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BLACK BOX (Part 2 of 2)

EVENT DATA RECORDERS

A Deeper Look Inside the 'Black Box'

An Event Data Recorder (EDR) is an integrated component of several sensory modules. It constantly cycles through 5- to 8-second data streams, receiving input from various locations in the car and deleting data at the end of the cycle. When a significant collision occurs, the EDR memorizes the last cycle of data, providing a window into the five seconds before the crash. The triggering event may occur whether or not the airbag was deployed. In most devices, data following a deployment event is permanently retained, while non-deployment events are only temporarily retained for varying lengths of time.

In 2004, an estimated 40 million passenger vehicles were equipped with EDRs. By carefully collecting and analyzing the details provided by the growing number of EDR-equipped vehicles, state transportation agencies, the highway safety research community, and accident reconstructionists have an unprecedented opportunity to understand the interaction of the vehicle-road-driver system as experienced in thousands of U.S. highway accidents each year.

Event Data Recorder Capabilities

PRE-CRASH

As shown in Figures 1-1 and 1-2, EDRs can store up to five seconds of pre-crash data. Data elements include vehicle speed, engine throttle position, engine revolutions per minute, and brake status versus time for the five seconds preceding the time the airbag control module believes that a crash has begun. These data elements provide a record of the actions taken by the driver just prior to the crash. One example of a scenario resulting in data of this pattern is as follows:

Attempting to beat a red light, a driver slams on the brakes and collides 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 1-1: *Example of Pre-Crash Data*

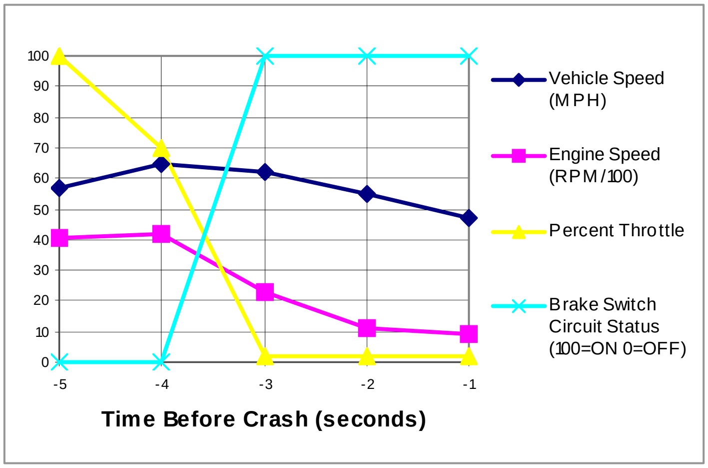

Figure 1-2: *Graph of Pre-Crash Data*

POST-CRASH

EDR post-crash data measures forward vehicle speed in miles per hour, at 10 millisecond increments for up to 300 milliseconds after the impact (see figures 2-1 and 2-2). Arguably the most valuable data element stored in the EDR, this information is crucial in establishing, from up to two events, the severity of the impact in both magnitude and duration.

The example below indicates a maximum velocity change of 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 2-1: *Example of Post-Crash Data*

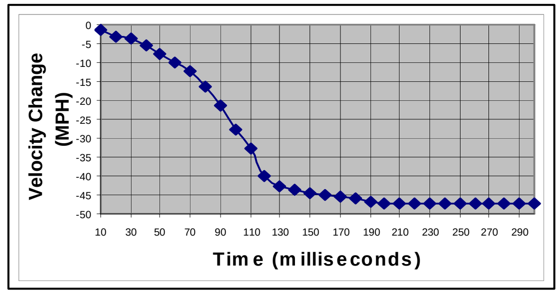

Figure 2-2: *Graph of Post-Crash Data*

SYSTEM STATUS

Most Event Data Recorders also provide the system status of the airbag warning lamp, driver's seat belt, passenger airbag switch, number of times the vehicle has been started prior to and since deployment, time between impact and deployment, and time (if within 5 seconds) between a near deployment event and a deployment event (figure 3). Under certain circumstances, some or all of 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.

