DEVELOPMENT AND IMPLEMENTATION OF A DRIVER SAFETY HISTORY INDICATOR INTO THE ROADSIDE INSPECTION SELECTION SYSTEM

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ABSTRACT

The majority of prior research and analysis has indicated driver-related factors as the main cause of most commercial vehicle-related crashes. The main goal of the current project is to provide a greater concentration on the commercial driver in order to have the most significant impact on the number of crashes.

The ultimate outcome of this study is to save lives, prevent injuries, and prevent property damage associated with commercial vehicle-related crashes. To accomplish this crash reduction goal, the current study combines and expands on two previous research efforts -- the development of the Inspection Selection System, and a project analyzing the use of driver traffic conviction data to better identify high safety risk motor carriers.

To accomplish the greater focus on the commercial driver, the first objective of the current project was to further analyze the data and weightings associated with the carrier driver conviction measure created through the conviction data study. Utilizing the results of this first objective, the second objective of the present project was to then integrate the carrier driver conviction measure into the current Inspection Selection System and conduct a pilot test of this new ISS algorithm, termed ISS-D.

Results from the pilot test indicate an approximate 10 percent increase in driver out-of-service rates after the ISS-D algorithm implementation. In addition, there was an almost doubling of the driver out-of-service rate when ISS-D recommended the inspection.

INTRODUCTION

The majority of prior research and analysis has pointed toward driver-related factors as the leading cause of most commercial vehicle-related crashes. The primary goal of the current project is to focus greater attention on the commercial driver in order to have the most profound impact on the number of crashes. However, the main safety-related prioritization algorithms in use today are focused at the company level. A working premise for the present research study is the idea that a lack of a driver safety management culture of a company is one indication of overall safety performance. We explore this premise through the development of a carrier-based driver safety measure. The ultimate outcome of this study is to save lives, prevent injuries, and prevent property damage associated with commercial vehicle-related crashes.

To accomplish this crash reduction goal, the current study combines and expands on two previous research efforts — the development of the Inspection Selection System and a project analyzing the use of traffic conviction data to better identify high safety risk motor carriers.

The Inspection Selection System is an algorithm and software program used by safety inspectors at the roadside to help identify which vehicles and drivers to inspect based on prior carrier safety history. The ISS has been in use nationwide since 1995, and has demonstrated to be very effective in identifying drivers and vehicles of carriers that are most likely to be placed out-of-service for safety problems (*1*). The ISS inspection values and information are available through the SAFER (Safety and Fitness Electronic Records) system, and can be accessed by roadside inspectors either through the ISS software or through the web application, Query Central. In addition, many states use the ISS inspection values for their electronic clearance programs and systems.

The conviction data study concluded that linking driver conviction data from the Commercial Driver's License Information System to the employing motor carrier provides an additional method to identify those motor carriers with safety problems. A carrier driver conviction measure, which was created based on the average number of convictions of drivers associated with carriers, is significantly correlated with the carriers' out-of-service rates, accident rates, and SafeStat Safety Evaluation Area (SEA) scores. Carriers with higher (worse) driver safety conviction measures are also more likely to have higher OOS rates, accident rates, and SEA scores.

To accomplish the greater focus on the commercial driver, the present project has two specific objectives. The first objective is to further analyze the data and weightings associated with the carrier driver conviction measure created through the conviction data study. This analysis is to help confirm previous findings.

Utilizing the results of the first objective, the second objective of the present project is to integrate the carrier driver conviction measure into the current Inspection Selection System, and conduct a pilot test in a select number of states.

CREATION AND ANALYSIS OF THE CARRIER DRIVER CONVICTION MEASURE

The following discussion relates a brief summary of the initial study that created the carrier driver conviction measure. This section describes how the measure was first developed and its significant relationship with several safety variables.

Background

Previous driver-related research examined 1994 traffic citation data from two states, Indiana and Michigan. In most states, when a commercial motor vehicle driver is given a traffic citation, the employing motor carrier is not identified on the citation. However, the state police in these two states do try to identify the employing motor carrier, and note it on the traffic citation. Thus, driver citation data was able to be linked to the employing motor carrier for this analysis. The main conclusions from this study were that driver citation rates significantly differ among carriers, and that higher driver citation rates for a carrier are also associated with higher accident rates for that carrier (*2*). Therefore, if a nationwide method existed to link driver citation information to motor carriers, it could provide useful information regarding higher safety risk motor carriers.

