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National Highway Traffic Safety Administration

NHTSA

DOT HS 813 586

June 2024

Special Crash Investigations: On-Site Air Bag Inflator Rupture Investigation; Vehicle: 2012 Mercedes-Benz C250; Location: Florida; Crash Date: November 2020

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15. Supplementary Notes

Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was submitted.

16. Abstract

This report documents the on-site investigation of a crash that involved a 2012 Mercedes-Benz C250 and the inflator rupture of the passenger's frontal air bag module that resulted in severe injuries to the 24-year-old unbelted female front passenger. The Mercedes-Benz rear-ended a 1998 Dodge Ram pickup truck that was stopped in traffic. The crash deployed the driver and passenger frontal air bags and driver knee air bag. During the deployment of the passenger's frontal air bag, the inflator ruptured and projected metal fragments through the air bag that struck the front passenger, producing severe traumatic injuries. She was transported by ambulance to a level 2 regional trauma center where she was treated for her injuries and then transferred to a level 1 trauma center for more specialized care. The unbelted 26-year-old male driver of the Mercedes-Benz suffered minor injuries. He was transported by private vehicle to a level 2 trauma center where he was treated and released. The Mercedes-Benz sustained disabling damage and was towed from the scene to a local salvage yard. The Dodge sustained police-reported minor damage. Its 26-year-old-male driver was not injured.

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On-Site Air Bag Inflator Rupture Crash Investigation
Office of Defects Investigation
SCI Case Number: CR20037
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Location: Florida
Crash Date: November 2020

Background

This report documents the on-site investigation of a crash that involved a 2012 Mercedes-Benz C250 (Figure 1) and the inflator rupture of the passenger's frontal air bag module that resulted in severe injuries to the 24-year-old unbelted female front passenger. The Mercedes-Benz rear-ended a 1998 Dodge Ram pickup truck that was stopped in traffic. The crash deployed the driver and passenger frontal air bags and driver knee air bag. During the deployment of the passenger frontal air bag, the inflator ruptured and projected metal fragments through the air bag that struck the front passenger, producing severe injuries. She was transported by ambulance to a level 2 regional trauma center where she was treated for her injuries and then transferred to a level 1 trauma center for more specialized care. The unbelted 26-year-old male driver of the Mercedes-Benz suffered minor injuries. He was transported by private vehicle to a level 2 trauma center where he was treated and released. The Mercedes sustained police-reported disabling damage and was towed to a local salvage yard. The Dodge sustained police-reported minor damage. Its 26-year-old-male driver was not injured.

Figure 1. Front right oblique view of the frontal damage to the 2012 Mercedes-Benz

Notification of the crash was received by the National Highway Traffic Safety Administration in November 2020 from the attorney representing the vehicle's occupants. NHTSA's Crash Investigation Division assigned an on-site investigation to the Special Crash Investigations team at Crash Research & Analysis, Inc., in December 2020. The SCI team coordinated with the attorney and the technical representatives for the vehicle manufacturer to schedule a joint vehicle

inspection that was completed in January 2021. SCI investigators, the attorney, and consultants representing Mercedes-Benz, as well as the attorney and consultants for the front passenger were present to document and inspect the ruptured air bag module. The on-site activities included the examination and documentation of the ruptured air bag inflator, exterior and interior inspections of the Mercedes-Benz to measure exterior deformation, interior damage and intrusion, document occupant contact, and to examine the manual and supplemental restraint systems. The Mercedes-Benz was not equipped with an event data recorder (EDR) supported by the Bosch Crash Data Retrieval tool.

Summary

Crash Site

The crash occurred in the left lane of a 5-lane, east/west roadway in a suburban setting during daytime (Figure 2). Reported weather conditions included mostly cloudy skies, a temperature of 26.6 ºC (80 ºF), and wind speeds of 24 km/h (15 mph). There were two through lanes in each direction that were separated by an opposable left turn lane. Roadway markings consisted of a painted double yellow median with intermittent designated left turn lanes for the local intersecting streets and travel lanes separated by broken black and white lane lines in both directions. The edges of the roadway were bordered by concrete curbs. The bituminous travel lanes were straight and level and the posted speed limit was 56 km/h (35 mph). The crash scene was not inspected due to logistics and time constraints. However, a crash diagram is included at the end of this report that was reconstructed using satellite imagery.

