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National Motor Vehicle Crash Causation Survey

Report to Congress

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EXECUTIVE SUMMARY

Understanding the events leading up to a motor vehicle crash is crucial in preventing the crash from occurring in the first place. With that objective, the U.S. Congress authorized the National Highway Traffic Safety Administration (NHTSA) of the U. S. Department of Transportation to conduct a National Motor Vehicle Crash Causation Survey (NMVCCS). NHTSA's National Center for Statistics and Analysis (NCSA) has completed a nationwide survey of crashes involving light passenger vehicles, with a focus on the factors related to pre-crash events – a survey of critical importance to the stakeholders in traffic safety. A sound methodology, which has been reviewed by a panel of experts, was used for this purpose. A nationally representative sample of crashes was investigated from 2005 to 2007. NMVCCS ceased investigating crashes on December 31, 2007. The data collected through the investigated crashes will better equip NHTSA and other safety advocates to evaluate and develop vehicle-related crash avoidance technologies.

Crash avoidance technologies such as electronic stability control (ESC) systems, lane departure warning systems, run-off-the-road warning systems, adaptive cruise control, adaptive headlights, electronic brake distribution, and brake assist systems are in various stages of design, development, and refinement. There is also an emerging trend to use these and other systems to automatically prepare the vehicle and its occupants for an unavoidable collision in order to mitigate injuries. The NMVCCS data will aid in the evaluation and improvement in the performance of such systems. NMVCCS has collected information on road surveillance, condition of the vehicle, malfunctions of vehicle systems, driver distraction or inattention, aggressive driving, adequacy of evasive actions, and control of the vehicle. Such information can be used to evaluate these crash prevention systems. The driver-related information can be beneficial in studying the behavioral issues and other human factors in crash occurrence.

NMVCCS investigated a total of 6,950 crashes during the 3-year period from January 2005 to December 2007. However, this report uses a nationally representative sample of 5,471 crashes that were investigated during a 2 ½- year period from July 3, 2005, to December 31, 2007. The remaining 1,479 crashes were investigated but were not used in this report because (1) these crashes were investigated during the transition period from January 1, 2005, to July 2, 2005, when the data collection effort was being phased in, or (2) these crashes were investigated after the phase-in period, but ultimately determined not to meet the requisite sample selection criteria. However, the data from the 1,479 crashes is still suitable for clinical, case-by-case evaluations and will be part of the file that will be released for the public use. Each investigated crash involved at least one light passenger vehicle that was towed due to damage. Data was collected on at least 600 data elements to capture information related to the drivers, vehicles, roadways, and environment. In addition, the NMVCCS database includes crash narratives, photographs, schematic diagrams, vehicle information, as well as event data recorder (EDR) data, when available. This additional information will be vital to researchers seeking to perform in-depth clinical reviews of crashes.

During the data collection process, the NMVCCS researchers had the advantage of a unique arrangement with local law enforcement and emergency responders who granted them timely permission to be on the scene of the crash. Arriving on the scene before the crash was cleared by the law enforcement gave the researchers (1) access to relatively undisturbed information pertaining to the events and factors that led up to the crash, (2) the opportunity to discuss the circumstances of the crash with the drivers, passengers, and witnesses while it was still fresh in their minds, and (3) the opportunity to immediately and accurately reconcile the physical evidence with the witnesses' descriptions. The researchers on the scene were in an ideal position to gather first-hand information related to the vehicle, the roadway, the environmental conditions, and the human behavioral factors. When available, the researchers were also able to download the information from the vehicles' event data recorders. Using this and any other available information, an assessment was made of the critical event that preceded the crash, the reason for this event and other associated factors that might have played a role.

Some of the highlights from the investigated crashes related to the critical pre-crash event that occurred are:

- About 36 percent of the vehicles were turning or crossing at intersections just prior to the crashes – characterized as the critical pre-crash events. The information collected on crashes at intersections will be beneficial to the development of the Cooperative Intersection Collision Avoidance System (CICAS), which would warn a driver about an imminent violation of the traffic control device at the intersection.

- About 22 percent of the vehicles ran off the edge of the road -- a potential application of this information would be in the evaluation of Electronic Stability Control (ESC) systems.

- About 11 percent of the vehicles failed to stay in the proper lane – information that could be used in the evaluation of lane departure warning systems.

- An additional 12 percent of the vehicles were stopped and about 9 percent lost control prior to the crash. The information collected on these crashes will be beneficial in the development of collision-avoidance/warning systems that warn a driver of possible collisions.

Another important feature of NMVCCS is the assessment of the critical reason underlying the critical event. The critical reason is determined by a thorough evaluation of all the potential problems related to errors attributable to the driver, the condition of the vehicle, failure of vehicle systems, adverse environmental conditions, and roadway design. Some of the highlights of the critical reason underlying the critical event are presented below.

In cases where the researchers attributed the critical reason to the driver, about 41 percent of the critical reasons were recognition errors (inattention, internal and external distractions, inadequate surveillance, etc.). In addition, about 34 percent of the critical reasons attributed to the driver were decision errors (driving aggressively, driving too fast, etc.) and 10 percent were performance errors (overcompensation, improper directional control, etc.). The researchers also made an assessment of other factors associated with the crash, such as interior non-driving activities. In fact, about 18 percent of the drivers were engaged in at least one interior non-driving activity. The most frequent interior non-driving activity was conversation, either with other passengers in the vehicle or on a cell phone, especially among young (age 16 to 25) drivers. Among other associated factors, fatigued drivers were twice as likely to make performance errors as compared to drivers who were not fatigued. The information about driver-related critical reasons will assist in the development of crash avoidance systems and collision warning systems, as well as improve the design of dashboard electronics, or telematics, that reduce the potential for driver inattention. The effectiveness of vehicle-based countermeasures in mitigating the effects of various driver performance, recognition, and decision errors could be evaluated using this information.

Assessments of vehicles were made by the NMVCCS researchers to identify potential reasons attributed to vehicle systems, such as failure of the brake system or the tire/wheel assembly. In cases where the assessment of the vehicle revealed a critical reason related to the vehicle, the failure of a tire/wheel was the most frequent critical reason, followed by the failure of the braking system. This information can be used in the evaluation of various types of Tire Pressure Monitoring Systems (TPMS), as well as other onboard-warning systems that provide information on the condition of critical vehicle elements, such as brake-system hydraulics and tires.

The NMVCCS researchers also made assessments about critical reasons related to, but not limited to, the roadway design, signage, traffic control devices, and sight distance. Critical reasons related to weather and roadway surface conditions were also evaluated by the researchers. In cases where the researchers attributed a critical reason related to the roadway or environment, slick roadway surfaces due to ice or debris was the most common reason followed by obstructions to driver vision. The information collected from such crashes will help in the development of collision avoidance systems that adapt to adverse weather and roadway surface conditions.

One of the objectives of NMVCCS is to build a national database containing detailed information on events and factors leading up to a crash. The data collected through NMVCCS are being passed through rigorous quality checks and will be made available to the public. To replicate the estimates presented in this report, researchers should use the data collected from July 3, 2005, to December 31, 2007, as tagged in the file to be released to the public by September 2008. The NMVCCS data is best suited for analyses directed toward answering questions related to crash risk assessment, identification of possible crash contributing factors, and not merely estimating rates. NHTSA plans to produce reports describing factors contributing to crashes, as well as conducting analytical studies specifically addressing priority safety issues.

1. Introduction

While the fatality rate on U.S. highways has steadily declined over the last several years, the number of fatalities has remained relatively constant. The nation, as a whole, lost 41,059 lives in 2007 to traffic crashes. In fact, in 2005, motor vehicle traffic crashes were the leading cause of death for every age from 3 through 6 and 8 through 34.

The traffic safety community has made great strides in the crashworthiness of vehicles – the ability of vehicles to protect their occupants during a crash. To substantially reduce the high number of traffic fatalities and injuries, more needs to be done in primary prevention (i.e., finding ways to prevent crashes by understanding the events leading up to a crash.) The automotive industry has already applied significant resources into the research and development of crash avoidance features in vehicles. Many of the new features (ESC, traction control, lane-departure warning systems, etc.) are starting to appear in the fleet of newer model vehicles. NHTSA and other safety researchers are currently evaluating the effectiveness of these new technologies. Available databases, such as the National Automotive Sampling System (NASS) Crashworthiness Data System (CDS) do not provide information that can specifically serve the purpose of identifying pre-crash scenarios and the reason underlying the critical pre-crash events -- information critical to the evaluation and development of emerging crash avoidance technologies. Additional data are needed to identify factors associated with crash causation. With this objective, in 2005 NHTSA was authorized under Section 2003(c) of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) to conduct a national survey to collect on-scene data pertaining to events and associated factors related to a crash. NHTSA's National Center for Statistics and Analysis (NCSA) has conducted the National Motor Vehicle Crash Causation Survey of crashes with focus on the factors related to pre-crash events involving light passenger vehicles. A sound methodology, which has been reviewed by a panel of experts, was used for this purpose. One of the objectives of NMVCCS is to build a national database containing detailed information on factors and events leading up to a crash.

This report presents information from a sample of 5,471 crashes investigated during a two-and-a-half-year period from July 3, 2005, to December 31, 2007. Descriptions of the survey methodology as well as case studies have been provided to illustrate the nature of the information collected by NMVCCS researchers. The primary focus of NMVCCS researchers was to determine the critical pre-crash events and the reasons underlying the critical event through a thorough assessment of all possible contributing factors related to the drivers, vehicles, roadways, and the environment. This report presents estimates of some of these crash elements based on the data analyzed compiled as of April 30, 2008.

2. Background and Objective

Nearly 30 years have passed since the last on-scene crash causation study was conducted (the Indiana Tri-Level Study in 1979). The information from the Indiana Tri-Level Study is seriously outdated due to the changing nature of the vehicle fleet and vehicle technologies. Also, since the last study, driver behavior has changed due to a variety of dashboard electronics, also called telematics pertaining to entertainment, navigation, and communication. Furthermore, the Tri-Level Study was not nationally representative in that it was only conducted in one small part of the country and was not based upon a statistical design. In 2006, NHTSA concluded a 100-car naturalistic study that was an instrumented-vehicle study undertaken with the primary purpose of collecting large-scale, naturalistic driving data. While this study captured information on overall driving behavior in crashes, near-crashes and other incidents, it was not designed to conduct in-depth, on-scene investigations of crashes that are necessary to determine the factors related to pre-crash events. Crash-avoidance technology (e.g., collision-avoidance systems) continues to be introduced, and data is needed to evaluate these systems, as well as establish priorities among investments in emerging technologies. Recognizing the need for such data, Congress asked NHTSA to conduct NMVCCS – the first nationally representative survey aimed at providing information on the pre-crash environment in crashes involving light vehicles and building up a national database containing detailed information on events and factors leading up to a crash.

