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CALSPAN ON-SITE INFLATABLE SAFETY BELT CRASH INVESTIGATION

SCI CASE NO.: CA12004

VEHICLE: 2012 FORD EXPLORER

LOCATION: GEORGIA

CRASH DATE: DECEMBER 2011

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract This on-site investigation focused on the crash of a 2012 Ford Explorer and the deployment of its second row inflatable safety belt system. The Ford was involved in an intersection crash with a 1996 GMC Sonoma. The crash resulted in the deployment of the Ford's Certified Advanced 208-Compliant (CAC) frontal air bag system, both Inflatable Curtain (IC) air bags, the front right seat back-mounted side impact air bag, and both second row inflatable safety belts. At the time of the crash the Ford was occupied by a 44-year-old female driver, a 13-year-old male front right passenger, an 8-year-old female second row left passenger, and an 11-year-old female second row right passenger; none of whom sustained injury.			
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BACKGROUND

This on-site investigation focused on the crash of a 2012 Ford Explorer (**Figure 1**) and the deployment of its second row inflatable safety belt system. The Ford was located by the Calspan Special Crash Investigations (SCI) team through an online search of vehicles of interest at a vehicle salvage facility. The Calspan team contacted the facility to confirm deployment of the inflatable safety belt system and obtained insurance company contact information. Telephone contact was then established with the insurance company, which provided details of the crash. Based on that information, the SCI team contacted the local law enforcement agency where the crash occurred and obtained a copy of the Police Crash Report (PAR) to verify vehicle occupancy and crash conditions. Notification of the crash and accompanying details were provided by the SCI team to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) on February 10, 2012. The CID subsequently assigned the crash for on-site investigation on the same day. Having already established cooperation with the salvage facility and the vehicle's insurer, the Calspan SCI's on-site investigation was scheduled and took place February 15-16, 2012. This involved the detailed inspection and documentation of the Ford with specific focus on its inflatable safety belts and other occupant protection systems. Additionally, the Ford's Event Data Recorder (EDR) was imaged. The SCI Investigator located the other vehicle involved in the crash at a different vehicle salvage facility, established cooperation with its respective parties, and performed a detailed exterior inspection. Interviews were conducted by the SCI Investigator with the drivers of both involved vehicles. The SCI Investigator also traveled to the site of the crash and documented the crash scene, and visited a local vehicle dealership for exemplar purposes.

Figure 1: Overhead view of the 2012 Ford Explorer at the time of the SCI inspection.

The Ford was involved in an intersection crash with a 1996 GMC Sonoma. The crash resulted in the deployment of the Ford's Certified Advanced 208-Compliant (CAC) frontal air bag system, both Inflatable Curtain (IC) air bags, the front right seat back-mounted side impact air bag, and both second row inflatable safety belts. At the time of the crash, the Ford was occupied by a 44-year-old female driver, a 13-year-old male front right passenger, an 8-year-old female second row left passenger, and an 11-year-old female second row right passenger, none of whom sustained injury.

CRASH SUMMARY

Crash Site

The crash occurred at the three-leg intersection of a four-lane divided roadway with a two-lane roadway in a suburban area. The asphalt-surfaced divided roadway was oriented in a north-south direction, with its travel lanes physically divided by a median strip (without positive barrier). At the time of the crash, the Ford was traveling in the 3.8 m (12.5 ft) wide left lane. For the Ford's pre-crash environment, the roadway was straight and level. The 3.6 m (12 ft) wide right travel lane was supported by a 3 m (9.8 ft) wide right shoulder. The travel lanes were delineated by a single-dashed white line, and supported by single-solid white/yellow lines. Raised curbs bordered both the median and shoulder roadway edges. A south-facing view of the roadway and crash site for the Ford's trajectory is depicted in **Figure 2**.

Figure 2: South-facing view of the Ford's pre-crash travel trajectory.

Figure 3: East-facing view of the GMC's pre-crash travel trajectory.

The GMC was approaching the intersection in the 4.4 m (14.5 ft) wide right travel lane, which was not supported by a shoulder. The opposing lane was 5.8 m (19 ft) wide, and the roadway was straight and level. An east-facing view of the roadway and crash site for the GMC's trajectory is depicted in **Figure 3**. Speed was regulated by a posted limit of 64 km/h (40 mph) in all travel directions. A Crash Diagram is included on page 24 of this technical report.

Pre-Crash

As stated by the owner of the Ford during the SCI interview, she was traveling south on the divided roadway in the inboard (left) travel lane. According to local reports, weather conditions in the locality included a steady light rain under overcast skies, with an ambient temperature of 12 Celsius (51.3 Fahrenheit) degrees and relative humidity of 48%. There was a 7.4 km/h (4.6 mph) north-easterly breeze, and the wet roadway was dark with limited artificial lighting due to the dusk time of the crash.

The Ford's driver recalled approaching the intersection while maintaining a speed that she estimated to have been 64-72 km/h (40-45 mph). These claims were supported by the data imaged from the Ford's EDR, which indicated that the Ford's speed consistently measured 64 km/h (40 mph) for all half-second intervals from 5 to 0.5 seconds prior to the Algorithm Enable (AE).

Coincident to the Ford's travel, the GMC was traveling east approaching the same intersection. The 68-year-old male driver brought the vehicle to a controlled stop in observance of the posted signage controlling the intersection for his travel direction. These actions were supported by witness statements made to the investigating law enforcement agency. The driver recalled during the SCI interview that he looked both ways while stopped to check for oncoming traffic. He recounted having observed a vehicle traveling in a southerly direction towards his location, but concluded that it was of a sufficient distance away to provide enough time for him to resume travel into the intersection and execute a left turn. Subsequently, the driver accelerated the GMC from its stopped position and entered the intersection, attaining a speed that he estimated to be 16 km/h (10 mph). The driver of the GMC did not detect the Ford or its movement and maintained travel into the intersection.

The Ford's driver recalled that despite not being distracted, she did not detect the GMC's encroachment into the intersection and did not initiate any avoidance action prior to the crash. Data imaged from the EDR showed that the Brake Switch Circuit State remained "Off" from 5 to 0.5-seconds prior to AE, but was "On" at time zero. Steering wheel angle data imaged from the EDR showed that a left steering input was initiated at 0.3-seconds prior to AE. Combined, this data indicated an abrupt braking and left steering input by the driver immediately prior to impact. The driver stated to the SCI Investigator during the interview that she did not detect any activity related to the vehicle's Collision Warning system. Based on the impact configuration, this crash type likely fell outside of the parameters of the Collision Warning system's capabilities.

Crash

The first event occurred when the right aspect of the Ford's frontal plane impacted the forward aspect of the GMC's left plane in an L-shaped configuration. Resultant directions of force were within the 12 o'clock sector for the Ford and the 10 o'clock sector for the GMC. Corresponding impact forces resulted in the actuation of the Ford's front safety belt pretensioners and the deployment of the CAC frontal air bags and second row inflatable safety belt systems. The steering-wheel hub-mounted air bag within the GMC also deployed.

Impact areas included the bumper and frontal components of the Ford and the left front fender and left front axle position of the GMC. As the two vehicles crushed to maximum engagement, impact forces induced counterclockwise (CCW) rotation to the Ford and clockwise (CW) rotation to the GMC. The vehicles subsequently separated as they were redirected toward the southern portion of the intersection.

As the Ford and GMC maintained their forward trajectories while rotating in their respective CCW and CW directions, the rear aspect of the GMC's left plane contacted the middle-to-rear aspect of the Ford's right plane in a typical side-slap configuration (Event 2). Resultant directions of force were within the 3 o'clock sector for the Ford and the 9 o'clock sector for the GMC. Corresponding impact forces resulted in the deployment of the Ford's right seat back-mounted side air bag and both IC air bags.

The Ford maintained its forward trajectory and traversed onto the raised concrete median strip as it departed the southern portion of the intersection. This movement did not affect the vehicle's trajectory or result in any damage or injury to the occupants. The Ford ultimately traveled to final rest straddling the median and left turn lane of the opposing (northbound) portion of the roadway. The GMC maintained its CW rotation and slid to final rest within the southbound travel lanes at the southwest intersection quadrant.

Post-Crash

The driver of the Ford recalled that all four of the occupants had believed that the vehicle was potentially on fire as a result of the crash, based on their observations of what appeared to them to be smoke emanating from within the vehicle and its engine compartment. For this reason, the driver of the Ford stated to the SCI Investigator that she and the three children rapidly exited the vehicle immediately after it came to rest. Unbeknownst to them, the particulates in the air were actually the powder residue expelled by the air bag systems during their respective deployments, combined with steam that was emitting from the vehicle's compromised radiator/engine cooling system. The 11-year-old female in the second row right position encountered difficulty in her attempts to open the right rear door due to deformation to the door and its frame sustained during the Event 2 impact. She abandoned her efforts to exit through the right rear door and followed the second row left occupant's path of egress, exiting the vehicle through the left rear door.

Although the vehicle was equipped with an automatic crash notification system, its functionality was not enabled at the time of the crash because the driver had not yet paired her cellular telephone to the vehicle's wireless system. Cellular telephone calls placed to the local emergency response system reported the location of the crash, and local law enforcement, fire department, and Emergency Medical Services (EMS) personnel were dispatched to the scene. First arriving personnel located all four occupants of the Ford out of the vehicle and walking around, uninjured. All of the Ford's occupants refused EMS treatment/transport at scene, and left with a relative.

The driver of the GMC also exited his vehicle without assistance. He was transported via ground ambulance to a local hospital for evaluation and treatment of minor severity injuries, including small lacerations to his face. The Ford and the GMC were towed by a local recovery and towing service to a local tow lot, where they were held pending inspection by their respective insurance companies. Both vehicles were later transferred to the regional vehicle salvage facilities by their respective insurers, where they were located and inspected for this SCI investigation.

2012 FORD EXPLORER

Description

The 2012 Ford Explorer (**Figure 4**) was manufactured in September 2011 and identified by the Vehicle Identification Number (VIN): 1FMHK7F80CGxxxxxx. The odometer reading at the time of the crash was 783.9 km (487.1 mi). The front-wheel drive Ford was propelled by a 3.5 L, V-6 internal combustion engine. It was equipped with a console-mounted shift lever that enabled manual selectivity for the 6-speed automatic transmission.

Figure 4: Overhead view of the 2012 Ford Explorer.