Figure 2. Overhead view of the crash site. Google Maps © 2022 Maxar Technologies, U.S. Geological Survey Map Data

Pre-Crash

The Mercedes-Benz was driven by an unbelted 26-year-old male with an unbelted 24-year-old female front passenger. It was traveling east in the left lane at a police-reported speed of 40 km/h (25 mph). Meanwhile, the Dodge was stopped in traffic in the left eastbound lane ahead of the approaching Mercedes-Benz. According to the police crash report (PCR), the Mercedes-Benz driver was inattentive and was not focused on the roadway or traffic ahead. However, based on the underride damage to the front end, the driver probably braked to avoid the crash, which resulted in the front of the Mercedes-Benz pitching down.

Crash

The front of the Mercedes-Benz struck and underrode the back of the Dodge. Directions of force were in the 12 o'clock sector for the Mercedes-Benz and the 6 o'clock sector for the Dodge. The impact resulted in deployments of both frontal air bags, the driver knee air bag, and the second-row seat belt pretensioners. The deployment of the passenger frontal air bag caused the inflator to rupture, projecting inflator fragments through the air bag and striking the passenger. Both vehicles came to final rest at or near the point of impact.

Post-Crash

Local law enforcement and EMS were dispatched to the crash scene. The Mercedes-Benz driver was transported by private vehicle to a level 2 trauma center where he was treated and released. The front passenger was observed in the vehicle with major head/facial trauma. She was transported by ambulance to a level 2 trauma center. At this facility, her injuries were initially treated, then she was transferred to a level 1 trauma center for more specific treatment of her injuries. The Mercedes-Benz was towed from the crash site and transferred to a storage facility of an attorney where it was inspected for this investigation. The driver of the Dodge was not injured and the vehicle was driven from the crash site.

2012 Mercedes-Benz C250

Description

The Mercedes-Benz (Figure 3) was a rear-wheel-drive, 4-door sedan manufactured in September 2011, identified by Vehicle Identification Number WDDGF4HB0CAxxxxxx. It had a 1.8-liter, 4-cylinder, turbocharged gas engine linked to a 7-speed automatic transmission. The service brakes were hydraulic power-assist 4-wheel disc with ABS, with brake assist and electronic brakeforce distribution. Steering was hydraulic assist, speed proportional rack-and-pinion. Additional equipment included traction control, electronic stability control, and a tire pressure monitoring system. The gross vehicle weight rating was 2,020 kg (4,453 lb) with gross axle weight ratings of 955 kg (2,105 lb) front and 1,095 kg (2,414 lb) rear. The curb weight was 1,590 kg (3,505 lb).

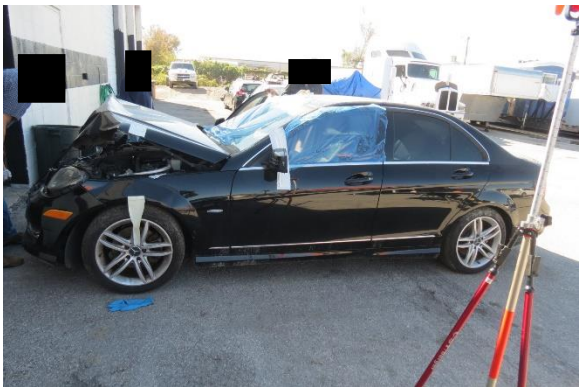

Figure 3. Left side view of the 2012 Mercedes-Benz

The Mercedes-Benz had Cosmo MuchoMacho performance-type tires, size 225/45ZR17 on the front wheels and 245/40ZR17 on the back wheels in accordance with the vehicle manufacturer's recommendation. There was no restriction or damage to the tires. All tires had 6 mm (7/32 in) of tread depth remaining.

