Tech Brief

Programs of the Federal Motor Carrier Safety Administration (FMCSA) encompass a range of issues and disciplines, all related to motor carrier safety and security. FMCSA's Office of Analysis, Research and Technology defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understand-ing that will improve safety, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" is a program that adopts, develops, tests, and/or deploys innovative driver and/or vehicle best safety practices and technologies that will improve safety and reduce the number and severity of commercial motor vehicle crashes. An "analysis program" is defined as economic and environmental analyses done for the agency's rulemakings, as well as program effectiveness studies, state-reported data quality initiatives, and special crash and other motor carrier safety performance-related analyses. A "large truck" is any truck with a Gross Vehicle Weight rating or Gross Combination Weight rating of 10,001 pounds or greater.

Currently, FMCSA s Office of Analysis, Research and Technology is conducting programs in order to produce safer drivers, improve safety of commercial motor vehicles, produce safer carriers, advance safety through information-based initiatives, and improve security through safety initiatives. The study described in this Tech Brief was designed and developed to support the strategic objective to produce safer drivers. The primary goals of this initiative are to ensure that commercial drivers are physically qualified, trained to perform safely, and mentally alert.

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Analysis of Risk as a Function of Driving-Hour: Assessment of Driving Hours 1 through 11 Final Report

Background

Crashes involving large trucks constitute a significant risk to the driving public and an occupational risk to truck drivers. In 2005, some 442,000 large trucks (weighing over 10,000 lbs each) were involved in vehicle crashes; 4,951 of these large-truck crashes resulted in fatalities. Driver impairment due to drowsiness is a known contributing factor in many crashes involving commercial motor vehicle (CMV) drivers (Maycock, 1997). The Large Truck Crash Causation Studies found that 13 percent of truck drivers were coded as having been fatigued at the time of the crash (Federal Motor Carrier Safety Administration [FMCSA], 2006).

On April 28, 2003, FMCSA published a revised set of regulations concerning the Hours-of-Service (HOS) of CMV drivers. These published regulations were amended on September 30, 2003 and implemented on January 4, 2004. One central component of the revisions was a two-hour extension of off-duty time from eight to 10 hours. One rationale given in an FMCSA posting in the Federal Register (2005) was that the additional two hours of off-duty time would provide drivers with "… substantially more opportunity to obtain restorative sleep."

Overview of the Current Study

The current study examines some important issues pertaining to the HOS debate, particularly with regard to time-on-task or driving-hours. Hanowski et al. (2005) reported on an analysis that concerned a comparison of critical incidents involving CMVs that occurred in the 10th and 11th driving-hours. This was a timely analysis effort, as it provided insight into questions associated with the revised 2003 HOS regulations. Two limitations of the 2005 analysis of Hanowski et al. were that: (i) it included only a partial dataset and (ii) it compared only the frequency of critical incidents that occurred in the 10th and 11th driving-hours. Since that report was written, data collection for the naturalistic study on which the analysis of Hanowski et al. (2005) was based has been completed (Hanowski et al., in press). These two limitations associated with the initial analysis can be addressed in the current study. In addition, to provide a comprehensive and thorough examination of the topic, additional analyses were conducted to address how critical incidents may vary as a function of driving-shift and time-of-day.

