PB2000-104508

UNIFORMITY OF ROADSIDE SAFETY INSPECTIONS OF COMMERCIAL VEHICLES AND DRIVERS ON THE NATIONAL LEVEL

A COMPENDIUM OF RESEARCH STUDIES IN THE FIELD OF SAFETY INSPECTIONS FOR MOTOR CARRIERS AND DRIVERS

Sponsored by

U. S. DEPARTMENT OF TRANSPORTATION
OFFICE OF MOTOR CARRIER SAFETY

Compiled by

THE ILLINOIS STATE POLICE

OCTOBER 1999

Technical Report Documentation Page

1. Report No.	2. PB2000-104508	3. Recipient's Catalog No.
4. Title and Subtitle Uniformity of Roadside Safety Inspections of Commercial Vehicles and Drivers on the National Level		5. Report Date 10-14-99 6. Performing Organization Code MSP-10
7. Author(s) Illinois State Police		8. Performing Organization Report No.
9. Performing Organization Name and Address Illinois State Police 103 Armory Bldg. Springfield, Illinois 62794		10. Work Unit No. (TRAIS) 11. Contract or Grant No. MC-97-17-333
12. Sponsoring Agency Name and Address FHWA/Office of Motor Carrier Safety National and International Safety Programs 400 7th Street, SW, Rm. 3419, MSP-10 Washington, D.C. 20590		13. Type of Report and Period Covered Compendium of Research Studies in the Field of Safety Inspections for Motor Carriers and Drivers, October, 1999 14. Sponsoring Agency Code MSP-10

15. Supplementary Notes

16. Abstract

The goal of the project was to provide practical information fo FMCSA, commercial carriers, MCSAP agencies, and the CVSA which will be used to guide and improve standardized roadside enforcement of commercial vehicle regulations across North America.

A component of this project grant was to develop a compendium of previous research in motor carrier safety. This document serves as that component.

17. Key Words	18. Distribution Statement
Research; inspection; defect detection; accident causation; vehicle out-of-service criteria; peer review; MCSAP; inspection selection system.	Unlimited - Available through the National Technical Information Service, Springfield, VA

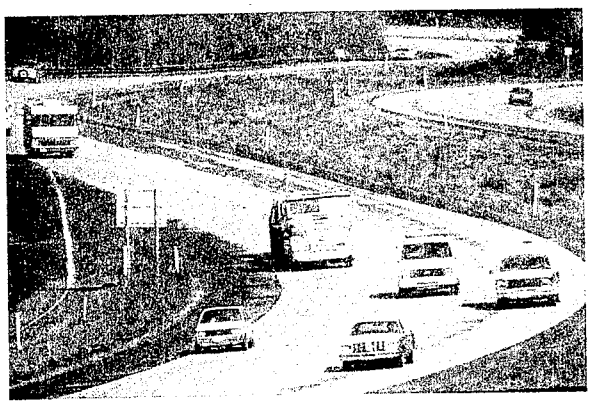
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	57	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

INTRODUCTION

In 1996 alone, 394,000 large trucks were involved in traffic crashes in the United States; 4,740 were involved in fatal crashes. One out of eight fatal crashes resulted from a collision involving a large truck. Moreover, according to a report published in Accident Analysis and Prevention titled "Defective Equipment and Tractor-Trailer Crash Involvement," (1989) tractor-trailers with mechanical defects are twice as likely as those without defects to be in crashes. In 1992, a three-day nationwide inspection revealed 26 percent of trucks had mechanical defects serious enough to put them out of service.



In 1996, 1 out of 8 fatal crashes resulted from a collision involving a large truck.

To help the Federal Highway Administration improve highway safety, Congress passed 12 commercial vehicle safety enactments since 1982. However, the passage of the Motor Carrier Act of 1980, which significantly deregulated the trucking industry and allowed many new entrants, is what initiated the profound interest in commercial vehicle safety. Reflecting this concern, the Bureau of Motor Carrier Safety, once a small agency within the FHWA, was elevated to prominence as the Office of Motor Carriers in 1985. In October, 1999 the agency became the Office of Motor Carrier Safety (OMCS).

The OMCS and the states work closely together. The Motor Carrier Safety Assistance Program, which was established by the Surface Transportation Act of 1982, is one example of this cooperation. As MCSAP was created to reduce the number and severity of commercial vehicle crashes, it provides federal funds to the states in order for them to conduct increased commercial motor vehicle safety activities. These safety activities include conducting roadside inspections, educational contacts and compliance reviews.

INSPECTION PROCESS

More than 2,000,000 trucks undergo safety inspections each year (compared to approximately 36,000 before MCSAP). Inspections involve an examination of vehicles, drivers and hazardous material cargo. Inspections focus on critical safety regulations and include provisions for placing drivers or vehicles out-of-service if unsafe conditions are discovered. Out-of-service problems must be corrected before continuation of a trip. Safety inspections of drivers and/or vehicles are conducted either at weigh stations or along the roadside. There are several types or levels of roadside inspections.

Level I

North American Standard Inspection: This inspection involves a thorough check of the driver and the vehicle including an underneath-the-vehicle inspection.

Level II

Walk-Around Driver/Vehicle Inspection: This inspection also involves an examination of the driver and vehicle. However, only those items which can be inspected without physically getting under the vehicle are included.

Level III

Driver-Only Inspection: This inspection examines only the driver.

Level IV

Special Inspection: This level of inspection typically includes a one-time examination of a particular item. These examinations are normally made in support of a study or to verify or refute a suspected trend.

Level V

Vehicle-Only Inspection: This inspection includes each of the vehicle inspection items specified under Level I. They are typically conducted without a driver present and at any location.

NORTH AMERICAN STANDARD INSPECTION PROCEDURE

The Commercial Vehicle Safety Alliance, an organization of federal, state and provincial government agencies, and representatives from private industry, is responsible for the administration and enforcement of motor carrier safety laws in the United States, Canada and Mexico. The CVSA, along with the MCSAP, encourages uniform inspection criteria and enforcement from state to state.

Accordingly, the goals of the CVSA are to improve safety, the efficiency and uniformity of inspections, and data collection and dissemination. It is with these goals in mind that the CVSA has worked continuously since 1981 to develop and maintain out-of-service criteria relating to commercial motor vehicles. According to CVSA, inspections are conducted to check 14 critical safety items known to cause crashes or breakdowns.

GOALS OF MCSAP AND CVSA

Motor Carrier Safety Assistance Program
Reduce the number and severity of commercial vehicle crashes; provide Federal funds to states to conduct increased commercial vehicle safety activities.

Commercial Vehicle Safety Alliance
Improve safety, the efficiency and uniformity of inspections, data collection and dissemination.

- brake systems
- tires
- wheels and rims
- exhaust systems
- frames
- windshield wipers
- coupling devices
- fuel systems
- lighting devices
- steering
- suspension
- van and open-top trailer bodies
- safe loading
- emergency exits for buses

These items are collectively known as the **Critical Vehicle Inspection Items of the North American Standard Inspection Procedure**. CVSA states this standard "targets only those critical components on commercial vehicles that have been identified as accident contributors."

EXECUTIVE SUMMARY

In late 1997, the Office of Motor Carriers through the Illinois Department of Transportation, awarded a grant to the Illinois State Police to fund the project entitled, *Uniformity of Roadside Safety Inspections of Commercial Vehicles and Drivers on the National Level.* One component of this project grant was to develop a compendium of previous research in motor carrier safety. This document serves as that component.

A variety of motor carrier research has been conducted throughout the country. While some studies overlapped existing studies, surprisingly few were duplicative. Also, no study was located which refuted other study results.

The following summarizes some of the research findings.

Issue: Do roadside safety inspections improve motor carrier safety?

The Highway Safety Research Institute (1977) examined this issue and showed quality maintenance and inspection procedures were strongly related to a decline in defect-related crashes. This relationship between inspections and crashes was also demonstrated in a 1991 study by Jack Faucett Associates. This group showed the application of out-of-service criteria influenced a decrease in defect-related truck crashes.

The opinions of individuals involved in motor carrier safety reflect these findings. A large majority of motor carrier management as well as nearly all state MCSAP administrators indicated their belief that roadside inspections improve safety for the industry, based on the 1995 survey by the Upper Great Plains Transportation Institute. Another study UGPTI conducted in 1998 indicated 78.1 percent of commercial vehicle drivers and 87.9 percent of vehicle inspectors believe vehicle inspections improve safety for the industry. A smaller majority of both groups also believed driver inspections improve safety for the industry.

Issue: Should roadside inspections concentrate on certain items or areas?

In 1989, the Pennsylvania State University stated inspections do not concentrate enough on factors related to drivers who cause crashes since drivers are the main cause of crashes yet most out-of-service violations are vehicle-related. That same year, the Oregon State University recommended reducing out-of-service criteria to those items which most contribute to commercial vehicle crashes, namely brakes; safe loading; and tires, wheels and rims.

Issue: Is there a relationship between roadside inspection performance and safety/compliance review record?

A study conducted by Jack Faucett Associates (1991) found carriers with unsatisfactory performance ratings also had poor inspection performance. This was reconfirmed in 1993 by the Upper Great Plains Transportation Institute. They showed carriers with satisfactory performance ratings had lower out-of-service rates and carriers with less than satisfactory performance ratings had higher out-of-service rates.

Issue: Which inspection level is the best to conduct?

Jack Faucett Associates (1992) compared the time and cost of conducting various level inspections with the probability of detecting crash-causing defects. Based on this analysis, they concluded Level I and Level III inspections should be conducted more frequently than Level II inspections.

The Utah Highway Patrol in cooperation with the Utah Department of Transportation (1998) studied the level of inspections based on whether the inspection was conducted at a roadside or fixed facility. They concluded fixed facilities should concentrate on Level I inspections while roadside facilities should concentrate on Level III. Again, Level II inspections were not the preferred level.

