

On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS08015
2006 Ford Explorer
Washington
April 2008

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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 investigation focused on a 2006 Ford Explorer that was involved in a rollover crash. This two-vehicle crash occurred in April 2008 at 1825 hours in the state of Washington. The crash scene was a four-leg intersection. The Ford was being operated by a 38-year-old male who was traveling westbound at a police reported high rate of speed. The other vehicle was a 2003 Saab 9-5 sedan which was being driven northbound by a 30-year-old female. The subject vehicle disregarded a posted stop sign and contacted the other vehicle in the middle of the intersection. The subject vehicle continued west, contacted a raised curb on the intersection's northwest corner, and overturned. The other vehicle was redirected west and contacted a sign on the intersection's southwest corner. Neither driver was transported. The driver of the subject vehicle attempted to leave the scene and was later arrested for felony hit and run.			
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TABLE OF CONTENTS

Background	1
Summary	1
Crash Site	1
Pre Crash	2
Crash	2
Post Crash	2
Vehicle Data - 2006 Ford Explorer	3
Vehicle Damage	3
Exterior Damage	3
Interior Damage	4
Manual Restraints	5
Supplemental Restraint System	5
Rollover Dynamics	6
Vehicle Data - 2003 Saab 9-5	6
Occupant Demographics - 2006 Ford Explorer	6
Occupant Kinematics	6
Attachment 1. Scene Diagram	8

BACKGROUND

This investigation focused on a 2006 Ford Explorer that was involved in a rollover crash (**Figure 1**). This two-vehicle crash occurred in April 2008 at 1825 hours in the state of Washington. The crash scene was a four-leg intersection. The subject vehicle was being operated by a 38-year-old male who was traveling westbound at a police reported high rate of speed. The other vehicle was a 2003 Saab 9-5 sedan which was being driven northbound by a 30-year-old female. The subject vehicle disregarded a posted stop sign and contacted the other vehicle in the middle of the intersection. The subject vehicle continued west, contacted a raised curb on the intersection's northwest corner, and overturned. The other vehicle was redirected west and contacted a sign on the intersection's southwest corner. Neither driver was transported. The driver of the subject vehicle attempted to leave the scene and was later arrested for felony hit and run.



Figure 1. Subject vehicle, 2006 Ford Explorer

This on site rollover investigation was identified by the National Highway Traffic Safety Administration (NHTSA) from a review of police reports. On May 13, 2008, DSI was sent the police report and was instructed to locate the subject vehicle. The vehicle was being held at an auto salvage facility. On May 21, 2008, DSI obtained permission to inspect the vehicle. DSI was assigned the case on May 22, 2008. The vehicle inspection and field work were completed during the week of May 25, 2008. The driver refused to be interviewed.

SUMMARY

Crash Site

This crash occurred within a 4-leg intersection which was controlled by stop signs for east and westbound traffic. The east leg of the intersection was comprised of two travel lanes (**Figure 2**). The asphalt roadway was dry at the time of the crash and had an 8.8% negative grade for westbound traffic. The roadway was bordered by low profile curbs. Parking was permitted on the south side of the roadway. The speed limit was 40 km/h (25 mph). The south leg of the intersection was comprised of two northbound travel lanes, two southbound travel lanes, and a center turn lane (**Figure 3**). The outboard lanes were separated from the inboard lanes by a solid white line.



Figure 2. Westbound approach

The observed common practice was to use the outboard northbound lane as a travel lane when there were no vehicles parked in the lane. The inboard travel lanes were separated from the turn lane by a solid yellow line, followed by a dashed yellow line. The northbound lanes had a 5% positive grade. The speed limit for the south leg of the intersection was 48 km/h (30 mph).

Pre Crash

The Ford was traveling westbound approaching the intersection. The Saab was traveling northbound in the outboard lane at an unknown speed.

