

CRASH DATA RESEARCH CENTER
Calspan Corporation
Buffalo, NY 14225

OFFICE OF DEFECTS INVESTIGATION
CALSPAN REMOTE ALLEGED SUDDEN ACCELERATION CRASH INVESTIGATION

NASS/SCI COMBO CASE NO: 2008-12-077A
VEHICLE: 2005 TOYOTA CAMRY
LOCATION: MICHIGAN
CRASH DATE: APRIL, 2008

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

<i>1. Report No.</i> 2008-12-077A	<i>2. Government Accession No.</i>	<i>3. Recipient's Catalog No.</i>	
<i>4. Title and Subtitle</i> Office of Defects Investigation Calspan Remote Alleged Sudden Acceleration Crash Investigation Vehicle: 2005 Toyota Camry Location: Michigan		<i>5. Report Date:</i> November 2008	
		<i>6. Performing Organization Code</i>	
<i>7. Author(s)</i> Crash Data Research Center		<i>8. Performing Organization Report No.</i>	
<i>9. Performing Organization Name and Address</i> Calspan Corporation Crash Data Research Center P.O. Box 400 Buffalo, New York 14225		<i>10. Work Unit No.</i> C00500.0000.0047	
		<i>11. Contract or Grant No.</i> DTNH22-07-C-00043	
<i>12. Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		<i>13. Type of Report and Period Covered</i> Technical Report Crash Date: April 2008	
		<i>14. Sponsoring Agency Code</i>	
<i>15. Supplementary Note</i> An investigation of an alleged sudden acceleration and road side departure crash involving a 2005 Toyota Camry.			
<i>16. Abstract</i> <p>This remote investigation focused on the alleged sudden acceleration and the crash dynamics surrounding the single vehicle crash of a 2005 Toyota Camry and the fatal outcome of the 77 year old female driver. The Toyota Camry was equipped with a 2.4 liter transverse mounted four-cylinder engine linked to a four-speed automatic transmission with a console mounted shifter. The engine was equipped with an Electronic Throttle Control (ETC). The Camry was equipped with manual three-point lap and shoulder safety belts with retractor pretensioners and Certified Advanced 208-Compliant (CAC) frontal air bags for the driver and front right passenger. A CAC vehicle is certified by the vehicle manufacturer to meet the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The vehicle was traveling at a high rate of speed on a residential street and departed the left road side. The Camry overrode a rock landscape area, sideswiped a large diameter tree and traveled 15.8 m (52 ft) striking a second large diameter tree with the front left aspect of the vehicle. The severe frontal impact actuated the driver's pretensioner and deployed the driver's air bag. The restrained driver expired from her injuries at the scene.</p>			
<i>17. Key Words</i> Road side departure High speed Fixed object Fatal injury		<i>18. Distribution Statement</i> General Public	
<i>19. Security Classif. (of this report)</i> Unclassified	<i>20. Security Classif. (of this page)</i> Unclassified	<i>21. No. of Pages</i> 11	<i>22. Price</i>

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BACKGROUND

This remote investigation focused on the alleged sudden acceleration and the crash dynamics surrounding the single vehicle crash of a 2005 Toyota Camry (**Figure 1**) and the fatal outcome of the 77 year old female driver. The Toyota Camry was equipped with a 2.4 liter transverse mounted four-cylinder engine linked to a four-speed automatic transmission with a console mounted shifter. The engine was equipped with an Electronic Throttle Control (ETC). The Camry was equipped with manual three-point lap and shoulder safety belts with retractor pretensioners and Certified Advanced 208-Compliant (CAC) frontal air bags for the driver and front right passenger. A CAC vehicle is certified by the vehicle manufacturer to meet the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The vehicle was traveling at a high rate of speed on a residential street and departed the left road side. The Camry overrode a rock landscape area, sideswiped a large diameter tree and traveled 15.8 m (52 ft) striking a second large diameter tree with the front left aspect of the vehicle. The severe frontal impact actuated the driver's pretensioner and deployed the driver's air bag. The restrained driver expired from her injuries at the scene.



Figure 1: Left front oblique view of the Camry.

