

On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS09031
2008 Ford Escape
Washington
September 2009

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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 <p>This on-site investigation focused on the dynamics of a 2008 Ford Escape involved in a two-vehicle crash and subsequent rollover. The crash occurred in September 2009 in the state of Washington. The Ford was being driven by a 30-year-old female and an 8-year-old female occupied the front right seat. The other vehicle was a 2000 Honda Civic that was being driven by an 18-year-old female; a 16-year-old female occupied the front right seat. The crash site was a four-leg intersection that was controlled by posted stop signs for northbound and southbound traffic.</p> <p>The Ford was traveling westbound and entered the intersection. The Honda was traveling northbound, entered the intersection, and the front end of the Honda impacted the left side of the Ford. The Ford initiated a counterclockwise rotation, overturned, and rolled two quarter-turns. The Ford came to rest on its roof in the west leg of the intersection and the Honda came to rest within the intersection.</p> <p>The Ford was equipped with combination rollover/side impact inflatable curtain (IC) air bags and during the crash the left and right IC air bags deployed. The occupants of the Ford sustained minor injuries and were transported to a local hospital. The Ford was towed due to damage and later declared a total loss by the insurance company.</p>				
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Background

This on-site investigation focused on the dynamics of a 2008 Ford Escape (**Figure 1**) involved in a two-vehicle crash and subsequent rollover. The crash occurred in September 2009 in the state of Washington. The Ford was being driven by a 30-year-old female, and an 8-year-old female occupied the front row right seat. The other vehicle was a 2000 Honda Civic that was being driven by an 18-year-old female, and a 16-year-old female occupied the front right seat. The crash site was a four-leg intersection.



Figure 1. Subject vehicle, 2008 Ford Escape

The Ford was traveling westbound and entered the intersection. The Honda was traveling northbound, entered the intersection, and the front end of the Honda impacted the left side of the Ford. The Ford initiated a counterclockwise rotation, overturned, and rolled two quarter-turns. The Ford came to rest on its roof in the west leg of the intersection and the Honda came to rest within the intersection.

The Ford was equipped with combination rollover/side impact inflatable curtain (IC) air bags and during the crash the left and right IC air bags deployed. The occupants of the Ford sustained minor injuries and were transported to a local hospital. The Ford was towed due to damage and later declared a total loss by the insurance company. Neither occupant in the Honda was injured. The Honda was driven from the scene; it was later declared a total loss by the insurance company and sold to a private party on October 21, 2009. The Honda was not inspected.

This on-site rollover investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) during a review of National Automotive Sampling System (NASS) General Estimates System (GES) police reports. On October 23, 2009, DSI was forwarded the police report with instructions to obtain cooperation. DSI obtained permission to inspect the subject vehicle and the case was assigned on October 28, 2009. The vehicle was inspected at an insurance auction facility on November 3, 2009. During the inspection the Ford's Event Data Recorder (EDR) was removed from the vehicle; it was then sent to the NHTSA and imaged.

Summary

Crash Site

The crash site was a four-leg intersection consisting of an undivided east/west roadway and an undivided north/south roadway. (**Figure 2**). The east/west roadway was configured with one lane for each direction; each lane measured 6.5 m (21.2 ft) in width. The lanes were separated by a dashed yellow painted stripe. The roadway was bordered on each side by raised concrete curbs

measuring 13.0 cm (5.1 in) in height and curb parking was allowed on both sides. The roadside areas included paved sidewalks, grass lawns and a mix of residential and commercial buildings. The roadway composition was concrete and the alignment was straight. The profile of the westbound lane had a negative slope approaching the intersection and including the area of impact. At 61.0 m (200.0 ft) east of the point of impact (POI) the profile was -2.1 percent; at 30.5 m (100.0 ft) east of the POI the profile was -1.9 percent; and at the POI the profile was -0.7 percent.



Figure 2. Crash site, looking west

The north/south roadway was configured with one lane for each direction and each lane measured 3.8 m (12.5 ft) in width. The travel lanes were not delineated. The roadway was bordered on each side by raised concrete curbs measuring 13.0 cm (5.1 in) in height and curb parking was allowed on both sides. The roadside included paved sidewalks. The roadway composition was concrete and the alignment was straight. The profile of the northbound lane was level approaching the intersection and measured positive 1.0 percent at the POI.

