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ON-SITE ROLLOVER INVESTIGATION

CASE NUMBER - IN09016
LOCATION - TEXAS
VEHICLE - 2007 FORD F150 SUPERCREW
CRASH DATE - April 2009

Submitted:

September 24, 2009

Contract Number: DTNH22-07-C-00044

Prepared for:

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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 focused on the rollover of a 2007 Ford F150 Supercrew pickup truck that occurred following an impact with a 1995 Mercury Cougar XR-7. The Ford's restrained 34-year-old male driver was traveling north in the inside lane of an 8-lane, divided U.S. highway. The Mercury was traveling north in the outside lane. The Mercury's front plane impacted the Ford's right rear wheel following an avoidance action of a non-contact vehicle by the driver of the Mercury. The impact on the Ford's right rear wheel caused the vehicle to rotate clockwise and it rolled over, left side leading. Following the rollover, the Ford impacted a longitudinal traffic barrier three times. The Ford's driver was transported by ambulance to a hospital. He sustained minor injuries and was treated in the emergency room and released.			
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This on-site investigation focused on the rollover of a 2007 Ford F-150 Supercrew pickup truck. This crash was brought to the attention of the National Highway Traffic Safety Administration (NHTSA) on April 22, 2009 by the sampling activities of the National Automotive Sampling System-General Estimates System. This investigation was assigned on May 1, 2009. The crash involved the Ford (**Figure 1**) and a 1995 Mercury Cougar XR7. The crash occurred in April, 2009 at 2137 hours, in Texas and was investigated by the city police department. The Ford was inspected on May 6, 2009. A partial crash scene inspection was conducted on May 7 2009. The driver of the Ford was interviewed on October 13, 2009 following initial submission of this report. This report is based on the police crash report, vehicle inspection, partial crash scene inspection, exemplar vehicle inspection, occupant kinematic principles, and evaluation of the evidence.

Figure 1: The damaged 2007 Ford F150 Supercrew pickup truck

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the Ford was traveling was an 8-lane, divided U.S. highway that traversed in a north-south direction. The trafficway had four travel lanes in each direction and was separated by a concrete median barrier and bordered by concrete traffic barriers. The roadway was initially straight and curved slightly right in the area of the crash. Due to heavy traffic volume, only a partial crash scene inspection could be conducted. The posted speed limit was 97 km/h (60 mph). At the time of the crash the light condition was dark with overhead lighting, the atmospheric condition was cloudy, and the roadway was dry concrete. The traffic density was unknown and the site of the crash was urban commercial. See the Crash Diagram on page 9 of this report.

Pre-Crash: The Ford's restrained 34-year-old male driver was traveling north in the inside lane (**Figure 2**) of the roadway. The Mercury's 21-year-old male driver was traveling north in the outside lane. The police crash report stated that the Mercury's driver initiated a passing maneuver into the second lane from the right. Simultaneously, a non-contact vehicle in the third lane from the right was moving into the same lane. The Mercury's driver braked and steered and avoided a crash with the non-contact vehicle. However, the Mercury lost directional control and entered the Ford's travel lane.

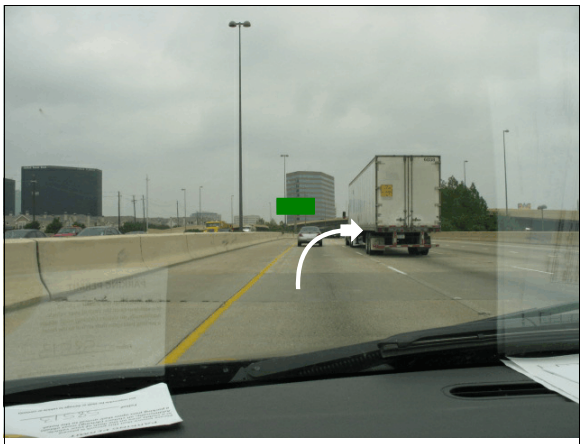


Figure 2: Approach of the Ford to the area of the crash; arrow illustrate Ford's travel path to rollover following initial impact with the Mercury

