CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

CASE NO: CA04-021

VEHICLE: 2004 FORD TAURUS

LOCATION: WEST VIRGINIA

CRASH DATE: MARCH 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. CA04-021	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2004 Ford Taurus Location: State of West Virginia		*5. Report Date*: June 2006 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0205 *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: March 2004 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the severity of the crash and the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Ford Taurus SE.			
16. Abstract This on-site investigation focused on the severity of the crash and the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Ford Taurus SE. The manufacturer of this vehicle has certified that 2004 Taurus meets the advanced air bag requirements for Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system consisted of dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right seat occupant presence sensor, safety belt buckle switches and buckle pretensioners. The system was monitored and controlled by a Restraints Control Module (RCM) that also recorded crash data through an Event Data Recorder (EDR) function. The EDR was removed from the Taurus and forwarded to NHTSA for download by Ford. The EDR output was not received; therefore, it is not included in this report. The Taurus was driven by a 30-year old male driver with a height of 193 cm (76”) and weight of 181 kg (400 lb). He was restrained by the manual 3-point lap and shoulder belt system. A 1990 Chevrolet Lumina crossed the centerline of a two lane road and struck the Taurus in a head-on configuration. The impact fired the driver’s safety belt buckle pretensioner; however, the driver’s air bag did not deploy in this threshold level crash. The driver of the Taurus sustained safety belt related contusions of the anterior left shoulder, chest and abdomen and soreness of the neck. He also sustained a contusion of the left forehead from steering wheel contact. The driver was transported to a local hospital where he was treated and released. Both vehicles sustained disabling damage and were towed from the crash scene.			
17. Key Words Certified Advanced 208-Compliant occupant protection Non-deployment of air bag system Deployment of seat belt pretensioners		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 10	*22. Price*

TABLE OF CONTENTS

CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION
SCI CASE NO.: CA04-021
VEHICLE: 2004 FORD TAURUS
LOCATION: WEST VIRGINIA
CRASH DATE: MARCH 2004

BACKGROUND

This on-site investigation focused on the severity of the crash and the performance of the Certified Advanced 208-Complaint (CAC) frontal air bag system in a 2004 Ford Taurus SE. The manufacturer of this vehicle has certified that 2004 Taurus meets the advanced air bag requirements for Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system consisted of dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right seat occupant presence sensor, safety belt buckle switches and buckle pretensioners. The system was monitored and controlled by a Restraints Control Module (RCM) that also recorded crash data through an Event Data Recorder (EDR) function. The EDR was removed from the Taurus and forwarded to NHTSA for download by Ford. The EDR output was not received; therefore, it is not included in this report. The Taurus was driven by a 30-year old male driver with a height of 193 cm (76") and weight of 181 kg (400 lb). He was restrained by the manual 3-point lap and shoulder belt system. A 1990 Chevrolet Lumina crossed the centerline of a two lane road and struck the Taurus in a head-on configuration **(Figure 1)**. The impact fired the driver's safety belt buckle pretensioner; however, the driver's air bag did not deploy in this threshold level crash. The driver of the Taurus sustained safety belt related contusions of the anterior left shoulder, chest and abdomen and soreness of the neck. He also sustained a contusion of the left forehead from steering wheel contact. The driver was transported to a local hospital where he was treated and released. Both vehicles sustained disabling damage and were towed from the crash scene.

Figure 1. Front three-quarter view of the 2004 Ford Taurus.

The crash was identified from a list of potential CAC vehicle crashes that was provided to NHTSA by an insurance company. The list was pared down by NHTSA and forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up. The 2004 Ford Taurus was located at an insurance salvage yard and permission was granted to the SCI team to inspect the vehicle and remove the EDR for download. The on-site investigation for this March 2004 crash was conducted on April 22, 2004.

