EDR PRE-CRASH DATA: POTENTIAL FOR APPLICATIONS IN ACTIVE SAFETY TESTING

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ABSTRACT

Passive safety testing has been based on accident research where objective physical evidence can be compiled and analysed when establishing technical test requirements. Active safety tests pose new challenges because objective data is more difficult to obtain. Until pre-crash variables became available in Event Data Recorders (EDR), the only sources of pre-crash vehicle motions were tire marks or witness statements. Both data sources have limitations since they may not always be available and require interpretation by the analyst. The pre-crash EDR data variables provide an objective source of data to active safety test development. However, the suitability of the data has not been thoroughly investigated in the published literature.

The review of existing data shows that the variables identified in the new EDR requirement in Part 563 are useful but incomplete for a comprehensive analysis of vehicle dynamics manoeuvres prior to a crash. In particular, the absence of vehicle yaw rate reduces the positioning accuracy of the vehicle in reconstructions. The objective data in the limited cases were used to compile the frequency of pre-crash braking and steering, and when possible, the magnitude of these driver inputs.

Active Safety test development will benefit with more EDR analysis but the older data that does not conform to Part 563 has limited application.

INTRODUCTION

Vehicle manufacturers have been offering newer or improved driver support features that can increase safety to the occupant. Adaptive Cruise Control and Lane Departure Warnings systems are examples of systems that increase comfort and safety during driving because the vehicle is able to monitor its position relative to the other vehicles (ACC) or the road (LDW). Technological developments have led to more autonomous systems that not only warn the driver, but may even initiate autonomous interventions. The most notable example is the Automatic (or Autonomous) Emergency Braking systems that are now offered as standard equipment on several vehicle models some passenger vehicles [1]. These systems intervene with the driving process and apply the brakes under predetermined conditions. Corresponding functions are being developed for the steering system as electric power steering facilitates the possibility for automatic steering corrections.

There are many issues that need to be resolved before autonomous functions take over significant periods in the driving task. The current trend is to activate a function when a collision is unavoidable, thus limiting the liability issues that arise. Issues related to the responsibility of the driver and liability for actions of autonomous systems are beyond the scope of the reported study. There is, however, a critical need to identify conditions for activation and the amount (magnitude and duration) of system intervention during safety critical events. Both regulatory and consumer testing programs are being prepared. For example heavy vehicles in Europe will be required to be fitted with AEB to comply with a new ECE Regulation [2]. EuroNCAP is now crediting vehicles AEB and will begin testing AEB systems in 2014 [3]. NHTSA has proposed test protocols for Dynamic Brake Support [4] and Collision Imminent Braking [5] that were published for comments in 2012.

Research efforts to define test protocols and performance criteria have increased considerably in the last years. The European Commission funded activities include the recently completed "ASSESS[6]" project and the ongoing AsPeCSS[7] project that address car-to-car and car-to-pedestian safety issues including pre-crash assessments. Smaller scale projects have been initiated with different groupings of project partners such as the AEB Test Group [8]. Similar activities have been reported in the US with NHTSA being a focal point for the project reporting. Large scale research programs like Advanced Crash Avoidance

Technologies (ACAT) sponsored by NHTSA [9] have focused on specific countermeasures and evaluation methodologies while naturalistic driving studies such SHRP2[10] have been directed at fundamental data collection to investigate driver-vehicle-infrastructure interactions.

Test methods for assessing active safety systems to avoid or reduce the severity of a crash must address the following points:

- Scenario for evaluation
- Facility and equipment
- Assessment criteria

The first point, the traffic scenario, is critical for the subsequent development of the test protocol. A scenario addresses the pre-crash orientation of the traffic elements, type of road users involved, and outlines the needs of the system under of evaluation. The development of the scenario thus needs information on safety critical events to both identify the frequency and outcomes of different incidents as well as the specific information describing the actual sequence of events. The current trend in active safety test development is to develop forgiving targets that vehicle sensor systems will perceive as cars or pedestrians. The surrogates must move like their real life counterparts and part of the challenge for the test development is to identify how fast a target should move in terms of absolute speed and speed relative to the tested vehicle. EDR data contains both information relevant for defining test speeds for the vehicle under investigation, as well as the positioning requirements for test targets or other test infrastructure.