Issue: How should drivers and vehicles be selected for inspection?

Lantz, Blevins and Hillegass reviewed the Inspection Selection Process in 1996. They determined the benefit of this selection system when they found inspections recommended by the Inspection Selection Process had a 35 percent higher driver out-of-service rate and a 75 percent higher vehicle out-of-service rate.

They replicated their study that same year and had similar findings. This next study concluded that use of the Inspection Selection System will help target unsafe carriers while reducing the inspection burden on safer carriers.

In 1997, the Office of Motor Carriers formed an Inspection Quality Team comprised of representatives of stakeholder groups in motor carrier safety. This group developed a series of recommendations for improving the quality of roadside inspections. While they indicated driver and vehicle selection should be done fairly, according to the jurisdiction's policies and procedures, they also stated use of the Inspection Selection System would increase the success of the inspection process.

Motor Carrier Safety Research
HIGHLIGHTS

1977

Inspection, Defect Detection and Accident Causation in Commercial Vehicles
Highway Safety Research Institute

- There is a strong relationship between quality maintenance and inspection procedures and a decline in crashes related to defects.
- Brake, tire, wheel and lighting defects are most likely to cause defect-related crashes.
- Defects most likely to cause crashes are all visually detectable, and daily driver vehicle inspection is considered the most effective way to discover these defects.

1989

The Efficiency of Quality Roadside Inspections in Reducing Heavy Truck Crashes
Pennsylvania State University

- Most out-of-service violations are vehicle-related and the most common involve the braking system.
- Drivers are cited as the main cause of crashes, but the majority of out-of-service violations are vehicle-related.
- Inspections do not concentrate enough on factors related to drivers who cause crashes.

1991

Evaluation of Vehicle Out-of-Service Criteria
Jack Faucett Associates

- The application of the out-of-service criteria through the MCSAP roadside inspection program has had a significant influence on decreasing the rate of truck crashes where mechanical or safety defects were cited as primary contributing factors.
- To minimize crashes 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.

- Carriers with unsatisfactory ratings as a result of Safety Reviews or Compliance Reviews have:

  - a significantly higher percentage of out-of-service vehicles;
  - a higher average number of violations per inspection; and
  - worse inspection performance overall than carriers rated satisfactory.

1992

Adequacy and Effectiveness of Roadside Inspection Procedures: Relative Effectiveness of Level I, II, and III Roadside Inspections
Jack Faucett Associates

- 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 crashes, Level I and Level III inspections should be conducted more frequently and less emphasis should be placed on Level II inspections.

- The significant differences in driver and vehicle out-of-service rates indicate disparities in inspection procedures, training and other factors which should be identified and developed for the benefit of the entire program.

1993

Analysis of Roadside Inspection Data and its Relationship to Accident and Safety/Compliance Data Reviews of Previous and Ongoing Research in this Area
Upper Great Plains Transportation Institute

- Carriers rated satisfactory as a result of Safety Reviews or Compliance Reviews had lower out-of-service rates than those rated conditional or unsatisfactory. Findings indicate the same pattern is present when comparing driver out-of-service rates.

1994

Evaluation of the Differences Between Spontaneous and Anticipated Roadside Inspections of Motor Carriers
Brenda Lantz and the Upper Great Plains Transportation Institute

- Fixed facilities should concentrate on Level I inspections and roadside facilities should concentrate on Level III inspections. This concentration is best suited to finding the most out-of-service violations.

1995

Peer Review of Out-of-Service Verification
University of South Carolina, college of Criminal Justice and South Carolina Department of Public Safety

- The team believed each state could improve its out-of-service verification results by developing a balance of activities in each of the following:
  - educational efforts;
  - prevention efforts;
  - enforcement procedures;
  - sanctioning practices; and
  - Inspection Repair Audit Program procedures.
- Overt surveillance at 24-hour locations virtually guarantees compliance with out-of-service orders until repairs are made or the driver meets requirements.
- Concern with the absolute numbers of inspections conducted remains the primary focus of regulatory efforts, despite changes permitting substitution of program effectiveness goals in place of inspection counting.

Perceptions of the MCSAP: Motor Carrier Management and State Administrators
Upper Great Plains Transportation Institute

- Motor carrier management and state MCSAP administrators both perceive the MCSAP as a beneficial program which makes a positive contribution to motor carrier safety.
- Motor carrier management offers the following suggestions to improve the MCSAP:
  - Improve consistency of inspections between states and inspectors.
  - Use technology for selecting carriers for inspection based on past history and previous inspections.
  - Increase funding for more officers and more inspections.
  - Decrease time required for or extent of inspections.
  - Perform drug and alcohol testing at the roadside versus by the carrier.
  - Send copies of inspection reports to the carrier.

1996

Evaluation of Roadside Inspection Selection System for Commercial Vehicles
Brenda Lantz, Michael Blevins and Thomas Hillegass

- Both driver and vehicle overall out-of-service rates were notably higher for inspections in which the Inspection Selection System recommended the inspection versus those done on carriers not recommended for inspection.

Inspection Selection System Recommended Inspections
versus
Inspections NOT Recommended by the Inspection Selection System

Overall Driver Out-of-Service Rate	→	35% higher
Overall Vehicle Out-of-Service Rate	→	75% higher
Overall Out-of-Service Rate	→	60% higher

Evaluation of Roadside Inspection Selection System for Commercial Vehicles, A Replication
Lantz, Blevins and Hillegass

- Consistent use of the Inspection Selection System as a selection tool for inspections could substantially increase the number of vehicles and drivers placed out of service.

- Use of the Inspection Selection System will help target relatively unsafe carriers and reduce the inspection burden on carriers proven to be safe.

1997

Peer Exchange on Hours-of-Service Compliance, Final Report
North Dakota State University, Upper Great Plains Transportation Institute

- There are seven key elements fundamental to an effective hours-of-service compliance program:

  1) Program management - All levels of the agency should understand the goals of the program. Management should be responsive, flexible and supportive.

  2) Roadside enforcement - Activities should include interview techniques, training, use of technology, a selection process, consistent penalties and use of innovative practices.

3) Compliance reviews - Reviews should support roadside enforcement activities and provide educational contacts and outreach to motor carriers

4) Training - Minimally, training should include the 40-hour North American Standard course. On-going and consist training throughout the state is also recommended.

5) Data analysis - Proper analysis of data from all sources is essential. Performance based programs, where decisions are support by data analysis, are recommended.

6) Technology - Technology should be used to enhance motor carrier safety programs.

7) Industry outreach - Partnerships between motor carriers, state and federal agencies promote voluntary compliance and safer highways.

1998

A Study of Commercial Vehicle Safety Alliance's Out-of-Service Criteria
Oregon State University

- This study recommended CVSA, federal agencies and motor carrier industry consider reducing the number of items in the out-of-service criteria to include only those which highly contribute to crashes:
  - brakes
  - safe loading
  - tires, wheels and rims.

- Brakes, safe loading, tires, wheels and rims account for 68.9 percent of all defects contributing to commercial vehicle crashes where a mechanical defect was the cause of the crash.

Utah Performance Based Pilot Project
Utah Highway Patrol and Utah Department of Transportation (1998)

- A performance based system provides program flexibility and enables limited resources to be concentrated on "bad" carriers which need attention.

An Evaluation of Commercial Vehicle Drivers' and Roadside Safety Inspectors' Opinions Regarding the MCSAP, the Roadside Inspection Process, and Motor Carrier Safety
Upper Great Plains Transportation Institute (1998)

- Roadside inspections of vehicles improve safety for the motor carrier industry.
  - 78.1 percent of *drivers* "agree" or "strongly agree."
  - 87.9 percent of *inspectors* "agree" or "strongly agree."
- Roadside inspection of drivers improve safety for the motor carrier industry.
  - 67.8 percent of *drivers* "agree" or "strongly agree."
  - 78.0 percent of *inspectors* "agree" or "strongly agree."
- About 70 percent of drivers agreed roadside inspections improve safety for their company (compared to 43 percent of motor carrier managers from the 1995 survey).
- Most drivers indicated roadside inspectors are doing an excellent job. While rated highly, a couple problematic areas were noted:
  - About 20 percent of drivers indicated they had a CVSA inspection with no violations and did not receive an inspection report.
  - About 40 percent of drivers indicated they had a complete vehicle inspection with no violations and did not receive a CVSA decal. *(24 percent of drivers also indicated they were required to go through another inspection only hours after receiving a CVSA decal.)*

MOTOR CARRIER SAFETY RESEARCH

"Inspection, Defect Detection and Accident Causation in Commercial Vehicles"

Highway Safety Research Institute (1977)

One of the initial studies of inspections and crashes was conducted in 1977 by the Highway Safety Research Institute. The study was initiated by OMC (which was 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..." (McDole, p. 1)

Data Sources

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

Findings and recommendations

The study concluded that there was a strong relationship between thorough inspection procedures with follow-up quality maintenance and a decline in crashes related to defects. The analysis found 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.

Defects Most Likely to Cause Crashes
- ✓ brakes
- ✓ tires/wheels
- ✓ lights

Furthermore, results indicated the defects most likely to cause crashes were those associated with brakes, tires/wheels and lights. Since these defects are all visually detectable, the researchers believed that daily driver inspection was the most effective way to discover these defects. In addition, frequent periodic inspections and repairs by maintenance personnel were suggested. Roadside inspections were then seen as a backup to the above to provide incentive to maintain vehicles and also to cause repair of vehicles found with defects. (McDole, p. 3)

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

"The Efficiency of Quality Roadside Inspections in Reducing Heavy Truck Crashes"

Pennsylvania State University (1989)

This 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 crashes involving large trucks. The study began by addressing the issue that crashes are unique occurrences which involve many interrelated factors--driver, vehicle and environment--and there are no quick and simple explanations as to why trucks are involved in crashes. (Patten et al., p. 269)

Data Sources

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

A brief description of the inspection process was given emphasizing items checked which are crucial to operating the vehicle safely. Violations found were divided into two categories:

- those not posing immediate danger, such as record keeping or minor vehicle defects; and
- those requiring a driver/vehicle to be placed out of service until the violation is fixed.