SUMMARY

Crash Site

The crash occurred on a two-lane east/west state route in a rural area. At the time of the daylight crash, the conditions were police reported as clear and dry. The Taurus approached the crash site on a straight segment of roadway with 3.3 m (10.8') wide travel lanes for the east/westbound travel directions. The travel lanes were divided by a double yellow center line. The road edges were painted with white fog lines and bordered by paved shoulders. Parking lots for a motel complex bordered both shoulders. A portable trash dumpster was positioned at the east edge of the parking lot that bordered the south road edge. The Chevrolet Lumina was traveling westbound exiting a right curve that transitioned onto the straight segment of road. At this location, the road surface was level. There were no defects in the asphalt road surface and the speed limit was posted at 89 km/h (55 mph). **Figure 2** is an eastbound view of the crash site. The crash schematic is attached as **Figure 13**, Page 10 of this report.

Figure 2. Eastbound view of the crash site.

Vehicle Data

2004 Ford Taurus

The involved 2004 Ford Taurus SE was manufactured on 10/03 and was identified by Vehicle Identification Number (VIN): 1FAHP53U64A (production number deleted). The Taurus was powered by a 3.0 liter transverse mounted gasoline engine linked to a four-speed automatic overdrive transmission with a column mounted selector lever. The braking system consisted of power-assisted front disc/rear drum brakes with anti-lock (ABS). Although the vehicle was without battery power at the time of the SCI inspection, the driver reported that the odometer reading was approximately 15,600 km (9,700 miles). The Taurus was equipped with P215/60R16 all-season Continental Touring Contact AS tires mounted on five-spoke OEM alloy wheels. The manufacturer recommended tire pressure was 207 kPa (30 PSI). The specific tire data for the Taurus at the time of the SCI inspection is displayed in the following table:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
LF	231 kPa (33.5 PSI)	7 mm (9/32")	None, gravel embedded into outer bead
LR	228 kPa (33 PSI)	7 mm (9/32")	None
RF	231 kPa (33.5 PSI)	7 mm (9/32")	None
RR	224 kPa (32.5 PSI)	7 mm (9/32")	None

The interior of the Taurus was equipped with a split bench front seat with a flip-and-fold center seat position/folding armrest. At the time of the crash, this unit was extended

forward in the armrest/console position. The driver and right passenger positions were equipped with adjustable head restraints and reclining seat backs. Both front head restraints were adjusted to the up-position, 8 cm (3.25") above the top surface of the seat backs. The driver's seat was power-adjustable. The rear seat was a three-passenger bench seat with forward folding seat backs. The 60/40 passenger side wide seat backs were upright and locked at the time of the crash. There were no rear head restraints. The rear seat was equipped with LATCH (Lower Anchorages and Tethers for CHildren). The Taurus was also equipped with adjustable pedals. The adjustment switch was mounted on the horizontal surface of the left instrument panel immediately below the instrument cluster, left of the steering assembly. The brake pedal pad was embossed with ADJUSTABLE. At the time of the SCI inspection, the pedals were adjusted 4 cm (1.4") forward of the full rear position **(Figure 3)**. In this position, the pedals were adjusted rearward, toward the driver.

Figure 3. Adjustable pedal jackscrews.

That 2004 Ford Taurus SE was owned by a local Ford Dealer and was used as a loaner car for service customers. The vehicle was provided to the driver by the dealership approximately 30 minutes prior to the crash. He was traveling to his residence when the crash occurred. Although the driver was restrained, he was not aware that the Taurus was equipped with adjustable pedals or the CAC frontal air bag system. It should be noted that since the Taurus was a dealer loaner car, the factory installed protective plastic covering over the front carpeting remained in place and that the OEM floor mats were inverted with the rubber side up. Protective paper floor mats were then placed over the inverted OEM mats.

1990 Chevrolet Lumina

The at-fault 1990 Chevrolet Lumina was not inspected during this on-site investigation. The owner/driver moved the vehicle off-road to the motel parking lot following the crash. He subsequently left the area and could not be located. The Lumina was a four-door sedan and was identified by the police reported VIN of 2G1WL54R7L1 (production number deleted). This VIN identified the Lumina as equipped with a 2.5 liter, four-cylinder engine and automatic door mounted lap and shoulder belts for the front outboard positions.

