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Collection and analysis of EDR data from crash-involved vehicles: 2020-21 summary report

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TITLE

Collection and analysis of EDR data from crash-involved vehicles: 2020-21 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 June 2019 to June 2021, CASR successfully retrieved EDR data from 416 crashed vehicles, of which 316 (76.0%) had associated police vehicle collision reports. This collection has contributed to a current total of 729 EDR records with 558 (72.1%) matched to police reports, over three years of data collection; 531 from the auction yard and 27 from Major Crash. 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 96.5%. A case study involving a head-on collision with a vehicle travelling 20 km/h over the road speed limit has been included to demonstrate the information available in the CASR EDR database.

KEYWORDS

Speeding, Road trauma, Event Data Recorder

Executive 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 2019-2021 EDR data has been funded by the Transport Accident Commission (TAC) and the Department for Infrastructure and Transport (DIT). In the period June 2019 to June 2021, CASR successfully retrieved EDR data from 416 crashed vehicles, of which 316 (76.0%) had associated police vehicle collision reports. This collection has contributed to a current total of 729 EDR records with 558 (72.1%) matched to police reports, over three years of data collection; 531 from the auction yard and 27 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 1190 crash involved vehicles and 1621 crash participants. Around half the crashes resulted in injury. A total of 116 hospital records have been collected, with AIS injuries coded.

The sample of EDR cases collected was found to be reasonably representative from a vehicle-based examination of all police reported crashes in South Australia (according to injury severity, speed zones and crash types).

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

- 298 EDR vehicles (265 with speed data recorded) of the 531 matched EDR vehicles classified as bullet vehicles with 24.5% travelling above the posted speed limit by any amount,
- 135 EDR vehicles were classified as travelling at a driver-selected free-speed prior to a crash with 37.8% travelling above the posted speed limit by any amount,
- 17.0% of the free-speed vehicles were travelling more than 10 km/h above the posted speed limit,
- 96.5% of the 315 frontal occupants had their seatbelt buckled at the time of the crash.

A case study involving a head-on collision with a vehicle travelling 20 km/h over the road speed limit has been included to demonstrate the information available in the CASR EDR database.

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 to 2021 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 per year from July 2019 to June 2021. The South Australian Department for Infrastructure and Transport (DIT) also provided funding for collection of 100 EDR downloads per year for the same period.

Data collection in the second quarter of 2020 was affected by the COVID-19 pandemic. This resulted in the target for data collection of 200 cases not being met for the financial year 2019-2020. Extra data collection was undertaken in the second half of 2020 to make up for this shortfall.

The purpose of this report is to provide a summary of the data collection to date, a basic examination and discussion of the representativeness of the sample, and basic results relating to key variables in the EDR data.

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 on 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 vehicle deformation are recorded. Occasionally, the OBD-II port is not accessible, and in these instances the airbag control module (ACM) that contains the EDR data is requested from the purchaser of the vehicle for a monetary value. Three 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), specific 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 Subaru (from 2012) and specific Mitsubishi models (from 2011).

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 generally treated independently from the data collected from the auction yard as it is sampled from a different crashed vehicle population, though both data sources may be combined for specific analyses, such as injury analyses, or if appropriate weighting is applied.

Figure 2.1
Crashed vehicles at the holding yard (left) and a CASR researcher undertaking 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 transcribe the ambulance service and hospital case notes related to the crash participant. These transcriptions 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, though there was some disruption to this in 2020 due to the influence of COVID-19 on both the hospital system and The University of Adelaide. Injury data collection resumed in 2021 at two of the major hospitals in South Australia, though data has only been collected for 2020 crashes to date. It is hoped that injury data collection can resume at the other four major hospitals in the second half of 2021.

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 and interpreted from the police report.

The drivers of EDR vehicles that were classified as having travelled at a free-speed (unhindered, self-selected speed) prior to crashing were examined in more detail, by extracting and examining their driving offence history. Details of any offences and the type of offence that occurred enable insight into the driving histories and patterns of offending.

3 Results

3.1 Data collected and matched

During the period June 2019 to March 2020, EDR data was successfully retrieved from 177 crashed vehicles. From mid-March 2020 to late-May 2020 there were no cases collected from the auction yard due to COVID-19 restrictions, but one case was obtained from the South Australian Police Major Crash Unit. During the period late-May 2020 to May 2021, EDR data was successfully retrieved from 238 crashed vehicles. Over the whole two-year funding period, EDR data was retrieved from 416 crashed vehicles, with 316 (76.0%) vehicles having both a genuine crash event record and matching police report. The 100 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 four 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 729 vehicles have been downloaded from, with 558 (72.1%) having EDR information that could be matched to police reports. This includes 531 written off vehicles from the auction yard and 27 from Major Crash. From the 558 matched police reports, there were a total of 1190 active vehicles (in motion or stationary in traffic at time of the crash) with 1,621 occupants distributed throughout 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 year downloaded

