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Special Crash Investigations:

On-Site Driver's Frontal Air Bag Non-Deployment Crash Investigation;

Vehicle: 2011 Volkswagen Passat CC;

Location: Georgia;

Crash Date: April 2019

DISCLAIMER

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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 published.

16. Abstract

This report documents the non-deployment of a driver frontal air bag in a 2011 Volkswagen Passat CC during a head-on crash with a 2008 Audi Q7 SUV. The Volkswagen's 26-year-old, unbelted female driver sustained fatal injuries during the crash. None of the Volkswagen's air bags deployed during the crash, which occurred in April 2019. In December 2020 the driver's father notified NHTSA's Office of Defects Investigation of the crash.

The crash occurred at night in the northbound lane of a two-lane, unlighted, undivided State highway. The driver was the sole occupant in the Volkswagen. The Audi was a 4-door SUV driven by a belted 30-year-old female. The Volkswagen was traveling north in the northbound lane and the Audi was traveling south in the southbound lane. The Audi crossed into the northbound lane and struck the Volkswagen head-on. The Volkswagen driver sustained fatal injuries and was pronounced deceased at the crash scene. The Audi driver sustained police-reported "C" (possible) injuries and was transported by ambulance to a medical facility. After investigation, the root cause of the non-deployment of the driver frontal air bag in the Volkswagen could not be determined.

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Special Crash Investigations
On-Site Driver's Frontal Air Bag Non-Deployment Crash Investigation
Office of Defects Investigation
Case No: CR21004
Vehicle: 2011 Volkswagen Passat CC
Location: Georgia
Crash Date: April 2019

Background

This report documents the non-deployment of a driver frontal air bag in a 2011 Volkswagen Passat CC (Figure 1) during a head-on crash with a 2008 Audi Q7 SUV in April 2019. The Volkswagen's 26-year-old, unbelted female driver sustained fatal injuries during the crash. None of the Volkswagen's air bags deployed during the crash. In December 2020 the driver's father notified NHTSA's Office of Defects Investigation (ODI) of the crash.

An on-site investigation was assigned to the Special Crash Investigations team at Crash Research & Analysis, Inc., in February 2021. The SCI team contacted the driver's father, who kept the Volkswagen in his garage, and established cooperation to inspect the vehicle. The Volkswagen and scene inspections were completed in February 2021. A partial interview with the driver's father was completed at that time. The crash site was photographed and mapped by the Nikon total station. The Audi was deemed a total loss by its insurer after the crash and was sold prior to the notification of the crash. It was not inspected. The police crash report and on-scene photographs were obtained.

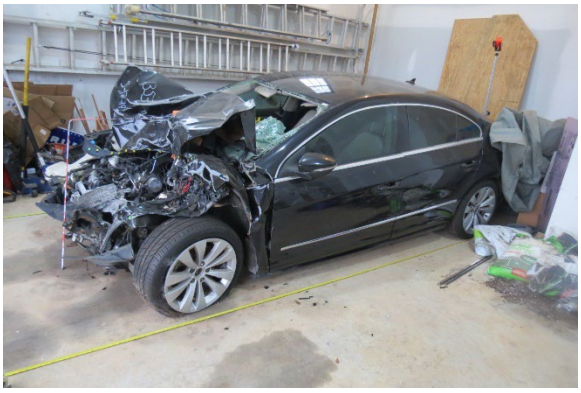


Figure 1. 2011 Volkswagen Passat CC

The crash occurred at night in the northbound lane of a two-lane, unlighted, undivided State highway. The driver was the sole occupant in the Volkswagen. The Audi was a 4-door SUV driven by a belted 30-year-old female. The Volkswagen was traveling north in the northbound lane and the Audi was traveling south in the southbound lane. The Audi crossed into the northbound lane and struck the Volkswagen head-on. The Volkswagen driver sustained fatal injuries and was pronounced deceased at the crash scene. The Audi driver sustained police-reported "C" (possible) injuries and was transported by ambulance to a hospital.

The Volkswagen had certified advanced 208-compliant frontal air bags, front outboard, seat-mounted, side impact air bags, inflatable curtain (IC) air bags, and front-row seat belt retractor pretensioners. Only the pretensioners actuated during the crash.