Findings and Recommendations

> "The driver was the prime cause of a large majority of truck crashes."

The study found that in all of the data sets examined, the vast majority of out-of-service violations discovered were vehicle related--the most common involving the brake system. Driver related out-of-service violations were much less common. Due to the design of the inspection, there are only a few items for which a driver can be placed out of service while there are many that can cause a vehicle to be placed out of service. It was difficult to tell how accurate a driver's logbook actually was or how fatigued he/she was before going on duty. Further, the study found that the driver was the prime cause of the large majority of truck crashes. In conclusion, the authors stated although the driver was the prime cause of the large majority of truck crashes, roadside inspections "provide a useful tool for enforcement officials to remove some potentially unsafe vehicles from the highway." Also, inspections do not concentrate enough on factors related to drivers that cause crashes. (Patten et al., p. 272)

Some recommendations offered by the authors included:

- increasing the levels of identifying and citing or educating unsafe drivers;
- devising a plan to make sure out-of-service violations are actually repaired before a driver/vehicle returns to service; and
- requiring drivers to complete a certified training program before being issued a commercial driver's license.

In conclusion, the authors suggested additional avenues of research, for example, driver fatigue, joint carrier/driver responsibility for violations, anti-lock brakes and on-board monitoring systems. (Patten et al., p. 275)

"Evaluation of Vehicle Out-of-Service Criteria"

Jack Faucett Associates (1991)

A major study of roadside inspection data was conducted by Jack Faucett Associates in 1991. The study had several objectives including:

- determining if out-of-service criteria influenced a decline in crashes;
- determining the relationship between a carrier's roadside inspection performance, its crash rate and its safety/compliance review record; and
- examining the relative efficiency of the out-of-service criteria.

Data Sources

The first data source used was the Motor Carrier Safety files for 1984-88. These files established the frequency of certain mechanical defects existing in reported crashes.

A second major source was the 1988-1989 SafetyNet data which contain inspection records for motor carriers. Records available for analysis from this database alone totaled 812,978. Violations in this database were labeled as either out-of-service or non-out-of-service; classified as driver, vehicle or hazardous materials; and given a severity rating from one (least severe) to seven (most severe). To develop carrier profiles only those carriers with three or more inspections in the year prior to their most recent safety review/compliance review were used for a total of 5,830 carriers.

A third data source employed was the 1987-89 safety review/compliance review file. After eliminating 1987 data and records with multiple carrier reviews, 41,253 carriers were analyzed.

A fourth data source utilized was state crash data from state agencies. These data were used to determine whether the out-of-service criteria influenced a decline in crashes. The authors examined differences in crash rates between the year the state entered MCSAP and two years later and included a breakdown of vehicle types and a precise identification of vehicle defects. Only 13 states had crash data meeting these requirements for this analysis.

A final source of data for this study was annual vehicle miles traveled for the 13 states. Vehicle miles traveled was used to develop crash rates that took into account possible exposure to crashes according to the number of miles a driver/truck traveled per year.

Findings and Recommendations

Of the 13 states examined, there were significant decreases reported in the defect crash rate in nearly every state between the year the state entered MCSAP and two years later. While the number of inspections conducted increased almost three-fold, truck defect crashes decreased by over 12 percent.

The mean rate of decrease was .032 crashes per million miles. Examining individual defects, the authors reported crashes with:

- brake defects declined (15%);
- tire, steering, "other" defects declined (10-12%); and
- light defects declined (5%).

The authors concluded by stating their "analyses indicate the application and enforcement of the out-of-service criteria through the MCSAP roadside inspection program has had a significant impact in decreasing the rate of truck crashes where mechanical or safety defects were cited as primary contributing factors." (Faucett, p. 21)

Under the second objective, comparisons were made between the average out-of-service performance for carriers rated "Satisfactory," "Conditional" and "Unsatisfactory." Carriers with an "Unsatisfactory" rating had a significantly higher percentage of out-of-service vehicles (and a higher mean of out-of-service violations per inspection) than those with a "Satisfactory" rating. Similarly, those carriers rated "Unsatisfactory" or "Conditional" had significantly worse inspection performance than those rated "Satisfactory."

Under the final objective, the goal was to ascertain which violations are the most critical to detect in order to minimize the financial expense of truck crashes. The study found:

- crashes with a drive line or fuel system defect are approximately three times more deadly; but
- brake and wheel/tire defects have the highest costs connected with them as these defects occur most often.

Whether one wishes to minimize crashes or crash costs, the authors stated that wheels, tires and the suspension system should receive more inspection time than they had previously and less attention should be paid to lights, windshield/wipers and the frame/body. (Faucett, p. 52-69)

"Adequacy and Effectiveness of Roadside Inspection Procedures: Relative Effectiveness of Level I, II, and III Roadside Inspections"
Jack Faucett Associates (1992)

A study conducted by Jack Faucett Associates (1992) for OMC examined differences among the three main types of inspections:

Level I	(full inspection)
Level II	(walk around driver/vehicle inspection)
Level III	(driver only inspection)

The main goal of the study was "to provide guidance on the differences among the three inspection levels in their abilities to reduce the potential for crashes and balance that potential against the time/cost of conducting the inspections." (Faucett, p. 1) More specifically, the study aimed to determine:

- the average number of vehicle out-of-service violations found per inspection;
- the average number of driver out-of-service violations found per inspection; and
- the average length of an inspection measured in absolute terms and in estimated labor minutes expended.

By linking the individual violations with the likelihood each has been assessed as a crash contributing factor, the analysis determined whether differences exist between the different levels of inspections in contributing to crash reduction. Moreover, by comparing the relative crash reduction contribution with the relative time-cost of each inspection type, the analysis provided information needed to make recommendations about the distribution of resources among the types of inspections and the consequences of such distributions.

Data Sources

The answers to these questions required data from states where all three types of inspections are performed. Based on 1990 SafetyNet roadside inspection data, states in which each inspection level accounted for at least 10 percent of the state's total inspections were selected for the analysis. The following states were included: Arkansas, Illinois, Iowa, Montana, Nebraska, New Mexico, North Dakota, Wisconsin and Wyoming.

Findings and Recommendations

As shown in Table 2, Level I inspections have a significantly higher average number of vehicle out-of-service violations than Levels II and III. In contrast, Level III inspections had a greater mean

number of driver out-of-service violations than Levels I or II. When considering the average for the overall out-of-service rate, Level I had the highest rate followed by Level II and then Level III.

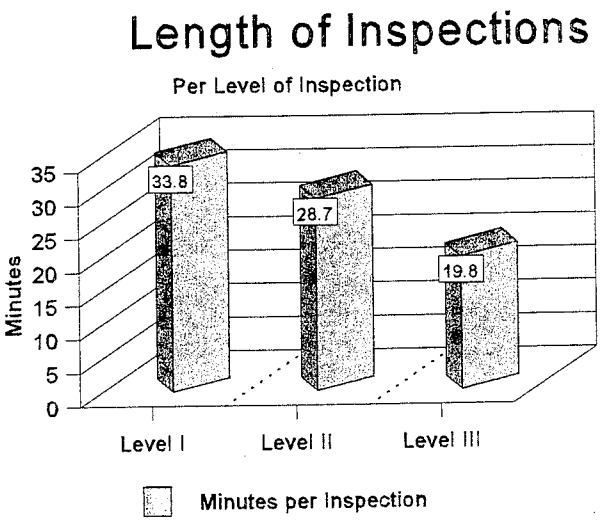
In summary, Level I inspections were found to have significantly more average out-of-service violations than Level II inspections which, in turn, had more than Level III inspections. This was largely due to the overwhelming difference in the number of vehicle violations found during Level I, II and III inspections.

Table 2: Comparison of Out-of-Service Rates Across Levels of Inspection

	Vehicle OOS Rate	Driver OOS Rate	Overall OOS Rate
Level I	36.20%	5.89%	39.58%
Level II	11.16%	6.33%	16.93%
Level III	.02%	13.02%	13.08%

Researchers also found significant differences in the three types of inspections in terms of length of time needed to conduct an inspection:

- Level I inspections averaged 33.76 minutes;
- Level II inspections averaged 28.72 minutes and;
- Level III inspections averaged 19.82 minutes.



There are statistically significant differences among the types of inspections regarding the extent to which they uncover vehicle and driver violations. It was not surprising that Level III inspections dominate Level I and Level II inspections in terms of driver out-of-service violations as Level III focuses only on the driver. In contrast, Levels I and II focus on the vehicle. Accordingly, these inspections found more vehicle out-of-service rates. More specifically, Level I found more vehicle defects as a result of a more thorough investigation which includes looking underneath the vehicle.

The key to any assessment of the relative worth of each level of inspection is the linkage between the possibility a particular defect is detected during an inspection and the likelihood the defect contributes to a crash. For a number of defect categories, there was a direct link between defects identified in an inspection and factors contributing to a crash.

Defects Linked to Crashes

Vehicle Defects	*	tires	*	windshield wipers
	*	steering	*	other vehicle violations
	*	brakes		-fuel system
	*	lighting devices		-wheels and suspension
	*	cargo securement		
Driver Defects	*	intoxication	*	other driver violations
	*	illegal substance possession		-illness
	*	fatigue		-violation of license restriction
				-paperwork or passenger violation

The study found that for violations relating to tires, lights and cargo securement, Levels I and II were almost equally effective. However, Level I was much more adept at discovering violations related to wheels/studs/clamps, steering, suspension, brake adjustment, other brake violations, coupling devices, exhaust system and frame. All three levels discovered driver violations (fatigue, paperwork, medical and driver license/qualification violations) virtually the same. However, Level III tended to discover hours-of-service violations more frequently than other levels (as well as driver intoxication/possession).