Crash Sequence

Pre-Crash

The driver of the Ford Taurus was traveling in an easterly direction on the two lane state road, en route to his residence. He estimated his travel speed at 72 km/h (45 mph) as he approached the impending crash site. A police officer had conducted a routine traffic stop of a westbound motorist and parked his vehicle on the north shoulder. The driver of the Chevrolet Lumina was traveling in a westerly direction and was negotiating the right curve as he approached the stopped police officer and the motel parking lots. The Lumina driver slowed his vehicle as he crossed the centerline of the roadway to observe the person that was stopped by the officer. Additionally, the Lumina driver was preparing to turn left into the motel parking lot, where he had taken up temporary residence while working in the area. The driver of the Taurus observed the Lumina cross the centerline into the eastbound lane. He stated that he applied a heavy braking force by "literally standing on the brake pedal". The Taurus was equipped with anti-lock brakes. The driver had no recall of the ABS activating during his braking maneuver. At the time of the on-site SCI investigation, there were no pre-impact tire marks visible on the asphalt road surface.

Crash

The frontal area of the Lumina impacted the front left area of the Taurus in a head-on, offset configuration. The resultant direction of force for the Taurus was within the 12 o'clock sector. Although the Lumina was not inspected during the on-site investigation, the vehicle experienced an impact force that was in the 1 o'clock sector. The Missing Vehicle Algorithm of the WinSMASH model was used to compute a velocity change for the Taurus. The output yielded a total delta V of 16 km/h (9.9 mph) with respective longitudinal and lateral components of -16 km/h (-9.9 mph) and 3 km/h (2 mph). As a result of the frontal crash, the Taurus' RCM commanded the firing of the driver's safety belt buckle pretensioner.

The Taurus was deflected to its right where it traversed the shoulder and entered the paved parking lot at the south road edge. The Taurus traversed the east edge of the lot and impacted a portable trash dumpster **(Figure 4)** that was mounted on casters. The center front area of the Taurus impacted the dumpster which deformed the front bumper fascia and hood edge. The 12 o'clock direction of force impact displaced the dumpster rearward. The back casters engaged asphalt curbing around the parking lot which tripped the dumpster onto its back side.

Figure 4. Struck trash dumpster and final rest position of the Taurus.

Post-Crash

The Taurus came to rest off-road on the asphalt parking lot, facing in an easterly direction. The driver momentarily remained in the vehicle until he regained his composure following the crash and attempted to exit the vehicle. The police officer, who was stopped at the scene of the crash, assisted the driver in opening the front left door. The driver was subsequently transported by ambulance to a local hospital where he was treated and released.

The Lumina was rotated in a counterclockwise direction and displaced east of the point of impact. The vehicle came to rest on the roadway, straddling the centerline, facing in an easterly direction. Immediately following the crash, the driver of the Lumina was assisted in pushing the vehicle off-road into the mouth of the parking lot at the north road edge. The officer arranged for towing of the Taurus while the driver of the Lumina arranged to have his vehicle removed at a later time. The location of the Lumina was not known.

Vehicle Damage

Exterior - 2004 Ford Taurus

The Ford Taurus sustained moderate severity frontal damage **(Figure 5)** from the head-on crash sequence with the 1990 Chevrolet Lumina. The direct contact damage began on the bumper fascia, 51 cm (20.25”) right of center and extended 125.1 cm (49.25”) to the left bumper corner. Maximum crush measured 19 cm (7.5”) and was located at the left corner of the bumper beam. The impact fractured the bumper fascia and the underlying Styrofoam filler panel, and deformed the full width of the bumper beam resulting in a combined induced and direct contact damage length of 131 cm (51.75”). The crush profile **(Figure 6)** was documented at the level of the bumper beam and was a follows: C1 = 19 cm (7.5”), C2 = 17 cm (6.625”), C3 = 11 cm (4.5”), C4 = 8 cm (3.0”), C5 = 4 cm (1.75”), C6 = 1 cm (0.25’). Components damaged by the impact included the front bumper fascia, filler panel, grille, hood, both front headlamp assemblies, both front fenders, the composite radiator support panel, radiator, air conditioning condenser, and the front frame rails. The Collision Deformation Classification (CDC) for this event was 12-FYEW-1.

Figure 5. Frontal damage to the Ford Taurus.

