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IDENTIFICATION OF OVER-REPRESENTED PARAMETERS FOR WORK ZONE CRASHES IN ALABAMA, MICHIGAN, AND TENNESSEE

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ABSTRACT

Much roadway maintenance and construction work takes place in the presence of traffic, which is often traveling at high speeds. A reasonable goal is for work zones to pose no greater safety risks for motorists than non-work zone areas. Another is to minimize safety risks for workers due to exposure to traffic. Paying attention to the differences in work zone and non-work zone crash characteristics can help to direct safety enhancement efforts.

This paper discusses not only characteristics that occur with the highest frequency, but also those that are over-represented or under-represented in work zone crashes when compared to non-work zone crashes. Work zone crash data in Alabama, Michigan, and Tennessee were reviewed and found to have many common characteristics. A summary of the findings for work zone crashes is listed below.

- Locations
  - Highest Frequency: Urban areas; speed limits between 41 and 55 miles per hour; 2-lane roadways
- Temporal Characteristics
  - Highest Frequency: May through October; between 3:00 and 4:00 pm; Fridays; clear weather
- Drivers
  - Highest Frequency: Causal driver between 25 and 34 years of age; no pedestrian involvement; male driver; driver wearing seatbelt; driver residence less than 25 miles from crash site
  - Significantly Over-represented: Out-of-state drivers
- Vehicle Characteristics
  - Highest Frequency: 2 vehicles involved; passenger cars and station wagons
  - Significantly Over-represented: More than 2 vehicles involved; large trucks pulling trailers and other heavy trucks; vehicles used for transporting property, construction, or other business
- Causation Characteristics
  - Highest Frequency: Causal driver misjudges stopping distance; causal vehicle is slowing, stopping, merging, or changing lanes; second vehicle is slowing or stopped in traffic
- Severity of Crash
  - Highest Frequency: Vehicle not disabled; damage to causal vehicle is most often on front end; damage to second or third vehicle is on rear or attachment; no injury or fatality

These characteristics of work zone crashes can be used to plan projects to enhance the safety of highway workers and motorists.

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INTRODUCTION

Increasing demands on our expanding and aging roadways require maintenance and construction work to take place without completely interrupting travel on the roadway. The work must be done in the presence of traffic, which is often traveling at high speeds. While much has been done to reduce the number of crashes in work zones, there is continued interest among contractors and highway agencies in making work zones safer for workers and for the traveling public.

Injuries and fatalities from crashes in work zones continue to be a problem around the country. The Federal Highway Administration reports that although the number of work zone fatalities across the country has remained fairly constant throughout the 1980s and 1990s, the number of work zones has increased. As the number of work zones continues to increase, the potential exists for increased fatalities (1). The issue of work zone safety cannot be properly addressed without attempting to understand fully the problems associated with work zones.

OBJECTIVES

Specific objectives of this research are:

- Perform a comprehensive analysis of computerized work zone crash data in Alabama, Michigan, and Tennessee and identify patterns in those characteristics
- Compare and contrast characteristics in the three states
- Construct the circumstances of a "typical" work zone crash

As a first step toward accomplishing these tasks, a comprehensive literature review of national work zone safety enhancement efforts was performed along with identification of work zone safety parameters. Next, a study was performed to compare all crashes occurring in work zones with all crashes occurring outside of work zones in Alabama, Michigan, and Tennessee. The purpose of this study was to gain understanding of the characteristics specific to work zone crashes and to compare and contrast the findings for the different states in order to determine whether problems are local or global. Safety engineers nationwide will be able to use the information to plan work zone safety projects to enhance the safety of highway workers and motorists.

DATA COLLECTION

Computerized work zone crash data was used from three states:

- Alabama, 1994 – 1998
- Michigan, 1996 – 1998
- Tennessee, 1996 – 1997

The data is available through the Critical Analysis Reporting Environment (CARE) software (2). CARE is a software system designed to provide direct access to crash and incident information for individual decision-makers within the traffic and aviation safety communities. Because the available variables differ for all four data sets, it was not possible to compare all of the characteristics found for any particular state with those for the other states. Although only two years of data are common to all three states, this study includes all of the available data for each state.

CARE Statistical Test Information

The study was greatly facilitated by using the Information Mining for Producing Accident Countermeasure Technology (IMPACT) module of the CARE. IMPACT compares a test subset (crashes in work zones) with a control subset (crashes outside of work zones) and calculates the over- or under-representation of any code within any given variable. In Alabama, for example, 38% of work zone crashes occur in rural areas, which is more than the 28% of non-work zone crashes occurring in rural areas. Although rural crashes do not constitute a majority of work zone crashes, because the proportion of rural crashes is much higher in work zones than outside of work zones, rural crashes are said to be over-represented in work zones.

