Special Study
Large Truck and Bus Analysis
for the State of Alabama
Data: 2011-2015; Last Update 2018

Alabama Department of Transportation
and
The University of Alabama Center for Advanced Public Safety (CAPS)

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For more information on this subject from NHTSA and other sources, please see:
http://www.safehomealabama.gov/tag/large-trucks-and-cmvs/

Recommendations and Executive Summary

Recommendations

This section will attempt to stay away from the typical traditional safety recommendations in order to concentrate on those discovered from the research that is summarized in the next section. This does not mean that the safety practices typically taught as standard large truck training are not important. They are important and should be given priority, both in training and in practice. The following is a partial list given for review:

- Observe speed limits and avoid all aggressive driving practices;
- Absolutely no mind-altering drugs or alcohol – check with your doctor on prescription drugs;
- Always fasten restraints;
- Avoid all electronic communication devices;
- Anticipate and avoid bad weather if at all possible;
- Obtain equipment and provide training to assure that loads are adequately fastened to prevent cargo falls or load shifts;
- Drive defensively, which includes: (1) constantly surveying the horizon well ahead looking for potential hazards (such as brake lights), (2) special efforts to put distance between you and other vehicles if at all possible, and (3) let aggressive drivers pass by tapering off your speed until they do.
- Perform all required safety checks to assure equipment is more than adequate for the trip, recognizing that tires are the number one cause of vehicle-defect crashes;
- Use standard practices for mitigating the effects of a tire blow-outs.

The recommendations that emerged from this study will be given within their respective categories below.

Aggressive Driving. It is good to note here first that aggressive driving was under-represented in all large truck and bus units, and for that reason no attention was given to it in this special study, since it is covered here: http://web01-staging.caps.ua.edu/safehome/caps-special-studies/ However, there were 7767 (1553 per year) cases reported in large truck units, and because of the intimidation of such units, this could cause a negative response from the driving public. We highly recommend that drivers take a break if they are feeling at all stressed, especially if it is caused by frustration with the surrounding traffic.

At-Fault Findings. The finding that LTs are only 20% at fault in fatal crashes (out of an expected 50%) is a major finding that is counterintuitive to the driving public, if not to the traffic safety community. (Similar results were indicated for buses.) Its ramifications impact most of the recommendations given below in that it is clear that the passenger car driver is in need for behavioral modification as they interact with the larger vehicles. These will be mentioned in the following recommendations.

EMS Arrival Delays and Crash Severity. Since rural, higher-speed (even if speed limits are observed) tend to result in more fatal crashes, our recommendation is that truck and bus drivers be given *voluntary* pre-first responder training to the extent that is practical. This is not to make them into EMTs or anything close to that, but to give them some major tips on how to preserve life until a first responder unit (police or EMS) arrives. They should also be instructed on whatever Good Samaritan laws are in effect in the areas where they operate.

Driver Age. The records show an increasing driver age distribution that has very little chance of being reversed in the next decade. If the projections remain, this will result in an increase in the average age of drivers by two years. While this does not seem to be large, this increase at the upper end of the distribution could be problematic. This distribution is currently centered around 46-50 years of age. Over a recent five year period there were 412 crashes caused by truck drivers over the age of 70. It is recommended that trucking and bus companies monitor the health of their employees and provide free medical checkups and a graceful way to enable those who become disabled because of age to retire or to be given lighter duty that will not be impacted by any health problems. (Recognize that companies may not be able to see medical records because of HIPAA.) The age distribution for buses is effectively the same as for large trucks, and the same increase in the average age is expected.

Driver Gender. Female causal drivers have a higher fatality rate than their male counterparts since they are much more apt to be the driver of the passenger car when a crash involves a male and a female driver. This argues for training and PI&E with regard to passenger car drivers' behavior around large trucks to be targeted toward women drivers.

Blind Spots. Drivers have been trained and experienced to deal with blind spots, but the over-represented crashes in the (1) Primary Contributing Circumstance areas of Improper Lane Change/Use, Made Improper Turn, and Unseen Object/Person/Vehicle; (2) the "Same Direction Sideswipes" Manner of Crash; and (3) Changing Lanes in the Vehicle Maneuver, in large truck crashes indicates that this problem persists. We do not see too much improvement from training. Instead, we recommend that electronic devices be installed (ultimately possibly mandated) on large trucks to enable the drivers to monitor their blind spots and/or to provide warnings when the vehicle is moving in the direction of a crash. We also recommend that additional training and testing of passenger vehicle drivers be conducted to make them mindful of the need to spend as little time as possible in a truck or bus blind spot. Bus characteristics of crashes are nearly identical to those for LTs, and so recommendations for buses are effectively the same as for large trucks.

Slopes. The effect of slopes on the operation (mainly speed) of large trucks is something that passenger car drivers need to realize, since it is largely beyond the control of the LT driver. Recommended is increased training and testing on this subject, since it seems that currently there is a lack of recognition of the issue.

Time of Travel. If at all possible, use the results of Sections 4.2.1 and 4.2.2 to choose times when crashes are at their lowest levels. Notice that while fewer crashes are recorded to occur very late night and early morning, these times are not recommended for two reasons. Impaired driving (ID) is at its highest during these times, especially on holidays and weekend, and it is very difficult for those who typically do not drive at these times to fight off drowsy driving, which can be as deadly as ID.

Executive Summary

This summary will be ordered according to the section numbers in the report to provide for easy reference to the source data.

1. Introduction. The introduction presented the following:

- Definition of a "large truck (LT)."
- Definition of "Bus."
- Definition of involvement.
- Time period for the study = 2011-2015.

1.1 – Overall Crash Summaries by Severity

1.1.1 – LT and Bus Involvement Compare to Other Crash Types

- LTs have 20 times the number of crashes than buses.
- LTs have 50 times higher the number of fatalities than buses.

1.1.2 Severity IMPACT Comparing LT with non-LT Crashes

- LT fatal crashes are over-represented by an Odds Ratio of 2.442 compared to all non-LT vehicles.
- Incapacitating injuries were also significantly over-represented but by a smaller Odds Ration (1.149).

1.1.2.1 Estimated Impact Speed Comparison LT with non-LT

- LTs typically have higher impact speeds compared to collisions that do not involve LT, probably due to the roadway speed limits on which most of them travel.
- Every increase in impact speed of approximately 10 MPH doubles the chance of the crash being fatal.

1.1.2.3 EMS Arrival Delay Speed IMPACT comp LT with non-LT

- The shortest two arrival time intervals are under-represented.
- This is fairly typical of the rural-urban mix in which these trucks typically operate.
- It could contribute heavily to the higher death rate in LT crashes.

1.1.3 Severity IMPACT: Bus Involved vs non-Bus Involved Crashes

- Of the 8 fatalities found, none were recorded to have been bus occupants: they were: 4 in passenger cars, 1 in an SUV, 2 pedestrians and 1 not recorded.
- The fatality rate for bus crashes is not significantly different from that of the overall crash population.

1.1.3.1 Estimated Impact Speed IMPACT Comparison Bus with non-Bus

- This result showed a very large contrast with LTs (Display 1.1.2.1) in that the impact speeds were relatively low.
- This is fairly typical for traffic operations in general that are concentrated in urban areas.

1.1.3.2 EMS Arrival Delay Speed IMPACT comp Bus with non-Bus

- None of the values for delay time were significantly different from what would be expected in the general population of crashes.
- While EMS arrival delay is not an issue in general, it is a major factor in certain remote crashes that involve heavy injury, and further research is warranted on this subject.

1.2 Trend Analysis for Large Truck Crashes

1.2.1 Overall Large Truck (LT) Crash Trend

- The LT crash trend for 2006-2015 was down reflecting the overall trend in traffic crashes over the past ten years, due largely to the reduction in mileage caused by the economic downturn.
- Unfortunately, the crash pattern of the last three years trended back up, again probably because of the rebound of the economy in 2013-2015.
- The number of trucks on the road at any given time is the largest predictor of crash frequency.

1.2.2 Large Truck At-Fault Trend – see Section 2.1.

1.2.3 Fatality Large Truck Crash Trend

- The slope of the regression line is about -4.75 crashes per year, estimating an average reduction of 48 fatality crashes over the ten year period.
- The correlation coefficient (r-squared) of 0.4756, indicating that 47.56% of the variance in the number of fatal crashes is correlated to the year value. This is a very positive result.

1.2.4 Large Truck Crash Causal Driver Age Trend

- The average age of LT drivers was found to be generally increasing over the ten year period of the study, with an average increase of about 2 years over the ten year period.
- The slope of the regression line was 0.2153 average driver age (in years) per year, with a correlation coefficient (r-squared) of 0.6961, indicating that 69.61% of the variance in average ages can be attributed to the year value.

1.3 Issues with the Trend Analysis for Bus Crashes

- The data prior to CY2014 is both inconsistent and incomplete, and thus the observed differences should be used only for information about the data and not indicative of increasing number of bus crashes.
- Reasons for the data deficiencies are discussed in this section.

2 At-Fault Analyses by Severity

Definition. This At-Fault analyses required that there be two vehicles in the crash, so all single vehicle crashes were excluded from consideration. For LTs, the objective is to determine for any crash involving a large truck and another type of vehicle, what is the probability that the LT was at fault. Similarly for bus crashes.

2.1 At Fault Analysis for Large Trucks

- The probability of a LT being at-fault in any given two-vehicle crash is highly dependent on the severity of the crash.
- The over-representation in PDO and Total (includes PDOs) is somewhat expected.
- Their dramatic under-representation in fatal crashes (only 20%, out of an expected 50%) is notable since these crashes involve much more detailed investigation, and thus it is not just the opinion of one reporting officer.

2.2 At Fault Analysis for Buses

- There were only eight fatal crashes in the bus dataset used for analysis (2001-2005), and only one of them was caused by the bus unit.

- The relative low fault probabilities for all crashes, and especially for all injury crashes, tends to validate the finding that buses have an excellent record for all severity classifications, but especially for those involving injury.

3 Driver Analysis for Large Trucks

3.1 Driver Demographics

3.1.1 Causal Driver Gender IMPACT comparison

- The raw numbers do not take into effect that there are far more male than female drivers, so there can be no implication that the one gender causes more than the other.
- However, it is clear that female drivers are over-represented in fatal and injury crashes relative to their proportion in the driver population. This was found to be caused by the overwhelmingly high proportion of female drivers of the passenger vehicles when they are involved in crashes with large trucks.

3.1.2 Causal Driver Age

- There is almost a perfectly normal distribution centered around 46-50 years, which tends to match the mean of the professional driver age.
- Causal ages that tend to be over-represented are at the youngest (31-35 years and younger) and the oldest (71 years and older) extremes.

3.2 Driver Related Crash Causes

3.2.1a PCC IMPACT comparing LT with non-LT (Over-Representations)

- Most over-represented were Improper Lane Change/use; Defective Equipment, Cargo fell or Load Shift, Made Improper Turn and Unseen Object/Person/Vehicle.

3.2.1b PCC IMPACT Comparing LT with non-LT (Under-Representations)

- Most under-represent for LT involved crashes were: (1) several distracted driving categories, (2) several failure to yield categories, (3) two high speed categories, and (4) misjudge stopping distance, all of which are highly correlated with lack of driver experience and risk-taking.
- Truckers typically have relatively few problems with DUI.

3.2.2 First Harmful Event IMPACT Comparing LT with non-LT

- The highest percentage First Harmful Event (FHE) was Collision with Vehicle in Traffic. The percentage of Collision with Vehicle in Traffic was 72.48% for non-LTs but was only 70.12% for LTs (significantly under-represented), although still the predominant FHE.
- As with the over-represented PCC categories, most of the over-represented FHEs are closely associated with large truck issues as opposed to anything that was found to be unexpected.

3.2.3 Manner of Crash IMPACT comparing LT with non-LT

- Sideswipes in the same direction are by far the largest over-represented value, which is clearly an issue of the truck blind spots.
- Future innovations need to detect and warn drivers when they are in blind spots since they are often too busy with their electronic devices to notice.

3.2.4 Causal Unit Vehicle Maneuver IMPACT Comparison

- Changing Lanes in this analysis is closely related to Same Direction Sideswipes in the Manner of Crash analysis.

- Contrast Turning Right with Turning Left, which is under-represented since LT drivers have better visibility on the left side.
- Slowing/Stopping in this attribute corresponds heavily to Rear Ends in the Manner of Crash and to Misjudging Stopping Distance in the PCC attribute.

4 Large Truck Crash Analysis

4.1 Geographical and Roadway Aspects

4.1.1 Rural-Urban IMPACT Comparing LT Involved with non-LT

- Urban crashes outnumber the rural crashes for LTs, but they are over-represented in rural areas almost by a factor of 2.
- Due largely to the increased speeds in the rural road system fatal crashes and those of the higher two severity classifications are over-represented in the rural areas.

4.1.2 Highway Classification IMPACT Comparing LT Involved with non-LT

- Interstates are over-represented by more than a factor of 3, and Federal and State roads are significantly over-represented, but not nearly as much.
- The higher speeds on these roadway types clearly cause more fatal and injury crashes.

4.1.3 Weather IMPACT comp LT with non-LT

- LTs were found to be under-represented in rain when compared to other vehicle types.
- This is probably due to the truck drivers' experience in wet weather.

4.1.4 Roadway Curvature and Grade IMPACT Comparing LT with non-LT

- The primary issue seems to be with grades, either up or down.
- "Up" increases interaction with faster moving traffic.
- "Down" renders larger vehicles more difficult to control.

4.1.5 Workzone IMPACT comp LT with non-LT for Crashes in Workzones

- Workzones were involved in about 6.7% of all LT crashes, while the non-LT vehicles had only 1.7% involved in workzones, so the LTs are dramatically over-represented in workzone crashes.
- The following factors might be given special consideration: (1) Some of the crashes involving equipment could be LT equipment; (2) the most under-represented location (Between the Warning Signs and the Work Area) should not be neglected since, in this case, since it has the highest frequency; and (3) while the workzone reporting codes are not mutually exclusive, they probably give the best description for any particular crash.

4.2.1 Time of Day IMPACT Comparing LT with non-LT

- The morning rush hour and the following hours are seen to be a problem right through 3:59PM.
- The presence of other issues at these times would probably not make either the morning or the afternoon rush hours good times to do LT selective enforcement.
- The most under-represented times are late afternoon on through to before midnight.
- Optimal times for enforcement would seem to be from 8:00 AM through 2:59 PM.

4.2.2 Day of the Week IMPACT comp LT with non-LT

- As expected, the over-represented days reflect the days that the majority of LT vehicles are on the road, and especially those times when other traffic is not (ideal situation).

- Saturday and Sunday are probably way down because of the reluctance of those receiving freight to be working on those days.
- Friday is the only under-represented week-day, and although the frequency is quite high on Friday, officers are generally working on other issues on Friday, especially in the afternoons.
- The optimal time for enforcement would seem to be Monday through Thursday hoping that there would be a halo carry over for Fridays.

4.2.4 Month IMPACT comp LT with non-LT – no practically significant results found

5 Large Truck Vehicle and Cargo Analysis

5.1 Analysis by Hazardous Cargo

- This section contains information that will be of use to those involved with hazardous cargo, and especially first responders.

5.2 Vehicle Defects

- The most pervasive vehicle defect that caused crashes in HTs was the same as that mose predominant in vehicles in general: Tire Blowout/Separation. The degree is about the same as well, being about twice the next defect.
- Those defects with more than 50 occurrences, in order of their frequencies over the five year period: Tire Blowout/Separation (577), Brakes (416), Wheels (136), Power Train (87), Tralier Hitch/Coupling (84), and Steering (60).
- Related to tire failure was Improper Tread Depth, which had 41 occurrences.

5.3 Vehicle Attachment

- There is no implication that the attachment (e.g., trailer) caused the crash in any way; it is just recorded as an item to define the vehicle for the record. Without a control subset (e.g., the distribution of all attachments in HT vehicles), there is no way to determine if any one of these is more prone to be involved in a crash than any other.

6 Bus Crash Analyses

6.1 Driver Demographics for Bus Involved Crashes

6.1.1 Causal Driver Gender for Bus Involved Crashes

- Bus causal driver gender is not significantly different from that of crashes in general.
- This amounts to about 50-52% male, 42-44% female, and 5.5-6.0% unknown.

6.1.2 Causal Driver Age for Bus Involved Crashes

- The age distribution for buses is much the same as for large trucks (see Section 3.1.2).
- The only notable difference is in the 16-20 and the 21-25 year olds, which are not nearly as under-represented for buses as they are for large trucks.

6.1.3 Driver Related Causes for Bus Involved Crashes

6.1.3.1 Primary Contributing Circumstances (PCCs) for Bus Involved Crashes

- Generally the most over-represented categories are those associated with the control of a larger vehicle and the restrictions on the ability of the driver to see and be aware of hazards.
- In order of their over-represented proportions: Made Improper Turn, Unseen Object/Person/Vehicle, Improper Backing, Improper Lane Change Use and Crossed Centerline.

6.1.3.2 First Harmful Event for Bus Involved Crashes

- The highest First Harmful Event for buses was Collision with Vehicle in Traffic, which amounted to 1035 (75.66% of the) bus crashes, which was significantly over-represented from the expected value from all other vehicles of 68.34%.
- Removing this and those with five or less crashes in the five-year period, the only two that were significantly over-represented for buses were: Collision with Parked Motor Vehicle, and Collision with Vehicle in (or from) another Roadway.

6.1.3.3 Manner of Crash for Bus Involved Crashes

- This appears to be one attribute that buses and large trucks have in common, obviously because of the inability of the driver to see in the blind spots.
- They are both significantly over-represented in both sideswipe categories and in Side Impact (angled).

6.1.3.4 Causal Unit Vehicle Maneuver for Bus Involved Crashes

- The following are the four vehicle maneuvers where buses are significantly over-represented (frequency, over-representation factor): Turning Right (151, 2.43); Backing (122, 2.08); Turning Left (188, 1.33); and Overtaking/Passing (26, 1.98).

6.2 Bus Crash Analysis

6.2.1 Bus Rural-Urban

- The bus rural-urban location comparison shows a considerably different pattern than that given for large trucks, in which rural crashes were over-represented.
- For buses, urban crashes are significantly over-represented when compared to crashes involving all other vehicle types.
- However, a rural-urban severity comparison showed amazingly similar results as that obtained when considering bus crashes.
- Buses' lower speeds on urban roadways, and the fact that buses have a much higher proportion of urban crashes than large trucks accounts for their generally lower fatality and severe injury rates.

6.2.2 Bus Highway Classification

- There was a dramatic over-representation of crashes on municipal roadways, with Interstate, state and federal roads being under-represented.
- All of the differences are significant with the exception of county roads, which were essentially equal in proportion.

6.2.3 Bus Weather Analysis

- As was true of large trucks, weather does not seem to be a major factor for bus crashes in comparison to non-bus crashes.
- Over the five year period, buses had only 89 crashes in the rain, which accounted for 6.51% as opposed to 11.11% for non-bus crashes, a statistically significant difference that indicates greater skill in bus drivers in dealing with inclement weather.

6.2.4 Bus Roadway Curvature and Grade

- The vast majority of bus crashes occur on straight and level roadways, 78.69%, which is significantly higher than the 69.08% of all other vehicles.
- A major reason for this is that they probably tend to operate on more straight and level roadways than the traffic in general. Omitting the straight and level from consideration, buses are over-represented

in both the down-grade and the up-grade categories, with the Straight with Down Grade being statistically significant.

6.2.5 Bus Workzone Analysis

- Only 20 of the 1,370 bus crashes were reported to have occurred in workzones, which is about 1.46% of bus crashes, as compared to 1.81% for all other vehicles.
- So, although buses are a slight bit under-represented in workzones, this cannot be considered significant with such a small sample size.

6.3 Bus Time Factors

6.3.1 Bus Time of Day

- There are three hours when bus crashes are particularly over-represented that should be of note:
    - 6:00-6:59 AM when buses have about three times their expected proportion of crashes;
    - 7:00-7:59 AM which is the second highest in frequency (219 crashes over the five years); while this time slot has a lower over-representation ratio (2.59 as opposed to 3), its frequency (219) is over twice that of the previous hour; and
    - 3:00-3:59 PM, the early afternoon rush hour, which has the highest proportion, with a frequency of 299 crashes and a over-representation ratio of over double (2.411).
- The extremely large combined early morning and early afternoon rush hour over-representations may be a pattern that need to be investigated carefully, and it should be subject to further research. While no conclusive results can be reached without further analyses.
- It might be hypothesized that fatigue could be an issue with drivers coming to the end of a long period of driving and at the same time encountering heavy traffic.
- Since most buses operate on tight schedules, there is little that drivers can do to account for times except to be aware of those times when they are going to have to deal with more traffic.

6.3.2 Bus Day of the Week

- The over-representations reflect the days at which buses are in operation as well as the density of other traffic.
- Monday, Tuesday and Friday's over-representations were statistically significant. These days (along with the two other week-days) would have much higher rush hour traffic than would Saturday and Sunday, so there is distinct correlation between the time of day and the day of the week.

6.3.3 Bus Month of the Year

- The best months over the past five years for bus crashes has been June and July.
- The two worst months are September and October.
- Additional analyses would be warranted to compare these two time periods to determine what may be the causes for these large and significant disparities.

7 County Summaries for 2014 and 2015

7.1 Large Trucks and Buses by County

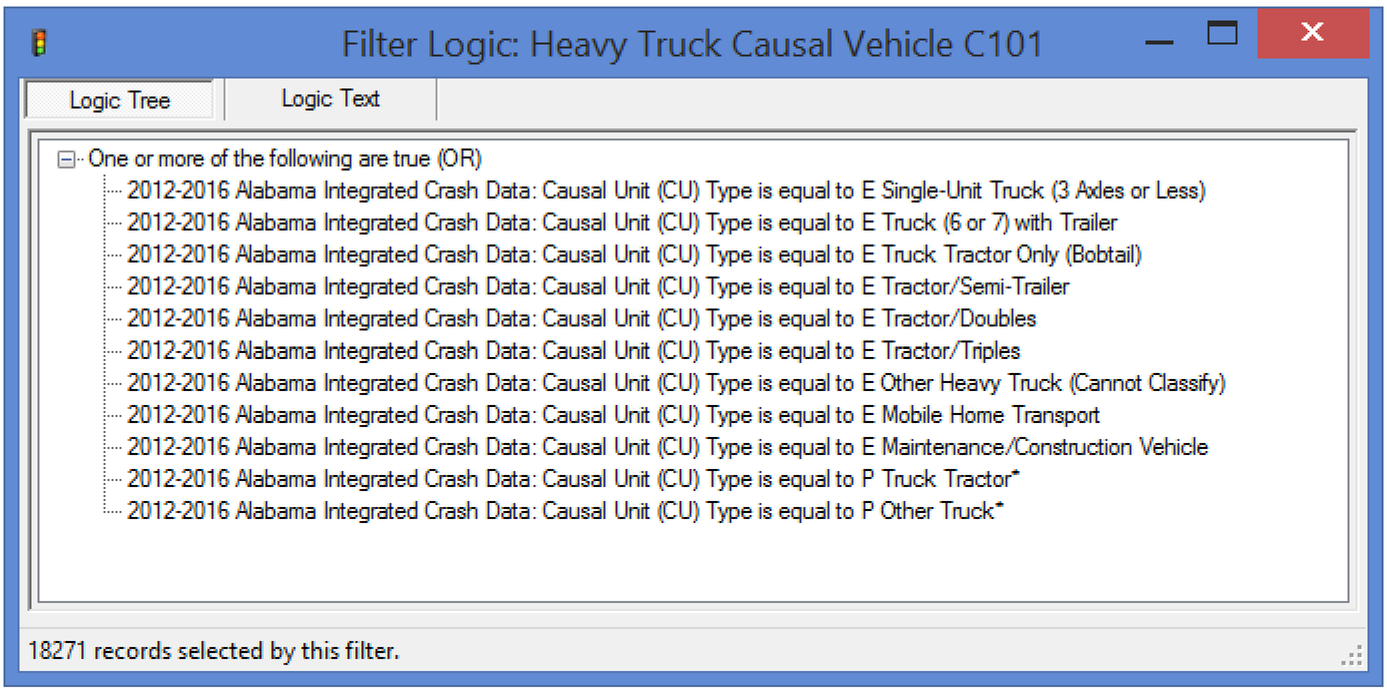
These summaries are presented so that local traffic safety and CMV professionals might see what it going on in their local counties or those in which they have an interest.

1 Introduction; Crash Overview and Trends

The purpose of this document is to produce information that will be useful to Alabama decision-makers in reducing the number of fatalities and other suffering and loss due to crashes involving large trucks (LTs) and buses in the state. The following definitions of these vehicle types is important to understanding the scope and application of the results given:

Large truck. The following is the technical logical definition for a Large Truck (LT) obtained from the CARE filter.

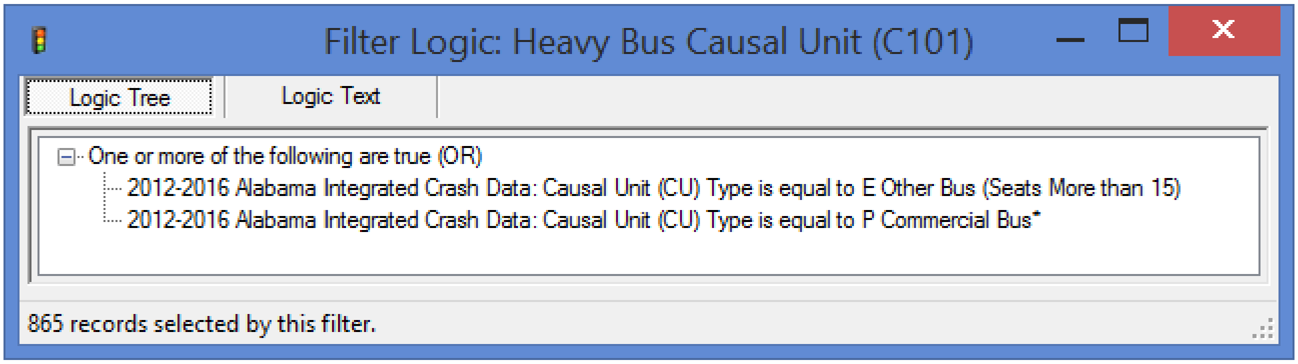
Display 1a Technical Definition of a Large Truck (LT)



While the filter definition above is for the causal vehicle (C101), the attribute numbers to which this was applied were both C101 (Causal Unit Type) and C501 (Vehicle 2 Type). These two were logically ORed together to form the subset of Large Trucks (LTs) used in this report. The objective of this specification was to obtain crashes involving all large trucks independent of their CMV specification. It is important in interpreting the results to only apply them to this subset. While it is highly representative of all large cargo vehicle types on the roadway, some might be excluded. The term Large Truck (LT) used in this document will apply only to those defined above.

Bus. Display 1b is the technical CARE filter logical definition for the word "bus" that will be used throughout this report.

Display 1b Technical Definition of "Bus" as used in This Document



While the filter specification given is for C101, these attribute specification were applied to both C101 (Causal Unit Type) and C501 (Vehicle 2 Type), and they were logically ORed together to create the subset that was used to produce the results reported in this document. The objective of this specification was to obtain crashes involving all relevant buses independent of their CMV specification. The concern here is with the commercial buses, such as Greyhound, Trailways, etc., and similar interstate buses, not school or local transit buses so they were excluded, as were several other types of buses. So the word "bus" used in this study does not apply to all buses in general, only to those defined above. While the results presented are quite precise for the subset of buses as defined above, the reader must determine the extent to which this subset might infer results for buses in general for any given attribute.

Large truck involved. We define "involvement" to mean that a large truck (as defined above) was either the first (causal unit) or the second unit specified by the reporting officer in the crash report. There is no assumption of fault in the word "involved." A decision was made to exclude from the crash comparisons crashes in which the large truck was the third or higher vehicle; however, they are included in the vehicle counts.

Bus involved. Similarly, a "bus involved" crash is defined as a crash in which either the causal or the second unit was a bus (as defined above), and the other qualifiers for vehicle counts also apply.

This introduction will continue in Section 1.1 by giving some overall crash and victim counts by severity so that an appreciation for the magnitude of LT and bus crashes in the state can be better understood. It will also consider ten-year trends for LTs in Section 1.2.

Time period for the data. The basic study was done using five years of data 2011-2015. Most of these results are comparative and they will remain stable and will not change into 2017 or 2018. However, where it was seen that there were significant changes in 2016, results from this year were added to further qualify and update the results.

1.1 Overall Crash Summaries by Severity

1.1.1 Large Truck (LT) and Bus Involvement Compared to Other Crash Types

This section contains a crash comparisons of LT crashes against bus crashes and all crashes so that their relative importance by the general traffic safety community can be assessed. Display 1.1.1 presents this comparison in a nutshell. In both the LT and the bus results the percent of crashes and the percent of vehicles involved are very close to each other indicating that the number of vehicles in these types of crashes is only slightly greater than that of crashes in general. Clearly the LT crashes greatly exceed those of buses (as defined above), with the LTs having over 20 times the number of crashes, and about the same for number of vehicles involved. In addition, the number of fatal crashes and persons killed is in the order of magnitude of 50 times higher for LTs than for buses, indicating that their crashes are of significantly higher severity.

