

CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION

SCI CASE NO.: CA09020

VEHICLE: 2009 MITSUBISHI GALANT ES

LOCATION: NORTH CAROLINA

CRASH DATE: MARCH 2009

Contract No. DTNH22-07-C-00043

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

<p><i>1. Report No.</i> CA09020</p>	<p><i>2. Government Accession No.</i></p>	<p><i>3. Recipient's Catalog No.</i></p>	
<p><i>4. Title and Subtitle</i> Calspan Remote Rollover Crash Investigation Vehicle: 2009 Mitsubishi Galant ES Location: State of North Carolina</p>		<p><i>5. Report Date:</i> April 2010</p>	
		<p><i>6. Performing Organization Code</i></p>	
<p><i>7. Author(s)</i> Crash Data Research Center</p>		<p><i>8. Performing Organization Report No.</i></p>	
<p><i>9. Performing Organization Name and Address</i> Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225</p>		<p><i>10. Work Unit No.</i></p>	
		<p><i>11. Contract or Grant No.</i> DTNH22-07-C-00043</p>	
<p><i>12. Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p><i>13. Type of Report and Period Covered</i> Technical Report Crash Date: March 2009</p>	
		<p><i>14. Sponsoring Agency Code</i></p>	
<p><i>15. Supplementary Note</i> This on-site investigation focused on a rollover crash that involved a 2009 Mitsubishi Galant ES four-door sedan.</p>			
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<p><i>17. Key Words</i> Certified Advanced 208-Compliant (CAC) Rollover Inflatable Curtain (IC) 2009 Mitsubishi Galant ES Minor Injuries</p>		<p><i>18. Distribution Statement</i> General Public</p>	
<p><i>19. Security Classif. (of this report)</i> Unclassified</p>	<p><i>20. Security Classif. (of this page)</i> Unclassified</p>	<p><i>21. No. of Pages</i> 13</p>	<p><i>22. Price</i></p>

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CALSPAN ON-SITE ROLLOVER CRASH INVESTIGATION
SCI CASE NO.: CA09020
VEHICLE: 2009 MITSUBISHI GALANT ES
LOCATION: NORTH CAROLINA
CRASH DATE: MARCH 2009

BACKGROUND

This on-site investigation focused on a rollover crash that involved a 2009 Mitsubishi Galant ES four-door sedan (**Figure 1**). The vehicle was equipped with four-wheel anti-lock brakes, a Certified Advanced 208-Compliant frontal air bag system (CAC), side impact air bags located in the front seat backs, and Inflatable Curtain (IC) air bags. The Mitsubishi, occupied by four adults, departed the roadway to the right and rotated counterclockwise before rolling over and coming to rest on its wheels. The frontal air bags, the front right side impact air bag, and the IC air bags



Figure 1. 2009 Mitsubishi Galant case vehicle

on both sides deployed. The Mitsubishi was occupied by a 20-year-old female driver, 19-year-old female front right passenger, a 21-year-old female rear left passenger, and an 18-year-old female rear right passenger. All occupants were restrained by the manual safety belt systems. The driver and rear seat passengers were transported by ambulance to a regional hospital where they were treated in the emergency department for minor severity injuries and released. The front right passenger sustained a pulmonary contusion and was admitted for treatment.

The crash was identified through a visit to a regional salvage facility on March 30, 2009. The police report was obtained using information from the insurance company that transferred the Mitsubishi to the salvage yard. Based on the rollover of the late model year vehicle and the deployment of the IC air bags, this case was assigned for on-site investigation on March 30, 2009. The on-site investigation was conducted on April 1-3, 2009, and involved the inspection and documentation of the Mitsubishi and the crash site, an interview with relatives of the driver and rear left and right passengers of the vehicle, and an interview with a representative of the rental company that owned the vehicle. The driver of the vehicle refused to be interviewed.

