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**Special Crash Investigations
On-Site Air Bag Non-Deployment
Crash Investigation
Vehicle: 2006 Mazda 6
Location: Maryland
Crash Date: March 2018**

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16. Abstract This report documents the on-site investigation of a crash involving a 2006 Mazda 6 sedan, in which none of the air bag systems deployed. According to a person who reported the crash to the National Highway Traffic Safety Administration, the crash occurred when the Mazda swerved to avoid a non-contact vehicle and struck a concrete barrier on a limited-access roadway. The claimant reported that there were no warning indicators illuminated prior to the crash and the air bags did not deploy. The 22-year-old belted female driver sustained police-reported possible (C-level) injuries and was transported by ambulance to a local hospital. The Mazda was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions, as well as front seat-mounted and inflatable curtain (IC) side impact air bags. Based on SCI expertise, vehicle crashes similar in severity and magnitude to that experienced by the Mazda typically result in the actuation and deployment of multiple supplemental restraint devices. Ultimately, the lack of supplemental restraint actuation/deployment was determined to have resulted from the vehicle not recognizing or recording a crash event. However, the reason for the lack of crash event recognition by the vehicle could not be determined.			
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Special Crash Investigations
On-Site Air Bag Non-Deployment Crash Investigation
Office of Defects Investigation
Case No: CR18017
Vehicle: 2006 Mazda 6
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BACKGROUND

This report documents the on-site investigation of a crash involving a 2006 Mazda 6 sedan (**Figure 1**), in which none of the air bag systems deployed. According to a person who reported the crash to the National Highway Traffic Safety Administration, the crash occurred when the Mazda swerved to avoid a non-contact vehicle and struck a concrete barrier on a limited-access roadway. The claimant reported that there were no warning indicators illuminated prior to the crash and the air bags did not deploy. The 22-year-old belted female driver sustained police-reported possible (C-level) injuries and was transported by ambulance to a local hospital. The Mazda was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions, as well as front seat-mounted and inflatable curtain (IC) side impact air bags.



Figure 1: Front left oblique view of the 2006 Mazda 6.

The crash was reported to NHTSA in March 2018. Notification was forwarded to the Crash Investigation Division (CID) and assigned for on-site investigation by the Special Crash Investigations (SCI) team at Crash Research & Analysis in July 2018. The SCI investigator obtained cooperation to inspect the vehicle, and the on-site portion of this SCI investigation took place in July 2018. The on-site investigation included the documentation and measurement of the Mazda's exterior damage, identification of occupant contact, and an assessment of the vehicle's manual and supplemental restraint systems. The Mazda was not equipped with an event data recorder (EDR) supported by the Bosch Crash Data Retrieval (CDR) tool/software, so no data could be imaged during the SCI inspection. However, proprietary data from the vehicle was provided by the Mazda's manufacturer to NHTSA prior to SCI case assignment. This data was shared with the SCI investigator, and indicated that no crash pulse or event was recorded in relation to the crash under investigation.

Through the course of this SCI investigation, it was determined that the Mazda was equipped with original manufacturer supplemental restraint devices, and had not been involved in any prior crashes or required any service/maintenance to its supplemental restraint systems. The SCI inspection of the vehicle documented a significant front plane damage profile produced by the barrier impact, which included a collision deformation classification (CDC) of 11FDEW3 and maximum longitudinal deformation of 52 cm (20.5 in). The corresponding SCI reconstruction of the crash determined a total vehicle velocity change (delta-V) of 49 km/h (30 mph). Based on SCI expertise, vehicle crashes similar in severity and magnitude to that experienced by the Mazda typically result in the actuation and deployment of multiple supplemental restraint devices. Ultimately, the lack of supplemental restraint actuation/deployment was determined to have resulted from the vehicle not recognizing or recording a crash event. However, the reason for the lack of crash event recognition by the vehicle could not be determined. A detailed discussion concerning the Mazda's supplemental restraint non-deployment is below.