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 3: *System Status at Deployment*

DATA ACCURACY

Event information consists of discrete and variable data. Discrete data includes: brake switch status, manual passenger airbag cutoff switch position, and the driver seat belt switch status. Variable data includes: the change in vehicle speed, engine RPM, and throttle position. Figure 4 shows the accuracy and resolution for the variable-type parameters.

Parameter	Full Scale	Resolution	Accuracy	How Measured	When Updated
ΔV	± 55.9 mph	0.4 mph	~ ± 10%	integrated acceleration	recorded every 10 msec, calculated every 1.25 msec.
Vehicle speed	158.4 mph	0.6 mph	± 4 %	Magnetic pickup	vehicle speed changes by ≥ 0.1 mph
Engine Speed	16383 RPM	1/4 RPM	± 1 RPM	Magnetic pickup	RPM changes by ≥ 32 RPM.
Throttle Position	100% Wide open throttle	0.4 %	± 5%	Rotary potentiometer	Throttle position changes by ≥ 5%.

Figure 4: *Accuracy and Resolution of EDR Data*

Common Terms Associated with EDR Technology

Sensing and Diagnostic Module (SDM) – A module that senses and discriminates crash pulses to identify those requiring airbag deployment. They can deploy frontal airbags and pretensioners for frontal impacts and side airbags in side impacts.

Diagnostic and Energy Reserve Module (DERM) - Older GM term for the airbag module.

Diagnostic Trouble Code (DTC) – A set of codes used by the SDM in order to indicate specific supplemental inflation restraint (SIR) system malfunctions.

On Board Diagnostic (OBD) – A sensing and controlling module that regulates many different controls of the automotive electronic system. It can range from regulating basic engine functions and diagnostics to more complex systems like anti-lock brakes. Its primary purpose is to read codes generated by the control modules, sensors and switches and store them for extraction by a technician at a later date.

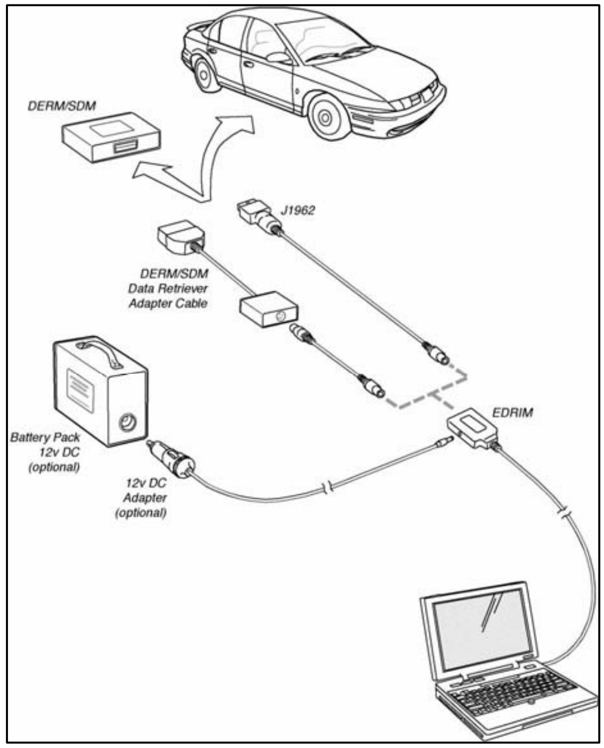

Figure 5: *Diagram of retrieval process*

Crash Data Retrieval (CDR) – A system enabling the information stored on the EDR to be accessed through a data port and read by the appropriate software.

Current Vehicles with CDR-compatible EDR Systems

Vehicles Requiring Older CDR Software		*Vehicles Requiring Updated CDR Software*	
General Motors	1994 - 2005	General Motors	2005
Ford	2001 - 2004	Ford	2001 - 2005
Isuzu	2000 - 2004	Isuzu	2005
		Saab	2005

Conclusion

Black box and other complementary technologies can provide insight into accident and injury causation in auto claims. Today, accident reconstructionists can employ this technology to significantly reduce loss costs by accelerating and improving the accuracy of auto claim evaluations. Additionally, these complementary technologies allow the auto insurance industry to develop data and strategies that could profoundly improve its underwriting and pricing models. As with any technology, the ultimately successful solutions will require responsible interpretation and utilization of the data.