CRASH DATA RESEARCH CENTER
Calspan Corporation
Buffalo, NY 14225

ON-SITE AIR BAG NON-DEPLOYMENT/DRIVER FATALITY INVESTIGATION
CALSPAN CASE NO: CA05-060

VEHICLE: 2004 FORD F150 PICK-UP TRUCK
LOCATION: NORTH CAROLINA
CRASH DATE: AUGUST, 2005

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are 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 STANDARD TITLE PAGE

1. Report No. CA05-060	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle On-Site Air Bag Non-Deployment/Driver Fatality Investigation Vehicle: 2004 Ford F150 Location: North Carolina		*5. Report Date*: March 2006	
		6. Performing Organization Code	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Calspan Corporation Crash Data Research Center P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0329	
		11. Contract or Grant No. DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: August 2005	
		14. Sponsoring Agency Code	
15. Supplementary Note An investigation of the non-deployment of the driver air bag in a 2004 Ford F150 in a frontal crash.			

16. Abstract

This investigation focused on the crash dynamics, fatal injury sources, and the issues surrounding the non-deployment of the driver air bag in a 2004 Ford F150 Supercab Pick-up Truck during a fixed-object crash. The 66 year old driver of the Ford was restrained at the time of the crash by the manual safety belt and sustained fatal injuries due to contact with the steering wheel rim/column. He was the vehicle's sole occupant. The subject Ford departed the left side of the road for unknown reasons, and sustained an undercarriage impact with an embankment covering a culvert prior to a frontal impact with a hardwood tree. The Ford F150 was equipped with a Certified Advanced 208-Compliant (CAC) air bag system. The manufacturer of this vehicle certified that the F150 met the requirements of the advanced 208 Federal Motor Vehicle Safety Standard (FMVSS 208). The CAC system was comprised of the following components: advanced dual-stage frontal air bags, driver seat track position sensor, front safety belt buckle switch sensors, front safety belt pretensioners, and a front right occupant presence detection sensor. The vehicle's Restraint Control Module (RCM) was designed to tailor the deployment of the front seat belt pretensioners and frontal air bags based the crash severity and inputs from these components. The RCM in the subject vehicle was not supported by the Vetronix Crash Data Retrieval (CDR) tool; therefore any potential crash related data stored within the module was not publicly accessible. Neither the pretensioner nor the driver air bag deployed in the crash.

17. Key Words Certified Advanced Compliant FMVSS 208 Air Bag Non-Deployment Fatal injury Undercarriage Impact Frontal Impact		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 11	*22. Price*

TABLE OF CONTENTS

ON-SITE AIR BAG NON-DEPLOYMENT/DRIVER FATALITY INVESTIGATION
CALSPAN CASE NO: CA05-060

VEHICLE: 2004 FORD F150 PICK-UP TRUCK
LOCATION: NORTH CAROLINA
CRASH DATE: AUGUST, 2005

BACKGROUND

This investigation focused on the crash dynamics, fatal injury sources, and the issues surrounding the non-deployment of the driver air bag in a 2004 Ford F150 Supercab Pick-up Truck during a fixed-object crash. The 66 year old driver of the Ford was restrained at the time of the crash by the manual safety belt and sustained fatal injuries due to contact with the steering wheel rim/column. He was the vehicle's sole occupant. The subject Ford, **Figure 1**, departed the left side of the road for unknown reasons, and sustained an undercarriage impact with an embankment covering a culvert prior to a frontal impact with a hardwood tree. The Ford F150 was equipped with a Certified Advanced 208-Compliant (CAC) air bag system. The manufacturer of this vehicle certified that the F150 met the requirements of the advanced air bag Federal Motor Vehicle Safety Standard (FMVSS 208). The CAC system was comprised of the following components: advanced dual-stage frontal air bags, driver seat track position sensor, front safety belt buckle switch sensors, front safety belt pretensioners, and a front right occupant presence detection sensor. The vehicle's Restraint Control Module (RCM) was designed to tailor the deployment of the front seat belt pretensioners and frontal air bags based the crash severity and inputs from these components. The RCM in the subject vehicle was not supported by the Vetronix Crash Data Retrieval (CDR) tool; therefore any potential crash related data stored within the module was not publicly accessible. Neither the pretensioner nor the driver air bag deployed in the crash.

