

**CRASH DATA RESEARCH CENTER**

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**CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION  
GRACO SNUG RIDE CHILD SAFETY SEAT  
SCI CASE NO: CA05-051**

**VEHICLE: 1998 MAZDA 626  
LOCATION: MARYLAND  
CRASH DATE: JUNE, 2005**

Contract No. DTNH22-07-C-17002

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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 the crash dynamics and the fatal injury sources of an ejected 17 year old female driver and a 7 month old male infant seated in a Graco Snug Ride Rear Facing Child Safety Seat (CSS). The CSS was restrained in the second row center position of a 1998 Mazda 626 by the vehicle's manual three-point lap and shoulder safety belt. The Mazda was involved in a run-off road/ two quarter turn rollover crash subsequent to a police reported road rage incident. The unrestrained driver was ejected during the rollover sequence and sustained unknown fatal injuries. The male infant was removed from the child safety seat by a police officer responding to the crash. The infant had sustained unspecified injuries and was pronounced dead at the scene by the first responders. The Mazda was also occupied by a restrained 14 year old female front right passenger and a restrained 15 year old female rear right passenger. These passengers sustained police reported incapacitating injuries and were transported to local hospitals. Both frontal air bags in the vehicle deployed.</p> <p>This June 2005 double-fatality crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration and was assigned to the Calspan Special Crash Investigations (SCI) team for follow-up investigation on August 28, 2005. Cooperation with the investigating police department and vehicle insurance company was established by the SCI team. The child safety seat was held in evidence by the investigating State Police and the vehicle was located at an insurance salvage yard. The child seat and vehicle were both available for inspection. The on-site portion of the investigation was conducted on September 9, 2005.</p>			
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**TABLE OF CONTENTS**

BACKGROUND ..... 1

SUMMARY

VEHICLE DATA

    1998 Mazda 626..... 1

CRASH SITE..... 2

CRASH SEQUENCE ..... 3

1998 MAZDA 626

    Exterior Damage ..... 3

    Interior Damage ..... 5

    Frontal Air Bag System ..... 5

    Manual Restraint System ..... 6

CHILD SAFETY SEAT DATA ..... 7

OCCUPANT DEMOGRAPHICS ..... 8

DRIVER INJURY ..... 8

DRIVER KINEMATICS ..... 9

FRONT RIGHT PASSENGER INJURY ..... 9

FRONT RIGHT PASSENGER KINEMATICS..... 9

REAR RIGHT PASSENGER INJURY ..... 9

REAR RIGHT PASSENGER KINEMATICS ..... 9

REAR CENTER RIGHT PASSENGER INJURY ..... 10

REAR CENTER PASSENGER KINEMATICS..... 10

CRASH SCHEMATIC ..... 11

**CALSPAN ON-SITE CHILD SAFETY SEAT/CHILD FATALITY INVESTIGATION  
GRACO SNUG RIDE REAR FACING CHILD SAFETY SEAT**

**SCI CASE NO: CA05-51  
VEHICLE: 1998 MAZDA 626  
LOCATION: MARYLAND  
CRASH DATE: JUNE, 2005**

***BACKGROUND***

This investigation focused on the crash dynamics and the fatal injury sources of an ejected 17 year old female driver and a 7 month old male infant seated in a Graco Snug Ride Rear Facing Child Safety Seat (CSS). The CSS was restrained in the second row center position of a 1998 Mazda 626 by the vehicle's manual three-point lap and shoulder safety belt. The Mazda (**Figure 1**) was involved in a run-off road/ two quarter turn rollover crash subsequent to a police reported road rage incident. The unrestrained driver was ejected during the rollover sequence and sustained unknown fatal injuries. The male infant was removed from the child safety seat by a police officer responding to the crash. The infant had sustained unspecified injuries and was pronounced dead at the scene by the first responders. The Mazda was also occupied by a restrained 14 year old female front right passenger and a restrained 15 year old female rear right passenger. These passengers sustained police reported incapacitating injuries and were transported to local hospitals. Both frontal air bags in the vehicle deployed.



