Analysis of Roadside Inspection Data and Its Relationship to Accident and Safety/Compliance Review Data and Reviews of Previous and Ongoing Research in These Areas

Brenda M. Lantz

Upper Great Plains Transportation Institute
North Dakota State University
Fargo, North Dakota

January 1993

ACKNOWLEDGEMENTS

This study was conducted in an effort to improve motor carrier safety by developing a better understanding of the statistical relationships that may exist within and among the Motor Carrier Management Information System (MCMIS) data bases. This study was made possible through the cooperation of several agencies. Specifically, special thanks goes to the North Dakota State Highway Patrol, the Federal Highway Administration Office of Motor Carriers, the Upper Great Plains Transportation Institute, and to all those involved with each of these agencies who aided in the preparation and review of this report.

ABSTRACT

The main objective of the present study is to analyze roadside inspection data and its relationship to safety/compliance review and accident data. Data used for this analysis is provided by the Office of Motor Carriers and includes a sample of larger carriers with the most recent inspection information and safety ratings. As part of this paper, summaries of past work in this area and in other related areas are given, as well as reviews of ongoing research. The current study finds strong support for a relationship between the aforementioned data sets and the findings are compared with the earlier work reviewed. In addition, some preliminary results of further research into the characteristics of those firms with little inspection data are presented.

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INTRODUCTION

The primary purpose of the current research project is to examine roadside inspection data and how it relates to accident and safety/compliance review (SR/CR) data. This study is completed in order to explore if information obtained from the roadside inspections of a carrier can be utilized in conjunction with other knowledge about that carrier, such as its size or the type of commodities they carry, to aid in targeting carriers for review and assigning safety ratings to them. The aforementioned data bases are all maintained in the Motor Carrier Management Information System (MCMIS) by the Office of Motor Carriers (OMC). Included in MCMIS is information concerning commercial motor carriers which are subject to the Federal Motor Carrier Safety Regulations (FMCSR) and the Hazardous Materials Regulations (HMR).

This paper is divided into several sections. First, three previous inspection-related studies are reviewed. These include (1) a study conducted by the Highway Safety Research Institute to examine the effect of proper vehicle inspection and maintenance on safety, (2) a study completed by Pennsylvania State University to compare roadside inspections with the causes of accidents, and (3) a study performed by Jack Faucett Associates (for OMC under contract number DTFH61-89-C-00062) which examines if the out-of-service criteria influenced a decrease in accidents; the relationship between carriers' accident rates, safety/compliance review (SR/CR) record, and their performance on roadside inspections; and the relative efficiency of the out-of-service criteria.

The second section describes two other studies reviewed. Specifically, it details briefly work completed by Northwestern University which compares accident rates to the SR/CRs. Also, it relates a study by Kent State University which investigates the relationship between accident rates and carriers' profitability.

The third section reports the details and findings of the present study as described above and compares them to earlier work which was completed.

The fourth section reviews three studies in progress and outlines ideas for further research. These studies include (1) a project being conducted by Jack Faucett Associates (for OMC under contract number DTFH61-90-C-00013) which examines differences among the three main types of inspections,

(2) an ongoing study by Linda Taylor, Federal Programs Manager (FPM) in Oregon, which proposes an update to the safety rating methodology that would incorporate roadside inspection performance, and (3) a project which developed as a result of the present one which examines carriers that have had fewer than three roadside inspections completed.

The final section relates a brief summary and conclusions.

PREVIOUS RELATED RESEARCH

Study and Objectives:

One of the initial studies of inspections and accidents was conducted in 1977 by the Highway Safety Research Institute. It was initiated by OMC (then called the Bureau of Motor Carrier Safety) to "determine the effect of proper commercial vehicle inspection and maintenance procedures on safety, and to document the need for improved or modified inspection and maintenance requirements in the FMCSR, Section 396" (McDole, p.1).

Data Sources

Some of the data sources used for this study were Michigan, Pennsylvania, and Texas truck accidents reported by police, accidents reported to OMC by carriers, reports from "road check" inspections, and the 1972 U.S. Bureau of the Census Truck Inventory and Use Survey. In addition, meetings were held with maintenance personnel from randomly selected carriers in the above three states as well as with experts in the area of truck safety (McDole, p.2).

