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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN08034
LOCATION - MISSOURI
VEHICLE - 2007 FORD RANGER XLT
CRASH DATE - September 2008

Submitted:

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Contract Number: DTNH22-07-C-00044

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
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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 2007 Ford Ranger XLT. The focus of this on-site investigation was the Ford's rollover. The Ford was traveling north behind two passenger vehicles and a tractor-semitrailer. The Ford's driver began to pass the vehicles as they traveled downhill and the Ford's left side wheels departed the west edge of the roadway. The driver steered right and the vehicle reentered the roadway, and he then steered left. The vehicle began rotating counterclockwise and departed the west (left) side roadway where it rolled over right side leading three quarter turns. The restrained 47-year-old male driver was entrapped between the crushed roof and his seat back. He sustained a fatal injury and was transported from the crash scene directly to a local funeral home.			
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This crash was brought to the National Highway Traffic Safety Administration's attention on September 12, 2008 by Special Crash Investigation (SCI) team 2. This on-site investigation was assigned on October 2, 2008. The crash involved a 2007 Ford Ranger XLT pickup truck (**Figure 1**), which departed the roadway and rolled over. The crash occurred in September, 2008 at 0612 hours, in Missouri and was investigated by the Missouri State Highway Patrol. The focus of this on-site investigation was the Ford's rollover. This contractor inspected the scene and the Ford, and interviewed the county coroner on October 8 and 9, 2008. This report is based on the police crash report, scene and vehicle inspections, an interview with the county coroner, the coroner's on-scene photographs, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2007 Ford Ranger XLT; roof was cut off by rescue personnel

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Ford was traveling was a 2-lane, US highway that traversed in a north-south direction. The trafficway was straight and had one travel lane in each direction and bituminous shoulders. Each travel lane was nominally 3 m (9.8 ft) in width and each shoulder was nominally 1.2 m (3.9 ft) in width. The roadway pavement markings consisted of solid white edge lines, a broken yellow center line for northbound traffic, and a solid yellow no passing center line for southbound traffic. The roadway had a negative 5% grade on the Ford's approach and a negative 3.5% grade in the area of the initial roadway departure. The roadway was level in the area of the Ford's final roadway departure prior to the rollover. A stream passed through a concrete culvert at the point of the roadway departure. The vertical drop from the roadway edge to the point where the vehicle initially touched down during its first quarter roll was 1.6 meters (5.2 feet). The posted speed limit was 97 km/h (60 mph). At the time of the crash the light condition was dark with no artificial lighting. The atmospheric condition was cloudy and the roadway was dry bituminous. The traffic density was light and the site of the crash was rural. See the Crash Diagram on page 7 of this report.

Figure 2: The Ford's northbound travel to the area it began to pass three vehicles

Pre-Crash: The Ford's restrained 47-year-old male driver was traveling north behind two passenger vehicles and a tractor-semitrailer at a witness reported speed of 72 km/h (45 mph). The Ford's driver began to pass the vehicles as they traveled down a 5% negative grade (**Figure 2**). As the Ford was passing, its left side wheels departed the west edge of the roadway and the driver steered right and reentered the roadway

(**Figure 3**). The vehicle crossed the southbound lane and the driver steered left as the vehicle reentered the northbound lane. As a result of the left steering maneuver, the vehicle began to yaw counterclockwise. The vehicle's right front and right rear tires produced yaw marks on the roadway as the vehicle rotated counterclockwise toward the west roadside where the rollover occurred (**Figure 4**).

Crash: The Ford was yawed counterclockwise 105 degrees from the roadway's northbound direction as it departed the west shoulder and entered the grass. The vehicle traversed 9 meters (29.5 feet) down a negative 18% grass slope at which point it traveled off the edge of the culvert (**Figure 5**) and began to rollover right side leading (rollover initiation type: fall-over). As it was airborne, it fell a vertical distance of 1.1 meters (3.6 feet) from the edge of the culvert and traversed a horizontal distance of 7 meters (23 feet) as it fell to the point of touchdown. The right side of the vehicle (**Figure 6**) touched down on the north embankment of the stream (**Figure 5**) and the vehicle continued to rollover as it again became airborne. It continued to rotate counterclockwise as it rolled over and the top impacted the ground (**Figure 5**) near the top of the embankment. The vehicle then rolled onto its left side to final rest heading southeast (**Figure 7**). The vehicle rolled over a total of three quarter turns across a horizontal distance of 19.6 m (64.3 ft) from the point it traveled off the edge of the culvert to its final rest position.

