

CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CVPI REAR CRASH/FIRE INVESTIGATION

SCI CASE NO.: CA06-023

VEHICLE: 2005 FORD CROWN VICTORIA POLICE INTERCEPTOR

LOCATION: OHIO

CRASH DATE: SEPTEMBER 2006

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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 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.

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BACKGROUND

This on-site investigation focused on the severity of the crash, the source of the ensuing fire, and the cause of death of two on-duty police officer's who occupied a 2005 Ford Crown Victoria Police Interceptor (CVPI) and the female driver of the involved 2004 Chevrolet Silverado pickup truck. The CVPI was traveling in an easterly direction on a two-lane road during nighttime hours, reportedly (witness statements) with the overhead emergency lights and siren activated. The asphalt road surface was wet due to heavy rain. The



Figure 1. On-scene image of the crash site and the involved vehicles.

The Chevrolet Silverado was traveling westbound. The 29-year old male driver of the CVPI lost directional control of the vehicle which resulted in a counterclockwise rotation of the vehicle. The CVPI rotated approximately 190 degrees into the westbound lane directly into the path of the Silverado. The frontal area of the Silverado impacted the back plane of the CVPI resulting in severe crush to the back of the Ford and near total compression of the vertically mounted fuel tank. The left side of the CVPI's fuel tank ruptured and the sending unit separated resulting in an immediate loss of fuel. The CVPI's fuel tank was filled approximately 20 minutes prior to the crash. The CVPI displaced the Chevrolet rearward as both vehicles came to rest adjacent to the north shoulder. A fire ensued which consumed both vehicles (**Figure 1**). The driver of the CVPI and his 45-year old front right passenger remained in their respective positions post-crash and expired. The 32-year old female driver of the Silverado was found slumped across the interior of the pickup truck with the front right door partially opened. She expired at the scene. The responding fire department arrived on-scene approximately nine-minutes following the crash and suppressed the fire with water. Hydraulic equipment was used to remove the driver's door of the CVPI and the right front door of the Silverado to remove the driver's bodies. The passenger's body of the CVPI was removed through the right front door.

Notification of the crash was provided to NHTSA's Office of Defects Investigation on September 28, 2006 by the Ohio Highway Patrol. The notification was forwarded to the Calspan Special Crash Investigations team on Friday, September 29, and assigned as an on-site investigative effort. A joint inspection of the vehicles was initiated on Monday, October 2nd, at the Ohio State Police service facility in Columbus, OH. Involved in this investigation were representatives of the Ohio Highway Patrol, the Calspan SCI team, Ford Motor Company, the Missouri Highway Patrol, and the New York State Police. The SCI investigation involved a detailed documentation of the exterior crush profiles and resultant damage, assessment of the CVPI interior intrusions and occupant contact

points, removal and inventory of the trunk contents, and the thorough inspection of the vehicle's undercarriage with subsequent removal of the fuel tank to determine the probable source of the fire.

SUMMARY

Crash Site

The crash occurred on a two-lane state route during nighttime hours. At the time of the crash, the weather conditions were overcast with heavy rain. The asphalt road surface was free of defects and was delineated by a double yellow centerline that transitioned to a painted flush median immediately west of the point of impact, extending east. The road edges were painted with solid white lines. The travel lanes were 3.8 m (12.4') in width with a 1.3 m (4.3') wide asphalt shoulder at the north edge and a 1.8 m (5.9') wide asphalt south shoulder.



Figure 2. Trajectory of the CVPI at 25 m prior to impact.

The CVPI approached the crash site in an easterly direction on a straight segment of roadway. Located 44.5 m (146') west of the impending point of impact was a change in pavement with a lateral cut line that extended the full width of the paved surfaces. At this line, the roadway began to curve left for eastbound travel. The grade of the roadway was estimated at less than one percent, positive to the east. There was no significant crown or super elevation of the roadway. At the point of impact, the speed limit transitioned from 89-64 km/h (55-40 mph) for eastbound traffic and increased from 64-89 km/h (40-55 mph) for westbound traffic flow. **Figure 2** is an overall view of the crash site at 25 m (82') west of the point of impact. The Crash Schematic is included as **Figure 20** of this narrative report.

Vehicle Data – 2005 Ford CVPI

The 2005 Ford CVPI was identified by Vehicle Identification Number (VIN) 2FAHP71W65X (production number deleted). The vehicle was purchased by the Ohio Highway Patrol through a fleet purchase order and received on March 25, 2005. The CVPI was prepped by the maintenance shop which installed the center console that contained the police radio, computer terminal, and siren and emergency light switches. In addition, shop personnel installed the overhead light bar, the prisoner safety cage, a shotgun rack to the top center aspect of the cage, and the trunk organizer bin. The vehicle was placed in service on April 13, 2005 and assigned to the driver. The vehicle's odometer reading at the time of the crash was approximately 77,330 km (48,052 miles).