Crash: The left corner of the Mercury impacted the Ford's right rear wheel (event 1). The Mercury separated from the Ford and its front plane impacted the concrete median barrier (event 2). The Ford rotated clockwise and rolled over (event 3), left side leading. The Ford rolled over an estimated 4 quarter turns across an unknown distance, returned to its wheels, and began traveling backwards. It traveled northeast across the roadway and the back left bumper corner (**Figure 3**) impacted the concrete traffic barrier (event 4) adjacent to the east shoulder. The impact caused the vehicle to rotate counterclockwise and the left side plane (**Figure 4**) impacted the barrier (event 5) as the vehicle rode up the barrier. The front portion of the vehicle continued onto the top of the barrier as the vehicle continued to rotate counterclockwise and the undercarriage (**Figure 5**) impacted the top of the barrier (event 6). The Ford departed the barrier and came to final rest on the east shoulder of the roadway heading southwest. None of the Ford's air bags deployed as a result of the crash.

Figure 3: Arrow shows damage to Ford's back bumper from the impact with concrete traffic barrier (event 4)

Figure 4: Damage on the Ford's left side plane due to the rollover and concrete barrier impact

Figure 5: Undercarriage damage at front of Ford

Post-Crash: The police were notified of the crash at 2143 hours and arrived on scene at 2149 hours. Emergency medical and rescue personnel also responded to the crash scene. The Ford's driver was transported by ambulance to a hospital. The Mercury's driver was not injured. Both vehicles were towed from the crash scene due to damage.

ROLLOVER DISCUSSION

The Ford was not equipped with Electronic Stability Control (ESC) or a rollover inflatable curtain air bag system. The NHTSA has given this vehicle a four star rollover rating on a five star scale and a Static Stability Factor (SSF) of 1.22[1]. A four star rating indicates that the vehicle has a 10%-20% chance of a rollover when involved in a single vehicle crash. The specific chance of a rollover for this vehicle model was given as 17%. The SSF is a calculation based on the vehicle's track width and height of its center

[1] www.safercar.gov, 5/22/09

of gravity. The result of the calculation is a measure of a vehicle's resistance to rollover. A higher SSF indicates a more stable vehicle. The majority of passenger vehicles have an SSF of 1.30 to 1.50[2]. The test vehicle also did not tip in the dynamic steering maneuver test in which the test vehicle is put through a fish-hook shaped steering maneuver (i.e., hard left and hard right steer) at a speed of between 56 km/h-80km/h (35-50 mph).

The initial impact to the right rear wheel caused the Ford to rotate clockwise and it tripped and rolled over, left side leading. Due to the heavy traffic volume, a partial crash scene inspection was conducted, but any remaining crash induced physical evidence could not be identified or documented. As a result, the distance traversed during the rollover could not be determined. Based on the damage to the vehicle a reasonable estimate of 4 quarter turns was assigned.

CASE VEHICLE

The 2007 Ford F-150 Supercrew was a rear-wheel drive, 4-door, pickup truck (VIN: 1FTRW12W77K-------) that was manufactured in August, 2007. It was equipped with a 4.6L, V8 engine, 3-speed automatic transmission, 4-wheel, anti-lock disc brakes with electronic brake force distribution, and an Event Data Recorder (EDR). The front row was equipped with bucket seats, adjustable head restraints, lap-and-shoulder belts, and dual stage driver and front right passenger frontal air bags. The second row was equipped with a split bench seat (80/20) with a folding seat cushion, lap-and-shoulder belts, adjustable head restraints, and Lower Anchors and Tethers for Children (LATCH) in the outboard seating positions. The vehicle's specified wheelbase was 352 cm (138.5 in).

CASE VEHICLE DAMAGE

Exterior Damage: The damage from the impact with the Mercury (event 1) involved the right rear wheel. The wheel broke off the vehicle during the rollover and there was no crush on the right side plane related to this impact (**Figure 6**).

