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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN10007

LOCATION - TEXAS

VEHICLE - 2008 FORD ESCAPE XLT

CRASH DATE - December 2009

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. <i>Abstract</i> This on-site investigation focused on the side impact air bag system of a 2008 Ford Escape XLT and the sources of the driver's injuries. The restrained 57-year-old female driver of the Escape was traveling south through a signalized 4-leg intersection and was decelerating to turn left. A 2008 Chevrolet Silverado was traveling north through the intersection and was impacted on the right side plane by the front plane of a westbound 2000 Ford Taurus (event 1). The Taurus continued west and its front plane impacted the left side plane of the Escape (event 2). The force direction on the Escape was within the 10 o'clock sector and the impact force was sufficient to trigger deployments of the left front seat-mounted side impact air bag and the left rollover/side impact inflatable curtain (IC) air bag. The impact caused the Escape to roll over onto its right side (event 3). The Chevrolet rotated clockwise and departed the roadway at the northeast corner of the intersection where the front plane impacted a traffic signal pole (event 4). The driver of the Escape was transported by ambulance to a hospital and was hospitalized for one day. She sustained a cervical strain from loading her head on the left IC air bag and a transient monoparesis of the left leg from contacting the left front door arm rest. | | | | | |
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CRASH DIAGRAM 9

This on-site investigation focused on the side impact air bag system of a 2008 Ford Escape XLT (**Figure 1**) and the sources of the driver's injuries. This crash was brought to our attention by the National Highway Traffic Safety Administration (NHTSA) on January 29, 2010, through the sampling activities of the National Automotive Sampling System-General Estimates System (NASS-GES). This investigation was assigned on March 5, 2010. The crash involved the Escape, a 2000 Ford Taurus SE, and a 2008 Chevrolet C1500 Silverado crew cab pickup truck. The crash occurred in December, 2009, at 0852 hours, in Texas and was investigated by the city police department. The Escape was inspected on March 8, 2010. The crash scene inspection and an interview with the driver of the Escape were completed on March 9, 2010. The Taurus could not be located and was not inspected. This report is based on the police crash report, vehicle and crash scene inspections, driver interview, driver medical records, occupant kinematic principles, and evaluation of the evidence.



Figure 1: Left side view of the damaged 2008 Ford Escape

CRASH CIRCUMSTANCES

Crash Environment: The trafficway that the Escape and Chevrolet were traveling on was a 2-lane, undivided city street that traversed in a north-south direction. Both vehicles were approaching a 4-leg intersection that was controlled by 3-phase traffic signals. The traffic signal was on the green phase for both vehicles. The roadway was straight and level and had two bituminous travel lanes bordered by concrete curbs. The northbound travel lane was 4.9 m (16.1 ft) in width, while the southbound travel lane was 4.6 m (15.1 ft) in width. The trafficway that the Taurus was traveling on was a 7-lane, divided, city street, traversing in an east-west direction. The Taurus was approaching the same 4-leg intersection. The traffic signal was on the red phase. On the east leg of the intersection the bituminous roadway had 3 westbound through lanes, a left turn lane, a raised concrete median, and three eastbound through lanes. Each through lane was approximately 3.0 m (9.8 ft) in width, while the left turn lane was 3.6 m (11.8 ft) in width. The median was 1.3 m (4.3 ft) in width. The roadway was straight and had a positive 5% grade. The speed limit was 48 km/h (30 mph) for the Escape and Chevrolet and 56 km/h (35 mph) for the Taurus. The crash occurred during daylight hours under clear and dry conditions. The traffic density was heavy and the site of the crash was residential. The Crash Diagram is on page 8 of this report.

Pre-Crash: The Escape was occupied by a restrained 57-year-old female driver. The vehicle was traveling south into the intersection (**Figure 2**) and the driver was intending to turn left and travel east. The restrained 83-year-old male driver of the Taurus was traveling west in the second lane from the right (**Figure 3**) and intended to continue straight through the intersection. The restrained 45-year-old male driver of the Chevrolet was traveling north and intended to continue

straight through the intersection. As the Chevrolet was traveling through the intersection, the driver of the Escape was decelerating to initiate a left turn. The driver of the Escape did not take any avoidance actions prior to the crash.

