EVALUATION REPORT

Evaluation of the I-95 Commercial Vehicle Operations Roadside Safety and SAFER Data Mailbox Field Operational Tests

F M C S A
Federal Motor Carrier Safety Administration

I-95 CORRIDOR COALITION

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Volume 1: Report

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EXECUTIVE SUMMARY

Background

In 1998, the United States experienced nearly 400,000 crashes involving large trucks, resulting in approximately 5,000 deaths. Although new research (e.g., the Large Truck Crash Causation Project) is being planned by the Federal Motor Carrier Safety Administration (FMCSA) to better understand the causes of these crashes, vehicle safety defects and driver violations of the Federal Motor Carrier Safety Regulations (FMCSR) are known to contribute to some portion of these crashes. Recent studies indicate that approximately 10 percent of all large truck crashes, and the resulting lives lost, could have been avoided if all trucks and drivers were in compliance with safety regulations.

The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation on January 1, 2000. Formerly a part of the Federal Highway Administration, the FMCSA has as its primary mission the prevention of commercial motor vehicle-related fatalities and injuries. Administration activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations, targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness. To accomplish these activities, the Administration works with Federal, state, and local enforcement agencies, the motor carrier industry, labor safety interest groups, and others. In 1999, the Agency announced as one of its specific goals to reduce commercial truck-related injuries and fatalities by 50 percent before 2010.

Over the past few years new technologies, including computer software and database and communication systems, have been developed to assist in the enforcement of motor carrier safety regulations. These systems, which are now being tested by state enforcement agencies, have significant potential for improving highway safety.

This document summarizes the results of the evaluations of two field operational tests (FOTs) of innovative technologies for deployment and exchange of roadside safety information:

- The Safety and Fitness Electronic Record (SAFER) Data Mailbox (SDM) system, a real-time data exchange system that enables roadside enforcement staff to submit commercial vehicle inspection results to a centralized database (SAFER) and to obtain prior inspection reports from other locations, including out of state, in order to identify carriers violating out-of-service (OOS) orders.
- I-95 Corridor Coalition's Field Operational Test (FOT) 7, which tested a wide range of inspection procedures and technologies used by roadside enforcement personnel to target high-risk carriers.

In 1997, the states of Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia agreed to participate in a FOT to evaluate the performance, costs, and benefits of SDM. Funding for the SDM system was originally authorized by the U.S. Congress in the Department of Transportation and Related Agencies Appropriations Bill, 1996 (published August 4, 1995). Connecticut, a state with extensive experience using laptop computers in its commercial vehicle enforcement program, joined the project in early 1998. However, Connecticut's participation in the SDM project was not funded through the Eastern States coalition grant. Because all of the state participants in the SDM project were members of the I-95 Corridor Coalition, it was agreed to continue the deployment of SDM under the I-95 FOT program. The Coalition's FOT 7, which focused on roadside safety enforcement technologies, included six eastern states: Connecticut, Maryland, Massachusetts, New York, Pennsylvania, and Rhode Island.

The results of these projects are presented jointly in this report because of the overlap in states participating and the shared evaluation objectives. Many states combined funds from the SDM project and FOT 7 to accomplish the same objectives. In addition, Battelle, as evaluation contractor for both projects, as well as for the Commercial Vehicle Information System and Networks (CVISN) Model Deployment Initiative, coordinated evaluation data collection and analysis activities among these projects. While SDM focused more narrowly on technologies for identifying out-of-service order violators, there are common issues related to time, cost, and institutional concerns raised by all three projects, leading to closely related conclusions.

A challenge in evaluating SDM and FOT 7 was the variation among states in commercial vehicle enforcement practices and in the degree to which they have adopted safety information exchange technology. The uses of these technologies and related systems vary with both individual characteristics of the inspectors and with the characteristics of the administrative systems in which they operate. Chapter 2 of this report provides an overview of current commercial vehicle enforcement practices in the participating states.

Objectives

The evaluation goals for CVISN, the SDM project, and for FOT 7 were established by the member states. Specific hypotheses or study questions were developed to guide the analysis of each evaluation goal. While the goals for the two projects were not identical at the outset, they had common components which can be summarized as follows:

FOT 7, SDM, and CVISN Evaluation Goals

- Demonstrate the effectiveness of using current safety performance data to help identify high-risk carriers, drivers, and vehicles and to identify out-of-service (OOS) order violators during roadside enforcement,
- Evaluate the time, cost, and other impacts of electronic collection of roadside safety information for upload and dissemination to regional and national databases,
- Identify institutional issues and benefits related to the use of this technology, and
- Assess the effectiveness of public outreach programs for deterring OOS violations.

As detailed in the SDM and FOT 7 Evaluation Plans, a single set of tests, representing a variety of data collection and/or analysis efforts, were proposed to address the evaluation goals and hypotheses. Several of these tests were also designed to be used in the CVISN evaluation. The tests were modified as necessary to ensure that SDM and FOT 7 were addressed. Chapter 4 provides a summary of each test conducted, and Chapter 5 details the findings of these tests.

Findings

The findings from this study lead to several general conclusions and trends:

- Utilization of laptop computers with ASPEN software, including components of SAFER Data Mailbox, has increased steadily since the system became operational in 1997. Most eastern states are uploading inspection results to SAFER on a regular basis, but the time between completion of the inspection and uploading the report varies from state to state, depending on the type of communication technologies used.
- Inspectors report a general satisfaction with the ASPEN system, and report that laptop computers have become an integral part of conducting motor carrier inspections.
- Computer technology is seen as helping inspectors (a) gather more complete inspection information, (b) work more efficiently, and (c) save time compared with traditional paper-based inspection systems. Findings on actual time savings versus paper were equivocal. Some inspectors reported a net time savings, while others reported that computer-based systems required just as much time as paper-based systems to conduct inspections at roadside or at weigh stations.
- Inspectors perceive that using more current and accurate inspection data, as provided by computer-based inspection technologies, helps them (a) target their inspection efforts better, (b) find recent out-of-service orders more readily, and (c) spot patterns in motor carrier violations more easily.
- Until electronic screening technologies are deployed and integrated with the Inspection Selection System (ISS), it is not practical to screen all trucks on the highway using ISS. However, it was demonstrated that inspection selection efficiency, measured in number of out of service orders per inspection, increased by about 2 percent when ISS is used in combination with manual pre-screening.

Simulation results indicated that inspection selection efficiency will increase by 11 percent when ISS is integrated with electronic screening.

- Few violators of out-of-service orders have been identified using SAFER Data Mailbox. However, inspectors have found that past inspection results provide useful information for detecting current violations.
- The full potential for SAFER Data Mailbox will not be realized until all states upload inspection results in a timely manner (i.e., in less than 2 hours). Greater potential is possible if the system is used in combination with electronic screening systems which automatically identify the vehicle at highway speeds.
- Inspectors responded most positively to the improved uniformity, legibility, and neatness of the computer-generated inspection reports.
- Roadside tests of the Inspection Selection System in Connecticut showed that computers offered a marginal advantage in helping inspectors target high-risk carriers for inspection over vehicles from other carriers in the general population.
- Costs for equipment were estimated to range from $7,500 to $9,175 per system, with itemized component costs as follows:
  - Sierra Wireless MP210 — $800 – 1,615
  - Desktop PC plus internal modem — $1,200 – 1,600
  - Brayley box — $2,300
  - Laptop PC — $3,000 – 3,360
  - Printer — $200 – 300
- Inspectors tended to speak more of immediate, day-to-day operational benefits of the computers than any perceived long-term, national benefits in highway safety resulting from the wider adoption of computer-based inspection technologies.
- Issues remaining to be resolved include
  - The overlapping of government jurisdictions and responsibilities for purchasing equipment, maintaining systems, and training staff
  - Data security and reliability
  - Convenience of laptop computer and peripheral equipment used in patrol vehicles and at roadside inspection sites
  - Costs and availability of wireless communication services, especially in rural areas.

Lessons Learned

The I-95 FOT-7 and SDM projects encountered many of the challenges that are typical of attempts to deploy new technologies to improve complex operations, such as those involved commercial vehicle safety enforcement. All of the states participating in these FOTs agree that these improvements are needed and support the use of information exchange technologies such as ASPEN software and programs like SAFER Data Mailbox. However, there are many factors that affect the success of such deployments. For example, ASPEN underwent several revisions during the testing phase of SDM. Also, each state participating in the project had to deal with unique problems involving software installations, hardware maintenance, system training, and integration of databases. Most states agree that smaller, more targeted projects may be more effective in testing technologies like SDM.

The biggest challenge faced by states implementing SDM involved the use of wireless communications. Connecticut was successful in converting to wireless systems partly because of their own in-house capabilities, but also because they have wide coverage with CDPD communication services. Other states found themselves investigating more costly and technically challenging alternatives. For example, New York and Pennsylvania investigated the use of satellite technology. However, it was never implemented due to cost constraints, technical challenges, safety concerns, and delays in deploying the required satellite infrastructure.

The following are some lessons learned by participants in the SDM project. These lessons are expected to provide guidance for long-term implementation of SDM statewide, in other states, and implementation of similar projects in the future.

- States should be included in the consultant selection process.
- Project responsibilities should be shared among all participating states.
- Identify features unique to a state and take those into account in designing and implementing the project. Information exchange and other things that work in one state may not necessarily work with other agencies or states.
- Redesign the Brayley box with commercial vehicle inspectors and their working environment in mind. Brayley boxes are not considered effective by some states. The laptop (MDT) configuration was found to be more flexible compared to Brayley boxes.
- In implementing SDM systems, communication costs should be taken into account.
- It became clear that the level of available wireless communication services varied greatly between states. Coastal states like Delaware, Connecticut, and Rhode Island generally had CDPD services available statewide, while larger, inland states like New York and Pennsylvania often lacked such coverage in large portions of their state. Furthermore, alternative analog services available in these areas were expensive and not reliable. Unfortunately, the technical consultant to the SDM project made the initial assumption that CDPD coverage would be available to almost all areas of the seven participating states, which turned out to be incorrect. In response, New York is continuing to explore other wireless options, such as CDMA, that is showing some promise upstate. Attempts to deploy and test an alternate system in Pennsylvania using satellite communications were not successful.
- Early on, the SDM project was envisioned to test out various wireless technologies beyond CDPD once it became apparent that adequate coverage was not available in all the involved seven Eastern States. Unfortunately, the technical consultant never demonstrated adequate knowledge of the alternatives, including the use of analog wireless and satellite wireless. In many cases, the states were left to solve their own technology deployment issues, after the consultant made the initial technology selection for them.

- For larger states, the issue of providing ISS type data for all carriers—both interstate and intrastate—also was identified. States view all carriers the same but only interstate carriers are under the jurisdiction of USDOT. Inspectors need to be able to have real-time access to safety and credentialing data for all carriers, but most systems developed by USDOT to date have provided this for only interstate carriers. FMCSA appears to understand this issue and is trying to address it.

Directions for Future Research

The customization or adaptation of computer systems to the roadside working environment, noted in the focus groups and interviews, are important indicators of the degree to which inspectors are accepting the technology. Firsthand observations or accounts of such user adaptations, if analyzed in greater detail, may provide clues to not only the degree to which inspectors are invested in the technology, but also the practical, operational needs the inspectors face in day-to-day operations.

The integration of safety information exchange technologies with electronic screening systems could produce significant benefits by focusing enforcement efforts on high risk carriers. This will result in fewer crashes involving unsafe trucks and drivers. However, research is need to find the best ways to use the safety information to identify trucks and drivers that represent the biggest risks.

Satellite communication may offer an alternative for wireless exchange of data to and from the roadside. While initial and operating costs seem high, and data transfer rates are relatively low, satellite communication may provide states a way to avoid the substantial cost of building, deploying, and maintaining new statewide infrastructure for existing wireless technologies such as CDPD.

Future research should also explore the ratio of time to information that is at the center of the inspection system. The time spent in conducting and reporting on an inspection using paper and computer-based systems could be compared and analyzed, as could the amount, accuracy, and timeliness of information available to decision-makers resulting from both ways of conducting inspections.

The effect of computer-based inspection technologies on the motor carrier companies and the truck drivers themselves could be explored. The tests discussed in this report were more concerned with the adoption of the technology among the inspector community. It can be assumed that changes in inspection practices will lead to adaptations among drivers and operating companies. Many of the same tests used to gauge inspector attitudes and opinions, such as interviews, focus groups, and observations, plus more quantitative measures of compliance and highway safety, could also be applied to the motor carrier community.

1. INTRODUCTION

In the United States in 1998, a total of 4,935 large commercial vehicles were involved in fatal crashes, an estimated 89,000 were involved in injury crashes, and an estimated 318,000 were involved in property-damage-only crashes (FMCSA 2000). Although new research (e.g., the Large Truck Crash Causation Project) is being planned by the Federal Motor Carrier Safety Administration (FMCSA) to better understand the causes of these crashes, vehicle safety defects and driver violations of the Federal Motor Carrier Safety Regulations (FMCSR) are known to contribute to some portion of these crashes. According to a study conducted at Oregon State University, 4.6 percent of all commercial vehicle crashes involved truck mechanical defects as a factor contributing to the crash (Miller, et al. 1996). Another study (Volpe 1999) estimated that 5.7 percent of truck crashes had driver-contributing factors that could have been identified during roadside inspections. Combining these figures, one could conclude that approximately 10 percent of all large truck crashes, and the resulting lives lost, could have been avoided if all trucks and drivers were in compliance with safety regulations.

While it may not be feasible to eliminate all violations of safety regulations, these statistics (approximately 400,000 crashes and 5,000 deaths) are useful for defining the potential benefits of improving safety enforcement processes at the roadside. Over the past few years new technologies, including computer software and database and communication systems, have been developed to assist in the enforcement of motor carrier safety regulations. These systems, which are now being tested by state enforcement agencies, have significant potential for improving these processes.

In the 1990s the Department of Transportation (DOT) initiated several efforts to further develop and test these technologies. The development efforts included the establishment of the Safety and Fitness Electronic Record (SAFER) database system and related software for accessing and distributing data. SAFER provides local enforcement agencies with access to useful safety information on interstate motor carriers, including recent inspection reports on individual trucks.