To determine the "relative worth" of each level, the authors compared how often a defect occurs in crashes with the probability this defect was discovered in an inspection. Based on this comparison, the authors found Level I inspections were clearly advantageous. When the time/cost factor was considered, the authors found Level III had the advantage. Combining the probability of detecting a defect that occurs often in crashes with the time element, the authors concluded that Level I was much preferred to Level II, but only slightly preferred to Level III. Furthermore, Level III was preferred to Level II, largely due to its lower cost and higher probability of detecting hours-of-service violations.

In conclusion, to be most effective the roadside inspection program must:

- focus on only the most critical safety elements; and
- significantly increase the emphasis on the driver elements of the inspection.

This analysis found Level I and III inspections were nearly identical in their benefit-cost ratio. With these two inspection types, crash prevention was achieved in different ways. Level I inspections tend to mitigate vehicle violation-caused crashes whereas Level III inspections tend to mitigate crashes caused by driver out-of-service violations.

Level II inspections as they are presently conducted are not as beneficial as Level I or Level III inspections.

Based on these findings, the authors recommended performing a Level III inspection when it is not feasible to conduct a Level I inspection. Both levels are almost identical in influencing a decline in crashes. (Driver-related factors are cited as the main cause of many crashes.) Moreover, they stated Level II inspections as they are presently conducted are not as beneficial as Level I or III. The reasons for the relative ineffectiveness of the Level II inspections were not entirely clear to the researchers. Although the Level II inspection certainly has a place within the overall inspection and enforcement scheme, it requires additional study of the content and circumstances under which it is used so its overall effectiveness can be improved.

An important finding of this study was the wide variation in driver and vehicle out-of-service rates around the country. Some regional variations in these rates were expected. However, because the differences in rates were so significant, it indicated that disparities in inspection procedures, training or other factors must be involved. These disparities across the country should be identified and addressed for the benefit of the entire program.

"Analysis of Roadside Inspection Data and its Relationship to Accident and Safety/Compliance Review Data Reviews of Previous and Ongoing Research in this Area"

Upper Great Plains Transportation Institute (1993)

A study conducted by the Upper Great Plains Transportation Institute (1993) examined the relationship between a carrier's performance on roadside inspections and crash rates and a carrier's performance on the safety or compliance review. This study was completed to explore if information from roadside inspections of carriers can be coupled with knowledge about other carrier data, such as carrier size or type of commodities carried, to aid in targeting carriers for review and assigning carrier safety ratings.

Data Sources

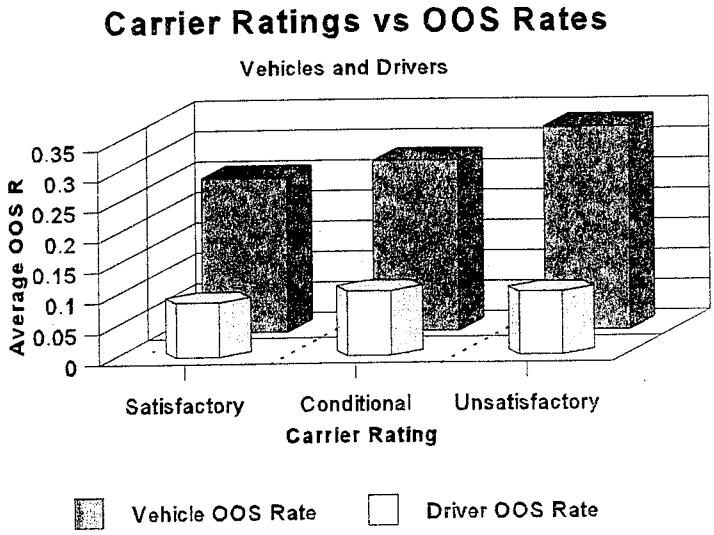
Due to time constraints and the need for a statistically stable sample, the study was restricted to data from larger firms. Accordingly, the analysis included carriers having at least 20 drivers, having had 10 or more roadside inspections (Levels I, II, or III) and having been assigned a safety rating in the last year. With those restrictions 1,334 drivers were examined.

Findings and Recommendations

Upon examination, as shown in Table 1, a general trend was found moving from carriers performance rated "Satisfactory" to those rated "Conditional" to those rated "Unsatisfactory." Specifically, in every case, those carriers rated "Satisfactory" had lower out-of-service rates in comparison with those rated "Conditional" or "Unsatisfactory." The mean out-of-service vehicle rate for carriers rated "Satisfactory" was .2532. This means approximately 25.3 percent of their inspections resulted in a vehicle being placed out of service. In comparison, carriers rated "Conditional" had a mean out-of-service vehicle rate of .2802, and carriers rated "Unsatisfactory" had a mean out-of-service vehicle rate of .3349. Further findings indicate that this same pattern is present when comparing driver out-of-service rates.

Table 1: Carrier Ratings and Respective Out-of-Service Rates

	Satisfactory Rating	Conditional Rating	Unsatisfactory Rating	Significance Level
Mean OOS Vehicle Rate	.2532	.2802	.3349	.0007
Mean OOS Driver Rate	.0880	.1048	.1019	.0017



This study found carriers rated "Satisfactory" overall had lower driver/vehicle out-of-service rates than those carriers rated "Conditional" or "Unsatisfactory." These findings indicate a carrier's out-of-service rates are important indicators of overall safety performance.

"Evaluation of the Differences Between Spontaneous and Anticipated Roadside Inspections of Motor Carriers"

Brenda Lantz and Upper Great Plains Transportation Institute (1994)

The general characteristics of inspections were the focus in a study conducted by Brenda Lantz and the Upper Great Plains Transportation Institute (1994). The goal of this study was to improve the effectiveness of highway safety inspections of motor carriers. The authors characterized these inspections as either anticipated or spontaneous.

- **Anticipated inspections** were defined as those in which the driver is usually aware there is a high probability an inspection will take place, for example, at fixed sites, such as weigh stations.

- **Spontaneous inspections**, in contrast, are those in which the driver may be unaware that an inspection will occur. These inspections are most likely conducted at roadside facilities, such as rest stops, check points or even on the shoulder of a road.

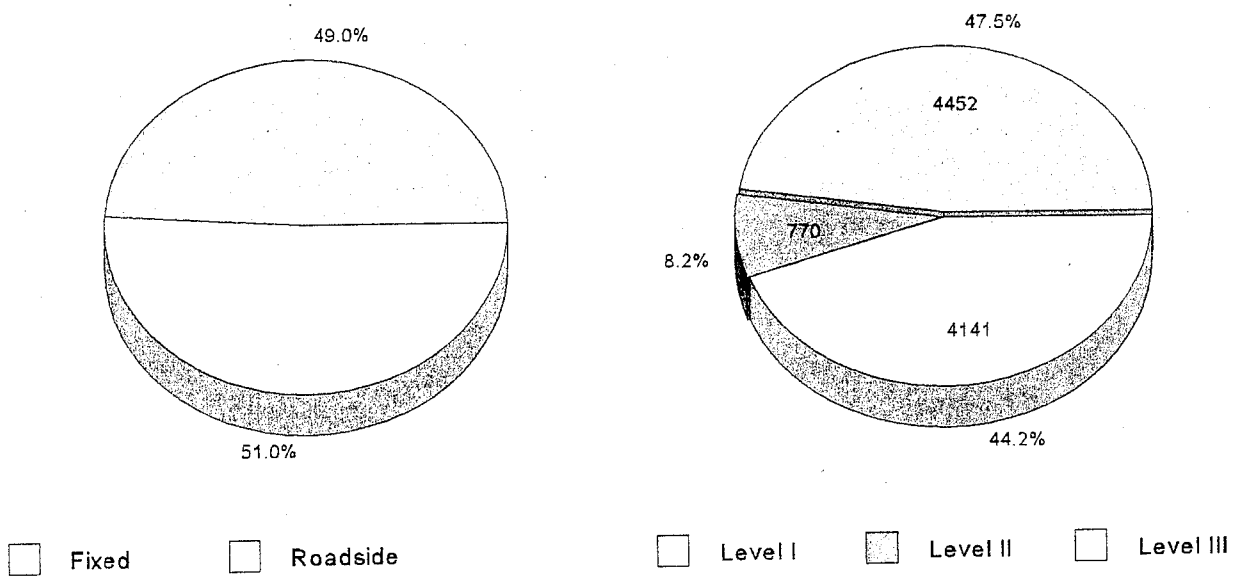
In classifying inspections into two categories, this project was able to evaluate the differences found between types of inspections. The analysis would then provide OMC and DOT management with information and data that would allow them to improve the effectiveness of the roadside inspection program and remove the maximum number of unsafe drivers and vehicles from the highway. This would, in turn, lead to a reduction of crashes and, thus, contribute to achieving FHWA's overall safety goals.

Data Sources

Data from SafetyNet on all roadside inspections conducted in North Dakota in 1993 were used for this study. The data included the date, duration, location and level of inspection; the facility (fixed or roadside); total number of violations and indication whether or not they were out-of-service violations; violation code and category; and whether the truck inspected was interstate or intrastate.

Findings and Recommendations

There were 9,363 Level I, II and III inspections conducted in North Dakota in 1993. Of these, 49.0 percent were conducted at fixed facilities, and 51.0 percent were conducted at roadside facilities. A breakdown by level showed that 47.5 percent were Level I, 8.2 percent were Level II and 44.2 percent were Level III.



