CRASH DATA RESEARCH CENTER
Calspan Corporation
Buffalo, NY 14225

OFFICE OF DEFECTS INVESTIGATION
2003 FORD CROWN VICTORIA POLICE INTERCEPTOR
REAR IMPACT CRASH AND FIRE INVESTIGATION

CALSPAN CASE NO: CA04-035

LOCATION: TEXAS
CRASH DATE: AUGUST, 2004

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. CA04-035	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Office of Defects Investigation Rear Impact Crash and Fire Invetigation 2003 Ford Crown Victoria Police Interceptor Location: Texas		*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 Transportation Sciences Crash Data Research Center Advanced Information Engineering Services P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0227 *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 2004 *14. Sponsoring Agency Code*	
15. Supplementary Note On-site investigation of a 2003 Ford Crown Victoria Police Interceptor involved in a rear impact crash and crash induced fire.			
16. Abstract This investigation focused on the rear-impact crash of a 2003 Ford Crown Victoria Police Interceptor (CVPI), and the cause of its subsequent crash-induced fire. The fire consumed 95 percent of the vehicle and caused minor thermal burns to the 30 year old male on-duty police officer. The officer was working speed enforcement and had pulled over a 1999 Acura 3.2TL driven by a 41 year old male. The Ford CVPI was parked on the right shoulder of the interstate behind the Acura with its emergency lights activated, when it was struck from behind by a 2003 Nissan Xterra sport utility vehicle. The police officer had just pulled the Acura over and was in the process of exiting the vehicle at the time of the crash. The force of the impact displaced the Ford forward into a secondary crash with the back plane of the Acura. A fuel-fed fire started immediately following the initial impact. The officer was initially rendered unconscious by the force of the initial impact. Motorist passing by the crash site stopped and removed the officer through the window opening of the front left door. He was transported to a regional trauma center and admitted for treatment of a possible closed head injury and burns to his left lower extremity. The 21 year old male driver and 22 year old front right passenger of the Nissan sustained police reported minor injuries. The male driver seated in the Acura was not injured.			
17. Key Words Police Interceptor Fuel System Rear Impact Crash induced fire		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 14	*22. Price*

TABLE OF CONTENTS

OFFICE OF DEFECTS INVESTIGATION
REAR IMPACT CRASH AND FIRE INVESTIGATION

2003 FORD CROWN VICTORIA POLICE INTERCEPTOR
CALSPAN CASE NO: CA04-035
LOCATION: TEXAS
CRASH DATE: JULY, 2004

BACKGROUND

This investigation focused on the rear-impact crash of a 2003 Ford Crown Victoria Police Interceptor (CVPI), and the cause of its subsequent crash-induced fire. The fire consumed 95 percent of the vehicle and caused minor thermal burns to the 30 year old male on-duty police officer. The officer was working speed enforcement and had pulled over a 1999 Acura 3.2TL driven by a 41 year old male. The Ford CVPI, (**Figure 1**), was parked on the right shoulder of the interstate behind the Acura with its emergency lights activated, when it was struck from behind by a 2003 Nissan Xterra sport utility vehicle. The police officer had just pulled the Acura over and was in the process of exiting the vehicle at the time of the crash. The force of the impact displaced the Ford forward into a secondary crash with the back plane of the Acura. A fuel-fed fire started immediately following the initial impact. The officer was initially rendered unconscious by the force of the initial impact. Motorist passing by the crash site stopped and removed the officer through the window opening of the front left door. He was transported to a regional trauma center and admitted for treatment of a possible closed head injury and burns to his left lower extremity. The 21 year old male driver and 22 year old front right passenger of the Nissan sustained police reported minor injuries. The male driver seated in the Acura was not injured.

Figure 1: Left side view of the 2003 Ford CVPI.

Notification of this crash was provided to the Calspan Special Crash Investigations team by the Fleet Manger of the New York State Police on Monday July 26, 2004. The SCI team subsequently notified the Crash Investigation Division of the National Highway Traffic Safety Administration and an on-site investigative effort was assigned. Cooperation was established with the investigating police agency and the Ford and Nissan were impounded pending an inspection. A joint inspection took place on August 25 and 26, 2004 for the purposes of documenting the involved vehicles and conducting an autopsy of the CVPI fuel system. The Calspan SCI team, the investigating police agency, technical representatives of Ford Motor Company, and various legal representatives participated in the inspection. The Acura 3.2TL was not available for inspection.