To test these systems, DOT funded a variety of field operational tests (FOTs) and the Commercial Vehicle Information Systems and Networks (CVISN) Model Deployment Initiative, which included a wider range of technologies applicable to commercial vehicle operations. DOT also funded coalitions of states, such as the I-95 Corridor Coalition, which promoted collaboration among states and the development of regional solutions to certain problems.

Software and Systems at a Glance

The following are some of the most important software applications and intelligent transportation systems in use in commercial vehicle operations and enforcement today. A list of abbreviations and their definitions appears at the end of this report. More information can be found in a CVISN glossary prepared by Johns Hopkins University (1998).

Aspen: A pen-based roadside inspection system that allows commercial vehicle inspection data to be electronically transferred to SAFETYNET, either via AVALANCHE or the CVIEW/SAFER Data Mailbox System.

AVALANCHE: Serves as a communications handler and preprocessor for inbound vehicle inspection reports coming from the ASPEN inspection software.

BLIZZARD: A software system for managing exchanges of inspection data between SAFER Data Mailbox, CVIEW, and SAFETYNET.

CDLIS (Commercial Driver's License Information System) A software system that serves as a pointer to the complete record kept by the state issuing the license. The system is intended to provide states with the ability to check a nationwide information system for possible duplicates or for a suspended license before issuing a commercial driver's license to an applicant.

CVIEW (Commercial Vehicle Information Exchange Window) A state-based system that provides carrier, vehicle, and driver safety and credential information to fixed and mobile roadside inspection stations.

CVISN (Commercial Vehicle Information Systems and Networks) The collection of state, Federal, and private-sector information systems and communications networks that support commercial vehicle operations. When fully deployed, the system will enable the delivery of electronic services to states and carriers in areas such as safety, credentials, and electronic clearance.

ISS (Inspection Selection System): A software algorithm that prioritizes carriers using SAFER snapshot data.

NCIC (National Crime Information Center) A national, computerized central index operated by the FBI and linking documented files of local and State criminal justice agencies for real-time inquiries.

PC*MILER: A commercially available point-to-point highway routing, mileage, and mapping software application, offered by ALK Associates, Inc. (Princeton, NJ). Provides latitude/longitude routing, route optimization, leg and cumulative mileage, time and cost estimates, detailed driving instructions, etc. The system is used by both motor carriers and state safety investigators.

PIQ (Past Inspection Query) A module of Aspen that retrieves information on past inspections of a specific vehicle (by license plate number) and driver from the SAFER/driver-vehicle system. The PIQ system requires landline or wireless communications between the roadside and a central database system.

SAFER (Safety and Fitness Electronic Record) An on-line nationwide data network that, when fully deployed, is intended to return a standard carrier safety fitness record to the requestor in a few seconds.

SafeStat (Safety Status Measurement System) A summary measure of a motor carrier's safety performance and history.

SAFETYNET: A distributed system for managing safety data on both interstate and intrastate motor carriers and for the federal and state offices to electronically exchange data on interstate carriers with MCMIS.

SIE (Safety Information Exchange) The electronic exchange of safety data and supporting credential information regarding carriers, vehicles, and drivers involved in commercial vehicle operations. These decisions would be based on the ready availability of historical safety performance information.

Source: Johns Hopkins (1998, 2000)

FOTs that involved the development and deployment of safety information exchange technologies for use by state safety enforcement personnel include the SAFER Data Mailbox (SDM) FOT, involving six eastern states, and three safety-related FOTs (FOT 7, FOT 9, and FOT10) sponsored by I-95 Corridor Coalition Commercial Vehicle Operations (CVO) Working Group. In particular, FOT 7 tested a wide range of technologies for use by roadside enforcement personnel.

The SDM system uses a variety of advanced database and electronic communication technologies to provide up-to-date motor carrier and vehicle-specific safety information to enforcement officers at the roadside. The SDM FOT was designed to demonstrate the feasibility of using SDM technology to help enforcement staff identify commercial vehicles and drivers that violate out-of-service (OOS) orders. In part, this initiative was an outgrowth of several activities undertaken by states and the Federal Highway Administration (FHWA) in the mid-1990s to ensure that serious commercial vehicle safety violations were corrected before these operators returned to the nation's highways.

The Corridor Coalition's FOT 7 is closely linked to the SDM project, partially because it involves some of the same states, but, more importantly, because they share the same objectives. Both FOTs use the same communication links to help focus enforcement resources on high-risk carriers and drivers and to evaluate the broader impacts of safety information exchange technology.

The SAFER Data Mailbox Field Operational Test

In 1997, the states of Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia agreed to participate in a FOT to evaluate the performance, costs, and benefits of SDM. Connecticut, a state with extensive experience using laptop computers in its commercial vehicle enforcement program, joined the project in early 1998. However, Connecticut's participation in the SDM evaluation was not funded through the Eastern States coalition grant. The FOT was divided into two phases. In Phase 1, SDM provided the capability to send electronic inspection reports from the roadside to the national SAFER database immediately after an inspection is performed. Phase 2 tested the ability to retrieve past inspection results on specific vehicles. These are the key features of SDM that allow enforcement officers to identify violators of OOS orders. The FOT was officially completed by the end of January 1999. However, most states planned to expand the deployment of SDM and related technologies after the test was completed. Descriptions of SDM and its key components are provided in Chapter 2. Because all of the states participating in SDM were members of the I-95 Corridor Coalition it was agreed to continue the deployment of SDM under the I-95 FOT program.

In addition to the seven Eastern states, participants in the SDM project included the Johns Hopkins Applied Physics Laboratory (SAFER development), SAIC (SAFER operations and maintenance), RSIS (SDM support contractor), and the FMCSA (formerly the Office of Motor Carriers of the FHWA), the funding agency and developer of the ASPEN software system.

Battelle, prime contractor for ITS Program Assessment Support to the ITS Joint Program Office, and Battelle's subcontractor, Castle Rock Consultants, were responsible for SDM evaluation.

The I-95 Corridor Coalition's Safety-Related FOTs

The I-95 Corridor Coalition is a partnership of the major public and private transportation agencies, enforcement agencies, toll authorities, and industry associations that serve the Northeast Corridor of the United States, from Maine to Virginia. The Coalition places a high priority on commercial vehicle operations because of the significant role that motor carriers play in moving goods and people throughout the region. The goal of the Coalition's CVO program is to enhance the safety and economic well-being of the I-95 Corridor. To accomplish this goal, the Coalition funded FOTs in four areas: inspection procedures and technologies that target high-risk carriers (FOT 7), electronic registration (FOT 8), electronic screening (FOT 9), and safety management (FOT 10). Because of its concurrent role in the evaluation of CVISN and SDM, Battelle was contracted to serve as the independent evaluator for the safety-related FOTs (FOTs 7, 9, and 10).

At the time that this evaluation got under way, Virginia, the state participating in FOT 9, was reassessing its approach to conducting the electronic screening test. For this reason, the Coalition's CVO Program Track Safety Subcommittee directed the evaluation team to defer plans to evaluate FOT 9.

The objective of FOT 10, Coordinated Safety Management, was to move toward a performance-based motor carrier safety compliance and management program that would reduce highway accidents and incidents in the I-95 corridor. The Coalition funded two projects. The state of Maine was to implement a modification to its state databases to allow use of a single U.S. DOT number for interstate, and some intrastate, vehicle credentialing. Participants in the second project included the states of Connecticut, New York, and Pennsylvania, and the ATA Foundation. This project was to study best practices in CVO enforcement and motor carrier safety compliance programs. The FOT would result in a CVO enforcement "toolbox" and a motor carrier safety "toolbox," as well as educational materials and recommendations for outreach. This project complemented and extended the other safety-related tests, and therefore did not require a separate evaluation. Instead, results from of FOT 10 were to be used as input to the evaluation of FOT 7.

Because of the delayed status of FOT 9, and the interrelationship between FOT 7 and FOT 10, the Subcommittee directed the Battelle evaluation team to focus only on FOT 7. FOT 8, which dealt with electronic credentialing, was being evaluated separately.

FOT 7

The Coalition requested letters of intent for states to participate in FOT 7 in early 1997. The purpose of the FOT was to test the implementation of procedures and technologies that enable state inspectors and enforcement officers to focus roadside inspections on high-risk motor carriers. Six states were awarded funds to participate: Connecticut, Maryland, Massachusetts, New York, Pennsylvania, and Rhode Island. The project was designed to:

- Accelerate the deployment of pen-based and laptop computers [initiated under the Motor Carrier Safety Assistance Program (MCSAP)] and provide uniform training in their use to roadside inspectors and enforcement officers throughout the Corridor.
- Use these computers and specialized decision-support software (developed by the Volpe National Transportation Systems Center and others for the FHWA) to assist inspectors and enforcement officers in the selection of carriers for roadside inspection.
- Use these computers and specialized data entry software (developed by the FHWA) to streamline inspection procedures and reporting.
- Establish roadside communication links to the SAFER system (developed by the FHWA) so that inspectors and enforcement officers have real-time access to motor carrier safety performance records, and
- Pilot test the SAFER data mailbox system so that inspectors and enforcement officers have immediate access to regional and national data on vehicle and driver out-of-service orders and recent motor carrier inspection reports.

Battelle and its subcontractors were also responsible for evaluating FOT 7. Chapter 2 includes details on states' approaches to implementing this test.

Coordination of SDM and FOT 7 Results in this Final Report

The approach developed to evaluate the SDM project was described in the *SAFER Data Mailbox Evaluation Plan* (March 1999). The plan presented the evaluation goals and hypotheses to be tested and described the variety of data collection and/or analysis efforts proposed to answer the study questions. A similar plan described the evaluation approach to the I-95 Corridor Coalition Safety-Related Field Operational Tests, primarily focusing on FOT 7 (*Draft Evaluation Plan,* April 1999). There was substantial overlap in the evaluation objectives of both FOTs, as well as in the number of states participating. Connecticut, New York, Maryland, and Pennsylvania were participants in both programs. Many states combined funds from the SDM project and FOT 7 to accomplish the same objectives. The evaluation plans highlighted the close coordination among the SDM project, the Corridor Coalition's FOTs, and a third project, the CVISN Model Deployment Initiative (MDI) involving ten prototype and pilot states (Maryland, Virginia, Washington, Oregon, California, Colorado, Minnesota, Michigan, Kentucky, and Connecticut).

As evaluation contractor for all three efforts, Battelle coordinated data collection and analysis activities in order to make maximum use of available evaluation resources and to reduce the "evaluation burden" on states participating in multiple projects using the same technology. In recognition of the shared interests of the two projects, this report presents the results of both the SDM demonstration and FOT 7. While SDM focused more narrowly on out-of-service violators, there are common issues related to time, cost, and institutional concerns raised by both projects, leading to closely related conclusions.

Organization of this Document

In the remainder of this document, we provide an overview of safety information exchange technology deployment and the approaches employed by the participating states (Chapter 2). Chapter 3 presents the evaluation goals, measures to be tested, and hypotheses or study questions originally posed for the SDM and FOT 7 projects, as well as the combined four goals addressed in this report. In Chapter 4, we describe the technical approach to the evaluation with a brief synopsis of the primary data collection and analysis efforts undertaken. Chapter 5 presents our findings, and conclusions are stated in Chapter 6. References and a list of abbreviations are also included.

Appended to this report are several documents that expand on or provide background for the information and results:

- Appendix A presents a summary and analysis of quantitative and open-ended responses to a survey of motor carrier inspectors, along with detailed tabulations of numerical answers and transcripts of verbal responses.
- Appendix B presents results from in-person interviews and focus groups conducted with motor carrier inspectors.
- Appendix C gives the results of a roadside screening assessment study in Connecticut.
- Appendix D is summary a tabulation of safety information system deployment plans as reported by nine Eastern states.
- Appendix E presents the results of a study of costs and institutional issues related to SDM technology deployment.

2. OVERVIEW OF SAFETY INFORMATION EXCHANGE TECHNOLOGY DEPLOYMENT

A challenge in evaluating SDM and FOT 7 was the variation among states in commercial vehicle enforcement practices and in the degree to which they have adopted safety information exchange technology. The uses of technologies such as ASPEN, the Inspection Selection System (ISS), SAFER, and related systems vary with both individual characteristics of the inspectors and with the characteristics of the administrative systems in which they operate. The following provides a brief overview of current commercial vehicle enforcement practices in general and the specifics of deployment in the participating states. Appendix D summarizes responses from nine states to a questionnaire on current commercial vehicle enforcement practices.

Current Commercial Vehicle Enforcement Practices

All participating states have fixed sites and mobile units for conducting commercial vehicle enforcement, ranging from one site in Delaware to as many as 200 sites in New York. Most inspections are performed along major interstates and state highways at fixed weigh stations, rest areas, exit parking areas, or other suitable roadside locations. States use various resources while conducting commercial vehicle inspections such as

- Trained personnel—Department of Transportation or Public Utility Commission safety inspectors, State Police Officers, etc.
- Vehicles—vans, trucks, patrol cars
- Computer equipment—file servers, laptops, pen-based computers, etc., and
- Communication technologies for reporting inspection results or to obtain prior inspection reports—paper, diskette, telephone land lines, switch circuit cellular, cellular digital packet data (CDPD) technology, 800 MHz wireless, and satellites.

A typical inspection team consists of two or three inspectors. The inspectors usually select trucks for inspection randomly, on the basis of reasonable cause (e.g., an observed potential violation), or based on recommendations of the ISS. In general, vehicles displaying current Commercial Vehicle Safety Alliance (CVSA) decals are not selected unless an obvious violation is noted. For interstate carriers, inspectors equipped with laptop computers use ISS ratings and related safety information (available on laptops) to focus the inspection on particular areas. For example, ISS may influence the inspectors decision on what level of inspection is performed and then in turn indicate that special attention may be warranted in certain areas such as brakes, suspension, or driver violations.

The type of inspection performed is influenced by carrier reputation, ISS rating information, and inspector experience. A roadside safety inspection typically involves checking the driver's license and the vehicle. If the inspection is performed at a weigh station, the vehicle weight may also be checked.

For roadside screening processes, the inspectors/troopers currently use the ISS data that is downloaded from MCMIS and is provided to them on diskettes. The registration, tax, and driver license data are all available through call-in when the inspectors require additional driver and vehicle information. In the case of Connecticut, CDPD mobile data terminals are used to obtain weekly ISS updates from SAFER and access CDLIS, NLETS, and NCIC data in real-time. Most of the participating states indicated that safety information on in-state carriers is not currently available at the roadside, although New York developed a drop-down data base of intrastate carriers and had begun to collect safety inspection information that might be used to identify high-risk intrastate carriers in the future.

