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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN97-032
LOCATION - OKLAHOMA
VEHICLE - 1995 MITSUBISHI GALANT S
CRASH DATE - August, 1997

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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 be 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 Documentation Page

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On-site air bag deployment investigation involving a 1995 Mitsubishi Galant S, four-door sedan, with manual safety belts and dual front air bags, and a 1992 Dodge Ram D350, commercial utility truck

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1995 Mitsubishi Galant S (case vehicle) and a 1992 Dodge Ram D350 commercial utility truck (other vehicle). This crash is of special interest because the case vehicle's unrestrained, front right passenger (2-year-old female) sustained a fatal cervical spinal cord injury from the deploying front right passenger air bag. The case vehicle was traveling south in the southbound lane of a two-lane, undivided, state roadway and was approaching a five-leg intersection. The Dodge truck had stopped in the southbound lane of the same two-lane, undivided, state roadway, intending to make a left turn; however, because of the heavy northbound traffic, it started to accelerate forward. The crash occurred in the southbound lane of the state roadway near the five-leg intersection of the three trafficways. The front of the case vehicle impacted the back of the Dodge truck, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's front right passenger was seated with her seat track located in its forward-most position, and she was not using either a child safety seat or her available, active, three-point, lap-and-shoulder, safety belt system. Based on her medical records, she sustained fatal injuries which included: a complete laceration of the upper cervical spinal cord with an atlanto-occipital and atlanto-axial dislocations; a critical nonanatomic brain injury; bilateral subdural hematomas and subarachnoid hemorrhages; contusions to her mediastinal pleura and liver; abrasions and contusions to her face, neck, and right forearm; and lacerations to her upper lip and tongue. The case vehicle's driver (50-year-old female) was seated with her seat track located in its forward-most position, and the tilt steering wheel was located between its middle and down-most positions. She was using her available, active, three-point, lap-and-shoulder, safety belt system. The case vehicle's back left passenger (9-month-old female) was seated in a rear facing child safety seat (RFCSS) and was restrained by the available harness on her child safety seat and the child seat was secured by the available, active, three-point, lap-and- shoulder, safety belt system. According to her interview and medical records, the driver sustained: abrasions to her chin and neck; contusions to her right cheek, lower abdomen, and bilateral knees; and unspecified injuries to the right shoulder and right foot. The back left passenger did not sustain any injuries as a result of the crash.

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on September 25, 1997 by a private consultant. This crash involved a 1995 Mitsubishi Galant S (case vehicle) and a 1992 Dodge Ram D350 commercial utility truck (other vehicle). The crash occurred in August, 1997, at 3:44 p.m., in Oklahoma and was investigated by the applicable city police department. This crash is of special interest because the case vehicle's unrestrained, front right passenger [2-year-old, White (non-Hispanic) female] sustained a fatal cervical spinal cord injury from the deploying front right passenger air bag. This contractor inspected the scene and vehicles on September 26,1997. This contractor interviewed the driver for the case vehicle during the first quarter of 1998. This report is based on the Police Crash Report, interviews with the State Medical Examiner's investigator and the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, state roadway and was approaching a five-leg intersection, intending to continue traveling southward. The Dodge truck had stopped in the southbound lane of the same two-lane, undivided, state roadway, intending to make a left turn. Because of the heavy northbound traffic, the Dodge truck's driver decided to continue southbound to the next intersection and started to accelerate forward. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the southbound lane of the state roadway near the five-leg intersection of the three trafficways; see **CRASH DIAGRAM** below.

The front of the case vehicle impacted the back of the Dodge truck, causing the case vehicle's driver and front right passenger supplemental restraint*s* (air bags) to deploy. The case vehicle veered slightly to its right and continued southward a short distance toward the southwest corner of the five-leg intersection before coming to rest in the center of the east-west roadway. The Dodge truck was nudged farther forward (southward), and the Dodge Ram's driver drove it over to the west shoulder post-crash. The speed limit for the state trafficway is 72 km.p.h. (45 m.p.h.). According to the Police Crash Report, at impact the case vehicle was traveling approximately 48 km.p.h. (30 m.p.h.) and the Dodge truck was traveling approximately 16 km.p.h. (10 m.p.h.).

The case vehicle's front right passenger [94 centimeters and 14 kilograms (37 inches, 31 pounds)] was not using either a child safety seat or her available, active, three-point, lap-and-shoulder, safety belt system. There was a child safety seat in the back right seating area of the case vehicle; however, a post-mortem evaluation by the applicable medical examiner's office indicated that this child safety seat was too small to have secured the front right passenger. Further, there were abrasions to the undersurface of the front right passenger's chin and anterior neck. Initially these abrasions were interpreted as belt pattern abrasions and suggested evidence of safety belt usage (i.e., torso portion); however, based on this contractor's experience in Special Crash Investigations, these abrasions were from interaction with the fabric of the deploying front right passenger's air bag. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no definite evidence of loading.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of her available safety belts, the front right passenger most likely moved forward just prior to impact. The case vehicle's impact with the Dodge truck enabled the case vehicle's front right passenger to continue forward and upward as the case vehicle decelerated. The damage on the case vehicle was primarily above the bumper resembling an underride impact pattern. The underride type damage resulted in the air bag deploying late during the sequence of the impact. This delayed deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V–i.e., ramp versus spike). The underride type damage resulted in the air bag deploying late during the sequence of the impact. This late deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V--i.e., ramp versus spike). The delayed deployment combined with the front right passenger's forward movement and her close proximity to the front right passenger's air bag module would have put this passenger easily within the excursion of the deploying air bag. The distance from this passenger's seat back to the right instrument panel was 89 centimeters (35.0 inches) while the untethered, front right air bag's outward excursion was approximately 60 centimeters (23.6 inches). The deploying front right passenger's air bag impacted this passenger in the right side of her face, just underneath her chin, across her neck, and in her chest. As a result her head was snapped backwards, and she was lifted upwards where she most likely contacted the front right sun visor with her forehead before being pushed backwards towards the right side of her seat back, the right front door, and possibly the right "B"-pillar. The upwards lift to her head from the air bag is what caused her fatal cervical injuries. At final rest the child was laying unconscious in her seat slumped forward.