Unfortunately, there is no national traffic citation database, nor any standard for such state databases. In addition, there are only a few states which record the U.S. Department of Transportation (DOT) carrier number on traffic citations, and these states have problems with state or local police officers accurately identifying the employing motor carrier when issuing a traffic citation. Thus, without such a national program, it is not feasible to use citations to identify higher risk motor carriers. In addition, there have been concerns expressed with the use of citation data because of the general principles of due process.

Therefore, an analysis was conducted to examine whether a correlation exists between traffic conviction data (the subset of citations that have gone through the adjudication process) that are accessible through the Commercial Driver's License Information System (CDLIS), and high risk motor carriers linked to drivers through inspection and accident reports contained in the Motor Carrier Management Information System (MCMIS).

Description of CDLIS

CDLIS was created in response to the Commercial Motor Vehicle Safety Act (CMVSA) of 1986. It is a nationwide source of CDL drivers’ traffic conviction data. CDLIS is a distributed, relational database that provides a linkage between the various state driver records systems using a central index. Successful use of driver conviction data from CDLIS to identify high safety risk motor carriers would eliminate the need to create a new national driver citation/conviction information system. The most critical problem with using CDLIS data in this way is that it is a driver-based system that does not identify the motor carrier employing the driver.

CDLIS has been in full operation since April 1992. The central index serves as a clearinghouse that each of the 51 jurisdictions (the 50 states and the District of Columbia) can check before issuing a commercial driver's license (CDL) to ensure that no other state has issued a CDL to that driver anywhere in the nation, and that the records for that driver’s CDL will be transferred to the new state where the driver is applying. It also assists states in reporting out-of-state convictions to the licensing state where they are made part of the driver's record (*3*).

Description of MCMIS

FMCSA maintains a centralized database of carrier-based information about accidents and roadside inspections of commercial motor vehicles and drivers. This information is entered by states into their local SAFETYNET information system. The states then transmit relevant data for carriers electronically to FMCSA's Motor Carrier Management Information System (MCMIS).

Most accident and roadside inspection reports in MCMIS identify both the driver and the motor carrier the driver was working for at the time of the accident or roadside inspection. There are approximately three million roadside inspections and 100,000 accidents reported each year. MCMIS also contains census information regarding each motor carrier (i.e., address, number of power units, number of drivers, cargo carried, etc.).

Methodology

A stratified random sampling scheme was used for this initial study. Based on data from MCMIS, carriers were assigned to one of seven size categories and to one of 10 different regions of the country. Accident or inspection reports within the one-year time frame between September 1999 and September 2000 were used to associate drivers with carriers. If there were no drivers able to be associated with the carrier, the next carrier was selected until there was at least one driver associated. For each carrier randomly selected from each group, drivers associated with that carrier were randomly selected, with a maximum of 50 drivers per carrier. In order that there would not be duplicate driver histories associated with carriers, checks were completed to ensure that a driver was not associated with the same carrier more than once. However, it was acceptable, and expected, that a driver could be associated with more than one carrier.

The initial selection resulted in a sample of 15,829 carriers, with an associated 79,244 drivers. The identifying information for each of the drivers in the sample was sent through CDLIS to obtain the driver history records. Driver convictions for the sample of drivers selected for this study were requested for the three-year time period between September 1997 and September 2000. CDLIS was able to successfully match and obtain driver history records for 64,711 of the drivers, associated with 13,829 carriers as illustrated in Figure 1.