Figure 6: The Ford sustained no damage to the right side plane as a result of the Mercury's impact to the right rear wheel; the wheel was broken off during the rollover

The damage from the rollover (event 3) involved the vehicle's top plane and both side planes (**Figures 4** and **6**). The direct damage on the top plane began at the front left corner of the hood and extended 522 cm (206 in) to the back left corner of the truck bed. It involved the full width of the roof, 127 cm (50 in). The hood, roof, and the top left side of the truck bed were directly damaged.

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

The direct damage on the left side plane (**Figure 4**) began at the front left bumper corner and extended, 532 cm (209 in) rearward to the back of the truck bed. The left fender, both doors, and the left side of the truck bed were directly damaged.

Figure 7: Damage from the rollover on the vehicle's right side and roof

The direct damage on the right side (**Figures 6** and **7**) began 52 cm (20.5 in) forward of the right front axle and extended 382 cm (150 in) rearward along the upper right side to the end of the passenger compartment. There was no other direct damage on the right side plane except for the right side of the rear bumper (**Figure 6**). The induced damage involved the right front door. The maximum lateral and vertical crush occurred at the top of the right A-pillar (**Figure 8**) and were 13 cm (5.1 in) and 10 cm (3.9 in), respectively.

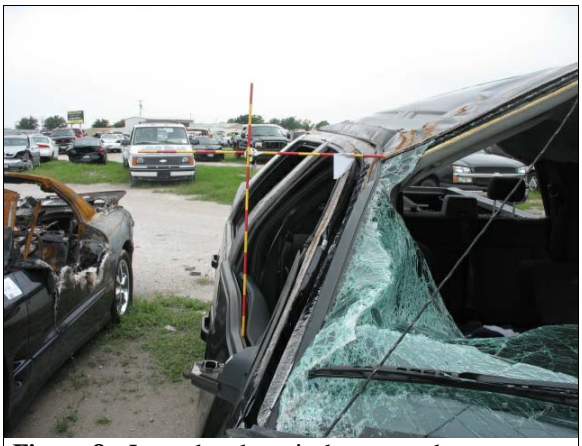


Figure 8: Lateral and vertical max crush

The initial barrier impact (event 4) involved the back plane. The direct damage began at the left bumper corner and extended 11 cm (4.3 in) along the bumper. The crush measurements were taken at the bumper level (**Figure 3**) and the maximum residual crush was 6 cm (2.4 in) occurring at C_1. Induced damage from this impact involved the lower left bed, directly forward of the back bumper, and the remainder of the back bumper. The table below shows the back bumper crush profile.

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	4	11	6	180	6	1	0	0	0	0	-86	0
in		4.3	2.4	70.9	2.4	0.4	0.0	0.0	0.0	0.0	-33.9	0.0

The second impact to the same barrier (event 5) involved the Ford's left side plane (**Figure 4**). The direct damage involved both doors and the truck bed. The direct damage began 94 cm (37 in) rear of the left front axle and extended 285 cm (112.2 in) rearward along the left side. Due to the angle of the damage, the crush measurements were taken diagonally from just above the sill to the top of the bed. The maximum residual crush was 6 cm (2.4 in) occurring at C_1. The induced damage involved the left side doors and the bed. The table below shows the left side crush profile.

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	5	285	4	325	0	3	4	2	0	0	-61	-82
in		112.2	1.6	128.0	0.0	1.2	1.6	0.8	0.0	0.0	-24.0	-32.3

The third impact to the same barrier involved the undercarriage (event 6). The lower portion of the front spoiler (**Figure 5**) and the undercarriage were directly damaged.

Damage Classification: The Ford's Collision Deformation Classifications were **03-RBWN-1** (**90** degrees) for the impact with the Mercury (event 1), **00-TDDO-3** for the rollover (event 3), **06-BLLS-1 (190** degrees**)** for the back left bumper corner impact to the concrete traffic barrier (event 4), **00-LZEW-1** for the left side impact with the barrier (event 5), and **00-UYYW-2** for the undercarriage impact with the barrier (event 6). A Delta V could not be calculated for events 1 and 3-6 since the impacts were out of scope of the program. Based on the extent of the roof crush, the severity of the damage due to the rollover was moderate. Based on the damage to the vehicle, the severity of the damage for the remaining events was minor.

