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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN08037
LOCATION - MICHIGAN
VEHICLE - 2008 FORD ESCAPE XLT
CRASH DATE - September 2008

Submitted:

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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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16. *Abstract* This report covers an On-Site Rollover Investigation that involved a 2008 Ford Escape XLT, which rolled over on the roadway following a right side impact with a 1995 Toyota Camry. The focus of this investigation was the Ford's rollover. The Ford was occupied by a restrained 25-year-old female driver and a restrained 47-year-old female front right passenger. The driver was traveling northwest approaching a 4-leg urban intersection. She failed to stop for a stop sign and entered the intersection where the Ford's right quarter panel was impacted by the front of the Toyota. The Ford rotated clockwise approximately 110 degrees and rolled over, left side leading, one quarter turn and came to final rest on its left side. The Ford's front left and front right seat back-mounted side impact air bags and both inflatable side curtain air bags deployed during the crash. The Ford's driver accompanied the front right passenger in the ambulance to a hospital. The front right passenger sustained minor injuries and was treated and released from the emergency room. The driver was not injured.			
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IN08037

The focus of this on-site investigation was the on-roadway rollover of a 2008 Ford Escape XLT, which occurred following a right side plane impact by a 1995 Toyota Camry. This crash was brought to the National Highway Traffic Safety Administration's attention on October 17, 2008 by the sampling activities of the National Automotive Sampling System. This investigation was assigned on October 27, 2008. This crash involved a 2008 Ford Escape XLT (**Figure 1**) and a 1995 Toyota Camry LE. The crash occurred in September, 2008 at 1115 hours, in Michigan and was investigated by the local police department. This contractor inspected the crash scene and the Ford, on October 28 and 29, 2008. The driver was interviewed on November 4, 2008. The Toyota could not be located. This report is based on the police crash report, scene and vehicle inspections, driver interview, occupant medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2008 Ford Escape XLT

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Ford was traveling was a 2-lane, undivided, city street, that traversed in a northwest-southeast direction and intersected a 4-lane city street. The trafficway was straight and had one travel lane in each direction. Each travel lane was 3.8 m (12.5 ft) in width. There were no roadway pavement markings and the approach to the intersection was controlled by a stop sign. The Ford had a negative 2.9% grade on the approach to the intersection and a negative 1.7% grade in the area of impact and final rest. The trafficway on which the Toyota was traveling was a 4-lane, undivided, level, one-way, city street, traversing in a southwest direction. Each travel lane was nominally 3.8 m (12.5) in width. The roadway pavement markings consisted of broken white lane lanes. At the time of the crash, the light condition was daylight, the atmospheric condition was clear, and the roadway was dry bituminous. The speed limit was 40 km\h (25 mph) for both vehicles. There was light traffic at the time of the crash and the site was urban, residential. See the Crash Diagram on page 8 of this report.

Figure 2: The Ford's approach to intersection and the area of impact; arrow shows the approach of the Toyota

Pre-Crash: The Ford was occupied by a restrained 25-year-old female driver and a restrained 47-year-old female front right passenger. The driver was traveling northwest approaching the 4-leg intersection (**Figure 2**). The driver stated during the SCI interview that she was intending to continue northwest. She saw the stop sign but did not stop and continued into the intersection. She took no actions to avoid the

crash. The Toyota's restrained 52-year-old female driver was traveling southwest in the second lane from the right and was approaching the same intersection (**Figure 3**). The crash occurred within the intersection.

Figure 3: The Toyota's approach to intersection and impact area; arrow shows the approach of the Ford

Crash: The front of the Toyota impacted the Ford's right side plane (**Figure 4**, event 1). The impact redirected the Ford in a westerly direction and caused it to rotate clockwise approximately 110 degrees. The vehicle was equipped with Electronic Stability Control (ESC) but the impact induced rotation caused the vehicle to roll over (event 2) with the left side leading one quarter turn (**Figure 5**). The vehicle came to final rest on it's left side on the southeast lane in the northwest quadrant of the intersection. Both front seat back-mounted side impact air bags and inflatable side curtain air bags deployed during the crash.