Bryden (1999) states that while some reduction in levels of service may be unavoidable, it is reasonable to expect that well-designed traffic control plans can result in no measurable increases in accident severity or frequency during the highway construction period (3). If work zones presented no additional causes for crashes, the proportions of accidents, injuries, and fatalities should be roughly the same for work zone crashes and for non-work zone crashes. Determining which variables are over-represented in work zones will help to define the problems associated with work zones that should be the focus of safety enhancement efforts.

In the data tables in this paper, an asterisk (*) indicates a clear over-representation to a statistically significant alpha of at least 99% confidence. Over-representation in the non-work zone category is equivalent to under-representation in the work zone category. For data not presented in tables, an over-representation (O-R) factor is given, which is calculated by dividing the percent of work zone crashes by the percent of non-work zone crashes. If the factor is greater than 1, then the characteristic is over-represented in work zones. If the factor is less than 1, then the characteristic is under-represented in work zones. An asterisk (*) by the O-R factor indicates a statistically significant difference.

It must be noted that because analysis of crashes depends on police accident reports for data and there are no nationally recognized definitions of work zones or work zone related accidents (4), it is likely that work zone crashes have been substantially under-reported (5). There is much discrepancy in reported work zone statistics. According to the FHWA, many states disagree with the Fatal Accident Reporting System (FARS) database, claiming that the actual numbers of work zone fatalities are greater than those reported in FARS (1). So that officers can clearly know where the work zone is located, Turner (1999) reports that the FHWA and several other groups have proposed standard definitions for work zone and work zone accident (4). Until there is more consistency in the reporting of work zone related crashes, it is impossible to determine precisely the nationwide impact of work zones on safety.

GENERAL CHARACTERISTICS OF WORK ZONE CRASHES

This study found the typical work zone crash includes the following factors: an on-the-job male driver, age 24 to 35, while driving in clear weather during mid-afternoon on a federal or interstate roadway comes upon slow or stopped traffic due to construction and crashes into another vehicle; or else in the process of avoiding such, crashes into a barrier, construction equipment, or a pedestrian. Fatalities were significantly over-represented in work zones crashes in Alabama, but not in Michigan or Tennessee. It was

also found that the likelihood for a work zone crash to involve subsequent vehicles was relatively large. In all three states, work zone crashes are more likely to involve speeding and large trucks, which justifies the continued efforts toward reducing speeds in work zones and suggests the need for increased attention to the maneuverability requirements of large trucks when designing traffic control plans for work zones.

Information in the following sections elaborates on these trends. Table 1 shows the number of crashes that occurred in work zone and non-work zone locations for all the available years in each state. It must be noted that differences in numbers of crashes for the different states could be due to differences in the amount of vehicle miles of travel. Table 2 shows the average annual vehicle miles of travel for each state.

Where Work Zone Crashes Occur

Table 3 shows that in Alabama and Tennessee, work zone crashes occur most often in urban areas, as do non-work zone crashes. Rural work zone crashes, however, are significantly over-represented in both of those states. Although Alabama and Tennessee have nearly the same average annual vehicle miles of travel on rural roads, a higher percentage of Tennessee's work zone crashes occur in rural areas than do Alabama's work zone crashes. And while Tennessee has more annual vehicle miles of travel on urban roads, Alabama has a higher percentage of work zone crashes in urban areas. Michigan data did not allow rural and urban comparisons. The Institute for Transportation Engineers reports that nationally 55% of work zone fatalities occur in rural areas and that the amount of rural fatalities is disproportionately greater than the amount of rural travel (3).

Table 4 summarizes the percentage of crashes by highway classification. While non-work zone crashes most frequently occur on municipal roads in all three states, work zone crashes occur less frequently there. The greatest numbers of work zone crashes occur on federal highways in Alabama, on county or city roads in Michigan, and on interstates in Tennessee. Work zone crashes are significantly over-represented on interstates and federal highways in all three states. State roads are significantly over-represented in Alabama and Michigan, but significantly under-represented in Tennessee.

The speed limit at a crash site is most frequently between 41 and 55 miles per hour as shown in Table 5. In Alabama and Tennessee, speed limits greater than 40 miles per hour are over-represented in work zones and those lower than 40 are under-represented. In Michigan, speed limits greater than 25 miles per hour are over-represented. This coincides with the highway classification and rural/urban findings described above.

