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**Special Crash Investigations:
On-Site Reported Air Bag Non-
Deployment Crash Investigation;
Vehicle: 2007 Volkswagen GTI;
Location: Florida;
Crash Date: March 2017**

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Special Crash Investigations
On-Site Reported Air Bag Non-Deployment Crash Investigation
Office of Defects Investigation
Case Number: CR17017
Vehicle: 2007 Volkswagen GTI
Location: Florida
Crash Date: March 2017

Background

This report documents the on-site investigation of the reported non-deployment of all air bag systems in a 2007 Volkswagen GTI (Figure 1). The Volkswagen departed the roadway on a curve, sideswiped a utility pole, struck a tree, rotated through a fence, and then sank in a pond. A belted 23-year-old male driver sustained fatal injuries in the crash. During its manufacture, the vehicle was originally equipped with front seat belt retractor pretensioners and certified advanced 208-compliant (CAC) frontal, front seat-mounted side impact, and roof side rail-mounted inflatable curtain (IC) air bags. The SCI investigator was unable to conclude whether the driver's frontal air bag deployed in the crash because the driver's entire frontal air bag module was missing from the vehicle at the time of the SCI inspection. The actuation status of the front retractor pretensioners also could not be confirmed. None of the Volkswagen's other supplemental restraint systems were deployed.



Figure 1. Left-front oblique view of the 2007 Volkswagen GTI at the time of the SCI vehicle inspection

The crash was reported to the National Highway Traffic Safety Administration by the deceased driver's family. The notification and on-site investigation assignment were forwarded to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in July 2017. The SCI team contacted the reporting person to obtain specifics concerning the crash, and then located the vehicle at an insurance vehicle salvage facility. The on-site portion of this investigation took place in July 2017 after cooperation was achieved with the vehicle's insurer. The on-site investigation consisted of an inspection of the vehicle that included measurement of the exterior and interior damage and intrusion, identification of occupant contact, and assessment

and documentation of the manual and supplemental restraint systems. No total station measurements of the Volkswagen could be documented due to the catastrophic damage to the vehicle. The SCI investigator also traveled to the crash site and documented the physical environment. The Volkswagen was not equipped with an Event Data Recorder (EDR) supported by the Bosch Crash Data Retrieval tool; therefore, no data could be imaged from the vehicle during the SCI inspection.

It was apparent to the SCI investigator that the crash event with the large-diameter tree was a significant impact that produced catastrophic longitudinal deformation to the Volkswagen. Under such circumstances, frontal supplemental restraint actuation/deployment commands would be expected. However, the deployment status of the driver's frontal air bag remains unknown because the entire module was missing from the vehicle at the time of the inspection. No EDR data were obtained from the vehicle to confirm or dispute the presence of actuation/deployment commands. With exception to the tree impact, the other crash events likely would not have resulted in supplemental restraint system deployment commands due to their minor severity/direction of force.

Summary

Crash Site

The crash occurred on a north/south roadway at night. Law enforcement documentation reported areas of dense fog with dark but lighted conditions. According to the national weather service, conditions at the time of the crash in the suburban locale included clear skies with a temperature of 15 °C (59 °F), a 90-percent relative humidity, and calm winds. A Nikon Nivo 5.M+ total station was used to document the physical environment of the roadway and crash site during the SCI inspection. Both northbound and southbound travel lanes were 3.5 m (11.5 ft) wide, separated by a painted center median with double-solid yellow lane lines and bordered by single solid white fog lines. In the area of the crash, the roadway curved left for southbound traffic along the Volkswagen's travel trajectory (Figure 2). The radius of the curve measured 315 m (1,033 ft). Speed was regulated by a posted limit of 64 km/h (40 mph).



Figure 2. Southbound view of the Volkswagen's pre-crash travel trajectory

The northbound lane was unsupported, with less than 0.2 m (0.6 ft) of asphalt present between the northbound fog line and the road edge. The southbound lane was bordered to the west by a narrow 0.6 m (2.0 ft) asphalt strip and concrete curb with concrete apron. West of the roadway, a 2.8 m (9.2 ft) wide sidewalk was separated from the west curb by a 3.4 m (11.1 ft) grass roadside. Utility poles with streetlights were positioned in this grass roadside. The roadway and sidewalk surfaces were bituminous (asphalt). A white vinyl fence was located beyond the sidewalk west of the roadway. It served as a visible barrier for a man-made drainage pond. Trees were also scattered along the roadside. The trunk of one of these trees measured 48 cm (18.9 in) in maximum overall diameter and was located 8.5 m (27.9 ft) west of the roadway edge (curb). A crash diagram is included at the end of this report.

Pre-Crash

The 23-year-old male was the sole occupant of the Volkswagen at the time of the crash. According to surrogate interviews conducted as part of the law enforcement investigation, it was established that the driver had attended an adult nightlife entertainment venue with his roommate the night of the crash. They returned to their residence, at which point the roommate had gone to bed. At some point, the driver left the residence on his own. His destination, route of travel, and the timeline of his activities remain unknown. Autopsy results showed a blood alcohol concentration of .198 g/dL, more than twice the legal limit.

He drove the Volkswagen south on the local roadway. Although the roadway was lined with overhead streetlights, weather conditions at the time of the crash included locally dense ground-level fog, which may have hindered visibility. He was unable to maintain the roadway as he proceeded southbound, and the Volkswagen began to drift right after it entered the left curve. The law enforcement investigation determined from the on-scene evidence they documented that he drove the Volkswagen at high speed. Although there was no EDR data obtained to support their conclusion, damage to the vehicle observed by the SCI investigator indicated that the Volkswagen had been traveling in excess of the 64 km/h (40 mph) posted limit when it struck the tree.

