Evaluations of Five Advanced Driver Assistance System (ADAS) Features, Including:

- Automatic Emergency Braking (AEB),
- Blind Spot Warning (BSW),
- Lane Keeping Assistance (LKA),
- Pedestrian AEB or Detection (PAEB/PD), and
- Rear Cross Traffic Warning (RCTW)

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Introduction

Generally, the goal of the analytics approach applied in this document is to determine the effectiveness of specific ADAS features (those given in the title). There are some others mentioned in Consumer Reports (CR) that will be discussed below when a more complete table of ADAS features is given. For now, we want to keep the discussion general to apply to any ADAS feature that is subject to evaluation.

There seems to be no alternative to accomplishing an evaluation of an ADAS feature than that of comparing the crash history of vehicles with the ADAS feature against a comparable set of vehicles that do not have this feature. This would need to be done over a relatively large number of test and control cases in order to get practically significant results. In this case the "test" subset will be crashes for those vehicles with a given ADAS feature. A control subset is defined to be a subset that is (ideally) in all other respects like the test subset, but which does not have the ADAS feature. If the ADAS feature is to reduce a given type of crash (e.g., pedestrian crashes), the Primary Contributing Circumstances and/or the Contributing Circumstance given in the crash records might be used to determine the effectiveness in reducing those crash types.

<u>Consumer Reports</u> (*CR*) has provided a list of ADAS features that indicates the Year, Make and Model in which a variety of features were present. We searched for other similar make, model year and model specifications but this is the only one that was found. We assume that if an ADAS feature is present in a given year, it will also be present in subsequent years. It was also generally required that we specify the makes, models and years for which the given ADAS feature was not present so that a legitimate control group could be created.

It is essential that we understand what is being measured and compared by these analytics. We will call the numbers that will be produced below in the IMPACT displays *Vehicle-Crashes*. This can be thought of as one vehicle that is involved in one crash. This definition is mindful of the fact that a vehicle cannot get into the database unless it has had a crash. It is obviously impossible when this is the primary metric to determine how many crashes were averted by a given ADAS feature. However, we can determine the extent to which the various attributes of these crashes change.

As an example, consider Section 2.0 of this report, which documents the study of Blind Spot Warning (BSW). The decisions was made to use Toyotas for the BSW subset (592 vehicle-crashes), and Mazdas for the NonBSW subset (361 vehicle-crashes). These two subsets were compared by a CARE IMPACT analysis, and the results are given at the end of Section 2.0.

Table 1 lists all of the ADAS feature types that are given in CR. These will be discussed in more detail after the table.

Zzzz Update

Acronym	Acronym Meaning	Status	Comment
ACC*	Adaptive Cruise Control	0	No models given by CR
AEB ss	Automatic Emergency Braking V07	6	AEB=CAEB+HAEB
AEB/FCW	Combination Of AEB and FCW	7	Nissan $AEB = FCW$
BSW	Blind Spot Warning	6	
CAEB	City Automatic Emergency Braking	6	AEB=CAEB+HAEB
FCW ss	Forward Collision Warning Ss And Validation	6	No AEB; Review SS
HAEB	High-Speed Automatic Emergency Braking	6	AEB=CAEB+HAEB
LCA*	Lane-Centering Assist	0	No models given by CR
LDW ss	Lane Departure Warning	6	Review SS
LKA	Lane Keeping Assistance	6	Needs work
PD	Pedestrian AEB and Detection, PD/PAEB	6	Used Crash comparison
RCTW	Rear Cross Traffic Warning	6	
Rear AEB*	Rear Automatic Emergency Braking	0	No models given by CR

Table 1. ADAS Acronym Checklist

* ACC, LCA and Rear AEB were not listed in any of the Consumer Reports ADAS tables.

SS after the acronym indicates that there is a separate special study on this ADAS feature. These are available here:

http://www.safehomealabama.gov/caps-special-studies/

under the Vehicle-Related subject heading.

Status Codes that were used in the process of these studies to manage further development:

- 0. No applicable models in CR
- 1. No consideration yet
- 2. Being investigated for processing
- 3. Initial processing
- 4. Preliminary draft
- 5. In final draft revision
- 6. Project completed but needs further review, e.g. addition of more vehicle-crash cases
- 7. No further review anticipated

To get a brief description of each of the above features, please see the <u>Consumer Reports</u> (CR) article.

Brief Clarification of the ADAS features listed in Table 1

The following presents the ADAS features given in Table 1, and indicates if they have prior studies, and how they will be handled in the remainder of this report:

- Adaptive Cruise Control (ACC*). This feature will not be considered further at this time since no models were given by CR.
- Automatic Emergency Braking (AEB ss). A special study exists for this feature that is available on <u>SafeHomeAlabama</u>, and so it will not be documented further here. This report is a combination of Automatic Emergency Braking (AEB) for both City (CAEB) and High-Speed (HAEB).
- AEB Combined with FCW (AEB/FCW). Section 1.0 in this report.
- Blind Spot Warning (BSW). Section 2 of this report.
- City Automatic Emergency Braking (CAEB). See Automatic Emergency Braking (AEB), above, which is a combination of CAEB and HAEB.
- Forward Collision Warning Ss and Validation (FCW ss). A special study exists for this feature that is available on <u>SafeHomeAlabama</u>, and so it will not be documented here.
- High-Speed Automatic Emergency Braking (HAEB). See Automatic Emergency Braking (AEB), above, which is a combination of CAEB and HAEB.
- Lane-Centering Assist (LCA*). This feature will not be considered further at this time since no models were given by CR.
- Lane Departure Warning (LDW ss). A special study exists for this feature that is available on <u>SafeHomeAlabama</u>, and so it will not be documented further here.
- Lane Keeping Assistance (LKA). Section 3.0 of this report.
- Pedestrian AEB or Detection (PAEB/PD). Section 4.0 of this report.
- Rear Cross Traffic Warning (RCTW). Section 5 of this report.
- Rear Automatic Emergency Braking (Rear AEB*). This feature will not be considered further at this time since no models were given by CR.

The table in the next section below was generated to assist in choosing which vehicles makes to consider. Those in the top tier (1000 and above) were used most often. It is obvious that a large number of vehicles of a given make will potentially produce more models that are of a given feature as well as those without the feature for the control. However, the features (or absence of such) had to be specified in the CR report in order to be used.

This report will continue by providing the procedure applied in each of the five evaluations and the findings in terms of IMPACT displays.

🖡 CA	RE 10.2.1.3 - [Frequ	uency Resu	lts - 2018-2020	Alabama Integ	rated Driver-Veh	icle Data - Filter	= Mo	_		×
🔋 <u>E</u> il	le <u>D</u> ashboard	<u>F</u> ilters	<u>A</u> nalysis F <u>r</u> e	quency <u>T</u> oo	s <u>W</u> indow	<u>H</u> elp			-	. 8 ×
*	2018-2020 Alabama	Integrated [Driver-Vehicle Da	ita 🗸 🗸	Model `	Years 2018-2020				
Order:	Frequency	~ Desc	cending	V Supp	ress Zero-Valued	Frequencies				
D209:	Make		Frequency	Cum. Frequency		Cum. Percent	<u>^</u>	209: Make	J	
▶ _	Toyota		8387	8387	14.26	14.26				
	Ford		7123	15510	12.11	26.37				
	Chevrolet		7051	22561	11.99	38.36				
	Nissan		6373	28934	10.83	49.19				
	Dodge		3647	32581	6.20	55.39				
	Honda		3592	36173	6.11	61.50				
	E Hyundai		3453	39626	5.87	67.37				
	E Kia		2891	42517	4.91	72.28				
	Jeep		2114	44631	3.59	75.88				
	GMC		1722	46353	2.93	78.80				
	Freightliner		1670	48023	2.84	81.64	~			
1	Se 🖉					Display	Average	🗌 Disp	lay Filte	r Name
			2018-202	0 Alabama Integ D209:	rated Driver-Vehi Make	cle Data				
Frequency	10,000	I								
	0		Peterbuilt Moto	rs Co.	Kawasaki	E Osh Motor Tr			E Sko	da
					D209: Make					

Number of Vehicles in 2018-2020 Database (Minimum 3000)

1.0 ADAS AES Combined with FCW

Combination of Automatic Emergency Braking (AEB) and Forward Collision Warning (FCW)

Introduction

This section evaluates the combination of AEB and FCW working together as a unit.

Consumer Reports listed two types of Automatic Emergency Braking (AEB); CAEB (city automatic emergency braking) and HAEB (high-speed automatic emergency braking), the only difference being the speeds at which they are designed to work. However, in most of their makes they combined these two features into what they called CAEB/HAEB. To abbreviate this further, we will analyze them combined and refer to them collectively as AEB.

In addition to this combination, it was found that the same models and model years that defined the AEB and Non-AEB subsets, also defined the FCW and Non-FCW subsets. This means that whenever a Nissan model had AEB, it also had FCW, and whenever a Nissan model was Non-AEB it was also Non-FCW. This led to the opportunity to evaluate these two ADAS features as one collective ADAS unit, which we will reference as AEB/FCW.

Methodology Applied

The All-Nissan Subset was used in to create models with AEB/FCW and Non-AEB/FCW.

CARE 10.2.	1.3 - [Crosstab Result	s - 2018-2020 Alabai	ma Integrated Drive	er-Vehicle Data - Filte	er = Nissan All 🗕 🗆 🗙
🚦 <u>F</u> ile <u>D</u> a	shboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rossta	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp	_ & ×
2018-202	20 Alabama Integrated I	Driver-Vehicle Data	~	Nissan All 2018-2020	G 🕘
Suppress Zero	Values: Rows and Co	lumns 🗸 Select	Cells: 🔳 🗸 %	9	Column: Model Year ; Row: Make ญ
	2018	2019	2020	TOTAL	
Nissan	3806	2124	443	6373	
TOTAL	3806	2124	443	6373	
		-	-		

1. Start with all Nissan 2018-2020

This same raw data will be used to generate both the Nissan AEB/FCW and the Nissan Non-AEBFCW subsets since the differences between them will be in the models. Note a total of 6373 Nissan vehicle-crashes are in the 2018-2020 Driver-Vehicle file. The model years of 2018-2020 will be for the specific AEB/FCW and Non-AEB/FCW subset generations. In the discussions that follow, the FCW has been eliminated from AEB/FCW strictly for brevity purposes.

2. The contents of the subset from 1 is obtained from a DataGen using the filter above. Essential variables that must be included in this DataGen are:

- 208 Model Year,
- 209 Make,
- NCV003 Care DV Case Number NCV, and
- NCV005 Vehicle Model NCV.