The SCI on-site investigation consisted of the inspection of the Volkswagen to measure and document exterior and interior damage, assess the manual and supplemental restraint systems, and identify points of occupant contact. Due to the vehicle date of manufacture, the Volkswagen's event data recorder (EDR) was not supported by the Bosch Crash Data Retrieval software and no EDR data was available through the use of the scan tool. ODI requested that the SCI investigator remove the driver frontal air bag module, clockspring, and EDR from the Volkswagen and forward the components to NHTSA's Vehicle Research Test Center (VRTC) for further analysis.

After the inspection, the SCI investigator disassembled the steering column and removed the driver frontal air bag and clockspring and removed a module from the center console that at the time was believed to be the EDR. These items were packaged and shipped to VRTC in February 2021. In July 2021 SCI was told that the removed module was not the EDR but in fact was the parking brake control module. Immediate efforts to locate the Volkswagen commenced; however, it was determined that the vehicle was sold for salvage in May 2021 and it could not be located. Any potential data that may have resided in the EDR was lost.

The SCI investigation determined that the Volkswagen experienced a frontal impact with an underride configuration; the Audi struck the front of the Volkswagen and crushed the components at and above the bumper level. The driver frontal air bag in the Volkswagen did not deploy. The driver was not belted and she sustained fatal chest injuries from striking the steering assembly. The root cause of the driver frontal air bag non-deployment could not be determined.

Crash Summary

Crash Site

This crash occurred at night on the two-lane, undivided roadway (Figure 2). At the time of the crash the environmental conditions were northwest winds at 19 kmh (12 mph) and a temperature of 5.6 °C (42.0 °F) according to the National Weather Service. The police-reported conditions were clear and dry. The bituminous roadway traversed in a general north/south direction and the travel lanes were 3.6 m (11.8 ft) wide with a positive grade of 2.1 percent to the north. The crash occurred at the apex of a left curve for northbound traffic. The roadway markings consisted of a double solid yellow center line and solid white edge lines. Both road edges were bordered by narrow stone shoulders ranging in width from 0.3 to 0.6 m (1.0 to 2.0 ft). The roadsides were natural terrain with trees. The posted speed limit was 64 kmh (40 mph). A crash diagram is included at the end of this report.

Figure 2. Northbound view of the crash site.

Pre-Crash

The Volkswagen was traveling north in the northbound lane and had just entered the left curve. The Volkswagen driver was traveling with a small dog. The driver of the Audi and her husband had departed a nightclub and were in separate vehicles traveling southbound with the husband's vehicle ahead of the Audi. The driver of the Audi crossed over the painted double yellow center lines and was completely in the northbound lane as she entered the right curve for southbound traffic. Based on the configuration of the crash, resulting damage and post-crash displacement of the Volkswagen, the Volkswagen driver probably applied the brakes immediately prior to impact. This probable braking reduced the pre-crash momentum of the northbound Volkswagen, and the southbound Audi became the dominant vehicle in the crash, reversing the direction of the Volkswagen and forcing it off the road. Due to the long duration between the crash date and the SCI investigation, there was no physical evidence at the crash site. The post-crash police investigation determined that the Audi driver was not under the influence of alcohol or drugs, and she was not using her cellphone at the time of the crash.

Crash

The vehicles struck head-on in the northbound travel lane (Figure 3). A remaining gouge mark in the pavement at the crash site supported the location of the impact. The police reconstruction also determined the southbound Audi was fully in the northbound lane at impact. SCI inspection

of the Volkswagen's front impact damage determined there also was an underride configuration. The front of the Audi stuck and then overrode the front of the Volkswagen. This was attributable to the height differential of the vehicles and the probable pre-crash braking by the driver of the Volkswagen that would have compressed the front suspension, thus pitching the vehicle down. There was no damage to the Audi's hood. The resultant directions of force were 11 o'clock for the Volkswagen and 12 o'clock for the Audi. The crash actuated the pretensioners in the Volkswagen, although the driver did not use the seat belt system. The driver frontal air bag did not deploy. The driver frontal air bag in the Audi did deploy.

Figure 3. Southbound view of the location of the point of impact in the northbound lane. Image provided by the investigating police agency.

The Audi's momentum at impact stopped the forward velocity of the Volkswagen and displaced it rearward as the two vehicles remained engaged from the point of impact (Figure 4). Based on police documentation, the Audi came to final rest approximately 29 m (95 ft) south of the point of impact with its left side tires on the east shoulder facing south. The Volkswagen was displaced rearward off-road, rotated approximately 360° clockwise, and came to final rest approximately 28 m (92 ft) south of the point of impact, facing north (Figure 5).

