

On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS08019
2007 Ford F150
Oregon
June 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 <p>This on-site investigation focused on a 2007 Ford F150 that was involved in a rollover crash. The subject vehicle was occupied by a restrained 41-year-old female driver, a restrained 51-year-old female front right passenger, and three male children in the rear seat, ages 3, 5, and 6. The 3-year-old and 5-year-old children were seated in booster seats in the outboard positions and were restrained by the vehicle's lap and shoulder belts. The 6-year-old was seated in the middle seat position and was restrained by the vehicle's lap and shoulder belt. The Ford was traveling northbound in the inboard lane of an interstate highway and was passing an empty log truck. The Ford was pulling a travel trailer. As the Ford changed lanes, the trailer began to sway. The driver was unable to control the motion and the left side of the trailer contacted the center divider. The driver steered back to the right and Ford began a clockwise rotation. The trailer separated from the Ford. Both the Ford and the trailer departed the roadway to the east and overturned. The driver and front right passenger were entrapped in the Ford and required extrication. The driver sustained multiple contusions and abrasions, in addition to unspecified injuries to her hip and right leg. She was transported to a local hospital. The front right passenger sustained a right side skull fracture, a scalp laceration, a spinal injury, and had internal bleeding. She was transported to a local hospital and then transferred to an area trauma center. According to the interviewee, the three children sustained minor seat belt related abrasions. The Ford and the trailer were both towed from the scene. The Ford was later declared to be a total loss by the insurance company.</p>				
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Background

This on-site investigation focused on a 2007 Ford F150 that was involved in a rollover crash (**Figure 1**). The subject vehicle was occupied by a restrained 41-year-old female driver, a restrained 51-year-old female front right passenger, and three male children in the rear seat, ages 3, 5, and 6. The 3-year-old and 5-year-old children were seated in booster seats in the outboard positions and were restrained by the vehicle's lap and shoulder belts. The 6-year-old was seated in the middle seat position and was restrained by the vehicle's lap and shoulder belt. The Ford was traveling northbound in the inboard lane of an interstate highway and was passing an empty log truck. The Ford was pulling a travel trailer. As the Ford changed lanes, the trailer began to sway. The driver was unable to control the motion and the left side of the trailer contacted the center divider. The driver steered back to the right and Ford began a clockwise rotation. The trailer separated from the Ford and both the Ford and the trailer departed the roadway to the east and overturned. The driver and front right passenger were entrapped in the Ford and required extrication. The driver sustained multiple contusions and abrasions, in addition to unspecified injuries to her hip and right leg. The front right passenger sustained a right side skull fracture, a large laceration, a spinal injury, and had internal bleeding. She was transported to a local hospital and then transferred to an area trauma center. According to the interviewee, the three children sustained minor seat belt related abrasions. The Ford and the trailer were both towed from the scene. The Ford was later declared to be a total loss by the insurance company.



Figure 1. Subject vehicle, 2007 Ford F150

This on-site rollover investigation was identified in an online news article. The National Highway Traffic Safety Administration (NHTSA) was notified of the article on June 21, 2008. On June 23, 2008 DSI was instructed to locate the subject vehicle. The police report was obtained and the Ford was located at a local tow facility. It was in the process of being moved to an auto salvage facility. The insurance company was contacted and permission to inspect the vehicle was obtained on June 26, 2008, and DSI was assigned the case on June 27, 2008. The vehicle inspection and field work were completed during the week of July 7, 2008.



Figure 2. Overview of crash site (north)

Summary

Crash Site

This single vehicle crash occurred on a divided interstate highway in June 2008 (**Figure 2**). At the time of the crash, there were no adverse weather conditions and the asphalt roadway surface was dry. The roadway had a positive 3.6 percent grade. The northbound roadway was configured with two northbound lanes that were separated by dashed white lines. The roadway was bordered to the west by a solid yellow line and a concrete median barrier and to the east by a solid white line and an asphalt shoulder with a rumble strip. Beyond the shoulder was a 1.9 m (6.4 ft) area of gravel with negative 18 percent grade followed by an area of grass with a negative 19 percent grade. The posted speed limit was 105 km/h (65 mph).

Pre Crash

The subject vehicle was a 2007 Ford F150 being driven by a 41-year-old female. A 51-year-old female was seated on the front right seat. There were three children occupying the second row left, center, and right seats. The second row left occupant was seated in a Dorel convertible child seat that was being used as a belt positioning booster seat. The second row center occupant was using the manual lap and shoulder belt. The second row right occupant was seated in an Evenflo Sightseer booster seat. The children in the booster seats were using the vehicle lap and shoulder belts. They had gotten into the seats and had belted themselves in without the assistance of any adults. This was their normal practice. The Ford was traveling northbound in the inboard lane of the interstate. The Ford was pulling a Northwood Nash 7.6 m (25 ft) travel trailer. It is not yet known if the Ford had the correct load capacity to tow this particular trailer. The driver was familiar with the subject vehicle and had towed the involved trailer on numerous occasions.