The contents generated by the DataGen are under the Nissan ALL 2018-2020 tab of the ADAS AEB Datagen Proc-v01.xlsx Excel file. The DataGen for the filter above produced 6,373 records. These were then used to produce the Nissan AEB and the Nissan NonAEB filters.

3. Creating AEB/FCW filter for 2018-2020 Nissans. To qualify for AEBFCW: 2020: <u>Altima</u>, Armada, <u>Kick, Leaf, Maxima, Murano, Pathfindes, Rogue</u>, Rogue Sport, Sentra, Titan, TitanXD and Versa; 2019: <u>Altima</u>, Armada, <u>Kick, Leaf, Maxima, Murano, Pathfindes</u>, <u>Rogue</u>, Rogue Sport; 2018: <u>Altima, Kick, Leaf, Maxima, Murano, Pathfindes</u>, Number found with AEB features = 3767.

The text file name generated from this reduced DataGen is ADAS AEB Nissan 2018-20.txt. The filter generated by this text file was called ADAS AEB Nissan 2018-2020. It produced the following:

B CARE 10.2.1.	3 - [Crosstab Results	s - 2018-2020 Alabai	ma Integrated Driv	er-Vehicle Data -	Filter = ADAS AEB Nissan 20	- 🗆	×		
🚦 <u>F</u> ile <u>D</u> ash	board <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	low <u>H</u> elp			- 8 ×		
2018-2020	Alabama Integrated D	Driver-Vehicle Data	~	ADAS AEB Nissa	an 2018-20	~ 9	15		
Suppress Zero Values: Rows and Columns 🗸 Select Cells: 🖬 🗸 🥳 Column: Model Year ; Row: Make 👰									
	2018	2019	2020	TOTAL					
Nissan	2229	1124	414	3767					
TOTAL	2229	1124	414	3767					

All vehicle-crashes specified here were 2018-20 Nissans.

4. Creating Non-AEB/FCW filter for 2018-2020 Nissans. To qualify for Non-AEB: 2018: **Frontier, GT-R;** <u>NV, NV200</u>, **Titan, TitanXD**, **Versa, VersaNote;** 2019: **Frontier, GT-R;** <u>NV, NV200</u>, **Titan, TitanXD**, **Versa, VersaNote;** 2020: **GT-R;** <u>NV, NV200</u>. The number found with Non-AEB feature = 1237. The text file name generated from this reduced DataGen is **ADAS Non-AEB Nissan 2018-20.txt**. The filter generated by this text file was called **ADAS Non-AEB Nissan 2018-2020. It produced the following:**

CARE 10.2.1.3	3 - [Crosstab Results	- 2018-2020 Alabai	ma Integrated Drive	er-Vehicle Data - Fil	ter = ADAS Non-AEB	Niss —		(
🖡 <u>F</u> ile <u>D</u> ash	board <u>F</u> ilters <u>i</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			- 8	×		
2018-2020	Alabama Integrated D)river-Vehicle Data	\sim	ADAS Non-AEB Nis	san 2018-2020		~ 💡 🏆			
Suppress Zero Va	Suppress Zero Values: Rows and Columns 🗸 Select Cells: 🗐 🗸 🌠 Column: Model Year ; Row: Make 👰									
	2018	2019	2020	TOTAL						
Nissan	758	413	66	1237						
TOTAL	758	413	66	1237						

5. The AEB/FCW subset can now be compared with the Non-AEB/FCW subset. The ADAS Non-AEB Nissan 2018-2020 filter is made current, and it is compared against the subset generated by the ADAS AEB Nissan 2018-2020 filter. The following IMPACT comparisons were obtained for the combination of AEB and FCW, since both had the same applicable model years.

IMPACT Evaluations for the AEB and FCW Combination

Because the Nissans used in these comparisons have effectively the same models in effect for AEB and Forward Collision Warning (FCW), these IMPACT displays should be viewed as applying when both of these features are in effect simultaneously.

D015 Primary Contributing Circumstances AEB and FCW Combination

CA	🔋 CARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabama Integrated Driver-Vehicle Data - ADAS Non-AEB Nissan 2018-2020 vs. AD – 🛛 🗙										
E E	le <u>D</u> ashboard <u>Filters A</u> nalysis <u>I</u> mpact	t <u>T</u> ools	: <u>W</u> ind	dow <u>H</u>	<u>l</u> elp			_ & ×			
6 2	2018-2020 Alabama Integrated Driver-Vehicle Data		~	ADAS	Non-AEB	Nissan 2	018-2020	Y Y Y 1/ 1/2018			
Order	Max Gain V Descending V	🗌 🗆 Su	ppress Ze	ero-Value	d Rows	Signific	ance: Ove	r Representation V Threshold: 2.0			
D015	Primary Contributing Circumstance	Subset	Subset	Other quency	Other Percent	Odds Ratio	Max ^ Gain	D007: Week of the Year of Crash D008: Time of Day of Crash			
	Misjudge Stopping Distance	139	11.24	344	9.13	1.231	26.038	D009: Data Source			
	Followed too Close	217	17.54	582	15.45	1.135	25.884	D011: Highway Classifications			
	E Ran off Road	18	1.46	25	0.66	2.193	9.791	D015: Primary Contributing Circumstand D017: First Harmful Event			
	E Failed to Yield Right-of-Way from Traffic Signal	31	2.51	70	1.86	1.349	8.014	D019: E Most Harmful Event			
	E Other Improper Action	29	2.34	64	1.70	1.380	7.984	D020: E Distracted Driving			
	Improper Parking/Stopped in Road	10	0.81	12	0.32	2.538	6.059	D023: E Manner of Crash			
	E Fatigued/Asleep	14	1.13	28	0.74	1.523	4.805	D024: School Bus Related			
	Driving too Fast for Conditions	25	2.02	62	1.65	1.228	4.641	D025: Crash Severity D035: EMS Arrival Delay			
	Improper Backing	44	3.56	120	3.19	1.117	4.595	D042: Highway Patrol Troops			
	E Other Distraction Outside the Vehicle	26	2.10	66	1.75	1.200	4.327	D043: Highway Patrol Posts			
	DUI	24	1.94	60	1.59	1.218	4.297	D045: ALDOT Area			
	Defective Equipment	17	1.37	42	1.11	1.233	3.208	D046: ALDOT Region			
	E Ran Stop Sign	16	1.29	39	1.04	1.249	3,193	D047: ADECAAHSO Region D048: Regional Planning Organization			
	E Aggressive Operation	23	1.86	61	1.62	1.148	2.969	D053: Number of Persons in this Vehicle			
	E Improper Crossing	4	0.32	4	0.11	3.045	2.686 🗸	Sort by Sum of Max Gain			
				1							
	2018-2020 Alabama Integrated Driver	-Vehicle I	Data - Filt	ter = ADA	S Non-AE	B Nissan	2018-2020	vs. ADAS AEB Nissan 2018-20			
		D01	5: Primary	y Contribu	uting Circu	umstance					
	20										
	-										
1	5										
	10 10										
<u>د</u>								4 1			
							1				
	the sheet of										
	0UUBUBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB	1					l				
	E Other Faile	ed to Yield			erable Ťra			Over Correcting/Over Steering			
			D015: F	Primary C	ontributing	g Circum	stance				

Items with a Max Gain less that 2.0 are not shown. The following crash types could possibly be eliminated or mitigated by the AEB/FCW combination (rounded Max Gain): Misjudge Stopping Distance(26), Following too Close (26), Ran Off Road (10), Driving Too Fast for Conditions (5).

D204 Sequence of Events #1



Collision with Parked Motor Vehicle, which rarely has one of the highest Max Gains is probably the crash type that has the highest potential to be reduced by the AEB/FCW combination. The Odds Ratio shows that the reduction of the Ran Off the Road Right crash type is significant, with a reduction in the proportion of about 60%. The rationale for including this as a positive factor is that the chances of there being some obstacle on the roadside is very high, especially on roads that do not have large cleared roadsides. Many of the other crash types could be reduced by AEB/FCW.

D017 First Harmful Event



Items with a Max Gain of one or less are not shown. It is notable that the item with the highest Max Gain is relevant to AEB/FCW in that this is exactly the type of crash that these features were designed to prevent, i.e., any type of crash with a stationary object. About half of the items listed would qualify. See the list on the next page.

List of Crash Types that Could be Reduced by AEB/FCW

Collision with Parked Motor Vehicle E Collision with Vehicle in (or from) Other Roadway E Ran Off Road Left E Ran Off Road Right E Collision with Other Non-Fixed Object Collision with Tree E Collision with Guardrail End E Collision with Other Traffic Barrier Collision with Other Traffic Barrier Collision with Culvert Headwall Collision with Bridge Abutment/Rail Collision with Light Pole (Non-Breakaway) E Collision with Embankment Collision with Bridge Support/Column E Collision with Other Post/Pole/Support

The total Max Gain that indicates the potential reduction is 196 vehicle-crashes.

D023 Manner of Crash



The attribute with the highest Max Gain (46) here would definitely be influenced by AEB/FCW. Side impacts could also be reduced or mitigated by AEB/FCW.

D025 Crash Severity (in worst first order)



There are severity gains in all injury categories, and the gain in Possible Injury is statistically significant. This demonstrates that even if a crash is not averted by AEB/FCW, its severity could be reduced to prevent fatalities and severe injuries.

End of AES combined with FCW analysis.

2.0 ADAS Blind Spot Warning (BSW) Example

Methodology Applied to Blind Spot Warning

Toyota subset used in to create models with BSW:

1. Start with all Toyotas 2018-2021

CARE 10.2.1.3	- [Crosstab Results	- 2018-2020 Alabar	ma Integrated Drive	r-Vehicle Data - Fil	ter = ADAS All Toyo	tas 2018-2021]		_	
File Dash	board <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp					_ 8 ×
2018-2020	Alabama Integrated D	river-Vehicle Data	\sim	ADAS All Toyotas 2	018-2021	~	· 💡 🐺	1/ 1/2018 $\scriptstyle \lor$	9/14/2020 \vee
Suppress Zero Va	alues: Rows and Col	umns 🗸 Select		Column:	Model Year ; Ro	w: Make 👔			
	2018	2019	2020	2021	TOTAL				
Toyota	5046	2612	729	2	8389				
TOTAL	5046	2612	729	2	8389				

This same basic subset will be used to generate both the Toyota BSW and the Toyota Non-BSW subsets since the differences between them will be the models. Note a total of 8389 Toyota vehicle-crashes are in the 2018-2020 Dri-Veh file. The model years of 2018-2021 will be for the specific BSW and Non-BSW subset generations.