Previously, NHTSA used the existing infrastructure of NASS for the Large Truck Crash Causation Study (LTCCS) conducted jointly with the Federal Motor Carrier Safety Administration (FMCSA). Using the existing NASS infrastructure is a cost-effective approach to achieve national representation of the data. The NMVCCS also used the existing NASS infrastructure to collect information about the events and factors that possibly contributed to the crash.

The objective of NMVCCS was to collect on-scene information on the events and associated factors leading up to crashes that involve light vehicles. This information will facilitate the statistical and clinical analyses that would help identify, develop, and evaluate current and emerging crash avoidance technologies for the improvement of highway safety.

The purpose of this report is to describe the events and factors leading up to a crash, based on recent snapshots of data collected in NMVCCS. Of particular interest are the statistics related to the driver, vehicle, roadway, and environment that often play a role in the crash.

3. Scope of NMVCCS

Like any well-designed sample, NMVCCS had strict guidelines for a crash to qualify for an on-scene investigation. First, only crashes occurring between 6 a.m. and midnight were considered for possible investigation. In order to facilitate the timely collection of on-scene crash data, a determination had to be made by the NMVCCS researcher as to whether a crash qualified to be investigated. Taking into consideration the operational and statistical issues, NHTSA set the following criteria that a crash must meet in order to qualify for an investigation:

- The crash must have resulted in a harmful event associated with a vehicle in transport on a trafficway.
- EMS must have been dispatched to the crash scene.
- At least one of the first three crash-involved vehicles must be present at the crash scene when the NMVCCS researcher arrives.
- The police must be present at the scene of the crash when the NMVCCS researcher arrives.
- At least one of the first three vehicles involved in the crash must be a light passenger vehicle that was towed or will be towed due to damage.
- A completed police accident report for this crash must be available.

The priority at the scene of the crash was to conduct interviews of people involved in the crash, as well as witnesses and surrogates for the drivers who could not be interviewed due to injuries or other reasons. The objective of the interview was to obtain information about the driver's perception of the pre-crash event environment and the events leading up to the crash, as well as crash configuration and any crash avoidance actions taken. Questions were related to the driving trip, emotional state, fatigue, driving experience, vehicle-related factors, and factors related to the roadway and environment. Vehicle assessment and evaluation of the roadway infrastructure and conditions were performed where necessary. Driver-related data including distractions and recognition or decision errors were documented.

4. Sample Design, Sample Size, and Case Weights

A multistage probability sample design was used to acquire a nationally representative sample of crashes. The probability of crash occurrence was taken into account by considering both the geographic location and day/time of the crash. This resulted into a two-dimensional sampling frame. While this frame was fixed in terms of the geographical area, day and time were dynamically overlaid on these areas.

4.1 Sample Design

Using this sampling frame, crash selection for possible NMVCCS investigation was done in four stages:

- In Stage I, a primary sampling unit (PSU) is selected from a stratum of PSUs that is based on the geographical area and urbanization type across the entire United States. In fact, in order to use the NASS infrastructure, the same set of PSUs was selected as in the Crashworthiness Data System of NASS.

- In Stage II, a time interval is selected during which the researchers in the selected PSU monitor the EMS/police radio frequencies to be able to reach the crash scene before it is cleared. The selection at this stage is done according to the sampling procedure, “systematic probability proportional to size,” where the size is the number of crashes that occurred during the same time interval in the previous year.

- In Stage III, a day of the week is selected from the selected time interval during which the researchers in the PSU responded to crashes. This selection used the same procedure as Stage II, though the size was the number of crashes that occurred on the same day in the previous year.

- In Stage IV, a crash is selected. Once a time interval and day of the week combination (time block) is selected, the researcher responds to every crash during this time block until a crash occurs that satisfies the NMVCCS criteria listed in Section 3.

Due to operational issues, some local adjustments were made in certain PSUs. Similarly, in order to handle special situations, such as larger volume of transmissions or very large geographical area in a PSU, sub-sampling was implemented in certain PSUs. For a more detailed description of the sampling procedure used in NMVCCS, please refer to the NHTSA technical report[1] on the NMVCCS sample design.

4.2 Sample Size

Based on the sample design detailed above, NMVCCS collected data on a total of 6,950 crashes over a span of 13,019 time blocks during a two-and-a-half-year period, July 3, 2005, to December 31, 2007. The estimates presented in this report are based on a sample of 5,471 investigated crashes that meet the criteria for estimation.

4.3 Case Weights for National Estimates

To make the NMVCCS sample representative of all similar types of crashes for the whole of the United States, each of the 5,471 investigated crashes has been assigned a certain weight based on the sample design used in this survey. This is done by taking into account the probability of selecting a crash through the four stages of the sample design, given by

Prob (Crash selection) = *Prob* (Selection of PSU)
x *Prob* (Selection of sub-sampling unit in some PSUs)
x *Prob* (Selection of time strip, i.e., time interval of day)
x *Prob* (Selection of days of week within the selected time strip)
x *Prob* (Selection of a crash within the selected time block),

where *Prob* stands for *Probability* and the symbol x for the algebraic operation of multiplication. The final case (crash) weights are calculated by taking the reciprocal of the probability of crash selection.

National estimates of crashes for this survey population can be obtained by using the weights assigned to the sampled crashes. In this complex sample design involving stratification, clustering, and missing adjustments, a computer-intensive variance estimation method[2] available in the SAS[3] software package can be used to compute the standard errors of the estimates.

[1] Choi, Eun-Ha, et. al. (2008) A Sampling Design Used in the National Motor Vehicle Crash Causation Survey, DOT HS 810 930, April 2008. Washington, DC: National Highway Traffic Safety Administration.

[2] Lohr, S. L., *Sampling*: *Design and Analysis*. Duxbury Press, 1999

[3] *SAS/STAT 9.1 User's Guide*, SAS Institute Inc., Cary, NC. 2004, pp. 4,185-4,240

5. NMVCCS Data

Like the Large Truck Crash Causation Study, much of the same information is targeted in NMVCCS that was collected in the Indiana Tri-Level Study. However, this survey differs from these two studies in certain respects. The Tri-Level Study lacked national representation and the data collected were mainly meant for clinical investigation. NMVCCS data, on the other hand, embodies a nationally representative sample of crashes that can be used for both analysis and clinical investigation. Similarly, the LTCCS data is restricted to large trucks while the NMVCCS data pertains to light vehicles that constitute a considerably larger proportion of the U.S. vehicle fleet.

5.1 Data Collection Methodology

The NMVCCS collected comprehensive and detailed information on a large number of variables related to vehicle, drivers, roadways, and environment. For that reason, field researchers took extensive training in the identification, collection, and documentation of the relevant pre-crash information. In addition, every effort was taken to prevent loss of information that could shed light on the pre-crash environment of a crash.

NHTSA's past experience in data collection has shown that the availability of crash data often diminishes with the passage of time. For example, when the case investigation is initiated a day or more later, vehicles towed from the scene are more difficult to locate. Even if located, the vehicles may have been altered from their immediate post-crash condition. Similarly, disappearance of evidence from the scene results in a considerable loss of information on events and factors leading up to a crash. Most important, with the passage of time a driver's memory of events may fade and willingness to cooperate with the researcher may diminish, too. Once away from the scene, the individuals involved in the crash are likely to rethink the events and possibly alter them. This makes it difficult to obtain an untarnished account of events. It is, therefore, imperative that the crash investigation begin as quickly as possible. Keeping these facts in view, every effort was made for the timely arrival of the NMVCCS researcher at the crash scene. These researchers constantly monitored crash occurrences and coordinated with EMS and police.

Once at the crash scene, the researcher confirms if the crash satisfies the NMVCCS crash qualification criteria listed in Section 3. The subsequent crash investigation aims at acquiring the targeted information from all possible sources: the crash scene, police, drivers or surrogates of the drivers, passengers, vehicles, and witnesses. The priority at the crash scene is to conduct interviews of crash participants as well as surrogates of the drivers who, due to injuries or other reasons, cannot be interviewed. The targeted information is collected using a set of field forms and a portable computer.

5.2 Information Collected in NMVCCS

NMVCCS adopted the approach proposed by Perchonok[4] (1972). Accordingly, a crash in this survey is considered as a simplified linear chain of events ending with the critical event that precedes the "first harmful event" (i.e., the first event during the crash occurrence that caused injury or property damage.) The researcher made an assessment of the crash based on this concept of the causal chain. Drivers were interviewed to obtain information about the drivers' perception of the pre-crash event environment and the events leading up to the crash. The targeted information was captured mainly through four data elements: critical pre-crash event, movement prior to critical crash envelope, critical reason for the critical pre-crash event, and the crash-associated factors. Among these elements, the critical pre-crash event documents the circumstance that led to this vehicle's first impact in the crash sequence. This element identifies the event that made the crash imminent and is coded for each of the first three in-transport vehicles involved in the crash. The movement prior to critical crash envelope refers to movement of the vehicle immediately before the occurrence of the critical event. The critical reason is the immediate reason for the critical event and is often the last failure in the causal chain (i.e., closest in time to the critical pre-crash event.) The critical reason can be attributed to the driver, vehicle, roadway, or atmospheric condition. To give a few examples, this may be a critical reason attributed to:

- Driver (e. g., distraction, driving too fast, panic, etc.)
- Vehicle (e.g., tires/wheels, brakes, etc.)
- Roadway (e.g., roadway geometry, wet or slick road surface, etc.)
- Atmospheric condition (e.g., rain, snow, glare, etc.)

In addition to the critical pre-crash event, movement prior to critical crash envelope, and the critical reason underlying the critical event, the researcher documented the presence of other factors associated with the crash.

Identifying a critical pre-crash event and the critical reason(s) underlying that critical event is integral to the information sought in this survey. However, the critical event, the critical reason underlying the critical event, or the associated factors should not be interpreted as the cause of the crash.

NMVCCS data span a set of at least 600 variables or factors related to drivers, vehicles, roadways, and environment. The NMVCCS researchers collected information that includes crash narratives, photographs, schematic diagrams, vehicle information, as well as data from the event data recorder

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[4] Perchonok, K. "Accident Cause Analysis," Cornell Aeronautical Laboratory, Inc., July 1972.

(EDR) whenever available. During the investigation, several factors present in the crash were identified and listed. The researchers ensured the facts were recorded as precisely as possible, but made no judgment as to whether or not a factor contributed to the crash.

5.3 NMVCCS Crash Investigation, Coding, and Crash Avoidance Technologies – Some Case Examples

Four case studies are presented in this section to illustrate NMVCCS crash assessment and coding and provide examples of vehicle-, environment-, and driver-related factors. Potential crash avoidance technologies and countermeasures that might have prevented the crash or mitigated its severity are also presented in the case studies – guidance that was not provided by the on-scene researchers but was made by NHTSA's evaluation of the cases.