CRASH SUMMARY

Crash Site

The crash occurred in the southbound portion of a divided limited-access roadway during daylight in March 2018. According to the National Weather Service, conditions in the locale at the time of the crash included mostly cloudy skies with a temperature of 8 °C (46 °F), a northeasterly breeze of 11 km/h (7 mph), and relative humidity of 31%. Due to high traffic congestion and the limited-access roadway location of the crash site, the SCI inspection consisted only of multiple drive-by passes of the crash site. There were multiple areas of crash-related debris and physical evidence, but it was impossible for the SCI investigator to discern which of them, if any, were related to the crash under investigation. Absent of physical measurements during the scene inspection, a schematic of the crash site was constructed using high-resolution satellite imagery.

The southbound portion of the roadway consisted of four travel lanes, which each measured approximately 3.7 m (12.1 ft) wide. They were delineated by a single solid white right fog line, broken white center lane lines, and a single solid yellow median line. They were supported by an approximate 3.6 m (11.8 ft) wide west shoulder and an approximate 3.4 m (11.2 ft) wide east shoulder. Concrete barriers bordered both roadway edges (**Figure 2**). Speed of traffic on the roadway was regulated by a posted limit of 89 km/h (55 mph). A crash diagram is included at the end of this report.



Figure 2: South-facing view of the limited access roadway in the vicinity of the crash site.

Pre-Crash

The Mazda was occupied by the belted 22-year-old female driver as it traveled south on the limited-access roadway. According to the driver during SCI interview, she was headed to her residence after leaving her place of employment and running a few errands. She had several bags of groceries and a popcorn maker in the trunk, as well as a backpack with a laptop sitting on the second row bench seat in the left position. The total weight of her cargo was estimated at 46 kg (101 lb).

The Mazda occupied the third travel lane from the right, adjacent to the high-occupancy vehicle (HOV) lane. By the driver's estimate, she was traveling at approximately 97 km/h (60 mph). According to the driver, a non-contact vehicle (NCV) was traveling in the lane second from the right and in advance of the Mazda. The NCV began suddenly merging left into the Mazda's lane, without signaling, as the Mazda approached it from behind. The driver of the Mazda initiated a rapid left steering maneuver with braking, directing her vehicle into the HOV lane. The driver further stated that the Mazda began to lose traction, and she steered back to the right. This back-and-forth movement induced an instability about the Mazda's vertical axis, which induced a counterclockwise yaw. The driver again steered the vehicle left and then back to the right as she overcorrected, ultimately losing control of the Mazda. The vehicle traversed back across the HOV lane, entered the left shoulder, and approached the concrete barrier.

Crash

The crash (Event 1) occurred as the front plane/left aspect of the Mazda struck the face of the concrete barrier. Impact forces accentuated the vehicle's counterclockwise rotation, and the entire width of the front plane engaged the barrier. The Mazda was redirected by the barrier and rebounded toward the southwest (back toward the travel lanes). It ultimately slid to final rest straddling the travel lane second from the right, facing north. **Figure 3** depicts the concrete barrier with impact damage in the area of the crash site. However, due to the numerous impacts to the barrier, the SCI investigator was unable to determine which specific area of contact was related to the Mazda's impact.



Figure 3: Southeast-facing view of the concrete barrier in the area of the crash.

Post-Crash

Witnesses to the crash contacted the local emergency response system to report the crash. Law enforcement, fire department, and emergency medical services personnel responded to the crash scene.

The driver of the Mazda was transported by ambulance to a local hospital for evaluation and treatment of possible (C-level) injuries. A local towing service recovered the vehicle from the crash site and transferred it to a local yard. The Mazda's insurer subsequently deemed it a total loss, and it was transferred to the regional vehicle salvage facility where it was located at the time of the SCI vehicle inspection. Of note, the Mazda had been inspected by unknown representatives from the vehicle's manufacturer and NHTSA personnel prior to SCI case assignment. Associated with their inspection was the partial disassembly of the Mazda's interior and the removal of both frontal air bag modules.