VEHICLE DATA

2003 FORD CROWN VICTORIA

The 2003 Ford Crown Victoria, **Figure 2**, was identified by the Vehicle Identification Number (VIN): 2FAHP71W53X (production sequence deleted). The four-door, rear-wheel drive, body-on-frame, sedan was equipped with the Police Interceptor Package. Its power train consisted of a 4.6 liter/V8 engine linked to a four-speed automatic transmission. The service brakes were four-wheel disc with ABS. The manual restraint system consisted of 3-point lap and shoulder belts with retractor pretensioners for the front occupant positions. The Supplemental Restraint System consisted of advanced dual stage driver and front right passenger air bags with front right occupant presence detection. Design changes incorporated into the 2003 model year vehicle included: new rack and pinion steering, an enhanced performance–oriented front suspension redesign, and a redesigned frame for improved crash stiffening and performance. The rear aspect of the frame had a wider width between the frame members to accommodate the redesigned rear suspension that moved the shock absorbers outboard the fuel tank. The 2003 model was also equipped with the factory-installed OEM shields covering the sway bar brackets and the fuel tank straps, a molded rubber grommet that recessed the bolt heads on the lower aspect of the rear differential cover and a redesigned vapor canister mounted to the lower surface of the trunk. This police agency did not use the trunk pack in their vehicles that was developed by Ford. The vehicle was owned and operated by a municipal police department in Texas and was put into service on July 17, 2003. The service records obtained from the motor pool indicated the vehicle had no prior crash history and had been serviced for routine normal wear over its use. The vehicle was serviced 11 days prior to the crash. The odometer reading at the time of that service was 26,230 km (16,299 miles). The Ford's front left and front right tire positions were equipped with a Goodyear RSA Plus and a Firestone Firehawk. PV41. Both tires were size P225/60R16 and were mounted on the OEM steel wheels. The rear tires were consumed by the fire. The manufacturer's recommended tire pressure was 241 kpa (35 psi). The specific measured tire data was as follows:

Figure 2: Right side view of the CVPI.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	221 kpa (32 psi)	6 mm (7/32)	No	None
LR	Unknown	Unknown	Unknown	Consumed by fire
RF	55 kpa (8 psi)	8 mm (10/32)	No	None
RR	Unknown	Unknown	Unknown	Consumed by fire

The police officer was approximately 6.5 hours into his shift at the time of the crash. Reportedly, the vehicle had been refueled at the start of the shift. It was estimated that the fuel

tank was ½ to ¾ full at the time of the crash. This fuel level amounted to 36.0 to 53.9 liters (9.5 to 14.3 gallons) based a 72 liter (19 gallon) full tank.

The subject Ford CVPI was used by multiple police officers over a two shift cycle (10 hour) per day cycle. During these shifts, the vehicle was used for routine Road Patrol, DWI Enforcement and Commercial Vehicle Enforcement depending on the assignment. The weight of a similarly equipped exemplar patrol car was 2,087 kg (4,600 lb). At the time of the crash, the police officer driver was assigned to road patrol duties. Located within the trunk were a set of four Model MD400 Portable Truck Scales manufactured by GEC Inc. used during Commercial Vehicle enforcement, **Figure 3**. Each scale measured 52.1 cm x 30.5 cm x 7.6 cm (20.5 in x 12.0 in x 3.0 in), length by width by height, was manufactured from aluminum and weighed approximately 27 kg (60 lb). The four scales were housed vertically within a partitioned wooded box. The box was located on the approximate vehicle centerline, oriented longitudinally, at the time of the crash. Additional items located within the trunk included: the OEM spare tire and jack, a box of flares, a mechanics creeper, four to five orange cones, chock blocks, and radio equipment packaged within a wooden box on the right side of the trunk.

Figure 3: GEC Inc. MD400 truck scale.