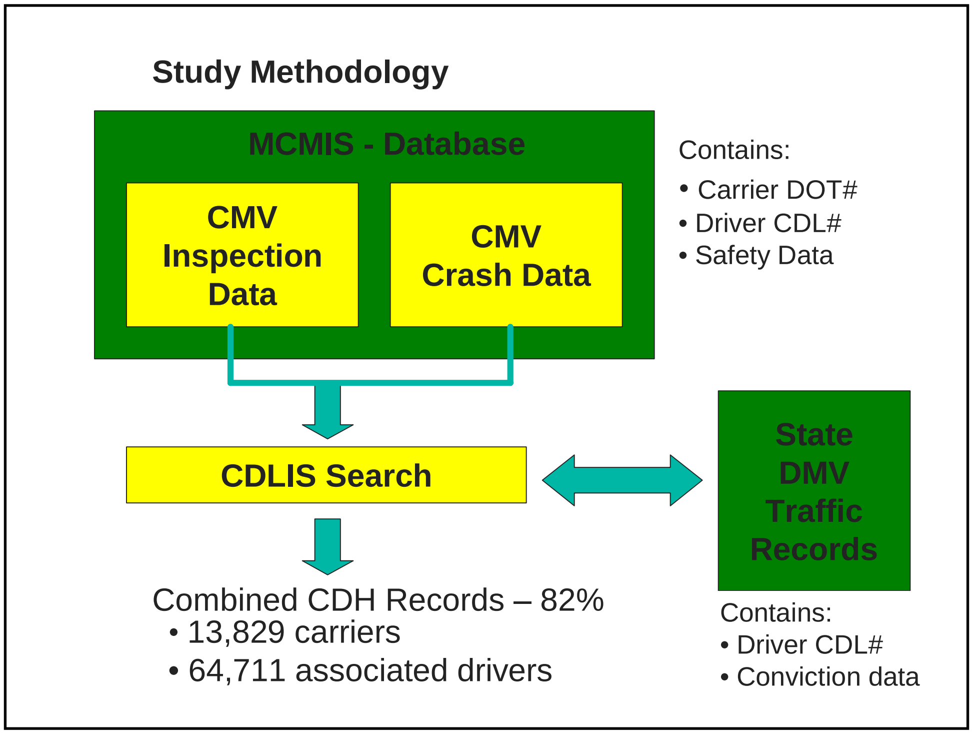

Figure 1. Study Methodology

For each driver, the data obtained from the driver history record included the driver's date-of-birth and state, as well as information regarding any traffic convictions in the three-year time frame. The conviction information detailed the date of the conviction, whether or not it was for a commercial vehicle offense and the associated American Association of Motor Vehicle Administrators (AAMVA) Code Dictionary (ACD) conviction code and detail. This AAMVA Code Dictionary is available upon request from the AAMVA web site at http://www.aamva.org/.

For each carrier, in addition to their MCMIS census information such as state, number of power units and number of drivers; other critical safety information was also obtained. This data included the number and type of accidents, number and type of out-of-service roadside inspections and violations, as well as the carriers' scores in each Safety Evaluation Area (SEA) of the Motor Carrier Safety Status Measurement System (SafeStat). SafeStat evaluates carriers in four areas: accidents, drivers, vehicles, and safety management. If a carrier has sufficient data in a 30-month time period to be evaluated in a SEA, they receive a score of zero to 100 in that area, with 100 being worst. For further detail regarding the calculation of SafeStat SEA values, please refer to the SafeStat Methodology report (*4*). The safety data for each carrier was obtained as of September 2000.

The Carrier Driver Conviction Measure (CDCM)

In order to test for a correlation between traffic conviction rates of drivers employed by a carrier and the carrier's safety record, a driver conviction measure (DCM) was required. Rather than simply summing the convictions for each driver, it was decided to weight the convictions based on severity (Figure 2). The CDL regulations identify certain convictions as serious offenses, and others as disqualifying offenses. An example of a serious offense would be driving more than 15 miles over the posted speed limit, while an example of a disqualifying offense would be driving under the influence of alcohol.

To create the carrier driver conviction measure (CDCM) for each carrier, the mean of all the weighted driver conviction measures associated with the carrier was calculated (Figure 2).