The interior had seating for five occupants with leather-covered front row bucket seats and a three-passenger second row split-bench with a folding back seat. The driver's seat track was in the middle position while the passenger's seat track was in the forward most to middle position. All seat positions had adjustable head restraints. The front head restraints were mechanically actuated active restraints that offered protection in rear-end crashes. At the time of the SCI inspection, the front head restraints were adjusted 12 cm (4.7 in) above the seatbacks.

Vehicle History

The documented vehicle history included six owners, no major service performed, no previous crashes, and one open recall at the time of this crash. On December 6, 2019, a recall was initiated for the passenger's frontal air bag.

The first owner purchased the vehicle new in Florida in November 2011 at a reported odometer reading of 8 km (5 mi). This ownership continued as the vehicle was transferred to New Jersey in July 2013. Owner #2 purchased the vehicle in March 2014 at an odometer reading of 44,055 km (27,375 mi) and titled the vehicle in Indiana. Owner #3 purchased the Mercedes-Benz and titled

the vehicle in New Jersey. The latter two owners appeared to be dealers who purchased the vehicle for resale. Owner #4 purchased the vehicle in October 2014 and titled the vehicle in Florida. The odometer reading at this time was 46,571 km (28,938 mi). Owner #5 purchased the Mercedes-Benz in June 2018 at an odometer reading of 129,053 km (80,190 mi). Owner #6, the owner at the time of the crash under investigation, titled the vehicle in Florida in May 2019 and had a routine oil change service performed by a local oil change business in September 2020 at an odometer reading of 189,239 km (117,588 mi). This was the last reported odometer reading.

NHTSA Recalls and Investigations

A recall for the replacement of the front right passenger air bag module was issued December 5, 2019, during the current ownership (owner #6). The recall was not addressed by the owner. Additionally, a CarFax report was obtained, and it did not indicate any repairs for this issue. The details of this recall are as follows.

> NHTSA Recall # 17V017
> Mercedes-Benz Recall # 2019110016
> Takata Front Passenger Side Air Bag MY 2012 C-Class (204) Campaign Launch
> Date Dec 6, 2019
> Status: Remedy Available
>
> *Description:* Mercedes-Benz USA is recalling certain Model Year 2010-2011 C-Class (204), 2010-2012 GLK-Class (X204), 2010-2011 E-Class Coupes and Cabriolet (207), and 2011-2015 SLS-Class (197) Mercedes-Benz vehicles equipped with front passenger side air bags affected by defect decision of TK Holdings, Inc. (Takata). Under certain circumstances during a crash that necessitates passenger-side air bag deployment, the defect in your passenger side air bag inflator may cause the inflator housing to explode. A front passenger side air bag inflator explosion during deployment could result in metal fragments striking the passenger or other occupants, possibly causing serious injury or death. Replacement parts are available now! Please use dealer locator to contact your closest authorized dealer immediately.
>
> According to Takata, in the event of an inflator explosion, metal fragments could pass through the air bag cushion material, which may result in injury or death to vehicle occupants.
>
> *Remedy:* An authorized Mercedes-Benz dealer will replace the front passenger-side air bag. Replacement parts are available now! Please use MBUSA's dealer locator to contact your closest authorized dealer immediately.

Exterior Damage

The Mercedes-Benz sustained direct and induced damage extending across the front end-width of the vehicle. The direct contact damage consisted of two vertical creases that extended through the bumper fascia into the bumper beam, through the grille area and into the hood (Figures 4 and 5). Abrasive type scratches were present on the hood face between the vertical creases. The contact damage to the Mercedes-Benz indicated that there was probably an aftermarket fixture that was mounted to the back plane of the Dodge.