Display 1.1.1 Summary of LT and Bus Crashes Relative to All Crashes (2011-2015)

Statistic	Number/Frequency	Number for All Crashes	Percent of All
Large Truck (LT) Crashes			
Number of Crashes	27,643	665,380	4.15%
Total Vehicles Involved	51,626	1,215,712	4.24%
Total Large Trucks Involved	29,250	-	-
Number of Fatal Crashes	377	3,917	9.62%
Number Killed	416	4,392	9.47%
Number Injured	7,299	120,420	6.06%
Bus Crashes			
Number of Crashes	(1,370*) 2,345	665,380	0.35%
Total Vehicles Involved	(2,666*) 4,563	1,215,712	0.37%
Total Buses Involved	(1,393*) 2,384	-	-
Number of Fatal Crashes	8	3,917	0.20%
Number Killed	8	4,392	0.18%
Number Injured	(615*) 1,053	120,420	0.87%

* These values have been increased by proration since an analysis of the data itself indicated that only 58.4% of the crashes were included in the five year subset; see Section 1.3 for details.

The following two sections will compare the severity of LT and bus crashes against vehicle crashes in general. The tool used in these analyses is the CARE Information Mining Prioritization, Analysis Control Technique (IMPACT), which will be describe in detail in the next section.

1.1.2 Severity IMPACT Comparing LT with non-LT Crashes

Display 1.1.2 gives a comparison of the severities of LT crashes with all other crashes. As expected, LT crashes are much more severe to the victims, with fatal crashes being over-represented by a factor of 2.442. In the table above the chart the Odds Ratio indicates this over-representation, and it has a background that has been set to turn red for all values that are twice or more times their expectation. An asterisk (*) on any of the odds ratios indicates that they are statistically significant at a very high alpha level (0.001 or less chance of stating that a difference that exists is merely due to chance). Considering these Odds Ratios, the two highest injury severities are over-represented, and the two lower injury categories are under-represented, while Property Damage Only (PDO) crashes are slightly over-represented (albeit significantly).

The comparision in Display 1.1.2 is not between LTs and buses as given above, it is between crashes that involved LTs and all crashes that did not involve an LT (LT as defined by the filter specificaiton above). In all of the CARE IMPACT tables given in this document, the "Subset Frequency" will either be LTs or buses (in this case it is LTs), and the "Other Frequency" will be all other crashes (the complement of the subset). Similarly with the "Subset Percent" and the "Other Percent," the corresponding definitions apply.

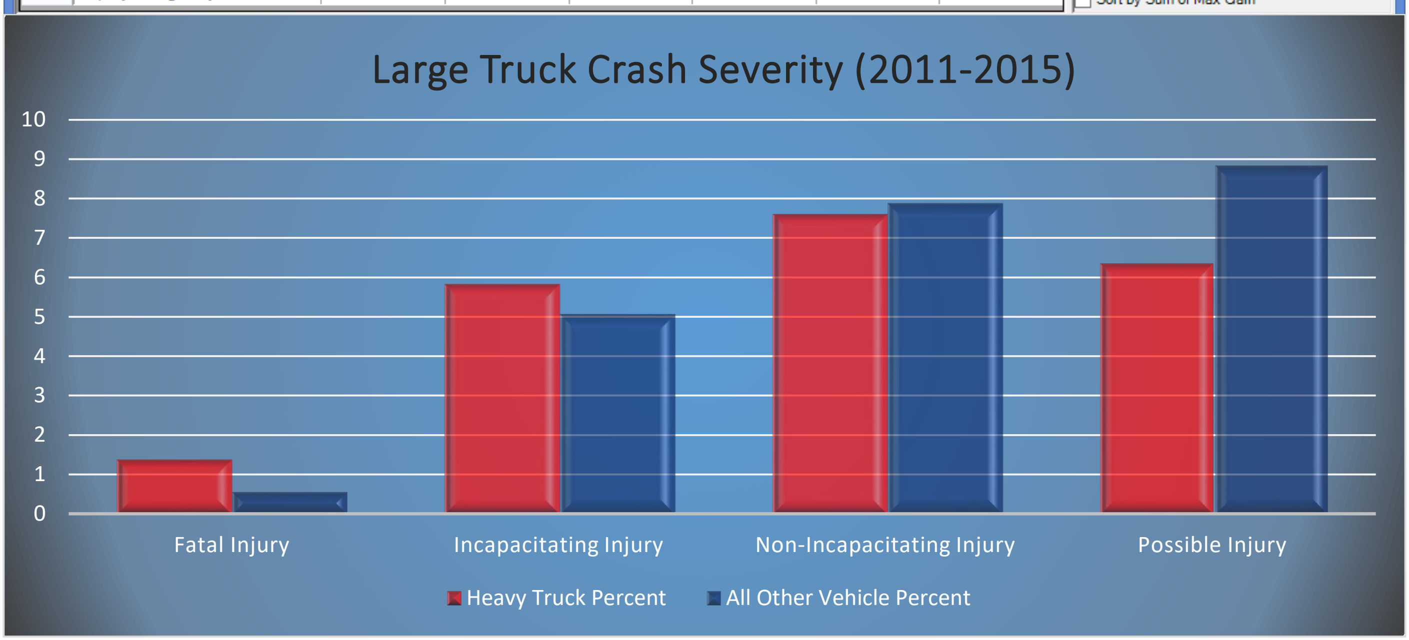
Display 1.1.2a Comparison of LT Crash Severity With All Other Crashes (2011-2015)

Order: Max Gain | Descending | ☑ Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C025: Crash Severity Value	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	377	1.39	3540	0.57	2.442*	222.588
Incapacitating Injury	1579	5.83	31504	5.08	1.149*	204.820
Non-Incapacitating Injury	2057	7.60	48890	7.88	0.965	-75.544
Possible Injury	1719	6.35	54814	8.83	0.719*	-671.945
Property Damage Only	21335	78.82	481781	77.64	1.015*	320.082

C025: Crash Severity

☐ Sort by Sum of Max Gain



The double-bar chart under the table shows the comparisons for the injury categories – the PDO category was removed since it dwarfed the other categories and made the chart unreadable. So the chart results are strictly for crashes in which injuries were recorded. The trimming of the data to improve chart readability will be noted in several display in this document.

In this and all other IMPACT comparison charts, the red bars indicate LTs (or buses if it is a bus comparison); the blue bars indicate the proportion of the crashes for the complement of the subset – all other crashes. In essence the blue bars are an excellent proxy for crashes in general, and they can be considered as an experimental control subset, while the red bars represent various test subsets.

In addition to the disparity between the vehicles which collide, there are three major factors that are highly correlated with crash severity: (1) impact speed, (2) EMS response time, and (3) rural or urban crash location, which has a major effect on the first two factors. We will address the first two of these factors for LTs in the following two sections, but will defer consideration of the rural-urban factor to Section 4.1.1, where it will be considered in the context of other geographical factors.

Severity comparison update for 2012-2016. Display 1.1.2b below gives the output comparable to that above but for the 2012-2016 time frame as opposed to 2011-2015. The 2016 calendar year was particularly bad for fatalities with a general 24% increase in all fatal crashes (not just trucks). This effect shows in the fatal crash numbers over the five years. However, the bar charts appear virtually the same as do the odds ratios. This demonstrates that even a dramatic change in one year does not cause the overall conclusions of the various analyses to change. In cases where they do, additional analyses will be performed. I should be noted that there has been a 10% reduction in all fatal crashes for the first 9 months of 2017 as compared to the first 9 months of 2016.

Display 1.1.2b Comparison of LT Crash Severity With All Other Crashes (2016 Updated)

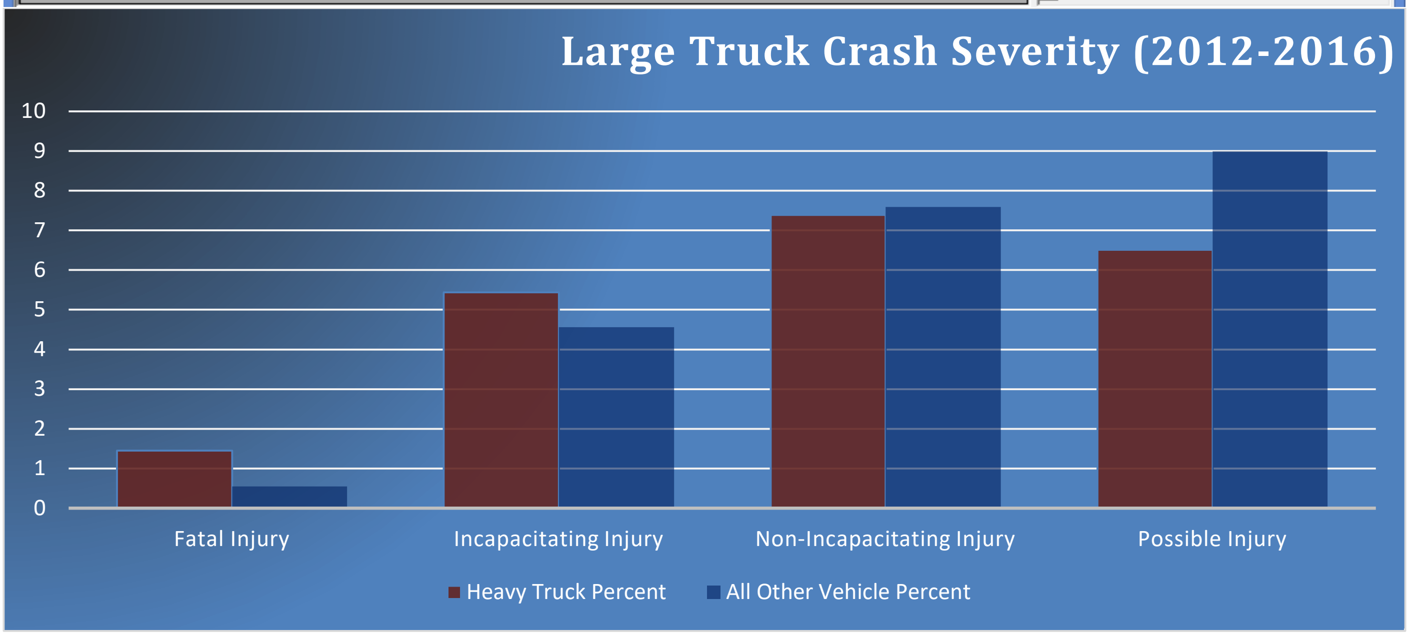
2012-2016 Alabama Integrated Crash Data | Heavy Truck Involved C101 OR C501 | 1/ 1/2012 | 12/31/2016

Order: Max Gain | Descending | Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	414	1.49	3690	0.57	2.611*	255.459
Incapacitating Injury	1548	5.56	30415	4.69	1.185*	241.222
Non-Incapacitating Injury	2102	7.54	50578	7.80	0.967	-71.079
Possible Injury	1851	6.64	59930	9.24	0.719*	-723.887
Property Damage Only	21948	78.77	503893	77.70	1.014*	298.284

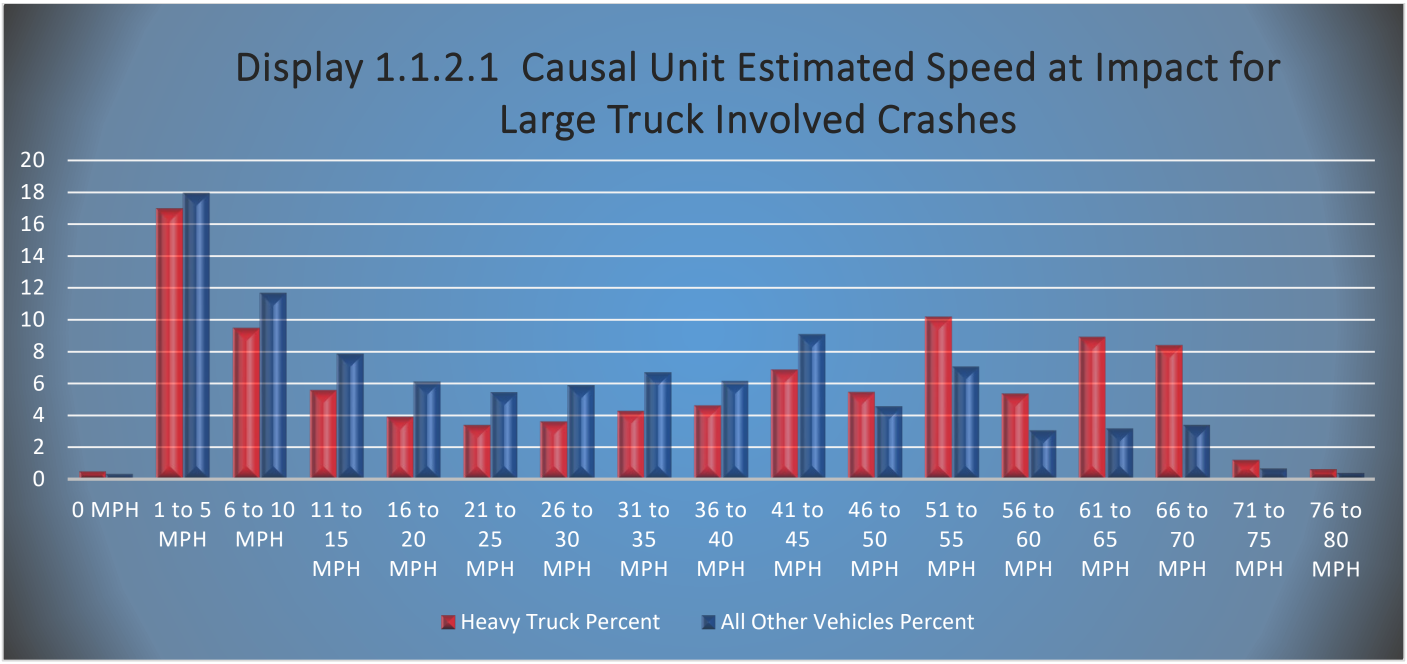
C025: Crash Severity

Sort by Sum of Max Gain



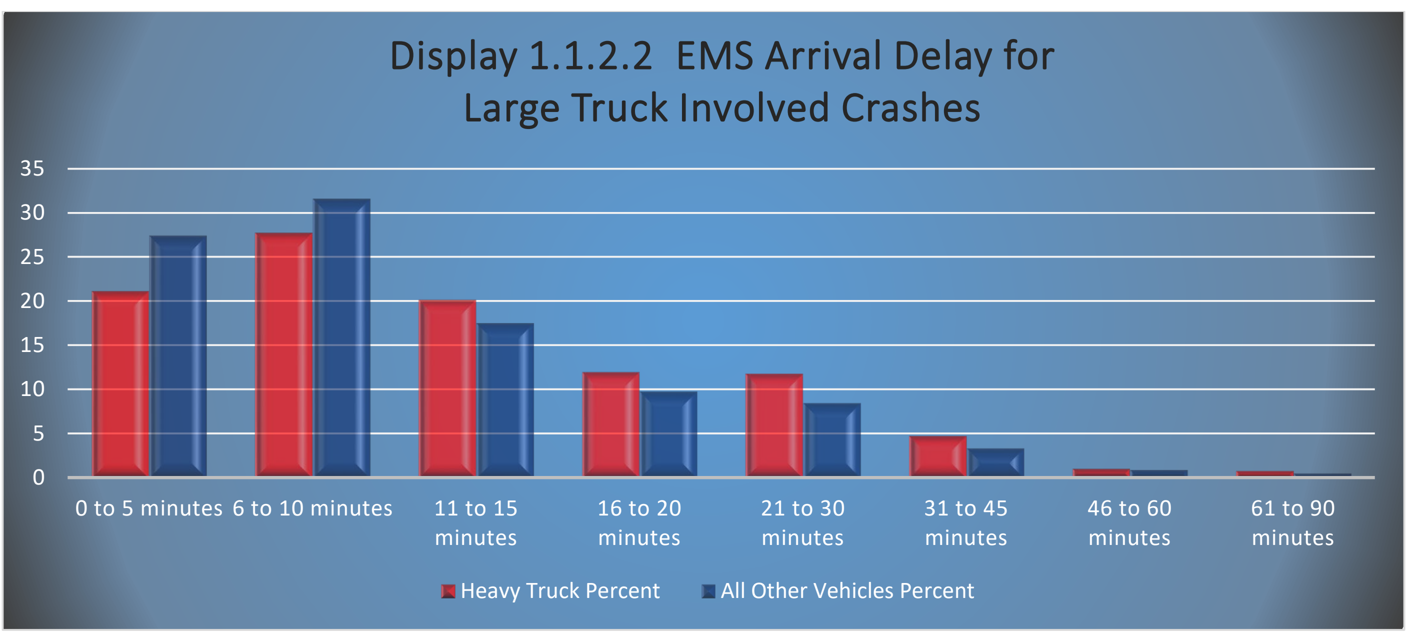
1.1.2.1 Estimated Impact Speed Comparison LT with non-LT

Display 1.1.2.1 presents a picture of the impact speeds for LT crashes. The over-represented cells are indicative of the roadways upon which these vehicles are most often driven. Higher impact speed would clearly be the cause of a higher fatality rate for LT-involved crashes. The general rule of thumb established by crash data within Alabama is that the fatality probability doubles for each increase in impact speed above 40 MPH.



1.1.2.2 EMS Arrival Delay Speed IMPACT comp LT with non-LT

Display 1.1.2.2 indicates that the shortest two arrival intervals are under-represeted, while all of the longer arrival intervals are over-represented. This is fairly typical of the rural-urban mix in which these trucks typically operate, and it is no doubt a contributor to the higher death rate for LTs.



1.1.3 Severity IMPACT: Bus Involved vs non-Bus Involved Crashes

Display 1.1.3 gives a comparison of the severities of bus crashes with all other crashes. Buses are some of the safest vehicles to ride in, and the fatality figure reflects this. *None of the fatalities were recorded to have been bus occupants.* They were: 4 in passenger cars, 1 in an SUV, 2 pedestrians and 1 not recorded.

In the table above the chart the Odds Ratios indicate that the number of fatalities is not significantly different from that of the overall crash population, which has a relative refrequency of about one fatality crash in every 167 crashes (0.06%). All three of the injury classifications are under-represented, with the top most severe being significantly so. The PDO crashes for buses are over-represented, but they have not been shown in the chart in order to be able to see the relative weights of the other severity classifications. Buses had a PDO percentage of about 83%, which is significantly higher than the general PDO rate of about 78%.

Considerations for factors involved with severity are given for buses (comparable to those for LTs given above) in the next two sections.

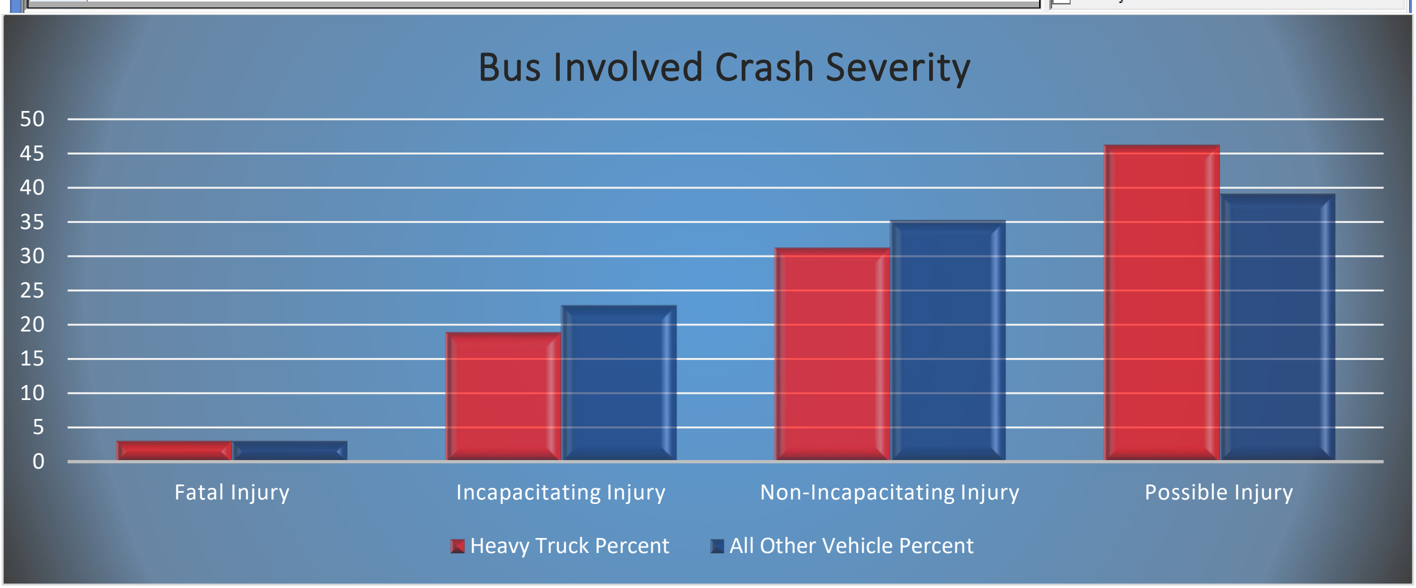
Display 1.1.3 Comparison of Bus Crash Severity With All Other Crashes

Order: Max Gain | Descending | Suppress Zero-Valued Rows | Significance: Over Representation | Threshold: 2.0

C025: Crash Severity	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
Fatal Injury	8	0.60	3909	0.60	0.997	-0.026
Incapacitating Injury	43	3.24	33040	5.11	0.634*	-24.842
Non-Incapacitating Injury	71	5.35	50876	7.87	0.680*	-33.465
Possible Injury	105	7.91	56428	8.73	0.906	-10.865
Property Damage Only	1100	82.89	502016	77.68	1.067*	69.198

C025: Crash Severity

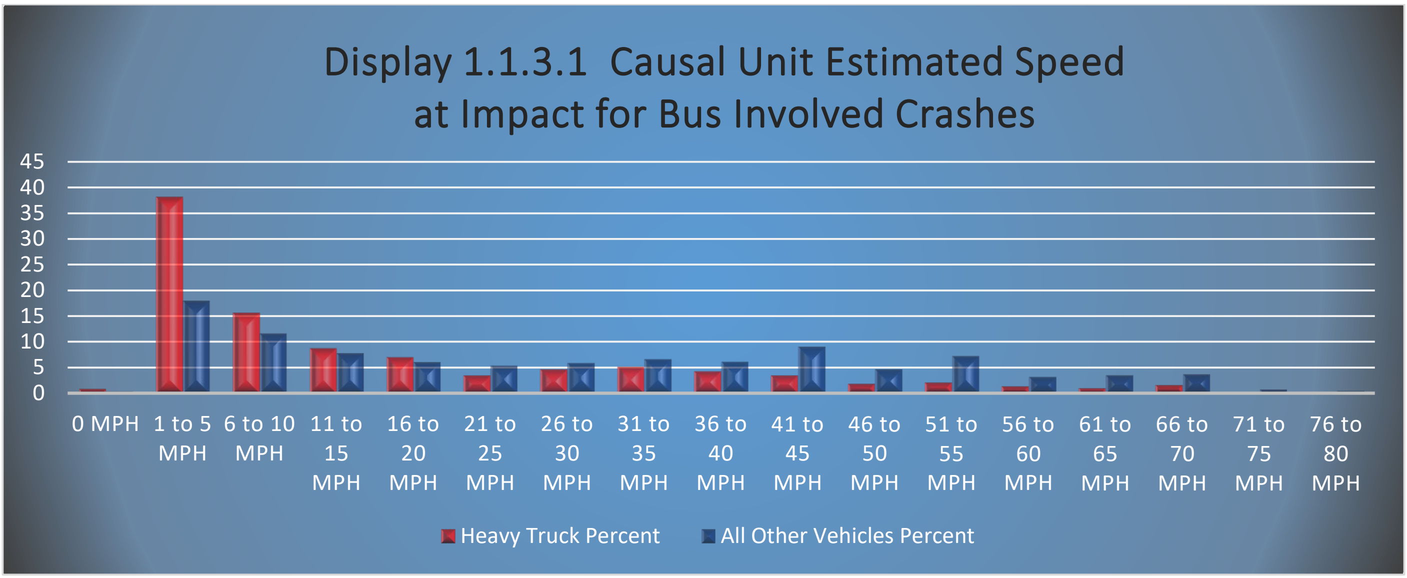
Sort by Sum of Max Gain



1.1.3.1 Estimated Impact Speed IMPACT Comparison Bus with non-Bus

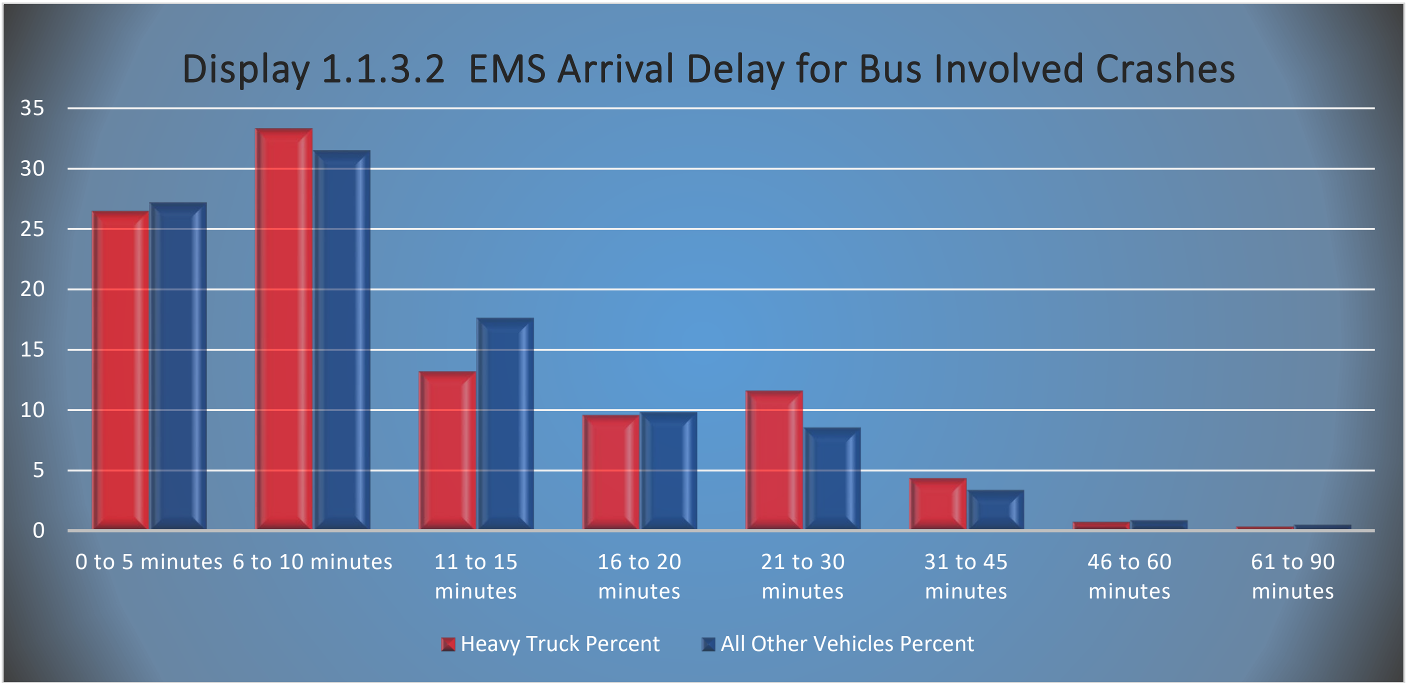
One large reason for the low severity of bus crashes has to do with impact speeds, which from Display 1.1.3.1 show a very large contrast with LTs (Display 1.1.2.1). This is fairly typical for traffic operations in general that are concentrated in urban areas. We would suspect that most buses traval at a slower rate than the traffic in general. The extreme over-representation in the 1-5 MPH category would indicate a large number of backing crashes and collisions with parked vehicles. These will be discussed further in the bus crash analysis in Section 6.

Display 1.1.3.1 Speed of Impact Comparison of Bus and non-Bus Crashes



1.1.3.2 EMS Arrival Delay Speed IMPACT comp Bus with non-Bus

Display 1.1.3.2 shows the comparison between buses and non-buses as far as ambulance arrival time is concerned. Probably because of the low sample sizes involved for bus crashes, none of the values for delay time were significantly different from what would be expected in the general population of crashes. While EMS arrival delay is not an issue in general, it is a major factor in certain remote crashes that involve heavy injury, and further research is warranted on this subject.