The transfer of inspection data from the roadside to state and federal agencies can be accomplished many different ways. Before inspectors were equipped with laptop computers, the inspection data were mailed to the state SAFETYNET sites for keying, verification, and analysis and reporting; then uploaded to MCMIS. Several options are available when inspectors are equipped with laptop computers, depending on the particular technologies and systems deployed in the state. The traditional approach (before SDM and wireless communication) involves entering the inspection data into ASPEN; then transmitting the data to SAFETYNET using telephone lines or loading the data onto diskettes and mailing them to the SAFETNET sites where they are processed and sent on to MCMIS. The state then retrieved the data for in-state use. During the SDM project, states tested various methods of wireless communication to send inspection results directly to SAFER via the data mailbox system.

Connecticut uses a slightly different approach. The inspection data from ASPEN are transmitted to an application server via CDPD, then to SAFETYNET using a LAN connection. Finally, the inspection data are uploaded to MCMIS via telephone lines. Configurations involving SDM are discussed in more detail in the next section.

The sites and circumstances under which inspections are conducted can vary widely among the states. For example, Connecticut's Union Scale represents the high-technology, high capital investment end of the continuum. This facility is equipped with dual scales, including one weigh-in-motion (WIM) scale. It has a long approach, minimizing the problem of trucks backing up into the highway. It has a remotely controlled sign that directs trucks to the scales, so inspectors can turn the flow on and off at will and there is no need to rush a high volume of trucks through to maintain a safe traffic situation. The site includes a systematic screening mechanism to select trucks for inspection. Vehicles are pre-screened for further inspection at the WIM scale. The pre-screening is based on such variables as operating weight, excessive speed over the scale, apparent driver avoidance of the scales by half-straddling, and an automated random selection process coupled with electronic signs directing drivers to a static scale queue or back to the highway. The vehicles selected in the pre-screening are diverted by an automated signal onto a fixed scale where they are weighed more precisely and where inspectors can examine the truck and use the ISS.

In New York, at the Glens Falls site, in contrast, there is only a parking lot at a rest area. There is no weighing mechanism. A crew of inspectors selects trucks by sight, seeking obvious violations, or what some inspectors term “a ragged truck.” If there are no trucks with apparent violations, the inspectors choose trucks more or less randomly as they complete one inspection and are ready for the next.

Another variant among sites is the ability to operate in adverse conditions or at night. Most sites are not sheltered, and in inclement conditions an inspector may elect not to conduct a Level I (full driver/vehicle) inspection because water dripping from the rig creates difficult and possibly hazardous working conditions. On rainy days, many inspectors report they do almost entirely Level III (driver only) inspections. Similarly, where inspections occur at rest areas, such as in Glens Falls, New York, inadequate lighting makes it impossible to conduct a full inspection at night. The Union Scale includes a sheltered and lighted inspection facility which enables inspectors to provide consistent ratios of inspections at all levels regardless of weather or time of day (Figure 1).

Figure 1. Enclosed inspection facility at Union, Connecticut

The Middletown Scale in Connecticut is typical of many single, fixed-scale sites where a single line of trucks file through, and trucks are chosen for inspection based on obvious violations or at random (Figure 2). States also use portable scales at locations that are rotated so that truckers find it difficult to predict and avoid the inspection.

Figure 2. Trucks lined up to cross the scale at Middletown, Connecticut

SAFER Data Mailbox

SAFER Data Mailbox is a real-time data exchange system that enables roadside enforcement staff to submit commercial vehicle inspection results to a centralized database (SAFER) and, conversely, obtain prior inspection reports obtained at other locations, including those in other states. This technology is designed to help enforcement staff identify commercial vehicle drivers that are violating out-of-service (OOS) orders. The basic components of the SDM system are: Sierra Wireless MP210, personal computer with a modem and serial ports, printer, Windows 95 or higher operating system with a dial-up networking facility, and ASPEN. The essential component for portable operations is the Sierra Wireless MP210 that supports CDPD and circuit-switched dial-up (AMPS) communications.

Figure 3 describes the typical configuration of SDM that is being implemented in the Eastern States Coalition's field operational test. For this interim configuration the roadside units communicate directly with SAFER through the data mailbox. Figure 4 describes the configuration currently being used by Connecticut. The main difference is that, in Connecticut, inspection results are first sent to Connecticut's SAFER-CVIEW application server via CDPD. This server is then polled every 15 seconds for incoming inspections and if any are found they are forwarded the FMCSA-developed BLIZZARD32. The BLIZZARD32 module then sends one copy of the data to the SDM and one copy to SAFETYNET 2000 for integration into state systems that upload to SAFER. SAFER then forwards the inspections to MCMIS. The interim configuration described in Figure 3 shows inspection results initially going to the SDM, and then back to the state databases. The initial long-term vision for the SDM configuration by the participating Eastern States was much closer to the design currently used by Connecticut. That is, inspection data would initially be transmitted from the roadside to a state data system and then immediately transferred to SAFER, but FMCSA's consultants were unable to accommodate that approach at the onset.

The FMCSA developed the CVIEW system as a data exchange mechanism that is operated on the state level. Although it operates like SAFER, it is operated by the state, allowing greater control and increased flexibility regarding interfaces with state legacy systems. More importantly, CVIEW is used to exchange both intrastate and interstate snapshots of vehicles within the state and connects to SAFER to exchange interstate snapshots. CVIEW communicates directly with the state roadside system (ASPEN) and several legacy credentialing and safety information systems within the state.

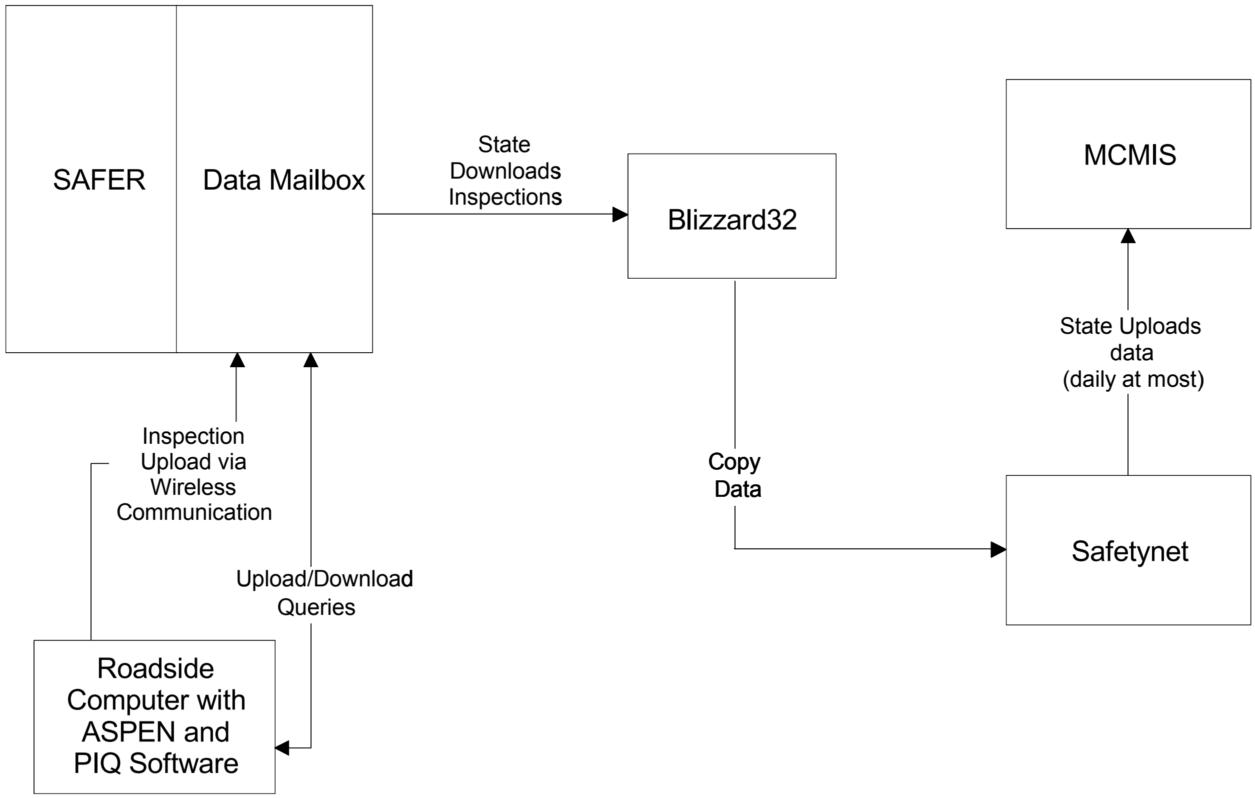

Figure 3. Eastern States Coalition SAFER Data Mailbox Configuration

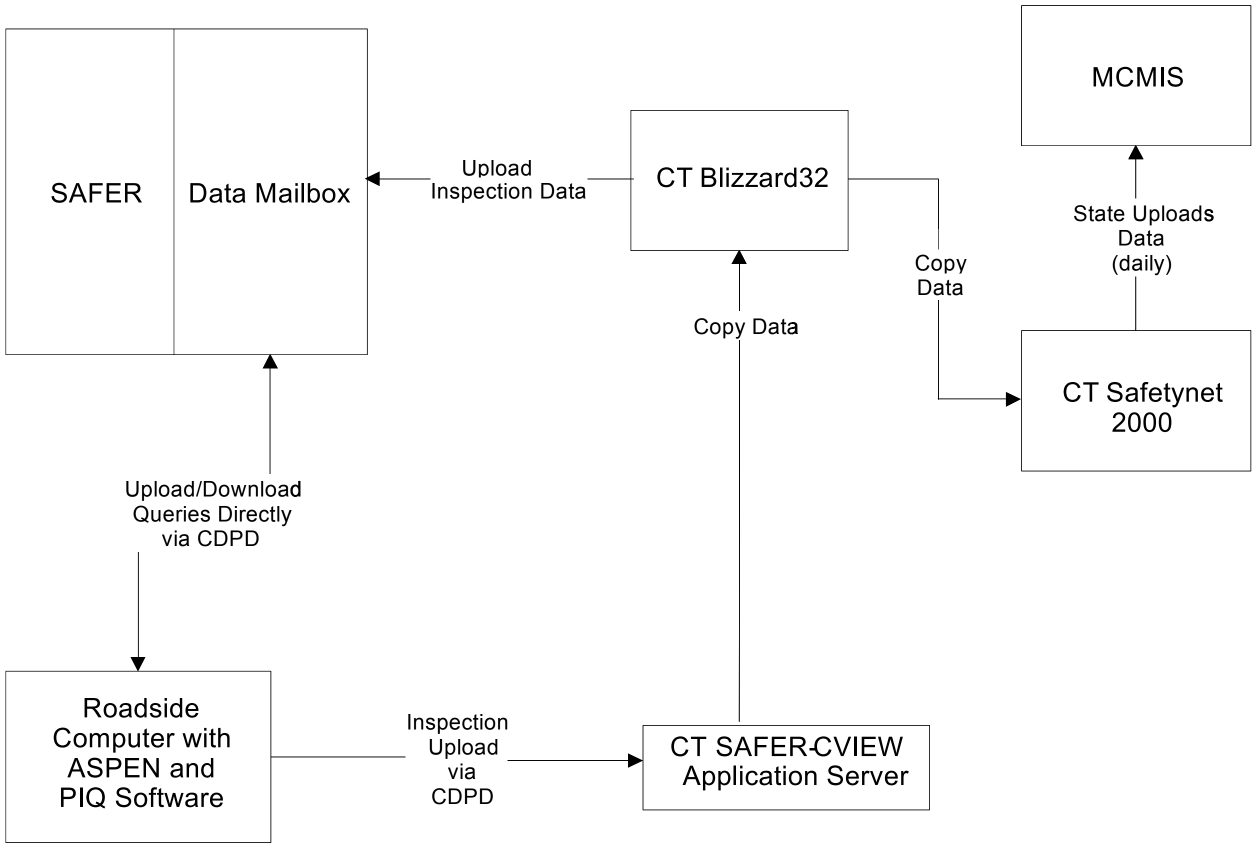

Figure 4. Connecticut SAFER Data Mailbox Configuration

Under either configuration, SAFER stores inspection reports for up to 60 days. Using ASPEN, the officer in the field can perform a Past Inspection Query (PIQ) to obtain copies of recent inspections of a particular vehicle. If the vehicle or its driver had a recent OOS order, the officer will determine whether or not corrective action was taken.

State Approaches to Safety Information Exchange Deployment

At the time FOT 7 was initiated, states participating in CVISN and/or the SAFER Data Mailbox project had already succeeded in demonstrating the ability to upload and download data from state and national safety databases. Participation in FOT 7 provided support to increase the number of computers available for inspection and enforcement, and to enhance their use and evaluation. Three participating states, Connecticut, Rhode Island, and Massachusetts, were working on a regional approach to ensure interoperable communication among all roadside inspectors for real-time data exchange to eliminate duplicative inspections and to help identify high-risk carriers.

The participating states pursued different approaches to implementation of the safety information exchange technology, particularly in regard to uploads to SAFER, updates from SAFER to ISS, the use of the PIQ. The variation can be explained in part by differences among states in the physical set-up of the equipment, and in the inspectors' familiarity with the systems. In states such as Connecticut and Rhode Island, where all inspectors are using wireless units, the process of uploading to SAFER is simple and convenient. Uploads occur at least daily. In other states, the frequency of uploads is no more than weekly, and often less.

The states also differ markedly in the frequency and method of making updates from SAFER to ISS. In Connecticut, inspectors download updates weekly through their wireless systems, and their ISS files are therefore up to date. In other states, updates are sent on CD-ROM from the state police to the field users monthly, quarterly, or even less often.

In addition, the PIQ process is used in different ways in the participating states. In Connecticut, a PIQ is run at each inspection, in part because it is so convenient to do so. In New York, PIQs were not being used at the time of the pilot. Two reasons were (1) potential legal concerns regarding probable cause requirements and (2) the limited number of wireless connections that are available at mobile inspection sites due to limited CDPD coverage. PIQ usage has increased significantly since then in areas where wireless coverage is available to the inspector. The PIQ may be used in Maryland if there seems to be an important reason to run it, and if the land line computer connection is available.

