TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION SCI TECHNICAL SUMMARY REPORT

CASE NO. CA03-041

VEHICLE – 2003 ACURA MDX

LOCATION - STATE OF MICHIGAN

CRASH DATE – JULY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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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

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16. Abstract This on-site investigative effort focused on the crash severity and the performance of the Certified Advanced 208-Compliant frontal air bag system in a 2003 Acura MDX sport utility vehicle. The manufacturer of this vehicle has certified that this 2003 Acura MDX meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The 2003 Acura MDX was equipped with dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, safety belt pretensioners, and an Event Data Recorder (EDR). A 34-year-old male driver of the MDX was restrained by the 3-point lap and shoulder safety belt and was operating the vehicle on a two-lane roadway during a rain storm with high winds. The high wind fractured a tree limb on the right roadside, which fell onto the roadway across the path of the MDX. The driver applied the brakes as he approached the tree limb in the roadway. The tree trunk fractured above the base and began to fall at this point in time. The MDX struck the limb with the lower aspect of the bumper fascia which resulted in an EDR-reported near deployment event. The fractured tree trunk struck the windshield header and right A-pillar as it fell. This impact produced damage to the front of the green house area of the MDX and resulted in an above threshold deceleration which was sufficient to deploy the driver's air bag and both front seat retractor-mounted safety belt pretensioners. After the impact, the driver brought the vehicle to a controlled stop on the roadside. He sustained minor facial lacerations, minor right hand lacerations, and minor right leg lacerations from the flying glass. He did not receive medical treatment and was not transported to a medical facility.			
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BACKGROUND

This on-site investigative effort focused on the crash severity and the performance of the Certified Advanced 208-Compliant frontal air bag system in a 2003 Acura MDX sport utility vehicle. The manufacturer of this vehicle has certified that this 2003 Acura MDX meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The 2003 Acura MDX was equipped with dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, safety belt pretensioners, and an Event Data Recorder (EDR). A 34-year-old male driver of the MDX was restrained by the 3-point lap and shoulder safety belt and was operating the vehicle on a two-lane roadway during a rain storm with high winds. The high wind fractured a tree limb on the right roadside, which fell onto the roadway across the path of the MDX. The driver applied the brakes as he approached the tree limb in the roadway. The tree trunk fractured above the base and began to fall at this point in time. The MDX struck the limb with the lower aspect of the bumper fascia which resulted in an EDR-reported near deployment event. The fractured tree trunk struck the windshield header and right A-pillar as it fell. This impact produced damage to the front of the green house area of the MDX **(Figure 1)** and resulted in an above threshold deceleration which was sufficient to deploy the driver's air bag and both front seat retractor-mounted safety belt pretensioners. After the impact, the driver brought the vehicle to a controlled stop on the roadside. He sustained minor facial lacerations, minor right hand lacerations, and minor right leg lacerations from the flying glass. He did not receive medical treatment and was not transported to a medical facility.

Figure 1. Damaged 2003 Acura MDX

The Police Accident Report (PAR) for this July 4, 2003 crash was forwarded to NHTSA following routine sampling activities for NASS by PSU 12. The PAR was faxed to the General Dynamics SCI team on July 23rd for telephone follow-up to locate the vehicle for inspection. The SCI team gained cooperation from the insurance company and an on-site investigation was initiated on July 25th. The vehicle inspection and EDR retrieval occurred on August 6th. The EDR was removed from the vehicle for download by Honda. The EDR output is summarized in this report.

