ANALYZING HIGHWAY WORK ZONE CRASHES AND TRAFFIC CONTROL EFFECTIVENESS

By

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M.A.Sc., Ryerson University 2003

Submitted to the graduate degree program in Civil Engineering and the
Faculty of the Graduate School of the University of Kansas
In partial fulfillment of the requirements for the degree of
Doctor of Philosophy

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ABSTRACT

Work zones on the United States highway system create an inevitable disruption to regular traffic flows and have resulted in traffic safety problems. Systematically investigating work zone crashes is a critical step towards developing effective safety countermeasures to reduce these crashes. In this research, a comprehensive analysis of severe work zone crashes was conducted in an effort to catalyze improvement to highway work zone safety. The primary objectives of the research were:

1. to discover the general and unique characteristics of fatal and injury crashes in highway work zones,
2. to evaluate and quantify the effectiveness of work zone temporary traffic control (TTC) devices and suggest traffic control improvements accordingly,
3. to identify the risk factors that could lead to high-severity crashes in highway work zones, and
4. to develop crash-severity-index (CSI) models for evaluating the risk levels of work zones with given travel conditions and relevant environmental factors.

The crash data analyzed in the study included the fatal and injury crashes between 1992 and 2004 in Kansas highway work zones. The researcher utilized a variety of statistical methods to achieve the objectives. The crash characteristic

investigation employed both single-variable and multi-variable frequency analyses and chi-square tests; the logistic regression technique was used in the evaluation of traffic control effectiveness and the development of CSI models; and chi-square statistics and Cochran-Mantel-Haenszel (CMH) statistics were employed to identify work zone risk factors. Outcomes of this research included the general and unique characteristics of fatal and injury work zone crashes, the quantified effectiveness of work zone TTC devices, the identified work zone risk factors, and a set of developed CSI models for work zone risk evaluation. Based on these findings, potential work zone safety improvements were recommended in the areas of traffic control, public education, and crash reporting. In addition, the application of CSI models in work zone planning or work zone safety inspection was also recommended to improve work zone safety. Promising future research tasks are suggested at the end of the dissertation, as well.

ACKNOWLEDGEMENTS

The accomplishment of the degree of Doctor of Philosophy is one of the most important milestones in my life. On the journey to this achievement, the warm encouragement and appreciation from my mother Landi Guo and my father Wenpian Li, have always accompanied me in every single moment of my life. The true love and trust from my dear wife Chunxiao Liu helped me overcome every difficulty that I would otherwise have hesitated to confront. I sincerely appreciate them for everything they have given and will continue to give to me.

The success of this dissertation research was greatly aided by many other individuals. I would like to thank Dr. Yong Bai, the advisor of this dissertation research, for his critical advice through the entire process of this research. Thanks also goes to professors in the Department of Civil, Environmental, and Architectural Engineering including Dr. Thomas E. Mulinazzi, Dr. Thomas E. Glavinich, and Dr. Oswald Chong, for being my dissertation committee members and for their valuable suggestions leading to the improvement of this thesis. Dr. Yaozhong Hu, the dissertation committee member from Department of Mathematics, provided critical advice on the mathematical methods used throughout the research. I also would like to thank Mr. Anthony Alrobaire and Mr. Rex McCommon from Kansas Department

of Transportation (KDOT) for their assistance on data collection. Financial support for this research was partly provided by KDOT.

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Chapter 1
INTRODUCTION

1.1 PROBLEM STATEMENT

As the American highway system ages, federal and state government agencies have to allocate a greater percentage of their funding for preserving, expanding, and enhancing existing highway networks. As a result, the traveling public has encountered more and more highway work zones. For instance, an average of 23,745 miles of roadway had federal aid roadway improvement projects underway every year between 1997 and 2001. During the peak summer roadwork season of 2001, there were more than 3,000 work zones on the National Highway System (FHWA 2005a). Work zones create a disruption to regular traffic flows and have resulted in traffic safety problems. Improving safety in highway work zones without sacrificing the utilization of highways has become one of the significant challenges that traffic engineers and researchers have to confront.

Nationally, great effort has been devoted to improving the safety and mobility of work zone traffic. Congress has addressed concern about work zone safety in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and National Highway System Designation Act of 1995 (FHWA 1998). The recent Safe,

Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) included a number of provisions emphasizing highway work zone safety and other work zone-related issues (FHWA 2005b). In addition, the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) have established leading roles on this subject and have developed practical highway work zone safety guides and programs. Many state Departments of Transportation (DOTs) have initiated research projects to improve work zone safety in their states. Other interested organizations and research individuals have also participated in this campaign by conducting meaningful research on various work zone safety issues.

Despite this effort, nationwide work zone safety remains unsatisfactory. Work zone crash rates by work zone vehicle-miles traveled (VMT) are not precisely known, but annual work zone crash statistics have shown a safety concern. Annually, the number of work zone fatalities in the United States has risen from 872 in 1999 to 1,074 in 2005 (an average of more than 1,000 per year), adding more than 40,000 work zone related injuries per year (FHWA 2004a; 2007). The direct cost of highway work zone crashes, estimated based on the crash data from 1995 to 1997, was as high as $6.2 billion per year: an average cost of $3,687 per crash (Mohan and Gautam 2002).

Figure 1.1 presents a ten-year trend of nationwide work zone fatalities. As shown in the illustration, the nation's death toll in work zone crashes climbed from 1997's 658 to 2002's 1,181. Although the number dropped slightly in 2005, still more

than 1,000 people were killed in work zone crashes that year. The alarming numbers have raised the need to improve work zone safety nationwide.

Actual crash experience is always the best source for identifying safety deficiencies and developing effective countermeasures. Because of the severity of the work zone crashes including both fatal and injury cases, it is necessary to thoroughly understand the characteristics of these crashes and particular safety deficiencies they imply so that effective countermeasures can be further developed to improve safety for both work zone travelers and highway construction workers. With this motivation, a systematic study of the crashes that occurred in highway work zones was conducted, based on Kansas work zone crash data. The researcher studied the characteristics of both fatal and injury work zone crashes, assessed the effectiveness of several commonly-used temporary traffic control (TTC) devices, determined the risk factors in highway work zones, and developed the crash severity index (CSI) method for evaluating the risk level of work zone traffic conditions. The outcomes provide significant safety insights that can be valuable for the design of safer work zones and the selection of more effective work zone traffic control strategies.

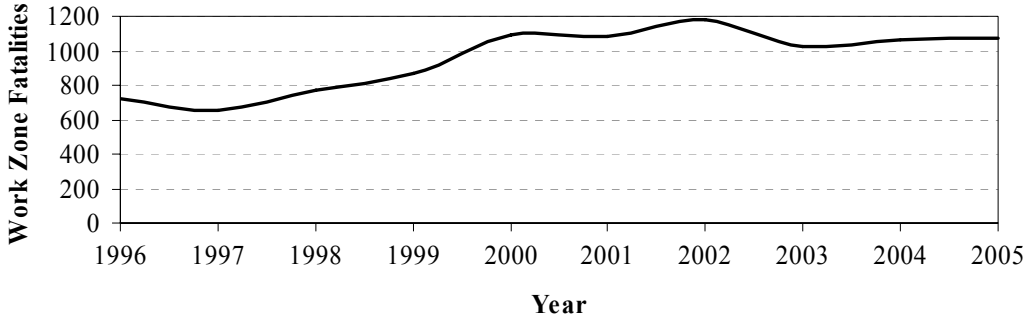


Figure 1.1. Ten-Year (1996 – 2005) Work Zone Fatality Trend

1.2 RESEARCH OBJECTIVES AND SCOPE

The primary objectives of this research were:

1. To discover the general and unique characteristics of fatal and injury crashes in highway work zones;
2. To evaluate and quantify the effectiveness of work zone TTC devices and suggest traffic control improvements accordingly;
3. To identify the risk factors that could lead to severe crashes in work zones; and
4. To develop CSI models for evaluating the risk levels given specific work zone travel conditions and relevant environmental factors.

The scope of this research was limited to the fatal and injury crashes between 1992 and 2004 in Kansas highway work zones. In particular, three sets of crash data were used for the systematical analyses. They were:

1. A total of 157 fatal crashes that occurred in Kansas highway work zones during 1992 and 2004;
2. A sample of 460 injury crashes randomly drawn from the 4,443 injury crashes between 1992 and 2004; and
3. The 654 highway work zone crashes including both fatal and injury crashes in Kansas between 2003 and 2004.

1.3 RESEARCH METHODOLOGY

The research objectives were achieved by the following four steps:

Literature review. A comprehensive literature review was conducted first to provide the state-of-the-art background of highway work zone safety research. The review synthesized the findings from the previous literature in work zone safety-related subjects such as work zone crash characteristic studies, work zone traffic control studies, work zone intelligent transportation system (ITS) applications, and typical statistical methods for crash analysis. The reviewed literature included, but was not limited to, journal papers, research reports, conference proceedings, theses, dissertations, and Internet publications. The review enabled the researcher to understand the current work zone safety research status and to perform innovative and practical studies in the right direction.

Data collection. First, fatal and injury work zone crash data from 1992 to 2004 was extracted from the Kansas Department of Transportation (KDOT) accident database. Then, data were recompiled to spreadsheets that were suitable for computer-aided statistical analysis without missing critical information. The original accident reports of some cases were investigated to insure data accuracy.

Data analyses. The researcher analyzed the collected data to determine crash characteristics, traffic control effectiveness, work zone risk factors, and the work zone CSI models. Various statistical analysis methods including frequency analysis, tests of independence, and regression techniques were used through out the research. The statistical software package, SAS, was utilized for the data analyses.

Conclusions and recommendations. Based on the results of the data analyses, the researcher drew conclusions and recommendations, accordingly. The conclusions included important work zone crash characteristics, traffic control effectiveness, work zone risk factors, and the advantages of applying CSI for work zone risk evaluation. In addition, work zone safety improvements and promising future research were recommended.

1.4 DISSERTATION ORGANIZATION

This dissertation includes seven chapters. Besides the introduction chapter, the other chapters are:

Chapter 2: Literature Review. This chapter presents the findings from a comprehensive literature review. The literature reviewed includes the areas such as work zone crash characteristic study, work zone traffic control study, work zone ITS applications, and statistical analyses of traffic crashes.

Chapter 3: Data Collection. This chapter describes the detailed data collection procedure and the final collected datasets.

Chapter 4: Work Zone Crash Characteristics. This chapter presents the results of data analyses on the characteristics of fatal and injury crashes in Kansas highway work zones. The findings of the analyses were organized by fatal crash characteristics, injury crash characteristics, and comparison between fatal and injury crash characteristics.

Chapter 5: Evaluating Work Zone Traffic Control Effectiveness. This chapter presents the quantified effectiveness of several commonly used work zone TTC devices using binary logistic regression technique.

Chapter 6: Work Zone Risk Factor Determination and Crash Severity Index Model Development. This chapter incorporates the determination of the risk factors in highway work zones and the development of the CSI models. These analyses used statistical methods such as chi-square statistics, Cochran-Mantel-Haenszel (CMH) statistics, and logistic regression statistic.

Chapter 7: Conclusions and Recommendations. Conclusions and recommendations of this research are presented in this chapter.

Chapter 2
LITERATURE REVIEW

A highway work zone refers to a highway section where highway construction or maintenance is carried out. The Manual on Uniform Traffic Control Devices (MUTCD) divides a work zone into four areas (Figure 2.1): the advance warning area, the transition area, the activity area, and the termination area (FHWA 2003). Road users traveling through a work zone are warned of the upcoming hazardous area in the advanced warning section and then are directed out of their normal path in the transition area. The activity area frequently forms a bottleneck that can dramatically reduce the traffic throughput. The termination area is the section following the activity area where road users return to their normal path.

Highway work zones disturb regular traffic flows and thus create safety problems. Nationally, highway work zone safety has been a research focus for decades and some early research results on this subject were published in the 1960s (California Department of Public Works 1965; Munro and Huang 1968). To date, a number of studies on highway work zone safety have been published where researchers emphasized their findings on various safety-related subjects. This section presents the findings from a comprehensive literature review of highway work zone

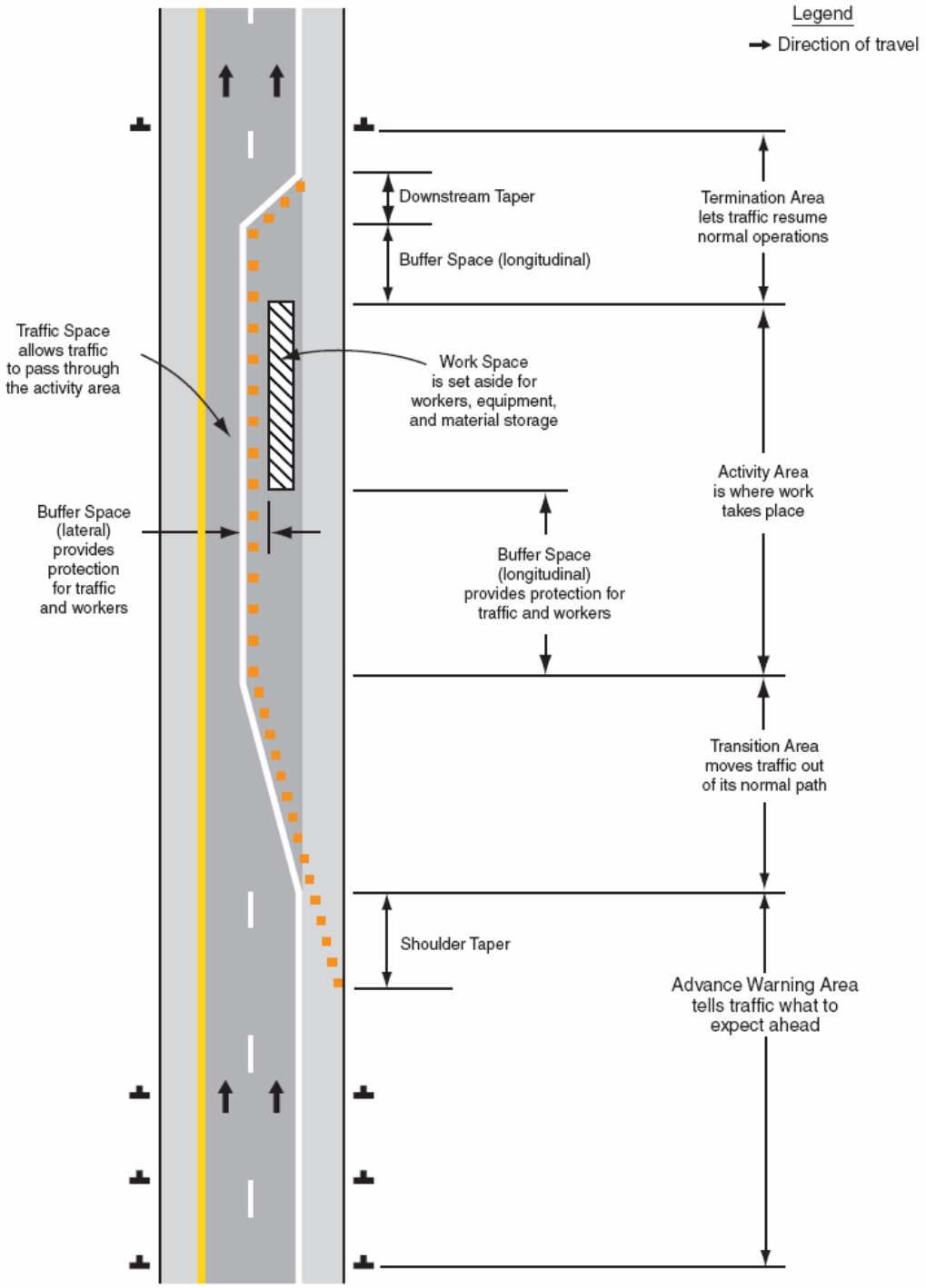


Figure 2.1. Component Areas of a Highway Work Zone
Source: MUTCD (2003 Edition, page 6C-3)

safety-related studies. The findings were organized in four categories including highway work zone crash characteristics, highway work zone traffic control effectiveness, intelligent traffic system (ITS) applications in highway work zones, and statistical methods for traffic crash analysis.

2.1 HIGHWAY WORK ZONE CRASH CHARACTERISTICS

Table 2.1 lists the work zone crash studies after the late 1970s that are included in this literature review. Most of these studies were conducted statewide, although a few addressed nationwide work zone safety issues. Because of the diversity of the data scopes, study findings are somewhat inconsistent. The predominant work zone crash characteristics concluded in these studies are summarized in terms of severity, rate, type, time, location, and causal factors.

Crash Severity

When compared with non-work zone crashes, inconsistent conclusions have been reached about whether more severe crashes occur in work zones. Some studies from Virginia (Garber and Zhao 2002), Texas (Ullman and Krammes 1990), Kentucky (Pigman and Agent 1990), and Ohio (Nemeth and Migletz 1978) documented significant increases of severe crashes in work zones. A national study (AASHTO 1987) also discovered that both fatal crash frequency and average fatalities per crash were higher in work zones across the nation. However, several other studies (Chembless et al. 2002; Ha and Nemeth 1995; Hall and Lorenz 1989) did not find significant changes on work zone crash severity. The work zone crashes

were even found less severe in a few other studies (Wang et al. 1996; Garber and Woo 1990; Rouphail et al. 1988; Hargroves 1981).

Table 2.1. Previous Work Zone Crash Studies

Subject	No.	Study Data	State	Ref.
Crash characteristics	1	Statewide WZ crashes (1996-1999)	Virginia	Garber and Zhao 2002
	2	Alabama crashes (1994 - 1998); Michigan crashes (1996 – 1998); Tennessee crashes (1994–1997)	Alabama, Michigan, Tennessee	Chembless et al. 2002
	3	Crashes of three states (1991-1992)	--	Wang et al. 1996
	4	Crashes of 20 WZ's (1986-1987)	Kentucky	Pigman and Agent 1990
	5	Statewide WZ crashes (1982-1986)	Ohio	Ha and Nemeth 1995
	6	Crashes on Interstate and other primary highway systems (1984-1985)	National (46 states)	AASHTO 1987
	7	Statewide WZ crashes (1983-1985)	New Mexico	Hall and Lorenz 1989
	8	2,127 WZ crashes (1977)	Virginia	Hargroves 1981
	9	151 crashes of 21 WZ's (1973)	Ohio	Nemeth and Migletz 1978
	10	Crashes of 79 long-term WZ's	Multi-state	Graham et al. 1977
Crash characteristic and traffic control study	11	Crashes in long-term and short-term WZ's in Chicago (1980-1985)	Illinois	Rouphail et al. 1988
Crash costs	12	3,686 WZ crashes (1990–1993) from Liberty Mutual Insurance Company Database	--	Mohan and Gautam 2002
Crash rate	13	Crashes before and after 7 interstate WZ's	Indiana	Pal and Sinha 1996
Fatal crash characteristics	14	Statewide fatal WZ crashes (1992-2004)	Kansas	Bai and Li 2006
	15	77 fatal WZ crashes throughout Texas (02/2003– 4/2004)	Texas	Schrock et al. 2004
	16	376 fatal crashes (1997-1999)	Texas	Hill 2003
	17	181 fatal WZ crashes (1995-1997)	Georgia	Daniel et al. 2000
Long-term WZ crashes	18	Crashes at 5 long-term WZ's (1984-1988)	Texas	Ullman and Krammes 1990
Truck drivers' crash experience	19	834 surveys to truck drivers (1993)	Illinois	Benekohal et al. 1995
Urban WZ crashes	20	Crashes of 26 urban WZ's (1982-1985)	--	Garber and Woo 1990

Note: Unless otherwise defined, the crashes here are work zone crashes; WZ: work zone.

Crash Rate

Since highway work zones disrupt regular traffic flows, higher crash rates would be an anticipated outcome. Many studies (Garber and Zhao 2002; Pigman and Agent 1990; AASHTO 1987; Hall and Lorenz 1989; Pal and Sinha 1996; Graham et al. 1977) agreed on the higher crash rates in highway work zones. In particular, some studies (Ullman and Krammes 1990; Rouphail et al. 1988) suggested that considerable crash-rate increases could be expected in long-term highway work zones.

Crash Type

The prevailing types of work zone crashes vary with different locations and times, but it was agreed by most of the previous studies that the rear-end collision was one of the most frequent work zone crash types (Mohan and Gautam 2002; Garber and Zhao 2002; Pigman and Agent 1990; Nemeth and Migletz 1978; Chembless et al. 2002; Hall and Lorenz 1989; Wang et al. 1996; Garber and Woo 1990; Rouphail et al. 1988; Hargroves 1981). Other major crash types in work zones include same-direction sideswipe collision (Pigman and Agent 1990; Garber and Woo 1990) and angle collision (Pigman and Agent 1990). Some studies ranked hit-fixed-object as another dominant type of work zone crash (Mohan and Gautam 2002; Nemeth and Migletz 1978; Hargroves 1981). A study in Georgia found that single-vehicle crashes, angle-side impact, and head-on collisions were the dominant types of fatal work zone crashes (Daniel et al. 2000).

Another major work zone safety concern is the frequent involvement of heavy trucks in work zone crashes. Several studies found that the percentage of truck-

involved crashes was much higher in work zones (Pigman and Agent 1990; AASHTO 1987) and heavy truck related crashes were more likely to involve multiple vehicles and, hence, frequently resulted in fatalities and high monetary loss (Bai and Li 2006; Pigman and Agent 1990; Schrock et al. 2004; Hill 2003). Because of the alarming number of heavy-truck crashes, Benekohal et al. (1995) found that 90% of the surveyed truck drivers considered driving through work zones to be more hazardous than in other areas.

Crash Time

Work zone crashes frequently occur in the daytime (Mohan and Gautam 2002; Chembless et al. 2002; Hill 2003) during the busiest construction season between June and October (Pigman and Agent 1990). Nighttime work zone crashes, however, were found to be much more severe in most cases (Garber and Zhao 2002; Pigman and Agent 1990; AASHTO 1987). Nemeth and Migletz (1978) found that the proportion of tractor-trailer- or bus- caused crashes at darkness was greater than the proportion of other vehicles, which consequently resulted in more severe crashes due to the large sizes of tractor-trailers and buses.

Crash Location

Researchers of the previous studies agreed on the unbalanced crash distribution along the work zones, but they did not reach consistent conclusions on the most dangerous work zone areas. The activity area (Garber and Zhao 2002; Schrock et al. 2004), the advanced warning area (Pigman and Agent 1990), the transition area, and the termination area (Nemeth and Migletz 1978; Hargroves 1981) were highlighted as

the most dangerous areas in terms of severe crash frequency in different literatures. In addition, a nationwide study (AASHTO 1987) found that the work zones on rural highways accounted for 69% of all fatal crashes. In particular, the rural interstate systems (Pigman and Agent 1990; AASHTO 1987; Chembless et al. 2002) or two-lane highways (Rouphail et al. 1988) are the places where work zone crashes most likely happen. However, a Virginia study (Garber and Zhao 2002) argued that, in general, urban highways had much higher percentage of work zone crashes than rural highways.

Causal Factors

Most previous studies pointed at human errors, such as following too close, inattentive driving, and misjudging, as the most common causes for work zone crashes (Mohan and Gautam 2002; Pigman and Agent 1990; Chembless et al. 2002; Hargroves 1981; Daniel et al. 2000). Some studies also indicate that speeding (Garber and Zhao 2002) and inefficient traffic control (Ha and Nemeth 1995) are two other factors causing crashes in work zones. Hill (Hill 2003) found that there was a significant difference in types of driver errors between daytime crashes and nighttime crashes. Researchers proved that adverse environmental and road surface conditions did not contribute more to work zone crashes than to non-work zone crashes (Nemeth and Migletz 1978; Garber and Woo 1990).

Summary of Work Zone Crash Characteristics

The characteristics of the work zone crashes studied in the previous research projects are summarized as following:

1. Work zone safety has been attracting research efforts since 1960s. To date, most work zone crash studies have been done statewide, but Kansas work zone crashes have not been investigated. The researcher did not find any study addressing the fatal and injury characteristic differences based on systematical comparisons between these two types of crashes.
2. There is no consistent conclusion on whether work zone crashes are more or less severe than other crashes. However, previous researchers agreed on that truck-involved and nighttime work zone crashes are more severe than non-work zone crashes.
3. Most previous study results showed that it was more likely to have crashes in work zones than in non-work zones. Particularly, higher crash rates had been found in rural and long-term highway work zones.
4. Rear-end, same-direction sideswipe, and angle-side impacts were the most frequent work zone crash types. Single-vehicle crashes, angle-side impacts, and head-on collisions were frequently found among fatal work zone crashes. Truck-involved crashes were more frequent and severe in work zones.
5. Most work zone crashes occur in the daytime. However, work zone crashes during nighttime were more severe than both daytime work zone crashes and non-work zone crashes.
6. No consistent conclusions were reached on the most dangerous areas in work zones. In addition, study results indicated that rural interstate highways were most likely to have work zone crashes.

7. Human errors and inefficient traffic controls were the major causes of work zone crashes. Adverse environmental factors, in contrast, were not contributing more for work zone crashes than for non-work zone crashes.

2.2 LOGISTIC REGRESSION AND OTHER STATISTICAL METHODS USED IN TRAFFIC CRASH ANALYSES

Logistic regression analysis is a statistical technique developed for describing the relationships between a set of independent explanatory variables and a dichotomous response variable or outcome. Because traffic crash analyses involve establishing the relationships between the occurrence of a crash and the presence of various contributing factors, this regression technique arises as a suitable analysis tool.

Since a logistic regression model is a direct probability model that has no requirements on the distributions of the explanatory variables or predictors (Harrell 2001), it is more flexible and more likely to yield accurate results in traffic crash analyses where the safety impacts of contributing factors need to be quantified. In addition, logistic regression models yield probabilities with values between zero and one for interesting events, which makes the statistic ideal for developing models to estimate numerical outcomes with specified ranges, such as CSI models (CSIs are numbers between zero and one) that were developed in this study. Currently, logistic regression has been used in traffic data studies to quantify the impacts of crash related variables. This section presents the basic theories of logistic regression statistic and

some applications of logistic regression and related statistics in traffic crash data analyses. An index of studies covered in this review is listed in Table 2.2.

Herein briefly described is the basic mathematical theory of the logistic regression method. If Y denotes an event (Y = 1 and Y = 0 denote occurrence and nonoccurrence, respectively) and let a vector $\boldsymbol{X}$ be a set of predictors $\{X_1, X_2, ..., X_k\}$, then the expected value of Y given $\boldsymbol{X}$ is the probability (P) of the occurrence of Y given $\boldsymbol{X}$, which can be expressed in linear regression form as:

$$E\{Y|\boldsymbol{X}\} = P\{Y = 1|\boldsymbol{X}\} = \boldsymbol{X\beta},$$

where $\boldsymbol{\beta}$ is the regression parameter vector and $\boldsymbol{X\beta}$ stands for $\beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k$. Because the probability determined in this model can exceed 1, the following binary logistic regression model is generally preferred for the analysis of binary responses:

$$P\{Y = 1|\boldsymbol{X}\} = [1 + exp(-\boldsymbol{X\beta})]^{-1} = exp(\boldsymbol{X\beta})/[1 + exp(\boldsymbol{X\beta})]$$

The above equation can be expressed in the following logistic form:

$$logit\{Y = 1|\boldsymbol{X}\} = log[P/(1 - P)]$$

$$= \beta_0 + \beta_1 X_1 + ... + \beta_k X_k$$

For the above model, the maximum likelihood method can be used to estimate the parameter combination that maximizes the likelihood of the observed outcomes. Given the estimated β's as $\hat{\beta}_0, \hat{\beta}_1, \cdots, \hat{\beta}_k$, the estimated probability $\hat{P}$ of an event Y happens, can be computed based as:

$$\hat{P}\{Y = 1|\boldsymbol{X}\} = exp(\boldsymbol{X}\hat{\boldsymbol{\beta}})/[1 + exp(\boldsymbol{X}\hat{\boldsymbol{\beta}})]$$

where $\boldsymbol{X}\hat{\boldsymbol{\beta}}$ stands for $\hat{\beta}_0 + \hat{\beta}_1 X_1 + \cdots + \hat{\beta}_k X_k$.

Table 2.2. List of the Articles Sited

No	Researchers	Research Scope	Research Objective
1	Lu et al.	Median crossover crashes in Wisconsin	Crash severity prediction
2	Chang and Yeh	Motorcycle single-vehicle crashes in Taiwan	Risk factor identification
3	Dissanayake and Lu	Single-vehicle fixed-object crashes involving young drivers	Crash severity prediction
4	Kim et al.	Alcohol-impaired motorcycle crashes in Hawaii	Estimation of the crash likelihood as a function of rider characteristics and environmental and temporal factors
5	Ouyang et al.	Car-truck collisions	Study of the interrelationships among the injury severity outcomes
6	Chen and Jovanis	Bus-involved crashes	Proposing crash variable selection procedure

The significance of logistic regression technique in the analysis of traffic safety has been recognized for years. Hill (2003) and Li and Bai (2006) have applied this technique in the analysis of work zone fatal crashes to quantify the effectiveness of traffic control devices. Recently, Lu et al. (2006) utilized logistic regression to develop models that could predict the severity of median crossover crashes in Wisconsin based on road, driver, and traffic characteristics. The researchers found that driver age and time of year affected crash severity on high volume roadways; Road condition had impacts on the severity when traffic volume was low; and weather condition and emergency response time were significant if median width was inadequate. However, the researchers found no close causal relationships between most of the studied variables and the severity of the median crossover crashes and, hence, failed to develop general prediction models.

Logistic regression was used by Chang and Yeh (2006) in the analysis of fatality risk factors of motorcyclists in Taiwan. The study compared risk factors

between non-motorcycle drivers and motorcyclists based on the single-vehicle crash data in Taiwan in the year of 2000. The crash factors screened in the analysis included drivers' characteristics, roadway and environmental factors, vehicle type, and crash type. The researchers developed two logistic regression models to assess the fatality risks of the two types of crashes. The models indicated that motorcyclists had approximately a three-time-higher fatality risk than non-motorcycle drivers and some common features, such as being male, a higher age, and occurring between the hours of 10:00 p.m. and 6:00 a.m., led to a greater likelihood of fatality for both types of drivers.

A set of sequential binary logistic regression models was developed by Dissanayake and Lu (2002) to analyze the contributing factors and predict the crash severity of single-vehicle fixed-object crashes involving young drivers. Their research focused on young drivers because they have been considered to be the age group most likely involved in severe traffic crashes. The researchers utilized the SAS software package to develop the regression models and then organized them from the lowest severity level to the highest. Their models took into account several important crash factors such as gender, driver impairment, and geometric conditions of crash locations. They concluded that factors such as restraint device usage and being a male clearly reduced the tendency of high severity, while some other variables, such as weather condition, residence location, and physical condition, were not important at all. However, one limitation to their methodology was that it did not account for multi-vehicle crashes involving young drivers and the condition of the crash vehicles.

Kim and his colleagues (2000) used logistic regression to facilitate their analysis on motorcycle crash characteristics. By studying the differences between impaired and non-impaired riders in motorcycle crashes in terms of various demographic characteristics, helmet use, license status, roadway environments, and injury outcomes, a logistic regression model was formulated to explain the likelihood of an alcohol-related motorcycle crash as a function of rider characteristics and environmental and temporal factors. The researchers used SAS to estimate the parameters of this model and then to calculate various likelihoods. According to their results, they found that: 1) motorcycle safety needed to be improved by focusing both educational and enforcement efforts on specific age groups at specific times and at key locations; and 2) there was a significant safety problem involving unlicensed riders. The researchers suggested that future research might entail more detailed surveys of both trip assignment and alcohol consumption. In addition, more efforts to identify impaired riders before they were involved in crashes should be devoted.

The traditional logit or probit models for traffic crash severity analysis can only model one severity at a time, while many advanced analyses require modeling multiple severities simultaneously. Ouyang et al. (2002) developed a methodology which used a simultaneous binary logit model to describe the interrelationships among the injury severity outcomes in multi-vehicle collisions. The model addressed the highway design and environmental issues, along with human factors, in a multivariate context using a simultaneous multinomial logit approach. A random data sample of 2,986 car-truck collisions in the period from 1990 to 1996 was used in the

verification and demonstration of their newly developed model. Using their model, the impacts of various factors such as different vehicle types, collision vehicle conditions, driver and occupant factors, collision locations and their speed limits, and weather related factors on the severity of multi-vehicle collisions, were examined one by one. The authors concluded that their simultaneous multinomial logit model was more efficient than the traditional ones.

Since a large number of factors may affect the severity of a traffic collision, how to identify those that are most significant to crash severity can be a challenge. To address this issue, Chen and Jovanis (2000) developed a variable-selection procedure to identify the most significant factors affecting traffic crashes. The procedure included several steps. First, using the Pearson chi-square test, the original variable categories were collapsed and significant individual variables were selected. Second, the interactions between the selected significant variables were tested to identify significant variable combinations. Third, the interactions of the insignificant variables were examined to further detect possible significant combinations omitted by the first step. Fourth, all significant variables were grouped based on their interaction relationships discovered in steps two and three. Finally, for each group, associations were investigated by logistic regression models and indirect variables were further eliminated. Through the application of their procedure to the analysis of real data, the researchers concluded that the new procedure was superior in the following three functions: 1) collapsing categories to reduce their number while conserving the homogeneity in each category, 2) avoiding the influence of sparse cases, and 3)

detecting the variables that may or may not have main effects on the response variable.

2.3 WORK ZONE TRAFFIC CONTROL DEVICES AND EFFECTIVENESS

The dissatisfaction with traffic safety in highway work zones indicates room for further traffic control improvements. Highway work zones use TTC devices to provide continuity of reasonably safe and efficient traffic flows during road works. As included in the MUTCD (FHWA 2003), some TTC devices that are commonly used in work zones include flaggers, traffic signs, arrow panels and portable changeable message signs, channelizing devices, pavement markings, lighting devices, temporary traffic control signals, and rumble strips. A review of these traffic control devices and their related studies is presented herein. Table 2.3 lists the studies cited in this section.

Flagger Control

Flaggers are qualified personnel wearing high-visibility safety apparel and equipped with hand-held devices such as STOP/SLOW paddles, lights, and red flags to control road users through work zones. The MUTCD suggests that flaggers should be located such that approaching road users have sufficient distance to stop at an intended stopping point. Flaggers should be preceded by an advance warning sign or signs and be illuminated at night.

Table 2.3. Previous Studies on Traffic Control Devices

No.	Research Subject	Traffic Control Devices	Reference
1	Manual on Uniform Traffic Control Devices for Streets and Highways	--	FHWA 2003
2	Examination of several speed control methods	Flaggers, changeable message signs	Richards and Dudek 1986
3	Work zone crash study	Flaggers, static traffic signs	Garber and Woo 1990
4	Work zone fatal crash study	Flaggers, STOP/GO signals	Hill 2003
5	Truck drivers' experiences in highway work zones	Flaggers, warning signs	Benekohal et al. 1995
6, 7	Evaluation of the effectiveness of changeable message signs	Changeable message signs	Garber and Patel 1994 Garber and Srinivasan 1998
8	Evaluation of some traditional work zone traffic control devices	Channelizing devices	Pain et al. 1983
9	Evaluation of the effectiveness of optical speed bars	Optical speed bars	Meyer 2004
10	Study of the possibility of maintaining two lanes open in some work zones	Changeable message signs	Huebschman et al. 2003
11	Evaluation of the effectiveness of using police in work zones for speed control	Police presence	Arnold 2003

An evaluation (Richards and Dudek 1986) showed that flaggers were most efficient on two-lane, two-way rural highways and urban arterials, where they had the least competition for drivers' attention; flaggers were also well suited for short-duration applications (less than one day) and for intermittent use at long-duration work zones. Garber and Woo (1990) concluded that the most effective combination of traffic control devices for work zones on multilane highways was cones, flashing arrows and flaggers, and the effective combinations of traffic control devices for work zones on urban two-lane highways were cones and flaggers, and static signs and flaggers. Hill (2003) proved that flaggers were effective in reducing fatal work zone crashes. However, the study by Benekohal et al. (1995) indicated there was a need for

improving flagging for heavy-truck traffic. Their survey showed that one third of the surveyed truck drivers responded that flaggers were hard to see and half of them thought the directions of flaggers were confusing.

Traffic Signs

As listed in the MUTCD, traffic signs in work zones include regulatory signs, warning signs, and guide signs. Regulatory signs inform road users of traffic laws or regulations and indicate the applicability of legal requirements that would not otherwise be apparent. Most regulatory signs are rectangular with a black legend and border on a white background. Warning signs notify road users of specific situations or conditions on or adjacent to a roadway that might not otherwise be apparent. Common warning signs are diamond-shaped with a black legend and border on a yellow background and are placed in advance of work zones. Guide signs along highways provide road users with information to help them through work zones.

Traffic signs in work zones are important in informing travelers about interrupted traffic conditions. A survey indicated that 50% of the surveyed truck drivers wanted to see warning signs 3-5 miles in advance (Benekohal et al. 1995). Garber and Woo (1990) found that static traffic signs could effectively reduce crashes in work zones on urban two-lane highways when used together with flaggers.

Arrow Panels and Portable Changeable Message Signs

An arrow panel is a sign with a matrix of elements capable of either flashing or sequential display. A portable changeable message sign is a message sign with the flexibility to display a variety of messages. Arrow panels and portable changeable

message signs usually contain luminous panels with high visibility that makes them an ideal traffic control supplement in both daytime and nighttime.

Garber and Patel (1994) and Garber and Srinivasan (1998) conducted a two-phase research project to evaluate the effectiveness of changeable message signs in controlling speeds in work zones of Virginia. The changeable message signs (CMS) displayed a real-time warning message to the speeding drivers after their excessive speeds were detected by its actuator. The researchers concluded that CMS was a more effective means than traditional work zone traffic control devices in reducing the number of speeding vehicles in work zones. Richards and Dudek (1986) commented that changeable message signs could result in only modest speed reductions (less than 10 mph) when used alone and they would lose their effectiveness when operated continuously for long periods with the same messages. Huebschman et al. (2003) argued that changeable message signs were actually no more effective than traditional message panels.

Channelizing Devices

Channelizing devices are used to warn road users of changed traffic conditions in work zones and to guide travelers to drive safely and smoothly through work zones. Channelizing devices include cones, tubular markers, vertical panels, drums, barricades, and temporary raised islands. Results of a study (Pain et al. 1983) showed that most of the channelizing devices were effective in alerting and guiding drivers, but the devices only obtained their maximum effectiveness when properly deployed as a system or array of devices. Garber and Woo (1990) however, found

that the use of barricades in any combination of traffic control devices on urban multilane highways seemed to reduce the effectiveness of other traffic control devices.

Temporary Pavement Markings

Temporary pavement markings are maintained along paved streets and highways in all long- and intermediate- term stationary work zones. In addition, temporary raised pavement markers and delineators are used sometimes to supplement pavement markings to outline the travel paths. Pavement markings can be used to control speeds. A traffic control strategy using optical speed bars modified to meet the conditions of highway work zones has been applied to control speeds in work zones. Optical speed bars are an innovative speed control technique that uses transverse stripes spaced at gradually decreasing distances on pavement to affect the driver's perception of speed. Meyer (2004) conducted a study to evaluate the effectiveness of this strategy in reducing work-zone speed in Kansas. The study showed that the speed bars had both warning effect and perceptual effect and were effective in controlling speeds and reducing speed variations.

Lighting Devices

Lighting devices are used based on engineering judgment to supplement retroreflectorized signs, barriers, and channelizing devices. The four types of lighting devices commonly used in work zones are floodlights, flashing warning beacons, warning lights, and steady-burn electric lamps. These devices attract drivers' attentions and can illuminate work zones or warn drivers of the complicated travel

conditions at both daytime and nighttime. Some studies (Huebschman et al. 2003; Arnold 2003) found that flashing warning lights, especially police vehicles with flashing lights, were one of the most effective approaches for reducing speeds in work zones.

Temporary Traffic Control Signals

Temporary traffic control signals are typically used for conditions such as temporary one-way operations in work zones with one lane open and work zones involving intersections. The MUTCD suggests that temporary traffic control signals should be used with other traffic control devices, such as warning and regulatory signs, pavement markings, and channelizing devices. In addition, the design and placement of temporary traffic control signals should include interconnection to other traffic control signals along the subject roadway and those not in use should be covered or removed. Some analyses of work zone fatal crashes showed that certain temporary traffic control signals, such as STOP/GO signals, were very effective in reducing fatal crashes in work zones (Hill 2003).

Rumble Strips

Rumble strips consist of intermittent narrow, transverse areas of rough-textured or slightly raised or depressed road surface that extend across the travel lanes to alert drivers of unusual traffic conditions through noise and vibration. Longitudinal rumble strips are rough-textured road surfaces located along the shoulder to alert road users that they are leaving the travel lanes. Rumble strips are effective in reducing

driver errors, especially inattentive driving, that frequently contributes to the crashes in work zones.

2.4 ITS APPLICATIONS IN HIGHWAY WORK ZONES

ITS technologies represent a modern traffic control and management trend in highway work zones. Currently, various ITS have been implemented in highway work zones to improve safety and mitigate congestion. These systems usually involve the use of electronics, computers, and communication equipment to collect real-time information, process it, and send it to engineers for making traffic control decisions accordingly. ITS applications in highway work zones may function for one or several of the following purposes (FHWA 2006b):

- Traffic monitoring and management
- Providing traveler information
- Incident management
- Enhancing safety of both the road user and worker
- Increasing capacity
- Enforcement
- Tracking and evaluation of contract incentives/disincentives (performance-based contracting)
- Work zone planning

This section reviews the typical ITS applications in highway work zones. A list of the reviewed typical ITS applications are presented in Table 2.4.

Table 2.4. ITS Applications in Work Zones

No.	ITS Technology	Effectiveness	Reference
1	Real-time traffic control systems	Improved work zone traffic flow and safety	FHWA 2002
2	Dynamic lane merge systems	Reduced average delay and number of vehicles stops	FHWA 2004b
3	Temporary traffic management systems	Real-time traffic information for pre-trip route planning	FHWA 2002
4	Work zone traffic and incident management systems	Improved in work zone safety and mobility	FHWA 2004c
5	Work zone travel time systems	Reduced work zone delays	FHWA 2004d
6	Advanced Traveler Information Systems	No significant increase on vehicle diversion, user acknowledgement	Pesti et al. 2004; Bushman and Berthelot 2005

Real-Time Traffic Control Systems (RTTCS)

A RTTCS was deployed in a work zone on I-55 by the Illinois Department of Transportation (IDOT) to reduce congestion and improve safety (FHWA 2002). The RTTCS consisted of portable dynamic message signs (DMS), portable traffic sensors, and portable closed circuit television (CCTV) cameras. The traffic sensors detected types and traveling speeds of the approaching vehicles and then based on predefined thresholds, the DMS displayed proper messages to warn the drivers of traveling hazards. The sensors and cameras also sent data to a real-time congestion map displayed on IDOT's Web site for public information and provided congestion/incident detection alerts to IDOT staff for further traffic management actions. IDOT staff believed that the system effectively improved the work zone traffic flow and safety, and provided important traffic information for trip planning with minimal human intervention or downtime.

Dynamic Lane Merge Systems (DLMS)

The Michigan Department of Transportation (MDOT) rebuilt a large section of I-94 near Detroit during the 2002 and 2003 summer construction seasons. During the project, MDOT implemented a DLMS to help smooth traffic flow and reduce aggressive driving prior to transitioning to the construction area (FHWA 2004b). The system used microwave radar sensors installed on five trailers to detect traffic volume, vehicle speed, and traffic density. It then analyzed these data and automatically changed the messages displayed on the DMS to enforce different merging strategies and regulate merging traffic. The evaluation performed by MDOT indicated that the system was effective in reducing average delay time and number of vehicle stops. It also considerably decreased aggressive merging maneuvers and, consequently, resulted in fewer work zone crashes.

Temporary Traffic Management Systems (TTMS)

A TTMS was employed by the Michigan Department of Transportation (MDOT) during a construction project that involved a total closure of I-496 in downtown Lansing, Michigan (FHWA 2002). The ITS system included traffic detection and surveillance equipment along with changeable message signs and a public information Web site. These features were used to help guide motorists to alternate routes and alleviate traffic congestion on surrounding roads when the major freeway was closed. Real-time traffic data were collected by the on-site detection and surveillance equipment and sent back to a server at the Construction Traffic Management Center (CTMC) via wireless radio frequency communication

equipment. The server processed the data and then informed CTMC operators of problem areas where queues were building up and automatically updated the DMS to display a map with color-coded average roadway speeds on the Web site for trip planning. The system allowed daily commuters to make informed choices regarding their travel plans and thus mitigated congestion in the work zone.

Traffic and Incident Management Systems (TIMS)

An example of work-zone TIMS was demonstrated in a large highway project conducted by the New Mexico State Highway and Transportation Department (NMSHTD) (FHWA 2004c). The system consisted of a series of DMS, CCTV cameras, and highway advisory radio (HAR) units, all linked to a central traffic management center. The CCTV cameras detected the real-time traffic conditions and sent them to the traffic management center, where trained staff identified incidents and other adverse traffic conditions and initiated appropriate responses immediately. Meanwhile, the DMS displayed appropriate messages and the HAR units transmitted them to the motorists. NMSHTD's evaluation showed that the system improved work zone mobility by effectively reducing congestion and incident response and clearance time. In addition, the system resulted in a 32% reduction in crashes during the first three months of its installation.

Work Zone Travel Time Systems (TTS)

The Arizona Department of Transportation (ADOT) used a TTS to support work zone operations during the reconstruction and widening of State Route 68 (SR 68) in northern Arizona (FHWA 2004d). The system consisted of two monitoring

stations and a central processor. Each monitoring station included an inductive loop embedded in the roadway, a control cabinet with a communication system, and two digital cameras (one for each direction of traffic) linked to the cabinet via fiber-optic cables. The system captured images of individual vehicles and calculated their travel times through the work zone. Based on the travel times, ADOT staff estimated the delays and assessed the contractor a disincentive fee when excessive delay occurred. By doing so, the contractor was forced to flexibly adjust their construction operations to mitigate the work zone travel delays to meet the travel time provision set by ADOT. The system allowed ADOT staff to effectively monitor the construction process and reduced excessive travel delays in the work zone.

Advanced Traveler Information Systems (ATIS)

ATIS are designed to disseminate real-time traffic information including route and delay conditions to drivers to allow them make reasonable travel decisions. The information is usually communicated through changeable message signs (CMS) or other media. An ATIS serving as work zone speed advisory system was deployed in advance for a work zone on northbound I-680 by the Nebraska Department of Roads (NDOR) to advise drivers on the real-time work zone speeds and encourage them to divert to alternate routes to avoid congestion (Pesti et al. 2004). The system was composed of a video detection system, two portable CMSs, and a central computer that coordinated communications between the detection system and the CMS. NDOR engineers were informed about detected speeds, which enabled them to display real-time advisory messages accordingly. The evaluation of this system, however,

suggested that it did not significantly increase vehicle diversion during the study period. Bushman and Berthelot (2005) evaluated a similar system implemented in North Carolina through a public survey and found that most motorists acknowledged the benefits of the system.

2.5 SUMMARY OF LITERATURE REVIEW

As the first step of this dissertation research, a comprehensive literature review was conducted to synthesize the background knowledge from previous studies. The review covered several areas relevant to this research including work zone crash characteristic studies, logistic regression statistic and its applications in traffic crash analyses, work zone traffic control studies, and ITS applications in work zones. Results of the literature review are summarized as follows.

To date, many research efforts have been devoted to investigating work zone crash characteristics. Most of the previous work zone crash studies were based on statewide crash data; only a few studies used multi-state data. Some of the studies analyzed the general characteristics of work zone crashes of all severities and others studied the crashes of a certain severity, such as fatal crashes or injury crashes. The researcher did not find studies that compared the characteristics of fatal and injury crashes in work zones.

Logistic regression is a statistical method suitable for analyses of massive crash data, especially when the probabilities of dichotomous outcomes are modeled given traffic conditions defined by multiple variables. This technique has been

applied in traffic crash analyses; it was also used in some of the previous studies to estimate the likelihood of certain crashes in given traffic conditions. However, the relationships between crash severities and multiple risk factors in highway work zones were not explored by either logistic regression or other multivariate statistical methods. The concept of using CSI to evaluate the driving risk levels in existing or proposed highway work zones was not found in previous research either.

Various studies have evaluated the effectiveness of common work zone traffic control devices. Some of these evaluations were based on analyses of work zone crash data. Several researchers applied logistic regression techniques in the study of traffic control effectiveness. The author did not find studies quantifying the effectiveness of the work zone traffic control devices or strategies in reducing the severity of work zone crashes.

ITS technology has been applied in highway work zones to mitigate congestion and improve traffic safety. Typical ITS applications collect, analyze, and distribute real-time traffic information for various purposes such as incident management, public information, traffic controlling, and project monitoring. Follow-up evaluations showed that most of the applications were effective in achieving the design goals.

Chapter 3
DATA COLLECTION

This study focused on the fatal and injury crashes that occurred in Kansas highway work zones from January 1, 1992 to December 31, 2004. The crash data were provided by KDOT from its accident database. Because the database included information about all parties in each crash, a single case was frequently recorded in multiple data rows. In addition, the involvement of multiple traffic controls or driver errors in a crash also leaded to multiple data rows. In contrast, the data analyses of this research required simply formatted yet comprehensive information that could be readily fed into analysis tools such as SAS software. Thus, compiling each crash into a single row in a spreadsheet without missing useful information became a critical task.

3.1 DATA COLLECTION PROCEDURE AND CRASH VARIABLES

The data collection procedure included two steps. First, based on KDOT's database, the responsible driver/vehicle for each crash was identified and the crash information was extracted. Then, the original accident reports (a sample report is shown in Appendix I) containing detailed crash descriptions and scene sketches were

examined for crashes with missing or unclear information. Crash-related information was recorded numerically in a single row format in spreadsheets.

Six major categories of accident information were abstracted from the accident reports. Each category included several crash variables and each variable had a number of detailed observations. The observations were decided based on the KDOT accident reports in an effort to incorporate crash information into a specific group or dataset. For example, the crash variable "gender" was categorized under "at-fault driver" and had two observations known as male and female. Note that, for some crash variables, the detailed observations were grouped into more general observation groups. This regrouping was intended to eliminate unnecessary data details that may have led to inaccuracies in some analyses, such as Chi-square statistics used for multivariate frequency studies. The six categories and their variables are listed in Table 3.1 and are described as following:

1. At-fault driver: This category included basic information about the drivers who were responsible for the work zone crashes. There were two variables, age and gender, in the category. Age was divided into seven groups (see Appendix II, Table 1) and gender had two observations: male and female (see Appendix II, Table 2).
2. Time information: This category included the temporal variables of the crashes such as the occurrence time and date. The time of day was divided into four periods: 6:00 a.m. – 10:00 a.m. as morning peak hours; 10:00 a.m. – 4:00 p.m. as daytime non-peak hours; 4:00 p.m. – 8:00 p.m. as afternoon peak

hours; and 8:00 p.m. – 6:00 a.m. as nighttime hours. Other temporal variables included day of week and month. Tables 3 – 6 in Appendix II show the observations of the four variables in this category.

Table 3.1. Crash Data Categories and Variables

No.	Category	Variable	Observations
1	At-Fault Driver	Age	See Table 1 in Appendix II
		Gender	See Table 2 in Appendix II
2	Time Information	Time	See Table 3 in Appendix II
		Day	See Table 4 in Appendix II
		Month	See Table 5 in Appendix II
		Year	See Table 6 in Appendix II
3	Climatic Environment	Light Condition	See Table 7 in Appendix II
		Weather Condition	See Table 8 in Appendix II
		Road Surface Condition	See Table 9 in Appendix II
4	Crash Information	Vehicle Maneuver Before Crash	See Table 10 in Appendix II
		Crash Severity	See Table 11 in Appendix II
		Crash Type	See Table 12 in Appendix II
		Vehicle Body Type	See Table 13 in Appendix II
		Number of Vehicles Involved	Using actual numbers
5	Road Condition	Road Class	See Table 14 in Appendix II
		Road Character	See Table 15 in Appendix II
		Number of Lanes	Using actual numbers
		Speed Limit	Using actual numbers
		Crash Location	See Table 16 in Appendix II
		Surface Type	See Table 17 in Appendix II
		Road Special Feature	See Table 18 in Appendix II
		Area Information	See Table 19 in Appendix II
		Traffic Control	See Table 20 in Appendix II
6	Contributing Factor	Driver Factor	See Table 21 in Appendix II
		Pedestrian Factor	See Table 22 in Appendix II
		Environment Factor	See Table 23 in Appendix II
		Vehicle Factor	See Table 24 in Appendix II

3. Climatic environment: The climatic environmental information documented the light, weather and road surface conditions of work zones where crashes occurred. Light conditions included five observations according to factors affecting visibility such as daylight and darkness. Weather conditions had 14

observations that might have impacts on traffic safety. Road surface conditions had seven observations reflecting different characteristics of highway surfaces. The observations of these three variables were further regrouped as good condition or poor condition. The observations of these variables are listed in Tables 7 – 9 in Appendix II.

4. Crash information: The crash information gathered from KDOT's reports included vehicle maneuver before crash, crash severity, crash type, vehicle body type, and number of vehicles involved. The before-crash vehicle maneuvers included 16 observations based on the reports. The crash severity had three observations including fatal, injury or near fatal, and property damage only. The focus of this study was only on fatal and injury crashes. For crash type, 16 different observations were included which were further regrouped as "vehicle-vehicle" and "vehicle-other" crashes. The vehicle body types were classified into ten observations reflecting vehicle classes such as heavy trucks, light-duty vehicles, motorcycles, pedestrians, etc. Quoted hereafter, (light-duty) vehicles include vehicle types such as passenger cars, minivans, pickups, campers or RVs, sport utility vehicles (SUVs), and all-terrain vehicles (ATVs). Trucks, as opposed to light-duty vehicles, include single-unit large trucks, truck and trailers, tractor-trailers, and buses. The observations of vehicle body type were also regrouped as three general observations. The number of vehicles involved in a crash was recorded using

the actual number. The observations of these variables are listed in Tables 10 – 13 in Appendix II.

5. Road conditions: The variables in this category described the road conditions where a fatal or an injury work zone crash occurred. These variables included road class, road character, number of lanes, speed limit, crash location, surface type, road special feature, area information, and traffic control. Road class included seven road classifications that were defined in the KDOT's reports. Road character had seven observations that describe the geometric alignments of a crash highway section such as curves and grades. Six observations for crash location were determined according to if the crashes occurred near intersections or crossovers. The surface type variable included six observations, such as blacktop (asphalt), brick, concrete, etc. Road special feature had eight observations that were categorized according to the presence of features such as bridges, ramps, and interchanges. Area information had two observations: urban and rural. There were 11 observations for traffic control devices. Many crashes had multiple traffic control devices on site. Multiple columns were added under the heading of "Traffic Control" in the spreadsheet to accommodate all traffic control devices at the crashes. A similar strategy was used to record the driver factor variable that frequently had multiple observations for a single crash. Other variables, including number of lanes and speed limit, were recorded using the actual number on the spreadsheet. In this data category, the observations of variables, such as

road character and road special feature were regrouped. Tables 14 – 20 in Appendix II show the observations of these variables in detail.

6. Contributing factors: This category listed the variables that were identified on the KDOT's reports as the principal contributing factors to the crashes. These variables included driver factors, which had 26 human-error observations (Table 21 in Appendix II), pedestrian factor which had nine observations (Table 22 in Appendix II), environment factor which had 11 observations (Table 23 in Appendix II), and vehicle factor which had 11 observations (Table 24 in Appendix II).

The observations of each variable were assigned integer values and, hence, the spreadsheets contained only numbers.

3.2 RESEARCH DATA SETS

Three sets of data were collected to analyze the work zone crashes. These data sets included: 1) total fatal crashes in Kansas highway work zones between 1992 – 2004 (Appendix III), 2) a sample of the injury crashes in Kansas highway work zones between 1992 – 2004 (Appendix IV), and 3) total injury and fatal crashes in Kansas highway work zones between 2003 – 2004 (Appendix V).

Fatal Crashes

A total of 157 fatal crashes in Kansas highway work zones were reported to KDOT from January 1, 1992 to December 31, 2004. These crashes involved deaths of either drivers, passengers of crash vehicles, construction workers, or pedestrians in

the work zones. Information on these crashes was collected and analyzed to discover the characteristics of the most severe crashes in the highway work zones of Kansas.

Injury Crashes

Kansas had 4,443 injury crashes during 1992 and 2004 in highway work zones. It would be extremely time-consuming, yet not statistically meaningful, to compile and analyze this entire injury dataset. Instead, 460 injury crashes were randomly sampled from the KDOT's database and analyzed for injury work zone crash characteristics to save data collection time while maintain reasonable accuracy of analysis results.

The sample size was determined based on the method of Thompson (2002). Considering that the data would be used for frequency analysis of characteristics reflected through the proportions of the different crashes marked by different variable observations, the sample size was determined such that those proportions could be estimated accurately. Based on normal approximation, to obtain a proportion estimator $\hat{p}$ with a probability of at least 1- α of being no farther than d (error) from the true population proportion p, one would choose a corresponding sample size such that

$$P(|\hat{p} - p| > d) < \alpha .$$

When $\hat{p}$ is an unbiased, normally distributed estimator of p, the variable

$$\frac{\hat{p} - p}{\sqrt{\text{var}(\hat{p})}}$$

has a standard normal distribution N(0, 1). For estimating a proportion, an unbiased estimator of the variance var($\hat{p}$) can be estimated by:

$$\text{var}(\hat{p}) = \left(\frac{N-n}{N}\right)\frac{\hat{p}(1-\hat{p})}{n-1},$$

where N is the population size.

With the above theoretical basis, to obtain an estimator $\hat{p}$ of the true proportion *p* with *1- α* confidence of having an error less then *d*, the minimum sample size n_{min} required should be computed by the following equation:

$$n_{\min} = \frac{Np(1-p)}{(N-1)(d^2/z_{\alpha/2}^2) + p(1-p)},$$

where $z_{\alpha/2}$ is the upper α/2 point of the standard normal distribution.