Identifying and prioritising scenarios has evolved from the analysis material and procedures applied in occupant protection, or passive safety, research. The existing crash databases contain information outlining the type of collisions and the environment surrounding the crash. The focus in this research has been the analysis of the crash severity and injury outcome. Analytical assessment tools in accident reconstruction provide the majority of this information in databases such as NASS[11], GIDAS[12], CCIS[13], etc. Event Data Recorders (EDR) or Crash Recorders have complemented the knowledge on crash severity by recording vehicle motions during the crash for those vehicles equipped with a recording system. A review of EDR systems and analysis of data gathered up to 2005 is documented by de Silva [14]. NHTSA has now imposed a requirement that after September 2012, all vehicles equipped with an EDR shall supply a minimum set of data elements according to Code of Federal Regulation Part 563 [15], including data prior to the impact.

The quality of analytically reconstructed crashes is suitable for detailing some of the pre-crash conditions that are needed to develop a test protocol. This data is not as reliable when it comes to addressing the timing of pre-crash inputs from the driver such as braking and steering, that may influence the performance of a system and be crucial in its evaluation. EDR data provides a direct record of variables such as vehicle speed allowing the potential to investigate the prevalence and relevance of driver actions recorded during a crash.

OBJECTIVES

The study investigates the availability and suitability of EDR that is available from the NASS data gathering program. The type of data, variation of data within the vehicle fleet, and its applicability to developing active safety test protocols will be assessed. The sensitivity of data elements will also be explored to identify the reliability of EDR outputs when applied to active safety test development. The study focuses on the analysis of EDR data related to the most mature active safety testing procedure which is rear end impacts.

METHODS AND DATA SOURCES

The data investigated in this study primarily comes from the EDR files collected in the NASS data activities. This data is publicly available and the data connected with the NASS Crashworthiness Data System cases which are well documented by the case investigators.

EDR OVERVIEW

The details of EDR systems and the associated data are well described on the NHTSA EDR website [16] and [14]. In short, EDRs consist of a computer memory that is connected to the vehicle supplemental restraint system (SRS). The system continuously logs data but only activates permanent storage when the restraint system deployment algorithms “wake up”. Depending on the violence of the event, the system logs the event as a “deployment” or “non-deployment” if any of the restraint system components such airbags or seatbelt pre-tensioners deploy. Most EDRs store the two most recent events.

Until Part 563 came into place, there were no requirements for manufacturers to have harmonised variable and recording formats. Different groups have defined interface and output protocols (SAE J1698[17], IEEE 1616[18]), but the actual data elements had not been defined interface and output protocols until NHTSA published Part 563. Most of the EDR data was focused on passive safety information such as crash pulse and airbag deployment times and pre-crash data was limited, if not absent, in the first EDRs introduced before the year 2000. Part 563 stipulates the minimum data elements, recording intervals, and data formats for EDR systems. This does not preclude the manufacturer from supplementing Part 563 with richer storage protocols. Table 1 provides the minimum data specifications for Part 563. Suggestions for additional data elements are also provided.

Table 1 – Data Elements Required for All Vehicles Equipped with an EDR[15]

Data Element	Recording Interval/Time[1] (Relative to time zero)	Data Sample Rate Samples per Second
Delta-V, longitudinal	0 to 250 ms	100
Maximum delta-V, longitudinal	0-300 ms	n.a.
Time, maximum delta-V	0-300 ms	n.a.
Speed, vehicle indicated	-5.0 to 0 sec	2
Engine throttle, % full (or accelerator pedal, % full)	-5.0 to 0 sec	2
Service brake, on/off	-5.0 to 0 sec	2
Ignition cycle, crash	-1.0 sec	n.a.
Ignition cycle, download	At time of download	n.a.
Safety belt status, driver	-1.0 sec	n.a.
Frontal air bag warning lamp, on/off	-1.0 sec	n.a.
Frontal air bag deployment, time to deploy, in the case of a single stage air bag, or time to first stage deployment, in the case of a multi-stage air bag, driver	Event	n.a.
Frontal air bag deployment, time to deploy, in the case of a single stage air bag, or time to first stage deployment, in the case of a multi-stage air bag, right front passenger	Event	n.a.
Multi-event, number of events (1,2)	Event	n.a
Time from event 1 to 2	As needed	n.a.
Complete file recorded (yes, no)	Following other data	n.a.