As the Ford changed lanes to pass the empty logging truck that, the trailer began to sway.

Crash

The driver steered back and forth but was unable to regain control of the Northwood trailer. The trailer contacted the center divider with its left side, depositing a 2.7 m (9 ft) mark (**Figure 3**). The trailer then rotated clockwise and separated from the Ford. The Ford began a clockwise rotation,



Figure 3. Evidence of trailer contact with center divider



Figure 4. Path of Ford to rollover and impact with post

traveled across the adjacent travel lane, and onto the eastern shoulder. Near the edge of the shoulder, the vehicle tripped and began a left side leading rollover (**Figure 4**). After rolling four quarter turns, the left side of the Ford struck and sheared a wooden pole supporting a traffic sign. The Ford rolled one additional quarter turn and came to rest on its left side facing southeast (**Figure 5**). After contacting the barrier, the trailer crossed the adjacent travel lane, departed the roadway to east and overturned onto its left side, north of the Ford and approximately 61 m (200 ft) north of the barrier contact point.



Figure 5. Subject vehicle, 2007 Ford F150, at final rest

Post Crash

The driver and front right passenger were entrapped in the Ford and required extrication. The children in the rear of the vehicle were assisted and removed from the vehicle by bystanders. The driver sustained multiple contusions and abrasions, in addition to unspecified injuries to her hip and right leg. She was transported to a local hospital where she was treated and released. The front right passenger sustained a right side skull fracture, a large scalp laceration, a spinal injury, and had internal bleeding. She was transported to a local hospital and then transferred to an area trauma center where she was hospitalized for 14 days. The three children sustained minor seat belt related abrasions. They were transported to a local hospital where they were examined and released. The Ford and the trailer were both towed from the scene. The Ford was later declared to be a total loss by the insurance company.

Vehicle Data - 2007 Ford F150

The 2007 Ford F150 XLT crew cab pickup was identified by the Vehicle Identification Number (VIN): 1FTPW14577Fxxxxxx. The mileage was unavailable due to the electronic odometer and absence of power to the vehicle. The Ford was equipped with a 5.4 liter, 8 cylinder engine, a 4-speed automatic transmission, 4-wheel drive, and ABS brakes. Efforts are underway to determine the type of hitch that was being used to pull the trailer and if the load rating for the Ford was proper for hauling that particular trailer. The vehicle manufacturer's recommended tire size for the front and rear tires was P255/70R17. The recommended tire pressure was 241 kPa (35 psi). The Ford was configured with four General Ameritrac P255/70R17 tires. The tire manufacturer's maximum tire pressure was 303 kPa (44 psi). The left front tire had grass in the bead that measured 10 cm (3.9in) along the rim. The left rear rim edge had a 32 cm (12.6 in) long gouge. There was also grass found in the bead of the right front tire that measured 81 cm (31.9 in) along the rim. The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	193 kPa (28 psi)	10 mm (13/32 in)	No	None
LR	310 kPa (45 psi)	10 mm (12/32 in)	No	None
RR	228 kPa (33 psi)	11 mm (14/32 in)	No	None
RF	221 kPa (32 psi)	10 mm (13/32 in)	No	None

The first row seating was configured with a 40/20/40 split bench seat with adjustable head restraints for the outboard seats. The second row seating was configured with a bench seat with adjustable head restraints for the outboard seats.

Vehicle Damage

Exterior Damage - 2007 Ford F150

The 2007 Ford F150 sustained moderate damage from the rollover event, minor intra-unit damage from the trailer, and minor damage from the impact with the breakaway sign post. The right side A-pillar, B-pillar, and C-pillar were cut during extrication efforts.

The intra-unit damage consisted of a single circular contact that was located 13 cm (5.1 in) to the right of the vehicle centerline and measured 5 cm (1.9 in) in width. The Collision Deformation Classification (CDC) for this contact was 05BCM1. There was also damage to the trailer power connection below the bumper. The status of the hitch itself is not yet known.