VEHICLE DATA – 2003 ACURA MDX

The 2003 Acura MDX was identified by the Vehicle Identification Number (VIN): 2HNYD18203H (production sequence omitted). At the time of the vehicle inspection, the electronic odometer could not be read, as power was absent from the vehicle. The driver estimated the vehicle's odometer reading at 8,851 km (5,500 miles). The vehicle was a four-door sport-utility vehicle that was equipped with a 3.5 liter, V-6 engine, a five-speed, automatic transmission, all-wheel-drive, four-wheel disc brakes with ABS, traction control, an engine immobilizer, power steering, and a tilt-steering wheel with integrated radio controls and cruise controls. The MDX was equipped with Goodyear Integrity P235/65R17 tires. The vehicle manufacturer's recommended tire pressure for each tire was 220 kpa (32 psi). The specific tire data is as follows:

Tire	Measured Pressure	Maximum Pressure	Tread Depth	Restricted	Damage
LF	248.2 kpa (36.0 psi)	303.4 kpa (44.0 psi)	8 mm (10/32")	No	None
LR	244.8 kpa (35.5 psi)	303.4 kpa (44.0 psi)	9 mm (11/32")	No	None
RF	244.8 kpa (35.5 psi)	303.4 kpa (44.0 psi)	8 mm (10/32")	No	None
RR	251.7 kpa (36.5 psi)	303.4 kpa (44.0 psi)	9 mm (11/32")	No	None

The Acura MDX was configured with front bucket seats with adjustable head restraints. The driver's seat was positioned 8.9 cm (3.5") forward of the full-rear track position and 12.7 cm (5.0") rear of the full-forward track position. The distance between the steering wheel hub and the driver's seat back measured 54.6 cm (21.5") at that seat track position. The second row seating positions were configured with a split bench seat with folding backs. The two third row seating positions were configured with a split bench seat with seat backs that folded forward for stowage.

At the time of the crash, the driver stated that a mountain bike was stowed on an exterior bike rack, which was attached to the tow receiver on the rear plane of the MDX.

CRASH SITE

This single vehicle crash occurred during the daylight hours of July 2003 in the state of Michigan. At the time of the crash, the weather involved heavy rain and high, gusty, winds. The asphalt roadway surface was wet, although, the driver stated that there was no ponding of water on the roadway at the time of the crash. The north/south roadway **(Figure 2)** was configured with one travel lane in each direction separated by a broken yellow centerline for southbound traffic and a solid yellow line for northbound traffic. A no-passing zone for northbound and southbound traffic began south of the crash site and "no-passing zone" signs were present

Figure 2. Overall view of crash scene

on both sides of the roadway for southbound traffic. The east roadside did not exhibit a shoulder, but was bordered by grass and wooded areas. A narrow gravel shoulder was present on the west roadside. The posted speed limit was 72 km/h (45 mph). The scene schematic is included as **Figure 13** of this narrative report.

CRASH SEQUENCE

Pre-Crash

The 34-year-old male was operating the Acura MDX in a southbound direction on the two-lane roadway **(Figure 3)**. The driver stated that the vehicle was traveling approximately 81 km/h (50 mph) prior to the impact. As the vehicle approached the crash site, he observed a large tree limb fracture and fall onto the roadway. The driver applied the brakes as the MDX approached the tree limb in the roadway. The tree trunk that measured 45.7 cm (18.0") in diameter fractured 134.6 cm (53.0") above the base **(Figure 4)** and began to fall at this point in time.

Figure 3. Southbound approach for the MDX

Figure 4. View of the base of the fractured tree

Crash

The frontal area of the MDX struck the tree limb that had fallen onto the roadway. The initial contact with the fractured tree limb involved the lower right aspect of the bumper fascia. The initial impact resulted in an EDR-reported near deployment event prior to the second event. The fractured tree trunk subsequently fell across the front aspect of the green house area. The tree trunk fell across the right A-pillar, windshield, windshield header, and right roof side rail. The impact with the tree trunk resulted in moderate damage to the MDX and the longitudinal deceleration was sufficient to deploy the first and second stages of the driver's frontal air bag and both safety belt retractor pretensioners. The tree trunk was deflected off the MDX and onto the roadside after the impact **(Figure 5)**. The driver stated that he brought the MDX to a controlled stop in the travel lane after the impact, and subsequently drove it onto the right roadside out of the travel lane.