Table 6 summarizes the percentage of crashes according to total number of traffic lanes. In all three states, crashes occur most often on 2-lane roadways, but crashes on 2-lane roads are under-represented in work zones. 4-lane highways are over-represented in work zones in Alabama.

Temporal Characteristics of Work Zone Crashes

Table 7 shows that work zone crashes most frequently occur during August in Alabama and Tennessee and during October in Michigan. The summer and early fall months are significantly over-represented, when traffic volumes are increased and work zone presence is likely at a peak. December, January, and February are significantly under-

represented. Even though traffic volumes rise during the winter holiday season, there are not as many construction or maintenance operations at that time.

Figure 1 summarizes the Alabama data by time of crash. The Alabama data is representative of the data for all three states. The majority of both work zone and non-work zone crashes happen during the afternoon hours between noon and 5:00 pm, with the peak hours being from 3:00 to 4:00 pm for work zones and from 5:00 to 6:00 pm for non-work zones. Work zone crashes are significantly over-represented during daylight hours, which is more likely when the work is being done and there is more traffic. Nighttime hours are significantly under-represented.

Percentages of crashes sorted by day of week are given in Table 8. Fridays have the highest frequency of crashes both in and out of work zones, but Tuesday, Wednesday, and Thursday are over-represented in work zones. A majority of work zone and non-work zone crashes occur in clear weather, however clear-weather crashes are significantly over-represented in work zones (O-R: AL-1.1*, MI-1.2*, TN-1.1*). Again, this is probably when more work zone activity and more traffic are present.

Driver Demographics In Work Zone Crashes

Age of the causal driver is shown in Table 9. In all three states, drivers involved in all crashes are most frequently 25 to 34 years old. Younger drivers, aged 16 to 20, are significantly under-represented in work zone crashes.

More than 99% of crashes both in and out of work zones do not involve pedestrians. In all three states, there were no significant differences between work zone and non-work zone crashes for any pedestrian variables.

In all three states, drivers involved in crashes were found most likely to be male (WZ: AL-62%, MI-61%, TN-62%) and to be wearing lap and shoulder belts (WZ: MI-80%, TN-81%). While most crashes involve drivers who live in the state less than 25 miles from the crash site (WZ: AL-70%, TN-56%), out-of-state drivers are over-represented in work zone crashes (O-R: AL-1.0, MI-1.6*, TN-2.9*).

Vehicle Characteristics Involved in Work Zone Crashes

All crashes most frequently involve 2 vehicles, as shown in Table 10, but crashes in work zones are more likely than non-work zone crashes to involve more than 2 vehicles. Crashes involving one or two vehicles are significantly under-represented in work zones.

Though passenger cars and station wagons are involved most often, they are under-represented in work zone crashes as shown in Table 11. Large trucks pulling trailers and other heavy trucks are most significantly over-represented in all three states. Vehicles in work zone crashes are more likely than those in non-work zone crashes to be in use for transporting property (O-R: AL-2.1*), for construction, or for other business rather than for personal use. This indicates that work zone crashes are more likely than non-work zone crashes to involve on-the-job drivers.

Benekohal and Shim (1999) report that in terms of vehicle miles traveled, the fatal crash rates for large trucks have been consistently higher than the rates for passenger cars and that the semi trailer trucks are under-represented in the property-damage-only and injury crashes, but over-represented in fatal crashes. Analysis of truck drivers' assessment of work zone safety revealed that a vast majority of truck drivers considered work zones to be more hazardous than non-work zone areas. Issues that were found to

make truck drivers uncomfortable in work zones include visibility, clarity of the flagger's message, pavement drop-off, loose construction materials, lack of shoulder, and lane width (6).

Causation Characteristics For Work Zone Crashes

Table 12 shows the actions of drivers in work zone crashes. Most frequently in work zone crashes, a driver is going straight ahead, slowing, stopping, merging, or changing lanes and runs into the back of another vehicle that is slowing, stopping, or stopped in traffic. In Alabama, causal vehicles are more likely to be traveling at higher speeds (36 to more than 70 mph) in work zone crashes than in non-work zone crashes (O-R: AL-1.3*). Overturned vehicles are over-represented in work zone crashes in Alabama (O-R: AL-1.1*), but under-represented in Michigan (O-R: MI-0.52*).

