Commercial Motor Vehicle Driver Retention and Safety

March 2003

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FOREWORD

The purpose of this project is to gain a better understanding of the extent to which truck crashes during long-haul, over-the-road operations can be linked to job-hopping or "churning" among commercial drivers.

Study methods in this project include an analysis of driver, carrier, and crash information in the Motor Carrier Management Information System (MCMIS) database, a review of existing literature in this area, and supplemental contacts with key segments of the trucking industry.

Through the MCMIS analyses, it was found that the odds of being involved in a crash begin to increase when a driver has averaged more than two job changes a year, and that this risk increases as the job change rate increases.

The literature review identifies six areas (selection and hiring, training procedures, dispatch operations, working conditions for long-haul operators, safety-related rewards and incentives, and improving perceptions of the truck driving profession) where specific changes hold the potential to improve driver retention and safety. Furthermore, drivers attain satisfaction from a sense of achievement and recognition, and that key factors influencing how long a driver remains with an employer are steadiness of work, level of pay and benefits, company support while on the road, genuine respect from management, and amount of time at home.

The analyses and findings reported herein are dependent upon the quality of data contained within the Motor Carrier Management Information System (MCMIS). The Federal Motor Carrier Safety Administration (FMCSA), which maintains MCMIS, relies upon the receipt of authenticated crash and inspection data from States, and does not alter, change, or modify State data after it has been uploaded to MCMIS.

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16. Abstract

Within this research, the study team analyzed the Motor Carrier Management Information System (MCMIS) database to develop estimates of the increased risk of crash involvement experienced by commercial drivers who change jobs frequently, conducted a literature review, and contacted industry experts to identify strategies with the best potential to improve trucking companies' retention of safe drivers.

The database analyses quantified the risk of single- and multiple-crash involvement as a function of annual job change rate, and expressed the relative risk for drivers with more versus fewer job changes through calculation of the "odds ratio" statistic. Significant odds ratio values were found, indicating that crash risk begins to rise when a driver has averaged more than two jobs with different employers each year for two years or longer, and that the odds of being involved in multiple crashes more than doubles for drivers with three or more jobs per year during this same interval.

The literature review coupled with contacts with drivers, motor carrier management, motor carrier insurers, and other groups and associations supported recommendations in the areas of selection and hiring of new driver applicants; new driver orientation; driver training, including refresher training; driver-dispatcher operations; the measurement and recognition of safe driving performance by trucking companies; scheduling and hours-of-service compliance; and the needs of industry to improve perceptions of the profession and to convey respect for and a commitment to its drivers.

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Unclassified	Unclassified	62	A05

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lbs)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m2	cd/m2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	Yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lbs)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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EXECUTIVE SUMMARY

This project's purpose was to gain a better understanding of the extent to which truck crashes during long-haul, over-the-road operations can be linked to job-hopping or "churning" among commercial drivers, and to identify strategies with the greatest potential to improve driver retention and safety. Study methods included analysis of driver, carrier, and crash information in the Motor Carrier Management Information System (MCMIS) database, a review of existing literature in this area, and supplemental contacts with key segments of the trucking industry.

The MCMIS analyses, though limited in scope, succeeded in quantifying a relationship between a driver's annual job change rate, monitored over a period of at least two years, and his or her level of crash experience. This extends to what was previously understood on a largely anecdotal basis to an actual calculation of the increased risk of crash involvement for a given number of job changes. Still, the present work represents only a "first phase" of analysis; this is because many promising avenues of study to identify specific variables to explain the broad relationship between job change rate and safety, were simply beyond the scope of this project. Generally speaking, this analysis found that the odds of being crash-involved begin to increase when a driver has averaged more than two job changes a year. This increase in risk is gradual at first, then accelerates as the job change rate increases. If a driver has averaged three or more jobs with different carriers each year, the odds of being involved in multiple crashes are *more than twice as high* as they are for drivers with a lower job change rate.

The literature review identified six areas where specific changes hold the potential to improve driver retention and safety: selection and hiring, training procedures, dispatch operations, working conditions for long-haul operators, safety-related rewards and incentives, and improving perceptions of the truck driving profession. Overall, this review suggests that drivers attain satisfaction from a sense of achievement and recognition, and that key factors influencing how long a driver remains with an employer are steadiness of work, level of pay and benefits, company support while on the road, genuine respect from management, and amount of home time. The independent lifestyle associated with long-haul trucking emerges as a critical attribute; in helping define the profession, it may also influence more and better recruits to join it as a first career choice, thereby alleviating the pressing shortage of qualified truck drivers.

The supplemental contacts within the trucking industry that were carried out in this research supported a qualitative analysis of driver opinion, the perspectives of motor carrier management and of insurance companies, and viewpoints reflected by other groups and associations in the industry. Key issues in the retention-safety relationship were pinpointed through this work. These included the effect of carrier size on truck driver opinions and their desires for safety recognition, incentives and rewards; whether pre-testing can identify a driver's disposition toward one form of reward or recognition versus another; whether pre-testing can identify drivers who have a more mature and "positive" attitude toward safety; the limited value of driver age and experience, considered alone, in predicting safety outcomes; how to measure driver satisfaction and how to correlate such measures with driver retention; how to relate measures of drivers' satisfaction to their safety records; and, the role of external factors (e.g., shipper treatment) on driver turnover and satisfaction. While stopping short of any prescriptions for "best practices," the results of the industry contacts reinforced conclusions from the literature review regarding the complex interrelationships governing a driver's decision to change jobs.

INTRODUCTION AND BACKGROUND

The trucking industry has experienced a shortage of qualified drivers for roughly two decades. This has been attributed to growth in business, drivers who retire or leave the profession, and fewer young persons choosing commercial driving as a career. Perhaps the most significant factor contributing to the shortage of qualified drivers however, is the phenomenon of job-hopping. Also known as "churning," high rates of turnover in the industry account for as much as 80 percent of the demand for commercial operators experienced by some carriers at any given time (Gallup and ATA Foundation, Inc., 1997).

Understandably, there are substantial recruitment, training, and other costs borne by the industry that result from high job change rates among commercial drivers. But the greatest impact of job-hopping may be in the area of safety. An analysis of safety audit data from almost 2,000 ICC-certificated (common) motor carriers found that carriers with higher driver turnover had significantly higher crash rates than did carriers with low turnover rates (Corsi and Fanara, 1988). Experts find this plausible for a number of reasons, especially within the long-haul truckload segment of the industry. Drivers who frequently switch jobs never really get acclimated to their new environment, whether it's an adjustment to a new vehicle or cargo type that is required, or learning new routes, delivery locations, rest stops, and weigh stations.

This research was initiated to gain additional insights about the association between commercial driver retention and safety, and to identify guidelines for improved practices for the trucking industry that are supported by available evidence. Three parallel and converging sets of activities were undertaken to meet these goals. The first activity was to plan and carry out analyses of Motor Carrier Management Information System (MCMIS) data that could quantify the relationship between job change rates and crash experience among for-hire drivers engaged in interstate commerce, and, wherever possible, to identify the most important contributing factors in explaining significant results of these analyses. Next, a comprehensive review of the technical literature was conducted to update the state-of-the-knowledge about why drivers change jobs, and how job-hopping might be reduced through strategies other than simply an increase in driver compensation. Finally, a brief survey of major stakeholders in the industry (carriers, insurers, professional associations, and drivers) was performed to insure that diverse points of view and as many sources of potential solutions as possible, would receive consideration in this work.

DIMENSIONS OF THE PROBLEM: PHASE 1 ANALYSIS

As noted earlier, prior research has suggested that a general relationship exists in the direction of greater crash risk with higher driver turnover. The precise dimensions of this problem are unknown, however. Specifically, the present review could identify no reliable estimates of *the extent to which crash risk is increased as a function of how frequently a driver changes jobs*. Accordingly, a program of analysis was defined that, in its first phase, should be able to quantify these functions and test the statistical significance of the obtained relationships. Given the size and complexity of the MCMIS database, at the outset of this work it was also recognized that more extensive and in-depth analyses would probably be necessary to fully understand the relative importance of potential explanatory variables. Thus, the analyses reported below, while fruitful in their own right, are best viewed as a first phase of study to establish the empirical basis for conclusions regarding driver retention and safety.

The subject database for this analysis, MCMIS, is operated and maintained by the Federal Motor Carrier Safety Administration (FMCSA). It contains information on commercial motor carriers and hazardous materials shippers subject to federal regulations that, in principle, can be sorted and filtered by public and private sector users as desired within the constraints of the Privacy Act of 1974. This Act restricts access to information that identifies individual drivers. For research purposes only, this restriction was waived for the present analysis. Driver, carrier, and crash data critical to this analysis were distributed across a number of files in MCMIS, in particular the Crash File, the Census File, and the Inspection File.

Beginning with State police-reported crash data containing a uniform set of data elements, a *Crash File* within MCMIS contains approximately 80 elements pertaining to the motor carrier, driver, vehicles, and circumstances of all incidents where trucks or buses are involved in fatal, injury, and tow-away crashes. Approximately 100,000 crashes per year are captured. Unfortunately, information on crash causation, contributing factors, or fault is *not* contained in MCMIS; such inferences must be made through analyses such as those performed in this project.

Also important for this work is the *Census File* in MCMIS. This file contains records for 600,000 interstate carriers and shippers. Each entity, which is assigned a unique identifying number, is coded in terms of extensive identifying information, classifications of its type of business and operations, type of cargo carried or shipped, number of trucks and drivers in its operations, and safety review data and ratings provided by FMCSA.

The FMCSA *Inspection File* data tables in MCMIS were equally critical in the present analyses to establish links between drivers and carriers at specific points in time. The file contains information recorded at every State and Federal inspection action conducted at roadsides throughout the U.S., in the majority of cases, under the Motor Carrier Safety Assistance Program (MCSAP). Carrier, driver, and violation information derived from 2.3 million annual safety inspections is recorded in nine tables within the *Inspection File*; together, these tables include 3 gigabytes (GB) of inspection data for each year.

The methods and results of this analysis were first to develop a measure of the job change rate for commercial drivers, and then to determine its relationship with their level of involvement in single and multiple crashes. These are described in the following pages.

Methods

Prior to conducting statistical analyses, the MCMIS data had to be imported into a database where they could be more easily sorted and manipulated. Extensive filtering was also required to remove invalid or poor quality records and to correct registration errors of the elements within multiple data tables. All of the steps described in this section were conducted using Microsoft Access and standard text processing software.

Initial Data Formatting

Complete and unrestricted MCMIS files, upon receipt from FMCSA, were imported into Microsoft Access. Due to the 1 GB table size limit in Access, each of the tables had to first be linked as external text files and then parsed using Structured Query Language (SQL) programs with Microsoft Access. The parsing was performed by converting the provided Oracle control files (.ctl extension) into SQL format using a conversion program developed especially for this project. The resulting SQL text files were then pasted into the SQL view within Access.

Once the SQL files were created, tables were constructed containing only those variables that were required for this analysis. This was done to reduce the size of each table to less than 1 GB. This allowed individual tables to be readily imported into Access databases, which improved the speed of data processing.

Description of MCMIS Tables Used in the Analyses

The key data requirements for this analysis included driver information that could be linked to corresponding job history and crash records. The following tables from the MCMIS database were used in this analysis.

INSPECTION (INSPECT) *Table (6,395,644 records)*

This is the main inspection table containing information obtained during commercial motor vehicle inspections. It includes variables that identify the report state (RPTSTATE), report number (RPTNUM), inspection date (INSPDATE), start hour (STHOUR), start minute (STMIN), end hour (ENDHOUR), end minute (ENDMIN), region (REGION), inspector code (INSPCODE), site code (SITE), and facility code (FACILITY), as well as the shipper, the carrier, hazardous materials carried (if any), and the results of the inspection. Inspection violations include driver, vehicle, and hazardous material violations. Violation severity is indicated by out-of-service (OOS) violations, which are serious enough to take the vehicle or driver off the road until the circumstances which caused the violation are resolved.

The primary linking (or key) variable for all inspection tables is Report Number (RPTNUM). In order to obtain *unique links* among records in separate inspection tables, it was necessary to link to Inspection Report State (RPTSTATE), Inspection Date (INSPDATE), and Inspection Start Time (STHOUR, STMIN). This is due to the fact that there are redundant report numbers for records that appear to be from separate inspections. For example, there were two records with report number "00ZA000118." Both inspections were conducted in Massachusetts but on different days and for different census numbers.

DRIVER INSPECTION (INSPDRIV) *Table (6,395,644 records)*

This table contains driver information obtained during inspections. In addition to the linking variables (RPTSTATE, RPTNUM, INSPDATE, STHOUR, STMIN) this table contains driver license number, name, date of birth, license state, and start time for the inspection. This table was used to define the Master Driver License table, which was an important step in producing the final analysis file.

