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Collection and analysis of EDR data from crash-involved vehicles: 2019-20 summary report

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TITLE

Collection and analysis of EDR data from crash-involved vehicles: 2019-20 summary report

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ABSTRACT

Event Data Recorders (EDRs) are installed in many modern vehicles. EDRs constantly record vehicle variables such as speed, seatbelt usage, accelerator/brake pedal position, delta-V and safety system deployment. When a crash occurs, a snapshot of the final few seconds of the vehicle variables are saved on the EDR. In 2017, CASR established a data collection process whereby a large number of crash-involved vehicles could be accessed regularly from a single location (an auction yard) and the EDR data downloaded. Additionally, the South Australian Police Major Crash unit provided EDR data to CASR, downloaded from vehicles involved in investigated serious crashes. In the period July 2019 to June 2020, CASR successfully retrieved EDR data from 146 crashed vehicles, of which 110 (75.3%) had associated police vehicle collision reports. This collection has contributed to a current total of 490 EDR records with 374 matched to police reports and 101 injured occupants matched to hospital injury data. In the sample of cases collected by CASR from the auction yard, 25% of bullet (striking) vehicles, and 38% of free speed vehicles were found to be speeding. The rate of seatbelt wearing for front seat occupants in the sample was 97.6%. Two case studies on vehicles that were both speeding in the seconds preceding their crash have been included to demonstrate the value of EDR data in identifying speeding in crashes.

KEYWORDS

Event data recorder (EDR), Speed, Speeding, Restraint use, Crash data

Summary

Event Data Recorders (EDRs) are installed in many modern vehicles. EDRs constantly record vehicle variables such as speed, seatbelt usage, accelerator/brake pedal position, delta-V and safety system deployment. When a crash occurs, a snapshot of the final few seconds of the vehicle variables are saved on the EDR.

In 2017, CASR established a data collection process whereby a large number of crash-involved vehicles could be accessed regularly from a single location (a vehicle auction yard). Additionally, the South Australian Police Major Crash unit provided EDR data to CASR, downloaded from vehicles involved in investigated serious crashes. Collection of the 2019-2020 EDR data has been funded by the Transport Accident Commission (TAC) and the Department for Infrastructure and Transport (DIT). In the period July 2019 to June 2020, CASR successfully retrieved EDR data from 146 crashed vehicles, of which 110 (75.3%) had associated police vehicle collision reports. This collection has contributed to a current total of 490 EDR records with 374 matched to police reports, over three years of data collection; 353 from the auction yard and 21 from Major Crash.

The police reports supplemented the EDR data with crash location, site features, crash descriptions, and driver and occupant information. Information pertaining to other vehicles and occupants involved in the crashes, in addition to the EDR vehicle, were obtained. The matched cases yielded details from a total of 792 crash involved vehicles and 1090 crash participants. Of the 1090 crash participants, 187 were treated at a hospital, 32 were admitted to a hospital, and 19 were fatally injured. A total of 101 hospital records have been collected, with AIS injuries coded.

The sample of EDR cases collected was found to be reasonably representative of all police reported crashes in South Australia (according to injury severity and speed zones).

In the sample of cases collected by CASR from the auction yard:

- 195 EDR vehicles (171 with speed data recorded) of the 353 matched EDR vehicles classified as bullet vehicles with 24.6% travelling above the speed limit by any amount,
- 80 EDR vehicles were classified as travelling at a driver-selected free-speed prior to a crash with 37.5% travelling above the posted speed limit by any amount,
- 17.5% of the free-speed vehicles were travelling 10 km/h or more above the posted speed limit,
- 97.6% of the 207 frontal occupants had their seatbelt buckled at the time of the crash.

Two case studies on vehicles that were both speeding in the seconds preceding their crash have been included to demonstrate the value of EDR data in identifying speeding in crashes.

Contents

1 Introduction

A significant number of modern vehicles contain event data recorders (EDRs) that detect when a collision has occurred and log the last few seconds of driving data prior to the crash. Data downloaded from the EDR of a crash-involved vehicle can reveal key information related to safety; such as travel speed, impact speed, brake/accelerator pedal position, steering wheel angle, crash impact severity (delta-V), seatbelt usage, and safety system deployment (e.g. airbags). Travel speed, pedal position and seatbelt usage are particularly valuable for road safety research as they are not easily attainable through other means.

In 2017, CASR established a data collection process whereby a large number of crash-involved vehicles could be accessed regularly from a single location (a vehicle auction yard) and from the South Australian Police Major Crash unit. The EDR data collected is matched to a police report (whenever possible) to provide crash location, a description of the crash circumstances, vehicle details, occupant details, site features and police-reported injury severity for relevant crash participants. Detailed hospital case notes are also collected for individuals involved in the crashes that were listed on the police report as having attended a major metropolitan hospital, and the injuries are coded according to the abbreviated injury scale (AIS). This data was found to be broadly representative of crashes that occur in South Australia in terms of police reported injury severity. The EDR collection project was continued in 2018, 2019 and 2020 to expand the sample of crashes.

The Transport Accident Commission (TAC) provided continued funding for the collection of 100 EDR downloads from crash-involved vehicles from July 2019 to June 2020. The South Australian Department for Infrastructure and Transport (DIT) also provided funding for collection of 100 EDR downloads for the same period. Due to the COVID-19 pandemic, EDR data collection was paused in March 2020. This resulted in a total of 146 vehicles that were successfully downloaded from during the period July 2019 to March 2020. Hospital data is collected in batches approximately every 6 months. The pandemic prevented the second batch of hospital data from being collected therefore hospital data has been matched up to December 2019. These shortfalls caused by the pandemic will be addressed in the next funding period.

2 Method

EDR data from crashed vehicles was accessed by attending a holding yard of a vehicle auction company on the day before their weekly auction (when the vehicle yard was open for public inspection). Around 80-90% of the insured written off vehicles in South Australia reportedly come through this single holding yard.