As of May 2000, more than 1,200 inspections were being uploaded to SAFER each day from approximately 24 states. This represents about 20 percent of all inspections performed. Figure 5 shows that 12 states, including seven from the I-95 Corridor Coalition, are uploading at least 50 percent of their inspections to SAFER. Some of these inspections are being uploaded directly from roadside locations using wireless communication.

The states that have developed or are testing wireless communication systems are able to query SAFER and download past inspection results on individual trucks that were inspected within the past 60 days. Currently there are approximately 50 past inspection queries (PIQs) performed each day by inspectors in 18 states. As shown in Figure 6, seven states, including five from the I-95 Corridor Coalitions, perform PIQs on a regular basis (at least 5 PIQs per day). Connecticut performs approximately 20 PIQs per day, which represents about one-third of all vehicles inspected. Other states are using PIQs on a less frequent basis.

It should be noted that these values are based on the latest available data. Between 1999 and 2000 the number of inspections uploaded to SAFER has tripled and the number of PIQs performed has nearly doubled. Since then, utilization has continued to increase and states are continuing to explore new ways to make use of these technologies. As wireless communications systems continue to expand into rural areas, these technologies will become more prevalent. Also, many of the I-95 Corridor Coalition states are exploring the use of electronic screening systems, which allow safe carriers to bypass inspection stations. Combined with ASPEN and improved roadside communication systems, states in the I-95 corridor will realize dramatic increases in the efficiency of their roadside safety enforcement activities.

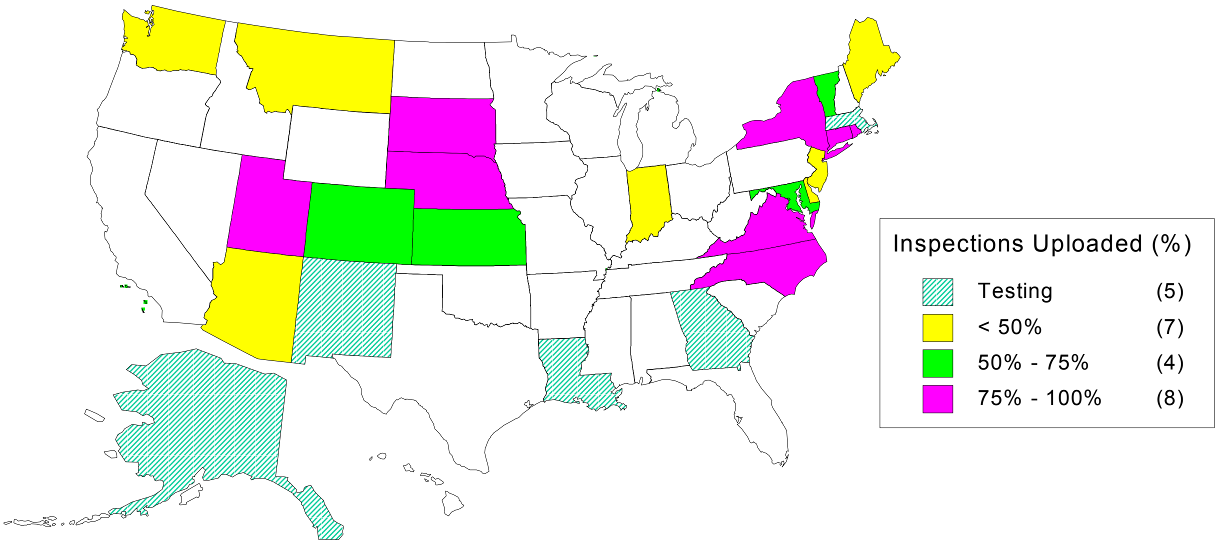

Figure 5. **States Uploading Safety Inspection Results to SAFER (May 2000) - by Percent of States Inspections**

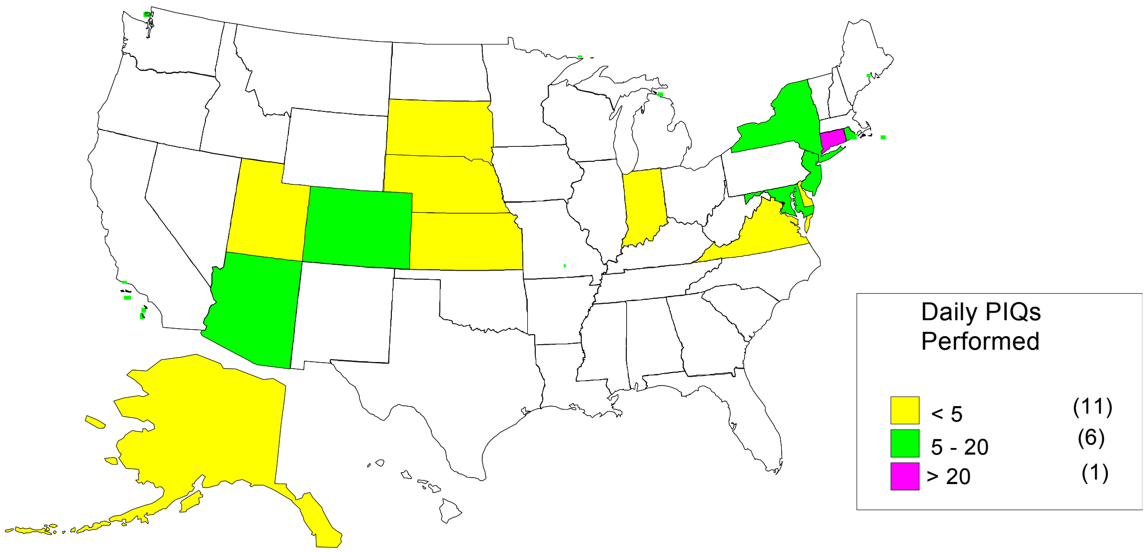

Figure 6. **States Performing Past Inspection Queries (PIQs) from the Roadside (May 2000) - by Average Number Performed Per Day**

3. EVALUATION GOALS, MEASURES, AND HYPOTHESES

As noted previously, in 1998 the U.S. experienced nearly 400,000 crashes involving large trucks, resulting in approximately 5,000 deaths. The Federal Motor Carrier Safety Administration (FMCSA) has set as one of its major objectives to reduce the numbers of fatalities and injuries from accidents involving CMVs by 50 percent by 2010. In an effort to achieve this objective, several programs have been or will soon be implemented to address various factors that may contribute to crashes. Many such programs address unsafe driving, both in terms of unsafe vehicles and unsafe drivers. The goal of these programs is to develop and evaluate methods for better identifying unsafe drivers and vehicles and removing them from the road until such time as they become safe.

The I-95 Corridor Coalition's safety-related CVO FOT 7 is one program that compares methods for improving the identification of unsafe driving. It is being evaluated in close coordination with two other related efforts:

- The SAFER Data Mailbox (SDM) FOT currently underway involving the states of Connecticut, Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia, and
- The Commercial Vehicle Information Systems and Network (CVISN) Model Deployment Initiative (MDI) involving ten prototype and pilot states (Maryland, Virginia, Washington, Oregon, California, Colorado, Minnesota, Michigan, Kentucky, and Connecticut).

Because FOT 7 is a deployment of CVISN technologies and involves many of the components being tested in the SDM project, the evaluation plan builds upon the goals identified in the CVISN and SDM evaluation plans. The I-95 Corridor Coalition CVO Program Track Safety Subcommittee members from FOT 7 states participated in establishing a set of evaluation goals and related study questions that were to be addressed in FOT 7. Their goals were essentially the same as the evaluation goals established for SDM and CVISN. The four basic goals for all three studies are:

<u>Evaluation Goals</u>

1. Demonstrate the effectiveness of using current safety performance data to help identify high-risk carriers, drivers, and vehicles and to identify out-of-service order violators during roadside enforcement,
2. Evaluate the time, cost, and other impacts of electronic collection of roadside safety information for upload and dissemination to regional and national databases,
3. Identify institutional issues and benefits related to the use of this technology, and
4. Assess the effectiveness of public outreach programs for deterring OOS violations.

In the following sections of this chapter, a more detailed discussion of the evaluation goals is presented. This discussion includes the hypotheses and study questions to be addressed in FOT 7 and SDM.

Demonstrate the effectiveness of using current safety performance data to help identify high-risk carriers, drivers, and vehicles and to identify out-of-service order violators during roadside enforcement

This goal focuses on how state inspection and enforcement personnel are using pen-based or laptop computers and links to safety databases to target high-risk carriers. A key aspect of this goal is to evaluate how well these systems are working at the roadside and to determine whether the use of these systems results in an increase in the number or rate of out-of-service (OOS) orders. Specifically, the following questions will be addressed:

- Do inspectors perceive that these methods are effective for targeting high-risk carriers?
- Does the use of technology improve an inspector's ability to identify high-risk carriers?
- Is SAFER Data Mailbox an effective tool for identifying OOS order violators?
- Does this technology improve an inspector's ability to identify high-risk carriers that come from other states or were previously inspected in other states?
- What percent of roadside inspectors have access to FHWA ISS (SDM) database for interstate carrier data on intrastate carriers in their own state?

Evaluate the time, cost, and other impacts of electronic collection of roadside safety information for upload and dissemination to regional and national databases

This goal has three distinct parts. The first part involves determining the impact of SDM and other electronic screening technologies on the amount of time for inspection or screening activities. The second part involves evaluating any other impacts that the use of SDM or other screening technologies may have on the inspection and screening process. The third part involves evaluating any cost changes in utilizing the SDM or other electronic screening systems for acquiring timely inspection data. The following questions illustrate the type of information needed to meet this goal:

- What systems (software, hardware) are states using to access safety performance data? Document/summarize technology in use. If possible, identify advantages of particular technologies under particular circumstances. Which technical solutions work best in certain situations?
- How are "high risk" carriers identified, or conversely, how are non-high risk carriers eliminated from consideration (Out-of-service orders? Recent inspection reports? Accident data? CVSA decal? Obvious defect? Inspector judgment)?
- What is the effect on uniformity of inspections? Is deployment of laptop computers improving uniformity of inspections?

- What are the true costs of purchasing, maintaining, and using the equipment?
- How much and what type of training is required for enforcement officers to be proficient on use of equipment?
- How are inspection procedures at roadside affected by need to electronically enter data? Is it feasible to do so?
- Are there other cost implications of real-time data access associated with new enforcement strategies, improved morale, and increased productivity?

The purpose of the cost analysis was to determine actual costs, not to evaluate U.S. DOT program funds used to advance the deployment or to subsidize the operational tests.

Identify institutional issues and benefits related to the use of this technology

There are a substantial number of organizations involved in and affected by innovations in roadside enforcement practices; each has its own objectives, priorities, and abilities. These organizations include state agencies with CVO responsibilities, federal agencies, contractors supporting these agencies, motor carriers, drivers, and regional and national CVO-related associations. This goal seeks to identify the institutional issues related to the success of implementing this FOT. Issues such as "probable cause," data privacy, multi-agency responsibilities and communications, and outreach to carriers were to be identified and documented. Many of these issues are common to the participating states, but some issues may be unique. Differences among states will be explored. Questions that illustrate the type of information needed include:

- What are the institutional impediments to use of technology? (e.g., laws that affect use of information (probable cause), privacy issues, agreements with carriers about sharing data)
- What are institutional benefits?
- Do these impediments/benefits vary among the participating states? Highlight key differences and, if possible, identify causes.

Assess the effectiveness of public outreach programs for deterring OOS violations

One of the primary goals of the technologies examined during FOT 7 is to reduce violation of OOS orders. The direct means of achieving this goal (i.e., identifying violators at the roadside) was addressed in the first evaluation goal. The indirect means involves educating the commercial vehicle operator community about the capabilities of the technologies in aiding identification of violators of OOS orders and, thereby, creating a deterrent to potential OOS order violators. The goal here is to assess the degree to which carriers and drivers are aware of this technology and measure the deterrent effectiveness of the public outreach program. Questions that were to be addressed under this goal include:

- To what extent do motor carriers and drivers know that states will have real-time access to recent inspection reports?
- In what ways does an awareness of new enforcement practices change motor carrier behavior?
- Which media (brochures, ads, newsletters, trade publications, word-of-mouth) are most effective for making SAFER capabilities known to drivers and motor carriers?
- Are drivers and motor carriers are aware of penalties for violating OOS orders?

Although this goal and the related questions are still of interest to SDM partners, it was not practical to devote evaluation resources in this area. Originally, the SDM project was to include a public outreach component. Some progress was made at developing outreach materials. However, technical problems in deploying SDM caused resources to be diverted from the public outreach effort. Thus, the public outreach component was never fully developed.

4. TECHNICAL APPROACH

As detailed in the SDM and FOT 7 Evaluation Plans, a set of tests, representing a variety of data collection and/or analysis efforts, were proposed to address the evaluation goals and hypotheses. Several of these tests were also designed to be used in the CVISN evaluation as well. The tests were modified as necessary to ensure that SDM and FOT 7 were addressed. Table 1 shows how each evaluation test addressed one or more of the evaluation goals. In the remainder of this chapter, we present an overview of each test that was conducted.

Table 1. Overview of goals addressed by different SDM and FOT 7 evaluation tests

Test	Goal 1	Goal 2	Goal 3	Goal 4
1. Inspector Interviews	T	T	T	
2. Inspector Surveys	T	T	T	
3. Driver and Motor Carrier Surveys	T			T
4. Connecticut Roadside Study	T	T		
5. SDM Utilization, Data Timeliness, and Response Times	T	T		
6. SAFER Cost and Institutional Benefits Survey	T	T	T	
7. Others (ATA studies, discussions with administrators, FOT 10 results)	T	T	T	
8. ATA	T	T	T	

Test 1: Inspector Interviews

Focus groups and individual interviews with roadside inspectors were held in Connecticut, Maryland, Massachusetts, New York, Pennsylvania, and Rhode Island (Appendix B). More than 50 inspectors participated. Inspectors were interviewed individually or in small focus groups. The qualitative interviews were designed to avoid disrupting the work of the inspectors. Interviews were conducted at various places, including fixed-site weigh stations, agency headquarters, roadside inspection sites, and a professional conference. In states where several agencies have responsibility for roadside inspections, we attempted to interview representatives from each agency. The results of this data collection provided insights related to five topics:

- Differences among and within states in adoptions of ASPEN, ISS, SAFER, and related systems
- Similarities among states in use of these systems
- Advantages and disadvantages as perceived by the inspectors using the systems
- Suggested changes in the systems
- Suggested topics for including in the quantitative research to follow.