Findings and Recommendations

The main conclusion arrived at from this study was that there is a strong relationship between quality maintenance and inspection procedures and a decline in accidents related to defects. The point was made that larger firms appear to have better maintenance and inspection procedures than smaller or private firms as it is more economically beneficial for them to do so. Further results indicated that the defects most likely to cause accidents were those associated with the brakes, tires/wheels, and lights. Since these defects are all detectable visually, the author believed that daily driver inspection is the most

effective way to discover these defects. In addition, frequent periodic inspections and repairs by maintenance personnel of the carrier are suggested. Roadside inspections are then seen as a backup to the above to provide incentive to maintain vehicles (to avoid sanctions) and also to cause repair of vehicles found with defects (McDole, p.3).

Some of the recommendations suggested by the study were that complete inspections of vehicles should be conducted both before and after trips (preferably written) and that records of these inspections should be kept with the vehicle as well as with the carrier. In addition, it was advised that educational and instructional materials should be developed and widely distributed to increase awareness of regulations and good safety practices (McDole, p.7).

Study and Objectives:

A second study, conducted by Michael Patten, Joseph Carroll, and Evelyn Thomchick of Pennsylvania State University (1989), had the main objective of comparing roadside inspections with the causes of accidents involving large trucks. The study begins by addressing the issue that accidents are unique occurrences which involve many interrelated factors - driver, vehicle, and environment - and that there are no quick and simple explanations as to why trucks are involved in accidents (Patten, p.269-270).

Data Sources

Accident and inspection data sources for this study included the Pennsylvania Department of Transportation (1986-1987), OMC published material (1983-1984), the National Highway Traffic Safety Administration (1987), and the Oregon Public Utilities Commission (1984). The findings from inspections were compared to the factors that were most often cited as causing accidents (Patten, p.271-272).

A brief description of the inspection process is given emphasizing that items are checked which are crucial to operating the vehicle safely. Violations found are divided into two categories - those such as record keeping or minor vehicle defects not posing any immediate danger, and those more severe that require a driver/vehicle to be placed out-of-service (OOS) until the violation is fixed. It is noted, however, that there are some problems associated with enforcing OOS penalties (i.e., an officer can't always

remain at the site to ensure the violation is corrected and citations are difficult to enforce on non-residents) (Patten, p.271-272).

Findings and Recommendations

Some of the findings of this study include that in all of the data sets examined, the vast majority of OOS violations found were vehicle related - the most common involving the brake system - and that driver related OOS violations are much less common. It is noted that this is due to the design of the inspection (i.e., there are only a few items a driver can be placed OOS for while there are many that can cause a vehicle to be). Also, it is difficult to tell how accurate a driver's logbook actually is, or how fatigued he/she may be due to their actions before going on duty. Further, the study finds that the driver is the prime cause of the huge majority of truck accidents. In conclusion, the authors state that although roadside inspections "provide a useful tool for enforcement officials to remove some potentially unsafe vehicles from the highway" they don't concentrate enough on factors related to drivers that cause accidents (Patten, p.272-274).

Some recommendations offered are to increase levels of identifying and citing or educating unsafe drivers. Also suggested is devising a plan to make sure that OOS violations are actually repaired before a driver/vehicle returns to service and that drivers be required to complete a certified training program before being issued a commercial driver's license. Additional suggestions for further research are also offered (such as considering driver fatigue, joint driver/carrier responsibility for violations, anti-lock brakes, and on-board monitoring systems) (Patten, p.275-276).

Study and Objectives

A third major study of roadside inspection data was conducted for OMC by Jack Faucett Associates (JFA) (1991). It had several objectives including (1) determining if OOS criteria influenced a decline in accidents, (2) what the relationship is between a carrier's roadside inspection performance, their accident rate, and their safety/compliance review record, and (3) to examine the relative efficiency of the OOS criteria.

Data Sources

The MCS 50-T files for 1984-88 were used to establish the frequency of certain mechanical defects that were existing in accidents reported by individuals. Although there are weaknesses associated with these files (i.e., underreporting of accidents or not reporting mechanical defects present), the authors believed that this would not effect the analysis as they are simply determining that given a defect is present at the time of the accident, what the probability is of it being a specific defect. Defects suitable for their analysis were found in 3.45% (5,702) of the records in the data base. In addition, the authors used several studies to determine the average expenses associated with injuries and deaths (they calculate the cost of an injury to be $16,213 and a death to be $1,996,461 in 1986 dollars) (JFA, p.3-8).