The CVPI was equipped with the Ford Police Interceptor Package that included a 4.6 liter V-8 engine with a four-speed automatic overdrive transmission with a column mounted shifter, four-wheel disc brakes with anti-lock (ABS), and 12-window OEM steel wheels with Goodyear Eagle RS-A Plus all-season tires, size P225/60R16. The tires were

consumed by the fire, therefore the specific tread depths and tire pressures were unknown at the time of the crash.

The interior of the CVPI was equipped with cloth surfaced front bucket seats and a fixed bench, three-passenger rear seat that was surfaced with vinyl. The front seat positions were configured with adjustable head restraints that appeared to be adjusted to the full-up position at the time of the crash. Both front seats were adjusted to a rear track position.

The service history of the vehicle consisted of routine maintenance and one previous crash that occurred in July 2006. This car-deer crash was minor in severity and involved the front right area with a reported repair cost of \$586.50. The reported odometer reading at the time of the crash was 70,077 km (43,545 miles). A left rear axle repair was made on September 13, 2006, at a cost of \$125. The odometer reading at the time of this repair was 74,871 km (46,524 miles).

2004 Chevrolet Silverado Pickup Truck

The 2004 Chevrolet Silverado pickup truck was a four-door extended cab built on a 365 cm (143.5”) wheelbase. The truck was configured with rear doors hinged at the C-pillars which opened rearward. The drive train consisted of a conventionally mounted 4.8 liter V-8 gasoline engine linked to a four-speed automatic transmission with overdrive and four-wheel drive. The service brakes were four-wheel disc with ABS. A partial VIN was obtained from the truck which identified the vehicle as follows: 2GCEK19?841 (production number deleted).

The interior of the Silverado was configured with a split bench front seat with separate back cushions and a forward folding center armrest/seat back support. The outboard positions had adjustable head restraints and integrated safety belt systems. The center front position was equipped with a manual lap belt. The interior of the vehicle was completely consumed by the ensuing fire.

The Silverado was equipped with 41 cm (16”) five-spoke alloy wheels which survived the fire. The tires were burned with the majority of the tire remaining at the right front position, and partial tires remaining at the left front and right rear positions.

Crash Sequence

Pre-Crash

Prior to the crash, the 29-year old Trooper was operating the 2005 Ford CVPI as part of his normal shift duties. He had been on-duty approximately 6.5 hours. The Ford CVPI was the driver’s assigned vehicle. The police investigation determined that the Trooper stopped at the police sub-station and refueled the Ford approximately 20-30 minutes prior to the crash. After refueling the CVPI, the Trooper drove and picked up the 45-year old front right passenger at his residence which was located approximately 3.2 km (2 miles) west of the impending crash site.

The Ford CVPI was traveling eastbound on the two-lane road approaching the shallow left curve. The road surface was wet with standing water due to the heavy rain fall;

however, there were no apparent defects in the road. The police investigation reported that the emergency lights on the CVPI were active and a local resident reported that he heard a siren prior to the crash. For unknown reasons, the driver of the Ford lost directional control and the CVPI began to rotate counterclockwise (CCW). The vehicle crossed the centerline and entered the westbound lane as it continued to rotate in a CCW direction.

Coincident to these events, the 2004 Chevrolet Silverado was traveling westbound and was driven by a 32-year old female. Reportedly, this driver had just dropped her daughter off at her place of employment and was in the process of returning to her residence. The driver was the sole occupant of the Chevrolet at the time of the crash.

The CVPI rotated directly into the path of the Chevrolet. The Ford had rotated approximately 190 degrees CCW at the time of the crash. Based on the location of the physical evidence at the crash site, the right side tires of the Chevrolet were approximately on the white fog line. This would indicate that the driver of the Chevrolet Silverado apparently steered right immediately prior to impact in an attempt to avoid the crash, or to yield to the approaching emergency vehicle. A conservative speed reconstruction utilizing the principles of Conservation of Linear Momentum and Conservation of Energy calculated the speed of the Chevrolet at approximately 32-40 km/h (20-25 mph) and the speed of the CVPI was approximately 105 km/h (65 mph). The Crash Schematic is attached to the end of this report as **Figure 20**.

Crash

The front plane of the Chevrolet struck the back plane of the Ford in a 75 percent offset front-to-rear impact configuration. The front plane of the Chevrolet 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 Chevrolet and Ford, respectively. The force of the impact collapsed the trunk space of the CVPI with resultant deformation extending to the right B-pillar area. The right aspect of the CVPI's fuel tank was completely compressed between the forward trunk wall and the rear axle. The build-up of hydraulic pressure within the full fuel tank ruptured the left wall of the tank. A fire ignited immediately upon impact as the vehicles crushed to maximum engagement. The post-crash fire spread from the CVPI to the Chevrolet.



Figure 3. CVPI's trajectory at the point of impact.

