CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NO.: CA05-050

VEHICLE: 2004 INFINITI QX56

LOCATION: VIRGINIA

DATE OF CRASH: AUGUST 2005

Contract No. DTNH22-01-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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LOCATION - STATE OF VIRGINIA
CRASH DATE – AUGUST 2005

BACKGROUND

This on-site investigation focused on the side impact inflatable occupant protection system that deployed in a 2004 Infiniti QX56 full size sport utility vehicle **(Figure 1)**. The system consisted of seat back mounted side impact air bags for the front seating positions and canopy air bags for the six outboard seating positions. In addition, the Infiniti was equipped Vehicle Dynamic Control and Traction Control, a Certified Advanced 208-Compliant (CAC) frontal air bags system, dual front safety belt pretensioners, and an Event Data Recorder. The EDR data is summarized in the ***Event Data Recorder*** section of this report. The Infiniti was occupied by a restrained 18-year-old female driver, an unrestrained 18-year-old male right front occupant, an unrestrained 17-year-old female rear left occupant, and an unrestrained 17-year-old male rear right occupant. The Infiniti was involved in a run-off-road collision with a large diameter tree and subsequently rolled onto its roof. As a result of the crash, the left side seat back mounted side impact air bag, left and right side canopy air bags, and the frontal air bags deployed. Additionally, the front safety belt pretensioners fired. The driver sustained massive head trauma and was pronounced deceased at the crash site. The right front, rear left, and rear right occupants sustained minor to severe injuries and were transported to a local trauma center for treatment. The Infiniti sustained severe left side damage and was towed from the crash site.

Figure 1. Subject vehicle 2004 Infiniti QX56.

Notification of this crash was provided to NHTSA by a local police officer that was called to the scene of the crash for reconstruction purposes. An Internet news article and images of the vehicle were forwarded to the Calspan Special Crash Investigations team on the day of the crash. The crash was assigned for an on-site investigation due to the deployed side impact protection system. The vehicle and crash site were inspected on August 25, 2005.

SUMMARY

Crash Site

This run-off-road crash occurred during the early morning hours of August 2005 under dark and dry conditions. The crash occurred off-road of an east/westbound two-lane, two-way, rural roadway. The east/westbound roadway was configured with one travel lane in each direction that were delineated by double-yellow centerlines and bordered by white fog lines. The roadway was recently resurfaced with asphalt that included both shoulders that extended beyond the painted fog lines. The roadway curved slightly right for westbound travel. Additionally, there was a sag in the roadway east of the crash location. The south roadside consisted of a ditch, wooden signpost, grass embankment, and a tree line. The posted speed limit for the east/west roadway was 72 km/h (45 mph). The scene schematic is included as **Figure 12** of this report.

Vehicle Data – 2004 Infiniti QX56

The 2004 Infiniti QX56 was identified by the Vehicle Identification Number (VIN): 5N3AA08C24 (production sequence omitted). The odometer reading at the time of the inspection was unknown due to the expended vehicle battery and digital readout. The vehicle was a full-size four-door sport utility vehicle that was equipped with a 5.6-liter, V-8 engine, 5-speed automatic transmission, four-wheel drive, power-front and rear disc brakes with anti-lock and electronic brake force distribution, Vehicle Dynamic Control (VDC) and Traction Control (TC), direct tire pressure monitoring system, OEM alloy wheels, power-steering, and a tilt steering wheel. The Infiniti was equipped with Continental Contitrac tires, size P265/70R18. The manufacturer recommended tire pressure was 241 kPa (35 PSI). The specific tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	7 mm (9/32)	No	De-beaded
LR	214 kPa (31 PSI)	7 mm (9/32)	No	None
RF	207 kPa (30 PSI)	6 mm (8/32)	No	None
RR	207 kPa (30 PSI)	6 mm (8/32)	No	None

The seating positions in the Infiniti were leather upholstered front buckets seats with height adjustable head restraints. The front seat head restraints were both adjusted to the full-down positions at the time of the vehicle inspection. The second row was configured with a three-passenger split (60/40) bench seat with height adjustable head restraints for the outboard positions. The second row head restraints were adjusted to the full-down position at the time of the SCI inspection. The third row was configured with a two-passenger bench seat with height adjustable head restraints. The third row head restraints were adjusted to the full-down positions.