The front right occupant was transported by a police squad car to the hospital and subsequently air lifted to a trauma facility for children. Based on her medical records, the medical examiner's report, and her autopsy, she sustained fatal injuries and was pronounced dead approximately four hours post-crash. The injuries sustained by the case vehicle's front right passenger included: a complete laceration of the upper cervical spinal cord with an atlanto-occipital dislocation at the occipital condyles and an atlanto-axial dislocation; a critical nonanatomic brain injury; bilateral subdural hematomas at the top of her head; bilateral subarachnoid hemorrhages over her cerebral hemispheres; contusions to her mediastinal pleura and anteromedial right lobe of liver; abrasions to her mid-to-right forehead, right cheek, right face, forward-most undersurface of chin, anterior neck, and anteromedial forearm; contusions to her mid-to-right forehead, right face, anterior neck, and right anteromedial forearm; **and** lacerations to her upper lip and tongue. This occupant's brain, cervical, facial, chest, and abdominal injuries were caused by her contact with the case vehicle's front right passenger air bag.

The 1995 Mitsubishi Galant S was a front wheel drive, four-door sedan (VIN: 4A3AJ46GXSE------). The case vehicle was equipped with anti-lock brakes. The 1992 Dodge Ram D350, 4x2, one-ton, conventional cab, chassis cab with a commercial utility box mounted on the truck chassis (VIN: 1B6KE3652NS------). The case vehicle was towed due to damage, and the Dodge truck was driven from the scene. Based on the vehicle inspection, the CDCs were determined to be: **12-FDEW-1** (**10** degrees) for the case vehicle [maximum crush was 23 centimeters (9.1 inches) at C_5-C_6] and **06-BDLN-1** (**190** degrees) for the Dodge truck [maximum crush was 2 centimeters (0.8 inches) at C_3]. The WinSMASH reconstruction program, barrier

algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.2 km.p.h. (14.4 m.p.h.), -22.9 km.p.h. (-14.2 m.p.h.), and -4.0 km.p.h. (-2.5 m.p.h). The barrier algorithm was used because of the unknown total weight of the Dodge truck.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each 8 centimeters (3.1 inches) wide. The driver's air bag had two vent ports, approximately 2.5 centimeters (1.0 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was elliptical with a height of approximately 62 centimeters (24.4 inches) and a width of approximately 67 centimeters (26.4 inches). There was no visible contact evidence readily apparent on the driver's air bag; however, there were numerous black scuff marks from the cover flaps consistent with evidence of occupant loading.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right air bag module's cover flap had two areas of what looked like oily smears but were later discounted because of the lack of corresponding injuries. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 6 centimeters (2.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 48 centimeters (18.9 inches). There was contact evidence (i.e., oil smears and skin flakes) readily apparent on the front upper right portion (only) of the front right air bag. There was also several black scuffs to the top portion of the air bag (noncontact related) from the cover flap and rear view mirror.

Inspection of the case vehicle's interior revealed that during the front right air bag module's deployment, the air bag's fabric had contacted the rearview mirror and tilted it towards the driver's side of the windshield and the right side of the center instrument panel, depositing a brush abrasion. There was a possible contact (i.e., scuff, oil transfer) to the right knee bolster from the front right passenger and a scuff just to the right of the steering column most likely from the driver's right knee. Furthermore, there was a skin transfer and blood evidence along the interior surface of the driver's door, a black transfer to the left roof side rail, a possible oil smear to the driver's sun visor, and a probable contact to the right sun visor. Initially there was thought to be evidence of contact on the front right air bag module's cover flap (i.e., two oil smears), but these areas were later discounted as a direct contact from the front right passenger because there were no corresponding injuries. Finally, inspection of the "D"-ring encasement for the front right passenger's seat belt system revealed an anomaly (i.e., slight separation), indicating either a possible manufacturer's defect or a contact by the head of the front right passenger during this passenger's reward, rebounding movement.

Immediately prior to the crash the case vehicle's front right passenger was seated in an upright posture but with her torso turned to the left eating some ice cream that was in a cup holder located in the center instrument panel. The left side of her lower back was against the seat back, both feet were hanging over the front edge of the seat's cushion, angled downward, her right hand on her lap, and her left hand towards the center instrument panel. Her seat track was located in its forward-most position, and the seat back was slightly reclined.

It should be noted that initially the case vehicle's driver claimed that the front right passenger was restrained in a child safety seat in the back right seating position and at impact flew out of the safety seat striking the deploying air bag. This allegation was discounted by the police, medical examiner, and this contractor because first, the inspection of the Galant's interior did not support this claim, and second, a witness at a fast food, drive-through restaurant observed the child occupant, shortly before the crash, unrestrained in the front right seating position.

The case vehicle's driver [50-year-old, White (non-Hispanic) female] was seated upright with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel at the 3 and 9 o'clock positions. Her seat track was located in its forward-most position, and the tilt steering wheel was located between its middle and down-most positions. The case vehicle's driver [157 centimeters and 68 kilograms (62 inches, 150 pounds)] was using her available, active, three-point, lap-and-shoulder, safety belt system. However, the inspection of the case vehicle's driver seat belt webbing, "D"-ring, and latch plate showed no definite evidence of loading.