SUMMARY

Crash Site

This crash occurred during the evening hours of March 2009 on the east road side of a two-lane north/south roadway. Police reported conditions were clear, dry and dark. The area was not lighted. Traveling north, the roadway curved to the left with a radius of curvature of 325 m (1066 ft). The traffic lanes were 3.6 m (11.8 ft) in width and were surfaced with asphalt. The east and west lanes were bordered with narrow asphalt shoulders that were 1 m (3.3 ft) in width. The posted speed limit on this section of roadway was 72 km/h (45 mph). There was an asphalt surfaced commercial driveway on the east side of the roadway that was 10.2 m (33.5 ft) in width. The south road edge of this driveway formed the Reference Point (RP) of the scene reconstruction. The roadway transitioned to a divided

roadway with a painted flush median 48.1 m (157.8 ft) south of the RP. This painted median transitioned to a raised concrete median 33.1 m (108.6 ft) north of the RP. South of the RP, the roadside consisted of a grassy ditch area. The center of the ditch was 4.6 m (15.1 ft) east of the east road edge. This area had a negative grade of -28 percent. North of the driveway, the east roadside consisted of a grassy field that was 28.7 m (94.2 ft) in width and greater than 100 m (328 ft) in length. This field was level. The Crash Schematic is included as **Figures 10** and **11** of this report.

Vehicle Data

2009 Mitsubishi Galant

The case vehicle was a 2009 Mitsubishi Galant ES four-door sedan. The vehicle was manufactured in May of 2008 and was identified by the Vehicle Identification Number (VIN) 4A3AB36FX9E (production number deleted). The vehicle was a short-term rental car. The front-wheel drive Mitsubishi was powered by a 2.4-liter inline-four cylinder engine linked to a four-speed Sportronic automatic transmission. The service brakes consisted of power-assisted four-wheel disc brakes with anti-lock and electronic brake force distribution. The Mitsubishi was also equipped with a Tire Pressure Monitoring System (TPMS). All windows were closed at the time of the crash. The windshield was OEM AS-1 laminated glass. The side and backlight glazing were AS-2 tempered glass. The Mitsubishi was equipped with four matching Yokohama Radial 376 tires with a Tire Identification Number (TIN) of FDF1 NTY 0808. The tire size was the manufacturer recommended P215/60R16. The tires were mounted on OEM multi-spoke alloy wheels. The manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and rear tires. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left Front	Flat	5 mm (6/32 in)	De-beaded
Left Rear	179 kPa (26 PSI)	6 mm (7/32 in)	None
Right Rear	152 kPa (22 PSI)	6 mm (7/32 in)	None
Right Front	Flat	5 mm (6/32 in)	De-beaded

The interior of the Mitsubishi was configured with cloth surfaced five-passenger seating. The front bucket seats were separated by a center console and equipped with adjustable head restraints. The left head restraint was in the full-down position. The right head restraint was found 13 cm (5.1 in) above the full-down position. The second row seat was a bench with folding back. The rear outboard seating positions were equipped with integral head restraints.

The interior occupant safety systems consisted of three-point lap and shoulder belts for the five designated positions, front safety belt pretensioners (retractor mounted), dual stage frontal air bags, front seat back mounted side impact air bags and IC air bags that provide protection to the four outboard seating positions.

Crash Sequence

Pre-Crash

The restrained 20-year-old female driver of the Mitsubishi was traveling in a northeast direction on the two-lane roadway and entered a curve to the left (**Figure 2**). The

Mitsubishi was traveling at a police estimated speed of 145 km/h (90 mph). The vehicle departed the right side of the roadway at a shallow departure angle. The Mitsubishi traveled for approximately 155 m (508.5 ft) on the roadside, gradually entering the ditch and yawing approximately 10 degrees counterclockwise as it approached a culvert for the commercial driveway.



Figure 2: Mitsubishi's pre-crash trajectory



Figure 3: Start of rollover evidence on ground

Crash

The right side tires of the Mitsubishi furrowed into the ditch bank and the undercarriage of the vehicle impacted the sloped culvert embankment. This impact tripped the Mitsubishi in to a right side leading rollover as the vehicle vaulted the driveway. While airborne, the Mitsubishi continued rotating counterclockwise as it continued to roll to the right. The Mitsubishi impacted the ground 23.9 m (78.7 ft) from the vault point with the rear aspect of its right side. At this point, the vehicle yawed approximately 50 degrees counterclockwise. The Mitsubishi continued to roll to the right along the grass roadside for a distance of 49 m (160.8 ft) completing 12-quarter turns (**Figure 3**). The Mitsubishi came to rest on its wheels facing in a westerly direction.

The crash sequence actuated the front safety belt pretensioners and deployed the driver and front right passenger's CAC air bags. The front right side impact air bag and the IC air bag also deployed. The front left side impact air bag did not deploy.