Crash Sequence

Pre-Crash

The restrained 18-year-old female driver of the Infiniti was operating the vehicle eastbound on the two-lane roadway. The driver was negotiating a slight right curve and descending a negative grade at a high rate of speed. For unknown reasons, the driver allowed the vehicle to depart the right roadside **(Figure 2)** where she applied an aggressive left steering maneuver to correct the

roadside departure. Consequently, this steering input and speed of the vehicle induced a counterclockwise (CCW) rotation that was evidenced by yaw marks on the asphalt road surface **(Figure 3)**. Although the vehicle was equipped with VDC and TC, the rapid left steering input and velocity of the vehicle induced a yaw that was typical of a vehicle without these systems. The Infiniti crossed both travel lanes and departed the south (left) roadside and traversed the asphalt shoulder. The driver probably counter steered to the right as the vehicle traversed the shoulder allowing the front left aspect of the vehicle to enter the ditch in a near tracking mode. The EDR recorded no lateral acceleration at the onset of this event. Additionally, the VDC system possibly assisted in redirecting the vehicle in a clockwise direction.

Figure 2. Right side road departure.

Figure 3. Infiniti re-enters the roadway and traverses the travel lanes toward the embankment.

Crash

The vehicle traveled down the shallow ditch with the left front wheel, which resulted in the Infiniti to pitch down and to the left. The EDR recorded an 11-degree roll angle with a total roll rate of 130 degrees per second to the left, which triggered the deployment of the left and right canopy air bags. The center front of the Infiniti struck a wood signpost, which yielded to the impact and did not alter the vehicle's trajectory **(Figure 4)**. This impact was minor and produced minimal longitudinal deceleration to the vehicle.

Figure 4. Ditch contact and first impact with the wood signpost.

Figure 5. Tree impact at the top of the embankment.

The Infiniti continued its off-road travel. The undercarriage contacted the embankment, which was evidenced by a gouge on the backside of the embankment. The vehicle continued forward and struck a large diameter tree with the front left corner outboard of the frame rail **(Figure 5)**. The direction of force was 12 o'clock for this impact. The impact location allowed the vehicle to continue its forward movement resulting in contact to the left side of the Infiniti. The tree crushed the greenhouse at the area of the left A-pillar and continued down the left side plane to the left D-pillar area. The EDR recorded a low-level frontal deceleration and deployed the frontal air bags at 56 milliseconds after Algorithm Enable (AE). The EDR commanded the deployment of the left side seatback mounted side impact air bag at 67 milliseconds into the event.

The left side contact induced a CCW rotation and the vehicle rotated approximately 180 degrees and began to travel down the embankment laterally. The negative grade and lateral travel resulted in the left side wheels to dig into the dirt/grass embankment producing a tripping mechanism. Due to the negative slope of the embankment, the rollover type was classified as a trip/fall over. The Infiniti rolled two-quarter turns onto its roof where it came to rest facing in an easterly direction approximately 180 degrees of its initial heading.

The multiple plane impact sequence was outside the scope of the WINSMASH program. The WINSMASH program is a one-dimensional program that could not capture the to the front and left side planes; therefore the computed delta-V would not be representative of the crash. The vehicle's EDR did not record a longitudinal delta-V for this crash.

Post-Crash

Police and EMS personnel responded to the crash site. The driver sustained massive head trauma and was pronounced deceased at the crash scene. The three occupants sustained minor to severe injuries and were transported by ambulance to a local trauma center where they were treated for their injuries. The Infiniti sustained severe damage and was towed from the crash site.