Immediately prior to the crash the case vehicle's back left passenger [9-month-old, White (non-Hispanic) female] was seated reclined in a rear facing child safety seat (RFCSS) with her back against the child safety seat's seat back, both feet hanging down, and both hands on her lap. The back left passenger [61 centimeters and 9 kilograms (24 inches, 20 pounds)] was restrained by the available harness on her child safety seat and the child seat was secured by the available, active, three-point, lap-and- shoulder, safety belt system. The inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading. The child safety seat was not available at the time of this contractor's inspection but, according to the interview with the case vehicle's driver, it was determined that the child seat was manufactured by Cosco but the exact model is unknown.

The case vehicle's driver and back left passenger were both transported by ambulance from the scene to the hospital. The driver sustained minor injuries and was treated and released. According to her interview and medical records, the driver sustained: abrasions to her chin and neck; contusions to her right cheek, lower abdomen, and bilateral knees; and unspecified injuries to the right shoulder and right foot. The back left passenger was taken for precautionary reasons, checked for injuries--of which there were none, and released.

CRASH CIRCUMSTANCES

The case vehicle was traveling south in the southbound lane of a two-lane, undivided, state roadway and was approaching a five-leg intersection, intending to continue traveling southward

(**Figure 1**). The Dodge truck had stopped in the southbound lane of the same two-lane, undivided, state roadway, intending to make a left turn. However, according to the Police Crash Report, the Dodge truck's driver decided, because of the heavy northbound traffic, to continue southbound to the next intersection and started to accelerate forward. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the southbound lane of the state roadway near the five-leg intersection of the three trafficways; see **CRASH DIAGRAM** below.

Figure 1: Case vehicle's southward travel path toward five-lane intersection showing approximate point of impact (i.e., red cone) with Dodge truck (case photo #02)

The state roadway was straight and level at the area of impact. The pavement was bituminous, and the width of the southbound lane width was 3.3 meters (10.9 feet). The shoulders were not improved, but there were 0.3 meter (1 foot) gravel shoulders adjacent to both the east and west sides of the north-south roadway. Pavement markings consisted of a double solid yellow center lines for both north and southbound traffic. In addition, solid white edge lines were present (**Figure 1**). The estimated coefficient of friction was 0.75 when dry. The five-leg intersection was uncontrolled for north and southbound traffic while there were STOP signs (Manual on Uniform Traffic Control Devices, R1-1) for the southwest, east, and westbound legs. The legal speed limit is 72 km.p.h. (45 m.p.h.). At the time of the crash the light condition was daylight, the atmospheric condition was raining, and the road pavement was wet. Traffic density was heavy, and the site of the crash was primarily rural residential with some commercial areas along the state roadway.

Figure 2: Case vehicle's frontal underride damage from impact with back of Dodge truck (case photo #05)

Figure 3: Case vehicle's front underride deformation viewed from left of front with contour gauge present (case photo #09)

The front (**Figure 2** and **3**) of the case vehicle impacted the back (**Figure 4** below) of the Dodge truck, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle veered

slightly to its right and continued southward a short distance toward the southwest corner of the five-leg intersection before coming to rest in the center of the east-west roadway. The Dodge truck was nudged farther forward (southward), and the Dodge Ram's driver drove it over to the west shoulder post-crash. According to the Police Crash Report, at impact the case vehicle was traveling approximately 48 km.p.h. (30 m.p.h.) and the Dodge truck was traveling approximately 16 km.p.h. (10 m.p.h.).

Figure 4: Damaged back of Dodge truck viewed from right of back; Note: direct damage begins at back right bumper corner and extends to left (case photo #63)

CASE VEHICLE

The 1995 Mitsubishi Galant S was a front wheel drive, five-passenger, four-door sedan (VIN: 4A3AJ46GXSE------) equipped with power-assisted rack-and-pinion steering, a 2.4L, SOHC MPFI, I-4 engine, and a four-speed automatic transmission. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle wheelbase was 263 centimeters (103.7 inches), and the odometer reading at inspection was 62,172 kilometers (38,632 miles).

Inspection of the vehicle's interior revealed electronic window and door locks; adjustable front bucket seats with adjustable head restraints; a nonadjustable back bench seat which was not equipped with head restraints; and continuous loop, three-point, lap-and-shoulder, safety belt systems at the front and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed from contact; although, there was a scuff on the driver's side. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both front seat air bags deployed as a result of the case vehicle's frontal impact with the Dodge truck.

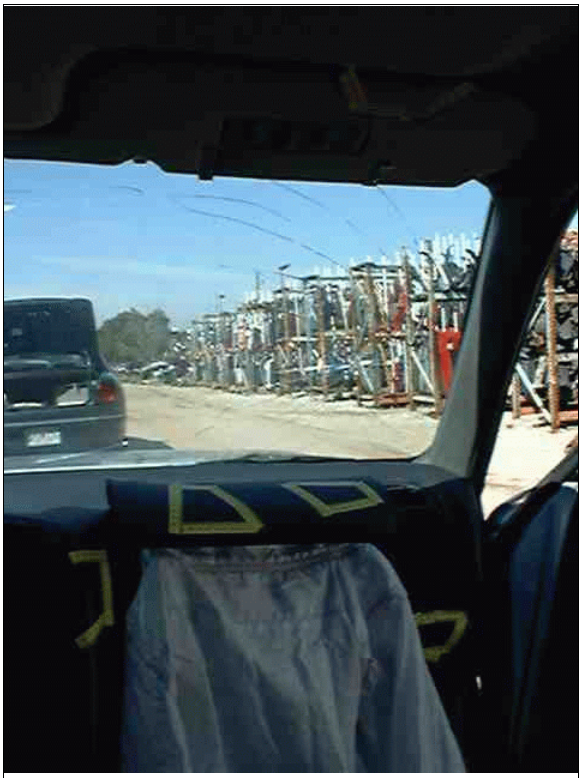


Figure 5: Case vehicle's front right seating area showing deployed front right passenger air bag, cracked windshield glazing, and possible contact evidence on cover flap, center instrument panel, lower right instrument panel, and sun visor (case photo #22)