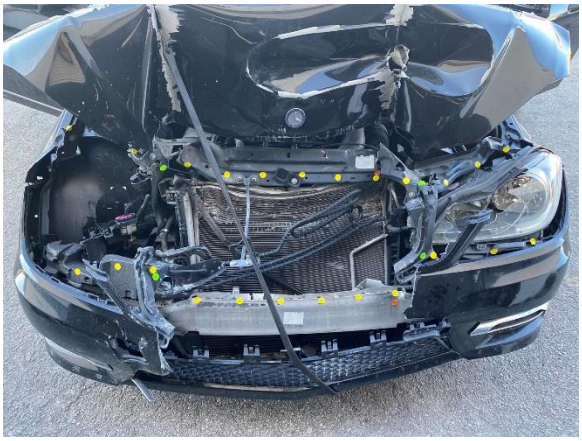

Figure 4. Front plane damage to the Mercedes-Benz

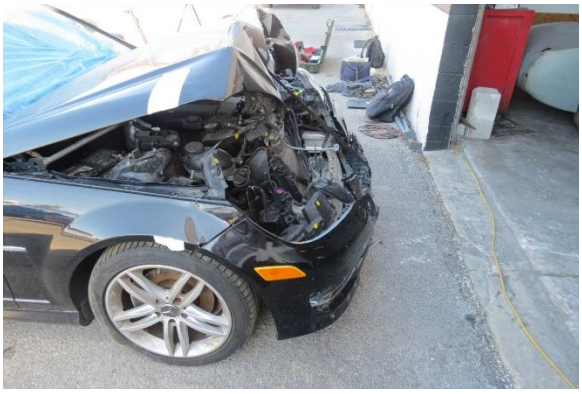

Figure 5. Right lateral view showing the extent of frontal crush

The direct damage started 46 cm (18.1 in) left of the vehicle's centerline and extended right across the front plane 79 cm (31.1 in). Minimal damage occurred to the bumper beam. Based on the NHTSA measurement protocol, the residual crush was documented by total station at two levels, the bumper beam, and the upper radiator support. The Field L was 136 cm (53.5 in). The average crush profile between the bumper beam and radiator support was as follows: C1 = 23 cm (9.1 in), C2 = 15 cm (5.9 in), C3 = 22 cm (8.7 in), C4 = 22 cm (8.7 in), C5 = 21 cm (8.3 in), C6 = 24 cm (9.4 in). The maximum crush was 39 cm (15.3 in) and was located 24 cm (9.4 in) left of the centerline.

The "missing vehicle" algorithm of the WinSMASH program was used to determine the severity of the crash, calculating a total delta V of 41 km/h (25.5 mph). The longitudinal and lateral velocity changes were -41 km/h (25.5 mph) and 0 km/h, respectively. The results were considered borderline and high. The collision deformation classification for the Mercedes-Benz was 12FDEW2.

Event Data Recorder

The Mercedes-Benz was not equipped with an EDR that was supported by the Bosch Crash Data Retrieval tool/software at the time of inspection.

Interior Damage

The Mercedes-Benz interior sustained minor severity damage associated with the air bag deployment. There was no intrusion of the passenger compartment and all four doors remained operational. The laminated windshield was fractured by the top-mount passenger's frontal air bag module cover flap. After the crash, the fractured windshield sagged into the passenger compartment due to weathering. At the time of the crash, both front windows were partially open. All other non-fixed glazing was closed.

Occupant contact to the structure of the interior was minimal. Blood evidence was present on the upper right quadrant of the driver's air bag. Additionally, blood and hair were found on the rearview mirror and on the passenger sun visor. It was later determined the blood on the rearview mirror and passenger sun visor was blood splatter and not a contact.

Manual Restraint Systems

The Mercedes-Benz had 3-point, continuous-loop lap and shoulder seat belts for the five seat positions and all were configured with sliding latch plates. Both front row belts had adjustable D-rings that were in the full-down positions. The driver's seat belt retracted onto an emergency locking retractor while the others were switchable automatic locking retractors. Both front-row and the second-row outboard positions had retractor pretensioners.

