

**CRASH DATA RESEARCH CENTER**

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**CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION  
SYSTEM CRASH INVESTIGATION**

**SCI CASE NO: CA09034**

**VEHICLE: 2000 JAGUAR S-TYPE**

**LOCATION: NEW JERSEY**

**CRASH DATE: APRIL 2009**

Contract No. DTNH22-07-C-00043

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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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# CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

**SCI CASE NO: CA09034**  
**VEHICLE: 2000 JAGUAR S-TYPE**  
**LOCATION: NEW JERSEY**  
**CRASH DATE: APRIL 2009**

## BACKGROUND

This on-site investigation focused on the side impact inflatable occupant protection system in a 2000 Jaguar S-Type (**Figure 1**). The Jaguar was equipped with front seat back-mounted side impact air bags. In addition to the side impact air bag system, the Jaguar was equipped with redesigned frontal air bags and retractor-mounted safety belt pretensioners. The Jaguar was involved in intersection crash with a 2007 Honda Pilot. The crash sequence actuated the safety belt pretensioners, and deployed the frontal air bags and the left seat back-mounted side impact air bag in the Jaguar. The advanced driver air bag in the Honda also deployed. The vehicles impacted again in a secondary side slap that deployed the right inflatable curtain of the Honda. The Jaguar was driven by a 64-year-old restrained female and was the vehicle's sole occupant. She sustained a police reported shoulder contusion and was transported to a hospital. The Honda was driven by a 25-year-old restrained female. She sustained police reported knee contusions and was also transported to a local hospital for treatment.



**Figure 1: Case vehicle - 2000 Jaguar S-Type.**

This crash was identified through the weekly sampling of police reported crashes conducted by the General Estimates System (GES). The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) forwarded the police report to the Calspan Special Crash Investigations (SCI) team on May 20, 2009. Calspan SCI initiated follow-up investigation and established cooperation with the insurance carrier for the Jaguar. The Jaguar and Honda were both considered total losses and were available for inspection at an insurance salvage yard. The vehicle and scene inspections were conducted on May 29, 2009.

## SUMMARY

### *Vehicle Data – 2000 Jaguar S-Type*

The 2000 Jaguar S-Type was a four-door sedan that was identified by Vehicle Identification Number (VIN) SAJDA01C0YF (production number deleted). The Jaguar was powered by a 3.0-liter six-cylinder engine linked to a five-speed automatic transmission with rear wheel drive. The braking system consisted of power-assisted front and rear disc brakes with an Antilock Braking System (ABS). The Jaguar's standard features also included a traction control system. The tires on the vehicle were Cooper Zeon Sport, size P225/55ZR16, mounted on five-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32

PSI) for the front and 234 kPa (34 PSI) for the rear. The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	200 kPa (29 PSI)	5 mm (6/32 in)	Suspension fractured, tire/wheel separated
Left Rear	221 kPa (32 PSI)	5 mm (6/32 in)	None
Right Front	145 kPa (21 PSI)	6 mm (7/32 in)	None
Right Rear	214 kPa (31 PSI)	6 mm (7/32 in)	None

The interior of the Jaguar was configured with leather upholstered five-passenger seating. The front bucket seats were separated by a center console and equipped with height adjustable head restraints. The front head restraints were adjusted to the full-down positions. The rear seating consisted of a three-passenger bench seat. The outboard positions of the rear seat were equipped with adjustable head restraints, both adjusted to the full-down positions. The Jaguar's safety systems consisted of a redesigned frontal air bag system, retractor-mounted safety belt pretensioners, and front seat back-mounted side impact air bags. The safety belt pretensioners actuated and the frontal air bags and the left seat back air bag deployed during the initial impact.

#### ***2007 Honda Pilot***

The 2007 Honda Pilot was identified by the VIN 5FNYP18117B (production number omitted) and was manufactured in 03/07. The Honda Pilot was a sport utility vehicle that was equipped with a 3.5-liter six-cylinder engine linked to an automatic transmission with all-wheel drive. The Honda was also equipped ABS, traction control, and electronic stability control. The tires on the vehicle were Bridgestone Dueler HT, size P235/70R16, mounted on five-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and rear. The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Tire/Wheel Damage</b>
Left Front	269 kPa (39 PSI)	3 mm (4/32 in)	None
Left Rear	255 kPa (37 PSI)	6 mm (7/32 in)	None
Right Front	262 kPa (38 PSI)	3 mm (4/32 in)	None
Right Rear	248 kPa (36 PSI)	6 mm (7/32 in)	None