An extensive set of data has been collected; it includes on-scene photographs of the crash, including vehicles and the scene evidence. A detailed database with much more information than presented below is being populated. Data collected includes a summary narrative of the crash, a detailed scaled scene diagram, and information on crash events. Also included are vehicle descriptions including tire, glazing, and equipment information, the EDR data (if available), rollover data, and collision damage information. Information on the roadway environment has also been collected including weather and traffic control device information. Detailed driver information including health, driver training, vehicle and road familiarity, drug (prescription and others) presence, blood alcohol concentration, sleep and work patterns, and distractions have been documented. The pre-crash movements of the vehicles are described. Basic information on all people including vehicle occupants and involved pedestrians and bicyclists are also included.

More case examples illustrating driver medications and interior distraction, driver cell phone distraction and inexperience, and driver view obstruction are presented in Appendix A.

<u>NMVCCS Case Example 1: Illustrating vehicle deficiency</u>

<u>Case description:</u>
This crash involving a 1997 Isuzu Hombre pickup truck and a 2002 Ford Windstar minivan occurred in the early afternoon on a weekday under rainy and overcast conditions. The location was the southbound lanes of an urban highway that curved left and was divided by a concrete barrier wall. The highway narrowed from four lanes to three as it transitioned from a 5-percent downgrade 120 meters pre-crash to a 9-percent uphill grade 35 meters pre-crash.

The Isuzu pickup was traveling in the center lane attempting to pass the minivan, which was in the left lane. When the 26-year-old female driver of the pickup downshifted and tried to accelerate past the minivan, she lost control. The pickup rotated and crossed in front of the minivan before striking the concrete barrier wall with its rear bumper. It then ricocheted back into the travel lanes where it struck the minivan in the left door.

The Isuzu pickup truck's two rear tires had only 1/32 inch of tread depth. The driver stated that as she overtook the other vehicle she felt the rear end "slip." Other associated factors were wet roads, rain, and an inappropriate/unsuccessful evasive action by the driver. The critical event was "this vehicle lost control due to traveling too fast for the conditions." The critical reason for the event was "too fast for conditions specified as heavy rain."

The Ford minivan also had associated factors that included the wet roads and rain. The driver was taking prescription medications for depression and conversing with the passenger at the time of the crash.

NMVCCS coding:
Having collected the targeted information from the available sources and done the necessary crash assessment, this case was coded as shown in Table 1.

Table 1. NMVCCS Coding of the Case Illustrating Vehicle Deficiency

Coded variable	Vehicle 1	Vehicle 2
Vehicle Type	Pickup truck	Minivan
Driver	25-year-old female	43-year-old female
Crash-Associated Factors	Tire/wheel deficiency Wet roads, raining Inappropriate/unsuccessful evasive action	Wet roads, raining Conversation with passenger Medications
Critical Pre-Crash Event	This vehicle control loss due to traveling too fast for conditions	Not involved in first harmful event
Critical Reason for the Critical Event	Driver decision error: too fast for conditions	Not coded to this vehicle

NMVCCS Case Example 2: Illustrating headlight glare and gap/speed misjudgment

Case description:
The crash occurred at a straight and level four-way intersection controlled by a traffic signal. The environmental conditions were dark but the streetlights were illuminated. A 1995 Ford Taurus traveling eastbound attempted to turn left at the intersection across the path of a 1998 Honda Accord going westbound straight through the intersection.

The 46-year-old female who was driving the Ford said it appeared to her as if she had time to make the turn even though her view of the other vehicle was obscured by headlight glare from oncoming traffic. The critical reason for the event was a misjudgment of the gap between the vehicles or other vehicle's speed. The Honda was driven by a 39-year-old male, who assumed the other vehicle would stop. He was conversing with a passenger just before the crash.

NMVCCS coding:
Having collected the targeted information from the available sources and done the necessary crash assessment, this case was coded as shown in Table 2.

Table 2. NMVCCS Coding of the Case Illustrating Glare and Gap/Speed Misjudgment		
Coded variable	Vehicle 1	Vehicle 2
Vehicle Type	Passenger car	Passenger car
Driver	46-year-old female	39-year-old male
Crash-Associated Factors	Headlight glare Misjudgment of gap and velocity of other vehicle	Conversation with passenger False assumption
Critical Pre-Crash Event	This vehicle turning left at intersection	Other vehicle encroaching from opposite direction over left lane line
Critical Reason for the Critical Event	Driver decision error: misjudgment of gap or other's speed	Not coded to this vehicle

NMVCCS Case Example 3: Illustrating driver emotional factors, fatigue, and vehicle/road unfamiliarity

Case description:
A constant rain made the roadway wet with puddles, causing a slow traffic flow on a rural expressway. A 2004 Chevrolet Trailblazer EXT was northbound in the middle of three lanes negotiating a curve when the vehicle began to rotate counterclockwise. The driver of this vehicle attempted to regain control by counter-steering but was unsuccessful. The vehicle departed the roadway to the left side and its right wheels contacted the soft mud surface adjacent to the paved shoulder resulting in a rollover. The vehicle completed 9 quarter-turns before finally coming to rest on its right side approximately 48 meters from the initial trip point.

The driver, a 22-year-old female, had just flown into town to be part of her mother's wedding the following weekend. The driver stated that her brother had been a runaway for the past three weeks, and the family was extremely concerned. When the driver arrived in town and went to her mother's home, the police department had recently located the brother and was holding him in police custody until someone could pick him up.

The driver took a friend with her for the three-hour trip to the police department, where they picked up the brother and were on their way back to the mother's residence when the crash occurred. It was determined that the driver spent 14 of the last 24 hours either in an airport or on an airplane where she attempted to sleep. She claimed that at the time of the crash she was not tired, but did have many issues on her mind. The vehicle was equipped with all-wheel drive/ four-wheel drive, but the driver elected to operate in two-wheel drive mode.

NMVCCS coding:
Having collected the targeted information from the available sources and made the necessary crash assessment, this case was coded as shown in Table 3.

Table 3. NMVCCS Coding of the Case Illustrating Driver Emotional Factors, Fatigue, and Vehicle/Road Unfamiliarity	
Coded variable	Vehicle 1
Vehicle Type	SUV
Driver	22-year-old female
Crash-Associated Factors	Emotional factor Fatigued Vehicle inexperience Unfamiliarity with roadway Wet road, raining Vehicle in 2WD mode Inattention Interior distraction Performance error
Critical Pre-Crash Event	This vehicle control loss due to traveling too fast for conditions
Critical Reason for the Critical Event	Driver decision error: too fast for conditions

<u>NMVCCS Case Example 4: Illustrating roadway-related factor</u>

<u>Case description:</u>
The crash occurred at a four-way intersection on a weekday afternoon commute with dry roads and clear skies. Each of the roads was straight and level with three lanes. A 2000 Ford Mustang was traveling southbound approaching a stop sign that controlled access to the intersection. Traveling eastbound was a 2006 Honda Pilot that had no traffic controls. The front of the Ford struck the left side of the Honda in the middle of the intersection.

A 63-year-old female was driving the Ford and didn't see the stop sign as she approached the intersection because it was completely covered by overgrown tree leaves and branches. The driver insisted that she looked for a traffic signal or stop sign but, not seeing one, proceeded forward. She was on her way home from work, but normally took a different route that she was more familiar with. The critical event was "this vehicle passing through intersection." The critical reason for this event was a highway-related factor, "sign erroneous/defective." The driver was also thinking about an appointment later that evening.

<u>NMVCCS coding</u>**:**
Having collected the targeted information from the on-scene available sources and done necessary crash assessment, this case was coded as shown in Table 4.

Table 4. NMVCCS Coding of the Case Illustrating Roadway-Related Factors		
Coded variable	Vehicle 1	Vehicle 2
Vehicle Type	Passenger car	SUV
Driver	63-year-old female	74-year-old female
Crash-Associated Factors	Roadway factor Unfamiliarity with roadway Inattention	None
Critical Pre-crash Event	This vehicle passing through intersection	Other vehicle encroaching from crossing street across
Critical Reason for the Critical Event	Roadway related factor: signs erroneous/defective	Not coded to this vehicle

Three additional examples are presented in Appendix A to illustrate crash assessment and coding of NMVCCS crashes related to medication, interior and cell phone distraction, inexperience, and view obstruction.

5.4 Data Quality Control

To effectively use the information collected in NMVCCS, it is necessary to conduct appropriate analyses using error-free data. However, at the time of data collection and compilation, errors are likely through many sources, such as human errors in recording, translation mismatches between the electronic application and the database, etc.

To ensure that the NMVCCS data is correct and logical, several quality control checks have been applied at different stages of data compilation. Prior to the data entry, each case (investigated crash) was reviewed by the assigned researcher and then by another trained team member. Computer-generated edit checks were applied when the data was entered into the automated application. These checks are primarily meant to ensure that all data points lie within their respective plausible ranges. Additional edit checks were then run to ensure the validity and consistency of the data by verifying the relationships among different variables. Based on these checks, the data points were either rejected or subjected to further verification and approval. Subsequently, the NMVCCS cases were reviewed at one of the two NASS Zone Centers. These centers oversee the field data collection operation of the crash research teams, maintenance of the field research quality, technical guidance for each NASS PSU, and serve as resource centers providing the teams with expert technical guidance in crash investigation. The Zone Centers closely monitored the performance and productivity of each NMVCCS PSU under close supervision by NHTSA to ensure that the researchers interpreted the data correctly and accurately, and that all variables have been coded and the flagged inconsistencies have been resolved.

5.5 Use of the NMVCCS Data and Its Limitations

The items necessary for data collection in NMVCCS were identified using various studies and resources. Thus, the data resulting from this survey contain abundant information that can provide in-depth knowledge about the causal chain of crashes: movement prior to critical crash envelope, critical pre-crash event, and critical reason for the critical pre-crash event. However, the data has certain limitations in terms of the sample size, data usage, and interpretation of results.

The NMVCCS data embodies pre-crash assessment of crashes in terms of the critical event, critical reasons, and associated factors. However, none of these is suggestive of the cause of the crash or an assignment of the fault to the driver, vehicle, or environment. Therefore, care needs to be taken in interpreting the results of the exploratory and descriptive analyses of the data or of the clinical investigation. Also, as in any survey, national estimates obtained from the NMVCCS data is subject to sampling errors, as these estimates are based on a sample rather than on a census. NMVCCS only collects data on crashes that meet certain criteria. For this reason, estimates obtained from NMVCCS should not be compared with those from other databases such as NHTSA's General Estimates System (GES) or the NASS CDS.

The NMVCCS data is best suited for analyses directed toward answering questions related to crash risk assessment, identification of possible crash contributing factors, etc., and not merely estimating rates. It is important to note that data covering a period of two and a half years (July 3, 2005, to December 31, 2007) has been weighted and is best suited for statistical analysis, whereas the first six months (January 1, 2005, to July 2, 2005) of data has not been weighted but can be used for clinical studies. Last but not least, caution needs to be used in analysis and interpretation of results that use the data of subjective nature.