The intersection was controlled by posted stop signs for northbound and southbound traffic. The stop signs were located on the northwest and southeast corners. The posted speed limit for all traffic was 48 km/h (30 mph).

Pre-Crash

At the time of the crash, the weather was clear, conditions were daylight, and the roadway was dry. The Ford was traveling westbound at an EDR-reported speed of 30.01 km/h (18.65 mph) at 1 second prior to Algorithm Enable (AE). The Honda was traveling northbound, stopped at the stop sign, then accelerated forward and entered the intersection at an unknown speed. The Honda crossed the eastbound lane, then entered the westbound lane and crossed into the path of the Ford.

Crash

The crash sequence included two events. The front end of the Honda impacted the left side of the Ford in the passenger compartment section (Event 1). The impact to the Ford was slightly aft of the longitudinal center of gravity; consequently, the vehicle was displaced to the right in response to the direction of force and it initiated a counterclockwise rotation. The vehicle rotated counterclockwise approximately 90 degrees, then its right side tires engaged the roadway with sufficient opposing force to induce a right side leading turn-over type rollover (Event 2). The Ford rolled two quarter-turns and came to rest in the west leg of the intersection. Based on the interview and scene inspection, the distance traveled from the vehicle-to-vehicle impact to final rest was approximately 18.0 m (59.0 ft). The Honda was displaced to the left in response to the direction of force, then came to rest in the intersection.

For the Ford, the Missing vehicle algorithm of WinSMASH calculated a Total Delta-V of 8.0 km/h (5.0 mph); the longitudinal and lateral components were -4.0 km/h (-2.5 mph) and 6.9 km/h (4.3 mph), respectively. The results appear reasonable based on the vehicle's crush profile and post-crash trajectory.

For the Honda, WinSMASH calculated a Total Delta-V of 12.0 km/h (7.5 mph); the longitudinal and lateral components were -10.4 km/h (-6.5 mph) and -6.0 km/h (-3.7 mph), respectively. The results should be considered borderline.

Post-Crash

The driver unbuckled her safety belt first and then unbuckled her daughter's safety belt. The front row right window glazing disintegrated during the crash and a police officer came to that window to assist the front right occupant. The 8-year-old female occupant exited the vehicle through the front right window opening with assistance from the driver and the police officer. The driver then exited the vehicle through the front right window opening with assistance from the police officer. The occupants were alert and ambulatory at the scene while they awaited transport. EMS was dispatched at 1645 hours and the driver was in transport to the hospital at 1710. She arrived at the emergency department at 1735 with a Glasgow Coma Score (GCS) of 15, was treated for minor injuries, and discharged at 2115 hours. The driver missed two days from work due to her injuries and did not seek follow-up treatment.

The front right occupant arrived at the emergency room at 1708 hours with a GCS of 15. She was treated for minor injuries, admitted overnight for observation, then discharged the next day. Her school was not in session at the time of the crash and she later resumed classes on schedule.

According to the police report, the occupants of the Honda were not injured or transported, and the vehicle was driven from the scene.

Vehicle Data - 2008 Ford Escape

The Ford was identified by the Vehicle Identification Number (VIN): 1FMCU94198Kxxxxxx. The vehicle's date of manufacture was unknown because the VIN placard was missing. The odometer reading was 47,971 km (29,808 mi). The vehicle was equipped with a 3.0-liter, 6-cylinder engine, automatic transmission, 4-wheel drive, electric power steering with tilt column functionality, and a tire pressure monitoring system. The braking and suspension systems included 4-wheel anti-lock brakes, Assisted Braking System (ABS), Electronic Traction Control, Roll Stability Control (RSC), electronic brake distribution, independent front strut suspension with stabilizer bar and coil springs, multi-link independent rear suspension with coil springs, rear shocks, and independent rear suspension.