As shown in Table 13, the primary contributing circumstance in work zone crashes is misjudging stopping distance as opposed to failure to yield right of way, which is most often cited in non-work zone crashes. Over-representation by misjudging stopping distance, following too closely, improper lane change, road defects, and vision obstruction is not surprising in work zones. Failure to yield right of way, failure to heed sign, and weather are significantly under-represented as contributing circumstances in work zone crashes, which correlates with the under-representation of intersections and over representation of clear weather. DUI is significantly under-represented in work zones in Alabama, probably because the crashes most likely occur during daylight hours on weekdays.

Other contributing driver conditions such as fatigue and illness are also under-represented in work zones in Tennessee (O-R: TN-1.3). Vehicle defects are rarely contributing factors in work zone crashes, but road defects such as holes/bumps (O-R: AL-12*, TN-5.2) and shoulders too low (O-R: AL-6.0*) are over-represented, as expected.

In Michigan, drivers of causal vehicles are significantly more likely to receive a traffic citation stemming from involvement in a work zone crash than in a non-work zone crash (O-R: MI-1.2*). Drivers are less likely to receive a citation in work zone crashes in Alabama and Tennessee (O-R: AL-0.76, TN-0.95). While speeding was slightly over-represented as a contributing factor in work zone crashes in Alabama (O-R: 1.2), it was significantly under-represented in Michigan (O-R: 0.64*). There were no significant differences in speeding in work zone and non-work zone crashes in Tennessee.

Severity of Crashes in Work Zones

Although vehicles are most often not disabled in work zone crashes, Table 14 shows the point of impact is most often on the front end of the causal vehicle and on the rear of the second vehicle. Damage to the undercarriage, attachment, and top of the causal vehicle are over-represented (O-R: AL-1.5*, MI-2.9*). On vehicle 2, damage to the rear or to an attachment is over-represented (O-R: AL-1.4*, MI-1.5*).

Table 15 summarizes the severity of crashes for all three states. The majority of work zone crashes involve no injury or fatality, but injuries are significantly over-represented in work zone crashes in Michigan. In Alabama and Tennessee, there is no significant difference in the number of injury crashes between work zones and non-work zone locations. In Alabama, a work zone crash is significantly more likely to involve a

fatality than a non-work zone crash. Fatal crashes are only slightly over-represented in work zones in Michigan and Tennessee, but possible incapacitating injury is significantly over-represented in Michigan (O-R: MI-1.2*).

REMEDIES FOR IMPROVING WORK ZONE SAFETY

To address these issues in trying to reduce the number of work zone crashes, many techniques are being employed around the country that focus on various aspects of the problem, which include, but are not limited to:

- Reducing exposure of motorists to work zones through innovative contracting techniques
- Reducing speeds in work zones through the use of traffic control devices and/or partnerships between departments of transportation and law enforcement agencies
- Increasing training and certification requirements of workers and designers of traffic control plans
- Increasing public awareness of the safety hazards of work zones
- Informing the public of active work zone locations through web sites and bulletin boards in rest areas

Further research should be done to quantify the effectiveness of these techniques in increasing safety in work zones.

SUMMARY AND CONCLUSIONS

Work zone crashes in Alabama, Michigan, and Tennessee have many common characteristics. This paper discusses not only characteristics that occur with the highest frequency, but also those that are over-represented or under-represented in work zone crashes when compared to non-work zone crashes. A reasonable goal is for work zones not to pose any additional safety risks for motorists in excess of those present in non-work zone areas. Paying attention to the differences in work zone and non-work zone crash characteristics can help to direct safety enhancement efforts. Those characteristics that are significantly over-represented or under-represented have the highest potential for countermeasure effectiveness.

A summary of the findings for work zone crashes is listed below.

- Locations
    - Highest Frequency: Urban areas (in Alabama and Tennessee); federal highways in Alabama, county or city roads in Michigan, interstates in Tennessee; speed limits between 41 and 55 miles per hour; 2-lane roadways
    - Significantly over-represented: Rural (Alabama and Tennessee); interstates and federal highways (all three states); state roads (Alabama and Michigan); speed limits greater than 40 miles per hour
    - Significantly Under-represented: Urban areas (Alabama and Tennessee); State roads (Tennessee), county and municipal roads; speed limits less than 40 miles per hour (Alabama and Tennessee); 2-lane roadways (Alabama and Michigan)
- When Crashes Occur
    - Highest Frequency: August and October; Between 3:00 and 4:00 pm; Fridays; clear weather