Crash: The Taurus entered the intersection and the front plane impacted the right rear corner of the Chevrolet (event 1). The Taurus continued west and the front plane impacted the left side plane of the Escape (**Figure 4**, event 2). The direction of force on the Escape was within the 10 o'clock sector. The impact force was sufficient to trigger deployments of the Escape's left front seat-mounted side impact air bag and rollover/side impact inflatable curtain (IC) air bag. As a result of this impact, the Escape rolled over onto its right side plane (**Figures 5**, event 3). The Escapes right IC air bag also deployed during the crash. Following the impact with the Taurus, the Chevrolet rotated clockwise and traveled northeast. It departed the roadway at the northeast corner of the intersection and the front plane impacted a traffic signal pole (event 4). At final rest, the Escape was on its right side plane heading south and the Taurus was heading west. The Chevrolet came to final rest heading northeast with its front plane against the traffic signal pole.

Post-Crash: The police were notified of the crash at 0914 hours and arrived at the crash scene at 1010 hours. Passers-by rolled the Escape back onto its wheels prior to the arrival of the emergency responders. Rescue personnel mechanically forced open the driver's door and assisted the driver out of the vehicle. The driver was transported by ambulance to a hospital as were the occupants of the other vehicles. All the vehicles were towed from the crash scene due to damage.



Figure 2: Approach of the Escape to the intersection; arrow on left shows approach of the Taurus; arrow on right shows approach of the Chevrolet



Figure 3: Approach of the Taurus; arrow on right shows the approach of the Escape; arrow on left shows the approach of the Chevrolet



Figure 4: Damage on the left side plane of the Escape from the impact by the front plane of the Taurus

The Escape’s rollover mitigation features consisted of rollover sensing and Electronic Stability Control (ESC). The rollover sensor detects an impending overturn condition of the vehicle and triggers deployment of the IC air bags. The NHTSA has given the vehicle a three star rollover rating on a five star scale and a Static Stability Factor of 1.13¹. 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 a rollover for this vehicle model was given as 23%. The Static Stability Factor (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 resistance to a rollover. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50². The NHTSA test vehicle also did not tip-up during the dynamic steering maneuver test in which the test vehicle was 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).



Figure 5: Intermittent scratches on the right side plane of the Escape from the rollover

The impact with the Taurus caused the Escape to roll over 1 quarter turn onto its right side. It was estimated that the vehicle traversed 2 m (6.6 ft) during the rollover.

CASE VEHICLE

The 2008 Ford Escape XLT was a front-wheel drive, 4-door, sport utility vehicle (VIN: 1FMCU03Z28K-----) that was manufactured in March 2008. It was equipped with a 2.3-liter, I-4 engine, 4-speed automatic transmission, 4-wheel anti-lock disc brakes with electronic brake force distribution, traction control, and ESC. The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder safety belts, dual stage driver and front right passenger frontal air bags, seat-mounted side impact air bags, and rollover/side impact IC air bags that provided protection for the front and second rows. The second row was equipped with a split bench with folding backs, adjustable head restraints, lap-and-shoulder safety belts, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle was without power and the mileage could not be determined at the time of the inspection. During the SCI interview, the driver estimated that the vehicle’s mileage was approximately 38,000 miles (61,155 kilometers). The specified wheelbase was 262 cm (103.1 in).

¹ www.safercar.gov, 03/23/10

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

Exterior Damage: The Escape sustained left side plane damage during the impact with the Taurus. The direct damage involved the lower left A-pillar, the left front door, left B-pillar, and the left rear door. The direct damage began 63 cm (24.8 in) forward of the left rear axle and extended 137 cm (53.9 in) forward along the left side. The crush measurements were taken at the lower door level and the residual maximum crush was 20 cm (7.9 in) occurring at C₆. The vehicle's sill height was 43 cm (16.9 in) and the height of the maximum crush was 51 cm (20.1 in). The Door Sill Differential was 3 cm (1.2 in). The induced damage involved the left fender and left rear door. The table below presents the crush profile for the left side plane impact.

| Units | Event | Direct Damage | | Field L | C ₁ | C ₂ | C ₃ | C ₄ | C ₅ | C ₆ | Direct | Field L |
|-------|-------|---------------|-----------|---------|----------------|----------------|----------------|----------------|----------------|----------------|--------|---------|
| | | Width CDC | Max Crush | | | | | | | | ±D | ±D |
| cm | 1 | 137 | 20 | 183 | 0 | 4 | 13 | 13 | 18 | 20 | 4 | -19 |
| in | | 53.9 | 7.9 | 72.0 | 0.0 | 1.6 | 5.1 | 5.1 | 7.1 | 7.9 | 1.6 | -7.5 |

The Escape sustained right side plane damage during the rollover. The direct damage began 259 cm (102 in) forward of the right rear axle and extended rearward 318 cm (125.2 in). The direct damage consisted of scratches and extended vertically in intermittent areas from the roof side rail to the sill. There was no lateral crush to the passenger compartment.