The file containing the NMVCCS data will be released to the public around the end of September 2008. This file is expected to contain approximately 6,950 crashes. The crash count in the file will differ from that in this report in that the public-use file will also contain crashes from the initial six months between January 1, 2005, to July 2, 2005, that were not used in this study. The survey was being phased in during this initial period across the sampling frame and hence the sampled crashes are not considered to be nationally representative. Also, crashes that were selected for investigation but did not qualify for the estimation process will be included in the file. These cases will be assigned a zero weight and are intended for use in clinical reviews of cases only. Analysts seeking to replicate the estimates in this report should use the crashes that will be appropriately tagged in the public-use file.

The data used in this report came from crashes sampled during the two-and-a-half-year period from July 2005 through December 2007, which is still being run through the final stages of quality control at the time of this report. Data, compiled as of April 30, 2008, was used in this report. Minor changes might occur to these data between now and the time the data are released to the public due to the various checks being performed on the data. For this reason, those looking to replicate the estimates in this report with the data to be released later this year might observe marginal discrepancies.

6. Highlights Based on the NMVCCS Data

A total of 5,471 crashes investigated during the period July 3, 2005, to December 31, 2007, have been used as a sample to obtain national estimates reported in this section. The statistics about some crash characteristics are presented in Table 5(a) through Table 5(g), while Table 6 through Table 13 present statistics related to the pre-crash assessment of crashes and the associated factors.

These tables show the unweighted frequencies and the corresponding national estimates, for the two-and-a-half year period, that are weighted frequencies and percentages of the crashes, people, vehicles, roadways, and environmental conditions. The weighted frequencies and the corresponding percentages have been obtained by using case weights described in Section 4. The national estimates are subject to sampling errors as they are based on a sample rather than a census. In addition, it should be noted that the coding for some of the variables is based on multiple choices. Thus, the totals presented for such variables may not match the actual totals of crashes, vehicles, or drivers. For the same reason, the percentages in some of the tables may not add up to 100 percent.

An explanation of the variable attributes used in this section can be found in the NMVCCS coding manual that will be available when the data are released.

6.1 Crash-, People-, Vehicle-, Roadway-, and Environment-Related Summary Statistics

Based on the weights attached to a sample of 5,471 crashes, at the national level, this sample represented an estimated 2,189,166 crashes, involving 3,943,244 drivers and 4,031,226 vehicles. The corresponding coefficients of variation of these estimates are 14.9, 13.9, and 13.6 percent, respectively. In NMVCCS, the targeted information is collected only on the first three vehicles that are referred to as case vehicles. Of the estimated total number 4,031,226 of vehicles involved in 2,189,166 crashes, 3,894,983 are treated as case vehicles.

Crash-related statistics

Table 5(a) shows the breakdown of the 5,471 crashes by the number of vehicles involved in the crash and the corresponding national estimates, as well as the weighted percentages. While a majority (57.2%) of the crashes involved two case vehicles, about 31 percent involved a single case vehicle and a comparatively smaller percentage (12.0%) involved three or more vehicles.

Table 5(a). Crashes by Number of Vehicles Involved in a Crash

Number of Vehicles in the Crash	Number of Crashes		Weighted Percentage
	Unweighted	Weighted	
Single vehicle	1,444	674,313	30.8%
Two vehicles	3,230	1,252,220	57.2%
Three or more vehicles	797	262,633	12.0%
Total	5,471	2,189,166	100%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

The breakdown of crashes by crash configurations (i.e., the orientations of case vehicles with respect to the trafficway in the first crash event) is presented in Table 5(b). At the national level, about 33 percent of the crashes were single-vehicle crashes. In about 27 percent of the crashes, the crash configuration was change of trafficway or vehicle turning; and in about 21 percent of the crashes,

Table 5(b). Crashes by Crash Configuration

Crash Configuration	Number of Crashes		Weighted percentage
	Unweighted	Weighted	
Single-vehicle events†	1,569	713,272	32.6%
Change trafficway, vehicle turning	1,526	584,775	26.7%
Same trafficway, same direction	1,212	458,018	20.9%
Intersecting straight paths	788	261,410	11.9%
Same trafficway, opposite direction	242	119,948	5.5%
Miscellaneous (U-turn, etc.)	134	51,742	2.4%
Total	5,471	2,189,166	100%

†Estimates differ from those in Table 5(a) as these are based on the first harmful event in the crash.
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

the vehicles were traveling in the same trafficway and same direction. About 12 percent of the crashes occurred on the intersecting straight paths, and a much smaller percentage (5.5%) of crashes occurred with vehicles in the same trafficway but opposite direction.

People-related statistics

Table 5 (c) shows the breakdown of crash-involved people, based on their role. The statistics in this table show that among the estimated 5,933,373 people involved in a period of two and a half years, about 67 percent were drivers and 33 percent were passengers.

Table 5(c). People Involved in Crashes by Role of Occupant

Role	People Involved in Crashes		Weighted Percentage
	Unweighted	Weighted	
Drivers	10,234	3,943,244	66.5%
Passengers	5,282	1,984,921	33.5%
Unknown	2	1,880	~ 0.0%
Total	15,518	5,933,373	100%

~ 0.0: percentage close to zero
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Vehicle-related statistics

Table 5(d) shows breakdown of crash-involved vehicles, based on their body type, such as passenger car, SUV, etc. The statistics in this table show that among the estimated 4,031,226 vehicles, most (56.7%) were passenger cars, followed by SUVs (18.8%). Light trucks and vans made up smaller percentages, about 13 and 7 percent, respectively.

Table 5(d). Vehicles Involved in Crashes by Vehicle Body Type			
Vehicle Body Type	**Number of Vehicles Involved in Crashes**		**Weighted Percentage**
	Unweighted	Weighted	
Passenger cars	5,982	2,285,392	56.7%
SUVs	1,899	759,493	18.8%
Light trucks	1,384	535,578	13.3%
Vans	830	292,577	7.3%
Other body types	399	158,186	3.9%
Total	10,494	4,031,226	100%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Roadway-related statistics

Table 5(e) shows break down of case vehicles, based on the number of travel lanes and trafficway flow. The statistics in this table show that of the estimated 3,894,983 case vehicles, about 52 percent were involved in crashes on roadways with three or more lanes, about 46 percent on roadways with two lanes, and a very small percentage (2.6%) in single-lane crashes. Similarly, about 62 percent of all case vehicles were on trafficways that were not physically divided, 34 percent were on divided trafficways, and a small percentage (4.9%) on one-way trafficway.

Table 5(e). Case Vehicles by Number of Travel Lanes and Trafficway Flow			
Number of Travel Lanes	**Number of Case Vehicles**		**Weighted Percentage**
	Unweighted	Weighted	
Single lane	262	101,888	2.6%
Two lanes	3,884	1,772,805	45.5%
Three or more lanes	5,938	2,020,290	51.9%
Total	10,084	3,894,983	100%
Trafficway Flow	**Number of Case Vehicles**		**Weighted Percentage**
	Unweighted	Weighted	
One-way traffic	644	192,230	4.9%
Not physically divided	5,991	2,393,662	61.5%
Divided trafficway	3,449	1,309,091	33.6%
Total	10,084	3,894,983	100%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008.

Atmospheric condition-related statistics

More than one atmospheric condition might have been coded for some crashes, while in the case of natural lighting condition only one condition per crash has been coded. As a result, the totals in Table 5(f) will be larger than the totals in Table 5(g). Table 5(f) presenting breakdown of crashes based on atmospheric conditions shows that most (74%) of the crashes occurred in clear weather, about 18 percent when it was cloudy, and about 9 percent in rainy conditions.

Table 5(f). Crashes by Atmospheric Conditions (Based on multiple choices per crash)			
Atmospheric Condition	**Number of Crashes**		**Weighted Percentage**
	Unweighted	Weighted	
Clear	4,125	1,619,002	74.0%
Cloudy	962	389,050	17.8%
Rainy	482	204,681	9.3%
Snow/sleet	103	60,045	2.7%
Other weather conditions	64	31,749	1.5%
Unknown	3	286	~ 0.0%
Total	5,739	2,304,813	105.3%†

~ 0.0: percentage close to zero
† percentage greater than 100, due to multiple choice
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Table 5(g) presents a breakdown of crashes by natural lighting condition. The statistics in this table show that a majority (71%) of the crashes occurred in daylight. About 13 percent of the crashes occurred in dark conditions, and about 10 percent occurred when it was dark but lighted. The low percentage of crashes occurring at dawn or dark could be attributed to the fact that the NMVCCS sample only covered crashes occurring between 6 a.m. and midnight.

Table 5(g). Crashes by Natural Lighting Conditions			
Natural Lighting Condition	**Number of Crashes**		**Weighted Percentage**
	Unweighted	Weighted	
Daylight	4,101	1,554,348	71.0%
Dark	430	279,219	12.8%
Dark but lighted	658	223,635	10.2%
Dawn	127	74,515	3.4%
Dusk	153	56,880	2.6%
Unknown	2	569	~ 0.0%
Total	5,471	2,189,166	100%

~ 0.0: percentage close to zero
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

6.2 Injury Severity of the Crash-Involved Drivers

In NMVCCS, injury severity is coded according to the injury-coding scheme used in the police accident reports. This coding is referred to as “KABCOU,” defining six injury levels as shown in Table 6, where “K” stands for killed, “A” for incapacitating injury, “B” for non-incapacitating injury, “C” for possible injury, “O” for no injury, and “U” for injury severity unknown. This table shows the percent (weighted) frequency distribution of male and female drivers by gender, age, and injury severity. The corresponding frequencies and the weighted frequencies are presented in Table B1 and Table B2 in Appendix B. The statistics in Table 6 show that out of the estimated 3,043,244 drivers involved in crashes, about 54 percent were male and about 45 percent were female. Additionally, of all the age groups, the young drivers (16 to 25 years old) had the highest crash involvement with about 15 percent males and about 14 percent females. Of all the crash involved drivers, the highest percentage (21.9%) was of the drivers who suffered possible injuries. The percentage of drivers with non-incapacitating injury (14%) was larger than that of the drivers with incapacitating injury (10.5%). Of the 0.8 percent drivers killed in crashes, 0.6 percent drivers were male and 0.2 percent females.