Figure 4. Northbound view of the Volkswagen off-road trajectory to final rest. Image provided by the investigating police agency.

Figure 5. Easterly view of the final rest position of the Volkswagen. Image provided by the investigating police agency.

Post-Crash

The Volkswagen driver was pronounced deceased at the crash scene. Her body was removed from the vehicle and transported to the medical examiner's office for autopsy. The Audi driver sustained police-reported "C" (possible) injuries and was transported by ambulance to a hospital.

2011 Volkswagen Passat CC

Description

The Volkswagen (Figure 6) was a front-wheel-drive, 5-passenger, 4-door sedan manufactured in June 2010 and identified by the VIN WVWMN7AN3BExxxxxx. The vehicle was powered by a 2.0-liter, turbocharged, 4-cylinder, gasoline engine linked a 6-speed automatic transmission with a console-mounted shifter. The service brakes were 4-wheel power-assisted disc with ABS. Steering was speed-sensitive, electric-power rack-and-pinion. Additional features included stability control, emergency brake assist, electronic brakeforce distribution, emergency brake assist, traction control, and a tire pressure monitoring system. The wheelbase was 271 cm (106.7 in) and the curb weight was 1,530 kg (3,366 lb). The vehicle's information placard stated the gross vehicle weight rating was 1,980 kg (4,366 lb) with gross axle weight ratings of 1,050 kg (2,315) front and 960 kg (2,117 lb) rear. The vehicle manufacturer's recommended tire size was P235/45R17. It was equipped a Kumho Ecsta tires, size P225/45R17 on the left front wheel and Continental Extreme Contact tires, size P225/45R17 on the other three wheels. All tires were in good condition, with at least 6 mm (7/32 in) of tread depth. The tires were mounted on OEM multi-spoke alloy wheels.

Figure 6. Right-front oblique view of the Volkswagen.

The Volkswagen interior had seating for four occupants with front row bucket seats and a split back second row seat with a fold down center armrest and a console between the seat cushions. All seating surfaces were leather. The four seat positions were equipped with adjustable head restraints. The bottom of the driver head restraint was adjusted 9 cm (3.5 in) above the top of the seatback. At the time of SCI inspection, the driver's power-adjustable seat track was in the full-rear position. The at-crash position of the seat was unknown.

Vehicle History

A vehicle history report for the Volkswagen identified four different owners. The original owner purchased the vehicle new in July 2010 in Florida and sold the vehicle in December 2013. During this ownership period, there were no reported service issues over the 32,762 km (20,358 mi) odometer reading. Owner #2 purchased the Volkswagen in Florida in December 2013 and sold it in January 2017 with an odometer reading of 90,243 km (56,076 mi). There was no service records of significance during the ownership period. Owner #3 purchased the vehicle in February 2017 in Georgia and sold it in July 2018 with approximately 145K km (90K mi) on the odometer. During this ownership period, two recalls were announced and were not repaired. The Volkswagen was sold at an auto auction in August 2018 at a reported odometer reading of

146,673 km (91,141 mi). Owner #4, the owner and driver of the Volkswagen at the time of the crash, purchased the vehicle in October 2018. The last reported odometer reading was 164,462 km (102,195 mi) in March 2019 for routine maintenance. This April 2019 crash was reported in the history report. No major service history or previous crashes were reported.

NHTSA Recalls and Investigations

A VIN query of the NHTSA recall database (www.nhtsa.gov/recalls) in April 2021 and again in December 2022 revealed two open recalls for the vehicle under investigation. These recalls were unrelated to the crash under investigation but are listed here for completeness.

Recalls:

- NHTSA No. 17V509 This recall involved an issue with the electrical power supplied to the fuel pump and was issued August 16, 2017.
- NHTSA No. 18V148 This recall was for the replacement of the driver frontal air bag due to a risk of a faulty deployment (explosion) during a crash and was issued March 15, 2018.

Two searches of the database by year/make/model at case initiation and in December 2022 revealed one open investigation.

Investigations:

- NHTSA No. EA18003 This investigation involved the potential for clockspring failure in 40 Volkswagen models in production years 2010-2014. The investigation was opened April 18, 2018 and remains open.