Post-Crash: The driver of one of the vehicle's that the Ford had passed called 911. The investigating police officer was notified at 0626 hours and arrived on scene at 0650 hours. An ambulance, emergency rescue personnel and the county coroner also responded to the scene. The driver was entrapped within his seat by the crushed roof and rescue personnel cut the top off the vehicle and cut the seat belt in order to

Figure 3: Arrows show police reported area of initial roadway departure and area where Ford reentered the roadway

Figure 4: Fords yaw marks leading to area of rollover; yaw mark A is from right rear tire and other mark is from right front tire; arrow shows location of Ford's final rest

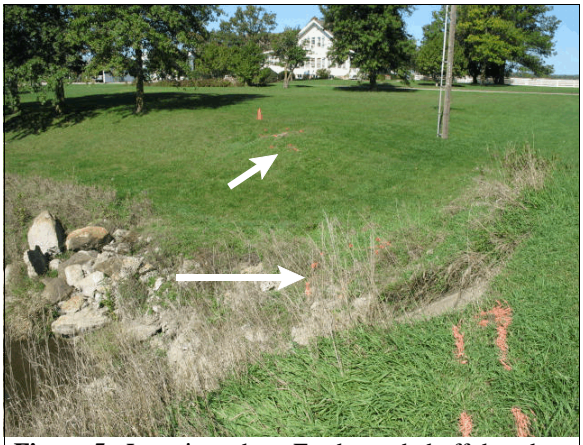


Figure 5: Location where Ford traveled off the edge of the culvert and became airborne; arrow in foreground shows location where right side of vehicle touched down on the stream embankment during first quarter turn; arrow in background shows area where top impacted the ground during second quarter turn

extricate him. The driver was pronounced deceased by the coroner and transported from the crash scene to a local funeral home. The Ford was towed from the scene due to damage.

Figure 6: Damage to Ford's right side from the initial touchdown on the north stream embankment during the first quarter turn of the rollover

Figure 7: Coroner's on-scene photographs of Ford's final rest position

Figure 8: Damage to the Ford's hood and left side from the rollover

Figure 9: Damage to Ford's roof from the rollover and rescue activities; roof viewed back to front

CASE VEHICLE

The 2007 Ford Ranger XLT was a rear wheel drive, 2-door, regular cab pickup truck (VIN: 1FTYR10D27P------) equipped with a 2.3L engine, 5-speed manual transmission, 4-wheel anti-lock brakes, and a tire pressure monitoring system. The front row was equipped with a split bench seat with folding backs and integral head restraints, dual stage driver and front right passenger frontal air bags, lap-and-shoulder belts in the outboard positions and a center lap belt. The Ford was also equipped with Lower Anchors and Tethers for Children (LATCH) at the front center and front right seating positions. The vehicle was not equipped with electronic stability control. The vehicle's mileage could not be determined because it was equipped with an electronic odometer. The vehicle's specified wheelbase was 283 cm (111.4 in).

CASE VEHICLE DAMAGE

Exterior Damage: The damage from the rollover involved the top and both sides of the vehicle (**Figures 6**, **8** and **9**). The direct damage to the top plane extended the full length and width of the top. It was not possible to determine the maximum crush to the roof since it had been cut off the vehicle. The direct damage to the right side began 26 cm (10.2 in) forward of the right rear axle and extended 322 cm (126.8 in) forward along the right side. The maximum residual crush to the right side was 25 cm (9.8 in) and

occurred at the bottom of the right front door 185 cm (72.8 in) forward of the right rear axle. The direct damage to the left side was in intermittent areas along the entire side of the vehicle and began at the corner of the left fender.

Damage Classification: The Ford's Collision Deformation Classification was **00-TDDO-4**. The extent zone was estimated based on the on-scene photographs. The WinSMASH program could not be used to calculate a Delta V because rollovers are out of scope for the program. The severity of the rollover was severe based on the estimate of the extent of the roof crush.