UNIT INSPECTION (INSPUNIT) *Table (11,207,792 records)*

This table was used to obtain the type of vehicle and the number of units. The number of times a particular record number is repeated corresponds, in part, to the number of units for the inspection. For example, semi-trailers (coded as ST) are treated as separate inspections for a given report number.

CENSUS Table (857,859 records)

Information for each carrier entered in the MCMIS database is entered in this table. In addition to a census number, which is linked to driver/inspection/crash data, this table contains critical information pertaining to each carrier such as carrier classification (13 classifications including authorized-for-hire, exempt-for-hire, and private), and cargo classification (30 classifications including general freight, household goods, and metal/sheets/coils/rolls).

Of the 857,859 carriers recorded in this table, the vast majority (760,483) are interstate carriers.

ACCIDENT Table (867,365 records)

Crashes involving carriers are recorded in this table. Most importantly, the license number of the driver involved in the crash is recorded; this provided the primary linking variable with the inspection data. Other important variables in this table are carrier information, road geometry, vehicle information, road surface condition, weather condition, light condition, driver condition, sequence of events (1 to 4), crash location, and number of vehicles in the crash.

Preliminary Filtering Steps

The first step in producing an analyzable database was to filter through all records and find valid driver licenses. The following filter steps, conducted in Access, were applied to the INSPDRIV table to obtain a master list of valid driver license numbers:

- *State Filter*: Exclude records where the state of the report and the driver's license state were not equal to one of the following state codes (listed approximately north to south by region):

  Eastern states: ME, VT, NH, NY, MA, CT, RI, PA, NJ, DE, MD, DC, VA, NC, SC, GA, FL, WV
  Central states: ND, MN, WI, MI, SD, IA, IL, IN, OH, NE, KS, MO, KY, OK, AR, TN, TX, MS, AL, LA
  Western states: WA, ID, CO, MT, OR, UT, WY, CA, NV, AZ, NM

These 49 jurisdictions (including Washington, DC, but excluding Alaska and Hawaii) were included in the analysis. It should be noted that some of the entries for report state were "US." Fortunately, there is an entry for the state, district, or province of the county where the inspection took place that is also listed, in a variable labeled CCODESTATE. In almost all instances where "US" was entered for report state, the entry in CCODESTATE was an actual

state. Because of this, CCODESTATE was used to determine whether records were to be included in the analysis.

- *Driver License Filter*: The following entries for driver license were judged to be invalid and were filtered out:

  - Entries of "000", "000 000", "000 000 OOO", or "000 OOO OOO"
  - Any entry with one or more "#" characters for the entire field
  - Any entry with "NVOL" in any part of the field
  - Any entry with "JAL" in any part of the field
  - Any entry with "SON" or "SIN" in any part of the field
  - Any entry with 4 numbers together (such as "1111" or "9999")
  - Any entry with "UK" in any part of the field
  - Any entry with "UNK" in any part of the field
  - Any entry with "TEMP" or "TAMP" in any part of the field

It became apparent during this analysis effort that MCMIS contains a number of driver license numbers that have been entered incorrectly. For example, "0092345" might be entered correctly in one place, but elsewhere as ")092345". Although it is very likely that the later record belongs to the former driver, it was beyond the scope of this effort to attempt to find matches for all such cases, where the entry was off by one character, so these records were accordingly filtered out. It is assumed that such data entry errors are present in but a small percentage of all records; in any event, such errors may be taken into account in stating the study's conclusions since deleting such errors will always result in an *underestimation* in job change rates and crashes.

- *Inspection Number Filter*: Drivers with just *one inspection* had to be removed from the analysis because no driver variables can be estimated from one sample. *A priori*, it is most likely that the majority of these drivers did not change jobs, but there is simply no way to determine for whom one sample is sufficient.

It is important to note that 42% of drivers had only two inspections within the sample period of our entire analysis database, 1/2/98 to 6/28/01 (approximately 42 months). Allowing these drivers to remain in the analysis database raises the possibility that "number of jobs" could be undersampled for many drivers, i.e., a driver could have a large number of job changes but only two would be detected, because carrier information for that person would have been sampled on only two inspection dates. At the same time, it was recognized that two inspections would be sufficient for an accurate measure of the number of jobs held by some drivers—those who changed jobs only once or not at all during the timeframe bounded by the two inspection dates. The practical consequence of this limitation in the present analysis is that the obtained relationships between job change rate and crash experience may be understated; this could occur if a substantial number of drivers with high job change rates go undetected because they also happened to be among those who were sampled in the fewest roadside inspections.

For drivers with *two or more* inspections, the representativeness of the sample depends on the specific number of inspections, and also on the time interval between inspections relative to the number of job changes and time between the job changes. When the number of samples

(inspections) and the number of jobs are the same, the data will tend to *underestimate* the actual number of jobs. For example, if a particular driver has had six inspections and for each of those six inspections a different census number was recorded, then it is likely that the driver had more job changes than the data indicate. This well-known problem of undersampling the distribution, and its implications for this study, are discussed in the report conclusions.

- *Census Number Filter*: This number, also called the DOT Number, is a unique number given to all carriers included in the MCMIS census database.

A number of records had entries of "00000000" for census number. Since these invalid entries would have artificially increased the calculation of job change rate, they were eliminated.

- *Inspection Sampling Period Filter*: Inspection sampling period (ISP) was calculated for each driver by taking the difference between the maximum and minimum valid inspection dates.

ISP is an important measure of sample quality. However, at some level, this value is simply too brief to serve as a representative sampling interval. Unfortunately, there are no clear guidelines in this area. For example, an ISP of one month was judged to be unacceptable, and drivers with less than one month between their first and last inspections in the database were removed from the analysis. But is an ISP of one year too brief to obtain a representative sample? In order to define the optimal ISP cutoff, a detailed analysis of the data was required to determine the value that minimizes sampling bias while including enough cases for meaningful analysis. If it is the case that 90% of the drivers have ISPs over one year, increasing the cutoff value to obtain better sample quality would be beneficial. This operation is very difficult to do in Access, however. The definition of the ISP cutoff was thus determined using the statistical analysis program SYSTAT, during development of our Preliminary Analysis File.

Preliminary Analysis File

A Preliminary Analysis File resulted from applying the filters described above. After eliminating unusable records according to the indicated filtering strategies, the total number of records from the INSPDRIV table included in the analysis was 5,039,176 (out of 6,395,644). This represents 944,563 drivers. The resulting list of 944,563 drivers was then used as the master list of eligible drivers for this analysis.

The Preliminary Analysis File containing 944,563 drivers—plus relevant inspection and crash data—was imported into SYSTAT from Access. Specific data imported to perform the Phase 1 analyses included:

- DRLICNUM$: Driver's license number
- MINOFINSPDA$: Minimum (earliest) inspection date
- MAXOFINSPDA$: Maximum (latest) inspection date
- INSPDATEDIFF: Difference (in days) between latest and earliest inspections (sample interval)
- COUNTOFDRLIC: Number of inspections (sample size)

- COUNTOFCENSN: Number of unique jobs
- COUNTOFUNITT: Number of unique unit—or vehicle—types
- BO1YR: Count of crashes occurring *over 1 year before* earliest inspection
- B1YR: Count of crashes occurring *1 year before* earliest inspection
- DYR: Count of crashes occurring *during* inspection sampling period
- A1YR: Count of crashes occurring *1 year after* latest inspection
- AO1YR: Count of crashes occurring *over 1 year after* latest inspection

Determination of an Optimum ISP Cutoff Value

As explained in the following pages, a critical inspection interval of 24 months was defined as the optimum ISP, to minimize known sources of bias in the analyses while preserving as large a number of drivers (and crashes) in the analysis as possible. Because this cutoff value in effect determines exactly which drivers (and linked data elements) are finally analyzed to quantify the relationship between job change rate and crash experience, it is important to understand the rationale behind its selection.

The MCMIS data serving as input for these analyses included 6,395,644 inspection records obtained from January 2, 1998 to June 28, 2001 and 867,365 crash records obtained between July 5, 1988 and June 23, 2001. After filtering out unusable inspection records, the number of drivers included in the Preliminary Analysis File was 944,563, as noted above.

The inspection sampling period (ISP) impacts data quality in this analysis because (1) it limits the minimum endpoint of driver parameters involving time—such as the number of jobs and job number rate—and, (two) the longer the inspection interval, the more likely it is that a driver will have more inspections.

The inspection sampling period was calculated for all 944,563 drivers in the Preliminary Analysis File by taking the difference, in days, between the first and last inspection recorded in the database for each driver. The distribution of resulting ISP values for each driver is plotted in Figure 1. The mean of this distribution is 393 days (1.08 years), the standard deviation is 263 days (.72 years), and range is 0 to 1,263 days (3.46 years).

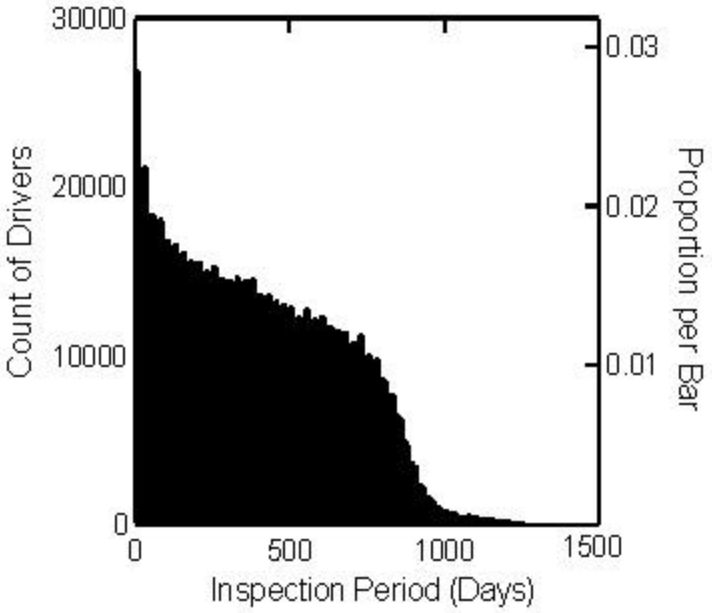

Figure 1. Distribution of inspection periods for drivers in the Preliminary Analysis File.

Although it is clear that drivers with very brief ISPs should not be included in the analysis, it was difficult to define *a priori* what cutoff should be used. Several concerns impacted upon the eventual decision to use a 24-month cutoff value.

First, the number of inspections experienced by a given driver was of concern; as the number of inspections increase, so do the number of jobs and job changes that can be detected. With no ISP cutoff, the correlation between these variables was $r = .35$. At the same time, too brief of a sampling interval would result in a dataset containing a majority of drivers with an insufficient number of inspections for a valid analysis. As discussed earlier, only drivers with a minimum of two inspections could be included in this analysis. Accordingly, the number of drivers with only two inspections was examined, as a function of sampling interval. Not surprisingly, as ISP increased there was a monotonic decline in this measure. While the number of drivers with two inspections never reaches zero, the proportion of drivers with two inspections stabilizes after about two years. Consistent with this observation, at an ISP cutoff value of 24 months the correlation between the number and the period of inspections is much reduced ($r = .14$).

Another concern in selecting an optimum ISP cutoff value was the obvious relationship between inspection sampling period length and number of jobs; that is, using a longer sampling interval inevitably results in the detection of higher job counts. In fact, the correlation between these variables was calculated at $r = .33$ across all drivers in the Preliminary Analysis File.

Since inspection period and number of jobs are presumably independent events, a high correlation again suggests a possible bias in the analysis. It is not until a sample period of two years that the distribution of the number of inspections by driver becomes constant from month to month. In other words, at an ISP above 24 months, the month-to-month frequency distributions of number of driver inspections performed are nearly congruent, showing a mean sampling rate of slightly over 2.5 inspections per year. Furthermore, with an ISP of 24 months, the correlation of number of jobs with inspection sampling period is much smaller ($r = .07$). Thus, limiting the analysis sample to drivers with over two-year ISPs effectively eliminates any sample bias caused by ISP.

Figure 2 shows how many drivers had what numbers of inspections when the sampling interval cutoff is set at 24 months. The smallest number of inspections for drivers sampled in this interval was two; the largest number was 20. This means that bias caused by small ISPs has been effectively eliminated. However, the distribution shown in this figure also indicates that there are relatively few drivers who have had more than 10 inspections, which is another type of bias. In fact, drivers who are included in the sample when the ISP cutoff is set at 24 months have an average of 6.1 inspections (standard deviation = 3.2). Across the entire period represented by the MCMIS data, this translates to an average of 2.66 inspections per year.