Post-Crash

Following the crash, the driver retrieved her cellular phone and called the 9-1-1 emergency response system to report the crash. Police, emergency medical personnel and a tow operator responded to the crash site. The driver and passengers exited the vehicle unassisted prior to the arrival of the first responders. All four occupants were transported by ground ambulance to a regional hospital for treatment of their injuries.

Vehicle Damage

Exterior Damage

The exterior of the Mitsubishi sustained moderate severity damage to the top, left and right side planes, and minor severity damage to the undercarriage as a result of this multiple impact/rollover crash. The first impact was to the undercarriage as the Mitsubishi traveled up the culvert wall out of the ditch and became airborne. The damage was limited to the frontal area of the undercarriage and extended left to right. The Collision Deformation Classification (CDC) assigned to this impact was 00-UFDW-1.

The rollover damage consisted of scratches to the roof and sides that were oriented in multiple directions, indicating that the vehicle had rotated during the rollover. The maximum crush locations for lateral and vertical crush were located at the same point on the greenhouse area, the junction of the left C-pillar and backlight header. The maximum vertical crush to the roof was 10 cm (3.9 in). The maximum lateral deformation was 6 cm (2.8 in). The direct contact damage across the roof was 112 cm (44.1 in), extending from side rail to side rail. The longitudinal contact damage extended from the front right corner to the rear right corner, a distance of 445 cm (175.2 in). **Figures 4 and 5** depict the rollover damage sustained by the Mitsubishi. The CDC assigned for this impact was 00-TDDO-3.



Figure 4: Maximum rollover crush to greenhouse



Figure 5: Rollover damage from top left

Other exterior damage occurred to the hood and top body panel. The hood latch released and the frame of the hood was displaced longitudinally into the windshield during the rollover resulting in a 10 cm by 4 cm (3.9 in by 1.6 in) hole in the windshield. The outer sheet metal skin of the hood separated from the vehicle and was unavailable for inspection. The spot welds at the rear aspect of the roof panel at the side rail separated. This resulted in a 43 cm (16.9 in) separation of the metal roof body panel from the roof side rail (**Figure 6**).



Figure 6: Partial separation of roof body panel

Interior Damage

The Mitsubishi sustained moderate severity interior damage that was attributed to occupant contact and passenger compartment intrusion. The driver's loading force was transmitted through the deployed frontal air bag and into the steering wheel rim resulting in 4 cm (1.6 in) of deformation of the upper half of the steering wheel rim. There was no compression of the steering column.

The front left sun visor was separated from the support bar with hair on this support bar. There was a scuff with hair located on the left roof headliner located 4 to 9 cm (1.6 to 3.5 in) above the roof side rail and 9 to 21 cm (3.5 to 8.3 in) forward of the rear attachment point of the front left passenger assist handle. The rear lower quadrant of the left front

door was scuffed and smeared with body fluid on the left armrest, located 16 to 27 cm (6.3 to 10.6 in) forward of the aft end of the armrest.

The upper quadrant of the rear left door panel was scuffed 14 to 23 cm (5.5 to 9.1 in) forward of the rear edge of the door and 4 to 14 cm (1.6 to 5.5 in) above the top edge of the armrest. The headliner was scuffed 29 to 62 cm (11.4 to 24.4 in) aft of the B-pillar and 2 to 28 cm (0.8 to 11 in) above the bottom edge of the roof side rail.

The rear upper quadrant of the right rear door panel was scuffed 3 to 16 cm (1.2 to 6.3 in) above the top edge of the armrest and 42 to 61 cm (16.5 to 24 in) rearward of the B-pillar. The aft end of the armrest was cracked extending forward 8 cm (3.1 in).

The intrusion to the interior of the Mitsubishi is listed on the following table:

Position	Component	Direction	Magnitude
Row 1 left	A-pillar	Lateral	6 cm (2.4 in)
Row 1 left	B-pillar	Lateral	6 cm (2.4 in)
Row 1 left	Roof side rail	Lateral	5 cm (2 in)
Row 2 left	Roof side rail	Lateral	6 cm (2.4 in)
Row 1 left	Roof side rail	Vertical	10 cm (3.9 in)
Row 2 left	Roof side rail	Vertical	10 cm (3.9 in)
Row 2 left	C-pillar	Lateral	6 cm (2.4 in)
Row 1 left	Roof	Vertical	10 cm (3.9 in)
Row 2 left	Roof	Vertical	10 cm (3.9 in)
Row 2 right	Roof side rail	Lateral	4 cm (1.6 in)
Row 2 right	C-pillar	Lateral	6 cm (2.4 in)