Figure 1: On-scene police photograph of the Ford at final rest.

The National Highway Traffic Safety Administration's (NHTSA's) Office of Defects Investigation (ODI) was notified of the crash by the law firm representing the driver's family on November 3, 2005. On November 8, 2005, ODI asked NHTSA's Crash Investigation Division to assign an on-site crash investigation to the Calspan Special Crash Investigations team. The law firm had supplied NHTSA with a police report, on-scene police photographs, and the medical examiner's death certificate. The Calspan SCI team initiated contact with the law firm, established cooperation and requested an inspection of the vehicle. The Ford F150 was in the possession of the law firm and was located in a storage facility. The on-site portion of the investigation took place December 1, 2005.

SUMMARY

Crash Site

The crash occurred during the daylight hours of August 2005. At the time of the crash, the weather was cloudy and the road surface was dry. At the crash site, the north/south two-lane asphalt road was straight and level. The road was comprised of two 3.1 m (10.1 ft) lanes with (0.4 m) 1.2 ft wide shoulders. A 46 cm (18 in) deep ditch bordered the east road side and was centered 4.5 m (14.7 ft) east of the road edge. The terrain along the east side of the road was level immediately outboard the road edge and began to slope into the ditch 2.5 m (8.1 ft) from the pavement. The ditch terminated into a culvert pipe which then ran under an unimproved driveway. The driveway measured 12 m (39 ft) in width. An open field was located south of the driveway. The point of impact was a 47 cm (18.5 in) diameter hardwood tree located along the south edge of the field. The location of the tree measured 9.4 m (30.8 ft) east of the road edge and 25 m (83 ft) south of the driveway (along the Ford's trajectory). **Figures 2 through 4** are views of the crash site. **Figure 2** is a trajectory view depicting the Ford's gradual road departure taken during the police investigation. **Figure 3** is a trajectory view from termination of the ditch taken during the SCI investigation. (Note: the struck tree is in the center background of the photograph.) **Figure 4** is a view of the struck tree.

Figure 2: Police photograph of the Ford's trajectory.

Figure 3: Trajectory view at the culvert.

Figure 4: View of the struck tree.

CRASH SEQUENCE

Pre-Crash

The Ford F150 was driven by a 66 year old restrained male and was traveling southbound. The driver was the vehicle's sole occupant. For unknown reasons, the driver relinquished directional control of the vehicle allowing the Ford to cross the centerline, pass through the opposing travel lane, and depart the east (left) side of the road. The vehicle departed the road at a shallow angle (estimated at 5 degrees) in a tracking trajectory. Refer to **Figure 2** above.

Crash

The Ford departed the road 67 m (221 ft) north of the point of impact with the tree. The police report documented approximately 31 m (103 ft) of rotating tire marks along the vehicle's off-road trajectory. The Ford remained in a tracking mode with the left side tires entering the ditch. At the ditch's termination to the culvert, the left undercarriage of the Ford impacted the embankment evidenced by a 2 m x 1.2 m (6 ft x 4 ft) area of gouged earth (Event 1). The vehicle then traversed the driveway and traveled an additional 35 m (114 ft) to a frontal impact with the hardwood tree (Event 2). The tree trunk was scarred around two-thirds of its circumference from ground up to an elevation of 12 cm (32 in). A 1.6 square cm (4 square in) plug of the tree trunk fractured and was removed as a result of the impact. The plug was found embedded in the deformed end of the vehicle's right frame rail. The removed trunk section was located 6 cm (16 in) above the ground and defined the Ford's impact alignment. Refer to **Figure 5**. The depth of the plug measured 1.6 cm (4 in). The delta V of the Ford calculated by the Damage Algorithm of the WINSMASH model was 54.9 km/h (34.1 mph). That calculation underestimated the true delta V based on SCI field experience. The dynamics of this impact were beyond the limits of the WINSMASH model due to the severity of the deformation coupled with the narrow object impact. Neither the safety belt pretensioner nor frontal air bags in the vehicle deployed as a result of the impact.