Table 6. Weighted Percentage of Crash-Involved Drivers by Gender, Age, and Police-Reported Injury Severity (KABCOU)

Gender	Age	Injury Severity (KABCOU)						Unknown injury status	Total
		Killed (K)	Incapacitating injury (A)	Nonincapacitating injury (B)	Possible injury (C)	No injury (O)	Injury severity unknown (U)		
Male	Under 16	*	~0.0%	~0.0%	~0.0%	0.1%	*	*	0.1%
	16-25	0.1%	1.2%	2.1%	3.0%	8.3%	0.30%	0.1%	15.1%
	26-35	0.1%	0.9%	1.2%	2.1%	6.2%	0.10%	0.0%	10.6%
	36-45	0.1%	1.0%	1.1%	1.6%	5.5%	0.20%	0.0%	9.5%
	46-55	0.1%	0.8%	1.0%	1.3%	4.7%	0.20%	0.1%	8.2%
	56-65	~0.0%	0.4%	0.6%	1.1%	2.4%	0.10%	~0.0%	4.6%
	Over 65	0.2%	0.5%	0.8%	1.1%	2.5%	0.10%	~0.0%	5.1%
	Unknown	*	~0.0%	~0.0%	~0.0%	0.1%	~0.0%	0.5%	0.7%
	Subtotal	0.6%	4.8%	6.7%	10.2%	29.7%	1.00%	0.8%	53.9%
Female	Under 16	*	*	~0.0%	~0.0%	~0.0%	*	*	0.1%
	16-25	0.1%	1.8%	2.2%	3.5%	6.2%	0.40%	0.1%	14.3%
	26-35	~0.0%	1.3%	1.7%	2.5%	4.2%	0.40%	0.1%	10.2%
	36-45	~0.0%	1.0%	1.3%	2.1%	2.7%	0.20%	0.1%	7.4%
	46-55	~0.0%	0.8%	0.8%	1.4%	2.2%	0.30%	~0.0%	5.5%
	56-65	~0.0%	0.4%	0.5%	1.1%	1.7%	0.20%	~0.0%	4.0%
	Over 65	~0.0%	0.3%	0.8%	0.9%	1.2%	0.10%	~0.0%	3.4%
	Unknown	*	*	~0.0%	0.1%	0.1%	~0.0%	~0.0%	0.2%
	Subtotal	0.2%	5.7%	7.3%	11.7%	18.4%	1.60%	0.3%	45.1%
Unknown		*	*	*	*	0.1%	~0.0%	0.8%	1.0%
Total		0.8%	10.5%	14.0%	21.9%	48.2%	1.90%	2.60%	100%

* Sample size 0
~ 0.0: percentage close to zero
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

6.3 Pre-Crash Assessment

In NMVCCS, the information is collected by following a causal chain with three elements: “movement prior to critical crash envelope,” “critical pre-crash event,” and “critical reason for the critical pre-crash event.” Both the movement prior to critical crash envelope and the critical pre-crash event refer to the vehicles that are assigned critical reason (i.e., the immediate reason that made the crash imminent). However, none of these may necessarily reflect the cause of the crash. The following results and discussion pertain to these three pre-crash assessment parameters.

6.4 Movement Prior To Critical Crash Envelope

The movement prior to critical crash envelope of a vehicle defines its movement immediately before the occurrence of the critical event that made the crash imminent. Table 7 presents the frequency distribution of the movement prior to critical crash envelope of vehicles that were assigned a critical reason. The statistics in this table show that in about 46 percent of the estimated 2,189,166 crashes, the vehicles were going straight prior to the occurrence of critical pre-crash event. The other types of prominent types of movement prior to critical crash envelope included negotiating a curve (21.0%) and stopped in the traffic lane (16.0%). While no vehicle was coded as entering a parking position, in about 0.5 percent of the crashes, the vehicles were involved when leaving a parking position. Also, turning left was a more common (1.7%) movement prior to critical crash envelope as compared to turning right (0.6%).

Table 7. Movement Prior to Critical Crash Envelope of Vehicles With Critical Reason

Movement prior to critical crash envelope	Number of Crashes		Weighted Percentage
	Unweighted	Weighted	
Going straight	2,675	1,014,835	46.4%
Negotiating a curve	883	459,920	21.0%
Stopped in traffic lane	869	349,627	16.0%
Decelerating in traffic lane	238	96,329	4.4%
Avoidance maneuver to a previous critical event	182	64,923	3.0%
Changing lanes	145	46,426	2.1%
Turning left	122	36,757	1.7%
Accelerating in traffic lane	95	31,693	1.4%
Passing or overtaking another vehicle	58	22,352	1.0%
Turning right	37	13,189	0.6%
Starting in traffic lane	42	12,806	0.6%
Leaving a parking position	32	10,961	0.5%
Merging	18	5,884	0.3%
Backing up (other than for parking position)	11	5,270	0.2%
Making a U-turn	14	4,300	0.2%
Other	10	3,441	0.1%
Unknown (includes driver not present cases)	40	10,451	0.5%
Total	5,471	2,189,166	100%

Estimates may not add up to totals due to independent rounding.

Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

6.5 Critical Pre-Crash Event

The critical pre-crash event refers to the action or the event that puts a vehicle on the course that makes the collision unavoidable, given reasonable driving skills and vehicle handling of the driver. It could be associated with the vehicle that was assigned a critical reason or with one of the other case vehicles. Table 8 presents unweighted and weighted frequencies and weighted percentages of the critical pre-crash events, based on the vehicles with the critical reasons. Of all the critical pre-crash events coded in NMVCCS, about 70 percent were related to vehicle's position in relation to the roadway just prior to the crash, such as turning or crossing at the intersection, off the edge of the road, etc. In about 36 percent of the crashes, the vehicles with critical reason were turning or crossing intersection. This information can be used in the development of the CICAS, which would warn a driver about an imminent violation of the traffic control device at the intersection. Among other such critical events, about 22 percent went off the edge of the road, and about 11 percent were running over the lane line. While the knowledge about the former is valuable in evaluating ESC systems, that of the latter is critical in the development of new lane departure warning systems. Regarding the role of the other case vehicle, in about 12 percent of the crashes the critical reason was the other vehicle stopped prior to the critical pre-crash event, 4.8 percent had the other case vehicle traveling in the same direction, and only a small percentage (0.1) traveling in the opposite direction. In about 9 percent of the crashes, the critical pre-crash event was the loss of vehicle control. This type of information collected on crashes will be beneficial in the development of collision-avoidance/warning systems that warn a driver of possible collisions.

Table 8. Critical Pre-Crash Event of Vehicles with Critical Reasons

Critical Pre-Crash Event		Number of Crashes		Weighted Percentage
		Unweighted	Weighted	
Vehicle traveling	Turning or crossing at intersection	2,185	791,768	36.2%
	Off the edge of the road	1,080	485,518	22.2%
	Over the lane line	583	237,241	10.8%
	Others	33	16,401	0.7%
	Subtotal	3,881	1,530,928	69.9%
Other vehicle in lane	Stopped	643	267,821	12.2%
	Traveling in same direction	312	105,766	4.8%
	Traveling in opposite direction	7	2,510	0.1%
	Others	7	3,005	0.1%
	Subtotal	969	379,102	17.3%
Vehicle control loss	Traveling too fast	195	109,932	5.0%
	Poor road condition	84	43,541	2.0%
	Vehicle problem	68	25,304	1.2%
	Others	41	15,212	0.7%
	Subtotal	388	193,989	8.9%
Other vehicle encroachment	From crossing street	39	11,524	0.5%
	From adjacent lane	33	11,175	0.5%
	From opposite direction	18	6,023	0.3%
	From driveway	5	539	~ 0%
	Subtotal	95	29,261	1.3%
Object or animal		72	30,025	1.4%
Others		61	24,490	1.1%
Unknown		5	1,372	0.1%
Total		5,471	2,189,166	100.0%

~ 0.0: percentage close to zero

Estimates may not add up to totals due to independent rounding.

Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

6.6 Critical Reason for the Critical Pre-Crash Event

The critical reason is the immediate reason for the critical pre-crash event and is often the last failure in the causal chain. The information about these critical reasons as collected in NMVCCS can be useful in evaluating the effectiveness of vehicle-based countermeasures in mitigating the effects of various driver performance, recognition, and decision errors. A critical reason can be attributed to a driver, vehicle, or environment. Normally, one critical reason is assigned per crash and as such, can be subjective in nature. Although the critical reason is an important element in the sequence of events leading up to a crash, it may not be the cause of the crash nor does it imply the assignment of fault to a vehicle, driver, or environment, in particular. The critical reason related statistics are presented in Table 9(a) through Table 9(c). It should be noted that in 110 crashes, due to various reasons, the critical reason could not be determined and hence not assigned to the driver, vehicle, roadway, or environment. Accordingly, the sum total of crashes: 5,096 in Table 9(a), 130 in Table 9(b), and 135 in Table (c) is different from the actual total (5,471) of crashes and so is the case with the totals of the weighted frequencies.

Critical reasons attributed to drivers

The unweighted frequencies, weighted frequencies, and weighted percentages for the driver-related critical reasons, broadly classified into recognition errors, decision errors, performance errors, and nonperformance errors, are presented in Table 9(a). The statistics in this table are based on the crashes in which the critical reason was attributed to the drivers. The term crash in this subsection refers to a crash in which the critical reason was attributed to the driver.

About 41 percent of the driver-related critical reasons were recognition errors that include inattention, internal and external distractions, inadequate surveillance, etc. Of these, the most frequently occurring critical reason was inadequate surveillance that refers to a situation in which a driver failed to look, or looked but did not see, when it was essential to safely complete a vehicle maneuver. This critical reason was assigned to drivers in about 20 percent of crashes. Internal distraction as a critical reason was assigned to drivers in about 11 percent of the crashes.

About 34 percent of the driver-related critical reasons were decision errors that included too fast for conditions (8.4%), too fast for curve (4.9%), false assumption of others' actions (4.5%), illegal maneuver (3.8%), and misjudgment of gap or others' speed (3.2%). In about 10 percent of the crashes, the critical reason was a performance error, such as overcompensation (4.9%), poor directional control (4.7%), etc.

Among the nonperformance errors assigned as critical reasons to drivers in about 7 percent of the crashes, sleep was the most common critical reason (3.2%). The effectiveness of vehicle-based countermeasures used in mitigating the effects of various driver performance, recognition, and decision errors could be evaluated using this information.