The manufacturer's recommended tire size was P225/70R15 and the vehicle was equipped with the recommended size tires. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	207	30	207	30	3	4	None, but grass in bead	No	No
LR	200	29	207	30	7	9	None, but grass in bead	No	No
RR	207	30	207	30	6	8	None, but grass in bead	No	No
RF	Flat	Flat	207	30	8	10	Bead separation	No	Yes

Vehicle Interior: The inspection of the Ford's interior revealed light scuff marks on the lower left instrument panel located on both sides of the steering column due to contact by the driver's knees. A light scuff mark was also located on the back of the driver's seat belt buckle, and the center arm rest was bent to the right. This was the result of loading by the driver's right hip. Evidence of occupant contact was also located on the bottom of the steering wheel rim and left roof. The bottom of the steering wheel rim was bent forward 1 cm (0.4 in) and there was blood and an impression on the liner of the left roof area. This contact evidence was the result of the driver's thighs loading the bottom of the steering wheel and the intruding roof loading his head when the vehicle landed on its top plane during the second quarter turn. The on-scene photographs showed passenger compartment intrusion of the roof, windshield header, both A-pillars and both roof side rails. The extent of intrusion could not be directly measured due to the removal of the roof. The intrusion values of these components were estimated to be in a range of 15 to 30 cm (5.9 in to 11.8 in) based on an on-scene photograph and the top extent zone values. The left front and left rear doors were jammed shut and the left front door had been forced open by rescue personnel. The windshield glazing had been removed during rescue operations and the backlight glazing was disintegrated. Glass fragments in the top of the left front window frame indicated that the left front window was closed, but the status of the right front window could not be determined. Both the left front and right front window glazing were disintegrated.

The Ford was equipped with frontal air bags that were certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The driver air bag was located within the steering wheel hub and the front right passenger air bag was located within the middle of the instrument panel. Neither of these air bags deployed. The frontal air bag system is not designed to deploy in a rollover crash.

MANUAL RESTRAINT SYSTEM

The Ford was equipped with lap-and-shoulder belts for the driver and front right seating positions and a lap belt in the front center seating position. 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 up 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 middle position. The lap belt was equipped with a locking latch plate. The driver and front right passenger seat belts were equipped with buckle-mounted pretensioners and load limiters. The pretensioners did not actuate in the crash.

The driver's latch plate was found latched in the buckle and the seat belt had been cut out of the vehicle. A portion of it was being used to tie the left front door closed. Inspection of the latch plate and D-ring revealed load abrasions on the latch plate belt guide (**Figure 10**) and the D-ring (**Figure 11**). The on-scene photographs showed a portion of the cut seat belt across the driver's chest. The evidence indicated that the driver was restrained by the lap-and-shoulder belt. The remaining seat positions were unoccupied.