The vehicle manufacturer's recommended tire size was P235/70R16 for the front and rear and the recommended cold tire pressure was 221 kPa (32 psi). The vehicle was equipped with Continental Contitrac P235/70R16 tires. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	228 kPa (33 psi)	7 mm (9/32 in)	No	None
LR	Tire flat	8 mm (10/32 in)	No	Sidewall gouged
RR	228 kPa (33 psi)	8 mm (10/32 in)	No	None
RF	228 kPa (33 psi)	6 mm (7/32 in)	No	None

The Ford's interior was equipped with seating for five occupants. The front row seating consisted of outboard bucket seats with adjustable head restraints. The second row seating consisted of a 60/40 split bench seat with adjustable head restraints and folding backs.

Vehicle Damage - 2008 Ford Escape

Exterior Damage

The Ford sustained direct and induced damage to the left side resulting from the vehicle-to-vehicle impact (Event 1) and direct and induced damage to the right side and top resulting from the rollover (Event 2). Direct damage to the left side began at the left rear axle, extended 160.0 cm (63.0 in) forward, and ended 101.0 cm (39.8 in) aft of the left front axle. The Field L began 34.0 cm (13.4 in) forward of the left rear axle, extended 126.0 cm (49.6 in) forward, and ended 101.0 cm (39.8 in) aft of the right front axle (**Figure 3**). Six crush measurements were taken at lower-door level as follows: $C_1 = 5.0$ cm (2.0 in), $C_2 = 7.0$ cm (2.8 in), $C_3 = 8.0$ cm (3.2 in), $C_4 = 4.0$ cm (1.6 in), $C_5 = 3.0$ cm (1.2 in), $C_6 = 0$ cm. Maximum crush was located 84.0 cm (33.1 in) forward of the right rear axle at C_3 . The Collision Deformation Classification (CDC) for Event 1 was 10LZEW1.

The vehicle-to-vehicle impact resulted in direct damage to the Ford's left B-pillar, left C-pillar, and left side doors. At the second row left side door, the height of maximum door crush measured 48.0 cm (18.9 in), the sill height measured 41.0 cm (16.1 in), and the Door Sill Differential (DSD) was 6.0 cm (2.4 in).

For the rollover, the direct damage to the right side



Figure 3. Left side crush profile, 2008 Ford Escape



Figure 4. Maximum vertical crush measurement, 2008 Ford Escape

began at the D-pillar, 65.0 cm (25.6 in) aft of the right rear axle; the damage extended 372.0 cm (146.5 in) forward to the right front fender. Vertically, the damage began at the sill and extended upward 177.0 cm (46.1 in) to the roof side rail. The direct damage to the top plane began on the forward aspect of the hood, extended rearward 371.0 cm (146.1 in), and ended on the rearward aspect of the roof. Laterally, the damage was distributed 126.0 cm (49.6 in) from roof side rail to roof side rail. Maximum lateral crush to the right roof side rail was located 157.0 cm (61.8 in) forward of the right rear axle and measured 16.0 cm (6.3 in). Maximum vertical crush to the left windshield header was located 8.0 cm (3.2 in) right of the left roof side rail and measured 12.0 cm (4.7 in) (**Figure 4**). The CDC for the rollover was 00TDDO2.

Interior Damage

The Ford sustained moderate interior damage resulting from passenger compartment intrusions and occupant loading. The front row right side glass disintegrated and the windshield fractured during the rollover; the remaining glass was intact. The side doors and rear hatch remained closed and operational. The vehicle's passenger compartment sustained lateral intrusion of the front right door panel in the forward upper quadrant, front left door panel in the forward lower quadrant, right B-pillar, and the center console. The left and right windshield header, left and right roof side rail, right roof and B-pillar intruded vertically.

Evidence of occupant loading was present on the front row safety belts, front row door panels, steering wheel rim, center console, front right seat back, and the right IC air bag.

Manual Restraints

The vehicle's front row seating positions were equipped with 3-point manual lap and shoulder safety belts with sliding latch plates, adjustable D-rings, and retractor and buckle pretensioners. The driver's safety belt had an Emergency Locking Retractor (ELR) and the front right passenger's safety belt had a switchable ELR/Automatic Locking Retractor (ALR).