Figure 5: Close-up view of the tree and the removed plug.

Post-Crash

The police and ambulance personnel responded to the scene. The driver was pronounced deceased at the crash site. The driver sustained fatal injuries due to contact with the steering wheel rim/column. The medical examiner's death certificate indicated the driver suffered a closed head injury and closed chest trauma. An autopsy was not performed.

2004 FORD F150 SUPERCAB

Figure 6: Exemplar 2004 Ford F150 Supercab.

The 2004 Ford F150 Supercab Pick-up truck was identified by the Vehicle Identification Number (VIN): 1FTRX12W54N (production sequence deleted). **Figure 6** is a front view of an exemplar Ford F150 Supercab. The 4X2, four door extended cab was configured with a 367 cm (144.4 in) wheelbase and had a Gross Vehicle Weight Rating of 3039 kg (6700 lb). The power train consisted of a 4.6 liter/V8 engine linked to a four-speed automatic transmission with overdrive. The service brakes were a front and rear disc system with four-wheel ABS. The vehicle had the seating capacity for six passengers. The manual safety restraints consisted of three-point lap and shoulder belts for the outboard front and three rear seated occupants. The front center position was equipped with a lap belt. The front restraints utilized buckle pretensioners. The Ford was equipped with Michelin LTX A/S P255/65R17 tires on OEM alloy wheels. The recommended tire pressure was 240 kPa (35 PSI). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	209 kPa (30.5 PSI)	7.1 mm (9/32 in)	No	None
LR	209 kPa (30.5 PSI)	7.1 mm (9/32 in)	No	None
RF	158 kPa (23.0 PSI)	7.1 mm (9/32 in)	Yes	None
RR	206 kPa (30.0 PSI)	7.1 mm (9/32 in)	No	None

The Ford F150's date of manufacture was November 2003. The electronic odometer was inoperable at the time of the inspection; therefore the mileage at the time of the crash was unknown. The truck was purchased new by the fatally injured driver in November 2004. He was the vehicle's sole owner and there were no reported crashes in the vehicle's history.

EXTERIOR DAMAGE

The exterior damage to the Ford consisted of dirt and debris embedded in the front undercarriage (Event 1), and severe impact damage to the front right aspect of the vehicle as a result of the tree impact (Event 2). **Figure 7** is a front view of the Ford. The alignment of the vehicle at impact was defined by the lateral location of the right frame rail relative to the plug fractured from the tree trunk. At impact, the centerline of the truck was located 53 cm (20.7 in) left of the center of the tree. The centerline of the truck was not involved in the direct contact. The direct contact damage at the bumper elevation began 9 cm (3.5 in) right of center and extended to a point located 56 cm (22.0 in) right of center. The direct damage along the hood face began 10 cm (4.0 in) right of center. The right frame rail collapsed and buckled longitudinally. The maximum crush of the rail measured 127 cm (50.1 in). Due to the penetration of the tree, the bumper

system and front structures of the Ford wrapped around the trunk. **Figure 8** is an overhead view of the bumper profile and its projection to the ground. The left frame rail deformed inboard and rearward due to bending. The end of the deformed left frame rail measured 55 cm (21.9 in) rearward and 55 cm (21.7 in) inboard of its original location. The residual crush profile was as follows: C1 = 15 cm (5.9 in), C2 = 127 cm (50.0 in), C3 = 129 cm (50.6 in), C4 = 94 cm (36.9 in). The right lower radiator mount was displaced rearward 77 cm (30.3 in). **Figure 9** is a right side view of the Ford. The right wheelbase was foreshortened 33 cm (12.9 in) and its suspension was rotated 90 degrees inboard. The left wheelbase was lengthened 22 cm (8.6 in) due to frame bending. The rake angles of the right and left A-pillars measured 53 degrees and 38 degrees, respectively. For reference, the rake angle of the A-pillar measured on an exemplar vehicle was 35 degrees. The steeper angle of the deformed right A-pillar caused a 26 cm (10.3 in) vertical buckle in the front right roof area. There was evidence of direct cab-to-bed contact at both left and right B-pillars due to compression. All the doors were open at the time of the inspection and could not be closed due to the body deformation. The Collision Deformation Classifications (CDC's) of the Ford were 00-UYDW1 and 12-FZAW6 for Events 1 and 2, respectively. The dynamics of the narrow object impact were beyond the limits of the WINSMASH model. The delta V of the crash was in excess of 55 km/h (34 mph).