Figure 5. View of the final rest position of the fractured tree

Post-Crash

The driver stated that he used a cellular telephone to call for assistance. He exited the vehicle under his own power through the driver's door. He sustained minor lacerations from flying glass. The driver was evaluated at the scene by rescue personnel, however, he refused additional medical treatment. He was not transported to any medical facility and did not seek follow-up treatment.

VEHICLE DAMAGE

Exterior Damage – 2003 Acura MDX

The 2003 Acura MDX sustained minor lower front bumper fascia damage as a result of the initial impact **(Figure 6)** with the tree limb. There was no residual crush, and the direct contact abrasions began at the centerline and extended 53.3 cm (21.0") to the right. The combined direct and induced damage across the bottom of the plastic fascia began at the centerline and extended 76.2 cm (30.0") to the right. The Collision Deformation Classification (CDC) for the impact with the tree limb was 12-FZEW-1.

Figure 6. Frontal view showing minor lower bumper fascia damage

The MDX sustained moderate green house damage as a result of the impact with the fractured tree trunk **(Figure 7)**. The direct damage began on the right A-pillar, 19.1 cm (7.5") above the belt line, and extended 48.9 cm (19.3") upward along the right A-pillar. The direct damage extended laterally across the entire width of the windshield, windshield header, forward aspect of the roof, and the right roof side rail. The windshield header and right A-pillar were crushed vertically approximately 25 cm (10") from their original position. The maximum longitudinal crush on the windshield header measured 26.0 cm (10.3") and was located 31.1 cm (12.3") to the right of the centerline. The right roof side rail was crushed vertically from the right B-pillar forward, and the windshield was fractured and holed. A semi-circular damage pattern on the right A-pillar that measured 45.7 cm (18.0") in diameter was located 22.9 cm (9.0") above the belt line from direct contact with the tree **(Figure 8)**. The combined direct and induced damage measured 132.1 cm (52.0") across the windshield header. Six longitudinal crush measurements were documented along the windshield header and were as follows: C1 = 0.6 cm (0.3"), C2 = 4.2 cm (1.7"), C3 = 15.2 cm (6.0"), C4 = 24.1 cm

Figure 7. Frontal view of green house damage to the MDX

Figure 8. Lateral view showing direct damage from the tree

(9.5”), C5 = 20.1 cm (7.9”), C6 = 10.8 cm (4.3”). The right aspect of the hood was slightly deformed as a result the deflection of the tree from the vehicle onto the roadside. The CDC for the impact with the fallen tree trunk was 00-TPDW-4.

The right front fender, right front door, and right rear door sustained minor rearward displacement **(Figure 9)**. Minor induced buckling was present on the right roof side rail at the centerline of the right C-pillar.

Figure 9. Left side view of the damaged MDX

Figure 10. Interior view showing passenger compartment intrusions

Interior Damage – 2003 Acura MDX

The 2003 Acura MDX sustained moderate interior damage as a result of passenger compartment intrusion **(Figure 10)**. Numerous tree fragments were present in the vehicle. The windshield was fractured and holed from direct contact with the tree. The right front window, right rear window (cargo area), and the sunroof glazing disintegrated as a result of the impact. Fractured glazing was present throughout the vehicle. A scuff mark was present on the rear outboard aspect of the plastic trim on the rear of the driver’s seat cushion from engagement against the safety belt webbing. The scuff mark measured 6.4 cm (2.5”) in width and was diagonally oriented. The headliner fabric was torn adjacent to the right sun visor arm and was separated along the width of the windshield header. The rear view mirror was separated. Multiple intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Front left	Windshield header	13.3 cm (5.3”)	Vertical
Front left	Roof	5.1 cm (2.0”)	Vertical
Front center	Windshield header	20.3 cm (8.0”)	Vertical
Front center	Roof	27.9 cm (11.0”)	Vertical
Front right	Windshield header	28.6 cm (11.3”)	Vertical
Front right	Roof	34.3 cm (13.5”)	Vertical

Position	Intruded Component	Magnitude of Intrusion	Direction
Front right	Right roof side rail	8.3 cm (3.3”)	Vertical
Front right	Right A-pillar	19.1 cm (7.5”)	Vertical

A scuff mark from contact with the driver’s head was located on the left roof side rail 24.1 cm (9.5”) forward of the left B-pillar centerline. The scuff mark measured 10.8 cm (4.5”) in length and 7.6 cm (3.0”) in height.

