Vehicle Defect IMPACT Analysis

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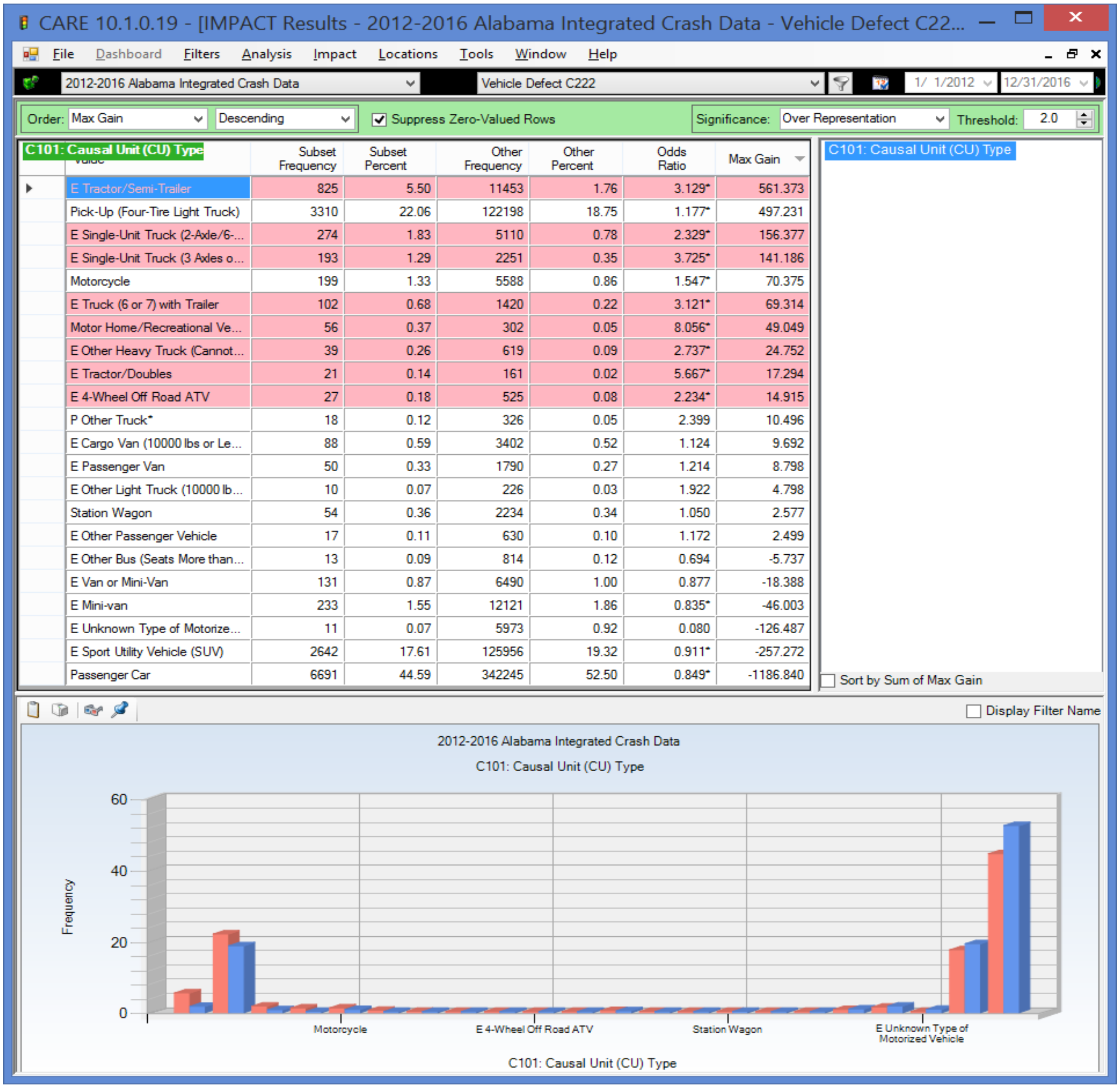
1.0 Introduction: C101 Causal Unit Type

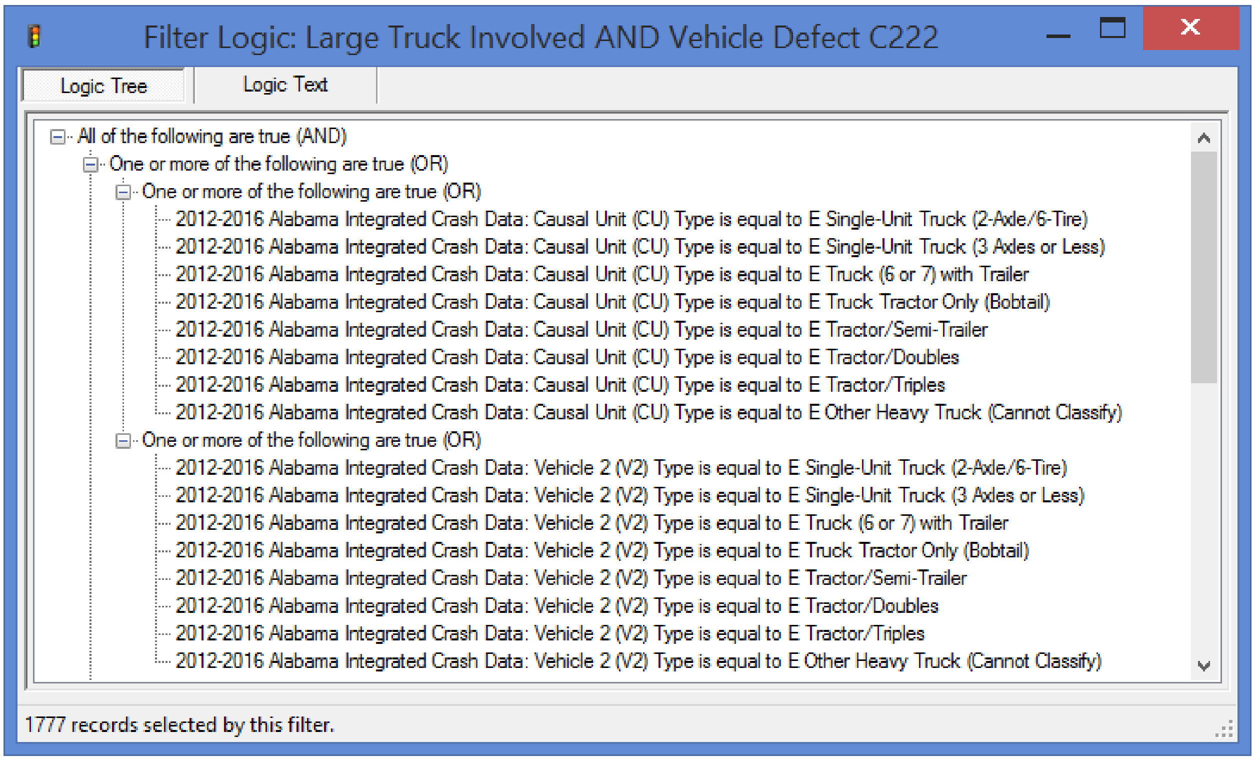
The high level analysis of vehicles in general for vehicle defects showed a high correlation of the defect type and the vehicle type, which is expected since certain defects apply only to trucks. The Causal Unit analysis given immediately below establishes that: (1) the most over-represented vehicles are heavy trucks (as we might expect), but (2) the highest frequency is in the Passenger Cars and SUVs, which are the most UNDER-represented.



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tractor/Semi-Trailer	825	5.50	11453	1.76	3.129*	561.373
Pick-Up (Four-Tire Light Truck)	3310	22.06	122198	18.75	1.177*	497.231
E Single-Unit Truck (2-Axle/6-...	274	1.83	5110	0.78	2.329*	156.377
E Single-Unit Truck (3 Axles o...	193	1.29	2251	0.35	3.725*	141.186
Motorcycle	199	1.33	5588	0.86	1.547*	70.375
E Truck (6 or 7) with Trailer	102	0.68	1420	0.22	3.121*	69.314
Motor Home/Recreational Ve...	56	0.37	302	0.05	8.056*	49.049
E Other Heavy Truck (Cannot...	39	0.26	619	0.09	2.737*	24.752
E Tractor/Doubles	21	0.14	161	0.02	5.667*	17.294
E 4-Wheel Off Road ATV	27	0.18	525	0.08	2.234*	14.915
P Other Truck*	18	0.12	326	0.05	2.399	10.496
E Cargo Van (10000 lbs or Le...	88	0.59	3402	0.52	1.124	9.692
E Passenger Van	50	0.33	1790	0.27	1.214	8.798
E Other Light Truck (10000 lb...	10	0.07	226	0.03	1.922	4.798
Station Wagon	54	0.36	2234	0.34	1.050	2.577
E Other Passenger Vehicle	17	0.11	630	0.10	1.172	2.499
E Other Bus (Seats More than...	13	0.09	814	0.12	0.694	-5.737
E Van or Mini-Van	131	0.87	6490	1.00	0.877	-18.388
E Mini-van	233	1.55	12121	1.86	0.835*	-46.003
E Unknown Type of Motorize...	11	0.07	5973	0.92	0.080	-126.487
E Sport Utility Vehicle (SUV)	2642	17.61	125956	19.32	0.911*	-257.272
Passenger Car	6691	44.59	342245	52.50	0.849*	-1186.840

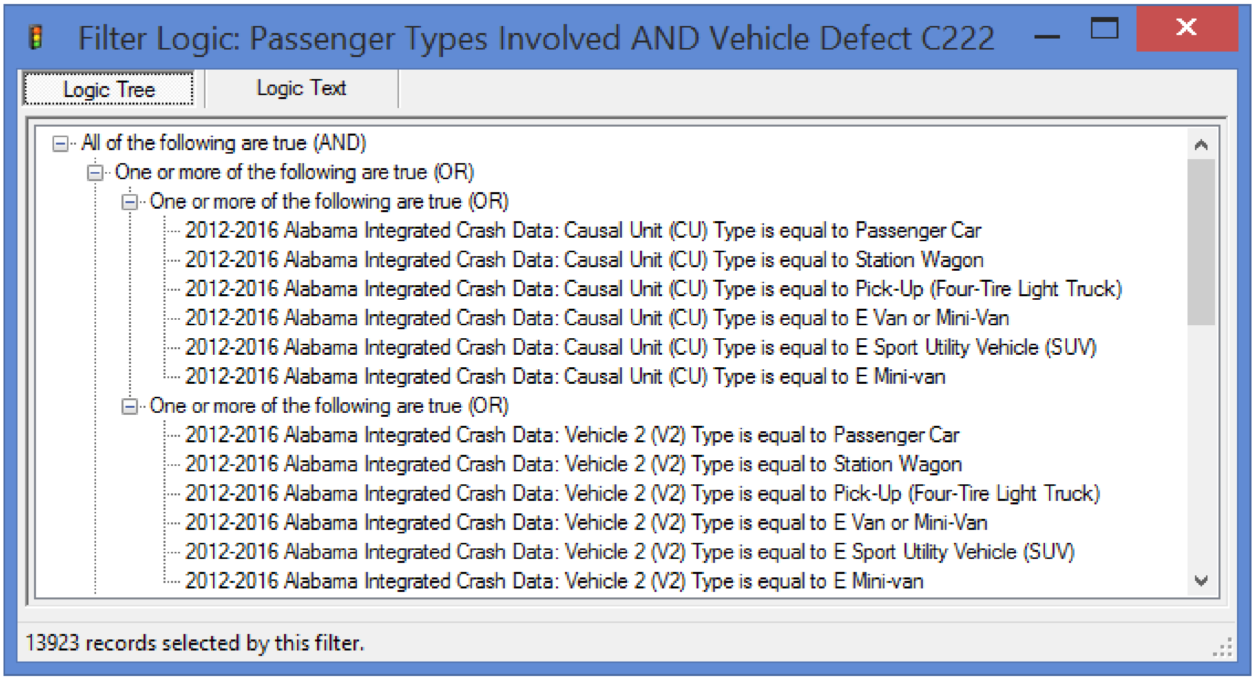
This demonstrates that Passenger Cars and SUVs are getting the high number of vehicle defect crashes not because they have more defects per vehicle, but because of their sheer number on the roadway.

This led to the decision to separate passenger cars from large trucks in this analysis because considering them simultaneously would produce confusing results, with some vehicle defects resulting from the cars and others almost exclusively from the trucks. To solve this problem, two separate runs were performed, where the subdivision is based on C101 – CU Unit Type and C501 Vehicle 2 Type. Specifically, the display below indicates how “large trucks” were defined for this study.



Similarly, the display at the top of the following page shows how “passenger cars” were defined for this study.

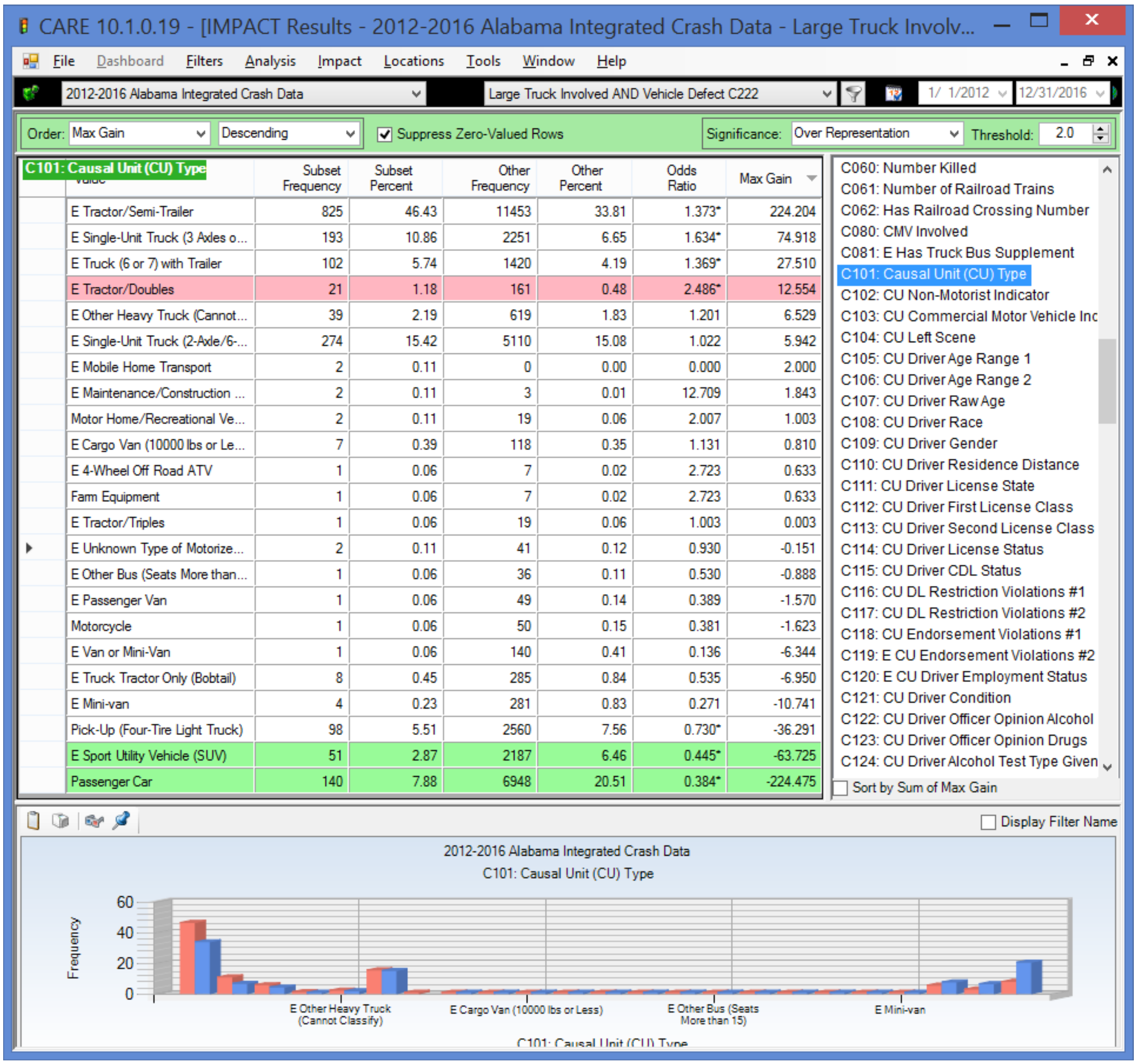
The goal of the two analyses was to determine the other attributes given in the crash report that are correlated with vehicle defects. These are given in the Table of Contents above. Each of the analyses will start out with a summary of the Causal Unit (CU) vehicle defects themselves (C222 CU Contributing Vehicle Defect). This is followed by a number of attributes that were considered to be relevant from the results.


Filter Logic: Passenger Types Involved AND Vehicle Defect C222
Logic Tree
Logic Text
All of the following are true (AND)
One or more of the following are true (OR)
One or more of the following are true (OR)
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Passenger Car
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Station Wagon
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to Pick-Up (Four-Tire Light Truck)
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Van or Mini-Van
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Sport Utility Vehicle (SUV)
2012-2016 Alabama Integrated Crash Data: Causal Unit (CU) Type is equal to E Mini-van
One or more of the following are true (OR)
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to Passenger Car
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to Station Wagon
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to Pick-Up (Four-Tire Light Truck)
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Van or Mini-Van
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Sport Utility Vehicle (SUV)
2012-2016 Alabama Integrated Crash Data: Vehicle 2 (V2) Type is equal to E Mini-van
13923 records selected by this filter.

2.0 Large Truck Analysis

2.1 C101 Causal Unit (CU) Type Analysis When Large Truck Involved

This comparison is between vehicles with defects against those without defects, restricted to crashes that involved large trucks (on both sides of the comparison). Most of the two-vehicle crashes involve a passenger car, since truck-truck crashes are rare. The following display indicates the vehicle type for the unit that caused the crash. Large truck involvement is no implication that the truck caused the crash; but since both subsets were constrained to involve trucks, it is reasonable that a relatively large number of the crashes would be caused by large trucks.