**Figure 1: 1998 Mazda 626.**

This June 2005 double-fatality crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration and was assigned to the Calspan Special Crash Investigations (SCI) team for follow-up investigation on August 28, 2005. Cooperation with the investigating police department and vehicle insurance company was established by the SCI team. The child safety seat was held in evidence by the investigating State Police and the vehicle was located at an insurance salvage yard. The child seat and vehicle were both available for inspection. The on-site portion of the investigation was conducted on September 9, 2005.

***SUMMARY***

***VEHICLE DATA***

***1998 Mazda 626***

The 1998 Mazda 626 was manufactured on 4/22/1998 and was identified by Vehicle Identification Number (VIN): 1YVGF22D9W5 (production number deleted). The vehicle was a four-door sedan powered by a transversely mounted 2.5 liter V-6 engine linked to a four-speed automatic transmission and was equipped with the LX-V6 trim package. The service brakes were four-wheel disc with anti-lock. The manual restraint system consisted of three-point lap and shoulder belts for the five seat positions. The vehicle was equipped with redesigned frontal air bags for the driver and front right passenger. The odometer reading at the time of the SCI

inspection was unknown due to the expended battery. The Mazda 626 was equipped with OEM seven-spoke alloy wheels with Goodyear AquaTred 3 tires size, P205/60R15. The manufacturer recommended front and rear tire pressure was 221 kPa (32 PSI) and 17 kPa (26 PSI), respectively. The specific measured tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Damage
Left Front	Tire not present	Unknown	Fracture of the spokes from the outer rim of the alloy wheel resulting in complete separation of outer rim and tire
Left Rear	0 kPa	6 mm (7/32")	Tire de-beaded
Right Front	200 kPa (29 PSI)	5 mm (6/32")	None
Right Rear	193 kPa (28 PSI)	6 mm (7/32")	None

The interior of the Mazda consisted of cloth-upholstered front bucket seats and a split forward folding (60/40) rear bench seat. The front head restraints were height-adjustable. The driver's head restraint was adjusted between the mid to full up position and the front right head restraint was adjusted to the full down position. The rear outboard seats were equipped with integrated head restraints.

**CRASH SITE**

The crash occurred during the daylight hours of June 2005. At the time of the crash, the Mazda drove into a heavy downpour of rain. The crash occurred on the west roadside of a divided two-lane north/south asphalt road immediately south of a three-leg intersection. **Figure 2** is a southbound trajectory view of the Mazda. The southbound roadway was configured with two 3.7 m (12 ft) wide lanes separated by a broken centerline and delineated by white fog lines. The outboard shoulder measured 3.7 m (12 ft wide). The terrain west of the shoulder sloped into a drainage ditch. Heavy undergrowth, shrubs and numerous trees were located along the roadside. The posted speed limit in the area of the crash was 89 km/h (55 mph). Due to the passage of time between the crash date and the SCI crash notification, the growth of the roadside vegetation and erosion of the road evidence hampered the identification of the specific crash site. **Figure 3** is a view of the approximate crash site.



**Figure 2: Trajectory view of the Mazda.**



**Figure 3: View of the approximate crash site.**

## ***CRASH SEQUENCE***

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

The Mazda 626 was traveling southbound and was driven by a 17 year old female. The Mazda was also occupied by a restrained 14 year old female front right passenger and a restrained 15 year old female rear right passenger. A 7 month old male infant was restrained within a Graco Snug Ride Rear Facing Child Safety Seat (CSS) positioned in the center of the Mazda's second row.

The 17 year old female was operating the Mazda in the right southbound lane. Reportedly during this travel, the Mazda was cut off by a non-contact vehicle. This action resulted in an aggressive driving pursuit of the non-contact vehicle by the Mazda driver over the next several miles. During this pursuit, the driver of the Mazda was observed gesturing and communicating with the non-contact driver through the open window. Witnesses then reported that the Mazda driver threw an empty plastic drink container from the front left window at the non-contact vehicle. Immediately after this occurred, the vehicles entered a heavy downpour of rain and the Mazda driver lost directional control of the vehicle. The rear tires of the Mazda lost traction and the vehicle began to rotate clockwise. The police investigation identified two tire scuffs (unknown length) attributed to the Mazda's roadside departure. A general scene schematic based on the police crash report is included as **Figure 13** at the end of this report.