MANUAL RESTRAINT SYSTEMS – 2003 ACURA MDX

The 2003 Acura MDX was configured with manual 3-point lap and shoulder belts for the front seating positions. The driver’s safety belt was equipped with an Emergency Locking Retractor (ELR) with a load limiter, a sliding latch plate, and an adjustable D-ring that was adjusted to the full-up position. The front right passenger’s safety belt was equipped with a switchable/Automatic Locking Retractor (ALR) with a load limiter, and a sliding latch plate. The plastic-coated D-rings were configured with a metallic finish on the bottom aspect of the opening that engaged with the safety belt webbing. The driver’s safety belt webbing was restricted in the used position **(Figure 11)**. The total webbing that was exposed between the B-pillar trim and the anchor measured 192.4 cm (75.8”) in length. The webbing exhibited stretching as a result of occupant loading that began 56.5 cm (22.3”) from the anchor and extended 97.8 cm (38.5”) upward along the lap and shoulder aspects. A full-width plastic transfer was located 18.4 cm (7.5”) above the anchor from engagement against the plastic trim on the outboard aspect of the driver’s seat cushion. The plastic-coated latch plate was abraded as a result of occupant loading, and the D-ring exhibited minor scuffing on the forward aspect of the plastic.

Figure 11. View of restricted driver's lap and shoulder

The front right, second row, and third row seating positions were configured with manual 3-point lap and shoulder belts. Each was equipped with a switchable/ALR and a sliding latch plate.

CERTIFIED ADVANCED 208-COMPLIANT SAFETY SYSTEM

Frontal Air Bag System – 2003 Acura MDX

The Acura MDX was equipped with a Certified Advanced 208-Compliant safety system that included dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, safety belt pretensioners, and an Event Data Recorder (EDR). The manufacturer of this vehicle has certified that this 2003 Acura MDX meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Acura MDX was also equipped with side impact air bags that were located in the outboard aspects of the front seat backs. The side impact air bags did not deploy in this crash.

The driver's air bag deployed as a result of the impact with the fallen tree. The driver's air bag **(Figure 12)** deployed from the steering wheel hub and was designed with symmetrical H-configuration cover flaps. The flaps measured 7.6 cm (3.0") in height and 15.6 cm (6.1") in width at the tear seam. The deployed air bag measured 61.0 cm (24.0") in diameter. The air bag was vented by two circular ports that measured 3.8 cm (1.5") in diameter and were located at the 1 and 11 o'clock positions on the rear of the air bag. The air bag was tethered by three internal straps that measured 6.4 cm (2.5") in width and were located at the 12, 4, and 8 o'clock aspects around the center of the air bag. A small light colored fabric transfer that measured 1.0 x 1.0 cm (0.4 x 0.4") was located 17.1 cm (6.8") above the horizontal centerline and 1.6 cm (0.6") to the right of the vertical centerline. Small amounts of body fluid were present on the upper right quadrant of the air bag face. Two additional small light colored fabric transfers were present on the 2 o'clock aspect of the rear of the air bag.

Figure 12. Deployed driver's air bag

The Acura MDX was configured with retractor-mounted safety belt pretensioners for both front seat positions. Both front seat pretensioners actuated as a result of the crash, evidenced by the restriction of the driver's safety belt retractor in the used position and the tight restriction of the front right passenger's safety belt retractor in the stowed position. The front right passenger's adjustable D-ring cover was slightly displaced as a result of the downward force exerted on it from the removal of the slack from the webbing by the pretensioner.

