TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian Engineering
Buffalo, New York 14225

VERIDIAN ON-SITE AIR BAG FATALITY INVESTIGATION

VERIDIAN CASE NO. CA00-015

VEHICLE - 1992 BUICK ROADMASTER

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - MARCH, 2000

Contract No. DTNH22-94-D-07058

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

1. *Report No.* CA00-015	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Veridian On-Site Air Bag Fatality Investigation Vehicle - 1992 Buick Roadmaster Location - State of North Carolina		5. *Report Date*: June, 2000 6. *Performing Organization Code*	
7. *Author(s)* Crash Research Section		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0280.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Report Crash Date - March, 2000 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* On-site investigation of a frontal collision (into a fixed object) that involved a 1992 Buick Roadmaster 4-door sedan equipped with a driver frontal air bag.			
16. *Abstract* This on-site investigation focused on the injury mechanisms that caused the death of a 57 year old female driver of a 1992 Buick Roadmaster 4-door sedan. The Buick was equipped with a driver frontal air bag which deployed as a result of a frontal collision with a brick pilaster. The Buick Roadmaster was stationary and facing north in a strip mall parking space when the driver became disoriented and allowed the vehicle to rapidly accelerate forward into the store front area. As the Buick approached the building, the front left area struck a brick pilaster resulting in moderate vehicle damage. At this point, the vehicle rotated counterclockwise as the right rear side surface impacted a plate glass window/glazing frame which resulted in minor damage. The unrestrained 57 year old female driver was presumed to be seated in an upright posture with the seat track adjusted to the full forward position. At impact with the pilaster, she was out of position forward against the driver air bag module. The air bag expanded against her anterior neck which hyper-extended the neck resulting in a cervical and basilar skull fracture. The driver was pronounced deceased at the scene.			
17. *Key Words* Collision Deformation Classification (CDC): 12-FYEN-2 WinSMASH damage and trajectory algorithm Full forward seat track position Basilar skull fracture		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 8	22. *Price*

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BACKGROUND

This on-site investigation focused on the injury mechanisms that caused the death of a 57 year old female driver of a 1992 Buick Roadmaster 4-door sedan. The Buick was equipped with a driver frontal air bag which deployed as a result of a frontal collision with a brick pilaster. The Buick Roadmaster was stationary and facing north in a strip mall parking space when the driver became disoriented and allowed the vehicle to rapidly accelerate forward into the store front area. As the Buick approached the building, the front left area struck a brick pilaster resulting in moderate vehicle damage. At this point, the vehicle rotated counterclockwise as the right rear side surface impacted a plate glass window/glazing frame which resulted in minor damage. The unrestrained 57 year old female driver was presumed to be seated in an upright posture with the seat track adjusted to the full forward position. At impact with the pilaster, she was out of position forward against the driver air bag module. The air bag expanded against her anterior neck which hyper-extended the neck resulting in a cervical and basilar skull fracture. The driver was pronounced deceased at the scene.

The crash notification was provided to NHTSA by a local law enforcement agency on Tuesday, May 16, 2000 and immediately assigned to the Veridian SCI team as an on-site investigative effort. The on-site investigator departed on May 17 and conducted the investigation on Thursday, May 18, 2000.

SUMMARY

Crash Site

This single vehicle crash occurred during the afternoon hours of March, 2000. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in a strip mall with store fronts located approximately 4.3 meters (14.1 feet) north of the adjacent parking area **(see Figure 13 - page 8)**. Small diameter poles supported the awning with brick faced pilasters measuring 30.0 cm (11.8 in) in width and 18.0 cm (7.1 in) in depth protruding from the building. The asphalt parking area was bordered by barrier curbs with diagonal parking spaces 3.1 meters (10.2 feet) apart. The speed limit at the crash site was 16 km/h (10 mph).

Pre-Crash

The 57 year old female driver of the 1992 Buick Roadmaster entered the diagonal parking space in the strip mall to shop at a nearby department store **(Figure 1)**. Witnesses noted the driver engaged in several activities while parked with the front of the vehicle exposed to the store front area. These included her attempt to consume a bagel and stop a nose bleed. Based on the impending crash, she apparently attempted these activities while the vehicle was running and the automatic transmission selector placed in the "drive" position. The surrogate interview confirmed this as she often "fumbled with her purse or smoked a cigarette" while leaving the automatic transmission selector in the "drive" position and her right foot on the brake pedal.