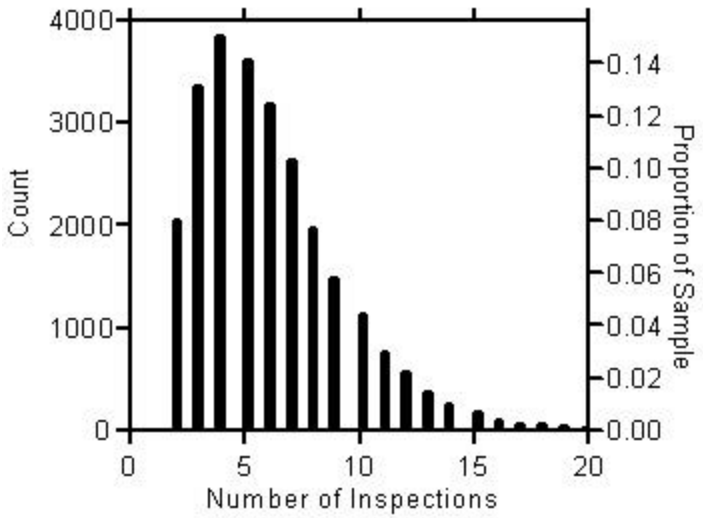

Figure 2. Distribution of number of inspections for drivers sampled using an ISP cutoff of 24 months.

The practical effect of the "inspection sample rate" noted above is a limitation in the maximum number of jobs that can be detected for any driver during the ISP. The analysis "undersamples" drivers with a high number of jobs, because job changes can only be detected during inspections, and as noted above there are relatively few drivers who have a high number of inspections during the ISP. To prevent such sampling bias, the sample rate must be greater than the maximum expected value for number of jobs, in fact it should be at least twice as high; this is typically referred to as the "Nyquist limit." And, this assumes equally-spaced intervals between inspections. Since this cannot be assumed to be the case for commercial drivers, a requirement to sample (conduct inspections) at *more than twice* the rate for the event being measured (job changes) is indicated, to eliminate this potential bias. Clearly, this is not feasible in the present analysis. The extent to which this analysis may underestimate the number of jobs held by drivers has implications for applying the study's findings; these will be discussed in the report's conclusions.

Based on the above considerations, the Preliminary Analysis File was filtered using an inspection sampling period (ISP) cutoff criterion of 24 months, before performing the calculations reported in the following section. That is, all drivers included in this analysis had a period of 24 months or more between their earliest and latest inspection dates recorded in the database. As discussed, it was judged that this criterion would maximize the number of records in the Final Analysis Dataset while minimizing sample bias.

Results

After applying the 24-month ISP cutoff criterion to the Preliminary Analysis File, the relationship between number of jobs and job change rate (annualized) and crash experience was analyzed for all crash-involved drivers captured in the sample. It should be reiterated that the approach in this analysis is inspection-based, i.e., all driver information was recorded during routine roadside inspections, during an inspection sampling period (ISP) that was at least 24 months long for every driver included in the analysis.

Relationships between job changes and both single and multiple crash involvements were examined for a dataset, resulting from the application of the 24-month ISP cutoff that contained 174,394 crashes distributed among 147,058 drivers. As a frame of reference for the analyses that follow, it should be noted that the number of drivers with at least one crash (147,058) represents 15.6% of the total number of drivers in the Preliminary Analysis File (944,563), while 13,530 drivers or 1.4% of drivers were involved in two or more crashes.

Partitioning of Crash Records

The crash records imported from MCMIS included events that occurred before the first inspection and after the last inspection during the ISP for each driver. Assuming that crashes occurring well before or after job changes are unrelated, crashes were partitioned into separate bins as shown in Table 1, so that crashes occurring during the ISP could be isolated for the present analyses. In a later phase of analysis, a comparison of drivers' crash experience over time could potentially provide insights about the extent to which crashes during the ISP may be explained by a history of safety problems in addition to, or perhaps instead of, the phenomenon of job hopping, *per se*. This level of analysis exceeded the present scope of work, however.

Table 1. Temporal distribution of crashes in the database relative to ISP.

Cell Counts are for:	Over 1 Year Before ISP	1 Year Before ISP	*During ISP*	1 Year After ISP	Over 1 Year After ISP
All Crashes (174,394 crashes)	99,400	25,201	*38,288*	10,294	1,211
Drivers with 1 or more crashes (147,058 drivers)	86,344	24,512	*36,619*	10,082	1,185
Drivers with 2 or more crashes (13,530 drivers)	11,138	669	*1,585*	204	26

What may be noted with respect to the data displayed in Table 1 is that a moderate negative correlation was found between the frequency of drivers' crash involvements in the "over 1 year before ISP" bin versus the "1 year before ISP" bin (r = -.29) and a strong negative correlation was found between the frequency of drivers' crash involvements in the "over 1 year before ISP" bin versus the "during ISP" bin (r = -.51). A sampling artifact may account for this finding. Alternately, these outcomes could reflect the rarity of crashes, such that drivers who have a crash in any earlier period are less likely to experience a crash in a later period than drivers who did not have a crash in the earlier period, when the entire population of drivers is considered. Additional analyses would be required to better understand these data.

Analysis Variables and Outcomes

The key variables in this analysis are events (crashes) and driver factors. Only crashes occurring within the ISP were analyzed, and two outcome variables were defined by these events. Specifically, for each driver it was determined whether he or she was involved in *a)* one or more crashes within the Inspection Sampling Period, and *b)* two or more crashes within the Inspection Sampling Period. These measures were both used as outcome variables because it was judged that a stronger inference of fault can be made when a driver has been involved in multiple crashes. In other words, there will always be a great deal of random error when attempting to account for variance in crash occurrence, which makes any inference of fault problematic in the absence of contributing factors or fault codes in the database. However, if a driver has multiple crashes within the ISP, it is assumed to be somewhat more likely that he/she was at fault in at least one of these events. This is important in the present analyses because, if

statistical tests revealed a relationship between job hopping and safety, it was hypothesized that this relationship would be demonstrated most clearly and at the highest levels of significance for at-fault crashes.

The Final Analysis Dataset consisted of 25,609 drivers with inspection periods over 24 months. Of these, 16,249 had no crashes and 9,360 had one or more crashes. Of the latter group, 8,797 had one crash, and 563 had two or more crashes.

Next, although MCMIS contains a number of driver variables of potential interest, the number of jobs is the most fundamental to this analysis. Deriving the number of jobs, and the associated measure of job change rate, was a primary analysis task. For all drivers in the Final Analysis Dataset, number of jobs was calculated by excluding null values ("00000000") and missing values which would have artificially elevated the job counts for some drivers, then counting the number of *unique* census numbers associated with each driver's license number. To illustrate, consider a driver whose inspection records indicate two job changes: Job 1-to-2 and then Job 2-to-3 (a total of 3 jobs). However, Job #1 and #3 are with the same carrier. In the current analysis, the second job change was *not counted*; accordingly, the number of jobs for this driver would be two. This approach reflects the judgment that a job change back to a former employer, especially within the relatively short timeframe of this sample, connotes lower risk relative to a job change to a new carrier.

The first analysis outcome is shown in Figure 3, which contains frequency distributions for drivers with 1 or more crashes (black bars) and drivers with no crashes (white bars) during the ISP, as a function of the number of jobs. The plot indicates that there were more drivers without crashes than drivers who were crash involved, among those who had only one job during the ISP. But, for drivers who had two or more jobs during the ISP, more of the drivers sampled were crash involved than were crash free.

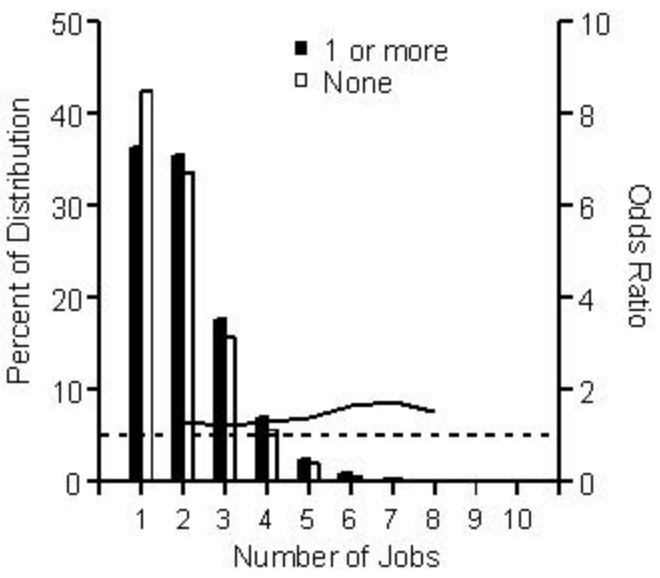

Figure 3. Frequency distributions of crash-involved and crash-free drivers as a function of number of jobs during the sampling period.

The statistic used to measure the strength of this relationship is the *odds ratio*. As shown in Figure 3, an odds ratio (OR) value is calculated at each step along the x-axis. This value is represented by the curve superimposed over the bar graph, and may be read from the right vertical axis. The OR value expresses the odds that a driver will be crash-involved if he or she has had a given number of jobs (i.e., as indicated on the x-axis) versus the odds of being crash-involved if he or she has had less than the indicated number of jobs. In effect, an OR value predicts the risk of a negative outcome. The dashed line in Figure 3 indicates a "reference value" of 1.0; at this OR, the number of jobs a driver has had in the ISP makes no difference, in terms of the odds of being crash-involved.

As an example, Figure 3 shows that, for drivers with six or more jobs during the ISP, the calculated OR is 1½ or slightly more (actual value = 1.6). This means that the odds of being involved in a crash if a driver has had six or more job changes during the ISP is increased by a factor of 1.6 compared to drivers with fewer than six jobs. This is a statistically significant difference (χ^2 = 14.47, p<.0001), however, its operational significance may be slight. This issue will be discussed after additional results are presented.

The same data presented in Figure 3 are reformatted in Figure 4 using a logarithmic instead of a linear scale on the y-axis. This change makes it easier to observe the relative counts of crash involved and crash free drivers at each number of jobs marked on the x-axis. At each step along the x-axis in the direction of increasing number of jobs, the height of the black bar (representing the proportion of drivers who were crash involved) exceeds the height of the white bar (which represents crash free drivers) by an increasing amount. The log transform does not alter the calculated odds ratio values, thus the OR curve remains the same in Figure 4 as in Figure 3.

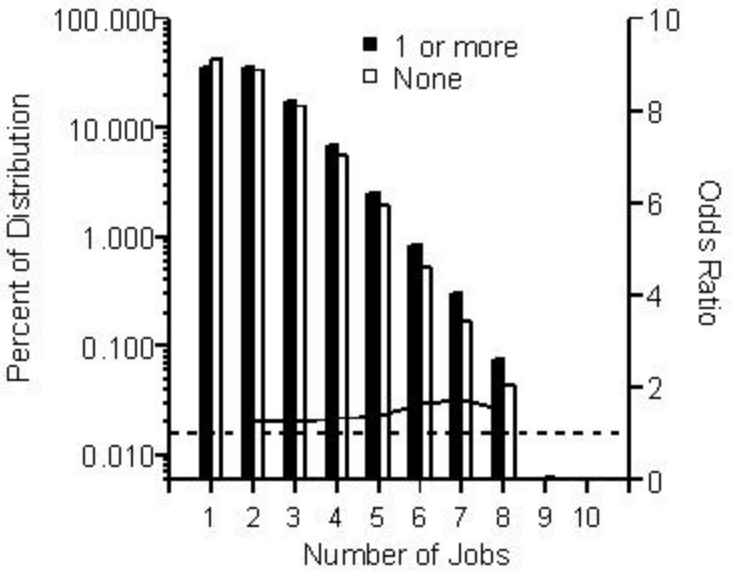

Figure 4. Log transformed distributions of crash-involved versus crash-free drivers as a function of number of jobs during the sampling period.

Next, the identical relationships were analyzed using the more stringent safety measure of *multiple* crash involvement. Specifically, odds ratio calculations were performed comparing the distributions of drivers who are crash free and drivers with two or more crashes within the sampling period. Figure 5 plots these relationships as a function of the number of jobs held by drivers within each group. In Figure 6, the same data are transformed logarithmically, to highlight the differences between the analysis groups.

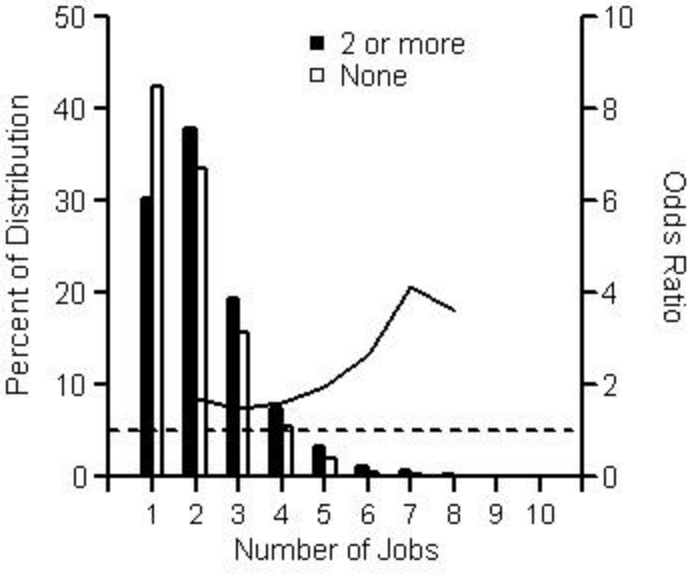

Figure 5. Distributions of multiple-crash-involved versus crash-free drivers as a function of number of jobs during the sampling period.