In addition to the interviews and focus groups, an observer visited inspection sites, watched inspections in progress, and noted aspects of system use at weigh stations and other roadside inspection sites.

Test 2: Inspector Surveys

Information was collected from motor carrier inspectors in Connecticut, Maryland, Massachusetts, New York, Pennsylvania, and Rhode Island using a four-page self-administered questionnaire (Appendix A). Approximately 370 completed questionnaires were analyzed, which represented a response rate of about 50 percent. The surveys sought information in the following categories, among others:

- Background information on the respondents
  - Agency they worked for
  - Experience in performing inspections
  - Experience in using computers
  - Training
- Details on the technology and inspection systems in use
  - Length of time required for inspections at various levels
  - Software and hardware used, including types, amount of time used, and frequency of use
- Satisfaction with the equipment
  - Overall satisfaction
  - Satisfaction with various system components and features
  - Suggestions for improvements to the system
- Perceived benefits
  - Time savings
  - Completeness of information
  - Improved safety
  - Ability to identify high-risk carriers
  - Comparison of computer-based to paper-based inspection methods.

Test 3: Driver and Motor Carrier Surveys

The evaluation strategy for SDM was to use motor carrier and driver surveys that were being planned as part of the CVISN MDI evaluation project. These surveys are being modified to obtain information on motor carrier awareness of and attitudes toward these roadside enforcement technologies. However, the surveys will not be completed until late summer 2000. Nevertheless, the goals and hypotheses will be addressed in the evaluation report for the CVISN MDI.

Test 4: Connecticut Roadside Study

The primary objective of the Connecticut Roadside Screening Study was to measure screening effectiveness at several sites both where CVISN technologies have been deployed and where they had not been deployed (Appendix C). Comparisons among the various sites allowed for an assessment of how effective the CVISN technologies were. Specifically, the screening effectiveness was measured as the rate at which vehicles representing "high-risk" carriers versus non-high-risk carriers were inspected at specific sites, and, secondarily, as the rate at which vehicles from carriers with insufficient data were inspected after adjustments for inspection of high-risk carriers.

The data that were collected to assess screening effectiveness included data collected in the field, historical inspection data, and interviews with inspectors and agency personnel responsible for the management of inspection programs. Field data were collected by observing inspection operations of two different agencies at four different sites in the winter and spring of 1999. The two agencies who conduct motor carrier safety inspections are the Department of Motor Vehicles (DMV) and the Department of Public Safety (DPS). The four facilities that were observed were Union, Greenwich, Middletown, and Danbury. Historical data consisted of the results from over 58,000 inspections conducted in Connecticut between October 1995 and June 1999.

The historical inspection data obtained from the state of Connecticut were divided into three phases based on the degree to which the Inspection Selection System (ISS) was deployed. The three phases considered were:

- Phase 1: June 1996 to May 1997
- Phase 2: June 1997 to May 1998
- Phase 3: June 1998 to May 1999.

During Phase 1, the DMV utilized ISS while the DPS did not. During Phase 2, the DPS made the transition to the use of ISS. In Phase 3, both the DMV and the DPS had full access to ISS technology. During all three phases, only Greenwich and Union utilized ISS, while Middletown and Danbury did not. The DMV and DPS performed inspections at all four sites during all three phases, with one exception: there were no DPS inspections at Union during Phase 1.

Two analyses were performed in order to assess the efficiency of ISS in selecting vehicles from high-risk carriers. The first analysis compared the screening efficiency at sites with and without ISS during Phase 3 alone. Three subpopulations were considered in this analysis: pooled over DMV and DPS, DMV only, and DPS only. The second analysis compared the screening efficiencies of the two agencies within each of the three phases as a surrogate for a comparison of ISS usage versus non-ISS usage. This analysis was done using data from the ISS sites only.

Test 5: SDM Utilization, Data Timeliness, and Response Times

A study was conducted in several Eastern states, with special emphasis on roadside inspection activities in Connecticut. Its purpose was to document the extent to which inspection data collected in surrounding states was made available to inspectors, allowing them to identify out-of-service violators. Inspectors were observed during normal operations to document the amount of time required to enter license plate numbers and perform a PIQ. The data were analyzed to determine how long it took from the completion of an inspection for data to be uploaded to SAFER and/or other databases, and how long it took for these reports to be available at the roadside. Another focus was to document the results of PIQs on inspection outcomes.

Test 6: SAFER Costs and Institutional Benefits Survey

This survey collected data to estimate the costs to deploy and operate SDM and assess the institutional issues and benefits associated with its implementation (Appendix E). The questionnaire was distributed to representatives of all 10 states participating in the SDM test and the I-95 Corridor Coalition. We received responses from Connecticut, Maine, Maryland, New York, Pennsylvania, Rhode Island, and Virginia. The survey solicited information used to estimate the costs of hardware, software, labor, training, and communication costs, and identify a wide range of institutional issues and benefits. These estimates were intended to represent actual costs to the agencies, not the amounts received from U.S. DOT for the advancement of the evaluation program. Purchase, operating, and maintenance costs were included.

The questionnaire comprised three sections:

- Costs—for purchase, operation, and maintenance of equipment such as computer hardware, supporting software, data processing, testing and development, and training
- Technology solutions—configurations necessary to implement SDM
- Institutional issues and benefits—non-technical issues supporting or impeding deployment; policy implications; and expected effects on agency and carrier procedures.

Test 7: Other Data Collection Activities

In addition to the above listed tests, the evaluation incorporated complementary studies, such as the results of the I-95 Corridor Coalition's FOT 10, Coordinate Safety Management, performed by the ATA Foundation; discussions with participating state administrators; and feedback from presentations of preliminary results at technical meetings.

5. FINDINGS

The findings of the various tests performed to evaluate the SDM and I-95 Safety FOTs are presented in this chapter according to the joint goals shared by the two projects. Detailed findings from the separate tests are provided in Appendices A through E.

Goal #1: Demonstrate the effectiveness of using current safety performance data to help identify high-risk carriers, drivers, and vehicles, and to identify out-of-service order violators during roadside enforcement

We used four measures of effectiveness in addressing this goal. First, the perceived effectiveness of computer-based inspection technology was assessed in a general way through surveys, interviews, and quantitative studies of data timeliness. Next, an analysis of data from a roadside study conducted in Connecticut compares "inspection efficiency" at inspection sites that use CVISN and related ISS technology with and those that do not use these technologies. Various analyses are used to address hypotheses concerning the effectiveness of SDM for identifying OOS order violators. Finally, we discuss effectiveness as measured by the levels of deployment among various states.

Perceived Effectiveness

Surveys and interviews involving roadside inspectors revealed that using current safety performance data in roadside enforcement helps inspectors focus on problem areas and leads to increased inspections of high-risk carriers. The studies indicate that performing past inspection queries (PIQs) yields results that inspectors can use. There are definitely trucks on the road with recent out-of-service (OOS) orders, and each is a potential violator.

Focus group participants indicated that ISS scores are used as one tool to supplement the inspector's observation. At this time, ISS scores are not usually used to screen trucks, but instead serve as a supplemental piece of information to help target the inspection. Additional findings from the surveys and focus groups are presented under Goal Area 2.

Improvement in Inspection Efficiency as Measured in Connecticut Roadside Study

The *Connecticut Roadside Screening Study* was conducted to estimate the effectiveness of the CVISN safety information exchange deployment in Connecticut, which consisted of ASPEN/ISS systems accessed from laptop computers. The inspection operations of two agencies, the Department of Motor Vehicles (DMV) and the Department of Public Safety (DPS), were observed at four different weigh stations in the winter and spring of 1999. Data were collected from more than 10,000 vehicles entering these stations to characterize the distribution of trucks at each location and to evaluate the inspection selection process.

Following the roadside data collection, the motor carrier safety ratings for every truck observed at the Connecticut sites were determined using the SafeStat algorithm (VNTSC 1999b; VNTSC 1998). In addition, over 58,000 historical records from inspections conducted between October 1995 and June 1999 were used to determine the distribution of inspected CMVs among risk categories. The proportion of high-risk CMVs inspected was estimated and compared to the proportion of high-risk CMVs in the population to determine the inspection efficiency conducted with laptops and ASPEN. These data were also used to estimate the effects of using ISS in combination with manual pre-screening on the number of OOS orders issued for a fixed number of inspections performed. The major findings from the Connecticut Roadside Screening study are presented below. Additional analyses are in Appendix C.

Connecticut's roadside enforcement program presented a unique opportunity to evaluate the use of ISS as a selection tool. Connecticut, one of the first states to widely deploy laptop computers with Aspen and ISS, conducts a large number of inspections at four fixed weigh stations. Each station is equipped with a fixed scale, and all trucks are required to enter the station when it is open. Commercial vehicle inspectors are assigned at each station. However, at two of the stations, Danbury and Middletown, inspectors select vehicles for inspection using only judgment and experience. Inspections are then conducted with the aid of Aspen and ISS. At the other two sites, Union and Greenwich, all vehicles are pre-screened using weigh-in-motion results and quick visual inspections. Some trucks are allowed to bypass the fixed scale and return to the highway. The remaining trucks are sent to the fixed scale, and their identification numbers are entered into a roadside computer, which contains Aspen and ISS. The ISS information is then use to select vehicles for inspection.

The primary finding relevant to the effectiveness of ISS is that when ISS is used in combination with manual pre-screening to select commercial vehicles for inspection (as currently performed at Union and Greenwich sites in Connecticut), the number of OOS orders issued for a fixed number of inspections will increase by 1.9 percent compared to sites that do not use ISS and manual pre-screening for inspection selection. Although this is a small increase in inspection selection efficiency, it is important to recognize that ISS is used to select vehicles for inspection after most of the vehicles have been eliminated during manual pre-screening.

As CVISN deployment expands and begins to integrate the use of ISS with electronic screening, roadside enforcement officials should be able to improve the efficiency with which they select high-risk CMVs for inspection. Currently, only a few states use ISS or similar tools in combination with electronic screening. However, even in these states, carrier enrollment in electronic screening is not sufficient to demonstrate any impacts on the inspection selection process. Therefore, to illustrate what could happen, the impact of using ISS with electronic screening was simulated using results from the Connecticut Screening Assessment Study. An analysis was performed under the scenario that (a) all states deploy electronic screening at all major inspection sites and (b) all of the motor carriers with SafeStat ratings in the low-risk category (representing approximately 52 percent of all trucks) choose to enroll in the electronic screening program.

Under this scenario, enforcement officials could choose to let the low-risk vehicles bypass the inspection site and focus all of their efforts on inspecting medium- and high-risk carriers and carriers with insufficient safety data. It is assumed that ISS will be used with manual pre-screening on the 48 percent of trucks that are not allowed to bypass the inspection site. The following analysis demonstrates that, under this scenario, the number of OOS orders will increase by 11.2 percent compared to the average number that would be achieved using ISS with manual pre-screening as currently conducted at Union and Greenwich sites in Connecticut.

Key Findings from the Connecticut Screening Assessment Study

This section presents the analyses that support the key findings from the Connecticut Screening Assessment Study.

As discussed above, the Connecticut Screening Assessment Study was conducted at four commercial vehicle weigh stations in Connecticut to evaluate the effectiveness of ISS for improving the inspection selection efficiency of roadside operations. Inspection selection efficiency is measured by the number of OOS orders issued per 100 vehicles inspected. Increased efficiency means that more unsafe vehicles or drivers will be removed from the highway for the same number of inspections performed. During 13 days of data collection, approximately 10,000 vehicle identification numbers were recorded for all trucks entering the four weigh stations. At two of the stations (Danbury and Middletown), vehicles are selected for inspection without the aid of ISS. At the other sites (Union and Greenwich), vehicles are pre-screened using weigh-in-motion (WIM) and visual inspection. Vehicles sent to the fixed scale for weighing are then screened for inspection using ISS ratings. Figure 7 shows the configuration of the Union facility.

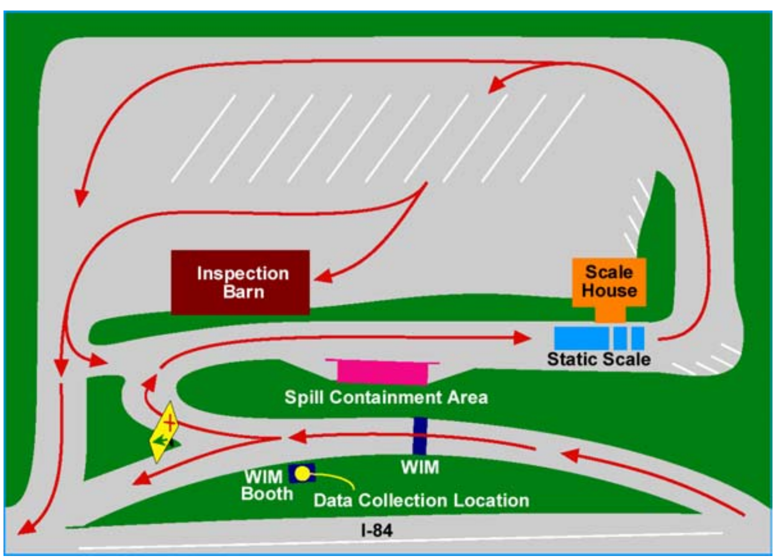

Figure 7. Schematic of Connecticut's Union Facility with WIM Sorting

The vehicle identification numbers were used to characterize the distribution of trucks in terms of safety risk at each inspection site. This was achieved during the analysis phase by calculating the SafeStat score for each truck. SafeStat is an automated motor carrier safety status measurement system developed for FMCSA that combines current and historical safety data to measure the relative fitness of motor carriers (VNTSC 1999b; VNTSC 1998). In addition to the inspection results obtained during the data collection phase, results of over 58,000 inspections performed over a four-year period at these sites were analyzed.