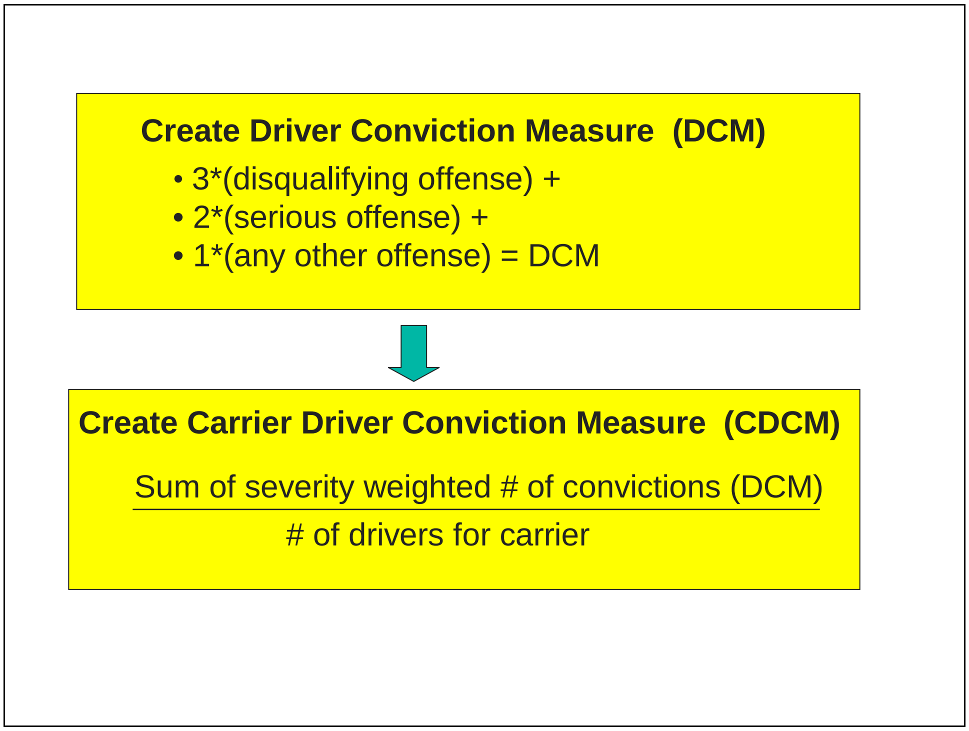

Figure 2. Calculation of DCM and CDCM

Analysis results

The initial analyses consisted of overall correlation analyses between the carrier driver conviction measure and the carrier safety-related data. The first set of safety variables examined was the vehicle and driver roadside inspection out-of-service (OOS) rates. These are calculated by dividing the number of inspections that resulted in a vehicle or driver being placed out-of-service by the total number of applicable inspections. Roadside inspections follow a standard known as the North American Standard which was developed by the Commercial Vehicle Safety Alliance in cooperation with the Federal Highway Administration. Inspections involve an examination of vehicles, drivers, and hazardous material cargo; and focus on critical safety regulations. They include provisions for placing vehicles and/or drivers out-of-service (OOS) if unsafe conditions are discovered, for example, brakes out-of-adjustment or a driver driving more than the number of daily hours allowed. Any problems identified must be corrected prior to the continuation of a trip. OOS rates were only calculated for carriers that had at least three roadside inspections during the time period. The second set of safety variables examined was the number of accidents per power unit and the number of accidents per driver during the time period. The final set of safety variables analyzed was the carriers' score in each of the four SafeStat Safety Evaluation Areas (SEAs) as defined previously. Although the carrier driver conviction measure is a driver-based carrier indicator, each of these safety variables, including vehicle OOS rates and the Vehicle SEA score, is an indicator of overall carrier safety. The results of these analyses are displayed in Table 1.

These results (Table 1) indicate significant, positive, linear correlations between the carrier driver conviction measure and every safety variable examined except the driver accident rate. This insignificant result with the driver accident rate is most likely a factor of the poor driver demographic data at the time. FMCSA has since implemented a mandatory biennial update, and carriers must now update their demographic data on file with FMCSA every two years. In general, the higher (worse) a carrier's driver conviction measure score, the higher the driver and vehicle OOS rates, accident rates, and SEA scores of the carrier.