What is apparent in examining both Figure 5 and Figure 6, are the higher OR values found as number of jobs increases.

Now, for drivers with six or more jobs during the ISP, the calculated odds ratio is 2.2 versus 1.6 when the safety measure was single crash involvement. While this OR is significant (χ^2 = 6.96, p<.01), the test statistic is actually lower than that calculated for single crash involvement. This is due to the much smaller number of drivers in the sample with multiple crashes, which results in a loss of statistical power. At the same time, the operational significance, which is presumed to be tied to the value of the odds ratio itself, has increased. As before, the proportion of drivers who were involved in multiple crashes begins to exceed the proportion who were crash free at the level of two jobs during the ISP, and the separation in bar height between the black bars and the white bars grows steadily as the number of jobs increases.

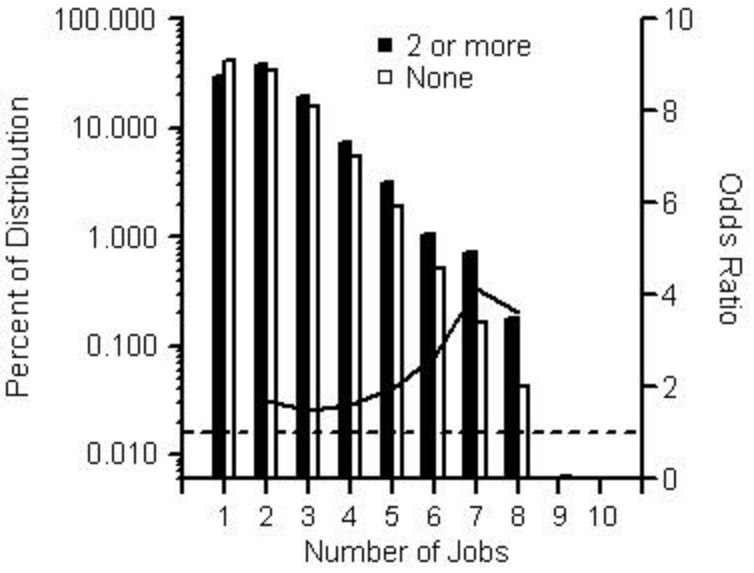

Figure 6. Log transformed distributions of multiple-crash-involved versus crash-free drivers as a function of number of jobs during the sampling period.

To assist in developing recommendations, the Final Analysis Dataset was re-analyzed to express the present findings in terms of an annualized job change *rate*. This will, in effect, normalize the crash and driver data using the 'common denominator' of number of jobs per year (NJY). NJY is derived by dividing the number of jobs held by each driver during his/her sample period by the length of the ISP (in years). One important benefit of this approach is that it controls the variation in ISP from driver to driver, and permits the comparison of drivers with similar rates of job change.

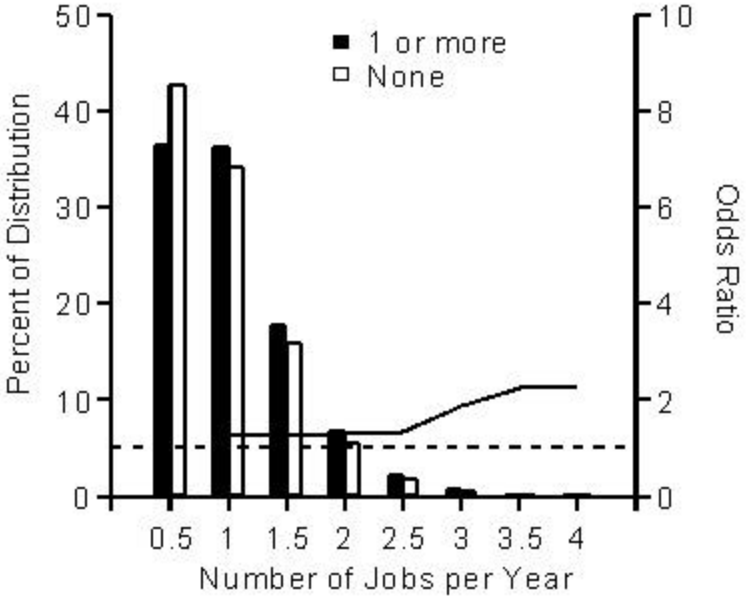

Figure 7. Frequency distributions of crash-involved and crash-free drivers as a function of (annualized) job change rate.

Figure 7 presents the results of odds ratio calculations comparing the proportions of drivers with one or more crashes and drivers who were crash-free as a function of job change rate. As shown above, there is a break in the curve indicating that the odds of being involved in a crash versus the odds of being crash-free begin to climb sharply when a driver has changed jobs at a rate exceeding 2.5 jobs per year.

Figure 8 presents the relationship between number of jobs per year and the odds of commercial driver crash involvement calculated in this analysis using the same type of log transform plot described earlier. This figure shows the same monotonic increase in crash risk for drivers who have over 2.5 jobs per year that was displayed in Figure 6, but more clearly illustrates the disparity between the proportions of crash involved and crash free drivers as job change rate rises above this critical level. It may be noted that all calculated OR values are statistically significant ($p<.01$) for NJY values of 3 and under. OR values at 3.5 and 4, though of greater magnitude, are not statistically significant due to low counts of drivers in those analysis conditions.

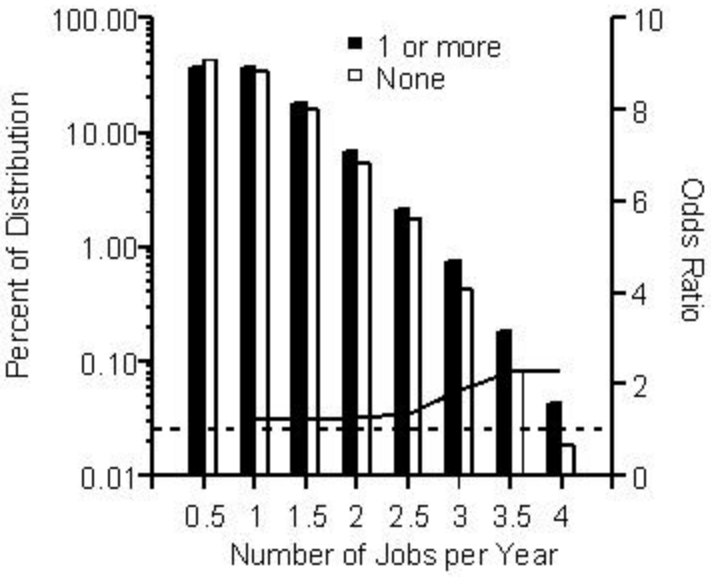

Figure 8. Log transformed distributions of crash-involved versus crash-free drivers as a function of (annualized) job change rate.

Finally, the results displayed in Figures 9 and 10 reflect the more focused analysis comparing crash-free drivers to those drivers who have been involved in multiple crashes. It should be emphasized that the baseline group of drivers without crashes remains constant. Also, the out-come variable remains dichotomous, as drivers with one crash simply were excluded. As discussed earlier, it was felt that a stronger case could be made that at least one incident for these drivers would reflect an at-fault crash, and that differences between safe and unsafe drivers would become more pronounced under these analysis conditions.

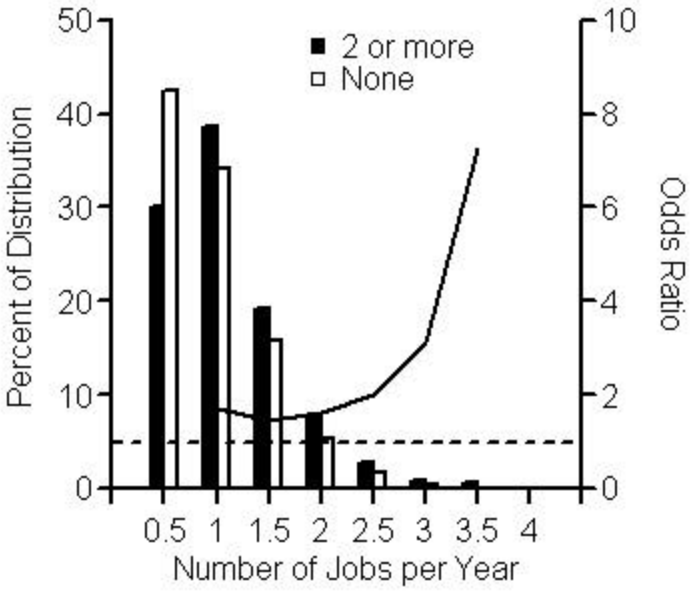

Figure 9. Distributions of multiple-crash-involved versus crash-free drivers as a function of (annualized) job change rate.

In Figure 9, the linear plot of these analysis results shows that calculated OR values increase as a function of number of jobs per year. A gradual increase in this function is apparent at the level of two jobs per year, with a slightly steeper slope evident at a job change rate of 2.5, then a dramatic upturn at the level of 3 jobs per year. The difference in the proportion of multiple-crash-involved drivers is statistically significant at an NJY of 2.5 ($\chi^2 = 7.1$, $p<.01$), but at higher levels of number-of-jobs-per-year there are too few individuals for test results to be reliable.

In Figure 10, the logarithmic transformation of the y-axis values more clearly illustrates the increasing disparity in the heights of the black versus the white bars as number of jobs per year increases, connoting a systematic trend towards higher relative proportions of drivers with two or more crashes.

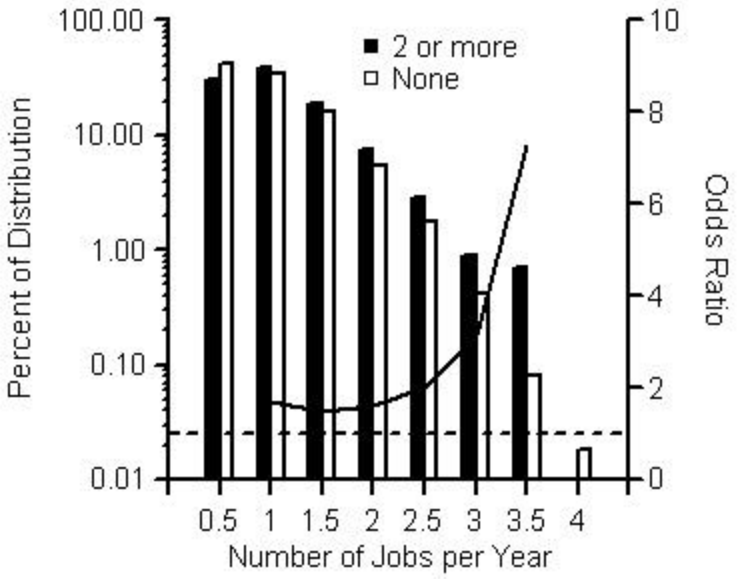

Figure 10. Log transformed distributions of multiple-crash-involved versus crash-free drivers as a function of (annualized) job change rate.

Summary

These analyses have examined the relationship of safety records of crash-involved commercial drivers with the number of jobs they have held, or more precisely their job change rates, over a sampling period of at least two years. Of course, at any *particular* job change rate, some drivers in the analysis sample will have been crash-involved and some will not. What has been found in these analyses is that the relative proportion of crash-involved drivers to non-crash-involved drivers in the sample increased, without exception, as the job change rate increased. This relationship was most pronounced when the analyses focused on multiple instead of single crash involvement, as would be expected if, as assumed, this outcome variable connotes a greater likelihood of operator error, negligence, performance failure (i.e., driver factors), etc. as the cause of the crash.

Quantitatively, these analyses relied upon the calculation of odds ratios to express how much more likely single or multiple crash involvement was for drivers in the present sample if they held a specified number of jobs or evidenced a specified job change rate, versus if they did not[1]. Generally speaking, when a driver has changed employment more than two times a year, the odds of that driver being crash-involved begin to increase relative to drivers who have averaged two or fewer jobs per year. This increase in risk is gradual at first, then accelerates as the job change rate increases. If a driver has averaged three or more jobs with different carriers each year, during an employment history that is two years or longer, the calculated odds of being involved in an at-fault crash reach a level that is *more than twice as high* as they are for drivers with lower job change rates.