[1]Pre-crash data and crash data are asynchronous. The sample time accuracy requirement for pre-crash time is –0.1 to 1.0 sec (*e.g.*, T = -1 would need to occur between –1.1 and 0 seconds.)

DATA REVIEWED

To investigate the utility of EDR data for active safety test development, the EDR data for NASS year 2009 was downloaded from the NHTSA website. At the time of writing, this was the most recent data set available for a full calendar year. NASS EDR data for 2010 and 2011 have been recently uploaded but has not been incorporated herein. A total of 690 EDR reports were retrieved by NASS investigators. Of these cases, 291 had reported a deployment of the SRS and 339 had no deployments. Fortunately the EDR will still save data with an event that initiates an algorithm "wake-up".

The EDR data was grouped into different collision categories to identify the distribution of incidents relative to the priorities for active safety test methods under development. Data from different cases were reviewed to see if the EDR records contained relevant data for the analysis.

An important piece of information in Table 1 is the note about the pre-crash and crash data timing. The data is asynchronous for the pre-crash and crash sequences and a 1 second uncertainty can exist.

Further analysis was done with a reconstruction of a case to identify how well the recommendation reflects the needs for test protocol developments. This reconstruction was conducted using simplified vehicle dynamic models programmed in Matlab using the pre-crash data elements stored in the EDR.

RESULTS

NASS has a variable for accident type (ACCTYPE) in the NASS General Vehicle dataset. The variable describes the vehicle manoeuvre at the time of the crash and is the most relevant parameter for use in the analysis described here. The ACCTYPE variable has 6 main categories identifying single vehicle collisions, rear end collisions, etc. The categories contain subgroups (e.g. depart road left, depart right) and the subgroups contain a number of specific accident types. There are 13 subgroups and 93 accident type codes[19]. Table 2 shows the frequency and proportion of crashes with EDR records.

The 3 most common type of collisions were: Changing Trafficway, Vehicle Turning (turning conflicts); Single Vehicle; and Same Trafficway, Same Direction (i.e. rear end crashes). If the accidents are broken down into each crash type where an active safety system would have reduced or eliminated the consequences of a crash then the 15 most common types are presented in Table 3.

The distribution of model years captured in the data sample is shown in Figure 1. The plot shows the relatively even distribution of cases over the interval 2001-2008. This reflects the penetration of EDR equipped vehicles in the fleet. The oldest vehicles in the sample are GM. The oldest Ford case is a 2001 year model with the oldest Chrysler being a 2004 year model. No other manufacturers were identified in the 2009 sample.

Table 3: Proportion of EDR cases for each NASS Accident Type Category

Collision Type	Frequency	Proportion
68 Initial Opposite Directions (Left/Right)	52	8.3%
69 Initial Opposite Directions (Going Straight) Directions (Going Straight)	48	7.6%
2 Control/Traction Loss	44	7.0%
20 Stopped	36	5.7%
7 Control/Traction Loss	33	5.2%
83 Turn Into Opposite Directions (Going Straight)	31	4.9%
1 Drive Off Road	29	4.6%
86 Striking from the Right	23	3.7%
88 Striking from the Left	21	3.3%
6 Drive Off Road	14	2.2%
28 Decelerating (Slowing), Gowing Right	12	1.9%
50 Lateral Move (Left/Right)	10	1.6%
51 Lateral Move (Going Straight)	10	1.6%
65 Lateral Move (Going Straight)	10	1.6%
13 Pedestrian/Animal	9	1.4%
Total	382	60.6%

Figure 1: Distribution of Model Year in the 2009 EDR Database

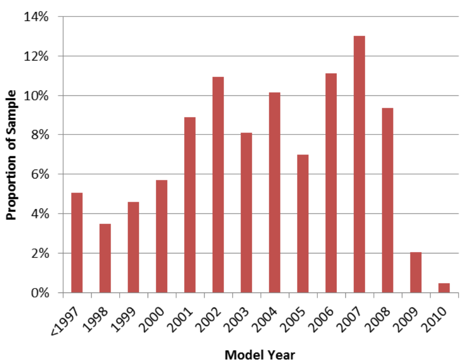

Figure 1: Distribution of Vehicle Model Years Sampled in the 2009 NASS Dataset with EDR Data

Relevant Cases for Active Safety Testing

Several initiatives to develop active safety tests have been identified and the common themes have been rear end and pedestrian collisions. As seen in Tables 1 and 2, these are relevant but are not the most common according to the sample, being the third most common event type.