The eastbound momentum of the Ford arrested the forward motion of the Chevrolet as the vehicles reached maximum engagement. The force of the impact reversed the travel direction of the Chevrolet and the vehicles separated and headed on their post-crash trajectories (**Figure 3**). The Chevrolet was displaced rearward 24.3 m (79.7') and came to rest off the north side of the shoulder facing west. The Ford CVPI came to rest straddling the white edge line 26.1 m (85.6') east of the point of impact facing

southwestward. **Figure 4** is an on-scene police image of the vehicles at final rest. The damage algorithm of the WINSMASH program calculated delta Vs of 69 km/h (42.9 mph) and 71 km/h (44.1 mph) for the Ford and Chevrolet respectively. The WINSMASH calculated delta Vs were consistent with the values calculated from the speed reconstruction.

Post-Crash

Police, fire, and ambulance personnel responded to the scene of the crash. Members of a professional ambulance service were located approximately 100 m (300') from the crash site. These members heard the crash and several responded on foot to the site as they exited their building and observed flames. These members heard voices within the vehicles and observed motion; however, due to the intensity of the fire, they could not approach the vehicles. The first fire unit reportedly arrived on-scene nine minutes post-crash. The fire fighters used water to extinguish the fire. The occupants of both vehicles were incapacitated by the force of the impact and were unable to remove themselves from either vehicle. All three occupants expired at the scene. Fire fighters used hydraulic equipment to cut the left B-pillar from the CVPI and force open the left front door. This was required to remove the driver's body from the vehicle. The right front door was opened by rescue personnel to retrieve the passenger's body. There was no evidence of forcible entry through the right front door. The right front door of the Silverado appeared to be partially open prior to the removal of the driver's body. Fire fighters cut the right front door hinges and removed the door for this task. Both vehicles were towed from the scene and transported to a service facility at the Ohio Highway Patrol headquarters where they were impounded and held for this joint investigation. **Figures 4 and 5** are of the final rest positions of the vehicles and their location relative to the crash site.



Figure 4. On-scene image of the vehicles at final rest.



Figure 5. Final rest position with respect to the roadway.

Vehicle Damage

Exterior – CVPI

The 2005 Ford CVPI sustained severe damage to the back plane (**Figure 6**) from the impact with the Chevrolet Silverado. Maximum crush was 174 cm (68.4”) located at the right corner of the rear wall of the trunk. The impact crushed the rear bumper system and trunk into the rear seat area of the CVPI and engaged the C-pillars which deflected the backlight header forward. The crush jammed the left side doors and right rear door in the closed positions. The right front door remained closed during the crash and was opened

post-crash during the extrication of the front right passenger's body from the CVPI. The crush to the back plane of the CVPI totally eliminated the second row seat area as the rear wall of the passenger compartment was crushed against the interior prisoner cage. In an effort to accurately document the crush, three profiles were documented at the levels of the rear bumper beam, the rear wall of the trunk, and the backlight header.

The bumper fascia was completely burned in the ensuing fire. The direct contact damage to the back plane of the CVPI was derived from impact produced dents to the trunk lid. The direct contact damage began approximately 23 cm (9") left of center and extended 102 cm (40") to the back right corner. The full width of the bumper beam was crushed resulting in a "Field L" measurement of 70 cm (27.5"). Six equidistant crush values were documented at the level of the bumper beam and were as follows: C1 = 88 cm (34.6"), C2 = 143 cm (56.5"), C3 = 153 cm (60.4"), C4 = 158 cm (52.1"), C5 = 158 cm (62.4"), C6 = 155 cm (61.1"). The maximum crush at the level of the bumper beam was located at the C5 location.

The full width of the back wall of the trunk was crushed forward. The corner areas were projected to the reference line resulting in a Field L measurement of 69 cm (27"). The crush profile at this level was as follows: C1 = 100 cm (39.25"), C2 = 132 cm (51.9"), C3 = 144 cm (56.6"), C4 = 161 cm (63.4"), C5 = 167 cm (65.6"), C6 = 174 cm (68.4"). The trunk latch released during the crash, however, the trunk hinges remained intact as the trunk deck was crushed vertically. The left wheelbase was reduced in length by 32 cm (12.6") while the right wheelbase was reduced by 82 cm (32.3").

The C-pillars were displaced forward by the impact resulting in deformation across the full width of the backlight header. The corners of the header were projected to the established reference line which resulted in a "Field L" measurement of 115 cm (45.25"). The residual crush profile at this level was as follows: C1 = 29 cm (11.5"), C2 = 39 cm (15.25"), C3 = 42 cm (16.5"), C4 = 43 cm (16.75"), C5 = 42 cm (16.5"), C6 = 43 cm (16.75"). The crush profiles are shown in **Figure 7**. The Collision Deformation Classification (CDC) for this crash was 06-BZEW-7.



Figure 6. Right side view of the extent of crush and deformation.



Figure 7. Overhead view of the crush depth.

The laminated windshield of the CVPI was completely melted by the fire. Remnants of the melted glass remained in the cowl area of the vehicle. There was no damage to the frontal area of the vehicle or induced deformation of the upper A-pillar/windshield header area, therefore the windshield probably remained intact during the crash. The tempered glass of the backlight and both rear doors was shattered by the impact based on the damage to the vehicle. The crushed length of the right rear door was 57 cm (22.5"). The right front door glass possibly survived the crash. There was no damage to the left front door; therefore, this glazing probably remained intact during the crash. Due to the reported heavy rain at the time of the crash, all side windows were presumed to be closed pre-crash.

