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Special Crash Investigations: On-Site Driver Air Bag Inflator Rupture Crash Investigation; Vehicle: 2006 Ford Ranger; Location: Louisiana; Crash Date: March 2017

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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 on-site investigation of the rupture of the driver's frontal air bag inflator in a 2006 Ford Ranger during a frontal impact with a parked 2005 Nissan Armada. The 52-year-old male driver suffered police-reported A-level (incapacitating) injuries. The crash occurred as the Ford was traveling southbound on a two-lane residential street operated by the vehicle's sole occupant. He reported to the police that he swerved to the right to avoid a dog that ventured into the vehicle's path. The Ford then departed the right side of the street where its front plane struck the front plane of a 2005 Nissan Armada parked and unoccupied on the west roadside. The impact caused the driver's frontal air bag in the Ford to deploy. During the deployment sequence, the driver's frontal air bag inflator ruptured. Separated fragments of the inflator were projected rearward and penetrated the right aspect of the driver's chest. The driver was transported by ambulance to a hospital for emergency surgery and treatment of his injury.

A query on www.nhtsa.gov/recalls using the search by the vehicle identification number feature indicated that this Ford Ranger was subject to one unrepaired recall, identified by NHTSA recall number 18V023, issued on January 11, 2018. This recall concerned the high risk for the inflators of the driver's frontal air bag to rupture in the event of a crash. The referenced recall was an expanded action to the driver's frontal air bag recall in the Ford Ranger, originally issued on January 25, 2016 (NHTSA recall number 16V036). The date of the crash under SCI investigation was March 2017.

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Background

This report documents the on-site investigation of the rupture of the driver's frontal air bag inflator in a 2006 Ford Ranger (Figure 1) during a frontal impact with a parked 2005 Nissan Armada. The 52-year-old male driver suffered police-reported A-level (incapacitating) injuries during the event. The legal representative for the driver provided notification of the crash to the National Highway Traffic Safety Administration in April 2018. The notification was forwarded to the Special Crash Investigations (SCI) group and assigned for an on-site investigation in May 2018. Safety systems in the Ford included 3-point lap and shoulder seat belts with buckle pretensioners, and single-stage driver's and passenger's frontal air bags.

Figure 1. Front-right oblique view of the damage to the 2006 Ford Ranger

A query of www.nhtsa.gov/recalls using the search by the vehicle identification number feature indicated that this Ford Ranger was subject to one recall, identified by NHTSA recall number 18V023, issued on January 11, 2018. This recall concerned the high risk for the frontal air bag inflators to rupture in the event of a crash. The referenced recall was an expansion of the earlier recall of driver's air bag inflators installed in the 2004 to 2006 Ford Ranger. The original recall, issued on January 25, 2016, was identified by NHTSA recall number 16V036. It was then superseded by NHTSA recall number 17V787 on December 11, 2017.

The Ford Ranger was in the possession of the driver's attorney, who retained possession and stored it since the March 2017 crash. At the attorney's request, the on-site SCI inspection was scheduled and conducted in June 2018. Technical representatives from Ford Motor Company attended and participated in the vehicle inspection and the removal and disassembly of the driver's frontal air bag module.

The crash occurred as the Ford was driven southbound on a two-lane residential street operated by a belted 52-year-old male, the sole occupant. The driver reported to the police that he swerved to the right to avoid a dog that ventured into the vehicle's path. The Ford then departed the right side of the street, where its front plane struck the front plane of a 2005 Nissan Armada parked and unoccupied on the west roadside. The impact caused the driver's frontal air bag in the Ford to deploy, during which the air bag inflator ruptured. Inflator fragments projected rearward and penetrated the right aspect of the driver's chest. The driver was transported by ambulance to a hospital for emergency surgery.

The on-site investigation involved measurements of the Ford's exterior and interior damage, the identification of occupant contact points, passenger compartment intrusion, and an evaluation of the manual restraint systems. Additionally, a detailed examination of the supplemental restraint systems and its driver's frontal air bag module for the inflator rupture was performed. The Ford had a restraint control module (RCM) that had Event Data Recorder (EDR) capabilities supported by the Bosch Crash Data Retrieval (CDR) tool/software. The EDR data were imaged by Ford, and an electronic copy of the file was provided to SCI. Due to the 14-month time frame between the date of the crash and the SCI crash notification, the crash site was not inspected.

Summary

Crash Site

The crash occurred in the morning on a two-lane local street in an urban, residential area in daylight. The National Weather Service reported the conditions as scattered clouds with a temperature of 24 ºC (75 ºF) with northerly winds of 13 km/h (8 mph) and a relative humidity of 85 percent. The police-reported conditions were clear and dry. Details regarding the crash site were obtained using online satellite imagery and mapping software.

The crash occurred on a straight and level section of a local street in a residential neighborhood. The street consisted of two lanes providing for traffic flow in the north and southbound directions. The surface was asphalt, and it was void of pavement marking. Gravel and cut grass bordered both sides of the street and provided for off-road parking. The crash location was reported by the police as 46 m (150 ft) from an intersecting street. There were no traffic controls for north or southbound traffic. The posted speed limit was 56 km/h (35 mph). Figure 2 is a southbound street view of the crash site obtained from an internet mapping software. The parked/struck position of the Nissan was captured in the image.

Figure 2. Southbound view of the crash site and the final rest position of the Nissan (image obtained from an online mapping software)

Pre-Crash

The 52-year-old male driver of the Ford was operating the vehicle in a southerly direction at a police-reported speed of 56 km/h (35 mph). The EDR in the 2006 Ford Ranger was not capable of recording pre-crash vehicle speed data. The driver stated that he steered right to avoid a dog that entered the street directly in front of him. The 2005 Nissan Armada was parked on the west roadside of the local street facing north, exposing its front end to southbound traffic. The driver's avoidance of the dog caused the Ford to depart the right edge of the street onto the roadside.

Crash

The front of the Ford struck the front of the Nissan (Figure 3) in an off-set head-on configuration involving impact forces within the 12 o'clock sector to both vehicles. Structurally, the damage was concentrated on the front-plane, right, and center aspects of both vehicles. The crash forces

were sufficient to deploy the frontal air bags in the Ford. The driver's module ruptured during deployment, displacing a metal fragment into the right-upper quadrant of the driver's chest. As the vehicles crushed to maximum engagement, the momentum of the Ford displaced the Nissan rearward. Both vehicles likely came to rest near the point of impact, either engaged or in close proximity to one another.