Year downloaded	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	220	160	72.7%
2021	73	62	84.9%
Total	729	558	76.3%

Table 3.2 shows the hospitalised participants by year of crash, the type of hospital they attended and the percentage that had hospital injury data and notes retrieved. The year 2020 is not included in this table as hospital data was suspended due to the pandemic. Over a third (38.9%) 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. Pre-2020 this percentage was much higher (57%) as COVID-19 and associated events impacted on hospital data collection. Hospital case notes could also not be collected when the hospital they attended was not a major metropolitan hospital, or not specified on the police report. Not all injury data was able to be retrieved from injured EDR participants. The possible reasons for this may be because the police report stated an injured person attended hospital when they may not have, the hospital details in the report were incorrect, hospital case notes may not have been entered into the system (possibly due to nil injuries being detected), or early departure from the hospital emergency department. There were 10 crash participants that attended the Women's and Children's Hospital (a major metropolitan hospital), but none of these cases were able to be retrieved. It is anticipated that hospital data for 2020 and 2021 can be collected in late 2021.

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

Year of crash	Attended hospital (Police report)	Major metropolitan hospital	Other hospital	Hospital not specified	Hospital data collected	Retrieval rate of injured participants
2017	26	21	4	1	19	73.1%
2018	55	45	6	4	36	65.5%
2019	103	81	18	4	50	48.5%
2020	89	61	25	3	11	12.4%
2021	25	23	1	1	-	-
Total	298	231	54	13	116	38.9%

3.2 Representativeness of sample obtained through the auction yard

To assess the representativeness of the crashes collected in the EDR database, the sample was compared to all police reported crashes in South Australia recorded in the Traffic Accident Reporting System (TARS). Comparisons were made with TARS data at both the vehicle level and at the crash level. The vehicle level comparison was recently added to better match the sampling method. Only passenger vehicles were extracted from TARS for the vehicle level comparisons to match the EDR sample as no EDR data was retrieved from other vehicle types in this study.

Location

The locations of the 531 matched cases (not including Major Crash cases) are shown in Figure 3.1. A total of 437 (82.3%) crashes occurred in the metropolitan area of Adelaide, distributed across various suburbs. The remaining 94 (17.7%) crashes occurred in rural and outer rural areas of South Australia. In South Australia, from 2017 to 2020, this compared to 19.2% of all police reported crashes and 15.0% of passenger vehicles involved in a crash occurring in rural areas.