Fire department personnel used hydraulic equipment to cut the left B-pillar from the vehicle. The pillar was cut from the level of the beltline to the roof side rail. The left front door was pried open to extricate the body of the driver. **Figure 8** is a frontal view of the CVPI documenting the extent of damage due to fire and extrication efforts.



Figure 8. Front left view of the CVPI and associated fire and rescue damage.

Interior – CVPI

The interior of the CVPI was severely damaged by the crash and consumed by the ensuing fire (**Figure 9**). The three rear seat positions of the vehicle were completely crushed by the forward displacement of the rear wall of the passenger compartment. This intrusion engaged the prisoner cage and displaced the cage forward into the front seat backs. The maximum forward displacement of the front right seat back was 37 cm (14.5"), while the front left seat back was displaced 10 cm (3.75") forward. The residual intrusion of the cage at the inboard aspect of the front right seat back was 21 cm (8.25").



Figure 9. Front interior view of the CVPI.

The front right passenger's head loaded the head restraint that was adjusted to the full-up position. The frame of the head restraint was deformed rearward while the front left head restraint frame appeared to be undamaged. Both occupants loaded the seat backs during the crash. There was no loading evidence to the seat backs as the frames were deformed forward by intrusion.

CVPI OEM Steel Wheels

The OEM steel wheels of the CVPI were a new design for 2005. The deep dish style steel wheel was identified as a 12 window wheel, with 12 rectangular slots around the outboard circumference. All four wheels were equipped with OEM hubcaps that melted during the fire. The inboard and outboard bead areas of the right rear tire were deformed from the extreme crush located at the back right corner of the vehicle. The remaining wheels were not damaged with tire cord fragments remaining on the wheels. The Goodyear Eagle tires were completely burned by the fire. There no weld fractures or cracking of the wheels. **Figure 10** is of the right rear wheel of the CVPI.



Figure 10. Right rear wheel of the CVPI.

Figure 10 is of the right rear wheel of the CVPI.

Exterior – 2004 Chevrolet Silverado

The Silverado sustained moderate severity frontal damage as a result of the crash with the CVPI. The direct contact damage on the hood face began approximately 44 cm (17.5”) right of center and extended 130 cm (51”) to the left corner (**Figure 11**). The impact crushed the full frontal width of the vehicle resulting in a combined induced and direct contact damage length of 148 cm (58.5”) along the deformed bumper. Maximum crush was 76 cm (29.75”) located at the left corner of the bumper. The crush profile documented at bumper level (**Figure 12**) was as follows: C1 = 76 cm (29.75”), C2 = 60 cm (23.75”), C3 = 60 cm (23.5”), C4 = 53 cm (21”), C5 = 29 cm (11.5”), C6 = 14 cm (5.5”). The CDC for this impact event was 12-FDEW-3.



Figure 11. Frontal damage to the Chevrolet Silverado.



Figure 12. Left lateral view documenting the extent of crash.

The left wheelbase was reduced in length by 37 cm (14.4”) while the right wheelbase was elongated by 6 mm (0.25”). The frontal impacted displaced the left A-pillar rearward which resulted in minimal buckling of the roof aft of the pillar. Both left side doors were jammed closed. The front right door was open at final rest, a possible indicator that the driver attempted to exit the vehicle. The right rear door remained closed. Rescue personnel removed the right front door to extricate the body of the driver. All glass was

completely consumed by the fire. Based on exterior damage, the windshield was probably cracked by exterior deformation. All other glass probably remained closed and intact immediately following the crash.

Interior – 2004 Chevrolet Silverado

The interior of the Silverado was completely consumed by the fire (**Figure 13**). Available evidence related to the trajectory and contact points of the driver was limited to minimal forward deflection of front left seat back. This seat was equipped with an integrated safety belt system. It was unknown if the driver was restrained, however, seat back deflection was a subtle indication of possible safety belt use and loading.

This vehicle was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that consisted of dual stage frontal air bags for the driver and front right passenger position, seat track positioning sensors, a front right occupant presence sensor, and safety belt buckle switches. Although unconfirmed by vehicle evidence, the driver's air bag system probably deployed as a result of this crash.



Figure 13. Left side interior view of the Silverado.

The police performed an inspection of the interior of the Silverado and removed debris in search of the vehicle's Event Data Recorder. The driver's safety belt buckle and latch plate were not recovered during the police and SCI inspection of the vehicle. The EDR was mounted under the driver's seat and removed by police. The cast alloy casing for the Sensing and Diagnostic Module (SDM) survived the fire; however, the electrical contents of the SDM were burned and melted by the fire. This unit could not be downloaded using the available CDR tool.