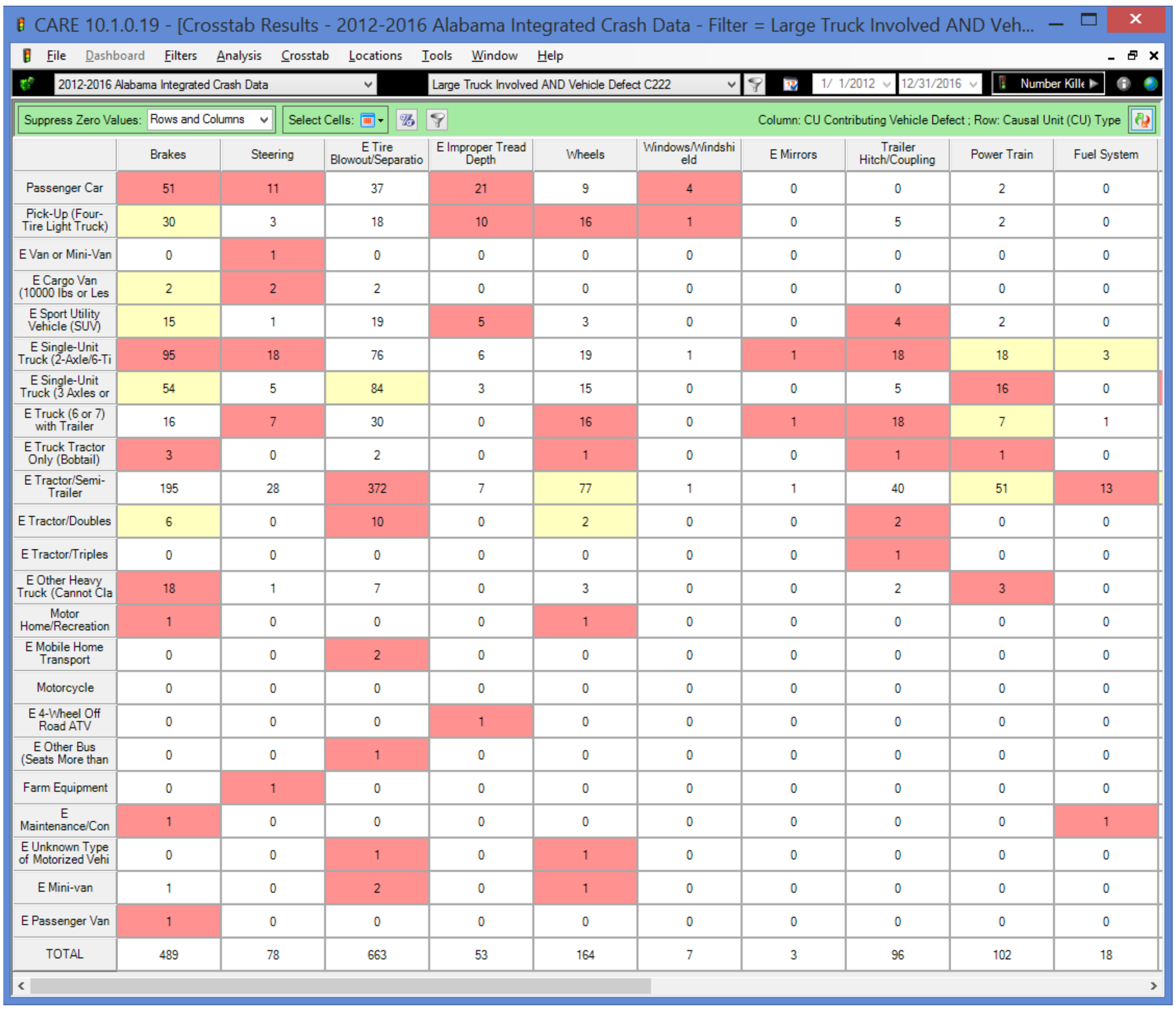
C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tractor/Semi-Trailer	825	46.43	11453	33.81	1.373*	224.204
E Single-Unit Truck (3 Axles o...	193	10.86	2251	6.65	1.634*	74.918
E Truck (6 or 7) with Trailer	102	5.74	1420	4.19	1.369*	27.510
E Tractor/Doubles	21	1.18	161	0.48	2.486*	12.554
E Other Heavy Truck (Cannot...	39	2.19	619	1.83	1.201	6.529
E Single-Unit Truck (2-Axle/6-...	274	15.42	5110	15.08	1.022	5.942
E Mobile Home Transport	2	0.11	0	0.00	0.000	2.000
E Maintenance/Construction ...	2	0.11	3	0.01	12.709	1.843
Motor Home/Recreational Ve...	2	0.11	19	0.06	2.007	1.003
E Cargo Van (10000 lbs or Le...	7	0.39	118	0.35	1.131	0.810
E 4-Wheel Off Road ATV	1	0.06	7	0.02	2.723	0.633
Farm Equipment	1	0.06	7	0.02	2.723	0.633
E Tractor/Triples	1	0.06	19	0.06	1.003	0.003
E Unknown Type of Motorize...	2	0.11	41	0.12	0.930	-0.151
E Other Bus (Seats More than...	1	0.06	36	0.11	0.530	-0.888
E Passenger Van	1	0.06	49	0.14	0.389	-1.570
Motorcycle	1	0.06	50	0.15	0.381	-1.623
E Van or Mini-Van	1	0.06	140	0.41	0.136	-6.344
E Truck Tractor Only (Bobtail)	8	0.45	285	0.84	0.535	-6.950
E Mini-van	4	0.23	281	0.83	0.271	-10.741
Pick-Up (Four-Tire Light Truck)	98	5.51	2560	7.56	0.730*	-36.291
E Sport Utility Vehicle (SUV)	51	2.87	2187	6.46	0.445*	-63.725
Passenger Car	140	7.88	6948	20.51	0.384*	-224.475

The output above is ordered by Max Gain, which considers both the number of crashes in which the unit was at fault (the first numerical column) and the over-representation (as measured by the Odds Ratio). The Max Gain is the number of crashes that would be eliminate if there was some countermeasure implemented that could eliminate its over-representation. In the first item list, which has a causal frequency of 825 crashes, 224 of these could be eliminated if the effect of vehicle defects was eliminated. This list enables motor-carrier professionals to determine which vehicle types need the greatest emphasis when it comes to reducing their vehicle defects.

We will continue with the IMPACT results that had the highest total max gains, and also those with the most practical significance.

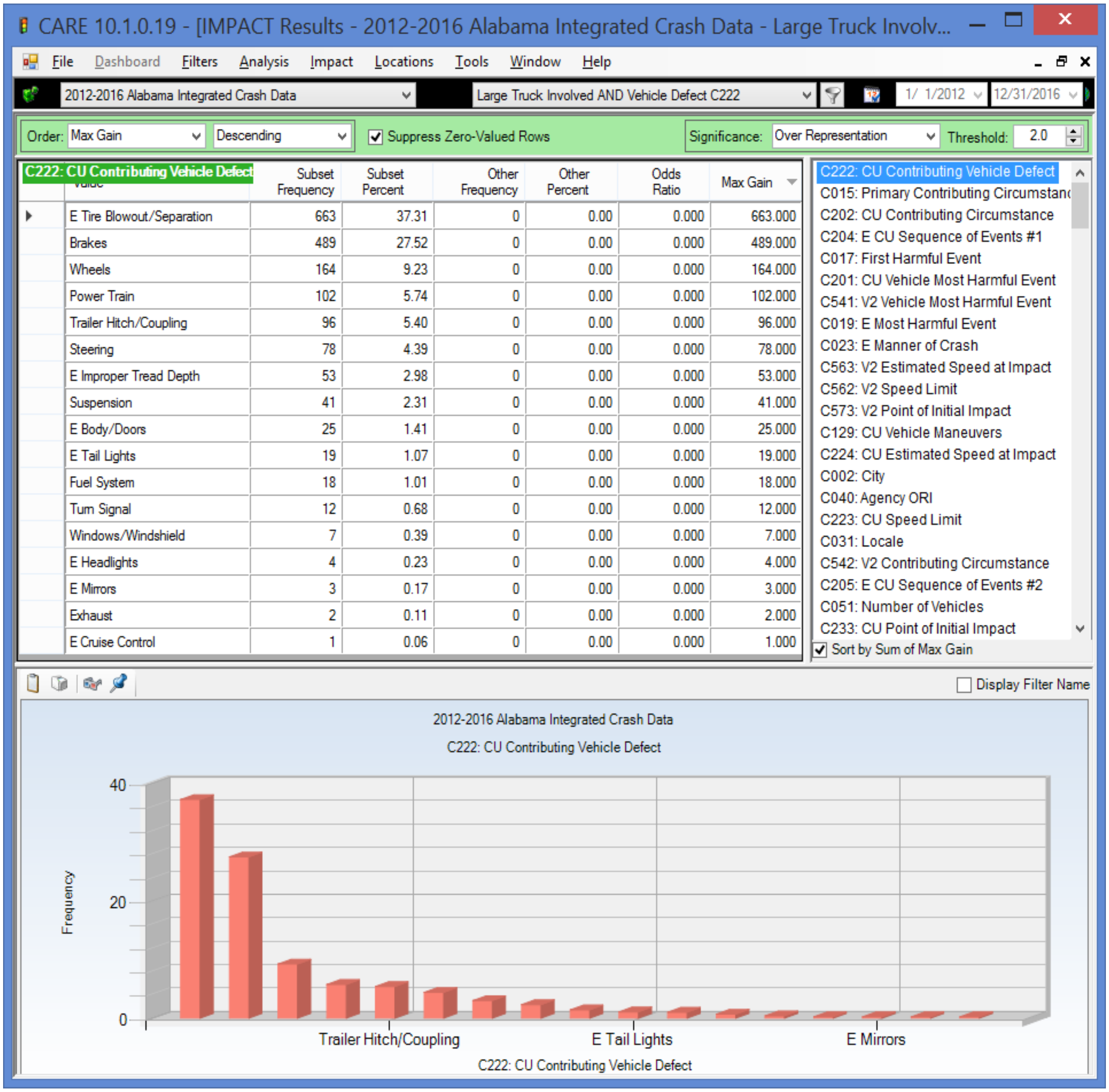
2.2 C222 CU Contributing Vehicle Defect

This summary result (top of next page) was not produced to do an IMPACT comparison because the control subset does not have defects, so the control items all came out to be zero. However, this shows what defects this overall large truck analysis is considering; and it answers in general the question of in general, what vehicle defects are being considered in the analysis given above. Further per-vehicle-type analysis are easily obtained by a cross-tabulation of C101 by C222. The following is a partial example of such a cross-tabulation. All of the vehicle types are included, but the vehicle defect types are truncated at Fuel System.



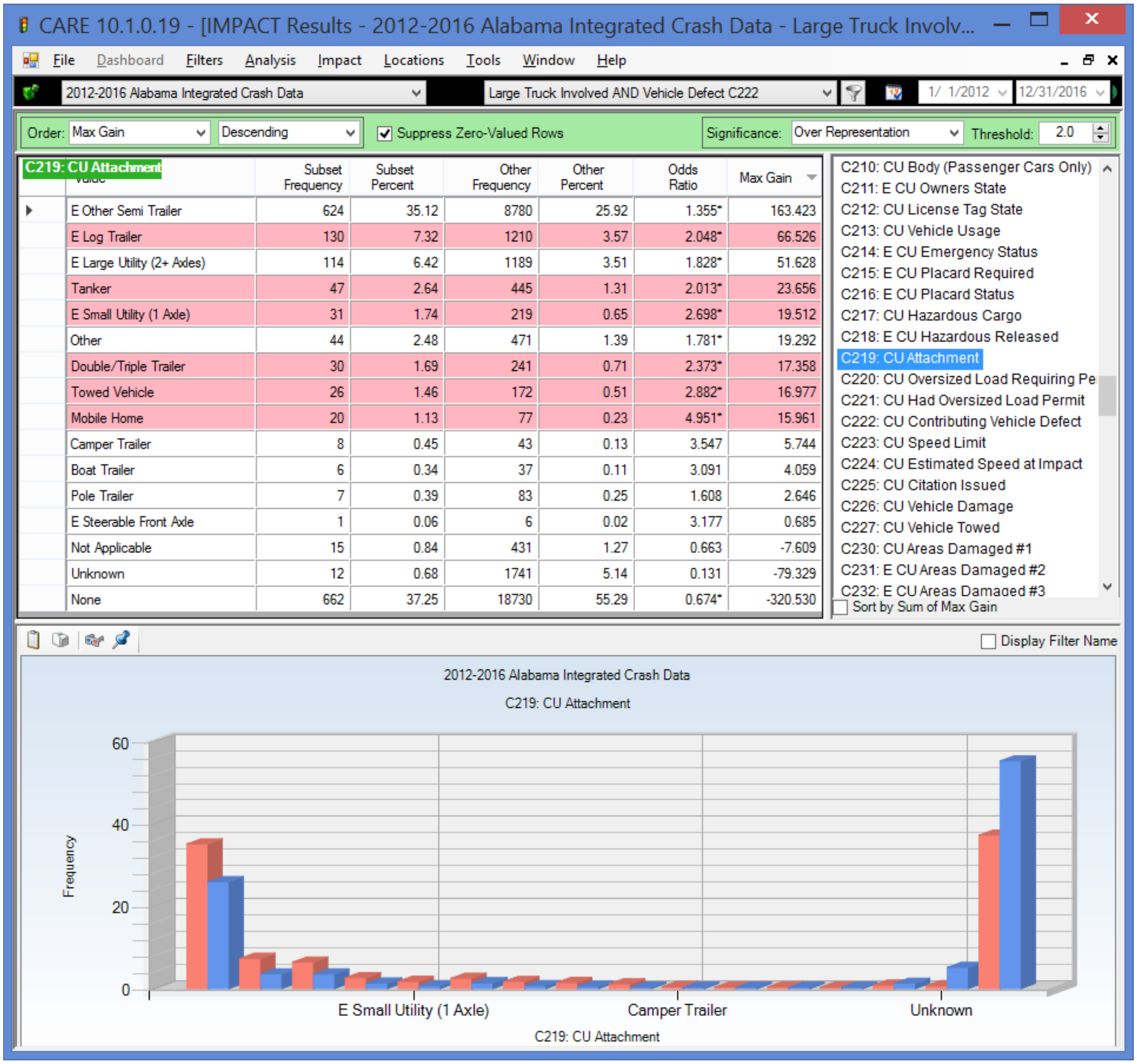
	Brakes	Steering	E Tire Blowout/Separatio	E Improper Tread Depth	Wheels	Windows/Windshi eld	E Mirrors	Trailer Hitch/Coupling	Power Train	Fuel System
Passenger Car	51	11	37	21	9	4	0	0	2	0
Pick-Up (Four-Tire Light Truck)	30	3	18	10	16	1	0	5	2	0
E Van or Mini-Van	0	1	0	0	0	0	0	0	0	0
E Cargo Van (10000 lbs or Les	2	2	2	0	0	0	0	0	0	0
E Sport Utility Vehicle (SUV)	15	1	19	5	3	0	0	4	2	0
E Single-Unit Truck (2-Axle/6-Ti	95	18	76	6	19	1	1	18	18	3
E Single-Unit Truck (3 Axles or	54	5	84	3	15	0	0	5	16	0
E Truck (6 or 7) with Trailer	16	7	30	0	16	0	1	18	7	1
E Truck Tractor Only (Bobtail)	3	0	2	0	1	0	0	1	1	0
E Tractor/Semi-Trailer	195	28	372	7	77	1	1	40	51	13
E Tractor/Doubles	6	0	10	0	2	0	0	2	0	0
E Tractor/Triples	0	0	0	0	0	0	0	1	0	0
E Other Heavy Truck (Cannot Cla	18	1	7	0	3	0	0	2	3	0
Motor Home/Recreation	1	0	0	0	1	0	0	0	0	0
E Mobile Home Transport	0	0	2	0	0	0	0	0	0	0
Motorcycle	0	0	0	0	0	0	0	0	0	0
E 4-Wheel Off Road ATV	0	0	0	1	0	0	0	0	0	0
E Other Bus (Seats More than	0	0	1	0	0	0	0	0	0	0
Farm Equipment	0	1	0	0	0	0	0	0	0	0
E Maintenance/Con	1	0	0	0	0	0	0	0	0	1
E Unknown Type of Motorized Vehi	0	0	1	0	1	0	0	0	0	0
E Mini-van	1	0	2	0	1	0	0	0	0	0
E Passenger Van	1	0	0	0	0	0	0	0	0	0
TOTAL	489	78	663	53	164	7	3	96	102	18

The display below gives the distribution of the vehicle defects that occurred in the vehicles given in the analysis in Section 2.1. The table indicates that Tire Blowout/Separation is the highest frequency, with Brakes, Wheels and Power Train following. Apparently Improper Tread Depth is not as large a problem for large trucks as it is for passenger cars, as we will see in comparing this output with the one given for cars in Section 3.2 below. We expect this is because of the continual inspections given to large trucks by FMCSA and the ALEA Motor Carrier unit.



C222: CU Contributing Vehicle Defect	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Tire Blowout/Separation	663	37.31	0	0.00	0.000	663.000
Brakes	489	27.52	0	0.00	0.000	489.000
Wheels	164	9.23	0	0.00	0.000	164.000
Power Train	102	5.74	0	0.00	0.000	102.000
Trailer Hitch/Coupling	96	5.40	0	0.00	0.000	96.000
Steering	78	4.39	0	0.00	0.000	78.000
E Improper Tread Depth	53	2.98	0	0.00	0.000	53.000
Suspension	41	2.31	0	0.00	0.000	41.000
E Body/Doors	25	1.41	0	0.00	0.000	25.000
E Tail Lights	19	1.07	0	0.00	0.000	19.000
Fuel System	18	1.01	0	0.00	0.000	18.000
Turn Signal	12	0.68	0	0.00	0.000	12.000
Windows/Windshield	7	0.39	0	0.00	0.000	7.000
E Headlights	4	0.23	0	0.00	0.000	4.000
E Mirrors	3	0.17	0	0.00	0.000	3.000
Exhaust	2	0.11	0	0.00	0.000	2.000
E Cruise Control	1	0.06	0	0.00	0.000	1.000

2.3 C219 CU Attachment

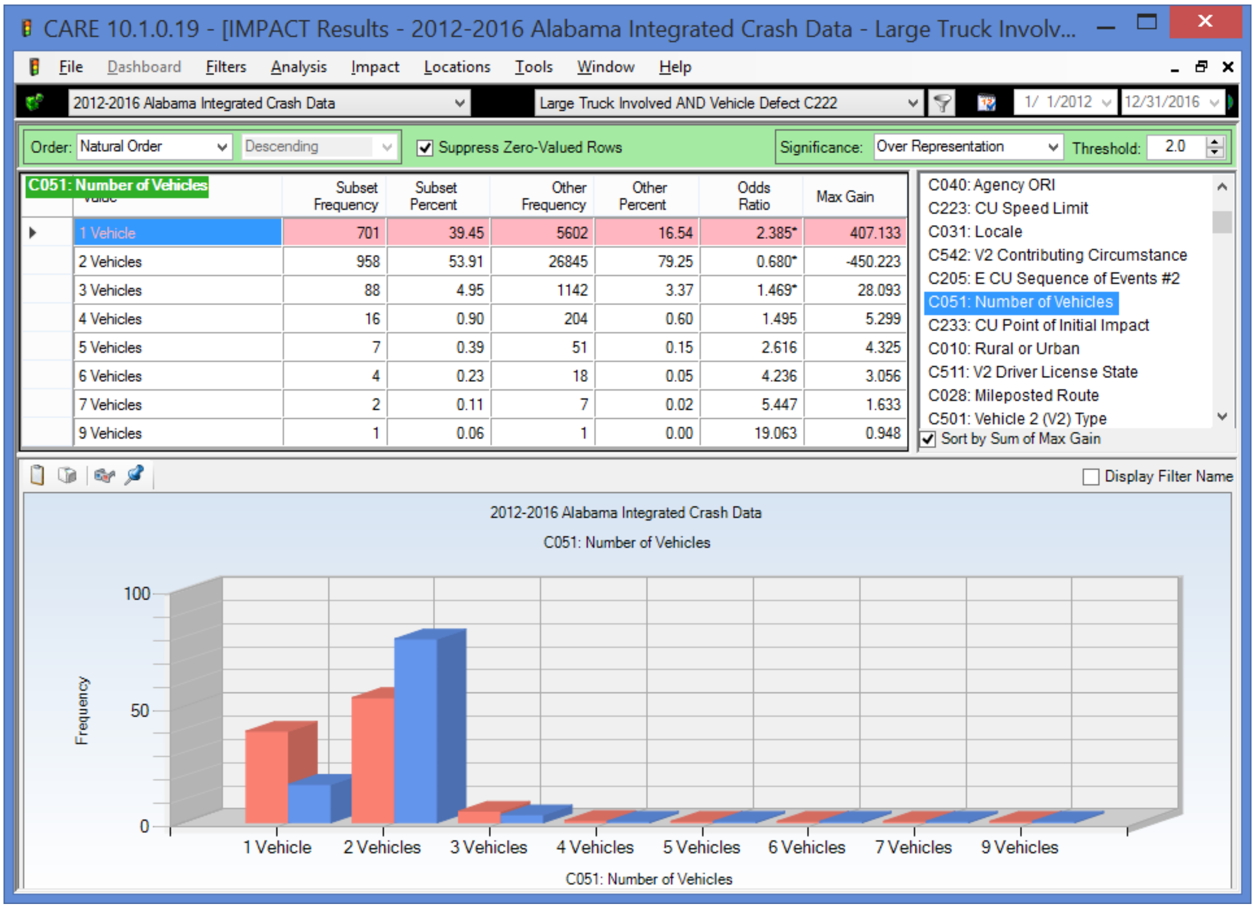


C219: CU Attachment	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Other Semi Trailer	624	35.12	8780	25.92	1.355*	163.423
E Log Trailer	130	7.32	1210	3.57	2.048*	66.526
E Large Utility (2+ Axles)	114	6.42	1189	3.51	1.828*	51.628
Tanker	47	2.64	445	1.31	2.013*	23.656
E Small Utility (1 Axle)	31	1.74	219	0.65	2.698*	19.512
Other	44	2.48	471	1.39	1.781*	19.292
Double/Triple Trailer	30	1.69	241	0.71	2.373*	17.358
Towed Vehicle	26	1.46	172	0.51	2.882*	16.977
Mobile Home	20	1.13	77	0.23	4.951*	15.961
Camper Trailer	8	0.45	43	0.13	3.547	5.744
Boat Trailer	6	0.34	37	0.11	3.091	4.059
Pole Trailer	7	0.39	83	0.25	1.608	2.646
E Steerable Front Axle	1	0.06	6	0.02	3.177	0.685
Not Applicable	15	0.84	431	1.27	0.663	-7.609
Unknown	12	0.68	1741	5.14	0.131	-79.329
None	662	37.25	18730	55.29	0.674*	-320.530

The Attachment display above tends to show the causal vehicle use. The causal vehicle would except in rare cases have a vehicle defect, although it might not be indicated in all crashes as the cause for the crash. The above comparison is against the same types of vehicles but which did not have defects. As an example, log trucks (second vehicle listed) had 7.32% of the defective vehicle crashes, but only 3.57% of the non-defective vehicle crashes, creating an odds ratio of over twice what would be expected (2.048). The Max Gain of 66.526 crashes represents the number that could be reduced if the over-representation was eliminated (i.e., the Odds Ratio somehow was forced to be 1; reducing the 7.32% to its expected value of 3.57%.