Manual Safety Belt Systems

The Mitsubishi was equipped with manual three-point lap and shoulder belts for the five designated seating positions. All belt systems utilized continuous loop webbing with sliding latch plates. The driver's belt retracted onto an Emergency Locking Retractor (ELR) with a retractor pretensioner. The upper D-ring was height adjustable and was set to the full-down position. The driver was using the safety belt at the time of the crash, which was supported by loading evidence and body fluid on the belt webbing. The loading evidence consisted of a frictional abrasion near the latch plate. Specifically, the abrasion was located 72 to 76 cm (28.3 to 29.9 in) above the floor anchor. The body fluid was located 97 to 127 cm (38.2 to 50 in) above the floor anchor. Additionally, the retractor pretensioner locked the safety belt in the worn position. The total length of spooled out webbing measured 184 cm (72.4 in).

The front right belt retracted onto a switchable ELR/Automatic Locking Retractor (ALR) with a retractor pretensioner. The upper D-ring was height adjustable and was set to the full-down position. The front right passenger was using the safety belt at the time of the crash, which was supported by loading evidence on the belt webbing. This evidence consisted of a frictional abrasion near the latch plate. Specifically, the abrasion was located 71 to 77 cm (28 to 30.3 in) above the floor anchor. Additionally, the actuated retractor pretensioner locked the safety belt in the used position. The total length of spooled out webbing measured 157 cm (61.8 in).

The rear left belt retracted onto a switchable ELR/ALR retractor. There was no height adjustment to the belt in this seating position. The rear left passenger was using the belt at the time of the crash, which was supported by occupant contact evidence on the belt webbing. This evidence consisted of body fluid on the belt webbing. Specifically, the body fluid was located 65 to 75 cm (25.6 to 29.5 in) above the lower seat attachment of the belt. There was no pretensioner present, but the belt appeared to be locked in the used position. The total length of spooled out webbing measured 148 cm (58.3 in).

The rear right belt retracted onto a switchable ELR/ALR retractor. There was no height adjustment to the belt in this seating position. The rear right passenger was using the belt at the time of the crash, which was supported by occupant contact evidence on the belt webbing. This evidence consisted of a frictional abrasion on the belt webbing. The abrasion was located 107 to 124 cm (42.1 to 48.8 in) above the lower seat attachment of the belt. There was no pretensioner present, but the belt appeared to be locked in the used position. The total length of spooled out webbing measured 157 cm (61.8 in).

The rear center belt retracted into a switchable ELR/ALR retractor. There was no height adjustment to the belt at this seating position. This position was not occupied at the time of this crash.

Frontal Air Bag System

The Mitsubishi was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system. The CAC system includes dual-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, retractor pretensioners, and a front right occupant presence sensor. The manufacturer of the Mitsubishi has certified that the vehicle is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) Number 208. The driver's air bag was concealed within the center hub of a four-spoke steering wheel by two asymmetrical cover flaps. The top flap was



Figure 7: Deployed driver's frontal air bag

13 cm (5.1 in) in width at the horizontal tear seam and 8 cm (3.1 in) in height. The lower flap measured 13 cm (5.1 in) in width at the horizontal tear seam and 6 cm (2.4 in) in height. The air bag membrane (**Figure 7**) measured 56 cm (22 in) in diameter in its deflated state. The air bag was vented by two vent ports located at the 11 and 1 o'clock positions. The air bag was tethered by two tethers located at the 9 and 3 o'clock positions of a 13 cm (5.1 in) diameter tether seam located at the center of the face of the membrane. There were no occupant contact on the air bag; however there was a vertically oriented plastic-type deployment transfer that was 9 cm (3.5 in) in width located on the upper rear of the membrane, 6 to 11 cm (2.4 to 4.3 in) above the top cover flap.

The front right air bag was mounted within the top aspect of the right instrument panel and was concealed by two symmetrical cover flaps. The flaps were 22 cm (8.7 in) in width and 7 cm (2.8 in) in height. The air bag membrane was rectangular in shape and measured 50 cm (19.7 in) in width and 40 cm (15.7 in) in height in its deflated state. The air bag was

vented by two vent ports located at the 10 and 2 o'clock positions and was not tethered. The face of the bag was marked with the following nomenclature:

GA220-00450C
SE8005 989

There were no occupant contact points on the front right air bag.