Figure 2.1 shows a section of the vehicle holding yard and a CASR researcher undertaking a download. To download the data from a crashed vehicle, a Bosch Crash Data Retrieval (CDR) tool is used to access and decode the data contained in the crashed vehicle's EDR via the OBD-II port. Photographs are taken around the exterior of the vehicle as well as the interior of the vehicle, and basic measurements of the deformation are recorded. On the rare occasions that the OBD-II is not accessible, the airbag control module (ACM) that contains the EDR data is requested from the purchaser of the vehicle for a monetary value. Two modules have been obtained by this method.

Typically, 200 to 400 vehicles are auctioned every week, but only around 10-15% of these vehicles have an EDR that is supported by the Bosch CDR tool. The majority of vehicles that capture EDR data in our dataset are vehicles manufactured by Toyota and Holden. EDR data can be obtained from these vehicles manufactured from as early as 2002 and 2007, respectively. Other vehicle manufacturers that have EDR data that is accessible via the Bosch CDR tool include Audi (from 2018), Chrysler (from 2006), Dodge (from 2005), Fiat (from 2012), select Fords (from 2015), Jeep (from 2006), Lancia (from 2012-2015), Lexus (from 2000), Opel (from 2013), RAM (from 2010), Volkswagen (from 2018), and Volvo (from 2014). Bosch has been actively increasing the number of supported vehicles and manufacturers over the years, including recently supporting Mitsubishi (from 2011) and Subaru (from 2012).

The South Australian Police Major Crash unit provides EDR files from vehicles that are supported by the Bosch CDR tool and have been involved in fatal or high severity crashes. The data collected from Major Crash is separated from the data collected from the auction yard as it is sampled from a different crashed vehicle population, though it may be acceptable to combine both data sources for some analyses.

Figure 2.1
Crashed vehicles at the holding yard (left) and a CASR researcher performing an EDR download via the OBD-II port (right)

Vehicle collision reports were obtained directly from the South Australian Police by supplying a registration plate number, vehicle identification number, vehicle make, and vehicle model. This ensured prompt EDR and police report data matching.

Detailed injury information was obtained from the six major metropolitan hospitals in South Australia. This process involved matching patient records by name and date of birth and physically attending the hospitals to copy the ambulance service's and hospital's case notes related to the crash participant. These case notes were then transferred to CASR's EDR database and the injuries were coded according to the Abbreviated Injury Scale (AIS). Hospitals were attended for data collection approximately once every six months.

The information from the EDR files and police reports were then entered into a searchable database to enable later analyses. Each database record includes all data from the EDR files, the police report, a photo of the main area of vehicle damage and a basic collision diagram of the crash based on information derived from the police report.

3 Results

3.1 Data collected and matched

During the period July 2019 to March 2020, EDR data was successfully retrieved from 146 crashed vehicles, with 110 (75.3%) vehicles having both a genuine crash event record and a matching police report. The 36 cases that were not successfully matched included cases where there was no police report that could be matched to the corresponding vehicle damage observed or there was no EDR data that corresponded to the observed damage. There were a few cases where the EDR could not be accessed through the OBDII port and the ACM was not able to be obtained from the vehicle purchaser.

Since June 2017, a total of 490 vehicles have been downloaded from, with 374 (76.3%) having EDR information that could be matched to police reports. This includes 353 written off vehicles from the auction yard and 21 from Major Crash. From the 374 matched police reports, there were a total of 792 active vehicles (in motion or stationary in traffic at time of the crash) with 1090 occupants distributed within these vehicles. The number of cases collected and matched to police reports for each collection year is shown in Table 3.1.

Table 3.1
EDR cases collected and matched to police reports by years

Year	EDR files downloaded	EDR file matched to police report	Percent matched
2017	91	69	75.8%
2018	128	98	76.6%
2019	217	169	77.9%
2020	54	38	70.4%
Total	490	374	76.3%

Table 3.2 shows the hospitalised participants by year, the type of hospital they attended and the percentage that had hospital notes collected. The year 2020 is not included in this table as hospital data was suspended due to the pandemic. Around half of the participants that were listed on the police report as being hospitalised had their hospital case notes collected, and their injuries coded according to the AIS. Hospital case notes could not be collected when the hospital they attended was not a major metropolitan hospital, or the hospital they attended was not specified on the police report. The difference between the numbers in the hospital data collected column and the numbers in the major metropolitan hospital column may be due to; the police report stating they attended hospital when they did not, the police incorrectly listing the hospital they attended, some emergency department doctors not entering case notes into the system (possibly due to nil injuries being detected), or early departure from the emergency department. There were also three crash participants that attended the Women's and Children's Hospital, a major metropolitan hospital, that CASR is authorised to collect data from but finds it difficult to do so due to administrative difficulties.

Table 3.2
Hospital data collection rates of all participants in EDR crashes by years

Year	Attended hospital (Police report)	Major metropolitan hospital	Other hospital	Hospital not specified	Hospital data collected	Collection rate
2017	38	29	5	4	18	47.3%
2018	50	37	10	3	23	46.0%
2019	119	97	17	5	60	50.4%
Total	207	163	32	12	101	48.8%

3.2 Representativeness of sample obtained through the auction yard

To gain an indication of the representativeness of the crashes collected in the EDR database, the sample is compared to all police reported crashes in South Australia, retrieved through the Traffic Accident Reporting System (TARS). As 2019 crash data was not complete, 2017 and 2018 crash data were used in the comparison.

Location

The locations of the matched 353 cases are shown in Figure 3.1. A total of 287 (81.3%) crashes occurred in the metropolitan area of Adelaide, distributed across the different suburbs. The remaining 66 (18.7%) crashes occurred in rural and outer rural areas of South Australia. This compares to 19.7% of all police reported crashes in South Australia in 2017 and 2018 occurring in rural areas.