### ***Crash***

The Mazda departed the right side of the road with a clockwise rotation, traveled across the roadside grass and encountered the roadside ditch. The left aspect of the front plane impacted the backslope of the ditch. This impact resulted in the probable deployment of the frontal air bags. The left side leading attitude of the Mazda coupled with the slope of the terrain and the frontal impact tripped the vehicle into a left side leading rollover. During the rollover, the left side of the vehicle impacted and uprooted several small diameter trees. The Mazda rolled two quarter turns and came to rest on its roof facing west.

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

Police and emergency medical personnel responded to the crash. During the rollover sequence the driver was ejected through the left front window and sustained fatal injuries. The driver was located approximately 5 to 6 m (15 to 20 ft) north of the vehicle's final rest position. A responding officer removed the child safety seat and 7 month old infant from the vehicle. The infant sustained unknown fatal injuries and was pronounced deceased at the scene. The front right and rear seat teenage passengers sustained incapacitating injuries and were transported to a local hospital for treatment. The Mazda sustained disabling damage and was towed to the police impound. Upon completion of the police investigation, the Mazda was released to its insurance company and deemed a total loss. The vehicle was located at a local salvage yard at the time of the SCI inspection.

## ***1998 MAZDA 626***

### ***Exterior Damage***

**Figures 4 through 6** are the front, left rear oblique and right side views of the Mazda 626. The vehicle's exterior damage was consistent with a frontal impact, left side impact and a two-quarter turn rollover event. The direct contact damage to the front plane extended across the full 147 cm

(58 in) end width. The impact caused the front bumper reinforcement bar and fascia to separate from the vehicle. Debris from the ground impact was observed throughout the forward undercarriage. The frontal crush was measured to the exposed front mounts and along the lower radiator support. The left bumper mount was crushed rearward 27 cm (10.7) and deformed inboard an estimated 13 cm (5 in). The crush of the right bumper mount measured 6 cm (2.2 in). The maximum crush of the lower radiator was located at its left corner and measured 14 cm (5.5 in). The Collision Deformation Classification (CDC) of the impact was 10-FDEW2.



**Figure 4: Front view of the Mazda.**

The left rear door and quarterpanel of the Mazda contacted several trees during the rollover sequence. The direct contact to the left rear door measured 51 cm (20 in). The direct damage began 89 cm (35 in) forward of the left rear axle and extended rearward. The maximum lateral crush measured 16 cm (6.2 in) at the belt line. The left rear quarterpanel exhibited direct contact damage over a 38 cm (15 in) region. The direct contact began 41 cm (16 in) aft of the left rear axle and extended to the rear corner of the left side. The maximum lateral crush was an estimated 5 cm (2 in). The CDC was 09-LZAW3.



**Figure 5: Left rear oblique view.**



**Figure 6: Right side view.**

There was severe deformation to the greenhouse area. The vertical crush of the right and left A-pillars measured 25 cm (10 in) and 11 cm (4.5 in), respectively. The CDC of the rollover was 00-TDDO4. The windshield was fractured and all window glazings had disintegrated. The left rear door was jammed shut and deformed from the impact with the tree. The right front door was jammed shut by body deformation. The right rear door was operational but could not be latched closed. The left front door was jammed shut and was deformed inboard. Its exterior sheet metal had separated. The position of the left front door did not appear to be crash related, rather it appeared to have been forced into that position by the post-crash responders or salvage yard.



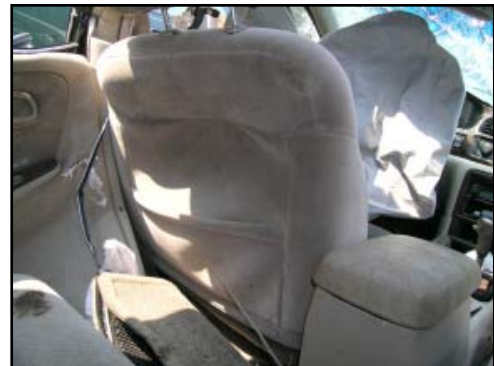
The center spokes of the left front wheel fractured from the outer rim and the rim and tire separated. The left wheelbase was reduced 21 cm (8.2 in). The right wheelbase was unchanged. The shock absorber for the right rear wheel had separated from its upper mount.