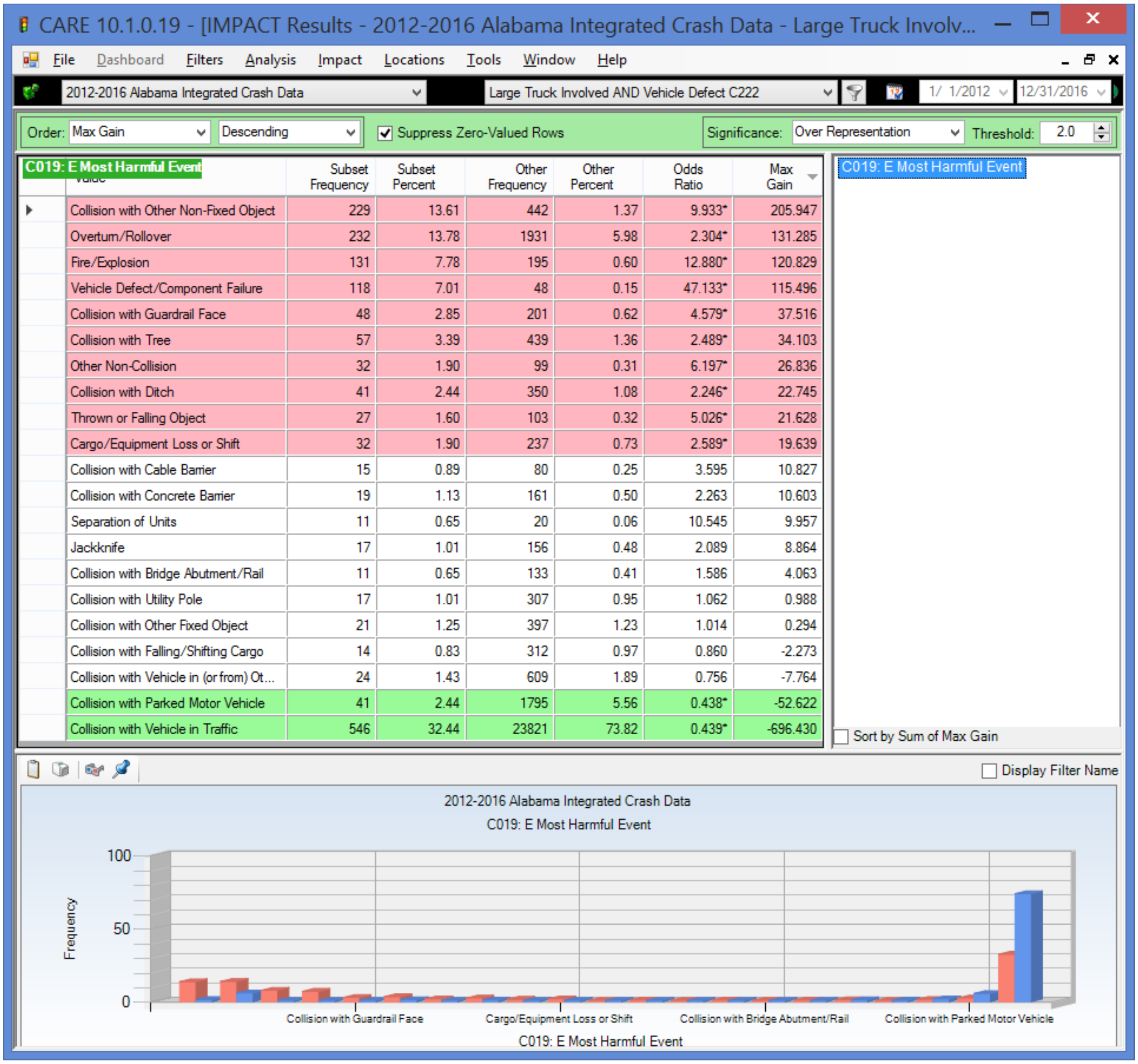
2.4 C051 Number of Vehicles

This attribute plays a large role in many of the attributes discussed in the following sections. Single vehicle crashes are over-represented, as are all multi-vehicle crashes with three or more vehicles. Two vehicle crashes are under-represented with 0.680 of the proportion that occurs in non-vehicle-defect crashes. The Odds Ratio indicates that single vehicle crashes occur over twice their expected proportion. These results are quite similar to those for passenger cars (Section 3.3).



2.5 C019 Most Harmful Event

The following was trimmed to exclude all events that had less than ten occurrences.

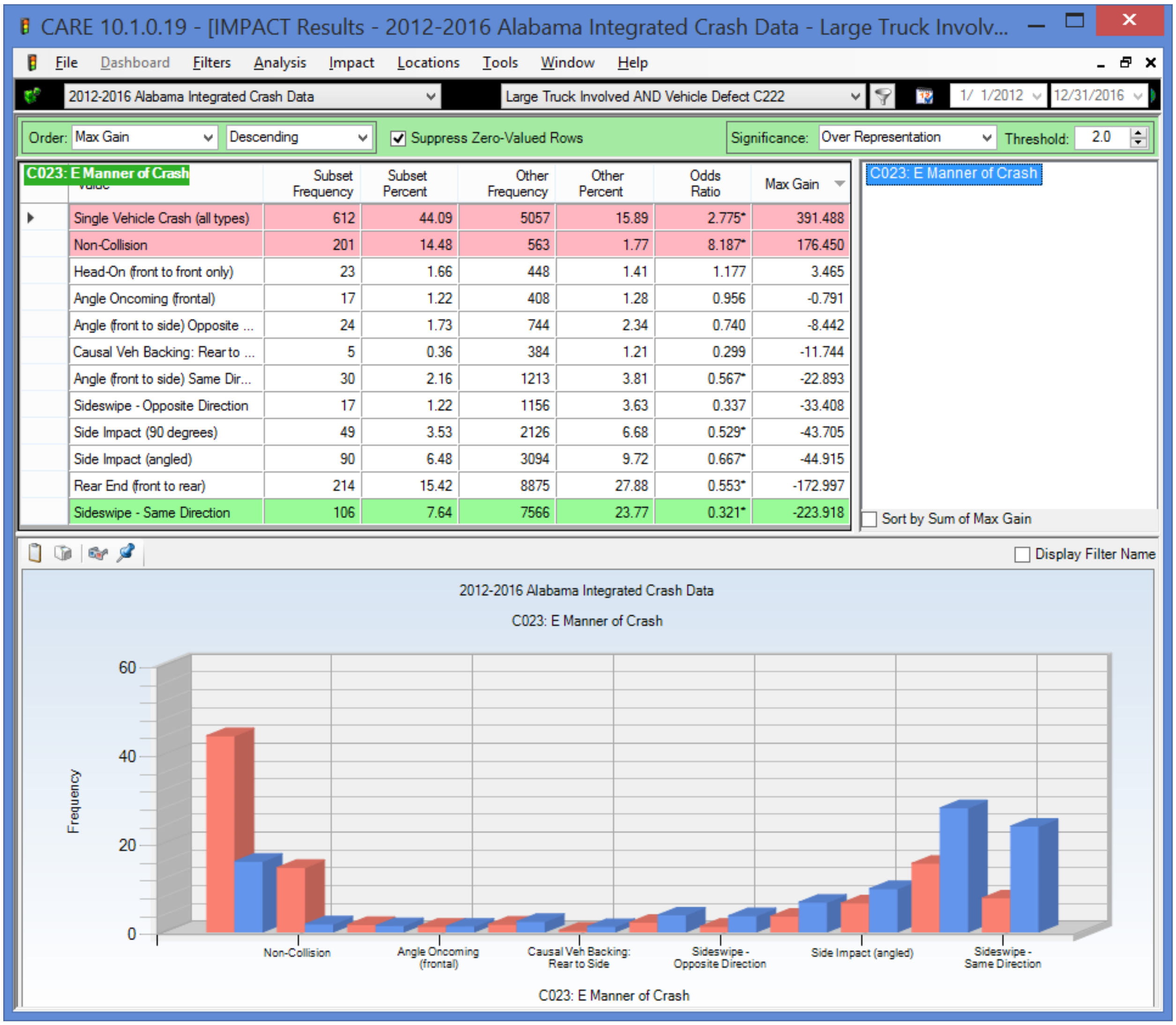


C019: E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Collision with Other Non-Fixed Object	229	13.61	442	1.37	9.933*	205.947
Overturn/Rollover	232	13.78	1931	5.98	2.304*	131.285
Fire/Explosion	131	7.78	195	0.60	12.880*	120.829
Vehicle Defect/Component Failure	118	7.01	48	0.15	47.133*	115.496
Collision with Guardrail Face	48	2.85	201	0.62	4.579*	37.516
Collision with Tree	57	3.39	439	1.36	2.489*	34.103
Other Non-Collision	32	1.90	99	0.31	6.197*	26.836
Collision with Ditch	41	2.44	350	1.08	2.246*	22.745
Thrown or Falling Object	27	1.60	103	0.32	5.026*	21.628
Cargo/Equipment Loss or Shift	32	1.90	237	0.73	2.589*	19.639
Collision with Cable Barrier	15	0.89	80	0.25	3.595	10.827
Collision with Concrete Barrier	19	1.13	161	0.50	2.263	10.603
Separation of Units	11	0.65	20	0.06	10.545	9.957
Jackknife	17	1.01	156	0.48	2.089	8.864
Collision with Bridge Abutment/Rail	11	0.65	133	0.41	1.586	4.063
Collision with Utility Pole	17	1.01	307	0.95	1.062	0.988
Collision with Other Fixed Object	21	1.25	397	1.23	1.014	0.294
Collision with Falling/Shifting Cargo	14	0.83	312	0.97	0.860	-2.273
Collision with Vehicle in (or from) Ot...	24	1.43	609	1.89	0.756	-7.764
Collision with Parked Motor Vehicle	41	2.44	1795	5.56	0.438*	-52.622
Collision with Vehicle in Traffic	546	32.44	23821	73.82	0.439*	-696.430

Red in the tabular portion of the output indicates that that Harmful Event had an over-representation of twice its expectation (odds ratio > 2) when compared to crashes for that harmful event that were not caused by a vehicle defects. Clearly there are many harmful events whose probabilities of occurrence are greatly increased by vehicle defects.

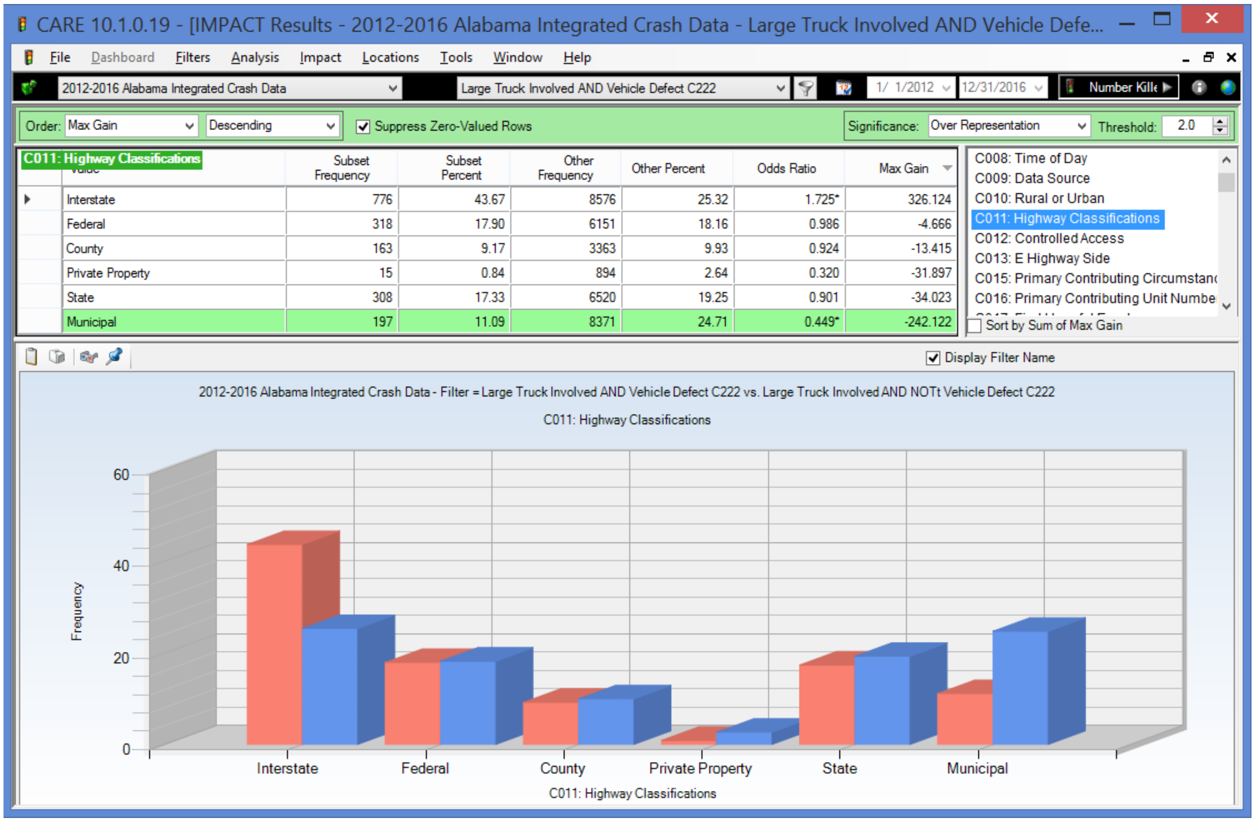
2.6 C023 Manner of Crash

For two-vehicle crashes, this gives an idea of how the two vehicles came together. But note that a large plurality of crashes (44.09%) were single vehicle, much higher than expected. The same is true for the non-collisions. An example of this might be where a defective tire caused a vehicle to run off the road and the incident was reported even though no collision resulted.

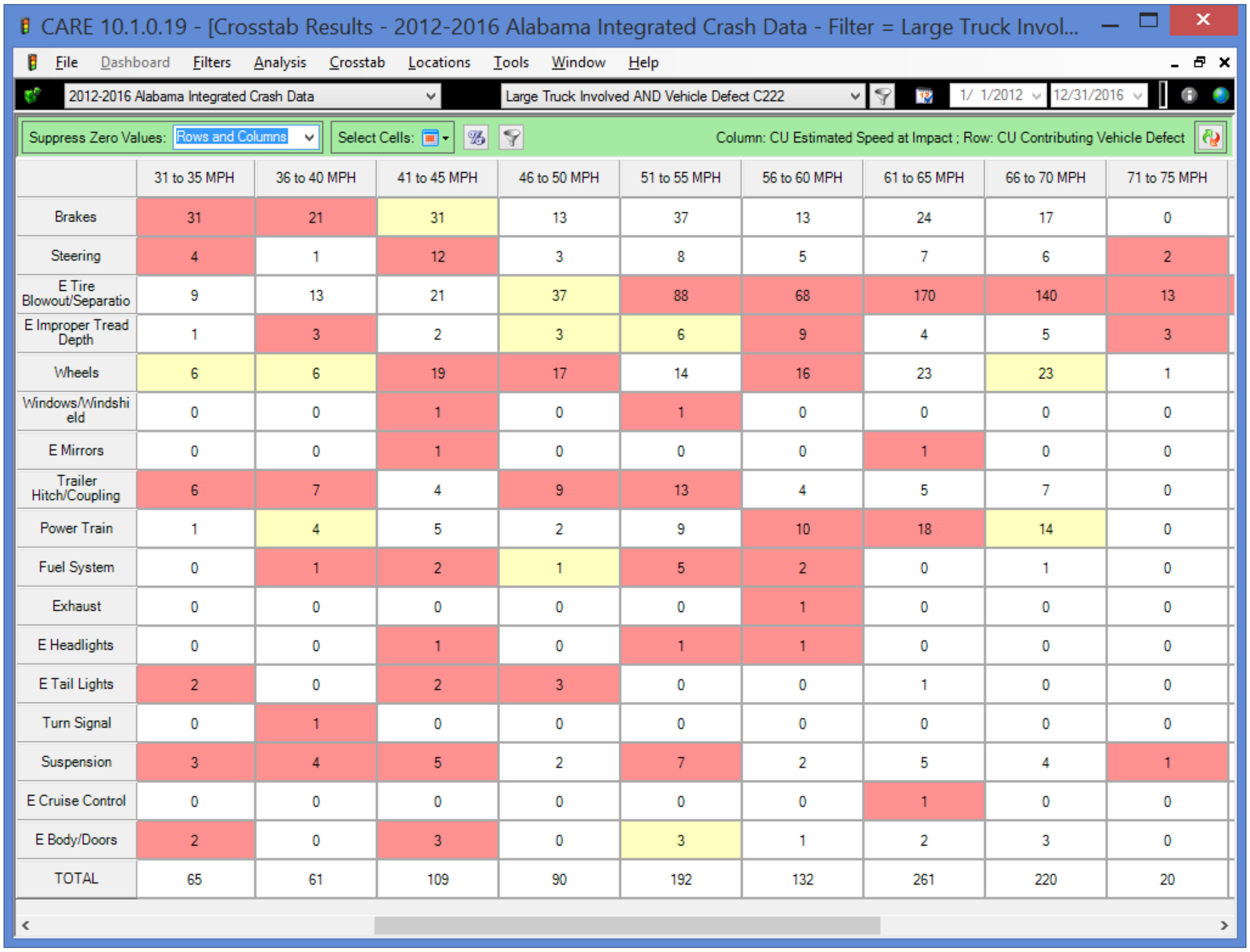


C023: E Manner of Crash	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Single Vehicle Crash (all types)	612	44.09	5057	15.89	2.775*	391.488
Non-Collision	201	14.48	563	1.77	8.187*	176.450
Head-On (front to front only)	23	1.66	448	1.41	1.177	3.465
Angle Oncoming (frontal)	17	1.22	408	1.28	0.956	-0.791
Angle (front to side) Opposite ...	24	1.73	744	2.34	0.740	-8.442
Causal Veh Backing: Rear to ...	5	0.36	384	1.21	0.299	-11.744
Angle (front to side) Same Dir...	30	2.16	1213	3.81	0.567*	-22.893
Sideswipe - Opposite Direction	17	1.22	1156	3.63	0.337	-33.408
Side Impact (90 degrees)	49	3.53	2126	6.68	0.529*	-43.705
Side Impact (angled)	90	6.48	3094	9.72	0.667*	-44.915
Rear End (front to rear)	214	15.42	8875	27.88	0.553*	-172.997
Sideswipe - Same Direction	106	7.64	7566	23.77	0.321*	-223.918

2.7 C011 Highway Classification and Speeds



All other things being equal, it is expected that each Highway Classification will have the same proportion of crashes as the defective vehicle-miles traveled on it over the course of the study. In this case, Interstates probably have over twice the traffic of vehicle-miles (in this case by large trucks) that might have vehicle defects. So the over-representation on Interstate highways is reasonable. Also, tire blowouts tend to occur at higher speeds, as shown in the following cross-tabulation of impact speeds by vehicle defect.