The Ford had a 286 cm (113 in) wheelbase with a Gross Vehicle Weight Rating (GVWR) of 2,803 kg (6,179 lb). The front and rear Gross Axle Weight Ratings (GAWR) were 1,397 kg (3,080 lb) and 1,497 kg (3,300 lb), respectively. The manufacturer's recommended tire size was P255/50R20 front and rear, with cold tire pressures of 241 kPa (35 PSI). At the time of SCI inspection, the vehicle was equipped with Hankook Optimo H426 tires of the recommended size and with matching Tire Identification Numbers (TIN) of 5MYP PDLH at all four axle positions. Specific tire data was as follows:

Position	Measured Pressure	Measured Tread Depth	Restriction	Damage
LF	234 kPa (34 PSI)	8 mm (10/32 in)	No	None
LR	228 kPa (33 PSI)	8 mm (10/32 in)	No	None
RR	228 kPa (33 PSI)	8 mm (10/32 in)	No	None
RF	234 kPa (34 PSI)	8 mm (10/32 in)	No	None

The Ford was equipped with the Limited trim package, which included interior configuration for the seating of up to six occupants. There were three rows of two forward-facing, two-toned leather-surfaced bucket seats with an open rear cargo area. The second and third seating rows were capable of folding forward and downward to expand the available interior cargo space capacity. A center console spanned the center of the vehicle in the first row from the front instrument panel to the rear of the seat backs. The second row seats were positioned toward the outer perimeter of the passenger compartment, such that their placement created a center aisle to provide access to the third row seating.

The Limited package included an entertainment and navigational system integrated into the vehicle's environment controls. It had the capacity to be paired with a cellular telephone to enable hands-free calling, audible text-messaging, cell phone application integration, and 911Assist (a form of automatic crash notification). It also included climate control settings, internet connectivity, vehicle health reporting, and driving efficiency tracking. The system was controlled via voice-activation or manual input to a 21 cm (8 in) [diagonal] liquid-crystal display (LCD) touch-screen incorporated into the center instrument panel.

The involved Ford Explorer was equipped with numerous automated safety systems, including AdvanceTrac®, Anti-lock disc Brakes (ABS) with Electronic Brakeforce Distribution (EBD), trailer-sway control, brake assist, active Tire Pressure Monitoring System (TPMS), and several driver assistance technologies. According to the manufacturer's literature, the AdvanceTrac® system incorporated Electronic Stability Control (ESC), Roll Stability Control (RSC), Curve Control, and Traction Control to ensure that the driver maintained control despite adverse driving conditions or avoidance actions. Driver assistance technologies included a Blind Spot Information System (BLIS), back-up camera with Cross-traffic Alert and Reverse Sensing, Adaptive Cruise Control, Collision Warning with Brake Support, and Active Park Assist. According to the manufacturer's literature, the BLIS served to warn the driver of any vehicles present in the lateral rear blind zones, which was achieved through the illumination of an amber indicator light in the upper corner of the respective side mirror. The Collision Warning system provided for the identification of a risk of impending frontal collision by detecting another vehicle in front and its approaching proximity. It was capable of alerting the driver through illumination of a red indicator on the windshield with an audible alert. The system featured integrated Brake Support, which pre-charged the brakes to enable an immediate braking response upon driver input.

Vehicle History

The Ford's owner purchased the vehicle new from the manufacturer's retail dealership network in December 2011. She stated to the SCI Investigator during an interview that she had coincidentally only just assumed possession of the vehicle on the day preceding the crash. Thus, the vehicle had not yet required any maintenance or service, nor had any problems occurred.

The owner shared with the SCI Investigator that the vehicle was so new that she was still in the processes of familiarizing herself with the vehicular controls, comfort adjustments, and other features. She was still learning the intricacies of its automated systems and advanced technologies, and had not yet fully explored the vehicle's complex entertainment and navigational systems, nor had she had the opportunity to pair her cellular telephone to the vehicle's wireless recognition. The owner was affirmative that her lack of familiarity with the vehicle's technology did not contribute any distractions that precipitated the crash. She further stated that she was extremely pleased with the outcome of the crash in terms of the lack of injury to her children, and had already replaced the vehicle with another, similarly equipped, Ford Explorer.

Exterior Damage

The front and right planes of the Ford sustained moderate to minor damage as a result of the crash. Frontal plane damage included moderate deformation to the bumper, hood, right front fender, radiator, and surrounding engine compartment components as a result of the L-shaped configuration Event 1 impact with the GMC. Direct and induced damage on the frontal plane began 39 cm (15.4 in) left of centerline on the bumper and extended 114 cm (44.9 in) to the right front bumper corner. There was no extension of direct contact damage onto the top surface of the hood, although there was continual contact wrapping around the right front bumper corner and extending approximately 30 cm (11.8 in) down the right plane on the right front fender.

The Event 1 damage pattern consisted of longitudinal deformation and the partial separation of the front bumper fascia, disintegration of the grille and headlight assemblies, and body surface deformation/abrasions (**Figure 5**). Throughout this damage pattern was a reddish paint transfer.

Figure 5: Overhead view of the Event 1 frontal damage sustained by the Ford (*note bumper beam deformation*).

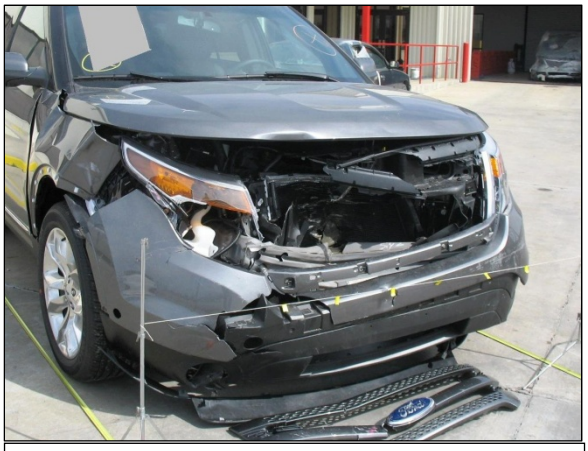


Figure 6: Frontal plane damage pattern and residual crush profile to the Ford from the Event 1 impact.

A residual crush profile (**Figure 6**) documented at the mid-bumper beam produced the following measurements: C1 = 0 cm, C2 = 13 cm (5.1 in), C3 = 24 cm (9.4 in), C4 = 38 cm (15 in), C5 = 26 cm (10.2 in), and C6 = 12 cm (4.7 in). The maximum crush was observed at the location of the C4 measurement. The Collision Deformation Classification (CDC) assigned to the 2012 Ford Explorer for the Event 1 damage pattern was 12FZEW2. The Damage Algorithm of the WinSMASH model was used to calculate the severity (delta-V) of the impact. The total calculated delta-V of the Ford for the Event 1 impact was 22 km/h (13.7 mph). The longitudinal and lateral components of this delta-V were -22 km/h (-13.7 mph) and -4 km/h (-2.5 mph), respectively.

The right plane sustained minor damage as a result of the side-slap impact (Event 2), with damage located on the right rear aspect door, right rear fender, and C-pillar areas. Direct contact damage began 40 cm (15.7 in) forward of the right rear axle and extended 61 cm (24 in) rearward. This damage pattern included minor lateral displacement and deformation to the right rear door panel, right rear fender, and right C-pillar, with disintegration of the glazing above the right rear axle. A residual crush profile with Field-L of 70 cm (27.6 in) documented at mid-door level (**Figure 7**) produced the following measurements: C1 = 0 cm, C2 = 1 cm (0.4 in), C3 = 1 cm (0.4 in), C4 = 6 cm (2.4 in), C5 = 1 cm (0.4 in), and C6 = 0 cm.

Figure 7: Event 2 damage pattern to the right plane of the Ford.

Maximum crush was measured at C4, located at the forward aspect of the right rear fender, above the right rear axle position. The CDC corresponding to the Event 2 damage pattern was 03RZHW2. The Damage Algorithm of the WinSMASH model was used to calculate the severity (delta-V) of the impact. The total calculated delta-V of the Ford for the Event 2 impact was 3 km/h (1.9 mph). The longitudinal and lateral components of this delta-V were zero and -3 km/h (-1.9 mph), respectively.

Event Data Recorder

The Ford was equipped with a Restraints Control Module (RCM) that was mounted to the the floor beneath the center tunnel. The RCM had EDR capabilities to record up to two "Deployment" events. There was a 5-second pre-crash buffer that recorded Vehicle Speed, Accelerator Pedal Position, Brake Status, Engine Speed (RPM), and Wheel Torque data. It also monitored and recorded ABS activity, transmission gear selection, brake Powertrain torque request, and traction control status for the same time intervals.

The data from the Ford's EDR was imaged using the Bosch Crash Data Retrieval Tool software version 4.3, via the Diagnostic Link Connector (DLC). The EDR data imaged from the Ford had two stored events, termed "locked frontal event" and "locked side event", which were related to Events 1 and 2 of the subject crash. Both occurred on the ignition counter number of 149, with complete event recording reported by the EDR. The data was reported together as one record, termed "Deployment Data (First Record)", with the following recorded pre-crash buffer data:

Time (Seconds)	Vehicle Speed	Accelerator Pedal Position	Brake Status	Engine (RPM)	Wheel Torque
-5.0	64 km/h (40 mph)	23.6%	OFF	1,590	616
-4.5	64 km/h (40 mph)	2.8%	OFF	1,466	460
-4.0	64 km/h (40 mph)	0.0%	OFF	1,460	116
-3.5	64 km/h (40 mph)	21.7%	OFF	1,688	340
-3.0	64 km/h (40 mph)	23.3%	OFF	1,634	584
-2.5	64 km/h (40 mph)	13.1%	OFF	1,536	544
-2.0	64 km/h (40 mph)	0.0%	OFF	1,492	184
-1.5	64 km/h (40 mph)	11.2%	OFF	1,472	12
-1.0	64 km/h (40 mph)	16.7%	OFF	1,644	384
-0.5	64 km/h (40 mph)	16.7%	OFF	1,546	372
0.0	63 km/h (39 mph)	0.0%	ON	1,478	268

For all pre-crash time intervals, the ABS remained "non-engaged", the Powertrain torque request remained "No", the gear selection remained "Drive", and the traction control remained "non-engaged". The air bag warning lamp, Brake Telltale, ABS Telltale, ESC/TC Telltale, Powertrain Wrench Telltale, Speed Control Telltale, and Malfunction Indicator Light (MIL) Telltale were also all "Off". Pre-crash data for the steering wheel angle and stability control (lateral acceleration, longitudinal acceleration, yaw rate, and roll rate) remained within a range consistent with controlled, straight-path travel for all time intervals from 5 to 0.5 seconds prior to AE.