Inspection of the case vehicle's interior revealed that during the front right air bag module's deployment, the air bag's fabric had contacted the rearview mirror, tilting it towards the driver's side of the windshield. Furthermore, the deploying air bag contacted the right side of the center instrument panel, depositing a brush abrasion (**Figure 5** above). Possible contacts (i.e., scuff, oil transfer) were identified to the right knee bolster from the front right passenger's knee (**Figure 5** above) and just to the right of the steering column (i.e., a scuff) most likely from the driver's right knee. There was a skin transfer and blood evidence along the interior surface of the driver's door (**Figure 6**), a black transfer to the left roof side rail, a possible oil smear to the driver's sun visor (**Figure 7**), and a probable contact to the right sun visor (**Figure 5** above). Initially there was thought to be evidence of contact on the front right air bag module's cover flap (i.e., two oil smears), but these areas were later discounted as a direct contact from the front right passenger because there were no corresponding injuries (**Figure 8**). Finally, inspection of the "D"-ring encasement for the front right passenger's seat belt system revealed an anomaly (i.e., slight separation), indicating either a possible manufacturer's defect or a contact by the head of the front right passenger during this passenger's reward, rebounding movement (**Figure 9**).

Figure 6: Interior surface of case vehicle's driver door showing blood and skin transfers along window sill (case photo #23)

Figure 7: Contact evidence to case vehicle's left roof side rail and driver's sun visor (case photo #26)

Figure 8: Case vehicle's front seating area showing deployed driver and front right passenger air bags and front right air bag module's cover flap with discounted evidence of contact (case photo #20)

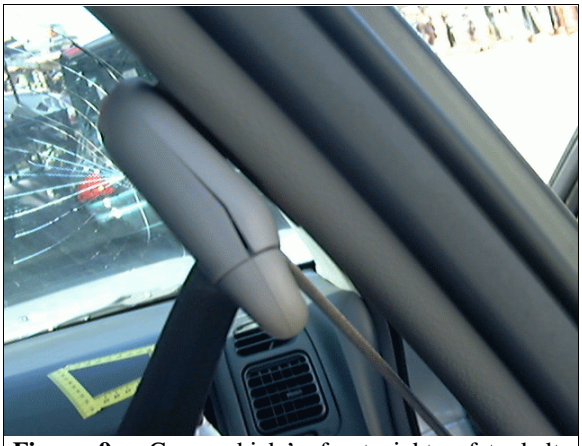


Figure 9: Case vehicle's front right safety belt showing separation to "D"-ring's encasement; Note: cracked windshield glazing in background (case photo #31)

Figure 10: Case vehicle's front underride deformation viewed from right of front; Note: bumper fascia torn away (case photo #16a)

The case vehicle's contact with the Dodge truck involved its front with direct damage extending across the entire front, both above and at the bumper levels (**Figure 10**). This impact resulted in an uneven damage pattern, indicating it underrode the rear bumper of the Dodge truck. The field L and direct damage went from bumper corner to bumper corner, a measured distance of 153 centimeters (60.2 inches). Maximum crush was measured as 23 centimeters (9.1 inches) at C_5-C_6. The residual crush across the entire front bumper was measured at approximately 7 centimeters (2.8 inches). The residual crush across the entire grille ranged from 19 centimeters (7.5 inches) at C_1 to 23 centimeters (9.1 inches) at C_6. The wheelbase on the case vehicle's was not shortened on either the left or the right side. The front bumper, bumper fascia, grille, hood, radiator, and right and left headlight and turn signal assemblies were directly damaged and crushed rearward. Neither of the front tires were physically restricted from the frontal damage. The case vehicle's right windshield sustained induced damage (i.e., a spider web crack) as well as both the right and left fenders from the frontal impact.

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDEW-1** (**10** degrees). The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 23.2 km.p.h. (14.4 m.p.h.), -22.9 km.p.h. (-14.2 m.p.h.), and -4.0 km.p.h. (-2.5 m.p.h). The barrier algorithm was used because of the unknown total weight of the Dodge truck. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained frontal air bags at the driver and front right passenger positions. Both air bags deployed as a result of the frontal impact with the Dodge truck. The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 17 centimeters (6.7 inches) at the horizontal seam and 6 centimeters (2.4 inches) vertically for the upper flap and 7 centimeters (2.8 inches) vertically for the lower flap. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with two tethers, each 8 centimeters (3.1 inches) wide sewn to the interior of the air bag at the 9 and 3 o'clock positions. The driver's air bag had two vent ports, approximately 2.5 centimeters (1.0 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was elliptical with a height of approximately 62 centimeters (24.4 inches) and a width of approximately 67 centimeters (26.4 inches). There was no visible contact evidence readily apparent on the driver's

air bag; however, there were numerous black scuff marks from the cover flaps consistent with evidence of occupant loading (**Figure 11**).