The analyses performed with these data are summarized in Table 2. The SafeStat scores for the 10,000 trucks that entered the sites were used to estimate the distribution of trucks that would be inspected if vehicles were selected at random. This serves as a baseline which allows us to make valid comparisons of inspection selection strategies at each site. For example, at the Danbury site, which does not use ISS for vehicle selection, the distribution of trucks includes 8.6 percent high-risk vehicles (according to SafeStat scores) and 47.2 percent low-risk vehicles. The actual inspection results show that inspectors are selecting more high-risk (12.0 percent versus 8.6 percent) and fewer low-risk (36.1 percent versus 47.2 percent) vehicles for inspection then they would if vehicles were selected at random. Multiplying these percentages by the statewide OOS rate gives the expected number of OOS orders per 100 vehicles inspected within each risk category. The statewide OOS rate for low-risk carriers is 38 percent compared to rates of 42 percent to 63 percent for the other risk categories (Medium, Insufficient Data, and Unknown). The totals represent the expected number of OOS orders for a given inspection selection strategy. The inspectors at Danbury average 48.4 OOS orders per 100 inspections using their own judgment and experience to select vehicles for inspection. Random selection would produce only 46.76 OOS orders per 100 inspections. Combining the Danbury and Middletown results, we see that inspector judgment and experience produce 3.5 percent more OOS orders than random selection. Even though Connecticut's OOS rates are much higher than the national average, the percent difference in these rates is consistent with similar findings from the National Fleet Safety Survey (1997).

The same calculations were performed with the data from the Greenwich and Union, which use ISS and manual pre-screening with WIM, in addition to judgment and experience, to make inspection selection decisions. This inspection selection process produces 5.4 percent more OOS orders than random selection. Using an odds ratio to adjust for differences in populations, we estimate that using ISS with manual pre-screening produces a net effect of 1.9 percent more OOS orders than would be achieved with inspector judgment and experience.

To simulate the impact of electronic screening under full deployment, we assumed that all low-risk carriers would enroll and be permitted to bypass all inspection sites. Since no low-risk carriers will be inspected, we assumed that inspectors would proportionally allocate the inspections among the other risk categories. The predicted number of OOS orders with electronic screening was then calculated in the same manner. The relevant finding is that by using electronic screening to eliminate the low-risk carriers (and thereby target high-risk carriers) can increase OOS orders by 11.2 percent.

Table 2. Estimating the Improvements in OOS Rates Resulting from the Use of ISS and Electronic Screening in Roadside Enforcement.

Station	Risk Category	CMV Inspection Selection Percentages: Random Selection [1]	Actual Inspection Selections [2]	With Electronic Screening [3]	State OOS Rate (%)	No. OOS Orders per 100 Inspections [4]: With Random Selection	Predicted from Actual Inspections	With Electronic Screening
Danbury (non-ISS)	High	8.6	12.0	18.8	63	5.42	7.56	11.83
	Medium	30.5	33.1	51.8	59	18.00	19.53	30.56
	Low	47.2	36.1	0.0	38	17.94	13.72	0.00
	Insufficient Data	10.7	13.7	21.4	42	4.49	5.75	9.00
	Unknown	3.0	5.1	8.0	53	1.59	2.70	4.23
	Total Expected OOS Orders per 100 Inspections					**47.43**	**49.26**	**55.63**
Middletown (non-ISS)	High	5.1	6.8	11.3	63	3.21	4.28	7.14
	Medium	26.1	27.4	45.7	59	15.40	16.17	26.94
	Low	49.8	40.0	0.0	38	18.92	15.20	0.00
	Insufficient Data	13.8	16.2	27.0	42	5.80	6.80	11.34
	Unknown	5.2	9.6	16.0	53	2.76	5.09	8.48
	Total Expected OOS Orders per 100 Inspections					**46.09**	**47.54**	**53.90**
Average for Non-ISS Sites						**46.76**	**48.40**	**54.77**
Percent Increase in OOS orders compared to random inspections							**3.5%**	**17.1%**
Greenwich (with ISS)	High	5.1	7.8	10.8	63	3.21	4.91	6.81
	Medium	29.2	26.9	37.3	59	17.23	15.87	21.98
	Low	45.4	27.8	0.0	38	17.25	10.56	0.00
	Insufficient Data	16.2	25.9	29.7	42	6.80	10.88	15.07
	Unknown	4.1	11.6	7.5	53	2.17	6.15	8.52
	Total Expected OOS Orders per 100 Inspections					**46.67**	**48.38**	**52.37**
Union (with ISS)	High	4.6	11.1	18.3	63	2.90	6.99	11.50
	Medium	25.8	32.2	53.0	59	15.22	19.00	31.25
	Low	55.7	39.2	0.0	38	21.17	14.90	0.00
	Insufficient Data	11.9	13.8	22.7	42	5.00	5.80	9.53
	Unknown	2.0	3.7	6.1	53	1.06	1.96	3.23
	Total Expected OOS Orders per 100 Inspections					**45.34**	**48.64**	**55.51**
Average for ISS Sites						**46.01**	**48.51**	**53.94**
Percent Increase in OOS orders compared to random inspections							**5.4%**	**17.1%**
Percent increase in OOS orders due to use of ISS — versus non-ISS							**1.9%**	
Percent increase in OOS orders with electronic screening of low-risk carriers — compared to ISS users without electronic screening								**11.2%**

1. Random selection percentages were determined from SafeStat scores of more than 10,000 vehicles that were observed at specified inspection stations during the Screening Assessment study (Spring 1999).
2. Actual selection percentages are based on more than more than 58,000 inspections performed at the specified inspection stations between October 1995 and June 1999.
3. Distribution was derived from actual selection percentages (note 2) and the assumption that electronic screening will eliminate low-risk carriers from the selection process (e.g., for Danbury high-risk category 18.8 percent = 12.0 percent/(1-0.361).
4. Product of CMV selection percentage and state OOS rate.

Thus, the primary findings from this study are that states can achieve a 1.9 percent increase in OOS orders using ISS with manual pre-screening or an 11.2 percent increase in OOS orders using ISS in combination with electronic screening. The implications of these findings should be viewed in the context of the number of crashes avoided because of an enhanced roadside enforcement program. Such an analysis was performed as part of the evaluation of the CVISN Model Deployment Initiative (Battelle, 2002). The analysis demonstrated that a 1.9 percent increase in OOS orders will result in 84 fewer commercial vehicle crashes in the U.S. each year. The 11.2 percent increase in OOS orders will result in 589 fewer crashes. More substantial benefits are possible if enhanced enforcement programs cause carriers to improve their compliance with safety regulations. However, there is currently no evidence that carrier compliance has changed since the introduction of these technologies.

Effectiveness of SAFER Data Mailbox for Identifying OOS Order Violators

The goal of this analysis was to demonstrate the effectiveness of using SDM, coupled with innovative enforcement strategies, to identify OOS order violators. Four hypotheses were evaluated:

- **Inspection reports will be made available to other roadside sites in a timely manner.**

- **Information on trucks with existing OOS orders will be available in SAFER.**

- **There will be trucks on the road with recent OOS orders**

- **It will be feasible to make use of real-time data to screen trucks (during inspection, not for selection) for OOS order violators under actual roadside conditions.**

The first two hypotheses focus on issues related to populating and querying the SAFER Data Mailbox. Inspectors must upload completed inspections in a timely manner, and they must find the information valuable if they are going to perform past inspection queries (PIQs). The third hypothesis addresses the degree to which there might be OOS order violators on the road. Finally, the fourth hypothesis deals with the logistics of using these technologies under actual roadside conditions.

For an inspection report to be available to other roadside sites in a timely manner it must be uploaded to the SAFER data mailbox shortly after the inspection is completed. Data from approximately 13,500 inspections uploaded to SAFER between May and June 1999 were available to assess the timeliness of inspection uploads. The analysis of upload times was restricted to states in the Eastern Standard Time (EST) zone. Figure 8 shows the distribution of time between the completion of the inspection report and upload of the inspection data to SAFER. For example, approximately 16 percent of the inspection reports were uploaded to SAFER within one hour of completion, and 56 percent were uploaded within 24 hours. Another 10 percent were uploaded between 24 and 48 hours later, and the remaining 32 percent were not uploaded for at least two days. However, these percentages vary greatly among states. Figure 9 shows how the distributions of upload time vary from state to state. States with facilities and access to wireless communications, such as Connecticut and Delaware, are able to upload most of their inspections within a few hours. Rhode Island (not shown) also tends to upload most of their inspection reports within hours of completing the inspection. The remaining states — such as New York and Maryland, for example — demonstrated the ability to upload inspection reports from the roadside. However, the majority of their inspection results are delivered to a central location and uploaded to SAFER in batch mode on a less frequent basis.

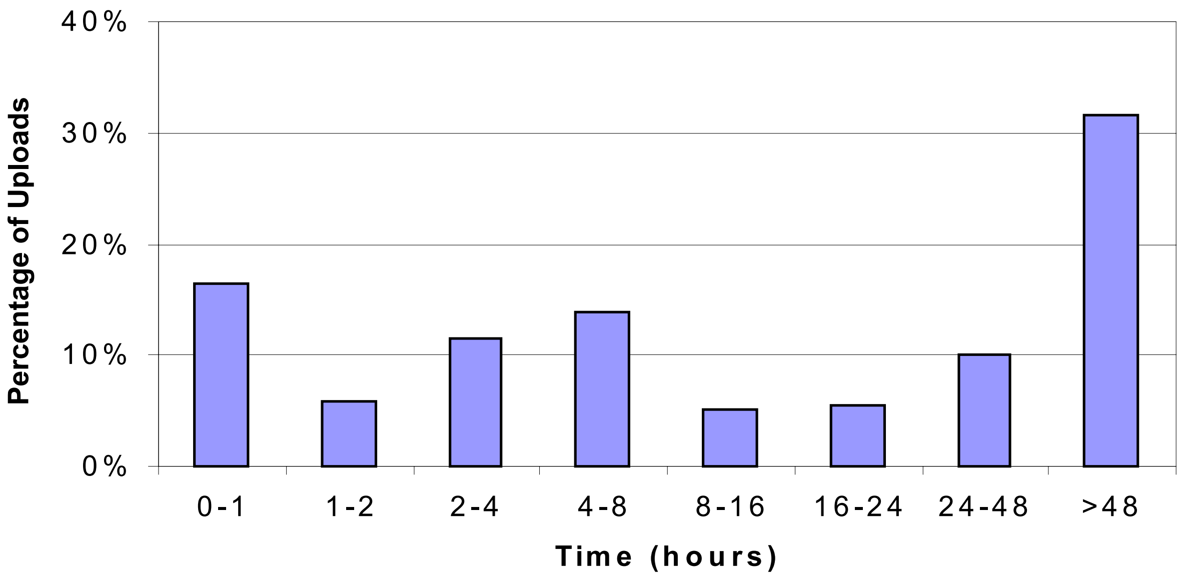

Figure 8. Distribution of Time Between Inspection and Upload of Inspection Report

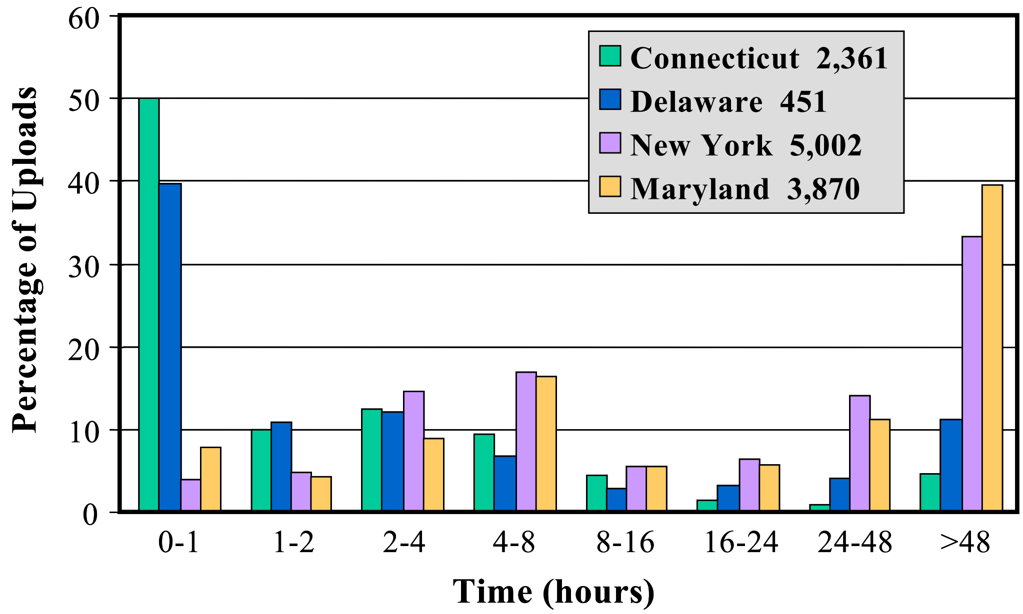

Figure 9. Distribution of Time Between Inspection and Upload of Inspection Report - by State (showing number of inspections uploaded in May and June 1999)

The second hypothesis deals primarily with the issue of utilization of SAFER. For information on trucks with existing OOS orders to be available for identifying violators, inspection results with OOS orders must have been uploaded and a PIQ must be performed on those trucks. The extent to which inspection results are being uploaded to SAFER was discussed in the previous section. As of May 2000, approximately 20 percent of all inspection reports are being uploaded to SAFER. Seven of the I-95 Corridor Coalition states are uploading at least 50 percent of their inspection. These percentages have been steadily increasing in recent years and it is anticipated that all states will eventually upload all of their inspection reports to SAFER.

The other aspect of utilization is whether inspectors performed PIQs during inspections, which is the only way to determine if a previous OOS order had been issued for the vehicle. Connecticut is the only state that routinely performs PIQs during inspections. As of May 2000 Connecticut was performing about 20 PIQs per day, which represents approximately one-third of all vehicles inspected. Again, this is possible because of Connecticut's widespread use of wireless communication technologies.

Data from PIQs performed during the two-month period of April and May in 1999 and 2000 were analyzed to determine the frequency with which PIQs performed at the roadside revealed at least one prior inspection report during the previous 60 days. Table 3 contains the results from the four eastern states that performed at least 200 PIQs during either time period, as well as the results from all states. The percentage of PIQs showing prior inspections ranged from 8 percent in Rhode Island to 38 percent in New Jersey. These differences may be due to many factors, including characteristics of the truck traffic in the state and the protocols the states use to select trucks for performing inspections and PIQs. Overall, we see that percentage of trucks with prior inspections increased from 19 percent to 25 percent between 1999 and 2000. This difference is statistically significant. The most likely reason for this change is the increase in the number of inspections that states uploaded to SAFER. During this period, the number of inspections uploaded to SAFER tripled, increasing from 12,000 to 35,000 per month.