However, the steering wheel angle increased sharply from 5.9 degrees at 0.4 seconds prior to AE to 39.1 degrees at 0.1 seconds prior to AE. A slight increase in the vehicle's longitudinal deceleration from 0.006 g to -0.455 g occurred over the same time interval, coupled with an increase from 0.025 g to 0.256 g in lateral acceleration. This data was indicative of an abrupt left steering and braking input by the driver within the final half-second prior to AE.

Data for the event reported that the driver and front passenger belt status' were both "Buckled", with their respective seat track positions "Not forward". The "Deployment Data (First Record)" reported the following sequence of deployments for the equipped air bag and pretensioner systems:

Restraint System	Post-AE Time Interval (milliseconds)
Retractor pretensioner, driver	26.5
Retractor pretensioner, front right passenger	26.5
Inflatable safety belt, second row left	26.5
Inflatable safety belt, second row right	26.5
Frontal air bag, driver, 1st stage	27.5
Frontal air bag, front right passenger, 1st stage	27.5
Buckle pretensioner, driver	31.5
Buckle pretensioner, front right passenger	31.5
Frontal air bag, driver, 2nd stage	37.5
Frontal air bag, front right passenger, 2nd stage	37.5
Inflatable Curtain, left	485.0
Inflatable Curtain, right	485.0
Side (thorax) air bag, front right passenger	485.0

The maximum RCM recorded longitudinal delta-V was -28.34 km/h (-17.61 mph) and occurred at 300 milliseconds after AE. Similarly, the maximum recorded lateral delta-V was -8.60 km/h (-5.34 mph) and occurred at 127 milliseconds after AE. The Rollover Sensor was enabled, and its maximum recorded roll angle measured -3.29 degrees at 1 second post-AE. Data imaged from the Ford Explorer's RCM is included at the end of this technical report as **Attachment A**.

Interior Damage

Interior damage sustained by the Ford as a result of the multiple event crash was attributable to supplemental restraint system deployment and limited occupant contact. There was no intrusion into the passenger compartment.

Occupant contact within the Ford was confined to the frontal components within each seating positions' respective area. Indentified contact damage included a scuff to the left lower instrument panel from the driver's right knee, a scuff to the right lower instrument panel from the front right passenger's right knee, bi-lateral scuffs to the rear aspect of the driver's seat back from the second row left occupant's feet, and a scuff to the rear aspect of the front right passenger's seat back from the second row right passenger's right foot. All four contacts were attributed to direct occupant interaction during the first impact event.

It should be noted that although no direct contact damage evidence was identifiable, all occupants contacted and loaded the webbing of their respective safety belt systems and the faces of their respective deployed air bags/inflatable restraints.

Glazing damage sustained by the Ford was limited to the disintegration of the third row right glazing (AS-3 tempered with original tint). This was attributed to direct contact during the Event 2 impact. It should be noted that there was no evidence present to indicate intrusion into the passenger compartment, despite the Event 2 integrity loss. All remaining glazing remained intact and was not damaged. At the time of the crash, all non-fixed glazing was fully closed due to the weather conditions.

All doors remained closed during the crash. At the time of the SCI inspection, the right rear door remained closed and was operational with an applied force greater than that which was required to open the vehicle's three remaining doors. Considering the second row right occupant's age and physical stature in comparison to an adult, she may not have had the muscular strength or ability required to operate the deformed door post-crash despite its operational status. All remaining doors remained closed and operational.

Manual Restraint Systems

The Ford was equipped with manual 3-point lap and shoulder safety belts for all six seating positions. The second row was equipped with the optional inflatable safety belt system, described in detail on page 13 of this technical report. The third row safety belts were equipped with switchable Emergency Locking Retractor/Automatic Locking Retractor (ELR/ALR) retractors and sliding latch plates with fixed D-ring anchor locations; though neither of the third row safety belt systems was in use at the time of the crash.

The front row safety belts incorporated continuous loop webbing with sliding latch plates, and were height-adjustable at their respective pillar-mounted D-ring anchor locations. The driver's safety belt system was equipped with an ELR, a retractor pretensioner, and a buckle pretensioner. The front right passenger's belt system was equipped with an ELR/ALR, a retractor pretensioner, and a buckle pretensioner.

Both the driver's and front right passenger's respective retractor and buckle pretensioners had actuated as a result of the frontal impact (Event 1). According to data imaged from the Ford's EDR, retractor and buckle pretensioner deployment was commanded at 26.5 and 31.5 milliseconds, respectively, after AE. Both front row belt webbings were locked in used positions by the actuation of the retractor pretensioners, with 149 cm (58.7 in) of the driver's webbing and 145 cm (57 in) of the front right passenger's exposed. Abrasions and longitudinal stretching of the webbing material's threads in the areas of the sliding latch plates on both belt systems was consistent with occupant loading and evidenced restraint usage. These areas of loading were present 80-84 cm (31.5-33 in) and 86-90 cm (33.9-35.4 in) from the left and right D-ring anchor points, respectively, as depicted in **Figures 8 and 9**.

Figure 8: Loading evidence on the driver's safety belt webbing and latch plate within the Ford.

Figure 9: Latch plate and safety belt webbing loading from the Ford's front right passenger.

Supplemental Restraint Systems

The Ford Explorer was equipped with six air bags for supplemental restraint, including a Certified Advanced Compliant (CAC) frontal air bag system, front seat back-mounted side impact air bags, and roof side rail-mounted IC air bags.

The frontal air bag system consisted of dual-stage air bags mounted in the steering wheel hub and top right instrument panel. It also incorporated safety belt buckle switches and a front right occupant weight sensor. The manufacturer of the Ford Explorer has certified that vehicle's frontal air bags were compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. Side impact protection within the Ford incorporated IC air bags and front seat back-mounted side impact air bags. The rollover sensing IC air bags extended along both roof side rails and provided protection for all three outboard seating positions (front, second, and third rows).

The driver's position steering wheel hub-mounted air bag deployed as a result of the Event 1 impact during the crash. It deployed through the I-configuration cover flaps of the module without damage. In its deflated state, the air bag was circular in shape with an overall diameter of 52 cm (20.5 in), with interior tethers stitched to the lower aspect of the bag's face. There were two 3.5 cm (1.4 in) diameter vents on the rear of the bag, evenly spaced from the centerline, at its upper aspect. The alphanumeric sequence 312311 630d was located on the rear of the air bag. Contact evidence was limited to slight scuffing on the face of the air bag from probable driver interaction.

The front right passenger's frontal air bag deployed through a cover flap from the top of the right instrument panel. To provide occupant protection, it was designed to deploy rearward toward the occupant approximately 40 cm (15.7 in). In its deflated state, the air bag's overall height and width were 60 cm (23.6 in) and 55 cm (21.7 in), respectively. There was a 5 cm (2 in) vent on either side of the air bag. A bar code and label affixed to the air bag within the module declared that the air bag was constructed of semicrystalline polyamide (PA66 nylon) material, and was manufactured in Mexico. A scuff was present on the lower right quadrant of the air bag's face, attributed to probable interaction with the front right passenger.

Figure 10: Deployed air bag systems within the front left seating position of the Ford.

Figure 11: Deployed air bag systems within the front right seating position of the Ford.

Side impact protection within the Ford incorporated IC air bags and front seat back-mounted air bags. The front right seat back-mounted and both IC air bags deployed during the crash. In its deflated state, the deployed front right seat back-mounted air bag measured 29 cm (11.4 in) wide at its upper aspect, 24 cm (9.4 in) wide at its lower aspect, and 60 cm (23.6) in overall height. The bag provided 56 cm (22 in) of vertical coverage from the seat bight. It deployed through 55 cm (21.6 in) of stitching on the outboard aspect of the seat, and was 14 cm (5.5 in) in height at the module. According to an alphanumeric sequence and barcode label affixed to the air bag's base, it was manufactured of semicrystalline polyamide material in Mexico. There was no damage or contact evidence present on the front right seat back-mounted air bag to support occupant interaction.

The left and right rollover-sensing IC air bags deployed through the headliner from the module mounted to the roof side rail. Mirror images of each other, the air bags were oval in overall shape with a respective length and height measurements 282 cm (111 in) and 54 cm (21.3 in). The IC air bags had a 32 cm (12.6 in) wide by 44 cm (17.3 in) tall forward sail panel that incorporated a 10 cm (4 in) A-pillar tether anchor. They provided 54 cm (21.3 in) of vertical coverage between the A- and B-pillars, 52 cm (20.5 in) at the B-pillar, 42 cm (16.5 in) at the C-pillar, and 40 cm (15.7 in) between the C- and D-pillars. At the air bag's rear aspect was a 35 cm (13.8 in) D-pillar tether anchor. The IC air bags provided outboard coverage for all six occupants at all three rows. Both bags were devoid of contact evidence or crash-related damage to support occupant interaction or intrusion.

The deployed air bags for the front seating positions are depicted in **Figures 10 and 11**. As detailed previously, the vehicle had been purchased new and had only been in the driver's possession for one day. The driver stated that because of this fact, none of the supplemental restraint systems had ever required maintenance or replacement. The supplemental inflatable restraints warning light within the instrument panel was not illuminated at any time prior to the crash.

Inflatable Safety Belt System

The involved 2012 Ford Explorer Limited was equipped with the optional package that included inflatable safety belt systems for the second row seating positions. These safety belt systems appeared and functioned similarly to traditional 3-point lap and shoulder safety belts, but incorporated an inflatable shoulder portion.

According to literature published by the vehicle's manufacturer, the inflatable second row safety belts effectively distribute crash forces on the occupant over an area five times larger than traditional safety belts. The inflatable safety belts were comprised of a pressurized gas cylinder, specially designed buckle and latch plate, traditional continuous-loop lap belt webbing, accordion-folded tubular air bag, specially designed non-continuous loop shoulder belt webbing, upper C-pillar mounted shoulder ELR, and lower C-pillar mounted ELR/ALR. **Figures 12-15** depict the inflatable safety belt's specialized latch plate, which had overall measurements of 10 cm (3.9 in) in length, 6.5 cm (2.6 in) in width, and 3 cm (1.8 in) in thickness.

Figure 12: Top view of the inflatable safety belt latch plate within the Ford.

Figure 13: Underside view of the inflatable safety belt latch plate within the Ford.