Figure 7: Front view of the F150.

Figure 8: Overhead view of the bumper deformation.

Figure 9: Right side view.

INTERIOR DAMAGE

Due to the magnitude and location of the exterior impact force, the extent of the interior damage was biased to the right side; however, the interior damage to the Ford did extend across the width of the occupant compartment. The longitudinal intrusion of the right corner of the instrument panel measured 30 cm (12.0 in). The center instrument panel was in contact with the seat cushion of the center position. Measurements from an exemplar vehicle revealed the center intrusion was 33 cm (13.0 in). The left corner of the instrument panel intruded 10 cm (4.0 in). The intruded values of the right and left toe pan measured 44 cm (17.5 in) and 41 cm (16.3 in), respectively.

Figure 10: Left front interior.

The driver seat was located in a rear track position that measured 5 cm (1.9 in) forward of full rear. The total seat track travel measured 22 cm (8.5 in). The seat back was reclined 15 degrees. Although the seat back deflected forward due to the driver's use of the integrated seat belt during the crash sequence, there was no noted permanent deflection. The post-crash horizontal distance from the seat back to the driver air bag module located in the center of the steering wheel measured 44 cm (17.5 in).

The four-spoke steering wheel rim was rotated 80 degrees clockwise at inspection. The cast alloy rim was deformed forward 15 cm (6.0 in) in the 3 o'clock sector and the 3 and 5 o'clock spokes were fractured. The deformed rim became elliptical in shape measuring 39 cm (15.5 in) in the 3/9 sector and 30 cm (12.0 in) in the 6/12 sector. The fractured spokes exposed the non-deployed driver air bag module. The intrusion of the steering wheel rim/column measured at the center hub was 14 cm (5.5 in).

Figure 11: Deformed steering wheel rim and undeployed driver air bag module.

Two contact areas attributed to the driver's lower extremities were identified. The handle of the parking brake release was fractured due to contact with the left lower extremity. This contact was located on the lower instrument panel, 29 cm (11.5 in) left of the steering column. The right lower extremity contacted the bolster 18 cm (7.0 in) right of the steering column evidenced by a 10 cm x 8 cm (4 in x 3 in) scuff mark. A 3 cm (1 in) diameter fluid spatter was identified on the outboard aspect of the left sunvisor.

MANUAL RESTRAINT SYSTEM

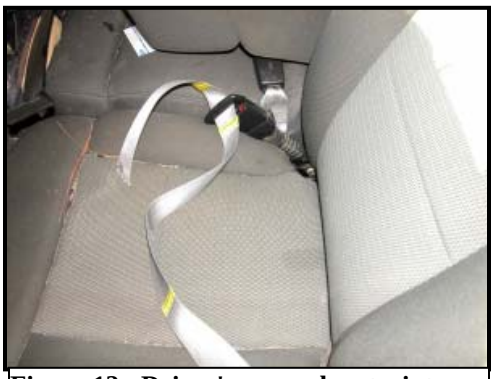


Figure 12: Driver's manual restraint.