Occupant Sensing System – 2003 Acura MDX

The front right passenger's air bag did not deploy in this crash. The front right seat was equipped with a seat track sensor that was designed to alter the deployment of the front right passenger's air bag if the seat was in a forward track position. The seat was also configured with a weight sensor that detected occupant presence and suppressed the front right passenger's air bag if there was no occupant detected in the seat. Seat belt buckle switches were also present for both for both front seat occupants, which provided input into the air bag deployment logic.

Event Data Recorder (EDR) – 2003 Acura MDX

The MDX was equipped with an EDR. The air bag control module, which performed diagnostics and sensing for the safety systems contained the EDR. The control module was located under the forward aspect of the center console, and was removed from the vehicle by the SCI investigator during the vehicle inspection. The control module was forwarded to the Crash Investigation Division of NHTSA who subsequently forwarded it to Honda for analysis of the EDR. The EDR output identified the driver's position as "belted" and the front right passenger's position as "unbelted." In addition, since the seat weight sensor reported the front right seat as "unoccupied", the air bag fire mode was reported as "inhibit." The driver's air bag fire mode was

"high", which suggested a dual-stage deployment. Both pretensioners were also reported to have fired. The synopsis of the EDR summary stated that the driver's air bag fired with "high inflation (simultaneous)", both pretensioners fired, and the system inhibited the front right passenger's air bag due to the lack of occupancy in the seat.

The following chart details the EDR summary:

	Left Side	**Right Side**
Seat belt Status	Belted	No
Pretensioner Fire	Yes	Yes
Seat weight Sensor		Unoccupied
Airbag Fire Mode	High	Inhabit
SRS ECU "ON" Time	Not Available	
Front Crash Sensor "ON" Time	NA	NA
Side Crash Sensor "ON" Time	No Trigger	No Trigger

OCCUPANT DEMOGRAPHICS – 2003 ACURA MDX

Driver

Age/Sex:	34-year-old/Male
Height:	168 cm (66")
Weight:	68 kg (150 lb)
Seat Track Position:	8.9 cm (3.5") forward of full-rear and 12.7 cm (5.0") rear of full-forward
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	Prescription contact lenses
Type of Medical Treatment:	Did not receive medical treatment

Driver Injuries

Injury	**Injury Severity (AIS 90/Update 98)**	**Injury Mechanism**
Minor facial lacerations	Minor (290602.1,0)	Flying glass
Minor right hand lacerations	Minor (790602.1,1)	Flying glass
Minor right leg lacerations	Minor (890602.1,1)	Flying glass

Injury source: Driver interview

Driver Kinematics

The 34-year-old male driver was restrained by the manual 3-point lap and shoulder belt and was seated in an upright posture. He stated that his hands were positioned at the 10 and 2 o'clock positions on the steering wheel rim. He applied the brakes when he detected the tree falling across the roadway. The driver was minimally displaced as the MDX struck the tree branch in

the roadway, and the safety belt prevented significant forward motion. At impact with the tree trunk, both front seat pretensioners actuated and the first and second stages of the driver's air bag deployed. The driver initiated a forward trajectory and loaded the manual restraint. He contacted the deployed air bag with his face and torso, which mitigated contact with the steering wheel and instrument panel. He rebounded rearward into the seat back as the windshield header and roof intruded vertically. The disintegrated right side glazing and fragments of the holed windshield were projected into the passenger compartment. The driver sustained minor lacerations on his face, right hand, and right leg from flying glass, and possible tree debris. The vehicle stopped in the travel lane as a result of the driver's brake application. He drove the MDX onto the roadside and used a cellular phone to call for help. The driver exited the vehicle through the driver's door under his own power. He was evaluated by rescue personnel on-scene, but he refused ambulance transport to a medical facility. He did not seek follow-up medical treatment after the crash.