2006 MAZDA 6

Description

The Mazda (**Figure 4**) was manufactured during August 2005 and was identified by the VIN 1YVHP80C465xxxxx. It was a 4-door sedan built on a 268 cm (105.5 in) wheelbase with a 2.3 liter, inline, 4-cylinder gasoline engine. The Mazda's electronic odometer reading could not be read during the SCI inspection due to electrical system inoperability. However, salvage facility auction information indicated that the vehicle's odometer reading when it arrived at the facility was 202,890 km (126,070 mi). The Mazda had a gross vehicle weight rating of 1,941 kg (4,279 lb). Front and rear axle ratings were

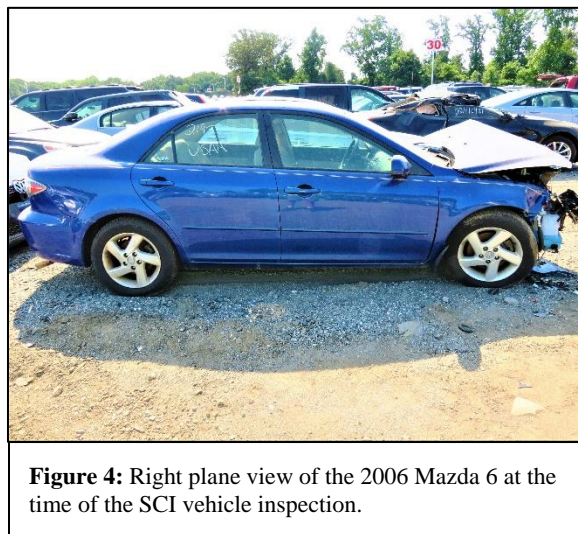


Figure 4: Right plane view of the 2006 Mazda 6 at the time of the SCI vehicle inspection.

1,005 kg (2,216 lb) and 936 kg (2,064 lb), respectively. The curb weight was 1,402 kg (3,091 lb). Placarding on the frame of the left front door stated that the vehicle manufacturer's recommended tire size and cold tire pressure for all four axle positions was P205/60R16 at 220 kPa (32 PSI). At the time of the SCI inspection, the vehicle was equipped with Firestone FR710 M+S tires of the recommended size at all four axle positions. All tires had ample tread and remained inflated without damage or restriction. The front tires had matching tire identification numbers (TINs) of W2XV 712 0817, while the rear tires had matching TINs of IV20 DDD 2516.

The interior of the Mazda was configured for the seating of up to five occupants (2/3). The front row consisted of forward-facing bucket seats with adjustable head restraints. The front seats were capable of 23 cm (9.1 in) of seat track position adjustment. At the time of the SCI inspection, the driver's seat was adjusted 12 cm (4.7 in) forward of full-rear (middle track position) with the seat back slightly reclined. The driver's head restraint was positioned 5 cm (2.0 in) upward. The Mazda's second row consisted of a non-adjustable bench seat. Manual safety features in the Mazda included 3-point lap and shoulder seat belts for all five seat positions. Supplemental restraint systems included the CAC frontal, front seat-mounted side impact, and side impact IC air bags.

Exterior Damage

Damage to the exterior of the Mazda was located on the front plane, associative to the front plane crash event with the concrete median barrier. Direct contact spanned the entire 140 cm (55.1 in) end width of the Mazda. The bumper fascia was fractured and entirely separated from the front of the vehicle, with longitudinal crush to the exposed bumper beam. Both headlight assemblies were fractured, and the grille/fascia was missing. Deformation was observed to the hood and both front fenders, and the engine compartment components were displaced by the overall front plane deformation that was biased to the left aspect.



Figure 5: View of the front plane crush profile as documented during the SCI inspection.