There was damage to the top and sides from the rollover event (**Figure 6**). There was 535 cm (210.6 in) of direct contact along the left side that extended along the top of the bed, into the C-pillar and left rear door, along the top of the driver's door into the A-pillar and along the top of the left front fender. There were vertical striations/scratches present in the left front and left rear sideglass. The direct damage on the right side began 71 cm (27.9 in) forward of the rear axle and extended 352 cm (138.5 in) forward along the right side plane. There was damage to the fender,



Figure 6. Right side damage, 2007 Ford F150



Figure 7. Left side damage from post impact

upper right front door, and above the right rear door. There was lateral crush to the right B-pillar/sideglass frame that extended 34 cm (13.4 in) to the left. The right bumper corner was deformed laterally 32 cm (12.6 in) to the left. There was damage to the roof that extended from the backlight header forward 349 cm (137.4 in). The damage on the right side, at the rail, was 58 cm (22.8 in) wide. The damage on the left side, at the rail, was 15 cm (5.9 in) wide. The maximum vertical crush was located at the right B-pillar, but the damage was masked by extrication efforts. The CDC for the rollover event was 00TDDO3.

There was minor damage to the F150 from the impact with the wooden pole (**Figure 7**). The damage was located 67 cm (26.4 in) rear of the front axle and measured 14 cm (5.5 in) in width. The height along the door was 30 cm (11.8 in). The field L measured 21 cm (8.3 in). The side view mirror was knocked off by this impact. Six crush measurements were taken near the beltline level as follows: C1 = 0 cm, C2 = 2 cm (0.8 in), C3 = 3 cm (1.2 in), C4 = 2 cm (0.8 in), C5 = 1 cm (0.4 in), C6 = 0 cm. The maximum crush was located at C3. The CDC for the pole impact was 09LPHN2.

Interior Damage - 2007 Ford F150

The 2007 Ford F150 sustained moderate interior damage as a result of passenger compartment intrusion. There was lateral and vertical intrusion into the passenger compartment from the A-pillar, B-pillar, and right side glass frame. There was vertical intrusion from the roof, backlight header, and right side roof rail. There was a minor lateral intrusion from the right front door.

All the doors remained closed and operational. The right side windows disintegrated during the rollover. There was damage to the windshield from the rollover and extrication efforts. The backlight and its frame were located in the bed of the vehicle and were likely removed by rescue personnel.

There was blood located on the driver's window, the steering wheel rim, both front safety belts, and on the center seat. The center lower instrument panel was dented and the glove compartment door was open and would not close. There was hair trapped along the right front window frame from the right side occupant that was light brown in color and measured 2-3 cm (0.8-1.2 in) in length. The driver's seat back was twisted 9 cm (3.5 in) in a counterclockwise direction

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Front seat right	Window frame	35 cm (13.7 in)	Lateral
Second seat right	C-pillar	25 cm (9.8 in)	Lateral
Front seat right	B-pillar	16 cm (6.3 in)	Lateral
Front seat right	A-pillar	12 cm (4.7 in)	Lateral
Second seat middle	Roof	11 cm (4.3 in)	Vertical
Front seat left	Roof side rail	9 cm (3.5 in)	Vertical
Front seat right	Roof side rail	9 cm (3.5 in)	Vertical
Front seat right	Door-undetermined location	6 cm (2.4 in)	Lateral
Second seat right	Roof	6 cm (2.4 in)	Vertical
Second seat right	Roof side rail	6 cm (2.4 in)	Vertical
Second seat left	Roof side rail	2 cm (0.8 in)	Vertical
Front seat right	Roof	Unknown	Vertical

Manual Restraint Systems - 2007 Ford F150

The 2007 Ford F150 was equipped with 3-point manual lap and shoulder belts for the first row outboard seat positions. The belts were configured with adjustable D-rings. The driver side D-ring was adjusted to the mid position. The seat belt webbing was trapped within the D ring. The right passenger side D-ring position was not known due to movement/damage during extrication. The front row outboard safety belts were configured with sliding latch plates and Emergency Locking Retractors (ELR). The driver's belt exhibited wear marks to the seat belt latch plate. There was blood found on the driver's belt that measured 31 cm (12.2 in) length and was located 132 cm (51.9 in) from the anchor point. The right passenger's safety belt was cut twice by emergency personnel. The belt was cut 47 cm (18.5 in) from the anchor point and the length of the cut belt measured 155 cm (61.0 in). The middle seat position was equipped with a lap belt. There was blood located on the belt that measured 17 cm (6.7 in) in length and was located 57 cm (22.4 in) from the anchor point. Both front outboard safety belts were configured with buckle pretensioners that did not actuate. Both front seat belts were used during this crash.

The three second row safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The second row left belt exhibited loading at a point 74 cm (29.1 in) from the anchorage. The second row left and second row right safety belts were being used with booster seats.