Fire Suppression System – 2005 Ford CVPI

The involved 2005 Ford CVPI was not equipped with a fire suppression system. There was no OEM system available at the time of manufacturer and the 2006 Ford system was not available as a retrofit system. The aftermarket FirePanel system was not purchased by the Ohio State Highway Patrol (OSHP). The vehicle was equipped with OEM shields that were positioned on the rear axle mounted sway bar brackets, the differential cover, and the fuel tank straps.

2005 Ford CVPI

Undercarriage and Fuel System

Figure 14 is an undercarriage view of an exemplar 2005 Ford Crown Victoria Police Interceptor depicting the layout of the rear undercarriage and fuel tank. **Figure 15** is a similar view of the undercarriage of the subject CVPI. The front of the vehicles is toward the bottom in both images. The fuel tank was located immediately forward of the trunk wall, approximately 25 cm (10") aft of the rear axle. The steel fuel tank was secured to the front wall of the trunk by two band straps attached to the upper and lower aspects of

the wall. The tank is steel in construction and formed of two halves with an electrically welded perimeter seam. The tank had a capacity of approximately 72 liters (19 gallons). The fuel tank was reportedly full of gasoline at the time of the crash.

Both the exemplar CVPI and the subject CVPI were equipped with the factory installed shield kits. The kit included two molded fiberglass reinforced plastic shields that covered the sway bar brackets on the respective sides of the vehicle, a molded rubber guard that covered the lower rear aspect of the differential cover and recessed the bolt heads and two rubber guards that protected the tank in the area of the lower tank straps. The purpose of the kit was to provide a layer of protection between the fuel tank and the rear axle/suspension components during a rear impact. Referring to the subject vehicle, the remnants of the burned fiberglass shields are visible and the rubber guards remained in place.

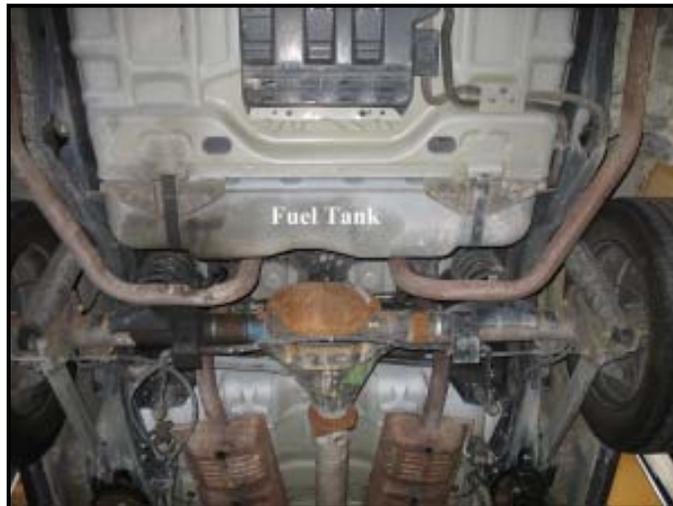


Figure 14: Exemplar CVPI undercarriage view.

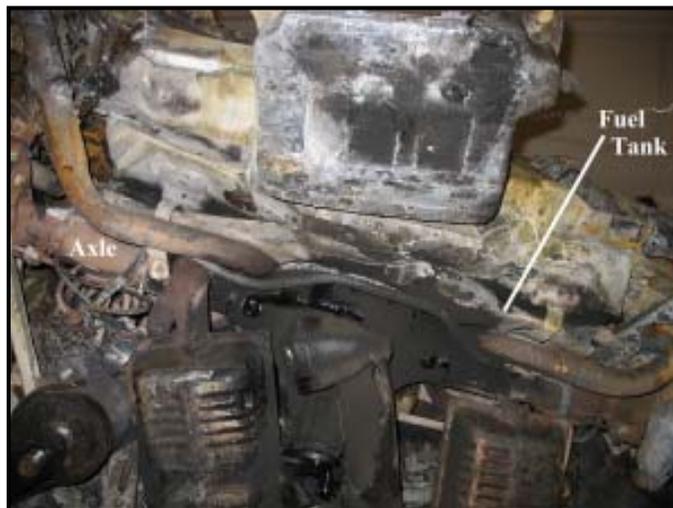


Figure 15: Deformed undercarriage of subject CVPI.

During the impact sequence, the aft section of the CVPI crushed and deformed forward. The fuel tank mounted on the forward wall of the trunk was in-turn displaced forward and into contact with the differential and rear axle. The aluminum drive shaft fractured forward of the differential yoke and separated. An examination of the tank revealed that its lower central and right aspects were crushed to near full-thickness due to the right bias of the impact location. As the deformation occurred, hydraulic pressure developed within the steel fuel tank. The over-pressurization exceeded the strength of the sidewall of the tank, therefore the left side of the tank ruptured. The aft wall of the tank compressed the full depth of the tank and the sending unit located on the forward side of the tank was dislodged.