The manual restraint system consisted of three-point lap and shoulder belts for the five seat positions. The front safety belts were equipped with retractor pretensioners. The driver pretensioner actuated during the crash. The Pilot was equipped with Certified Advanced 208-Compliant (CAC) frontal air bags. The driver air bag deployed as a result of the initial impact. The frontal air bags were certified by the vehicle manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard No. 208. Additionally, the vehicle was equipped with front seat back mounted side impact air bags and inflatable side curtains. The right inflatable curtain deployed as a result of the secondary side slap.

### ***Crash Site***

This two-vehicle crash occurred during the daylight hours of April 2009. At the time of the crash, it was raining and the asphalt road surface was wet. The crash occurred at the three-leg intersection of a two lane north/south road and a four lane east/west road. A stop sign for southbound traffic controlled the intersection. The north/south road measured 10.2 m (33.5 ft) in total width. The total width of east/west road measured 17.2 m (56.4 ft) and was configured with two traffic lanes in the respective travel directions. At the time of the SCI scene inspection, there were no apparent obstructions that would have obscured driver visibility to intersecting traffic. The speed limit for the north/south roadway was 40 km/h (25 mph). The posted speed limit for the east/west roadway was 64 km/h (40 mph). **Figure 2** is a southeast view of the intersection.



**Figure 2: Southeast ward of the intersection, the perspective of the Jaguar driver.**

### ***Crash Sequence***

#### ***Pre-Crash***

The 2000 Jaguar S-Type was stopped at the stop sign facing south and was operated by a 64-year-old restrained female. It was the driver's intention to turn left and travel east. The 2007 Honda Pilot was westbound on the inboard lane operated by a 25-year-old restrained female. The crash occurred when the Jaguar accelerated forward into the path of the Honda. A schematic of the crash is attached to the end of this report, **Figure 9**.

#### ***Crash***

The front plane of the Honda impacted the forward left side of the Jaguar in a T-configuration. The directions of the impact force were in the 1 o'clock sector for the Honda and in the 10 o'clock sector for the Jaguar. This impact resulted in the actuation of the safety pretensioners in the Jaguar and the deployment of the vehicle's frontal and left side air bags. The Honda driver's pretensioner actuated and the Pilot's advanced driver air bag also deployed. The Damage Algorithm of the WINSMASH model was used to calculate the severity (delta V) of the crash. The total delta V of the Jaguar was 27 km/h (16.8 mph). The longitudinal and lateral delta V components were -14 km/h (-8.7 mph) and 23 km/h (14.3 mph), respectively. The Honda's total delta V was 23 km/h (14.3 mph) with longitudinal and lateral components of -20 km/h (-12.4 mph) and -12 km/h (-7.5 mph).

The force of the impact forward of the Jaguar's center of gravity caused the vehicle to rotate clockwise approximately 85 degrees. The Honda was redirected to its left. The left quarterpanel of the Jaguar struck the right plane of the Honda in a secondary side slap. The secondary side slap resulted in the deployment of the right inflatable side curtain of the Honda. The vehicles separated and came to rest facing westward on the road approximately 14 m (45 ft) from the area of impact.

### ***Post-Crash***

The police and ambulance personnel responded to the crash. Both drivers exited their respective vehicle unassisted. The Jaguar driver had a police reported shoulder contusion. The driver of the Honda sustained police reported knee contusions. Both individuals were transported by ground ambulance to a local hospital and treated for minor injuries. The Jaguar and Honda were towed from the crash site and deemed total losses by their insurance companies.

### ***Exterior Vehicle Damage – 2000 Jaguar S-Type***

**Figures 3 and 4** are left side views of the damaged Jaguar. The exterior of the Jaguar sustained moderate severity left fender damage as a result of the intersection crash (Event 1). The direct contact damage for the initial impact with the Honda measured 154 cm (60.6 in) in length. The damage began at the front left corner of the vehicle and extended rearward to a point 314 cm (124 in) forward of the back plane. The induced damage began 296 cm (116.5 in) forward of the back plane. The maximum crush measured 38 cm (15.0 in) and was located at the forward aspect of the left fender. The impact involved the left front tire and wheel causing the left front wheel to separate due to a fractured lower suspension. The residual crush profile documented along the left fender was as follows: C1 = 1 cm (0.4 in), C2 = 2 cm (0.8 in), C3 = 16 cm (6.3 in), C4 = 19 cm (7.5 in), C5 = 38 cm (15.0 in), C6 = 21 cm (8.3 in). The Collision Deformation Classification (CDC) for this impact was 10-LYEW3.