2. The contents of the subset from 1 is obtained from a DataGen using the filter above. Essential variables that must be included in this DataGen are:

- 208 Model Year,
- 209 Make,
- NCV003 Care DV Case Number NCV, and
- NCV005 Vehicle Model NCV.

The contents generated by the DataGen are under the **Toyota ALL 2018-21** tab of the **ADAS BSW Datagen Proc-v01.xlsx** Excel file. The DataGen for the filter above produced 8,389 records. These will be used to produce the Toyota BSW and the Toyota NonBSW filters.

3. Creating BSW filter for 2018-2020 Toyotas. To qualify for BSW: 2019 and 2020: Avalon, <u>Land Cruiser</u>, Marai (not listed for 2020; possible discontinue), <u>Sequoia</u>; 2018: Not Avalon, <u>Land Cruiser</u>, Marai, <u>Sequia</u> (if all three, underlined).

Number after eliminating doubtful and non-BSW models = 97. The text file name generated from the reduced DataGen is **ADAS BSW Toyota.txt**.

4. The filter generated from the was called **ADAS BSW Toyota 2018-2020**. Of the 97 in the original list, 97 vehicle crashes were generated according to this filter generation:

2018-2020 Alabama Integrated Driver-Vehicle Data V ADAS BSW Toyota 2018-2020 V V	CARE 10.2.1.3	3 - [Crosstab Results	; - 2018-2020 Alabai	ma Integrated Drive	er-Vehicle Data - Fil	lter = ADAS BSW Toyo	ta 2 —					
	🖡 <u>F</u> ile <u>D</u> ash	board <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rossta	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			- 8				
Suppress Zero Values: Rows and Columns 🗸 Select Cells: 🗐 🗸 😵 Column: Model Year ; Row: Make	2018-2020	2018-2020 Alabama Integrated Driver-Vehicle Data 🗸 ADAS BSW Toyota 2018-2020 🗸 🖓 🏆										
	Suppress Zero V	n: Model Year ; F	Row: Make 🛛 💦									
2018 2019 2020 TOTAL		2018	2019	2020	TOTAL							
Toyota 30 57 10 97	Toyota	30	57	10	97							
TOTAL 30 57 10 97	TOTAL	30	57	10	97							

All vehicle-crashes specified here were 2018-20 Toyotas; not sure how/why we lost the 2021s.

5. Creating Non-BSW filter for 2018-2020 Toyotas. To qualify for Non-BSW: all 2018, 2019 and 2020: **4Runner and 86.** Some others qualified but not in all years. Yaris was ambiguous.

Number after eliminating doubtful and clearly non-BSW models = 592. These are in the ADAS LKA Datagen Proc-v01.xlsx under the **Toyota Non-BSW 2018-2020** tab. The text file name generated from this DataGen is **ADAS Non-BSW Toyota.txt**.

6. The filter generated from this was called **ADAS Non-BSW Toyota 2018-2020**. Of the 592 in the original list, all 592 survived the filter generation.

CARE 10.2.1	3 - [Crosstab Result	s - 2018-2020 Alabar	ma Integrated Driv	er-Vehicle Data - F	Filter = ADAS Non-BS	SW Toy	- 🗆	×
🚦 <u>F</u> ile <u>D</u> as	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	low <u>H</u> elp				- 8 ×
2018-202) Alabama Integrated [Driver-Vehicle Data	~	ADAS Non-BSW	Toyota 2018-2020		~ ¥ §	12
Suppress Zero	/alues: Rows and Co	Colu	ımn: Model Yea	ar ; Row: M	ake 👰			
	2018	2019	2020	TOTAL				
Toyota	357	194	41	592				
TOTAL	357	194	41	592				

7. The BSW subset can now be compared with the Non-BSW subset. The ADAS Non-BSW Toyota 2018-2020 filter is made current, and it is compared against the subset generated by the ADAS BSW Toyota 2018-2020 filter.

8. However, since there does not seem to be a comparable number of vehicle-crashes in the two subsets, we will look to add to the BSW effective subset by adding vehicles from the All Mazda file. Models that qualify as BSW in that subset include: 2020: 6, CX-3, CX-5, CX-9; 2019:

same; 2018: all but CS-3. These were selected in the and others eliminated under the Mazda BSW 2018-2020 tab. Of the 592 Mazda units, 361 qualified according to specifications above.

9. The filter generated from these produced:

B CARE 10.2.	1.3 - [Crosstab Result	s - 2018-2020 Alabar	ma Integrated Driv	er-Vehicle Data - Fi	ilter = ADAS BSW Mazd	la 2 —		\times	
🖡 <u>F</u> ile <u>D</u> a	shboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	dow <u>H</u> elp			-	ð×	
2018-20	20 Alabama Integrated [Driver-Vehicle Data	~	ADAS BSW Mazda	a 2018-2020	`	1	12	
Suppress Zero Values: Rows and Columns 🗸 Select Cells: 💷 🗸 🌠 Column: Model Year ; Row: Make 👰									
	2018	2019	2020	TOTAL					
Mazda	245	99	17	361					
TOTAL	245	99	17	361					
		•	-						

This filter was used as the "Other" filter and compared against the ADAS Non-BSW Toyota 2018-2020 filter, which was set up as the Subset filter, with the results that follow.

IMPACT Evaluations for Blind Spot Warning

D015 Primary Contributing Circumstances



Swerved to Avoid Vehicle type crashes could have been affected by BSW, which had a Max Gain of a little over 10 vehicle-crashes.

D023 Manner of Crash

🔋 CA	RE 10.2.1.3 - [IMPACT Results - 2018-	2020 Ala	bama Int	egrated	Driver-Ve	hicle Dat	a - ADA	S No	on-BSW Toyota 2018 — 🗆 🗙
🔋 <u>E</u> i	le <u>D</u> ashboard <u>Filters A</u> nalysi	s <u>I</u> mp	act <u>T</u> o	ols <u>W</u>	indow	<u>H</u> elp			_ & ×
*	2018-2020 Alabama Integrated Driver-Ve	ehicle Data	а	\sim	AD	AS Non-E	SW Toy	ota 2	2018-2020 🗸 🌱 😨
Order	Max Gain V Descending		<u> </u>	Suppress	Zero-Va	lı Signific	ance: C	Over	Representation V Threshold: 2.0
D023:	E Manner of Crash	Subset	Subset	Other quency	Other Percent	Odds Ratio	Max Gain	^	D011: Highway Classifications D015: Primary Contributing Circumstanc
	Rear End (front to rear)	289	48.82	171	47.37	1.031	8.579		D017: First Harmful Event
	Angle (front to side) Same Direction	20	3.38	7	1.94	1.742	8.521		D019: E Most Harmful Event
	Head-On (front to front only)	15	2.53	4	1.11	2.287	8.440		D020: E Distracted Driving D023: E Manner of Crash
•	Sideswipe - Same Direction	68	11.49	37	10.25	1.121	7.324		D024: School Bus Related
	Angle (front to side) Opposite Direction	14	2.36	5	1.39	1.707	5.801		D025: Crash Severity
	Causal Veh Backing: Rearto Rear	7	1.18	1	0.28	4.269	5.360		D035: EMS Arrival Delay
	Non-Collision	2	0.34	0	0.00	0.000	2.000		D042: Highway Patrol Troops
	Single Vehicle Crash (all types)	42	7.09	25	6.93	1.024	1.003		D043: Highway Patrol Posts
								*	
00) 🗇 🖉								
		201		labama Ir	-		hicle Da	ita	
				D023: E I	Manner of	Crash			
	60								
	§ 40 40								
	20 20 20 20 20 20 20 20 20 20 20 20 20 2								
	0								
	Angle (iront to side) Opposite I			ecord from		tem	Other
ļi				D02	3: F Mann	er of Cra	sh		

Although not statistically significant, there was a reduction in the proportion of cases in the Sideswipe – Same Direction category of a little over 12%. The low sample size made it impossible to draw any conclusions with regard to Crash Severity, and it is recommended that this analysis be repeated with higher sample sizes.

End of BSW anslysis.

3.0 ADAS Lane Keeping Assistance (LKA)

Procedure Implemented for LKA

1. Toyota subset used in to create models with LKA; start with all Toyotas 2018-2021

CARE 10.2.1.3	- [Crosstab Results	- 2018-2020 Alabar	ma Integrated Drive	r-Vehicle Data - Fil	ter = ADAS All Toyo	tas 2018-2021]		_	
🚦 <u>F</u> ile <u>D</u> ashb	ooard <u>F</u> ilters <u>/</u>	<u>A</u> nalysis <u>C</u> rosstał	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp					- 8 ×
2018-2020	Alabama Integrated D	river-Vehicle Data	\sim	ADAS All Toyotas 2	018-2021	``	~ 💡 🏆	1/ 1/2018 $\scriptstyle \lor$	9/14/2020 ∨
Suppress Zero Va	lues: Rows and Col	umns 🗸 Select	Cells: 🔳 🔹 %	9			Column:	Model Year ; Rov	v: Make 👔
	2018	2019	2020	2021	TOTAL				
Toyota	5046	2612	729	2	8389				
TOTAL	5046	2612	729	2	8389				

This same basic subset will be used to generate both the Toyota LKA and the Toyota Non-LKA subsets since the differences between them will be the models. Note a total of 8389 Toyota vehicle-crashes are in the 2018-2020 Dri-Veh file. 2018-2021 will be the model years for the specific LKA and Non-LKA subset generations.

2. The contents of the subset from 1 is obtained from a DataGen using the filter above. Essential variables that must be included in this DataGen are:

- 208 Model Year,
- 209 Make,
- NCV003 Care DV Case Number NCV, and
- NCV005 Vehicle Model NCV.

The contents generated by the DataGen are under the **Toyota ALL 2018-21** tab of the **ADAS LKA Datagen Proc-v01.xlsx** Excel file. The DataGen for the filter above produced 8,392 records. These will be used to produce the Toyota LKA and the Toyota Non-LKA filters.

3. Creating LKA filter for 2018-2020 Toyotas. To qualify for LKA: all 2018, 2019 and 2020: Avalon, C-HR, Camry, Highlander, Oeius, Prius prime, [NOT PriusC,] Rav4 and Sienna. Number after eliminating non-qualifyin non-LKA models = 4914. The text file name generated from the reduced DataGen is ADAS LKA Toyota.txt.