An improved understanding of the variables mediating this apparent relationship between increasing job change rates and the odds of being crash-involved could be explored through later, more in-depth analyses. In particular, it might be learned whether it is the number of jobs *per se* that controls these relationships, or whether they also (and perhaps even more strongly) depend upon changes in cargo types, geography, carrier characteristics, or some other factor(s).

[1] It may be demonstrated that the results of calculations using an alternative methodology, *relative risk* analysis, are the same as the results of the odds ratio calculation when critical outcome (crash) event counts are small.

STATE-OF-THE-PRACTICE: A REVIEW OF TECHNICAL LITERATURE

The prior analysis results reinforce a broad understanding among those in industry and government that new hires tend to be more prone to crashes and that, while experience *per se* is an important predictor of safety, even experienced drivers who change jobs represent an increased crash risk during the first three-to-six months with the new carrier. The following review of the technical literature updates the research that exists concerning why drivers change jobs and how job-hopping might be reduced, with a focus on factors *other than* the level of compensation a driver receives.

To introduce this review, it should be emphasized that the factors known to influence motor carrier safety, aside from compensation, are many and complex, and logically will interact to varying degrees with length of employment. Generally speaking, for example, the less training a driver has, the greater the likelihood of a crash. Drivers who maintain union membership have fewer crashes overall than non-union drivers. Drivers who carry varying load and cargo types; travel unfamiliar routes; exceed hours-of-service guidelines; and are assigned the least-preferred, most congested roads, and travel times are also likely to have the shortest tenure on the job. As discussed below, improved practices in at least six areas hold the potential to improve driver retention and, consequently, commercial motor carrier safety:

- Driver selection and hiring
- Training procedures
- Dispatch operations
- Working conditions for long-haul operators
- Safety-related rewards and incentives
- Improving perceptions of the truck driving profession

Driver Selection and Hiring

The tremendous demand for qualified truck drivers has placed a burden on companies' recruiters. It has been reported that there is such a demand for truck drivers that some recruiters will hire unqualified drivers, if the alternative is having trucks sit idle in their lots (Lemay, Taylor, and Turner, 1998). On a more positive note, processes documented in this review indicate that many fleet recruiters take up to two weeks checking out potential drivers. They conduct complete background checks, as well as give drug tests and a thorough physical, including a back x-ray. Psychological tests are also given. These efforts are time-consuming and expensive, but in the long run, more cost-effective than having to recruit and hire again (Mele, 1989; Lemay, Taylor, and Turner, 1998).

The most important tool for screening potential drivers is the information on an employment application. In many cases, that information will not be correct or complete. Employers must verify every statement on the application. First, driving history information should be checked. Practically all State DOTs will provide this information within 24 hours. Next, employment history should be checked. This is more difficult because many companies have merged or gone out of business. Still, as suggested by the analyses conducted in this research, a driver's job change rate over the most recent 2-year period for which data are available could be a useful predictor of future safety problems. Recruiters should require applicants provide copies of W-2 forms for previous years and/or obtain a list of previous

employers from the Social Security Administration to verify their employment history.

Third, if attendance at a truck driving school is listed on a driver application, it should be verified. Fourth, an applicant's credit history should be checked. In addition, employers should determine whether an applicant has any criminal history. Some effort may be necessary to ensure that requests for this information are filed with the correct jurisdiction; because such requests are important, especially for companies that haul bonded loads or that cross international borders (Modern Bulk Transporter, 1996).

Finally, while background checks and mandatory drug tests and physical examinations are very important, the use of psychological tests also deserves consideration in the selection and hiring process. Without endorsing any particular instrument, the experience of recruiters who perform such tests confirms their potential to determine if a job candidate can handle the stresses of the profession. Related instruments are used to obtain recruits' answers to questions dealing primarily with attitudes toward safety and professional truck driving; this "occupation analysis" of the driver's responses helps predict job performance and equally important, points out potential problems with suggestions for management to address those problems (Skipper, 1995).

One area of concern with the recruitment process is that many recruiters only present potential new drivers with the positive aspects of the job, downplaying what might be perceived as troublesome areas. Truck companies with low driver turnover not only conduct extensive screening and background checks, they also provide interviewees with accurate information on what the job entails. This includes an emphasis not only on benefits that the company offers, with full disclosure of its compensation practices including time or activities for which drivers are *not* compensated, but also a description of its human resource policies and safety programs (Lemay, Taylor, and Turner, 1998). Allowing company drivers themselves to participate in the recruiting and selection process also helps recruits attain a clear understanding of actual job conditions (Inderbitzen, 1995).

Recruiters have found that it is to the long term advantage of both the driver and the employer to accurately convey to potential drivers what the demands of the job will be, and also to communicate this with their spouses. This is most important when hiring someone new to the profession. The goal is to ensure that both people recognize the significant lifestyle adjustments for a long-haul, over-the-road truck driver (Skipper, 1995). The industry has identified a need to attract drivers at an earlier age to get people to consider trucking as a first profession, not as an afterthought (Schulz, 1996). For novices in the 18-26 year old group, family support can be critical to staying on the job, and a realistic expectation of what the job entails by both driver and spouse is a necessary precondition.

One very effective practice in this regard is to provide recruits with an orientation period. Orientation programs give recruits a chance to see all operations within the company, from the mail desk through payroll and sales, and to learn about the procedures and responsibilities of their driver managers and dispatchers. Spending a period of time on the road with an experienced driver can be the most helpful to a recruit; this allows beginning drivers to evaluate their desire to enter the profession, which may require substantial costs to attend a driving school, and gives experienced drivers a feel for those aspects of day-to-day operations that most strongly affect him or her (Davis, 1995). A similar concept is for companies to offer "trucking apprenticeships," where recruits are placed with established drivers for on-the-job experience to complement classroom training in a state's vocational education system (Transport Topics,

1995).

This section concludes by noting that better selection and hiring practices, such as conducting comprehensive background checks on recruits; performing drug, physical, and psychological testing; and taking whatever steps are necessary to present recruits with an accurate picture of what the job entails, can be accomplished at a relatively modest cost that is paid back many times over through the hiring of more qualified drivers who will stay with the company. If this research is accurate, they will also perform their jobs more safely.

Driver Training Procedures

Companies have provided training programs for many years. However, the practice is evolving and becoming more far-reaching as the needs of the drivers change and standard-setting organizations become more involved. In the past, many "finishing" programs simply involved having a novice travel for a few weeks with an experienced driver, but in recent years training programs have become more sophisticated. The Professional Truck Driving Institute (PTDI), an organization that establishes standards for driver education, has set criteria for accredited finishing programs (Johnson, 2000).

Recent enhancements to traditional training programs focusing exclusively on technical or safety-related subjects include an emphasis on company policy and procedures, including, for example, the maintenance of logbooks, customer relations, and material which makes explicit the lifestyle of the long-haul driver (Modern Bulk Transporter, 1996; Johnson, 2000).

On-road components of current training programs supplement classroom instruction, addressing such topics as defensive driving, logbooks, and securing loads with a driver trainer who evaluates a new driver's safety knowledge and situational awareness in a real-world driving context. The driver trainers for this type of course themselves receive training that covers what they'll be teaching recruits, plus adult learning theory and communication skills (Johnson, 2000).

The most progressive training programs offer drivers the potential for advancement to other positions in the company, whether it be in management or sales (Mele, 1989). If drivers receive training that allows them to advance in a company, they are less likely to change jobs. Training should be designed to prepare drivers for promotion through company ranks. Although driving may remain a driver's primary task, other jobs such as training or crash investigation could be a part of a career path. Other opportunities might be a move into dispatch or the safety department (Modern Bulk Transporter, 1996).

Driver finishing programs are valuable to carriers not just because they improve driver safety, but also for economic reasons. These programs reduce a carrier's liability for a lawsuit in the event of a crash, and many insurance companies are beginning to scrutinize carriers' training programs when writing policies (Johnson, 2000).

Follow-on training for experienced drivers is also very important. Such training ranges from one-time courses to continuing programs. Many companies use safety manager instruction, videos, or multi-media presentations to make sure their drivers are safety conscious and fully knowledgeable about DOT regulations, especially for drug and alcohol requirements, and to provide instruction on nutrition, sleeping, and other fitness-to-drive issues that supplement

traditional safety content. In addition, such training gives drivers an opportunity to keep current with new technologies, including the use of on-board computers and global positioning system (GPS) navigational tools. PC-based training can often be scheduled at the driver's convenience, with a requirement only that they complete the program of instruction within some assigned interval. Continuous programs have a demonstrated potential to reduce crash risks (Beilock, Capelle, and Page, 1989; Thompson, 1996).

A comprehensive training program, that not only addresses technical and safety requirements, but also devotes attention to lifestyle issues and to the personal challenges truckers face in their profession, conveys a message that the company cares about them and wants them to succeed. The payoff carriers can anticipate from providing this level of training through initial course work and on-road instruction, and on a continuous basis for experienced drivers, not only includes gains in safety and productivity but also results in drivers who feel more committed to the company (Johnson, 2000).

Dispatcher Operations

Dispatchers, often called fleet managers, are responsible for finding and assigning loads to drivers and providing the logistics to coordinate loads from destination to destination for their assigned fleets. A fleet manager's performance is measured by driver productivity, driver turnover, miles running, fuel economy, accidents, cargo, and other aspects of operating a fleet (McCullough and Ryder, 1990). Many dispatchers work in an office with maps, charts, and other screens that constantly monitor weather, company performance, computer message boards, and other information that helps them manage their fleet and driver resources as efficiently as possible. It is a stressful job; dispatchers get caught in the middle trying to make things work for the trucker as well as the company.

Dispatchers are measured by their performance, and the only way to achieve successful performance is for each dispatcher to work as closely as he or she can with his or her assigned team of truckers. An effective team requires honesty, trust, and dependable communication. Truckers know that without dispatchers quickly finding and coordinating loads, they would have a hard time tracking down enough hauls to stay in business (Hanson, 1993).

However, there is a high turnover among dispatchers. This creates a situation in which dispatchers often do not know the drivers personally. Truck drivers get very frustrated when they call in for location checks or other information and find out it's a new dispatcher (McCullough and Ryder, 1990).

In fact, available research indicates that the behaviors of dispatchers are a key influence on a driver's satisfaction and likelihood of remaining with a particular carrier (Taylor, 1991). Dispatchers deal with many driver issues. Drivers will call in for guidance and requests, including: job orders, directions, break time, maintenance time, time-off/vacation/sick, family emergencies, preference in type of load or destination, weather condition concerns, and explanation for delay (Hanson, 1993; and Hatfield, 1998).

A recent study by Keller and Ozment (1999), tried to identify the variables associated with dispatchers who have lower turnover among their drivers. They used drivers' exit interviews to identify dispatcher's attitudes, behaviors, personal demographics, and job characteristics. The sample was comprised of drivers who had voluntarily left the firm. These

drivers are more costly to a firm than those drivers who are fired or laid off. Results of the study suggested that dispatcher responsiveness, that is, the degree of action taken by a dispatcher to follow through and resolve driver issues, is important for reducing driver turnover. Dispatchers having more experience in their present dispatch position had significantly lower levels of driver turnover. It appears that experienced dispatchers may be better equipped to manage the retention of the drivers assigned as their responsibility. They may be more familiar with the drivers, as well, and thus more knowledgeable, helpful, and truthful. Not surprisingly, study findings indicate that dispatchers who route drivers home more often retain more drivers. However, it also found that younger dispatchers were associated with lower driver turnover, and the study authors suggested that their youth translated into an eagerness to satisfy drivers and a willingness to listen to their opinions that is much rarer among mature dispatchers (Keller and Ozment, 1999).

Credibility in communications between dispatcher and driver is a must. When the dispatcher promises that a driver will get home, such promises must be kept. Otherwise, drivers perceive it to be a breach of confidence. Company managers should monitor driver "due-home" dates and work with dispatchers to ensure that these deadlines are met, just as if they were customer "required delivery dates" (Wittenberg, 1998).

Carriers should be encouraged to reevaluate the number of drivers that can effectively be managed by a single dispatcher (Keller and Ozment, 1999). In addition, companies need to consider dispatchers' compensation packages based on performance criteria only. The retention of their drivers, as well as safety performance, needs to be considered as a measure of work performance.

Finally, training for dispatchers should incorporate human relations issues to better understand both the truckers' concerns and their job demands. Researchers suggest that managers foster organizational environments that promote healthy interpersonal relationships with drivers. Industry offers evidence that by developing such relationships, similar to those fostered with customers, firms may retain more drivers more effectively (Keller and Ozment, 1999). In this respect, the dispatcher is a critical link in the relationship between management and the driver.

Working Conditions for Long-Haul Operators

Driving a truck, especially long-haul, is a difficult lifestyle. There are long and irregular hours; poor living conditions on the road; and large amounts of time away from home. Often, according to the Gallup Organization (1997), these conditions are exacerbated by poor treatment from shippers, receivers, and even their own company personnel.