***Interior Damage***

The interior damage to the Mazda consisted primarily of roof and left rear door panel intrusion. The interior intrusion of the Mazda is listed in the table blow:

<i>Position</i>	<i>Component</i>	<i>Magnitude</i>	<i>Direction</i>
Row 1 Left	Roof	10 cm (4 in)	Vertical
Row 1 Right	Roof	30 cm (11 in)	Vertical
Row 2 Left	Door Panel	15 cm (6 in)	Lateral
Row 2 Left	Roof Side Rail	10 cm (4 in)	Lateral

The driver seat was adjusted to a mid-track position that measured 11 cm (4.5 in) forward of full rear. The total seat track travel measured 23 cm (9 in). The seat back angle measured 18 degrees aft of vertical. The back side of the seat back was deformed 5 cm (2 in) forward by contact from the child safety seat. This deformation was located 13 cm (5 in) below the top of the seat (**Figure 7**). The horizontal distance from the rear bench seat back to the driver’s seat back measured 89 cm (35 in). The tilt steering wheel was adjusted to a center position. There was no steering wheel deformation or shear capsule displacement. There was no identified contact to the knee bolster.



**Figure 7: View of the deformed driver seat back.**

The front right seat was adjusted to a mid-track position that measured 9 cm (3.5 in) forward of full rear. The total seat track travel measured 23 cm (9 in). The seat back angle measured 35 degrees aft of vertical. There was no identified occupant contact to the lower right instrument panel. The horizontal distance from the rear bench seat back to the front right seat back measured 76 cm (30 in).

The 60/40 split rear bench seat was found to be disengaged from the respective latches at the time of SCI inspection. The seat back for the center/left section was rotated forward approximately 5 cm (2 in). The seat back for right section was rotated forward approximately 15 cm (6 in). The trunk contents included a stroller and miscellaneous items totally approximately 23 kg (50 lb). It could not be determined if the rear seat unlatched during the crash sequence or if the seat’s condition was post-crash related.

***Frontal Air Bag System***

The Mazda was equipped with redesigned frontal air bags for the driver and front right passenger. The driver’s air bag was located within the four-spoke steering wheel rim and concealed by two symmetrical H-configuration cover flaps. The flaps measured 14 cm (5.5 in) in height at the horizontal tear seam and 7 cm (2.75 in) in width. The air bag membrane

measured 61 cm (24 in) in diameter in its deflated state and was tethered. Two vent ports located on the backside of the bag at the 11 and 1 o'clock sectors vented the bag into the passenger compartment. There was no damage or evidence of driver contact on the face of the deployed air bag.

The front right passenger air bag was a mid-mount design incorporated into the right instrument panel. A single cover flap concealed the bag which measured 29 cm (11.2 in) in width and 15 cm (6 in) in height. There was no damage or contact evidence to the cover flap. The face of the deflated front right passenger bag measured 46 cm x 46 cm (18 in x 18 in) width by height. The rearward excursion of the bag measured 51 cm (20 in) from the face of the instrument panel. No discernible occupant contact evidence was located on the air bag membrane however, numerous blood spatters were noted. Additionally, the membrane was soiled from its exposure to the weather.

### ***Manual Restraint Systems***

The Mazda was equipped with three-point lap and shoulder belt systems for the five seat positions. The driver's restraint consisted of continuous loop webbing, sliding latch plate, adjustable D-ring and an Emergency Locking Retractor (ELR). The D-ring was adjusted to the full-down position. Inspection of the driver's restraint revealed the webbing was stowed within the retractor and the retractor was locked. Additionally, the webbing was trapped by the B-pillar deformation. The condition of the driver's restraint indicated it was not in use at the time of the crash.

