

CRASH DATA RESEARCH CENTER

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**CALSPAN REMOTE SAFETY BELT RELATED
PLACENTAL ABRUPTION CRASH INVESTIGATION
NASS/SCI CASE NO: 2008-09-026C**

**VEHICLE: 2006 MERCEDES-BENZ E350
LOCATION: MARYLAND
CRASH DATE: JANUARY, 2008**

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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</p> <p>This investigation focused on an intersection crash of a 2006 Mercedes-Benz E350 and a 2005 Ford Explorer Sport Trac that resulted in an AIS 3 placental abrupton injury to the restrained 40 year old pregnant female front right passenger in the Mercedes. The placental abrupton prompted an emergency cesarean delivery of a 24 week old premature female infant who died the day following the crash. The placental abrupton injury was sourced to the loading of the vehicle's safety belt. The 42 year old restrained male driver of the Mercedes sustained police reported incapacitating injuries and was transported to a local hospital. The 69 year old restrained male driver of the Ford was also transported to a local hospital with police reported incapacitating injuries.</p> <p>The crash occurred when the Ford turned left at the intersection directly across the path of the Mercedes. The front plane of the Mercedes impacted the left side plane of the Ford. The Mercedes E350 was equipped with front and rear seat safety belt pretensioners, Certified Advanced 208-Compliant (CAC) frontal air bags, front seat back mounted side impact air bags, rear door mounted side impact air bags and rollover sensing roof-rail mounted side curtains. The frontal air bags in the Mercedes were certified by the vehicle manufacturer to meet the advanced air bag portion of Federal Motor Vehicle Safety Standard No. 208. The front safety belt pretensioners actuated and the frontal air bags deployed as a result of the impact. The Ford Sport Trac was equipped with frontal air bags that did not deploy during the crash.</p> <p>This crash was initially selected for research within the National Automotive Sampling System (NASS) during the routine sampling procedures conducted within the system. During Zone Center coding of the crash, the placental abrupton injury was identified and notification of the crash was forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). A combined investigation of the crash was assigned June 18, 2008 to the Calspan Special Crash Investigations (SCI) team due to the Agency's interest in the placental abrupton injury related to the safety belt loading.</p>			
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NASS/SCI CASE NO: 2008-09-026C**

**VEHICLE: 2006 MERCEDES-BENZ E350
LOCATION: MARYLAND
CRASH DATE: JANUARY, 2008**

BACKGROUND

This investigation focused on an intersection crash of a 2006 Mercedes-Benz E350 (**Figure 1**) and a 2005 Ford Explorer Sport Trac that resulted in an AIS 3 placental abruption injury to the restrained 40 year old pregnant female front right passenger in the Mercedes. The placental abruption prompted an emergency cesarean delivery of a 24 week old premature female infant who died the day following the crash. The placental abruption injury was sourced to the loading of the vehicle's safety belt. The 42 year old restrained male driver of the Mercedes sustained police reported incapacitating injuries and was transported to a local hospital. The 69 year old restrained male driver of the Ford was also transported to a local hospital with police reported incapacitating injuries.



Figure 1: Left front oblique view of the Mercedes.

The crash occurred when the Ford turned left at the intersection directly across the path of the Mercedes. The front plane of the Mercedes impacted the left side plane of the Ford. The Mercedes E350 was equipped with front and rear seat safety belt pretensioners, Certified Advanced 208-Compliant (CAC) frontal air bags, front seat back mounted side impact air bags, rear door mounted side impact air bags and rollover sensing roof-rail mounted side curtains. The frontal air bags in the Mercedes were certified by the vehicle manufacturer to meet the advanced air bag portion of Federal Motor Vehicle Safety Standard No. 208. The front safety belt pretensioners actuated and the frontal air bags deployed as a result of the impact. The Ford Sport Trac was equipped with frontal air bags that did not deploy during the crash.