However, these levels were not distributed evenly among the fixed and roadside facilities. Of the fixed facility inspections, 63.8 percent were Level I. Conversely, the majority of roadside facility inspections were Level III.

Table 3: Level of Inspection Conducted at Inspection Facility

	Fixed Facility	Roadside Facility
Level I	63.8%	32%
Level II	7%	9.4%
Level III	29.2%	58.6%
TOTAL	100%	100%

Regarding the main objective of this study, the comparison between fixed and roadside inspections, it was apparent a simple overall comparison was not appropriate as the facilities conduct the levels of inspections at varying degrees. Accordingly, the only way to make an unbiased comparison was to examine each level of inspection individually as shown in the following table.

Table 4: Summary of Out-of-Service Rates Between Fixed and Roadside Facilities by Level of Inspection

	Fixed Facility			Roadside Facility		
Category	Level I	Level II	Level III	Level I	Level II	Level III
Total Inspections (overall n = 9,363	2,923	322	1,339	1,529	448	2,802
Total Driver OOS Violations (overall n = 831	232	39	110	160	56	234
Driver OOS Violation Rate (overall = 0.0888)	0.0794	0.1211	0.0822	0.1046	0.1250	0.0835
Total Drivers OOS (overall n = 708)	196	33	101	125	44	209
Driver OOS Rate (overall = 0.0756)	0.0671	0.1025	0.0754	0.0818	0.0982	0.0746
Total Vehicle OOS Violations (overall n = 2,402)	1,518	126	0	671	87	0
Vehicle OOS Violation Rate (overall = 0.4600)	0.5193	0.3913	0.0000	0.4388	0.1942	0.0000
Total Vehicles OOS (overall n = 1,421)	913	73	0	377	58	0
Vehicle OOS Rate (overall = 0.2721)	0.3124	0.2267	0.0000	0.2466	0.1295	0.0000
Total OOS Violations (overall n = 3,252)	1,761	170	110	834	143	234
Total OOS Violation Rate (overall = 0.3473)	0.6025	0.5280	0.0822	0.5455	0.3192	0.0835
Total Inspections Resulting in OOS (overall n = 1,998)	1,042	104	101	451	91	209
Total OOS Rate (overall = 0.2134)	0.3565	0.3230	0.0754	0.2950	0.2031	0.0746

As shown in the above table the only category where the roadside facility seemed at all to dominate was the driver out-of-service violation rates. The roadside facilities had higher rates across all three levels of inspection in this category. The authors found these results somewhat surprising as they thought if the fixed facilities represented a more "anticipated" inspection, while the roadside facilities represented a more "spontaneous" inspection, there would be more violations found at the roadside

facilities where drivers are not quite as prepared to be inspected. Obviously, this was not the case. The authors, therefore, assumed roadside facilities were not truly "spontaneous" and drivers probably did anticipate them somewhat. Another possibility suggested by the authors was inspectors at fixed facilities are better trained to find violations.

In terms of policy implications, these results suggest that since roadside facilities only seemed to be able to compete with the fixed facilities in driver violation categories, maybe roadside facilities should be confined to only conducting Level III inspections. This possibility is not entirely negative. According to Faucett (1992), Level III inspections are considered almost identical to the Level I inspections in terms of influence on crash decline. Accordingly, combining the results of this study and the Faucett (1992) study, the authors recommended concentrating Level I inspections at fixed facilities and Level III inspections at roadside facilities. They argue that this concentration of resources is best suited to finding the most out-of-service violations. Furthermore, both these levels are about equal in influencing a decline in crashes.

"Peer Review of Out-of-Service Verification"

University of South Carolina, College of Criminal Justice and South Carolina Department of Public Safety (1995)

This project, conducted in by the University of South Carolina in 1995, was a combined federal/state effort to identify the best practices of a specific element of the MCSAP program within a defined period of time. In this effort, the Peer Review Team examined current practices that promote compliance with out-of-service orders.

> About nine percent of drivers and/or vehicles placed out-of-service for serious or critical safety defects identified during an inspection violate their out-of-service order.
> *(South Carolina Department of Public Safety, 1995).*

The intent of the Peer Review was the identification of "Innovative and effective enforcement and compliance activities for out-of-service verification with information and guidance (to) be provided to all MCSAP agencies on how to implement effective verification programs that address the unique needs of the various states, including measures of the effectiveness of the states' activities." (p. 7)

Data Sources

The team visited several states including South Carolina (the host state), Arizona, Colorado, Connecticut, Kansas, Maryland, Missouri and Utah to observe innovative practices being employed. In each state the team followed a model itinerary which included:

- an on-site orientation to the state's program with distribution of descriptive material and discussion of practices selected for field visits;
- two days of field visits and direct observation;
- collection and team review of findings; and
- an informal debriefing with site leadership prior to departure.

Findings and Recommendations

The team found no state visited had a perfect system for preventing violations of out-of-service orders. Although they observed a great number of effective procedures, what was missing was a continuum of effort in several areas:

- educational efforts;
- prevention efforts;
- enforcement procedures;
- sanctioning practices; and
- Inspection Repair Audit Program procedures.

The team believed each state could improve its out-of-service verification results by developing a balance of activities in each of the categories listed above. Although each state tended to concentrate its efforts at some point on the program continuum listed above, they often did so at the expense of efforts in other categories. The team stressed:

> *"any effective system should seek to preserve and nurture what appears to be a generally constructive relationship between drivers, carriers, shippers and enforcement and regulatory personnel."*

Approaches which emphasize the proactive dimensions of education and prevention foster this constructive climate by helping the industry avoid violations.

The team also found that efforts to make the inspection process as "painless" as possible encouraged safety compliance and helped to diffuse the tension of the process without compromising effectiveness. State personnel at each site seemed to be sensitive to the economic impact of their efforts on both drivers and carriers. This resulted in a climate of mutual respect between the vast majority of drivers and enforcement personnel.

The team also stated their belief that "overt surveillance" at 24-hour locations virtually guarantees compliance with out-of-service orders until repairs are made or the driver meets requirements. Once violators are identified, the best means of assuring they make repairs or correct driver problems was to keep the vehicle and driver under constant surveillance. Towers, video cameras and other approaches were all useful in this regard, but nothing equaled 24-hour operations coupled with "overt surveillance" as a deterrent to "jumping" out-of-service orders. All drivers the team talked to agreed that when the port or station functioned continuously there was virtually no likelihood that they would risk "jumping." Most admitted they would be tempted to "jump" if the facility closed, personnel departed and there was no likelihood of readily completing repairs.

"Inspection counting" goals appear to be a serious impediment to innovation.

Concern with the absolute numbers of inspections conducted remains the primary focus of regulatory efforts, despite changes that have permitted the substitution of "program effectiveness" goals in place of "inspection counting." This perception, which was evident at every level of most state efforts, appears to be a serious impediment to innovation. Consequently, a strong effort is needed to assure that MCSAP participants understand that *the program accepts verification of corrections to dangerous truck or driver conditions as a meaningful measure of state effort, even at the expense of reducing the total number of initial inspections.*

Another recommendation was every program should have a basic "education/prevention" component, both for the direct benefits and for the constructive climate this component helps to promote. At their best, these efforts helped to show carriers, drivers and shippers how to earn a positive reputation and keep the public's acceptance which has been threatened by the recent rise in motor carrier crashes.

In conclusion, the Peer Review process appeared to accomplish two goals simultaneously:

Goal 1: Made available a reservoir of ideas deemed ripe with incentive and insight.

Goal 2: Promoted a sense of common purpose and a constructive relationship that can help the current state network evolve into a more smoothly functioning and effective system.

"Perceptions of the MCSAP: Motor Carrier Management and State Administrators"

Upper Great Plains Transportation Institute (1995)

As MCSAP is the integral component of many state and federal initiatives focusing on highway and large truck safety, a study was conducted by the Upper Great Plains Transportation Institute (1995) to establish a better understanding of how state agencies responsible for carrying out the MCSAP program and the motor carrier industry relate to MCSAP. Specific objectives of the study included:

- identifying how state administrators and motor carrier management perceive MCSAP;
- soliciting suggestions for improvement of the MCSAP from these two groups;
- determining the perception of the three groups of the degree to which they currently partner with each other and to what degree they would like to partner; and
- determining how familiar motor carrier management is with the Intelligent Transportation Systems for Commercial Vehicle Operations concept.

Data Sources

The scope of the study was nationwide. All the continental United States and Washington, D.C., were included in the part of the study pertaining to the state agencies, with the exception of South Dakota which was not participating in MCSAP at the time of the study. The geographic representation of the trucking industry was developed as broadly as possible given there is no known source or listing of all the motor carriers operating in the United States. Accordingly, sampling the trucking industry is problematic. The study included members of four major trucking industry association groups:

- the Interstate Truckload Carriers Conference (ITCC);
- the Regular Common Carrier Conference (RCCC);
- the Specialized Carriers and Riggins Association (SCRA); and
- the National Private Truck Council (NPTC).

The methodology for this study was a mail questionnaire based on the two main MCSAP operational program activities, roadside inspections and compliance reviews. The response rate for the state administrators was 66.7 percent. Motor carrier management had an average response rate of 15.2 percent; the ITCC had the greatest return with 21.9 percent. Carriers from 41 different states responded to the survey. The overall response rate was high enough from both groups to provide confidence in the results.

Findings and Recommendations

Both motor carrier management and state administrators perceived the MCSAP as a beneficial program which makes a positive contribution to motor carrier safety. While both viewed the program favorably, state administrators were stronger in their beliefs than motor carrier management in all instances.

- 61.7 percent of motor carrier management respondents believed the MCSAP improved safety "somewhat" to "very much" for the industry.

  ✓ Only 40.7 percent believed the MCSAP improved safety *for their firm*.

