

CRASH DATA RESEARCH CENTER

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**CALSPAN REMOTE ADULT PASSENGER AIR BAG RELATED SERIOUS
INJURY CRASH INVESTIGATION**

NASS/SCI COMBO CASE NO: 2004-45-245J

VEHICLE: 2004 FORD EXPLORER

LOCATION: TENNESSEE

CRASH DATE: DECEMBER 2004

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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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<p>16. Abstract The remote investigation focused on the severity of a crash and the source of a closed head injury for a restrained 14-year old female front right passenger of a 2004 Ford Explorer. The Explorer was equipped with dual stage frontal air bags that deployed as a result of a head-on crash with a 2003 Honda Civic. A restrained 40-year old driver was operating the Explorer in a westerly direction on a two-lane roadway as the front right passenger began to experience a seizure. The front right passenger had a medical history of seizures and was taking the prescribed medication for this condition. The driver who instinctively began to aid the front right passenger relinquished control of the vehicle and it crossed the centerline of the roadway. The Explorer drifted into the eastbound lane and struck the Honda in a head-on configuration. A six-year old male child seated in a Cosco backless booster seat the second row center also occupied the Explorer. The six-year old child alerted the driver of the impending crash and the driver applied her brakes in avoidance. The driver of the Explorer sustained a right medial malleolus fracture and multiple soft-tissue injuries to her face and extremities. The front right passenger sustained an 8 mm intraparenchymal hemorrhage of the left frontal region of her brain, a facial contusion from contact with the expanding air bag, and an abdominal contusion from loading the lap belt. The child seated in the second row center position suffered a right eyelid contusion, a left facial contusion, and a left shoulder contusion. The driver was transported to a local hospital by ambulance, where she underwent open reduction internal fixation of the right ankle. The front right passenger was transported to a local hospital by ambulance with a Glasgow Coma Score (GCS) of 15 and was held for a period of 23 hours for observation. She was discharged with the instruction to continue her anti-seizure medication. The 6-year old child was taken to a local hospital by family members later that day for treatment of his soft-tissue injuries and was then released.</p>			
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BACKGROUND

The remote investigation focused on the severity of a crash and the source of a closed head injury for a restrained 14-year old female front right passenger of a 2004 Ford Explorer (**Figure 1**). The Explorer was equipped with dual stage frontal air bags that deployed as a result of a head-on crash with a 2003 Honda Civic. A restrained 40-year old driver was operating the Explorer in a westerly direction on a two-lane roadway as the front right passenger began to experience a seizure. The front right passenger had a medical history of seizures and was taking the prescribed medication for this condition. The driver who instinctively began to aid the front right passenger relinquished control of the vehicle and it crossed the centerline of the roadway. The Explorer drifted into the eastbound lane and struck the Honda in a head-on configuration. A six-year old male child seated in a Cosco backless booster seat the second row center also occupied the Explorer. The six-year old child alerted the driver of the impending crash and the driver applied her brakes in avoidance. The driver of the Explorer sustained a right medial malleolus fracture and multiple soft-tissue injuries to her face and extremities. The front right passenger sustained an 8 mm intraparenchymal hemorrhage of the left frontal region of her brain, a facial contusion from contact with the expanding air bag, and an abdominal contusion from loading the lap belt. The child seated in the second row center position suffered a right eyelid contusion, a left facial contusion, and a left shoulder contusion. The driver was transported to a local hospital by ambulance, where she underwent open reduction internal fixation of the right ankle. The front right passenger was transported to a local hospital by ambulance with a Glasgow Coma Score (GCS) of 15 and was held for a period of 23 hours for observation. She was discharged with the instruction to continue her anti-seizure medication. The 6-year old child was taken to a local hospital by family members later that day for treatment of his soft-tissue injuries and was then released.



Figure 1 - Damaged 2004 Ford Explorer.

This case was initially selected for investigation by the NASS-system. The National Highway Traffic Safety Administration (NHTSA) identified the case as a possible air bag related serious injury case and assigned the tasks of case review and report preparation to the Calspan Special Crash Investigations (SCI) team on March 17, 2005. The front right female passenger's injuries were reviewed by physicians associated with the CIREN project who determined that her head injury was trauma related and not the result of the seizure.