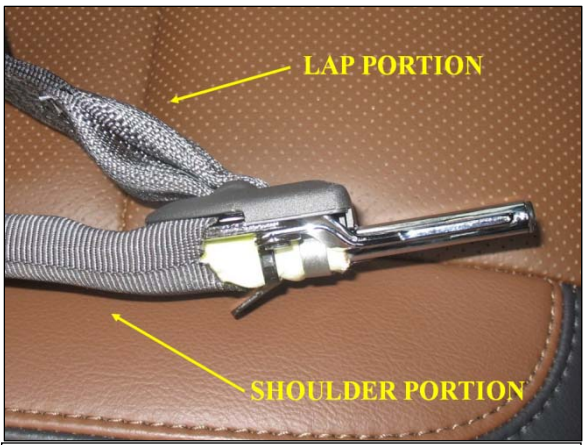


Figure 14: Lateral view of the inflatable safety belt latch plate within the Ford.

Figure 15: Compressed gas delivery tube within the Ford's inflatable safety belt latch plate.

Deployment of the inflatable safety belt system occurred in conjunction with any frontal deployment commanded by the RCM (frontal safety belt pretensioners and/or frontal air bags). As the accordion-folded air bag expanded, the surrounding specialized webbing tore apart to expose the inflating air bag. According to the manufacturer, the inflatable safety belt air bag was designed to remain inflated for six seconds after deployment.

Inflation of the safety belt air bag was achieved through the rapid discharge of a cold, compressed gas cylinder through the delivery tube within the buckle and latch plate, into the air bag. The latch plate engaged within the buckle is depicted in **Figure 16**. Due to this design, the inflatable safety belts were only capable of deploying if the latch plate was engaged within the buckle. Furthermore, the use of compressed gas to inflate the air bags resulted in a "cold" temperature inflation, unlike the "hot" inflation caused by traditional pyrotechnic air bag modules. This, combined with the shape and texture of the non-continuous loop shoulder webbing, reportedly made the inflatable safety belts more comfortable for the occupant. According to the manufacturer, the inflatable safety belts were compatible with most infant and child safety car seats and belt positioning booster seats when installed in conjunction with the Lower Anchors and Tethers for CHildren (LATCH) system.

Figure 16: Inflatable safety belt latch plate engaged in buckle within the Ford.

Figure 17: Deployed second row inflatable safety belts within the Ford at the time of SCI inspection.

At the time of the SCI inspection, both rear inflatable safety belts were deployed (**Figure 17**). The air bags within the shoulder portion of both second row inflatable safety belt systems measured 53 cm (20.9 in) long and 21.5 cm (8.5 in) wide in their deflated state. The inflatable safety belt air bag was enclosed within a 76 cm (29.9 in) section of non-continuous loop webbing that was 4.4 cm (1.7 in) wide and 0.4 cm (0.16 in) thick. It deployed through a 55 cm (21.7 in) long portion of the webbing, beginning 20 cm (7.9 in) above the latch plate.

The deployed air bag was rectangular in overall shape, gathered together at both ends. A close-up view of the second row right inflatable safety belt air bag is depicted in **Figure 18**, and the second row left inflatable safety belt system is depicted in **Figure 19**.

Figure 18: Second row right inflatable safety belt air bag within the Ford.

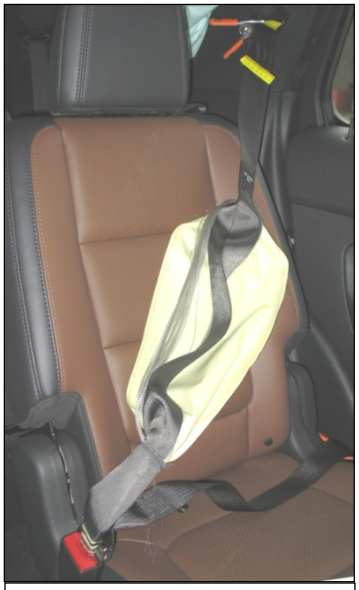


Figure 19: The Ford's second row left inflatable safety belt.

Figure 20: Second row left loading evidence within the Ford.

Loading evidence from occupant interaction was identified during the SCI inspection on both second row inflatable safety belt systems. This consisted of abrasions to the webbing that were present 87-97 cm (34.25-38.2 in) and 96 cm (37.8 in) from the latch plate on the second row left and second row right systems, respectively. Loading on the second row left inflatable safety belt is depicted in **Figure 20**. Based on the inflatable safety belt systems' deployed statuses and their condition at the time of the SCI inspection, restraint usage by both second row occupants during the crash was confirmed.

2012 FORD EXPLORER OCCUPANTS

Driver Demographics

Age / Sex:	44 years / Female
Height:	160 cm (63 in)
Weight:	64 kg (141 lb)
Eyewear:	None
Seat Type:	Bucket
Seat Track Position:	Between middle and full-rear
Manual Restraint Usage:	3-point lap and shoulder safety belt
Usage Source:	Vehicle inspection
Air Bag(s):	CAC frontal air bag, IC air bag
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle without assistance through left front door
Transport from Scene:	None
Medical Treatment:	Follow-up care at her discretion

Driver Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Right wrist strain with localized swelling and pain	740402.1	Steering wheel	Probable

Source: Interview (Same person)

Driver Kinematics

The 44-year-old female driver of the Ford was seated in the forward facing bucket seat. She had adjusted the seat to a middle-to-rear track position, with the seat back slightly reclined. The driver was restrained by the manual 3-point lap and shoulder safety belt. Restraint usage was determined from the post-crash condition of the safety belt system during the SCI inspection.

The driver initiated a forward trajectory in response to the initial frontal impact event. Her body contacted the safety belt webbing, but her movement was restricted by the actuation of the retractor pretensioner and subsequent actuation of the buckle pretensioner. The driver's right hand loaded the steering wheel, resulting in the right wrist strain.

As the vehicles engaged and the crash forces increased in magnitude, the driver contacted and loaded the deployed frontal air bag. Her right hand deflected off of the steering wheel and probably contacted the center instrument panel. The driver's legs also extended forward, and her knees contacted and loaded the lower instrument panel without inducing injury.

Due to her restrained status, the driver remained within her seating position as the vehicle was redirected toward the south intersection quadrant. The second event impact did not produce crash forces of sufficient magnitude to affect the driver's kinematics. Although the IC air bag deployed in response to the lateral component of the Event 2 crash forces, the low magnitude of the lateral forces did not enable occupant interaction with the IC air bag. As the vehicle came to rest straddling the median, the driver remained restrained within her respective seating position.

The driver became immediately concerned for the welfare of the three child occupants. All four occupants observed the powder particulates within the air as a result of the inflatable restraints' deployment, coupled with the steam emanating from underneath the vehicle's hood, and concluded that the vehicle was potentially on fire. The driver rapidly unbuckled her safety belt and exited the vehicle through the left front door. She gathered with the other occupants outside of the vehicle to await the arrival of emergency services personnel.

The driver refused medical treatment/transport at the scene. She later went to a local hospital for X-rays and evaluation of a potential injury to her right wrist that became aggravated in the hours following the crash. She was diagnosed with a wrist strain and released within hours.

Front Right Passenger Demographics

Age / Sex:	13 years / Male
Height:	163 cm (64 in)
Weight:	52 kg (115 lb)
Eyewear:	None
Seat Type:	Bucket
Seat Track Position:	Middle
Manual Restraint Usage:	3-point lap and shoulder safety belt
Usage Source:	Vehicle inspection
Air Bag(s):	CAC frontal air bag, IC air bag, seat back-mounted air bag
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle without assistance through right front door
Transport from Scene:	None
Medical Treatment:	None

Front Right Passenger Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Facial contusion above left eye	210402.1	Air bag	Certain

Source: Interview (Surrogate: Other occupant; Driver)

Front Right Passenger Kinematics

The 13-year-old male front right passenger of the Ford was seated in the forward facing bucket seat. He had adjusted the seat to a mid-track position, with the seat back slightly reclined. The front right passenger was restrained by the manual 3-point lap and shoulder safety belt. Restraint usage was determined from the post-crash condition of the safety belt system during the SCI inspection.

The front right passenger initiated a forward trajectory in response to the initial frontal impact event. He contacted the safety belt webbing, but his movement was restricted by the actuation of the retractor pretensioner and subsequent actuation of the buckle pretensioner. As the vehicles engaged and the crash forces increased in magnitude, the front right passenger's head flexed forward and contacted the deployed frontal air bag. This resulted in a contusion to the front right passenger's face, above his left eye.

The front right passenger's legs extended forward and his knees contacted and loaded the lower instrument panel, without inducing injury. Due to his restrained status, the front right passenger remained within his seating position as the vehicle was redirected toward the south intersection quadrant. The second event impact did not produce crash forces of sufficient magnitude to affect his kinematics. Although the front right seat back-mounted and IC air bags deployed in response to the lateral component of the Event 2 crash forces, the low magnitude of the lateral forces did not enable occupant interaction with either air bag. As the vehicle came to rest straddling the median, the front right passenger remained restrained within his respective seating position.

The front right passenger immediately unbuckled his seat belt and exited the vehicle through the right front door. He, and the other three occupants, observed powder particulates within the air as a result of the inflatable restraints' deployment, coupled with steam emanating from underneath the vehicle's hood, and concluded that the vehicle was potentially on fire. He gathered with his relatives outside of the vehicle and awaited the arrival of emergency services personnel.

The front right passenger refused medical treatment/transport at the scene. He did not seek treatment at any time in response to the crash. According to the front right passenger's mother during an SCI interview, he sustained no injuries other than the contusion to his face.

Second Row Left Passenger Demographics

Age / Sex:	8 years / Female
Height:	122 cm (48 in)
Weight:	19 kg (42 lb)
Eyewear:	None
Seat Type:	Graco backless booster seat within bucket with folding back
Seat Track Position:	Forward-most
Manual Restraint Usage:	3-point lap and shoulder inflatable safety belt
Usage Source:	Vehicle inspection
Air Bag(s):	Inflatable safety belt, IC air bag
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle without assistance through left rear door
Transport from Scene:	None
Medical Treatment:	None

Second Row Left Passenger Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
N/A	None	N/A	N/A	N/A

Source: Interview (Surrogate: Other occupant; Driver)

Second Row Left Passenger Kinematics

The 8-year-old female second row left passenger of the Ford was seated on an unknown model Graco backless booster seat (not available for inspection) within the forward facing bucket seat with folding back. The seat was adjusted to a forward-most track position, and the second row left passenger was restrained by the manual 3-point lap and shoulder inflatable safety belt. Restraint usage was determined from the deployed status of the inflatable safety belt system.

The second row left passenger initiated a forward trajectory in response to the initial frontal impact event. Her body contacted the safety belt webbing, but her movement was restricted by the deployment of the inflatable safety belt. As the vehicles engaged and the impact forces increased in magnitude, the second row left passenger loaded the inflated safety belt and rode-down the crash forces. Her legs extended forward, and her feet contacted the lower aspect of the rear of the driver's seat back, without inducing injury.