CARE 10.1.0.19 - [Crosstab Results - 2012-2016 Alabama Integrated Crash Data - Filter = Large Truck Invol...

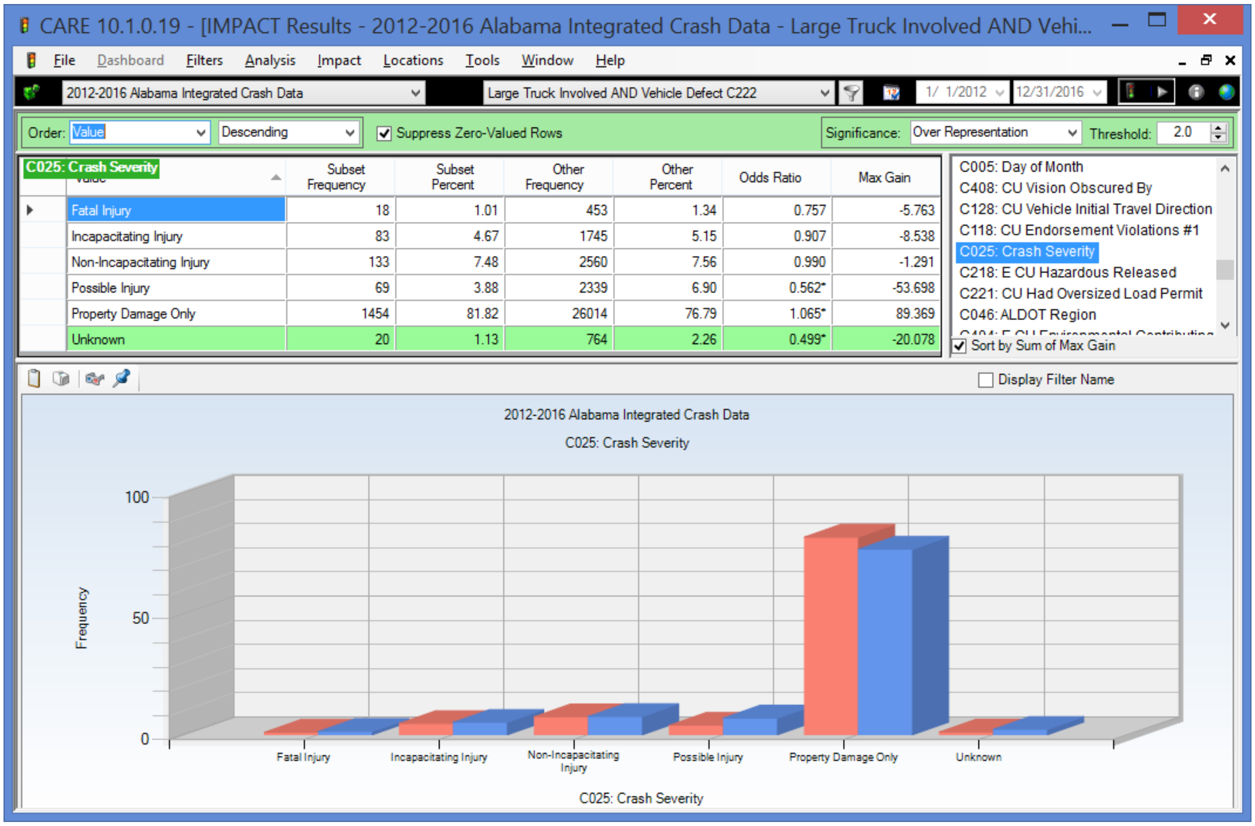
File Dashboard Filters Analysis Crosstab Locations Tools Window Help

2012-2016 Alabama Integrated Crash Data | Large Truck Involved AND Vehicle Defect C222 | 1/ 1/2012 | 12/31/2016

Suppress Zero Values: Rows and Columns | Select Cells: | Column: CU Estimated Speed at Impact ; Row: CU Contributing Vehicle Defect

	31 to 35 MPH	36 to 40 MPH	41 to 45 MPH	46 to 50 MPH	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH
Brakes	31	21	31	13	37	13	24	17	0
Steering	4	1	12	3	8	5	7	6	2
E Tire Blowout/Separatio	9	13	21	37	88	68	170	140	13
E Improper Tread Depth	1	3	2	3	6	9	4	5	3
Wheels	6	6	19	17	14	16	23	23	1
Windows/Windshi eld	0	0	1	0	1	0	0	0	0
E Mirrors	0	0	1	0	0	0	1	0	0
Trailer Hitch/Coupling	6	7	4	9	13	4	5	7	0
Power Train	1	4	5	2	9	10	18	14	0
Fuel System	0	1	2	1	5	2	0	1	0
Exhaust	0	0	0	0	0	1	0	0	0
E Headlights	0	0	1	0	1	1	0	0	0
E Tail Lights	2	0	2	3	0	0	1	0	0
Turn Signal	0	1	0	0	0	0	0	0	0
Suspension	3	4	5	2	7	2	5	4	1
E Cruise Control	0	0	0	0	0	0	1	0	0
E Body/Doors	2	0	3	0	3	1	2	3	0
TOTAL	65	61	109	90	192	132	261	220	20

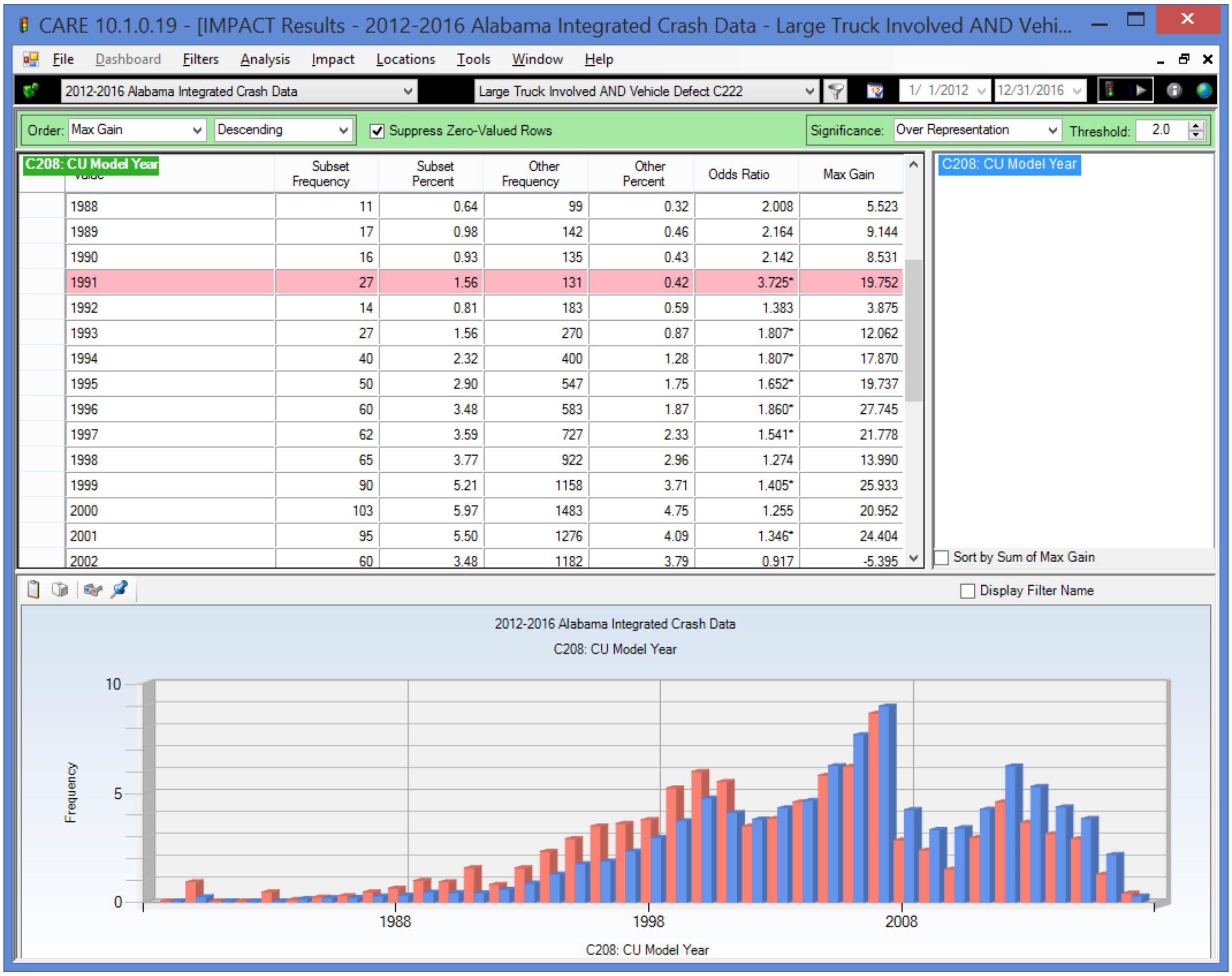
2.8 C025 Crash Severity



Crashes involving large trucks that caused by vehicle defects are much less severe than those caused by other factors. We surmise that this is because the drivers can sense when something is not quite right, and they slow down or stop to address the problem. Even if they only reduce speed in anticipation of a potential problem, this can dramatically lower the severity of the crash. Other studies have shown that the probability of a fatality approximately doubles for every 10 MPH increase in impact speed.

2.9 C208 CU Model Year

The age of the vehicle would definitely impact its chances for its containing defective components. The model years begin to be significantly over-represented in1991, and this continues through 2001, after which they become under-represented.

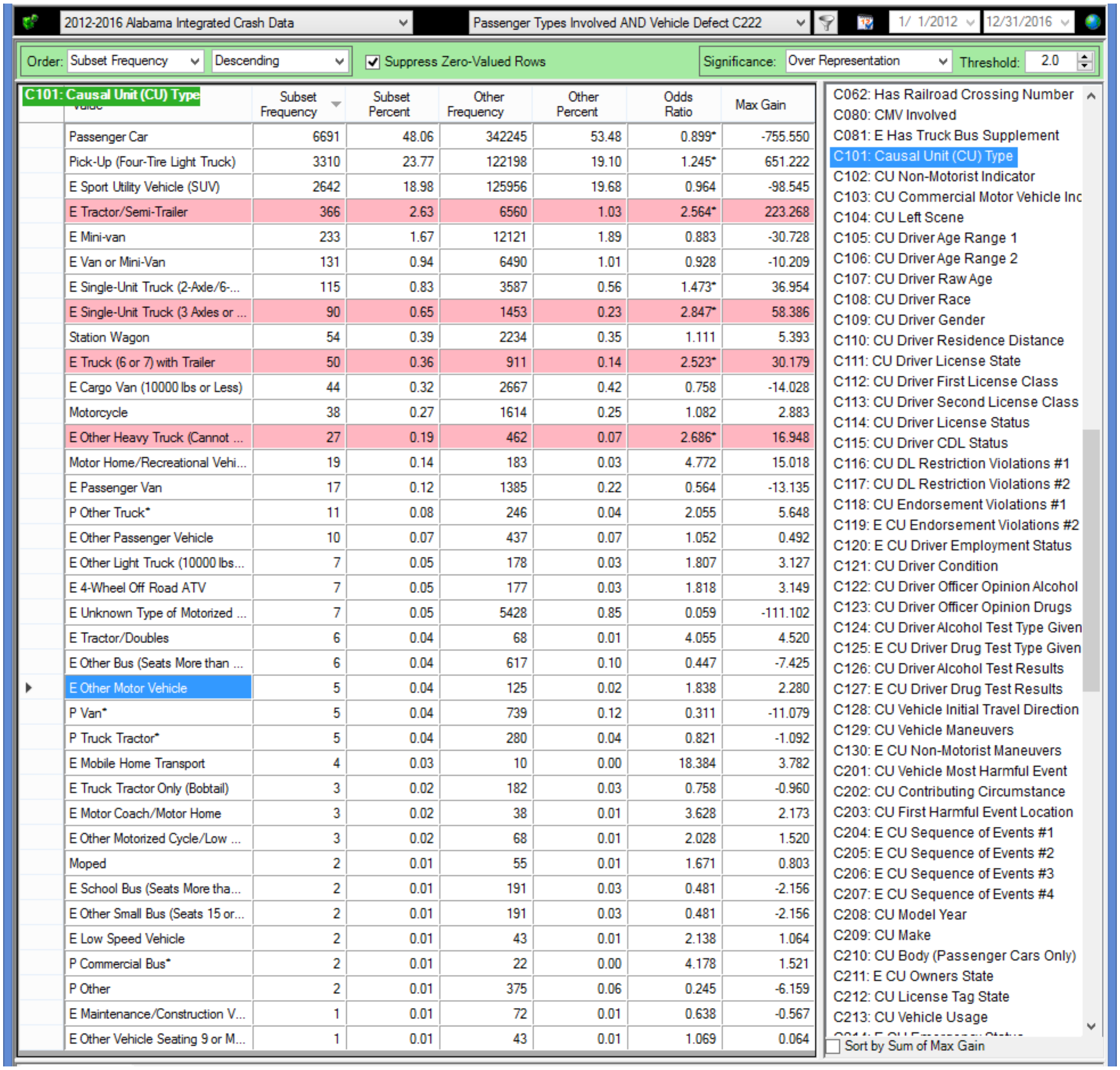


C208: CU Model Year Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1988	11	0.64	99	0.32	2.008	5.523
1989	17	0.98	142	0.46	2.164	9.144
1990	16	0.93	135	0.43	2.142	8.531
1991	27	1.56	131	0.42	3.725*	19.752
1992	14	0.81	183	0.59	1.383	3.875
1993	27	1.56	270	0.87	1.807*	12.062
1994	40	2.32	400	1.28	1.807*	17.870
1995	50	2.90	547	1.75	1.652*	19.737
1996	60	3.48	583	1.87	1.860*	27.745
1997	62	3.59	727	2.33	1.541*	21.778
1998	65	3.77	922	2.96	1.274	13.990
1999	90	5.21	1158	3.71	1.405*	25.933
2000	103	5.97	1483	4.75	1.255	20.952
2001	95	5.50	1276	4.09	1.346*	24.404
2002	60	3.48	1182	3.79	0.917	-5.395

3.0 Passenger Vehicle Analysis

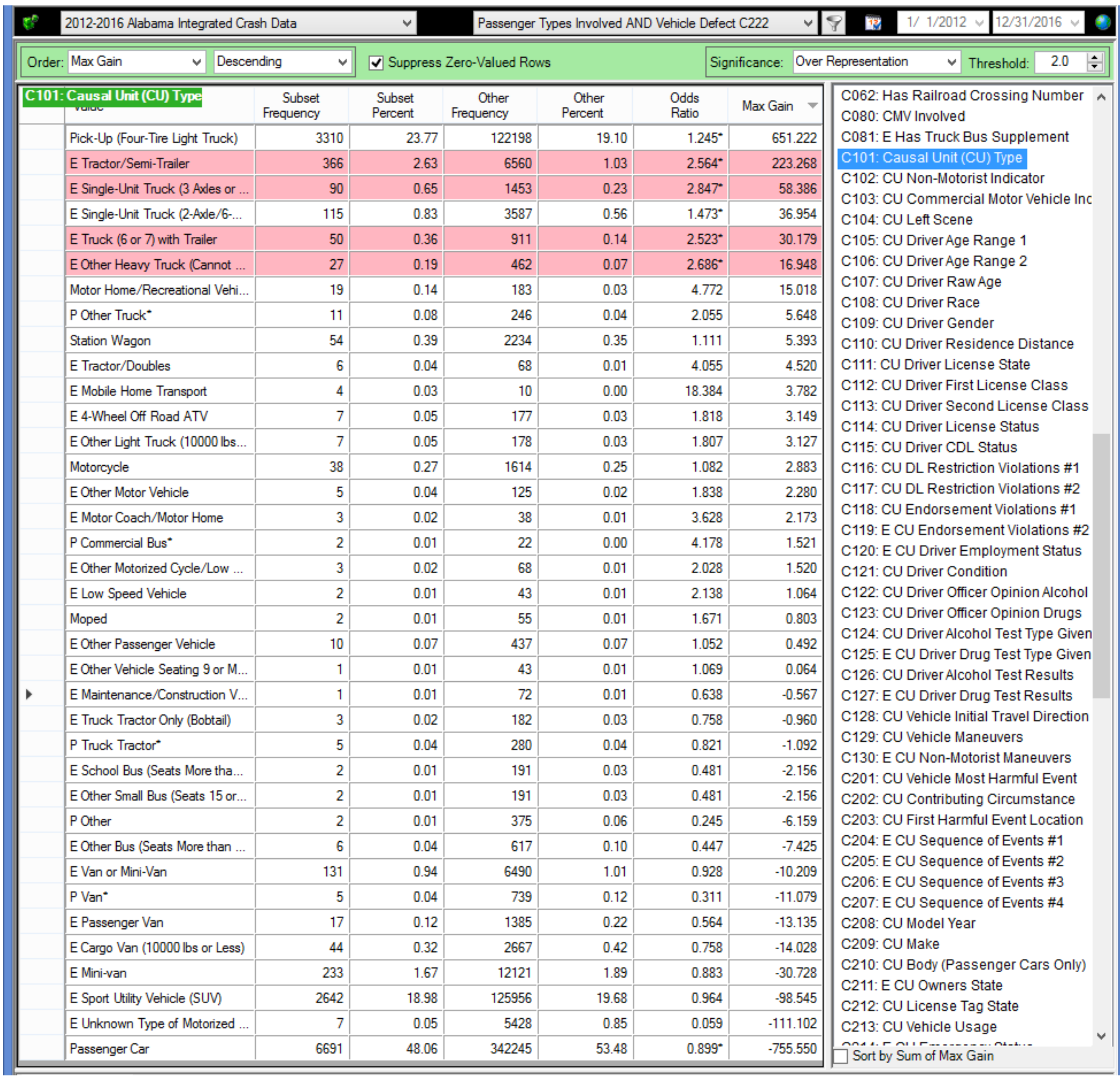
3.1 C101 Causal Unit (CU) for Passenger Vehicles Involved

The filter used to perform this study required that a passenger vehicle was either the Causal Unit or the victim unit (Vehicle 2) in the cases that included two-vehicle crashes. Large trucks were not excluded from consideration, but unlike the analysis above, there was no requirement for the presence of a large truck in the crash. See the Introduction (Section 1.0) above for a formal definition of the particular vehicle type that had to be involved to qualify for these analyses.