SUMMARY

Crash Site

The crash occurred on a two-lane rural roadway during daylight hours. The asphalt roadway was straight at the point of impact; however, it was windy in nature and the Explorer had recently negotiated a left curve prior to the impact. The east/west roadway was delineated by double-yellow painted center lines and the road edges contained asphalt shoulders denoted by white painted edge lines. The lanes were 3.3 m (8.4') in width on a steep grade that was negative (downhill) for westbound traffic. The roadway was bordered by natural growth and sporadic dwellings. The posted speed limit was 64 km/h (40 mph). The scene schematic is included as **Figure 11** at the end of the narrative report.

Vehicle Data

2004 Ford Explorer

The subject vehicle in this crash was a 2004 Ford Explorer sport-utility vehicle. The Explorer was manufactured in 12/03 and was identified by Vehicle Identification Number (VIN): 1FMZU62KX4U (production number omitted). The Explorer was equipped with a 4.8-liter, 6 cylinder engine linked to a five-speed automatic transmission with a console mounted transmission shifter. The braking system for this rear-wheel drive vehicle consisted of four wheel disc brakes with anti-lock (ABS). The vehicle had a Gross Vehicle Weight Rating of 2595 kg (5721 lb). The Explorer was equipped with Michelin Cross Terrain P235/70R16 tires. The manufacturer recommended tire pressure was 241 kPa (35 PSI). The specific tire pressures and tread depths at the time of the NASS inspection were as follows:

Position	Tire Pressure	Tread Depth	Damage
Left Front	241 kPa (35 PSI)	6 mm (8/32")	None
Right Front	241 kPa (35 PSI)	6 mm (8/32")	None
Left Rear	228 kPa (33 PSI)	6 mm (8/32")	None
Right Rear	234 kPa (34 PSI)	6 mm (8/32")	None

The interior of the Explorer was configured as a five-passenger vehicle with front bucket seats and a rear split bench seat with folding backs. The front bucket seats had manually operative seat tracks and recline features with adjustable head restraints. At the time of the NASS inspection, the front seat tracks were adjusted to the mid-position and the head restraints were full-down. The second row seating consisted of fixed seat tracks and adjustable head restraints all of which were in a full-down position. Three point lap and shoulder belts were present in at all five seating positions. The front belts were configured with sliding latch plates and adjustable D-rings that were full-down at the inspection. The rear safety belts were equipped with sliding latch plates, switchable retractors, and fixed D-rings.

2003 Honda Civic EX

The other vehicle in this crash was a 2003 Honda Civic EX 2-door coupe. The Honda was identified by the VIN: 1HGEM22563L (production number omitted). The vehicle was equipped with a 2.4-liter, 4-cylinder engine linked to a four-speed automatic

transmission. The braking system consisted of four-wheel disc brakes with ABS. The front-wheel drive vehicle was equipped with Firestone FR-380 P185/70R14 tires. The recommended tire pressure for the tires was 207 kPa (30 PSI). The specific tire pressures and tread depths at the time of the NASS inspection were as follows:

Position	Tire Pressure	Tread Depth	Damage
Left Front	207 kPa (30 PSI)	6 mm (8/32")	None
Right Front	207 kPa (30 PSI)	5 mm (6/32")	None
Left Rear	207 kPa (30 PSI)	6 mm (8/32")	None
Right Rear	214 kPa (31 PSI)	6 mm (8/32")	None

Crash Sequence

Pre-Crash

The 40-year old female driver of the 2004 Ford Explorer was traveling westbound on a two-lane roadway (**Figure 2**). A 21-year old female was operating the 2003 Honda Civic and was traveling eastbound on the same roadway (**Figure 3**). The driver of the Explorer had recently exited a left curve onto a straight portion of the roadway that contained a steep westbound negative grade. The driver's 14-year old daughter seated in the front right position began to have a seizure, which distracted the driver. The driver attempted to aid her daughter and in doing so crossed the centerline of the roadway and drifted into the eastbound lane. The driver's 6-year old son saw the approaching Honda and cautioned his mother who panicked and applied the brakes resulting in a driver-reported lock-up of the ABS system. The roadway yielded no evidence as to pre-crash avoidance measures by either vehicle.