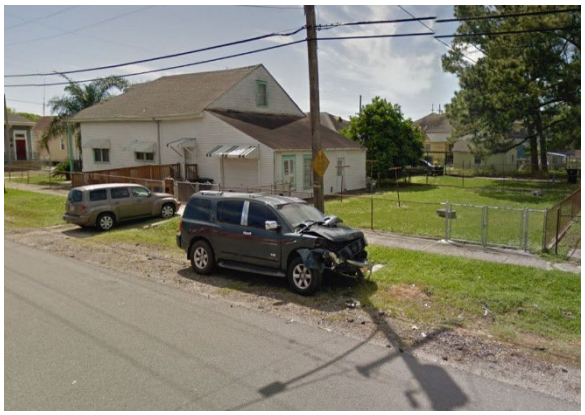


Figure 3. Oblique view of the Nissan at its final rest position (image obtained from an online mapping software)

Post-Crash

A resident at the crash site notified the emergency response system and requested police and medical assistance. The first police officer arrived within 5 minutes of the crash. This officer told the driver that emergency medical services (EMS) personnel were in route. EMS personnel arrived within 7 minutes of the call and evaluated the driver in the vehicle. He was removed from the Ford, placed on a cot, and transported by ambulance to a local Level-1 trauma center, where he was rushed into surgery for treatment of a penetrating wound of the upper right chest. The police conducted an investigation at the scene, and the Ford was towed to a local tow facility. The Ford was subsequently transferred to a secured storage facility in Alabama for future litigation. SCI conducted the investigation and inspection of the vehicle at this facility. The parked Nissan was located off-road and was left at the scene for owner/insurance transfer. Due to the time between the crash and this investigation (14 months), this vehicle was not inspected.

2006 Ford Ranger

Description

The 2006 Ford Ranger (Figure 4) was manufactured in April 2006, identified by the Vehicle Identification Number 1FTYR14U76Pxxxxxx. The odometer reading at the time of the crash is unknown. The Ford was a super-cab pickup truck, configured with 2 doors and fixed B-pillars. It was built on a 319 cm (125.6 in) wheelbase and had a gross vehicle weight rating of 2,250 kg (4,960 lb). Front and rear axle ratings were 1,139 kg (2,510 lb) and 1,179 kg (2,600 lb), respectively. The Ford's curb weight was 1,502 kg (3,312 lb). Its powertrain consisted of a 3.0-liter, V-6, gasoline engine, linked to a 5-speed automatic transmission with a column-mounted shifter. The service brakes were power-assisted with front disc/rear drum with ABS. The vehicle manufacturer's recommended tire size and cold tire pressure were P235/75R15 front and rear, at 205 kPa (30 PSI) front and 240 kPa (35 PSI) rear. At the time of the SCI inspection, the Ford had a mismatch of tires with the left-front tire and wheel missing from the vehicle. The tires were mounted on OEM-style steel wheels. The tires at the time of the SCI inspection were as follows:

Position	Tire Manufacturer/Model	Tire Identification Number	Measured Tread Depth	Restricted	Damage
LF	Unknown, missing from vehicle	Unknown	Unknown	No	Unknown
LR	Ironman Radial RB-12	YCJM HPCR xxxx	6 mm (7/32 in)	No	None
RR	Dayton SR	HYUU DD3 4606	2 mm (2/32 in)	No	None
RF	Goodyear Wrangle Radial	PJHL FNWR 5116	8 mm (10/32 in)	No	None, debeaded

Figure 4. Overhead view of the Ford

The interior of the Ford had seating for five occupants. The front row was a forward-facing, split bench seat (left side wide) with integrated head restraints for the driver and front-right positions. Both portions of the bench seat had manual seat track and seat back recline adjustments. The center position seatback was a folding armrest. At the time of the SCI inspection, the driver's seat was adjusted to its full-rear track position, with the seatback slightly reclined. The second row consisted of two jump seats, with folding seat cushions. Manual safety features included 3-point lap and shoulder seat belts for both the driver and the front-right positions, with lap belts for the front-center and second-row positions. Supplemental restraint systems consisted of buckle pretensioners and single-stage driver's and passenger's frontal air bags. The Ford had an OEM cut-off (suppression) switch for the front-right air bag. This switch was in the "On" (activated) position at the time of the SCI inspection and was located at the lower center instrument panel area.

Vehicle History

According to a vehicle history report obtained from a commercial service based on National Motor Vehicle Title Information System data, this specific 2006 Ford Ranger had two owners. It was reported as delivered to a manufacturer dealer in October 2005 and then sold in October 2005 to the first reported owner, in Louisiana. Two previous crashes were reported during this ownership period. The first was in November 2007 and involved a rear impact with minor-to-moderate damage and no air bag deployment. The second crash was reported in July 2008 and involved a left-front impact. There was no indication in the history report whether this crash was a deployment or non-deployment event. During the first ownership period, numerous reports of dealer-based routine service were performed to include oil and filter changes, brake pad and rotor replacement, and tire rotations. The last odometer reading during the first ownership period was 147,407 km (91,597 mi) in February 2014. This ownership period was last reported in May 2015.

The Ford was purchased and registered in Louisiana by the second owner in June 2016. During this ownership, a crash was reported in August 2016 involving another vehicle. The damage was reported to the left plane, and no air bags deployed. The vehicle was repaired. The next entry in the vehicle history record was the crash under SCI investigation that occurred in March 2017. The damage was reported as moderate-to-severe, front-end and right-front damage with air bag deployment.

NHTSA Recalls and Investigations

A query of NHTSA's recall database (www.nhtsa.gov/recalls) using the VIN of this specific 2006 Ford Ranger, at the time of the investigation and again at the time of this final report submission, revealed that there was one active/incomplete recall. It was identified by NHTSA recall number 18V023 and by the vehicle manufacturer recall number 18S02. This recall, issued on January 11, 2018, was an expansion to earlier recalls of Ford Ranger's air bags that are listed below. The 2004 to 2006 Ford Ranger trucks, manufactured from March 24, 2003 to May 4, 2006, were affected. The Ford under SCI investigation was manufactured in April 2006.