Figure 6. Lateral view documenting the depth of crush to the bumper beam.

Following the initial impact, the center front of the Taurus impacted the portable trash dumpster. The minor severity impact produced green paint transfers to the damaged bumper fascia and hood **(Figure 7)**. The paint transfer on the bumper fascia began at the vehicle's centerline and extended 5 cm (1.9") to the right. The diagonally oriented transfer pattern extended onto the hood face and was located 17-22 cm (6.75-8.5") right of the centerline. A 2 cm (0.75") deep dent was associated with the hood face contact with corner of the dumpster. The CDC for this event was 12-FCEN-1.

Figure 7. Green paint transfers from the dumpster impact.

Interior – 2004 Ford Taurus

The interior of the Ford Taurus sustained minor severity damage that was attributed to occupant loading. There was no damage associated with exterior deformation or intrusion of the passenger compartment. The large stature driver applied a heavy braking force pre-crash with his right foot. The placement of his foot against the right aspect of the brake pedal at impact resulted in loading induced deformation of the pedal **(Figure 8)**. The right aspect of the pedal was rotated approximately 7.6 cm (3.0") forward. There was no bending noted to the brake pedal arm.

Figure 8. Deformed brake pedal from driver loading.

Manual Restraint Systems – 2004 Ford Taurus

The Taurus was equipped with 3-point lap and shoulder belts for the front outboard and three rear seat positions. The front center position was equipped with a lap belt with a locking latch plate.

Figure 9. Driver's manual belt system.

The front 3-point lap and shoulder belt systems consisted of continuous loop webbing with sliding latch plates and adjustable D-rings **(Figure 9)**. The driver's D-ring was adjusted to the full-up position and the front right D-ring was adjusted 4 cm (1.75") below the full-up position. Both D-rings were designed with a series of detents over an 8 cm (3.25") vertical adjustment range. The driver's side retractor was an Emergency Locking Retractor (ELR) with a belt sensitive feature. The front right retractor incorporated a switchable

mode for both ELR and Automatic Locking Retractor (ALR) functions. The front seat retractors were equipped with load limiters that consisted of a torsion bar axle within the retractor. Both front buckle assemblies were equipped with pretensioners and buckle switches. The vehicle's RCM detected a threshold level crash and fired the driver's pretensioner **(Figure 10)**. The front right seat was not occupied; therefore, the pretensioner did not fire. Measurements of the fired and non-fired pretensioner barrels indicated the driver's pretensioner travel was 5 cm (1.8"). Although the driver was restrained by the manual belt system, there was no loading evidence to the belt webbing or hardware components.

Figure 10. Fired driver's buckle pretensioner.

The rear seat belt systems utilized continuous loop webbings with sliding latch plates and ALR/ELR retractors with the webbing sensitive locking feature. The center rear retractor was mounted to the upper right parcel tray bracket and was positioned to the right of this seated position.

Certified Advanced 208-Complaint Frontal Air Bag System

The 2004 Ford Taurus was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that consisted of dual stage air bags for the driver and front right positions, seat track positioning sensors, a front right occupant presence system, and safety belt buckle switches with pretensioners. The system was controlled and monitored by a Restraints Control Module (RCM) that was located on the center front tunnel of the Taurus, below the center instrument panel. A single satellite sensor was mounted to the hood latch bracket at the mid point of the vehicle. This sensor was positioned approximately 5 cm (2") above the front bumper beam. The passenger air bag activation status indicator **(Figure 11)** was located in the center mid instrument panel.

Figure 11. Passenger Air Bag ON/OFF status indicator lamp.

Figure 12. View of the non-deployed CAC frontal air bag system.

The driver's air bag was concealed in a module that was mounted within the four-spoke steering wheel rim **(Figure 12)**. The spoke locations were positioned at the 3/9 and 5/7 o'clock positions. The non-deployed air bag was concealed by what appeared to be a single D-shaped cover flap. There was no contact evidence to the module cover.

The front right passenger air bag was a top mount design with the leading edge of the single cover flap extending onto the mid instrument panel **(Figure 12)**. The forward hinged front right air bag cover flap measured 45 cm (17.75") in width and 33 cm (13.0") in depth. There was no damage or contact evidence to the cover flap.