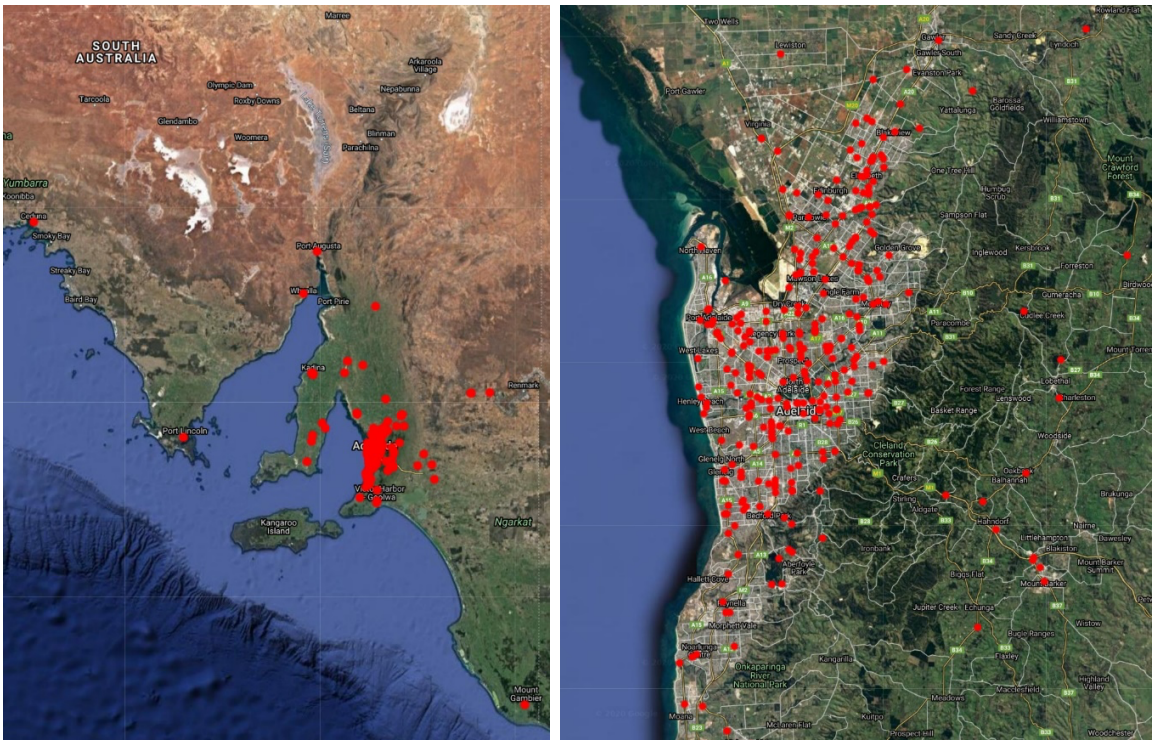


Figure 3.1
Locations of EDR crashes

Speed zone

The EDR cases and all police reported crashes in South Australia are shown in Table 3.3 by speed zone. The EDR cases have a similar distribution of speed limits compared to the data from TARS, although crashes in 110 km/h zones appear to be somewhat under-represented in the EDR sample.

Table 3.3
Comparison of matched EDR data to all police reported crashes in South Australia from the TARS database by speed limit

Speed Zone	EDR matched cases		TARS 2017-2018	
	Count	Percentage	Count	Percentage
≤ 40	13	3.7%	589	2.2%
50	77	21.8%	7115	26.5%
60	183	51.8%	12591	46.9%
70	8	2.3%	725	2.7%
80	33	9.3%	2335	8.7%
90	11	3.1%	593	2.2%
100	18	5.1%	1682	6.3%
110	10	2.8%	1206	4.5%
Total	353	100.0%	26836	100.0%

Injury severity

The injury severity of the participants in the EDR injury cases was obtained from the matched police reports. These are shown in Table 3.4 and are compared to TARS data from 2017 and 2018. The distribution of injury severities of the EDR cases is reasonable similar to all police reported crashes in TARS. The main differences lie in a lower proportion of non-injury crashes and a higher proportion of hospital treated crashes in the EDR cases.

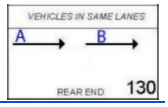
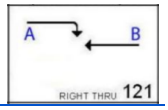
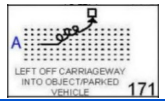
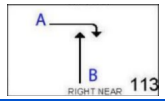
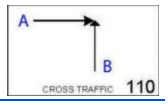
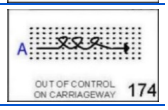
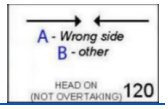
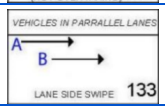
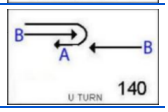
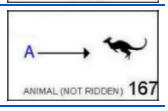
Table 3.4
Comparison of matched EDR data to all police reported crashes in South Australia from the TARS database by speed limit by injury severity

Injury severity	EDR matched cases		TARS 2017-2018	
	Count	Percentage	Count	Percentage
Non injury	195	55.2%	16883	62.9%
Doctor / Minor Injury	32	9.1%	2476	9.2%
Hospital treated	112	31.7%	6291	23.4%
Hospital admitted	13	3.7%	1018	3.8%
Fatal	1	0.3%	168	0.6%
Total	353	100.0%	26836	100.0%

3.3 Crash types of EDR matched cases

The crash types of all the EDR vehicles have been aggregated into simple crash type categories in Table 3.5. Over a third (35%) of the crashed vehicles were involved in rear-end crashes and almost a quarter (23%) were involved in right-turn crashes. The right-turn crashes have been split into two categories, where the initial travel directions of the two vehicles involved in the crash were either opposite directions or adjacent directions. The complete South Australian Definition for Coding Accidents (DCA) is included in Appendix A.