- NHTSA recall number 15V322 issued May 28, 2015 for the passenger's frontal air bag
- NHTSA recall number 16V036 issued January 25, 2016 for the driver's frontal air bag

These recalls were then superseded on December 11, 2017, by NHTSA recall numbers 17V787 and 17V788 for the driver's and passenger's air bag inflators. The earlier recalls were superseded by the vehicle manufacturer to implement a final repair. Further information can be found at www.nhtsa.gov/recalls.

Exterior Damage

Damage to the exterior of the Ford was located on the front end, biased to the center and right aspects (Figures 5 and 6). At the time of the vehicle inspection, the front-bumper fascia and the left-front tire and wheel were separated from the vehicle and missing. The frontal damage consisted of deformation to the bumper beam, both front-frame rails, the lower radiator support, the grille, the hood face, the right-headlamp assembly, and the right-front fender. The right-frame rail was deformed 8 cm (3.1 in) to the left. The left-frame rail deformed to the left 3 cm (1.0 in). The right wheelbase was reduced 6 cm (2.4 in). The right door was operational at the inspection, but slightly restricted by body panel deformation. The left door was open and would not latch closed. There was no glazing damage.

Figure 5. Frontal damage to the Ford

Figure 6. Overhead view of the crush profile to the Ford

A crush profile was documented and measured using a Nikon Nivo 5.M+ total station mapping system. The direct contact damage began 39 cm (15.5 in) left of the center and extended 115 cm (45.5 in) to the right corner of the vehicle. The combined induced and direct contact damage spanned the Ford's entire 152 cm (60.0 in) frontal width. The unsupported right aspect of the bumper beam outboard the frame rail had sheared and was missing. The frontal crush was measured along the bumper beam from the deformed location of the right-frame rail to the left corner. This Field L measured 117 cm (46.0 in). The bumper beam crush profile less freespace was as follows: C1 = 0, C2 = 0, C3 = 8 cm (3.1 in), C4 = 15 cm (5.9 in), C5 = 20 cm (8.0 in), and C6 = 26 cm (10.2 in). Maximum crush was 26 cm (10.2 in) located at the right corner; however, this value was underestimated due to the shearing and separation of the end of the bumper beam. The collision deformation classification for this damage was 12FDEW2.

Using the "missing vehicle" algorithm of the WinSMASH model, a reconstruction of the Ford's velocity change from the impact with the Nissan was calculated. The calculated total delta V of the Ford was 26 km/h (16 mph). Longitudinal and lateral components of the calculated delta V were -26 km/h (-16 mph) and 0, respectively. The results were considered reasonable.

Event Data Recorder

The 2006 Ford Ranger had a restraints control module (RCM) that commanded actuation/deployment of supplemental restraint systems (pretensioners and air bags). The RCM also had limited EDR capabilities. The Ford's RCM was mounted to the center tunnel, beneath the center instrument panel and adjacent to the accelerator pedal. Representatives of a law firm imaged the data from the Ford's RCM using version 17.5 of the Bosch CDR hardware and software, via a direct connection to the RCM and with external power supplied to the interface. The CDRx file was shared with the vehicle manufacturer and the SCI investigator. The data, attached at the end of this report, are reported with software version 21.4.1.

The Ford's EDR had limited recording capabilities due on the date of its manufacture. It had the capability to recognize either "deployment" or "non-deployment" event types, but it had the capacity to record only one event to memory. By definition, a non-deployment event did not command actuation/deployment of a supplemental restraint, whereas a deployment event type actuated/deployed a pretensioner and/or air bag device. Each event was characterized by the recording of longitudinal deceleration data. The RCM did not have a pre-crash buffer or other expanded data capabilities.

A deployment event was stored in the Ford's EDR, which was determined to be related to this crash. There were no diagnostic trouble codes at the time of the event's recording. The EDR recorded the passenger air bag switch position as activated. Pretensioner actuation and frontal air bag deployment were commanded at 11.25 milliseconds. The maximum cumulative longitudinal delta V recorded by the Ford's RCM for the event was -34.12 km/h (-21.20 mph) at 116 milliseconds. Seat belt status was not reported.

Interior Damage

The interior of the Ford (Figure 7) was inspected for crash-related intrusion, damage, and occupant contact. There was no intrusion into the occupant compartment space, nor was there any interior damage associated with the crash events. Aside from pre-crash wear to the vehicle's

interior, the only discernable interior crash-damage was related to the deployment of the supplemental restraint systems and the rupture of the driver's frontal air bag inflator. A hole with staining and sagging of the headliner above the front-row right occupant position was noted, but it was not attributed to this crash. Its location was inboard of the right B-pillar.

Figure 7. Left lateral view of the Ford's interior

Manual Restraint Systems

The Ford had 3-point lap and shoulder seat belt systems for the driver and the front-right positions, and lap belts for the front-center position and the second-row jump seats. The 3-point lap and shoulder seat belts used continuous loop webbing and sliding latch plates, with height-adjustable D-rings. The driver's seat belt system retracted onto an emergency locking retractor (ELR), while the front-right passenger's seat belt used an ELR/automatic locking retractor (ALR). Both front-seat belt systems were equipped with buckle pretensioners, which actuated in the crash.

At the time of the SCI inspection, the driver's seat belt system was found retracted against the left B-pillar. The D-ring was adjusted to its lowest height. No loading evidence was observed on the webbing. Subtle frictional abrasions were present on the polymer surfaces of the latch plate and the D-ring (Figure 8) from driver loading in response to the frontal crash forces. Based on the observations of the SCI investigator and the post-crash condition of the seat belt system, it was determined that the driver's seat belt system was in use at the time of the crash.

Supplemental Restraint Systems

The Ford had seat belt buckle pretensioners and single-stage driver's and passenger's frontal air bags. Based on a review of the vehicle's history report, the Ford had been involved in three prior crashes, none involving air bag deployment. There was no reported service or maintenance to the frontal air bag system. This crash resulted in the actuation of the pretensioners, as well as the deployment of both the driver's and passenger's frontal air bags.