The front right restraint consisted of continuous loop webbing, sliding latch plate, adjustable D-ring and a switchable ELR/Automatic Locking Retractor (ALR). The D-ring was adjusted to the center position. Upon inspection, the webbing was in an extended position and the retractor was locked. The webbing was roped and captured in the D-ring. Minor frictional abrasions were observed on the latch plate hardware. This restraint was in-use at the time of the crash and was loaded by the 14 year old female passenger during the crash sequence.

The rear right restraint consisted of continuous loop webbing, sliding latch plate, and a switchable ELR/ALR retractor. The webbing was cut by the first responders 32 cm (12.5 in) above the seat and 36 cm (14 in) below the retractor. The retractor was locked due to the force of the crash. The cut webbing section was used to tie the right rear door closed. The length of the cut webbing was consistent with its use at the time of the crash. Additionally, the police report indicated that this belt was cut by the responders to remove the right rear passenger from the vehicle.

The rear center restraint was a detachable three-point belt system utilizing a sliding latch plate and a switchable ELR/ALR retractor. The rear center safety belt was used to install the rear-facing child safety seat, **Figure 8**. Its use was supported by evidence that consisted of loading/creasing of the belt system. This evidence began 16 cm (6.2 in) above the end of the webbing at the detachable buckle and extended to 48 cm (18.7 in) above



**Figure 8: View of the rear center**

the buckle. Additional loading evidence/creasing was located from 102 cm (40.2 in) to 115 cm (45.2 in) above the detachable end of the webbing. The location of the loading evidence related to the position of the webbing over the top of the CSS shell in the rear-facing orientation. The CSS base was not in use at the time of the crash. A label was present on the webbing that indicated the webbing was to be fully extended and the retractor switched to the locking mode when this safety belt was used to restrain a CSS. The CSS was removed from the vehicle by the responding police, thus the status ELR/ALR retractor at the time of the crash was not known.

### ***CHILD SAFETY SEAT DATA***

**Figure 9** is a front view of the Child Safety Seat (CSS) in use at the time of the crash. The CSS was held in police evidence and inspected at the barracks station. The seat could not be released and returned to the vehicle. The seat was heavily soiled and had molded from storage.

The CSS was a Graco Snug Ride rear-facing infant seat Model No: 7350D0H, Serial No: 0504042698, manufactured May 04, 2004. The seat was designed and labeled for use by infants 9 kg (20 lb) or less with a height 66 cm (26 in) or less. The seat consisted of the shell with an integral five-point harness system, a pivoting carrying handle, and a detachable base. The base was not in-use at the time of the crash and was not available for inspection. The overall length of the shell measured 71 cm (28 in).

The harness straps were routed through the top slots. The harness straps did not exhibit crash related evidence. The straps were not folded over, roped, or creased. The chest retainer clip was located 38 cm (15 in) above the seat base. The length of the left strap measured 57 cm (22.5 in); the right strap measured 58 cm (22.8 in).

Stress marks were present on the pivoting carrying handle. The stress marks were symmetrical and were located 28 cm (11 in) from the mid-point of the handle in both directions. The upper aspect of the shell was stressed and fractured, **Figure 10**. The fracture measured 5 cm (2 in) and extended from a mold point into the center cut-out for the shell/base release handle. A second fracture measuring 18 cm (7 in) extended



**Figure 9: Front view of the CSS.**



**Figure 10: View of the stressed and fractured upper shell.**

from the bottom aspect of the center cut-out to the lower left harness strap slot. Refer to **Figure 11**. The right side of the shell exhibited stress marks at the belt path, **Figure 12**.



**Figure 11:** View of the fractured shell.



**Figure 12:** View of the stressed right belt path.

***OCCUPANT DEMOGRAPHICS***

	<b><i>Driver</i></b>	<b><i>Front Right Passenger</i></b>
Age/Sex:	17 year old/Female	14 year old/Female
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Seat Track Position:	Mid-track	Mid-track
Restraint Use:	None	Three-point lap and shoulder belt
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	None; Ejected and fatally injured	Transported via ground ambulance and hospitalized with unknown injuries
	<b><i>Rear Center Passenger</i></b>	<b><i>Rear Right Passenger</i></b>
Age/Sex:	7 month old/Male	14 year old/Female
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Seat Track Position:	Rear-facing child safety seat	Fixed bench
Restraint Use:	Five-point harness	Three-point lap and shoulder belt
Usage Source:	SCI inspection	SCI inspection
Medical Treatment:	None; Removed from vehicle and pronounced deceased at the scene	Transported via ground ambulance and hospitalized with unknown injuries