Method

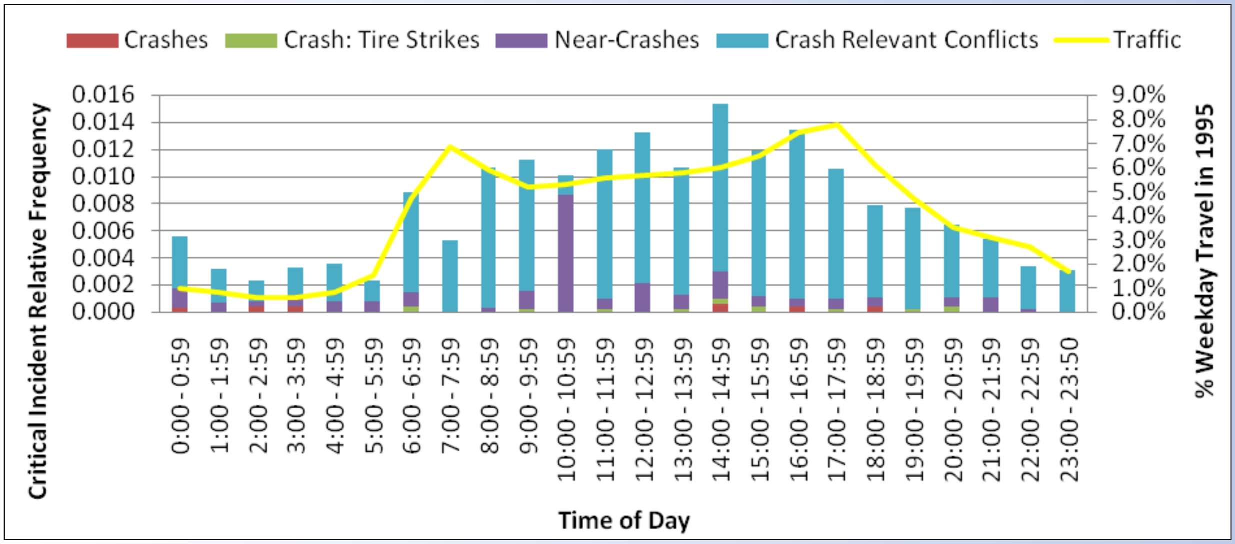
Data for these analyses were collected during a Field Operational Test (FOT) of a Drowsy Driver Warning System (DDWS). This FOT was co-sponsored by NHTSA, FMCSA, and the Federal Highway Administration's (FHWA) Intelligent Transportation System Joint Program Office (ITS JPO). A description of the methodology used in the FOT can be found in Hanowski, Nakata, and Olson (2004) and the final data collection report is in press (Hanowski et al., in press). Data collection for the FOT began in May 2004 and ended in September 2005. A total of 103 drivers participated in the study (102 males, 1 female; mean age = 40.03 years; age range = 24–60 years). The gender and age distribution of the 98 drivers included in the driving-hour analyses were: 97 males, 1 female; mean age = 39.96 years; age range = 24–60 years.

The data collection system, including the video cameras, became active when the ignition system of the vehicle was activated. The system was programmed to remain active and to gather data as long as the engine was on and the vehicle was in motion. The system was programmed to shut down when the ignition was turned off, and the system was programmed to pause if the vehicle ceased motion for a 10-minute period. Data collection resumed when the vehicle was again in motion.

Driver performance was assessed through the occurrence of critical incidents (crashes, near-crashes, and crash-relevant conflicts). Briefly, a crash was defined as any contact with an object, either moving or fixed, at any speed. A near-crash was defined as any circumstance that required a rapid, evasive maneuver (e.g., hard braking) by the subject vehicle or any other vehicle, pedestrian, cyclist, or animal, in order to avoid a crash. A crash-relevant conflict was defined as any circumstance that required a crash-avoidance response on the part of the subject vehicle, any other vehicle, pedestrian, cyclist, or animal that was less severe than a rapid evasive maneuver (as defined above), but greater in severity than a normal maneuver. A crash-avoidance response can include braking, steering, accelerating, or any combination of control inputs. Examples of potential crash-relevant conflicts include hard braking by a driver because of a specific crash threat or proximity to other vehicles. Evasive maneuvers resulting in unsafe and/or illegal maneuvers or situations were included in this category (or as near-crashes, if more severe).