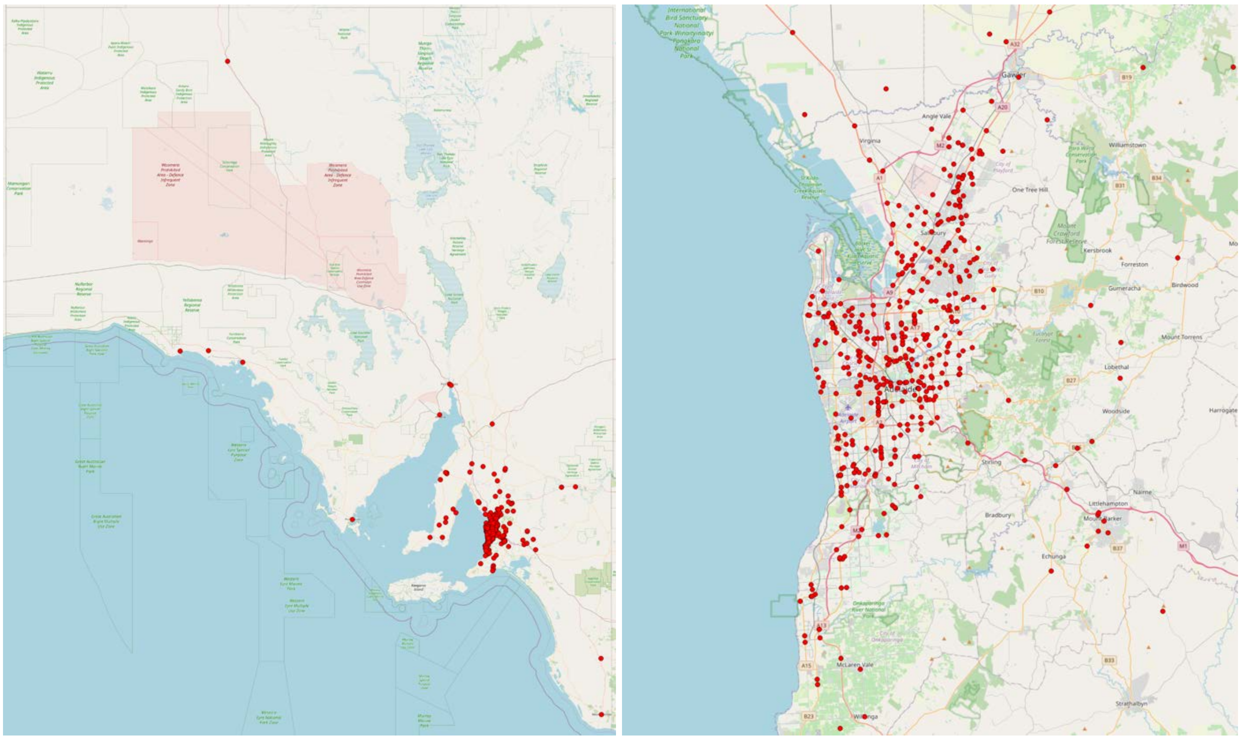


Figure 3.1
Locations of EDR crashes

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 by speed limit compared to the data from TARS, especially when they are compared on a vehicle basis.

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 (km/h)	EDR matched cases/vehicles		TARS passenger vehicles 2017-2020		TARS crashes 2017-2020	
	Count	Percentage	Count	Percentage	Count	Percentage
≤ 40	19	3.6%	1467	1.9%	1161	2.3%
50	121	22.8%	18632	24.0%	13467	26.2%
60	275	51.8%	40621	52.3%	24231	47.2%
70	12	2.3%	2533	3.3%	1481	2.9%
80	49	9.2%	6788	8.7%	4542	8.8%
90	14	2.6%	1709	2.2%	1046	2.0%
100	27	5.1%	3559	4.6%	3187	6.2%
110	14	2.6%	2316	3.0%	2219	4.3%
Total	531	100.0%	77625	100.0%	51334	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 to 2020 (inclusive). Non-injury crashes are under-represented in the EDR sample and hospital treated crashes are over-represented.

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

Crash injury severity	EDR matched cases		TARS passenger vehicles 2017-2020		TARS crashes 2017-2020	
	Count	Percentage	Count	Percentage	Count	Percentage
Non injury	286	53.9%	49669	64.0%	32637	63.6%
Doctor / Minor Injury	46	8.7%	7466	9.6%	4312	8.4%
Hospital treated	179	33.7%	17557	22.6%	11651	22.7%
Hospital admitted	19	3.6%	2571	3.3%	2371	4.6%
Fatal	1	0.2%	362	0.5%	363	0.7%
Total	531	100.0%	77625	100.0%	51334	100.0%

Crash types

The crash types of the EDR vehicles have been aggregated into simple crash type categories based on their DCA (Definition for Coding Accidents) codes. Table 3.5 compares the distribution of these simple crash types in the EDR sample with crashes and crash involved passenger vehicles from TARS. The distribution of crash types for the EDR cases has similarities with the crash type distribution of passenger vehicles in TARS, with the major differences noted in the hit parked vehicle, side swipe, pedestrian, and "other" crashes. The DCA codes included in each simple crash type group can be seen in Table 3.6.

Table 3.5
Comparison of matched EDR data to all police reported crashes and passenger vehicles in South Australia from the TARS database by crash type

Crash type	EDR matched cases		TARS passenger vehicles 2017-2020		TARS crashes 2017-2020	
	Count	Percentage	Count	Percentage	Count	Percentage
Rear end	187	35.2%	26961	34.7%	12950	25.2%
Right-turn – opposite directions	71	13.4%	7325	9.4%	3948	7.7%
Right turn – adjacent directions	70	13.2%	6713	8.6%	3702	7.2%
Single vehicle into object	56	10.5%	6945	8.9%	7513	14.6%
Right angle	50	9.4%	6841	8.8%	3931	7.7%
Hit parked vehicle	20	3.8%	4653	6.0%	3063	6.0%
Rollover	18	3.4%	1995	2.6%	3123	6.1%
Side swipe	15	2.8%	5247	6.8%	4282	8.3%
U-turn in front	12	2.3%	1548	2.0%	871	1.7%
Head on	11	2.1%	1684	2.2%	985	1.9%
Hit animal	6	1.1%	583	0.8%	700	1.4%
Left turn – adjacent directions	5	0.9%	1340	1.7%	893	1.7%
Pedestrian	0	0.0%	1337	1.7%	1596	3.1%
Other	10	1.9%	4453	5.7%	3777	7.4%
Total	531	100.0%	77625	100.0%	51334	100.0%

3.3 Crash types and vehicle positions or actions

The crash types by DCA code and the position or action of the EDR vehicle in the crash are shown in Table 3.6. An example DCA code diagram is also shown in Table 3.6. For the complete set of DCA codes used in South Australia, see Appendix A. In rear end crashes, the EDR vehicle was most commonly the rear, or striking vehicle. The EDR vehicles in intersection crashes (right turn, right angle) were almost evenly split between the through vehicles and those crossing or turning in front of the through vehicle. The EDR vehicle in hit parked vehicle crashes was almost exclusively the vehicle that was not parked.

