193	28	5	6	None	No	No
RF	234	34	200	29	6	7	None	No	No

Vehicle Interior: The inspection of the Subaru's interior revealed no discernable occupant contact evidence. The passenger compartment intrusion involved the roof and windshield header. The maximum intrusion occurred on the roof (**Figure 6**), which intruded vertically 6 cm (2.4 in) into sector 12. All of the window glazing was either closed or fixed. The windshield glazing was in place and cracked from impact forces but all other window glazing was undamaged. All the doors remained closed and operational.

[1] The vehicle's tire placard indicated that the recommended cold pressure was 29 psi for the front tires and 28 psi for the back.

The Subaru was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front right passenger air bags, driver seat position sensor, seat belt usage sensors, retractor-mounted pretensioners and a front right passenger weight sensor. The manufacturer has certified that the vehicle is compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

The driver air bag was located within the steering wheel hub and the front right passenger air bag was located on the top of the instrument panel. Neither air bag deployed because the frontal air bag system is not designed to deploy in rollover crashes. The vehicle was also equipped with front seat back-mounted side impact air bags, which also did not deploy in this crash.

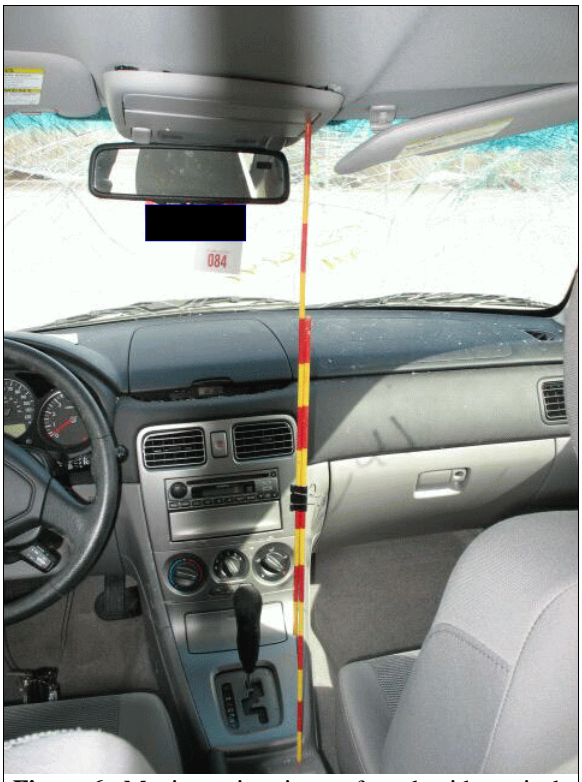


Figure 6: Maximum interior roof crush with vertical scale

MANUAL RESTRAINT SYSTEM

The Subaru was equipped with lap-and-shoulder belts for the driver and front right seating positions. The driver's seat belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), sliding latch plate, and an adjustable upper anchor that was in the full up position. The front right seat belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), sliding latch plate, and adjustable upper anchor that was also located in the full up position. The driver and front right passenger seat belts were equipped with retractor mounted pretensioners and load limiters. The pretensioners did not actuate in the crash consistent with non-deployment of the frontal air bags.

Figure 7: Driver's seat belt system

Inspection of the driver's seat belt assembly revealed historic usage scratches on the latch plate and the belt webbing (**Figure 7**) was slightly stiff with a slight stretched appearance. The evidence was consistent with usage of the seat belt in the

crash and the driver's statement that he was restrained. The remaining seat positions were unoccupied.