The driver's safety belt D-ring was in the full-up position and the latch plate was scratched indicating historical usage. The safety belt retractor pretensioner had actuated during the crash and the safety belt webbing was locked in the used position. The buckle pretensioner also actuated and the buckle stalk measured 23.0 cm (9.0 in) in length, resulting in of pretensioner distance of 1.0 cm (0.4 in). The safety belt latch plate was scuffed where the webbing was routed as a result of occupant loading (**Figure 5**). The scuff to the back side measured 4.0 cm (1.6 in) in width. The safety belt webbing exhibited three scuff marks resulting from occupant loading: the first scuff was located 38.0 cm (15.0 in) above the stop button at the latch plate, the second scuff was located 50.0 cm (19.7 in) above the stop button at the driver's

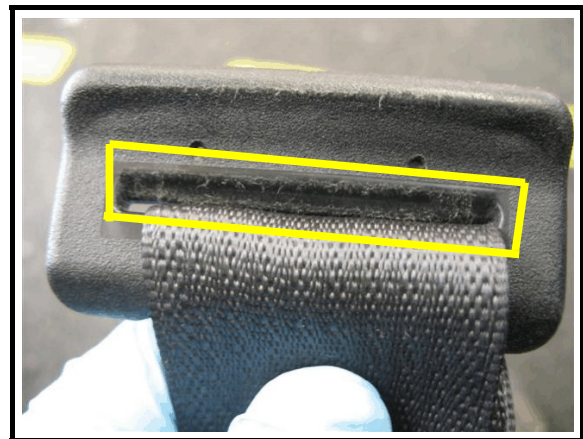


Figure 5. Driver's safety belt latch plate, 2008 Ford Escape

abdomen, and the third scuff was located 110.0 cm (43.3 in) above the stop button at the D-ring. A load mark at the D-ring measured 1.0 x 4.0 cm (0.4 x 1.6 in). Based on the vehicle inspection, the front row left safety belt was determined to have been used to restrain the driver during the crash.

The front row right passenger's safety belt D-ring was set to the middle position and the latch plate was scratched indicating historical usage. The safety belt retractor pretensioner had actuated during the crash and the safety belt webbing was locked in the used position. The buckle pretensioner also actuated and the stalk measured 20.0 cm (7.9 in) in length, resulting in a pretensioner distance of 4.0 cm (1.2 in). The safety belt latch plate exhibited load marks on both sides where the webbing was routed. The scuffs on the latch plate measured 4.0 cm (1.6 in) in width and was equal to the width of the webbing. The safety belt webbing yielded load marks in three areas: the first was located 24.0 cm (9.4 in) above the stop button at the latch plate (**Figure 6**); the second was located 53.0 cm (20.9 in) above the stop button at the occupant's right shoulder; the third was located 92.0 cm (36.2 in) above the stop button at the D-ring. A scuff to the D-ring measured 1.0 x 4.0 cm (0.4 x 1.6 in). Based on the vehicle inspection, the front row right safety belt was determined to have been used to restrain the front right occupant during the crash.



Figure 6. Front right occupant's safety belt webbing, 2008 Ford Escape

The second row seats were equipped with 3-point manual lap and shoulder belts for all three positions. The safety belts were equipped with ELR/ALR retractors. The safety belt webbing revealed wear marks and the latch plates were scratched indicating historical usage for all three seat positions.

The second row outboard seats were equipped with lower anchor (LATCH) hardware used for installing child restraints.

Supplemental Restraint System

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM), driver and passenger frontal air bags, seat-mounted side air bags for the front row, IC air bags for the front and second rows, and safety belt retractor and buckle pretensioners for the front row. Based on the interview, the vehicle had been in one previous minor crash in which no air bags deployed. The vehicle's air bags had not been serviced or replaced since the vehicle was purchased.

The IC air bags were combination Rollover/Side Impact types. The SRS in this vehicle keeps the IC air bags inflated up to six seconds during rollover deployments.¹ Based on the EDR report, the

¹ <http://media.ford.com>, Personal Safety System Combine Multiple Technologies

left and right IC air bags deployed and the safety belt pretensioners actuated as a result of the rollover.