Figure 6: Overhead view of the front crush profile to the Mazda.

A residual crush profile was documented using a Field-L width across the entire 118 cm (46.5 in) front bumper beam of the Mazda (**Figure 5**). This profile produced the following resultant measurements: C1 = 52 cm (20.5 in), C2 = 52 cm (20.5 in), C3 = 46 cm (18.1 in), C4 = 40 cm (15.7 in), C5 = 32 cm (12.6 in), and C6 = 18 cm (7.1 in). Maximum crush in the profile was observed at the left end of the beam. The left wheelbase was reduced by 5 cm (2.0 in). Based on the observed damage to the Mazda, the CDC assigned for the Event 1 impact was 11FDEW3. **Figure 6** depicts the damage profile to the front of the Mazda from an overhead perspective.

The damage algorithm of the WinSMASH model was used to calculate a vehicle velocity change (delta-V) reconstruction of the crash. The calculated total delta-V of the Mazda for the Event 1 impact with the concrete barrier was 49 km/h (30 mph). Longitudinal and lateral components of the calculated delta-V were -46 km/h (-29 mph) and 17 km/h (11 mph), respectively. These results appeared reasonable, based on SCI expertise, the observed damage profile, and the circumstances of the crash.

Event Data Recorder

The Mazda was not equipped with an EDR supported by the Bosch CDR tool/software. Support of the Mazda make/model vehicles did not begin until the 2011 model year. Therefore, the SCI investigator could not image any data from the vehicle during the inspection process.

Interior Damage

The interior of the Mazda was inspected for crash-related damage, including intrusion and occupant contact. There was no occupant compartment intrusion to the first or second rows of the vehicle's interior associated with the crash. All four of the Mazda's left and right doors remained closed during the crash and were operational post-crash. Although the windshield was cracked from impact forces, the remaining glazing of the Mazda remained intact and was not damaged by the crash or contacted by the occupant.

The entire front aspect of the Mazda's interior was covered with a projected splattering of maroon-colored residue/droplets. It was learned during interview of the driver that she had a large disposable container full of approximately 900 mL (32 oz) of strawberry lemonade in the cupholder of the center console at the time of the crash. This liquid was the source of the observed sticky residue/droplets. Several areas of occupant contact were identified in the Mazda that evidenced the kinematics of its occupant. There was a scuff mark to the left lower instrument panel from the driver's left knee, and the entire polymer panel was separated from the instrument panel's sub-structure. The left louvre of the heating, ventilation, and air conditioning system in the center instrument panel was displaced (**Figure 7**), and the wiper/signal control stalk on the right side of the steering column was fractured (**Figure 8**). The SCI investigator concluded that both of these areas were from contact by the driver's right wrist and hand.



Figure 7: Fractured vent louvre in the Mazda.



Figure 8: Fractured signal/wiper stalk in the Mazda.

Manual Restraint Systems

The Mazda was equipped with 3-point lap and shoulder seat belt systems for all five seating positions. The front seat belt systems used continuous loop webbing with sliding latch plates and adjustable D-rings. The driver's seat belt system retracted onto an emergency locking retractor (ELR), while the front right passenger's seat belt used an ELR/automatic locking retractor (ALR). All three second row systems were equipped with ELR/ALR retractors.

At the time of the SCI inspection, the driver's D-ring was adjusted fully upward. Webbing spooled freely and retracted upon release. A polymer transfer was observed on the webbing from the D-ring (**Figure 9**), and there were subtle loading abrasions observed to the polymer surface of the latch plate in the belt path (**Figure 10**). It was apparent that the Mazda's driver was using the system for manual restraint when the crash occurred.



Figure 9: Webbing of the driver seat belt system in the Mazda with polymer transfer from the D-ring.



Figure 10: Latch plate of the Mazda's driver seat belt system with visible loading abrasions in the belt path.