Vehicle Damage

Exterior Damage – 2004 Infiniti QX56

The 2004 Infiniti QX56 sustained minor severity damage as result of the impact with the wood signpost. The direct contact damage from this impact was located at the centerline. The damage consisted of a vertical fracture line to the bumper fascia. Also, the upper radiator support was crushed approximately 3 cm (1.0") at the centerline. The Collision Deformation Classification (CDC) for this impact was 12-FCEN-1.

Figure 6. Overall view of the frontal and left side damage.

The frontal damage from the embankment impact was overlapped by the tree impact; therefore, a crush profile was not documented for this impact. The CDC for this impact was 00-UFDW-1.

The Infiniti sustained moderate severity frontal damage and severe left side damage as a result of the corner impact with the tree **(Figure 6)**. The damaged frontal components included the bumper fascia and beam, hood, and the left headlight assembly. The direct contact damage measured approximately 36 cm (14.0") and was located left of the vehicle centerline and extended to the front left bumper corner. The frontal damage was captured by measuring six equidistant points along the full frontal width (Field L) of 116 cm (45.5") of the bumper beam. The crush measurements were as follows: C1 = 6 cm (2.5"), C2 = 5 cm (2.0"), C3 = 5 cm (1.8"), C4 = 4 cm (1.7"), C5 = 4 cm (1.5"), C6 = 4 cm (1.6"). The CDC for the tree impact was 12-FLAE-9.

Figure 7. Overall view of the left side damage.

The left side components that were damaged in the crash included the left front fender, A-pillar, roof rail, doors, sill, and the quarter panel **(Figure 7)**. Additionally, a reduction in the left side wheelbase of 8 cm (3.0") was noted. The left side crush was documented vertically and laterally along the full length of the roof side rail, which measured 196 cm (77.0") in length. The residual lateral crush was measured at six locations along the left roof side rail and were as follows: C1 = 18 cm (6.9"), C2 = 22 cm (8.5"), C3 = 38 cm (15.1"), C4 = 20 cm (7.7"), C5 = 6 cm (8.7"), C6 = 25 cm (9.8").

The vertical crush along the left roof side rail was as follows: C1 = 56 cm (22.0"), C2 = 57 cm (22.3"), C3 = 22 cm (8.8"), C4 = 31 cm (12.5"), C5 = 24 cm (9.3"), C6 = 27 cm (10.8").

Additionally, the left side doors were cut and removed by rescue personnel and the vehicle glazing was disintegrated

The rollover event damage was minor and was masked by the deformation from the large tree impact. Therefore, the assigned CDC for this impact was 00-TDDO-2.

Interior Damage – 2004 Infiniti QX56

The 2004 Infiniti QX56 sustained moderate interior damage as a result of occupant contacts and passenger compartment intrusion. The interior compartment of the Infiniti was distorted from exterior deformation. A large area of body fluid was pooled on the front left area of the roof. This fluid was dispersed through out the vehicle's interior when the vehicle was rolled onto its wheel for removal from the crash site. As result, possible occupant contact points may have been masked.

The driver's contact points consisted of deformation of the steering wheel rim from her torso as the steering wheel was intruded rearward and laterally right. Also noted was a fractured plastic left A-pillar panel from contact with the driver's head. The driver's head appeared to have contacted the roof at the junction of the left A-pillar, which was evidenced by body fluid. Body

fluid was present on the rear of the right front seatback from possible contact from the rear right occupant. The passenger compartment intrusions are listed in the table below:

Seat Position	Intruded Component	Magnitude	Direction
Front left	A-pillar	25 cm (9.8”)	Vertical
Front left	B-pillar	38 cm (15.1”)	Lateral
Front left	Instrument panel	40 cm (15.8”)	Longitudinal
Front left	Steering wheel	22 cm (8.5”)	Longitudinal
Front left	Steering wheel	Approximately 26 cm (10.0”)	Lateral
Front left	Roof	27 cm (10.8”)	Vertical
Front left	Windshield header	27 cm (10.8”)	Vertical
Front center	Instrument panel	11 cm (4.5”)	Longitudinal
Front left	Seatback	39 cm (15.5”)	Longitudinal
Rear left	Roof	27 cm (10.8”)	Vertical
Rear left	Side rail	25 cm (9.8”)	Vertical
Rear center	Roof	27 cm (10.8”)	Vertical