Figure 4: Right side impact area outlined in yellow tape

Post-Crash: The police, emergency medical, and rescue personnel responded to the scene three minutes after it was reported. Passers-by pushed the Ford back onto its wheels and both passengers exited from the vehicle. The Ford's driver and front right passenger were transported by ambulance to a hospital. Both vehicles were towed due to damage.

Figure 5: Left side damage from the rollover

ROLLOVER DISCUSSION

The Ford's rollover mitigation features consisted of ESC and inflatable side curtain air bags with rollover sensing. The NHTSA has given the vehicle a three star rollover rating on a five star scale and a Static Stability Factor (SSF) of 1.13[1]. A three star rating indicates that the vehicle has a 20%-30% chance of a rollover when involved in a single vehicle crash. The specific chance of rollover for this vehicle model was given as 23%. The SSF is a calculation based on the vehicle's track width and height of its center of gravity. The result of the calculation is a measure of a vehicle's resistence to rollover. A higher SSF indicates a more stable vehicle. The

[1] www.safercar.gov, 5/29/09

majority of passenger vehicles have an SSF of 1.30 to 1.50[2]. This vehicle model also did not tip-up during the dynamic steering maneuver test in which the test vehicle is put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at between 56 km/h-80km/h (35-50 mph).

In this crash, the front of the Toyota impacted the Ford in the right rear wheel and quarter panel, which caused the Ford to rotate clockwise approximately 110 degrees. The opposing force on the left side wheels continued to build as the vehicle rotated. The force on the left side wheels was sufficient to induce a roll moment, and the vehicle rolled over, left side leading, one quarter turn onto its left side and came to final rest. Based on the police crash schematic and the crash scene inspection, it was estimated that the vehicle traversed a distance of approximately 3 m (9.8 ft) during the rollover.

CASE VEHICLE

The 2008 Ford Escape XLT was a front wheel drive, 4-door, multi-purpose vehicle (VIN: 1FMCU03Z68K------) manufactured in April of 2007. The vehicle was equipped with a 2.3L, I-4 engine, automatic transmission, 4-wheel anti-lock brakes with electronic brake force distribution, traction control, and ESC. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder belts, dual stage driver and front right passenger frontal air bags, seat back-mounted side impact air bags, and inflatable side curtain air bags with rollover sensing, which extended to the second row. The second row was equipped with a bench seat and folding back, adjustable head restraints, and lap-and-shoulder belts. The Ford was also equipped with Lower Anchors and Tethers for Children (LATCH) at the second row outboard seating positions. The mileage at the time of the inspection could not be determined because the vehicle was equipped with an electronic odometer and was without power. The driver estimated the vehicle's mileage as approximately 4,827 kilometers (3,000 miles). The vehicle's specified wheelbase was 262 cm (103.2 in).

CASE VEHICLE DAMAGE

Exterior Damage: The damage from the impact with the Toyota involved the Ford's right rear side plane. The direct damage began 57 cm (22.4 in) forward of the right rear axle and extended 111 cm (43.7 in) rearward along the right side (**Figure 4**). There was direct damage to the lower back portion of the right rear door and quarter panel as a result of this impact, but there was no sheet metal crush because the front of the Toyota primarily engaged the right rear wheel. There were only scuffs on the sheet metal of the door and quarter panel, and the right rear wheel was negatively cambered approximately 10 degrees. The right and left side wheelbases were unchanged. Induced damage involved the left quarter panel.

The damage from the rollover involved the entire left side plane (**Figure 5**), beginning 39 cm (15.3 inches) forward of the left front axle and extending 370 cm (145.7 in) rearward to the

[2] "Trends in the Static Stability Factor of Passenger Cars, Light Trucks, and Vans", NHTSA Technical Report, DOT HS 809 868, June 2005

back bumper. The vehicle sustained no vertical and lateral crush on the roof structure and there was no induced damage.