***DRIVER INJURIES***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update)</i></b>	<b><i>Injury Source</i></b>
Unknown fatal injuries	N/A	Unknown

*Medical records were not available.*

***DRIVER KINEMATICS***

The 17 year old female driver of the 1998 Mazda was seated in an unknown posture and was not restrained by the manual belt system. Immediately prior to the crash, the driver was observed driving aggressively in a reported road rage pursuit and throwing an object from the front left window of the Mazda at a non-contact vehicle. The Mazda then entered a heavy downpour of rain and the driver lost directional control of the vehicle. The Mazda rotated clockwise, departed the right side of the road and entered the roadside drainage ditch. The front plane of the vehicle impacted the backslope of the ditch resulting in the deployment of the frontal air bags and subsequently rolled over two quarter turns.

The driver initiated a left and forward trajectory in response to the 10 o'clock direction of the frontal impact. The driver may have been partially pre-positioned out the front left window due to her pre-crash actions. The combination of the frontal impact and rollover caused the driver to be ejected out the front left window. The driver sustained unknown fatal injuries and was pronounced deceased at the scene.

***FRONT RIGHT PASSENGER INJURIES***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update)</i></b>	<b><i>Injury Source</i></b>
Injured, details unknown	N/A	Unknown

*Medical records were not available.*

***FRONT RIGHT PASSENGER KINEMATICS***

The 14 year old female front right passenger was seated in a presumed upright posture and was restrained by the three-point manual belt system. The female passenger responded to the 10 o'clock direction of the frontal impact by initiating a left and forward trajectory. The passenger loaded the locked safety belt system and deployed front right passenger air bag. During the rollover sequence, she remained within the front right area as a result of her belted status. The passenger sustained unknown police reported injuries and was transported to a local hospital where she was admitted for treatment.

***REAR RIGHT PASSENGER INJURIES***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update )</i></b>	<b><i>Injury Source</i></b>
Injured, details unknown	N/A	Unknown

*Medical records were not available.*

***REAR RIGHT PASSENGER KINEMATICS***

The 15 year old female rear right passenger was seated in a presumed upright posture and was restrained by the three-point manual belt system. The female passenger responded to the frontal impact by initiating a left and forward trajectory. The passenger loaded the locked safety belt system and rode down the force of the impact. During the rollover sequence, the passenger remained within the rear right seating area and continued to load the safety belt. The passenger

came to rest in the rear right area and sustained unknown police reported injuries. She was transported to a local hospital where she was admitted for treatment.

***REAR CENTER PASSENGER INJURIES***

<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 Update)</i></b>	<b><i>Injury Source</i></b>
Unknown fatal injuries	N/A	Unknown

*Medical records were not available.*

***REAR CENTER PASSENGER KINEMATICS***

The 7 month old male passenger was seated in a Graco Snug Ride rear facing child safety seat and was restrained by the seat’s integral five-point harness system. The child seat was installed using the vehicle’s manual three-point safety belt system routed across the top of the shell in the rear center position. The child responded to the frontal crash forces by initiating a forward trajectory and loading the child seat shell with his back. This in-turn resulted in the child safety translating forward and loading the vehicle’s three-point safety belt. Additionally, the top aspect of the shell contacted and loaded the left front seat back. Due to the interior dimensions of the Mazda relative to the size of the child seat, the child seat was pre-positioned in-close proximity to the front seat backs. During the rollover sequence, the child seat remained in contact and continued to load the front seat back; however the child seat also rode down the force of the crash through its continued loading of the vehicle’s safety belt.

The seat back loading resulted in an overload fracture of the child safety seat shell. Additionally, it was probable that the male passenger sustained his fatal injuries as a result of that loading given the close proximity of the head to the seat back contact. The lack of blood evidence within the child seat and vehicle interior was indicative of a probable closed head injury.