During the crash sequence, the scales were driven forward through the forward trunk wall by the force of the impact resulting in an 8 cm x 13 cm (3 in x 5 in) angular tear of the back side of the fuel tank. The width of the tear was irregular and measured 1.0 cm (0.4 in) along its center aspect. The tear was the source of the fuel leak that fueled the ensuing fire.

2003 NISSAN XTERRA

The Nissan Xterra, **Figure 3**, was identified by the Vehicle Identification Number (VIN): 5N1ED28T83C (production sequence deleted). The 4x2, four-door sport utility vehicle was a body-on-frame design. The rear-wheel drive vehicle was manufactured with a 264.9 cm (104.3 in) wheelbase. The power train consisted of a 3.3 liter, V6 engine linked to a four-speed automatic transmission. The service brakes were front disc/rear drum with two wheel (front) ABS. The manual restraint system consisted of three point lap and shoulder belts in the four outboard seat positions. The center rear position was lap belt equipped. The frontal air bag system consisted of dual-stage air bags for the driver and front right passenger. The vehicle sustained moderate direct frontal damage as a result of the impact and was involved in the post-crash fire.

Figure 4: Left side view of the Nissan Xterra.

1999 ACURA 3.2TL

The Acura 3.2TL was identified by the Vehicle Identification Number (VIN): 19UUA564XXA (production sequence deleted). The four-door, front wheel drive sedan was equipped with a 3.2 liter,V6 engine linked to a 4-speed automatic transmission. The service brakes were a front disc/rear drum system with four-wheel ABS. The Acura had the capacity to seat five passengers. Reportedly, the vehicle sustained moderate severity damage to its back plane as a result of its secondary collision with the front plane of the Ford. The vehicle was released from police custody prior to SCI involvement in the investigation and was reportedly under repair. It was not available for SCI inspection.

SUMMARY

Crash Site

This multi-vehicle crash occurred during the nighttime hours of July 2004. At the time of the crash, it was dark and the weather was not a factor. The asphalt highway surface was dry. The crash occurred on the outboard (right) shoulder of the westbound lanes of an interstate highway. **Figure 5** is a view looking eastward along the road shoulder from the area of final rest. The roadway was configured with three 3.7 m (12.0 ft) wide travel lanes. A 3.2 m (10.5 ft) wide outboard shoulder bordered the traffic lanes. The grassy terrain outboard the shoulder sloped away from the road into swale centered approximately 2.4 m (8.0 ft) north of the road edge. The roadway was straight and had a negative grade (estimated less than two percent). There were no obstructions that would have reduced the visibility along the roadway. The speed limit in the area of the crash was 97 km/h (60 mph).

Figure 5: Look back view from the area of final rest.

Crash Sequence

Pre-Crash

Prior to the subject crash, the 30 year old police officer was operating the subject 2003 Ford CVPI as part of his normal shift duties and had been conducting speed enforcement on the interstate highway. He had been on-duty approximately 6.5 hours. During the course of his interstate patrol, the officer stopped a westbound 1999 Acura 3.2TL driven by a 41 year old male for an apparent traffic law violation. The driver of the Acura stopped his vehicle on the outboard (north) road shoulder and the police officer stopped the CVPI approximately one car length behind the Acura. The emergency lights on the CVPI were activated. The officer was seated in the Ford and was in the process of exiting his vehicle at the time of the crash. Reportedly, he released his seat belt immediately prior to the impact.

Coincident to these events, a 2003 Nissan Xterra was westbound in the right lane of the highway. The Nissan was occupied by a 21 year old male driver and a 22 year old female front right passenger. The police investigation determined both individuals were alcohol impaired. Witnesses to the crash reported that the Nissan was being operated erratically (weaving) in the

outboard lane of the highway. One individual reported passing the Nissan and then witnessed the crash by looking in his rear view mirror. He reported that the Nissan moved laterally from the right lane onto the shoulder and impacted the Ford CVPI. The flow of traffic based on the witness statements was approximately 97 km/h (60 mph).

