

Beyond Event Data Recorders: Analysis of Vehicle Safety Systems in Support of Accident Reconstruction

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In the field of accident investigation and reconstruction, we are often faced with investigations related to suspicious claims, misleading information or even staged collisions. Often the vehicles involved in these situations include some type of deployable safety restraint system (e.g., airbags or seatbelt pre-tensioners).



Airbags and airbag control modules are apparently among the least-understood areas for those involved in staged collisions, or those attempting to misrepresent their claim with misleading information.

While almost every vehicle on the road today contains frontal airbags for the driver and right front passenger, many vehicles now include integrated safety systems that may also employ seatbelt pre tensioners, side thorax airbags and side curtain airbags, among other things. Some vehicles will also have some data recording capability associated with the airbag system, along with other vehicle system parameters that can be stored in the event of a crash. We often refer to vehicles that have this capability to record data as having an event data recorder (EDR); however, this term can be somewhat

misleading, as the vehicles do not contain a separate dedicated module that records crash-related data. Event data is often stored within the airbag control module; it can also be found in some powertrain control modules (PCM) and rollover sensors (ROS).

Before going much further, we should provide a brief description as to what would be considered an "event." An event is an occurrence that has the capability to "wake up" the airbag control module and cause it to begin a decision process as to whether it needs to deploy the airbags and/or seatbelt pre-tensioners, within a given time frame and in a given sequence. Not all events will result in the deployment of an airbag or seatbelt pre-tensioner, and not all events are recorded. Some vehicles will record an event that simply woke up the module, due to the detection of an acceleration of the vehicle, while others will only record events that resulted in deployment of an airbag or seatbelt pre-tensioner. Events that do not result in the deployment of an airbag or pre-tensioner are typically referred to as "non-deployment" events, while an event that does result in a deployment is aptly referred to as a "deployment" event. Vehicles that contain EDRs which are capable of recording non-deployment events may record an event following any significant jolt to the vehicle, or in some cases may only record an event when a minimum threshold impact speed change has occurred, typically about 5 mph. Many newer vehicles are resorting to the latter, while earlier modules were capable of recording any significant event. When an event is recorded by an EDR, the data may contain information related specifically to the moment of the crash pulse, or it may also contain

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some pre-crash data, such as vehicle speed, throttle position, brake switch status, steering angle and other parameters for several seconds prior to the crash event. This information can be very useful in a complete crash reconstruction.

As mentioned, not all vehicles are equipped with EDRs, and of those with EDRs, not all can be downloaded using commercially available equipment. North American manufacturers have been leading the way

in equipping their vehicles with this capability, and providing access to that data through commercial tools; however, additional manufacturers are expected to come to the table shortly. For example, Toyota now has made tools available to allow data to be downloaded from their vehicles; however, these tools are currently very limited in their availability, and access to the data is only available through contacting Toyota's customer support service. It is expected



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that access to Toyota data may soon become available using tools already used in the accident reconstruction community.

If a vehicle involved in a suspicious claim is equipped with an EDR, useful information is often contained in it that can help the reconstructionist, by providing clues to the circumstances surrounding a collision. Additionally, the data contained in the EDR can help to determine whether the airbags, or other deployable safety systems, were legitimately deployed as a result of the collision. Even a lack of information recorded by the EDR can often provide clues to accident details. For example, we have analyzed collisions in which the event data recorder from a vehicle involved in a collision revealed that no event was recorded, even though the damage level clearly indicated that an event decision was warranted. Such a finding indicated that the collision scenario was not as described by the insured, and that the vehicle had actually been parked, with the ignition in the off position, when it was involved in the reported collision.