When there is no estimate of *p* available and *N* is large, a worst-case value of *p = 0.5* can be used in determining the minimum sample size:

$$n_{\min} = \frac{1}{(N-1)/Nn_0 + 1/N} \approx \frac{1}{1/n_0 + 1/N}, \qquad [3.1]$$

where:

$$n_0 = \frac{z_{\alpha/2}^2 p(1-p)}{d^2} = \frac{0.25 z_{\alpha/2}^2}{d^2}.$$

Note that the minimum sample size determined using this equation is theoretically appropriate to estimate the proportion of the crashes with only binary variables. In fact, variables frequently have several values and multiple proportions need to be estimated simultaneously. For example, the "age" variable is usually divided into several groups (i.e. 15-19, 20-24, 25-29…) and the accident proportions

of all these groups need to be estimated simultaneously. In this situation, the sample size should be adjusted accordingly. Based on the same rationale, Thompson (2002) provided a table (Table 3.2) of adjusted n_0 when the population size N is large.

Table 3.2. Sample Size n_0 for Simultaneously Estimating Several Proportions within Distance d of the True Values at Confidence Level (1- α)
(Table Source: Thompson 2002)

α	$d^2 n_0$	n_0 with $d = 0.05$	m
0.5	0.44129	177	4
0.4	0.50729	203	4
0.3	0.60123	241	3
0.2	0.74739	299	3
0.1	1.00635	403	3
0.05	1.27359	510	3
0.025	1.55963	624	2
0.02	1.65872	664	2
0.01	1.96986	788	2
0.005	2.28514	915	2
0.001	3.02892	1212	2
0.0005	3.33530	1342	2
0.0001	4.11209	1645	2
Note:	The worst-case minimum sample size occurs when some m of the proportions in the population are equal and the rest are zero.		

Based on Equation *[3.1]* and Table 3.2, given the 4,443 injury crashes, the minimum sample size needed for frequency analyses at confidence level 95% with an error d less than 5% was determined as the following equation and rounded to 460:

$$n_{\min} \approx \frac{1}{1/n_0 + 1/N} = \frac{1}{1/510 + 1/4443} = 457 .$$

Injury and Fatal Crashes for Years 2003 and 2004

This research included traffic control effectiveness analyses and CSI model development using logistic regression. These studies would be more significant when

conducted on more up-to-date data of both fatal and injury work zone crashes. A dataset containing the information of the most current highway work zone crashes was collected separately for these studies. A total of 654 crashes including 29 fatal crashes and 625 injury crashes that occurred between January 1, 2003 and December 31, 2004 in Kansas highway work zones were included in this dataset.

3.3 SUMMARY

As a key step towards data analyses, the data collection procedure was developed. Using the procedure, the original crash data was categorized, collected, and compiled into spreadsheets that were suitable for computer-aided statistical analyses. The final spreadsheets contained only crash variables whose observations were all represented by numerical values. Three sets of data were used for the different analyses of this study. They were:

1. The 157 fatal work zone crashes between January 1, 1992 and December 31, 2004;
2. A sample of 460 injury crashes between January 1, 1992 and December 31, 2004; and
3. The total 654 work zone crashes including both the injury and the fatal crashes between January 1, 2003 and December 31, 2004.

The next chapter presents the results of work zone crash characteristics analyses.

Chapter 4
WORK ZONE CRASH CHARACTERISTICS

4.1 INTRODUCTION

Traffic crash statistics indicate that highway work zone safety remains a serious concern in Kansas. According to statistics in Table 4.1 that were provided by KDOT, there were 15,434 work zone crashes reported in Kansas in the past 13 years (1992-2004) and 30% or 4,600 of them involved injuries or fatalities. Figure 4.1 shows the composition of Kansas work zone crashes and Figure 4.2 illustrates the 13-year (1992-2004) trend of work zone fatalities in Kansas. Over the past 13 years, the number of annual work zone severe crashes first decreased from 416 in 1992 to 204 in 2000 and then went back up to 360 in 2004.

The characteristics of fatal and injury crashes in Kansas highway work zones between 1992 and 2004 were studied in detail. A total of 157 fatal crashes were analyzed for fatal crash characteristics while the characteristics of injury crashes were explored based on the information from 460 sample cases. Due to the considerably larger number of injury crashes, exploring the fatal and injury crashes simultaneously would result in the important characteristics of fatal crashes overwhelmed by those of the injury crashes. In addition, knowledge of different characteristics between crashes

of different severity levels (i.e., injury versus fatal) may be valuable for traffic engineers to reduce the percentage composition of fatal crashes in the total crashes.

Table 4.1. Kansas Work Zone Crash Statistics (1992-2004)

Year	No. of Fatal Crashes	No. of Deaths	No. of Injury Crashes	No. of Injuries	No. of PDO* Crashes	Total Crashes
1992	15	18	401	667	695	1111
1993	9	12	372	578	755	1136
1994	3	3	344	548	743	1090
1995	14	17	480	750	1049	1543
1996	12	15	509	773	1126	1647
1997	19	22	433	742	942	1394
1998	9	13	326	541	829	1164
1999	11	12	267	466	671	949
2000	9	9	195	329	570	774
2001	13	15	253	408	674	940
2002	14	16	238	368	705	957
2003	11	13	283	425	974	1268
2004	18	24	342	528	1101	1461
Total	157	189	4443	7123	10834	15434

PDO: Property Damage Only.

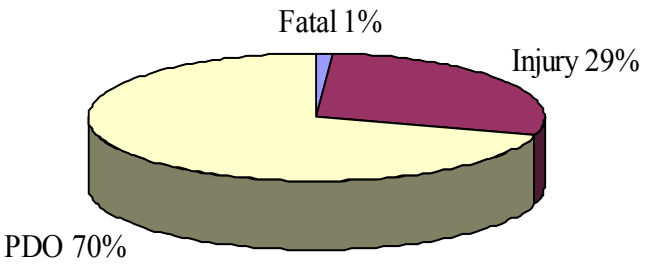


Figure 4.1. Overall Work Zone Crash Composition (1992-2004)

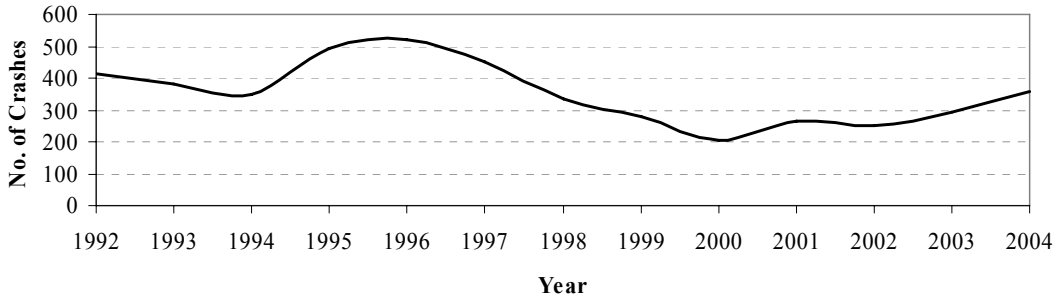


Figure 4.2. Kansas Work Zone Severe Crashes (Fatal & Injury) (1992-2004)

Fatal and injury crashes were first analyzed separately in this study to explore the characteristics of both types of crashes. The results were then compared between fatal and injury crashes to highlight both general characteristics and important characteristic differences. Significant factors that contributed to these crashes and the potential crash severity increase were identified based on the characteristic investigations. The results would benefit the design of work zone traffic control strategies that could be more effective in controlling both the number of total crashes and the proportion of high severity crashes.

The characteristics were explored in two steps. First, the basic characteristics of the crashes were investigated by analyzing the crash frequencies based on single crash variables. Then the interrelated variable pairs were identified using statistical tests and the crash frequencies were further analyzed based on these variable pairs to explore the indistinct yet important characteristics.

Pearson chi-square test and likelihood ratio chi-square test methods were used to identify all possible combinations between factors. The Pearson chi-square test method, originally proposed by Karl Pearson, is known as one of the most common

test methods for independence between two sets of variables. Suppose that results of a random experiment are classified by two attributes ***A*** and ***B*** having *a* and *b* values, respectively. Let x_{ij} denote the frequency of this random experiment with attributes A_i and B_j, and let $x_{i.}$ and $x_{.j}$ be $\sum_{j=1}^{b} x_{ij}$ and $\sum_{i=1}^{a} x_{ij}$ respectively. It has been proved that, if the total frequency *n* is large and the attributes ***A*** and ***B*** are mutually independent, then the random variable

$$Q = \sum_{j=1}^{b} \sum_{i=1}^{a} \frac{[x_{ij} - n(x_{i.}/n)(x_{.j}/n)]^2}{n(x_{i.}/n)(x_{.j}/n)}$$

has an approximate chi-square distribution with (a – 1)(b – 1) degrees of freedom (Hogg et al. 2005).

The Pearson's chi-square test is a more robust test of independence for small samples. On the other hand, the likelihood ratio statistic is more appropriate for use in hierarchical models (University of Texas at Austin 2005). This test involves the ratios between the observed frequencies x_{ij} and expected frequencies e_{ij}: when the attributes ***A*** and ***B*** are mutually independent, the random variable

$$G^2 = 2\sum_{i}\sum_{j} n_{ij} \ln(\frac{n_{ij}}{e_{ij}})$$

is known to have an approximate chi-square distribution with (a – 1)(b – 1) degrees of freedom (SAS 2004a).

Regardless of the different advantages of the two chi-square test methods, they were both adopted to test the relationships among the factors of the crashes to assure the maximized probability of identifying all interrelated factors. A dependant

relationship was determined if one or both tests supported it at a 5% level of significance. Note that in the chi-square tests, the observations used for some variables were the general observation groups as described in the data collection chapter and illustrated in Appendix II.

4.2 FATAL WORK ZONE CRASH CHARACTERISTICS

4.2.1 Fatal Crash Characteristics by Single-Variable Frequencies

Driver Characteristics

A traffic crash is a human-machine interaction event; drivers play a key role in crashes. Gender analyses found that approximately 75% of the drivers who were responsible for fatal work zone crashes were males.

Figure 4.3 illustrates the age distribution of the drivers responsible for the fatal work zone crashes. Drivers 35 – 44 years old had the highest proportion (24%) of the crashes, while those between 55 and 64 had less then 5% of the crashes. The driver group with the second highest fatal work zone crash rate was drivers 65 or older. This driver group caused 18% of the fatal crashes in work zones. Teenage drivers (15-19 years old) also created a safety problem: they had 12% of the total fatal crashes. Compared with the relatively small proportion of teenagers in the entire driving population, this percentage was even more noteworthy.

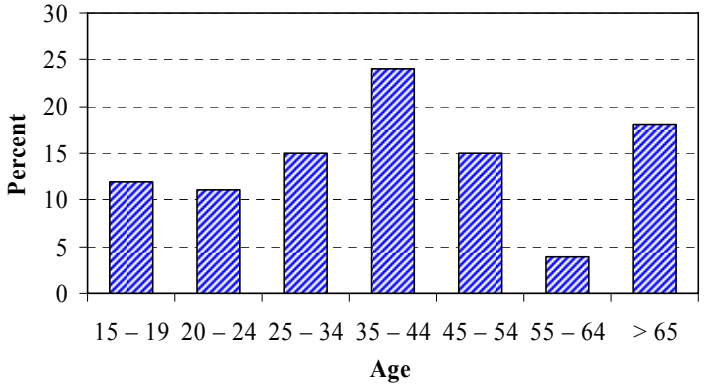


Figure 4.3. Crash Distribution by Age

Time Characteristics

Table 4.2 shows the time-of-day distribution of the fatal work zone crashes. A total of 63% of the crashes occurred during daytime. Daytime non-peak hours had the highest fatal work zone crash frequency. In the two peak-hour periods, when traffic volumes were expected to be higher, the hourly crash rates were actually lower than that of daytime non-peak hours. Furthermore, given the relatively lower traffic volume, the nighttime period had a notable frequency of fatal work zone crashes.

The researcher did not find significant differences in crash frequencies among the seven days of a week. When crashes were observed over the twelve months of a year, data analyses indicated that a large proportion of the crashes took place between April and November, the busiest season for highway construction projects. The other 18% of the crashes took place in January, February, March, and December. The crash frequencies by day of week and month of a year are shown in Figure 4.4 and Figure 4.5, respectively.

Table 4.2. Crash Distributions over Time

Time	Length	No. of Crash	Percent (%)	Hourly Rate	30-Day Rate
6:00 a.m. – 10:00 a.m.	4 hours	22	14	1.16/1000hr.	0.84/30d.
10:00 a.m. – 4:00 p.m.	6 hours	51	32	1.79/1000hr.	1.29/30d.
4:00 p.m. – 8:00 p.m.	4 hours	26	17	1.37/1000hr.	0.99/30d.
8:00 p.m. – 6:00 a.m.	10 hours	58	37	1.22/1000hr.	0.88/30d.
Average	-	-	-	1.38/1000hr.	0.99/30d.

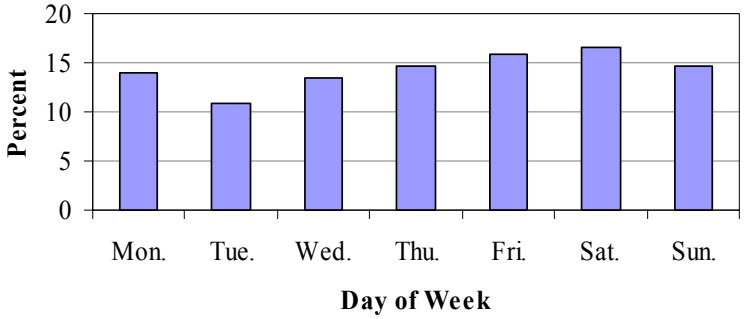


Figure 4.4. Crash Distributions by Day-of-Week

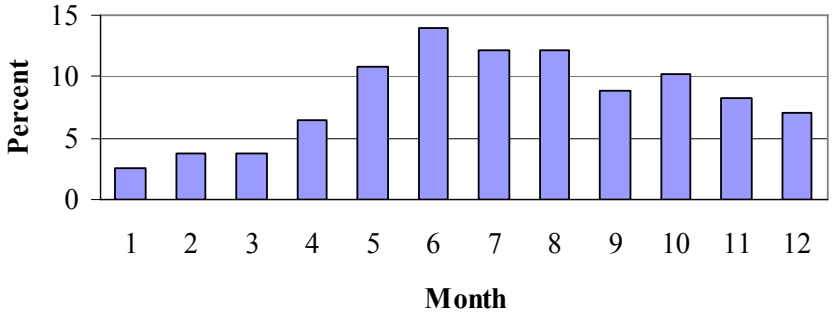


Figure 4.5. Crash Distributions by Month

Climatic Environmental Characteristics

Environmental factors, such as light conditions, weather conditions, and road surface conditions, were examined to verify if adverse conditions contributed to fatal

crashes in work zones. It was found that 53% of the fatal work zone crashes occurred during favorable light conditions. As shown in Figure 4.6, among the crashes during adverse light conditions, a significant portion (32% of the total) happened in darkness without streetlights. The study also found that only very small proportions of fatal work zone crashes happened in adverse weather or road surface conditions: about 9% occurred under inclement weather conditions and 12% happened when road surfaces were not dry, as illustrated in Figure 4.7 and Figure 4.8, respectively.

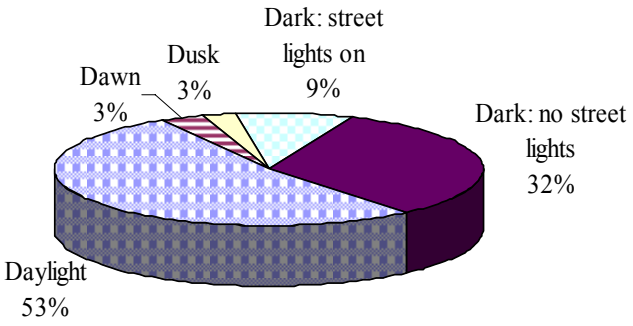


Figure 4.6. Crash Distributions in Different Light Conditions

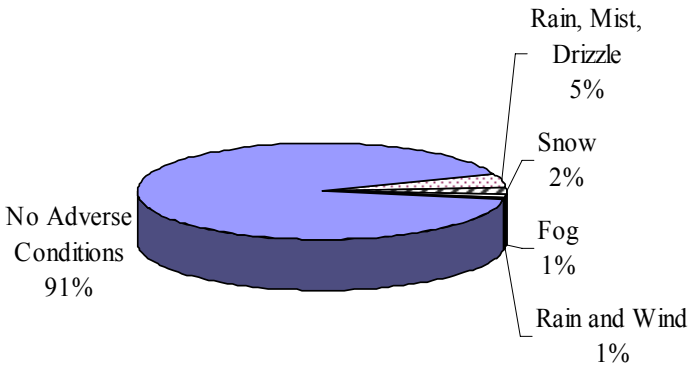


Figure 4.7. Crashes in Various Weather Conditions

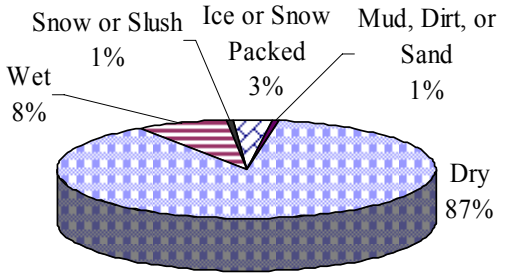


Figure 4.8. Crashes in Different Road Surface Conditions

Crash Information

To better understand the causes of the fatal work zone crashes, the responsible vehicle's maneuver right before the occurrence of a crash was studied. As listed in Table 4.3, most of the responsible vehicles (74%) were following roadway alignments before they caused fatal crashes. Complicated maneuvers, such as turning or stopping movements, only coincided with 26% of fatal work zone crashes. Therefore, it was concluded that complicated vehicle maneuver was not a significant causal factor for fatal work zone crashes.

Table 4.3. Crash Frequencies by Vehicle Maneuvers

Vehicle Maneuver	No. of Crash	Percent (%)
Following Road	116	74
Left Turn	6	4
Right Turn	1	<1
U-Turn	2	1
Overtaking	10	6
Changing Lanes	6	4
Avoiding	5	3
Slowing/Stopping	1	<1
Other	10	6
Sum	157	100

Data analyses showed that 67% of the fatal crashes involved multiple vehicles. Among multi-vehicle collisions, two-vehicle crashes were the dominant crash type (53% of total). Particularly, as shown in Figure 4.9, head-on was found to be the most frequent work zone crash type (24%), followed by angle-side-impact (20%), rear-end (16%), overturn (11%), and fixed-object (11%). These results are consistent with the fact that most of the Kansas fatal work zone crashes were multi-vehicle collisions.

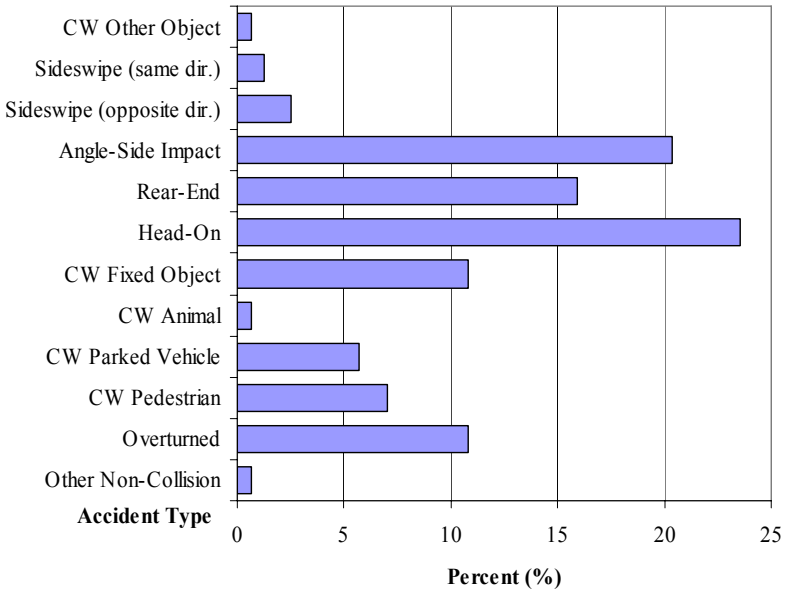


Figure 4.9. Crash Frequencies by Crash Types

As found in previous studies, crashes with heavy trucks had a higher fatality rate in work zones nationwide. In KDOT's crash reports, heavy trucks include single-unit large trucks, trucks and trailers, tractor-trailers, and buses. About 40% of the fatal work zone crashes involved heavy trucks. Truck-vehicle collisions were the dominant

collision type among truck-involved crashes, which had a percentage of 34%. Detailed frequencies by vehicle type are listed in Table 4.4. The term "vehicle" here refers to such light-duty vehicle types as passenger car, minivan, pickup, SUV, camper or RV, and ATV. Vehicle-vehicle collisions constituted 31% of total crashes.

Table 4.4. Crash Distribution over Vehicle Types

Vehicle Type	No. of Crash	Percent (%)
Truck vs. truck	3	2
Truck vs. vehicle	53	34
Truck vs. Motorcycle	2	1
Truck vs. ped./worker	3	2
Truck vs. object	1	<1
Vehicle vs. vehicle	49	31
Vehicle vs. motorcycle	1	<1
Vehicle vs. pedestrian./worker	6	4
Vehicle vs. object	15	10
Other	24	15
Sum	157	100

Road Information

Roadway characteristics directly affect traffic safety levels and hazardous roadway features may cause crashes. Potential relationships between basic highway characteristics and fatal work zone crashes were studied in this project. These characteristics include road class, road character (geometric alignment), number of lanes, speed limit, crash location, surface type, road special features (such as overhead bridges, railroad crossings, ramps and interchanges), area information, and traffic control.

As shown in Figure 4.10, 87% of the crashes occurred on interstate highways and other principal arterials. Results of the analyses also showed that about half (49%) of the crashes occurred on unfavorable highway geometric alignments, whereas about 25% of the crashes happened in work zones where the highway section alignments were straight on grade, as shown in Figure 4.11. This may suggest that poor geometric alignments could be a contributing factor to a higher highway work zone fatal crash frequency.

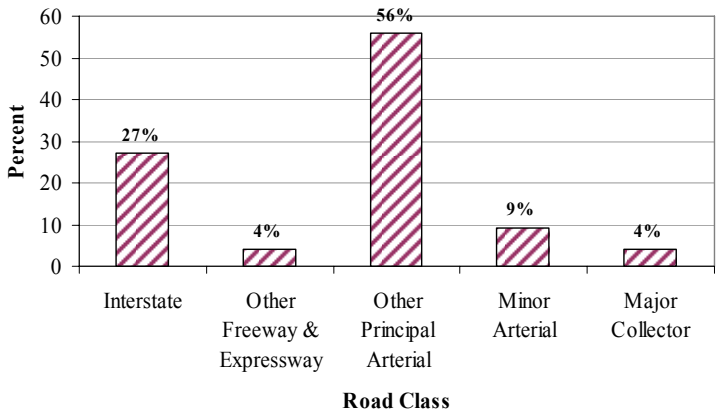


Figure 4.10. Fatal Crash Frequencies by Road Class

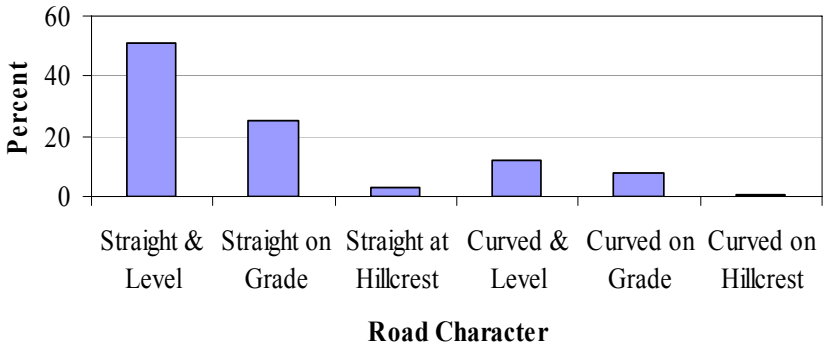


Figure 4.11. Crash Frequencies by Different Road Geometries

The study showed that most of the crashes (63%) occurred on two-lane highways and 31% of the crashes occurred on four-lane highways. Approximately 92% of the crashes happened on highways with speed limits between 51 miles per hour (mph) and 70 mph, among which 47% occurred in 51 – 60 mph speed zones and 45% occurred in 61 – 70 mph speed zones. The National Association of Counties (NACo 2005) reported that approximately 92% of the roadways in Kansas are rural. Data analyses indicated that 84% of the work zone fatal crashes happened on rural highway systems in Kansas. Figure 4.12 presents the rural work zone crash distribution by speed limit and number of lanes. As shown in this figure, about 74% of the rural crashes happened on two-lane rural highways and 96% of the rural crashes occurred on the highways with speed limits between 51 mph and 70 mph. This clearly indicates that the two-lane rural highways with speed limits between 51 mph and 70 mph were the most hazardous in terms of fatal work zone crash frequencies.

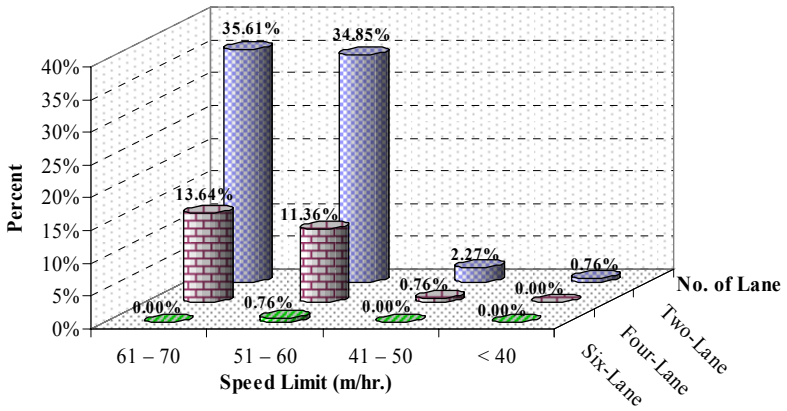


Figure 4.12. Rural Fatal Work Zone Crashes by Lane Number and Speed Limit

It was found that most Kansas fatal work zone crashes (67%) occurred at non-intersection or interchange areas (Table 4.5). In addition, 69% of the crashes happened on roadways that had blacktop (asphalt) pavements, while only 30% occurred on concrete pavements (Table 4.6). The results might be correlated to the high percentage of two-lane asphalt highways in Kansas. In addition, as listed in Table 4.7, highway special features, such as overhead bridge or on-/off- ramps, had no significant impact on work zone safety in terms of fatal crash frequencies: 85% of the crashes occurred on highway sections where no such special features were present.

Table 4.5. Crash Frequencies by Crash Locations

Crash Location	No. of Crash	Percent (%)
Non-intersection	105	67
Intersection	20	13
Intersection related	4	3
Interchange Area	5	3
Other	23	15
Sum	157	100

Table 4.6. Crash Frequencies by Pavement Type

Surface Type	No. of Crash	Percent (%)
Concrete	47	30
Blacktop	109	69
Brick	1	<1
Sum	157	100

Table 4.7. Crash Frequencies by Road Special Feature

Road Special Feature	No. of Crash	Percent (%)
None	134	85
Bridge	8	5
Bridge overhead	2	1
Railroad bridge	1	<1
Interchange	6	4
Ramp	3	2
Other	3	2
Sum	157	100

Effective work zone traffic control devices regulate traffic flows and minimize traveling hazards in highway work zones. Because KDOT's crash report form was not specifically designed for work zone crash analysis, some of the work zone traffic control devices such as channelizing devices and arrow panels were not listed in the report. Therefore, it was recorded as "other control" in the crash reports if these traffic controls were on site. Nevertheless, the effectiveness of the work zone traffic control devices was studied based on the available information. According to the results shown in Figure 4.13, 80% of the crashes occurred on the pavements marked with center/edge lines and 20% were in no passing zones. In addition, 11% of the total crashes occurred when there were officers or flaggers directing the traffic and 10% of the crashes occurred with presence of stop signs or signals.

Contributing Factors

The analyses showed that 8% of the crashes were caused by factors such as pedestrian, environment, and vehicle mechanical problems. In contrast, 92% of the fatal work zone crashes were caused by driver errors. It was found that "inattention" and "too fast for condition/speeding" were the two most frequent errors that

represented 53% and 25% of the total crashes, respectively. As shown in Figure 4.14, following these two factors in frequency were: disregarded traffic signs/signals (21%), wrong side or wrong way (20%), and alcohol influence (13%).

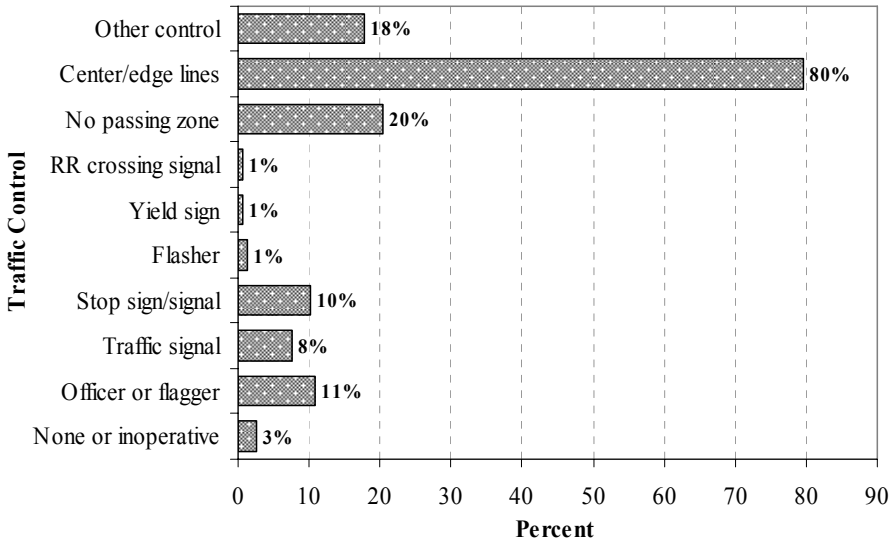


Figure 4.13. Fatal Crash Frequency by Traffic Control Devices

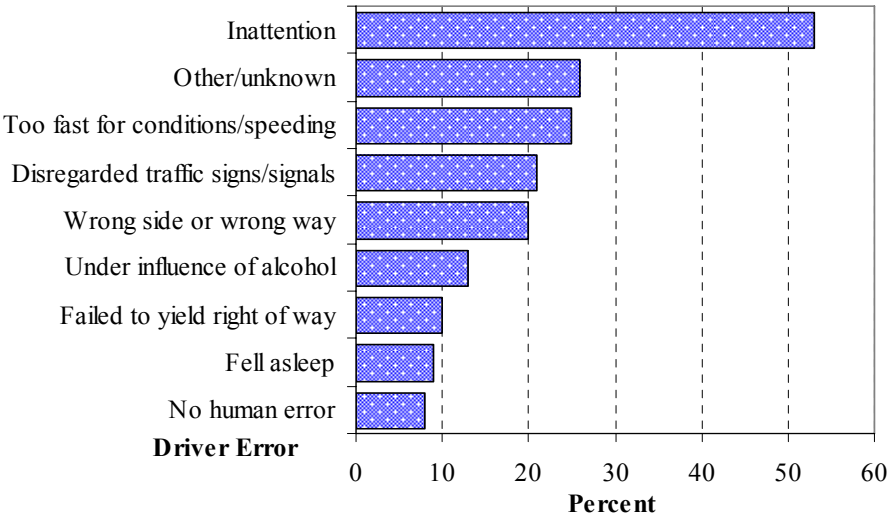


Figure 4.14. Fatal Crash Frequencies by Driver Error

4.2.2 Fatal Crash Characteristics by Bivariate Frequencies

The previous frequency analysis of the fatal work zone crashes in Kansas has revealed the most frequent observations of various crash characteristics. Besides these, there is a great interest in how factors simultaneously affect work zone safety and interrelationships between factors. Table 4.8 shows the interrelated factors at a 5% significance level. The results of crash frequency analyses based on these interrelated variables are presented as follows.

Driver Characteristics

As shown in Figure 4.15, drivers of different ages caused different amounts of crashes in different time periods and light conditions. A significant percentage (95%) of the crashes that occurred during nighttime (8:00 p.m. – 6:00 a.m.) was caused by drivers younger than 55. Drivers between 25 – 44 caused half of the crashes during 10:00 a.m. – 4:00 p.m.

Table 4.8. Interrelated Fatal Crash Variables at 5% Level of Significance

Interrelated Factor Pairs		Pearson Chi-Square	Likelihood Ratio Chi-Square
Age	Time	No	Yes
	Light condition	Yes	Yes
Light condition	Number of vehicles	Yes	Yes
	Number of lanes	Yes	Yes
	Speed limit	Yes	Yes
	Area information	Yes	Yes
Vehicle type	Light condition	Yes	Yes
	Number of vehicles	Yes	Yes
	Number of lanes	Yes	Yes
	Area information	Yes	Yes
Number of vehicles	Time	Yes	Yes
	Number of lanes	Yes	Yes
Speed limit	Time	Yes	Yes

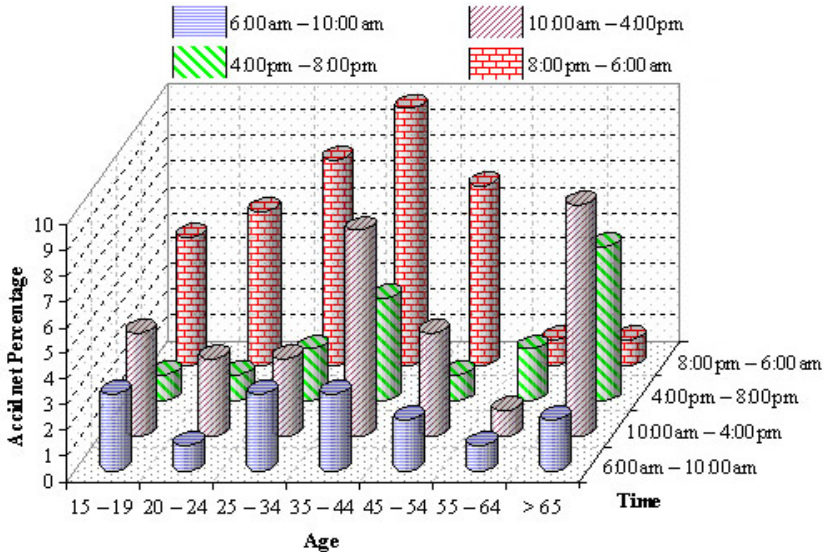


Figure 4.15. Crash Frequencies by Age and Time

Under different light conditions, drivers of different ages acted differently. Crash frequency analysis with respect to different ages and light conditions showed that, although generally more crashes occurred when light conditions were good, a considerable proportion occurred under adverse light conditions such as darkness with no streetlights on. As listed in Table 4.9, drivers between 35 – 54 years of age caused about half of the crashes in adverse light conditions. It was also observed that most of the crashes caused by senior drivers ($\geq$65) occurred in daytime when light conditions were good.

Table 4.9. Crash Frequencies by Age and Light Condition

Light condition/Age	15 – 19	20 – 24	25 – 34	35 – 44	45 – 54	55 – 64	$\geq$ 65	**Total**
Good	4	4	8	14	4	3	15	53
Fair	3	3	2	1	4	0	1	14
Bad	4	3	6	9	6	<1	3	33
Total	12	11	15	24	15	4	18	100

Light Conditions

To better understand the impacts of light conditions, these conditions were classified into two groups: good condition or daylight with good visibility, and poor conditions including daylight with poor visibility, dawn, dusk, nighttime with streetlights, and nighttime without streetlights. Tests showed that light condition was related to the number of vehicles involved in a crash. As shown in Table 4.10, the percentage of the single-vehicle fatal crashes in poor light conditions were two times more than that in good light conditions (25% of total vs. 7% of total), which indicated that poor light condition had notable impacts on work zone drivers.

Table 4.10. Crash Frequencies by Light Condition and Number of Vehicles

No. of vehicles/ Light condition	1	2	≥3	**Total**
Good	7	36	10	53
Poor	25	17	5	47
Total	32	53	15	100

When comparing the crashes by light conditions and number of lanes, as illustrated in Table 4.11, a significant amount of crashes (36% of total) occurred on two-lane highways with good light condition while 27% of the crashes were reported on two-lane highways with poor light conditions. In terms of area type and light condition, almost half of the crashes (47% of total) happened in rural areas when light conditions were good and 28% occurred in rural areas with poor light conditions.

Table 4.11. Crash Frequencies by Light Condition and Number of Lanes

No. of lanes/ Light condition	Two-lane	Multi-lane	**Total**
Good	36	17	53
Poor	27	20	47
Total	63	37	100

Vehicle Type and Number of Vehicles

Crashes involving trucks were statistically related to light conditions, number of crash vehicles, number of lanes at the crash location, area types, and driver errors. Analysis results showed that under good light conditions, the percentage of truck-involved crashes (27% of total) was slightly higher than that of non-truck-involved crashes (25% of total). Non-truck-involved crashes were observed as the prevalent crash type when light conditions were poor. Furthermore, non-truck-involved crashes were evenly distributed regardless of light conditions.

As indicated in previous studies, this project also found that truck-involved crashes frequently resulted in collisions of multiple vehicles. Results showed that truck-involved collisions had a higher frequency rate than non-truck-involved collisions (11% vs. 4%) in crashes involving three or more vehicles, as illustrated in Figure 4.16. This phenomenon strongly suggested that heavy trucks tend to cause severe multi-vehicle work zone crashes.

In addition, as listed in Table 4.12, most heavy truck-involved work zone collisions (29% of all crashes) were reported on two-lane highways compared to only 11% on multi-lane highways. Non-truck-involved crashes on two-lane highways

constituted 34% of the total, and 26% of all crashes occurred on multi-lane highways. Both truck- and non-truck- involved crashes were most likely to happen in the work zones on rural highways.

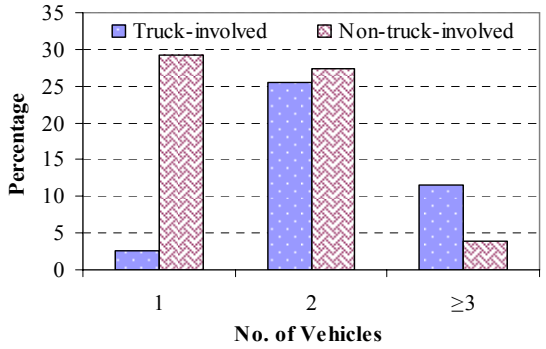


Figure 4.16. Crash Frequencies by Vehicle Type and Number of Vehicles

Table 4.12. Crash Frequencies by Number of Lanes and Vehicle Type

Vehicle type/No. of lanes	Two-lane	Multi-lane	**Total**
Truck-involved	29	11	40
Non-truck-involved	34	26	60
Total	63	37	100

The crash distributions over number of vehicles and crash time were shown in Figure 4.17. Multi-vehicle crashes were the dominant type of all daytime crashes, while the proportions of single- and multi- vehicle crashes were roughly equal during nighttime (both were 18% of total). A large proportion of multi-vehicle crashes (26% of total crashes) occurred in daytime non-peak hours (10:00 a.m. – 4:00 p.m.), which indicated that high volume was not an important causal factor for fatal work zone crashes.

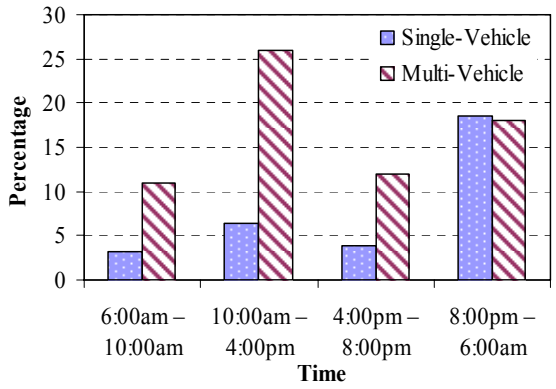


Figure 4.17. Crash Frequencies by Time and Number of Vehicles

Results of analyses also showed that most multi-vehicle fatal work zone crashes in Kansas happened on two-lane highways instead of multi-lane highways. To be specific, 48% of the crashes were multi-vehicle collisions that occurred on two-lane highways (Figure 4.18).

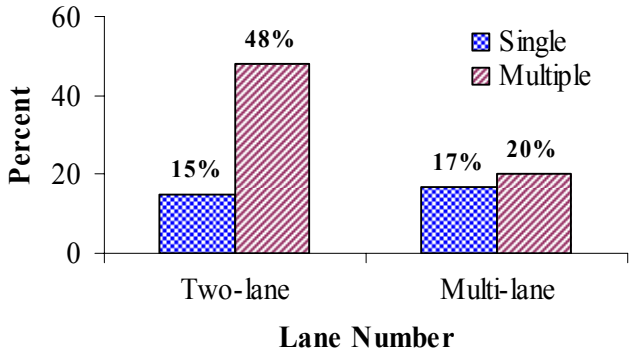


Figure 4.18. Crash Frequencies by Number of Lanes and Number of Vehicles

Speed Limit

When categorizing the fatal crashes by time and speed limit, as shown in Figure 4.19, a significant percentage (24%) of the crashes occurred during nighttime

(8:00 p.m. – 6:00 a.m.) within 51 mph – 60 mph speed zones. Another significant proportion (20%) was reported during daytime non-peak hours (10:00 a.m. – 4:00 p.m.) on highways with speed limits between 61 mph – 70 mph. Only 11% occurred in morning peak hours (6:00 a.m. – 10:00 a.m.) within 51 mph – 60 mph and 61 mph – 70 mph speed zones. Once again, darkness had negative impacts on drivers, and high volumes of traffic did not necessarily cause more fatal crashes.

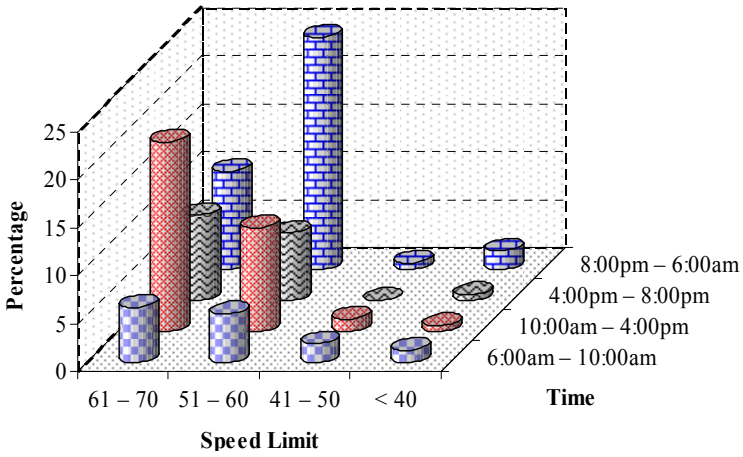


Figure 4.19. Crash Distributions over Time and Speed Limit

4.2.3 Summary of Work Zone Fatal Crash Characteristics

Table 4.13 shows the observation with the highest frequency for each crash variable. The major characteristics of the Kansas highway work zone fatal crashes during 1992 and 2004 are summarized as follows.

Table 4.13. Summary of the Most Frequent Observations

Category	Variable	Observation	Percent (%)
Driver characteristics	Gender	Male	75
	Age	35-44	24
Time characteristics	Time*	10:00 a.m. – 4:00 p.m.	32
	Day	Saturday	17
	Month	June	14
Climatic environment factors	Light Condition	Daylight	53
	Weather Condition	No Adverse Weather	91
	Surface Condition	Dry	88
Crash information	Vehicle maneuver	Following road	79
	Crash type	Head-on	24
	Vehicle body type	Truck-vehicle	34
	No. of crash cars	2	53
Road conditions	Road Class	Other Principle Arterial	56
	Road character	Straight & level	51
	Lane Number	2	63
	Speed Limit	51 – 60	47
	Crash location	Non-intersection	67
	Surface Type	Black Top	69
	Road special feature	None	85
	Area information	Rural	84
	Traffic control	None or inoperative	46
Contributing factors	Driver factor	Inattention	53

*: Determined according to hourly rate.

At-Fault Driver

Male drivers caused about 75% of fatal work zone crashes in Kansas. Teenage drivers, drivers between 35 – 44, and older than 65 were the driver groups most frequently causing fatal crashes in work zones.

Time

Thirty seven percent of the crashes occurred at nighttime. The majority of nighttime crashes were caused by drivers younger than 55. In terms of average hourly rate, daytime non-peak hours (10:00 a.m. – 4:00 p.m.) had the highest crash rate followed by nighttime (8:00 p.m. – 6:00 a.m.). Most single-vehicle crashes occurred

during nighttime while multi-vehicle crashes frequently occurred during both daytime non-peak hours and nighttime. No significant differences in numbers of crashes were found among days of a week.

Location

Work zones on two-lane rural highways with speed limits from 51 mph to 70 mph had the highest fatal crash frequency. Interstate system roads and other major arterials had many more fatal work zone crashes than other road classes. Truck-involved crashes and multi-vehicle crashes were more likely to occur in the work zones on two-lane roads.

Type

About 68% of the crashes were multi-vehicle crashes. Among multi-vehicle collisions, head-on, angle-side impact, and rear-end were the three most frequent collision types. Results of analyses showed that the most severe crashes frequently involved heavy trucks. About 40% of the crashes were caused by heavy trucks and almost all of these crashes involved multiple vehicles.

Causal factors

Inclement weather conditions and unfavorable road special features did not significantly contribute to fatal work zone crashes. Light conditions and complex highway geometric alignments, especially slopes, might have contributed to fatal work zone crashes. Human errors were a significant contributing factor to fatal work zone crashes and inattention and misjudgment/disregarding traffic controls were the top two human errors causing fatal work zone crashes in Kansas.

4.3 INJURY WORK ZONE CRASH CHARACTERISTICS

4.3.1 Injury Crash Characteristics by Single-Variable Frequencies

Driver Characteristics

Among the 460 sample injury crashes in Kansas highway work zones between 1992 – 2004, 66% were caused by male drivers. Drivers younger than 35 caused the highest proportions of the injury crashes: drivers between 15 – 19 and 20 – 24 years of age combined caused 33% of the crashes and drivers between 25 and 34 caused 20%. Drivers between 55 and 64, and senior drivers (older than 65 years of age), were responsible for only 7% and 8% of the crashes, respectively; see details in Figure 4.20.

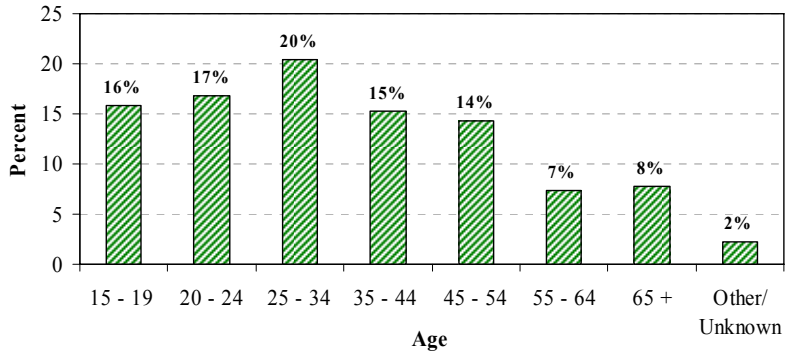


Figure 4.20. Injury Crash Frequencies by Age

Time Information

As shown in Table 4.14, daytime non-peak hours (10:00 a.m. - 4:00 p.m.) had the highest injury crash frequency based on hourly percentage in Kansas highway work zones, followed by afternoon peak hours (4:00 p.m. - 8:00 p.m.) and morning

peak hours (6:00 a.m. - 10:00 a.m.). Nighttime (8:00 p.m. - 6:00 a.m.) had the lowest proportion of the crashes with an hourly percent of 1.8%.

Table 4.14. Injury Crash Frequency by Crash Time

Accident Time	Frequency	Percent	Hourly Percent*
6:00 a.m. - 10:00 a.m.	72	16	4.0
10:00 a.m. - 4:00 p.m.	194	42	7.0
4:00 p.m. - 8:00 p.m.	109	24	6.0
8:00 p.m. - 6:00 a.m.	83	18	1.8
Unknown	2	0	0

*Hourly percent is calculated by dividing the total percent for a time period by the number of hours in that period.

Regarding the crash frequency by day of week, Friday and Wednesday had the highest percentages of 18% and 17%, respectively. In contrast, Sunday had only 7% of the crashes. A majority (84%) of the injury crashes occurred in the construction season from April to November, while January, February, March, and December only had 16%. Figure 4.21 and Figure 4.22 show the injury crash frequencies by day of week and month, respectively.

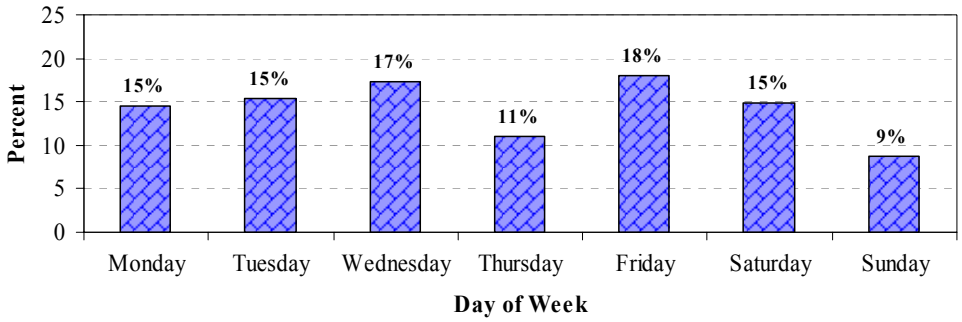


Figure 4.21. Injury Crash Frequencies by Day of Week

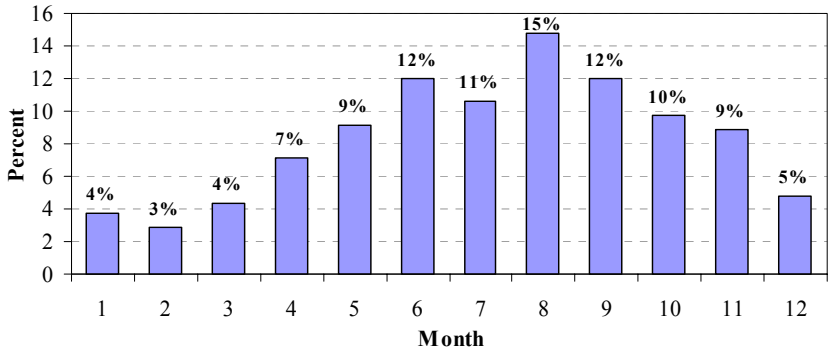


Figure 4.22. Injury Crash Frequencies by Month

Climatic Environment Characteristics

In Kansas highway work zones, 75% of the injury crashes occurred during daytime with favorable light conditions. As shown in Figure 4.23, among poor light conditions, "dark with no street lights on" had the highest crash percentage of 7%. In terms of weather condition, a majority (87%) of the crashes occurred when no adverse weather conditions were observed. Correspondingly, 84% of the injury crashes occurred on dry pavements.

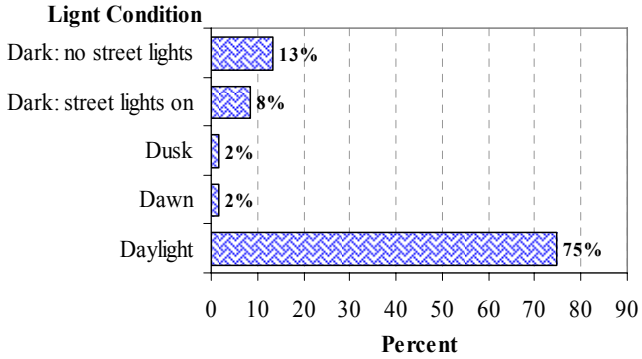


Figure 4.23. Injury Crash Frequencies by Light Condition

Crash Information

According to the results of data analysis, most (68%) of the drivers who were responsible for crashes were traveling straight or following the roads before they caused collisions. Each of the more complicated maneuvers including left turn, slowing or stopping, and the avoiding maneuver coincided with 6% of the crashes (Figure 4.24). Other maneuvers such as lane changing and overtaking only contributed to 3% and 2%, respectively.

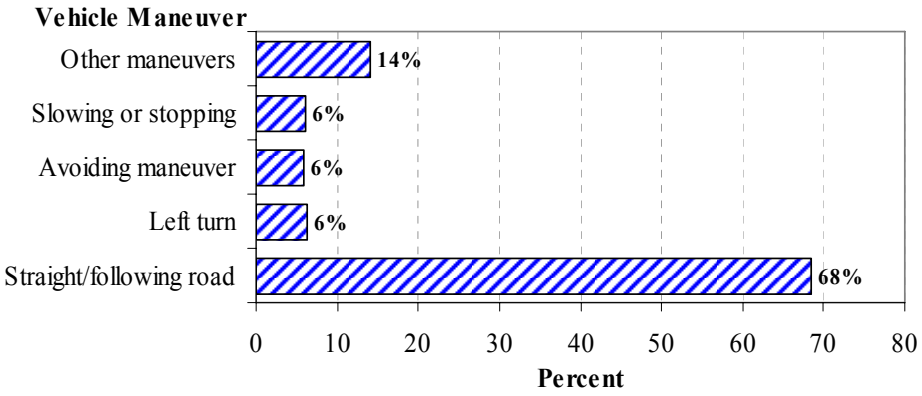


Figure 4.24. Injury Crash Frequencies by Vehicle Pre-Crash Maneuver

The study of the numbers of crash vehicles showed that 70% of the crashes involved multiple vehicles and 50% were two-vehicle crashes, as illustrated in Figure 4.25. Figure 4.26 shows the injury crash frequencies by crash type. In the study period (1992 – 2004), the dominant type of injury crash was rear-end collision which constituted roughly half (46%) of the total crashes. Other common injury crash types included angle-side impact collisions (18%), fixed-object collisions (13%), and overturned crashes (10%).

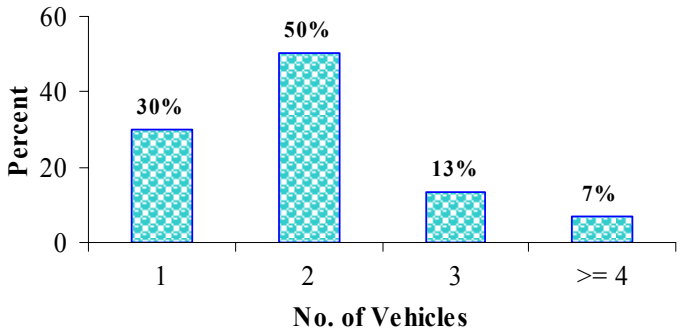


Figure 4.25. Injury Crash Frequencies by Number of Crash Vehicles

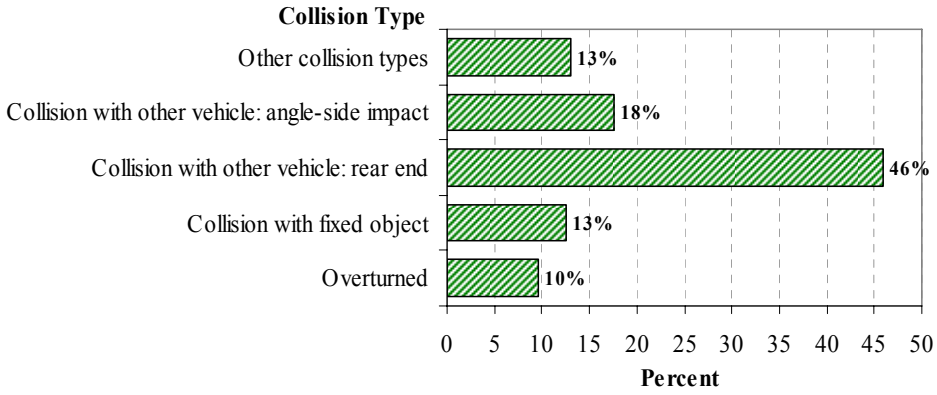


Figure 4.26. Injury Crash Frequencies by Crash Type

As shown in Figure 4.27, the most common crash type was vehicle-vehicle crashes (58%), followed by vehicle-object collisions (24%), and truck-vehicle collisions (9%). Truck-truck collisions only accounted for 1% of the studied crashes. Here "truck" includes single large trucks, trucks and trailers, tractor-trailers, and buses. Other vehicle types including passenger cars, minivans, pickups, SUVs, ATVs, and campers or RVs are categorized as "vehicle" as opposed to trucks.

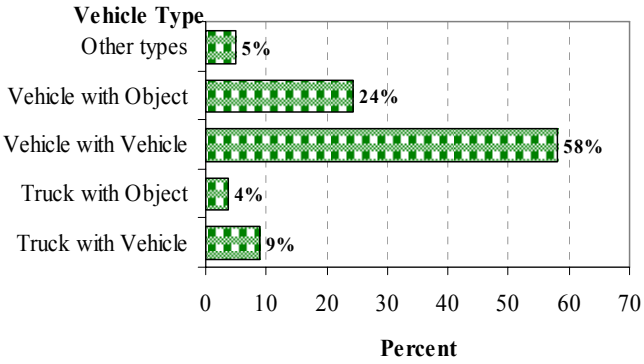


Figure 4.27. Injury Crash Frequencies by Vehicle Type

Road Information

Among the injury work zone crashes, 45% occurred on principal roads other than interstate highways, freeways, or expressways. Interstate highways had 33% of the crashes and other freeways and expressways had 15% (see Figure 4.28 for details). Results of data analyses showed that 66% of the injury crashes occurred in work zones on straight and level highway sections. Complicated highway alignments contributed to some percentage of the crashes: 18% on straight on grade highway sections, 9% on curved and level highway sections, and 7% on other alignments.