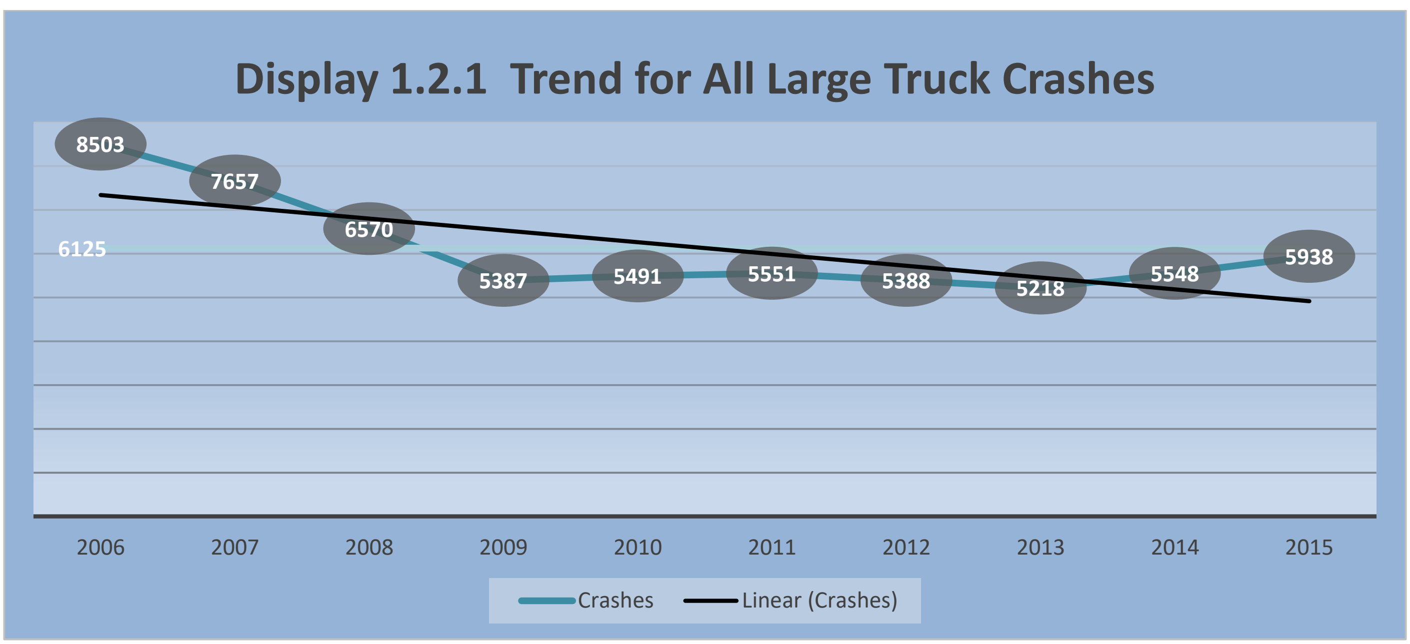


1.2 Trend Analysis for Large Truck Crashes

1.2.1 Overall Large Truck (LT) Crash Trend

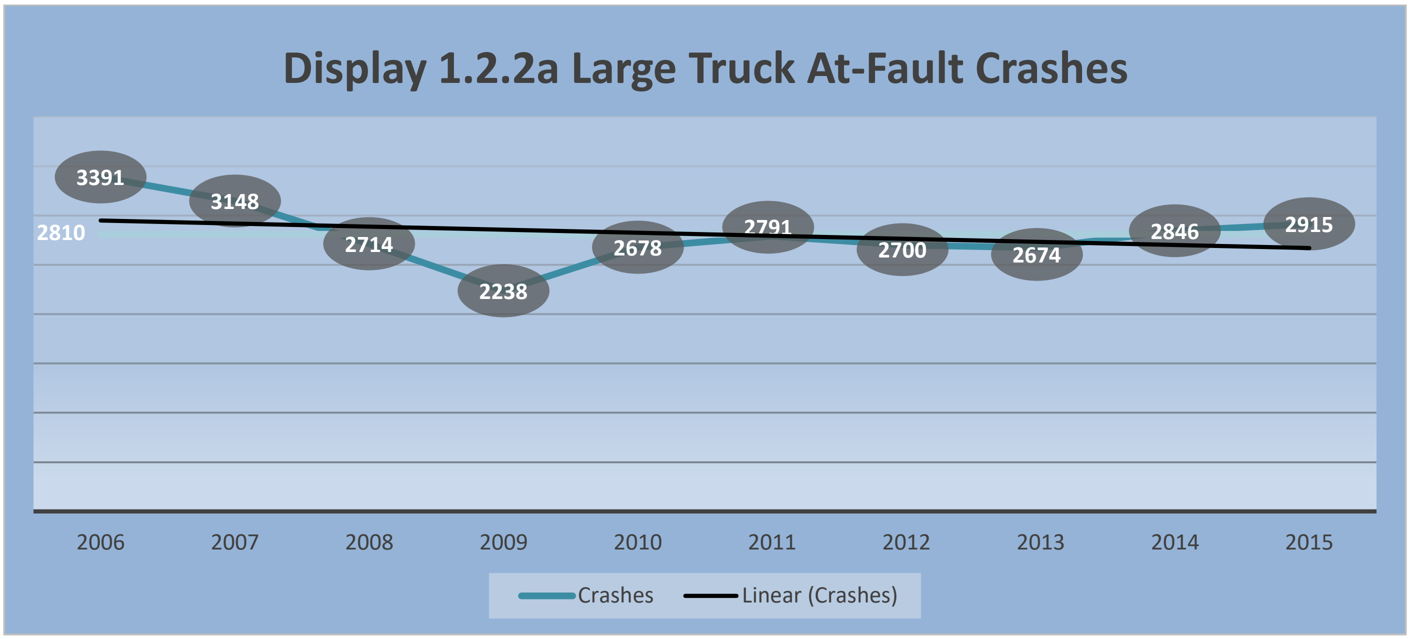
Display 1.2.1 shows the ten year (2006-2015) trend for all large truck (LT) crashes. The display contains (1) the actual data in number of crashes per year; (2) a regression line that indicates the overall trend; and (3) a constant average line for general reference. Clearly the trend is down reflecting the overall trend in traffic crashes over the past ten years, due largely to the reduction in mileage due to the economic downturn. Unfortunately, it is also following the crash pattern of the past three years which is trending back up. The slope of the regression line is -270.00 crashes per year, estimating an average reduction of 2700 crashes over the ten year period, with a correlation coefficient (r-squared) of 0.5364, indicating that 53.64% of the variance in the number of crashes is correlated to the year value.

It is important to recognize that the number of LT crashes is dependent not only on the number of LTs on the road, but also on the other non-LT traffic. In fact, the decline in LT mileage during the relative recession did not diminish nearly to the extent that overall traffic did. LT mileage has a relatively small discretionary proportion since many goods and services continue to be delivered independent of the economic conditions. The same number of trucks in a traffic mix that contains a significantly higher number of passenger vehicles will also result in more crashes. Other factors contributing to the trend included: (1) a leveraged economic effect on the worse drivers – young people and those driving older vehicles; so that a relatively small economic downturn can have a much larger effect on crashes; (2) the cost of fuel, which was higher during the downturn, but is now significantly lower than it was at its lowest level; and (3) the effect of the lack of personal income on the purchase of alcoholic beverages, especially in restaurants and clubs.



1.2.2 Large Truck At-Fault Trend

Display 1.2.2a is limited to those crashes that were caused by large trucks. The overall pattern is about the same but the overall trend is not statistically significant. Display 1.2.2b presents the comparison of total and at-fault crashes for LTs over the ten years. It increased and peaked in the 2011-2013 time frame, but has decreased slightly in the two more recent years. A more detailed at-fault analysis is given in Section 2.1. The results there are slightly different in that only the first two vehicles were considered, whereas in this analysis all LTs were considered, and those with unit numbers 2 or above were considered non-causal.

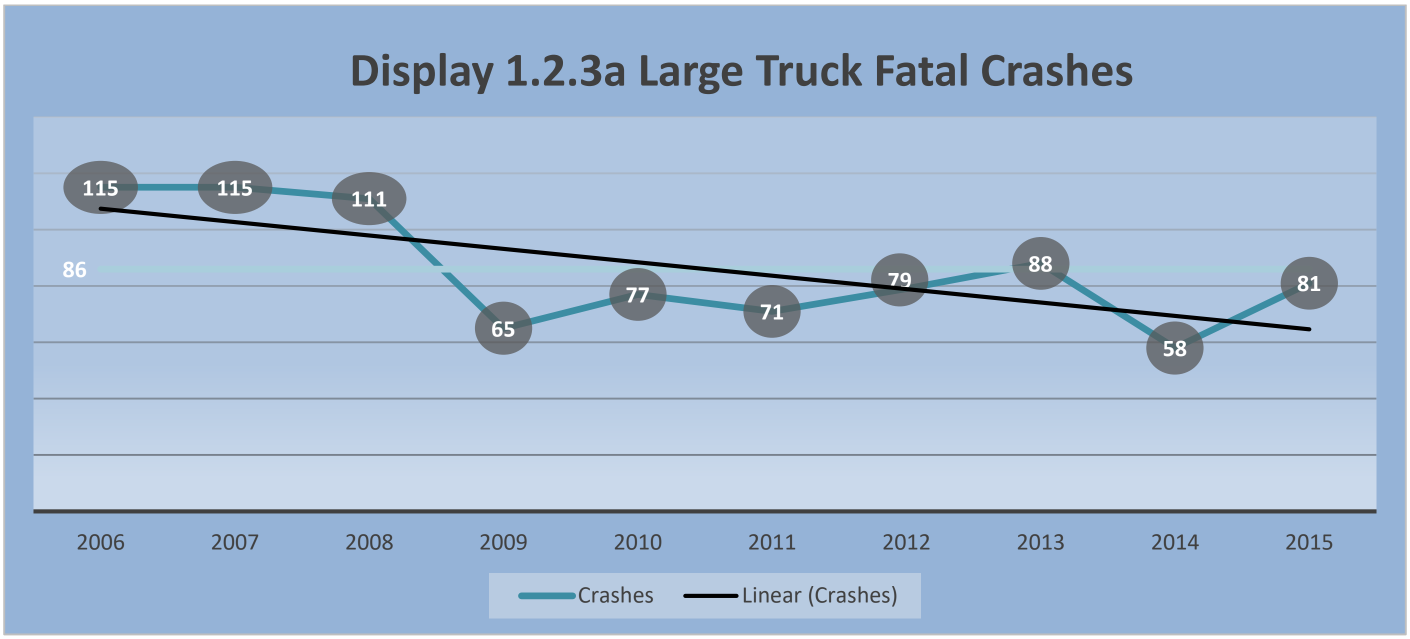


Display 1.2.2b Large Truck Proportion At-Fault Trend

Year	All Large Truck Related	Large Truck At-Fault	Large Truck At-Fault Percent
2006	8,503	3,391	39.88%
2007	7,657	3,148	41.11%
2008	6,570	2,714	41.31%
2009	5,387	2,238	41.54%
2010	5,491	2,678	48.77%
2011	5,551	2,791	50.28%
2012	5,388	2,700	50.11%
2013	5,218	2,674	51.25%
2014	5,548	2,846	51.61%
2015	5,938	2,915	49.09%
Total	61,251	28,095	45.87%

1.2.3 Fatality Large Truck Crash Trend

In Section 2.1 it will be demonstrated that large trucks account for only about 20% of fatality crashes in which they are involved, and thus it is expected that the pattern shown in Display 1.2.3a would reflect the overall statewide fatality figures. They average out to be about 9.03% of the total fatalities. Display 1.2.3b shows how this percentage has varied over the ten years of the study. The slope of the regression line is about -4.75 crashes per year, estimating an average reduction of 48 fatality crashes over the ten year period, with a correlation coefficient (r-squared) of 0.4756, indicating that 47.56% of the variance in the number of fatal crashes is correlated to the year value.



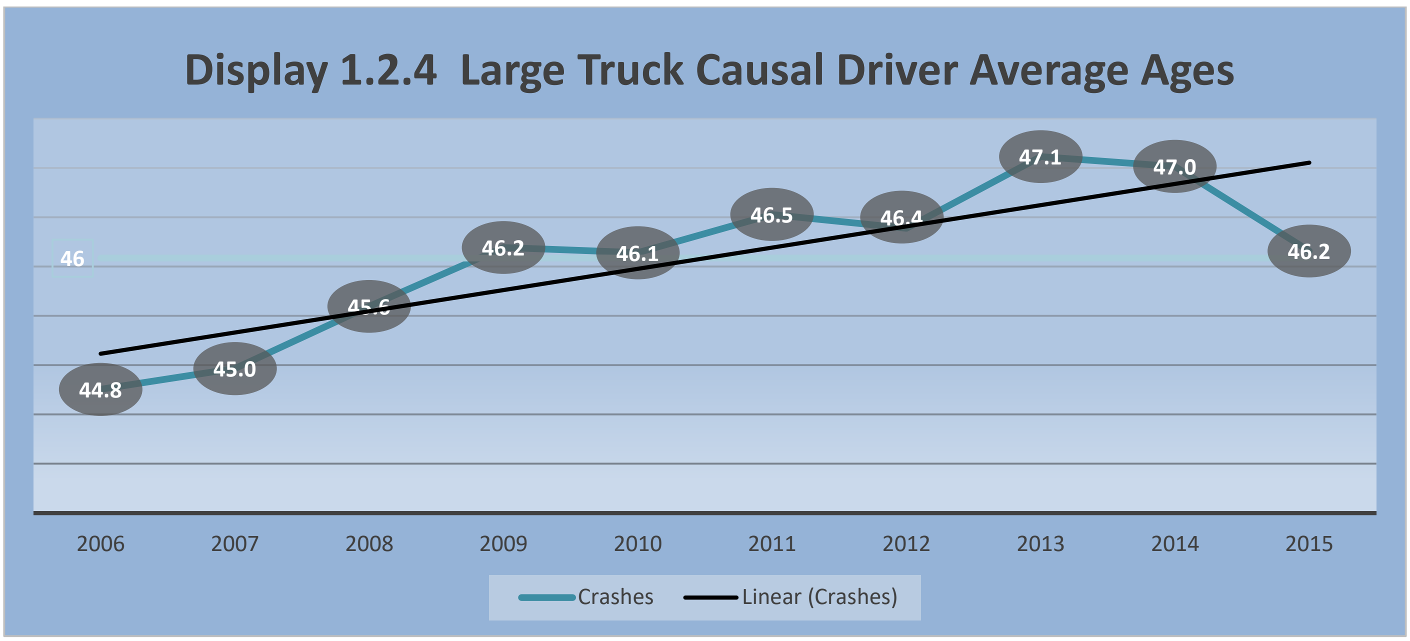
Display 1.2.3b Comparison with Statewide Fatalities

Year	Large Truck Related	All Fatalities	Large Truck Percent
2006	115	1,207	9.52%
2007	115	1,110	10.36%
2008	111	967	11.48%
2009	65	847	7.67%
2010	77	862	8.93%
2011	71	895	7.93%
2012	79	865	9.13%
2013	88	853	10.32%
2014	58	820	7.07%
2015	81	849	9.54%
Total	845	9275	9.20%

1.2.4 Large Truck Crash Causal Driver Age Trend

The ten year average causal driver age trend is given in Display 1.2.4. These include both the LT drivers and the non-LT drivers for multi-vehicle LT involved crashes. However, because of the high number of LT drivers in the subset, this will be heavily influenced by their ages. It is expected that this age will generally increase, and so the results in Display 1.2.4 are expected.

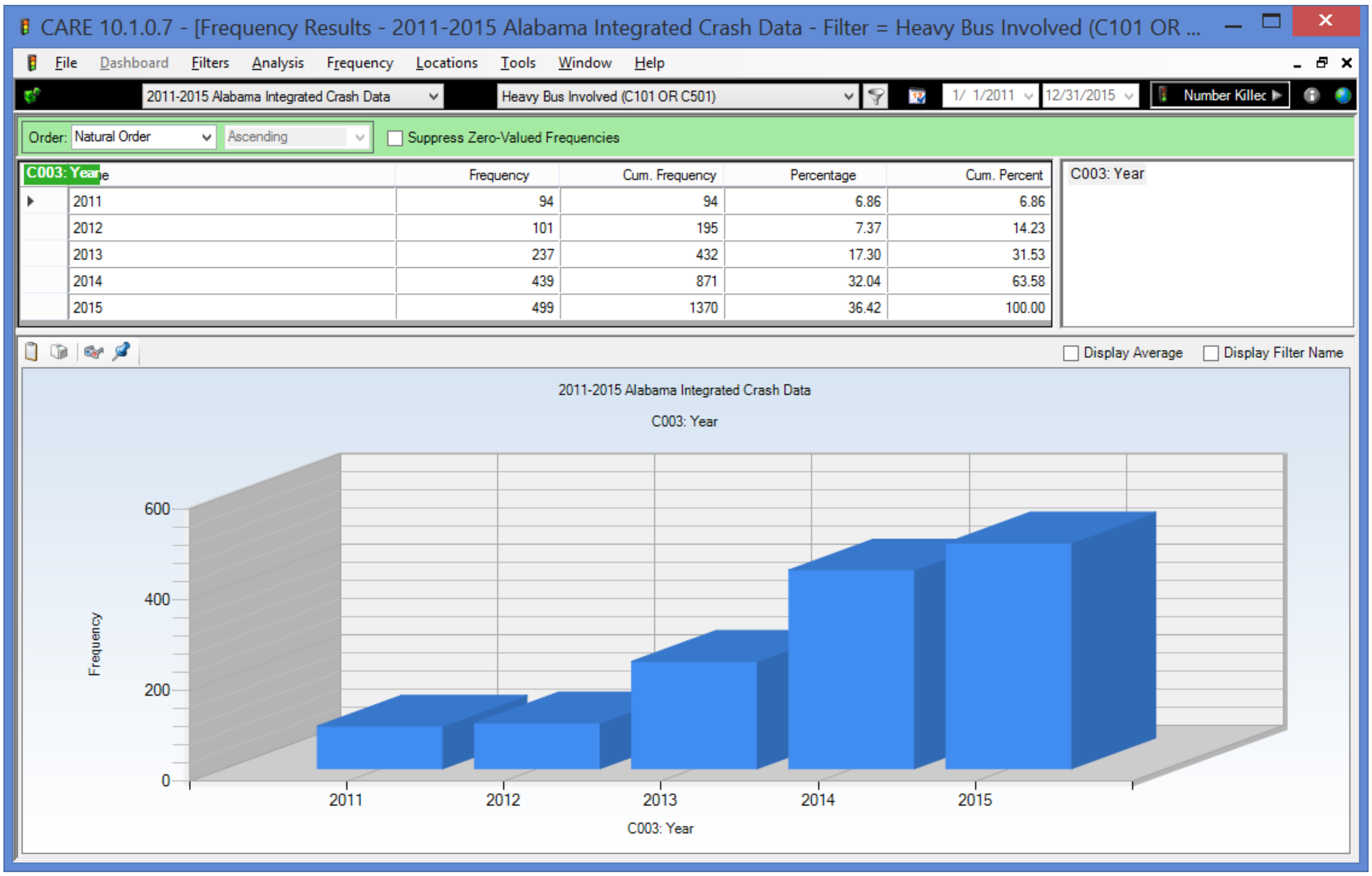
The slope of the regression line is 0.2153 average driver age (in years) per year, estimating an average increase of about 2 years over the ten year period, with a correlation coefficient (r-squared) of 0.6961, indicating that 69.61% of the variance in the recorded ages can be attributed to the year value.



1.3 Issues with the Trend Analysis for Bus Crashes

Display 1.3 presents the overall summary of bus crashes by year for the five years of the bus dataset.

Display 1.3 Illustration of Data Issues with Bus Crash Reports



The data prior to CY2014 is both inconsistent and incomplete, and thus Display 1.3 should be used only for information about the data – it is erroneous to infer that this indicates an increasing number of bus crashes.

There were two reason for the data deficiencies: (1) the shift from paper to eCrash in July 2009; and (2) a recent edict from FMCSA that forced the officers to report buses differently starting sometime mid-2010. The eCrash data elements were structured differently from those within the paper data collection form, and the mapping from one to the other was quite problematic. On top of that, FMCSA mandated another change that was implemented during mid-CY2013. This change is observable in Display 1.3 in that the pre-2013 years are at one level, and the post 2013 years are at a different level. A further complication is that all officers were not trained at reporting bus crashes in the revised way simultaneously. So, it was possible that while most of the ALEA officers were probably aware of the required change, many local law enforcement might still be reporting in the traditional way.

A number of attempts were made to create filters that would normalize the reported bus crashes over a ten year period. Based on this experimentation, it was determined that the data elements as they currently exist could not create any true picture of reality over this entire period. The recommendation was to allow the data to stabilize and begin measuring any trends starting from CY2014.

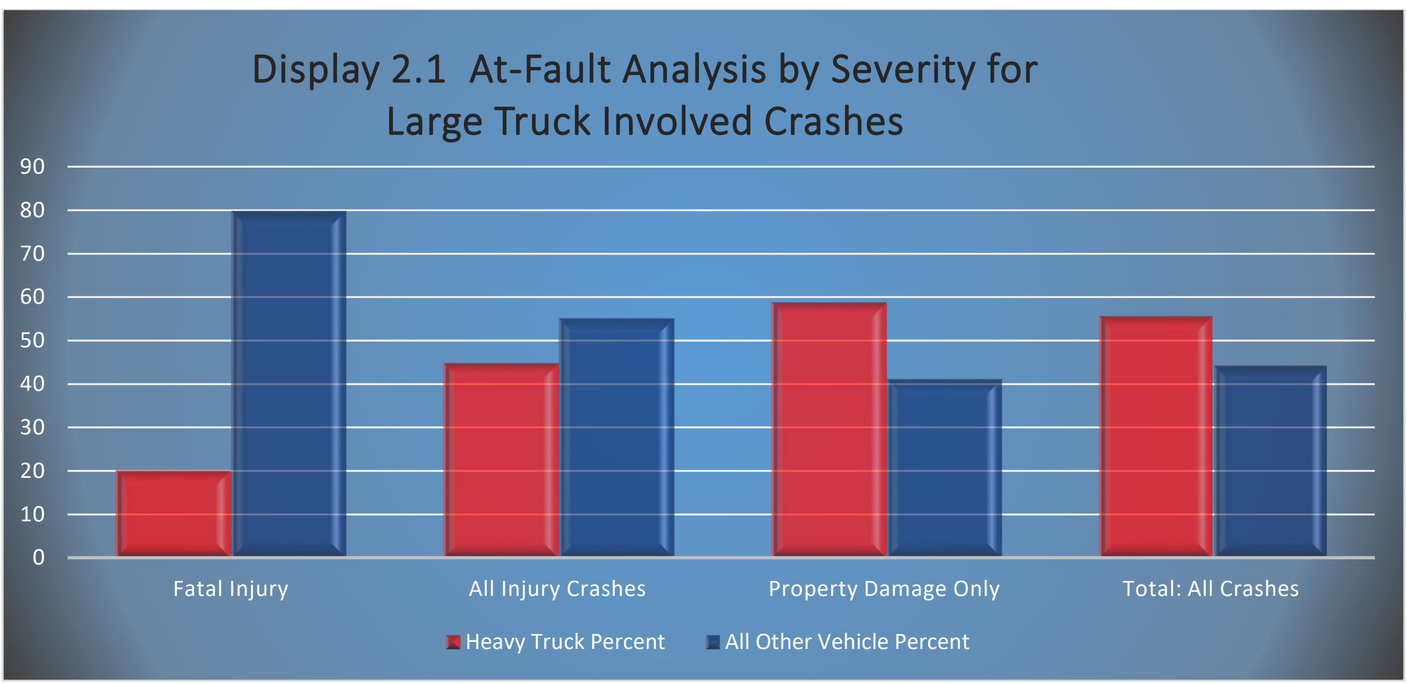
The problem in not getting exactly the same vehicles over the years is NOT as much a problem with IMPACTs since the filter defines the subset and whatever qualifies goes in and creates that subset which is a sample of all such records (crashes) that qualify. The inferences that we make on the whole based on this sample are valid. To illustrate, if the last two years are considered to be a 100% sample of those two years, then the average of these two is 469 bus crashes per year. This will give an average total of 2,345 over the five year period. The actual total is 1,370. This is an estimated 54.8% sample of the crashes over the five year period. Assuming this sample is internally consistent according to the filter applied, this is an excellent sample size for making the inferences that have been made in the IMPACT analyses. A random sample of this size if far more reliable than a larger sample for which the randomness is of question.

2 At-Fault Analyses by Severity

This At-Fault analyses required that there be two vehicles in the crash, so all single vehicle crashes were excluded from consideration. For LTs, the objective is to determine for any crash involving a large truck and another type of vehicle, what is the probability that the LT was at fault. Similarly for bus crashes. These are discussed in the next two sections, respectively.

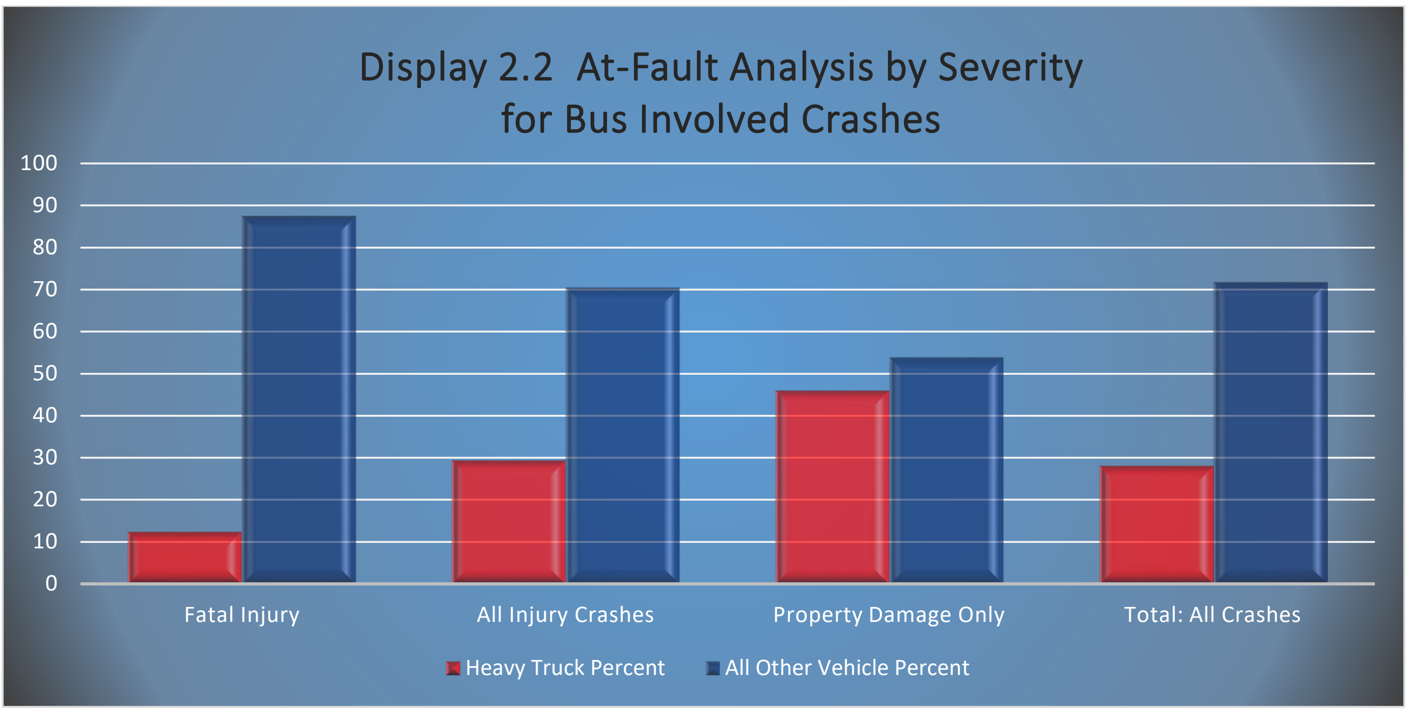
2.1 At Fault Analysis for Large Trucks

Display 2.1 presents the findings from the LT at-fault analysis. All other things being equal, we would expect that all of these bars would be at 50%. For these at-fault charts, any two bar set will sum to 100%. The greater the deviation above 50% for either vehicle type, the greater their chances of causing the crash. As shown in the display, the probability of a LT being at-fault in any given two-vehicle crash is highly dependent on the severity of the crash. It might be expected for crashes in general that LTs would be more often at fault just from the skill that it takes to handle such a large vehicle. The over-representation in PDO and Total (includes PDOs) is somewhat expected. Their dramatic under-representation in fatal crashes is notable since these crashes involve much more detailed investigation, and thus it is not just the opinion of one reporting officer.



2.2 At Fault Analysis for Buses

Display 2.2 presents the findings from the bus at-fault analysis. There were eight fatal crashes in the bus dataset used for analysis (2001-2005), and only one of them was caused by the bus unit. While this is a very small sample size, the relative low probabilities for all crashes, and especially for all injury crashes, tends to validate this finding. It is clear that buses have an excellent record for all severity classifications, but especially for those involving injury.



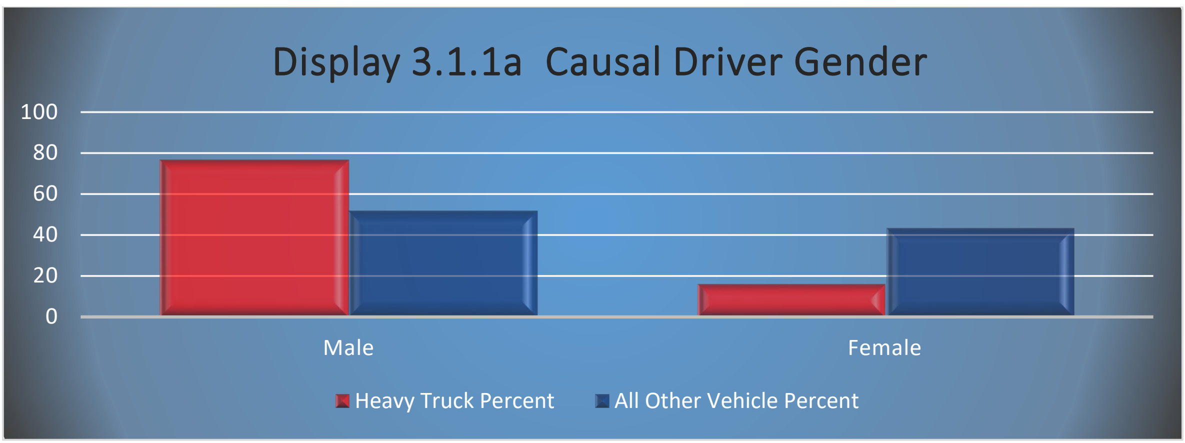
3 Driver Analysis for Large Trucks

The goal of the LT driver analysis is to determine differences between the causal drivers in LT-involved crashes and those in non-LT crashes. All causal drivers are being considered together in these analyses, and there should be no inference that the causal driver is the LT driver. The rationale for including all causal drivers is that countermeasures for LT crashes are as important for the non-LT vehicle and driver as they are for the LT.