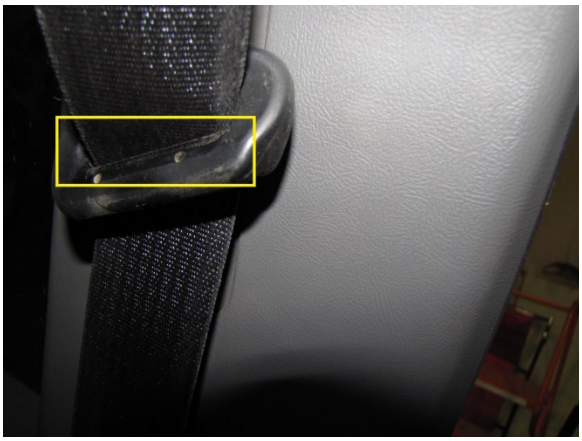


Figure 8. Frictional abrasions to the polymer surface of the D-ring from the driver loading

Driver's Frontal Air Bag and Inflator Rupture

The initial inspection of the deployed driver's frontal air bag revealed several tears in the fabric on both the front and back aspects (Figures 9 and 10). These were determined to have resulted from the rupture and separation of metal fragments from the inflator during the early stages of deployment as the air bag began to unfold. On the face of the air bag, a 7 cm (2.75 in) straight-line tear originated 7 cm (2.75 in) from the center of the air bag and extended toward the 8 o'clock position (Figure 11). A 19 cm (7.5 in) horizontal tear was located on the back side of the air bag near the top surface and extended through the left-side (with respect to the vehicle) vent port (Figure 12). The tear was located 25 cm (9.75 in) from the center of the air bag. In its deflated state, the air bag measured 61 cm (24.0 in) in overall diameter, with a 15 cm (5.9 in) diameter center tether stitch pattern.

A bar-coded label affixed to the air bag near the inflator identified the air bag by the number 2400449293258. The backside of the air bag was stamped with the following identifiers: 2400449AD, 1307052409, 1307052409, and 18 07 05 G. This last identifier indicated the probable driver's frontal air bag manufacture date of July 18, 2005. This air bag was reported by the vehicle manufacturer as original equipment.

Figure 9. Overall view of the tear in the face of the deployed driver's frontal air bag prior to removal from the Ford

Figure 10. View of the tear in the fabric on the back side of the driver's frontal air bag in the Ford

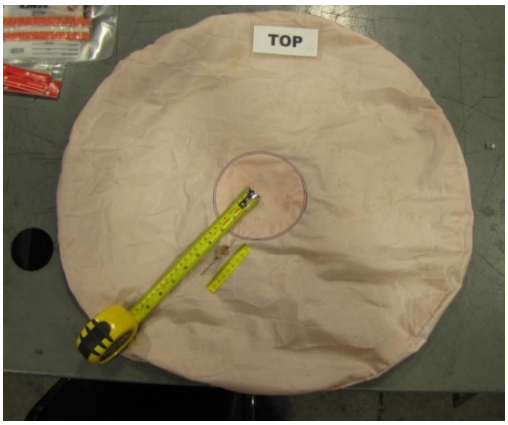


Figure 11. Tear to the lower left quadrant face of the driver's frontal air bag removed from the Ford

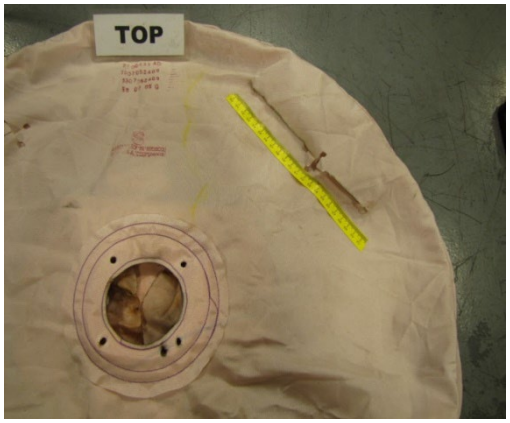


Figure 12. Tear to the back side of the driver's frontal air bag removed from the Ford

The air bag, mounting bracket, inflator, and external cover were removed from the steering wheel mount by removing two laterally oriented bolts at the 3 and 9 o'clock positions from the hub-mounted bracket. Once removed, the squib (ignitor) remained on the steering wheel

mounting bracket, which indicated that the deployment had separated the squib from the inflator (Figure 13).

Figure 13. Close-up image of the center aspect of the Ford's steering wheel and the driver's frontal air bag squib separated during the deployment

The inflator housing was removed from the air bag module's housing for further inspection (Figures 14 and 15). This was accomplished by removing the four nuts from the mounting bracket studs. The inflator contained six symmetrical portals surrounding the circumference of the inflator, all of which were clearly open. The internal filtering mesh remained intact on the inside circumference of the inflator. The center aspect of the forward portion of the inflator (area directed toward driver) separated from the inflator housing during the deployment and was missing. This circular diameter steel fragment was believed to have penetrated through the air bag's fabric and struck the right-upper quadrant of the driver's chest. The police reported that a metal fragment was surgically removed from the driver. This fragment was not retained as evidence or available for inspection.

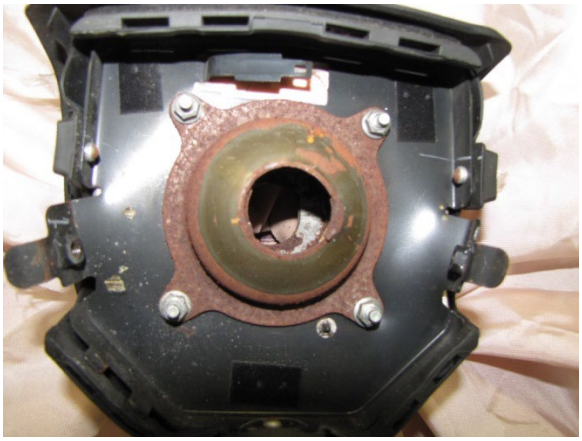


Figure 14. Back side of the driver's frontal air bag module and inflator removed from the Ford

Figure 15. Front aspect of the inflator depicting the separated top area of the Ford's inflator. The separated (missing) fragment penetrated the air bag fabric and struck the driver's chest.