Crash

The front plane of the Nissan struck the back plane of the Ford in a near in-line front-to-rear impact configuration. The front plane of the Nissan and the rear plane of the Ford sustained severe impact damage. The directions of force were 12 o'clock and 6 o'clock for the Nissan and Ford, respectively. The westbound momentum of the Nissan displaced the Ford forward, as the vehicles reached maximum engagement and a common velocity. The Ford and Nissan remained engaged during the balance of the crash sequence. Witnesses reported the fire started immediately after the impact.

The forward displacement of the Ford resulted in a secondary collision between the front of the Ford and the back of the stopped Acura. The right and center aspects of the Ford's front plane impacted the left and center aspects of the Acura's back plane in an offset 12/6 impact configuration. The force of this impact caused the driver air bag in the Ford to deploy. The momentum of the coupled Ford and Nissan then displaced the Acura to the west. The Ford initiated a counterclockwise rotation as it slid westward to rest. The CVPI came to rest straddling the fog line facing southward (nearly perpendicular to the travel lanes) approximately 24 m (80 ft) from the point of impact. The Nissan came to rest facing west in contact with the Ford. Reportedly, the Acura came to rest approximately 46 m (150 ft) west of its point of impact. The post-crash distance traveled by the Acura and the dynamics of the crash suggest the Acura's final rest position was the result of the force of the impact and driver input. The total station survey of the crash site documented by the police investigation has been requested. A preliminary schematic of the crash is attached to the end of this report as **Figure 21**.

Post-Crash

Several civilian witnesses and several off-duty police officers witnessed the crash and responded to the emergency. These individuals parked their vehicles along the shoulder of the interstate and/or along the service road that ran parallel to the highway. By the time they arrived along the side the vehicle the rear section of the CVPI was in flames. Reportedly, the front door windows of the Ford were closed and the doors were jammed shut by the deformation. The police officer driver was struggling to get out of the vehicle. One of the civilians broke the left front window glazing with his forearm and the driver was removed through the window opening. The driver was carried east of the crash site and laid on the shoulder. The driver sustained burns to his left lower extremity, an occipital scalp laceration and a forehead contusion. He was transported via helicopter to a regional trauma center due to the severity of his injuries. The driver and front right passenger of the Nissan were removed through the front left door of the vehicle and transported to a local hospital for their injuries. The driver of the Acura was not injured in the event.

2003 FORD CROWN VICTORIA

Exterior Damage

Figure 6 is the rear view of the damaged CVPI. **Figures 7 and 8** are the left and right views of the rear damage and **Figure 9** is an overhead view of the damaged rear plane. The back plane of the Ford CVPI sustained severe direct and induced damage as a result of the impact. The direct contact began at the left rear bumper corner and extended 152 cm (62 in) to the right rear bumper corner. The dynamics and force of the impact compressed the volume of the trunk space around the commercial vehicle scales and displaced the scales forward through the trunk wall. The scales are visible in Figure 9 below.

The rear residual deformation profile of the CVPI was documented along the rear bumper reinforcement bar and along the aft edge of the trunk. The average rear crush profile resultant to those measurements was as follows: C1 = 63.0 cm (24.8 in), C2 = 72.0 cm (28.3 in), C3 = 63.0 cm (24.8 in), C4 = 58.0 cm (22.8 in), C5 = 47.0 cm (18.5 in), C6 = 54.0 cm (21.3 in). The maximum crush measured 79.0 cm (31.1 and was located along the aft edge of the trunk at C2. The residual crush measured at the end of the left and right frame rails was 58.1 cm (22.9 in) and 34.0 cm (13.4 in), respectively. The trunk latch released during the impact and the lid was displaced forward through the backlight and into contact with the roof. The rear aspect of the roof buckled. The longitudinal deformation of the upper left and upper right corners of the roof measured 13.3 cm (5.3 in) and 3.5 cm (1.4 in), respectively. The deformation and compression of the body caused by the rear impact jammed the doors of the vehicle shut. The fuel neck disengaged from the crushed left rear quarterpanel during the crash sequence. The filler neck remained in tact and relatively undeformed. There was no fuel leakage along the neck. The left wheelbase was reduced 30.4 cm (12.0 in). The left axle tube separated from the differential housing and the left axle shaft fractured inside the differential. The right wheelbase reduced 13.3 cm (5.3 in).