3.1 Driver Demographics

3.1.1 Causal Driver Gender IMPACT comparison

Display 3.1.1a presents the findings from the LT causal driver gender analysis.

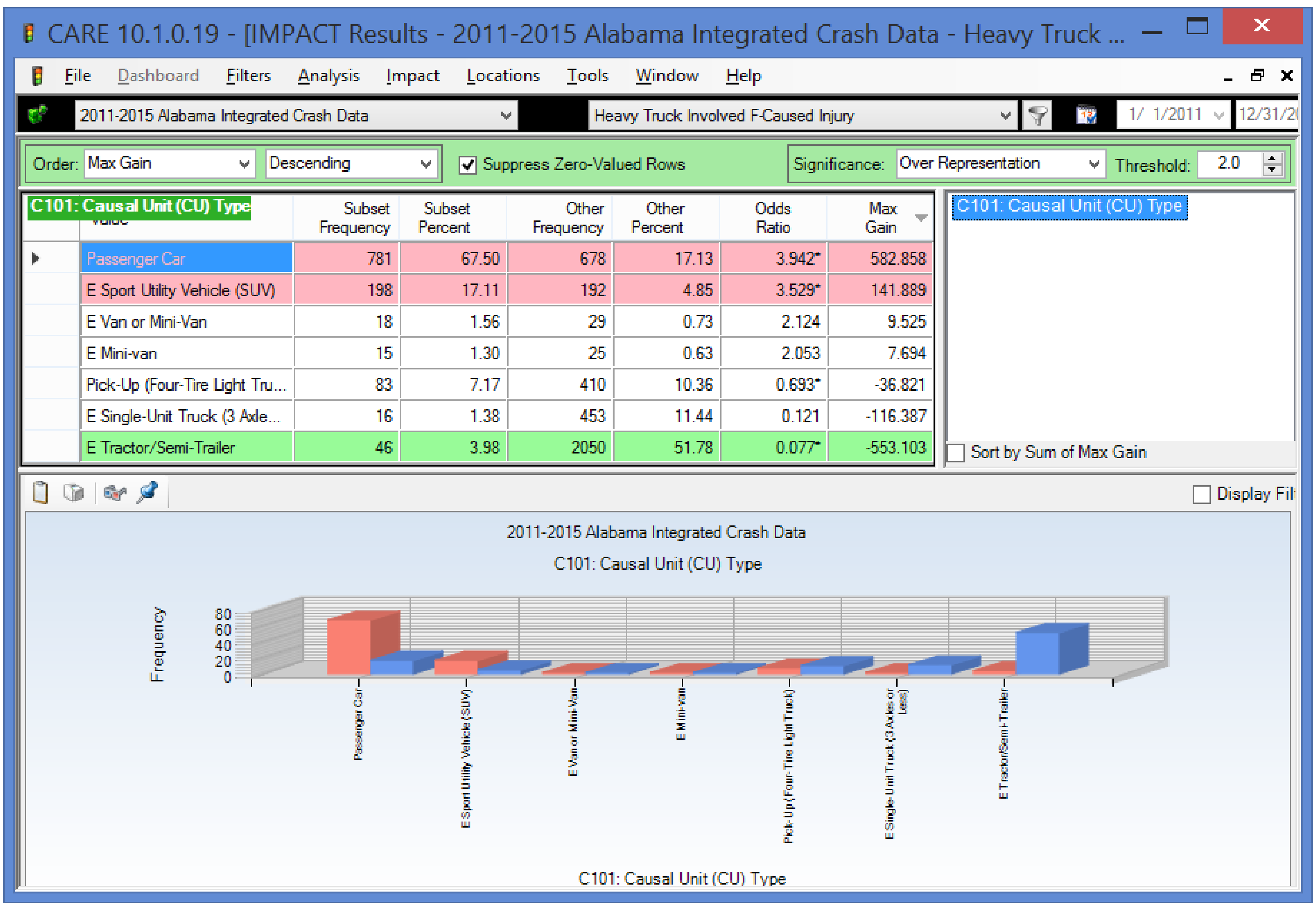


Display 3.1.1b Crash Severity by Gender

	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Male	284 75.33%	1210 76.63%	1591 77.35%	1325 77.08%	16181 75.84%	423 73.44%	21014 76.02%
Female	86 22.81%	344 21.79%	410 19.93%	341 19.84%	3138 14.71%	101 17.53%	4420 15.99%

It is expected by the general proportion of male truck drivers that males will be predominate in being the causal driver. Even for those crashes caused by the non-LTs, males are over-represented. Thus, the findings of Display 3.1.1a are not surprising. A further analysis by severity, however, shows the female causal drivers to have far more than their share of fatal and injury crashes (all injury severities). The red in the cross-tabulation indicates that the percentage of the cell is more than 10% higher than its expectation (e.g., for fatal injury, 22.81% is greater than 10% higher than 15.99%). These results would infer that when women cause the crash, it results in a much more severe crash.

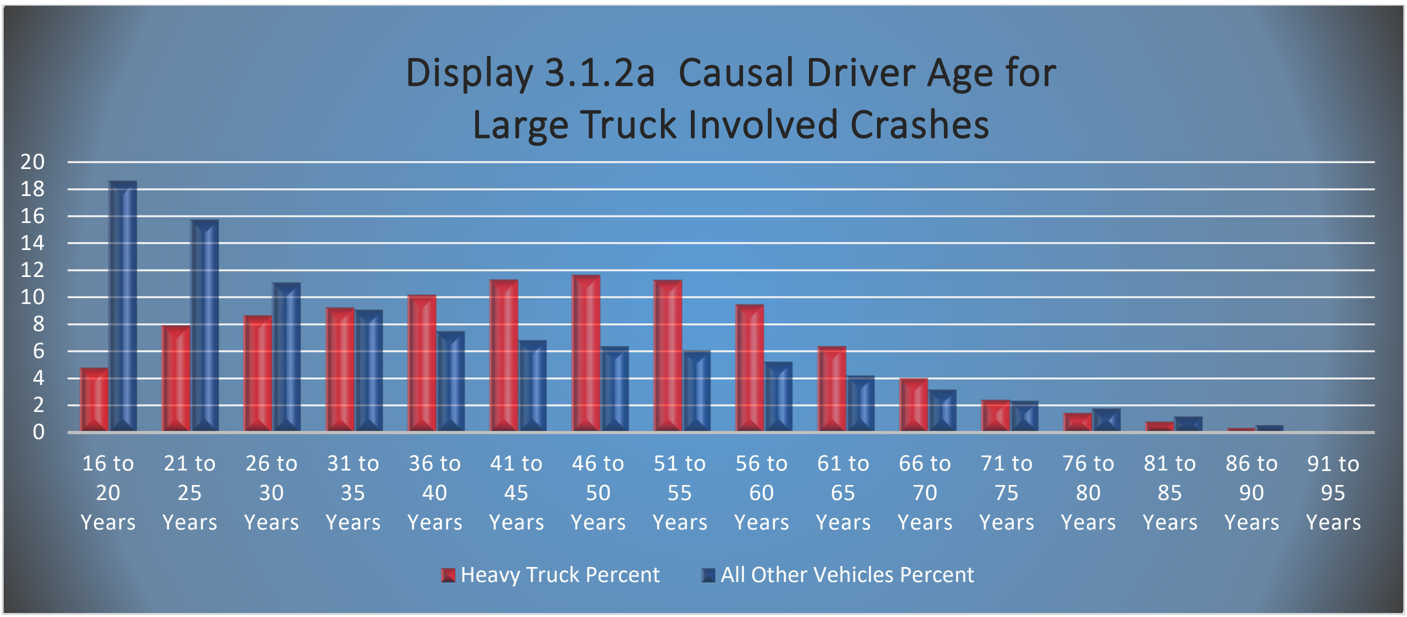
A further analysis of those crashes in which the large truck was at fault shows the opposite results – in these crashes the men were over-represented. This leads to the conclusion that the women drivers over-represented in causing fatal crashes are not truck or bus drivers, but are the drivers of passenger cars. A further IMPACT analysis was run comparing the male and female caused crashes over all of the injury severity classifications, since females were over-represented in all four injury classifications. The explanation at that point was fairly simple: *in a crash between a large truck and a passenger vehicle, where a female caused the crash, the female is overwhelmingly more likely to be the driver of the passenger vehicle*. The following illustrates this disparity, where the comparison is between female-caused (Subset) and male-caused (Other).



This would lead to the larger proportion of the injury crashes being attributed to women, since the large truck is less apt to be at fault in the higher severity injury crashes. This explanation would argue for more behavioral changes being required of women drivers, both for their survival and that of the passengers.

3.1.2 Causal Driver Age

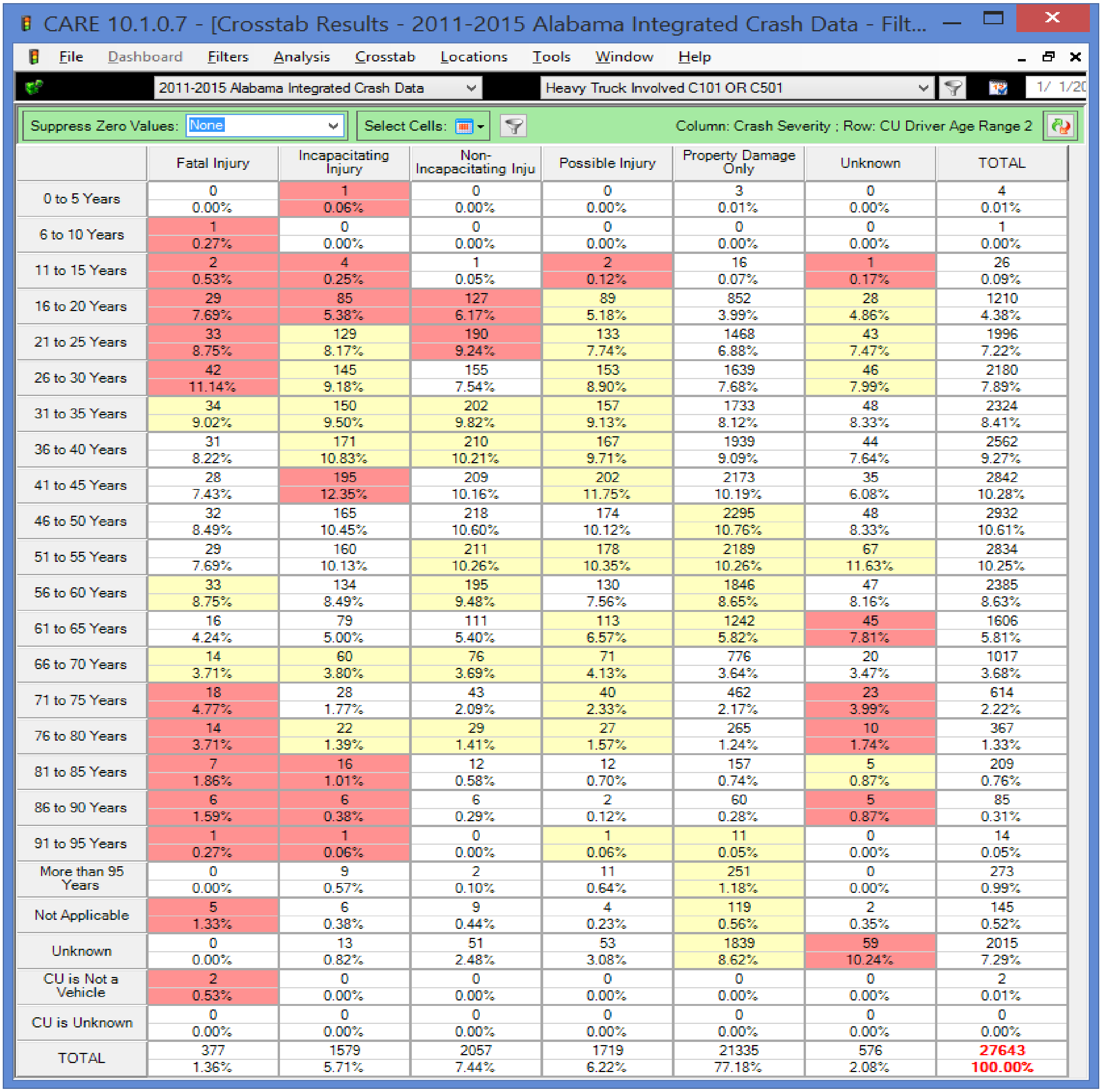
Display 3.1.2 presents the findings from the LT causal driver age analysis.



There is a great disparity between causal driver age of LT-involved crashes and crashes in general. The is seen especially in the younger driver ages (16-30). Obviously at the extreme youngest ages, these individuals are not driving LTs, and the predominance of their crash locations (e.g., near school zones) does not bring them into close proximity to LTs. Instead we observe almost a perfectly normal distribution centered arnd 46-50 years, which tends to match the mean of the professional driver age.

Display 3.1.2b provides a further subdivision of these ages by crash severity. The cells that tend to be over-represented are at the youngest and oldest extremes.

Display 3.1.2b Causal Driver Age by Severity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2011-2015 Alabama Integrated Crash Data | Heavy Truck Involved C101 OR C501

Suppress Zero Values: None | Select Cells: | Column: Crash Severity ; Row: CU Driver Age Range 2

	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
0 to 5 Years	0 0.00%	1 0.06%	0 0.00%	0 0.00%	3 0.01%	0 0.00%	4 0.01%
6 to 10 Years	1 0.27%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.00%
11 to 15 Years	2 0.53%	4 0.25%	1 0.05%	2 0.12%	16 0.07%	1 0.17%	26 0.09%
16 to 20 Years	29 7.69%	85 5.38%	127 6.17%	89 5.18%	852 3.99%	28 4.86%	1210 4.38%
21 to 25 Years	33 8.75%	129 8.17%	190 9.24%	133 7.74%	1468 6.88%	43 7.47%	1996 7.22%
26 to 30 Years	42 11.14%	145 9.18%	155 7.54%	153 8.90%	1639 7.68%	46 7.99%	2180 7.89%
31 to 35 Years	34 9.02%	150 9.50%	202 9.82%	157 9.13%	1733 8.12%	48 8.33%	2324 8.41%
36 to 40 Years	31 8.22%	171 10.83%	210 10.21%	167 9.71%	1939 9.09%	44 7.64%	2562 9.27%
41 to 45 Years	28 7.43%	195 12.35%	209 10.16%	202 11.75%	2173 10.19%	35 6.08%	2842 10.28%
46 to 50 Years	32 8.49%	165 10.45%	218 10.60%	174 10.12%	2295 10.76%	48 8.33%	2932 10.61%
51 to 55 Years	29 7.69%	160 10.13%	211 10.26%	178 10.35%	2189 10.26%	67 11.63%	2834 10.25%
56 to 60 Years	33 8.75%	134 8.49%	195 9.48%	130 7.56%	1846 8.65%	47 8.16%	2385 8.63%
61 to 65 Years	16 4.24%	79 5.00%	111 5.40%	113 6.57%	1242 5.82%	45 7.81%	1606 5.81%
66 to 70 Years	14 3.71%	60 3.80%	76 3.69%	71 4.13%	776 3.64%	20 3.47%	1017 3.68%
71 to 75 Years	18 4.77%	28 1.77%	43 2.09%	40 2.33%	462 2.17%	23 3.99%	614 2.22%
76 to 80 Years	14 3.71%	22 1.39%	29 1.41%	27 1.57%	265 1.24%	10 1.74%	367 1.33%
81 to 85 Years	7 1.86%	16 1.01%	12 0.58%	12 0.70%	157 0.74%	5 0.87%	209 0.76%
86 to 90 Years	6 1.59%	6 0.38%	6 0.29%	2 0.12%	60 0.28%	5 0.87%	85 0.31%
91 to 95 Years	1 0.27%	1 0.06%	0 0.00%	1 0.06%	11 0.05%	0 0.00%	14 0.05%
More than 95 Years	0 0.00%	9 0.57%	2 0.10%	11 0.64%	251 1.18%	0 0.00%	273 0.99%
Not Applicable	5 1.33%	6 0.38%	9 0.44%	4 0.23%	119 0.56%	2 0.35%	145 0.52%
Unknown	0 0.00%	13 0.82%	51 2.48%	53 3.08%	1839 8.62%	59 10.24%	2015 7.29%
CU is Not a Vehicle	2 0.53%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	2 0.01%
CU is Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	377 1.36%	1579 5.71%	2057 7.44%	1719 6.22%	21335 77.18%	576 2.08%	27643 100.00%

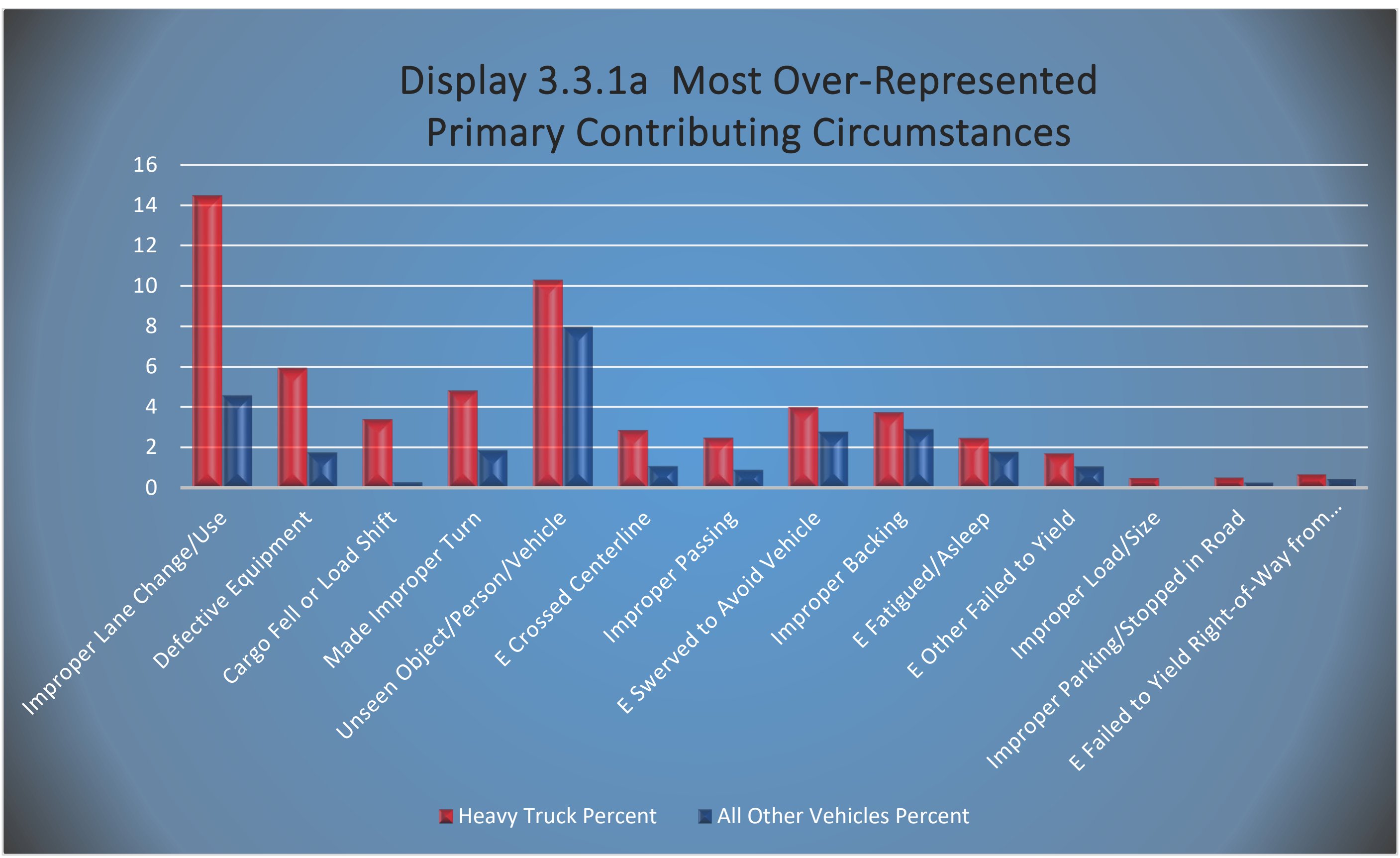
3.2 Driver Related Crash Causes

These are given in their respective sections:

- 3.3.1a Primary Contributing Circumstance (PCC) Over-Representations
- 3.3.1b Primary Contributing Circumstance (PCC) Under-Representations
- 3.3.2 First Harmful Event
- 3.3.3 Manner of Crash
- 3.3.3 Vehicle Maneuver

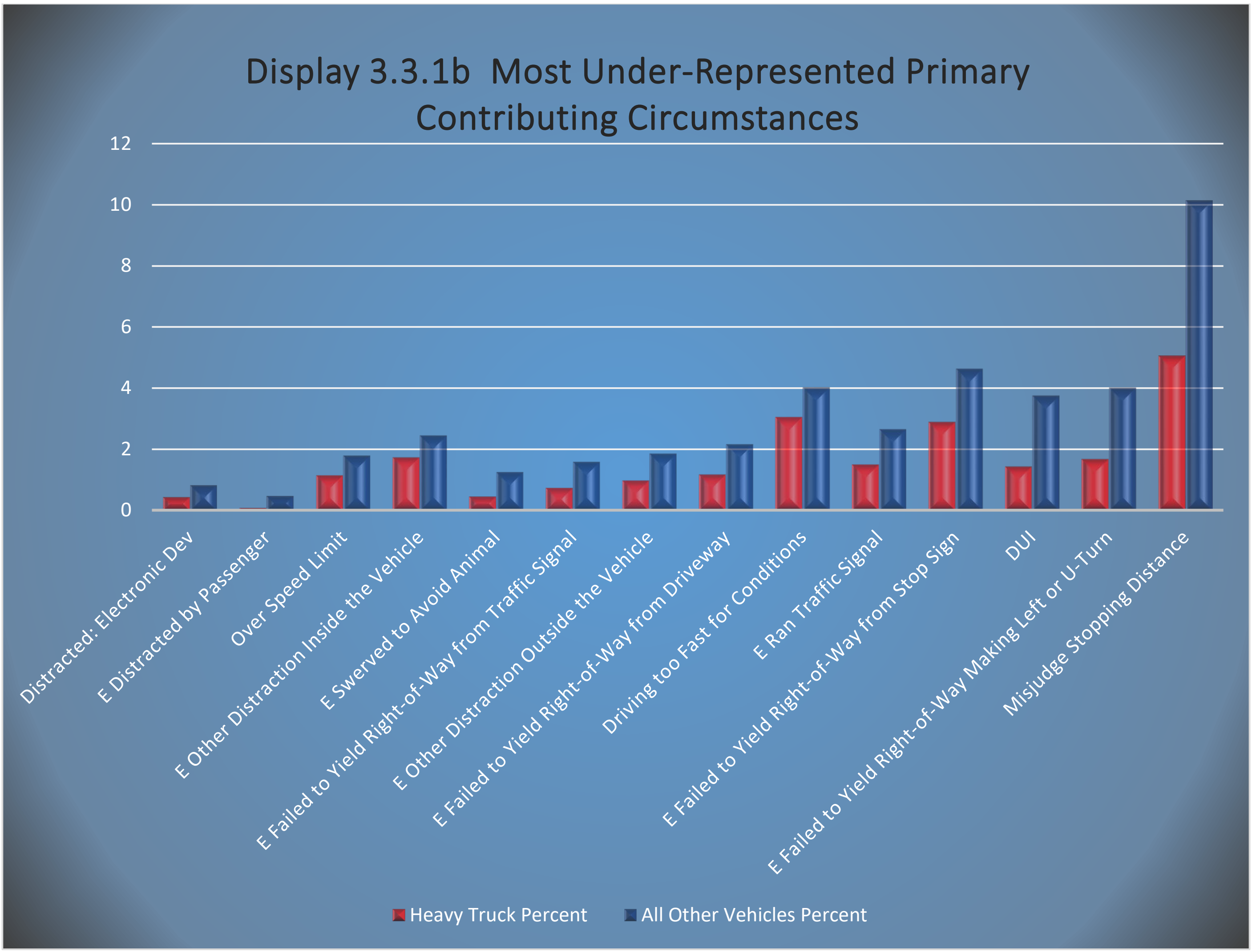
3.2.1a PCC IMPACT comparing LT with non-LT (Over-Representations)

Display 3.3.1a presents the findings from the LT Primary Contributing Circumstance (PCC) analysis. This is the PCC for the entire crash and thus is not linked to any vehicle, causal or otherwise. None of these are particularly surprising in that they are all heavily associated with large trucks.



3.2.1b PCC IMPACT Comparing LT with non-LT (Under-Representations)

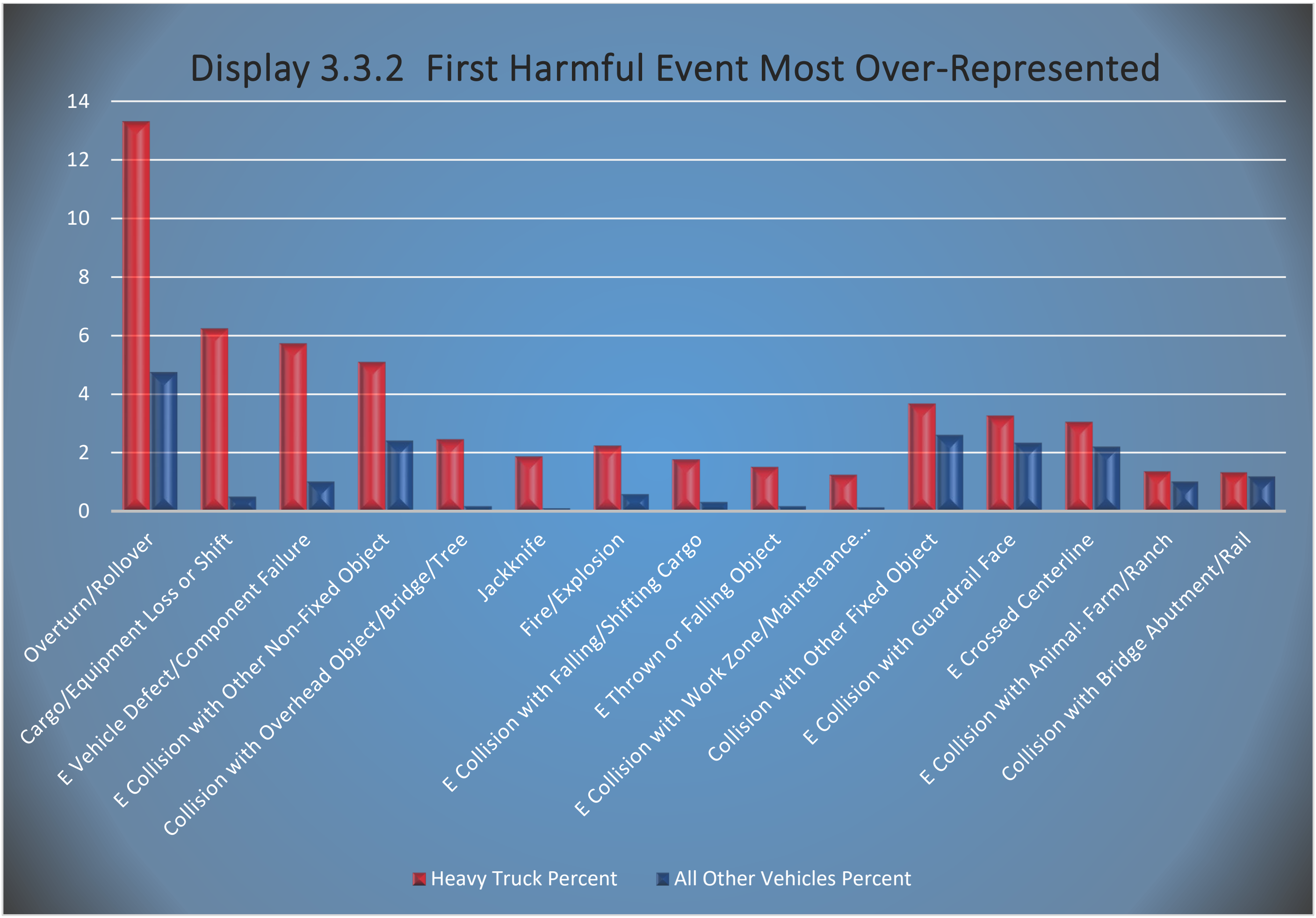
Display 3.3.1b presents the findings from the LT PCC analysis from the other end of the spectrum – those PCCs that are least likely to be associated with LT involved crashes.



Several of these are of note since they tend to reflect the professionalism of the LT drivers, e.g., under-representation in (1) several distracted driving categories, (2) several failure to yield categories, (3) two high speed categories, and (4) misjudge stopping distance, which is highly correlated with lack of drive experience. Also, truckers typically have relatively few problems with DUI.