Table 3.6
Crash types of EDR vehicles (excluding Major Crash cases)

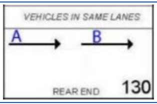
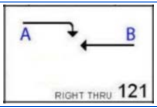
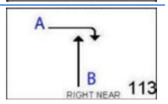
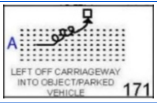
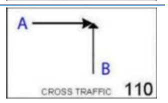
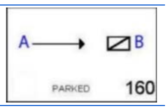
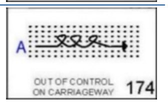
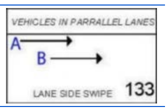
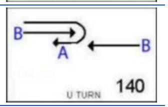
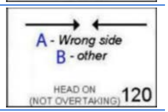
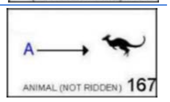
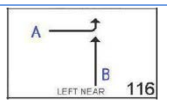
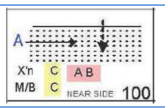
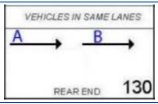
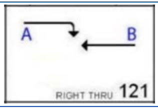
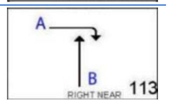
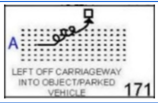
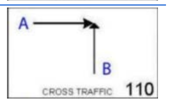
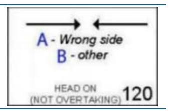
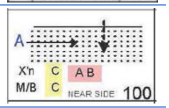
Crash type	Vehicle position/ action	Frequency	Crash type total	Indicative DCA code diagram
Rear end	A (rear/striking)	86	187	
(DCA 130,131,132,154)	Middle	47		
	B (front)	54		
Right-turn – opposite directions	B (through)	35	71	
(DCA 121)	A (turning)	33		
	Other	3		
Right-turn – adjacent directions	A (turning)	37	70	
(DCA 111, 113)	B (through)	33		
Single vehicle into object	A (vehicle)	55	56	
(DCA 141,164,171, 173, 181, 183)	Other	1		
Right angle	A (crossing right of way)	25	50	
(DCA 110,147)	B (right of way)	25		
Hit parked vehicle	A (vehicle)	19	20	
(DCA 160,161,162,163)	B (parked)	1		
Rollover	A (vehicle)		18	
(DCA 170,172,174,176,180, 182,184)				
Side swipe	A (correct lane)	7	15	
(DCA 133,134,135,136, 137,142,153)	B (changing lanes)	8		
U-turn in front	B (through)	8	12	
(DCA 140)	A (turning)	4		
Head on	B (correct side)	7	11	
(DCA 120,150)	A (incorrect side)	4		
Hit animal	A (vehicle)		6	
(DCA 167)				
Left turn – adjacent directions	A (turning)	3	5	
(DCA 116)	B (through)	1		
	Other	1		
Hit pedestrian	A (vehicle)		0	
(DCA 100,101,102,103,104, 105,106,107,108,109)				
Other			10	
(All other DCAs)				
Total			531	

Table 3.7 shows the distribution of crash types and vehicle actions of the EDR vehicles in the cases collected from Major Crash. Head on crashes were the most frequent crash type in the Major Crash sample.

Table 3.7
Crash types of EDR vehicles (Major Crash cases only)

Crash type	Vehicle position/ action	Frequency	Crash type total	Indicative DCA code diagram
Rear end (DCA 130,131,132,154)	A (rear/striking)		1	
	Middle			
	B (front)	1		
Right-turn – opposite directions (DCA 121)	B (through)	1	2	
	A (turning)	1		
Right-turn – adjacent directions (DCA 111,113)	A (turning)	2	4	
	B (through)	2		
Single vehicle into object (DCA 141,164,171, 173, 181, 183)	A (vehicle)	5	5	
Right angle (DCA 110,147)	A (crossing right of way)	2	3	
	B (right of way)	1		
Head on (DCA 120, 150)	B (correct side)	3	10	
	A (incorrect side)	7		
Hit pedestrian (DCA 100,101,102,103,104, 105,106,107,108,109)	A (vehicle)	2	2	
Other (All other DCAs)			0	
Total			27	

3.4 Data contained in the EDR files

The information contained on an EDR differs for various vehicle makes, models and generations of EDRs. Table 3.8 shows the rates of the different key 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 two 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. Speed, brake status (off, on), and accelerator pedal position were also present in most cases. ABS activity and ESC status are only present in a few EDR files download to date.