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Passenger Car	6691	48.06	342245	53.48	0.899*	-755.550
Pick-Up (Four-Tire Light Truck)	3310	23.77	122198	19.10	1.245*	651.222
E Sport Utility Vehicle (SUV)	2642	18.98	125956	19.68	0.964	-98.545
E Tractor/Semi-Trailer	366	2.63	6560	1.03	2.564*	223.268
E Mini-van	233	1.67	12121	1.89	0.883	-30.728
E Van or Mini-Van	131	0.94	6490	1.01	0.928	-10.209
E Single-Unit Truck (2-Axle/6-...	115	0.83	3587	0.56	1.473*	36.954
E Single-Unit Truck (3 Axles or ...	90	0.65	1453	0.23	2.847*	58.386
Station Wagon	54	0.39	2234	0.35	1.111	5.393
E Truck (6 or 7) with Trailer	50	0.36	911	0.14	2.523*	30.179
E Cargo Van (10000 lbs or Less)	44	0.32	2667	0.42	0.758	-14.028
Motorcycle	38	0.27	1614	0.25	1.082	2.883
E Other Heavy Truck (Cannot ...	27	0.19	462	0.07	2.686*	16.948
Motor Home/Recreational Vehi...	19	0.14	183	0.03	4.772	15.018
E Passenger Van	17	0.12	1385	0.22	0.564	-13.135
P Other Truck*	11	0.08	246	0.04	2.055	5.648
E Other Passenger Vehicle	10	0.07	437	0.07	1.052	0.492
E Other Light Truck (10000 lbs...	7	0.05	178	0.03	1.807	3.127
E 4-Wheel Off Road ATV	7	0.05	177	0.03	1.818	3.149
E Unknown Type of Motorized ...	7	0.05	5428	0.85	0.059	-111.102
E Tractor/Doubles	6	0.04	68	0.01	4.055	4.520
E Other Bus (Seats More than ...	6	0.04	617	0.10	0.447	-7.425
E Other Motor Vehicle	5	0.04	125	0.02	1.838	2.280
P Van*	5	0.04	739	0.12	0.311	-11.079
P Truck Tractor*	5	0.04	280	0.04	0.821	-1.092
E Mobile Home Transport	4	0.03	10	0.00	18.384	3.782
E Truck Tractor Only (Bobtail)	3	0.02	182	0.03	0.758	-0.960
E Motor Coach/Motor Home	3	0.02	38	0.01	3.628	2.173
E Other Motorized Cycle/Low ...	3	0.02	68	0.01	2.028	1.520
Moped	2	0.01	55	0.01	1.671	0.803
E School Bus (Seats More tha...	2	0.01	191	0.03	0.481	-2.156
E Other Small Bus (Seats 15 or...	2	0.01	191	0.03	0.481	-2.156
E Low Speed Vehicle	2	0.01	43	0.01	2.138	1.064
P Commercial Bus*	2	0.01	22	0.00	4.178	1.521
P Other	2	0.01	375	0.06	0.245	-6.159
E Maintenance/Construction V...	1	0.01	72	0.01	0.638	-0.567
E Other Vehicle Seating 9 or M...	1	0.01	43	0.01	1.069	0.064

The above was listed out in order of crash frequency, which is useful in determining patterns for causal vehicles. The following is the same analysis, but in order of Max Gain. While pick-up truck have the highest Max Gain, the over-representation leaders for this crash subset are the large trucks despite the fact that they were to some extent excluded from the test subset. Despite their over-representation, however, they account for a relatively small percentage of these crashes – note that the combination of pick-ups and passenger cars adds up to over 10,000 crashes as compared to about 800 in the heavy truck category. The creation of the two subsets being compared had no consideration at all for the causal vehicle type.



C101: Causal Unit (CU) Type	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Pick-Up (Four-Tire Light Truck)	3310	23.77	122198	19.10	1.245*	651.222
E Tractor/Semi-Trailer	366	2.63	6560	1.03	2.564*	223.268
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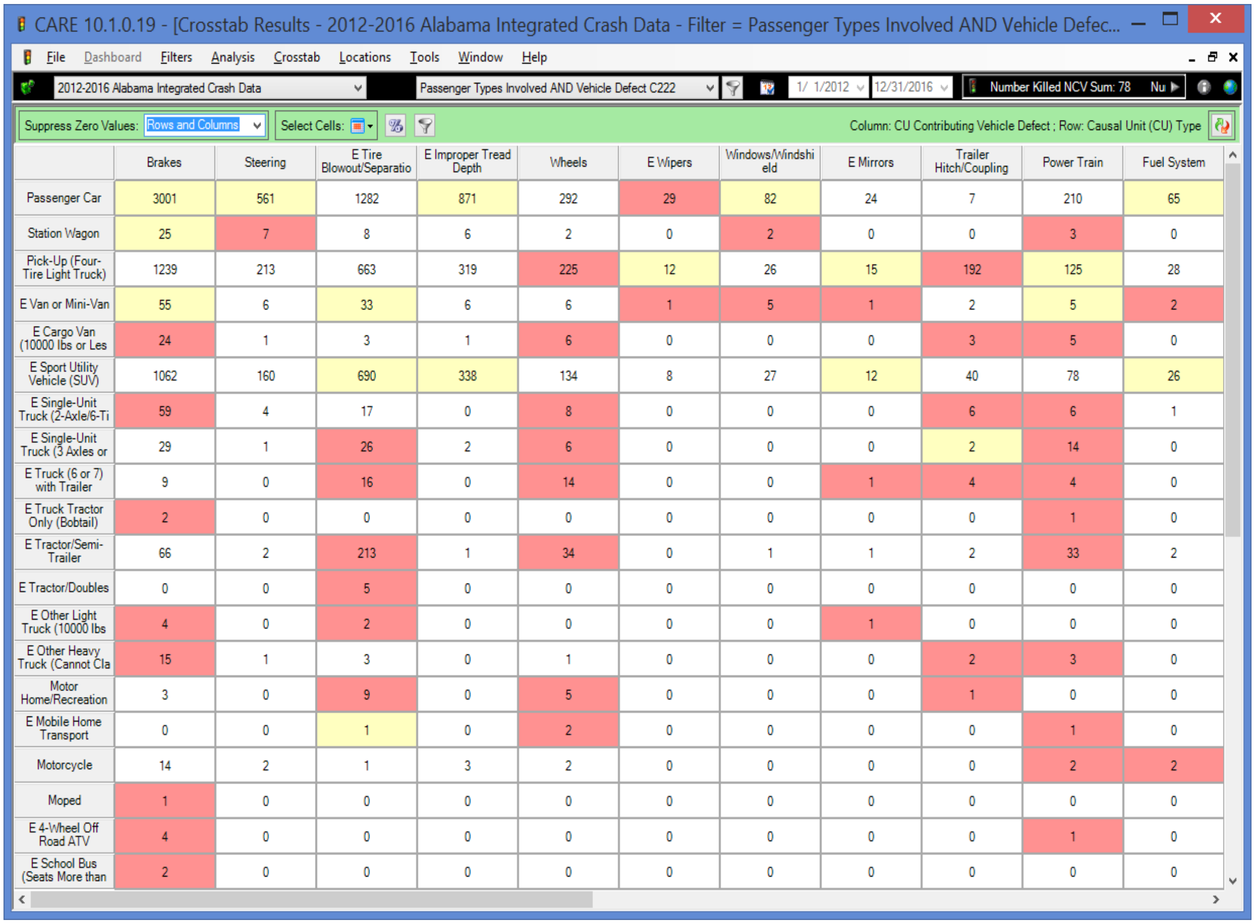
E Single-Unit Truck (2-Axle/6-...	115	0.83	3587	0.56	1.473*	36.954
E Truck (6 or 7) with Trailer	50	0.36	911	0.14	2.523*	30.179
E Other Heavy Truck (Cannot ...	27	0.19	462	0.07	2.686*	16.948
Motor Home/Recreational Vehi...	19	0.14	183	0.03	4.772	15.018
P Other Truck*	11	0.08	246	0.04	2.055	5.648
Station Wagon	54	0.39	2234	0.35	1.111	5.393
E Tractor/Doubles	6	0.04	68	0.01	4.055	4.520
E Mobile Home Transport	4	0.03	10	0.00	18.384	3.782
E 4-Wheel Off Road ATV	7	0.05	177	0.03	1.818	3.149
E Other Light Truck (10000 lbs...	7	0.05	178	0.03	1.807	3.127
Motorcycle	38	0.27	1614	0.25	1.082	2.883
E Other Motor Vehicle	5	0.04	125	0.02	1.838	2.280
E Motor Coach/Motor Home	3	0.02	38	0.01	3.628	2.173
P Commercial Bus*	2	0.01	22	0.00	4.178	1.521
E Other Motorized Cycle/Low ...	3	0.02	68	0.01	2.028	1.520
E Low Speed Vehicle	2	0.01	43	0.01	2.138	1.064
Moped	2	0.01	55	0.01	1.671	0.803
E Other Passenger Vehicle	10	0.07	437	0.07	1.052	0.492
E Other Vehicle Seating 9 or M...	1	0.01	43	0.01	1.069	0.064
E Maintenance/Construction V...	1	0.01	72	0.01	0.638	-0.567
E Truck Tractor Only (Bobtail)	3	0.02	182	0.03	0.758	-0.960
P Truck Tractor*	5	0.04	280	0.04	0.821	-1.092
E School Bus (Seats More tha...	2	0.01	191	0.03	0.481	-2.156
E Other Small Bus (Seats 15 or...	2	0.01	191	0.03	0.481	-2.156
P Other	2	0.01	375	0.06	0.245	-6.159
E Other Bus (Seats More than ...	6	0.04	617	0.10	0.447	-7.425
E Van or Mini-Van	131	0.94	6490	1.01	0.928	-10.209
P Van*	5	0.04	739	0.12	0.311	-11.079
E Passenger Van	17	0.12	1385	0.22	0.564	-13.135
E Cargo Van (10000 lbs or Less)	44	0.32	2667	0.42	0.758	-14.028
E Mini-van	233	1.67	12121	1.89	0.883	-30.728
E Sport Utility Vehicle (SUV)	2642	18.98	125956	19.68	0.964	-98.545
E Unknown Type of Motorized ...	7	0.05	5428	0.85	0.059	-111.102
Passenger Car	6691	48.06	342245	53.48	0.899*	-755.550

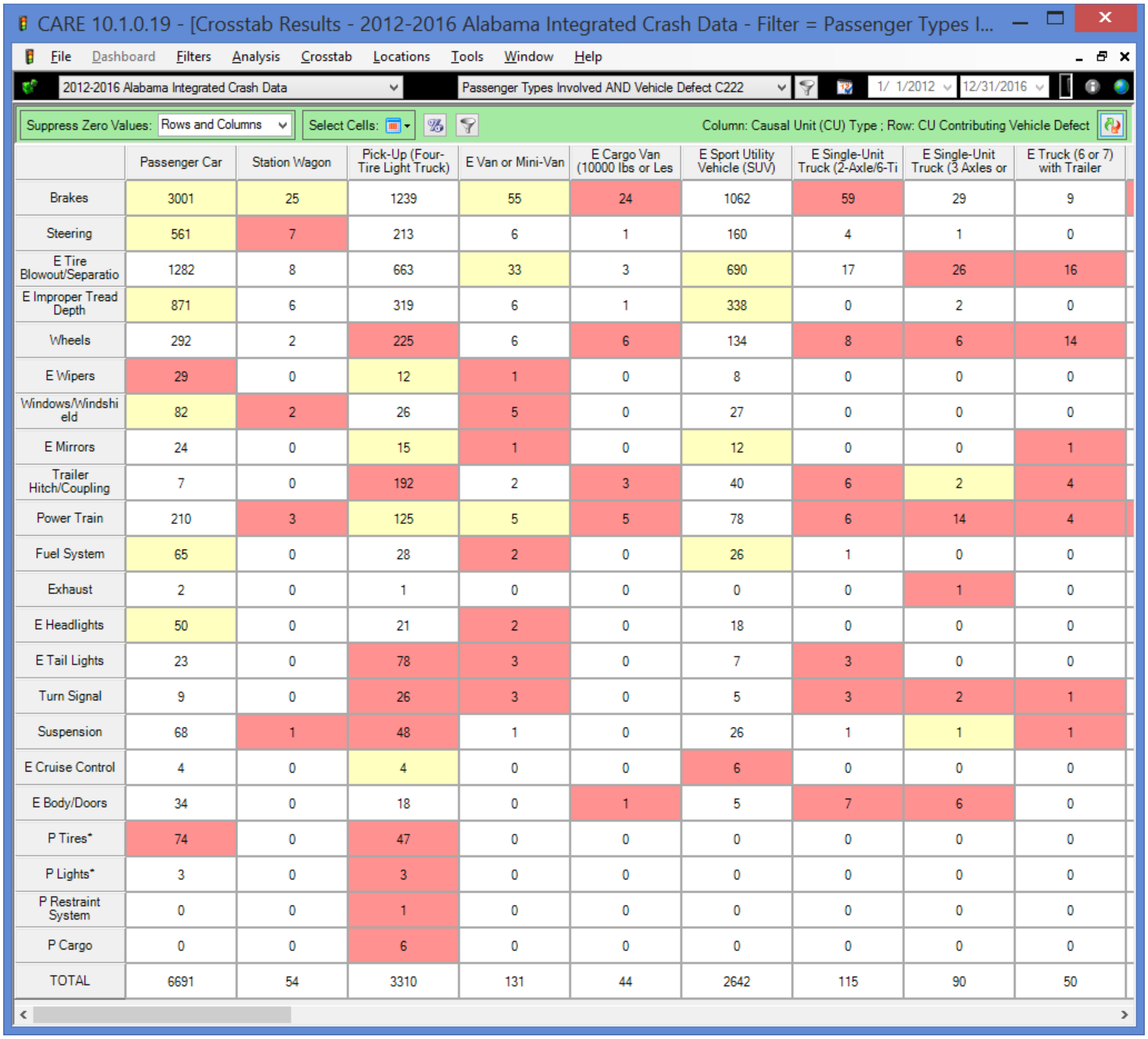
3.2 C222 CU Contributing Vehicle Defect

Per-vehicle-type defect analyses are easily obtainable by a cross-tabulation of C101 by C222. The following is a partial example of such an analysis. In this example the vehicle types are truncated at E School Bus, and the vehicle defect types are truncated at Fuel System.



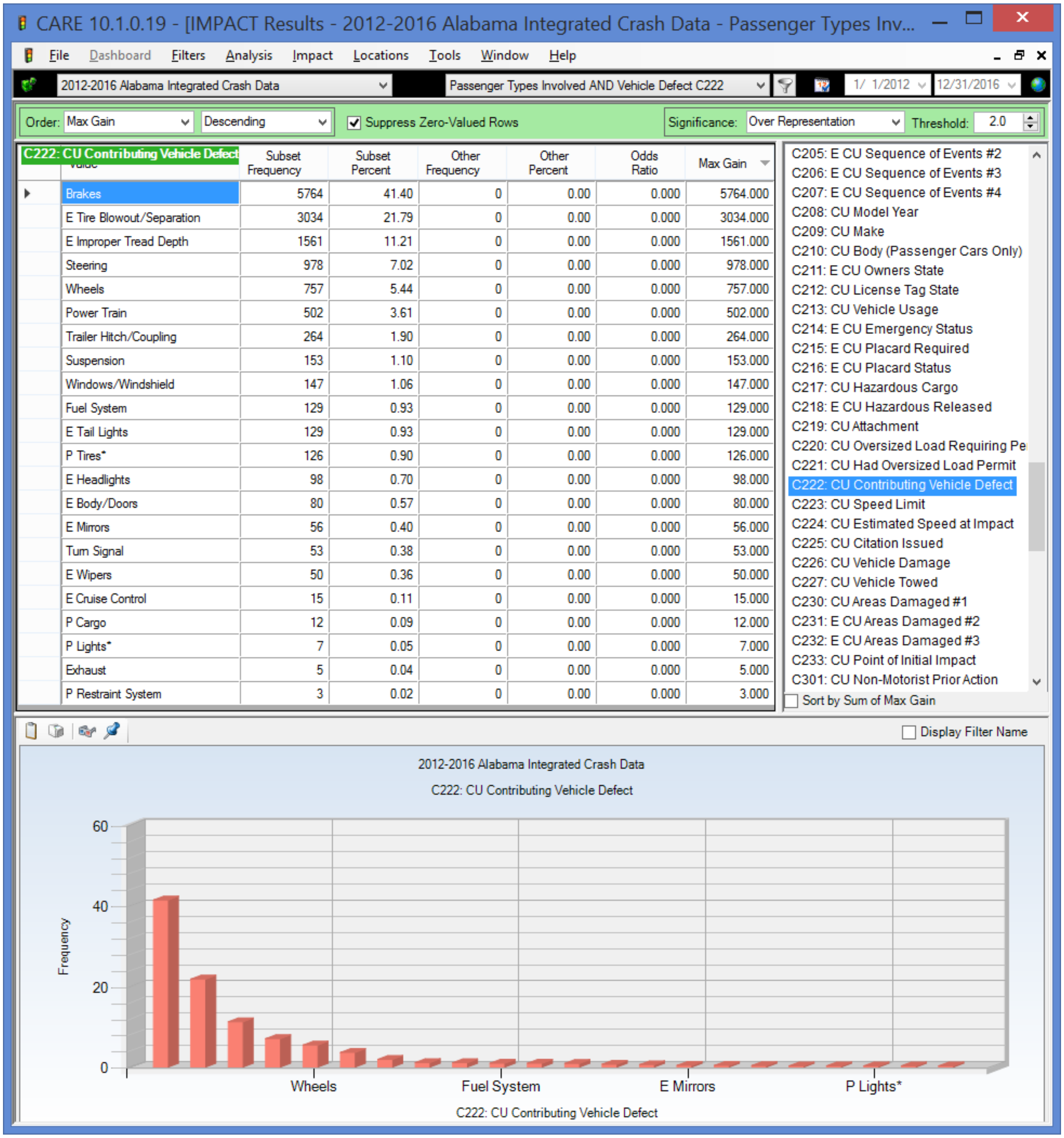
	Brakes	Steering	E Tire Blowout/Separatio	E Improper Tread Depth	Wheels	E Wipers	Windows/Windshi eld	E Mirrors	Trailer Hitch/Coupling	Power Train	Fuel System
Passenger Car	3001	561	1282	871	292	29	82	24	7	210	65
Station Wagon	25	7	8	6	2	0	2	0	0	3	0
Pick-Up (Four-Tire Light Truck)	1239	213	663	319	225	12	26	15	192	125	28
E Van or Mini-Van	55	6	33	6	6	1	5	1	2	5	2
E Cargo Van (10000 lbs or Les	24	1	3	1	6	0	0	0	3	5	0
E Sport Utility Vehicle (SUV)	1062	160	690	338	134	8	27	12	40	78	26
E Single-Unit Truck (2-Axle/6-Ti	59	4	17	0	8	0	0	0	6	6	1
E Single-Unit Truck (3 Axles or	29	1	26	2	6	0	0	0	2	14	0
E Truck (6 or 7) with Trailer	9	0	16	0	14	0	0	1	4	4	0
E Truck Tractor Only (Bobtail)	2	0	0	0	0	0	0	0	0	1	0
E Tractor/Semi-Trailer	66	2	213	1	34	0	1	1	2	33	2
E Tractor/Doubles	0	0	5	0	0	0	0	0	0	0	0
E Other Light Truck (10000 lbs	4	0	2	0	0	0	0	1	0	0	0
E Other Heavy Truck (Cannot Cla	15	1	3	0	1	0	0	0	2	3	0
Motor Home/Recreation	3	0	9	0	5	0	0	0	1	0	0
E Mobile Home Transport	0	0	1	0	2	0	0	0	0	1	0
Motorcycle	14	2	1	3	2	0	0	0	0	2	2
Moped	1	0	0	0	0	0	0	0	0	0	0
E 4-Wheel Off Road ATV	4	0	0	0	0	0	0	0	0	1	0
E School Bus (Seats More than	2	0	0	0	0	0	0	0	0	0	0

The following is an inversion of the above cross-tabulation, which enables the viewing of all of the vehicle defects for the vehicles that are listed across the top of the display, which are truncated at E Truck (6 or 7) with Trailer.



	Passenger Car	Station Wagon	Pick-Up (Four-Tire Light Truck)	E Van or Mini-Van	E Cargo Van (10000 lbs or Les	E Sport Utility Vehicle (SUV)	E Single-Unit Truck (2-Axle/6-Ti	E Single-Unit Truck (3 Axles or	E Truck (6 or 7) with Trailer
Brakes	3001	25	1239	55	24	1062	59	29	9
Steering	561	7	213	6	1	160	4	1	0
E Tire Blowout/Separatio	1282	8	663	33	3	690	17	26	16
E Improper Tread Depth	871	6	319	6	1	338	0	2	0
Wheels	292	2	225	6	6	134	8	6	14
E Wipers	29	0	12	1	0	8	0	0	0
Windows/Windshield	82	2	26	5	0	27	0	0	0
E Mirrors	24	0	15	1	0	12	0	0	1
Trailer Hitch/Coupling	7	0	192	2	3	40	6	2	4
Power Train	210	3	125	5	5	78	6	14	4
Fuel System	65	0	28	2	0	26	1	0	0
Exhaust	2	0	1	0	0	0	0	1	0
E Headlights	50	0	21	2	0	18	0	0	0
E Tail Lights	23	0	78	3	0	7	3	0	0
Turn Signal	9	0	26	3	0	5	3	2	1
Suspension	68	1	48	1	0	26	1	1	1
E Cruise Control	4	0	4	0	0	6	0	0	0
E Body/Doors	34	0	18	0	1	5	7	6	0
P Tires*	74	0	47	0	0	0	0	0	0
P Lights*	3	0	3	0	0	0	0	0	0
P Restraint System	0	0	1	0	0	0	0	0	0
P Cargo	0	0	6	0	0	0	0	0	0
TOTAL	6691	54	3310	131	44	2642	115	90	50

It is clear that brakes and tire defects produce the largest numbers. We will see below that tire problems eclipse the braking issues when it comes to causing fatalities.