3.2.2 First Harmful Event IMPACT Comparing LT with non-LT

Display 3.3.2 presents the findings from the First Harmful Event (FHE) analysis. This is the FHE for the entire crash and thus is not linked to any vehicle, causal or otherwise.

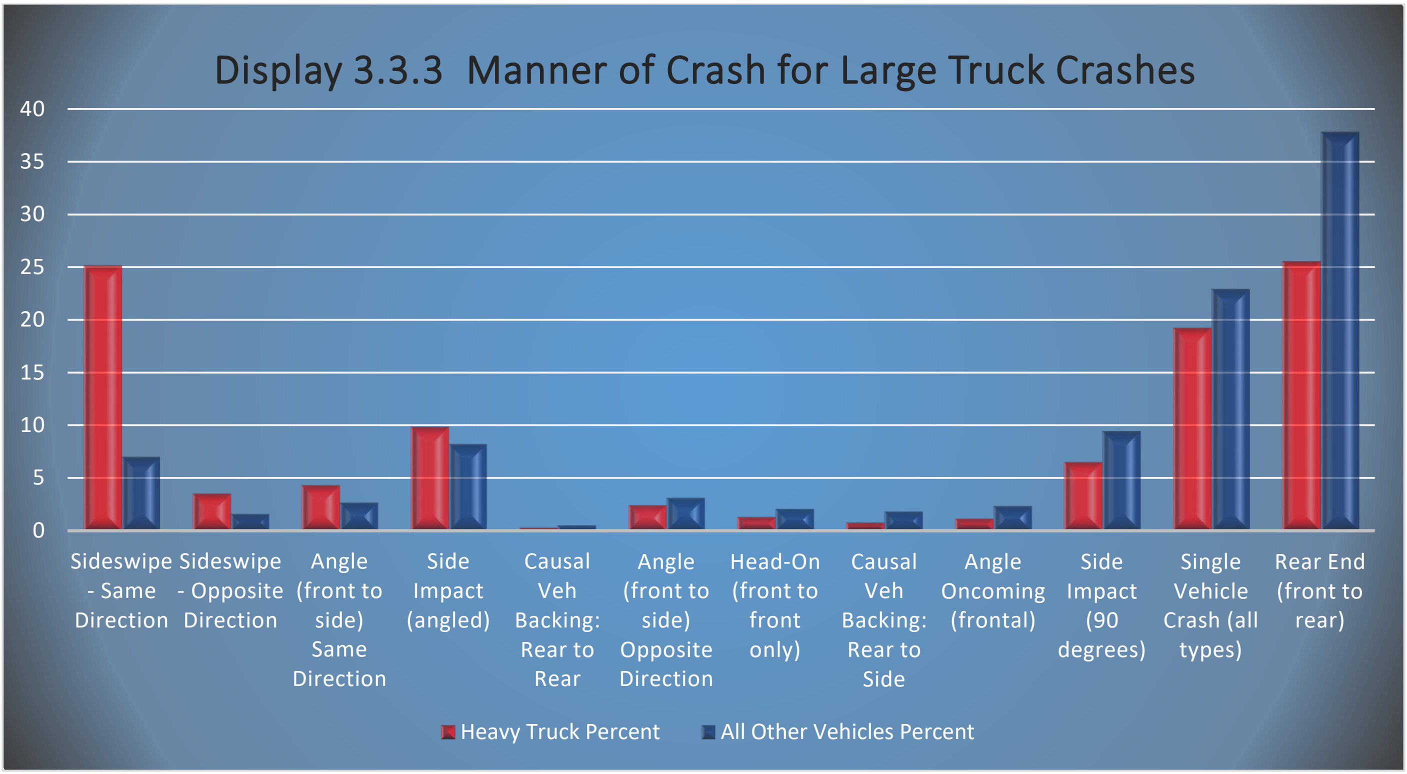


The highest percentage First Harmful Event (FHE), Collision with Vehicle in Traffic, was excluded from this display in order to keep from dwarfing the other categories. The percentage of Collision with Vehicle in Traffic was 72.48% for non-LTs but was only 70.12% for LTs (significantly under-represented), although still the predominant FHE. As with the over-represented PCC categories, most of the over-represented FHEs are closely associated with large truck issues.

3.2.3 Manner of Crash IMPACT comparing LT with non-LT

Display 3.3.3 presents the findings from the Manner of Crash analysis. This is the Manner of Crash reported for the entire crash and thus is not linked to any vehicle, causal or otherwise.

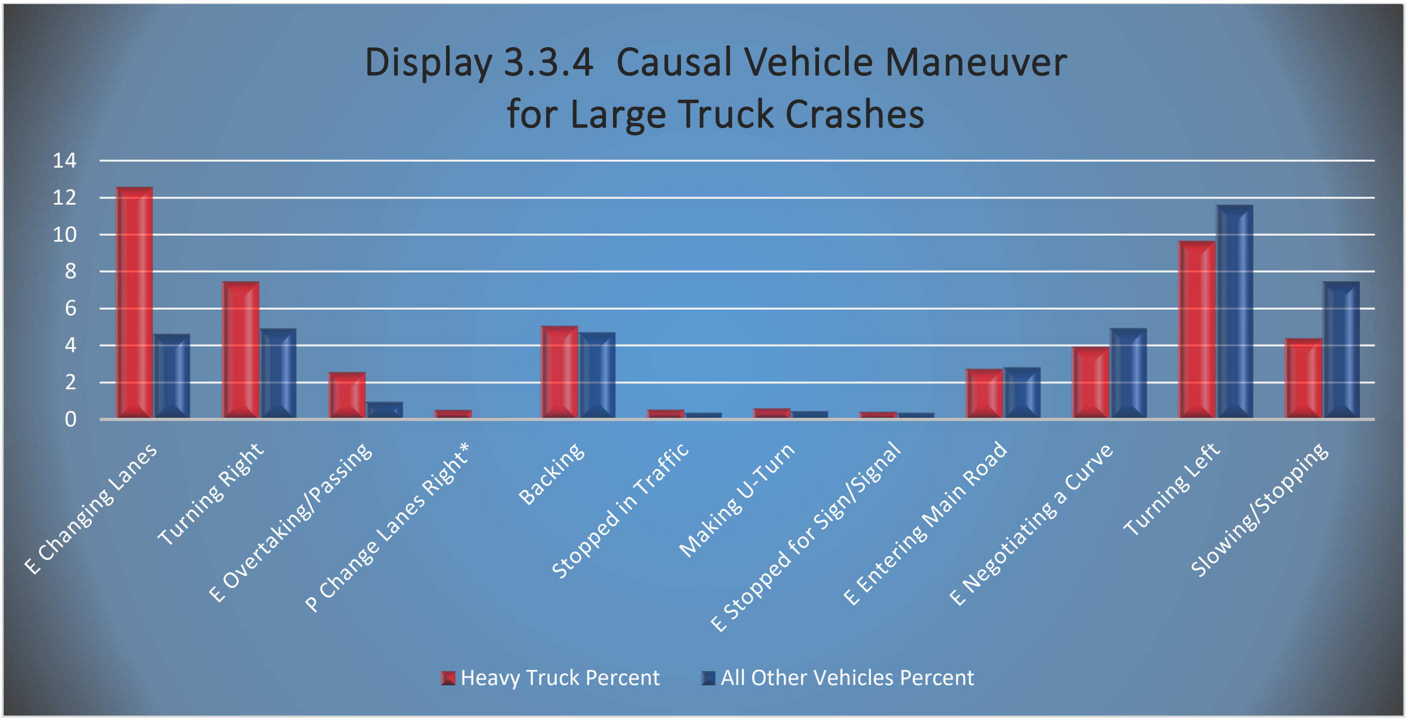
Display 3.3.3 Manner of Crash



The display contains both the over- and under-represented Manner of Crash values. Sideswipes in the same direction are by far the largest over-represented value, which is clearly an issue of the truck blind spots, often resulting from passenger cars staying in these blind spots for too long. Typically this would not be a problem in heavy traffic where cars are essentially forced to stay in the blind spots, since it is unlikely that trucks would change lanes in this situation. This is an issue that can and should be dealt with by educating the general driving public. Cruise control is often at fault since if it is depended upon it can keep cars in blind spots indefinitely. Future innovations need to detect and warn drivers when they are in blind spots since they are often too busy with their electronic devices to notice.

3.2.4 Causal Unit Vehicle Maneuver IMPACT Comparison

Display 3.3.4 presents the findings from the Vehicle Maneuver analysis. This is the Vehicle Maneuver reported for the causal vehicle only.



Changing Lanes in this analysis is closely related to Same Direction Sideswipes in the Manner of Crash analysis in the previous section. It is interesting to contrast Turning Right category with Turning Left, which would seem to be under-represented in that the driver has better visibility on the left side. Slowing/Stopping in this attribute corresponds heavily to Rear Ends in the Manner of Crash and to Misjudging Stopping Distance in the PCC attribute.

4 Large Truck Crash Analysis

Crash analyses are subdivided into two broad classifications (1) geographical and roadway aspects, and (2) time factors.

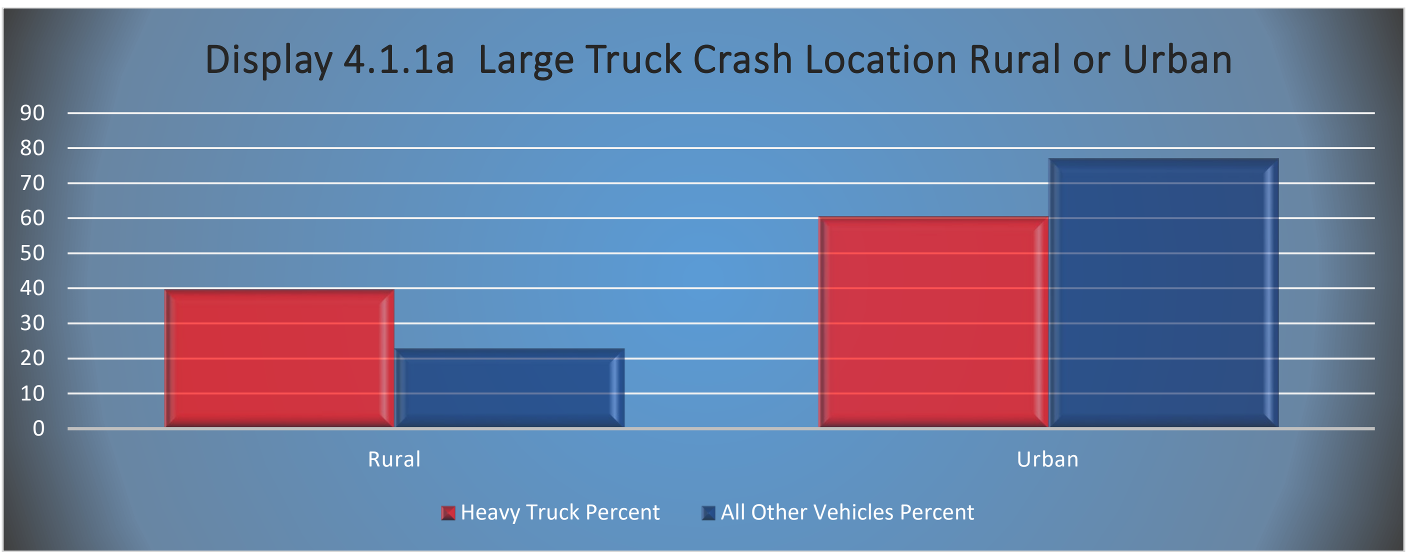
4.1 Geographical and Roadway Aspects

Geographical and roadway aspects are further subdivided as follows:

- 4.1.1 Rural-Urban
- 4.1.2 Highway classification
- 4.1.3 Weather
- 4.1.4 Roadway curvature and grade
- 4.1.5 Workzones

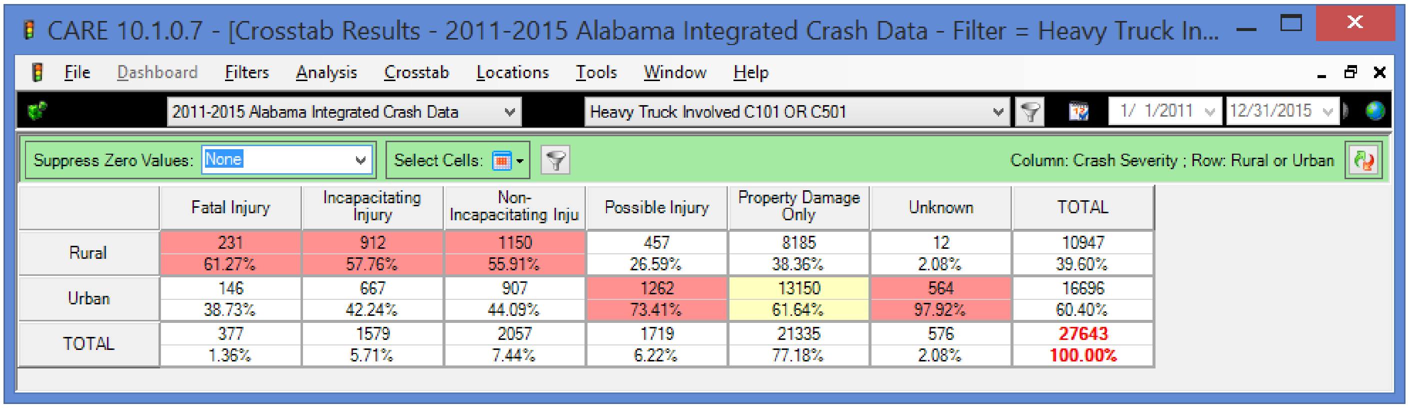
4.1.1 Rural-Urban IMPACT Comparing LT Involved with non-LT

Display 4.1.1a presents the findings from the Rural-Urban analysis. This is and attribute of the crash that is independent of causal vehicle.



While urban crashes outnumber the rural crashes for LTs, they are over-represented in rural areas almost by a factor of 2. This has to do with the types of roads that they run on, which is considered next. The more lethal aspects of rural roadways cannot be underestimated, and it is largely due to the increased speeds in the rural road system. Display 4.4.1b shows the crash severity broken down by the rural-urban classification. It is clear that fatal crashes and those of the higher two severity classifications are over-represented in the rural areas.

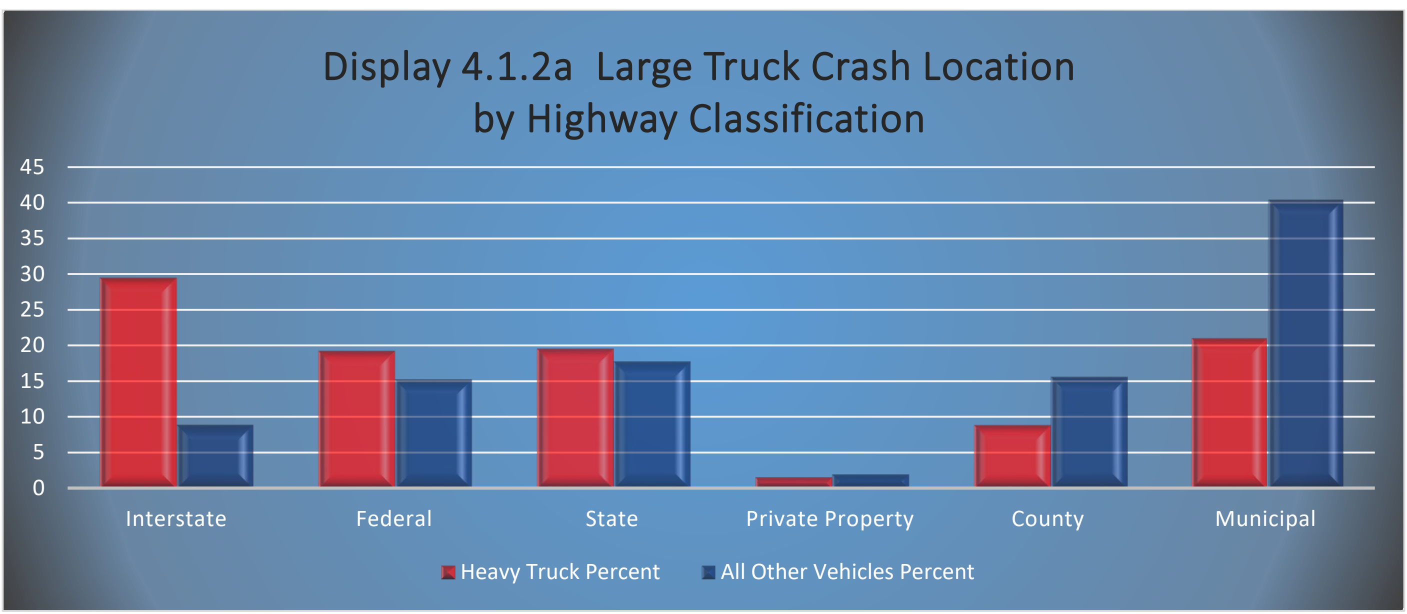
Display 4.1.1b Crash Severity by Rural-Urban Classification – Large Trucks



	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Rural	231 61.27%	912 57.76%	1150 55.91%	457 26.59%	8185 38.36%	12 2.08%	10947 39.60%
Urban	146 38.73%	667 42.24%	907 44.09%	1262 73.41%	13150 61.64%	564 97.92%	16696 60.40%
TOTAL	377 1.36%	1579 5.71%	2057 7.44%	1719 6.22%	21335 77.18%	576 2.08%	27643 100.00%

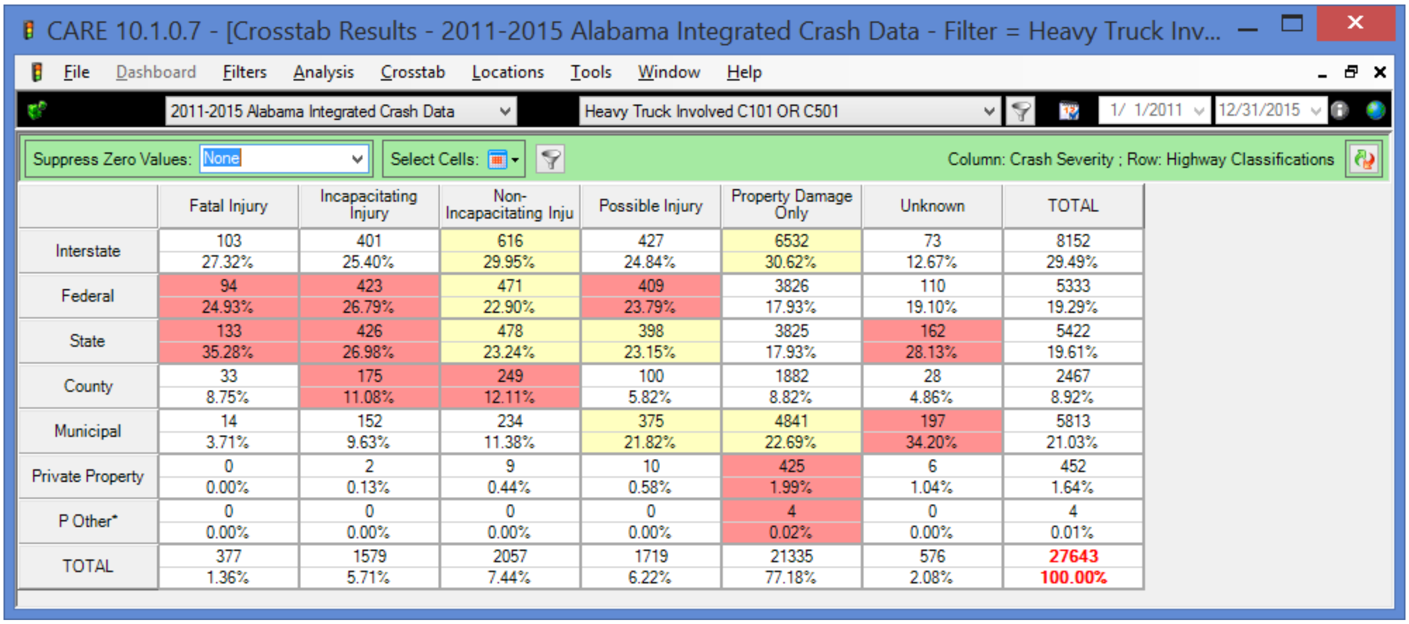
4.1.2 Highway Classification IMPACT Comparing LT Involved with non-LT

Display 4.1.2a presents the findings from the Highway Classification analysis. This is an attribute of the crash that is independent of causal vehicle.



There is no doubt that a primary cause of the over-representations are due mainly to the mileage that LTs put on these various roadway types. It is interesting to do a severity analysis to see the ramification of the various highway classification crashes. This is shown in Display 4.1.2b. It is quite interesting that Interstate highways, which clearly have the highest speeds for LTs are under-represented in fatalities and the highest non-fatal injury classification. We can propose two reasons for this: (1) the forgiveness of the roadway in providing guardrails, impact attenuators and other countermeasures to mitigate the effect of many crashes, (2) clear roadsides and ample shoulders, and (3) the speed with which Emergency Medical Services are able to respond.

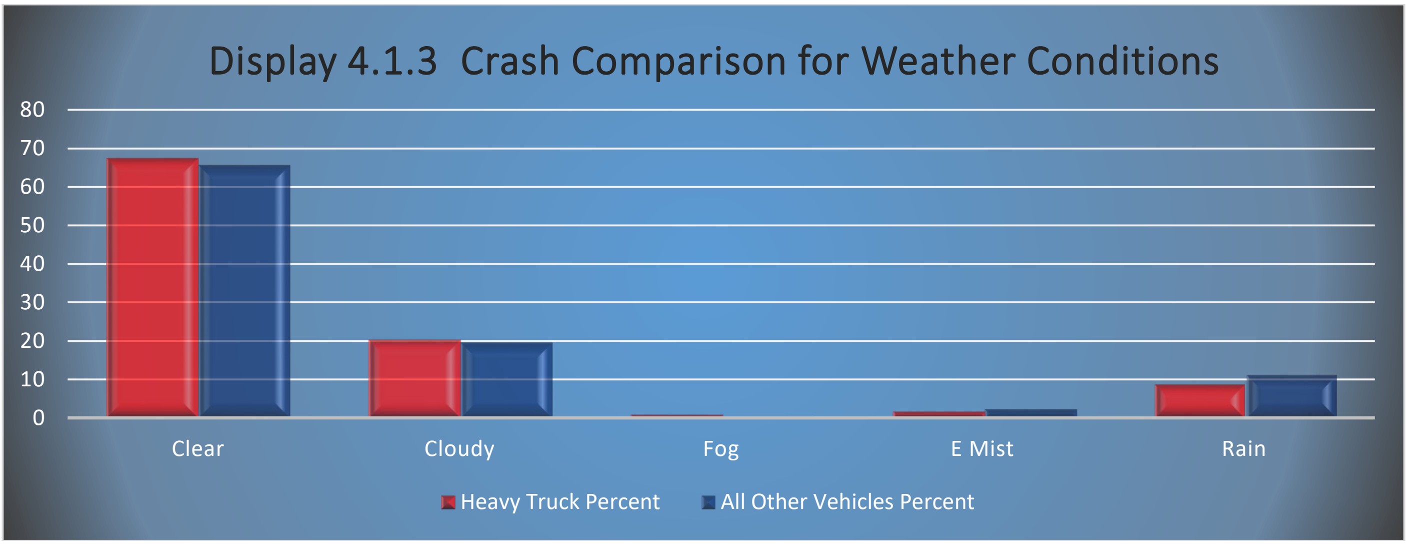
Display 4.1.2b Crash Severity by Highway Classification



	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Interstate	103 27.32%	401 25.40%	616 29.95%	427 24.84%	6532 30.62%	73 12.67%	8152 29.49%
Federal	94 24.93%	423 26.79%	471 22.90%	409 23.79%	3826 17.93%	110 19.10%	5333 19.29%
State	133 35.28%	426 26.98%	478 23.24%	398 23.15%	3825 17.93%	162 28.13%	5422 19.61%
County	33 8.75%	175 11.08%	249 12.11%	100 5.82%	1882 8.82%	28 4.86%	2467 8.92%
Municipal	14 3.71%	152 9.63%	234 11.38%	375 21.82%	4841 22.69%	197 34.20%	5813 21.03%
Private Property	0 0.00%	2 0.13%	9 0.44%	10 0.58%	425 1.99%	6 1.04%	452 1.64%
P Other*	0 0.00%	0 0.00%	0 0.00%	0 0.00%	4 0.02%	0 0.00%	4 0.01%
TOTAL	377 1.36%	1579 5.71%	2057 7.44%	1719 6.22%	21335 77.18%	576 2.08%	27643 100.00%

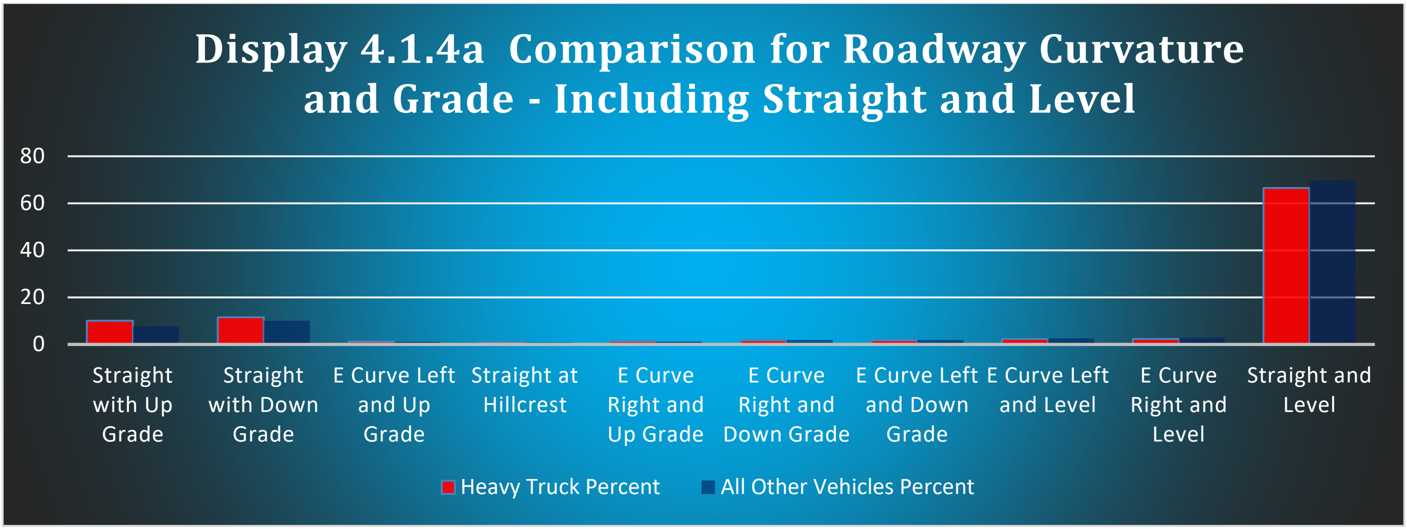
4.1.3 Weather IMPACT comp LT with non-LT

Display 4.1.3 presents the findings from the Weather analysis. LTs were found to be under-represented in rain when compared to other vehicle types. This is probably due to the truck drivers' experience in wet weather.

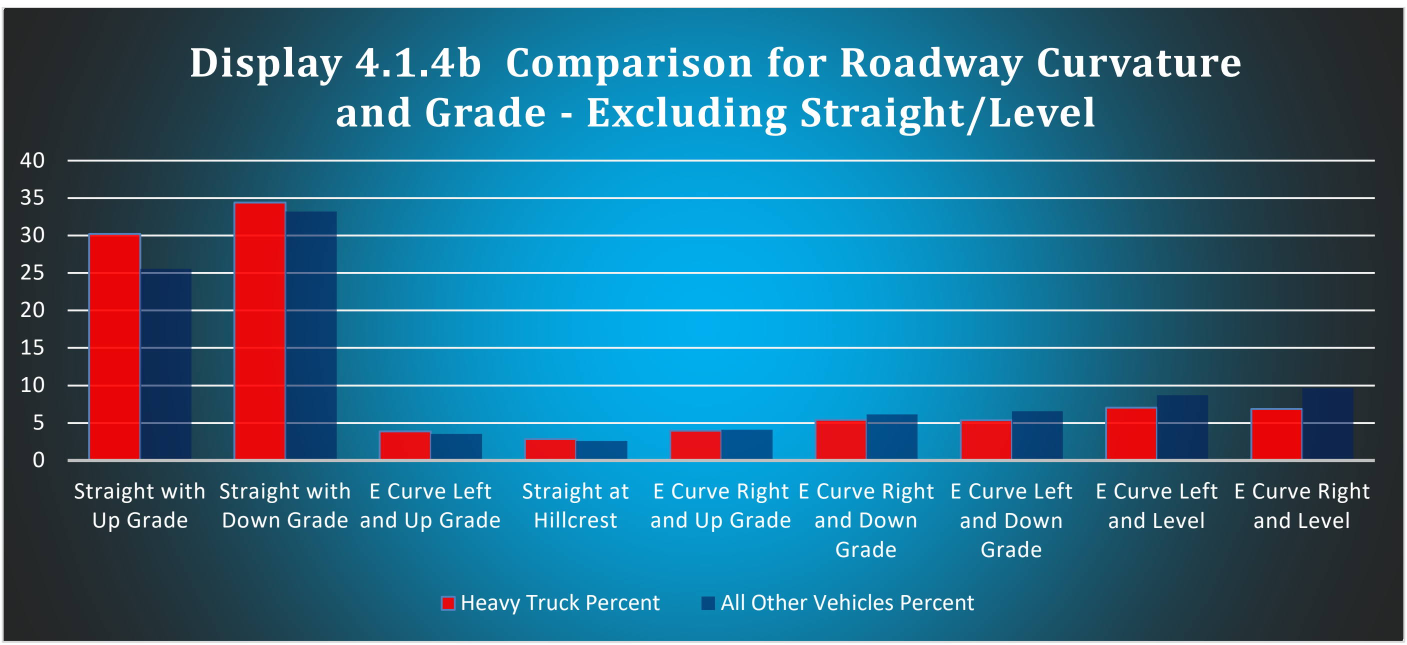


4.1.4 Roadway Curvature and Grade IMPACT Comparing LT with non-LT

Display 4.1.4a and b present the results for curvature and grade of the causal vehicle. The primary issue seems to be with grades, either up or down. The straight and level category was eliminated from Display 4.4.1b in order to make the relative effects of the other categories more visible.