Figure 6: View of the damaged back plane.

The Collision Deformation Classification (CDC) of the Ford was 06-BDAW-6. The total Delta V of the CVPI calculated by the Damage Algorithm of the WINSMASH model was 36.2 km/h (22.5 mph). The longitudinal and lateral components were +36.2 km/h (+22.5 mph) and 0 km/h, respectively. This calculation utilized the model's default stiffness coefficients; therefore the calculation underestimated the severity of the crash. The presence of the scales in the trunk increased the rear stiffness of the Ford, altered the vehicle deformation and affected the crash dynamics due to the pocketing of the front plane Nissan around the scales.

Figure 7: Left view of the rear CVPI damage.

Figure 8: Right view of the CVPI rear damage.

Figure 9: Over head view at the damaged back plane.

Note: the rear baseline in Figures 6-9 was set 31.5 cm (12.4 in) shorter than the original length of the vehicle. The crush measurements were adjusted for this offset.

The force of the rear impact displaced the CVPI forward into contact with the Acura. The center and right aspects of the CVPI's frontal plane, **Figure 10**, impacted and underrode the back plane of the Acura. The frontal plane's direct contact damage began 15.5 cm (6.1 in) right of center and extended 61 cm (24 in) to the right front corner. This direct contact pattern wrapped around the right front corner as a result of the Ford's counterclockwise rotation and extended 18 cm (7 in) along the right side. The combined width of the direct and induced damage extended across the vehicle's entire 152 cm (60 in) frontal end width. The

Figure 10: Front view of the CVPI.

residual crush was documented along both the bumper reinforcement bar and upper radiator support elevations due to the underride impact configuration. The resulting average frontal crush profile was as follows: C1 = 1.0 cm (0.4 in), C2 = 0, C3 = 9.0 cm (3.5 in), C4 = 13.0 cm (5.1 in), C5 = 18.0 cm (7.1 in), C6 = 32.0 cm (12.6 in). The maximum crush measured 54.0 cm (21.3 in) and was located at on the upper radiator support at C6. The hood buckled and v'ed at the fold point. The right front fender shifted rearward and deformed. There was no structural damage to either front suspension and there was no front axle displacement. The CDC of the frontal damage was 12-FZEW-2.

The total delta V of the Ford's frontal impact calculated by the Missing Vehicle Algorithm of the WINSMASH model was 17.9 km/h (11.1 mph). The longitudinal and lateral components were -17.9 km/h (-11.1 mph) and 0 km/h, respectively. This calculation should be used as a reference value only as the Nissan was still engaged with the Ford during this impact and affected the impact dynamics. Based on SCI experience, the severity of the frontal deformation warranted frontal air bag deployment. It was probable that the driver air bag deployed during the impact with the Acura.

Interior Damage

Figure 11 is an interior view of the Ford through the left front window. The interior of the vehicle was completely burned. The front seats were in an estimated rear track position. The angle of the driver seat back frame measured 40 degrees. The front and rear interior compartments were separated by a safety cage. The residual longitudinal intrusion of the rear seat was measured along the forward edge of the package shelf and is listed in the table below:

Rear Left	*Center*	*Rear Right*
50.5 cm (19.9 in)	55.4 cm (21.8 in)	32.8 cm (12.9 in)

The crush and deformation of the body panels at the left lower C-pillar location created a 51 cm x 15 cm (20 in x 6 in), height by width, opening into the interior compartment from the undercarriage. The separation of the right lower C-pillar measured 33 cm x 8 cm (13 in x 3 in). The sheet metal surrounding the spot welds in the areas of these separations failed by overload. The left rear door buckled and deformed outboard creating a 28 cm x 10 cm (11 in x 4 in), length by width, opening at the sill. These separations/openings created direct paths for the fire to enter the occupant compartment.

Figure 11: Left interior view of the Ford.

The 2003 Ford CVPI was equipped with a Restraint Control Module (RCM) with Event Data Recorder (EDR) capabilities. The RCM controlled and monitored the deployment of the vehicle's safety systems (pretensioners and air bags). The RCM was located under the center instrument stack on the vehicle's center tunnel. Inspection of the RCM revealed it was damaged by the heat of the fire and was not able to be downloaded by the Vetronix CDR tool.