Table 3.5
Crash types of EDR vehicles

Crash type	Vehicle position/ action	Frequency	Crash type total	Indicative DCA code diagram
Rear end (DCA 130,131,132)	A (rear/striking) Middle B (front)	63 27 42	132	
Right-turn – opposite directions (DCA 121)	B (through) A (turning)	28 24	52	
Single vehicle into object (DCA 171, 173, 181, 183)	A (vehicle)		44	
Right-turn – adjacent directions (DCA 113)	A (turning) B (through)	21 14	35	
Right angle (DCA 110)	A (crossing right of way) B (right of way)	17 11	28	
Hit parked vehicle (DCA 160, 161, 162, 163)	A (vehicle)		10	
Rollover (DCA 170, 172, 174, 180, 182, 184)	A (vehicle)		10	
Head on (DCA 120, 150)	B (correct side) A (incorrect side)	10 8	18	
Side swipe (DCA 133, 134, 135, 136, 137)	A (correct lane) B (changing lanes)	6 4	10	
U-turn in front (DCA 140)	B (through) A (turning)	5 2	7	
Hit animal (DCA 167)	A (vehicle)		4	
Other (All other DCAs)			24	
Total			374	

3.4 Data contained in the EDR files

The information contained in an EDR differs for various vehicle makes and generations of EDRs. Table 3.6 shows the rates of the different data variables recorded by the EDR devices in the sample collected from the auction yard. In most crashed vehicles, longitudinal or lateral delta-V was recorded as part of the airbag deployment system. Only three cases in the sample did not have any delta-V recorded. Some EDRs only record lateral delta-V when a crash event is classified as a side crash.

Table 3.6
Number of cases by data available (excluding major crash cases)

Data field	Recorded	Not recorded	Total	Percentage recorded
Longitudinal delta-V	339	14	353	96.0%
Lateral delta-V	191	162	353	54.1%
Speed history	312	41	353	88.4%
Driver seatbelt status	192	161	353	54.4%
Passenger seatbelt status	102	251	353	28.9%

Impact speeds and speeding

Vehicle speed-time history was recorded in 312 of 353 (88.4%) of crashed vehicles (not including Major Crash cases), which allows determination of crashed vehicle travel speeds and impact speeds. The maximum travel speeds of the vehicles can be used to determine the speeding rates of vehicles when compared to the road speed limit. A common vehicle classification used in describing vehicle impact interactions in road crashes is the “bullet” (or striking) vehicle. These are vehicles that are travelling in a forward direction and strike another vehicle. Bullet vehicles are ones which have right of way (if travelling through an intersection) and are usually travelling at a greater speed than the other vehicle involved. For crashes where a vehicle is performing a turn across traffic, the bullet vehicle is the through vehicle. In rear-end crashes, the rear-most vehicle is the bullet vehicle. For single vehicle crashes, the main vehicle is always classified as the bullet vehicle. In head-on crashes, both vehicles are classified as bullet vehicles. For side-swipe crashes, neither vehicles are classified as a bullet vehicle. Figure 3.2 shows the frequency of the various impact speed ranges of the bullet vehicles and Figure 3.3 shows the frequency of travel speed variation relative to the speed limit (maximum recorded travel speed above road speed limit) of bullet vehicles. A total of 195 EDR vehicles (171 with speed data recorded) of the 353 matched EDR vehicles were classified as bullet vehicles with 24.6% travelling above the speed limit in the seconds before a crash.

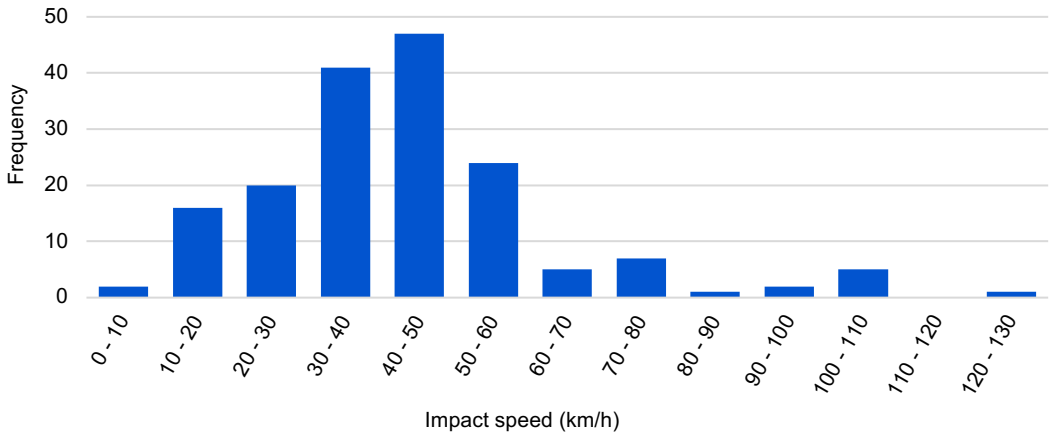


Figure 3.2
EDR bullet vehicle impact speeds (not including Major Crash cases)

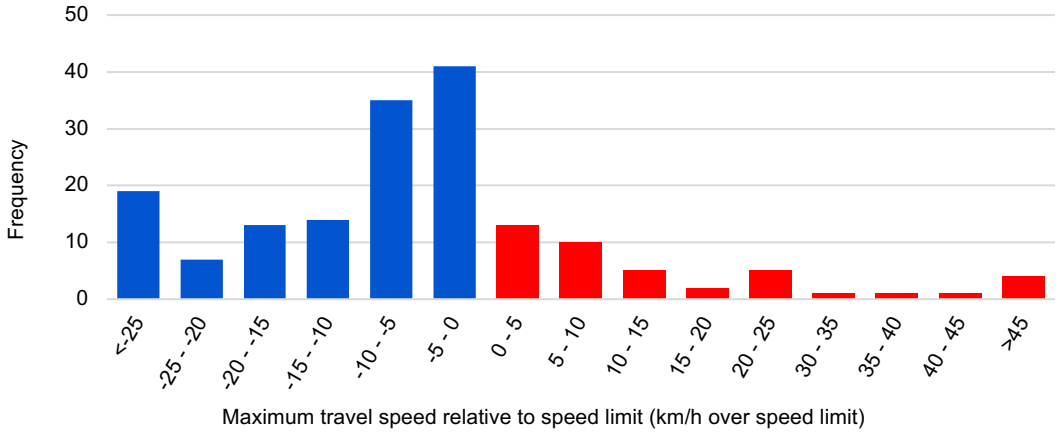


Figure 3.3
EDR bullet vehicle maximum travel speed relative to speed limit (not including Major Crash cases)