A second data source was the 1988-89 SAFETYNET data which contains inspection records for motor carriers. After eliminating inspections of carriers without a DOT census number and those of buses, 812,978 records were available for analysis. Violations in the data set were labeled as either OOS or non-OOS, classified as driver, vehicle, or hazardous materials, and given a severity rating from 1 (least severe) to 7 (most severe). To develop carrier profiles, only those carriers with three or more inspections in the year prior to their most recent SR/CR were used for a total of 5,830 carriers (JFA, p.8-14).

A third data source employed was the 1987-89 SR/CR file. After eliminating 1987 data and records with multiple carrier reviews, 41,253 carriers were available to analyze. As aforementioned, 5,830 of these were able to be matched with having three or more inspections in the year prior to their review. Actual analysis, however, used only 5,805 carriers as 25 had no annual vehicle miles traveled (VMT) data available.

A fourth data source utilized was the State accident data base managed by NHTSA which contains accident reports filed by investigators or State police for all types of vehicles and, thus, is seen to be more reliable than the MCS 50-T files. This data was used for the first objective of whether the OOS criteria have influenced a decline in accidents. Since the authors were examining differences in accident rates between the year the State entered MCSAP and two years later, and because they also required a breakdown of vehicle types and a precise identification of vehicle defects, thirteen states were available for this analysis (JFA, p.15-17).

The final data source for this study was State VMT data for 1985-88 for the thirteen states mentioned above. This was used to develop accident rates that took into account exposure to accidents (JFA, p.18-20).

Findings and Recommendations

Of the thirteen states examined, there were significant decreases reported in the defect accident rate in nearly every one between the year the State entered the MCSAP program and two years later. The mean rate of decrease was .032 accidents per million miles. This occurred while the number of inspections conducted increased almost three times. Non-truck accidents for the same states and years remained nearly constant while truck defect accidents decreased by over 12% (overall truck accidents decreased by 2%). Examining individual defects, the authors report that brake defect accidents declined the most (15%), followed by tire, steering, and other (10-12%), and then lights (5%). *The authors conclude by stating that their "analyses indicate that the application and enforcement of the OOS criteria through the MCSAP roadside inspection program have had a significant impact in decreasing the rate of truck accidents where mechanical or safety defects were cited as primary contributing factors"* (JFA, p.21-26).

Under the second objective, comparisons were made between the average OOS performance for carriers rated Satisfactory, Conditional, or Unsatisfactory for each of five groups classified by VMT (vehicle miles traveled). Carriers were classified this way as significant differences were noted between these five groups in inspection performance (i.e., higher VMT carriers had better performance). For carriers in the lowest and highest VMT groups, there were some problems in arriving at conclusions due to the small number of carriers in the fifth group and underreporting of VMT observed in the first group. For the remaining groups, carriers with an Unsatisfactory rating had a significantly higher percentage of OOS vehicles (and a higher mean number of OOS violations per inspection) than those with a Satisfactory rating. Similarly, those carriers in the second and third groups rated Unsatisfactory or Conditional on Part 396 (Inspection, Repair, and Maintenance) of the SR/CR had significantly worse inspection performance than those rated Satisfactory. There was also evidence for a significant relationship between better inspection performance and "yes" answers to specific questions of the SR/CR

(those referring to complying with inspection procedure, if the carrier can produce maintenance files on a specific vehicle, presence of a driver safety/orientation program, and if the carrier reviews their safety compliance status periodically). The authors reach the conclusion that although there are significant relationships between vehicle inspections and SR/CRs, they are not perfect substitutes (JFA, p.27-43).

When comparing the OOS measures to accident rates, the authors point out that the relationship may differ for small and large carriers. For smaller carriers, if they have a higher OOS rate, they may have a lower accident rate because of their vehicles being placed OOS and repaired. Conversely, for larger carriers, a higher OOS rate may indicate poor overall safety practices and, thus, one might expect them to have a higher accident rate.

The authors found that as the size of the carrier increases, the average accident and fatality rates decrease. They also found a positive significant relationship between accident and OOS rates for carriers in the third and fourth groups. It is noted, however, that this analysis doesn't control for other factors, such as driver error, that may cause accidents. The association seems to be best with injury and fatality rates and not quite as strong with accident and preventable accident rates (that include less serious accidents) (JFA, p.44-51).