Vehicle Dynamic Control and Traction Control – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with Vehicle Dynamic Control (VDC) and Traction Control (TC) systems. The VDC system uses various sensors to determine the vehicle’s steered path. In the event of under-steer or over-steer, the VDC can apply appropriate brake application to individual wheels and or reduce engine output to aid the vehicle on the intended steered path.

The TC system senses wheel spin and automatically reduces engine output to the slipping wheel (s). Although the vehicle was equipped with VDC and TC, the rapid steering input and velocity resulted in the directional control loss by the driver of the Infiniti. However, the vehicle began a clockwise rotation prior to entering the ditch, which probably resulted from counter steering by the driver and possible activation of the VDC system.

Canopy Air Bags – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with canopy air bags for the six outboard seating positions. The canopy air bags were designed to deploy in the event of a rollover or side impact and remain inflated for a longer period of time than the frontal air bags. In the subject crash, the left and right side canopy air bags deployed **(Figure 8)**. The Infiniti utilized one canopy air bag membrane for the first and second rows and a

Figure 8. Deployed right side curtain air bag.

separate canopy air bag membrane for the third row. The first and second row canopy air bags deployed from the left roof side rail. The air bag membrane measured 166 cm (65.5”) in length and was tethered at the A- and C-pillars. The height of the canopy air bag membrane was 43 cm (17.0”) at the first row and 46 cm (18.0”) at the second row. The third row canopy air bag deployed from the roof side rail. The membrane for this air bag measured 60 cm (23.5”) in height and 66 cm (26.0”) in length. No occupant contacts points were present on the canopy air bags; however, dirt and body fluid were noted on the membrane.

Side Impact Air Bags – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with seatback mounted side impact air bags for the front seating positions. As a result of the left side engagement with the tree, the left side impact air bag deployed **(Figure 9)**. The air bag deployed through a 38 cm (15.0”) tear seam in the seatback. The air bag membrane was of a semi-circular shape and measured 33 cm (13.0”) in height and 36 cm (14.0”) in width. The air bag was free of occupant contact points or damage. A large area of body fluid was noted to the upper aspect of the inboard panel of the air bag membrane. In addition, the air bag membrane contained several areas of dirt from exposure to the weather and outdoor elements.

Figure 9. Deployed left side seatback mounted side impact air bag.

Frontal Air Bag System – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with a Certified Advanced 208-Compliant frontal air bag system for the driver and front right passenger. Due to the frontal crash forces, the frontal air bag system deployed. The driver’s air bag was conventionally located within the steering wheel hub. Three cover flaps concealed the air bag membrane. The top cover flap measured 8 cm (3.0”) in height and 16 cm (6.3”) in width. Two symmetrical cover flaps were utilized on the bottom, which measured 6 cm (2.5”) in height and 6 cm (2.5”) in width. The air bag membrane was 43 cm (17.0”) in diameter and contained two circular stitch patterns in the center for tethers. The outer stitch pattern was 23 cm (9.0”) in diameter and the inner measured 9 cm (3.5”) in diameter. Due to the intruding steering column, the driver loaded through the deployed air bag and deformed the steering wheel rim.

Figure 10. Deployed driver's frontal air bag.

Figure 11. Deployed front right air bag.

The front right air bag was a top-mount design in the right instrument panel and was concealed by a single cover flap. The air bag membrane was 46 cm (18.0") in height and 37 cm (14.5") in width. No damage or contact evidence was present on the air bag membrane; however, dirt was present on the air bag.