When studying the crashes by number of lanes (two direction), 33% occurred on two-lane highways and 67% on multi-lane highways. For the latter, 49% occurred on four-lane highways and a total of 18% occurred on six-lane highways and eight-lane highways. The researcher also found that 47% of the injury crashes occurred on highway sections with speed limits between 51 mph and 60 mph, and 21% occurred in 61 mph–70 mph speed zones. This fact indicates that injury crashes were related to relatively high vehicle speeds. Figure 4.29 shows the crash frequency by speed limit.

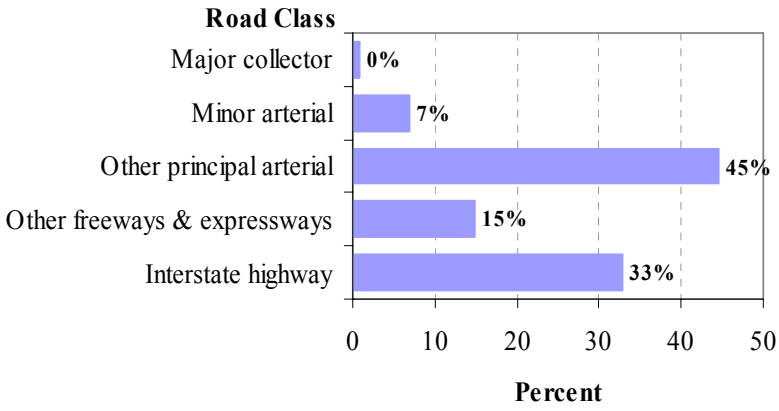


Figure 4.28. Injury Crash Frequencies by Road Class

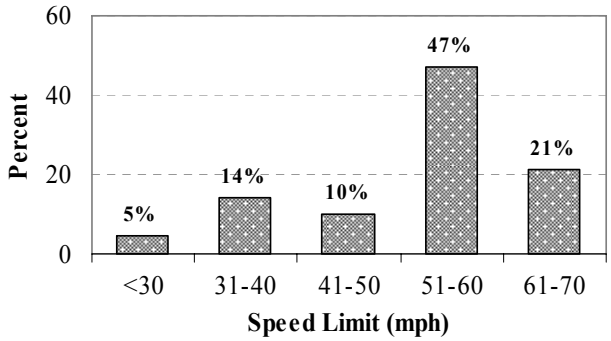


Figure 4.29. Injury Crash Frequencies by Speed Limit

Among the injury crashes, 58% happened in non-intersection areas and 24% occurred in intersections or intersection-related areas. About 8% of the crashes took place in work zones that overlapped with interchange areas (see Figure 4.30 for details). Regarding the impact of road special features such as bridges, interchanges, or ramps, a majority (85%) of the crashes were in the work zones where no such features were present. Only 6% coincided with bridges, 5% with interchanges, and 3% with ramps, as illustrated in Figure 4.31. In addition, 61% of the crashes occurred on asphalt pavements; only 39% were found on concrete pavements.

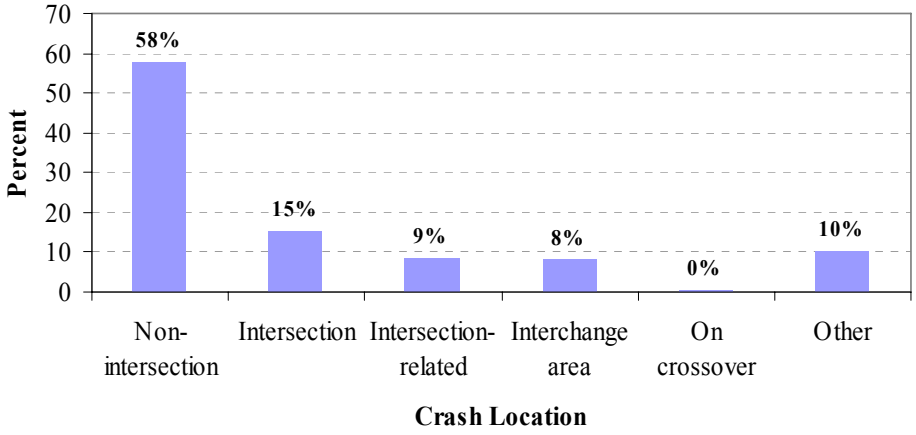


Figure 4.30. Injury Crash Frequencies by Crash Location

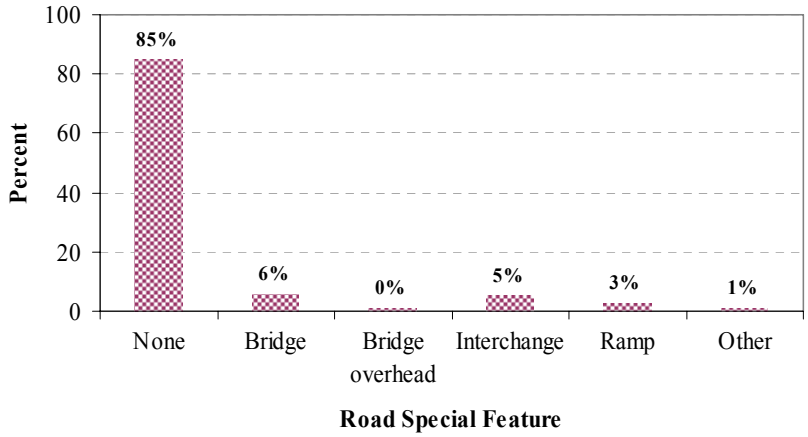


Figure 4.31. Injury Crash Frequencies by Road Special Feature

Most (85%) of the injury crashes took place in rural highway work zones. As shown in Figure 4.32, 43% of the crashes occurred in 51 mph – 60 mph speed zones on rural highways and 20% in 61 mph – 70 mph speed zones on rural highways. Therefore, rural highways with speed limits higher than 51 mph were the places where an injury work zone crash most likely to occur.

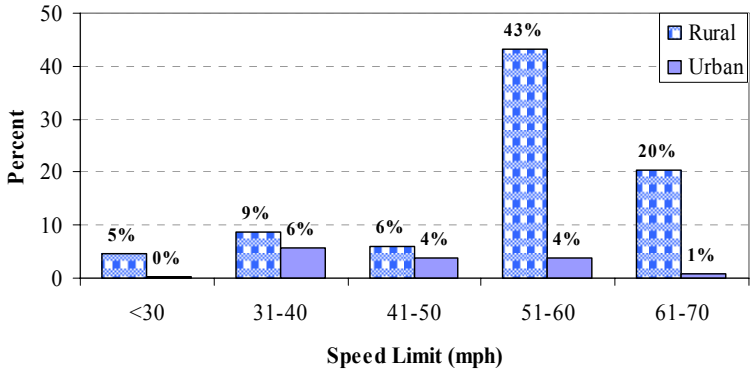


Figure 4.32. Rural and Urban Injury Crashes by Speed Limit Groups

Figure 4.33 shows the frequency of various traffic control devices in the injury crash locations. As seen from the figure, 72% of the crashes occurred on the pavements marked with center/edge lines. Other traffic control devices common in crash work zones included: other control (15%), traffic signal (15%), no passing zone (14%), and stop sign/signal (7%). Eleven percent of the crashes occurred in work zones with no or inoperative traffic control devices.

Contributing Factors

The study found that 82% of the injury crashes were due to driver errors. As shown in Figure 4.34, among the driver errors, inattention contributed to 51% of the crashes, followed by followed too closely (18%), too fast for conditions (16%), and disregarded traffic signs, signals, or markings (10%). In addition, among the crashes without driver errors, 4% were caused by environment factors such as inclement weather conditions and animal interfering and another 4% were caused by vehicle factors. Less than 1% of the crashes were caused by pedestrians.

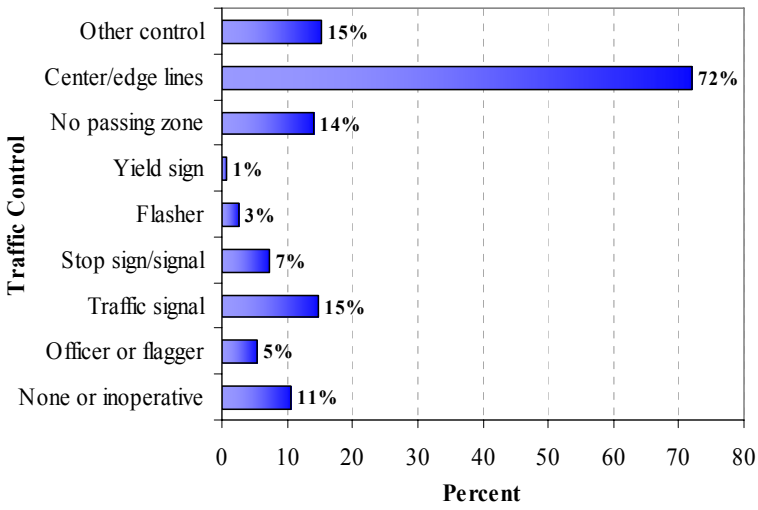


Figure 4.33. Injury Crash Frequencies by Traffic Control Device

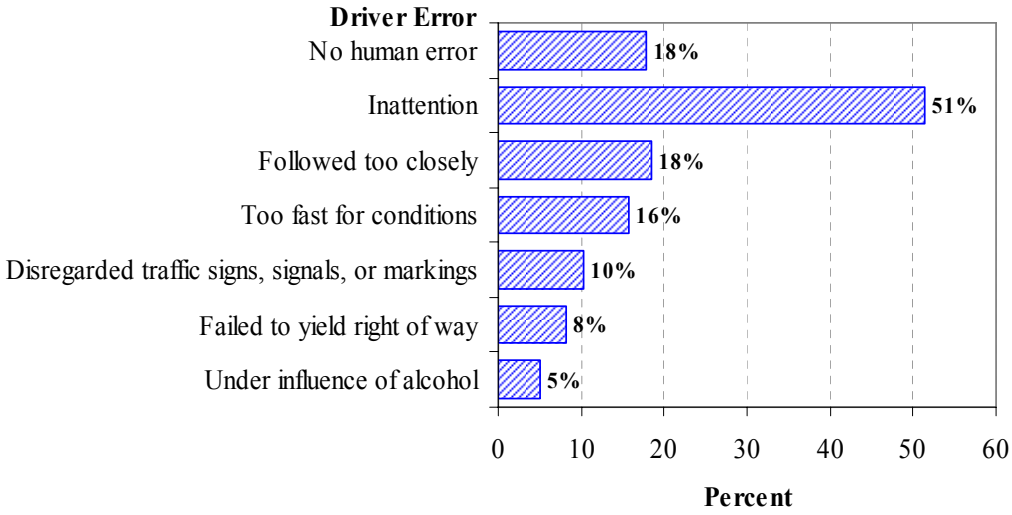


Figure 4.34. Injury Crash Frequencies by Major Driver Errors

4.3.2 Injury Crash Characteristics by Bivariate Frequencies

Table 4.15 shows the important interrelated factors at 5% level of significance tested using SAS software. The researcher did not include those statistically

interrelated but practically meaningless variable pairs such as weather condition and road surface condition (inclement weather conditions are usually accompanied by poor road surface conditions) and crash time and light conditions (nighttime commonly have poor light conditions) in the tests.

At-Fault Driver Information

The results of frequency analysis showed that most (83%) of the injury crashes involved only vehicles as opposed to trucks. Among these vehicle-only crashes, as shown in Figure 4.35, young drivers between 15 and 24 years of age caused 29% (15% plus 14%) of the total crashes, followed by the driver group between 25 and 34 years of age who were responsible for 17% of the total crashes.

Table 4.15. Interrelated Injury Crash Variables at 5% Level of Significance

Interrelated Factor Pairs		**Pearson Chi-Square**		**Likelihood Ratio Chi-Square**	
		p-Value	**Related?**	**p-Value**	**Related?**
Age	Vehicle Type	0.03	Yes	0.02	Yes
Gender	Surface Condition	0.02	Yes	0.02	Yes
Gender	Vehicle Type	<0.01	Yes	<0.01	Yes
Gender	Number of Vehicles	0.08	No	0.04	Yes
Crash Time	Number of Vehicles	<0.01	Yes	<0.01	Yes
Light Condition	Number of Vehicles	<0.01	Yes	<0.01	Yes
Vehicle Type	Number of Vehicles	<0.01	Yes	<0.01	Yes
Number of Vehicles	Road Character	0.05	Yes	0.05	Yes
Number of Vehicles	Speed Limit	<0.01	Yes	<0.01	Yes
Number of Vehicles	Crash Location	<0.01	Yes	<0.01	Yes
Number of Vehicles	Road Class	<0.01	Yes	<0.01	Yes
Road Class	Area Information	<0.01	Yes	<0.01	Yes
Number of Lanes	Speed Limit	<0.01	Yes	<0.01	Yes

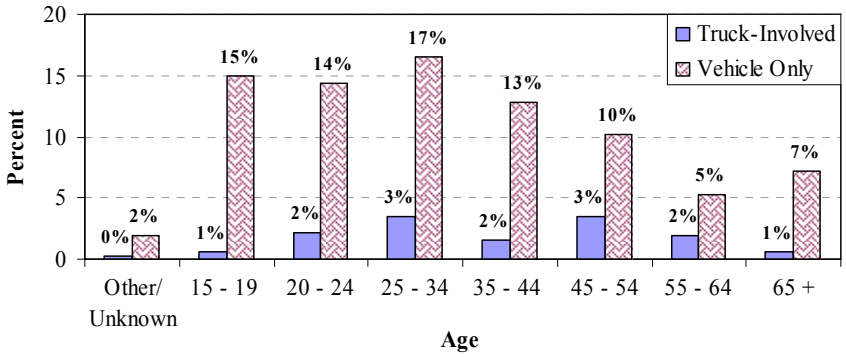


Figure 4.35. Crash Frequencies by Age and Vehicle Type

When studying the crash frequencies by gender and road surface condition, it was found that 54% of the injury crashes were caused by male drivers on a good (dry) road surface. For the same surface condition, females caused about 31% of the total crashes. In addition, most (88%) of the truck-involved crashes (12% of the total crashes) were caused by male drivers, which is probably due to the high composition of males in the truck driver population. Compared with the 64% of the multi-vehicle crashes (45% of the total crashes) caused by males, the study found that 71% of the single-vehicle crashes (21% of the total crashes) were caused by male drivers. The detailed crash distributions over gender and road surface condition, vehicle type, and number of vehicles are listed in Table 4.16.

Table 4.16. Crash Frequencies by Gender and Surface Condition, Vehicle Type, and Number of Vehicles

Gender	Road Surface Condition		Vehicle Type			Number of Vehicles	
	Good	Poor	Truck-Involved	Vehicle Only	Other	Single	Multiple
Male	54	12	12	51	2	21	45
Female	31	3	2	32	1	9	25

Crash Time

The statistical test results showed that crash time was related to number of crash vehicles. As shown in Figure 4.36, one third of the injury crashes (33%) were multi-vehicle crashes that occurred during daytime non-peak hours (10:00 a.m. – 4:00 p.m.).

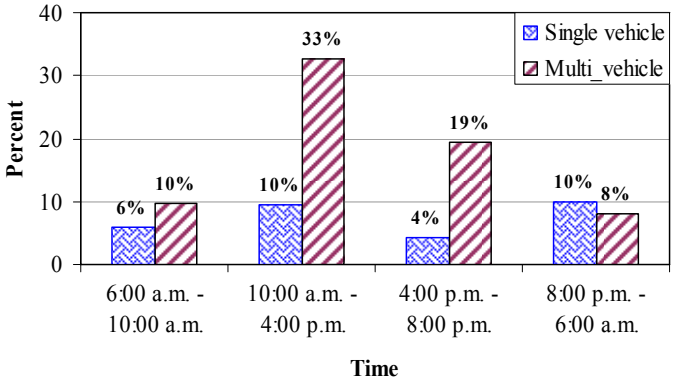


Figure 4.36. Injury Crash Percent Frequencies by Crash Time and Number of Vehicles

Light Condition

Results showed that light condition was interrelated with number of vehicles. Compared to the 18% of the multi-vehicle crashes in poor light conditions (13% of the total crashes), 43% of the single-vehicle crashes (13% of the total) occurred in poor light conditions. The detailed frequencies are listed in Table 4.17. As opposed to good light condition (daylight), poor light conditions refer to the conditions such as "dawn," "dusk," "dark with street lights," and "dark without street lights."

Table 4.17. Crash Percent Frequencies by Light Condition and Number of Vehicles

Light Condition	Number of Vehicles	
	Single	Multiple
Good	17	57
Poor	13	13
Total	30	70

Vehicle Type and Number of Vehicles

Although only 14% of the injury crashes involved heavy trucks, 79% (11% out of 14%) of these truck-involved crashes were multi-vehicle crashes (see Table 4.18). In contrast, 71% (59% out of 83%) of the light-duty vehicle-only crashes were multi-vehicle crashes.

Table 4.18. Percent Frequencies by Vehicle Body Type and Number of Vehicles

Number of Vehicles	Vehicle Body Type		
	Truck-involved	Vehicle-only	Other
Single-vehicle	3	24	2
Multi-vehicle	11	59	1
Total	14	83	3

As illustrated in Table 4.19, almost half of the single-vehicle crashes (14% of total) occurred in work zones on highway sections with complicated alignment features such as grades or slopes while most of the multi-vehicle crashes (49% out of 70%) occurred on simple (i.e., straight and level) highway alignments. Regarding the crash frequencies by number of vehicles and speed limit, Figure 4.37 shows that the percentage of multi-vehicle crashes occurred in 51 – 60 mph speed zones was 32%,

followed by multi-vehicles crashes in 31 – 40 mph speed zones. Multi-vehicle crashes were the dominant in all speed zones except the highways with speed limits between 61 mph and 70 mph where both single- and multi- vehicle injury crashes were 11% of the total. In addition, among the two-vehicle crashes, a significant percentage (40%) occurred in intersection or intersection-related areas.

As shown in Figure 4.38, almost half (49%) of the single-vehicle crashes occurred on interstate highways. Instead, almost half (49%) of the multi-vehicle crashes occurred on "other principal arterials" (principal arterials other than interstate and other freeways or expressways).

Table 4.19. Crash Percent Frequencies by Number of Vehicles and Road Character

Road Character	No. of Vehicles		Total
	Single	Multiple	
Simple alignment	16	49	65
Complicated alignments	14	21	35
Total	30	70	100

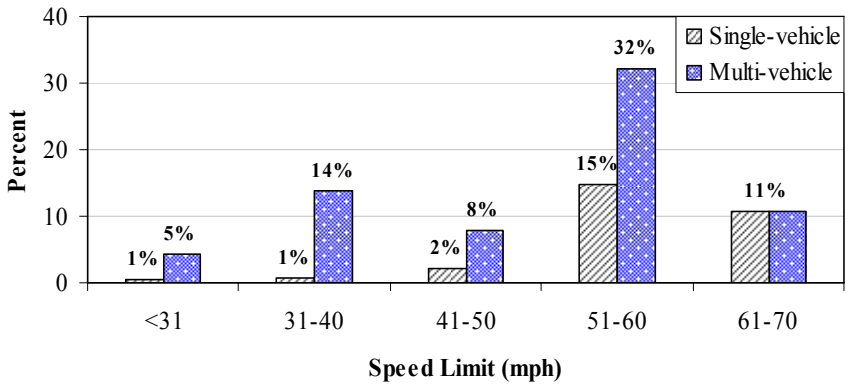


Figure 4.37. Crash Frequencies by Number of Vehicles and Speed Limit

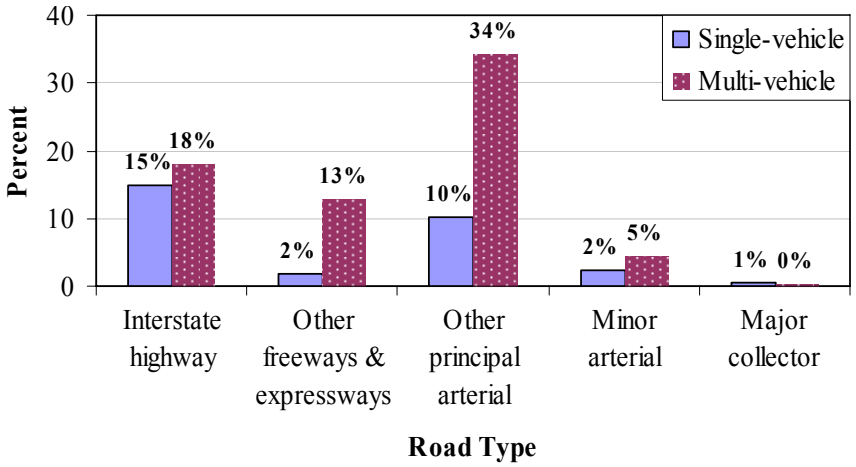


Figure 4.38. Injury Crash Frequencies by Road Class and Number of Vehicles

Road Class

The statistical test results showed that there was an interrelationship between road class and area information. The study indicated that most (72%) of the crashes occurred on rural interstate highways and other principal arterials. Figure 4.39 illustrate the crash frequencies by road class and area type.

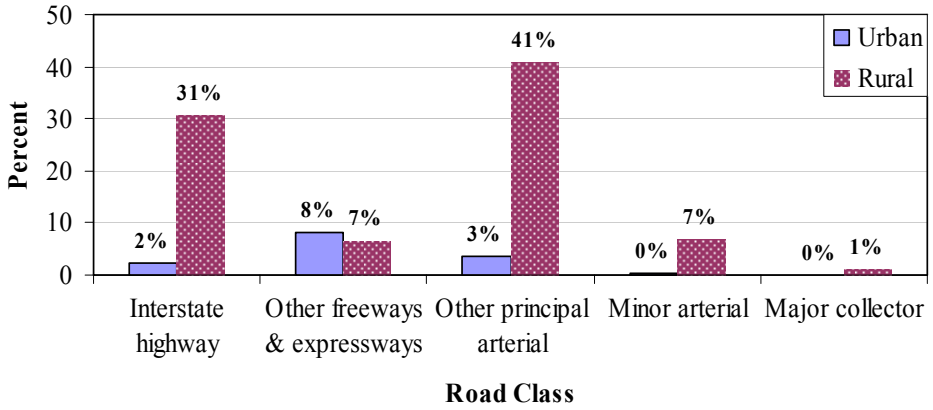


Figure 4.39. Injury Crash Frequencies by Road Class and Area Information

Number of Lanes

As shown in Figure 4.40, work zones on multi-lane highways with speed limits between 51 – 60 mph were the locations that accounted for the highest percentage (29%) of the injury crashes. Other locations such as two-lane highways with speed limits between 51 – 60 mph and multi-lane highways with speed limits between 61 – 70 mph were also common places where injury crashes occurred.

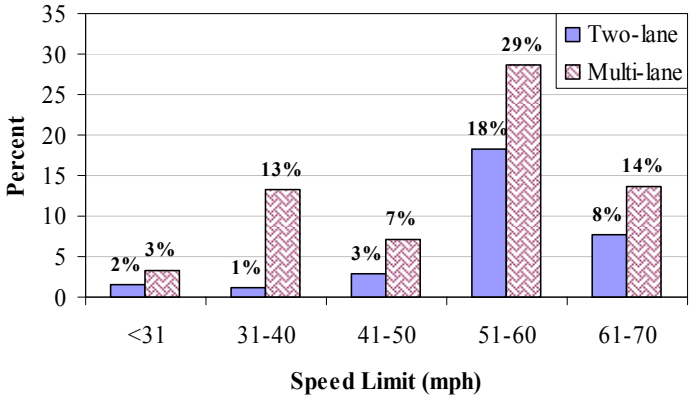


Figure 4.40. Injury Crash Frequencies by Number of Lanes and Speed Limit

4.3.3 Summary of the Characteristics of Injury Crashes in Work Zones

Table 4.20 lists the observation with the highest frequency rate for each crash variable. A summary of the characteristics of the injury crashes is presented as follows.

At-Fault Driver Characteristics

Male drivers caused two thirds of the injury crashes in Kansas work zones. Young drivers between 15 – 24 years of age had high frequencies of injury crashes in

work zones. Among these young drivers, teenage drivers between 15 – 19 years of age caused 16% of the injury work zone crashes, and male teenage drivers were responsible for 94% (15% of total) of these crashes. Most of the light-duty vehicle crashes were caused by drivers younger than 34.

Table 4.20. Most Frequent Observations for Injury Crash Variables

Category	Variable	Observation	Percent
At-Fault Driver	Age	15-24	33
	Gender	Male	66
Time Information	Time	10:00 a.m. - 4:00 p.m.	42
	Day	Friday	18
	Month	August	15
Climatic Environment	Light condition	Daylight	75
	Weather condition	No adverse conditions	87
	Road surface condition	Dry	84
Crash Information	Vehicle maneuver before crash	Straight/following road	68
	Crash type	Rear-end	46
	Vehicle body type	Vehicle with vehicle	58
	Number of vehicles involved	Two	50
Road Condition	Road class	Other principal arterial	45
	Road character	Straight and level	66
	Number of lanes	four	49
	Speed limit	51-60 mph	47
	Crash location	Non-intersection	58
	Surface type	Blacktop	61
	Road special feature	None	85
	Area information	Rural	85
	Traffic control	Center/edge lines	72
Contributing Factor	Driver factor	Inattention	51

Time

Daytime non-peak hours (10:00 a.m. - 4:00 p.m.) had the highest crash frequency (42%). The afternoon peak hours (4:00 p.m. - 8:00 p.m.) had many more (24% vs. 16%) injury crashes than the morning peak hours (6:00 a.m. - 10:00 a.m.). Among all the crashes, the most frequent were multi-vehicle crashes during daytime

non-peak hours (33% of total). The lowest crash frequency was observed on Sundays. A majority (84%) of the crashes took place during the construction season from April to November.

Location

It was found that 45% of the injury crashes occurred on "other principal highways" and 33% occurred on interstate highways. Almost half (49%) of the single-vehicle crashes took place on interstate highways. Two thirds of the injury crashes were found on multi-lane highways, especially on four-lane highways. Work zones on highways with speed limits higher than 50 mph accounted for most (68%) of the crashes. Particularly, 51 – 60 mph speed zones had 47% of the total crashes. In addition, a majority of the crashes (85%) occurred in rural work zones. Rural areas with 51 – 70 mph speed limit ranges had 63% of the crashes.

Type

The study found that 70% of the injury crashes involved multiple vehicles and 50% of the crashes were two-vehicle collisions. Rear-end collisions were the dominant crash type, accounting for 46% of the total injury crashes, followed by angle-side impact collisions (18%) and fixed-object collisions (13%). Most (83%) of the crashes involved light-duty vehicles and only 13% involved heavy trucks.

Causal factors

According to the injury crash data, 82% of the injury crashes were attributed to driver errors. Among the driver errors, inattentive driving was the most common error (51%), followed by followed too close (18%) and too fast for conditions (16%).

Data analysis results did not support significant contributions of factors such as inclement weather conditions and unfavorable pavement conditions to injury crashes. Poor light conditions were most likely to contribute to single-vehicle crashes. Road special features such as bridges, interchanges, or ramps did not significantly contribute to the injury crashes. Complex geometric alignment features such as grades and curves had some impact on the occurrences of the injury crashes: 34% of the crashes occurred on complicated alignments and almost half (46%) of the single-vehicle crashes took place on complex alignments. The fact that 23% of the injury crashes or 40% of the two-vehicle crashes occurred in intersections or intersection-related areas, indicated that the presence of an intersection in highway work zones might be a contributing factor for injury crashes.

4.4 COMPARING FATAL AND INJURY WORK ZONE CRASH CHARACTERISTICS

In this section, the characteristics of both fatal and injury crashes were compared and significant differences were determined. The purpose of the comparison was to unveil the factors that could lead to severity increase during the crashes. The comparison also helps in thoroughly understanding the general characteristics of work zone fatal and injury crashes as well as the unique ones distinguishing them. The comparisons were based on percentages because the injury crash characteristics were studied based on a random sample of 460 cases instead of the total crashes. In addition, comparing on a percentage basis rather than absolute

numbers would avoid the important characteristics of fatal crashes being overwhelmed by those of the injury crashes that had much larger numbers of cases.

4.4.1 Characteristic Comparison between Injury and Fatal Crashes

At-Fault Driver

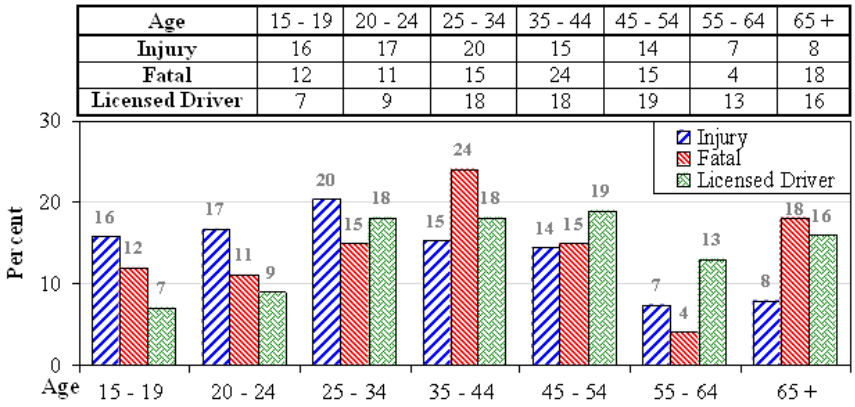
Table 4.21 summarizes the frequencies of the top two observations for each variable describing the drivers responsible for the crashes. As indicated in the table, for both work zone fatal and injury crashes, male drivers, who constituted about 50% of the total licensed drivers in Kansas in 2004 (FHWA 2004e), caused many more crashes than female drivers did. The percentage of at-fault male drivers for the fatal crashes was higher than that for the injury crashes by 9% (75% vs. 66%).

Drivers between 15 and 34 years of age caused a higher percentage of injury crashes than fatal crashes. The percentages of drivers between 15 and 24 who caused injury crashes were much higher then the percentages of the drivers with the same ages in the total number of licensed drivers in Kansas.

The drivers aged 35 to 44 caused the highest percentage (24%) of the fatal crashes among all the age groups, which was 9% higher than the injury crashes caused by the same age group and 6% higher than their percentage in the total Kansas licensed driver population (FHWA 2004e). Senior drivers (65 or older) were found to be responsible for a larger proportion of fatal crashes than for injury crashes (18% vs. 8%) in work zones. Figure 4.41 exhibits the fatal and injury crash distributions by at-fault drivers' age and the Kansas licensed driver age distributions.

Table 4.21. Most Frequent Observations for At-Fault Driver Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Gender	Male (75%)	Female (25%)	Male (66%)	(Female 34%)
Age	35 – 44 (24%)	15 – 24 (23%)	15 – 24 (33%)	25 – 34 (20%)



(Note: the Kansas licensed driver percentage distributions were estimated based on FHWA (2004e) 2004 data. Crashes caused by drivers with unknown ages were not included in the graph.)

Figure 4.41. Fatal and Injury Crash Frequencies and Kansas Licensed Drivers by Age (in Percentages)

Time Information

It was found that daytime non-peak hours between 10:00 a.m. – 4:00 p.m. accounted for the highest hourly percentages for both fatal and injury crashes. Compared with injury crashes, a larger proportion (37% vs. 18%) of work zone fatal crashes occurred at nighttime (8:00 p.m. – 6:00 a.m.). The percentage of nighttime work zone fatal crashes was only slightly higher (37% vs. 36%) than that of all Kansas fatal crashes during the same period for last 5 years (KDOT 2006). Figure 4.42 show the frequencies of both fatal and injury crashes by crash time.

Regarding the seven days of week, no significant proportional differences were found. In addition, most of the fatal and injury crashes occurred in the construction season from April to November. The two most frequent observations of the crash temporal variables such as time, day, and month for both fatal and injury work zone crashes are listed in Table 4.22.

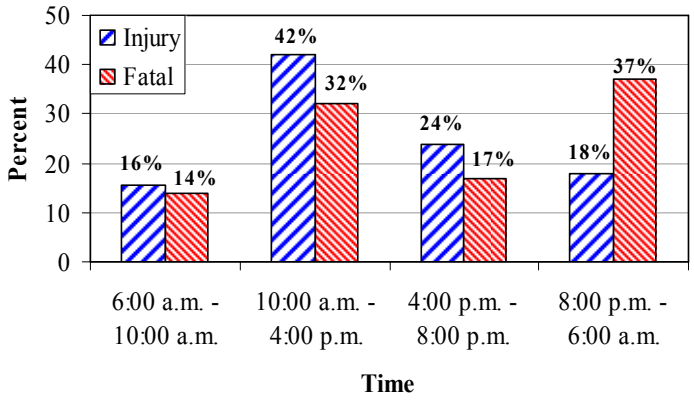


Figure 4.42. Fatal and Injury Crash Percent Frequencies by Crash Time

Table 4.22. Most Frequent Observations for Time Information Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Time	8:00pm – 6:00am (37%)	10:00am – 4:00pm (32%)	10:00am – 4:00pm (42%)	4:00pm – 8:00pm (24%)
Day	Saturday (17%)	Friday (16%)	Friday (18%)	Wednesday (17%)
Month	June (14%)	July/August (12%)	August (15%)	June/Sept. (12%)

Climatic Environment Information

Table 4.23 presents the most frequent observations for climatic environmental variables such as light condition, weather condition, and road surface condition.

Generally, comparison showed that poor light conditions contributed to a larger proportion of fatal crashes than for injury crashes. As shown in Figure 4.43, 32% of the fatal crashes occurred in darkness without streetlights, while this unfavorable light condition only contributed to 13% of the injury crashes. Correspondingly, there were 22% more injury crashes than fatal crashes (75% vs. 53%) that occurred in daylight condition. The considerable differences indicate that poor light conditions could result in high-severity work zone crashes. Regarding the other environmental variables such as weather condition and road surface condition, the comparison showed no notable differences between fatal and injury crashes.

Table 4.23. Most Frequent Observations for Climatic Environment Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Light condition	Daylight (53%)	Dark: no street lights (32%)	Daylight (75%)	Dark: no street lights (13%)
Weather condition	Good (91%)	Rain, mist, or drizzle (5%)	Good (87%)	Rain, mist, or drizzle (8%)
Road surface condition	Dry (88%)	Wet (8%)	Dry (84%)	Wet (12%)

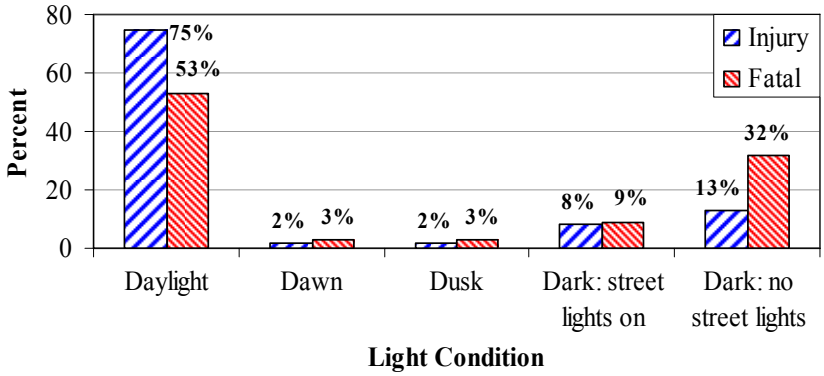


Figure 4.43. Fatal and Injury Crash Percent Frequencies by Light Condition

Crash Information

Crash information was described by several variables including vehicle maneuver before crash, crash type, vehicle body type, and number of vehicles. The comparisons for vehicle maneuver before crash and number of vehicles did not show any significant differences between fatal and injury crashes; straight following the roads and two-vehicle crashes were the most frequent observations for these two variables, respectively. Instead, the comparisons in terms of crash type and vehicle body type showed differences worth discussing.

Figure 4.44 shows the injury and fatal crash frequencies by crash type. The dominant type for injury crashes was "collision with other vehicles: rear-end" which accounted for 46% of the total injury crashes, 30% higher than the fatal crashes. The head-on crash was the most common type for work zone fatal crashes and attributed to 24% of the total fatal crashes, while this crash type only represented 2% of the injury crashes. This pronounced difference indicated that head-on collisions could significantly increase the crash severity and cause fatalities. In addition, fatal and injury crashes had comparable proportions of angle-side impact, fixed object, and overturned crashes.

The comparison by vehicle body type indicated that truck-involved work zone crashes had a higher probability of causing fatalities. As shown in Figure 4.45, the most common fatal crashes were truck-vehicle crashes that comprised 34% of the total fatal crashes, 25% more than the injury crashes. Overall, trucks were involved in 40% of the fatal work zone crashes (34% truck-vehicle crashes, 2% truck-truck

crashes, and 4% truck-other crashes). This percentage was much higher than the 16% of all Kansas fatal crashes involving heavy trucks during the past 13 years (1992-2004, KDOT 2006). The term "truck" here refers to the heavy vehicle types such as single-unit large truck, truck and trailer, tractor-trailer, and buses. The term "vehicle," as opposed to trucks, includes such light-duty vehicle types as passenger car, van, pickup truck, SUV, ATV, and camper or RV. Vehicle-vehicle crashes were found to be most frequent for the injury crashes, accounting for 58%. These facts imply that truck involvement was a catalyzing factor for work zone traffic fatalities. The most frequent observations of the crash information variables for both fatal and injury crashes are listed in Table 4.24.

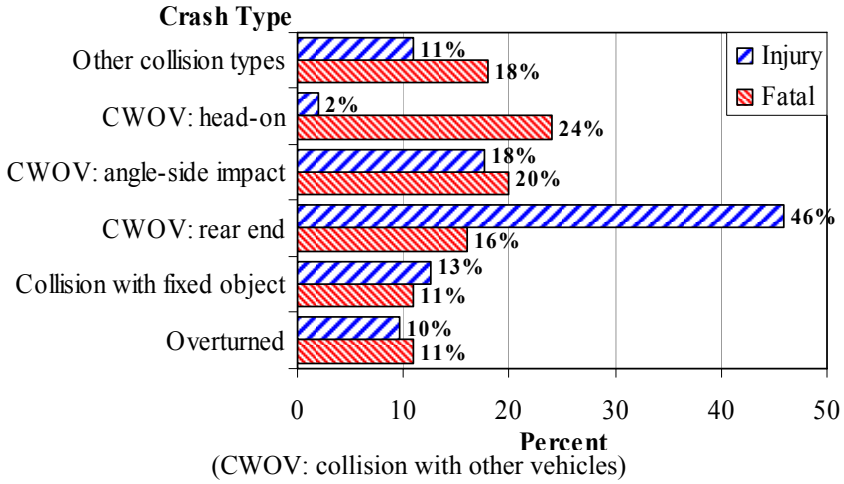


Figure 4.44. Fatal and Injury Crash Percent Frequencies by Crash Type

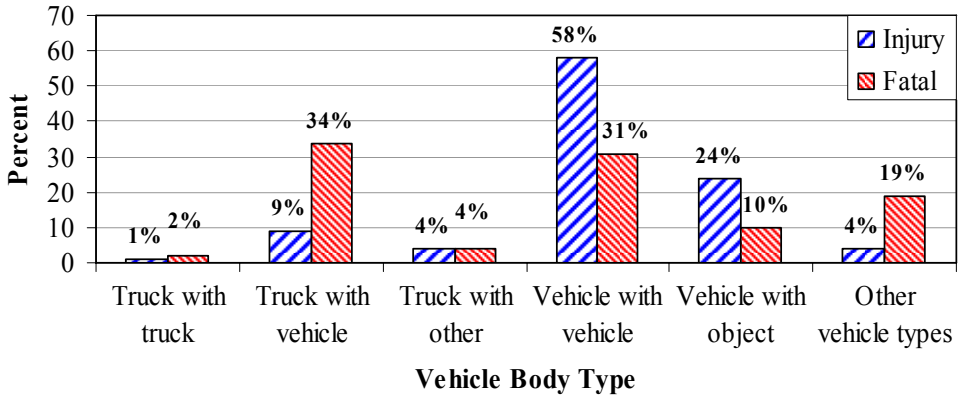


Figure 4.45. Fatal and Injury Crash Percent Frequencies by Vehicle Body Type

Table 4.24. Most Frequent Observations for Crash Information Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Vehicle maneuver before crash	Following road (74%)	Overtaking (6%)	Following road (68%)	Left turn (6%)
Crash type	Head-on (24%)	Angle-side (20%)	Rear-end (46%)	Angle-side (18%)
Vehicle body type	Truck-vehicle (34%)	Vehicle- vehicle (31%)	Vehicle-vehicle (58%)	Vehicle-object (24%)
No. of vehicles involved	Two-vehicle (53%)	Single-vehicle (32%)	Two-vehicle (50%)	Single-vehicle (30%)

Road Condition

Road condition had nine variables describing the conditions related to the crash highway section. As indicated in Table 4.25, the crash frequencies of some of these variables had significant differences between fatal and injury crashes.

Most of the fatal and injury crashes occurred on interstates and other principal arterials, shown in Figure 4.46. In particular, 11% more fatal crashes (56% vs. 45%) were found in the work zones on the principal arterials other than interstates and other

freeways or expressways. On the contrary, interstate highways and other freeways or expressways totally had 17% more injury crashes than fatal crashes.

Table 4.25. Most Frequent Observations for Road Condition Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Road class	Other principle arterials (56%)	Interstate (27%)	Other principal arterials (40%)	Interstate (33%)
Road character	Straight & level (51%)	Straight on grade (25%)	Straight & level (66%)	Straight on grade (18%)
Number of lanes	Two-lane (63%)	Four-lane (31%)	Four-lane (49%)	Two-lane (33%)
Speed limit (mph)	51 – 60 (47%)	61 – 70 (45%)	51 – 60 (47%)	61 – 70 (21%)
Crash location	Non-intersection (67%)	Intersection (13%)	Non-intersection (58%)	Intersection (15%)
Surface type	Blacktop (69%)	Concrete (30%)	Blacktop (61%)	Concrete (39%)
Road special feature	None (85%)	Bridge (5%)	None (85%)	Bridge (6%)
Area information	Rural (84%)	Urban (16%)	Rural (86%)	Urban (14%)
Traffic control	Center/edge lines (80%)	No passing zone (20%)	Center/edge lines (72%)	Traffic signal (15%)

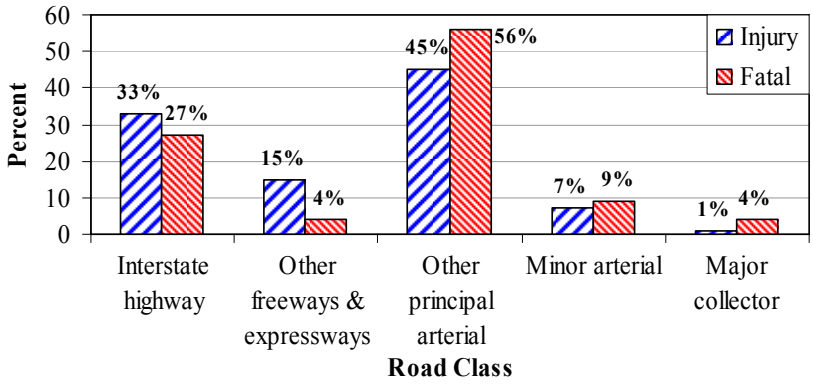


Figure 4.46. Fatal and Injury Crash Percent Frequencies by Road Class

Figure 4.47 exhibits the frequencies of fatal and injury work zone crashes by road character. It was found that 66% of the injury crashes occurred in work zones on straight and level highway sections and 34% of the injury crashes were on highway sections with complicated geometric alignments. However, almost half (49%) of the fatal crashes were in the work zones on highway sections with complex alignment characters such as grades and curves. In particular, among the complex alignment conditions, straight on grade contributed to the highest proportion of both injury crashes (18%) and fatal crashes (25%). These differences indicated that the presence of complicated highway alignment combinations, especially straight on grade, could potentially increase the severity of a work zone crash.

The analyses of fatal crashes in Kansas highway work zones showed that most (63%) of the fatal crashes took place on two-lane highways, as shown in Figure 4.48. On the contrary, only one-third (33%) of the injury crashes were on two-lane highways while the rest were on multilane highways. In addition, the percentage of the work zone crashes on two-lane highways (63%) was much higher than the percentage (35%) for all Kansas fatal crashes during 2000 – 2004 (KDOT 2006). Combining the facts that the most common crash type for the injury crashes was rear-end and the most common type for fatal crashes was head-on, the different proportional distributions of fatal and injury crashes over number of traffic lanes implied that injury crashes were more attributed to high volumes of traffic than fatal crashes.

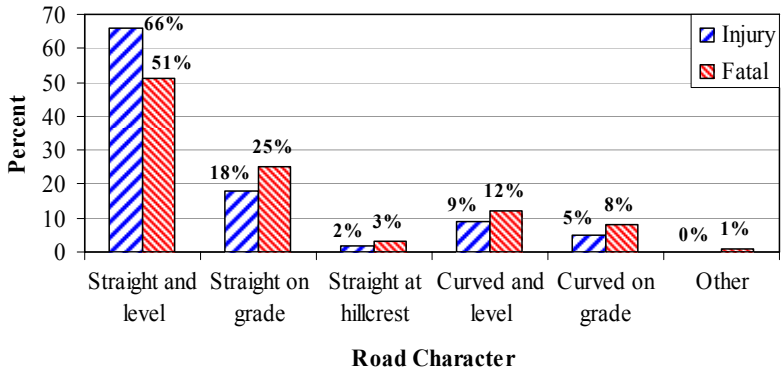


Figure 4.47. Fatal and Injury Crash Percent Frequencies by Road Character

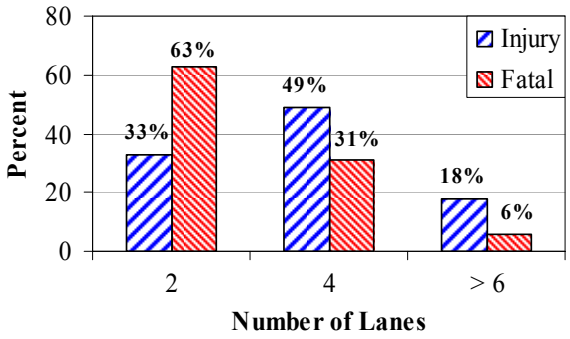


Figure 4.48. Fatal and Injury Crash Percent Frequencies by Number of Lanes

The fatal and injury crash distributions over speed limits are shown in Figure 4.49. Results illustrated that 51 – 60 mph speed zones had the highest proportion (47%) of both fatal and injury crashes. A much larger proportion of fatal crashes (45% vs. 21%) occurred on highways with high speed limits between 61 – 70 mph. With speed limits decreasing, highway work zones tended to have higher percentages of injury crashes than fatal crashes. For instance, a much larger proportion of injury crashes were found in highways with speed limits lower than 51 mph. This tendency confirmed that a high-speed crash increased the possibility of involving fatalities.

When comparing the fatal and injury crash distributions by crash location, it was found that slightly higher percentages of injury crashes took place in intersections, intersection-related areas, and interchange areas. As shown in Figure 4.50, a majority (67%) of fatal crashes occurred in non-intersection areas while 58% of injury crashes were found in the same areas.

The comparisons based on other road condition variables including surface type, road special feature, and area information showed no significant differences between fatal and injury crashes. Generally, most fatal and injury crashes occurred on blacktop (asphalt-paved) highways, highways without special features such as bridges, railroad crossings, interchanges/ramps, and highways in rural areas. The comparison of the crash distributions by traffic control devices was illustrated in Figure 4.51. Center/edge line was the most common traffic control used at crash sites. In addition, "none or inoperative traffic control" coincided with 8% more injury crashes than fatal crashes (11% vs. 3%).

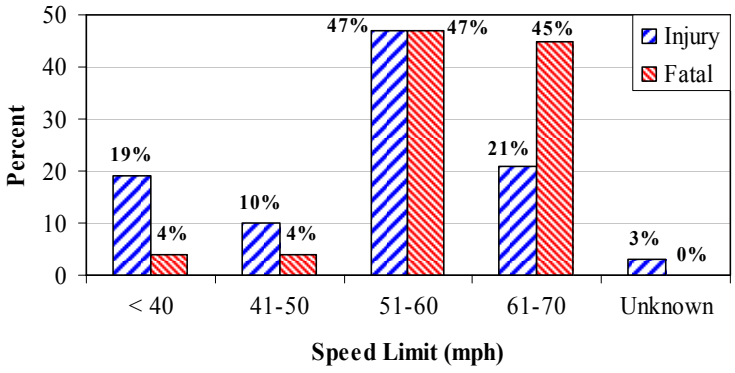


Figure 4.49. Fatal and Injury Crash Percent Frequencies by Speed Limit

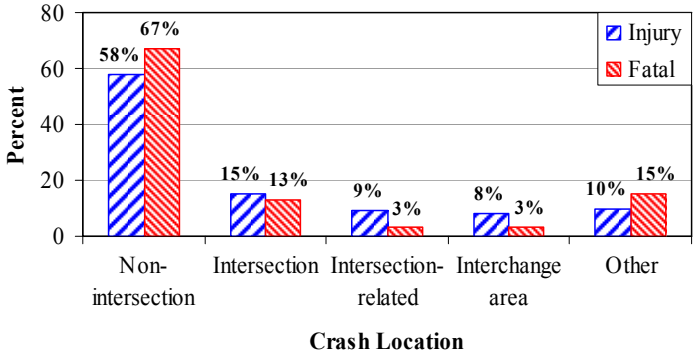


Figure 4.50. Fatal and Injury Crash Percent Frequencies by Crash Location

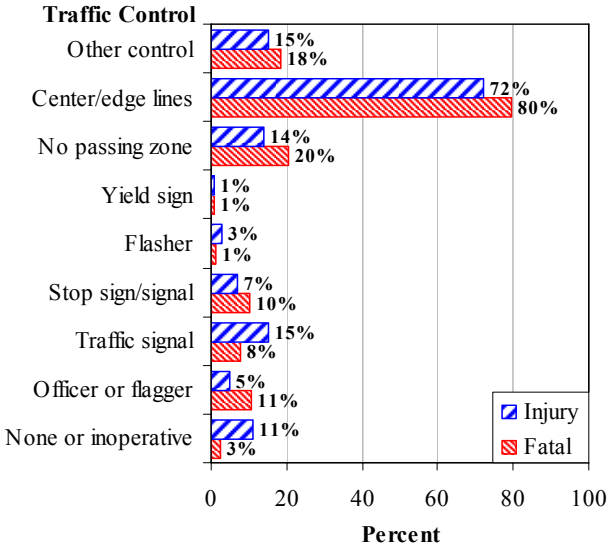


Figure 4.51. Fatal and Injury Crash Percent Frequencies by Traffic Control

Contributing Factor

As discovered in the separate analyses of fatal and injury crash characteristics, pedestrian factors, environmental factors, and vehicle factors contributed only a trivial percentage for both types of work zone crashes. Thus, the comparison

discussed was only based on driver errors, which had been proved as the major causal factors for most crashes. Among the various driver errors, inattentive driving contributed to more than half of both the fatal and injury crashes. Followed too closely caused 14% more injury crashes than fatal crashes (18% vs. 4%). On the other hand, some other driver errors such as "disregarded traffic signs, signals, or markings" and "under influence of alcohol" resulted in notably higher percentages of fatal crashes than injury crashes. The detailed crash distributions due to driver errors are shown in Table 4.26 and the crash frequencies by major driver errors are highlighted in Figure 4.52. The most frequent observations for the contribution factor variables are listed in Table 4.27.

Table 4.26. Fatal and Injury Crash Percent Frequencies by Driver Error

Driver Factor	Injury (%)	Fatal (%)
Inattention	51	53
Too fast for conditions/speeding	18	25
Disregarded traffic signs, signals or markings	10	21
Wrong side or wrong way	2	20
Under influence of alcohol	5	13
Failed to yield right of way	8	10
Fell asleep	3	9
Followed too closely	18	4
Improper lane change	2	4
Improper passing	1	4
Ill or medical condition	1	4
Avoidance or evasion action	3	3
Not comply-license restrictions	1	1
Other/unknown	5	6
No human error	18	8

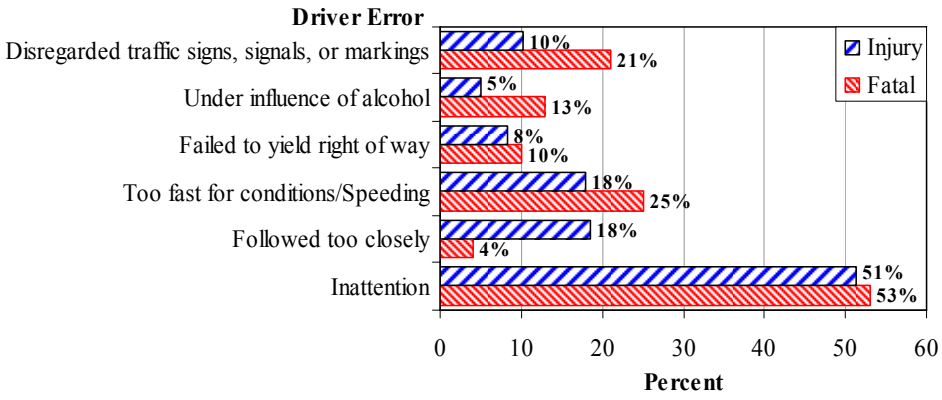


Figure 4.52. Fatal and Injury Crash Percent Frequencies by Driver Error

Table 4.27. Most Frequent Observations for Contribution Factor Variables

Variable	Top Two Observations			
	Fatal Crash		Injury Crash	
Driver factor	Inattention (53%)	Too fast/ Speeding (25%)	Inattention (51%)	Followed too close (25%)
Pedestrian factor	Illegal in road (2%)	--	--	--
Environment factor	Rain, mist, or drizzle (2%)	--	Rain, mist, or drizzle (2%)	--
Vehicle factor	Tires (1%)	--	Brakes/tires (1%)	--

Note: "--" indicates a percentage less than 1%.

4.4.2 Summary of Fatal and Injury Crash Characteristics

In this study, the characteristics of fatal and injury crashes in highway work zones were compared based on frequencies of various crash variables. The comparisons helped to thoroughly understand the general characteristics of the work zone crashes as well as the unique ones distinguishing different severities. The results provide practical insights to facilitate the development of work zone traffic control strategies that could not only reduce the number of crashes but also mitigate the crash severity.

Summarized in Tables 4.28 and 4.29 are the major similar characteristics and different characteristics between fatal and injury crashes in Kansas highway work zones, respectively. Based on the comparison results, the researcher found that complicated geometric highway alignments (especially grades), unfavorable light conditions, involvement of trucks, alcohol impairment, and disregarding traffic control, were the primary factors that contributed to the potential increase of crash severity in work zones. Comparison results also suggested that the fatal crashes were more related to high speeds while the injury crashes were more related to high traffic volumes.

Table 4.28. Similar Characteristics between Fatal and Injury Crashes

Category	Comparable Characteristics
At-fault drivers	1. Male drivers caused most of the crashes. 2. Male drivers caused most of the truck-involved crashes and single-vehicle crashes.
Crash time	1. Both types of crashes had the highest frequencies during daytime non-peak hours (10:00 a.m. – 4:00 p.m.). 2. Most of the crashes occurred in the construction season from April to November.
Crash location	1. A majority of the crashes occurred on rural highways. 2. Most of the crashes took place on interstates and other principal arterials. 3. Most of the crashes occurred in non-intersection areas without the impacts of road special features such as bridges, interchanges, or ramps.
Crash type	1. Multi-vehicle crashes were the most common type for the crashes. 2. Most truck-involved crashes were multi-vehicle crashes.
Causal factors	1. Human errors, inattentive driving in particular, were the primary causal factors for the crashes. 2. Poor light conditions were a contributing factor for the crashes. 3. Adverse weather conditions, poor road surface conditions, pedestrian factors, and vehicle problems were not important contributing factors for the crashes.

Table 4.29. Different Characteristics between Fatal and Injury Crashes

Category	Fatal Work Zone Crash	Injury Work Zone Crash
At-fault drivers	Drivers between 35-44 and older than 64 frequently caused more fatal crashes.	Drivers younger than 35, especially those between 15-24, frequently caused injury crashes.
Crash time	A much larger proportion occurred during nighttime.	Daytime non-peak hours had the highest crash frequency.
	The distribution of fatal crashes had no significant differences over the seven days of a week, but Sundays accounted for much more (15% vs. 9%) fatal crashes than injury crashes.	Fridays and Sundays had the respective highest and lowest percentages of injury crashes (18% vs. 9%).
Crash location	Most crashes took place in 51-60 mph and 61-70 mph speed zones.	51-60 mph speed zones had almost half of the crashes; the rest were relatively evenly distributed over other speed zones.
	Two-lane highways had a higher proportion of fatal crashes.	Four-lane highways had a higher proportion of injury crashes.
	A higher percent of fatal crashes occurred in non-intersection areas.	A higher percent of injury crashes occurred in intersection or intersection-related areas.
Crash type	Head-on was the dominant type.	Rear-end was the dominant type.
	A large percent of crashes involved trucks.	A majority of crashes involved only light-duty vehicles.
Causal factors	Disregarded traffic control, alcohol impairment, and speeding caused a much larger proportion.	Followed too close caused a much higher percent.
	Unfavorable light conditions, especially nighttime darkness, contributed to a larger proportion.	A majority of the crashes occurred when light conditions were favorable.
	Complicated road geometries contributed to a larger proportion.	A majority of the crashes occurred on straight and level highways.

Note: The comparison was based on percentages.

Chapter 5
EFFECTIVENESS OF WORK ZONE TEMPORARY TRAFFIC CONTROL TECHNIQUES

The development of safe and cost-effective work zone traffic control plans is one of the key steps towards improving work zone safety. Evaluating the effectiveness of current work zone traffic control devices based on work zone crash data will enhance the practices of work zone traffic control design. In this section, the effectiveness of several commonly used work zone traffic control devices was assessed using the binary logistic regression technique. The results of the analyses can be used by traffic engineers for the selection of TTC devices that will result in not only reduced number of crashes but also mitigated crash severity in work zones.