Under the final objective, the goal was to ascertain which violations are the most critical to detect in order to minimize the expense of truck accidents. It was found that accidents with a driveline or fuel system defect are approximately three times more deadly, but brake and wheels/tires defects have the highest costs connected with them as they occur the most often. A regional analysis was also completed and it was noted that Utah and California had the highest fatality rates and average accident costs, while Oregon, Iowa, and Arkansas had the lowest. Whether one wishes to minimize accidents or accident costs, the authors find that wheels, tires, and the suspension system should receive more inspection time than they did in 1988 and that less attention should be paid to lights, windshield/wipers, and the frame/body (JFA, p.52-69).

As an appendix to this report, the authors add an annotated bibliography of literature they have reviewed that the reader may be interested in examining.

OTHER STUDIES REVIEWED

Work has also been recently conducted linking accident rates to factors other than roadside inspection results. One major study, conducted by Moses and Savage (1992), compared findings of the SR/CRs to accident rates. Utilizing the SR/CR data base for the period of 1986-91, the authors find that accident rates per million miles are lower for larger firms, and that short-trip or private carriers have lower rates than long-distance or for-hire carriers. In addition, general freight and specialized carriers were reported to have similar rates, but agricultural carriers' rates were lower, and hazardous materials carriers' rates were higher than others. Finally, it was found that older firms tend to have lower accident rates than newly incorporated firms (Moses, p.1-3).

Another area investigated by Bruning (1989) is the relationship between accident rates and profitability in trucking firms. As sources of data, the author used the MCS 50-T accident forms as well as data from the ATA's *Financial and Operating Statistics* report for 1984. The findings indicate evidence that as carrier profitability declines, accident rates increase. Other conclusions include that general freight and specialized carriers differed with respect to some accident rate factors. For example, size of the carrier didn't influence accident rates for general freight carriers, but did for specialized carriers (rates increased with size). Also, it was found that the less time overall that drivers have been employed by the company, the higher its accident rate, but there appeared to be no relationship between accident rates and the percentage of owner-operators employed. Furthermore, the author reports that the state of equipment a company uses (i.e., its age or defect rate) accounts for some accident rates, but that weather conditions don't appear to have a significant impact (Bruning, p.41-42, 47-48).

PRESENT STUDY

The current research project examines the relationships between a carrier's performance on roadside inspections and their accident rate and performance on the SR/CR. Because of the time constraints of the study and the need for a statistically stable sample, it was decided to limit the data to larger firms. In this way, general trends could be observed and compared to earlier findings. Therefore, included in the present analysis are those carriers that have at least twenty drivers, that have had ten or more roadside inspections (Level I, II, or III) completed on their trucks during calendar years 1990 and

1991, and that have been assigned a safety rating in the last year. With these restrictions, 1,334 carriers were available to examine.

Table 1 illustrates how the carriers' safety ratings relate to their OOS Rate (the number of vehicles/drivers they have had placed out-of-service divided by their total number of inspections) and to their Violation Rate (the number of driver/vehicle violations found per inspection). Examining the table, one can see a general trend for most factors as we move from carriers rated Satisfactory to those rated Conditional to those rated Unsatisfactory. Specifically, in every case, those carriers rated Satisfactory have lower OOS and Violation rates than those rated Conditional or Unsatisfactory. For example, the mean OOS Vehicle Rate for carriers rated Satisfactory overall is .2532 (i.e., approximately 25.3% of their inspections have resulted in a vehicle being placed out-of-service). Compare this with carriers rated Conditional which have a mean OOS Vehicle Rate of .2802 and carriers rated Unsatisfactory which have a mean OOS Vehicle Rate of .3349. Similarly, this same trend holds for the mean Vehicle Violation Rate. Carriers rated Satisfactory overall have a mean Vehicle Violation Rate of .5311 (i.e., on average there is about a 53.1% chance of finding one vehicle violation during an inspection) compared with the Vehicle Violation Rate of those rated Conditional of .5890 and Unsatisfactory of .7126. The trend also holds when comparing the rating on Part 396 (Inspection, Repair, and Maintenance) to the Vehicle OOS and Violation rates. These findings support those of JFA in their research.