**Figure 3: Jaguar left fender deformation.**

The side slap (Event 2) resulted in minor severity damage to the left rear aspect of the Jaguar. The direct contact damage measured 26 cm (10.2 in) and began 12 cm (4.7 in) forward of the back plane. The combined length of the direct and induced damage (Field L) measured 97 cm (38 in). The crush profile along the left quarterpanel of the Jaguar was as follows: C1 = 6 cm (2.4 in), C2 = 15 cm (5.9 in), C3 = 10 cm (3.9 in), C4 = 4 cm (1.6 in), C5 = 4 cm (1.6 in), C6 = 0 cm. The CDC assigned to this impact was 09-LBEN2.



**Figure 4: Left quarterpanel damage.**

The four doors remained closed during the crash and were operational at the time of the SCI inspection. The windshield exhibited fractures at the lower left aspect from body deformation and at the right aspect from contact with the cover flap of the deploying front right air bag. The remainder of the glazing was not damaged during the crash.

### ***Interior Damage***

Inspection of the passenger compartment revealed a single occupant contact point. This contact consisted of the driver's left hip/flank loading through the side impact air bag and fracturing the rear aspect of the left front door panel. The contact measured 36 cm x 13 cm (14 in x 5 in) height x width and encompassed the rear upper and lower quadrants of the door panel, (**Figure 5**). There was no intrusion of the passenger compartment.



**Figure 5: Left front door panel contact.**

The driver's bucket seat was adjusted to a mid-to-rear track position. The driver's seat back was reclined 20 degrees aft of vertical. The horizontal distance from the seat back to the driver air bag module measured 61 cm (24 in). The adjustable steering column was found to be in the full-up position. There was no deformation of the steering wheel rim, column, or shear capsules.

### ***2007 Honda Pilot***

#### ***Exterior Damage***

The 2007 Honda Pilot sustained moderate frontal damage as a result of the impact with the Jaguar (Event 1). The direct contact damage began 55 cm (21.5 in) left of center and extended to the right front bumper corner. The combined width of the direct and induced damage extended across the 165 cm (65 in) front end width. The maximum crush measured 41 cm (16.1 in) and was located immediately right of the centerline. The forward termination of the right frame was deformed inboard 18 cm (7 in). The residual crush profile documented along the bumper reinforcement beam of the Pilot was as follows: C1 = 0 cm, C2 = 13 cm (5.1 in), C3 = 26 cm (10.2 in), C4 = 41 cm (16.1 in), C5 = 20 cm (7.9 in), C6 = 4 cm (1.6 in). The CDC for this impact was 01-FZEW2.



**Figure 6: Honda frontal damage.**

The Honda sustained minor deformation to the right rear door and quarter panel from the secondary impact with the Jaguar (Event 2). The direct contact damage was 34 cm (13.3 in) in length and began 124 cm (48.8 in) forward of the rear plane. The maximum deformation was 3 cm (1.2 in) located on the right rear door. The residual crush profile documented at the mid-door elevation was: C1 = 0 cm, C2 = 1 cm (0.4 in), C3 = 2 cm (0.8 in), C4 = 2 cm (0.8 in), C5 = 1 cm (0.4 in), C6 = 0 cm. The CDC for this impact was 09-RPEN1.



**Figure 7: Right side slap damage.**

***2000 Jaguar S-Type  
Manual Safety Belt Systems***

The Jaguar was equipped with manual three-point lap and shoulder safety belts for the five seat positions. All belt systems utilized continuous loop webbing with sliding latch plates. The driver's belt was equipped with an Emergency Locking Retractor (ELR) and a retractor pretensioner. The upper D-ring was adjustable and was set to the full-up position. The driver used the safety belt at the time of the crash evidenced by the minor frictional abrasions of the latch plate, a corresponding webbing crease, and the extended position of the safety belt by the actuated retractor pretensioner. The length of the exposed webbing measured 189 cm (74.5 in). An abrasion to the webbing measured 6 cm (2.5 in) in length and was located immediately below the D-ring. This abrasion occurred as the webbing was spooled onto the retractor by the actuating pretensioner.