5.1 EVALUATION METHODOLOGY

The binary logistic regression method was used for the evaluation of the effectiveness of TTCs in work zones. This method is a statistical technique for describing the relationship between a set of independent explanatory variables and a dichotomous response variable or outcome. Because traffic crash analyses involve establishing the relationship between the occurrence of a crash and a combination of

various contributing factors, this technique arose as an ideal method. A binary logistic regression model is a direct probability model that has no requirements on the distributions of the explanatory variables or predictors (Harrell 2001). Compared to other statistical methods, development of a binary logistic regression model is more flexible and likely to yield accurate results in traffic crash analyses.

The significance of a predictor (a crash variable) was tested using three statistical methods. The first method is the Likelihood Ratio (LR) Test Method. This test method compares the deviation of the model with the predictor and that without the predictor. Two other methods used to test the significance of a predictor were the Wald Test and the Score Test (Hosmer and Lemeshow 2000). The Wald statistic was obtained by comparing the maximum likelihood estimate of the slope parameter (the coefficient of an analyzed variable) to an estimate of its standard error. The Score Test was based on the distribution theory of the derivatives of the log likelihood. Results of the previous studies have shown that Wald Test could fail to reject the null hypothesis (the coefficient is not significant) when the coefficient is actually significant. The Score Test was a multivariate test requiring matrix calculations which were not available in some statistical software (Hosmer and Lemeshow 2000). SAS software program has a logistic regression function that includes these three test-of-significance methods and thus was utilized as the primary tool for the evaluation.

The basic theories of logistic regression were introduced in the literature review chapter. The following is a brief description about the applications of the logistic regression theories on the effectiveness of TTC techniques. Quantifying the

safety impact of an explanatory variable can be treated as a special binary case of logistic regression, and the logistic regression models are:

$$logit\{Y = 1|X = 0\} = \beta_0$$

$$logit\{Y = 1|X = 1\} = \beta_0 + \beta_1$$

where Y denotes an event ($Y = 1$ and $Y = 0$ denote occurrence and nonoccurrence, respectively), X is a variable to be analyzed, and βs are the coefficients. Accordingly, the estimated probability $\hat{P}$ that an event (a crash) occurs ($Y = 1$) when the test factor is present ($X = 1$) is:

$$\hat{P}\{Y = 1|X = 1\} = exp\{\hat{\beta}_0 + \hat{\beta}_1\}/(1 + exp\{\hat{\beta}_0 + \hat{\beta}_1\})$$

and the estimated probability $\hat{P}$ that this event happens ($Y = 1$) when the test factor is absent ($X = 0$) is:

$$\hat{P}\{Y = 1|X = 0\} = exp\{\hat{\beta}_0\}/(1 + exp\{\hat{\beta}_0\})$$

In this study, odds ratio was used to measure the difference between the univariate logistic regression model pair. Odds ratio is defined as the ratio of the two odds given the two values of the test variable. Given the estimated odds of an event $\{Y = 1|X\}$ as:

$$Odds\{Y = 1|X\} = \hat{P}\{Y = 1|X\}/(1 - \hat{P}\{Y = 1|X\})$$

the odds ratio for the single-variable case is:

$$Odds\ ratio\ (X = x_1 : X = x_2) = exp[\hat{\beta}_1\ (x_1 - x_2)]$$

5.2 EVALUATING TTC EFFECTIVENESS IN MITIGATING WORK ZONE CRASH SEVERITY

Based on the available crash information, the effectiveness of several commonly used work zone TTC techniques was evaluated. The crash data used for the evaluation included the fatal and injury work zone crashes in Kansas highway work zones between January 2003 and December 2004. The dataset had a total of 655 severe crashes among which 29 were fatal crashes and 626 were injury. The evaluated TTC methods included flagger/officer, stop sign/signal, flasher, no passing zone, and center/edge lines.

5.2.1 Effectiveness of Flagger/Officer

For estimating the effectiveness of flagger/officer control in reducing the severity of work zone crashes, the response variable *Y* represented a severe crash (*Y = 1* for fatal crashes and *Y = 2* for injury crashes) and the explanatory variable *X* represented the presence of a flagger (*X = 1* for presence and *X = 0* for absence). The logistic regression model was estimated as following:

$$logit\{Y = 1|X\} = -2.42 - 0.81X.$$

The three test-of-significance statistics (Likelihood Ratio, Score, and Wald) all indicated a high level of significance (i.e. 0.01) for the flagger variable.

According to this model, the conditional probability of having fatalities, given the occurrence of a severe crash (either fatal or injury), when a flagger control was present was estimated as:

$$\hat{P}\{Y = 1|X = 1\} = exp\{\hat{\beta}_0 + \hat{\beta}_1\}/(1 + exp\{\hat{\beta}_0 + \hat{\beta}_1\}) = 0.04$$

and the corresponding probability without a flagger control was:

$$\hat{P}\{Y = 1|X = 0\} = exp\{\hat{\beta}_0\}/(1 + exp\{\hat{\beta}_0\}) = 0.08$$

The estimated odds ratio between the occurrence of a fatal crash with a flagger control and without a flagger control was:

$$Odds\ ratio\ (X = 1 : X = 0) = exp[\hat{\beta}_1\ (x_1 - x_2)] = exp[-0.81 \times (1 - 0)] = 0.44.$$

Hence, statistically, using a flagger in a work zone could reduce the odds of a severe crash resulting in fatality by 56%. In terms of probability, the presence of a flagger in a work zone could lower the probability of causing fatalities by 4% (or from 0.08 to 0.04) when a severe crash occurred. Table 5.1 lists the parameters of the fitted logistic regression model and the estimated probabilities and odds ratio based on the model.

Table 5.1. Model Parameters and Evaluation Results for Flagger Control

Coefficient		**p-Value of Significance Test***			**Probability of Causing Fatalities**		**Odds Ratio (X = 1 : X = 0)****
$\hat{\beta}_0$	$\hat{\beta}_1$	LR***	Score	Wald	*X = 1*	*X = 0*	
-2.42	-0.81	0.01	0.00	0.00	0.04	0.08	0.44

*: p-Value is the output value of the statistical tests of significance. A p-value less than 0.1 indicates that the test variable is significant at 0.1 level of significance, and is underlined in the table.

**: X = 1 when the variable was present and X = 0 when it was absent.

***: Likelihood Ratio.

5.2.2 Effectiveness of Flasher Device

In the case of modeling the effectiveness of a flasher in reducing the crash severity in work zones, the response variable *Y* was assigned with values of one and

two to denote fatal and injury crashes, respectively. Using the SAS software, the following logistic regression model was generated:

$$logit\{Y = 1|X\} = -2.24 - 0.86X.$$

Listed in Table 5.2 are the results of the three tests of significance and the respective probabilities of a severe crash resulting in fatalities with and without a flasher control device. The odds ratio of having a fatal crash with and without a flasher control device is also included in the table. The results indicated that using a flasher device in a work zone could reduce the odds of a severe crash resulting in fatalities by 58%. In terms of probability, having a flasher device in work zones could lower the probability of causing fatalities when a severe crash occurred by 6% (or 0.10 to 0.04).

Table 5.2. Model Parameters and Evaluation Results for Flasher Control

Coefficient		**p-Value of Significance Test***			**Probability of Causing Fatalities**		**Odds Ratio** ***(X = 1 : X = 0)****
$\hat{\beta}_0$	$\hat{\beta}_1$	LR***	Score	Wald	*X = 1*	*X = 0*	
-2.24	-0.86	0.20	<u>0.09</u>	0.13	0.04	0.10	0.42

*: p-Value is the output value of the statistical tests of significance. A p-value less than 0.1 indicates that the test variable is significant at 0.1 level of significance, and is underlined in the table.

**: X = 1 when the variable was present and X = 0 when it was absent.

***: Likelihood Ratio.

5.2.3 Effectiveness of Pavement Center/Edge Lines

To assess the effectiveness of center/edge lines in mitigating work zone crash severity, the response variable *Y* was assigned with values of one and two to denote fatal and injury crashes, respectively. In addition, the variable "center/edge lines" was

assigned with values of one and zero which respectively represent the presence and absence of this traffic control in a work zone. The logistic regression model was developed using SAS software as shown below:

$$logit\{Y = 1|X\} = -3.63 - 0.80X.$$

Table 5.3 shows the other results including the three test-of-significance statistics, the estimated probabilities, and the odds ratio. The regression analysis results suggested that the use of center/edge lines in work zones could reduce the odds of causing fatalities when severe crashes occurred by 55%. In terms of probability, the use of center/edge lines could decrease the probability of involving fatalities in severe crashes (either fatal or injury) by 2%.

Table 5.3. Model Parameters and Evaluation Results for Center/Edge Lines

Coefficient		**p-Value of Significance Test***			**Probability of Causing Fatalities**		**Odds Ratio** ***(X = 1 : X = 0)****
$\hat{\beta}_0$	$\hat{\beta}_1$	LR***	Score	Wald	*X = 1*	*X = 0*	
-3.63	-0.80	0.01	0.02	0.03	0.01	0.03	0.45

*: p-Value is the output value of the statistical tests of significance. A p-value less than 0.1 indicates that the test variable is significant at 0.1 level of significance, and is underlined in the table.
**: X = 1 when the variable was present and X = 0 when it was absent.
***: Likelihood Ratio.

5.2.4 Effectiveness of Stop Sign/Signal

The tests of significance showed that the presence of a stop sign/signal control device in a work zone was not significantly related to the involvement of fatalities in severe crashes. Hence, the effectiveness of a stop sign/signal control device in reducing the severity of crashes was not assessed.

5.2.5 Effectiveness of "No-Passing Zone" Control

Results of the three tests of significance including Likelihood Ratio Test, Score Test, and Wald Test all suggested that a work zone no-passing zone control was not significantly related to the crash severity. Thereby, based on the available data, the effectiveness of this traffic control technique in reducing work zone crash severity was not evaluated.

5.3 SUMMARY

In this chapter, the effectiveness of several TTC techniques commonly used in work zones was evaluated and results were presented. TTC techniques selected in this study included flagger/officer, stop sign/signal, flasher, no passing zone, and center/edge lines. The evaluation was intended to provide valuable knowledge for developing traffic control strategies that can effectively reduce high-severity crashes such as those involving fatalities. According to the logistic regression analyses, the presence of a flagger or officer directing traffic could reduce the odds of having fatalities in a severe crash by 56%; having flashers or center/edge lines in work zones could reduce the odds by more than 50% as well. However, based on the available crash data, the statistics could not establish close associations between the usages of stop signs/signals and no passing zones in work zones and the involvement of fatalities in severe crashes.

Chapter 6
DEVELOPMENT OF WORK ZONE CRASH-SEVERITY-INDEX MODELS

Work zone safety remains unsatisfactory nationwide and the numbers of work zone crashes have shown no sign of declining. This maybe partly due to the fact that the safety level of a work zone is influenced by combinations of various risk factors and some of them may not have been fully taken into consideration during work zone traffic control designs. A work zone risk is defined as an adverse travel condition that might result in severe crashes in a work zone. Understanding risks associated with work zone crashes might have great potential to lower risk levels and prevent the occurrence of severe crashes.

In this study, the concept of the crash severity index, or CSI, was proposed for the evaluation of risks in work zones. A CSI is a numerical value between zero and one calculated from the given work zone risk factors. It is interpreted as the likelihood of having fatality/fatalities when a severe crash occurs. The basic assumption used for the development of CIS is: if the likelihood of having fatality/fatalities is high when a crash occurs, the work zone travel condition has a high risk level. A CSI of zero means that a crash will have maximum likelihood of

having only injury/injuries if the crash occurs in the given travel conditions, while a CSI of one indicates the maximum likelihood of having fatality/fatalities if the crash takes place in the given conditions. CSIs provide traffic engineers with straightforward measures of work zone risk levels based on the screening of multiple variables that might contribute to potential occurrences of severe crashes. By assessing the risk level of either an existing work zone or a newly proposed work zone, traffic engineers will have an opportunity to implement safety countermeasures to eliminate and/or mitigate the risks for the traveling public.

6.1 CSI MODEL DEVELOPMENT PROCEDURE

The models used to estimate CSIs were developed based on the information about severe work zone crashes resulting in injuries or fatalities. The procedure of model development included three steps. First, the risk factors in work zones that had impact on crash severity were determined based on the collected crash data. Second, a set of CSI models were developed by incorporating these risk factors. Finally, the predictability of the developed models was validated using work zone crash data. Crash data were divided into two groups. One group was used for CIS model development. Another group was utilized for model validation. The logistic regression method was chosen to develop the models since it is suitable for describing the relationships between a set of explanatory variables and a dichotomous response variable or outcome and it has no requirements on the distributions of the explanatory variables or predictors (Harrell 2001). Using this method is more flexible and more

likely to yield accurate results in the traffic crash analysis where the safety impact of contributing factors need to be quantified.

Table 6.1 shows the two sets of Kansas work zone crash data used for model development and validation. The dataset used for model development had a total of 334 severe work zone crashes including 67 fatal crashes during 1998 and 2003 and 267 injury crashes in 2003. Adding the fatal crashes of the previous five years (1998 – 2002) in the model development dataset enriched the fatal crash information and thus increased model accuracy, especially for estimating CSIs of traffic conditions with high risk level (i.e., a risk level at which fatal crashes may occur). The dataset for model verification included 355 severe crashes in year 2004 in Kansas highway work zones, among which 18 were fatal crashes and 337 were injury crashes. The data collection procedure was presented in Chapter 3: Data Collection.

Table 6.1. Two Datasets Used for CSI Model Development and Verification

Crash Type	Group1: Model Development	Group 2: Model Validation
Fatal	67	18
Injury	267	337
Total	334	355

6.2 WORK ZONE RISK FACTOR DETERMINATION

Risk factors were determined based on the dataset containing the fatal crashes between 1998 and 2003 and the injury crashes in 2003. Statistical tests and previous

crash investigation results were utilized to determine the risk factors from the crash variables. The selected risk factors were used later to develop CSI models.

6.2.1 Crash Variables for Risk Factor Determination

As described in the data collection chapter, six major categories of crash information were abstracted from KDOT's reports. In each category, the variables that might relate to crash severity were selected to determine their risk levels. The detailed observations for some variables were reclassified into more general observation groups so that the frequencies of the cross-categorized observations were increased. The increased data frequencies would minimize the errors caused by data sparseness in statistical tests and logistic regression. In addition, the values assigned to the observations of some variables were slightly modified to avoid the use of zeros. The crash variables and their values are described as following.

1. Responsible driver variables. Two variables describing responsible drivers were included: age and gender. These two variables and their values are listed in Table 6.2.

Table 6.2. Responsible Driver Variables and their Values

Variable Name	Variable Values
Age	1 (15-19 years old) 2 (20-24 years old) 3 (25-34 years old) 4 (35-44 years old) 5 (45-54 years old) 6 (55-64 years old) 7 (65 or older)
Gender	1 (Male) 2 (Female)

2. Time information variables. Two temporal variables that describe the time information of the crashes were tested, including time of day and day of week. The values of these two variables are listed in Table 6.3.

Table 6.3. Time Information Variables and their Values

Variable Name	Variable Values
Time of Day	1 (6:00 a.m. - 10:00 a.m.) 2 (10:00 a.m. - 4:00 p.m.) 3 (4:00 p.m. - 8:00 p.m.) 4 (8:00 p.m. - 6:00 a.m.)
Day of Week	1 (Monday) 2 (Tuesday) 3 (Wednesday) 4 (Thursday) 5 (Friday) 6 (Saturday) 7 (Sunday)

3. Climatic environmental variables. Three variables were included in this category including light condition, weather condition, and road surface condition that describe the environmental information of the crashes. The values of these variables are shown in Table 6.4.
4. Crash information variables. As listed in Table 6.5, the two crash information variables included in the risk factor determination were vehicle body type and number of vehicles involved. The vehicle body type variable describes the types of the crash vehicles such as heavy trucks or light-duty vehicles. This variable had two values: truck involved and non-truck involved. The number of vehicles involved in a crash was recorded using the actual number.

Table 6.4. Environmental Variables and their Values

Variable Name	Variable Values
Light Condition	1 (Good condition i.e., daylight) 2 (Fair conditions including dawn, dusk, and dark with streetlights) 3 (Poor condition i.e., dark without streetlights) 4 (Other unfavorable light conditions)
Weather Condition	1 (Good condition i.e., no adverse conditions) 2 (Poor conditions including rain, mist, drizzle, sleet, snow, fog, smoke, strong winds, blowing dust or sand, freezing rain, rain & fog, rain & wind, sleet & fog, snow & winds, and other)
Road Surface Condition	1 (Good condition i.e., dry surface) 2 (Fair conditions including wet, mud, dirt, sand, and debris) 3 (Poor conditions including snow, slush, ice, and snow packed)

Table 6.5. Crash Information Variables and their Values

Variable Name	Variable Values
Vehicle Body Type *	1 (Truck involved) 2 (Non-truck involved)
No. of Vehicles	Actual number of the vehicles involved in a crash

*: trucks include single large trucks, truck and trailers, tractor-trailers, and buses.

5. Road condition variables. Road conditions variables used to determine risk factors were road class, road character, number of lanes, speed limit, crash location, surface type, road special feature, and area information. These variables and their values are shown in Table 6.6.
6. Traffic control and human error variables. Six traffic control variables and six driver error variables that could affect crash severity were selected, as shown in Table 6.7.

In summary, 29 variables that could have impact on work zone crash severity were collected. The observations of some variables were regrouped to minimize the effects of data sparseness while maintaining reasonable data details. The values of these variables were organized in a spreadsheet that could be readily inputted into SAS software for risk factor determination.

Table 6.6. Road Condition Variables and their Values

Variable Name	Variable Values
Road Class	1 (Interstates and other freeways and expressways) 2 (Other principal arterials and minor arterials) 3 (Low-classification roads including major collectors, minor collectors, and local roads)
Road Character	1 (Straight and level) 2 (Straight on grade) 3 (Curve and level) 4 (Curve on grade) 5 (Other geometric alignments)
Number of Lanes	Actual number of the traffic lanes in two directions.
Speed Limit	1 (≥61 mph) 2 (51 mph – 60 mph) 3 (41 mph – 50 mph) 4 (≤40 mph)
Crash Location	1 (Non-intersection areas) 2 (Intersection or Intersection related areas) 3 (Other areas including interchange areas, crossover areas, and other)
Surface Type	1 (Concrete) 2 (Blacktop) 3 (Other types including gravel, brick, dirt, and other)
Road Special Feature	0 (No special feature impact) 1 (Impacted by special features including bridge, overhead bridge, railroad bridge, railroad crossing, interchange, ramp, and other)
Area Information	1 (Urban area) 2 (Rural area)

Table 6.7. Traffic Control and Driver Error Variables and their Values

Variable Name	Variable Values
Traffic Control	
None or inoperative	0 (Not present); 1 (Present)
Officer or flagger	0 (Not present); 1 (Present)
Stop sign/signal	0 (Not present); 1 (Present)
Flasher	0 (Not present); 1 (Present)
No-passing zone	0 (Not present); 1 (Present)
Center/edge lines	0 (Not present); 1 (Present)
Driver Error	
No driver error	0 (Not present); 1 (Present)
Drug or alcohol impairment	0 (Not present); 1 (Present)
Disregarding traffic signs, signals, and markings	0 (Not present); 1 (Present)
Exceeded posted speed limits or too fast for conditions	0 (Not present); 1 (Present)
Following too closely	0 (Not present); 1 (Present)
Inattentive driving*	0 (Not present); 1 (Present)

*: Inattentive driving includes such errors on the KDOT accident reports as "fell asleep," "inattention," "other distraction in or on vehicle," "distraction-cell phone," and "distraction-other electronic devices."

6.2.2 Risk Factor Determination Methodology

The determination of risk factors associated with work zone crash severity was a critical step towards developing CSI models with high accuracy and predictability. The determination process involved an examination of as many as 29 work zone crash variables. Some of the variables may have negligible impact on the crash severity. These variables should be abandoned because incorporating these variables in the CSI models might not only complicate the models, but also lower their accuracies. Although most of the crash variables of this study were mutually independent, some variables associated with each other and certain combinations of these variable pairs may interactively affect the crash severity. Thus, identifying the

risk factors that both individually and interactively affect work zone crash severity became critical.

Chi-square statistics and Cochran-Mantel-Haenszel (CMH) Statistics were employed to ensure the accuracy of risk factor identification. These statistics have been applied in some previous crash data analyses (Chira-Chavala and Mak 1986; Chen and Jovanis 2000). As shown in Figure 6.1, the identification procedure included three steps described as follows:

Step 1. The variables that are statistically associated with the crash severity were selected first as risk factors through chi-square statistics. Pearson chi-square and Likelihood Ratio chi-square tests were utilized in this step. A variable was selected when at least one of the two tests supported its relationship with the crash severity (i.e., a level of significance less than or equal to 10%).

Step 2. In this step, the insignificant variables from the previous step were further examined by CMH statistics to detect those that affect work zone crash severity interactively with certain selected risk factors. In other words, these variables may be closely associated with the crash severity only in certain conditions defined by other risk factors. The direct impact of these variables may not strong enough to be statistically detected through chi-square tests. CMH statistics test the relationships between initially unselected variables and the crash severity variable in a three-way contingency table by controlling the selected risk factors. The significant variables supported by CMH statistics in this step were selected as risk factors.

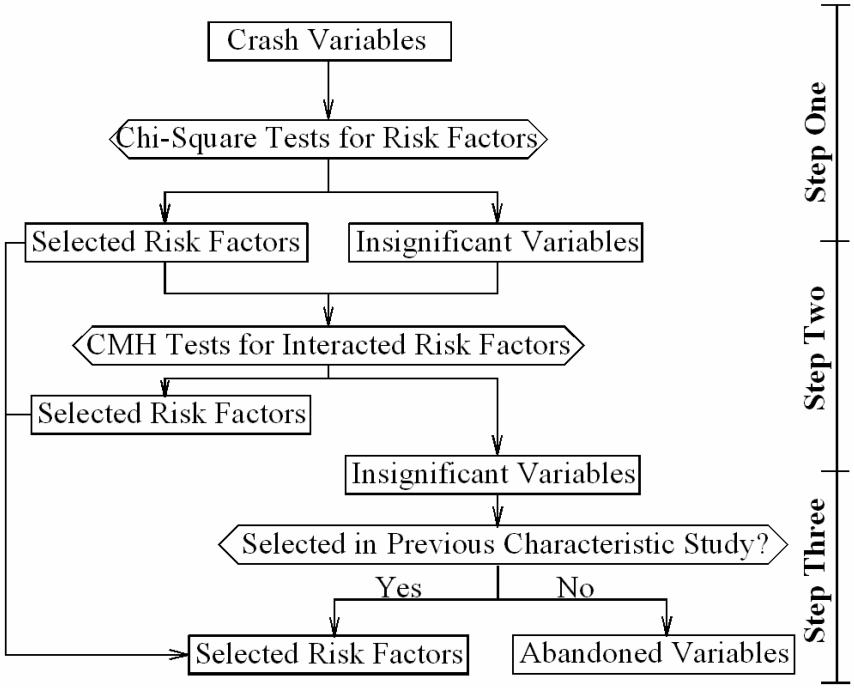


Figure 6.1. Risk Factor Section Flowchart

Step 3. Because of data sparseness, the test methods in the previous two steps may not be able to identify all risk factors. In addition, the amount of available data used for model development may not be big enough to statistically illustrate the potential impact of some variables. To identify all risk factors, the results of the characteristic comparisons between fatal and injury crashes were consulted and the risk factors concluded based on the comparisons yet not detected in the previous two steps were selected.

The mathematical theories of Pearson chi-square and likelihood ratio chi-square statistics have been introduced in the Chapter 4 of this thesis. Herein described is the basic theory of CMH statistics (SAS 2004b); detailed description of CMH can be found in Agresti (1996). As in a typical three-way contingency table illustrated in

Table 6.8, suppose the control variable Z has q strata, indexing each of them by $h = 1, 2, ..., q$. Each stratum contains a two-way contingency table with X representing the test variable and Y representing the outcome variable. For table h, denote the cell frequency in row i and column j by n_{hij}, with corresponding row and column marginal totals denoted by $n_{hi\cdot}$ and $n_{h\cdot j}$, and the overall stratum total by n_h. To test the conditional association between X and Y, the null hypothesis, H_0, is that there is no association between X and Y in any of the strata. Thus, the respective expected value and covariance matrix of the frequencies are calculated as:

$$\mathbf{m}_h = \mathbf{E}[\mathbf{n}_h \mid H_0] = n_h(\mathbf{P}_{h\cdot *} \otimes \mathbf{P}_{h*\cdot})$$

and

$$\mathbf{Var}[\mathbf{n}_h \mid H_0] = \frac{n_h^2}{n_h - 1}((\mathbf{D}_{\mathbf{P}_{h\cdot *}} - \mathbf{P}_{h\cdot *}\mathbf{P}_{h\cdot *}^{'}) \otimes (\mathbf{D}_{\mathbf{P}_{h*\cdot}} - \mathbf{P}_{h*\cdot}\mathbf{P}_{h*\cdot}^{'}))$$

where:

$$\mathbf{n}'_{hi} = (n_{hi1}, n_{hi2}, ..., n_{hiC})$$

$$\mathbf{n}'_h = (\mathbf{n}'_{h1}, \mathbf{n}'_{h2}, ..., \mathbf{n}'_{hR})$$

$$p_{hi\cdot} = n_{hi}/n_h$$

$$p_{h\cdot j} = n_{h\cdot j}/n_h$$

$$\mathbf{P}'_{h*\cdot} = (p_{h1\cdot}, p_{h2\cdot}, ..., p_{hR\cdot})$$

$$\mathbf{P}'_{h\cdot *} = (p_{h\cdot 1}, p_{h\cdot 2}, ..., p_{h\cdot C})$$

and $\otimes$ denotes Kronecker product multiplication and $\mathbf{D_a}$ is a diagonal matrix with elements of $\mathbf{a}$ on the main diagonal.

Table 6.8. Notations in a Typical Three-Way Contingency Table

Control Variable Z (q strata)	**Dependent Variable** Y	**Test Variable** X				
		x_1	…	x_i	…	Total
Stratum 1	y_1	n_{111}	…	n_{1i1}	…	$n_{1\cdot 1}$
	…	…	…	…	…	…
	y_j	n_{11j}	…	n_{1ij}	…	$n_{1\cdot j}$
	Total	$n_{11\cdot}$	…	$n_{1i\cdot}$	…	
…	…	…	…	…	…	…
Stratum h	y_1	n_{h11}	…	n_{hi1}	…	$n_{h\cdot 1}$
	…	…	…	…	…	…
	y_n	n_{h1j}	…	n_{hij}	…	$n_{h\cdot j}$
	Total	$n_{h1\cdot}$	…	$n_{hi\cdot}$	…	
…	…	…	…	…	…	…
Stratum q	y_1	n_{q11}	…	n_{qi1}	…	$n_{q\cdot 1}$
	…	…	…	…	…	…
	y_n	n_{q1j}	…	n_{qij}	…	$n_{q\cdot j}$
	Total	$n_{q1\cdot}$	…	$n_{qi\cdot}$	…	

Given the expected value and covariance matrix of the frequencies, the generalized CMH statistic is defined as:

$$Q_{CMH} = \mathbf{G}'\mathbf{V}_{\mathbf{G}}^{-1}\mathbf{G}$$

where:

$$\mathbf{G} = \sum_h \mathbf{B}_h(\mathbf{n}_h - \mathbf{m}_h)$$

$$\mathbf{V}_{\mathbf{G}} = \sum_h \mathbf{B}_h(\mathbf{Var}(\mathbf{n}_h \mid H_0))\mathbf{B}'_h$$

and where $\mathbf{B}_h$ is the Kronecker product of the column scores $\mathbf{C}_h$ and row scores $\mathbf{R}_h$. When the null hypothesis is true, the CMH statistic has an asymptotic chi-square distribution with degree of freedom equal to the rank of $\mathbf{B}_h$.

SAS outputs three CMH statistics: the nonzero correlation statistic, the row mean scores statistic, and the general association statistic. These statistics test the H_0

of no association against different alternative hypotheses (H_1). The alternative hypotheses for these three statistics are:

1. The nonzero correlation statistic: there is a linear association between X and Y in at least one stratum.
2. The row mean scores statistic: for at least one stratum, the mean scores of the R rows are unequal.
3. The general association statistic: for at least one stratum, there is some kind of association between X and Y.

6.2.3 Determined Work Zone Risk Factors

Table 6.9 shows the crash variables that had relatively small p-values (i.e., significant at 10% level of significance) when tested by chi-square statistics at the first step of the risk factor determination. According to the two chi-square tests, 13 out of 29 variables had significant relationships with the crash severity and thus these variables were first selected as work zone risk factors.

Table 6.10 shows the variables that had impact on crash severity by interacting with certain selected risk factors. At least one of the three CMH statistics had a p-value less then 0.1 (i.e. the level of significance). As indicated in the table, the variables including crash time, road special feature, and area information were selected as risk factors as well.

Table 6.9. Risk Factors Selected by Chi-Square Tests at Step One

Risk Factor	DF*	Pearson χ^2		LR** χ^2	
		Value	*p*-Value	Value	*p*-Value
Age	7	47.21	<0.001	44.77	<0.001
Light Condition	3	12.70	0.005	11.78	0.008
Vehicle Type	1	18.97	<0.001	16.87	<0.001
Road Class	2	13.75	0.001	13.90	0.001
Road Character	4	8.78	0.067	8.49	0.075
Number of Lane	3	51.33	<0.001	53.07	<0.001
Speed Limit	3	27.97	<0.001	30.58	<0.001
Surface Type	2	12.08	0.002	12.65	0.002
None/Inoperative TC***	1	5.30	0.021	7.31	0.007
Flagger	1	4.07	0.044	3.46	0.063
Stop Sign/Signal	1	11.70	0.001	9.40	0.002
Disregarded TC***	1	14.13	<0.001	11.76	<0.001
Following too Close	1	17.74	<0.001	25.51	<0.001

*: Degree of Freedom. **: Likelihood. ***: Traffic Control.

Table 6.10. Risk Factors Interactively Affecting Crash Severity

Control Factor*	Interacted Risk Factors	Type of Test	DF**	Value	*p*-Value
Age	**Crash Time**	Nonzero Correlation	1	5.55	0.019
		Row Mean Scores	1	5.55	0.019
		General Association	3	6.77	0.080
Light Condition	**Road Special Feature**	Nonzero Correlation	1	3.76	0.052
		Row Mean Scores	1	3.76	0.052
		General Association	1	3.76	0.052
Vehicle Type	**Crash Time**	Nonzero Correlation	1	3.90	0.048
		Row Mean Scores	1	3.90	0.048
		General Association	3	4.00	0.261
Road Class	**Crash Time**	Nonzero Correlation	1	3.96	0.047
		Row Mean Scores	1	3.96	0.047
		General Association	3	4.22	0.239
Number of Lanes	**Crash Time**	Nonzero Correlation	1	4.50	0.034
		Row Mean Scores	1	4.50	0.034
		General Association	3	4.51	0.212
Speed Limit	**Area Information**	Nonzero Correlation	1	4.09	0.043
		Row Mean Scores	1	4.09	0.043
		General Association	1	4.09	0.043

*: Risk factor selected at the first step and used as the control factor in CMH tests.
**: Degree of Freedom.

Through the first two steps, 16 out of 29 variables were selected as work zone risk factors based on statistical analyses. To maximize the likelihood of complete selection, previous work zone crash study results were utilized and the risk factors that potentially increased crash severity were identified based on crash characteristic comparison during the process of the risk factor determination. As presented in Section 4.3, the fatal and injury crashes between 1992 – 2004 had noteworthy distribution differences over certain variables. These variables may affect work zone crash severity and including them in the CSI models would improve the accuracy. Brief descriptions of these variables are presented as follows.

1. Age. The percentage distributions of fatal and injury crashes had major differences over the age of at-fault drivers. In particular, drivers between 35 – 44 and older than 64 caused much higher percentages of fatal crashes than those of injury crashes.
2. Crash time. The results of the characteristic study showed that the fatal and injury crash distributions over crash time had large percentage differences. For instance, a much large proportion of fatal crashes occurred during nighttime than those of injury crashes (37% vs. 18%).
3. Speed limit. The fatal and injury crash distributions over speed limit had significant differences. For example, the percentage of the fatal crashes in high-speed zones (i.e. 61 – 70 mph) was considerably higher than that of injury crashes (45% vs. 21%).

4. Vehicle type. The previous study showed that a much larger percent of the fatal crashes involved heavy trucks while a majority of the injury crashes involved only light duty vehicles.
5. Light condition. The crash characteristic study showed that some unfavorable light conditions, especially nighttime darkness without streetlights contributed a larger proportion of fatal crashes than that of injury crashes.
6. Road character. The previous study showed that complicated road geometric alignments contributed to 15% more fatal crashes than injury crashes.
7. Some driver error variables such as disregarded traffic control, alcohol/drug impairment, and too fast for conditions/speeding contributed to notably larger percentages of fatal crashes than those of injury crashes, and following too close contributed to a larger percent of injury crashes than that of fatal crashes.

Based on the above comparison results, such variables as alcohol/drug impairment and too fast for conditions/speeding, which were not selected in the first two steps, were chosen as risk factors. Thus, through the three-step process, 18 out of 29 variables were selected as risk factors. A summary list of these factors and their values is presented in Table 6.11.

Table 6.11. Selected Work Zone Risk Factors

No.	Risk Factor	Abbr.	Variable Value	Selection Step
1	Age	AG	1 (15-19 years old); 2 (20-24 years old); 3 (25-34 years old); 4 (35-44 years old); 5 (45-54 years old); 6 (55-64 years old); 7 (65 or older)	First step
2	Light condition	LC	1 (Good condition i.e., daylight) 2 (Fair conditions including dawn, dusk, and dark with streetlights) 3 (Poor condition i.e., dark without streetlights) 4 (Other unfavorable light conditions)	First step
3	Vehicle type	VT	1 (Truck involved); 2 (Non-truck involved)	First step
4	Road class	RC	1 (Interstates and other freeways and expressways) 2 (Other principal arterials and minor arterials) 3 (Low-classification roads including major collectors, minor collectors, and local roads)	First step
5	Road character	RCH	1 (Straight and level); 2 (Straight on grade); 3 (Curved and level); 4 (Curved on Grade) 5 (Other geometric alignments)	First step
6	Number of Lanes	LN	Actual number of the traffic lanes in two directions.	First step
7	Speed limit	SL	1 (≥61 mph); 2 (51 mph – 60 mph); 3 (41 mph – 50 mph); 4 (≤40 mph)	First step
8	Surface type	SUR	1 (Concrete); 2 (Blacktop); 3 (Other low level types including gravel, brick, dirt, and other)	First step
9	None/inoperative traffic control	NTC	0 (Not present); 1 (Present)	First step
10	Flagger	FL	0 (Not present); 1 (Present)	First step
11	Stop sign/signal	ST	0 (Not present); 1 (Present)	First step
12	Disregarded traffic control	DTC	0 (Not present); 1 (Present)	First step
13	Following too Close	FC	0 (Not present); 1 (Present)	First step
14	Crash time	CT	1 (6:00 a.m. – 10:00 a.m.); 2 (10:00 a.m. – 4:00 p.m.); 3 (4:00 p.m. – 8:00 p.m.); 4 (8:00 p.m. – 6:00 a.m.)	Second step
15	Special feature	SF	0 (No special feature impacts) 1 (Impacted by special features including bridge, overhead bridge, railroad bridge, railroad crossing, interchange, ramp, and other)	Second step
16	Area information	AI	1 (Urban area); 2 (Rural area)	Second step
17	Alcohol/drug impairment	AL	0 (Not present); 1 (Present)	Third step
18	Exceeded posted speed limits or too fast for conditions	SP	0 (Not present); 1 (Present)	Third step

6.3 DEVELOPMENT OF CSI MODELS

The work zone CSI models were developed in two steps. First, the models were generated using the dataset containing 67 fatal crashes between 1998 and 2003 and 267 injury crashes in 2003. Second, the models were validated using the 2004 Kansas work zone crash data including 18 fatal crashes and 337 injury crashes. The purpose of the validation was to check the accuracies of the developed models.

6.3.1 Model Development

Based on the risk factors selected, two sets of CSI models (each set has two models) were developed using logistic regression: two driver-independent CSI (DI-CSI) models and two driver-dependent CSI (DD-CSI) models. The DI-CSI models only included the risk factors that described the travel conditions in highway work zones. These models can be used to estimate the driving risks in work zones without knowing human factors. The estimated CSI values reflect the risk levels of proposed or existing highway work zones for traveling public. The DD-CSI models, on the other hand, are associated with particular drivers by including not only the risk factors related to work zones but also those risk factors that only certain drivers may possess such as demographic characteristics and driver errors.

Developed DI-CSI Models

Table 6.12 presents the variables and the estimated coefficients for the first driver-independent model (comprehensive DI-CSI model) generated by SAS that included all driver independent risk factors. The Wald chi-square statistic in the SAS

software was used to test the variable significance for the logistic regression models. A smaller *p*-value indicated that the variable was more statistically significant. SAS also outputted the values of three statistics for assessing the goodness-of-fit for the logistic regression model including the AIC statistic, the SC statistic, and the -2Log Likelihood statistic. The log likelihood statistic was used to test the global null hypothesis that all the parameters associated with covariates were zero (under the null hypothesis, the -2 Log Likelihood statistic has a chi-square distribution). The AIC (Akaike Information Criterion) and SC (Schwarz Criterion) statistics adjusted the -2 Log Likelihood statistic for the number of terms in the model and the number of observations used. These statistics are used when comparing different models for the same data and lower values of these statistics indicate a model with better goodness-of-fit. The equations for calculating these statistics are: (SAS 2003):

- -2 Log Likelihood:

$$\text{-2 Log L} = -2\sum_j w_j f_j \log(\hat{\pi}_j)$$

- Akaike Information Criterion:

$$\text{AIC} = \text{-2 Log L} + 2p$$

- Schwarz Criterion:

$$\text{SC} = \text{-2 Log L} + p\log(\sum_j f_j)$$

where w_j and f_j were the weight and frequency values of the jth observation of the modeled event; $\hat{\pi}_j$ was the estimated probability of the observed response; p was the number of parameters in the model.

Table 6.12. Variables and Coefficients for the Comprehensive DI-CSI Model

Variable	Coeff.	Standard Error	Wald Chi-Square	*p*-Value
Constant	7.62	2.20	12.00	0.001
Crash Time (CT)	-0.11	0.22	0.26	0.613
Light Condition (LC)	0.55	0.29	3.46	0.063
Vehicle Type (VT)	-0.91	0.36	6.19	0.013
Road Class (RC)	-0.67	0.53	1.57	0.210
Road Character (RCH)	0.13	0.15	0.74	0.389
No. of Lanes (LN)	-0.86	0.23	13.61	0.000
Speed Limit (SL)	-0.74	0.23	10.36	0.001
Surface Type (SUR)	0.29	0.41	0.48	0.490
Special Feature (SF)	-0.59	0.48	1.52	0.218
Area Information (AI)	-1.74	0.61	8.05	0.005
None/Inoperative Traffic Control (NTC)	-2.69	1.09	6.04	0.014
Flagger (FL)	-0.48	0.60	0.63	0.427
Stop Sign/Signal (ST)	1.51	0.66	5.31	0.021

AIC = 258.8; SC = 312.1; -2 Log Likelihood = 230.8.
Testing global null hypothesis: $\boldsymbol{\beta} = 0$:
Likelihood Ratio Chi-Square (chi-square value, p-value): 104.1, <0.001;
Score Chi-Square (chi-square value, p-value): 89.6, <0.001;
Wald Chi-Square (chi-square value, p-value): 58.3, <0.001.

Thereby, the first (comprehensive) DI-CSI model is:

$$DI\text{-}CSI = exp[g_1(\mathbf{x})]/(1 + exp[g_1(\mathbf{x})])$$

where:

$$g_1(\mathbf{x}) = 7.62 - 0.11CT + 0.55LC - 0.91VT - 0.67RC + 0.13RCH - 0.86LN - 0.74SL + 0.29SUR - 0.59SF - 1.74AI - 2.69NTC - 0.48FL + 1.51ST$$

descriptions of the variables can be found in Table 6.11.

The relationship between CSI and the *g(x)* in CSI models is illustrated in Figure 6.2. As shown in this figure, CSI increases with the increase of *g(x)*. CSIs with approximate values of one (the maximum risk level) are obtained when the value of *g(x)* is greater than five and CSIs with approximate values of zero (the minimum risk

level) are obtained when the value of *g(x)* is less than negative five. A *g(x)* with the value of zero gives a CSI of 0.5 (the medium risk level).

In Table 12, the Wald chi-square *p*-values of some variables are large (i.e., larger than the pre-selected criterion of 0.3). These variables included Crash Time (*p*-value = 0.613), Road Character (*p*-value = 0.389), Surface Type (*p*-value = 0.49), and Flagger/Officer (*p*-value = 0.427). Purely from the statistical viewpoint, dropping these variables from the regression model may not lose much data information. Thus, another simplified DI-CSI model was developed to include only the statistically significant variables that had relatively small *p*-values. The variables and their coefficients of the second DI-CSI model are presented in Table 6.13.

Accordingly, the second (simplified) DI-CSI model is:

$$DI\text{-}CSI = exp[g_2(\mathbf{x})]/(1 + exp[g_2(\mathbf{x})]),$$

where:

$$g_2(\mathbf{x}) = 7.64 - + 0.54LC - 0.93VT - 0.59RC - 0.54SF - 0.86LN - 0.70SL - 1.62AI - 2.71NTC + 1.40ST$$

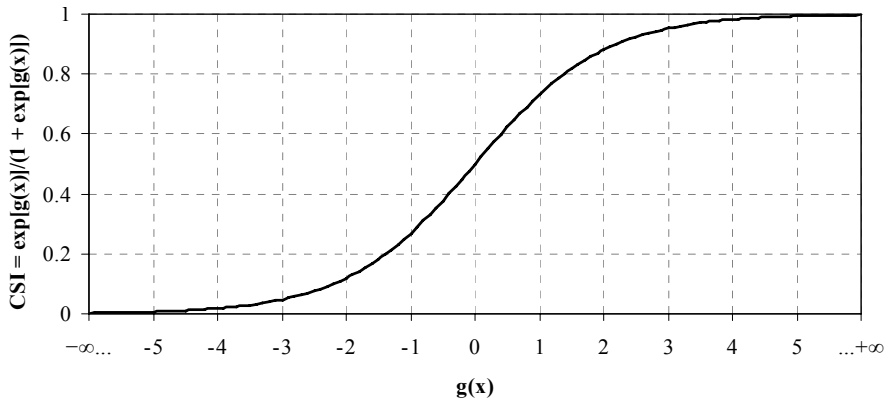


Figure 6.2. The Relationship between CSI and *g(x)*

Table 6.13. Variables and Coefficients for the Simplified DI-CSI Model

Variable	Coeff.	Standard Error	Wald Chi-Square	*p*-Value
Constant	7.64	2.06	13.79	0.000
Light Condition (LC)	0.54	0.20	7.40	0.007
Vehicle Type (VT)	-0.93	0.36	6.67	0.010
Road Class (RC)	-0.59	0.52	1.27	0.260
Special Feature (SF)	-0.54	0.45	1.43	0.232
No. of Lanes (LN)	-0.86	0.23	14.16	0.000
Speed Limit (SL)	-0.70	0.22	9.79	0.002
Area Information (AI)	-1.62	0.60	7.25	0.007
Non/Inoperative Traffic Control (NTC)	-2.71	1.09	6.21	0.013
Stop Sign/Signal (ST)	1.40	0.64	4.78	0.029

AIC = 252.9; SC = 291.0; -2 Log Likelihood = 232.9.
Testing global null hypothesis: $\boldsymbol{\beta} = 0$
Likelihood Ratio Chi-Square (chi-square value, p-value): 101.9, <0.001;
Score Chi-Square (chi-square value, p-value): 88.4, <0.001;
Wald Chi-Square (chi-square value, p-value): 57.8, <0.001.

Developed DD-CSI Models

Table 6.14 lists the variables and the estimated coefficients for the first (comprehensive) DD-CSI model generated by SAS that included all risk factors. The DD-CSI can be calculated as:

$$DD\text{-}CSI = exp[g_3(\mathbf{x})]/(1 + exp[g_3(\mathbf{x})])$$

where:

$$g_3(\mathbf{x}) = 5.25 + 0.03CT + 0.51LC - 0.80VT - 0.59RC + 0.16RCH - 0.70LN - 0.84SL + 0.40SUR - 0.37SF - 1.69AI - 2.52NTC - 0.82FL + 0.78ST + 0.32AG - 0.81AL + 1.18DTC - 0.61SP - 1.98FC$$

Descriptions of the variables can be found in Table 6.11.

Table 6.14. Variables and Coefficients for the Comprehensive DD-CSI Model

Variable	Coeff.	Standard Error	Wald Chi-Square	*p*-Value
Constant	5.25	2.33	5.07	0.024
Crash Time (CT)	0.03	0.24	0.01	0.917
Light Condition (LC)	0.51	0.32	2.48	0.116
Vehicle Type (VT)	-0.80	0.39	4.13	0.042
Road Class (RC)	-0.59	0.57	1.07	0.301
Road Character (RCH)	0.16	0.17	0.84	0.359
No. of Lanes (LN)	-0.70	0.25	8.02	0.005
Speed Limit (SL)	-0.84	0.26	10.65	0.001
Surface Type (SUR)	0.40	0.45	0.79	0.375
Special Feature (SF)	-0.37	0.51	0.53	0.465
Area Information (AI)	-1.69	0.67	6.36	0.012
None/Inoperative Traffic Control (NTC)	-2.52	1.13	4.94	0.026
Flagger (FL)	-0.82	0.72	1.31	0.252
Stop Sign/Signal (ST)	0.78	0.73	1.15	0.284
Age (AG)	0.32	0.10	10.24	0.001
Alcohol/Drug Impairment (AL)	-0.81	0.67	1.45	0.228
Disregarded Traffic Control (DTC)	1.18	0.57	4.30	0.038
Speeding/too Fast for Condition (SP)	-0.61	0.52	1.35	0.244
Following too Close (FC)	-1.98	1.07	3.39	0.066

AIC = 244.0; SC = 316.4; -2 Log Likelihood = 206.0.
Testing global null hypothesis: $\boldsymbol{\beta} = 0$
Likelihood Ratio Chi-Square (chi-square value, p-value): 128.9, <0.001;
Score Chi-Square (chi-square value, p-value): 105.8, <0.001;
Wald Chi-Square (chi-square value, p-value): 58.9, <0.001.

Using the same methods mentioned before, a simplified DD-CSI model was developed as well by including only the statistically significant variables. The eliminated variables that had large p-values in the comprehensive model included Crash Time (*p*-value = 0.917), Road Class (*p*-value = 0.301), Road Character (*p*-value = 0.359), Road Surface Type (*p*-value = 0.375), and Road Spatial Feature (*p*-value = 0.465). The following is the simplified DD-CSI model and the variables and their coefficients are listed in Table 6.15.

$$DD\text{-}CSI = exp[g_4(\mathbf{x})]/(1 + exp[g_4(\mathbf{x})])$$

where:

$$g_4(\mathbf{x}) = 4.88 + 0.63LC - 0.81VT - 0.58LN - 0.87SL - 1.77AI - 2.63NTC - 0.70FL + 0.73ST + 0.33AG - 0.85AL + 1.08DTC - 0.52SP - 2.01FC$$

Table 6.15. Variables and Coefficients for the Simplified DD-CSI Model

Variable	Coeff.	Standard Error	Wald Chi-Square	p-Value
Constant	4.88	1.80	7.32	0.007
Light Condition (LC)	0.63	0.22	7.93	0.005
Vehicle Type (VT)	-0.81	0.39	4.22	0.040
No. of Lanes (LN)	-0.58	0.16	13.44	0.000
Speed Limit (SL)	-0.87	0.25	12.46	0.000
Area Information (AI)	-1.77	0.65	7.33	0.007
None/Inoperative Traffic Control (NTC)	-2.63	1.13	5.47	0.019
Flagger (FL)	-0.70	0.70	1.02	0.313
Stop Sign/Signal (ST)	0.73	0.69	1.12	0.291
Age (AG)	0.33	0.10	11.12	0.001
Alcohol/Drug Impairment (AL)	-0.85	0.67	1.65	0.199
Disregarded Traffic Control (DTC)	1.08	0.55	3.88	0.049
Speeding/too Fast for Condition (SP)	-0.52	0.49	1.12	0.289
Following too Close (FC)	-2.01	1.06	3.57	0.059

AIC = 236.9; SC = 290.2; -2 Log Likelihood = 208.9.
Testing global null hypothesis: $\boldsymbol{\beta} = 0$
Likelihood Ratio Chi-Square (chi-square value, p-value): 120.9, <0.001;
Score Chi-Square (chi-square value, p-value): 103.6, <0.001;
Wald Chi-Square (chi-square value, p-value): 60.5, <0.001.

6.3.2 Model Validation

The four models were first verified using the original model development data as a supplementary test to access how effectively the developed models describe the original data. This assessment was a straightforward way to show how well these models were fitted with the data. Table 6.16 lists the accuracies of the four models for estimating the values of CSI with the work zone travel conditions given in the model

development data. To determine the accuracy, a CSI greater than or equal to 0.5 was treated as a fatal outcome and a CSI less than 0.5 was considered as an injury outcome. Estimated outcomes were then compared with the actual crash severity observations. The accuracy was defined as the result of the number of the accurate estimations divided by the total number of crashes. As shown in the table, the four models predicted around 95% of the injury cases correctly and approximately 40% to 55% of the fatal crashes correctly.

Table 6.16. Goodness-of-Fit of the CSI Models Assessed by Model Development Data

Fatal Crash		**Injury Crash**		**Fatal and Injury**	
Accurate Estimations	**Accuracy**	**Accurate Estimations**	**Accuracy**	**Accurate Estimations**	**Accuracy**
Comprehensive DI-CSI Model					
26	38.8%	253	94.8%	279	83.5%
Simplified DI-CSI Model					
26	38.8%	254	95.1%	280	83.8%
Comprehensive DD-CSI Model					
34	50.7%	252	94.4%	286	85.6%
Simplified DD-CSI Model					
37	55.2%	250	93.6%	287	85.9%

No. of Total Crashes = 334, No. of Fatal Crashes = 67, No. of Injury Crashes = 267.

In addition to the verification using original data, the developed models were validated using 355 severe crash cases including 18 fatal crashes and 337 injury crashes in Kansas highway work zones in 2004. In this dataset, a fatal crash was assigned with a CSI of one, while an injury crash was assigned with a CSI of zero. By defining the conditions of the severe crashes in the dataset, an index number (the estimated probability of being a fatal crash if there was a severe crash in the given

conditions) between zero and one was calculated for each crash. An estimated CSI number that is close to one indicated a very high risk level or a great likelihood of having a fatal crash for the given work zone travel conditions, while a CSI that is close to zero indicated a relative moderate risk level or a great likelihood of having a less severe crash such as an injury crash. The predicted CSI values were compared with the actual crash outcomes to illustrate the prediction accuracies. In addition, the four developed models were compared with each other and the potential of using CSI numbers for work zone travel risk evaluation or prediction was assessed.

Table 6.17 presents the comparison results between the estimated CSI numbers and the real crash severities. It shows minor differenced between the two CSI models in each category in terms of accuracy. Figures 6.3 – 6.6 graphically illustrate the estimated indices of the crashes using the four models, respectively. When setting 0.5 as the criterion for the CSI (i.e. CSI $\geq$ 0.5 for having a fatal crash and CSI < 0.5 for having an injury crash), on average, the models predicted about five fatal crash cases (with CSI values greater than or equal to 0.5) out of the 18 fatal cases. On the other hand, all four models predicted about 95% of the injury cases (CSI < 0.5). Based on the 2004 injury and fatal crash data, the simplified DI- and DD-CSI models were slightly better than the comprehensive models for both accuracies in percentage and average estimated CSI values.

Using the four models, the average CSI for the travel conditions of injury crashes were all around 0.11, while the average CSI for fatal cases fell between 0.3 and 0.36. In addition, the models captured the differences of the input work zone

travel conditions and successfully separated different traffic conditions by assigning them with different CSI values (i.e., not dramatically clustered in a certain small range). This phenomenon corresponded with the fact that different travel conditions yielded different levels of risk of having severe crashes.

Table 6.17. Prediction Accuracies of the CSI Models

Model	**Accuracy**						$\sum (ACS - CSI)^2$ *
	Fatal		Injury		Total		
	# of CSI $\geq$ 0.5	Acc.	# of CSI < 0.5	Acc.	Accurate predictions	Acc.	
Comprehensive DI-CSI	5	28%	320	95%	325	92%	22.3
Simplified DI-CSI	6	33%	320	95%	326	92%	21.8
Comprehensive DD-CSI	4	22%	319	95%	323	91%	22.9
Simplified DD-CSI	5	28%	321	95%	326	92%	21.6

*: Sum of squared errors, where ACS = actual crash severity (1 for fatal and 0 for injury), and CSI = estimated crash severity index.

Note: Acc. = accuracy; No. of fatal crashes = 18; No. of injury crashes = 337; No. of total crashes = 355.