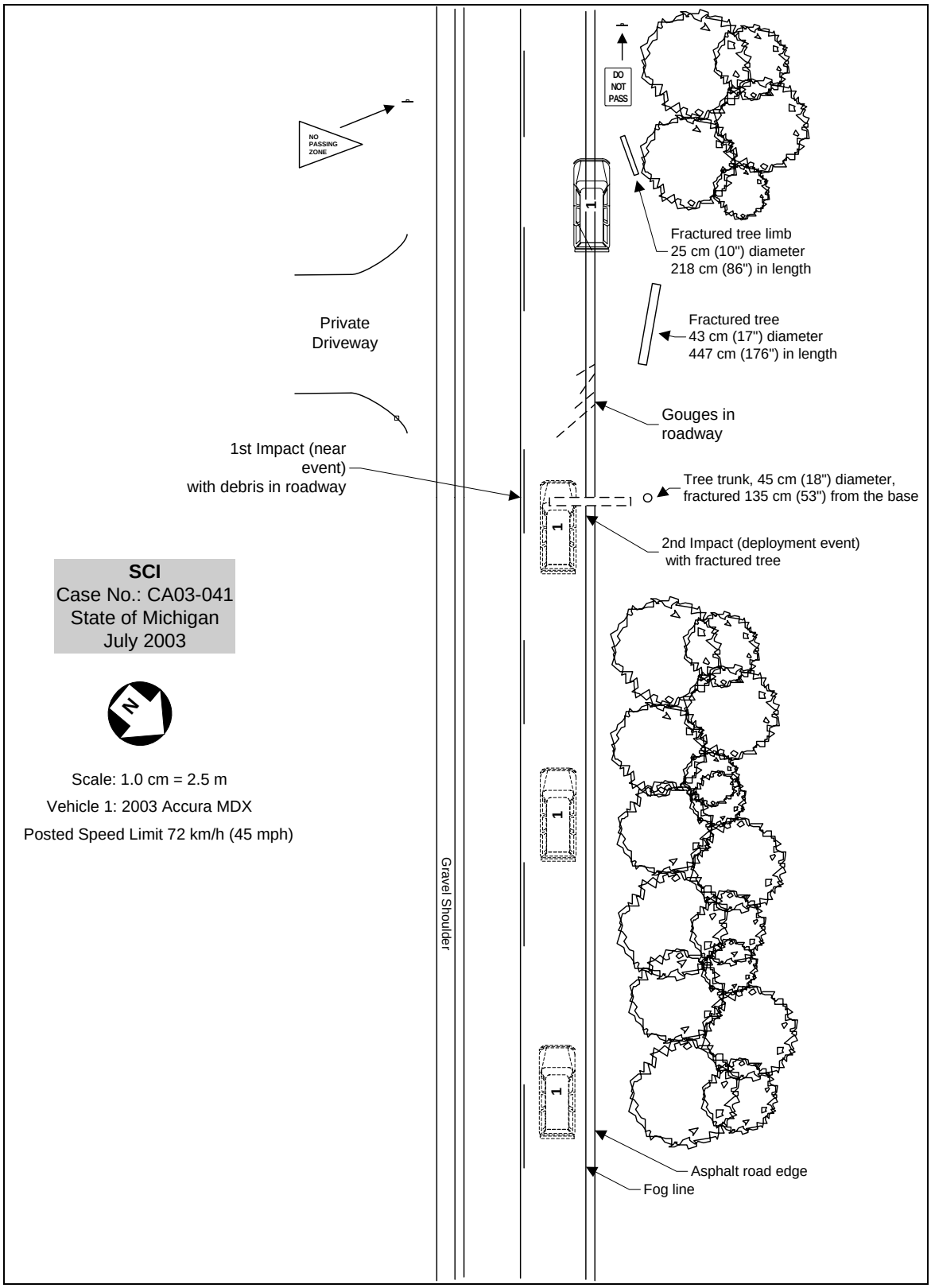

Figure 13. Scene Schematic