Figure 10: Load mark abrasions on the driver's latch plate belt guide

Figure 11: Load mark abrasions on the driver's D-ring

CASE VEHICLE DRIVER KINEMATICS

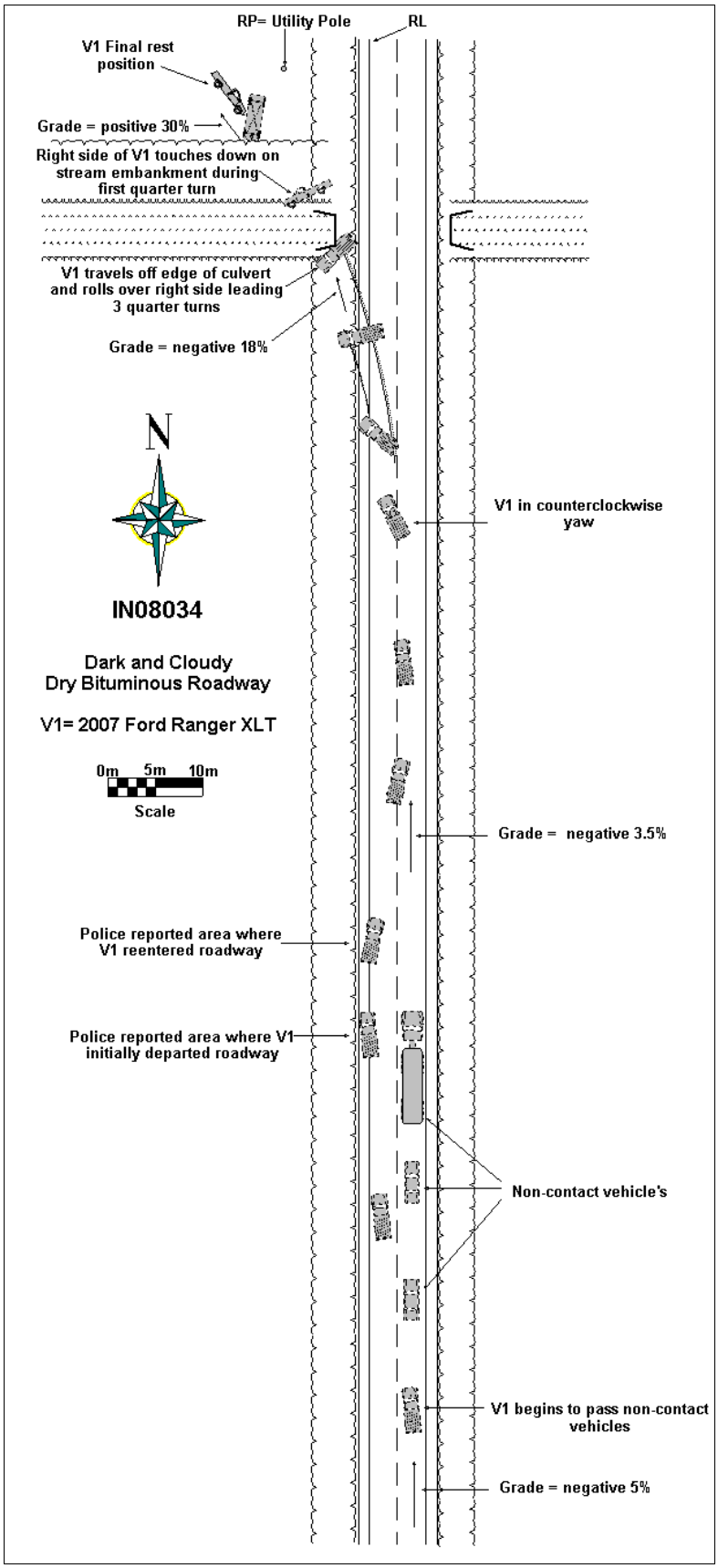
The Ford's driver [47-year-old, male; 183 centimeters and 118 kilograms (72 inches, 260 pounds)] was seated in an unknown posture. The seat track was adjusted to the full rear position and the seat back was slightly reclined. The tilt steering column was located in the center position.

The Ford was in a counterclockwise yaw as it departed the roadway just prior to the rollover, and due to the yaw the driver's seat belt retractor was probably locked. When the vehicle touched down on its right side, the driver was displaced to the right and his right hip loaded the back of the seat belt buckle and the arm rest. As the vehicle continued to roll over, the driver was redirected toward the roof as the vehicle landed on its top plane during the second quarter turn. The driver loaded the seat belt, his knees impacted the lower left instrument panel, and his thighs loaded the steering wheel rim. As the vehicle's roof was crushed vertically downward, the roof loaded his head causing unspecified blunt head trauma and an unspecified cervical injury. His body became entrapped between the roof and the seat.

CASE VEHICLE DRIVER INJURIES

The driver was pronounced deceased at the crash scene by the county coroner 62 minutes following the crash. No autopsy was performed. The table below shows 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	Blunt head trauma, not further specified	unknown 115999.7,0	Roof	Certain	Coroner's record
2	Blunt cervical spine injury, not further specified	unknown 615999.7,6	Roof {Indirect injury}	Certain	Interviewee (coroner)
3	Abrasion abdomen, not further specified	minor 590202.1,8	Lap portion of safety belt system	Certain	Interviewee (coroner)
4	Abrasion left thigh, not further specified	minor 890202.1,2	Lap portion of safety belt system	Probable	Interviewee (coroner)


RP= Utility Pole
RL
V1 Final rest position
Grade = positive 30%
Right side of V1 touches down on stream embankment during first quarter turn
V1 travels off edge of culvert and rolls over right side leading 3 quarter turns
Grade = negative 18%
N
V1 in counterclockwise yaw
IN08034
Dark and Cloudy
Dry Bituminous Roadway
V1= 2007 Ford Ranger XLT
0m 5m 10m
Scale
Grade = negative 3.5%
Police reported area where V1 reentered roadway
Police reported area where V1 initially departed roadway
Non-contact vehicle's
V1 begins to pass non-contact vehicles
Grade = negative 5%