2003 NISSAN XTERRA

Exterior Damage

Figures 12 and 13 are the front and overhead views of the Nissan. The vehicle's front plane sustained 147 cm (58 in) of direct contact damage that spanned the entire end width of the vehicle. The nature of the direct damage was indicative of an in-line front-to-rear impact configuration. The forward frame's lower cross member was deformed into a U-shape that conformed to the shape of the scales located in the CVPI trunk. The width of the U measured 51 cm (20 in) and had a maximum depth on centerline of 31.8 cm (12.5 in). Refer to **Figure 14**. The residual crush of the Nissan was documented along the bumper reinforcement bar and was as follows: C1 = 31.0 cm (12.2 in), C2 = 19.0 cm (7.5 in), C3 = 27.0 cm (10.6 in), C4 = 33.0 cm (13.0 in), C5 = 35.0 cm (13.8 in), C6 = 43.0 cm (16.9 in). The left wheelbase was reduced 4.8 cm (1.9 in) and the right wheelbase was reduced 7.1 cm (2.8 in). All the doors remained closed during the impact. At the time of the inspection, the doors were inoperative as a result of the fire. The plastic (combustible) fasteners attaching the mechanical linkage inside the door panel had burned allowing the linkage to fall to the bottom, of the door. The front doors probably were operational prior to the fire. At the scene, reportedly, both occupants exited the vehicle through the front left door.

The CDC of the vehicle was 12-FDEW-3. The total delta of the Nissan calculated by the Damage Algorithm of the WINSMASH model was 39.1 km/h 24.3 mph. The longitudinal and lateral components were -39.1 km/h (-24.3 mph) and 0, respectively. This calculation underestimated the crash severity due to the altered stiffness and damage profile related to the CVPI previously discussed. The frontal air bags of the Nissan probably deployed as a result of the impact based on SCI experience. Air bag deployment could not be determined due to the consequences of the fire.

Figure 12: Nissan front view.

Figure 13: Overhead view of the frontal damage.

Figure 14: Deformed lower frame caused by the scales in the CVPI trunk.

2003 FORD CROWN VICTORIA

Fuel Tank Removal and Examination

After the exterior inspection of the CVPI by all the involved parties, a procedure to inspect the undercarriage of the vehicle and to remove the fuel tank was discussed and developed. To facilitate this process, the CVPI was rolled onto its right side. In this manner the vehicle could be safely inspected and sequentially disassembled to access the fuel tank. **Figure 15** is an overall view of the Ford's undercarriage. **Figure 16** is a view of the aft section of the CVPI depicting the damaged fuel tank and rear axle.

Figure 15: Overall undercarriage view.

Figure 16: Aft undercarriage view.

During the impact sequence, the aft section of the CVPI crushed and deformed longitudinally forward. The fuel tank mounted on the forward wall of the trunk was in-turn displaced forward and into contact with the differential. Referring to Figure 16 above, examination of the tank revealed that its lower central aspect was crushed to near full thickness. With the lower aspect of the tank captured by the differential, the top aspect of the tank and trunk wall rotated over the top

of the axle during maximum engagement. The straps attaching the tank to the trunk wall separated during the rotation. The sway bar engaged the lower forward side of the tank across its width. Areas of substantial contact between the sway bar bracket shields and tank were noted. The shields protecting the sway bar brackets appeared structurally sound, although partially burned by the fire. The forward left side of the tank heavily engaged the left axle housing. There were no punctures of the forward side of the fuel tank from engagement with the undercarriage, differential, or suspension components. The drive axle fractured in an irregular manner forward of the differential yoke. Heavy deposits of asphalt were noted to be embedded in the yoke from the post-crash travel of the vehicle to rest.

After the undercarriage examination, the rear axle, exhaust pipes, suspensions links and sway bar were removed. The fuel tank was engaged with the forward trunk wall and retained by the deformation. With the tank removed, the forward trunk exhibited deformation directly related to the dimensions of the scales. **Figure 17** is a view of the forward trunk wall with the tank removed. The wall was deformed over a 46 cm (18 in) width and protruded approximately 13 cm (5 in). The sheet metal in the area highlighted by the yellow tape was torn from contact by the lower forward corner of the wooden box containing the scales. The sheet metal tear was irregular due to the deformation and was approximately 20 cm (8 in) in length.