Results

This study resulted in a major finding that is relevant to the assessment of the 2003 HOS regulations. Specifically, the results from the analysis on critical-incident relative frequency, used as a surrogate for driver performance decrement, generally showed no statistical difference in the hours between the 2nd through 11th driving-hours (for almost all analyses); and the statistical difference between the 1st driving-hour and the 11th driving-hour is in the opposite direction of what would be expected had there been a time-on-task effect. That is, the results of this study do not support the hypothesis that there is an increased risk resulting from CMV drivers driving in the 11th driving-hour as compared to the 10th driving-hour, or any hour. These results from this research suggest time-on-task as being a poor predictor of crashes and safety-related traffic events. In fact, a significant spike in the rate of critical incidents was found during the 1st driving-hour. This spike was found across all possible trips and on only those trips in which the truck driver drove into the 11th driving-hour. The latter statement suggests that even on those trips in which the driver drove into the 11th driving-hour, the critical-incident relative frequency was highest in the 1st driving-hour (significantly more compared to driving-hours 2 though 11 for almost all analyses). Additional analyses found a strong time-of-day effect which, upon closer examination, appeared to have resulted from hour-by-hour traffic density variations. The authors hypothesized that exposure to heavy traffic conditions, and possibly sleep inertia and an increase in complex driving situations that may be typical in the 1st driving-hour, may be the key predictors of critical- incident occurrence as shown in the figure below:



Critical-Incident Relative Frequency as a Function of Time-of-Day, with Traffic-Density Plot Superimposed

Follow-up analyses were conducted, one of which considered traffic density as a function of driving-hour. Traffic-density data were plotted against the hour-by-hour critical-incident relative frequency plots. The yellow line (Traffic) in the figure above displays the U.S. distribution of daily weekday traffic across each hour of the day in 1995 (Festin, 1996). Festin (1996) used two primary data sources, highway statistics for annual vehicle miles traveled and 5,000 automatic traffic recorders sites across the United States, to estimate annual travel trends in the United States. As suggested by the plotted data, the results showed a strong positive linear relationship between the two variables with a correlation (r) of 0.83. With an R^2 of 0.69, there is a strong linear relationship between critical-incident relative frequency and traffic density (i.e., the two increase and decrease with similar patterns).

Conclusion

For this analysis the relative frequency of critical incidents were used as a surrogate for decrements in driver performance; this analysis showed no statistical difference between the 2nd through 11th driving-hours (for almost all analyses); and the statistical difference between the 1st driving-hour and the 11th driving-hour lies in the direction opposite to what would be expected, had there been a time-on-task effect. That is, the results from this study do not support the hypothesis that there is an increased risk resulting from CMV drivers driving in the 11th driving-hour as compared to the 10th driving-hour, or any hour, although caution must be used in interpreting these results, due to the small sample of drivers represented in the study as compared to the larger CMV driver population. That is, although a dataset of over 2 million VMT collected from 98 drivers driving 46 instrumented trucks is the largest known continuously collected naturalistic dataset available; it captures only a small segment of the number of CMV driver population. Nonetheless, these are perhaps the best data available to investigate this important safety question.

These results are consistent with Wylie et al. (1996) with regard to time-on-task being a poor predictor of crashes and safety-related traffic events. In fact, a significant spike in the rate of critical incidents was found during the 1st driving-hour. These results are not consistent with the contention that crash risk increases as hours of driving increase (see Kaneko and Jovanis, 1992; Lin, Jovanis, and Yang, 1993; Park et al., 2005). This spike was found across all possible trips and only those trips on which the truck driver drove into the 11th driving-hour. The latter statement is noteworthy because it suggests that even in those trips on which the driver drove into the 11th driving-hour, the critical-incident relative frequency was highest in the 1st driving-hour (significantly more than in driving-hours 2 though 11 for almost all analyses).

Researcher: This study, "Analysis of Risk as a Function of Driving-Hour: Assessment of Driving-Hours 1 Through 11" was conducted by Virginia Tech Transportation Institute, 3500 Transportation Research Plaza (0536), Blacksburg, VA 24061

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