4. The filter generated from the was called. Of the 4914 in the original list, 4913 vehicle crashes were generated according to this filter generation:

CARE 10.2.1	.3 - [Crosstab Results	; - 2018-2020 Alabai	ma Integrated Drive	er-Vehicle Data - Filt	ter = ADAS LKA Toyota 2028-2020]	_		×
🖡 <u>F</u> ile <u>D</u> as	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	o <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			-	₽×
2018-202	0 Alabama Integrated [Driver-Vehicle Data	\sim	ADAS LKA Toyota 2	2028-2020	~ 9	1/	1/2018
Suppress Zero V	/alues: Rows and Co	umns 🗸 Select	Cells: 🔳 🔻 %	9	Column: Mc	odel Year ; F	low: Make	(
	2018	2019	2020	TOTAL				
Toyota	3140	1490	283	4913				
TOTAL	3140	1490	283	4913				
					-			

All vehicle-crashes specified here were 2018-20 Toyotas; not sure how/why e lost the 2021s.

5. Creating Non-LKA filter from 2018-2020 Toyotas. To qualify for Non-LKA: all 2018, 2019 and 2020: 4Runner, 86, Land Cruiser, Sequoia, Tacoma, Tundra, Yaris Sedan (IA), Yaris Hatchback. Number after eliminating doubtful and non-LKA models = 1830. These are in the ADAS LKA Datagen Proc-v01.xlsx under the Toyota Non-LKA 2018-2020 tab. The text file name generated from this DataGen is ADAS Non-LKA Toyota.txt.

6. The filter generated from this was called **ADAS Non-LKA Toyota 2018-2020**. Of the 1829 in the original list, all 1829 survived the filter generation.

CARE 10.2.1	.3 - [Crosstab Results	; - 2018-2020 Alabaı	ma Integrated Drive	er-Vehicle Data - Filt	ter = ADAS Non-LKA	Toyota 2018-2 —	
🚦 <u>F</u> ile <u>D</u> as	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			_ 8 ×
2018-202	0 Alabama Integrated [Driver-Vehicle Data	\sim	ADAS Non-LKA Toy	ota 2018-2020	~ 💡	1/ 1/2018
Suppress Zero	Values: Rows and Col	umns 🗸 Select	Cells: 🔳 🔻 %	8		Column: Model Year ; I	Row: Make 🙀
	2018	2019	2020	TOTAL			
Toyota	1071	632	126	1829			
TOTAL	1071	632	126	1829			

7. The LKA subset can now be compared with the Non-LKA subset. The ADAS Non-LKA Toyota 2018-2020 filter is made current, and it is compared against the subset generated by the ADAS LKA Toyota 2018-2020 filter.

Creating Additional Non-LKA Models

8. Addition of Mazda Non-LKA models. DataGen got 572 cases for all Mazdas, but only 51 were the right models.

CARE 10.2.1.3	3 - [Crosstab Results	- 2018-2020 Alabar	ma Integrated Drive	er-Vehicle Data - Filt	ter = Mazda All 2018-2020]	_		×
🚦 <u>F</u> ile <u>D</u> ash	board <u>F</u> ilters <u>i</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			-	₽×
2018-2020	Alabama Integrated D	river-Vehicle Data	\sim	Mazda All 2018-202	0	~ 9	1/	1/2018
Suppress Zero V	alues: Rows and Col	umns 🗸 Select	Cells: 🔳 🔻 %	9	Colur	nn: Model Year ;	Row: Make	- 🕢
	2018	2019	2020	TOTAL				
Mazda	410	137	25	572				
TOTAL	410	137	25	572				
	_	-			d			

9. Addition of Chevys for non-LKA models. Chevy Non-LKA models: Camaro, Colorado, Corvette, Silverado (all except 1500), Sonic, Spark, Trax. DataGen exported 7051 vehiclecrashes. The filter for all Chevys is Chevy 2018-2020, which may be useful in other analyses.

CARE 10.2.1.3	- [Crosstab Results	- 2018-2020 Alabar	ma Integrated Drive	er-Vehicle Data - Filt	er = Chevy 2018-2020]		_		×
🚦 <u>F</u> ile <u>D</u> asht	board <u>F</u> ilters <u>A</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp				-	₽×
2018-2020	Alabama Integrated D	viver-Vehicle Data	\sim	Chevy 2018-2020		~ 9	1/ 1	1/2018 ∨	9/14/
Suppress Zero Va	Ilues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🔻 %	9		Column: Mo	odel Year ; R	low: Make	2
	2018	2019	2020	TOTAL					
Chevrolet	4357	2107	587	7051					
TOTAL	4357	2107	587	7051					
			-						

10. Sort by model to easily find the applicable Non-LKA models. 2043 were found to be Non-LKA. The text file for these was called **ADAS Non-LKA Chevy.txt**.

11. The filter generated for these was called **ADAS Non-LKA Chevy 2018-2020.** It included all 2043 vehicle-crashes.

2018-2020	Alabama Integrated D	viver-Vehicle Data	\sim	ADAS Non-LKA Che	vy 2018-2020 ~ 🌱 😨 1/ 1/2018 ~ 9/14/
Suppress Zero Va	Ilues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🔻 %	9	Column: Model Year ; Row: Make 🔃
	2018	2019	2020	TOTAL	
Chevrolet	1233	638	172	2043	
TOTAL	1233	638	172	2043	

12. The Mazda, Chevy and Toyota Non-LKA models were concatenated to form a collective filter that was called **ADAS Non-LKA Maz-Chev-Tot.** This produced the following:

CARE 10.2.1	.3 - [Crosstab Result	s - 2018-2020 Alabai	ma Integrated Driv	er-Vehicle Data - Fil	ter = ADAS Non-LKA Maz-Chev-To	y] —		Х
File Das	hboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rossta	b <u>T</u> ools <u>W</u> ind	low <u>H</u> elp			-	₽×
2018-202	0 Alabama Integrated I	Driver-Vehicle Data	~	ADAS Non-LKA Mag	z-Chev-Toy	~ 💡 🔞	1/ 1/20	18 ~
Suppress Zero	Values: Rows and Co	lumns 🗸 Select	Cells: 🔳 🛛 📆	9	Colun	nn: Model Year ;	Row: Make	• 🕢
	2018	2019	2020	TOTAL				
Chevrolet	1233	638	172	2043				
Mazda	27	22	1	50				
Toyota	1001	606	117	1724				
TOTAL	2261	1266	290	3817				
		-	-					

This Non-LKA filter was run against the ADAS LKA Toyota 2018-2020 filter to generate the IMPACT results given below.

IMPACT Results for LKA

D015 Primary Contributing Circumstances

6	2018-2020 Alabama Integrated Driver-Vehicle Data	\sim	1	ADAS Noi	n-LKA Ma	z-Chev-To	оу		✓
Order:	Max Gain V Descending V	Suppre	ss Zero-\	/alued Ro	ws	Signific	ance: C)ver	Representation V Threshold: 2.0
D015:	Primary Contributing Circumstance	Subset	Subset	Other quency	Other ^p ercent	Odds Ratio	Max Gain	^	D015: Primary Contributing Circumstance
	E Aggressive Operation	59	1.61	56	1.19	1.355	15.458		
	E Swerved to Avoid Vehicle	77	2.10	82	1.74	1.208	13.242		
	Defective Equipment	43	1.17	42	0.89	1.317	10.343		
	E Failed to Yield Right-of-Way at Uncontrolled Interse	29	0.79	24	0.51	1.554	10.339		
	Driving too Fast for Conditions	96	2.62	111	2.35	1.112	9.693		
	E Other Distraction Outside the Vehicle	94	2.56	110	2.33	1.099	8.470		
	Traveling Wrong Way/Wrong Side	21	0.57	20	0.42	1.350	5.449		
	E Crossed Centerline	59	1.61	69	1.46	1.100	5.350		
	E Ran Stop Sign	36	0.98	43	0.91	1.077	2.566		
	Over Speed Limit	22	0.60	25	0.53	1.132	2.561		
	E Failed to Yield Right-of-Way from Yield Sign	23	0.63	27	0.57	1.096	2.006		
	E Other Improper Action	68	1.85	86	1.82	1.017	1.131		
	E Failed to Yield Right-of-Way from Traffic Signal	67	1.83	85	1.80	1.014	0.909		
	Cargo Fell or Load Shift	21	0.57	26	0.55	1.039	0.784		
	Other	116	3.16	150	3.18	0.995	-0.631		
	Improper Passing	28	0.76	37	0.78	0.973	-0.769		
	E Failed to Yield Right-of-Way from Stop Sign	188	5.12	243	5.15	0.995	-0.943		
	E Over Correcting/Over Steering	20	0.54	27	0.57	0.953	-0.994		
	Followed too Close	648	17.66	835	17.69	0.998	-1.248		
	E Ran off Road	27	0.74	37	0.78	0.939	-1.769		
	Not Applicable	20	0.54	28	0.59	0.919	-1.771		
	E Failed to Yield Right-of-Way from Driveway	75	2.04	101	2.14	0.955	-3.532		
	E Other Failed to Yield	40	1.09	57	1.21	0.903	-4.320		
	E Other Distraction Inside the Vehicle	80	2.18	110	2.33	0.935	-5.530		
	Improper Backing	120	3.27	163	3.45	0.947	-6.739		
•	Improper Lane Change/Use	269	7.33	355	7.52	0.975	-7.028		
	Made Improper Turn	64	1.74	95	2.01	0.866	-9.867		
	E Failed to Yield Right-of-Way Making Left or U-Turn	159	4.33	221	4.68	0.925	-12.837		
	E Ran Traffic Signal	118	3.22	171	3.62	0.887	-14.960		
	Misjudge Stopping Distance	382	10.41	523	11.08	0.939	-24.655		
	Unseen Object/Person/Vehicle	236	6.43	350	7.42	0.867	-36.140		
	Unknown	142	3.87	230	4.87	0.794	-36.835	¥	Sort by Sum of Max Gain

All PCCs with less than 20 occurrences were removed from the display. The following show a potential positive result of LKA (Max Gain to the nearest number of vehicle-crashes reduced): Swerved to Avoid Vehicle (13), Traveling Wrong Way/Wrong Side (5), and Crossed Centerline (5). On a negative note, the Improper Lane Change/Use showed a higher proportion of this crash type for the LKA than for the non-LKA, although the small difference would argue that they were effectively the same.