Side Impact Air Bag System

The Mitsubishi was equipped with front seat back mounted side impact air bags and roof side rail mounted IC air bags. The front right seat back air bag and both IC air bags deployed during the crash sequence.

The front right side air bag deployed from the upper outboard aspect of the front right seat back. The area it deployed from began at the bottom of the seat back and extended upward 41 cm (16.1 in) and began at the forward edge of the seat back and extended rearward 12 cm (4.7 in). The membrane measured 20 cm (7.9 in) in width and 41 cm (16.1 in) in height. The air bag was vented by a single vent port located at the three o'clock forward position. The air bag was not tethered. There was no occupant contact to the air bag.

The IC air bags deployed from their respective roof side rails. The IC air bags measured 148 cm (58.3 in) in length. At the front seating positions, the membrane measured 44 cm (17.3 in) in height and 42 cm (16.5 in) in height at the rear seating positions. Both IC air bags were tethered to the A-pillars by a 28 cm tether strap. The IC air bags provided coverage vertically to a level below the belt line at all outboard seating positions. The IC air bags provided coverage from the A-pillar to the C-pillar. There was a void at the A-pillar area resulting in a triangular opening that was 45 cm (17.7 in) in length, 33 cm (13 in) in height at the forward edge of the curtain, and 15 cm (5.9 in) in height at the forward edge of the A-pillar.

There was a scuff mark on the left IC air bag located 14 to 23 cm (5.5 to 9.1 in) above the lower edge of the membrane and 23 to 36 cm (9.1 to 14.2 in) from the rear edge of the membrane. There was a scuff on the right IC air bag located 12 to 22 cm (4.7 to 8.7 in) above the lower edge of the membrane and 19 to 27 cm (7.5 to 10.6 in) from the rear edge of the membrane. There was no damage to the IC air bags. It was probable that the deployed IC air bags prevented the potential partial ejection of an occupant's head and/or upper extremity. **Figures 8 and 9** depict the IC air bags.



Figure 8: Left IC air bag



Figure 9: Right IC air bag

Occupant Demographics/Data

Driver

Age/Sex: 20-year-old/Female
Height: 168 cm (66 in)
Weight: 91 kg (200 lb)
Eyewear: None
Seat Track Position: Mid track
Manual Safety Belt
Use: Three-point lap and shoulder belt
Usage Source: Vehicle inspection
Egress from Vehicle: Exited unassisted
Mode of Transport
From Scene: Ambulance
Type of Medical Treatment: Treated at a local hospital and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
3 cm full thickness Left elbow laceration	Minor (790602.1,2)	Left front door panel – forward upper quadrant
Deep abrasion of the left elbow	Minor (790202.1,2)	Left front door panel – forward upper quadrant
Anterior neck abrasion	Minor (390202.1,5)	Shoulder belt webbing
Cervical strain	Minor (640278.1,6)	Impact force
Scalp contusion	Minor (190402.1,9)	Unknown
Facial contusion	Minor (290402.1,9)	Unknown

Source –Emergency room records and Interview data

Driver Kinematics

The 20-year-old female driver was seated in a mid-track position and was restrained by a manual three-point lap and shoulder belt system. She was operating the vehicle while under the influence of alcohol with a hospital reported BAC of .23. During the crash, the driver's frontal and left IC air bags deployed and the safety belt pretensioner actuated. During the events, the driver initiated a forward trajectory and loaded the manual safety belt system. As a result of belt loading, the driver sustained an abrasion of the anterior neck. She loaded the deployed air bag and compressed the air bag against the steering wheel, deforming the upper half of the rim 4 cm (1.6 in) forward. Her head impacted the sunvisor, evidenced by hair transfer and separation of the visor from the mounting stalk. Her head also impacted the left roof side rail as evidenced by hair transfer. The driver sustained a scalp contusion; however, the specific location of the contusion was unknown. The source of this contusion could not be determined.

The driver's motion during this 12-quarter turn rollover event resulted in cervical strain as her body was restrained by the manual safety belt system. The driver contacted the left front door panel resulting in a 3 cm laceration and deep abrasion to her left elbow. She also loaded the center console and possibly contacted the front right passenger. The driver sustained an unspecified abrasion of the face that was attributed to an unknown source.

As the Mitsubishi came to rest, the driver unbuckled the safety belt system and exited the vehicle unassisted. She was subsequently transported by ground ambulance to a local hospital where she was treated for her minor severity injures and released.