Table 3. PIQs that Produced Prior Inspection Reports During the Previous 60 Days [1]

State	Year	Number of Trucks with Prior Inspections	Number of PIQs Performed	Percent of PIQs with Prior Inspections
CT	1999	115	1,095	11%
	2000	165	1,040	16%
RI	2000	18	229	8%
NY	2000	57	269	21%
NJ	2000	80	208	38%
All States	1999	318	1,718	19%
	2000	631	2,566	25%

[1] Data from states performing at least 200 PIQs during the April-May of 1999 or 2000, as well as all states (including those not shown) during the two-month periods.

Identifying trucks with prior inspections is valuable for two reasons: (1) the prior inspection results are used by inspectors to focus the current inspection on previous problem areas, and (2) it is a necessary condition to identifying trucks with current OOS conditions. So far, there have been a few reports of vehicles stopped for inspection and the PIQ revealed an existing OOS order. There are additional cases where the vehicle or driver had the same OOS condition that was cited for violation during a previous inspection, even though the original violation was corrected. Detailed documentation of findings from individual states would be needed to conduct a more quantitative assessment of these occurrences.

The third hypothesis is concerned with the question of whether there are enough trucks on the road with current OOS orders to justify using the PIQ feature of SDM for catching OOS order violators.. The Connecticut screening study provided an opportunity to investigate this issue by simulating what would happen if PIQs were performed on all trucks. During the 13-day field test, the license plate numbers of every truck passing through the weigh stations were recorded. Later, these license plate numbers were electronically matched with SAFER inspection reports to determine the proportion of trucks passing each weigh station that had a recent OOS order. Specifically, for each passing truck, we determined whether the truck had undergone a recent inspection, exactly how long ago the inspection occurred, and if an OOS order had been issued. This gave us an idea of what the general population of trucks on the road looked like in terms of prior inspections and violations.

Table 4 summarizes the results. There were 9,417 trucks in the representative sample of the truck population observed at the weigh stations. Approximately 97 percent of the trucks did not have a prior inspection report on file in SAFER. So, if a PIQs had been performed on every truck, only three percent would have revealed a prior inspection in the past 60 days. Furthermore, approximately 0.7 percent would have shown an OOS order issued during that time period. Table 4 also shows the amount of time that passed since the prior inspection was also performed. It seems likely that the shorter the amount of time, the more probable the driver would be in violation. About 0.03 percent of the vehicles,or 3 trucks, had a prior inspection within the past 12 hours, of which one had an OOS order issued. This vehicle may or may not be violating an OOS order. The majority of the prior inspections and OOS orders occurred more than one week prior to the time of the simulated PIQ (i.e., the data collection time). Thus, it would appear that at the time of this study (Winter and Spring 1999) there were relatively few opportunities to catch OOS order violators using SDM. Of course, these probabilities are likely to increase as more states upload inspections to SAFER

Table 4. Results of Simulated Past Inspection Queries (PIQs) on General Truck Population in Connecticut

Number of Trucks	Number with No Prior Inspections	Number of Trucks with Prior Inspections				
		<12 hrs	12-24 hrs	24 hrs to one week	> one week	Total
9,417 (100%)	9,134 (97%)	3 (0.03%)	2 (0.02%)	58 (0.62%)	220 (2.34%)	283 (3.01%)
OOS Orders Issued?		1 (0.01%)	0 (0.00%)	10 (0.11%)	54 (0.57%)	65 (0.69%)

The results of simulated PIQs on a sample of 1,621 trucks that were actually inspected in Connecticut in 1999 were very close to those seen in the general population of trucks. About 2 percent were found to have prior inspections within the past 60 days, and 0.7 percent found to have prior OOS orders.

To address the fourth hypothesis, we conducted tests to determine the amount of time required to perform the uploads and queries using ASPEN with different communication technologies. Also, our survey and focus groups with inspectors from several I-95 Corridor

Coalition states included several questions concerning the practicality of using these technologies under actual roadside conditions.

For it to be feasible to make use of real-time data to screen trucks for OOS order violators under actual roadside conditions, the system must be efficient and easy for inspectors to use. For instance, the methods that other roadside sites use to access the SAFER data mailbox system and its contents must be fairly quick or inspectors will be reluctant to utilize them. Table 5 shows the amount of time required to access the SAFER data mailbox system and perform activities, such as PIQ's or subscription uploads. The times varied according to the function being used and the communication method with SAFER (i.e., landline connection or CDPD). Performing a PIQ or an ISS carrier refresh were generally the fastest (and most frequently used) functions, taking approximately 1 minute. For PIQs, the time for a CDPD connection to return results was between 25 and 75 seconds, and a landline connection took 50 to 70 seconds. Only a landline connection was used to time other functions, with a carrier refresh taking between 40 and 70 seconds, while a full subscription upload (3,800 carriers) took 6 minutes.

Table 5. Time Required to Access SAFER and Perform SDM Activities

Activity	Communication Method	
	Land Line	CDPD wireless
PIQ	50-70 seconds	25-75 seconds
ISS Carrier Refresh	40-70 seconds	14-25 seconds
Subscription Upload	6 minutes for 3,800 carriers	<5 minutes (if done weekly)

Data from a survey of inspectors in CT, MA, MD, NY, PA, and RI provided additional information concerning performance under actual roadside conditions and possible reasons for the differences in usage among the states. Some of the issues affecting usage are as follows:

- The methods of transmitting reports to SAFER included use of wireless and landline connections, delivery of diskettes to state offices for submission to SAFER, and paper reports that another person transmitted at a later time. These methods resulted in vastly different upload times, and long upload times limited the usefulness of SAFER, because prior inspections were not available immediately.
- There were differences in the time it took to use the SAFER data mailbox systems, resulting in different attitudes by the inspectors. If they felt the process was very time consuming and/or not perceived as beneficial, then inspectors were not likely to use it.
- States used different approaches to using ASPEN. Most used ASPEN (including ISS and PIQs) after a truck was selected for inspections. Others used ISS to make the decision to stop a truck. PIQs were always performed after the truck was selected for inspection.

These types of information should illustrate the feasibility of using real-time systems to screen trucks for violators using the current SAFER data mailbox system. It should also give us valuable insight into how the system can be improved.

Effectiveness as Measured by Deployment Across States

Finally, an important measure of effectiveness is the degree to which the technology is deployed among states. As discussed earlier, most eastern states are uploading inspection results to SAFER and are using personal computers with ASPEN to conduct nearly all of their roadside inspections. However, there were many challenges in getting certain components, especially those related to wireless communications, to work reliably. Connecticut's success was unique partly because they developed the in-house capabilities needed to deploy and maintain these systems over a period of several years. Also, the major challenges in deploying these systems are the costs and accessability of wireless communication services. States such as Connecticut, Rhode Island, and Delaware, which have wide coverage areas for digital cellular services, had an easier time using CDPD technology. Other states found themselves investigating more costly and technically challenging alternatives. For example, New York and Pennsylvania investigated the use of satellite technology. At the time, there were plans to have the entire country covered by low level geosynchronous satellites, but the plans were not implemented due to funding issues. Also, the corresponding land-based units emitted significant amounts of radiation and the cost per communication was nearly ten times the cost of cellular alternatives. Therefore, this approach was not implemented.

In general, the states will not deploy systems that do not work reliably in the field. However, they are committed to finding solutions and will deploy the new technologies when it can be demonstrated that they will work under the constraints of their environment. Figure 10 shows the current level of deployment of supporting technologies, such as wireless modems, landline modems, vehicle mountings for laptop computers, and portable printers, for various agencies across six states. Deployment level is measured by the percent of inspectors equipped with the various systems.

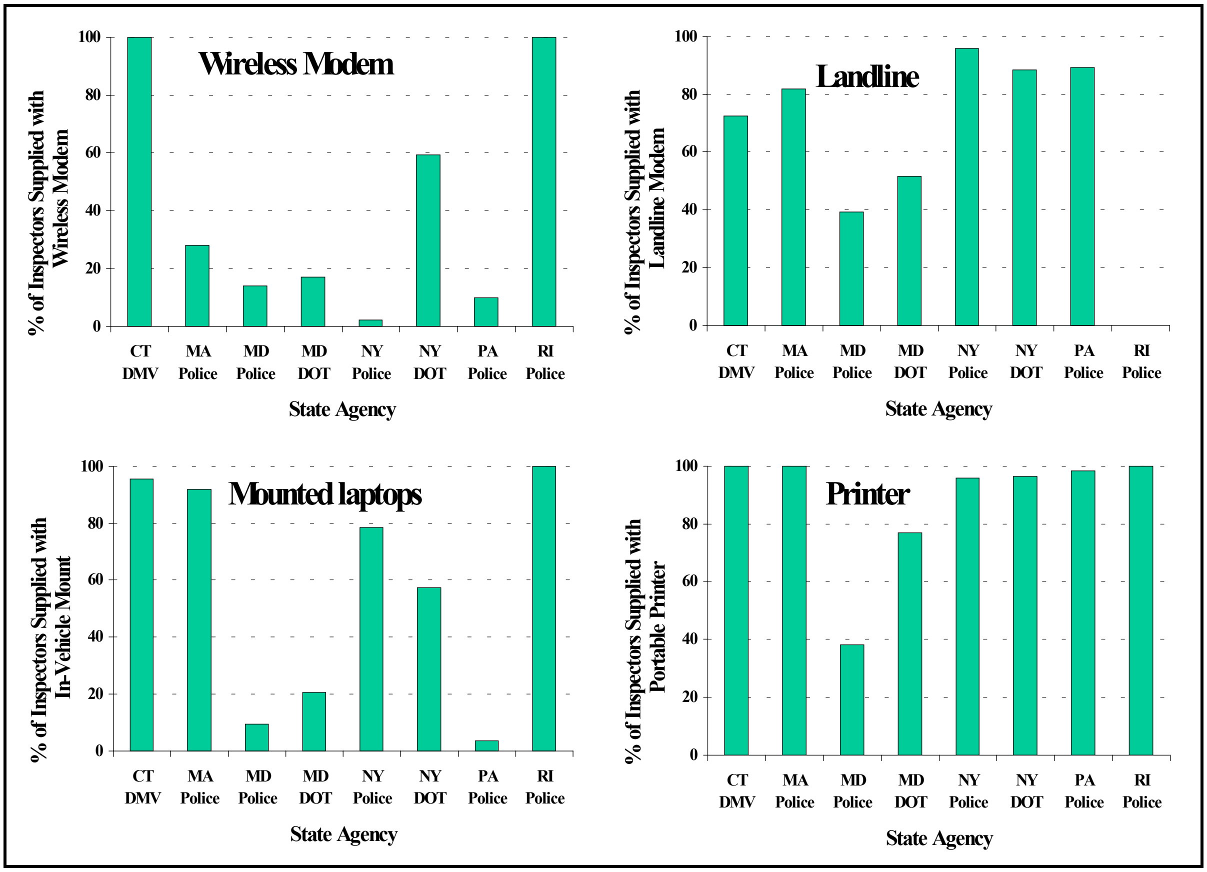

Figure 10. Percentage of Inspectors Equipped with Safety Information Exchange Components

Goal #2: Evaluate the time, cost, and other impacts of electronic collection of roadside safety information for upload and dissemination to regional and national databases

<u>Time savings and other benefits of the technology</u>

Using safety information exchange technology has become integral to the jobs of most roadside inspectors studied. This technology can save time for roadside inspectors and improve the speed and accuracy of data reporting. Other benefits reported include more uniform reporting and credibility with the carriers. The states demonstrated variation in the number of inspections uploaded to SAFER, and in the number of PIQs performed. Aside from Connecticut, the level of utilization of the SDM among the states was low, so the impacts of a fully deployed system have not yet been realized.

Inspectors who participated in focus groups noted time savings as the most important benefit of electronic inspection systems, especially in completing inspection forms using ASPEN and in selecting proper violation codes. The drop-down menu of violation codes was helpful in reducing delay and confusion caused by handwriting or clerical errors.

Inspectors generally agreed that the technology saved overall inspection time and time spent specifying violation codes, especially in Connecticut and Rhode Island. However, when compared to other results in the survey, this result is contradictory. Inspectors indicated that conducting a Level I inspection would take longer using ASPEN than using paper forms only. Level II and III inspections were reported to take about the same amount of time either way. A related time factor is the clerical and administrative time spent entering, checking, and correcting data from paper forms. This effort is reduced when inspectors enter information themselves.

In response to open-ended survey questions about the benefits of using the laptop system, inspectors reported that the neatness or professional appearance of the reports was the most important benefit. Other comments noted time savings, accuracy, legibility, and the availability of prior inspection reports.

A study of the time required to access the SAFER data mailbox system and perform activities such as PIQs or subscription uploads was conducted, to evaluate the feasibility of using real-time data to screen trucks during inspection. PIQs and carrier refresh functions required approximately 1 minute, depending on the telecommunication technology being used. As another example, a full carrier subscription refresh across a landline modem required 6 minutes.

Use of laptops, software, and communications technology

Laptop computers and portable printers are widely used in conducting motor carrier inspections. Most inspectors reported using paper reports in fewer than ten of their last 100 inspections. Inspectors participating in the focus group reported using a core of computer-based services related to ASPEN, ISS, and SAFER, but their patterns of use varied widely. Among four software applications, the Inspection Selection System (ISS) enjoys the most widespread use in inspections. Other applications reported to be used less often were the Past Inspection Query (PIQ), the Commercial Driver License Information System (CDLIS), the National Crime Information Center (NCIC), and PC*MILER. In one state, all inspectors reported running a PIQ on every inspection, while in another state, inspectors run such PIQs only sporadically because they must use a separate, more distant computer for the PIQs

Inspectors reported that they were generally satisfied with the ASPEN system. Satisfaction with the reliability of the computer, support for solving problems, and computer training were more varied across the states and agencies surveyed. Because inspectors had different levels of access to ITS hardware, equipment, and software, the expressed preferences are influenced by each inspector's degree of access and his/her familiarity with ASPEN and the other software features.