Table 3.8
Number of cases by data available (excluding Major Crash cases)

Data field	Recorded	Not recorded	Percentage recorded (n=531)
Longitudinal delta-V	507	24	95.5%
Lateral delta-V	328	203	61.8%
Speed history	478	53	90.0%
Driver seatbelt status	291	240	54.8%
Passenger seatbelt status	161	370	30.3%
Pretensioner deployment	151	380	28.4%
Brake status	478	53	90.0%
Brake oil pressure	117	414	22.0%
Accelerator pedal position	468	63	88.1%
Steering wheel angle	151	380	28.4%
ABS activity	13	518	2.4%
ESC status	12	519	2.3%

Impact speeds and speeding

Vehicle speed-time history was recorded in 478 of 531 (90.0%) 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 classifying certain vehicles as a "bullet" vehicle. A bullet vehicle is defined differently for different crash types, but is generally a vehicle that has right of way (if travelling through an intersection) and strikes another vehicle or object. For crashes where a vehicle is performing a turn across traffic, a 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 a 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 298 EDR vehicles (265 with speed data recorded) of the 531 matched EDR vehicles were classified as bullet vehicles with 65 vehicles (24.5%) travelling above the speed limit in the seconds before a crash.

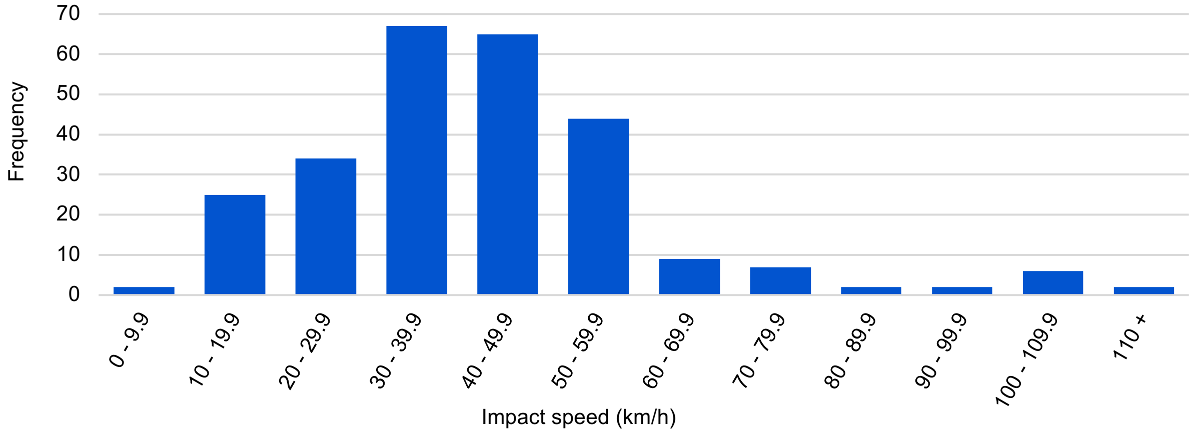


Figure 3.2
EDR bullet vehicle impact speeds (excluding Major Crash cases)

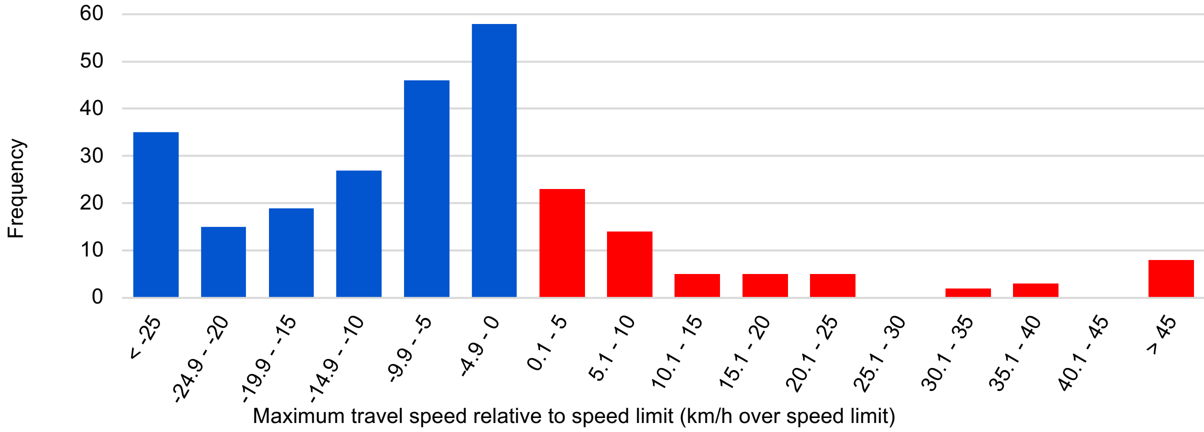


Figure 3.3
EDR bullet vehicle maximum travel speed relative to speed limit (excluding Major Crash cases)

A vehicle travelling at a free-speed is also an important classification in road safety analyses. Free-speed vehicles are vehicles that are travelling at an unhindered (not influenced by other traffic) speed self-selected by the driver. 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 135 EDR vehicles were categorised as free-speed vehicles, with their speeding rates shown in Table 3.9. Figure 3.4 displays the distribution of speeding levels of the 135 free-speed EDR vehicles, with 51 (37.8%) travelling above the speed limit by any amount.