  - Significantly Over-represented: Summer and early fall months; daylight hours; Tuesday, Wednesday, and Thursday; clear weather
  - Significantly Under-represented: December, January and February; nighttime hours; Saturday and Sunday
- Who is involved
  - Highest Frequency: Causal driver between 25 and 34 years of age; no pedestrian involvement; male driver; driver wearing seatbelt; driver residence less than 25 miles from crash site
  - Significantly Over-represented: Out-of-state drivers
  - Significantly Under-represented: Causal driver between 16 and 20 years of age
- Vehicle characteristics
  - Highest Frequency: 2 vehicles involved; passenger cars and station wagons
  - Significantly Over-represented: More than 2 vehicles involved; large trucks pulling trailers and other heavy trucks; vehicles used for transporting property, construction, or other business
  - Significantly Under-represented: 1 or 2 vehicles involved
- Causation Characteristics
  - Highest Frequency: Causal driver misjudges stopping distance; causal vehicle is slowing, stopping, merging, or changing lanes; second vehicle is slowing or stopped in traffic
  - Significantly Over-represented: Misjudging stopping distance; following too closely; improper lane change; road defects; vision obstruction; overturned vehicle (Alabama)
  - Significantly Under-represented: Failure to yield right-of-way; failure to heed sign; weather; overturned vehicle (Michigan)
- Severity of Crash
  - Highest Frequency: Vehicle not disabled; damage to causal vehicle is most often on front end; damage to second or third vehicle is on rear or attachment; no injury or fatality
  - Significantly Over-represented: Damage to undercarriage, attachment, and top of causal vehicle; fatality (Alabama); possible incapacitating injury (Tennessee)

Many attempts have been made to combat various issues affecting safety in work zones but more research is needed to quantify the effectiveness of the techniques that have been employed.

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TABLES

FIGURES

TABLE 1 Total Number of Crashes

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	WZ	NWZ	WZ	NWZ	WZ	NWZ
1994	2,230	128,112	-	-	-	-
1995	2,462	130,928	-	-	-	-
1996	2,461	134,004	5,811	429,666	1,160	166,509
1997	2,764	136,580	7,049	418,744	1,395	167,798
1998	2,548	134,960	7,408	396,355	-	-
Annual Average	2,493	132,917	6,756	414,922	1,278	167,154

- *Data not available.*

TABLE 2 Average Annual Vehicle Miles of Travel, 1994 - 1997 (in Millions)

	Rural		Urban		Total	
	All Roads	Interstate	All Roads	Interstate	All Roads	Interstate
Alabama	25,787.75	5,168	25,331	5,018	51,118.75	10,186
Michigan	32,969.25	6,354.50	55,244.75	12,829.75	88,214	19,184.25
Tennessee	25,818.75	7,824.75	31,606	7,654.75	57,424.75	15,497.50

TABLE 3 Crashes in Rural and Urban Locations

	Percent of Rural Crashes		Percent of Urban Crashes		Percent of Total Crashes	
	WZ[a]	NWZ[b]	WZ[a]	NWZ[b]	WZ[c]	NWZ[c]
Alabama						
1994 - 1998	* 35%	28%	65%	* 72%	1.8%	98%
Michigan						
1996 - 1998	-	-	-	-	1.6%	98%
Tennessee						
1996 - 1997	* 45%	29%	55%	* 71%	0.76%	99%

** Indicates significant over-representation.*

[a]*Percent is of State Total Work Zone Crashes.*

[b] *Percent is of State Total Non-Work Zone Crashes.*

[c] *Percent is of State Total Crashes.*

- Data not available.

TABLE 4 Highway Classification

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
	WZ	NWZ	WZ	NWZ	WZ	NWZ
Interstate	* 23	6.7	* 23	6.8	* 57	8.0
Federal	* 27	17	* 9.2	7.1	* 13	10
State	* 24	22	* 21	17	15	* 21
County	10	* 17	34	* 58[a]	4.2	* 16
Municipal	16	* 37	-	-	9.5	* 42
Other	0.040	0.060	13	11	0.75	2.8

** Indicates significant over-representation.*

- Data not available.