Display 4.1.4b Crash Comparison by Roadway Curvature and Grade – Excluding Straight/Level

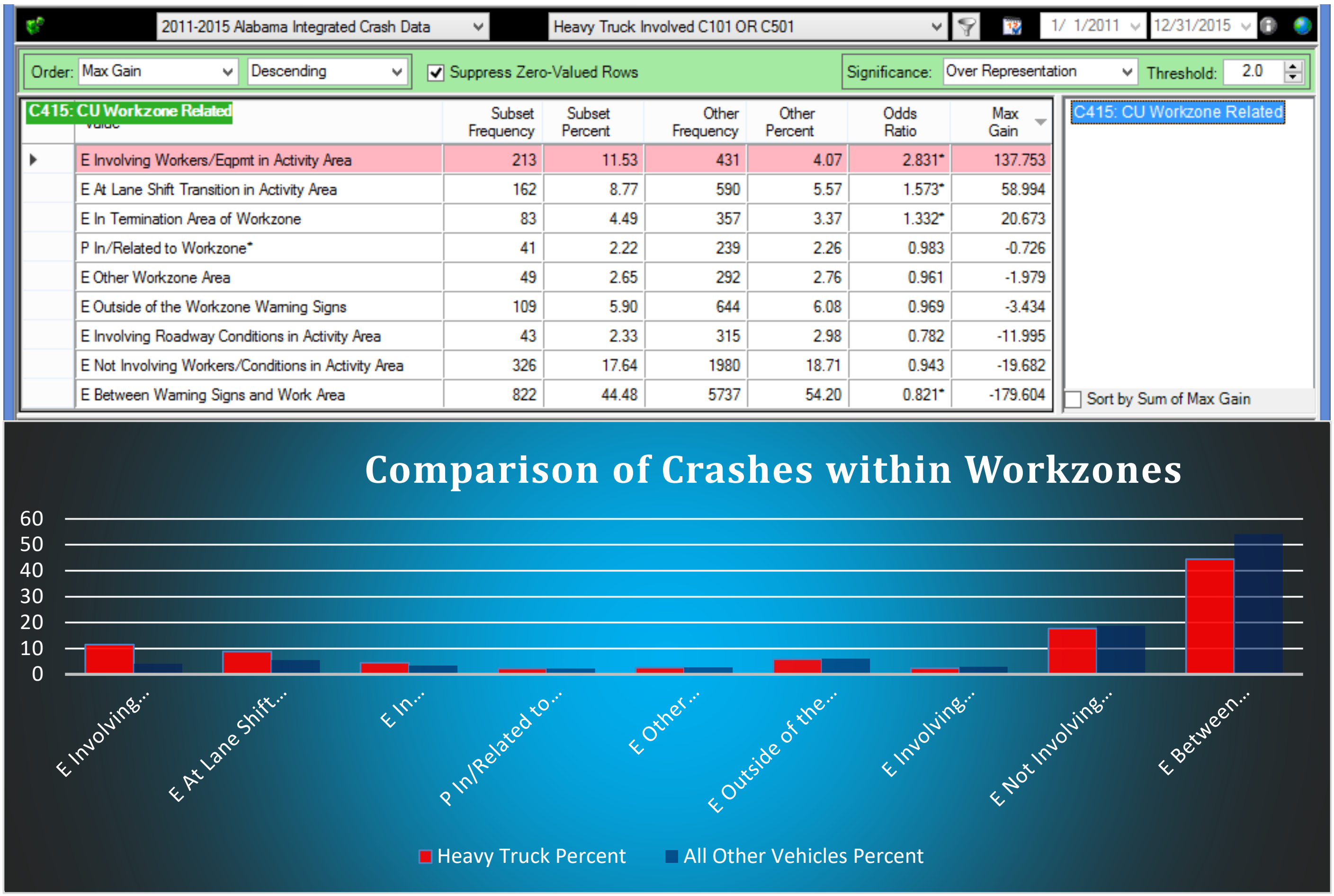


4.1.5 Workzone IMPACT comp LT with non-LT for Crashes in Workzones

During the five year peiord (2011-2015), there were 1,848 LT crashes that involved workzones, which was about 6.7% of all LT involved crashes. Only 1.7% of non-LT vehicles involved workzones, so the LTs are dramatically over-represented in these crashes. Display 4.1.5 presents the distribution of those LT crashes that occurred within workzones comparing them to the proportions for all other vehicle types. The nonworkzone crashes were excluded from Display 4.15, since this amounted to 93.16% of the LT crashes and 98.24% of the nonLT crashes, and thus its inclusion would have made the other attributes unreadable.

The following factors might be given special consideration: (1) Some of the 213 crashes involving equipment could be LT equipment; (2) the most under-represented should not be neglected because it has the highest frequency – 822; and (3) while the workzone reporting codes are not mutually exclusive, they probably give the best description for any particular crash.

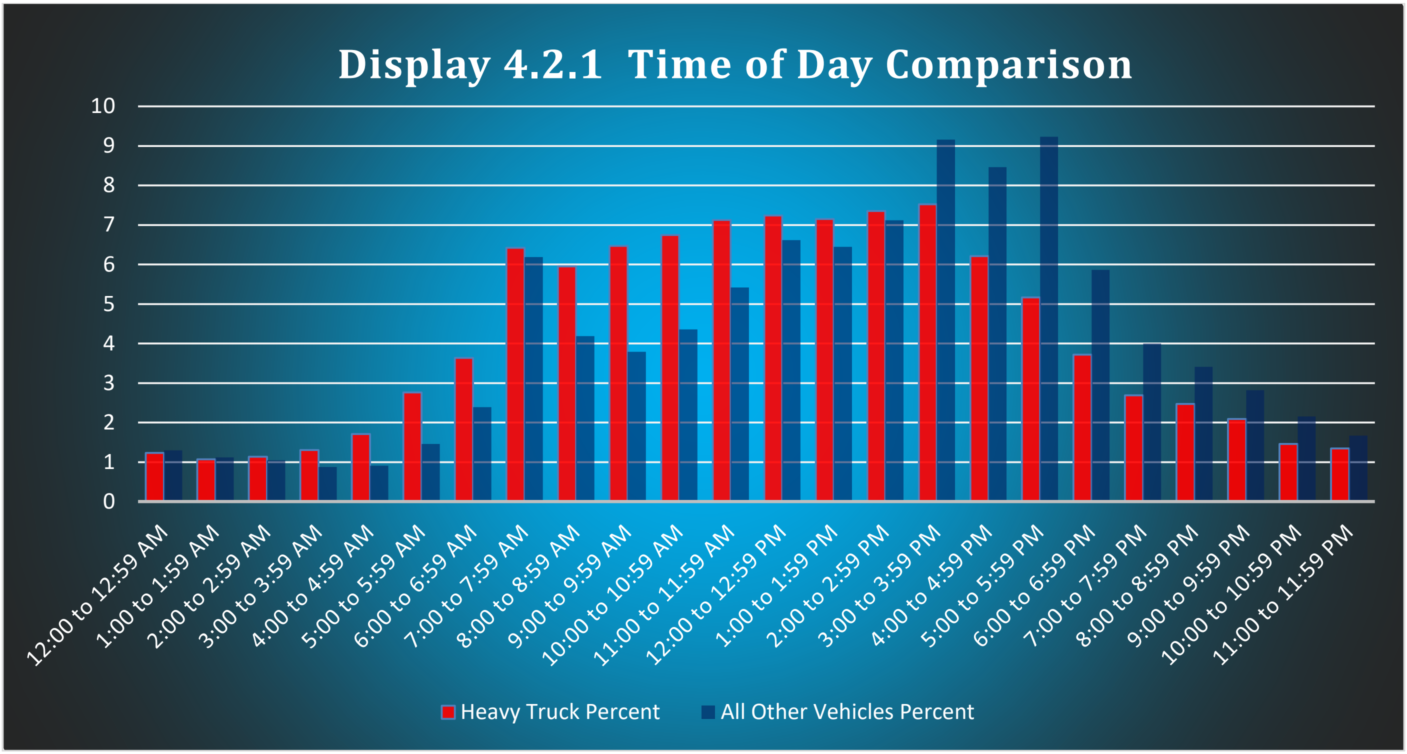
Display 4.1.5 Crash Comparison of Crashes within Workzones



C415: CU Workzone Related	Subset Frequency	Subset Percent	Other Frequency	Other Percent	Odds Ratio	Max Gain
E Involving Workers/Eqpmt in Activity Area	213	11.53	431	4.07	2.831*	137.753
E At Lane Shift Transition in Activity Area	162	8.77	590	5.57	1.573*	58.994
E In Termination Area of Workzone	83	4.49	357	3.37	1.332*	20.673
P In/Related to Workzone*	41	2.22	239	2.26	0.983	-0.726
E Other Workzone Area	49	2.65	292	2.76	0.961	-1.979
E Outside of the Workzone Warning Signs	109	5.90	644	6.08	0.969	-3.434
E Involving Roadway Conditions in Activity Area	43	2.33	315	2.98	0.782	-11.995
E Not Involving Workers/Conditions in Activity Area	326	17.64	1980	18.71	0.943	-19.682
E Between Warning Signs and Work Area	822	44.48	5737	54.20	0.821*	-179.604

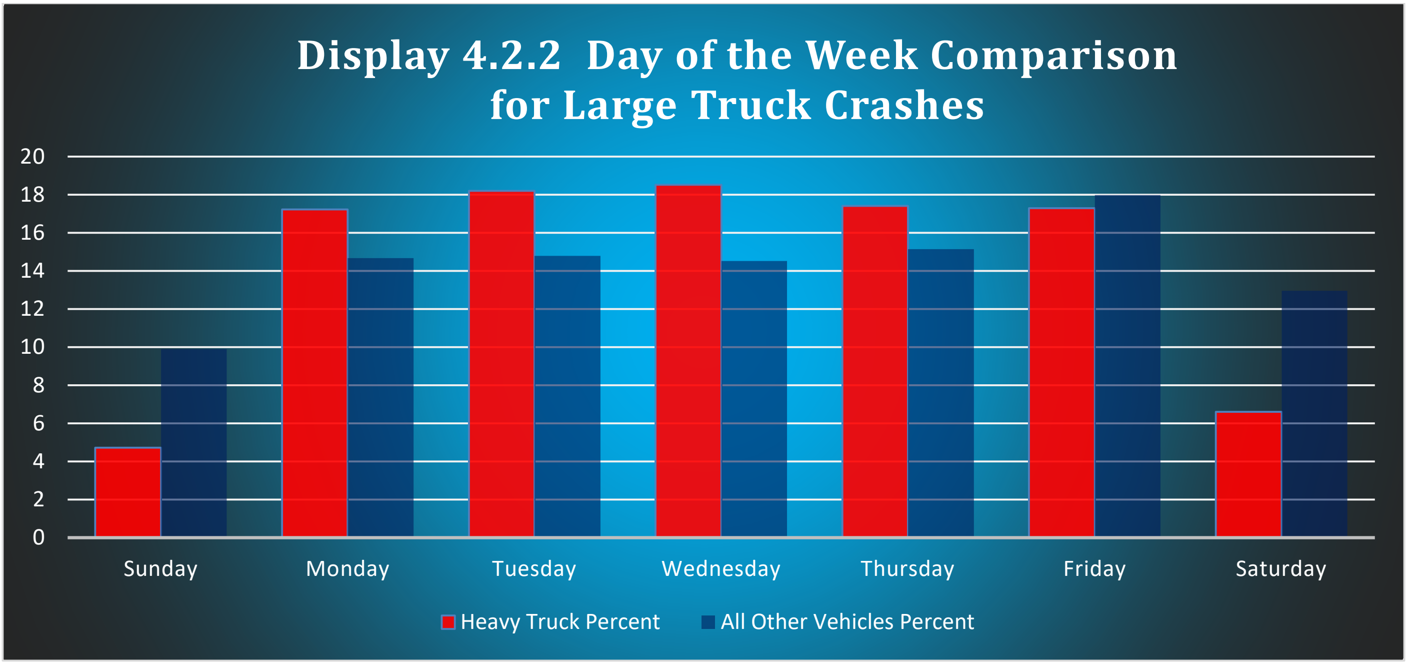
4.2 Time Factors

4.2.1 Time of Day IMPACT Comparing LT with non-LT



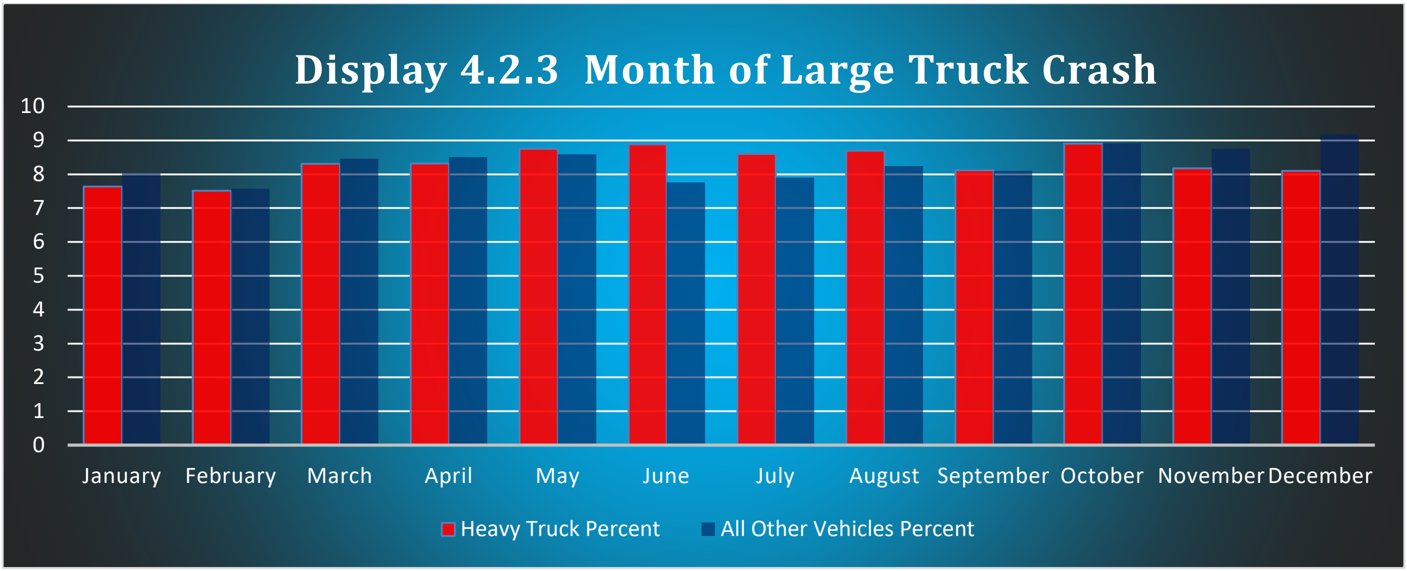
Time of day is closely related to the times of exposure, and the crash distribution could almost be a proxy of when the LTs are on the road. There is some over-representation early morning from 4 AM through 7 PM, but the frequencies are not high at this time. The morning rush hour is a problem, but LTs are not significantly over-represented in the 7;00 to 7:59 time frame, and the presence of other issues at these times would probably not make either the morning or the afternoon rush hours good times to do enforcement. The most under-represented times are late afternoon on through to before midnight. The optimal times for enforcement would seem to be from 8:00 AM through 2:59 PM.

4.2.2 Day of the Week IMPACT comp LT with non-LT



Similar to time of day, the day of the week distribution, given in Display 4.2.2, reflects the days that the majority of LT vehicles are on the road. Saturday and Sunday are probably way down because of the reluctance of those receiving freight to be working on those days. Friday is the only under-represented week-day, and although the frequency is quite high on Friday, officers are generally working on other issues on Friday, especially in the afternoons. The optimal time for enforcement would seem to be Monday through Thursday.

4.2.4 Month IMPACT comp LT with non-LT



The only pattern of over-representation seems to be in the summer months of June, July and August. This is probably not a significant enough factor to warrant any further study.

5 Large Truck Vehicle and Cargo Analysis

5.1 Analysis by Hazardous Cargo

Display 5.1a presents the number of crashes involving hazardous cargo over the five year period of reporting (2011-2015). The standard LT filter was applied to obtain those in the middle column. It was felt for hazardous materials that all vehicles be included and not just LTs. So an additional run was made that included all vehicles carrying hazardous materials; thus, some part of the entries in Display 5.1a could include hazardous materials carried by pickup trucks and other smaller vehicles. However, it was felt best that all hazardous cargo crashes be considered, due to the potential harm that can come from hazardous materials release. For future reference the following are the hazmat-related variables in Driver-Vehicle dataset: 217, 452, 453, and 456.

Display 5.1a Number of Vehicles Involved in Hazardous Cargo

Hazardous Cargo	LT Involved in Crashes	All Vehicles Involved in Crashes
Gasoline	272	306
Other Flammable Liquid	202	301
Corrosive Material	76	205
Other	61	91
Oxidizer/Peroxide	24	27
Flammable Solids	22	29
Other Explosives	16	24
Poison	13	16
Radioactive Material	1	1
TOTAL	687	1,000

Hazardous materials were recorded to have been release from 107 of the vehicles that were carrying hazardous materials. Display 5.1b gives the types of hazardous materials that were released.

Display 5.1b Type of Hazardous Cargo Released (All Vehicles)

CARE 10.1.0.7 - [Crosstab Results - 2011-2015 Alabama Integrated Driver-Vehicle Data]

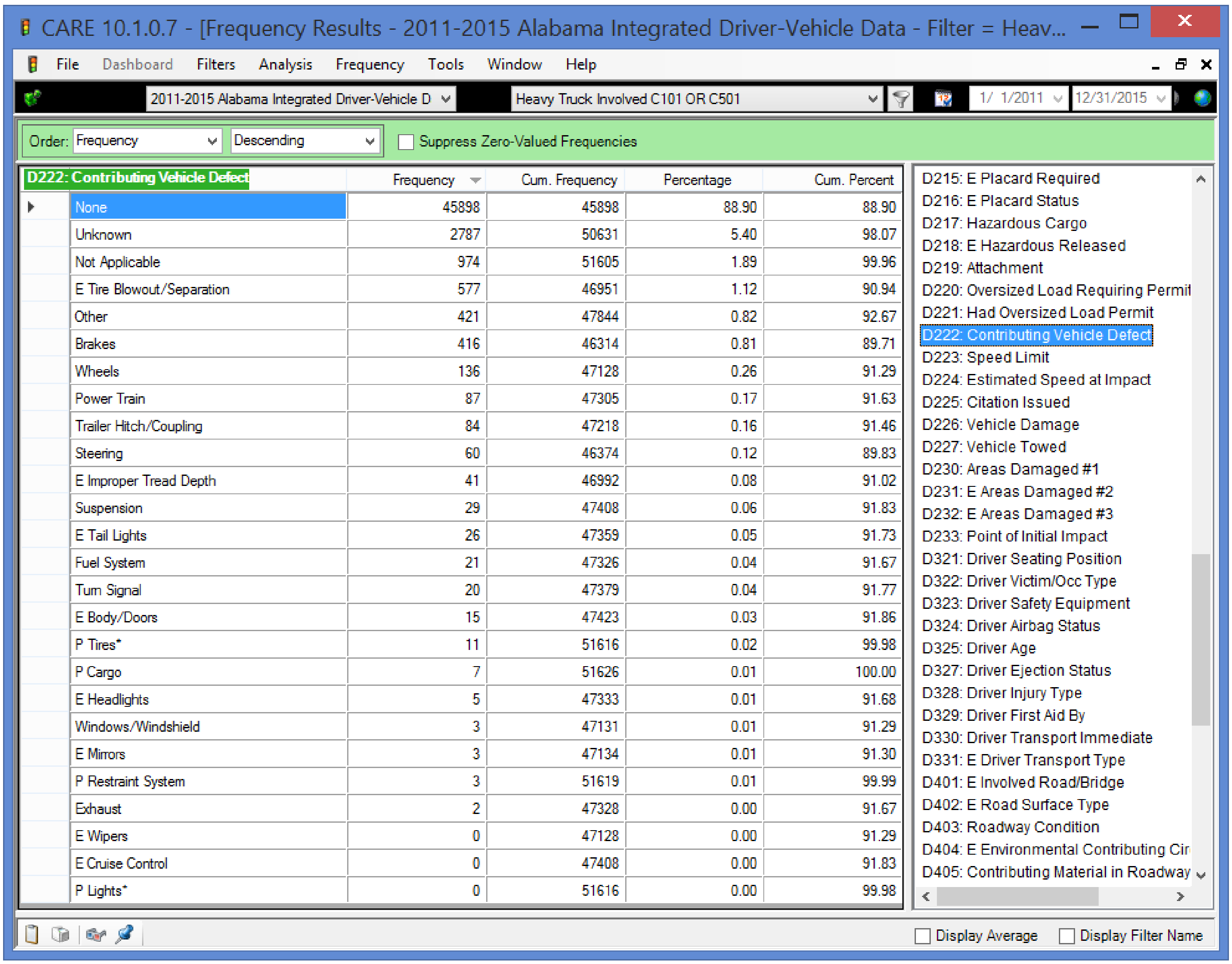
Column: E Hazardous Released ; Row: Hazardous Cargo

	Yes	No	Unknown	Not Applicable/No Hazardous Cargo	Record from Paper System	TOTAL
None	0 0.00%	0 0.00%	0 0.00%	50061 4.50%	1323 1.82%	51384 4.23%
Gasoline	32 29.91%	261 26.77%	1 0.00%	12 0.00%	0 0.00%	306 0.03%
Other Flammable Liquid	28 26.17%	237 24.31%	1 0.00%	11 0.00%	24 0.03%	301 0.02%
Flammable Solids	2 1.87%	12 1.23%	0 0.00%	2 0.00%	13 0.02%	29 0.00%
Oxidizer/Peroxide	4 3.74%	21 2.15%	0 0.00%	0 0.00%	2 0.00%	27 0.00%
Other Explosives	2 1.87%	20 2.05%	0 0.00%	2 0.00%	0 0.00%	24 0.00%
Poison	2 1.87%	10 1.03%	0 0.00%	4 0.00%	0 0.00%	16 0.00%
Radioactive Material	0 0.00%	1 0.10%	0 0.00%	0 0.00%	0 0.00%	1 0.00%
Corrosive Material	11 10.28%	67 6.87%	0 0.00%	127 0.01%	0 0.00%	205 0.02%
Other	4 3.74%	64 6.56%	2 0.01%	9 0.00%	12 0.02%	91 0.01%
Unknown	22 20.56%	282 28.92%	29781 99.99%	118 0.01%	22 0.03%	30225 2.49%
Not Applicable (Not a CMV)	0 0.00%	0 0.00%	0 0.00%	1061689 95.47%	71430 98.08%	1133119 93.20%
TOTAL	107 0.01%	975 0.08%	29785 2.45%	1112035 91.47%	72826 5.99%	1215728 100.00%

5.2 Vehicle Defects

Display 5.2 presents the summary of the Contributing Vehicle Defects variable from the Driver-Vehicle dataset. No IMPACT was run because of the unique nature of a large number of these values; i.e., many of them do not occur in any non-LT vehicle. The defect values are ordered by the frequency to surface those that might be most critical.

Display 5.2 Frequency and Relative Frequency of Contributing Defects

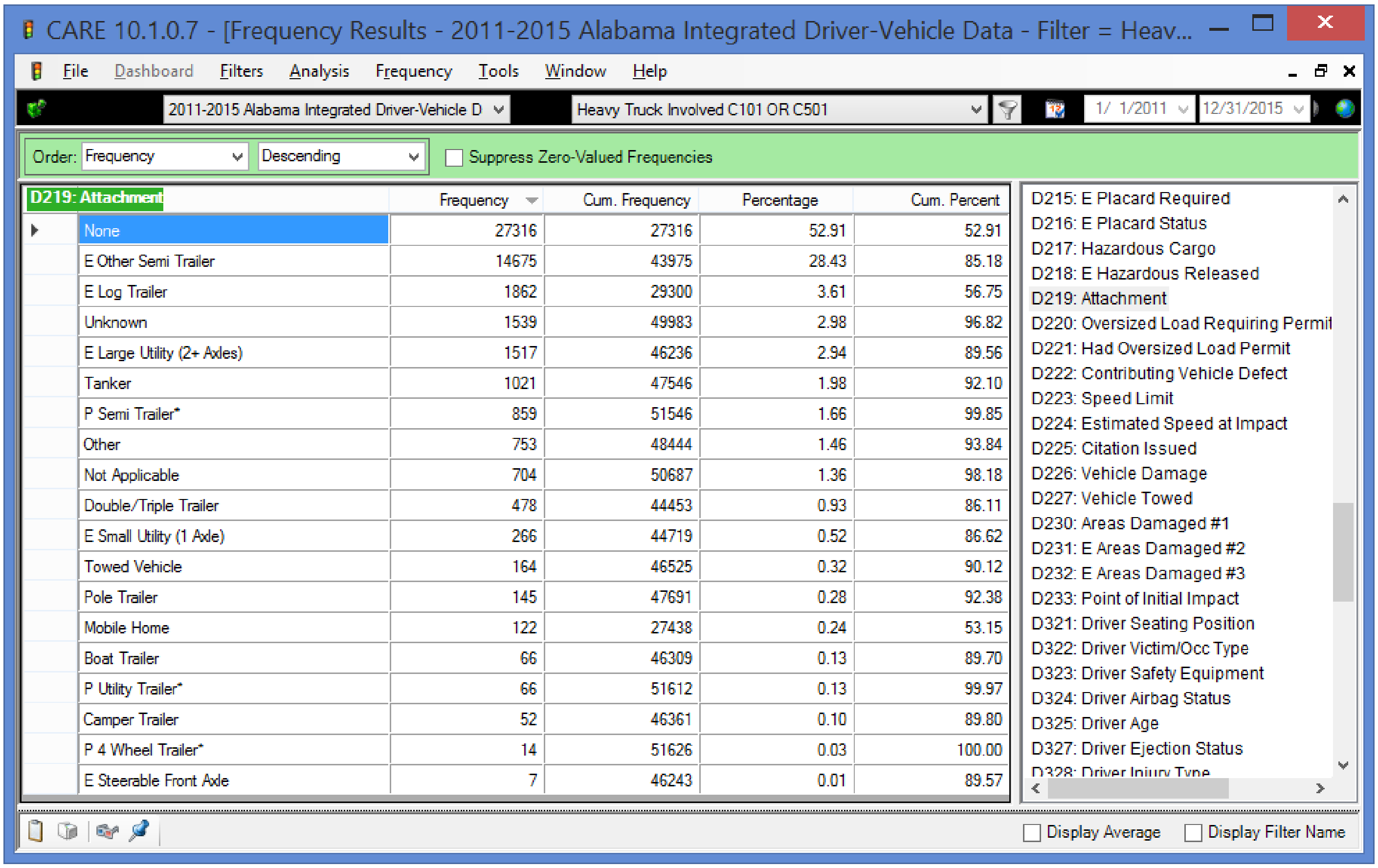


D222: Contributing Vehicle Defect	Frequency	Cum. Frequency	Percentage	Cum. Percent
None	45898	45898	88.90	88.90
Unknown	2787	50631	5.40	98.07
Not Applicable	974	51605	1.89	99.96
E Tire Blowout/Separation	577	46951	1.12	90.94
Other	421	47844	0.82	92.67
Brakes	416	46314	0.81	89.71
Wheels	136	47128	0.26	91.29
Power Train	87	47305	0.17	91.63
Trailer Hitch/Coupling	84	47218	0.16	91.46
Steering	60	46374	0.12	89.83
E Improper Tread Depth	41	46992	0.08	91.02
Suspension	29	47408	0.06	91.83
E Tail Lights	26	47359	0.05	91.73
Fuel System	21	47326	0.04	91.67
Turn Signal	20	47379	0.04	91.77
E Body/Doors	15	47423	0.03	91.86
P Tires*	11	51616	0.02	99.98
P Cargo	7	51626	0.01	100.00
E Headlights	5	47333	0.01	91.68
Windows/Windshield	3	47131	0.01	91.29
E Mirrors	3	47134	0.01	91.30
P Restraint System	3	51619	0.01	99.99
Exhaust	2	47328	0.00	91.67
E Wipers	0	47128	0.00	91.29
E Cruise Control	0	47408	0.00	91.83
P Lights*	0	51616	0.00	99.98

5.3 Vehicle Attachment

Display 5.3 presents the summary of the Vehicle Attachments variable from the Driver-Vehicle dataset. No IMPACT was run because most of these values do not occur in any non-LT vehicle. The attachment values are ordered by the frequency to surface those that might be most critical.