The information contained in the EDR should always be compared to the physical evidence during the vehicle examination. A review of the data obtained from the download from the subject vehicle may provide information regarding the status of the various safety systems at the time of the collision. Additionally, the data will also indicate which, if any, of the deployable systems were activated during the collision. A comparison of the information stored by the EDR to the evidence presented by the vehicle at the time of inspection can provide some very compelling conclusions. For example, we have investigated a number of collisions in which it was reported

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that at least one of the vehicle's airbags had been deployed. A download of the EDRs in those vehicles indicated that no deployment command was ever sent to either the driver or passenger airbag modules, yet the airbags were clearly hanging out and visible within the occupant space. Were the airbags really deployed, or was something suspicious going on? Careful examination

of the physical evidence revealed the answer. In some cases, we have found that the airbags were physically cut out to make the accident appear more severe, and testing of the airbag circuits revealed that the "deployed" airbags were still live.

Often, it is vehicles without EDRs that are chosen for staged or suspicious collisions, probably on the assumption that without EDR data, it

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will not be possible to determine whether an apparent airbag deployment was legitimate. That assumption would be wrong! It is very difficult, if not nearly impossible, to leave no clues of the false deployment of an airbag, or other deployable restraint. Careful examination of the airbag modules and the vehicle's electrical wiring can often provide clues to the legitimacy of the deployment. For example, the proper deployment of an airbag will often result in slightly frayed or jagged edges along the seam of the airbag cover, where the inflating airbag is designed to tear through as it deploys. Inspection of that seam may reveal faint cut lines or very clean edges, indicating that the airbag door was purposely cut open and the airbag simply pulled out. Other examples have been seen to be crudely cut out, not even following the correct embossed seam that the airbag is designed to deploy through. Photographs showing a properly deployed airbag and some that were cut out are shown in Figures 1 to 4.

Additionally, inspection of the airbag wiring may reveal areas where the wiring has been compromised, to allow for an electrical current to be supplied directly to the airbag module, and thereby cause a false deployment. We have found cases in which the wiring leading to an airbag circuit has been cut and stripped, as well as cases in which the insulation has been carefully peeled back to expose the wiring within. Figure 5 shows an example in which the wiring insulation was pulled back to gain access to the airbag circuit. Removal of interior trim panels and other components is usually required to root out some of the methods used to falsely deploy an airbag. However, in many



Figure 1. A close-up view of a driver airbag that was found in the "deployed" condition. The seams of the airbag door were very clean and sharp, and cut lines were evident leading to the centre emblem area. The airbag was removed, tested and found to still be "live."



Figure 2. A close-up view of an airbag that was legitimately deployed in a controlled environment. The seam of the airbag door exhibited a slightly jagged appearance after deployment, and no cut lines were evident in the area around the centre emblem.

cases, the perpetrator often leaves the access covers off after completing his or her handiwork, providing investigators with a head start. There are many potential clues available to those who are willing to do a little sleuthing.

Many vehicles, even those without available EDR data, may provide diagnostic trouble codes that can help, through careful evaluation, to determine whether airbags were deployed via the airbag control module or by other means, perhaps intentionally. Some of these diagnostic trouble codes can only be downloaded by brand-specific equipment, and the co-operation of a dealership or repair facility might be required. Other vehicles may allow access to certain codes simply through specific ignition key sequences. Codes accessible via the ignition key method will often be read through some form of flashing telltale light sequence on the instrument panel gauge cluster. A review of the individual model service manual is a great place to start to determine what information can be readily obtained regarding any of the restraint systems.

Beyond the obvious checks, while in the process of the vehicle examination, additional tests can be performed to indicate the true status of an apparently deployed airbag or seatbelt pre-tensioner. Airbags and pre-tensioners are single-use commodities. Once an airbag has been deployed, it cannot be redeployed, and there is no such thing as a partial deployment. Once deployed, the propellant that inflates the airbag, or that retracts the seatbelt, is consumed, and the electrical circuit continuity is typically altered. Physical testing of the airbag module can be performed to determine the status of the airbag circuits, and whether



Figure 3. This driver airbag exhibited a very crudely cut airbag cover. Note the uneven profile along the bottom edge.