Several sections of a yellow label and a bar-coded label separated from the inflator during the deployment sequence due to the heat of the inflation. Pieces of the label were found on the floor pan. One piece was found in the air bag fabric. These labels were determined to have originated from the inflator.

Passenger's Frontal Air Bag

The passenger's frontal air bag (Figure 16) deployed from the module located in the mid-aspect of the right instrument panel through H-configuration cover flaps. The vehicle manufacturer determined through examination of a bar-code identification label located on the module assembly that the passenger's frontal air bag was original equipment to the Ford.

Figure 16. Deployed passenger's frontal air bag in the 2006 Ford Ranger

In its deflated state, the air bag measured approximately 65 cm (25.6 in) wide and 56 cm (22.0 in) tall. It deployed approximately 50 cm (20 in) rearward from the module. The air bag was vented on both sides by 6 cm (2.4 in) X-shaped vents. An additional 8 cm (3.1 in) diameter vent

was located on the left side of the air bag. There was no evidence of crash-related damage or occupant contact to the passenger's frontal air bag. The front passenger seat was not occupied.

2006 Ford Ranger Occupant

Driver Demographics

Age/sex:	52 years/male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Forward-facing split bench seat with integrated head restraint
Seat track position:	Rearmost
Manual restraint usage:	3-point lap and shoulder seat belt system
Usage source:	Vehicle inspection
Air bags:	Single-stage frontal air bag, deployed
Alcohol/drug data:	None, not tested
Egress from vehicle:	Removed by EMS personnel
Transport from scene:	Ambulance
Type of medical treatment:	Transported to a level-1 trauma center where he was admitted for surgical treatment of his injuries

Driver Injuries

Injury No.	Injury Description	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Penetrating injury to right-upper chest, not further specified	416000.1	Isolated IPC Left Air Bag – Steering wheel hub (module rupture)	Certain

Source: police report; medical records not available.

Driver Kinematics

The 52-year-old male driver of the Ford was in the driver's seat with the seat track adjusted to a rear-track position and the seat back slightly reclined. The driver used the 3-point lap and shoulder seat belt system for manual restraint, with the D-ring adjusted to its lowest height position. His use of the seat belt system was determined through an examination by the SCI investigator of the post-crash condition of the seat belt system during the vehicle inspection. Subtle frictional abrasions were present on the polymer surfaces of the latch plate and D-ring from driver loading.

At impact with the Nissan, the seat belt buckle pretensioner actuated, and the driver's frontal air bag deployed. The driver responded to the force of the frontal impact by initiating a forward trajectory. He remained in the left-front area of the Ford and loaded the seat belt with his torso and pelvis. There was no visible contact evidence to the lower instrument panel/knee bolster area, and there was no bending or deformation of the steering assembly to support driver loading. This, coupled with the subtle seat belt hardware loading, confirmed seat belt use.

During the deployment sequence, the driver's frontal air bag inflator experienced an explosive rupture. The metallic casing of the inflator fragmented and separated, which projected a metallic fragment rearward at a high velocity. The fragment tore through the air bag fabric and entered the occupant compartment, where it struck and penetrated the upper right chest area of the driver.

The Ford came to rest engaged against the parked Nissan. First responders arrived on-scene within 5 minutes of the crash. The driver was evaluated in the vehicle and was removed by EMS personnel and transported to a Level-1 trauma Center, where he was admitted for emergency surgery to remove the inflator fragment.

2005 Nissan Armada

Description

The 2005 Nissan Armada full-size SUV was parked and unattended on the roadside. The Nissan was identified by a police-reported VIN of 5N1AA08A85Nxxxxxx. Based on specifications, the Nissan was a 4-door SUV powered by a 5.6-liter, V-8, gasoline engine linked to a 7-speed automatic transmission. This vehicle was visible in the street-view images of an internet mapping website.

Exterior Damage

The Nissan sustained frontal damage that was distributed across the right and center aspects (Figure 17). The damage consisted of crush to the front bumper with fracturing of the grille and right-headlamp assembly and deformation of the hood and right-front fender. The estimated CDC for this damage is 12FZEW1.

