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AUTO DAMAGE REPAIR REPORT

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AUTOMOTIVE BLACK BOX TECHNOLOGY

INTRODUCTION

A black box in an automobile? If this is true, where is it located and what does it look like? Is a black box really black? Once I find it, can an audio recording be played back to see if I too (just seconds before impact) emphatically blurted out those two most commonly used words (__ ____!)? If not, then what can it tell us and of what significance is the black box to insurance companies, vehicle owners and others? As a damage estimator or collision repairer, why do I need to be aware of black boxes?

This report will answer these and many other questions while providing the most recent developments in automotive black box technology. This information is not only fascinating but maybe of extreme importance to anyone involved in automobile collisions and/or the collision repair process.

WHAT IS A BLACK BOX?

Similar to a flight data recorder found on an aircraft, an automotive black box, also known as an Event Data Recorder (EDR) is capable of recording certain information when activated by an *event*. An event is best described as a change in vehicle velocity that exceeds the manufacturer's predetermined threshold. Events are classified according to airbag status and are identified as either a *deployment* event or a *near deployment* event. Near Deployment events can be anything from moderate impacts (that do not deploy the airbag) to a more trivial velocity change such as a minor impact, or it could even be activated by severe braking alone on some vehicles. Although some data may be obtained from other circuits, the majority of data is provided by the air bag system. As a result, the airbag control module in an automobile is actually used as the EDR or "black box". Confusing the issue, different manufacturers use different names for the EDR. For instance, General Motors calls their air bag control module (since 1996) a Sensing Diagnostic Module (SDM) while Ford calls it a Restraint Control Module or RCM (see figure 1).

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Figure 1 *The GM black box or Sensing Diagnostic Module (SDM) is shown here.*

DO ALL VEHICLES HAVE A BLACK BOX?

Nearly all vehicles with an air bag have some type of a crash recorder. However, General Motors was the first to allow public access to EDR data, initially including only 1996 and newer GM vehicles. Select 1994 and 1995 GM vehicles have since been added and eventually crash data from all air bag equipped GM vehicles 1990 and newer will become harvestable. In 2002, Ford has followed suit by allowing access to the following models: 2000 & up Taurus and Sable, the 2001 & up Crown Victoria, Grand Marquis, Windstar and Lincoln Town Car. Other manufacturers also have EDR's capable of recording crash data but have not yet provided the codes needed to interpret the information.

WHAT DATA CAN A BLACK BOX PROVIDE?

The EDR is capable of recording and storing a variety of pertinent information but may differ from one manufacturer or model to another. Some may include *post-crash* data only while others may also (or only) provide *pre-crash* data. GM modules that do store pre-crash information typically record at one-second intervals from five (5) seconds prior to the event. GM *pre-crash* data includes vehicle (wheel) speed, engine RPM, throttle percentage and brake switch status (see figure 2). Such information could assist in establishing liability in the event of conflicting stories. For example, the pre-crash data in figure 2 shows a rapid acceleration followed by heavy braking. If this information was obtained from a vehicle involved in an intersection collision, the 100% throttle at 5 seconds and an eight MPH increase at 4 seconds followed by braking at 3 seconds and a 15 MPH reduction in speed within the next 2 seconds could imply the driver was attempting to beat a red light just before slamming the brakes and colliding with another vehicle.

Seconds Before AE	Vehicle Speed (mph)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	57	4032	100	OFF
-4	65	4160	70	OFF
-3	62	2304	2	ON
-2	55	1088	2	ON
-1	47	896	2	ON

Figure 2 *Example of PRE-CRASH DATA.*

GM *post-crash* data measures **forward** velocity changes in mile per hour (MPH), at 10 millisecond (10/1000 of a second) increments for up to 300 milliseconds after the impact (see figure 3). This is the information that is crucial in establishing the severity of the impact in both magnitude and duration. This particular example would indicate the maximum velocity change experienced by the vehicle was 47.1 mph at approximately 200 milliseconds post impact, representing a **very** severe collision.