Further findings indicate that this same pattern is present when comparing Driver OOS and Violation Rates to overall safety ratings and also to safety ratings on Part 391 (Qualifications of Drivers) and on Part 395 (Hours of Service of Drivers). Part 392 (Driving of Motor Vehicles) safety ratings weren't analyzed as there were only three carriers in the present sample rated Unsatisfactory on this part.

The significance levels reported in the tables indicate whether or not there is a difference among the three ratings for each item. A significance level of .05 or lower is generally accepted to indicate a significant difference between groups. Therefore, a level of .0001 would indicate extreme significance. To obtain these significance levels, two types of analyses were used. First, the usual ANOVA F-test was run and a square root transformation on the dependent variable was used to stabilize variances when necessary. In addition, because it was not absolutely positive if the normality assumption could be made, the nonparametric Kruskal-Wallis One-Way Analysis of Variance by Ranks was run as it does not

require this assumption. In each case, both these tests gave very similar significance levels. The significance levels reported are those associated with the ANOVA F-test.

TABLE 1. MEAN VEHICLE / DRIVER OUT-OF-SERVICE AND VIOLATION RATES BY SAFETY RATINGS

	Overall Safety Rating			
	Satisfactory (n=1001)	**Conditional** (n=287)	**Unsatisfactory** (n=46)	**Significance Level**
Mean Vehicle Violation Rate	.5311	.5890	.7126	.0007
Mean OOS Vehicle Rate	.2532	.2802	.3349	.0001
Mean Driver Violation Rate	.1028	.1226	.1150	.0057
Mean OOS Driver Rate	.0880	.1048	.1019	.0017
	Part 391 Safety Rating (Qualifications of Drivers)			
	Satisfactory (n=989)	**Conditional** (n=281)	**Unsatisfactory** (n=64)	**Significance Level**
Mean Driver Violation Rate	.1042	.1122	.1367	.0954
Mean OOS Driver Rate	.0891	.0972	.1157	.0938
	Part 395 Safety Rating (Hours of Service of Drivers)			
	Satisfactory (n=843)	**Conditional** (n=422)	**Unsatisfactory** (n=69)	**Significance Level**
Mean Driver Violation Rate	.0973	.1247	.1257	.0001
Mean OOS Driver Rate	.0821	.1097	.1062	.0001
	Part 396 Safety Rating (Inspection, Repair, and Maintenance)			
	Satisfactory (n=1178)	**Conditional** (n=129)	**Unsatisfactory** (n=27)	**Significance Level**
Mean Vehicle Violation Rate	.5353	.6515	.6956	.0004
Mean OOS Vehicle Rate	.2552	.3025	.3531	.0001

Table 2 illustrates how each of the Vehicle / Driver Violation and OOS Rates relate to the Reportable Accident Rate (the number of reportable accidents per million miles) for carriers. A reportable accident is defined as one where there is a death of a person, bodily injury to a person requiring immediate medical treatment away from the accident site, or total property damage of $4,400 or more. The Reportable Accident Rate is determined by dividing the total number of reportable accidents a carrier has had by their total miles driven for the time period and then multiplying by one million. A check was made to determine if the total miles a carrier reported is reasonable. Specifically, if a carrier reported less than 5,000 miles or more than 180,000 miles per power unit (owned or term leased) then they weren't used for this analysis. Due to this, there were 73 carriers eliminated for a total of 1,261 carriers to examine.

Studying Table 2, one can notice that Reportable Accident Rates are significantly positively correlated with both Driver and Vehicle OOS and Violation Rates. Specifically, if a carrier in this sample has a larger OOS or Violation Rate they also have a significantly larger Reportable Accident Rate. The correlation isn't perfect due to the fact that there are many factors which cause an accident, but it does definitely suggest that OOS and Violation Rates should be taken into account when targeting carriers for review.

TABLE 2. SPEARMAN RANK CORRELATION COEFFICIENTS FOR VEHICLE / DRIVER OUT-OF-SERVICE AND VIOLATION RATES BY REPORTABLE ACCIDENT RATES

Reportable Accident Rate By:	Correlation Coefficient	Significance Level
Vehicle Violation Rate	0.151	< .0001
OOS Vehicle Rate	0.131	< .0001
Driver Violation Rate	0.075	< .005
OOS Driver Rate	0.079	< .005

Although it wasn't a main objective of this study, Reportable Accident Rates were compared with overall Safety Ratings as well as ratings on specific parts of the SR/CR. Analysis was only conducted on those parts where there were at least 10 carriers in each category (Satisfactory, Conditional, and Unsatisfactory). Of these, only the Overall Safety Ratings and the ratings on Part 394 (Notification and Reporting of Accidents) had significant differences. These are shown in Table 3.