Impacts with stationary or objects travelling in the same direction as the subject vehicle are among the easiest collision types to address with automated systems. Rear end impacts are a relatively simple event for vehicle sensors to monitor compared to events where threats cross the path of the vehicle. Cameras, radar, and other detection systems have the greatest effectiveness when looking forward so that the vehicle's path is monitored. Current technologies have a limited field of view and the ability for a threat detection algorithm to be effective depends on the length of time the potential

Table 2: Proportion of EDR cases for each NASS Accident Type Category

Category	Frequency	Proportion
IV: Changing Trafficway,	189	30.0%
I Single Vehicle	153	24.3%
II Same Carriageway, Same direction	124	19.7%
V: Intersecting Paths (Vehicle Damage)	77	12.2%
VI: Miscellaneous	48	7.6%
III: Same Trafficway,	37	5.9%
Uncoded	2	0.3%
Total	630	100%

threat is in the sensor's field of view. The fact that rear end impacts are amenable to active safety countermeasures makes these collisions relevant for analysis of EDR data availability.

Single vehicle collisions are the second most frequent group of collisions in terms of EDR data availability. Many of the cases identified in the dataset involve loss of control conditions. As this collision type is addressed by ESC systems, further investigation is not pursued in this analysis but is recommended for further development, particularly in combination with the other single vehicle collisions that could benefit from lane keeping and lane departure warning systems.

The most common collision type was where approaching vehicles cross paths due to intersection or other lane departure manoeuvres. Although lane departure waning is not pursued in this study, the applicability of EDR data to approaching vehicles is studied to get an understanding of the sensitivity of EDR data elements.

Rear End Impacts

There are a number of test methods proposed for detecting stopped or slower moving vehicles in the subject vehicle's path. Relevant inputs to these tests are the speed of the vehicles and the lateral orientation of the vehicles prior to impact.

The EDR dataset contains no positioning information prior to impact. For vehicles complying with the Part 563 protocol, steering wheel angle is an optional variable that is recommended but part of the mandatory set in Table 1. All the 2009 cases reviewed contained no steering wheel information other than one case with a steering wheel angle of 0 deg. Although the database does contain vehicles with pre-crash steering information, none were involved in this particular crash configuration or had any steering input prior to the crash.

Vehicle speed prior to the impact is relevant to identify both the initial speed of the vehicle and the driver actions up to the point of impact. Figure 2 shows brake application (off - on) prior to impact. There is no obvious trend for the limited cases analysed but one can notice that there is tendency for brake application in the last 3 seconds prior to the crash. daSilva reported that brake application in rear end crashes was observed mostly in the last 3 seconds prior to collision, but still only 50% of striking had active braking in the last second before impact [14].

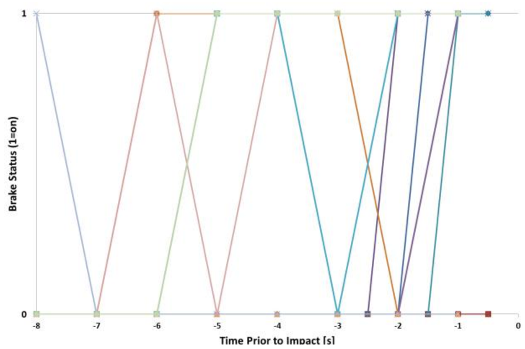

Figure 2: Brake Switch Status Prior to Crash in Rear End Collisions

Figure 3 shows a selection of pre-crash speed prior to the impact. As one would expect, there is a large amount of scatter with impact speeds up to 105 km/h being recorded. This reflects the range of accident locations where rear-end crashes can occur, spanning high speed motorways and low speed urban settings. The majority of pre-impact speeds are between 30 and 80 km/h in the last 3 seconds prior to impact, and is agreement with current test proposals [4,5,6,8].