Crash

The driver of the Ford disregarded the stop sign, entered the intersection, and crossed the path of the Saab. The frontal plane of the Saab impacted the left side of the Ford. The impact severity to the Ford was minor and resulted in the deployment of the driver's seat-mounted side air bag and the actuation of the driver's seat belt pretensioner. The Missing Vehicle algorithm of the WinSmash program computed a total Delta V of 9 km/h (5.6 mph) based on the Ford's left side crush profile. The longitudinal and lateral components were -6 km/h (-3.6 mph) and 7 km/h (4.3 mph), respectively. The Ford was displaced to the right and initiated a counterclockwise rotation. The vehicle rotated approximately 90 degrees before it contacted a 5 cm (2 in) curb with its right rear tire (**Figure 4**). The contact along the curb edge measured 50 cm (19.6 in) in length by 12 cm (4.7 in) in width. The vehicle tripped on the curb and began a right side leading rollover. The Ford rolled one quarter turn before coming to rest on its right side facing east. The Saab was redirected in a westbound counterclockwise rotation after the impact. The vehicle departed the roadway at the southwest corner of the intersection and impacted a sign post with its front end.

Post Crash

The driver of the Ford exited the vehicle under his own power. Police reported that he did not sustain any injuries. He fled north from the crash site for an unknown distance until he was apprehended by the police. The driver of the Saab remained in her vehicle initially. She complained of pain in her chest, left knee, left toe, and head. She was evaluated on-scene by the fire department and was not transported. Both vehicles were towed from the scene due to damage. The Ford was later declared to be a total loss by the insurance company.



Figure 3. Northbound approach



Figure 4. Contact to curb during rotation (area of trip)

VEHICLE DATA - 2006 Ford Explorer

The 2006 Ford Explorer was identified by the Vehicle Identification Number (VIN): 1FMEU63E66Zxxxxxx. The vehicle was manufacturer in August 2005. The odometer read 58,480 km (36,339 miles). The Ford was a 4-door sport utility that was equipped with 4.0 liter, 6-cylinder engine, an automatic transmission, and rear wheel drive. The Ford was equipped with Ford's AdvanceTrac with Roll Stability Control (RSC). AdvanceTrac with RSC is an integrated system of four components that includes an anti-lock brake system (ABS), traction control, yaw control, and a vehicle roll motion sensor. The system utilizes a gyroscopic sensor to help monitor roll motion approximately 150 times per second. If it detects the possibility of a rollover, the system automatically engages AdvanceTrac. The Ford was equipped with Michelin Cross Terrain P23570R16 tires. The vehicle manufacturer's recommended cold pressure was 241 kPa (35 psi); the tire manufacturer's recommended maximum pressure was 303 kPa (44 psi).

The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	228 kPa (33 psi)	10 mm (13/32 in)	No	None
LR	207 kPa (30 psi)	5 mm (6/32 in)	Yes	Tire canted
RR	248 kPa (36 psi)	4 mm (5/32 in)	No	None
RF	241 kPa (35 psi)	6 mm (7/32 in)	No	None

The seating in the Ford was configured with front bucket seats with adjustable head restraints and a rear split-bench seat with folding backs. Both front seats were adjusted to the full-rearward track positions and the seat backs were slightly reclined.

Vehicle Damage

Exterior Damage

The Ford sustained moderate left side damage as a result of the impact with the Saab (**Figure 5**). The direct damage began 81 cm (31.8 in) aft of the front axle, and extended 195 cm (76.7 in) rearward along the left side plane. The maximum lateral crush was located between C3 and C4 and measured 14 cm (5.5 in). The Field L began 60 cm (23.6 in) aft of the front axle and extended 216 cm (85.0 in) rearward along the left side plane. The left rear tire was twisted in a clockwise direction and the left wheelbase was shortened by 16 cm (6.3 in).