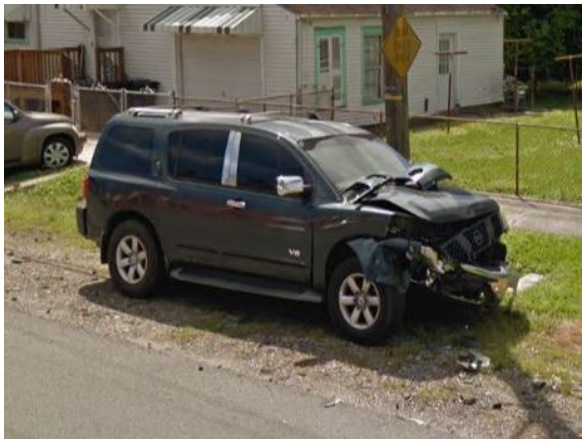
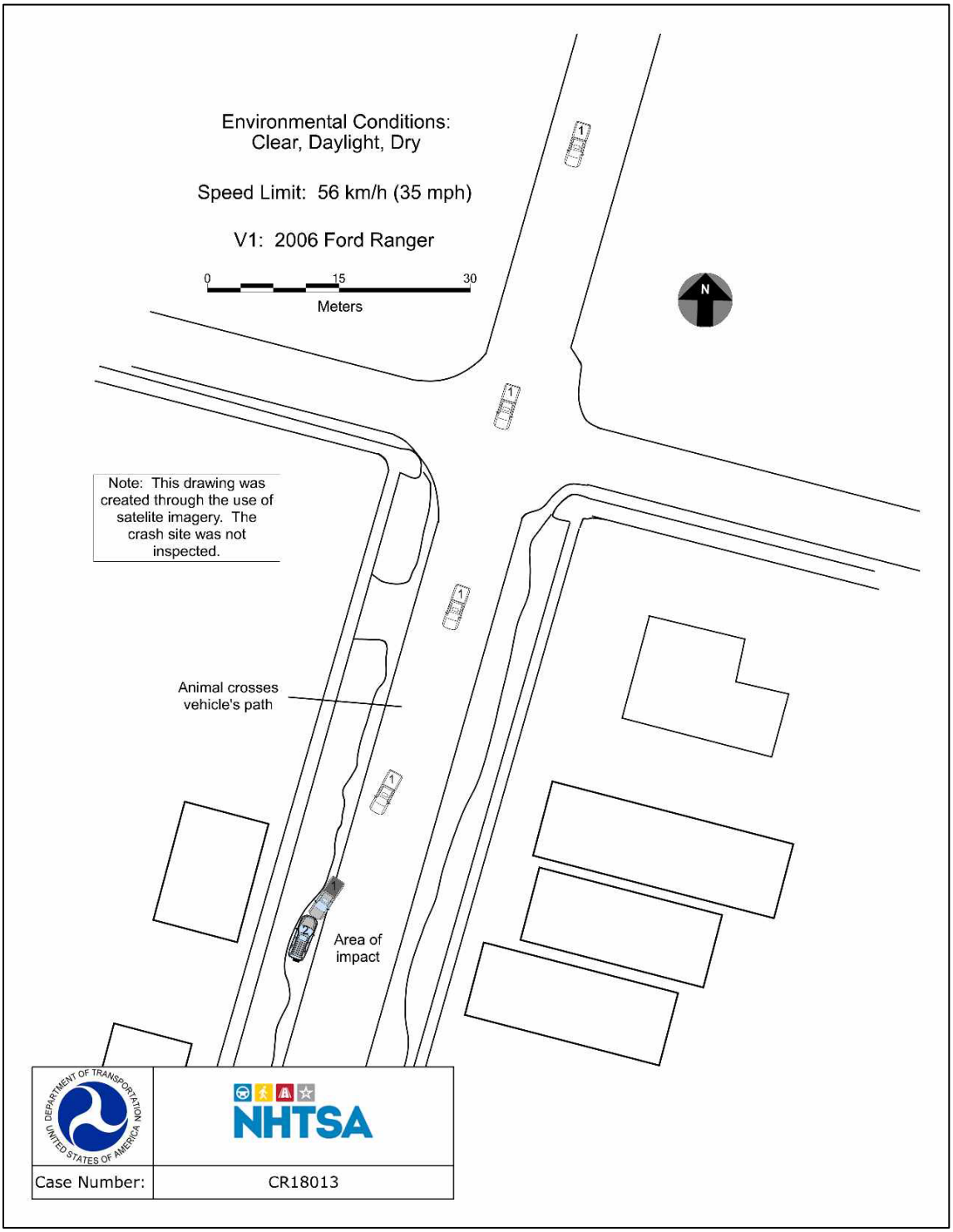


Figure 17. Exterior damage to the Nissan Armada (street-view image obtained from an internet mapping website)

Crash Diagram



Appendix A: Event Data Recorder Report for 2006 Ford Ranger[1]

[1] The EDR contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1FTYR14U76P******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR18013_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.5
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 21.4.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Deployment

Comments

No comments entered.

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a court order or search warrant, as indicated by the CDR tool user on .

Data Limitations

Important Limitations on Bosch Crash Data Retrieval (CDR) Tool Capabilities.

Disclaimer: This Restraint Control Module (RCM) records longitudinal deceleration data for the purpose of understanding the input data the Restraint Control Module used to determine whether or not to deploy restraint devices. This module does not record vehicle speed, throttle position, brake on-off, and other data, which may be recorded in some 1999 model year and later General Motors modules. The deceleration data recorded by Ford's module during a crash can subsequently be mathematically integrated into a longitudinal Delta-V. Delta-V is the change in velocity during the recording time and is NOT the speed the vehicle was traveling before the accident, and is also not the Barrier Equivalent Velocity. The Bosch CDR Tool will read and interpret both acceleration in G's and Delta-V in mph. RCM's in Ford vehicles that can be read by the Bosch CDR tool are listed in the Bosch Help Files.

Important

If there is any question that the restraint system did not perform as it was designed to perform, please read the system only through the diagnostic link connector. The Bosch CDR kit provides an RCM interface cable to plug directly into the restraint control module. The Bosch CDR RCM Interface Cable connects only power, ground, and memory read pins to the relevant vehicle restraint control module. The other RCM pins normally connect to inputs, such as sensors, and outputs, such as airbags, are not connected when you use the RCM Interface Cable to plug directly into the module. Since the vehicle restraint control module is constantly monitoring airbag system readiness (when powered), it will detect that the sensors and airbags are not connected. The restraint control module may record a new diagnostic trouble code into memory for each device that is not connected. These new diagnostic trouble codes may record over previously written diagnostic trouble codes present prior to the accident and spoil evidence necessary to determine if the restraint system performed in the accident as it was designed to perform. Not only could this prevent Ford from being able to determine if the system performed as it was designed to perform, but, regardless of innocent inadvertence, you could raise issues of evidence spoliation in any litigation that may arise out of the accident. If you cannot read the module via the diagnostic link connector, and if you suspect improper system performance, contact Ford Motor Company and request their assistance to read the module with a proper vehicle simulator attached.

While data stored in RCM's is accurate, accident reconstructionists must be aware of the limitations of the data recorded in Ford's control modules and should compare the recorded data with the physical evidence at the accident scene using professional accident reconstruction techniques (i.e. vehicle crush characteristics, skid marks, etc) before making any

assumptions about the import and validity of the data recorded in the module with respect to the crash event being analyzed. The following describes specific limitations that must be considered when analyzing recorded data. Investigators should obtain permission of the vehicle owner or have sufficient legal authority prior to reading any data.

1. There may be no deceleration data recorded in the module.
Loss of power (cut wires, damaged battery, crushed fuse box) to the module during or immediately after the crash may prevent the crash data from being recorded. A backup power supply within the module has sufficient power to continue to analyze the deceleration data and deploy restraint devices if needed, but there is no backup power for recording.

If the deceleration input does not create a vehicle longitudinal Delta-V above 4 mph within 100 milliseconds, there may not be any data recorded.

2. In unusual circumstances, deceleration data stored in the module may be from a crash other than the one you are currently analyzing.
The module will record data from some non-deploy events. If, after the module has recorded data from a non-deploy event, and there is a subsequent event in which there is a loss of power and no new recording is made for that subsequent event, the deceleration data in the module's memory may be from the prior event. If the new, subsequent event is a deploy event and recording has occurred, the deployment times should be recorded. If there are no deployment times recorded, but airbags or other restraint devices are observed to have deployed, the recorded data that you read are most likely from a prior event.