As the driver was attending to these tasks within the vehicle, she became disoriented and inadvertently accelerated the vehicle. The right rear tire broke traction on the asphalt parking lot surface and produced an acceleration mark that continued over a mountable-type curb continuing onto the concrete sidewalk for a distance of 9.8 meters (32.0 feet). It should be noted that the curb displaced the rear of the vehicle slightly in a clockwise direction. The continued acceleration caused the Buick to "fish tail" slightly prior to impact. The vehicle continued in an acceleration mode across the sidewalk into the store front area **(Figure 2)**.

Figure 1. View north of pre-impact stationary position in parking space.

Figure 2. Northern approach trajectory into struck store front.

Crash

The front left area of the Buick Roadmaster impacted the brick faced pilaster (Figure 3) at a WinSMASH computed speed of 29.8 km/h (18.5 mph). The crash resulted in an impact force of 12 o'clock and a barrier equivalent velocity change of 29.5 km/h (18.3 mph) with a respective longitudinal component of -29.5 km/h (-18.3 mph). The speed change exceeded the threshold required for deployment, therefore, the driver's air bag deployed.

As the vehicle crushed to maximum engagement, the offset left impact induced a slight counterclockwise (CCW) rotation. The right rear quarter panel area side slapped a plate glass window and the corner (aluminum) glazing frame **(Figure 4)**. As a result of the 3 o'clock impact force, the Buick sustained minor damage to the side surface. The plate glass window cracked and the corner frame was deflected inward. Although the impact occurred with a yielding object, the barrier algorithm of the WinSMASH program computed a velocity change of 1.7 km/h (1.1 mph) with a matching (negative value) lateral component. The Buick came to rest with the frontal area engaged against the pilaster and the right side surface resting against the struck window frame.

Figure 3. Police photo of vehicle and struck pilaster.

Figure 4. Police photo of vehicle and struck plate glass window/glazing frame.

Post-Crash

A dentist who operated a practice at the location of the crash was the first person to respond to the event. He observed the driver slumped over to the right and opened the left front door to evaluate her condition. The dentist immediately removed the driver from the vehicle and placed her on the sidewalk adjacent to the vehicle. He performed CPR as he instructed others to call for emergency assistance.

Local fire and paramedic personnel responded to the crash scene. The driver did not respond to CPR efforts and she was pronounced deceased at the scene of the crash. The body was transported to the medical examiner's office for an autopsy. The 1992 Buick Roadmaster was towed from the scene with disabling damage.

VEHICLE DATA

The 1992 Buick Roadmaster Limited was manufactured on 2/92 and identified by the vehicle identification number (VIN): 1G4BT5378NR (production number deleted). The driver was reported by police as the owner of the vehicle. The vehicle was a 4-door sedan equipped with rear-wheel drive, ABS and a 5.7 liter, V-8 engine. At the time of the crash, the odometer had recorded 133,561 km (82,993 miles). The seating was configured with front split (with separate backs) and rear bench seating. Although the surrogate interview reported no previous crashes or maintenance on the Buick's driver air bag system, the vehicle's history was unknown prior to the purchase (used) in late January, 2000. No cellular phone was present or in use at the time of the collision.

VEHICLE DAMAGE

Exterior

The Buick sustained moderate frontal damage as a result of the impact with the brick pilaster **(Figure 5)**. The direct contact damage began 34.0 cm (13.4 in) to the right of the front left bumper corner and extended 28.0 cm (11.0 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 136.0 cm (53.5 in). Six crush measurements were documented at the level of the bumper: C1= 25.0 cm (9.8 in), C2= 55.0 cm (21.7 in), C3= 32.0 cm (12.6 in), C4= 18.0 cm (7.1 in), C5= 5.0 cm (2.0 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this initial impact to the Buick was 12-FYEN-2 with a principal direction of force of 0 degrees. The hood was deformed up and rearward from engagement against the pilaster. The left fender was displaced rearward which restricted the left front wheel/tire (not deflated). Reduction in the left side wheelbase measured 10.0 cm (3.9 in). The windshield fractured at the lower left A-pillar area from exterior impact forces (only).

Direct contact damage was also identified along the right rear side surface attributed to the plate glass window/glazing frame impact (Figure 6). The direct contact damage began 10.0 cm (3.9 in) forward of the right rear bumper corner and extended 31.0 cm (12.2 in) forward. Although the deformation was concentrated mainly at the level of the frame, surface scratching was noted above and below the frame level. Six crush measurements were documented at the level of the mid-door: C1= 0 cm, C2= 2.0 cm (0.8 in), C3= 1.0 cm (0.4 in), C4= 0 cm, C5= 0 cm, C6= 0 cm. The CDC for this secondary impact to the Buick was 03-RBEN-1 with a principal direction of force of (+) 90 degrees. Black scuffs and a bright red paint transfer were noted to the front right bumper corner. This damage pattern could not be

matched to the crash scene and was probably pre-existing. Blue paint transfers were found on the upper right quarter panel area with the deformation pattern non-horizontal in nature. This damage pattern was probably from an object that fell from the struck window, however, this could not be verified.