The United States Department of Transportation (USDOT) was notified of this crash by the concerned son-in-law of the driver and requested the National Highway Traffic Safety Administration (NHTSA) conduct an investigation of the crash due to a possible safety defect with the Toyota. In turn, NHTSA's Office of Defects Investigation (ODI) requested that the Crash Investigation Division (CID) of the NHTSA assign an investigation of the crash to the Calspan Special Crash Investigations (SCI) team. The SCI team determined that the crash had already been selected for research within the National Automotive Sampling System (NASS) during routine case sampling. The assigned NASS researcher had completed the vehicle inspection, scene inspection and had conducted a telephone interview with the reporting family member prior to SCI involvement. The completion of the field research by the NASS team prompted the CID to assign this investigation as a combined remote NASS/SCI effort. The issues associated with the investigation included the possibility of sudden acceleration caused by a displaced floor mat positioned against the accelerator pedal, the possible downloading of the Toyota's Event Data Recorder (EDR), the injury severity and the cause of the driver's death, and the possibility that a medical episode contributed to the loss of control. The subsequent SCI

investigation revealed that the Camry was not equipped with floor mats and the driver's family declined removal of the EDR for download by the manufacturer.

VEHICLE DATA

The 2005 Toyota Camry was identified by the Vehicle Identification Number (VIN): 4T1BE32K95U (production sequence deleted).

Figure 2 is an oblique view of an exemplar Toyota Camry. The vehicle was manufactured in October 2004 and the digital odometer reading was unknown. The four-door sedan was equipped with a 2.4 liter, I4 engine linked to a five-speed automatic transmission. The Camry was equipped with front disc/rear drum brakes with four-wheel antilock (ABS). The interior of the vehicle was configured for five passenger seating. Each seat position was equipped with a three point lap and shoulder restraint. The front safety belts were equipped with retractor pretensioners. The Camry was equipped with Certified Advanced 280-Compliant (CAC) air bags for the driver and front right passenger. The vehicle's tires were Continental P205/65R15 steel belted radials mounted on OEM steel wheels. The vehicle manufacturer recommended cold tire pressure was 200 kPa (29 PSI), front and rear. The specific tire data at the time of the NASS inspection was as follows:



Figure 2: Exemplar Toyota Camry.

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	Tire flat	6 mm (8/32 in)	Rim damage, tire debeaded
Left Rear	193 kPa (28 PSI)	6 mm (8/32 in)	Rim damage
Right Front	Tire flat	6 mm (8/32 in)	Tire debeaded
Right Rear	Tire flat	6 mm (8/32 in)	Tire debeaded

The driver's son-in-law stated to the SCI team that he had purchased the pre-owned Toyota for the driver approximately three years prior to the crash date. The mileage at the time of purchase was unknown. He further stated that it was out of character for his mother-in-law to drive at a high rate of speed, as she rarely drove over 48 m/h (30 mph). He thought he had purchased a safe vehicle for her use and the reported high rate of vehicle speed concerned him, prompting him to inquire about the possibility of a safety defect.

CRASH SITE

This single vehicle crash occurred during the daylight hours in April 2008. At the time of the crash, the weather was clear and the asphalt road surface was dry. The crash occurred on a two-lane east/west city street in a residential neighborhood approximately 61 m (200 ft) west of a four-leg intersection. The width of the road measured 8.0 m (26.3 ft). The centerline of the road was not marked. The street was bordered by barrier curbs with large diameter trees located between the curb line and the sidewalk. The trees were located approximately 2.1 m (7 ft) from

the curb. Residential driveways intersected both sides of the street. The posted speed limit was 40 km/h (25 mph). **Figure 3** is a westbound trajectory view of the Toyota at the point of the roadside departure. An area of landscape rocks was overridden by the front left wheel rim and an 80 cm (31.5 in) diameter tree was sideswiped as the Toyota left the road. A 53 cm (20.9 in) diameter tree was located 15.8 m (52 ft) downstream and was the point of the frontal impact, **Figure 4**. A section of the tree's bark was stripped and removed during the impact. This section was located 1.4 m to 2.6 m (4.5 ft to 8.5 ft) above the ground and extended approximately 40 percent around the tree's circumference. Two scrapes in the asphalt road surface oriented in the northwest direction extended beyond the second tree and evidenced the vehicle's path to final rest. The scrapes measured 5.2 m (17 ft) in length and were attributed to contact from the rear wheel rims. An area of fluid spill and run-off was noted throughout the area of final rest.