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SUMMARY

Vehicle Data

2006 Mercedes-Benz E350

The 2006 Mercedes-Benz E350 was manufactured in December 2005 and was identified by the Vehicle Identification Number (VIN): WDBUF56J46A (production sequence deleted). The four-door, rear-wheel drive sedan was equipped with a 3.5 liter, V6 engine linked to a seven-speed automatic transmission. The service brakes were front/rear disc with four-wheel anti-lock (ABS) and brake assist. The vehicle was also equipped with Traction Control and an Electronic Stability Program (ESP). The manual restraint system consisted of three-point lap and shoulder belts in the five seat positions. The front and rear outboard positions were equipped with pretensioners. The E350 was equipped with CAC frontal air bags, front and rear side (thorax) impact air bags and rollover sensing roof rail mounted side curtains. The 2006 Mercedes-Benz E350 was not equipped with the Pre-Safe safety system. The Mercedes was equipped with Michelin Pilot HMXV4 P245/45R17 snow tires mounted on OEM alloy rims. The vehicle manufacturer's recommended cold tire pressure was 190 kPa (28 PSI) front and 230 kPa (33 PSI) rear. The specific measured tire data and the time of the NASS inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	Tire flat	8 mm (10/32)	Yes	None
LR	Tire flat	9 mm (11/32)	No	None
RF	Tire flat	5 mm (6/32)	No	None
RR	186 kPa (27 PSI)	7 mm (9/32)	No	None

2005 Ford Explorer Sport Trac

The Ford Explorer Sport Trac was identified by the Vehicle Identification Number (VIN): 1FMZU77K65U (production sequence deleted) and was manufactured in June 2005. The four-door, four-wheel drive vehicle was equipped with a 4.0 liter V6 engine linked to a five speed automatic transmission. The brakes were a front and rear disc system was four-wheel antilock (ABS). The manual restraint system consisted of three-point lap and shoulder belts in all five set positions. The driver and front right passenger positions were equipped with dual stage frontal air bags. The vehicle was not equipped with inflatable side impact protection. The Sport Trac was equipped with Goodyear Wrangler RT/S P255/70R16 tires mounted on OEM alloy rims. The vehicle manufacturer's recommended cold tire pressure was 207 kPa (30 PSI) front and 241 kPa (35 PSI) rear. The specific measured tire data and the time of the NASS inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	207 kPa (30 PSI)	7 mm (9/32)	No	None
LR	200 kPa (29 PSI)	8mm (10/32)	No	None
RF	Unknown	Unknown	Unknown	Tire separated and missing
RR	138 kPa (20 PSI)	8 mm (10/32)	No	None

CRASH SITE

The crash occurred during the daylight hours of January 2008. At the time of the crash, the weather was clear and the asphalt road surface was dry. The crash occurred at the four-leg intersection of a four lane divided north/south road and a two lane east/west road located in a suburban setting. At the intersection, the north/south roadway was configured with a right turn only lane, two through lanes and a left turn only lane. The opposing lanes were separated by a 13 m (43 ft) wide grass median. The east/west road was configured with two travel lanes in either direction separated by a double yellow centerline. The intersection traffic was controlled by overhead traffic signals (red/amber/green). There was an embankment with a positive slope outboard the west shoulder of the south leg. The speed limit in the area of the crash was 89 km/h (55 mph). **Figure 2** is a southbound trajectory view of the Mercedes. **Figure 3** is a northbound trajectory view of the Ford.



Figure 2: Mercedes trajectory view.



Figure 3: Ford trajectory view.

CRASH SEQUENCE

Pre-Crash

The 2005 Ford Explorer Sport Trac was traveling north in the left turn lane and was driven by a 69 year old restrained male. The 2006 Mercedes Benz E350 was traveling south on the inboard through lane, operated by a 42 year old restrained male. The front right passenger was a 40 year restrained pregnant female. The crash occurred when the Ford failed to yield the right-of-way and turned left at the intersection directly across the path of the Mercedes. **Figure 7**, attached to the end of this narrative report, is a schematic of the crash developed during the NASS investigation.

Crash

The front plane of the Mercedes struck the right side plane of the Ford in a 11/2 o'clock impact configuration. The force of the impact resulted in the actuation of the safety belt pretensioners and the deployment the CAC frontal air bags. The Damage Algorithm of the WINSMASH model was used to calculate the severity of the impact (Delta V). The total Delta V of the Mercedes was 39 km/h (24 mph). The longitudinal and lateral components of the Delta V were -

37 km/h (-23 mph) and 13 km/h (8 mph), respectively. The total Delta V of the Ford was 35 km/h (22 mph) with longitudinal and lateral components of -18 km/h (-11 mph) and -30 km/h (-19 mph).