Figure 11: Case vehicle's deployed driver air bag showing no visible evidence of contact on air bag's fabric (case photo #38)

Figure 12: Case vehicle's front right passenger air bag showing areas (i.e., yellow tape) of oil and skin transfers to fabric's upper right quadrant from front right passenger; Note: highlighted possible contact evidence on cover flap was discounted (case photo #44)

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame which acted as the hinge point for the deploying flap. The flap's dimensions were 35 centimeters (13.8 inches) at the lower horizontal seam and 22 centimeters (8.7 inches) along both vertical seams. The profile of the case vehicle's instrument panel was flush with the leading edge of the cover flap. An inspection of the front right air bag module's cover flap and air bag revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap (**Figure 12**). Although there was a crack to the right windshield's glazing (**Figure 9** above), this contractor determined that the front right air bag module's cover flap could not reach the windshield during the module's deployment. The front right air bag module's cover flap had two areas of what looked like oily smears but were later discounted because of the lack of corresponding injuries. The front right passenger's air bag was designed without any tethers. The front right air bag had two vent ports, approximately 6 centimeters (2.4 inches) in diameter, located at the 10 and 2 o'clock positions. The deployed front right air bag was rectangular with a height of approximately 50 centimeters (19.7 inches) and a width of approximately 48 centimeters (18.9 inches). Examination of the front right passenger air bag revealed two small (i.e., oil smears and skin flakes) transfers to the right side of the front portion of the air bag (**Figure 12**). One of the areas of oil/skin evidence on the front of the air bag was approximately 3 x 2 centimeters (1.2 x 0.8 inches). This evidence started 17 centimeters (6.7 inches) down from the top horizontal edge of the air bag and 10 centimeters (3 .9 inches) in from the right edge of the air bag. The second area was approximately 2 x 4 centimeters (0.8 x 1.6 inches). This evidence started 25 centimeters (9.8 inches) down from the top horizontal edge of the air bag and 22 centimeters (8.7 inches) in from the right edge of the air bag. There was also several black scuffs to the top portion of the air bag, towards the left side, from contact with the cover flap and/or lower right corner of the rear view mirror.

Immediately prior to the crash the case vehicle's front right passenger [2-year-old, White (non-Hispanic) female] was seated in an upright posture but with her torso turned to the left eating some ice cream that was in a cup holder located in the center instrument panel. The left side of her lower back was against the seat back, both feet were hanging over the front edge of the seat's cushion, angled downward, her right hand on her lap, and her left hand towards the center instrument panel. Her seat track was located in its forward-most position, and the seat back was slightly reclined.

The contractor would like to note an inconsistency found during the vehicle inspection. Specifically, the front right passenger's seat track was located in its middle position. This inconsistency can be explained by the fact that the medical examiner's investigator, police personnel, the tow truck operator, and the family of the deceased front right passenger all inspected the case vehicle prior to this contractor's inspection and, as a result, the seat track's original position was most likely altered.

It should be noted that initially the case vehicle's driver claimed that the front right passenger was restrained in a child safety seat in the back right seating position and at impact flew out of the safety seat striking the deploying air bag. This allegation was discounted by the police, medical examiner, and this contractor because first, the inspection of the Galant's interior did not support this claim, and second, a witness at a fast food, drive-through restaurant observed the child occupant, shortly before the crash, unrestrained in the front right seating position.

The case vehicle's front right passenger [94 centimeters and 14 kilograms (37 inches, 31 pounds)] was not using either a child safety seat or her available, active, three-point, lap-and-shoulder, safety belt system. The upper anchorage for the front right passenger's torso belt was adjusted between its middle and full up positions. Further, there were abrasions to the undersurface of the front right passenger's chin and anterior neck. Initially these abrasions were interpreted as belt pattern abrasions and suggested evidence of safety belt usage (i.e., torso portion); however, based on this contractor's experience in Special Crash Investigations, these abrasions were from interaction with the fabric of the deploying front right passenger's air bag. In addition, the inspection of the front right passenger's seat belt webbing, "D"-ring, and latch plate showed no definite evidence of loading (**Figure 13**).

Figure 13: Close-up of "D"-ring for case vehicle's front right safety belt showing no evidence of loading (case photo #29A)

The NHTSA's recommended restraint use for a 2-year-old passenger is that the child be properly restrained in a child safety seat that is **NOT** positioned in front of a supplemental restraint system (air bag). There was an unknown child safety seat (i.e., not observed by this contractor) in the back right seating area of the case vehicle; however, a post-mortem evaluation by the

applicable medical examiner's office indicated that this child safety seat was too small to have secured the front right passenger.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the nonuse of her available safety belts, the front right passenger most likely moved forward just prior to impact. The case vehicle's impact with the Dodge truck enabled the case vehicle's front right child passenger to continue forward and upward as the case vehicle decelerated. The damage on the case vehicle was primarily above the bumper resembling an underride impact pattern. The underride type damage resulted in the air bag deploying late during the duration of the impact. This late deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V--i.e., ramp versus spike). The delayed deployment combined with the front right passenger's forward movement and her close proximity to the front right passenger's air bag module would have put this passenger easily within the excursion of the deploying air bag. The distance from this passenger's seat back to the right instrument panel was 89 centimeters (35.0 inches) while the untethered, front right air bag's outward excursion was approximately 60 centimeters (23.6 inches). The deploying front right passenger's air bag impacted this passenger in the right side of her face, just underneath her chin, across her neck, and in her chest. As a result her head was snapped backwards, and she was lifted upwards where she most likely contacted the front right sun visor with her forehead (**Figure 14**) before being pushed backwards towards the right side of her seat back, the right front door, and possibly the right "B"-pillar. The upwards lift to her head from the air bag is what caused her fatal cervical injuries. At final rest the child was laying unconscious in her seat slumped forward.