Table 9(a). Critical Reasons for Critical Pre-Crash Event Attributed to Drivers				
Critical Reason for Critical Pre-Crash Event		Number of Crashes		Weighted Percentage
		Unweighted	Weighted	
Recognition error	Inadequate surveillance	1,080	414,626	20.3%
	Internal distraction	482	218,548	10.7%
	External distraction	229	77,496	3.8%
	Inattention (i.e., daydreaming, etc.)	194	65,712	3.2%
	Other/unknown recognition error	109	51,926	2.5%
	Subtotal	2,094	828,308	40.6%
Decision error	Too fast for conditions	348	171,604	8.4%
	Too fast for curve	181	100,713	4.9%
	False assumption of other's action	260	92,583	4.5%
	Illegal maneuver	232	78,112	3.8%
	Misjudgment of gap or other's speed	212	65,221	3.2%
	Following too closely	85	30,452	1.5%
	Aggressive driving behavior	99	31,026	1.5%
	Other/unknown decision error	335	125,805	6.2%
	Subtotal	1,752	695,516	34.1%
Performance error	Overcompensation	211	100,090	4.9%
	Poor directional control	249	95,165	4.7%
	Other/unknown performance error	30	7,751	0.4%
	Panic/freezing	20	7,137	0.3%
	Subtotal	510	210,143	10.3%
Non-performance error	Sleep, actually asleep	160	65,141	3.2%
	Heart attack or other physical impairment	133	48,822	2.4%
	Other/unknown critical nonperformance	76	31,881	1.6%
	Subtotal	369	145,844	7.1%
Other/unknown driver error		371	162,132	7.9%
Total		5,096	2,041,943	100%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

<u>Critical reasons attributed to vehicles</u>

The information about critical reasons related to the vehicles is important in evaluating on-board systems that warn the driver about the condition of critical vehicle systems such as tires and brakes. Table 9(b) presents the related statistics, based on the crashes in which the critical reason was attributed to the vehicle. The term crash in this subsection will refer to a crash in which the critical reason was attributed to the vehicle. The most frequently occurring vehicle-related critical reason was tire failure or degradation/wheel failure, which was assigned in about 43 percent of the crashes, followed by brake failure/degradation that was assigned to 25 percent of the vehicles. Steering/suspension/transmission/engine failure as a critical reason was assigned in 10.5 percent of the crashes, while various other vehicle failures/deficiencies were assigned for about 21 percent of the crashes. Various types of tire pressure monitoring systems (TPMS) and other dashboard-warning systems are already in use. These systems provide information on the condition of critical vehicle elements such as brake-system hydraulics, tire pressure and condition, etc. The information about the vehicle-related critical reasons can be used in evaluating these systems.

Table 9(b). Critical Reasons for Critical Pre-Crash Event Attributed to Vehicles			
Critical Reason for Critical Pre-Crash Event	Number of Crashes		Weighted Percentage
	Unweighted	Weighted	
Tires failed or degraded/wheels failed	56	19,320	43.3%
Brakes failed/degraded	39	11,144	25.0%
Other vehicle failure/deficiency	17	9,298	20.8%
Steering/suspension/transmission/engine failed	16	4,669	10.5%
Unknown	2	212	0.5%
Total	130	44,643	100%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 December 31, 2007), NHTSA, compiled as of April 30, 2008

Critical reasons attributed to roadway and atmospheric conditions

Table 9(c) presents statistics related to crashes in which the critical reason was attributed to roadway and atmospheric conditions. The term crash in this subsection will refer to a crash in which the critical reason was attributed to roadway or atmospheric conditions. Among such crashes, about 75 percent were related to roadway conditions, such as slick roads, view obstruction, signs and signals, road design, etc. This consisted of about 50 percent crashes in which the critical reason was attributed to slick roads in contrast with view obstruction that accounted for only 11.6 percent, and signs and signals that accounted for 2.7 percent. In addition, in 8.4 percent of the environment-related crashes, the critical reason was the weather condition, the most frequent (4.4%) being fog/rain/snow. Glare as a critical reason accounted for about 16 percent of the environment-related crashes. This information will help in the development of collision-avoidance systems that adapt to adverse weather and roadway surface conditions.

Table 9(c).Critical Reasons for Critical Pre-Crash Event Attributed to Roadway and Atmospheric Conditions				
Critical Reason for Critical Pre-Crash Event		Number of Crashes		Weighted Percentage
		Unweighted	Weighted	
Roadway	Slick roads (ice, loose debris, etc.)	58	26,350	49.6%
	View obstructions	19	6,107	11.6%
	Signs/signals	5	1,452	2.7%
	Road design	3	745	1.4%
	Other highway-related condition	9	5,190	9.8%
	Subtotal (Roadway)	94	39,844	75.2%
Atmospheric Conditions	Fog/rain/snow	11	2,338	4.4%
	Other weather-related condition	6	2,147	4.0%
	Subtotal (Weather)	17	4,485	8.4%
	Glare	24	8,709	16.4%
Total		135	53,038	100.0%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

6.7 Crash-Associated Factors

A crash-associated factor is the factor that is likely to add to the probability of crash occurrence and can be attributed to any of the crash elements: driver, vehicle, roadway, or environment, or even to a combination of them. As examples, interior non-driving activity and performance error can be associated with the driver; brake failure, tire/wheel deficiency, etc., with the vehicle; and road surface condition, view obstruction, etc., with the roadway. Each of these variables has several associated factors that are coded based on the multiple choices. The statistics presented in this section refer to the first three vehicles involved in a crash, referred to as case vehicles.

<u>Driver-related, crash-associated factors</u>: Interior non-driving activity

The information about driver-related crash-contributing factors can be used in the evaluation and development of crash avoidance, as well as collision warning systems. This can also aid automobile manufacturers design onboard electronics, or "telematics," that reduce the potential for driver inattention.

Table 10 presents the weighted percentage frequency distribution of the drivers of case vehicles by age and the associated factors identified as interior non-driving activities. The corresponding frequencies in Table 10 show that of the estimated 3,894,983 drivers of case vehicles, about 18 percent were engaged in at least one interior non-driving activity. In addition, about 59 percent of the drivers were not engaged in any non-driving activity and in the case of about 23 percent of the drivers, the non-driving activity was unknown.

Table 10. Weighted Percentage of Crash-Involved Drivers of Case Vehicles by Age and Interior Non-Driving Activities (Based on multiple choices per driver)

Age of the Driver	Interior Non-driving Activity						At least one interior non-driving activity
	Looking at movements/ actions of other occupants	Dialing/ hanging up phone	Conversing	Adjusting radio/CD player/ other vehicle controls	Retrieving objects from floor/seat/ other location	Other interior non-driving activities	
Under 16	~ 0.0%	*	~ 0.0%	~ 0.0%	~ 0.0%	*	0.1%
16-25	0.5%	~ 0.0%	4.1%	0.5%	0.9%	1.1%	6.6%
26-35	0.3%	~ 0.0%	2.3%	0.2%	0.3%	0.8%	3.9%
36-45	0.2%	0.1%	1.9%	0.1%	0.2%	0.4%	3.0%
46-55	0.1%	~ 0.0%	1.3%	~ 0.0%	0.1%	0.2%	1.7%
56-65	~ 0.0%	0.1%	0.9%	~ 0.0%	~ 0.0%	0.4%	1.4%
Over 65	0.1%	~ 0.0%	0.8%	*	~ 0.0%	0.1%	1.0%
Unknown	~ 0.0%	*	0.2%	*	~ 0.0%	~ 0.0%	0.2%
Total	1.3%	0.2%	11.6%	0.9%	1.6%	3.0%	17.9%

* Sample size = 0
~ 0.0: percentage close to zero.
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Also, among the drivers of case vehicles, the drivers between ages of 16 to 25 had the highest percentage (6.6%) of being engaged in at least one interior non-driving activity. The percentages of drivers of other age groups who were engaged in at least one interior non-driving activity were comparatively much lower. Conversing on a cell phone or with a passenger was the most frequent interior non-driving activity associated with about 12 percent of the drivers of case vehicles. The highest percentage (4.1%) of the drivers of case vehicles engaged in conversing belonged to the 16-to-25 age group, while only about 2 percent were between ages of 26 to 35 and about 2 percent between ages 36 to 45.

Drivers are also likely to make performance errors. Fatigue is one of the factors likely to cause performance errors. Of the estimated 3,894,983 drivers of case vehicles, about 7 percent were fatigued and about 65 percent were not fatigued. The fatigue status of the rest (28%) was unknown. The estimates of the performance errors as associated factors by the fatigue status of the drivers of case vehicles are presented as weighted percentages in Table 11. The corresponding frequencies and the weighted frequencies are presented in Table B5 and Table B6 in Appendix B. The statistics in Table 11 show that about 23 percent of the drivers were fatigued and made at least one performance error as compared with about 11 percent of the drivers who were not fatigued and made at least one performance error. In fact, by examining the weighted frequencies of the drivers of case vehicles, as highlighted in Table B6 in the appendix, it can be determined that the fatigued drivers are twice as likely to make performance errors as compared to drivers who are not fatigued. Also, about 14 percent of all drivers were fatigued males who made a performance error as compared to 9 percent that were fatigued females who made a performance error. The more common performance errors among fatigued drivers were overcompensation (12.1%) and poor directional control (11.5%), while among nonfatigued drivers poor directional control was the most common (6.5%).

Table 11. Weighted Percentage of Crash-Involved Drivers of Case Vehicles by Fatigue Status, Gender, and Performance Error (Based on multiple choices per driver)

Fatigue Status / Gender		Performance Error				At least one performance error
		Panic or freezing	Over compensation	Poor directional control	Other performance error	
Fatigued	Male	0.9%	8.2%	7.1%	~ 0.0%	14.2%
	Female	0.4%	3.9%	4.5%	0.4%	9.0%
	Total	1.3%	12.1%	11.5%	0.4%	23.2%
Not Fatigued	Male	0.3%	2.2%	3.8%	0.1%	5.7%
	Female	0.5%	2.5%	2.6%	0.1%	5.0%
	Total	0.8%	4.7%	6.5%	0.2%	10.8%
Unknown		0.1%	4.6%	10.8%	0.7%	14.0%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Vehicle-related, crash-associated factors: Vehicle conditions

A breakdown in a vehicle system, such as a tire, wheel, or braking system deficiency, is considered adverse to driving and is likely to increase the risk of a crash. Table 12 presents some statistics of the vehicles with such conditions. Of the estimated 3,894,983 case vehicles, 6.8 percent had at least one adverse condition as compared to 88.2 percent vehicles that had no adverse vehicle condition. In the case of 5 percent, the vehicle condition was unknown. Of all the conditions listed in this table, tire and wheel deficiency had the highest percentage (4.9%) of occurrence. This information can be used in the evaluation of various types of tire pressure monitoring systems (TPMS), as well as other onboard warning systems that provide information on the condition of critical vehicle elements such as brake-system hydraulics, tire pressure and condition, etc. Only 0.6 percent of vehicles had braking system deficiency followed by 0.5 that had view obstruction as the adverse condition. A very small percentage (0.4%) of vehicles had adverse conditions related to the steering or the engine.