Figure 3: Trajectory view of the Toyota at the road side departure.



Figure 4: Trajectory view to the frontal impact.

CRASH SEQUENCE

Pre-Crash

The driver's son-in-law reported to the SCI team that at the time of the crash the driver was enroute to a store that she owned with her husband. She was delivering his lunch which was part of her daily routine. The 77 year old driver of the Toyota departed her residence and was traveling westbound on the two-lane street. The crash occurred approximately 640 m (0.4 mile) west of the driver's residence. Four intersections were located between her house and the scene of the crash. The traffic flow through these intersections was regulated by stop signs for east/west traffic. A witness traveling eastbound approximately 30 m (100 ft) east of the crash site observed the approaching Toyota traveling down the center of the road at a high rate of speed. This witness pulled to the right, stopped and observed the Toyota travel through the intersection located immediately east of the crash site without stopping. The witness then observed the vehicle depart the roadside and impact the tree.

Crash

The Toyota departed the left side of the road at a shallow angle (estimated at 10 degrees) at the mouth of a driveway. The vehicle entered the grass area immediately outboard the curb line and the front tires overrode the rock landscape area located at the base of an 80 cm (31.5 in) diameter

tree (refer to **Figure 3** above). As the Toyota continued its southwest trajectory, the left fender and front door of the vehicle sideswiped the tree. This impact redirected the vehicle's trajectory to its right and the Toyota continued along the grass area with a trajectory nearly parallel to the road.

It was reported at the time of the crash that the Toyota became airborne and struck the second tree approximately 1.2 m (4 ft) above the ground. The SCI investigation determined that this information was inaccurate. The damage to the rock landscape area, the elevation of the swiping damage to the first tree and location of the fender damage on the Toyota indicated the tires of the Toyota were on the ground as this impact occurred. The level terrain between the trees did not provide a ramping mechanism to cause the vehicle to become airborne as it travelled to the frontal impact.

The Toyota travelled 15.8 m (52 ft) and the front left aspect of the vehicle impacted the 53 cm (20.9 in) diameter tree located 2.1 m (7 ft) outboard the curb line.

Figure 5 is a close-up view of the tree and the point of impact. The force of this impact was severe and resulted in the deployment of the vehicle's driver air bag and actuation of the safety belt pretensioner. The severity of the crash (delta V) calculated by the Damage Algorithm of the WINSMASH model was 91 km/h (57 mph). The longitudinal and lateral components delta V were -91 km/h (-57 mph) and 0, respectively.

The force of the impact resulted in a vertical buckling of the hood. The deformed hood penetrated the bark of the tree 1.4 m (4.5 ft) above the ground. As a consequence of the offset left impact, the Camry rotated counterclockwise (CCW) approximately 145 degrees as it separated from the tree. During the rapid rotation of the vehicle, the hood's contact with the bark stripped/separated a 1.2 m (4 ft) section of bark from the tree trunk. The separated section of the bark was located 1.4 m to 2.6 m (4.5 ft to 8.5 ft) above the ground. The Camry came to rest on the roadway facing southeast. The post-impact trajectory of the Toyota was evidenced by multiple scratch/gouge marks and an area of fluid spills at the scene. A schematic of the crash is included at the end of this report as **Figure 11**.

Post-Crash

The police and ambulance personnel responded to the scene. The driver was found in the vehicle restrained by the vehicle's safety belt. She was unresponsive and pronounced deceased. The driver was extricated from the vehicle and transported to a regional trauma center under the direction of the county medical examiner. An autopsy was conducted and the cause of death was ruled as blunt force trauma to the head and neck. The Toyota Camry was towed from the crash site and subsequently deemed a total loss by its insurance carrier.



Figure 5: Close-up view of the point of impact.