The Mercedes impacted the Ford forward of its center of gravity and caused the Sport Trac to rapidly rotate counterclockwise (CCW). The force of the impact separated the Ford's right front wheel/tire from its suspension. The right rear corner of the Ford then struck the left side of the Mercedes in a secondary side slap. The Mercedes separated from the crash with a southeast trajectory and came to rest on the west leg of the intersection. The impact momentum of the Mercedes and force of the impact redirected the Ford to a southeast trajectory as it continued to rotate CCW. The front right suspension of the Ford contacted the pavement and tripped the vehicle into a right side leading rollover. The Sport Trac rolled one-quarter turn onto its right side and slid approximately 12 m (40 ft) into contact with the roadside embankment in the southwest quadrant of the intersection.

Post-Crash

The police and ambulance personnel responded to the crash. The driver and front right passenger of the Mercedes were removed from the vehicle and transported by ground ambulance to a local hospital with incapacitating injuries. The front right passenger was 24 weeks pregnant. Upon arrival at the hospital, she complained of head, chest and abdominal pain with vaginal bleeding. An ultra-sound of the pregnancy revealed a depressed fetal heart rate and a placental abruption. A cesarean section was conducted two hours post-crash. A 686 gram (1 lb - 8 oz) live female was delivered. The infant was taken to the Neo-natal Intensive Care Unit (NICU) in critical condition. Medical efforts to sustain the infant were unsuccessful and the infant died approximately 26 hours after delivery. The female passenger was hospitalized six days for recovery from the cesarean section and additional crash related injuries. There was no record of treatment for the driver of the Mercedes. His injuries were unknown.

The driver of the Ford was transported by ground ambulance to a hospital with reported incapacitating injuries; however, there was no record of treatment at the reported hospital.

VEHICLE EXTERIOR DAMAGE

2006 Mercedes-Benz E350 Exterior

Figure 4 is a frontal view of the Mercedes. The vehicle's front plane sustained direct and induced damage that extended across its entire 150 cm (59 in) end width. The NASS researcher did not measure the frontal crush of the Mercedes due to its tight parked position within the salvage yard. The deformation of the vehicle was estimated at the Zone Center. The maximum crush located at the centerline of the vehicle's bumper was an estimated 47 cm (18.5 in). The Zone Center estimated frontal crush profile was as follows: C1 = 27 cm (10 in), C2 = 44 cm (17 in), C3 = 47 cm (18 in), C4 = 47 cm (18 in), C5 = 41 cm (16 in), C6 = 30 cm (12 in). The bumper fascia separated during the impact. Both fenders buckled and crushed rearward. The hood deformed at its fold points into an inverted V-shape. There was an estimated 10 cm (4 in) reduction in both wheelbase dimensions. The windshield was fractured from the exterior force of the frontal impact. The Collision Deformation Classification (CDC) was 11-FDEW2.

The left side of the Mercedes exhibited body panel deformation consistent with a secondary side slap impact with the right side of the Ford. The side slap damage extended across both left door panels and onto the left rear quarterpanel. The direct contact ended 31 cm (12 in) aft of the right rear axle. Semicircular abrasions were noted below the rub strip on the left rear door panel from contact with the Ford's right rear wheel rim. The rear quarterpanel was deformed 5 cm (2 in) laterally at the base of the C-pillar as a result of contact with the right rear corner of the Ford. Both of the left side glazings disintegrated in the impact. The CDC of this impact was 09-LDAW2.



Figure 4: Frontal view of the Mercedes.