Due to her restrained status, the second row left passenger remained within her seating position as the vehicle was redirected toward the south intersection quadrant. The second event impact did not produce crash forces of sufficient magnitude to affect her kinematics. Although the IC air bags deployed in response to the lateral component of the Event 2 crash forces, the low magnitude of the lateral forces did not enable occupant interaction with the IC air bag. As the vehicle came to rest straddling the median, the second row left passenger remained restrained within her respective seating position.

The second row left passenger immediately unbuckled her seat belt and exited the vehicle through the left rear door. She and the other three occupants observed powder particulates within the air as a result of the inflatable restraints' deployment and, coupled with steam emanating from underneath the vehicle's hood, concluded that the vehicle was potentially on fire. She gathered with her family members outside of the vehicle to await the arrival of emergency services personnel.

The second row left passenger refused medical treatment/transport at the scene. She did not seek treatment at any time in response to the crash. According to the second row left passenger's mother during an SCI interview, she did not sustain injury in the crash.

Second Row Right Passenger Demographics

Age / Sex:	11 years / Female
Height:	135 cm (53 in)
Weight:	27 kg (60 lb)
Eyewear:	None
Seat Type:	Bucket with folding back
Seat Track Position:	Rear-most
Manual Restraint Usage:	3-point lap and shoulder inflatable safety belt
Usage Source:	Vehicle inspection
Air Bag(s):	Inflatable safety belt, IC air bag
Alcohol/Drug Data:	None
Egress from Vehicle:	Exited vehicle without assistance through left rear door
Transport from Scene:	None
Medical Treatment:	None

Second Row Right Passenger Injuries

Injury No.	Injury	AIS 2005/08	Injury Source	Confidence Level
1	Contusion to the right anterior neck	310402.1	Inflatable safety belt	Certain

Source: Interview (Surrogate: Other occupant; Driver)

Second Row Right Passenger Kinematics

The 11-year-old female second row right passenger of the Ford was seated in the forward facing bucket seat with folding back. The seat was adjusted to a rear-most track position, and the occupant was restrained by the manual 3-point lap and shoulder inflatable safety belt. Restraint usage was determined from the deployed status of the inflatable safety belt system.

The second row right passenger initiated a forward trajectory in response to the initial frontal impact event. Her body contacted the safety belt webbing, but her movement was restricted by the deployment of the inflatable safety belt. As the vehicles engaged and the impact forces increased in magnitude, the second row right passenger loaded the inflated safety belt and rode-down the crash forces. This contact resulted in a contusion to the passenger's right anterior neck. Her legs extended forward, and her feet contacted the lower aspect of the rear of the front right passenger's seat back, without inducing injury.

Due to her restrained status, the second row right passenger remained within her seating position as the vehicle was redirected toward the south intersection quadrant. The second event impact did not produce crash forces of sufficient magnitude to affect her kinematics. Although the IC air bag deployed in response to the lateral component of the Event 2 crash forces, the low magnitude of the lateral forces did not enable occupant interaction with the IC air bag. As the vehicle came to rest straddling the median, the second row right passenger remained restrained within her respective seating position.

The second row right passenger immediately unbuckled her seat belt and attempted to exit the vehicle through the right rear door. Because of the child's limited strength in comparison to an adult, she was unable to open the door due to body deformation associated with the Event 2 impact. Subsequently, she wasted no time in following the second row left occupant out through the left rear door. She then gathered with her family members outside of the vehicle and awaited arrival of emergency services personnel. The second row right passenger refused medical treatment/transport at the scene. She did not seek treatment at any time in response to the crash. According to the second row right passenger's mother during an SCI interview, she did not sustain injury in the crash other than the contusion to her neck.

1996 GMC SONOMA

Description

The 1996 GMC Sonoma was manufactured in November 1995 and identified by the VIN: 1GTCS1445T8xxxxxx. The odometer reading at the time of the crash was 252,862 km (157,121 mi). The rear-wheel drive GMC (**Figure 21**) was powered by a 2.2 L, inline-4 cylinder internal combustion engine linked to a 5-speed manual transmission. It was equipped with front disc/rear drum anti-lock brakes (ABS). The GMC had a 275 cm (108 in) wheelbase with a Gross Vehicle Weight Rating (GVWR) of 1,905 kg (4,200 lb). The front and rear Gross Axle Weight Ratings (GAWR) were 1,134 kg (2,500 lb) and 1,043 kg (2,300 lb), respectively.

Figure 21: Front/right oblique view of the GMC Sonoma at the time of the SCI inspection.

The manufacturer's recommended tire size was P205/75R15 front and rear, with cold tire pressures of 241 kPa (35 PSI). At the time of the SCI inspection, the GMC was equipped with Catalyst All Weather tires of size P215/70/R15 with matching TIN: 4NFV 1508 for both front axle positions. The left rear tire was a Milestar Touring SE size P215/70R15 with TIN: OUCW TCI 1608, while the right rear was a Cooper CS4 Touring in size P205/70R15 with TIN: U9YT CL1. Specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restriction	Damage
LF	Flat	5 mm (6/32 in)	Yes	Tire cut/torn, puncture in tread and sidewall
LR	303 kPa (44 PSI)	4 mm (5/32 in)	No	None
RR	310 kPa (45 PSI)	6 mm (8/32 in)	No	None
RF	303 kPa (44 PSI)	4 mm (5/32 in)	No	None

The interior of the GMC was configured for the seating of up to three occupants. There was a cloth-surfaced, three-passenger bench seat with folding back that was equipped with a lap belt for the center position and 3-point lap and shoulder safety belts for the outboard positions. There was also an available steering wheel hub-mounted air bag for supplemental restraint of the driver.

Vehicle History

The GMC's owner/driver stated to the SCI Investigator during an interview that he purchased the vehicle new from the manufacturer's retail dealership in the mid-1990's. Since then, he has performed all regular maintenance and necessary service immediately, as required. He described the vehicle as being in excellent condition for its age, with no prior damage, rust, or mechanical problems. According to the owner/driver, the GMC had been involved in one prior collision. He described having been stopped at an intersection when the vehicle was rear-ended by another. There was no apparent residual damage as a result of the low-speed impact, and the inflatable supplemental restraints did not deploy.

Exterior Damage

The left plane of the GMC sustained moderate damage as a result of the crash. This damage was distributed across two distinct patterns, at both the front and rear aspects. The frontal aspect damage to the left plane consisted of the lateral crush and deformation to the left front fender, left front bumper corner, left front axle, hood, and left A-pillar. This damage pattern resulted from the Event 1 impact engagement with the Ford. Direct and induced damage began at the left front bumper corner and extended 96 cm (37.8 in) and 103 cm (40.5 in), respectively, to the left A-pillar. A residual crush profile was documented at the upper door level, which produced the following measurements after appropriate stand and free space adjustments: C1 = 1 cm (0.4 in), C2 = 11 cm (4.3 in), C3 = 21 cm (8.3 in), C4 = 27 cm (10.6 in), C5 = 34 cm (13.4 in), and C6 = 28 cm (11 in).

The maximum crush was observed to the left front fender between C4 and C5, with a magnitude of 43 cm (16.9 in). The CDC assigned to the GMC for the Event 1 damage (**Figure 22**) was 10LFEW3. The Damage Algorithm of the WinSMASH model was used to calculate the severity (delta-V) of the crash. The total calculated delta-V of the GMC for the Event 1 impact was 34 km/h (21.1 mph). The longitudinal and lateral components of this delta-V were -17 km/h (-10.6 mph) and +29 km/h (+18 mph), respectively.

Figure 22: Forward left plane damage to the GMC from the Event 1 impact.

The rear aspect of the left plane sustained minor damage as a result of the Event 2 side-slap. This damage consisted of minor lateral crush and deformation to the left rear fender area on the side of the pickup bed, with disintegration of the left rear taillight assembly and minor lateral crush to the left rear bumper corner. Direct contact damage began at the left rear bumper corner and extended 38 cm (15 in) forward (**Figure 23**). The induced damage extended 57 cm (22.4 in) forward from the left rear bumper corner. A residual crush profile documented at mid-door level produced the following measurements after stand and free space adjustments: C1 = 13 cm (5.1 in), C2 = 5 cm (2 in), C3 = 9 cm (3.5 in), C4 = 4 cm (1.6 in), C5 = 2 cm (0.8 in), and C6 = 1 cm (0.4 in). Maximum crush was documented at C1. The CDC corresponding to the Event 2 damage pattern was 09LBEN1. The Damage Algorithm of the WinSMASH model was used to calculate the severity (delta-V) of the crash. The total calculated delta-V of the GMC for the Event 1 impact was 5 km/h (3.1 mph). The longitudinal and lateral components of this delta-V were zero and +5 km/h (+3.1 mph), respectively.

Figure 23: Event 2 damage pattern to the rear aspect of the GMC's left plane.