The driver's manual restraint consisted of an integrated 3-point lap and shoulder belt with continuous loop webbing, sliding latch plate, Emergency Locking Retractor (ELR), and buckle pretensioner. Initial inspection of the manual restraint revealed the webbing had been cut by the first responders. The latch plate was still buckled into the receiver. The length of the cut webbing measured 91 cm (36 in) referenced to the outboard anchor. The balance of the webbing had spooled back into the seatback mounted retractor and was not visible for inspection. The lap portion of the cut webbing revealed 34 cm (13.5 in) of loading evidence. The loaded section began 25 cm (10.0 in) above the anchor. The webbing was creased within a 6 cm (2.5 in) section at the latch plate and an examination of the latch plate hardware revealed the friction surface of belt path was abraded. The latch plate revealed evidence of historical use. The buckle pretensioner did not fire. The measured length of the pretensioner barrel was 57 mm (2.25 in) consistent with the unused front right pretensioner measurement. This pretensioner measurement was also verified with an exemplar vehicle. Inspection of the driver's manual restraint indicated he was restrained at the time of the crash and loaded the safety system during the ride-down of the event.

FRONTAL AIR BAG SYSTEM

The frontal air bag system in the subject 2004 Ford F150 consisted of Certified Advanced 208 Compliant driver and front right passenger air bags. The manufacturer of the vehicle certified the F150 met the requirements of the advanced air bag FMVSS 208 standard. The system consisted of dual stage frontal air bags, a driver seat track position sensor, front safety belt buckle switch sensors, front safety belt pretensioners, and a front right occupant presence detection system. The system was monitored and controlled by a Restraint Control Module (RCM) mounted under the center instrument panel. The RCM was designed to deploy the appropriate safety systems based on the crash severity and inputs from those components. The crash and safing sensors were mounted within the RCM. The system also utilized a front satellite crash sensor mounted on the vehicle's centerline at the radiator plane. The purpose of the satellite sensor was to enhance the transmission of a "soft" crash pulse to the RCM that may occur from a narrow object frontal impact between the frame rails. **Figure 13** is a view of the satellite sensor. The sensor was not involved in the direct contact and was undamaged.

The following manufacturer's nomenclature identified the driver air bag module and the front satellite sensor:

Driver Air Bag Module	4L35 15043B13 BF32NC DP BD31020BJ
Front Satellite Sensor:	413A-14B006-AB B39357JS2102

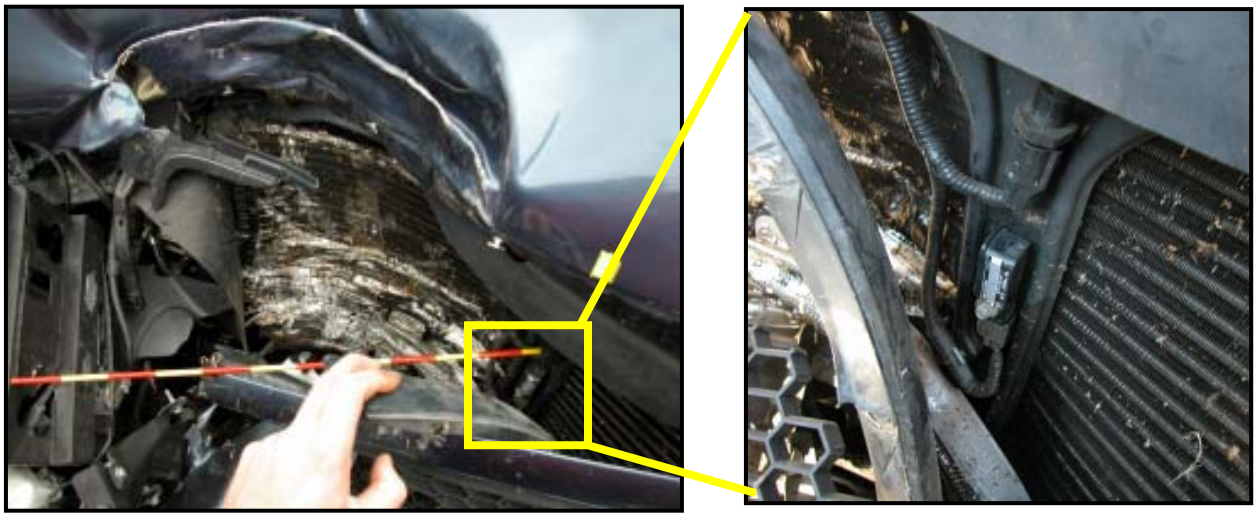


Figure 13: View of the undamaged front satellite sensor.