Crash

The first crash event occurred as the Volkswagen's right front tire mounted the curb of the west roadway edge (Event 1). This impact was of insufficient magnitude to affect or alter the vehicle's errant trajectory and did not produce occupant injury. However, damage to the concrete surface of the curb and possibly to the vehicle (overlapped by subsequent events) evidenced the event. The second crash event then occurred as the Volkswagen's undercarriage scraped and gouged the grass/soil surface of the roadside (Event 2). This event also did not produce occupant injury or alter the vehicle's trajectory, but it was evident in the law enforcement documentation of the crash site. Figure 3 shows the Volkswagen's crash trajectory, as viewed from the area of initial roadside departure. Note the shallow angle of the departure and the gouged ground. No crash event was assigned to the subsequent curb strike of the left front tire/wheel, due to a lack of physical damage to the vehicle and a lack of evidence at the crash site. The third crash event occurred as the rear aspect of the Volkswagen's right plane sideswiped the concrete utility pole (Event 3). Minor sideswiping damage (longitudinal abrasions) was noted to the vehicle. However, the minimal engagement was of insufficient severity to affect or alter the Volkswagen's errant trajectory.

Tire marks documented by law enforcement indicated that the vehicle maintained southbound momentum as the driver provided a left steering input. The Volkswagen crossed over the sidewalk and continued through the roadside. Tire marks evidenced the vehicle's arcing path from the utility pole swipe through the grass, across the sidewalk, and toward the large-diameter tree. This evidence (Figure 4) was visible in the on-scene images obtained from the investigating law enforcement agency. The Volkswagen's front plane struck the large-diameter tree in an off-set, head-on configuration (Event 4). This severe impact induced a rapid counterclockwise rotation to the Volkswagen as severe deformation occurred to the vehicle's front plane. Front plane and engine compartment components became separated from the vehicle and projected

about the area by the crash forces. The driver would have sustained substantial injury relative to this severe impact and the associated crash forces.



Figure 3. Location of the Volkswagen's roadside departure and first crash events (on-scene image obtained from the investigating law enforcement agency)

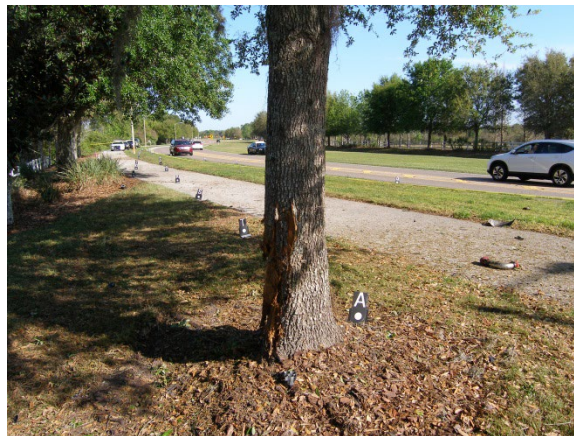


Figure 4. North-facing lookback view of the large-diameter tree along the vehicle's crash trajectory travel path (on-scene image obtained from the investigating law enforcement agency)

Following impact with the large-diameter tree, the Volkswagen rotated counterclockwise and was redirected to the west. The fifth impact event occurred as the vehicle's right and back planes contacted and displaced sections of a white vinyl fence (Event 5). Due to the slope of the roadside toward a drainage pond, the Volkswagen traversed backward along the downslope. Its undercarriage overrode the concrete end of a drainage culvert system (Event 6) that served the pond. This impact did not alter the vehicle's trajectory or induce occupant injury. The Volkswagen continued rearward and into the drainage basin, where it came to rest fully submerged in the water (Figure 5).



Figure 5. Southwest-facing view of the large-diameter tree, white vinyl fence, and concrete drainage culvert, with the vehicle at final rest in the pond (on-scene image obtained from the investigating law enforcement agency)

Post-Crash

There were no witnesses to the crash, and it was not discovered until several hours afterward by an unknown female who was out for a morning jog. While she was running along the sidewalk, she observed scattered vehicle debris and then saw the roof of the severely damaged vehicle submerged in the pond. The woman called the emergency dispatch center, which prompted a response by emergency services.

An on-scene investigation was conducted by local law enforcement, and the vehicle was recovered from the pond. The driver's body was found in the vehicle following removal from the pond, and he was pronounced deceased at the crash site by emergency responders. No medical treatment or transport was rendered. A medical examiner removed the driver's body from the vehicle for autopsy. The vehicle was then transferred to a local yard and held on impound before being declared a total loss by its insurer. It was later transferred to the vehicle salvage facility, where it was located at the time of the SCI inspection.

2007 Volkswagen GTI

Description

The 2007 Volkswagen GTI (Figure 6) was identified by the Vehicle Identification Number WVWHV71K77Wxxxxxx. It was a 4-door hatchback with front wheel drive, powered by a 2.0-liter, inline, 4-cylinder gasoline engine. The electronic odometer reading could not be obtained during the vehicle inspection due to complete disintegration of the instrument panel during the crash. The Volkswagen had a center-console-mounted shift lever for its 6-speed automatic transmission. It had a 258 cm (101.6 in) wheelbase and a curb weight of 1,406 kg (3,100 lb). Due to vehicle damage, the SCI investigator had no access to the vehicle's VIN placard. Gross vehicle weight rating and tire information specific to this vehicle remain unknown. At the time of the SCI inspection, the Volkswagen was equipped with four tires of size P205/40R17. Specific tire data were as follows:

	Make Model	Tire Identification Number (TIN)	Tread Depth	Restriction	Damage
LF	Haida Racing HD921	33A8 5015	6 mm (8/32 in)	Unknown	Wheel assembly separated from vehicle
LR	Lion Sport Lead	YCFB LUHP	6 mm (8/32 in)	None	None
RR	Lion Sport Lead	YCFB LUHP 2615	6 mm (8/32 in)	None	None visible
RF	Haida Racing HD921	33A8 5015	6 mm (8/32 in)	Unknown	Tire separated from wheel rim

The Volkswagen's interior had seating of up to five occupants. The driver and front-right seats were cloth-surfaced, forward-facing bucket seats with adjustable head restraints and manual seat track/seatback recline adjustments.