Figure 14: Close-up of case vehicle's front right sun visor showing probable contact evidence (case photo #39)

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right occupant was transported by a police squad car to the hospital and subsequently air lifted to a trauma facility for children. Based on her medical records, the medical examiner's report, and her autopsy, she sustained fatal injuries and was pronounced dead approximately four hours post-crash. The injuries sustained by the case vehicle's front right passenger included: a complete laceration of the upper cervical spinal cord with an atlanto-occipital dislocation at the occipital condyles and an atlanto-axial dislocation; a critical nonanatomic brain injury; bilateral subdural hematomas at the top of her head; bilateral subarachnoid hemorrhages over her cerebral hemispheres; contusions to her mediastinal pleura and anteromedial right lobe of liver; abrasions to her mid-to-right forehead, right cheek, right face, forward-most undersurface of chin, anterior neck, and anteromedial forearm; contusions to her mid-to-right forehead, right face, anterior neck, and right anteromedial forearm; **and** lacerations

to her upper lip and tongue. This occupant's brain, cervical, facial, chest, and abdominal injuries were caused by her contact with the case vehicle's front right passenger air bag.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {separation}, complete, of spinal cord at junction of medulla oblongata and upper cervical spine with atlanto-occipital dislocation at occipital condyles and atlanto-axial dislocation (between C_1 and C_2)	640276.6[1] untreatable	Air bag, front right passenger's	Certain	Autopsy
2	Nonanatomic brain injury; unconscious, flaccid, no response to painful stimuli	160824.5 critical	Air bag, front right passenger's	Certain	Emergency room records
3	Hematoma, subdural, bilateral–on both sides of falx[2]	140654.5 critical	Right "B"-pillar, window frame or sill, and/or roof side rail	Possible	Autopsy
4 5	Hemorrhage, subarachnoid over both cerebral hemispheres	140684.3 140684.3 serious	Air bag, front right passenger's	Probable	Autopsy
6	Contusion {hematoma} to mediastinal pleura	441804.2 moderate	Air bag, front right passenger's	Probable	Autopsy
7	Contusion {hematoma}, 0.8 cm (0.3 in), on anteromedial right lobe of liver	541812.2 moderate	Air bag, front right passenger's	Probable	Autopsy
8	Abrasion over mid-to-right forehead	290202.1 minor	Sun visor, front right passenger's	Probable	Autopsy
9	Contusion, 3.5 x 1.5 cm (1.4 x 0.6 in) over mid-to-right forehead	290402.1 minor	Sun visor, front right passenger's	Probable	Autopsy
10	Abrasion, linear, right cheek	290292.1 minor	Air bag, front right passenger's	Certain	Autopsy
11	Lacerations (2) oral surface of upper lip	290601.1 minor	Air bag, front right passenger's	Certain	Autopsy

[1] This lesion was detailed in this occupant's autopsy; therefore, it is assumed that the cord syndrome was complete.

[2] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
falx (falks) pl. ***fal′ces***: a sickle-shaped organ or structure; used as a general term in anatomical nomenclature to designate such a structure.
f. ce′rebri, f. of cerebrum: the sickle-shaped fold of dura mater that extends downward in the longitudinal cerebral fissure and separates the two cerebral hemispheres.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Laceration {injury}, 5 mm (0.2 in), to both sides of tongue (i.e., left dorsal and right ventral surfaces)	243402.1 minor	Air bag, front right passenger's	Certain	Autopsy
13	Abrasion, pattern, right face	290202.1 minor	Air bag, front right passenger's	Certain	Autopsy
14	Contusion, pattern, right face	290402.1 minor	Air bag, front right passenger's	Certain	Autopsy
15	Abrasion, 3 cm (1.2 in), at forward-most undersurface of chin	290202.1 minor	Air bag, front right passenger's	Certain	Autopsy
16	Abrasions[3] across anterior neck from left to right	390202.1 minor	Air bag, front right passenger's	Certain	Autopsy
17	Contusions[4] across anterior neck from left to right	390402.1 minor	Air bag, front right passenger's	Certain	Autopsy
18	Abrasion and friction burn, 11.5 x 4 cm (4.5 x 1.6 in), to right anteromedial forearm, including curvilinear abrasions, 3-4 cm (1.2-1.6 in), at the distal right forearm	790202.1 minor	Air bag, front right passenger's	Certain	Autopsy
19	Contusion {ecchymosis and yellow-tan discoloration} right anteromedial forearm	790402.1 minor	Air bag, front right passenger's	Certain	Autopsy

CASE VEHICLE DRIVER KINEMATICS

The case vehicle's driver [50-year-old, White (non-Hispanic) female] was seated upright with her back against the seat back, her left foot on the floor, her right foot on the brake, and both hands on the steering wheel at the 3 and 9 o'clock positions. Her seat track was located in its forward-most position, the seat back was upright, and the tilt steering wheel was located between its middle and down-most positions. The case vehicle's driver [157 centimeters and 68 kilograms (62 inches, 150 pounds)] was using her available, active, three-point, lap-and-shoulder, safety belt system. However, the inspection of the case vehicle's driver seat belt webbing, "D"-ring, and

[3] The autopsy indicated that the abrasions were in a webbed pattern, consistent with fabric.