Table 12. Crash-Involved Case Vehicles by Vehicle Condition as Crash-Associated Factor (Based on multiple choices per vehicle)

Vehicle-Condition-Related Factors	Number of Case Vehicles		Weighted Percentage
	Unweighted	Weighted	
Tire/wheel deficiency	526	192,277	4.9%
Braking system deficiency	66	25,233	0.6%
View obstruction	44	18,375	0.5%
Steering deficiency	20	7,709	0.2%
Engine deficiency	20	7,347	0.2%
Lighting deficiency	7	3,150	0.1%
Transmission deficiency	15	2,275	0.1%
Suspension deficiency	12	2,743	0.1%
Others	36	18,646	0.5%
At least one adverse vehicle condition	703	262,791	6.8%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

<u>Environment-related, crash-associated factors</u>: Roadway-related factors

Any adverse roadway condition is likely to increase the crash risk. Table 13 shows a list of some of the more commonly observed adverse road conditions together with their unweighted frequencies, weighted frequencies, and the corresponding weighted percentages. This table shows that of the estimated 3,894,983 case vehicles, 16.3 percent vehicles had at least one roadway-related factor, while in the case of 83.6 percent vehicles there was no roadway-related factor. Roadway condition (wet, slick surface, etc.) was the most common (12.2%) condition. Roadway view obstruction due to design, object, or other vehicle was relatively higher (2.1%) than the roadway geometry (1.0%), narrow shoulder or road (0.7%), and traffic sign (0.3%). The roadway-related information can be used in the development of collision-avoidance systems that adapt to adverse weather and roadway surface conditions.

Table 13. Roadway-Related Factors in Crash Involvement of Case Vehicles (Based on multiple choices per vehicle)

Roadway-Related Factors	Number of Case Vehicles		Weighted Percentage
	Unweighted	Weighted	
Roadway condition (wet, slick surface, etc.)	1,148	472,751	12.2%
Roadway view obstruction (design, object, or other vehicle)	265	80,195	2.1%
Roadway geometry	110	39,964	1.0%
Narrow shoulder or road	64	26,810	0.7%
Traffic sign/signal missing	26	10,631	0.3%
Lane delineation problem	16	7,783	0.2%
Other	115	54,918	1.4%
At least one roadway-related factor	1,629	633,392	16.3%

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 –December 31, 2007), NHTSA, compiled as of April 30, 2008

7. Conclusions

The traffic safety community has made significant strides in the crashworthiness of vehicles – the ability of vehicles to protect their occupants during a crash, as well as in the driver's awareness of other safety issues such as the use of seat belts. In order to significantly reduce the high number of highway traffic fatalities and injuries, more needs to be done for primary prevention (i.e., finding ways to prevent crashes by understanding the pre-crash circumstances.) The information that was collected through NMVCCS will aid in the development of vehicle-based crash avoidance technologies to address the myriad of driver-, vehicle-, and environment-related factors associated with crashes.

NMVCCS is the first nationally representative survey of events and associated factors leading up to crashes involving light passenger vehicles. This report presents results from a nationally representative sample of 5,471 crashes investigated during a two and a half year period from July 3, 2005, to December 31, 2007. Each of these crashes has been assigned a weight with the purpose of generating national estimates of the pre-crash events and factors. Being based on the sample, these estimates are subject to sampling errors.

The elements that were collected and coded for each crash represent a linear causal chain, which is a sequence of the movement immediately prior to the crash, the critical pre-crash event, the reason underlying the critical pre-crash event, and other associated factors. Understanding the critical pre-crash events and the reasons underlying the critical pre-crash events is important, as these are essential parameters in the design and evaluation of crash-avoidance technologies. However, these data elements themselves should not be considered as the causes of the crash, but when analyzed with proper statistical methods, they can lead to a better understanding of the causal chain of the crash and reveal possible causes of the crash occurrence.

National estimates generated from the crashes that were sampled show that of all the vehicles assigned a critical reason, about 36 percent were turning or crossing at an intersection just prior to the crash – characterized as the critical pre-crash event. An additional 22 percent of such vehicles ran off the edge of the road, and 11 percent failed to stay in the proper lane. The information pertaining to the crashes at intersections can be used in the design of intersection collision avoidance technologies. The data from run-off-the-road crashes can be beneficial in evaluating the effectiveness of ESC systems. The design of the emerging lane-departure warning systems can be enhanced by analyzing the data pertaining to vehicles that failed to stay in the proper lane.

The critical reason underlying the critical event is assigned by the NMVCCS researcher after on-scene evaluation of the potential problems related to the vehicle, roadway, environment, and driver. This is achieved through prompt investigations, interviews with the drivers, assessment of the vehicle components, and an evaluation of the roadway condition and geometry. Through such multifaceted evaluations, the critical reason for the critical pre-crash event was attributed to the driver in a large proportion of the crashes. Many of these critical reasons included a failure to correctly recognize the situation (recognition errors), poor driving decisions (decision errors), or driver performance errors. The information on such crashes will be greatly beneficial in designing vehicle-based crash avoidance technologies that can address the driver-related critical reasons like distraction and inattention, or loss of control of the vehicle.

Among the critical reasons attributed to drivers, about 41 percent were recognition errors, about 34 percent were decision errors, about 10 percent were performance errors, and about 7 percent were nonperformance errors. About 18 percent of the drivers were involved in at least one nondriving activity, with the majority (about 12%) engaged in conversing either with other passengers or on a cell phone. The effectiveness of emerging crash avoidance technology that use existing vehicle systems such as adaptive cruise control, braking systems, seat belt pretensioners, motorized seats, sunroofs, etc., in mitigating the effects of various driver performance, recognition, and decision errors can be assessed using this information.

The researchers, through their assessment of the vehicles, also assigned critical reasons to the vehicles. In such cases, failure of the tires/wheels was the most frequent vehicle-related critical reason followed by the failure of the braking system. The design and refinement of dashboard warning systems monitoring the status of critical vehicle elements such as the brake system, tire pressure, tread depth, etc., will benefit from such information.

In some cases, the NMVCCS researchers also assigned critical reasons pertaining to the roadway or the environment through an assessment of the roadway design, environmental conditions, and participant interviews. Among such cases, roads slick with ice and other debris was the most frequent roadway-related critical reason, followed by an obstruction to the driver's vision as attributable to flawed highway designs, poor signage, and inadequate infrastructure maintenance. The information collected on such crashes can help in the development and evaluation of crash avoidance technologies that adapt to adverse weather and roadway conditions.

A large number of descriptive statistics about the crashes investigated in NMVCCS has been presented in this report. The nationally representative sample of crashes collected through NMVCCS will enable statisticians, automotive engineers and human-factors researchers to perform more in-depth analyses of various aspects of crash avoidance. NHTSA believes that this may enhance its capability, as well as that of the automotive industry and other private organizations, in designing and evaluating the effectiveness of emerging crash avoidance technologies. This will also aid in making refinements to existing crash avoidance systems thereby supporting NHTSA's mission of saving lives, preventing injuries, and reducing vehicle-related crashes.

NHTSA is beginning to conduct analyses using the data collected in NMVCCS. In addition, based on these data, NHTSA plans to produce reports describing factors contributing to crashes, as well as conducting studies specifically addressing the priority safety issues.

Appendix A. NMVCCS Crash Investigation and Coding — Additional Case Examples

To demonstrate how a crash is assessed and coded in NMVCCS, four case examples were presented in Section 5.3. Three more case examples are presented from the NMVCCS along with the potential crash avoidance technology and countermeasures that might have prevented the crash or mitigated its severity. These example cases are NMVCCS-investigated crashes related to medications, interior and cell phone distraction, inexperience, and view obstruction.

There is an extensive set of data being collected. It includes on-scene photographs of the crash, including vehicles and the scene evidence. A detailed database with much more information than presented below is being populated. Data collected includes a summary narrative of the crash, a detailed scaled scene diagram, and information on crash events. Also included are vehicle descriptions including tire, glazing, and equipment information, the EDR data (if available), rollover data, and collision damage information. Information on the roadway environment is collected including weather and traffic control device information. Detailed driver information including health, driver training, vehicle and road familiarity, drug (prescription and others) presence, blood alcohol concentration, sleep and work patterns, and distractions is documented. The pre-crash movements of the vehicles are described. Basic information on all people including vehicle occupants and involved pedestrians and bicyclists are also included.

NMVCCS Case Example A1: Illustrating driver medications and interior distraction

Case description:
A two-vehicle collision occurred at dusk in congested rush hour traffic heading north on a one-way freeway off-ramp. The posted speed limit for the roadway was 60 mph while the ramp had an advisory speed limit of 20 mph posted. At the bottom of the off-ramp stop signs were posted at an intersection with a cross street. A 2006 Ford Focus four-door sedan was traveling north on the ramp, and a 2002 Kenworth tractor-trailer was ahead of this vehicle. The tractor-trailer had decelerated and stopped for the traffic ahead at the intersection when its trailer was rear-ended by the Ford behind.

The driver of the Ford was a 25-year-old male with a schizoid affective disorder. He was taking several medications for this disorder, whose side effect was slowed reactions. It was his first time driving this vehicle on this roadway. He may have been physically tired because his job involved very strenuous activity, though he reported that he had rested well. The driver indicated that as he was exiting the freeway his cell phone rang, making an unusual noise. After answering the call, he told the caller that he would call him right back. He stated that he was looking at the cell phone trying to figure out why it had rung with the unusual sound. While doing so, he did not realize that the traffic ahead of him had stopped and thus rear-ended the tractor-trailer.

NMVCCS coding:
Having collected the targeted information from the available sources and necessary crash assessment, this case was coded as follows.

Table A1. NMVCCS Coding of the Case Illustrating Driver Medications and Interior Distraction

Coded Variable	Vehicle 1	Vehicle 2
Vehicle Type	Passenger car	Tractor trailer
Driver	25-year-old male	50-year-old male
Crash-Associated Factors	Physical condition Medications Interior distraction Too fast for conditions False assumption Inadequate surveillance Fatigued Traffic congestion Unfamiliarity with roadway Vehicle inexperience	Traffic congestion
Critical Pre-crash Event	Other motor vehicle in lane, stopped	Other motor vehicle in lane, traveling in same direction with higher speed
Critical Reason for the Event	Driver recognition error: internal distraction	Not coded to this vehicle

NMVCCS Case Example A2: Illustrating driver interior distraction and inexperience

Case description:
A 2003 Mitsubishi Eclipse driven by a 16-year-old female was traveling southbound in the left lane of a four-lane undivided highway. The driver of this vehicle made a left turn at a signalized intersection across the path of a 2004 Ford F-350 truck traveling northbound in the right lane driven by a 62-year-old male.

The 16-year-old driver was unfamiliar with the area and indicated that at the time of the impact she was talking on her cell phone, trying to obtain travel directions to her destination. She subsequently realized the conversation had distracted her attention from the driving task. The driver incorrectly assumed it was safe to turn left, based on a van she followed into the intersection that successfully made the left turn prior to her. Additionally, she didn't recall seeing the pickup until impact and could not recall whether the intersection had a green left turn arrow, which it did not. Crash-associated factors coded to the driver of the Mitsubishi include conversation, inadequate surveillance, this being her first time on the roadway, and driver inexperience. The critical pre-crash event for the Mitsubishi was "this vehicle traveling, turning left at intersection." The critical reason for this event was "internal distraction, a driver related factor."