- 96.9 percent of state administrator respondents believed the MCSAP improved safety "somewhat" to "very much" for the industry.

Similar attitudes prevailed in perceptions of roadside inspections.

- 69.5 percent of motor carrier management respondents believed roadside inspections improved safety for the industry.

  ✓ Only 43.4 percent believed roadside inspections improved safety *for their firm*.

- 96.9 percent of state administrators believed roadside inspection improved safety for the industry.

Managers exhibited concern about the fairness with which roadside inspections were conducted, with 32 percent indicating inspections were not conducted fairly. The managers' unfamiliarity with the roadside inspection selection process may also be a factor. Only 36 percent of managers indicated they were familiar with the selection process, which indicates an area which should be addressed through education or other means.

Both state administrators and motor carrier managers were asked how familiar they were with the Intelligent Transportation System - Commercial Vehicle Operations concepts. While most state administrators were quite familiar with these concepts, the majority of motor carrier respondents indicated they were not familiar with several of the concepts. This indicated another area to partner through education and information dissemination.

Both groups stated their beliefs that more resources should be devoted to the program. In that vein, both parties suggested several means of improving the MCSAP program through education and review of selection processes for both roadside inspection and compliance review. These actions, if taken, would most likely strengthen an already effective program in the eyes of state administrators and motor carrier management.

Suggestions Offered to Improve the MCSAP

By Motor Carrier Managers	By State Administrators
• Improve consistency of inspections between states and inspectors.	• Deploy technology such as the Inspection Selection System for pre-screening.
• Use technology for selecting carriers for inspection based on past history and previous inspections.	• Increase the use of technology for driver logs and general information gathering and dissemination.
• Increase funding for more officers and more inspections.	• Increase the number of inspectors and facilities.
• Decrease time required for or extent of inspections.	• Increase emphasis on probable cause and decrease emphasis on randomness.
• Perform drug and alcohol testing at the roadside verus by the carrier.	• Educate drivers better about the process and information requirements.
• Send copies of inspection reports to the carrier.	• Limit inspection criteria to critical items identified as causing crashes.
• Focus the process more on safety and less on revenue generation.	• Reduce out-of-service criteria.
• Increase inspections on non-interstate highway routes.	

"Evaluation of Roadside Inspection Selection System for Commercial Vehicles"

Brenda Lantz, Michael Blevins and Thomas Hillegass (1996)

Congress mandated, as part of the MCSAP Site Project, at least 100 MCSAP inspection sites use prior carrier safety data to guide the selection of commercial vehicles/drivers for roadside inspection. To guide this activity, an Inspection Selection System was developed. The main objectives of the system are to recommend a roadside inspection for those commercial vehicles/drivers of carriers with:

- poor prior safety performance as evidenced by an unsatisfactory safety compliance rating and/or higher than average driver/vehicle inspection out-of-service rates and/or
- very few or no roadside inspections in the previous two years relative to the carrier's size.

> Out-of-service rates can be an excellent indicator of a company which may have some safety problems.

These objectives help to better distribute roadside inspections among motor carriers and target those with continuous poor safety performance. A study by Brenda Lantz, Michael Blevins and Thomas Hillegass (1996) was conducted to monitor the development and process of the Inspection Selection System.

It has long been realized there is a distinct relationship between the results of roadside inspections, the results of safety/compliance reviews and crash rates. Specifically, those carriers with high out-of-service rates are more likely to have conditional or unsatisfactory ratings and higher crash rates. Furthermore, out-of-service rates can be an excellent indicator of a company which may have some safety problems and needs a higher level of inspection. However, to calculate this rate, the company has to have had an acceptably representative number of roadside inspections in an acceptably recent time period. Three roadside inspections in a two-year period is generally accepted as sufficient to determine out-of-service rates. Although many companies have met this three-inspection criterion, there are still many more that have not.

Using Motor Carrier Management Information Systems data for 1992 and 1993, and this three-inspection criterion as a guide, an out-of-service rate could <u>not</u> be determined for approximately 153,497 or two-thirds of all carriers.

Table 6: Motor Carrier Management Information Systems Data - 1992 and 1993

Number of Carriers	Percent of Carriers	Number of Inspections	Could Out-of-Service Rate be Determined?
88,248	38.4%	None	No
65,249	28.4%	1 - 2	No
76,315	33.2%	3 or more	Yes
229,812	100%	All Categories	Out-of-service rate could not be determined for 66.8 % of carriers.

Conversely, 59 carriers had more than 2,000 roadside inspections, 11 carriers had more than 5,000 roadside inspections and four carriers had more than 10,000 roadside inspections. It has also been shown these carriers have lower out-of-service rates on average than the rest of the population. Thus, it seems logical to divert some of the inspection resources away from these carriers and toward those carriers with a worse safety performance or toward those where there is little or no information. In fact, a goal of the MCSAP site project is to better distribute the inspections among carriers thereby reducing the over sampling of certain carriers for roadside inspections.

The Inspection Selection System, which is available as an aid to the inspector at the roadside, is viewed as a possible solution to these problems. The main goals of the Inspection Selection System are to target those carriers with the worst past safety performance and to reduce over sampling or under sampling of other carriers at the roadside. The Inspection Selection System serves as a tool to help the inspector select the best commercial vehicles to inspect based on several characteristics.

Inspection Selection System
(characteristics for selecting vehicles for inspection)

- the out-of-service rate (driver and vehicle) of the company;
- the company's current safety compliance rating; and
- the number of previous roadside inspections the carrier has had relative to its size (measured by power units and drivers).

Data Sources

Ten states were involved in the initial testing of the Inspection Selection System although most states throughout the country are currently using the system. A study analyzing the results of the Inspection Selection System for the 10 introductory states was conducted by the Transportation Research Board. In these 10 states, over a three-month time frame, 22,309 roadside inspections were conducted. However, since this study only analyzed those inspections done with pen-based computers, the analysis was based on a total of 7,142 inspections. To determine whether the Inspection Selection System was recommending the desired types of carriers for inspection, in accordance with its implementation goals, characteristics of carriers recommended for inspection were compared with characteristics of carriers not recommended for inspection.

EXPECTATIONS

Carriers recommended for inspection by the Inspection Selection System would have *higher average out-of-service rates.*

Carriers not recommended for inspection by the Inspection Selection System would have *lower average out-of-service rates.*

The percentage of carriers with fewer than three previous roadside inspections in the last two years would be *recommended for inspection by the Inspection Selection System at a much higher rate.*

Findings and Recommendations

Uniformly, across all 10 states, about 50 percent of the inspections were conducted on carriers where Inspection Selection System recommended an inspection. One reason for this occurrence was that in some states inspections must be done by random selection. It was also found the actual overall out-of-service rate was notably higher for inspections in which the Inspection Selection System recommended the inspection than those realized for inspections done on carriers not recommended for inspection.

Inspection Selection System Recommended Inspections
(compared to those not recommended for inspection)

- Overall driver out-of-service rate 37% Higher
- Overall vehicle out-of-service rate 75% Higher
- Overall out-of-service rate 60% Higher

"Evaluation of Roadside Inspection Selection System for Commercial Vehicles, A Replication"

Lantz, Blevins and Hillegass (1996)

To confirm the results of their previous study, an additional analysis was completed in early September 1996 by Lantz, Blevins and Hillegass, which analyzed all roadside inspections conducted in the same 10 states from January through August 1996. In total, 43,188 inspections were conducted on pen-based computers during this time frame.

Findings and Recommendations

The results were remarkably similar to those discovered previously, lending credence to the conclusion:

Consistent use of the Inspection Selection System as a selection tool substantially increases the number of vehicles and drivers placed out of service.

In a survey distributed to inspectors within the 10 states, researchers found inspectors overall are using the Inspection Selection System about 26 percent of the time to decide whether to inspect a vehicle or driver. This frequency ranged from an average of almost 50 percent in Kansas to less than five percent in Ohio. As mentioned previously, the low percentage in some states may have been due to state policies requiring random inspections. As the Inspection Selection System becomes available for wider use, this percentage is expected to dramatically increase. Researchers also found slightly more than 54 percent of inspectors indicated the Inspection Selection System was "somewhat helpful" to "very helpful" to them. Furthermore, 70 percent would recommend the Inspection Selection System for use in other states.

> The Inspection Selection System will help to target relatively unsafe carriers and reduce the inspection burden on carriers proven to be safe.

The results from this study indicate as inspectors use the Inspection Selection System to a greater degree, the desired impact of the system will be achieved. The Inspection Selection System will help to target relatively unsafe carriers and reduce the inspection burden on carriers proven to be safe. A 60 percent increase in the number of drivers or vehicles placed out of service would have a significant impact both on cost savings for the safe motor carriers and on safety for society as a whole.

Peer Exchange on Hours-of-Service Compliance

North Dakota State University,
Upper Great Plains Transportation Institute (1997)

This project was funded by the Federal Highway Administration's Office of Motor Carriers through a grant to the North Dakota Highway Patrol (NDHP). Analysis of crash data had revealed that human factors are the most frequently cited crash contributing factors. Driver fatigue was cited as a predominant driver factor in crashes not involving alcohol. While commercial vehicle driver fatigue is addressed through the Federal Motor Carrier Safety Regulations, Hours-of-Service rules, hours-of-service violations remain a significant problem across the nation. Therefore, the Office of Motor Carriers convened a national peer exchange to focus on hours-of-service compliance. The mission of the peer exchange was to identify best hours-of-service compliance practices as they are applied in selected states by state and federal agencies.

A team of Federal and State motor carrier safety specialists during site visits to 11 states reported on the "best practices" found in regards to hours-of-service compliance. The Upper Great Plains Transportation Institute at North Dakota State University acted as a consultant to facilitate the peer exchange. The following states were selected for the site visits: Arizona, Colorado, Florida, Iowa, Maryland, Nebraska, North Dakota, Pennsylvania, Utah, Washington, and Wyoming.