There is strong evidence of a link between the economic and scheduling pressures on drivers, and crashes and violations of hours-of-service-regulations (Corsi and Fanara, 1988; Williams and Monaco, 1998). In this context, it is not surprising that speeding is the most frequent factor in serious truck accidents (Page, 1988); a high proportion of long-haul drivers must violate hours-of-service rules or speed limits or both in order to maintain their schedules. One survey study in Florida found that from 17 to 30 percent of drivers exiting the peninsula had violation-suspect schedules. This study also showed that the average solo driver worked 58 hours weekly, including 46 hours of actual driving. A more precise breakdown showed that seventy-five percent of the drivers worked over 49 hours per week, including 39 hours of actual driving; and half the drivers exceeded 65 hours per week, with 52 hours of actual driving. Finally, a quarter of the drivers worked more than 81 hours per week, including 64 hours of actual driving time (Beilock, 1995).

Another report indicates that the typical nonunion long-haul driver puts in a 70 hour week, which is 10 hours more than the current legal limit. The long hours, combined with low pay, have combined to result in a situation where the average nonunion trucking firm now has to replace the equivalent of its entire work force every year (Longman and Yablon, 2000).

Analyses of how these working conditions affect safety revealed that truckers who drive in excess of hours-of-service regulations, young drivers, and interstate drivers are the most likely to have an increased relative risk of crash involvement (Jones and Stein, 1987). One study found early and late morning driving over multiple days associated with the highest crash risk. The lowest risk associated with the number of consecutive hours driving was during the first four hours, and the highest risk was beyond nine hours. While driver age and the number of hours off-duty immediately prior to a trip may not appear to significantly affect crash risk, driver experience and the number of consecutive hours driving do. Drivers with one to five years of experience comprised the highest risk, while drivers with less than one year of experience comprised the second highest risk group (Kaneko and Jovanis, 1992).

The National Transportation Safety Board (NTSB) has estimated that 31 percent of all truck-driver fatalities and 58 percent of all single vehicle truck crashes are fatigue-related (Schulz, 1998). Compounding the fatigue associated with long hours, over-the-road truckers experience irregular sleeping patterns and travel across different time zones. The disruption of circadian rhythms (biorhythms) that occurs with shift changes and crossing time zones can be extremely debilitating (Monaco and Williams, 2000).

Ameliorating the poor working conditions that contribute to driver turnover and safety problems is an urgent need in the industry. To a degree, this may result from the improved reliabilities and the amenities, including larger and more comfortable sleeper berths, which are found in newer model tractors. More and better rest areas, with greater capacity for safely parking tractor-trailers, also will help. And, modest reductions in transit times may be achieved through company-provided conveniences such as electronic toll passes. Finally, an essential

component in reducing the exposure of long-haul truckers to those working conditions that pose the most serious risks to health and safety is more effective monitoring and more stringent enforcement of carrier compliance with hours-of-service regulations.

Safety-Related Rewards and Incentives

Research indicates that a commitment to safety from management carries over to drivers, with results that show up in the bottom line. Companies surveyed said that, since their safety incentive programs were initiated, the incidence of insurance claims, workers' compensation claims, and crashes have been reduced by 65 percent, with one firm saving over half a million dollars (Kennedy, 1995). There are reasons to believe that providing such programs, and the way in which they are structured, could have a beneficial effect on driver turnover as well.

The features carriers include in their safety programs vary widely. These programs can provide incentives in the form of monetary rewards (e.g., savings bonds), bonuses, gifts, discounts at truck stops, and recognition programs (e.g., patches, pins, plaques, wallet cards, watches, or rings) (Kennedy, 1995).

Wilde concluded that incentive programs for truck drivers can be effective if they are operated under the following elements: managerial vigor, rewarding the "bottom line," attractiveness of the reward, progressive safety credits, simple rules, perceived equity, perceived attainability, short incubation period, stimulating peer pressure towards safe conduct, involving the family, employee participation in program design, prevention of accident under-reporting, rewarding multiple levels of the organization, supplementing rewards with safety training, and maximizing net savings versus maximizing benefit-cost. He also emphasized that incentive programs need to be tailored to take into account the differences in working conditions of different types of operators, including truck drivers employed by private companies, employed truck drivers operating for hire-trucks, owner-operators working under contract with private companies, and owner-operators active in for-hire operations (Wilde, 1995).

Many safety-related incentive programs include recognition for passing certain milestones for "accident-free" miles driven. Some carriers give ceremonies recognizing drivers for passing the one million and two million mile "accident-free" milestones. Trophies, gifts, and other items of recognition are given to these individuals. Safety bonuses also are very popular (Whistler, 1999). For some carriers, bonuses are earned through a point system. Each "accident-free" month, six months, and/or attendance at safety seminars qualifies drivers to earn points which transfer to bonus money that gets included into their paychecks (Kennedy, 1996).

Other carriers reward drivers who are crash free for a full year with a savings bond. The amount of the bond increases with each consecutive year of driving for the company—an important feature (Kennedy, 1996). Incentive programs that offer progressively increasing safety bonuses for longer and longer periods of crash free operation would be expected to give drivers a material reason for staying with their employers rather than moving to another place of work, where they would have to start again to accumulate safety credits (Wilde, 1995).

Improving Perceptions of the Profession

Evidence indicates that public perceptions of the truck driving profession today are ambivalent. In an ATA/Gallup survey, the overall view of drivers of large trucks was positive for 80 percent of the public. At the same time, 64 percent of the public felt that truck drivers exceed the speed limit frequently, and a majority believed that a substantial number of drivers engage in drug use, drinking, violence, and recklessness, and that truck drivers are more concerned with deadlines than safety. However, the public also feels that truck drivers are highly independent; this is a prized and respected characteristic in our society, and one that the industry can capitalize on in improving public perceptions and in recruiting and retaining drivers (ATA/Gallup Survey, 1998).

Improved perceptions of the profession depend not only on the public, but also on the attitudes of the drivers themselves. Lang (1998) reports that a good driver attitude about his or her employer can be expected to result from (*in addition to* competitive pay and benefits) limiting office turnover (i.e., retaining good dispatchers), pursuing driver-friendly freight practices that reduce loading and unloading requirements for drivers, having management staff accessible to address driver grievances, developing non-pay incentives, and providing training and orientation programs that focus on "30 days at a time" for each new hire.

Other experts in this field have suggested that a good first step both in retaining current drivers as well as attracting new drivers is to adopt a classification system for the commercial driving profession (Griffin, Kalnbach, Lantz, and Rodriguez, 2000). Specifically, the industry could devise a graduated system for commercial drivers that connotes increasing competence and professionalism, such as: undergraduate driver, graduate driver, certified driver, advanced driver, senior driver, and master driver. Criteria for moving between the levels could include miles driven, crash-free miles, length of time employed, customer service proficiency, scheduling quotas, hazardous materials experience, and training. Rewards for achievement could include additional pay, additional benefits, more managerial roles and responsibility, team driving, shorter lengths of time out, or choosing equipment and options. Inherent in this system are opportunities for advancement and pay increases for drivers. It also distinguishes new drivers from experienced drivers, defines goals for drivers, determines what is important for companies, improves the image of drivers in the public's eyes, and, most importantly for the present discussion, provides an incentive to stay with a company (Griffin, Kalnbach, Lantz, and Rodriguez, 2000).

To the extent that this approach might also facilitate a transition to other opportunities within the company, a certain validation is provided by driver opinion. According to Barnes (1999), drivers feel that a career path will improve retention. This study, commissioned by the Truckload Carriers Association, found that 75 percent of 725 drivers surveyed said a career path would make them more interested in staying with the same company for a longer period of time; 59 percent replied they would be less likely to quit their jobs if opportunities to take on non-driving responsibilities were available to them; 73 percent liked the idea of integrating the driver into non-driving aspects of trucking; 77 percent would like training in non-driving responsibilities; and 86 percent thought promotions should be based on performance and other factors, not just seniority (Barnes, 1999).

INDUSTRY PERSPECTIVES ON THE RETENTION- SAFETY RELATIONSHIP

An additional and essential perspective on the relationship between driver satisfaction, driver retention and fleet and driver safety is provided by the key stakeholders in the trucking industry. To insure that these perspectives were not overlooked in the present research, a series of case studies was undertaken by the ATA Foundation. These efforts accessed primary and secondary data sources, collected and organized data by stakeholder groupings, and developed analyses and recommendations based on the best information currently available.

Four stakeholder groups received attention in this work. First, the experiences and opinions of *truck drivers* themselves are obviously critical to understanding the factors that influence satisfaction, retention and, indirectly, commercial vehicle safety. Next, *motor carrier management* has an important voice in this discussion; these individuals institute safety programs, training courses, and driver recognition activities which, as documented in the literature review, all can exert a powerful influence on driver satisfaction and turnover rates. The perspective of *commercial motor vehicle insurers* is also informative, based on their role in safety program development, and especially when drawing conclusions based on their own industry's considerable efforts to investigate and analyze motor carrier safety. Finally, this research of current practices included contacts with other, *trade and professional groups and associations* that represent the interests of particular segments of the industry.

The Driver's Perspective

According to the Gallup organization (1997), truck drivers formulate general attitudes toward trucking companies and their operations, which include safety, driver recognition and driver training programs. Formed over time, these qualitative perspectives directly impact a driver’s satisfaction level. Driver satisfaction is essential to a company’s retention goals and, conversely, driver dissatisfaction may lead to higher turnover rates.

This report on the driver's perspective presents the ATA Foundation's analysis of qualitative data, covering a range of commercial motor vehicle (CMV) issues including safety. These data are well distributed by company size, type, driver age and gender; however, the number of drivers sampled remains too small for analyses of statistical significance.

To begin with, it was recognized that there are many interacting factors that may determine a driver's level of satisfaction with his or her job. It was anticipated that these would include, but not necessarily be limited to, direct financial benefits and compensation plans; management attitudes toward business practices, employee relations and morale, and safety; training and support programs; vehicle maintenance; and safety programs. Nevertheless, the ATA Foundation's analysis was directed to the following three questions:

1) What is the identifiable set of factors that affect driver satisfaction and, hence, retention?

2) How are these factors weighted and prioritized as part of the cognitive basis for developing both specific attitudes and overall satisfaction levels?

3) What conclusions and recommendations can be drawn from driver data?

Driver responses, when asked to identify hallmarks of "good" trucking companies, showed a surprisingly high level of consistency, such that factors that were identified in this exercise were generally uniform across companies of widely varying size and operating characteristics. Responses were in the form of specific questions, in particular subject areas, that drivers need to be able to answer affirmatively. These are given below.

- Topic: *Compensation* – Does the company provide a "livable" wage? Are there other compensation rewards including bonuses and fringe benefits?
- Topic: *Management Attitude* – Does management place a high value on employees, safety, and sound business practices? Is there a strong communications system in place? Does the company develop and value employee relations programs and training programs?
- Topic: *Company Staff/Employees* – Are the people at the company capable, friendly, and conscientious?
- Topic: *Safety and Maintenance* – Does the company value safety and safety programs? Does the company maintain its vehicles in excellent working condition?

When the responses of drivers were reexamined to draw inferences about what, in their opinion, makes a trucking company "safe," a broad consensus across different-sized companies and industry sectors again was found for each of the following criteria as indicators of a company's commitment to safety:

- The quality and quantity of safety and training programs;
- The level of respect for and compliance with regulations and policies governing CMV operations;
- Maintenance of clean facilities and equipment in good working order; and
- Recognition of drivers with good safety attitudes and driving records.

The last step in this qualitative analysis of drivers' opinions was to attempt to detect differences at a finer level, by comparing and contrasting driver responses according to various company and driver factors. The results of these efforts are summarized below.

- Drivers' preferences for the type of recognition they receive for safe performance appears to be related to company size. The larger a trucking company is, the more positive drivers regard intangible rewards such as recognition events, certificates, jacket patches, and safe driver clubs for safe performance. The smaller the company, the more likely it is that drivers will desire a safety bonus or other form of financial reward. This relationship was found to apply across all industry sectors, though it may be noted that no comparisons between union and non-union drivers were performed.

- Among drivers, there is little support for the notion that age itself is significantly related to a good or bad safety record. However, drivers feel that experience is very important, because the longer drivers are on the road, the more situations and "learning opportunities" they will encounter. With increased experience, however, the likelihood that drivers will become dissatisfied and cynical about the profession also increases. Taking both of these factors into account, the driver responses analyzed by the ATA Foundation indicate a "hybrid effect," where younger, less experienced drivers with a positive

attitude toward their company and profession are perceived to be equally safe as drivers who are older and more experienced but who have developed a negative attitude.

- Drivers' opinions about the relationship between length of employment and safety are, in the aggregate, quite ambivalent. Responses spanned the range from "loyalty equals safety" to "no effect" to "complacency can set in after a long time with a company."