[4] According to the autopsy, this lesion was in an approximate quadrilateral shape. On the left anterolateral neck the lesion was horizontally directed and 2 centimeters (0.8 inches) wide (i.e., high). On the right anterior neck this lesion splayed out to 3 centimeters (1.2 inches) wide (i.e., high) and became oblique and upwardly directed. The posterior (bottom) edge was 9.5 centimeters (3.7 inches) across, and the anterior (top) edge was 12.0 centimeters (12.0 inches) across.
According to the RANDOM HOUSE WEBSTER'S UNABRIDGED DICTIONARY, this term is defined as follows:
splay: to spread out, expand, or extend. to have an oblique or slanting direction. to spread or flare.

latch plate showed no definite evidence of loading (**Figure 15**) . The driver's adjustable "D"-ring was located between its middle and full-up position. Due to low severity of the crash and the driver's close proximity to the steering wheel, this contractor would not expect to find conclusive evidence of loading to the restraint system.

Figure 15: Case vehicle's driver safety belt showing no visible evidence of loading on belt's webbing (case photo #52)

The contractor would like to note several inconsistencies found during the vehicle inspection. Specifically, the driver's seat track was located in its rearmost position, and the case vehicle's tilt steering wheel was located in its upmost position. Both of these inconsistencies can be explained by the fact that the medical examiner's investigator, police personnel, the tow truck operator, and the family of the deceased front right passenger all inspected the case vehicle prior to this contractor's inspection and, as a result, the original positions were most likely altered.

The case vehicle's driver braked, attempting to avoid the crash. Presumably, the case vehicle's driver was distracted by one of the children in the case vehicle and did not observe the Dodge truck stop in front of her until just prior to the crash. As a result of this attempted avoidance maneuver and the use of her available safety belts, the driver most likely moved slightly forward just prior to impact. The case vehicle's impact with the Dodge truck enabled the case vehicle's short statured, forward positioned driver to continue forward and slightly upward into the deploying driver's air bag as the case vehicle decelerated. The damage on the case vehicle was primarily above the bumper resembling an underride impact pattern. The underride type damage resulted in the air bag deploying late during the duration of the impact. This late deployment occurred due to the prolonged change in time (Delta T) relative to the change in speed (magnitude of Delta V--i.e., ramp versus spike). The delayed deployment combined with the driver's forward movement would have put this passenger within the excursion of the deploying air bag. The deploying driver's air bag impacted this passenger in the chin, cheek, and neck. This forward movement also enabled the driver's knees to contact the lower instrument panel/knee bolster. At final rest the driver most likely remained near her pre-crash travel position, she was consciousness, and exited the vehicle under her own power.

CASE VEHICLE DRIVER INJURIES

The case vehicle's driver was transported by ambulance to the hospital. She sustained minor injuries and was treated and released. According to her interview and medical records, the driver sustained: abrasions to her chin and neck; contusions to her right cheek, lower abdomen, and bilateral knees; and unspecified injuries to the right shoulder and right foot.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Injury (not specified) to right shoulder	790099.1 minor	Air bag, driver's	Possible	Emergency room records
2	Abrasion {friction burn} to chin	290202.1 minor	Air bag, driver's	Probable	Interviewee (same person)
3	Contusion {bruise} right cheek	290402.1 minor	Air bag, driver's	Possible	Interviewee (same person)
4	Abrasion {friction burn} neck, location not specified, but most likely anterior	390202.1 minor	Air bag, driver's	Probable	Interviewee (same person)
5	Contusion {bruise} across lower abdomen	590402.1 minor	Lap portion of safety belt	Probable	Interviewee (same person)
6 7	Contusions {bruises} knees, bilaterally	890402.1 890402.1 minor	Left instrument panel and below Center instrument panel and below	Probable Certain	Interviewee (same person)
8	Injury (not specified[5]) to right foot	890099.1 minor	Toe pan	Possible	Emergency room records

CASE VEHICLE BACK LEFT PASSENGER KINEMATICS

Immediately prior to the crash the case vehicle's back left passenger [9-month-old, White (non-Hispanic) female] was seated reclined in a rear facing child safety seat (RFCSS) with her back against the child safety seat's seat back, both feet hanging down, and both hands on her lap. The back left passenger [61 centimeters and 9 kilograms (24 inches, 20 pounds)] was restrained by the available harness on her child safety seat and the child seat was secured by the available, active, three-point, lap-and- shoulder, safety belt system. The inspection of the back left passenger's seat belt webbing and latch plate showed no evidence of loading. The child safety seat was not available at the time of this contractor's inspection but, according to the interview with the case vehicle's driver, it was determined that the child seat was manufactured by Cosco but the exact model is unknown.

The case vehicle's driver braked, attempting to avoid the crash. As a result of this attempted avoidance maneuver and the use of her available child safety seat and safety belts, the back left passenger most likely moved slightly forward just prior to impact. The case vehicle's impact with the Dodge truck enabled the case vehicle's infant, back left passenger to continue forward within her child safety seat as the case vehicle decelerated. At final rest the back left passenger remained secured in her child safety seat.

[5] This occupant indicated that her right big {first} toe was fractured. The emergency room physician stated that no fracture was identified; however, he also indicated that it was certainly questionable in the first metatarsophalangeal area (i.e., big toe).

The case vehicle's back left passenger was transported by ambulance to the hospital. The back left passenger was taken for precautionary reasons, checked for injuries--of which there were none, and released.