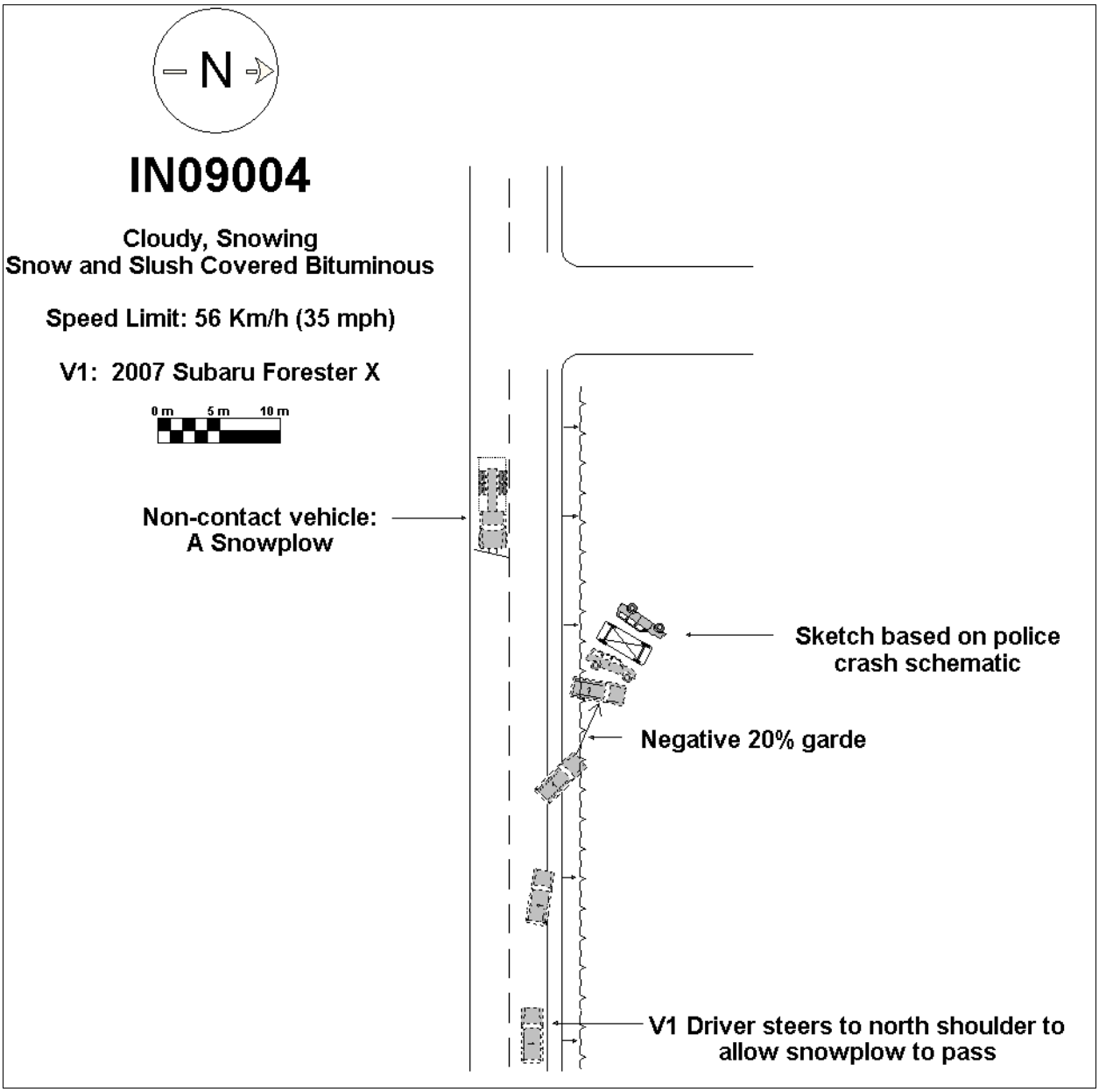
CASE VEHICLE DRIVER KINEMATICS

The Subaru's driver [48-year-old, male; 170 cm and 73 kg (57 in and 160 lbs)] was seated in an upright posture with both hands on the steering wheel, left foot on the floor, and right foot on the accelerator pedal. The seat track was adjusted to the middle position and the seat back was slightly reclined. The tilt steering column was located in the full up position. The driver was not wearing glasses at the time of the crash.

The Subaru was in a clockwise yaw as it departed the north shoulder just prior to the rollover. When the Subaru began to roll over left side leading, the driver was displaced to the left within the seat belt. While there was no discernable evidence of occupant contact on the left front door, the driver's left hip and thigh probably contacted the door during the rollover. As the vehicle rolled over, the driver was redirected toward the roof. When the roof impacted the ground, the driver loaded the seat belt. There was no discernable evidence that any part of the driver's body contacted the roof during the rollover.

CASE VEHICLE DRIVER INJURIES

The driver was not injured in this crash. He was not treated or transported from the crash scene to a hospital.


N
IN09004
Cloudy, Snowing
Snow and Slush Covered Bituminous
Speed Limit: 56 Km/h (35 mph)
V1: 2007 Subaru Forester X
0 m 5 m 10 m
Non-contact vehicle:
A Snowplow
Sketch based on police crash schematic
Negative 20% garde
V1 Driver steers to north shoulder to allow snowplow to pass