At the time of the SCI inspection, the front seat belt systems exhibited signs of historical usage but no evidence to support usage during this crash. The webbing from both front seat positions extended freely from the retractors at the time of the SCI investigation, indicating the pretensioners did not actuate. According to the Mercedes-Benz owner's manual, the front row seat belt pretensioners will only actuate when the seat belt is buckled, and the seat is occupied. Based on the weight of the occupants and severity of the crash, loading evidence typically is observed in these crash dynamics. Due to the lack of loading evidence and the pretensioners not actuating, it was determined that the driver and front passenger were not belted during this crash sequence. According to the PCR, the driver was reported as restrained by lap and shoulder belt and the front passenger was erroneously reported as a non-motorist.

The unoccupied second row left and right pretensioners did actuate, indicated by the yellow arrows in Figure 6, and locked the belt webbing taut against the seatbacks. According to the owner's manual, the second row pretensioners will actuate whether the seat belts are buckled or not.

Supplemental Restraint Systems

The Mercedes-Benz had certified advanced 208-compliant driver's and passenger's frontal air bags, driver knee air bag, outboard seat-mounted side impact air bags for the front row, and roof side rail-mounted inflatable curtain (IC) air bags. The impact with the Dodge resulted in the deployment of both frontal air bags and the driver's knee air bag (Figures 7 and 8).

Figure 6. 2012 Mercedes-Benz second row pretensioner actuation evidence

Figure 7. Deployed drivers frontal air bag and blood transfers of the upper right

Figure 8. Deployed driver knee air bag

The deployed driver's frontal air bag was located in the steering wheel hub and the deflated air bag measured 46 cm (18.1 in) in diameter. The air bag module had overall dimensions of 14 cm (5.5 in) vertically and 16 cm (6.3 in) horizontally and the module cover consisted of five flaps that opened at designated tear points. Evidence of blood was found in the upper right quadrant of the driver's air bag.

A bar-coded label affixed to the driver's frontal air bag module identified it as manufactured by TP Holding Inc. with a manufacture date of 2011 (Figure 9). This label indicated the driver's frontal air bag module was original to the Mercedes-Benz.

Figure 9. Driver's air bag module bar-coded label providing identification

The driver knee air bag deployed from the module located in the lower instrument panel below the steering column. The deployed knee air bag measured 26 x 54 cm (10.2 x 21.3 in). The single cover flap was 9 x 32 cm (3.5 x 12.6 in). No residual contact evidence was found on the driver knee air bag.

The passenger's frontal air bag was located in the upper right instrument panel and deployed through a forward hinged cover flap that measured 19 x 31 cm (7.5 x 12.2 in). At deployment, the cover flap opened upward fracturing the laminated windshield.

Figure 10. View of passenger's side showing the air bag as found at time of the SCI Inspection

Figure 11. View of the front right instrument panel after removal of air bag and air bag module components during the SCI Inspection

Passenger's Frontal Air Bag Inflator Rupture Discussion

The deployment of the passenger's frontal air bag (Figures 10 & 11) resulted in an apparent over-pressurization in the inflator and caused a total rupture of the inflator and the components in the air bag module. There was also a complete separation of the air bag fabric from the module.

SCI investigators, the attorney, and consultants representing Mercedes-Benz, as well as the attorney and consultants for the front passenger were present to document and inspect the ruptured air bag module. The passenger's frontal air bag fabric was removed from the Mercedes-Benz and placed on an inspection table. The air bag was approximately 71 cm (28 in) by 80 cm (31 in) and was catastrophically damaged with tear points throughout as indicated by the yellow measurements in Figures 12 and 13 identifying the location of the damage. There were several large tears to both sides of the air bag fabric from the air bag inflator and housing components rupturing and projecting through the air bag. Figure 12 shows the damage sustained to the front, and Figure 13 shows the damage sustained to the back of the air bag.