Methods of wireless communication are not consistent among the states. A large percentage of inspectors in three states appeared to be supplied with wireless modems for mobile transmission of inspection data. Other states relied more heavily on landline modems, CD-ROM distribution, or diskette distribution to update data files in the field and at a central computer facility. The variation in methods of transmitting reports to SAFER resulted in vastly different upload times, and long upload times limited the usefulness of the data, because prior inspections were not available immediately.

The level of available wireless communication services varied greatly between states. Coastal states like Delaware, Connecticut, and Rhode Island generally had CDPD services available statewide, while larger, inland states like New York and Pennsylvania often lacked such coverage in large portions of their state. New York is continuing to explore other wireless options, such as CDMA, that are showing some promise upstate. Attempts to deploy and test an alternate system in Pennsylvania using satellite communications were not successful.

Areas for improvement for the computer technology included support and training, the use of ISS to select vehicles for inspection, frequency of ISS/carrier refresh events, and the frequency of inspection report transmissions.

The physical arrangement of the computer and printer in the patrol vehicle was frequently noted as an area for improvement by focus group participants, especially when inspections involved stopping a moving vehicle. Because of the variety of patrol vehicles and computer hardware, it is difficult for states to provide uniform, efficient mounting hardware that is usable and portable while protecting the computer and remaining convenient for the inspector. Important issues are ensuring safety and providing a mounting system that does not interfere with other enforcement vehicle systems (e.g., wiring, radios, airbags) or with normal operations.

Focus group participants listed the following as the most needed improvements in computer and peripheral hardware: laptop screens that are visible in sunlight, greater damage resistance for laptop computers to be used outdoors, and greater coverage area for wireless communication services. Recommended improvements in software included

- Greater selection of codes in the drop-down menu for specific violations, especially in the area of HAZMAT violations
- Better warnings to prevent inspectors from exiting the system before forms are complete
- Better access to other programs from within the ASPEN environment
- Ticket writing capability
- Better method of customizing fields for particular jurisdiction, and some way of preserving the customized settings when software is upgraded or reinstalled
- Availability of Canadian postal codes

- Addition of tollbooth locations as valid points of origin in PC*MILER, and some way of preserving tollbooth records given greater adoption of EZ Pass and similar automated systems
- More advanced training in using the ASPEN system
- Capability to add or append longer notes to an electronic inspection report
- Automation of certain commonly used violation criteria (e.g., lookup tables for brake adjustment violations

<u>Costs</u>

Based on cost survey responses from seven of the ten states participating in the SDM test and the I-95 Corridor Coalition, equipment costs (in 1999 U.S. dollars) are expected to range from $7,500 to $9,175 for one each of the main SDM system components, as outlined below:

- Sierra Wireless MP210 — $800 – 1,615
- Desktop PC plus internal modem — $1,200 – 1,600
- Brayley box — $2,300
- Laptop PC — $3,000 – 3,360
- Printer — $200 – 300

These costs do not include power converter, mounting hardware, or docking stations. Software other than that normally provided with new PCs is also not included in these average cost estimates. Total equipment costs for states participating in the SDM evaluation program ranged from $7,613 to $216,570. Estimates for the costs of long-term statewide deployment of electronic equipment to support commercial vehicle inspections ranged from $72,500 to $831,400 per state.

Telecommunication costs are expected to constitute the largest share of operating cost for the SDM equipment. During the evaluation program, communication costs were $55 per month per unit for connection charges only (not including air time charges). Some states anticipate higher overall telecommunication costs when the system is deployed. Connecticut's costs on a per-unit basis (now $39 per unit per month), however, are expected to decline with increased use.

In general, respondents expected labor costs and inspection time to remain steady following deployment of SDM equipment.

Maintenance costs were not analyzed, in part because most states did not have separate maintenance budgets for SDM systems being evaluated. All states deploying SDM technology will incur training costs, but the extent of these costs has not been estimated. In one example, Connecticut provides 16 hours for inspectors to train in using SDM equipment.

Goal #3: Identify institutional issues and benefits related to the use of this technology

The studies identified institutional obstacles to the widespread implementation of safety information exchange technology, but no insurmountable barriers were identified. Based on cost survey responses from seven of the ten states participating in the SDM test and the I-95 Corridor Coalition, one important institutional issue is the overlapping of responsibilities in some states between law enforcement and regulatory agencies in inspecting commercial vehicles. This division of responsibilities could result in problems in budgeting for equipment, operation, maintenance, and telecommunication. In general, the agencies responsible for law enforcement, vehicle size and weight enforcement, and economic regulations are in charge of SDM deployment.

Other potential concerns include information security, data privacy, electronic fire walls for data security, and data reliability. The survey noted that no state laws (e.g., requirements for probable cause to inspect) are likely to be affected by SDM implementation.

Institutional benefits are expected to include

- SDM-related safety improvements that may reduce political and public pressure to improve truck safety
- Increased efficiency in roadside enforcement, resulting from quicker access to more accurate data
- Enhanced prosecution of OOS violators
- Timely sharing of enforcement data among states and jurisdictions.

The following policies or procedures are likely to be changed as a result of SDM implementation:

- Frequency of updating inspection data (because of expected daily uploads and real-time access to safety information)
- Storage and retrieval protocols (because of real-time access and changes in frequency of uploads)
- Quality improvements in roadside inspections and the resulting data (because of ready access to prior data)
- Screening protocols (because of the potential for use of SDM for mainline screening for previous inspections)
- Management of roadside operations.
- Availability of near-real-time access to safety inspection data that may deter OOS jumping, if this capability were commonly available to roadside inspectors/ troopers.

The following are some lessons learned from the SDM project. These lessons are expected to provide guidance for long-term implementation of SDM statewide, in other states, and implementation of similar projects in the future.

- Smaller, more targeted projects may be more effective in testing technologies like SDM.
- States should be included in the consultant selection process.
- Project responsibilities should be shared among all participating states.
- Identify features unique to a state and take those into account in designing and implementing the project. Information exchange and other things that work in one state may not necessarily work with other agencies or states.
- Redesign the Brayley box with commercial vehicle inspectors and their working environment in mind. Brayley boxes are not considered effective by some states. The laptop configuration was found to be more flexible compared to Brayley boxes.
- In implementing SDM systems, communication costs should be taken into account.
- It became clear that the level of available wireless communication services varied greatly between states. Coastal states like Delaware, Connecticut, and Rhode Island generally had CDPD services available statewide, while larger, inland states like New York and Pennsylvania often lacked such coverage in large portions of their state. Furthermore, alternative analog services available in these areas were expensive and not reliable. Unfortunately, the technical consultant to the SDM project made the initial assumption that CDPD coverage would be available to almost all areas of the seven participating states, which turned out to be incorrect. In response, New York is continuing to explore other wireless options, such as CDMA, that is showing some promise upstate. Attempts to deploy and test an alternate system in Pennsylvania using satellite communications were not successful.
- Early on, the SDM project was envisioned to test out various wireless technologies beyond CDPD once it became apparent that adequate coverage was not available in all the involved seven Eastern States. Unfortunately, the technical consultant never demonstrated adequate knowledge of the alternatives, including the use of analog wireless and satellite wireless. In many cases, the states were left to solve their own technology deployment issues, after the consultant made the initial technology selection for them.
- For larger states, the issue of providing ISS type data for all carriers — both interstate and intrastate — also was identified. States view all carriers the same but only interstate carriers are under the jurisdiction of USDOT. Inspectors need to be able to have real-time access to safety and credentialing data for all carriers, but most systems developed by USDOT to date have provided this for only interstate carriers. FMCSA appears to understand this issue and is trying to address it.

Respondents to focus group interviews reported that the availability of technical support staff was important in improving the effectiveness and deployment of the laptop computer systems.

In general, adoption of computer-based enforcement systems is dependent on solid commitment or “buy-in” from upper levels of state governments and from the managers of the technical support infrastructure agencies. Experience suggests that when a program’s “champion” leaves, the program can be set back.

With few exceptions, focus group participants tended to indicate that computer-based inspections represent a significant improvement over paper-based systems, making their work more efficient. One example comment given by several inspectors in Connecticut: "You can take away my gun before I'll let you take away my laptop!"

Three primary advantages cited by focus group participants were (1) saving time in certain aspects of the inspection, (2) legibility of the reports, and (3) efficiency and effectiveness of the total process. Inspectors tended to speak in terms of immediate, day-to-day benefits rather than long-range impacts on highway safety.

Goal #4: Assess the effectiveness of public outreach programs for deterring OOS violations

As noted above, this goal is still of interest to SDM partners, but the course of SDM deployment led resources to be diverted from the public outreach effort. This component of the programs was never fully developed.

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6. CONCLUSIONS AND IMPLICATIONS

Overall Conclusions

The findings from this study lead to several general conclusions and trends:

- Utilization of laptop computers with ASPEN software, including components of SAFER Data Mailbox, has increased steadily since the system became operational in 1997. Most eastern states are uploading inspection results to SAFER on a regular basis, but the time between completion of the inspection and uploading the report varies from state to state, depending on the type of communication technologies used.
- Inspectors report a general satisfaction with the ASPEN system, and report that laptop computers have become an integral part of conducting motor carrier inspections.
- Computer technology is seen as helping inspectors (a) gather more complete inspection information, (b) work more efficiently, and (c) save time compared with traditional paper-based inspection systems. Findings on actual time savings versus paper were equivocal. Some inspectors reported a net time savings, while others reported that computer-based systems required just as much time as paper-based systems to conduct inspections at roadside or at weigh stations.
- Inspectors perceive that using more current and accurate inspection data, as provided by computer-based inspection technologies, helps them (a) target their inspection efforts better, (b) find recent out-of-service orders more readily, and (c) spot patterns in motor carrier violations more easily.
- Until electronic screening technologies are deployed and integrated with the Inspection Selection System (ISS), it is not practical to screen all trucks on the highway using ISS. However, it was demonstrated that inspection selection efficiency, measured in number of out of service orders per inspection, increased by about 2 percent when ISS is used in combination with manual pre-screening. Simulation results indicated that inspection selection efficiency will increase by 11 percent when ISS is integrated with electronic screening.
- Few violators of out-of-service orders have been identified using SAFER Data Mailbox. However, inspectors have found that past inspection results provide useful information for detecting current violations.
- The full potential for SAFER Data Mailbox will not be realized until all states upload inspection results in a timely manner (i.e., in less than 2 hours). Greater potential is possible if the system is used in combination with electronic screening systems which automatically identify the vehicle at highway speeds.
- Inspectors responded most positively to the improved uniformity, legibility, and neatness of the computer-generated inspection reports.
- Roadside tests of the Inspection Selection System in Connecticut showed that computers offered a marginal advantage in helping inspectors target high-risk carriers for inspection over vehicles from other carriers in the general population.

- Costs for equipment were estimated to range from $7,500 to $9,175 per system, with itemized component costs as follows:
  - Sierra Wireless MP210 $800 – 1,615
  - Desktop PC plus internal modem $1,200 – 1,600
  - Brayley box $2,300
  - Laptop PC $3,000 – 3,360
  - Printer $200 – 300
- Inspectors tended to speak more of immediate, day-to-day operational benefits of the computers than any perceived long-term, national benefits in highway safety resulting from the wider adoption of computer-based inspection technologies.
- Issues remaining to be resolved include
  - The overlapping of government jurisdictions and responsibilities for purchasing equipment, maintaining systems, and training staff
  - Data security and reliability
  - Convenience of laptop computer and peripheral equipment used in patrol vehicles and at roadside inspection sites.
  - Costs and availability of wireless communication services, especially in rural areas.

Directions for Future Research

The customization or adaptation of computer systems to the roadside working environment, noted in the focus groups and interviews, are important indicators of the degree to which inspectors are accepting the technology. Firsthand observations or accounts of such user adaptations, if analyzed in greater detail, may provide clues to not only the degree to which inspectors are invested in the technology, but also the practical, operational needs the inspectors face in day-to-day operations.

The integration of safety information exchange technologies with electronic screening systems could produce significant benefits by focusing enforcement efforts on high risk carriers. This will result in fewer crashes involving unsafe trucks and drivers. However, research is need to find the best ways to use the safety information to identify trucks and drivers that represent the biggest risks.

Satellite communication may offer an alternative for wireless exchange of data to and from the roadside. While initial and operating costs seem high, and data transfer rates are relatively low, satellite communication may provide states a way to avoid the substantial cost of building, deploying, and maintaining new statewide infrastructure for existing wireless technologies such as CDPD.

Future research should also explore the ratio of time to information that is at the center of the inspection system. The time spent in conducting and reporting on an inspection using paper and computer-based systems could be compared and analyzed, as could the amount, accuracy, and timeliness of information available to decision-makers resulting from both ways of conducting inspections.

The effect of computer-based inspection technologies on the motor carrier companies and the truck drivers themselves could be explored. The tests discussed in this report were more concerned with the adoption of the technology among the inspector community. It can be assumed that changes in inspection practices will lead to adaptations among drivers and operating companies. Many of the same tests used to gauge inspector attitudes and opinions, such as interviews, focus groups, and observations, plus more quantitative measures of compliance and highway safety, could also be applied to the motor carrier community.

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8. ABBREVIATIONS

ATA	American Trucking Associations
CDLIS	Commercial Driver License Information System
CDPD	Cellular digital packet data
CMV	Commercial Motor Vehicle
CVIEW	Commercial Vehicle Information Exchange Window
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial vehicle operations
CVSA	Commercial Vehicle Safety Alliance
DMV	Department of Motor Vehicles
DOT	U.S. Department of Transportation
DPS	Department of Public Safety [Connecticut]
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulations
FOT	Field Operational Test
HAZMAT	Hazardous materials
HR	High risk
ID	Insufficient data
ISS	Inspection Selection System
ITS	Intelligent Transportation System
MCMIS	Motor Carrier Management Information System
MCSAP	Motor Carrier Safety Assistance Program
MDI	Model Development Initiative
ML	Medium or low risk
MMDI	Metropolitan Model Deployment Initiative
NCIC	National Crime Information Center
NLETS	National Law Enforcement Telecommunication System
OOS	Out of service

OS/OW	Oversize/overweight
PIQ	Past Inspection Query
SAFER	Safety and Fitness Electronic Records
SafeStat	Safety Status Measurement System
SCA	SAFER-CVIEW Application
SDM	SAFER Data Mailbox
WIM	Weight in motion