NMVCCS coding:
Having collected the targeted information from the available sources and done the necessary crash assessment, this case was coded as follows.

Table A2. NMVCCS Coding of the Case Illustrating Interior Distraction and Inexperience

Coded variable	Vehicle 1	Vehicle 2
Vehicle Type	Passenger car	Pickup truck
Driver	16-year-old female	62-year-old male
Crash-Associated Factors	Interior distraction Driver inexperience Unfamiliarity with roadway Inadequate surveillance	None
Critical Pre-Crash Event	This vehicle turning left at intersection	Other vehicle encroaching from opposite direction over left lane line
Critical Reason for the Critical Event	Driver recognition error: interior distraction	Not coded to this vehicle

NMVCCS Case Example A3: Illustrating driver view obstruction

Case description:
The collision occurred at a “T” intersection of a five-lane arterial street and a three-lane side street. A 2002 Toyota Solara coupe was heading north in the left turn lane. A 2000 Subaru Outback station wagon was heading south in the outside lane. The Toyota turned left at the intersection into the path of the Subaru. The front of the Subaru hit the right rear of the Toyota.

The driver of the Toyota was a 73-year-old female who could not recall how the crash happened. She was on her way home from an errand, rarely drives this roadway, and had only been driving about 5 minutes when the crash occurred. She reported herself to be in good health and taking two preventative medications. The driver of the Subaru was a 25-year-old male who stated there was a truck about half a car length in front of him in the adjacent lane that caused a sight line obstruction with the Toyota and he had no time to react before the collision.

The critical pre-crash event for the Toyota was coded "this vehicle traveling, turning left at intersection.” The critical reason for this event was assigned to this driver as a driver-related decision factor, “turned with obstructed view". The view of the other vehicle was blocked by the truck and the Toyota driver made a false assumption that it was clear to make her turn not realizing the other vehicle was behind the truck. A vehicle factor coded was that the Subaru had three tires that were under inflated by more than 34 kPa (5 psi).

NMVCCS coding:
Having collected the targeted information from the on-scene available sources and done necessary crash assessment, this case was coded as follows.

Table A3. NMVCCS Coding of the Case Illustrating Driver Emotional Factors, Fatigue, and Vehicle/Road Unfamiliarity

Coded Variable	Vehicle 1	Vehicle 2
Vehicle Type	Passenger car	Station wagon
Driver	73-year-old female	25-year-old male
Crash-Associated Factors	View obstructed Sightline restriction Inadequate surveillance False assumption Unfamiliarity with roadway Medications	View obstructed Sightline restriction Three tires under inflated
Critical Pre-crash Event	This vehicle turning left at intersection	Other vehicle encroaching from opposite direction over left lane line
Critical Reason for the Event	Driver decision error: Turned with obstructed view	Not coded to this vehicle

Appendix B. Unweighted and Weighted Frequencies of Crash-Involved Drivers by Gender, Age, and Injury Severity

Table 6 in Section 6.2 presents the percent frequency distribution of drivers by gender, age, and police-reported injury severity expressed as KABCOU. Table B1 and Table B2 below present, respectively, the corresponding frequency and weighted frequency distributions.

Table B1. Crash-Involved Drivers by Gender, Age, and Injury Severity (KABCOU) (Unweighted frequencies)

Gender	Age	Injury Severity (KABCOU)						Died prior to crash	Injury status unknown	Total
		Killed (K)	Incapaci-tating injury (A)	Non-incapaci-tating injury (B)	Possible injury (C)	No injury (O)	Injury severity unknown (U)			
Male	Under 16	*	1	1	5	8	*	*	*	15
	16-25	10	75	258	333	860	25	*	19	1,580
	26-35	9	53	147	256	670	10	2	8	1,155
	36-45	11	53	120	207	610	13	*	11	1,025
	46-55	6	50	116	173	499	13	*	7	864
	56-65	4	31	72	131	265	9	*	4	516
	Over 65	16	33	78	122	257	7	*	2	515
	Unknown	*	1	1	2	18	6	*	49	77
	Subtotal	56	297	793	1,229	3,187	83	2	100	5,747
Female	Under 16	*	*	1	3	4	*	*	*	8
	16-25	7	81	206	377	579	27	*	11	1,288
	26-35	1	59	139	294	398	18	*	5	914
	36-45	6	47	120	262	332	18	*	10	795
	46-55	1	43	111	193	246	19	1	5	619
	56-65	3	21	60	130	142	12	*	2	370
	Over 65	3	29	80	114	127	8	*	4	365
	Unknown	*	*	1	5	2	2	*	2	12
	Subtotal	21	280	718	1,378	1,830	104	1	39	4,371
Unknown		*	*	*	*	12	5	*	99	116
Total		77	577	1,511	2,607	5,029	192	3	238	10,234

* Sample size = 0
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Table B2. Crash-Involved Drivers by Gender, Age, and Injury Severity (KABCOU) (Weighted frequencies)										
Gender	Age	Injury Severity (KABCOU)						Died prior to crash	Injury status unknown	Total
		Killed (K)	Incapa-citating injury (A)	Non-incapaci-tating injury (B)	Possible injury (C)	No injury (O)	Injury severity unknown (U)			
Male	Under 16	*	239	52	1,169	2,449	*	*	*	3,910
	16-25	5,570	45,651	82,328	116,890	328,793	10,282	*	4,337	593,851
	26-35	3,091	37,224	46,168	82,553	243,112	4,124	869	1,453	418,594
	36-45	3,826	40,453	41,712	62,814	215,883	8,647	*	1,948	375,282
	46-55	4,052	29,967	39,459	52,215	184,150	7,232	*	5,606	322,682
	56-65	1,217	15,470	21,869	44,010	95,417	2,840	*	1,477	182,301
	Over 65	6,111	21,050	31,566	42,175	96,808	3,755	*	178	201,645
	Unknown	*	425	788	179	5,107	828	*	18,389	25,715
	Subtotal	23,868	190,479	263,942	402,005	1,171,719	37,709	869	33,388	2,123,979
Female	Under 16	*	*	140	1,640	1,599	*	*	*	3,379
	16-25	4,632	70,803	86,499	137,081	244,003	17,458	*	3,364	563,840
	26-35	182	53,190	66,118	99,468	165,454	15,209	*	2,078	401,699
	36-45	1,658	38,025	49,802	83,488	107,913	8,243	*	2,456	291,586
	46-55	169	32,936	32,158	55,984	85,866	9,992	248	1,266	218,619
	56-65	1,229	17,044	20,830	43,244	68,389	8,318	*	264	159,318
	Over 65	1,286	11,168	31,795	36,724	48,228	4,252	*	660	134,112
	Unknown	*	*	341	3,466	2,616	550	*	278	7,251
	Subtotal	9,155	223,167	287,684	461,094	724,068	64,023	248	10,365	1,779,804
Unknown		*	*	*	*	5,554	1,631	*	32,276	39,460
Total		33,024	413,646	551,626	863,099	1,901,341	103,362	1,117	76,029	3,943,244

* Sample size = 0
Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Table B3. Unweighted Frequencies of Crash-Involved Drivers of Case Vehicles by Age and Interior Non-Driving Activities (Based on multiple choices per driver)							
Age	**Interior Non-driving Activity**						At least one interior non-driving activity
	Looking at movements/ actions of other occupants	Dialing/ hanging up phone	Conversing	Adjusting radio/CD player/ other vehicle controls	Retrieving objects from floor/seat/ other location	Other interior non-driving activities	
Under 16	1	*	5	1	1	*	8
16-25	45	11	430	46	60	90	623
26-35	27	8	237	16	25	63	351
36-45	18	8	216	6	23	53	310
46-55	7	5	158	5	14	33	219
56-65	5	3	82	1	1	27	122
Over 65	3	1	70	*	9	12	94
Unknown	1	*	5	*	1	1	7
Total	107	36	1,203	75	134	279	1,734

* Sample size = 0

Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Table B4. Weighted Frequencies of Crash-Involved Drivers of Case Vehicles by Age and Interior Non-Driving Activities (Based on multiple choices per driver)							
Age	**Interior Non-driving Activity**						At least one interior non-driving activity
	Looking at movements/ actions of other occupants	Dialing/ hanging up phone	Conversing	Adjusting radio/CD player/ other vehicle controls	Retrieving objects from floor/seat/ other location	Other interior non-driving activities	
Under 16	1,122	*	922	586	52	*	2,682
16-25	20,065	1,929	157,832	21,129	34,892	42,158	257,834
26-35	11,219	971	90,080	8,303	11,508	29,546	151,285
36-45	9,428	2,400	75,323	1,974	8,518	16,953	114,773
46-55	3,166	442	51,029	1,175	3,503	8,387	66,900
56-65	1,440	3,049	33,387	220	235	13,625	53,779
Over 65	1,983	185	32,601	*	1,710	4,475	39,838
Unknown	269	*	8,850	*	254	254	9,357
Total	48,692	8,976	450,023	33,386	60,673	115,398	696,447

* Sample size = 0

Estimates may not add up to totals due to independent rounding.

Data source: NMVCCS (July 3, 2005 –December 31, 2007), NHTSA, compiled as of April 30, 2008

Table B5. Unweighted Frequencies of Crash-Involved Drivers by Fatigue Status, Gender, and Performance Error (Based on multiple choices per driver)							
Fatigue Status / Gender		**Performance Error**				At least one performance error	No perform-ance error
		Panic or freezing	Over com-pen-sation	Poor directional control	Other performance error		
Fatigued	Male	7	36	58	1	82	337
	Female	4	22	29	2	54	248
	Total	11	58	87	3	136	585
Not Fatigued	Male	25	135	230	11	358	3,495
	Female	36	132	182	8	322	2,719
	Total	61	267	412	19	680	6,214
Unknown		11	80	221	13	287	1,297

Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

Table B6. Weighted Frequencies of Crash-Involved Drivers by Fatigue Status, Gender, and Performance Error (Based on multiple choices per driver)							
Fatigue Status / Gender		**Performance Error**				At least one performance error	No performance error
		Panic or freezing	Over compensation	Poor directional control	Other performance error		
Fatigued	Male	2,543	22,150	19,068	97	38,403	116,168
	Female	1,021	10,595	12,049	1,019	24,330	86,932
	Total	3,564	32,745	31,117	1,116	62,733	203,099
Not Fatigued	Male	7,279	56,339	97,205	2,417	145,275	1,223,367
	Female	12,902	62,599	66,536	1,975	127,786	1,020,701
	Total	20,181	118,938	163,740	4,393	273,061	2,244,068
Unknown		1,464	50,451	117,701	7,426	152,279	631,985

Estimates may not add up to totals due to independent rounding.
Data source: NMVCCS (July 3, 2005 – December 31, 2007), NHTSA, compiled as of April 30, 2008

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