Table 3.9
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
At least 10 km/h under	16	11.9%
Between 9.9 and 0 km/h under	68	50.4%
Between 0.1 and 5 km/h over	17	12.6%
Between 5.1 and 10 km/h over	11	8.1%
More than 10 km/h over	23	17.0%
Total	135	100.0%

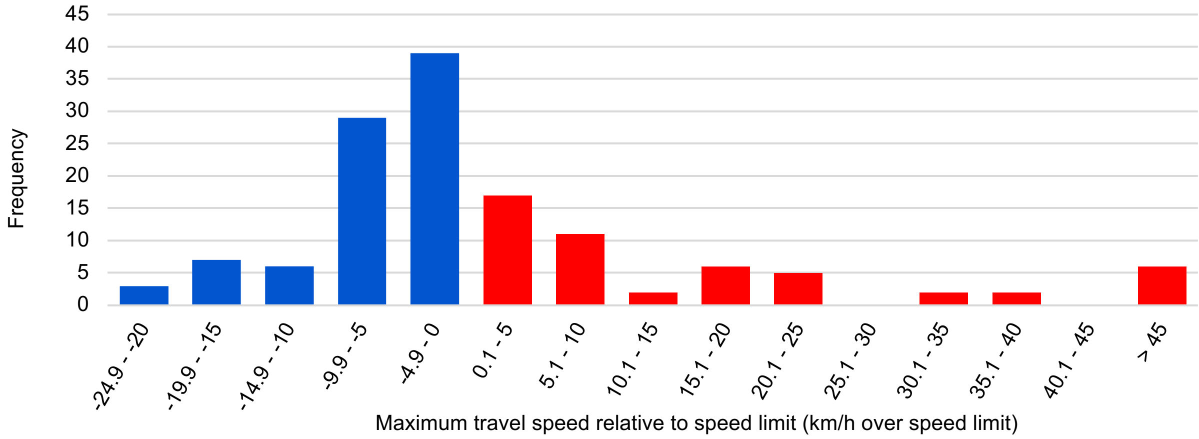


Figure 3.4
EDR free-speed vehicle's maximum travel speed relative to speed limit (not including Major Crash cases)

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 3.10. Of the 291 EDRs (not including Major Crash cases) that recorded driver seatbelt usage, 283 (97.3%) of the drivers had their seatbelt buckled at the time of the crash. Of the 161 EDR reports (not including Major Crash cases) with passenger seatbelt usage recorded, only 24 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 24 left-front passengers, 21 (87.5%) were recorded as having their seatbelt buckled at the time of the crash.

Table 3.10
Seatbelt use by occupants in EDR vehicles (not including Major Crash cases)

Position	EDR seatbelt buckled	EDR seatbelt unbuckled	Percentage positive	Total
Driver	283	8	97.3%	291
Front seat passenger	21	3	87.5%	24
Total	304	11	96.5%	315

Impact severity (delta-V)

Delta-V is 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 and has been correlated with injury: higher delta-Vs 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. The majority (92.0%) have a delta-V of less than 30 km/h.