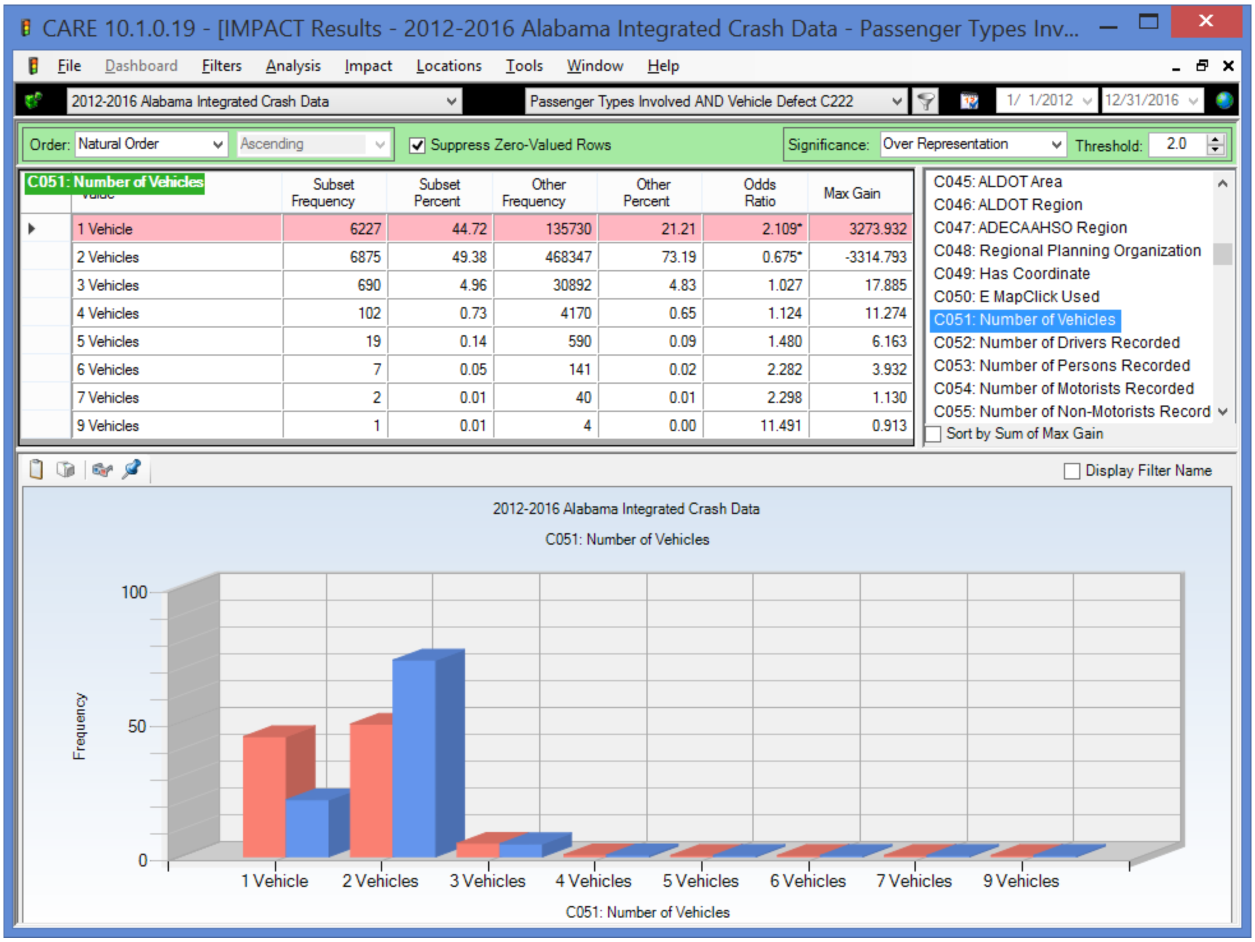


C222: CU Contributing Vehicle Defect	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Brakes	5764	41.40	0	0.00	0.000	5764.000
E Tire Blowout/Separation	3034	21.79	0	0.00	0.000	3034.000
E Improper Tread Depth	1561	11.21	0	0.00	0.000	1561.000
Steering	978	7.02	0	0.00	0.000	978.000
Wheels	757	5.44	0	0.00	0.000	757.000
Power Train	502	3.61	0	0.00	0.000	502.000
Trailer Hitch/Coupling	264	1.90	0	0.00	0.000	264.000
Suspension	153	1.10	0	0.00	0.000	153.000
Windows/Windshield	147	1.06	0	0.00	0.000	147.000
Fuel System	129	0.93	0	0.00	0.000	129.000
E Tail Lights	129	0.93	0	0.00	0.000	129.000
P Tires*	126	0.90	0	0.00	0.000	126.000
E Headlights	98	0.70	0	0.00	0.000	98.000
E Body/Doors	80	0.57	0	0.00	0.000	80.000
E Mirrors	56	0.40	0	0.00	0.000	56.000
Turn Signal	53	0.38	0	0.00	0.000	53.000
E Wipers	50	0.36	0	0.00	0.000	50.000
E Cruise Control	15	0.11	0	0.00	0.000	15.000
P Cargo	12	0.09	0	0.00	0.000	12.000
P Lights*	7	0.05	0	0.00	0.000	7.000
Exhaust	5	0.04	0	0.00	0.000	5.000
P Restraint System	3	0.02	0	0.00	0.000	3.000

The display above gives the distribution of all of the vehicle defects that occurred in the vehicles given in the analysis in Section 3.1. This result was not produced to do an IMPACT comparison because the control subset does not have defects, so the control items all came out to be zero. However, this shows the distribution of the defects that this overall passenger car analysis is considering.

3.3 C051 Number of Vehicles

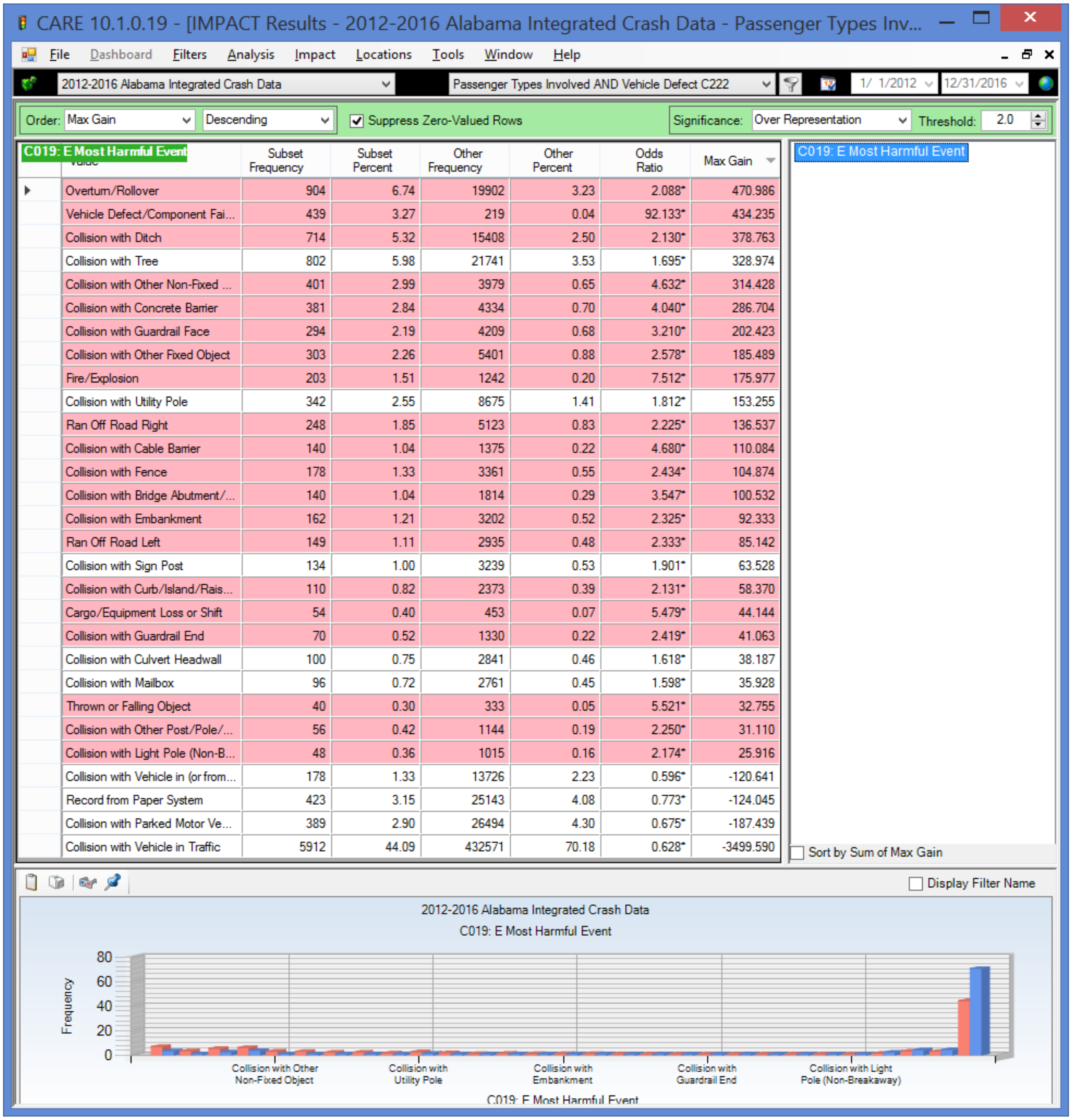
This attribute plays a large role in many of the attributes discussed below. Single vehicle crashes are over-represented, as are all multi-vehicle crashes with three or more vehicles. Two vehicle crashes are under-represented with 0.675 of the proportion that occurs in non-vehicle-defect crashes. The Odds Ratio indicates that single vehicle crashes occur over twice their expected proportion.



C051: Number of Vehicles	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1 Vehicle	6227	44.72	135730	21.21	2.109*	3273.932
2 Vehicles	6875	49.38	468347	73.19	0.675*	-3314.793
3 Vehicles	690	4.96	30892	4.83	1.027	17.885
4 Vehicles	102	0.73	4170	0.65	1.124	11.274
5 Vehicles	19	0.14	590	0.09	1.480	6.163
6 Vehicles	7	0.05	141	0.02	2.282	3.932
7 Vehicles	2	0.01	40	0.01	2.298	1.130
9 Vehicles	1	0.01	4	0.00	11.491	0.913

3.3 C019 Most Harmful Event

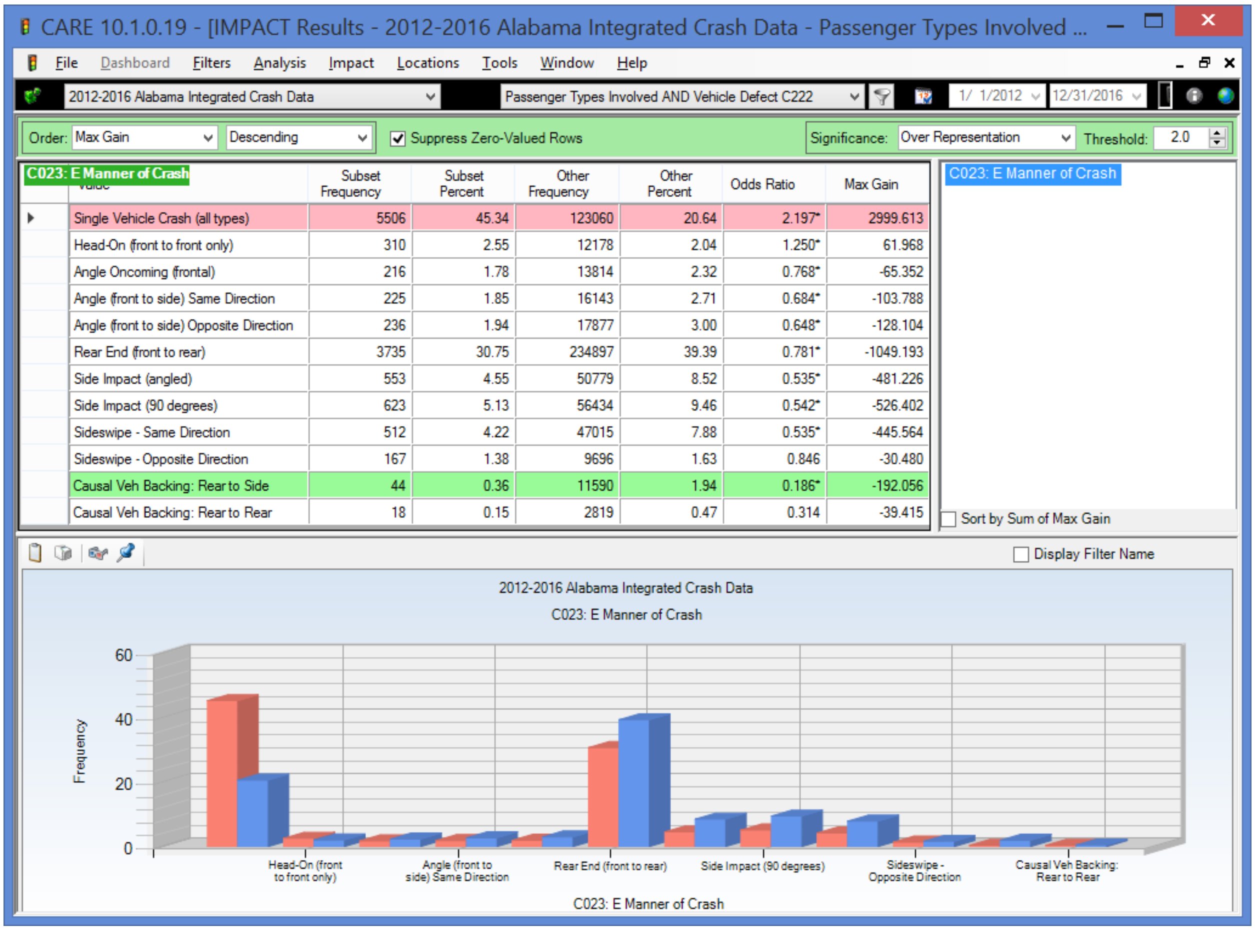
The following is a listing of Most Harmful Events for those having 40 or more occurrences. The effect of single-vehicle crashes accounts for most of the over-representations.



C019: E Most Harmful Event	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Overturn/Rollover	904	6.74	19902	3.23	2.088*	470.986
Vehicle Defect/Component Fai...	439	3.27	219	0.04	92.133*	434.235
Collision with Ditch	714	5.32	15408	2.50	2.130*	378.763
Collision with Tree	802	5.98	21741	3.53	1.695*	328.974
Collision with Other Non-Fixed ...	401	2.99	3979	0.65	4.632*	314.428
Collision with Concrete Barrier	381	2.84	4334	0.70	4.040*	286.704
Collision with Guardrail Face	294	2.19	4209	0.68	3.210*	202.423
Collision with Other Fixed Object	303	2.26	5401	0.88	2.578*	185.489
Fire/Explosion	203	1.51	1242	0.20	7.512*	175.977
Collision with Utility Pole	342	2.55	8675	1.41	1.812*	153.255
Ran Off Road Right	248	1.85	5123	0.83	2.225*	136.537
Collision with Cable Barrier	140	1.04	1375	0.22	4.680*	110.084
Collision with Fence	178	1.33	3361	0.55	2.434*	104.874
Collision with Bridge Abutment/...	140	1.04	1814	0.29	3.547*	100.532
Collision with Embankment	162	1.21	3202	0.52	2.325*	92.333
Ran Off Road Left	149	1.11	2935	0.48	2.333*	85.142
Collision with Sign Post	134	1.00	3239	0.53	1.901*	63.528
Collision with Curb/Island/Rais...	110	0.82	2373	0.39	2.131*	58.370
Cargo/Equipment Loss or Shift	54	0.40	453	0.07	5.479*	44.144
Collision with Guardrail End	70	0.52	1330	0.22	2.419*	41.063
Collision with Culvert Headwall	100	0.75	2841	0.46	1.618*	38.187
Collision with Mailbox	96	0.72	2761	0.45	1.598*	35.928
Thrown or Falling Object	40	0.30	333	0.05	5.521*	32.755
Collision with Other Post/Pole/...	56	0.42	1144	0.19	2.250*	31.110
Collision with Light Pole (Non-B...	48	0.36	1015	0.16	2.174*	25.916
Collision with Vehicle in (or from...	178	1.33	13726	2.23	0.596*	-120.641
Record from Paper System	423	3.15	25143	4.08	0.773*	-124.045
Collision with Parked Motor Ve...	389	2.90	26494	4.30	0.675*	-187.439
Collision with Vehicle in Traffic	5912	44.09	432571	70.18	0.628*	-3499.590

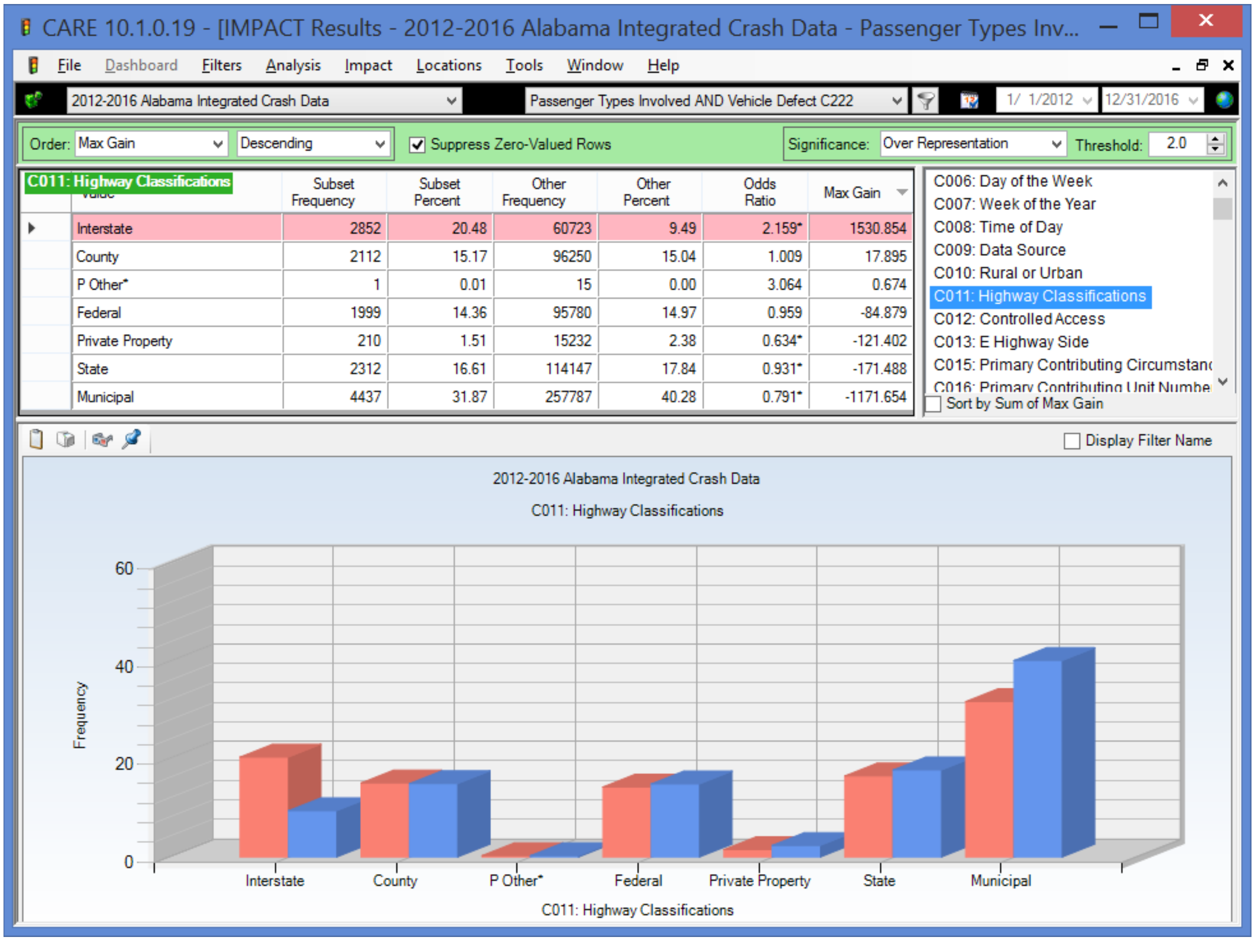
3.5 C023 Manner of Crash

The following presents a summary of the Manner of Crash for passenger car vehicle defect crashes. It gives insight especially into those crashes that did not involve just a single vehicle. Non-descriptive values were removed from this display, including: Other, Non-Collision, Unknown, and Record from Paper System.