Figure 6. Front-right oblique view of the 2007 Volkswagen GTI at the time of the SCI vehicle inspection

At the time of the SCI inspection, the driver's seat was adjusted to a rearward track position, with the back slightly reclined and the head restraint fully downward. The second row was a non-adjustable, three-passenger bench seat. The seat track and seatback were fixed in position, and there were adjustable head restraints available for each seating location. All seat positions in the Volkswagen were originally equipped with 3-point lap and shoulder seat belt systems, as are described in the *Manual Restraint Systems* section of this report. The vehicle was equipped with an OEM supplemental restraint system that included front seat belt pretensioners and CAC frontal, seat-mounted side impact, and IC air bags, as are described in the *Supplemental Restraint Systems* section of this report.

Vehicle History

A commercially available vehicle history report was obtained from an independent company that used registration and reported title information. According to this history report, the Volkswagen had two separate owners during its history. The vehicle was first sold and registered in Virginia in 2007. It was then registered in Georgia in 2010, with an odometer reading of 87,550 km (54,401 mi). In 2012, its Georgia registration was renewed with an odometer reading of 123,258 km (76,589 mi).



Figure 7. Front-left oblique view of the 2007 Volkswagen GTI when listed for sale in 2015 (image obtained from a commercially available vehicle history report)

The Volkswagen was then offered for sale in January 2015. Records indicate that it remained listed for sale during 2015 before being sold in Florida at auction in December 2015. At the time, its odometer reading was noted as 180,247 km (112,000 mi). Figure 7 shows a left front oblique view of the Volkswagen from its classified sale listing in March 2015. This and other images were categorized in the commercially obtained vehicle history report. Aside from the incident crash, there were no other crashes or other damage reports in the Volkswagen's documented history.

Exterior Damage

Damage to the front, right, and undercarriage planes of the Volkswagen occurred relative to the events of the crash. No total station measurements of the vehicle could be documented because

the complete separation of all front plane structural components and the overall catastrophic damage to the vehicle would have made the results inaccurate and unable to be replicated. Tire/wheel damage from the initial curb strike (Event 1) was overlapped by subsequent events. However, the occurrence of the impact was documented by the visible physical damage to the concrete curb in the law enforcement images of the crash scene.

Impact forces were of insufficient severity to affect the vehicle's trajectory, induce occupant injury, or produce residual deformation to the vehicle. The Collision Deformation Classification (CDC) assigned for Event 1 was 12FRWN3. No WinSMASH calculations could be performed because the impact type was beyond the scope of the model's capabilities. The undercarriage of the vehicle could not be inspected for damage corresponding to the ground impact (Event 2) due to an inability of the SCI investigator to elevate the vehicle for such an inspection. The occurrence of the undercarriage impact was documented by visible gouging to the soil surface of the roadside by the law enforcement's on-scene photographs. Associated crash forces were of insufficient magnitude to affect the Volkswagen's trajectory or induce occupant injury. The estimated CDC assigned to the Volkswagen for the undercarriage ground impact (Event 2) was 00UDDW99. No WinSMASH calculations could be computed due to the non-horizontal nature of the impact forces that were beyond the scope of the model.



Figure 8. Right-rear oblique view of the Volkswagen's Event 3 damage, overlapped by damage from Event 5

Minor damage was visible to the rear aspect of the Volkswagen's right plane from the sideswiping impact with the concrete utility pole (Event 3). This damage was overlapped by damage from the impact with the white vinyl fencing (Event 5). However, the distinct differences in the type of the deformation patterns from these events made it possible to distinguish the damage attributable to each specific event. Associated with the sideswipe of the concrete utility pole was minor lateral deformation of the right quarter panel, with lengthy longitudinal abrasions that extended across the right quarter panel. The most pronounced deformation and damage was located on the fender flare directly above the right rear axle (Figure 8). The CDC assigned for the Event 3 damage was 12RBES1. No WinSMASH calculations could be computed due to the lack of residual deformation and sideswiping nature of the crash forces that were beyond the scope of the model's capabilities.

Catastrophic damage occurred to the forward half of the vehicle relative to the frontal impact with the large-diameter tree (Event 4). The front bumper fascia, bumper filler, grille, headlights, and entire bumper beam were completely separated from the vehicle. Underhood components, including the entire engine and transmission, had sheared from their mounts and were completely separated during the impact. The hood was separated on the left side, with a distinct U-shaped pattern of deformation on its leading aspect. The front plane damage included the collapse of the left frame rail, which was wrapped outward and rearward with the end of the frame rail displaced to the area of the left sill/left lower A-pillar. The structure of the Volkswagen's left plane was deformed/displaced outward from the front plane to the left B-pillar, with separation of the left front fender, left sill, left A-pillar, and left front door.