Exterior Damage

The Volkswagen sustained significant damage to the front plane. The bumper, bumper fascia, grill, radiator support, hood, all turn and headlamp assemblies, and left fender were directly damaged. The direct damage (Figure 7) began at the left front bumper corner and extended 150 cm (59.1 in) to the right. The combined direct and induced damage (field L) was 144 cm (56.7 in). Two sets of crush measurements were taken because the crush at the upper radiator support level exceeded that at the bumper level by the required 13 cm (5 in) to necessitate crush averaging as per vehicle measurement protocols. The maximum residual crush at the bumper level was 52 cm (20.5 in), occurring at 40 cm (15.7 in) left of the vehicle centerline. The maximum residual crush at the upper radiator support was 64 cm (25.2 in), occurring 75 cm (29.5 in) left of the centerline. The crush values at each level were averaged by protocol and the final crush values were: C1 = 47 cm (18.5 in), C2 = 52 cm (20.5 in), C3 = 56 cm (22.0 in), C4 = 33 cm (13.0 in), C5 = 24 cm (9.4 in), C6 = 3 cm (1.2 in). The collision deformation classification (CDC) was 11FDEW4 (340 degrees).

Figure 7. Front plane damage of Volkswagen

The total delta V calculated by the "missing vehicle" algorithm of the WinSMASH program was 54 kmh (34 mph). The longitudinal and lateral velocity changes were -51 kmh (-32 mph) and 19 kmh (12 mph). Use of the missing vehicle algorithm and the underride element of the impact necessitated that the quality of the crash reconstruction be coded as borderline in the database. However, the results of the calculation appear reasonable based on SCI experience.

Interior Damage

The Volkswagen interior was not significantly reduced in size by intrusion and damage was the result of driver contact to frontal components. Intrusion was limited to the left toe pan, which intruded 5 cm (2.0 in) rearward. The hood was crushed rearward, and had contacted and fractured the windshield, evidenced by abrasions to the painted surface of the hood. The windshield was holed and in place, but this was likely due to weathering during the approximate 2-year time lag between the crash date and the SCI inspection.

The unbelted driver initiated a forward trajectory and loaded the steering wheel, lower instrument panel/knee bolster, steering column, and the windshield (Figures 8 and 9). Steering wheel loading consisted of bending of the three spokes with approximately 6 cm (2.5 in) of lower steering wheel rim deformation. Additionally, the energy absorbing steering column was compressed.

Her left knee contacted the lower left instrument panel/knee bolster. The panel was scuffed and deformed and partially separated from its attachment points. In addition, the light switch was displaced from its mounting point in the mid instrument panel. The driver's right knee contacted and scuffed the steering column cover. The lower right corner of the column cover was fractured.

All doors remained closed during the crash and were operational post-crash. The laminated windshield was fractured by rearward folding of the hood. All door and backlight glazing was intact. The Volkswagen was not equipped with a roof window.

Figure 8. Contacts to steering wheel rim, column, and knee bolster

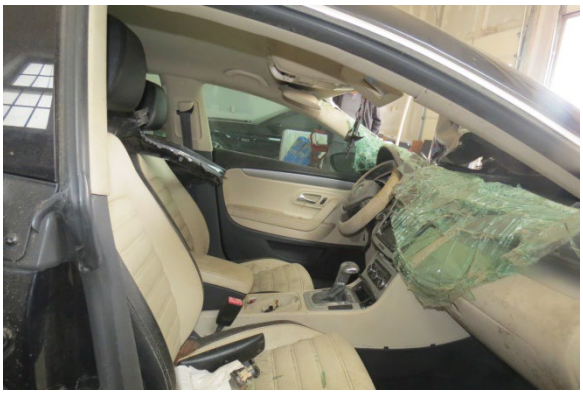


Figure 9. Right lateral view showing the displacement of the steering wheel rim, the stowed driver's seat belt, and the non-deployed air bags

Manual Restraint Systems

The Volkswagen had manual 3-point lap and shoulder seat belts for all four seat positions. The driver's belt system consisted of continuous loop webbing that retracted onto an emergency locking retractor (ELR) with a sliding latch plate with the polymer-surfaced D-ring adjusted to the full-up position. The driver was not wearing the seat belt system at the time of the crash. Both front seat belt retractor pretensioners actuated during the crash. The driver's belt webbing was in the stowed position and was drawn taut to the B-pillar by pretensioner actuation.