The data in Figures 2 and 3 only reflect the following, or striking vehicle. It is important to not only consider the absolute speed, but even the relative speed between vehicles. The database contains many cases where an EDR recorded the struck vehicle speed and not the striking vehicle. This information is useful for evaluating the status of a vehicle target in a test procedure. One case was available with EDR data in both vehicles. The speeds of the two vehicles are shown in Figure 4. The struck vehicle was decelerating while the striking vehicle accelerated in the 5 seconds recorded prior to the crash. The relative velocity at the time of impact was approximately 50 km/h, based on the EDR time base. The struck vehicle was coded as stationary vehicle – while the EDR data demonstrates that the collision type was better represented as a decelerating vehicle.

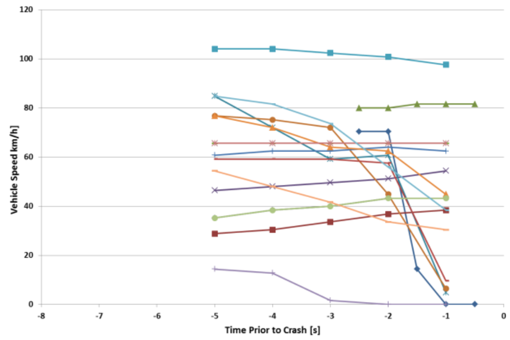

Figure 3: Vehicle Speed Prior to Rear End Crashes

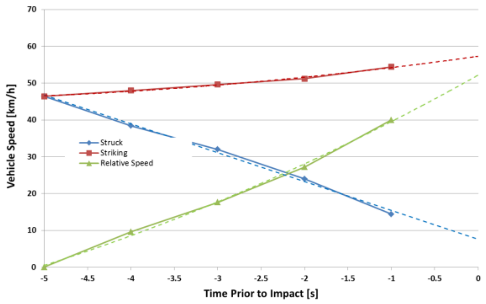

Figure 4: Time-Speed History of Vehicles Involved in a Rear End Collision.

In all the data plotted above, there is a gap between the last data point (typically T= -1.0 in the older EDRs) and T=0, the assumed crash time. As noted in Table 1, the timing of the sample points relative to the actual crash T=0 may be shifted by 1s. The dotted lines in Figure 4 show the predicted speeds of the vehicles based on the preceding intervals but it cannot be rigorously stated that the relative collision speed was the one identified at T=0 (52 km/h) in the graph, but may have been anywhere from 40 to 52 km/h, depending on the time of contact between the vehicles. The sensitivity of sample rate and time shift are discussed in the following analysis.

Crossing Paths

The preceding case contained no pre-crash steering input. A further analysis of a case with vehicles that crossed paths was investigated. The vehicle that crossed the path of the approaching vehicle had EDR data detailing the steering input. The steering data was stored at a lower sample rate than specified in Part 563 as the vehicle model preceded the implementation of Part 563. The steering and vehicle speed data were recorded in 1 second intervals, 7 seconds prior to impact. The vehicle speed was converted to effective braking deceleration and used with the steering information to predict the vehicle motions prior to the impact. A 3 DOF simplified vehicle model was used in a parameter study.

As described previously, the time of impact is unclear in the EDR data and there is no direct timing information between the crash pulse T=0 and pre-crash T=0. The sample timing within each one second interval is therefore unknown relative to impact. As shown in Figure 5, the data points can be at the start, middle or end of the one second interval. For this case it was assumed that all state variables (speed, steering wheel angle, brake switch status, etc.) were polled and recorded within a few milliseconds and no other timing shift existed within the sampling interval. Five possible sampling variations, essentially addressing 250 ms intervals, were investigated. These simulations could be combined to show the possible error in vehicle position or speed.

Figure 5: Possible timing of data points

Figure 6 shows the uncertainty of the pre-crash positioning of the vehicle given a common point of impact where the uncertainty of the vehicle position 7 seconds before impact can be seen at the left end of the curves. A similar diagram can be used with a given start point (at T=-7s) and see how much the impact point varies due to the timing uncertainty in the EDR.