Motor Carrier Management Perspective

With responsibility for development and implementation of almost all driver programs ranging from training to safety initiatives to safe driver recognition programs, motor carrier management can have a critical influence on driver satisfaction and retention. More precisely, the role of motor carrier management in both driver retention and overall safety can be described as one of *facilitation*. While highway safety ultimately comes down to situations and actions on the road, trucking companies play essential roles in providing drivers with the physical and psychological tools needed to deal with the myriad safety situations that arise while driving.

In this project activity undertaken by the ATA Foundation, motor carriers were asked a series of questions about driver retention and safety, including the processes used to calculate safety rates and turnover, and the design and effect of formal and informal safety programs. The motor carrier management personnel interviewed in this effort were executives and senior managers, including safety directors. The survey template used to solicit responses from motor carriers is shown in Table 2.

Table 2. Questions asked of motor carrier contacts in this research.

MOTOR CARRIER MANAGEMENT SURVEY

1. What is your turnover rate and how is it calculated?
2. What are the formal, company-administered driver retention/driver satisfaction programs and how do they rank in effectiveness?
3. What are the *informal* driver retention/driver satisfaction programs, who is their sponsor, and how do they rank in effectiveness?
4. Describe your driver safety program including training, driver incentives and rewards.
5. Describe your accident reporting process and the information contained therein including thresholds for disciplinary action or dismissal.
6. Describe driver recruitment and hiring processes.
7. What do you believe is the relationship between driver turnover and safety?

The responses received from carriers to this request for information were recorded as a series of five case studies that were summarized to present a management perspective on the trucking company's role in promoting driver retention and safety. From the case studies (see Appendix), three broad categories of responses were defined: *pre-emptive programs, outcome-based programs,* and *personal support programs.*

- Pre-emptive programs: These programs focus on safety training and education with the objective of providing preventative measures. In most cases, they are designed as group-based programs. They also encompass remedial training for drivers involved in crashes. However, vehicle maintenance programs may also be classified in this category as they are often viewed as safety and satisfaction programs by drivers.

- Outcome-based programs: These can typically be described as proactive incentive and/or reward programs. They can be plotted along two continuums: *formal to informal programs* and *financial to non-financial benefits.* Anecdotal evidence indicates that the larger the company, the more organized and sophisticated the programs become. While many of these programs attempt to reward individuals for safety merit, it is almost always done in a public forum or through peer recognition. Formal programs include safety recognition dinners and exclusive "million mile" clubs, and become more informal *vis-a-vis* driver meetings that highlight new company safety data or recognize an individual driver's efforts. Financial rewards in the form of "safety bonuses" are fairly common in the trucking industry. Non-financial rewards include plaques, trophies, safety badges, and gift certificates.

- Personal support programs: Many trucking companies recognize that employee satisfaction is closely tied to initiatives that focus on the driver as an individual, a human being integral to the success of the company. Consequently, trucking companies have developed targeted driver outreach programs that pair drivers with trainers, managers, ombudsmen and even counselors. The goal is to provide immediate support and response to driver issues and concerns. There is little empirical data to indicate how successful these programs are, but it is the understanding of management that efforts to "humanize" the driver through attention to individual needs are, from the driver's perspective, an essential component of job satisfaction.

The Perspective of Motor Carrier Insurers

Skyrocketing financial liability associated with commercial motor vehicle crashes has driven up insurance premiums for carriers, regardless of their safety record. Now, almost all companies insuring motor carriers take a proactive role in supporting trucking safety programs. Further, insurers collect and analyze substantial data on commercial motor vehicle crash rates and driver history. The ATA Foundation asked insurance industry contacts to provide input into this discussion of driver retention and its role in safety, as per the questions included in Table 3.

The responses, when combined, revealed a shared emphasis on a number of key points bulleted below. Together, the following comments represent the views of companies that insure a significant majority of all carriers. As a financial stakeholder in safety, the insurance industry

Table 3. Questions asked of insurance industry contacts in this research.

MOTOR CARRIER INSURANCE COMPANY QUESTIONS
1. What do you believe are the hallmarks of safer carriers?
2. What factors should be used in rating carriers as safe or not safe?
3. What benchmarks or safety definitions do you use for defining and tracking truck safety?
4. What do you believe is the relationship between driver retention and safety?
5. Is there data that exists supporting the relationship between driver retention and safety? If not, what other data sets exist that could be used?
6. What role do you believe training plays in making drivers safer?
7. What role do you believe experience plays in making drivers safer?
8. What role does age play in making drivers safer?
9. What role does length of employment with a particular company play in making drivers safer?
10. What role do company-sponsored rewards or incentives play in making drivers safer?
11. What do you believe is the role for government in developing safety programs?

has clear opinions with regard to driver retention and safety, generally viewing this as a direct cause-and-effect relationship. Uniformity of responses was found on two points:

- Employment screening and internal safety auditing should be based on *all* crashes, not just DOT-reportable incidents.

- The most financially stable trucking companies are the safest companies.

The industry is in strong agreement, though there is not unanimity, on the perspectives summarized below.

- Safety flows downward: Insurers strongly believe that the primary and paramount criterion of a safe trucking company is a strong commitment to safety at the senior management level. This high-level attention to safety should result in the creation of a safety program that has direct reporting functions to a high-level officer such as the President or Vice President.

Next, successful safety programs extend beyond "training" to education—education on safety issues, driver actions, the physics of vehicle movement, etc., which moves drivers beyond the basics, and provides them with the intellectual tools needed to react to unexpected and uncontrollable occurrences.

Finally, safety programs should focus on individuals, to ensure that both training and safe driving recognition "is not lost in the crowd." The smaller a company is, the more important it is that it provide one-on-one support and training.

- Safe driver factors: The insurance industry strongly believes that safe drivers can be molded and produced by a good safety program. The effort should start with the hiring and screening processes, where high standards must be developed and promulgated. Once drivers are hired, they should be considered a company's most valuable asset, and, given that hiring and screening costs can exceed $6,000 per driver, companies should be financially motivated to retain drivers. High turnover can siphon scarce financial resources away from safety programs.

  Insurers put considerably less emphasis on the role that "age," "experience," and "length of time with a particular company" play in safety. In fact, insurers believe that crash data refutes any presumed, singular effects of age and experience in safety. Rather, additional variables must be considered including familiarity with driving routes, maturity (which was not defined), vehicle maintenance, level and type of safety training or education, and years of crash-free driving.

  In particular, insurers believe that age alone is not a good indicator of safety. Some crash databases (unspecified) indicate that younger drivers are involved in more accidents but older drivers are involved in more severe accidents. Consequently, programs including graduated CDLs and "buddy driving" could dramatically improve safety among younger drivers.

  Further, experience is not solely associated with age. Older drivers can enter the CMV work force later in life, making them less experienced by definition. Experience should be defined as situational experience, total recurrent training/education, and total years of crash-free driving (not just trucks), rather than just years behind the wheel of a truck.

- Role of government: Insurers believe that safe drivers are a public commodity and responsibility, and that government programs should focus more on safety training, education, and enforcement, and less on regulatory compliance. Insurers argued that this would result in improved safety training for all CMV drivers regardless of their place or length of employment. It would also catch and address safety training for high turnover drivers.

  Insurers indicated that there is not a high correlation between safety rating scores and future crash rates, and believe that crash rates and driver history are the best predictors of future crash likelihood. They also believe that DOT intervention in the form of training and safety program development assistance is the best method for correcting poor carrier safety records. They fear that regulatory compliance may divert funds from hands-on training to procedural paperwork. Punitive measures would also affect a carrier's ability

to adequately fund safety, and unsafe drivers may simply move on to different companies in the meantime.

A Carrier/Driver Association Perspective

To allow for as broad a range of opinion as possible in this qualitative analysis, the ATA Foundation supplemented the industry contacts identified above with input from an organization representing the interests of small firms (i.e., generally operating fewer than 100 vehicles). This was the National Association of Small Trucking Companies (NASTC). It is a strongly held belief among the membership at NASTC that smaller trucking companies offer operational benefits to drivers that encourage driver retention and result in safer operations *even if the actual level of pay is somewhat lower than what drivers could earn at a larger firm*.

To better quantify this relationship, the NASTC undertook a survey of its membership requesting data on turnover rates. The results are shown below:

- 132 company responses were received from the membership of NASTC, representing a cumulative driver population of 3,182.

- Average turnover rate of 49%, calculated as the sum of W-2s and 1099s filed by a company in a year, divided by the actual number of drivers employed, either as company drivers or owner-operators.

According to NASTC, there are a number of reasons why small companies have lower driver turnover rates, relative to larger companies. They include:

- Drivers have a more personal relationship with owners, managers, and dispatchers.

- Drivers appreciate the sense of ownership or "say" in the company and feel that their opinions count in operational decisions such as dispatches, equipment purchases and general business decisions.

- The terminals, customers and types of runs are a characteristic of smaller companies and allow them to give their drivers plenty of miles while still getting them home on weekends.

- Smaller companies demonstrate driver appreciation through safe driving awards. Awards banquets/events involving the drivers' families, cash or merchandise awards, and bonuses tied to safe performance are among the incentives used most often. The latter are often team-based, which creates a greater support network among the drivers.

CONCLUSIONS AND RECOMMENDATIONS

It may be concluded from the results of this research that a significant relationship exists between job change rate and crash involvement. Practically speaking, there is evidence that drivers whose (verified) employment history indicates that they have averaged more than two jobs with different carriers each year, for a period of two years or more, deserve special scrutiny during the hiring process to determine whether there are mitigating circumstances that have placed the individual in an increased-risk category. If a driver has averaged three or more jobs with different carriers each year, during a period of two years or longer, he or she may represent an unacceptably high level of crash risk. If hired, these individuals deserve extra attention during orientation and training on the new job. They should also receive priority for on-road training and assessment with a safety manager if this practice is discretionary for a given carrier.

Another conclusion that can be drawn from this study is that additional phases of analysis, based on the present methodology, have the potential to yield even greater benefits by identifying specific factors that can explain the broad statistical relationship between job change rate and safety. It is logical to assert that certain types of job changes, for certain categories of driver and vehicle variables, will better predict the likelihood of crash involvement than others.

Because of the more specific information about risk factors that could be provided, the most useful guidance for industry in selection, hiring, and training would be expected to result from follow-on analyses including, though not necessarily limited to, those recommended below.

- Temporal sequencing of critical events: To address the unanswered question of whether frequent job changes lead to (increased risk of) crashes or having a crash leads to a job change, it is important to know the precise order of crashes and job changes that occur close together in time. In other words, did the crash occur first, or did the job change?

- Cargo type: It may be hypothesized that drivers who go from hauling produce to hauling cement will have a much steeper learning curve, and presumably an increased crash risk, compared to drivers transferring to another carrier hauling produce. MCMIS divides cargo into 30 categories based on the most common types such as trash, lumber, metal, liquid gas, and livestock. With supplemental coding of this variable, the extent to which changing from one cargo type to another can account for the apparent effect of changing jobs could be analyzed. The following re-grouping is recommended.

  a) Shifting cargo (cement, livestock) versus non-shifting cargo (metal, lumber)
  b) Hazardous (chemicals, liquid gas) versus non-hazardous cargo (produce, U.S. mail)
  c) Heavier cargo (metal, large machinery) versus lighter cargo (paper products, trash)

- Vehicle type and/or Gross Vehicle Weight Rating (GVWR): The number of unique vehicle types for each driver, sometimes but not always with their associated GVWR's, are recorded in MCMIS. It is possible for a driver to have more vehicle types than jobs in his or her file. With that in mind, it could be asked: Is a driver who changes vehicle types but remains with the same employer at a higher or lower risk of a crash than a driver who changes employers but continues to drive the same type of vehicle?

One finding in the present analyses that at first seems surprising is that, in the aggregate, commercial drivers who have had crashes prior to a point or period of evaluation will be *less* likely to have a crash during a later observation interval than drivers *without* prior crashes. This makes good sense, however, when considering how rarely crashes occur and how, at any given moment, there will always be many, many times more drivers without crashes than with crashes. Still, this analysis outcome reinforces a common finding from the qualitative data synthesized in this project, i.e., the fact that a driver applicant has previously been involved in a (single) crash is not, in itself, a sufficient basis upon which to make a hiring decision or to predict how safely he or she will perform in a new job.

Other conclusions and recommendations that can be drawn from the review of literature and the opinions of industry contacts follow:

- First, the goal of retaining safe drivers in the industry can be achieved, in part, by doing a better job of attracting safe drivers. An industry-wide campaign to improve perceptions of the profession by the public, emphasizing a commitment to safety, should also focus on attracting capable and motivated individuals to commercial driving as a "first career" choice. The independent lifestyle afforded by the profession should be an important element in this campaign.