The Ford was a Certified Advanced 208-Compliant (CAC) vehicle. A CAC vehicle is certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Ford's advanced dual-stage frontal air bags were designed to deploy based on the level of impact severity. The frontal air bags did not deploy. Additionally, the vehicle's seat-mounted side air bags did not deploy during the crash.

The left IC air bag deployed from the left roof side rail over the front and second rows. The IC air bag measured 150.0 cm (59.1 in) in length by 45.0 cm (17.7 in) in height. The air bag covered the entire second row side glass and most of the front row side glass. The coverage to the front row side glass began at the top of the A-pillar and extended the down to 12.0 cm (4.7 in) below the top of the door panel. The full height of the glazing was covered; the forward aspect of glazing measuring 40.0 x 40.0 x 56.0 cm (15.7 x 15.7 x 22.0 in) was not covered by the IC air bag. The air bag was designed without vent ports and was constructed with inflatable and non-inflatable sections. It was configured with a 35.0 cm (13.8 in) tether at the leading edge and a 5.0 cm (2.0 in) tether at the trailing edge. The forward tether was cut or torn into two pieces during post-crash activities. A tear measuring 2.0 cm (0.8 in) was located at the bottom edge of the IC air bag at 45.0 cm (17.7 in) aft of the leading edge. The air bag was probably torn during post-crash activities. No evidence of occupant loading was observed in the front row section of the air bag and based on the vehicle inspection and the interview the driver did not load the IC air bag. The second row section of the IC air bag exhibited striation marks and the outboard side of the air bag was unremarkable.

The right IC air bag deployed from the right roof side rail over the front and second rows. The air bag's tethers were intact. The front row section of the air bag exhibited two blood deposits measuring 1.0 cm (0.4 in) in size and 10.0 cm (3.9 in) apart. The first blood deposit was located 26.0 cm (10.2 in) aft of the leading edge and 7.0 cm (2.8 in) below the roof side rail. The second deposit was located 34.0 cm (13.4 in) aft of the leading edge and 13.0 cm (5.1 in) below that roof side rail. The blood was probably deposited by the front right occupant after the vehicle came to rest. She had sustained a chin abrasion during the crash, she was suspended upside down at final rest, and she exited the vehicle through the front row right side the window opening. The second row inboard side and the outboard side of the right IC air bag was unremarkable.

Event Data Recorder

The Event Data Recorder (EDR) recorded one event, which was the rollover event.

Restraint Control Module Analysis deployment times were summarized as follows:

- A rollover event was recorded.
- Driver Retractor Pretensioner = 185 msec.
- Passenger Retractor Pretensioner = 185 msec.
- Driver Pretensioner = 190 msec.
- Passenger Pretensioner = 190 msec.
- Driver Curtain = 185 msec.

- Passenger Curtain = 185 msec.
- The roll rate at the time of deployment was -135 degrees per second.
- The roll angle at the time of deployment was -29.54 degrees.
- There were 1.83 minutes from key-on until rollover algorithm wake-up.

System Status At the Start of the Event was summarized as follows:

- Driver safety belt status was Buckled.
- Passenger safety belt status was Buckled.
- Driver Seat Track status was Rearward.
- Passenger seat status was N/A.
- Driver Belt Minder Enabled was Yes.
- Passenger Belt Minder status was Yes.
- Belt Minder Warning on Key-cycle was No.

Pre-Crash Data at 1 second Before Event was summarized as follows:

- Vehicle Speed was 30.01 km/h (18.65 mph).
- Throttle Position (percent) was 0.
- Stability Control in Progress was No.
- ABS in Progress was Yes.
- Traction Control Brakes in Progress was No.
- Traction Control Engine in Progress was No.
- Brakes Depressed was No.
- Passenger Occupant Classification was Small Adult.

Rollover

The Ford had a Static Stability Factor (SSF) rating of 1.17. The SSF of a vehicle is an at-rest calculation of its rollover resistance, which is based on its track width and center of gravity. The vehicle had a rollover resistance rating of 3 out of 5 stars, and had a 20 percent chance of rollover.² The vehicle was configured with the following equipment that could possibly increase its rollover resistance: power steering, 4-wheel drive, 4-wheel anti-lock brakes, Assisted Braking System (ABS), Electronic Traction Control, Roll Stability Control (RSC), electronic brake distribution, a tire pressure monitoring system, independent front strut suspension with stabilizer bar and coil springs, multi-link independent rear suspension with coil springs, rear shocks, and independent rear suspension.