Findings and Recommendations

The team reported on the best practices from all the site visits. The best practices were categorized into seven key elements fundamental to an effective hours-of-service compliance program:

① **Program Management**

- There should be a clear understanding of the goals at all levels of the agency.
- Allow flexibility in the organizational scheme to target local, district and regional issues.
- Develop a well-balanced program in terms of focused activities and types of inspections.
- Support data collection.
- Coordinate with state and federal agencies for enforcement, training and data sharing.
- Cooperate and coordinate with the Federal Office of Motor Carriers.
- Support legislative and judicial branches' efforts for consistent hours-of-service regulations.
- Support open communications within the agency.
- Give program personnel support and encouragement.

② Roadside Enforcement

- Adequate training is a key element to a successful hours-of-service enforcement program.
- Good interview techniques are key to an effective driver inspection.
- Information can be effectively gathered through interviews and examination of supporting documents.
- The use of technology to support roadside enforcement activities enables agencies to more effectively accomplish their missions.
- The agency should develop a sound selection system.
- Coverage should vary based on data analysis and varied shift assignments.
- Consistency of fines in all jurisdictions in the state is an integral part of the enforcement program.
- Innovative practices, such as personal initiative of the officer help improve the roadside enforcement process.

③ Compliance Reviews

- Management should recognize the importance of compliance reviews.
- Use a priority list to target motor carriers for compliance reviews.
- Obtain available information on the carrier prior to compliance review.
- Compliance reviews should have well-organized processes including detailed steps and forms for conducting the reviews.
- Consistent penalty structures and additional penalties are recognized good practices.
- Technology is an effective tool for compliance reviews.

④ Training

- Training should be an on-going process.
- Consistent training in the state is enhanced by coordination between the MCSAP agency and other federal and state agencies.
- At a minimum, officers should receive the basic hours-of-service element of the 40-hour North American Standard course.
- Trainees develop a better comfort level by working with experienced officers.
- Specialty training is sometimes helpful in officer response to special needs or enhancing performance in hours-of-service enforcement.

⑤ Data analysis

- There is a strong move toward performance-based programs where decisions are supported by proper data analysis.
- Data analysis is essential for developing plans, targeting problem areas and carriers and making the best use of available resources.

⑥ Technology

- Use of computers is enhancing efforts in such areas as conducting inspections, entering data, uploading data, accessing databases and using specialized software.
- Software applications which assist officers in their activities have been proven successful.
- Other equipment, tools and resources which also support hours-of-service inspections include telephones, cellular phones fax machines, radars, radar detectors and maps.

⑦ Industry Outreach

- Improving the safety of the motor carrier industry is achieved more effectively through strong partnerships between motor carriers, state and federal agencies.

- Several activities have been developed to increase motor carriers' awareness of safety including holding regular meetings with industry groups and participating in industry meetings to answering special training and information requests by motor carriers.

Inspection Quality Team

Office of Motor Carriers (1997)

Based on several of the above studies, namely Peer Review and the Perception of the MCSAP, OMC formed an Inspection Quality Team (IQ Team), comprised of representatives of stakeholder groups, to research the elements of a quality roadside inspection (1997). The IQ Team met to address the following goals:

- reach a consensus on the elements of a quality roadside inspection;
- identify cost-effective improvements to the roadside inspection process that can be implemented quickly; and
- develop recommendations for implementing an inspection quality process throughout North America.

INSPECTION QUALITY AND RECOMMENDATIONS

During the conference, the team came up with 13 goals and recommendations:

Recommendation 1

Program managers should select inspection locations based on an analysis of available safety information, including data on crashes and other commercial vehicle problems. Agencies must focus their scarce resources on problem areas within their jurisdiction.

Recommendation 2

The inspector should consistently use an inspection site that is safe for the driver, the inspector and the motoring public. This recommendation was based on a survey in which 48 percent of drivers felt they had been stopped for an inspection at a location that they believed to be unsafe.

Recommendation 3

The inspector and the driver should understand the meaning and recognize the validity of a current CVSA decal. Inspector should apply a CVSA decal whenever a vehicle passes a Level I or Level V inspection.

- This recommendation stems from complaints from service representatives that current CVSA decals are not always honored by inspectors in other jurisdictions. Furthermore, there have been indications that some commercial vehicle drivers do not understand the meaning of the decal.

CVSA Decals

- ✔ Decals are only issued for Level I and Level V inspections.
- ✔ A decal covers only the vehicle that is stickered.
- ✔ Although re-inspection is costly and, therefore, discouraged, inspectors have the right to perform an inspection on a decaled vehicle for cause.

- Moreover, inspectors may not issue a decal for several reasons. First, they may be out of decals. Second, the inspector may not be CVSA-certified or there may be confusion about when a sticker should be issued. In any event, all stakeholders agreed a decal should be issued whenever a vehicle/driver passes a Level I or Level V inspection.

Recommendation 4
The inspector should select drivers and vehicles for inspection fairly, according to the jurisdiction's current policies and procedures.

- This recommendation is essential to the success of the roadside inspection process. Success is increased by the use of the Inspection Selection System which, as described in the preceding section, is a computer system that uses carrier data, including inspection data, to assign a priority to the inspection of a particular carrier's vehicles or drivers.

Recommendation 5
The inspector should communicate clearly and positively to drivers the basis for the selection, the level of inspection and all instructions regarding the inspection. The driver and inspector should treat one another with courtesy, respect and professionalism. The inspector should communicate the results of the inspection to the driver and deliver a copy of the inspection report to the motor carrier or its agent.

Recommendation 6
The inspector should be trained to CVSA requirements and follow the North American Standard Recommended Driver/Vehicle Inspection Procedure for the level of inspection being performed. The agency should ensure an ongoing process for consistency in training by monitoring inspector certification and providing refresher training.

- This element addresses the issue of uniformity in the inspection process and the training required to achieve it. This recommendation stems from the survey in which one-third

of the inspectors stated they had received their training from the old North American Standard Driver/Vehicle Inspection course. Moreover, 38 percent of inspectors responded they have received no refresher training. The new North American Standard Driver/Vehicle Inspection course trains inspectors to apply the North America Standard inspection procedure. CVSA recommends this procedure for inspector safety, efficiency and completeness, but neither CVSA nor OMC requires it. Both organizations have given jurisdictions latitude to use any procedure that is systematic. Consequently, there is little consistency in the inspection procedure from jurisdiction to jurisdiction or even within jurisdiction.

Recommendation 7
The inspector should accurately identify and verify all motor carrier and driver data on the inspection report.

- Currently, an average of 13.5 percent of inspections are non-matches in which inspectors attribute their inspections to the wrong carriers. Although there will always be non-matches as there will always be new carriers not in the system, it is OMC's goal to reduce the amount of non-matches to seven percent through use of the Inspection Selection System and training.

Recommendation 8
When available, inspectors should use appropriate, functional technology to support the inspection.

- The use of the Inspection Selection System as well as the use of pen-based and laptop computer systems to record inspection data greatly increases the accuracy of the inspection as established carriers are identified and violations are already coded. While it is certainly possible to conduct an inspection without computerized technology, the inspection is more likely to be accurate with the use of a computer.

Recommendation 9
The inspector should conduct the inspection efficiently and conclude it in a reasonable period of time, given the condition of the driver, vehicle, cargo and inspection site.

- This element is critical to OMC's goal of promoting a safe, economical and efficient motor carrier operation throughout the country. The IQ Team recommended an average of 30 minutes per Level I inspection.

Recommendation 10
The inspector should clearly and accurately record specific descriptions of the violations, section numbers and enforcement actions on the inspection report.

- The inspection report is a written communication from the inspector to the SafetyNet program, the driver, the mechanics, motor carrier safety personnel and program managers. Unless all of the information is documented clearly and accurately, the communication fails. Computer technology has simplified the documentation process, but the technology is not completely satisfactory and less than half of the inspectors use this technology.

Recommendation 11
The inspector should take enforcement action consistent with the laws and policies of the jurisdiction. When placing a driver or vehicle out of service, the inspector should consider the safety of the driver, vehicle and cargo by adhering to the CVSA procedure contained in the North American Uniform Out-of-Service Criteria.

Recommendation 12
The inspector or agency should upload inspection data accurately and in a timely manner, in accordance with current standards, even if there are no violations.

Recommendation 13
The agency should have in place a balanced system for preventing violations of out-of-service orders.

- The IQ Team suggested a system involving five categories of out-of-service verification efforts that all states should have: (1) educational efforts; (2) prevention efforts; (3) enforcement procedures; (4) sanctioning practices; and (5) Inspection Repair Audit Program procedures.

"An Evaluation of Commercial Vehicle Drivers' and Roadside Safety Inspectors' Opinions Regarding the MCSAP, the Roadside Inspection Process, and Motor Carrier Safety"

Upper Great Plains Transportation Institute (1998)

In 1995, the Upper Great Plains Transportation Institute studied motor carrier managers' and state administrators' perceptions of the MCSAP. In 1998, UGPTI continued in this vein when it studied the opinions of commercial drivers and safety inspectors regarding the roadside inspection process and motor carrier safety.

Data Sources

Surveys were developed by the UGPTI in cooperation with the North Dakota Highway Patrol and the Office of Motor Carriers. There were 46 states/jurisdictions (including Washington, D.C.) which participated in the study. A total of 1,703 inspector surveys and 8,515 driver surveys were mailed to the jurisdictions. Jurisdictions distributed up to 50 surveys to their inspectors. Each of the inspectors distributed five surveys to drivers as part of the Level I CVSA inspection. There were 563 inspector and 642 driver surveys returned from 42 states.