Figure 2 - Westbound approach of Explorer.



Figure 3 - Eastbound approach of Honda.

Crash

The front center and left area of the Explorer impacted the entire front end of the Honda. The resultant directions of force for both vehicles were within the 12 o'clock sector. The frontal impacts to both vehicles resulted in a 45-degree counterclockwise rotation and they came to rest near the point of impact. The damage algorithm of the WinSMASH program computed total velocity changes of 26 km/h (16.2 mph) for the Explorer and 44 km/h (27.3 mph) for the Honda. The specific longitudinal and lateral components were -26 km/h (-16.2 mph) and 0 km/h for the Explorer and -44 km/h (-27.3 mph) and 0 km/h for the Honda. As the result of the impact, the frontal air bags in both vehicles deployed.

Post-Crash

Emergency personnel arrived on scene and removed the three passengers of the Explorer from the vehicle. The driver and front right passenger were stabilized and transported to a local hospital by ambulance. They were both admitted for one day. The rear center child passenger was evaluated at the scene and released to family members. Later that day, after complaining of pain, he was taken to the emergency room where he was diagnosed with minor injuries and released. The driver of the Honda was removed from her vehicle by emergency personnel and transported by ambulance to a local hospital where she was admitted for 10 days. Both vehicles sustained moderate damage and were towed from the scene.

Vehicle Damage

Exterior – 2004 Ford Explorer

The 2004 Ford Explorer sustained moderate severity frontal damage (**Figure 4**). The direct contact damage began at the left front bumper corner and extended 99 cm (40”) to the right, terminating 20 cm (7.9”) inboard of the right front bumper corner. The combined direct and induced damage encompassed the entire front bumper width measuring 144 cm (56.7”). The maximum crush was located at the left front bumper corner and measured 35 cm (13.8”) in depth. The crush profile was documented along the bumper beam the results of which follow: C1 = 35 cm (13.8”), C2 = 26 cm (10.2”), C3 = 24 cm (9.4”), C4 = 20 cm (7.9”), C5 = 6 cm (2.4”), C6 = 2 cm (0.8”). The SCI revised Collision Deformation Classification (CDC) for this event was 12-FYEW-2.



Figure 4 - Measured 2004 Ford Explorer.

Interior – 2004 Ford Explorer

The interior of the 2004 Ford Explorer sustained minor damage in the form of passenger compartment intrusion and occupant contact (**Figure 5**). The intrusion was limited only to the toe pan in the front left position, which intruded longitudinally 8 cm (3.2”). The driver’s air bag was contacted, evidenced by make-up transfers at the center of the air bag. The front right passenger’s air bag was also contacted by the face of the front right passenger. This was supported by make-up transfers on the bottom left quadrant of the air bag.



Figure 5 - Interior of Ford Explorer.

The driver’s lower extremities loaded the left knee bolster causing scuffing and indenting of the rigid plastic cover. The intruded toe pan was sourced to injuries to the driver’s ankle; however, no distinct evidence can be derived from the images. The glove

compartment door was contacted and damaged from the front right passenger's lower extremities. The glove compartment door was found to be opened during the NASS inspection.

Exterior – 2003 Honda Civic EX

The 2003 Honda Civic sustained moderate damage as a result of the frontal impact (**Figure 6**). The direct contact damage began at the left front bumper corner and extended the full width of the damaged bumper beam measuring 105 cm (41.3"). The combined direct and induced Field-L damage was also 105 cm (41.3"). The maximum crush was located 19 cm (7.5") right of the vehicle's centerline and measured 56 cm (22") in depth. The crush profile was measured along the vehicle's bumper beam the results of which are as follows: C1 = 40 cm (15.7"), C2 = 40 cm (15.7"), C3 = 41 cm (16.1"), C4 = 49 cm (19.3"), C5 = 50 cm (19.7"), C6 = 25 cm (9.8"). The CDC for this impact was 12-FDEW-3.