[a] *Michigan combines County and Municipal roads into a single category.*

TABLE 5 Speed Limit At Crash Site

	Alabama 1994 - 1998		Michigan 1996 - 1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
mph	WZ	NWZ	WZ	NWZ	WZ	NWZ
0 to 5	1.3	2.2	0.11	0.29	5.2	* 13
6 to 10	0.04	0.16	0.05	0.080	-	-
11 to 15	0.54	0.71	0.34	0.41	0.08	0.50
16 to 20	0.48	0.93	0.05	0.13	0.27	0.94
21 to 25	5.3	* 12	12	* 18	0.67	1.7
26 to 30	6.4	* 12	* 7.0	6.3	4.6	* 19
31 to 35	11	* 16	* 17	14	8.9	* 15
36 to 40	11	* 11	* 8.6	7.2	6.3	* 16
41 to 45	* 27	16	* 25	14	* 20	15
46 to 50	6.2	5.9	* 4.3	3.2	* 6.0	2.7
51 to 55	* 24	17	12	* 28	* 37	13
56 to 60	* 1.5	0.73	* 4.4	0.020	0.080	0.010
61 to 65	* 3.5	2.3	3.0	3.0	* 10	3.0
66 to 70	* 2.6	2.22	0.00	0.00	-	-
Uncoded	0.00	0.46	5.6	* 6.1	0.00	0.080

** Indicates significant over-representation.*
- Data not available.

TABLE 6 Number Of Traffic Lanes

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
Number Of Lanes	WZ	NWZ	WZ	NWZ	WZ	NWZ
1	2.6	2.8	* 7.8	2.7	-	-
2	45	* 53	43	* 55	33	52
3	3.4	* 4.7	* 18	9.4	-	-
4	* 36	27	16	16	31	23
5	2.9	* 4.0	11	* 12	-	-
6 or more	* 9.0	6.9	3.7	4.5	-	-
Other/Error	1.0	1.6	0.20	0.32	36	26

** Indicates significant over-representation.*

- Data not available.

TABLE 7 Month of Crash

	Alabama 1994-1998			Michigan 1996-1998			Tennessee 1996-1997		
	Percentage of Crashes			Percentage of Crashes			Percentage of Crashes		
	WZ		NWZ	WZ		NWZ	WZ		NWZ
Jan	6.2	*	8.0	2.5	*	9.9	5.1	*	8.0
Feb	6.2	*	7.8	2.3	*	7.2	4.0	*	7.1
Mar	8.0		8.3	3.2	*	8.0	6.1	*	8.0
Apr	8.0		8.4	6.6		6.9	8.1		8.3
May	* 9.1		8.5	* 10		7.9	8.6		8.8
Jun	* 9.4		8.1	* 12		8.0	* 9.5		8.2
Jul	* 9.7		8.3	* 13		7.4	* 10		8.4
Aug	* 10		8.1	* 13		7.3	* 12		8.3
Sep	* 9.0		8.0	* 14		7.6	* 10		8.2
Oct	8.8		9.0	* 14		9.5	* 11		9.2
Nov	8.0		8.5	6.6	*	10	8.9		8.9
Dec	7.5	*	9.1	3.0	*	10	6.5	*	8.7

** Indicates significant over-representation.*

TABLE 8 Day of Week

	Alabama 1994-1998			Michigan 1996-1998			Tennessee 1996-1997		
	Percentage of Crashes			Percentage of Crashes			Percentage of Crashes		
	WZ		NWZ	WZ		NWZ	WZ		NWZ
Monday	15		15	* 15		14	14		15
Tuesday	15		14	* 16		15	15		15
Wednesday	* 15		14	* 16		15	* 16		14
Thursday	* 17		15	* 16		15	16		15
Friday	19		19	17		17	18		18
Saturday	11	*	14	12	*	14	12	*	0.88
Sunday	7.4	*	9.5	7.4	*	10	10		9.9

** Indicates significant over-representation.*

TABLE 9 Age of Driver of Causal Vehicle

	Alabama 1994-1998			Michigan 1996-1998			Tennessee 1996-1997		
	Percentage of Crashes			Percentage of Crashes			Percentage of Crashes		
Years of Age	WZ		NWZ	WZ		NWZ	WZ		NWZ
15 or Under	0.34		0.72	0.24		0.59	0.16		0.38
16	3.2	*	4.4	2.2	*	3.5	1.5	*	4.2
17	3.4	*	4.4	2.7	*	3.7	1.9	*	4.2
18	3.6	*	4.3	2.9	*	3.7	3.2	*	4.4
19	3.7		4.0	2.8	*	3.2	2.9	*	4.0
20	3.3		3.5	2.6		2.8	2.5	*	3.4
21	3.0		3.3	2.5		2.5	2.8		3.0
22 to 24	8.1		8.5	7.1		6.8	8.3		7.9
25 to 34	* 22		21	* 22		20	24		21
35 to 44	* 18		16	18		18	18		16
45 to 54	* 12		9.9	* 12		11	14		9.9
55 to 64	* 7.0		6.2	6.3		5.8	6.9		5.6
65 to 74	5.4		5.1	4.8		4.0	4.5		4.2
75 or Over	3.8		3.8	3.4		3.0	2.5		2.9
Uncoded/Error	3.4		4.8	11	*	12	6.6		8.9