VEHICLE DAMAGE

Exterior Damage

Figure 6 is a front view of the damaged Toyota Camry. The Camry sustained severe damage as a result of the road side impact sequence. The Toyota sideswiped an 80 cm (31.5 in) diameter tree immediately after departing the road. Although partially masked by the overlapping frontal damage, this swiping contact was observed on the left fender and left front door. The contact measured 112 cm (44.0 in) in length. The lateral extent zone was unknown. The Collision Deformation Classification of this impact was 12-LYES9.



Figure 6: Front view of the Camry.

The Camry continued along the road side to the frontal engagement with the 53 cm (20.9 in) diameter tree. The direct contact to the front bumper began 16 cm (6.2 in) left of center and extended 26 cm (10.2 in) to the left front corner. The impact was biased to the left side of the front structure and as the front left structures crushed rearward into the engine compartment, the front right bumper corner was pulled inboard. This resulted in a Field L of 67 cm (26.3 in) across the front plane. The residual crush measured along the front bumper was as follows: C1 = 90 cm (35.4 in), C2 = 126 cm (49.6 in), C3 = 116 cm (45.7 in), C4 = 56 cm (22.0 in), C5 = 27 cm (10.6 in), C6 = 7 cm (2.8 in). The left wheelbase was reduced 29 cm (11.4 in). The right wheelbase was unchanged. The left front door was jammed shut and removed by the first responders. The left rear, right front and right rear doors were operational. The CDC of the frontal tree impact was 12-FYEN6.

Interior Damage

The interior Camry sustained severe intrusion into the driver's interior space as a result of the frontal impact. **Figures 7-9** are interior views depicting the magnitude and severity of the intrusion. The deformed steering wheel rim was in close proximity to the driver seat back. The left floor pan deformed in an inverted V-pattern and was intruded to the forward edge of the driver seat cushion. Floor mats were not installed in the left floor pan.

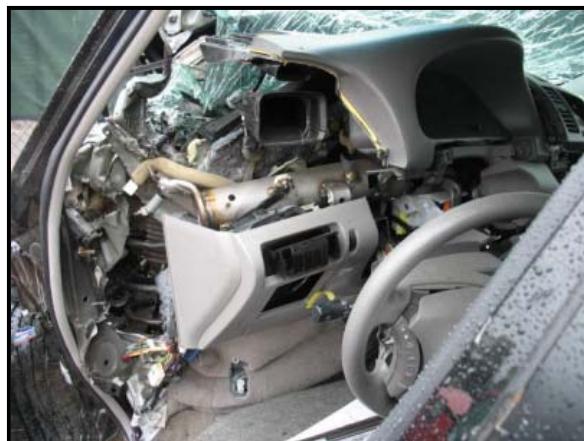


Figure 7: Left front interior intrusion.



Figure 8: Right lateral view of the intruded steering wheel.



Figure 9: Floor pan intrusion. Floor mats were not present.

The documented intrusion is identified in the table below:

Position	Component	Intrusion	Direction
Row 1 Left	Left instrument panel	27 cm (10.6 in)	Longitudinal
Row 1 Left	Steering assembly	39 cm (15.4 in)	Longitudinal
Row 1 Left	Toe pan	48 cm (18.9 in)	Longitudinal
Row 1 Left	Foot controls (brake pedal)	60 cm (23.6 in)	Longitudinal
Row 1 Left	Foot controls (accelerator)	55 cm (21.7 in)	Longitudinal
Row 1 Center	Center instrument panel	25 cm (9.8 in)	Longitudinal
Row 1 Center	Toe pan	30 cm (11.8 in)	Longitudinal
Row 2 Left	Floor pan	10 cm (3.9 in)	Vertical

The driver seat was located in a mid-track position. The NASS researcher observed multiple points of driver contact. Two knee scuffs were observed to the lower instrument panel/knee bolster. Contact with the driver's feet was observed on the deformed toe pan. The windshield header forward of the driver was scuffed from a possible head contact. A blue fabric transfer was noted on the forward aspect of the left door panel from contact with the driver's left arm. The steering column was completely disengaged from the instrument panel. The lower half of the four-spoke steering wheel rim was deformed 6 cm (2.4 in) forward from loading of the driver's chest. The researcher also noted that the seat back had deformed rearward due to loading from the driver.