Damage Classification: The Collision Deformation Classifications (CDC) were 10LPEW3 (290 degrees) for the left side plane impact and 00RDAO2 for the rollover. The Missing Vehicle algorithm of the WinSMASH program calculated the Escape's total Delta V as 24 km/h (14.9 mph). The longitudinal and lateral velocity changes were -8.2 km/h (-5.1 mph) and 22.6 km/h (14 mph), respectively. Based on the damage sustained by the Escape, the results appeared reasonable. The severity of the damage from the rollover was minor.

The vehicle manufacturer's recommended tire size for the Escape was P235/70R16. The manufacturer's recommended cold tire pressure was 221 kpa (32 psi). The tire information for the Escape is not known since the vehicle's wheels had been sold for salvage.

Vehicle Interior: The inspection of the interior of the Escape revealed no discernable evidence of occupant contact. There was no damage to the steering wheel or compression of the energy absorbing steering column.

The vehicle's left front and left rear doors were jammed shut as a result of the left side plane impact. The right front and right rear doors remained closed and operational. Prior to the crash, all the window glazings were either closed for operable windows or fixed for the others. The windshield was in place and cracked from impact forces. The right front window glazing was disintegrated during the rollover. The remaining glazings were undamaged.

The vehicle's passenger compartment sustained six intrusions, which resulted from the left side plane impact. The most severe intrusions into the driver's space involved the lower left A-pillar, the side panel forward of the A-pillar, and the forward lower quadrant of the left front door. Each of these components intruded 12 cm (4.7 in) laterally.

AUTOMATIC RESTRAINT SYSTEM

The Escape was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front passenger air bags, driver seat position sensor, seat belt usage sensors, retractor and seat belt buckle-mounted pretensioners and a front passenger weight sensor. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, a frontal satellite air bag impact sensor was located on the center radiator support. 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. Neither frontal air bag deployed in this crash.

The Escape was also equipped with rollover/side impact ICs and front seat-mounted side impact air bags. The vehicle's side impact sensors were located within the lower B- and C-pillars. Both IC air bags and the driver's seat-mounted side impact air bag deployed during the crash.

The left IC air bag was located along the roof side rail inside the headliner (**Figure 6**) and extended from the top of the A-pillar to the C-pillar. The deployed IC air bag was 145 cm (57.1 in) in width and 42 cm (16.5 inches) in height. It was attached at the lower A-pillar by a 43 cm (16.9 in) rope tether. The IC air bag extended 11 cm (4.3 in) below the beltline. The gap between the bottom of IC air bag and the A-pillar was 43 cm (16.9 in). There was no visible tether at the C-pillar. Inspection of the IC air bag revealed no discernable evidence of occupant contact and no damage. The right IC air bag was of the same dimensions and features.

The driver's seat-mounted side impact air bag was located in the outboard side of the seat back and deployed through a tear seam (**Figure 7**). The deployed air bag (**Figure 8**) was 22 cm (8.7 in) in height at the seat back and 30 cm (11.8 in) in width. There was what appeared to be a vent port on the front edge of the air bag. Inspection of the deployed air bag revealed no damage and no discernable evidence of occupant



Figure 6: The Escape's left side IC air bag and seat-mounted side impact air bag



Figure 7: The Escape's left front seat back-mounted side impact deployed through a tear seam

contact. The air bag had several areas of dirt or grease smears on it, probably from post-crash handling.

MANUAL RESTRAINT SYSTEM

The Escape was equipped with lap-and-shoulder safety belts in all the seating positions. The driver’s safety 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 passenger safety belt was similar but had an ELR/Automatic Locking Retractor (ALR). The driver and front passenger safety belts were equipped with retractor-mounted and buckle-mounted pretensioners. The second row lap-and-shoulder safety belts were similar to the front passenger safety belt but had fixed upper anchors and were not equipped with pretensioners.



Figure 9: The deployed left front seat-mounted side impact air bag

Inspection of the driver’s safety belt assembly revealed extensive historical usage scratches on the latch plate. The buckle stalk was reduced in length 6 cm (2.4 in) from pretensioner actuation. The retractor functioned normally. There were a few light load abrasions on the latch plate belt guide. This evidence supported the driver’s interview statement that she was restrained at the time of the crash. The remaining seat positions were unoccupied.