D202 Contributing	Circumstances
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🚦 CA	ARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alaban	na Integrat	ed Driver	-Vehicle I	Data - AD	AS Non-	LKA Maz-0	Chev-Toy vs. ADAS La — 🛛 🗙
E E	ile <u>D</u> ashboard <u>F</u> ilters <u>A</u> nalysis <u>I</u> mpact	Tools	<u>W</u> indov	v <u>H</u> elp	•			_ & ×
6	2018-2020 Alabama Integrated Driver-Vehicle Data	~		ADAS No	n-LKA Ma	z-Chev-To	oy	✓ ♥ 〒 1/ 1/2018 ∨
Order	r: Max Gain V Descending V	🗹 Supp	ress Zero	-Valued R	ows	Signific	ance: Ove	er Representation V Threshold: 2.0
D202	Contributing Circumstance	Subset	Subset	Other quency	Other Percent	Odds Ratio	Max / Gain	D124: Driver Type Alcohol Test Given A D125: E Driver Type Drug Test Given
	Followed too Close	190	4.98	153	3.11	1.598*	71.131	D126: Driver Alcohol Test Results
	Misjudge Stopping Distance	117	3.07	114	2.32	1.321	28.431	D127: E Driver Drug Test Results
	DUI	35	0.92	17	0.35	2.650	21.792	D128: Initial Travel Direction D129: Vehicle Maneuvers
	Driving too Fast for Conditions	46	1.21	36	0.73	1.645	18.031	D129. Vehicle Most Harmful Event
	Improper Backing	60	1.57	58	1.18	1.332	14.939	D202: Contributing Circumstance
	E Aggressive Operation	32	0.84	22	0.45	1.872	14.908	D203: First Harmful Event Location
	Other	79	2.07	86	1.75	1.182	12.185	D204: E Sequence of Events #1
	E Other Distraction Inside the Vehicle	33	0.86	27	0.55	1.573	12.023	D205: E Sequence of Events #2 D206: E Sequence of Events #3
•	E Crossed Centerline	27	0.71	23	0.47	1.511	9.131	D200: E Sequence of Events #3
	E Other Distraction Outside the Vehicle	36	0.94	35	0.71	1.324	8.808	D208: Model Year
								V DOOD Male
_	E Swerved to Avoid Vehicle Second Se	53 Filter = AD	1.39 AS Non-Li	57 KA Maz-C	1.16	1.197 /s. ADAS	8.716 Lane Keepi	Sort by Sum of Max Gain
_) (() /) () () () () () () ()	Filter = AD	AS Non-Ll 0202: Corr	KA Maz-C 2020 Pributing C		/s. ADAS		Sort by Sum of Max Gain
	2018-2020 Alabama Integrated Driver-Vehicle Data - ARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabam ile <u>Dashboard</u> <u>Eilters</u> <u>A</u> nalysis <u>I</u> mpact	Filter = AD	AS Non-Ll 0202: Cort	KA Maz-C 2020 Bributing C -Vehicle I v <u>H</u> elp	ihev-Toy v Circumstar Data - AD	/s. ADAS nce AS Non-	Lane Keepi LKA Maz-(r Sort by Sum of Max Gain ☐ Dis Ing Assistance (LKA)\ADAS LKA Toyota 2028- Chev-Toy vs. ADAS La — □ × _ ₽ ×
	Image: Second State Sta	Filter = AD [na Integrat <u>T</u> ools	AS Non-Li D202: Correct ted Driver <u>W</u> indov	KA Maz-C 2020 Pributing C -Vehicle I v <u>H</u> elp ADAS No	ihev-Toy v Circumstar Data - AD	/s. ADAS nce AS Non- z-Chev-Tr	Lane Keepi LKA Maz-(Sort by Sum of Max Gain Sort by Sort b
	2018-2020 Alabama Integrated Driver-Vehicle Data - ARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabam ile <u>Dashboard</u> <u>Eilters</u> <u>A</u> nalysis <u>I</u> mpact	Filter = AD [na Integrat <u>T</u> ools	AS Non-LI)202: Correct	KA Maz-C 2020 Pributing C -Vehicle I v <u>H</u> elp ADAS No	ihev-Toy v Circumstar Data - AD	/s. ADAS nce AS Non-	Lane Keepi LKA Maz-(r Sort by Sum of Max Gain □ Dis Ing Assistance (LKA)\ADAS LKA Toyota 2028- Chev-Toy vs. ADAS La — □ × _ @ ×
CA CA CA Corder	Image: Second State Sta	Filter = AD [na Integrat <u>T</u> ools	AS Non-Li D202: Correct ted Driver <u>W</u> indov	KA Maz-C 2020 Pributing C -Vehicle I v <u>H</u> elp ADAS No	ihev-Toy v Circumstar Data - AD m-LKA Ma ows Other	/s. ADAS nce AS Non- z-Chev-Tr	Lane Keepi LKA Maz-(Sort by Sum of Max Gain Sort by Sum of Max G
CA CA CA Corder		Filter = AD	AS Non-Li)202: Correct wed Driver Windov	KA Maz-C 2020 Pributing C 	ihev-Toy v Circumstar Data - AD m-LKA Ma ows Other	rs. ADAS nce AS Non- z-Chev-Tr Signific Odds	Lane Keepi LKA Maz-(oy ance: Over Max	Chev-Toy vs. ADAS La Chev-Toy vs. ADAS La Chev-Toy vs. ADAS L
CA CA CA Corder	2018-2020 Alabama Integrated Driver-Vehicle Data - ARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabam ile Dashboard Eilters Analysis Impact 2018-2020 Alabama Integrated Driver-Vehicle Data r: Max Gain Contributing Circumstance Valoe	Filter = AD	AS Non-Li)202: Correct ed Driver <u>W</u> indov ress Zero Subset	KA Maz-C 2020 Wibuting C -Vehicle I v Help ADAS No -Valued R Other :quency	ihev-Toy v Circumstar Data - AD on-LKA Ma ows Other Percent	rs. ADAS nce AS Non- z-Chev-Ti Signific Odds Ratio	Lane Keepi LKA Maz-(oy Max Gain	Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Dialog Sort by Sum of Max Gain Sort by Sum of Max Gain Dialog Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by Sum of Max Gain Sort by
CA CA CA Corder		Filter = AD	AS Non-Li)202: Correction ied Driver <u>W</u> indov ress Zero Subset 0.39	KA Maz-C 2020 Wibuting C Vehicle I v Help ADAS No Valued R Other squency 30	ihev-Toy v Circumstar Data - AD on-LKA Ma ows Other Percent 0.61	/s. ADAS nce AS Non- z-Chev-Tr Signific Odds Ratio 0.644	Lane Keepi LKA Maz-C oy :ance: Ov Max Gain -8.308	Chev-Toy vs. ADAS La Chev-Toy vs. ADAS La Chev-Toy vs. ADAS L
CA CA CA Corder	Image: Second State Sta	Filter = AD [na Integrat Tools Subset 15 105	AS Non-Li D202: Correct eed Driver <u>W</u> indov ress Zero Subset 0.39 2.75	KA Maz-C 2020 Vehicle I Vehicle I ADAS No Valued R Other squency 30 147	ihev-Toy v Circumstar Data - AD on-LKA Ma ows Other Percent 0.61 2.99	/s. ADAS nce AS Non- z-Chev-Tr Signific Odds Ratio 0.644 0.919	Lane Keepi LKA Maz-(oy xance: Ovi Max Gain -8.308 -9.207	Chev-Toy vs. ADAS La Chev-Toy vs. ADAS La Chev-Toy vs. ADAS L

This attribute has one positive result. At the top, there is a reduction of over 50% in the proportion of Crossed Centerline crashes, indicating a savings of over 9 crashes. However, at the bottom of this attribute is an Improper Lane Change/Use result that shows a larger proportion in the LKA subset than in the non-LKA subset.

🗸 Dis

D023 Manner of Crash



LKA may have caused potential proportionate reductions in Sideswipe – Opposite Direction (26) and Sideswipe – Same Direction (10).

D204 Sequence of Events #1

<u>File</u>	ashboard <u>F</u> ilters <u>A</u> nalysis <u>I</u>	mpact <u>T</u> o	ols <u>W</u> ine	dow <u>H</u> el	р			- 8
2018-2	020 Alabama Integrated Driver-Vehicle	Data	\sim	ADAS N	lon-LKA Ma	z-Chev-Toy		✓ ♥ 1/ 1/2018
Order: Max G	aain ~ Descending		Suppress Z	ero-Valued I	Rows	Significan	ce: Over Repre	esentation V Threshold: 2.0
)204: E Seq	uence of Events #1	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max – ^ Gain	D123: Driver Officer Opinion Drugs D124: Driver Type Alcohol Test Giver
Evasi	ve Action (Swerve/Brake)	152	3.98	125	2.54	1.565*	54.885	D125: E Driver Type Drug Test Giver
Ran C)ff Road Right	104	2.72	92	1.87	1.455*	32.524	D126: Driver Alcohol Test Results
Collisio	on with Animal: Deer	62	1.62	56	1.14	1.425	18.493	D127: E Driver Drug Test Results D128: Initial Travel Direction
Ran C)ff Road Left	59	1.55	61	1.24	1.245	11.608	D129: Vehicle Maneuvers
Crosse	ed Centerline	42	1.10	46	0.94	1.175	6.262	D201: Vehicle Most Harmful Event
Cargo	/Equipment Loss or Shift	9	0.24	4	0.08	2.896	5.892	D202: Contributing Circumstance
Vehicl	e Defect/Component Failure	5	0.13	2	0.04	3.218	3.446	D203: First Harmful Event Location D204: E Sequence of Events #1
Collisio	on with non-Motorist: Pedalcycle	5	0.13	3	0.06	2.145	2.669	D205: E Sequence of Events #1
Other	Non-Collision	11	0.29	11	0.22	1.287	2.454	D206: E Sequence of Events #3
Collisio	on with Guardrail Face	4	0.10	2	0.04	2.574	2.446	D207: E Sequence of Events #4
Overtu	um/Rollover	2	0.05	0	0.00	0.000	2.000	D208: Model Year
Collisio	on with Bridge Abutment/Rail	2	0.05	0	0.00	0.000	2.000	D209: Make D210: Body (Passenger Cars Only)
Collisio	on with Fence	2	0.05	0	0.00	0.000	2.000	D211: E Owners State
Collisio	on with Animal: Other	6	0.16	6	0.12	1.287	1.338	D212: License Tag State
Collisio	on with Culvert Headwall	2	0.05	1	0.02	2.574	1.223 🗸	Sort by Sum of Max Gain
1 🕼 🔤	\$,
2018-20	20 Alabama Integrated Driver-Vehicle	Data - Filter		n-LKA Maz-(2020 E Sequence			ne Keeping Assi	istance (LKA)\ADAS LKA Toyota 2028-
Frequency	50							
	0 Collision with	Guardrail Face	c	ollision with	and the	Collision wi	ith Other	Collision with Sign Post

The proportion of the following crash types (Max Gain) could have been the result of LKA: Evasive Action -- Swerve/Brake (55), Ran Off the Road Right (33), Ran Off the Road Left (12), Colliion with Guardrail/Fence (2).