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100
Velocity Change (MPH)	-1.54	-3.07	-3.51	-5.27	-7.68	-10.09	-12.29	-16.24	-21.50	-27.86
Time (milliseconds)	110	120	130	140	150	160	170	180	190	200
Velocity Change (MPH)	-32.69	-39.93	-42.78	-43.44	-44.32	-44.98	-45.42	-46.07	-46.95	-47.17
Time (milliseconds)	210	220	230	240	250	260	270	280	290	300
Velocity Change (MPH)	-47.17	-47.17	-47.17	-47.17	-47.17	-47.17	-47.17	-47.17	-47.17	-47.17

Figure 3 *Example of POST-CRASH DATA.*

The GM EDR also provides the system status at deployment which includes air bag warning lamp, driver seat belt, passenger air bag switch, how many times the vehicle has been started prior to and since the deployment, the time from the impact until the deployment (in milliseconds) and the time (if within 5 seconds) between a near deployment event and a deployment event (see figure 4). Again, information of this nature is not significant in every collision; however, under certain circumstances this data could be crucial to an investigation. For example, recording both a near deployment and a deployment event may determine who hit whom first in a multi-vehicle front end accident. The time between the impact and the deployment could also be of significance when investigating the possibility of an improper previous repair or the use of faulty replacement parts. Likewise, whether or not the driver was seat belted or the status of the air bag warning lamp may be of importance.

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Supression Switch Circuit Status	ON
Ignition Cycles Since Deployment	187
Ignition Cycles At Investigation	213
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	18.75
Time From Algorithm Enable to Pretensioner Deployment Command Criteria Met (msec)	18.75
Time from Near Deployment to Deployment (msec)	N/A

Figure 4 *System Status at Deployment.*

In addition to forward impact situations, Ford EDR's will also record data from ***side*** impacts on vehicles equipped with side air bags although only post-crash data will be initially available.

HOW IS THE DATA OBTAINED?

The Vetronix Corporation, who has been closely involved with GM to produce a variety of electronic equipment, has now developed the Crash Data Retrieval (CDR) system. The CDR module is connected to a laptop PC loaded with the Vetronix software and also connected via cable to the diagnostic link connector, also known as the OBDII port. This is a standard and uniform connection located under the instrument panel for all vehicles sold in the United States since 1996 (see figure 5). If the OBDII port is damaged or inaccessible or if the vehicle's electrical system is not operational, data can also be

Figure 5 *The OBDII port located under the instrument panel can be used to obtain diagnostic data.*

obtained directly from the EDR/SDM/RCM/air bag control module/black box, etc. (see figure 6). If the location of the EDR is unknown, help files within the CDR system can be accessed. The appropriate cable must be used to connect the retrieval module to the EDR. Presently, as many as five different cables may be needed to collect data since five different EDR hardware ports could be used depending on the make and model. As more vehicles are produced with harvestable data, software upgrades for the CDR system and the need for additional cables will be likely. The CDR system includes two of the five cables and costs approximately $2,500.00 (excluding the PC).

Figure 6 *The Crash Data Retrieval (CDR) tool can also be connected directly to the black box commonly located under the drivers seat as shown here. The second cable is connected to a laptop computer.*

If the crashed vehicle has no electrical power the retrieval module can be powered by connecting the cigarette lighter adapter to another vehicle. As a third option, the EDR could be removed from the vehicle when necessary and retrieval could be later performed by using the 12-volt AC/DC power supply that comes with the CDR system. Data can usually be retrieved in 5-10 minutes unless the OBDII and EDR ports are no longer accessible due to the collision. Additional time to remove the EDR or other parts necessary to access the data ports would be required in such cases. In rare instances of severe collisions causing significant impact or stress directly to the EDR module or when subjected to extreme heat from flames or when submerged under water EDR data may be unretrievable.

The vehicles' VIN is used as the file name for downloaded information. Downloading the data from the EDR will **not** alter or erase the stored data. Meaning that the same information could be extracted over and over and by different individuals. Those who may be interested in EDR data or who may be contracted to harvest the data may include insurance companies, independent adjusters, collision repair facilities, air bag service personnel, attorneys, forensic experts, government and law enforcement agencies. As a result, each time the ignition is turned on to harvest the data the cycle count (as shown in figure 4) will be advanced. In the case of GM vehicles, *near* deployment events are recorded and stored for 250 ignition cycles before being cleared. If the vehicle experiences another *near* deployment, the EDR will store the event that has the greatest velocity change. *Deployment* events are **permanently** stored, which explains GM's recommendation to replace the EDR (SDM) following air bag deployment.

LOW VELOCITY IMPACTS

For many years insurers have been plagued by claims of soft tissue injuries resulting from otherwise minor accidents. Insurers often overpay such claims since this type of injury is difficult for a doctor to either prove or disprove. Unlike broken bones, soft tissue injuries do not show up on an x-ray, often leaving them subject to opinion and speculation. Furthermore, the involvement of experts in *every* injury claim is cost prohibitive.