The second row outboard seats were equipped with Lower Anchors and Tethers for Children (LATCH) hardware and all three second row seats were equipped with tether mounts.

Supplemental Restraint Systems - 2007 Ford F150

The 2007 Ford F150 was equipped with first row frontal air bags for the driver and the front right occupant. The air bags did not deploy. The Ford was not equipped with side curtain air bags.

Rollover Dynamics

The 2007 Ford F150 was equipped with 4-wheel drive and ABS, and was pulling a travel trailer. The drive control switch was set to 2H (2 wheel drive - high speed). The Ford had a Rollover Resistance Rating of four stars, indicating that it had a chance of rollover of between 10 and 20 percent. The Rollover Resistance Rating is an estimate of the risk of rolling over if a person has a single vehicle crash in which the vehicle is tripped by a curb, ditch or soft soil. It does not predict the likelihood of that crash. The Rollover Resistance Rating is based on "static stability factor," a measure of a vehicle's center of gravity and track width to determine how top-heavy the vehicle is.

The Ford F150 was northbound and the driver lost control of the vehicle as she changed lanes. The left side of the trailer struck the concrete barrier. The driver steered to the right and the Ford began a clockwise rotation. At some point during the initial rotation the trailer separated from the vehicle. The Ford continued a clockwise rotation as the vehicle crossed the outboard lane of the roadway and traveled onto the asphalt shoulder. Just prior to departing the shoulder, the Ford tripped and began a left side leading rollover. The Ford rolled four quarter turns before striking a wooden pole with its left side. The Ford rolled one additional quarter turn before coming to rest on its left side.

Child Safety Seats

Dorel High Back Booster Car Seat

The 3-year-old male second row left occupant was seated in a Dorel High Back Booster Car Seat (**Figure 8**). The model number was 22-209 RDO and the date of manufacture was June 13, 2006. The seat was designed to be used as a forward facing child seat or a belt-positioning booster seat. The 5-point internal harness had been removed and the seat was being used as a belt-positioning booster seat. When used as a booster, the manufacturer recommended the seat be used for children greater than 1 year of age, whose weight was between 18-36 kg (40-80 lbs), and whose height was between 109-132 cm (43-52 in). The 3-year-old using the seat weighed 16 kg (36 lbs) and was 104 cm (41 in)



Figure 8. Dorel High Back Booster Car Seat

tall. He did not fall within the manufacturer recommendations. The child had gotten into the seat on his own and had put on his own seat belt. According to the interviewee, the lap and shoulder belt was being worn properly with the shoulder belt webbing routed through the upper guide. There was 9 cm (3.5 in) of scuffed plastic located at and below the left lower belt guide (**Figure 9**). The damage likely occurred during the rollover sequence as the left side of the seat came into contact with the left rear door.

Evenflo Sightseer Booster Seat

The 5-year-old male second row right occupant was seated in an Evenflo Sightseer booster seat (**Figure 10**). The model number was 2692198P2 and the date of manufacture was October 12, 2001. The manufacturer recommended the seat be used for children who are between 94-137 cm (37-54 in) in height, who weigh 9-36 kg (20-80 lbs), and whose ears are below the top of the restraint back. The 5-year-old child weighed 21 kg (46 lbs) was 107 cm (42 in) tall. He was within the manufacturer's weight and height recommendations. The child had gotten into the seat on his own and had put on his own seat belt. According to the interviewee, the lap and shoulder belt was being worn properly with the shoulder belt webbing routed through the upper shoulder belt guide. There were indications of seat belt loading along the left lower seat belt guide (**Figure 11**).



Figure 9. Scuffed plastic loading mark to left lower belt guide



Figure 11. Loading to left lower seat belt guide



Figure 10. Evenflo Sightseer Booster Seat

OCCUPANT DEMOGRAPHICS - 2007 Ford F150

	Driver	Front Row Right Passenger
Age/Sex:	41/Female	51/Female
Seated Position:	Front row left	Front row right
Seat Type:	40/20/40 split bench	40/20/40 split bench
Height:	163 cm (64 in)	178 cm (70 in)
Weight:	Unknown	127 kg (280 lbs)
Alcohol/Drug Involvement:	None	N/A
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, actively steering	Unknown
Foot Position:	Right foot on brake	Unknown
Restraint Usage:	Lap and shoulder belt used	Lap and shoulder belt used
Air bag:	Driver air bag available. Did not deploy.	Passenger air bag available. Did not deploy.