Supplemental Restraint Systems

The Volkswagen had certified advanced 208-compliant frontal air bags, front seat-mounted side impact air bags, and IC air bags. None of the air bags deployed during this crash.

The driver frontal air bag was contained with the steering wheel-mounted module and concealed by cover flaps with the Volkswagen logo centered in the flaps. The passenger frontal air bag was mounted in the top of the right instrument panel. The front seat-mounted side impact air bags were located in the outer aspect of the seatbacks and labeled with a sewn-on tag. Both IC air bags were mounted to the roof side rails and concealed by the headliner. An inspection of the air bag locations did not yield evidence of damage, deployment, or removal.

The driver frontal air bag and clockspring were disassembled from the steering column and shipped to VRTC at the request of NHTSA. Both components had 2010 dates of manufacture and appeared to be original equipment to the vehicle.

Air Bag Non-Deployment Discussion

For undetermined reasons, the driver frontal air bag in the Volkswagen did not deploy in this crash. Although there was an element of underride to the frontal crash configuration, crashes of this overall severity, in similar class vehicles, generally result in air bag deployment. Several confounding factors exist.

- The driver and front passenger seat belt retractor pretensioners did actuate with the belt in the stowed position. Therefore, crash recognition was achieved.

- No obvious indicators of malfunction or error were observed during disassembly of the driver air bag and clockspring.
- The driver frontal air bag module and clockspring appeared to be original equipment with 2010 manufacture dates.
- The pre-crash status of the air bag warning indicator lamp remains unknown.
- Data potentially available in the EDR was not available for analysis.

2011 Volkswagen Passat CC Occupant Data

Driver Demographics

Age/sex:	26 years/female
Height:	170 cm/67 in
Weight:	109 kg/240 lb
Eyewear:	Corrective lenses
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Unknown
Manual restraint usage:	None
Usage source:	Vehicle inspection, police crash report
Air bags:	Front, seat-mounted, IC available; none deployed Note: Air bag deployment was (incorrectly) coded Yes on PCR
Alcohol/drug involvement:	None
Egress from vehicle:	Fatal before removal
Transport from scene:	Transported to medical examiner
Treatment	None; fatal

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Transection of thoracic aorta	420210.5	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
2	Right hemothorax (1200 mL)	442200.3	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
3	Left hemothorax (800 mL)	442200.3	Isolated IPC Front – Steering wheel (combination of rim and hub/spoke)	Certain
4	Left femur fracture, NFS	853000.3	Isolated IPC Front – Left lower instrument panel (includes knee bolster)	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
5	Open fracture of right tibia, NFS	854001.3	Isolated IPC - ICS #1: Front – Steering column, transmission selection lever, other attachment ICS #2: Floor – Floor (including toe pan)	Possible Possible
6	Open fracture of right fibula, NFS	854442.2	Isolated IPC - ICS #1: Front – Steering column, transmission selection lever, other attachment ICS #2: Floor – Floor (including toe pan)	Possible Possible
7	Multiple liver lacerations, NFS	541820.2	Isolated Front - Steering wheel rim	Certain
8	Frontal scalp hemorrhage	110402.1	Isolated Front - Windshield	Certain
9	Abrasions to face: 4 x 4 inch area on center and left forehead, left cheek, tip of nose, and 2 x 2 inch area to chin	210202.1	Isolated Front - Windshield	Certain
10	1 inch linear abrasion on left lower aspect of chest	410202.1	Isolated Front - Steering wheel rim	Certain
11	Abraded contusions with linear orientation in 6 x 6 inch area of upper and right aspects of abdomen	510402.1	Isolated Front - Steering wheel rim	Certain
12	Abrasions to posterior right forearm	710202.1	Isolated Front - Left instrument panel	Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
13	Abrasions to posterior and anterior left forearm	710202.1	Isolated Front - Left instrument panel	Possible
14	Contusions to posterior aspect of right hand	710402.1	Isolated Front - Left instrument panel	Possible
15	Contusions to posterior aspect of left hand	710402.1	Isolated Front - Left instrument panel	Possible
16	Abrasions to right knee	810202.1	Isolated Front – Steering column, transmission selection lever, other attachment	Certain
17	Abrasions to left knee	810202.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain

Source: Medical Examiner report (internal)

Driver Kinematics

The driver of the Volkswagen was seated in an upright driving posture evidenced by interior occupant contact points and documented injury. The power-adjustable seat was in an unknown track position. At inspection, it was found in the full-rear track position, but it may have been moved during the process to remove her body. The driver head restraint was adjusted 9 cm (3.5 in) above the top of the seatback at the time of the SCI inspection. She was not restrained by the manual seat belt system. The seat belt webbing was stowed against the B-pillar and locked taut due to the actuation of the retractor pretensioner.