Event Data Recorder

The 2004 Ford Taurus was equipped with an Event Data Recorder (EDR) that was incorporated into the vehicle's Restraints Control Module (RCM) located on the center tunnel of the vehicle below the center instrument panel. The RCM was removed from the Taurus with permission from the insurance company and forwarded to NHTSA for download by Ford. The EDR output data was not received by the SCI team, therefore it is not included in this report.

Side Impact Air Bag System

The 2004 Ford Taurus was equipped with the optional seat back mounted side impact air bags. The side air bags did not deploy in this crash.

Driver Demographics – 2004 Ford Taurus

Age/Sex:	30-year old/Male
Height:	193 cm (76")
Weight:	181 kg (400 lb)
Seat Track Position:	Full rear track
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, driver interview
Eyeware:	Prescription eyeglasses
Egress from Vehicle:	Exited through the left front door
Mode of Transport From Scene:	Ambulance
Medical Treatment:	Transported to a local hospital where he was treated for minor severity injuries and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98	Injury Mechanism
*Contusion of the left anterior shoulder	Minor (790402.1,2)	Shoulder belt loading
*Contusion of the left forehead	Minor (290402.1,7)	Steering wheel rim
+Contusion across chest	Minor (490402.1,4)	Shoulder belt loading
+Contusion right abdomen	Minor (590402.1,1)	Lap/shoulder belt webbing

*Injury Data Source: * Emergency Room Records, +driver interview.*

Driver Kinematics

The driver of the Ford Taurus dropped his pickup truck off for service at a local dealership and was provided the Ford Taurus as a loaner vehicle. He was not aware that the vehicle was equipped with the CAC frontal air bag system or the adjustable pedal option. The pedals were adjusted 4 cm (1.4") forward of the full-rear position (toward driver). As the driver entered the vehicle, he adjusted the seat to the full rear track position and buckled the manual safety belt system. The seat back angle was reclined to a measured 20 degrees aft of vertical. The five-position adjustable steering wheel was set to the mid position. In these adjusted positions, the horizontal distance between the mid point of the driver air bag module cover flap and the seat back was 70 cm (27.6"), measured at 51 cm (20") above the seat bight. The adjustable head restraint was adjusted 8 cm (3.25") above the seat back.

Immediately prior to impact, the driver detected the Lumina as it crossed the centerline into the eastbound travel lane. He applied a heavy braking force with his right foot and stated that he was "literally standing on the brake pedal" in an attempt to slow the Taurus for the impending crash.

At impact with the Lumina, the RCM detected the frontal crash and fired the driver's safety belt buckle pretensioner. The driver initiated a forward trajectory and loaded the manual belt webbing. Due to the driver's size, the load limiter in the retractor spooled out webbing which allowed the driver to ride down the crash forces. Although there was no loading evidence on the belt system, the driver sustained a diagonally oriented seat belt contusion of his left anterior shoulder, chest, and right abdomen. The driver's head jackknifed over the belt system and struck the upper steering wheel rim which resulted in a left forehead contusion.

His right foot loaded the brake pedal, which rotated the right aspect of the pedal plate forward. The driver did not sustain injury of the leg and denied pain of the foot and ankle.

The driver rebounded into the left front seat back as the vehicle was deflected to its right and traversed the parking lot. The center frontal area of the Taurus impacted a portable garbage dumpster. This minor severity impact did not displace the driver.

As the Taurus came to rest, the police officer who was positioned on the north road edge ran to the aid of the driver. Within minutes, the driver regained his composure and unbuckled the manual restraint system and exited the vehicle.

Medical Treatment

The driver of the Taurus was transported by ambulance to a local hospital where he was examined for possible injury. The driver's chief complaint was pain of the left anterior shoulder and the attending emergency room physician ordered a diagnostic X-ray of the shoulder which was negative for internal injury. The driver was released within two hours and was transported by private vehicle to a meeting at a volunteer fire department. He also reported to his assigned work shift at 2300 hours on the evening of the crash.