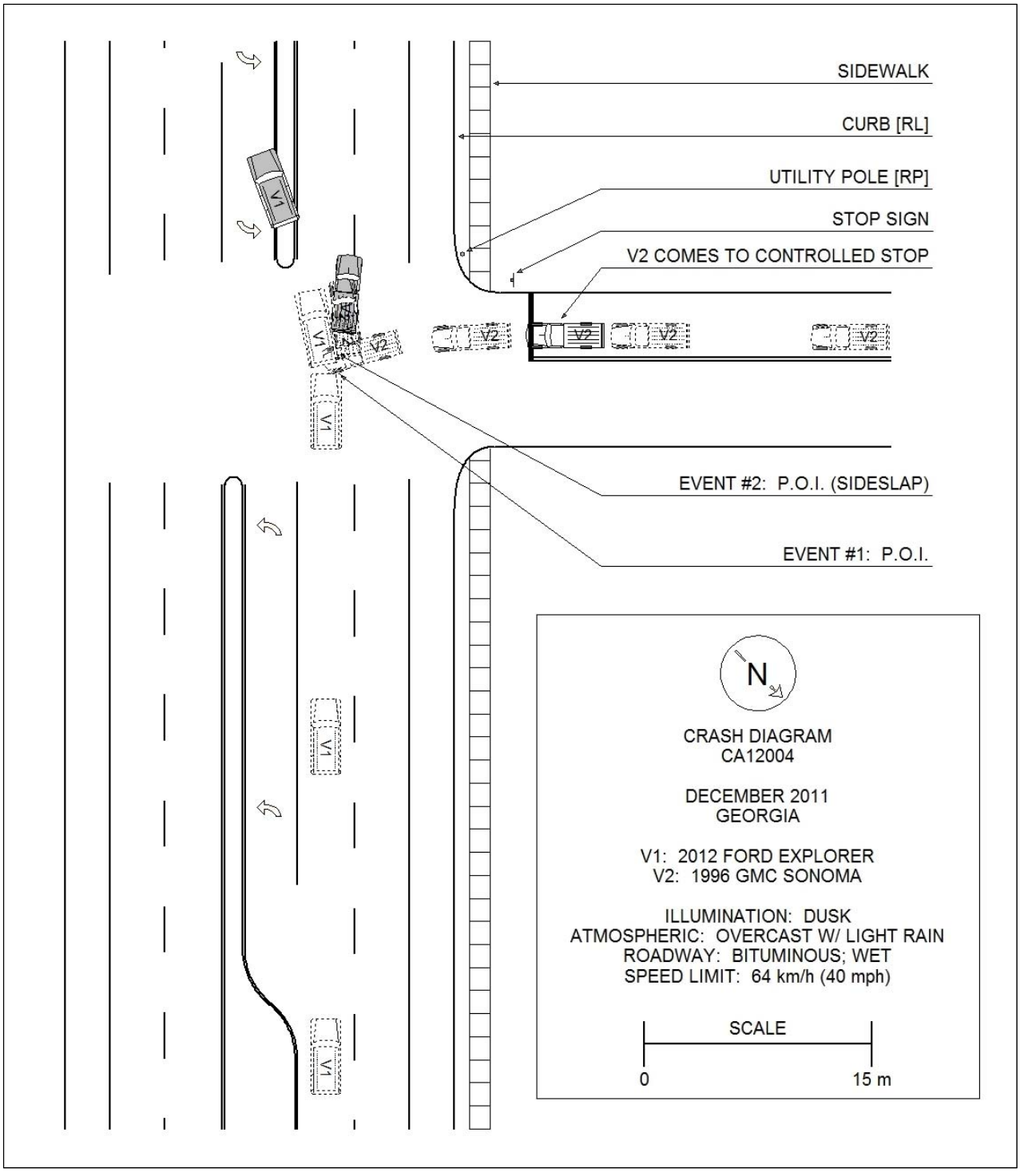
The left front door of the GMC was open at the time of the SCI inspection and would not re-latch or close due to door frame deformation. Abrasions and deformation found within the door frame suggested that the door had been pried open using some form of a pry bar or similar lever-action object. Based on statements made by the GMC's owner concerning his post-crash egress through the right front door, the pried-open status of the left front door occurred at some point post-crash prior to the SCI inspection, for an unknown reason.

The GMC was not supported by the Bosch Crash Data Retrieval software version 4.3 at the time of the SCI inspection.

Occupant Data

The GMC was occupied by its 68-year-old male driver, who was 178 cm (70 in) tall and weighed 77 kg (170 lb). According to the driver during an interview with the SCI Investigator, he was restrained by the available 3-point lap and shoulder safety belt at the time of the crash. Based on the vehicle inspection, the steering wheel hub-mounted frontal air bag deployed during the crash. The driver exited the vehicle without assistance post crash. He was transported via ground ambulance to a local hospital for evaluation and treatment, and was released within 24 hours. According to the driver, his injuries included a minor head injury (with no loss of consciousness) and minor lacerations to his face.

CRASH DIAGRAM



ATTACHMENT A:

2012 Ford Explorer EDR 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	1FMHK7F80CG******
User	
Case Number	
EDR Data Imaging Date	02/15/2012
Crash Date	
Filename	CA12004_V1_ACM.CDRX
Saved on	Wednesday, February 15 2012 at 13:56:53
Collected with CDR version	Crash Data Retrieval Tool 4.3
Reported with CDR version	Crash Data Retrieval Tool 4.3
EDR Device Type	Airbag Control Module
ACM Adapter Detected During Download	No
Event(s) recovered	locked frontal event locked side event

Comments

No comments entered.

Data Limitations

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a subpoena or search warrant, as indicated by the CDR tool user on Wednesday, February 15 2012 at 13:56:53.

Restraints Control Module Recorded Crash Events:
Deployment Events cannot be overwritten or cleared from the Restraints Control Module (RCM). Once the RCM has deployed any airbag device, the RCM must be replaced. The data from events which did not qualify as deployable events can be overwritten by subsequent events. The RCM can store up to two deployment events.

Airbag Module Data Limitations:

- Restraints Control Module Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced from the point of algorithm wake up. It is not the speed the vehicle was traveling before the event. Note that the vehicle speed is recorded separately five seconds prior to algorithm wake up. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change.
- Event Recording Complete will indicate if data from the recorded event has been fully written to the RCM memory or if it has been interrupted and not fully written.
- If power to the Airbag Module is lost during a crash event, all or part of the crash record may not be recorded.
- For 2011 Ford Mustangs, the Steering Wheel Angle parameter indicates the change in steering wheel angle from the previously recorded sample value and does not represent the actual steering wheel position.

Airbag Module Data Sources:

- Event recorded data are collected either INTERNALLY or EXTERNALLY to the RCM.

  - INTERNAL DATA is measured, calculated, and stored internally, sensors external to the RCM include the following:
    > The Driver and Passenger Belt Switch Circuits are wired directly to the RCM.
    > The Driver's Seat Track Position Switch Circuit is wired directly to the RCM.
    > The Side Impact Sensors (if equipped) are located on the side of vehicle and are wired directly to the RCM.
    > The Occupant Classification Sensor is located in the front passenger seat and transmits data directly to the RCM on high-speed CAN bus.
    > Front Impact Sensors (right and left) are located at the front of vehicle and are wire directly to the RCM.

  - EXTERNAL DATA recorded by the RCM are data collected from the vehicle communication network from various sources such as Powertrain Control Module, Brake Module, etc.

02007_RCM-RC6_r002

System Status at Time of Retrieval

VIN as programmed into RCM at factory	1FMHK7F80CG******
Current VIN from PCM	1FMHK7F80CG******
Ignition cycle, download (first record)	152
Ignition cycle, download (second record)	N/A
Restraints Control Module Part Number	BB5T-14B321-AH
Restraints Control Module Serial Number	7123843400000000
Restraints Control Module Software Part Number (Version)	BB5T-14C028-AD
Left/Center Frontal Restraints Sensor Serial Number	14EED2CF
Left Side Restraint Sensor 1 Serial Number	51324232
Left Side Restraint Sensor 2 Serial Number	14F4F906
Right Frontal Restraints Sensor Serial Number	14F0617F
Right Side Restraint Sensor 1 Serial Number	D2130C32
Right Side Restraints Sensor 2 Serial Number	15001C9F

System Status at Event (First Record)

Recording Status	Locked Record
Complete file recorded (yes,no)	Yes
Multi-event, number of events (1,2)	1
Time from event 1 to 2 (msec)	N/A
Lifetime Operating Timer at event time zero (seconds)	79,830
Key-on Timer at event time zero (seconds)	2,875
Vehicle voltage at time zero (Volts)	12.879
Energy Reserve Mode entered during event (Y/N)	Yes

Faults Present at Start of Event (First Record)

No Faults Recorded

Deployment Data (First Record)

Frontal airbag deployment, time to first stage deployment, driver (msec)	27.5
Frontal airbag deployment, time to 2nd stage, driver (msec)	37.5
Side curtain airbag deployment, time to deploy, driver side (msec)	485.0
Pretensioner (retractor) deployment, time to fire, driver (msec)	26.5
Inflatable Seatbelt deployment, time to fire, left row 2 (msec) (if equipped)	26.5
Frontal airbag deployment, time to first stage deployment, front passenger (msec)	27.5
Frontal airbag deployment, time to 2nd stage, front passenger (msec)	37.5
Side curtain airbag deployment, time to deploy, right side (msec)	485.0
Side (thorax) airbag deployment, time to deploy, right front passenger (msec)	485.0
Pretensioner (retractor) deployment, time to fire, right front passenger (msec)	26.5
Inflatable Seatbelt deployment, time to fire, right row 2 (msec) (if equipped)	26.5
Pretensioner (buckle) deployment, time to fire, driver (msec)	31.5
Pretensioner (buckle) deployment, time to fire, right front passenger (msec)	31.5
Maximum delta-V, longitudinal (MPH [km/h])	-17.61 [-28.34]
Time, maximum delta-V longitudinal (msec)	300
Maximum delta-V, lateral (MPH [km/h])	-5.34 [-8.60]
Time, maximum delta-V lateral (msec)	127
Left, rear, side satellite sensor safing	Yes
Right, rear, side satellite sensor discriminating deployment	Yes
Right, rear, side satellite sensor safing	Yes
RCM, side left sensor safing	Yes
RCM, side right sensor safing	Yes
Left or center front, satellite Sensor discriminating deployment	Yes
Left or center, front satellite Sensor safing	Yes
Right, front satellite sensor discriminating deployment	Yes
Right, front satellite sensor safing	Yes
RCM, front sensor discriminating deployment	Yes
RCM, front sensor safing	Yes
Longitudinal Delta-V Time Zero Offset	7.5 ms
Lateral Delta-V Time Zero Offset	7.5 ms
Roll Angle Time Zero Offset	67.5 ms

Pre-Crash Data -1 sec (First Record)