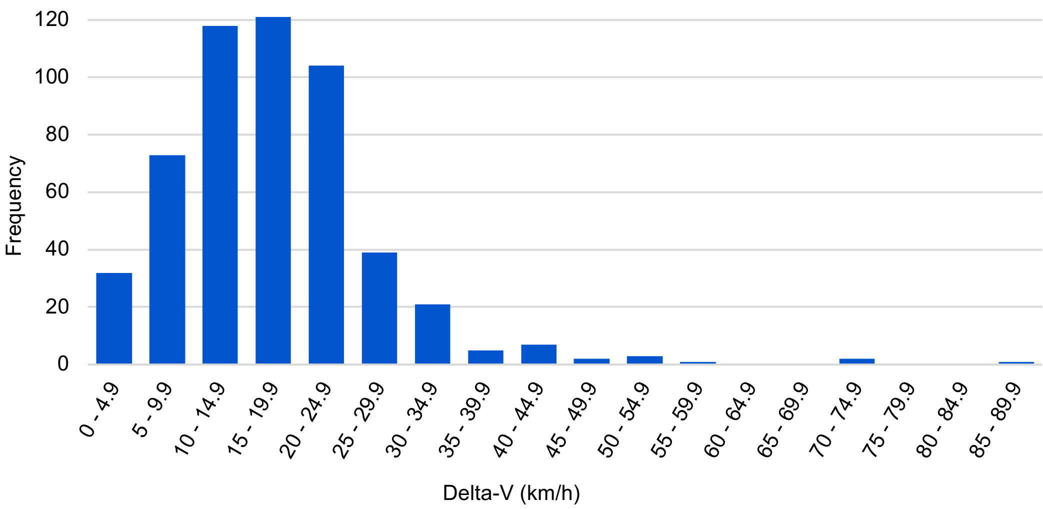


Figure 3.5
Frequency of delta-V of EDR vehicles in 5 km/h increments

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 South Australia. The matching rates of EDR downloads to police records was 76.3%, and the matching rate of injury data from hospitals for police reported hospital-attendees was 38.9% over the 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 or often unreliable, self-reported speeds. Around a quarter of bullet vehicles (24.5%) were found to be speeding before a crash, and 37.8% of free-speed vehicles were found to have been speeding, with nearly half of those (17.0%) travelling more than 10 km/h above the speed limit. The seatbelt usage reported by the EDR files indicated that 96.5% of frontal occupants were buckled at the time of the crash.

The speed data from EDRs is not only useful for determining actual rates of 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 who 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 as they interact with road challenges and infrastructure (curves, roundabouts etc.), and
- 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 both injury and 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.

4.1 Representativeness of the data and implications for its use

When using data that is a sample of a larger population, for example all crashes in South Australia, a key consideration is how well the sampled data represents the population. In so doing, biases can be detected and accounted for in analyses and the limitations of the dataset can be understood. Central to understanding the representativeness is considering how the data was sampled.

Sample collected at auction yard

Crashes in the CASR EDR database are selected on the basis that:

- An involved vehicle had an EDR that was supported by the current Bosch CDR tools,
- This vehicle was declared a repairable or statutory write-off due to the crash damage,
- The impact resulted in the EDR detecting and storing a crash event,

- The vehicle was delivered to the auction yard CASR attends, and
- The vehicle was due to be auctioned the week CASR's researchers attended.

A crash is therefore sampled due to vehicle-based factors. This results in the probability of a crash being sampled related to the number of vehicles in the crash: the more vehicles in a crash the more likely it is to have a vehicle that meets the sampling criteria. When considering the sample as a whole, this results in an overrepresentation of crashes involving more than one vehicle and an underrepresentation of single vehicle crashes. However, when conducting an analysis where only one type of vehicle from each crash is considered, for example, the at fault vehicle, this bias can be reduced. This is demonstrated in the results when comparing against the speed zones, locations and crash types being more closely aligned when compared to all passenger vehicles in the TARS data rather than comparing with all crashes.

An example of the implications of this bias is the examination of speeding shown in Figure 3.3. For this analysis only bullet vehicles were considered. This selects only one vehicle from each crash with two exceptions; both vehicles in a head-on crash are considered bullet vehicles and no vehicles in a side-swipe crash are considered bullet vehicles. As these crash types make up less than 5% of the sample this is unlikely to have a large effect on the result and this result can be considered representative. Ensuring head on and side swipe crashes were represented proportionally would improve this, albeit marginally, and should be included in such analyses in the future.

Another bias to consider in the sample is the requirement for an EDR to record an event. For this to occur the vehicle must have the ignition on and a recording threshold must be met. Hit parked vehicle crashes are under-represented in the sample because one of the vehicles involved in the crash usually has their ignition switched off. Analyses that only select the bullet or striking vehicles would correct for this. The recording threshold of an EDR can lead to crashes that result in a low delta-V not being recorded. This would be expected to result in the sample being biased towards injury crashes, and that is reflected in the results shown in Table 3.4, with non-injury crashes being under-represented crashes resulting in hospital treatment being over-represented. This bias should be considered when using the data. The recording threshold may also result in collisions with pedestrians or cyclists not being recorded as the vehicle does not experience a high delta-V in such crashes.

The final selection criterion to consider that may bias the sample is that the vehicle must be written off. It is likely that this has a similar effect to the EDR recording threshold, biasing the sample towards more severe crashes. This also makes it less likely that pedestrian crashes or crashes with cyclists will appear in the sample as they are less likely than other crashes to result in a sufficient level of damage to write-off the vehicle. A pedestrian crash has not yet been collected in the sample of written off vehicles.

Sample collected from Major Crash

The key bias in the sample collected from Major Crash is that it only includes vehicles involved in a fatal, or very serious crash with the potential to be fatal crash. If these cases are to be analysed in conjunction with the much larger sample collected from the auction yard, this must be taken into account through a weighting method or a similar way.