The driver experienced pain across the posterior neck and shoulder region and sought treatment from a local chiropractor. Following several appointments to the chiropractor, the driver reported the pain was alleviated.

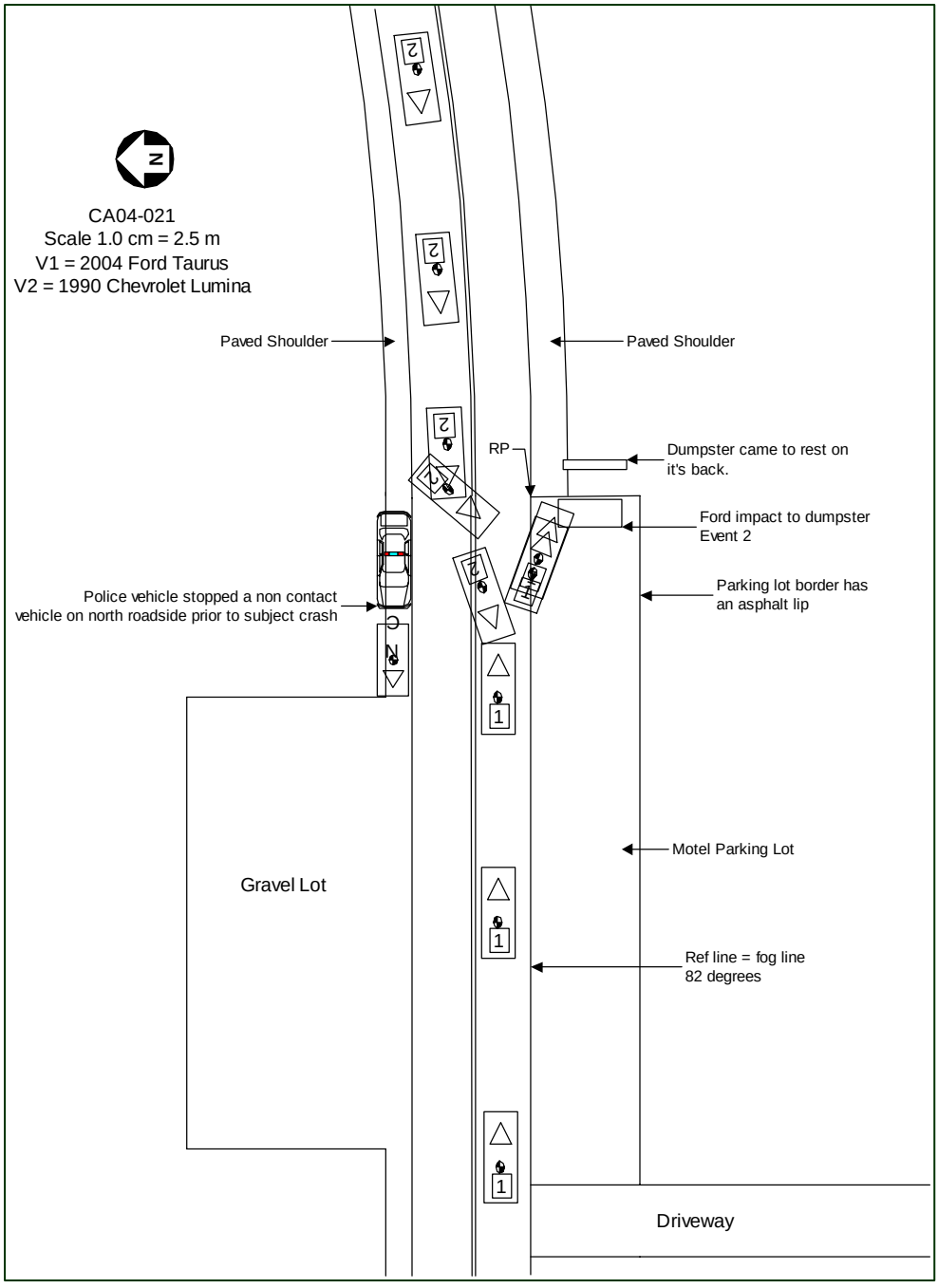

Figure 13 – Scene Schematic