Supplemental Restraint Systems

The Mazda was equipped with front seat belt pretensioners and multiple inflatable supplemental restraints. These included a CAC frontal air bag system that consisted of frontal air bags for the driver and front right passenger positions, with seat belt buckle switch sensors, seat track position sensors, and a front right occupant presence (weight) sensor. The Mazda was further equipped with front seat-mounted and roof side rail-mounted IC air bags that were designed for deployment in side-impact crashes.

According to a commercially available vehicle history report, the Mazda had not been involved in any prior crashes. The supplemental restraint systems were original equipment, and had not required or received any specific service or maintenance. None of the vehicle's supplemental restraint devices (pretensioners or air bags) was commanded to actuate or deploy as a result of the crash.

NHTSA Recalls and Investigations

A query of the 2006 Mazda 6's VIN on www.safercar.gov identified that there were no open recalls and no investigations concerning this specific vehicle as of the date of this report.

Air Bag Non-Deployment Discussion

None of the Mazda's available supplemental restraint systems (pretensioners and air bags) actuated or deployed in the incident crash. Due to the make/model and age of the Mazda, it was not supported by the Bosch CDR software/tool and the SCI investigator had no means by which to obtain crash data from the vehicle.

However, prior to notification of the crash to NHTSA’s CID and prior to SCI case assignment, representatives of NHTSA and the Mazda’s manufacturer conducted an inspection of the Mazda at the vehicle salvage facility. During that inspection, the air bag control unit, sensors, and both frontal air bag modules were disassembled from the Mazda. The air bag control unit and sensors were then retained by the Mazda’s manufacturer for further analysis. Proprietary data was retrieved by the manufacturer and provided to the NHTSA representatives. That data was then provided to the SCI investigator at the time of case assignment.

A review of the manufacturer’s proprietary data revealed that the Mazda did not recognize or record a crash event in relation to the crash under investigation. There were, however, four prior recorded “near-crash” records (presumably when the algorithm was activated, but no crash pulse/impact developed). All four of the “near-crash” records were old (historical) with respect to the life timer of the data at the time when the data was imaged from the module. There were no indicated faults, and the control module was operating normally when the system was interrogated.

The SCI investigator examined both frontal air bag modules, which had been deposited loose in the Mazda’s second row by the unknown prior inspectors. The driver’s air bag module (**Figure 11**) and the front right passenger’s module (**Figure 12**) both appeared to be genuine original manufacturer components. Proper manufacturer markings and serialization codes were observed on the module and inflator components. There was no damage or abnormal wear to either module, with no evidence to suggest that either module would not operate as designed.



Figure 11: Driver’s frontal air bag module from the Mazda as found in the vehicle during the SCI inspection.



Figure 12: View of the Mazda’s passenger’s frontal air bag module at the time of the SCI inspection.

The electrical connections to the air bag modules’ inflators were in pristine condition, with no evidence of corrosion or degradation. Polymer connectors and wiring in the vehicle were intact, with no evidence of tampering or modification.

As a result of the SCI inspection, the following conclusions regarding the non-deployment of the Mazda's supplemental restraint systems were determined:

1. According to a commercially available vehicle history report, the Mazda had not been involved in any prior crashes or required any service/maintenance to the supplemental restraint systems.
2. As observed during the SCI inspection, the Mazda's driver's and passenger's frontal air bag modules were original manufacturer components. They were not damaged or altered, and showed no evidence of malfunction or other adverse condition.
3. The manufacturer's proprietary data from the Mazda indicated that the crash event (impact with barrier) was not recognized or recorded by the air bag control module.
4. It is inherently not possible for an air bag control module to command pretensioner actuation or air bag deployment if no crash event is recognized or recorded.
5. SCI inspection of the Mazda determined that the front impact with the concrete barrier produced a damage pattern with a CDC of 11FDEW3, corresponding to a significant frontal impact with maximum longitudinal deformation of 52 cm (20.5 in). The SCI reconstruction of the crash determined a total vehicle velocity change (delta-V) of 49 km/h (30 mph).
6. Based on SCI expertise, vehicle crashes similar in severity and magnitude to that experienced by the Mazda typically result in the actuation and deployment of multiple supplemental restraints.
7. The Mazda's lack of actuation/deployment was a direct result of the vehicle not recognizing or recording a crash pulse in relation to the barrier impact. The SCI investigator was unable to determine why the vehicle did not detect, measure, or record a crash pulse/event.