Given the advanced safety systems and components incorporated into the design of this vehicle, it is probable that the RCM controlling the air bag system had the capabilities to record crash data. However, any potential the crash data recording capability by this model was not currently supported by the Vetronix Crash Data Retrieval tool and the vehicle data could not be downloaded. Any potential crash data would only be accessible through the manufacturer.

The root cause of the non-deployed safety systems in this crash was not directly identified. There were no obvious mechanical or electrical faults. The subject vehicle was not involved in any known previous crashes; therefore a faulty repair was not an issue. Given that the location of the tree impact was directly on the frame rail, the force of the impact should have been immediately transmitted through the vehicle's frame to the crash sensors in the RCM. However, neither the driver air bag nor the driver pretensioner deployed in this crash. Upstream from the tree impact event, the Ford underwent a significant undercarriage impact with the ground beyond the culvert end. In terms of crash sensing, this event would have "woken-up" the system but the severity of the crash pulse did not require deployment of the safety systems. The vehicle then traveled over comparatively rough terrain to impact. It has been theorized that during this off-road trajectory, the sensing algorithm probably continued to analyze the long duration event and during this period the system either did not reset or timed-out, thereby suppressing the deployment of the safety systems. The non-deployed state of both the pretensioner and the driver air bag is indicative of a possible anomaly in the crash sensing, rather than a failure of a single component.

DRIVER DEMOGRAPHICS

	Driver
Age/Sex:	66 year old/Male
Height:	175 cm (69 in)
Weight:	86 kg (190 lb)
Seat Track Position:	Rear track 5 cm (1.9 in) forward of full rear
Restraint Use:	Integrated 3-point lap and shoulder
Usage Source:	SCI inspection, observations of the first responders
Medical Treatment:	None, expired at scene

DRIVER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Source***
Closed head injury	Unknown (115999.7,0)	Steering wheel/column
Closed chest trauma	Unknown (415999.7,0)	Steering wheel/column

The above injuries were identified on the Medical Examiner's Death Certificate. No autopsy was performed.