To better understand the differences between the travel conditions of different risk levels, some typical cases and their CSI values predicted by the comprehensive DI-CSI and DD-CSI models were reviewed. Tables 6.18 and 6.19 present some example work zone travel conditions with very low or very high CSI values estimated by the two comprehensive models. Comparing the travel conditions shown in these tables, typically, risk factors such as poor light condition, truck involvement, having only two travel lanes, and high speed limit will lead to high CSI values and equivalently, high risk levels. Note that, in the two tables, the travel conditions with

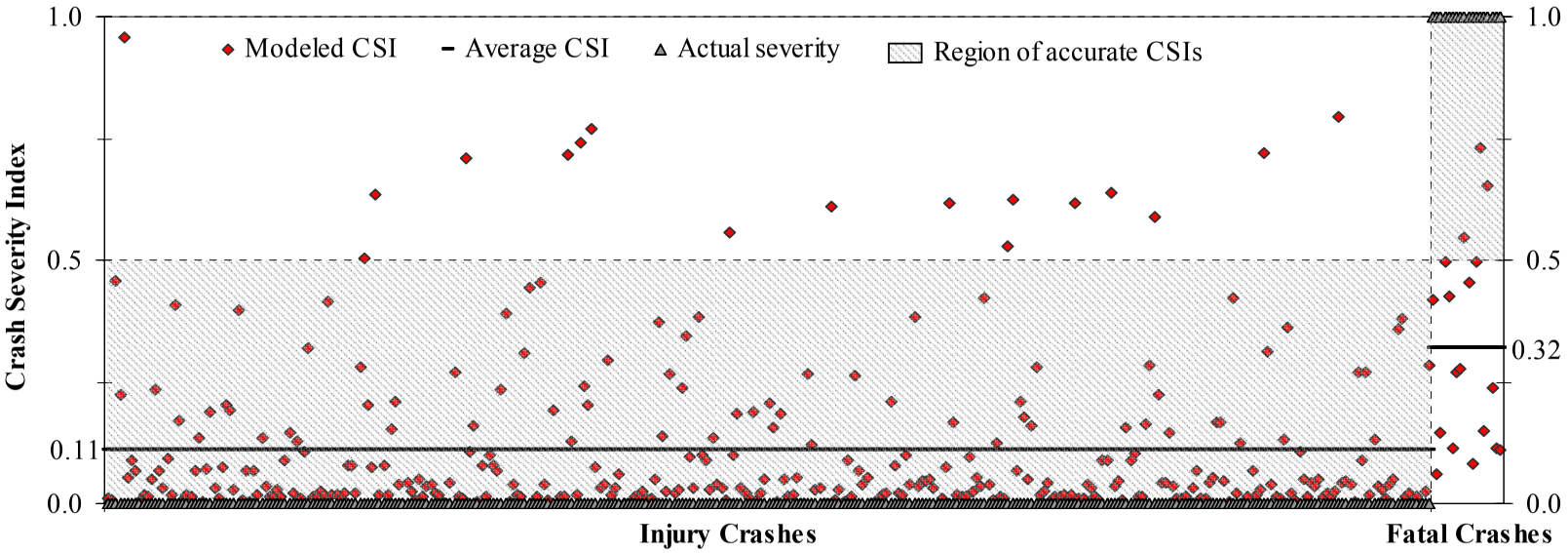


Figure 6.3. CSIs Estimated by the Comprehensive DI-CSI Model

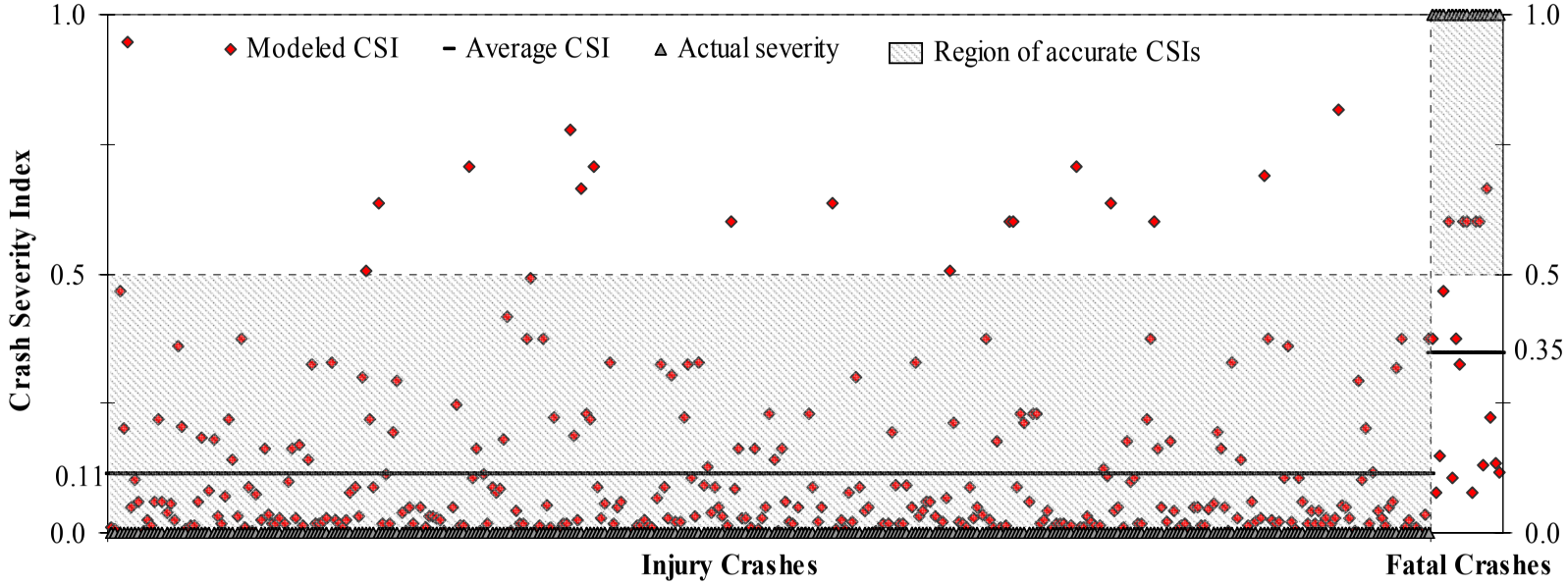


Figure 6.4. CSIs Estimated by the Simplified DI-CSI Model

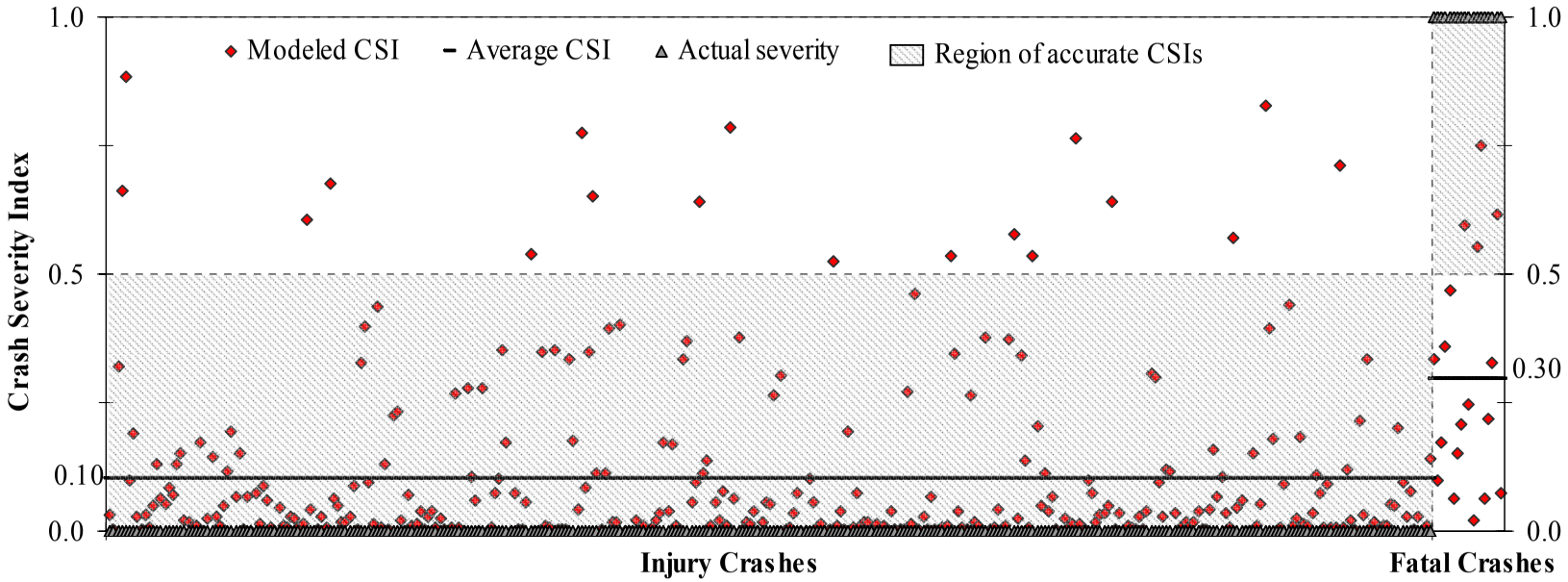


Figure 6.5. CSIs Estimated by the Comprehensive DD-CSI Model

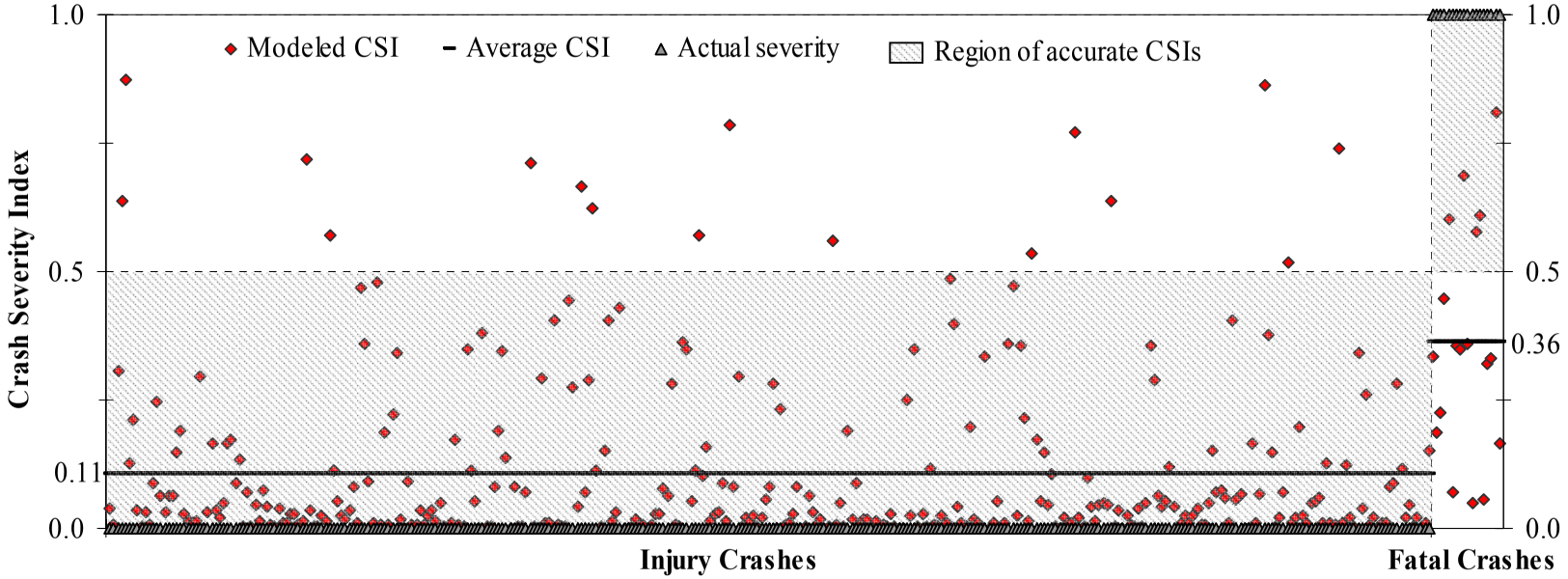


Figure 6.6. CSIs Estimated by the Simplified DD-CSI Model

very-high CSI values included an injury case. This indicated that a high CSI may not necessarily coincide with a fatal crash; a CSI with a high value implies that the condition is risky and could cause high-severity crashes such as fatal crashes.

Table 6.18. Example Conditions with Very- Low or High CSIs by Comprehensive DI-CSI Model

Crash Variable	**Low-CSI Conditions**			**High-CSI Conditions**		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
CSI	**<0.01**	**0.01**	**0.02**	**0.65**	**0.73**	**0.96**
No. of Crashes	1	7	10	1	1	1
Crash Severity	Injury	Injury	Injury	Fatal	Fatal	Injury
Crash Time	8:00 p.m. - 6:00 a.m.	4:00 p.m. - 8:00 p.m.	6:00 a.m. - 10:00 a.m.	8:00 p.m. - 6:00 a.m.	10:00 a.m. - 4:00 p.m.	8:00 p.m. - 6:00 a.m.
Light Condition	Fair conditions	Good condition	Good condition	Poor condition	Good condition	Poor condition
Vehicle Type	Non-truck involved	Non-truck involved	Non-truck involved	Truck involved	Truck involved	Truck involved
Road Class	Interstates and other freeways and expressways	Interstates and other freeways and expressways	Interstates and other freeways and expressways	Other principal arterials and minor arterials	Other principal arterials and minor arterials	Other principal arterials and minor arterials
Road Character	Straight and level	Straight and level	Straight and level	Straight and level	Other alignments	Curved and level
No. of Lanes	8	6	6	4	2	2
Speed Limit	≥61 mph	51 mph – 60 mph	51 mph – 60 mph	51 mph – 60 mph	≥61 mph	≥61 mph
Surface Type	Concrete	Concrete	Concrete	Blacktop	Blacktop	Blacktop
Special Feature	No special feature impacts	No special feature impacts	No special feature impacts	No special feature impacts	No special feature impacts	No special feature impacts
Area Info.	Rural area	Rural area	Rural area	Urban	Rural area	Rural area
None/ Inoperative TC	Present	Not present	Not present	Not present	Not present	Not present
Flagger/ Officer	Not present	Not present	Not present	Not present	Not present	Not present
Stop Sign/ Signal	Not present	Not present	Not present	Not present	Not present	Not present

TC = Traffic control.

Table 6.19. Example Conditions with Low or High CSIs by the Comprehensive DD-CSI Model

Crash Variable	Low-CSI Conditions			High-CSI Conditions		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
CSI	**<0.01**	**<0.01**	**<0.01**	**0.62**	**0.75**	**0.88**
No. of Crashes	1	2	4	1	1	1
Crash Severity	Injury	Injury	Injury	Fatal	Fatal	Injury
Age	15-19	20-24	25-34	65 or older	35-44	35-44
Crash Time	10:00 a.m. - 4:00 p.m.	6:00 a.m. - 10:00 a.m.	6:00 a.m. - 10:00 a.m.	10:00 a.m. - 4:00 p.m.	10:00 a.m. - 4:00 p.m.	8:00 p.m. - 6:00 a.m.
Light Condition	Good condition	Good condition	Good condition	Good condition	Good condition	Poor condition
Vehicle Type	Non-truck involved	Non-truck involved	Non-truck involved	Non-truck involved	Truck involved	Truck involved
Road Class	Interstates and other freeways and expressways	Interstates and other freeways and expressways	Interstates and other freeways and expressways	Other principal arterials and minor arterials	Other principal arterials and minor arterials	Other principal arterials and minor arterials
Road Character	Straight on grade	Straight and level	Straight and level	Straight and level	Other alignments	Curved and level
No. of Lanes	6	6	6	4	2	2
Speed Limit	≤40 mph	51 mph – 60 mph	51 mph – 60 mph	51 mph – 60 mph	≥61 mph	≥61 mph
Surface Type	Blacktop	Concrete	Concrete	Concrete	Blacktop	Blacktop
Special Feature	No special feature impacts	No special feature impacts	No special feature impacts	Impacted by special features**	No special feature impacts	No special feature impacts
Area Info.	Urban area	Rural area	Rural area	Urban area	Rural area	Rural area
None/ Inoperative TC	Present	Not present	Not present	Not present	Not present	Not present
Flagger/ Officer	Not present	Not present	Not present	Not present	Not present	Not present
Stop Sign/ Signal	Not present	Not present	Not present	Not present	Not present	Present
Alcohol/ Drug Impairment	Not present	Not present	Not present	Not present	Not present	Not present
Disregarded TC	Not present	Not present	Not present	Present	Not present	Not present
Speeding/ Too Fast for Condition	Not present	Not present	Not present	Not present	Not present	Present
Following Too Closely	Present	Present	Present	Not present	Not present	Not present

** Special features may include bridge, overhead bridge, railroad bridge, railroad crossing, interchange, ramp, and other. TC = traffic control.

6.4 SUMMARY AND DISCUSSION

In this chapter, four CSI models were developed and validated. The models were developed based on the risk factors that were determined using chi-square tests, CMH tests, and results of the previous characteristic study. In addition, Kansas highway work zone crash data including fatal crashes between 1998 and 2004 and injury crashes between 2003 and 2004 was utilized during the development of the models. The CSI models quantify the risk level of a work zone using a numerical value between zero and one. A CSI of one indicates a very high risk level in a given work zone, which infers that a fatal crash might take place if a crash occurs. On the other hand, a CSI of zero indicate a condition that a crash will have a moderate severity if it occurs.

Two groups of models were developed in this study, including two driver-independent CSI or DI-CSI models and two driver-dependent CSI or DD-CSI models. The DI-CSI models were developed for the work zone travel risk assessment without considering human factors or specific driving groups; the DD-CSI models, on the other hand, addressed travel conditions along with human errors and the characteristics of specific driving group. Thus, DD-CSI models are suitable for the driving risk assessment for given driving groups in given highway work zones. The two types of models may be used in evaluating the safety level of either existing highway work zones or proposed highway work zones. Using these models, engineers may identify work zone risks caused by certain combinations of risk factors that may be otherwise not detectable using only engineering judgment.

Model validation showed only minor accuracy differences between the comprehensive models and the simplified models. Therefore, the researcher could not reach the conclusion on which models were credibly superior. Additional validations are needed with large datasets. If there is sufficient information, it is recommended that the comprehensive models be used since they include all risk factors identified based on both statistical tests and crash characteristic studies.

While the predicted CSI values for most of the travel conditions for injury crashes were consistent with the actual crash severity observed, the predicted CSI values for some of the fatal crash cases were not as accurate as they should be. Reasons for these inconsistencies may include:

1. The covariate pattern examination showed that both fatal and injury crashes were observed for some risk conditions. A covariate pattern is known as a certain combination of crash variables with particular values. This suggests that a minor fraction of fatal and injury crashes could not be separated according to travel conditions shown in the KDOT's crash reports. The CSI numbers for these risk conditions would be either low (if the conditions were dominated by injury crashes) or high (if the conditions were dominated by fatal crashes).
2. The existence of very severe injury crashes (e.g., near-fatal injury crashes) and some fatal crashes whose fatalities were due to reasons other than work zone risk factors such as physical vulnerability or not wearing a seat belt in both model development and model validation datasets might reduce the accuracy

of the models. A larger dataset that contains more fatal crashes might eliminate or mitigate this type of error from the statistical viewpoint.

3. The crash data used for model validation had only 18 fatal crash cases. The size of the fatal crash sample might not be large enough to validate the developed models under typical fatal conditions.

Chapter 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Highway work zones have been a nationwide traffic safety concern for decades. The complicated traffic conditions in work zones require special safety countermeasures that can effectively reduce the risks associated with work zone traffic crashes. Actual crash experience is always the best source for identifying safety deficiencies and developing effective countermeasures. Because work zone crashes result in fatalities and injuries, eliminating these crashes becomes the most urgent challenge.

This research was aimed to provide valuable insights for improving the safety of highway work zones based on systematic analyses of work zone fatal and injury crashes. Major tasks of the research included an in-depth investigation of the characteristics of both fatal and injury crashes, the quantification of the effectiveness of TTC devices that were commonly used in work zones, the identification of work zone risk factors, and the development of CSI models for work zone risk level evaluation. The results of this research have great potential to improve the highway work zone safety by reducing both the number of total work zone crashes and the

proportion of high-severity crashes. Based on the results of the research, conclusions were drawn and are presented as follows.

Fatal and Injury Crash Characteristic Analyses

The characteristics of fatal and injury crashes were examined systematically based on the crash data between 1992 and 2004 in Kansas highway work zones. The two types of crashes were first studied separately to document their unique characteristics and causal factors. The characteristics of the fatal and injury crashes were then compared and both identical characteristics and unique characteristics were determined. A comparison between fatal and injury crashes had not been conducted in previous studies, yet it is important to reveal the different characteristics between fatal and injury crashes and the risk factors that could potentially increase crash severity. These in-depth crash analyses provided valuable insights on the deficiencies of safety countermeasures in the work zones. The findings on the significant work zone crash characteristics can be also utilized for public education.

The following conclusions have been reached based on the analyses of fatal and injury crash characteristics.

1. Male drivers caused much more work zone fatal and injury crashes than females. Drivers younger than 25 and between 35 – 44 were the high-risk driver groups in work zones because they caused the highest proportions of injury and fatal crashes, respectively. In addition, a nontrivial proportion of the fatal work zone crashes were caused by senior drivers older than 64 years of age.

2. The daytime non-peak hours (10:00 a.m. – 4:00 p.m.) had the highest frequency of the fatal and injury crashes. Nighttime (8:00 p.m. – 6:00 a.m.) had a large proportion of the fatal crashes. The noteworthy proportion of the crashes during slow-construction season (November – March) suggested that traffic control devices should be maintained and inspected regularly during this season.
3. Work zones on rural highways with speed limits from 51 mph to 70 mph were high-risk locations where the largest proportions of the fatal and injury crashes occurred. Work zones located on complex geometric alignments also had a large percentage of injury and fatal crashes. Work zones on two-lane highways had a high proportion of fatal crashes while those on four-lane highways had a high proportion of injury crashes.
4. Most of the crashes were multi-vehicle crashes. Among the multi-vehicle collisions, head-on was the most common type for fatal crashes and rear-end was the most frequent type for the injury crashes in the work zones. In addition, analyses showed that most of the fatal crashes involved heavy trucks and the fatal and injury crashes caused by trucks frequently involved multiple vehicles.
5. Human errors such as inattentive driving and misjudgment/disregarded traffic controls contributed to most fatal and injury crashes in work zones. Inclement weather conditions and unfavorable road features (interchange areas, ramps, etc.) did not significantly contribute to the severe work zone crashes. Poor

light conditions and complex highway geometric alignments increased driving risks in work zones. In addition, a larger proportion of injury crashes took place in the work zones located at or near the intersections.

6. The investigation revealed a number of noteworthy differences in characteristics between fatal and injury crashes. The crash characteristic comparison showed that complicated highway geometric alignments (especially grades), unfavorable light conditions, involvement of heavy vehicles, alcohol impairment, and disregarding traffic control, were factors that could potentially increase the crash severity (result in fatality) in work zones. Comparison results also illustrated that the fatal crashes were more related to high speeds while the injury crashes were more related to high traffic volumes.

Effectiveness of Work Zone Traffic Control Devices

The evaluation of the effectiveness of TTC devices commonly used in work zones was conducted based on the crash data. The evaluation was primarily focused on the traffic control effectiveness in mitigating crash severity. The results of the evaluation of TTC devices can be utilized to develop efficient and effective work zone traffic control strategies for reducing both the total number of crashes and the proportion of fatal crashes. The results may also provide useful implications on the safety levels in certain types of work zones where the evaluated TTC methods were regularly installed. The evaluation of the TTC methods including flagger/officer, stop sign/signal, flasher, no passing zone, and center/edge lines showed that:

1. Having a flagger/officer, flashers, and center/edge lines in work zones reduced the odds of causing fatalities in severe work zone crashes by more than 50%.
2. Based on the available crash data, the statistics were unable to establish significant relationships between the use of stop signs/ signals and no passing zones and the involvement of fatalities in severe crashes in the work zones.

Risk Factors and CSI Model Development

The concept of using crash severity indices, or CSIs, to evaluate work zone travel risks was proposed and four CSI models were developed and validated. CSIs are measurements of work zone travel risk levels and the determination of CSIs took into account a comprehensive range of risk factors that had impact on work zone crash severities. Prior to the development of the CSI models, the risk factors that had impact on work zone crash severity were identified based on a three-step procedure including chi-square test, CMH test, and review of the findings of previous crash characteristics. Among the 29 variables, 18 were identified as risk factors using the procedure (Table 6.11). These risk factors were used to develop the CSI models.

Among the four CSI models, two were driver-independent models and the other two were driver-dependent models. The former assess risk levels based on only work zone factors independent of vehicle drivers, while the latter estimate the risk levels based on both work zone factors and human factors. Results of the model validation showed that:

1. Compared to the real crash severity outcomes, the CSI values estimated by the CSI models were roughly 95% accurate for the injury cases when setting the

criterion CSI at 0.5 (i.e., a CSI number less than 0.5 for travel conditions with injury crashes observed). On the other hand, the CSI numbers estimated for the travel conditions with fatal crashes observed were less consistent with the actual severity outcomes. The low consistency may be partly attributed to the limited number of fatal cases in both datasets used for model development and validation.

2. Implementation of the developed models has the potential to reduce work zone severe crashes and improve work zone safety. By deploying these models during work zone planning or work zone safety inspection, risk factors may be identified so that engineers can utilize safety countermeasures to prevent severe crashes from being triggered.

7.2 RECOMMENDATIONS

This study of fatal and injury crashes revealed some safety deficiencies that existed in highway work zones. To improve safety, the researcher makes the following recommendations.

1. Development of more effective speed control strategies. The large proportion of crashes in high-speed zones indicated a strong relationship between high speeds and injury and fatal crashes in the work zones. Therefore, controlling speed is a key step towards improving work zone safety. The results of the crash analyses suggested that there is a need to develop effective speed control strategies that could be strictly enforced in highway work zones to prevent

high-severity crashes. In particular, strictly enforced speed limits should be considered in work zones with complex highway geometric alignments.

2. Development of effective headway control strategies. Crash investigation showed that the most common type of injury crashes was rear-end and a majority of the truck-involved crashes were multi-vehicle collisions. In addition, in many work zones, the remaining travel lanes were usually separated from construction areas by chanalization devices. It is often impossible to escape from a reckless high-speed vehicle coming behind. Therefore, there is a need to develop strategies that can effectively control and enforce safe headways between consecutive vehicles especially when the platoon contains heavy vehicles. Such a strategy could be an installation of a headway detector controlled by intelligent algorithms and it can send instant warning messages to changeable message signs. Work zone driving regulations can also be developed to enforce safe headways.
3. Development of more effective warning devices. The fact that inattentive driving contributed to the most of the fatal and injury crashes in work zones suggests that there is an urgent need to develop effective approaches to warn the inattentive drivers of upcoming work zone conditions. When construction workers and/or other personnel are present, devices that can effectively alert inattentive drivers become extremely important. The researcher therefore recommends the use of more effective warning devices such as temporary rumble strips or other raised pavement markings in highway work zones.

These devices may have both physical vibration and visual impact which can be effective in alerting drivers.

4. Improvements of other traffic controls. The study of injury and fatal work zone crashes also suggested that there is a need to improve other traffic controls. For instance, the high percentage of nighttime fatal crashes might be reduced by installing illumination or highly retroreflective devices in the work zones during nighttime. Installation of median separators should be considered in some work zones to eliminate head-on crashes, one of the major collision types for fatal crashes. Special traffic control strategies need to be developed to reduce the heavy-truck involvement in highway work zone crashes.
5. Public education. In addition to improvements in work zone traffic controls, public education is another strategy to improve safety. The results of crash investigation showed that male drivers caused most of fatal and injury crashes in Kansas highway work zones. Drivers younger than 25 years of age, especially males in the teenage driver population, were responsible for a large proportion of the injury crashes. Drivers aged 35 to 44 and older than 64 were the groups with the highest fatal crash rate. Truck drivers also contributed to a large percentage of work zone fatal crashes. The researcher suggests launching a risk-driver-oriented education program to raise the awareness of highway work zone safety. The fact that a major cause of most crashes was human error indicated an urgent need to develop effective education programs for the traveling public.

6. Improvement of crash reports. Some sections of the State of Kansas Motor Vehicle Accident Report should be modified to better facilitate work zone crash investigation. For instance, the traffic control devices listed on the report do not include temporary traffic control devices such as channelization devices and temporary warning devices that are commonly used in work zones. As a result, crash investigators usually either classify those temporary work zone traffic control devices as "other" on the reports or do not record them at all. Revisions should also be considered for other sections such as pedestrian identification (regular pedestrian or construction worker), and crash locations within work zones (advance warning area, transition area, activity area, or termination area). Descriptions of the work zone including the construction work types, basic work zone configurations, and the status of construction work at the crash time should be included in the crash reports.
7. Implementation of CSI models. The researcher also recommends that the CSI models should be used in work zone planning or work zone safety inspection so that work zone risk factors could be identified and safety countermeasures could be developed accordingly to mitigate them. Utilization of CSI models will help engineers to reveal work zone risks that are created by subtle combinations of a wide range of variables which otherwise may be not detectable solely based on engineering experience.
8. Future research. Future research is recommended for the improvement of the CIS models. When available, a larger dataset should be used for the future

development and validation of the CSI models. The CIS models can also be improved by taking into consideration the crashes of other severities such as property-damage-only crashes. In addition, more detailed classification of crash severities should be used during future development of CSI models so that the CSIs with intermediate values can be interpreted with corresponding severities. Information on work zone configurations, if available, should also be included in the CSI models to improve their accuracies.

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APPENDICES

Appendix I
State of Kansas Motor Vehicle Accident Report (2004 edition)

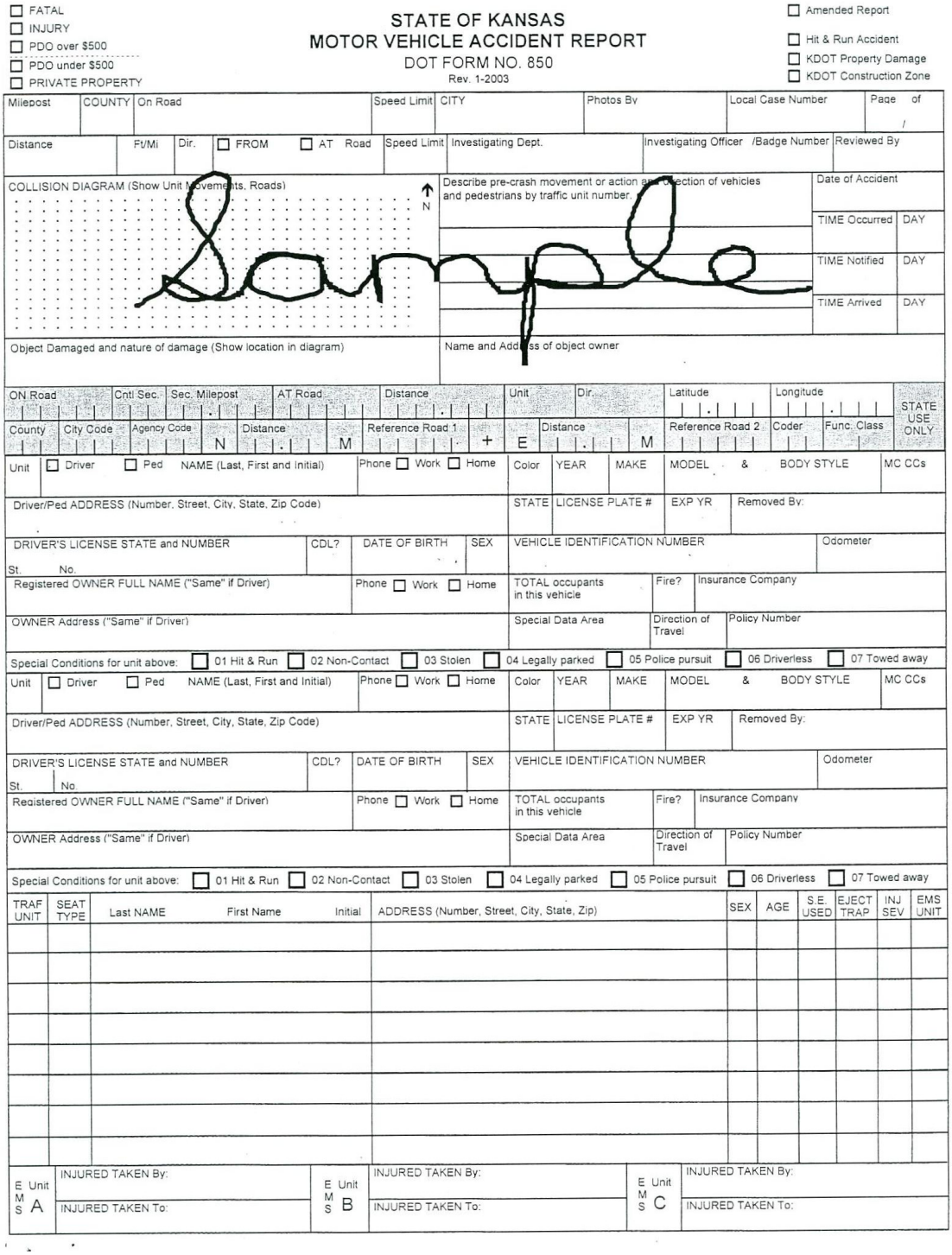
Appendix II
Tables of Observations for the Compiled Accident Information

Appendix III
Fatal Crash Data in Kansas Highway Work Zones (1992-2004)

Appendix IV
Sample Injury Crash Data in Kansas Highway Work Zones (1992-2004)

Appendix V
Fatal and Injury Crash Data in Kansas Highway Work Zones (2003-2004)

APPENDIX I: KDOT ACCIDENT REPORT SAMPLE



☐ FATAL
☐ INJURY
☐ PDO over $500
☐ PDO under $500
☐ PRIVATE PROPERTY

STATE OF KANSAS
MOTOR VEHICLE ACCIDENT REPORT
DOT FORM NO. 850
Rev. 1-2003

☐ Amended Report
☐ Hit & Run Accident
☐ KDOT Property Damage
☐ KDOT Construction Zone

Milepost	COUNTY	On Road	Speed Limit	CITY	Photos By	Local Case Number	Page of
							/

Distance	Ft/Mi	Dir.	☐ FROM ☐ AT Road	Speed Limit	Investigating Dept.	Investigating Officer /Badge Number	Reviewed By

COLLISION DIAGRAM (Show Unit Movements, Roads)	Describe pre-crash movement or action and direction of vehicles and pedestrians by traffic unit number.	Date of Accident
N		TIME Occurred / DAY
		TIME Notified / DAY
		TIME Arrived / DAY

Object Damaged and nature of damage (Show location in diagram)	Name and Address of object owner

ON Road	Cntl Sec.	Sec. Milepost	AT Road	Distance	Unit	Dir.	Latitude	Longitude	STATE USE ONLY
		.		.			.	.	

County	City Code	Agency Code		Distance		Reference Road 1		Distance		Reference Road 2	Coder	Func. Class
			N	.	M		+	E	.	M		

Unit	☐ Driver ☐ Ped NAME (Last, First and Initial)	Phone ☐ Work ☐ Home	Color	YEAR	MAKE	MODEL & BODY STYLE	MC CCs

Driver/Ped ADDRESS (Number, Street, City, State, Zip Code)	STATE	LICENSE PLATE #	EXP YR	Removed By:

DRIVER'S LICENSE STATE and NUMBER St. No.	CDL?	DATE OF BIRTH	SEX	VEHICLE IDENTIFICATION NUMBER	Odometer

Registered OWNER FULL NAME ("Same" if Driver)	Phone ☐ Work ☐ Home	TOTAL occupants in this vehicle	Fire?	Insurance Company

OWNER Address ("Same" if Driver)	Special Data Area	Direction of Travel	Policy Number

Special Conditions for unit above: ☐ 01 Hit & Run ☐ 02 Non-Contact ☐ 03 Stolen ☐ 04 Legally parked ☐ 05 Police pursuit ☐ 06 Driverless ☐ 07 Towed away

Unit	☐ Driver ☐ Ped NAME (Last, First and Initial)	Phone ☐ Work ☐ Home	Color	YEAR	MAKE	MODEL & BODY STYLE	MC CCs

Driver/Ped ADDRESS (Number, Street, City, State, Zip Code)	STATE	LICENSE PLATE #	EXP YR	Removed By:

DRIVER'S LICENSE STATE and NUMBER St. No.	CDL?	DATE OF BIRTH	SEX	VEHICLE IDENTIFICATION NUMBER	Odometer

Registered OWNER FULL NAME ("Same" if Driver)	Phone ☐ Work ☐ Home	TOTAL occupants in this vehicle	Fire?	Insurance Company

OWNER Address ("Same" if Driver)	Special Data Area	Direction of Travel	Policy Number

Special Conditions for unit above: ☐ 01 Hit & Run ☐ 02 Non-Contact ☐ 03 Stolen ☐ 04 Legally parked ☐ 05 Police pursuit ☐ 06 Driverless ☐ 07 Towed away

TRAF UNIT	SEAT TYPE	Last NAME	First Name	Initial	ADDRESS (Number, Street, City, State, Zip)	SEX	AGE	S.E. USED	EJECT TRAP	INJ SEV	EMS UNIT

E M S Unit A	INJURED TAKEN By:	E M S Unit B	INJURED TAKEN By:	E M S Unit C	INJURED TAKEN By:
	INJURED TAKEN To:		INJURED TAKEN To:		INJURED TAKEN To:

INVESTIGATIVE - FATALITY REPORT

COUNTY	ON Road	CITY	DATE of Accident	☐ Fatal, narrative & diagram on fatal accident (required by State) ☐ Investigative Report	Page of /

STATE USE ONLY	INVESTIGATIVE DEPT.	TIME Occurred	Day	Invest. OFFICER	BADGE No.	Local Case Number

Sample

FATALITY DATA

TIME EMS NOTIFIED	EXTRICATION WAS REQUIRED FOR THE FOLLOWING PERSONS	SPECIAL JURISDICTION	VEHICLE DAMAGE	VEHICLE DAMAGE
TIME EMS ARRIVED		00 Not Special 01 National Park Service 02 Military 03 Indian Reservation 04 College/University Campus 05 Other Federal properties 88 Other 99 Unknown	I = P = FRONT ☐ Undercarriage ☐ No Damage Estimated Speed,MPH	I = P = FRONT ☐ Undercarriage ☐ No Damage Estimated Speed,MPH
TIME EMS ARRIVED AT HOSPITAL				

IMPACT POINTS: Show initial impact point by arrow and label "I".
Show principal impact point by arrow and label "P".

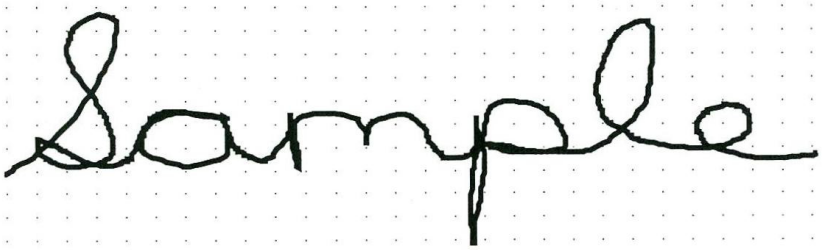
Rev. 1-95

D.O.T FORM NO. 851

COLLISION DIAGRAM Draw scene as observed. Refer to vehicles, drivers, and pedestrians by numbers assigned in this report.

SHOW (1) Outline of street and access points and identify specifically by number.
(2) Paths of units prior to and after impact, skidmarks, and point of impact (POI).
(3) Location of signs, traffic controls, and reference points.
(4) Location of other property hit or damaged (trees, signs, etc.).
(5) Specific features at location (bridge, overpass, culvert, railroad crossing, etc.).
(6) Location of temporary highway conditions.
(7) All measurements to locate the accident relative to specific, fixed, and identifiable points.

↑ NORTH



TRUCK - BUS SUPPLEMENT

☐ Completed post-crash inspection

Supplement required for accidents involving trucks with at least 2 axles and 6 tires, OR buses with a seat capacity of 15 or more, OR any vehicle transporting hazardous material.

COUNTY	ON Road	CITY	DATE of Accident	TIME Occurred	Day	Traffic Unit No.	Page of /

STATE USE ONLY	Investigating Dept.	Investigating Officer	Badge No.	Local Case Number

CARRIER NAME (CORPORATE BUSINESS NAME)

KANSAS PERMITS (Issuer and Permit Number)

1. _____ _____

CARRIER ADDRESS CITY STATE ZIP CODE

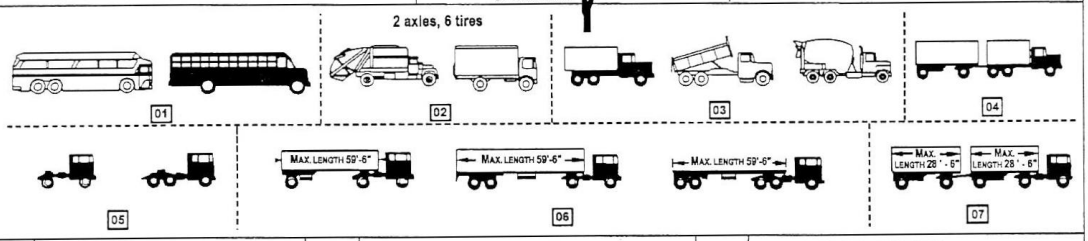
2. _____ _____

U.S. GOVERNMENT PERMITS (Issuer and Number)

SOURCE OF NAME (enter code only)
01 Side of vehicle 03 Driver
02 Shipping papers or manifest 04 Logbook

3. _____ _____

USDOT _____ ICC MC _____



VEHICLE CONFIGURATION

01 Bus _____ (capacity)
02 Single-unit truck (2-axle, 6-tires)
03 Single-unit truck (3 or more axles)
04 Truck and trailer
05 Truck tractor (bobtail)
06 Truck tractor and semi-trailer
07 Truck tractor and double trailer
08 Truck tractor and triple trailer
09 Heavy truck, cannot classify

CAB TYPE (for single truck or tractor)

01 Cab behind engine
02 Cab over engine

CARGO BODY TYPE

01 Van or enclosed box
02 Hopper
03 Tank
04 Flatbed
05 Dump
06 Concrete mixer
07 Auto transporter
08 Garbage or refuse

88 Other _____

ON ROAD LANE TYPE

00 Undivided
01 One-way roadway
02 Divided roadway, medianstrip without barrier
03 Divided roadway, medianstrip with barrier

CARGO TYPE

00 Empty
01 Driveaway or towaway
02 Explosives
03 Farm and other animals
04 Farm products
05 Gases
06 General freight (packages)
07 Heavy machinery, objects
08 Household goods
09 Liquids (bulk)
10 Logs, poles, lumber
11 Metal (coils, sheets, etc.)
12 Mobile / Modular home
13 Motor vehicles
14 Refrigerated foods
15 Solids (bulk)
16 Rock, sand, gravel, salt
17 Food products
18 Plastic products

88 Other _____

ACCESS CONTROL

00 No control (unlimited access)
01 Full control (entry/exit only by ramp)

88 Other _____

SEQUENCE OF EVENTS (list up to 4)

1 _____
2 _____
3 _____
4 _____

00 Ran off road
11 Jackknife
12 Overturn
13 Downhill runaway
14 Cargo loss or shift
15 Explosion
16 Fire
17 Separation of units
18 Trailer swing

COLLISION WITH:

21 Pedestrian
22 Motor vehicle in transport
23 Parked motor vehicle
24 Train
25 Pedalcycle
26 Animal
27 Fixed object
28 Other object

88 Other event _____

TRAILERS			TOTALS				HAZARDOUS MATERIALS DATA		
	WIDTH (inches)	LENGTH (feet)	Total Length (feet)	No. of Axles	No. of Trailers	Gross Vehicle Weight	Material ID No.	Weight (pounds)	Spill or Release?
Trailer 1									
Trailer 2									
Trailer 3									

USE CODE "99" FOR UNKNOWN

Placard? Class:

Rev. 1-2003

D.O.T FORM NO. 852

ACCIDENT CODING LIST

Contributing Circumstances -- List in order of significance

(Example: Officer's Opinion ... D1 07 OR 02 interpretation: driver 1 - made imporper turn; On Road - icy or slushy)

D (n) DRIVER (1, 2, etc.)

01 Under influence of drugs
02 Under influence of alcohol
03 Failed to yield right of way
04 Disregarded traffic signs, signals, or markings
05 Exceeded posted speed limit
06 Too fast for conditions
07 Made improper turn
08 Wrong side or wrong way
09 Followed too closely
10 Improper lane change
11 Improper backing
12 Improper passing
13 Improper or no signal
14 Improper parking
15 Fell asleep
16 Inattention
17 Did not comply - license restrictions
18 Other Distraction in or on vehicle
19 Avoidance or evasion action
20 Impeding or too slow for traffic
21 Ill or medical condition
22 Distraction - mobile (cell) phone
23 Distraction - other electronic devices
24 Aggressive / Antagonistic driving
25 Reckless / Careless driving

P (n) - PEDESTRIAN/CYCLIST (1, 2, etc.)

01 Under influence of illegal drugs
02 Under influence of alcohol
03 Failed to yield right of way
04 Disregarded traffic control
05 Illegally in roadway
06 Pedalcycle violation
07 Clothing not visible
08 Inattention
09 Distraction - mobile (cell) phone

E - ENVIRONMENT

01 Fog, smoke, or smog
02 Sleet, hail, or freezing rain
03 Blowing sand, soil, or dirt
04 Strong winds
05 Rain, mist, or drizzle
06 Animal
07 Vision Obstruction: building, vehicles, objects made by humans
08 Vision Obstruction: vegetation
09 Vision Obstruction: glare from sun or headlights
10 Reduced visibility due to cloudy skies
11 Falling Snow

V (n)VEHICLE (1, 2, etc.)

01 Brakes
02 Tires
03 Exhaust
04 Headlights
05 Window or windshield (includes ice on windshield & designer tinting)
06 Wheel(s)
07 Trailer coupling
08 Cargo
09 Unattended or Driverless (in motion)
10 Unattended or Driverless (not in motion)
11 Other lights

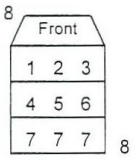
O/A (On/At) R (Road)

01 Wet
02 Icy or slushy
03 Debris or obstruction
04 Ruts, holes, bumps
05 Road construction or maintenance
06 Traffic control device inoperative
07 Shoulders - low, soft, high
08 Snow packed

Miscellaneous Codes:

Occupant Seat Position Codes

01 DRIVER (any vehicle type)
02 Center front
03 Right front
04 Left rear
05 Center rear
06 Right rear
07 Other seat position IN vehicle
08 Any position ON or Outside vehicle
09 Unknown location IN or ON vehicle
10 Motorcycle passengers
11 Extra person on driver's seat or lap
12-17 Extra person on passenger's lap



Train Occupant Seat Codes

31 Train Crew (List all in control whether injured or not)
32 Train passenger (List only if injured)

Pedestrian Type Codes

21 Pedestrian
22 Pedalcyclist
23 Rider of animal
24 In animal-drawn vehicle
25 In vehicle NOT IN TRANSPORT
26 Machine operator or passenger
88 Other

Injury Severity

N Not injured
P Possible injury
I Injury, not incapacitating
D Disabled, incapacitating
F Fatal injury
U Unknown

Safety Equipment Use

S Shoulder and Lap belt
X Shoulder only
L Lap belt only
I Infant seat / restraint system
C Child seat / restraint system
T "Booster" seat / restraint system
P Airbag deployed only (Passive System)
R Airbag deployed - Shoulder & Lap belt
J Airbag deployed - Shoulder belt only
W Airbag deployed - Lap belt only
F Airbag deployed - Infant seat
D Airbag deployed - Child seat
K Airbag deployed - "Booster" seat
B Both MC helmet and eye protection
E Motorcyclist eye protection
H Motorcyclist or pedalcycle helmet
N None used
U Unknown

Ejected / Trapped

N No
E Ejected
P Partially Ejected
T Trapped
U Unknown

Hazardous Material Classes

1 Explosives
2 Gases
3 Flammable/Combustible Liquid
4 Flammable/Combustible Solid
5 Oxidizers & organic peroxides
6 Poisonous/Infectious substance
7 Radioactive material
8 Corrosive material
9 Miscellaneous hazardous material

Gender

M Male
F Female
U Unknown

Animal Type Codes

01 Deer
02 Other wild animal: bobcat, coyote, etc.
03 Cow
04 Other domestic animal: cat, dog, etc.
05 Horse

APPENDIX II: CRASH VARIABLE TABLES

Table 1. Observations for Age
Table 2. Observations for Gender
Table 3. Observations for Crash Time
Table 4. Observations for Day of the Week
Table 5. Observations for Month of the Year
Table 6. Observations for Year of Crash
Table 7. Observations for Light Condition
Table 8. Observations for Weather Condition
Table 9. Observations for Road Surface Condition
Table 10. Observations for Vehicle Maneuver before Crash
Table 11. Observations for Crash Severity
Table 12. Observations for Crash Type
Table 13. Observations for Vehicle Body Type
Table 14. Observations for Road Class
Table 15. Observations for Road Character
Table 16. Observations for Crash Location
Table 17. Observations for Surface Type
Table 18. Observations for Road Special Features
Table 19. Observations for Area Information
Table 20. Observations for Traffic Controls
Table 21. Observations for Driver Factor
Table 22. Observations for Pedestrian Factor
Table 23. Observations for Environment Factor
Table 24. Observations for Vehicle Factor

Table 1. Observations for Age

Number	Name of Observation
1	15-19
2	20-24
3	25-34
4	35-44
5	45-54
6	55-64
7	65+

Table 2. Observations for Gender

Number	Name of Observation
0	Male
1	Female

Table 3. Observations for Crash Time

Number	Name of Observation
1	6:00 a.m. - 10:00 a.m.
2	10:00 a.m. - 4:00 p.m.
3	4:00 p.m. - 8:00 p.m.
4	8:00 p.m. - 6:00 a.m.

Table 4. Observations for Day of the Week

Number	Name of Observation
1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Sunday

Table 5. Observations for Month of the Year

Number	Name of Observation
1	January
2	February
3	March
4	April
5	May
6	June
7	July
8	August
9	September
10	October
11	November
12	December

Table 6. Observations for Year of Crash

Number	Name of Observation
1	1992
2	1993
3	1994
4	1995
5	1996
6	1997
7	1998
8	1999
9	2000
10	2001
11	2002
12	2003
13	2004

Table 7. Observations for Light Condition

Number	Name of Observation	Observation Group
1	Daylight	Good Condition
2	Dawn	Poor Condition
3	Dusk	Poor Condition
4	Dark: street lights on	Poor Condition
5	Dark: no street lights	Poor Condition

Table 8. Observations for Weather Condition

Number	Name of Observation	Observation Group
1	No adverse conditions	Good Condition
2	Rain, Mist, Drizzle	Poor Condition
3	Sleet	Poor Condition
4	Snow	Poor Condition
5	Fog	Poor Condition
6	Smoke	Poor Condition
7	Strong winds	Poor Condition
8	Blowing dust, sand	Poor Condition
9	Freezing rain	Poor Condition
10	Rain & fog	Poor Condition
11	Rain & wind	Poor Condition
12	Sleet & fog	Poor Condition
13	Snow & winds	Poor Condition
14	Other	Other

Table 9. Observations for Road Surface Condition

Number	Name of Observation	Observation Group
1	Dry	Good Condition
2	Wet	Poor Condition
3	Snow or slush	Poor Condition
4	Ice or snowpacked	Poor Condition
5	Mud, dirt or sand	Poor Condition
6	Debris	Poor Condition
7	Other	Other

Table 10. Observations for Vehicle Maneuver before Crash

Number	Name of Observation
1	Straight/following road
2	Left turn
3	Right turn
4	U-turn
5	Overtaking (passing)
6	Changing lanes
7	Avoiding maneuver
8	Merging
9	Parking
10	Backing
11	Stopped awaiting turn
12	Stopped in traffic
13	Illegal parked
14	Disabled in roadway
15	Slowing or stopping
16	Other

Table 11. Observations for Crash Severity

Number	Name of Observation
1	Fatal
2	Injury or near fatal
3	Property Damage Only

Table 12. Observations for Crash Type

Number	Name of Observation	Observation Group
1	Other non-collision	Vehicle-other
2	Overturned	Vehicle-other
3	Collision with pedestrian	Vehicle-other
4	Collision with parked motor vehicle	Vehicle-other
5	Collision with railway train	Vehicle-other
6	Collision with pedalcycle	Vehicle-other
7	Collision with animal	Vehicle-other
8	Collision with fixed object	Vehicle-other
9	Collision with other vehicle: head on	Vehicle-vehicle
10	Collision with other vehicle: rear end	Vehicle-vehicle
11	Collision with other vehicle: angle-side impact	Vehicle-vehicle
12	Collision with other vehicle: sideswipe-opposite direction	Vehicle-vehicle
13	Collision with other vehicle: sideswipe-same direction	Vehicle-vehicle
14	Collision with other vehicle: backed into	Vehicle-vehicle
15	Collision with other vehicle: other	Vehicle-vehicle
16	Other object	Vehicle-other

Table 13. Observations for Vehicle Body Type

Number	Name of Observation	Observation Group
1	Commercial Truck with Commercial Truck	Truck-involved
2	Commercial Truck with Vehicle	Truck-involved
3	Commercial Truck with Motorcycle	Truck-involved
4	Commercial Truck with Pedestrian/Worker	Truck-involved
5	Commercial Truck with Object	Truck-involved
6	Vehicle with Vehicle	Vehicle-only
7	Vehicle with Motorcycle	Vehicle-only
8	Vehicle with Pedestrian/Worker	Vehicle-only
9	Vehicle with Object	Vehicle-only
10	Other	Other

Note: Vehicle includes passenger cars, SUV, minivan, ATV, camper or RV, and pickup

Table 14. Observations for Road Class

Number	Name of Observation
1	Interstate highway
2	Other freeways & Expressways
3	Other Principal Arterial
4	Minor Arterial
5	Major collector
6	Minor collector
7	Local roads

Table 15. Observations for Road Character

Number	Name of Observation	Observation Group
1	Straight and level	Favorable alignment
2	Straight on grade	Complicated alignment
3	Straight at hillcrest	Complicated alignment
4	Curved and level	Complicated alignment
5	Curved on grade	Complicated alignment
6	Curved at hillcrest	Complicated alignment
7	Other	Complicated alignment

Table 16. Observations for Crash Location

Number	Name of Observation
1	Non-intersection
2	Intersection
3	Intersection-related
4	Interchange area
5	On crossover
6	Other

Table 17. Observations for Surface Type

Number	Name of Observation
1	Concrete
2	Blacktop
3	Gravel
4	Dirt
5	Brick
6	Other

Table 18. Observations for Road Special Features

Number	Name of Observation	Observation Group
1	None	No feature impact
2	Bridge	Feature impact
3	Bridge overhead	Feature impact
4	Railroad bridge	Feature impact
5	Railroad crossing	Feature impact
6	Interchange	Feature impact
7	Ramp	Feature impact
8	Other	Feature impact

Table 19. Observations for Area Information

Number	Name of Observation
0	Urban
1	Rural

Table 20. Observations for Traffic Controls

Number	Name of Observation
1	None or inoperative
2	Officer or flagger
3	Traffic signal
4	Stop sign/signal
5	Flasher
6	Yield sign
7	RR gates or signal
8	RR crossing signal
9	No passing zone
10	Center/edge lines
11	Other control

Table 21. Observations for Driver Factor

Number	Name of Observation
0	No human error
1	Under influence of drugs
2	Under influence of alcohol
3	Failed to yield right of way
4	Disregarded traffic signs, signals, or markings
5	Exceeded posted speed limit
6	Too fast for conditions
7	Made improper turn
8	Wrong side or wrong way
9	Followed too closely
10	Improper lane change
11	Improper backing
12	Improper passing
13	Improper or no signal
14	Improper parking
15	Fell asleep
16	Inattention
17	Did not comply-license restrictions
18	Other distraction in or on vehicle
19	Avoidance or evasion action
20	Impeding or too slow for traffic
21	Ill or medical condition
22	Distraction-cell phone
23	Distraction-other electronic devices
24	Aggressive/Antagonistic driving
25	Reckless/Careless driving
26	Other/unknown

Table 22. Observations for Pedestrian Factor

Number	Name of Observation
1	Under influence of illegal drugs
2	Under influence of alcohol
3	Failed to yield right of way
4	Disregarded traffic controls
5	Illegally in roadway
6	Pedalcycle violation
7	Clothing not visible
8	Inattention
9	Distraction-cell phone

Table 23. Observations for Environment Factor

Number	Name of Observation
1	Fog, smoke, or smog
2	Sleet, hail or freezing rain
3	Blowing sand, soil or dirt
4	Strong winds
5	Rain, mist, or drizzle
6	Animal
7	Vision obstruction: building, vehicles, objects made by humans
8	Vision obstruction: vegetation
9	Vision obstruction: glare from sun or headlights
10	Reduced visibility due to cloudy skies
11	Falling Snow

Table 24. Observations for Vehicle Factor

Number	Name of Observation
1	Brakes
2	Tires
3	Exhaust
4	Headlights
5	Window or windshield
6	Wheels
7	Trailer coupling
8	Cargo
9	Unattended or driverless (in motion)
10	Unattended or driverless (not in motion)
11	Other lights

APPENDIX III: FATAL CRASH DATA IN KANSAS HIGHWAY WORK ZONES (1992-2004)

Accident Number (Key #)	Age	Gen.	Tim.	Day	Mon.	Year	Light Condition	Weather Condition	Road Sur Condition	Vehicle Maneuver	Accident Severity	Accident Class	Vehicle Type	No. of Vehicles	Road Class	Road Character	No. of Lanes	Speed Limit	Accident Location	Surface Type	Road Sp Feature	Traffic Control 1	Traffic Control 2	Traffic Control 3	Area Infor.	Driver Factor 1	Driver Factor 2	Driver Factor 3	Driver Factor 4	Pedes. Factor	Envir. Factor	Vehicle Factor
19920032160	5	1	4	2	3	1	4	1	1	1	1	9	6	2	1	4	6	55	1	2	1	10	0	0	0	4	8	16	0	0	0	0
19920033190	2	0	4	7	5	1	4	1	1	7	1	10	6	2	3	1	2	55	1	2	1	3	10	0	1	5	5	16	2	0	0	0
19920033250	3	0	4	7	6	1	4	1	1	1	1	11	2	1	2	2	4	45	2	2	1	3	10	0	0	2	4	0	0	0	0	0
19920106070	3	0	4	5	7	1	5	1	1	7	1	8	9	1	2	4	4	40	6	1	1	3	11	0	0	26	0	0	0	0	0	0
19920161610	5	0	2	1	6	1	1	1	1	7	1	8	6	2	1	2	4	65	6	1	1	10	0	0	1	15	16	8	0	0	0	0
19920161720	7	0	2	4	7	1	1	1	1	1	1	8	9	1	3	1	4	55	1	1	1	1	0	0	1	4	6	8	0	0	0	0
19920161740	3	0	4	7	7	1	5	1	1	1	1	2	10	1	3	4	4	65	1	2	1	10	0	0	1	2	6	16	0	0	0	0
19920161880	3	1	3	2	8	1	1	1	1	1	1	10	2	2	5	1	2	55	1	2	1	9	10	0	1	3	4	6	0	0	0	0
19920201790	1	0	4	3	8	1	4	1	5	1	1	11	6	2	3	1	4	55	2	1	1	8	0	0	1	4	3	6	0	0	0	0
19920201800	4	1	3	6	8	1	1	1	1	1	1	9	6	2	3	5	2	55	1	2	1	11	0	0	1	2	6	0	0	0	0	0
19920201910	2	0	2	4	9	1	1	1	1	1	1	10	2	2	3	5	2	55	1	2	1	11	0	0	1	3	5	16	0	0	0	0
19920306440	6	0	4	2	9	1	5	1	1	1	1	4	3	1	5	4	2	55	1	2	1	10	0	0	1	4	6	16	0	0	0	0
19920415420	4	1	4	3	10	1	1	1	1	1	1	10	2	2	3	1	2	55	1	2	1	2	10	0	1	16	0	0	0	0	0	0
19920064005C	4	0	3	1	6	1	1	1	1	1	1	10	2	6	3	2	2	55	1	2	1	2	10	0	1	4	16	6	0	0	0	0
19920064008C	5	1	4	3	6	1	5	1	1	1	1	12	2	2	3	2	2	55	1	2	1	10	0	0	1	16	8	0	0	0	0	0
19930000200	1	0	1	4	1	2	5	2	4	1	1	10	2	3	3	1	2	55	1	2	1	10	0	0	1	9	6	0	0	0	0	0
19930000430	3	0	4	1	2	2	5	1	1	1	1	8	9	1	3	4	2	55	6	2	1	10	0	0	1	15	0	0	0	0	0	0
19930000980	2	0	2	2	5	2	1	1	1	1	1	3	4	1	1	2	4	65	1	2	1	2	9	0	1	16	6	0	0	0	0	0
19930000110	7	0	1	5	5	2	1	1	1	16	1	9	6	2	3	1	2	55	6	2	1	10	0	0	1	4	16	8	0	0	0	0
19930299140	1	0	2	5	8	2	1	1	1	1	1	8	9	1	1	1	4	65	6	1	3	11	10	0	1	16	6	0	0	0	0	0
19930299150	6	0	1	5	8	2	1	1	1	1	1	11	6	3	2	1	4	35	2	1	1	3	10	0	0	4	0	0	0	0	0	0
19930299530	5	0	4	3	9	2	5	1	1	1	1	8	5	1	1	1	4	65	1	2	2	11	10	0	0	15	16	0	0	0	0	0
19930448090	7	0	2	5	9	2	1	1	1	5	1	9	6	3	3	4	2	55	1	2	8	4	10	0	1	9	16	0	0	0	0	0
19930556110	2	0	4	4	12	2	5	1	1	1	1	8	9	1	3	1	2	55	1	2	1	10	0	0	1	26	0	0	0	0	0	0
19940317990	4	1	2	7	8	3	1	2	2	1	1	12	2	2	4	4	2	55	1	2	1	10	0	0	1	16	8	0	0	0	0	0
19940522470	2	0	4	1	9	3	4	1	1	1	1	10	6	2	4	1	2	55	1	2	1	11	0	0	1	5	16	6	0	0	0	0
19940523280	1	0	4	7	12	3	4	1	1	7	1	1	10	1	3	1	4	55	2	1	1	10	0	0	1	16	0	0	0	0	0	0
19950216610	4	0	4	5	3	4	5	1	1	5	1	13	2	3	3	2	2	55	1	1	1	10	0	0	1	9	12	0	0	0	0	0
19950216980	7	0	3	3	5	4	1	2	2	16	1	9	6	2	3	2	2	55	1	2	1	10	0	0	1	21	0	0	0	0	0	0
19950217060	3	0	2	4	5	4	1	1	1	1	1	3	4	2	4	1	2	55	1	2	1	2	10	0	1	4	16	6	0	0	0	0
19950217200	2	1	4	7	5	4	5	1	1	1	1	11	6	2	1	1	2	65	1	1	1	9	11	10	1	16	2	0	0	0	0	0
19950470560	4	1	4	2	7	4	5	1	1	1	1	3	8	1	1	1	6	55	1	1	1	10	0	0	1	2	16	0	0	0	0	0
19950470670	1	0	2	7	7	4	1	1	1	5	1	9	6	2	3	6	2	55	1	2	1	9	10	0	1	4	5	8	12	0	0	0