Findings and Recommendations

Both drivers and inspectors indicated a positive perception of roadside inspections. About 81 percent of inspectors and 52 percent of drivers indicated that safety is a problem in the commercial vehicle industry. Both groups agreed roadside inspections improve safety for the motor carrier industry. Specifically, vehicle and driver inspections were evaluated.

★ Roadside inspections of vehicles improve safety for the motor carrier industry.

- 78.1 percent of *drivers* "agree" or "strongly agree."
- 87.9 percent of *inspectors* "agree" or "strongly agree."

★ Roadside inspections of drivers improve safety for the motor carrier industry.

- 67.8 percent of *drivers* "agree" or "strongly agree."
- 78.0 percent of *inspectors* "agree" to "strongly agree."

About 70 percent of drivers agreed roadside inspections improve safety for their company. In the 1995 study, only 43 percent of motor carrier managers agreed with this statement.

Drivers were extremely positive in their responses evaluating inspectors, indicating roadside inspectors are doing an excellent job. While rated highly, a couple problematic areas were noted:

- About 20 percent of drivers indicated they had a CVSA inspection with no violations and did not receive an inspection report.

- About 40 percent of drivers indicated they had a complete vehicle inspection with no violations and did not receive a CVSA decal. *(24 percent of drivers also indicated they were required to go through another inspection only hours after receiving a CVSA decal.)*

The majority of the survey results were quite positive regarding the MCSAP and roadside inspections. A few areas which the study indicated could improve:

- Educate drivers on the seriousness of an out-of-service order.
- Improve consistency in roadside inspections from state to state.
- Inspectors should issue CVSA decals when appropriate and honor issued CVSA decals.
- Improve partnerships between drivers, inspectors, state administrators of MCSAP and motor carrier management.
- Give more consideration to the safety of inspection locations.
- Educate companies and shippers of the importance of hours-of-service regulations and the need for drivers to rest without fear of penalty.
- Passenger drivers and commercial drivers should learn to "share the road."
- Information should be better distributed to drivers on where to obtain answers to commercial vehicle safety questions.

"Utah Performance Based Pilot Project"

Utah Highway Patrol and Utah Department of Transportation (1998)

The Utah Highway Patrol along with the Utah Department of Transportation, Office Of Motor Carriers, conducted a Performance Based Pilot Project intent on reducing single-vehicle crashes along Interstate 80 (1998). The project focused direct attention on this stretch of highway by increasing Level III inspections and educational outreach efforts concerning fatigue. The study also conducted a Specific Compliance Review from the inspections focusing on the driver and determined whether there were particular drivers with violations or the problem was company-wide. Civil action was then taken against the carrier, when warranted, with fines of $2,000 per incident per day. These fines were progressive, meaning if a particular carrier was fined and then later stopped along this same stretch of highway with hours-of-service violations, the fine would double.

Findings and Recommendations

Data analysis on crash statistics during the time period of the study indicated the performance-based approach had positively impacted the problem of fatigue-related crashes along this particular stretch of highway. In the one-year study, Utah conducted 1,312 inspections. During this year, they had an out-of-service rate of 41.8 percent. Although this may be considered high, it should be noted an increase in out-of-service violations was expected due to increased enforcement activities. Also, the personnel along I-80 were a group of MCSAP troopers who had completed the Long Distance Training on Hours-of-Service from Boise State University.

In conjunction with the Utah Highway Patrol, OMC conducted compliance reviews on those carriers domiciled in the state and who warranted reviews due to the seriousness of the violations. A total of 42 compliance reviews were conducted from inspection reports. Of these 42 reviews, 16 carriers were assessed a civil penalty resulting from an inspection conducted at the roadside.

> A performance based system provides program flexibility and enables limited resources to be concentrated on "bad" carriers which need attention.

Based on the crash data, this stretch of I-80 had a total of four fatigued driver or single-vehicle crashes during the performance based project. This is significantly lower than the year prior to implementation. Furthermore, since the project, only one fatal crash resulting from fatigue occurred along this corridor. Therefore, the researchers are encouraged by the performance-based approach and will continue to effectively measure the outcome for the next three to five years.

"A Study of Commercial Vehicle Safety Alliance's Out-of-Service Criteria"

Oregon State University (1998)

Oregon State University conducted a study in which CVSA's out-of-service criteria were reviewed. The primary objective of this research was to assess the validity of the out-of-service criteria as related to commercial vehicle safety. The underlying assumption is that vehicle defects having a strong correlation to crashes should have a strong representation in the out-of-service criteria. The two-phase research approach consisted of:

- a background information review and survey and
- a crash analysis.

Background Information Review

The first phase focused on synthesizing information regarding the development and justification of the out-of-service criteria. In addition, a survey was conducted of inspection and commercial motor vehicle industry representatives assessing their opinion of the relative importance of the out-of-service criteria and their contribution to crashes.

Survey and Crash Analysis

In the second phase, the focus was on crash data analysis. A sampling plan was developed and implemented to collect and analyze crash reports from individual states. In addition, several national databases and post-crash inspection reports were analyzed.

As stated previously, the purpose of out-of-service criteria has been to define situations that are so unsafe a commercial vehicle should not be allowed to proceed until the condition leading to the out-of-service notice is completely corrected. The vehicle criteria can be broken down into three general categories, each of which represent an imminent hazard for an accident:

- conditions that could lead to loss of control of the vehicle;
- conditions that could result in falling debris or fluid being spilled on the road; and
- conditions that could cause other vehicles to run into or under a truck or its cargo.

The researchers assigned a qualitative level of support (high, medium or low) to each criterion in which the level of support was indicative of the criterion's contribution to a crash.

Table 5: Criteria Contributing to Crashes

High	brakes, safe loading, tires, wheels and rims
Moderate	coupling devices, fuel systems, lighting devices, steering and suspension
Low	exhaust systems, frames, van and open-top trailer bodies and windshield wipers

The criteria with the highest level of support from the study sample -- brakes, safe loading, tires and wheels and rims -- accounted for 68.9 percent of all defects contributing to commercial motor vehicle crashes where a mechanical defect was the cause of the accident. The criteria with the lowest level of support were exhaust systems, frames, van and open-top trailer bodies, and windshield wipers. Although each of these may occasionally contribute to an imminent hazard, the probability is low, and in general, operators keep these in good condition. The remaining criteria -- coupling devices, fuel systems, lighting devices, steering and suspension -- have only moderate support.

Findings and Recommendations

Oregon State University recommended the CVSA, federal agencies and motor carrier industry use the information gathered in this study to evaluate reducing the number of items in the out-of-service criteria to include only those in the group that have "high" support in contributing to crashes. The authors also stress that crashes involving commercial motor vehicles are generally a result of many interacting variables -- driver related, vehicle related or related to driving conditions.

BIBLIOGRAPHY

Bibliography

Griffin, G. C., Lantz, B. M., & Titus, M. J. (October 1995). *Perceptions of the MCSAP: Motor Carrier Management and State Administrators.* North Dakota: The Upper Great Plains Transportation Institute.

Hancock, S. (March 1998). *Utah Final Report, SMCSP-Pilot, FY-1997.* Washington, D.C.: Federal Highway Administration.

Jack Faucett Associates. (July 1992). *Adequacy and Effectiveness of Roadside Inspection Procedures: Relative Effectiveness of Level I, II, and III Roadside Inspections DTFH61-90-00013,* Washington, D.C.: Federal Highway Administration.

Jack Faucett Associates. (May 1991). *Evaluation of Vehicle Out-of-Service Criteria DTFH61-89-C-00062,* Washington, D.C.: Federal Highway Administration.

Jones & Stein. (1989). *Defective Equipment and Tractor-Trailer Crash Involvement.* Accident Analysis and Prevention.

Lantz, B. M. (August 1994). *Evaluation of the Differences Between Spontaneous and Anticipated Roadside Inspections of Motor Carriers.* North Dakota: The Upper Great Plains Transportation Institute.

Lantz, B. M. (January 1993). *Analysis of Roadside Inspection Data and Its Relationship to Accident and Safety/Compliance Review Data and Reviews of Previous and Ongoing Research in this Area.* North Dakota: The Upper Great Plains Transportation Institute.

Lantz, B. M., Blevins, M. W., & Hillegass, T. J. (1996). *Evaluation of Roadside Inspection Selection System for Commercial Vehicles.* Transportation Research Record.

McDole, T. L. (Highway Safety Research Institute) (1977). *Inspection, Defect Detection, and Accident Causation in Commercial Vehicles.* Society of Automotive Engineers, Inc.: Warrendale, PA.

MELE Associates. (December, 1997). *Elements of a Quality Roadside Inspection DTFH 61-97-F-00102,* Washington, D.C.: Federal Highway Administration.

National Center for Statistics and Analysis of the National Highway Traffic Safety Administration. (1996). *Traffic Safety Facts 1996.* Washington, D.C.: U. S. Department of Transportation.

Patten, M., Carroll, J., and Thomchick, E. (1989). *The Efficiency of Quality Roadside Inspections in Reducing Heavy Truck Crashes.* Journal of the Transportation Research Forum, 29 (2) (pp. 269-272).

Randhawa, S. U., Miller, S. G., Bell, C. A., & Montagne, P. E. (1998). *A Study of Commercial Vehicle Safety Alliance's Out-of-Service Criteria.* Accident Analysis and Prevention, 30 (1) (pp. 61-67).

North Dakota State University, Upper Great Plains Transportation Institute (1997). *Peer Exchange on Hours-of-Service Compliance Final Report.*

South Carolina Department of Public Safety, State Transport Police Division (May 1995). *Peer Review of Out-of-Service Verification.* Washington, D.C.: Federal Highway Administration.

U.S. Department of Transportation. (September 1993) *Motor Carrier Activities of the Federal Highway Administration, FHWA-MC-93-023.*

INDEX