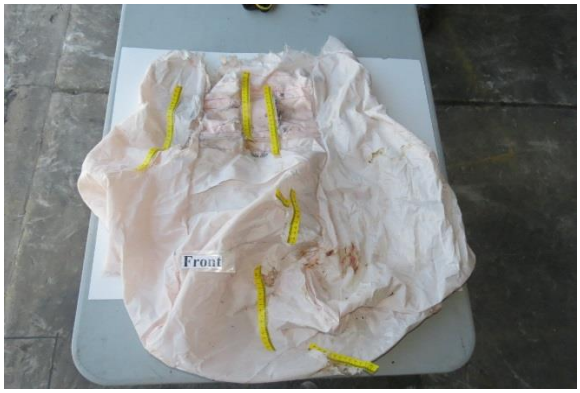

Figure 12. Front view of the passenger's frontal air bag

Figure 13. Rear view of the passenger's frontal air bag

In a stepwise manner, passenger's frontal air bag components were located in the vehicle by consultants for the passenger's attorney and a description label of each component was placed where the component was found in the vehicle, the majority of them in the right front floor area. Each labeled component was then moved to a table where it could be analyzed and imaged. Figure 14 shows the labeling of air bag module components that were found in the passenger floorboard of the Mercedes-Benz. Figure 15 shows air bag module components that were removed from the Mercedes-Benz and placed on the documentation table with a label that matched the label placed in the Mercedes-Benz.

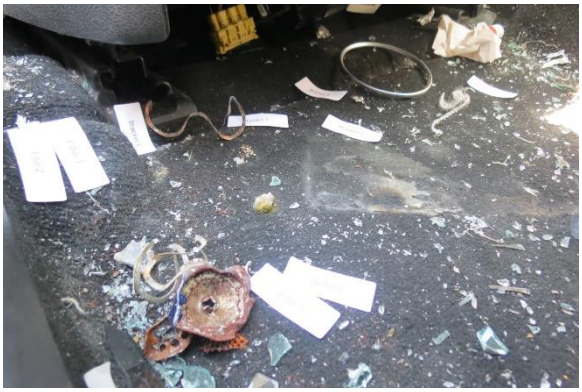

Figure 14. View of passenger floorboard showing air bag module components with labels as found

Figure 15. View of table where air bag module components were moved to after removal from the vehicle

During the inspection, the air bag inflator casing was found to have split lengthwise crossing through the vent holes. Figure 16 shows the casing with the yellow tape indicating the vents where the split occurred. Additionally, a plastic housing for the air bag module was found that had the manufacture label still intact. Based on this label, it was determined that the air bag module was manufactured by Takata in 2011. This label indicated that this air bag module was the original equipment installed in the vehicle and was never replaced as required by the NHTSA recall. Figure 17 highlights this data in the red boxes. On-site Mercedes-Benz representatives would not confirm or deny this label as being accurate to indicating an original Takata air bag at the time of the inspection. It was later confirmed by Mercedes-Benz that this was the original air bag installed in the vehicle at the time of manufacturing.

Figure 16. Image of the split air bag module casing

Figure 17. Image of the air bag module manufacture label

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2012 Mercedes-Benz C250 Occupants

Driver Demographics

Age/sex:	26 years/male
Height:	178 cm (70 in)
Weight:	102 kg (225 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Middle track position
Manual restraint usage:	Lap and shoulder seat belt available, not used
Usage source:	Vehicle inspection, medical records
Air bags:	Frontal, knee, seat-mounted, and IC air bags equipped; frontal and knee air bags deployed
Alcohol/drug involvement:	Not tested
Egress from vehicle:	Exited under own power
Transport from scene:	Transported by private vehicle to level 2 trauma center
Medical treatment:	Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Rupture of right tympanic membrane	240216.1	Isolated Right Air Bag – Right top instrument panel (noise due to inflator rupture)	Probable
2	Small laceration to right forehead	210602.1	Isolated Right Air Bag – Right top instrument panel (inflator rupture shrapnel)	Possible

Source: Emergency room records

Driver Kinematics

The driver was unbelted and seated upright, as indicated during an interview. The power seat was adjusted to the middle track position with the seatback reclined in normal limits and the head restraint adjusted 12 cm (4.7 in) above the seatback.