The vehicle manufacturer's recommended tire size was P265/60R18. The Ford was equipped with P275/55R20 size tires. All the wheels except the right front were broken off the vehicle during the crash. The specific axle positions of the dislodged wheels could not be determined. The Ford'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			
Unk	Flat	Flat	345	50	6	7	Debeaded	No	Yes
Unk	Flat	Flat	345	50	6	7	None	No	Yes
Unk	152	22	345	50	6	8	None	No	No
RF	Flat	Flat	345	50	5	6	Debeaded	No	Yes

Vehicle Interior: The inspection of the Ford's interior (**Figure 9**) revealed no discernable evidence of occupant contact. The Ford's left rear door was jammed shut. The remaining doors remained closed and operational. The pre-crash status of all the window glazings was either closed or fixed. The windshield was in place and cracked from impact forces, while all the remaining window glazings were disintegrated due to impact forces.

The vehicle's passenger compartment sustained 14 intrusions. The most severe intrusions involved the right A-pillar, B-pillar, and roof. The B-pillar and roof intruded vertically (**Figure 10**) into the front right occupant space 40 cm (15.7 in) and 28 cm (11 in), respectively. The A-pillar intruded laterally 13 cm (5.1 in).

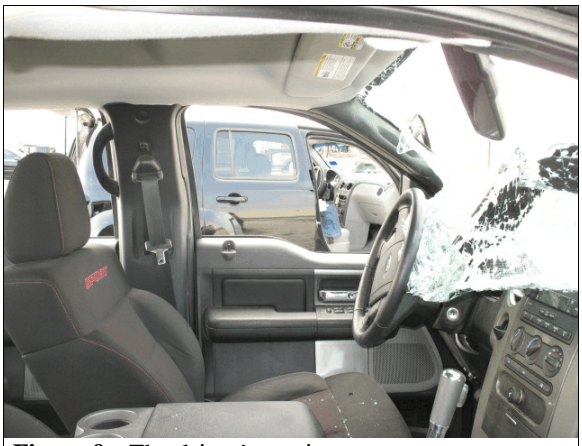


Figure 9: The driver's seating area

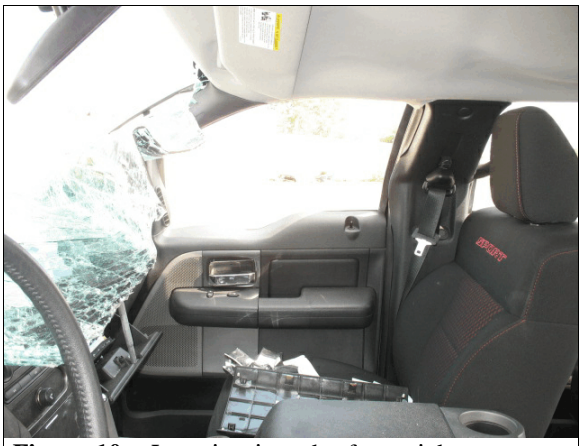


Figure 10: Intrusion into the front right occupant space

EVENT DATA RECORDER

The vehicle's EDR data was imaged using the required cable, adapter, and version 3.1 of the Bosch Crash Data Retrieval tool via connection to the vehicle's diagnostic link connector. The imaged data was subsequently read using software version 3.3. The only data that was available for imaging was from the Power Control Module (PCM). The PCM records only pre-crash related data. It will be locked in memory if the PCM receives a Restraint Deployment Signal (RDS) from the Restraint Control Module (RCM). Since no air bags or pretensioners deployed in this crash, no RDS was issued by the RCM and the pre-crash data was not locked. The PCM recorded zeros for all the pre-crash speed and engine RPM data. This indicated that the PCM's circular buffer either continued recording after the vehicle came to final rest, or the ignition was subsequently turned to the run position at some point following the crash thereby overwriting the pre-crash data.

AUTOMATIC RESTRAINT SYSTEM

The Ford was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual stage driver and front right passenger air bags, driver seat position sensor, seat belt usage sensors, buckle-mounted pretensioners, and a front right passenger weight presence sensor. Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the frontal air bag impact sensors were located on the lower 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. None of the Ford's air bags deployed as a result of the crash.