Damage Classification: The Collision Deformation Classifications were **02-RZEW-1** (**70** degrees) for the impact with the Toyota and **00-LDAO-3** for the rollover. The WinSMASH program could not be used to calculate the Ford's Delta V for the right side impact because the Toyota was not inspected and the Ford sustained no residual crush as a result of the impact. The crash severity for the right side impact was estimated to be minor. The severity of the rollover damage was minor since there were only surface scratching and dents on the vehicle's left side.

The vehicle manufacturer's recommended tire size was P235/70R16 and the Ford 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 Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	207	30	221	32	6	8	Abraded sidewall	No	No
LR	214	31	221	32	8	10	Abraded sidewall	No	No
RR	214	31	221	32	7	9	None	No	No
RF	207	30	221	32	7	9	None	No	No

Vehicle Interior: The inspection of the Ford's interior revealed scuff marks on the inflatable left side curtain air bag (**Figure 6**) due to loading by the driver's face. A scuff mark was also present on the back of the driver's seat belt buckle, probably due to loading by the driver's right hip. A scuff mark was located on the glove box door (**Figure 7**), due to loading by the front right passenger's right knee. There was no deformation on the steering wheel rim or steering column, and the vehicle sustained no passenger compartment intrusions. The right rear door and tailgate were jammed shut while the remaining doors remained closed and operational. The windshield glazing was in place and cracked due to impact forces and the second left rear glazing was disintegrated due to impact force during the rollover. The pre-crash status of all the window glazing was closed or fixed with the exception of the sunroof, which the driver stated was partially open at the time of the crash.

Figure 6: Yellow tape shows location of a scuff mark on the left side curtain air bag from driver contact

The Ford was equipped with a manufacturer 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 and seat belt buckle-mounted pretensioners and a front right passenger weight sensor. Neither of the frontal air bags deployed in this crash. The vehicle was also equipped with front seat back-mounted side impact air bags and roof side rail-mounted inflatable side curtain air bags with rollover sensing, all of which deployed in this crash.

Figure 7: Glove box contact by front right passenger

The driver's seat back-mounted side impact air bag was mounted within the left side of the seat back. The air bag was 26 cm (10.2 in) in height as measured at the seat back and 27 cm (10.6 in) in width (**Figure 8**). There was what appeared to be one vent port at the front of the air bag that was 2 cm (0.8 in) in width. There was no damage and no discernable occupant contacts on the air bag.

Figure 8: Driver's seat back-mounted side impact air bag

The driver's inflatable side curtain air bag was located within the left roof side rail and extended from the top of the A-pillar to the C-pillar (**Figure 6** and **Figure 9**). The inflatable side curtain air bag was 148 cm (58.3 in) in width and 42 cm (16.5 in) in height. The scuff mark (**Figure 6**) associated with the driver's face contacting the air bag was located 40 cm (15.7 in) rear of the front edge of the air bag and 15 cm (5.9 in) from the top. At the belt line, the gap between the front of the air bag and the A-pillar was 25 cm (9.8 in). The gap at the top of the air bag was 9 cm (3.5 in).

Figure 9: Entire left inflatable side curtain air bag

The front right seat back-mounted side impact air bag and right inflatable side curtain air bag were the same dimensions as mentioned above. There was no damage to either air bag and no discernable evidence of occupant contact.

The Ford was equipped with lap-and-shoulder belts for all five front and second row 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 down 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 located in the full down position. The driver and front right passenger seat belts were equipped with buckle-mounted and retractor-mounted pretensioners, which did not actuate in this crash.

Inspection of the driver's seat belt assembly revealed light load abrasions on the latch plate belt guide (**Figure 10**), but none on the belt webbing or D-ring. Also, the retractor was jammed and the belt webbing would not retract. The length of belt that was extended out of the retractor was 97 cm (38.1 in) as measured from the stop button to the D-ring. There was no reduction in the length of the buckle-stalk, which indicated that the buckle-mounted pretensioner did not actuate during the crash. The seat belt loading evidence and condition of the retractor supported the driver's interview statement that she was restrained by the lap-and-shoulder belt.