Figure 9. Overhead view of the damaged Volkswagen at the time of the SCI inspection

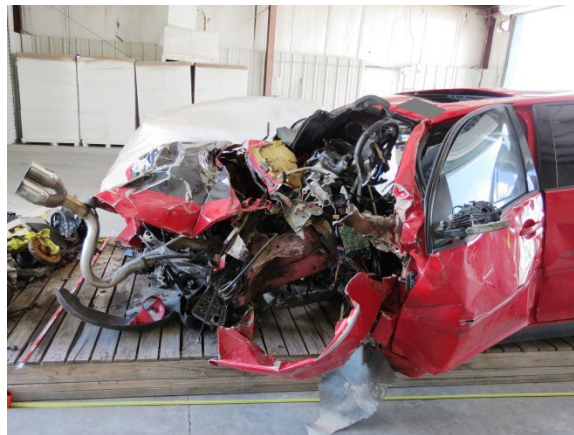


Figure 10. Left-lateral view of the damaged Volkswagen at the time of the SCI inspection

Figure 9 is an overhead perspective of the Volkswagen showing the separation of front components, structural overload, and the outward separation of the forward left plane. Figure 10 shows a left lateral view of the deformation severity and extent. The CDC assigned to the Volkswagen for the Event 4 impact with the large-diameter tree was 12FDEW5.

The severity of the Volkswagen's front plane damage and separation of all structural members typically used for crush assessment prevented standardized documentation of the vehicle's

deformation profile. The separated bumper beam of the Volkswagen was located during the vehicle inspection process, and it was observed that the deformed beam had a distinct U-shaped deformation pattern that matched the approximate dimensional width of the large-diameter tree it struck. In its deformed state, the overall width of the bumper beam measured 68 cm (26.8 in). Although not representative of the total crush to the vehicle, a profile of the separated bumper beam was documented using calibrated measuring tape and rods (Figure 11) to provide at least some representation of the deformation to the Volkswagen and facilitate an estimation of the absolute minimum delta V for analysis purposes. This profile produced the following measurements: C1 = 0 cm (0 in), C2 = 21 cm (8.3 in), C3 = 40 cm (15.7 in), C4 = 40 cm (15.7 in), C5 = 20 cm (7.9 in), and C6 = 0 cm (0 in). Maximum crush was located near the bumper beam's centerline and measured 42 cm (16.5 in) in magnitude. Again, these measurements were substantially less than and not representative of the actual deformation to the vehicle, but they provided a minimum degree of estimation/analysis. WinSMASH calculations using the bumper beam crush alone produced a calculated minimum delta V of 39 km/h (24 mph). This value is a substantial underrepresentation of the actual delta V of tree impact (Event 4), provided for informational purposes only and not to be used as a reliable source of crash severity in this crash.



Figure 11. Overhead view of the deformed and separated bumper beam, with the crush measurement gauge

Damage to the Volkswagen from the Event 5 impact with the vinyl fence was located at the right rear corner of the vehicle and partially overlapped the Event 3 damage pattern. However, the damage from the white vinyl fence was more angular to the vehicle's right plane, and therefore was distinguishable from the Event 3 damage profile. The white fence left multiple small dents in the right quarter panel/C-pillar area of the vehicle that were highlighted with white transfer onto the vehicle's red-painted surface. There were also spots of white vinyl transfer on the backlight of the Volkswagen's hatch, as well as on the red polymer surface of the right taillight assembly. The minor severity of the damage profile did not include a measurable deformation profile. However, distribution of the damage above the beltline increased the extent of the damage. The CDC assigned to the Volkswagen for the vinyl fence impact was 05RBAE2. No WinSMASH calculations could be computed for this event due to the lack of deformation and yielded status of the struck object, which were beyond the scope of the model.

Damage associated with the sixth and final crash event was located on the Volkswagen's undercarriage from impact with the concrete culvert end. Although the SCI investigator was not able to elevate the vehicle for inspection, it was noted that the vehicle's exhaust tips/ends (originally located beneath the rear bumper) extended awkwardly out from beneath the front of the damaged vehicle. The exhaust ends had engaged the concrete culvert ends during the vehicle's rearward displacement (evidenced by gouges and scrapes on the concrete) and subsequently were bent around underneath the vehicle as it continued rearward. The rear bumper fascia was also separated completely from the vehicle. The CDC assigned to the Volkswagen for the Event 6 damage was 00UDDW2. No WinSMASH calculations could be computed for the event due to the non-horizontal nature of the impact forces that were beyond the scope of the model.

Event Data Recorder

The 2007 Volkswagen GTI had an air bag control module (ACM) mounted to the floor on the center tunnel beneath the center console. The specific functions of the Volkswagen's ACM remain undefined due to the inability of the SCI investigator to retrieve data during the inspection. In a generic sense, the defining functions of an ACM include monitoring the diagnostic functions of the vehicle's restraint systems (seat belt pretensioners and air bags) and controlling the actuation/deployment of those devices dependent upon crash event trigger severity. The Volkswagen was not equipped with an EDR supported by the Bosch CDR software/tool. No crash data were obtained from the Volkswagen during or after the SCI vehicle inspection.

Interior Damage

The interior of the Volkswagen was inspected for crash-related damage and occupant contact. Catastrophic front plane deformation associated with the Event 4 impact with the large-diameter tree included severe rearward intrusion of frontal components in the Volkswagen's interior.

