Advanced Event Data Recorders

Abstract

Current event data recorders provide data on an expanded range of occupant protection systems, in addition to a wide variety of data elements relating to pre-crash driver actions and the performance of collision avoidance systems.

Résumé

Les enregistreurs actuels de données d'événements fournissent des données sur une grande gamme de systèmes de protection des occupants, en plus d'une grande variété d'éléments de données relatives aux actions des conducteurs avant la collision et à la performance des systèmes anti-collision.

Event data recorders (EDR's) have been installed in many production vehicles since the introduction of frontal air bags into the fleet in the 1990's. On-going advancements in automotive electronic systems have produced vast changes in the features and capabilities of these on-board crash recorders.

Today's EDR's will report on deployment parameters for a wide range of air bag systems, including multi-stage frontal air bags, side air bags, head curtains, and deployable knee bolsters. In addition, data are often available on pyrotechnic systems associated with seat belts, such as buckle retractors, webbing pre-tensioners, and inflatable belt systems. Not only do EDR's indicate that such devices have been deployed as a result of a crash, they also provide details of the timing of the deployments.

Deployment Command Data (Most Recent Event)

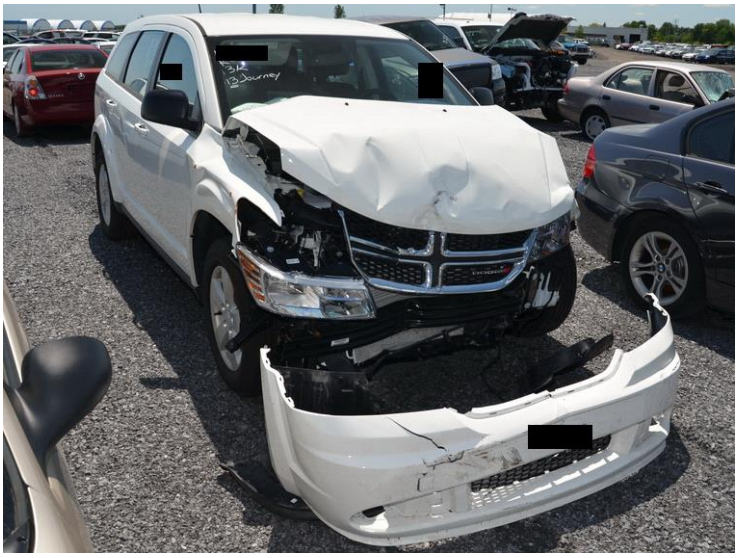
Frontal Airbag Deployment, 1st Stage, Driver	Yes
Frontal Airbag Deployment, 2nd Stage, Driver	Yes
Frontal Airbag Deployment, Time to First Stage Deployment, Driver (msec)	28
Frontal Airbag Deployment, Time to 2nd Stage Deployment from T0, Driver (msec)	101
Frontal Airbag Deployment, 1st Stage, Passenger	Yes
Frontal Airbag Deployment, 2nd Stage, Passenger	Yes
Frontal Airbag Deployment, Time to First Stage Deployment, Passenger (msec)	28
Frontal Airbag Deployment, Time to 2nd Stage Deployment from T0, Passenger (msec)	151
Knee Airbag Deployment, Driver	Yes
Buckle Pretensioner, Driver	No
Retractor Pretensioner, Driver	Yes
Frontal Airbag Deployment, Passenger 3rd Squib	Yes
Buckle Pretensioner, Passenger	Yes

Such data are frequently accompanied by detailed crash pulses in the form of acceleration and/or change in velocity (delta-V) profiles. Together these data provide valuable information on the nature of crashes, their severity, and timing, and can enable automotive engineers to optimize vehicle structural characteristics, and restraint system designs, in order to afford the best possible protection to vehicle occupants.

Some early EDR's also provided pre-crash data; however, these were generally limited to five "snapshots", taken at one second intervals, of vehicle speed, engine RPM, percentage throttle application, and brake light status (on or off). Today's systems normally have greatly expanded capabilities with, for example, additional data elements and readouts of parameters of interest being made every tenth of a second for the five second period prior to impact.

New elements that may be present in the pre-crash data stream include individual wheel speeds, accelerator pedal voltage, engine throttle position, brake fluid pressure, and steering system input. Information may also be available on the pre-crash activity associated with on-board collision avoidance systems such as antilock brakes (ABS) and electronic stability control (ESC). Other pre-crash data elements may include the transmission's gear selection, cruise control setting, electronic traction control (ETC) status, and individual tire pressures.