D025 Crash Severity

CA	RE 10.2.1	.3 - [IMP/	ACT Result	ts - 2018-2020 /	Alabama Integ	rated Driver-\	/ehicle Data - A	DAS Non-LKA	Maz-Chev-To	oy vs. ADAS La	_		×
E E	ile <u>D</u> as	hboard	<u>F</u> ilters	<u>A</u> nalysis <u>I</u> r	npact <u>T</u> ools	<u>W</u> indow	<u>H</u> elp					-	₽ ×
6 °	2018-202	0 Alabama	a Integrated	l Driver-Vehicle (Data '	~ A	DAS Non-LKA N	Maz-Chev-Toy		~ 9	12	1/ 1/201	8 ~
Order	Natural C	Order	∼ De	scending	🗸 🖂 Su	ppress Zero-V	alued Rows	Significanc	e: Over Repre	esentation ~	Threshol	d: 2.0	÷
D025	Crash S	everity		Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	D020: E Distr D023: E Mann		-	^
•	Fatal Inju	iry		13	0.34	13	0.26	1.287	2.900	D024: School		ed	
	Suspecte	ed Serious	Injury	63	1.65	74	1.51	1.096	5.508	D025: Crash	-		
	Suspecte	ed Minor Ir	njury	249	6.52	283	5.76	1.132	29.132	D035: EMS An D042: Highwa	· · · · ·		
	Possible	Injury		314	8.23	405	8.24	0.998	-0.652	D043: Highwa	*		
	Property	Damage (Only	3115	81.61	4039	82.21	0.993	-22.973	D045: ALDOT	Area		~
	Unknow	n		63	1.65	99	2.02	0.819	-13.915	Sort by Sum	of Max Gain	l -	
00) 🗞 y	3											🗸 Dis
2	2018-2020	Alabama	Integrated	Driver-Vehicle	Data - Filter = /	ADAS Non-LKA	A Maz-Chev-Toy 2020	/ vs. ADAS Lan	e Keeping Assi	istance (LKA)\AD/	AS LKA Toy	ota 2028-	
						D025:	Crash Severity						
		100											
												_	
	>												
	Frequency	50											
	Freq	-										_	
		_										_	
		0											
		- 1		Fatal Injury	Suspected Serious Injury	Suspec Minor In		ble Injury D	Property amage Only	Unknown			
						D0	25: Crash Sever	rity					

All of the most severe crash types were reduced. This shows that LKA could have the effect of warning the driver so that preventive or defensive action could be taken prior to an imminent crash.

End of LKA analysis.

4.0 ADAS Pedestrian AEB (PAEB) and Pedestrian Detection (PD)

The original pedestrian study that used vehicle models is available in version v01 of this document. It was determined that this *Crash-Based* study was more complete and accurate.

Application of the Crash-Based Analysis to PAEB/PD

A Crash-Based study is one where the initial data are obtained from the CARE Crash files as opposed to the CARE Vehicle-Driver files, which is the approach used in all of the other studies in this document.

Pedestrian Automatic Emergency Braking (PAEB) and Pedestrian Detection (PD) were chosen as the first example of a Crash-Based study because it is fairly easy to separate pedestrian crashes from non-pedestrian crashes. We will henceforth call the two pedestrian protection features PAEB/PD. The objective of these types of studies are to determine the change in the probability of a give crash type based on the number of crashes that qualify divided by the total number of crashes in the particular data subset. Consider the data to be in four divisions, as follows:

Numerator	Denominator
Number of Pedestrian crashes in PAEB/PD subset	Total in All-PAEB/PD subset
Number of Pedestrian crashes in Non-PAEB/PD	Total in All-Non-PAEB/PD Subset

Establishing the records (makes and model years) that qualify as PAEB/PD

Makes and Years for which All Models	Were Predominantly PAEB/PD
--------------------------------------	----------------------------

Make	Applicable Years	PAEB Year	PD Year	Е-	Ео	#M	#Crashes
Acura	2020 and 2019	2020	2019	2	0	12	31
BMW	2020 and 2019	2020	2019	0	3	31	63
Cadillac	2020	2020		1	1	7	9
Ford	2020	2020		1	3	14	150
Genesis	2020 and 2019	Not Found	Not Found	0	0	3	
Jaguar	2020 and 2019	2020	2019	0	4	13	7
Land Rover	2020 and 2019	2020	2019	0	2	13	25
Lexus	2020 and 2019	2020	2019	1	0	22	74
Lincoln	2020	2020		0	0	6	1
Mazda	2020	2020		0	0	6	8
Mercedes	2020	2020		3	3	18	21
Mini	2020	Not Found	Not Found	0	0	3	
Tesla	a 2020 and 2019 Not Found Not Found		Not Found	0	0	7	
Volvo	2020 and 2019	2020	2019	0	0	14	123

Applicable Years. Either 2020 or 2019, or both. Entered are the years that were selected that best qualified. In the All Models PAEB/PD table, years that had a significant number of models with a not required (-) or an optional (o) entry were excluded and that year would appear as blank space in the table. For the Non-PAEB/PD Models table, all of the makes were found to be predominantly Non-PAEB/PD.

PAEB and PD Years. In both tables this shows where PAEB and PD were recorded in the Consumer Reports headings for their model tables. In all cases, model year 2020 had an indication for PAEB but none for PD, and model year 2019 had an indication for PD but none for PAEB. This led us to believe that they were probably using these two acronyms interchangeably.

Exception Acronyms. E- (E minus) is the number of exceptions where the model was not PAEB/PD. Eo is the number of exceptions where PAEB/PD was optional. #M is the total number of models listed for each make. All make, model and model year information is from Consumer Reports: <u>Cars With Advanced Safety Systems - Consumer Reports</u>

Blank Space and Not Found. Not found indicates that no crashes could be found for that make. This could be that these makes had no crashes. Or, it is also possible that they did not appear in the list of possible makes in the data entry process. Also, if a given year did not qualify because there were too many Non-PD entries in 2019, then a blank space will appear where 2019 might be expected.

2018-2020	Alabama Integrated C	rash Data	\sim	2019 OR 2020 ModYr PAEB
Suppress Zero Va	Iues: Rows and Colu	umns 🗸 Select	Cells: 🔳 🗸 🔣	S Column: CU Model Year ; Row: CU Make 🚺
	2019	2020	TOTAL	
E Acura	22	9	31	-
BMW	42	21	63	
Cadillac	0	9	9	
Ford	0	150	150	
Jaguar	5	2	7	
E Land Rover	18	7	25	
E Lexus	60	14	74	
Lincoln	0	1	1	
Mazda	0	8	8	
Mercedes-Benz	0	21	21	
Volvo	95	38	133	
TOTAL	242	280	522	

The cross-tabulation above indicates the number of crashes for each make and year for the PAEB/PD vehicles. The following is a summary of these results:

Total number of crashes for the above: 522 Total number of pedestrian crashes of the PAEB/PD vehicles: 0

Establishing the records (makes and model years) that qualify as Non-PAEB/PD

Make	Applicable Years	PAEB Year	PD Year	ES	Eo	#M	# Crashes
Chevy	2020 and 2019	2020	2019	1	12	34	1151
Chrysler	2020 and 2019	2020	2019	0	0	5	64
Dodge	2020 and 2019	2020	2019	0	0	10	692
Fiat	2020 and 2019	2020	2019	0	0	7	2
GMC	2020 and 2019	2020	2019	1	5	16	276
Jeep	2020 and 2019	2020	2019	0	0	11	402
Ram*	2020 and 2019	Not Found	Not Found	0	0	8	

Makes and Years for which All Models Were Predominantly Non-PAEB/PD

*Not found in the crash database, and was assumed to be part of the Dodge crashes reported.

CARE 10.2.1.3	3 - [Crosstab Results	- 2018-2020 Alabar	ma Integrated Cra	sh Data	- Filter = A	DAS PAEB	Analysis\2019-2020	_		×
🚦 <u>F</u> ile <u>D</u> ash	board <u>F</u> ilters <u>/</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>L</u> ocations	<u>T</u> ools	<u>W</u> indow	<u>H</u> elp			-	a ×
2018-2020	Alabama Integrated C	ìrash Data	~	2019-	2020 ModYr	NON-PAEB		~	9	1/ 1
Suppress Zero Va	alues: Rows and Col	umns 🗸 Select	Cells: 🔳 🛛 🔏	9			Column: CU Model Ye	ear ; Row	: CU Mak	e 役
	2019	2020	TOTAL							
Chevrolet	913	238	1151							
Chrysler	51	13	64							
Dodge	621	71	692							
Fiat	2	0	2							
GMC	229	47	276							
Jeep	332	70	402							
TOTAL	2148	2587								
	_									

The cross-tabulation above indicates the number of crashes for each make and year for the PAEB/PD vehicles. The following is a summary of these results:

Total number of crashes for the above: 2587 Total number of pedestrian crashes of the Non-PAEB/PD vehicles: 7

This last result was obtained by looking at the C057 Number of Pedestrians for the crashes defined by the filter for the Non-PAED/PD crashes given above. The following is the frequency display for that result:

F	CARE 1	10.2.1.3 - [Freq	uency Res	sults - 2018-2	020 Alabar	ma Integrated	Crash Data -	Filter = A	DAS PAE	B Analysis\2019-202	–		×
۶	<u>F</u> ile	<u>D</u> ashboard	<u>F</u> ilters	<u>A</u> nalysis	F <u>r</u> equency	y <u>L</u> ocation	s <u>T</u> ools	<u>W</u> indow	<u>H</u> elp			-	. 8 ×
¢?	201	8-2020 Alabama	a Integrated	d Crash Data		\sim	2019-202	0 ModYr N	ION-PAEB		~	9	1/1
Ore	der: Na	tural Order	~ As	cending	~	Suppress Z	Zero-Valued F	requencies	ŝ	_			
CO		mber of Pedes	trians	Frequer	псу	Cum. Frequency	Percentag	e Cum.	Percent	C057: Number of	of Pedesti	rians	
	No	Pedestrians Inv	olved		2580	2580	99.	73	99.73				
	1 P	edestrian Involv	ved		6	2586	0.3	3	99.96				
	2 P	edestrians Invol	lved		1	2587	0.0)4	100.00				
0		¥ 🖉								Display Averag	e 🗌 Di	splay Filte	er Name

According to this estimate, the probability of a Non-PAEB/PD vehicle being involved in a pedestrian strike is 7/2587 or 0.00271, which is about one in every 370 crashes.