Display 5.3 Frequency and Relative Frequency of Vehicle Attachments



D219: Attachment	Frequency	Cum. Frequency	Percentage	Cum. Percent
None	27316	27316	52.91	52.91
E Other Semi Trailer	14675	43975	28.43	85.18
E Log Trailer	1862	29300	3.61	56.75
Unknown	1539	49983	2.98	96.82
E Large Utility (2+ Axles)	1517	46236	2.94	89.56
Tanker	1021	47546	1.98	92.10
P Semi Trailer*	859	51546	1.66	99.85
Other	753	48444	1.46	93.84
Not Applicable	704	50687	1.36	98.18
Double/Triple Trailer	478	44453	0.93	86.11
E Small Utility (1 Axle)	266	44719	0.52	86.62
Towed Vehicle	164	46525	0.32	90.12
Pole Trailer	145	47691	0.28	92.38
Mobile Home	122	27438	0.24	53.15
Boat Trailer	66	46309	0.13	89.70
P Utility Trailer*	66	51612	0.13	99.97
Camper Trailer	52	46361	0.10	89.80
P 4 Wheel Trailer*	14	51626	0.03	100.00
E Steerable Front Axle	7	46243	0.01	89.57

6 Bus Crash Analyses

The following indicates the sections and subjects of bus analyses *that have been given above*:

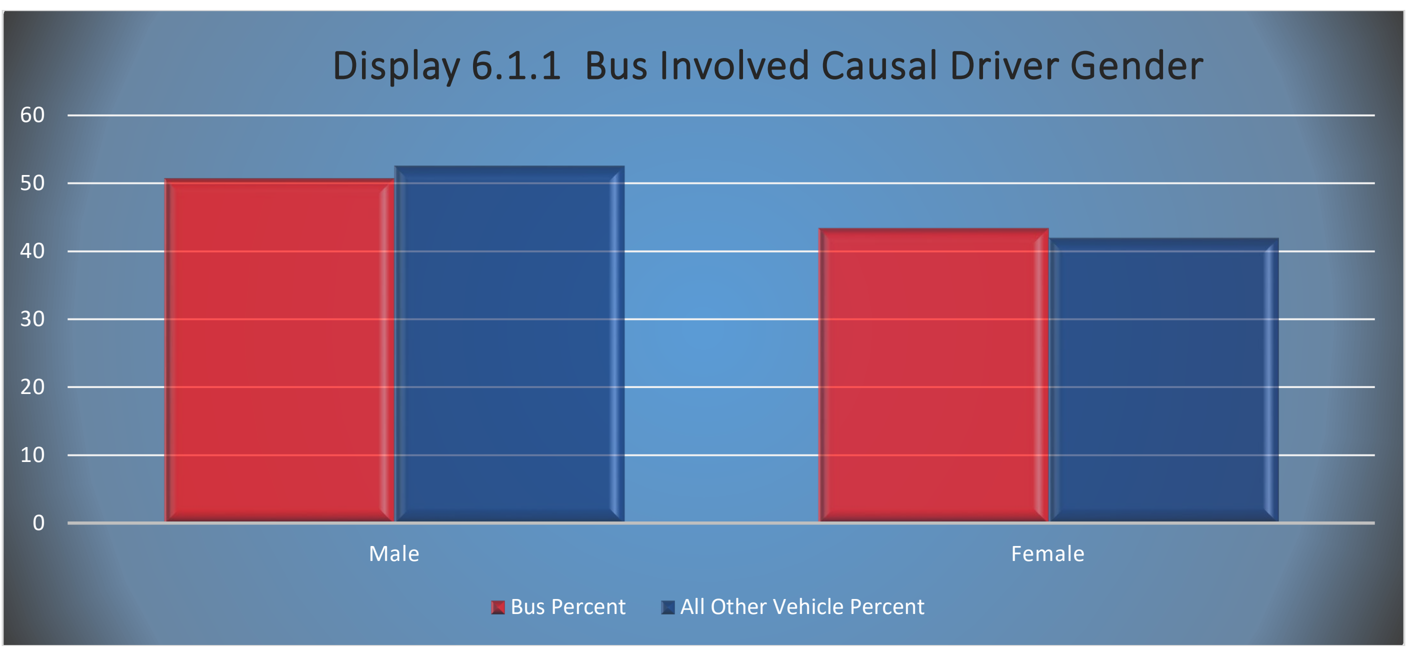
Section	Bus Subject Covered
1	Definition of the buses considered in this report
1.1.1	Bus involvement compared to other crash types
1.1.3	Severity of bus crashes
1.1.3.1	Analysis of bus impact speeds
1.1.3.2	Analysis of bus ambulance delay times
2.2	At fault analysis for buses

It should be noticed that school buses are excluded from the definition of the bus vehicle type that is under consideration here. This section will continue by presenting bus crash causal driver demographics (6.1), general geographical and roadway bus crash analysis (6.2), and time factors for bus crashes (6.3).

6.1 Driver Demographics for Bus Involved Crashes

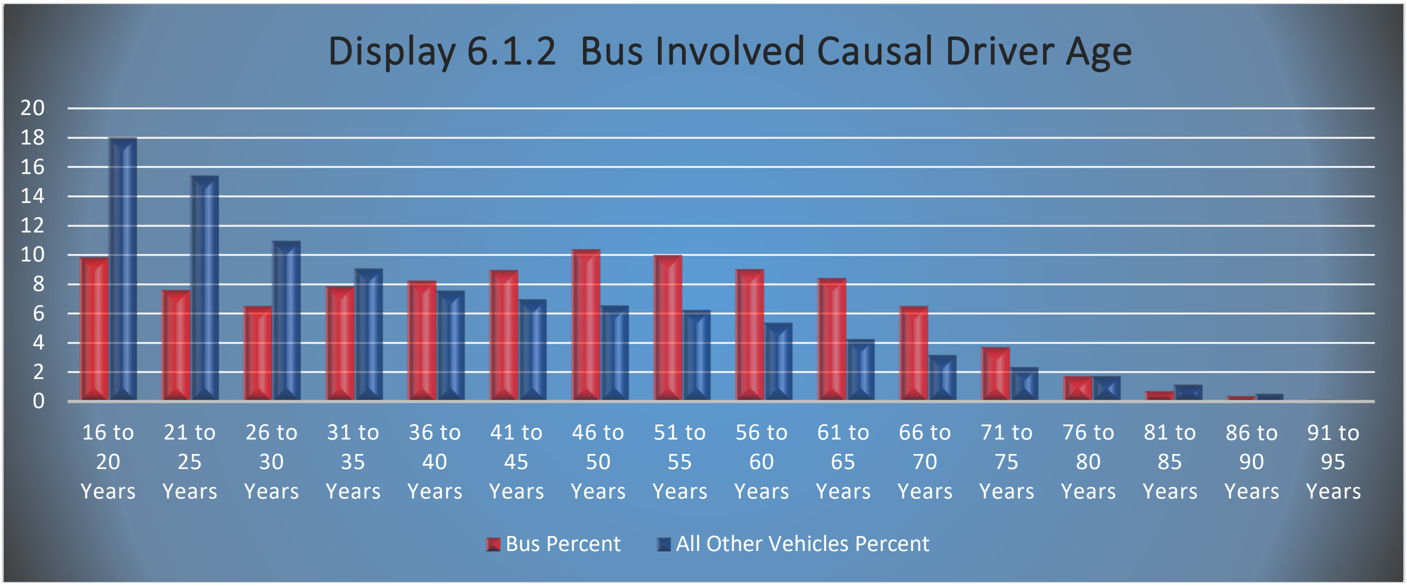
6.1.1 Causal Driver Gender for Bus Involved Crashes

Display 6.1.1 shows that bus causal driver gender is not significantly different from that of crashes in general. This amounts to about 50-52% male, 42-44% female, and 5.5-6.0% unknown.



6.1.2 Causal Driver Age for Bus Involved Crashes

Display 6.1.2 shows a distribution for buses that is much the same as for large trucks (see Section 3.1.2). The only notable difference is in the 16-20 and the 21-25 year olds that are not nearly as under-represented for buses as they are for large trucks.

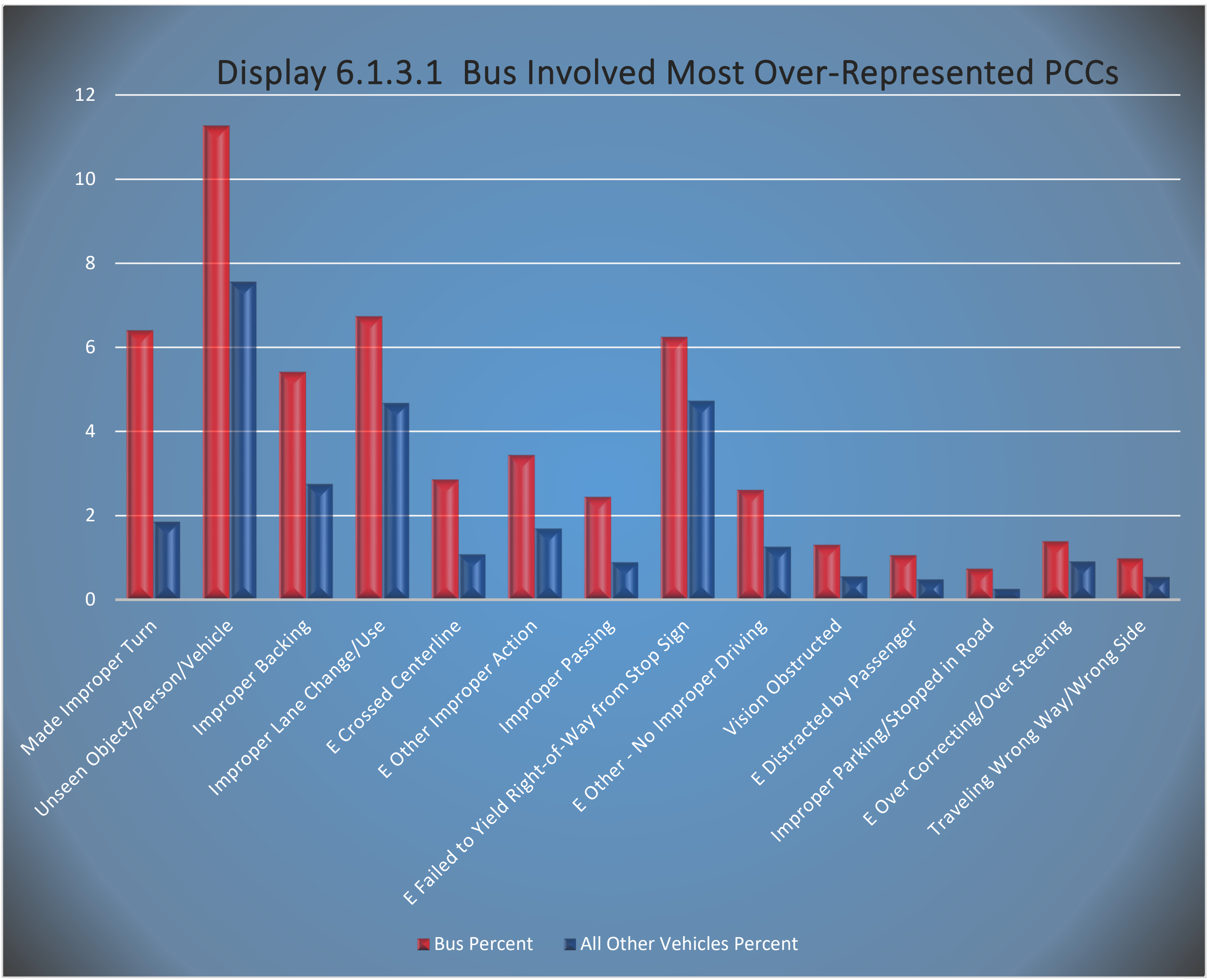


6.1.3 Driver Related Causes for Bus Involved Crashes

In this section we will consider causal driver Primary Contributing Circumstances (6.1.3.1), First Harmful Event (6.1.3.2), Manner of Crash (6.1.3.3), and Causal Unit Vehicle Maneuver (6.1.3.4)

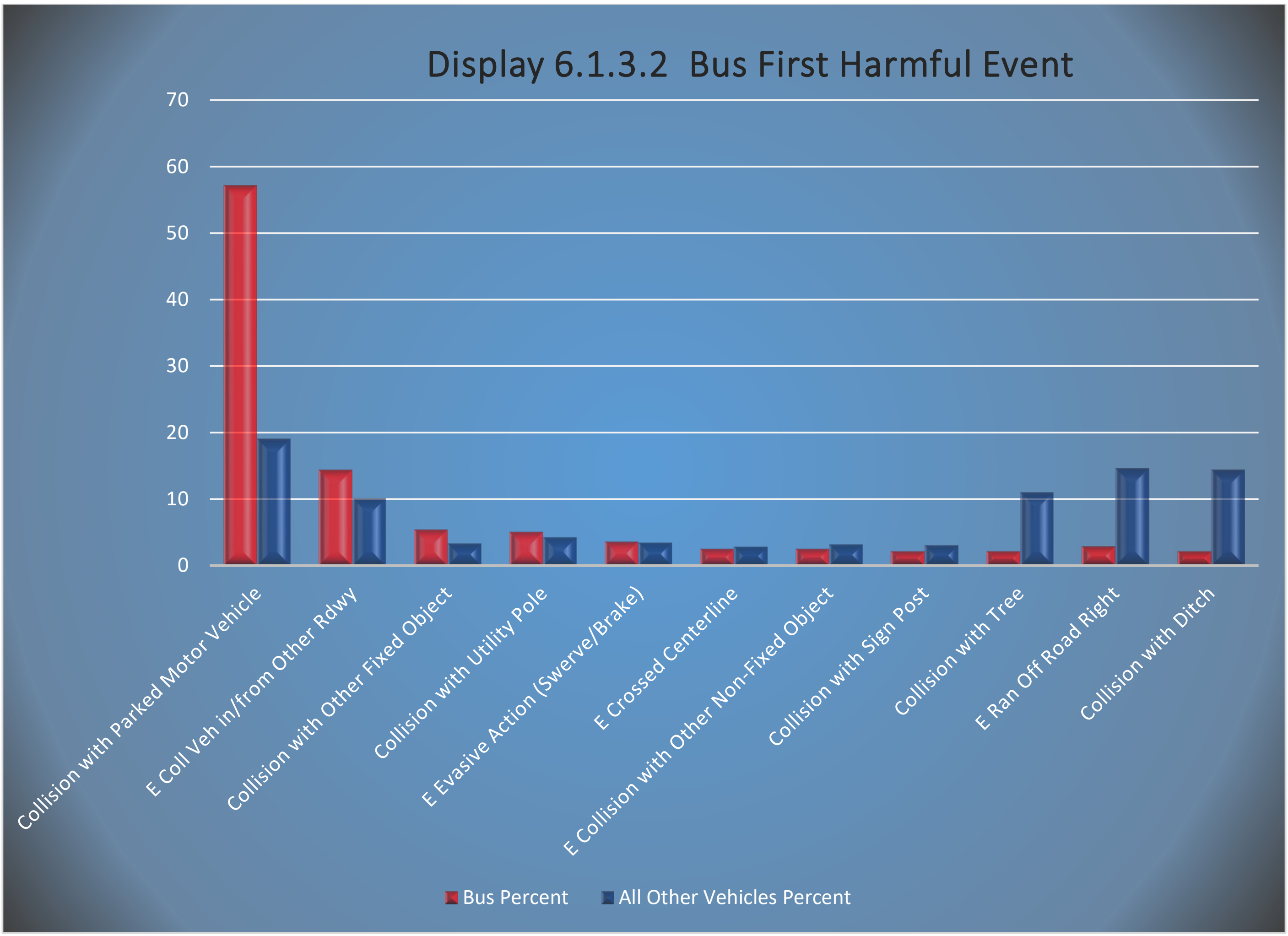
6.1.3.1 Primary Contributing Circumstances (PCCs) for Bus Involved Crashes

Generally the most over-represented categories are those associated with the control of a larger vehicle and the restrictions on the ability of the driver to see and be aware of hazards. This chart includes only the top 14 over-represented categories; it should be noticed that all categories in the chart are all over-represented. This covered all significantly over-represented categories for which there were at least 10 bus crashes.



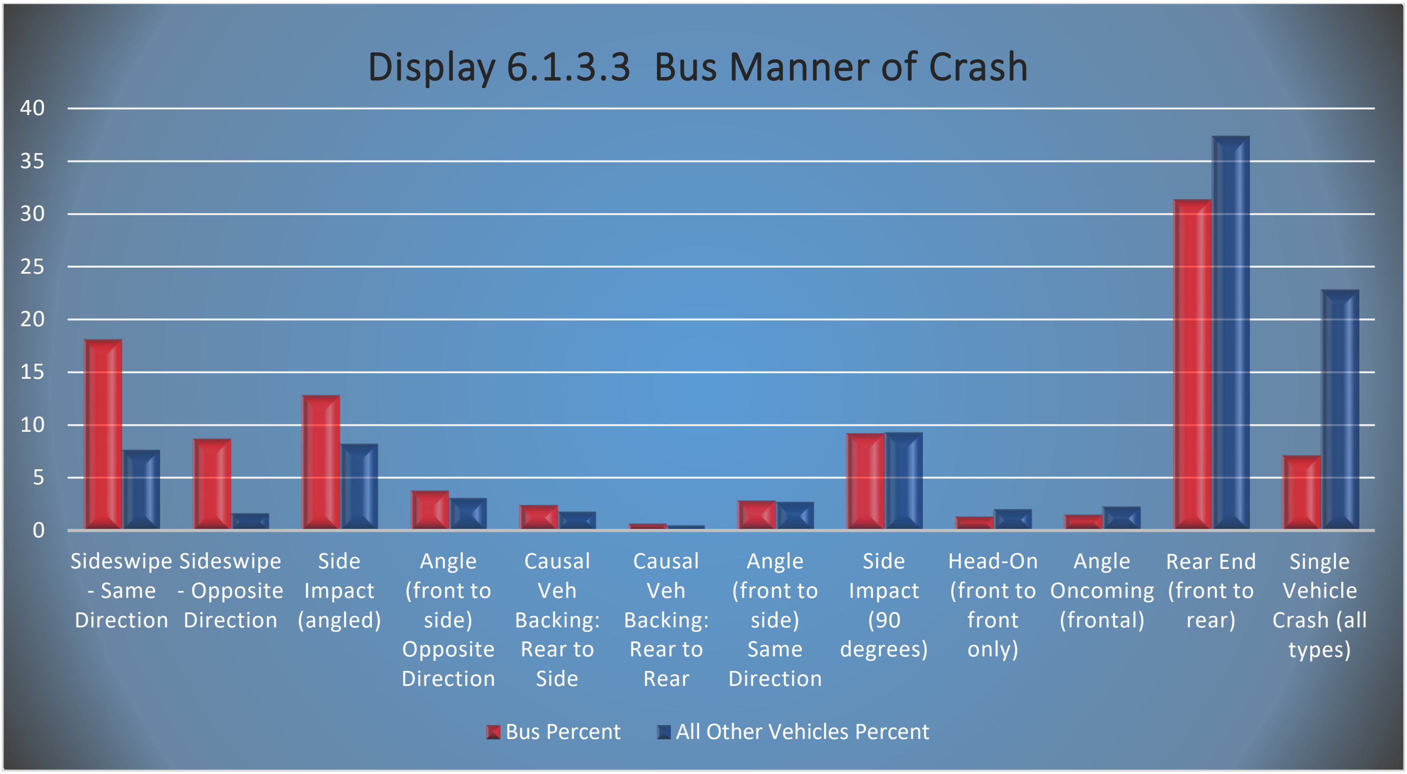
6.1.3.2 First Harmful Event for Bus Involved Crashes

The highest First Harmful Event for buses was Collision with Vehicle in Traffic, which amounted to 1035 (75.66% of the) bus crashes. This is significantly over-represented from the expected value from all other vehicles of 68.34%. Display 6.1.3.2 has this value (Collision with Vehicle in Traffic) removed, so it only represents a little over 24% of the bus crashes. Also, all categories with five or less bus crashes over the five year period were excluded. Of those remaining, the first two shown were the only two that were significantly over-represented for buses: Collision with Parked Motor Vehicle, and Collision with Vehicle in (or from) another Roadway.



6.1.3.3 Manner of Crash for Bus Involved Crashes

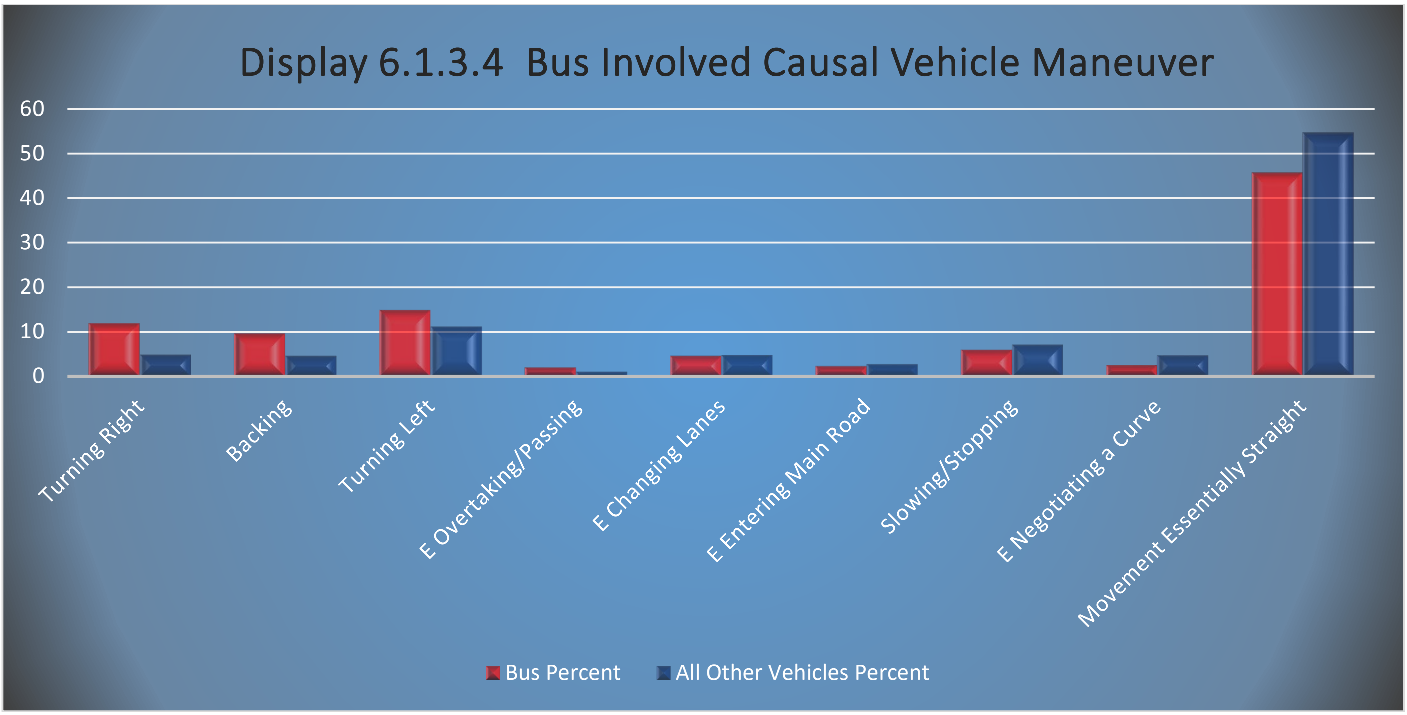
This appears to be one attribute that buses and large trucks have in common. They are both significantly over-represented in both sideswipe categories and in Side Impact (angled).



6.1.3.4 Causal Unit Vehicle Maneuver for Bus Involved Crashes

Display 6.1.3.4 shows four vehicle maneuvers where buses are significantly over-represented (frequency, over-representation factor):

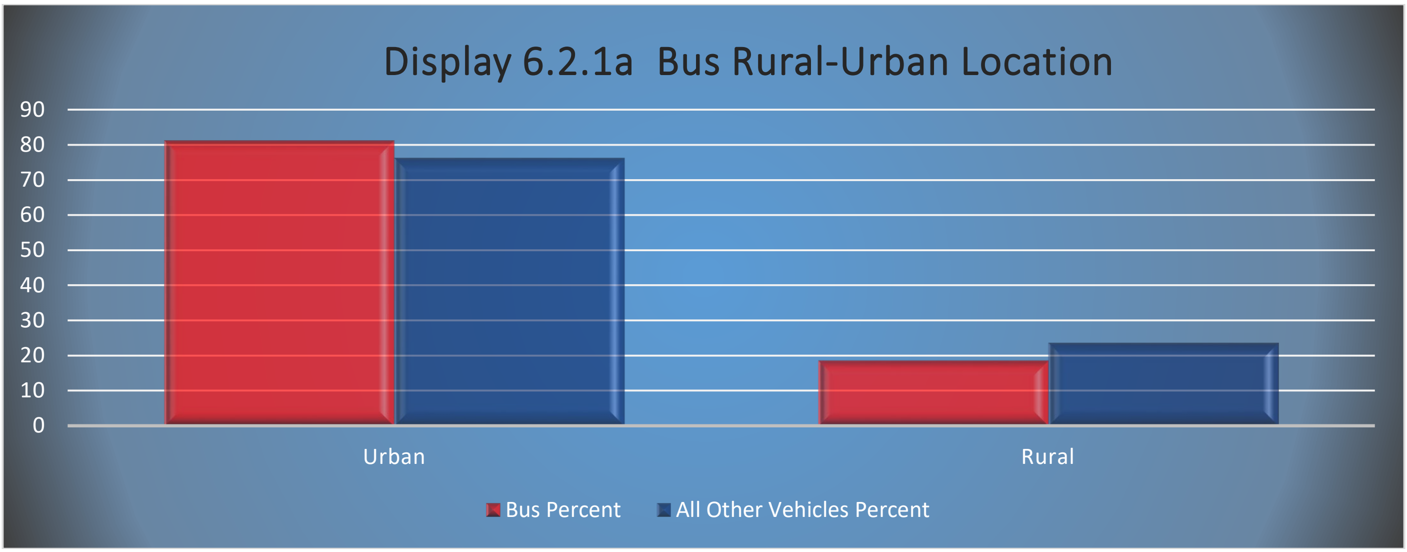
- Turning Right (151, 2.43);
- Backing (122, 2.08);
- Turning Left (188, 1.33); and
- Overtaking/Passing (26, 1.98).



6.2 Bus Crash Analysis

6.2.1 Bus Rural-Urban

The bus rural-urban location comparison given in Display 6.2.1a shows a considerably different pattern than that given for large trucks, which rural crashes were over-represented. In this case urban crashes are significantly over-represented when compared to crashes involving all other vehicle types.



A severity comparison is given in Display 6.2.1b, which shows amazingly similar results as that obtained when considering bus crashes, as given in Display 4.1.1b. This is due to the lower speeds on urban roadways, and the fact that buses have a much higher proportion of urban crashes than large trucks accounts for their generally lower fatality and severe injury rates.

Display 6.2.1b Crash Severity by Rural-Urban Classification – Buses

CARE 10.1.0.7 - [Crosstab Results - 2011-2015 Alabama Integrated Crash Data - Filter = Heavy Bus Inv...

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

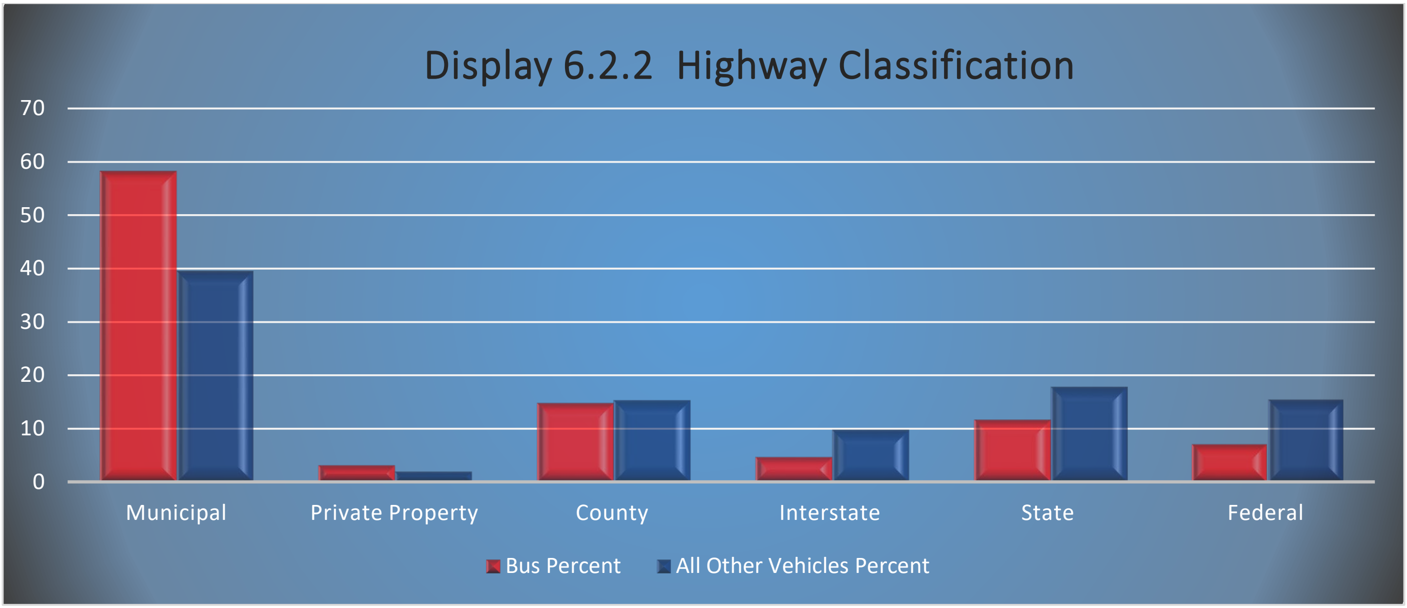
2011-2015 Alabama Integrated Crash Data | Heavy Bus Involved C101) OR C501 | 1/ 1/2011 | 12/31/2015

Suppress Zero Values: Rows and Columns | Select Cells: | Column: Crash Severity ; Row: Rural or Urban

	Fatal Injury	Incapacitating Injury	Non-Incapacitating Inju	Possible Injury	Property Damage Only	Unknown	TOTAL
Rural	3 37.50%	20 46.51%	23 32.39%	8 7.62%	202 18.36%	1 2.33%	257 18.76%
Urban	5 62.50%	23 53.49%	48 67.61%	97 92.38%	898 81.64%	42 97.67%	1113 81.24%
TOTAL	8 0.58%	43 3.14%	71 5.18%	105 7.66%	1100 80.29%	43 3.14%	1370 100.00%

6.2.2 Bus Highway Classification

Display 6.2.2 shows a dramatic over-representation of crashes on municipal roadways. All of the differences are significant with the exception of county roads, which were essentially equal in proportion.