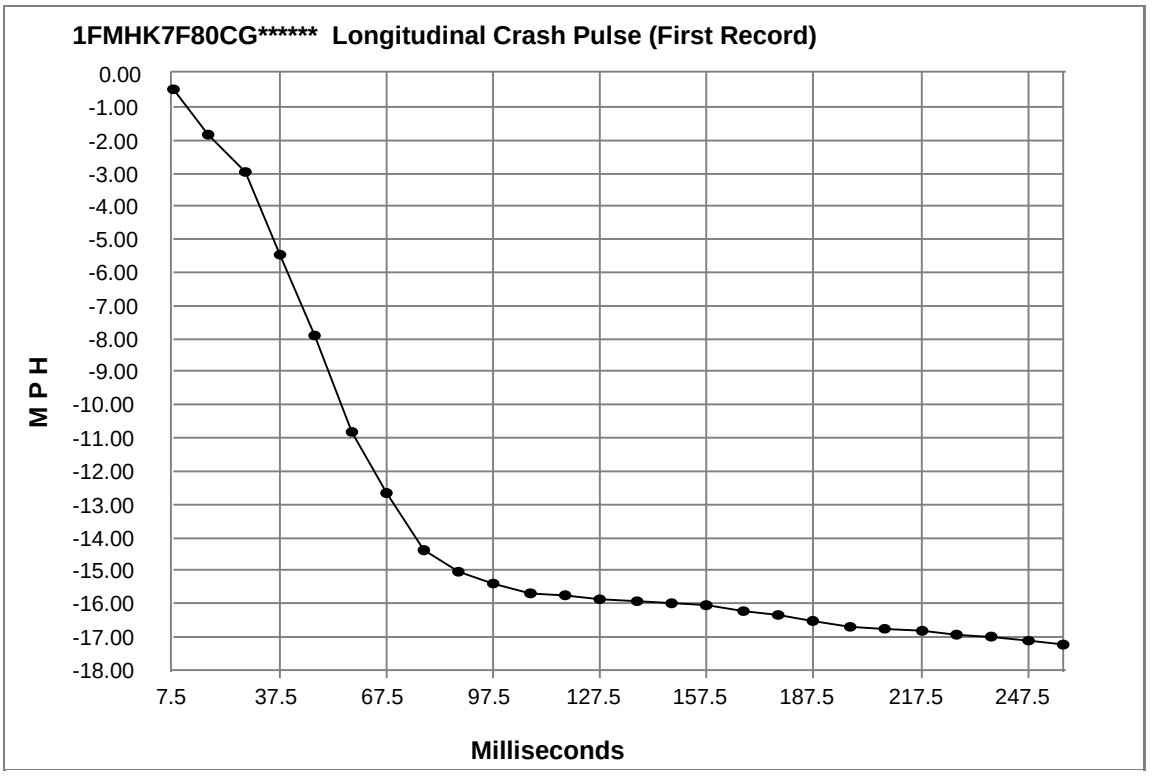
Ignition cycle, crash	149
Frontal air bag warning lamp, on/off	Off
Occupant size classification, front passenger (Child size Yes/No [Hex value])	No [$08]
Safety belt status, driver	Driver Buckled
Seat track position switch, foremost, status, driver	Not Forward
Safety belt status, front passenger	Passenger Buckled
Seat track position switch, foremost, status, front passenger	Not Forward
Brake Telltale	Off
ABS Telltale	Off
ESC/TC Telltale	Off
ESC/TC Off Telltale	Default
Powertrain Wrench Telltale	Off
Speed Control Telltale	Off
MIL Telltale	Off

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record)

Times (sec)	Speed vehicle indicated MPH [km/h]	Accelerator pedal, % full	Service brake, on/off	Engine RPM	ABS activity (engaged, non-engaged)	Brake Powertrain Torque Request	Driver Gear Selection	Traction Control via Brakes	Wheel Torque
- 5.0	40 [64]	23.6	Off	1,590	non-engaged	No	Drive	non-engaged	616
- 4.5	40 [64]	2.8	Off	1,466	non-engaged	No	Drive	non-engaged	460
- 4.0	40 [64]	0.0	Off	1,460	non-engaged	No	Drive	non-engaged	116
- 3.5	40 [64]	21.7	Off	1,688	non-engaged	No	Drive	non-engaged	340
- 3.0	40 [64]	23.3	Off	1,634	non-engaged	No	Drive	non-engaged	584
- 2.5	40 [64]	13.1	Off	1,536	non-engaged	No	Drive	non-engaged	544
- 2.0	40 [64]	0.0	Off	1,492	non-engaged	No	Drive	non-engaged	184
- 1.5	40 [64]	11.2	Off	1,472	non-engaged	No	Drive	non-engaged	12
- 1.0	40 [64]	16.7	Off	1,644	non-engaged	No	Drive	non-engaged	384
- 0.5	40 [64]	16.7	Off	1,546	non-engaged	No	Drive	non-engaged	372
0.0	39 [63]	0.0	On	1,478	non-engaged	No	Drive	non-engaged	268

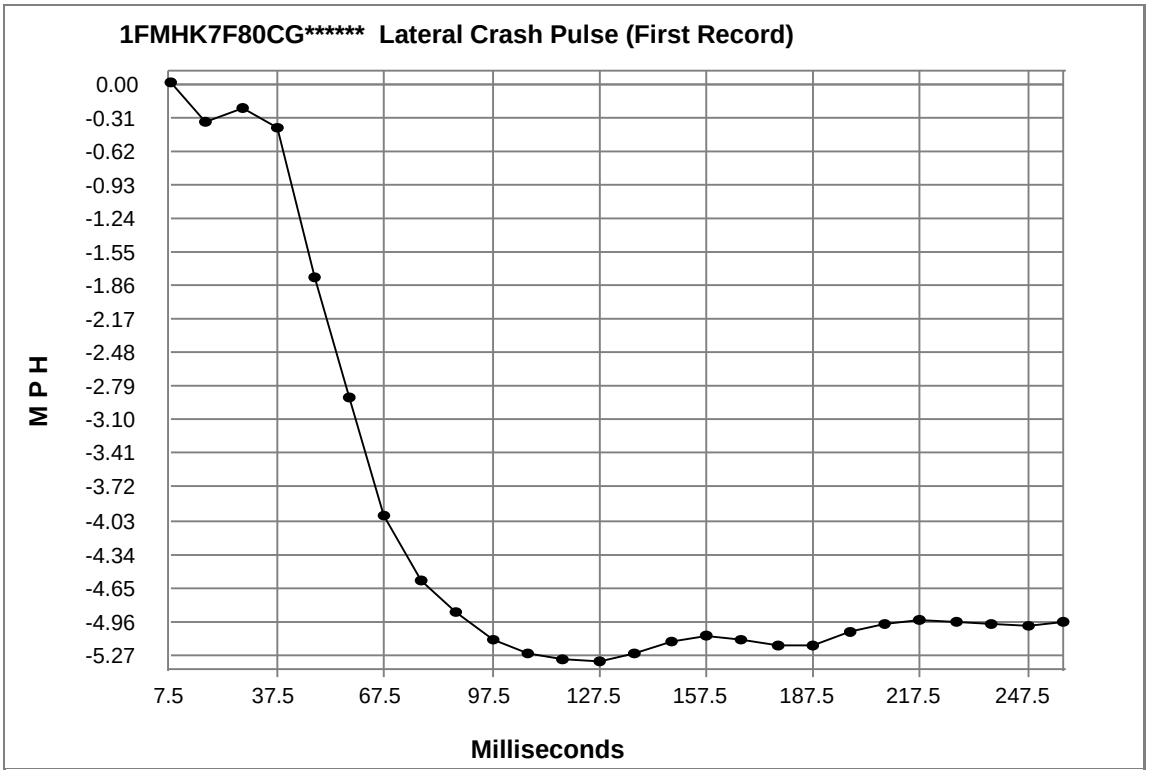
Pre-Crash Data -5 to 0 sec [10 samples/sec] (First Record)

Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)	Stability Control Roll Rate (deg/sec)
- 5.0	1.9	-0.023	0.039	0.62	-0.5
- 4.9	1.9	0.02	0.041	0.62	0.25
- 4.8	1.9	-0.016	0.039	0.0	1.25
- 4.7	1.9	0.017	0.009	1.0	0.0
- 4.6	1.9	-0.001	0.024	1.12	0.12
- 4.5	1.9	0.017	0.006	0.5	-1.75
- 4.4	1.9	0.0	-0.008	0.87	-0.25
- 4.3	1.9	-0.009	0.0	0.62	-0.12
- 4.2	1.9	-0.02	0.001	0.62	0.87
- 4.1	2.1	0.022	-0.031	0.37	1.12
- 4.0	2.2	0.007	-0.031	0.62	0.62
- 3.9	2.4	0.003	-0.008	0.5	-0.12
- 3.8	2.4	0.002	-0.008	0.0	-1.12
- 3.7	2.4	-0.007	-0.011	0.12	-1.5
- 3.6	2.6	-0.001	0.027	0.25	-0.75
- 3.5	2.6	-0.02	0.074	-0.12	-0.5
- 3.4	2.8	-0.012	0.009	1.25	1.0
- 3.3	2.8	-0.006	0.069	0.12	0.87
- 3.2	2.8	0.037	0.051	1.0	0.25
- 3.1	2.6	0.018	0.029	0.75	0.0
- 3.0	2.6	0.033	0.019	0.62	-0.62
- 2.9	2.6	-0.01	0.046	0.5	-0.87
- 2.8	2.6	-0.025	0.041	0.62	0.62
- 2.7	2.6	0.021	0.034	1.0	0.0
- 2.6	2.6	-0.017	0.029	1.0	0.87
- 2.5	2.6	-0.019	0.027	0.62	0.0
- 2.4	2.6	0.026	0.027	0.37	0.25
- 2.3	2.6	-0.017	0.006	0.37	0.25
- 2.2	2.6	-0.039	0.006	1.12	0.62
- 2.1	2.6	0.037	0.006	1.0	-0.25
- 2.0	2.4	-0.017	-0.003	0.87	0.75
- 1.9	2.4	-0.01	-0.029	0.0	0.75
- 1.8	2.4	0.031	-0.029	0.37	0.62
- 1.7	2.4	0.025	-0.026	1.12	-1.12
- 1.6	2.4	0.015	-0.031	0.62	0.37
- 1.5	2.4	-0.031	0.001	0.12	0.0
- 1.4	2.4	0.017	0.014	0.62	-0.12
- 1.3	2.4	0.039	0.053	0.75	-0.37
- 1.2	2.6	0.007	0.027	0.87	0.0
- 1.1	2.6	0.007	0.046	0.62	-0.87
- 1.0	2.6	0.033	0.032	0.5	-0.5
- 0.9	2.6	-0.04	0.027	0.37	0.0
- 0.8	2.6	0.019	0.024	0.25	0.25
- 0.7	2.6	-0.011	-0.008	0.62	-0.12
- 0.6	2.6	0.036	0.006	0.37	-0.87
- 0.5	2.6	0.012	0.006	1.0	-0.75
- 0.4	5.9	0.025	0.006	0.62	0.25
- 0.3	14.3	0.07	-0.011	3.0	2.12
- 0.2	21.4	0.213	-0.046	4.75	3.62
- 0.1	39.1	0.256	-0.455	8.5	3.87
0.0	28.0	0.198	-0.467	9.75	-2.37