Manual Restraint Systems

The Toyota Camry was equipped with three-point lap and shoulder belts in the five seat positions. The driver's restraint consisted of continuous loop webbing, a sliding latch plate, an adjustable D-ring and an Emergency Locking Retractor. The retractor was equipped with a pretensioner. The pretensioner actuated as a result of the impact and locked the webbing in the exposed position. The driver's D-ring was adjusted to the full up position. The exposed webbing was lying on the driver's seat at the time of the NASS inspection. A 46 cm (18 in) region of blood evidence was observed on the shoulder portion of the webbing and the webbing

was stretched. Based on the evidence identified during the inspection, the driver was restrained by the safety belt at the time of the crash.

Air Bag System

The Toyota Camry was equipped with CAC frontal air bags for the driver and front right passenger. A CAC air bag is certified by the vehicle manufacturer to meet the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC system was controlled by an Air bag Control Module (ACM) located under the center instrument stack, immediately inboard of the accelerator pedal.

It is not known if the ACM had Event Data Recorder capabilities. The data possibly recorded by the EDR include pre-crash brake, throttle position, engine speed and vehicle speed data that could have been used to more accurately address the issues of a possible sudden acceleration. The operation of the EDR was proprietary information and was only available through the manufacturer. Removing the ACM from the vehicle and forwarding the module to the manufacturer for a possible data download was addressed with the driver's son-in-law. The driver's family elected to retain possession of the module and declined the download request from SCI.

The driver air bag (**Figure 10**) deployed from an H-configuration module located in the center of the steering wheel rim. The module cover flaps opened as designed. There was no occupant contact to the flaps. The air bag was tethered and was vented by two ports located on the back side of the bag in the 11/1 o'clock sectors. A 20 cm x 14 cm (8 in x 5.5 in) red/yellow make-up transfer was noted to the central face of the bag. A large area of post-crash blood evidence was observed on the back side of the air bag in the 6 to 9 o'clock sectors. A smaller area of post-crash blood evidence was observed on the back side of the bag in the 12 o'clock sector.

The front right air bag module was a top-mount design located in the right aspect of the instrument panel. The deployment of this air bag was suppressed by the CAC system, as designed, due to the absence of a front right passenger.



Figure 10: Driver air bag contact evidence.

Occupant Data

Driver

Age / Sex:	77 year old / Female
Height:	155 cm (61 in)
Weight:	54 kg (119 lb)
Seat Track Position:	Mid-track position
Restraint Use:	Three-point lap and shoulder belt
Usage Source:	Vehicle inspection
Medical Treatment:	No treatment, expired at the scene

Driver Injury

<i>Injury</i>	<i>Injury Severity (AIS Update 98)</i>	<i>Injury Source</i>
Fracture dislocation of the Atlanto-occipital, C2/C3; complete transaction of the spinal cord at that level	Maximum (640276.6,6)	Steering wheel/column
Thin diffuse cerebral subdural hemorrhage, NFS	Severe (140650.4,9)	Steering wheel/column
Diffuse cerebral subarachnoid hemorrhage, NFS	Serious (140684.3,9)	Steering wheel/column
Bilateral rib fractures, anterior and mid regions; right 1 - 6 and left 1 - 5	Serious (450230.3,3)	Steering wheel/column
Near total avulsion of the right foot, ankle is fractured with exposed fractured tibia and fibula	Minor (811002.3,1)	Toe pan
Left fibula fracture, distal to the knee	Moderate (851605.2,2)	Knee bolster
Left tibia fracture, distal to the knee	Moderate (853404.2,2)	Knee bolster
Sternum fracture at the level of the third rib	Moderate (450804.2,4)	Steering wheel hub/spokes
Right temporal scalp contusion (0.7 cm x 1.2 cm)	Minor (190402.1,1)	Driver air bag
Right forehead contusion and right eyebrow contusion (0.2 cm x 0.6 cm)	Minor (290402.1,7)	Driver air bag
Right eyelid contusion, NFS	Minor (297402.1,1)	Driver air bag
Scattered pinpoint irregular contusions to the bridge of the nose	Minor (290402.1,4)	Driver air bag
Lower lip frenulum laceration and minor 9 cm x 3 cm chin laceration, NFS	Minor (290600.1,8)	Driver air bag
2 cm x 0.5 cm abrasion inferior to the left side mouth	Minor (290202.1,8)	Driver air bag
10 cm x 3 cm left neck abrasion	Minor (390202.1,2)	Safety belt