OTHER VEHICLE

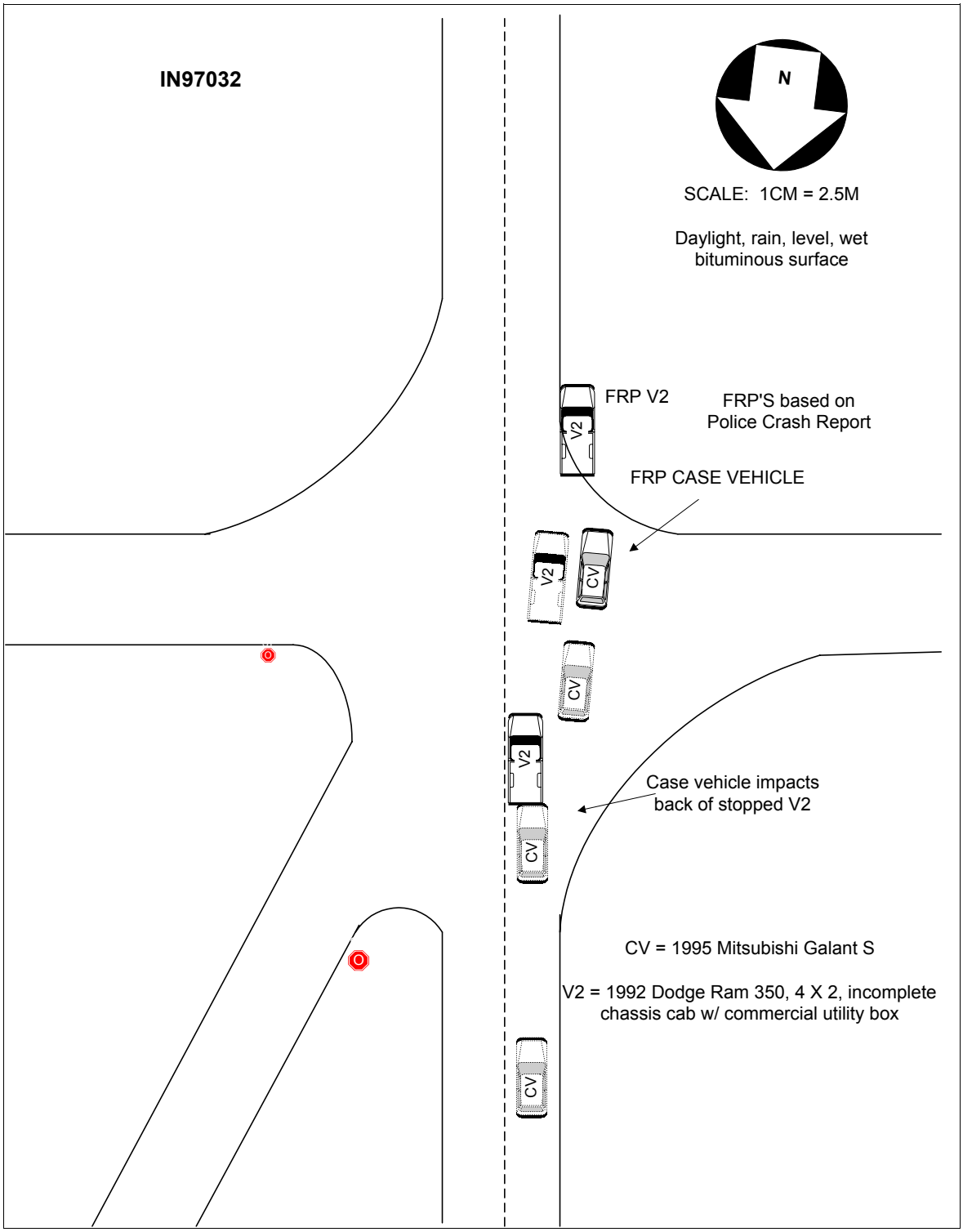
The 1992 Dodge Ram D350 was a rear wheel drive, 4x2, three-passenger, two-door, one-ton, conventional cab, chassis cab with a commercial utility box mounted on the truck chassis (VIN: 1B6KE3652NS------) equipped with a rotary value power steering, a 5.9L, NHP, V-8 engine, and a four-speed automatic transmission with overdrive. The commercial utility box was designed for a telephone utility vehicle and was equipped with a ladder rack, metal storage bins along both sides, and a tow ball on the heavy duty rear bumper. Braking was achieved by a power-assisted, front disc and rear drum system. Four-wheel anti-lock brakes were not available for this model. The Dodge truck's wheelbase was 333 centimeters (131.0 inches), and the odometer reading at inspection was 94,380 kilometers (58,645 miles).

The Dodge truck was equipped with manual, three-point lap and shoulder restraints at the outboard seat positions and a lap belt in the center seat position. The vehicle had a bench seat with adjustable head restraints in the outboard seating positions. The Dodge truck was not equipped with a supplemental restraint system.

The Dodge truck's contact with the case vehicle involved its back right two-thirds. Direct damage began at the back right bumper corner and extended inward, a measured distance of 155 centimeters (61.0 inches), along the back bumper. The maximum crush was measured 2 centimeters (0.8 inches) at C_3–near the tow ball (**Figure 4** above). The rear bumper was slightly rotated upwards (**Figure 16**). There was no other visible damage to this vehicle sustained during this crash.

Figure 16: Reference line view from right of Dodge truck showing back bumper's upward rotation (case photo #61)

Based on the vehicle inspection, the CDC for the Dodge truck was determined to be: **06-BDLN-1 (190)**. The Dodge truck was driven from the scene. The driver sustained no injuries as a result of this crash.


IN97032
N
SCALE: 1CM = 2.5M
Daylight, rain, level, wet
bituminous surface
FRP V2
FRP'S based on
Police Crash Report
FRP CASE VEHICLE
V2
CV
Case vehicle impacts
back of stopped V2
CV = 1995 Mitsubishi Galant S
V2 = 1992 Dodge Ram 350, 4 X 2, incomplete
chassis cab w/ commercial utility box