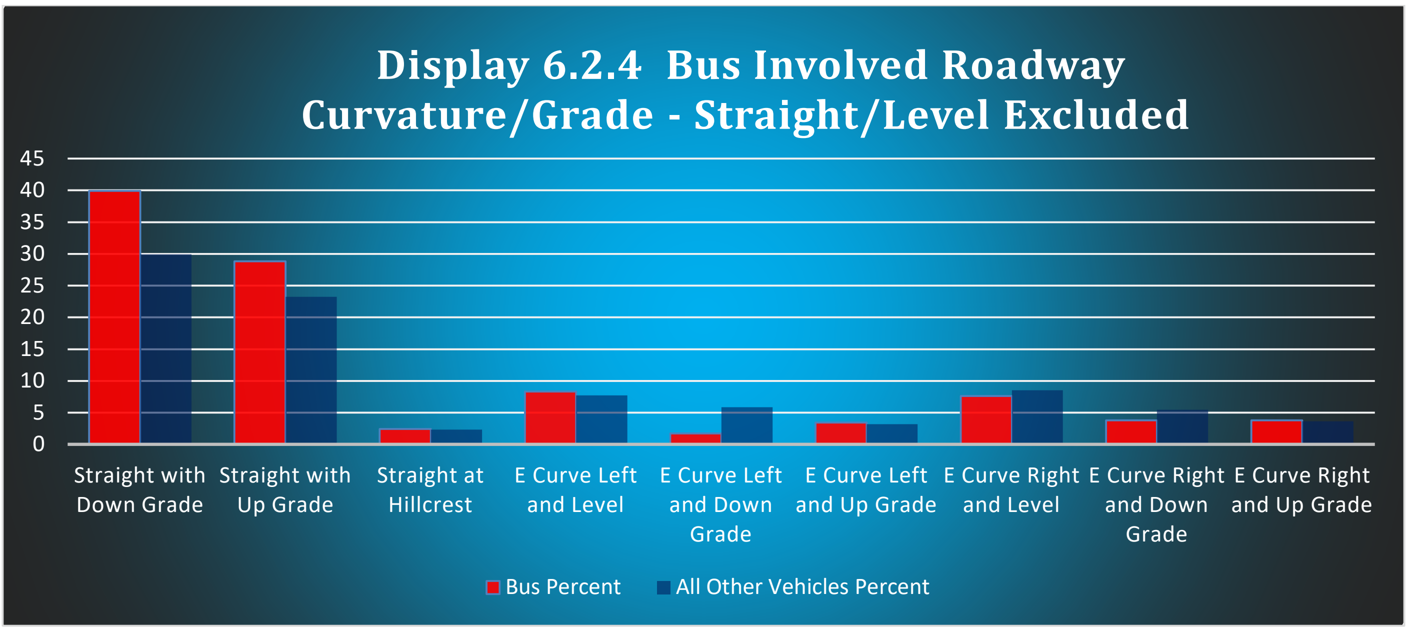


6.2.3 Bus Weather Analysis

As with large trucks, weather does not seem to be a major factor for bus crashes in comparison to non-bus crashes. Over the five year period, buses had only 89 crashes in the rain, which accounted for 6.51% as opposed to 11.11% for all other crashes, a statistically significant difference that indicates greater skill in bus drivers in dealing with inclement weather.

6.2.4 Bus Roadway Curvature and Grade

The vast majority of bus crashes occur on straight and level roadways, 78.69%, which is significantly higher than the 69.08% of all other vehicles. The major reason for this is that they tend to operate on more straight and level roadways than the traffic in general. Since this category would dwarf all of the others in comparison, the Straight and Level category was omitted from Display 6.2.4, which indicates that buses are over-represented in both the down-grade and the up-grade categories, with the Straight with Down Grade being statistically significant.



6.2.5 Bus Workzone Analysis

Only 20 of the 1,370 bus crashes were reported to have occurred in workzones. This is about 1.46% of bus crashes, as compared to 1.81% for all other vehicles. So buses are a slight bit under-represented in workzones, although this cannot be considered significant with such a small sample size. Safety considerations for buses in workzones should be about the same as all other vehicles.

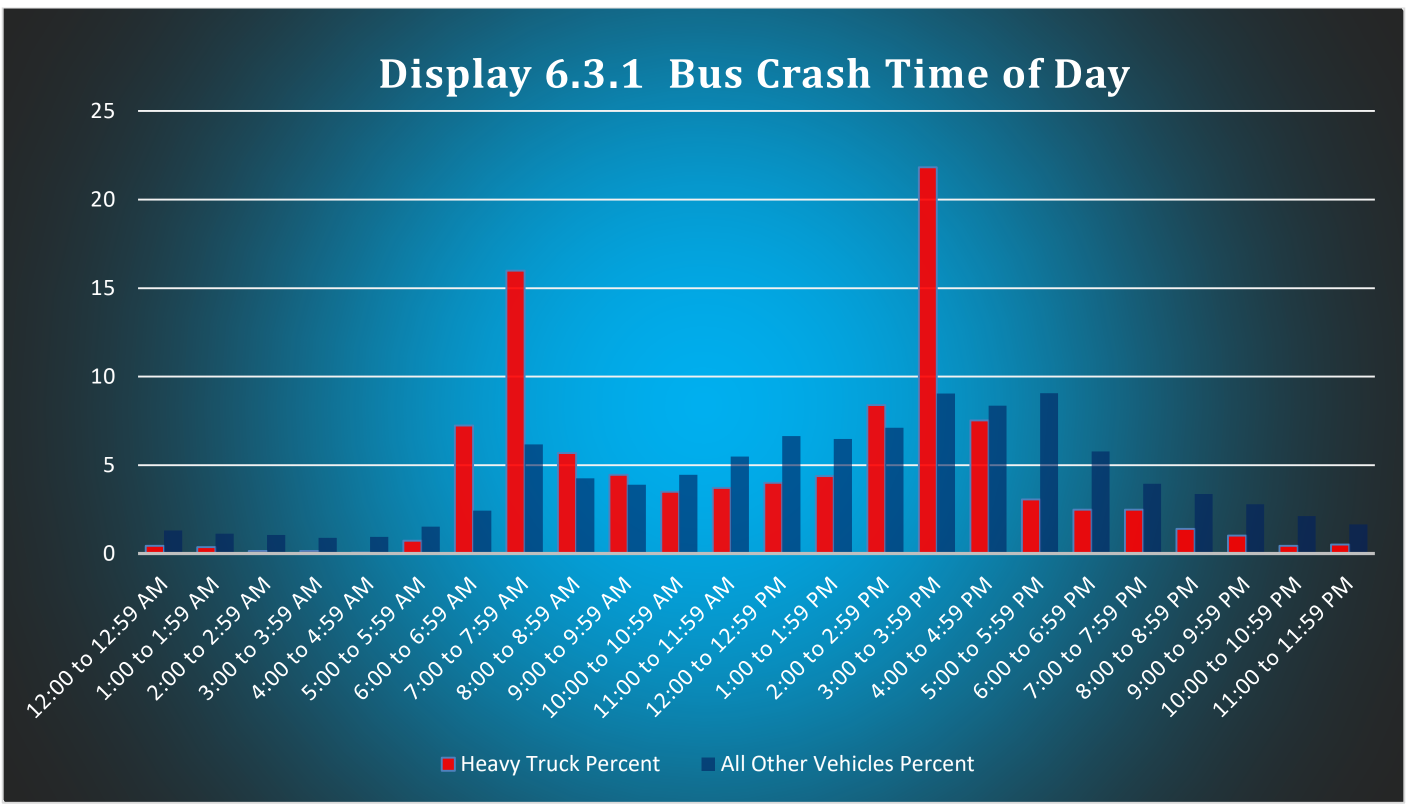
6.3 Bus Time Factors

6.3.1 Bus Time of Day

While the bus time of day distribution tends to follow the times when buses are most in operation, there are three hours when bus crashes are particularly over-represented that should be of note:

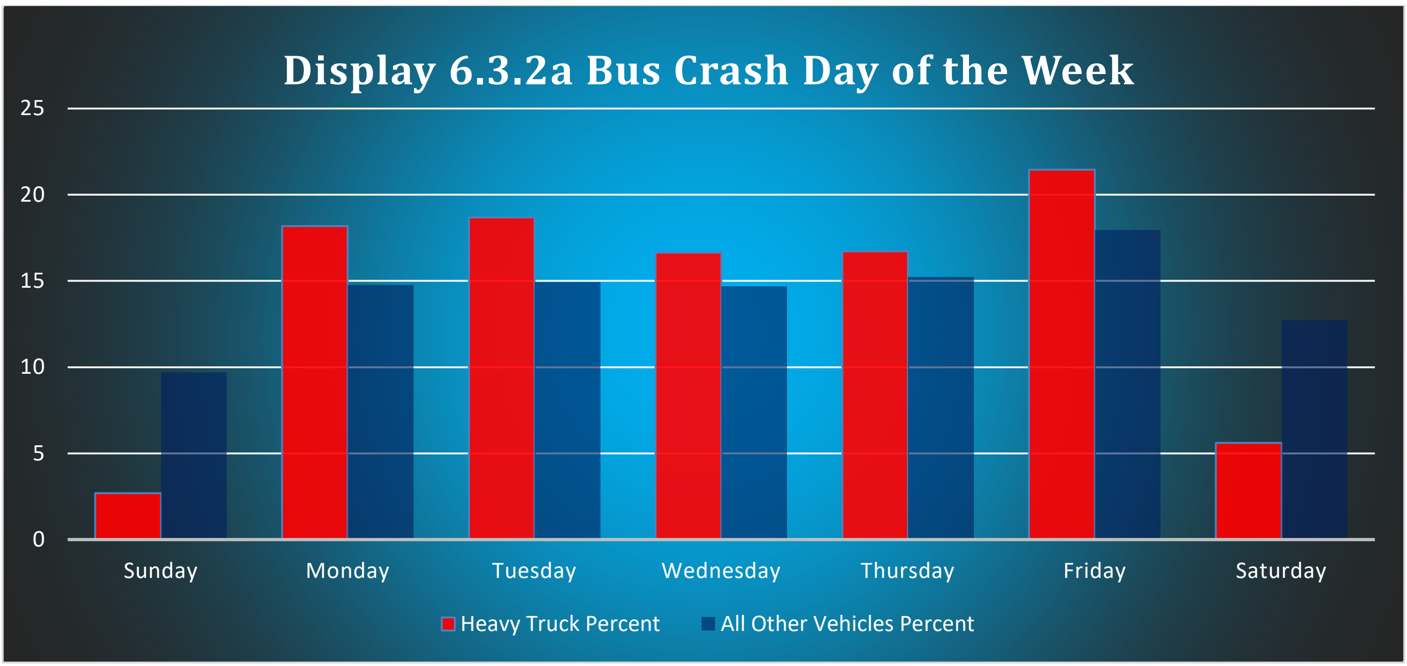
- 6:00-6:59 AM when buses have about three times their expected proportion of crashes;
- 7:00-7:59 AM which is the second highest in frequency (219 crashes over the five years); while this time slot has a lower over-representation ratio (2.59 as opposed to 3), its frequency (219) is over twice that of the previous hour; and
- 3:00-3:59 PM, the early afternoon rush hour, which has the highest proportion, with a frequency of 299 crashes and a over-representation ratio of over double (2.411).

The extremely large combined early morning and early afternoon rush hour over-representations may be a pattern that need to be investigated carefully, and it should be subject to further research. While no conclusive results can be reached without further analyses, it might be hypothesized that fatigue could be an issue with drivers coming to the end of a long period of driving and at the same time encountering heavy traffic. Other causes for this pattern should also be proposed and evaluated.



6.3.2 Bus Day of the Week

The distribution given in Display 6.3.2a probably reflects the days at which buses are in operation. It also reflects the density of other traffic as was certainly true of the time of day analysis, reflecting what seems to be a multiplier effect of traffic density when it comes to bus crash causation. In this case Monday, Tuesday and Friday's over-representations were statistically significant. These days (along with the two other weekdays) would have much higher rush hour traffic than would Saturday and Sunday, so there is distinct correlation between the time of day and the day of the week.



Display 6.3.2b shows the time of day by day of the week distribution for bus crashes. Note particularly the numbers on the 6:00-7:59 AM lines and those on the 3:00-3:59 PM. These show a stark contrast between what is happening during the week as opposed to the weekends.

Display 6.3.2b Bus Crash Time of Day by Day of the Week

CARE 10.1.0.7 - [Crosstab Results - 2011-2015 Alabama Integrated Crash Data - Filter = Heavy Bus Involve...

File Dashboard Filters Analysis Crosstab Locations Tools Window Help

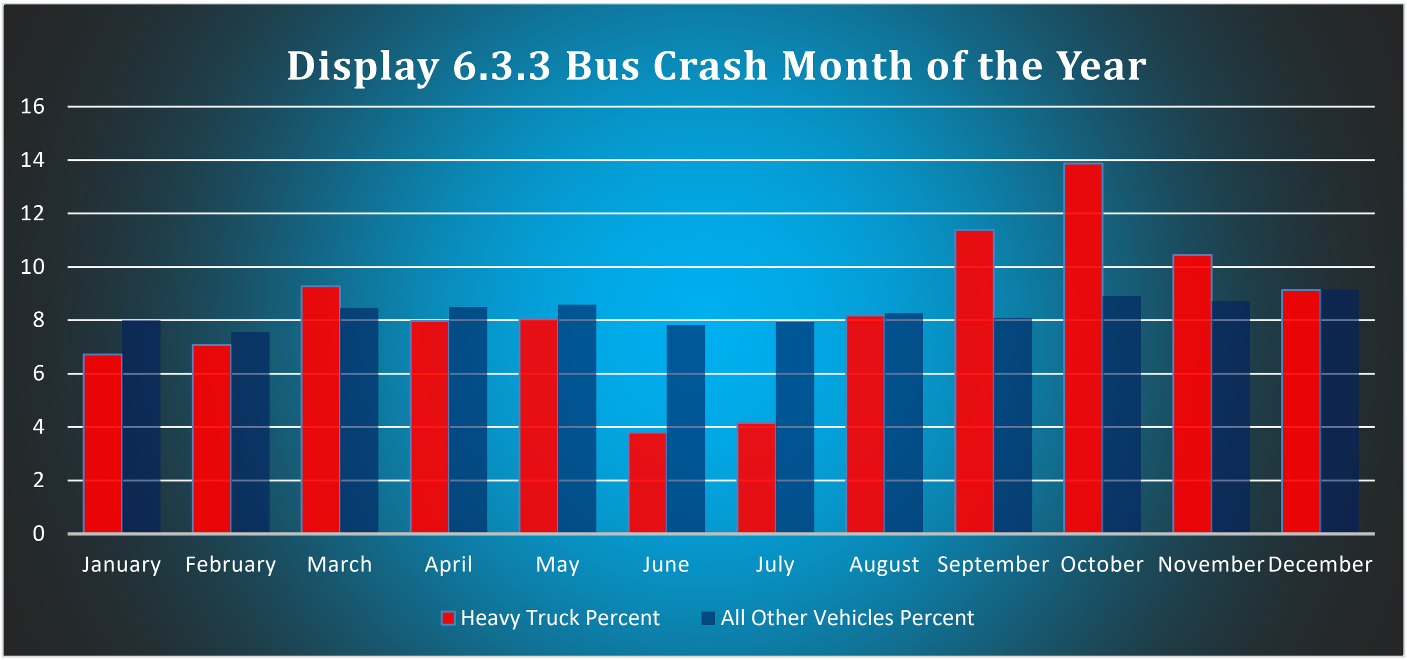
2011-2015 Alabama Integrated Crash Data | Heavy Bus Involved (C101 OR C501) | 1/ 1/2011 | 12/31/2015

Suppress Zero Values: None | Select Cells: | Column: Day of the Week ; Row: Time of Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	TOTAL
12:00 Midnight to 12:59 AM	2 5.41%	1 0.40%	1 0.39%	0 0.00%	0 0.00%	0 0.00%	2 2.60%	6 0.44%
1:00 AM to 1:59 AM	2 5.41%	1 0.40%	0 0.00%	0 0.00%	0 0.00%	1 0.34%	1 1.30%	5 0.36%
2:00 AM to 2:59 AM	1 2.70%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.34%	0 0.00%	2 0.15%
3:00 AM to 3:59 AM	1 2.70%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 1.30%	2 0.15%
4:00 AM to 4:59 AM	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 1.30%	1 0.07%
5:00 AM to 5:59 AM	1 2.70%	3 1.20%	2 0.78%	2 0.88%	1 0.44%	0 0.00%	1 1.30%	10 0.73%
6:00 AM to 6:59 AM	0 0.00%	20 8.03%	22 8.59%	20 8.77%	18 7.86%	18 6.12%	1 1.30%	99 7.23%
7:00 AM to 7:59 AM	1 2.70%	41 16.47%	45 17.58%	45 19.74%	39 17.03%	47 15.99%	1 1.30%	219 15.99%
8:00 AM to 8:59 AM	2 5.41%	17 6.83%	16 6.25%	14 6.14%	9 3.93%	15 5.10%	5 6.49%	78 5.69%
9:00 AM to 9:59 AM	5 13.51%	11 4.42%	8 3.13%	11 4.82%	9 3.93%	13 4.42%	4 5.19%	61 4.45%
10:00 AM to 10:59 AM	2 5.41%	9 3.61%	10 3.91%	6 2.63%	8 3.49%	10 3.40%	3 3.90%	48 3.50%
11:00 AM to 11:59 AM	1 2.70%	6 2.41%	11 4.30%	9 3.95%	9 3.93%	11 3.74%	4 5.19%	51 3.72%
12:00 Noon to 12:59 PM	2 5.41%	15 6.02%	10 3.91%	5 2.19%	5 2.18%	14 4.76%	4 5.19%	55 4.01%
1:00 PM to 1:59 PM	4 10.81%	6 2.41%	12 4.69%	4 1.75%	9 3.93%	20 6.80%	5 6.49%	60 4.38%
2:00 PM to 2:59 PM	1 2.70%	21 8.43%	27 10.55%	18 7.89%	27 11.79%	20 6.80%	1 1.30%	115 8.39%
3:00 PM to 3:59 PM	1 2.70%	60 24.10%	45 17.58%	58 25.44%	46 20.09%	83 28.23%	6 7.79%	299 21.82%
4:00 PM to 4:59 PM	3 8.11%	21 8.43%	21 8.20%	16 7.02%	19 8.30%	18 6.12%	5 6.49%	103 7.52%
5:00 PM to 5:59 PM	0 0.00%	5 2.01%	9 3.52%	6 2.63%	9 3.93%	7 2.38%	6 7.79%	42 3.07%
6:00 PM to 6:59 PM	3 8.11%	2 0.80%	5 1.95%	5 2.19%	10 4.37%	3 1.02%	6 7.79%	34 2.48%
7:00 PM to 7:59 PM	2 5.41%	3 1.20%	7 2.73%	4 1.75%	7 3.06%	3 1.02%	8 10.39%	34 2.48%
8:00 PM to 8:59 PM	2 5.41%	6 2.41%	4 1.56%	0 0.00%	1 0.44%	4 1.36%	2 2.60%	19 1.39%
9:00 PM to 9:59 PM	1 2.70%	0 0.00%	1 0.39%	4 1.75%	1 0.44%	4 1.36%	3 3.90%	14 1.02%
10:00 PM to 10:59 PM	0 0.00%	1 0.40%	0 0.00%	0 0.00%	1 0.44%	2 0.68%	2 2.60%	6 0.44%
11:00 PM to 11:59 PM	0 0.00%	0 0.00%	0 0.00%	1 0.44%	1 0.44%	0 0.00%	5 6.49%	7 0.51%
Unknown	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
TOTAL	37 2.70%	249 18.18%	256 18.69%	228 16.64%	229 16.72%	294 21.46%	77 5.62%	1370 100.00%

6.3.3 Bus Month of the Year

Display 6.3.3 shows that the best months over the past five years for bus crashes has been June and July. The two worst months are September and October. Additional analyses would be warranted to compare these two time periods to determine what may be the causes for these disparities.



7 County Summaries for 2014 and 2015

7.1 Large Trucks and Buses by County

Display 7.1 Large Truck and Bus Crashes by Severity for 2014 and 2015

	Total Large Truck and Bus Crashes						Large Truck Crashes						Bus Crashes					
	NUMBER OF CRASHES		PERSONS KILLED		PERSONS INJURED		NUMBER OF CRASHES		PERSONS KILLED		PERSONS INJURED		NUMBER OF CRASHES		PERSONS KILLED		PERSONS INJURED	
COUNTY	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Autauga	55	62	3	1	18	20	50	53	3	1	16	18	5	9	0	0	2	2
Baldwin	173	148	2	1	37	43	165	137	2	1	35	38	8	11	0	0	2	5
Barbour	31	36	2	0	10	10	27	36	2	0	10	10	4	0	0	0	0	0
Bibb	20	22	3	2	9	12	16	20	2	2	8	12	4	2	1	0	1	0
Blount	35	38	0	0	13	12	34	38	0	0	13	12	1	0	0	0	0	0
Bullock	12	10	0	0	2	5	12	10	0	0	2	5	0	0	0	0	0	0
Butler	59	70	2	0	16	18	58	69	2	0	16	18	1	1	0	0	0	0
Calhoun	137	122	0	0	27	40	129	109	0	0	27	31	8	13	0	0	0	9
Chambers	35	40	0	0	12	10	34	36	0	0	12	6	1	4	0	0	0	4
Cherokee	30	35	1	2	11	9	30	33	1	2	11	9	0	2	0	0	0	0
Chilton	62	61	1	1	13	15	60	60	1	1	10	15	2	1	0	0	3	0
Choctaw	20	25	0	0	10	9	19	25	0	0	10	9	1	0	0	0	0	0
Clarke	55	50	1	1	20	19	50	45	1	1	19	16	5	5	0	0	1	3
Clay	15	14	1	0	8	8	15	13	1	0	8	6	0	1	0	0	0	2
Cleburne	93	74	0	1	32	20	92	74	0	1	29	20	1	0	0	0	3	0
Coffee	37	56	0	0	12	16	33	49	0	0	12	15	4	7	0	0	0	1
Colbert	55	83	0	2	16	25	53	80	0	2	14	25	2	3	0	0	2	0
Conecuh	55	62	0	2	14	19	53	62	0	2	14	19	2	0	0	0	0	0
Coosa	22	19	3	0	10	2	20	19	3	0	10	2	2	0	0	0	0	0
Covington	22	24	0	1	2	15	22	23	0	0	2	6	0	1	0	1	0	9
Crenshaw	13	13	0	0	4	4	13	12	0	0	4	4	0	1	0	0	0	0
Cullman	104	141	2	3	15	23	104	139	2	3	15	23	0	2	0	0	0	0
Dale	39	52	0	1	13	13	36	51	0	1	13	13	3	1	0	0	0	0
Dallas	61	58	1	3	22	23	57	51	1	3	22	23	4	7	0	0	0	0
Dekalb	70	62	1	2	20	17	69	60	1	2	20	16	1	2	0	0	0	1
Elmore	51	50	0	0	13	16	45	40	0	0	12	16	6	10	0	0	1	0
Escambia	57	64	0	1	31	29	54	60	0	1	17	28	3	4	0	0	14	1
Etowah	123	125	5	3	37	28	118	119	5	3	35	28	5	6	0	0	2	0
Fayette	14	16	1	0	5	3	12	16	1	0	5	3	2	0	0	0	0	0
Franklin	25	28	0	0	13	9	24	26	0	0	4	9	1	2	0	0	9	0
Geneva	17	15	0	1	9	1	17	15	0	1	9	1	0	0	0	0	0	0
Greene	41	65	1	0	10	13	38	65	1	0	10	13	3	0	0	0	0	0
Hale	19	21	0	0	4	11	18	20	0	0	4	10	1	1	0	0	0	1

Display 7.1 Large Truck and Bus Crashes by Severity for 2014 and 2015 (continued)

	Total Large Truck and Bus Crashes						Large Truck Crashes						Bus Crashes					
NUMBER OF CRASHES			PERSONS KILLED		PERSONS INJURED		NUMBER OF CRASHES		PERSONS KILLED		PERSONS INJURED		NUMBER OF CRASHES		PERSONS KILLED		PERSONS INJURED	
COUNTY	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Henry	19	27	0	1	3	6	18	27	0	1	3	6	1	0	0	0	0	0
Houston	130	127	3	0	26	22	121	115	3	0	25	22	9	12	0	0	1	0
Jackson	53	75	1	2	16	29	50	70	1	2	16	29	3	5	0	0	0	0
Jefferson	1,093	1,260	6	9	217	254	981	1,137	4	9	181	216	112	123	2	0	36	38
Lamar	15	18	0	0	6	7	15	18	0	0	6	7	0	0	0	0	0	0
Lauderdale	46	41	0	2	7	15	40	37	0	2	7	14	6	4	0	0	0	1
Lawrence	40	47	3	2	9	34	39	43	3	2	9	17	1	4	0	0	0	17
Lee	196	191	0	0	72	36	183	179	0	0	68	35	13	12	0	0	4	1
Limestone	79	91	0	0	35	37	73	87	0	0	33	29	6	4	0	0	2	8
Lowndes	27	29	0	0	9	8	27	28	0	0	9	8	0	1	0	0	0	0
Macon	75	64	4	1	23	23	73	62	4	0	23	23	2	2	0	1	0	0
Madison	205	225	5	2	81	43	180	190	5	2	55	40	25	35	0	0	26	3
Marengo	28	38	0	1	16	26	28	36	0	1	16	15	0	2	0	0	0	11
Marion	34	51	0	1	37	8	33	48	0	1	10	5	1	3	0	0	27	3
Marshall	69	83	0	0	27	33	64	78	0	0	21	33	5	5	0	0	6	0
Mobile	471	494	2	4	117	127	420	424	2	4	104	110	51	70	0	0	13	17
Monroe	25	17	0	2	9	8	24	17	0	2	8	8	1	0	0	0	1	0
Montgomery	369	363	2	8	102	132	335	328	2	8	86	114	34	35	0	0	16	18
Morgan	134	124	1	0	23	37	125	122	1	0	22	34	9	2	0	0	1	3
Perry	4	12	0	1	4	5	4	12	0	1	4	5	0	0	0	0	0	0
Pickens	32	28	1	2	14	21	31	25	1	1	14	6	1	3	0	1	0	15
Pike	51	64	1	0	9	18	46	63	1	0	7	18	5	1	0	0	2	0
Randolph	18	14	0	0	6	4	16	13	0	0	6	4	2	1	0	0	0	0
Russell	90	119	1	1	51	58	81	108	1	1	24	53	9	11	0	0	27	5
Shelby	179	228	1	3	37	43	169	212	1	3	34	41	10	16	0	0	3	2
St Clair	116	124	0	2	27	42	110	121	0	2	18	42	6	3	0	0	9	0
Sumter	68	57	1	3	41	23	66	57	1	3	41	23	2	0	0	0	0	0
Talladega	107	104	3	5	34	38	102	100	3	5	32	37	5	4	0	0	2	1
Tallapoosa	24	7	1	0	4	0	21	7	1	0	4	0	3	0	0	0	0	0
Tuscaloosa	401	429	3	5	118	119	366	392	3	5	108	90	35	37	0	0	10	29
Walker	77	61	1	2	29	17	76	56	1	2	26	17	1	5	0	0	3	0
Washington	19	16	0	1	6	9	19	16	0	1	6	9	0	0	0	0	0	0
Wilcox	17	17	1	0	7	15	17	16	1	0	7	8	0	1	0	0	0	7
Winston	19	31	0	2	7	8	18	29	0	2	6	8	1	2	0	0	1	0