The steering column was displaced rearward and vertically with the instrument panel, such that it intruded longitudinally into the driver's area. However, occupant loading had contributed to the column's deformation, such that measurement of the intrusion of the steering wheel and column could not be accurately documented. Documented occupant compartment intrusions included the following:

Component	Magnitude	Direction
Left instrument panel	>=30 cm (11.8 in) but < 46 cm (18.1 in)	Longitudinal
Left toe pan	>=15 cm (5.9 in) but < 30 cm (11.8 in)	Longitudinal
Right toe pan	>=15 cm (5.9 in) but < 30 cm (11.8 in)	Longitudinal
Left floor pan	>=8 cm (3.1 in) but <15 cm (5.9 in)	Vertical
Right instrument panel	<=2 cm (0.8 in)	Longitudinal

The submergence of the vehicle into the pond during the crash, in conjunction with the passage of time since the date of the crash, and the open exposure of the vehicle's interior to the elements prevented identification during the SCI vehicle inspection of any occupant contact that had consisted of skin/tissue transfers, blood, cosmetics transfer, and others. However, the SCI investigator was able to identify probable occupant loading to the steering wheel/column and left

instrument panel. Forward of the driver's space, the instrument panel was flattened forward and displaced upward. The steering wheel was collapsed, and the column was displaced vertically. It was evident that the driver had experienced severe loading of the steering wheel, steering column, and instrument panel during the crash sequence. Figure 12 shows a forward-facing view of the instrument panel from the second-row center perspective. Figure 13 shows an overhead lateral perspective of the collapsed steering wheel and displaced column.



Figure 12. Forward-facing view of the Volkswagen's intruded and heavily damaged instrument panel



Figure 13. View of the Volkswagen's displaced and severely damaged steering column

All four of the Volkswagen's doors had remained closed during the crash. Both left side doors were jammed shut by the deformation associated with the crash. With exception to the vehicle's laminated windshield and tinted sunroof, all the Volkswagen's side and backlight glazing remained intact and undamaged post-crash. The sunroof had disintegrated, and the windshield glazing had completely fractured and partially separated during the crash sequence.

Manual Restraint Systems

The Volkswagen was equipped with 3-point lap and shoulder OEM seat belt systems for all five seat positions. Both the driver's and front passenger's seat belt systems used continuous loop

webbing with sliding latch plates and height-adjustable D-rings at their respective B-pillar-mounted positions. The driver's seat belt system retracted onto an emergency locking retractor (ELR), while the passenger's seat belt used an ELR/Automatic Locking Retractor (ALR). Both were equipped with retractor pretensioners.

At the time of the SCI vehicle inspection, the driver's seat belt system was locked in position. In the absence of EDR data and an inability to disassemble the driver's retractor for inspection, it remains unknown if the driver's retractor was locked due to actuation of the pretensioner or from the engagement of the system's ELR mode. Much of the webbing had retracted into the pillar, with little slack remaining. The SCI investigator documented the exposed webbing and seat belt system, then attempted to spool the remainder of the webbing from the retractor. More webbing was fed into the retractor, but the retractor remained locked in position. The SCI investigator was unable to spool any additional webbing from the retractor, therefore unable to inspect the condition of the remaining webbing. However, there was evidence of heavy loading visible in the belt path of the latch plate (Figure 14). Based on the post-crash condition of the driver's seat belt system observed by the SCI investigator, it was apparent that the driver was belted at the time of the crash. This conclusion was supported by on-scene photographs obtained from the investigating law enforcement agency, which showed the upper portion of driver's body restrained by the shoulder portion of the buckled driver's seat belt system.



Figure 14. Heavy loading evidence visible in the belt path of the Volkswagen driver's seat belt latch plate

The front-right seat belt system was loosely retracted against the right B-pillar at the time of the inspection. Webbing spooled freely from the operational retractor. The right-front position was not occupied at the time of the crash, and the belt system therefore was not in use.

Supplemental Restraint Systems

The 2007 Volkswagen GTI was equipped with OEM supplemental restraints for occupant protection. A CAC frontal air bag system incorporated the driver's and passenger's OEM frontal air bags with front seat belt retractor pretensioners, front seat track position sensors, front seat belt buckle switch sensors, and a front-right occupant presence (weight) sensor. The Volkswagen was further equipped with seat-mounted and IC air bags for side impact protection.

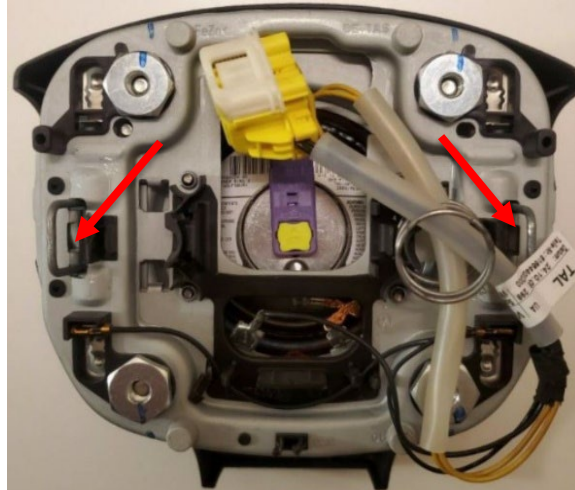


Figure 15. Rear view of an exemplar 2008 Volkswagen Golf driver air bag module, with the press-fit retainer clasps indicated by the red arrows

The design of the Volkswagen's driver air bag module consisted of a press-fit module retained by tension. There were two metallic, U-shaped hooks, one each at the 3 o'clock and 9 o'clock positions on the rear aspect of the driver's air bag module (Figure 15), which clasped onto the steering wheel hub when the module was pressed into position. The U-shaped clasps held the module in the hub using tensional and frictional forces; there were no hardware/fasteners. Because no mechanical fasteners were used in its design to physically secure the driver's air bag module in the steering wheel hub, removal of the module could be done using only a flathead screwdriver. The process¹ began by disconnecting the battery and adjusting the steering wheel to its highest and fully extended position, rotated 90 degrees counterclockwise. The screwdriver was then inserted into a hole on the rear of the wheel to a depth of approximately 8 mm (0.3 in) and rotated to unlock the right U-shaped hook. The wheel was then rotated 180-degrees clockwise, with the same process using the screwdriver repeated to disengage the left U-shaped hook. The entire air bag module could then be completely separated from the vehicle by disconnecting the wiring harnesses.