Figure 4. A view of the underside of the driver airbag door from the same airbag as shown in Figure 3. The bottom edge of the door (top of photo) is very roughly cut, and the airbag clearly did not deploy through the embossed seams that were moulded into the back side of the airbag cover, as designed. This airbag was also removed, tested and shown to be "live."

or not the airbag is still “live,” or if it has been deployed. If the subject airbag is deemed to be “live” or undeployed, despite its appearance of being a deployed airbag, irrefutable confirmation can be achieved by physically deploying the airbag in a controlled environment, at the request of the client. As stated above, airbags are single-use commodities, and they cannot be deployed twice. If it goes “bang” in the controlled test, it surely didn’t deploy during the reported collision, regardless of any claims to the contrary. Figures 6 and 7 show an airbag that we found in an apparently deployed condition, which was later deployed when removed from the vehicle.

Research into the vehicle design specifications and deployment

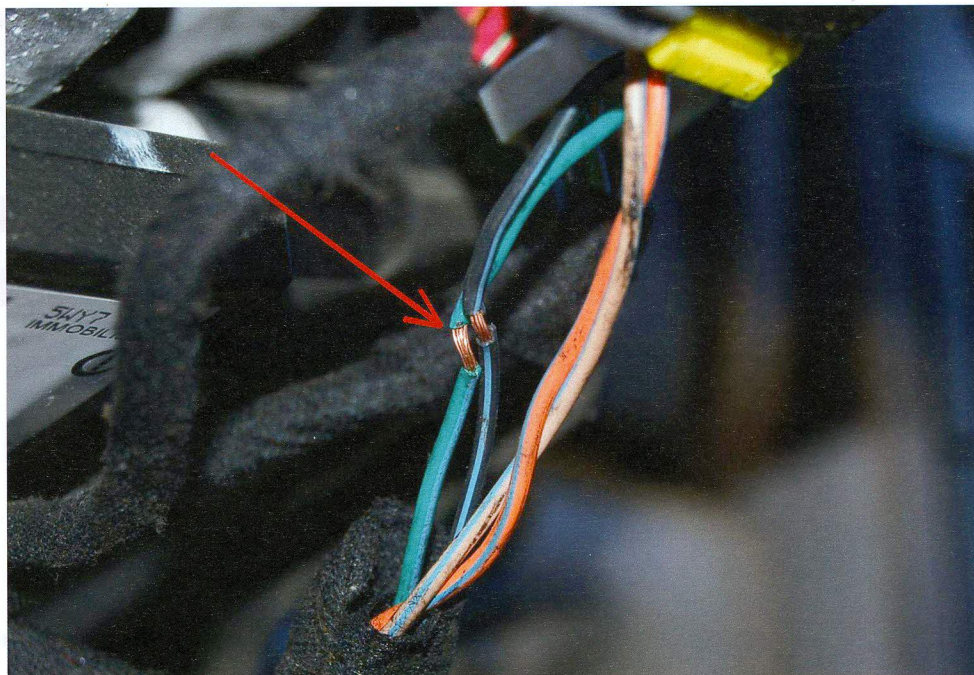


Figure 5. The airbag electrical wiring on this vehicle was carefully stripped and peeled back, exposing the copper conductor, allowing an electrical current to be applied directly to the airbag module.



Figure 6. This vehicle was found with the airbags hanging out in the “deployed” condition, while the EDR recorded only a non-deployment event. The airbags were then removed and preserved for future testing.

strategies can help an investigator determine how the various safety systems in a given vehicle interact. For example, do the frontal airbags and seatbelt pre-tensioners deploy together, or does one system deploy ahead of the other? When do the side airbags deploy, and how do they interact with other built-in safety systems? Does the vehicle have an occupant classification system, and how does that control the strategy of the airbag deployments? Can you draw any conclusions regarding the number of occupants in the vehicle, and their seating positions, based on this information? All of these questions should be researched and understood before deciding about the legitimacy of any given airbag deployment. Vehicle owners' manuals, service manuals and other vehicle-specific publications can be a great tool for understanding the integrated approach to the safety systems in the subject vehicle.