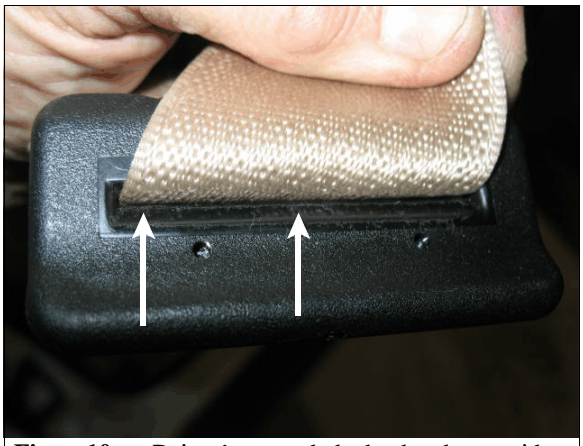


Figure10: Driver's seat belt latch plate guide; arrows show light load abrasions on the plastic

Inspection of the front right passenger's seat belt assembly revealed no evidence of loading. The belt webbing would spool freely in and out of the retractor. There was no reduction in the length of the buckle stalk, which indicated that the buckle-mounted pretensioner did not actuate during the crash. The driver stated that the front right passenger was restrained by the lap-and-shoulder belt at the time of the crash.

CASE VEHICLE DRIVER KINEMATICS

The Ford's driver [25-year-old, female; 152 cm and 64 kg (60 in and 140 lbs)] was seated in an upright posture with her back against the seat back, right foot on the accelerator pedal, and left foot on the floor. Her left hand was on her lap and her right hand was on the steering wheel. The seat track was adjusted to between the full forward and middle track position and the seat back was slightly reclined. The tilt steering column was located in the full down position. The driver was wearing glasses at the time of the crash.

The Ford's impact with the Toyota initially displaced the driver forward and to the right, opposite the 2 o'clock direction of force. As the vehicle rotated clockwise and rolled over on its left side, the driver was redirected to the left and toward the roof, within the seat belt. The driver remained restrained in her seat and exited the vehicle through the left front door after passers-by tipped the vehicle back onto its wheels. The driver accompanied the front right passenger in the ambulance to a hospital.

The police crash report indicated that the driver sustained a B (non-incapacitating) injury; however, she refused treatment at the hospital emergency room. She reported no injuries during her interview and missed no work days due to the crash.

CASE VEHICLE FRONT ROW RIGHT PASSENGER KINEMATICS

The Ford's front row right passenger [47-year-old, female; 165 cm and 113 kg (65 in, 250 lbs)] was seated in an upright posture with her back against the seat back. The seat track was adjusted to between the middle and rear most positions [i.e., 18 cm (7.1 in) rear of the full forward position] and the seat back was slightly reclined. The passenger was not wearing glasses.

The Ford's impact with the Toyota initially displaced the front right passenger forward and to the right, opposite the Ford's 2 o'clock direction of force, and her right knee impacted and scuffed the glove box door. She was redirected to the left and toward the roof within her seat belt as the Ford rolled over onto its left side. She remained restrained in her seat and exited the vehicle through the right front door after passers-by tipped the vehicle back onto its wheels.