MANUAL RESTRAINT SYSTEM

The Ford was equipped with lap-and-shoulder belts for the front and second row seating positions. The driver's seat belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), a sliding latch plate, and an adjustable upper anchor that was in the full-

up position. The front right seat belt was similarly equipped but had a switchable ELR/Automatic Locking Retractor (ALR), and the adjustable upper anchor that was located in the full-down position. The driver and front passenger seat belts were equipped with buckle-mounted pretensioners. The second row lap-and-shoulder belts consisted of continuous loop belt webbing, sliding latch plates, switchable ELR/ALRs, and fixed upper anchors.

Inspection of the driver's seat belt revealed historic usage scratches on the latch. The seat belt webbing, D-ring, and latch plate belt guide showed no evidence of loading. There was no evidence that the driver's buckle-mounted pretensioner actuated. The length of the driver and front passenger's buckle stalks was not reduced, and the distance from each pretensioner piston to the end of housing was 5 cm (2 in). The driver's medical records reported a contusion on his left shoulder that was consistent with restraint usage in this crash. The remaining seat positions were unoccupied.

CASE VEHICLE DRIVER KINEMATICS

Based on the SCI interview, the driver of the Ford [34-year-old, male; 180 cm (71 in) and 91 kg (200 lbs)] was seated in an upright posture with his back against the seat back. He had his left hand on the steering wheel and his right foot on the accelerator pedal. The seat track was adjusted between the middle and rear positions and the seat back was slightly reclined. The tilt steering column was located between the center and full-up position.

The initial impact to the right rear wheel probably displaced the driver to the right to some degree within his seat belt. As the Ford rotated clockwise, the driver was probably displaced to the left. When the vehicle rolled over, left side leading, the driver was displaced to the left and toward the roof within the seat belt. He loaded the seat belt during the rollover, which caused a contusion on the anterior and lateral portion of the left shoulder. He also sustained an abrasion on the outside of the left shoulder, which was probably due to contact with the left B-pillar. The driver remained restrained within his seat position throughout the crash sequence. He exited the vehicle under his own power through the left front door following the crash.

CASE VEHICLE DRIVER INJURIES

The driver sustained police reported B-injuries and was transported by ambulance to a hospital. He was treated in the emergency room and released. The table below shows his injuries and injury sources.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
	Pain, acute, neck[3] with anterior tenderness	not coded			Emergency room records

[3] According to the patient's medical records, his neck was negative for acute changes; there was no midline tenderness, no step-offs, painless active and passive range of motion, no visible signs of trauma, and no stiffness or rigidity.