Following a thorough visual inspection and documentation of the Ford's undercarriage, a vehicle autopsy was conducted in order to access and remove the fuel tank. This procedure involved removing the deformed exhaust system and solid rear axle. The rear suspension components were cut and the rear axle was removed as a complete assembly. Removal of these components allowed access to the fuel tank straps. The lower aspect of each strap was cut. The upper aspect of each strap had sheared during the impact. Hydraulic spreaders were then used to spread the deformed sheet metal rearward, using the crushed vehicle frame as a pry point. The fuel tank was subsequently removed. The fuel filler neck in the left rear quarter panel had disengaged from the panel during the crash. This end of the filler neck was passed through the deformed inner fender and remained with the tank.

After removal of the fuel tank, an examination of the forward trunk wall found that it was primarily intact. A four-way aftermarket lug wrench located in the deformed left lower aspect of the tank pierced the wall and protruded approximately 20 cm (8") forward. This protrusion was located outboard of the deformed tank. It did not contact or damage the tank.

Figures 16 and 17 are views of the forward and rear sides of the tank, respectively. There were no punctures of these major exposed sides. A small 2 cm x 2 cm (0.8" x 0.8") hole was located on the top surface of the deformed tank. It was located 15 cm (5.8") inboard of the left tank strap. This hole was not the result of a direct puncture, but occurred as the result of a crease and subsequent tear of the steel as the tank was



Figure 16. Forward aspect of the fuel tank.



Figure 17. Rear aspect of the tank.

compressed against the undercarriage of the CVPI. The sending unit was dislodged by mechanical deformation, **Figure 18**. The sending unit was fastened to the tank by cap screws that engage a retaining ring that was crimped in place by the tank's sheet metal. The sending unit completely dislodged due to a combination of the deformation of the crimp holding the retaining ring in place and by contact between the internal fuel pump and the crushed rear tank wall.

Figure 19 is a view of the ruptured left side of the tank. The ruptured area deformed into a triangular pattern. The rupture measured 32x14 cm (12.5x5.5"), length by height. It should be noted that the rupture occurred in the parent metal outboard of the welded seam. The welded seam remained intact along its entire length. The fuel filler neck was not damaged during the deformation and was intact.



Figure 18. Displaced sending unit from forward aspect of tank.



Figure 19. Ruptured left side of the fuel tank with filler tube in place.

2005 CVPI Trunk Contents

After removal of the fuel tank, the trunk of the subject CVPI was opened and searched for content. The trunk was crushed full thickness which required the use of hydraulic spreaders to expand the deformation for examination. The vehicle was not equipped with the OEM spare tire. A sliding tray was mounted on the upper shelf that contained the communication and video vault for the cruiser. An aftermarket plastic trunk organizer, manufactured by Pro-Guard, was positioned in the well of the trunk to contain the standard police equipment. The trunk organizer was not equipped with a Kevlar shield similar to the Ford Trunk Pack. This was consumed by the post-crash fire. A four-way lug wrench was positioned in the bottom of the trunk and penetrated the left side wall of the deformed trunk. One of the lug arms was fractured by the impact. None of the trunk contents penetrated the fuel tank. The trunk contained the following standard field equipment issued by the OSHP:

- Five 46 cm (18”) orange traffic cones
- Measuring wheel
- Hand tools (lug wrench, screw driver, pliers)
- Fiberglass tape measure
- Tow strap
- Spike strips
- Steel ammunition box
- First aid kit
- Riot bag inclusive of a baton and helmet
- Rescue rope
- Fire extinguisher
- Digital camera w/gadget bag
- Minimum of 12 road flares
- Axe

Frontal Air Bag System – 2005 CVPI

The 2005 CVPI was equipped with a Certified Advanced 208-Complaint frontal air bag system. The system was certified by the manufacturer to meet the advanced air bag requirements of Federal Motor Vehicle Safety Standard 208. The system consisted of dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right passenger presence sensor, safety belt buckle switches, and retractor pretensioners. Two outboard crash sensors were mounted to the forward face of the upper radiator support panel. This CAC air bag system should not have deployed as a result of this severe rear-end crash. The air bags probably deployed during the post-crash fire. The driver and passenger air bag modules were completely consumed by the fire.

In addition, the CVPI was equipped with a Restraints Control Module (RCM) that monitored system readiness and predicted crash severity and deployed the appropriate safety systems following input from the onboard sensors. This RCM had EDR capabilities; however, it was not supported by the current Vetronix CDR software. The police and fire department removed the RCM from the vehicle following the joint inspection effort. Although intact, it was doubtful that the EDR survived the fire.

Side Impact Air Bag System – 2005 CVPI

The CVPI was equipped with seat back mounted side impact air bags for the front outboard positions. The inflator manifolds remained fastened to the seat back frames. Again, these side air bags should not have deployed as a result of the crash, but may have deployed during the fire.