In response to the 11 o'clock impact force, the driver was displaced forward and slightly to her left. Her knees contacted the lower instrument panel and the steering column cover evidenced by scuff marks and fractures to the polymer components (Figure 10). She sustained abrasions to the knees. The energy from the knee loading was transmitted into the left femur resulting in an unspecified femur fracture. The driver also sustained open, but unspecified fractures of the right tibia and fibula. These fractures possibly resulted from loading steering column or from loading the intruding the left toe pan. The anatomical location of the fracture site was not specified.

Figure 10. Driver's knee contacts to the lower steering column cover and lower instrument panel/bolster

As her torso translated forward and engaged the steering wheel rim and spokes, her hands separated from the steering wheel rim and contacted the left instrument panel. She sustained contusions of the posterior aspects of the hands and abrasions to the posterior forearms.

The driver's torso loaded the steering wheel with sufficient force to deform the lower aspect of the wheel rim 6 cm (2.4 in) forward and bend all three spokes. Additionally, her loading force compressed the energy-absorbing steering column. Her loading of the steering assembly resulted in a transected aorta, bilateral hemothoraces, liver lacerations, an abrasion of the chest, and a large area of contusion over the upper right aspect of the abdomen. Her head flexed over the top of steering wheel rim and contacted the windshield, resulting in abrasions of the face and forehead and a frontal scalp hemorrhage.

The Volkswagen's forward momentum was stopped by the impact and the vehicle was displaced rearward off the roadway and traveled approximately 28 m (92 ft) before coming to final rest facing northward. It is unlikely any further injuries were caused by this movement. The driver was pronounced deceased at the scene.

The Volkswagen driver's injuries likely would have been reduced in severity had she used the 3-point lap and shoulder seat belt system. Additional crash protection and injury mitigation may have been provided by the deployment of the driver frontal air bag

2008 Audi Q7

Description

The Audi was an all-wheel-drive, 7-passenger, 4-door SUV identified by VIN WA1EY74L18Dxxxxxx. Due to the 22-month lag time between the crash date and the date this case was assigned to SCI, the Audi was no longer available for inspection. Manufacturer specification and standard equipment provided the following. The Audi was powered with a 3.6-liter, V-6 engine and a 6-speed shiftable transmission. The vehicle was also equipped with power-assisted 4-wheel disc brakes with ABS, stability control, traction control, electronic brakeforce distribution, and emergency brake assist. The vehicle was configured on a 300 cm (118.1 in) wheelbase and the listed curb weight was 2,480 kg (5,468 lb). The interior had frontal air bags, front seat-mounted side impact air bags, IC airbags protecting all three seating rows, and seat belt retractor pretensioners for the first two seating rows.

Exterior Damage

Images of the Audi were provided to the SCI team by the investigating police agency. The Audi sustained damage that was distributed across the full width of the front plane with the heaviest concentration of damage occurring at bumper level (Figures 11 and 12). The hood face was not damaged as the frontal structure overrode the front plane of the Volkswagen. Based on the police images, maximum crush was estimated at 61 cm (24 in). The left wheelbase was reduced approximately 15 cm (6 in) restricting the tire. The CDC assigned to this damage pattern was 12FYEW3.

Figure 11. Final rest position of the Audi and the resultant frontal damage. Image obtained from the investigating police agency.