Once an airbag or other restraint device has been commanded to deploy, the data recorded in connection with that deployment are "locked", and subsequent crashes cannot be recorded.

If a vehicle is being repaired, the RCM should be replaced after any crash in which restraint devices deploy. Early printed shop manuals refer to re-using modules by clearing the "crash data memory full" code, but this is no longer true and the latest on-line electronic shop manual directs that modules be replaced.

Crashes that involve multiple impacts will record only one of the impacts. If there is a deployment, the deployment event will be recorded and locked. If no restraint device is commanded to deploy, the recorded data are not "locked", and subsequent impacts may record over any previous recorded data. Further analysis will be required to determine which of the events was actually recorded.

3. The computed longitudinal Delta-V may understate the total Delta-V

Many real-world crashes can last longer than the memory has the capacity to record. Therefore, the actual Delta-V of the event may be higher than the Delta-V calculated and displayed by the Bosch CDR System output. Review the end of the longitudinal acceleration/deceleration pulse - if it has not settled to zero G's by the end of the recording, the vehicle longitudinal Delta-V is most likely understated. If there is a clear decaying trend line you may choose, at your own risk, to estimate the total Delta-V by extrapolating the decay trend to zero and to calculate the additional Delta-V not captured.

Under some circumstances where power is interrupted, during the recording of data, or the module re-sets during the recording of data, a partial recording may occur. This will be shown as "no data" in the data table and will not be plotted on the graph of acceleration. When some portion of the acceleration data is not recorded, the Delta-V during that time cannot be calculated. A Delta-V will be calculated for the points that are valid, but the user must be aware that the partial Delta-V calculated will further underestimate the actual event total Delta-V.

4. This module records only longitudinal acceleration/deceleration of the vehicle. You must compute lateral or resultant total acceleration based on your estimated Principal Direction of Force (PDOF).

5. Vertical acceleration/decelerations are not recorded. Vehicle spin about a point not centered on the Restraints Control Module sensor may add or subtract from bulk vehicle motion.

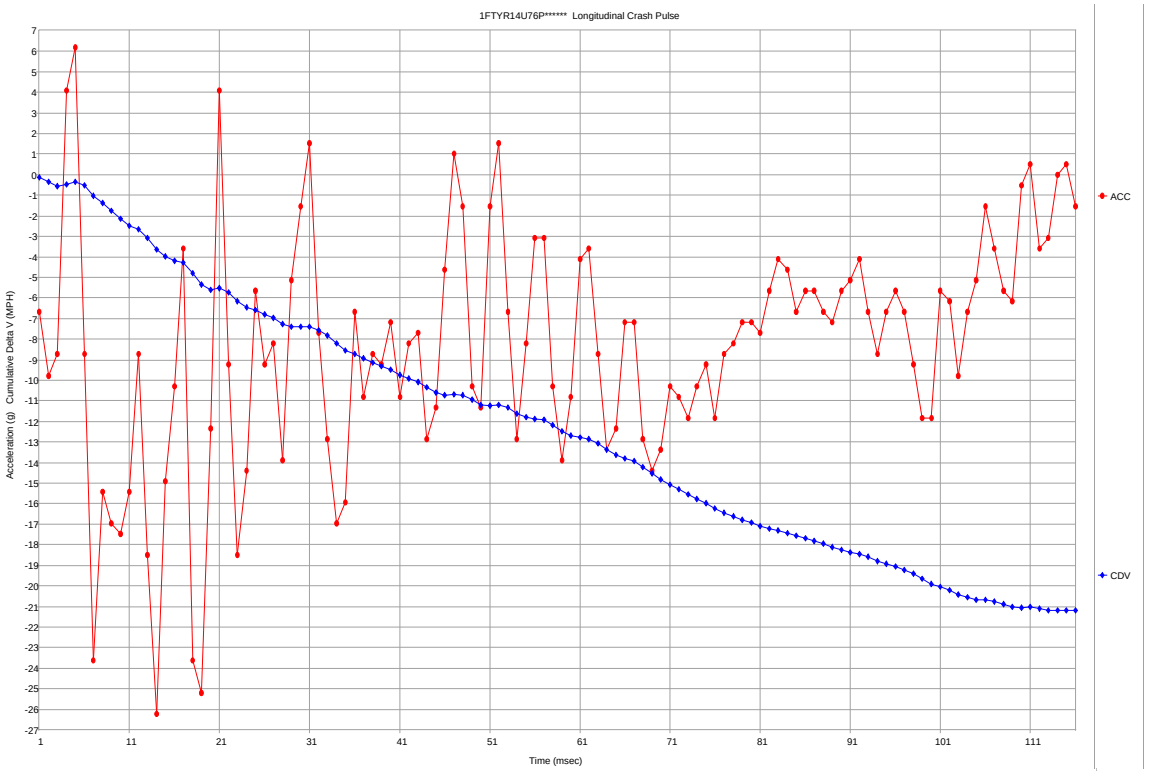
6. This module is not intended to record acceleration/deceleration in a side-impact event. If the side impact generates a longitudinal deceleration component sufficient to wake up the frontal deployment algorithm, there may be a recording of longitudinal deceleration in a side impact event.

Any Longitudinal Delta-V determined by using data read from the air bag module should be verified with physical evidence from the crash (such as vehicle crush, skid marks) and assumed accident sequence. Multiple impacts, angular collisions, side impacts, vehicle spin, etc should be considered in addition to the data read from the air bag module.