2006 MAZDA 6 OCCUPANT DATA

Driver Demographics

Age/sex: 22 years/female
 Height: 168 cm (66 in)
 Weight: 98 kg (215 lb)
 Eyewear: None
 Seat type: Forward-facing bucket seat with adjustable head restraint
 Seat track position: Seat at middle track position
 Manual restraint usage: 3-point lap and shoulder seat belt
 Usage source: Vehicle inspection
 Air bags: CAC frontal, seat-mounted, and IC air bags available; None deployed
 Alcohol/drug involvement: None
 Egress from vehicle: Exited under own power
 Transport from scene: Ambulance to local hospital
 Type of medical treatment: Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Dermal avulsion to right wrist, 2 cm ¹	710802.1	Column-mounted signal/wiper stalk	Certain
2	Right wrist sprain ¹	772410.1	Column-mounted signal/wiper stalk	Certain
3	Abrasion to right wrist ²	710202.1	Column-mounted signal/wiper stalk	Certain
4	Injury of head, NFS ¹	100099.9	Seat belt webbing, shoulder portion	Possible
5	Chest contusions ²	410402.1	Seat belt webbing, shoulder portion	Certain
6	Contusion of lower abdominal wall ¹	510402.1	Seat belt webbing, lap portion	Certain
7	Superficial abrasion to lower abdomen ¹	510202.1	Seat belt webbing, lap portion	Certain
8	Contusion of right knee ¹	810402.1	Left lower instrument panel	Certain
9	Abrasion of right knee ¹	810202.1	Left lower instrument panel	Certain
10	Contusion to left knee ²	810402.1	Left lower instrument panel	Certain
11	Abrasion to left knee ²	810202.1	Left lower instrument panel	Certain