TABLE 1. Overall Correlation Analysis Between the Carrier Driver Conviction Measure and Safety Variables

	Correlation with Carrier Driver Conviction Measure		
Carrier Safety Variable	**Sample Size**	**Pearson Correlation Coefficient**	**Significance Level**
Vehicle OOS Rate	7,991	0.043	0.0001
Driver OOS Rate	8,789	0.149	0.0001
Accidents per Power Unit Rate	12,802	0.085	0.0001
Accidents per Driver Rate	12,110	0.009	0.3208
Accident SEA	2,946	0.175	0.0001
Driver SEA	9,745	0.188	0.0001
Vehicle SEA	8,980	0.080	0.0001
Safety Management SEA	915	0.097	0.0035

A measure of the strength of the linear relationship between two variables is the Pearson correlation coefficient. This measure, denoted by the symbol r, can range between –1 and +1. When $r=0$, it implies no linear correlation. Not surprisingly, the Pearson correlation coefficients are highest with the driver OOS rate ($r=0.149$) and the driver SEA score ($r=0.188$). However, there was a relatively high correlation with the accident SEA score as well ($r=0.175$). The SEA scores are perhaps the best safety variables to examine as several data quality and sufficiency checks are completed before the scores are assigned to the carrier.

CONFIRMATION OF ANALYSIS RESULTS

In order to further test the weightings and correlations associated with the carrier driver conviction measure, a follow-up analysis was completed using MCMIS data from April 2003. Utilizing the same procedure described previously, there were approximately 130,000 U.S. drivers with driver history records returned and matched to 46,000 carriers available for analysis. After calculation of the CDCM for each carrier, the same significant correlations were observed with the CDCM and each carrier safety variable. Testing different weightings and calculations of the CDCM did not reveal an improvement in any of these correlations and, therefore, the calculation of the CDCM was left the same.

INTEGRATION OF THE CDCM INTO THE INSPECTION SELECTION SYSTEM

Based on the strong correlations discovered and reconfirmed between the carrier driver conviction measure and various safety variables, a methodology was designed to test this measure as a part of the current Inspection Selection System, and validate the results in a real-world setting.

There were two potential ways identified to integrate the CDCM into the ISS. Since the calculation of the ISS inspection values is primarily based on the SafeStat SEA values, the CDCM could be incorporated into the SafeStat algorithm. To that end, a weighted carrier driver conviction indicator was created in a manner similar to what is currently used to calculate the SafeStat moving violations indicator (*4*). Testing of this indicator revealed that it does provide additional information beyond what is currently being captured in the existing SafeStat measures.

A second method to integrate the CDCM into the ISS would be to simply incorporate it directly into the ISS algorithm itself, and then distribute this database and test its effectiveness on a pilot basis. Due to the time constraints for this project, it was decided to move forward with this second option.

Methodology

In order to modify the ISS algorithm, the carrier driver conviction indicator (a 1 to 100 percentile rank of the CDC measure) was calculated for each carrier. This indicator was added to the Safety Management Safety Evaluation Area of SafeStat as it was determined that it is primarily an indication of a carrier's hiring practices. Carriers are required to complete a motor vehicle record check before any new driver is hired, and at least once per year upon employment. Thus, the carrier should be aware of all the drivers' convictions before and after hiring.

If a carrier already had a Safety Management SEA value based on other available data, the higher of their current value or the CDC indicator was used as the final value. This revised Safety Management SEA value was used in addition to the other SafeStat SEA values in the ISS algorithm, resulting in an enhanced algorithm termed ISS-D. Please refer to the publication by the current author, Lantz (2000), for a complete description of how the ISS algorithm is calculated (*1*).

Twelve states were selected in order to conduct a "real-world" pilot test of ISS-D. Criteria for selection included states with the highest frequency of commercial vehicle crashes, states willing to test the new ISS software using handheld computers, and/or states willing to test the new algorithm with their electronic screening system. For each state in the pilot test, an analysis was conducted regarding their OOS rates and crash rates before and after implementation of the ISS-D.

The ISS software was modified to include the ISS-D algorithm and distributed to the 12 states in December 2004. It was installed for the majority of users in Idaho, North Carolina, Ohio, and Utah in mid-January 2005; and for the majority of users in Alaska, Connecticut, Kentucky, and Vermont in mid-March 2005. Missouri, West Virginia, Arizona, and Washington installed it simply for a limited sample of users.