The RSC uses gyroscopic technology to detect when a vehicle corners too sharply or maneuvers in a way that could induce a trip rollover. The system applies braking to the wheels on the outside of the turn which then induces understeering and improves stability. The system also functions when tires lose traction and then spin by decreasing engine power which helps the tires regain traction.

² www.safercar.gov

Based on the EDR report, at one second prior to AE the RSC was not activated, ABS was activated, Traction Control Brakes and Engine systems were not activated, and the brakes were not depressed. At one second prior to AE the vehicle was traveling at an EDR-reported speed of 30.01 km/h (18.65 mph). The Ford was impacted by the other vehicle aft of the Ford's longitudinal center of gravity. At impact, the Ford initiated a counterclockwise rotation in response to the 10 o'clock direction of force. This dynamic caused the driver of the Ford to lose control of the vehicle. Based on the driver interview, the Ford remained in the westbound lane post-impact. The Ford rotated counterclockwise approximately 90 degrees, to a point at which the right side tires engaged the roadway with sufficient opposing lateral force as to induced a right side leading turn-over type rollover. The relatively high coefficient of friction generated between the tires and the dry concrete surface contributed to the rollover dynamics and caused the vehicle to turn-over sooner in its post-impact trajectory than might have occurred on a wet or asphalt roadway. The vehicle's right side tires sidewalls were scuffed and the rims were gouged indicating contact with the roadway during the rollover.

During the first quarter-turn, the driver removed her hands from the steering wheel rim to reach for the front right occupant. At that moment she was neither steering nor braking. Due to the vehicle's post-impact rotational dynamics and the absence of driver input, the vehicle's roll resistance technology was ineffective. The first quarter-turn resulted in deployment of the IC air bags and safety belt pretensioners, disintegration of the front row right window glazing, and 16.0 cm (6.3 in) of lateral crush to the right roof side rail. Additionally, the front right door panel, right B-pillar, and right roof side rail intruded laterally into the occupant compartment.

The second quarter-turn resulted in vertical intrusion of the left and right windshield header, left and right roof side rails, and right roof. The Ford came to final rest on its roof in the west leg of the intersection near the centerline and facing southwest. The direct damage to the hood indicated the vehicle continued rotating between the second quarter-turn and final rest, with the hood in contact with the roadway. Based on the vehicle's post-impact trajectory and the number of quarter-turns, the estimated roll distance was 7.0 m (23.0 ft).

The Ford's tire tread measured 7-8 mm (9-10/32 in) and their inflated pressure was within the manufacturer's recommended range, except for the left rear tire which was flattened due to damage sustained in the vehicle-to-vehicle impact (Event 1). Based on vehicle inspection, it was determined the condition or maintenance of the tires were not contributory to the rollover.

Vehicle Data - 2000 Honda Civic

The Honda Civic (**Figure 7**) was identified by VIN: 1HGEJ6179YL8xxxxx. The vehicle was a 2-door coupe was equipped with a 1.6-liter, 4-cylinder engine. The vehicle was manufactured in the U.S.A. for the Canadian market. The odometer reading was 99,131 km (61,598 mi). The vehicle was sold at an insurance auction facility and photographs obtained from the facility show that partial tear-down of the vehicle's damaged sheet



Figure 7. Other vehicle, 2000 Honda Civic

metal had taken place before the sale. The missing components included the grille, front bumper fascia, and left and right front fenders. The hood was buckled and exhibited induced minor damage distributed laterally across the front.