C023: E Manner of Crash Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Single Vehicle Crash (all types)	5506	45.34	123060	20.64	2.197*	2999.613
Head-On (front to front only)	310	2.55	12178	2.04	1.250*	61.968
Angle Oncoming (frontal)	216	1.78	13814	2.32	0.768*	-65.352
Angle (front to side) Same Direction	225	1.85	16143	2.71	0.684*	-103.788
Angle (front to side) Opposite Direction	236	1.94	17877	3.00	0.648*	-128.104
Rear End (front to rear)	3735	30.75	234897	39.39	0.781*	-1049.193
Side Impact (angled)	553	4.55	50779	8.52	0.535*	-481.226
Side Impact (90 degrees)	623	5.13	56434	9.46	0.542*	-526.402
Sideswipe - Same Direction	512	4.22	47015	7.88	0.535*	-445.564
Sideswipe - Opposite Direction	167	1.38	9696	1.63	0.846	-30.480
Causal Veh Backing: Rear to Side	44	0.36	11590	1.94	0.186*	-192.056
Causal Veh Backing: Rear to Rear	18	0.15	2819	0.47	0.314	-39.415

3.6 C011 Highway Classification and Speeds



C011: Highway Classifications	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Interstate	2852	20.48	60723	9.49	2.159*	1530.854
County	2112	15.17	96250	15.04	1.009	17.895
P Other*	1	0.01	15	0.00	3.064	0.674
Federal	1999	14.36	95780	14.97	0.959	-84.879
Private Property	210	1.51	15232	2.38	0.634*	-121.402
State	2312	16.61	114147	17.84	0.931*	-171.488
Municipal	4437	31.87	257787	40.28	0.791*	-1171.654

All other things being equal, it is expected that each Highway Classification will have the same proportion of crashes as the defective vehicles on over the course of the study. This distribution varies sharply from that of large trucks, especially in the Municipal road category. While Interstate highways still shows over twice the expected proportion, the proportion of total vehicle defect crashes in Interstate highways is 20.48% for passenger cars, while it was over twice that at 43.67% for large trucks.

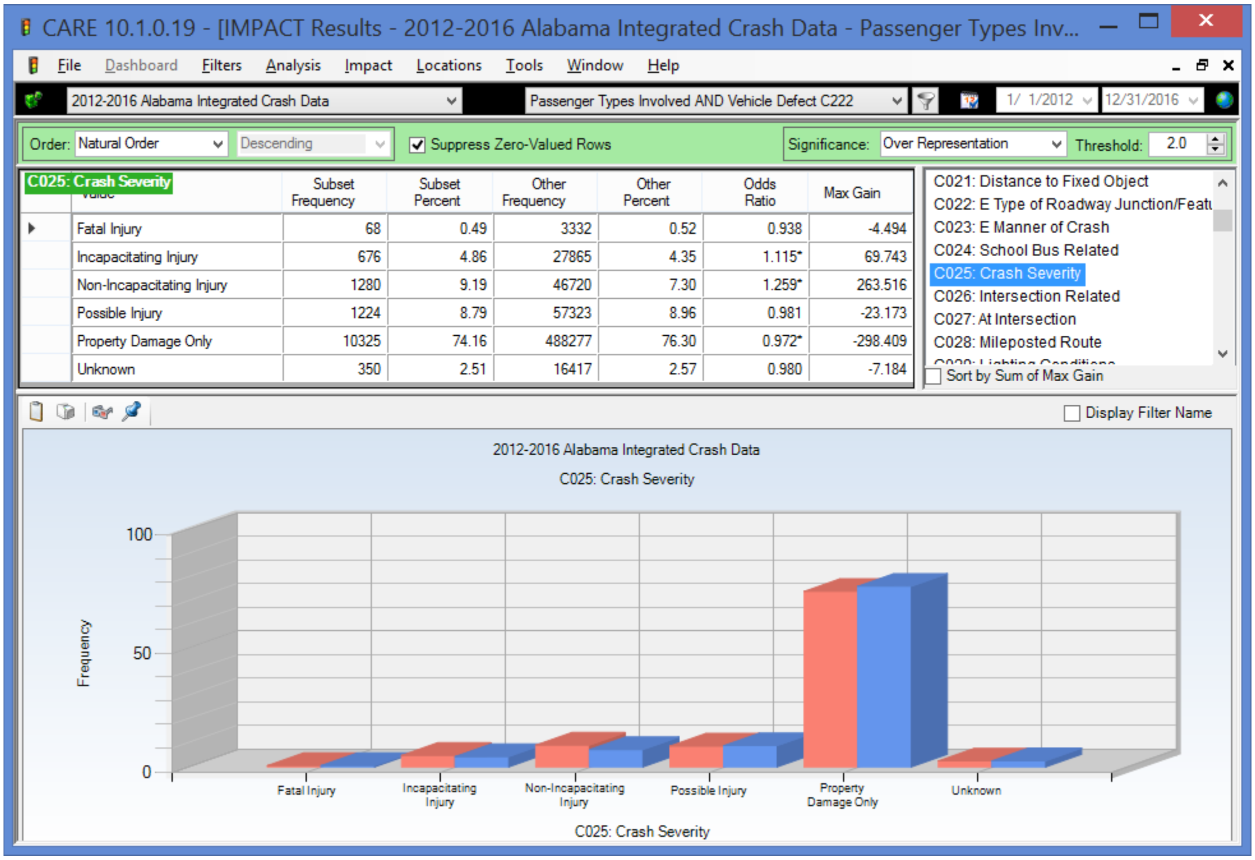
Tire blowouts and tread depth issues tend to occur at higher speeds, as shown in the following cross-tabulation of impact speeds by vehicle defect.   This accounts for their increased severity, which is covered in the next section.

CARE 10.1.0.19 - [Crosstab Results - 2012-2016 Alabama Integrated Crash Data - Filter = Passenger Types I...

Column: CU Estimated Speed at Impact ; Row: CU Contributing Vehicle Defect

	36 to 40 MPH	41 to 45 MPH	46 to 50 MPH	51 to 55 MPH	56 to 60 MPH	61 to 65 MPH	66 to 70 MPH	71 to 75 MPH	76 to 80 MPH
Brakes	299	327	131	133	51	40	49	12	3
Steering	70	109	48	73	28	35	39	6	2
E Tire Blowout/Separatio	89	197	117	295	194	384	745	82	31
E Improper Tread Depth	102	170	106	200	103	131	114	17	9
Wheels	39	58	55	74	38	42	68	3	1
E Wipers	4	2	1	3	1	1	1	0	0
Windows/Windshi eld	8	7	2	2	1	2	2	0	0
E Mirrors	4	5	0	0	0	2	2	0	0
Trailer Hitch/Coupling	27	22	10	17	9	16	11	0	0
Power Train	21	37	13	33	15	26	37	0	1
Fuel System	6	12	3	4	2	3	14	0	1
Exhaust	0	0	0	0	0	0	0	0	0
E Headlights	7	13	1	4	3	4	1	0	0
E Tail Lights	4	4	6	4	3	3	1	1	0
Turn Signal	2	0	0	1	0	1	0	0	0
Suspension	11	15	11	15	8	13	6	0	0
E Cruise Control	0	1	1	1	2	1	2	0	0
E Body/Doors	2	7	2	7	3	5	7	0	0
P Tires*	14	8	8	1	12	5	1	1	0
P Lights*	0	0	0	0	0	0	0	0	0
P Restraint System	0	0	0	0	0	0	0	0	0
P Cargo	1	0	3	0	2	1	0	0	0
TOTAL	710	994	518	867	475	715	1100	122	48

3.7 C025 Crash Severity



C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	68	0.49	3332	0.52	0.938	-4.494
Incapacitating Injury	676	4.86	27865	4.35	1.115*	69.743
Non-Incapacitating Injury	1280	9.19	46720	7.30	1.259*	263.516
Possible Injury	1224	8.79	57323	8.96	0.981	-23.173
Property Damage Only	10325	74.16	488277	76.30	0.972*	-298.409
Unknown	350	2.51	16417	2.57	0.980	-7.184

The severities of vehicle defect crashes are not nearly as reduced (comparatively speaking) with the passenger car subset as they were with large trucks. The difference in Fatal Injury is not statistically significant, and the increases in both Incapacitating and Non-Incapacitating injury types are significantly higher in proportion than what is expected from the non-vehicle-defect group. To analyze this attribute further, a cross-tabulation was run that analyzed the various severity levels by the vehicle defect type, as given below.

CARE 10.1.0.19 - [Crosstab Results - 2012-2016 Alabama Integrated Crash Data - Filter = Passenger Ty...

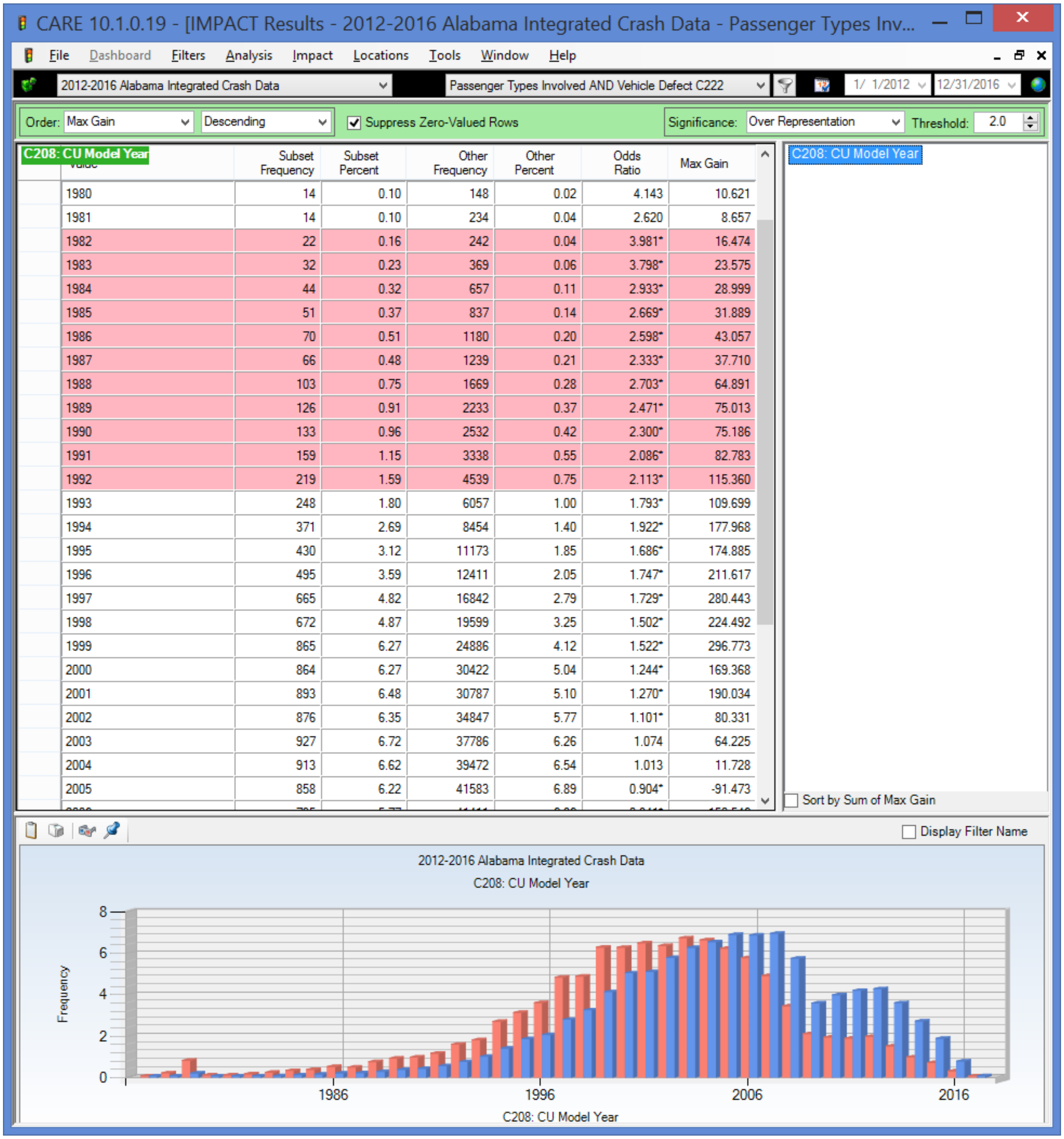
2012-2016 Alabama Integrated Crash Data | Passenger Types Involved AND Vehicle Defect C222 | 1/ 1/2012 | 12/31/2016

Column: Crash Severity ; Row: CU Contributing Vehicle Defect

	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Brakes	9 13.24%	172 25.44%	409 31.95%	636 51.96%	4353 42.16%	185 52.86%	5764 41.40%
Steering	1 1.47%	49 7.25%	107 8.36%	97 7.92%	689 6.67%	35 10.00%	978 7.02%
E Tire Blowout/Separatio	24 35.29%	175 25.89%	349 27.27%	194 15.85%	2244 21.73%	48 13.71%	3034 21.79%
E Improper Tread Depth	28 41.18%	175 25.89%	202 15.78%	144 11.76%	997 9.66%	15 4.29%	1561 11.21%
Wheels	2 2.94%	19 2.81%	63 4.92%	51 4.17%	599 5.80%	23 6.57%	757 5.44%
E Wipers	0 0.00%	2 0.30%	4 0.31%	8 0.65%	33 0.32%	3 0.86%	50 0.36%
Windows/Windshield	1 1.47%	7 1.04%	15 1.17%	9 0.74%	109 1.06%	6 1.71%	147 1.06%
E Mirrors	0 0.00%	0 0.00%	3 0.23%	4 0.33%	48 0.46%	1 0.29%	56 0.40%
Trailer Hitch/Coupling	1 1.47%	7 1.04%	13 1.02%	12 0.98%	230 2.23%	1 0.29%	264 1.90%
Power Train	0 0.00%	13 1.92%	33 2.58%	26 2.12%	425 4.12%	5 1.43%	502 3.61%
Fuel System	1 1.47%	4 0.59%	9 0.70%	2 0.16%	109 1.06%	4 1.14%	129 0.93%
Exhaust	0 0.00%	0 0.00%	0 0.00%	0 0.00%	5 0.05%	0 0.00%	5 0.04%
E Headlights	0 0.00%	12 1.78%	12 0.94%	11 0.90%	58 0.56%	5 1.43%	98 0.70%
E Tail Lights	1 1.47%	16 2.37%	22 1.72%	8 0.65%	78 0.76%	4 1.14%	129 0.93%
Turn Signal	0 0.00%	1 0.15%	8 0.63%	1 0.08%	41 0.40%	2 0.57%	53 0.38%
Suspension	0 0.00%	2 0.30%	16 1.25%	9 0.74%	122 1.18%	4 1.14%	153 1.10%
E Cruise Control	0 0.00%	3 0.44%	2 0.16%	0 0.00%	8 0.08%	2 0.57%	15 0.11%
E Body/Doors	0 0.00%	3 0.44%	9 0.70%	5 0.41%	56 0.54%	7 2.00%	80 0.57%
P Tires*	0 0.00%	15 2.22%	4 0.31%	7 0.57%	100 0.97%	0 0.00%	126 0.90%
P Lights*	0 0.00%	1 0.15%	0 0.00%	0 0.00%	6 0.06%	0 0.00%	7 0.05%
P Restraint System	0 0.00%	0 0.00%	0 0.00%	0 0.00%	3 0.03%	0 0.00%	3 0.02%
P Cargo	0 0.00%	0 0.00%	0 0.00%	0 0.00%	12 0.12%	0 0.00%	12 0.09%
TOTAL	68 0.49%	676 4.86%	1280 9.19%	1224 8.79%	10325 74.16%	350 2.51%	13923 100.00%

Clearly tire issues are the major factors for both severe injury and deaths. The two tire defects are quite different in the way that they cause crashes. Tire Blowout/Separation is quite intuitive in the way it would cause a loss of control. Improper Tread Depth, however, would usually have other contributing factors, such as a wet road surface, speed, or both to result in the loss of control. Comparing these two, while there are about twice as many Tire Blowout/Separations, the proportion of the most severe injury and fatal crashes are nearly identical. No doubt, tire issues rise to the top concern of passenger car crashes. Brake defects are a distant second priority, albeit with a much higher overall frequency (5,764 for brakes as compared to the tire issues of 3,934 for blowouts and 1,561 for tread depth).