Occupant Demographics/Data

Driver - 2005 Ford CVPI

Age/Sex: 29-year old male
Height: 196 cm (77")
Weight: 103 kg (228 lb)
Seat Track Position: Rearward
Manual Safety Belt Usage: 3-point lap and shoulder belt (probable)
Usage Source: Final rest position of body
Egress from Vehicle: Body removed by rescue personnel
Type of Medical Treatment: None, expired at scene
Cause of Death: Inhalation of products of combustion with a CO concentration of 52mg percent

Driver Injuries - CVPI

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Thermal charring of the entire body with loss of the calvarial skull and sparring of the back, waist, inguinal areas, and feet.	Maximum (992032.6,0)	Post-crash fire
Trachea and epiglottis mucosal injury with inhalation of products of combustion, carboxyhemoglobin concentration 52mg %	Critical (919206.5,0)	Post-Crash fire
Multiple bilateral posterior rib fractures, left 1-3, 6, 7; right 2,3,5-8,11	Severe (450240.4,3)	Loading of the seat back and the intruding safety cage
Bilateral pulmonary contusions, posteriorly	Severe (441410,4,3)	Loading of the seat back and the intruding safety cage
Slight bilateral subdural hemorrhage over the convexities, greater on the left	Serious (140654.5,3)	Loading of the head restraint and the intruding safety cage
Mid shaft right radius and ulna fractures	Moderate (752802.2,1; 753202.2,1)	Intruding safety cage

**Source – Autopsy Report*

Special Note: The autopsy noted frontal lobe lacerations (disruptions) with embedded fragments of foreign matter and loss of the overlying skull due to charring. The Medical Examiner suggested that this was a possible postmortem artifact; therefore the lacerations were not coded in the injury table.

Driver Kinematics - CVPI

The 29-year old male driver of the 2005 CVPI was presumably restrained by the manual 3-point lap and shoulder belt system. He was seated in a rear track position with the head restraint adjusted to the top position. The driver was dressed in his police uniform and was wearing his utility belt.

At impact, the driver responded to the severe rear impact force by initiating a rearward trajectory and loading the front seat back. The seat back was subsequently loaded from behind by the intruding prisoner cage as the back plane of the vehicle crushed forward. As a result of this loading, the driver sustained multiple bilateral posterior rib fractures, and pulmonary contusions. His head loaded the head restraint that was reinforced by the intruding safety cage which resulted in bilateral subdural hemorrhage. The driver’s right arm probably flailed rearward and impacted the intruding safety cage resulting in mid shaft fractures of the right radius and ulna.

The post-crash fire consumed the interior of the vehicle. The front doors were jammed closed by body deformation as the driver remained conscious (observations of first responders/witnesses) post-crash. He expired due to an inhalation injury of the trachea and epiglottis with a carboxyhemoglobin concentration of 52mg percent. The driver’s body sustained 2nd and 3rd degrees burns with loss of the calvarial skull and sparring of the back, waist, inguinal areas and feet. The body was found in an upright seated position evidenced by the remaining fabric on the seat back and seat cushion surfaces. All other interior components were completely consumed by the post-crash fire.

Front Right Passenger - CVPI

Age/Sex: 45-year old male
 Height: 178 cm (70’’)
 Weight: 108 kg (240 lb)
 Seat Track Position: Rearward
 Manual Safety Belt Usage: 3-point lap and shoulder belt (probable)
 Usage Source: Final rest position of body
 Egress from Vehicle: Body removed by rescue personnel
 Type of Medical Treatment: None, expired at scene
 Cause of Death: Multiple blunt force injuries to head and neck (lacerated brain stem)

Front Right Passenger Injuries - CVPI

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Distal brain stem laceration	Maximum (140212.6,8)	Head restraint backed by intruding safety cage
Post-mortem thermal charring of body with sparring of the areas of back, inguinal areas, waist, and feet; carboxyhemoglobin concentration less than 10mg %	Maximum (992032.6,0)	Post-crash fire

Thoracic aorta laceration with associated slight dissection to the aortic root	Critical (420212.5,4)	Acceleration of torso from loading against the seat back and intruding safety cage
Multiple bilateral rib fractures with hemothoraces, left ribs 1-4 anteriorly, 5-7 laterally, 8-11 posteriorly; right ribs 1-3 anteriorly, #8 anteriorly	Severe (450232.4,3)	Loading of seat back and intruding safety cage
Basilar and posterior fossa subarachnoid hemorrhage	Serious (140466.3,9)	Head restraint backed by intruding safety cage
Capsular spleen laceration	Moderate (544222.2,2)	Loading of seat back and intruding safety cage
Right pelvic fracture, NFS	Moderate (852600.2,1)	Loading of seat back and intruding safety cage
Cervical spine fractures at C3 and C4, NFS	Moderate (650216.2,6; 650216.2,6)	Loading of seat back and intruding safety cage
Thoracic spine fractures of T2 and T3, NFS	Moderate (650416.2,7)	Loading of seat back and intruding safety cage
Right sternoclavicular dislocation	Moderate (751230.2,1)	Loading of seat back and intruding safety cage
Right clavicle fracture	Moderate (752200.2,1)	Loading of seat back and intruding safety cage

**Source – Autopsy Report*

Front Right Passenger Kinematics – CVPI

The front right passenger of the CVPI was seated in a rear track position with the head restraint adjusted to the full-up position. He was dressed in his police uniform. It was presumed that the passenger was restrained by the manual safety belt system based on police policy and the final rest position of his body within the vehicle. At rest, his body was against the front right seat back.