The front right safety belt system utilized a switchable ELR and Automatic Locking Retractor (ALR) and a retractor pretensioner. The front right safety belt system was not used during crash; however, the retractor pretensioner actuated during the crash restricting the webbing in the stowed position. The three rear belt systems utilized switchable ELR/ALR retractors. These positions were unoccupied at the time of the crash.

***Side Impact Inflatable Occupant Protection System***

The 2000 Jaguar S-Type was equipped with front seat back-mounted side impact air bags. The left seat back-mounted air bag deployed during Event 1 of the crash sequence (**Figure 8**). The air bag was designed to offer protection to the upper torso and head in side impact crashes and was concealed within the outboard aspect of the seat back. The air bag deployed through a 43 cm (17 in) tear seam at the forward aspect of the seat back. The air bag measured 61 cm (24 in) in height and 23 cm (9 in) in width and was comprised of two panels sewn together at the forward edge. Two 9 cm (3.5 in) wide tethers were sewn to the air bag at the center and upper third aspects. The air bag extended vertically over the side glazing to the headliner. The air bag did not provide full coverage across the entire left front glazing. With the air bag membrane placed in the deployed position, a triangular shaped void was present at the left front glazing adjacent to the A-pillar. The dimensions of the void were 76 cm (30 in) in length and 34 cm (13.5 in) in maximum height. There was no damage or occupant contact points to the seat back-mounted side air bag.



**Figure 8: Right lateral view of the deployed side air bag.**

***Frontal Air Bag System***

The Jaguar was equipped with a redesigned frontal air bag system that deployed during the initial impact sequence with the Honda. The driver's frontal air bag was conventionally mounted within the center of the three-spoke steering wheel rim and was concealed by two cover flaps.

The cover flaps opened at the designated 29 cm (11.5 in) horizontal seam across the air bag module. The driver’s air bag measured 51 cm (20 in) in diameter in its deflated state and had a maximum rearward excursion of 25 cm (10 in). The air bag was vented by two vent ports at the 11 and 1 o’clock positions. There was no damage or occupant contact points present on the air bag membrane. The air bag contained several areas of black expansion transfers.

The front right air bag was a top-mount design incorporated into the right instrument panel and was concealed by a single cover flap. The cover flap’s dimensions were 36 cm x 18 cm (14 in x 7 in), height x width. The air bag was rectangular in shape and measured 56 cm (22 in) in height and width. The air bag was tethered to the module and was vented by two vent ports on the upper aspects of the side panels. The front right air bag was free of occupant contact points and damage.

***Driver Demographics***  
***2000 Jaguar S-Type***

Age/Sex: 64-year-old/Female  
 Height: 150 cm (59 in)  
 Weight: 77 kgs (170 lbs)  
 Seat Track Position: Between the mid-to-full rear track position  
 Safety Belt Usage: 3-point manual lap and shoulder safety belt  
 Usage Source: SCI vehicle inspection  
 Egress from Vehicle: Unassisted  
 Mode of Transport from Scene: Ground ambulance  
 Type of Medical Treatment: Treated and released

***Driver Injuries***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 90 Update 98)</i></b>	<b><i>Injury Source</i></b>
Left wrist sprain and contusion	Minor (751420.1,2), (790402.1,2)	Door panel
Left chest wall sprain	Minor (442214.1,2)	Door panel
Left shoulder sprain	Minor (751020.1,2)	Door panel
Left hip sprain	Minor (850606.1,2)	Door panel

*Source: Medical Report*

***Driver Kinematics***

The 64-year-old female driver of the Jaguar was seated in a mid-to-full-rear track position with a slightly reclined seat back. She was restrained by the manual lap and shoulder safety belt system. At the initial impact, the ELR retractor locked and the pretensioner actuated. The pretensioner actuation removed potential webbing slack and tightened the webbing about the driver. The frontal air bags and left seat back-mounted side impact air bags deployed.

The driver initiated a left lateral and slight forward trajectory in response to the 10 o'clock direction of the impact force. The driver's left shoulder, flank, and hip contacted and loaded the deployed side air bag backed up by the door panel. This contact resulted in the chest, shoulder, and hip injuries. The driver's wrist contacted the door panel resulting in the soft tissue injuries to this body region. The left front door window was closed and remained intact during the crash. The deployed thorax/head air bag prevented potential head contact to the glazing and the hard surfaces of the B-pillar. There was no evidence of head contact to the air bag. The subsequent side slap impact was closely spaced to the initial impact. The driver initiated a secondary response to her left and continued to load the deployed side air bag that would have remained inflated during the interval between impacts. The driver loaded through the expanded side air bag that was back up by the door panel resulting in a police reported left shoulder contusion. This contact was evidenced by the noted compression and fracturing of the left door panel. The driver exited the vehicle unassisted, was taken to a local hospital and was treated and released.