2005 Ford Explorer Sport Trac Exterior

Figure 5 is a right front oblique view of the Ford Explorer. The right plane of the vehicle sustained two regions of impact damage as a result of the intersection impact and subsequent side slap. The direct contact damage (due to the contact with the front of the Mercedes) began immediately aft of the front right corner, 300 cm (118 in) forward of the rear axle. The direct contact extended rearward across the fender and the right doors 156 cm (61.4 in). The front right tire was involved in the direct contact and separated from its suspension. The combined induced and direct primary damage began on the fender and extended rearward 300 cm (118 in). The induced damaged ended 80 cm (31.5 in) forward of the right rear axle. The residual crush measured at the mid-door elevation was as follows: C1 = 2 cm (0.8 in), C2 = 13 cm (5.1 in), C3 = 34 cm (13.4 in), C4 = 33 cm (13.0 in), C5 = 21 cm (8.3 in), C6 = 11 cm (4.3 in). The maximum crush measured 44 cm (17.3 in) and was located on the mid aspect of the front door 229 cm (90.2 in) forward of the rear axle. The CDC of this impact was 02-RYEW3.



Figure 5: Right front oblique view of the Ford.

The secondary side slap damage was limited to the right rear corner area of the Ford. The direct damage was an estimated 20 cm (8 in) in length. Abrasions to the right quarterpanel, right end of the rear bumper and right tail light deformation evidenced the impact. The CDC of this impact was 03-RBEN1.

As the Ford separated from the Mercedes and slid to rest, the Explorer tripped over the dragging front right suspension into a right side leading one-quarter turn rollover. Vertical abrasions to

the right side body panels and the right roof rail evidenced the rollover event. The NASS researcher noted that the maximum vertical and lateral deformation of the right structures was located at the right A-pillar. The CDC of the rollover event was 00-RDA03. The Ford came to rest with its hood in contact with road side embankment. This contact resulted in abrasions to the surface of the hood.

VEHICLE INTERIOR DAMAGE

2006 Mercedes-Benz E350 Interior

The interior damage to the Mercedes consisted of the deployment of the driver and front right passenger air bags. There was no intrusion or damage to the interior components that was attributed to the exterior force of the crash. There were no identified interior occupant contact points. The center console, the deployed driver air bag membrane and the deployed front right passenger air bag membrane exhibited body fluid evidence. Body fluid evidence generally is not considered to be direct contact evidence and most likely occurred post-crash. **Figure 6** is a left interior view of the vehicle.



Figure 6: Left interior view of the Mercedes.

The driver seat was located in a mid-to-rear track position and the seat back was upright. The tilt steering wheel was mounted on a telescoping steering column. The tilt adjustment was located between the mid-position and full up. The telescoping adjustment was located between the mid-position and full back (toward the driver). There was no deformation of the steering wheel rim. There was no steering column shear capsule displacement.

The front right passenger seat was located in a mid-to-rear track position. The seat back was reclined at the time of NASS inspection. It was most-likely moved to that position by the EMS personnel post-crash.

MANUAL RESTRAINTS

2006 Mercedes-Benz E350

The manual restraint system in the Mercedes consisted of three-point lap and shoulder belts in all five seat positions. The front restraints were equipped with retractor pretensioners that actuated during the frontal impact. The driver's restraint consisted of a continuous loop webbing, an adjustable D-ring, a sliding latch plate and an Emergency Locking Retractor (ELR). The webbing of the driver's restraint was observed in the extended position and locked by the actuated pretensioner. The condition of the safety belt indicated the driver was restrained at the time of the crash.

The front right passenger restraint consisted of a continuous loop webbing, an adjustable D-ring, a sliding latch plate and a switchable Automatic Locking Retractor/ Emergency Locking

Retractor (ALR/ELR). The front right passenger used the safety belt in the crash; evidenced by the actuated pretensioner which locked the webbing in the used position.

AIR BAG SYSTEMS

2006 Mercedes-Benz E350

The Mercedes-Benz E350 was equipped with Certified Advanced 208-Compliant (CAC) frontal air bags, front seat-back mounted side impact air bags, rear door-mounted side impact air bags, and roof rail mounted side curtains. A CAC vehicle is certified by the manufacturer to be compliant Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No 208. The CAC frontal air bags deployed as a result of the crash. The side air bags and the side curtains did not deploy in the crash.

The driver air bag deployed from an H-configuration module located in the center hub of the steering wheel. The driver air bag was tethered. Body fluid evidence was noted in the 6 o'clock sector. The front right passenger air bag deployed from a module located in the right aspect of the instrument panel. The front right passenger air bag was tethered. Blood spatters were noted on the inboard side panel. There was no residual evidence of direct occupant contact to the face of either air bag.