Source – (1) hospital emergency department records and (2) driver interview

Driver Kinematics

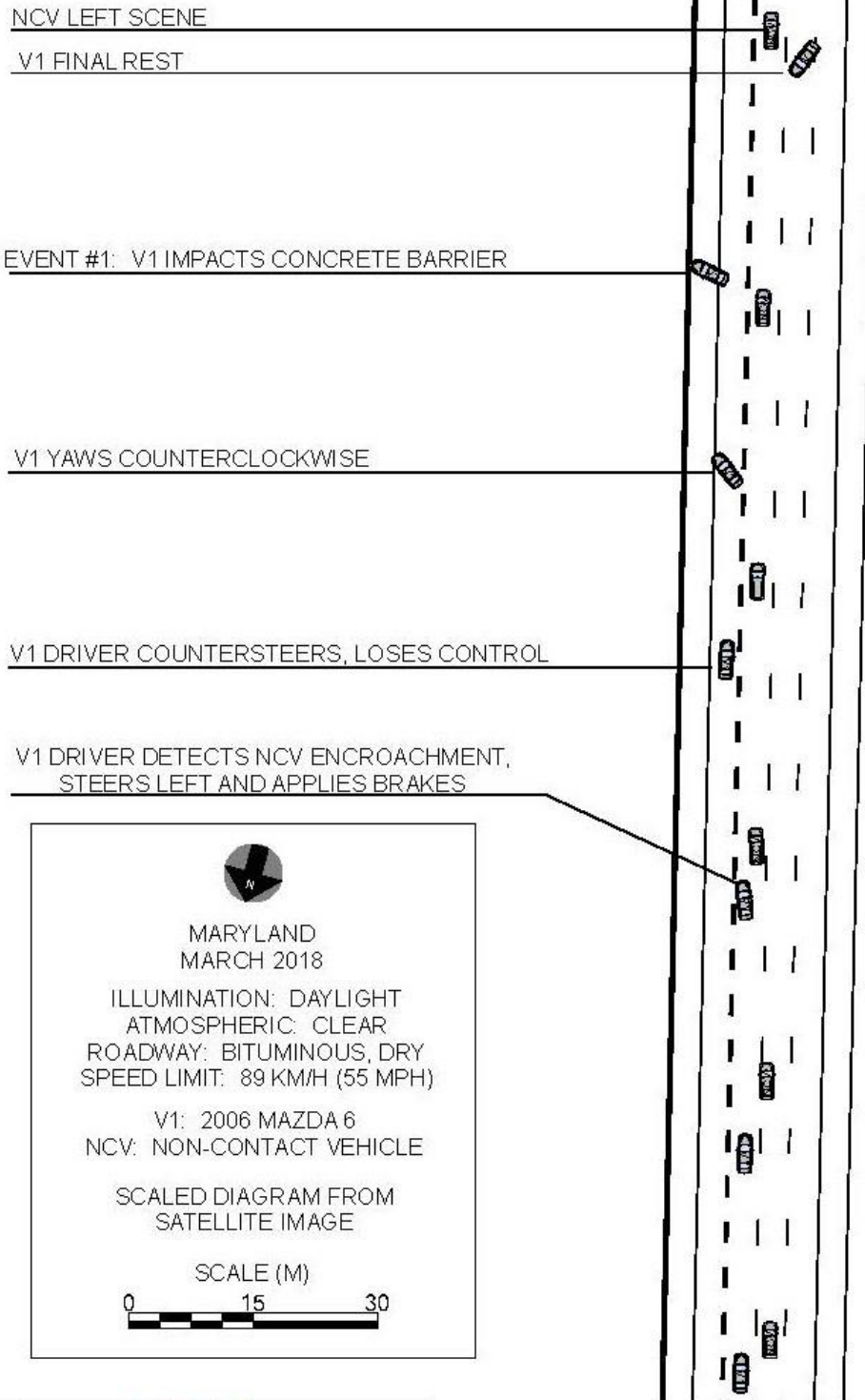
The 22-year-old female driver was positioned in the Mazda's driver seat, with the seat back slightly reclined and the track in a middle position. She used the available 3-point lap and shoulder seat belt system, evidenced by the post-crash condition of the system as observed by the SCI investigator during inspection.

The driver operated the Mazda southbound on the limited access roadway. She observed an unknown make/model vehicle encroach into her travel lane from the right, and reacted by steering left and applying the brakes. This maneuver resulted in a loss of control, and the Mazda initiated a counterclockwise yaw. The driver remained restrained as the vehicle yawed left and struck the median concrete barrier. She responded to the frontal impact forces by initiating a forward trajectory. The driver loaded the manual restraint system, resulting in soft tissue contusions and an abrasion to her abdomen and chest. Her knees moved forward and contacted the left lower instrument panel, producing abrasions and contusions to her knees.

The driver's right hand separated from the steering wheel rim, causing her right wrist to contact and fracture the signal/wiper stalk from the steering column and her right hand to engage the vent louvre in the left aspect of the center instrument panel. This contact resulted in a right wrist avulsion, abrasion, and sprain.

The driver rebounded into the driver's seat as the Mazda was redirected back into the travel lanes. Her use of the manual restraint system mitigated her displacement during the crash and prevented her interaction with the windshield or other frontal components. She unbuckled the seat belt system and exited the Mazda under her own power following the crash. Emergency personnel evaluated the driver and the crash site and transported her by ambulance to a local hospital, where she was treated and released within 5 hours of the crash.

CRASH DIAGRAM



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