Figure 6 - Damaged 2003 Honda Civic.

Frontal Air Bag System – 2004 Ford Explorer

The Explorer was equipped with a dual stage frontal air bag system that deployed as a result of the impact with the Honda Civic (**Figures 7 and 8**). The driver's air bag was concealed within the steering wheel hub by trapezoidal cover flaps. The upper flap was 25 cm (9.8") horizontally and 5 cm (2") vertically. The bottom flap was 15 cm (5.9") horizontally and 6 cm (2.4") vertically. The driver air bag membrane measured 50 cm (19.7") in its deflated state. The air bag was tethered by two straps and was vented by two ports located near the 11 and 1 o'clock positions. The tether straps were sewn to the face of the air bag with three rows of stitching forming a circular pattern. There was a substantial make-up transfer at the central and lower aspects of the air bag.



Figure 7 - Deployed driver's air bag.



Figure 8 - Deployed front right air bag.

The front right air bag was concealed within the top aspect of the front right instrument panel by a top-hinged cover flap. The cover flap was 35 cm (13.7") horizontally and 18 cm (7.1") vertically. The rectangular air bag membrane measured 55 cm (21.7") in

height and 50 cm (19.7”) in width in its deflated state. The air bag was not tethered and was vented by two ports located near the 10 and 2 o’clock positions. There was significant make-up transfers located on the front bottom left aspect due to occupant loading.

Manual Safety Belt Systems – 2004 Ford Explorer

The Explorer was configured as a five passenger vehicle and was equipped with manual lap and shoulder belts for all seating positions. The four outboard belt systems consisted of continuous loop lap and shoulder belt webbing with sliding latch plates. The driver’s belt was configured with an Emergency Locking Retractor (ELR). The remaining outboard belts consisted of switchable ELR/Automatic Locking Retractors (ALR’s). The front restraints were configured with adjustable D-rings of which both were in full-down position at the time of the NASS vehicle inspection. The rear center seating position was equipped with an integral lap and shoulder restraint. The NASS vehicle inspection did not identify any loading evidence on the belt systems; however, the inspection did reveal historical usage indicators on the latch plates.

Child Safety Seat – 2004 Ford Explorer

Graco Turbo Booster

A forward-facing backless booster Child Safety Seat (CSS) was properly installed in the rear center seating position of the 2004 Ford Explorer. The model number was 8491RGB and the date of manufacture was July 13, 2003. The serial number was JJ 0712031095978. The booster seat was designed for forward-facing only and had belt paths on each side of its base. The CSS can be used with a back support or independent of a support. The CSS was used without a back support in this crash. The seat was designed for children between the ages of 3 and 10 years old, who weigh between 14 kg (30 lb) and 45 kg (99 lb), and whose height is within the parameters of 101cm (40”) and 145 cm (57”). The 6-year old child who occupied this booster seat was 145 cm in height and 28 kg in weight. The NASS investigation revealed no contact evidence on the CSS. **Figures 9 and 10** illustrate the CSS at the time of the inspection.



Figure 9 – Front view of Booster CSS.



Figure 10 - Top view of booster CSS.

Occupant Demographics/Data

Driver – 2004 Fords Explorer

Age/Sex: 40-year old/Female
Height: 168 cm (66")
Weight: 61 kg (135 lb)
Seat Track Position: Mid-track position
Manual Restraint Usage: 3-point lap and shoulder restraint
Usage Source: Vehicle inspection
Eyewear: None
Type of Medical Treatment: Transported by ambulance to local hospital and admitted for one day.

Driver Injuries:

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Tibia fracture – medial malleolus	Moderate (853412.2,1)	Toe pan
Facial abrasion – left cheek	Minor (290202.1,2)	Expanding driver’s air bag
Facial abrasion – right cheek	Minor (290202.1,1)	Expanding driver’s air bag
Right knee abrasion	Minor (890202.1,1)	Knee bolster
Right ankle contusion	Minor (890402.1,1)	Foot pedals
Right knee contusion	Minor (890402.1,1)	Knee bolster
Facial contusion*	Minor (290402.1,9)	Expanding driver’s air bag
Left forearm contusion*	Minor (790402.1,2)	Expanding driver’s air bag
Right thigh contusion	Minor (890402.1,1)	Left side armrest

Source: Medical records, interview.