Event Data Recorder – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with an Event Data Recorder (EDR). Investigators from the Nissan Motor Corporation attended the SCI inspection of the vehicle. The EDR module was located forward of the center console under the instrument panel. The EDR was removed by the SCI investigators and provided to the Nissan investigators for download. A summary of the data was provided to NHTSA and was forwarded to the Calspan SCI team for inclusion in this report. Two crash events were recorded and recovered from the EDR module. The EDR data indicated that the first event recorded was a rollover-type event, which was related to the vehicle entering the ditch. This event recorded an 11-degree roll angle to the left with a roll rate of 130-degrees per second. Additionally, the left and right side canopy air bags were commanded to deploy during this phase of the crash.

The tree impact was recorded as a low level frontal deceleration with both frontal air bags deploying at 56 milliseconds after AE. The driver's safety belt was noted as buckled and the front right was unbuckled at the time of AE. The EDR detected a child occupant in the front right seat. The unrestrained front right occupant bottomed out into the seat as the vehicle entered the ditch and then rebounded upward. At this point in time, the right front seat sensor detected the child passenger. This may have resulted when the vehicle entered the ditch, displacing the front right occupant upward off the vehicle seat. Furthermore, the EDR data shows that the left side impact air bag deployed at 67 milliseconds after AE.

Manual Restraints System – 2004 Infiniti QX56

The 2004 Infiniti QX56 was equipped with manual 3-point lap and shoulder safety belts for the seven seating positions. The driver's safety belt was configured with a sliding latch plate, an Emergency Locking Retractor (ELR), a retractor mounted pretensioner, and a buckle mounted pretensioner. As result of the crash, both pretensioners fired. The driver used the safety belt in the crash, which was supported by loading abrasions on the latch plate and D-ring. Additionally, the fired retractor pretensioner restricted the safety in the used position and the safety belt webbing was cut during the removal of the driver.

The front right safety belt was configured with a sliding latch plate, a retractor mounted pretensioner, and a buckle mounted pretensioner, and a switchable ELR/Automatic Locking Retractor (ALR). The front right occupant did not utilize the safety belt in the crash, which was supported by the fired retractor pretensioner that restricted the safety belt in the stowed position, taut against the B-pillar.

The second and third row safety belt systems were configured with sliding latch plates and retracted on ELR/ALR's. The second row center safety belt was integrated into the seatback. The second row occupants did not use the safety belts in the subject crash, which was supported by the lack of loading evidence on the belt systems.

Occupant Demographics – 2004 Infiniti QX56

Driver

Age/Sex:	18-year-old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear third track
Manual Restraint Use:	Manual lap and shoulder safety belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Pronounced deceased at the crash site.

Driver Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Massive head trauma	Unknown Severity (115999.7,0)	Left roof side rail

Source – Medical Examiner

Driver Kinematics

The 18-year-old female driver of the 2004 Infiniti QX56 was seated in a presumed upright posture with the seat track adjusted to the rear third track position. The driver was restrained by the manual 3-point lap and shoulder belt system. The driver applied a sharp left steering input to regain directional control of the Infiniti as a result of the right roadside departure. This resulted in a CCW rotation of the vehicle and displaced the driver to the right. The belted status of the driver allowed for minimal right displacement. The vehicle entered a ditch, which caused the vehicle to pitch downward and to the left, deploying the left and right side canopy air bags and firing of the dual pretensioners. Due to the safety belt usage and firing pretensioners, the driver was minimally displaced by this event.

As the Infiniti ascended the backside of the ditch, the suspension compressed forcing the vehicle to move downward creating a vertical direction of force. The driver responded to the down force by loading the seat cushion. The front corner of the Infiniti struck a large tree resulting in the deployment of the frontal air bag system. The driver initiated a forward trajectory in response to the 12 o'clock direction of force; however, her forward movement was minimal due to the safety belt usage and fired pretensioners.