- Once applications are received by a carrier, a comprehensive screening of the driver applicant's background is essential. At a minimum, the driving history, prior training experience, credit history, criminal check, and substance abuse history should be investigated. Concerns about the security of the nation's trucking operations suggest that U.S. citizenship status may also deserve consideration during the screening process. And, as underscored by the present analyses, the number of prior driving jobs held by the applicant, verified through W-2's, should also be taken into account as an evaluation factor.

- If a driver applicant passes a company's background checks and screening processes, he or she should be provided with a realistic picture of what the responsibilities and expectations are for his or her role in the company's operations, and what level of compensation and amount of time home can realistically be anticipated. As part of this process, company drivers who are most experienced with the carrier's personnel and procedures that will most strongly affect the new driver's satisfaction with the job, should be available to have frank and confidential discussions with the applicant. These discussions should cover not only the company's expectations of its drivers, but also should give the applicant an opportunity to state his or her expectations of the company, and to learn how realistic it is that they are achievable. Getting the message across that the company's most valuable asset is its drivers should begin at this point.

- Once hired, a new driver's orientation and training must insure not only basic skills and full knowledge of safety regulations and procedures, but also demonstrated competence in the specialized skills needed for the specific types of cargo to be hauled and/or the vehicle type(s) that will be driven. Periodic refresher training for experienced drivers also is important to keep skills current, and if properly delivered can reinforce a sense of commitment by the company to the driver's well-being. Candidate topics for such training include classroom or video training covering the latest DOT regulations, current

and traditional safety, health, and fitness-to-drive issues, new communication and information technology issues that impact safety or productivity, and other driving and hauling-related issues.

- A good relationship between dispatchers and drivers is essential. Companies should set up one-on-one meetings between dispatchers and new hires for each to discuss job requirements, and to establish a good working relationship based on an understanding of each other's work and personal needs. This action can be expected to improve communication and scheduling requirements at both ends of the company.

- A continuing focus on safety is essential by all trucking companies, regardless of industry sector or company size. Recognition programs for safe performance are recommended; these should be based upon all crashes, not just DOT-reportable incidents. Rewards for safe performance may include both monetary bonuses and intangible rewards, namely company activities that confer social and professional status on the awardee. Research indicates that company size will play a role in determining which types of rewards will be most effective in promoting a positive attitude and improving retention of good drivers; the larger the company, the more important a monetary reward is to achieving these outcomes.

- Closely related is the need to more closely monitor drivers' daily and weekly hours of service. Company policies must not only comply with DOT regulations; they must not impose requirements on drivers that encourage illegal or unsafe behaviors or deprive drivers of time at home beyond levels identified during the hiring and orientation process.

Finally, it is important to point out that recommendations for continuing research in this arena are complicated by the subjectivity of many of the outcome measures of potential interest. This is particularly true with respect to "job satisfaction," which can mean different things to different people. Driver retention is more concrete, however. The methodology for gauging job change rate applied in this study, plus further developments and refinements that were beyond the scope of the present investigation, can effectively quantify the dimensions of the problem associated with job-hopping or "churning" among commercial drivers. Such information can only advance our understanding of how specific selection and training procedures, dispatch operations, recognition programs, and other aspects of the management practices highlighted in this report translate into measurable gains in driver retention and safety.

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APPENDIX: CASE STUDIES OF MOTOR CARRIER MANAGEMENT CONTACTS

Carrier #1 – Nationwide Truckload Carrier

Carrier #2 – Nationwide Household Goods Mover

Carrier #3 – Regional Specialized Carrier

Carrier #4 – Nationwide LTL Carrier

Carrier #5 – Nationwide Mid-Sized Truckload Carrier

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CASE STUDY: Carrier #1 – Nationwide Truckload Carrier

Carrier #1 is a national truckload carrier with a non-union driver force of over 12,900 drivers. They report a turnover rate of 121% for the period January 2001 through September 2001. Turnover rate includes all drivers who leave the company either through voluntary termination or company termination. Employees counted in the driver force include all who receive an employment offer after completing the company's three-day orientation, regardless of whether or not they drive for the company.

This company ranks two specific company-sponsored programs as providing the greatest driver satisfaction:

- Driver Recognition – achievement awards to show appreciation for drivers, including appointment to a Driver Advisory Board; and
- Dedicated Fleet Operations – as throughout the truckload segment, time away from home is an issue for the drivers. This program allows drivers to have a dedicated run, providing for more predictability in their route and schedule. The carrier reports that there is greater retention among dedicated run drivers.

Other important driver satisfaction programs, in rank order are:

1. Safety Awards and Driver of the Month Awards – drivers are rewarded with company belt buckles, watches, patches, achievement pins, t-shirts and gift certificates.
2. Free Driver Training for Spouse – allows spouse to train for commercial drivers license at home, opening up more opportunities for husband and wife driver teams.
3. Monthly Reviews – each driver has an overall performance review done monthly by their driver manager where goals are set and driver needs are discussed.
4. Rider Program – offered to the driver's spouse, roommate, child or pet.

Carrier #1 also provides less formal programs in order to increase driver satisfaction, including quarterly cookouts for drivers, opportunities to meet with company management to discuss driver issues, and encouraging drivers to take part in truck driving safety rodeos.

To improve retention among new hires, Carrier #1 offers a retention bonus of $1,000, with $500 paid after the first six months of employment and the remaining $500 paid upon completion of 12 months of employment. Similarly, Driver Trainers are offered bonuses that promote safety and retention among new hires. A Driver Trainer can receive a per student bonus after the eighth week of employment by the student, provided that the student has completed training and has not had any preventable accidents totaling over $1,000 in damages. After six months of employment without a preventable accident totaling $1,000 or more in damages, the Driver Trainer can receive an additional bonus.

New hires, both experienced and inexperienced, are recruited through information seminars held nationwide. Driver applications are processed to ensure compliance with all DOT requirements, after which the applicant is invited to a three-day orientation. Carrier #1 has a minimum driver age of 23 and drivers without experience are recruited and hired from accredited driver training programs.

Two different opportunities for training are provided to inexperienced drivers through the company's Driver Finishing Program. The first is a six week over-the-road training program that requires the student driver to have a minimum of 40 days with a Driver Trainer or 23,500 trip-miles during the six weeks. The other training option, the 4x4 Program, places a student driver with a Driver Trainer for 28 days minimum or 15,000 trip miles and then the student is teamed with another driver for an additional four weeks.

Driver Trainers are also offered continuing education through the company's "Train to Retain" class. This course provides the Driver Trainer with the skills for building rapport with students and resolving conflicts when they arise. The main focus of the "Train to Retain" course is overall safety and long-term commitment to the carrier.

Carrier #1 believes that turnover resulting from safety compliance is a relatively minor issue. This carrier feels that the majority of the turnover they experience is the result of job satisfaction based on operational considerations such as dispatched miles, time at home, payroll problems, and dispatch/driver manager conflicts.

CASE STUDY: Carrier #2 – Nationwide Household Goods Mover

Carrier #2 is a national household goods mover with a non-union driver force of over 4,000 drivers. They report a turnover rate of approximately 32%. Turnover rate is calculated as follows:

Processings ¸ (Beginning Fleet Size + Processings) x 100

Carrier #2 lists as their only company-administered driver retention program a safety/service/longevity bonus of up to 5% of gross earnings.

Carrier #2 hires only experienced drivers, who must be a minimum of 21 years old and have at least one year of driving experience. Prospective drivers are required to:

- have a good driving record and employment history;
- take and pass a controlled substance test; and
- meet or exceed all minimum physical requirements as set forth in the FMCSRs.

Once hired, drivers must attend a one week orientation, after which there is no probationary period.

Drivers are monitored on five safety performance measures:

- DOT reportable, preventable accidents;
- All other preventable accidents;
- Lost time due to injuries;
- Serious traffic violations; and
- Hours of service violations.

Mandatory remedial training is provided for drivers who have poor safety or quality performance records. Conversely, excellent performance is rewarded with up to an additional 5% of gross earnings as described above.

Carrier #2 believes there is a direct and proportionate relationship between driver turnover and safety. In this fleet, drivers with less than one year experience have 4.3 DOT-reportable accidents per million miles while drivers with 1-3 years experience have only 1.6 DOT-reportable accidents per million miles.

CASE STUDY: Carrier #3 – Regional Specialized Carrier

Carrier #3 is a regional specialized carrier focusing on oversize/overweight loads including heavy equipment. With a non-union driver force of 169 drivers, this carrier reports a turnover rate of 45%.

This carrier lists the following as its three most important driver retention/driver satisfaction programs:

- Regular and frequent time at home;
- Driver compensation and benefits; and
- Quality and maintenance of company equipment.

Additional factors leading to driver retention and satisfaction include an open door policy by management, satellite communications for use by the drivers while on the road, quick settlements for trips made and direct deposit for payroll, and a prevailing sense that drivers are individuals within the company, not a number.

New hires are required to be at least 23 years of age with two years driving experience. New hires must also pass the DOT physical and drug screening, and be able to work unsupervised. These same criteria are used in hiring owner-operators, but in addition owner-operators must have a three-axle tractor not more than five years old. Once hired, drivers are required to complete a three-day orientation.

Driver incentives used to promote safety include quarterly monetary bonuses, and company shirts and jackets. Drivers reaching the million mile safe driving milestone also become part of the company's Million Mile Club with additional rewards. Years of service with the company are rewarded also, with the top reward being a company diamond ring.

Carrier #3 believes that the greater the turnover at a company the greater the frequency of accidents with new drivers. Carrier #3 believes that older drivers have fewer accidents, but finds those accidents are typically more severe than those experienced with the younger drivers.

CASE STUDY: Carrier #4 – Nationwide LTL Carrier

Carrier #4 is a nationwide less-than-truckload carrier with a unionized driver force of over 10,000. Annual driver turnover, as reported in the third quarter 2001, is 3.14%. This carrier calculates their turnover using the following formula:

340 Separations ¸ 10,821 Active Employees = .0314 x 100% = 3.14%

Carrier #4's Satisfaction/Retention program consists of a yearly survey administered to all company employees. The survey is compiled and analyzed per facility and job group, providing information specific to drivers. The local management teams are responsible for developing action plans, with the objective being continuous improvement in employee satisfaction.

Carrier #4 has an extensive driver safety program developed as part of the overall corporate Safety Management Model, focusing on a behavioral-based injury/accident prevention process. The model is comprised of six key components:

- Employee Involvement – Safety is every employee's responsibility. Everyone needs to be actively engaged in the prevention process for safety to be successful.
- Training – Focused training in safe work methods and hazard detection;
- Reinforcement and Enforcement – Safety coaching and accountability for safe work practices;
- Measurement – Scorecard: "How are we doing?" and "Where is improvement needed?"
- Rewards and Recognition – Earned recognition and incentives for safe work performance; and
- Facilities and Equipment – Maintaining good housekeeping practices, safe operation and timely maintenance of equipment.

While the framework for this injury and accident improvement process was developed at the corporate level, the particulars are developed at the local level, providing ownership and buy-in from drivers. A number of measurement indices are established and rewards accrue both to the facility and the individual driver.

Facility rewards are in the form of reward "dollars" which the facility can utilize for celebrations and reinforcement. Annual rewards for top-performing facilities can exceed $150 per driver. Rewards based on individual driver performance are in the form of points that are redeemable for catalog merchandise. Additionally, drivers can annually compete for Individual Milestone Awards, given to drivers who drive a minimum of 65,000 miles annually with no preventable accidents or on the job lost time or medical cost injuries.

CASE STUDY: Carrier #5 – Nationwide Mid-Sized Truckload Carrier

Carrier #5 is a national truckload carrier with 350 tractors and 275 drivers. The company has a minimum hiring age of 23 and requires that all drivers have at least 2 years of experience and/or 200,000 driving miles.

This carrier does not formally calculate and track driver turnover. The basis for this management position is that:

- Driver turnover is an inherent issue in the trucking industry; and
- Turnover rates are both static and significant.

The company's ongoing hiring process is permanent (i.e., not affected by increases and decreases in turnover rates).

This company's first premise is that all satisfied drivers will stay with a company. When this isn't the case, their position is that external factors come into play and there is nothing that the company can do (beyond creating satisfaction) to keep the driver.

Based on this philosophy, Carrier #5 focuses their resources on creating personal support programs for drivers (versus large multi-employee training and recognition programs). The Operations Manager, who is designated as the driver liaison, personally contacts all drivers on a regular basis to solicit concerns and ideas. The Operations Manager is then required to follow-up within a certain time frame on any issues raised by the driver.

All accidents are investigated internally; when there is joint responsibility, drivers are required to undergo additional safety training exercises. When there is major driver liability, the driver's employment is usually terminated.

All drivers are asked to view a series of safety-related videos which are maintained in a video library. The only employee-wide safety program is a mandatory Safety Program meeting held each year.

For more information on the Federal Motor Carrier Safety Administration and the Office of Research and Technology, check our website at www.fmcsa.dot.gov.

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