The child came to rest suspended by the harness straps of the child seat. The child and seat were removed from the vehicle. The child was pronounced deceased at the scene.

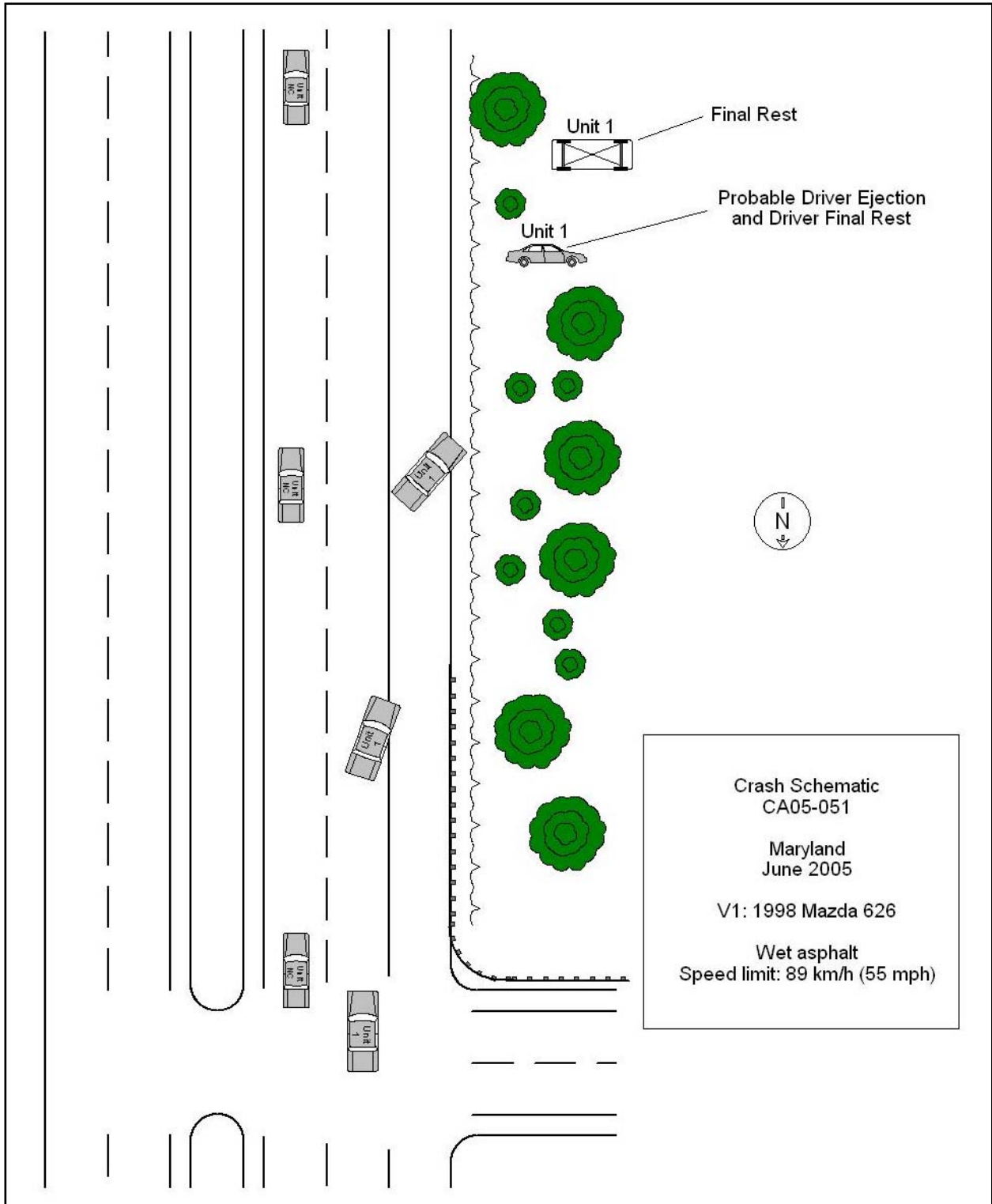


Figure 13: Crash Schematic.