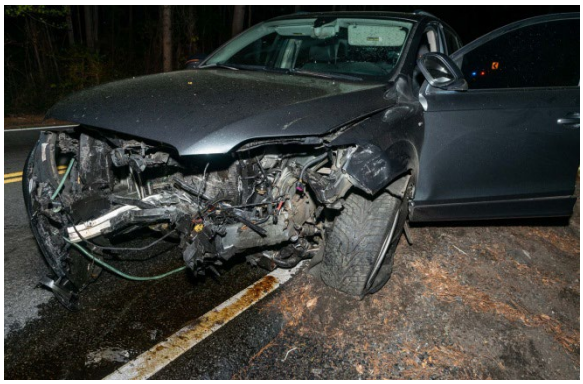
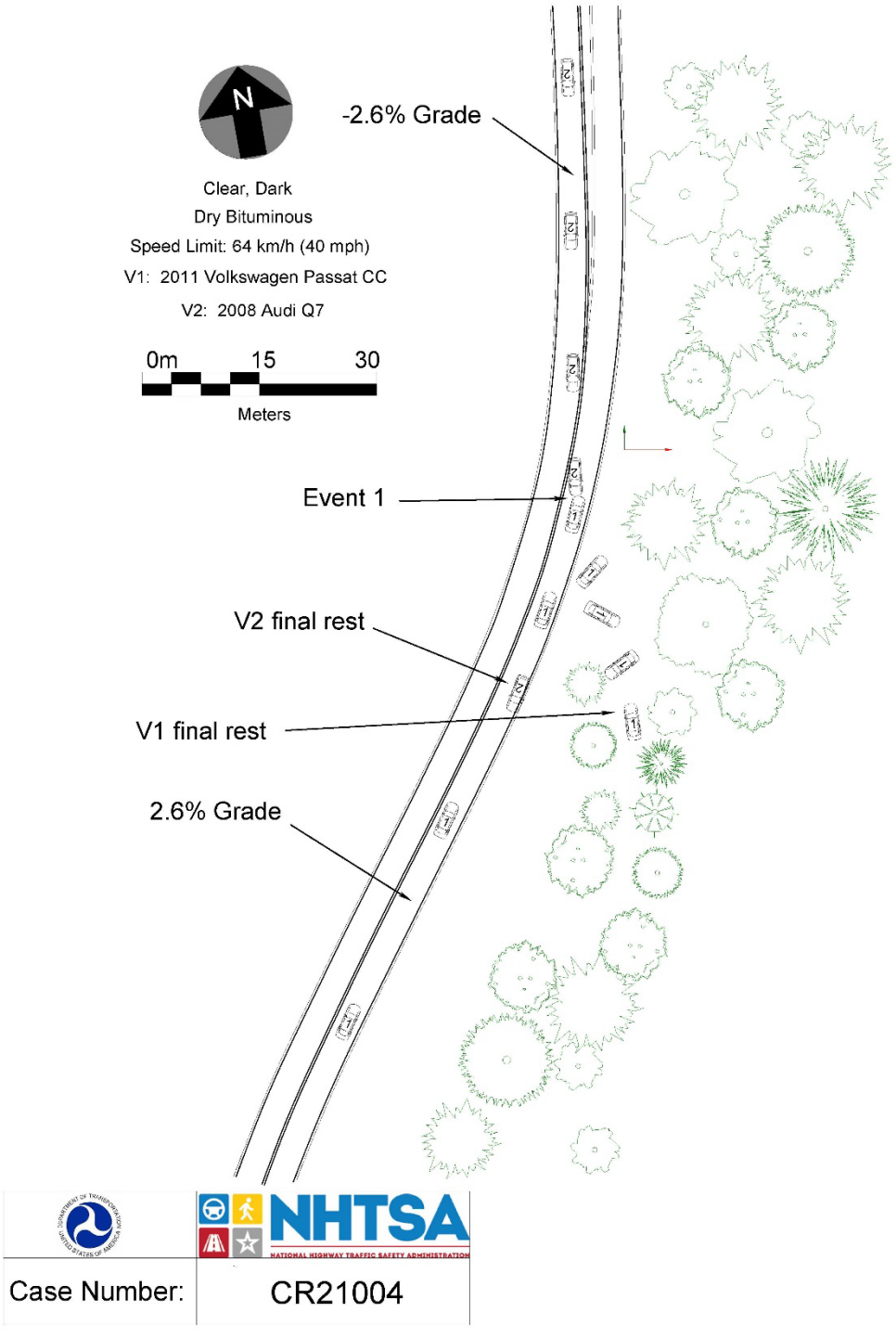


Figure 12. Frontal damage to the Audi. Image obtained from the investigating police agency.

Occupant Data

The Audi driver was a 30-year-old female. The police crash report indicated she was restrained by the lap and shoulder seat belt with additional protection provided by the deployment of the driver frontal air bag. She sustained police-reported C-level (possible) injuries and was transported by ambulance to a local hospital. Her treatment was unknown.

Crash Diagram



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