Figure 5. Frontal damage to the 1992 Buick Roadmaster Limited.

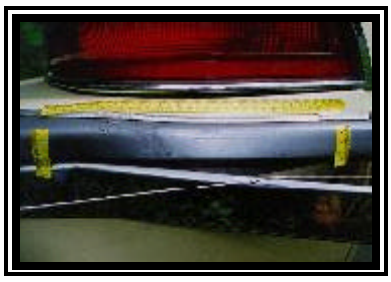

Figure 6. Right rear side surface damage.

Interior

Interior damage to the Buick identified through the vehicle inspection was moderate and was attributed to occupant contact and minimal component intrusion **(Figures 7 & 8)**. Scuff marks were documented on the left knee bolster (rigid plastic type). Deformation to the steering wheel rim measured 3.5 cm (1.4 in) at the upper section and 2.0 cm (0.8 in) at the lower section along with 1.0 cm (0.4 in) of column compression. In addition, the tilt lever was fractured at the left side of the column *(column "free floating")*. Blood pooling was noted to the front right seat cushion and center arm rest area. Blood spattering was also noted along the left roof side rail and front/rear left head restraints. A partially eaten bagel was found on the dash with a spilled beverage can and bloody nose tissue discovered on the front left floor area. Longitudinal intrusions into the driver space involved 6.0 cm (2.4 in) of toepan intrusion and 2.0 cm (0.8 in) of instrument panel intrusion.

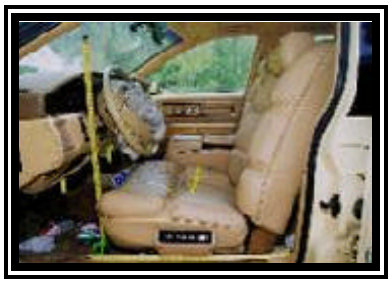

Figure 7. Interior view.

Figure 8. Knee strikes to the driver bolster.

MANUAL RESTRAINT SYSTEMS

The interior of the Buick Roadmaster consisted of a six passenger seating configuration with front split (with separate backs) and rear bench seats which accommodates three individual seating positions. There was no loading evidence on the belt systems and the systems yielded minimal routine usage indicators for the high recorded mileage. The driver 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a locking latchplate and dual mode retractors (inertial lock/belt sensitive). The front right 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a locking latchplate and retractors equipped with inertial and switchable lock mechanisms. The rear outboard seated positions were equipped with 3-point manual lap and shoulder belt systems which consisted of continuous loop belt webbings with sliding latchplates that retracted into dual mode locking retractors. The front/rear center seating positions were equipped with a 2-point manual lap belt system.

SUPPLEMENTAL RESTRAINT SYSTEMS

The Buick Roadmaster was equipped with a driver frontal air bag system which deployed as a result of the impact with the brick pilaster. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were nearly symmetrical in shape as the upper flap measured 19.5 cm (7.7 in) in width and 5.0 cm (2.0 in) in height while the lower flap measured 19.5 cm (7.7 in) in width and 6.0 cm (2.4 in) in height. Extensive contact evidence was identified on the exterior surface of the module cover flaps which included indentations and multiple longitudinal striations. A hair strand was documented on the upper flap along with skin oil, scuffs and blue fabric transfers to the lower flap **(Figure 9)**. The diameter of the driver air bag measured 65.5 cm (25.8 in) in its deflated state **(Figure 10)**. Although no contact evidence was found on the face of the air bag, very light yellow fabric transfers were documented on the rear upper left quadrant along with blue fabric transfers to the lower (centered) section **(Figure 11)**. Multiple black vinyl transfers were noted to the rear lower section of the air bag from expansion within the module, indicative of an impeded deployment. The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the rear aspect of the air bag. No internal tether straps were present.

The driver was seated in a forward track position, however, due to her activities within the vehicle, she was out-of-position forward at impact. The driver's chest was against the air bag module at deployment which restricted the normal deployment path of the air bag membrane. The cover flaps opened at the designated tear seams against the chest of the driver, however, as the air bag membrane began to expand, it encountered the forward positioned driver. The lower aspect of the bag membrane deployed between the lower module cover and the steering wheel rim. This captured the air bag in a figure 8-type deployment pattern between the module cover **(Figure 12)**. The upper aspect of the membrane deployed normally through the H-configuration flaps. Expansion of the air bag was sufficient to compress the chest of the driver and hyper-extend the neck resulting in fatal injuries.