A vehicle travelling at a free-speed is also an important classification in road safety analyses. Free-speed vehicles are those that are travelling at a driver-selected, non-restricted speed. A common quantifiable definition includes vehicles that have a minimum of four seconds of no traffic ahead of them. Therefore, vehicles involved in rear-end crashes have not been included in this classification, as there is insufficient information to determine if these vehicles were travelling at a self-selected free-speed. Vehicles that are performing manoeuvres, accelerating from stationary positions, performing illegal manoeuvres, travelling through work zones, or with drivers suffering from illness or fatigue are not included as free-speed vehicles. A total of 80 EDR vehicles were categorised as free-speed vehicles, with their speeding rates shown in Table 3.7. Figure 3.4 displays the distribution of speeding levels of the 80 free-speed EDR vehicles, with 30 (37.5%) travelling above the speed limit by any amount.

Table 3.7
Maximum travel speed of free-speed EDR vehicles
in 5 seconds preceding crash (not including Major Crash cases)

Maximum vehicle speed relative to road speed limit	Count	Percentage
Less than 10 km/h under	7	8.8%
Between 10 and 0 km/h under	43	53.7%
Between 1 and 5 km/h over	8	10.0%
Between 5 and 10 km/h over	8	10.0%
Greater than 10 km/h over	14	17.5%
Total	80	100.0%

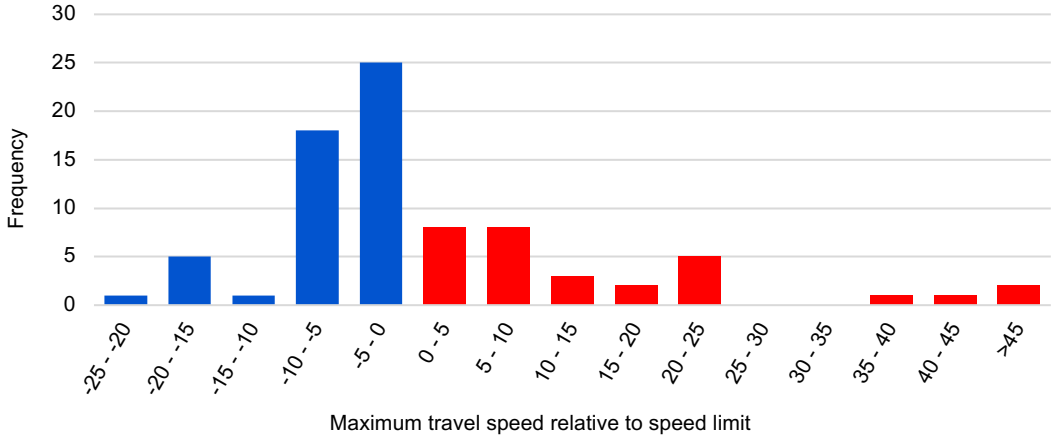


Figure 3.4
EDR free-speed vehicle's maximum travel speed relative to speed limit (not including Major Crash cases)

Seatbelt use

Seatbelt usage by vehicle occupants is an important parameter recorded by the EDR. A summary of results of seatbelt use is shown in Table 3.8. Of the 192 EDRs (not including Major Crash cases) that recorded driver seatbelt usage, 188 (97.9%) of the drivers had their seatbelt buckled at the time of the crash. Of the 102 EDR reports (not including Major Crash cases) with passenger seatbelt usage recorded, only 15 of the vehicles had a person seated in the left-front seat at the time of the crash according to the matched police report. Of the 15 left-front passengers, 14 (93.3%) were recorded as having their seatbelt buckled at the time of the crash.

Table 3.8
Seatbelt use by occupants in EDR vehicles (not including Major Crash cases)

Position	EDR seatbelt buckled	EDR seatbelt unbuckled	Percentage positive	Total
Driver	188	4	97.9%	192
Front seat passenger	14	1	93.3%	15
Total	202	5	97.6%	207

Impact severity (Delta-V)

Delta-V is a measurement of the change in velocity that occurs for a vehicle during an impact. It is a commonly used parameter that is indicative of the impact severity has been correlated with injury: higher delta-V's are associated with higher probability of injury. The distribution of maximum delta-Vs (in 5 km/h increments) recorded by the EDR vehicles for all cases is shown in Figure 3.5