TABLE 3. MEAN REPORTABLE ACCIDENT RATE BY SAFETY RATINGS

	Overall Safety Rating			
	Satisfactory (n=942)	**Conditional** (n=278)	**Unsatisfactory** (n=41)	**Significance Level**
Mean Reportable Accident Rate	.4841	1.4977	1.7828	.0001
	Part 394 Safety Rating (Notification and Reporting of Accidents)			
	Satisfactory (n=948)	**Conditional** (n=266)	**Unsatisfactory** (n=47)	**Significance Level**
Mean Reportable Accident Rate	.6863	.9063	1.1445	.0031

In conclusion, the present study has helped to confirm results of earlier research which was summarized above as well as provide some additional findings which weren't previously examined. Specifically, the major findings are that carriers rated Satisfactory overall and on various parts of the SR/CR have lower Driver / Vehicle Violation and OOS Rates than those rated Conditional or Unsatisfactory. In addition, both Driver / Vehicle Violation and OOS Rates are significantly positively correlated with the Reportable Accident Rates for carriers. As aforementioned, these findings certainly indicate that a carriers' Violation and OOS Rates are important indicators of overall safety performance.

FURTHER RESEARCH AND STUDIES IN PROGRESS

A study currently in progress, again conducted by JFA (1992) for OMC, examines differences among the three main types of inspections - Level I (full inspection), Level II (walk around driver/vehicle inspection), and Level III (driver only inspection). The main goal of the study is "to provide guidance on the differences among the three inspection levels in their abilities to reduce the potential for accidents and balance that potential against the time/cost of conducting the inspections" (JFA, p.1).

Roadside inspection data was collected for nine states that, based on 1990 SAFETYNET data, had inspections from all three levels with each level accounting for at least 10% of the total inspections. In addition, Indiana accident reports from 1987 were used to obtain the frequency of different factors which contribute to accidents (labeled as the "relative risk" of the defect) (JFA, p.1-4).

Some of the findings thus far include that Level I inspections have a significantly higher average number of vehicle OOS violations found than Level II (and Level III, of course) while Level III has a greater mean number of driver OOS violations found than Level I or II. When considering the total OOS rate, Level I has the highest rate, followed by Level II, and then Level III. This same pattern holds for length of inspections (Level I inspections take the longest on average, followed by Level II, then Level III). The study also finds that for violations relating to tires, lights, and cargo securement, Level I and II are almost equally effective. However Level I is much better at discovering violations related to wheels/studs/clamps, steering, suspension, brake adjustment, other brake violations, coupling devices, exhaust system, and frame. Considering driver violations, all three levels discover fatigue, paperwork, medical, and driver license/qualification violations about the same, but Level III tends to discover hours-of-service violations much more than the other levels (as well as driver intoxication/possession) (JFA, p.5-7).

In order to determine the "relative worth" of each level, the authors examined how often a defect occurs in accidents and compared that with the probability that this defect is discovered in an inspection. They found that, based on this comparison, Level I inspections are clearly the best. When the time/cost factor is considered, the authors find that Level III has the advantage. Combining both the above (probability of detecting a defect that occurs often in accidents and the time element), the conclusion is that Level I is much preferred to Level II, but only slightly preferred to Level III. Further, Level III is

preferred over Level II. The authors note that this is due to its lower cost and higher probability of detecting an hours-of-service violation (JFA, p.7-9).

Based on the above, the authors recommend performing a Level III inspection when its not feasible to conduct a Level I as they are almost identical in influencing a decline in accidents (due to driver-related factors cited as the main cause of many accidents). They state that Level II inspections as they are conducted presently are not as beneficial as Level I or III and, thus, believe they should be modified or less stressed (JFA, p.10).

A second inspection-related ongoing study is being conducted by Linda Taylor, Federal Programs Manager in Oregon. She has been reviewing the safety rating methodology and has proposed an update to it that would incorporate a carrier's roadside inspection performance into the rating process.