** Indicates significantly over-representation.*

TABLE 10 Number of Vehicles Involved in Work Zone Crash

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
Number	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
of Vehicles	WZ	NWZ	WZ	NWZ	WZ	NWZ
1	22	22	19	* 32	20	* 26
2	68	* 72	* 71	63	66	* 68
3	* 8.5	5.0	* 8.4	4.6	* 11	5.8
4	* 1.6	0.69	* 1.8	0.69	* 2.4	0.86
5	* 0.22	0.10	* 0.25	0.11	0.74	0.15
6 or more	0.12	0.030	0.070	0.040	0.36	0.050

** Indicates significent over-representation.*

TABLE 11 Causal Vehicle Characteristics

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	Percent of Crashes		Percent of Crashes		Percent of Crashes	
	WZ	NWZ	WZ	NWZ	WZ	NWZ
Type:						
Cycle	0.51	0.64	0.61	0.50	0.39	0.65
Passenger/Station Wagon	64	70	69	* 71	64	73
Pickup	24	23	14	* 15	20	19
Van/Motor Home	* 0.16	0.070	* 7.9	7.3	0.67	0.25
Truck under 10,000lb	* 3.5	1.9	1.8	1.6	2.7	1.6
CDL Truck/Bus	5.9	2.8	* 5.1	2.2	9.9	2.6
Construction/Road/Farm Equipment	0.80	0.070	0.98	0.14	0.39	0.030
Other/Uncoded	1.3	1.4	0.82	1.8	2.0	2.9
Attachment:						
Pulling Trailer	8.1	3.8	* 1.1	0.64	* 13	3.2
Use:						
Construction	* 3.8	0.83	* 0.72	0.040	-	-
Commercial	* 10	6.1	* 8.8	4.7	-	-
Private	83	* 90	86	* 91	-	-
Other	3.0	3.1	4.8	4.6	-	-

** Indicates significent over-representation.*

- Data not available.

TABLE 12 Vehicle Maneuver in Work Zone

	Alabama 1994-1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes	
	WZ	NWZ	WZ	NWZ
Causal Driver:				
Going Straight Ahead	* 55	52	67	50
Slowing, Stopping	* 12	8.4	7.3	4.1
Merging	* 2.2	1.4	-	-
Changing Lanes	* 5.0	3.4	-	-
Avoiding Object in Road	* 1.8	1.4	-	-
Other	25	34	25	45
Driver 2:				
Going Straight Ahead	32	* 38	50	45
Slowing, Stopping	* 11	6.3	17	9.8
Stopped in Traffic	* 23	18	4.1	2.7
Unit Does Not Exist	-	-	20	25
Other	33	37	9.4	17

** Indicates significant over-representation.*

- Data not available.

Michigan data not available.

TABLE 13 Primary Contributing Circumstance

Alabama 1994 - 1998		Percentage of Crashes WZ		NWZ
Follow Too Close	*	12		7.9
Misjudge Stopping Distance	*	15		11
Improper Lane Change	*	4.5		3.0
Road Defect	*	0.92		0.089
Vision Obstructed	*	0.81		0.64
Failure to Yield ROW		11	*	17
Failure to Heed Sign		3.4	*	5.3
Parts, Cargo Fell	*	0.72		0.51
Inoperable Traffic Control	*	0.19		0.053
Load Shift	*	0.21		0.11
DUI		2.7	*	3.6
Other		48		51

Michigan 1996 - 1998		Percentage of Crashes WZ		NWZ
Clear Distance	*	30		18
Improper Lane Usage	*	6.4		3.6
Improper Passing		1.3		1.2
Wrong Way	*	0.21		0.15
Speed Too Slow		0.27		0.28
Disregard Traffic Control		3.2	*	3.7
Fail to Yeild		13	*	16
Speed Too Fast		6.0	*	9.4
Other		39		48

Tennessee 1996 - 1997		Percentage of Crashes WZ		NWZ
Following Too Close	*	27		13
Improper Passing		1.6		1.4
Vision Obstructed		0.82		0.87
Reckless Driving		1.2		1.4
Drinking		4.3		4.7
Speeding		2.2		2.9
Disregard Signal or Sign		1.4	*	3.4
Weather		3.3	*	5.6
Failure to Yield		13		24
Other		45		43