The driver's frontal and knee air bags deployed as a result of the collision with the Dodge. The driver responded to the 12 o'clock direction of force and translated forward from his pre-crash seat position. His knees and lower legs contacted the deployed knee air bag that prevented possible contact with the lower instrument panel/knee bolster area. There was no injury from this engagement. He sustained a small laceration to the right side of his forehead, possibly due to shrapnel from the ruptured right front air bag inflator. Due to the noise of the deployment and rupture on the passenger's frontal air bag inflator, the driver sustained a rupture of his right tympanic membrane. The driver exited the Mercedes-Benz unassisted and was transported by private vehicle to a level 2 trauma center where he was treated for his injuries and released.

Front Passenger Demographics

Age/sex:	24 years/female
Height:	168 cm (66 in)
Weight:	101 kg (223 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Between forward most and middle track position
Manual restraint usage:	Lap and shoulder seat belt available; none used
Usage source:	Vehicle inspection
Air bags:	Frontal, seat-mounted, and IC air bags equipped; frontal deployed
Alcohol/drug involvement:	None
Egress from vehicle:	Removed from vehicle due to perceived serious injuries
Transport from scene:	Transported to level 2 trauma center
Medical treatment:	Treated in emergency room and transferred to level 1 trauma center

Front Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Large left frontal avulsion injury with exposed skull, 8 x 8 cm	210804.2	Isolated IPC Right Air Bag – Right top instrument panel (inflator rupture)	Certain
2	Ruptured left ocular globe	241200.2	Isolated IPC Right Air Bag – Right top instrument panel (inflator rupture)	Certain
3	Slightly depressed slightly comminuted fracture of floor of left orbit; extensive fractures of medial wall of left orbit	251205.2	Isolated IPC Right Air Bag – Right top instrument panel (inflator rupture)	Certain
4	Subtle fracture of posterior medial wall of left maxillary sinus	250800.2	Isolated IPC Right Air Bag – Right top instrument panel (inflator rupture)	Certain
5	Large macerated laceration to left eyebrow extending to eyelid	210602.1	Isolated Right Air Bag – Right top instrument panel (inflator rupture)	Certain
6	Left eye ecchymosis	210402.1	Isolated Right Air Bag – Right top instrument panel (inflator rupture)	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
7	Contusion to right lateral neck	310402.1	Isolated Right Air Bag – Right top instrument panel (inflator rupture)	Certain
8	Left shoulder blistering/burn less than 1 percent surface area; left lateral thigh blistering/burn	912002.1	Isolated Right Air Bag – Right top instrument panel (inflator rupture)	Certain

Source: Emergency room records

Front Passenger Kinematics

The unbelted front passenger's seat track was between the forward most and middle track position with the seatback in a normal recline and the head restraint adjusted 12 cm (4.7 in) above the seatback.

The deployment of the passenger's frontal air bag and rupture of the inflator projected the inflator and housing fragments through the air bag fabric. The fragments struck the front passenger in the face, causing a large left frontal avulsion with exposed skull, fractures of the left orbit and maxillary sinuses, a ruptured left ocular globe, a large, macerated laceration of the left eyebrow area, and left eye ecchymosis. She also sustained a contusion of the right lateral neck from additional fragments and a thermal burn injury of the left shoulder and left lateral thigh.

Following the crash, she was removed from the vehicle by medical personnel and transported by ambulance to the emergency room of a level 2 trauma center then transferred to a level 1 trauma center for additional medical treatment and care. The extent of her hospitalization and care is unknown.