Specifically, she has recommended using a carrier's driver and vehicle OOS rate as a basis for evaluation. The procedure would then be that the safety specialist would check if the carrier had three or more inspections completed on their trucks in the last two years. If not, nothing more would be done. If so, the specialist would determine if the average vehicle OOS rate is greater than 10% and if it is will enter a "No" for Part 396, Question 4 of the SR/CR (Is the carrier complying with the vehicle inspection procedure?). Similarly, if the average driver OOS rate is greater than 5%, the specialist will enter a "No" for Part 391, Question 12 (Can the carrier produce completed driver qualification files on drivers selected at random?), for Part 392, Question 1 (Does the carrier have established procedures concerning the use of alcohol and drugs?), or for Part 395, Question 11 (Does the carrier have a system to effectively control the drivers' hours of service?) as applies. All of these areas have been shown to correlate with safety ratings and accident rates as described above and, therefore, it seems appropriate to be utilizing the information available on a carrier in this way.

One may have noticed that, in most studies conducted, whenever a carrier had less than three inspections, they were automatically dropped from all further analysis. One study conducted for the Oregon Public Utility Commission addresses this issue by examining carriers both with and without inspection data to determine the feasibility of obtaining a safety index for all carriers (Richards, p.1).

Data was used from 33,079 motor carriers operating in Oregon in 1987. Within the two groups, those with inspections and those without, carriers were divided into "Safe" and "Unsafe" classifications.

"Safe" was defined as those carriers with no preventable accidents and the maximum miles per vehicle while "Unsafe" were those that have the minimum total miles per preventable accident, thus achieving the two "ends of the safety continuum" (Richards, p.1-2).

Findings indicate that the two populations, safe and unsafe, differ on certain variables. Specifically, those with inspection data were found to differ on the number of late payments, the average age of vehicles, critical and total violation ratio, OOS inspections, and brake, steering, and frame violations. Those without inspection data differed on the number of late payments, number of non-sufficient funds, number of suspensions, average miles per vehicle, and the average age of vehicles. The study concludes by stating that it is possible to develop an accurate safety index for motor carriers as a means to prioritize them for audit and inspection (Richards, p.2-4). Analysis is still continuing in this area.

Additional research under way is looking into certain characteristics of those firms who have had fewer than three roadside inspections. Aspects such as where are they located, how many power units they own, and their safety ratings are being examined to try and determine reasons why they have had so few inspections and speculate as to what can be done to target them.

Preliminary analysis completed has identified 22,289 carriers who have more than five power units and yet have had less than three inspections completed on their trucks since 1989. It was decided to drop out those with zero inspections as they may have gone out of business. The remaining 9,116 have thus far been divided out by state and compared with the number of active carriers in that state as illustrated in Table 4. They are ordered in the table from the best (i.e., Mexico has only 0.23% of their carriers with more than 5 power units and only 1 or 2 inspections) down to the worst (Prince Edward Island has 6.98% of their carriers with the above conditions).

TABLE 4. PERCENT OF ACTIVE CARRIERS THAT HAVE HAD FEW INSPECTIONS BY STATE			
State / Province	**Number of Carriers With Only 1 or 2 Inspections and 5+ Power Units (1989-Present)**	**Total Active Carriers (1992)**	**Percent (Ordered from Best to Worst)**
Mexico	1	436	0.23
Nova Scotia	2	252	0.79
British Columbia	10	680	1.47
Hawaii	4	273	1.47
South Dakota	42	2,489	1.69
Alberta	12	670	1.79
Arkansas	90	4,545	1.98
Mississippi	97	4,780	2.03
Maine	64	3,021	2.12
Saskatchewan	6	277	2.17
Oklahoma	81	3,579	2.26
Montana	34	1,394	2.44
Nebraska	91	3,667	2.48
Utah	57	2,207	2.58
Puerto Rico	9	348	2.59
New Brunswick	14	532	2.63
Colorado	63	2,367	2.66
Washington	107	3,976	2.69
Florida	186	6,893	2.70
Illinois	280	10,304	2.72
Louisiana	130	4,750	2.74
New Hampshire	102	3,709	2.75
Idaho	74	2,631	2.81
Missouri	185	6,543	2.83
Province of Quebec	33	1,162	2.84
Iowa	170	5,963	2.85
Rhode Island	88	2,960	2.97
Kansas	134	4,171	3.21
Alabama	167	5,161	3.24
Kentucky	180	5,411	3.33