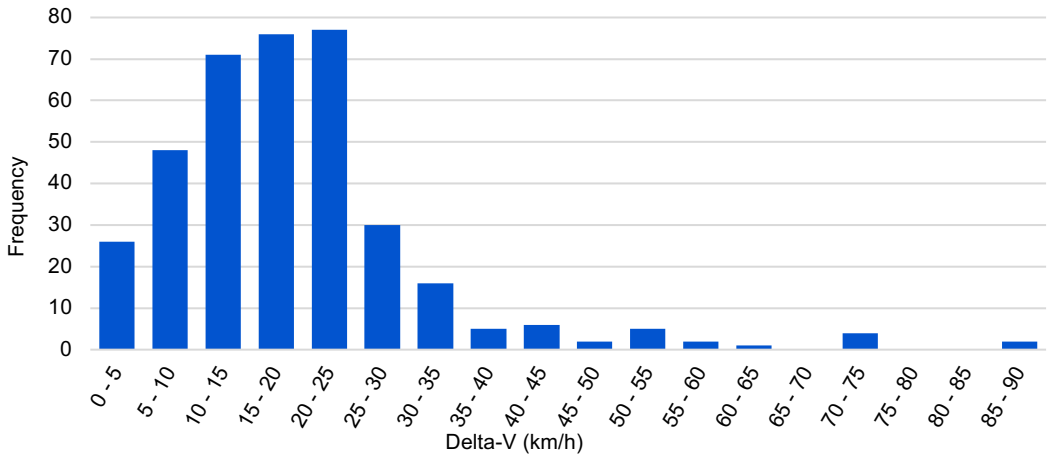


Figure 3.5
Frequency of delta-V of EDR vehicles in 5 km/h increments

4 Discussion

This project achieved its primary aim of expanding the number of EDR cases matched to police reports and hospital data, with this summary report showing that the data collected is broadly representative of the crashes that occur in the South Australian crash sample population. The matching rates of EDR downloads to police records was 76%, and the matching rate of injury data from hospitals for police reported hospital-attendees was 49% over the three years of data collection. The data from the project was used to determine the percentage and extent of speeding in crashes by bullet vehicles and by vehicles travelling at a free-speed, something that can only generally be undertaken with detailed crash investigations and reconstructions. Around a quarter of bullet vehicles (24.6%) were found to be speeding before a crash, and 37.5% of free-speed vehicles were found to have been speeding, with nearly half of those (17.5%) travelling 10 km/h or more above the speed limit. The seatbelt usage reported by the EDR files indicated that 97.6% of frontal occupants were buckled at the time of the crash.

The speed data from EDRs is not only useful for determining speeding but has the potential to be useful for other applications such as:

- Exploring driver reactions and avoidance strategies from crash-involved vehicles
- Determining characteristics of drivers that choose to travel above the speed limit
- Examining the timing of pre-impact braking in different crash scenarios
- Investigating the level and effectiveness of pre-impact braking
- Determining the effects of different vehicle technologies and how/if they would avoid a crash
- Examining the speeds of vehicles navigating different infrastructure
- Investigating the relationship between delta-V and injury risk

It is important to note that this project has allowed for the efficient collection of data from non-injury crashes. Non-injury crashes are important for use as the denominator when calculating risk. They are also important for comparison and contrast between the desired outcome should a crash occur (no injury), and an undesirable outcome (injury). Current methods of detailed data collection are typically resource intensive and focus their finite resources on injury crashes.

5 Case studies

5.1 High level speeding, EDR380

Case EDR380 involved a 2012 Toyota Corolla. It had sustained damage to the front of the vehicle, offset to the left, as shown in Figure 5.1. The impact had missed the left chassis rail and the intrusion had continued to the left front wheel. Both front airbags had deployed as had the knee airbag and the curtain airbags on both sides.

Figure 5.1
Damage on EDR380

The police report had two descriptions, one made based on the initial attending officer's report that stated: "Unit 1, collided with barricades at shopping centre … Vehicle crossed two lanes and stopped on median strip. Driver absconded prior to police arrival", and the other appears to be based on a statement from the driver made 11 hours after the crash, "Vehicle travelling North on … to turn left onto … Driver states vehicle's brakes have stopped working. Vehicle has collided with barrier." (Identifying parts of the description have been removed).

The police report also revealed that the crash occurred on a metropolitan arterial road with a speed limit of 60 km/h around 2:30am on a Saturday morning. The weather was fine, and the road was dry. The speed prior to impact was marked as "unknown" and no alcohol or drug results were listed, presumably because the tests could not be conducted within the legal timeframe.

The pre-impact EDR data from the vehicle is shown in Figure 5.2. It shows that 4.85 seconds prior to impact the vehicle was travelling at 132 km/h in the 60 km/h zone. It is possible that it had been travelling slightly faster than this, as light brake pressure was being applied at this first pre-impact data point. It is clear from the EDR data that the driver's claim that the brakes failed was false. The driver was always pressing the brake pedal, except momentarily at the -3.85 second time point and the vehicle slows significantly in response, from 132 km/h down to 53 km/h at impact. Furthermore, the brake oil pressure rises in response to the braking, reaching 86% pressure of the maximum brake pressure (10.42 MPa at impact out of the maximum value of 12.14 MPa). The EDR data also shows that the driver began to attempt the 90-degree left turn into the side street around 1.85 seconds prior to impact, when the vehicle

was still travelling at 100 km/h, with the steering wheel angle increasing between then and the impact to -231 degrees.

Pre-Crash Data, -5 to 0 seconds (1st Prior Event, TRG 3)

Time (sec)	-4.85	-4.35	-3.85	-3.35	-2.85	-2.35	-1.85	-1.35	-0.85	-0.35	0 (TRG)
Vehicle Speed (MPH [km/h])	82 [132]	80.2 [129]	78.3 [126]	75.8 [122]	72.7 [117]	66.5 [107]	62.1 [100]	54.1 [87]	46.6 [75]	38.5 [62]	32.9 [53]
Accelerator Pedal, % Full (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percentage of Engine Throttle (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Engine RPM (RPM)	4,000	3,800	3,700	3,600	3,400	3,100	2,900	2,900	2,600	2,200	2,100
Motor RPM (RPM)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Service Brake, ON/OFF	ON	ON	OFF	ON	ON	ON	ON	ON	ON	ON	ON
Brake Oil Pressure (Mpa)	0.91	0.91	0.00	1.73	2.30	3.65	4.18	8.06	9.94	10.18	10.42
Longitudinal Acceleration , VSC Sensor (m/sec^2)	-2.082	-2.369	-0.861	-2.656	-3.948	-4.737	-8.398	-6.245	-6.030	-4.307	-8.973
Yaw Rate (deg/sec)	0.49	0.49	0.00	0.49	0.00	-0.98	-2.44	-6.34	-17.57	-6.83	-7.81
Steering Input (degrees)	0	0	0	0	0	0	-15	-33	-75	-135	-231

Figure 5.2
Pre-impact vehicle data of EDR380

Without the EDR data, it would have been almost impossible to know that the driver was travelling at such a high speed prior to the crash. The braking prior to the crash, while reasonably heavy, appears to be below the threshold where clear tyre marks would have been left. Tyre marks may have been left when he began to turn the steering wheel sharply, but even if these could have been used to calculate speed, the speed at this point was only around 70 km/h. The damage itself also gives no clues to the high travel speed, as his impact speed was only 53 km/h. This is a prime example of how EDR can give insight into speeding not previously possible and can refute a driver's false claims of why a crash occurred.