The corner impact allowed the vehicle to continue forward and engage the tree with the left side. The left side contact commanded the deployment of the left seatback mounted side impact air bag. The tree crushed the passenger compartment at the area of the A-pillar and displaced the left A-pillar and left roof area, left instrument panel and steering column rearwards and laterally right. These intruding components reduced the driver's space. The intruding steering wheel caused the driver to load through the frontal air bag and deform the steering wheel rim. Additionally, the reduction in the driver's space allowed for the A-pillar and left roof area to be in close proximity to the driver's head. Due to the intrusion of the left A-pillar and left roof area, the driver contacted the roof at the junction of the A-pillar with her head. The driver sustained massive head trauma and was pronounced deceased at the crash site.

Front Right Occupant Demographics

Age/Sex:	18-year-old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear third track
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a trauma center for treatment

Front Right Occupant Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Unknown	Unknown	Unknown

Front Right Occupant Kinematics

The 18-year-old male occupant was seated in a presumed upright posture in the front right seat and was not restrained by the 3-point manual safety belt system. The left steering maneuver displaced this unbelted occupant to the right, which probably resulted in loading of the right front door panel. Although this loading was not supported by evidence, the unrestrained occupant was most likely displaced into the right front door. The unrestrained front right occupant bottomed out into the seat as the vehicle entered the ditch and then rebounded upward. As result of this movement, the EDR detected a child occupant in this seating position.

The vehicle struck a signpost with the frontal aspect, which was minor and probably resulted in no forward displacement of this occupant. As the vehicle climbed the backside of the ditch, the suspension compressed which produced a vertical direction of force, which caused him to respond in a downward trajectory. The downward movement returned him to the right front seat, to a presumed upright posture. The vehicle struck a large diameter tree with the front left corner, which caused the occupant to respond to the 12 o'clock direction of force. He contacted and loaded the frontal air bag, which prevented him from possible contact with the interior components. He sustained moderate injuries and was transported to a local trauma center where he was treated and released.

Rear Left Occupant Demographics

Age/Sex:	17-year-old female
Height:	163 cm (64")
Weight:	50 kgs (110 lbs)
Seat Track Position:	Rear third track
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a trauma center admitted for treatment

Rear Left Occupant Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Bilateral pulmonary with acute respiratory distress syndrome	Severe (441410.4,3)	Rear of front left seat back
Grade IV splenic laceration with devasculized left kidney	Severe (544226.4,2)	Rear of front left seat back
Grade III open left femur fracture, comminuted mid-shaft	Serious (851814.3,2)	Rear of front left seat back
Fracture of the left side of L-1 transverse process	Moderate (650620.2,8)	Left rear door
Comminuted fracture of the nasal bone	Moderate (251004.2,4)	Rear of front left head restraint
11 cm (4.5”) gapping laceration into the right thigh muscle	Minor (890602.1,1)	Unknown
4 cm (1.5”) laceration to the bridge of the nose	Minor (290602.1,4)	Rear of front left head restraint
Laceration to the upper lip	Minor (290602.1,8)	Rear of front left head restraint
4 cm (1.5) laceration to the right side of face (cheek)	Minor (290602.1,1)	Rear of front left head restraint
Laceration to the right elbow	Minor (790602.1,1)	Unknown
Left renal laceration, NFS	Minor (541620.1,2)	Left rear door
Left eyelid contusion	Minor (297402.1,2)	Rear of front left head restraint
Abrasions to the right and left side of face (cheeks)	Minor (290202.1,1) (290202.1,2)	Rear of front left head restraint

Source – Medical records

Rear Left Occupant Kinematics

The 17-year-old female occupant was seated in the rear left position and was not restrained by the vehicle’s belt system. She was presumed to be seated in an upright posture. At the onset of the crash phase, the driver’s aggressive left steering maneuver resulted in this occupant to be displaced laterally right. The 17-year-old female probably contacted the rear right occupant, which stopped her trajectory and prevented her from possible contact with the right side components. The Infiniti entered the ditch and the left front of the vehicle pitched downward which produced a vertical downward movement of this occupant.