Front Right Passenger

Age/Sex: 19-year-old/Female
 Height: 178 cm (70 in)
 Weight: 79 kg (175 lb)
 Eyewear: None
 Seat Track Position: Full-rear track
 Manual Safety Belt Use: Three-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Egress from Vehicle: Exited unassisted
 Mode of Transport From Scene: Ambulance
 Type of Medical Treatment: Admitted to a local hospital for treatment of her injuries
 Length of Hospitalization: Unknown

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Small right mid lobe pulmonary contusion	Serious (441406.3,1)	Shoulder belt webbing
Right forearm abrasion	Minor (790202.1,1)	Front right door panel – forward upper quadrant
Right arm contusions	Minor (790402.1,1)	Front right door panel – rear upper quadrant
Contusion across lower abdomen	Minor (590402.1,4)	Safety belt webbing
16 cm (6 in) contusion on right knee	Minor (890402.1,1)	Front right door panel – forward lower quadrant

Source –Emergency room records and Interview data

Front Right Passenger Kinematics

The 19-year-old female front right passenger was seated in a full-rear track position and was restrained by a manual three-point lap and shoulder belt system. During the crash sequence, the passenger’s frontal air bag, the right seat back mounted side impact air bag, and the right IC air bag deployed. Additionally, the retractor pretensioner actuated. The front right passenger loaded the safety belt webbing during the crash. Her loading force against the belt webbing resulted in a right pulmonary contusion and contusions across the anterior abdomen. Her right arm contacted the door panel resulting in contusions and abrasions of the arm. She also sustained a large contusion of the right knee from probable contact with the right door panel. There was no evidence of contact to the door panel.

Following the crash, the front right passenger exited the vehicle unassisted. She was transported by ground ambulance to a local hospital where she was admitted for treatment of her pulmonary contusion.

Rear Left Passenger

Age/Sex: 21-year-old/Female
 Height: 173 cm (68 in)
 Weight: 73 kg (160 lb)
 Eyewear: None
 Manual Safety Belt Use: Three-point lap and shoulder belt
 Usage Source: Shoulder belt webbing
 Egress from Vehicle: Exited unassisted
 Mode of Transport
 From Scene: Ambulance
 Type of medical treatment: Treated at a local hospital and released

Rear Left Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Cervical strain	Minor (640278.1,6)	Headliner/roof side rail
Thoracic strain	Minor (640478.1,6)	Headliner/roof side rail
Right hand abrasion	Minor (790202.1,1)	Right rear occupant
Left side facial contusion	Minor (290402.1,2)	Left IC air bag
Right lower arm contusion	Minor (790402.1,1)	Rear right occupant

Source - Emergency room records and Interview data

Rear Left Passenger Kinematics

The 21-year-old female rear left passenger was restrained by a manual three-point lap and shoulder belt system. During the crash sequence, the left IC air bag deployed. She responded to the rollover crash forces by loading the safety belt system. During the rollover, the passenger’s head contacted the roof side rail and the headliner. This loading force probably resulted in the cervical and thoracic strain. The left aspect of her face contacted the IC air bag resulting in the soft tissue contusion of the left face. The passenger’s left arm and torso loaded the left rear door panel. Her right arm flailed and struck the rear right passenger resulting in the contusion of the right forearm and abrasion to her right hand.

Post-crash, the rear left passenger unbuckled her safety belt system and exited the vehicle unassisted. She was transported by ground ambulance to a local hospital where she was treated in the emergency room and released.

Rear Right Passenger

Age/Sex: 18-year-old/Female
Height: 173 cm (68 in)
Weight: 73 kg (160 lb)
Eyewear: None
Manual Safety Belt Use: Three-point lap and shoulder belt
Usage Source: Vehicle inspection
Egress from Vehicle: Exited unassisted
Mode of Transport
From Scene: Ambulance
Type of Medical Treatment: Treated at a local hospital and released

Rear Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Cervical strain	Minor (640278.1,6)	Impact force
Thoracic strain	Minor (640478.1,6)	Impact force
Lumbar strain	Minor (640678.1,6)	Impact force
Left dorsal hand abrasion	Minor (790202.1,2)	Disintegrated glazing
Left hand superficial laceration	Minor (790602.1,2)	Disintegrated glazing

Source - Emergency room records

Rear Right Passenger Kinematics

The 18-year-old female rear right passenger was restrained by the manual three-point lap and shoulder belt system. During the crash sequence, the right IC air bag deployed. The rear right passenger responded to the rollover dynamics and loaded the safety belt webbing. Her right torso arm areas contacted the right door panel and her face/head loaded the deployed IC air bag.