At the time of the SCI vehicle inspection, the steering wheel assembly was observed to be severely deformed, and the entire driver's frontal air bag assembly was missing from its mounted location. The wheel was collapsed circumferentially about the hub. The column was deformed vertically and laterally, and awkwardly protruded upward through the opening created by the missing windshield glazing (refer to Figure 13, page 13). The hub was fractured through its center aspect, as well as at both of the air bag module's press-fit anchor locations (Figure 16) and also around its outer circumference. Therefore, in this case, the severe compromise of the hub/assembly had the potential to release the tension on the U-shaped hooks, which could possibly release the air bag module from the hub and allow the entire air bag module to separate from the vehicle.

¹ 2007 Volkswagen GTI 2.0, Mitchell Repair Information Company, January 2022. <https://eautorepair.net/Marketing/Default.asp>.

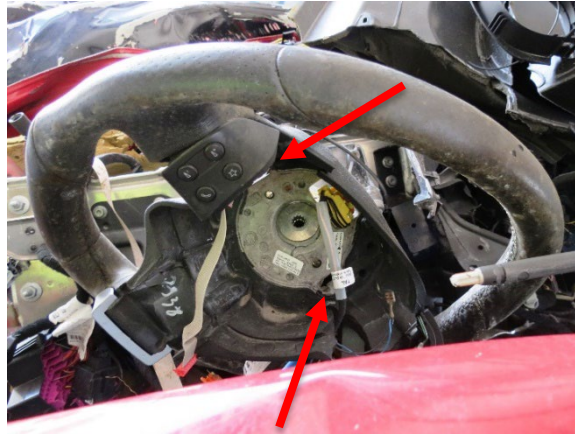


Figure 16. View of the Volkswagen's fractured steering wheel hub, with fractured clasp locations highlighted by red arrows



Figure 17. Law enforcement image of the steering column and damaged electrical wiring/connectors

Electrical wires, including those for the air bag module, were pulled apart from the hub and exposed. Several of the connectors and wires were broken and/or severed. One of the law enforcement images showed the severed/pulled electrical wires during their on-scene investigation of the crash (Figure 17). The vehicle history report had no indication of service, replacement, or alteration to the vehicle's supplemental restraint systems, and the vehicle was equipped with the OEM steering wheel/assembly. However, the driver's air bag module was missing from the steering wheel hub/assembly and was not with the vehicle at the time of the SCI inspection. Law enforcement documentation reported the observation that the driver's air bag module was missing from the vehicle and could not be located following recovery of the vehicle from the pond. No EDR data were available during the SCI vehicle inspection to confirm that the driver's retractor pretensioner and driver's frontal air bag were commanded to actuate/deploy relative to the crash. However, the SCI inspection of the vehicle concluded that none of the vehicle's remaining supplemental restraint systems actuated or deployed in the

incident crash, including the front-right retractor pretensioner, passenger's frontal air bag, front seat-mounted air bags, and IC air bags.

Air Bag Non-Deployment Discussion

The SCI reconstruction of the crash determined that the primary and most severe crash event was the impact of the Volkswagen with the large-diameter tree. Although there were no EDR data to support the reconstruction, the remaining crash events were likely of minor severity and would not be expected to produce supplemental restraint actuation/deployment commands. The SCI investigator was unable to image any EDR data from the Volkswagen, which was not compatible with or supported by the Bosch CDR tool/software. Without formal data concerning the Volkswagen's ACM and its ability to recognize crash events, no conclusions regarding an anomaly of the vehicle's supplemental restraint systems could be made. Facts related to this crash include the following:

- Event 1 (right-front tire/wheel with the curb of the roadway) produced minimal crash forces, and supplemental restraint actuation/deployment would not be expected.
- Event 2 (undercarriage with the grass/soil surface) also produced minimal forces, and supplemental restraint actuation/deployment would not be expected.
- Event 3 (right-rear aspect with the concrete utility pole) produced minimal sideswiping crash forces. Such minimal severity forces well outside of the vehicle's center of mass would not be expected to result in supplemental restraint actuation/deployment.
- Event 4 (front plane with the large-diameter tree) was a catastrophic crash event. Severe deceleration and longitudinal forces resulted from the vehicle's crash into the tree, which produced severe deformation to frontal components with substantial displacement/intrusion in the vehicle's interior. Impacts of this magnitude in similar vehicles would be expected to produce supplemental restraint actuation and deployment, particularly with regard to frontal crash protection systems.
- Event 5 (right-rear aspect with the vinyl fence) was a minor severity crash event that produced low-magnitude lateral crash forces and forward longitudinal crash forces. Such events would not be expected to produce supplemental restraint deployment in similar vehicles or under similar circumstances.
- Event 6 (undercarriage with the concrete culvert end) did not produce forces of sufficient magnitude to elicit supplemental restraint actuation or deployment. The positive longitudinal nature and minor severity of the associated crash forces would not be expected to produce actuation/deployment commands in similar vehicles.
- SCI inspection of the vehicle confirmed that the Volkswagen had an OEM steering wheel and hub assembly, with wiring harnesses and connections for a driver's frontal air bag module. However, the entire module was missing after the crash, as documented by the law enforcement agency, and was not with the vehicle at the time of the SCI inspection.
- Several injuries to the driver documented by the medical examiner included sliding/burning type abrasions to the face, as well as abrasions to the neck, chin, and chest. His body responded to the severe frontal impact with the tree by translating

forward and loading the seat belt system, as well as other frontal components. However, despite the severe deformation to the vehicle and interior intrusion, the driver did not sustain any rib or sternum fractures.