5.2 Low level speeding, EDR345

Case EDR345 involved a 2006 Toyota Yaris. When inspected at Pickles, the front bumper and grille were missing and there was relatively minor damage to the front cross member, as shown in Figure 5.3. Both frontal airbags had deployed.

Figure 5.3
Damage on EDR345

The police report described the crash as follows, “Unit 1 SOUTH on … approaching Intersection … Unit 2 stationary at Stop Sign on … Road at intersection with … Unit 2 turned right to travel NORTH on … Unit 1 front bumper collided with driver side rear 1/4 panel & wheel of Unit 2. Minor Injuries to passenger in Unit 2.” (Identifying parts of the description have been removed).

The police report listed the speed zone as 80 km/h, but the GPS co-ordinates and description revealed that the speed zone changed from 80 km/h to 60 km/h 140 metres prior the intersection where the crash occurred. The police report also listed the speed prior to impact for the Yaris as being 80 km/h. The struck vehicle contained a driver, left front seat passenger, right rear seat passenger, and a left rear seat passenger, who was an 8-month-old infant. The driver of the striking vehicle was a 17-year-old who held a provisional P1 licence.

The pre-impact EDR data from the Yaris is shown in Figure 5.4. The vehicle was travelling at 66 km/h, 4.2 seconds prior to impact, 6 km/h above the speed limit. We can be sure that the Yaris was in the 60 km/h speed zone at this point, as we can calculate that it would have been, at most, 75 metres from the point of impact at the intersection. This means that the Yaris would have been at least 65 metres past the 60 km/h sign when it was still travelling 66 km/h, with the accelerator pedal slightly depressed (0.78 V represents 0% accelerator pedal, anything above this value represents the pedal being pressed to some degree).

The driver braked sometime between 1.2 seconds and 0.2 seconds prior to the crash. Given that the speed reduction between the -1.2 and -0.2 time points is only 10 km/h, it is likely that emergency braking only began around 0.5 seconds before the crash. The EDR shows the speed at impact as being 38 km/h but this is lower than the true speed of the vehicle, an issue that can occur when heavy braking causes under-rotation of the wheels from which the speed is measured. Fortunately, this problem is easy to detect as the maximum braking achievable by most road vehicles is around 0.95g, or slowing 33 km/h per second, whereas the difference in speed between the last two data points shown below represents slowing of 70 km/h per second, or around 2g. The true impact speed was calculated to be 47 km/h.

Pre-Crash Data, -5 to 0 seconds (Most Recent Event, TRG 2)

Time (sec)	-4.2	-3.2	-2.2	-1.2	-0.2	0 (TRG)
Vehicle Speed (MPH [km/h])	41 [66]	39.8 [64]	39.8 [64]	38.5 [62]	32.3 [52]	23.6 [38]
Brake Switch	OFF	OFF	OFF	OFF	ON	ON
Accelerator Rate (V)	1.05	0.98	1.02	1.09	0.78	0.78
Engine RPM (RPM)	1,600	1,600	1,600	1,600	1,200	1,200

Figure 5.4
Pre-impact vehicle data of EDR345

The change in velocity (delta-V), which is a measure of impact severity, recorded by the EDR was 10.5 km/h, as shown in Figure 5.5. A delta-V that is only around 20% of the impact speed is consistent with an impact centred towards either end of the struck vehicle, far away from the centre of gravity. This is consistent with the location of impact being the rear quarter panel, as described in the police report.

Longitudinal Crash Pulse (Most Recent Event, TRG 2 - table 1 of 2)

Recording Status, Time Series Data	Complete
Max Longitudinal Delta-V (MPH [km/h])	-6.5 [-10.5]

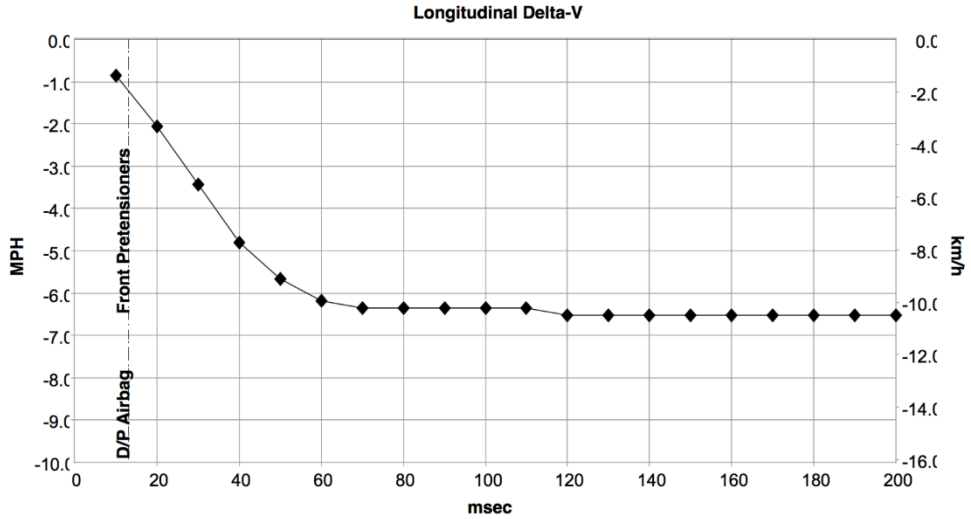


Figure 5.5
EDR345 longitudinal delta-V crash pulse

The occupants in the struck vehicle were only listed in the police report as suffering minor injuries that did not require treatment by a private doctor or at a hospital but a hospital record was found for the driver of the vehicle, who was treated at hospital and underwent a CT scan, which did not detect any injuries. The location of the impact being behind the occupant compartment most likely contributed to the low injury severity outcome. The driver of the striking vehicle was uninjured. Had the impact occurred more towards the centre of the vehicle the outcome may have been different. It is also likely that if the driver had not been speeding the crash would not have occurred at all, as the struck vehicle would have moved out of the path of the striking vehicle before it reached the original impact point.