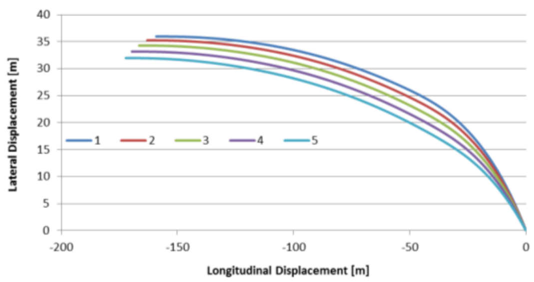

Figure 6: Uncertainty in pre-crash motion using common impact point as a reference

Vehicle dynamic models are sensitive to the road/tire parameters. An investigation of the sensitivity of vehicle trajectory to the tire model coefficients suggest that these parameters were not too influential on the results but exact comparison of the simulation results to the physical vehicle responses were not pursued in this analysis.

The pre-impact positioning of the vehicle (via simulation) using the EDR data was not able to accurately position the vehicle within the travel lane. As seen in Figure 5, the uncertainty of the vehicle position 7 seconds prior to the crash is on the order of a lane width (typically 3.5 m) and thus other information is needed to complement the EDR data if accurate positioning of the vehicle is needed.

The case had EDR data which contained rapid steering wheel motions in the last second before impact. This extreme handling condition can be simulated but the yaw rate of the vehicle needs to be available to determine if the vehicle model is correct and that the vehicle slip angles are consistent with the ESC system thresholds on the vehicle. The steering input caused a relatively high predicted yaw rate (40 deg/s) and could be near ESC system intervention. According to the EDR, no ESC intervention occurred. Without yaw rate data, it can be difficult to establish a reference condition for the vehicle dynamic simulations at the start of the simulation which also restricts the ability to accurately reconstruct the vehicle's position prior to impact.

The knowledge of the rest positions of the vehicle was needed to filter the possible solutions from the EDR. Given the uncertainty in the sampling times relative to the crash "0" time point, the range of impact speeds can create inconsistent collision speeds for the actual rest positions. Figure 6 shows that only Case 4 & Case 5 resulted in impact speeds consistent with the rest positions. This information could be used to refine the pre-impact position highlighted in Figure 5. When scene evidence was available, the vehicle positioning could be narrowed to within 1 m at the initiation of EDR recording (comparison of Cases 4&5 in Figure 5).

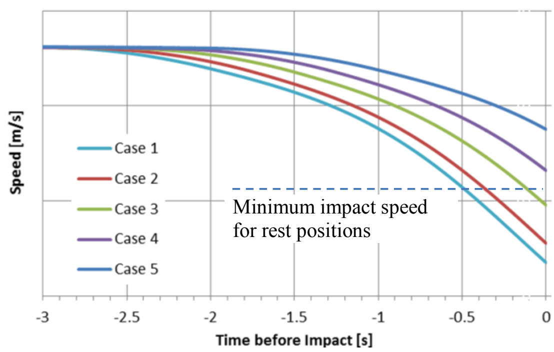

Figure 7: Vehicle speeds prior to impact

DISCUSSION

The historic application of EDR data has been the analysis of occupant injuries during a crash. The use of pre-crash EDR data elements has not been fully exploited to date. The development of active safety test procedures needs detailed data and EDRs provide important, objective data that cannot be not be reliably reported in analytical reconstructions. At the time of writing, few references could be found describing analyses of EDR pre-crash data [20][21]

EDRs are penetrating the vehicle fleet and the number of EDR files recovered in NASS can be expected to increase. For example there were over

1200 cases in 2011 compared to the 630 in 2009. Even without SRS deployments, EDR records of pre-crash data were available in the majority of cases. Collating the data over several years will increase the sample sizes for the different collision types and improve the analysis reliability.

The review of some of the individual cases highlights the need to validate the case information. Some data elements are subjective and reflect the investigators interpretation of the events. For example the rear end impact depicted in Figure 4 was identified as a vehicle striking a stopped vehicle when it appears the forward vehicle was actually decelerating. These details are critical for developing active safety tests as it creates different demands on the test devices. Test devices that represent a moving vehicle will require positioning requirements that must be repeatable and synchronised with the tested vehicle.