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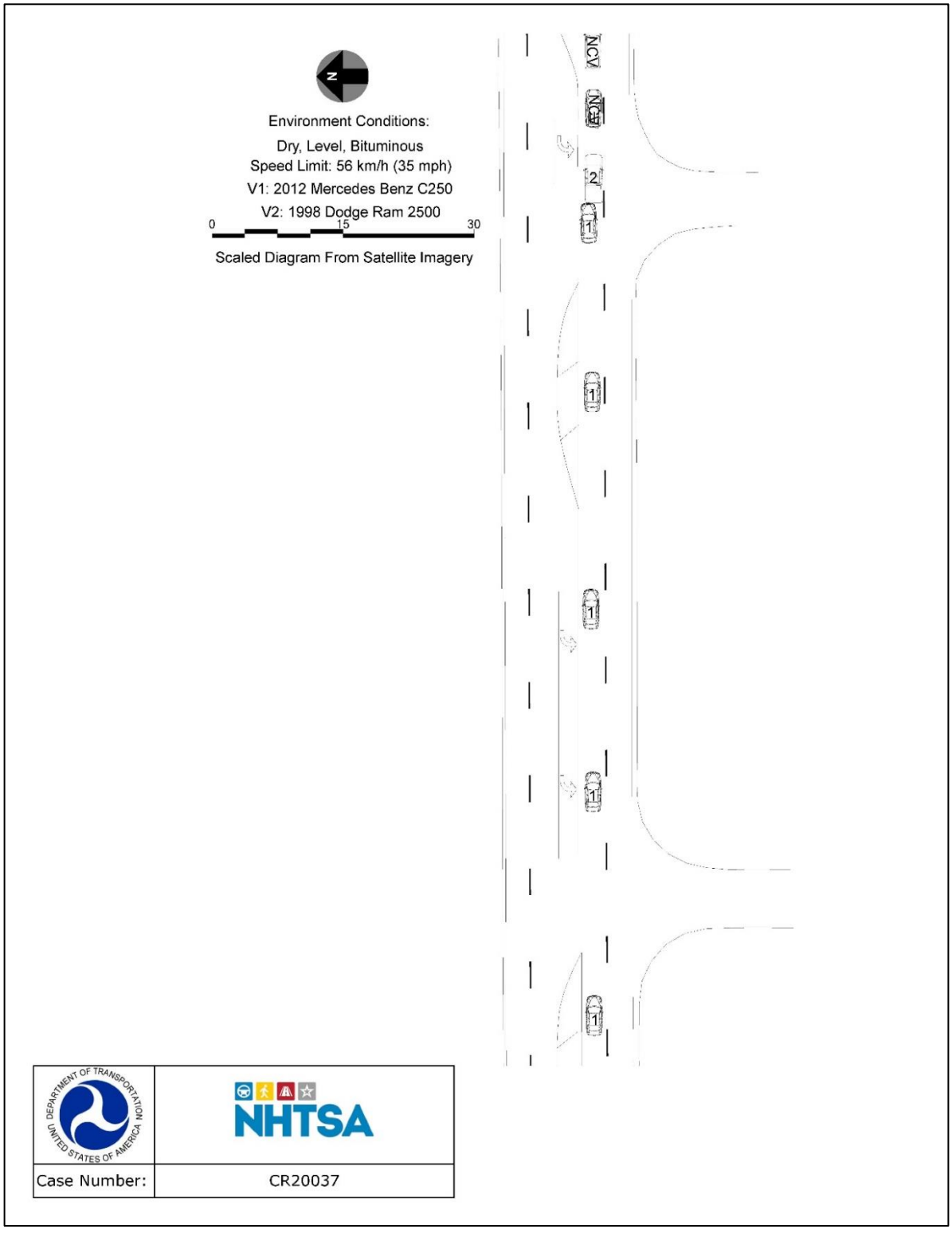
1998 Dodge Ram

Based on the police-reported VIN of 1B7KC23D9WJxxxxxx, the Dodge was 4-door, club cab pickup truck powered by a 5.9-liter diesel engine linked to a 5-speed automatic transmission with rear-wheel drive. The vehicle was built on a wheelbase of 342 cm (154.7 in) with a regular length cargo bed.

The Dodge Ram was struck in the back plane and driven from the scene. The Dodge Ram was not available for inspection. The driver was not injured.

Crash Diagram



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**National Highway
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