CASE VEHICLE FRONT ROW RIGHT PASSENGER INJURIES

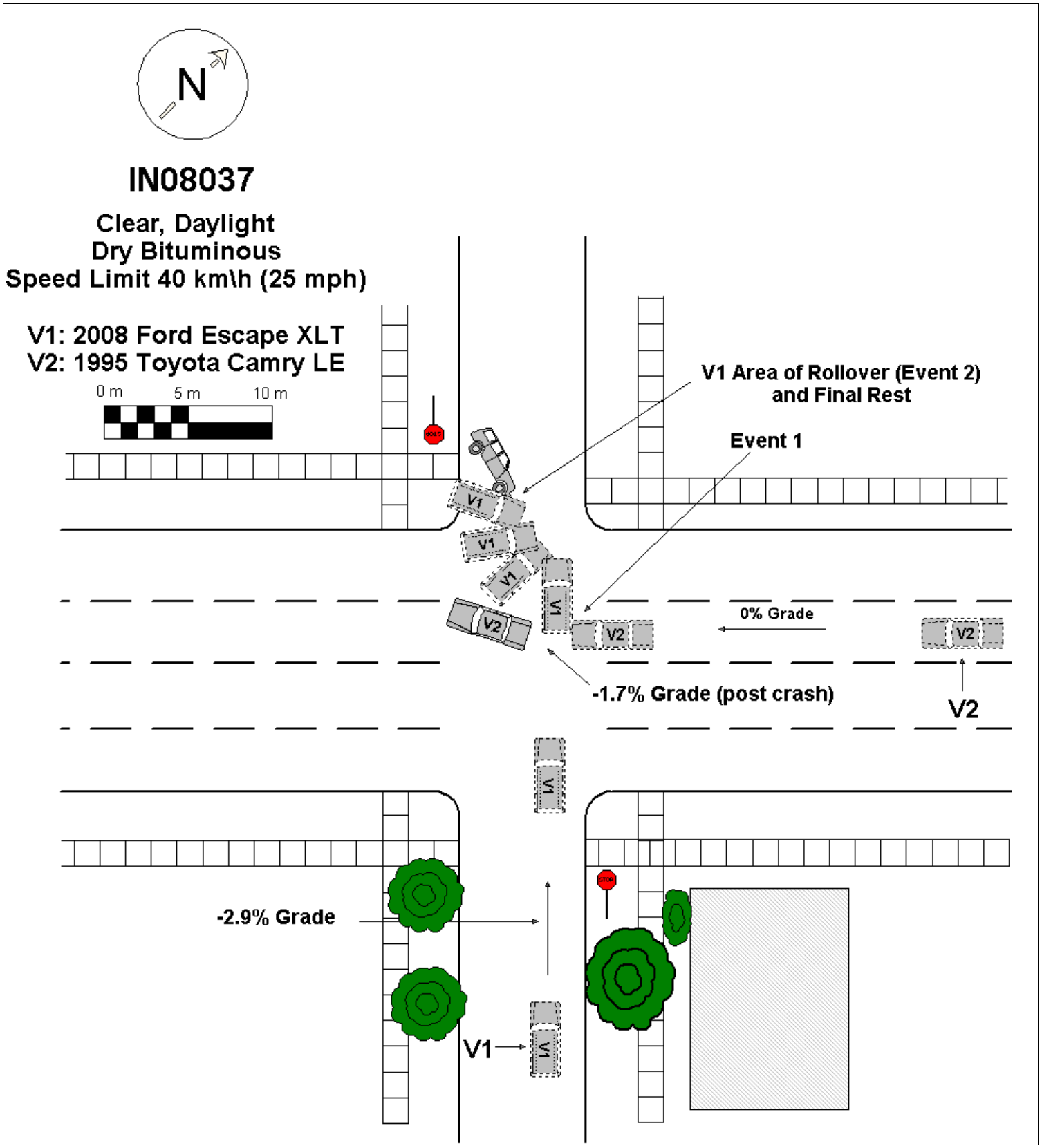
The front row right passenger sustained minor injuries and was transported by ambulance to a hospital where she was treated and released from the emergency room. The table below shows the passenger's injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with questionable loss of consciousness and no recollection of event	moderate 160410.2,0	Unknown injury source	Unknown	Emergency room records
2	Strain, acute, cervical with loss of lordosis on CT scan and tenderness	minor 640278.1,6	Non-contact injury source, impact force	Probable	Emergency room records

OTHER VEHICLE

The 1995 Toyota Camry LE was a front-wheel drive, 4-door sedan (VIN: 4T1SK12E5SU------) equipped with driver and front right passenger air bags which deployed in this crash.

Other Vehicle's Occupants: The driver of the Toyota (52-year-old, female) sustained a police reported B (non-incapacitating) injury. She was not transported to a medical facility.


N
IN08037
Clear, Daylight
Dry Bituminous
Speed Limit 40 km\h (25 mph)
V1: 2008 Ford Escape XLT
V2: 1995 Toyota Camry LE
0 m
5 m
10 m
V1 Area of Rollover (Event 2)
and Final Rest
Event 1
V1
V2
0% Grade
-1.7% Grade (post crash)
-2.9% Grade