OCCUPANT DEMOGRAPHICS

	<i>Driver</i>	<i>Front Right Passenger</i>
Age/Sex:	42 year old/Male	40 year old/Female – Pregnant 2 nd trimester
Height:	Unknown	165 cm (65 in)
Weight:	Unknown	91 kg (201 lb)
Seat Track Position:	Mid-to-rear track	Mid-to-rear track
Restraint Use:	Lap and shoulder	Lap and shoulder
Usage Source:	Vehicle inspection	Vehicle inspection
Medical Treatment:	Treatment unknown	Transported via ground ambulance to a Trauma Center and hospitalized six days

DRIVER INJURY

The nature and extent of the driver's injury could not be determined. There was no record of the driver's treatment at the reported hospital.

DRIVER KINEMATICS

The driver was seated in a mid-to-rear track position in an unknown posture. He was restrained by the vehicle's lap and shoulder belt at the time of the crash. The driver initiated a forward trajectory in response to the 11 o'clock direction of the impact force. The driver loaded the locked safety belt and deployed driver air bag with his chest and head and rode down the force of the crash.

FRONT RIGHT PASSENGER INJURY

<i>Injury</i>	<i>Injury Severity (AIS98 Update)</i>	<i>Injury Source</i>
Placental Abruption, NFS	Serious (543400.3,8)	Safety belt (Possible)
Small right cerebral subarachnoid hemorrhage Left parietal temporal subarachnoid hemorrhage	Serious (140684.3,1) (140684.3,2)	Occupant to occupant contact (Possible)
Right fibula bi-malleolar fractures	Moderate (851612.2,1)	Floor pan (Probable)
Displaced chip fracture left lateral malleolus	Moderate (840402.2,2)	Floor pan (Probable)
Abdominal soft tissue contusion, NFS	Minor (590402.1,9)	Safety belt (Possible)
Two cm left eyebrow laceration with contusion	Minor (290602.1,7) (290402.1,7)	Occupant to occupant contact (Possible)
Frontal scalp abrasion, NFS	Minor (190202.1,5)	Occupant to occupant contact (Possible)
Cervical spine strain, NFS	Minor (640278.1,6)	Occupant to occupant contact (Possible)
Left chest contusion, NFS	Minor (490402.1,2)	Center console (Possible)

FRONT RIGHT PASSENGER KINEMATICS

The pregnant front right passenger was seated in a mid-to-rear track position in an unknown posture immediately prior to the crash. She was restrained by the vehicle's three-point lap and shoulder belt. The position of the safety belt and the manner in which the restraint was worn was unknown.

Upon impact, the safety belt pretensioner actuated and the frontal air bags deployed. The passenger initiated a forward trajectory in response to the 11 o'clock direction of the impact. She loaded the locked safety belt system and the deployed front right passenger air bag. Her legs loaded the floor pan resulting in the identified fractures. The abdominal loading of the belt webbing resulted in a soft tissue contusion and a placental abruption injury. The right rear corner of the Ford contacted the left side of the Mercedes in a secondary side slap event. This impact resulted in a leftward trajectory of the rebounding passenger. The passenger's head contacted the driver resulting in the brain hemorrhages and the soft tissue facial injuries. This contact also resulted in the identified cervical strain. The chest wall contusion resulted from probable contact with the center console. Other injury sources were considered for the facial and brain injuries. However, the stated sources, although low in confidence provided the most complete assessment of the sustained injury pattern.

The passenger was removed from the vehicle and was transported by ground ambulance to a trauma center located within 16 km (10 miles) of the crash site. She complained of head, chest and abdominal pain with vaginal bleeding. An immediate ultrasound was conducted which identified the placental abruption. A reduced fetal heart beat was also noted. The passenger was taken immediately to the emergency room for an emergency caesarean section. A live 686 gram (24.2 oz) female was delivered 120 minutes post-crash. The infant's APGAR scores were 1/2/4 at 1/5/10 minutes, respectively. The infant was taken to the Neo-Natal Intensive Care Unit (NICU) in critical condition. Medical intervention over the course of the next day proved unsuccessful and the infant was pronounced deceased approximately 26 hours post-delivery. An autopsy conducted the following day determined the infant's cause of death was prematurity as a consequence of the placental abruption.