- The driver's retractor pretensioner was locked in position. Although equipped with a pretensioner, the status of the pretensioner could not be determined due to the inability to disassemble the retractor for inspection and the lack of EDR data.
- No actuation/deployment occurred for the front-right seat belt pretensioner, passenger's frontal air bag, driver's seat-mounted air bag, front-right seat-mounted air bag, or the IC air bags.
- The steering wheel hub was fractured in several locations, including specific fractures at both of the press-fit anchor locations.

The SCI analysis of the crash identified that the only crash event associated with expectations of actuation/deployment commands was Event 4, the crash into the large-diameter tree. The actuation/deployment commands expected for the event would include the driver's seat belt retractor pretensioner and the driver's frontal air bag. No deployment of the passenger's frontal air bag would be expected due to likely suppression by the CAC system relative to the unoccupied status of the front-right seat.

2007 Volkswagen GTI Occupant

Driver Demographics

Age/sex: 23 years/male
 Height: 173 cm (68 in)
 Weight: 77 kg (169 lb)
 Eyewear: Unknown
 Seat type: Forward-facing bucket seat
 Seat track position: Unknown
 Manual restraint usage: 3-point lap and shoulder seat belt
 Usage source: SCI vehicle inspection
 Air bags: OEM with frontal, seat-mounted side impact, and IC air bags.
 Deployment status or presence of frontal air bag unknown; seat-mounted side impact and IC air bags not deployed
 Alcohol/drug data: BAC = .198 grams per deciliter
 Egress from vehicle: None
 Transport from scene: None
 Type of medical treatment: None; pronounced deceased at the crash scene

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Circumferential ring fracture to base of skull	150206.4	Steering wheel (combination of rim and hub/spoke)	Probable
2	Diffuse subarachnoid hemorrhage of the cerebellum	140466.2	Steering wheel (combination of rim and hub/spoke)	Probable
3	Closed fracture of right upper arm, NFS	751800.2	Left instrument panel	Probable
4	Closed fracture of right forearm, NFS	751900.2	Left instrument panel	Probable
5	Closed fracture of left femur, NFS	853000.3	Left lower instrument panel	Probable
6	Closed fracture of right foot, NFS	852004.2	Left toe pan	Probable
7	Diffuse hemorrhage of subgaleal tissues	110402.1	Steering wheel (combination of rim and hub/spoke)	Probable
8	Left frontal scalp contusion	110402.1	Steering wheel (combination of rim and hub/spoke)	Probable
9	Left frontal scalp focal red abrasions	110202.1	Steering wheel (combination of rim and hub/spoke)	Probable
10	Focal red abrasions to right posterior parietal scalp behind right ear	110202.1	Seatback	Possible
11	Mandible fracture, NFS	250600.1	Steering wheel (combination of rim and hub/spoke)	Probable
12	Left jaw laceration	210600.1	Steering wheel (combination of rim and hub/spoke)	Probable

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
13	Left jaw, chin, and facial abrasions	210202.1	Steering wheel (combination of rim and hub/spoke)	Probable
14	Facial contusions	210402.1	Steering wheel (combination of rim and hub/spoke)	Probable
15	Chin contusions	210402.1	Steering wheel (combination of rim and hub/spoke)	Probable
16	Neck abrasions	310202.1	Seat belt webbing, Steering wheel (combination of rim and hub/spoke)	Probable
17	Chest contusions	410402.1	Seat belt webbing	Probable
18	Chest abrasions	410202.1	Seat belt webbing	Probable
19	Scattered linear abrasions to the back	410202.1	Unknown	N/A
20	Abdominal contusions	510402.1	Seat belt webbing	Probable
21	Abdominal abrasions	510202.1	Seat belt webbing	Probable
22	Right upper extremity contusions	710402.1	Left instrument panel	Probable
23	Right upper extremity abrasions	710202.1	Left instrument panel	Probable
24	Left upper extremity contusions	710402.1	Left upper A-pillar	Probable
25	Left upper extremity abrasions	710202.1	Left upper A-pillar	Probable
26	Right knee laceration	810600.1	Left lower instrument panel	Probable
27	Lower right leg contusions	810402.1	Left lower instrument panel	Probable
28	Lower right leg abrasions	810202.1	Left lower instrument panel	Probable
29	Lower left leg contusions	810402.1	Left lower instrument panel	Probable
30	Lower left leg abrasions	810202.1	Left lower instrument panel	Probable

Source: medical examiner report.

Driver Kinematics

The 23-year-old male was positioned in the driver's seat of the Volkswagen, which was adjusted to an unknown track position. The driver's seat back was slightly reclined, and the adjustable head restraint was fully downward. Heavy loading evidence in the belt path of the latch plate observed by the SCI investigator during the inspection indicated that the driver was belted by the 3-point lap and shoulder seat belt system at the time of the crash. The exact positioning of the belt on the driver at the time of the crash remains unknown.

He drove the Volkswagen southbound on the local roadway. Based on the scene evidence documented by the law enforcement agency and the SCI crash site inspection, the Volkswagen traveled at high speed as it entered the left curve.

The driver remained restrained inside the vehicle, but he did not provide evasive steering or braking input when the Volkswagen began to drift right from its travel lane at the onset of the curve. The first and second impact events with the curb and ground were of insufficient magnitude to induce occupant injury. Arching tire marks from the vehicle through the roadside that began after the roadside departure indicated that the curb and ground impacts alerted the driver to the vehicle's errant trajectory. The driver provided a slight left steering input as the Volkswagen maintained its high-speed trajectory through the roadside. Sideswiping impact

forces associated with the third crash event with the concrete utility pole were of insufficient magnitude to alter the Volkswagen's trajectory or induce occupant injury.