Figure 5. Left side damage from impact with Saab

Six crush measurements were documented at the sill level as follows: C1= 0 cm, C2 = 6 cm (2.4 in), C3 = 13 cm (5.1 in), C4 = 9 cm (3.5 in), C5 = 6 cm (2.4 in), C6 = 0 cm. The Collision Deformation Classification (CDC) for the impact with the Saab was 10LZEW2.



Figure 6. Right side rollover damage

The Ford sustained minor right side damage as a result of the one quarter turn rollover (**Figure 6**). There was 358 cm (140.9 in) of direct contact longitudinally along the right side of the vehicle. The damage extended from the sill level near the rear bumper to the top of the B-pillar. Right side mirror had been knocked off. The maximum lateral crush was located at the right A-pillar and measured 2 cm (0.8 in). The CDC for the rollover was 00RDAO2.

Interior Damage

The Ford sustained minor interior damage as result of passenger compartment intrusion from the left side impact with the Saab. The left side B-pillar, sill, and door panel sustained lateral intrusion. The glazing disintegrated at the right front and right rear most windows. The windshield was fractured along the right A-pillar. All the doors remained closed and operational. There was a faint skin/oil transfer located near the center of the driver's side glass (**Figure 7**). The transfer measured 3 cm (1.2 in) by 2 cm (0.8 in).

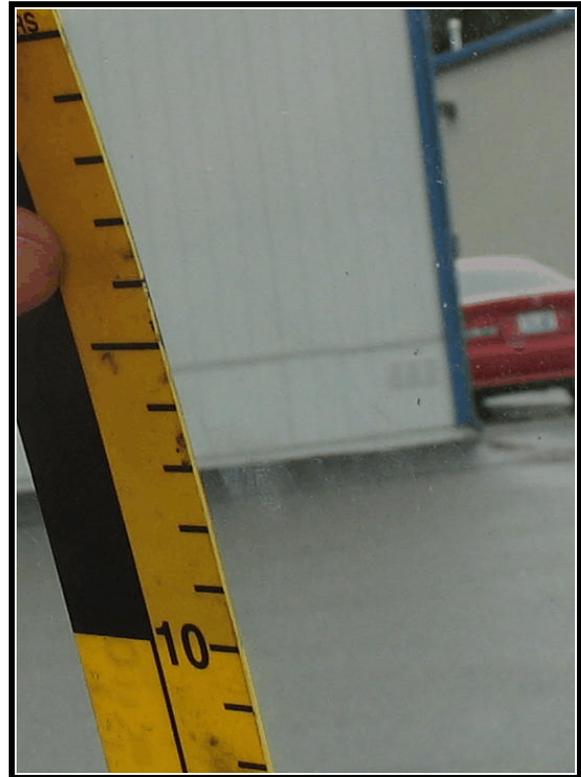


Figure 7. Contact to driver's side glass

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Front row left	B-pillar	2 cm (0.8 in)	Lateral
Second row left	Sill	3 cm (1.2 in)	Lateral
Second row left	Door panel	2 cm (0.8 in)	Lateral

Manual Restraints

The Ford was configured with 3-point manual lap and shoulder belts for each seating position. The front restraints were equipped with shoulder adjusters; the driver's was found in the full-down position and the front right passenger's was found in the full-up position. Both front safety belts were equipped with buckle pretensioners. The driver's seat belt pretensioner actuated during the impact with the Saab. The stalk compression measurement was 6 cm (2.4 in). There was no indication of loading to any of the safety belts.



Figure 8. Side air bag, inboard view

The rear outboard seats were configured with Lower Anchor and Tethers for Children (LATCH).

Supplemental Restraint System

The Ford was equipped with dual-stage frontal air bags and safety belt buckle pretensioners for the driver and front right passenger positions. The Ford was also equipped with seat-mounted side air bags. Side curtain air bags were an option but were not installed in this vehicle. The driver's seat-mounted side air bag deployed and the driver's seat belt pretensioner actuated. The seat-mounted side air bag deployed from a module installed within the seat back (**Figure 8-9**). The deployed air bag measured 28 cm (11.0 in) from the seat back forward and was 19 cm (7.4 in) in height. On the outboard side of the air bag there was a 2.5 cm (0.9 in) circular vent port. There were no indications of damage or occupant contact to the air bag.