In the absence of PAEB/PD, the PAEB/PD subset would expect to have 522/370 = 1.41 pedestrian crashes in the 522 crashes that were experienced. Zero crash frequency is a significant reduction from this estimate.

The probability that any given Non-PAEB/PD crash will *not* involve a pedestrian is 1.0 - 0.00271 = 0.9973. Thus, the probability that all 522 are not pedestrian strikes is $0.9973 \land 522 = 0.243$. This is the probability that all of the 522 crashes were non-pedestrian crashes given that PAEB/PD had no effect. If we assumed that PAEB/PD had no effect, the probability that one or more of the crashes in the Non-PAEB/PD subset would involve a pedestrian is 1.0 - 0.243 or about 76%. This represents the confidence that PAEB/PD had the effect of eliminating all of the pedestrian crashes in the PAED/PD subset.

End of PAEB/PD analysis.

5.0 ADAS Rear Cross Traffic Warning (RCTW)

Application of Methodology to RCTW

Nissan subset used in to create models with RCTW:

1. Start with all Nissan 2018-2020

CARE 10).2.1.3 - [Cro	sstab Result	s - 2018-202	20 Alabam	na Integrate	d Driver-V	ehicle Data - Fil	lter = Nissan All	_		\times
🔋 <u>F</u> ile	<u>D</u> ashboard	<u>F</u> ilters	<u>A</u> nalysis	<u>C</u> rosstab	<u>T</u> ools	<u>W</u> indow	<u>H</u> elp			-	₽×
2018-	-2020 Alabam	a Integrated I	Driver-Vehicl	e Data	~	Nis	san All 2018-202	20			
Suppress Z	ero Values:	Rows and Co	lumns 🗸	Select C	Cells: 🔳 🕶	36 9		Column: Mod	el Year ; F	Row: Make	
		2018	201	9	2020		TOTAL				
Nissan		3806	212	24	443		6373				
TOTAL		3806	212	24	443		6373				

This same basic subset will be used to generate both the Nissan RCTW and the Nissan Non-RCTW subsets since the differences between them will be the models. Note a total of 6373 Nissan vehicle-crashes are in the 2018-2020 Dri-Veh file. The model years of 2018-2020 will be for the specific RCTW and Non-RCTW subset generations.

2. The contents of the subset from 1 is obtained from a DataGen using the filter above. Essential variables that must be included in this DataGen are:

- 208 Model Year,
- 209 Make,
- NCV003 Care DV Case Number NCV, and
- NCV005 Vehicle Model NCV.

The contents generated by the DataGen are under the **Nissan ALL 2018-21** tab of the **ADAS RCTW Datagen Proc-v01.xlsx** Excel file. The DataGen for the filter above produced 6,373 records. These will be used to produce the Nissan RCTW and the Nissan NonRCTW filters. *[Note: these filters were mis-named RCTS.]*

3. Creating RCTW filter for 2018-2020 Nissans. To qualify for RCTW: 2020: Kick, Leaf, Maxima, Rogue, Rogue Sport, Sentra, Titan, Titan XD; 2019: Rogue, Rogue Sport; 2018: Rogue. Number found with RCTW feature = 2881. The text file name generated from this reduced DataGen is ADAS RCTW Nissan.txt. The filter generated by this text file was called ADAS RCTS Nissan 2018-2020. It produced the following:

CARE 10.2.1.	3 - [Crosstab Results	- 2018-2020 Alabar	ma Integrated Drive	er-Vehicle Data - Fil	ilter = ADAS RCTS Ni	issan 2	- 🗆	×
🚦 <u>F</u> ile <u>D</u> asi	nboard <u>F</u> ilters	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp			-	. 8 ×
2018-202) Alabama Integrated D	viver-Vehicle Data	\sim	ADAS RCTS Nissar	n 2018-2020		~ 9	12
Suppress Zero \	alues: Rows and Col	umns 🗸 Select	Cells: 🔳 🔻 🔣	9	Colu	mn: Model Yea	ar ; Row: Mał	(e 🕢
	2018	2019	2020	TOTAL				
Nissan	1701	1031	148	2880				
TOTAL	1701	1031	148	2880				
	_							

All vehicle-crashes specified here were 2018-20 Nissans.

4. Creating Non-RCTW filter for 2018-2020 Nissans. To qualify for Non-RCTW: 2020: <u>NV</u>, <u>NV200</u>; 2019: *Frontier*, <u>NV</u>, <u>NV200</u>, *Versa*, *VersaNote*; 2018: *Frontier*, <u>NV</u>, <u>NV200</u>, *Versa*, *VersaNote*. Underlined is all three; italicized are 2019 and 2018.

Number found with Non-RCTW feature = 1055. The text file name generated from this reduced DataGen is ADAS Non-RCTW Nissan.txt. The filter generated by this text file was called ADAS Non-RCTS Nissan 2018-2020. It produced the following:

CARE 10.2.1.	3 - [Crosstab Results	; - 2018-2020 Alabar	ma Integrated Drive	er-Vehicle Data - Fi	ilter = ADAS Non-RCTS Nis	– 🗆 ×
🚦 <u>F</u> ile <u>D</u> asi	nboard <u>F</u> ilters <u>/</u>	<u>A</u> nalysis <u>C</u> rosstal	b <u>T</u> ools <u>W</u> ind	ow <u>H</u> elp		_ 8 ×
2018-202) Alabama Integrated D)river-Vehicle Data	\sim	ADAS Non-RCTS	Nissan 2018-2020	~ 💡
Suppress Zero \	/alues: Rows and Col	umns 🗸 Select	Cells: 🔳 🔻 %	9	Column: Model	Year ; Row: Make [没
	2018	2019	2020	TOTAL		
Nissan	651	389	15	1055		
TOTAL	651	389	15	1055		
		-	-	-		

5. The RCTW subset can now be compared with the Non-RCTW subset. The ADAS Non-RCTW Nissan 2018-2020 filter is made current, and it is compared against the subset generated by the ADAS RCTW Nissan 2018-2020 filter. The following IMPACT comparisons were obtained.

IMPACT Evaluations RCTW

D015 Primary Contributing Circumstances

CA	RE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabama	a Integrat	ted Drive	r-Vehicle	Data - A	DAS No	n-RCTS Nis	san 2018-202 — 🗆 🗙
🖡 <u>E</u> i	le <u>D</u> ashboard <u>F</u> ilters <u>A</u> nalysis <u>I</u> mpact	<u>T</u> ools	<u>W</u> indo	w <u>H</u> el	р			_ & ×
6 2	2018-2020 Alabama Integrated Driver-Vehicle Data	~		ADAS N	on-RCTS	Nissan 2	018-2020	✓
Order:	Max Gain V Descending V	Supp	ress Zero	-Valued f	RSignific	ance: C	ver Represe	entation V Threshold: 2.0
D015:	Primary Contributing Circumstance	Subset	Subset	Other quency	Other Percent	Odds Ratio	Max ^ Gain	D007: Week of the Year of Crast A D008: Time of Day of Crash
	Followed too Close	182	17.25	447	15.52	1.111	18.255	D009: Data Source
	Misjudge Stopping Distance	120	11.37	283	9.83	1.158	16.332	D011: Highway Classifications D015: Primary Contributing Circ
•	Improper Backing	39	3.70	78	2.71	1.365	10.427	D015: First Harmful Event
	DUI	21	1.99	38	1.32	1.509	7.080	D019: E Most Harmful Event
	E Failed to Yield Right-of-Way from Traffic Signal	26	2.46	52	1.81	1.365	6.951	D020: E Distracted Driving
	Defective Equipment	15	1.42	25	0.87	1.638	5.842	D023: E Manner of Crash
	E Ran off Road	16	1.52	31	1.08	1.409	4.644	D024: School Bus Related
	Improper Parking/Stopped in Road	9	0.85	12	0.42	2.047	4.604	D025: Crash Severity D035: EMS Arrival Delay
	E Aggressive Operation	18	1.71	37	1.28	1.328	4.446	D042: Highway Patrol Troops
	Driving too Fast for Conditions	21	1.99	46	1.60	1.246	4.149	D043: Highway Patrol Posts
	E Other Improper Action	22	2.09	51	1.77	1.178	3.318	D045: ALDOT Area
	E Improper Crossing	3	0.28	1	0.03	8.190	2.634	D046: ALDOT Region
	E Ran Stop Sign	15	1.42	35	1.22	1.170	2.179	D047: ADECAAHSO Region D048: Regional Planning Organ
	E Failed to Yield Right-of-Way from Parked Position	3	0.28	5	0.17	1.638	1.168	D053: Number of Persons in thi
	E Distracted by Fallen Object	3	0.28	5	0.17	1.638	1.168 🗸	Sort by Sum of Max Gain
Frequency	20			S Non-RC			2020 vs. AD/	AS RCTS Nissan 2018-2020
	0 E Disregarded Traf Sign other than Stop	Sign		E Not Appli Unit is R V Contribu	ailroad Trair	n		Vision Obstructed
		DUI	s. Enimar	y Contribu	ung circi	umstance	,	

Items with a Max Gain less that 1.0 are not shown. In reviewing these results recognize that the vehicles involved were in a crash, but most of the crashes had nothing to do with RCTW in any way. The results for Improper Backing would be the exception, and they showed a 36.5% reduction proportion of these crash types for this RCTW. The estimate reduction in crashes for these vehicle-crashes is over 10 crashes as measured by the Max Gain. See also D204 below.