Accident Number (Key #)	Age	Gen.	Tim.	Day	Mon.	Year	Light Condition	Weather Condition	Road Sur Condition	Vehicle Maneuver	Accident Severity	Accident Class	Vehicle Type	No. of Vehicles	Road Class	Road Character	No. of Lanes	Speed Limit	Accident Location	Surface Type	Road Sp Feature	Traffic Control 1	Traffic Control 2	Traffic Control 3	Area Infor.	Driver Factor 1	Driver Factor 2	Driver Factor 3	Driver Factor 4	Pedes. Factor	Envir. Factor	Vehicle Factor
19950047068O	4	1	3	7	4	4	3	1	1	1	1	2	10	1	4	1	2	55	1	2	1	10	0	0	1	2	0	0	0	0	0	0
19950047086O	4	1	4	6	8	4	5	1	1	1	1	2	10	1	1	5	4	65	6	2	1	10	0	0	0	0	0	0	0	0	0	2
19950047102O	3	0	1	4	8	4	1	1	15	1	1	10	2	2	1	2	4	65	1	2	1	2	10	0	1	9	0	0	0	0	0	0
19950047130O	1	1	3	3	9	4	1	1	1	1	1	3	8	1	4	1	2	55	1	1	2	3	0	0	1	6	0	0	0	0	0	0
19950067602O	5	0	4	3	7	4	5	1	1	1	1	8	9	1	3	2	2	55	1	2	1	3	0	0	1	16	0	0	0	0	0	0
19950067662O	7	1	2	4	11	4	1	1	1	1	1	16	9	1	1	4	4	65	1	1	3	9	10	0	1	12	5	0	0	0	0	0
19950067681O	1	0	4	3	11	4	5	1	1	5	1	9	6	2	3	2	2	55	1	2	1	10	0	0	1	16	6	0	0	0	0	0
19950072311C	5	0	1	6	11	4	2	1	4	1	1	4	6	1	1	1	4	65	6	2	1	10	11	0	1	16	6	0	0	0	0	0
19960022473O	4	0	4	5	3	5	5	1	1	5	1	9	6	2	2	1	4	55	1	1	1	10	0	0	1	16	2	8	0	0	0	0
19960022523O	5	1	2	7	5	5	1	1	1	1	1	9	2	2	3	4	2	56	1	2	1	9	10	0	1	16	8	0	0	0	0	0
19960036553O	5	1	4	1	5	5	5	1	1	1	1	7	10	1	3	1	2	56	1	2	1	10	0	0	1	0	12	0	0	0	0	0
19960036583O	7	1	3	2	6	5	1	1	1	1	1	11	2	2	4	1	2	65	2	1	6	5	4	9	1	16	4	3	0	0	5	0
19960043971O	1	0	4	6	6	5	5	1	1	1	1	2	10	1	3	4	2	65	6	1	1	10	0	0	1	16	6	0	0	0	0	0
19960045160O	2	0	3	1	9	5	1	1	1	16	1	9	2	2	1	2	4	70	1	2	1	9	10	0	1	21	0	0	0	0	0	0
19960045162O	7	0	2	5	8	5	1	1	1	1	1	8	9	1	1	2	4	70	6	2	1	2	11	10	1	26	0	0	0	0	0	0
19960051451O	3	0	4	5	10	5	5	1	1	1	1	11	2	2	3	1	2	65	2	2	1	4	9	10	1	4	16	3	0	0	0	0
19960053474A	4	1	2	7	10	5	5	2	2	1	1	8	9	1	1	1	6	70	1	1	1	10	11	0	0	2	0	0	0	0	0	0
19960062272O	5	0	3	3	12	5	3	1	1	1	1	2	10	1	3	1	2	56	6	2	1	10	0	0	1	16	0	0	0	0	0	0
19960065865O	2	1	4	5	12	5	5	1	1	16	1	9	2	2	3	5	2	57	6	1	6	10	11	0	1	16	0	0	0	0	0	0
19960074256O	7	0	2	2	12	5	1	1	1	1	1	11	2	3	3	1	4	30	2	1	1	4	0	0	0	3	0	0	0	0	0	0
19970000012O	4	0	4	7	1	6	5	1	2	1	1	2	10	1	4	1	2	65	1	2	1	11	0	0	1	15	2	10	16	0	0	0
19970000027O	4	0	1	7	1	6	1	1	1	1	1	9	6	2	3	1	2	45	1	1	1	10	0	0	1	2	16	8	0	0	0	0
19970000046O	3	1	4	4	2	6	5	4	3	1	1	11	6	2	3	1	2	55	1	2	1	10	0	0	1	2	16	8	0	0	0	0
19970000053O	1	0	4	4	2	6	5	1	1	5	1	9	2	2	3	1	2	55	1	2	1	10	0	0	1	19	12	16	0	0	0	0
19970000056O	4	0	1	4	2	6	1	1	4	1	1	9	2	2	3	1	2	65	1	2	1	10	0	0	1	6	8	0	0	0	1	0
19970012031O	4	0	1	5	4	6	1	4	4	1	1	11	2	2	3	2	2	55	1	1	1	9	10	0	1	16	6	0	0	0	5	0
19970018836O	1	0	4	3	5	6	5	1	1	16	1	9	6	2	3	1	2	55	1	2	1	10	0	0	1	16	2	8	0	0	0	0
19970018838O	1	0	2	2	6	6	1	1	1	5	1	9	2	2	3	1	2	55	1	2	1	10	0	0	1	16	8	0	0	0	0	0
19970031212O	2	1	2	6	6	6	1	1	1	5	1	9	6	2	3	3	2	55	1	2	1	1	0	0	1	12	0	0	0	0	0	0
19970031239O	4	0	2	6	6	6	1	1	1	2	1	11	6	2	2	2	4	60	2	2	6	4	10	0	0	3	16	0	0	0	0	0
19970031246O	3	0	1	1	7	6	1	1	1	3	1	11	2	2	3	5	2	50	3	1	1	10	0	0	1	4	16	7	6	0	0	0
19970031247O	2	0	2	1	7	6	1	1	1	1	1	9	6	2	3	2	2	55	1	2	1	11	0	0	1	15	16	8	0	0	0	0
19970031252O	6	0	3	7	7	6	1	1	1	1	1	2	10	1	1	4	4	70	1	2	1	10	9	0	1	16	0	0	0	0	0	0

Accident Number (Key #)	Age	Gen.	Tim.	Day	Mon.	Year	Light Condition	Weather Condition	Road Sur Condition	Vehicle Maneuver	Accident Severity	Accident Class	Vehicle Type	No. of Vehicles	Road Class	Road Character	No. of Lanes	Speed Limit	Accident Location	Surface Type	Road Sp Feature	Traffic Control 1	Traffic Control 2	Traffic Control 3	Area Infor.	Driver Factor 1	Driver Factor 2	Driver Factor 3	Driver Factor 4	Pedes. Factor	Envir. Factor	Vehicle Factor
199700312590	3	0	3	5	7	6	1	1	1	1	1	11	2	2	1	1	4	55	1	1	1	10	9	11	1	9	16	8	0	0	0	0
199700448260	7	0	2	3	10	6	1	1	1	1	1	4	6	1	3	1	2	65	6	2	1	2	10	0	1	21	16	0	0	0	0	0
199700468150	4	0	3	6	10	6	1	1	1	5	1	9	6	2	5	3	2	55	1	2	1	9	0	0	1	12	16	0	0	0	0	0
199700468250	5	0	1	5	10	6	2	1	1	1	1	8	9	1	3	2	2	55	1	2	1	10	0	0	1	26	0	16	0	0	0	0
199700500110	2	0	2	6	11	6	1	1	1	1	1	11	6	2	3	5	2	65	2	1	1	4	0	0	1	4	3	16	0	0	0	0
1997007826 8B	1	0	2	6	10	6	1	1	1	6	1	11	6	2	2	5	4	65	1	1	1	1	0	0	0	6	0	0	0	0	0	0
199800064040	4	0	2	2	4	7	1	1	1	1	1	10	2	2	3	1	2	65	4	1	6	2	11	0	1	4	16	0	0	0	0	0
199800800260	7	0	2	2	5	7	1	1	1	1	1	11	6	3	3	4	4	45	1	2	1	9	0	0	1	8	0	0	0	0	0	0
199800800290	4	1	3	3	4	7	1	1	1	1	1	11	1	2	3	4	2	65	1	2	1	10	0	0	1	4	16	0	0	0	0	0
199800801440	3	0	2	3	7	7	1	1	1	5	1	11	2	5	3	1	2	45	1	1	1	3	11	10	1	15	10	16	6	0	0	0
199800801820	4	0	1	3	6	7	1	1	1	1	1	11	2	2	3	1	4	40	2	2	1	3	10	0	0	4	16	0	0	0	0	0
199800802100	7	0	3	3	9	7	1	1	1	1	1	11	6	2	3	3	2	55	2	1	1	4	6	10	1	4	3	16	0	0	0	0
199800802160	5	0	4	6	9	7	5	1	1	1	1	2	10	1	1	1	4	70	6	2	1	10	0	0	1	15	0	0	0	0	0	0
199800802710	7	0	1	6	10	7	1	1	2	1	1	9	6	2	3	1	2	55	1	2	1	10	0	0	1	16	8	0	0	0	0	0
199800803150	7	0	3	1	12	7	5	1	1	1	1	11	6	2	3	1	2	65	2	2	1	4	9	10	1	3	0	0	0	0	0	0
199900901170	1	0	4	4	5	8	5	1	1	1	1	9	2	3	1	2	4	60	1	2	1	9	0	0	1	8	0	0	0	0	0	0
199900901640	7	0	4	6	6	8	5	1	1	1	1	3	4	1	3	5	2	65	1	2	1	10	0	0	1	0	0	0	0	5	1	0
199900901780	4	0	4	1	6	8	5	2	2	1	1	4	6	1	1	1	4	70	1	2	8	10	11	0	1	16	0	0	0	0	5	0
199900901960	4	0	4	6	7	8	5	1	1	1	1	11	2	3	1	2	4	60	1	1	1	10	11	0	1	0	0	0	0	0	0	2
199900902010	4	0	2	7	7	8	1	4	1	1	1	9	2	3	1	2	4	60	1	1	1	10	0	0	1	21	7	2	8	0	0	0
199900902390	7	0	3	4	8	8	1	1	1	1	1	10	2	2	3	1	2	65	1	2	8	2	10	0	1	21	0	0	0	0	0	0
199900902530	4	0	2	3	8	8	1	1	1	1	1	10	2	4	3	1	2	65	1	2	1	2	9	10	1	4	19	16	0	0	0	0
199900902600	4	0	2	3	8	8	1	1	1	1	1	10	2	3	4	2	2	65	2	2	1	3	0	0	1	4	0	0	0	0	0	0
199900903090	7	1	1	1	9	8	2	1	1	1	1	10	6	3	1	2	4	60	1	2	1	11	0	0	1	0	0	0	0	9	0	0
199900903460	7	0	2	1	10	8	1	1	1	1	1	3	8	1	3	2	2	65	1	2	1	2	3	0	1	4	16	0	0	0	0	0
199900903630	5	0	4	5	11	8	4	1	1	1	1	3	8	2	1	5	4	60	1	1	1	9	10	0	0	0	0	0	0	5	0	0
200000901230	7	0	3	1	3	9	3	1	1	1	1	4	6	1	3	2	2	5	6	2	1	10	11	0	0	21	0	0	0	0	0	0
200000901290	5	0	4	4	5	9	4	1	1	1	1	3	10	1	3	1	4	55	1	2	1	10	0	0	0	0	0	0	0	3	0	0
200000901520	2	0	4	6	6	9	2	1	1	16	1	12	2	3	1	2	4	60	1	2	1	9	10	0	1	15	8	0	0	0	0	0
200000902310	3	0	2	5	7	9	1	1	1	6	1	9	2	2	3	1	2	65	1	1	1	10	0	0	1	8	0	0	0	0	0	0
200000902520	7	1	2	7	8	9	1	1	1	2	1	9	7	2	5	1	2	55	6	2	1	10	0	0	1	3	0	0	0	0	0	0
200000902560	7	0	2	5	8	9	1	1	1	1	1	10	1	2	3	2	2	65	1	2	1	11	0	0	1	16	6	0	0	0	0	0
200000902670	7	1	3	4	8	9	1	1	1	1	1	10	6	4	3	1	2	65	1	2	1	4	10	0	1	16	6	0	0	0	0	0

Accident Number (Key #)	Age	Gen.	Tim.	Day	Mon.	Year	Light Condition	Weather Condition	Road Sur Condition	Vehicle Maneuver	Accident Severity	Accident Class	Vehicle Type	No. of Vehicles	Road Class	Road Character	No. of Lanes	Speed Limit	Accident Location	Surface Type	Road Sp Feature	Traffic Control 1	Traffic Control 2	Traffic Control 3	Area Infor.	Driver Factor 1	Driver Factor 2	Driver Factor 3	Driver Factor 4	Pedes. Factor	Envir. Factor	Vehicle Factor
200000903040	1	0	1	4	10	9	5	2	2	1	1	11	2	3	1	2	4	70	1	2	2	10	0	0	1	16	0	0	0	0	0	0
200000903270	3	0	4	2	10	9	5	1	1	1	1	8	9	1	1	1	4	70	6	2	2	10	0	0	1	10	2	0	0	0	0	0
200100900130	5	0	2	1	2	10	1	1	1	1	1	4	6	2	1	4	6	60	1	2	1	10	11	0	0	16	0	0	0	0	0	0
200100900950	3	0	3	2	4	10	1	1	1	7	1	10	2	2	3	1	2	65	1	2	1	2	11	0	1	4	16	0	0	0	0	0
200100902090	6	1	3	1	7	10	1	1	1	1	1	11	6	2	4	1	2	65	2	2	1	4	9	0	1	4	3	16	0	0	0	9
200100902430	7	0	3	5	8	10	1	1	1	1	1	9	6	2	1	1	4	60	1	2	1	9	0	0	1	0	0	0	0	0	0	0
200100902710	4	0	4	7	8	10	5	1	1	1	1	2	10	1	1	2	4	60	4	1	7	4	10	0	1	15	4	6	0	0	0	0
200100903030	7	0	2	2	9	10	1	1	1	1	1	8	9	1	3	2	2	65	6	2	1	9	10	0	1	26	0	0	0	0	0	0
200100903110	3	0	4	6	10	10	5	1	1	1	1	2	10	1	4	1	2	65	6	2	1	11	0	0	1	17	16	0	0	0	0	0
200100903630	4	0	2	6	10	10	1	1	1	6	1	9	2	2	1	1	4	60	1	1	1	10	0	0	1	4	16	6	8	0	0	0
200100903750	6	0	3	7	11	10	5	1	1	1	1	11	2	2	3	1	2	65	2	2	1	4	9	0	1	4	3	16	0	0	0	0
200100903770	3	0	2	2	11	10	1	1	1	1	1	10	6	2	1	1	4	70	1	2	1	10	0	0	1	9	16	0	0	0	0	0
200100903840	1	0	2	6	11	10	4	1	1	1	1	8	9	1	4	2	2	65	1	2	2	10	0	0	1	26	0	0	0	0	0	0
200100904180	3	0	4	7	10	10	5	1	1	1	1	9	6	2	3	2	2	65	1	2	1	10	0	0	1	2	4	8	0	0	0	0
200100904190	4	1	4	6	11	10	5	1	1	1	1	2	10	1	3	5	2	60	2	2	1	10	11	0	1	15	0	0	0	0	0	0
200200901010	7	0	3	7	1	11	5	1	1	1	1	2	10	1	3	1	2	70	1	2	1	1	0	0	1	26	0	0	0	0	0	0
200200901390	7	0	2	3	5	11	1	1	1	1	1	4	6	2	1	2	4	70	6	2	1	3	10	0	1	15	19	0	0	0	0	0
200200901908	4	0	4	5	6	11	3	1	1	2	1	11	2	2	4	1	2	60	3	2	1	10	0	0	1	3	0	0	0	0	0	0
200200901920	4	0	1	3	7	11	1	1	1	1	1	2	10	1	1	4	6	50	6	2	1	10	0	0	0	5	0	0	0	0	0	0
200200902280	4	0	4	4	8	11	5	1	1	1	1	3	8	1	1	1	4	60	1	2	1	10	0	0	1	5	0	0	0	0	0	0
2002090266B	4	0	4	5	7	11	5	1	1	1	1	8	10	1	3	4	4	60	6	1	7	10	0	0	1	16	6	0	0	0	0	0
2002090307B	7	1	4	5	5	11	5	1	1	2	1	11	6	2	4	4	2	65	2	2	1	4	11	0	1	3	0	0	0	0	0	0
200200903250	2	1	4	2	10	11	4	1	2	1	1	2	10	1	1	5	4	60	1	1	1	9	10	0	0	16	0	0	0	0	0	0
200200903580	7	1	2	6	6	11	1	1	1	1	1	10	6	3	1	2	2	65	2	1	1	4	10	0	1	16	0	0	0	0	0	0
200200904150	5	1	3	7	11	11	5	1	1	16	1	11	2	2	3	3	2	65	4	5	4	9	10	0	1	0	0	0	0	0	0	0
200200904170	7	0	3	4	11	11	1	1	1	1	1	9	6	2	3	1	2	65	1	1	1	10	0	0	1	26	0	0	0	0	0	0
200200904360	1	1	2	1	12	11	1	1	1	1	1	11	2	2	3	2	2	65	1	2	1	10	0	0	1	19	0	0	0	0	0	0
200200904380	6	0	2	3	12	11	1	1	1	2	1	11	10	2	3	1	2	65	6	2	1	9	10	0	1	16	0	0	0	0	0	0
200200904400	5	0	4	5	12	11	5	1	1	1	1	9	6	2	3	2	2	60	1	2	1	10	0	0	1	2	4	8	0	0	0	0
203009900400	5	1	2	7	2	12	1	4	4	1	1	9	2	2	3	2	2	65	1	2	1	10	0	0	1	6	0	0	0	0	0	0
203009900910	5	1	1	6	4	12	5	1	1	1	1	2	10	1	3	1	2	65	1	2	1	10	0	0	1	26	0	0	0	0	0	0
203009901120	4	0	4	6	4	12	5	2	1	1	1	9	6	2	3	5	2	60	1	2	1	11	0	0	1	2	8	0	0	0	0	0
203009901470	5	1	2	5	5	12	1	1	1	16	1	9	2	3	3	1	2	60	1	2	1	9	10	0	1	8	0	0	0	0	0	0

Accident Number (Key #)	Age	Gen.	Tim.	Day	Mon.	Year	Light Condition	Weather Condition	Road Sur Condition	Vehicle Maneuver	Accident Severity	Accident Class	Vehicle Type	No. of Vehicles	Road Class	Road Character	No. of Lanes	Speed Limit	Accident Location	Surface Type	Road Sp Feature	Traffic Control 1	Traffic Control 2	Traffic Control 3	Area Infor.	Driver Factor 1	Driver Factor 2	Driver Factor 3	Driver Factor 4	Pedes. Factor	Envir. Factor	Vehicle Factor
200300901560	1	1	4	2	6	12	4	1	1	1	1	9	6	2	3	4	2	65	1	1	1	9	10	0	1	8	0	0	0	0	0	0
200300901730	4	0	3	7	3	12	1	1	1	1	1	11	2	2	3	1	2	65	2	2	1	4	10	0	1	3	0	0	0	0	0	0
200300901750	4	0	2	1	4	12	1	1	1	1	1	13	2	2	3	2	2	65	1	2	1	4	2	0	1	15	16	4	6	0	0	0
200300901800	3	1	4	7	6	12	5	1	1	1	1	9	6	2	3	1	2	60	1	2	1	9	10	0	1	8	0	0	0	0	0	0
200300902770	5	1	4	6	9	12	5	1	1	1	1	4	10	2	1	1	4	70	1	2	1	10	0	0	1	16	0	0	0	0	0	0
200300903160	1	0	1	2	10	12	1	1	1	1	1	9	2	2	3	4	2	65	1	2	1	10	0	0	1	15	16	8	0	0	0	0
200300903580	5	0	2	4	11	12	1	1	1	1	1	10	1	2	3	2	2	65	1	2	1	2	10	0	1	16	0	0	0	0	0	0
200400900390	3	0	1	4	4	13	1	11	2	6	1	9	6	2	3	1	2	65	1	2	1	10	0	0	1	8	0	0	0	0	0	0
200400900640	3	1	4	6	3	13	4	1	1	2	1	3	10	1	1	1	6	55	1	1	2	10	0	0	0	0	0	0	0	0	0	0
200400900660	3	1	2	6	4	13	1	1	1	6	1	11	6	2	0	1	6	70	1	1	1	10	0	0	0	0	0	0	0	0	0	0
200400900840	2	0	1	4	4	13	1	1	1	16	1	9	2	2	3	1	2	65	4	2	6	9	10	0	1	16	8	0	0	0	0	0
200400901090	6	0	2	1	5	13	1	1	1	1	1	10	2	4	3	1	2	65	1	1	1	2	10	0	1	16	0	0	0	0	0	0
200400901250	4	1	4	3	6	13	5	1	1	1	1	2	10	1	5	5	2	40	1	2	1	9	10	0	1	2	16	0	0	0	0	0
200400901410	2	0	4	5	5	13	5	1	1	1	1	3	8	1	5	1	2	35	2	1	1	10	0	0	0	0	0	0	0	0	0	0
200400901580	2	0	4	6	6	13	5	1	1	1	1	8	9	1	5	1	2	60	1	2	1	10	0	0	1	26	0	0	0	0	0	0
200400901640	5	0	2	1	6	13	1	1	1	1	1	10	2	4	3	1	2	65	3	1	1	11	10	0	1	16	0	0	0	0	0	0
200400901740	3	0	1	4	6	13	1	1	1	1	1	10	2	6	3	1	2	65	1	1	1	2	10	0	1	16	15	0	0	0	0	0
200400901900	1	1	1	5	7	13	4	2	2	6	1	2	10	1	1	1	6	60	4	1	6	10	0	0	0	2	10	0	0	0	0	0
200400902098	4	0	2	1	6	13	1	1	1	1	1	10	2	3	3	1	2	65	1	2	1	2	10	0	1	16	6	4	0	0	0	0
20040090245	4	0	2	1	9	13	1	1	1	16	1	12	2	2	3	3	2	65	1	2	1	10	0	0	1	16	10	0	0	0	0	0
20040090256	3	0	4	4	8	13	4	2	2	1	1	8	9	1	3	2	6	60	6	2	1	9	10	0	0	2	6	16	0	0	0	0
20040090277	5	0	4	1	9	13	5	1	1	1	1	10	3	3	3	1	4	55	3	2	1	3	10	0	0	6	9	16	0	0	0	0
20040090383	4	0	2	4	12	13	1	1	1	1	1	4	2	2	1	1	4	70	1	2	2	5	10	0	1	16	0	0	0	0	0	0
20040060388	7	0	2	6	11	13	1	1	1	4	1	11	6	2	4	1	4	60	1	1	7	10	0	0	0	4	10	0	0	0	0	0
20040090390	2	0	1	5	12	13	2	1	1	1	1	10	2	2	3	2	4	60	1	1	2	10	0	0	1	16	0	0	0	0	0	0

APPENDIX IV: SAMPLE INJURY CRASH DATA IN KANSAS HIGHWAY WORK ZONES (1992-2004)

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199200073260	1	1	2	6	5	1992	1	1	1	1	2	6	11	2	2	1	4	20	2	2	1	3				4				0	0	0	1
199200153310	4	0	4	6	6	1992	5	1	1	1	2	9	8	1	1	1	4	55	1	2	1	1				2				0	0	0	0
199200153330	3	0	1	4	6	1992	1	14	2	1	2	6	10	1	2	1	4	55	4	1	6	10				6				0	0	0	0
199200174520	7	0	3	5	5	1992	1	2	2	1	2	9	2	3	1	2	2	55	1	2	1	10				16				0	0	0	1
199200182610	5	0	2	3	6	1992	1	1	1	1	2	6	10	3	2	1	2	55	1	2	1	2				9	16			0	0	0	1
199200222290	2	0	3	4	4	1992	5	2	1	1	2	9	2	1	1	1	4	65	1	2	1	10				0				0	0	12	1
199200230670	4	1	4	1	5	1992	5	1	1	1	2	9	2	3	1	1	2	55	1	2	1	10				6	16			0	0	0	1
199200305920	5	1	2	4	6	1992	1	1	1	8	2	6	10	2	3	1	4	45	1	2	1	10	11			16				0	0	0	1
199200358570	6	0	1	2	9	1992	1	1	1	8	2	6	10	1	2	1	6	55	1	1	1	10				9				0	0	0	1
199200359100	4	0	3	6	9	1992	1	1	1	16	2	6	11	3	2	4	2	55	1	2	1	10				2	8			0	0	0	0
199200375720	5	0	2	2	11	1992	1	2	2	1	2	6	10	3	2	1	4	55	2	2	1	10				6	9	16		0	0	0	1
199200435880	1	0	2	2	7	1992	1	1	1	1	2	6	10	3	2	1	2	40	2	2	1	1				16				0	0	0	1
199200456160	3	0	3	3	7	1992	1	1	1	1	2	6	10	3	3	1	4	35	1	2	1	1				9	16			0	0	0	1
199200464410	3	1	1	6	12	1992	1	1	1	2	2	6	11	2	2	1	4	35	2	1	1	3				4	16			0	0	0	0
199200472900	2	1	4	3	8	1992	5	1	1	1	2	9	2	1	1	1	6	55	1	1	1	10				15				0	0	0	1
199200541600	4	0	2	5	10	1992	1	1	1	2	2	6	11	2	3	1	4	35	2	1	1	3			16	3	4	16		0	0	0	0
199200541870	2	0	4	1	11	1992	4	1	1	2	2	6	11	2	2	1	6	35	2	2	1	3	10			4	16			0	0	0	0
199200587120	4	0	4	5	11	1992	4	1	1	16	2	6	11	1	2	5	6	55	1	1	1	10				2	4	8		0	0	0	1
199200590250	1	0	3	4	10	1992	1	1	1	1	2	6	12	2	2	4	4	55	1	1	1	9				8				0	0	0	1
199200602720	5	0	2	4	10	1992	1	1	1	1	2	6	11	2	2	1	6	35	2	2	1	3	10			0				0	0	0	0
199200612830	4	0	2	6	12	1992	1	13	3	1	2	6	11	1	2	1	4	65	1	2	1	10				0				0	5	0	1
199200615070	1	0	4	1	11	1992	4	1	2	1	2	6	11	2	2	1	4	35	2	1	1	1				4				0	0	0	0
199200618930	3	1	2	0	10	1992	1	1	1	16	2	7	11	2	2	1	4	45	2	1	1	3				0				0	0	0	0
199200634400	1	1	3	0	6	1992	1	1	1	1	2	6	10	2	2	2	6	45	3	2	1	3				9	16			0	0	0	0
199200637710	7	1	2	2	9	1992	1	1	1	2	2	6	11	3	2	1	4	35	6	2	1	10				3				0	0	0	1
199200643760	2	0	3	3	12	1992	1	1	1	1	2	6	11	2	3	1	6	35	1	1	1	10				5				0	0	0	0
199200645000	3	0	2	2	9	1992	1	1	1	1	2	6	10	1	2	1	4	55	1	2	7	1				0				0	0	0	1
199300025260	5	0	2	5	1	1993	1	1	1	2	2	6	11	2	2	1	4	45	2	1	1	3				3				0	0	0	0
199300097680	7	1	2	1	3	1993	1	2	2	1	2	6	10	4	2	1	2	55	1	2	1	2	10			0				0	0	0	1
199300142760	2	0	2	5	3	1993	1	1	1	1	2	9	2	3	1	4	2	55	1	2	1	9			18	16				0	0	0	1
199300144990	1	0	4	6	2	1993	4	1	2	1	2	6	11	2	2	1	4	35	2	2	1	3	10	11		4	16			0	0	0	0
199300172050	4	0	3	3	5	1993	1	1	1	2	2	6	15	4	3	1	2	55	1	2	1	1				0				0	0	0	1
199300176540	3	0	1	1	5	1993	1	1	1	2	2	6	10	3	2	1	2	55	1	2	1	11				16				0	0	0	1
199300179000	1	0	1	1	5	1993	1	1	1	1	2	9	1	3	1	1	4	55	6	3	8	10				6				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199300216770	2	0	1	3	5	1993	1	1	1	7	2	5	2	1	1	5	4	65	1	1	1	2	11			16				0	0	0	1
199300228980	5	0	3	2	6	1993	1	1	1	16	2	2	10	3	2	1	4	45	3	2	1	3	9	10		9	16			0	0	0	1
199300239960	2	0	4	5	4	1993	4	1	1	2	2	6	11	2	2	1	6	35	2	2	3	3	11			4				0	0	0	0
199300247260	1	1	3	0	4	1993	1	1	1	1	2	6	11	3	2	1	4	35	2	2	1	3	10			3	18			0	0	0	1
199300261000	4	0	4	6	6	1993	5	1	1	1	2	9	2	3	1	4	2	55	6	2	1	10				16				0	0	0	1
199300275900	0	0	2	6	8	1993	1	1	1	1	2	6	10	2	2	1	6	55	1	1	1	10				16				0	0	0	0
199300289160	6	0	2	0	9	1993	1	1	1	1	2	9	8	1	1	1	4	65	4	2	6	10				15				0	0	0	1
199300319890	5	0	4	2	5	1993	4	1	1	1	2	6	10	3	2	1	6	55	1	2	1	1				6				0	0	0	0
199300323380	3	0	2	5	6	1993	1	2	2	1	2	6	10	2	4	5	6	55	1	1	6	10				6	17			0	0	0	0
199300325100	3	0	4	1	8	1993	5	1	2	2	2	6	12	3	2	1	2	55	2	2	1	4	10			0	16			0	0	0	1
199300325300	3	1	3	0	8	1993	1	1	1	5	2	2	13	1	2	2	4	65	1	2	1	10	11			5	16			0	0	0	1
199300337060	2	0	2	2	8	1993	1	1	7	5	2	5	2	4	1	5	2	55	1	2	1	9	10			4	6	12	16	0	0	0	1
199300345090	0	0	2	5	8	1993	1	1	1	1	2	8	3	3	1	1	2	55	1	2	1	2	10			16				0	0	0	1
199300349290	3	0	2	4	8	1993	1	1	1	1	2	6	10	3	3	1	4	50	3	2	1	3	10	11		9	16			0	0	0	1
199300387340	1	1	2	5	7	1993	1	1	1	1	2	6	10	2	2	1	4	35	3	2	1	10				16				0	0	0	1
199300445110	5	0	4	3	11	1993	5	1	1	6	2	5	8	1	1	4	4	65	6	2	6	5	9			0				0	0	0	1
199300471620	4	1	2	3	8	1993	1	1	1	1	2	6	10	3	2	2	4	40	3	2	1	10				9	16			0	0	0	1
199300479730	4	1	1	2	8	1993	1	1	1	1	2	9	1	1	1	1	6	55	1	1	2	10	11			0				0	0	0	0
199300505420	2	0	4	6	9	1993	5	1	1	1	2	7	11	3	2	1	4	35	4	1	6	3	10			0				0	0	0	1
199300507720	7	0	2	1	8	1993	1	1	1	1	2	6	11	2	2	1	6	45	2	2	1	3				4				0	0	0	0
199300507740	7	1	2	1	8	1993	1	1	1	1	2	6	11	2	2	1	4	35	2	2	1	3	10			4	16			0	0	0	0
199300515220	5	0	4	5	10	1993	5	1	1	1	2	9	8	3	1	1	2	55	1	2	1	3				0				0	0	0	1
199300527970	2	0	1	3	10	1993	1	1	1	1	2	2	10	3	3	1	4	30	1	2	8	3				16				0	0	0	1
199300565410	6	0	1	2	12	1993	5	1	4	1	2	9	2	1	1	1	4	65	6	1	1	10				6	16			0	0	0	1
199300592920	2	0	2	6	12	1993	1	1	1	6	2	6	13	2	2	1	4	55	3	1	1	3	10			10	16			0	0	0	1
199300635780	2	1	2	4	12	1993	1	1	1	1	2	6	11	2	2	1	6	45	2	2	1	3	10			4	16			0	0	0	0
199300647160	1	0	2	5	12	1993	1	2	2	1	2	6	10	3	3	1	2	55	3	2	1	3	10			6				0	0	0	1
199300686570	3	1	1	6	11	1993	1	1	1	12	2	6	10	2	2	5	6	45	3	1	1	10				0				0	0	1	0
199400031040	3	1	3	1	1	1994	1	1	1	1	2	2	11	3	2	1	2	30	2	2	1	4	10			3	16			0	7	0	1
199400045370	4	0	4	6	2	1994	4	1	1	1	2	9	8	2	1	1	4	50	2	2	1	3				2	16			0	0	0	1
199400077150	1	1	2	2	2	1994	1	1	1	5	2	6	10	2	3	2	4	35	3	1	1	3				16				0	0	1	0
199400117840	4	0	3	2	4	1994	1	2	3	1	2	10	2	3	1	4	2	55	1	1	1	10				6				0	0	0	1
199400117870	2	1	3	2	3	1994	1	1	1	2	2	6	10	3	2	5	2	55	3	1	1	10				0				0	0	0	1
199400154230	6	1	4	5	4	1994	4	1	1	1	2	6	11	2	2	1	6	45	2	1	1	3				4	16			0	0	0	0
199400166300	1	1	4	0	3	1994	4	1	1	1	2	9	2	3	1	1	4	35	1	1	2	1	3			0				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199400206400	2	1	2	3	5	1994	1	1	1	1	2	6	10	3	2	1	4	20	1	1	8	11				0				0	0	0	1
199400234690	3	0	2	1	6	1994	1	1	1	1	2	6	10	3	4	1	2	55	3	2	2	10				6	9	16		0	0	2	1
199400242950	5	0	3	1	6	1994	1	1	1	1	2	2	10	1	2	4	4	65	1	2	1	10				9	16			0	0	0	1
199400290090	3	0	4	6	7	1994	5	1	1	3	2	9	8	4	1	5	2	50	6	2	1	1				16				0	0	0	1
199400290140	6	0	3	2	8	1994	1	1	1	1	2	6	10	3	3	1	2	55	1	2	1	10				9	16			0	0	0	1
199400292800	2	1	2	2	7	1994	1	1	1	1	2	6	10	3	3	2	2	55	3	2	1	1	10	11		16				0	0	0	1
199400302340	3	0	1	5	7	1994	1	1	1	1	2	6	11	3	2	4	2	55	2	1	1	4	10	11		0				0	0	0	0
199400309060	2	0	1	1	7	1994	1	1	1	1	2	1	10	2	2	5	6	45	1	1	1	10				9	16			0	0	0	1
199400319080	0	0	4	5	8	1994	5	2	1	1	2	9	16	1	1	1	4	65	1	2	1	10				4	16			7	5	0	1
199400322040	1	0	3	3	7	1994	1	1	1	1	2	9	8	1	1	1	6	55	1	2	1	5	10	11		0				0	0	0	1
199400349620	2	1	1	6	7	1994	1	1	1	1	2	6	11	3	2	1	4	45	2	2	1	3				4	16			0	0	0	1
199400387030	2	0	4	6	8	1994	5	1	1	1	2	9	1	1	1	1	4	65	1	2	1	10				0				0	0	12	1
199400406780	2	1	2	2	8	1994	1	1	5	12	2	6	10	4	4	1	2	55	1	2	1	2	9	10		6	16			0	0	0	1
199400418910	2	0	4	3	7	1994	2	1	1	1	2	9	16	1	1	1	4	65	1	1	1	1				16				0	0	0	1
199400441880	2	1	2	5	8	1994	1	1	1	1	2	6	10	3	3	1	2	40	1	1	1	2				16	18			0	0	0	1
199400445460	3	1	2	3	9	1994	1	1	1	1	2	6	11	3	2	2	4	55	3	1	1	10				3	16			0	0	0	1
199400453890	1	0	2	5	9	1994	1	2	2	1	2	6	11	3	2	1	4	30	2	2	1	1	4			3	16			0	0	0	1
199400465530	3	0	3	3	9	1994	1	1	1	11	2	6	10	3	2	1	4	55	3	2	1	3				0				0	0	0	1
199400486710	1	1	3	5	10	1994	3	1	1	5	2	6	11	3	2	1	2	55	2	2	1	9				4	12	16		0	0	0	1
199400531390	5	0	4	4	10	1994	5	1	1	1	2	5	2	1	1	1	4	65	1	2	1	9	10			0				0	0	0	1
199400558500	2	0	3	2	10	1994	1	1	1	1	2	6	10	4	3	2	2	55	3	2	1	10				16				0	0	0	1
199400585560	4	0	3	0	11	1994	4	1	2	1	2	6	10	3	2	2	4	35	4	2	7	6				16				0	0	0	1
199400645630	5	0	4	6	11	1994	4	1	1	1	2	9	16	2	1	1	4	55	1	2	1	10				16				0	0	0	0
199500035480	3	0	4	6	1	1995	5	1	1	1	2	6	10	3	2	1	2	55	3	2	1	3				2	16			0	0	0	1
199500041040	2	1	2	4	1	1995	1	1	1	1	2	6	11	3	2	4	2	55	2	2	1	4	9	10		3	16			0	0	0	1
199500045180	2	0	2	1	1	1995	1	1	1	1	2	5	2	4	1	4	2	55	1	2	1	9	10	11		4	6			0	0	0	1
199500073000	7	0	2	2	2	1995	1	1	1	1	2	6	11	3	2	1	2	55	2	2	1	1	4			3				0	0	0	1
199500095690	2	0	2	6	2	1995	1	1	1	1	2	6	10	1	2	4	6	55	1	1	1	10				2	6	16	17	0	0	0	1
199500115470	2	0	3	5	3	1995	1	1	1	15	2	6	10	3	5	1	4	35	3	2	1	3				0				0	0	0	1
199500125350	4	0	1	0	1	1995	5	1	4	1	2	9	8	4	1	1	2	55	6	2	1	10				0				0	0	0	1
199500149000	4	0	3	3	3	1995	1	1	1	2	2	6	10	4	2	1	2	55	2	2	1	10				0				0	0	11	1
199500155550	0	0	3	1	3	1995	1	1	1	1	2	6	10	3	2	1	4	55	1	2	1	1				16				0	0	0	1
199500159340	3	1	3	2	3	1995	1	1	1	1	2	6	10	3	2	1	4	40	1	2	1	9				16				0	0	0	1
199500173170	5	0	1	1	4	1995	1	1	1	1	2	9	8	1	1	2	4	65	1	2	1	9				21				0	0	0	1
199500175700	1	1	3	6	4	1995	1	1	1	1	2	6	10	1	2	1	6	55	1	2	1	10				19				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic _Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199500203440	6	0	4	6	4	1995	4	1	1	1	2	6	10	3	2	1	4	40	2	1	1	10	11			16				0	0	0	1
199500204920	4	1	2	6	4	1995	1	1	1	1	2	6	10	3	2	2	2	55	1	2	1	9	10			9	16			0	0	0	1
199500220740	4	1	2	3	5	1995	1	1	1	7	2	6	11	3	2	1	4	30	1	2	1	10				19				0	0	0	1
199500226720	1	0	2	0	5	1995	1	1	1	1	2	10	8	3	1	1	2	55	1	2	1	1				0				0	0	2	1
199500241440	3	0	3	5	5	1995	1	1	1	1	2	6	10	3	4	1	4	30	1	1	2	11				16				0	0	0	1
199500313980	4	0	3	3	6	1995	1	1	1	1	2	6	11	1	3	1	6	55	1	2	1	1				6	16			0	0	0	1
199500321910	4	0	4	0	6	1995	1	1	1	1	2	10	2	1	1	2	6	55	4	1	7	10				6				0	0	0	1
199500333690	3	1	2	6	7	1995	1	1	1	1	2	6	10	3	2	2	4	45	1	1	1	10				16				0	0	0	1
199500335270	3	1	1	5	6	1995	1	1	1	1	2	6	10	3	2	1	2	55	1	2	8	3	10			6	16			0	0	0	1
199500337280	4	0	3	5	6	1995	1	1	1	2	2	6	11	3	2	1	4	50	2	2	1	4	11			3	16			0	0	0	1
199500349520	7	1	2	1	7	1995	1	1	1	1	2	6	10	2	2	1	4	50	3	1	1	10				16				0	0	0	0
199500355210	5	0	3	0	7	1995	1	1	1	1	2	2	10	3	2	3	2	55	3	2	1	9	10			6	16			0	0	0	1
199500361490	0	0	2	6	7	1995	1	1	1	1	2	6	11	3	2	1	4	40	2	1	1	4	9	10		3	4	16		0	0	0	1
199500363320	1	0	2	2	7	1995	1	1	1	1	2	9	8	3	1	1	2	55	1	2	1	10				16				0	0	0	1
199500373370	2	1	2	3	7	1995	1	1	1	1	2	6	10	2	3	2	4	55	4	1	1	5	10			16				0	0	0	1
199500381740	3	1	2	3	7	1995	1	1	1	1	2	6	10	1	3	1	8	55	1	2	1	10				9				0	0	0	1
199500381760	3	1	3	0	7	1995	1	1	1	1	2	6	10	1	3	1	8	55	4	1	1	10	11			6	9	16		0	7	0	1
199500391360	6	0	3	3	8	1995	1	1	1	3	2	6	11	4	2	1	4	55	6	2	1	9				3	16			0	0	0	1
199500394000	1	0	2	4	8	1995	1	1	1	1	2	6	10	2	2	2	6	55	1	1	1	10	11			6	9	16		0	0	0	0
199500399270	6	1	4	4	8	1995	5	1	1	1	2	9	8	3	1	1	2	55	1	6	1	1				0				0	0	0	1
199500405790	4	0	2	3	8	1995	1	2	2	1	2	6	10	1	6	5	6	55	1	1	1	10				6	16			0	5	0	1
199500421600	0	0	4	3	8	1995	4	1	1	1	2	6	10	1	2	5	6	55	1	2	1	5	11			9	16			0	0	0	1
199500423170	4	1	3	5	8	1995	3	1	1	2	2	6	11	4	2	1	4	55	2	2	1	10				16				0	0	0	1
199500443160	3	0	1	4	8	1995	1	1	1	1	2	5	2	3	1	2	2	55	6	2	1	10				16				0	0	0	1
199500445310	1	0	2	5	9	1995	1	1	1	5	2	6	11	3	2	1	2	55	2	2	1	3	10			4	12	16		0	0	0	1
199500447040	5	0	2	4	8	1995	1	1	1	1	2	9	1	3	1	1	2	55	1	2	1	10				18				0	0	0	1
199500453660	4	0	3	4	8	1995	1	1	1	5	2	6	10	1	2	4	6	55	3	1	7	3	11			9				0	0	0	0
199500453830	3	0	1	3	9	1995	1	1	1	15	2	2	10	1	4	2	6	55	1	2	1	5	10			16				0	0	0	1
199500474980	2	0	1	5	9	1995	1	1	1	1	2	6	10	1	2	1	8	55	1	1	1	10				9				0	0	0	1
199500475340	4	0	3	5	9	1995	1	1	1	6	2	2	10	2	4	1	6	45	1	1	2	10	11			10	16			0	0	0	0
199500478950	3	1	4	3	9	1995	4	2	2	1	2	6	10	3	2	1	4	35	3	1	1	3	10			2	16			0	0	0	1
199500487400	2	1	4	1	9	1995	1	1	1	15	2	6	10	3	3	1	4	35	6	2	1	10				9				0	0	0	0
199500495480	4	0	1	4	9	1995	1	1	1	1	2	10	10	1	1	1	4	55	4	2	2	10				0				0	0	0	1
199500503660	2	1	1	2	10	1995	2	1	1	1	2	9	8	1	1	1	4	55	6	1	1	10				16				0	0	0	1
199500513140	1	1	2	4	10	1995	1	1	1	1	2	6	12	3	2	1	2	55	1	2	2	1				0				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199500517340	7	0	2	3	9	1995	1	1	1	1	2	6	10	3	2	3	2	55	1	2	1	2	9	10		6	16			0	0	0	1
199500551440	4	1	4	0	10	1995	4	1	1	1	2	6	11	3	2	1	2	30	2	1	1	1	11			0				0	0	0	1
199500565410	5	0	1	6	10	1995	1	1	1	1	2	6	10	3	2	1	2	30	1	2	1	10				9				0	0	0	1
199500567820	2	0	3	4	11	1995	4	1	1	1	2	9	8	2	1	1	4	40	1	2	1	5				2				0	0	2	1
199500575940	2	0	2	3	11	1995	1	1	1	1	2	2	10	1	2	1	4	55	1	2	1	9	10			9	16			0	0	0	1
199500587460	3	1	4	3	11	1995	2	1	1	6	2	9	10	1	2	1	6	55	1	1	1	11				16				0	0	0	1
199500599660	2	0	2	6	11	1995	1	1	1	1	2	6	11	3	2	1	4	40	2	2	1	1	4			3	16			0	0	0	1
199500607930	6	0	3	2	11	1995	5	2	2	1	2	6	10	2	2	1	4	35	1	2	1	1				9				0	0	0	1
199500609160	5	1	3	6	11	1995	4	1	1	3	2	9	8	1	4	1	2	55	6	2	1	4				7	16			0	0	0	1
199500615620	3	1	3	4	11	1995	5	1	1	7	2	6	10	1	3	1	6	55	1	1	1	10				9	16			0	0	0	1
199500647650	3	0	4	0	11	1995	4	1	1	1	2	9	2	2	1	4	4	50	1	2	1	10				5				0	0	0	0
199500675710	3	0	2	2	12	1995	1	1	1	6	2	6	10	1	2	1	6	55	1	1	2	10	11			3	10	16		0	0	0	1
199500701520	5	1	3	3	12	1995	4	1	1	1	2	6	10	1	2	1	6	55	4	1	6	10				16				0	0	0	1
199500711760	3	0	1	3	12	1995	2	1	4	1	2	9	8	3	1	2	2	55	6	1	1	9	10			0				0	0	0	1
199600048980	5	1	2	1	1	1996	1	1	1	1	2	5	8	3	1	4	2	55	1	2	1	10				16				0	0	0	1
199600063370	1	1	1	5	1	1996	1	9	4	15	2	9	8	1	1	3	6	55	4	2	6	1				6				0	2	0	1
199600067540	5	0	1	4	2	1996	4	4	4	15	2	6	10	1	4	2	6	55	1	1	1	10				6				0	0	0	1
199600067740	3	1	3	3	1	1996	3	1	1	15	2	6	10	1	2	1	6	55	1	1	1	6				16				0	0	0	1
199600096950	7	1	2	6	2	1996	1	1	1	1	2	9	8	3	1	1	2	55	1	2	2	10				0				0	0	0	1
199600136940	5	0	4	0	3	1996	4	1	1	1	2	5	2	3	1	2	2	55	1	2	1	1				0				0	0	0	1
199600147550	3	1	4	3	3	1996	5	4	4	1	2	9	8	1	1	5	4	65	1	2	2	10				0				0	5	0	1
199600151830	2	0	3	0	3	1996	3	1	1	1	2	6	10	2	3	1	4	50	6	2	1	10				9				0	0	0	0
199600155440	3	0	1	6	3	1996	1	1	1	2	2	6	11	3	2	1	2	40	2	2	1	3				3				0	0	0	1
199600163490	4	0	4	3	3	1996	4	1	4	1	2	9	8	1	1	1	4	65	1	2	1	10	11			16				0	0	0	1
199600211390	4	0	1	1	4	1996	1	1	1	1	2	5	3	3	1	1	2	20	2	2	1	3				0				0	0	0	1
199600223620	7	0	2	2	4	1996	1	1	1	1	2	6	11	2	2	1	4	55	2	1	1	2	4	10		3	16			0	0	0	0
199600228850	3	0	2	2	4	1996	1	1	1	1	2	6	10	2	2	1	4	50	1	1	1	10				4	9	16		0	0	0	0
199600236560	2	0	4	1	5	1996	5	1	1	1	2	9	8	1	1	4	8	60	4	1	6	10				2	5	6	16	0	0	0	1
199600238400	1	0	2	2	5	1996	1	1	2	1	2	9	2	1	1	2	4	70	1	2	1	9	11			16				0	0	0	1
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199600292830	3	0	4	5	5	1996	4	1	1	1	2	6	10	3	2	1	4	35	1	2	1	10				2	9	16		0	0	0	0
199600294310	4	0	2	6	6	1996	1	1	2	6	2	6	10	2	2	3	4	55	1	2	1	10				6				0	0	0	1
199600298650	3	0	2	3	6	1996	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2	10			16				0	0	0	1
199600302530	4	0	3	6	6	1996	1	2	2	7	2	6	13	3	2	1	4	70	3	2	1	3	10			6				0	0	0	1
199600313390	2	1	2	1	6	1996	1	1	1	1	2	9	8	1	1	1	4	65	6	2	1	9	10			4	5	6	16	0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
199600318650	3	0	1	2	6	1996	1	1	1	12	2	9	3	3	1	1	2	57	1	1	1	4				4				0	0	0	1
199600320960	3	0	2	5	6	1996	1	1	1	12	2	6	10	1	2	1	6	60	1	1	7	10				0				0	0	0	1
199600321290	3	1	3	2	7	1996	1	1	1	1	2	6	10	2	3	2	4	55	4	2	1	1	9			16				0	0	0	1
199600350530	3	0	3	1	7	1996	1	1	1	1	2	2	10	3	4	1	2	65	1	2	1	2	9	10		4	16			0	0	0	1
199600367690	1	0	2	5	7	1996	1	1	1	1	2	9	1	1	1	1	4	70	1	1	1	9	10			0				0	0	0	1
199600373750	1	0	1	4	7	1996	1	1	1	1	2	6	10	1	3	1	6	60	1	1	1	10				5	16			0	0	0	1
199600393810	1	1	2	3	7	1996	1	1	1	16	2	6	11	3	3	1	4	35	2	2	1	1	4			3				0	7	0	1
199600407580	4	1	3	0	7	1996	1	1	1	7	2	9	2	1	1	2	4	70	6	2	1	9	10	6		0				0	0	2	1
199600410390	0	0	4	0	8	1996	5	2	2	16	2	6	10	1	2	1	4	65	1	1	1	1				0				0	0	0	1
199600415440	7	1	0	4	8	1996	1	1	1	7	2	9	6	3	1	1	4	57	1	1	1	1				0	9			0	0	0	1
199600425940	2	0	2	6	8	1996	1	1	1	1	2	6	10	1	2	2	4	65	1	1	1	10				6	9			0	0	0	1
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199600431380	4	0	2	2	8	1996	1	1	1	7	2	2	11	4	2	1	2	65	1	2	1	10				19				0	0	0	1
199600442380	5	0	1	2	8	1996	1	1	1	1	2	6	10	2	3	1	4	50	1	2	1	10				16				0	0	0	0
199600467750	5	0	4	5	7	1996	5	1	1	8	2	10	2	1	1	1	4	70	1	2	1	10	11			16				0	0	0	1
199600470360	3	0	2	1	9	1996	1	1	1	15	2	2	10	1	3	1	6	65	1	1	1	10				6	16			0	0	0	1
199600495670	2	0	2	0	9	1996	1	2	2	7	2	6	15	3	2	4	4	70	1	1	1	9	10	11		6	17			0	5	0	1
199600510070	1	0	2	1	10	1996	1	1	1	1	2	6	10	1	4	1	6	60	1	1	3	10				6				0	0	0	1
199600515500	3	0	2	5	9	1996	1	1	1	1	2	9	8	1	1	4	4	70	1	2	1	11				15				0	0	0	1
199600518310	4	1	1	3	10	1996	1	1	1	6	2	6	9	4	2	1	2	58	1	2	1	10				8	16			0	0	6	1
199600534280	1	0	3	5	9	1996	1	1	1	1	2	6	10	3	2	1	2	57	2	2	1	1				9				0	0	0	1
199600559730	5	0	4	2	10	1996	5	4	3	1	2	9	8	4	1	2	2	65	1	1	2	11				0				0	0	0	1
199600594530	4	0	1	3	10	1996	1	1	1	1	2	6	10	1	3	2	4	65	1	2	1	10				9				0	0	0	1
199600614200	2	0	3	3	11	1996	3	1	1	1	2	6	10	1	2	1	4	65	4	1	6	10				0				0	0	0	1
199600631360	3	0	2	1	9	1996	1	1	1	15	2	6	10	3	2	1	2	56	1	2	1	2				16				0	0	0	1
199600639580	5	0	4	1	11	1996	99	1	1	1	2	9	7	3	1	2	4	56	1	2	1	10				0				0	6	0	1
199600703820	5	1	2	1	11	1996	1	1	1	4	2	6	11	3	4	2	2	56	1	1	1	2				7				0	0	1	1
199600740320	5	0	1	5	12	1996	4	1	2	1	2	6	9	4	2	1	2	55	1	2	1	9	10			0				0	0	0	1
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199700001670	3	0	0	2	1	1997	1	1	2	1	2	6	10	3	2	1	2	57	3	1	1	9				9	16			0	0	0	1
199700029370	7	0	4	4	1	1997	5	1	1	1	2	1	11	3	2	1	2	65	2	2	1	4	9	10		3	4	16		0	0	0	1
199700101330	5	1	3	0	2	1997	1	1	1	1	2	9	8	3	1	4	2	45	6	1	1	10				16				0	0	0	1
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Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
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199700184850	5	1	2	2	5	1997	1	1	1	1	2	9	3	3	1	4	2	65	1	2	2	2	10			0				0	0	0	1
199700189740	3	0	2	2	4	1997	1	9	3	1	2	9	2	3	1	7	2	45	1	2	1	1				0				0	0	0	1
199700277070	0	0	2	2	6	1997	1	1	1	16	2	2	10	4	4	1	2	55	1	2	1	2				0				0	0	0	1
199700293260	5	0	2	2	6	1997	1	1	1	1	2	2	10	3	3	2	2	55	1	2	1	9	10			16				0	0	11	1
199700303440	4	0	3	1	7	1997	1	1	2	15	2	6	10	3	3	2	4	35	3	2	1	9	10			9	16			0	0	0	1
199700316730	1	1	1	3	6	1997	1	1	1	1	2	6	10	1	2	1	4	55	1	2	1	2	10			16				0	0	0	1
199700352980	3	0	1	5	6	1997	1	1	1	1	2	6	10	3	2	2	2	55	2	1	1	4	10			9				0	0	0	1
199700364980	1	0	1	4	7	1997	2	1	1	1	2	9	8	3	1	1	2	45	6	2	1	10	11			15	16			0	0	0	1
199700373890	2	1	3	1	5	1997	1	1	1	1	2	6	10	3	2	1	4	20	3	1	1	3	10			16				0	0	0	1
199700388870	7	1	3	5	8	1997	1	1	1	2	2	6	11	3	2	4	2	55	2	1	1	4	10			7	16			0	0	0	1
199700393330	4	1	2	1	6	1997	1	1	1	1	2	6	10	1	2	1	4	70	1	2	1	10				5	9	16		0	0	0	1
199700400680	1	0	4	3	7	1997	5	1	1	1	2	6	9	3	2	2	2	55	1	2	1	9	10			8				0	0	0	1
199700400950	1	1	2	3	8	1997	1	1	1	1	2	2	15	1	4	1	4	55	1	2	1	10				0				0	0	6	1
199700431960	6	0	2	5	6	1997	1	1	1	7	2	10	1	2	1	5	4	45	1	2	1	11				16				0	0	0	1
199700439660	2	0	2	4	7	1997	1	1	1	2	2	2	14	3	2	1	4	40	1	2	1	1				3	16			0	0	0	1
199700471940	3	1	2	0	9	1997	1	1	1	7	2	6	10	1	3	1	2	60	1	2	1	10				0				0	8	0	0
199700481220	3	0	3	5	9	1997	1	1	1	2	2	6	11	3	2	1	2	55	2	2	1	4	10			3	16			0	0	0	1
199700513030	5	0	2	5	8	1997	1	1	1	1	2	2	10	3	3	1	2	55	1	2	1	10	11			9	16			0	0	0	1
199700551730	3	0	3	2	12	1997	1	2	2	12	2	6	10	3	2	1	2	55	1	2	1	1				16				0	0	0	1
199700573470	4	1	4	1	12	1997	4	4	3	1	2	9	8	1	1	2	6		1	1	2	1				0				0	0	0	1
199700666820	7	1	3	5	9	1997	1	1	1	2	2	6	9	3	2	3	2	65	2	2	1	4	11			3				0	0	0	1
199700669260	3	1	4	6	10	1997	5	2	2	1	2	6	11	4	2	1	4	50	2	2	1	4	10			3	16			0	0	0	1
199700677640	7	0	2	2	10	1997	1	1	1	15	2	6	10	4	2	2	2	55	1	1	1	4				16				0	0	0	1
199700687320	5	1	2	1	11	1997	1	1	1	1	2	6	10	3	2	2	4	45	3	2	1	3				16				0	0	0	1
199700717780	1	1	3	2	10	1997	1	1	1	1	2	6	10	3	2	1	2	45	1	2	1	10	11			6	16			0	0	0	1
199700717790	7	0	3	2	10	1997	1	1	1	1	2	6	10	3	4	2	2	45	1	2	1	10	11			6	16			0	0	0	1
199700718870	5	1	2	5	8	1997	1	1	1	1	2	6	9	3	2	1	4	35	2	2	1	3				4	16			0	0	0	1
199700727620	5	0	3	3	8	1997	1	1	1	2	2	6	11	2	2	1	4	60	2	2	1	4	5			3				0	0	0	1
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199700730910	1	0	2	3	11	1997	1	14	2	16	2	6	11	3	2	1	4	40	2	1	1	3				7				0	0	0	1
199700734900	3	0	2	6	11	1997	1	1	1	1	15	2	11	3	2	4	4	35	1	2	1	10				0				0	0	0	1
199700735660	1	0	1	6	11	1997	1	1	1	2	2	6	10	3	2	1	4	40	3	2	1	3	10			16				0	0	0	0
199700738750	7	0	2	2	12	1997	1	1	1	2	2	6	9	3	2	2	4	30	6	2	1	1				16				0	0	0	1
199700750380	2	1	2	5	8	1997	1	1	1	4	2	6	9	3	2	1	2		6	2	1	10				16				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
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199700759960	7	1	2	1	12	1997	1	1	1	16	2	6	11	3	3	1	4	40	2	1	1	3				7				0	0	0	1
199700778760	1	0	3	3	10	1997	1	1	1	1	2	6	10	1	2	2	4		1	2	1	10	11			16				0	0	0	1
199800003500	5	0	1	1	3	1998	1	1	4	5	2	9	8	3	1	5	2	55	1	2	1	10				0				0	0	0	1
199800133280	5	0	2	2	2	1998	1	1	1	15	2	10	2	3	1	1	2	65	6	2	1	10				16				0	0	0	1
199800136860	3	0	2	2	4	1998	1	2	2	1	2	6	10	3	2	1	2	55	3	2	1	10				16				0	0	0	1
199800152290	7	0	4	4	5	1998	1	1	1	1	2	9	8	1	1	4	8	60	1	1	1	10				2	16			0	0	0	1
199800176470	5	0	2	5	6	1998	1	1	1	15	2	2	10	2	2	1	6	60	1	1	1	10				9				0	0	0	0
199800212680	1	0	2	2	4	1998	1	1	1	1	2	6	10	4	2	1	2	65	1	2	1	10				19				0	0	0	1
199800223660	2	0	3	3	5	1998	1	1	1	1	2	6	10	3	2	1	4	40	3	2	1	3	10			16				0	0	0	1
199800223830	5	0	4	3	5	1998	5	1	1	1	2	5	10	1	2	1	8	55	1	2	1	10				0				0	0	0	1
199800241270	2	1	2	0	4	1998	1	1	1	5	2	6	12	3	3	1	2	55	1	2	1	9	10			12	16			0	0	0	1
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199800261550	6	0	2	5	5	1998	1	1	1	1	2	6	10	5	2	1	2		1	2	1	10	11			16				0	0	0	1
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199800335810	3	0	4	6	6	1998	5	1	2	5	2	9	16	3	1	1	4	30	1	2	1	1				2	5	6	12	0	0	0	1
199800343720	3	0	2	2	6	1998	1	1	1	1	2	6	10	3	3	2	4	35	1	2	1	10				16	18			0	0	0	1
199800345020	3	1	3	3	8	1998	1	2	2	1	2	6	10	2	2	1	4	65	4	1	6	5	10			6				0	0	0	1
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199800351440	3	0	4	3	8	1998	4	1	1	15	2	6	10	1	2	1	8	65	1	1	1	10	11			19				0	0	0	1
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199800384310	3	0	3	2	10	1998	5	1	1	2	2	2	11	3	2	1	2	55	2	1	1	4	10			2	7			0	0	0	1
199800397200	4	1	2	0	7	1998	1	1	1	6	2	9	2	1	1	2	4	70	1	2	1	10				10				0	0	0	1
199800408680	2	0	4	6	7	1998	5	1	1	1	2	9	8	5	1	1	2	65	1	2	1	10				2	16			0	0	0	1
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199800419410	3	1	2	2	7	1998	1	1	1	7	2	9	8	1	1	1	8	60	6	1	1	10				16				0	0	0	1
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199800511500	4	0	2	2	8	1998	1	1	1	7	2	6	10	1	2	1	8	60	1	1	2	10	11			9				0	0	0	1
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199800617600	5	0	2	5	10	1998	1	2	2	1	2	2	11	3	2	1	2	30	1	1	1	9	10			9	16			0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
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199800733730	5	0	2	3	10	1998	1	1	1	1	2	2	10	3	4	1	2	65	1	2	1	2	9	10	11	6	9	16		0	0	0	1
199900009800	5	0	2	5	1	1999	1	4	4	1	2	9	2	3	1	1	2	65	1	2	1	1				16				0	0	0	1
199900071850	6	0	2	2	1	1999	1	1	1	1	2	6	10	3	2	1	4	40	1	2	1	10				9				0	0	0	0
199900127460	4	0	4	5	3	1999	5	1	1	7	2	9	3	1	1	4	8	60	1	1	1	10				0				1	0	0	1
199900153470	1	0	2	5	3	1999	1	4	2	7	2	6	10	4	2	4	4	65	3	2	1	10				6	16			0	0	0	1
199900163750	4	1	2	1	3	1999	1	1	1	1	2	6	10	3	2	4	4	40	6	2	1	10				16				0	0	0	0
199900227850	2	0	3	1	3	1999	1	1	1	1	2	6	10	3	2	1	4	40	3	1	1	3	10			9				0	0	0	0
199900319950	6	0	3	0	6	1999	1	1	1	1	2	6	10	2	3	2	4	55	1	1	1	10				9				0	0	0	1
199900327380	5	0	2	2	6	1999	1	1	1	1	2	6	10	3	4	1	4	40	1	1	1	10				16				0	0	0	0
199900345450	2	0	1	3	6	1999	1	2	2	1	2	9	8	1	1	1	4	70	1	2	1	10				6	16			0	0	0	1
199900368020	3	1	1	5	8	1999	1	1	1	2	2	6	11	3	2	1	4	65	5	2	1	10				7				0	0	0	1
199900423620	1	0	4	4	7	1999	5	1	1	1	2	6	11	3	2	1	4	40	2	2	1	3				4				0	0	0	0
199900441160	1	0	4	1	8	1999	5	1	1	1	2	9	1	4	1	2	2	55	1	2	1	10				0				0	0	0	1
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199900529150	4	1	2	1	9	1999	1	2	2	1	2	6	10	1	4	1	4	60	1	2	1	10				6	16			0	0	0	1
199900532940	6	1	1	3	9	1999	5	1	1	1	2	9	8	1	1	1	4	60	1	2	2	10	11			4	16			0	0	0	1
199900536810	6	0	1	1	8	1999	4	2	2	4	2	2	11	1	2	1	4	60	1	1	1	10	11			7	16			0	0	0	1
199900536860	5	0	3	5	9	1999	1	1	2	1	2	6	10	1	3	1	4	60	1	1	1	10				16				0	0	0	1
199900537020	3	1	2	4	9	1999	1	1	1	1	2	6	11	3	2	1	4	55	2	1	1	6	10			3	16			0	0	0	1
199900575760	1	0	2	5	10	1999	1	1	1	1	2	9	3	3	1	1	2		1	2	1	1				0				0	0	0	1
199900593530	7	0	2	2	9	1999	1	1	1	8	2	9	16	1	1	1	4	60	1	2	1	5				4				0	0	0	1
199900681350	4	0	4	6	11	1999	5	1	1	1	2	6	10	3	2	4	2	45	1	2	1	9				16				0	0	0	1
199900733330	4	0	3	2	11	1999	1	8	1	7	2	1	13	1	4	1	4	70	4	2	6	10				9	16			0	0	0	1
200000033440	5	1	1	5	1	2000	1	1	1	6	2	9	16	1	1	4	4	70	1	2	1	10				10	18			0	0	0	1
200000177380	6	1	2	4	4	2000	1	1	1	2	2	6	9	4	2	1	2	45	2	1	1	10	11			3	7			0	0	0	1
200000224970	5	0	1	6	4	2000	1	1	1	1	2	9	8	1	1	5	4	60	1	1	1	10				0				0	0	2	1
200000281450	2	0	3	5	5	2000	1	1	1	1	2	6	10	1	2	1	4	60	4	2	3	10				0				0	0	0	1
200000285300	6	0	2	2	5	2000	5	1	1	1	2	2	10	3	2	1	2		4	1	7	3	9	10		4	16			0	0	0	1
200000288850	5	1	2	5	5	2000	1	1	1	6	2	9	4	1	1	1	6	70	1	1	1	10				4	16			0	0	0	1
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200000319790	4	1	3	2	6	2000	1	7	1	15	2	6	10	2	2	2	4	70	1	1	1	10				6	16			0	4	0	1
200000331160	4	0	3	0	6	2000	1	1	1	15	2	6	10	1	2	1	4	60	1	2	1	10	11			9				0	0	1	1
200000341050	5	1	3	0	6	2000	1	1	1	7	2	6	16	3	2	1	4	70	1	1	1	10				16				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
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200000401110	1	0	2	6	7	2000	1	1	1	1	2	9	16	1	1	1	4		6	2	1	9	10	11		15				0	0	0	1
200000401290	3	0	4	6	7	2000	5	1	1	1	2	9	2	5	1	2	2		1	2	1	10				8	15	16		0	0	0	1
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200000405090	1	1	2	6	7	2000	1	1	15	1	2	6	10	1	4	2	4	70	1	1	1	10				9				0	0	0	1
200000409090	2	1	3	5	8	2000	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2	10			16				0	0	0	1
200000415900	2	1	1	3	7	2000	1	1	1	1	2	6	10	2	2	1	4	45	1	2	1	10				0				0	0	0	1
200000428910	4	0	2	5	8	2000	1	1	1	1	2	9	4	1	1	2	2	70	4	2	1	10				3	16			0	0	0	1
200000433240	2	1	1	1	8	2000	1	1	15	1	2	6	10	1	2	2	4	60	1	1	1	10				9	16			0	0	0	1
200000473490	1	1	2	6	8	2000	1	1	1	1	2	6	11	4	2	2	2	65	2	2	1	4	11			0				0	0	0	1
200000487330	4	1	2	2	9	2000	1	1	1	14	2	2	10	3	3	1	4	35	1	2	1	10				0				0	0	0	1
200000528920	6	0	4	3	9	2000	5	1	1	7	2	1	10	3	2	2	2	45	1	1	8	3	9	10		4	6	16		0	0	0	1
200000544000	3	1	4	3	9	2000	5	1	1	14	2	6	10	3	2	1	4	45	1	1	2	9	10			6	16			0	0	0	1
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200000713120	2	0	4	5	12	2000	4	1	1	1	2	6	10	3	2	1	4	45	1	2	1	3				1	6	15		0	0	0	1
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200000740930	7	0	3	5	11	2000	5	1	1	1	2	9	7	3	1	1	2	65	1	2	1	10				0				0	0	0	1
200100068210	6	0	2	2	1	2001	1	1	1	1	2	2	10	1	2	1	6	70	1	1	1	3	10			4	16			0	0	0	1
200100185320	1	1	3	6	4	2001	1	2	2	5	2	9	8	1	1	2	4		1	2	2	10				6	16			0	0	0	1
200100189300	4	1	4	4	4	2001	5	1	1	1	2	6	10	3	2	1	2	65	1	2	1	3				0				0	0	0	1
200100253270	6	0	2	1	3	2001	1	1	1	15	2	2	10	3	3	1	2		1	2	1	2				9				0	0	0	1
200100253460	3	0	3	3	5	2001	1	1	1	1	2	5	8	1	1	1	4	70	6	2	1	10				21				0	0	0	1
200100273460	2	1	3	4	5	2001	1	1	1	8	2	6	11	3	2	1	2	65	1	2	1	9	10			16				0	0	0	1
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200100371330	7	0	2	3	6	2001	1	1	1	1	2	6	11	3	2	2	4	35	2	2	1	4	11			4				0	0	0	1
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200100419720	3	0	3	4	9	2001	1	1	1	1	2	6	10	3	2	1	4	55	3	1	1	1	10			9	16			0	0	0	0
200100441300	3	1	2	6	9	2001	1	1	1	1	2	9	8	3	1	4	2	65	6	2	1	10				6	16			0	0	0	1
200100445090	7	0	2	5	6	2001	1	1	1	1	2	6	10	3	3	1	2	65	1	2	1	3				16				0	0	0	1
200100481360	5	1	2	6	9	2001	1	2	2	1	2	9	4	1	1	4	4	70	4	2	1	7	10			6				0	5	0	0
200100489370	7	1	3	2	9	2001	1	1	1	2	2	2	13	3	2	1	2	55	3	2	1	10				7				0	0	0	1
200100491850	3	1	2	2	10	2001	1	1	1	1	2	6	10	2	3	1	4	65	1	2	1	1				0				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
200100519730	3	0	1	1	10	2001	1	2	2	1	2	9	8	1	1	1	4	70	6	2	1	10	11			6				0	0	11	0
200100523490	4	0	3	5	10	2001	4	1	1	1	2	6	10	2	2	1	4	65	1	2	1	1				16				0	0	0	1
200100571990	3	1	1	5	11	2001	2	5	1	1	2	6	10	2	3	1	4	55	1	2	1	11				9				0	0	0	0
200100617460	1	0	3	0	11	2001	1	1	1	1	2	6	10	3	2	1	2	55	1	2	1	9	10	11		3	6	9	16	0	0	0	1
200100731830	3	1	3	0	11	2001	5	1	1	1	2	9	7	3	1	1	2	60	1	2	1	1				0				0	6	0	1
200100735890	5	0	3	2	11	2001	3	1	1	1	2	6	10	2	4	1	4	65	1	1	1	10				16				0	0	0	0
200200005220	4	1	3	2	1	2002	4	1	1	1	2	9	7	3	1	3	2	65	1	2	1	10				0				0	6	0	1
200200031720	3	0	3	0	1	2002	4	1	1	1	2	6	10	3	3	1	4	55	3	2	1	3				9				0	0	0	0
200200200750	2	0	1	6	4	2002	1	1	1	1	2	9	1	3	1	4	2	45	4	1	6	10				0				0	0	7	1
200200315680	1	1	3	2	6	2002	1	2	2	15	2	6	10	2	3	2	4	55	1	1	2	10				6				0	0	0	1
200200317340	5	0	2	6	6	2002	1	1	1	1	2	2	10	1	2	2	4	60	1	2	1	10	11			9	16			0	0	0	1
200200348410	2	0	2	6	5	2002	1	1	1	7	2	9	8	2	1	5	4		4	2	7	10				16				0	0	0	1
200200355750	1	0	2	6	6	2002	1	1	1	1	2	6	10	2	4	1	4	65	1	1	1	10				0				0	0	0	1
200200363560	1	0	2	5	6	2002	1	1	1	15	2	6	10	1	2	2	4	40	4	1	6	10				9				0	0	0	1
200200397280	6	1	4	4	7	2002	5	1	1	1	2	9	7	1	1	1	4	60	1	1	1	10				0				0	6	0	1
200200419630	2	1	2	6	7	2002	1	1	1	1	2	6	10	2	3	2	4	55	4	1	6	10				9				0	0	0	1
200200427110	1	0	2	1	7	2002	1	1	1	1	2	6	10	3	3	1	4	35	6	2	1	10				16				0	0	0	1
200200435600	1	1	3	0	8	2002	1	1	1	1	2	9	2	1	1	1	6	50	4	1	7	10				6	16			0	0	0	0
200200436210	3	0	2	3	7	2002	1	1	1	1	2	9	8	1	1	2	4	70	6	1	2	9	11			16	21			0	0	0	1
200200436240	3	0	2	1	7	2002	1	1	1	1	2	3	15	3	2	1	4	55	1	1	1	10				16				0	0	0	1
200200473180	6	1	2	6	8	2002	1	7	1	1	2	9	2	1	1	1	4	70	1	2	1	10				15				0	0	0	1
200200479540	1	1	2	6	8	2002	1	1	1	1	2	6	10	1	3	1	6	65	1	1	1	1				9				0	0	0	1
200200517100	2	0	4	5	9	2002	5	1	1	1	2	6	10	3	2	1	2	65	1	2	1	10	11			4	6	9	16	0	0	0	1
200200575370	5	0	2	1	10	2002	1	1	1	1	2	6	10	4	2	2	4	35	3	1	1	3				9				0	0	0	1
200200580830	4	0	2	1	10	2002	1	1	1	1	2	9	1	3	1	2	2	65	1	2	1	1				15				0	0	0	1
200200581250	7	1	2	1	9	2002	99	3	1	7	2	6	10	4	2	1	2	55	1	2	1	10				16				0	0	0	1
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200200617520	1	1	2	5	10	2002	1	1	1	1	2	6	10	1	2	1	4	60	1	2	1	9				16				0	0	0	1
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200200644570	7	0	4	3	10	2002	3	2	2	16	2	9	8	3	1	5	4	60	1	1	1	1				0				0	5	0	1
200200689510	3	0	4	1	11	2002	5	1	1	1	2	9	2	1	1	2	4	60	1	1	1	10				15				0	0	0	1
200200769390	7	0	3	5	12	2002	1	1	1	1	2	6	10	1	1	1	4	60	1	1	1	10				9				0	0	0	1
200300185090	5	0	1	6	4	2003	1	1	1	1	2	6	10	3	5	1	2	65	1	2	1	11				20				0	0	0	1
200300205540	1	1	3	5	5	2003	1	1	1	1	2	6	10	1	2	1	4	60	1	1	1	9	10	11		16				0	0	0	1
200300219850	4	1	2	3	4	2003	1	2	2	1	2	2	10	1	3	1	6	55	1	2	1	10				6				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
200300225150	2	1	4	3	5	2003	5	1	1	1	2	9	2	1	1	1	4	60	1	2	1	10				0				0	0	0	1
200300240750	7	0	2	4	5	2003	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2	10			9	16			0	0	0	1
200300249120	6	0	1	2	5	2003	1	1	1	1	2	9	1	1	1	1	4	60	1	2	1	10				0				0	0	0	1
200300252920	2	0	2	0	5	2003	1	7	1	1	2	9	2	3	1	1	2	65	1	2	1	10				0				0	0	0	1
200300256020	1	0	3	5	5	2003	1	1	1	6	2	2	8	1	2	5	6	45	1	1	1	9	10	11		2	4	10		0	0	0	0
200300265420	6	0	2	5	5	2003	1	1	1	7	2	5	2	1	1	1	4	60	6	1	1	9	10			19				0	0	0	1
200300270130	4	1	2	6	5	2003	1	1	2	7	2	10	2	1	1	1	4	50	1	2	1	10				19				0	0	0	1
200300289180	1	0	3	6	5	2003	1	1	1	7	2	6	11	3	2	1	4	60	1	1	1	10				8	19			0	0	0	1
200300329240	3	0	4	1	6	2003	5	1	1	1	2	5	2	1	1	1	4	70	1	2	1	10				0				0	0	12	1
200300333080	7	0	2	4	6	2003	1	1	1	1	2	9	1	3	1	1	4	55	1	1	1	10				4				0	0	0	1
200300381420	2	0	4	5	7	2003	2	1	1	1	2	9	2	4	1	1	2	65	1	2	1	1				16	18			0	0	0	1
200300411690	3	1	2	0	8	2003	1	1	1	1	2	6	10	1	2	2	6	55	1	2	1	10				16				0	0	0	1
200300416720	0	0	4	5	8	2003	5	1	1	1	2	9	10	3	2	1	2	35	1	2	1	3	9	10		4				0	0	0	1
200300417250	5	0	4	2	8	2003	5	1	1	1	2	9	8	2	1	1	4	60	6	2	1	9	10			2				0	0	0	1
200300443830	3	1	3	6	8	2003	1	1	1	15	2	6	10	1	2	2	6	55	4	2	6	10				6	16			0	0	0	1
200300443890	4	1	4	6	8	2003	5	1	1	1	2	6	10	1	2	1	6	55	1	1	1	9	10			9	16			0	0	0	1
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200300488870	1	1	4	0	10	2003	5	1	1	1	2	9	8	3	1	1	4	40	4	1	6	11				16				0	0	0	1
200300493330	5	0	4	1	9	2003	5	1	1	1	2	5	2	3	1	5	2	55	1	2	1	9	10	11		6				0	0	0	1
200300535930	5	0	2	1	9	2003	1	1	1	15	2	2	10	1	2	4	6	55	1	1	1	9	10			9				0	0	0	1
200300564130	3	0	2	6	11	2003	1	1	1	1	2	9	8	1	1	4	6	55	6	2	1	9	10			2	6			0	0	0	1
200300583420	1	0	2	2	11	2003	1	1	1	1	2	6	10	3	2	2	4	35	1	2	1	10				6	9	16		0	0	0	1
200300615840	4	1	3	6	10	2003	5	1	1	7	2	6	10	1	2	1	8	55	1	2	1	10				17				0	0	0	1
200300615970	6	1	1	4	10	2003	1	1	1	15	2	6	10	1	8	1	6	55	1	1	1	10				9				0	0	0	1
200300647470	2	0	2	2	10	2003	1	1	1	1	2	6	11	3	2	1	4	35	2	2	1	4	10			3				0	0	0	1
200300669630	2	1	3	5	11	2003	1	1	1	1	2	6	10	1	2	2	4	60	1	1	1	10				9	16			0	0	0	1
200300671990	4	0	2	0	10	2003	1	1	1	1	2	6	10	2	3	1	4	35	1	1	1	1				9				0	0	0	0
200300677080	2	0	1	3	11	2003	1	1	1	4	2	2	11	3	2	2	4	60	4	2	7	10				7				0	0	0	1
200300691480	6	0	4	4	9	2003	4	1	1	1	2	2	11	3	2	1	4	30	2	2	1	3				4				0	0	0	0
200300705090	4	0	2	2	12	2003	1	9	4	1	2	9	8	5	1	1	2	55	1	2	1	9				0				0	2	0	1
200300728810	4	1	2	3	10	2003	1	1	1	1	2	6	10	4	3	1	2	65	1	2	1	10	11			16				0	0	0	1
200400059660	1	0	2	5	2	2004	1	1	1	1	2	6	11	3	2	2	4	30	2	2	1	3				3	16			0	0	0	1
200400090640	2	1	2	1	2	2004	1	8	1	7	2	6	10	1	2	4	4	65	4	1	7	10	11			19				0	0	0	0
200400110310	4	0	2	3	2	2004	1	1	1	1	2	6	10	3	2	1	4	35	2	2	1	3	10			9				0	0	0	0
200400175220	5	0	3	5	4	2004	1	1	2	1	2	6	10	2	4	1	4	55	1	1	1	10				6				0	0	0	1