	Second Row Left Passenger	Second Row Middle Passenger	Second Row Right Passenger
Age/Sex:	3/Male	6/Male	5/Male
Seated Position:	Second row left	Second row middle	Second row right
Seat Type:	Bench	Bench	Bench
Height:	104 cm (41 in)	119 cm (47 in)	107 cm (42 in)
Weight:	16 kg (36 lbs)	29 kg (65 lbs)	21 kg (46 lbs)
Alcohol/Drug Involvement:	N/A	N/A	N/A
Body Posture:	Normal, upright	Normal, upright	Normal, upright
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used with CSS	Lap and shoulder belt used	Lap and shoulder belt used with CSS

OCCUPANT KINEMATICS

Driver Kinematics

The subject vehicle was traveling northbound at an unknown speed. The driver lost control, the trailer struck a concrete barrier, and the vehicle began a clockwise rotation. The vehicle tripped as it left roadway and began a left side leading rollover. The vehicle rolled a total of five quarter turns. The 41-year-old female driver occupied a split bench seat and was restrained by the 3-point manual lap and shoulder belt. The driver was actively steering and braking. As the Ford began the clockwise rotation, the driver was displaced slightly to the left. As the vehicle rolled, the driver was held in place by the lap and shoulder belt. The shoulder belt webbing was trapped in the D-ring adjustment, but there was no pretensioner actuation. The driver was trapped in the vehicle and required extrication. She sustained multiple contusions and abrasions, in addition to unspecified injuries to her hip and right leg. She was transported to a local hospital where she was treated and released.

Front Right Passenger Kinematics

The 51-year-old female passenger was seated in the front right position. She was restrained by the 3-point manual lap and shoulder belt. As the Ford rotated, she was displaced slightly to the left. As the vehicle began to roll, she was held in place by the lap and shoulder belt. Between the second and third quarter turns, the right side roof rail contacted the ground. The right side of this occupant's head came into contact with the roof rail/window frame area. She sustained a right side skull fracture, a large right side scalp laceration, a cervical spine injury, and had internal bleeding. She was transported to a local hospital and then transferred to an area trauma center where she was hospitalized for 14 days.



Figure 12. Window frame contact

Second Row Left Passenger Kinematics

The 3-year-old second row left occupant was seated in a booster seat and was restrained by the manual 3-point lap and shoulder belt. As the Ford went into the clockwise rotation, he was displaced slightly to the left. As the vehicle began to roll, he was held in place by the lap and shoulder belt. He sustained minor abrasions to his left shoulder and hips from the seat belt webbing. He was removed from the vehicle by bystanders and was transported to a local hospital where he was treated and released.

Second Row Middle Passenger Kinematics

The 6-year-old second row middle occupant was seated on the bench seat and was restrained by the manual 3-point lap and shoulder belt. As the Ford went into the clockwise rotation, he was displaced slightly to the left. As the vehicle began to roll, he was held in place by the lap and shoulder belt. He sustained minor abrasions to his left shoulder and abdomen. He was removed from the vehicle

by bystanders and was transported to a local hospital where he was treated and released.

Second Row Right Passenger Kinematics

The 5-year-old second row right occupant was seated in a booster seat and was restrained by the 3-point manual lap and shoulder belt. As the Ford went into the clockwise rotation, he was displaced slightly to the left. As the vehicle began to roll, he was held in place by the lap and shoulder belt. The interviewee reported that this occupant sustained "seat belt abrasions". He was removed from the vehicle by bystanders and was transported to a local hospital where he was treated and released.

OCCUPANT INJURIES - 2007 Ford F150

Driver: Injuries obtained from interviewee.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Multiple contusions and abrasions	990200.1,9 990400.1,9	Unknown	Unknown

Front Row Right Occupant: Injuries obtained from interviewee.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Right side skull fracture	150400.2,1	Window frame	Certain
Right scalp laceration	190600.1,1	Window frame	Certain
Cervical spinal injury. Coded as cervical strain without fracture or dislocation	640278.1,6	Window frame	Probable

Second Row Left Occupant: Injuries obtained from interviewee.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasion, left shoulder	790202.1,2	Seat belt webbing	Certain
Abrasions, bilateral hips	890202.1,3	Seat belt webbing	Certain

Second Row Middle Occupant: Injuries obtained from interviewee.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasion, left shoulder	790202.1,2	Seat belt webbing	Certain
Abrasion, abdomen	590202.1,0	Seat belt webbing	Certain

Second Row Right Occupant: Injuries obtained from interviewee.

<u>Injury</u>	<u>AIS Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
“Seat belt abrasions”	790202.1,1 490202.1,4 590202.1,9	Seat belt webbing	Certain

Attachment 1. Scene Diagram