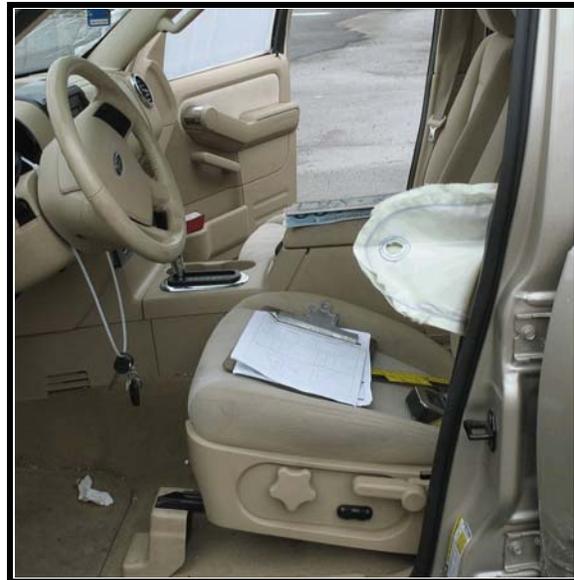


Figure 9. Seat-mounted side air bag, outboard view

Rollover Dynamics

The Ford had a three-star Rollover Resistance Rating (RRR) with a 20 to 30 percent chance of rollover and a Static Stability Factor (SSF) of 1.13. The SSF is a number that relates the height of the center of gravity of a vehicle to its width. As the Ford was struck in the left side, the vehicle began a counterclockwise rotation. The stability control system would not have provided any additional control due to the rapid lateral movement. As the vehicle continued to rotate, the right rear tire traveled over the curb. The vehicle's tire tripped on the curb and the vehicle began a right side leading rollover. The Ford rolled one-quarter turn and came to rest on its right side. The estimated roll distance from the trip point to final rest was 3 m (9.8 ft).

VEHICLE DATA - 2003 Saab 9-5

The 2003 Saab 9-5 was identified by the VIN: YS3EB49E133xxxxxx. The Saab was 4-door sedan that was equipped with a 2.3 liter, 4-cylinder engine, front wheel drive, and 4-wheel ABS. The vehicle sustained moderate front end damage from the impact with the side of the Ford and was towed from the scene. The vehicle was not available for inspection. The Missing Vehicle algorithm of the WinSmash program computed a total Delta V of 26 km/h (16.1 mph). The longitudinal and lateral components were -20 km/h (-12.4 mph) and -17 km/h (10.5 mph), respectively.

OCCUPANT DEMOGRAPHICS - 2006 Ford Explorer

	Driver
Age/Sex:	38/Male
Seated Position:	Front left
Seat Type:	Bucket
Height:	Unknown
Weight:	Unknown
Alcohol/Drug Involvement:	None
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt

OCCUPANT KINEMATICS

Driver Kinematics

The 38-year-old driver of the Ford was seated in an unknown posture and was wearing the 3-point manual lap and shoulder belt. At impact with the Saab, the driver's seat-mounted side air

bag deployed and the seat belt pretensioner actuated. The driver initiated a left lateral and slightly forward trajectory. He probably loaded the safety belt and contacted the deployed side air bag. As the vehicle rotated, he would have been displaced to the left. His head possibly contacted the side glass, but the contact found on the side glass might have been a post-crash artifact. As the vehicle tripped and began a right side leading rollover, the driver was displaced to the right. The driver was not injured. He exited the vehicle unassisted and then fled from the scene. He was later apprehended by the police.

Attachment 1. Scene Diagram