GARE 10.2.1.3 - [IMPACT Results - 2018-2020 Alabama Integrated Driver-Vehicle Data - ADAS Non-RCTS Nissan 2018-202... \times E File Dashboard Filters Analysis Impact Tools Window <u>H</u>elp 8 X 2018-2020 Alabama Integrated Driver-Vehicle Data ADAS Non-RCTS Nissan 2018-2020 1/Max Gain Descending Suppress Zero-Valued R Significance: Over Representation 2.0 ÷ Order: Threshold: D204: E Sequence of Events #1 D128: Initial Travel Direction Subset Subset Other Other Odds Max \land Percent quency Percent Ratio Gain D129: Vehicle Maneuvers Collision with Vehicle in (or from) Other Roadway D201: Vehicle Most Harmful Eve 46 4.36 66 2.29 1.903* 21.823 D202: Contributing Circumstanc Ran Off Road Right 35 3.32 67 2.33 1.426 10.457 D203: First Harmful Event Locat Collision with Vehicle in Traffic 809 76.68 2194 76.18 1.007 5.295 D204: E Sequence of Events #1 Crossed Centerline 14 1.33 24 0.83 1.592 5.208 D205: E Sequence of Events #2 Ran Off Road Straight 6 0.57 7 0.24 2.340 3.436 D206: E Sequence of Events #3 D207: E Sequence of Events #4 Collision with Other Non-Fixed Object 13 1.23 29 1.01 1.224 2.377 D208: Model Year Overtum/Rollover 2 0.19 0 0.000 0.00 2.000 D209: Make Non-Contact Vehicle 6 0.57 12 0.42 1.365 1.604 D210: Body (Passenger Cars O Thrown or Falling Object 2 0.19 2 0.07 2.730 1.267 D211: E Owners State Separation of Units 1 0.09 0 0.00 0.000 1 000 D212: License Tag State D213: Vehicle Usage Jackknife 1 0.09 0 0.00 0.000 1.000 D214: E Emergency Status Collision with Bridge Support/Column 1 0.09 0 0.00 0.000 1.000 D215: E Placard Required Collision with Other Traffic Barrier 1 0.09 0 0.00 0.000 1 0 0 0 D216: E Placard Status Collision with Other Post/Pole/Support 1 0.09 0 0.00 0.000 1.000 D217: Hazardous Cargo D218: E Hazardous Released Collision with Guardrail End 1 0.09 0.03 0.634 1 2.730 D219: Attachment Vehicle Defect/Component Failure 2 4 0.535 0.19 0.14 1.365 D220: Oversized Load Requiring Collision with Non-Motorist: Pedestrian 3 0.28 7 0.24 1 1 7 0 0.436 Sort by Sum of Max Gain 📋 🕼 🚳 🖉 2018-2020 Alabama Integrated Driver-Vehicle Data - Filter = ADAS Non-RCTS Nissan 2018-2020 vs. ADAS RCTS Nissan 2018-2020 D204: E Sequence of Events #1 100 Frequency 50 Downhill Runaway Collision with Fence D204: E Sequence of Events #1

D204 Sequence of Events #1

Collision with Vehicle from Other Roadway is not a category that usually rises to the top, but it well could be that this would be the source of vehicles in cross traffic that would be prevented by RCTW. The reduction in the proportions is statistically significant with a Max Gain of about 22.

D017 First Harmful Event

[(CARE 10.2	.1.3 - [IM	PACT Resu	ults - 2018-2	020 Alabar	ma Integrat	ed Driver-	/ehicle Data	- ADAS N	on-RCTS N	issan 2018-2	2020 AND Not Fir	st —		×
B	<u>F</u> ile <u>D</u> a	ashboard	<u>F</u> ilters	<u>A</u> nalysis	<u>I</u> mpact	<u>T</u> ools	<u>W</u> indow	<u>H</u> elp						-	ð×
😵 2018-2020 Alabama Integrated Driver-Vehicle Data 🗸 ADAS Non-RCTS Nissan 2018-2020 🗸 🖓 1/ 1/2018 🗸 9/14/2															
Orde	er: Max Ga	ain	~ [Descending	~	Suppr	ess Zero-V	alued Rows		Significa	nce: Over	Representation	✓ Thresho	ld: 2.0	÷
D01	7: First H	larmful E	vent			Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds	Max Gain	D017: First Ha	armful Event		
•	E Collis	ion with V	/ehicle in (o	r from) Other	Roadway	38	3.78	57	2.12	1.786*	16.723				
	E Collis	ion with C	ther Non-F	ixed Object		14	1.39	24	0.89	1.563	5.041				
	E Ran Off Road Right				16	1.59	31	1.15	1.383	4.428					
	Collision with Parked Motor Vehicle				62	6.16	158	5.86	1.051	3.021					
	E Ran Off Road Left				11	1.09	24	0.89	1.228	2.041					
	Collision with Vehicle in Traffic				830	82.50	2223	82.49	1.000	0.190					
	Collision with Tree				7	0.70	22	0.82	0.852	-1.212					
	E Crossed Centerline				6	0.60	20	0.74	0.804	-1.466					
	Collision with Ditch				9	0.89	35	1.30	0.689	-4.065					
	E Evasive Action (Swerve/Brake)				5	0.50	28	1.04	0.478	-5.452					
	E Collision with Animal: Deer					8	0.80	73	2.71	0.294	-19.250	Sort by Sum o	of Max Gain		
)	<i>s</i>												Dis	splay Fi
						2018-2	020 Alaban	na Integrated	d Driver-Vel	hicle Data					
							D017	: First Harm	ful Event						
	1	100	_												
		-						-							
	~	_													
	Frequency	50	_					_							
	requ	50													
	<u>.</u>	-	-												
		0													
		0		E Collision Other Non-Fix	n with red Object	Collisio Parked Mot	n with or Vehicle	Collisio Vehicle i	on with n Traffic	ECrossed	d Centerline	E Evasive Actio (Swerve/Brake			
	D017: First Harmful Event														

Items with less than 5 subset frequency values were removed from the display. It is notable that the item with the highest Max Gain is relevant to RCTW in that this is exactly the type of crash that RCTW was designed to prevent, i.e., where a vehicle is backing into a cross-street and fails to detect or properly allow for an oncoming vehicle.

D023 Manner of Crash

🔋 CA	RE 10.2.1.3 - [IMPACT Results - 2018-	2020 Alaban	na Integrat	ed Driver-Ve	hicle Data ·	ADAS Non	-RCTS Nissa	an 2018-202 — 🗆 🗙		
🔋 Ei	le <u>D</u> ashboard <u>Filters A</u> nalysis	s <u>I</u> mpact	<u>T</u> ools	<u>W</u> indow	<u>H</u> elp			_ & ×		
2018-2020 Alabama Integrated Driver-Vehicle Data 🗸 ADAS Non-RCTS Nissan 2018-2020 🗸 🌱 😨 1/ 1/										
Order	Max Gain V Descending	~	Suppress Zero-Valued R Significance: Over Representation V Threshold: 2.							
D023:	E Manner of Crash	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain 👻	D009: Data Source D011: Highway Classifications		
•	Rear End (front to rear)	447	42.37	1087	37.74	1.123*	48.811	D015: Primary Contributing Circ		
	Causal Veh Backing: Rearto Side	40	3.79	64	2.22	1.706*	16.556	D017: First Harmful Event		
	Angle (front to side) Opposite Direction	40	3.79	100	3.47	1.092	3.368	D019: E Most Harmful Event D020: E Distracted Driving		
	Other	28	2.65	73	2.53	1.047	1.259	D023: E Manner of Crash		
	Non-Collision	8	0.76	19	0.66	1.149	1.040	D024: School Bus Related		
	Head-On (front to front only)	20	1.90	53	1.84	1.030	0.585	D025: Crash Severity		
	Sideswipe - Same Direction	113	10.71	307	10.66	1.005	0.540	D035: EMS Arrival Delay		
	Record from Paper System	0	0.00	0	0.00	0.000	0.000	D042: Highway Patrol Troops D043: Highway Patrol Posts		
	Unknown	7	0.66	20	0.69	0.955	-0.326	D045: ALDOT Area		
	Causal Veh Backing: Rearto Rear	7	0.66	23	0.80	0.831	-1.425	D046: ALDOT Region		
	Sideswipe - Opposite Direction	14	1.33	43	1.49	0.889	-1.752	D047: ADECAAHSO Region		
	Angle Oncoming (frontal)	30	2.84	92	3.19	0.890	-3.701	D048: Regional Planning Organ D053: Number of Persons in thi		
	Angle (front to side) Same Direction	23	2.18	86	2.99	0.730	-8.503	D053: Number Injured (Non-Fat		
	Side Impact (90 degrees)	99	9.38	297	10.31	0.910	-9.797	D059: Number Injured (Includes		
	Side Impact (angled)	86	8.15	296	10.28	0.793	-22.431	D060: Number Killed in this Veh		
	Single Vehicle Crash (all types)	93	8.82	320	11.11	0.793	-24.222	Sort by Sum of Max Gain		
00			D	ADACH	BOTO N	2010.2		2 DOTO N' 2010 2020		
2018-2020 Alabama Integrated Driver-Vehicle Data - Filter = ADAS Non-RCTS Nissan 2018-2020 vs. ADAS RCTS Nissan 2018-2020 D023: E Manner of Crash										
	60									
	- 1	Non-Collision Causal Veh Backing: Rear to Rear Side Impact (angled)								
D023: E Manner of Crash										

The top two Max Gain items are both statistically significant, and they would seem to be relevant to RCTW. The first (Rear End, front to rear) has a 12.3% reduction in the crash proportion, while the second (Causal vehicle Backing: Rear to Side) has a 70.6% reduction.

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🔋 Ei	le <u>D</u> ashboard <u>F</u> ilter	s <u>A</u> nalysis	<u>I</u> mpact <u>T</u>	ools <u>W</u> ind					-	8 ×				
3 2018-2020 Alabama Integrated Driver-Vehicle Data V ADAS Non-RCTS Nissan 2018-2020 V 🖓 😨 1/ 1/														
Order:	Order: Natural Order Verkepresentation Verkepres													
D025:	Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain	D017: First Harm D019: E Most Ha		^				
•	Fatal Injury	3	0.28	3	0.10	2.730	1.901	D020: E Distract	-					
	Suspected Serious Injury	23	2.18	44	1.53	1.427	6.882	D023: E Manner of Crash D024: School Bus Relate						
	Suspected Minor Injury	78	7.39	237	8.23	0.898	-8.818	D024: School Bu D025: Crash Sev						
	Possible Injury	124	11.75	242	8.40	1.399*	35.351	D035: EMS Arriva						
	Property Damage Only	809	76.68	2283	79.27	0.967	-27.307	D042: Highway F	Patrol Troops	~				
	Unknown	18	1.71	71	2.47	0.692	-8.009	Sort by Sum of Max Gain						
Image:														
100														
	Source 1													
	0	Fatal Injury	Suspected Serious Injury	Suspect Minor Inj	ury		I Property amage Only	Unknown						
				D02	5: Crash Sever	rity								

D025 Crash Severity (in worst first order)

There are severity gains in all categories except Suspected Minor Injury. The gain in Possible Injury is statistically significant.

End of RCTW analysis.