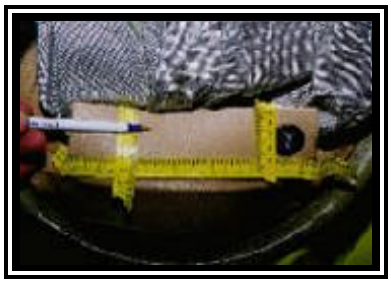

Figure 9. Contact evidence to the lower air bag module cover flap.

Figure 10. 1992 Buick Roadmaster driver air bag.

Figure 11. Contact evidence to the aft side of the air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	57 year old female
Height:	163 cm (64 in)
Weight:	53 kg (116 lb)
Seat Track Position:	Full forward position
Manual Restraint Use:	None
Usage Source:	Vehicle inspection, surrogate interview, police report
Eyeware:	None
Type of Medical Treatment:	Pronounced deceased at the scene

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
*Basilar skull fracture	Serious (150200.3,8)	Expanding driver air bag
*Cervical fracture (unknown location)	Moderate (650216.2,6)	Expanding driver air bag
+Right mandible fracture (NFS)	Minor (250600.1,1)	Expanding driver air bag
*Abrasion anterior/lower neck (6in x 1.5in)	Minor (390202.1,5)	Expanding driver air bag
*Contusion right upper chest (2in x 1.5in)	Minor (490402.1,1)	Expanding driver air bag/flap
*Abrasion mid-left chest (1.5in x .5in)	Minor (490202.1,2)	Expanding driver air bag/flap

*Sources: *-medical examiner report (non-invasive), +-police*

Driver Kinematics

The 57 year old female driver of the 1992 Buick Roadmaster was unrestrained (3-point manual lap and shoulder belt system available) and presumed to be seated in an upright posture with the seat track adjusted to the full forward position. Lack of restraint usage was determined by the trajectory of the driver and lack of blood stains to the webbing consistent with the blood pooling on the seat cushions and spattering to the left side interior surface. In addition, there was no loading evidence on the belt system and the system yielded minimal routine usage indicators for the recorded mileage.

Driver Kinematics (continued)

The driver was positioned against the module cover flaps at impact. The cover flaps opened at the designated tear seams and contacted the chest of the driver. Immediately following the cover flap contact, the air bag membrane expanded against the driver. Due to her forward position, the driver restricted the normal deployment path of the air bag. The lower segment of the air bag membrane deployed between the module cover and the steering wheel rim while the upper segment of the bag deployed normally through the cover flaps. Consequently, the air bag was captured between the module cover in a figure 8-type pattern **(Figure 12)**. Expansion of the air bag and the module cover flaps resulted in abrasions and contusions over the anterior chest of the driver. Although not medically documented, but based on previous investigations, this investigator believes that the driver probably sustained multiple bilateral rib fractures with underlying injury to the internal organs.

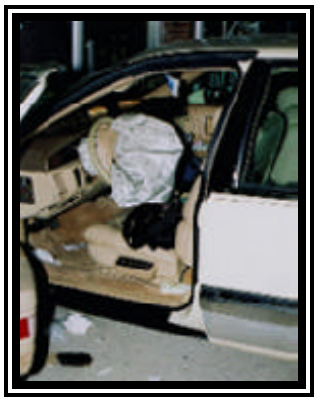

Figure 12. Police photo of vehicle interior with driver air bag and impeded deployment pattern.

Although constricted, the air bag membrane did expand with sufficient force against the anterior neck of the driver. This contact abraded the soft tissue and hyper-extended the neck. As a result of the hyper-extension, the driver sustained a basilar skull fracture and a unspecified cervical fracture.

The driver responded to the 12 o'clock impact force subsequent to air bag deployment. Her forward trajectory in combination with air bag expansion resulted in deformation of the steering wheel rim and compression of the energy absorbing steering column. Her knees contacted the plastic knee bolster and scuffed the component. No injury was reported to the lower extremities.

The driver was accelerated in an upward and rearward direction by the expanding air bag as evidenced by the blood spatters to the left side interior surface and rear left seat. She came to rest slumped across the front right seat cushion as evidenced by the blood pooling to the center console and front right seat cushion (bleeding profusely from the ears). Despite on-scene CPR efforts, the driver was pronounced deceased at the scene and transported to the medical examiner's office for an autopsy.