Key	Age	Gender	Acc_Time	Day	Month	Year	Ligt_Con	Wea_Con	Surf_Con	Veh_Man	Acc_Sev	Veh_Type	Acc_Class	Road_Class	No_of Vehs	Road_Char	Lane_No	Speed_Lmt	Acc_Loc	Sur_Type	Spe_ Feature	Traffic_ Con _1	Traffic _Con_2	Traffic Con_3	Traffic_ Con_4	Dr_Error_1	Dr_Error_2	Dr_Error_3	Dr_Error_4	Pe_Error	EV_Error	VE_Error	Area_Info
200400185640	3	0	1	1	4	2004	1	1	1	1	2	10	2	2	1	1	4	65	1	2	1	2	10	11		16				0	0	0	1
200400185990	3	0	4	6	4	2004	4	1	1	1	2	2	16	1	2	5	6	50	1	1	1	10	11			2	4	16		0	0	0	1
200400195610	2	0	3	4	4	2004	1	1	1	1	2	6	10	2	3	2	4	65	4	1	6	10				6	9	16		0	0	0	1
200400235950	1	1	4	3	5	2004	4	1	1	1	2	6	10	1	2	4	6	65	4	1	6	1				16				0	0	0	1
200400240250	0	1	3	6	5	2004	1	1	1	1	2	6	11	3	3	2	4	30	2	1	1	4				3	17			0	0	0	1
200400240970	6	1	3	4	5	2004	1	1	1	1	2	6	10	3	3	2	4	30	1	1	1	10				6	9	16		0	0	0	1
200400252380	1	1	3	4	4	2004	1	1	1	8	2	6	10	1	2	1	4	60	4	2	1	10				9	16			0	0	0	1
200400285910	3	1	1	5	6	2004	1	1	1	6	2	6	10	1	2	1	6	55	1	1	1	10				9	16			0	0	0	1
200400297550	4	1	4	1	6	2004	5	1	1	1	2	9	16	1	1	4	4	60	1	1	1	5	10	11		2	4	16		0	0	0	1
200400347680	3	1	1	1	6	2004	1	1	1	1	2	9	8	2	1	4	4	60	6	2	1	10				1	4			0	0	0	1
200400426080	3	0	4	4	8	2004	5	1	1	1	2	6	10	3	3	1	4	40	4	1	6	3	10			5	16			0	0	0	1
200400450710	2	0	2	1	8	2004	1	1	6	1	2	6	10	2	2	3	4	25	3	2	1	3	10			9				0	0	1	1
200400462690	6	0	2	5	9	2004	1	1	1	1	2	3	2	3	2	3	2	65	1	2	1	2	9	10		6	16			0	0	0	1
200400465760	5	0	3	3	8	2004	1	1	1	1	2	6	11	3	2	1	4	40	2	1	1	4	10			3	16			0	0	0	0
200400467360	3	0	1	3	9	2004	1	1	2	10	2	6	14	3	2	2	2	60	1	2	1	10				11				0	0	0	1
200400485830	5	1	2	4	9	2004	1	1	1	6	2	6	11	1	2	1	6	55	4	1	6	10	11			4	7			0	0	0	1
200400490880	3	1	1	5	8	2004	1	1	1	1	2	6	8	1	2	2	6	55	6	1	2	10				16				0	0	0	1
200400495220	4	1	2	1	8	2004	1	1	1	11	2	6	11	3	2	2	4	40	6	2	1	10				3				0	0	0	1
200400505910	1	0	4	4	9	2004	5	1	1	1	2	9	2	1	1	1	6	55	6	2	1	10				16				0	0	0	1
200400506240	4	0	1	5	8	2004	1	1	1	1	2	6	10	4	2	1	2	35	1	1	2	10				6	9			0	0	0	0
200400515600	1	0	2	3	9	2004	1	1	1	1	2	2	10	2	3	1	6	45	1	1	1	10				9	16			0	0	0	0
200400515610	1	1	1	0	9	2004	1	1	1	1	2	6	10	2	3	1	4	35	3	1	1	3	10			9	16			0	0	0	0
200400515900	5	0	1	4	9	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				16				0	0	0	1
200400535880	5	1	3	4	10	2004	1	2	2	6	2	6	10	1	2	1	6	60	1	1	1	10				6				0	0	0	1
200400607290	7	0	1	3	10	2004	5	5	2	1	2	2	11	3	2	1	2	60	6	2	1	10				0				0	0	0	1
200400625830	2	0	1	2	11	2004	1	1	1	1	2	6	10	1	5	2	6		1	1	2	10				9				0	0	0	1
200400645860	1	1	3	6	11	2004	1	1	1	7	2	9	8	1	1	1	6	55	1	1	1	10				19				0	0	0	1
200400666310	2	1	4	6	11	2004	4	1	1	1	2	9	8	1	1	4	6	55	6	1	1	10				2	6			0	0	0	1
200400680690	4	0	2	3	12	2004	1	1	1	1	2	6	10	1	2	1	4	60	1	1	2	10				9	16			0	0	0	1
200400698350	4	0	2	1	12	2004	1	2	1	1	2	6	11	3	2	2	2	30	2	1	1	1	4			3	16			0	0	0	1
200400721380	3	0	4	4	11	2004	4	1	1	1	2	9	8	1	1	5	6	55	6	1	1	10				2	6	10	23	0	0	0	1
200400735780	7	0	2	3	12	2004	1	1	1	1	2	6	11	3	2	1	4	35	2	1	1	4	10			3	16			0	0	0	1
19940068923C	4	1	2	3	2	1994	1	1	1	1	2	9	8	1	1	5	4	65	4	2	7	3	5	10		4	16			0	0	0	1
19950034198C	5	1	1	2	6	1995	1	1	1	15	2	6	10	2	3	1	6	55	1	1	1	10				9				0	0	0	0
19950072401C	4	0	2	0	5	1995	1	1	1	1	2	6	11	3	2	2	2	55	2	1	1	4	5	9	10	4				0	0	0	1

Area_Info	1	1	1	0	1	1
VE_Error	0	0	0	0	0	0
EV_Error	0	0	0	0	0	0
Pe_Error	0	0	0	0	0	0
Dr_Error_4						
Dr_Error_3	16					
Dr_Error_2	5					
Dr_Error_1	4	16	0	16	0	0
Traffic_ Con_4						
Traffic Con_3	10					
Traffic _Con_2	9					
Traffic_ Con _1	3	3	10	10	1	2
Spe_ Feature	1	1	1	1	6	1
Sur_Type	2	2	2	2	2	2
Acc_Loc	1	2	1	1	4	1
Speed_Lmt	55	55	55	40	60	65
Lane_No	2	4	6	4	4	2
Road_Char	1	1	1	1	4	1
No_of Vehs	4	2	2	2	1	3
Road_Class	3	3	1	3	1	3
Acc_Class	10	11	10	10	1	10
Veh_Type	6	6	6	6	9	6
Acc_Sev	2	2	2	2	2	2
Veh_Man	1	1	1	1	1	15
Surf_Con	1	1	1	2	1	1
Wea_Con	5	1	1	2	1	1
Ligt_Con	1	1	1	1	5	1
Year	1995	1995	1995	1998	2004	2004
Month	9	8	8	4	6	9
Day	3	5	5	1	3	2
Acc_Time	1	2	1	2	4	2
Gender	1	0	0	0	0	1
Age	7	7	2	1	4	2
Key	19950072435C	19950072777C	19950072845C	19980023567C	20040063718B	20040075658B

APPENDIX V: FATAL AND INJURY CRASH DATA IN KANSAS HIGHWAY WORK ZONES (2003-2004)

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
20030001390	4	0	2	3	1	2003	1	1	1	6	2	2	12	3	2	4	2	65	1	2	1	9	10	11		8							1
20030003690	1	0	2	3	1	2003	1	1	1	1	2	6	10	3	2	1	4	35	1	2	1	3	10			16							1
20030009000	1	0	1	4	1	2003	1	1	1	12	2	6	10	4	3	1	2	65	1	2	1	2	10			9	16						1
20030051560	3	0	4	5	2	2003	4	1	1	1	2	6	11	2	2	3	4	35	2	1	1	3	10			2	3	4	16				1
20030051690	1	0	2	3	2	2003	1	1	1	1	2	6	10	2	3	1	2	35	3	2	2	3				16							1
20030067810	5	0	2	1	2	2003	1	1	1	15	2	6	10	1	2	1	6	65	1	1	1	10				6							1
20030067820	5	0	1	3	2	2003	1	1	1	15	2	6	10	2	2	2	4	65	1	2	1	10				6							1
20030068220	2	0	4	5	1	2003	5	1	1	1	2	5	2	4	1	4	2	65	1	2	1	9	10			16							1
20030071320	4	1	2	2	1	2003	1	1	1	1	2	6	10	2	3	2	4	65	1	2	1	10				9	16						1
20030071730	3	1	3	4	1	2003	5	1	1	1	2	6	10	2	2	1	4	0	1	1	1	1				16							0
20030079900	3	0	2	0	2	2003	1	1	1	16	2	9	8	3	1	1	2	65	1	1	1	1				21							1
20030083340	2	1	2	3	2	2003	1	1	1	7	2	6	10	3	3	1	4	40	1	2	1	10				16							1
20030084850	3	0	4	2	2	2003	5	1	1	1	2	2	12	3	2	1	2	65	1	2	1	10				8	16						1
20030084880	4	0	4	0	2	2003	5	1	1	1	2	6	12	3	2	1	2	65	1	1	1	10				2	8						1
20030091610	2	0	2	2	2	2003	1	1	1	15	2	6	10	1	2	1	6	50	1	1	1	10				9							1
20030092210	1	1	2	0	2	2003	1	4	3	1	2	9	8	1	1	2	6	0	4	2	2	10				0							1
20030108250	3	0	1	5	2	2003	2	2	2	1	2	2	8	4	2	5	2	45	1	2	2	9	10			4	6				5		1
20030119430	4	1	3	6	3	2003	1	1	1	7	2	6	11	1	2	2	4	0	4	2	6	9	10			2	19						1
20030120070	1	0	3	0	2	2003	1	13	3	1	2	2	11	3	2	5	2	65	6	2	1	10				6							1
20030131800	3	0	3	4	3	2003	4	1	5	3	2	10	2	1	1	1	8	65	4	1	6	10	11			0							1
20030139800	3	1	4	6	3	2003	4	1	7	1	2	9	7	3	1	1	2	65	1	2	1	1				0				6			1
20030143830	2	1	2	3	3	2003	1	1	1	1	2	6	11	3	2	2	4	0	6	2	1	1				0							1
20030157630	5	0	3	6	2	2003	5	1	1	1	2	9	2	1	1	2	4	55	1	2	1	5	10	11		2	16					2	1
20030171840	3	1	4	6	3	2003	4	1	1	1	2	9	8	1	1	2	6	55	6	2	1	10				2							1
20030180080	3	0	4	5	4	2003	5	1	1	7	2	9	8	1	1	2	6	50	6	1	1	10				19							0
20030180230	7	0	2	4	4	2003	1	1	1	1	2	9	8	1	1	1	4	60	1	2	1	9				21							1
20030185010	6	1	1	5	4	2003	1	1	1	2	2	6	11	4	2	1	2	65	2	2	1	1	11			3							1
20030185090	5	0	1	6	4	2003	1	1	1	1	2	6	10	3	5	1	2	65	1	2	1	11				20							1
20030191410	2	0	1	5	3	2003	1	1	1	1	2	2	10	1	2	1	6	50	1	2	1	10	11			9	16						0
20030192290	3	0	2	2	4	2003	1	1	1	1	2	9	8	1	1	1	4	70	1	1	1	10				16							1
20030195970	0	1	3	2	4	2003	1	1	1	16	2	6	11	3	2	2	4	40	2	2	1	3				7							1
20030205540	1	1	3	5	5	2003	1	1	1	1	2	6	10	1	2	1	4	60	1	1	1	9	10	11		16							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200300207970	2	0	2	4	4	2003	1	1	1	15	2	6	10	1	3	5	6	65	1	1	1	5	10			0							1
200300215550	5	0	4	0	3	2003	4	1	1	1	2	2	10	2	2	1	4	50	3	2	1	3				9	16	25					0
200300215560	3	0	1	5	3	2003	1	1	1	1	2	6	11	2	2	1	4	50	2	1	1	3				4							0
200300215740	4	0	3	1	5	2003	1	1	1	3	2	6	10	4	2	2	4	40	4	1	6	10				9							0
200300217190	5	0	3	4	5	2003	1	1	1	1	2	2	10	3	2	1	4	60	1	2	1	10				9							1
200300217250	2	1	1	1	4	2003	1	1	1	8	2	2	11	1	2	1	4	35	4	2	6	10	11			3							1
200300219770	3	0	4	4	4	2003	4	1	1	7	2	9	8	1	1	1	8	55	1	1	1	10				19							1
200300219850	4	1	2	3	4	2003	1	2	2	1	2	2	10	1	3	1	6	55	1	2	1	10				6							1
200300220230	2	0	2	6	4	2003	1	2	2	1	2	9	8	1	1	2	6	55	1	1	1	10				6					5		1
200300225080	2	1	1	3	3	2003	1	5	2	1	2	2	10	4	2	1	2	65	1	1	1	1				6					1		1
200300225150	2	1	4	3	5	2003	5	1	1	1	2	9	2	1	1	1	4	60	1	2	1	10				19							1
200300231880	6	1	2	3	5	2003	1	1	1	1	2	2	13	3	2	2	4	30	3	2	1	3				12							1
200300232320	2	1	2	5	5	2003	1	1	1	6	2	6	13	1	2	2	6	55	1	1	1	10				10							1
200300232370	3	0	2	6	4	2003	1	1	1	1	2	9	8	1	1	1	4	60	6	1	2	9	10			0							1
200300233340	7	0	3	1	5	2003	1	1	1	1	2	6	10	3	3	3	2	65	1	2	1	2				16							1
200300233730	7	1	2	5	4	2003	1	1	1	7	2	6	13	3	4	1	2	65	1	2	1	9	10			4	16						1
200300237300	2	0	4	5	5	2003	5	1	1	1	2	9	8	4	1	4	2	45	1	2	2	10				15							1
200300240750	7	0	2	4	5	2003	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2	10			9	16						1
200300245300	5	0	4	5	5	2003	5	1	1	1	2	9	8	3	1	4	2	65	6	2	1	10				2							1
200300249120	6	0	1	2	5	2003	1	1	1	1	2	9	1	1	1	1	4	60	1	1	1	10				0							1
200300252920	2	0	2	0	5	2003	1	7	1	1	2	9	2	3	1	1	2	65	1	2	1	10				0							1
200300253440	3	0	4	6	4	2003	5	1	1	7	2	9	2	1	1	2	4	60	1	2	1	3	9	10		15							1
200300256020	1	0	3	5	5	2003	1	1	1	6	2	2	8	1	2	5	6	45	1	1	1	9	10	11		2	4	10					0
200300256250	5	0	2	5	5	2003	1	1	1	7	2	5	8	1	1	2	4	70	4	1	6	10	11			19							1
200300263690	3	1	1	5	5	2003	2	2	2	1	2	6	10	3	2	1	4	35	1	2	1	1				0							1
200300265420	6	0	2	5	5	2003	1	1	1	7	2	5	2	1	1	1	4	60	6	1	1	9	10			19							1
200300267560	2	0	4	3	5	2003	4	1	1	1	2	6	10	2	2	1	6	60	1	1	2	10				9	16						0
200300270130	4	1	2	6	5	2003	1	1	2	7	2	10	2	1	1	1	4	50	1	2	1	10				19							1
200300272770	7	0	2	5	6	2003	1	1	1	1	2	9	8	4	1	2	2	65	1	2	1	11				0							1
200300279600	2	0	4	0	3	2003	4	1	1	1	2	6	10	2	2	1	4	45	3	1	1	3				1	2	16	25				0
200300283530	1	0	2	3	5	2003	1	1	1	1	2	6	10	1	3	2	6	65	1	1	1	10				6	9						1
200300283700	3	1	2	1	6	2003	1	1	1	1	2	6	10	2	2	1	4	65	4	1	2	1				9							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200300289180	1	0	3	6	5	2003	1	1	1	7	2	6	11	3	2	1	4	60	1	1	1	10				8	19						1
200300291590	3	1	3	4	5	2003	1	1	1	15	2	6	10	3	3	1	4	55	4	1	6	10				9	16						1
200300292740	7	0	2	3	5	2003	1	1	1	8	2	2	13	1	2	1	4	70	4	1	6	10				3							1
200300292860	3	1	2	3	6	2003	1	1	1	1	2	6	10	3	2	1	4	55	1	2	2	10				9	9						1
200300292900	4	0	4	0	5	2003	5	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2	4	10			4	6	17				1
200300295740	4	0	4	5	5	2003	5	1	1	10	2	6	14	1	2	1	6	55	1	1	1	10				2	11						1
200300296000	5	0	4	6	6	2003	5	1	1	15	2	10	7	1	1	2	6	55	1	2	1	10				0	0				6		1
200300297600	2	1	2	5	6	2003	1	1	1	1	2	6	10	5	2	2	2	45	3	2	1	3	9	10		16							1
200300304360	7	0	2	4	6	2003	1	1	1	1	2	9	9	1	1	1	4	70	6	1	1	10				21							1
200300311440	4	0	3	5	6	2003	99	1	1	2	2	9	8	4	1	1	2	30	1	2	1	1				1							1
200300311700	6	0	3	2	6	2003	1	1	1	1	2	6	10	1	2	2	8	55	1	2	1	1				16							1
200300315780	3	1	2	5	6	2003	1	1	1	15	2	6	10	3	4	2	4	20	1	2	1	3	10			9	16						1
200300329240	3	0	4	1	6	2003	5	1	1	1	2	5	2	1	1	1	4	70	1	2	1	10				0					12		1
200300329250	2	0	4	6	5	2003	1	1	1	7	2	9	2	1	1	1	4	70	6	2	1	10				19					6		1
200300331790	2	0	4	2	6	2003	4	1	1	1	2	9	8	1	1	1	8	55	6	2	1	10				2							1
200300333080	7	0	2	4	6	2003	1	1	1	1	2	9	1	3	1	1	4	55	1	1	1	10				4							1
200300333320	6	0	3	5	6	2003	1	2	2	3	2	2	11	3	2	1	4	70	3	2	1	10				7							1
200300345390	3	0	4	4	7	2003	1	1	1	1	2	6	10	3	3	1	2	55	1	2	1	3	10			2							1
200300348830	1	0	2	4	6	2003	1	1	1	1	2	9	2	5	1	4	2	55	6	6	1	1				6							1
200300348880	6	0	2	5	7	2003	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	10				6	9						1
200300349180	3	0	3	6	6	2003	1	1	1	5	2	6	10	1	2	2	4	60	1	2	2	9	10			2	4	6	9				1
200300349190	1	0	2	5	6	2003	1	1	1	1	2	6	11	4	2	1	4	45	4	2	6	3	10			16							1
200300349600	2	1	2	1	6	2003	1	1	1	7	2	9	3	5	1	1	4	55	6	2	1	10				16	19			8			1
200300355520	3	0	3	2	7	2003	1	1	1	1	2	6	10	3	2	1	2	60	1	1	1	11				16							1
200300355750	3	0	2	5	6	2003	1	1	1	1	2	6	10	2	2	2	4	60	1	2	1	9	10			9	16						1
200300355760	4	1	3	2	7	2003	1	1	1	1	2	6	10	2	4	2	4	60	3	2	1	3	10			6	9	16					1
200300355940	2	0	4	4	6	2003	5	2	2	15	2	6	10	1	2	5	6	55	1	2	1	10				0					5		1
200300355990	0	0	3	6	7	2003	1	1	1	1	2	9	10	1	2	1	6	55	1	2	1	10				9							1
200300359570	7	0	2	3	6	2003	1	1	1	1	2	6	11	3	2	1	2	45	2	2	1	4	10			3							1
200300361390	4	0	4	1	7	2003	5	1	1	16	2	2	12	3	3	1	2	65	1	2	1	10				8	16						1
200300364810	6	0	1	1	6	2003	1	1	1	1	2	6	10	1	2	1	4	60	4	2	6	9				9	16						1
200300364840	3	0	4	0	7	2003	5	1	1	15	2	9	8	2	1	4	4	55	6	1	2	10				2	8						1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200300367970	1	0	2	3	7	2003	1	1	1	1	2	6	10	1	2	5	6	0	4	1	6	6				3							1
200300377590	2	0	2	5	7	2003	1	1	1	1	2	6	10	1	4	1	4	70	1	2	1	10				16							1
200300377630	2	0	2	6	7	2003	1	1	1	1	2	6	10	1	2	1	4	60	1	1	1	10				9	16						1
200300381310	4	0	3	5	6	2003	1	1	1	1	2	6	10	1	2	1	4	60	1	2	2	9				6	9	16					1
200300381320	4	0	3	5	6	2003	1	1	1	1	2	6	10	1	2	1	4	60	1	2	2	9				6	9	16					1
200300381420	2	0	4	5	7	2003	2	1	1	1	2	9	2	4	1	1	2	65	1	2	1	1				16	18						1
200300383160	3	0	4	5	7	2003	4	1	1	8	2	2	13	2	2	1	4	40	4	2	2	10				16							1
200300384120	3	0	4	5	7	2003	4	1	1	1	2	2	13	1	2	1	6	55	1	2	1	9	10			2	6	25					1
200300391080	5	0	2	6	7	2003	1	1	1	15	2	6	10	1	3	1	6	70	1	1	1	10				9							1
200300395320	2	0	3	5	6	2003	1	1	1	7	2	6	10	3	2	1	4	35	1	2	1	1											1
200300395990	5	0	3	2	7	2003	1	1	1	5	2	10	8	1	1	1	6	60	1	1	1	10				2	4		25				1
200300400000	6	0	2	6	5	2003	1	1	1	2	2	6	11	2	2	1	4	35	2	1	1	3				3							0
200300403470	3	0	1	5	5	2003	1	1	1	1	2	6	10	4	2	2	4	40	1	1	2	10				16							0
200300407710	1	1	4	2	8	2003	4	1	1	1	2	6	10	1	2	1	6	50	1	1	1	11				9							1
200300407840	3	1	2	3	8	2003	1	1	1	1	2	6	10	3	2	2	4	40	3	2	1	10				0							1
200300411640	4	1	4	5	8	2003	4	1	1	1	2	9	8	1	1	1	6	65	1	1	1	10				2	16						1
200300411690	3	1	2	0	8	2003	1	1	1	1	2	6	10	1	2	2	6	55	1	2	1	10				2							1
200300411700	3	1	2	6	8	2003	1	1	1	15	2	6	10	1	2	1	6	55	1	1	1	10				9							1
200300416720	0	0	4	5	8	2003	5	1	1	1	2	9	10	3	2	1	2	35	1	2	1	3	9	10		4							1
200300416730	5	0	1	3	8	2003	1	1	1	2	2	6	11	3	2	1	4	40	2	2	1	4	11			7	16	23					1
200300416910	0	0	3	1	7	2003	1	1	1	1	2	9	3	4	1	1	2	30	1	2	2	3	9			16							1
200300417100	3	1	4	6	8	2003	5	1	1	1	2	9	2	1	1	2	4	60	1	2	1	10				15							1
200300417120	1	0	1	3	8	2003	1	1	1	1	2	6	10	5	3	5	2	30	4	2	6	6	10			9							1
200300417160	2	1	1	4	8	2003	1	1	1	1	2	9	2	4	1	1	2	65	6	2	1	1				15	16						1
200300417250	5	0	4	2	8	2003	5	1	1	1	2	9	8	2	1	1	4	60	6	2	2	9	10			2							1
200300423110	1	0	4	4	7	2003	4	1	1	1	2	6	10	1	3	1	6	60	1	1	1	10				9						11	1
200300423130	5	0	2	6	8	2003	1	1	1	15	2	6	10	1	3	1	6	55	1	1	1	10				9							1
200300423140	3	0	4	0	8	2003	4	1	5	8	2	10	16	1	1	5	6	65	4	1	6	11				0							1
200300423430	2	1	4	2	7	2003	4	1	1	3	2	6	10	2	2	1	4	65	4	1	6	4	6			16							1
200300423990	1	0	3	1	8	2003	1	1	1	1	2	6	10	3	2	2	4	30	3	2	1	1				9	16						1
200300424130	5	1	4	4	6	2003	4	1	1	1	2	6	11	3	2	2	4	40	2	2	1	4				4	16						1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200300425370	3	0	4	3	7	2003	5	1	1	1	2	9	8	1	1	4	4	60	4	2	6	11				16							1
200300425410	1	0	2	2	7	2003	1	1	1	4	2	6	11	3	2	2	4	55	1	2	1	11				7							1
200300427900	6	1	2	1	8	2003	1	1	1	1	2	6	11	2	2	1	4	55	2	2	1	6	10			3	16						0
200300428790	4	0	4	2	8	2003	5	1	1	1	2	6	10	3	2	1	4	30	1	1	2	10				2	4	5					1
200300431500	7	0	3	4	5	2003	1	1	1	1	2	6	10	3	4	1	4	30	3	1	1	4				9	16						0
200300431800	5	1	4	0	8	2003	3	1	1	6	2	9	16	1	1	1	8	55	1	1	1	11				2	6	10	19				1
200300431830	4	0	4	1	7	2003	5	1	1	1	2	9	10	1	2	4	6	55	1	2	3	11											1
200300431840	3	0	3	4	7	2003	1	1	1	6	2	6	13	1	2	1	8	55	4	1	6	11				2	10						1
200300431950	4	1	2	1	8	2003	1	1	1	1	2	9	1	1	1	1	6	65	1	2	3	11				0							1
200300431980	5	1	2	1	8	2003	1	1	1	8	2	2	11	1	2	1	6	55	4	2	6	11				3							1
200300431990	5	0	1	2	7	2003	1	1	1	15	2	6	10	1	4	2	6	55	1	1	1	11				6	16						1
200300439650	1	1	4	6	8	2003	4	1	2	1	2	7	8	2	2	1	4	35	6	2	1	11				6							0
200300439750	4	0	1	1	6	2003	1	1	1	1	2	6	10	3	2	1	4	40	1	1	1	11				9	16						0
200300441070	3	0	2	3	8	2003	1	1	1	4	2	6	11	3	2	1	2	65	1	1	1	9	10			3							1
200300443830	3	1	3	6	8	2003	1	1	1	15	2	6	10	1	2	2	6	55	4	2	6	10				6	16						1
200300443840	4	0	2	6	8	2003	1	1	1	1	2	6	10	1	2	1	6	70	1	1	1	10				6	16						1
200300443890	4	1	4	6	8	2003	5	1	1	1	2	6	10	1	2	1	6	55	1	1	1	9	10			9	16						1
200300447130	5	0	2	1	7	2003	1	1	1	2	2	7	11	3	2	2	2	20	4	1	3	11			7	3	16						1
200300449180	4	1	3	5	8	2003	1	1	1	1	2	6	11	3	2	1	4	60	1	1	1	9	10			16							1
200300449380	5	1	2	4	8	2003	1	1	1	12	2	6	10	3	2	1	2	65	1	2	1	2	10			16							1
200300449410	1	0	4	0	8	2003	5	1	1	1	2	9	2	1	1	4	4	60	6	2	1	9				16							1
200300452870	4	1	2	0	8	2003	1	1	1	1	2	6	10	1	3	1	4	60	1	1	1	10				9							1
200300455770	3	0	2	5	8	2003	1	1	1	8	2	6	10	1	2	1	8	55	4	1	2	9	10			9							1
200300455780	6	0	3	2	8	2003	1	2	2	6	2	6	13	1	2	1	8	55	1	1	1	10				6				5			1
200300460960	3	0	3	1	9	2003	1	1	1	1	2	9	4	4	1	1	2	65	1	2	1	2				0							1
200300467550	1	0	1	1	8	2003	1	1	1	1	2	6	10	1	2	1	6	65	1	2	1	11				9							1
200300472910	1	1	2	6	9	2003	1	2	2	1	2	9	8	2	1	1	4	55	1	2	1	11				6							1
200300473080	7	0	4	2	9	2003	4	1	1	1	2	5	2	1	1	2	4	60	6	1	1	9	10	11		6	8						1
200300476410	4	0	2	3	8	2003	1	1	1	1	2	5	4	1	1	1	4	70	1	2	1	10				16							1
200300477390	5	0	1	4	9	2003	1	1	1	1	2	5	2	3	1	4	2	45	1	2	1	10				6	16						1
200300477530	2	0	2	2	9	2003	1	1	1	7	2	9	3	3	1	3	2	65	6	2	1	2	9	10		4	6	16	25				1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200300479780	2	1	1	5	9	2003	1	1	1	1	2	6	10	1	2	5	6	55	1	1	1	10				0							1
200300479990	1	1	3	0	8	2003	1	2	2	1	2	6	8	1	2	2	6	55	1	1	1	10				16							1
200300481060	6	0	2	2	9	2003	1	1	1	1	2	6	10	3	2	3	2	65	1	2	1	2				6	16						1
200300481370	1	1	3	5	9	2003	1	1	1	5	2	6	9	3	2	1	2	65	1	2	1	10				16							1
200300481400	5	0	1	4	9	2003	1	1	1	1	2	2	12	3	2	1	2	60	1	1	1	10				16							1
200300481410	4	0	2	1	9	2003	1	1	1	1	2	2	12	3	2	1	4	60	1	2	1	10				2							1
200300483470	1	1	2	4	9	2003	1	2	2	1	2	6	10	3	2	1	4	30	1	2	1	10				16							1
200300484080	3	1	4	2	9	2003	99	1	1	1	2	9	2	1	1	1	6	55	1	1	1	10				6							1
200300484310	2	1	4	1	9	2003	5	1	1	1	2	5	2	1	1	1	4	60	1	2	2	9	10			0							1
200300487820	5	0	2	0	9	2003	1	1	1	1	2	6	10	3	2	2	4	40	1	2	1	3	10			16						2	1
200300487980	1	0	1	3	9	2003	1	1	1	1	2	6	10	1	2	1	6	55	1	2	1	10				9							1
200300488870	1	1	4	0	10	2003	5	1	1	1	2	9	8	3	1	1	4	40	4	1	6	11				16							1
200300491680	7	1	1	6	7	2003	1	1	1	1	2	6	11	2	2	1	4	35	2	1	1	3	10			4	16						0
200300493200	6	0	1	5	9	2003	5	1	1	1	2	5	8	1	1	2	4	70	1	2	3	10				16	18						1
200300493330	5	0	4	1	9	2003	5	1	1	1	2	5	2	3	1	5	2	55	1	2	1	9	10	11		6							1
200300501360	4	0	4	5	6	2003	4	1	1	3	2	10	1	3	1	1	2	65	2	2	1	1	4			7	16						1
200300503550	2	0	2	4	9	2003	1	1	1	15	2	6	10	1	2	1	6	0	1	1	1	10				9							0
200300511740	4	1	2	4	8	2003	1	1	1	1	2	6	10	3	2	1	4	0	3	1	1	3	10			16							0
200300512170	1	1	1	5	9	2003	1	1	1	7	2	9	8	1	1	1	6	55	6	1	2	9	10			9							1
200300512210	4	0	2	4	10	2003	1	1	1	16	2	2	13	3	2	5	4	70	1	2	1	10				6	16						1
200300515620	4	1	2	0	10	2003	1	1	1	15	2	6	10	1	4	1	8	50	1	1	1	9	10			9							1
200300516020	3	0	4	0	9	2003	5	1	1	1	2	9	8	1	1	5	6	55	6	2	1	10				2	6	16	17				1
200300516520	4	0	2	1	9	2003	1	1	1	6	2	9	2	4	1	2	2	65	6	2	1	10	11			2	6	16	19				1
200300520990	3	1	4	6	9	2003	5	1	1	1	2	9	2	3	1	2	2	60	1	1	1	1				5	18						1
200300524990	2	0	1	3	10	2003	1	1	1	1	2	6	10	3	2	1	4	50	1	1	1	10				0							1
200300527460	2	1	3	0	10	2003	1	1	1	1	2	6	10	1	2	1	8	60	1	1	1	10				16							1
200300527540	1	0	4	0	9	2003	4	1	1	1	2	9	8	1	1	1	6	60	1	1	1	10	11			4							1
200300531770	1	0	1	5	7	2003	1	1	1	15	2	6	10	2	3	1	4	35	3	1	1	3				9						1	0
200300531780	0	0	2	5	7	2003	1	1	1	2	2	6	11	3	2	1	4	40	2	2	1	3				4							0
200300531820	1	0	1	4	10	2003	1	1	1	1	2	6	10	2	2	5	4	0	4	1	3	6	10			6	9	16					0
200300531870	1	0	4	4	10	2003	5	2	2	1	2	6	10	2	2	1	4	0	4	2	6	6	10			6	16						0

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200300531910	5	1	1	4	10	2003	1	1	1	1	2	9	7	2	1	1	4	45	1	1	6	10				0						6	0
200300532970	2	1	2	5	9	2003	1	7	1	1	2	6	10	3	3	1	4	0	1	1	1	3				0							1
200300532980	4	1	1	5	9	2003	1	2	2	2	2	6	11	3	3	1	4	0	2	1	1	3	11			3	4						1
200300533060	5	0	3	2	9	2003	1	1	1	1	2	6	10	3	4	1	4	45	1	2	1	2	9	10		16							1
200300533120	3	0	2	1	10	2003	1	1	1	15	2	5	8	5	1	1	2	55	6	2	1	10	11			0						1	1
200300535390	4	0	2	6	10	2003	1	1	1	15	2	6	10	3	2	1	6	55	1	1	1	10	6			9							1
200300535570	4	1	1	1	9	2003	5	1	1	8	2	6	10	3	2	2	4	0	4	2	6	6	9	10		16							1
200300535580	4	0	3	0	9	2003	1	1	1	1	2	6	10	3	2	1	4	35	4	2	6	6				9							1
200300535650	0	0	4	1	9	2003	4	1	1	1	2	9	3	1	1	1	4	65	1	1	1	10				0							0
200300535890	1	1	4	4	10	2003	4	1	1	1	2	9	8	1	1	1	8	55	6	1	1	10				0							1
200300535930	5	0	2	1	9	2003	1	1	1	15	2	2	10	1	2	4	6	55	1	1	1	9	10			9					6		1
200300535980	7	0	2	1	10	2003	1	1	1	1	2	6	10	1	3	4	6	55	1	1	1	10				6	16						1
200300537500	7	0	2	4	9	2003	1	2	2	1	2	9	2	1	1	1	4	60	1	2	1	10				15					5		1
200300537510	3	0	2	6	9	2003	1	1	1	4	2	6	11	3	2	1	4	60	4	1	1	9	10			7							1
200300539820	5	0	2	3	10	2003	1	1	1	1	2	6	10	3	2	2	4	55	1	2	2	10				9	16						1
200300539830	2	1	3	5	10	2003	1	1	1	8	2	6	10	1	2	1	6	45	1	1	1	10				9	16						1
200300539890	5	0	1	3	10	2003	1	1	1	15	2	2	10	1	2	1	6	55	1	1	1	10				9							1
200300543690	6	0	1	5	9	2003	1	1	1	15	2	6	10	3	3	1	4	40	6	2	1	10				16							1
200300543750	2	1	2	6	9	2003	1	1	1	1	2	6	10	2	2	1	4	35	3	1	1	3	10			16							0
200300544370	2	0	1	0	11	2003	2	1	1	7	2	9	8	4	1	4	2	65	1	2	1	1				16	19						1
200300547530	3	0	2	0	10	2003	1	1	1	15	2	6	10	1	2	2	6	65	4	2	6	10				6	16						1
200300549480	3	0	2	1	10	2003	1	1	1	1	2	2	10	1	2	1	4	60	1	2	1	2	9	10		9							1
200300549490	3	1	4	5	10	2003	5	1	1	15	2	2	10	1	2	1	4	60	1	2	1	9	10			0							1
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200300555530	4	1	1	2	10	2003	1	1	1	1	2	2	10	2	2	4	4	35	4	2	6	10				16							0
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200300557280	2	1	2	4	10	2003	1	1	1	1	2	6	10	4	3	2	2	60	1	2	1	9	11			9	16	18					1
200300557490	5	0	2	4	10	2003	1	1	1	1	2	1	10	1	2	1	4	60	1	2	1	10				9	19				7		1
200300560000	4	0	3	6	10	2003	1	1	1	8	2	6	10	1	2	1	6	50	1	1	1	10				9	19						1
200300563430	2	0	2	3	11	2003	1	1	1	15	2	6	10	3	2	2	4	35	1	2	1	10				16							1
200300564130	3	0	2	6	11	2003	1	1	1	1	2	9	8	1	1	4	6	55	6	2	1	9	10			2	6						1