*Denotes interview source

Driver Kinematics

The 40-year old driver was seated in an upright posture and was restrained by the manual 3-point lap and shoulder belt. At impact, the driver initiated a forward trajectory responding to the 12 o'clock direction of force and loaded the expanding driver's air bag. The driver sustained facial abrasions to both of her cheeks, a facial contusion and a left forearm contusion. Contact to the air bag is corroborated by a substantial make-up transfer on the air bag membrane. As the driver continued in a forward trajectory, her knees loaded the bolster and her right ankle was compressed by the intruding toe pan. She sustained a fractured tibia (medial malleolus) and an accompanying soft-tissue injury from probable contact with the foot controls. The absence of photographic documentation of the area of the left toe pan prevents precise determination of the driver's ankle injuries; however, these sources seem probable. The driver also sustained multiple soft tissue injuries to her knees from engagement against the bolster. The left knee bolster contained contact evidence in the form of scuffmarks and minor deformation. She was removed from her vehicle by emergency personnel and transported to a local hospital where she was admitted for one day.

Front Right Passenger – 2004 Ford Explorer

Age/Sex: 14-year old/Female
Height: 165 cm (65’’)
Weight: 54 kg (119 lb)
Seat Track Position: Mid-track position
Manual Restraint Usage: 3-point lap and shoulder restraint
Usage Source: Vehicle inspection, injury data
Eyewear: None
Type of Medical Treatment: Transported by ambulance by local hospital and admitted for one day.

Front Right Occupant Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
8 mm intraparenchymal hemorrhage of the left frontal region of her brain	Severe (140640.4,2)	Expanding front right air bag
Facial skin contusion*	Minor (290402.1,2)	Expanding front right air bag
Abdomen contusion*	Minor (590402.1,2)	Lap belt

Source: Medical records, driver interview.

**Denotes interview source.*

Front Right Passenger Kinematics

The 14-year old driver was restrained by the manual 3-point lap and shoulder belt, but was likely out of position forward due to experiencing a seizure and was displaced further forward by the pre-crash braking. Due to her forward position, she spooled out the shoulder belt webbing prior to the locking of the ELR. At impact, she initiated a forward trajectory responding to the 12 o’clock direction of force and loaded her safety belt. She was contacted in the head and face by the expanding driver’s air bag. She sustained an 8 mm intraparenchymal hemorrhage of the left frontal region of her brain accompanied by a contusion on the left side of her face from loading the expanding front right air bag. Evidence was present in the form of a substantial make-up transfer to the bottom left quadrant of the air bag membrane. She also loaded the lap portion of the manual belt system sustaining a contusion to the abdomen. She was removed from the vehicle by emergency personnel and transported to a local hospital where she was admitted for one day.

Rear Center Passenger – 2004 Fords Explorer

Age/Sex: 6-year old/Male
Height: 145 cm (57’’)
Weight: 28 kg (62 lb)
Seat Track Position: Not adjustable
Manual Restraint Usage: Backless booster CSS with 3-point lap and shoulder restraint
Usage Source: Vehicle inspection
Eyewear: None
Type of Medical Treatment: Transported to local hospital by family member where he was treated and released.

Rear Center Passenger Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Eyelid contusion	Minor (297402.1,1)	Shoulder belt
Facial skin contusion left cheek*	Minor (290402.1,2)	Shoulder belt
Left shoulder contusion*	Minor (790402.1,2)	Shoulder belt

Source: Medical records, driver interview.

**Denotes interview source.*

Rear Center Passenger Injuries

The 6-year old child passenger was seated in an upright posture and was restrained by the manual 3-point lap and shoulder belt within a backless booster CSS. At impact, the child initiated a forward trajectory responding to the 12 o’clock direction of force and loaded the lap and shoulder belt. As he loaded the shoulder belt, he sustained a contusion to his left shoulder. He also sustained an eyelid contusion and a contusion to his left cheek probably from his own hands as they flailed due to the impact. The child was removed from the vehicle and evaluated at the scene by emergency personnel who released him to the care of his family. As a cautionary measure, his family transported him to a local hospital later in the day where he was treated and released.