Driver Medical History / Medications

- *Hypertension*
- *Atherosclerotic Disease*[1]
- *Ischemic Heart Disease*[2]
- *Severe Peripheral Vascular Disease*[3]
- *Migraines*
- *Reportedly had taken morphine for chronic leg pain* *(toxicology reported a morphine level of 0.03mg/L)*
- *Reportedly had taken stimulants to stay awake*

[1] A progressive narrowing/hardening of the arteries over time.

[2] A temporary shortage of oxygen due to narrowing by spasm or disease.

[3] A disorder of the vessels carrying deoxygenated blood back to the heart.

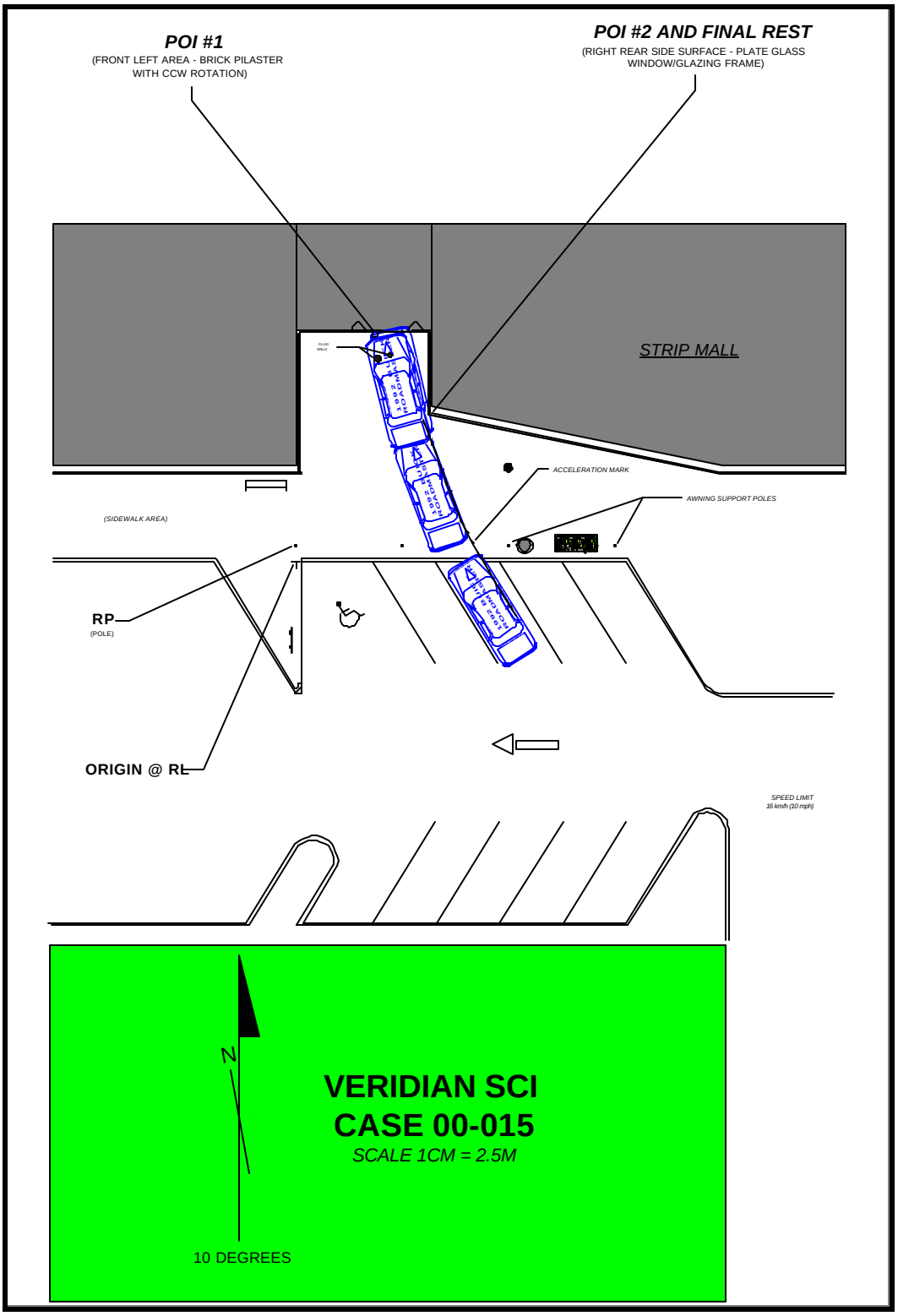

Figure 13. Scene Diagram