Figure 17: View of the deformed trunk wall.

Figures 18 and 19 are views of the forward and back side of the tank, respectively. The lower central aspect of the forward side of the tank was compressed to near full thickness. This area of deformation measured 25 cm x 38 cm (10 in x 15 in), width by height, and was caused by direct interaction with the rear differential. The sending unit was intact and undamaged. There was no leakage at the port. Based on inspection, the volume of the tank was reduced approximately 20 percent. As previous stated, there were no punctures or perforations of the forward side of the tank. The fuel neck was intact upon disassembly and there was no leakage at its junction with the tank. The rear side of the tank exhibited deformation related to its contact from the trunk wall and scales. The deformation was rectangular conforming to the shape of the scales and measured approximately 36.8 cm x 23 cm (14.5 in x 9 in), width by height. The deformation began 20 cm (8 in) inboard of the left side. The tank was punctured and the sheet metal was torn within the left upper corner of the deformation. The tear is highlighted by yellow tape in Figure 19. **Figure 20** is a close-up view of the tear. The tear was irregular in shape and measured 8 cm x 13 cm (3 in x 5 in). The orientation and location of the tank puncture related to the upper left corner of the truck scales housed within the trunk in its homemade wooden box. This tear was the source of the leak that fueled the post-crash fire. There were no other noted punctures or perforations to the fuel tank.

Figure 18: View of the forward side of the tank.

Figure 19: View of the back side of the tank.

Figure 20: Close-up view of the tank perforation.

DRIVER DEMOGRAPHICS

2003 Ford Crown Victoria Police Interceptor

	Driver
Age/Sex:	30 year old/Male
Height:	188 cm (74 in)
Weight:	109kg (240 lb)
Seat Position:	Rear track
Manual Restraint Use:	None, removed prior to crash
Usage Source:	Police and witness reports
Medical Treatment:	Hospitalized for treatment

DRIVER INJURY
2003 Ford Crown Victoria Police Interceptor

Injury	*Injury Severity (AIS 98 Update)*	*Injury Source*
Initial loss of consciousness, GCS=15 on admission without neurological deficit	Moderate (160406.2,0)	Safety cage contact
2-3 cm scalp laceration over the occipital region	Minor (190602.1,6)	Safety cage contact
Large contusion to the forehead	Minor (290402.1,7)	Rebound contact to the windshield (probable)
First and second degree thermal burns to the lateral aspect of the left lower extremity over a 6 to 7 percent area	Minor (892006.1,2)	Crash induced fire

Note: the above injury data was based on the driver's Emergency Room records.

DRIVER KINEMATICS

Prior to the crash, the on-duty male police officer stopped on the outboard road shoulder behind the Acura. He was seated in a full rear track position and had released his 3-point lap and shoulder belt. He was preparing to exit his vehicle.

Upon impact, the driver initiated a rearward trajectory in response to the 6 o'clock direction of the impact force. The driver loaded the seat back with his torso and was compressed into the seat. His head probably contacted the head restraint. Due to the magnitude of the impact, the driver probably began to ramp up the seat back. This kinematic pattern exposed his head to the safety cage separating the interior compartments. His head probably impacted a component of the safety cage causing the reported occipital scalp head laceration. The driver was reportedly rendered incapacitated/unconscious at this time.

During this impact sequence, the Ford was displaced forward and into a secondary collision with the back of the stopped Acura. The force of that crash caused the driver air bag in the CVPI to deploy. Coincident to these events, the stressed seat back and cushion began to unload, and the driver rebounded forward. The driver's forward rebound trajectory displaced him into the knee bolster, deployed driver air bag and a probable forehead contact with the windshield. The driver then slumped back into his seat where he was found by the passing motorists. These motorists reported that the driver was struggling to exit the vehicle and that flames had entered the occupant compartment upon their arrival. One of these individuals broke the left front window with his forearm and the driver was removed from the vehicle through the window. The driver suffered thermal burns to his left lower extremity. He was transported via helicopter to a local trauma center where he was admitted for treatment.