TABLE 4. PERCENT OF ACTIVE CARRIERS THAT HAVE HAD FEW INSPECTIONS BY STATE			
State / Province	**Number of Carriers With Only 1 or 2 Inspections and 5+ Power Units (1989-Present)**	**Total Active Carriers (1992)**	**Percent (Ordered from Best to Worst)**
North Dakota	65	1,933	3.36
Tennessee	217	6,433	3.37
Ohio	269	7,812	3.44
Oregon	135	3,886	3.47
Maryland	240	6,796	3.53
Massachusetts	375	10,553	3.55
North Carolina	246	6,800	3.62
Manitoba	17	454	3.74
Georgia	225	5,881	3.83
South Carolina	127	3,289	3.86
District of Columbia	18	464	3.88
West Virginia	142	3,593	3.95
Texas	414	10,447	3.96
Virginia	279	6,612	4.22
Delaware	74	1,735	4.27
New York	408	9,539	4.28
Vermont	73	1,658	4.40
New Jersey	340	7,701	4.42
Arizona	76	1,716	4.43
Pennsylvania	678	15,044	4.51
Indiana	326	7,106	4.59
Nevada	49	1,028	4.77
Michigan	286	5,986	4.78
New Mexico	76	1,540	4.94
Ontario	101	2,041	4.95
New Foundland	1	20	5.00
Wyoming	79	1,504	5.25
Wisconsin	303	5,548	5.46
Minnesota	282	5,161	5.46
California	478	8,654	5.52

TABLE 4. PERCENT OF ACTIVE CARRIERS THAT HAVE HAD FEW INSPECTIONS BY STATE			
State / Province	**Number of Carriers With Only 1 or 2 Inspections and 5+ Power Units (1989-Present)**	**Total Active Carriers (1992)**	**Percent (Ordered from Best to Worst)**
Connecticut	189	3,058	6.18
Alaska	12	181	6.63
Prince Edward Island	3	43	6.98

Other characteristics of these carriers are that approximately 63.4% (5,775) of them have been rated. Of these, 57.0% (3,293) are rated Satisfactory, 37.1% (2,144) are rated Conditional, and 5.9% (338) are rated Unsatisfactory. The number of power units owned range from 5 up to 2,188 (75% of them had 12 or less). In addition, 58.5% (5,333) had only one inspection and the remaining 41.5% (3,783) had two completed since 1989. Further research will attempt to locate these carriers by zip code and map them so as to observe which areas should be better targeted.

Other further research may include examining some of the same types of relationships as the present study has for a more representative sample and exploring the possibility of developing a model which could assign safety ratings from available data.

SUMMARY AND CONCLUSIONS

The main findings/conclusions of the studies conducted and reviewed are as follows:

* There is a strong relationship between quality maintenance and inspection procedures and a decline in accidents related to defects.

* Brake, tire/wheel, and lights defects are most likely to cause defect-related accidents.

* Drivers are cited as the main cause of most accidents, but the majority of OOS violations are vehicle related.

* The application of the OOS criteria through the MCSAP roadside inspection program has had a significant influence on decreasing the rate of truck accidents where mechanical or safety defects were cited as primary contributing factors.

* Carriers' accident rate and their performance on roadside inspections both significantly relate to their overall safety rating as well as to their ratings on specific parts of the SR/CR - the worse a carrier's inspection performance, the more likely they are to have a higher accident rate and a Conditional or Unsatisfactory safety rating overall and on related Parts of the SR/CR.

* To minimize accidents and their cost, more time on roadside inspections should be devoted to wheels, tires and the suspension system and less time to lights, windshield/wipers, and the frame/body.

* Accident rates have been shown to be significantly lower for carriers that are larger, short-trip, private, older, profitable, carry agricultural products, have low turnover, and have quality equipment.

* When considering the three main levels of inspections, and examining the time/cost associated with each and their probability of detecting a defect that is a main cause of accidents, Level I and Level III inspections should be conducted most often and less emphasis placed on Level II.

* Further research of carriers with fewer than three roadside inspections is being completed as well as a study of including roadside inspection information into the rating process.

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