Area_Info	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1
VE_CODE																																
EV_CODE												5				6																11
PE_CODE																																
Dr_Error4																																
Dr_Error3				16			16	16	16		6	16									15	18										
Dr_Error2	16			9			5	7	4	22	5	9	9						16		6	9	16		16	16						
Dr_Error1	6	16	16	6	0	16	2	3	3	9	2	6	6	17	25	0	10	0	6	0	2	4	6	3	6	9	16	9	16	6	7	17
Traffic_Con4																																
Traffic_Con3																																
Traffic_Con2								10	10	10			11			11						10		10	10		10					
Traffic_Con1	10	10	10	10	3	4	3	3	3	3	10	11	10	10	10	10	10	10	10	1	10	3	10	4	3	10	3	1	3	10	10	10
Special_Fea	2	1	1	1	2	1	1	1	1	1	6	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	3	2	6	1
Surf_Type	1	1	2	2	2	2	2	2	1	1	1	2	1	2	1	1	1	2	2	1	2	2	2	2	1	1	1	1	1	2	2	2
Acc_Loc	1	1	1	1	1	3	3	2	2	1	4	1	1	1	6	1	1	1	3	3	6	3	6	2	3	1	3	1	3	1	4	1
Speed_Limt	60	35	35	35	65	30	40	35	35	35	50	35	50	55	55	55	55	65	65	50	70	55	55	35	0	60	0	35	35	65	60	70
No_Lane	4	4	4	4	2	6	4	4	4	4	6	4	6	8	6	6	6	2	2	4	6	2	2	4	4	4	4	4	4	2	4	4
Road_Char	5	1	1	2	1	1	1	1	1	1	1	2	1	1	1	1	1	5	2	1	2	1	4	1	1	2	1	1	1	1	2	1
No_Vehicle	2	3	4	2	2	2	3	2	2	2	2	2	3	2	1	1	8	2	1	2	1	2	1	2	2	2	3	3	2	2	2	3
Road_Class	3	3	3	3	3	3	3	2	2	3	1	3	1	1	1	1	1	3	3	3	1	4	3	3	3	1	2	2	2	3	3	1
Acc_Class	12	10	10	10	10	10	10	11	11	10	11	10	10	10	8	7	10	10	2	10	8	10	2	11	10	10	10	10	10	11	11	11
Veh_Type	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	6	6	5	6	9	6	9	6	2	6	6	6	6	6	2	6
Acc_severity	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Veh_ Maneuver	1	15	1	1	1	1	1	2	1	1	1	1	1	7	7	1	15	15	1	2	1	15	1	1	1	1	1	1	1	6	4	1
Surf_Con	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	4	1	3
Weather_Con	7	1	1	1	5	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	13	1	13
Light_Con	1	1	3	1	1	1	4	1	1	1	4	4	1	5	5	1	1	1	5	4	4	1	5	1	1	1	1	1	1	2	1	5
Year	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003	2003
Month	11	10	11	11	10	10	11	11	11	11	11	12	11	10	11	10	10	12	12	11	12	11	10	10	11	11	11	10	12	12	11	12
Day	5	4	2	2	1	5	0	0	6	4	6	2	0	6	0	6	4	6	2	0	0	6	5	2	5	5	1	0	1	3	3	5
Acc_Time	1	1	3	2	1	2	4	2	1	3	4	3	3	3	3	2	1	2	3	4	4	2	4	2	2	3	2	2	2	1	1	4
Gender	1	0	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
Age	1	1	3	1	3	5	3	5	3	1	2	5	3	4	3	6	4	3	4	5	4	2	5	2	4	2	2	4	6	5	2	3
Key	20030564360	20030567700	20030583400	20030583420	20030589050	20030591790	20030595640	20030603730	20030603790	20030607700	20030608210	20030611810	20030615690	20030615840	20030615850	20030615960	20030615970	20030616980	20030621220	20030627400	20030628330	20030633980	20030641580	20030647470	20030668950	20030669630	20030671880	20030671990	20030675550	20030677070	20030677080	20030677240

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200300679960	3	1	3	6	12	2003	4	1	1	1	2	6	10	1	3	2	6	35	4	1	6	10				9							0
200300687580	5	1	1	4	11	2003	1	1	1	15	2	6	10	1	3	2	6	45	1	1	1	10				9							0
200300687670	6	0	3	3	12	2003	4	1	1	6	2	6	10	1	3	1	6	45	1	1	1	10				9							0
200300687710	1	1	2	2	11	2003	1	1	1	1	2	6	10	2	2	1	4	65	1	1	2	2	10	11		9							0
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200300688000	3	0	2	6	12	2003	1	1	1	15	2	6	10	1	4	1	6	55	1	1	1	1				9							1
200300691480	6	0	4	4	9	2003	4	1	1	1	2	2	11	3	2	1	4	30	2	2	1	3				4							0
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200300695590	4	1	3	2	9	2003	1	1	1	1	2	6	10	2	2	1	4	0	1	2	1	1				9	16						0
200300697050	1	0	2	2	11	2003	1	1	1	12	2	6	10	3	2	1	2	55	1	2	1	2	10			0							1
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200300707390	7	1	3	1	12	2003	3	1	1	2	2	6	11	3	2	4	4	35	2	2	1	4	10			3							1
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200300729040	3	0	2	3	10	2003	1	1	1	10	2	9	3	1	1	1	4	60	1	1	1	9	10			0							1
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200300732970	1	1	2	3	8	2003	1	1	1	1	2	9	2	3	1	2	2	65	6	2	1	10				0					12		1
200300733210	4	0	1	2	11	2003	1	1	1	4	2	6	11	1	2	1	4	60	4	2	6	9	10			7							1
200300735820	2	1	2	1	12	2003	1	2	2	1	2	6	10	3	2	1	4	35	1	1	1	1				16							0
200300751950	1	1	3	2	9	2003	1	1	1	1	2	6	10	2	2	1	4	35	1	1	1	1				16							0
200300764240	3	1	4	5	7	2003	1	1	1	8	2	6	10	1	2	2	4	0	4	2	6	6				16							1
200400000560	6	1	2	5	1	2004	1	2	2	1	2	9	8	4	1	1	2	55	1	2	2	1				16							1
200400007700	7	0	2	5	1	2004	1	2	2	1	2	6	10	3	2	2	4	30	4	1	6	10				9	16						1
200400012050	4	0	4	0	1	2004	5	4	4	1	2	9	8	4	1	2	2	60	1	2	1	9	10			2	16						1
200400012490	5	0	4	2	1	2004	5	1	1	1	2	9	8	4	1	5	2	45	1	2	2	3				4	16	18					1
200400012530	4	0	4	4	1	2004	5	1	1	1	2	5	2	4	1	4	2	65	2	2	1	4	10			6							1
200400016940	7	1	2	0	1	2004	1	1	1	2	2	9	8	3	1	1	4	55	2	2	1	10	11			6							1
200400027460	2	1	4	4	1	2004	4	1	1	1	2	6	11	3	2	1	4	35	2	2	1	3				4							0
200400027470	1	0	2	5	1	2004	1	1	1	1	2	6	10	3	4	1	4	35	6	2	1	10				16							0
200400043390	1	1	2	2	1	2004	1	1	1	6	2	9	1	3	1	4	4	55	1	2	1	1				0							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
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200400059660	1	0	2	5	2	2004	1	1	1	1	2	6	11	3	2	2	4	30	2	2	1	3				3	16						1
200400067500	4	1	2	3	2	2004	1	1	1	2	2	6	11	3	2	1	4	35	2	1	1	3				3							0
200400069320	4	1	1	4	1	2004	2	1	1	1	2	9	2	5	1	1	2	55	6	2	1	10				5					6		1
200400071880	3	0	3	6	2	2004	1	1	1	1	2	6	10	3	4	2	4	40	2	2	1	3	10			16							0
200400080380	1	0	4	5	2	2004	4	1	1	3	2	6	11	2	2	1	4	40	2	2	1	3	10			4	16						1
200400080990	2	1	1	4	1	2004	4	1	1	1	2	9	8	1	1	4	6	65	6	2	1	10				15							1
200400090420	5	0	2	5	1	2004	1	2	2	1	2	6	11	2	2	1	4	35	2	1	1	3				4							1
200400090640	4	0	2	1	2	2004	1	8	1	1	2	6	10	1	2	4	4	65	4	1	6	10	11			9							0
200400091240	4	0	4	1	1	2004	5	4	3	1	2	2	8	1	2	2	6	65	6	1	1	10				2							1
200400095610	5	0	2	1	3	2004	1	1	1	7	2	6	13	1	2	2	8	65	1	1	1	10				16							1
200400100350	0	0	2	4	2	2004	1	1	1	3	2	9	3	3	1	4	4	30	3	2	1	3	10			4	16						1
200400105330	3	0	2	1	3	2004	1	1	2	1	2	6	10	3	4	2	4	35	2	2	1	3	10			16							1
200400110310	4	0	2	3	2	2004	1	1	1	1	2	6	10	3	2	1	4	35	2	2	1	3	10			9							0
200400110440	4	0	4	0	3	2004	4	1	1	1	2	6	10	3	3	1	4	45	3	1	1	3				23							0
200400110480	1	0	2	6	3	2004	1	1	1	1	2	6	10	2	3	2	6	35	1	2	1	1				9							0
200400116190	1	1	2	1	3	2004	1	1	1	1	2	2	10	1	2	1	6	65	1	1	1	9	10			6	16						1
200400130730	2	0	2	3	3	2004	1	1	1	15	2	2	10	1	2	2	6	60	1	1	1	10				16	19						0
200400140940	4	0	1	3	3	2004	1	1	1	8	2	2	13	3	3	4	4	30	2	1	1	3				3	16						1
200400140970	3	1	4	6	3	2004	4	1	1	1	2	6	10	1	2	1	6	55	1	1	2	10				6	16						1
200400147620	1	0	4	3	4	2004	5	7	1	7	2	9	2	3	1	4	4	45	1	2	1	9	10	11		0							1
200400150970	1	1	2	3	4	2004	1	2	2	1	2	6	10	2	2	1	4	55	1	1	2	10				16							0
200400152810	3	0	3	2	4	2004	1	1	1	1	2	6	10	5	2	3	2	55	1	2	1	10	11			16							1
200400155940	5	0	2	6	4	2004	1	1	1	1	2	6	10	1	2	1	6	70	1	1	1	10				16							1
200400167760	1	0	3	5	1	2004	1	1	1	3	2	6	10	3	2	2	2	65	6	2	1	9	10	11		6	16						1
200400170540	0	0	3	3	4	2004	1	1	1	1	2	6	10	1	2	2	6	60	4	1	6	10	11			6							1
200400175220	5	0	3	5	4	2004	1	1	2	1	2	6	10	2	4	1	4	55	1	1	1	10				6							1
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200400180210	5	1	2	6	4	2004	1	1	1	7	2	6	11	2	3	1	4	30	1	1	1	10				6	16						1
200400185640	3	0	1	1	4	2004	1	1	1	1	2	10	2	2	1	1	4	65	1	2	1	2	10	11		16							1
200400185990	3	0	4	6	4	2004	4	1	1	1	2	2	16	1	2	5	6	50	1	1	1	10	11			2	4	16					1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400190940	6	0	2	6	4	2004	1	1	1	1	2	6	10	1	2	1	6	60	1	1	1	10				9							1
200400195450	4	1	3	6	4	2004	1	1	1	1	2	6	10	1	2	1	6	60	1	1	1	10				6	9						1
200400195550	3	0	4	6	4	2004	4	1	1	1	2	6	10	1	2	5	6	60	1	1	1	10	11			16							1
200400195570	7	0	3	3	4	2004	1	1	1	15	2	6	10	1	2	2	6	60	1	1	1	10	11			9							1
200400195610	2	0	3	4	4	2004	1	1	1	1	2	6	10	2	3	2	4	65	4	1	6	10				6	9	16					1
200400195630	4	0	2	5	4	2004	1	1	1	1	2	6	10	2	2	1	4	65	1	1	1	9	10	11		9							1
200400195640	2	0	4	5	4	2004	4	1	1	1	2	6	11	2	2	2	6	55	1	1	1	10	11			26							1
200400200200	0	0	4	4	4	2004	4	1	1	1	2	6	10	2	2	1	4	35	3	1	1	3				9							0
200400200380	4	0	2	6	3	2004	1	2	2	1	2	6	10	3	3	1	4	30	3	2	1	10				16							1
200400200390	7	0	3	6	4	2004	5	1	1	8	2	6	11	1	2	1	4	60	4	1	6	6	10			4							1
200400200470	2	1	3	2	4	2004	1	1	1	1	2	6	10	2	2	2	4	55	1	1	1	10	11			9							0
200400200790	2	1	1	3	4	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				9							1
200400200820	3	1	1	3	4	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				9	16						1
200400200840	5	1	4	1	4	2004	4	1	1	7	2	9	2	3	1	5	4	30	1	2	1	10				6	16						1
200400201240	1	0	4	0	4	2004	5	1	1	1	2	9	8	1	1	1	6	60	4	1	6	10				2							1
200400202510	7	0	1	4	4	2004	1	2	2	6	2	2	13	1	2	2	4	70	1	2	1	10				16					5		1
200400205820	6	0	3	0	4	2004	1	1	1	8	2	2	13	1	2	1	6	60	4	1	6	6	9	10		3							1
200400205830	6	0	2	4	4	2004	1	2	2	6	2	6	11	1	2	2	6	60	1	1	1	10	11			10	16						1
200400206100	5	0	3	1	4	2004	1	1	1	8	2	6	13	1	2	4	6	55	4	1	6	10				6	10						1
200400207510	4	1	1	2	5	2004	1	1	1	7	2	6	11	3	2	2	4	50	2	2	1	2				0							1
200400207590	3	1	4	0	5	2004	5	1	1	1	2	6	11	3	2	1	4	70	2	2	1	1	4	6		2	3						1
200400207940	7	0	2	2	5	2004	1	1	1	1	2	6	11	2	2	1	4	35	2	1	1	4	11			3	15	16					1
200400210760	2	0	4	5	5	2004	4	1	1	1	2	7	10	1	5	1	6	65	4	1	6	10				9	16						1
200400210870	6	1	2	5	5	2004	1	1	1	2	2	6	11	3	2	1	4	65	2	1	1	4	10			3	16						1
200400211170	4	0	4	5	4	2004	4	2	2	1	2	9	8	3	1	2	2	65	6	2	1	10				2							1
200400212650	2	1	4	5	3	2004	5	1	1	1	2	9	16	1	1	4	4	60	6	1	1	10	11			6	16						1
200400212680	4	0	2	1	4	2004	1	1	1	1	2	6	10	1	3	1	4	60	1	1	1	9	10			9	16						1
200400217610	1	1	3	5	2	2004	5	1	1	1	2	9	7	4	1	1	2	65	1	2	1	10				0					6		1
200400220500	1	0	2	0	3	2004	1	1	1	15	2	6	10	1	2	2	6	60	1	1	1	10	11			6							1
200400220540	4	1	4	3	5	2004	5	1	1	8	2	2	11	1	2	1	6	55	1	1	1	10				10	16						1
200400220890	5	1	1	5	4	2004	1	1	1	15	2	6	10	1	4	2	6	55	1	1	1	10				9							1
200400222340	5	1	3	2	4	2004	1	1	1	6	2	2	11	1	2	1	4	60	1	1	1	10				10							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400222640	3	0	4	6	5	2004	5	1	1	8	2	1	13	1	2	1	4	60	4	1	6	6	9			3							1
200400222780	1	0	3	6	5	2004	1	1	1	1	2	9	2	3	1	1	2	65	1	2	1	1				15							1
200400225800	4	1	1	5	3	2004	1	1	1	7	2	6	10	1	3	1	8	55	1	1	2	10				9	10						1
200400225930	4	0	3	4	3	2004	5	1	1	6	2	6	13	1	2	2	6	55	1	1	1	9	10	11		10							1
200400225940	1	1	3	5	4	2004	1	1	1	1	2	9	8	1	1	5	6	55	1	2	1	10				6	16						1
200400225970	3	1	2	2	4	2004	1	1	1	15	2	6	10	1	2	3	6	45	4	2	6	10				19							1
200400225980	1	0	4	5	3	2004	5	1	1	1	2	9	8	1	1	5	6	60	6	1	1	10				19							1
200400226000	5	0	1	1	5	2004	1	1	1	1	2	6	10	1	3	5	6	55	1	1	2	10				9							1
200400226040	1	1	3	0	5	2004	1	1	1	1	2	6	10	1	3	1	6	65	1	2	1	11				0							1
200400230680	2	0	2	0	5	2004	1	1	1	1	2	6	10	1	3	1	6	65	1	2	1	10				16							1
200400230910	3	0	3	5	4	2004	1	1	1	1	2	6	10	3	5	1	4	30	4	1	2	4	10			6	16						1
200400231000	5	0	2	5	4	2004	1	2	2	15	2	2	10	1	3	1	6	55	1	1	2	10				6							1
200400235950	1	1	4	3	5	2004	4	1	1	1	2	6	10	1	2	4	6	65	4	1	6	1				16							1
200400240120	4	0	4	3	5	2004	4	1	1	1	2	6	10	1	2	1	8	65	1	1	1	1				2	16						1
200400240250	0	1	3	6	5	2004	1	1	1	1	2	6	11	3	3	2	4	30	2	1	1	4				3	17						1
200400240360	5	1	4	1	5	2004	4	1	1	2	2	6	11	2	3	2	4	45	2	2	1	4	10			3							1
200400240720	1	0	2	3	5	2004	1	1	1	1	2	6	10	3	2	2	4	40	3	2	1	3				16							1
200400240970	6	1	3	4	5	2004	1	1	1	1	2	6	10	3	3	2	4	30	1	1	1	10				6	9	16					1
200400242740	1	0	1	2	4	2004	1	1	1	1	2	6	10	3	2	1	2	65	1	1	1	4				0							1
200400242850	3	1	3	4	4	2004	5	1	1	1	2	9	2	3	1	1	2	65	1	2	1	1				16	19						1
200400245830	6	0	2	2	5	2004	1	1	1	1	2	6	10	2	3	2	4	65	1	1	1	10	11			9	16						1
200400250560	5	0	3	6	5	2004	1	1	1	1	2	6	10	1	2	1	8	55	1	1	1	10				9							1
200400250570	7	0	4	5	5	2004	5	1	1	1	2	2	10	1	2	1	6	55	1	1	1	9	10			16							1
200400250580	2	1	3	6	5	2004	1	1	1	1	2	6	10	1	3	1	6	55	1	1	1	9				9							1
200400252380	1	1	3	4	4	2004	1	1	1	8	2	6	10	1	2	2	4	60	4	2	1	10				9	16						1
200400252510	3	0	3	5	5	2004	1	7	1	2	2	7	11	4	2	2	2	45	4	2	2	10				3	17						1
200400252530	3	1	4	0	4	2004	5	7	1	1	2	9	3	3	1	1	4	60	4	2	6	9	10	11		0				2	5		1
200400255640	5	1	1	3	5	2004	1	1	1	15	2	1	10	1	2	1	6	60	1	2	1	10				0						10	0
200400257580	2	0	4	6	5	2004	5	1	1	16	2	2	9	1	2	1	4	60	6	2	1	10				2	8	15					1
200400257690	5	1	1	5	5	2004	1	2	2	1	2	6	10	3	4	1	4	60	1	2	2	1				9							1
200400260430	5	1	2	4	4	2004	1	2	2	7	2	2	13	1	2	2	6	55	1	1	1	10				19					5		1
200400260550	4	0	3	1	5	2004	1	2	1	1	2	6	10	1	3	2	6	60	4	2	1	10				6	9	16					1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400260770	3	0	1	3	5	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				9	16						1
200400260880	4	1	4	3	5	2004	5	1	1	1	2	9	7	1	1	5	6	0	4	2	6	10				0							1
200400262660	7	1	1	3	5	2004	1	1	1	1	2	9	4	4	1	1	2	65	1	2	1	2	10			6	9	21					1
200400262720	4	0	4	2	5	2004	5	1	1	2	2	6	11	5	2	1	2	65	3	2	1	10				0							1
200400265670	5	0	2	1	4	2004	1	1	1	1	2	6	10	3	2	1	6	45	1	2	1	3				9							1
200400270220	2	0	2	1	6	2004	1	1	1	1	2	6	10	3	3	2	4	35	3	2	1	10				9	16						1
200400280890	0	0	1	5	6	2004	1	1	1	6	2	6	11	1	2	2	8	0	4	2	6	10				0							1
200400282380	4	0	2	5	5	2004	1	1	1	7	2	9	2	3	1	4	2	65	6	2	1	10				6	16						1
200400282720	4	0	3	2	6	2004	1	1	1	1	2	6	10	1	2	1	4	60	4	1	6	10				9							1
200400285400	3	0	3	0	6	2004	1	1	1	1	2	10	2	1	1	2	6	60	4	1	6	3	10			1						8	1
200400285560	5	0	3	5	6	2004	1	1	1	12	2	2	10	2	2	2	4	65	1	1	2	10				9							1
200400285590	5	0	4	6	6	2004	4	1	1	1	2	6	10	1	3	1	6	55	1	1	1	1	10			16							1
200400285910	3	1	1	5	6	2004	1	1	1	6	2	6	10	1	2	1	6	55	1	1	1	10				9	16						1
200400285980	3	1	1	2	6	2004	1	2	2	1	2	6	10	1	2	1	6	55	1	1	1	10				9	16				5		1
200400287930	1	0	4	5	5	2004	5	1	1	1	2	9	8	4	1	1	2	55	2	1	1	4	11			16							1
200400290540	7	1	4	5	4	2004	4	1	1	6	2	2	13	3	2	1	4	30	3	1	1	4				10							1
200400290960	7	0	3	3	6	2004	1	1	1	1	2	6	10	2	3	1	4	30	1	1	1	10				16							1
200400291120	6	0	2	3	5	2004	1	1	1	6	2	1	10	1	2	2	4	70	1	2	1	3	4			16							1
200400296240	3	1	2	1	5	2004	1	1	1	3	2	6	13	3	2	1	2	35	2	2	1	4	10			0							1
200400297550	4	1	4	1	6	2004	5	1	1	1	2	9	16	1	1	4	4	60	1	1	1	5	10	11		2	4	16					1
200400297600	6	1	2	5	6	2004	1	1	1	7	2	6	11	3	2	2	2	65	2	2	1	4	9	10		6	16						1
200400297630	5	1	2	3	6	2004	1	1	1	1	2	9	2	1	1	1	4	60	6	1	1	10				0						8	1
200400297710	1	1	1	3	6	2004	1	1	1	15	2	6	10	3	3	1	4	60	1	2	2	10				9							1
200400300510	5	0	4	5	6	2004	4	1	1	1	2	6	10	1	2	1	6	65	1	1	1	10				16							1
200400300520	5	0	2	5	6	2004	1	1	1	1	2	2	10	2	2	1	4	65	1	1	1	10				16							1
200400300860	2	1	3	6	6	2004	1	1	1	7	2	9	8	1	1	4	6	55	6	1	1	10				19							1
200400300890	2	1	4	4	6	2004	5	1	1	1	2	6	10	1	2	1	6	55	1	1	1	3	10			6							1
200400305710	7	1	3	2	5	2004	1	1	1	1	2	6	11	3	2	1	4	40	2	2	1	3	10			4	16						0
200400310280	4	0	3	3	6	2004	1	1	1	5	2	6	10	3	2	1	4	35	1	2	1	1				5	6	8	12				1
200400310540	5	0	3	6	6	2004	1	1	1	1	2	6	10	1	2	5	6	55	4	1	6	1				9							1
200400315250	4	1	2	5	6	2004	1	1	1	2	2	6	11	3	2	1	4	40	2	1	1	1	4			3							1
200400315270	1	0	2	6	6	2004	1	1	1	1	2	6	11	3	2	2	4	35	2	2	1	3	10			4							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
20400320250	1	1	2	6	5	2004	1	1	1	15	2	6	10	3	2	1	4	20	1	1	1	9	10			16							1
20400320710	1	0	2	5	6	2004	1	1	1	1	2	6	10	2	2	1	4	30	3	2	1	10				16							1
20400320720	1	1	2	2	6	2004	1	1	1	1	2	6	10	3	2	1	4	30	3	2	1	3	10			9	16						1
20400322380	1	0	2	2	6	2004	1	1	1	2	2	6	11	3	2	1	2	55	4	2	6	1				16							1
20400322390	2	0	4	3	6	2004	4	1	1	2	2	9	2	3	1	1	2	40	4	2	6	10				6	9						1
20400322900	3	1	2	2	6	2004	1	1	1	1	2	6	10	1	5	4	4	60	1	1	1	11				4	6	16					0
20400337180	2	1	2	3	6	2004	1	1	1	1	2	9	8	1	1	5	4	60	1	2	1	9	10	11		16							1
20400337600	5	0	2	2	7	2004	1	1	1	1	2	5	3	5	1	1	2	60	1	2	1	1				16							1
20400337610	4	0	2	2	6	2004	1	1	1	1	2	2	10	3	3	2	2	60	4	1	6	9	10			6							1
20400340560	0	0	3	5	6	2004	1	1	1	1	2	6	10	2	2	1	6	35	3	2	1	3	10			10							1
20400340860	2	1	2	5	6	2004	1	1	1	1	2	6	10	1	2	7	6	70	4	1	6	10				9	16						1
20400342480	6	0	2	3	6	2004	1	1	1	1	2	2	10	1	2	1	4	70	1	2	3	11				6	16						1
20400345600	4	1	2	1	7	2004	1	1	1	11	2	6	10	1	2	2	4	60	1	1	1	10				20							0
20400345630	4	0	3	3	7	2004	1	1	1	3	2	10	1	1	1	2	4	30	4	1	1	10				6							0
20400345990	4	1	4	2	7	2004	4	2	2	1	2	9	8	1	1	5	6	65	4	1	3	9	10			16					5		1
20400346180	7	0	1	1	6	2004	1	1	1	1	2	1	10	1	2	1	4	70	1	2	1	10				16							1
20400346220	4	0	2	0	6	2004	1	1	1	1	2	5	2	4	1	1	2	65	1	2	1	1				0							1
20400347290	2	0	3	5	7	2004	1	1	1	1	2	6	10	3	2	1	2	45	1	1	1	3	9	10		4	16						1
20400347650	3	0	3	3	5	2004	3	1	1	1	2	6	11	2	2	1	4	35	2	1	1	3				3	6	16			9		1
20400347680	3	1	1	1	6	2004	1	1	1	1	2	9	8	2	1	4	4	60	6	2	1	10				1	10						1
20400351240	2	0	4	2	6	2004	5	1	1	6	2	6	10	1	2	2	6	55	1	1	1	10				6	10						1
20400351260	5	0	2	0	6	2004	1	1	1	6	2	9	8	1	1	2	6	65	6	1	1	9				10							1
20400352420	4	1	3	1	6	2004	1	1	1	12	2	6	10	3	3	1	4	40	1	1	1	9	10	11		0							1
20400353150	7	0	1	2	6	2004	1	1	1	1	2	2	10	3	2	2	2	65	1	2	1	2				4	6	16					1
20400355550	5	0	1	6	6	2004	2	1	1	1	2	6	11	3	2	1	4	30	2	2	1	4	10			3	16						1
20400357820	6	0	2	6	6	2004	1	1	1	1	2	9	2	1	1	1	4	70	6	2	1	10				16					4		1
20400360610	1	1	1	3	6	2004	1	1	1	1	2	6	10	3	3	1	4	60	1	2	2	10				9							1
20400360760	3	0	4	5	7	2004	4	1	1	1	2	6	10	1	5	2	6	55	1	1	1	10				6							1
20400361100	2	0	4	5	7	2004	1	1	1	1	2	9	8	1	1	5	6	55	1	1	2	10				16							1
20400362350	5	0	3	4	7	2004	1	1	1	1	2	6	10	1	3	2	4	70	1	2	1	10				6	9						1
20400365780	4	1	2	6	7	2004	1	1	1	1	2	6	10	3	2	2	4	40	1	1	2	10				9	16						1
20400370340	4	1	4	4	7	2004	4	1	1	15	2	6	10	1	3	1	6	55	1	1	1	10	11			2							1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400370940	4	0	4	2	7	2004	5	2	2	1	2	9	8	1	1	5	6	55	1	1	1	9	10			6							1
200400372480	2	0	1	1	7	2004	1	1	1	1	2	6	10	3	2	1	2	60	1	1	1	10				6							1
200400372830	7	0	1	1	7	2004	1	1	1	1	2	6	10	5	2	3	2	60	1	2	1	2	9			16							1
200400375980	1	0	4	5	7	2004	4	1	1	1	2	6	10	1	3	1	6	65	1	1	1	1				2	16						1
200400377310	5	0	2	6	7	2004	1	1	1	1	2	9	8	1	1	1	4	70	1	2	1	10				0						2	1
200400380480	2	0	2	1	7	2004	1	1	1	1	2	6	10	3	3	1	4	35	1	1	1	10				9	16	17					0
200400380900	1	1	4	6	7	2004	4	2	2	1	2	9	8	3	1	1	4	30	1	1	1	10				19							1
200400381000	4	1	3	6	7	2004	1	1	1	16	2	9	8	1	1	5	6	55	1	1	1	10				16	18						1
200400390430	7	1	2	5	7	2004	1	1	2	1	2	6	11	3	2	1	4	40	2	2	1	4	10			3	16						1
200400390470	2	1	2	6	7	2004	1	1	1	15	2	6	10	3	2	2	4	20	3	2	1	1				16							1
200400390860	4	1	2	6	7	2004	1	1	1	7	2	6	10	1	2	1	6	55	4	1	6	1				16							1
200400392350	2	0	2	4	7	2004	1	2	2	1	2	6	10	3	2	2	2	20	1	2	1	3		9	10	2	4	16					1
200400392600	1	1	1	1	8	2004	1	1	1	1	2	6	11	1	3	2	4	60	1	2	1	9	10			15	16				9		1
200400395740	5	1	1	5	7	2004	1	2	2	1	2	6	10	2	2	1	6	40	1	2	1	10				9	16						1
200400400280	5	0	4	2	7	2004	5	1	1	15	2	6	10	1	2	1	6	55	1	1	1	10	11			9							1
200400400450	2	1	3	0	8	2004	1	1	1	15	2	6	10	1	2	1	6	55	1	1	1	1				16							1
200400400520	6	0	3	0	8	2004	1	1	1	15	2	6	10	1	3	1	6	55	1	1	1	1				16							1
200400402280	2	0	4	0	8	2004	5	1	1	1	2	9	2	4	1	1	2	65	1	2	1	10											1
200400405570	7	1	2	6	7	2004	1	2	2	11	2	6	11	2	2	1	4	35	2	2	1	1	4			3							1
200400405630	3	0	2	6	7	2004	1	1	1	1	2	6	10	2	2	1	6	45	4	2	6	10				16							0
200400405650	0	0	4	4	7	2004	4	1	1	1	2	9	3	3	1	1	4	40	1	1	1	1				16				5			0
200400405730	5	0	3	6	8	2004	1	1	1	1	2	7	10	1	2	4	6	55	1	1	1	10				0							0
200400405920	2	0	4	6	7	2004	5	1	1	1	2	7	10	3	2	2	4	40	4	1	6	3	10			5	16						1
200400407240	1	0	4	0	8	2004	5	1	1	1	2	9	8	4	1	1	2	45	6	2	1	3	9	10		6	25						1
200400407320	3	1	3	5	8	2004	1	1	1	1	2	6	10	1	3	1	4	60	1	1	1	10				9							1
200400407600	1	0	3	0	8	2004	1	1	1	1	2	6	11	4	2	2	2	35	4	2	6	10								9			1
200400410150	2	1	2	0	8	2004	1	1	1	2	2	6	11	3	2	1	4	35	6	2	1	4	10			16							1
200400410420	3	1	2	0	8	2004	1	1	1	7	2	2	10	1	2	5	8	55	1	1	1	1				16							1
200400410720	5	0	2	5	8	2004	1	1	1	16	2	9	8	1	1	6	8	55	6	1	1	10				21							1
200400410730	4	1	1	3	8	2004	1	1	1	15	2	6	10	1	5	1	8	55	1	1	1	10				9							1
200400410810	2	1	3	1	8	2004	1	1	1	8	2	6	10	1	2	5	6	55	1	1	1	10	11			3	6	16					1
200400410950	3	0	2	6	7	2004	1	1	1	1	2	6	10	1	2	2	6	55	1	2	1	10	11			9	16						1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400412310	4	0	2	6	7	2004	1	1	1	1	2	2	10	1	3	1	4	60	1	2	1	10	11			9							1
200400414890	2	0	4	4	8	2004	5	1	1	1	2	6	10	1	2	2	6	65	1	1	1	9	10	11		2	6	9					1
200400415270	1	1	2	4	7	2004	1	1	1	15	2	6	10	1	2	2	6	60	1	2	1	10				9							1
200400415280	3	1	3	3	8	2004	1	1	1	1	2	6	10	1	3	2	6	60	1	2	1	10				6	9						1
200400415300	5	0	4	5	7	2004	5	1	1	1	2	10	7	1	1	2	6	70	1	2	1	10				0					6		1
200400422310	3	0	2	6	8	2004	1	1	1	1	2	7	11	3	2	1	4	40	2	1	1	4	9	10	11	0							1
200400422710	1	0	1	3	7	2004	1	1	1	7	2	2	10	1	2	1	4	70	1	2	1	10	1			4	10	19					1
200400425510	1	0	1	0	8	2004	1	1	1	1	2	6	10	1	2	2	6	65	1	1	1	10				9							1
200400425760	3	0	2	5	7	2004	1	1	1	15	2	2	10	1	2	1	6	60	1	2	1	10				6	16						1
200400425860	0	0	3	4	7	2004	1	1	1	1	2	6	10	3	3	1	4	40	1	1	1	10				9	16						0
200400425870	5	0	2	5	7	2004	1	1	1	1	2	6	10	3	2	1	4	35	3	1	1	3	10			7	17					1	0
200400425990	4	1	2	6	8	2004	1	1	1	1	2	6	10	1	2	2	6	65	1	1	1	10				6	9						1
200400426050	3	0	3	6	7	2004	1	1	1	1	2	6	10	3	3	1	6	45	4	1	6	10				2	6	17					1
200400426080	3	0	4	4	8	2004	5	1	1	1	2	6	10	3	3	1	4	40	4	1	6	3	10			5	16						1
200400426230	3	1	2	2	8	2004	1	1	1	1	2	9	8	3	1	2	2	30	6	2	1	10				1	2	6	16				1
200400432130	3	1	1	2	7	2004	2	1	1	2	2	6	13	4	2	2	4	65	2	2	1	9	11			0							1
200400436160	7	0	2	1	8	2004	1	1	1	1	2	2	10	3	2	2	4	65	1	2	1	2	10			16							1
200400440420	2	1	2	0	8	2004	1	2	1	1	2	6	11	2	2	1	6	35	2	1	1	3				4							0
200400440820	1	1	1	1	8	2004	1	1	1	15	2	6	13	1	2	1	6	55	1	1	1	9	10			16							1
200400440990	3	1	1	1	8	2004	1	2	2	1	2	6	10	1	2	2	6	55	4	2	6	10				9					5		1
200400442590	7	1	2	1	8	2004	1	1	1	1	2	9	8	1	1	1	4	60	6	2	1	11				15							1
200400445440	2	0	4	6	8	2004	3	1	1	1	2	6	10	1	3	1	6	60	1	2	1	9	10			6							1
200400445530	1	0	2	2	8	2004	1	1	1	1	2	6	11	3	2	1	4	30	2	2	1	4	9			0							1
200400445890	0	1	2	6	8	2004	5	2	2	1	2	6	10	3	2	1	4	30	4	2	1	3				9	16						1
200400447520	3	0	2	0	8	2004	1	1	1	5	2	9	2	3	1	2	2	65	1	2	1	10				16							1
200400450710	2	0	2	1	8	2004	1	1	6	1	2	6	10	2	2	3	4	25	3	2	1	3	10			9						1	1
200400456070	4	0	3	3	8	2004	1	1	2	1	2	9	8	1	1	1	6	55	4	1	6	10	11			2							1
200400459810	3	0	4	0	8	2004	5	1	1	1	2	6	10	3	2	2	2	35	4	1	1	3	9			2	16						1
200400460720	3	1	3	2	8	2004	1	1	1	1	2	6	10	2	3	3	6	35	1	1	2	10				9	16						0
200400461000	1	0	3	2	9	2004	1	1	1	1	2	6	10	3	2	5	4	30	3	1	1	10				4	6	16					1
200400462070	3	0	2	1	8	2004	1	1	2	1	2	2	10	3	2	2	2	65	1	2	1	2				16	18						1
200400462690	6	0	2	5	9	2004	1	1	1	1	2	3	2	3	2	3	2	65	1	2	1	2	9	10		6	16						1

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
20400462750	6	1	3	4	9	2004	1	1	1	1	2	6	10	1	2	1	4	60	1	1	1	10				9	16						1
20400462840	5	0	4	4	8	2004	5	1	1	1	2	5	8	4	1	1	2	65	6	1	1	1				18							1
20400465760	5	0	3	3	8	2004	1	1	1	1	2	6	11	3	2	1	4	40	2	1	1	4	10			3	16						0
20400465900	4	0	2	2	8	2004	1	1	1	1	2	6	10	3	2	1	4	35	1	1	1	10				9	16						0
20400466160	7	1	2	4	7	2004	1	1	1	1	2	9	4	4	1	1	2	60	1	2	1	2	10			4	16						1
20400467360	3	0	1	3	9	2004	1	1	2	10	2	6	14	3	2	2	2	60	1	2	1	10				11							1
20400470460	6	1	2	0	9	2004	1	1	1	1	2	6	10	1	3	2	6	60	1	1	1	10	11			16							1
20400475940	7	0	2	6	8	2004	1	1	1	7	2	2	14	1	3	4	6	55	4	1	6	10				11							1
20400485780	3	0	1	5	9	2004	1	1	1	1	2	5	2	1	1	2	6	60	6	1	1	10	11			0							1
20400485830	5	1	2	4	9	2004	1	1	1	6	2	6	11	1	2	1	6	55	4	1	6	10	11			4	7						1
20400485850	4	0	3	2	9	2004	1	1	1	1	2	6	10	1	3	1	6	55	1	1	1	10				9	9						1
20400485870	1	0	3	3	9	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				6	9						1
20400485980	3	1	2	6	8	2004	1	1	1	6	2	6	10	1	2	1	6	60	1	2	1	9	10			10	16						1
20400486000	3	0	3	3	8	2004	1	1	1	15	2	6	10	1	3	1	6	55	1	1	2	10				6							1
20400487390	3	0	4	5	8	2004	5	1	1	1	2	9	7	3	1	5	2	40	1	2	1	1				0							1
20400487690	7	1	3	3	9	2004	1	1	1	1	2	6	10	4	3	1	2	65	1	2	1	2	4	11		4	6	16					1
20400490760	4	1	3	2	9	2004	5	1	1	6	2	9	2	1	1	1	6	0	6	1	1	10	11			4	10						1
20400490880	3	1	1	5	8	2004	1	1	1	1	2	6	8	1	2	2	6	55	6	1	2	10				16							1
20400490970	3	1	1	2	9	2004	1	2	1	1	2	6	10	1	2	2	6	60	4	1	6	10	11			9	16						1
20400490990	7	0	2	5	8	2004	1	1	1	1	2	6	10	1	2	1	6	65	1	2	1	10	11			6							1
20400495210	2	0	3	0	8	2004	3	1	1	1	2	6	11	3	2	3	4	20	2	2	1	3				4	16						1
20400495220	4	1	2	1	8	2004	1	1	1	11	2	6	11	3	2	2	4	40	6	2	1	10				3							1
20400495770	4	1	3	3	9	2004	1	2	2	1	2	6	11	3	2	1	4	30	2	1	1	3				4							1
20400495880	6	0	3	4	9	2004	1	1	1	1	2	2	10	1	3	1	4	60	1	1	2	10				9	16						1
20400495930	2	0	4	2	9	2004	4	1	1	1	2	10	8	4	1	1	2	40	1	2	1	10	11			25							1
20400502500	3	0	4	5	9	2004	5	1	1	1	2	9	7	3	1	2	2	65	1	2	1	10				0					6		1
20400502730	6	1	3	5	9	2004	1	1	1	1	2	6	10	1	2	1	4	0	1	1	1	10				9							1
20400505670	1	0	3	4	9	2004	1	1	1	1	2	6	10	2	2	1	6	45	1	1	1	10				9							0
20400505910	1	0	4	4	9	2004	5	1	1	1	2	9	2	1	1	1	6	55	6	2	1	10				16							1
20400505940	1	1	2	0	9	2004	1	1	1	15	2	2	10	1	3	1	6	35	1	1	1	10				9							1
20400506240	4	0	1	5	8	2004	1	1	1	1	2	6	10	4	2	1	2	35	1	1	2	10				6	9						0
20400515600	1	0	2	3	9	2004	1	1	1	1	2	2	10	2	3	1	6	45	1	1	1	10				9	16						0

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400515610	1	1	1	0	9	2004	1	1	1	1	2	6	10	2	3	1	4	35	3	1	1	3	10			9	16						0
200400515900	5	0	1	4	9	2004	1	1	1	1	2	6	10	1	2	1	6	55	1	1	1	10				16							1
200400515990	4	0	3	5	9	2004	1	1	1	1	2	7	10	1	2	1	6	60	1	1	1	10				9							1
200400517140	0	0	4	1	8	2004	5	1	1	1	2	9	2	1	1	1	4	55	1	1	1	10				5							1
200400517230	7	1	2	4	9	2004	1	1	1	1	2	6	10	3	2	1	2	65	1	2	1	2		11		6	16						1
200400517260	6	0	3	1	10	2004	1	1	1	15	2	6	10	3	2	2	2	65	1	2	1	11				9	16						1
200400517630	2	1	1	5	10	2004	1	2	2	1	2	6	10	1	2	2	4	70	1	2	1	5	10			6					5		1
200400520990	3	1	3	6	10	2004	5	1	1	1	2	6	10	1	3	2	6	55	1	1	1	10				6	16						1
200400521420	6	0	1	1	9	2004	2	1	1	1	2	9	16	1	1	2	4	70	1	6	1	1				15							1
200400525460	4	0	4	3	9	2004	5	1	1	1	2	6	10	3	2	1	2	35	1	2	1	3	9	10		2	4	5	16				1
200400525620	5	0	4	4	9	2004	4	1	1	1	2	9	16	3	1	1	4	45	1	2	1	10	11			2							1
200400525830	3	1	2	3	9	2004	1	1	1	1	2	6	10	2	3	1	4	40	3	2	1	1				9							0
200400530540	3	0	3	4	7	2004	1	2	2	1	2	6	10	3	2	1	4	35	1	2	1	10				16							1
200400535880	5	1	3	4	10	2004	1	2	2	6	2	6	10	1	2	1	6	60	1	1	1	10				6							1
200400535920	3	1	4	6	10	2004	4	1	1	7	2	6	13	1	2	4	8	55	1	1	1	10				0							1
200400535950	0	0	4	0	9	2004	5	1	1	16	2	6	10	1	2	1	6	55	1	1	1	10				0						11	1
200400536900	3	1	2	4	10	2004	1	2	2	1	2	9	8	3	1	4	4	60	6	2	1	10				6							1
200400540390	1	0	2	2	9	2004	1	1	1	1	2	6	10	3	2	1	4	35	1	1	1	3	10			16							1
200400540400	2	1	2	5	9	2004	1	1	1	1	2	6	10	3	2	1	4	35	3	1	1	3	10			16							1
200400540460	4	0	1	3	10	2004	5	1	1	1	2	2	10	1	2	1	4	60	1	1	1	1				16							1
200400545810	1	1	2	4	10	2004	1	2	2	6	2	6	13	1	2	2	6	0	1	2	1	10				0							1
200400545960	5	1	4	3	10	2004	4	1	1	6	2	6	13	1	2	1	6	70	1	2	1	10				10							1
200400547720	7	0	2	3	10	2004	1	1	1	1	2	2	10	1	2	1	4	60	1	1	1	9	10			9	16						1
200400557320	7	0	3	2	10	2004	1	2	2	15	2	6	10	1	2	1	4	70	1	2	1	10				9	16						1
200400560480	6	0	1	3	7	2004	1	1	1	7	2	10	2	3	1	1	4	30	2	1	1	4	10			0							1
200400570790	4	0	3	6	10	2004	3	1	1	6	2	6	13	2	2	1	6	45	1	1	1	1				10	16						0
200400571800	5	0	2	2	10	2004	1	1	1	1	2	5	2	1	1	4	4	70	1	2	1	10				16							1
200400575930	1	1	4	6	10	2004	4	1	1	8	2	9	8	1	1	1	6	55	4	1	1	9	10	11		4	10	17					1
200400577720	2	1	4	2	10	2004	5	1	1	7	2	9	1	1	1	1	4	60	6	2	2	10				2	8						1
200400580780	1	0	1	2	10	2004	1	2	2	15	2	6	10	2	2	3	6	45	1	1	3	1				9							0
200400585760	2	0	2	6	10	2004	1	1	1	1	2	6	10	3	2	2	4	30	3	2	1	3				6	9	16					1
200400590700	3	0	2	2	10	2004	1	1	1	1	2	6	11	3	2	1	4	35	2	2	1	3	10			4							0

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
200400600180	1	0	3	4	11	2004	4	1	1	15	2	6	10	3	2	1	4	30	1	2	1	10				16							1
200400600920	3	0	4	3	10	2004	5	1	1	12	2	6	10	1	2	5	6	55	1	1	2	10				0							1
200400607290	7	0	1	3	10	2004	5	5	2	1	2	2	11	3	2	1	2	60	6	2	1	10				0							1
200400617400	4	1	2	5	9	2004	1	1	1	1	2	6	10	3	3	2	2	65	1	2	1	2	10			4	6	21					1
200400621370	7	0	2	3	10	2004	1	2	2	1	2	2	13	1	4	5	6	55	1	2	2	10				16					5		1
200400625820	2	0	1	2	11	2004	1	1	1	1	2	6	10	1	3	1	6	55	1	1	1	10				9							1
200400625830	2	1	1	2	11	2004	1	1	1	1	2	6	10	1	5	2	6	0	1	1	2	10				9							1
200400625910	5	0	4	0	11	2004	5	1	1	1	2	6	10	3	2	1	4	40	4	1	6	3	10			2	5	16					1
200400627590	4	0	3	6	10	2004	5	1	1	15	2	9	8	3	1	4	2	65	1	2	1	1				2							1
200400633660	5	0	1	1	11	2004	5	1	1	1	2	9	7	1	1	1	4	70	1	1	1	10				0					6		1
200400635060	1	1	3	3	11	2004	4	1	1	1	2	6	10	3	3	2	4	40	3	2	1	10				16							1
200400636270	7	0	3	5	11	2004	1	1	1	10	2	5	2	5	1	2	2	30	6	4	1	1				17							1
200400637270	5	1	3	3	11	2004	5	1	1	1	2	9	7	3	1	1	2	65	1	2	1	1				0							1
200400642920	0	0	2	4	11	2004	1	1	1	1	2	6	10	3	2	1	4	30	3	1	1	3				16							0
200400645860	1	1	3	6	11	2004	1	1	1	7	2	9	8	1	1	1	6	55	1	1	1	10				19							1
200400650450	3	1	1	3	11	2004	1	1	1	1	2	6	10	2	2	1	6	45	1	1	1	10				16							0
200400657000	7	0	2	0	11	2004	1	1	1	1	2	9	8	3	1	3	2	60	1	2	1	1				0							1
200400665850	4	0	2	4	11	2004	1	2	2	1	2	2	13	1	3	5	6	55	1	1	1	10				0							1
200400665870	1	1	1	0	11	2004	1	1	1	6	2	6	11	1	2	1	6	55	1	1	1	10				10							1
200400665900	7	1	3	5	11	2004	4	1	2	1	2	9	8	1	1	1	6	55	6	1	1	10				19							1
200400666250	1	0	1	4	11	2004	1	1	2	1	2	9	8	1	1	1	6	55	1	1	1	10				16	18				2		1
200400666310	2	1	4	6	11	2004	4	1	1	1	2	9	8	1	1	4	6	55	6	1	1	10				2	6						1
200400668120	2	0	4	2	11	2004	5	11	2	1	2	5	2	3	1	1	2	65	1	2	1	10	11			0					6		1
200400680690	4	0	2	3	12	2004	1	1	1	1	2	6	10	1	2	1	4	60	1	1	2	10				9	16						1
200400681300	5	1	4	0	11	2004	5	1	1	7	2	9	8	1	1	1	6	55	1	2	1	10				19							1
200400681350	1	1	1	4	11	2004	2	2	2	1	2	9	2	1	1	5	6	55	1	1	1	10				0					5		1
200400685740	3	1	1	5	9	2004	1	1	1	7	2	9	8	1	1	1	6	65	1	1	1	1				19							1
200400690790	3	1	1	3	11	2004	5	2	2	8	2	2	10	1	2	1	4	60	4	1	6	10				3							1
200400695690	2	0	4	6	12	2004	4	1	1	1	2	6	10	3	2	1	4	40	1	2	1	10				2	16						0
200400696640	2	0	1	3	12	2004	2	1	1	1	2	6	11	3	2	4	2	45	1	2	1	9	10	11		4	16						1
200400698350	4	0	2	1	12	2004	1	2	1	1	2	6	11	3	2	2	2	30	2	1	1	4				3	16						1
200400720640	3	0	2	5	12	2004	1	1	1	1	2	6	10	3	3	1	4	45	3	2	1	3	10			9	16						0

Key	Age	Gender	Acc_Time	Day	Month	Year	Light_Con	Weather_Con	Surf_Con	Veh_ Maneuver	Acc_severity	Veh_Type	Acc_Class	Road_Class	No_Vehicle	Road_Char	No_Lane	Speed_Limt	Acc_Loc	Surf_Type	Special_Fea	Traffic_Con1	Traffic_Con2	Traffic_Con3	Traffic_Con4	Dr_Error1	Dr_Error2	Dr_Error3	Dr_Error4	PE_CODE	EV_CODE	VE_CODE	Area_Info
20040072065O	2	0	3	5	12	2004	1	1	1	1	2	6	10	2	1	1	6	45	1	1	1	10				9	16						0
20040072138O	3	0	4	4	11	2004	4	1	1	1	2	9	8	1	1	5	6	55	6	1	1	10				2	6	10	23				1
20040073577O	3	0	2	5	5	2004	1	1	1	1	2	6	10	3	3	4	4	30	6	1	1	9	10			0							1
20040073578O	7	0	2	3	12	2004	1	1	1	1	2	6	11	3	2	1	4	35	2	1	1	4	10			3	16						1
20040074091O	4	0	2	6	12	2004	1	1	1	1	2	6	10	3	3	1	4	35	3	1	1	3				16							0
20040075114O	3	0	1	3	12	2004	2	5	2	7	2	2	2	3	3	1	4	65	3	2	1	10				6	19						1
20040075443O	5	1	1	1	8	2004	1	1	1	1	2	6	10	3	3	2	2	65	1	1	1	3				9	16						1
20040075650O	4	0	4	3	6	2004	5	1	1	1	2	9	1	1	1	4	4	60	4	2	6	1				0							1
20030172978	1	0	3	5	1	2003	1	1	1	11	2	6	11	3	2	1	4	20	2	2	1	1	4			2							1
20030481018	6	0	4	6	9	2003	4	1	1	1	2	10	8	1	1	1	4	70	6	1	1	10				16	18						1
20030535568	2	0	4	4	7	2003	4	1	1	1	2	6	10	3	2	1	4	60	3	2	1	10				2	16						0
20030903028	2	0	2	0	3	2003	1	1	1	2	2	6	11	3	2	2	4	65	1	1	1	10				8							1
20040013513B	4	0	3	6	1	2004	1	2	2	1	2	6	11	2	2	1	4	40	2	2	1	3				3	4	16					1
20040062590B	0	0	4	5	10	2004	1	1	1	1	2	6	10	3	2	1	4	40	4	1	6	3	10			16							1
20040063718B	4	0	4	3	6	2004	5	1	1	1	2	9	1	1	1	4	4	60	4	2	6	1				0							1
20040068099B	0	0	4	3	11	2004	4	4	3	6	2	6	13	1	3	1	6	55	1	1	1	1				0							1
20040074093B	2	0	4	0	8	2004	4	1	1	1	2	6	10	2	2	1	6	35	1	1	1	10				2	16	25					0
20040075658B	2	1	2	2	9	2004	1	1	1	15	2	9	10	3	3	1	2	65	1	2	1	2				0							1
20030900400	5	1	2	7	2	2003	1	4	4	1	1	2	9	3	2	2	2	65	1	2	1	10				6							1
20030900910	5	1	1	6	4	2003	5	1	1	1	1	10	2	3	1	1	2	65	1	2	1	10				26							1
20030901120	4	0	4	6	4	2003	5	5	2	1	1	6	9	3	2	5	2	60	1	2	1	11				2	8						1
20030901470	5	1	2	5	5	2003	1	1	1	16	1	2	9	3	3	1	2	60	1	2	1	9	10			8							1
20030901560	1	1	4	2	6	2003	4	1	1	1	1	6	9	3	2	4	2	65	1	1	1	9	10			8							1
20030901730	4	0	3	7	3	2003	1	1	1	1	1	2	11	3	2	1	2	65	2	2	1	4	10			3							1
20030901750	4	0	2	1	4	2003	1	1	1	1	1	2	13	3	2	2	2	65	1	2	1	4	2			15	16	4	6				1
20030901800	3	1	4	7	6	2003	5	1	1	1	1	6	9	3	2	1	2	60	1	2	1	9	10			8							1
20030902770	5	1	4	6	9	2003	5	1	1	1	1	10	4	1	2	1	4	70	1	2	1	10				16							1
20030903160	1	0	1	2	10	2003	1	1	1	1	1	2	9	3	2	4	2	65	1	2	1	10				15	16	8					1
20030903580	5	0	2	4	11	2003	1	1	1	1	1	1	10	3	2	2	2	65	1	2	1	2	10			16							1
20040090039O	3	0	1	4	4	2004	1	11	2	6	1	6	9	3	2	1	2	65	1	2	1	10				8					5		1
20040090064O	3	1	4	6	3	2004	4	1	1	2	1	10	3	1	1	1	6	55	1	1	2	10				0				5			0

Area_Info	0	1	1	1	1	0	1	1	1	0	1	1	0	0	1	0	1
VE_CODE																	
EV_CODE																	
PE_CODE						8											
Dr_Error4																	
Dr_Error3											4		16	16			
Dr_Error2		8		16					15	10	6	10	6	9		10	
Dr_Error1	10	16	16	2	0		26	16	16	2	16	10	2	6	16	4	16
Traffic_Con4																	
Traffic_Con3																	
Traffic_Con2		10	10	10				10	10		10		10	10	10		
Traffic_Con1	10	9	2	9	10		10	11	2	10	2	10	9	3	5	10	10
Special_Fea	1	6	1	1	1	1	1	1	1	6	1	1	1	1	2	7	2
Surf_Type	1	2	1	2	1	1	2	1	1	1	2	2	2	2	2	1	1
Acc_Loc	1	4	1	1	2	2	1	3	1	4	1	1	7	3	1	1	1
Speed_Limt	70	65	65	40	35	60	1	65	65	60	65	65	60	55	70	60	60
No_Lane	6	2	2	2	2	2	2	2	2	6	2	2	6	4	4	4	4
Road_Char	1	1	1	1	5	1	1	1	1	1	1	3	2	1	1	1	2
No_Vehicle	2	2	4	1	1	1	1	4	6	1	3	2	1	3	2	2	2
Road_Class	1	3	3	5	5	5	5	3	3	1	3	3	3	3	1	4	3
Acc_Class	11	9	10	2	3	8	8	10	10	2	10	12	8	10	4	11	10
Veh_Type	6	2	2	10	8	9	2	2	2	10	2	2	9	3	2	6	2
Acc_severity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Veh_Maneuver	6	16	1	1	1	1	1	1	1	6	1	16	1	1	1	4	1
Surf_Con	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1
Weather_Con	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1
Light_Con	1	1	1	1	5	5	5	1	1	4	1	1	4	5	1	1	2
Year	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
Month	4	4	5	6	5	6	6	6	6	7	6	9	8	9	12	11	12
Day	6	4	1	3	5	6	1	1	4	5	1	1	4	1	4	6	5
Acc_Time	2	1	2	4	4	4	4	2	1	1	2	2	4	4	2	2	1
Gender	1	0	0	1	4	0	4	0	0	1	1	0	0	0	0	0	0
Age	3	2	6	4	2	2	2	5	3	1	4	4	3	5	4	7	2
Key	20400900660	20400900840	20400901090	20400901250	20400901410	20400901580	20400901640	20400901740	20400901900	2040090209B	20400090245	20400090256	20400090277	20400090383	20400060388	20400090390	