This line of thinking may be changing for some insurers since the introduction of WrExpert (pronounced wrecks-pert) in 1998. WrExpert is a software program developed by Injury Sciences that combines scientific principles with the individual circumstances of a collision to determine if certain injuries are possible. The program is based on decades of research, including the effects of various accelerations to the human body from both high and low velocity impacts and can derive impact severity on vehicles using its database of mass attributes, crash test results and other vehicle attributes on approximately 30,000 vehicles dating back to the early 70's. The direction, angle and point of impact are derived from photographs and the type and amount of damage listed on the estimate is also considered when analyzing the possibility of injury.

In October of 2001, Injury Sciences introduced WrExpert 4.0. This new version incorporates pre-crash speeds and braking

data along with the post-crash velocity change (Delta V) data harvested by the Vetronix CDR from the black box to further enhance the accuracy of an injury evaluation.

By identifying soft tissue injury claims that are questionable and in need of further investigation, WrExpert can discourage *bogus* whiplash claims and *ambulance chasing* attorneys, possibly avoiding potential litigation expenses altogether. In addition to soft tissue claims, impact severity data could possibly assist with diminished value claims (see ADR #323, "Understanding Diminished Value") and can also identify fraud by indicating whether or not the vehicle was even involved in a collision.

Injury Sciences also provides training on how to harvest the information while Vetronix provides the more intensive training and certification that is required to analyze the data. Since in most cases, the harvester and the analyst are not the same individual, Injury Sciences offers a secure website that can be used to upload and store the data. This website (listed below) also documents the who, where, and when of the harvesting activities for the end user of the information. The data can then be viewed and analyzed at another location from the Internet. A network of potential harvesters across North America is also provided. Injury Sciences can be contacted at:

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PRIVACY / OWNERSHIP ISSUES

Although subject to future legal precedent, it currently appears as though EDR data is the property of the vehicle owner. However, since the *insured* is obligated by the policy to mitigate loss and to cooperate with an investigation, the *insured* is also obligated to relinquish the data in order to receive payment for the loss. Third party losses, on the other hand, are not as well defined. Preliminary information indicates that access to EDR data can be requested; however, it can be denied at the *claimants'* discretion. If the *claimant* does agree to data retrieval a release should be obtained. It is also important to note that data retrieved from the *insured's* vehicle may also provide adequate data to accurately assess the possibility of injury to the occupant(s) of the *claimant* vehicle without actually obtaining data from the claimant vehicle. For example, if the insured rear-ended the claimant vehicle, a recorded frontal impact to the insured vehicle could provide ample data to analyze the potential of injury to the occupants of **both** vehicles. Also, due to direction and angle limitations of the air bag sensors, data recorded by the claimant vehicle in this situation would not provide accurate Delta V data.

Interestingly, in regards to privacy a recent survey indicates the general public is in favor of using EDR data for accident investigation and to establish liability. The same survey also indicates public opposition to using EDR systems for global positioning (GPS) purposes or to monitor driving habits for the purpose of establishing insurance rates.

LITIGATION

Will black box data and/or a scientific based evaluation of potential injuries stand up in court? One thing that is certain when insurance companies are involved in litigation is that very little is really certain. The most solid, seemingly clear-cut cases have been reduced to mere rubble, rendering jaw-dropping judgments. Even so, another thing that is certain is that a well-prepared and well-documented case produces the best chance to prevail. This includes documentation of even the smallest details such as the chain of data retrieval events, including but not limited to; who, when, where and how the data was retrieved. Any special circumstances involving the removal or storage of the EDR (see ADR #321 "How to Obtain and Preserve Evidence for Testing" and ADR #326 "The Power of Documentation"). Also, how, when and where the data was stored and/or transmitted as well as who, when, where and how the data was analyzed should be documented.

Furthermore, aircraft black boxes and other technological advancements have historically been relied upon as accurate and factual evidence. Even though GM indicates their primary motive in collecting crash data is to improve and advance safety and design features, they have been vindicated in the past by using crash data as evidence during product liability litigation.

CONCLUSION

As of this report approximately 15% of all private passenger vehicles on the highway have black box data that is harvestable. Therefore, in two vehicle accidents there is now about a 30% chance that one of the two vehicles has harvestable data. In addition, the number of vehicles with harvestable data is expected to increase at a rate of at least 2% with each new model year. When additional manufacturers provide access codes to black box data, these numbers will continue to increase. As the percentage of harvestable vehicles and insurance company interest in black box data increases, collision repairers and independent appraisers will be afforded more and more opportunities to be compensated for harvesting data. Who knows, it may even provide renewed incentive sufficient to have more vehicles undergo a physical inspection by qualified independent or staff estimators accompanied by an accurate assessment of the damage.

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