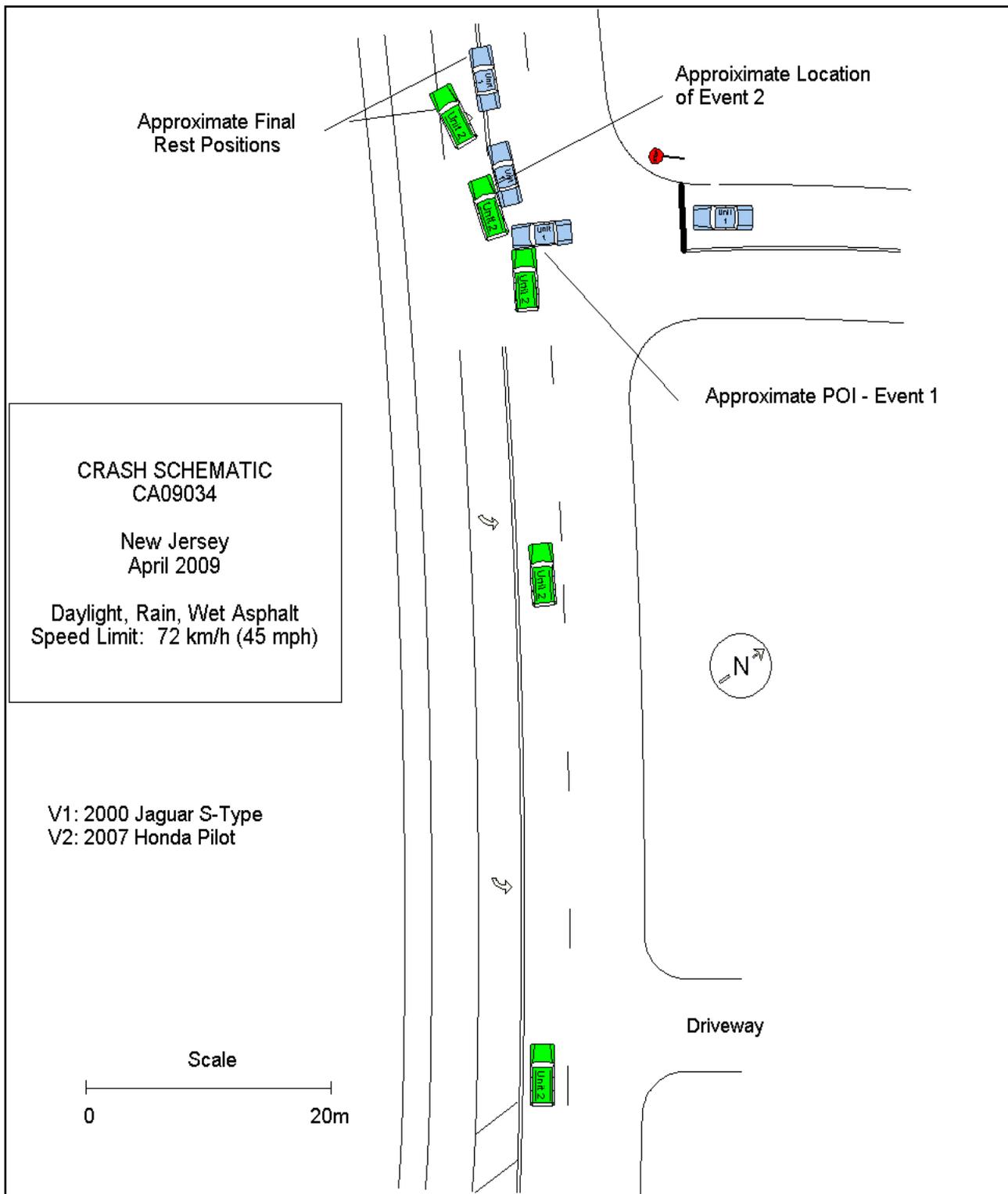


Figure 9: Scene Schematic