As the vehicle continued to roll, the rear right passenger continued to load the safety belt system. Additionally, she loaded the right aspect of the headliner immediately above the right roof side rail. The restrained passenger sustained spinal strain of the three regions. Although these strains could not be associated with a single contact point, the strains probably resulted from the motion of the occupant and the force of the crash. The right rear passenger also sustained a superficial laceration and abrasion to her left hand from disintegrated glazing

The rear right passenger exited the vehicle unassisted. She was transported by ground ambulance to a local hospital where she was treated in the emergency department and released.

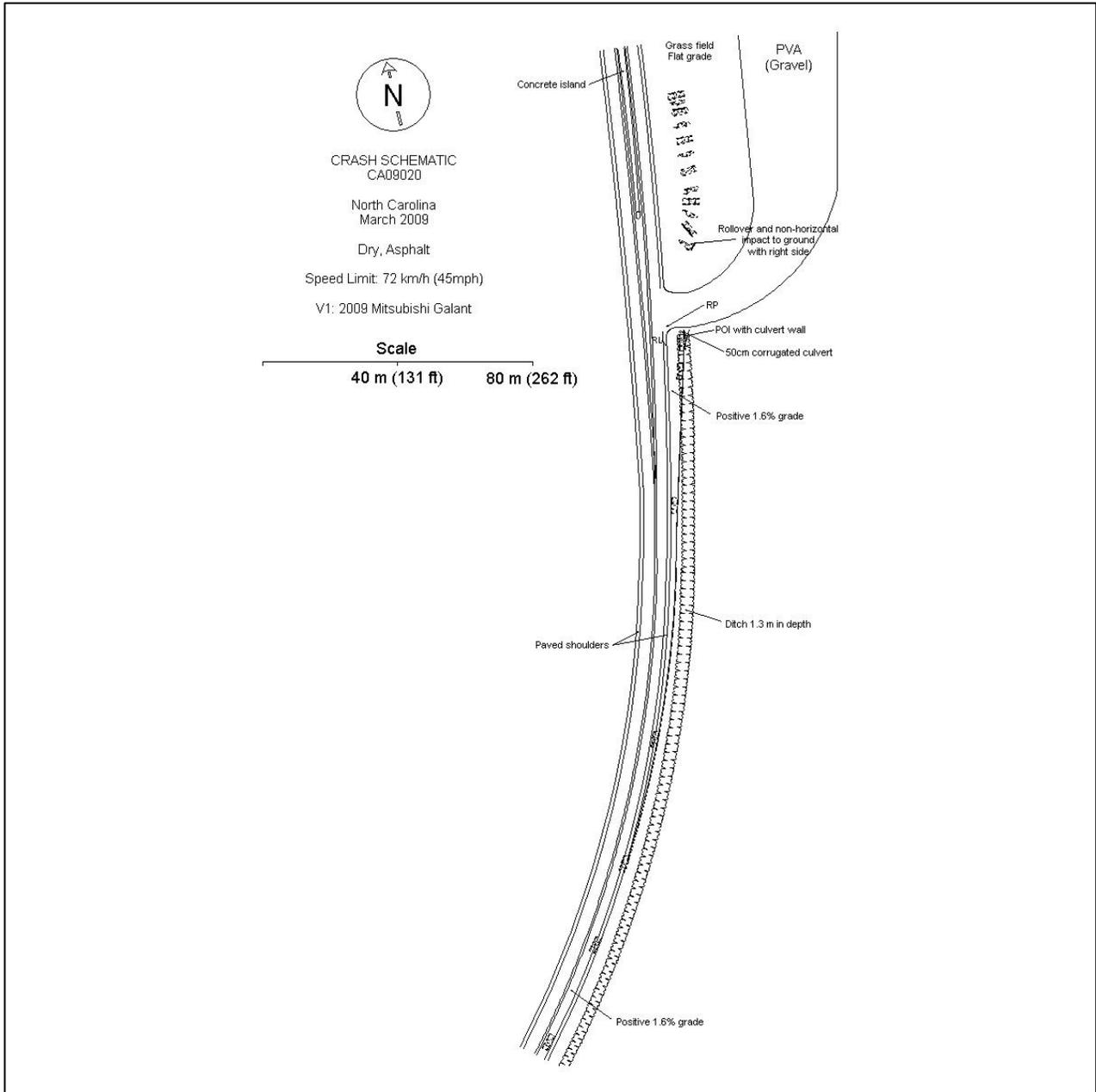


Figure 10: Crash Schematic

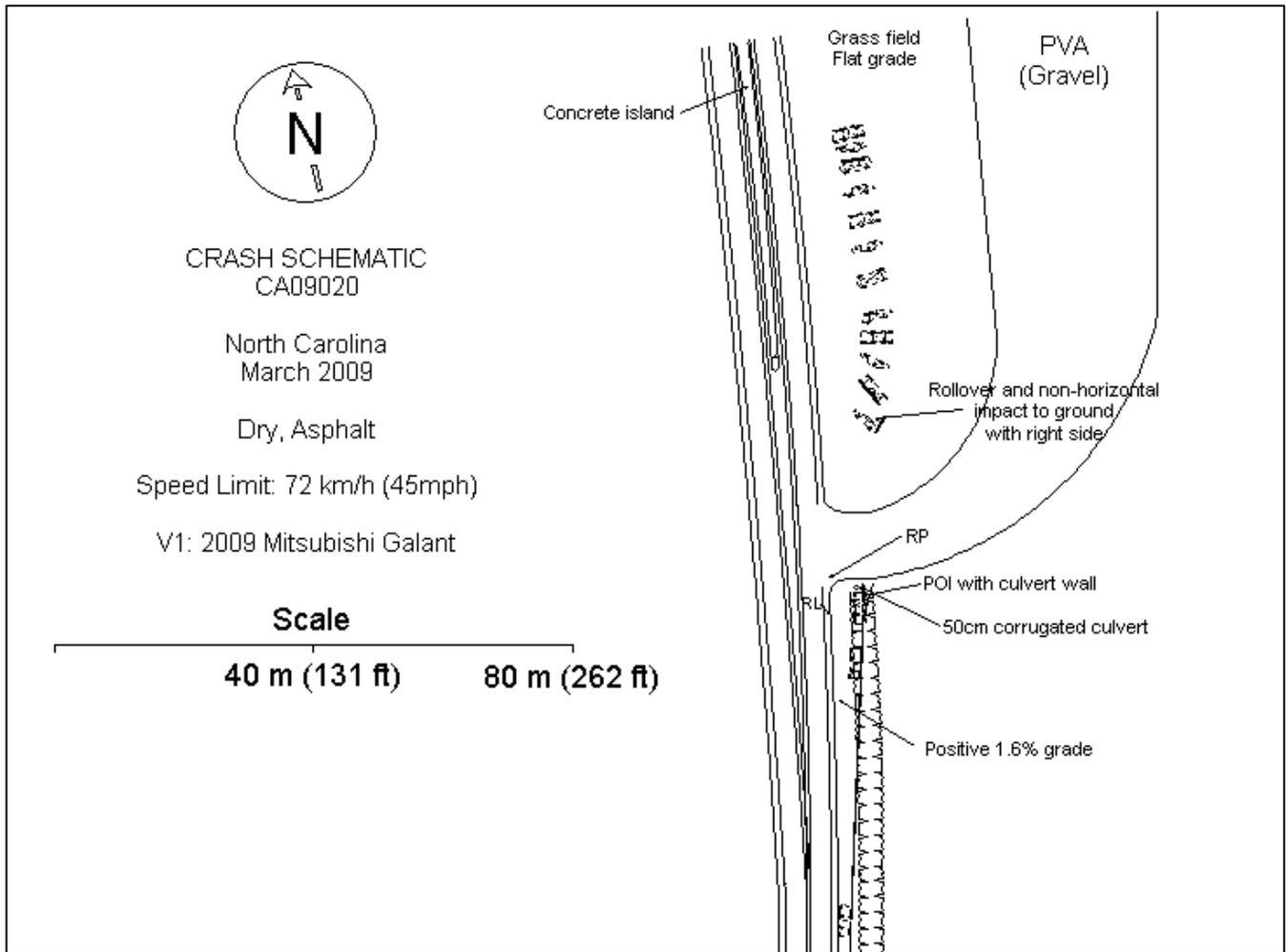


Figure 11. Crash Schematic of the Rollover Site