Two data elements were identified that need to be better defined if Part 563 to maximise the utility of EDR data. These parameters are the synchronisation of the time elements and the addition of yaw rate information. The pre-crash and crash events need to be synchronised so that speed, brake, and timing information can be more accurately interpreted. As seen in Figure 4, the difference in the pre-crash speed can differ considerably due to the timing uncertainty. Timing also is more important for synchronising the EDR records between two vehicles. Figure 4 does not address the timing uncertainty between the two vehicles and there can be a 2 second difference in the T=0 for each vehicle.

The sensitivity analysis identified in Figure 5 suggests that a 0.25 s sample interval (or 4 Hz sample rate) should be the longest sample period that can compensate for the T=0 time shift for pre-crash and crash records. The simulations showed that if the time at the end of the pre-crash record was within 0.25s of the start of the crash recording interval, vehicle dynamics for the event were consistent with the known vehicle positions. In the analysis, the vehicle's position was integrated using EDR data, but the vehicle position had to be extrapolated from the last pre-crash record (T= -1) to the first crash sample at T=0. If the time interval between the assumed pre-crash T=0 and actual T=0 was greater than 0.25s, the integration resulted in solutions inconsistent with the physical evidence. Some modern vehicles are recording pre-crash data at 10 Hz and demonstrate that a 4 Hz limit is not an excessive burden.

The yaw rate information is a key omission in the Part 563 dataset. Steering wheel information is useful but the yaw rate allows any simulation/analysis of steering inputs to be validated by the actual vehicle response. Yaw rate information also allows the effectiveness of other countermeasures, such as stability control, to be assessed objectively. This information is part of a standard electronic stability control system and a crucial piece of information. The analysis of vehicle positioning also showed the combination of sampling uncertainty and missing yaw rate information could introduce errors in predicted vehicle orientation. The 1s uncertainty in impact time produced a 45 deg. positioning range.

The review of the NASS year 2009 cases was not sufficient to draw conclusions for active safety test development. The EDR data requires extensive pre-processing to make the data amenable to more automated analyses. The data does not dispute the suggested test conditions such as the NHTSA [4,5]or AEB Test Group [8] test protocols, but more analysis of the EDR data should help refine the procedures.

An important issue in active safety test development is the role of driver interventions during a safety critical event. Bagdadi [22] reviewed the naturalistic driving data and identified driving braking behaviour was different in safety critical events. Braking, throttle, or steering inputs during incidents that may activate a system need to be studied to ensure the system is robust. EDR data is an invaluable source for this analysis if the timing issues are better understood. Even with the timing uncertainty, brake application and braking effort can be extracted from EDR data with a 1 second precision. This is not possible with classic accident reconstruction techniques. The benefit of NASS cases is that the data is associated with safety critical events and is easier to extract (in large numbers) than in vehicles instrumented in naturalistic driving studies (NDS). The naturalistic driving programs can only run a limited number of vehicles and there may not be any events of interest recorded during the study period. A future fleet of 100% EDR equipped vehicles is essentially a fulltime, wide spread data acquisition system. If Part 563 is made mandatory in the proposed standard FMVSS 405 [23], then this future is not too far away.

LIMITATIONS

This exploratory study highlights the issues in using EDR data when designing standardised tests. Due to the limited information investigated in this study, no final recommendations for specific tests, but priorities for different research topics (pre-braking, steering inputs) are formulated from the data to date. Future work with a larger dataset is planned by the authors.

CONCLUSIONS

The study shows the importance of objective field data that is needed for designing new active safety tests. Although not explored in the paper, the data is also relevant for analysing the effectiveness of different systems when they become more prevalent in the fleet and data becomes available.

The pre-crash EDR is, to date, underutilised. This is partly due to the pre-processing needs, but an important issue is the uncertainty in the crash timing, relative to the EDR pre-crash data timing. As demonstrated in this paper, this error is not negligible and must be addressed in analyses, particularly the older data with one second sample rates.

EDR data, conforming to Part 563, provides the potential to improve for active safety test development in terms of:

1) Identifying pre-crash travel speeds of test vehicles
2) Identifying pre-crash speed profiles for test targets
3) Identify timing and magnitude of pre-crash braking relevant from real world events

Inclusion of better clock functions and yaw rate information in Part 563 will allow vehicle steering and vehicle positioning information to be incorporated into test protocols. Development of more complex scenarios can also be undertaken when more complete vehicle dynamics data is available.

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