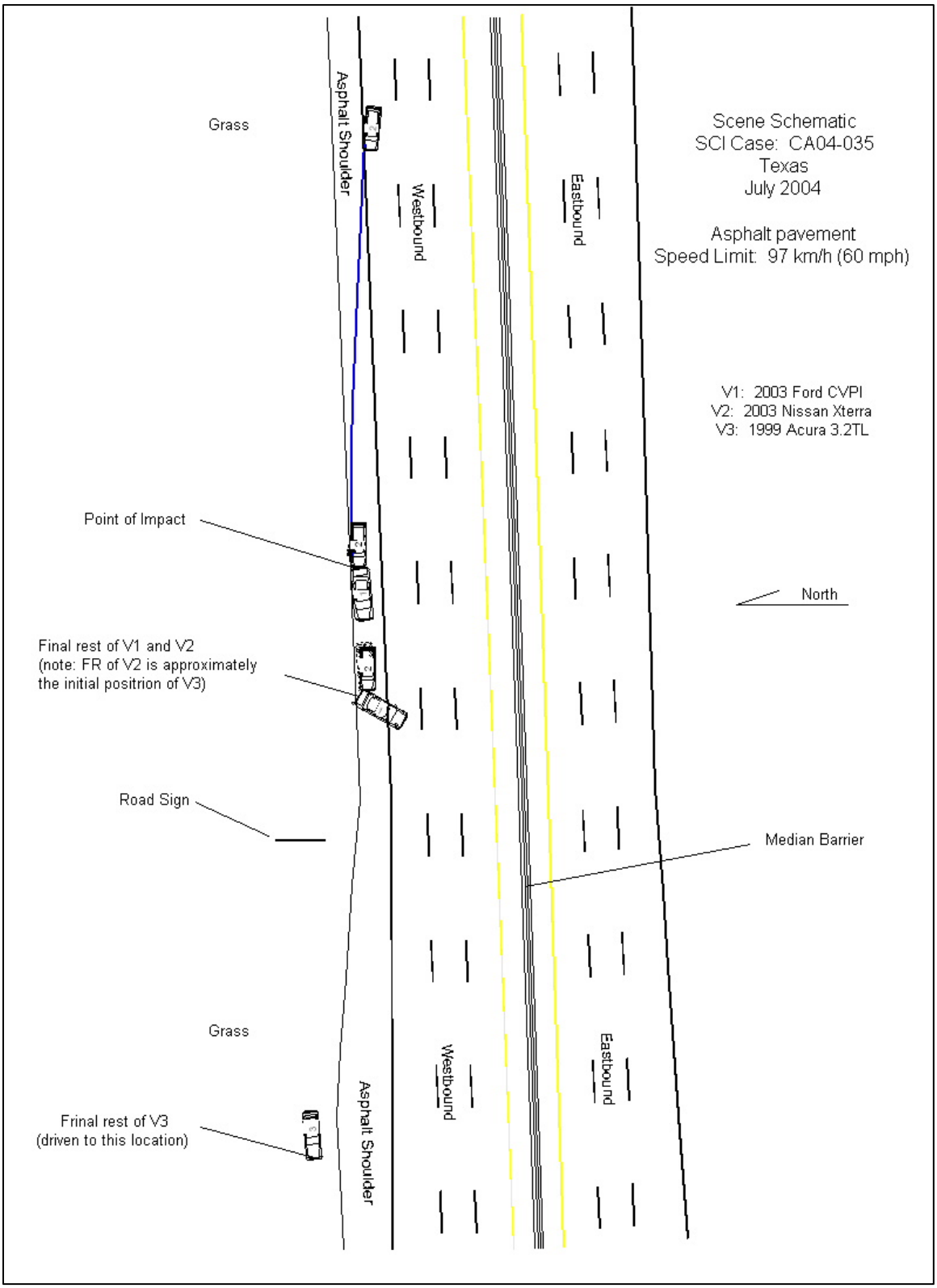

Figure 21: Crash schematic.