CASE VEHICLE DRIVER KINEMATICS

Based on the SCI interview, the driver of the Escape [57-year-old female, 175 cm (69 in) and 86 kg (190 lb)] was seated in an upright posture with her back against the seat back and both hands on the steering wheel at the 3 and 9 o’clock positions. The seat track was adjusted to the middle position. The seat back was reclined 22 degrees and the distance from the top of the seat back to the top of head restraint was 26 cm (7.9 in). The tilt steering column was located in the center position. The driver was not wearing glasses or contact lenses at the time of the crash.

The impact on the left side plane of the Escape displaced the driver to the left and slightly forward opposite the 10 o’clock direction of force and she loaded the safety belt. While there was no discernable evidence of occupant contact on the seat-mounted side impact air bag or left IC air bag, the driver’s left shoulder probably loaded the deployed seat-mounted side impact air bag and her head probably loaded the left IC air bag. Her left side also probably contacted the left front door. The driver was redirected to the right within the safety belt as the vehicle rolled over onto its right side. The driver sustained a transient monoparesis of the left leg from contacting the left front door arm rest, which probably aggravated an old central disk herniation at L₄-L₅. She sustained a cervical strain from loading her head on the left IC air bag. The driver also sustained a contusion on the right chest and left lower leg from loading the safety belt and contacting the left

front door, respectively. Passers-by rolled the vehicle back onto its wheels and rescue personnel mechanically forced open the driver's door and assisted the driver out of the vehicle.

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a hospital. She was hospitalized for one day and made one follow-up visit to an orthopedic doctor for treatment of neck and back pain. The driver was not working at the time of the crash. The table below presents the driver'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 | Injury disc with transient monoparesis ³ of left leg | moderate 650699.2,8 | Left front hardware/armrest, rear upper quadrant | Possible | Hospitalization records |
| 2 | Strain, acute, cervical with midline and paraspinous cervical tenderness | minor 640278.1,6 | Air bag, driver's side inflatable curtain | Probable | Emergency room records |
| 3 | Contusion of right chest wall with tenderness to palpation, not further specified | minor 490402.1,1 | Torso portion of safety belt system | Probable | Emergency room records |
| 4 | Contusion lateral (on side of) left lower leg, just below knee, not further specified | minor 890402.1,2 | Left front door panel, forward lower quadrant | Probable | Interviewee (same person) |

FIRST OTHER VEHICLE

The 2000 Ford Taurus was a front wheel drive, 5-passenger, 4-door sedan (VIN: 1FAFP5323YA-----) equipped with a 3.0-liter, V-6 engine, an automatic transmission, and redesigned frontal air bags. The Taurus was not inspected since it could not be located.

The Missing Vehicle algorithm of the WinSMASH program calculated the total Delta V for the Taurus as 24 km/h (14.9 mph). The longitudinal and lateral velocity changes were -22.6 km/h (-14.0 mph) and -8.2 km/h (5.1 mph), respectively. The results were based only on the damage on the Escape and should be considered a borderline reconstruction.

³ The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:

monoparesis (mon"o-pa-re'sis): paresis of a single limb.

paresis (pe-re'sis): slight or incomplete paralysis.

The patient could not move her left leg and had numbness all the way up to her left hip during her evaluation in the emergency department. The patient's MRI revealed a central disk herniation which appears old at L₄-L₅. There is also foraminal narrowing, worse on the left, at L₄-L₅ and foraminal narrowing on the left at L₅-S₁. There was no evidence of hematoma, direct trauma that could be seen, fractures, or ligamentous injury. As a result of this condition, the patient was hospitalized overnight for observation.

Other Vehicle's Driver: The police crash report indicated that the driver of the Taurus (83-year-old male) was restrained by the lap-and-shoulder safety belt and his frontal air bag did not deploy. The front passenger (5-year-old, male) was restrained by the lap-and-shoulder safety belt and his frontal air bag deployed. The driver sustained a B-injury and was transported by ambulance to a medical facility. The front passenger sustained a C-injury and was transported by ambulance to a medical facility.

SECOND OTHER VEHICLE

The 2008 Chevrolet Silverado 1500 was a rear wheel drive, 6-passenger, short bed, 4-door crew cab pickup truck (VIN: 2GCEC13C781-----) equipped with a 4.8-liter, V-8 engine, a 4-speed automatic transmission, 4-wheel anti-lock disc brakes, electronic stability control and dual stage driver and front right passenger frontal air bags. 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.

Other Vehicle's Driver: The driver of the Chevrolet (45-year-old male), the front passenger (12-year-old male), and the second row right passenger (13-year-old male) were all restrained by a lap-and-shoulder safety belt. The driver and front passenger sustained C-injuries and were transported by ambulance to a medical facility. The second row right passenger sustained a B-injury and was transported by ambulance to a hospital.