** Indicates significant over-representation.*

TABLE 14 Point of Vehicle Impact

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
	WZ	NWZ	WZ	NWZ	WZ	NWZ
Causal Vehicle:						
Front Left Angle	9.2	* 11	-	-	7.6	* 10
Front Center	* 57	53	* 36	33	* 54	50
Front Right Angle	9.6	* 10	-	-	7.5	* 9.4
Rear Left Angle	3.1	* 3.6	-	-	4.0	3.5
Rear Center	4.5	* 5.1	* 8.0	5.5	* 10	5.9
Rear Right Angle	3.3	* 4.3	-	-	3.1	3.9
Other	13	13	56	62	14	17
Vehicle 2:						
Front Left Angle	5.7	* 7.8	-	-	4.6	* 7.5
Front Center	15	* 19	* 12	12	11	* 20
Front Right Angle	5.2	* 6.3	-	-	5.7	6.2
Rear Left Angle	3.3	* 4.3	-	-	3.5	4.1
Rear Center	* 39	29	* 26	15	* 44	24
Rear Right Angle	2.4	* 3.3	-	-	2.0	* 2.9
Attachment	* 1.6	0.67	-	-	-	-
Under Carriage	* 0.23	0.092	-	-	-	-
Top	* 0.22	0.13	-	-	-	-
Other	53	63	62	73	29	36

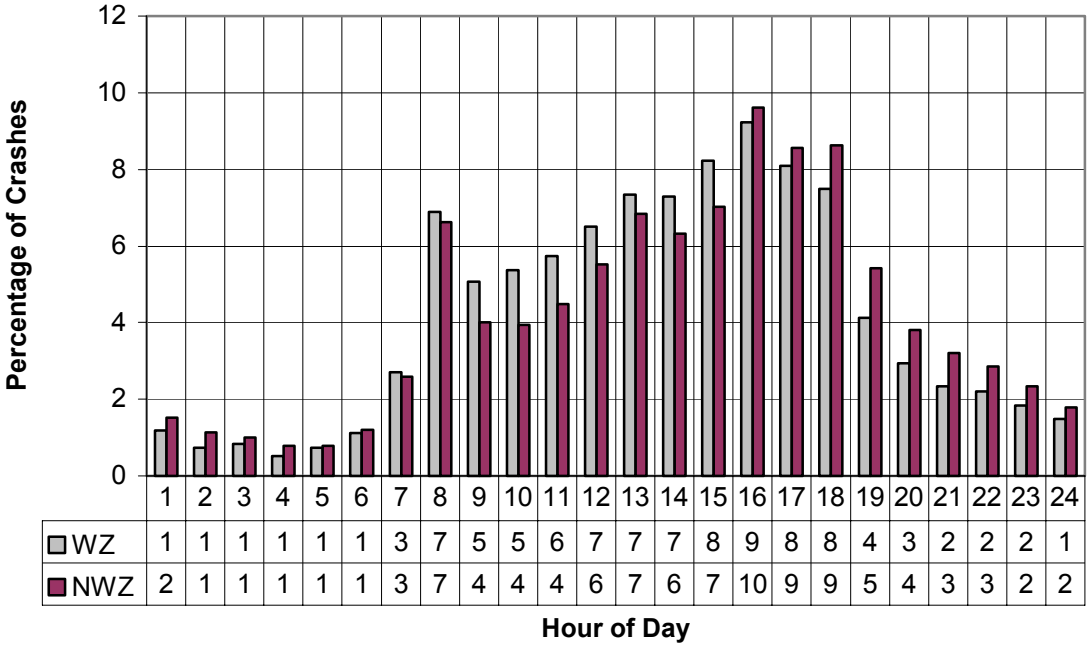
** Indicates significant over-representation.*
- Data not available.

TABLE 15 Crash Severity

	Alabama 1994-1998		Michigan 1996-1998		Tennessee 1996-1997	
	Percentage of Crashes		Percentage of Crashes		Percentage of Crashes	
	WZ	NWZ	WZ	NWZ	WZ	NWZ
Property Damage	75	75	76	* 77	69	68
Injury	24	24	* 24	23	30	31
Fatality	* 1.0	0.73	0.29	0.31	0.82	0.66

** Indicates significant over-representation.*

Figure 1 Time of Crash in Alabama, 1994 - 1998



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WZ	1	1	1	1	1	1	3	7	5	5	6	7	7	7	8	9	8	8	4	3	2	2	2	1
NWZ	2	1	1	1	1	1	3	7	4	4	4	6	7	6	7	10	9	9	5	4	3	3	2	2