Results

Results from the pilot test indicate an increase in driver out-of-service rates after ISS-D implementation. Specifically, as illustrated in Table 2, for Idaho, North Carolina, Ohio, and Utah, there were 38,270 Level 1, 2, 3, and 6 inspections conducted between October and December 2004 with a 7.72 percent driver OOS rate; and there were 38,812 Level 1, 2, 3, and 6 inspections conducted between February and April 2005 with a 8.33 percent driver OOS rate. Similarly, Table 3 illustrates an increase in the driver OOS rate from 6.43 percent to 7.10 percent after the ISS-D implementation in Alaska, Connecticut, Kentucky, and Vermont.

TABLE 2. Before and After Driver OOS Rate Analysis for ID, NC, OH, and UT

	Before ISS-D Implementation (October, November, and December 2004)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
ID, NC, OH, UT	38,270	2,953	7.72%
	After ISS-D Implementation (February, March, and April 2005)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
ID, NC, OH, UT	38,812	3,233	8.33%

TABLE 3. Before and After Driver OOS Rate Analysis for AK, CT, KY, and VT

	Before ISS-D Implementation (December 2004, January 2005, and February 2005)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
AK, CT, KY, VT	23,717	1,524	6.43%
	After ISS-D Implementation (April, May, and June 2005)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
AK, CT, KY, VT	30,069	2,136	7.10%

An additional within group analysis was completed using only the data from after the ISS-D implementation. These results are displayed in Table 4, and show that those carriers with "high" ISS-D values that were recommended for inspection had driver OOS rates approximately double those of carrier with "low" ISS-D values that were not recommended for inspection.

TABLE 4. After (Within Group) Driver OOS Rate Analysis

	Inspections on Carriers with High ISS-D Values (75 to 100)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
ID, NC, OH, UT	17,087	1,653	9.67%
AK, CT, KY, VT	11,664	1,011	8.67%
	Inspections on Carriers with Low ISS-D Values (1 to 49)		
States	**Total Level 1, 2, 3, and 6 Inspections**	**Number of Drivers Placed OOS**	**Driver OOS Rate**
ID, NC, OH, UT	11,213	546	4.87%
AK, CT, KY, VT	9,593	349	3.64%

Regarding crash analyses, it is anticipated that with the increases in driver OOS rates in the pilot test states, that the crash rates will decrease; however at the time of this writing, all the crash data has not been reported for the time frame of the analysis. Therefore, this analysis will be completed early 2006.

CONCLUSION

Based on extensive analysis, linking driver traffic conviction data to the employing motor carrier helps to identify motor carriers more likely to be higher safety risk. The carrier driver conviction measure, based on the mean of all the weighted driver conviction measures associated with the carrier, is significantly correlated with driver and vehicle out-of-service rates, accident rates, and SEA scores. Carriers with higher (worse) driver traffic conviction measures are also more likely to have higher driver and vehicle OOS rates, accident rates, and SEA scores. Further analysis reveals the potential contribution of this measure to SafeStat.

Based on this analysis, a methodology was designed to test this measure as a part of the current Inspection Selection System, and a pilot test was conducted in 12 states. Through the objectives of this project, there was increased commercial driver out-of-service rates observed in the pilot test states. Further analysis is being conducted regarding crash rates.

REFERENCES

(1) Lantz. Brenda M. The Integration of the Motor Carrier Safety Status (SafeStat) Measurement System into the Roadside Inspection Selection System. *Upper Great Plains Transportation Institute Publication* No. 134. 2000. Available at www.ugpti.org/research/carrier/projects.php

(2) AAMVAnet, Inc. and Keane Federal Systems. *Driver/Carrier Data Relationship Project: Phase II Report*. Federal Motor Carrier Safety Administration (formerly the Office of Motor Carriers, Federal Highway Administration), U.S. Department of Transportation, 1997. Available at dms.dot.gov

(3) TML Information Services, Inc. *Commercial Driver License Effectiveness Study*. Federal Motor Carrier Safety Administration (formerly the Office of Motor Carriers, Federal Highway Administration), U.S. Department of Transportation, 1998. Available at dms.dot.gov

(4) Volpe National Transportation Systems Center. *SafeStat Motor Carrier Safety Status Measurement System: Methodology Version 8.6.* Federal Motor Carrier Safety Administration, U.S. Department of Transportation, 2004. Available at ai.fmcsa.dot.gov