Injury	Injury Severity (AIS Update 98)	Injury Source
Right upper chest contusion (above the nipple level 20cm x 8 cm); left breast contusion (11 cm x 3 cm); lower chest contusion (epigastric region 9 cm x 14 cm)	Minor (490402.1,0)	Steering wheel/column
Abdominal epigastric contusion (part of above (9cm x 14 cm)	Minor (590402.1,7)	Steering wheel/column
Left upper abdomen 11cm x 1 cm band of red abrasions	Minor (590202.1,2)	Steering wheel
3 cm x 1.5 cm contusion to the right anterior forearm	Minor (790402.1,1)	Driver air bag
Abrasion to the back of the hand	Minor (790202.1,1)	Center instrument panel
1 cm laceration back of right hand and two smaller adjacent lacerations	Minor (790602.1,1)	Center instrument panel
Anterior right forearm abrasions	Minor (790202.1,1)	Driver air bag
Two small lacerations back of left hand	Minor (790602.1,2)	Left door panel forward upper quadrant
Abrasions to the back of the left hand and forearm	Minor (790202.1,2)	Left door panel forward upper quadrant
10 cm x 1 cm laceration inferior to the right knee	Minor (890602.1,1)	Center instrument panel
Right knee contusion (1 cm x 6 cm)	Minor (890402.1,1)	Knee bolster
Left medial calf contusion (1 x 1.4 cm)	Minor (890402.1,2)	Toe pan
Medial right calf laceration (12 cm x 4 cm)	Minor (890602.1,1)	Foot controls
0.5x 1 cm laceration just below the left knee (in the same area as the tib/fib fracture)	Minor (890602.1,2)	Knee bolster
Multiple bilateral thigh contusions	Minor (890402.1,3)	Steering wheel rim

Source – Driver's Autopsy Report

Driver Kinematics

Immediately prior to the crash, the Toyota was traveling at a witness reported high rate of speed and departed the left side of the road for unknown reasons. The driver's son-in-law reported that it was out of character for the driver to be operating the vehicle in excessive of the speed limit. The autopsy of the driver did not identify a pre-existing medical condition that may have led to loss of control.

The 77 year old driver of the Toyota Camry was seated in a mid-track position and was restrained by the vehicle's three-point lap and shoulder belt. Her posture was unknown. The forward aspect of the vehicle's left side plane sideswiped a tree immediately after departing the road. This relatively minor impact probably did not influence a change in the driver's posture.

The frontal impact caused the safety belt retractor to lock, pretensioner to actuate and the driver air bag to deploy. The driver responded to the 12 o'clock direction of the impact force and initiated a forward trajectory. The driver loaded the locked safety belt system with her chest and abdomen. The left D-ring adjusted to the full-up position resulted in the webbing riding high across the left neck of the short statured driver. As her upper torso decelerated, her head/neck flexed forward and the left aspect of the neck was abraded by the belt webbing. The expanding driver air bag abraded and contused the right anterior forearm, and displaced the both arms from the steering wheel. The soft tissue injuries to the back sides of the driver's upper extremities were caused by the left door panel and right instrument panel contact, respectively.

The driver loaded the expanded driver air bag with her head and her chest. The head contact was evidenced by the make-up transfer and facial soft tissue injuries. Coincident with this loading, the left instrument panel and steering column were intruding. The combined loading of the air bag and the intrusion resulted in the driver loading through (bottoming out) the air bag. The intruding steering column/wheel forced the head rearward, resulting in the atlanto-occipital fracture/dislocation and spinal cord transaction. The brain hemorrhages and the multiple blunt skeletal chest injuries also occurred as a result of the column/wheel loading. The driver's lower extremities contacted the knee bolster and sustained the identified injuries primarily as a result of the extensive intrusion. The driver rebounded and came to rest trapped within the driver seat. She was pronounced deceased at the scene.