It is likely that this sample also has some of the same biases as the auction yard sample. The sample still requires the EDR to record and event, but it does not require the vehicle to be written off. Crashes are still sampled on a vehicle basis and therefore the commentary above on that bias would be applicable to this sample as well. This sample is currently too small to make any meaningful comparisons to all fatal crashes.

5 Case study

Case EDR271 involved a coupe (Unit 1) and a work utility (Unit 2). Unit 1 was travelling south on a rural arterial road and travelled across the centreline into the oncoming traffic lane, where the work utility was travelling north in the opposite direction. It was around 5:30 AM on a Thursday morning. A site diagram shows the scenario in Figure 5.1. The two vehicles had an offset head-on collision, where the overlap of the two vehicles was very small. If the overlap of the vehicles were larger, the initial impact would have been much more severe. According to the police report, following the initial impact, Unit 2 “flipped over a few times before coming to a halt some distance away from where the initial contact had occurred”. The damage to Unit 1 is also shown in Figure 5.1. Both drivers were sole occupants of their vehicles, and the driver of Unit 1 was transported to hospital following the crash, whereas the driver of Unit 2 was uninjured.

Figure 5.1
Simple site diagram of EDR271 and photograph of damage to Unit 1

As a result of the crash, five airbags were deployed in Unit 1 (two frontal, right-hand curtain and side, and driver’s knee airbag), and both front-seat seatbelt pretensioners were deployed.

From the police report, the driver of the Unit 1 had a BAC reading of 0.130 g/100 mL, and matched offence history data revealed the driver of Unit 1 had a previous drink-driving offence eight years before the crash. The driver of Unit 1 was diagnosed with six different abrasions and contusions across their chest, arms and legs. These were all AIS 1 injuries.

The EDR record, shown in Figure 5.2, indicated that Unit 1 was travelling at a maximum speed of 110 km/h at 0.1 second before impact, even though the speed limit of the road was 90 km/h (20 km/h over the speed limit). The brake was not used in the 5 seconds preceding the crash, but the steering angle showed that Unit 1 reacted in the last milliseconds before the crash. The steering angle was 0 degrees (travelling exactly straight) for the entire 4.6 seconds before impact, but at 0.1 seconds before impact, the steering angle changed to 10 degrees anticlockwise (to the left), indicating that the driver was reacting to the situation and starting to swerve to avoid the other vehicle and return to its lane of travel. The delta-V for the impact was 9.7 km/h in the longitudinal direction (parallel to the normal travel direction of the vehicle) and 6.2 km/h in the lateral direction (perpendicular to the normal travel direction of the vehicle), which equates to a total delta-V of 11.5 km/h. Had the fronts of the vehicles been overlapping more when they collided, the delta-V would have been close to the average impact speed of the vehicles, potentially around 100 km/h. Such a high delta-V would almost certainly result in serious injury, and a fatality would not be unexpected.

Pre-Crash Data, -5 to 0 seconds (Most Recent Event, TRG 3)

Time (sec)	-4.6	-4.1	-3.6	-3.1	-2.6	-2.1	-1.6	-1.1	-0.6	-0.1	0 (TRG)
Vehicle Speed (MPH [km/h])	66.5 [107]	65.9 [106]	65.9 [106]	65.2 [105]	66.5 [107]	67.1 [108]	67.7 [109]	68.4 [110]	68.4 [110]	68.4 [110]	67.7 [109]
Accelerator Pedal, % Full (%)	3.5	7.5	14.0	18.0	36.0	37.5	34.5	18.0	14.5	0.0	0.0
Percentage of Engine Throttle (%)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Engine RPM (RPM)	2,900	2,900	2,800	2,800	2,900	2,900	3,000	3,000	3,000	2,900	2,900
Motor RPM (RPM)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Service Brake, ON/OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Brake Oil Pressure (Mpa)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Longitudinal Acceleration , VSC Sensor (m/sec^2)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Yaw Rate (deg/sec)	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
Steering Input (degrees)	0	0	0	0	0	0	0	0	0	10	20

Figure 5.2
EDR record of Unit 1 (Toyota 86) in EDR271

Considering what is known about this crash from the CASR EDR database, some interventions that would prevent or mitigated the crash can be identified. The installation of an in-vehicle alcohol interlock would prevent the vehicle from being started following a positive alcohol breath test. A lane support system like Lane Keep Assist which would keep the vehicle within its lane of travel would most likely have prevented the crash. A system that simply alerts the driver that they are crossing the centreline of the road may also have prevented the crash. There are also several road infrastructure based treatments that could have prevented or mitigated the crash. These include audio-tactile line markings, wide centrelines, a wide median and a centre barrier. The driver of Unit 1 being apprehended by the police for drink driving prior to the crash location would have also prevented the crash.

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Appendix A – DCA Codes