02001_RCM-1_r002

System Status At Deployment

Diagnostic codes active when event occurred	0
Passenger Airbag Switch Position During Event	Activated
Time From Side Safing Decision to Left (Driver) Side Bag Deployment (msec)	Not Deployed
Frontal and Pretensioner Fire time (ms)	11.25


1FTYR14U76P****** Longitudinal Crash Pulse
Acceleration (g) Cumulative Delta V (MPH)
Time (msec)
ACC
CDV

Crash Pulse Data

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
1	-6.68	-0.15
2	-9.77	-0.36
3	-8.74	-0.55
4	4.11	-0.46
5	6.17	-0.33
6	-8.74	-0.52
7	-23.64	-1.04
8	-15.42	-1.38
9	-16.96	-1.75
10	-17.48	-2.13
11	-15.42	-2.47
12	-8.74	-2.66
13	-18.50	-3.07
14	-26.21	-3.65
15	-14.91	-3.97
16	-10.28	-4.20
17	-3.60	-4.28
18	-23.64	-4.80
19	-25.19	-5.35
20	-12.34	-5.62
21	4.11	-5.53
22	-9.25	-5.73
23	-18.50	-6.14
24	-14.39	-6.45
25	-5.65	-6.58
26	-9.25	-6.78
27	-8.22	-6.96
28	-13.88	-7.27
29	-5.14	-7.38
30	-1.54	-7.41
31	1.54	-7.38
32	-7.71	-7.55
33	-12.85	-7.83
34	-16.96	-8.20
35	-15.93	-8.55
36	-6.68	-8.70
37	-10.79	-8.94
38	-8.74	-9.13
39	-9.25	-9.33
40	-7.20	-9.49
41	-10.79	-9.73
42	-8.22	-9.91
43	-7.71	-10.08
44	-12.85	-10.36
45	-11.31	-10.61
46	-4.63	-10.71
47	1.03	-10.69
48	-1.54	-10.72
49	-10.28	-10.95
50	-11.31	-11.19

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
51	-1.54	-11.23
52	1.54	-11.19
53	-6.68	-11.34
54	-12.85	-11.62
55	-8.22	-11.80
56	-3.08	-11.87
57	-3.08	-11.94
58	-10.28	-12.17
59	-13.88	-12.47
60	-10.79	-12.71
61	-4.11	-12.80
62	-3.60	-12.88
63	-8.74	-13.07
64	-13.36	-13.36
65	-12.34	-13.63
66	-7.20	-13.79
67	-7.20	-13.95
68	-12.85	-14.23
69	-14.39	-14.55
70	-13.36	-14.84
71	-10.28	-15.07
72	-10.79	-15.30
73	-11.82	-15.56
74	-10.28	-15.79
75	-9.25	-15.99
76	-11.82	-16.25
77	-8.74	-16.44
78	-8.22	-16.62
79	-7.20	-16.78
80	-7.20	-16.94
81	-7.71	-17.11
82	-5.65	-17.23
83	-4.11	-17.32
84	-4.63	-17.42
85	-6.68	-17.57
86	-5.65	-17.69
87	-5.65	-17.82
88	-6.68	-17.97
89	-7.20	-18.12
90	-5.65	-18.25
91	-5.14	-18.36
92	-4.11	-18.45
93	-6.68	-18.60
94	-8.74	-18.79
95	-6.68	-18.94
96	-5.65	-19.06
97	-6.68	-19.21
98	-9.25	-19.41
99	-11.82	-19.67
100	-11.82	-19.93
101	-5.65	-20.05
102	-6.17	-20.19
103	-9.77	-20.40

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
104	-6.68	-20.55
105	-5.14	-20.66
106	-1.54	-20.70
107	-3.60	-20.78
108	-5.65	-20.90
109	-6.17	-21.04
110	-0.51	-21.05
111	0.51	-21.04
112	-3.60	-21.11
113	-3.08	-21.18
114	0.00	-21.18
115	0.51	-21.17
116	-1.54	-21.20

Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

```
0800:  AD 42 40 5F 14 A2 58 2D 0D 23 0F 2D 38 57 C8 FF
0810:  10 FF EC 13 3C 78 32 9E 08 A2 F9 EF 19 99 52 49
0820:  2D 03 5F 0F 1E 0A F5 0A A1 5E 03 0E 1D 1E 00 25
0830:  0A 3C 80 28 05 28 4C 0A 28 0A 0B 36 03 84 B7 03
0840:  03 09 11 09 92 35 44 07 D0 00 82 00 E3 13 88 00
0850:  C8 00 C8 61 A8 02 BC 03 21 04 6A 00 35 00 B5 0B
0860:  0E 20 D0 02 20 00 00 00 F5 00 74 00 0A 07 37 7D
0870:  00 00 25 00 27 61 A8 0D 48 02 58 00 96 04 28 01
0880:  DC 00 23 00 99 00 88 01 4D 03 2A 00 42 00 00 1E
0890:  00 78 1F B4 64 64 3B 32 D1 36 02 18 44 01 FF 99
08A0:  14 FF 50 41 6C DC 43 FF FF FF FF FF FF FF FF 27
08B0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF 00 FF
08C0:  04 FF FF FF FF FF 17 13 64 36 4C 35 34 00 01 10
08D0:  02 FA 80 09 FA 80 0A FA 80 21 FA 80 23 FA 80 FF
08E0:  FF FF 00 FF FF 00 FF FF 00 FF FF 00 FF FF 00 FF
08F0:  04 06 00 00 0A 00 00 FF FF FF FF FF FF FF 00 00
0900:  02 FF 96 21 01 4A 11 FF FF FF FF FF 33 01 9C 15
0910:  FF 13 01 9D 1F 24 01 9D 24 29 61 75 14 23 FF FD
0920:  93 8D 8F A8 AC 8F 72 82 7F 7E 82 8F 7C 6D 83 8C
0930:  99 72 6F 88 A8 8E 7C 84 95 8E 90 85 96 9D A3 91
0940:  87 7F 81 93 8B 8F 8E 92 8B 90 91 87 8A 97 A2 9D
0950:  8C 8A 9D A3 93 87 90 9A 9A 8C 85 8B 98 99 8F 86
0960:  88 92 92 87 84 86 8C 8B 89 8C 8E 89 8F 90 92 92
0970:  91 95 98 97 93 95 95 93 92 95 96 98 93 8F 93 95
0980:  93 8E 89 89 95 94 8D 93 96 9D 99 95 94 9F A1 99
0990:  9A A0 A1 9D A0 F4 00 00 78 A0 00 2D 00 00 00 00
09A0:  00 00 00 B5 00 21 00 00 00 2A 00 4E 00 00 00 05
09B0:  00 00 00 89 00 2D 00 45 02 59 00 00 00 00 00 00
09C0:  00 00 2D FF 00 FF FF 07 6F 00 FF FF FF FF FF FF
09D0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
09E0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
09F0:  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

Disclaimer of Liability

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

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May 2022

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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