The Infiniti struck a wooden signpost with the front aspect; however, this impact was minor and did not produce forward motion of this occupant. Additionally, the front left corner of the vehicle struck a large tree, which resulted in a 12 o'clock direction of force. The 17-year-old female responded to the 12 o'clock direction of force and was displaced forward. Although, not supported by physical evidence the 17-year-old female contacted and loaded the rear of the driver's seat back and head restraint during the forward trajectory, which resulted in the following injuries: bilateral pulmonary with acute respiratory distress syndrome, grade four splenic laceration with devasculized left kidney, grade three open left femur fracture, comminuted mid-shaft, comminuted fracture of the nasal bone, 4 cm (1.5") laceration to the bridge of the nose, laceration to the upper lip, left eyelid contusion, and abrasions to the right and left side of face (cheeks).

The 17-year-old female rebounded into the left rear door as the vehicle rotated counter clockwise away from the tree impact. This contact resulted in the fracture of the left side of L-1 transverse process and the left renal laceration.

She also sustained the following injuries in which the sources could not be identified: 11 cm (4.5") gapping laceration into the right thigh muscle, laceration to the right elbow. The rear left occupant was transported to a local hospital where she was treated and released 16 days post-crash.

Rear Right Occupant Demographics

Age/Sex:	17-year-old male
Height:	180 (71")
Weight:	73 kgs (160 lbs)
Seat Track Position:	Not adjustable
Manual Restraint Use:	None used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a trauma center admitted for treatment

Rear Right Occupant Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Multiple posterior left side rib fractures 6-10, multiple ribs are displaced with small left side pneumothorax and hemothorax	Severe (450252.4,2)	Rear of front right seat back
Bilateral mid and lower lobe lung contusions	Severe (441410.4,3)	Rear of front right seat back
Grade III spleenic laceration	Serious (544224.3,2)	Rear of front right seat back
Abrasions to the right lower back	Minor (690202.1,8)	Right rear door

Injury	Injury Severity AIS90/Update 98	Injury Source
3 cm (1.2”) laceration of the right forehead	Minor (290602.1,7)	Rear of front right head restraint
Bilateral lower leg abrasions	Minor (890202.1,1) (890202.1,2)	Rear of front right seat back
Posterior right shoulder abrasions	Minor (790202.1,1)	Right rear door
Right hand abrasion	Minor (790202.1,1)	Rear of front right seat back
Left elbow abrasion	Minor (790202.1,2)	Rear of front right seat back

Source – Medical records

Rear Right Occupant Kinematics

The 17-year-old male occupant was seated in a presumed upright posture in the rear right seat and was not restrained by the 3-point manual safety belt system. The left steering maneuver displaced this unbelted occupant to the right, which probably resulted in loading of the rear right door panel. This contact was not supported by evidence; however, his unbelted status and lateral trajectory most likely displaced him into the rear right door. As the vehicle entered the ditch, he displaced downward and bottomed out into the vehicle seat.

The vehicle struck a signpost with the frontal aspect, which was minor and probably resulted in no forward displacement of this occupant. The large tree impact with the front left corner caused the occupant to respond to the 12 o’clock direction of force. He contacted the rear of the right front seatback and head restraint which resulted in the following injuries: multiple posterior left side rib fractures 6-10, with small left side pneumthorax and hemothorax, bilateral mid and lower lobe lung contusions, grade three spleenic laceration, 3 cm (1.2”) laceration of the right forehead, abrasions to the lateral upper anterior left thigh, bilateral lower leg abrasions, right hand abrasion, and the left elbow abrasion.

As the vehicle rotated counter clockwise away from the tree, the 17-year-old male rebounded and contacted the right rear door resulting in the posterior right shoulder abrasions and the abrasions to the right lower back He was transported to a local trauma center where he was treated and released four days post-crash.