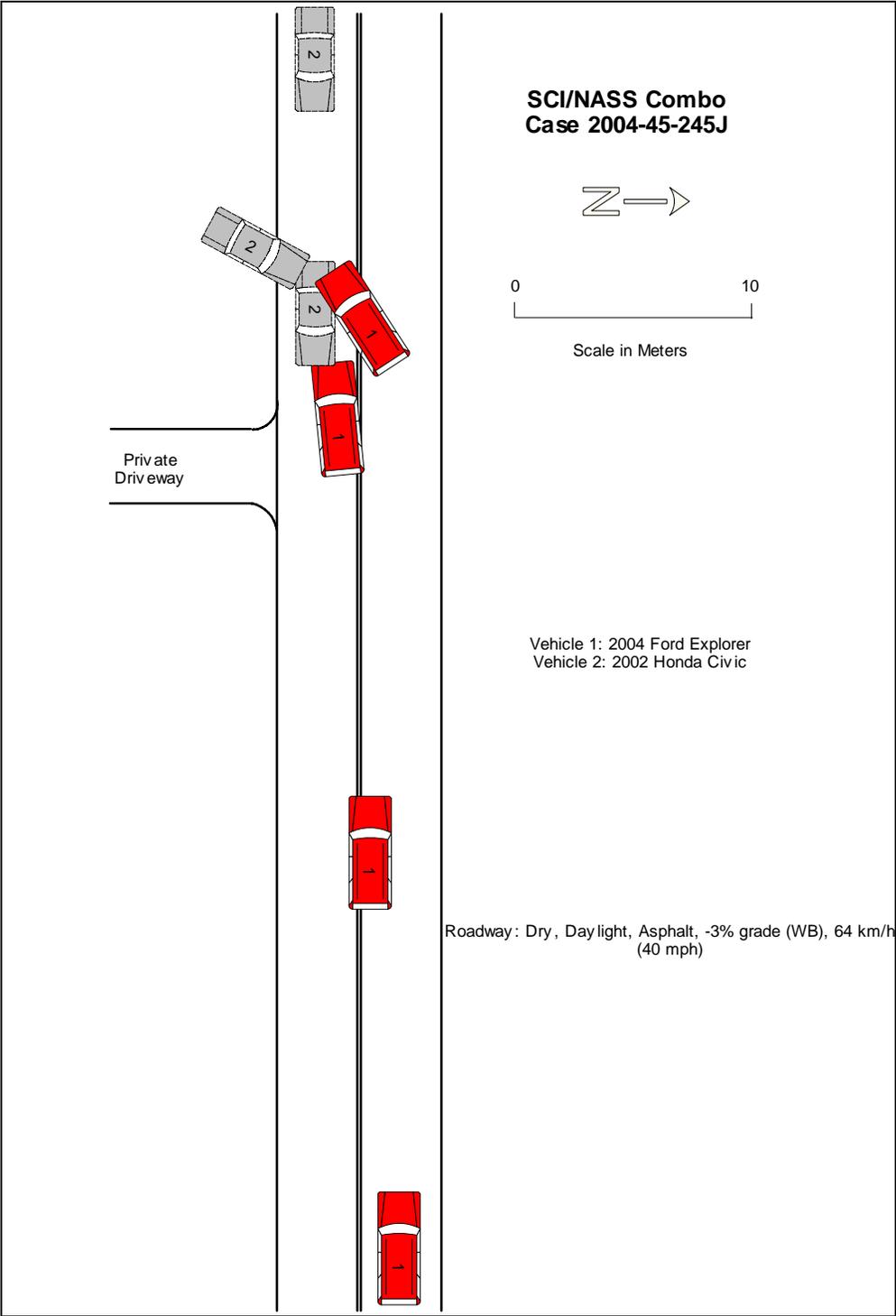


Figure 11 - NASS Scene Schematic