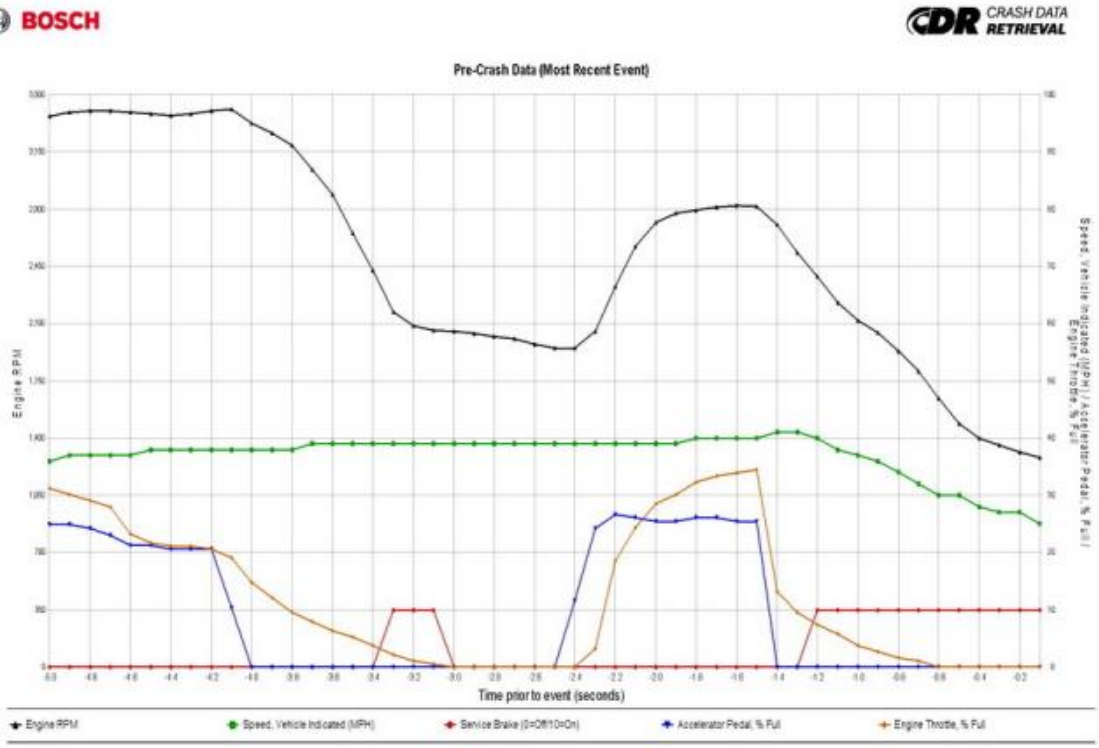
The availability of detailed pre-crash data affords researchers the opportunity to develop considerable insights into driver behaviour and the timing of avoidance manoeuvres under real-world conditions. Such research would best be performed in the context of a comprehensive collision causation study where all of the relevant data sources and analytical techniques would be brought to bear. Nevertheless, we may obtain some indication of the potential use of pre-crash data obtained from EDR's by considering a case example from a crashworthiness study, where detailed driver and witness statements relating to the collision events are not available.



The case collision involved a 2013 Dodge Journey utility vehicle that was travelling southbound on a six-lane, median-divided arterial roadway. The case vehicle was being driven at approximately 60 km/h in a 50 km/h zone, and was approaching a traffic-light controlled intersection. The traffic light was reported to be green. It was overcast and raining and, as a result, the asphalt pavement was wet.

As the Journey approached the intersection, a 2012 Chrysler 200 four-door sedan commenced a left turn. The Journey's driver braked and steered to the right; however, the front of the Journey struck the right side of the turning vehicle.

A graph of some of the pre-crash data elements captured by the Journey's EDR is shown in the following figure. From these curves, and the associated tabular data contained in the EDR report, it can be seen that, at 2.4 seconds prior to impact, and for a subsequent period of about one second, the driver pressed on the accelerator pedal by about 25% (blue curve). The engine speed (black curve) shows a corresponding, although lagged, increase; however, the vehicle's travel speed (green curve) increases only marginally, from 62 to 65 km/h.



At 1.2 seconds prior to impact, the driver of the Journey applied the vehicle's brakes, holding them on until impact, as demonstrated by the approximately linear decrease in vehicle speed. The anti-lock braking system engaged for part of this time (one second to 0.5 seconds prior to the crash).

At about the same time that the vehicle's brakes were applied, the driver also steered to the right by between 90 and 120 degrees. The latter steering wheel position was maintained for the final half second before impact, with the vehicle's electronic stability control engaging during this latter period.

Clearly we have no details of the timing of the phases of the traffic light signal from either infrastructure data or witness statements. However, given the above-noted driver actions, we might speculate that the light turned yellow as the Journey approached the intersection, and that the driver accelerated, intending to travel through the intersection.

What is clear, is that the Journey's driver observed the left-turning vehicle only about one second prior to collision. The speed-time data indicates that the vehicle's deceleration averaged approximately 0.6g over this time period which is not unreasonable for an ABS-equipped vehicle braking hard on a wet road. However, given the vehicle's 65 km/h travel speed prior to braking, a period of such hard deceleration of approximately three seconds would have been required for the driver to bring the vehicle to halt and so avoid the collision.

As noted earlier, due to a lack of detailed information, some of the above considerations are speculative in nature. Nevertheless, the breadth and detail of the pre-crash data that are available from current EDR systems can be seen to provide considerable potential benefits to traffic safety researchers who are interested in driver behaviour and their pre-collision actions, and also to automotive engineers and regulators who are developing collision avoidance measures.

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