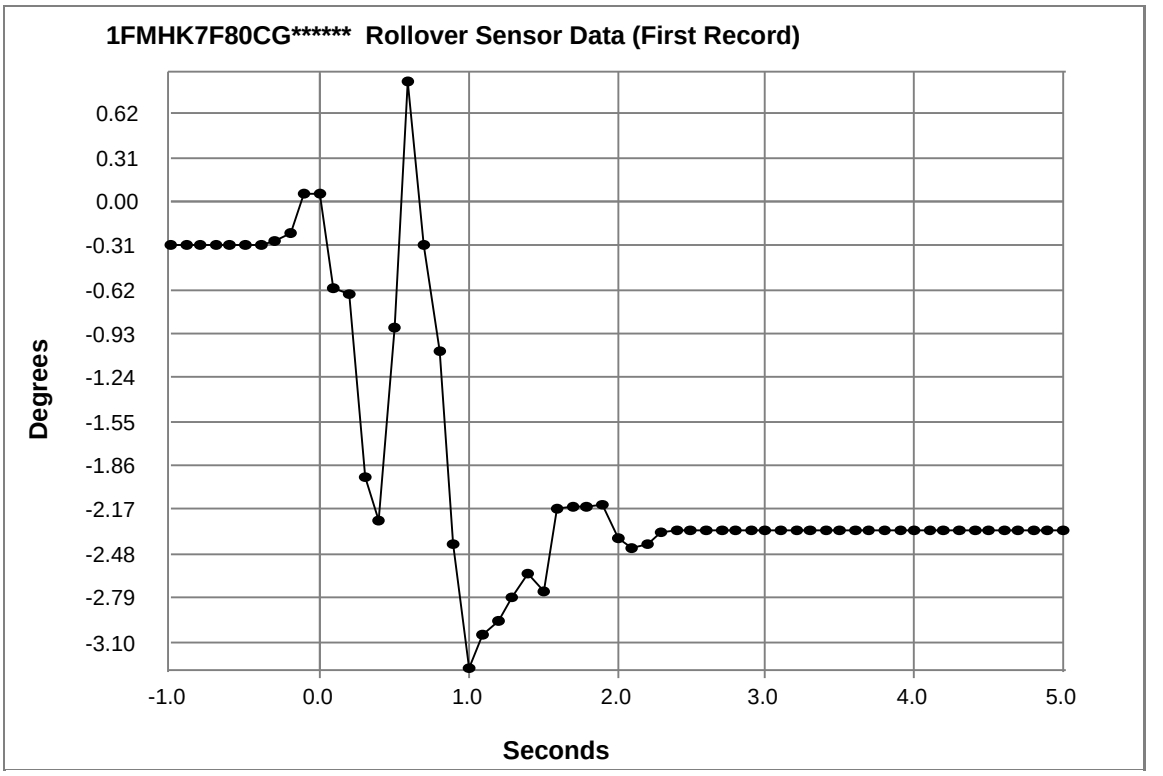
Longitudinal Crash Pulse (First Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
7.5	-0.48	-0.77
17.5	-1.85	-2.98
27.5	-2.95	-4.74
37.5	-5.48	-8.82
47.5	-7.89	-12.70
57.5	-10.84	-17.44
67.5	-12.63	-20.32
77.5	-14.38	-23.15
87.5	-15.00	-24.14
97.5	-15.36	-24.72
107.5	-15.70	-25.26
117.5	-15.77	-25.38
127.5	-15.86	-25.52
137.5	-15.92	-25.63
147.5	-15.97	-25.71
157.5	-16.05	-25.83
167.5	-16.21	-26.09
177.5	-16.36	-26.34
187.5	-16.52	-26.59
197.5	-16.68	-26.85
207.5	-16.75	-26.96
217.5	-16.82	-27.07
227.5	-16.92	-27.23
237.5	-17.01	-27.37
247.5	-17.14	-27.58
257.5	-17.24	-27.74



Lateral Crash Pulse (First Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
7.5	0.00	0.01
17.5	-0.35	-0.56
27.5	-0.23	-0.37
37.5	-0.41	-0.65
47.5	-1.79	-2.88
57.5	-2.90	-4.66
67.5	-3.99	-6.42
77.5	-4.59	-7.39
87.5	-4.87	-7.84
97.5	-5.13	-8.26
107.5	-5.26	-8.47
117.5	-5.30	-8.53
127.5	-5.34	-8.59
137.5	-5.25	-8.45
147.5	-5.15	-8.29
157.5	-5.10	-8.20
167.5	-5.13	-8.25
177.5	-5.17	-8.33
187.5	-5.17	-8.33
197.5	-5.05	-8.13
207.5	-4.98	-8.02
217.5	-4.94	-7.95
227.5	-4.97	-8.00
237.5	-4.98	-8.02
247.5	-5.01	-8.06
257.5	-4.96	-7.98



Rollover Sensor Data (First Record)

Time (sec)	Vehicle roll angle (degrees)
-1.0	-0.31
-0.9	-0.31
-0.8	-0.31
-0.7	-0.31
-0.6	-0.31
-0.5	-0.31
-0.4	-0.31
-0.3	-0.28
-0.2	-0.22
-0.1	0.06
0.0	0.05
0.1	-0.61
0.2	-0.66
0.3	-1.94
0.4	-2.24
0.5	-0.88
0.6	0.85
0.7	-0.3
0.8	-1.05
0.9	-2.42
1.0	-3.29

Time (sec)	Vehicle roll angle (degrees)
1.1	-3.05
1.2	-2.95
1.3	-2.79
1.4	-2.62
1.5	-2.75
1.6	-2.17
1.7	-2.15
1.8	-2.15
1.9	-2.14
2.0	-2.37
2.1	-2.44
2.2	-2.41
2.3	-2.33
2.4	-2.32
2.5	-2.32
2.6	-2.32
2.7	-2.32
2.8	-2.32
2.9	-2.32
3.0	-2.32
3.1	-2.32

Time (sec)	Vehicle roll angle (degrees)
3.2	-2.32
3.3	-2.32
3.4	-2.32
3.5	-2.32
3.6	-2.32
3.7	-2.32
3.8	-2.32
3.9	-2.32
4.0	-2.32
4.1	-2.32
4.2	-2.32
4.3	-2.32
4.4	-2.32
4.5	-2.32
4.6	-2.32
4.7	-2.32
4.8	-2.32
4.9	-2.32
5.0	-2.32

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.

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06 00 00 00

42 42 35 54 2D 31 34 42 33 32 31 2D 41 48 00 00 00 00 00 00 00 00 00 00

37 31 32 33 38 34 33 34 30 30 30 30 30 30 30 30

42 42 35 54 2D 31 34 43 30 32 38 2D 41 44 00 00 00 00 00 00 00 00 00 00

14 EE D2 CF 00 00 00 00 00 00 00 00 00 00 00 00

51 32 42 32 00 00 00 00 00 00 00 00 00 00 00 00

14 F4 F9 06 00 00 00 00 00 00 00 00 00 00 00 00

14 F0 61 7F 00 00 00 00 00 00 00 00 00 00 00 00

D2 13 0C 32 00 00 00 00 00 00 00 00 00 00 00 00

15 00 1C 9F 00 00 00 00 00 00 00 00 00 00 00 00

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E4 FA E4 46 E5 BA E5 34 E6 D7 E5 76 E7 80 E7 84 E7 89 E7 E1 E6 AF E6 C6 E6 FE E6
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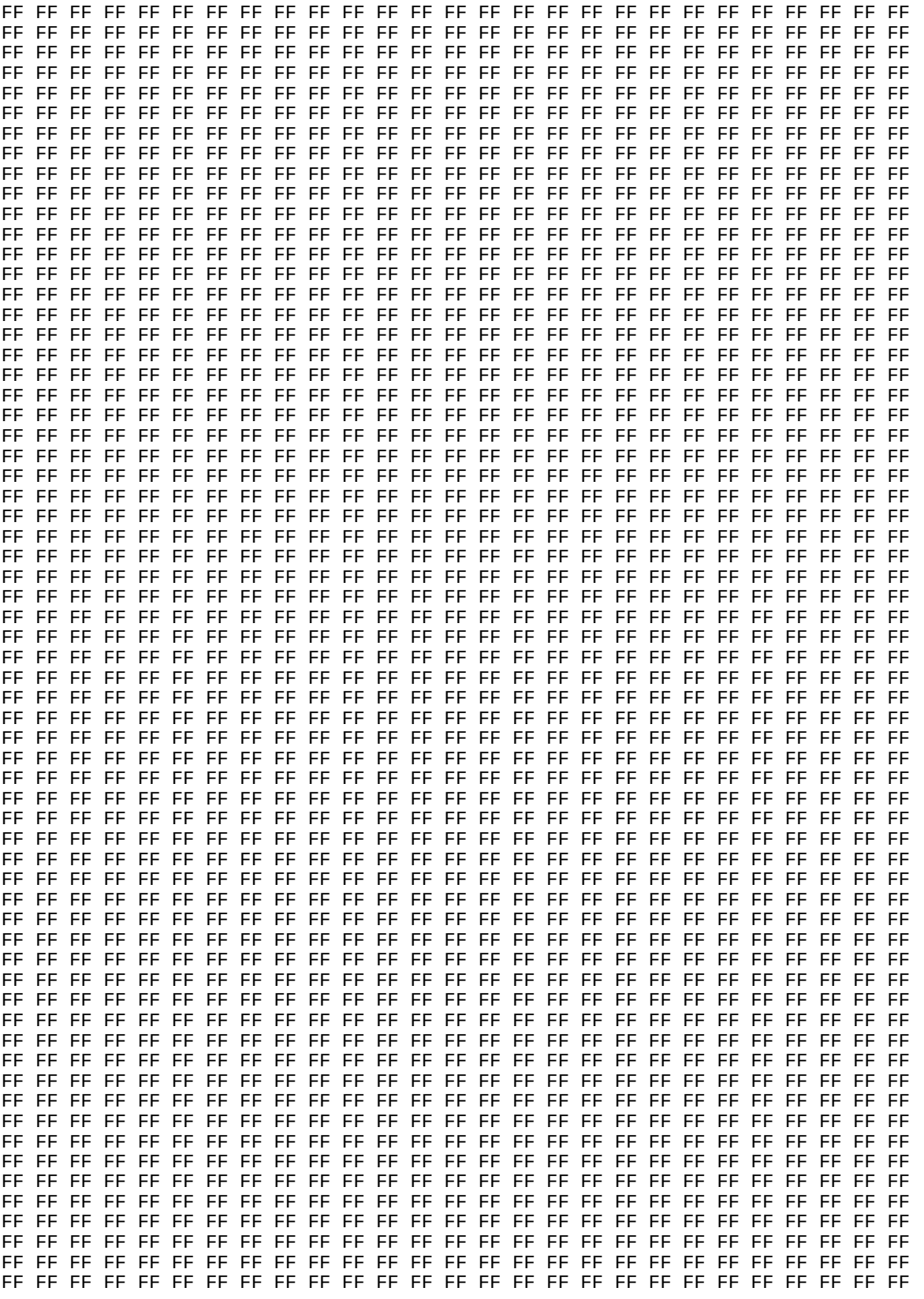

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