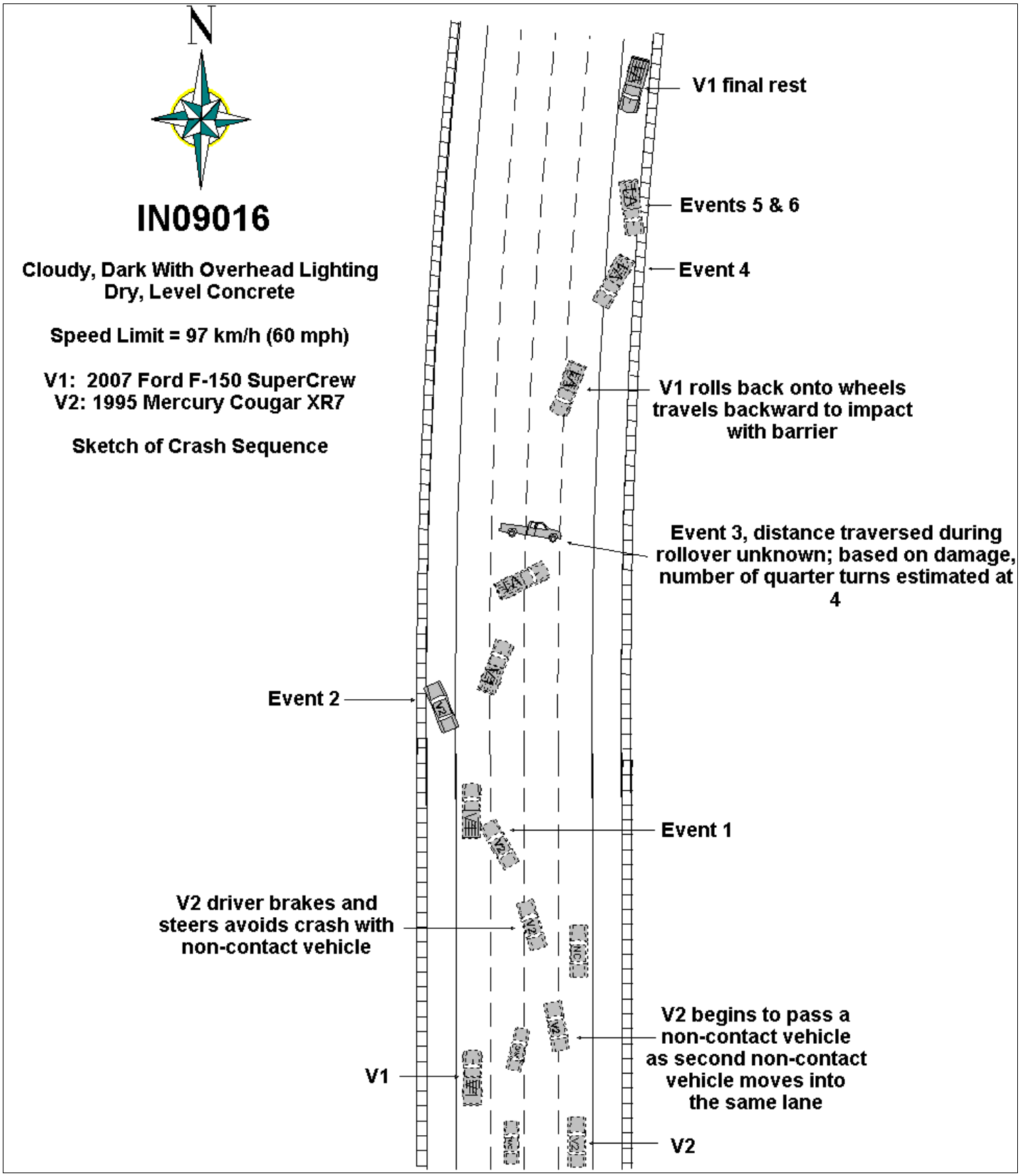
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Abrasions to left anterior shoulder	minor 790202.1,2	Torso portion of safety belt system	Probable	Emergency room records
2	Abrasions to left lateral shoulder, including biceps area	minor 790202.1,2	Left B-pillar	Probable	Emergency[4] room records

OTHER VEHICLE

The 1995 Mercury Cougar XR7 was a front wheel drive, 2-door coupe (VIN: 1MELM62W2SH------), equipped with frontal air bags. The Mercury sustained front plane damage and the police crash report indicated that the frontal air bags deployed. The vehicle was towed due to damage.

Other Vehicle's Driver: The Mercury's driver (21-year-old, male) did not sustain any police-reported injuries. He was not transported to a medical facility.

[4] This lesion was cited on both the patient's medical records and during the interview, but the injury source was identified during the interview.


N
IN09016
Cloudy, Dark With Overhead Lighting
Dry, Level Concrete
Speed Limit = 97 km/h (60 mph)
V1: 2007 Ford F-150 SuperCrew
V2: 1995 Mercury Cougar XR7
Sketch of Crash Sequence
V1 final rest
Events 5 & 6
Event 4
V1 rolls back onto wheels
travels backward to impact
with barrier
Event 3, distance traversed during
rollover unknown; based on damage,
number of quarter turns estimated at
4
Event 2
Event 1
V2 driver brakes and
steers avoids crash with
non-contact vehicle
V2 begins to pass a
non-contact vehicle
as second non-contact
vehicle moves into
the same lane
V1
V2