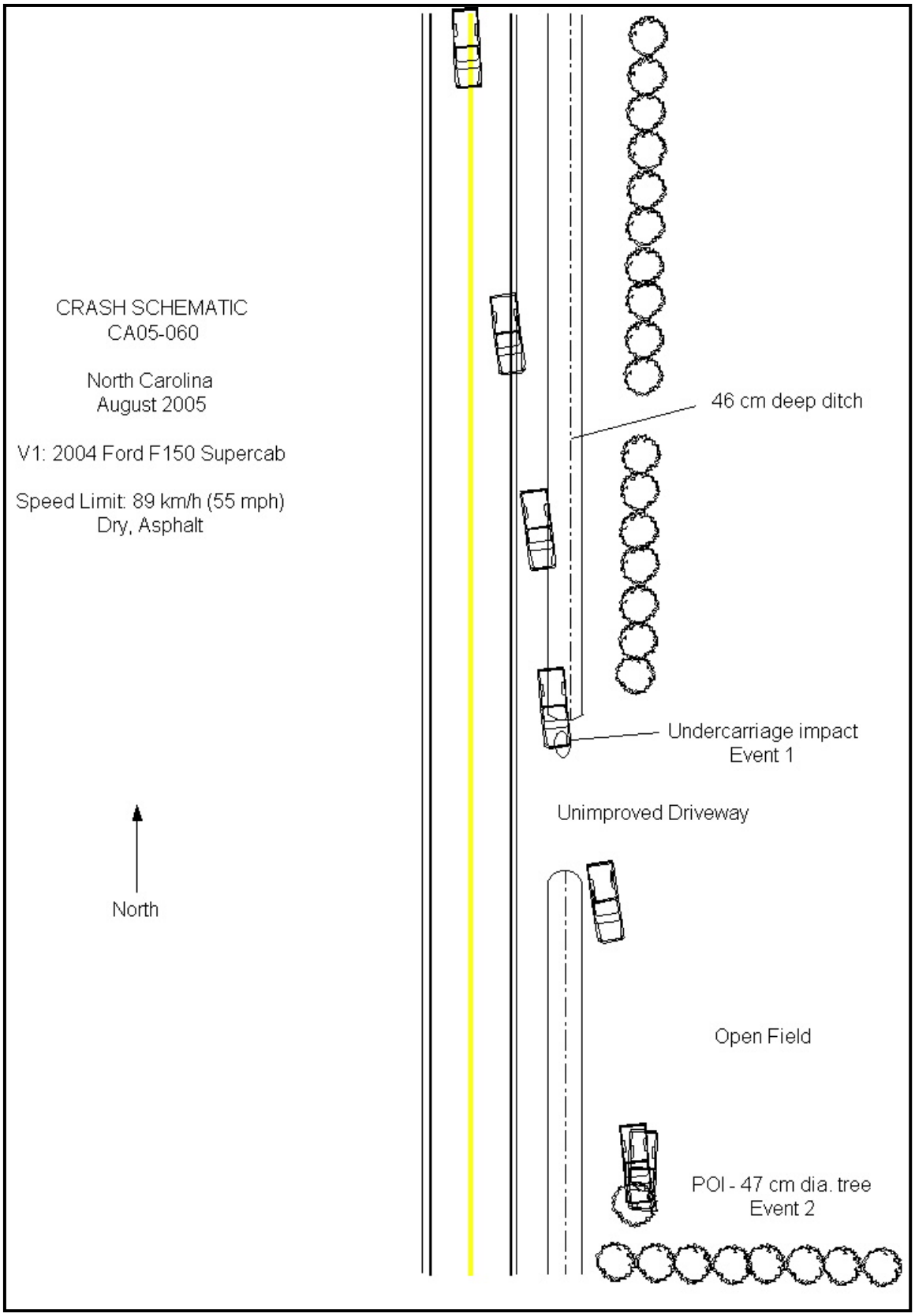
DRIVER KINEMATICS

Prior to the crash, the 66 year old driver was seated in a rear track position and was restrained by the integrated 3-point lap and shoulder belt. For unknown reasons, the driver lost directional control of the Ford and departed the left side of the road. The vehicle's left side tires entered and then followed the shallow road side ditch.

Upon reaching the end of the ditch, the left front undercarriage impacted the embankment covering the culvert. The sudden deceleration of the undercarriage impact (likely) locked the Emergency Locking Retractor (ELR) of the manual restraint system. The driver responded to the non-horizontal clock direction of the (relatively) minor deceleration force by translating forward and downward, compressing the seat cushion, and loading the safety belt. The vehicle then traveled along its trajectory to impact with the tree. The driver probably remained in his upright/slightly forward posture during this time. The retractor may have unlocked during this time.

Upon impact with the tree, the ELR locked and the driver loaded manual restraint system in response to the 12 o'clock direction of the impact. The safety belt pretensioner and driver air bag did not deploy. As the driver loaded the safety belt with his chest and pelvis and began to ride-down the crash, the seat back reacted to the increasing belt forces through the integrated belt guide and retractor. Due to the compliant structure of the seat back, the loading of the shoulder restraint caused the seat back to deflect forward. This in-turn allowed the driver to translate further forward. Coincident with this pattern, the interior structures of the vehicle were intruding rearward. The driver's chest contacted and fractured the intruded steering wheel rim resulting in the fatal blunt chest trauma. The driver's head continued forward due to its inertia and the neck flexed forward. This pattern caused the head travel in an arcing forward and downward path,

impacting the upper steering wheel rim resulting in the closed head injury. The driver then rebounded into the seat where he expired.


CRASH SCHEMATIC
CA05-060
North Carolina
August 2005
V1: 2004 Ford F150 Supercab
Speed Limit: 89 km/h (55 mph)
Dry, Asphalt
North
46 cm deep ditch
Undercarriage impact
Event 1
Unimproved Driveway
Open Field
POI - 47 cm dia. tree
Event 2