At impact, the front right passenger responded to the 6 o'clock direction of force by initiating a rearward trajectory with respect to the vehicle. His back area loaded the seat back which intruded forward due to the forward displacement of the prisoner safety cage. This engagement resulted in fractures of the thoracic spine at T2 and T3. Additionally, this loading fractured multiple bilateral ribs, the right clavicle, and dislocated the right sternoclavicular joint. He also sustained a splenic laceration and a right pelvic fracture from the loading and subsequent intrusion. The acceleration induced by the loading and intrusion lacerated the passenger's thoracic aorta.

His head and neck engaged the adjustable head restraint that was adjusted to an upper position. The stalks for the head restraint were deflected rearward to support the head/neck loading. The passenger sustained fractures of cervical vertebrae C3 and C4, a

distal brain stem laceration which caused his death, and basilar and posterior fossa subarachnoid hemorrhage.

The post-crash fire consumed the interior of the CVPI. The body of the passenger was charred with sparring of the back, inguinal areas, waist, and feet. His carboxyhemoglobin level was less than 10mg percent indicating death occurred prior to the fire. The front right passenger’s body was removed from the vehicle following the extinguishment of the fire. Similar to the driver, the passenger came to rest engaged against the seat back as the cushion and backrest fabric survived the fire.

The passenger’s use of the safety belt system could not be confirmed due to the extent of the post-crash fire. It should be noted that the belt system, if worn, could have contributed as a source of his injuries as his body was displaced forward against the locked shoulder belt system by the intruding safety cage. The static intrusion post-crash was measured at 37 cm (14.5”); however, dynamically this intrusion value was much greater. The compression against the shoulder belt could have contributed to the anterior rib fractures and the right clavicle fracture and dislocation. The right side rib fractures were located posterior at the lower levels, lateral at the mid levels, and anterior at ribs 1-4. This could have resulted from a torsional twisting of his torso as the seat back rotated forward, greater on the inboard side.

Driver – 2004 Chevrolet Silverado

Age/Sex: 32-year old/Female
 Height: 165 cm (65”)
 Weight: 73 kg (162 lb)
 Seat Track Position: Mid-to rear
 Manual Safety Belt Usage: Unknown
 Usage Source: Vehicle destroyed by fire
 Egress from Vehicle: Body removed by rescue personnel
 Type of Medical Treatment: None, expired at scene
 Cause of Death: Inhalation of products of combustion with a CO concentration of 55 percent

Driver Injuries – 2004 Chevrolet Silverado

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Thermal charring of the entire body with slight sparring of the posterior left shoulder and the mid buttock area	Maximum (992032.6,0)	Post-crash fire
Inhalation of products of combustion with tracheal and epiglottis mucosal injury, carboxyhemoglobin concentration of 55mg percent	Critical (919206.5,0)	Post-crash fire

Bilateral mid shaft femur fractures	Serious (851814.3,1; 851814.3,2)	Induced fractures from knee loading into the knee bolster
Right mid shaft fractures of the tibia and fibula	Moderate (853420.2,1; 851606.2,1)	Lower knee bolster
Left distal radius fracture	Moderate (752802.2,2)	Possible fling injury from left A-pillar contact

Source – Autopsy Report

Driver Kinematics – 2004 Chevrolet Silverado

The driver of the Chevrolet Silverado was seated in a mid-to-rear track position. Due to the severity of the fire, it was unknown if she was restrained by the integrated 3-point lap and shoulder belt system. The left aspect of the driver’s seat back was rotated forward, possibly indicative of loading the integrated belt system. The buckle and latch plate were not found in the vehicle.

At impact, the 32-year old female driver of the Silverado initiated a forward trajectory in response to the frontal impact. The driver’s air bag probably deployed. The expansion of the air bag possibly displaced the driver’s left hand from the steering wheel resulting in a fling contact to the left upper A-pillar. This contact probably resulted in the fracture of the distal left radius. Due to the severity of the crash, the driver would have loaded the air bag and the steering assembly with her face and torso. Based on the frontal impact force, her knees would have contacted the knee bolster which resulted in induced mid shaft fractures of the femurs. Her right lower leg contacted the lower bolster panel resulting in fractures of the mid right tibia and fibula.

The post-crash fire completely consumed the interior of the Silverado. Based on an on-site police image, the front right door of the Silverado appeared to be partially opened post-crash with the deceased driver’s head resting in the vicinity of the right lower B-pillar. The driver of the Silverado remained conscious immediately following the crash and could have attempted to exit the vehicle prior to succumbing to the fire.

The driver sustained an inhalation injury of the trachea and epiglottis mucosal with a carboxyhemoglobin concentration of 55mg percent. This was the cause of death as noted by the Medical Examiner. The driver’s body sustained thermal burns with slight sparring of the posterior left shoulder and the mid buttock area.