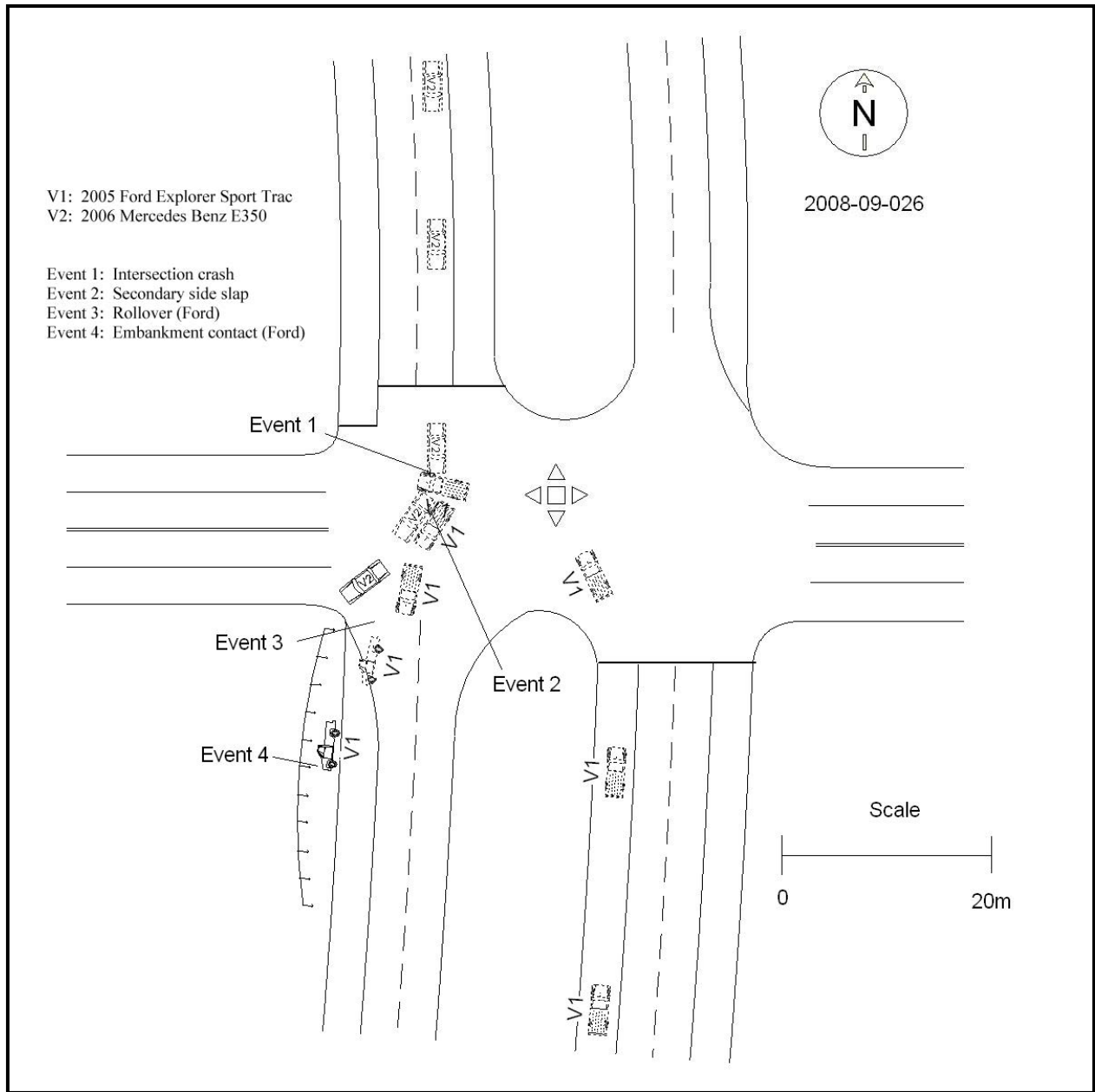


Figure 7: Crash schematic.