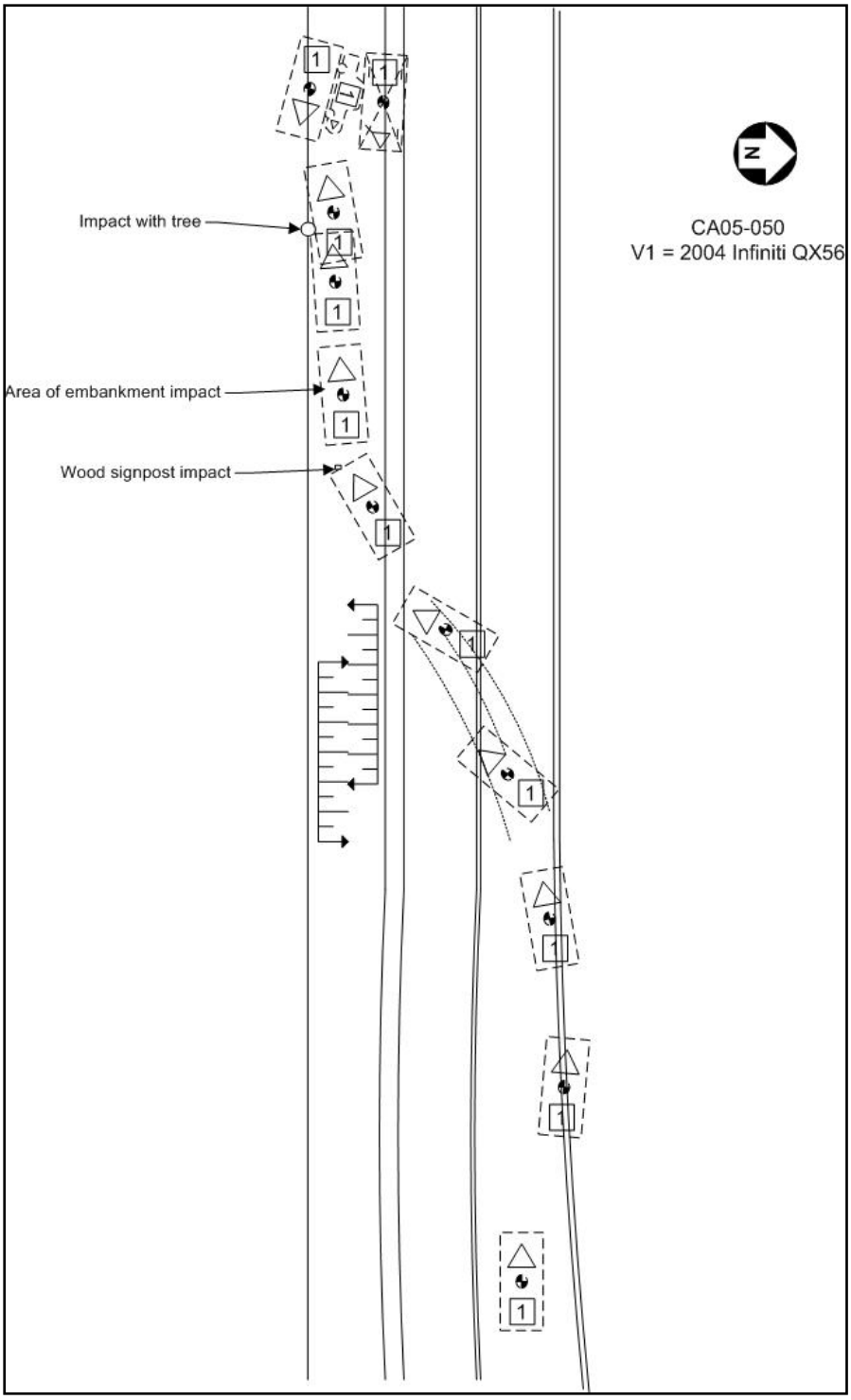

Figure 12. Scene schematic