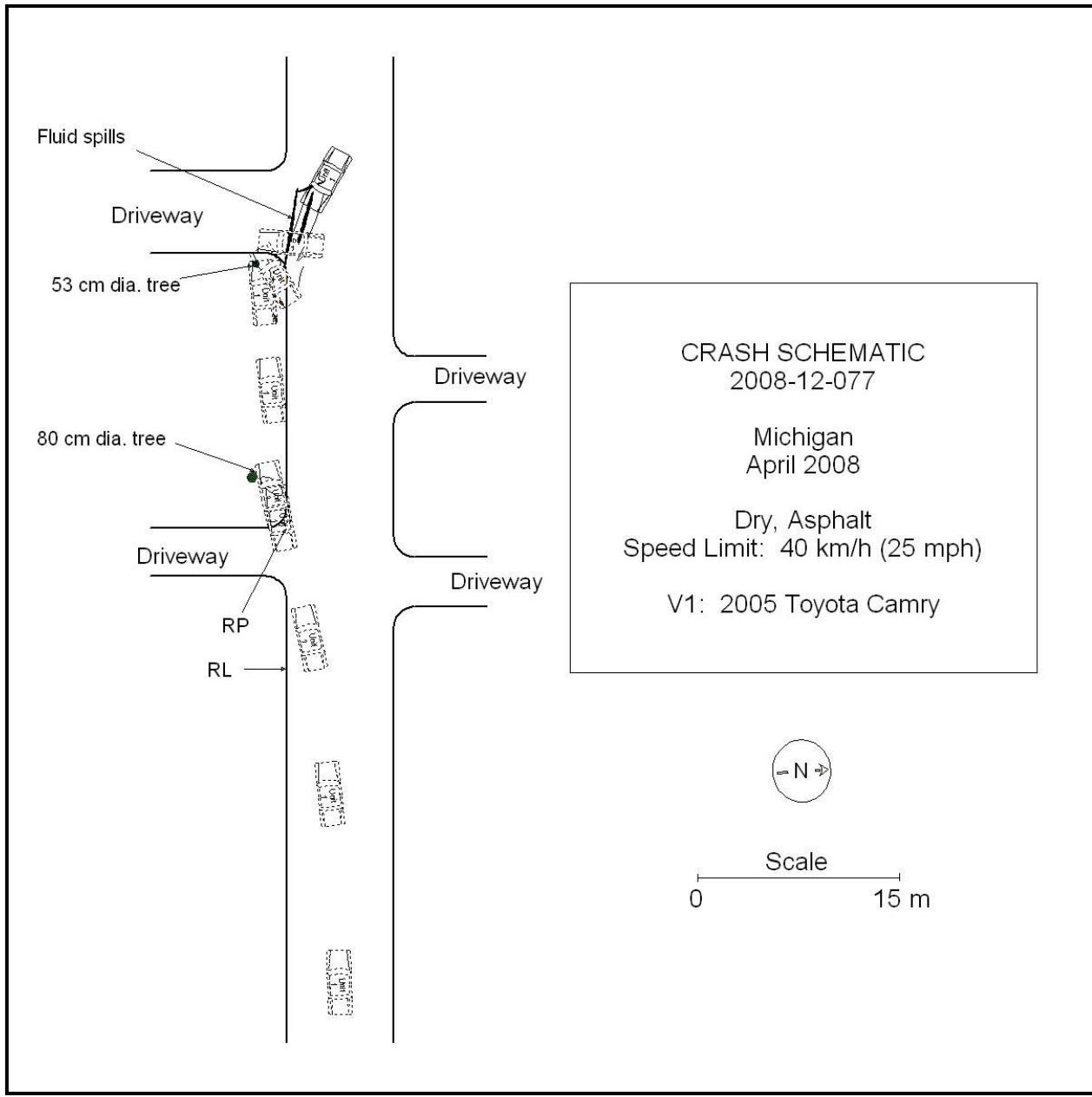


Figure 11: Crash Schematic.