A good example of these factors is a case in which we inspected a vehicle that reportedly had an adult passenger seated and buckled in the right front seat. A review of the owner's manual for that vehicle indicated that the vehicle was equipped with seatbelt pre-tensioners that were designed to deploy in a moderate to severe frontal collision, regardless of whether the seatbelts were buckled. The vehicle was also equipped with an occupant classification system for the frontal airbags, which would prevent deployment of the passenger airbag if the seat was either unoccupied or if the weight sensed on the seat was below a certain level. The right front passenger airbag had not deployed, and the seatbelt for that seating position was jammed in the fully retracted condition, consistent with the pre-tensioner deploying when the seatbelt was unbuckled.

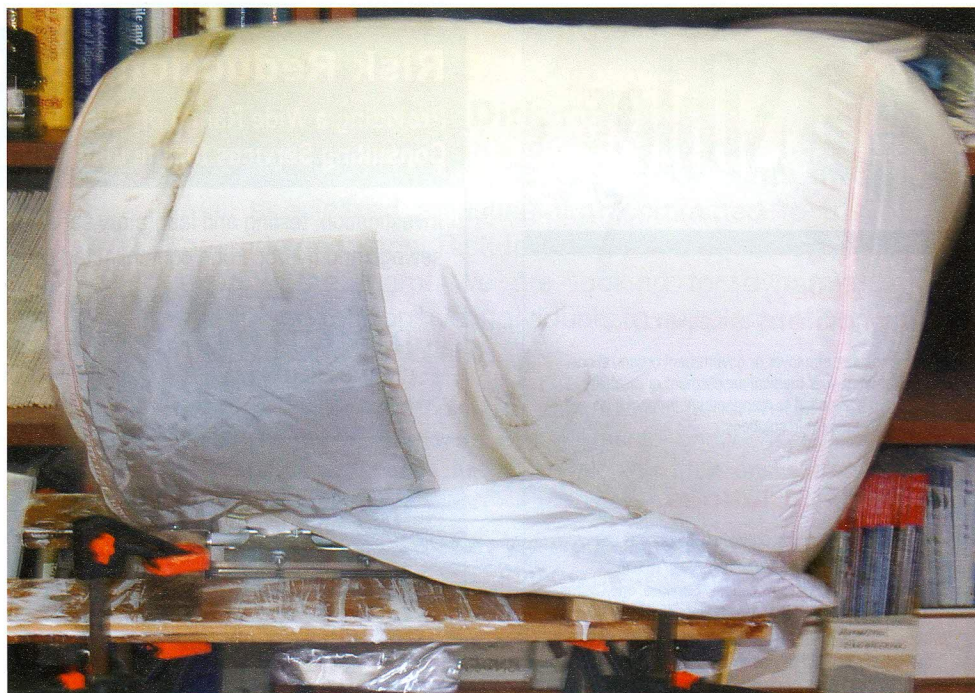


Figure 7. The airbag shown in Figure 6 was deployed in a controlled environment, and recorded with video and photographs. Despite the deployed appearance of the airbag within the vehicle, the airbag clearly inflated during the controlled test, proving that it did not deploy during the reported collision.

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Additionally, there were no occupant contact marks to be found, and no damage to the windshield as a result of an unbelted occupant. The condition of the restraints within that vehicle clearly indicated that no occupant had been seated in the right front passenger seat at the time that the collision occurred, contrary to the claims of the insured.

Very often, in staged collisions or misleading claims, the parties involved don't fully understand how these safety systems interact. Their misunderstanding of the airbag and seatbelt systems will often lead to incorrect statements, or obvious tampering with the airbag systems, which then leads to an incorrect deployment sequence within the vehicle. Trained and competent accident reconstructionists can use their understanding of these systems to piece the puzzle together and determine what really happened to result in the apparent deployment of an airbag.

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