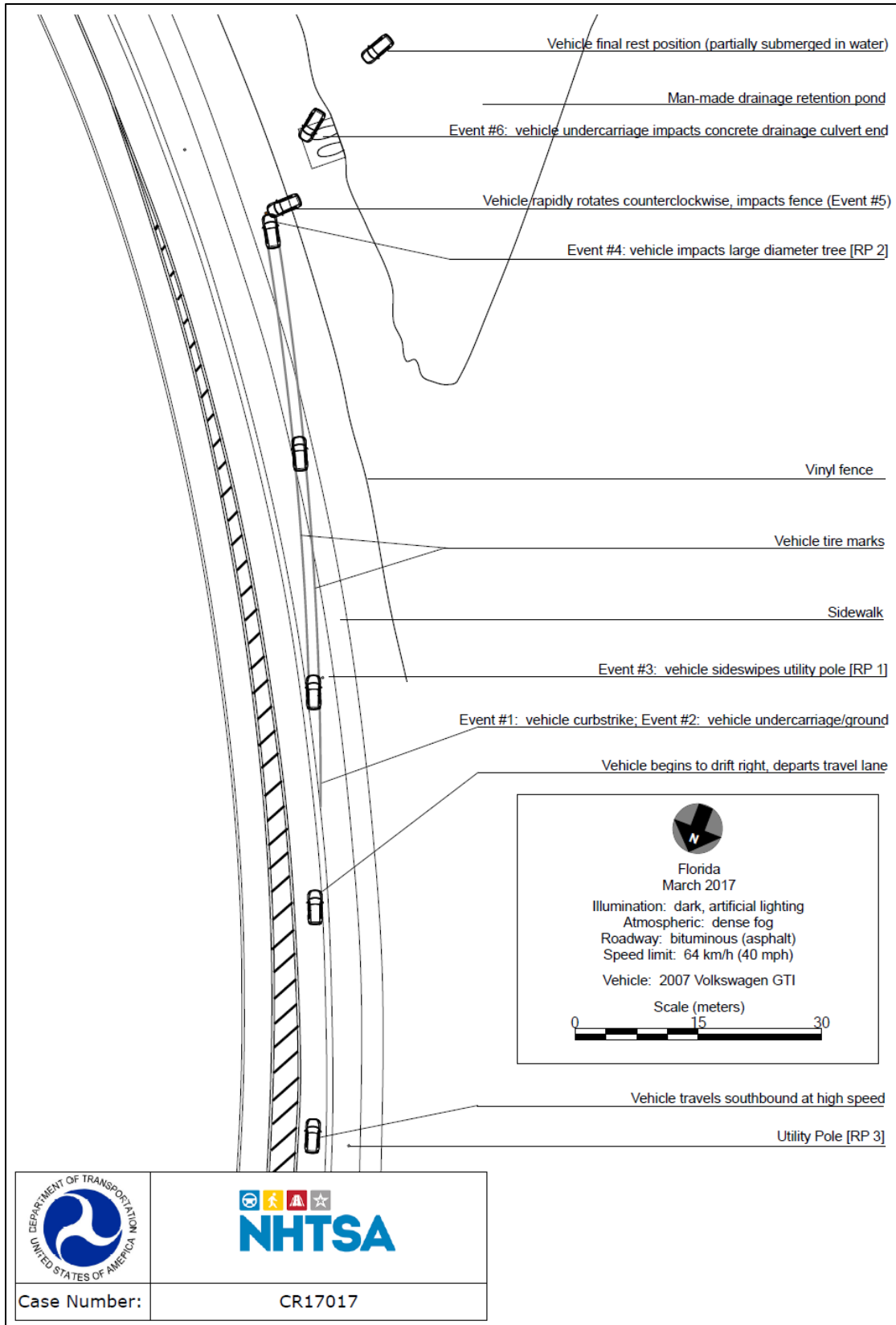
The driver remained belted in his seat as the vehicle approached the large-diameter tree. At impact, the driver initiated a rapid forward trajectory. He loaded the seat belt system, evidenced by heavy abrasions to the polymer surface of the latch plate as observed during the SCI vehicle inspection. As the Volkswagen struck the tree, the catastrophic deformation to the front of the vehicle resulted in severe longitudinal displacement of the vehicle's interior frontal components. The instrument panel and steering column intruded rearward and vertically toward the driver, while he maintained his forward trajectory. The steering wheel and column may have engaged the windshield header and/or upper A-pillar while they were displaced and deformed.

The driver suffered numerous injuries relative to his contact and loading of intruded components, including the belt system, steering wheel/column, and left instrument panel. Although he remained belted, the rearward intrusion of the frontal components and his forward response directed the driver's body and extremities downward. It was noted that the driver sustained sliding/burning type abrasions to the face, as well as abrasions to the neck, chin, and chest. However, despite the substantial intrusion of frontal components and the severe nature of the crash, the driver did not sustain any rib fractures.

The fifth impact event with the vinyl fence was of insufficient magnitude to elicit a kinematic response from the driver. The undercarriage impact with the drainage culvert also did not affect his kinematics.

At the time of the discovery of the crash and the driver, his body had been displaced from position due to the crash and submergence of the vehicle into the pond. His body had slid downward and forward, with his legs extended outward into the opening between the left A-pillar and the separated left door/left plane. The seat belt remained buckled. Although the pre-crash positioning of the belt on the driver remains unknown, post-crash the shoulder portion of the belt was beneath the driver's left arm and chin, and the lap portion was across his chest, resulting from his displacement during the catastrophic frontal crash. The driver was pronounced deceased without receiving any medical treatment/care. His body was removed from the vehicle by the medical examiner for autopsy. The autopsy listed blunt trauma as the cause of death.

Crash Diagram



DOT HS 813 287
May 2022



U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