Occupant Demographics

Driver

Age/Sex:	30 years/Female
Height:	168 cm (66 in)
Weight:	75 kg (165 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Mid-track
Manual restraint usage:	Lap and shoulder belt used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, seat-mounted side air bag, not deployed; IC air bag, deployed
Alcohol, drug involvement:	None
Type of medical treatment:	Transported, treated and released

Front Right Occupant

Age/Sex:	8 years/Female
Height:	142 cm (56 in)
Weight:	43 kg (95 lb)
Seat type:	Bucket with adjustable head restraint
Seat track position:	Mid-track
Manual restraint usage:	Lap and shoulder belt used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag, seat-mounted side air bag, not deployed; IC air bag, deployed
Type of medical treatment:	Transported, admitted for one day, and released

Occupant Kinematics

Driver

The 30-year-old female driver was seated in a normal, upright posture and was restrained by the vehicle's lap and shoulder belt. The seat cushion was set to mid-track and the seat back was slightly reclined. Her hands were on the steering wheel rim at the 2 and 9 o'clock positions, her left foot was on the floor, and her right foot was on the accelerator. The driver was not wearing eyewear or contact lenses. The vehicle was traveling westbound at an EDR-reported speed of 30.01 km/h (18.65 mph) at 1 second prior to AE. The driver was looking straight ahead and did not see the other vehicle prior to impact.

At impact with the Honda, the driver was displaced left and in response to the 10 o'clock direction of force. The driver's left wrist sustained a mild sprain, possibly resulting from contact with the steering wheel rim at impact. Her left foot possibly engaged the floor resulting in a mild right ankle sprain. She stated during the interview she did not recall loading any interior components other than the safety belt.

The Ford initiated a counterclockwise rotation the driver was displaced to the right. As the vehicle initiated the first quarter-turn of the rollover, the driver's safety belt pretensioners actuated and the left IC air bag deployed. The driver loaded the safety belt and scuffs were deposited to the webbing, latch plate and D-ring. During the interview, the driver stated that during the first quarter-turn, she reached out for the front right occupant in an attempt to hold onto the child. Her right shoulder possibly loaded her seat back and she sustained a right shoulder contusion. The driver's right hip loaded the center console armrest, deforming and displacing the padded top. The vehicle then rolled a second quarter-turn and the driver was held in her seat by the safety belt and actuated pretensioner. The vehicle came to rest on its roof and she was suspended upside down in her seat. She self-extricated through the right side window opening with assistance from an on-scene responder.

Front Right Occupant

The 8-year-old female occupant was seated in a normal, upright posture and was restrained by the vehicle's lap and shoulder belt. The seat cushion was set to mid-track and the seat back was slightly reclined. Her arms were at her sides and her feet were on the floor. The occupant was not wearing eyewear or contact lenses. At impact, the child was displaced left. The occupant's left pelvis loaded the seat back and deposited a group of scuffs above the safety belt buckle. The vehicle then initiated a counterclockwise rotation and the occupant was displaced to the right. As the vehicle initiated the rollover, the right IC air bag deployed and the occupant's safety belt pretensioners deployed. She loaded the safety belt resulting in an abrasion to her left abdomen; load marks were present on the webbing, latch plate, and D-ring. Additionally, the occupant's face loaded the shoulder portion of the safety belt webbing resulting in a linear abrasion on her right chin. At impact with the roadway, the front row right side glass disintegrated. The driver stated during the interview that the front right occupant was not contacted by flying glass due to the presence of the deployed right IC air bag. The occupant's right elbow loaded the IC air bag, resulting in abrasions to her right elbow. The IC air bag in turn loaded the left door panel's rear upper quadrant depositing two scuff marks measuring 2.0 and 3.0 cm (0.8 and 1.2 in), respectively. The vehicle then rolled a second quarter-turn and the

occupant was held in her seat by the safety belt and actuated pretensioners. The vehicle came to rest on its roof and this occupant was suspended upside down. The front right occupant self-extricated through the front right side window opening with assistance from the driver and an on-scene responder.

Occupant Injuries

Driver

The injury data was obtained from the driver's medical records and the interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, right shoulder	790402.1,1	Seat back	Possible
Sprain, left wrist	751420.1,2	Steering wheel rim	Possible
Sprain, left ankle	850206.1,2	Floor	Possible

Front Right Occupant

The injury data was obtained from the occupant's medical records and the interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasion, left abdomen	590202.1,2	Safety belt webbing	Probable
Abrasion, right elbow	790202.1,1	IC air bag	Probable
Abrasion, right chin	290202.1,1	Safety belt webbing	Probable