3.8 C208 CU Model Year



C208: CU Model Year	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
1980	14	0.10	148	0.02	4.143	10.621
1981	14	0.10	234	0.04	2.620	8.657
1982	22	0.16	242	0.04	3.981*	16.474
1983	32	0.23	369	0.06	3.798*	23.575
1984	44	0.32	657	0.11	2.933*	28.999
1985	51	0.37	837	0.14	2.669*	31.889
1986	70	0.51	1180	0.20	2.598*	43.057
1987	66	0.48	1239	0.21	2.333*	37.710
1988	103	0.75	1669	0.28	2.703*	64.891
1989	126	0.91	2233	0.37	2.471*	75.013
1990	133	0.96	2532	0.42	2.300*	75.186
1991	159	1.15	3338	0.55	2.086*	82.783
1992	219	1.59	4539	0.75	2.113*	115.360
1993	248	1.80	6057	1.00	1.793*	109.699
1994	371	2.69	8454	1.40	1.922*	177.968
1995	430	3.12	11173	1.85	1.686*	174.885
1996	495	3.59	12411	2.05	1.747*	211.617
1997	665	4.82	16842	2.79	1.729*	280.443
1998	672	4.87	19599	3.25	1.502*	224.492
1999	865	6.27	24886	4.12	1.522*	296.773
2000	864	6.27	30422	5.04	1.244*	169.368
2001	893	6.48	30787	5.10	1.270*	190.034
2002	876	6.35	34847	5.77	1.101*	80.331
2003	927	6.72	37786	6.26	1.074	64.225
2004	913	6.62	39472	6.54	1.013	11.728
2005	858	6.22	41583	6.89	0.904*	-91.473

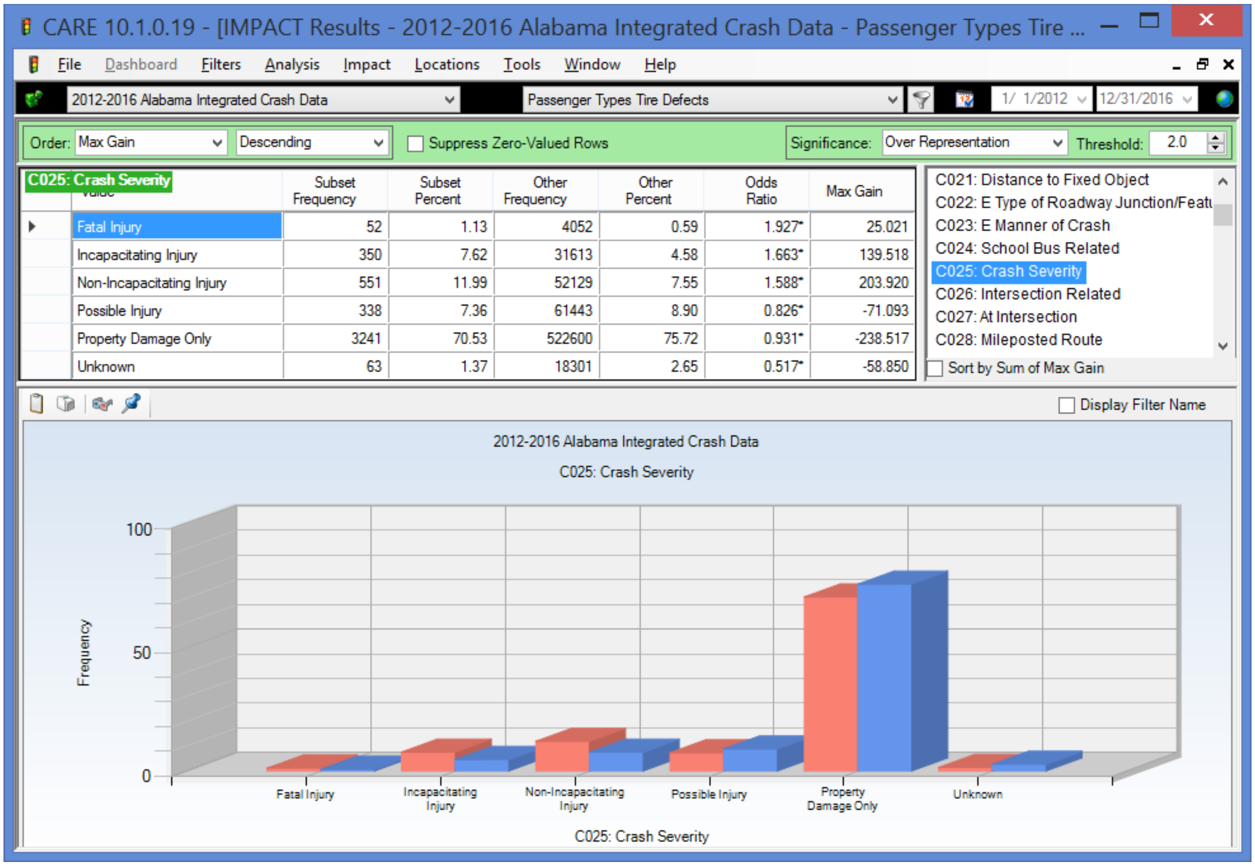
The significant over-represented model years are from 1982 through 2002. It is reasonable to expect that older vehicles would have more problems in this regard.

3.8 Passenger Vehicle Tire Issues Further Analysis

The single vehicle defect highest killer was in tire issues. Over five years there were 3,034 crashes caused by blowouts/tire separation, and 1,561 crashes caused by tread depth issues over the five years of the study (4,595 total for tire issues). While the cross-tabulation in Section 3.7 indicates that tread depth was a slightly higher cause of death with 28, as opposed to blowouts, which has 24, there is no implication that the difference between these two numbers is statistically significant. The 52 tire defect fatal crashes resulted in a total of 60 fatalities (12 fatalities per year).

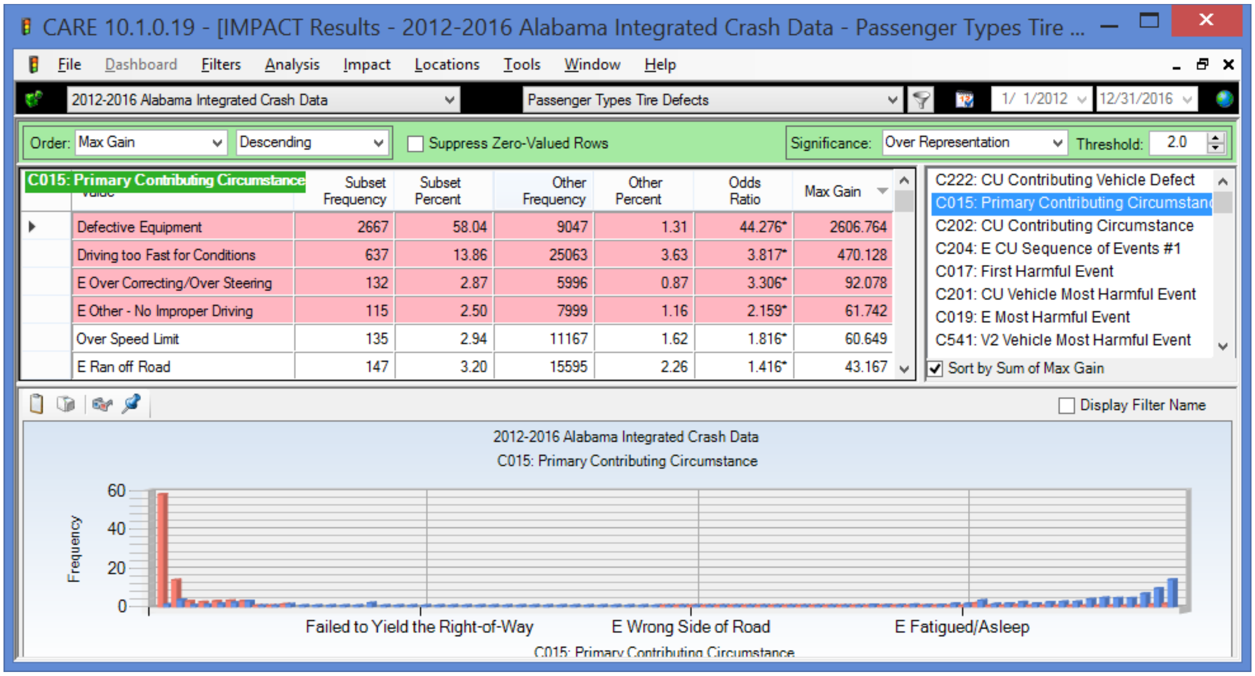
These two tire issues account for almost 80% of the fatalities, and the next highest (brakes) had only about 13%, with the remaining being distributed one-each among the other attribute values. It is clear that tire issues are head and shoulders over all other vehicle defect issues when it comes to passenger car fatalities.

This being the case, a subset was formed of the 4,595 defective tire cases in an effort to flush out the demographics and focus in on the source of these problems. The following gives a summary by severity as compared to all other crashes that occurred in the five year period.

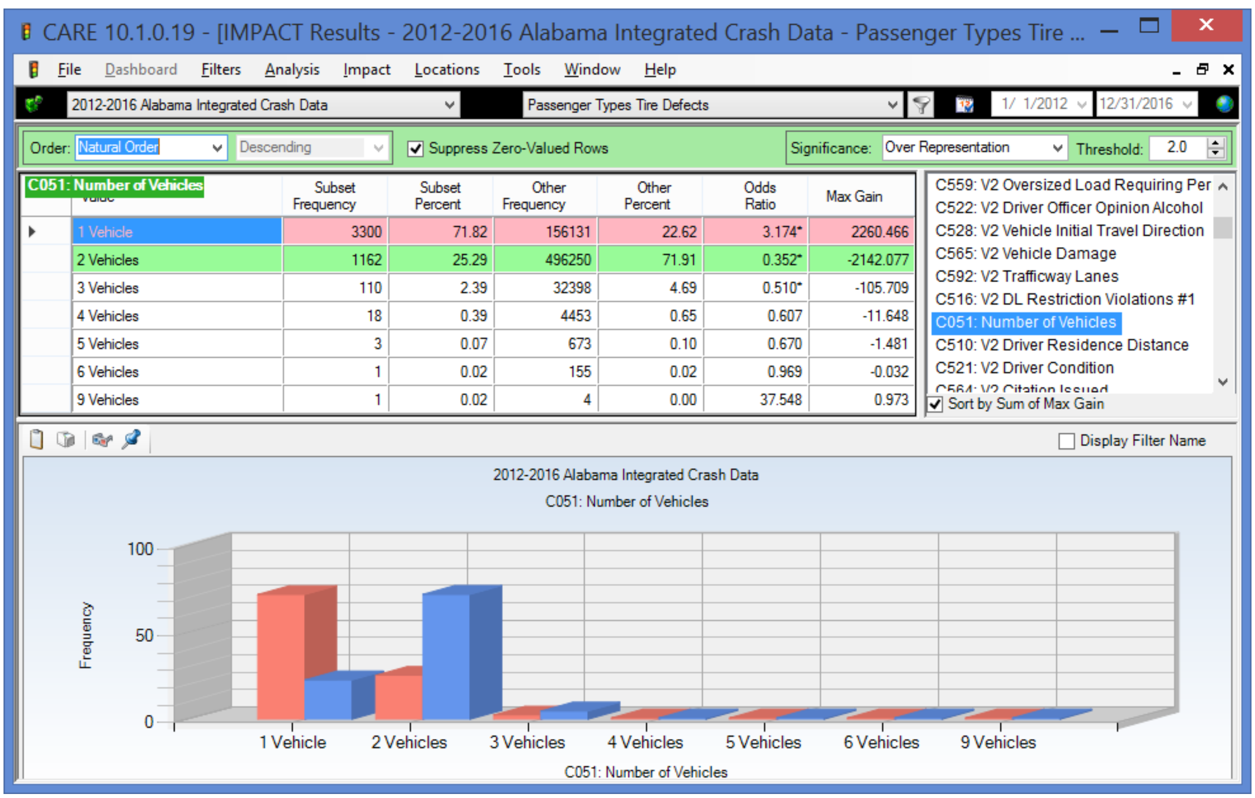


Notice that the proportion of Fatal Injury for these crashes is close to double what it is for all other crashes. The two highest injury categories are also over-represented by about 60% higher than expectation (58.8% and 66.3%). Thus, we can conclude that these are not minor problems, and something should probably be done to address them, if nothing other than a PSA.

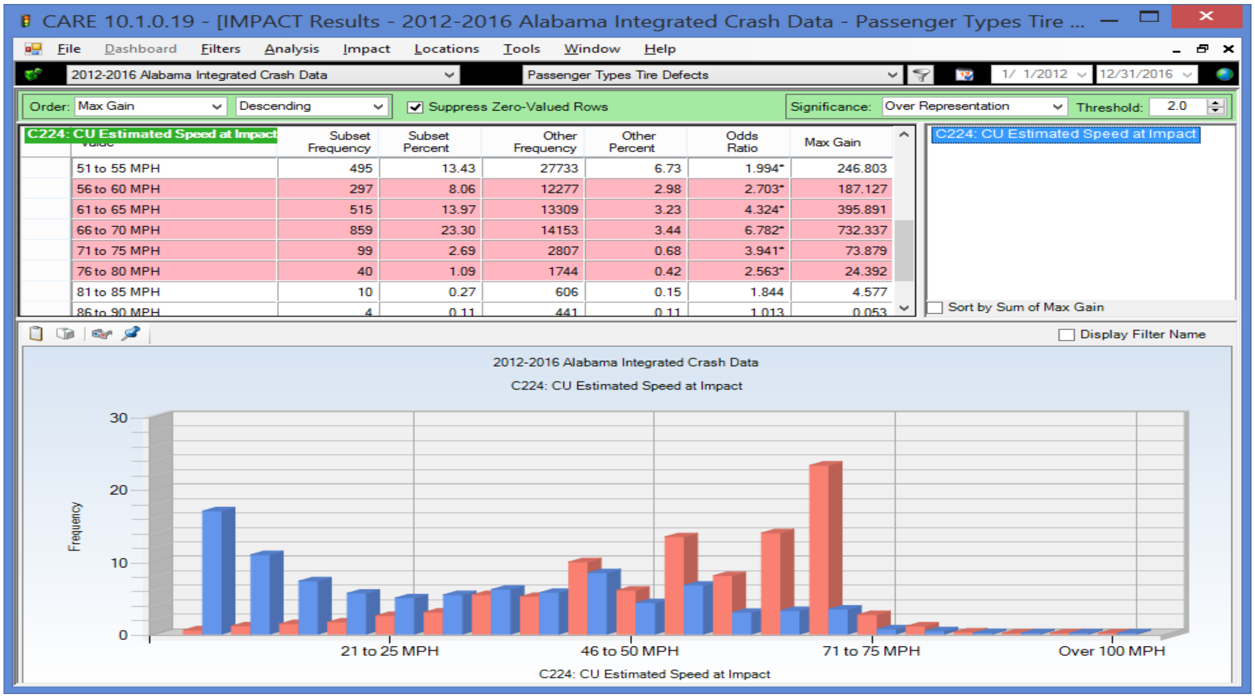
The following comparison for Primary Contributing Circumstances indicates that tire problems are usually coupled with speed in order to create the crash problem.



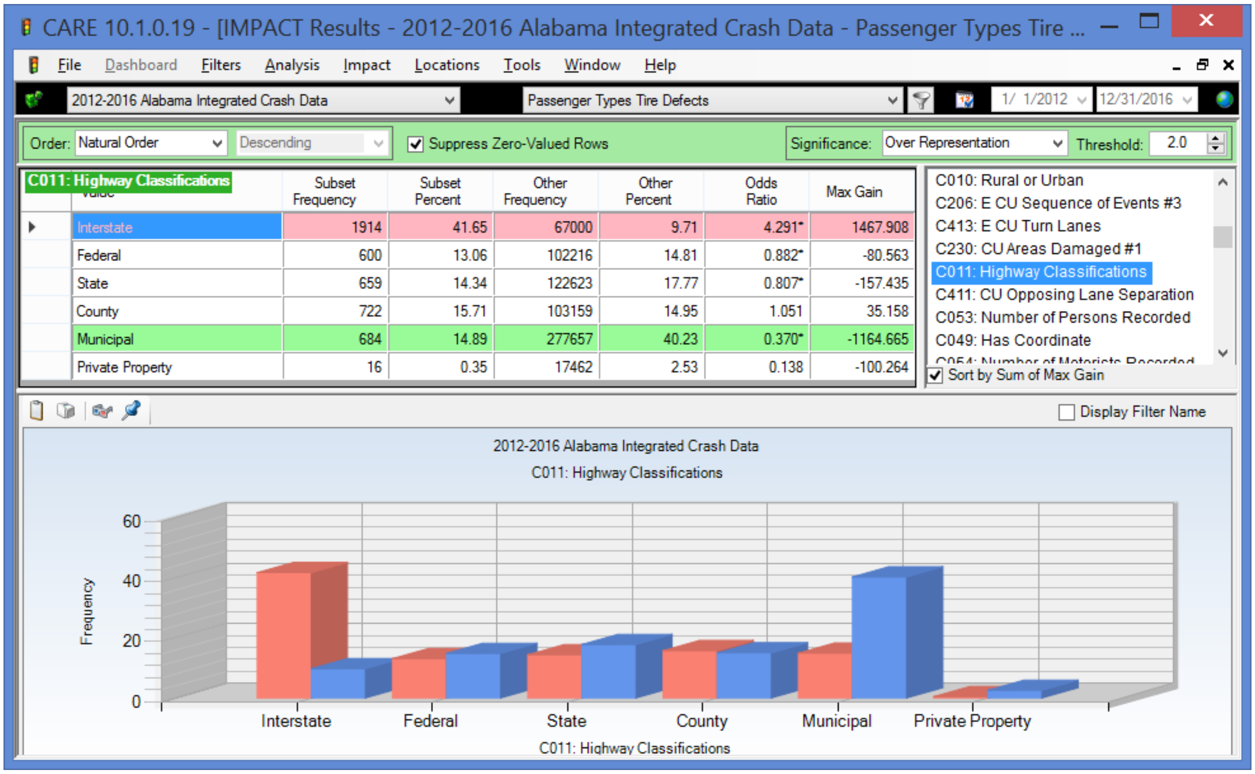
The vast majority of these crashes are single vehicle, as shown by the next display.



Impact speed for these crashes is relatively high, further reinforcing the speed cofactor, and as would be expected, they occur more in open country (rural areas).



C224: CU Estimated Speed at Impact Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
51 to 55 MPH	495	13.43	27733	6.73	1.994*	246.803
56 to 60 MPH	297	8.06	12277	2.98	2.703*	187.127
61 to 65 MPH	515	13.97	13309	3.23	4.324*	395.891
66 to 70 MPH	859	23.30	14153	3.44	6.782*	732.337
71 to 75 MPH	99	2.69	2807	0.68	3.941*	73.879
76 to 80 MPH	40	1.09	1744	0.42	2.563*	24.392
81 to 85 MPH	10	0.27	606	0.15	1.844	4.577
86 to 90 MPH	4	0.11	441	0.11	1.013	0.053



County roads are about as expected perhaps because it is difficult to travel these roads at too high a rate of speed. Federal and State roads are under-represented in favor of Interstates.

The causal unit model year follows about the same as given above, with the older vehicles (up to 2004 for this subset) being over-represented. Driver ages that are over-represented are those from 18-30 years if age. Wet roadways have about twice their expected number of crashes (we suspect that further analysis will show this coming from the low tread tires as opposed to the blowouts). Males are over-represented by about 24% higher proportion than expected. While day of the week is close to the DUI pattern (over-representations on weekend days), the time of day favors the two or three hours before the typical rush hours.

4.0 Discussion on Potential Inspection System for Alabama

Most of the promotion of vehicle inspection systems within the states has been conducted in isolation. If you consider the loss of one life and multiply it over the five year death toll of 68 fatal crashes (about 14 per year), the cost of implementing a vehicle inspection system is indeed cost-beneficial. What is not considered, however, is the downside of such an expenditure. Please see general considerations for traffic safety investments that is given here in the left panel under the title of "Optimal Traffic Safety Allocation" linked to here:

http://www.safehomealabama.gov/SafetyTopics/GeneralTrafficSafety.aspx

The failure is one of not seeing the effect that saving these 14 lives per year is going to have on failing to save even more of the average of 895 fatalities per year over the last five years. Advocates (in all areas) often fail to see the downside of their actions, and as a result, traffic safety resources will not produce the maximum savings of fatalities. Most traffic safety countermeasures have several downsides, but one that is always present is the zero sum game of the total safety budget, which any given program must deplete.

So, for example, if a given countermeasure costs $100,000 per year (for example) these dollars will have to come from other traffic safety programs. It is not a matter of going to the general fund; and even if it were, the same argument could be made, that this $100k should go to a countermeasure that has a higher benefit to cost ratio.

The cost of most countermeasures is fairly easy to obtain; however, the benefits that any one of them will produce is highly speculative, and we must turn to the traffic safety professionals to estimate these benefits. There are a number of resources to this effect available from NHTSA (e.g., *Countermeasure that Work;* https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812239_countermeasures_8thed_tt.pdf).

Few studies of effectiveness have been performed for vehicle inspection systems for a variety of reasons. But the major issue is in isolating the number of crashes that will be reduced by implementing the program. "The program" itself is not at all defined, since there are variations in every state that has implemented a program. So it is impossible to aggregate the results.

Please review the findings above. Recognize that large truck inspections are handled already by FMCSA mandates. In essence, they already have an inspection system. So, we are mainly talking about the second half of the findings given above – those for passenger cars. The major problem with passenger cars was found to be tires. Further analyses can and should be done if programs to address this problem are to be developed. This can easily generate the target groups and the demographics that should be employed to develop the most effective program.

The big question that must be answered: is a full scale inspection system necessary to deal with the issue of car tires. Could one be developed that just concentrated on these issues and perhaps the third item, which was brakes? Would a PI&E program be just as (perhaps more) effective, but at a fraction of the cost? Could tire providers be involved in not repairing tires that are prone to be defective?

We are not prepared to answer these questions at this point; we feel that raising them is sufficient to getting decision-makers thinking in the right direction. We urge decision-makers to consider how many lives might be saved if the cost of implementing an inspection program were to be invested in other more cost-effective countermeasures. We stand ready to provide additional information to help them if they feel that such an effort would be warranted.