It is interesting to note that the Yaris slows from 66 km/h to 62 km/h without braking, meaning that a traditional reconstruction that relies on brake marks would only have been able to determine the speed as 62 km/h at best, but the usual tolerances applied to such techniques would result in such a method not being able to confidently state that the vehicle was speeding. Tyre marks may not have been visible for a traditional reconstruction in any case, as the Yaris was equipped with ABS. This EDR case illustrates how EDRs can be used to detect low level speeding in crashes, and how speeding can result in a crash that could have otherwise been avoided.

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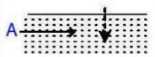
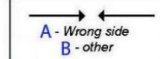
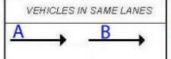
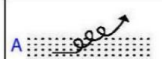
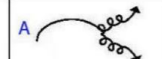
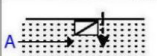
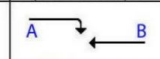
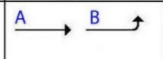
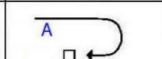
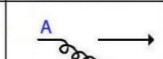
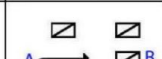
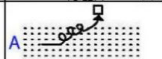
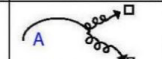
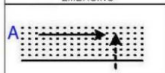
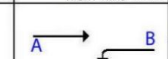
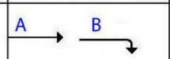
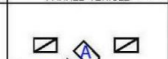
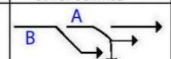
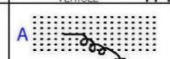
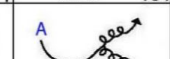
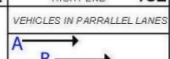
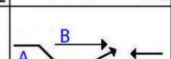
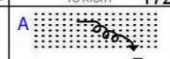
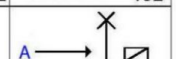
The views expressed in this report are those of the authors and do not necessarily represent those of the University of Adelaide or the funding organisations.

Appendix A – DCA Codes

Pedestrian on foot in toy/pram	Vehicles from adjacent directions (intersections only)	Vehicles from opposing directions	Vehicles from same direction	Manoeuvring	Overtaking	On path	Off path on straight	Off path on curve	Passenger and miscellaneous
 NEAR SIDE 100	 CROSS TRAFFIC 110	 HEAD ON (NOT OVERTAKING) 120	 REAR END 130	 U TURN 140	 HEAD ON (INCL SIDE SWIPE) 150	 PARKED 160	 OFF CARRIAGEWAY TO LEFT 170	 OFF CARRIAGWAY RIGHT BEND 180	 FELL IN/FROM VEHICLE 190
 EMERGING 101	 RIGHT FAR 111	 RIGHT THRU 121	 LEFT REAR 131	 U TURN INTO FIXED OBJECT/ PARKED VEHICLE 141	 OUT OF CONTROL 151	 DOUBLE PARKED 161	 LEFT OFF CARRIAGEWAY INTO OBJECT/PARKED VEHICLE 171	 OFF RIGHT BEND INTO OBJECT/PARKED VEHICLE 181	 LOAD OR MISSILE STRUCK VEHICLE 191
 FAR SIDE 102	 LEFT FAR 112	 LEFT THRU 122	 RIGHT END 132	 LEAVING PARKING 142	 PULLING OUT 152	 ACCIDENT OR BROKEN DOWN 162	 OFF CARRIAGEWAY TO RIGHT 172	 OFF CARRIAGWAY LEFT BEND 182	 STRUCK TRAIN 192
 Playing, working, lying, standing on carriageway 103	 RIGHT NEAR 113	 RIGHT LEFT 123	 LANE SIDE SWIPE 133	 ENTERING PARKING 143	 CUTTING IN 153	 VEHICLE DOOR 163	 RIGHT OFF CARRIAGEWAY INTO OBJECT/PARKED VEHICLE 173	 OFF LEFT BEND INTO OBJECT/PARKED VEHICLE 183	 STRUCK RAILWAY CROSSING FURNITURE 193
WALKING WITH TRAFFIC 104	TWO RIGHT TURNING 114	RIGHT RIGHT 124	LANE CHANGE RIGHT (NOT OVERTAKING) 134	PARKING VEHICLES ONLY 144	PULLING OUT - REAR END 154	PERMANENT OBSTRUCTION ON CARRIAGEWAY 164	OUT OF CONTROL ON CARRIAGEWAY 174	OUT OF CONTROL ON CARRIAGEWAY 184	PARKED CAR RUN AWAY 194
FACING TRAFFIC 105	RIGHT/LEFT FAR 115	LEFT LEFT 125	LANE CHANGE LEFT 135	REVERSING 145		TEMPORARY ROADWORKS 165	OFF END OF ROAD/ T INTERSECTION 175		
ON FOOTPATH/ MEDIAN 106	LEFT NEAR 116	126	RIGHT TURN SIDE SWIPE 136	REVERSING INTO FIXED OBJECT / PARKED VEHICLE INCLUDES DRIVEWAYS 146		STRUCK OBJECT ON CARRIAGEWAY 166			
DRIVEWAY 107	RIGHT/LEFT NEAR 117	127	LEFT TURN SIDE SWIPE 137	EMERGING FROM DRIVEWAY/LANE 147		ANIMAL (NOT RIDDEN) 167			
STRUCK WHILE BOARDING OR ALIGHTING VEHICLE 108	TWO LEFT TURN 118	128	138	INC BIKES FROM FOOTWAY 148					
BOARDING & STRUCK BY SAME THIS INCLUDES WORKING/ PUSHING VEHICLE OTHER PEDESTRIAN 109	OTHER ADJACENT 119	OTHER CROSSING 129	OTHER SAME DIRECTION 139	OTHER MANOEUVRING 149	OTHER OVERTAKING 159	HIT PARKED CAR OPPOSITE SIDE OF ROAD OTHER ON PATH 169	OTHER STRAIGHT 179	OTHER CURVE 189	? UNKNOWN 199